If you succeed in protecting the environment, by default you protect the sustainability of your community…

Evaluation of Anthropogenic and Geogenic Impacts on Marine Sediments of Egyptian Sector of the Red Sea by NAA and ICP-MS

By

Wael Badawy Ged, Atef El-Taher, Marina V. Frontasyeva, Hashem A. Madkour, and Ashraf E. M. Khater

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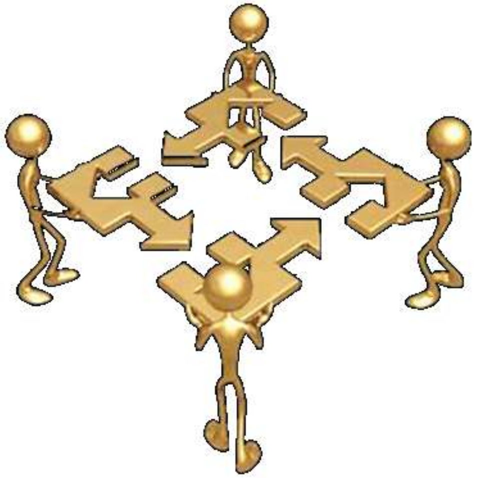
ISINN-26

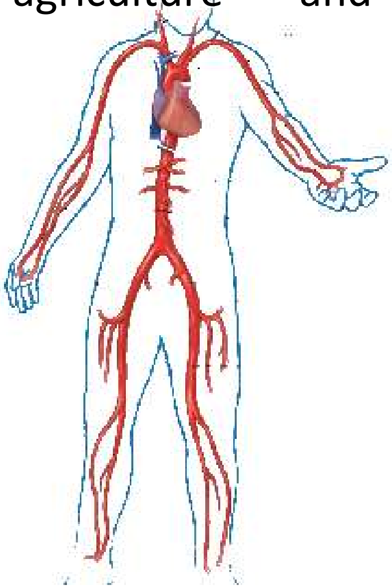
Xi'an, China, May 28th-June 1st, 2018

PROJECTS

- **1st Phase**
  - Assessment of the environmental situation in the basin of the River Nile using nuclear and related analytical techniques (2011-2014).
- **2nd Phase**
  - Environmental studies in Egypt using neutron activation analysis and other analytical techniques (2015-2018).
- **3rd Phase**
  - Assessment of the environmental situation in the marine ecosystems in Egypt using neutron activation analysis and other analytical techniques (2018-2020).



- Almost all population 91.6 M lives along the Nile River and Nile Delta.
- The Nile River is an artery for Egypt because of its being the main source of fresh water for all forms of life.
- Trace and major elements in soil and sediments
- Geology, geography, agriculture and aquaculture.



Outcomes of previous phases

ISSN 1547-4771, Physics of Particles and Nuclei Letters, 2015, Vol. 12, No. 4, pp. 637–644. © Pleiades Publishing, Ltd., 2015.

RADIOBIOLOGY, ECOLOGY AND NUCLEAR MEDICINE

Instrumental Neutron Activation Analysis of Soil and Sediment Samples from Siwa Oasis, Egypt[1]

Wael M. Badawy[a], Khaled Ali[b], Hussein M. El-Samman[c], Marina V. Frontasyeva[d], Svetlana F. Gundorina[d], and Octavian G. Duliu[e]

S. Harb., et al.: Estimation of Radioecological Parameters of Soil Samples ...
Nuclear Technology & Radiation Protection: Year 2016, Vol. 31, No. 2, pp. 165-172 165

ESTIMATION OF RADIOECOLOGICAL PARAMETERS OF SOIL SAMPLES FROM A PHOSPHATIC AREA

by

Shaaban HARB [1], Noor AHMED [1], Wael BADAWY [2], and Nagwa SAAD [1]*

Journal of Computational and Theoretical Nanoscience
Vol. 14, 1357–1361, 2017

Modeling the Coordination Between Na, Mg, Ca, Fe, Ni, and Zn with Organic Acids

Ali Okasha[1], Diaa Atta[1], Wael M. Badawy[2,3], Marina V. Frontasyeva[3,*], Hanan Elhaes[4], and Medhat Ibrahim[1,*]

Journal of African Earth Sciences 107 (2015) 57–64

Contents lists available at ScienceDirect

Journal of African Earth Sciences

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Geochemistry of sediments and surface soils from the Nile Delta and lower Nile valley studied by epithermal neutron activation analysis

Wafaa M. Arafa[a], Wael M. Badawy[b,d], Naglaa M. Fahmi[c], Khaled Ali[d], Mohamed S. Gad[e], Octavian G. Duliu[f], Marina V. Frontasyeva[d,*], Eiliv Steinnes[h]

Contents lists available at ScienceDirect

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Major and trace element distribution in soil and sediments from the Egyptian central Nile Valley

W.M. Badawy[a,e,*], E.H. Ghanim[b], O.G. Duliu[c,e], H. El Samman[d], M.V. Frontasyeva[e]

DE GRUYTER OPEN

DOI: 10.1515/eces-2016-0021 ECOL CHEM ENG S. 2016;23(2):297-310

Wael BADAWY[1,2*], Olesya Ye. CHEPURCHENKO[2], Hussein EL SAMMAN[3] and Marina V. FRONTASYEVA[2]

ASSESSMENT OF INDUSTRIAL CONTAMINATION OF AGRICULTURAL SOIL ADJACENT TO SADAT CITY, EGYPT

Con’t

1. Arafa, W.M., Badawy, W.M., Fahmi, N.M., Ali, K., Gad, M.S., Steinnes, E., 2015. Geochemistry of sediments and surface soils Nile valley studied by epithermal neutron activation analysis. Jo 107, 57-64, 10.1016/j.jafrearsci.2015.04.004.
2. Badawy, W., Chepurchenko, O.Y., El Samman, H., Frontasyev industrial contamination of agricultural soil adjacent to Sadat City, Egypt. Ecological Chemistry and Engineering S 23, 297-310, 10.1515/eces-2016-0021.
3. Badawy, W.M., Ali, K., El-Samman, H.M., Frontasyeva, M.V., Gundorina, S.F., Duliu, O.G., 2015. Instrumental neutron activation analysis of soil and sediment samples from Siwa Oasis, Egypt. Physics of Particles and Nuclei Letters 12, 637-644, 10.1134/s154747711504007x.
4. Badawy, W.M., Ghanim, E.H., Duliu, O.G., El Samman, H., Frontasyeva, M.V., 2017. Major and trace element distribution in soil and sediments from the Egyptian central Nile Valley. Journal of African Earth Sciences, http://doi.org/10.1016/j.jafrearsci.2017.03.029.
5. Harb, S., Ahmed, N., Badawy, W., Saad, N., 2016. Estimation of radioecological parameters of soil samples from a phosphatic area. Nuclear Technology and Radiation Protection 31, 165-172, 10.2298/NTRP1602165H.
6. Modeling the Coordination between Na, Mg, Ca, Fe, Ni, and Zn with Organic Acids, Ali Okasha, Diaa Atta, Wael M. Badawy, Marina V. Frontasyeva, Hanan Elhaes and Medhat Ibrahim. Journal of Computational and Theoretical Nanoscience, 2017, Vol. 14, p. 1-5. Doi:10.1166/jctn.2017.6457

