J Biochem Tech (2018) Special Issue (2): 19-29
ISSN: 0974-2328

Dispersion and Concentration of Minerals and Heavy Elements in the Spitak Nukabad River (North Khash)

Mohammadgol Kahrazeh

Received: 17 January 2018 / Received in revised form: 12 July 2018, Accepted: 16 July 2018, Published online: 05 September 2018

Abstract

The study area is located in the general geological division of Iran in Nehbandan-Khash zone. In the study area there are no older rocks than Cretaceous. So that the oldest and youngest rock units in the area belong to the Upper Cretaceous and the Quaternary, respectively. In the study area, after identifying the rock units according to the regional geomagnetic status and factors such as topography, river sinuosity, tectonics and alteration, 12 samples from the river bed were taken to perform heavy mineral studies. In the study of heavy minerals, methods such as acid treatment, bromoformation, magnetometry and microscopic study were used. After data processing, graphs and frequency maps for minerals such as (magnetite, rutile, barite, zircon, amphibole, hematite and pyroxene, pyrite oxide, garnet, altered minerals, calcite) were drawn using GIS and SPSS. The frequency distribution histogram of metamorphic minerals in the region follows an abnormal distribution and has a positive skewness. Carbonate minerals include calcite and carbonate. The largest concentration of this group of minerals is in the eastern part of sample p12 and the smallest in samples p5 and p10. In the study area, the mean amount of mineralized rocks group X = 16ppm, the standard deviation of mineralized rocks in the region S = 15.7 and the coefficient of variation is Cv = 246. The minimum amount of mineralized rocks in the region samples are about 1 ppm and the maximum is about 49ppm.

Keywords: Heavy Minerals, Espitak River, Magnetite, Hematite.

Introduction

The study area is located in Sistan and Baluchestan Province and in the western part of Taftan Mountain, about 170 km southwest of Zahedan and 65 km northwest of Khash. The Espitak River flows through the Towd Lang drainage basin and after crossing the Nukabad and the ancient village of Ezzat, enters into the Gohardasht plain (Figure. 1 and 1). The study area is located in Nehbandan-Khash zone (Aqanbati, 2004). Recognizing the origin of sediments in sedimentology is of high significance, particularly the erosion and sediment in the drainage basin. The origin, tectonic position, weather, and other conditions governing the area can be evaluated through recognizing the mineralogy composition of sedimentary particles and their percentage. Placard deposits are deposits that are concentrated in sediment degradation minerals through the composition.

The formation of heavy minerals depend on upper rocks and the amount of chemical weathering in the origin area during transport (Edwards & Atkinsob, 1998). Rivers are considered ideal sedimentary environments for heavy mineral studies. The type of heavy minerals can be observed through stream-sediments sampling (Yazdi, 2002). The exploration method of heavy minerals is the same as the system used in the geochemical exploration of stream-sediments. In general, the density of the sample depends on the density of the streams (Techmer et al., 2007). Typically, placer deposits are formed from the streams bed, rivers bed, rivers bank, their marginal terraces, or seafronts. In fact, placer deposits are composed of mechanical accumulation of durable minerals which their distribution is semi-economic in normal situation.

The formation of heavy minerals depend on upper rocks and the amount of chemical weathering in the origin area during transport (Whitmor, et al., 2004). Suitable places for the formation of placer reservoirs can be referred to the cavities down the waterfalls and rivers, behind the river and the front section of a sandy hill.

Experimental Studies

Samples were sent to the Zarazma Laboratory of Kerman to study the heavy minerals and sedimentology samples were sent to and the Geology Laboratory of Islamic Azad University, Zahedan. The heavy mineral study process included sample preparation, sample washing (panning and drying), bromoformation, and then the volumetric measurements were performed again. After separating heavy

Mohammadgol Kahrazeh
Department of Geology, Islamic Azad University, Zahedan Branch, Zahedan, Iran.

Email: kahrazeh@yahoo.com

minerals through magnetism separation method and dividing them into three groups of ferromagnetic minerals, paramagnetic minerals and dye-magnetic minerals, their study was performed with binocular microscope to identify various types of minerals in each group.

Data Processing

Graphs and distribution maps and frequency of elements and their correlation were analyzed using EXCEL, SPSS and GIS.

