J. Egypt. Acad. Soc. Environ. Develop., 24 (1):1-11 (2023) (D-Environmental Studies)
E. mail: easedjournal_egypt@yahoo.com ISSN 1110-8770
www.jades.journals.ekb.eg eISSN 2314-5471 (online)

Occurrence of trace elements in coastal seawater of the Egyptian Red Sea

Safaa A. Mahmoud[1], Lamiaa I. Mohamedein[2], Adel S. Orabi[3], Khalid M. El-Moselhy[2*] and Eman M. Saad[1]

1 Department of Chemistry, Faculty of Science, Suez University, Suez, Egypt
2 National Institute of Oceanography and Fisheries, NIOF, Cairo, Egypt
3 Department of Chemistry, Faculty of Science, Suez Canal University, Ismailia, Egypt
* Corresponding author: E-mail:khalidelmoselhy@yahoo.com
Co-author E-mail:emmsaad@yahoo.com (E.M. Saad)

Received: January 10, 2023
Accepted: February 9, 2023

ABSTRACT

The Red Sea serves a main role in the international economy with cargo containers travelling between the Indian Ocean and the Mediterranean Sea, thus shortening the route between Asia and Europe as compared to travelling around Africa via the Atlantic Ocean. In addition to this increases development in the regions around it. These aspects impelled us to investigate the pollution degree along the Red Sea coastal areas. Therefore, the present study planned to monitor the trace elements (Pb, Cd, Cu, Zn, Co, Ni, Mn and Fe) in seawater from different regions along the Egyptian Red Sea. Water samples were collected during winter and summer 2019 from nineteen stations representing different environmental situations of the Gulf of Suez, Aqaba Gulf and Red Sea proper. Concentrations of the studied elements were measured using Atomic Absorption Spectrophotometer technique. The investigated elements recorded an annual mean of 1.13, 0.25, 1.24, 11.65, 0.29, 0.97, 0.68 and 14.67 µg/L in the Suez Gulf ; 1.07, 0.25, 1.27, 11.88, 0.39, 0.88, 1.19 and 12.45 µg/L in the Gulf of Aqaba Gulf and 0.76, 0.18, 0.95, 12.28, 0.24, 0.63, 0.45 and 15.22 µg/L in the Red Sea proper for Pb, Cd, Cu, Zn, Co, Ni, Mn and Fe, respectively. Summer recorded the highest levels of all studied elements except Cd and Mn with significant temporal variations ($p < 0.05$) for Cu, Zn, Co, Ni and Fe. Gulf of Suez recorded high concentrations of Pb, Cd and Ni, while Cu, Zn, Co, Mn and Fe were presented in the Aqaba Gulf and Red Sea proper, with only significant variations for Ni and Mn ($p = 0.004$ and 0.025, respectively) between the different studied regions. Finally, levels of the studied elements in seawater from the Egyptian Red Sea were higher than those recorded for the background concentrations in the open ocean, but still lower than the recommended values for water quality.

Keywords: Trace elements, water, Red Sea, Gulf of Suez, Aqaba Gulf.

INTRODUCTION

The subject of pollution is the focus of widespread public interest and is seen as a priority area for research in both developed and developing countries (Harrison, 2001). There are different routes by which pollution can be presented into the aquatic environment, contamination inputs include industrial and/or domestic effluents, chemicals released in combination with oil exploration or the decommissioning of oil platforms and chemicals originating from agricultural run-off, such as fertilizers and pesticides. One of the most dangerous pollutants is the trace elements, which receive major attention due to their toxicity, accumulation in the biota and subsequent influence on the environment and human health. It well known that elements differ

from other toxic materials in that they are neither created nor destroyed by human. However, utilization by human influences the potential for health effects in at least two main ways: first, by environmental transport that is, by human or anthropogenic contributions to air, water, sediments and food; and second, by altering the speciation or the biochemical form of the element (Hamed, 1996; Hamed and Emara, 2006). Furthermore, trace elements enter the aquatic environment from both natural and anthropogenic sources. Natural sources are largely a result of chemical rock weathering and volcanic activity, while anthropogenic sources include the industrial processing of minerals and ores, industrial use of elements and element complexes, leaching of elements from waste disposal and urban surface runoff, and human and animal wastes that contain trace elements. For most trace elements, anthropogenic emission are more than or equal to natural emissions; however, several reports (Hutchison and Meema, 1987; El-Moselhy, 2002) suggested that natural emissions in some cases are quantitatively more important than anthropogenic sources.

