Application of Fracture Barrier Analysis in Well Stimulation Planning for Upper Baturaja Limestone Formation Based on Well Log & Drill Cutting Data from OBF-01 and OBF-04 Wells, Offshore Southeast Sumatra

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ABSTRACT

In general, the South Sumatra Regional Stratigraphy of the Baturaja Limestone Formation facies is deposited on the Buildup Carbonate (Reef) and the Limestone Clastic Carbonate of the Baturaja Formation which grows as a buildup reef on the platform in the Basement High (Horst) underneath is the Lemat Formation volcanic deposits. Referring to the facies model in general, the Baturaja Limestone Formation, the depositional environment starts from Shelf Lagoon Open Circulation - Winnowed Edge Sand - Organic Buildup - Fore Slope - Deep Shelf Margin - Open Sea Shelf - Basin, meaning that carbonate is formed starting from pure organic Cabonate Buildup Reef without / a little sludge / mud to the Carbonate Basin where more muddy / mud is present, this condition causes clay minerals to also more and more mix with Terigenous Clastics (Quartz, feldpar). The complexity of the Baturaja Limestone Formation requires fracture barrier analysis associated with well stimulation planning in order to increase oil productivity with the appropriate method.
Fracture barrier fracture analysis is an approach method to determine the depth interval that becomes a barrier in hydraulic fracturing by correlating the results of geomechanical analysis from well log data and mineralogical analysis from drill cuttings data, so that a commonly used well stimulation method can be selected, namely hydraulic fracturing, acidizing, and acid-fracturing.
From the ternary diagram plot the XRD (bulk) analysis results show that the distribution of the main minerals (Quartz, Clay, Calcite) is more dominant in the ductile zone, hard to frac category. This shows that all the depth intervals in the OBF-01 and OBF-04 wells are more ductile, and are not recommended for hydraulic fracturing. From the XRD (bulk) analysis, Calcite mineral is more dominant, so for well stimulation work it is recommended to use acidizing or acid-fracturing.

Keywords: baturaja limestone formation, drill cuttings, fracture barrier, well log, well stimulation

I. INTRODUCTION

The South Sumatra Basin is one of four basins located on the back side of the Sumatra portion of the Indonesian Island Arc complex. It consists of several structural sub-basins with Tertiary sedimentary section lying unconformably on the eroded and faulted topography of Pre-Tertiary basement metamorphic and igneous rocks. Late Tertiary anticlinal traps account for more than 75% of the known oil and gas reserves in the province (Hall, 2002).

Baturaja carbonate deposition within the study area began during the early Miocene at the onset of the marine transgression that followed the Eocene rifting phase. Throughout the area, the Baturaja carbonates appear to unconformably overlie the marine shales of the Pendopo Formation, the terrestrial deposits of the Talang Akar formation and the Pre-Tertiary age basement. Downdip, the Pendopo Formation appears to transition directly into the basal carbonates of the Baturaja formation, making it difficult to define the transition between the formations.

There are seven depositional environments were defined using the relative position of the well within the platform and the dominant lithofacies derived from log-based facies tied up to both core and mud log descriptions: Buildup/Reef; Fore reef/flank; Shoal; Sand/Mud Aprons; Platform Interior; Lagoon; and Basin The BRF carbonates had two distinct development stages: the initial basal transgressive phase and the final highstand phase. Carbonate buildup development took place along the platform margin during the initial basal transgressive phase and moved into the surrounding basement highs areas during the highstand phase (Sanchez & Danudjaja, 2013).

Referring to the facies model (Wilson, 1975) in general, the Baturaja Limestone Formation, the depositional environment starts from: Shelf Lagoon Open Circulation - Winnowed Edge Sand - Organic Buildup - Fore Slope - Deep Shelf Margin - Open Sea Shelf - Basin, meaning that carbonate is formed starting from Pure Organic Kabonate Buildup Reef without /

less mud / mud to Carbonate Basin where more muddy / mud is present, this condition causes clay minerals to also mix more and more with Terigenous Clastics (Quartz, feldpar).

In an effort to increase hydrocarbon production from reservoir rocks with low permeability, information is needed about the elastic properties of the rock (geomechanical parameters) as a basis for determining formation intervals with high fracability (Jin et al., 2014; Sui et al., 2015; Bai, 2016) , so a geomechanical analysis is needed to model the interval of prospect formation with high fracability using well log data (Lobo et al., 2017). Fracability is a function of the brittleness index which can be calculated from Young's Modulus and Poisson's ratio (Grieser and Bray, 2007; Yuan et al., 2017).

Sui et al. (2015) stated that fracability is a comprehensive reflection of geological and reservoir characteristics, especially those related to crustal stress, rock brittleness, brittle mineral content, clay content, rock strength, digenesis and natural fracture, where fracability is a term currently used in choose hydraulic fracturing interval.