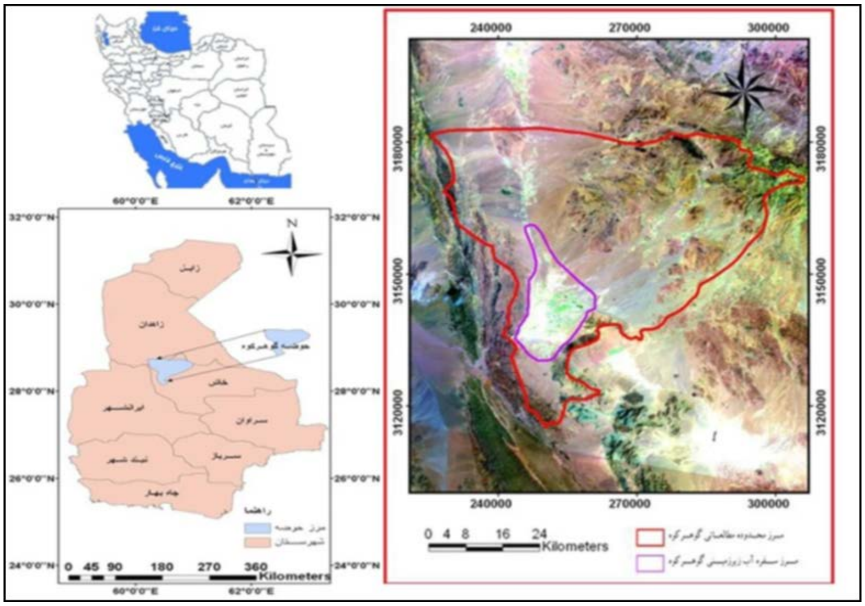

Fig. 1: Location of the Gowhar Kuh Basin

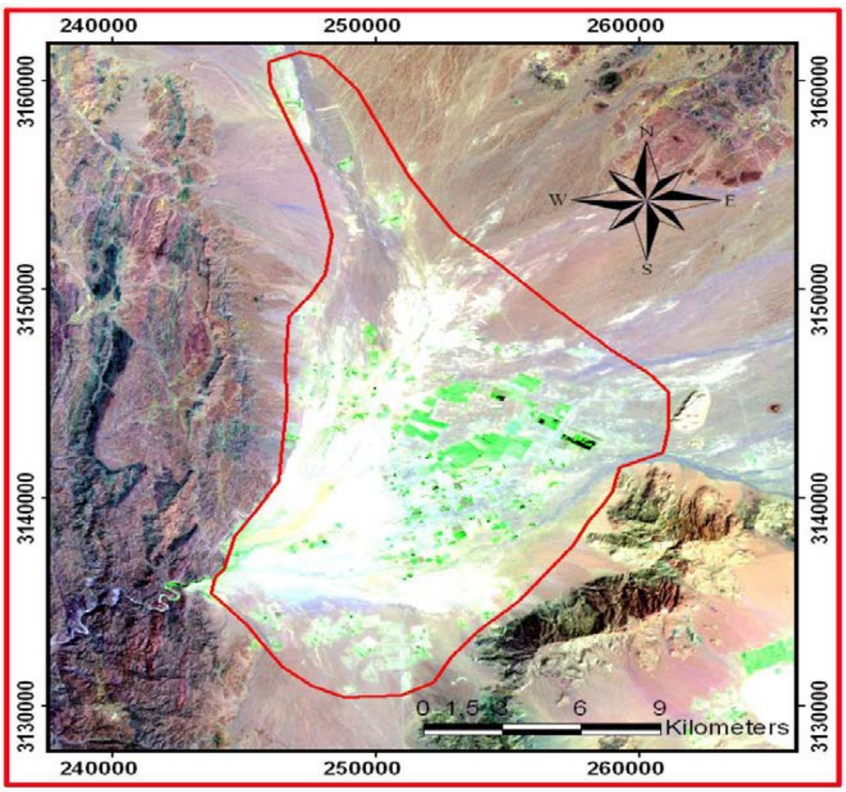

Fig. 2: Satellite Image of the Gowhar Kouh Aquifer Spreading Area in the RS Environment

General Geology of the Region

The geological surveys of the studied area were initially carried out by the water and Soilwater consultants in 1971. In these studies entitled as ‘Identification and preparation of a comprehensive plan for developing the exploitation of soil resources’, the geology of Khash regions, Poshtkuh and Gohardasht areas has been discussed in detail. Geological Survey of Iran, (2010). In these studies, the geology of the region includes stratigraphy, structural geology, along with geological and tectonics details of the studied area. Of the major geological phenomena in the area, Taftan volcano is located in northeastern of region, which is the product of volcanic activity in the Quaternary and Tarshir (Nabavi, 1976). Currently, the activity of this volcano is limited to the emission of sulfur gases from the crater and around the crater. Lava and volcanic intrusions have covered some of the tartar builders in the basin area (Tirrul, et al., 1983).

Tectonic movements have caused faults, joints and gaps in the Geological collection of drainage basin (Samani & Ashtari, 1992). The fault lines are generally north-south, north-west-south-east and north-east-southwest (Stocklin, 1968).

Heavy Mineral Sampling

In order to achieve and identify important minerals, especially the propagation of gold, in the study area, 12 heavy mineral samples have been taken from the stream-sediments (Table 1). All samples are rinsed and concentrated by experienced expert. Heavy mineral studies include sampling of waste water sediments and initial condensation, separation with heavy solutions, magnetic separation, and finally studying the remaining NM-AA-AV phases. The study of sediments originating from upstream rock masses and the observation of minerals in them can be used as a simultaneous or non-simultaneous exploration layer with explorations.

