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DETERMINING THE OPTIMAL DENSITY OF NEKA USING FRACTAL METHOD AND THE STUDY OF ITS GEOLOGICAL SITUATION

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ABSTRACT

In discovery geophysics, the primary aim is to determine the density of the studied targets which have definite density difference from host rocks. In this study, we express a method to determine the density of Bouguer plane, called fractal method. This method is based on minimization of surface roughness of Bouguer anomaly. From fractal dimension, the surface is used as a roughness criterion of Bouguer anomaly. Using this method, we can determine the optimum density of Neka region to use for modifications and monitoring the results in isostatic situation of region.

Keywords: Fractal dimention, Topography, Bouguer anomaly, Optimal density, Neka region, Isostatic.

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1. INTRODUCTION

According to Fig (1), Neka region is located at longitude $52^{\circ}46'\,48''$, $53^{\circ}28'\,48''$and latitude $36^{\circ}15'\,12''$, $36^{\circ}39'\,36''$, in which a part of Caspian sea oil field at 39 north zone, Mazandaran, is located.

The region of study includes 2006 gravitational measurement stations scattered in the area. This region has thick deposit layers of second and third epochs of geology with suitable conditions of structures with oil materials.

Geologically, a part of northern region has been covered by contemporary deposits and in eastern part, dolomite limestone and Jurassic- related limestone are seen. In the southern part of the region, limestone sand, Paleocene-related sand limestone, marl, silise marl, limestone marl limestone related to *upper_cretaceous* and shemshak formation related shale are observed.

The reservoir rock of the study was introduced by the report 333 of geology department of NIOC to be lower cretaceous, middle and upper Jurassic. Also, the coating rock and mother rock were clay deposit of Miocene and Shemshak formation, respectively.

As one of the steps to attain Bouguer anomaly is to determine Bouguer density to do the research and the measurement of gravitational change in host rock and evaporate rock coating is a criterion to follow construction traps and determination of reservoir (Goodchild, 1982) the application of wrong values of Bouguer density leads to the increase of error in determining the situation subsurface facials making it impossible to attain the reservoirs. Therefore, the modification of anomalies and proper estimation of density from rock tablet changes are necessary to follow rudimentary of oil fields in gravitational method (Mandelbrot, 1975). In the regions of high tectonic and number of construction contours, the Netelton pattern is not suitable to modify the effects of rock tablets (Aronson Peter and David, 1984). In Iran, due to use of this pattern, there is the possibility of error from topographic considerations (Fournier and Fussell, 1982).

Therefore, in this paper, a new fractal method has been used to reduce error.

