Open Access
2020, 17(1):9-22

Baghdad Science Journal

P-ISSN: 2078-8665
E-ISSN: 2411-7986

DOI: http://dx.doi.org/10.21123/bsj.2020.17.1.0009

Evaluation of Some Trace Elements Pollution in Sediments of the Tigris River in Wasit Governorate, Iraq

Murtadha J. Issa [1*] *Basim Shaker Al- Obaidi* [2] *Ruaa Issa Muslim* [3]

Received 4/10/2018, Accepted 20/5/2019, Published 1/3/2020

Abstract:

The main objectives of present study are to evaluate the trace elements pollution in the sediment of the Tigris River and drainage canals in Wasit Governorate, Iraq. Assessment of trace elements pollutants were conducted for 18 sediment samples collected in March 2017. Trace elements were analyzed in sediment Tigris River samples in Wasit Governorate. This metal pollution was evaluated using geo-accumulation (I-geo) index, Contamination Factor (CF) and Pollution Load Index (PLI). According to these statistical indices, the sediments collected from Tigris River in the study area are highly polluted with Titanium (71.9 ppm), Nickel (226.6 ppm) Chromium (425.2 ppm), Cadmium (2ppm) and Molybdenum (15.8 ppm) while the sediments were moderately polluted with Cobalt (25.1 ppm), Strontium (839.3 ppm), Copper (56.2), Manganese (106.1ppm), Vanadium (135 ppm), Niobium (9.79 ppm). However, the sediments of the Tigris River is not polluted by Lead, Barium, Gallium, Rubidium and, Zinc. Metals concentration levels in the sediments of the drainage canals that discharged into the Tigris River showed higher concentrations than the Tigris sediments in Ta, V, Ni, Cu, Ga, Br, Sr and Mo.

Key words: Contamination, Contamination factor, Mineralogy, Pollution load index, Trace elements.

Introduction:

Trace elements are introduced into river water either autochthonous or through anthropogenic sources introduced into river water (1). Metals that are naturally introduced into the river come primarily from sources such as rock and mineral weathering, and the dissolution of water-soluble salts. Heavy metals may be incorporated into the aquatic system from anthropogenic sources such as solid and liquid wastes of industries. Some degree of contamination may be caused from fall out of industrial emissions from the atmosphere (1). The Tigris River crosses longitudinally through the province from the north to the south for a length of 327 km, where most of the districts distributed along its bank (2). Water from the Tigris is mainly used for agricultural uses. Water quality in the basin is primarily threatened by rising salinity rates resulting from intensive irrigated agriculture and high evaporation rates (3). Pollution of rivers and its sediments are caused by toxic pollutants that have direct adverse effect on aquatic biota and by pollutants that indirectly affect aquatic biota like human and animal waste due to bacterial action on them, dissolved oxygen is used up which harms aquatic biota. Heavy metals which represent a potential hazard and occur in contaminated sediment Cd, Cr, Pb, Zn, Fe and Cu. The assessment of sediment enriched with elements can be achieved by various ways. Most common are the index of geo-accumulation (I-geo) and pollution load index (PLI) (4). This index is a quick tool to compare the pollution status of different places (4). The I-geo is a quantitative measure of the degree of pollution in aquatic sediments (5) and has been widely used as a measure of pollution although the pollution load index (PLI) represents the number of times by which the heavy metal concentrations in the sediment exceeds the background concentration (5) In addition, the I-geo values of the surface sediments of Shatt Al-Arab River classified the rivers sediments as moderately polluted with Ni (6). Wasit Governorate represents 17.153 km^2 in area. The main source of water in Wasit province is the Tigris River with a length of 327 km within the borders of the province (7). The importance of the problem of the study can be formulated as follows: products from most of the industrial activities and wastewater of sewage, rainfalls and thermal power

[1] Department of Geology, College of Science, University of Baghdad, Baghdad, Iraq
[2] Department of Soil & water Science, College of Agriculture. University of Tikrit, Iraq
[3] Departments of Chemistry, College of Science, University of Wasit, Iraq
[*]Corresponding author: murtatha20042000@yahoo.com
[*]ORCID ID: 0000-0002-3871-1364

Baghdad Science Journal
P-ISSN: 2078-8665
E-ISSN: 2411-7986

plant pipes and major industrial projects are liquid, solid or gas, as well as car exhaust and products of fuel combustion and produced elements are added to the environment, which are harmful or toxic when they are released directly and without treatment. The importance of the river for different uses as well as no past or pervious environmental study assessments of Wasit Governorate especially on toxic heavy metals and discharges of these pollutant in to Tigris River directly without any treatment, therefore, the main objective of this study is evaluate the pollution of heavy elements of the Tigris River sediments in this area.

Geological Setting

The platform part of the Iraqi territory is divided into two basic units; the Stable and Unstable Shelf. The Stable Shelf is characterized by reduced thickness of the sedimentary cover and by the lack of folding. The Unstable Shelf has a thick and folded sedimentary cover, the mesopotamian basin covered by aeolian and fluvial plain deposits of the Tigris and Euphrates Rivers (8).

Wasit region is located within the unstable Shelf. The northeastern part is characterized by the high mountain along the Iranian- Iraqi borders which are within low folded zone and other parts of Wasit governorate in Mesopotamian zone. The mesopotamian plain is covered mostly by quaternary deposits and is considered as a part of it. The old geological outcrops in the area belong to the Pliocene age represented by Bai Hassan and Mukdadiya Formations show in Fig.1. From the topographic point of view the area can be divided into two regions. The highly area in the northeastern part and the Mesopotamian plain area (9).

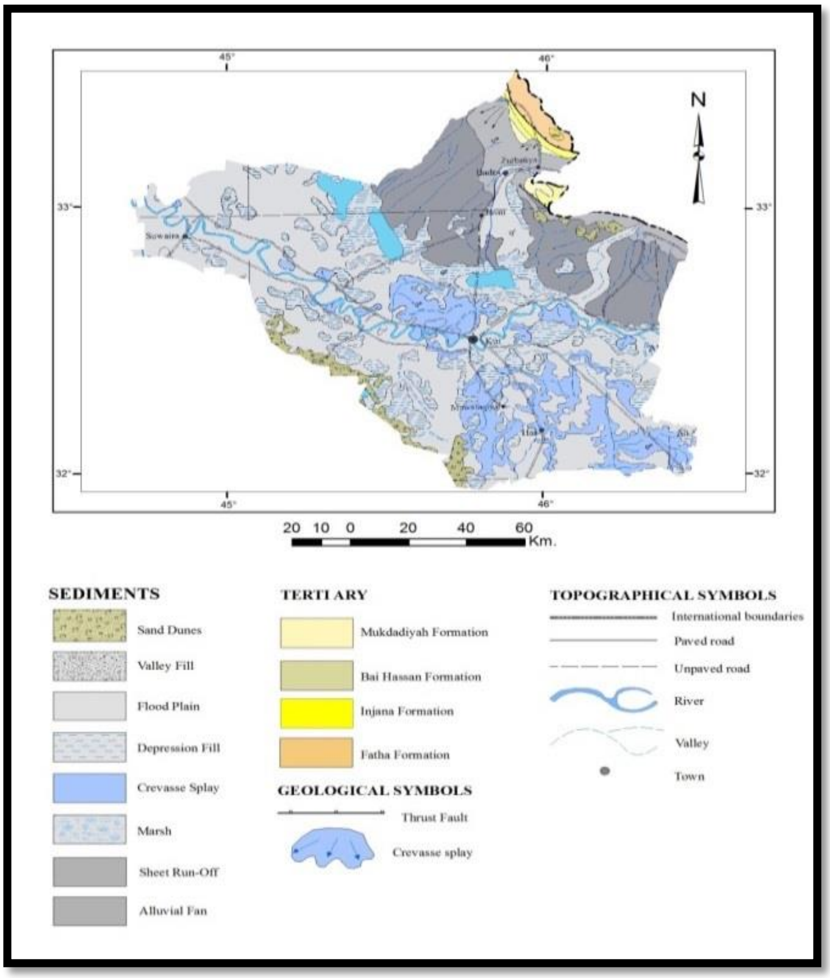

Figure1. Geological map of study area (10)

Materials and Methods:

Study area

Wasit Province is located in the southern part of the central region of Iraq between 31.934210-33.486720 N and 44.533030-46.597930 E. Wasit is intersected by the Tigris River, where most of the districts and areas of the province are located on both banks of the river. Present study covered sediments of Tigris River. Its branches and drainages canal throughout Al Suwayra to Al-hayy district in this region (Fig.2). Wasit has a dry, desert climate, with temperatures easily exceeding 43°C in summer. Rainfall is scarce and concentrated in the winter months (11).