Table 1: The Characteristics of the Samples

Sample	X	Y
P1	265075	3140226
P2	265522	3140119
P3	266026	3139979
P4	266364	3139587
P5	266871	3139620
P6	267286	3139326
P7	267669	3139003
P8	268172	3139082
P9	268673	3139137
P10	269137	3139137
P11	269644	3139430
P12	270145	3139484

Study of Heavy Mineral Parameters

Since in many cases the particles and minerals size were not similar in the samples, statistical processing will not be significant. In order to address this defect, the same minerals were grouped. In this case, the number of variables is reduced, and further statistical analysis can be performed with higher numbers. In the study area, 9 groups were formed for heavy mineral studies (Table 2).

Table 2: Descriptive Statistical Parameters for Heavy Minerals Grouping

	Mean	Median	Std. Deviation	Variance	Skewness	Kurtosis	Minimum	Maximum
FeGroup	1043.1	885.5	632.0	399371.9	2.9	9.2	482.0	2951.0
OreGroup	16.8	18.0	15.7	246.0	0.7	-0.2	1.0	49.0
AlteredGroup	421.9	374.0	160.9	25881.9	1.4	2.7	211.0	822.0
MetaGroup	26.7	30.5	26.1	680.2	0.3	-1.4	0.0	72.0
TiGroup	3.0	0.1	8.6	74.5	3.4	11.9	0.1	30.3
BasicRock	255.7	227.0	92.2	8505.2	1.0	1.2	126.0	466.0
AsidicRock	33.3	5.0	39.7	1572.2	1.0	-0.2	3.0	116.0
Pyrite	67.3	60.0	23.6	559.2	0.8	0.7	34.0	119.0
Carbonate	4.2	0.6	5.0	25.2	1.0	-0.1	0.3	14.7

Correlation Study

The correlation coefficients were calculated using heavy minerals. The Pearson correlation coefficients between grouped minerals are presented in Table 3. As shown, despite the grouping of minerals, the dominant correlation between groups is moderate to strong. However, the iron group has the highest correlation coefficient with titanium minerals group. The ore-forming minerals group has the highest correlation coefficient with the acidic minerals and carbonate groups. The altered minerals group shows the highest positive correlation coefficient with basic minerals and pyrite groups. The basic rocks group has the highest positive correlation coefficient with the pyrite group. The acidic minerals group has the highest positive correlation with the carbonate mineral group.

Table 3: Pearson Correlation Coefficient Matrix

Correlations

	FeGroup	OreGroup	AlteredGroup	MetaGroup	TiGroup	BasicRock	AsidicRock	Pyrite	Carbonate
FeGroup	1								
OreGroup	.647*	1							
AlteredGroup	.872**	.675*	1						
MetaGroup	.585*	.541	.753**	1					
TiGroup	.957**	.690*	.804**	.566	1				
BasicRock	.807**	.660*	.992**	.756**	.741**	1			
AsidicRock	.718**	.919**	.765**	.583*	.706*	.740**	1		
Pyrite	.787**	.639*	.988**	.758**	.712**	.998**	.736**	1	
Carbonate	.721**	.921**	.767**	.586*	.709**	.743**	1.000**	.739**	1

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

According to the Spearman correlation coefficient (Table 4), the iron group has the highest correlation coefficient with the altered minerals group and the rock group. The ore-forming minerals group has the highest correlation coefficient with titanium and carbonate groups. The altered minerals group shows the highest positive correlation coefficient with basic minerals and pyrite groups. Titanium minerals group has the highest positive correlation coefficient with carbonate and acidic minerals groups. The group of minerals shows the highest positive correlation coefficient with the pyrite group. The acidic minerals group shows the highest positive correlation coefficient with carbonate group.

Table 4: Spearman Correlation Coefficient Matrix

Correlations

		FeGroup	OreGroup	AlteredGroup	MetaGroup	TiGroup	BasicRock	AsidicRock	Pyrite	Carbonate
Spearman's rho	FeGroup	1.000								
	OreGroup	.442	1.000							
	AlteredGroup	.664*	.603*	1.000						
	MetaGroup	.544	.569	.711**	1.000					
	TiGroup	.677*	.814**	.825**	.557	1.000				
	BasicRock	.650*	.549	.993**	.740**	.768**	1.000			
	AsidicRock	.647*	.787**	.823**	.579*	.993**	.774**	1.000		
	Pyrite	.629*	.531	.979**	.769**	.758**	.993**	.774**	1.000	
	Carbonate	.642*	.809**	.825**	.589*	.995**	.776**	.998**	.776**	1.000

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Multivariate Calculations

One of the methods for interpretation of heavy mineral data through multivariate statistical methods is dandrogram drawing using cluster analysis. In this method, which is based on correlation coefficients, one can simultaneously examine the relationship between all variables.

