**Bulletin of Scientific Contribution**
**GEOLOGY**

**Fakultas Teknik Geologi**
**UNIVERSITAS PADJADJARAN**
homepage: http://jurnal.unpad.ac.id/bsc
**p-ISSN: 1693-4873; e-ISSN: 2541-514X**

**Volume 19, No.2**
**Agustus 2021**

# MAPPING CHANNEL DISTRIBUTION BASED ON SEISMIC AND WELL DATA IN WEST NATUNA

**Alma Ikramina*, Iyan Haryanto dan Abdurrokhim**
Faculty of Geological Engineering Padjadjaran University Indonesia
*Corresponding : Almaikraa@gmail.com

***ABSTRACK***
*Natuna is one of the regions in Indonesia that has potential in hydrocarbon with a siliciclastic reservoir which is generally characterized by a fluvial and deltaic environment. For this reason, it is important to identify the distribution channel to find out the distribution of the reservoir. This study using the well-logging and 3D seismic data interpretation methods. With the correlation between the horizon slicing method on seimsic data, lithology identification in well data, and also using seismic attributes, we can determine the distribution of reservoirs. In reseach area, reservoir distribution analysis in Arang and Muda Formation. Where Arang Formation identified 4 reservoirs, which 3 of them have oil content, with effective porosity value of 10-30%. Meanwhile, in Muda Formation, there are 3 reservoirs with effective porosity of Muda Formation is 20-27%.*
***Keywords**: Natuna, Reservoir, Channel*

**ABSTRAK**
Natuna merupakan salah satu daerah di Indonesia yang berpotensi memiliki hidrokarbon dengan reservoar silisiklastik yang umumnya dicirikan dengan lingkungan *fluvial* dan delta. Untuk itu pentingnya mengidentifikasi sebaran distribusi *channel* untuk mengetahui sebaran dari reservoar. Hal ini dilakukan dengan metode interpretasi data *well-logging* dan seismik 3D. Dengan korelasi antara metode *horizon slicing* pada data seimsik, identifikasi litologi pada data sumur, dan juga menggunakan atribut seismik kita dapat mengetahui peserbaran reservoar. Pada daerah penelitian, pesebaran reservoar berada pada Formasi Arang dan Muda. Dimana Formasi Arang memiliki 4 sebaran reservoar dengan 3 diantaranya terbukti terdapat kandungan minyak dengan porositas efektif sekitar 10-30%. Sementara Formasi Muda terdapat 3 reservoar dengan porositas efektif 20-27%.
**Kata Kunci**: Natuna, Reservoar, *Channel*

## Introduction

Siliclastic rock reservoirs in western Indonesia are generally characterized by rocks deposited in fluvial and deltaic environments (South Sumatra, Central Sumatra, Natuna, etc.). Channel deposition is very important because it is one of the important components in the petroleum system, namely the reservoir.

In West Natuna, siliciclastic reservoirs are found in Belut Formation, Gabus Formation, and Arang Formation. Thus, identifying and mapping distribution of these channels is very important. This study was conducted in the West Natuna Basin at Arang Formation and Muda Formation intervals. Although in Muda Formation does not find hydrocarbons, studying the method and distribution pattern of this channel is still very important and interesting.

In general, tectonostratigraphy in West Natuna Basin is divided into several phases, first: pre rifting phase at pre-tertiary, it is base formation of Natuna Basin. Then syn-rifting phase, due to collision between India and Asia (Tapponier, et al., 1982; op cit. Wongsosantiko and Wirojudo, 1984) at the early oligocene – late eosin. This caused the Natuna Basin became extensional and produce normal faults and half grabens which were followed by the deposition of Belut Formation and Lower Gabus Formation.

In post-rifting phase, basin experienced a saging face at the beginning at early miocene-late oligocene, where the sediment deposition did not change in thickness which was followed by deposition of Barat Formation, Udang Formation and Upper Gabus Formation. After that, syn-inversion

phase was due to the movement of Indochina block to
Sunda Shelf (Hamilton, 1979) in earlymiddle miocene which caused basin got compression and resulted structural reversal from normal fault to reverse faults, and the formation of anticlines followed by deposition of Arang Formation. The main structure in this basin has a general orientation of direction southwest-northeast (SWNE). And the latter at late miocenequaternary tectonic is relatively calm followed by deposition of Muda Formation.

