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ARTICLE REVIEW
EMPLOYMENT OF TRACE ELEMENTS IN THE ENVIRONMENTAL GEOCHEMISTRY STUDIES TO ASSESS THE POLLUTION FOR SELECTED AREAS IN IRAQ

Ruaa I. Muslim[1], Sattar O. Al-Mayyahi[2] and Najah A. Al_Ghasham[3]

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ABSTRACT

An environmental geochemistry review was carried out for selected areas of Iraq. This review highlights the importance of the presence of toxic trace elements as indicators of environmental pollution in soil, sediment, water, and air. The most important results of previous studies, 20 years ago, were discussed for the content of toxic trace elements (Cu, Zn, Co, Ni, Pb, Cr, and Cd) for water and sediments soil pollution, and the last 10 years of air pollution for the same elements. This article is concluded that sediments and soils have relatively more contamination with trace elements than water. This is due to the fact that the soils had cumulative pollution over a long time and it was adsorbed on clays and organic materials.

Likewise, trace elements are concentrated with heavy minerals' chemical formulas. Maximum concentrations in recorded studies of Cr (570 ppm). This was recorded in 2015 in the sediments of Al-Hammar Marsh. Soils of the capital, Baghdad, are contaminated with Zn (133.3 ppm), Co (30.7 ppm), and Pb (153.7) as a result of urban activities and authigenic the presence of clay minerals and organic matter. Iraqi agricultural soils are polluted with a high concentration of Ni and Cu, and this confirmed the highest percentage of Ni (193.4 ppm) in the Al-Mishkhab soils in the Najaf area as well as Cu (51.8 ppm) in Ishaqi farms. The Kirkuk Oil Refinery was a source of soil pollution with Cd with a concentration of (12.6 ppm) concentrations relative to other areas due to combustion products. The review revealed that Al-Hammar Marsh water symbolizes the most dangerous environmental pollution with studied trace elements Cu (38.4 ppm), Zn (233 ppm), Co (4.7 ppm), Ni (37.6), Pb (36 ppm), Cr (31 ppm), Cd (0.7 ppm and As (15 ppm). This is attributed to unsuitable human customs and oil waste in southern Iraq. The Baiji Industrial district has the maximum air pollution among the other industrial activity areas in Iraq. It is very evident in the high concentration of Cd (62.2 µg/m3).

[1, 2, 3] Department of Geology, College of Science, University of Wasit, Iraq,
e. mail: ralqurashy@uowasit.edu.iq, sobaid@uowasit.edu.iq, nauaiz@uowasit.edu.iq

مراجعة مصادر

توظيف العناصر النزرة في الدراسات الجيوكيميائية البيئية لتقييم التلوث لمناطق مختارة من العراق

رؤى عيسى مسلم، ستار عبيد مايوس المياحي، نجاح علوان عويز

الكلمات المفتاحية: الجيوكيمياء البيئية؛ العناصر النزرة؛ تقييم التلوث؛ العراق

المستخلص

تم إجراء مراجعة جيوكيميائية بيئية لمناطق مختارة من العراق من خلال توظيف العناصر النزرة في تقييم التلوث الناتج عن الأنشطة الحضرية المختلفة. تسلط هذه المراجعة الضوء على أهمية وجود العناصر النزرة السامة كمؤشرات للتلوث البيئي في التربة والرواسب والمياه والهواء. تم مناقشة أهم نتائج الدراسات السابقة، في الـ 20 سنة الماضية، لمحتوى العناصر النزرة السامة (Cd ،Cr ،Pb ،Ni ،Co ،Zn ،Cu) وتسببها في تلوث المياه والتربة، وآخر 10 سنوات من تلوث الهواء لنفس العناصر. استنتجت المقالة إلى أن الرواسب والتربة معرضة لخطر التلوث بالعناصر النزرة أكثر نسبيًا من الماء ويرجع ذلك إلى حقيقة أن التربة لديها تلوث تراكمي على مدى فترة طويلة وأنها تمتز وتمتص الملوثات في الاطيان أو المواد العضوية.

تحتوي المعادن الثقيلة أيضًا على عناصر ضئيلة في تركيبها الكيميائي. كانت التركيزات القصوى في الدراسات القياسية لـ Crهي (570جزء في المليون) في المرتبة الرئيسية. تم تسجيل ذلك في عام 2015 في رواسب هور الحمار. تلوثت تربة العاصمة بغداد بالزنك (133.3 جزء في المليون) والكوبلت (30.7 جزء في المليون) والرصاص (153.7 جزء في المليون) نتيجة للأنشطة الحضرية وارتفاع نسبة السكان بالإضافة إلى مصادرها الأصلية من المعادن الطينية والعضوية. المواد. تحتوي التربة الزراعية العراقية على تركيز عالٍ ملوث بالنيكل والنحاس، وهذا يؤكد أعلى نسبة من النيكل (193.4 جزء في المليون) في تربة المشخاب في منطقة النجف وكذلك النحاس (51.8 جزء في المليون) في مزارع الاسحاقي. كانت مصفاة نفط كركوك مصدرا لتلوث التربة وتركيزات الكادميوم العالية (12.6 جزء في المليون) مقارنة بالمناطق الأخرى كمنتجات احتراق. كشفت الدراسة؛ أن مياه هور الحمار تشير إلى أخطر تلوث بيئي بالعناصر النزرة المدروسة نحاس (38.4 جزء في المليون)، زنك (233 جزء في المليون)، كوبلت (4.7 جزء في المليون)، نيكل (37.6) رصاص (36 جزء في المليون)، كروم (31 جزء في المليون)، كادميوم (0.7 جزء في المليون)، الزرنيخ (15 جزء في المليون). ويعزى ذلك إلى العادات البشرية غير الملائمة ونفايات النفط في جنوب العراق. منطقة بيجي الصناعية هي أقصى تلوث للهواء من بين مناطق الأنشطة الصناعية الأخرى في العراق. يتضح هذا في التركيز العالي لـ Cd (62.2 μg/m3) مع أقصى محتوى بالإضافة إلى العناصر النزرة الأخرى (Cr وCd وPb وCu).

