Shallow Gas Features Based on Interpretation of Bottom Profilling Records at Topang Delta, Meranti Regency, Riau Province

Kenampakan Gas Dangkal dari Hasil Interpretasi Rekaman Penampang Bawah Permukaan Dasar Laut di Delta Topang, Kabupaten Meranti, Provinsi Riau

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ABSTRACT: One of the tasks in conducting a renewable energy research is finding a shallow gas contained commonly in river deltas. The location chosen is in Topang Delta,, Meranti District, Riau Province in 2015. The research was conducted by using sub-bottom profiling (SBP) method. Biogenic gas indications could be observed in the SBP records in the forms of free reflector, acoustic plumes and acoustic blanket. The shallow biogenic gas at research area is trapped in A and B sequences. Sequence A is characterized by plume gas and acoustic blanket, while B-type biogenic gas is showed by free-reflector feature of 10-15 meters depth. Sediment which does not have porocity such as old clay is required environment for anaerobic bacteria as catalyst in the formation of biogenic gas to be evolved. Old clay sediment is potential as a biogenic gas source rock afterwards migrated to a layer of sand as a reservoir rock. Some parts of biogenic gas does not appear to the surface because there have been traped in cap rock in form of young clay sediment.

Keywords: Topang Delta, Biogenic Gas, free reflector, acoustic plumes, acoustic blanket

ABSTRAK: *Salah satu tugas dalam melakukan penelitian energi terbarukan adalah pecarian gas dangkal yang biasa terdapat di delta-delta sungai. Lokasi yang terpilih adalah di delta Topang Kabupaten Kepulauan Meranti, Provinsi Riau pada tahun 2015. Penelitian yang dilakukan salah satunya menggunakan metoda sub bottom profilling (SBP). Indikasi gas biogenik tampak dalam rekaman subbottom profilling berupa reflektor bebas pantul, terobosan gas dan selimut akustik. Keterdapatan gas biogenik dangkal di lokasi penelitian terjebak dalam sekuen sedimen A dan B. Sekuen A dicirikan dengan kenampakan berupa terobosan gas dan selimut akustik, sedangkan biogenik gas tipe-B dicirikan dengan kehadiran reflektor bebas pantul* dengan ketebalan 10-15 meter. *Sedimen yang tidak memiliki porositas seperti lempung tua merupakan lingkungan yang dimungkinkan untuk bakteri anaerobik sebagai katalisator dalam pembentukan gas biogenik. Endapan lempung tua berpotensi sebagai batuan sumber biogenik gas kemudian bermigrasi ke lapisan sedimen pasir sebagai tempat tersimpannya gas biogenik. Sebagian gas biogenik tidak dapat muncul ke permukaan hingga lapisan atas karena terjebak dalam lapisan sedimen penutup berupa lempung muda.*

Kata Kunci : *Delta Topang, Gas Biogenik, bebas pantul, terobosan gas, selimut akustik*

INTRODUCTION

The occurrence of shallow gas in seabed sediment was recognized for a long time. Schuller (1952) was the first person to identify an effect on echosounder record on seabed sediment called “basin effect”. Gas on marine sediment first reported by Emery and Hoggan (1958). Many researchers reported the occurrence of methane and other gases near seabed sediment. The purpose of this article is to give description of the occurrence of biogenic gas in seabed sediment based on sub-bottom profiling record analyses. Research area is located at Delta Topang Island, Meranti Regency, Riau Province (Figure 1).

Topang Delta

River mouth might be a place where sediment accumulation were brought down by the stream to the sea or lake forming sediment body. Delta forms and facieses mostly influenced by material size and river debit, which also connected to wave energy, longshore drift, and tide current. Grain size from sediment was also influenced by water depth which varied from mud to gravel sizes. Delta can be defined as beach formed features where river sediment enters sea water or other watery body (Elliott 1986; Bhattacharya & Walker 1992). Delta generally could be classified based on dominant grain size and dominant influence processes

