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To cite this article: M A Basi *et al* 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* **579** 012016

IOP Conf. Series: Materials Science and Engineering **579** (2019) 012016 doi:10.1088/1757-899X/579/1/012016

Heavy metals concentration in the recent sediments along the sides of the road between Bangazi and Sirt Cities – Libya

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Abstract. Heavy metals concentrations of Pb ,Cd ,Zn ,Mn ,Cu , Co, Ni , and Fe , have been studied in the recent sediments along the sides of the road between Bangazi and Sirt cities. The results indicate normal range of the concentrations, which reflect no pollution. Moreover, the study indicates the increase in concentrations of Pb, Cd, Zn, Mn, Cu, Co, and Ni, on the edges of both sides of the road. The increase in concentration of most heavy metals in the sediments at the edges of the road is most probably related to hydrocarbon's exhaust of various vehicle.

1. Introduction

Environmental pollution is a problem of the present age, not only in the third world, but also at the global level. The pollution coincided with the emergence of the industrial revolution at the beginning of the eighteenth century. This revolution coincided with the increase in population in the world. The pollution includes the disposal of liquid waste, and factory waste beyond reasonable limits. Even the seas and oceans have not been spared from pollution through the quantities of oil and petroleum products that are heavily affected by marine life, especially fish wealth. This leads to the spread of diseases whose emergence is associated with pollutants and leads to thousands of victims on the other hand.

In order to be able to deal with the effects of pollution, individuals must have both their environmental conscious and environmental protection. The archaeological elements involved in the evolution of human life, such as lead, cadmium and zinc, lead to environmental disasters not in the short term only, but in the long term as it affects our future and the future of our generations [1,2].

This study involves the concentration of Pb, Cd, Zn, Mn, Cu, Co, Ni, and Fe in the sediments along the edges of the road between Banghazi and Sirt cities, Libya. Human activities along the road involve the effect of transport vehicles only. The effect of hydrocarbons emitted from vehicles on the sediments and plants have been indicated by various authors [3- 9].

2- Location of study area

The study area is located on both sides of the coastal road connecting the cities of Benghazi and Sirt in Libya (Figure 1). The coastal road is about 2 km east of the Mediterranean Sea, where recent sand deposits surround both sides of the road with various desert plants.Samples from the sediments were taken along vertical paths along the studied road (Figure 2).

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1-12

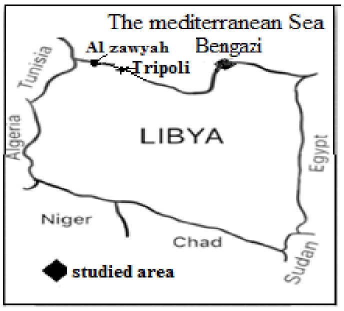

Figure 1. The location of the studied area
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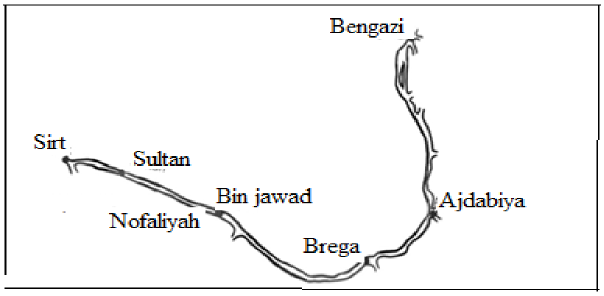

Figure 2. Location of the verticle paths in the studied area
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3- Experimental work

40 samples of recent sediment were collected from both sides of the public road linking the cities of Ajdabiya and Sirt. The samples were collected on May1997, in both sides of the road at Ajdabiya, Brega, Bin Jawad, Noufliya, and Sultan, as follow:

1- Deeply picked up 0-2 cm samples from the Ajdabiya, Brega, Bin Jawad, Nofaliya and Sultan paths at 5m, 20 m and 50 m distance from the edges of the road.
2- In addition to a depth 0-2cm, two additional samples were picked up at a depth of 2-5 cm, 5 -10 cm at 5m distance from the edges of the road for some locations at Bin Jawad, Nofaliya and Sultan paths.