This method can be useful in understanding the relationship between various variables of heavy mineral. Because the paragenesis relation between heavy mineral variables is shown. In order to determine the paragenesis relation between different variables and select the most suitable variables for drawing a distribution map of heavy mineral, multivariate analysis has been done through cluster method. the amount of ore-forming minerals existing in the area using these graphs.

A dendrogram derived from cluster analysis of grouped heavy minerals data is presented in Table (3). As observed, there are four groups that the first group is mainly related to carbonate, pyrite, titanium, ore groups, metamorphic and acidic minerals. The second group belongs to the deposits and altered minerals groups, which has a direct relationship between the two groups in the region. The third group belongs to the Altera minerals, as well as the basic rocky group. The fourth group is related to the iron group along with the previous three groups.

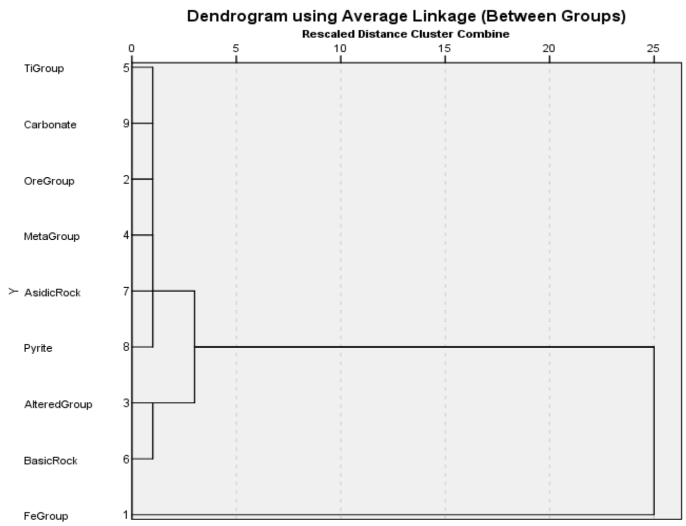

Fig. 3: Dendrogram of Grouped Data of Heavy Minerals

Description of Heavy Mineral Anomaly

● *Descriptions of the Pyrite Group Basins*

Pyrite group minerals include pyrite, pyrite oxide and pyrite limonite, and their distribution is shown in Figure 4. According to the results, sample P12 shows the highest and the sample P10 shows the lowest value in eastern part of the region.

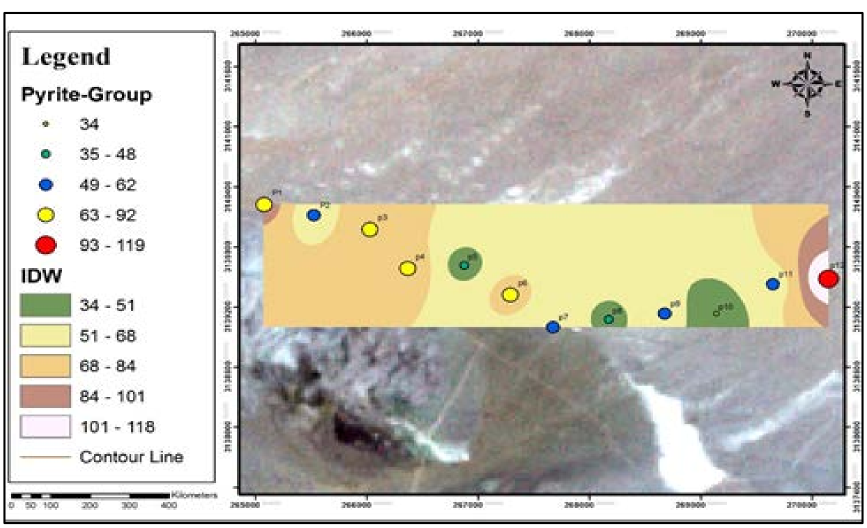

Fig. 4: Distribution Map of Pyrite Anomalies

In the study area, the mean level of Pyrite minerals group is 67.3ppm, the standard deviation of pyrite distribution in the region S = 23.6 and its coefficient of variation is Cv=559.2. The minimum pyrite in the samples is about 34ppm and the maximum is about 119ppm (Table 5). The histogram of pyrite distribution in the region follows a normal distribution (Figure 5) and the highest frequency of pyrite minerals is from 40 to 60 ppm.

