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# Optimizing "Sleeping Reservoir" The Low-Quality Reservoir (LQR) of "BE_1" Sand at "Semangat" Field: Outstanding Performances, Further Opportunities, and Challenges

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**Abstract.**
"Semangat" field is one of primary field located at Wilayah Kerja (WK) Rokan, PT. Pertamina Hulu Rokan. First oil flowed in 1972 and reached peak production in 1974 with 28,865 BO. The production wells produce multiple reservoirs with simple ESP completions. Cumulative oil production was 92.4 MMSTB with current recovery factor is ~ 54%.
"Semangat" field has 4 major formations with distributed across the field. Over time, "D" and "M" Formation were the high-quality reservoirs and contributed the most oil production while "BE" and "BA" Formation where low quality reservoir with mostly produce with medium to low rates.
Lookback has been conducted with resulted low quality reservoir performance showed less production contribution when comingle with high-rate reservoirs. SM#007 was chosen as pilot well to produced single "BE_1" Low Quality Reservoirs (LQR) due to latest swab still shown 21 BPH/50% (2016). Surprisingly, SM#007 delivered excellent result by 564 BFPD/23 BOPD/96% WC although located at flank area.
This result was triggered to accelerate produce "BE_1" LQR Sand at attic position. SM#046 was the next pilot well to produce single "BE_1" and the result shown outstanding performance with initial production 456 BFPD/257 BOPD/44% WC. By this excellent result concluded "BE_1" was still has big opportunity to be developed.
The workflow process to developed "BE_1" LQR Sands was done by conducted integrated subsurface and engineering analysis such as: high resolution stratigraphic analysis, re-calculation petrophysics, fluid contact OWC analysis, and validated with production data. The final output is to identify sweet spot to optimized "BE_1" LQR Sands.
Outstanding performances was delivered by "BE_1" LQR Sands from 7 wells executed with deliver ~ 400 BOPD incremental oil, achieve > 70% success rate workover and well intervention job, and reducing fluid. Those result increasingly convincing "BE_1" LQR Sand was "sleeping reservoir" with huge oil potential. The probable estimation size of prize from "BE_1" LQR Sands reach > 1 MMBO and identify more than 10 wells could produce this big opportunity by revisit interval and add new perforation of the "BE_1" LQR Sand.
By having integrated and creative deep review and analysis can provide excellent result by deliver an opportunity to unlock Low Quality Reservoirs in "BE_1" Sand. Additional data such as surveillance log (CO Log) and additional new wells can increase the technical confident level to optimize the LQR Sands.

**Keyword(s):** Low Quality Reservoir, Optimization

## 1 Introduction

"Semangat" field is one of primary field located at Wilayah Kerja (WK) Rokan, PT. Pertamina Hulu Rokan (Figure 1). The first oil flowed in 1972 and reached peak production in 1974 with 28,865 BO. The production wells produce multiple reservoirs with simple ESP completions. The cumulative oil production at end of 2020 was 92.4 MMSTB with current recovery factor is ~ 54%.

"Semangat" field has simple anticline four-way dips structural with has 4 major formations with distributed across the field. The stratigraphic column shown younger to older was "D", "BE", "BA", and "M" Formation (Figure 2). Over the time, "D" and "M" Formation were the high-quality reservoirs which have permeability > 2 Darcy were the most contributor oil production. While in other side, "BE" and "BA" Formation where low quality reservoir (permeability < 1 Darcy) produces with medium to low rates. The consequence in current practical in producing the oil from this field was "BE" and "BA" formation were contributed less compared to "D" and "M" Formation due to its quality reservoirs.

The workover (WO) lookback has been conducted for some wells that produce comingle "M_1" Sand with "BE_1" resulted low quality reservoir performance shown less production contribution when comingle with high-rate reservoirs. Based on lookback results obtained recommendations to try to produce single production from "BE_1" Low Quality Reservoir to prove the bypassed oil. SM#007 was chosen as pilot well to produced single "BE_1" Low Quality Reservoirs (LQR) due to latest swab still shown 21 BPH/50% (2016). Surprisingly, SM#007 was deliver excellent result by 564 BFPD/23 BOPD/96% WC (2019) although located at flank area.

