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INVESTIGATING THE DENSITY RATIOS OF GEOLOGICAL STRUCTURE THROUGH FRACTAL GEOMETRY CASE STADY: (DEHNO REGION IN FARSS OF IRAN)

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ABSTRACT

One of the most important steps to obtain the specified density Bouguer anomaly corrections for the topography of the page Bouguer is the most commonly used way in which the relationship between topography and Bouguer anomaly in the method assumes that topography of the rigid shell instead Isostasy balance is maintained. The method to determine the density of Bouguer provided by fractal analyze these are the lowest density dependence the topography of the area is considered as the optimal density and the fractal relationship to the topography of the fractal dimension using the Bouguer anomaly.

Keywords: Fractal dimension, Topography, Bouguer anomaly, Optimal density, Isostasy, Dehno region.

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1. INTRODUCTION

Bouguer Anomaly is most commonly quantities used ingravimetrically method. Indeed, this kind of anomaly is result of all local and regional gravitational resource. By considering that the field gravitational is usually lessroughness rather than the topography, Bouguer density has been determined by minimizing irregularities. This kind of irregularities is estimated by fractal dimension which possibly will create by measuring disordered irregularities given that the level should be in fractal shape, so, this paper aims to deal with comparing Bouguer Anomaly resulted from fractal geometry. Geometrical fractal is desirable method comparing with Euclidian geometrical method. Fractals are amongst the item that their spatial form are not smooth, therefore, they are called as disordered item. The best method to definite one fractal is to consider their features and specifications. So, it means that that their components are similar to integrated

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ones. Thorrarinsson and Magnusson (1990) proposed a new method to obtain density for Bouguer edition (Thorrarinsson and Magnusson, 1990).

In this paper is tried to consider region regard as its structure will be studied and for more exact analyzing in addition to ordinary methods of determining density also fractal method will be used.

Dehno anticline is located about 60 kilometers (air distance) west of Lamerd city, Fars province.

The studied area is located in the southeast fold-and-thrust belt of Zagros in the tectonic state of Fars covering an area of approximately 765 square kilometers with an average height of about 1100 meters. The region is in the range between 53°30' to 53°57'E longitude and 27°00' to 27°15'N latitude. Dehno anticline is bound to Hendorabi fault and salt anticline from the east, Tabnak anticline from the west, Gav-Bastanicline from the north, and Khalfani anticline and northern coast of Persian Gulf from the south.

The first stratigraphy of Dehno anticline is provided by Later, National Iranian Oil Company and French oil company Total jointly produced a 1:50000 scale map of Dehno anticline and the related geological report; a stratigraphic summary of the report is as follows:

Apart from the eastern salt dome in Dehno anticline, the oldest outcropped formation in this anticline has a Cretaceous age; therefore, all outcrop formations in this area have a Cretaceous to Quaternary age. These deposits include formations like Khami G., Bangestan, Gurpi, Pabdeh, Jahrom, Asmari, Fars, Bakhtiyari, and new deposits. Dehno consists of two smaller anticlines named Lavarstan (southern anticline) and Eshkanan (northern one). Lavarstan and Eshkanan are about 40 and 30 km long, respectively; their width together is about 15 km.

Bakhtiyari Formation: Bakhtiyari Formation's lithology in the area from the bottom up is as follows:

A) Coarse-grained and conglomeratic sandstones.

B) Coarse-grained conglomerate with sandy cement.

C) A very resistant, coarse-grained conglomerate mass with cells of about a meter in diameter.

225 meters of Bakhtiyari deposits in Kodian (north of Dehno anticline) were measured; this may increase in the synclines. Bakhtiyari Formation dates back to early Pliocene or Pliocene epoch (Genevraye *et al.*, 1967).

The lower boundary of this formation with Aghajari formation is in the form of angular unconformity. This formation is exposed to corroding forces in some areas, but in some places it is laid under new sediments (Kavoosi, 2000).

Mishan Formation: Mishan Formation contains yellow and gray limestone in the lower part and gray-green marl in the upper part. The thickness of Mishan Formation at Dehno anticline is 630 meters. This formation dates back to early to middle Miocene epoch (Genevraye *et al.*, 1967).