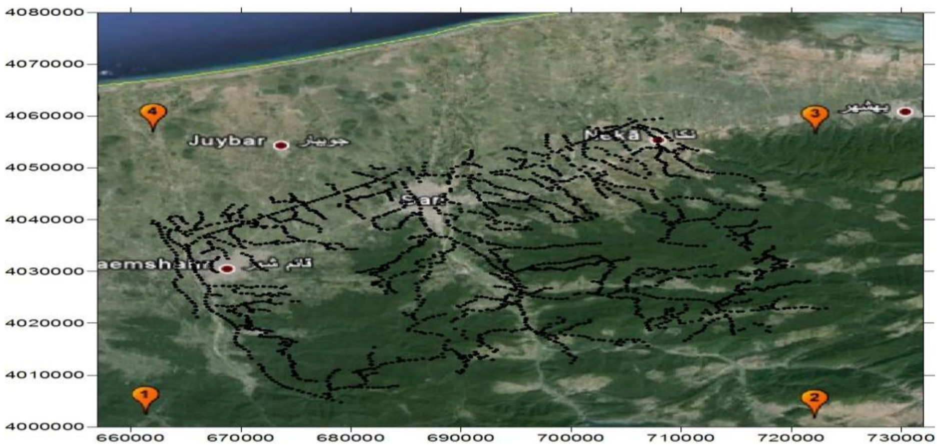

Fig-1. Satellite map of the study area

1.1. Fractal Analysis of Free Air Anomaly

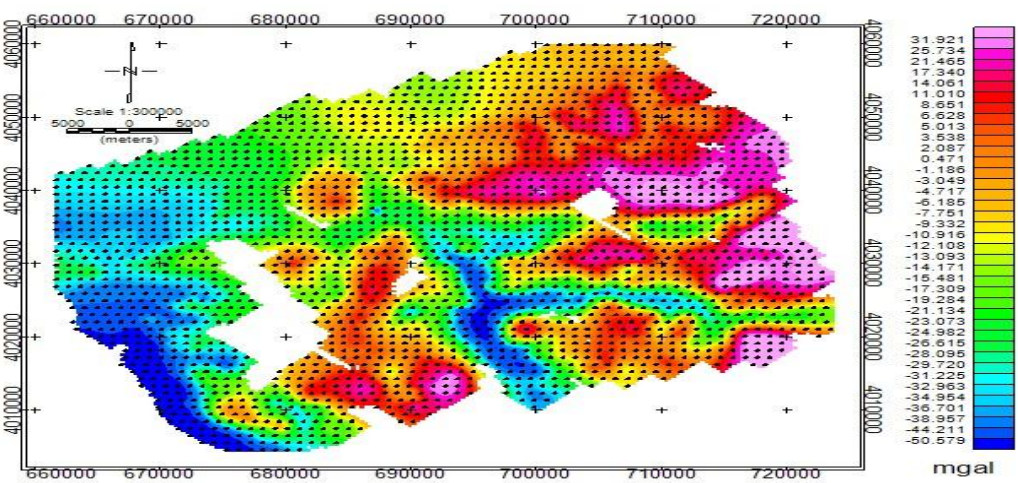

Fig-2. Free air anomaly map area.

Fig 2 shows the free-air anomaly of east region of Neka. The first stage, the gravitational data having been processed, is to use free-air anomaly under the skew relationship of distance to get the variables independent of costatic phenomenon of mantle.

To obtain this goal, the algorithmic procedure can be expressed as follow:

1) Geographical coordinates of measurement stations are turned in to Cartesian coordinates.
2) The center and radius of the great circle are determined.
3) The circle is drawn.
4) The drawn circle is divided into definite numbers of parts.
5) The data located in this circle are sorted in certain distance.
6) Variance of data in each set is calculated.
7) The logarithmic graph of variance versus distance is depicted.
8) The logarithmic graph of variance versus distance is depicted.
9) The line of least squares is fitted to a part of curve having fractal property.
10) the tangent line slope is Determined
11) the fractal dimension is obtained the slope

Data interpolation was carried out in Matlab linearly at 750 m distance(fig3). Due to concentration of data in the eastern region , the great circle was drawn in this part using most crop points. The circle diameter was divided in to 50 equal parts. The variogram of square mean of value difference (variance) versus distance was depicted. Based on Fig (4), the free air variance of Neka region shows a dual behavior; to 5 km, a fractal behavior with the dimension 2,6 showing the topography is supported by crust and the other part is influenced by region contours.