INTRODUCTION

Trace elements limited and restricted presence on the surface of Minerals and organic matter or within the crystal lattice of other minerals. Thus, they are considered as an environmental geochemical indicator and a strong scientific proof of the natural geochemical presence and for the pollution. The geochemistry of trace elements has proved extremely useful in gaining a better knowledge of the earth's evolution (William, 2009). Geochemically, a trace element is any concentration less than 1000 ppm or 0.1% of the composition of the rocks. In crystalline structures, trace elements can be used to replace network-forming cations. The origin of trace elements in surface and groundwater in addition to the atmosphere, and anthropogenic sources stemming from human activities for instance industrial production and agriculture (William, 2009).

A trace element is an element in a sample with an average absorption of less than 100 ppm measured in the atomic count. Trace elements are absorbed and therefore restrained in the sediments, organizing a potential risk to water-type presence as they can be liberated by the effect of physical-chemical changes. Mining of coal and mineral ores, as well as manufacturing and municipal waste streams, are the principal anthropogenic sources of trace elements in waterways and sediments. The construction of lithophile elements is such that they can be exhibited, bonding is predominantly ionic. The geochemical activities of lithophile trace elements are ruled via replacement with other ions (William, 2009). Principally recognized to absorb positions of soil atoms moreover also to the source cell the surface along with source exudates, biogeochemical obtainability, and bioavailability (Wolt, 1994). Biological substances as well are acting an important part in the sorption of trace elements. Water shows essential purposes in developments together geochemical in addition to biochemical. It is besides a leading carrier for every chemical element; It also quantifies chemical composition that controls element cycling in water-air-soil systems (Smith and Huyck, 1999). Accordingly, water is possibly the supreme intentional standard that managed the formulae of trace elements, which explored Cr; Se, Cu, As, Pb, Cd, and Hg must be considered in the record regularly (Das *et al*., 2001). Approximately 99% of fresh water, presented groundwater that is the main basis of household waste, industrialized, as well as an agricultural water resource (Bhattacharya and Mukherjee, 2002).

There are approximately ninety-two elements that occur naturally on earth. In the alive human body, 11 of these elements are instituted in greater than trace amounts. Any amount of 0.01% or less is considered trace elements found in very small amounts in vital tissues and body liquids. Although it is rare, however, it plays a significant character in dynamic purposes. The foundation of all these trace elements is the earth with its mineral composition, rocks, and water. The cycle of the elements in nature plays a major role in the restoration of the distribution of these elements in different geological derivations, and the biosphere of the earth is meant by plants. Animals are one of the stores of organic materials interacting. The human body obtains these elements in altered methods, but then its main origin is the land (Awadh, 2016). Later human healthiness is related to definite concentrations of each element within the human body, so from here emerges the role of medical geochemistry and its role in physiotherapy and maintaining public health (Awadh, 2016). So, the article review aims to explain the environmental geochemical uses of trace elements in pollution assessment in selected areas of Iraq.

METHODOLOGY

- **Fieldwork and Sampling analyses**

There is no fieldwork done by the authors of this article, however, all of the previous studies in this article used a trip to collect the samples. Exploration is concentrated on studying the geological viewpoint, mainly lithostratigraphy, in addition to hydrological conditions to enable the task of understanding the environmental geochemistry of the study area. Water samples were collected in plastic bottles. Sediment or soil samples were labeled and placed in the bag for preparation for examination in the laboratory. Air samples were collected by low volume air sampler or what is mostly known as the (Sniffer) which collects the suspended particles in the air. Concerning the previous studies and research selected in this resource review, analytical methods as well as the title of laboratories for trace element detection in water, soil and sediment, and air are recorded in Table 1.

Table 1: Methods of analysis of the water, soil or sediment and air analyses studied samples of previous studies

Researchers	Year	Analysis of soils or sediments
Al-Maliky	2005	Chemical analyses samples laboratories center of the Iraqi Geological Survey
Salman	2007	Chemical analyses of 5 grams of sample laboratories center of the Iraqi Geological Survey
Ali	2012	Atomic Absorption Spectrometry (AAS 240 FS Varian).
Ali	2013	Atomic Absorption Spectrometer (AAS) of an American origin
Al-Bassam & Yousif	2014	Atomic Absorption Spectrometry (AAS 240 FS Varian).
Al-Obaidy *et al.*	2014	Atomic Absorption Spectrometry (AAS 240 FS Varian).
Abdullah	2015	ALS global lab. Group by ICP-MS in Spain
Abed	2015	ICP-MS at acmelabs/Vancouver/Canada
Al Saady	2016	ICP-MS at the analytical lab. of Freiberg university – Germany (Jenner, 1996)
Qanbar	2016	Atomic Emission Spectrometry (ICP-AES).
Al-Hamdani	2017	Inductively Coupled Plasma Mass Spectroscopy (ICP-MS)
Hassan	2018	XRF Device in the German- Iraq laboratory in the Geology Department/ University of Baghdad
Hussein	2018	Inductively Coupled Plasma Mass Spectrometry (ICP-MS) in ALS Global laboratory group in Spain
Al-Quraishi	2019	In Iraq German Lab, spectra Germany 2010 By XRF technique (Potts *et al.*, 1990).
Al-Dabbas & Abdullah	2020	XRF examination by a SPECTRO XPOS tool (manufactured in Germany) in the XRF lab./ Department of Geology, University of Baghdad.
Al-Rubaiee & Al-Owaidi	2022	XRF examination by a SPECTRO XPOS tool (manufactured in Germany) in the XRF laboratory at the Department of Geology, University of Baghdad.
Researchers	**Year**	**Water**
Salman	2007	Titration with HCl of concentrated (5 ml) of concentrated HNO3.
Abdullah	2010	Titration with HCl of concentrated (5 ml) of concentrated HNO3.
Ahmed	2011	Inductively Coupled Plasma Mass Spectroscopy (ICP-MS in the Open University of Germany
Ali	2012	Inductively Coupled Plasma Mass Spectroscopy (ICP-MS) at hydrogeology lab. /Freiberg Univ. Germany.
Al-Quraishi	2013	Atomic-absorption spectrometer Ministry of Industry and Minerals, IBN SINA State Company
Al-Paruany	2013	Atomic Absorption spectrometer Lab. of Water Treatment Tech. at the Ministry of Science and Technology.
Abed	2015	Inductively Coupled Plasma Mass Spectroscopy (ICP-MS/ ICP-ES) at AcmeLab/Canada.
Abdullah	2015	X-Ray Fluorescence (XRF) device, sample sieved in 2mm grain size
Al-Mayyahi	2016	Atomic Absorption spectrometer Lab. of Water Treatment Tech. at the Ministry of Science and Technology.
Al Saady	2016	Inductively Coupled Plasma Mass Spectroscopy (21CP-MS) Themo Scientific Elements XSERIES
Al-Hamdani,	2017	Inductively Coupled Plasma Mass Spectroscopy (21CP-MS) Themo Scientific Elements XSERIES
Hassan	2018	XRF technique in the German- Iraq laboratory in the Geology Department / University of Baghdad
Abdullah & Al-Mashaikie	2018	
Al-Quraishi	2019	Atomic Emission Spectrometry (ICP-AES)/ Organic Chemist ALS Arabia Kuwait
Hashim	2021	Phenanthroline Spectrophotometric Koufa Office for scientific rehabilitation services