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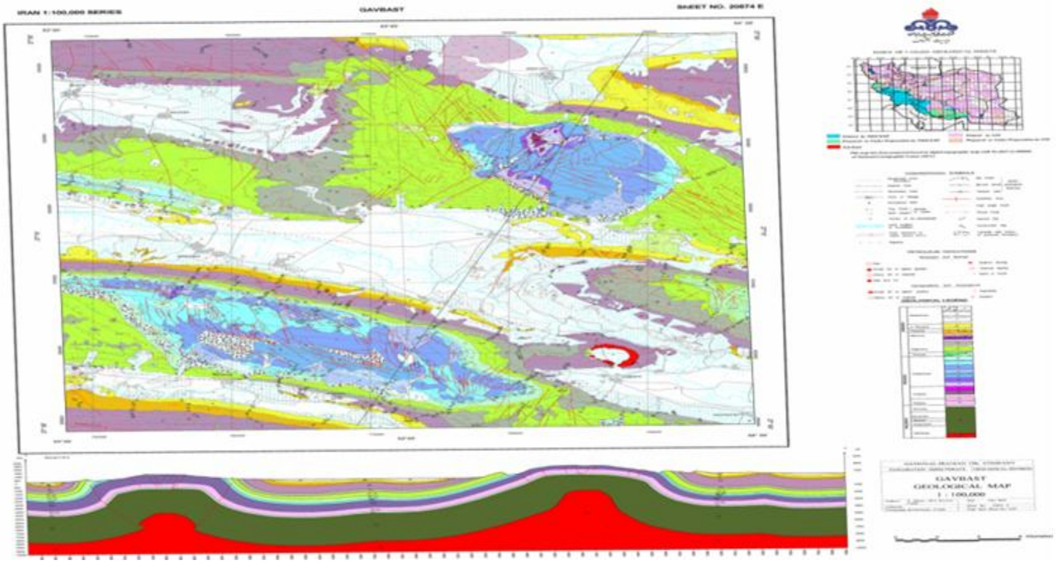

Figure-1. Regional geological setting

2. APPLICATION OF FRACTAL RELATIONS IN GRAVITY RESEARCH

Changes in physical quantities of land that results in the formation of various levels of anomie Field to be measured, due to differences in the formation of the corresponding component of the surface and the process of changing the nature of the anomaly coincides with a simple linear process is a complicated process. In these circumstances, traditional methods to predict the behavior of the(Euclidean) difficult and at times impossible, therefore the proposed for most components of the physical earth changes such as gravity, magnetic, seismic and electromagnetic mapping, allowing fractal relations for the index as a geometric Brownian complex environments is consistent with border Non-linear distribution coefficient anomaly after the logarithmic function (fractal dimension) namely, the fractal measure anomie in many ways has the following three characteristics:

(a) Anomaly is independent of the scale of observation and measurement device (scale independency).

(b) The interminable derived density function.

(c) Having an intrinsic component.

According to our current study linear trend variables are changed by the arrival of a complex situation and repeatable components are replaced with simpler types. In practice, the complexity and ambiguity of the derivatives in turbulence, of statistical indicators (such as mean and standard deviation) not suitable for identifying and calculating the fractal dimension of the self-similar communities can best offer for the separation of the corresponding communities. Euclidean perspective, relationships between fixed and geometrically proportional to changes in the level of anomie equal level 2 it is. While the visibility of fractal geometry, the coefficient is proportional to

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the angle of each level, the actual numerical value is greater than 3 times the diversity and distribution mechanism, the possibility of the emergence of the peak of conventional Brownian provides reproducible quantities. In theory, fractal function derived from certain power relationships in which a logarithmic number of independent features used to determine the distribution of the dependent variables used.

2.1. Determines the Fractal Dimension

First place in the region identified by latitude and longitude as the center of our consideration of the central point is plotted as the radius of the semicircular create. The variance between Bouguer data for each category is said to be calculated.

Changes in nonlinear methods based on the variogram surface anomaly gravity data have been introduced.