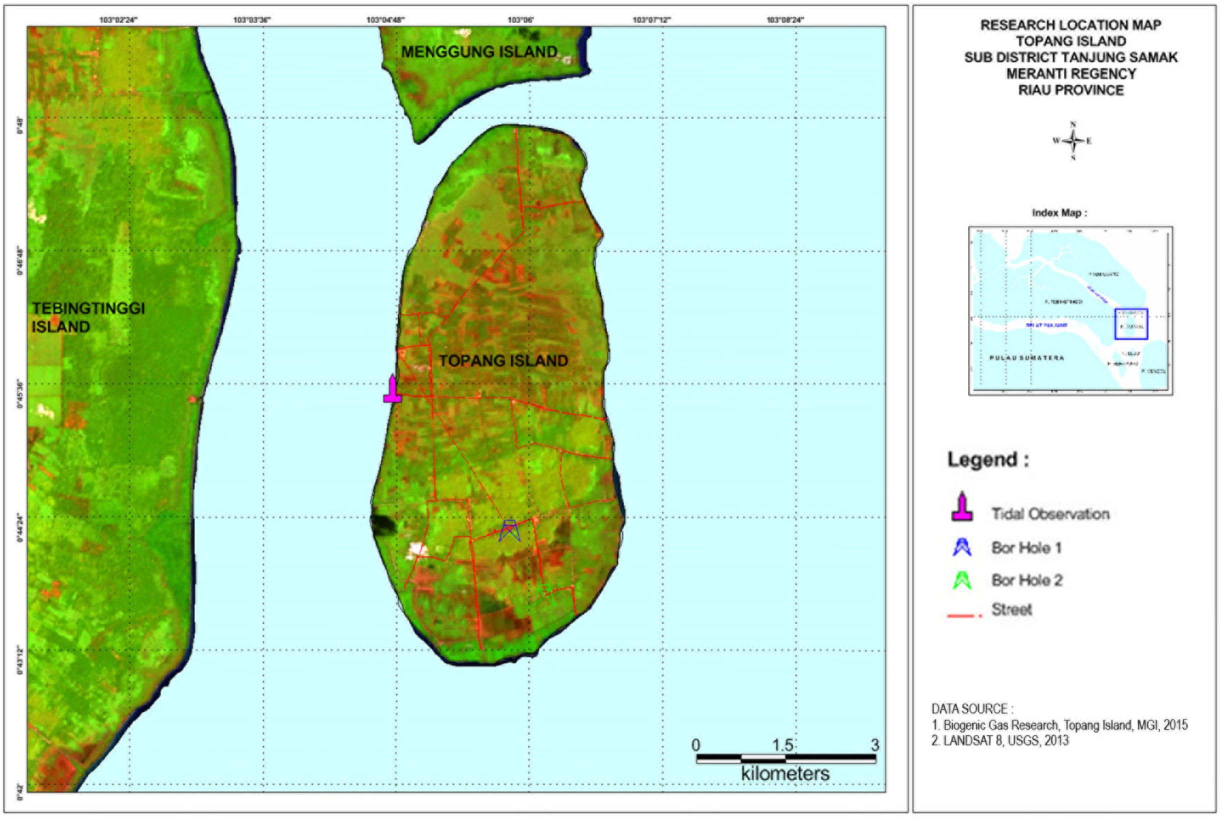

Figure 1. Study Area Location Map (Raharjo et al., 2015)

of fluvial, wave and tide (Figure.2, modified from Orton & Reading 1993). The scheme can be applied in modern delta and useful because delta sediment characteristics in the scheme can be used as basic to classify a strata called delta facies.

Each delta has different variables in size, process, and its natural sediment. River stream patterns gives sediment supply to lake or sea, forming sediment body in tens to hundreds meters size, where the largest delta reaches thousands of square kilometers. Delta type or form was influenced by three important factors which are river process, wave action, and tide (Figure 3).

Topang Delta was formed in Kampar River delta in northeastern coast of Sumatera. The delta was formed in the end of Holocene transgression. In delta formation, morphology patterns will develop as different sedimentary products. Delta morphology components are delta plain, delta front, and prodelta. From the Figure 3 Topang Delta was classified into a tide-dominated delta.

Delta morphology components such as delta plain, delta front, and pro-delta are occurred in the study area.

Research area in Topang Delta is a low level swamp area influenced by sea tide at the periphery of the island, while the middle part of the island has shallow ground water level. The characteristic of surface sediments are mud sediment contain remains of swamp plants, dead plant's roots and stem; and clay. Surface mud are wet in several places, dominated by sea

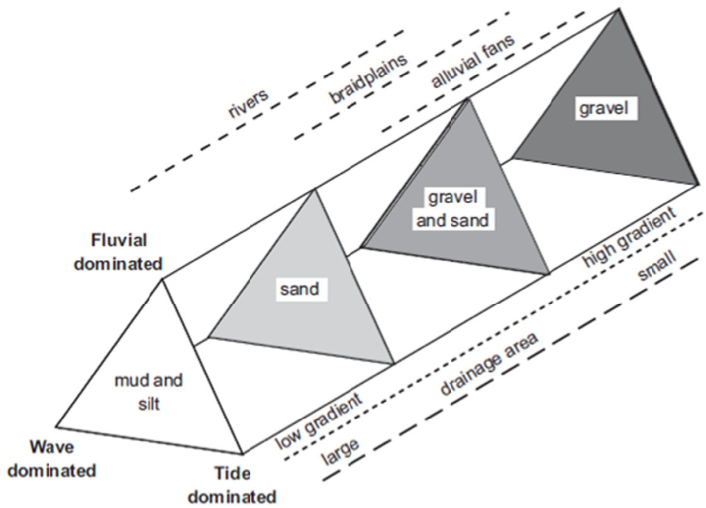

Figure 2. Classification of deltas involving grain size, and hence sediment supply mechanism, into account. (Modified from Orton & Reading 1993.)