All the sediment samples were dried at laboratory temperature, disintegrated and sieved to the size of less than 2 mm for chemical analysis. The samples were treated by concentrated nitric and hydrochloric acids, then analyzed by atomic absorption (Perkin- Elmer model 2380 AAS).The organic materials were analyzed by Page method [10].
Field study in the studied area (between Banghazi and Sirt) showed that the sediments are recent and consist mainly of fine to medium sand and have a reddish-brown color.

4. The results

The results of the chemical analysis for the studied elements (mostly at depth 0-2 cm) and the organic materials are listed in tables 1 and 2.
The analyzed elements are:

4.1 Lead

The concentration of lead ranged between 0.00-57.78 ppm with an average of 16.37ppm. The highest value was in samples **B7 and S7** (57.78 ppm), at Brega and Sultan paths, which are 5 meters from the edge of the road and the lowest value was in sample **N10** and **F14** (0.00 ppm) at Bin Jawad and Nofiliya paths, 50 meters from the edge of the road (Table-1).

4.2 Cadmium

The concentration of cadmium ranged between 0.11 - 3.47-ppm, with an average of 1.28 ppm. The highest value was in sample **J3** (3.47 ppm) at Ajdabya path, which is 5 meters from the edge of the road. The lowest value was in sample **F3** (0.11 ppm) at Nofiliya path, 5 meters from the edge of the road and at a depth 5-10 cm.

4.3 Zinc

Zinc concentration ranged between 3.81 - 10.61 ppm, with an average of 6.44 ppm. The highest value was in sample **J2** (10.61 ppm) at Ajdabiya path, which is at 5 meters from the edge of the road. The lowest value was in sample **N3** (3.81 ppm) at Bin Jawad path, 5 meters from the edge of the road and at a depth 5-10 cm.

4.4 Manganese

The concentration of manganese in the sediments ranged between 18.33 - 97.78 ppm, with an average of 53.76 ppm. The highest value was in sample **B1** (97.78 ppm) at Brega path, which is 5 meters from the edge of the road and the lowest value was in sample **N10** (18.33 ppm) at Bin Jawad path, 50 meters from the edge of the road.

4.5 Copper

The concentration of copper ranged between 1.08-6.61 ppm, with an average of 3.44 ppm. The highest value was in sample **J1** (6.61 ppm) at Ajdabiya path, which is 5 meters from the edge of the road. The lowest was in sample **N10** (1.08 ppm) at Bin Jawad path, 50 meters from the edge of the road.

4.6 Cobalt

Cobalt concentration ranged between 0.89 - 11.34 ppm, with an average of 4.81 ppm. The highest value was in sample **J3** (11.34 ppm) at Ajdabiya path, which is 5 meters from the edge of the road. The lowest value was in sample **N10** (0.89 ppm) at Bin Jawad path, 50 meters from the edge of the road.

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Table 1: Heavy metals concentrations (ppm) in the studied sediments

