Morphotectonic Analysis at Tanimbar Trench as a Base for Gas Pipe Laying Between Masela Block and Selaru Island, Moluccas Province

Analisis Morfotektonik di Palung Tanimbar Sebagai Dasar Untuk Peletakan Pipa Gas Antara Blok Masela dan Pulau Selaru, Propinsi Maluku

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(Received 16 January 2012; in revised form 1 May 2012; accepted 21 May 2012)

ABSTRACT: The study area is located at Masela Block and its surrounding, Moluccas Province. Result of the deep sea measurement and global data conversion provide description of three dimensions around the track lines area. This result is overlay with seismic data, that can give morphotectonic implication between Asian and Australian Plates.

Track lines of MGI-2010-MSL-1, 2 and 3 show that the profile of the sea floor, form the high morphology which represents the volcanic islands. It forms west – east direction of fold-thrust belt non-volcanic outer Banda arc. The southern part trench of the Australian Continent reflected the platform system and undulation morphology.

The sea floor profile (VE 1:5) show that the slope profile ranges between 0º and 8º. Furthermore, the morphology of the sea floor can be classified as a relatively flat slope. Due to this condition, this area may be used for gas pipe laying along 146 km distance, between the Well of Abadi 1 at the Masela Block and Selaru Island at south Tanimbar Islands.

Keywords: sea depth, sea floor morphology, seismic profile, tectonic, Masela Block

ABSTRAK: *Daerah penelitian terletak di Blok Masela dan sekitarnya, Provinsi Maluku. Hasil pengukuran kedalaman laut dan konversi data global diperoleh gambaran tiga dimensi di sekitar jalur lintasan. Hasil ini kemudian ditumpangtindihkan dengan data seismik, sehingga dapat memberikan gambaran morfologi dan implikasi tektonik antara Lempeng Asia dan Australia.*

Pada Lintasan MGI-2010-MSL-1, 2 dan 3, menunjukkan profil kedalaman dasar laut membentuk morfologi tinggian yang mewakili pulau-pulau vulkanik. Kondisi ini membentuk suatu jalur punggungan lipatan sesar naik non vulkanik Busur Luar Banda berarah barat – timur. Di bagian selatan palung, mewakili Benua Australia; menunjukkan suatu sistem paparan dan morfologi undulasi

Penampang dasar laut (VE 1 : 5) memperlihatkan bahwa kemiringan lereng berkisar antara 0º dan 8º. Selanjutnya morfologi dasar laut ini dapat diklasifikasikan sebagai lereng yang relative landai. Berdasarkan kondisi ini daerah ini kemungkinan dapat digunakan untuk peletakan pipa gas sepanjang 146 km, antara Sumur Abadi 1 di Blok Marsela dan Pulau Selaru di sebelah selatan Pulau Tanimbar..

Kata kunci: kedalaman laut, morfologi dasar laut, enampang seismik, tektonik, Blok Masela

INTRODUCTION

The study area is focused by coordinate between 128º30'00" - 132º00'00" E and 07º00'00" - 9º30'00" S (Figure 1). Geographically, the study area is located in Timor and Arafuru Seas close to the Exclusive Economy Zone (EEZ) between Indonesia – Australia, southern part of Masela Island, Tanimbar Islands. Masela block is located in northern part of border line between Indonesia and Australia, 170 - 180 km from south Yamdena Island, Moluccas Province or around 400 km north of Darwin, Australia.

Masela Block waters and adjacent areas is prospect area for gas exploration; and the recently is developed for gas production as biggest gas production in Indonesia. Result of seismic survey and well exploration during ten years ago shows that at Masela