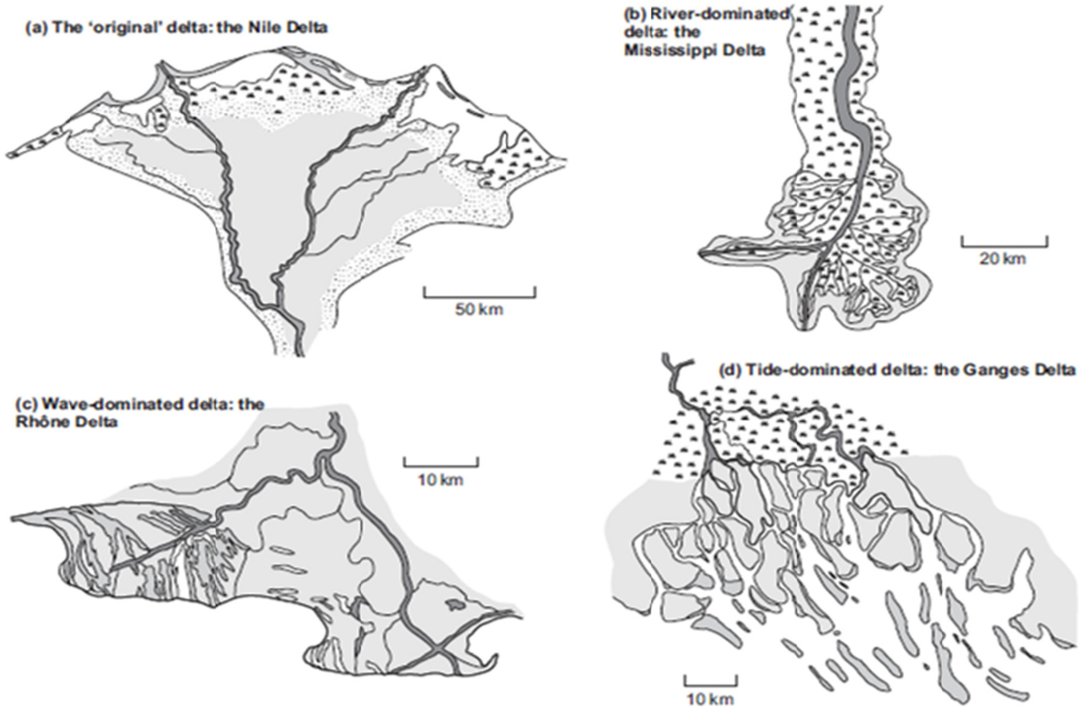

Figure. 3. The forms of modern deltas: (a) the Nile delta, the 'original' delta, (b) the Mississippi delta, a river-dominated delta, (c) the Rhone delta, a wave-dominated delta, (d) the Ganges delta, a tide-dominated delta. (Nichols Gary, 2009).

water. There was no outcrop found in research area, surfaces were covered by soil and swamp sediments. Morphology is a plain with elevation between 0-2 m asl (above sea level) and small river streams in several places rivermouthed around Topang Delta. The biogenic gas researched had been conducted in the surrounding sea around Topang Delta (Raharjo et al., 2015). Biogenic gas generally is dominated by methane (CH4) which has carbon chain shortest is known as alternatives energy (Rice, 1993).

Biogenic gas occurrence variation can be classified by sub-bottom profiling characters into: (1) Acoustic blanket, (2) Acoustic curtains, (3) Acoustic columns and (4) Acoustic turbidity (Taylor, 1992).

METHODS

Positioning tools are GPS *Trimble/DSM-212* H with signal receiver antenna, and GPS connected to navigational system with SEATRAC software, Toshiba T-1850 notebook, and 1 unit of 368 SX signal receiver antenna.

In this research data acquisition was done using sub-bottom profiling methods. Sub bottom profiling device used is ODEC, 10 kHz. This method sends sound wave pulses from sea water surface vertically by a transducer to the bottom of the sea. Reflected sound waves are received by transducer and recorded by Strata box PC software. The image of sediments are shown by difference in absorption by each sediment layer of sea bottom.

The types of gas features can also be classified into (Taylor, 1992) :

1. Acoustic plumes : gas appears above seabed sediment surface, can reach 15 meters in water column, accumulation recognized through high-amplitude, parabolic reflection with interval frequency along seismic line able to reach 100-200 m.
2. Cloudy turbidity : detected through sub-bottom profilling uniboom and echosounder records. Appearance without geometry like layers and cuts but always connected to gas accumulation in sediment layers.
3. Pock marks : represents morphology caused by fluid events breaching seabed surface. The appearance usually recorded in side scan sonar as black dots and in echosounder as depression in V letter form.

Sub bottom profiling records are divided into series. Boundary sequences have to be found, which might appear as on lap, erosional truncation, and deep assertive and continuous reflection (Ringis, 1986).

RESULTS

Gas accumulation in water area of Topang Delta can be classified into several types. The appearance can be distinguished from sub-bottom profiling records into biogenic gas distribution map. For scientific purposes, acquisition survey lines of sub bottom profiling have been presented (Figure. 4). Sub Bottom Profiling can penetrate shallow depth with high resolution in about 20 meters below the sea bed. The result is that sediments are identified charged with gas (Figure. 5). The record shows gas distribution in marine sediment upward to Holocene. Sediment patterns have been identified as west-east directional layer continuity.

On the Line 18C, 19E and 07A, the sediment separated into sequence A and sequence B. The emergence of gas seen in SBP recording are gas charged sediment (acoustic plumes) penetrates in to sequence B and gas blanked in the boundary of sequence A and sequence B. At below of sequence A from the sub bottom profilling recording is shown by a free reflector. On the Line 30B, the sediment separated into sequence A and sequence B. The emergence of gas seen in sub bottom profilling recording are gas charged sediment (acoustic plumes) penetrates into sequence B. Gas blanket in the boundary of sequence A and sequence B do not seem so clearly because reflector apparent on the sequence A.

In sub bottom profilling data, gas-charged sediments are indicated by 0,5 to 3 meters depth on the profiles as a dark refection in series A and B. Gas-charged distribution in research area can be divided in two types :

1. A-Type gas charged sediment trapped in sequence A. Lines with this condition can be seen on Table 1. It can be seen gas blanked in the study areas only covered by a layer of mud dominated with very fine sediment, the thickness ranged from 0.5 meters up to 3 meters. The mud would serve as a cover that is impermeable (very low porosity) so that biogenic gas does not come out from sub suface sediment. Biogenic gas was formed in sequence A. Examples of sub bottom profilling records of type A gas charged sediments can be seen in Figure 6 and Figure 7.
2. B-Type gas charged sediments are breached sequences A which trapped in sequence B and covered by delicate mud layers. Biogenic gas type B is a gas charged sediment derived from sequence A and appearing up to sequence B. The sub bottom profiling record was that gas dispersed in marine sediment until upward. The sediment pattern has been identified with the tendency of layers that insistent east-west direction. Lines with this condition can be seen on Table 2. Examples of strata box record of type B gas charged can be seen in Figure 8, Figure 9, and Figure 10.