Ser. No.	The dept. cm	The distanc e, m	Samp. No.	Pb	Cd	Zn	Cu	Mn	Co	Ni	Fe
1	0-2		J1	41.67 ± 0.00	3.39 ±0.04	9.86 ± 0.16	6.61 ± 0.57	82.5 2.45±	10 ±0.00	14.55 0.32±	6250 490±
2	2-5	5	J2	38.61 ± 3.93	3.03 ± 0.04	10.61 ± 0.63	5.94 ± 0.63	76.6 ±2.36	9.39 1.02±	13.59 0.47±	5861 628±
3	5-10		J3	28.33 ± 0.00	3.47 ± 0.04	7.42 ± 0.07	5.28 ± 0.16	67.7 2.08±	11.3 0.24±	14.56 ±0.16	4138 218±
4	0-2	20	J4	21.67 ± 0.00	2.78 ± 0.08	8.56 ± 0.10	5.17 ± 0.00	91.1 2.08±	9.67 0.24±	13.61 ±0.32	5833 ±360.
5		50	J5	19.44 ± 1.57	2.94 ± 0.08	7.97 ± 0.19	5.17 ± 0.00	89.4 2.08±	10.0 0.39±	13.75 +0.00	5611 437±
6	0-2	5	B1	31.67 ± 0.00	1.67 ± 0.00	7.75 ± 0.07	4.44 ± 0.08	97.7 3.14±	6.78 0.16±	10.28 ±0.16	6333 ±360.
7		20	B2	13.33 ± 0.00	2.36 ± 0.08	7.08 ± 0.20	3.89 ± 0.16	79.4 0.79±	6.34 0.24±	10.72 ±0.16	5000 180±
8		50	B3	16.67 ± 0.00	1.83 ± 0.00	6.83 ± 0.00	3.78 ± 0.16	77.8 3.14±	7.33 0.24±	11.28 ±0.16	4777 78.±
9	0-2	5	B4	22.78 ± 0.78	2.42 ± 0.00	8.53 ± 0.87	5.2 ± 0.24	77.2 2.75±	7.83 0.00±	10.72 +0.42	4138 463.±
10		20	B5	17.22 ± 0.78	2.42 ± 0.00	5.08 ± 0.25	3.56 ± 0.16	63.8 4.16±	7.61 0.16±	9.39 0.16±	2916 556±
11		50	B6	17.22 ± 0.78	2.2 ± 0.04	6.17 ± 0.00	3.67 ± 0.00	80.5 2.83±	8.0 0.24±	12.1 ±0.00	4611 578±
12		5	B7	57.78 ± 6.33	2.0 ± 0.14	8.64 ± 0.28	4.33 ± 0.00	82.7 ± 5.11	7.44 ± 0.34	10.1 ± 0.47	5111 ± 207
13	0-2	5	N1	7.22 0.78	1.39 ± 0.12	5.5 ± 0.38	2.22 ± 0.16	31.1 ± 2.08	2.11 ± 0.31	6.06 ± 0.55	3944 ± 257
14	2-5		N2	2.78 ± 0.78	0.41 ± 0.12	4.3 ± 0.24	1.75 ± 0.00	24.4 ± 0.79	1.67 ± 0.00	4.89 ± 0.34	3944 ± 171
15	5-10		N3	4.44 ± 1.57	0.33 ± 0.00	3.81 ± 0.08	2.89 ± 0.31	23.8 ± 0.79	2.22 ± 0.39	4.28 ± 0.16	3750 ± 117
16	0-2	20	N4	1.67 ± 0.00	0.31 ± 0.08	4.81 ± 0.16	2 ± 0.00	32.2 ± 0.78	1.95 ± 0.39	5.0 ± 0.24	4083 ± 245
17		50	N5	5.56 ± 1.57	0.42 ± 0.10	4.43 ± 0.25	2.45 ± 0.32	27.78 2.08	2.89 ± 0.23	5.5 ± 2.5	4972 ± 141
18	0-2	5	N6	5.56 ± 1.57	0.42 ± 0.13	4.78 ± 0.16	2.33 ± 0.47	28.8 ± 2.08	2.33 ± 0.49	5.16 ± 0.24	3583 ± 180
19	2-5		N7	7.22 ± 0.78	0.33 ± 0.00	4.92 ± 0.45	2.11 ± 0.16	28.3 ± 2.36	2.5 ± 0.00	5.44 ±0.55	4472 ±257.
20	5-10		N8	8.33 ± 0.00	0.5 ± 0.24	4.03 ± 0.16	1.92 ± 0.12	26.1 ± 1.57	2.5 ± 0.00	4.28 ±0.16	363 ±463.
21	0-2	20	N9	3.33 ± 0.00	0.25 ± 0.00	5.03 ± 0.91	1.75 ± 0.00	23.8 ± 2.08	1.95 ± 0.39	4.06 ±0.16	3694 ± 78.
22		50	N10	0 ± 0.00	0.42 ± 0.12	4.53 ± 0.93	1.08 ± 0.00	18.3 ± 1.36	0.89 ± 0.04	3.61 ± 0.16	372 ± 903

4.7 Nickel

The concentration of nickel ranged between 3.61 **-** 14.56 ppm with an average of 7.88 ppm. The highest value was in sample **J3** (14.56 ppm) at Ajdabiya path, which is 5 meters from the edge of the road and the lowest value was in samples **N10 and F3** (3.61 ppm) at Bin Jawad and Nofiliya paths, 50 meters from the edge of the road.

4.8 Iron

The concentration of iron ranged between 2916.67 – 8000 ppm, with an average of 5152.25 ppm. The highest value was in sample S8 (8000 ppm) at Brega path, which is 5 meters from the edge of the road and the lowest value was in sample B5 (2916.67 ppm) at Bin Jawad path, 20 meters from the edge of the road.

