Introduction

Exploration is an important activity in the energy industry in general. Exploration carried out to find the source of new reserves. In exploration is always preceded by preliminary surveys. The purpose of this preliminary survey was to get a broad overview of the geological conditions that can be selected several areas for research in detail. One of the geophysical methods that can be used in a preliminary survey is a survey using the gravity method. Gravity method selected for use in preliminary surveys for a relatively low cost, rapid implementation, and can provide a general overview of the study area.

The research area in North East Java (NEJ) basin is a sedimentary basin that was explored in Indonesia since the end of the 19th century. Until present, exploration and production activities are still ongoing in the region of both onshore and offshore. There are several significant discoveries of oil and gas fields in NEJ basin, as for example is the discovery of oil and gas fields such as Sragen Mudi in 2007 and Banyu Urip in 2009. Moreover, a survey was conducted by the gravity method to determine the oil and gas prospects in NEJ Basin. However, the study area was mostly just covers the Onshore (Panjaitan, 2010). Exploration conducted by Pertamina in East Java reported that oil and gas have been found in nearly all East Java Basin stratigraphic units, ranging from clastic reservoir Ngimbang Middle Eocene age until volcaniclastic reservoir Pucangan Pleistocene age. Configuration bedrock deformed shape and the lower altitude that makes this basin is rich in oil and gas kitchen.

This research aims to determine the structure in NEJ Basin of a Residual Bouguer Anomaly with SVD and FHD.

Geological Setting

The structural history of NEJ Basin cannot be separated from the structural history of South East Asia region. This basin located on the southeastern edge of the Sundaland Craton. The age of basement is Cretaceous to Tertiary. NEJ Basin is classified as back arc basin. The structures which developed in NEJ Basin have NE – SW orientation (Figure 1) which are asymmetry half graben structure (Darman & Sidi, 2000).

The development phase of tectonic in NEJ Basin is the result of subduction activity of the Indian – Australian plate under the Eurasian plate that produces magmatic arc. This subduction direction has changed several times throughout geologic time. General direction pattern NE – SW is the result of subduction in Cretaceous. This phase formed lineament with NE – SW orientation. The second phase extensional / Paleogene rifting that led to the development of normal faults with the NE – SW forming a ridge (Florence Ridge and Bawean Ridge) and trough (Pati Trough and North Tuban Trough). Neogene compressional wrenching phase (middle Miocene) is characterized the formation of structures and faults en echelon fold sliding which oriented SW – NE and W – E. Post-Neogene compressional phase inversion (Plio - Pleistocene) produce a reverse fault structure with the W – NE and shear fault NE – SW and NW – SE. This fault structure resulted in the reactivation of the main styles of products towards the N – S thus reversing sediments have been folded to form a reverse fault at the top of the crease.

The main exploration target is the sediment NEJ Basin - Middle Miocene sediments (Putra, 2007). Oligocene - Miocene NEJ Basin characterized by a number of deposition stage. Three stratigraphic intervals known are Kujung (carbonate mound and off the mound) ~ 28-22 Ma, Tuban (mixed carbonate - siliciclastic) ~ 22-15 Ma, and Ngrayong (siliciclastic) ~ 15-12 Ma (Sharaf, et al., 2005).

Methods

The data which be processed on this research are obtained from *Bureau Gravimétrique International* (International Gravimetric Bureau). Initial data processing yield complete Bouguer anomaly map which would be filtered using Upward Continuation to separate regional and residual anomaly. The residual anomaly data was processed using derivative analysis include First Horizontal Derivative (FHD) and Second Vertical Derivative (SVD). Those processes gave structure pattern, structure boundary, and type of dominant structure information in NEJ Basin. For more details can be seen in the flow chart of this research (Figure 2).

