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Measurement and evaluation of heavy metals (Ag, Cd, Cu, Fe) pollution in sediments of Tashklake (Fars, Iran)

Atefeh Hooshangiyan Shirazi[1], Mehrdad Karimi[*2]

[1]*Department of Geology, College of Sciences, Shiraz Branch, Islamic Azad University, Shiraz, Iran*

[2]*Department of Geology, College of Sciences, Shiraz Branch, Islamic Azad University, Shiraz, Iran*

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Abstract

Tashklake is located 161 kilometers southeast of Shiraz and 15 kilometers West of Neyriz N 22 ° 21'11" and E15 °11'1.86". Due to the role of heavy elements in the creation of ecological conditions and their impact on human and other organisms' health, studying the environmental impacts of heavy metals on Tashk lake and environmental conditions of lake sediments are very important .Therefore, this study is done to identify the distribution of heavy metals (Ag, Cd, Cu, Fe) sediments of Tashk lake. To investigate the distribution and the movement of potentially toxic elements, sampling was conducted from 11 stations throughout the region, and fine-grained clay samples (particles smaller than 63 microns) were chemically analyzed using ICP-OES method. The results indicated that, in this range, enrichment factor for elements (Ag, Cd, Cu, Fe) is low, geoaccumulation index for each of the 4 elements (Ag, Cd, Cu, Fe) was observed to be low. Pollution index for each of the four elements and the percentage of anthropogenic factors for Fe is moderate and for (Ag, Cd, Cu) is low.

***Corresponding Author:** Mehrdad Karimi ✉ karimimehrdad63@yahoo.com

Introduction

The Lake is one of the most unique ecosystems in country, which has the ability to attract contaminants and is very vulnerable. Unfortunately, in the past decade, the growing trend of development and human activities has led to the entry of contaminants such as heavy metals into the ecosystem, which is considered a serious threat to the life of the earth's ecosystems (Boekhold, 1993). Heavy metals due to their accumulation property, lack of degradability, and resistance to environmental and biological degradation change, after entering the environment are able to go on in life cycle and be stored in the tissues of consumers and thus cause lots of acute, chronic and genetic effects toxic hazards (Colin, 2006). From environmental geochemistry perspective, sediments are the most important part of the water sphere, because they are the final concentration of potentially toxic elements in the water. And in certain circumstances they can act as a source of water pollution. In this regard, to achieve this important goal, the project of measuring heavy metals in sediments of Lake Tashk has been implemented. Bakhtegan and Tashk Lakes are two between-mountain subsidences whose elevations from sea level is about 1558 meters. Lake Tashk is located with an area of approximately 800 square kilometers to north-west of Lake Bakhtegan and 161 kilometers to north of Shiraz. The only connecting path between the two lakes is through Lake Bakhtegan delta one part of whose flows into Bakhtegan and the other parts into Tashk. A number of small and large radiolarite, pelagic and Sarvak lime stones islands and peninsula are in these two lakes the most important of which are Lake Nargis and Gonbadan (in Lake Tashk) and Lake Menak in Lake Bakhtegan whose areas depend on annual rainfall conditions. The highest point in Gonban Island is 1354 meters above sea level which is about 185 meters higher than lake level. Lake Tashk is shallower than Bakhtegan and in the dry season, its connection with Bakhtegan is cut. The purpose of this study was to evaluate the four elements in lake sediments is heavy. Oathar and signs of pollution in aquatic creatures and plants found in the lake view in past studies and scientific research that this is our motivation in creating to study these elements has to be more precise, we review the matter in the sediments of Lake.

Material and methods

Area under study

Bakhtegan and Tashk Lakes are two between-mountain subsidences whose elevations from sea level is about 1558 meters. Lake Tashk is located with an area of approximately 800 square kilometers to north-west of Lake Bakhtegan and 161 kilometers to north of Shiraz. The only connecting path between the two lakes is through Lake Bakhtegan delta one part of whose flows into Bakhtegan and the other parts into Tashk (Elkhatib, 2000). A number of small and large radiolarite, pelagic and Sarvak lime stones islands and peninsula are in these two lakes the most important of which are Lake Nargis and Gonbadan (in Lake Tashk) and Lake Menak in Lake Bakhtegan whose areas depend on annual rainfall conditions.