Baghdad Science Journal
P-ISSN: 2078-8665
E-ISSN: 2411-7986

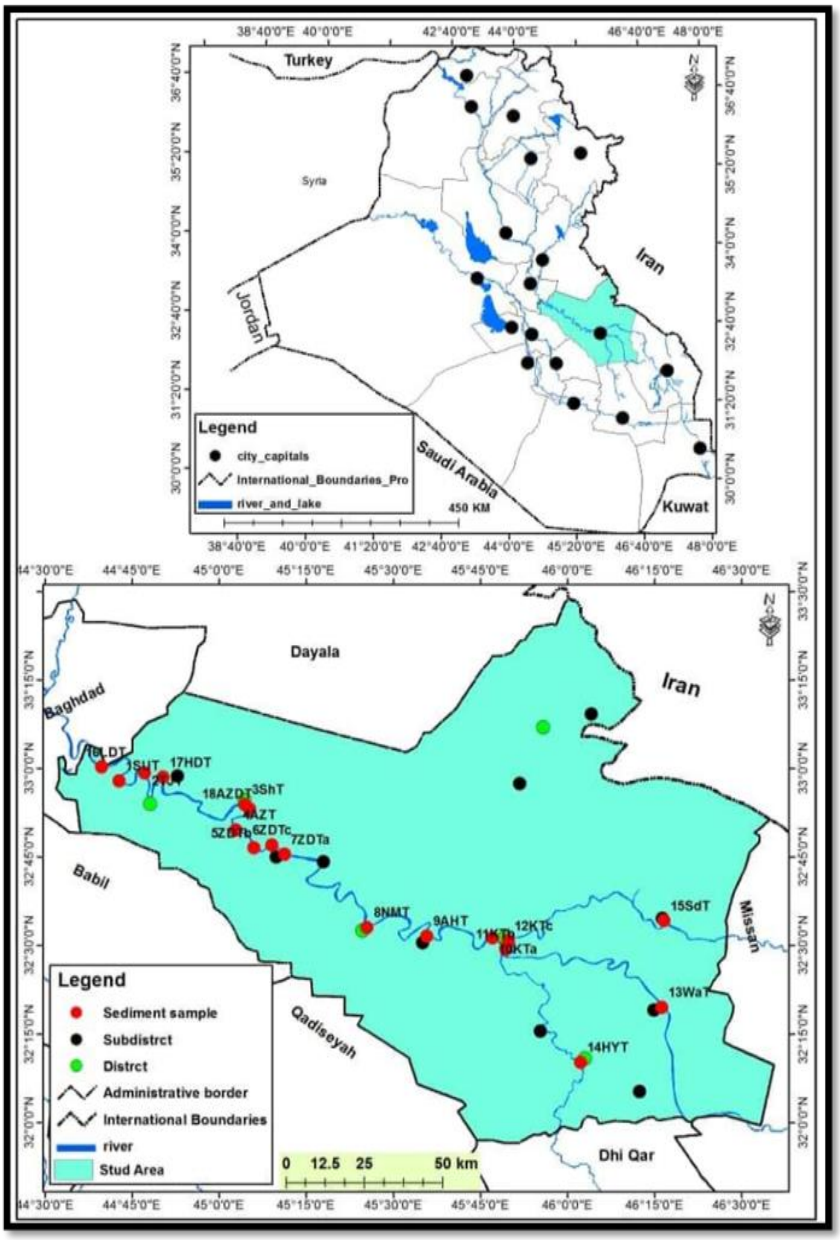

Figure 2. Sampling map of study area based on Arc map program 10.5 (map of Iraq scale 1:1000000)

Field and Sampling Works

Samples of sediments were taken from fifteen sediments (covering the sediments of Tigris River in Wasit Governorate) as well as three drainages canals sediment samples during March 2017. The samples were collected using clean plastic scoop and stored in polyethylene bags. Sample sites are selected on the base of cities distribution, populated community, wastewater drainage sites (thermal power plant), seepages, and other affected sites like agricultural areas on both banks of the Tigris River (Table 1).Geological formations, topography, and drainage system are clearly observed during field trip in order to assist in data interpreting.

Table 1. Geographic coordination of sampling location

Number	Samples	Station	N	E
1	1SUT	Al Suwayra Sediment Tigris	32.92094	44.795635
2	2TJT	Taj Aldin Sediment Tigris	32.985134	44.859647
3	5ShT	Sediment Tigris Al Shuhaymiya	32.901216	45.065334
4	4AZT	Al Aziziya Tigris	32.753249	45.215423
5	$5ZDT_b$	Al Zubaydia Tigris Sediment	32.793793	45.088591
6	$6ZDT_c$	Al Zubaydia Tigris Sediment	32.770125	45.113997
7	7 ZDTa	Al Zubaydia Tigris Sediment	32.794961	45.088997
8	8NMT	Al Numaniya Tigris Sediment	32.55492	45.420234
9	9AHT	Al Ahrarr Tigris Sediment	32.527463	45.604188
10	$10KT_a$	Al Kut Tigris Sediment	32.5058	45.806376
11	$11KT_b$	Al Kut Tigris Sediment	32.486788	45.826392
12	$12KT_c$	Al Kut Tigris Sediment	32.497285	45.816092
13	13WaT	Nahyat Wasit Dujaila Sediment	32.518771	46.405741
14	HYT14	Al Hayy Al Garaf Sediment	32.171627	46.038678
15	15SdT	Sheik Saad Tigris Sediment	32.571094	46.274087
16	16LDT	Drainage sediment Al- ling Taj Aldin	32.998749	44.775478
17	17 HDT	Taj Aldin Halata Drainage sediment	32.924245	44.912627
18	18 AZDT	Al Aziziya Drainage sediment	32.885738	45.087754

Laboratory Works

Sediment samples were air-dried in a circulating oven at 30 °C and thereafter sieved mechanically using a 2 mm, sieve and homogenized (12). The river and drainages canals sediments collected were analyzed using X- Ray diffraction (XRD) for mineralogical identification. Trace elements are analyzed in the Iraq German laboratory spectra Germany 2010 By XRF technique. XRF is fast method, accurate and non- destructive and usually requires only minimum of sample preparation, element oxides were estimated by this manner. Grain size analysis is achieved by pipette analysis method (13).

Software (Calculations and Statistical Package)

The following equations were used to evaluate the elements pollution and the calculations by Microsoft excel of the index criteria for the sediment collected along the Tigris River in Wasit Province. Geo-accumulation index is:

1- I-geo = Ln (Cn / 1.5 Bn)…1 ***Where***: Ln= the notations "ln x" and "loge x" bot h refer unambiguously to the natural logarithm of x. "log x" without an explicit base possibly will also refer to the natural logarithm. This usage is common in mathematics and certain scientific contexts in addition to in many software design languages. Cn = Measured concentration of heavy metal in the Tigris river sediment Bn = Geochemical background value according to (14) based on clay partition ratio of element n.