In the coastline regions of Egypt, fast growth, increase coastal residents, manufacturing and touristic growth, oil production, in addition to several commercial activities have created numerous environmental and ecological problems. Egyptian coastlines of the Red Sea, Gulf of Suez and Aqaba Gulf suffered from different land based sources causing various pollution complications. These sources may result in increased the pollutants such as trace elements and hydrocarbons, and consequently could affect the aquatic ecosystem. Therefore, the current study aim to assess the existence of trace elements “Pb, Cd, Cu, Zn, Co, Ni, Mn and Fe” in water samples collected from different regions of the Egyptian Red Sea coasts. The study includes the investigation of regional and temporal effects on the water content of elements.

MATERIALS AND METHODS

Study area

Red Sea is an important water body connecting the south and the north countries. However, Red Sea coast of Egypt is suffered from several contamination sources such as urban, land based activities, petroleum activities, mining, shipping, and tourism activities, as well as complexes environments similar to sea grass, mangrove and coral reef. All these pollution sources impelled us to select the stations of the present study that are well distributed alongside the coastline of the Egyptian Red Sea. The designated stations distributed along the Red Sea proper, Gulf of Suez and Aqaba Gulf are shown in Figure (1).

Studying stations

Nineteen locations were selected alongside the Egyptian Red Sea coast for collecting water samples considered the different impacts and ecological habitats. Nine stations were in the Gulf of Suez (SG1 – SG9) from Port Tawfic in the north to El-Tur City in the south. Three stations were in the Aqaba Gulf (AG1 – AG3) from Nuweibaa City in the north to Sharm El-Sheikh City in the south. Seven stations were in the Red Sea proper (RS1 – RS7) from north of Hurghada City in the north to Shalateen City in the south (Fig. 1).

Sampling and elements analysis in Water

Subsurface water samples (about 50 cm depth) were collected during winter and summer 2019 from the selected stations along Red Sea coast by using water sampler, kept in clean polyethylene container, then acidified and transported to the laboratory for analysis of trace elements. These elements in the water samples were pre-concentrated using APDC/MIBK

solvent extraction (Brewer *et al*., 1969 and APHA, 1999). Finally, trace elements were measured through AAS-Atomic Absorption Spectrophotometer (Perkin Elmer, AAnalyst 100), and the results were expressed as µg/L.

Chemicals, acids and solvents were of high analytical grade. Standard, blanks and solutions were freshly prepared using deionized distilled water. The vessels and glassware were soaked in 10% nitric acid, and then washed by distilled water. The precision of method was established through replicate measurements of the studied elements in the water samples, and the result showed precision of 8.4 – 15.2 % for the investigated elements.