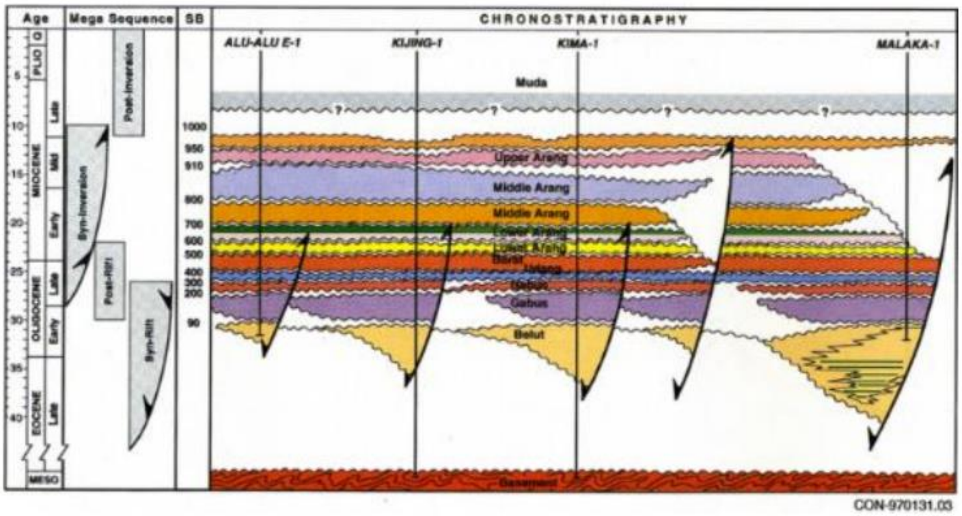
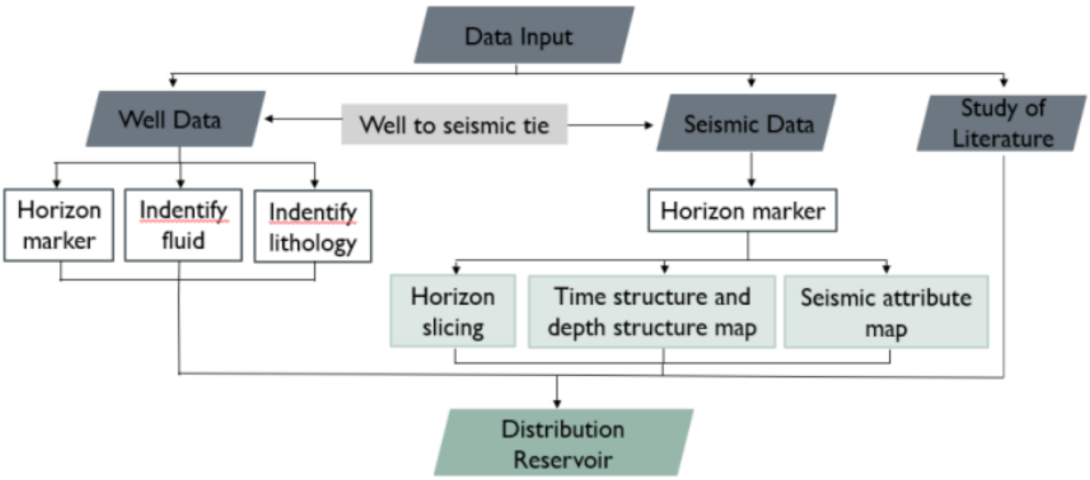