2- Contamination Factor

(CF)=C metal/C background value ….2

3- Pollution Load Index

(PLI)=n√ (CF1xCF2x CF3x…xCFn)….3

Where: CF = Contamination Factor, n= number of metals. C metal = metal concentration in contaminated sediments, C Background value = Background value of that metal according to (14) based on clay fraction ratio.

Results and Discussion:

Grain size analyses

One of the fundamental and most ubiquitous tests undertaken during the analysis of sediments in geological investigations is that of grain size distribution analysis, It's used to identify source of sediments, specifies the physical features of the sediment depending on several variables in which granular size is the most important among them in classifying sediment fragment, fine-grained sediment is a natural and essential component of river systems and plays a major role in the hydrological, geomorphological and ecological functioning of rivers (15).The transportation of the sediment from its source or sources will further affect the grain size distribution of the final sample. The clastic sediments are usually fine-grained consisting of clay-silt and sand particles. These are mainly derived from surface runoff depression, either from flows of water or from standing water bodies (16).

Seven samples were selected to represent the study area for grain size analyses; to identify the percentage of the clay fraction because the clay fraction in the river sediments have the ability to attract trace elements within the crystalline structure, also within the exchangeable ions, furthermore the adsorption of heavy metals on its surfaces (17). Any enclosed large flat-bottomed depression area, without vegetation, covered by fine and very fine sediments accumulated during very long time due to physical and chemical weathering of rocks from high surrounding areas flooded in wet seasons in area (16). In this study, the clay fraction content is the highest followed silt and sand. The fine clay fractions which are deposited provide a large surface area, thus its hold high quantities of heavy metals from the polluted water of the river. Studied samples are appeared in mud class according to (13) (Table 2).

Table 2. Grain size analysis of selected surface sediments samples of the Tigris River and drainage canals in Wasit Governorate

Number	Sample Name	Station	Sand	Silt	Clay
				%	
1	1SUT	Al Suwayra district	5.2	42.4	52.4
2	2TJ	Taj Aldin district	4.6	36.8	58.6
3	10KT	kut district	8.1	44.2	47.7
4	13WAT	Nahyat wasit	4.9	40.6	54.5
5	14HYT	Al Hayy district	7.7	42.0	50.3
6	15SdT	Sheik Saad district	8.4	40.6	52.5
7	16LDT	Al- Ling Drainage	4.2	39.3	56.5
8	Range	-----	4.2-8.4	36.8- 44.2	47.7- 58.6

Mineralogy:

Trace elements in primary silicate minerals, from which they may be released from crystals lattice of these minerals by chemical weathering (hydrolysis process) in river sediments, trace elements concentration in the River sediments are capable of changing with time and conditions (18). In General, Wasit Governorate, near Kut city's of XRD of sediments soil illustrates the high percentage of calcite and quartz, as well as various non-clay minerals which are (Dolomite, Gypsum, and Halite), whereas the clay minerals are (Phengite, Muscovite, Palygroskite, Illite and Chloride (19).

The present study, XRD technique used to study the clay and non- clay mineralogy and chemical characteristics of the river sediments (Fig.3): Non-clay minerals Quartz (22%) is considered a resistant mineral during weathering processes for a long-distance transportation. Feldspar (Albite 8.4**%**) is altered into clay mineral during chemical weathering such as kaolinite and Illite (20). Therefore, the stability of feldspar minerals refers to short distance transportation. Carbonate minerals Calcite (43. 2%) is one of the most common minerals on the surface of the earth, formed in many different geological environments. The Dolomite (5.2%), Calcite and dolomite are formed during many chemical and physical processes. Clay Minerals are significant to indicate the alterations in sedimentary environments when difference in the quality of clay minerals and in the distribution of stratification column, The types of clay minerals are controlled by the climate and the rocks source quality (21). Clay minerals owns several qualities that make them relevant in environmental studies, including that some clay minerals swell easily to double their thickness when hydrated and then increase their ability to adsorb ions from aqueous solutions and release these ions later when environmental condition change(21). Clay minerals are transported as classic material from the surrounding area, kaolinit(4.9%), palyogorsite (2.4%), illite (5.8%) and chlorite (8.2%) are characterized in XRD examination in the clay minerals of the selected study sediments samples.

Baghdad Science Journal

P-ISSN: 2078-8665
E-ISSN: 2411-7986

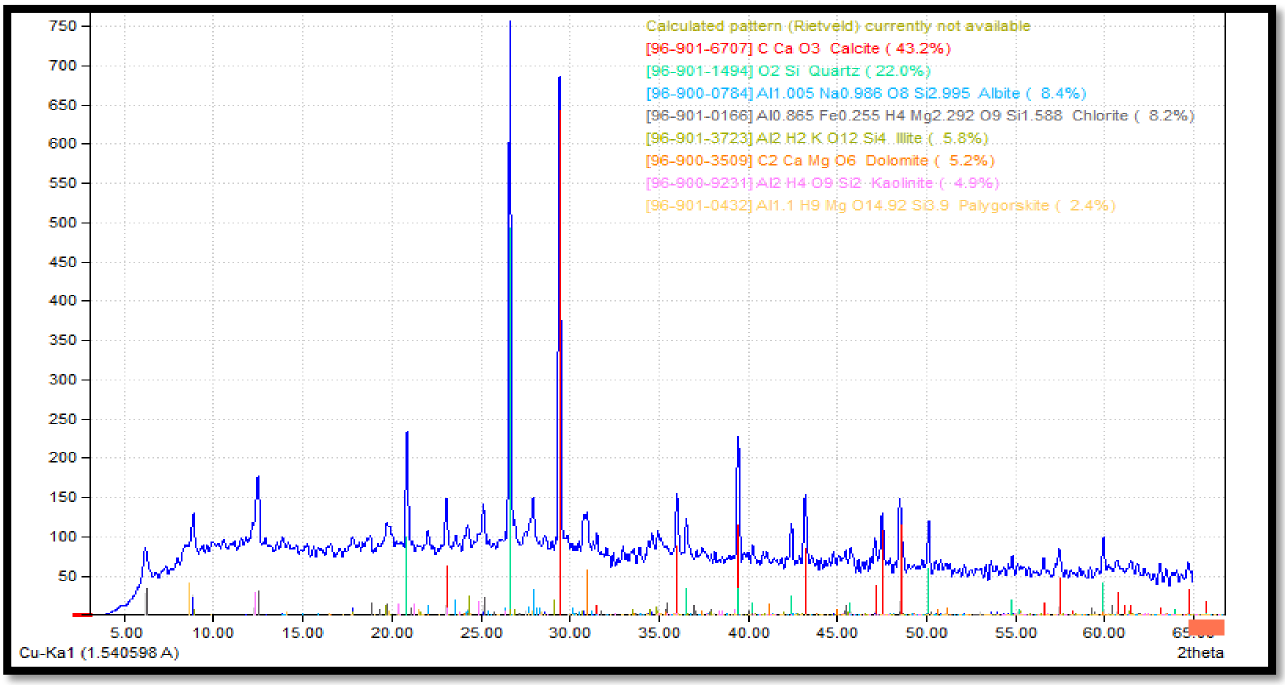

Figure 3. X-ray diffract graph of Tigris river sediments (Kut City, Sample 10KTa)

Evaluation of trace elements pollution

An associated geochemical process plays an important role in the deposition of trace and heavy elements from the water column to the bottom sediments such as physical,, chemical and biological conditions in an environment such as temperature, state of matter, acidity (pH), reduction-oxidation (redox) potential, bacterial activity. These elements are found in natural sediment in a minor ratio and their concentration increases in the environment as a result of human activities and the concentrations may increase due to levels to human and wildlife water pollution (22). In Iraq, the slightly moderate pollution of sediments occur as a result of anthropogenic activities including, oil spilling, and toxic wastes that are discharged to the main rivers (23**).** The contamination is resulting from human activities especially the agriculture processes, decomposition of the solid waste, sewage, and polluted air. This indicate that the agriculture operations, domestic sewage effluents, the human activities especially agriculture, sewage, garbage, and desalination plants and waste water represent the main sources of the contamination with contribution from the natural sources (24**).** The possible sources of contaminated sediments: some solutes are of anthropogenic sources (mainly fertilizers and petroleum extraction wastes), and others are from natural sources (25)**,** trace elements in sediment might originated from in one or more of the resulting forms: Soluble in sediment solution, exchangeable in organic and inorganic constituents, as structural components of the sediment minerals lattices, as insoluble precipitates with other sediment components as complexes.

