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Gravity Data Analysis and Modelling for Basin Sedimen of Eastern Java Blocks

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Abstract. The study of Eastern Java Basin was conducted by 3D modelling subsurface structure using gravity anomaly. The aims of this research are to describe and 3D modelling basin sedimentary system of Eastern Java Blocks based on gravity anomaly. The modelling construction was performed by inversion technique applying Singular Value Decomposition (SVD) method and Occam optimization. This projection method used equivalent central mass of Dampney with height 5.5 km and error data 1,84 x 10^{-17}. Separation of residual anomaly from the complete Bouguer anomaly on a flat plane was done using the upward continuation. This process uses the principle of low pass filter which passes low frequency. Sedimentary basin appears at a depth of 0.2 km to 1.4 km, is shown by their low anomaly in the area, as well as the visible appearance of basin in 3D modeling shown in figure. The result of inversion with Occam h has an error of 1,2 % and the SVD has an error of 11%. Sedimentary basin was dominant in Probolinggo, partially in Besuki and Lumajang. The formation occurs due to tectonic processes where the tectonic evolution of the material without significant lateral shift is called as the otokton models, and accompanied by the formation of the basin that follows the development of the subduction system, which is semi-concentric pattern. Sediments are dominated by volcanic sediment, the result of sedimentation because of volcanism events and types of volcanic sediments pyroclasts generally occur in a process or event explosive volcanic magma degassing

1. Introduction

Java is one of Indonesian Island part of volcanic arc along Sumatra to Nusa Tenggara [1]. Indonesia has 128 sedimentary basins, base on their age can be divided into Tertiary basin, pre-Tertiary basin, and developing basin since the pre-Tertiary to Tertiary [2]. Eastern Java Basin has a complex structure and stratigraphy of back arc basin of Indonesia. Eastern Java Basin is favorite area in Indonesia for the exploration of petroleum and make this area into a "hot spot" on the exploration [3]. East Java has a thickness of tertiary sedimentary basins around 6 km [4]. Gravity anomaly from 0 mGal to 20 mGal form into sedimentary system from host rock [5]. Gravity method is used to describe the subsurface geological structure by variations in Earth's gravitational field caused by contrast density between rocks. Gravity method can also be used to identify sedimentary basin which is indicated by low Bouguer anomaly. Basin is generally indicated by the appearance of deposits of sediment trapped on it. Surveys of hydrocarbons in Eastern Java are around the edge of the basin, but the survey of deeper basin has not significantly done. The area around Malang has the potential basin for example Probolinggo [6], which indicated by low Bouguer anomaly. Therefore, the gravity method can be used to modelling sedimentary basins in Eastern Java, especially block area of Probolinggo, Besuki, Jember

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and Lumajang and to predict that prospects for hydrocarbon exploration and gas. The aims of this research are to describe and 3D modelling basin sedimentary system of Eastern Java Blocks based on gravity anomaly. The research area is described in figure 1.

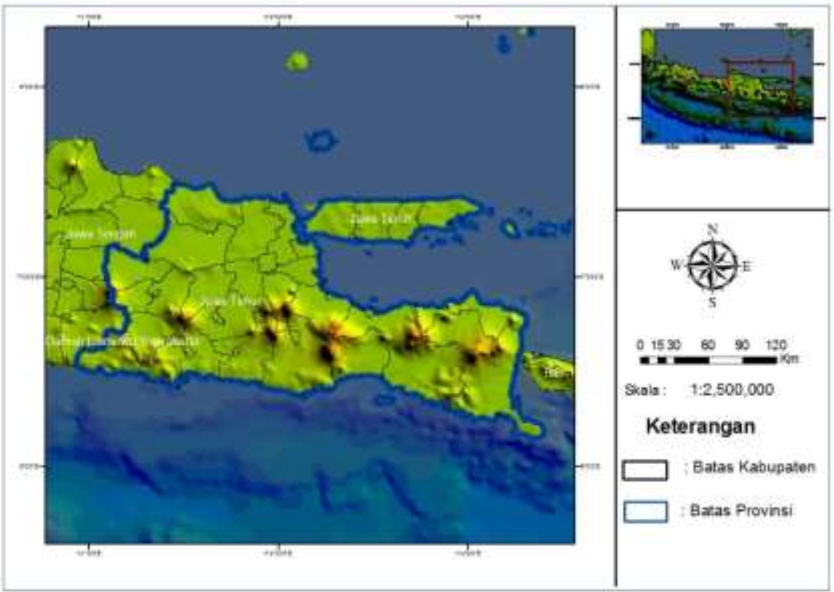

Figure 1 Map of the research area.