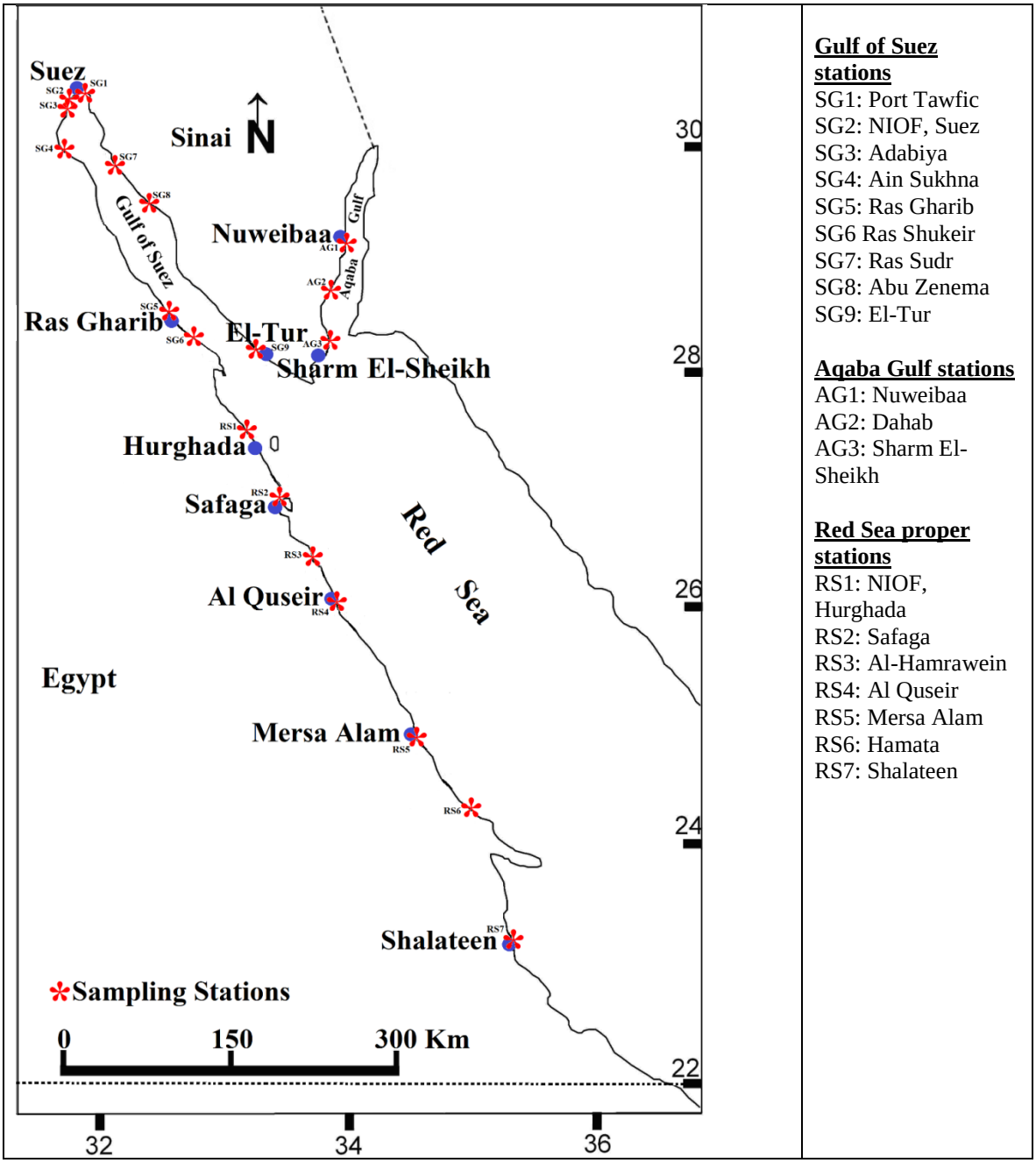

Fig. (1): Map of the Egyptian Red Sea showing the sampling stations

Statistical analysis

Trace elements in water were handled by ANOVA to observe the variations amongst areas and seasons (at $p \leq 0.05$). Tukey, Fisher, Bonferroni and Duncan tests were used to additional define the position of variance in the significant records. Software XLSTAT 2014.5.03, Origin Pro 9 and Excel were used for the data handling.

RESULTS AND DISCUSSION

The concentrations of Pb, Cd, Cu, Zn, Co, Ni, Mn and Fe were measured in water samples collected from the different Egyptian regions of the Red Sea during winter and summer (Tables 1-3), and annual mean in each part "Red Sea proper, Gulf of Suez and Aqaba Gulf " is shown in Figure (2). In general, it can be observed that the grand mean concentration, over all the studied stations, of Fe displayed the maximum level (14.11 µg/L) followed by Zn (11.94 µg/L) then Cu (1.15 µg/L), Pb (0.98 µg/L), Ni (0.83 µg/L), Mn (0.77 µg/L), Co (0.30 µg/L), and lastly Cd was the lowest element (0.23 µg/L). Concerning the seasonal difference, most of the investigated elements displayed its maximum mean in summer except Cd and Mn was in winter time. High elements concentration during summer season could be due to increase of land-based contribution and human activities during the hot seasons (Abouhend and El-Moselhy, 2015; El-Moselhy *et al*., 2019). This phenomenon may attributed to the excess in element accumulation level due to higher temperature with high the rate of evaporation and increasing the pollutants quantity flushed into the water body, particularly sewage wastewater. More or less comparable with the present study, Abouhend and El-Moselhy (2015) recorded that some elements in water from the Red Sea proper were found in high concentration during summer while others were in winter season. According to ANOVA analysis, significant variations between the trace elements mean concentrations of in the two seasons were recorded for Cu, Zn, Co, Ni and Fe ($p = < 0.0001$, 0.046, 0.001, 0.004 and 0.007, respectively), while Pb, Cd and Mn exhibited insignificant differences ($p = 0.249$, .335 and 0.058, respectively.

Regarding the local variations, Pb, Cd and Ni revealed its highest annual mean (1.129, 0.249 and 0.974 µg/L, respectively) in water from the Gulf of Suez; Cu (1.268 µg/L), Co (0.385 µg/L) and Mn (1.192 µg/L) were presented in the Aqaba Gulf; whereas Zn and Fe exhibited its maximum annual mean (12.284 and 15.215 µg/L, respectively) in the Red Sea proper (Fig. 2). Occurrence of the studied elements along the present investigated regions showed that there is a specific-element-region depends on the pollution sources. Gulf of Suez characterized by petroleum, industrial, shipping and harbor activities, which showing elevation of non-essential and toxic elements (Pb, Cd and Ni). While essential elements (Cu, Zn, Co, Mn and Fe) were found in the Aqaba Gulf and Red Sea proper, that characterized by natural sources as valleys overflow and wind loading fine silt from the adjacent mountains. Land based activities, harbors & ships activities, and industrial & sewage drainage system are the main pollution sources of elements in the Gulf of Suez (El-Moselhy *et al*., 1999 & 2016; El-Moselhy & Gabal, 2004; Mahmoud, 2017). In contrast, the lowest annual mean of the studied elements were recorded in the Red Sea proper and Aqaba Gulf that are relatively far from sources of pollution. Statistical analysis using ANOVA showed that only mean concentrations of Ni and Mn displayed significant variations ($p = 0.004$ and 0.025, respectively) between the different studied regions, whereas other elements revealed insignificant differences ($p > 0.05$). Furthermore, low concentrations of Ni and Mn in the Red Sea proper water, in contributing with high Ni in the Gulf of Suez and high Mn in the Aqaba Gulf, were the mean values responsible on the significant variations inside different regions.