Concentrations of some studied trace elements in the Tigris River sediments (ppm) in comparison in the sediments from drainage canals of the study area is presented in Table 3. The Contamination Factor (CF), (I-geo) and pollution load index (PLI) and geo-accumulation index were employed to evaluate the pollution of metals in the Tigris river and drainages canals sediment in study area. The geochemical investigation suggested that source of trace elements was natural in origin. Although the water of drainage canals receives significant amount of anthropogenic sources through land use activities, it seems, they are still not considered as major factor for pollution as compared with natural source (26).

Table 3. Concentration of trace elements of studied sample (B.G= Background concentrations depends on (27)

Samples Name	ppm																
	Cd	**Ta**	**Mn**	**V**	**Cr**	**Co**	**Ni**	**Cu**	**Zn**	**pb**	**Ga**	**Br**	**Rb**	**Sr**	**Nb**	**Mo**	Ba
1SUT	2	70.8	839.5	113	267.5	12.1	205.8	45.5	118.4	15.3	15.2	3.7	60.0	304.9	8.39	3.8	**254**
2TJT	2	68.7	825.5	111	243.6	22.3	180.9	39.9	90.7	13.5	15.9	3.4	62.9	281	8.67	4.1	**242**
3AZT	2	70.6	983.6	117	217.9	25.1	226.6	56.2	133.3	12	17.5	4.4	68.8	341.9	9.02	4.6	**267**
4SHT	2	66.7	930.1	129	312.8	18.5	213.3	46.9	109.7	15.4	16.3	4.4	59.2	347.5	9.16	7.4	**274**
5ZDTb	2	69.5	908.4	123	253.9	20.7	210.5	48.2	120.8	18.	15.3	5.9	58.3	313.2	9.79	8.6	**253**
6ZDTc	2	71.6	762.1	112	160.9	7.9	165.3	39.8	104.3	17.4	15.1	5.5	59.3	496.9	7.83	9.4	**247**
7ZDTa	2	70.2	737.9	121	252.4	18.2	199.2	48.4	190.3	35.2	14	6.1	55.6	340.9	8.32	14.2	**298**
8NMT	2	70	1069	124	285. 5	15.4	210	48.2	117.5	16.9	16.3	4.6	59.1	364.1	9.23	15	**246**
9AHT	2	70.6	867.4	135	229.3	12.9	196.5	46.8	90.1	14.2	14.6	4.4	59.8	305.6	9.16	7.9	**232**
10KT1	2	67.1	881.3	109	174.3	15	189.7	42.8	99.1	15.1	16.3	3.4	70.4	300.3	9.23	6.9	**234**
11KT2	2	71.8	765.7	77	416.3	11.0	157.2	30.5	74.1	11.5	12.6	4.3	48.3	317.8	6.92	7.9	**240**
12KT3	2	62.2	1037.	105	425.2	12.6	201.1	31.6	79.2	11.2	14.7	3.8	59.2	311	9.02	8	**254**
13WaT	2	69.4	873.6	95.8	304.1	19.2	197.3	45.8	120.	29.8	14.1	5.2	54.3	320.9	8.25	13.6	**270**
14HYT	2	71.3	537.7	77.3	116.9	3.2	108.1	29.1	74.7	10.9	12.2	13.4	47.5	839.3	5.59	7.1	**287**
15SdT	2	71.9	532.8	80.1	112.8	3.06	105.3	27	72.4	9.7	12.6	13.1	45	789.7	5.66	15.8	**282**
Mean	2	69.5	836	108.	249.1	25.4	184.5	41.8	106.3	16.4	14.8	5.7	57.8	398.3	8.3	9	**259**
Standard	0	2.55	155	18.4	111.8	6.49	36.29	8.59	30.41	9.11	1.54	3.17	7.07	176.4	1.28	3.92	**69.87**
Range	2-2	62.2-71.9	523.8-1069	77.3-135	112.8-425.2	3.06 -	105.3 -	27-56.2	72.4-190.3	9.7-35.2	12.2-17.5	3.4-13.4	45-70.4	218-839.3	5.59-9.79	3.8-15.8	**232-298**
16LDT	2	69	726.9	109.	149.8	10.1	152.8	35.7	88	11.3	16.3	7.4	57.8	476.3	8.09	14.1	**234**
17HDT	2	73.6	851.9	101.	254.4	8.5	212.6	39.4	85.9	12.8	13.5	8.5	54.9	686.4	8.46	8.7	**278**
18AZDT	2	70.8	717.5	102.5	167.1	8.9	149.2	35.9	94.3	13	15.7	4.6	55.5	466.3	8.32	7.1	**258**
Mean	2	71.2	765.4	104.	190.4	9.2	182.7	37	89.4	12.4	15.2	6.8	56.1	543	8.29	10	**257**
Standard deviation	0	2.31	75.03	4.56	56.01	0.83	109.64	2.1	4.37	0.93	1.47	2	1.53	124.23	0.1808	3.66	**22.03**
Range	2-2	69-73.6	717.5-851.9	101.4-109.8	149.8-254.4	8.5-10.1	149.2-212.6	35.7-39.4	85.9-94.3	11.3-13	13.5-16.3	4.6-8.5	54.9-57.8	466.3-686.4	8.09-8.46	7.1-14.1	**234-278**
B.G	1.1	1.1	418	60	42	6.9	18	14	62	25	1.2	----	50	147	12	1.8	**360**

Baghdad Science Journal
P-ISSN: 2078-8665
E-ISSN: 2411-7986

The concentrations of heavy metals in sediments variy according to the rate of particle sedimentation, the rate of heavy metals deposition, the particle size and the presence or absence of organic matter in the sediments, Fig. 4 shows the distribution of Mn, Sr, Ni, Rb, Co, Cu and Zn in the sediments of the Tigris River may be incorporated into carbonate and in that way transported from solution into the sediment under reducing conditions (16). The mean concentrations of Mn, Sr, Cr, Ni, V, Zn are mainly higher than global surface sediments according to (27) except Pb, Ba, and Nb, which were lower than this global limit. Concentrations of heavy metals (Cr, Co, Ni, Cu, Zn, Pb, and V) in studied samples were higher than the results of (26) and (28). The strontium may be incorporated with calcite mineral (43. 2%). Sr encountered in the clay fraction is mostly because of substitution for Ca in $CaCO_3$ derived from the rocks. The relatively high content of the sediments are possibly due to the impact of carbonate and clay minerals. Some of the trace elements may come from fertilizers to the agricultural activities such as Mo, Zn, Mn and Cu in reducing condition, high concentration of Zn which due to the extensive use of the fertilizers as the Iraq fertilizers are rich in zinc (29). Other trace elements in higher concentration indicate the industrial emissions source such as vanadium. High concentrations of some element were due to the autogenic formation in heavy and clay minerals structure such as Ta, Ba. High concentration of vanadium recorded in the Al Zubaydia and Al Numaniya stations is due to o fuel combustion and cooling tower water pipes from the Wasit thermal power plant, which is located on the Tigris River bank in the Al Zubaydia district. Slight increase of cadmium concentration, due to because the rainfall and sewages pipes spread along the river and discharged to it directly without any treatments, besides the fertilizers applied on agriculture lands along the river sides.

