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COMPARISON OF THE GRAVIMETRIC NETWORK IN ESFARAYEN REGION WITH THE NETWORK OF FRACTAL ANALYSIS

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ABSTRACT

The place of gravity stations is normally irregularly distributed. Although an ideal arrangement should be locally homogeneous, it is impossible in most cases, due to the availability issues. The surface areas due to more geological benefits and easier availability are more densely sampled which inevitably affects the measurement of the regular network as the interpolation error due to irregular distribution. The gravimetric data are usually presented by the color contour maps and it is required to be interpolated as a regular network. The combined distribution of the gravity stations are used in theoretical studies. It was found that there is an interval of the values for the random distribution of the data which has 2 fractal dimension dependent on Euclidean geometry for the spatial distribution of the data. And a new Bouguer was found using the grid and using anomaly fractal analysis in Esfarayen area gained, based on which a closer analysis of the explored area was conducted. The important anomaly in the region was recreated. Using the related fractal analysis reduces the number of data mined points.

Keywords: Bouguer anomaly, Networking, Fractal interpolation, Esfarayen.

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1. INTRODUCTION

Fractal dimension analysis was carried out for optimum designing of 2D gravity survey network and to find out an optimum range of gridding interval to generate least aliased Bouguer anomaly maps (Dimri, 1998). The number of sampling data points are optimized and then the data volume is increased and then the need for higher volume of computer memory for data analysis and then the lateral costs are increased.

Design of survey network plays an important role in optimizing number of data points and enhancing the quality of the data. Most of the geophysical data sets especially gravity observations are often irregularly distributed, thus survey design becomes a critical step, both to obtain sufficient data at minimum cost and to avoid problems related to survey spacing (i.e. data sampling). Data sampling problems generally cannot be resolved during processing and therefore must be dealt with at the survey design stage only. A careful data acquisition can significantly streamline subsequent quality control tasks and help to minimize related processing costs.

Korvin *et al.* (1990) showed that the spatial distribution of the South Australian gravity station network (over 65 000 stations) can be approximated by a fractal point set of correlation dimension. In this article the gravity data distribution of a region in North East of Iran is calculated and its optimized network distance is determined.

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1.1. Fractals

The physical objects are usually determined by one, two or three dimensions or as dimensionless. Our physical perception cannot recognize more dimensions. The ripples on the mountains, clouds, leaves of the trees, the turbulent river flow, coastal lines' morphology and other natural shapes cannot be defined by correct dimensions (Dimri, 1998). In primary stages of mining the minerals and classic and old methods of mining and discovering, these old methods were gradually replaced by the modern methods inspired by nature. Some of the phenomenon around us cannot be modified by the Euclidian geometry of dimensions using a value of one, two or three. Therefore, the Euclidian geometry can explain one, two or three dimensions. On the other hand, the dimensions should not be considered as a number but it should be accepted that they can continuously change from zero to one, one to two, two to three or more. For example, if the line can be one or two dimensional, a broken line breaks a hundred times on a sheet to create a shape which can be one or two dimensional based on the breaks. In this case, it can be introduced as a shape between line and the surface with a dimension between one and two. Figure 1 showed the transformation of a line to a shape and the changes in its dimension.

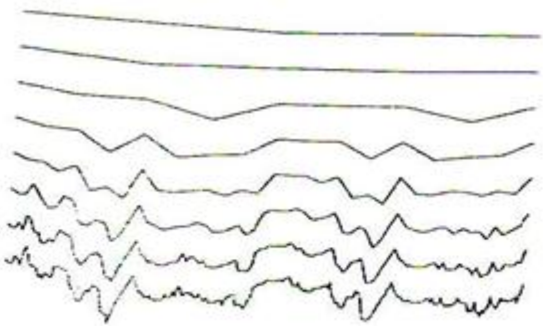


Figure-1. The process of changing a line to a surface and its fractal dimension

As it is observed, by increasing the breaks in this line, it seems that it can have more than one dimension. By increasing the line in the second dimension, the line changes gradually cover both dimensions and change to a surface.

2. NETWORKING AND METHODS

Geodetic networks or point networks on the earth with special forms are determined by mathematical measurement on a homogenized system and special coordination is determined for each point. In geophysical discoveries some of the most important physical features of the earth are measured by the special tools and surface condition is determined based on the interpretation of these results. The geophysical discoveries are usually looking for anomaly or deviation of the standard geological features.