Occurrence of trace elements in coastal seawater of the Egyptian Red Sea

By comparing levels of the present studied elements with those reported in the other Egyptian waters (Hamed and El-Moselhy, 2000, El-Moselhy *et al.*, 2005; Hamed, 2005; El-Moselhy and Hamed, 2006; Abou Hend, 2013; El-Metwally, 2014; Zaghloul, 2015, saad *et al.*, 2016; Mahmoud, 2017; Elmorsi *et al.*, 2019) it can be noticed that elements level in the current study was comparable with those found in other works. On the other hand, the elements level in seawater along the Egyptian Red Sea attained in the current study were higher than the background concentrations in the coastal water and open ocean reported by Bryan and Langston (1992); UNEP (1993); Law *et al.* (1994); USPHS (1997) and Johnston *et al.* (2002). However, level of Zn was only higher than the open ocean value but was within the range of coastal water level (0.30 – 70.0 µg/l) as stated by Bryan and Langston (1992) and UNEP (1993). In contrast, the present concentrations of elements were lower than the recommended values for water quality (EPA, 2002).

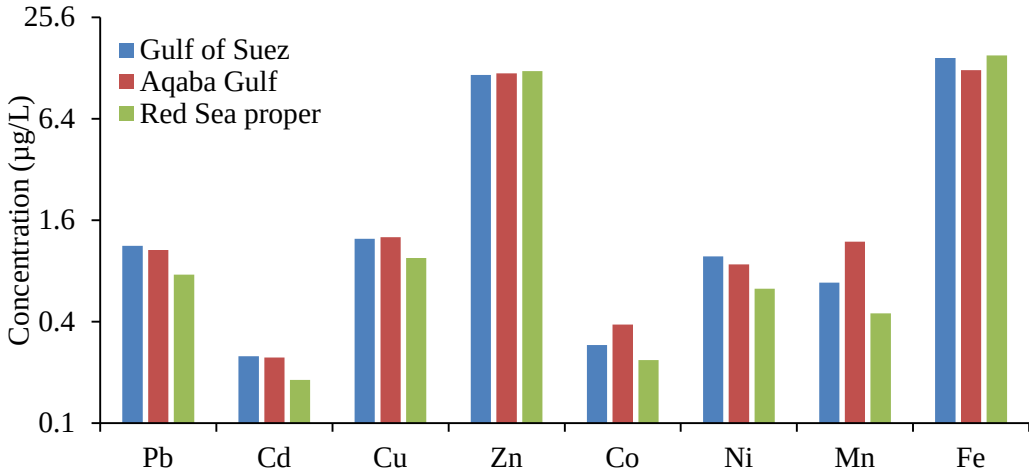

Fig. (2): Annual mean concentrations of trace elements in water (µg/L) collected from different regions of the Red Sea.

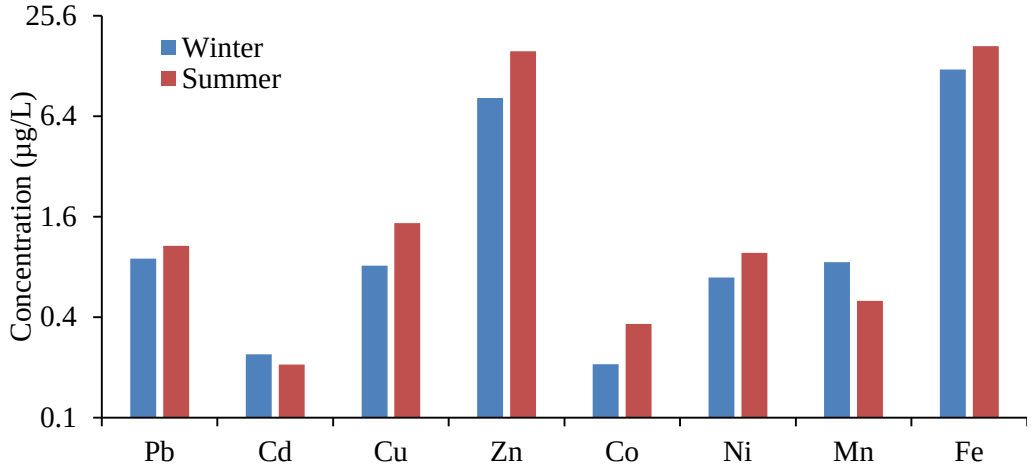

Fig. (3): Seasonal mean concentrations of trace elements in water (µg/L) collected along the Egyptian Red Sea coasts.