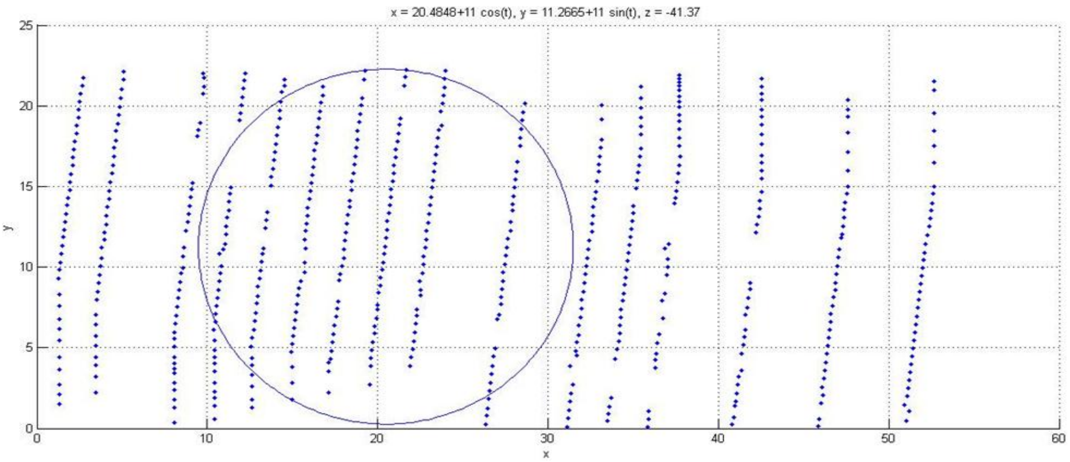

Figure-2. The big circle drawn in the harvest area

$$E\left[\left(z_p - z_q\right)^2\right] = \left(d_{\mathrm{pq}}\right)^{2\mathrm{H}} \qquad (1)$$

Which zp & zq respectively reflect the cost changes depending mm Gal at two point's p and q in terms of the anomaly and dpq the horizontal distance between the points mentioned in meters.

We can see that the expected value of E in $\left(z_p - z_q\right)^2$is proportional to the distance dpq and the type of relationship they can have with the 2H. So that we can write:

$$2H = 3 - FD \qquad (2)$$

To gather the classical statistical concepts, including expectation $E\left[\left(z_p - z_q\right)^2\right]$To gather the classical statistical concepts, including expectation $z_p \& z_q$in points. This means that we can write:

$$E\left[\left(z_p - z_q\right)^2\right] = \frac{\Sigma(\mathrm{z_i - z})}{\mathrm{N}} \qquad (3)$$

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In words $\frac{\Sigma(z_i - z)}{N}$, in order Zi to assess the expensive component in terms Z of per ml Gal and the severity of N the anomaly is distinct impression.

Results obtained from the relationship (1), (2), (3), confirming the relationship between the scattering powers of gravity changes distance placing anomaly 2H is proportional to the fractal dimension FD. Prerequisite for the achievement of the committee referred to in (3), geostatistical interpolation data exploration sought to create the impression of continuity and sufficient condition on the network, using logarithmic coordinates for the angular coefficient of FD is:

$$\log V_z = FD \log D_z \qquad (4)$$

As the logarithm of the logarithm of the diffraction diagram draw distance.

With the custom function log v- log D, the fractal dimension FD changes reflect a desire to form a rigid shell of the Earth's ability to support the points made by the fractal properties, and show y=mx+b that the least-squares regression line with their choice and we will fit the slope of the line obtained show that the fractal dimension using MATLAB programming written (Hasaani Pak, 2004).

3. FREE AIR ANOMALY

The variogram of free air anomaly in the region of Dehno anticline shows a perfect linear relation for short distances, for it is not dependent on the topography. This relationship will disappear in long intervals because the topography is not supported by earth’s crust. Accordingly, free air anomaly of the region shows fractal properties as long as it is supported by earth’s rigid shell. With the increasing size of topographic anomalies, they are supported by the isostatic compensation property of the region; at large distances, free air anomaly appears on the variogram with a slope of zero (Thorrarinsson and Magnusson, 1990).