**Figure 1.** Tectonostratigraphy West Natuna Basin (Sandra Phillips,1997)

**Methodology**
In this research, the data used includes one well data and cutting data at Arang and Muda Formation intervals as well as 3D seismic data. First, well data is used to interpret lithology and relative age, then we identify fluid in the rock (an indication of hydrocarbons or water) which is then validated with density log and neutron log by looking at the cross over formed from these two logs. Also we have to take a look from resistivity log data.
After that, do well to seismic tie with checkshoot data. Then on the seismic data, the horizon marker is drawn and horizon slicing is carried out on each horizon marker made. Then making a seismic map attribute (minimum amplitude attribute), and a cross plot between acoustic impedance and effective porosity. Where the amplitude is the result of the reflection coefficient with wavelet which becomes a wiggle seiscmic. Reflection coefficient is a function of acoustic impedance itself, so the relationship between acoustic impedance and amplitude has a proportional relationship, and amplitude value with porosity is inversely proportional.




Based on cutting data that is correlated with well data, it can be interpreted that there are 2 formations in research area. In cutting data, it is given that formation boundary is at a depth of 2850 feet and well data is marked by a change in deposition as shown in Figure 2.
From cutting data, Arang Formation is dominated by interbedded claystone and

sandstones. With sandstones having a light gray color, medium to coarse grain size, porosity is poorgood, non calcareous. Claystone has a brownish gray color, has a waxy surface structure, has traces of carbonaceous in some parts, and non calcareous. There are coal deposits at several intervals. Structure of waxy surfaces and carbonaceous sediments is formed due to the presence of high level plants. Where it is in terrestrial environment. Then, this condition is reinforced by the presence of coal deposits which usually characterize the swamp environment, in terrestrial environment.

Muda Formation has dominated by claystone with thin sandstone inserts. Claystone has a light-medium gray color. There are traces of forams, having 0 to slightly calcareous. With sandstones having light ash, the size of the sand is fine-very fine. Structure is fining upward. According to Darrin Burton and Lesli J. Wood (2010), Muda
Formation is influenced by transgression and regression processes, which are predicted to have a transitional depositional environment. With cutting description as above, we can conclude that Muda Formation was indeed deposited under the influence of marine sediment.