The excellent result of SM#007 was triggered to accelerate to produce "BE_1" LQR Sand at attic position with target to confirm the oil potential of this sand. SM#046 was the next pilot well to produce single "BE_1" with add new perforation and the result shown outstanding performance with initial production 456 BFPD/257 BOPD/44% WC. By those excellent result concluded "BE_1" was still has big opportunity to be developed.

## 2 Methodology

In order to develop the potential of "BE_1" LQR Sand, the integrated workflow of subsurface and engineering analysis was done such as: stratigraphic analysis, re-calculation petrophysics, fluid contact analysis, and validated with production data. The final output is to identify sweet spot to optimized "BE_1" LQR Sands.

### *2.1 Stratigraphic Analysis*

"BE" Formation consist of 2 sand unit reservoirs such as "BE_0" and "BE_1" Sand which those of sand unit shown low quality reservoirs (Figure 3). The high-resolution event stratigraphy (HIRES) has improved the resolving power of the chrono classification and the chrono correlation and resulted in the development of the high-resolution stratigraphy (Yuan-ren and He, 2001). Based on stratigraphic analysis shown "BE_0" Sand has thin sand with < 20 ft thickness and has pinch out to the NW part to be shale. While in other hand, the "BE_1" LQR Sand has thick sand (> 100 ft) with several lobe sands and distributed among the field. "BE_1" LQR Sand has divided into 3 flow unit: "BE_1", "BE_1A", and "BE_1B" Sand while oil was identified only at "BE_1" LQR Sand. Each flow unit sand was break by continuous shale section break and act as barrier for the reservoir.

### *2.2 Recalculation of Petrophysics*

Previously petrophysics analysis of "Semangat" Field including "BE_1" LQR Sand has shown optimistic result such as at shale section shown high oil saturation, permeability log calculation has different result with actual swab data and production, etc. Those facts led some miss interpretation to review and identify opportunity at lower quality reservoir especially at "BE_1" LQR Sand. Recalculation of Petrophysics was

done to accommodate those findings and resulted more reliable conclusion of "BE_1" LQR Sand that conclude oil opportunity only accumulated at "BE_1" flow unit sand that located upper part of "BE_1" Sand. In other hand, the new permeability log calculation is more accurate with swab and actual performance data.

### *2.3 Fluid Contact Analysis*

The identification of fluid contacts (gas-water contact – GWC, oil-water contact – OWC and gas-oil contact – GOC) is essential for field reserve estimates and field development and, also, for detailed formation evaluation (Niculescu and Ciuperca, 2019). The purposes of fluid contact analysis are to find out the oil potential of the "BE_1" LQR Sand and prioritize the wells located above the Current Oil Water Contact (COWC). COWC analysis was carried from the input of pressure data of the new wells, newest swab and production data, surveillance data (CO Log), and the resistivity value from the newest wells. (Figure 4) is the result of COWC Analysis of "BE_1" LQR Sand.

### *2.4 Surveillance Data*

For the mature field, surveillance data is needed to describe the condition of the oil behind casing pipe. One of the famous surveillance data uses in "Semangat" Field is Carbon Oxide (CO) Log. One of the key inputs to any reservoir management scheme is the timely monitoring of behind-pipe fluid saturation profiles across the field. Using the C/O ratio to compute water saturation offers many advantages over conventional techniques that depend on formation water salinity (Elshahawi et all, 2001). SM#046 has logged the latest surveillance data and shown "BE_1" LQR Sand still has good remaining saturation oil (SO) ~ 25%.

### *2.5 Production Validation*

Final step after completing the subsurface analysis is validate with actual production data such as swab test data and single production data. Validation and integration with production data is carried out to prove the potential that exists in each reservoir to be packaged into an opportunity and candidate for optimization plan.

## 3 Result

Below is the result of optimizing "BE_1" LQR Sand that have been executed, captured sweet spot area of interest to be optimized, and plan forward of this sand.