Figure (3) shows the diagram of its fractal dimension.

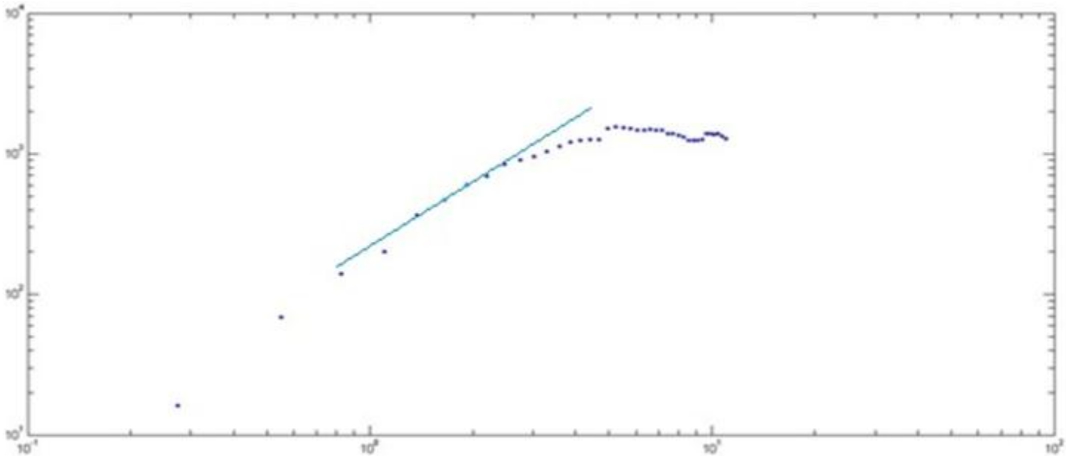

Figure-3. Linear regression to estimate fractal dimension in the free air anomaly

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Based on the above diagram, topography is held by the crust within 24 km, after that it is influenced by isostasy due to tectonic stress.

3.1. Determine the Density Bouguer

After reviewing the free air anomaly and elevation effects are independent of changes to prices, terms of diffraction distances for medium density ρ= 2.4 anomalies Bouguer and the results are shown as figure 3. based on the above chart, the emergence of low-threshold Bouguer in the fractal-like line ratio FD<2 Fed is bringing the quantities corresponding to the level of Brown and monitoring components(after 2.6th fractal) apparent. Thus, the density is determined by measuring the density changes only within a limited effect on the level of severity of expensiveness is possible to achieve reliable results, calculation of statistical indicators Bouguer times the density(1.9 to 2.9) a necessity.

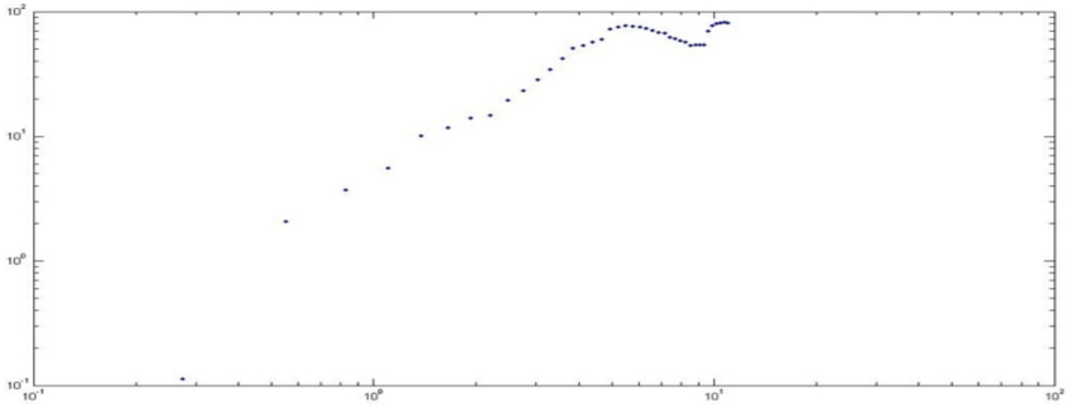

Figure-4. Linear regression Full anomaly in the density of 2.4

3.2. Determining Density through Statistical Method

Statistical methods were used to determine the optimum density in Dehno anticline; the results for 575 gravitational data have been obtained through Relation (5) in Excel software. These results are illustrated in Table (1). The maximum and minimum densities are 2.9 and 1.9, respectively.