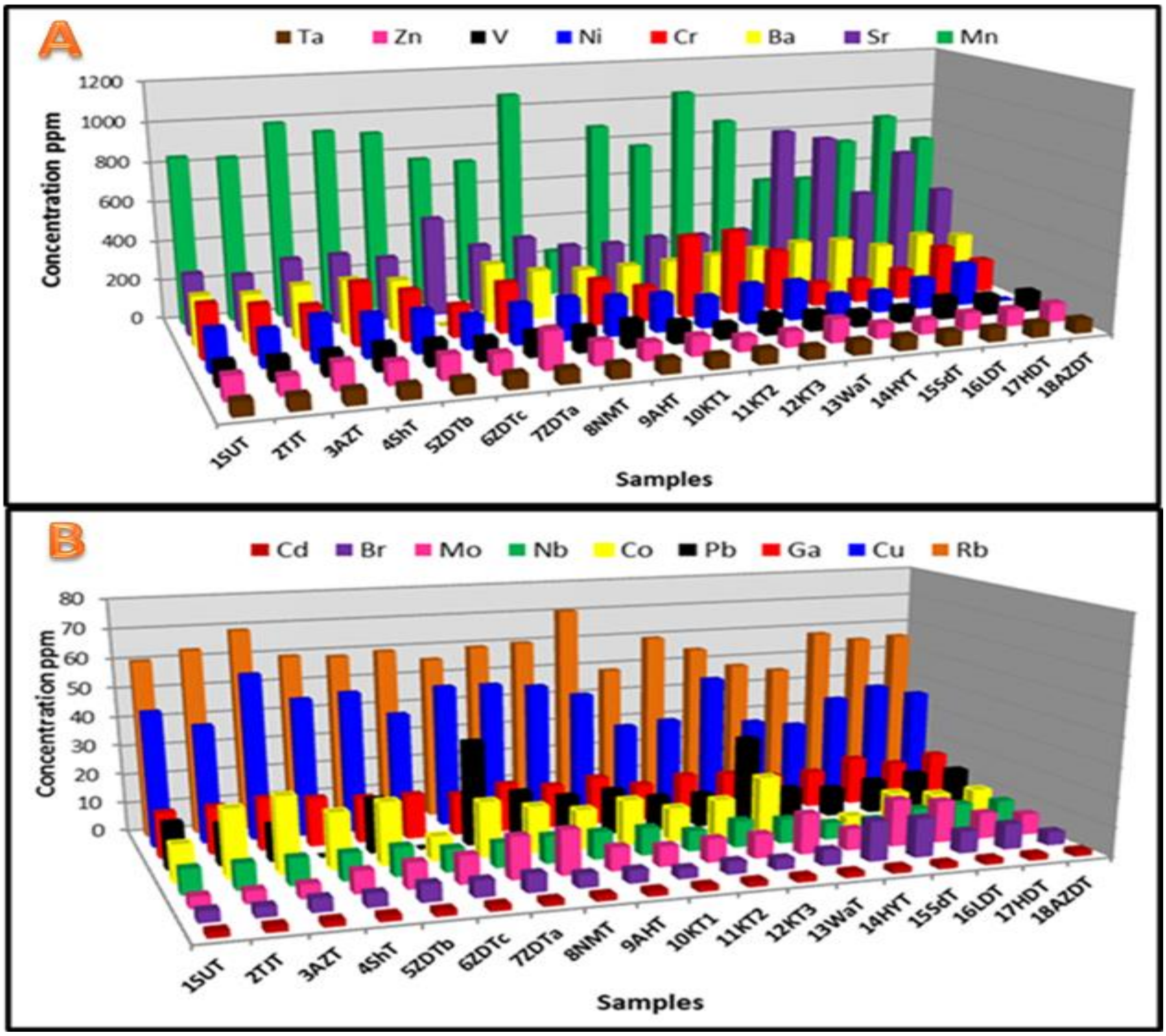

Figure 4. Bar shape for the heavy metals of Tigris River, its branches and drainages canal sediments in Wasit Governorate.

Contamination Factor and Pollution Load Index

The trace elements results displayed considered concentrations, which are derived from natural inputs and human activities (30). Mostly pollution load index (PLI) as developed by contamination factor (CF), CF is used to categorize the level of pollution of metals in the river sediment samples. The Contamination Factor is consistent with 31.The PLI value is classified according to(31) and derived from Contamination Factor CF (Table 4 and 5).

CF results show that Ta and Ni are very high; whereas Cd, Cr and Mo are considerable. For drainages content, CF results in study area sediments are listed in Table 6, based on the PLI results presented in Table 4, all stations samples are polluted. Pollution risk and its variation along the sites were

determined by applying the pollution load index. This index is a fast tool in order to compare the pollution station of different places (32)

Table 4. Contamination Factor values of studied sediments samples

Num.	Samples Name	CF																
		Cd	Ta	Mn	V	Cr	Co	Ni	Cu	Zn	pb	Ga	Br	Rb	Sr	Nb	Mo	Ba
1	1ST	4.	35.3	1.6	1.49	5.3	1.21	7.9	1.98	1.97	0.55	0.54	0.46	0.5	1.45	1.05	1.36	0.49
2	2TGT	4.	34.4	1.57	1.46	4.8	2.23	6.9	1.73	1.51	0.48	0.57	0.43	0.52	1.34	1.08	1.46	0.47
3	3AZT	4.	35.3	1.87	1.53	4.3	2.51	8.7	2.45	2.22	0.78	0.63	0.55	0.57	1.63	1.13	1.64	0.51
4	4ShT	4.	33.4	1.77	1.70	6.1	1.85	8.2	2.04	1.83	0.57	0.58	0.55	0.49	1.66	1.15	2.64	0.53
5	5ZDTb	4.	34.7	1.73	1.61	4.98	2.07	8.0	2.09	2.01	0.65	0.55	0.74	0.49	1.49	1.22	3.07	0.49
6	6ZDTC	4.	35.8	1.45	14.8	3.16	0.79	6.3	1.73	1.79	0.51	0.54	0.69	0.49	2.37	0.98	3.36	0.55
7	7ZDTa	4.	35.1	1.41	1.59	4.95	1.82	7.6	2.1	3.17	1.26	0.5	0.76	0.46	1.62	1.04	5.07	0.57
8	8NMT	4.	35.0	2.04	1.63	5.6	1.54	8.0	2.09	1.96	0.60	0.58	0.58	0.49	1.73	1.15	5.36	0.47
9	9AhT	4.	35.1	1.65	1.78	4.5	1.29	7.5	2.03	1.5	0.51	0.52	0.55	0.5	1.46	1.15	2.82	0.45
10	10KT1	4.	33.5	1.68	1.44	3.42	1.49	7.3	1.86	1.65	0.54	0.58	0.42	0.59	1.43	1.15	2.46	0.45
11	11KT2	4.	35.9	1.46	1.02	8.16	1.10	6.0	1.33	1.23	0.41	0.45	0.54	0.4	1.51	0.87	2.82	0.46
12	12KT3	4.	31.1	1.98	1.39	8.34	1.26	7.7	1.37	1.32	0.40	0.53	0.48	0.49	1.48	1.13	2.86	0.49
13	13WaT	4.	34.7	1.66	1.26	5.96	1.92	7.5	1.99	2	1.06	0.50	0.65	0.45	1.53	1.03	4.86	0.52
14	14HYT	4.	35.6	1.02	1.02	2.3	0.31	4.1	1.26	1.25	0.39	0.44	1.68	0.4	4	0.7	2.54	0.55
15	15SdT	4.	36	1.02	1.05	2.21	0.3	4.0	1.17	1.21	0.35	0.45	1.64	0.38	3.77	1.06	5.64	0.54
16	16LDT	4.	34.6	1.38	1.45	2.94	1.01	5.8	1.55	1.47	0.40	0.52	0.93	0.48	2.27	1.04	5.04	0.45
17	17HDT	4.	36.8	1.62	1.33	4.99	0.85	8.1	1.71	1.43	0.46	0.51	1.06	0.46	3.27	1.06	3.107	0.534
18	18AZD	4.	35.4	1.37	1.35	3.28	0.9	5.7	1.56	1.57	0.46	0.50	0.56	0.46	2.22	1.04	2.535	0.5