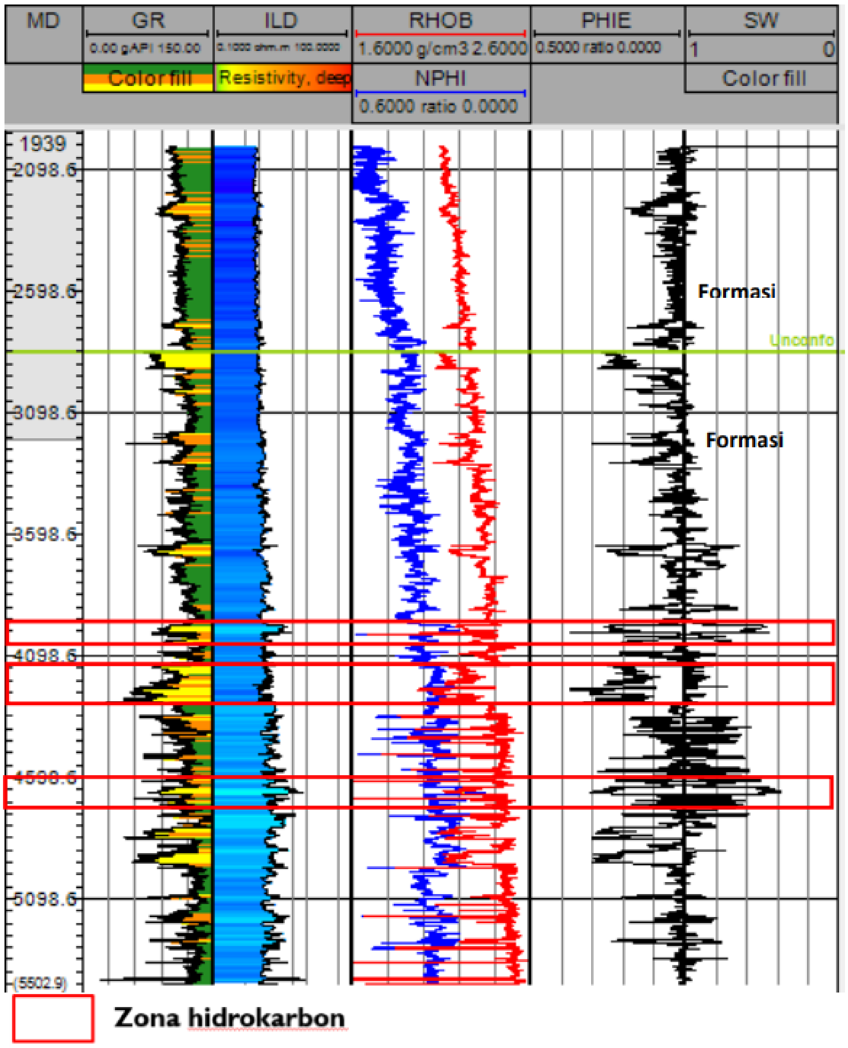



**Figure 2**. Well Data in research area

2. Seismic Data

Seismic data measuring 9 km x 8 km. Where authors interpreted there were 10 horizon markers based on the clearest seismic appearance, presence of feature channels that were tried to be observed, and also reservoir zones and hydrocarbons that were trying to be further identified. However, there are only 7 geometries that have clear and explainable shapes.

<u>ARANG FORMATION</u>

In Arang Formation, 4 channel geometries are found as shown in Figure 3, the left channel is older than the right channel. Where in this formation has a fluvial depositional facies with a relatively northwest - southeast depositional trend.

A. Channel 7

This channel is sliced 18 ms below horizon marker 9. The results of this slicing show the sandstone lithology in the well data. Seismic attribute shows that the yellow-purple (highlight) part has a lower amplitude value than the gray part. And when viewed from cross plot, the highlight part has a higher porosity value than the gray part. According to geological model from R. Smith (1987) and Marinus E. Donselaar and Irina Overeem (2008), channel geometry is a meandering channel morphology where the highlight attribute part is sandstone deposits from the point bar. With an effective porosity value of 0.15-0.28, which there is oil content in this section from cross over density log and neutron log.

B. Channel 6

Channel is sliced 24 ms below horizon marker 8. Where slicing results coincide with sandstone lithology in well data. Attribute colour of the bluepurple (highlight) part has a smaller amplitude than the gray part, which means that part has a higher porosity than the gray part.

Channel 6 can be interpreted as braided channel morphology according to the model from Fonnesu (1984). Sandstones are deposited as flow channels shown in attributes as part of the highlight and claystones are deposited as flood plain. With effective porosity value at this reservoir is 0.080.3. From well data, cross over from neutron and density log we know, that there is oil content in this channel.

C. Channel 5

The channel is sliced by 18 ms below horizon marker 7. Where the slicing results coincide with sandstones in well data. Purple part of seismic attribute has a lower amplitude value but has a higher porosity value than the gray part.

According to geological model from Einsele (1992) and Marinus E. Donselaar and Irina Overeem (2008), a channel is a meandering channel morphology. Where the purple part of the attribute is crevasse splay deposits with sandstones that have a log shape, funnel shape (Kendall, 2003). Then claystone is deposited as a clay plug from flow channel and flood plain. From figure 2, we can see there is oil content in this channel from cross over density and neutron log. With an effective porosity value of 0.1-0.3.

D. Channel 4

This channel is sliced 20 ms below horizon marker 5. Slicing results show siltstone in well data. The yellowpurple (highlight) attribute has a lower amplitude value but has a higher porosity value than the gray part.

Channel 4 is a meandering channel morphology according to geological model Marinus E. Donselaar and Irina Overeem (2008). The highlight attribute data is point bar sediment and the gray part is flow channel which is clay plug sediment and flood plain.

MUDA FORMATION

The results of horizon slicing in Muda Formation consist of 3 channel geometries, namely distributary channel, which is the depositional facies of the delta environment, which is more precise in the delta plain. The results of horizon slicing show a relatively northwest-southeast sedimentation trend. In Figure 4, the channel on the left is older than the channel on the right.

