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Reservoir Characterization Using Petrophysical Analysis and Acoustic Impedance Distribution (AI) Inversion of Based Model in Regional "BR" Kutai Basin, East Kalimantan

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Abstract. Petrophysical analysis, inversion model of acoustic impedance model based, have been applied to obtain reservoir characterization results for reference in the development of "BR" field, Kutai Basin of East Kalimantan. In this research, reservoir characterization was performed on three wells, namely BR-01, BR-02, and BR-03 located in sandstone reservoir layer with lime insertion and shale rock, Balang Island Formation and Balikpapan Formation. The purpose of reservoir characterization is to obtain the most potential hydrocarbon prospect zone information from three wells and the most productive well point will be used for the analysis of new well development using the model based inversion method. The model based inversion method produces a cross-section of the acoustic impedance model then from the acoustic impedance cross section section resulting in a map of the acoustic impedance distribution will provide the northeast flange growing zone information on the "BR" field from the BR-03 well point potentially as new hydrocarbon reservoirs. With the value of characterization of small clay volume reservoir average of 47%, the average water saturation is small from 53.6%, and the average porosity is more than 30%, Net-pay thickness is 122.43 m, acoustic acoustic impedance value is 7000-10000 (m/s) * (g/cc). So from the characterization of this reservoir can be considered for the direction of development of new wells in the field "BR".

Keywords: Petrophysical Analysis, Inversion, Acoustic Impedance, Model Based, Reservoir Characterization

1. Introduction

Increased industrial demand for energy sources and reduced petroleum reserves has prompted oil and gas companies to seek new reserves or rebuild the old wells to maintain equality of supply and demand. Efforts to increase production is still continue, one of them is through geological and geophysical studies of petrophysical analysis and seismic data modeling to reveal the detailed conditions of the field petroleum system. In this regard, this research is emphasized using petrophysical value analysis and integration methods between seismic data and well logs. Because both parameters are expected to be helpful in the study of reservoir characteristics that are useful for further analysis of possible increases in hydrocarbon production and the development of wellbore production in the "BR" field area.

2. Methodology

In this study, data used in the form of log data with *Triple Combo* model and other supporting data such as *post-stack* 3-D seismic data, *marker* data, and *checkshoot* data area both "BR". Data processing is done by using *Interactive Petrophysics (IP) software v3*.5 and *Humpson-Russel Software*. The data recorded on each well was interpreted qualitatively and quantitatively to obtain the results of petrophysical parameters such as porosity, content flakes and water saturation used as vertical wellbore analysis and lateral analysis performed 3-D seismic data modeling yielded an inversion model *based* on reveals a good outcrop area for determining the hydrocarbon potential of the BR well wells using the *Humpson-Russel Software* used to reveal the conditions of the wellbore layer at defined zone boundaries based on petrophysical analyzes.

2.1. Data Processing Petrophysical Analysis

The steps of data processing on petrophysical analysis, conducted from the input data format **.LAS** that contains log data, untill the quantitative analysis of petrophysical parameters resulting in a reservoir boundary zone based on lumping analysis. The results of a qualitative analysis (quicklook) conducted in petrophysical analysis are to help interpret the reservoir rock zone, the type of lithology or minerals, and the fluid formation of the wells observed prior to performing a quantitative analysis. Once the hydrocarbon zone is well known, the zone is divided by *the facies zone* or *marker data*. The input zone is done by selecting the Well-Manage Zone / Top-New menu. This data is then used in the process of calculating petrophysical parameters. Such as shale/clay content, porosity, permability and water saturation. From the process, we get values for the petrophysical parameters in each reservoir well zone. Before to *the cut-off* process do, the values are validated by the value of the cross-parameter results. If the results are good, the *cut-off* process uses petrophysical parameters such as effective porosity, rock water saturation, and clay volumes so the result of *the cut-off* is a *net-pay* zone from each reservoir's well zone. Then Lumping or disclosure means the cumulative value of petrophysical parameters in which there is an exploratory well of *the cut-off* method. By applying the result of the clipping value on the porosity, saturation and clay volume, a clean reservoir or a net summary will be generated.