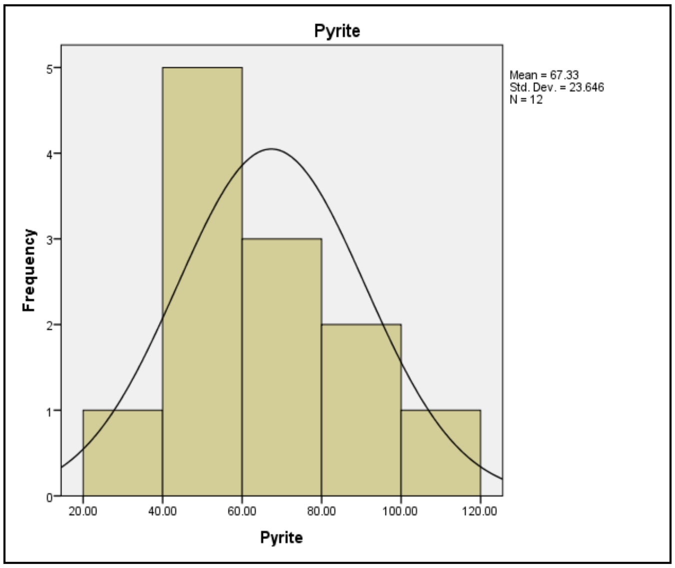

Fig .5: Histogram of Frequency Distribution of Minerals in Pyrite Group

Table 5: Statistical Parameters of Minerals in Pyrite Group

		Pyrite
N	Valid	12.0
	Missing	0.0
Mean		67.3
Median		60.0
Std. Deviation		23.6
Variance		559.2
Skewness		0.8
Kurtosis		0.7
Minimum		34.0
Maximum		119.0

- ***Description of Basins Containing Altered Minerals***

This group of minerals mainly contains minerals that are altered, epidote and chlorite.

If pyrite oxide and pyrite limonite minerals were are also added to this group of minerals, their dispersal is to some extent a reflection of the altered zones in the region. The distribution of these minerals is shown in Figure (6). The highly enriched zones of these minerals are mainly found in the eastern part of the study area in sample P12, indicating the alterity of the area and the improvement of the altered zone in the region. The existence of such an alteration can be attributed to mineralogy phenomena which will eventually show the potential for mineralization of the area. The Minimum enrichment of altered minerals is observed in samples P5 and P10.

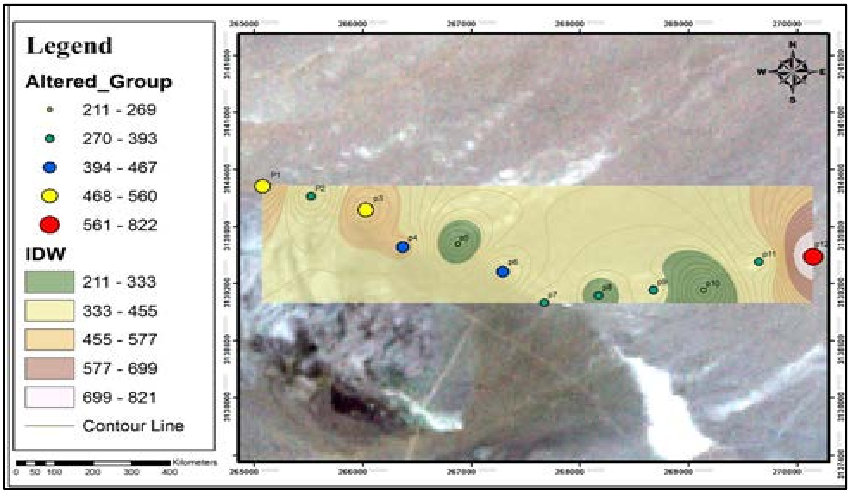

Fig. 6: Anomaly Map of Altered Minerals Group

Table 6: Statistical Parameters of the Altered Minerals Group

		AlteredGroup
N	Valid	12.0
	Missing	0.0
Mean		421.9
Median		374.0
Std. Deviation		160.9
Variance		25881.9
Skewness		1.4
Kurtosis		2.7
Minimum		211.0
Maximum		822.0

- *Descriptions of Basins Containing Iron Minerals*

This group of minerals includes hematite, magnetite, goethite, limonite, martite, etc. The distribution is shown in Figure (7). The highest concentrations of these minerals are observed in the eastern part of sample P12, and the smallest amount in the sample P5 is observed in the central part of area.