A. Channel 3

The channel is sliced 16 ms below the horizon marker unconformity. Where the well data shows sandstone lithology. In the attribute, the yellowpurple (highlight) part has a lower amplitude value but has a higher porosity value than the gray part.

Based on the model of G.P Allen, A. Coadou, and F. Mercier (1989) and Allen R.G (1998), channel is the morphology of the distributary channel. Distributary channel in attribute is the highlight part. With an effective porosity value of 0.08-0.2

B. Channel 2

This channel is sliced 20 ms below horizon marker 3 with claystone lithology shown by well data. The attribute shows that the yellow-purple (highlight) part has a smaller amplitude value than the gray part. However, the porosity value is higher.

Channel 2 is a distributary channel deposit in delta plain following model from G.P Allen, A. Coadou, and F. Mercier (1989). And after further review with geological model from Horne (1978), research area is in lower delta plain. Where the location of well is likely to be in interdistributary channel deposits. With an effective porosity value of 0.2-0.27.

C. Channel 1

Channel is sliced by 16 ms below horizon marker 2. Where the results of horizon slicing show claystone in well data. The highlight part atributte has a lower amplitude value but has a higher porosity value than the gray part. This channel is a distributary channel on edge delta plain deposits as in geological model of Allen, R.G (1998). This is because in horizon slicing, channel looks cut off in the middle but after seeing attributes, authors decide that channel is actually continuous. However, because of its location on the edge of delta plain, tides may play an active role. Effective porosity value is 0.22-0.27