Introduction

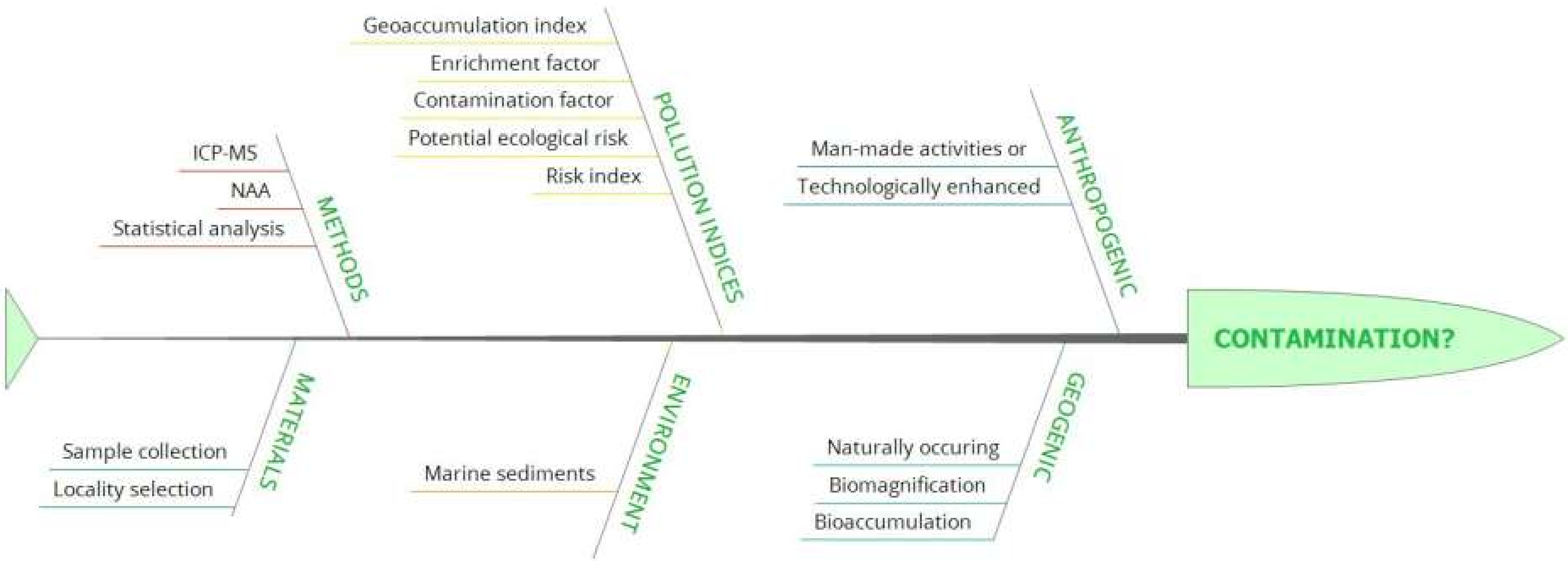
- The name of the sea may signify the seasonal blooms of the red-colored near the water's surface. Red Sea is bordered by 10 countries. One of the most prominent characteristics of the Red Sea is its use as a conjunction and transportation between the north (Mediterranean Sea) and south (Indian Ocean).
- The Red Sea has a surface area of roughly 438,000 km^2, is about 2250 km long and, at its widest point 355 km wide. It has an average depth of 490 m.

Con't

- The Red Sea is unique in all respects, including its tectonic history, environment and biology. The Red Sea is a marine biodiversity hotspot with abundant coral reefs, mangroves, and seagrass habitats.
- The main environmental problems and threats to the Red Sea include oil pollution, water pollution, solid waste disposal, navigation activities, phosphate shipment pollution, and fishing activities.

Root – Cause analysis

Fishbone diagram



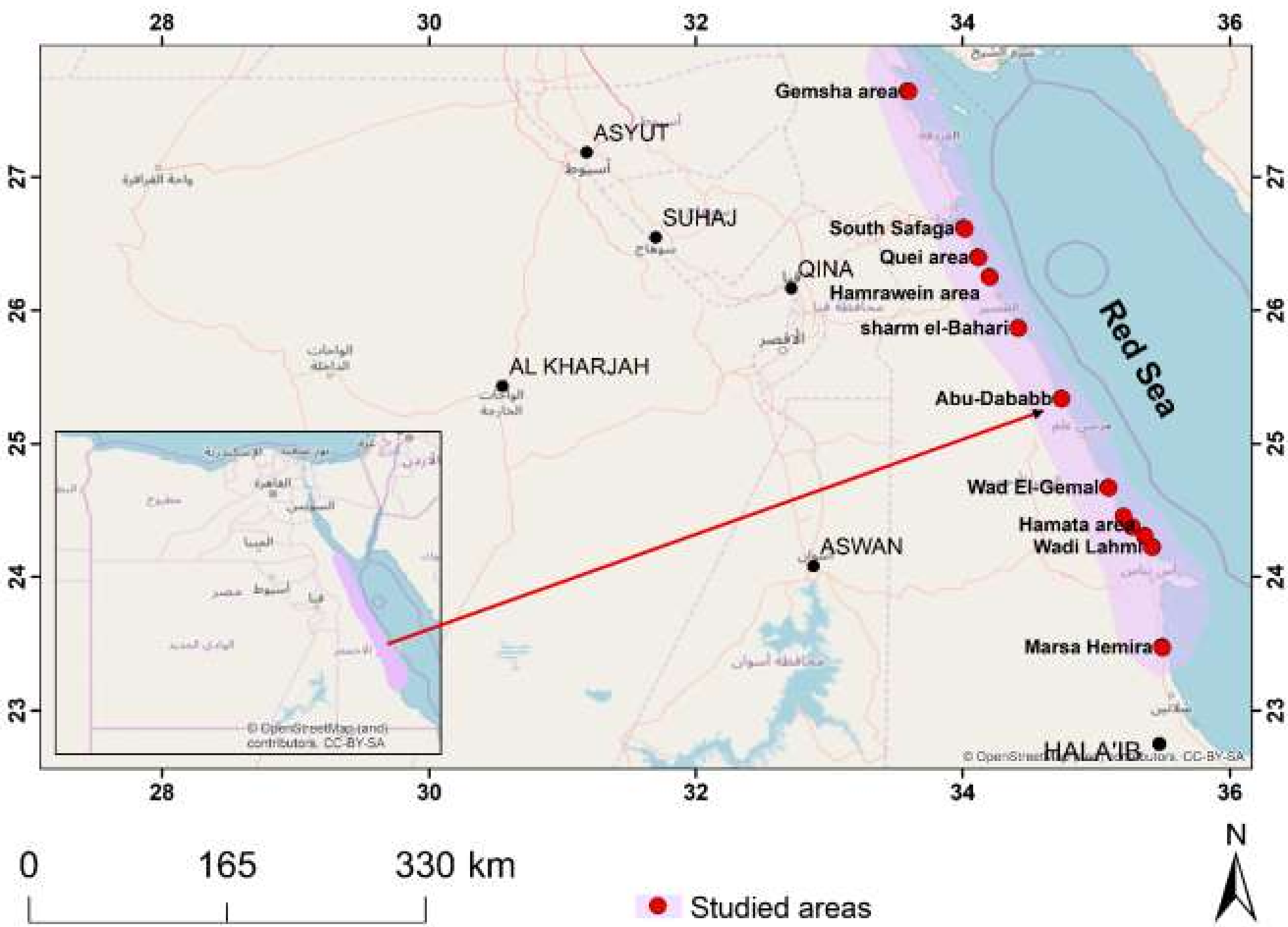
Whys analysis?