Table 1. Summrary Lumping Value of Wells "BR"

CUTOFF SUMMARY REPORT								
Well : BR-01								
Date : 2/23/2018 8:54:55 AM								
Reservoir SUMMARY								
Zn Zone Name	Top	Bottom	Gross	Net	N/G	Av Phi	Av Sw	Av Vcl
1	2578.76	2999.54	420.78	59.74	0.142	0.351	0.152	0.169
All Zones	2578.76	2999.54	420.78	59.74	0.142	0.351	0.152	0.169
Pay SUMMARY								
Zn Zone Name	Top	Bottom	Gross	Net	N/G	Av Phi	Av Sw	Av Vcl
1	2578.76	2999.54	420.78	59.74	0.142	0.351	0.152	0.169
All Zones	2578.76	2999.54	420.78	59.74	0.142	0.351	0.152	0.169
Depth Units : m								
Well : BR-02								
Date : 02/23/2018 06:09:04								
Reservoir SUMMARY								
Zn Zone Name	Top	Bottom	Gross	Net	N/G	Av Phi	Av Sw	Av Vcl
1	2439.92	2925.01	485.09	12.04	0.025	0.247	0.633	0.403
All Zones	2439.92	2925.01	485.09	12.04	0.025	0.247	0.633	0.403
Pay SUMMARY								
Zn Zone Name	Top	Bottom	Gross	Net	N/G	Av Phi	Av Sw	Av Vcl
1	2439.92	2925.01	485.09	12.04	0.025	0.247	0.633	0.403
All Zones	2439.92	2925.01	485.09	12.04	0.025	0.247	0.633	0.403
Depth Units : m								
Well: BR-03								
Date : 2/28/2018	9:27 AM							
Reservoir SUMMARY								
Zn Zone Name	Top	Bottom	Gross	Net	N/G	Av Phi	Av Sw	Av Vcl
1	2204.04	2856.86	652.82	122.43	0.188	0.3	0.536	0.472
All Zones	2204.04	2856.86	652.82	122.43	0.188	0.3	0.536	0.472
Pay SUMMARY								
Zn Zone Name	Top	Bottom	Gross	Net	N/G	Av Phi	Av Sw	Av Vcl
1	2204.04	2856.86	652.82	122.43	0.188	0.3	0.536	0.472
All Zones	2204.04	2856.86	652.82	122.43	0.188	0.3	0.536	0.472
Depth Units : m								

2.2. Data Processing Seismic Interpretation

The data processing conducted in the study uses the wavelet extraction that is convolved so as to produce a synthetic seismogram generated from the wavelet convolution and reflection coefficient series so that the seismic horizon can be positioned to the actual depth and the seismogram sealed by well data or well tie to bind the well data contained in depth to the seismic data contained in the time scale. The result of well seismic tie is done picking horizon on *Hampson-Russell software* for inversion based modeling. The vertical control points used in the initial modeling in this study amounted to 1 well found in the study area. As for lateral control use 2 *horizon*, that is *Top_MF6 horizon* and *Bottom_MF8 horizon*. The wavelet used in this study is the statistical wavelet obtained by extracting the wavelet from the seismic data cube around the target zone in Figure 1.