2.1. Calculating the Fractal Dimension of Gravimetric Data

The gravimetric data are usually presented as color contour maps and thus the data should be interpolated in a regular network. This network is used for providing other maps (Vertical or horizontal gradient) from other gravimetric fields. The interpolated network should show the measured main data. The interpolation error not only should be reduced in interpolating method but also the range of the networking or interpolation should be carefully selected.

If the observed data are ordered on a regular network then, the Shannon theorem states that the least number of samples (n) for recreating the gravity field is obtained as

$n = \pi x2/\lambda 2_{\text{min}}$

Where x is the local square size and $\lambda 2_{min}$ is the shortest wavelength in the field. The gravity data are not generally based on a regular network and based on Shannon theory need a selection. It is shown that using the fractals in data arrangement, a proper network distance can be determined in which the contoured map has the least amount of aliasing.

Korvin *et al.* (1990) showed that the spatial distribution of the South Australian gravity station network can be approximated by a fractal point set of correlation dimension 0, = 1.4. The fractality is established over more than 2 decades of distance. The fractal nature of the grid is possibly due to the multistage decisions involved in establishing a network; in each step, previously unexplored areas are dissected by geophysical traverses, as in the classical fractal fragmentation process. It is shown that we cannot observe the short-wavelength components of the gravity field if the dimension of the network is less than two and any attempt to interpolate onto a regular grid could lead to spurious anomalies due to aliasing.

The box counting method by described by was used for determining the fractal dimension of the gravity data.

The studied area was divided into N (δ) equal squares of δ sides where each square or box includes the counting points. This procedure is repeated for a series of squares by increasing the side

The fractal dimension D_f is obtained by the following equation:

$$N(\delta) \sim \delta^{-D_f} \qquad 2 \succ Df \succ 0$$

The fractal dimension is determined by drawing log N (δ) against δlog and is independent of the units used for δ.

As showed the fractal dimension of less than 2, recovers the sampling field by a number of aliasing. They also showed that a data arrangement with the fractal dimension of less than 2 cannot recognize the distributed phenomenon with Dp =2 – Df. They obtained new criteria for data arrangement. In order to increase the local resolution, the data set should have sufficient resolution. Thus, the fractal dimension of the gravity station distribution in theory can be used for the prediction of an interpolated network and help to find a proper networking distance.

The gravity networking of the region (Esfarayen) is located in North of Khorasan State, Iran and geometrically located in Kopet Dagh Basin. In this basin beginning in the Jurassic period, first the cement and calcareous sandstone layers are formed and then followed by the heavily composed layers of calcareous sediments and Chile sandstone and then end with the organization of the conglomerate, marl and sandstone. Geological formations of the studied area are related to the Cretaceous and Tertiary era and the recent sediments. The latter includes lime blur rock units during the third period of the formation of red sandstone and mudstone and conglomerate and recent alluvial deposits, which is the current context is the river. Kopet Dagh thickness is generally up to 10,000 meters and consists of Mesozoic and Cenozoic sediments that are drawn on the Paleozoic rocks of the North West and in the South East in the northeastern part of Iran (Aghanabati, 2004).

2.2. The Qualitative Interpretation of Bouguer Anomaly Esfarayen Area

Bouguer anomaly map was examined based on the geological structures in general considering the effects of different masses at different depths. Most of the buildings arisen due to faults have different process.

The main building includes three stalagmites can be found in the map anomalies as closed and semi-closed in the form of Low L1 to L3 and five anticline which has been shown in high forms, shapes H1 to H3. North West-South East trending syncline semi-L1 has a difference between a low-frequency effects and long-range mm Gal.

Resulting stalagmites in a north-south trending syncline dam site (L2) as well as the effects of low frequency by six mm scabies as long-wavelength gravity difference is encompassing a relatively large region. The syncline by two main fault with the Rand is limited on both sides of the river that leads to falling dam site and dam up the left and right sides of the bag is sent. Stalagmites L3 with respect to the effects of low-frequency anomaly map provides a wide range in the form of a semi-closed anomaly has been detected downstream side, stalagmites L2 resulting in dam construction site by two high-frequency anomaly package due to surface effects and small domains were created within the limestone formation And probably just Low karst cavities are crushed or lens-shaped structure with low density and high deposition is visible. All the positive anomalies (High) closed and semi-closed, North West - South East is the H4 closed anticline with more than one mm deep with scabies due to the effects of low frequency and relatively large wavelength that is visible in the map between the North West-South East. Other anomalies, which are semi-closed different prices with different anomalies (High) H1, H2 and H3 buildings closed and semi-closed are provided on both sides of the main axis of the dam which is shown in Figure 2 using the Geo Soft application.