Materials

Marine sediments

- Sampling
- Area selection

- *12 coastal areas*
- *32 marine sediment*
- *Phosphate mines and sea ports*
- *Oil shipping*



Area	Samples
South Safaga	3
Abu-Ghusun	2
Wad El-Gemal	3
Qola'an	2
Sharm El-Bahari	3
Gemsha	3
Abu-Dabab	4
Wadi Lahmi	3
Hamata	2
Quei	2
Hamrawein	3
Marsa Hemira	3

Sample preparation and analyzation

- ✓ A 30 g aliquot, if available, is encapsulated in a polyethylene vial and irradiated with flux wires and an internal standard (1 for 11 samples) at a thermal neutron flux of 7×10^{12} n $cm^{-2}s^{-1}$ (Hoffman, 1992).
- ✓ While, for ICP-MS, a 0.25 g sample is digested at 260°C with four acids beginning with hydrofluoric, followed by a mixture of nitric and perchloric acids, heated using precise programmer controlled heating in several ramping and holding cycles which takes the samples to dryness. Digested samples are diluted and analyzed by Perkin Elmer Sciex ELAN 6000, 6100 or 9000 ICP/MS.

Methods

- Instrumental
  - NAA
  - ICP-MS

- *43 elements were determined by the two techniques including 6 USEPA priority pollutants (Zn, As, Cr, Pb, Ni, and Cu).*

- Statistical
  - Descriptive
  - Normality
  - PCA with CLR transformation

- *Descriptive statistics*
- *Shapiro-Wilk normality test was calculated.*

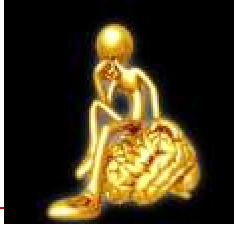
The way you look at data counts…

Plant Signal Behav. 2011 Jan; 6(1): 113–116.
Published online 2011 Jan 1. doi: 10.4161/psb.6.1.14191

To transform or not to transform:
That is the dilemma in the statistical analysis of plant volatiles

Yuvaraj Ranganathan and Renee M Borges

- PCA is a multivariate technique for transforming a set of related (correlated) variables into a set of unrelated (uncorrelated) variables that account for decreasing proportions of the variation of the original observations. The main aim of PCA is to explain the maximum amount of variance with the fewest number of principal components.
- Centered log ratio transformation is to construct a transformed matrix to un-constrain the data to reveal straight interpretations.



