Nuclear Materials Authority
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ISSN 2314-5609
Nuclear Sciences Scientific Journal
8, 173- 179
2019
http://www.ssnma.com

SEPARATING THE ANOMALOUS ZONES OF GAMMA-RAY SPECTROMETRIC DATA USING THE MEDIAN TO FIT THE MATHEMATICAL SURFACE ON EL-MISSIKKAT EL-GIDAMI AREA, CENTRAL EASTERN DESERT, EGYPT

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ABSTRACT

Traditionally, the least-squares method is applied to separate the highly radioactive zones of gamma-ray spectrometric maps in order to find the normal radioactive background of the host rocks. In the present study, the regional background of gamma-ray spectrometric data was calculated by using the median instead of least-squares method which is based on the mean. The obtained least-squares do not properly fit due to the strong effect of the few outlier data points that are extremely high or low. The median is less affected by outliers and skewed data. If we reject these anomalous zones data, the proper fitting takes place. This study deals with using the median as a more suitable measure of central tendency for data classified on an ordinal scale. The mean is not suitable when the data include exceptionally high or low values because these have great influence on the outcome. The median was applied to the gamma-ray spectrometric (Total Count) survey data of El-Missikkat-Gidami area to separate the radioactive anomalous zones from the normal radiation of the host rocks.

INTRODUCTION

The mean, median and mode are all valid measures of central tendency, but under different conditions, some measures of central tendency become more appropriate to use than others. Traditionally, the least-squares method (LSM) is applied to separate the highly radioactive zones of spectrometric maps in order to find the normal radioactive background of the host rocks (Abdelrahman et al., 2007) .

Abdelrahman et al. (2007) tried to apply the LSM approach to separate the radioactive anomalous zones from the normal radiation of the host rocks. The method consists of fitting a mathematical surface that approximates the regional component of the aero-radio-spectrometric data.

The mean is a not suitable to measure the central tendency value when the data include exceptionally high or low values because these have great influence on the outcome. The median is the most suitable measure of the central tendency for data classified on an ordinal scale in such cases (Heinz Kohler, 1958) .

In this study the median was applied on gamma-ray spectrometric (Total Count) survey data of El-Missikkat-Gidami area to separate the radioactive anomalous bodies from the normal radiation of the host rocks.

The constructed regional and residual data, by using the median to fit a mathematical surface that approximates the regional component of the Total Count map of El-Missikkat-Gidami as a sample area, were found to be the most proper.

Using the LSM to Fit a Mathematical Surface

Figure (1a) presents a data set of 100 points, where, 4 points have much higher values than median value and 5 points have much lower values. The rest of the points are of the common trend. It is clear that the obtained fitting is improper due to the strong effect of these few data points that are extremely high or low than the central tendency.

When we excluded these anomalous points as shown in Fig.(1b), the proper fitting is achieved. In other words once we reject the anomalous zones data , the proper fitting took place. For that reason the mean is not suitable when the data include exceptionally high or low values because these have great influence on the outcome.

Least-Squares Fitting of Polynomials

Suppose that we have M*N data points (map dimension) and wish to fit the observed data, in some sense, by a polynomial (F= a00 +a10 X + a01 Y). The deviation of the polynomial fit are called the residuals where (Residual = Observed - Regional) If we fit this data by a plane surface polynomial in least-squares sense.

$$a00 + a10\,X + a01\,Y = F \qquad (1)$$

Where a00, a10 and a01 are the coefficients to be determined.

To find a minimum, we naturally differentiate with respect to a00, a10 and a01 and then set the resulting expressions equal to zero. This process (normalization) gives the following three equations.

$$\begin{aligned} a00\; n + a10 \sum X + a01 \sum Y &= \sum F \\ a00 \sum X + a10 \sum X2 + a01 \sum XY &= \sum FX \qquad (2) \\ a00 \sum Y + a10 \sum XY + a01 \sum Y2 &= \sum FY \end{aligned}$$

The Median Method

The median was applied on gamma-ray spectrometric survey data by using two different formula for calculating the median,

