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Integration Petrophysical To Identify Reservoir Characterization Of Baturaja Limestone In "X" Well, North West Java Basin

Citra Wahyuningrum[1], Kevin[2], Assyeh Annassrul Majid[3]

[1,2,3]Teknik Perminyakan; Universitas Bhayangkara Jakarta Raya; Alamat Jl. Perjuangan No.18 Marga Mulya, Bekasi Utara Jawa Barat 17143 telp/fax (021)88955882
Korespondensi penulis: citra.wahyuningrum@dsn.ubharajaya.ac.id

Abstract. *Petrophysical evaluation of the Baturaja Formation on limestone reservoirs of the Field X, using conventional well log interpretation techniques and relating the results to core data based on laboratory analysis, shows that the reservoir characterization parameters to decide future plan for the well. This study shows the role of integrated petrophysical analysis it is possible that an acceptable and can be completed within the constraints and limitations of the available data, but sometimes additional data are needed. These new data, typically additional SCAL (Special Core Analysis), RCAL (Routine Core Analysis), well test data and mud loging data it's must be integrated. The results of research based on petrophysical parameters is baturaja formation are dominated by limestone. Based on the results of the analysis, the reservoir layer in the baturaja formation, the BRF-1 is a potential hydrocarbon zone while the BRF- 2 and BRF-3 are non-potential zones. The BRF-1 has an average shale volume is 0,187 which is classified as clean formation, a porosity is 0,134 which is classified as small and for a water saturation is 0,677. The calculation method used is the Archie method because it excels in clean formation. Meanwhile, the Simandoux method has advantages in shaly sand formation and the Indonesian method is suitable for formations in Indonesian regions where the dominant formations are shaly sand and low salinity water. Then, cuf-off for BRF-1 obtained a net reservoir of 25.9 m and a netpay of 3,4 m. The results of this data are used to obtain the initial hydrocarbon reserves using the volumetric method and the amount reserves are 84740.5 STB in the BRF-1 zone.*

Keywords : *Archie, Limestone, Baturaja, Petrophysics , Integrated*

1. INTRODUCTION

Oil and gas are the most important energy resources in the world. The oil and gas industry in Indonesia is developments from year to year to increase domestic demand for fuel. The oil and gas sector is the largest foreign exchange earner which is the mainstay of national development, therefore concrete efforts are needed to continue to increase thecountry's foreign exchange through the oil and gas sector by optimizing increased production and developing new fields. Given the important role of oil and natural gas for human survival, it is necessary to estimate the hydrocarbon reserves that are accurate foreach existing reservoir, such as analysis of reservoir properties (porosity, permeability, saturation, resistivity, reservoir rock distribution, and hydrocarbon content) which can be obtained by logging jobs. Petrophysical analysis is an important process in an effort to determine the characteristics of a reservoir. Petrophysical analysis begins with the acquisition of subsurface data through a well logging process in a drilling hole. Through petrophysical analysis, reservoir zone can be identified, type of lithology, identification of hydrocarbon prospects, porosity, volume of shale and water saturation.

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**Citra Wahyuningrum citra.wahyuningrum@dsn.ubharajaya.ac.id*

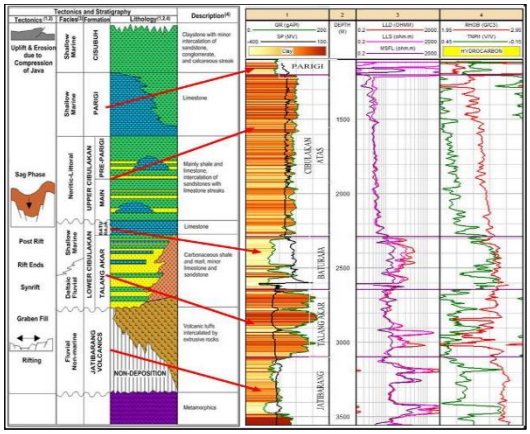


Figure 1. Sratigraphy of North West Java Basin

The North West Java Basin has good hydrocarbon reserves, of course supported by the existence of a petroleum system which makes this basin very potential. According to the petroleum system of this basin, according to (Noble, et al. 1991) states that in the North West Java Basin, there are three types of source rock, namely : fluvio-deltaic coals and shales, marine claystone and lacustrine shale. Meanwhile, reservoir rocks in the North West Java Basin consist of sediments with lithology consisting of rocks with good porosity and permeability characteristics, as well as reservoirs in the form of fractures from volcanic rocks in this basin. Cap rock in fractured volcanic reservoir consists of two types, namely shale in talang akar formation, and discontinuity from open fracture in reservoir.