In the biogenic gas distribution map (Figure 11) can be seen that the indication of biogenic gas which

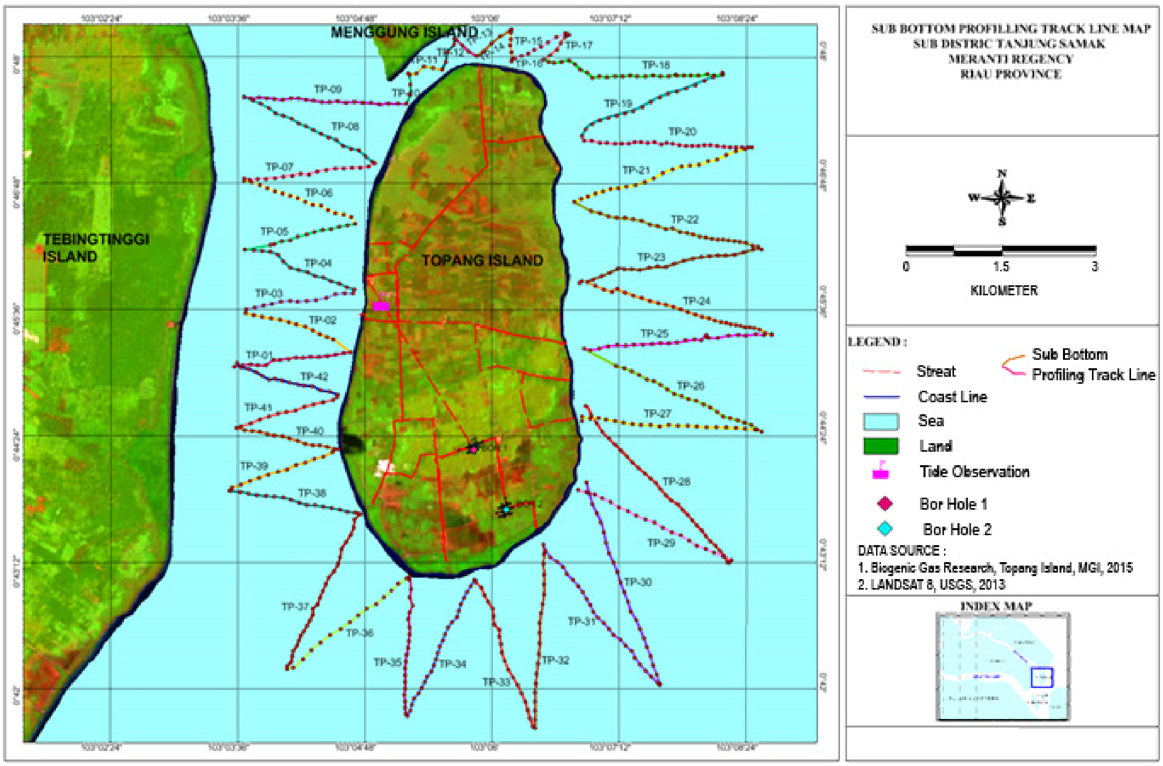

Fig 4. Sub Bottom Profilling Track Line Map (Raharjo et al., 2015)

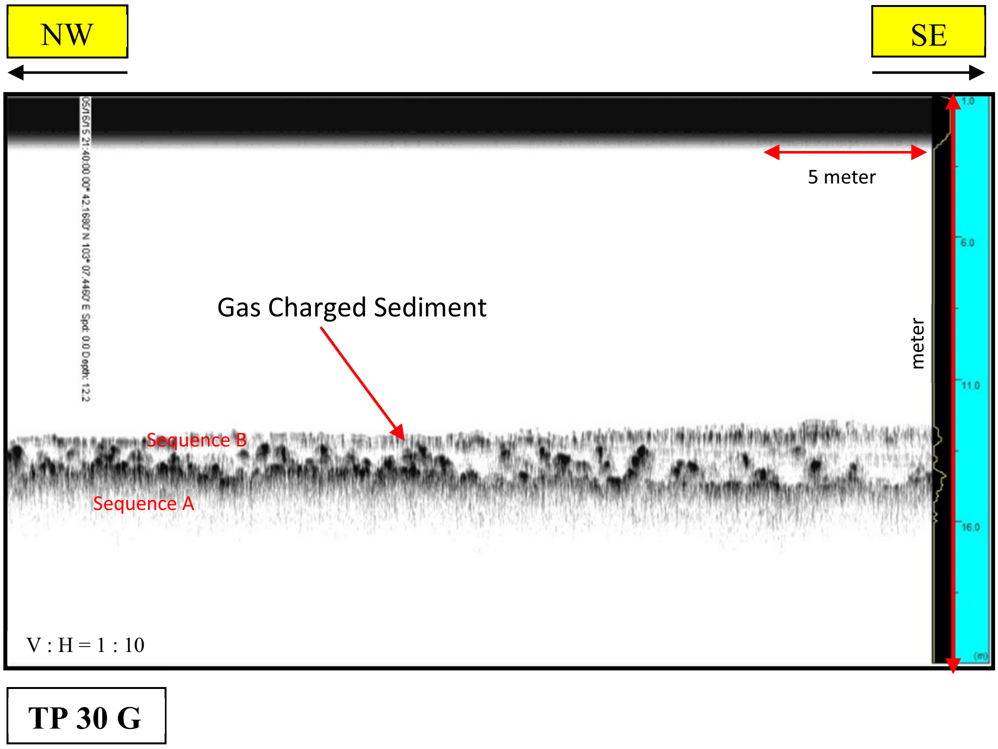

Figure 5. Appearance of gas charged sediment in sub bottom profiling record (Raharjo et al., 2015)