2. Gravity Methods

Gravity method is used to describe the subsurface geological structure by variations in Earth's gravitational field caused by contrast density between rocks. Gravity method can also be used to identify sedimentary basin which is indicated by low Bouguer anomaly. Complete Bouguer anomaly data that is still on topography need to project on a flat surface. Its principle is carried variation of heights into the slab mass with the same height to computed upward continuation. This projection method used equivalent central mass of Dampney [7] with height 5.5 km and a data error 1.84 x 10^{-17}. Separation of residual anomaly from the complete Bouguer anomaly on a flat plane was done using the upward continuation. This process uses the principle of low pass filter which passes low frequency with height 8 km. Modelling basin sedimentary is using residual anomaly. A residual gravity anomaly caused by the presence of objects which are close to the surface. Residual anomalies obtained by subtracting the complete Bouguer anomaly with regional anomalies. Modelling using forward modelling and inverse modelling. Forward Modelling is used to predict the simulated data based on hypothetical subsurface conditions. The simulation data are usually referred to the data or theoretical predictions data. The inversion method uses singular value decomposition (SVD) and occam's principle. Inversion by Singular value decomposition are inversion base, density and heights, inversion by occam's principle are occam density and heights.

3. Results and Discussion

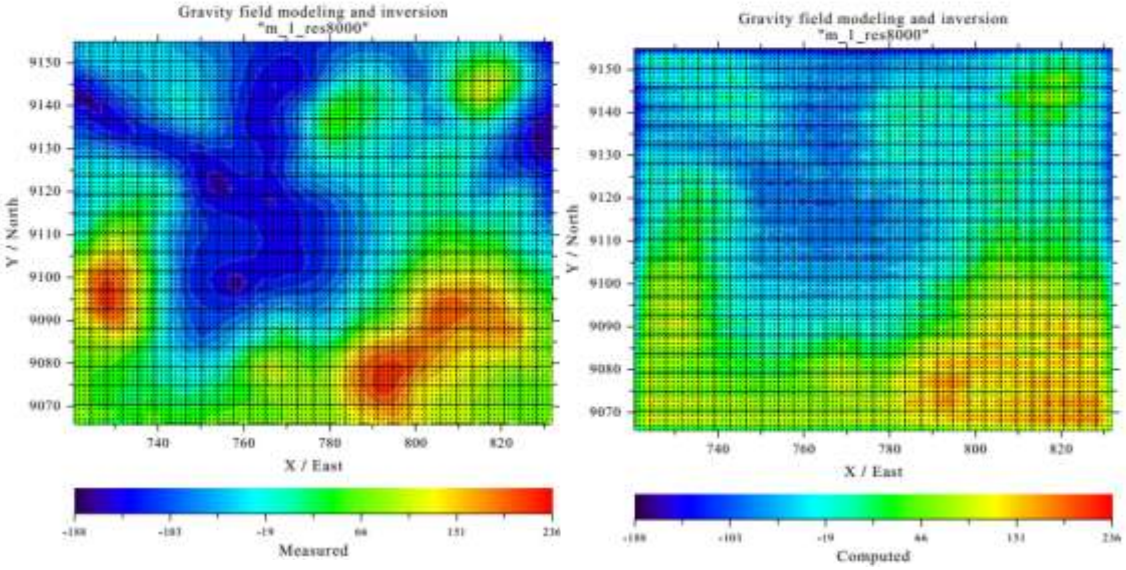

Figure 2 Density optimization of residual anomaly data.

Comparison between measured and computed of density Optimization showed that their pattern was almost same. Density Optimization was meant to get fit data between the model and the density value of measurement, density inversion results of the optimization is shown in Figure 1. Contour map obtained shows an error data of 13%. To obtain a better model with the smallest error density inversion is maximized by using Occam density (Occam d). The results of the optimization process using Occam d shows an error data of 7.6%.

