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Research Article

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Two-dimensional Modeling of Gravity Anomalies Map of Turkey-Kırklareli

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Abstract In this study, Talwani method, which is one of the most used methods in modeling two dimensional structures, was applied. Talwani method has quite common usage areas in modeling two and three dimensional gravity and magnetic anomaly maps. In this study, the relationship between changes in depth and density of synthetically produced prismatic structures and changes in their anomalies was also investigated. In the study of Kırklareli in Turkey Petroleum Corporation (TPAO) to be used in the map. There are two different buildings in the Kırklareli region. Among these structures, the anomaly of the mass giving positive anomaly was examined and examined. By applying Talwani method to the AB anatomy obtained here, it has been tried to find the estimated model structure parameters.

Keywords Gravity anomaly map, Talwani method, Kırklareli-Türkey

Introduction

Showing the behavior of an event with mathematical relations is called modeling. The purpose of modeling is to understand, explain and learn the details of the event under study. The first thing to model an event is to have the observations made correctly. It is requested that the observations made and the data obtained overlap. Various researchers have developed various methods in geophysical modeling. He has studies to find depth and density values from gravity data [1]. They found the gravity anomalies of the faults by inverse solution method [2]. They calculated the gravity and magnetic inverse solutions of two-dimensional polygonal structures using the Marquart solution technique [3]. Some rules have been applied to find the gravity effects of vertical circular cylinders and horizontal circular discs by inverse solution method [4]. They used Monte Carlo method in inverse solution problems [5]. They performed flat modeling by applying the Forced Neural Networks method to gravity and magnetic anomaly maps [6; 7]. They applied the Genetic algorithm method in modeling two-dimensional structures [8]. All of these studies are important information and valuable resources in the development of straight solution and inverse solution methods.

The gravity method has been applied in many areas such as oil fields, determination of geothermal fields, discovery of polymetallic mines, ground surveys since 1947. The operations performed in the gravity method, respectively; data collection, data-processing, interpretation, model building. Talwani Method is one of the methods used in creating models. This study was modeled using also located in the Marmara region in Turkey taken in Kırklareli district gravity anomaly map of Talwani method.

Methods

Modeling of two-dimensional structures with different shapes can be achieved with polynomials. The polynomial becomes more sensitive when the diagonal number is increased. Gravity from polynomial at any point P (Figure-1).

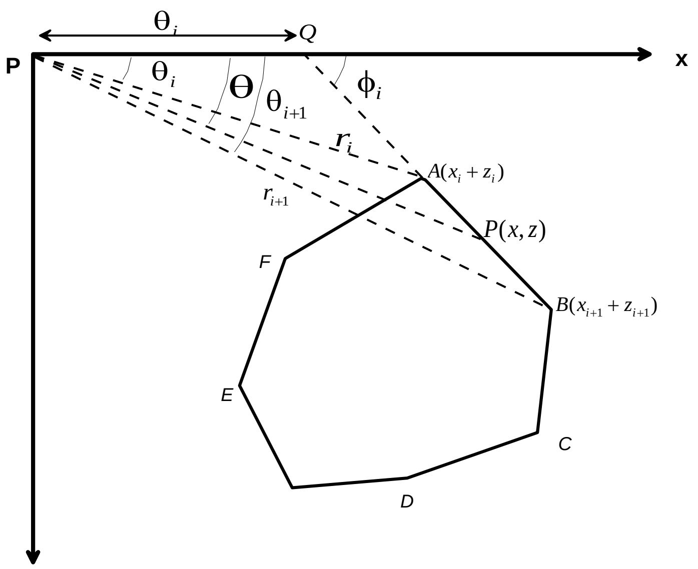

Figure 1: Representation of two-dimensional structures in the form of polygons

Vertical component of gravity gravity at point P [9],

$$g = 2G\rho\oint Zd\theta \tag{1}$$

The expression has been shown to be in the form. Here G is the gravitational constant, and is the density.