23	0-2	5	F1	10.83 ± 2.04	0.53 ± 0.08	5.42 ± 0.13	1.92 ±0.12	37.5 ± 2.45	3.33 ± 0.00	5.05 ± 0.32	4527 ± 141
24	2-5		F2	10 ± 2.36	0.33 ± 0.00	5.53 ± 0.19	1.75 ±0.00	35 ± 1.36	2.78 ± 0.39	5.5 ± 0.00	4889 ± 157
25	5-10		F3	2.78 ± 0.78	0.11 ± 0.04	3.97 ± 0.08	1.08 ±0.00	27.22 ± 0.78	1.17 ± 0.35	3.61 ± 0.16	3667 ± 180
26	0-2	20	F4	6.67 ± 0.00	0.61 ± 0.04	5.61 ± 0.17	2.67 ±0.27	49.44 1.96	3.33 ± 0.00	6.09 ± 0.12	6056 ± 79
27		50	F5	6.11 ± 2.08	0.89 ± 0.56	4.67 ± 0.18	1.28 ±0.28	41.11 ± 3.14	3.0 ± 0.24	4.83 ± 0.00	6278 ±463.
28		20	F13	6.11 ± 2.08	0.39 ± 0.04	4.61 ± 0.24	1.83 ±0.12	34.17 ± 0.68	2.94 ± 0.28	4.39 ± 0.31	4229 ±341
29		50	F14	0 ±0..00	0.61 ± 0.04	4.97 ± 0.25	3.22 ±0.16	51.11 ± 18.07	2.61 ± 0.08	5.89 ± 0.39	4972 ± 142
30	0-2	5	S1	13.33 ± 4.08	0.78 ± 0.08	7.08 ± 0.27	2.11 ±0.16	47.78 ± 0.78	4 ± 0.00	7.11 ± 0.16	5778 ±695
31	2-5		S2	27.78 ± 4.78	1.11 ± 0.08	9.75 ± 0.48	1.83 ±0.12	62.78 ± 2.08	4.56 ± 0.34	9 ± 0.7	5944 ± 671
32	5-10		S3	22.78 ± 0.78	1.0 ± 0.00	9.5 ± 0.07	2.44 ±0.16	64.44 ± 1.57	4.67 ± 0.00	8.95 ± 0.16	6500 ± 118
33	0-2	20	S4	10.83 ± 0.00	1.03 ± 0.26	7.64 ± 0.63	3.67 ±0.00	66.67 ± 7.58	4.33 ± 0.24	8.33 ± 0.95	7556 ±681
34		50	S5	10 ± 1.18	1.0 ± 0.00	6.72 ± 0.27	5.2 ±0.24	65 ±4.08	3.78 ± 0.32	8.0 ± 0.00	7694 ± 258
35	0-2	5	S6	10 ±1.18	1.36 ± 0.08	5.89 ± 0.10	4.78 ±0.19	56.11 ± 3.14	5.44 ± 0.55	8.11 ± 0.16	5806 ±453
36	2-5		S7	57.78 ± 6.32	1.36 ± 0.08	9.72 ± 0.39	4.28 ±0.21	62.22 ± 2.08	6.06 ± 0.16	8.78 ± 0.34	7472 ± 528
37	5-10		S8	54.17 ± 12.42	1.36 ± 0.08	6.53 ± 0.32	3.78 ±0.16	59.72 ± 6.95	5.0 ± 0.00	8.39 ± 0.34	8000 ± 1047
38	0-2	20	S9	23.33 ± 4.08	1.25 ± 0.00	8.11 ± 0.04	3.67 ±0.00	58.33 ± 0.00	4.67 ± 0.24	7.89 ± 0.16	6278 ± 393
39		45	S10	3.33 ± 0.00	0.67 ± 0.00	5.11 ± 0.16	5.28 ±0.16	41.67 ± 2.72	3.33 ± 0.00	4.64 ± 0.19	4528 ± 142
40		50	S11	6.67 ± 0.00	1.36 ± 0.08	6.46 ± 0.31	4.64 ±0.19	58.33 ± 1.36	4.56 0.08	7.56 ± 0.16	5527 ± 157
The average				16.37	1.28	6.44	3.44	53.76	4.81	7.88	5152