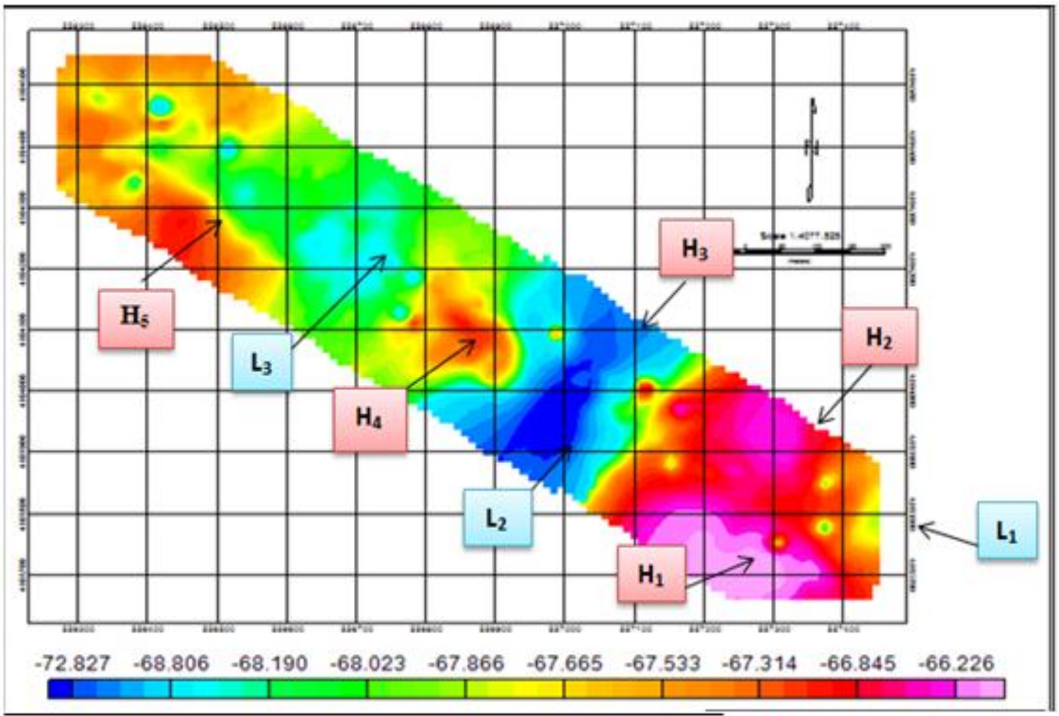


Figure-2. Bouguer anomaly map in Esfarayen area (in mm Gal)

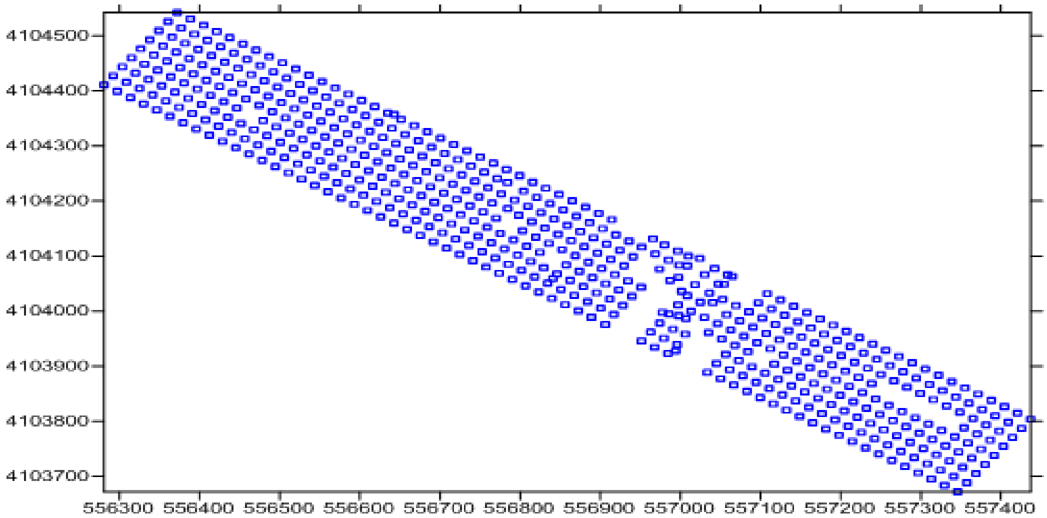


Figure-3. Gravity locations in Esfarayen stations located in Northern Khorasan

The fractal dimension of Esfarayen gravity network is calculated as follows:

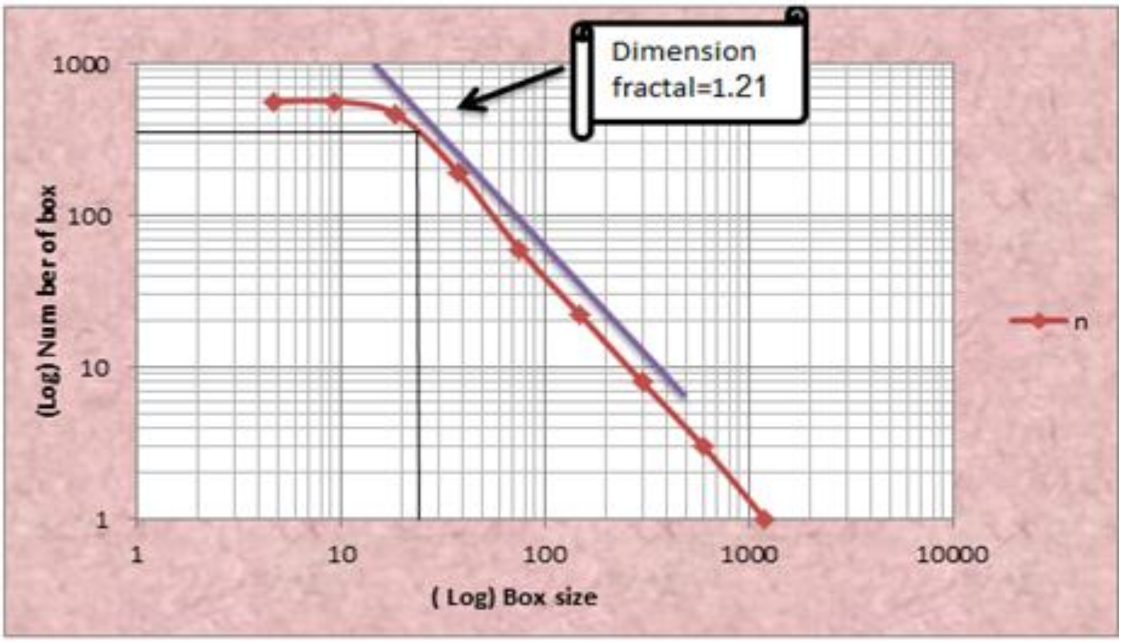


Figure-4. Shows the result of box counting method for gravity data in Esfarāyen area where the optimum distance of networking is 25 meters and the slope of the fitted line network fractal dimension is equal to 1.21.

To better illustrate the changes in the network area, Bouguer anomaly map from a height of 80 meters over continued filtering. In Figure 5 is shown in above ground level are going beyond what is shown as huge anomalies and surface are deleted. There is no problem in the upward climb from the ground due to lack of crime. As you can see we are going in the 80 meters higher and small anomaly have been removed, and the comparison method by going beyond the truth of fractals fractal method to detect anomalies in the region that goes way beyond a height of 80 meters fractal method is drawn similar to the MATLAB.

