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The Complexity of Basement Characterization from Ketaling Complex as a Revival of Gas Potential in West Ketaling Structure, Jambi Sub-Basin, South Sumatra Basin

Chandra Mustofa Eka Putra[1], Giovanno Leonardo Sihombing[1], Fannopo Rikardo[1], Erwin Dicky Dusyanto[1], Arief Prasetyo Handoyo[1]

[1]Pertamina EP Asset 1 Exploitation Ramba, Lirik, & Jambi Area
* Email: chandra.putra@pep.pertamina.com

Abstract. Ketaling Field is located 32 Km respectively south East and west-South West of Jambi. Ketaling area was a mature oil field whereas the Bulian complex area is toward the process for gas field development. Ketaling Structure has been acquired by sparse 2D seismic grid since 1978 to 1982. Pertamina continue to acquire 3D seismic 2003 Ketaling, in favor for field development.

Ketaling area are sitting in Jambi Sub-basin, which is located in NW nose of South Sumatra Basin. The basin divided into several blocks that controlled by basement high and low. Ketaling field is the example of the unique paleo-high setting in Jambi sub-basin divided into two physiographic units, mainly controlled by large normal strike slip fault.

The purpose of this study is to investigate the character, geometry and potential of the Basement zone which has found in well of KBS-X1 & KTB-X2 from structural analysis, biostratigraphy analysis, Production data test analysis and combined with our integrated analysis from 3D seismic data interpretation and electric-logs. From the result, there are several interesting findings, namely the Basement Rock found in the West Ketaling structure, which is a metamorphic type of phyllite rock, further evidenced by the mudlog data on KBS-X1 and new Exploration well in West Ketaling Structure namely TJA-X1.

Furthermore, it is stated that the data from the well test in KBS-X1 has a 3.5mmscfd QGas result with a 32/64 inch choke; despite the result in KTB-X2 well generated poor result; Qgas 0.003 mmscfd eventhough it is in the same zone. The main factor to this contrasting data is the intensity of the presence of faults and fractures in the basement are highly instrumental in determining the fractured basement distribution which correlated align both with porosity and the production rate of the formation itself. From this study, the basement model is capable to determine the expansion and character of basement which is crucial for future development opportunities.

Keyword: Regional Study, Seismic Intepretation, Structural Analysis, Log Analysis, Modelling Analysis

1 Introduction

West Ketaling Structure is one of the 9 (nine) active structures which located in Field Jambi, with main productive reservoirs from this structure is eq. Phase-2 BRF, eq. Phase-1 BRF, and Platform BRF. Furthermore, these formation are formed with similar configuration, although not conforming, with the main target Fractured Basement.

