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(Mg Na K Mn Al Zn Sb Pb Ni Cu Cr Co)

Sr As

Ni

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۴۴°،۵۹′،۵۱" ۴۴°،۴۷′،۲۴"

۳۹°،۱۱′،۲۷" ۳۹°،۰۰′،۲۱"

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Q_t Q_{al} Q_f

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ETM⁺

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Cd As

Al Fe Zn Sr Sn Sb Pb Ni Cu Cr Co
Mg Ca Na K Mn

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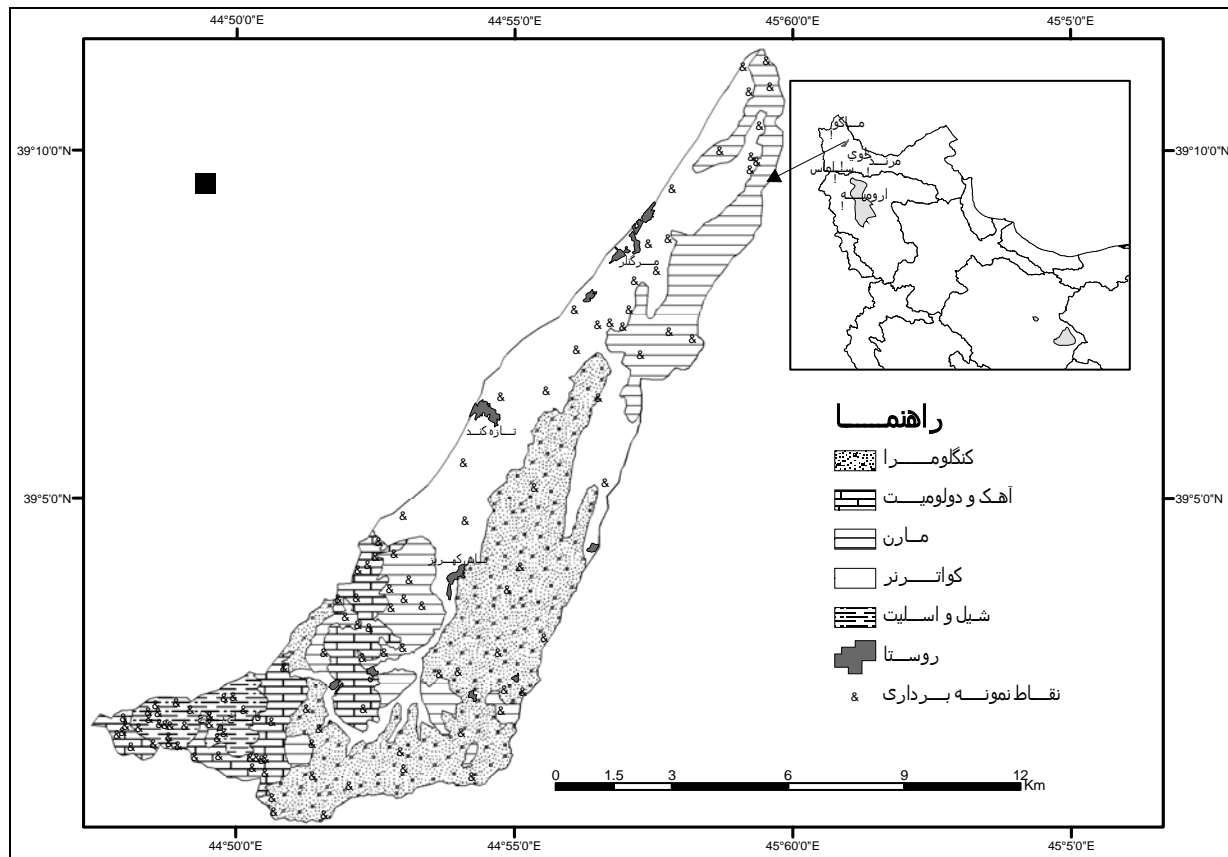
ICP- AES ICP- MS

HNO₃ HF)

(HCL HClO₃

)

/		Q _{al})	(
/		Q _f		
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/		QPL		
/		OMs		
/		OMq ²		
/		UT		
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$$Z_{jk} = a + W_1 X_{1k} + W_2 X_{2k} + \dots + W_n X_{nk} \quad ()$$

()

$$W_i = \frac{Z_j - Z_{jk}}{\sum_{i=1}^k X_{ik}} \quad ()$$

()

$$()$$

...