Results

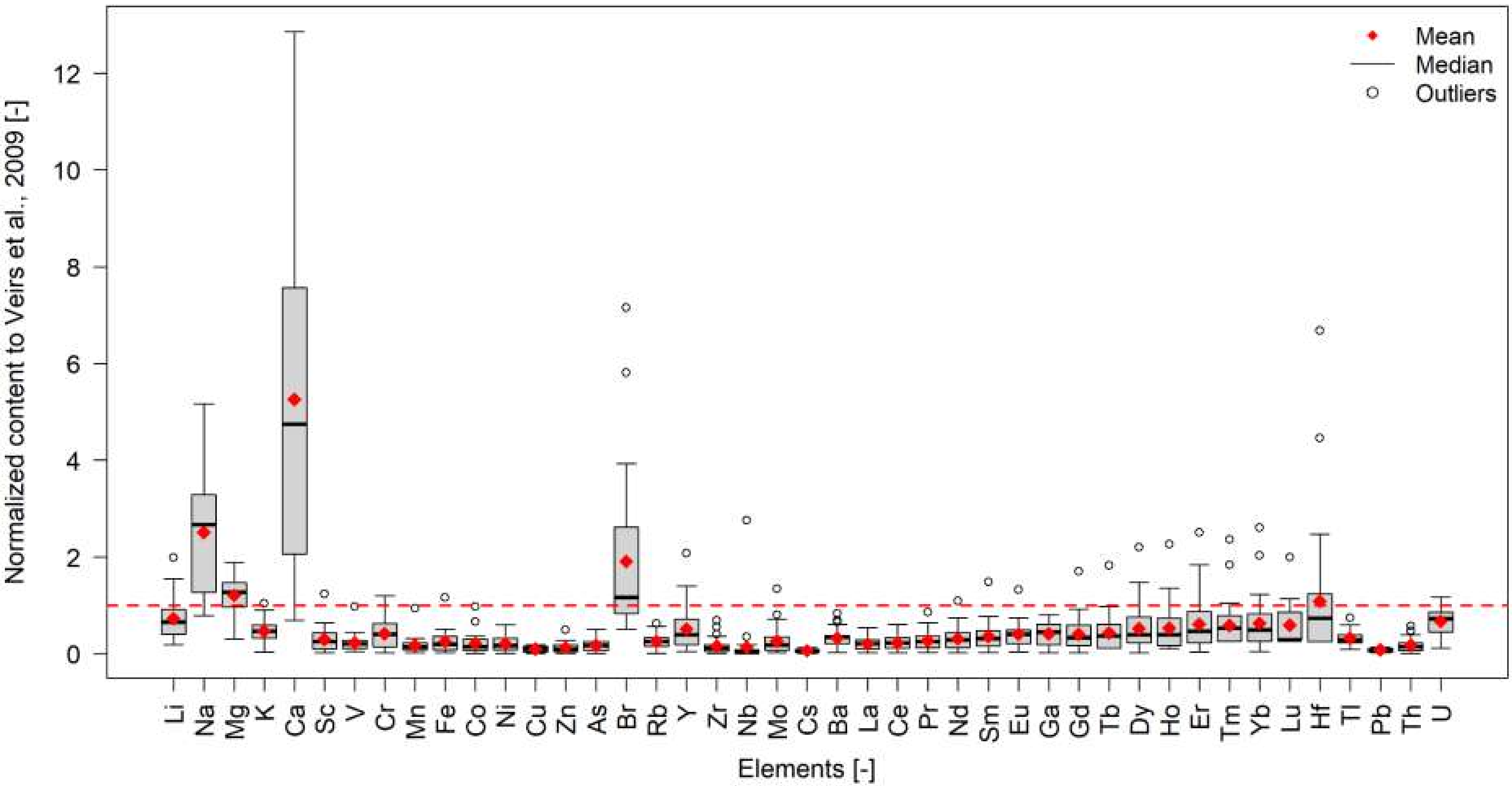
Multi-elemental analysis

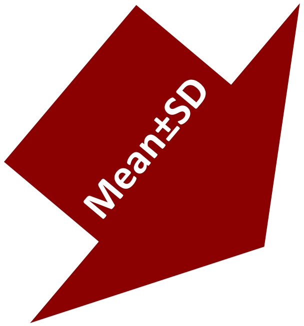
Pollution indices

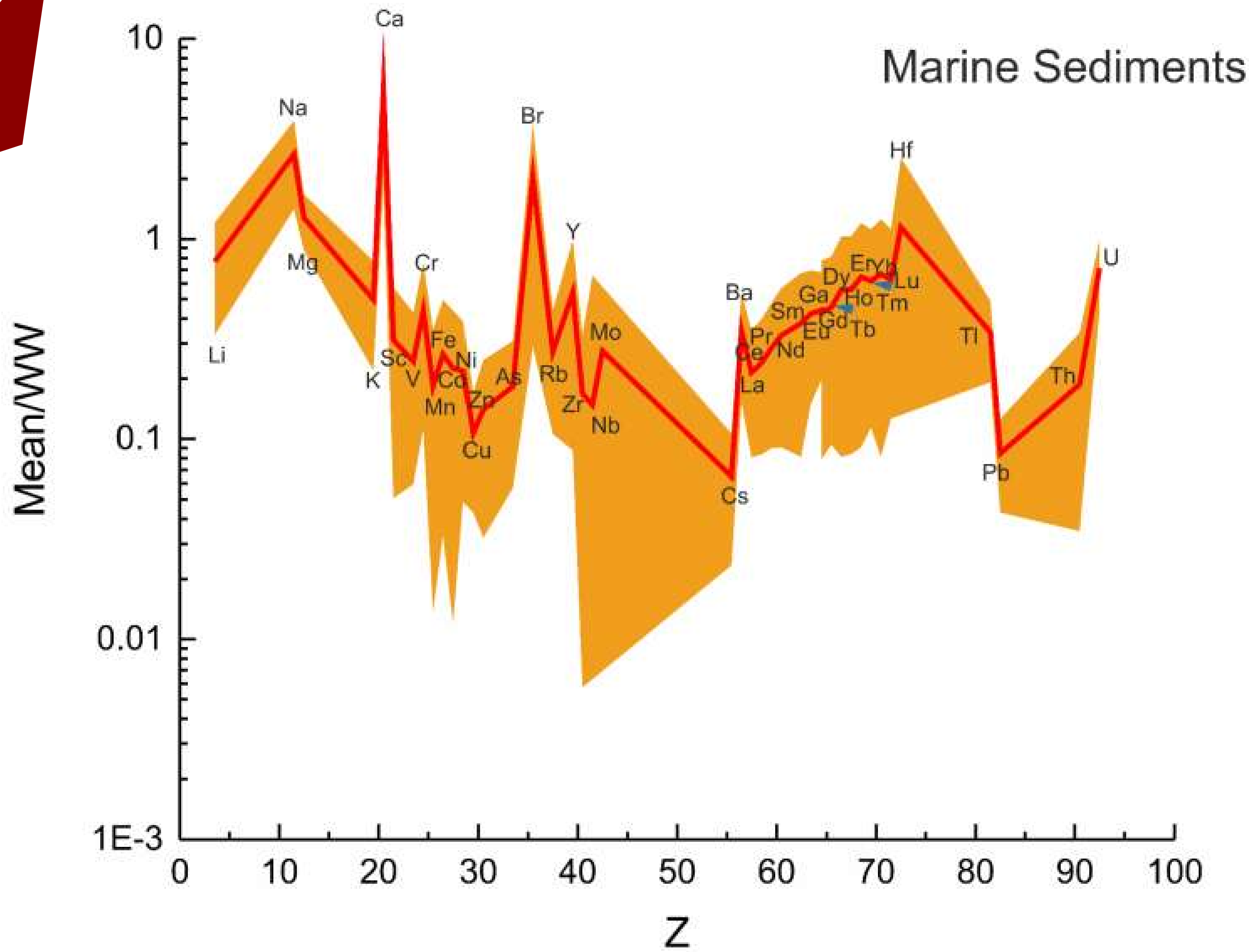
- Metal pollution index
- Enrichment factor
- Geoaccumulation index
- Contamination factor
- Potential ecological risk index
- Risk index

Box-plot

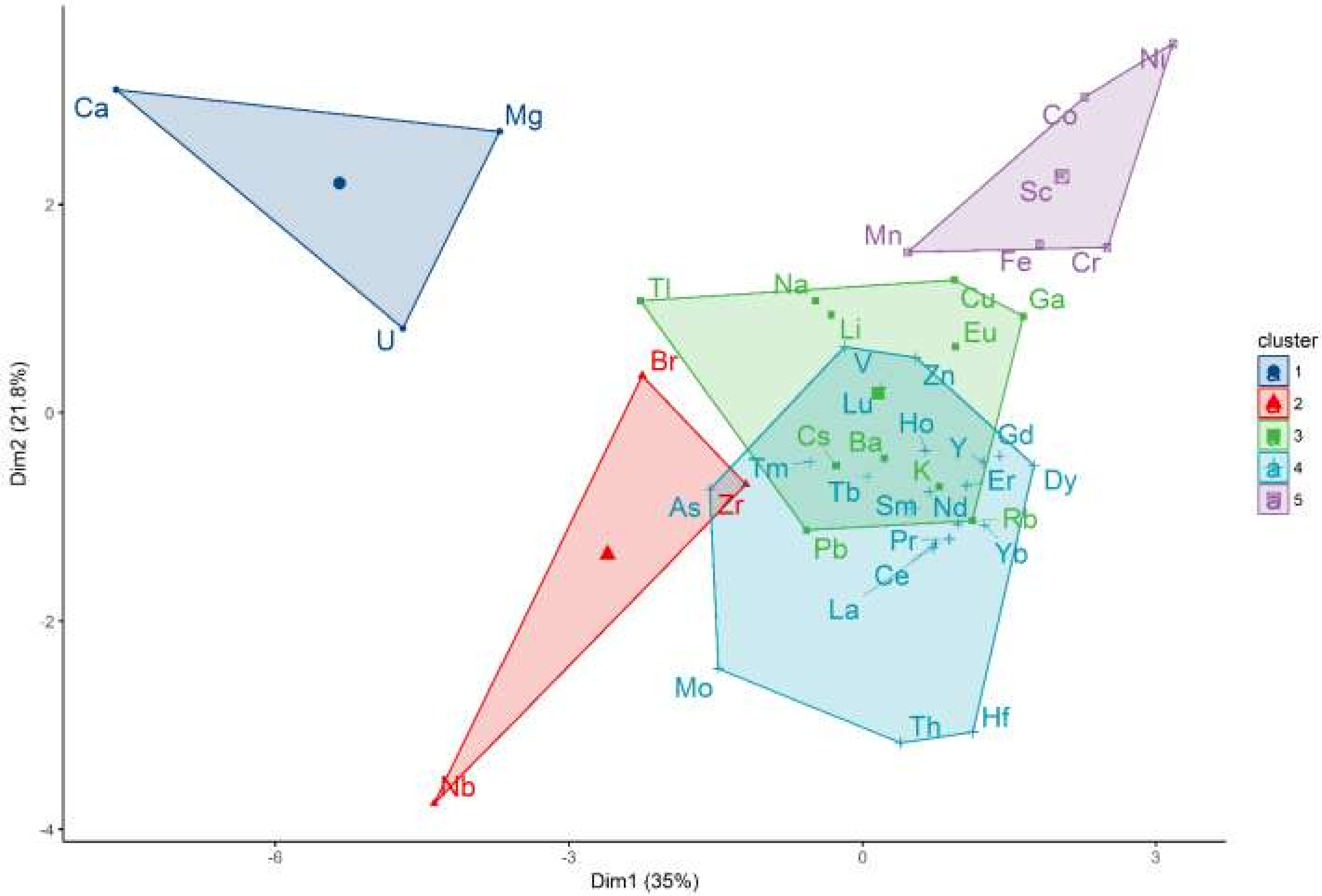
Viers-Normalized content of 43 elements in marine sediments