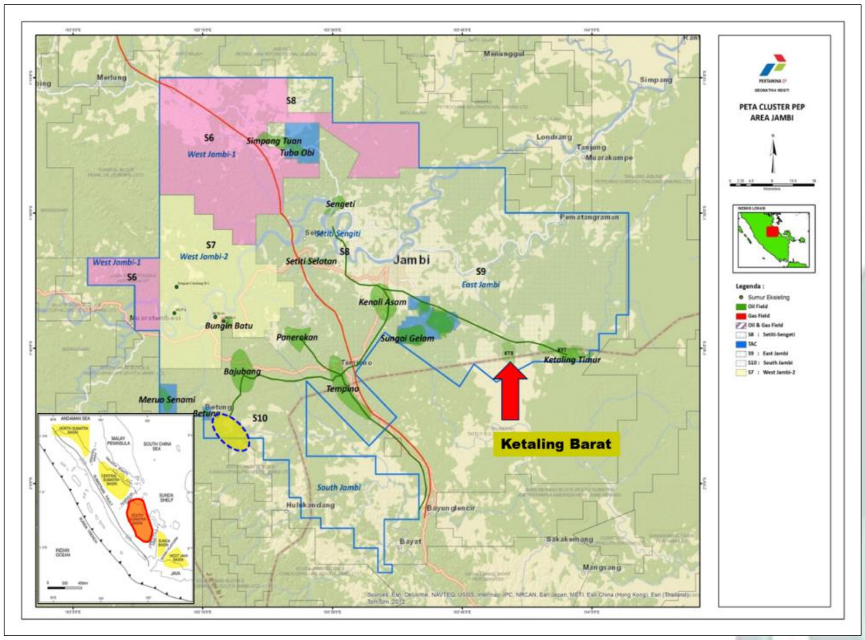


Figure 1. Location of West Ketaling Structure

Ketaling area are sitting in Jambi Sub-basin, which is located in NW area of South Sumatra Basin. The structural setting of high and low basement of Jambi Sub-basin were dominated by two trends, NE-SW and NW-SE which developed by three phases of tectonics events; the first is Eocene-Oligocene phase (45-28 ma) with extensional regime result in graben, half graben, and horst configuration which controlled syn-rift clastics sedimentation. The second phase is Late Oligocene-Middle Miocene phase (26-18 ma), characterized by decreasing tensional activities which caused intensive subsidence followed by eustacy that gave accommodation space filled by fluvial, transgressive estuarine-delta and a local development of carbonate on basement high, within this stage some weak fold belt with NW-SE orientation started to construct; the third phase is Middle Miocene-Recent phase (18 ma) reflected by rejuvenation event of North-South trending fault produced dextral strike-slip fault and compression in the back-arc basin.

Ketaling area is the example of the unique paleo-high setting in Jambi sub-basin divided into two physiographic units, mainly controlled by such structural features, such as large normal strike slip fault which separating the West Ketaling Field (Ketaling High) and East Ketaling Field (Ketaling Deep).

2 Methodology

2.1 Methodology A.1 : Geology Regional Basement Configuration

As initial geology regional interpretation mentioned above, we interpret the location of high and low basement on Ketaling Area, using Puspa 3D and Ketaling 3D arbitrary line. After we identified the structural features on seismic data, we characterized the dominant anticlinal and flower structures formed along the section. On the lithology description, we describe the basement high configuration in West Ketaling Structure that geologically formed separately with its low basement. From these faults, we determine the major fault that separates the existing field is the Eocene-Oligocene, with NE-SW orientation fault, which controlled syn-rift clastics sedimentation of the structure.