The highest point in Gonban Island is 1354 meters above sea level which is about 185 meters higher than lake level. Lake Tashk is shallower than Bakhtegan and in the dry season, its connection with Bakhtegan is cut (Mc Bride, 1999).

Water supply

The lake main water supplier of these two lakes is Kor which originates from Baraftab and Mousikhani mountains in 50 km south-west of Dehbid, and in north-west of Marvdasht, after becoming one with the Shadkan River (Shadkam), and crossing Marvdasht plains, lakes flows into lakes. And a considerable amount of water also comes into the lakes through springs which originate from limestone and dolomite around the lakes.

The sample

Sampling of soil in 15 stations to determine the concentrations of potentially toxic elements and mobility control agents was performed. Thus, all the

samples taken from the surface, from 0 to 15 cm depth of sediment were removed (Al-Khashman, 2006).

Location of sampling stations is shown Fig.1through Google Earth program satellite image output.

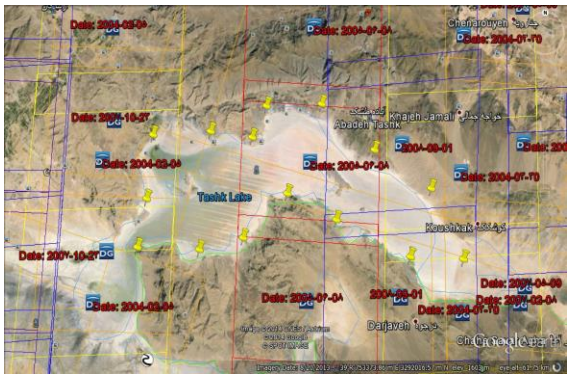

Fig. 1. The Google Earth satellite output image of Tashklake with the location of the sampling stations.

In order to determine the severity of pollution some samples of lake sediments were collected. To prepare, the sediment samples were dried in 25-30 ° C and then granulated particles passing through the sieve of 230 mesh sieve and were sent to the laboratory and ICP-OES analysis was performed on the samples. Analysis of sediment samples with the mean elements and Clark elements is given in Table 1.

According to this, silver at stations 5 and 12 show the highest concentrations. The highest concentrations of metals is observed at stations 3 and 5, 15 and 14. The highest amount of Cu is in stations 2 and 11. Finally, the highest iron concentration is at stations 2 and 11.

Table 1. Concentrations of (Ag, Cd, Cu, Fe) in the sediments of Tashklake (ppm).

Element	Fe	Cu	Cd	Ag	Al
SHA-01	8620	14	0.24	0.31	14806
SHA-02	7971	12	0.24	0.37	13887
SHA-03	10832	13	0.26	0.42	17161
SHA-04	9242	11	0.25	0.42	14799
SHA-05	8618	13	0.24	0.35	14694
SHA-06	10122	19	0.25	0.31	18032
SHA-07	10323	23	0.26	0.4	18624
SHA-08	16115	22	0.25	0.3	18939
SHA-09	25846	30	0.23	0.26	24218
SHA-10	21522	29	0.26	0.24	40340
SHA-11	12797	19	0.24	0.42	23061
SHA-12	6438	8	0.24	0.49	11498
SHA-13	6579	9	0.26	0.42	11476
SHA-14	6479	9	0.26	0.39	12912
SHA-15	5508	7	0.25	0.42	9344
Average	11200.8	15.86667	0.248667	0.368	17586.07
Max	25846	30	0.26	0.49	40340
Clarck	56300	55	0.2	0.07	32
Min	5508	7	0.23	0.24	9344

Fig. 2 shows the change process of the elements in lake sediments. Increasing concentration of contaminants in lake sediments (according to Clark of elements) represents the effect of anthropogenic

factors on sediment contamination in the study area. (Lu, 2009 Eby, 2004).