### *3.1 Excellence Workover Performance*

Currently there were 7 wells have been executed with total initial production 588 BOPD and average water cut 87%. The total incremental oil of executed wells about 400 BOPD with 57 BOPD/well and the success ratio ~ 70% (Figure 5). This excellence workover performance shown us that this "BE_1" LQR has the big opportunity to be optimized more.

### *3.2 Future Opportunity*

Based on integrated subsurface and engineering analysis, the "BE_1" LQR Sand had been mapped to unlock the big opportunity. Figure 6 is the area of interest mapping of "BE_1" LQR Sand that show the oil opportunity found with size of prize more than 1 MMBO. The field future opportunity strategy plan could be revisited intervals that have been closed for a long time, opening new zones that have never been perforated, and potential for fracturing. In addition, in terms of field development, there is also the potential to add development wells in places that still have enormous potential.

## 4 Conclusion

This part talk about the lesson learns, best practices, and challenges.

### *4.1 Lesson Learn*

"Semangat" Field shown the successful effort to differentiate reservoir management strategy of completion of high rate and low-rate reservoirs. Low-rate reservoirs that reflected from the low-quality reservoir could be optimized single production and or comingle with the same low-rate reservoirs.

### *4.2 Best Practices*

- Identifying potential work over campaign focusing 1 reservoir by checking Recovery Factor (RF) by sand and performing Value of Information (VOI) through work over to prove the remaining reserve.
- Find VOI candidate that have potentials not only in the target sand but also other proven sands as mitigation plan.
- After Identifying and proving potential in one well, draw estimate oil after contact and identify other well work candidates
- Producing in Lower Quality Reservoir not only increase production but also lowered water production.

### *4.3 Challenges*

Usually, lower quality reservoir with small and or no aquifer resulted in low inflow and could be difficult to be flown if produced single sand.

By having integrated and creative deep review and analysis can provide excellent result by deliver an opportunity to unlock Low Quality Reservoirs in "BE_1" Sand. Additional data such as surveillance log (CO Log) and additional new wells can increase the technical confident level to optimize the LQR Sands.

## References

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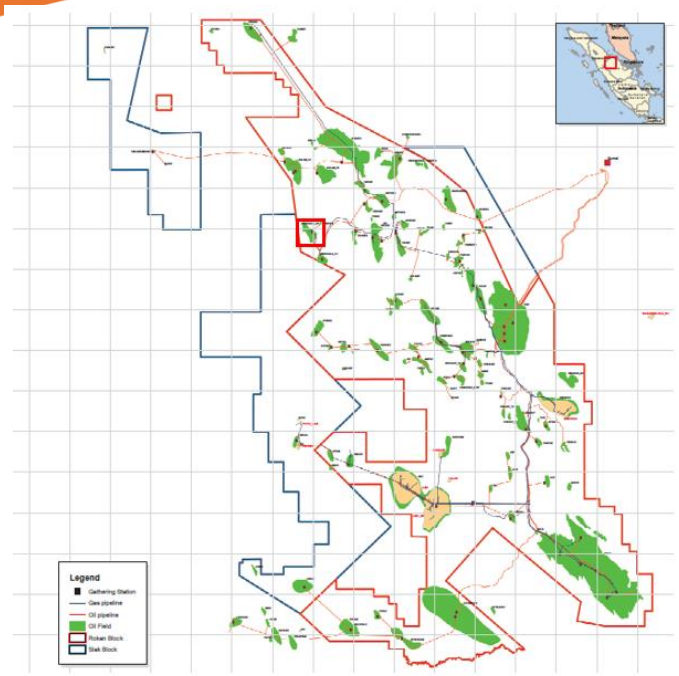