Continue Table 1:

Researchers	Year	Air
Abdul Sattar	2013	Atomic Absorption Spectrophotometer
Mohamed	2016	ALS Global laboratory group by Inductively Coupled Plasma Mass Spectrometer (ICP-MS).
Ali	2013	Atomic Absorption Spectrophotometer at the Ministry of Science Technology
Abed	2015	
Shaker	2019	
Hassan	2018	

RESULTS AND DISCUSSION OF THE GEOCHEMICAL ENVIRONMENTAL ASSESSMENT

Trace elements can substitute the main elements in the mineral that are similar to the geochemical affinity. They are an indicator for the assessment of the environmental pollution of soil, water, and air as a result of many urban, industrial, agricultural and residential activities.

To achieve the goal of this review article, the role of trace elements was discussed and explained in the selected previous studies in the geochemistry of different selected areas in Iraq. Therefore, in this article, this study will discuss the most important previous studies and the exact role of the trace elements that contribute and support to reaching accurate scientific conclusions. This evaluates and estimates the trace elements that are indicative of environmental pollution in sediments and soils, water, and air. These include the following:

- **Soil and sediment pollution assessments**

A positive relationship between Cr besides the fine granulometric particles in sediments has caused a high Cr content in silty plus loamy sediments than in sandy ones (Kabata-Pendias, 2001). Cr in sediment is associated primarily with the clay content, then to a smaller amount with Fe hydroxides as well as the organic materials (Kyziol, 2002). Anthropogenic Zn in agricultural deposits; possibly will originate from many other sources such as atmospheric deposition, fertilizers, pesticides, sewage sludge, and waste changes dependent upon its chemical type and the affinity of sediment and sediment features (Kabata-Pendias *et al.*, 1992). Cobalt is present in the three forms of rocks of the earth's crust (Aubert and Pinta, 1977). Cobalt is present in the clays by way of as a result of replacing Mg^{2+} in the crystalline structure of the clay minerals due to similarities in their radius as well as electric charge (Nicholls and Loring 1962). Nickel is considered through an extensive change in several sediments, its absorption depends on the richness of clay minerals, organic material, aluminum as well as iron hydroxides (Aubert and Pinta, 1977). Its content in surface sediments reproduces the additional influence of composed sediment-forming processes and pollution (Kabata-Pendias and Mukherjee, 2007). Nickel in sediments is slightly mobile and occurs mainly in the residual fraction, in over 50% of its total contents in loamy, sandy sediment, and in about 70% of its rate in estuary muck (Zhuang *et al.*, 2014). Cd is one of the maximum ecotoxic metals that exhibits adverse belongings in all biological manners (humans, animals, and plants) (Kabata-Pendias and Mukherjee 2007).

Precipitation of Cd may occur at high Cd^{2+} activities under alkaline conditions (pH >7.0) under anaerobic conditions, the Cd in sediment solution is governed by sulfide precipitation (Kabata-Pendias and Mukherjee, 2007). Lead is one of four metals that have the most damaging effects on human health. It can enter the human body through the acceptance of food 65%, water 20%, besides air 15% (Waaren and Haack, 2001).

Uses the trace elements as a presentation of natural background standards for approximately 70% of Iraq's soil and sediments. Soils and sediments were investigated by the Iraqi Geological Survey team, in the western desert and the Mesopotamian plain for selected elements such as Cu, Pb, Zn, U, Cr, Ni, and V were statistically preserved in this study. Then, acceptable background values were extracted for these terrains that characterize nearly 70% of the area within Iraq. The values of the analyses are evaluated by exploring soils in other parts of Iraq (Al-Bassam and Yousif, 2014).

Pollution index values exposed (EC, IGEO, CF) polluted surface soil and river sediments via Se, Ni, and As due to human activities (industrial plus agricultural activities) (Abed, 2015). It was emphasized that the noticed concentrated adsorption of definite elements on the surface soils was attributable to the ordinary causes in the clays and heavy minerals initiated from the carbonates. These elements could assignment to mineral construction of the surface soils from anthropogenic urban wastelands, unindustrialized in addition to industrial actions (Amana *et al*., 2021).