Table 2. The concentrations of organic substance, % in the studied

Serial No	Sample No.	% of organic Subs.	Serial .No	Sample No.	% of organic subs.
1	J1	1.037	21	N9	0.027
2	J2	0.451	22	N10	0.113
3	J3	0.323	23	F1	0.054
4	J4	0.369	24	F2	0.137
5	J5	0.301	25	F3	0.002
6	B1	0.181	26	F4	0.131
7	B2	0.188	27	F5	0.158
8	B3	0.195	28	F13	0.182
9	B4	0.219	29	F14	0.029
10	B5	0.057	30	S1	0.369
11	B6	0.147	31	S2	0.301
12	B7	0.874	32	S3	0.183
13	N1	0.040	33	S4	0.279
14	N2	0.027	34	S5	0.321
15	N3	0.099	35	S6	0.306
16	N4	0.048	36	S7	1.146
17	N5	0.069	37	S8	1.093
18	N6	0.212	38	S9	0.209
19	N7	0.346	39	S10	0.347
20	N8	0.029	40	S11	0.349

5. Discussion

The average concentrations of elements in the sediments of the studied area are: Lead 16.37 ppm, Cadmium 1.28 ppm, Zinc 6.44 ppm, Manganese 53.76 ppm, Copper 3.44 ppm, Cobalt 4.81 ppm, Nickel 7.88 ppm, and Iron 5152.25 ppm.

The average concentrations of the elements reveal no pollution in the studied area. The concentrations are within the limits of non-polluted terrestrial and marine sediments of Africa, Saudi Arabia, Kuwait and Bahrain in which the concentrations are ranged between 8-60 ppm lead, 0.1-2.5 ppm cadmium, 95-ppm zinc, and 770-ppm magnesium [11]. Aslam et al, [3] reported the concentrations of Pb (259.66-2784.45ppm) and Fe (325.64-5136.37ppm) in the United Arab Emirates road of traffic signals more than two. They [3]
considered the iron is within the range of background level and lead is high in concentration due to high traffic density. The average concentrations are very low also as compared with the concentrations of cobalt 9-29 ppm and nickel 13-90 ppm in the sediments of Greece and Egypt respectively [6].

Except the iron, the study also indicates the decrease in the concentrations of the elements away from the edges of the road, but there is no decrease in the concentration with depth. However, few samples did show an increase with depth. The wide range of concentrations of the elements and the decrease in concentration away from the road might be related to the size of minerals components, organic materials, wind direction and the effect of vehicles exhaust. [1, 2, 4].

Field and laboratory study shows no difference in the size of minerals composition of the sediments, and the sediments are fine to medium sands. The winds were not effective as they were variable in directions and some paths were taken along the opposite side of the road and the results show no difference in concentration. For organic materials (Table 2) the sediments have low concentration and therefore don't play a role in concentration of elements as the correlation coefficient between the organic materials and the elements concentrations is low. These are Pb 0.5908, Cd 0.163, Zn 0.337, Mn 0.162, Cu 0.397, Co 0.191, Ni 0.2, Fe 0.402.The concentrations for the elements except the iron shows clear trend of decrease in elements concentrations away from the edges of the road. The decreases were obvious in lead as indicated in table-3 and Figure 3 and for other elements (Table 3 and Figures 4-11).

Therefore, the variations in the concentration of the most elements and the decreases in concentration away from the edges of the road most properly related to the effect of transport vehicles exhaust, particularly from hydrocarbon emission. Moreover, electrical and engines of the vehicles, dyes, paints, tires, fats, formed additional sources for Zn, Cu, and Cr. These sources were reported for the high concentration of Zn, Cu, and Cr in the other sediments, [11,12]. Lead is the highest value of correlation coefficient with organic materials than other elements r = 0.5908 indicating that there are slight contribution by organic materials for lead and for other elements also.

The results of the study also showed that in exception of iron, the concentration at the distance of 20 meters, 50 meters for all elements were very close, and the concentrations are high at 5 meters only, and convergence in concentration at 20 and 50 meters, (Figures 3-11).

Table 3. Average concentration of elements at the surface sediments, at the depths 0-2 cm and at 5, 20 and 50 meters distance from the edges of the road.