Hydrocarbons migrate from the talang akar formation to the carrier bed and also the fractures until they finally accumulate. Hydrocarbons can be trapped if the existing fractures are not connected to other open fractures or the fractures are sealing if there is shale on top.

2. DATA AND METHODOLOGY

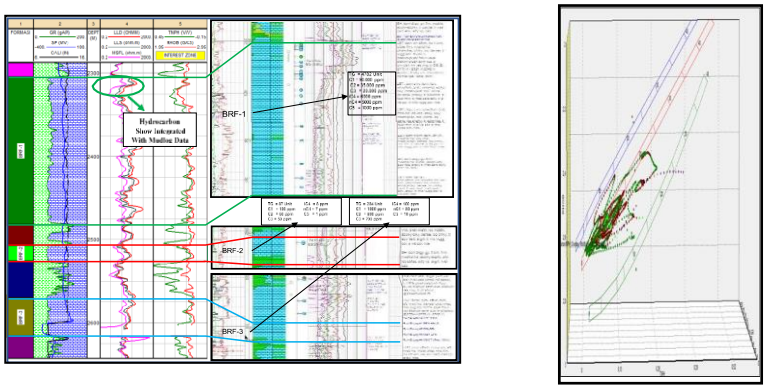
A literature study was carried out regarding the regional conditions of Field Y, North West Java Basin. The results of the library study are then poured into the theoretical basis and used to evaluate and formulate hypotheses as well as references in the discussion of research. The data obtained comes from exploration activities (well data). The well data obtained is in the form of logging data obtained from the measurement results of petrophysical parameters with various logs and outlined in the form of a file (.las) along with the well header data. The next data is in the form of data from laboratory analysis of core samples from the field, especially in baturaja formations, which are carried out routine core analysis (RCAL) and special core analysis analysis (SCAL). The last data is mud loggingdata in (.Pdf) format which is obtained during drilling activities in accordance with the mud logging unit parameters. At the stage of

interpreting the data that has been collected. Data processing by using software, the software used is Interactive Petrophysics 3.5, Petrel and Microsoft Excel qualitatively and quantitatively.

3. RESULT AND DISCUSSTION

MUDLOG ANALYSIS AND LITHOLOGY DETERMINATION

Validation of the mudlog data is carried out to further ensure the existence of a hydrocarbon indication zone, so what must be done is to integrate it with the mudlog data so that the final results of the analysis will be more valid and closer to the real value. Therefore, the calculation of the gas water ratio and liquid heavy ratio to determine the type of fluid contained. Based on the total gas reading (reading of total gas units) from the mudlog data, the total gas reading is 4782 units at BRF-1. Meanwhile, for BRF- 2, it reads that total gas is 87 units and in BRF-3 is 284 units. Then, on the calculation of the gas wetness ratio andliquid heavy ratio, the BRF-1 obtained a GWR value of 38.7% which indicates that the zoneis classified as productive oil where the GWR value is 0.5 <GWR <40 is productive oil, while for an LHR value is 3.59 then if it is correlated with the classification of balance ratio where the value of LHR<GWR is an indication of productive oil. In BRF-2, a GWR value is 63% which indicates that the zone contains residual oil because when the GWR value is> 40%, the zone contains residual oil, while the LHR value is 2.42 which indicates residual oil. At BRF-3, a GWR value is 62.8% which indicates a residual oil and an LHR of 2.022 which lso



indicates residual oil.