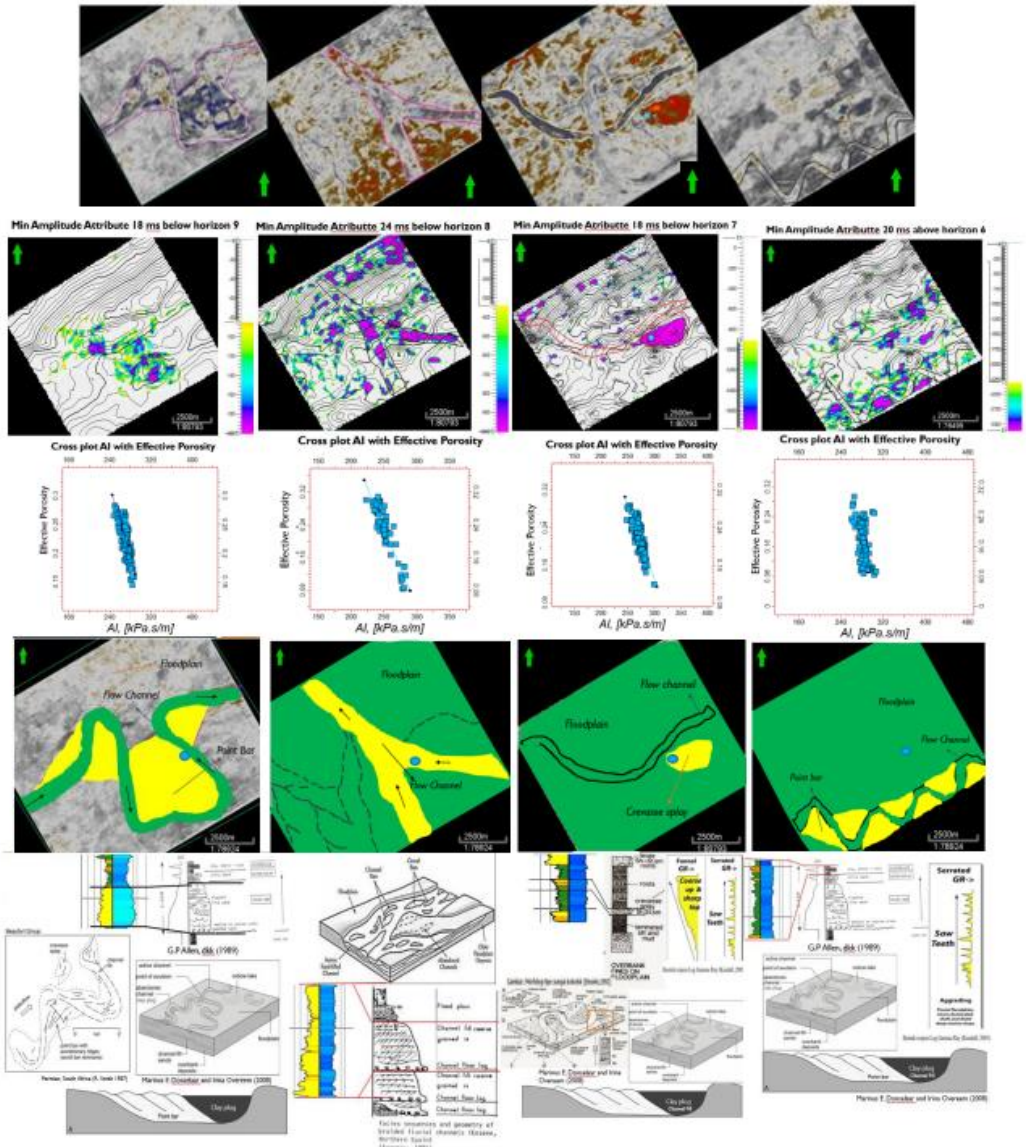



**Figure 3**. Interpretation channels in Arang Formation

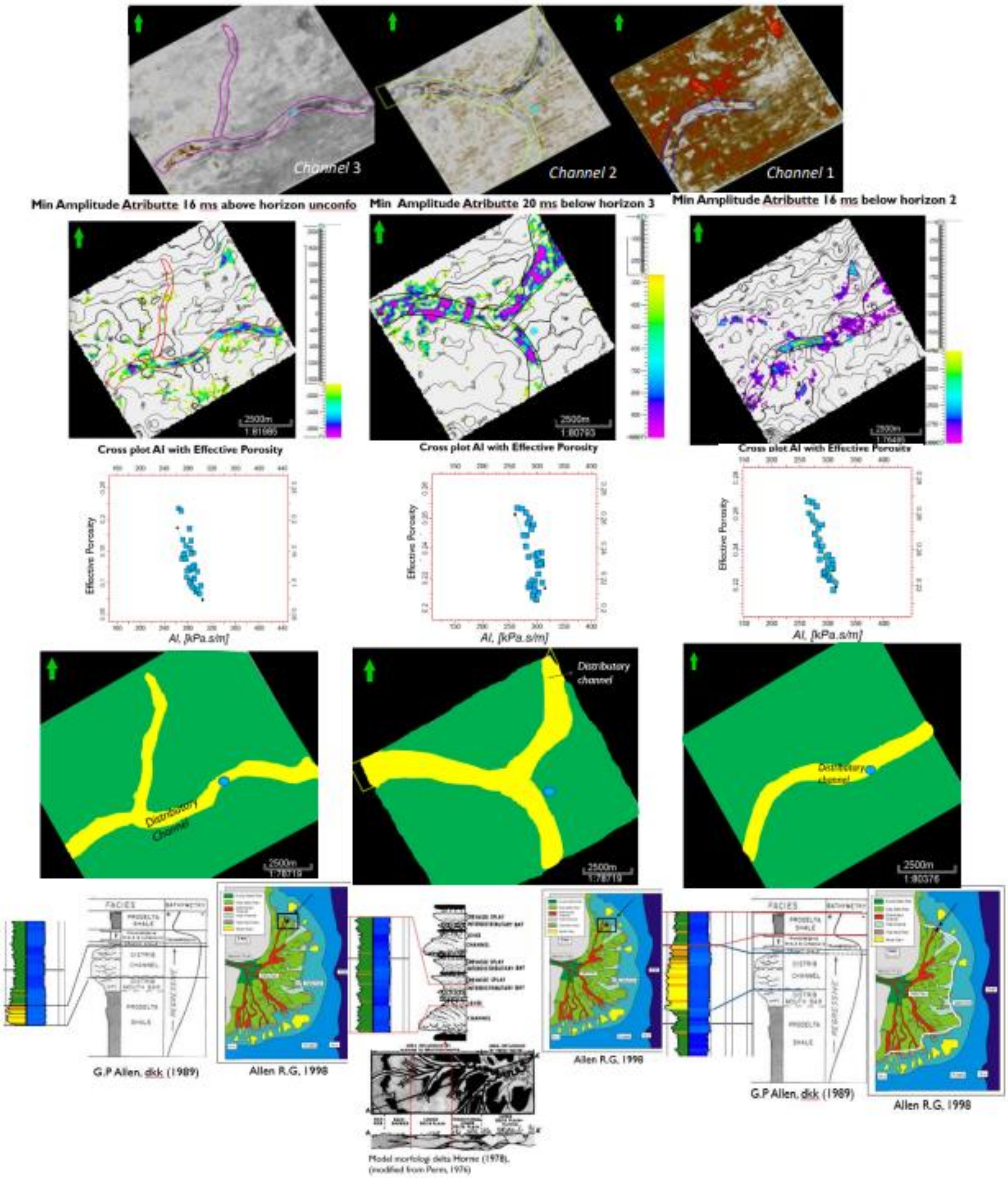



**Figure 4**. Interpetation channels in Muda Formation

## Conclusion

The research area passed through Arang Formation and Muda Formation, where Arang Formation identified 4 channel geometries that showed fluvial depositional facies, which 3 of them have oil content from cross over density and neutron log, with effective porosity value of 10-30%. Meanwhile, in Muda Formation, there are 3 channel geometries which are distributary channels with delta deposition facies. The effective porosity of Muda Formation is 20-27%. Both of these formations have a trending depositional of southwest-northeast.

## Acknowledgement

In the preparation of this paper, the support of various parties is inseparable. Author specially expresses his deepest gratitude to Mr. Hasrony Maridhona as a mentor of MEDCO, and the lecturers at Faculty of Geological Engineering, Padjadjaran University as supervisor

## References

Allen, G.P., 1989, Electrofacies Analysis of Clastic Depositional System, Total Exploration Laboratory Allen, R.G., etc. 1998 Crop Evapotranspiration: Guidelines For Computing Crop Water Requirements.

Rome: FAO Irrigation and Drainage Paper 56.

Darrin Burton dan Lesli J. Wood, 2010. Seismic geomorphology and tectonostratigraphic fill of half grabens, West Natuna Basin, Indonesia