Figure 1. Wilayah Kerja Rokan with "Semangat" Field at Red Box

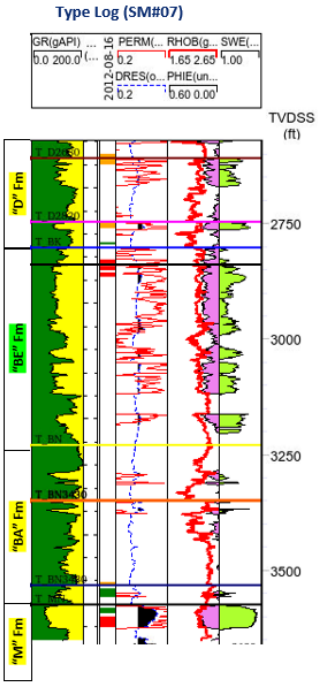


Figure 2. Stratigraphic Column of "Semangat" Field

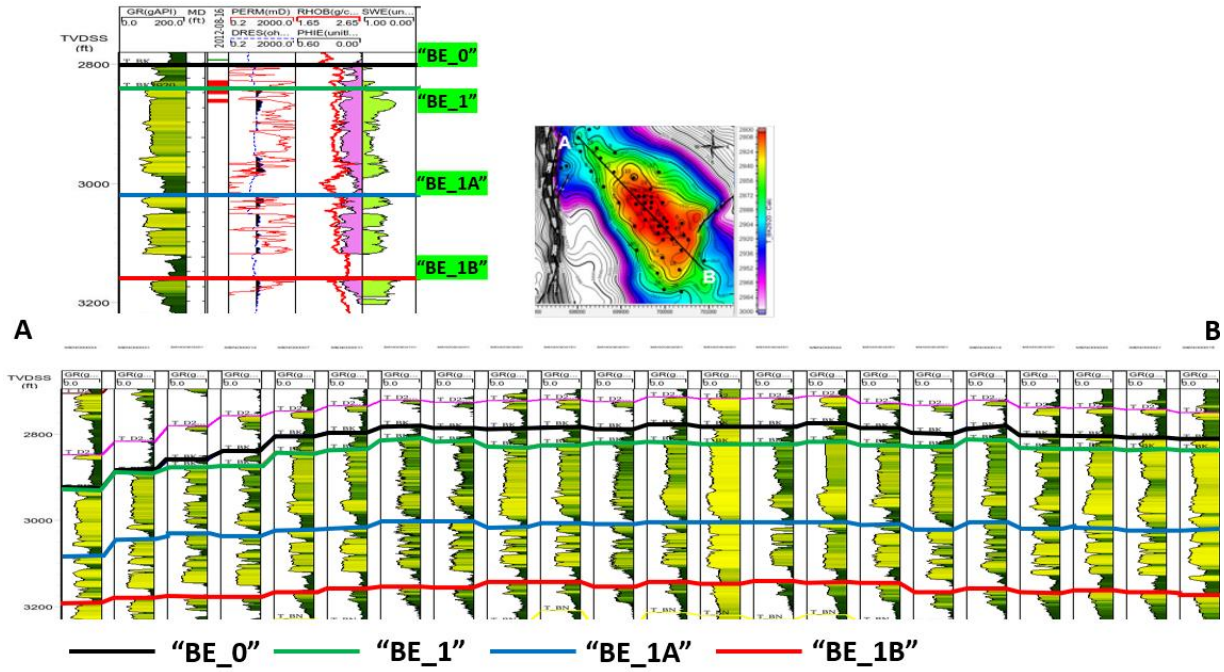


Figure 3. Stratigraphic Analysis of "BE" Formation that Show Every Flow Unit