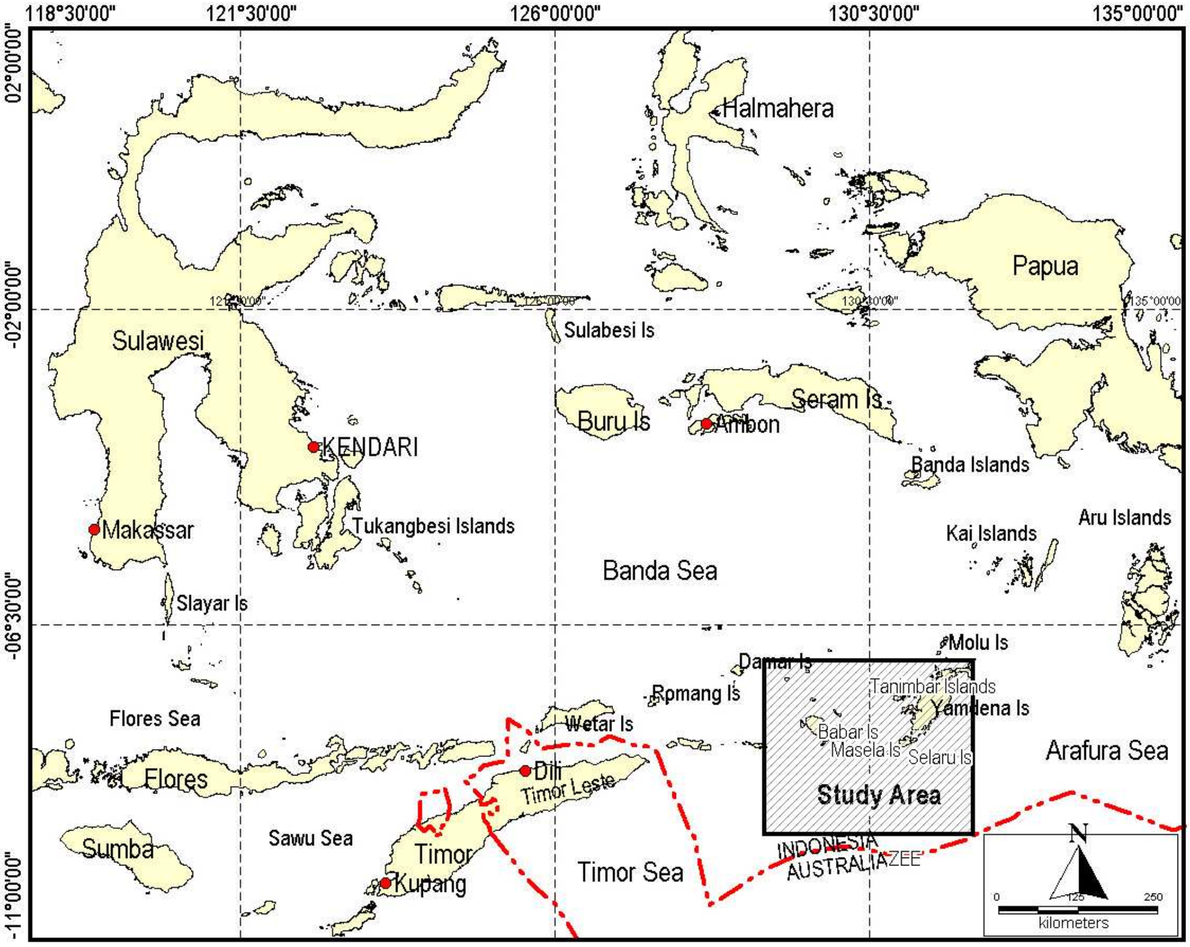

Figure 1. Location map of study area at the Masela Block and adjacent areas, Tanimbar Islands, Moluccas Province.

Block existed the gas proven. The operator at Masela Block will do the upstream survey for prepare the exploitation activity of gas from Well Abadi 1. The important aspect in order to gas production is geological and geophysical data as the support data in the alternative for exploitation technique and gas canalization for processing.

To distribute the gas from Masela Block to processing location will be done several alternatives such as undersea pipe to Selaru Island or floating refinery trough Tanimbar Trench. The wide of Tanimbar Trench that cut by lines of Masela Block – Selaru Island around 146 km distance and between Masela Block - Yamdena Island is about 175 km with sea bottom depth between 1000 to 1500 meters and trough slope of trench more strong in northern part of the trench.

The purpose of this study is to obtain the undersea morphology data as a base information to support the national policy for gas distribution with the methods of marine geology and geophysict about for geological setting and undersea morphology. The present data hopefully will be able to speed up the Masela Block development in relation to exploitation technique election and gas processing.

The several tectonic models of relationship between Australia and Asia Plates at the Tanimbar Trench have been published by the some authors. The tectonic models are overthrust model (Audley – Charles, 1968), Rebound Model (Chamalaun and Grady, 1978), Imbricate Model (Hamilton,1979), Duplex Model (Charlton et al, 1991), and Overthrust Margin Model (Sawyer et al, 1993).

The Rebound model according to Chamalaun and Grady (1978) is rise form of Australian Continent and while imbrication model according to Hamilton (1979) is result of accration-imbrication mix and sediment from Australian Craton enter to Eurasia Continent formed the accration, and accration mass more depth, expose above sea level, formed the islands arc non-volcanic and part of plate enter to continent (ophyolite, basic, and ultrabasic) on rise period at Plio-Pleistocene ages. The duplex model according to Charlton et al (1991), that the model is controled by imbrication at