Baghdad soils have positive anomalous content of Pb, Zn, Co, Cu, and Sr, then negative anomalous of Mn, Cr, and Ni, which were observed in the city on both sides. Rasafa side is an additional complex caused by high population density and dispersion of numerous human activities. Trace element concentrations of Tigris River display no abnormal concentration except for Br. It has raised concentration values as associated with the natural water parameters (Ali, 2012). After this study in the same area, trace elements were used as an indicator for their sources. The level of trace elements concentrations and sediment quality in the Tigris River and to define the natural and anthropogenic response of trace elements and pay attention to relationships amongst these elements and pollution in the Baghdad area (Al-Obaidy *et al*., 2014).

Cr, Mn, Ni, Cu, Zn, As, Zr, and Pb at industrial and residential areas in Hilla city, depending on the Pollution Load Index results, high is recorded for the mean of Ni, Zn, Pb, while the Cr, Cu, and As indicate major to moderate. Mn and Zr are considerably low concentrations in the mean values in the industrial area. In comparison, Ni and As were of high contamination. Cr, Zn, and Pb reported moderate contamination, but the Mn, Cu, and Zr elements are of low contamination values in the residential area. The main concentration trace elements in the studied area are Cr, Cu, Ni, As, Zn, and Pb; the lithological source or various anthropogenic origins may be the significant sources of these (Al-Rubaiee and Al- Owaidi, 2022).

In the middle of Mesopotamia, in the Al-Ahrar district at the Al-Ahdab oil field, west of the Kut region; trace elements concentrations, such as Zn, Cr, Ni, Cu, Co, Pb, and V in the studied samples of soil have height concentration for Cd, Cr, Pb, Ni in the air of the study area have an elevation concentration, which is exceeded the permissible limits (Hassan, 2018). The concentration of trace elements in the surface soils of Kut city was Pb, Ni, Zn, and Cd in descending order, and their averages in the main soils of the roads Zn, Ni, Pb, and Cd decreased in order (Jabbar, 2011). The concentration of Pb, Cd, and Ni have significant quantities, while an average decrease in the concentration of Cr in the soil in Maysan Governorate. This is through the relative correlation between the natural aspects of mineralogy, the role of pH, grain size, and organic matter, and the intensification of their concentration. The abundance of trace elements in the soil can be attributed to the main pollution factor coming later from human activities. Elevation in the concentration of Pb, Cd, Ni, and Cr was in industrial areas (Essmael, 2010). In Agricultural soils, it appeared very clear, that these soils are affected by using fertilizers from agricultural activities. Cu and Ni are concentrated in surface soil more than the sub-surface soils for the accumulation of these elements faster from the leaching process to the sub-surface soil depths. Co and Mn tend to transport in the case of sufficient water quantities in founding surface soil. Industrial soils detected the high-level concentration of Mo and V at Al Zubaydia sub-district is related to fuel combustion of Thermal Power Plants as product industrial wastes, Pb at Al-Kut district near bricks factories, Ga in Aziziya Station (Al-Quraishi, 2019).

At Al-Mishkhab rice agricultural fields in Al-Najaf Governorate – South West Iraq, all trace elements in cultivated soil are higher than those in uncultivated soil, except; As and Cr, which are a smaller amount, as a result of the consumption of fertilizers in cultivated soil and due to the behavior of trace elements in soil and plant. Chromium is very slightly soluble in soil solutions and not easily absorbed by plants, As, is comparatively strongly absorbed by the soil constituent part and certainly not ready transported to aboveground parts of the plants. The descending order of Cu, Pb, and Zn concentration in paddy crops was rooting > rice > stem, excepting Sb the concentration arranged is stem > root > rice (Hussein, 2018).

The North of Baghdad, the capital city of Iraq at Salah Al-Dean Governorate, Ishaqi area, trace elements points for soil pollution valuation in the study area. In surface soils, because of the relatively high percentages of clay pollution in the research region Co, Zn, Cu, and Pb can be found. Also, contamination with these trace elements is believed to be owing to altered sources, such as urban wilds and fertilizers. It is indistinct that the impurities affected the area soil that have comparatively high clay content (Al-Dabbas and Abdullah, 2020). In Kirkuk, Iraq, Ali, 2013 showed and clarified, that fuel combustion and oil operations affect the environmental elements in the air, water, and soil. This pollution consists of the environmental elements rich activates to create a serious question that requires a rapid solution. After a period of time, Al-Hamdani (2017) concluded from his study of the same area, that trace element parameters are used as indicators of urban environmental geochemistry in Kirkuk city. This study determined major and minor ions and heavy metals for 90 samples of urban soils with different soil kinds. Industrial soil was of high pollution level, lower pollution level was controlled in the open and green spaces. Al-Hammar marsh origin is from which the sediments were derived and is described by the majority of mechanical weathering processes in addition to the climate of the area being dry to semi-arid (Khaleel *et al*., 2022).

The concentrations and data for chemical analyzes were selected and tabulated (Table 2) from environmental geochemical studies over closely twenty years. Overall; the concentrations of trace elements in soils and sediments are the highest in relation to their concentrations in water.

The concentrations of trace elements in soils and sediments depend on weathering on the parent and transported rocks, especially, from the north and northeastern Iraq towards the Mesopotamian basin. That is, the presence of the trace element is governed by the background, environment, and geochemical affinity of the element and its mobility, then its substitutions geochemistry within minerals.

The maximum concentrations in most studies of chromium were in the first grade, which recorded its highest concentration in March 2015 in the sediments of Al-Hammar March (570 ppm). It is produced from residues of the oil industry from the Rumaila oil field as well as urban activity.

Nikel followed in the relative abundance; where the highest concentrations were recorded in the soils of the city of Najaf in 2018 in the city of Mashkhab in the rice farms (193.4 ppm), where the area of the agricultural soil. Zinc was concentrated at the highest concentration in Baghdad in 2005, which is concentrated in soils agricultural. Zn produces also from urban activities (133.3 ppm). The elevation of Cd concentrations was documented in 2013 in the soils of the Kirkuk Oil Refinery (12.6 ppm) as a product of fuel combustion, as it causes an increase in its content in the atmosphere and then deposited on the soil. Cd is also produced from industrial wastes.