Table (1): Concentrations of trace elements (µg/L) in water samples from the Gulf of Suez during winter and summer seasons 2019.

Element	Season	Gulf of Suez								
		SG1	SG2	SG3	SG4	SG5	SG6	SG7	SG8	SG9
Pb	Winter	1.17	0.85	0.55	0.56	1.45	1.91	0.72	0.89	1.29
	Summer	2.33	2.10	0.94	0.63	0.94	0.87	0.68	1.28	1.16
	Mean	**1.75**	**1.48**	**0.75**	**0.60**	**1.20**	**1.39**	**0.70**	**1.09**	**1.23**
Cd	Winter	0.31	0.13	0.24	0.29	0.45	0.17	0.23	0.27	0.24
	Summer	0.19	0.19	0.12	0.19	0.17	0.17	0.64	0.30	0.19
	Mean	**0.25**	**0.16**	**0.18**	**0.24**	**0.31**	**0.17**	**0.44**	**0.29**	**0.22**
Cu	Winter	1.53	0.57	1.11	0.70	0.92	0.89	0.64	0.57	0.78
	Summer	1.42	2.13	2.53	1.33	1.14	0.78	1.91	1.49	1.89
	Mean	**1.48**	**1.35**	**1.82**	**1.02**	**1.03**	**0.84**	**1.28**	**1.03**	**1.34**
Zn	Winter	11.72	8.51	8.31	10.90	10.72	7.26	6.21	6.01	9.57
	Summer	7.86	43.58	18.01	7.75	7.98	6.12	8.71	17.13	13.38
	Mean	**9.79**	**26.05**	**13.16**	**9.33**	**9.35**	**6.69**	**7.46**	**11.57**	**11.48**
Co	Winter	0.35	0.23	0.28	0.28	0.29	0.09	0.09	0.10	0.19
	Summer	0.33	0.45	0.41	0.34	0.35	0.32	0.43	0.34	0.36
	Mean	**0.34**	**0.34**	**0.35**	**0.31**	**0.32**	**0.21**	**0.26**	**0.22**	**0.28**
Ni	Winter	1.41	0.75	0.79	0.77	0.73	0.83	0.59	0.66	0.67
	Summer	1.39	1.91	1.20	0.99	0.86	0.63	1.10	1.15	1.10
	Mean	**1.40**	**1.33**	**1.00**	**0.88**	**0.80**	**0.73**	**0.85**	**0.91**	**0.89**
Mn	Winter	0.78	1.17	0.55	0.90	0.68	0.63	0.60	0.90	1.50
	Summer	0.46	0.48	0.54	0.42	0.52	0.41	0.48	0.65	0.62
	Mean	**0.62**	**0.83**	**0.55**	**0.66**	**0.60**	**0.52**	**0.54**	**0.78**	**1.06**
Fe	Winter	20.84	12.15	12.10	14.25	13.27	13.84	5.66	9.00	9.24
	Summer	11.67	29.86	18.77	10.84	18.72	11.28	9.39	23.64	19.55
	Mean	**16.26**	**21.01**	**15.44**	**12.55**	**16.00**	**12.56**	**7.53**	**16.32**	**14.40**

Table (2): Concentrations of trace elements (µg/L) in water samples from the Aqaba Gulf during winter and summer seasons 2019.

		Gulf of Aqaba		
Element	Season	AG1	AG2	AG3
Pb	Winter	0.81	1.28	1.30
	Summer	0.97	0.69	1.35
	Mean	**0.89**	**0.99**	**1.33**
Cd	Winter	0.30	0.26	0.35
	Summer	0.20	0.16	0.20
	Mean	**0.25**	**0.21**	**0.28**
Cu	Winter	1.04	0.77	1.07
	Summer	1.69	1.30	1.74
	Mean	**1.37**	**1.04**	**1.41**
Zn	Winter	8.87	8.81	19.62
	Summer	11.44	12.40	10.15
	Mean	**10.16**	**10.61**	**14.89**
Co	Winter	0.81	0.15	0.29
	Summer	0.31	0.35	0.40
	Mean	**0.56**	**0.25**	**0.35**
Ni	Winter	0.88	0.81	0.89
	Summer	0.93	0.92	0.82
	Mean	**0.91**	**0.87**	**0.86**
Mn	Winter	1.20	3.77	0.75
	Summer	0.62	0.31	0.50
	Mean	**0.91**	**2.04**	**0.63**
Fe	Winter	9.53	10.42	11.17
	Summer	15.71	13.08	14.77
	Mean	**12.62**	**11.75**	**12.97**

Table (3): Concentrations of trace elements (µg/L) in water samples from the Red Sea proper during winter and summer seasons 2019.