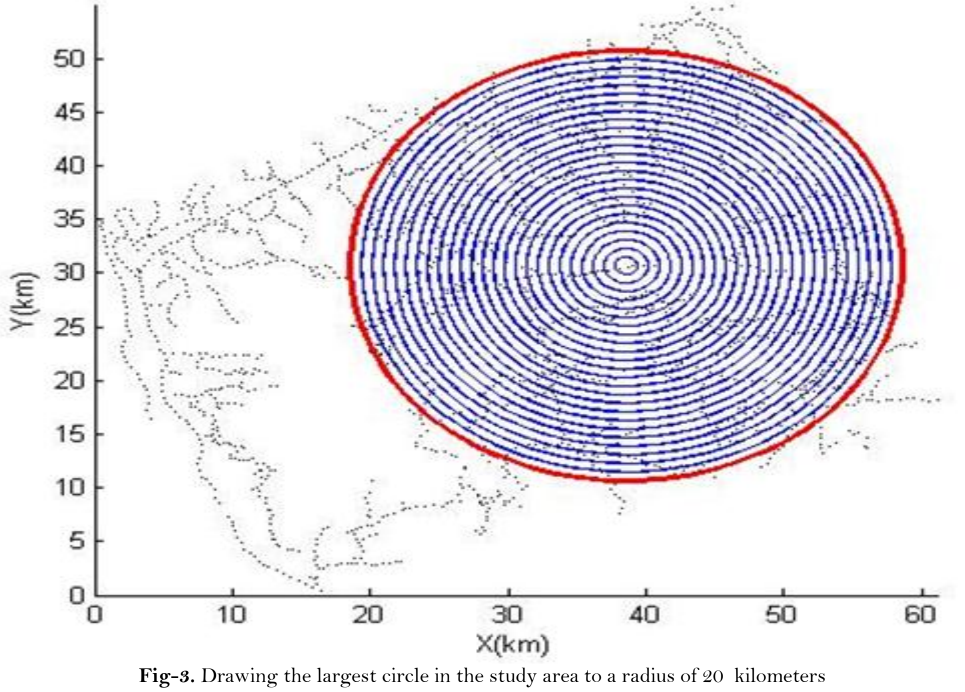

Fig-3. Drawing the largest circle in the study area to a radius of 20 kilometers

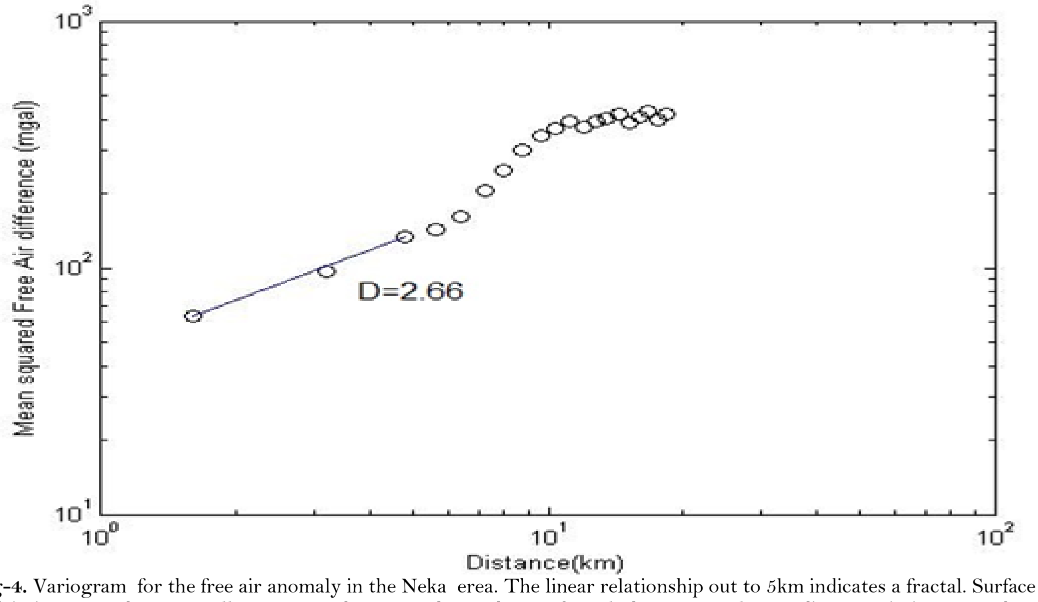

Fig-4. Variogram for the free air anomaly in the Neka erea. The linear relationship out to 5km indicates a fractal. Surface and is interpreted as crustally supported topography . The nonfractal character at larger distances is interpreted as isostatically compensated topography (Thorarinsson and Magnusson, 1988)

1.2. Optimum Mean Density of Region Using Fractal Method

Having surveyed the free air anomaly and recognized the gravitational changes independent of altitude effects of stations, we consider the relationship of distance-diffusion for Bouguer anomaly for different values of density (Samadi, 2013).

The density used ranged from 1.7 to 2.1 g/cm^3. Fig 5 shows the greatest circle covering most data points in the region. The circle is divided into 40 equal parts and variance-distance graph is depicted for different densities. The least dimension of density is calculated to be 1.95 g/cm^3