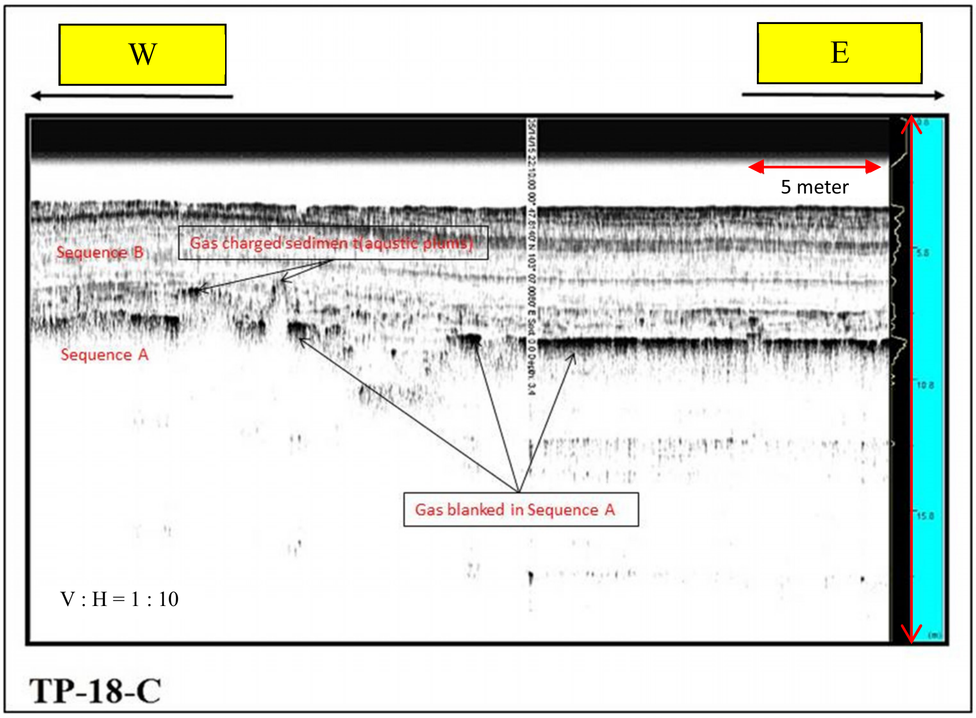

Figure 6. Appearance of A type acoustic plumes in line TP-18-C (Raharjo et al., 2015)

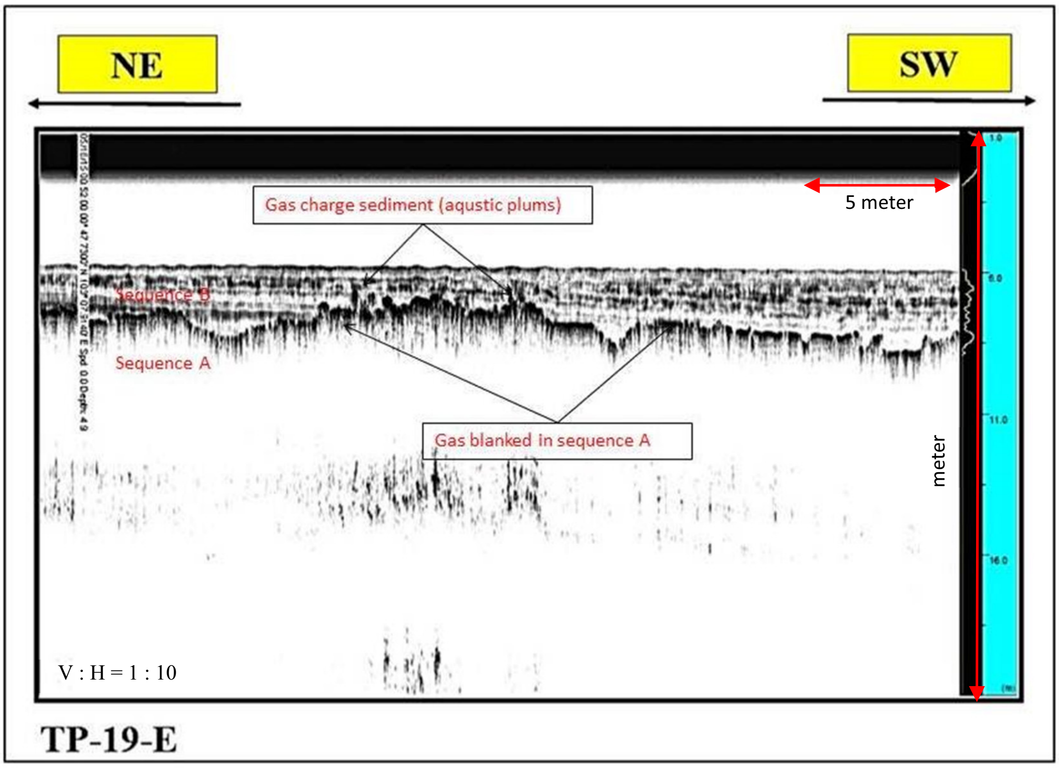

Figure 7. Appearance of type A acoustic plumes in line TP-19-E (Raharjo et al., 2015)