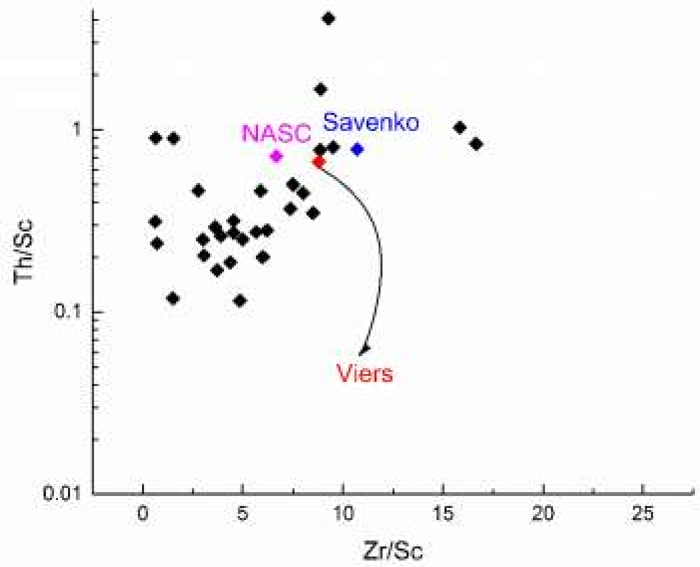

Mean±SD


Marine Sediments
Mean/WW
Z
10
1
0.1
0.01
1E-3
0
10
20
30
40
50
60
70
80
90
100
Li
Na
Mg
K
Ca
Sc
V
Cr
Mn
Fe
Co
Ni
Cu
Zn
As
Br
Rb
Y
Zr
Nb
Mo
Cs
Ba
La
Ce
Pr
Nd
Sm
Eu
Gd
Tb
Dy
Ho
Er
Tm
Yb
Lu
Hf
Tl
Pb
Th
U
Ga

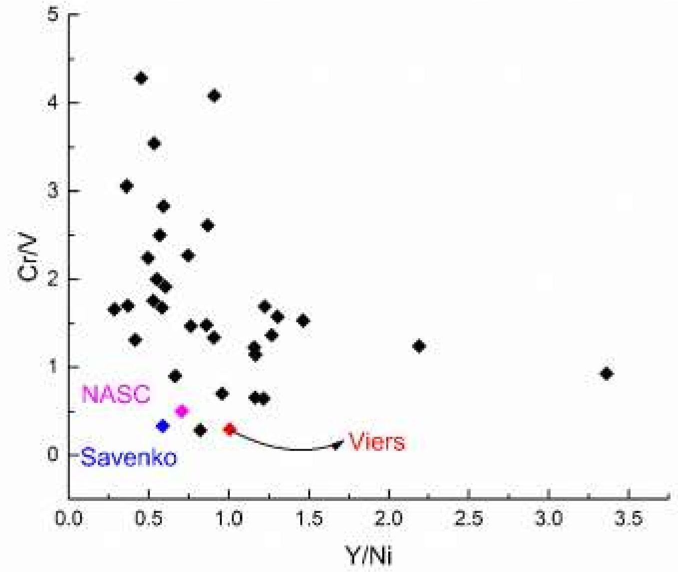
Factor map including all 43 elements investigated based on centered log-ratio transformation. PCA revealed 5 clusters as shown.

