EVALUATION OF GRAVITY DATA IN THE KIFL OIL FIELD AND ADJACENT AREAS, SOUTH OF IRAQ

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ABSTRACT

The study area located in southern part of Iraq, it covers about 4009 Km². The data used in this research consists of Bouguer anomalies (Regional and Residual anomalies) with scale of 1: 250 000. These data are mosaicked and clipped for the area of interest. The main interpretation of regional gravity map with contour interval 0.5 mGal showed three anomalies in the study area with different amplitudes and shapes. The main interpretation of residual gravity map with contour interval 0.1 mGal showed negative and positive anomalies with different shapes, sizes, and trends. It gave a good conception about the anomalies. The map could be important in hydrocarbon exploration. Two enhancement methods applied on residual anomalies data to obtain more information about their location, extent, shape, and trends, as well as information about faults and tectonic boundaries. The research illustrated that the convolution filter-kernel 7*7 horizontal is effective and gave better result to conception the gravity anomalies than convolution filter-kernel 7*7 vertical. In addition, the 3D enhancement map showed that some faults and tectonic boundaries, follow NW-SE trending were almost identical with the tectonic boundaries between (Najaf – Abu Jir – Hadhar Subzone) and (Tikrit – Amara Subzone).

Keywords: Gravity enhancement; Bouguer anomalies; Residual anomalies; Kifl oil field

INTRODUCTION

The gravity method was the first geophysical method to be used in petroleum exploration. It has continued to be an important and sometimes crucial constraint in a number of exploration areas. In petroleum exploration, the gravity approach is particularly applicable in salt areas, overthrust, and foothills belts, also the gravity method is used frequently in specialized investigations for shallow goals (Nabighian et al., 2005). The objective of gravity survey is to associate variations with differences in the distribution of densities and hence rock types (Sheriff, 1994). Gravity surveys are often undertaken prior to seismic surveys with the aim of delineating structural trends so
that seismic surveys can be designed in a cost-effective manner to maximum result (Fairhead, 2012).

The software is increasingly being used in petroleum exploration. (Piskarev and Tchernyshev, 1997) demonstrated a spatial relationship between hydrocarbon accumulations and features of gravity field anomalies in the vicinity of oil and gas reservoirs in Western Siberia. They showed that hydrocarbon accumulations coincide commonly with local gravity minima.

The study area lies southern part of Iraq. It covers about 4009 Km², and determined by the coordinates, 43° 51' 15", 44° 36' 51" E and 31° 57' 24", 32° 27' 51" N (Fig. 1). Tectonically the study area located within the stable shelf and unstable Shelf. Most of the study area is covered by Quaternary deposits represented by Gypcrete, Slope deposits, Flood Plain deposits, Shallow depression deposits, Sabkha deposits, Marsh deposits, Aeolian deposits, Valley fill deposits, Anthropogene deposits. Pre-Quaternary rocks are (Eocene – Miocene) represented by Dammam, Euphrates, Fatha, Injana, and Dibdibba Formations (Barwary and Slewa, 1994; Barwary and Slewa, 1995).

Fig. 1: Location map of the study area (University of Texas libraries, 2009)
The main aim of this study is to evaluate of gravity data in Kifl Oil Field and adjacent areas.

MATERIALS AND METHODS

The present study depends on analyzing of gravity data (Bouguer Anomalies: Regional and Residual anomalies) with scale 1: 250 000. These data are mosaicked and clipped for the area of interest.

The following software packages have been used:

1. *Erdas Imagine V.13* software was used to produce highly accurate multispectral images and create many kinds of images with various uses such as geometric correction, noise removal, spatial enhancement.

2. *ArcGIS V.10.2* software was used to management and analyses of data, a building of contour line, drawing maps, maps analysis, and display of maps.

3. *Surfer 10.3* software was used to produce contour mapping, maps analysis, and display maps.

Interpretation gravity data

Regional gravity field and residual gravity field have been derived by applying stretch method-type standard deviation using ArcGIS software. Regional gravity field has values of gravity from -44.5 to -28.5 mGal (Fig. 2) while residual gravity field, has values of gravity from -1.57 to 1.11 mGal (Fig. 3).

The anomalies maps in (Figs. 4 and 5) have been derived by applying Spatial Analyst using ArcGIS software. The map which is extracted from regional gravity field illustrate in (Fig. 4). The main interpretation of this map with contour interval 0.5 mGal shows three important anomalies in the study area with different amplitudes, two of them are the oval shape (A and B), and the third (C) is semi oval shape (open from the west). All three anomalies trend NW – SE. In the A anomaly the values decrease towards the center, reaches -42.5 mGal, therefore, it may represent syncline. In the B anomaly the values increase towards the center, reach -36 mGal, and the values of anomaly continue to decrease towards the NE, reaches -44 mGal, this anomaly may describe as anticline. The C anomaly locates in the NW part of the study area, the values increase towards the center reaches -30 mGal therefore, it may describe as anticline.
Fig. 2: Regional gravity field
(By applying stretch method-type standard deviation)

Fig. 3: Residual gravity field
(By applying stretch method-type standard deviation)
Fig. 4: Regional anomalies map (By applying Spatial Analyst)

Fig. 5: Residual anomalies map with contour interval 0.1 mGal (By applying Spatial Analyst)
The map in Figure (5) with contour interval 0.1 mGal shows negative and positive values range from -1.5 to 1.1 mGal and numerous smoothed contour line, numerous anomalies with different shapes, sizes, and trends. The general extend of the anomalies almost NW – SE direction. It can be observed from this map converge contour lines in many areas which could be normal faults or tectonic boundaries. The boundaries of anomalies in this map are distinguished, therefore it can perform the geometrical calculation on these anomalies such as sizes, length, width, and etc. This map gave obvious conception about the anomalies than the previous map in Figure (4).