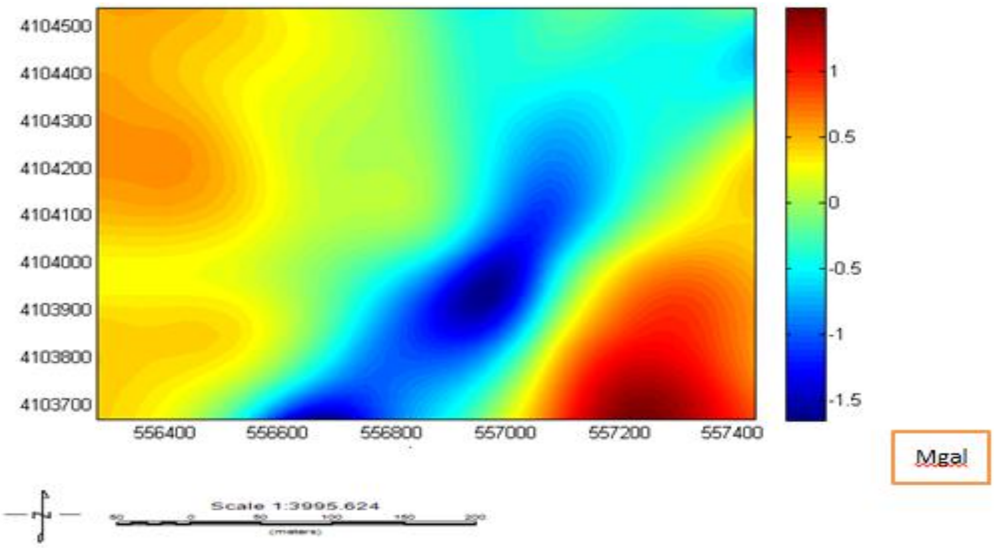


Figure-5. Bouguer anomaly map with a height of 80 meters beyond Filters Custom profiles in Esfarāyen area:

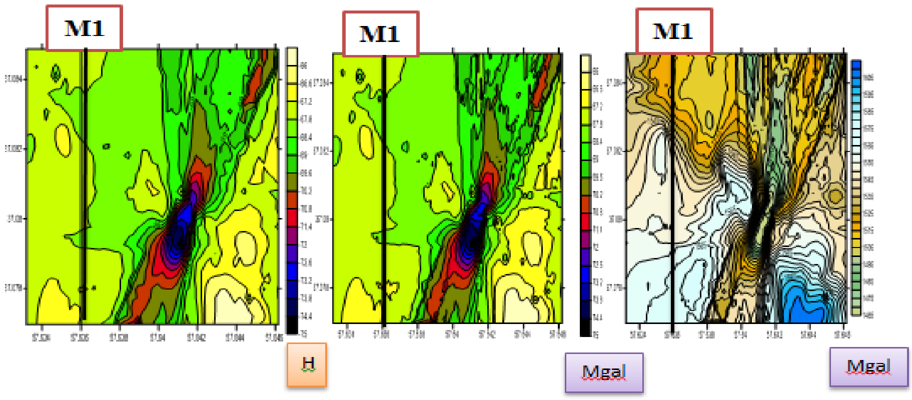
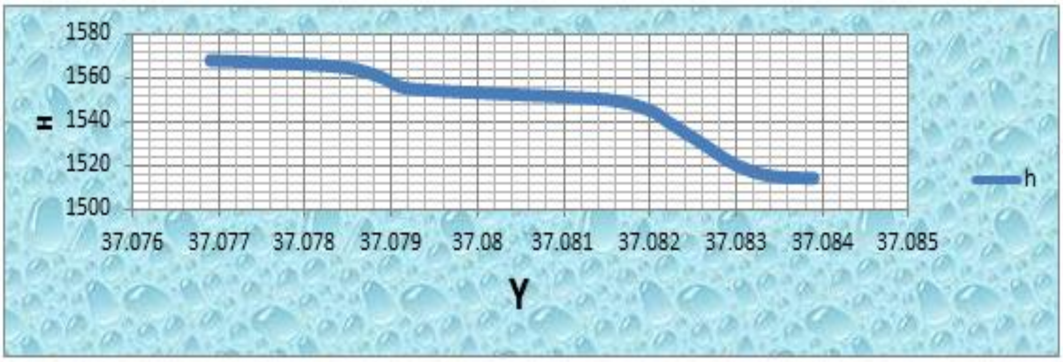
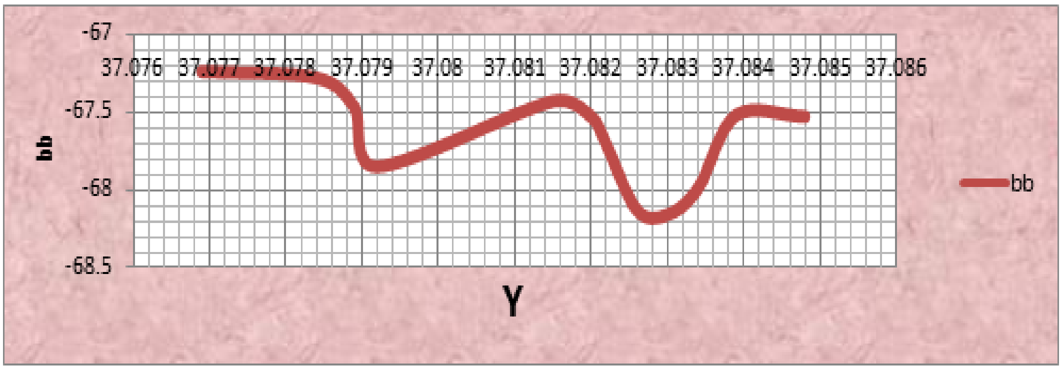