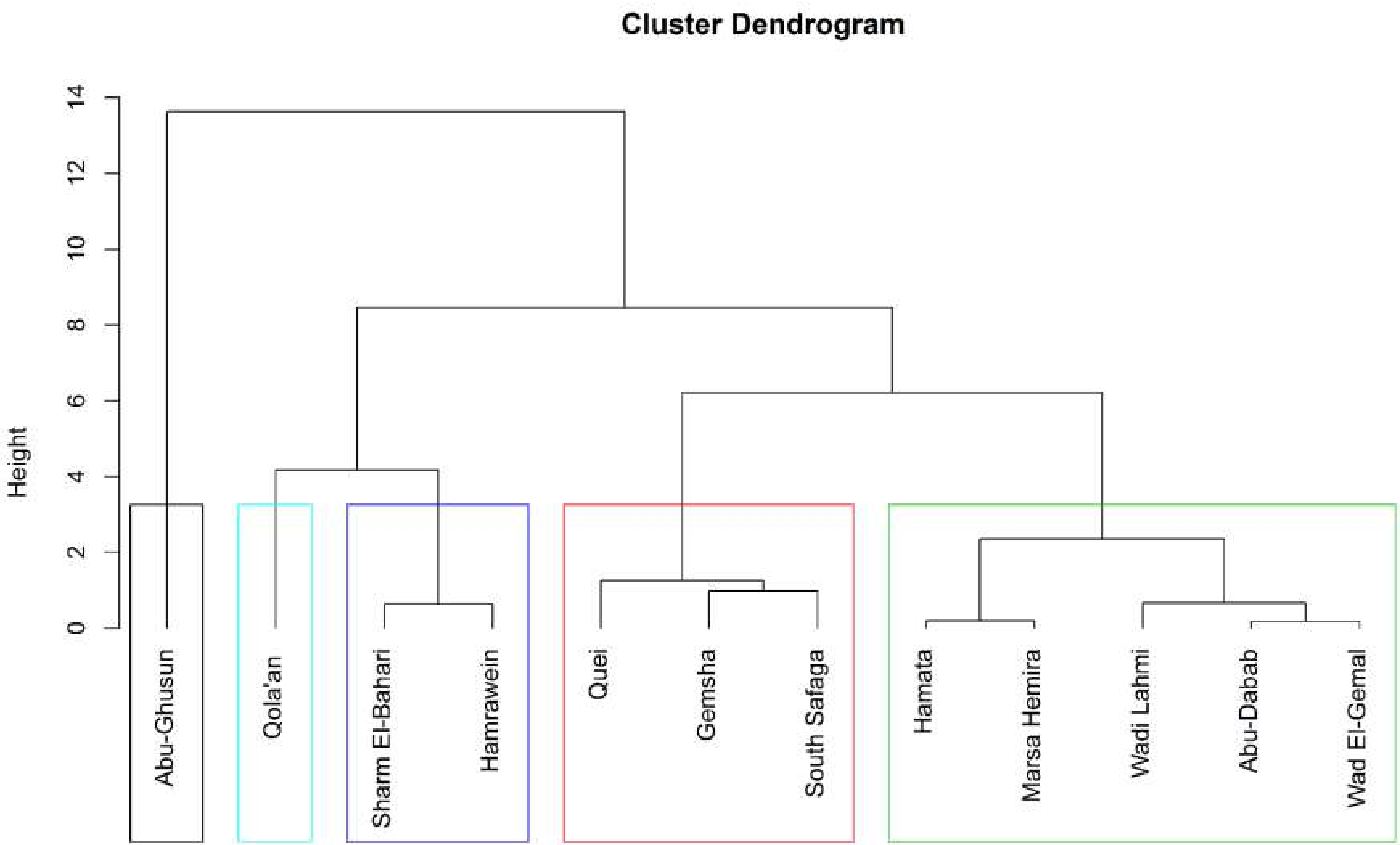


Sedimentary recycling monitor



Ferromagnesian trace elements monitor

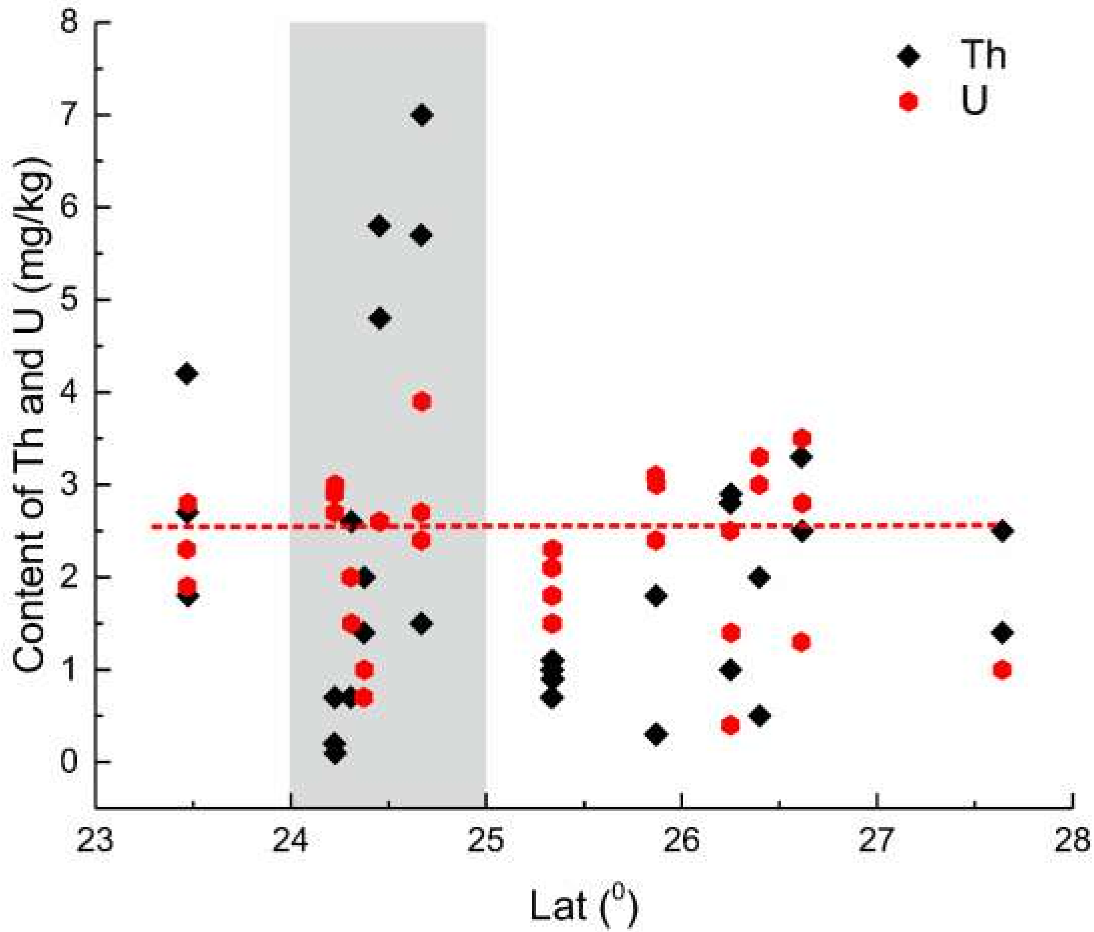


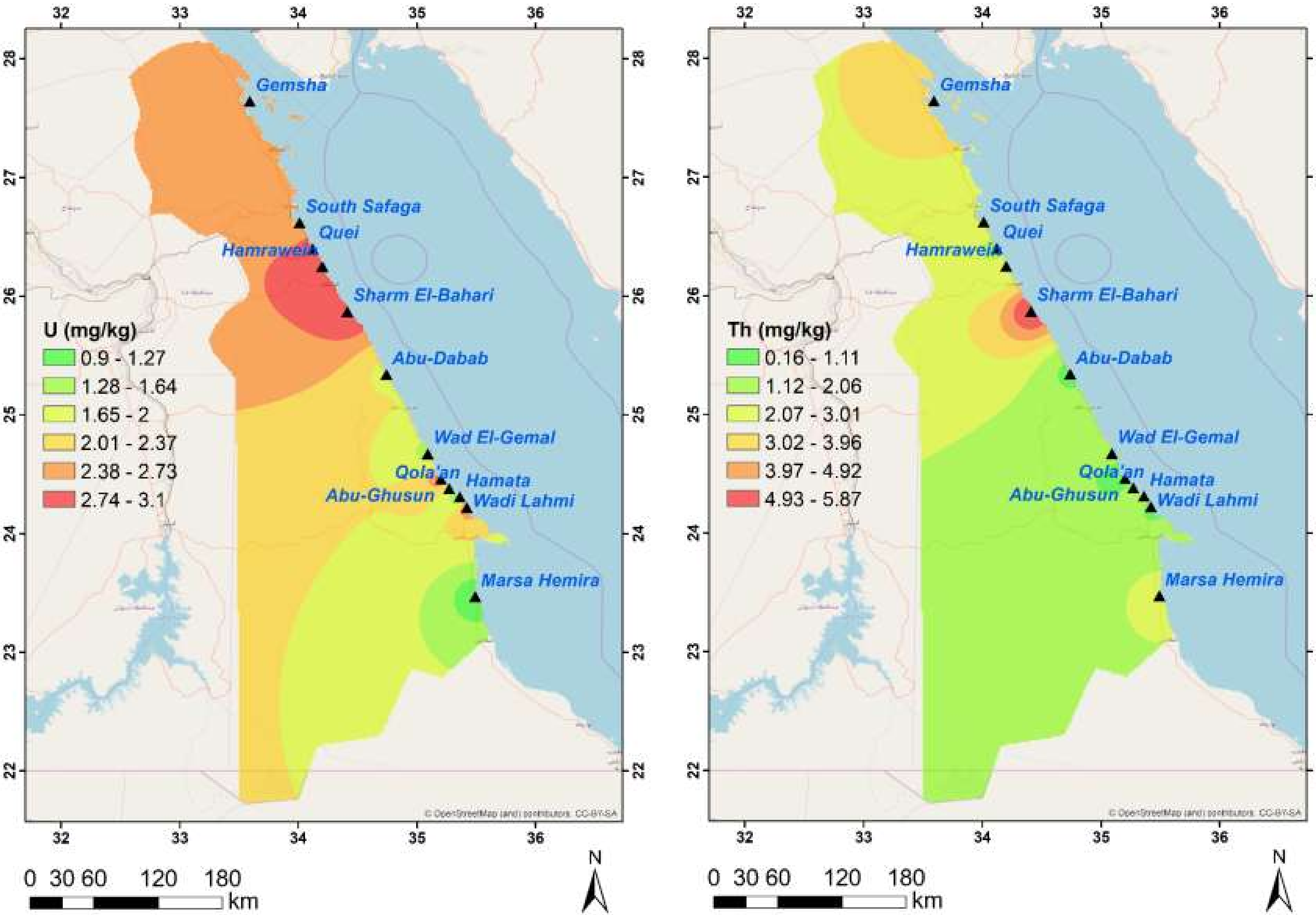


Five clusters

Distribution of Thorium and Uranium

- Slight increment of the contents of Th and U were observed between Latitudes 24° and 25°. This area is characterized by phosphate mines and industries, Red Sea harbors and granitic rocks.
- The obtained results are compared with those weighted worldwide and the Th/U ratio ≈ 1 seems to be less than reported by (Viers et al., 2009) 3.7, (Martin and Meybeck, 1979) 4.7, (Savenko, 1986) 4.2, (Rudnick and Gao, 2014) 3.9 in UCC and finally by (Badawy et al., 2017) 4.8.




U (mg/kg)
0.9 - 1.27
1.28 - 1.64
1.65 - 2
2.01 - 2.37
2.38 - 2.73
2.74 - 3.1
Th (mg/kg)
0.16 - 1.11
1.12 - 2.06
2.07 - 3.01
3.02 - 3.96
3.97 - 4.92
4.93 - 5.87
Gemsha
South Safaga
Quei
Hamraweia
Sharm El-Bahari
Abu-Dabab
Wad El-Gemal
Qola'an
Hamata
Abu-Ghusun
Wadi Lahmi
Marsa Hemira
0 30 60 120 180
km
N