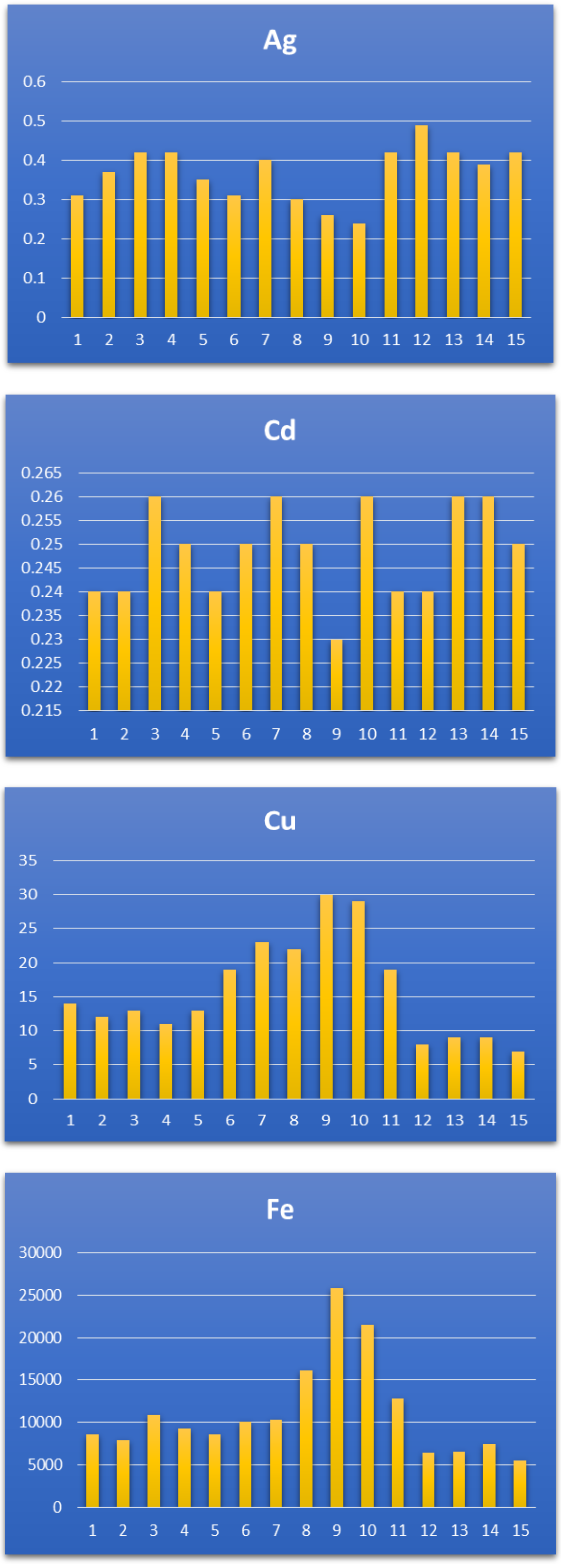

Fig. 2. Line graph of the element studied in Tashk lake sediments.

Result and discussion

geoaccumulationindex (igeo)

To better assess the extent of contamination of elements in soil and sediment and degree of their contamination, geoaccumulation index (Index of geoaccumulation) was used whose formula is shown below (Farkas, 2007).

$$\text{Igeo} = \log 2\,(Cn \div 1.5Bn) \qquad (1)$$

In this relation Igeo is geoaccumulation, Cn is concentration of element in soil samples or sediment under study and Bn is the quality of the earth of that element or amount of element in the reference area. Factor 1.5 is incorporated due to differences in initial concentration of deposits and the impact of above ground factors (Krauskopf, 1994, Farkas, 2007)

This index is usually checked for a sample sediment of a local or regional division. The division of the index main geoaccumulation is presented in Table 2. In Table 3 the average of geoaccumulation for is given (Ag, Cd, Cu, Fe).

Table 2. Guide to the use of geoaccumulation index based on Mueller's classification (Müller, 1969).