Element	Season	Red Sea proper						
		RS1	RS2	RS3	RS4	RS5	RS6	RS7
Pb	Winter	0.72	0.40	0.28	0.57	0.53	0.83	0.89
	Summer	0.72	2.34	0.21	1.02	0.58	0.57	0.97
	Mean	**0.72**	**1.37**	**0.25**	**0.80**	**0.56**	**0.70**	**0.93**
Cd	Winter	0.27	0.13	0.14	0.18	0.21	0.18	0.19
	Summer	0.13	0.22	0.14	0.20	0.23	0.15	0.16
	Mean	**0.20**	**0.18**	**0.14**	**0.19**	**0.22**	**0.17**	**0.18**
Cu	Winter	0.35	0.32	0.90	0.92	0.68	0.81	0.89
	Summer	0.98	1.65	0.65	1.05	1.92	0.99	1.23
	Mean	**0.67**	**0.99**	**0.78**	**0.99**	**1.30**	**0.90**	**1.06**
Zn	Winter	4.32	3.27	5.91	5.03	6.72	7.20	7.06
	Summer	7.24	60.26	2.65	5.10	39.01	11.61	6.60
	Mean	**5.78**	**31.77**	**4.28**	**5.07**	**22.87**	**9.41**	**6.83**
Co	Winter	0.10	0.06	0.06	0.26	0.09	0.10	0.14
	Summer	0.37	0.45	0.31	0.36	0.32	0.35	0.35
	Mean	**0.24**	**0.26**	**0.19**	**0.31**	**0.21**	**0.23**	**0.25**
Ni	Winter	0.51	0.34	0.41	0.59	0.44	0.48	0.57
	Summer	0.74	0.99	0.56	0.61	0.87	0.77	0.91
	Mean	**0.63**	**0.67**	**0.49**	**0.60**	**0.66**	**0.63**	**0.74**
Mn	Winter	0.61	0.21	0.35	0.45	0.38	0.45	0.33
	Summer	0.44	0.44	0.44	0.52	0.58	0.51	0.56
	Mean	**0.53**	**0.33**	**0.40**	**0.49**	**0.48**	**0.48**	**0.45**
Fe	Winter	10.49	8.07	16.37	9.88	13.66	15.50	16.24
	Summer	12.40	29.84	10.83	11.98	22.94	17.06	17.75
	Mean	**11.45**	**18.96**	**13.60**	**10.93**	**18.30**	**16.28**	**17.00**

Conclusion

Red Sea is a vital water route connecting the south nations with the north world. However, Red Sea coast of Egypt suffered from several contamination sources as industrial activities, oil production, many land based activities, mining, shipping, and tourism activities. All of these actions are the main sources of element pollution in the different regions of the Red Sea. The level of the current studied elements (Pb, Cd, Cu, Zn, Co, Ni, Mn and Fe) in seawater collected from Red Sea proper, Gulf of Suez and Aqaba Gulf were varied among regions and seasons. Summer showed the highest values of all studied except Cd and Mn which were high in winter. elements in the Gulf of Suez, which characterized by many activities as industrial, petroleum, harbor and shipping, displayed high values of non-essential toxic elements (Pb, Cd and Ni). While essential elements (Cu, Zn, Co, Mn and Fe) were recorded in the Aqaba Gulf and Red Sea proper, that characterized by natural sources of pollution.

REFERENCES

Abou Hend, A.S.A-M. (2013). Heavy metals distribution and biosorption by marine bacteria isolated from water and sediments along Hurghada, Red Sea coastline. M.Sc. Thesis, Fac. Sci., Menoufiya Univ., pp. 141.

Abouhend, A.S. and El-Moselhy, Kh,M. (2015). Spatial and seasonal variations of heavy metals in water and sediments at the northern Red Sea coast. Amer. J. Water Resour., 3(3): 73-85.

APHA, American Public Health Association (1999). Standard methods for the examination of water and wastewater (20th edition). Washington DC, USA.

Brewer, P.G.; Spencer, D.W. and Smith, C.L. (1969). Determination of trace metals in seawater by atomic absorption spectrophotometry. ASTM STP, 443: 70-77.

Bryan, G.W. and Langston, W.J. (1992). Bioavailability, accumulation and effects of heavy metals in sediments with special reference to United Kingdom estuaries: a review. Environ. Pollut., 76: 89-131.