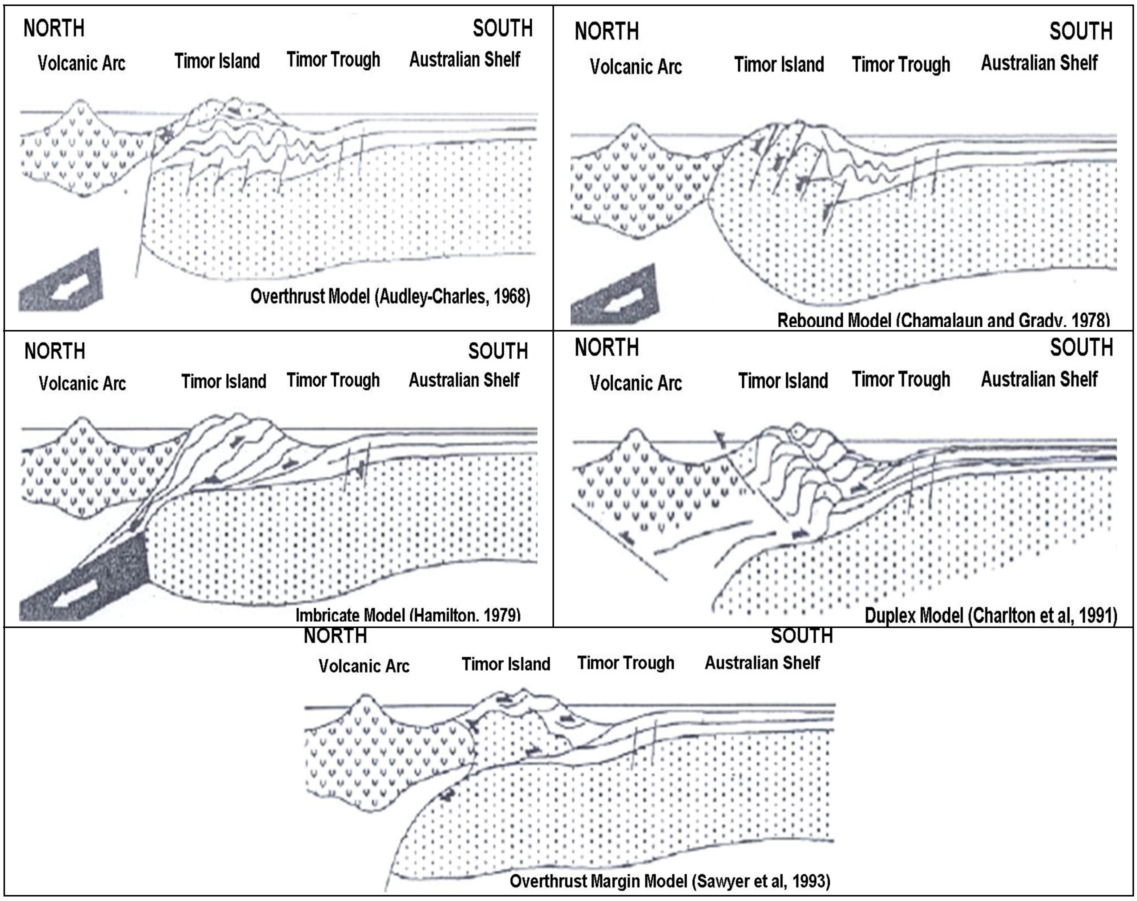

Figure 2. The tectonic models of relationship between Asia and Australia Plates

outer part of Australian Plate and arc complexs remain in the front of oceanic as a fold and thrust belt. While overthrust margin model by Sawyer et al (1993); is controlled by result of crack at the margin border of Australian Continent, and the part of Australian Plate enter to front the Eurasian Plate.

The formation of Masela, Selaru, Yamdena and Tanimbar Islands are derived from part of Australian Continent crust around 45 million years ago. Tanimbar Islands located at the northern part of Australian Continent than migrated to Indonesian region (Hall, 2006). Third island is located at around 500 km from north Australia represent upraised islands that are separated by Timor Sea. The islands at this area are formed by west-east system of fold-thrust belt of non-volcanic Outer Banda Arc at Eastern Indonesia with 2,000 km long at Tanimbar, Kai, Seram and Buru Islands.

The Sahul Shelf belongs in system of Australia-Irian continental from Gondwana lithospheric plate (Honda et al, 2006). At the northern part of Australian Continent system is an extended area of Australian Continent. Sahul Shelf does not correlated with Tertiary tectonic, but formed a pattern folding of Jurassic sediment since Middle Mesozoic to Cenozoic located in a bedrock block that broken in Paleozoic on early Mesozoic time.

METHODS

The study activity uses Research Vessel Geomarin III with equipments of seismic survey, geo-magnet, echosounder and gravity corer for collecting sediment samples. The methods that used in this study are measurement of bathymetry and global data conversion process. Measurement and data conversion is to obtain the distance data between sea surface and sea floor, furthermore as base data in undersea morphology to make three dimensional (3D). Data analysis uses the surfer software and global morphology data.

