

FACTOR ANALYSIS OF INTEGRATED RADIOMETRIC DATA AS AN AID
IN GEOLOGICAL MAPPING OF GEBEL ENEIGI AREA
SOUTH EASTERN DESERT, EGYPT

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إستخدام المعاملات الإحصائية للبيانات الإشعاعية المتكاملة

في رسم خريطة جيولوجية لمنطقة جبل عنيقى

بجنوب الصحراء الشرقية لمصر

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تم استخدام طريقة تحليل المعاملات الإحصائية على البيانات الإشعاعية الجوية الطيفية لمنطقة جبل عنيقى بالصحراء الشرقية لمصر حيث تم تحليل خرائط تركيزات كل من اليورانيوم والثوريوم والبوتاسيوم وكذلك النسب بينهم بالإضافة إلى خريطة المحصلة الكلية (Total count map) . وقد أظهرت النتائج ثلاثة معاملات رئيسية مثلت جميع المتغيرات المدروسة وعند توقيع قيم المعاملات بالنسبة لبعضها البعض أمكن فصل الوحدات الصخرية المختلفة وتم رسم خريطة جيولوجية تقريبية لمنطقة الدراسة .

Key Words: Factor analysis, Geological mapping, Gamma-ray spectrometric data.

ABSTRACT

Factor analysis technique was applied to airborne gamma-ray spectrometric data of Gebel Eneigi Area, South Eastern Desert of Egypt where the concentration maps of U, Th, K and their ratios besides the Tc (total count map) were analysed. The obtained results showed that three factors were sufficient to represent all the variables. Mapping of factor scores and plotting them against each other results in a statistical groupings in the form of rock units that correspond reasonably well to the mapped geology.

INTRODUCTION

The data from airborne gamma-ray spectrometric surveys in the form of concentration maps to the U, Th, K and their ratios (U/K, U/Th and Th/K) beside the Tc (total count map) frequently vary sympathetically; so they may be correlated, [1]. The interpretation of such maps is frequently subjected to some suitable statistical treatment to reduce its subjectivity. Accordingly the factor analysis technique was applied to execute this type of multivariate correlation between the obtained variables for the area under consideration, [2]. Essentially, factor analysis reduces the complex pattern of

correlations among many variables by grouping them in simpler sets which appear to erect from the same parent population. Factor analysis, however, does not explain the variations between the variables, it only demonstrates them in a more readily interpretable form [3]. The explanation of the factors must be in the context of known information about the variables.

The study area lies in the South Eastern Desert of Egypt. It is bounded by Latitude 23° and 23° 30' N and Longitude 33°30' and 34° 15' E. The geological map (Fig. 1) constructed by El Shazly *et al.*, [4] shows that the main lithologic units in the

study area range in their ages from Precambrian basement rocks to Quaternary sediments.

MATERIALS AND METHODS

Factors analysis arose from the idea that when a set of observed variables covaried, the resultant variables are decomposed into a number of theoretical vector components or factors which could be easily explained [5].

In the present work factor analysis has been computed using a SPSS program (version 7.0 package) in order to establish the common principal factors affecting rock classification or grouping in the study area. The analysed variables were the concentration maps of U, Th, K and their ratios (U/K, U/Th and Th/K) in addition to the Tc (total count map), [6].

RESULTS AND DISCUSSION

All the analysed seven variables of the gamma-ray spectrometric data could be represented by three factors (Table 1). This 3-factor model provides reasonable rock groupings in terms of known geology. Meanwhile, it is worth to note that these factors appeared as good indicators for certain specific characters such as radioactivity, alkalinity and basicity / acidity.