Table 2: Recognized hazard trace elements concentration in soils and sediments samples (in ppm)

Researcher **	year	Study area	Cu	Zn	Co	Ni	Pb	Cr	Cd
Al-Maliki	2005	Baghdad area soil	19.5	133.3	27.5	111	153.7	113	5.25
Salman	2007	Basrah area soil	18.2	---	18.8	20.5	38.8	155	5.8
Ali	2012	Baghdad area soil	29	116.4	30.7	136	66.8	250	1
Ali	2013	Kirkuk area soil	8.06	---	---	32.4	5.7	56.6	12.6
Al-Bassam & Yousif	2014	Mesopotamia plain deposit	15	55	---	83	5	180	---
Al-Obaidy *et al.*	2014	Tigris River sediments/ Baghdad area	35.7	123	---	45	35	37.3	0.6
Abdullah	2015	Al Hammar marsh sediments	34.8	75.4	18.7	166.7	11.6	570	0.12
Abed	2015	Baiji Area soil	39.8	86.8	19.5	154	14	208	0.25
Al Saady	2016	Zab river basin	17.7	36.1	12	71.9	5.4	---	0.1
Qanbar	2016	Euphrates sediments/ AlHindiya / AlNasiriya area	27.2	60.5	20.3	158	8.8	82.4	0.2
Al-Hamdani	2017	Kirkuk city soil	19	52	11	96	11	115	0.17
Hassan	2018	AlAhdab oil field/ AlAhrar district/ kut	36.6	80.8	22.5	179.2	10.9	209.5	---
Hussein	2018	Al- Najaf soil	49.2	73.8	23.2	193.4	13.34	109.9	0.26
Al-Quraishi	2019	Wasit soil	39.5	93.5	12.1	161.7	18.2	278	2.1
Al-Dabbas & Abdullah	2020	Ishaqi soil , Salah AlDean area	51.8	114.9	18.8	---	19.8	---	----
Al-Rubaiee & Al-Owaidi	2022	Hilla area soil	3.93	5.6	---	6.45	11.4	3.43	---

* Red color represents the highest concentrations of trace elements, ** Previous geochemical studies

Soils in Baghdad; were the strong indicator of Pb and Co pollution, where in 2005 the highest concentration of Pb was recorded at 153.7 ppm. An intensification in the lead content in parts of the center of Baghdad, being commercial and residential areas that are crowded with population activity.

Seven years later, in 2012, Co recorded the maximum content in Baghdad soil, with a concentration of 30.7 ppm as a result of its release of clay minerals and organic materials in addition to urban activities (Ali, 2012). Recently in 2020, Ishaqi farms, north of Baghdad, recorded a high concentration of Cu contamination (51.8 ppm). Cu here is produced from the weathering of clay minerals and the addition of chemical fertilizers used in agricultural activity in the area (Al-Dabbas and Abdullah, 2020).

- **Water pollution assessments**

This review will consider the most important references that have studied toxic trace elements for the purpose of evaluating pollution and making a comparison between the distribution of the highest concentration of these elements over time in the water, starting from the capital city of Iraq, Baghdad, and selected areas from different parts of Iraq. The three most pollutants in water are lead, cadmium, and mercury. In addition to nickel, copper, and cobalt, this study highlights the most important studies in Iraq that employed these elements to assess environmental pollution in surface and groundwater.

In Baghdad, trace elements were used as indicators for assessments of the hydrogeological and environmental conditions of the area. Geochemical concentrations of trace elements examination waters samples in bottled are less than those in tap water exclusively of B and Pb content values (Ali, 2012). Arsenic concentration illustrations rate located between contaminated and uncontaminated rank, which perhaps originates from compensations of tap besides wastewater networks and gave a good indication of the present state of metal contamination of testing water, which is at very low levels (Abdullah and Al-Mashaikie, 2018). By the side of the industrial District, Baji Area Mean concentrations of trace elements, Al, As, Ba, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Sb, Se, Ti, Zn, and U in Tigris River except for Br, which is much higher than WHO (Abed, 2015). The trace elements analysis results in groundwater confirm that groundwater is polluted with some elements for the reason that their content values are higher than the acceptable limits consistent with local and international standards (Hashim, 2021). Trace element content as well as other water quality characters display important spatial and seasonal variability. Sewages increasingly use pesticides, as well as different kinds of additional containments, which have been released from urban lands and agricultures areas of the lesser Zab river basin, northeast of Iraq basins (Al Saady, 2016).

Trace elements Zn, Pb, Cu, Cd, Ni, Co, As, Fe, Mn, Sr, and B have concentrations in Lake Sawa water that are higher than their concentrations in seawater, particularly boron, which is present there at a very high concentration (167 ppm), which is 37.5 times higher than the B in seawater (Al-Quraishi, 2013). Arsenic was 273 times more prevalent than it was in seawater (Al-Quraishi, 2013). Qazaniyah Area, Diyala province, trace elements indicator for spring water assessment. Springs water for both periods had a calcium sulfate category. Constructed to the World Health Organization principles, every one of the groundwater samples for two periods is not appropriate for human drinking, whereas the spring water is suitable for the consumption of animals (Fakhre and Abdul Hussein, 2020).

Salman (2007) deduced and explained that trace elements are in several ecological components, (Soil, shallow water, palm branches, ash, dust, and molluscan shells at Al-Basra Governorate. The concentrations of trace elements Pb, Ni, Co, Cd, Cu, Fe, and Cr in some environmental constituents in Al-Basra Province and suggestion to the possible causes of effluence and signify the good behavior procedures as well as comparing the concentrations of these elements in the studied ecological constituents with Iraqi and global limits. At Al-Basra Governorate also Al-Khafaji (2000) concluded that a preliminary survey of some trace elements in the waters of the Jubaila branch (Cd, Cu, Fe, Mn, Pb, and Zn) and their concentrations were high in the water, while the concentrations were higher in the sediments taken from the same site, while elemental concentrations of Cd, Pb were high, and the study concluded that the source of these two elements is human activities. The organic matter values are within the permissible limits (Daham, 2022), this is due to the industrial products.