EPA (2002). National Recommended Water Quality Criteria, Published by U.S. Environmental Protection Agency, EPA-822-R-02-047, 36 pp.

El-Metwally, M.E.A. (2014). Monitoring of heavy metals pollution in the Egyptian Red Sea coast and response of marine organisms. Ph.D. Thesis, Fac. Sci., Mansoura Univ., pp. 275.

Elmorsi, R.R.; Abou-El-Sherbini, Kh.S.; Mostafa, G.A-H. and Hamed, M.A. (2019). Distribution of essential heavy metals in the aquatic ecosystem of Lake Manzala, Egypt. Heliyon, 5: e02276

El-Moselhy, Kh.M. (2002). Accumulation and toxicity of heavy metals in marine organisms. Article Review, Nat. Inst. Oceanogr. & Fish., P. 73.

El-Moselhy, Kh.M. and Gabal, M.N. (2004). Trace metals in water, sediments and marine organisms from the northern part of the Gulf of Suez, Red Sea. J. Mar. Sys., 46: 39–46.

El-Moselhy, Kh.M. and Hamed, M.A. (2006). Impact of land-based activities on hydrographic condition and level of heavy metals in water and sediments along the Mediterranean coast of Egypt. Egypt. J. Aquat. Res., 32 (2): 63-82.

El-Moselhy, Kh.M.; Diab, A.A.; Tolba, M.R. and Mohamadein, L.I. (1999). Levels of some heavy metals in coastal water, sediment and the limpet *Patella sp*. from the northern part of the Gulf of Suez (Suez Bay). Egypt. J. Aquat. Biol. & Fish., 3(2): 69-84.

El-Moselhy, Kh.M.; Saad, E.M.; El-Shaarway, R.F.; Mohamadein, L.I. and Mahmoud, S.A. (2016). Assessment of heavy metals pollution using sediments and bivalve *Brachidontes variabilis* as bioindicator in the Gulf of Suez, Egypt. Inter. J. Mar. Sci., 6(26): 1 – 13. doi: 10.5376/ijms.2016.06.0025

El-Moselhy, Kh.M.; El Samra, M.I. and Abd El-Azim, H. (2005). Concentration of nine heavy metals in Suez Canal waters, Egypt. *Egypt.* J. Aquat. Res., 31(2): 145-165.

El-Moselhy Kh.M.; Saad, E.M.; Elshaarawy, R.F. and Mahmoud, S.A. (2019). Monitoring of Cadmium (II) Ions in Seawater from Suez Bay, Egypt. Adv. Oceanogr. & Mar. Biol., 1(5): 1-3. DOI: 10.33552/AOMB.2020.01.000521

Hamed, M.A. (1996). Determination of some microelements in the aquatic ecosystem and their relation to the efficiency of aquatic life. Ph. D. Thesis. Fac. Sci., Mansoura Univ., 134 p.

Hamed, M.A. (2005): Accumulation of heavy metal ions in some economic Fishes of Bitter and Temsah Lakes, Egypt. J. Aquat. Biol. & Fish., 9(3):165-186

Hamed, M.A. and El-Moselhy, Kh.M. (2000). Levels of some metals in the coastal water and sediments of the Red Sea, Egypt. A.M.S.E., 61 (1, 2): 43- 57.

Hamed, M.A. and Emara, A.M. (2006). Marine molluscs as biomonitors for heavy metal levels in the Gulf of Suez, Red Sea. J. Mar. Sys., 60: 220–234.

Harrison, R.M. (2001). Pollution: causes, effects and control, fourth edition, Royal society of chemistry, Cambridge, ISBN 9780854046218, pp 579.

Hutchison, T.C. and Meema, K.M. (1987). Lead, mercury and arsenic in the environment. Scope 31, Chichester, John Wiley and Sans, 360 p.

Johnston, P.; Bakker, N.; Brigden, K. and Santillo, D. (2002). Evaluation of trace contamination from the Baia Sprie mine tailings impoundment, Romania. Greenpeace Res. Laboratories, Technical Note (GRL-TN), 12 pp.

Law, R.J.; Waldock, M.J.; Allchin, C.R.; Laslett, R.E. and Bailey, K.J. (1994). Contaminants in seawater around England and Wales: results from monitoring surveys, 1990-1992. Marine Pollution Bulletin 28(11):668-675.

Mahmoud, S.A. (2017). Monitoring and removing of heavy metals in the northern part of Suez Gulf using new chitosan composites. M.Sc. Thesis, Fac. Sci., Suez Univ., 153 p.

Saad, A-E.A.; Emam, W.M.; El-Moselhy, Kh.M.; Abou El-Naga, E.H. and Baleg, A.O. (2016). Comparative study on some heavy metals in water, sediments and fish along the Suez Canal, Egypt. Inter. J. Environ, Sci. & Engineer. (IJESE), 7: 19–29.