Serial no.	The metals	5 meter	20 meter	50 meter
1	Pb	22.32	10.10	8.50
2	Cd	1.55	1.26	1.23
3	Zn	7.05	6.28	5.78
4	Mn	60.19	55.46	55.11
5	Cu	3.90	3.28	3.00
6	Co	5.47	4.77	4.64
7	Ni	8.58	7.72	7.72
8	Fe	5052.5	5071.7	5169.4

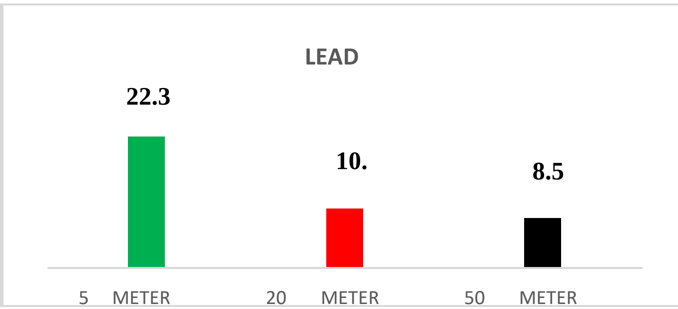

Figure 3. Average concentration of lead (ppm) in the surface sediments (0-2 cm) depth at different distances from the edge of the road.

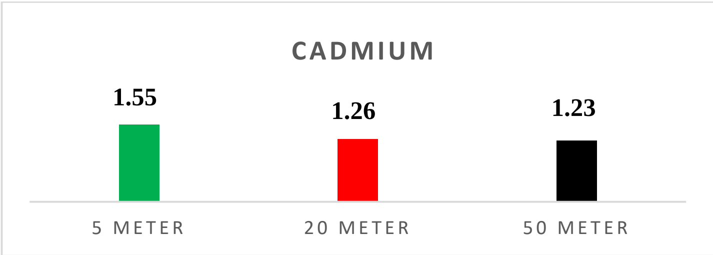

Figure 4. Average concentration of Cadmium (ppm) in the surface sediments (0-2 cm) depth at different distances from the edge of the road.

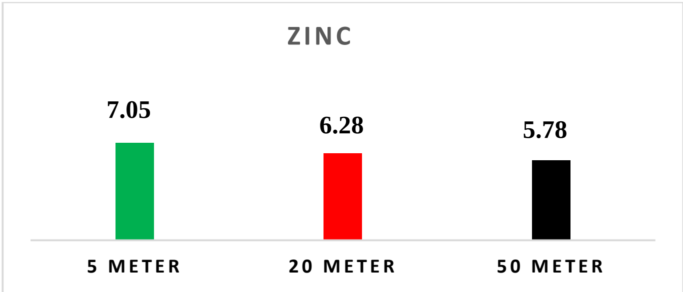

Figure 5. Average concentration of Zinc (ppm) in the surface Sediments (0-2 cm) depth at different distance from the edge of the road.

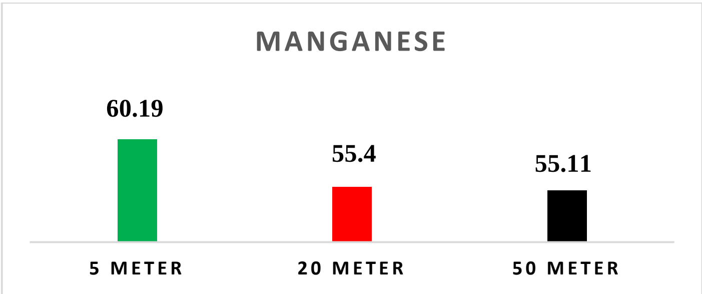

Figure 6. Average concentration of Manganese (ppm) in the surface sediments (0-2 cm) depth at different distances from the edge of the road.

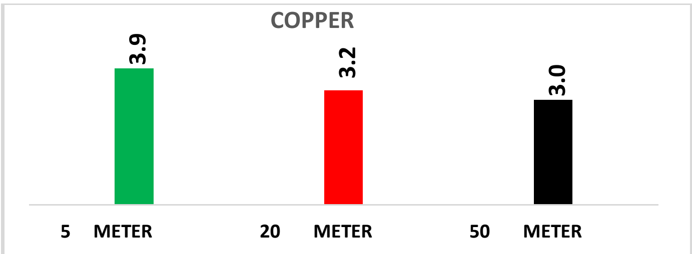

Figure 7. Average concentration of Copper (ppm) in the surface sediments (0-2 cm) depth at different distances from the edge of the road.