Previously, many argued that only brittleness could characterize natural fracture rock, assuming that formations with high brittleness would break easily (Sui et al., 2015). Chong et al. (2010) stated that brittleness alone is not sufficient to describe fracability, because formations with higher brittleness can also be a fracture barrier.

High-brittleness formations are considered as good candidates for hydraulic fracturing. However, this point of view is not entirely correct, because brittleness does not indicate rock strength (Jin et al., 2014; Jinbu, 2015). This can be found in the case of barrier faults between the upper and lower Shale Barnett formations, namely the presence of dolomite limestones from the Forestburg formation with higher brittleness, but instead become a fault barrier (Jin et al., 2014). To overcome the weaknesses of the high brittleness criteria in determining the hydraulic fracturing interval, the fracability index (FI) parameter was introduced, namely by integrating brittleness and energy absorption during hydraulic fracturing.

Thus, from the results of the fracture barrier analysis of the Baturaja limestone formation from the OBF-01 and OBF-04 wells of Offshore Southeast Sumatra using drill cuttings and well log data, a fracability model can be made that can be applied to determine the location and formation depth intervals in well stimulation planning accurately.

II. METHODS

2.1. Geological Setting of the South Sumatra Basin

The South Sumatra Basin formation has been divided in three major tectonic phases: 1) Eocene Tectonic extension, 2) Tectonic quiescence with late normal faulting from early Miocene to early Pliocene and 3) Basement compression and basin inversion since the Pliocene (Bishop, 2001). The extensional phase started in the Eocene with the rifting of Pre-Tertiary basement resulting in a series of half-grabens that were later filled by locally derived, syn-sedimentary deposits of Eocene-Early Miocene age. Tectonic quiescence and crustal cooling during the Early Miocene to Early Pliocene, along with the onset of a widespread marine transgression, provided the ideal conditions for carbonate deposition during the second tectonic phase. Compression and inversion of the basin began in Pliocene time (Bishop, 2001).

Baturaja limestone formation was deposited during the transition of the rifting stage and tectonic quiescence specifically in the early Miocene time. The Baturaja Formation carbonate facies in Letang, Rawa, and Tengah could be divided into two main units, which are the muddy wackestone/packstone platform facies and coral-algal floatstone/boundstone reefal facies. The platform facies predominantly consist of tight muddy wackestone to packstone distributed predominantly across the area with various thickness ranges from 5 – 100 meters, with the porosity of this unit ranges from 0 – 12%. The facies represent the early transgressive sequence and consists of carbonate basal layer unconformably overlying the syn-rift terrestrial-marine sediments and Pre-Tertiary basement rocks (Amir, et al., 2011).

The Baturaja limestone formation in general was deposited in the back-reef environment behind the edge of the basin during the Early Miocene (Maryanto, 2007).

Regional Stratigraphy of South Sumatra (Pujasmadi, 2002) in general, the Baturaja limestone formation facies are deposited in Buildup Carbonate (Reef) and Limestone Clastic Carbonate of the Baturaja formation which grows as buildup reef on the platform in Basement High (Horst) underneath is the Lemat Formation Volcanic Deposits. This data is strengthened by a seismic cross section (Sanchez & Danudjaja, 2013).

2.2. Literature Review

The types of minerals contained in rock samples can be identified using XRD (X-Ray Diffraction) analysis with the bulk method, and the result is that the peaks can be read by the type of mineral based on the determinant peaks (Bladh et al., 2001), and can be categorized into two groups, namely the major minerals and minor minerals. From the results of the

main minerals, i.e: Quartz, Clay, and Carbonate (Q-C-C), the brittleness index can be determined using the Jarvie Equation (2007), as follows:

$$BI_{(Jarvie,2007)} = \frac{W_{qtz}}{W_t} \quad \text{.....} \quad (1)$$

where;
BI = brittleness index
Wqtz = quartz mineral weight
Wt = total mineral weight (Quartz + Clay + Carbonate)

The brittleness index is the most widely used parameter to measure the brittleness of rocks (Perez and Marfurt, 2013). In general, brittleness is used as a descriptor in selecting formation depth intervals for hydraulic fracturing planning, so brittleness is one of the most important rock mechanical properties (Jarvie et al., 2007, Chong et al., 2010; Jinbu et al., 2015).

Sonic Log is a logging tool that is used to determine the mechanical properties of rocks, the principle of which works is to use sound speed waves that are sent or transmitted into the formation by the transmitter, where the reflected sound will be received by the receiver. The time it takes for sound waves to reach the receiver is known as the transit time interval (Δt). When these waves travel through rock samples, different wave types also experience different attenuation. During experimental measurements, S-waves are more difficult to obtain, so for most applications P-waves are used frequently. However, the determination of S-waves is very important for calculating the modulus of elasticity (E) or Young's Modulus and Poisson's ratio.