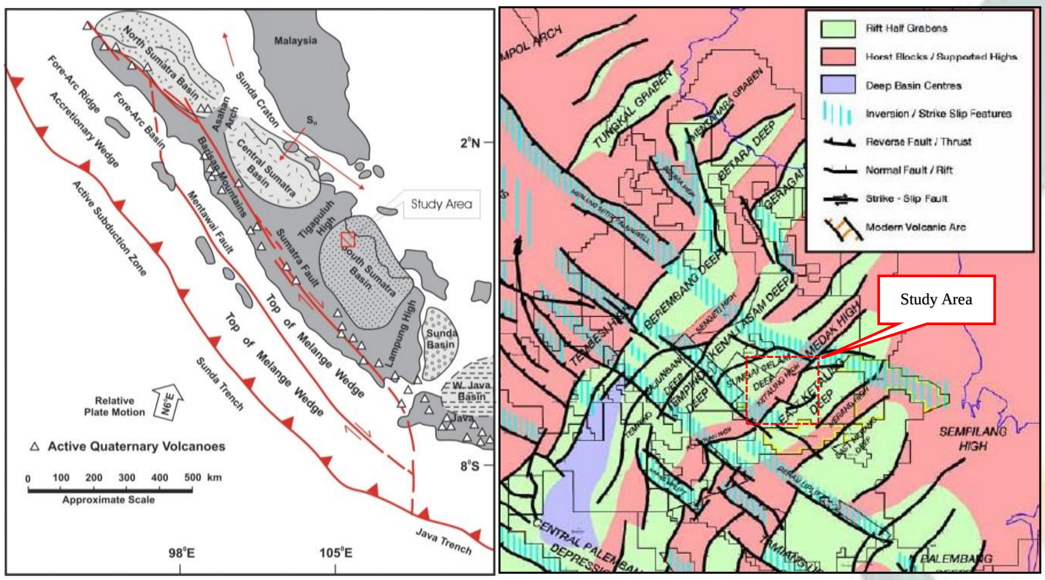


Figure 1.a. Regional tectonic configuration of South Sumatra Basin (Heidrik and Aulia, 1993)
Figure 1.b. Regional structural element of South Sumatra Basin (Ginger and Fielding, 2005)

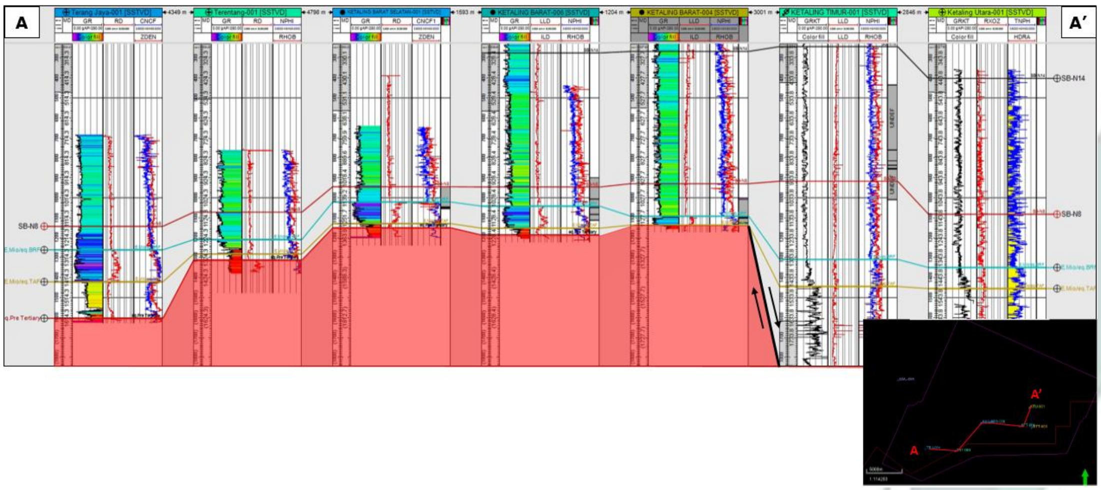
<u>Methodology A 1.1 : Key Well Correlation on Ketaling Area</u>

Key well correlation is made with well section along with regional basement configuration, with 5 (five) wells from TJA-X1 to KTU-X1. The well correlation itself able to differentiate the major distribution of Ketaling High basement. This correlation thus confirmed the initial hypothesis of the possibility of basement distribution as upside potential in West Ketaling Area. (Figure 2.a)

<u>Methodology A 1.2 : Seismic Regional Interpretation</u>

Initially, we use the regional paleogeography of Baturaja Formation as a guidance to regionally locate the basement configuration. Using Cross Section from Puspa to Ketaling below, we can combined both data to map the basement high distribution as the interest zone. With such resolution, we can describe the intensity of the major flower structure from the fault which distributed laterally along the basement high area.

With high possibility of occurrence of structural trap from the antithetic fault, we can predict the hydrocarbon to be migrated from Ketaling Deep as kitchen area. (Figure 2.b)