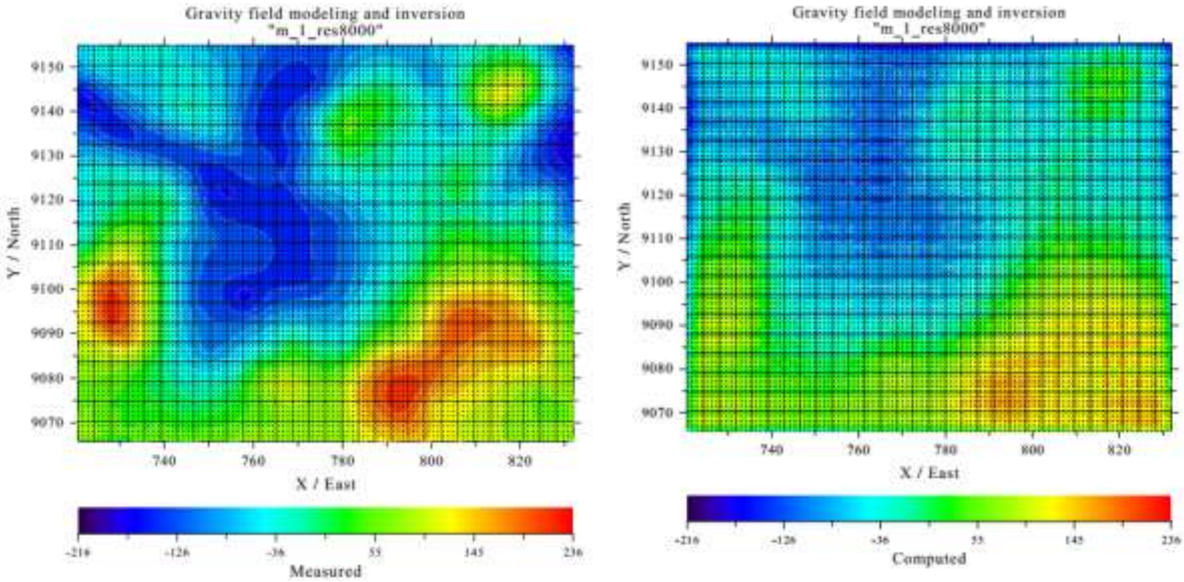

Figure 3 shows the result of occam heights optimization of residual anomaly data. Comparison between measured and computed of occam heights Optimization show that their pattern is almost same. Optimization height of the block (height) is intended to get the size of the minor blocks with a maximum height of each layer, where the height of the block illustrates the depth and thickness of each layer. Contour map obtained shows an error data of 11%. To obtain A better model with the smallest error heights inversion is maximized by using Occam heights (Occam h). The results of the optimization process using Occam h shows in figure 2 with an error data of 1.2%.