When calculating the $\oint Zd\theta$ integral for the gravity gravity component of a two-dimensional object whose cross section is a polygon; It starts with the calculation of the AB side of the polygon. The extension of edge AB intersects the x axis with the angle ϕ_i at point Q. $pQ = a_i$

Let's take it as. In this case, for point P on edge AB,

$$Z = x\tan\theta \tag{2}$$

like this. Same time

$$Z = (x - a_i)\tan\phi_i \tag{3}$$

Here, by making use of 2 and 3 relations,

$$Z = \frac{a_i \tan\theta \tan\phi_i}{\tan\phi_i - \tan\theta}$$

or

$$\int_{AB} Zd\theta = \int_A^B \frac{a_i \tan\theta \tan\phi_i}{\tan\phi_i - \tan\theta}d\theta = Z_i \tag{4}$$

From here, the vertical component of the gravity gravity of the polygon,

$$g = 2G\rho\sum_{i=1}^{n} Z_i \tag{5}$$

It happens in the form. Sums are made on the n side of the polygon. To solve the relation 4,

$$k = \tan\phi_i$$

$l = \tan\theta$ If the transformation is done, (6)

$$\theta = \arctan l$$

$$d\theta = \frac{dl}{(1 + l^2)}$$

$$Z_i = a_i \int \frac{kldl}{(1 + l^2)(k - l)} \tag{7}$$

happens. If this is integral,

$$Z_i = a_i\left[\frac{1}{k^2+1}\left(\int\left(-\frac{k}{1-k}+k\frac{1}{l^2+1}-\frac{1}{l^2+1}\right)dl\right)\right]$$

It is obtained in the form. This relation is

$$Z_i = a_i\frac{1}{k^2+1}\left(-k\log_e(l-k)+\frac{k}{2}\log_e(l^2+1)-\arctan l\right)_{\theta_i}^{\theta_{i+1}} \tag{8}$$

It can be written as. If we substitute k and l here,

$$Z_i = a_i \sin\phi_i \cos\phi_i\left[\theta_i-\theta_{i+1}+\tan\phi_i \log_e\frac{\cos\theta_i(\tan\theta_i-\tan\phi_i)}{\cos\theta_{i+1}(\tan\theta_{i+1}-\tan\phi_i)}\right] \tag{9}$$

is found. Thus, the solution is realized by moving the integration process on an edge onto the n-sided polygon.

$$\theta_i = \arctan\frac{Z_i}{x_i}$$

$$\phi_i = \arctan\frac{Z_{i+1}-Z_i}{x_{i+1}-x_i}$$

$$\theta_{i+1} = \arctan\frac{Z_{i+1}}{x_{i+1}}$$

$$a_i = x_{i+1}+Z_{i+1}\frac{x_{i+1}-x_i}{Z_i-Z_{i+1}}$$

Substituting the value of Zi in the equation 5,

$$g = 2G\rho\sum_{i=1}^{n}\frac{x_iZ_{i+1}-Z_ix_{i+1}}{(x_{i+1}-x_i)^2+(Z_{i+1}-Z_i)^2}\left[(x_{i+1}-x_i)(\theta_i-\theta_{i+1})(Z_{i+1}-Z_i)\log\frac{r_{i+1}}{r_i}\right] \tag{10}$$

This formula is included. Here, θ_i, θ_{i+1}, r_i ve r_{i+1} are necessarily expressed in terms of x_i and Z_i [10].

Application of the Method

Geology of the Land

The Thrace basin is the main tectonic of the Thrace region. The study area shown in Figure 2 covers the north of the Thrace basin (North Ergene basin) and İstranca region.