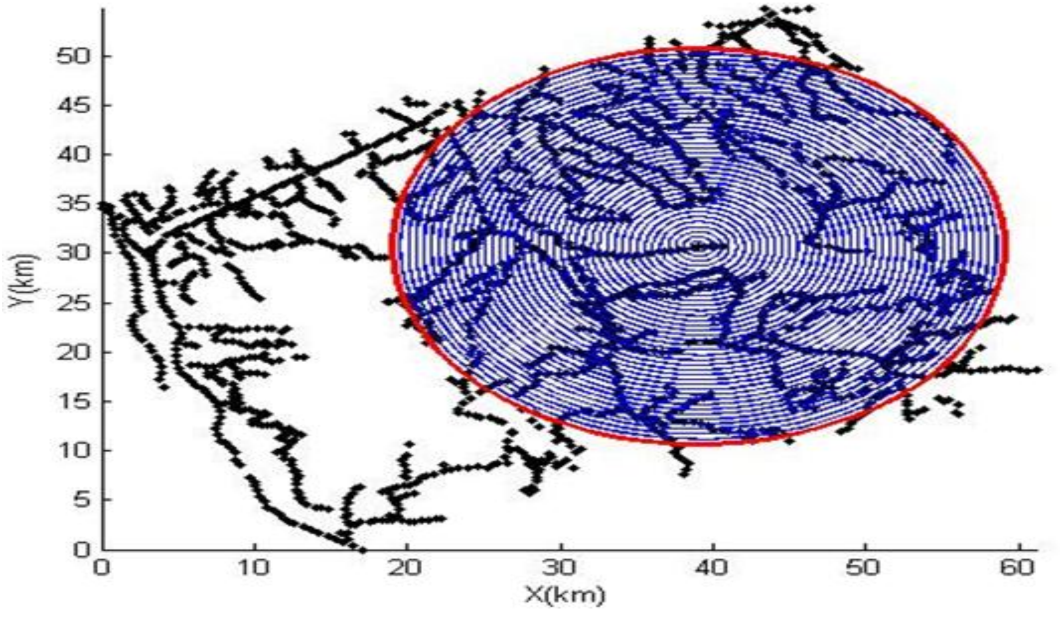

Fig-5. The largest circle that cover most of the data.

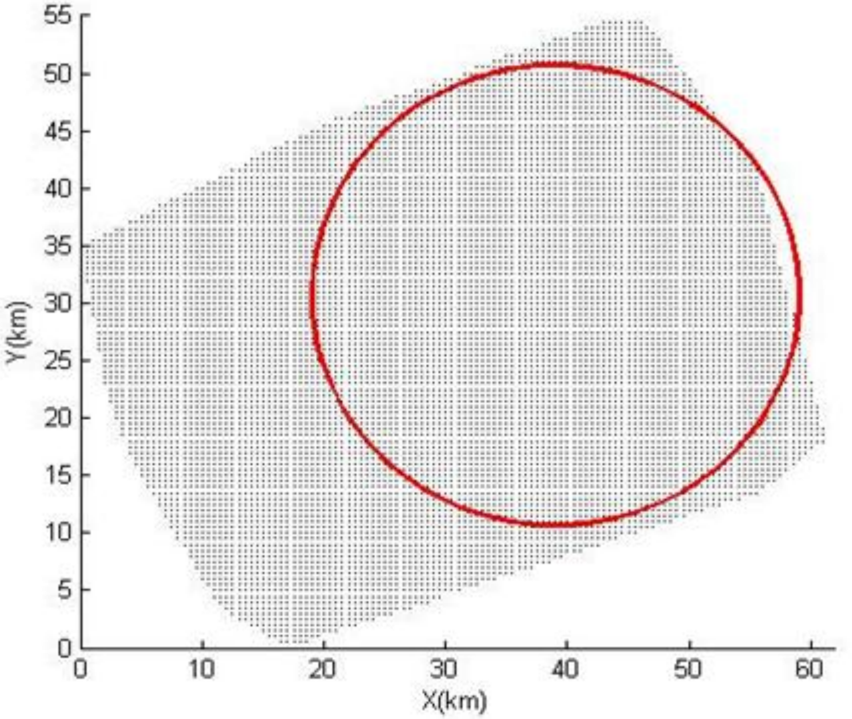

Fig-6. Data interpolation with a distance of 500 meters.

From the curve, the fractal dimension in the region for the density of lowest dimension is 1.95 g/cm^3.