At the center of Iraq, Al Ahdeb Oil Field in Al Ahrar, Wasit Governorate, at this point, trace elements content are used as a sign of the impact of the pollution in the Oil Field. This study concluded that the surface water of the study area has high concentrations of Pb and Cd (Hassan, 2018). Tigris River is unpolluted with trace elements except for Sr in water at Al-Kut city. This is due to the dilution, discharged the main river and load of the river are adsorbed the trace elements onto sediments. The source of some trace elements is heavy minerals and sediments clay in the main river. Distribution of Sr concentration in water samples, applicable to the cation Sr^2 especially Ca^{2+} and the bicarbonate and sulfate anions in water (Al-Quraishi, 2019). The trace elements in the groundwater and drainage water confirm pollution with Fe, Pb, and Ni in the Dujaila area (Al-Mayyahi, 2016).

Hashimiya area, this investigation proved that radon is a good environmental tracer to identify the interconnection between surface and groundwater in the study area. The comparison between Radon concentration in surface and groundwater indicates interflow from the river to the groundwater. The current study reveals that radon is a good environmental tracer to find the interconnection between surface and groundwater in the study area. The concentrations of radon rise as the groundwater changes away from the river which reveals that the groundwater flow originated fed from the river which causes diluting the groundwater with little concentrations of radon (Hasson, 2016).

Trace elements in sediment samples of Al-Hammar Marsh, Southern Iraq were in the order of Cr > Ni > Zr > V > Zn > Cu > Br > Co > Pb > Mo > As > U > Se > Cd. As stated by comparison of trace elements concentration by their natural abundant limits in world soil (Abdullah, 2015). Al-Hammar marsh sediments were polluted Br, Mo, Se, Ni, Cr, Zn, Cu, Co plus U surpassed its natural abundance. Mean concentration values of Cr, Ni, V, Cu, Pb, and U exceeded the mean concentration of background values for these elements in Mesopotamia soil and sediments (Abdullah, 2015). Concerning water resources between Haditha dam and the site of Al-Baghdadi Dam, the chief resources of those concentrations in the superficial water are anthropological actions besides the effect of fertilizers and the concentration weathering process. Zn^{2+}, Mn^{2+}, Pb^{2+}, Cd^{2+}, Fe^{2+}, B^{2+}, and As^{2+} concentrations of ground in addition to surface water display no abnormal concentration compared with local (Iraqi) and international standards (Al-Paruany, 2013).

In Kirkuk city; hydrogeochemical ions contributed to the pollution of groundwater caused by the infiltration of surface water polluted by domestic seepage pits as well as leakage from local green spaces parts (Al-Hamdani, 2017). Trace elements concentrations in the surface water and groundwater samples of the study area confirm that all these elements are within the permissible limits according to the Iraqi and international standards for drinking use, except for Pb and Cd in the groundwater samples because of their high concentrations as compared with the permissible limits. Human activities and fertilizer application are thought to be the main reasons for the abnormal concentrations of both Pb and Cd (Oleiwi, 2013).

From the above studies and hydrogeochemical sources, this study can summarize the distribution and content of hazard trace elements in the water. Chemical analyses of the hazardous different environmental geochemical studies in Iraq of the Tigris and Euphrates rivers, marshes, and lakes elements in the water that make the water unsuitable for human use and other purposes such as irrigation, agriculture, construction, and various industries have been scheduled. Through the labor of Table 3 for chemical data and analysis, for the purpose of observing and discussing temporal chemical changes. The level and concentrations of these elements are arranged in Table 3, hazardous trace elements were employed to assess the water pollution of the water areas.

Hazardous trace elements appear in most of the previous studies at relatively low concentrations compared to the sediment content of the same elements. Regarding the distribution of As, Cd, Cr, Cu, Pb, Ni, and Co, it was homogeneous and practically stable.

Zinc recorded the highest concentrations among the studied trace elements, and the lowest was cadmium content relatively.

Hammar Marsh is located south of the Mesopotamian basin, in addition to the discharge of sewage, its water is not suitable for human use for irrigation and livestock drinking. The marshes environment in southern Iraq is considered one of the integrated natural environments with its inhabitants, plant and animal resources, and its distinct natural characteristics that have a major role in the process of environmental balance in the region. The salts and the high rate of some hazardous trace elements in them, increased the pollution problems, especially after the restoration of the marshes in 2003.

Table 3: Documented hazard trace elements concentration in water samples (in ppm)

Researcher**	year	Study area	Cu	Zn	Co	Ni	Pb	Cr	Cd	As
Salman	2007	Tigris River /Basra area	0.6	---	0.2	0.5	0.6	0.2	0.11	----
Abdullah	2010	Tigris River /Basra area	0.12	---	0.05	0.07	0.05	0.05	0.02	0.12
Ahmed	2011	Euphrates river/ Al-Anbar	0.053	---	0.12	0.031	0.029	----	----	---
Ali	2012	Tigris River/ Baghdad area	0.005	0.13	0.15	0.001	0.003	0.001	0.11	0.001
Al-Quraishi	2013	Sawa Lake /southern desert	0.12	0.09	0.09	0.3	1.16	----	0.1	0.01
Al-Paruany	2013	Euphrates river/ Haditha	---	0.07	---	---	0.0025	---	0.15	0.0008
Abed	2015	Tigris River	1.5	13.2	0.1	0.5	0.68	0.86	---	1.3
Abdullah	2015	Al-Hammar Marsh	38.4*	233	4.7	37.6	36	31	0.7	15
Al-Mayyahi	2016	Dujaila River Tigris branch	0.02	0.03	---	0.005	0.006	---	0.005	---
Al Saady	2016	Lower Zab	1.13	9.25	0.12	1.2	12.66	3.24	0.007	---
Al-Hamdani,	2017	Tigris River / Kirkuk city.	0.9	60.4	4.7	4.76	0.62	23.09	0.15	0.48
Hassan	2018	drainage & river channel/ Kut area	0.06	0.04	---	---	0.99	---	0.24	---
Abdullah Al-Mashaikie	2018	Tigris river/ Baghdad area	---	---	0.05	0.07	0.05	0.03	0.02	0.12
Al-Quraishi	2019	Tigris River/ Kut area	0.001	0.12	0.001	0.001	0.001	0.001	0.0001	0.001
Hashim	2021	Al-Saqy Project/ Karbala area	---	0.07	---	0.53	0.06	0.03	0.05	---