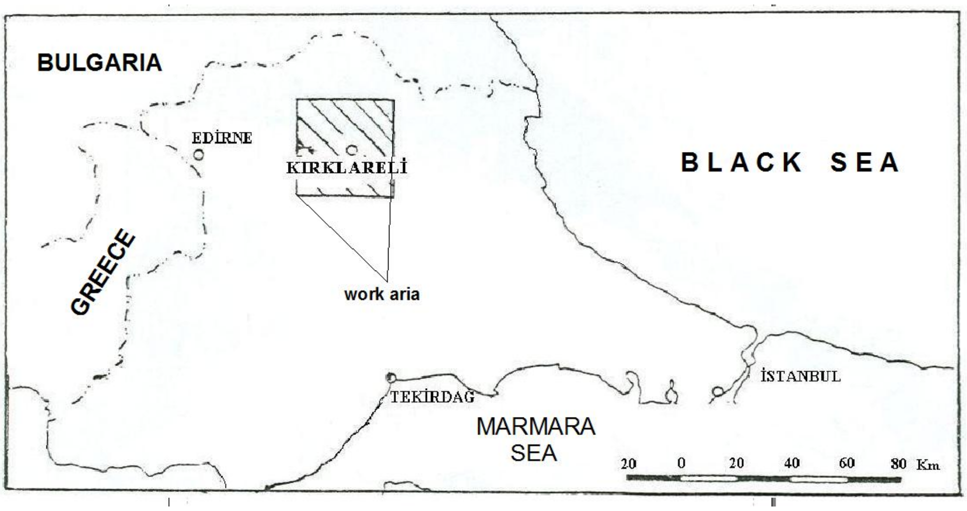

Figure 2: Area map showing the location of the study site

The Thrace basin is an intermontane type of sedimentary basin sandwiched between today's remnants of the old crystalline massifs. Crystalline massifs surrounding the basin on three sides and forming the source of the basin sediments are Strandja in the north, Rhodope in the northwest and west, and Menderes in the south.

It is highly probable that the basin sedimentation started in the late Middle Eocene. This deposition phase started with a deposition axis that developed in a north and north east direction from southwest. The transgressive period that developed along this axis was originally a small marine corridor. For this reason, the Thrace basin has developed in semi-closed marine environments. The development of the transgresive period coincides with the Upper Eocene - Lower Oligocene time interval. During the development period, the basin completely transformed into a marine environment, except for the small massive remains. Towards the end of the Lower Oligocene, the transgressive development period ended and a general regressional deposition environment started in the basin. The tectonism that caused folding and ruptures in the southwest of the basin has lost its effectiveness. As a result of this, a sedimentary sequence consisting mostly of thick lacustrine shales, marl and limestones and coal and fluvial sandstone and silt stones has developed.