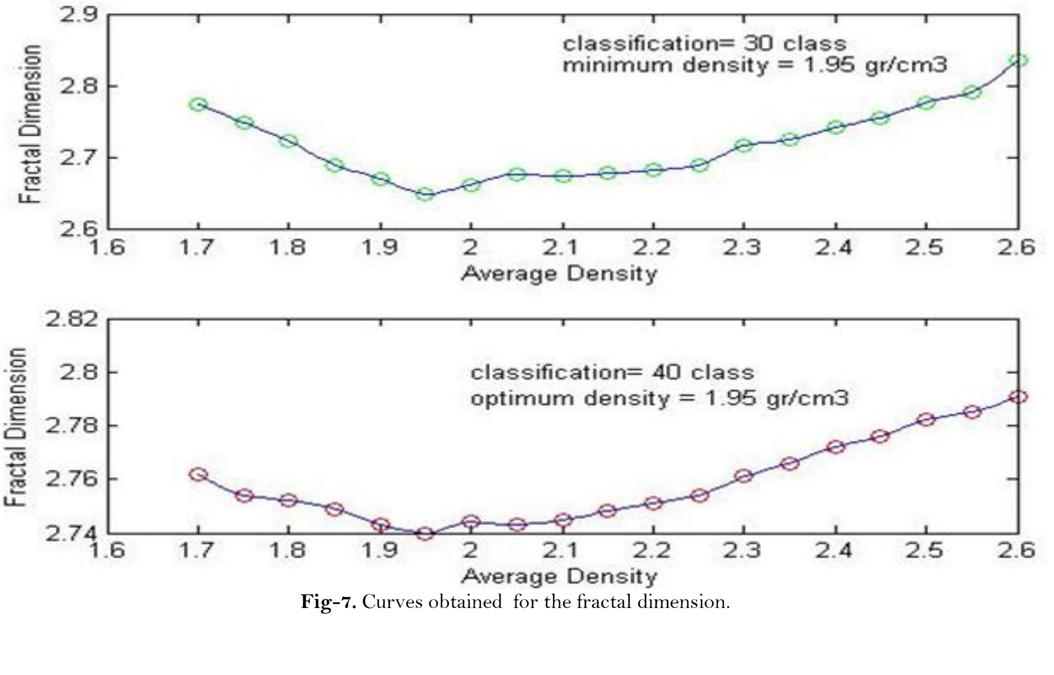

Fig-7. Curves obtained for the fractal dimension.

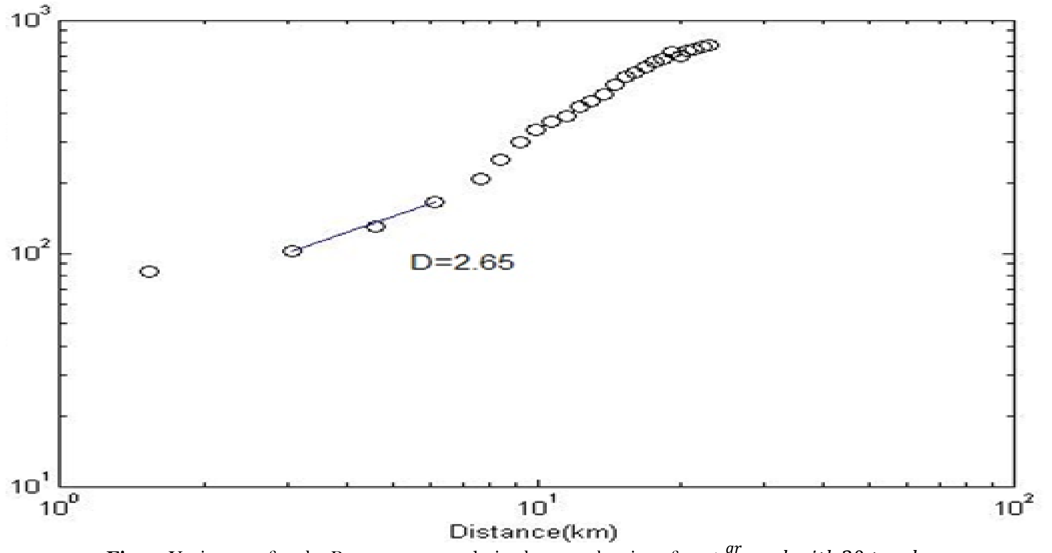

Fig-8. Variogram for the Bouguer anomaly in the erea density of $1.95\frac{gr}{cm3}$ *and with* 30 *topclass.*