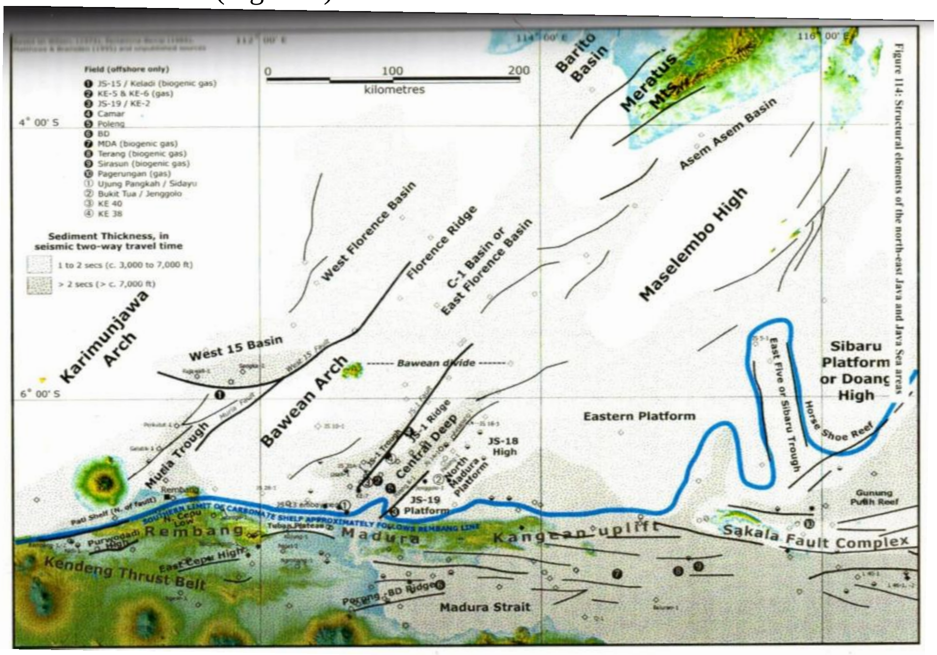


Figure 1 *Structural elements of the NEJ Basin area. The structure which dominated on this area is oriented in NE – SW (Lunt, 2013).*

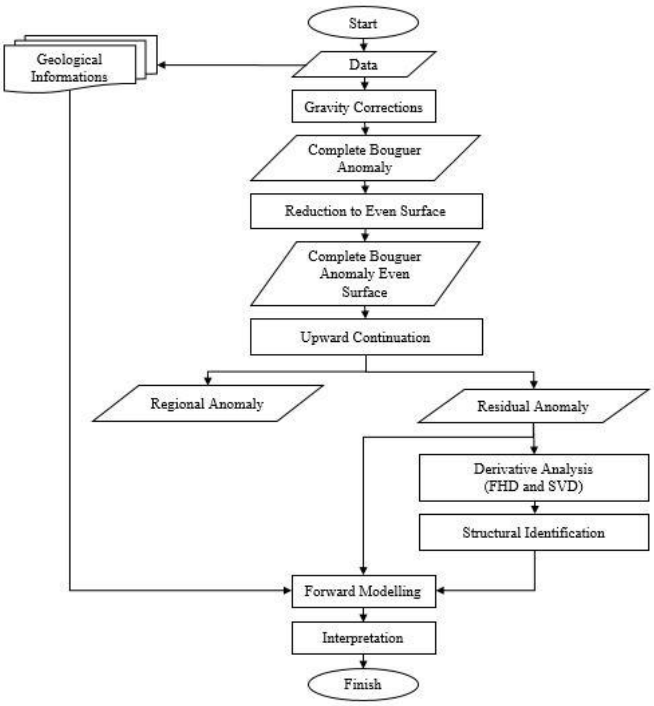
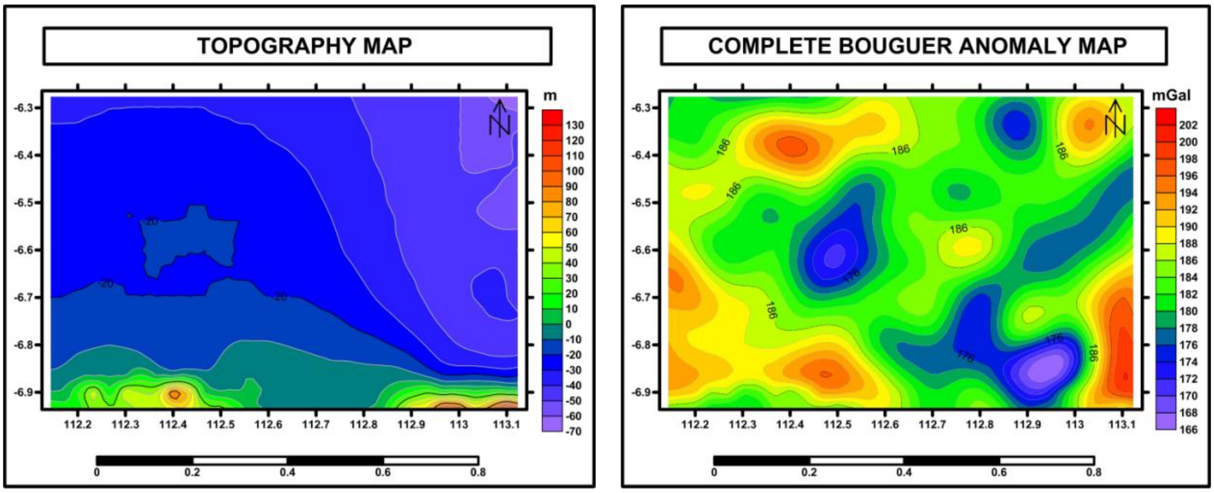