Residual Anomalies Enhancement

The goal of enhancing residual anomalies data is obtained more information on source location, extend, size, shape, trends, faults, tectonic boundaries, etc. Two methods have been applied to enhance residual anomalies data: Spatial Enhancement and 3D enhancement.

Spatial Enhancement

In this method, the enhancement of data has achieved by ERDAS software through the spatial enhancement (Convolution-Kernel 7*7 Horizontal) and spatial enhancement (Convolution-Kernel 7*7 Vertical). Convolution filtering is the process of averaging small sets of pixels across an image. A convolution kernel is a matrix of numbers that is used to average the value of each pixel with the values of surrounding pixels in a particular way. The numbers in the matrix serve to weight this average toward particular pixels. These numbers are often called coefficients because they are used as such in the mathematical equations (ERDAS Field Guide, 2005). Convolution filtering is used to change the spatial frequency characteristics of an image (Jensen, 1996). This filter also enhances short wavelengths while repress long wavelength signals which can be hard to identify deep-seated faults and boundaries.

In Figure (6) which is performed through convolution filter (Convolution-Kernel 7*7 Horizontal), it can recognize uplifts and depressions that have shallow depth within the sedimentary cover which represent a negative and positive anomaly or may reflect ridges, anticlines, and syncline within the sedimentary cover as well as may represent lithological change. The uplifts and depressions have different extent, trend, and amplitude. As illustrate in Figure (6) it can see the distributions of anomalies which represent uplift, anticline, and ridge in red color. Also, concentrate of some anomalies in
the SW part of the study area. The concentrate of these anomalies may attribute to effect Euphrates Boundary Fault Zone or Abu Jir Fault Zone. It is worth to mention that two of oil wells locate within the anomalies and other two oil wells locate on the boundaries of anomalies.

In Figure (7) which is performed through convolution filter (Convolution-Kernel 7*7 Vertical), it can recognize uplifts and depressions that represent a negative and positive anomalies, it can see in red color two of huge longitudinal residual anomaly in the NE part of the study area and may be interpreted as an important anticlines structures on the residual gravity, as well as there are some anomalies distribution in the study area which may reflect ridges, uplift, anticlines, within the sedimentary cover. All these anomalies have different extent, trend, and amplitude. This enhanced data gave a conception about residual anomalies less than the previous data. All oil wells in this data do not locate within the anomalies.

![Fig. 6: Residual anomalies enhanced using spatial enhancement (Convolution-Kernel 7*7 Horizontal)](image_url)
3D Enhancement

Another way to enhance residual anomalies is through 3D enhancement method using surfer software (by applying 3D Surface). In Figure (8) there are several positive and negative residual anomalies in the studied area related to ridges, anticlines, and synclines within the sedimentary cover. In general, the trends of axes for anomalies have different directions.

The boundaries between the negative and positive anomaly and contact area among bodies that have a different density as well as edges of basins or depressions may reflect locations of faults or tectonic boundaries. The residual anomalies in this method may give an idea about uplifts and depressions that have shallow depth within the sedimentary cover. Faults or tectonic boundaries and axes of high residual anomalies are delineated on the 3D enhancement map to obtain better conception about the anomalies. Some high residual anomalies could be interpreted as important anticlines structures for oil and gas exploration.
CONCLUSIONS

1. This research illustrates evaluation and interpretation the regional and residual anomalies in the study area. The main interpretation of the regional anomaly map (Fig. 4) shows three important anomalies, two of them (B and C) may be described as anticlines and could be important in hydrocarbon exploration. The main interpretation of the residual gravity map (Fig. 5) shows negative and positive anomalies with different shapes, sizes, and trends. In this map, the Kifl oil wells (3 and 4) locate at positive anomalies and Kifl oil well (1) locates at the flank of a positive anomaly. On the other hand, the Kifl oil wells (2) locates at the negative anomaly. It is worth to mention that the Kifl oil wells have evidence of hydrocarbon (Jumhoria and Hani, 2000).

2. The research applied a new method to enhance residual anomalies by using ERDAS software based on convolution filter. This method can be used to enhance gravity data and even magnetic data in any area.
3. Through 3D enhancement map, some faults and tectonic boundaries, particularly follow NW – SE trending were almost identical with the tectonic boundaries between (Najaf-Abu Jir-Hadhar Subzone) and (Tikrit-Amara Subzone) as shown in Figure (9).

Fig. 9: Tectonic map of the study area shows tectonic boundaries between (Najaf- Abu Jir- Hadhar Subzone) and (Tikrit-Amara Subzone) (Modified after Tectonic Map of Iraq, 1996)

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