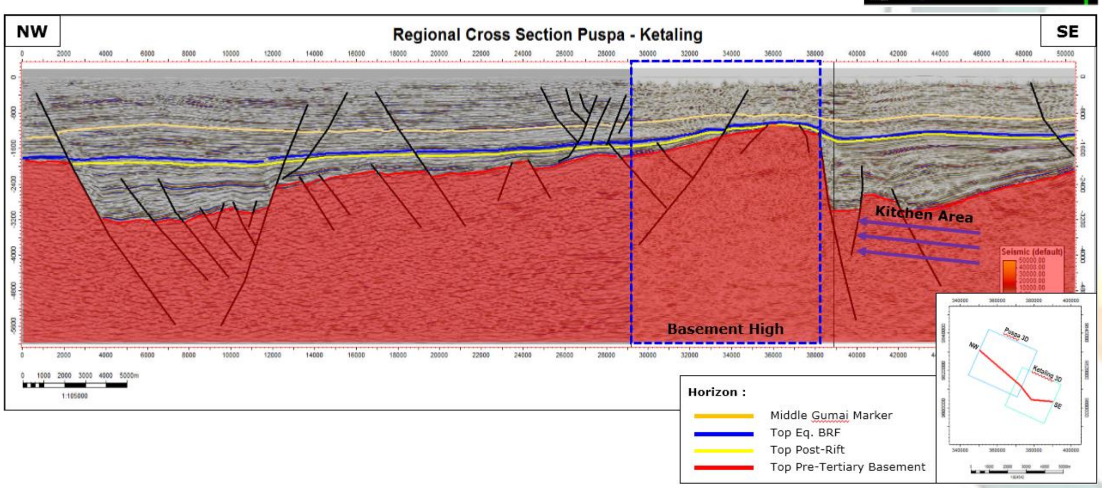


Figure 2.a. Key Well Correlation from West Ketaling to East Ketaling Structure
Figure 2.b. Regional Seismic Section from Puspa 3D to Ketaling 3D

2.2 Methodology A2 : Seismic Attribute for Pre-Tertiary Basement Facies Determination

At first, we try to expand the West Ketaling Basement area to create the Time Structure Map along the Ketaling Area, and disclose the basement distribution with the major faults. From the facies distribution, we attempt to measure the thickness of sealing formation, Talang Akar Formation as the seal for the fractured basement. As the thickness is generated in depth domain, we can conclude that the sealing formation and pre-tertiary fractured basement has a total thickness of 800 mTVD, with the expanded area of fractured basement isolated with two faults with relatively similar NE-SW orientation.

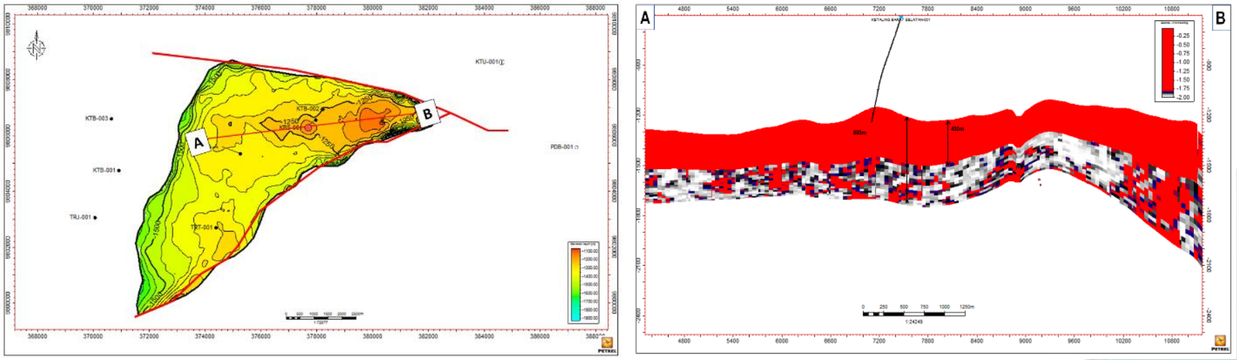


Figure 3.a. Expanded Area of West Ketaling Structure Pre-Tertiary Basement
Figure 3.b. Seismic section of ant-track attribute with W-E orientation

Seismic attribute is used to determine the facies of the basement using ant-track attribute to detect discontinuities. Using general ant tracking workflow, preprocessing can involve preparing the seismic with structural smoothing, filtering or other attributes, followed by discontinuity attributes, such as chaos (Randen et. al., 2000) or variance (Van Bemmel and Pepper, 2000). The resultant volume are tracked by the "ant" agents, which are tuned to follow the desired faults while avoiding known noise sources. (Cox and Seitz, 2007).