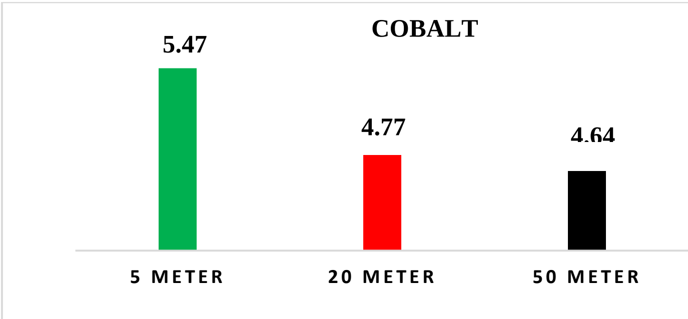

Figure 8. Average concentration of Cobalt (ppm) in the (0-2cm) depth at different distances from the edge of the road.

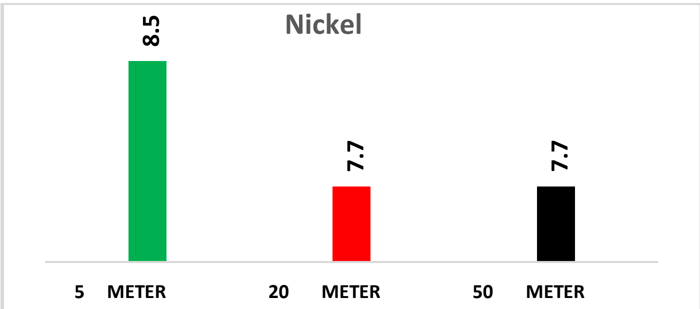

Figure 9. Average concentration of Nickel (ppm) in the surface sediments (0-2cm) depth at different distances from the edge of the road.

The high concentration at 5 meter and the convergence in concentration at 20 meter and 50 meter for most of the elements is most probably attributed to the less effect of vehicles exhaust at a distance more than 20 meter. Carson [13] pointed that the concentration of lead can reach 15 meter from the edge of the road while Abu Dhahi and Yunis [14] indicated that the concentration of lead might be reached up to 100 meter from the edge of the roads. Swaileh et al [4] indicated that the road side contamination by traffic Pb, Cu and Zn did not extend 20 m distance from the road edges. Moreover, the slight variation in the concentration of these elements might be related to the local differences in percentage of the minerals composition, organic material and chemistry at 20 and 50 meters from the edges of the road.

The study also showed that in the exception of iron, the concentration of the elements at Ajdabiya , Brega, and Sultan paths was higher than those in Bin Jawad and Nofaliya paths (Table 4). This increase is due to the high traffic density and low speed at Ajdabiya , Brega and Sultan, therefore more hydrocarbon emission and effect of vehicles at Ajdabiya, Brega , and Sultan paths in comparison with the other paths

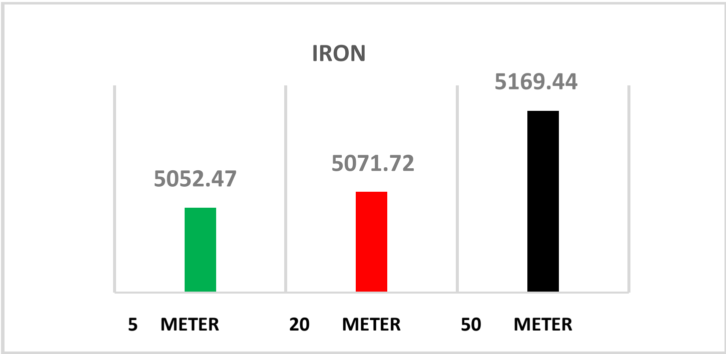

Figure (10) . Average concentration of iron (ppm) in the surface sediment at depth of (0 – 2 cm) depth at different distances from the edge of the road.