Figure-6. Profiles topographic contour map and Bouguer woman in normal and optimal Bouguer area

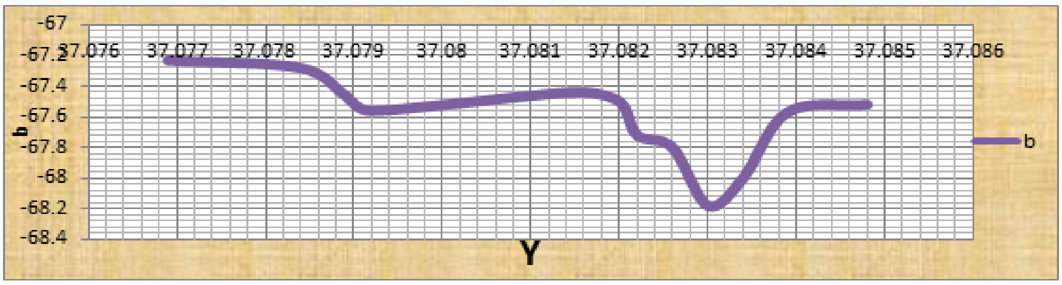
2.3. Profile America - South M1 (The Topography - Optimized Bouguer Anomaly - Normal Bouguer Anomaly



The M-1. Profiles drawn for north-south topography



The M-1. Profiles plotted for the North - South Regional Bouguer



The M-1. Profiles plotted for the North - South regular Bouguer

The following tables have been obtained using statistical program Spss (Pearson: parametric method is used for data with a normal distribution or large arrays):

Correlation questions:

Table 1 shows the result of applying the correlation method (normal topography - Bouguer) and (optimal topography - Bouguer) in the region

Table-1. Result of applying the correlation method (normal topography - Bouguer) and (optimal topography - Bouguer)

Correlation	bouguer	Correlation optimal bouguer
M 1	.912199	.880099
M 2	.713887	.585812
M 3	0.842912	0.840214
M 4	0.940598	0.899037

3. RESULT OF CORRELATION

Table 2: the result of applying the autocorrelation method (normal topography - Bouguer) and (optimal topography - Bouguer) in the region

Table-2. The result of applying the autocorrelation method (normal topography - Bouguer) and (optimal topography - Bouguer)

Auto Correlation optimal bouguer	Auto Correlation bouguer
0.946396	0.927856

4. CONCLUSION

Determining the fractal dimension distribution of gravity stations allow us to choose a suitable interpolation distance so that aliasing is minimized through interpolation. These are the smallest length in the fixed scale. However, a distance networking can be an appropriate choice does not imply complete elimination aliasing. In general, the gravitational field of a small wavelength. Ideally, an anti-aliasing filtering (low pass filter) to minimize the impact of these data should be used with short wavelength. This rarely is used for short-wavelength components of the waves in the data. The only way to reduce the aliasing is increasing the gravity stations. The location data should also be precisely calculated and also the quantities of gravity should be carefully picked.

Fractal interpolation method of interpolating data reduces the aliasing effects of a fixed amount from the optimal network for data suggests. Studies and extensive research in the area Esfarāyen in order to discover the geological structures and tectonic issues such as faults and crushed zones and karst limestone formations of holes in and get the density anomaly by creating and providing a model density difference between rock formations and units along the dam site have been made and are cutting station about 20 meters gravimetric survey is intended. Fractal Dimension Analysis of the spatial distribution of the gravity stations showed the optimized gravimetric indicates that is obtained as 25 meters. Maps (2) and (5) are obtained using the method of 4 major fault lines fractal in the region and the anomaly L1 and L2 and L3 (syncline) and four non-normative another H1, H2 and H3 and H4 (anticline), according to the geological region known highlights. And limits of the Western - eastern region are relatively split.

By comparing the Bouguer anomaly map obtained with conventional and fractal methods in Esfarayen area, as well as profiles plotted in Figure 6, also in Table 1 applying the correlation, it is clear that the optimized Bouguer anomaly has more independence than the topography. Table 2 shows the anomaly correlation procedure obtained more efficient Bouguer anomaly from normal Bouguer. Bouguer anomaly of fractal networking that (with the optimal distance of 25 m) with low correlation topography has confirmed that this is the principle of fractal analysis.

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

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