For this seismic attribute application, we use the workflow sequence to optimize the fault discontinuity determination. At first, we apply ant-track along the expanded basement area, and fine tuning the ant track resampling to increase the accuracy of the image.

Using this attribute, we can determine the zone into 2 (two) facies, fault zone and non-fault zone. By using this approach, we can determine the intensity of the fault zone with such accuracy from the top to bottom area of the fractured basement.

2.3 Methodology A3 : Determining Pre-Tertiary Basement Log Type

The concept of basement rock in an oil and gas basin (Koesoemadinata, 2008) is usually as igneous (plutonic) and metamorphic rocks. Economical basement rock is as a sedimentary layer undergone a very strong tectonic process, so it has a small chance to produce and keep the hydrocarbon accumulation.

Basement rock as an intrusive igneous rock contains or forms significant porosity. The existing porosity is initiated by cracks formed at magma cooling. The primary process of intrusion forms effective porosity. Interposes or rock joints are connected by cracks formed at the last tectonic phase. Some other crack systems are formed by hydrothermal occurrences, interrelated with magma differentiation at the last phase of andesitic and basaltic intrusion (Guttormsen at al., 2008).

Several types of data can be used as analog to distribute the physical properties of the basement rock itself. Data from production, exploration, and field development activity can be optimized by applying rock analysis technology to see the potency of basement rocks as oil and gas reservoirs.

Petrology and petrographic analyses are applied on old and new data as the effective models representing many ways of oil and gas exploration.

In this case study, we try to use the analog of two wells that have the high porosity analog to be distributed along the expanded basement area. Drill Stem Testing (DST) job which is conducted on year 2004, stated that the interval itself has potency of 3.5 MMscf of gas to be produced.

From mud log data of the well KBS-X1, the lithology of the basement itself indicating no obvious sign of hydrocarbon trace, with the phyllite itself did not contain any stain or odor, and poor oil show.