(b)

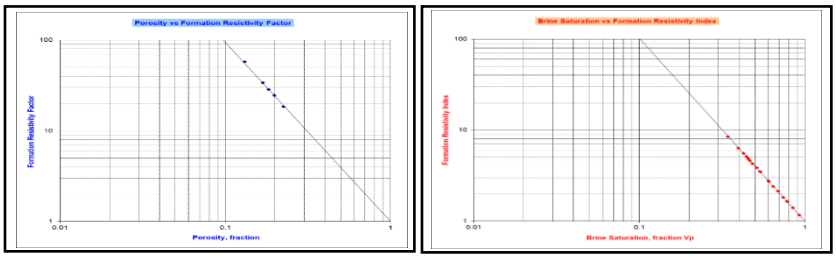
Figure 2.

(a) Integration and Validation of Well Logging Data with Data Mud Logging

(b) Crossplot TNPH-RHOB at Baturaja Formation

SCAL ANALYSIS

Special Core Analysis (SCAL) provides specific information to characterize a particular rock property, or through a selection of specialized tests, provides a more complete understanding of a reservoir rock on Baturaja Formation. In this case, Special core analysis includes relative permeability and electrical properties data. Electrical properties measurements are made using either the porous plate or dynamic displacement techniqueby using 4 electrode measurements at reservoir and surface conditions. Data include resistivities (Rw, Ro, Rt), formation factor (FF), resistivity index (I), cementation and saturation exponents (M and N).



(b)

Figure 3. (a) Formation Factor vs Porosity. (b) Water Saturation vs Resistivity Index

Table 1. The result of Electrical Properties

Parameters	Value	Unit
Salinity	16.000	PPM
Rw @77° F	0.3557	Ohm.m
Cementation Eksponent(m)	2.195	-
Saturation Eksponent (n)	2.3	-
Tortuosity Factor (a)	1	-

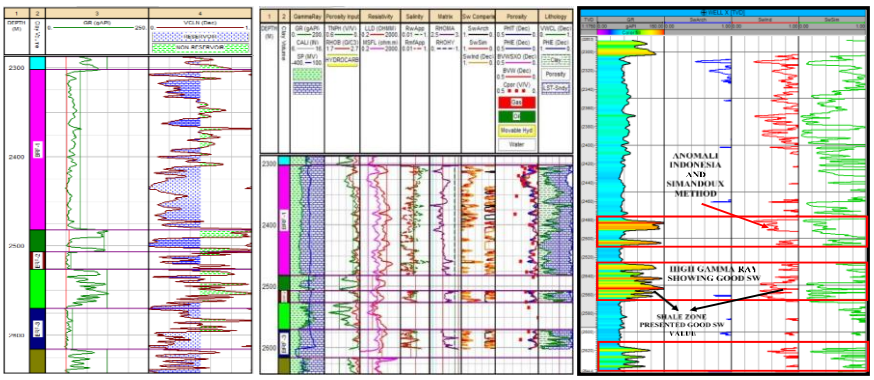
SHALE VOLUME CALCULATIONS

The determination of clay content was carried out using gamma-ray logs because it has good sensitivity in identifying radioactive elements which are dominated by shale rocks. Based on the calculation of the clay content in the BRF-1 zone which is classified aspotential, it has a clay content of 0.3329 which is at a depth of 2302,002-2481,986 m. In the BRF-2 zone which is not classified as potential because it has a large enough clay content, namely 0.429 which is at a depth of 2506.67-2526.03 m. And the BRF- 3 zone which is also classified as potential has a clay content of 0.335 which is at a depth of 2569,921- 2616.2 m.

POROSITY AND WATER SATURATION

The Archie method has the advantage of being able to determine the saturation value of water well in reservoirs that do not contain shale or clean sand formation. In some cases the Archie method can also determine the water saturation value of reservoirs containing carbonate rock. Sw Simandoux produces the smallest value, which will give the more optimistic hydrocarbon saturation value. The Simandoux method uses a density log and a neutron log to determine porosity. This method is good for sand containing dispersed and laminated shale. Indonesian Sw has small value. Because, this method was developed based on the characteristics of fresh water or fresh air in a formation and the high content of shale ranging from 30% - 70% which is often found in oil reservoirs in Indonesia (Poupon & Leveaux, 1971).

