Identification of Potential HC Reservoir in field “x” by using 3D Inversion Gravity Modeling and Magnetic Data

Ahmad Jahrudin¹, M.Syamsu Rosid¹, Imam Setiaji Ronoatmojo², Solehudin³, Ricky Adi Wibowo⁴

¹Department of Physics, FMIPA Universitas Indonesia, Kampus UI Depok, Depok 16424, Indonesia
²Faculty of earth and energy technology, Universitas Trisakti, Jl. Kyai Tapa No.1, Grogol Jakarta 11440.
³PT Elnusa Tbk, Graha Elnusa Lt. 15, Jl. TB. Simatupang Kav. 1B, Jakarta Selatan
⁴PT. Pertamina EP, Menara Standard Chartered No 164, Lt 16, Jl. Prof. DR. Satrio, Jakarta 12950

E-mail: Ahmad_Jahrudin@yahoo.com

Abstract. 3D inversion modeling of subsurface based on gravity anomaly data and magnetic anomaly data used for identification hydrocarbon potential in “x”. Where in the study area there are up dome structures that indicate some possibilities, including igneous rock intrusion, carbonate build up and also mud diapir. 3D inversion modeling of gravity and magnetic anomaly data correlated with two seismic section which available in study location. 3D inversion model is performed on the residual anomaly data on the gravity model and 2D in the magnetic anomaly. The result of 3D inversion modeling of gravity anomaly data shows that the peak up dome is at a depth of study located around 800 meters from the surface, this result corresponds to spectrum analysis and depth on the seismic cross section, while the density value of the up-dome body is approximately 2.78 g/cm³. While on the magnetic anomaly that has been done, structure of the dome indicates an intrusion structure with anomaly susceptibilities show the structure of igneous rock.

1. Introduction
The background of this research is based on seismic surveys that have been carried out, but from seismic cross section have high uncertainty, which can allow these structures to be rock intrusions or up dome and also reef carbonates. Researchers assume that up dome is igneous rock because in that area there is Slamet Mountain, as a product of tectonic activity [10,11,12]. The assumption of build up carbonate due to the surrounding location is a limestone outcrop [1]. The purpose of this study is to determine the type of rocks of the object, and also to determine whether there may be a reservoir on the site, if the rock is a carbonate stone it will be a good reservoir with a large enough volume. Therefore, this study requires another method to strengthen the seismic interpretation. One method that can be used to identify the type of rock, which is also often used to strengthen the seismic interpretation, is gravity [2], the advantage of gravity method compared with other methods is to determine rock density [6], from
density, what type of rock can be determined, and in addition to gravity method another method used is magnetic method, with magnetic method can measure magnetic properties of rocks, if magnetic value is high enough then the rock is the result of intrusion, but if the rock has a low susceptibility then the rock is sedimentary rocks.

2. Methodology
The data used are gravity and magnetic data in the excel format obtained from the measurements taken by Elnusa in Tegal, Central Java Province. The study used 125 gravity data and 386 magnetic data, which were acquired from September 3, 2107 to September 18, 2017. Line of acquisition for magnetic and gravity data as shown in Fig. 1, which also shows the regional geology map of Purwokerto and Tegal sheets, in Fig. 1 shows line for similar measurements on magnetic and gravity data to good interpretation.

2.1. Magnetic Process
The magnetic data processing done is to do diurnal corrected and IGRF to get the magnetic anomaly, which will then be filtered Reduce to pole and reduce to equator to eliminate the effect of the poles.

2.2. Gravity Process
The initial process of this research started from the processing of gravity data correction to 3D modeling. Correction is tidal correction, float correction, normal gravity correction, free air correction, and complete bouguer correction [3].
After doing corrections, the next steps in processing gravity data are:
1) doing gridding with surfer software 8
2) get the CBA contour
3) do a spectrum analyst to get the N value
4) performs the separation of regional and residual anomalies on the CBA anomaly map
5) Creating 3D Invert Models
3. Results and Discussion