Equipments that used in this study are recorder of singlechannel echosounder, reason type navisound 420DS, recording graphic in paper of odom hydrotrac. For depth up to 3,000 meters uses 12 transdusers with 3.5 kHz has been used and installed in above ship wall, and bathy 2010 get the position data from DGPS C-Nav and gives the digital depth data product (DBT, depth below transducer) to navigation system of Geonav.

Sounding data acquisition were done based on regional structure pattern and sea floor morphology. Structure pattern and morphology that are developing at the sea is parallel with tectonic system of Tanimbar Trench and Banda Trench with relatively west – east direction. Based on land and marine geological condition, track lines cuts both trenches area (Table 1).

Based on sea bottom data that was obtained during the cruise and global image data, the morphology pattern of sea bottom can be recognized. At the track line profile of MGI-2010-MSL-1 with north-south direction along 230 km (see Figure 2), the profile of sea bottom depth, shows as flat topography in the track line with variation depth from 289 to 4,892 meters.

In this analysis, two scales of 1 : 1 and 1 : 5 were used in order to obtain the true profile of sea bottom

Table 1. Track lines of geophysical survey at Masela Block waters, Tanimbar Islands.

Track line:	Coordinates		Distance (km)	Explanation:
	SOL	EOL		
MGI-2010-MSLA-1	130°14’ 38,37”E 07° 02’ 12,49”S	130°11’ 07,64”E 09° 06’ 22,06”S	230	To cut the Banda dan Timor Trench to Masela Block direction.
	Sept 28, 2010; 23:37 GM	Sept 29, 2010; 04:12 GMT		
MGI-2010-MSLA-2	130°11’ 07,64”E 09° 06’ 22,06”S	130°42’ 15,63”E 08° 50’ 33,14”S	64	At outer of Masela Block to avoid some wells and pountom.
	Sept 30, 2010; 04:31 GMT	Sept 30, 2010; 12:37 GMT		
MGI-2010-MSLA-3	130°42’ 15,63”E 08° 50’ 33,14”S	131°19’ 58,08”E 08° 07’ 56,10”S	105	Parallel with line of pipe from Masela Block to Selaru Island (Tanimbar Islands).
	Sept 30, 2010; 12:56 GMT	Oct 1, 2010; 02:18 GMT		

Exp: SOL=Start of line; EOL=End of line

The total length of geophysical seismic line, sounding and magnet around 399 km: MGI-2010-MSLA-1 (230 km), MGI-2010-MSLA-2 (64 km) and MGI-2010-MSLA-3 (105 km) (Figure 3).

Another method is multichannel seismic survey with some activities like acquisition of seismic data and seismic data processing. The equipments are used the streamer 1350 meters that consist of 108 active channels with space delivers channel 25 meters. Six units field (FDU) is installed in streamer functioned to change signal analog that accepted by hydrophone is digital, so that signal that sent to recording system at geophysics laboratory on RV. Geomarin III is also in digital data.

RESULTS

Sea Bottom Depth

Result of sea bottom depth mapping at study area shows that minimum depth is concentreted at southeast part of Masela Island and maximum depth at northern part of line the MGI-2010-MSLA-1 with 3,125 meters depth and in the trench around 1,400 to 1,600 meters (Figure 4).

(Figures 5 and 6). The minimum depth is approximately 289 meters located in shelf area at southern part of Masela Island. Maximum depth is around 4,892 meters at northern part of line 1 in Banda Sea.

The direction of track lines profile of MGI-2010-MSLA-2 and MGI-2010-MSLA-3, southwest – northeast. Profile of sea bottom depth on track line of MGI-2010-MSLA-2 along 64 km shows that relatively slope to northeast direction with depth ranges from 758 to 946 meters. This track lines does not show undulation form (high) from sea bottom that can be grouped as a flat morphology (Figures 7 and 8). On northeast part of track line of MGI-2010-MSLA-3 along 105 km, it shows sea bottom valley at 946 to 1,605 meter depth. At southern part off Selaru Island, the profile depth of sea bottom forms shelf morphology between 859 and 1,605 meters depth. Tanimbar Trench is characterized by 1,100 to 1,605 meters water depth.

3D Morphology and Seismic Profile

The study area are characterized by relatively shallow water depth (250 to 700 meters) and the deeper water depth (1,400 to 1,605 meters) where the deeper part was recognized as trench morphology.