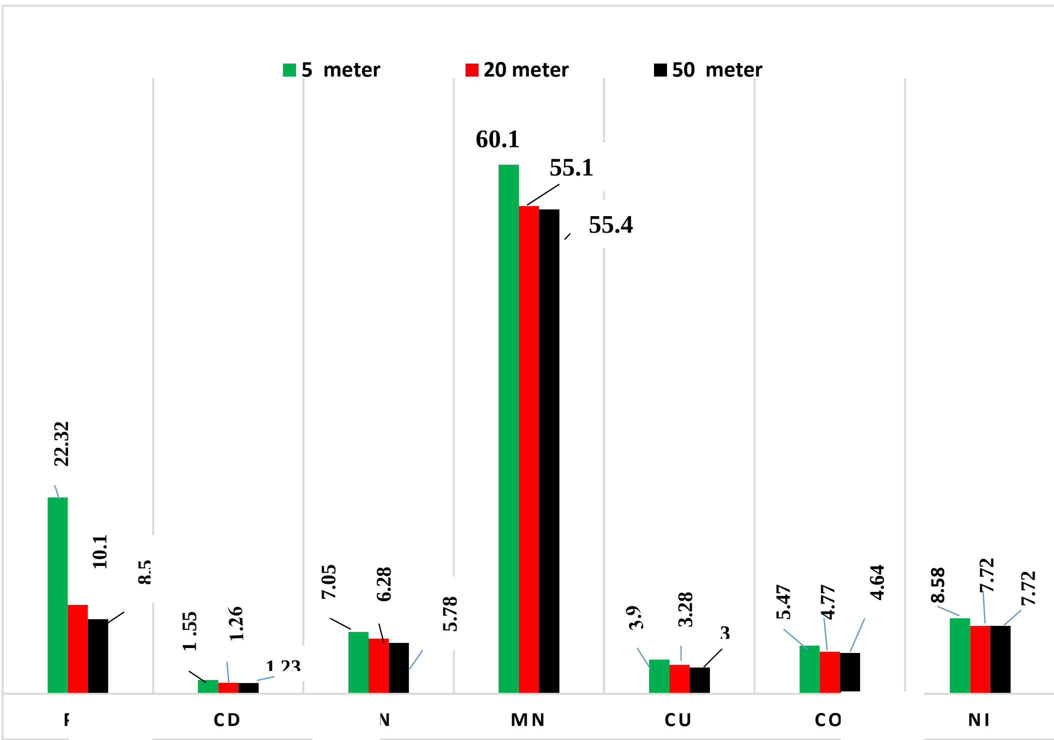

Figure (11): Average concentration of elements (ppm) in the surface sediments (0 – 2 cm) depth at different distances from the edge of the road.

The absence of a specific trend and the high concentration of the iron in the sediments of the studied area, which is arid to semiarid climate, might be related to the local difference in the rate of oxidation of iron. The oxidation of iron is the characteristic features of arid desert areas forming desert varnish [15]. However, organic materials do not exclude for the source of iron in this study as r =0.402 between iron concentration and organic materials.

Table 4 . Average concentration of elements (ppm) in the surface sediments at depth of (0-2 cm). depth at different distances from the edge of the road.

Serial No.	The path	Pb	Fe	Ni	Co	Mn	Cu	Zn	Cd
1	Ajdabyah	27.59	5898.15	13.97	9.91	87.69	5.65	8.8	3.04
2	Brega	25.24	4698.1	10.68	7.33	79.92	4.12	7.15	2.13
3	Nofiliya	5.94	5212.45	4.9	2.02	27.04	1.97	4.85	0.53
4	Bin Jawad	3.89	3999.99	4.9	2.02	27.04	1.97	4.85	0.53
5	Sultan	11.07	6166.66	7.37	4.30	56.27	3.55	6.71	1,11

6. Conclusions

Heavy metal concentrations in the recent sediments along the sides of the road between Bangazi and Sirt cities in Libya indicate the following conclusions:

1- Normal range of concentrations of the studied elements reflect no pollution.
2- Except the iron, the study indicates an increase in concentrations of the elements at 3m distance from the edges of the road.
3- The increase in concentrations of the elements at the edges of the road might be related to the effect of transport vehicles exhaust from hydrocarbon emission and vehicles effect.
4- Except the iron, the convergence in concentration of the elements at 20 m and 50 m distances is most probably indicated that the contamination caused by traffic was less than 20 m distance from the road edges.
5- The absence of the specific trend in the concentrations of the iron might be related to local differences in the rate of oxidation of the iron in the studied sediments.

Acknowledgements
The authors would like to acknowledge Mr. B. B., Fakbulo for chemical analysis, and Mr.Z.M. Albasher and Miss. K.M. Al Juhimy for their help in the samples preparation.

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