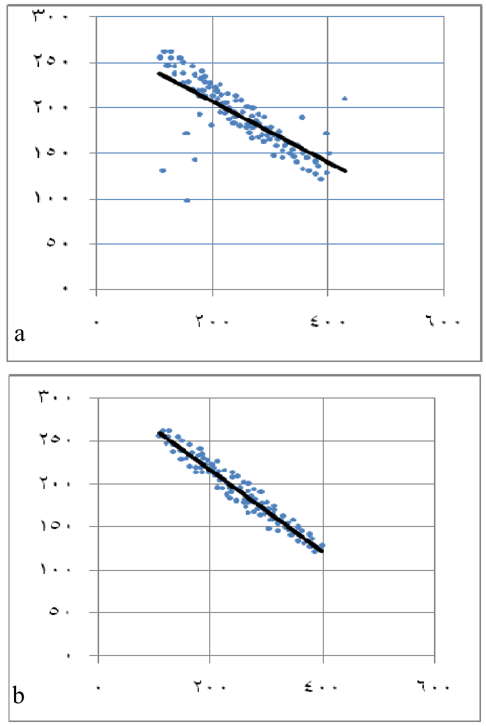

Fig.1:Least squares method technique strongly affected by arithmetic mean of the data

depending on whether the number of observations is odd, or even:

When the number of observations is odd the formula is:

$$x_m = x_{\frac{n+1}{2}} \qquad (3)$$

Where X_m is the median and n is the number of observations.

When the number of observations is even the formula is:

$$x_m = \frac{x_{\frac{n}{2}} + x_{\frac{n+2}{2}}}{2} \qquad (4)$$

Where X_m is the median and n is the number of observations.

Method

Assume that the spectrometric data are put in a form of a regular grid that represents the observation data as on Figure (2). TC (x_n, y_m) represents the observation data (n and m are numbers of vertical and horizontal cells of the grid). A grid is oriented so that cells are arranged parallel to the x and y coordinates. Cell labeling is given by the two variables: i= 1,2 ... n, and j = 1,2 ...m.

Starting from the bottom left cell the median of the column and the median of the row were calculated and their mean was allocated in the intersecting cell. The same calculations were made for the all cells of the grid. The residual is calculated by subtracting the calculated regional grid from the observed grid.

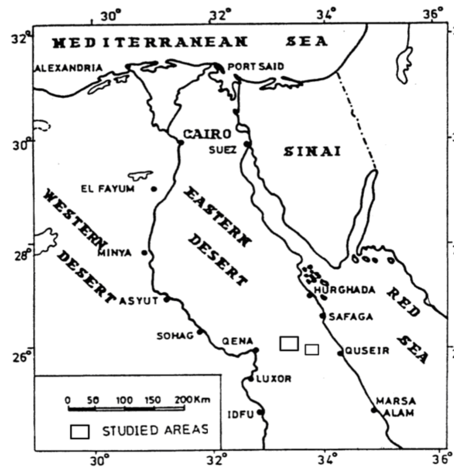

Fig.3:Map of Egypt showing the location of El-Missikat El-Gidami area, Central Eastern Desert, Egypt

Field example

The method was applied on El-Missikat-El-Gidami area, which is located in the central Eastern Desert of Egypt (Fig. 3).

El Missikat-El-Gidami area geological setting

The study area located between Lat. 26° 07'-26° 36'N and Long. 33° 08'-33° 30'E, (Fig.3).

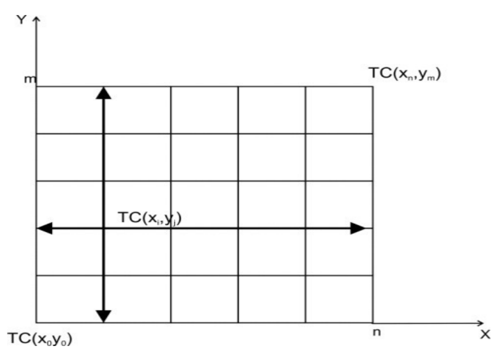

Fig.2:Regular grid that represents the observation data

The regional geology of the area is included in CONOCO, 1984, with scale 1:500,000. It was also included in the works of El Kassas (1974); Bakhit & El-Kassas (1989); Bakhit, (1978); Khamies and Abu-Deif (20070.

The investigated area comprises of the following rock units from oldest to youngest: metavolcanics, older granitoids, younger granites, gabbroic rocks, Taref formation, and Wadi deposits (Fig.4).