* Red color represents the highest concentrations of trace elements; ** Previous hydrogeochemical studies

The source of some trace elements may be the heavy minerals and clays, in addition to the organic matter of sediments in the main watercourse. This is due to the velocity of flow and drainage, in addition to the dilution process which shows reduces the high toxicity of trace elements, except for stagnant marsh waters with great biological diversity (Hammar Marsh in 2015). In 2015 the highest concentrations of trace elements were recorded in the Hammar Marsh Cu (38.4 ppm), Zn (233ppm), Co (4.7ppm), Ni (37.6ppm) Pb (36ppm), Cr (31ppm), Cd (0.7ppm), and As (15ppm) (Table 3).

- **Air pollution assessments**

One of the most serious issues the world faces today is air pollution. It is the variation in any atmospheric ingredient from the value that would have existed in the absence of human activity, which worsens ecological conditions. The concentration of gaseous and particle pollutants discharged into the environment has steadily increased over time as a result of increases in human population, road transportation, vehicular traffic, and industries (Seyyednejad, 2011).

Pollutants that contain heavy metals pose a serious threat to the environment's ecology. When released into the environment, they frequently cannot biodegrade (Mitra *et al*., 2022). Urban air pollution is an environmental problem in many countries. The sources of urban air pollution emanate mostly from combustion activities originating mainly from automobiles and industrial activities. In Iraq; The air contaminants are Zn, Cu, Co, Ni, and Cd (Al-Maliki, 2005). Iraq's Abu Smeache area, Southwest Babylon Governorate, has a brick industry, trace element pointer environmental impact assessment of brick factories in the study area. The analysis of filters displayed that the air of the region encompassing high concentrations of Pb, Ni, Cd, Mn, Co, Cu, Cr, and Zn in the air exceeded the permissible national and global limits. These elements are due to the industrial processes of the brick industrial unit. Heavy fuel used in the combustion process contains high concentrations of these elements that go into the atmosphere with the black smoke from the chimneys, and the dust blowing by wind movement may increase the concentration of these elements contents in the air. As well as the soil of the region is fragmented by the industrial processes, the high concentration of trace elements, and the total suspended particulate resulting from the factory's smoke. The arrival of pollutants into cities and residential complexes. It is noted that the higher concentration of pollutants in summer than in winter (for air) is due to the lack of precipitation, high rate of evaporation, and wind direction. Therefore, it has been noticed a higher concentration of pollutants outside the factory area than in factories (Shaker, 2019).

In this current review; despite the lack of environmental studies on air pollution, due to the lack of modern technologies necessary for accurate results, a collection of data for the last ten years as a result of the recent increase in industrial and urban activities (Table 3).

Table 3: Documented hazard trace elements concentration in air samples

Researcher**	year	Study area		µg/m3				
				Cd	Cr	Ni	Cu	Pb
Abdul Sattar	2013	Middle of Iraq	Al-Nahrawan, East Baghdad	---	2.02	13.95	---	39.22
Mohamed	2016	Middle of Iraq	East Baghdad oil field	0.61	0.52	0.5	0.84	5.16
Ali	2013	North of Iraq	Kirkuk Oil Refinery	0.045	0.096	0.745	0.474	0.115
Abed	2015	North Mesopotamian	Baiji Area	62.2*	26.6	178.5	12.9	225.8
Shaker	2019	Middle of Iraq	Manufacture of Bricks Abu Smeache Babylon	0.3	4.4	1.2	0.7	7.175
Hassan	2018	Middle of Iraq	Al Ahrar District, Wasit	0.33	4.3	6.47	---	3.47
WHO	1996	Standard	---	0.05	0.04	0.2	0.25	0.5

* Red color represents the highest concentrations of trace elements, ** Previous studies

From the mentioned environmental geochemical studies, Table 3 summarizes the distribution and content of toxic trace elements in the air for different areas in Iraq. These are characterized by industrial activity such as Al-Nahrawan areas, east Baghdad oil fields, East Baghdad and Manufacture of Bricks Abu Smeache Area – Babylon factories, or oil production activity such as Kirkuk Oil Refinery, Al-Ahdab oil field in Al-Ahrar district and Baiji district. Chemical analyzes of the elements in the air have been slated that make the concentrations of the elements lower than the standards of the world health organization except for the Baiji district. Baiji Industrial District recorded the highest concentrations of hazardous trace elements for air sample analyses in 2013 among more than other industrial areas in Iraq (Table 3 and Fig.1) At Baiji district in 2015 according to Abed (2015) "mean values concentrations of Cr, Cu, Pb, Ni, and Zn in the air were within the allowed limits by WHO (1996), but Cd (62.2 ng/m3) which is higher than this limit. maximum concentrations of Cd in the air attributable to the combustion of fossil fuel by an industrial oil refinery and power plants".