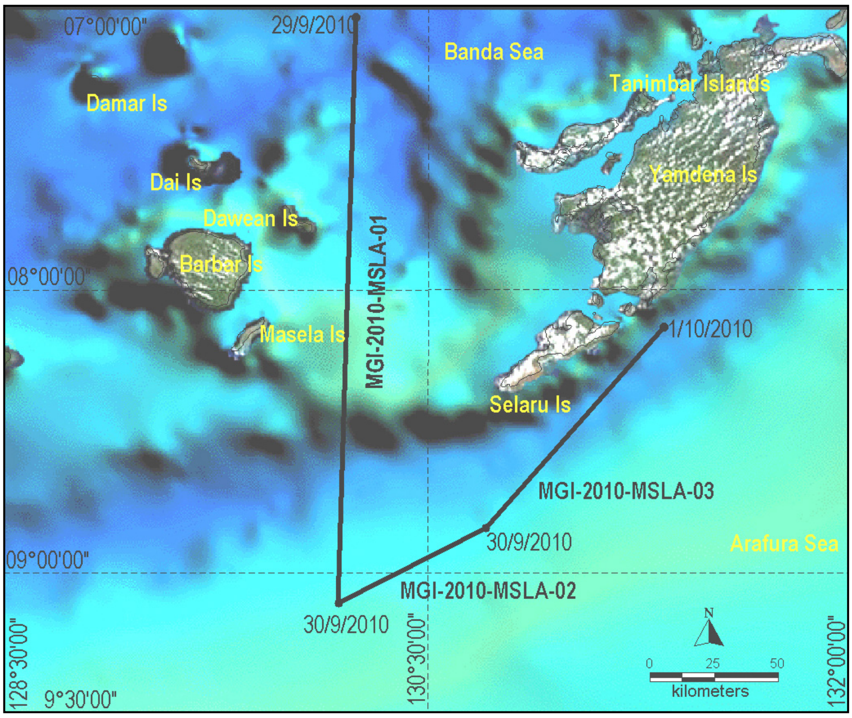

Figure 3. Map of geophysical track lines at study area, Tanimbar Islands.

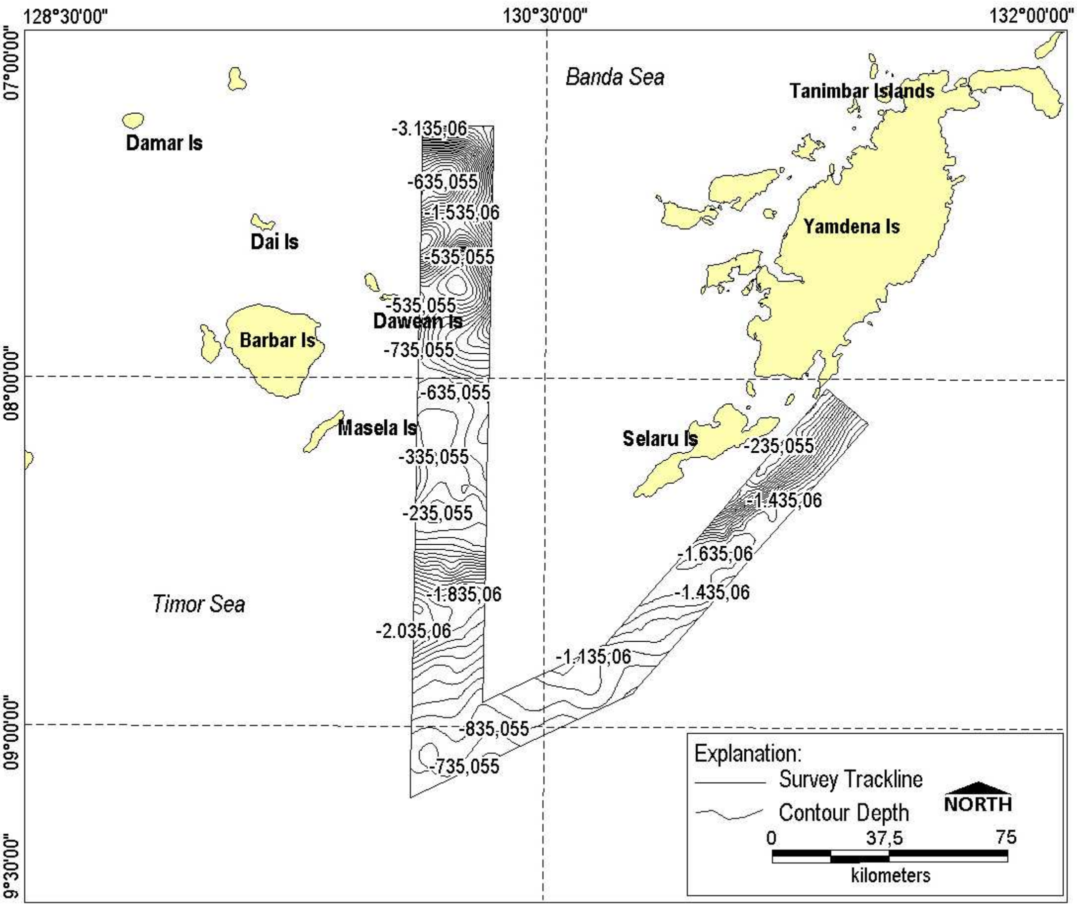

Figure 4. Map of sea bottom depth in the survey track lines and adjacent areas.