Table 5. Pollution Load Index (PLI) of trace elements in the study area of Tigris River, its branches and drainages canals

Number	Sample Name	PLI	Decision	Number	Sample Name	PLI	Decision
1	1ST	1.0899	Polluted	10	10KT1	1.1242	Polluted
2	2TJT	1.1113	Polluted	11	11KT2	1.0207	Polluted
3	3AZT	1.1881	Polluted	12	12KT3	1.1469	Polluted
4	4ShT	1.1732	Polluted	13	13WaT	1.2958	Polluted
5	5ZDTb	1.2368	Polluted	14	14HYT	1.0359	Polluted
6	6ZDTc	1.1521	Polluted	15	15SdT	1.0106	Polluted
7	7ZDTa	1.1479	Polluted	16	16LDT	1.0413	Polluted
8	8NMT	1.2401	Polluted	17	17HDT	1.2022	Polluted
9	9AHT	1.1311	Polluted	18	18AZDT	1.1103	Polluted
				19	Mean	1.13	Polluted
				20	Standard deviation	0.079	

Table 6. Mean Contamination Factor values trace elements in the study area of Tigris River, Tigris branches and drainages canals sediments.

		Present study												
Number		**CF**						**I-Geo**						
	Elements	**Tigris River sediments**		**Decision**	**Drainages canal sediments**		**Decision**	**Tigris River sediments**		**Decision**	**Drainages canal sediments**		**Decision**
		Mean	**Standard deviation**		**mean**	**Standard deviation**		**Mean**	**Standard deviation**		**Mean**	**Standard deviation**	
1	Cd	4.4	0	Significant	4.4	0	Significant	1.09	0	Unpolluted to Moderate	1.09	0	Unpolluted to Moderate
3	Ta	34.7	1.266	Very high	35.6	1.11	Very high	3.142	0.038	High Polluted	3.167	0.057	High Polluted
4	Mn	1.59	0.29	Moderate	1.46	0.141	Moderate	0.04	0.204	Unpolluted	-0.03	0.095	Unpolluted
5	V	2.33	3.461	Moderate	1.38	0.064	Moderate	0.09	0.634	Unpolluted to Moderate	0.09	0.043	Unpolluted to Moderate
6	Cr	4.94	1.8	Significant	3.74	1.098	Significant	1.13	0.394	Moderate Polluted	0.89	0.275	Unpolluted to Moderate
7	Co	1.45	0.651	Moderate	0.92	0.082	Low	-0.19	0.645	Unpolluted	-0.5	0.087	Unpolluted
8	Ni	7.1	1.392	Very high	6.58	1.335	Very high	1.53	0.234	Moderate Polluted	1.47	0.199	Moderate Polluted
9	Cu	1.82	0.374	Moderate	1.61	0.089	Moderate	0.17	0.216	Unpolluted	0.07	0.055	Unpolluted
10	Zn	1.78	0.51	Moderate	1.49	0.072	Moderate	0.14	0.265	Unpolluted	-0.01	0.045	Unpolluted
11	Pb	0.6	0.254	Low	0.44	0.034	Low	0.98	0.358	Unpolluted to Moderate	-1.22	0.075	Unpolluted
12	Ga	0.53	0.06	Low	0.51	0.01	Low	-1.05	1.1	Unpolluted	-1.08	0.021	Unpolluted
15	Br	0.72	0.39	Low	0.85	0.259	Low	-0.84	0.423	Unpolluted	-0.6	0.321	Unpolluted
16	Rb	0.48	0.058	Low	0.47	0.115	Low	-1.14	0.126	Unpolluted	-1.17	0.026	Unpolluted
17	Sr	2	0.84	Moderate	2.59	0.592	Moderate	0.17	0.343	Unpolluted to Moderate	0.53	0.219	Unpolluted to Moderate
21	Nb	1.06	0.131	Moderate	1.05	0.011	Moderate	-0.38	0.172	Unpolluted	0.11	0.439	Unpolluted to Moderate
22	Mo	3.2	1.4	Significant	3.56	1.312	Significant	0.67	0.451	Unpolluted to Moderate	0.82	0.349	Unpolluted to Moderate
23	Ba	0.5	0.039	Low	0.49	0.042	Low	-1.1	0.076	Unpolluted	-0.4	1.265	Unpolluted

Geo-accumulation index (I-Geo)

I-geo is classified into seven grades, according to (33). Results showed that the overall pollution indexes values (I- GEO, CF, and PLI) of trace elements were consistent in Wasit Governorate (34).

Pollution indices values showed polluted surface sediments of the Tigris River by Ni due to anthropogenic activities (industrial and agricultural activities (35) while Pollution indices values (CF with PLI, and I-geo) for the Euphrates River showed it as unpolluted to moderate polluted except Ni for which ranges from moderate to very polluted due to anthropogenic activities (36)

In this study, results of I- geo- accumulation in the study area shows that the main river sediments are highly polluted with Ta and unpolluted to moderately polluted with Cd, V, Cu, Zn,Pb, Sr and Mo. I- geo river sediments are moderately polluted with Cr and Ni and unpolluted with; Mn, Co, Ga, Br,Rb,Nb and Ba. Whereas results of drainage canals discharged to the river show sediments are polluted with Ta and moderate polluted with V, Cd, Cr, Ni, Nb, Sr and Mo. Drainage canals sediment is unpolluted with Co, Zn, Pb, Ga, Br, Rb and Ba sediments are listed in Table 6. Mean CF and i- geo in the all studied samples are listed in Table 7.

Table 7. I- GEO-accumulation index (I-Geo) values of studied sediments samples.