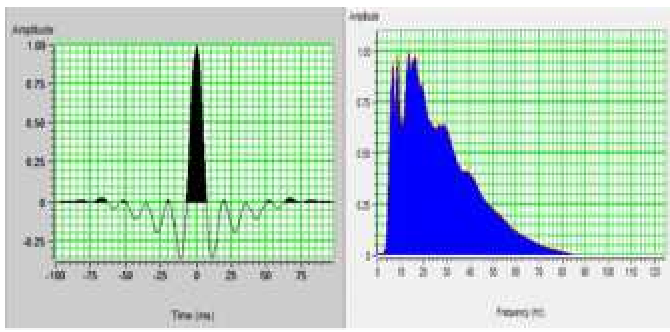

Figure 1. Wavelet statistical extraction

2.2.1 Seismic Inversion Process

The model based inversion method consists of two methods: constrained and stochastic method. In the constrained method, the extent to which the impedance changes from the inversion results over the initial model is determined by the boundary or constraints. While on the stochastic method is not determined how far the impedance changes from the inversion than the initial model. In this research is a model based constrained seismic based on model inversion. The parameters used in the inversion based on this model are considered the best input parameters. The input parameters used in this model based seismic inversion method are as follows:

- *Window: horizon Top* (900 ms) and *horizon Buttom* (3000 ms). This window can be defined as a time limit or vertical boundary within the time zone of the inversion process to be performed.
- *Model Constraint: soft constrained (0.5)*. The constraint model is selected 0,5, meaning that the inversion result is obtained from 50% model and 50% of the seismic. This means that if the parameter is selected 0.0 then the initial model is ignored or inversion is done on seismic data only. Whereas if 1.0 is selected then the seismic data is ignored and the inversion result will be exactly the same as the initial predicted model that has been made

- *Iterations: 10.*. This parameter determines how much it will take to get the inversion with the smallest error compared to the seismic data. In too many iterations will enlarge the error of log inversion with its real log.
- *Avarege block size : 4 ms.* The average block size chosen is 4 ms in accordance with the sampling of the seismic.
- *Prewhitening :*2%

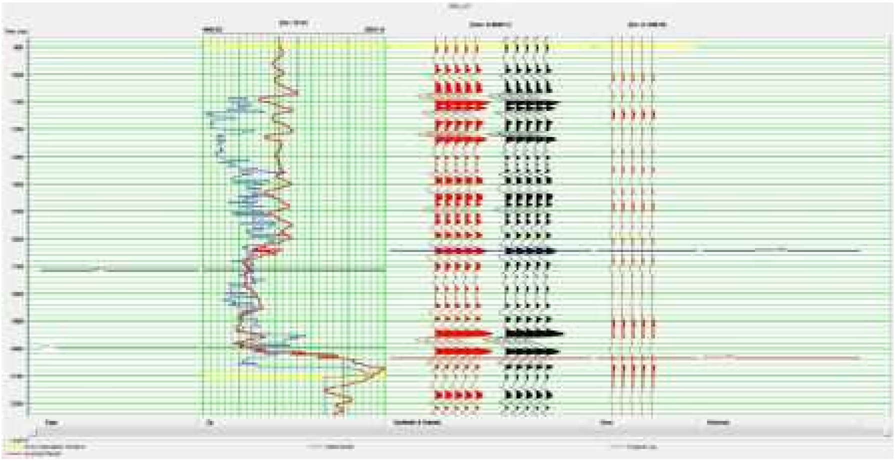

Figure 2. Pre-inversion analysis of based model on BR-03 well

3. Results and Discussion

The result of the inversion process shows that the top and bottom of the target zone has been achieved well enough. Based on the previous sensitivity analysis, the prospective spread of the BR-03 prospective layer on the lateral seismic data has a low acoustic impedance value. The inversion results show low acoustic impedance values spread over the horizon *Top_MF6* to the *Bottom_MF8* horizon, more precisely at 1700-2100 ms time domain with depth domain matching at 2200-2685 m depth which has an acoustic impedance value range (7000 (m / s) * g / cc - 10000 (m / s) * g / cc). In terms of the acoustic impedance value, the zone between the *Top_MF6* and *Bottom_MF8* horizons is a prospective dispersion zone of laterally dispersed hydrocarbons on the BR-03 target well shown in Figure 3.