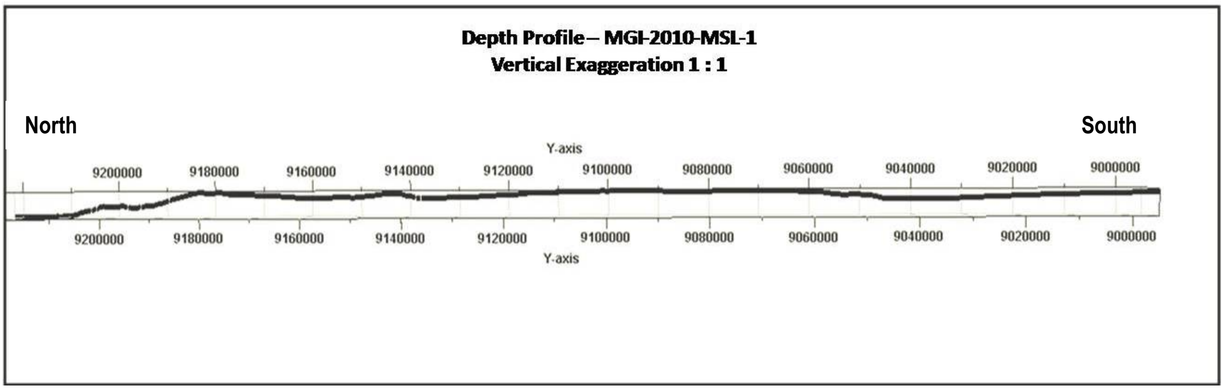

Figure 5. Profile of sea bottom depth of MGI-2010-MSL-1 with scale of vertical exaggeration 1:1

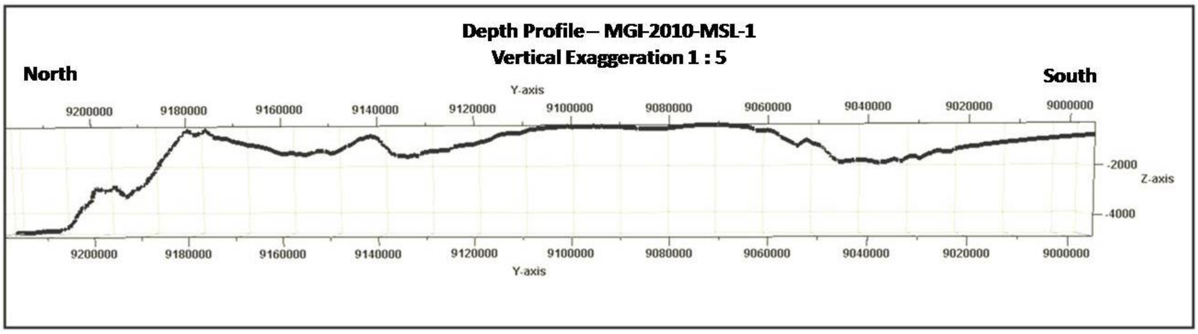

Figure 6. Profile of sea bottom depth at track line of MGI-2010-MSL-1 with scale of vertical exaggeration 1:5

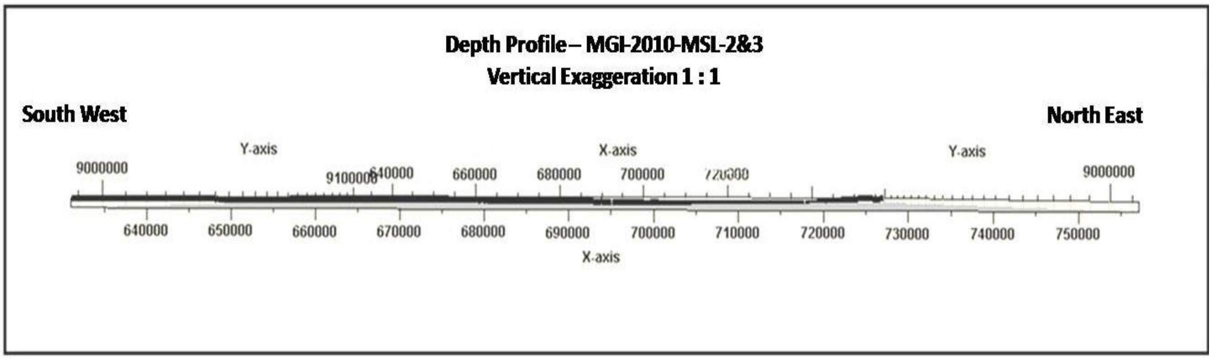

Figure 7. Profile depth of sea bottom depth at track line of MGI-2010-MSL-1 with exaggeration vertical 1:1.