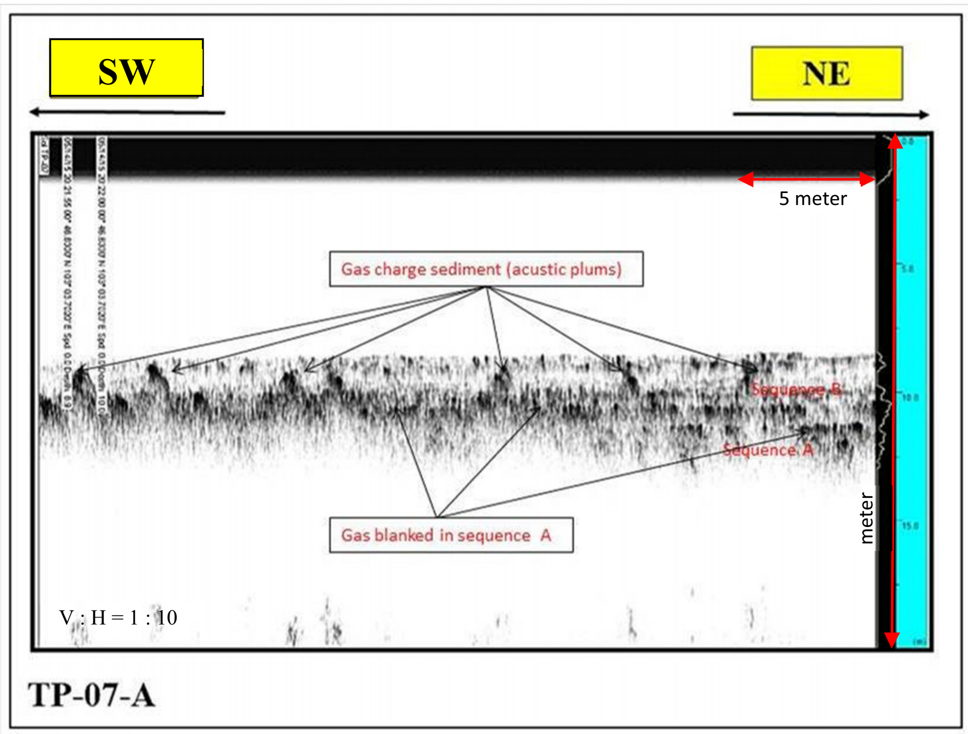

Figure 8. Appearance of Type B acoustic plumes in line TP-07-A (Raharjo et al., 2015)

Table 1. SBP Lines with A type gas charge

TP-01-A	TP-24-A	TP-28-C	TP-34-H
TP-08-A	TP-25-A	TP-28-D	TP-34-I
TP-09-A	TP-25-B	TP-31-G	TP-34-K
TP-17-A	TP-25-C	TP-31-L	TP-34-L
TP-18-C	TP-25-D	TP-32-G	TP-36-A
TP-19-E	TP-25-F	TP-33-A	TP-37-A
TP-20-A	TP-26-A	TP-33-C	TP-38-B
TP-23-B	TP-26-B	TP-34-D	TP-39-C
TP-23-D	TP-27-A	TP-34-E	TP-42-C

Table 2. SBP Lines with B-type Gas Charged Sediment

TP-02-A	TP-18-A	TP-21-F	TP-30-D	TP-32-H
TP-03-A	TP-18-B	TP-21-G	TP-30-E	TP-32-I
TP-04-A	TP-18-D	TP-22-B	TP-30-F	TP-33-B
TP-04-B	TP-18-E	TP-22-D	TP-30-G	TP-33-D
TP-04-C	TP-19-A	TP-22-A	TP-30-H	TP-33-E
TP-04-D	TP-19-B	TP-22-C	TP-30-I	TP-33-F
TP-05-A	TP-19-C	TP-23-A	TP-31-A	TP-34-A
TP-05-B	TP-19-D	TP-23-C	TP-31-B	TP-34-B
TP-06-A	TP-20-B	TP-24-B	TP-31-C	TP-34-C
TP-06-C	TP-20-C	TP-24-C	TP-31-D	TP-34-J
TP-06-D	TP-20-D	TP-24-D	TP-31-E	TP-37-B
TP-06-E	TP-20-F	TP-25-E	TP-31-F	TP-37-C
TP-07-A	TP-20-G	TP-26-C	TP-31-H	TP-39-A
TP-07-B	TP-20-H	TP-26-D	TP-31-I	TP-39-B
TP-07-C	TP-20-I	TP-26-F	TP-31-J	TP-39-D
TP-07-D	TP-20-J	TP-28-A	TP-31-K	TP-39-E
TP-08-B	TP-20-K	TP-28-B	TP-32-A	TP-40-A
TP-08-C	TP-21-A	TP-28-E	TP-32-B	TP-40-B
TP-08-D	TP-21-B	TP-28-G	TP-32-C	TP-42-A
TP-08-E	TP-21-C	TP-30-A	TP-32-D	TP-42-B
TP-09-A	TP-21-D	TP-30-B	TP-32-E	
TP-09-B	TP-21-E	TP-30-C	TP-32-F	