The two-dimensional correlation survey of Bouguer anomaly with topography illustrated in Table (1), which was obtained through spss software, indicates that Bouguer anomaly resulted from fractal method has less correlation with topography, as compared to Bouguer anomaly obtained from Nettleton method. According to Table (1), in two-dimensional correlation, the minimum value is 0.640 which is related to a 2.5 density.

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Table-1. Spearman two-dimensional correlation between topography and Bouguer anomaly with the original and optimized gravity

Correlation	Density
0.709	2.4
0.640	2.5

3.3. Determining Optimal Gravity through Fractal Method

In this study, we determine the optimum density in order to reduce the dimension of Bouguer surface anomalies. In this way, co-exponent points, i.e. the outcomes of Bouguer anomalies for various densities from 1.9 to 2.9, are obtained and the plot of fractal dimension variance against density is drawn; the focal point of the objective function is the density with minimum fractal dimension on Brwonian surface. The following relation is used to determine Bouguer anomaly proportional to density variance:

$$B_{\mathrm{new}} = B_{\mathrm{old}} + (P_{new} - P_{\mathrm{old}})(0.41667T - 0.04188h) \qquad (5)$$

in which B_{new} and B_{old} are unknown and known Bouguer anomalies (mgal), respectively; ρ_{new} and ρ_{old} are the new and old densities (kg/m^3), respectively. The old density of the region, i.e. Nettleton's, is 2.4; new densities vary from 1.9 to 2.9 which are expressed in terms of stations' altitude from the origin. In the related plot, X axis represents the distance (meters) and Y axis stands for Bouguer anomaly (mgal). Different dimensions were obtained for different densities using diffraction-distance diagram; for 1.9 to 2.9 densities the minimum dimension was at 2.5 value of density (Telford, 2008).

3.4. Analysis and Comparison of the Original and Optimal Bouguer Anomalies with Region's Topography

This section investigates and compares Bouguer anomaly with 2.4 g/cm^3 density, the Bouguer resulted from optimum density, i.e. 2.5 g/cm^3, and topography of the region. According to Figures (5) and (6) both Bouguer anomaly maps are very similar due to small differences in density variation.

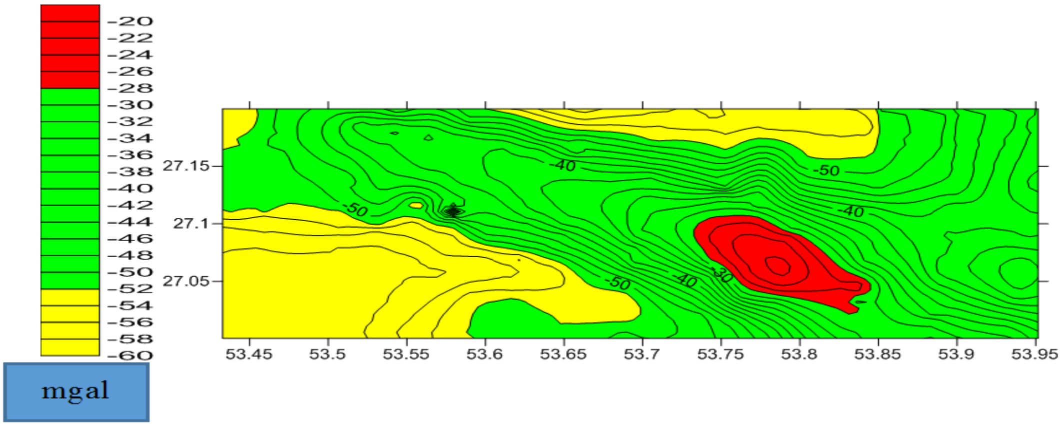

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Figure-5. Contour map of complete Bouguer anomaly with original density of 2.4