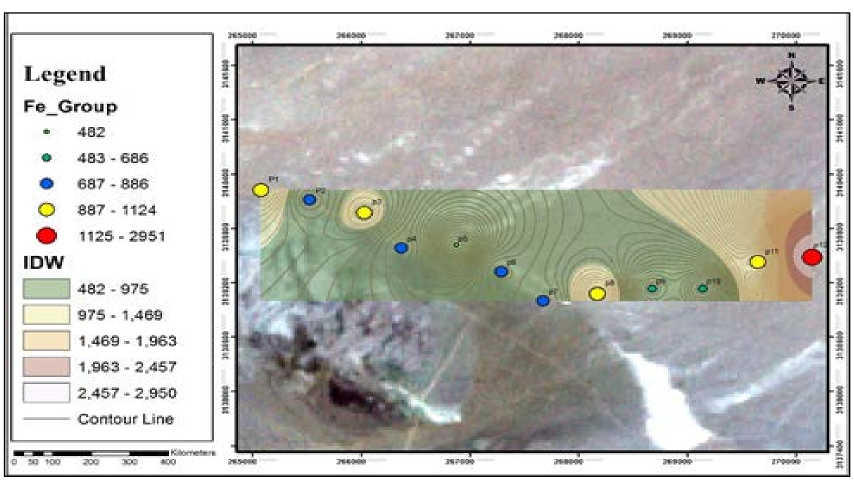

Fig. 7: Distribution Map of Iron Group Anomalies

In the study area, the mean level of iron minerals is X = 1043.1ppm, the standard deviation of iron minerals in the region is S = 632 and the coefficient of variation is CV=399371.9. The minimum amount of iron minerals in the P5 sample is about 482ppm and the maximum is 2951ppm in P12 sample (Table 7). Histogram of iron minerals frequency distribution in the region follows an abnormal distribution and has a positive skewness (Figure 8). The maximum frequency of iron minerals is in the range of 500 to 1000 ppm.

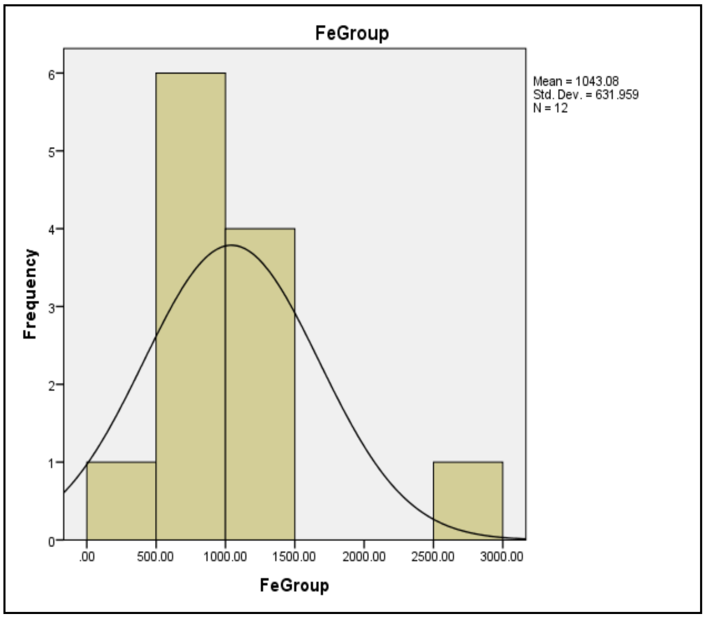

Fig. 8: Histogram of Frequency distribution of Iron Minerals

Table 7: Statistical Parameters of Iron Group Minerals

		FeGroup
N	Valid	12.0
	Missing	0.0
Mean		1043.1
Median		885.5
Std. Deviation		632.0
Variance		399371.9
Skewness		2.9
Kurtosis		9.2
Minimum		482.0
Maximum		2951.0

• Description of Titanium Minerals Basins

The minerals of the titanium group include anatase, ilmenite, leucoxene, rutile, sphene, etc. The distribution is shown in Figure (9). The highest concentrations of titanium minerals are found in the central part of sample P7 and the lowest in samples P5, P9, and P10.

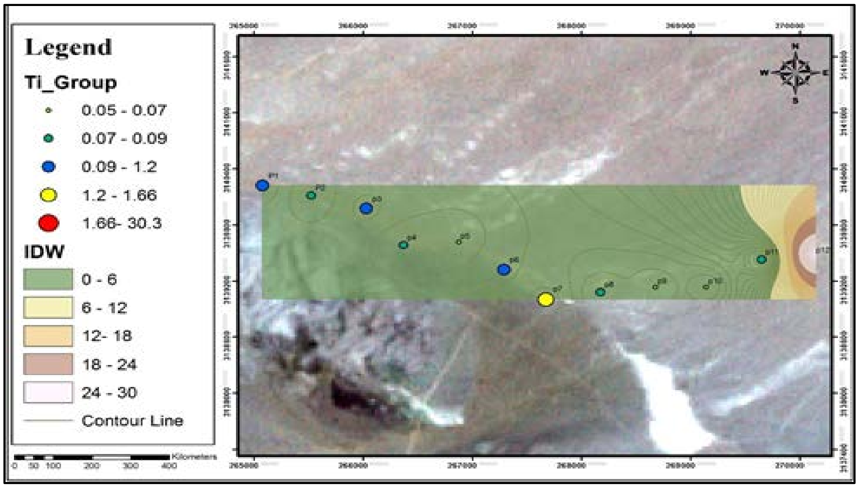

Fig. 9: Anomaly Distribution Map of Titanium Minerals Group

In the study area, the mean level of titanium minerals group is X = 3ppm, the standard deviation of titanium minerals distribution is S = 8.6 and the coefficient of variation is Cv=74.5. The minimum amount of titanium minerals is about 0.1ppm and the maximum is about 30.3ppm (Table 8). Histogram of the distribution of titanium minerals in the region follows an abnormal distribution and has a positive skewness (Figure 10). The highest frequency of titanium minerals is from 0 to 5 ppm.