The dynamic compressive strength of rocks can be determined using empirical equations obtained from P-wave velocity data (sonic log data) with equations from Kahraman (2007) for dolomite, sandstone, marl, limestone, shale, diabase and serpentinite rocks.

$$UCS = 9.95 \times V_P^{1.21} \quad \text{.....} \quad (2)$$

where;
UCS = Unconfined compressive strength, MPa
V_p = P-wave velocity, km/s

Dynamic Young's modulus of rocks can be determined using empirical equations obtained from the P-wave velocity and S-wave velocity data. With the limited data from Sonic Log, which only has a P-waves velocity value, it is therefore assumed that the S-waves value is based on the Castagna equation (1985). Castagna plotted Vp and Vs in the dominant Shale formation, resulting in the following equation:

$$V_s = 0.862\ V_p - 1.172 \quad \text{.....} \quad (3)$$

with dynamic Young's Modulus equation proposed by Fjær et al. (2008):

$$E = \rho V_s^2 \frac{(3V_p^2 - 4V_s^2)}{(V_p^2 - V_s^2)} \quad \text{.....} \quad (4)$$

where;
v_p = Primary velocity of propagation (km/sec)
v_s = Secondary velocity of sliding (km/sec)
ρ = Rock density (g/cc)
E = Young's Modulus (MPa)

Dynamics Poisson's ratio of rock can be determined using empirical equations obtained from P-wave velocity and S-wave velocity data with the equation according to Zoback (2007):

$$\upsilon = \frac{1-2\left[\frac{v_s}{v_p}\right]^2}{2\left[1-\left[\frac{v_s}{v_p}\right]^2\right]} \quad \text{or} \quad \upsilon = \frac{V_p^2 - 2V_s^2}{2(V_p^2 - V_s^2)} \quad \text{.....} \quad (5)$$

where;
v_p = Primary velocity of propagation (km/sec)

v_s = Secondary velocity of sliding (km/sec)
ρ = Rock density (g/cc)
υ = Poisson's ratio (dimensionless)

The Young's modulus of brittleness ($E_{brittleness}$) will have a value between 0 – 1, where the higher the modulus young value or approaching the maximum value of the modulus young rock calculation in a well with Equation 6, the rock will be brittle and vice versa, where the E_{max} value is obtained from the calculation results. The highest modulus young from the calculation of the well log, on the other hand, E_{min} is obtained from the lowest modulus young calculation from the well log calculation as in **Figure 1**, so that the determination of the modulus young brittleness can be determined by the equation:

$$E_{brittleness} = \frac{E - E_{min}}{E_{max} - E_{min}} \quad \text{.....} \quad (6)$$

where;

$E_{brittleness}$ = Young's modulus of brittleness, frction
E = Young's modulus, MPa
E_{min} = Minimum Young's modulus, MPa
E_{max} = Maximum Young's modulus, MPa

The Poisson's ratio of brittleness ($\upsilon_{brittleness}$) will be between 0 - 1 where the lower the Poisson's ratio value or close to the minimum value of the rock Poisson's ratio calculation with Equation 7, the rock will be brittle and vice versa, where the υ_{max} value is obtained from the highest Poisson's ratio calculation. From the calculation, on the contrary, U_{min} is obtained from the lowest Poisson's ratio calculation as in **Figure 1** so that the Poisson's ratio of brittleness can be determined by the equation:

$$\upsilon_{brittleness} = \frac{\upsilon - \upsilon_{max}}{\upsilon_{min} - \upsilon_{max}} \quad \text{.....} \quad (7)$$

where;

$\upsilon_{brittleness}$ = Poisson's ratio of brittleness, fraction
υ = Poisson's ratio, fraction
υ_{min} = Minimum Poisson's ratio, fraction
υ_{max} = Maximum Poisson's ratio, fraction

So, the brittleness average can be determined by averaging the $E_{brittleness}$ and $\upsilon_{brittleness}$ with the equation:

$$B_{avg} = \frac{E_{brittleness} + v_{brittleness}}{2} \quad \text{.....} \quad (8)$$

where;

B_{avg} = Brittleness Average, fraction
$v_{brittleness}$ = Poisson's ratio of brittleness, fraction
$E_{brittleness}$ = Young's Modulus of brittleness, fraction

Perez and Marfurt (2013) in their paper proposed the category of rock brittleness based on the brittleness index value as shown in **Table-1**.