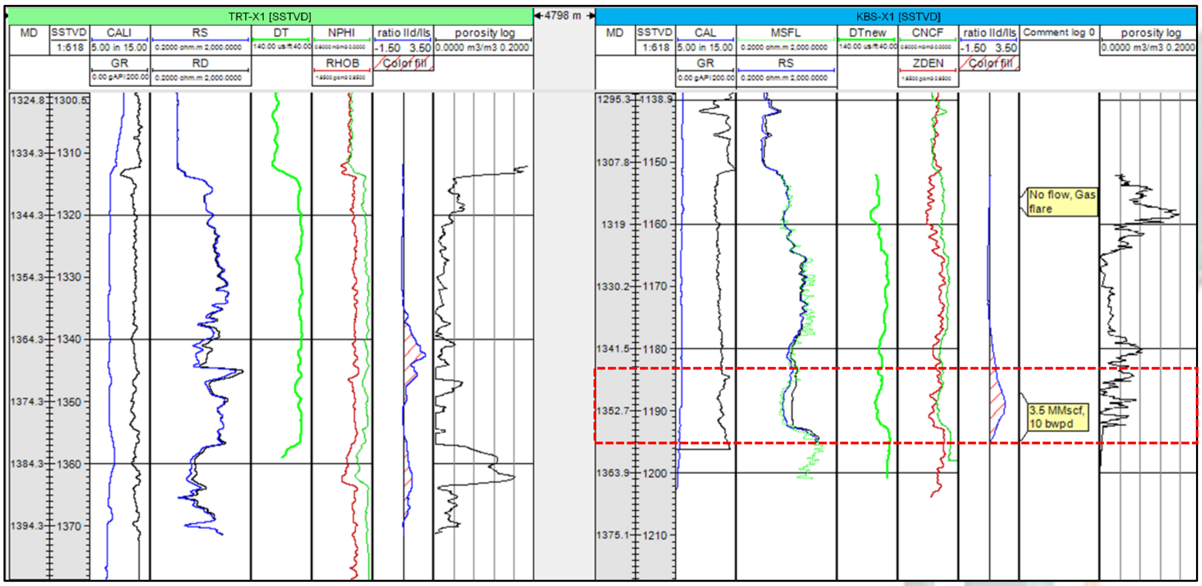


Figure 4. Type Log of Basement from Well TRT-X1 and KBS-X1

2.3.1 Methodology A.3.1 : Pore Volume Distribution

After determining the porosity analog from well KBS-X1, we try to apply the porosity value into the defined facies of fractured basement. Using section from well TRT-X1 to KBS-X1, we try to analyze with comparing the porosity value with and without log involvement.

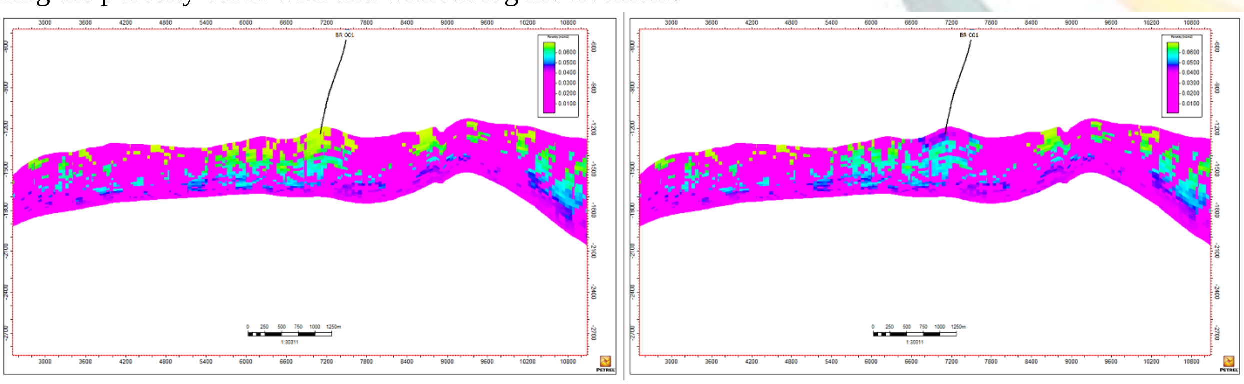


Figure 5. Comparison of pore volume distribution section on well BR-001
(left : without log involvement, right : with log involvement)