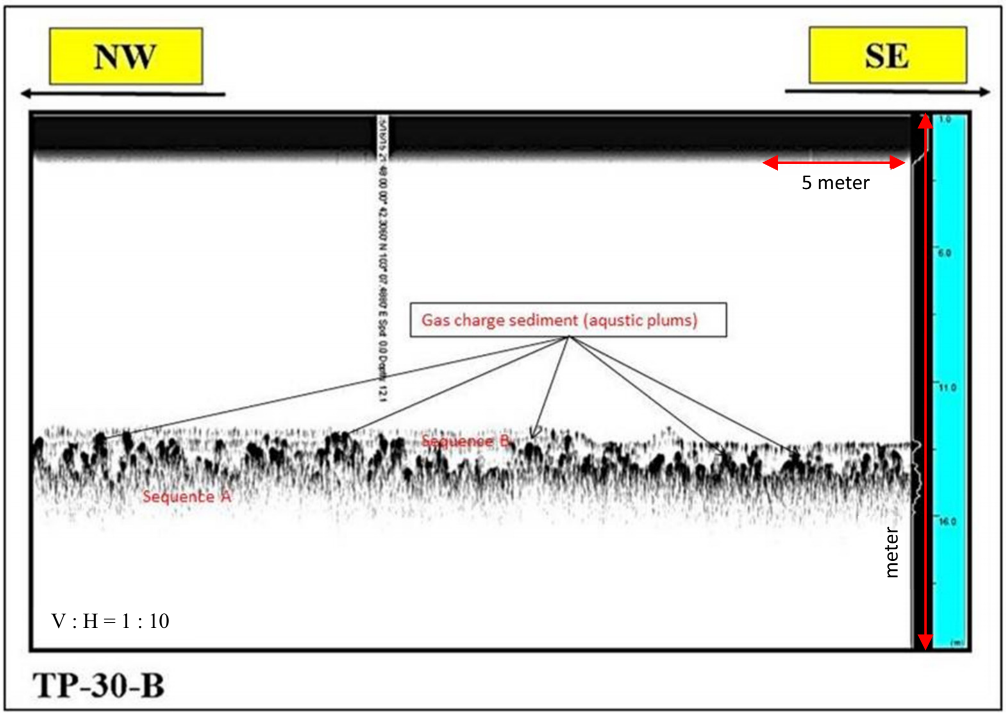

Figure 9. Appearance of B-type acostic plumes in line TP-30-B (Raharjo et al., 2015)

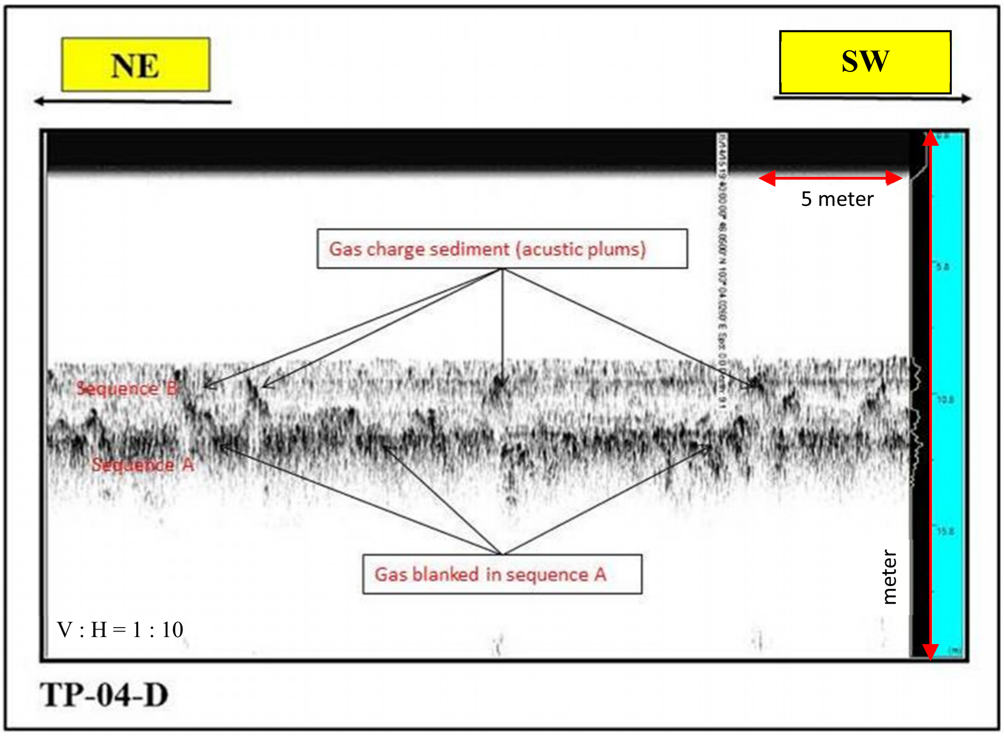

Figure 10. Appearance of Type B acoustic plumes in line TP-04-D (Raharjo et al., 2015)

mostly wide spread at north east (NE) and south east (SE) of Topang island. It shows that parts of east-south island having an indication biogenic gas the most form in sediment which contain abundantly organic material. In the west part of Topang Island biogenic gas indication was only a few, due to lower organic content in that part.

Data processing and analysis on sub bottom profiling records get two gas distribution characters as mentioned above, it is known that gas charged distribution in site only covered by mud layers with delicate thickness between 0.5 meters to 3 meters. Mud layers works as tight closure (low porosity) to prevent biogenic gas to escape subsurface sediment layer. It is assumed that biogenic gas was formed in sequence A and trapped in sequence B. Records show that gas was distributed in marine sediments upward to Holocene sediment.

Data processing of 42 strata box records give 144 points of coordinate contains biogenic gas indication and distributed gas charged sediment around Topang Delta. Based on the distributed 144 points, biogenic gas distribution indication in Topang Delta can be known from interpretation of point connecting in line. Data are presented in gas distribution map (Figure. 11). Map shows indications of biogenic gas occurrence mostly in northeast (NE) and southeast (SE) of Topang Island. Based on these results, it is assumed that southeast of Topang Delta which have most indications of biogenic gas occurrence mostly covered by sedimentary layers contain dominant organic materials. Few gas indications on the west side of Topang Delta; it is probably due to lower organic content in sedimentary layers.