I_{geo} Range	I_{geo} Value	I_{geo} Class	Designation Of Sediment Quality
$I_{geo} > 5$	>5	6	Highly Contaminated
$3 < I_{geo} < 5$	4-5	5	Most heavily Contaminated
	3-4	4	Polution
$1 < I_{geo} < 3$	2-3	3	Moderateto severe infections
	1-2	2	Moderate polution
$I_{geo} < 1$	0-1	1	To moderate noninfectious
	0	0	Non-infected

Table 3. Average of geoaccumulation of the elements studied in Tashk lake sediments (ppm).

Elements	Fe	Cu	Cd	Ag
Average Igeo	-0.21	-0.41	-0.53	-0.34
Commentary	Low pollution	Low pollution	Low pollution	Low pollution

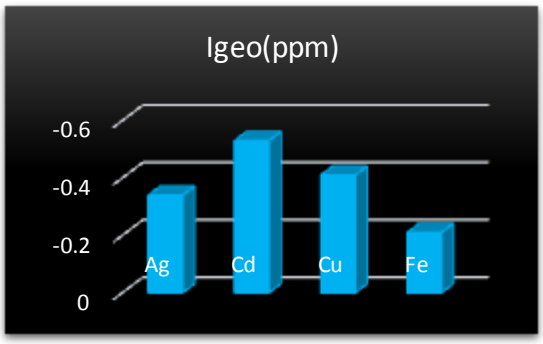

Fig. 3. Bar graph of index of the geoaccumulation of the elements studied in Tashk lake sediments.

The pollution index (PI)

Pollution coefficient index is also used to estimate the nature of an area. Pollution index (PI) is stated as the ratio of the concentration of an element in the soil, to the context of the element in the soil of the region under study, or the local standard (control) (8). According to PI three groups of pollution is observed- low pollution PI<1, moderate PI<3>1, and high PI>3. In table four average of PI for the elements (Ag, Cd, Cu, Fe) is given (Guo, 2012), (P. Papadopoulos, 1988)

Table 4. Average of PI for the elements under study in the sediments ofTashk lake (ppm).

Elements	Fe	Cu	Cd	Ag
Average PI	1.29	1.13	1.03	1.18
Commentary	Middling	Middling	Middling	Middling

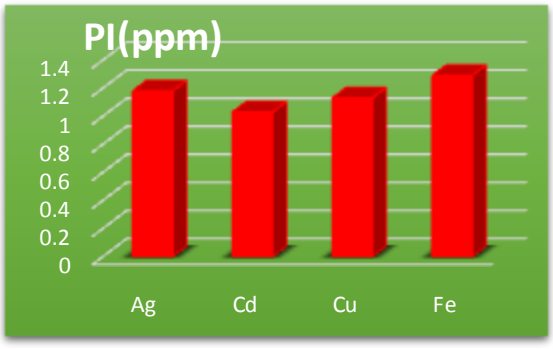

Fig. 4. Bar graph of PI elements under study in the sediments of Tashklake.

The Enrichment Factor(EF)

Enrichment factor analysis in environmental analysis is one of the most important factors to evaluate the anthropogenic and natural concentration. Enriched factor for a specific element in a given sample is the ratio of the concentration of the element in the sample or standard to the concentration of the element, which is calculated as the value of the field in this study. Background concentration amount is a certain amount of an element in soil which is not considered as pollution in the area. Reference element in determining the enrichment factor, is an element that has quite a geological origin and its distribution of content in the area is uniform. For this purpose, Alvarez- Ayusu suggested insoluble elements Ti , Zr , Aland Fe (Müller, 1969), (US EPA, 2006). In the study area A 1-element due to very small changes and little mobility in the geochemical environment was chosen as the reference element (Turekian, 1961).

$$EF = \frac{[Cx \div Cref]\text{camp le}}{[Cx \div Cref]\text{background}} \qquad (2)$$

In this relation Cx is the element concentration in the sample under study and Cref is the concentration of the element in the reference area. Cample is the amount of the element in samples and background is the concentration of the element in the background.