Number	Samples Name	I-Geo																
		Cd	Ta	Mn	V	Cr	Co	Ni	Cu	Zn	pb	Ga	Br	Rb	Sr	Nb	Mo	Ba
1	1SUT	1.09	3.16	0.06	-0.01	1.25	-0.21	1.67	0.28	0.28	-1.01	-1.02	-1.18	-1.1	-0.03	-0.36	-0.10	-1.12
2	2TJT	1.09	3.13	0.05	-0.03	1.16	0.4	1.53	0.15	0.01	-1.14	-1	-1.26	-1.05	-0.11	-0.32	-0.02	-1.17
3	3AZT	1.09	3.16	0.22	0.02	1.05	0.51	1.76	0.49	0.4	-0.66	-0.88	-1	-0.96	0.08	-0.29	0.09	-1.07
4	4ShT	1.09	3.10	0.17	0.13	1.41	0.21	1.7	0.31	0.2	-0.96	-0.95	-1	-1.11	0.1	-0.27	0.57	-1.05
5	5ZDTb	1.09	3.14	0.14	0.07	1.2	0.32	1.69	0.33	0.3	-0.84	-1.01	-0.71	-1.13	-0.02	-0.20	0.72	-1.13
6	6ZDTc	1.09	3.17	-0.03	2.29	0.74	-0.65	1.44	0.14	0.15	-1.08	-1.02	-0.78	-1.11	0.46	-0.43	0.81	-1
7	7ZDTa	1.09	3.15	-0.07	0.06	1.19	0.19	1.63	0.34	0.75	-0.18	-1.1	-0.68	-1.18	0.08	-0.37	1.22	-1
8	8NMT	1.09	3.15	0.31	0.09	1.32	0.03	1.68	0.33	0.27	-0.91	-1	-0.96	-1.11	0.15	-0.26	1.27	-1.15
9	9AHT	1.09	3.16	0.1	0.17	1.2	-0.15	1.62	0.3	0.02	-1.08	-1.06	-1	-1.1	-0.03	-0.27	0.63	-1.21
10	10KT1	1.09	3.11	0.11	-0.04	0.82	-0.01	1.58	0.21	0.1	-1.02	-0.95	-1.26	-0.94	-0.05	-0.26	0.5	-1.21
11	11KT2	1.09	3.18	-0.03	-0.39	1.69	-0.31	1.39	-0.12	-0.2	-1.29	-1.2	-1.03	-1.32	0.01	-0.55	0.63	-1.18
12	12KT3	1.09	3.03	0.28	-0.07	1.72	-0.18	1.64	-0.01	-0.13	-1.32	-1.05	-1.15	-1.11	-0.01	-0.29	0.64	-1.12
13	13WaT	1.09	3.14	0.1	-0.17	1.38	0.25	1.62	0.28	0.29	-0.34	-1.09	-0.84	-1.2	0.02	-0.38	1.18	-1.06
14	14HYT	1.09	3.17	-0.38	-0.39	0.42	-1.59	1.02	-0.17	-0.19	-1.34	-1.24	0.11	-1.33	0.98	-0.76	0.53	-1
15	15SdT	1.09	3.18	-0.39	-0.35	0.39	-1.59	0.99	-0.25	-0.22	-1.46	-1.2	0.09	-1.39	0.92	-0.75	1.33	-1.02
16	16LDT	1.09	3.1	-0.08	-0.04	0.68	-0.4	1.37	0.03	-0.02	-1.31	-1.06	-0.48	-1.14	0.41	-0.4	1.21	-1.21
17	17HDT	1.09	3.2	0.08	-0.12	1.2	-0.57	1.7	0.13	-0.05	-1.19	-1.07	-0.35	-1.19	0.78	0.35	0.73	1.03
18	18AZDT	1.09	3.2	-0.09	-0.11	0.78	-0.52	1.34	0.04	0.04	-1.17	-1.1	-0.96	-1.18	0.39	0.37	0.53	-1.11

Conclusions:

Identification and quantification of trace elements sources, as well as the fate of those elements, are important environmental scientific issues. The results of this study supply valuable information around some trace elements contents of sediment from different sites along Tigris River in Wasit Governorate , and we can conclude that: the grain size analysis of the sediments from the river., its branches and drainages canals are mainly silt and clay ,where the clay constitute between 47.7-58.6%, first rank in the term of the relative distribution while silt ranges between 36.8-44.2% and sand ranges between 4.2% - 8.4% respectively .The XRD analysis showed the presence of non-clay minerals: quartz, calcite, dolomite, gypsum and feldspar (Plagioclase and Albite) with clay minerals: Kaolinite, Palygorskite, Mica, and Chlorite, in the sediment of Tigris River.

Chemical analyses of trace elements in sediments reflected the effect of anthropogenic activity on the autogenic occurrence. The mean concentration of trace elements in the study area are in the order Mn> Sr> Ba> Cr> Ni> V> Zn> Ta> Rb> Cu> Co> Pb> Ga> Mo> Nb> Br and Cd. whilst, drainages canal record in the order Mn> Sr> Ba> Cr> Ni> V> Zn> Ta> Rb> Cu> Pb> Ga> Mo> Co> Nb> Br and Cd.

Sr concentrated in the clay fraction of main river sediments is mostly as a result of substitution for Ca in CaCO3 in carbonate and clay minerals. So, high level of V in studied sediment samples of Tigris River recorded in the Al Zubaydia and Al Numaniya stations, this relative increase is due to fuel combustion from the Wasit Thermal Power plant which is located on the Tigris River bank in the Zubaidia district. Some of trace elements come from fertilizers to the agricultural activates such as Mo, Zn and Mn. High level content of Ta, Ba and Nb in studied sediments samples as a result of autogenic source. Trace elements of drainages canal sediments were lower than the Tigris River but Mo, V, pb, Ga and Sr higher than main river, this refers to chemical fertilize are used in agricultural activity and sewage pipes, also the main river differs from drainages canals that discharged to it in load energy, speed of water as well as anthropogenic pollutants discharged from industrial, domestic such as Cd and agricultural wastewater into river water system.

Pollution guide values (CF with PLI, and I-geo) indicated unpolluted to moderate polluted river sediments, its branches and drainages by approximately all studied elements except Ta, Ni, Cr and Cd which is ranging from very high polluted to considerable to moderate. Generally, this is due to anthropogenic activities (sewage sludge, municipal wastes and agricultural activities). A number of heavy metals are concentrated in the sediments as natural source in clay, heavy minerals and perhaps will be incorporated into carbonate minerals. The different contaminants come from discharged by sewage and sludge deposits, which are discharged to Tigris River without any treatment, specially the trace elements Zn, Cr, Ni, Cd and Cu.

Conflicts of Interest: None.

References:

1. Khatri N, Tyagi S. Influences of natural and anthropogenic factors on surface and groundwater quality in rural and urban areas. Frontiers in Life Science. 2015 Jan 2;8(1):23-39.
2. Ministry of Environment. A Study on the impact of water scarcity on the quality of water resources in Wasit governorate) unpublished internal report for Improvement the Environment in the Southern Region of Wasit Environment, 2016
3. ESCWA-BGR Cooperation. Inventory of Shared Water Resources in Western Asia (Online Version). 2013; Chapter 4: Shared Tributaries of the Tigris River. Beirut
4. Adebowale KO, Agunbiade FO, Olu-Owolabi BI. Trace metal concentrations, site variations and partitioning pattern in water and bottom sediments from coastal area: a case study of Ondo coast, Nigeria. Environ.Res. J. 2009, 3 (2): 46-59.
5. Singh VK, Singh KP, Mohan D. Status of heavy metals in water and bed sediments of river Gomti – A tributary of the Ganga river, India, UNECE J. 2005; 105: 43−67.
6. Al- Hejuje M M, Al-Saad HT, Hussain NA. Application of geo-accumulation index (I-geo) for assessment the sediments contamination with heavy metals at Shatt Al-Arab River-Iraq. Scientific and Engineering Research J. 2018; 5(2):342-351
7. Shadher D K, Shinan S R, Jassim M K, Amed M K. Geological study of Wasit governorate and its economic resources. State company of geological survey and mining (Geosurv) department of regional bureaus. 2009; 35p
8. Aqrawi AM, Goff J C, Horbury AD, Sadooni FN. The Petroleum Geology of Iraq.1st ed., scientific press, UK. 2010; 424P.
9. Buday T, Jassim S Z. The Regional Geology of Iraq Geo. Surv. and Minr. Invest. Baghdad, Iraq, 1980; 1: 445p
10. Varoujan k. Sissakian, Fouad S. Geological Map of Iraq, Scale 1:1 1000000, 2016, GEOSURV.
11. Iraqi Meteorological Organization and Seismology (I.M.O.S). Department of Climate, Al Kut, Al Aziziya, Al Hayy and Badrah Stations Data, Unpub. Statistical Reports, Baghdad. 2017; 1994-2017
12. Agyarko K, Dartey E, Kuffour RA, Sarkodie PA. Assessment of Trace Elements Levels in Sediment and Water in Some Artisanal and Small-Scale Mining (ASM) Localities in Ghana. Current World Environment. 2014; 9(1): 07-16
13. Folk, RL. Petrology Sedimentary rocks. Hamphil pub. Co. Austin. 1974; 182 pp.
14. Kabata-Pendias A, Mukherjee AB. Trace Elements from Soil to Human. Springer- Verlag Berlin Heidelberg. 2007; 561pp.
15. Owens PN, Collins AJ. Soil Erosion and Sediment Redistribution in River Catchments: Measurement, Modelling and Management. CABI Publishers, Wallingford, UK. 2005.
16. Abboud, IA. Quaternary Palaeoenvironment, Palaeoclimate, and Palaeohydrology of Wadi Muqat Basin, Al-Badia, NE-Jordan. Ph. D. Thesis, Baghdad University 1999; 149p.
17. Mandzhieva S, Minkina T, Pinskiy D, Bauer T, Sushkova S. The role of soil's particle-size fractions in the adsorption of heavy metals. Eurasian Soil Science J .2014; 3: 197 - 205