In this study, a plot between the water saturation (Sw) parameters of the three methods was carried out with the gamma-ray log using petrel software. In the figure below, it can be seen that there is an anomaly where the zone dominated by shale actually has a higher Sw value in the Indonesian and Simandoux calculation methods than the Archie method. Anomalies like this may occur due to a mismatch between the approaches used by the calculation method and the calculated formations, which results in abnormal values. This means that the zone dominated by shale, which is a non-permeable rock, has a potential Sw value. Meanwhile, as in general, a high gamma-ray value will indicate a high Sw value as well or otherwise. However, the Archie method can be said to be true or valid because it shows a better proven value. Where the high gamma-ray value will present a low Sw value and can be used in rock lithology which is classified as clean sand while the baturaja formation has limestone lithology where the lithology is also classified as clean sand, so that this method can be used in baturaja formations.



(a) (b) (c)

Figure 4. (a) Clay Content Result (b) Porosity & Water Saturation Result (c) Sw Archie,

Simandoux, Indonesia vs Gamma-Ray Plot

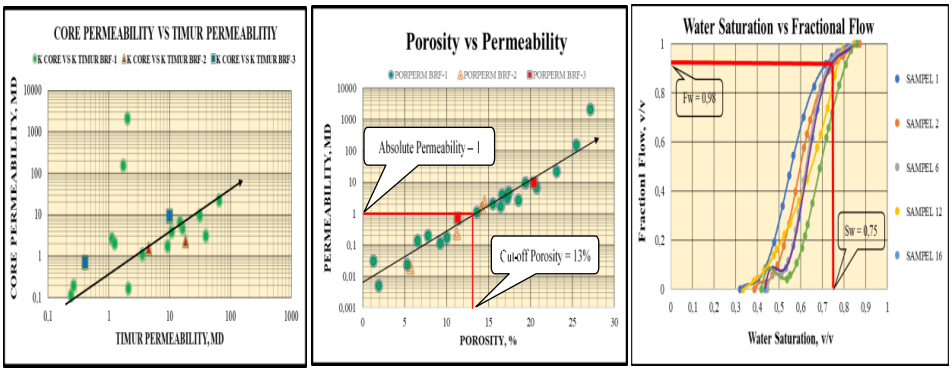
PERMEABILITY DETERMINATION

The determination of the permeability value is used to help determine the cut off value in the cut-off process. Because the permeability which is indicated by (K) is the ability to flow from the formation fluid. Permeability in the well "X" is between 0.1 to 40mD. Therefore, in this study the permeability value used is 1 mD and the permeability equation used is the Eastern equation. The following is a graph of the comparison between the permeability value of laboratory test results and the results of calculations using the Eastern equation or theoretically.

CUT-OFF / SUMMATION

Sw cut-off can be determined by the plot graph of Sw vs water cut. This Sw cut-off determination is qualitative, that is by determining the Sw cut-off value which divides the Cartesian graph into two distinct zones – the left side of the Sw cut-off value which is still pumping oil, and the right side of the Sw cut-off value [1]. The cut-off value is obtained by applying a porosity cut-off value is 13% which is obtained based on the porosity vspermeability plot which uses the absolute minimum permeability value of 1 mD and cut-off value of the clay content is 50%, and the cut-off value of water saturation is 75%. The above data can be obtained in various ways, such as through cut-off sensitivity and data well test (DST). However, 75% of the water saturation cut-off value can be obtained from the laboratory's relative permeability data using the Buckley-Leverett (1942) calculation method by relying on the graphical relationship between fractional flow (Fw) and water saturation (Sw).

(a) (b) (c)



Graph 1. (a) Kcore Vs Ktimur (b) Porosity vs Permeability (c) Sw Cut-off from Fractional Flow

RESERVOIR LUMPING

Lumping carried out to know the values of water saturation, porosity, and clay content as

well as the depth of a reservoir. The determination of lumping required a cut-offvalue for porosity is 13%, shale volume (Vsh) is 50% and water saturation (Sw) is 75%. The results of the reservoir lumping using the Archie method can be seen in the figure below:

Table 2. Reservoir Summary and Pay Summary Archie Method

CUTOFF (ARCHIE)													
ZONE	ZONE NAME	INTERVAL	GROSS	RESERVOIR					PAY				
				NET SAND	NTG	POR	SW	VSH	NET PAY	NTG	POR	SW	VSH
		M	M	M		V/V	V/V	V/V	M		V/V	V/V	V/V
1	BRF-1	2302.00-2481.99	179.98	25.9	0.144	0.143	0.904	0.241	3.4	0.019	0.134	0.677	0.187
2	BRF-2	2506.68-2526.03	19.36	0.15	0.008	0.103	1	0.479	---	---	---	---	---
3	BRF-3	2569.92-2616.25	46.33	---	---	---	---	---	---	---	---	---	---

INITIAL RESERVED

The initial reserve calculation is determine using the volumetric method to obtain the large amount of hydrocarbon reserves contained in the baturaja formation. It is known thatthe data area is 12,686 acres, the porosity value is 18.7%, the thickness of BRF-1 is 11.48ft thick, the water saturation is 0.677 and the formation volume factor is 1.377 Bbl / Stb. After calculating the initial reserves using the volumetric method, the amount of reservesin the baturaja formation is 84740.5 STB.

4. CONCLUSIONS

1. The lithological identification of the formation in the baturaja formation was dominated by limestone rocks. Determination of shale volume using the log gamma-ray approach and after the cut-off was carried out on the baturaja formation, the results were 0.187 for BRF-1, BRF-2 and BRF-3 were non-potential zones. Then for the determination of porosity using the neutron-density approach, the result is 0.134 for BRF-1, for BRF-2 and BRF-3 are non-potential zones.
2. Based on the results of the evaluation on the BRF-1 zone for each calculation method, if analyzed, the Sw Archie value is 0.677, Sw Simandoux is 0.658, and Sw Indonesia is0.668. The Archie method has the advantage of being able to determine the saturation value of water well in reservoirs that do not contain shale or clean formation. Then for Sw Simandoux has the smallest Sw value, which will give a more optimistic hydrocarbon saturation value and this method is superior in shaly sand formation. Meanwhile, Sw Indonesia has advantages, including in this method the presence of shale has begun to be taken into account. In addition, it is very good at calculating water saturation in formations containing low salinity water / fresh water and createdfor oil reservoirs in Indonesia.

3. Reservoir lumping, the reservoir net is about 25.9 m and the netpay is 3.4 m in BRF-1 zone. Then for BRF-2 has a net reservoir is 0.15 m and does not have a net reservoir, BRF-3 does not have a reservoir. This is obtained based on the cut-off value of shale volume is 50%, porosity is 13%, and water saturation is 75%.
4. The results of calculations using the volumetric method, the hydrocarbon reserves are 84740.5 STB at BRF-1.

REFERENCES

[1] Baouche R, Nedjari A 2006 Petrophysical Analysis in Reservoir Characterization – Application in the Triassic Hamra Gas Field, Algeria. *Canadian Well Logging Society.*Pp 1

[2] Dr. Ir. Ratnayu Sitaresmi, MT 2013 The Study of the Effect of Water Saturation (Sw) on Fractional Flow and Water Cut to Determine Sw Cutoff. *International Journal of Engineering Research & Technology (IJERT).* pp 3-4

[3] Glerys G, PDVSA and Hassan A, DIGITOIL 2013 Methodology For Advanced Interpretation Of Poor Quality Logs In Multimineral Carbonate Reservoirs. *J 2013 SPE WVPS Second South American Oil and Gas Congress held in Porlamar*

[4] Moses M, Mimonitu O 2019 Seonghyung J 2016 Petrophysical interpretation and fluid substitution modelling of the upper shallow marine sandstone reservoirs in the Bredasdorp Basin, offshore South Africa. *Journal of Petroleum Exploration and Production Technology (2020)*

[5] Setya D, Suryantini, Wahyu S 2006 Thermal modeling and heat flow density interpretationof the onshore Northwest Java Basin. *Putra et al. Geotherm Energy (2016) 4:12.* Pp 2

[6] Taeyoun K, Seho H, Seonghyung J 2016 Petrophysical approach for estimating porosity, clay volume, and water saturation in gas-bearing shale. *Austrian Journal of Earth Sciences*