Q / (Press's Q NG) (NG-1) (

Q :

$$press's Q = \frac{[N - (nK)]^2}{N(K - 1)} \quad ()$$

n N
K

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F

F
/ /

$$i \quad)^* \quad j \quad ()$$

$$= (j \quad i \quad j$$

$$) / (\quad) ()$$

$$j \quad = (j$$

)

Discriminant loadings
Potency index

Hit ratio

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Kruskal – Wallis

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() ()
/

() (Median ± MAD) ()

MAD

Median

Kolmogorov

Shapiro – Wilks - Smirnov

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MAD = / Median (| $x_i - x_{median}$ |) ()

()

() Box's M

() P

Boxplot

Quantile – Quantile plot

Collinearity

Multicollinearity

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i

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$$MD_i = ((X_i - \bar{X})^T C^{-1} (X_i - \bar{X}))^{1/2} \quad ()$$

()

Na K Pb Cu Cr

$$\bar{X} \quad i \quad X_i$$

$$C \quad (\quad)$$

(MD)

t

$$\frac{MD^2}{df}$$

() t

t

(df)

()

Box's M

(Median ± MAD)

()

Cd Sr As Ca

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$$\frac{MD^2}{df}$$

(df)

t

()

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$$\frac{MD^2}{df}$$

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t

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Bartlett

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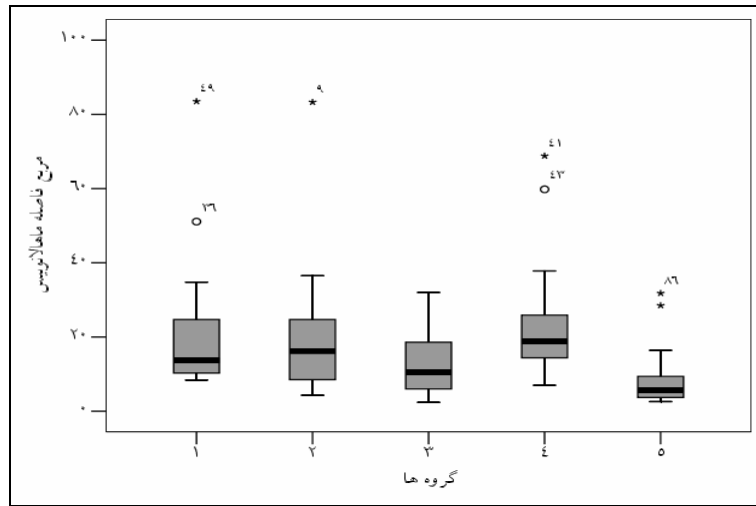
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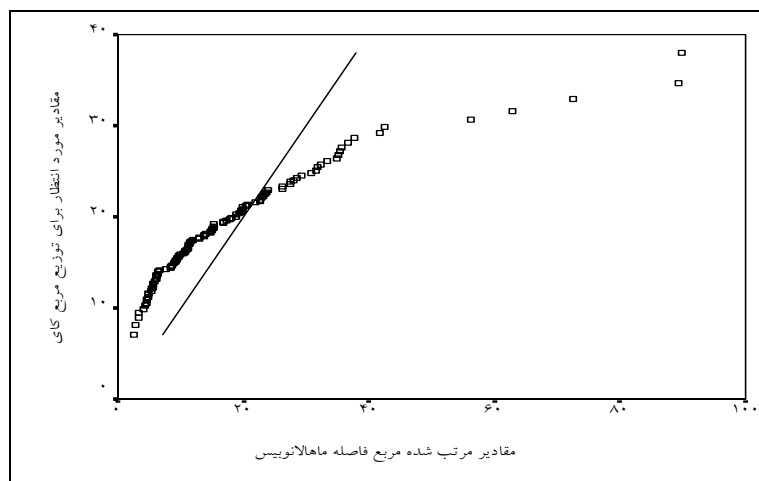
Sn Ni Fe Co Ca Al