Remarks on contamination assessment using pollution indices

- All of contamination indices are given and calculated based mainly on the enrichment or leaching ratio in its simple form (measured value divided by the background or reference value).
- A selected 6 US EPA pollutants vis., Zn, As, Cr, Pb, Ni, and Cu are considered in the present work.

Enriched elements EF

EF Value	Category	Enriched elements
EF < 1	No enrichment	Zn, Pb, Ni, Cu
1 < EF > 3	Minor enrichment	As, Cr
3 < EF > 5	Moderate enrichment	
5 < EF > 10	Moderate to strong enrichment	
10 < EF > 25	Strong enrichment	
25 < EF > 50	Very strong enrichment	
EF > 50	Extremely strong enrichment	

Geoaccumulation factor I_{geo}

Metal	I_{geo}	EF
Zn	-3.94	0.67
As	-3.59	**1.20**
Cr	-2.40	**1.83**
Pb	-4.46	0.50
Ni	-3.49	0.87
Cu	-4.25	0.54

Pollution indices

Contamination factor Cf

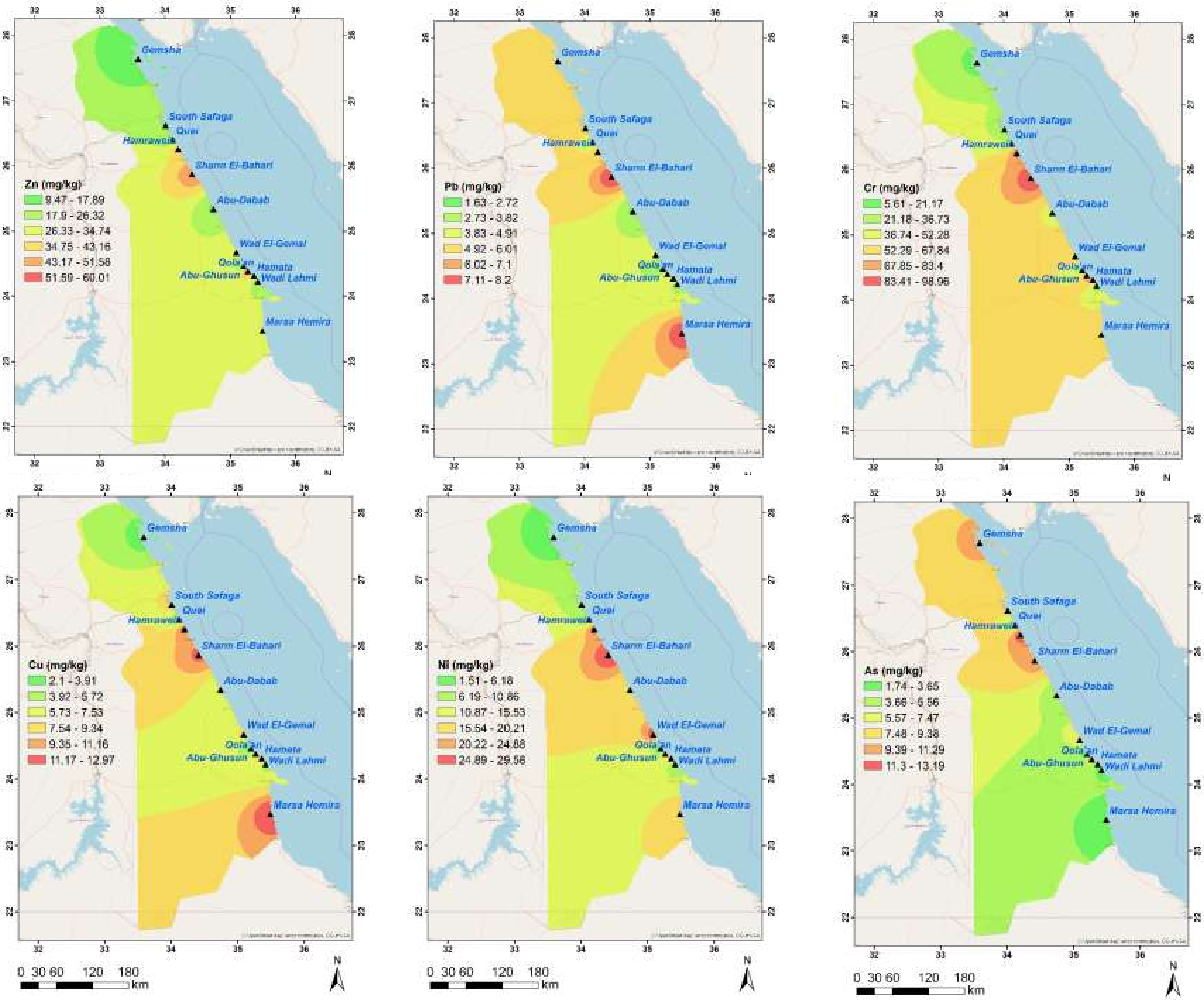
Cf Value	Category	Elements
$C_f < 1$	Low contamination	Zn, As, Cr, Pb, Ni, Cu
$1 \leq C_f < 3$	Moderate contamination	
$3 \leq C_f < 6$	Considerable contamination	
$C_f \geq 6$	Very high contamination	