Division of enrichment index is shown in Table 5 (Müller, 1969), (Bloomfield, 1980). In Table 6, the average enrichment index for elements (Ag, Cd, Cu, Fe) is given.

Table 5. Ranking for enrichment factor (Müller, 1969).

Commentary	Enriched factor
There has enriched the few	EF<2
Enriched medium	2< EF <5
High enriched	5< EF <20
Highly enriched	20< EF <40
Enriched extra	EF >40

Table 6. Average of enrichment factor for the elements studied in Tashklake (ppm).

Elements	Fe	Cu	Cd	Ag
Average EF	1.08	0.95	0.87	1
Commentary	Low pollution	Low pollution	Low pollution	Low pollution

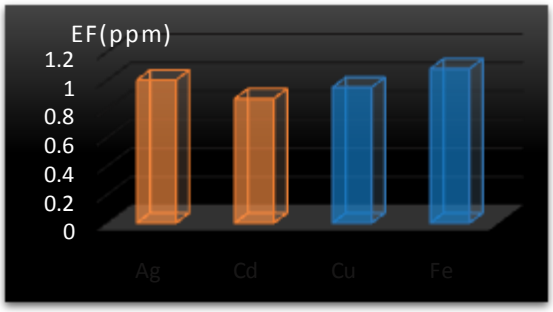

Fig. 5. Diagram of the enrichment factor for elements studied in Tashklake.

The percentage of Antropogenic Factors (An)

Percentage of anthropogenic factors for a specific element in a sample means the percentage of role of people in entering the element to the sample. Anthropogenic in environmental analysis after enrichment factor is one of the most important points in evaluating concentration of elements caused by anthropogenic and natural causes whose formula is as follows:

$$An(\%) = \frac{Mt - \left[M.s \times \frac{Mr}{M.r} \right]}{Mt} \times 100 \qquad (3)$$

In this formula

An: The percentage of endogenous human (anthropogenic). Mt :The amount of element in the sample. MS:Content reference element in the sample. Mr: the element in the reference. $M.r$: the amount of reference elementin the reference environment (Poppe, 2001), (Emhi, 2010). According to the calculated fig.s of chemical analysis of farming soil samples in the south of Hossien Abad copper index, the antropogenic factor average of the elements is given in table 7.

Table 7. Average of anthropogenic factors in the sediments under study in Tashklake (%).

Elements	Fe	Cu	Cd	Ag
Average An	5800%	-400.00%	-96200%	-94800%
Commentary	Middling	Low pollution	Low pollution	Low pollution

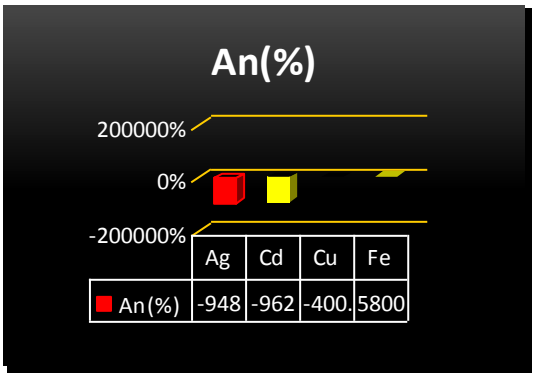

Fig. 6. Bar graph of anthropogenic factors for studied elements in sediments of Tashklake.

Conclusions

The results indicated that, in this range the factors of enrichment for elements (Ag, Cd, Cu, Fe) is low, the index accumulation index for every 4 elements (Ag, Cd, Cu, Fe) is low and pollution index for elements (Ag, Cd, Cu, Fe) is moderate and rate of anthropogenic factors for Fe element moderate and for the elements (Ag, Cd, Cu) is low. The results show that both natural and anthropogenic factors have an impact on pollution of these metals. The results of this study and statistical calculations show that the station 8, 9 and 10 in the study area show the most pollution of these metals and they are located in the northern part of the lake. And basic and ultra basic rocks near the station increase the elements (Ag, Cd, Cu, and Fe) which indicates that the source of the contamination is earth-induce (natural).

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