Table 1. Rocks brittleness category based on the brittleness index (Perez and Marfurt, 2013)

No	Brittleness Index	Category
1	0 - 0.16	Ductile
2	0.16 - 0.32	Less ductile
3	0.32 - 0.48	Less brittle
4	> 0.48	Brittle

Fracability is defined as a measure of the ease a formation can be broken. This parameter is a parameter that needs to be determined if hydraulic fracturing is to be performed in the reservoir rock to increase rock permability. Jin et al. (2014)

classified rock types based on the value of the fracability index, based on the relationship between Brittleness and Young's modulus as shown in **Table 2**.

Table 2. Classification of Rock Types Based on the Fracability Index (Jin et al., 2014)

No	Rock Type	Fracabilty Index (dimensionless)
1	Fracable	> 0.55
2	Not Fracable (hard to frac)	≤ 0.55

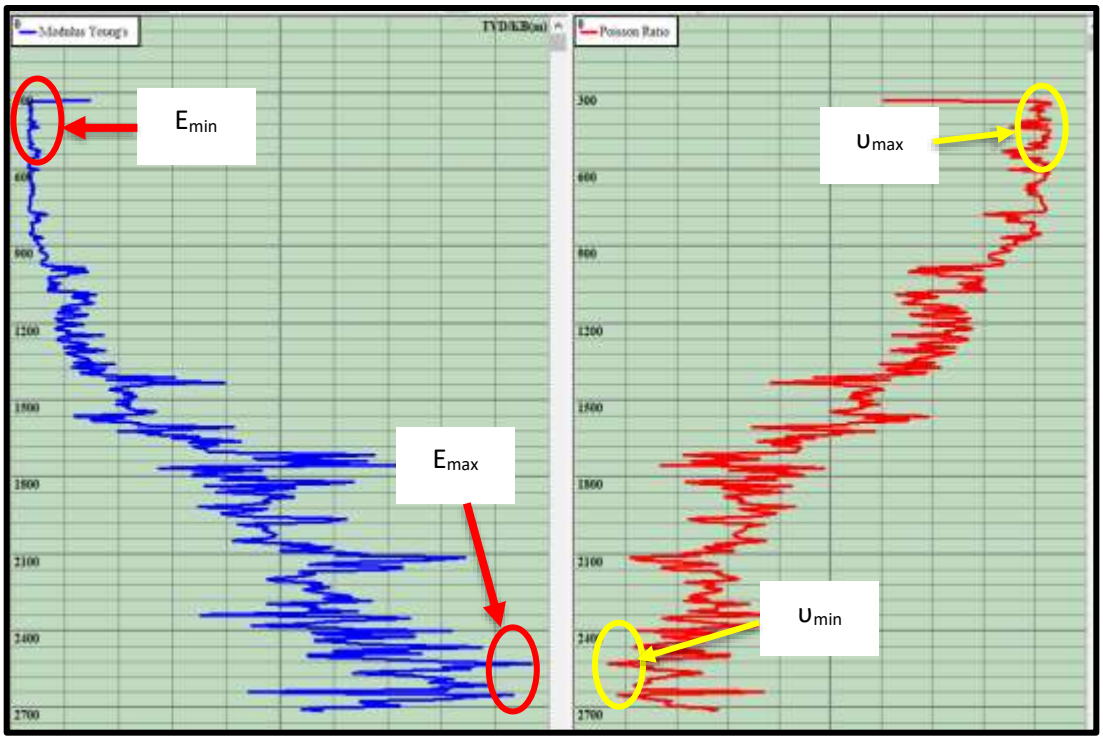

Figure 1. Determination of Maximum-Minimum Young Modulus and Poisson's Ratio Maximum-Minimum

Based on the **Table 2**, rocks can easily crack or break if it has a fracability index value greater than 0.55. Meanwhile, rocks will not easily crack or be difficult to break if they have a fracability index value of less than or equal to 0.55.

The mathematical model of the fracability index can be determined based on the parameters of Brittleness and Young's Modulus which are defined as follows:

$$FI = \frac{B_n + E_n}{2} \quad \text{.....} \quad (9)$$

where;

FI = Fracability index, fraction
B_n = Brittleness normalization, fraction
E_n = Young's Modulus normalization, fraction

Normalization of the brittleness index can be determined by the equation:

$$B_n = \frac{B - B_{min}}{B_{max} - B_{min}} \quad \text{.....} \quad (10)$$

where;

B_n = Brittleness normalization, fraction
B = Brittleness at analyzed depth, fraction
B_{min} = Minimum brittleness in formation is investigated, fraction
B_{max} = Maximum brittleness in formation is investigated, fraction

Normalization of Young's modulus can be determined by the equation:

$$E_n = \frac{E_{max}-E}{E_{max}-E_{min}} \quad \text{...} \quad (11)$$

where;

E_n = Young’s Modulus normalization, fraction

E = Young’s Modulus at anlayzed depth, MPa

E_{min} = Minimum Young’s Modulus in formation is investigated, MPa

E_{max} = Maximum Young’s Modulus in formation is investigated, MPa

III. RESULTS AND DISCUSSION

3.1. XRD (bulk) analysis results of the OBF-01 and OBF-04 wells

XRD (bulk) analysis to identify the main mineral types contained in each of the drill cutting samples from wells OBF-01 and OBF-4. Mineral types identified from the XRD analysis using the bulk powder method, i.e: 8 samples from Well OBF-01, and 8 samples from Well OBF-4 are shown in **Table 3** and **Table 4**.