Einsele, G., 1992. Sedimentary Basins: Evolution, Facies, and Sediment Budget: Springer-Verlag Berlin Heidelberg, Berlin

Fonnesu, F. (1984): Physical stratigraphy and facies analysis of the sequence of Figols between the Noguera Pallaresa River and Iscles (Prov. Of Lériday Huesca) .— Ph.D. Thesis, Fac. Sciences Univ. Autón. Barcelona, 317 p., Bellaterra

Hamilton, W.B., 1979, Tectonics of The Indonesia Region. United States Geo*log*ical Survey

J. C. Horne, Depositional Models in Coals Exploration and Mine Planning Appalachian Region, AAPG Bulletin, v.62, p. 23792411, 1978.

Kendall, C G. St. C., Abdulrahman. S. Alsharhan, Kurt Johnston and Sean R. Ryan; 2003; "Can The Sedimentary Record Be Dated From A Sea-Level Chart? Examples from the Aptian of the UAE and Alaska"

Marinus E. Donselaar, M.E dan Irina Overeem. 2008. Connectivity of fluvial point-bar deposit: An example from the Miocene Huesca fluvial fan, Ebro Basin, Spain. AAPG Bulletin 92(9):1109-1129

Phillips, S, dkk. May 1997, Sequence Stratigraphy of Tertiary Petroleum System in the West Natuna Basin, Indonesia. Proccedings of the Petroleum Systems of SE Asia and Australasia Conference, May 1997

Smith, R.M.H, 1987 Helical burrow casts of therapsid origin from the Beaufort Group (Permian) of South Africa

Wongsosantiko, A. and Wirojudo, G.K., 1984. Tertiary tectonic evolution and related hydrocarbon potential in the Natuna area. Proceedings of Indonesian Petroleum