UNEP (1993). Preliminary assessment of the state of pollution of the Mediterranean Sea by zinc, copper and their compounds and proposed measures. Mediterranean Action Plan UNEP (OCA)/MED/WG.66/ Inf.3, Athens 3-7 May 1993.

USPHS (1997). Toxicological profile on CD-ROM. Agency for Toxic Substances and Disease Registry.

Zaghloul, Gh. Y. H. (2015). Organic and Inorganic pollutants in Suez Canal. Ph.D. Thesis, Fac. Sci. (Girls Br.), Al Azhar Univ., pp. 269.

Occurrence of trace elements in coastal seawater of the Egyptian Red Sea

تركيز العناصر النادرة في المياه الساحلية للبحر الأحمر، مصر

صفاء على محمود[١]، لمياء إسماعيل خليل محمدين[٢]، عادل سيد عرابي[٣]، خالد محمد المصيلحى[٢]، إيمان محمد مجاهد سعد[١]

١ قسم الكيمياء ، كلية العلوم ، جامعة السويس ، السويس ، مصر

٢ المعهد القومي لعلوم البحار والمصايد ، NIOF ، القاهرة ، مصر

٣ ـ قسم الكيمياء ـ كلية العلوم ـ جامعة قناة السويس ـ الإسماعيلية ـ مصر

* المؤلف المراسل: البريد الإلكتروني: khalidelmoselhy@yahoo.com

بريد إلكتروني المؤلف المشارك: (E.M. Saad) (emmsaad@yahoo.com

المستخلص

يساعد البحر الأحمر بدور رئيسي في الاقتصاد العالمي وذلك من خلال نقل الحاويات بين المحيط الهندي والبحر المتوسط، كما يختصر الطريق بين أسيا وأوروبا مقارنةً بالسفر حول أفريقيا خلال المحيط الأطلسي. بالإضافة إلى ذلك زيادة النمو والتطور في المناطق التي تحيط بالبحر الأحمر. كل هذه الأسباب تدفعنا إلى دراسة درجة التلوث على طول المناطق الساحلية للبحر الأحمر. لذا فإن الدراسة الحالية تهدف إلى رصد العناصر النادرة (الرصاص، الكادميوم، النحاس، الزنك، الكوبلت، النيكل، المنجنيز، الحديد) في مياه البحر من مناطق مختلفة على طول البحر الأحمر المصري. تم تجميع عينات المياه خلال موسمي الشتاء والصيف ٢٠١٩ من ١٩ محطة تمثل حالات بيئية مختلفة في خليج السويس وخليج العقبة والبحر الأحمر. وتم قياس تركيز العناصر قيد الدراسة باستخدام جهاز طيف الامتصاص الذرى. وقد سجلت العناصر متوسط تركيزات قدر بـ ١.١٣، ٠.٢٥، ١.٢٤، ١١.٦٥، ٠.٢٩، ٠.٩٧، ٠.٦٨ و ١٤.٦٧ ميكروجرام / لتر في خليج السويس؛ ١.٠٧، ٠.٢٥، ١.٢٧، ١١.٨٨، ٠.٣٩، ٠.٨٨، ١.١٩ و ١٢.٤٥ ميكروجرام / لتر في خليج العقبة و ٠.٧٦، ٠.١٨، ٠.٩٥، ١٢.٢٨، ٠.٢٤، ٠.٦٣، ٠.٤٥ و ١٥.٢٢ ميكروجرام / لتر في البحر الأحمر لكل من الرصاص، الكادميوم، النحاس، الزنك، الكوبلت، النيكل، المنجنيز، الحديد، على التوالي. كما سجل الصيف أعلى مستوى لكل العناصر قيد الدراسة ماعدا الكادميوم والمنجنيز، مع اختلافات زمنية معنوية ($p < ٠.٠٥$) لكل من النحاس، الزنك، الكوبلت، النيكل والحديد. سجل خليج السويس أعلى تركيزات للرصاص، الكادميوم والنيكل، بينما التركيز الأعلى للنحاس، الزنك، الكوبلت، المنجنيز والحديد كان في خليج العقبة والبحر الأحمر، مع اختلافات معنوية فقط للنيكل والمنجنيز ($p = ٠.٠٠٤$ و ٠.٠٢٥، على التوالي) بين مناطق الدراسة المختلفة. وفى النهاية، فإن مستوى العناصر قيد الدراسة في المياه من البحر الأحمر المصري كانت أعلى من تلك المسجلة للتركيزات المرجعية في المحيطات المفتوحة، ولكن ما زالت أقل من القيم الموصى بها لجودة المياه.