Wadi Attala-EI-Missikat district is a Precambrian terrain that is unconformably overlain by the undeformed horizons of sediments of the Nubian Sandstone facies of Early Cretaceous. It lies within the northern part of the central tectonic block (Stern et al., 1985). It is also characterized by widespread younger granite exposures represent the magmatic activity marking the end of the cratonization process of the Pan-African orogeny. These granites are mostly affected by post magmatic deuteric and hydrothermal alteration activities associated with rare metal mineralization including uranium deposits. Also, NW lateral

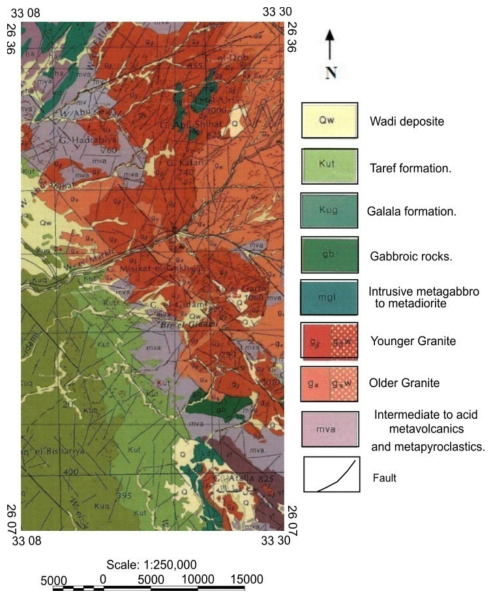

Fig.4:Geological map of El-Missikat El-Gidami area (After Conoco, 1984)

strike slip faults, similar to the Najd-fault system in the Arabian shield are well developed (Stern, 1985). They play an important role in uranium distribution in the study area. Wadi Attala-EI-Missikat area is featured by dykes and veins that were found to cut across both younger granites and older rocks, as dyke swarms.

They are mostly trending in NE to ENE and N-S to NNE directions. These dyke swarms are of acidic and mafic varieties. The acidic dykes are represented by granitic porphyries, aplites, and quartz veins.

The acidic dykes are represented by granitic porphyries, aplites, and quartz veins. On the other hand, the basic and intermediate dykes are mainly following N-S to NNE direction. The area is pervaded by networks of fracture systems of different trends which the NW and NE trends are the most pronounced ones.

Gamma-ray spectrometric survey

An airborne gamma-ray spectrometric survey for the Eastern Desert of Egypt was carried out by Aero-Service Division, Western Geophysical Company of America, USA, (Aero-Service, 1984 a&b).

Figure (5) shows filled–contour map of the aerial Total Count aero radio-metric data. Aerospectrometric surveys were conducted along parallel flight lines that were oriented in a NE-SW direction, at 1.0 km spacing. Meanwhile, the tie lines were flown perpendicularly to the NW-SE direction at 10 km intervals. A multichannel radiospectro-metric measurements were made at 93 m intervals at a nominal sensor altitude of 120 m terrain clearance. A high-sensitivity 256-channel airborne gamma ray spectrometer (50 l NaI “Tl” crystals) was used (Aero-Service,1984).

The obtained airborne radio-metric survey data were reduced, compiled, and finally presented in the form of contour and composite profile maps at a scale of 1:50,000

Applied Least Squares Method

As shown on Fig. (6) it was found that least squares technique strongly affected by arithmetic mean of the data. Incorrect estimation and removal of the background from the initial Total count observations yields, incorrect constructed residual map Fig. (7). Where part of the local component entering as part of regional component causing deformation in the composite residual.

By applying least-squares fitting a low-order polynomial to the observed field, a fictitious residual anomalies (up to-80 Ur) are arising when the regional field is subtracted from the observed data due to the mathematical procedures due to the fact that least squares method technique are strongly affected by arithmetic mean of the data. The maximum value of the original data is 220 Ur, while, the fictitious residual anomalies (up to-80 Ur) about (80/220) = 36% negative.