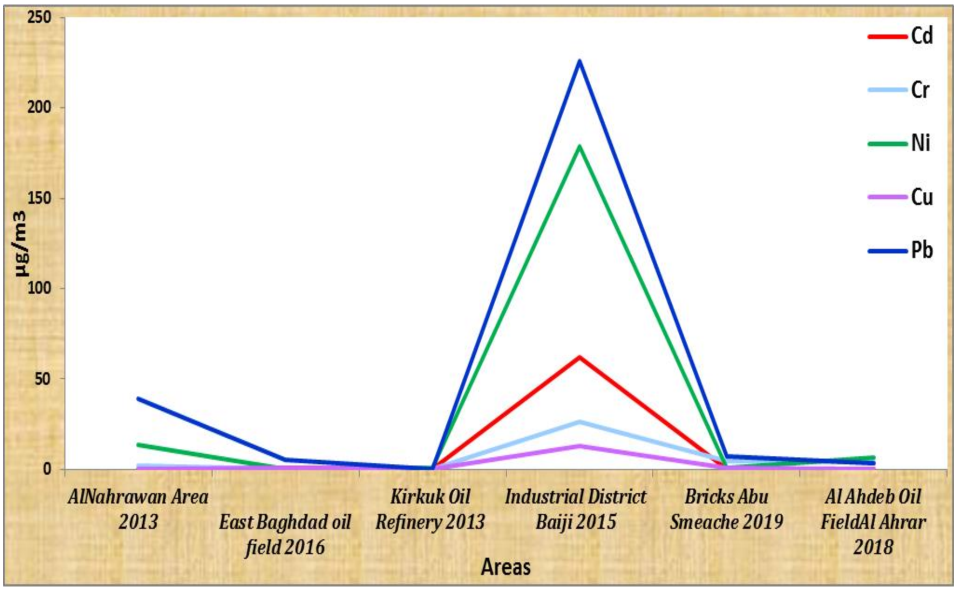

Fig.1: Chemical temporal changes of trace elements in the air for certain previous studies from land use areas

CONCLUSIONS

Trace elements have a distinguishing title role in environmental geochemistry; by reviewing previous scientific references and studies in environmental geochemistry. This occurred through employing the trace elements as a geochemical indicator of the natural relative abundance or the environmental pollution. Then; the study concludes the important points:

1. Increasing some of the elements in the soil due to the presence of organic materials and clay minerals or as a result of many urban activities. Trace elements in rocks, soil, and surface in Iraq are affected by several factors. The most important of these factors are the sedimentary environment of the element, chemical properties, geological formations, as well as climatic changes.
2. The soil of the capital, Baghdad, is contaminated with Zn, Co, and Pb as a result of urban activities in the overcrowded area with a relatively high percentage of the population in other provinces. Agricultural soils in Najaf have the highest nickel contamination due to the use of chemical pesticides and agricultural fertilizers.
3. Cd is concentrated as a product of combustion in the soil of Kirkuk Oil Refinery.
4. Ishaqi farms have a content of Cu contamination (51.8 ppm). This pollution is caused by clay minerals erosion and fertilizers.
5. The water of the Hammar Marsh is considered the most dangerous environmental pollution with studied toxic trace elements (Zn, Co, Ni, Pb, Cd, and Cu) compared to the

waters of the Tigris and Euphrates rivers and the rest of the water bodies and surface water in Iraq. This is due to the stagnant water of the marsh due to improper human use and therefore not suitable for human consumption. The sediments of the Al-Hammar Marsh are characterized by high Cr contamination as a result of weathering of heavy metals containing chromium transported from the northern parts that bounds the Mesopotamian basin.

6. Iraqi sediments and soils possess relatively more hazardous trace elements contamination than water. This is due to the fact that the soil has cumulative pollution over a large period of years, as the pollutants are adsorbed on clays and organic materials, or are transferred where it contains a heavy metal bug that contains it. While the water rushes the pollutants with the discharge of the river too far places in addition to the dilution of the pollutants when it mixes with the river water
7. The air of the Baiji industrial district is the most polluted among the areas of other industrial activities in Iraq. It is considered contaminated with a high level of Cd and studied with other trace elements (Cr, Pb, and Cu). It is characterized by significant amounts of toxic trace element concentrations as a result of fossil fuel combustion by industrial oil refineries in addition to power plants.

RECOMMENDATIONS

The current review recommends a detailed and inclusive study, and geochemical survey of trace elements for all regions (governorates) in Iraq for different samples (sediments, soils, water rivers, marshes, and lakes). Through geochemical exploration for trace elements, it was secured through a united and complete study to distinguish the geochemical anomalies and environmental pollution resulting from any part of Iraq. This is useful if the economic component can be extracted or the harmful component can be removed whenever possible

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About the authors

Mrs. Ruaa Issa Muslim Al-Quraishi holds a Ph.D. in geochemistry, from the University of Baghdad College of Science Dept. of Geology, in 2019 with a thesis titled (Environmental Geochemistry of Wasit Governorate, Iraq. She has an M.Sc. in geochemistry from the University of Baghdad College of Science Dept. of Geology in 2013 M.Sc., with a thesis titled (Hydrogeochemistry of the Sawa Lake, Southern Iraq). She obtained her B.Sc. degree in Geology from The University of Baghdad in 2004. She is a lecturer in Geology Dept. College of Science \ The University of Wasit. She is a member of the teaching staff of the Geology Dept. The University of Wasit. She has 10 published geological papers. She Supervised graduate studies for undergraduate students in the Department of geology/ College of Science, Wasit University.

e-mail: ralqurashy@uowasit.edu.iq

Mailing address: Al-Kut District, Wasit, Iraq

Sattar Obaid Maiws Al Mayyahi has an M.Sc. (Water Resources) Department of Geology, College of Science, Baghdad University, with a thesis titled “Assessment of Dujaila River water and its relationship with the agricultural soils of Dujaila project Wasit governorate- Central of Iraq". He has a Bachelor of Science (Geology) from the Department of Geology, College of Science, Baghdad University in 1990. He has 20 geological reports published papers. Participant in the presidency and membership of various administrative committees of more than 10 committees

e-mail: sobaid@uowasit.edu.iq

Mailing address: Al-Kut District, Wasit, Iraq

Najah Alwan Owayez Al-Ghasham is an assistant lecturer at the University of Wasit, College of Sciences, Department of Geology. Bachelor and M.Sc. of Geology from Baghdad University, Baghdad, Iraq (Rocks and Minerals). He has 3 geological reports published papers. Supervising graduate studies for undergraduate students in the Department of geology/ College of Science, Wasit University

e-mail: naja.alwan@gmail.com

Mailing address: Al Aziziya District, Wasit, Iraq