()

Median± MAD						()
	1/74	3/01	1/08	6/45	6/30	(%) Al
	254/00	2/70	29/15	12/10	19/97	(ppm) As
	26/70	0/11	4/16	1/08	9/09	(%) Ca
	0/56	0/08	0/08	0/17	0/19	(ppm) Cd
	41/90	7/10	5/33	22/65	21/74	(ppm) Co
	525/00	40/00	106/73	220/50	231/91	(ppm) Cr
	64/30	14/00	9/74	37/35	37/66	(ppm)Cu
	7/21	1/51	0/79	4/11	3/97	(%) Fe
	2/15	0/62	0/33	1/39	1/36	(%) K
	5/63	0/93	0/11	2/11	2/64	(%) Mg
	1110/00	200/00	190/32	1110/00	767/05	(ppm) Mn
	1/57	0/07	0/27	0/99	0/96	(%) Na
	502/00	36/40	73/73	155/00	153/61	(ppm) Ni
	29/30	5/90	3/13	12/75	13/11	(ppm) Pb
	1/10	0/25	0/20	0/54	0/51	(ppm) Sb
	3/30	0/70	0/55	1/70	1/74	(ppm) Sn
	3230/00	103/00	324/41	307/50	361/52	(ppm) Sr
	124/00	34/00	14/96	76/00	75/19	(ppm) Zn



	/	/	Ni	/	/	/	Cu	/	/	/	Al
/	/	/	Pb	/	/	/	Fe	/	.	/	As
/	/	/	Sb	/	/	/	k	/	/	/	Ca
	/	/	Sn	/	/	/	Mg	/	/	/	Cd
/	/	/	Sr	/	/	/	Mn	/	/	/	Co
/	/	/	Zn	/	/	/	Na	/	/	/	Cr



		Kruskal - Wallis				Shapiro - Wilk		Kolmogorov - Smirnov		
			H		F					
17/46	0/06	0/001	18/97	0/000	0/07	0/001	0/90	0/003	0/11	Al
1/38	0/72	0/000	30/03	0/217	1/47	.	0/40	.	0/28	As
17/33	0/06	0/021	11/00	0/001	4/80	.	0/89	.	0/16	Ca
1/06	0/64	0/001	18/27	0/000	0/72	.	0/77	.	0/2	Cd
18/00	0/00	0/000	07/00	0/000	19/13	.	0/94	0/01	0/1	Co
0/10	0/20	0/000	08/31	0/000	20/22	0/074	0/98	0/2	0/06	Cr
3/01	0/33	0/000	49/33	0/000	16/90	0/038	0/97	0/061	0/08	Cu
16/02	0/06	0/000	27/19	0/000	8/43	.	0/9	.	0/10	Fe
6/93	0/14	0/000	29/18	0/000	9/28	0/438	0/99	0/2	0/06	K
4/71	0/21	0/000	00/47	0/000	37/48	.	0/93	.	0/13	Mg
7/80	0/13	0/000	20/69	0/000	9/41	.	0/9	.	0/13	Mn
3/12	0/32	0/000	41/98	0/000	14/27	0/128	0/98	0/2	0/07	Na
12/40	0/08	0/000	82/91	0/000	02/77	.	0/93	0/013	0/1	Ni
6/33	0/16	0/001	19/73	0/000	6/10	0/003	0/96	0/06	0/08	Pb
4/46	0/22	0/000	01/98	0/000	20/09	0/007	0/96	0/006	0/11	Sb
11/03	0/09	0/000	46/87	0/000	24/08	0/008	0/97	0/02	0/09	Sn
1/61	0/62	0/017	12/00	0/220	1/46	.	0/42	.	0/28	Sr
0/03	0/20	0/003	10/78	0/010	3/03	0/017	0/97	0/2	0/07	Zn