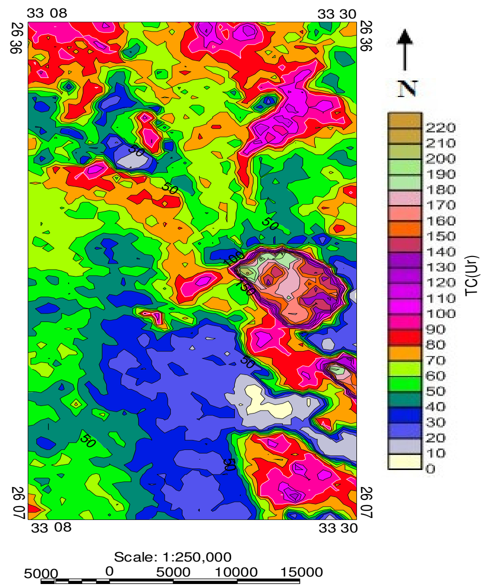

Fig.5:Filled-contour image map of the aerial total-count aero radiometric data

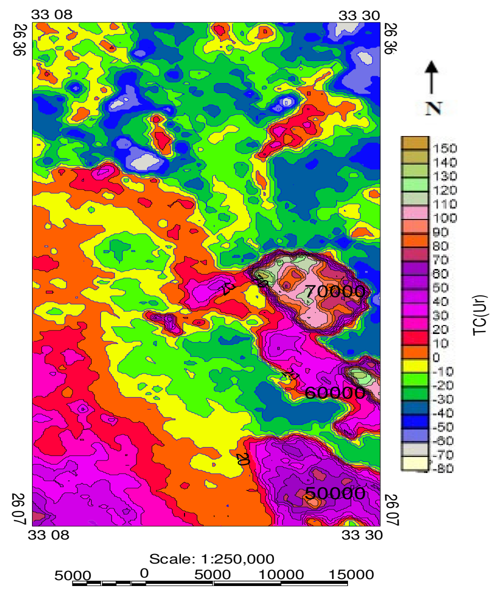

Fig.7:Filled-color contoured anomaly map of the first-order residual (T.C.) aeroradiometric data

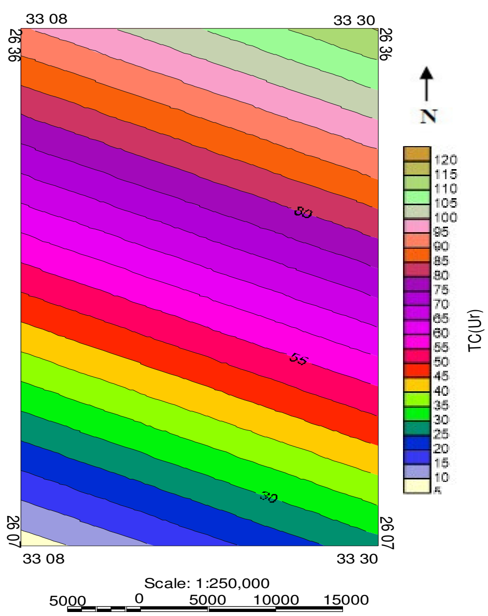

Fig. 6:Filled-color contoured anomaly map of the first-order regional (T.C.) aeroradiometric data

The proposed method was applied on the same data, instead of using the method of least squares, where it improved results and proved to be ideal for separation (no negative fictitious residual anomalies).

Applied Median Method

Median was applied on total count (TC) survey data of El Missikkat-El-Gidami as a sample area to separate the radioactive anomalous bodies from the normal radiation of the host rocks. The residual is obtained by simple subtraction.

The constructed regional and residual maps by using the median to fit a mathematical surface that approximates the regional component of the total count map of a sample area are shown on Figs.(8&9). The constructed regional (Fig.8) shows that there is almost N-S trend of high radioactive zone occupied the eastern part of the map. It seems that all younger granitic plutons are related to this high radioactive zone. The obtained airborne radiometric survey data were, compiled, and finally presented in the form of contour and composite profile maps at a scale of 1:50,000.