18. Al-Bassam K. Pollution impact and Pollution sources in the Euphrates River Environment. Study on sources of pollution in the water of the Euphrates River. The national program for the optimal use of water resources in the Euphrates River basin. 1980
19. Hassan RAA. The Impact of Al Ahdeb Oil Field on the Environment Pollution in Al- Ahrar District, Wasit Governorate, Iraq. M. Sc. Thesis. College of Science, University of Baghdad, Iraq 2018
20. Tucker ME. Sedimentary petrology, an introduction to origin of sedimentary rocks, 2nd ed. Black Well Scientific Lid. 1991; 560 P.
21. Millot G. Geology of Clays. Chapman & Hall, London. 1970; 429pp
22. Maiws SU. Assessment of Dujaila River Water and Its Relationship with the Agricultural Soils of Dujaila Project Wasit Governorate - Central of Iraq. M. Sc. Thesis. College of Science, University of Baghdad, Iraq 2016.
23. Al-Jaberi MHA, Al-Dabbas MA. Assessment of Heavy Metals Pollution in the Sediments of Iraqi Coastlines IJSR - International Scientific Research J. 2014; 3
24. Akesh AA. Analytical Study for Heavy Metals Pollution in Surface Water and Sediment for Selected Rivers of Basrah Governorate Kufa of Engineering J. 2017; 8 (2), 105-118
25. Al-Gburi HFA, Al-Tawash BS, Al-Lafta, HS. Environmental assessment of Al-Hammar Marsh, Southern Iraq. Heliyon J. 2017; 3 (e00256)
26. Al Saady YII. Environmental impact assessment of land use on lesser Zab River basin, north east of Iraq. PH.D. Thesis. College of Science, University of Baghdad, Iraq 2016.
27. Kabata-Pendias A, Pendias H. Trace elements in soils and plants, Third Edition, CRC Press, Boca Raton, FL. 2001
28. Al- Bassam KS, yousif MA. Geochemical and background values of some minor and trace elements in Iraqi soils and recent sediments. Iraqi Bulletin of Geology and mining J. 2014; 10 (2) : 109-156
29. Abed MF. Altawash BS, Ali SM. Environmental Assessment of Trace Elements Concentration and Distribution in Surface Soils at North Baiji City Iraqi J. of Science, 2015; 56(4B): 3176-3187
30. Gong Q, Deng J, Xiang Y, Wang Q, Yang L. Calculating pollution indices by heavy metals in ecological geochemistry assessment and a case study in parks of Beijing. J. Chin. Univ. Geosci.2008; 19 (3), 230–241.
31. Harikumar PS, Jisha TS. Distribution pattern of trace metal pollutants in the sediments of an urban wetland in the Southwest Coast of India. Int. J. Eng. Sci. Technol. 2010; 2 (5):840–850. variations and partitioning pattern in water and bottom sediments from coastal area: A case study
32. Debowale KO, Agunbide FO, Olu-Owolabi B. Trace metal concentration, site variations and partitioning pattern in water and bottom sediments from coastal area: A case study of Ondo Coast, Nigeria, Environ Res Public Health J. 2006; 3(2), pp: 46-59.
33. Buccolieri A, Buccolieri G, Cardellicchio N. Heavy metals in marine sediments of Taranto Gulf, Ionian Sea, Southern Italy. 2006; 99: 227–235.
34. Alftlawii LASA. Effect of Sedimentation Source on Mineralogical Characteristics and Heavy Metal for Some Soils of Wasit and Maysan Provinces. PH.d theses Agriculture at the University of Baghdad 2016.
35. Abed MF. Environmental Risk Assessment of Industrial District, Baiji Area. PH.d. Thesis. College of Science, University of Baghdad, Iraq 2016.
36. Qanbar AS. Environmental Geochemistry of Euphrates River from Al-Hindiya Barrage to Al-Nasiriya City, South Iraq MS.c. Thesis. College of Science, University of Baghdad, Iraq 2016.

تقييم تلوث بعض العناصر النزرة في رواسب نهر دجلة في محافظة واسط ، العراق

مرتضى جار عيسى [1] باسم شاكر العبيدي [2] رؤى عيسى مسلم [3]

[1] قسم الجيولوجي ، كلية العلوم ، جامعة بغداد، بغداد، العراق.
[2] قسم علوم التربه والمياة، كلية الزراعة ، جامعة تكريت، العراق.
[3] قسم الكيمياء، كلية العلوم، جامعة واسط، العراق.

الخلاصة:

تهدف الدراسه الحاليه بصوره الرئيسيه الى تقييم التلوث بالعناصر الثقيلة (Mn, Sr, Ba, Cr, Ni, V, Zn, Ta, Rb, Cu, Co, Pb, Ga, Mo, Nb, Br, Cd) ودراسه الجيوكيمياء في رواسب نهر دجله في محافظه واسط، / العراق . درست هذه العناصر بالاضافه جيوكيمياء الرواسب المتضمنة المعادن للرسوبيات لثمانية عشر عينه حيث تمت النمذجة في اذار 2017. تم دراسة تقييم تلوث المعادن الثقيلة باستخدام مؤشر جيو –التراكم الارضي (I-geo) ، عامل التلوث (CF) ومؤشر حمل التلوث (PLI) ، حيث تم تطبيق I-geo على نطاق واسع كمقياس للتلوث في منطقة عينات الرواسب. دليل لتراكم الجيولوجي قد طبق بشكل واسع كمقياس لدرجه التلوث في ترسبات نهر دجلة بينما دليل حمل التلوث يمثل عدد المرات التي خرجت بها العناصر الثقيلة الحد المسموح بها وتشير الى التلوث الكلي في النموذج المعين في المنطقة الواحدة بالعناصر الثقيلة للدراسة الحالية. نتائج العوامل الاحصائية للرواسب بينت ان ترسبات نهر دجله وللبزول المجاورة له التي تصب بالنهر هي ملوثه بالعناصر Cr, Cd, Mo, Ta, Ni, بشكل عالي ، وبشكل متوسط لكل من Co, Sr, Cu, Mn, V, Nb, وهي غير ملوثه بالفلزات Pb, Br, Ba, Ga, Rb, Zn . مستوى تراكيز العناصر النادرة في رواسب البزول التي تصب بنهر دجلة كانت اعلى مما هو عليه رواسب النهر في كل من Ta, V, Ni, Cu, Ga, Br, Sr , Mo.

الكلمات المفتاحيه: تلوث، معامل التلوث، معدنية، دليل حمل التلوث، العناصر النادرة.