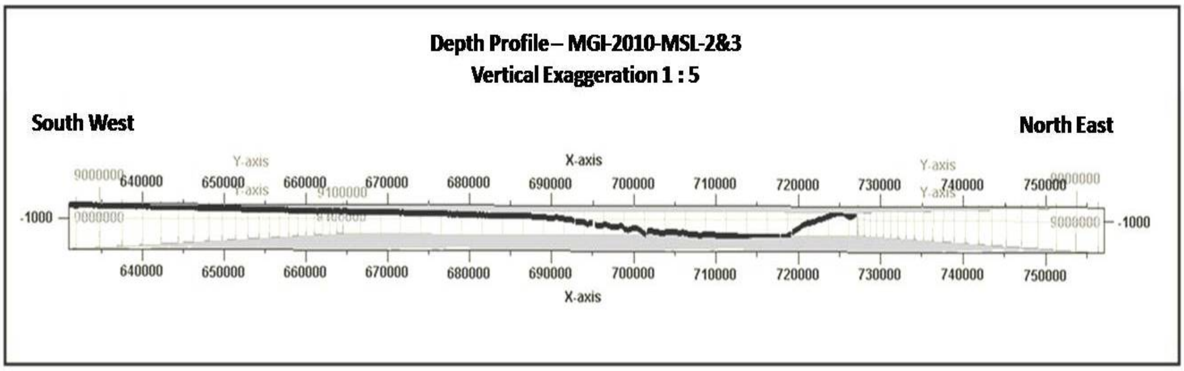

Figure 8. Profile depth of track line of MGI-2010-MSL-2 & 3 with exaggeration vertical 1:5

Bathymetrical data was resulted from analysis of bathymetry modeling that was integrated from bathymetry data, image global and seismic profile (Figure 9).

Generally, the regional morphology can be divided into four groups: accration, trench, undulation and shelf morphology. These morphology is influenced by tectonic activity between Australian Plate that move to the north direction and relativelly stable Eurasia Plate.

The existing islands such as Masela, Selaru and Yamdena Islands morphologycally are classified as accretion zone. These islands are influenced by uplift tectonic from movement of Australian Plate to push the part of Eurasian Plate margin.

Trench morphology is collision zone between Australian and Eurasian Plates. Undulation is caused by some processes such as tectonic, sedimentation and sub marine current. The shelf morphology is located at Masela Block and adjacent areas caused by sedimentation activity from Australian Continent. This shelf morphology is relatively flat with slope less then 8º as a part of Sahul Shelf. The geological condition of Sahul Shelf has samilarity with Sunda Shelf in western Indonesia, forms sediment thickness prospect towards hydrocarbon exploration. According to Honda et al (2006), the Sahul Shelf belongs to the system of Australian-Irian continents that is the extended area of Australian Continent and correlated with Jurassic sediment.

DISCUSSION

Sea bottom depth at Masela Block between 500 and 1,000 meters and trench between 1,400 and 1,600 meters. Basically, regional morphology at the study area can be divided into four groups: accration, trench, undulation and shelf morphogy (Usman et al, 2010).

Trench morphology is narrow valley morphology with west – east direction. This morphology is specific morphology because influenced by tectonic system in Eastern Indonesia. Based on some tectonic models, the