CONCLUSION

The present work suggests that, the median is the most suitable measure of central tendency for data classified on an ordinal scale with few extreme high and low values. The mean is not suitable when the data include exceptionally high or low values because these have great influence on the outcome. Medians were applied on gamma-ray spectrometric (Total Count) survey data of El-Missikkat-El-Gidami area to separate

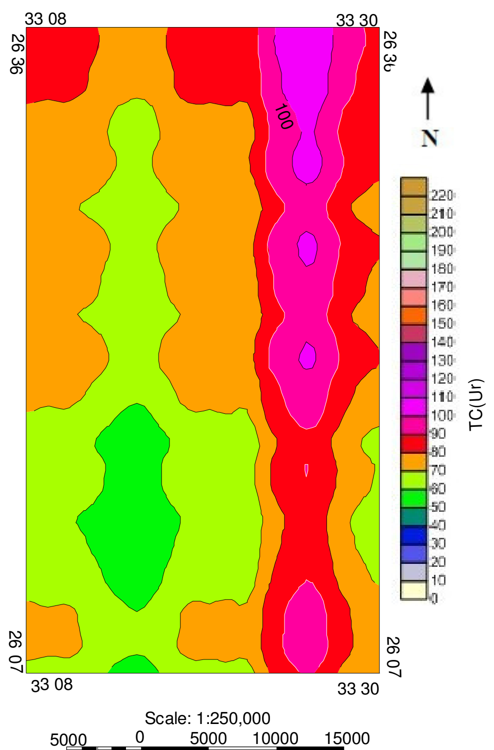

Fig.8:The constructed regional (T.C.) aeroradiometric map by using median

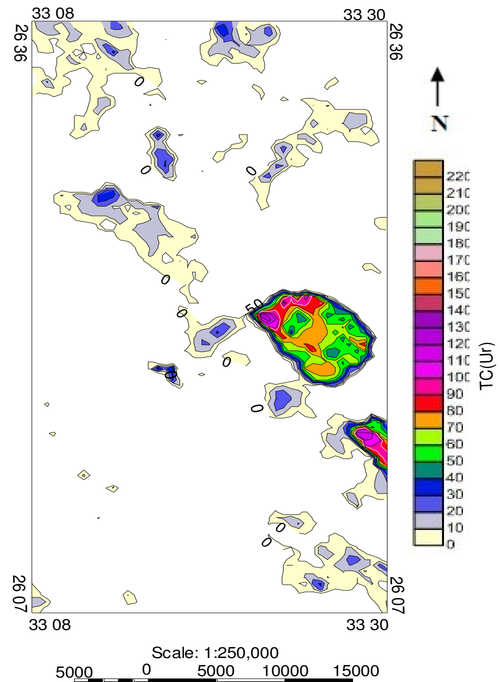

Fig.9:The constructed residual (T.C.) aeroradiometric map by using median.

the radioactive anomalous bodies from the normal radiation of the host rocks. The constructed regional data shows that there is an N-S trend of high radioactive zone occupying the eastern part of the map. All younger granitic plutons are related to this high radioactive zone. Moreover, the constructed residual data are related to the granitic rocks.

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فصل المناطق الشاذة من البيانات اشعة جاما الطيفية بإستخدام الوسيط الحسابى لتناسب السطح الرياضى فى منطقة المسيكات والجدامى وسط الصحراء الشرقية، مصر

احمد ابراهيم كامل

تقليديا، يتم تطبيق طريقة المربعات الصغرى لفصل النطاقات عالية الإشعاع من خرائط اشعة جاما الطيفية من أجل العثور على الخلفية الإشعاعية للصخور المضيفة. في هذه الدراسة، تم حساب الخلفية الإقليمية للبيانات الإشعاعية الطيفية باستخدام الوسيط بدلا من طريقة المربعات الصغرى التي تقوم على أساس المتوسط مما يجعل طريقة المربعات الصغرى تتأثر بشدة بعدد قليل من نقاط البيانات العالية جدا أو المنخفضة جداعن المتوسط. بينما يعتبرالوسيط أقل تأثرا بقيم البيانات الشاذة نظرا لكونه يستبعد بيانات النطاقات الشاذة . تتناول هذه الدراسة استخدام المتوسط كمقياس أكثر ملائمة لقياس النزعة المركزية للبيانات الاشعاعية حيث يقوم بترتيبها واستبعاد البيانات ذات القيم المرتفعة أو المنخفضة لما لها تأثير استثنائي على النتيجة. تم تطبق طريقة استخدام المتوسط على بيانات المسح الاشعاعي الكلي لمنطقة المسيكات و الجدامى لفصل النطاقات عالية الإشعاع من أجل حساب الخلفية الإشعاعية للصخور المضيفة.