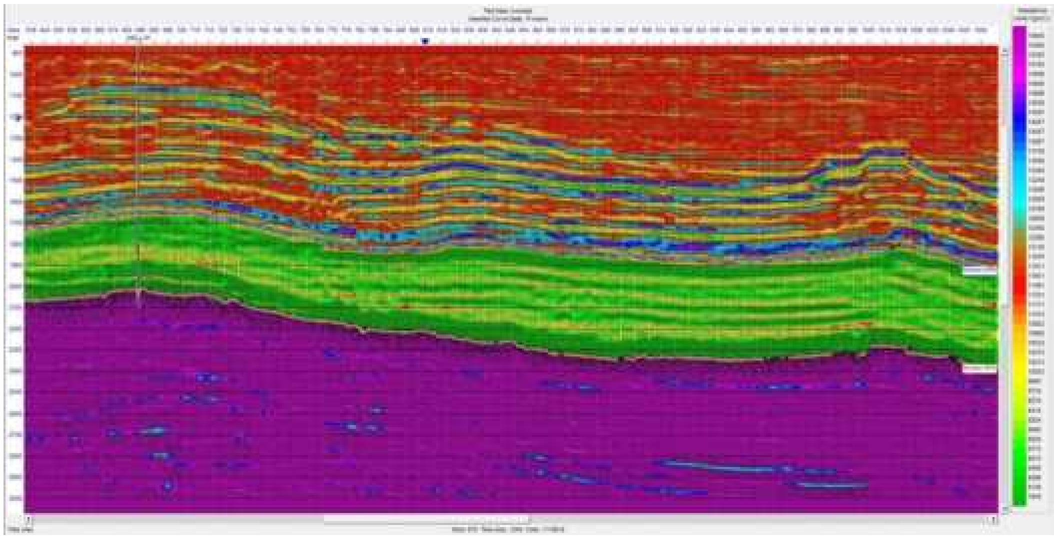

Figure 3. Inversion Result of based inline model 576 of BR-03 well correlation

The result of this inversion is an acoustic impedance model used to create a map of acoustic impedance distribution. The distribution of acoustic impedance from the BR-03 well correlation and the surrounding area has a less acoustic impedance but for the northeast and east direction of the BR-03 inversion correlation can be seen the distribution of the acoustic impedance tends to have a low value seen in Figure 4.

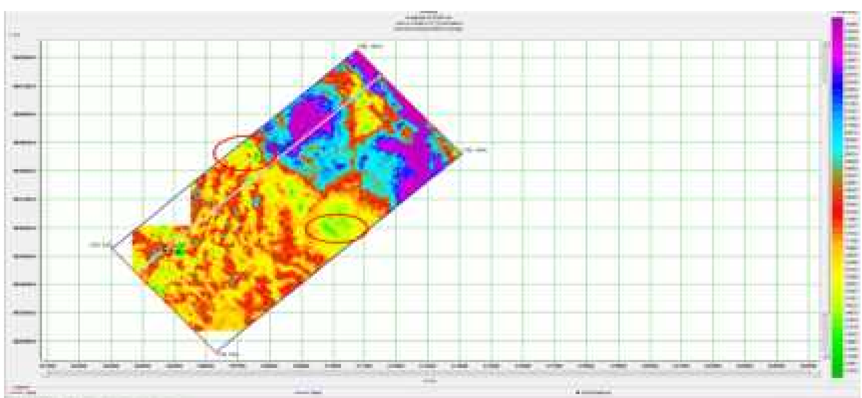

Figure 4 Map of acoustic impedance of BR-03 well correlation

4. Conclusions

Based on the results of petrophysical analysis and map of the acoustic impedance distribution in the "BR" diamond field there is a zone that can be developed north-east direction from the BR-03 well point on the target layer, potentially as a hydrocarbon reservoir with a small average clay volume value of 47% , average water saturation of 53.6%, average porosity more than 30%, *net-pay* thickness of 122.43 m, acoustic acoustic value of acuity of 7000 (m / s) * g / cc-10000 (m / s) * g / cc.

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