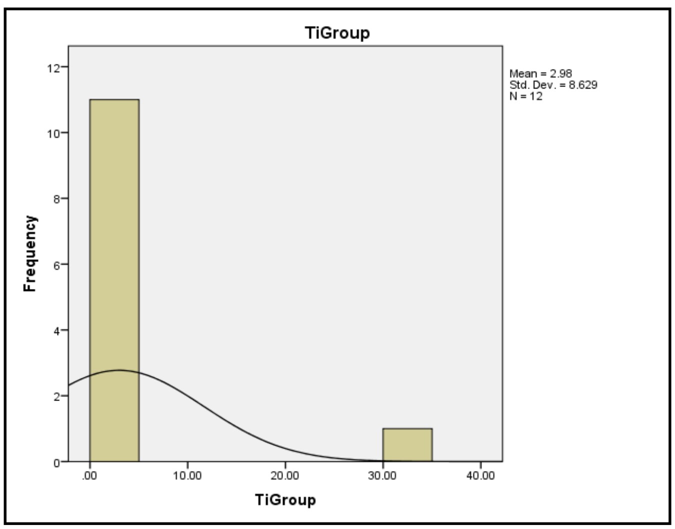

Fig. 10: Histogram of Frequency Distribution of Titanium Minerals

Table 8: Statistical Parameters of the Titanic Mining Group

		TiGroup
N	Valid	12.0
	Missing	0.0
Mean		3.0
Median		0.1
Std. Deviation		8.6
Variance		74.5
Skewness		3.4
Kurtosis		11.9
Minimum		0.1
Maximum		30.3

• *Descriptions of Basic Rocks*

The basic rocks are composed of minerals of amphibole, biotite, olivine, pyroxene, etc., in which the distribution of rocks is shown in Figure (11). The highest concentration of this group of rocks in the eastern part is in the P12 sample, as well as in the central part in the P6 sample and the western part in the samples P1, P3 and P4 and the lowest concentration in the P10 sample.

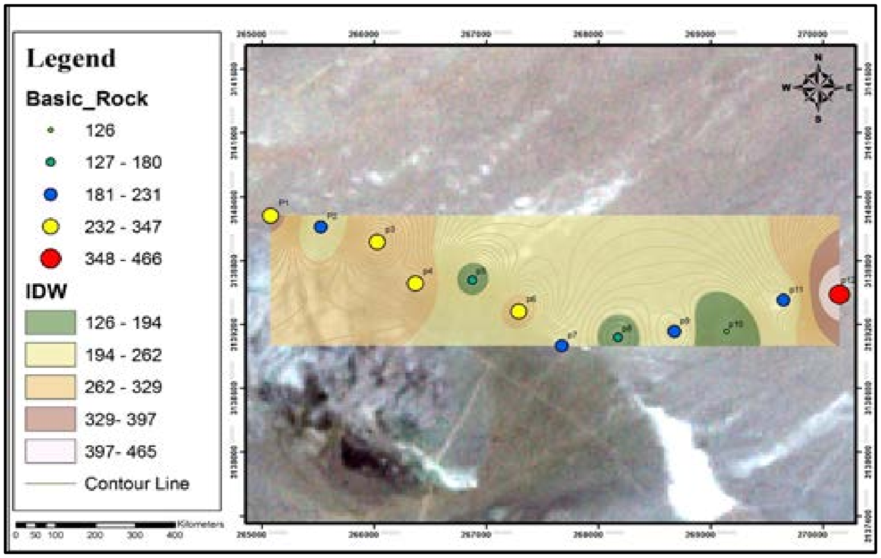

Fig. 11: Anomaly Distribution Map of the Basic Rock Group

In the study area, the mean amount of ore-forming basic minerals is X = 255.7ppm, the standard deviation of the distribution of minerals in the region is S = 92.2 and its coefficient of variation is Cv=8505.2. Minimum content of minerals is about 126 ppm and the maximum is about 466ppm (Table 9). Histogram of the frequency distribution of basic minerals in the region follows an abnormal distribution and has a positive skewness (Figure 12). The highest amount of basic minerals is from 200 to 250 ppm.