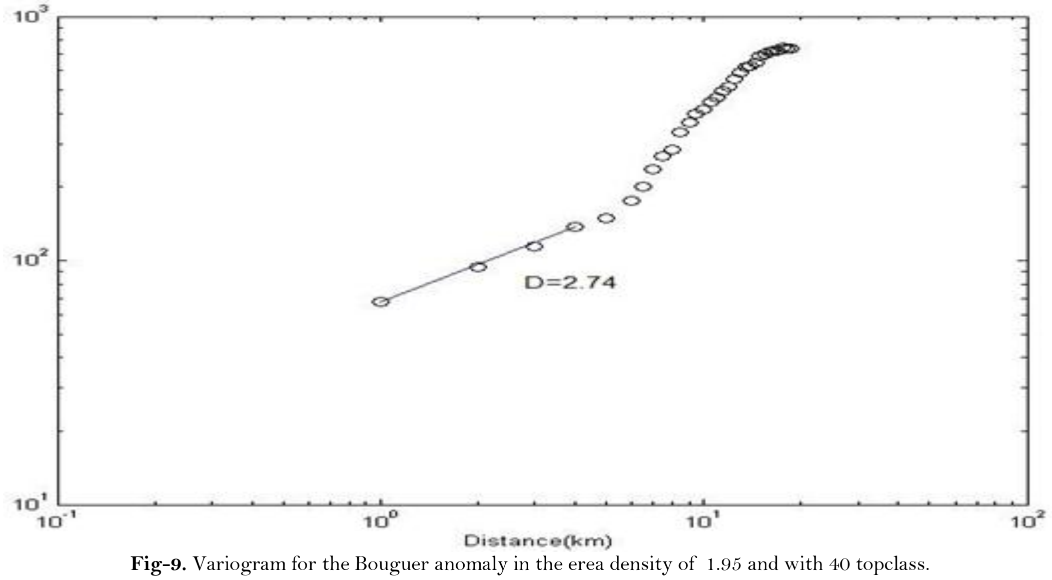

Fig-9. Variogram for the Bouguer anomaly in the erea density of 1.95 and with 40 topclass.

1.3. Region Mean Density Using Netelton Method

To obtain the region mean density, we used the gravitational data by NIOC as we did not have the Netelton's data of region and the calculation method by NIOC was Netelton method. The mean density was obtained to be 2.1 g/cm^3.

$\delta g_{B=0.04188\rho h}$

1.4. The Comparison of Bouguer Anomaly Correlation Made By Region Profile

The comparison of Bouguer anomaly correlation made by region profiles with four profiles on Bouguer anomaly map from optimum density, mean and topography map, the following results were obtained.

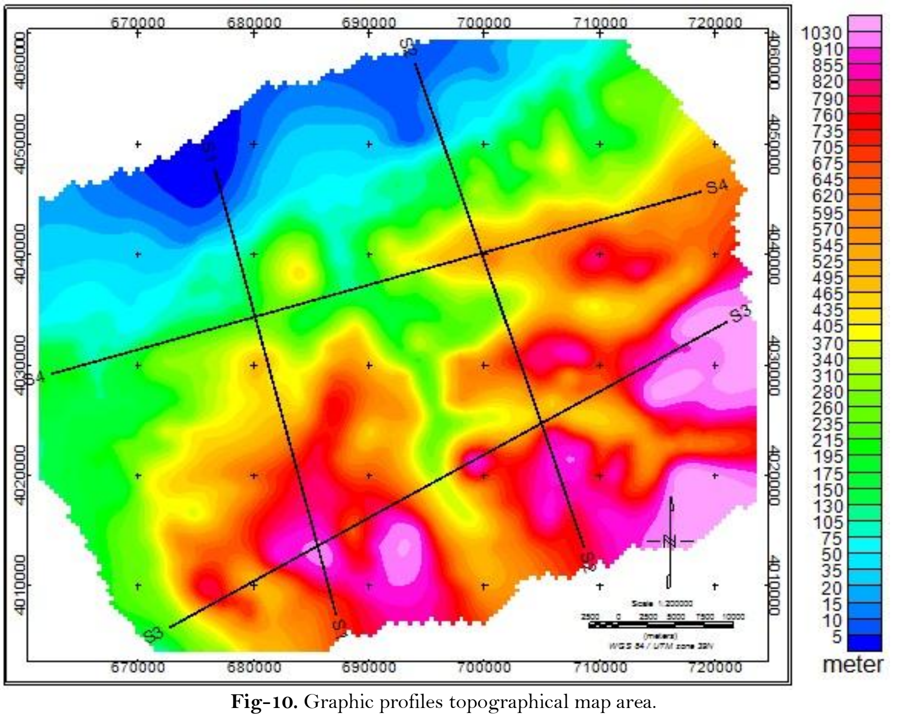

Fig-10. Graphic profiles topographical map area.