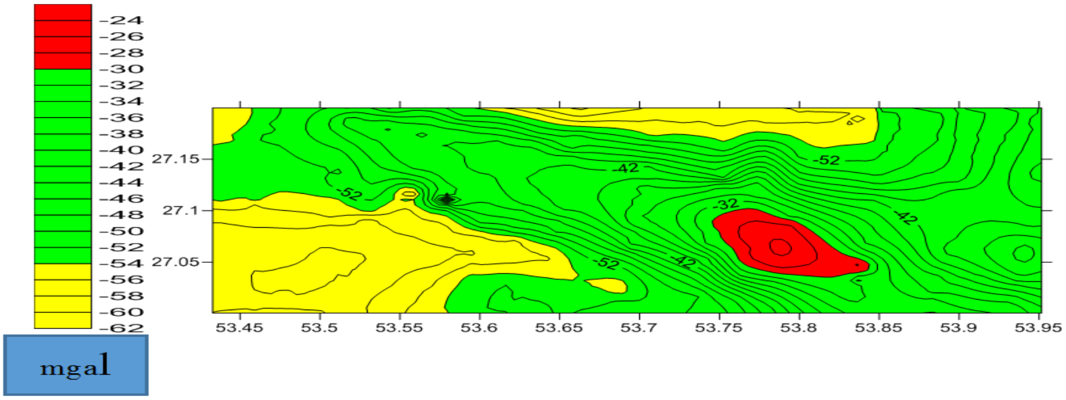

Figure-6. Contour map of complete Bouguer anomaly with optimal density of 2.5

An anticline is seen in both maps; none of these maps has produced spurious anomalies. As observed, the map of Bouguer anomaly with optimal density of 2.5 is better in illustrating the spread of Dehno anticline. An investigation of two-dimensional correlation of Bouguer anomaly with the topography of the region which has been implemented through spss software (Table 2) indicates that the Bouguer anomaly obtained from fractal method has less correlation with topography as compared to the Bouguer anomaly resulted from Parasnis approach (Nettleton, 1939).

Table-2. Spearman two-dimensional correlation between topography and Bouguer anomaly with the original and optimized gravity

Correlation	Density
0.709	2.4
0.640	2.5

A survey of north-south and east-west sections delivers the same result. As illustrated in the maps 7, 8, and 9, east-west and north-south profiles in the region have been used to confirm the optimum density.