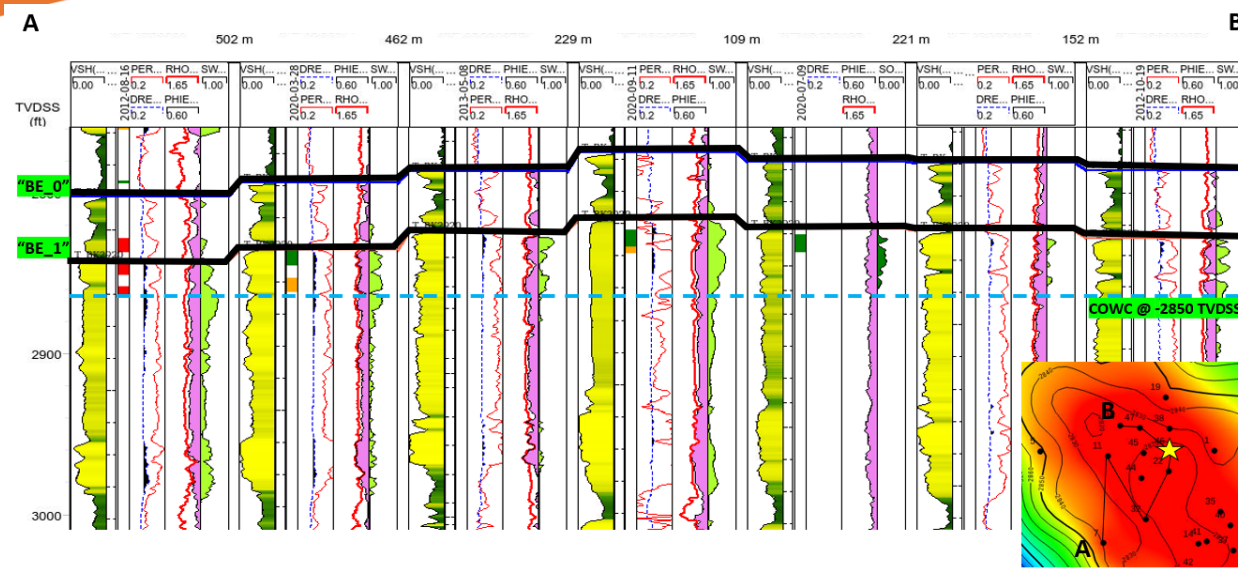


Figure 4. Current Oil Water Contact (COWC) Analysis of "BE_1" LQR Sand

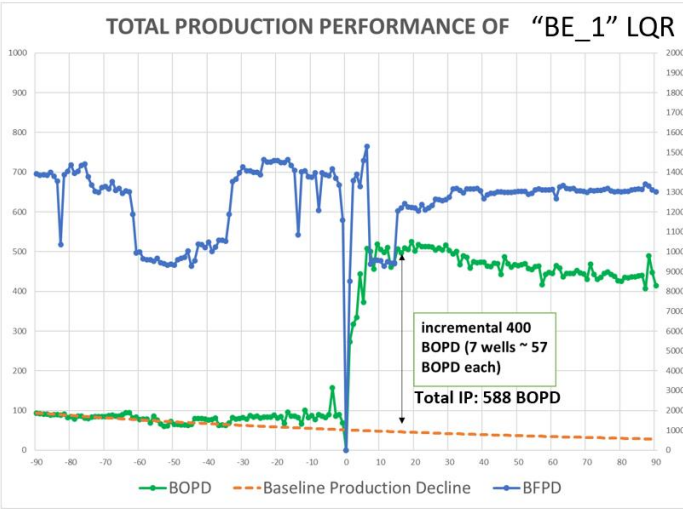


Figure 5. Excellent Performance Result of "BE_1" LQR Sand

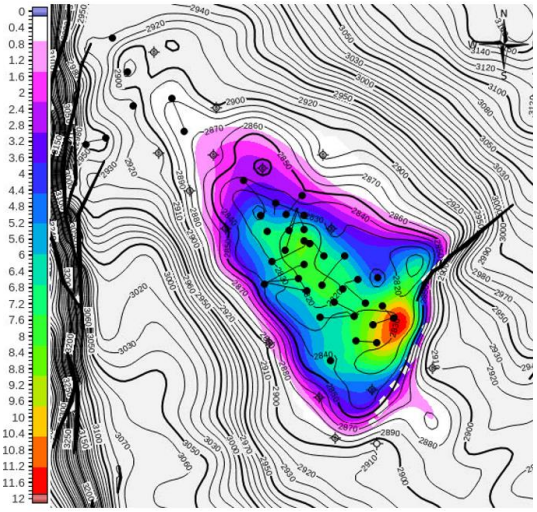

Figure 6. Area of Interest to Optimize "BE_1" LQR Sand