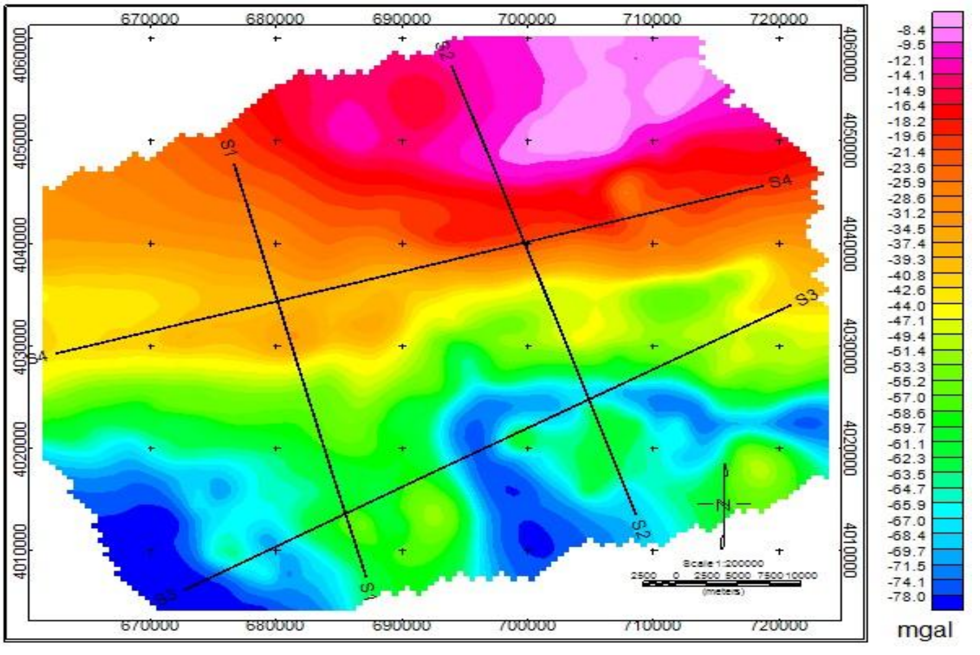

Fig-11. The graphical profiles that is creat on the Bouguer anomaly map whit optimal density.

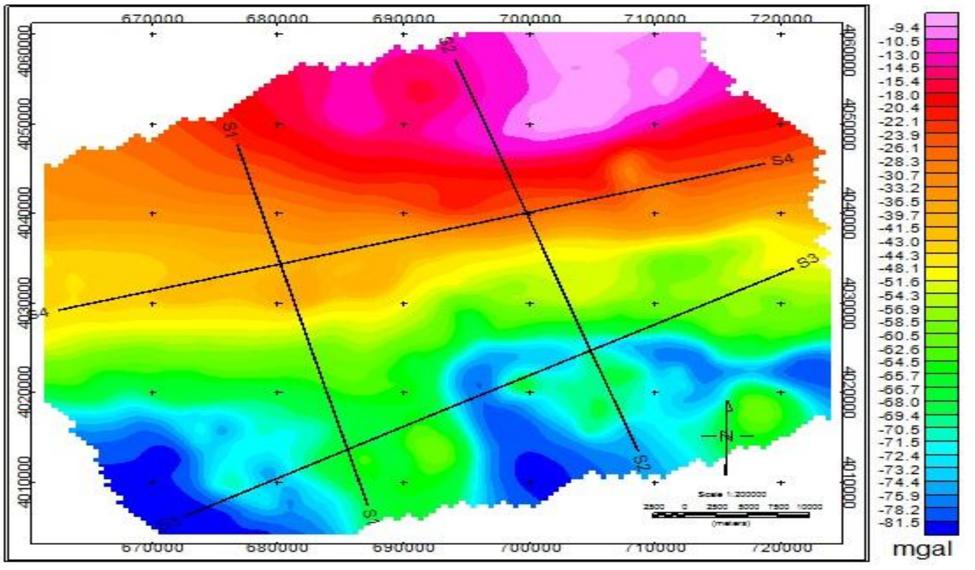

Fig-12. The graphical profiles that is creat on the Bouguer anomaly map whit mean density.

