

## Using R-mode factor analysis method and Event probability analysis to determine prospectus areas, Case Study: 1:100000 sheet of Dolat-abad in Kerman province

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### Abstract

*The main objective of a small scale stream sediments geochemical survey, is to determine areas of geochemical anomaly of the elements to be explored by means of pathfinder elements, to obtain paragenetic relationship among elements by means of correlation analysis, to explore and define mineralization zones and potential areas. In this research, 811 geochemical samples from 1:100000 sheet of Dolat-Abad located in Kerman province are studied and 20 elements are analyzed. To achieve the goal, R-mode factor analysis and Even probability analysis (P.N) are used. In R-mode factor the relation among M variables with P uncorrelated factor scores, their maps have been prepared and 9 anomaly areas were detected. Then in order to investigate the accuracy of obtained results from R-mode method, data were studied by P.N method. In Event probability analysis, at first step, threshold value of each interested element within the geochemical sample must be determined. In this paper it is intended to use the occurrence probability of the enrichment factor to detect the anomalous areas. Obtained results of this technique is in good agreement to those acquired*

### 1- Introduction

Preparation of 1:100000 geochemical maps as one of the most important information layer plays an important role in reconnaissance of promising areas. Dispread of both old and resent alluviums, fans, diluvial plains, can mentioned as suitable places for exploration of mining deposits. رخمنون of ultramafic rocks in geochemical states are hopeful regions in geochemical explorations[1]. Classic and modern statistical analysis (multivariate analysis) and also fiscal method of enrichment are done on the outcome raw data of analysis of 811 geochemical samples in 1:100000 sheet of Dolat-abad limit. For data processing, SPSS, Surfer, Auto Cad softwares are used. According to spread of ultrabasic to basic and semi-acidic rocks, all samples are analyzed by means of spectrometer. These considerations cause exploration and introduction of potential zones specially Cr, Co, Ni and partially Cu.

### 2- Description of study

#### 2-1 general geology of area

The case study is in Kerman province, south-western 1:250000 Haji-abad square and has geographical coordinate as: longitude of 56°30' - 57°00' E and latitude of 28°00' - 28°30' N. There are different theories about geology situation of this area which situated in ophiolite

belt. But this mentioned belt is mostly reported in relation with Sanandaj-Sirjan or Orumie-Isfandaghe. Oldest rocks of this region belong to Paleozoic and upper Precambrian.

In middle Paleozoic (between upper and lower Devonian) there are though alteration rocks such as Amphibolites of region that spread on North-Western of area and are result of metamorphism. Abshour Complex is Collection of white calcite and brown marmorized dolomite marnoliths and that are Amphibolites. All the mentioned rocks belong to Sanandaj-Sirjan belt. Large parts of area have Mesozoic rocks specially are upper Jurassic and lower Cretaceous.

## **2-2 Sampling**

In studied area, based on dispersion factor of rocky units and fault net, per 3 km<sup>2</sup> one sample was selected. In this method we tried to sample from mineral outcrops that specified on the map more ( like ultrabasic rocks outcrop) and around faulted areas too. In this project, the number of samples was an important priority in designing sampling points so that there weren't any rocky outcrop without sample. Stream sediments samples in every station, after checking their geological and geographical situation and recording all geological phenomenon and etc. have passed from 80 mesh sieve in quantity of 200 gr.. All geochemical samples and rock samples after preparing for analysis the element have sent to the Iran Geology Organization Spectrometric Laboratory.

Analyzed oxides and elements are: P<sub>2</sub>O<sub>5</sub>, TiO<sub>2</sub>, MnO<sub>2</sub>, Na<sub>2</sub>O, K<sub>2</sub>O, MgO, CaO, Fe<sub>2</sub>O<sub>3</sub>, Al<sub>2</sub>O<sub>3</sub>, Zn, V, Sr, Sn, Pb, Ni, Cu, Cr, Co, Bi, Ba, B, Ag.

## **2-3 Preparation of data**

There have been investigation to analyze the data:

- 1) Digitizing the existence topographies in topographic maps such as streams, samples situation, ways, cities and villages, geology structure, etc.
- 2) Preparation of related raw data to chemical analysis of samples in Excel software.
- 3) Integration of chemical analysis data with related data to the streams and samples situation.
- 4) Classification of lithology units according to multiplicity of geology units in studied area and determination of upstream rock( because by increase in geology units, number of upstream rocks invreas and thus make problem in its interpretation, preferably group the existent geology units on the basis of material and then on the basis of age.
- 5) Processing of determination of upstream rock performing this procedure was based on rocky grouping in prior stage and divided to stony one groups, stony tow groups, stony three groups, stony four groups, stony five groups on the basis of number of upstream rocks per sample and the number of existent samples in each family was specified.
- 6) Outlier amounts can't be received in separate classification forms, but we should use them in analysis.

## **2-4 Univariate statistical studies**

Statistical parameters related to chemical analysis of samples in Dolat-abad sheet have shown in table 1. First to third columns of these statistics are mean, mediam, mod that show way of inclination to the center of data. The second group of these statistics which are in next columns show standard deviation and variance that proceed to manner of dispersion and transmittance of data from the mean.