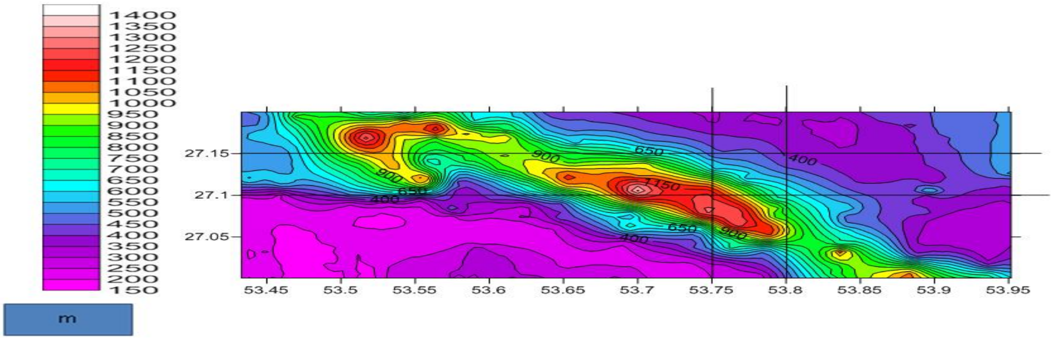

Figure-7. Profiles in the topography map

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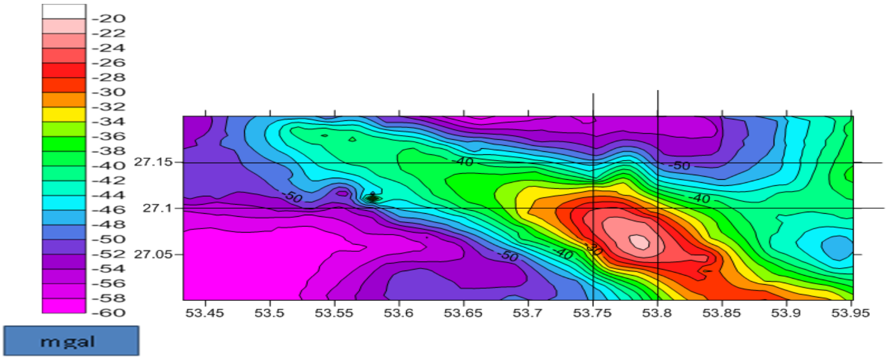

Figure-8. Profiles in the original Bouguer anomaly map

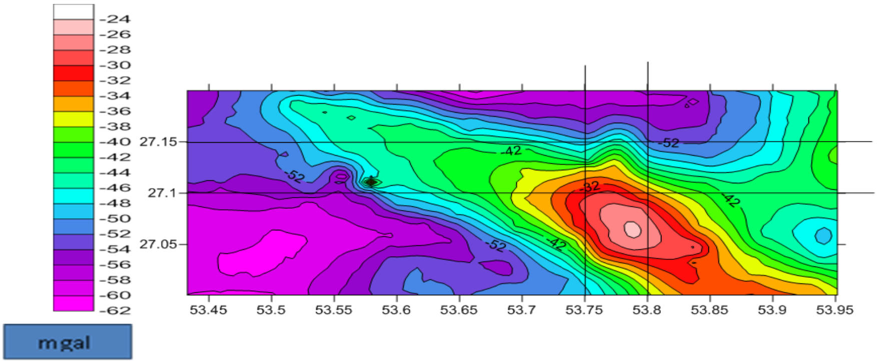

Figure-9. Profiles in the optimal Bouguer anomaly map

In the profiles and Table (3) which together show the correlation between the plotted areas and topography, the created profiles with the Bouguer anomaly map and the optimum density are more independent than the created profiles with the Bouguer anomaly and the original density of the region. The obtained numerical values about correlation indicate that the numbers for the density of 2.5 g/cm^3 in both east-west and north-south areas are less than the numbers for 2.4 density. Bouguer anomaly curves in optimum density are slightly smoother than Bouguer anomaly in the original density (e.g. in the south-eastern region).

Table-3. Sections' correlation in the original and optimal density

Optimai Density	Normal Density	Cross Section
0.71003	0.764716	A
0.388509	0.546557	B
0.883908	0.908223	C
0.93399	0.942564	D

4. CONCLUSION

Low and high levels of Bouguer density in Bouguer plate as well as topographic correction increases the impact of topography on Bouguer anomaly results. Assuming that the gravitational field is generally less rough than topography, we determine Bouguer density by minimizing the

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surface roughness of Bouguer anomaly. The level of this roughness is determined by estimating the fractal dimension of the surface. Using fractal method and the proposed method by Aronson and Mark (1984) Bouguer optimum density was determined to be 2.5 g/cm^3 according to the fractal dimension-density diagram. This value is different from that determined through Parasnis method. It is expected that the Bouguer anomaly resulted from 2.5 density is independent from structural processes of the Zagros and geometrically has the sufficient range to show gravitational self-similarity. Free air variogram shows a limited linear relationship for short distances; this relationship disappears for larger distances. The fractal dimension-density plot, which illustrates Bouguer anomaly variance against fractal dimension variance, can indicate that the proposed method by Aronson and Mark (1984) is consistent with the gravitational data in the region. A survey of Bouguer anomaly contour map with 2.4 and 2.5 values for density shows that both maps exhibit the structural condition of the area, and that they do not offer a great variability with respect to the spread of the region. However, color maps reveal some differences in Bouguer density. According to the plots resulted from regional profiles (Nettleton, 1939) it became clear that the profiles in Bouguer anomaly contour map with the optimum density of 2.5 are less dependent on the topography of the region, as compared to the profiles in Bouguer anomaly contour map with 2.4 density. If there was boring and well-log data in the region, no doubt that the difference between the two maps could be monitored more carefully.

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