Table 1
Varimax - rotated factor matrix

Variable	Factors		
	F1	F2	F3
Tc	0.8933	-0.1422	-0.0877
K	0.8206	0.1297	0.1420
Th	0.8093	-0.1030	0.0196
U	0.4502	-0.5490	0.2668
U/K	-0.1989	-0.5390	0.2094
U/Th	-0.0281	0.1788	-0.8016
Th/K	-0.1772	-0.6157	-0.1226

Reviewing Table 1 which was obtained through using the varimax method (Comery, 1973), we can conclude that the high positive loadings for Tc, K and Th beside the moderate values of U in the first principal factor seemed mainly responsible for the geometry of the resulted factor analysis patterns. However, the relatively high values of K and Th suggest that they contribute about equally to the principal factor (F1) which reflects to a great degree most of the actual geology. On the other hand, the U values seem to have little influence on this factor (F1) with respect to K and Th. Meanwhile, its relative increase in the third factor (F3) which outlines most of the Quaternary sediments may be a good reflection for Uranium formed by deposition after surface leaching from the surrounding higher topography.

The respectively high negative loadings for the ratios of both U/K and Th/K in the second factor (F2) call attention to the alkaline nature of the portrayed rocks from mapping the factor scores. On the other hand, the outstanding high negative

loading of U/Th in the third factor (F3) sheds a light towards the possibility of differentiating basic and acidic rocks where the resulted factor scores apt to coincide with the more acidic rocks.

Finally, the resulted factor scores were plotted against each other and the map (Fig. 2) was resulted. This factor analysis map was nominated as integrated radiometric-map for the study area. Such a map with different patterns seems to correlate well with known geology (Fig. 1). The rock unit names in this map were derived essentially from the corresponding geological map.

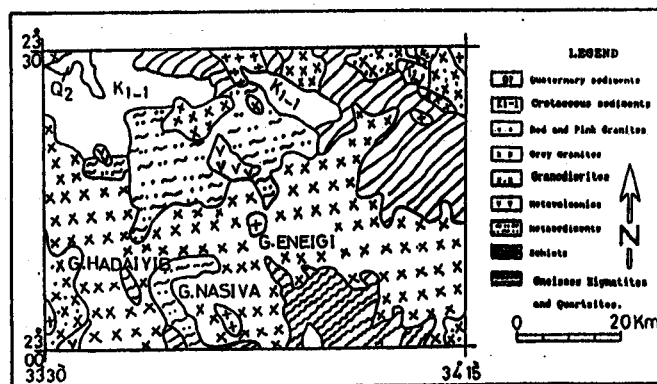


Fig. 1: Geological map of the study area, (After El Shazly et al., 1980).

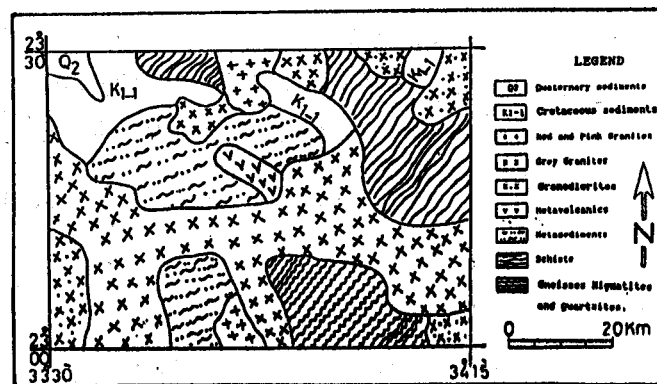


Fig. 2: Rock unit map interpreted from factor scores.

CONCLUSION

Application of factor analysis technique for the analysis of airborne gamma-ray spectrometric data resulted in three factors which we can call them as integrated geological factors. Each factor is somewhat specific for a certain character; namely, F1 for radioactivity, F2 for alkalinity and F3 for basicity / acidity.

It appears that mapping factor scores is a robust tool in rock classification; meanwhile, it sheds a light towards areas of anomalous radioactivity or geochemical character. So, this analysis provides a useful guide to field geologist for extending known geology or for preparing a preliminary geological map from integrated spectrometric data.

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