Histogram, normal line diagram at zero level and normal at tow way at zero level were drawn and seen that any raw data don't follow the normal distribution. Considering that in most

statistical calculations it is a presupposition for next processing, so, normalize the data in two steps:

- a) At first step outlier samples on the basis of Box and Whisker method are removed from collection data, then those data converted to the normal distribution by Cox and Box transformation method
- b) In second stage, all data entered into normalization process, so that Outlier data that first had set aside from the calculations, according to the obtained coefficient from the first stage, normalized for each element and added to first stage. Statistical parameters related to the various elements are in table 1.

### 2-5 Multivariate statistical studies

The aim of multivariate analysis on geochemical data, is geochemical and statistical analysis, configuring the relation between main and secondary elements and probability of use of these correlations to achieve an exploratory model.

Multivariate statistical techniques, analyze several measurements in each observation simultaneously. Every definite group of elements with respect to some environmental conditions shows almost same sensitiveness. Data processing is done in SPSS software and by help of tow method PCA (principle component analysis) and cluster analysis (Fig1)

#### 2-5-1 Determination of correlation coefficient of elements

In this research, to show the genetic relation, correlation coefficient of different elements together used by rank method of Spearman, cluster interpretation and factor analysis method. Correlation matrix of data has shown in table 1

#### 2-5-2 Calculation of KMO quantity

To define the correctness and confirmation of PCA and also number of data being sufficient, both KMO correlation and  $\chi^2$  should be calculated simultaneously. Quantities around 0.9 for KMO is so appropriate for factor analysis, around 0.8 is appropriate, around 0.7 is balanced, around 0.6 is average, around 0.5 is poor, and less than 0.5 is inappropriate. Standard amount of KMO is more than 0.6. As you see, it is 0.767, it means performance of factor analysis can be acceptable.

**KMO and Bartlett's Test**

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.767
Bartlett's Test of Sphericity	Approx. Chi-Square	11433.395
	df	171
	Sig.	.000

#### 3-5-3 Factor analysis of case study data

One of the major suppositions of factor method is that data should have standard normal probability distribution. In order to do this, at first data were standardized and at first step of factor analysis, correlation coefficients matrix of elements is calculated by means of SPSS software. By help of this matrix, we check quantity of correlation between variables. Then, first P factor are selected by calculation of eigenvalues and by use of one of scales. Unfortunately there is no worldwide opinion about selection criterion of factors number, but there are lots of suggestions such as: percentage of cumulative variance (table 2), eigenvalues greater than one and Scree Plot (fig 2). According to the table 2, there are just 10 eigenvalues

greater than one and furthermore 10 first factors are able to justify more than 87% of variations studied area. Finally, according to the Scree plot (Fig. 2) 5 factors are selected.

This research shows that Varimax Rotation yields the best results for selecting the factors.

According to the table of rotated matrix (table 3) and software calculations, 5 main factors are separated.

First factor: This factor mostly is influenced by Co, Mg, Ni, Cr elements.

Second factor: This factor mostly is influenced by Al, Ba, P.

Third factor: This factor mostly is influenced by Al<sub>2</sub>O<sub>3</sub>, Ba, P.

Fourth factor: This factor mostly is influenced by Ca, CaO, Sr, Sn.

Fifth factor: This factor mostly is influenced by Cu, Pb, Zn.

#### 4 Conclusion

- 1) Presence of geology structure and tectonics characteristics cause close relation between mineralization and geology. Tensile fractures frequency and adaptation of anomaly zones and existence indices confirm control role of tectonic activities.
- 2) Obtained results of classic and modern statistical calculations show that, at least in exploratory zones the کانسار ساز elements, V, Ni, Co, Cr, have rich procreative relation rich genitival relation and perfect geographical overlapping.
- 3) Base metals, copper, lead, zinc in some parts of exploratory zone have complete adaptation and confirm the correlation and multifactor calculations of procreative relation of hydrothermal deposit type.
- 4) Ba, B, Sr, elements, near relation and probable formation of these elements in relation with sedimentary environment and specially CaO oxide, and in particular dispersion limit of some of these elements seen in many parts of sedimentary rocks.
- 5) Dispersion of abnormal limits of elements, specially Ni, Co, Cr, V, Cu, and their overlapping with same group rock units and also mines and mine indices specially chromite, show correctness of explorations and probability of achievement to new chromite ذخایر in abnormal limits.
- 6) According to the thesaurus got from integration of data, at least 9 promising areas are explored and introduced, that on the basis of developed priorities, should do geochemical semi-detailed exploration on them.

#### 5 References

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Fig. 1: Statistical analysis of data flow sheet

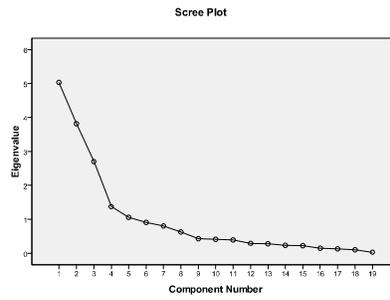


Fig. 2: Scree Plot