From the results of the bulk analysis of the drill cutting samples of the OBF-01 and OBF-04 wells, a plot of the main minerals (Quartz, Clay and Calcite) was carried out with the ternary diagram shown in **Figure 2**. From **Figure 2**, it can be seen that the distribution of main minerals (Quartz, Clay, and Calcite) is more dominant in Zone 4 (Ductile, hard to frac category). This shows that all the depth intervals in the OBF-01 and OBF-04 wells are more ductile, so hydraulic fracturing is not recommended. From the results of the bulk analysis, Calcite mineral is more dominant, so for well stimulation work it is recommended to use acidizing or use acid fracturing.

Table 3. XRD (bulk) analysis results of drill cutting samples of well OBF-01

No	Main Mineral				Minor Mineral							Total (%)
	Depth (ft)	Quartz (%)	Calcite(%)	Clay (%)	Feldspar (%)	Apatite (%)	Pyrite (%)	Dolomite (%)	Sillimanite (%)	Kaliophilite (%)	Epidote (%)	
1	5120	25,92	19,42	31,15	9,41	3,43	3,77	0,00	0,00	0,00	6,89	100
2	5180	25,43	36,74	24,37	0,00	0,00	3,82	0,00	0,00	0,00	9,65	100
3	5200	21,77	35,13	25,14	3,14	0,00	3,29	2,85	0,00	0,00	8,66	100
4	5220	64,66	14,51	15,71	0,00	0,00	1,81	0,00	0,00	0,00	3,31	100
5	5240	26,91	37,00	22,99	0,00	0,00	3,79	0,00	0,00	0,00	9,31	100
6	5260	25,60	33,22	24,01	7,16	0,00	3,92	0,00	0,00	0,00	6,09	100
7	5280	20,82	38,88	16,42	16,27	0,00	2,34	0,00	0,00	0,00	5,27	100
8	5328	32,80	36,23	19,68	0,00	0,00	2,90	0,00	0,00	0,00	8,39	100

Table 4. XRD (bulk) analysis results of drill cutting samples of well OBF-04

No	Main Mineral				Minor Mineral							Total (%)
	Depth (ft)	Quartz (%)	Calcite(%)	Clay (%)	Feldspar (%)	Apatite (%)	Pyrite (%)	Dolomite (%)	Sillimanite (%)	Kaliophilite (%)	Epidote (%)	
1	5160	28,97	19,15	34,34	4,83	0,00	3,32	3,17	0,00	0,00	6,21	100
2	5188	31,98	18,19	30,93	6,81	0,00	3,44	0,00	0,00	0,00	8,66	100
3	5200	41,91	22,38	27,85	0,00	0,00	2,92	0,00	0,00	0,00	4,94	100
4	5360	25,59	27,80	21,71	3,36	1,97	2,19	3,75	7,15	0,00	6,48	100
5	5380	28,27	30,08	22,81	5,63	1,88	3,20	2,40	0,00	0,00	5,72	100
6	5400	29,97	26,17	24,86	4,98	0,00	3,46	4,12	4,26	0,00	2,18	100
7	5410	33,00	27,31	22,34	4,59	2,61	2,71	0,00	2,65	0,00	4,78	100
8	5420	32,73	26,07	17,60	7,97	0,00	2,89	2,83	2,79	0,00	7,13	100

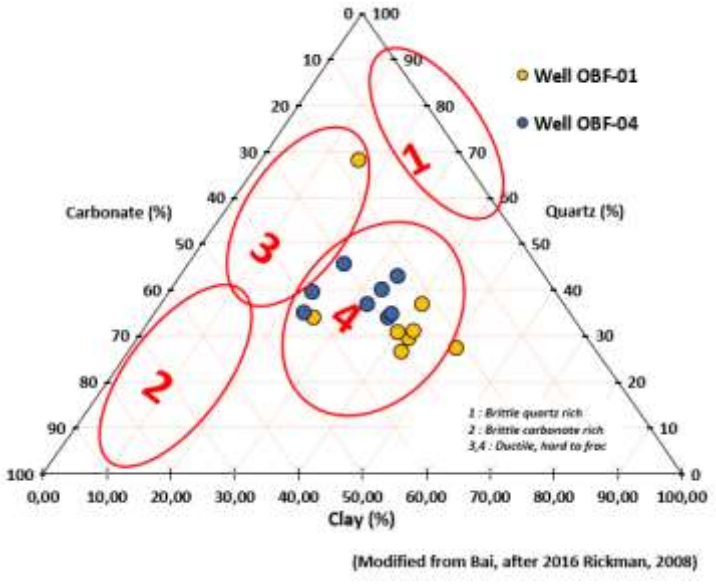

Figure 2. Plot of the main mineral in ternary diagram from the results of the XRD analysis (bulk) of drill cutting samples OBF-01 and OBF-04 wells