3.1. Magnetic data

After the correction of the magnetic data, and obtained magnetic anomaly as in Figure 2a, in Figure 2a we can’t interpret directly, because the picture is still seen there are effects of polar effects, which seems there is more than one body, as shown in the circle. Then the next process is done Reduce to Equator (RTE), the result of RTE as shown in Figure 2b, in Figure 2b the anomaly looks unaffected by the poles, but there is little doubt in the RTE interpretation associated with Figure 2a, in Figure 2a an anomaly negative value is greater than positive, which indicates that the rock body is more likely to be negative, because it is processed and uses the reduced to pole (RTP) method, the result of RTP shown in Figure 2c, in Figure 2c is seen in the observation (center given a circle sign), this has a fairly high negative anomaly value, this corresponds to the magnetic anomaly in Fig. 2a. This is in accordance with the research that has been done by Sudhir Jain[8] in the journal Magnetic field Reduction field-the pole or Equator, it is more suitable to do RTP for the equator, as well as in Yaoguo Li and Douglas research [9], the study about the reduction for equator areas done is RTP Filtering. From the results of the process that has been done seen in Figure 2c (RTP) shows anomaly which has a high negative amplitude, it indicates that the rock up dome structure is the rock of intrusion.
3.2. Gravity Data
Gravity data Processing to separate the regional and residual anomalies, the research used the Moving Average method that needs an optimal N value by means of spectrum analysis [5]. This spectral analysis data was obtained from CBA anomaly map based on gravity measurement path, as for the Line showed like Figure 3 below.

Figure 3. Line spectrum analysis

Next, do the calculations of the spectrum data by using excel. As shown in Figure 4
Figure 4. Graphic and result analysis spectrum

From the Figure above, obtained the value of N amounted to 17.80658 rounded to 19.

After doing spectrum analysis, filter CBA anomaly map by using Moving Average method. Its method produces regional anomaly map. Then, to get a Residual anomaly map, by doing reduction between CBA anomaly with Regional anomaly [5], as shown in Figure below.

Figure 5. Separation anomaly map

After getting the data of Residual anomaly, the next step is to make a 3D modeling by using software Grav3dc. The steps are first, create a mesh for container that will be entered by Gravity data, next input Residual data to the software. The result is as shown in Figure below
Figure 6. 3D modeling Residual anomaly data is visible from the south side

Figure 7. 3D modeling Residual anomaly data is visible from the West side

Figure 8. Modeling Residual anomaly with value range density of 2.72-2.90

Based on the result of gravity data modeling that is correlated with seismic data, the result between 3D modeling gravity data with seismic section has the same depth and goes through the formation of the halang at a depth of approximately 780 m. As shown in Figure 9 below.

Figure 9. Seismic section in research area (source: Pertamina EP)
4. Conclusions
From the results of seismic interpretation, magnetic anomaly and modeling of 3D gravity modeling, from magnetic anomaly at result RTP, shows anomaly which has a high negative amplitude, it indicates that the rock up dome structure is the rock of intrusion, and from gravity modeling it shows an density anomaly of about 2.78 g/cm³. This anomaly goes into the type of diorite rock. So, it can be concluded that the body of the up dome is the result of intrusion igneous rock. Based on the results of the interpretation at the research location, we can be sure that the research location has no prospect of hydrocarbon reservoir. It’s because the up dome is the result of breakthrough igneous rocks. And, the intrusions penetrate into the formation of the halang at a depth of about 780-800 m.

References
[1] Mulyana, H., T. Chairil Basri, and H. Moechtar. 2010 J. Geo-Sciences. Vol. 20

[2] Telford, W. M., Geldart, L.P., Sheriff, and R.E., Keys D.A. 1990. Applied Geophysics 2nd edition. Cambridge University Press

[3] Caineng, Zou. 2013. Volcanic Reservoirs in Petroleum Exploration, published by Elsevier

[4] Djuri, M., H. Samodra., T.C Amin., dan S. Gafor. 1996. Peta geologi lembar Purwokerto dan Tegal, Jawa.

[5] Purnomo, Jarot., Sorja Koesuma, Mochtar Yunianto. 2013. Indonesian Journal of Applied Physics ISSN:2089-0133

[6] Nurdiyanto, Boko, S. 2013. Analisis Potensi Panasbumi Kepahiang, Bengkulu Menggunakan Metode Gaya Berat Dan Magnetotellurik, Universitas Indonesia, Depok

[7] Nettleton, L. L. 1976. Gravity and Magnetics in Oil Prospecting, McGraw-Hill, New York

[8] Sudhir, Jain. 1988. Total Magnetic field Reduction-the Pole or Equattor? A Model Study, Journal of Exploration geophysics. Vol 24. P 185-192

[9] Yaoguo, Li and Douglas, W. Oldenburg. 2001. Stable reduction to the pole at the magnetic equator. Journal geophysics. Vol 66. P 571-578,7 FIGS