Figure 2 *Flow chart of research using gravity method with FHD and SVD.*

Topography Map and Complete Bouguer Anomaly (CBA)

The research area is located in topographic surface between -70 until 130 meters above mean sea level or offshore (Figure 3a). CBA is yield from processing data after applying some gravity correction into raw data. The low value of CBA (Figure 3b) is shown in value between 166 until 176 mGal (blue colour) whereas the high CBA value is shown in value between 192 until 202 mGal (red colour).

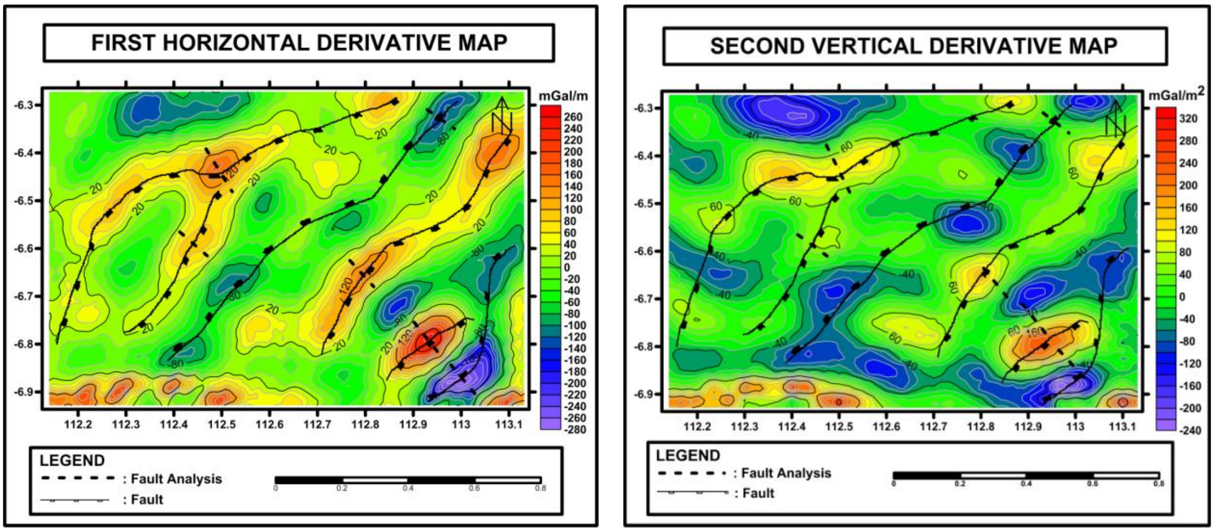


(a) (b)

Figure 3 *(a) Topographic map of research area which indicates offshore area. Minus (-) sign indicate area which below mean sea surface (offshore). (b) CBA map of research area in mGal unit.*

First Horizontal Derivative (FHD) and Second Vertical Derivative (SVD)

FHD determines the structure boundary. This boundary indicated maximum and minimum contour closure. In this research the FHD process using 0°, 30°, 45°, 60°, 120°, 135°, and 150°. The 135° angle was chosen for structure analysis purpose due to appropriate trend structure in Second Vertical Derivative (SVD). SVD is applied for determining type of structure in this research area and is correlated with FHD map in structure analysis. This structure on SVD map is indicated by zero value SVD (green colour). Based on FHD map (Figure 4a) and SVD map (Figure 4b), it can be seen six structures.