3.2. Fracture Barrier Analysis of Well OBF-01:

Figure 3 shows the plot of the results of XRD (bulk) analysis (Q-C-C and BI) from drill cutting samples of the Upper Baturaja Formation with a depth interval of 5120 - 5328 ft, where Calcite is the most dominant (31.39% Avg), compared to Quartz (30.49% Avg), and Clay (22.43% Avg). Brittleness Index (0.36) < 0.48, including rocks with the Ductile category (Perez & Marfurt, 2013).

Figure 4 shows the plot of the results of the well log analysis (UCS, BI and FI) of the well OBF-01 from the Upper Baturaja Formation at the interval of 5120 - 5328 ft, where the Brittleness Index is generally < 0.48, including rocks with the Ductile category (Perez & Marfurt, 2013). In general, the Frability Index < 0.55, is not fracable (hard to frac) or difficult to do hydraulic fracturing (Jin et al., 2014).

Figure 5 shows the correlation of the results of XRD analysis & well log of well OBF-01 (Upper Baturaja Formation), it can be concluded that all depth intervals are fracture barriers. From the results of XRD (bulk analysis), with the predominance of Calcite (31.39% Avg), the Upper Baturaja Formation for well stimulation, it is recommended to use acidizing or acid-fracturing (a combination of acidizing and fracturing).

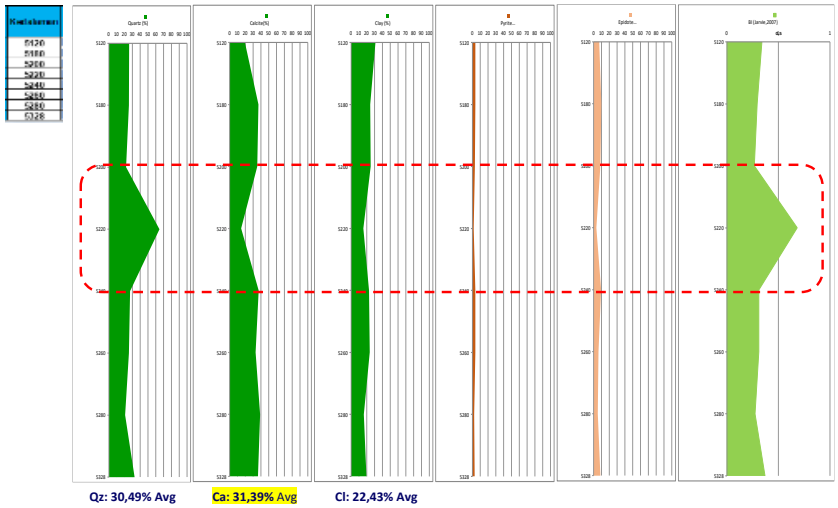

Figure 3. Plot of XRD Analysis (Bulk) Results of the Well OBF-01 of the Upper Baturaja Formation (5120 – 5328 ft)

Figure 4. Well Log Analysis of the Well OBF-01 of the Upper Baturaja Formation (5120 – 5328 ft)

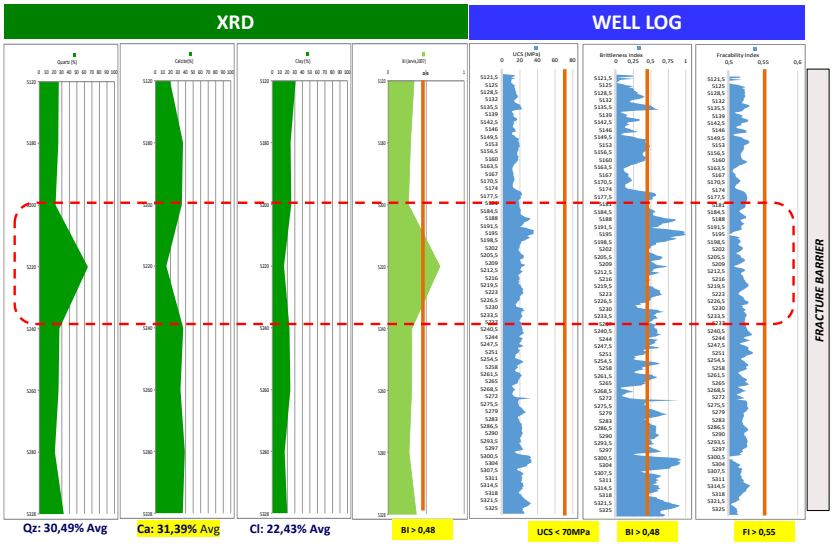

Figure 5. Correlation of XRD Analysis and Well Log of Well OBF-01, Upper Baturaja Formation