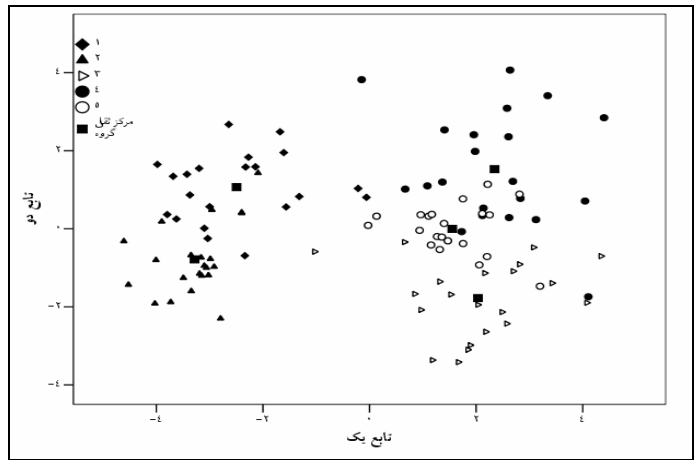
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		F	Wilks' Lambda			
1/00	/	0/460	0/119	0/05	Al	
3/13	/	0/164	0/280	0/35	Sb	
3/51	/	0/014	0/196	1/09	Zn	
5/27	/	0/000	0/139	2/24	K	
3/61	/	0/000	0/085	3/64	Ni	
6/09	/	0/000	0/074	4/19	Mn	
1/98	/	0/000	0/061	4/72	Cu	
6/73	/	0/000	0/053	5/28	Co	
2/73		0/000	0/044	5/71	Cr	
2/26	/	0/000	0/030	6/06	Na	
1/98	/	0/000	0/020	6/76	Mg	
4/01	/	0/000	0/018	7/39	Pb	

		Wilks' Lambda						
/	/	0/02	/	0/93	66/73	66/73	6/15	1
/	/	0/13	0/08	0/78	13/16	16/43	1/51	2
/	/	0/32	0/03	0/71	94/29	11/13	1/03	3
/	/	0/66	0/01	0/59	100/00	5/71	0/53	4

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		۴	۳	۲	۱	۴	۳	۲	۱	
۵۲/۷۷	۰/۲۲۷	۰/۰۱۱	۰/۰۰۰	۰/۰۰۰	۰/۲۱۶	-۰/۴۳	۰/۰۱	-۰/۰۲	۰/۵۷	Ni
۳۷/۴۸	۰/۱۶۱	۰/۰۰۰	۰/۰۰۶	۰/۰۱۵	۰/۱۴۰	-۰/۰۹	-۰/۲۴	۰/۳۰	۰/۴۶	Mg
۲۵/۲۲	۰/۱۰۸	۰/۰۰۰	۰/۰۰۰	۰/۰۰۰	۰/۱۰۷	۰/۰۹	۰/۰۶	۰/۰۴	۰/۴۰	Cr
۲۵/۰۹	۰/۱۰۸	۰/۰۰۳	۰/۰۰۰	۰/۰۰۳	۰/۱۰۲	۰/۲۳	-۰/۰۳	۰/۱۴	-۰/۳۹	Sb
۲۴/۵۸	۰/۰۷۵	۰/۰۰۲	۰/۰۱۷	۰/۰۰۰	۰/۰۵۶	-۰/۲۶	۰/۱۹	-۰/۱۲	۰/۳۳	Sn
۱۹/۱۳	۰/۰۸۲	۰/۰۰۴	۰/۰۰۴	۰/۰۰۲	۰/۰۷۲	-۰/۰۱	-۰/۰۳	-۰/۲۵	۰/۳۰	Co
۱۶/۹۰	۰/۰۷۳	۰/۰۰۰	۰/۰۰۰	۰/۰۱۱	۰/۰۶۲	۰/۱۹	۰/۱۰	-۰/۰۸	۰/۲۹	Cu
۱۴/۲۷	۰/۰۶۱	۰/۰۰۲	۰/۰۰۱	۰/۰۰۱	۰/۰۵۷	۰/۱۲	۰/۱۷	-۰/۲۲	۰/۲۱	Na
۹/۴۱	۰/۰۴۰	۰/۰۰۱	۰/۰۰۳	۰/۰۰۸	۰/۰۲۸	۰/۰۵	-۰/۰۷	۰/۲۲	-۰/۰۶	Mn
۹/۲۸	۰/۰۴۰	۰/۰۰۷	۰/۰۲۰	۰/۰۰۲	۰/۰۱۱	۰/۰۱	۰/۰۱	-۰/۰۴	۰/۰۴	K
۸/۴۳	۰/۰۲۱	۰/۰۰۰	۰/۰۰۸	۰/۰۰۶	۰/۰۰۸	۰/۳۴	۰/۴۲	۰/۱۲	-۰/۱۳	Fe
۶/۱۰	۰/۰۲۶	۰/۰۰۱	۰/۰۱۰	۰/۰۰۰	۰/۰۱۵	۰/۱۷	۰/۳۹	-۰/۰۵	-۰/۲۹	Pb
۵/۷۲	۰/۰۰۱	۰/۰۰۰	۰/۰۰۰	۰/۰۰۰	۰/۰۰۱	۰/۱۸	۰/۳۳	-۰/۲۲	-۰/۰۵	Cd
۵/۵۷	۰/۰۲۴	۰/۰۰۲	۰/۰۱۲	۰/۰۰۸	۰/۰۰۲	-۰/۰۲	۰/۳۱	۰/۱۶	۰/۰۲	Al
۴/۸۵	۰/۰۱۶	۰/۰۰۲	۰/۰۱۰	۰/۰۰۱	۰/۰۰۲	۰/۰۹	۰/۳۰	۰/۰۱	-۰/۱۵	Ca
۳/۵۳	۰/۰۱۵	۰/۰۰۰	۰/۰۱۱	۰/۰۰۴	۰/۰۰۰	-۰/۲۰	-۰/۳۰	۰/۰۹	-۰/۰۵	Zn
۱/۴۷	۰/۰۰۱	۰/۰۰۱	۰/۰۰۰	۰/۰۰۰	۰/۰۰۰	-۰/۰۲	۰/۲۷	-۰/۱۹	۰/۱۱	As
۱/۴۶	۰/۰۱۱	۰/۰۰۰	۰/۰۰۱	۰/۰۰۸	۰/۰۰۳	-۰/۱۱	-۰/۰۴	-۰/۰۳	-۰/۰۱	Sr