DISCUSSIONS

Based on the biogenic gas distribution map, the gas are dominant in eastern and southeast of Topang Delta. Topang Delta well developped from west to east, so, the easten and southeasternparts belongs to their delta front (Figure 11). The most sediment supply for biogenic gas formation in the study area was derived from Rangsang Island located in the north of Topang Delta. Sequence A is an acoustic basement or the deepest sequence that is unpenetrable by the equipment of sub bottom profiling. Sequence B having a thickness range between 3 and 5 meters and is the youngest sequence where the sedimentation process is still ongoing until now. The SBP records showed that they are two types of gas accumulation at the sediment those are trapped and those are not penetrated to the surface. The records show configuration of free reflector,

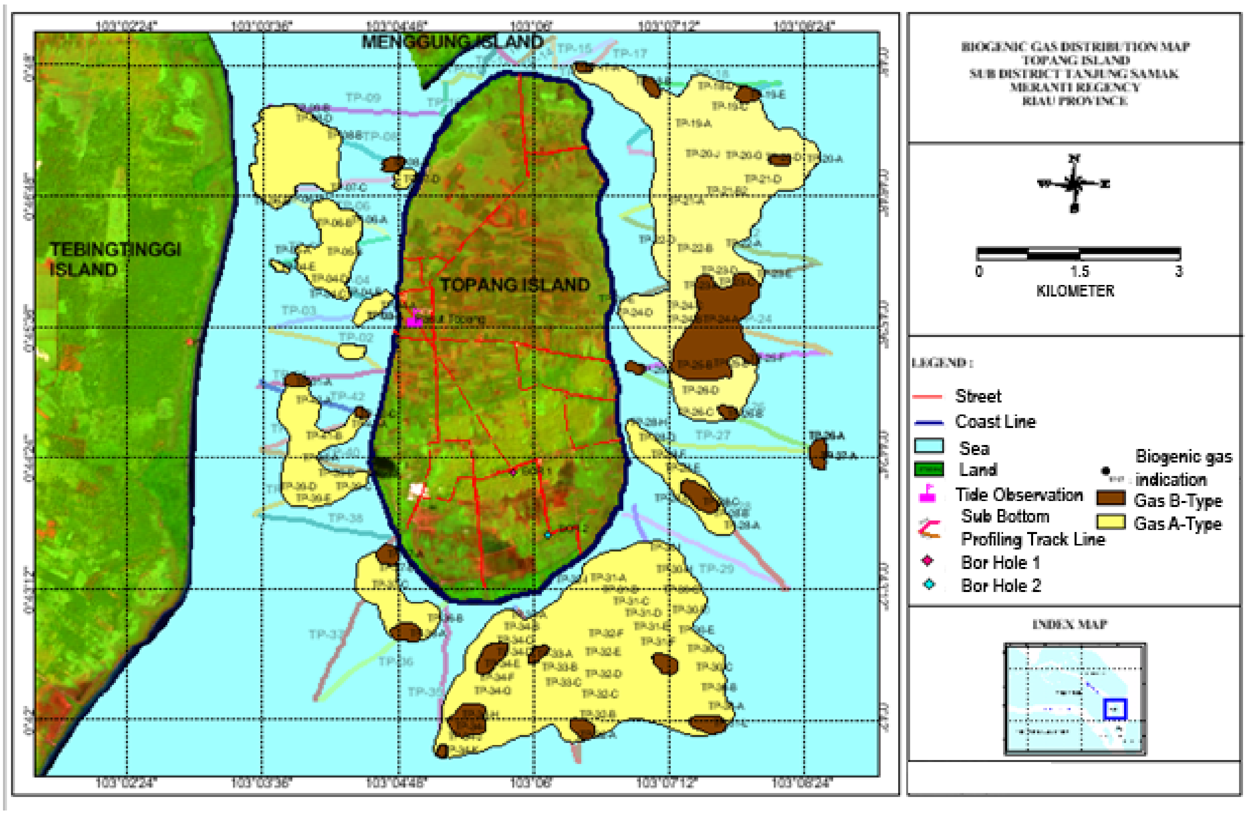

Figure 11. Biogenic Gas Distribution Map in Topang Island waters (Raharjo et al., 2015)

homogeneous and not stratified; while The others is free rfelector characterized by the presence of configuration with very low amplitude and continuity. The configuration of this pattern could be interpreted as mud and silt layers. Each delta is not pure produced by one factor but control by fluvial, tidal and wave rather is the result of an interaction between two or even three factors control (Galloway, 1975). The stratigraphy at study areas base one drilling data composed of sand sediment, old clay, silt and yong clay which sedimented in Qurternery. Sediment which does not have porosity such as clay is required environment for anaerobic bacteria as catalyst in the formation of biogenic gas to be evolved. Old clay sediment is potential as a biogenic gas source rock afterwards migrated to a layer of sand as a reservoir rock. Some parts of biogenic gas does not appear to the surface because there have been trapped in form of young clay sediment (Raharjo et all., 2015). Biogenic gas can be formed well in north east and north west study area becouse accessible source rock, reservoir rock dan cap rock.

CONCLUSIONS

Morphologically, Topang Delta is a delta formed by the interaction of fluvial and tidal processes. The results of SBP record is interpreted as a distribution of biogenic gas A-type is more extent than B-type. Biogenic gas A-type unable to penetrate to sequence B, due to covered by the inpermeable sediment. Based on SBP records, sediment of the seabed are distinguished into two sequences, namely the sequence A in the bottom and overlaid by sequence B of 10 to 15 meters thick as acoustic plumes or gas charged sediment. Acoustic blanket can be seen as the black zone at the boundary between sequence A and B. Undifferentiated reflectors is the visibility without configuration reflectors because waves energy absorbed by sediment layers containing the gas or organic material.

Sequence B having a thickness range between 3 and 5 meters and is the youngest sequence where the sedimentation process is still ongoing until now. Gas distribution characters as is known that gas charged distribution in site only covered by mud layers. Mud layers works as tight closure (low porosity) to prevent biogenic gas to escape subsurface sediment layer. It is assumed that biogenic gas was formed in sequence A and trapped in sequence B. Records show that gas was distributed in marine sediments upward to Holocene sediment.

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