3.3. Fracture Barrier Analysis of Well OBF-04:

Figure 6 shows the plot of the results of XRD (bulk) analysis (Q-C-C and BI) for drill cutting samples of the Upper Baturaja Formation with a depth interval of 5160 - 5420 ft, where Quartz minerals are the most dominant (31.55% Avg), compared to Clay (25.31% Avg) and Calcite. (24.97% Avg. Brittleness Index (0.39 Avg) <0.48, including rocks with the Ductile category (Perez & Marfurt, 2013).

Figure 7 shows the plot of the results of well log analysis (UCS, BI and FI) of well OBF-04 in the Upper Baturaja Formation, the interval of 5160 - 5420 ft, where the Brittleness Index is generally < 0.48, including rocks categorized as Ductile (Perez & Marfurt, 2013). In general, the Frability Index < 0.55, is not fracable (hard to frac) or difficult to do hydraulic fracturing (Jin et al., 2014).

Figure 8 shows the correlation of the results of XRD analysis & well log of well OBF-04 (Upper Baturaja Formation), it can be concluded that all depth intervals are fracture barriers. From the results of the XRD (bulk analysis) test, with the predominance of Calcite (31.39% Avg), the Upper Baturaja Formation for well stimulation, it is recommended to use acidizing (acidizing) or acid-fracturing (a combination of acidizing and fracturing).

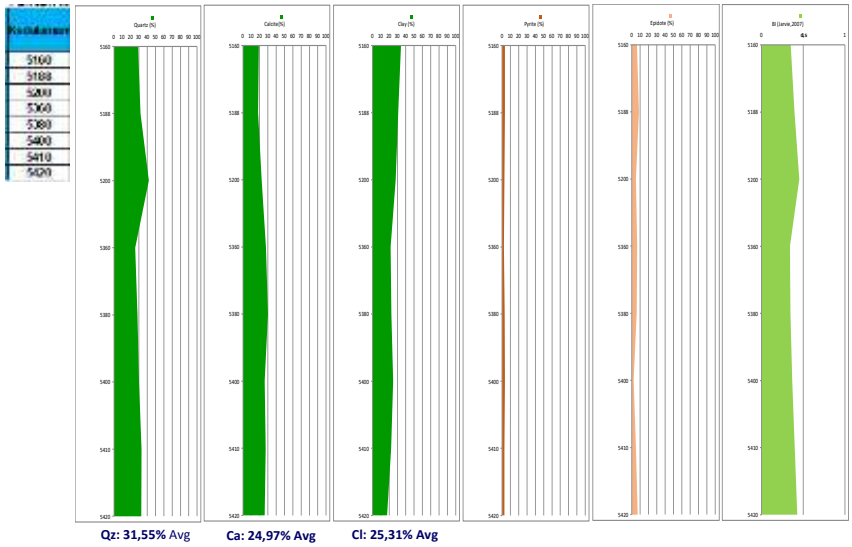

Figure 6. Plot of XRD (Bulk Analysis) Results of the Well OBF-04 of the Upper Baturaja Formation (5160 – 5420 ft)

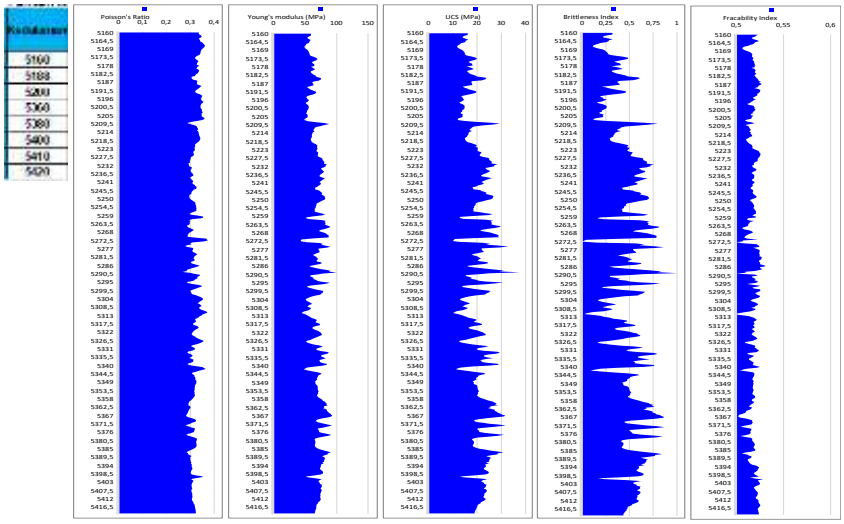

Figure 7. Well Log Analysis of the Well OBF-04 of the Upper Baturaja Formation (5160 – 5420 ft)