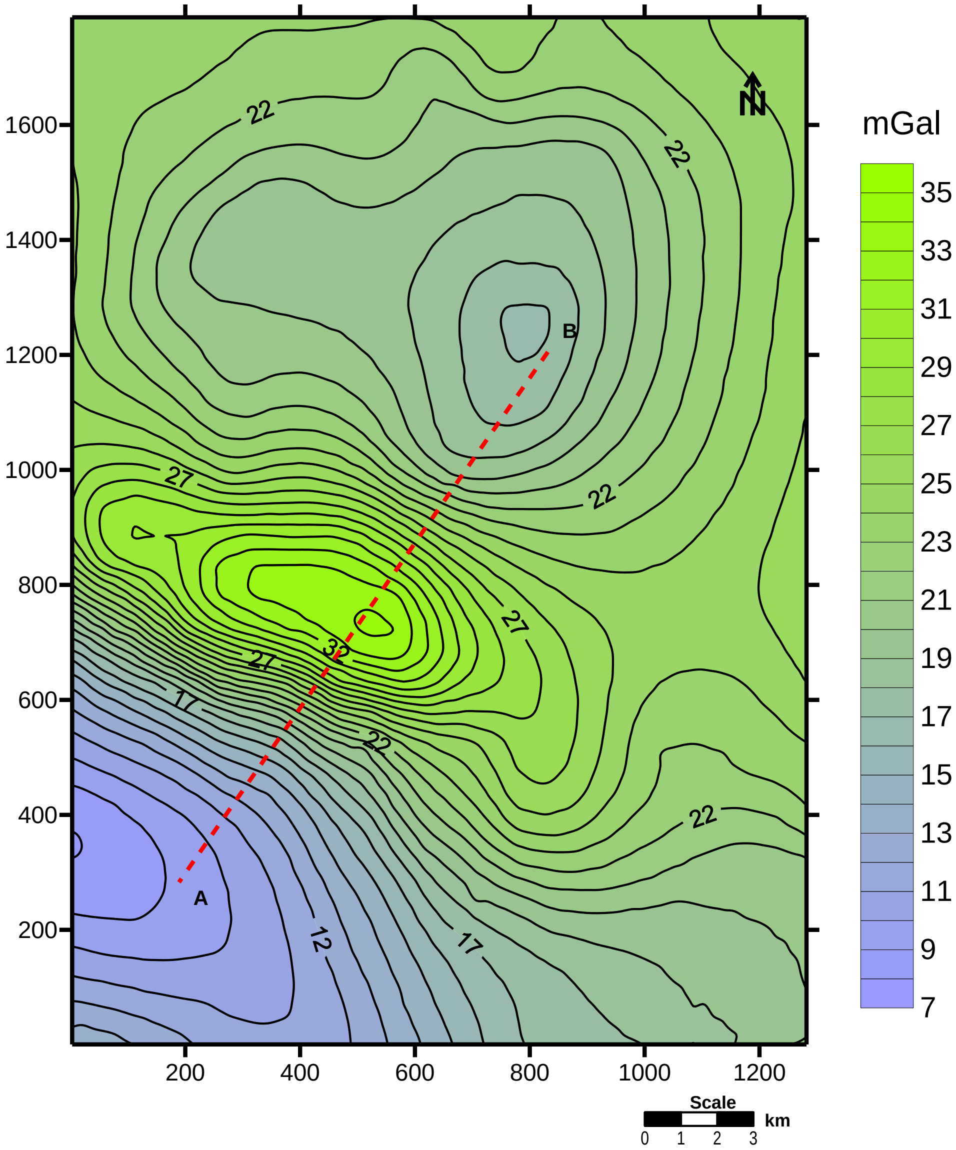

Figure 3: Bouger anomaly map of Kırklareli region

The Thrace basin has undergone a transgression phase that started in the late Middle Eocene and continued until the end of the Lower Oligocene. Gaziköy and Hamitabat shales deposited during this time period contain organic matter. For this reason, they have the characteristic of being a good bedrock. Gas and oil found in the basin are proof that the organic matter in these shales has reached maturity [11]. The basis of the study area is

Triassic aged schists and Permian mylonitic gneisses. Tertiary sediments located on this metamorphic basement belong to the Eocene, Oligocene, Miocene and Pliocene periods.

Application of the Method to the Gravity Anomaly Map

Bouguer anomaly map of Kırklareli region taken from TPAO is examined in figure 3. Two structures are seen in the middle of the section along the AB section taken from the map. The structure in the southwest of the map has a high anomaly and the structure seen next to it has a lower anomaly. A section along A-B was taken from the Kırklareli bouguer anomaly map given in Figure 3 and the anomaly of the land was drawn along the section. The underground structure has been modeled using the Talwani method. The purpose of the Talwani method is that the cross-section anomaly and the anomaly found as a result of the talwani overlap or appear very close to each other. The values are changed and the process is repeated until the anomalies coincide. The Talwani method was applied to the A-B section taken in Figure 3 and an underground geographic structure was modeled. Accordingly, the model structure given in Figure 4 was revealed.

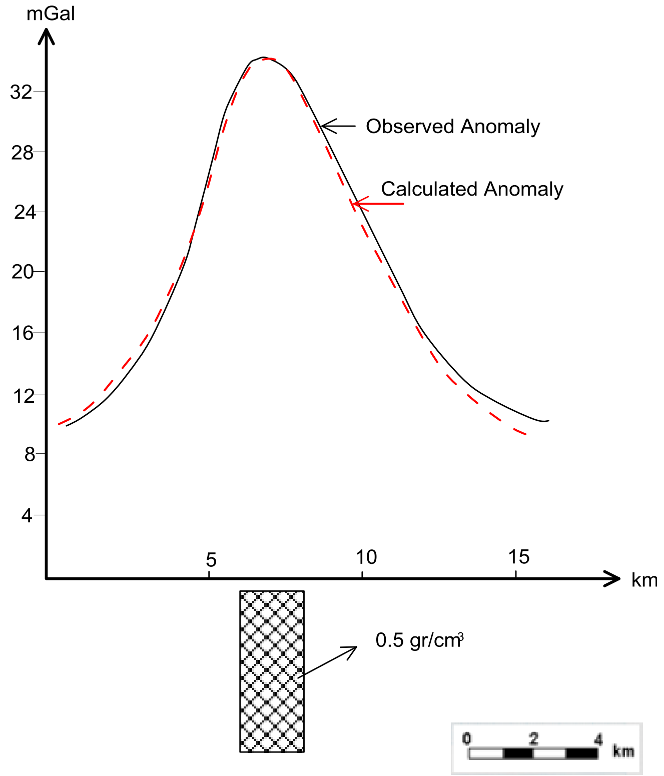

Figure 4: The black anomaly is the section anomaly taken from the field, the red anomaly is the anomaly created by its talwan.

4. Result

As seen in Figure 4, the density, depth and width of the structure affect the anomalies. While modeling, the density was increased to 0.56gr /cm^3, the upper surface depth was reduced to 1.2 km, and the lower surface depth was increased to 10.8 km. According to these values, the anomaly formed according to the Talwani method is the anomaly drawn in red. The anomaly drawn in black is the anomaly observed by taking an A-B section. The lines of the black and red anomaly are close to each other and the estimated geological structure underground is modeled.

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