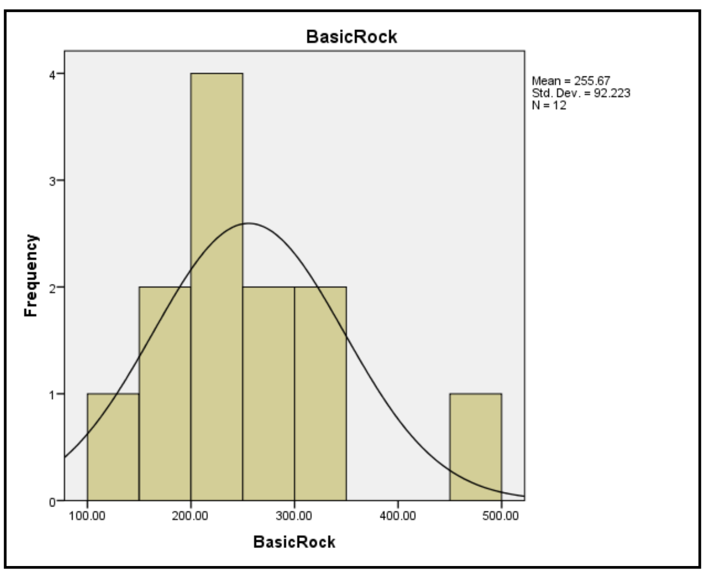

Fig. 12: Histogram of the Frequency of Basic Rock

Table 9: Statistical Parameters of Basic Rock

		BasicRock
N	Valid	12.0
	Missing	0.0
Mean		255.7
Median		227.0
Std. Deviation		92.2
Variance		8505.2
Skewness		1.0
Kurtosis		1.2
Minimum		126.0
Maximum		466.0

Conclusion

- The study area is located in the Nehbandan-Khash zone in the general geological division of Iran. In the studied area there are no older rocks than cretaceous. So that the oldest and youngest rock units in the region belong to the upper cretaceous and quaternary, respectively.
- In the studied area, as mentioned above, there is a cretaceous fluorite that is at that time a part of the oceanic crust (Neobalooch Ocean) between the Helmand and Lut blocks, and in paleogene during the closure of the oceanic basin Marine sedimentary deposits coexist with orogeny (flysch), which in the region often consists of limestone, sandstone and shale, are covered with ophiolite.
- Lithological units in the region in terms of lithology and tectonic structure that exhibit resistance to degradation, erosion and production of origin at different sizes such that fine particles of the origin of shale and tuffs are highly weathered and particles coarse particles show the origin of dacite sandstone and andesite.
- A dendrogram is derived from cluster analysis of grouped heavy minerals data. As you can see, there are four groups that the first group is mainly related to carbonate, pyrite, titanium, ore deposits, metamorphic and acidic rocky minerals. The second group belongs to ore-forming and the altered minerals groups, which has a direct relationship between the two groups in the region. The third group belongs to the Altera minerals group, as well as the basic rock group. The fourth group is related to the iron group with the previous three groups. Histogram of the frequency distribution of altered minerals in the region follows an abnormal distribution and has a positive skewness.
- Carbonate minerals include calcite, carbonate. The largest concentration of this group of minerals is in the eastern part of sample p12 and the smallest is in samples P5 and p10.
- In the study area, the mean mineralized rocks group is X = 16ppm, the standard deviation of mineralized rocks in the region is S = 15.7 and the coefficient of variation is Cv=246. The minimum mineralized rocks in the samples are about 1 ppm and the maximum is about 49ppm.
- In the study area, the mean mineralized rocks group is X = 16ppm, the standard deviation of mineralized rocks is in the region S = 15.7 and the coefficient of variation is Cv=246. The minimum mineralized rocks in the samples are about 1 ppm and the maximum is about 49ppm.

References

Aqanbati, A., 2004, ‘Geology of Iran’, Geological Survey of Iran, p. 6

Samani, B., Ashtari, M., 1992, ‘Geological Development of the Sistan and Baluchestan Region’, Quarterly of Geosciences, No. 4, pp. 26-14.

Nabavi, M. H., 1976, an introduction to the Geology of Iran, Publications of Geological Survey & Mineral Explorations of Iran.

Yazdi, M., 2002, ‘Conventional Methods in Geochemical Exploration of Heavy Minerals’, Publication of Shahid Beheshti University, p. 180.

Edwards, R., Atkinson, K., 1998,”Ore Depsit Geology”, Translated by Moore, F., &NekouvaghtTak, M., 289-290.

Stocklin, J., 1968, Structural history and tectonics of Iran: A review, Am. Assoc. Pet. Geol. Bull. 52 _7, 1229-1258.

Techmer, A., Dill, H.sG. Weber, B., Fubi, M., 2007,” Mineralogical and chemical distribution patterns of placers and ferricretes in Quaternary sediments in SE Germany”, the impact of nature and man on the unroofing of pegmatites. 2-3

Tirrul,R., Bell, I.R., Griffis, R.J., and camp, V.E., 1983, The Sistan suture zone of eastern Iran, Geol. Soc. Am, Bull.V.94,134-150p.

Whitmor, G. P., Crook, K. A., gohnson, D. P., 2004,”Grain size control of mineralogy and geochemistry in modern river sediment”, New Guinea collision, Papua New Guinea; sedimentary Geology, Vol. 171, 129 – 157.