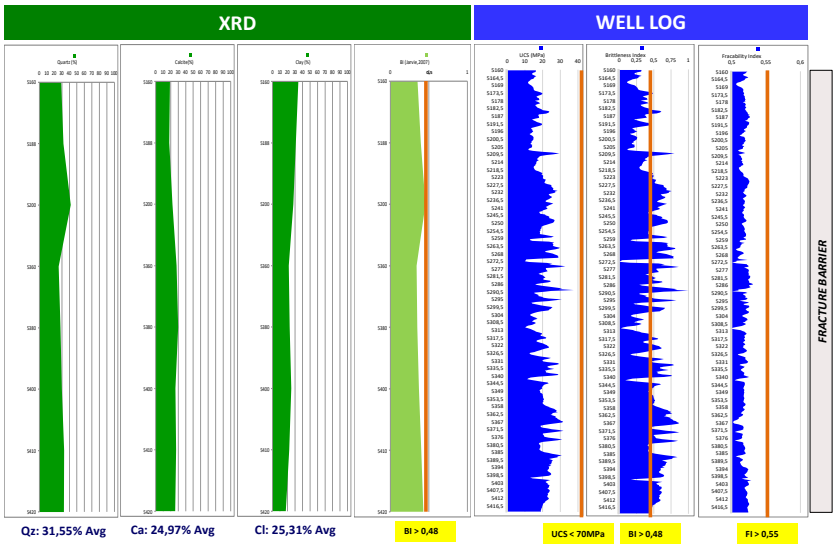

Figure 8. Correlation of XRD Analysis and Well Log of Well OBF-04, Upper Baturaja Formation

3.4. Summary of Fracture Barrier Analysis Results

In general, the results of bulk XRD analysis of cutting samples from OBF-01 and OBF-04 wells in the Upper Baturaja Formation (UBR), show that Calcite is the most dominant mineral compared to Quartz and Clay. Brittleness Index <0.48, including rocks with the Ductile category (Perez & Marfurt, 2013).

In general, the results of well log analysis (UCS, BI and FI) of OBF-01 and OBF-04 wells in the Upper Baturaja Formation, Brittleness Index generally <0.48, including rocks with the Ductile category (Perez & Marfurt, 2013). In general, the Frability Index <0.55, is not fracable (hard to frac) or difficult to do hydraulic fracturing (Jin et al., 2014).

Correlation of XRD analysis results and well logs of OBF-01 and OBF-04 wells (Upper Baturaja Formation), it can be concluded that all depth intervals are fracture barriers.

In general, the XRD test results (bulk analysis), with the predominance of Calcite minerals, the Upper Baturaja Formation for well stimulation, are recommended to use acidizing or acid-fracturing (a combination of acidizing and fracturing).

In fracture barrier analysis, the presence of minor minerals (Feldspar, Pyrite, Epidote, etc.) does not have a significant effect on the properties of the Upper Baturaja Formation.

IV. CONCLUSION

1. From the results of the XRD analysis (bulk), based on plot from the ternary diagram, it shows that the distribution of the main minerals (Quartz, Clay, and Calcite) is more dominant in the Ductile zone, hard to frac category. This indicates that all intervals in the OBF-01 and OBF-04 wells are more ductile, and hydraulic fracturing is not recommended. From the results of the bulk analysis, Calcite mineral is more dominant, so for well stimulation work it is recommended to use acidizing or acid fracturing.
2. In general, the results of XRD (bulk) analysis of drill cutting samples from the OBF-01 and OBF-04 wells in the Upper Baturaja Formation (UBR), show that Calcite mineral is the most dominant mineral compared to Quartz and Clay. Brittleness Index < 0.48, including rocks with the Ductile category.
3. In general, the results of well log analysis (UCS, BI and FI) from the OBF-01 and OBF-04 wells in the Upper Baturaja Formation, Brittleness Index generally < 0.48, including rocks with the Ductile category. Frability Index in general < 0.55, is not fracable (hard to frac) or difficult to apply hydraulic fracturing.
4. Correlation of XRD and well log analysis results of the OBF-01 and OBF-04 wells (Upper Baturaja Formation), it can be concluded that all depth intervals are fracture barriers. In general, from the results of the XRD (bulk) analysis, with the predominance of Calcite mineral, it is recommended to use acidizing or acid-fracturing for well stimulation planning in the Upper Baturaja Formation.

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