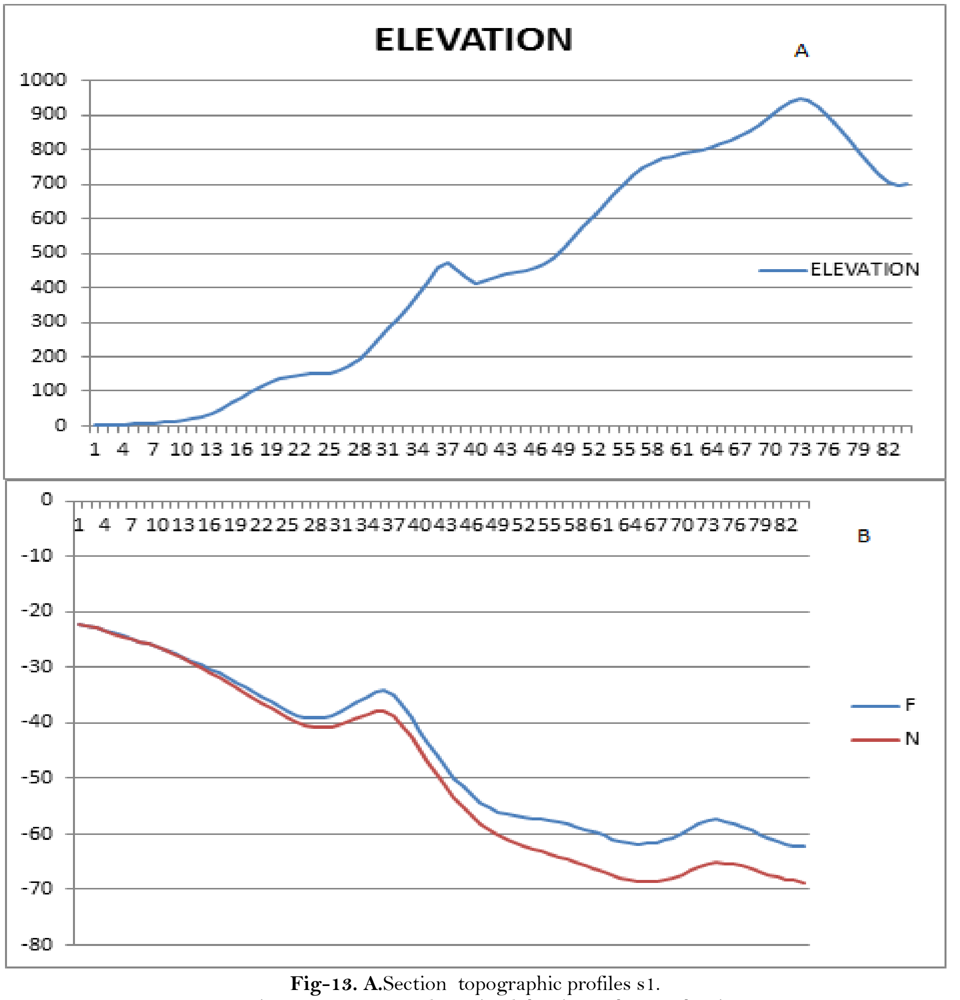

Fig-13. A. Section topographic profiles s1.
B.Section Bouguer anomaly optimal density and mean density.

Table-1. Table section of optimal density and mean density .

Bouguer anomaly correlation of fractal density and topography	Bouguer anomaly correlation of netleton density and topography	Profiles
0/942	0/959	S1
0/8471	0/8746	S2
0/862	0/905	S3
0/957	0/962	S4

The numbers in table and the procedure profile curves s_1, confirm the principles of fractal analysis.

Survey and comparison of Bouguer anomaly correlation and topography of all region data by pearson method using correlation statistical method.

In this section, using pearson correlation method, we compared the Bouguer anomaly data from both densities with topography as shown in table 2.

Table-2. Pearson correlation table.

Full bouguer correlation between topography and the optimal density of the fractal	0/543
Full bouguer correlation between topography and the regional average density	0/601

2. INTERPRETATION OF RESULTS

- The results show that fractal distribution of gravitational data aiming at assessing Bouguer anomaly change in the region provides better results due to use of corresponding quantities focusing on fractal properties which make it possible to estimate density in a situation independent of topography compared with modification pattern of Netelton.
- Using fractal method, we obtained the optimum density to be 1.95 g/cm^{3}and Bouguer density was obtained from Netelton method at 2.1 g/cm^3 showing that Bouguer density from fractal method in vast region is of greater accuracy and lower error the Netelton method.
- From this research, making gravitational profiles on Bougeur anomaly map from optimum and Netelton density(mean), and topography, we concluded that profile obtained from fractal density is smoother, confirming the fractal analysis because the optimum density is obtained for the lowest fractal dimension.
- Variogram of free air change shows a limited linear relationship for short distance which is vanished for greater distances.
- The data of this region are fractal to 5 km and topography is under the support of crust expressing the dependence of free-air anomaly and topography in these distances.
- The values of pearson correlation show that anomaly of fractal density had less dependence on topography and this density is obtained by minimizing anomaly Bouguer anomaly roughness, because applying density values mistakenly in modifying roughness of Bouguer anomaly is influential.

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Contributors/Acknowledgement: All authors contributed equally to the conception and design of the study.

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