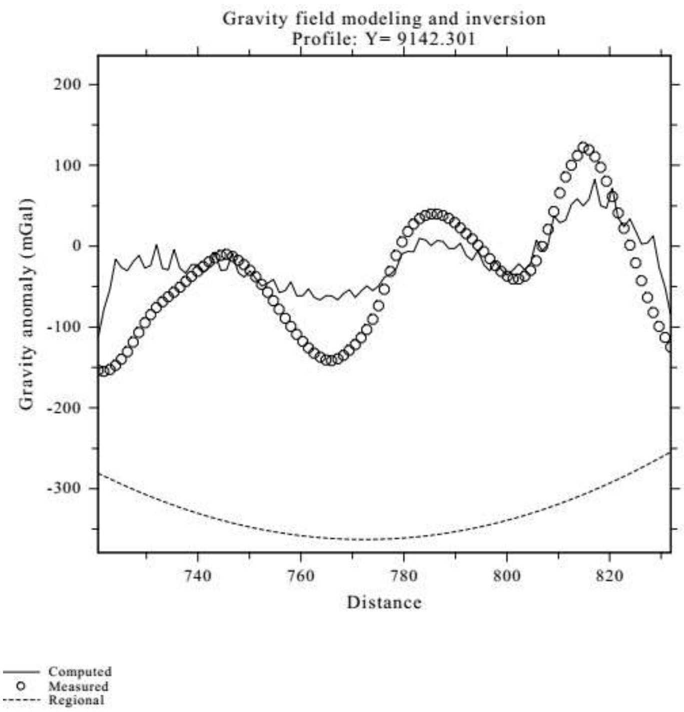

Figure 4 show a cross section at y = 9142.301. Comparison between measured and computed of cross section at profile y = 9142.301 show that their pattern is almost same. It's mean that the proses data of inversion model can be used as model for modelling basin sedimentation.

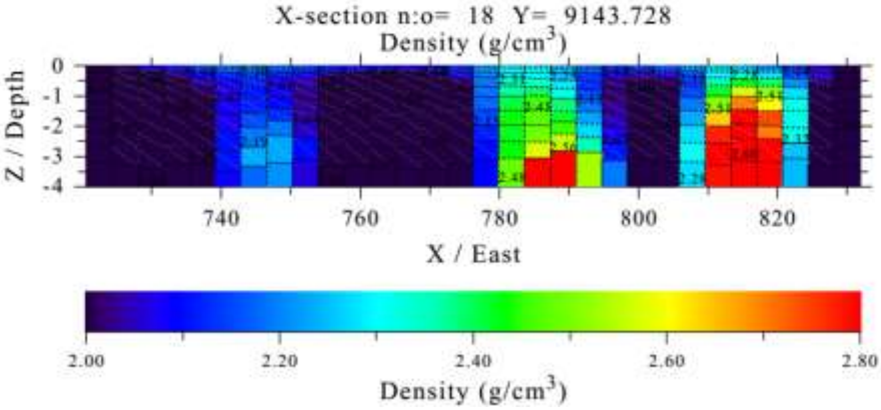

Figure 5 shows a mass with high density ~ 2.8 exactly below Raung's Mountain. We assume that it is intrusion of magma. The position of magma intrusion is located at the longitude 810-820 km. This is make a sense with the information on the data released by the Centre for Geological Research and Development that there is a layer of volcanic breccia which have an insert with andesite lava. The depth of magma intrusion is estimated between 2-8 km. Sedimentary basins shown by their low anomaly that is spread on three areas, at the longitude 720-740 km, 756-776 km and 830-835 km. Sedimentary basin dominant in Probolinggo, partially in Besuki .

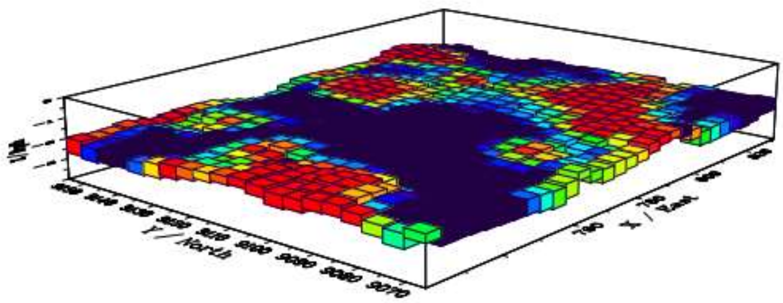

Figure 6 shows 3D modelling sedimentary basin of Eastern Java Blocks with deep at 1.9 km. sedimentary basin is shown by their low anomaly. We modelling basin sedientary system at each layer from 0 km to 3.1 km. The initial model is 30 block mayor toward x axis, 20 toward y axis, and 10 toward z axis at deep model 4 km from surface.

In conclusion, sedimentary basin appear at a depth of 0.2 km to 3.1 km, is shown by their low anomaly. Sedimentary basin is dominant in Probolinggo, partially in Besuki. The formation occurs due to tectonic processes where the tectonic evolution of the material without significant lateral shift is called the otokton models, and accompanied by the formation of the basin that follows the development of the subduction system, which is semi-concentric pattern [8]. Sediments are dominated by volcanic sediment, the result of sedimentation because volcanism events and types of volcanic sediments pyroclasts generally occurs in a process or event explosive volcanic magma degassing [9].

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