3 Result and Discussion

3.1 Result A.1 : Volume Calculation of West Ketaling Pre-Tertiary Fractured Basement

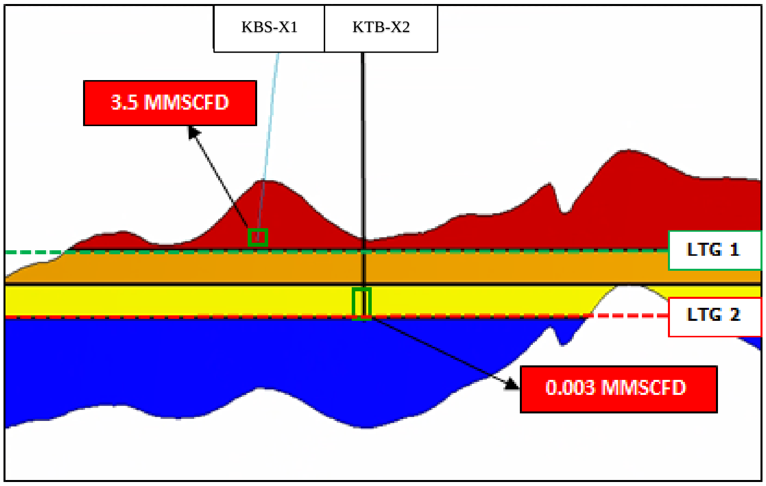


Figure 6. LTG Case 1 and Case 2 for Fractured Basement Volume Calculation

Table 1. Property Estimation for Pre-Tertiary Fractured Basement Reservoir

Volumetric Calculation	Bulk Volume	Average Por	Average Sw	Bg
Case 1 : LTG Well BR-01				
P1 / LTG	78	0.0252	0.40	0.001082
P2	331	0.0252	0.40	0.001082
P3	895	0.0252	0.40	0.001082
	12	0.0252	0.40	0.001082
Case 2 : LTG Well TB-02				
P1 / LTG	1304	0.0252	0.40	0.001082

3.2 Result A.2 : Pore Volume Distribution Map on Expanded Fractured Basement on West Ketaling Structure

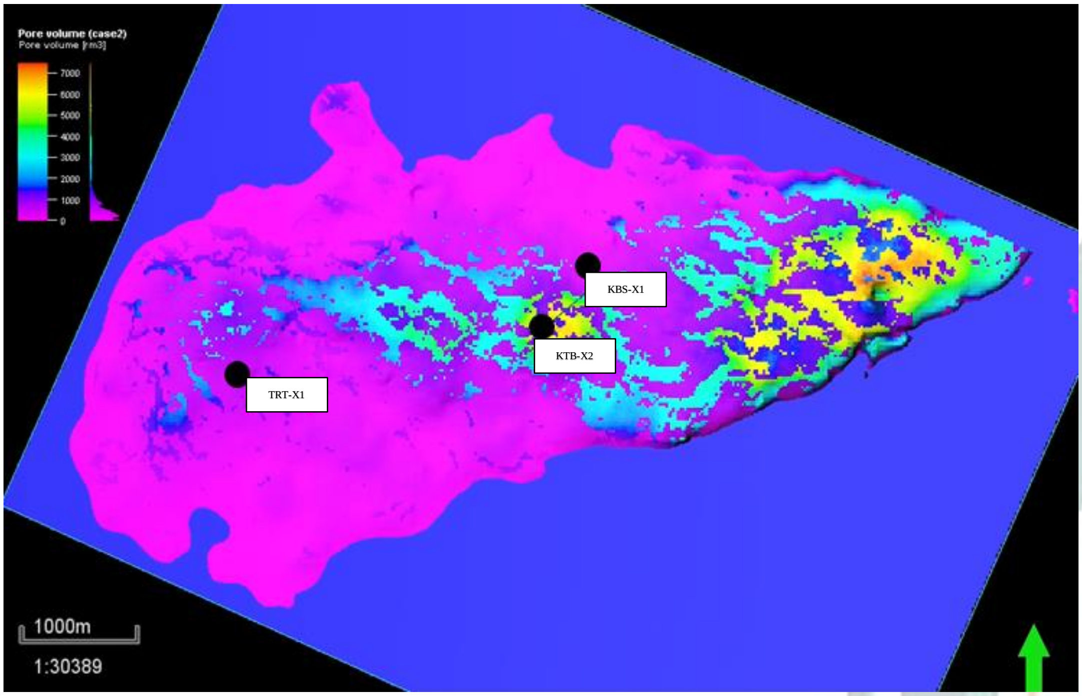


Figure 7. Pore Volume Distribution Map on Pre-Tertiary Fractured Basement on West Ketaling Structure

4 Conclusion

- The complexity of pre-tertiary fractured basement distribution can be mapped with geology regional of Jambi Sub-Basin and Ketaling 3D seismic data, and resulted in finding of expanded area through Western to Southern part of West Ketaling Field.
- Ant-track seismic attribute can be useful in determining fault facies distribution within the expanded basement area in West Ketaling Structure.
- Using the initially distributed facies, added with field development data, such as Lowest Tested Gas (LTG) case and production rate from perforation, porosity trend map of pre-tertiary fractured basement can be further used to measure the probability of gas potential in West Ketaling Field.

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