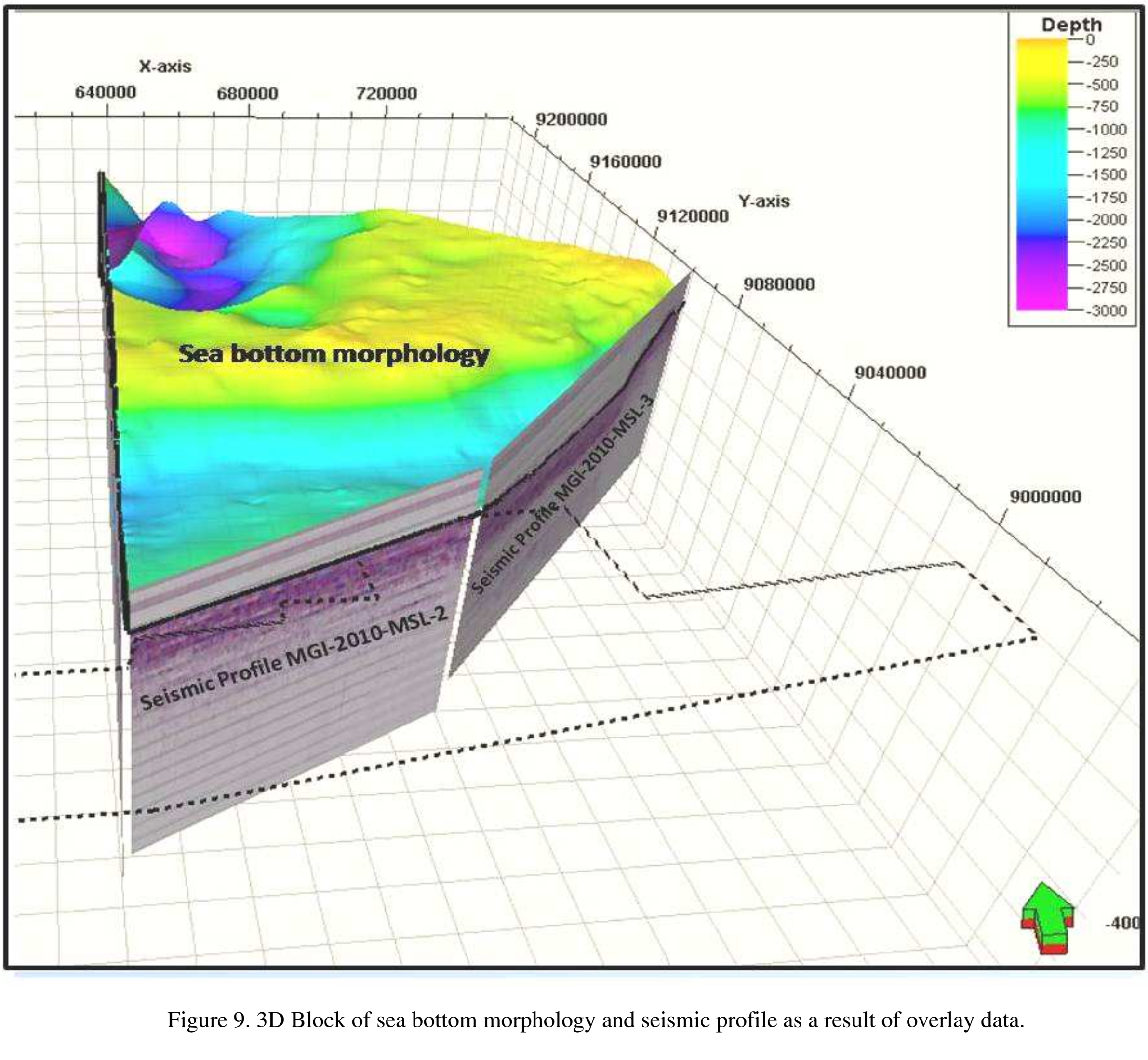

Figure 9. 3D Block of sea bottom morphology and seismic profile as a result of overlay data.

relationship between Australian and Eurasian Plate are influenced by tectonic and morphology at the study area. But, based on seismic interpretation (Usman et al, 2010; Honda et al, 2006), the relationship between both plates are duplex model (Carlton et al, 1991). This model shows the collision system, because both plate are continental type (Australian and Eurasian Continents). Beside that, the meeting both plates causes the formation of shelf system, then called as Sahul Shelf.

The condition of sea bottom profile on trackline of MGI-2010-MSLA-2 and MGI-2010-MSLA-3 showes that morphology generally flat with small slope between 0 – 8 . In the central track line of MGI-2010-MSLA-3 is dominated by flat and undulating morphology. This condition is able to support the stability of pipe line between Masela Block to Selaru and Yamdena Islands. But, the undulating morphology should be paid attention due to its occurence, tectonically can influence the movement of Australian Continent and submarine current.

CONCLUSIONS

The sea bottom morphology in gas pipe laying plan on the sea floor of study area is only influenced by tectonic system of Neogene age. This system is assumed still continuing that can be seen by accretion process which form the islands, undulation at the southern of trench area and trench morphology as collision zone between Australian and Eurasian Plates.

Based on the analysis of profile depth, it can be recognized that the slope of sea bottom ranges between 0 and 8 , therefore it may not influence the future plan of construction and sea bottom gas pipe laying plan as a media for gas distribution from Masela Block to Selaru and Yamdena Islands.

Furthermore, it also can be suggested that the importance of detail study of Neogene tectonic system is required, because Tanimbar Trench is interpreted relatively still move.

AKNOWLEDGEMENT

The authors thank to Head of Marine Geological Institute, Dr. Susilohadi, for his permission and support to publish this paper. Also thank to technicians and crews of the R/V Geomarin III for cooperation during the survey.

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