(a) (b)

Figure 4 *(a) FHD in the research area including structure and the structure analysis. The structures coincide with maximum and minimum anomaly closure contour. The scale is on mGal/m unit. (b) Second Vertical Derivative (SVD) of the research area including structure analysis. The structure analysis coincides in zero value SVD in mGal/m² unit.*

Residual Bouguer Anomaly (RBA)

Based on structure analysis which has been done on FHD and SVD, it enables to pick trend structure on RBA map. The RBA map is interpreted with correlated by geological data of research area. Then it yields the structure information.

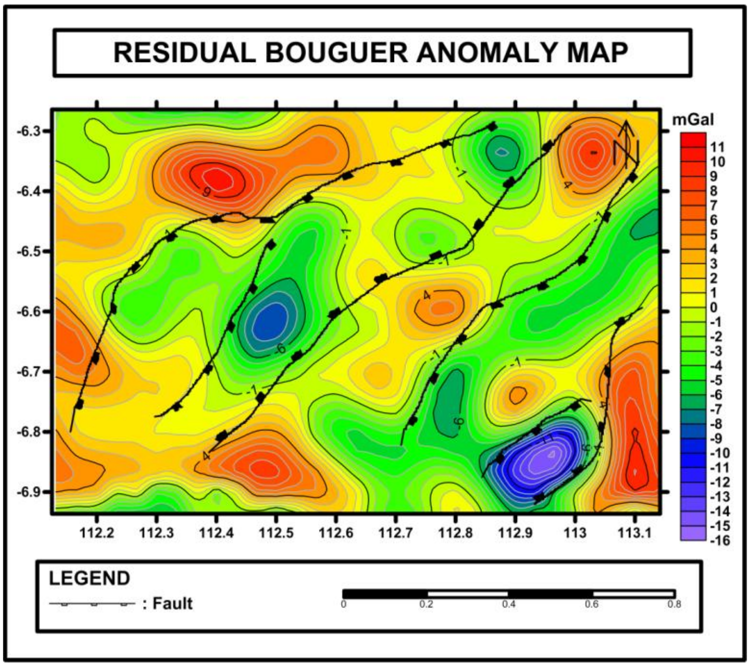


Figure 5 *Residual Bouguer Anomaly (RBA) map in the research area include the fault structure which has been interpreted. It can be seen the normal fault which NE – SW oriented and it is forming the half graben structure.*

Conclusion

Residual Bouguer Anomaly is more detail and reflect the local anomaly which shallower than CBA. The low RBA values which range between -16 until -8 mGal are shown with blue colour. Meanwhile the high RBA values which range between 6 until 11 mGal are represented by red colour. Based on the analysis structure in the FHD and SVD map obtained fault structure with NE – SW oriented. Comparing this result with geological data of the research area, it can be concluded that the structures which dominated on the research area are normal fault associated with half graben structure. The half graben structures are shown with contour closure pattern in RBA map. The high area (ridge) shown with high RBA value and low area (trough) represented with low RBA value.

Acknowledgement

Authors thanked to Mr. Surya Aji Saputra who share the knowledge and give suggestion, until this research has been finished.

References

Darman, H. & Sidi, F. H. [2000] *An Outline of The Geology of Indonesia*. Indonesian Association of Geologists, Jakarta.

Lunt, P. [2013] *The Sedimentary Geology of Java*. Indonesian Petroleum Association, Jakarta.

Panjaitan, S. [2010] Prospek Migas pada Cekungan Jawa Timur dengan Pengamatan Metode Gayaberat. *Buletin Sumber Daya Geologi*, 5(3), 168 - 181.

Putra, S. P. [2007] Sekuen Pengendapan Sedimen Miosen Tengah Kawasan Selat Madura. *Jurnal Riset Geologi & Pertambangan*, 17(1), 20 - 36.

Sharaf, E., Simo, J. A., Caroll, A. R. & Shields, M. [2005] Stratigraphic Evolution of Oligocene-Miocene Carbonates and Siliciclastics, East Java Basin, Indonesia. *AAPG Bulletin*, V(6), 799-819.