Pb

Kruskal – Wallis

Sr Cd As

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Kruskal – Wallis

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Kruskal – Wallis

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Wilks' Lambda

Al

	Cd	Sr	As	Co	Sn		
Ni			Zn	Ca	Al		()
		Sr	As				
	()) ()	
						() ()	()
		Sr	As				()
						press's Q /	
)	
							()
		(Sn	Fe	Cd	Ca)		
							F
							F
							F
							()

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Determining a suitable subset of geochemical elements for Separation of lithological types of Poldasht waterspreading station basin

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Abstract

Because of many problems associated with traditional procedures for identifying sediment sources, fingerprinting techniques, based on physical, chemical and organic properties of sediment and source materials, are increasingly being used as a valuable and effective alternative approach to assemble such information. The first step involved in the application of this approach is the selection of a composite of diagnostic properties which clearly discriminate sediment sources. In this study, it is tried to choose a suitable composite of geochemical elements with the ability to discriminate lithological types in subareas of main subbasin of Poldasht water spreading station basin, located in Makoo County, West Azarbaijan Province. The lithological maps were prepared, and lithological types as sediment sources were classified in five groups. Totally, 106 samples representing lithological characteristics, including uses, slope steepness and surface and subsurface erosions, were selected. Samples below 63 μm were separated and concentration of 18 geochemical elements was measured. Then, after being assured of the absence of outliers and insubstantial contribution of non-normality and inequality of covariance matrices to the results, the discriminant analysis was used to select the suitable subset of elements from the 18 geochemical elements. In order to eliminate the effects of multicollinearity on the discriminant analysis results, a subset (composite fingerprint) of elements, which enjoys both characteristics of least multicollinearity and highest discriminating power, was selected. The identified subset included 12 elements (Al, Co, Cr, Cu, Na, Zn, Mn, Ni, Pb, Mg, Sb and K) and was able to discriminate and classify over 87.7 percent of soil samples correctly. Meanwhile, all the 18 elements were ranked based on their relative ability to distinguish lithological groups, among which Ni was the most important and As and Sr played the least important role.

Key words: Geochemical elements, Sediment sources, Lithological types, Poldasht, Source fingerprinting, Discriminant analysis