Degree of contamination factor Cd

Degree of Cf Value	Category	Elements
$C_d < 8$	low degree	Zn, As, Pb, Ni, Cu
$8 \leq C_d < 16$	Moderate degree	Cr
$16 \leq C_d < 32$	Considerable degree	
$C_d \geq 32$	Very high degree	

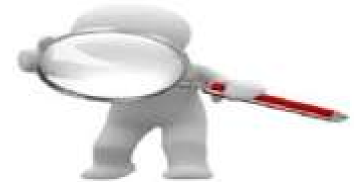
Potential ecological risk PER and Risk Index RI

PER value	RI value	Category	Elements
PER < 40	RI < 150	low potential ecological risk	Zn, As, Pb, Ni, Cu, Cr
40 ≤ PER < 80	150 ≤ RI < 300	moderate potential ecological risk	
80 ≤ PER < 160	300 ≤ RI < 600	considerable potential ecological risk	
160 ≤ PER > 320	RI ≥ 600	high potential ecological risk	
PER ≥ 320	RI < 150	very high ecological risk	



Gemsha
South Safaga
Quei
Hamrawein
Sharm El-Bahari
Abu-Dabab
Wadi El-Gemal
Qola'an
Hamata
Abu-Ghusun
Wadi Lahmi
Marsa Hemira
Zn (mg/kg)
9.47 - 17.89
17.9 - 26.32
26.33 - 34.74
34.75 - 43.16
43.17 - 51.58
51.59 - 60.01
Pb (mg/kg)
1.63 - 2.72
2.73 - 3.82
3.83 - 4.91
4.92 - 6.01
6.02 - 7.1
7.11 - 8.2
Cr (mg/kg)
5.61 - 21.17
21.18 - 36.73
36.74 - 52.28
52.29 - 67.84
67.85 - 83.4
83.41 - 98.96
Cu (mg/kg)
2.1 - 3.91
3.92 - 5.72
5.73 - 7.53
7.54 - 9.34
9.35 - 11.16
11.17 - 12.97
Ni (mg/kg)
1.51 - 6.18
6.19 - 10.86
10.87 - 15.53
15.54 - 20.21
20.22 - 24.88
24.89 - 29.56
As (mg/kg)
1.74 - 3.65
3.66 - 5.56
5.57 - 7.47
7.48 - 9.38
9.39 - 11.29
11.3 - 13.19
0 30 60 120 180
km
N

Overall outcomes



- Overall data shows that concentrations of the elements are less than the corresponding data published locally and regionally with an exception for Ca, Na, Br, Mg, and Hf.
- The ratio of Zr/Sc shows slight enrichment of zircon resulting from sedimentary sorting and recycling.
- The distribution of Th and U versus latitude shows a uniform distribution along the coastal areas of the Egyptian Red Sea except the areas between latitudes 24^{o} and 25^{o} to be slight increment in the content of Th and U. The spatial maps of Th and U show peak values in two areas viz., Sharm El-Bahari area and Qola'an.
- All the calculated contamination indices show that the concentrations do not pose possible potential risk to the environment except a minor enrichment of As and Cr was observed.

Con’t

- Spatial maps show that the peak values are located in Sharm El-Bahari and it may be explained by the existence of the Seaport.
- The obtained results are representing bank of data that may be used by other scientists for analyses according to their tasks and allow us to construct a radioecological atlas for Egypt from two points of view (radiological and ecotoxicological).
- Overall outcome, the distributions of possible pollutants such suggest that the investigated areas of the Red Sea is NOT seriously contaminated with heavy elements, so that, in spite of human activities, the Egyptian section of the Red Sea continues to be less affected by any anthropogenic activity.

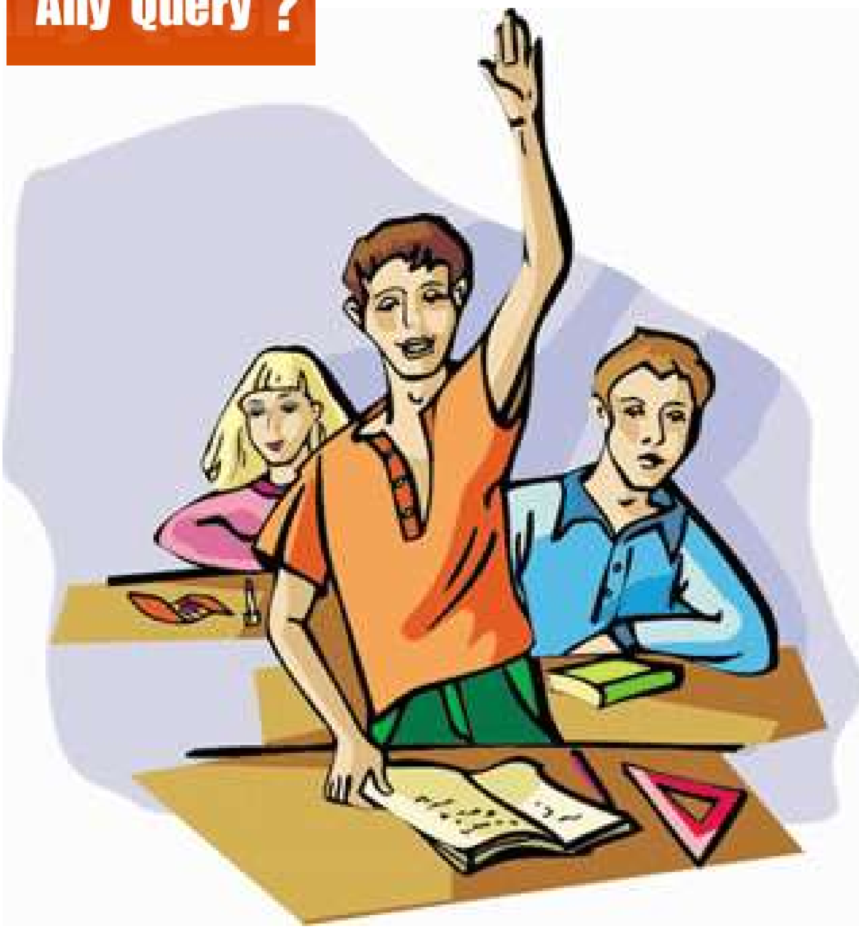
Prospective

- Ecological situation assessment using different biotic and abiotic components of the marine ecosystems of the Egyptian Red Sea coast and air pollution by means of NAA using:
  - Moss Bags
  - Marine sediments,
  - coral reefs,
  - mangrove,
  - algae,
  - Molluscs…etc.





Any Query ?



Thanks for your paying attention

Choose a job you love and you will never have to work a day in your life.

***Confucius: 551-* 479 B.C.**