PROCEEDINGS
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Overpressure in Budi Field, Palmerah Block, Jambi Sub-basin

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Abstract

Budi Field in Palmerah Block has been producing hydrocarbon (oil) since 2013. This oil comes from Air Benakat sandstone reservoirs, ranging in depth of 360 m to 680 m. The Air Benakat Formation is in hydrostatic or normal pressure in this area. A number of 15 wells have been drilled in Budi greater area, however only 1 well penetrated deep enough to the basement.

Currently Tately N.V. just finished to drill another exploration well to penetrate deeper formation, i.e. Talang Akar Formation, in order to discover more hydrocarbon. Top of an overpressure is recognized in a depth about 1960 mMD, based on deep resistivity, density, and sonic wireline logs. This overpressure zone is not only identified using the conventional method, but it is also confirmed by cross plot of density and sonic logs, that introduced by Dutta – Katahara as a new method.

Furthermore, the plotted data of density and sonic nicely follow the transition line, then stops in illite line of Dutta – Katahara diagram. Disequilibrium compaction is the reason for the overpressure. The existence of overpressure zone is also supported by pressure data during well drilling. By understanding the pressure regime, future drilling campaign will be enhanced in order to lead for hydrocarbon discovery.

Introduction

Tately N.V. has been exploring and producing oil in Palmerah Block for 16 years. Palmerah Block is located in the backarc sedimentary basin of South Sumatra (Figure 1). South Sumatra Basin has been well known as a hydrocarbon producing basin for a long time.

Since 2013, oil has been exploited in this block, coming out from sandstone reservoirs of Air Benakat Formation (Figure 2). At least 5 separated sandstone layers role as good reservoirs in this formation, distributed in depth interval between 360 m and 680 m. These reservoirs have been penetrated by 15 wells to lift oil to surface.

In 2007, the first well (B1) was drilled and penetrated older rocks below Air Benakat Formation, with no issue related to overpressure reported. The next 14 wells were drilled in order to appraise and exploit oil in Air Benakat sandstones.

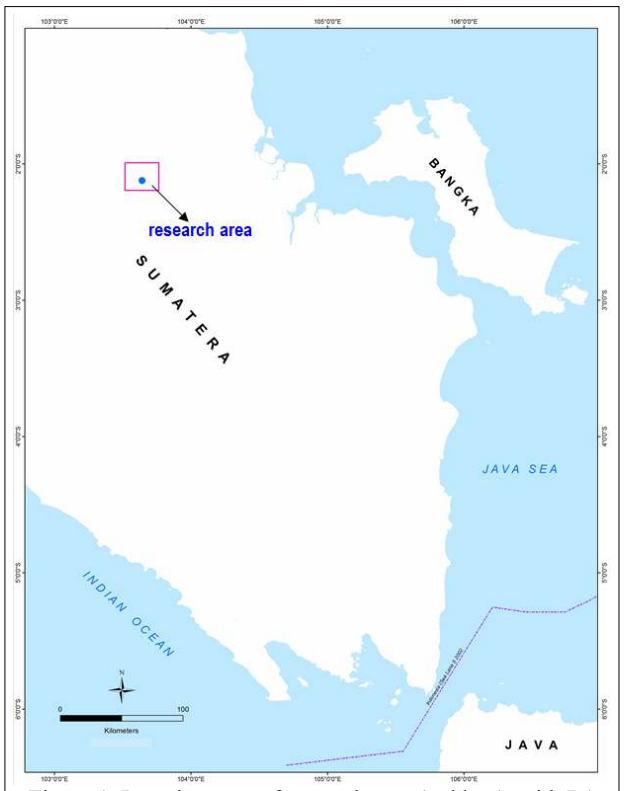

Figure 1. Location map of research area (red box), with B1 and BD1 wells (blue circle)

During end of 2018 to early 2019, BD1 well was drilled to test reservoirs in Talang Akar Formation and basement. Below Air Benakat Formation, overpressure was recognized. Drilling this well was not easy and facing problem due to overpressure.

Look back to data of B1 well and limited data of BD1 well, this paper shows that overpressure indeed occurs in this area. Drilling of BD1 well was facing lots of problem due to the existing of the overpressure.

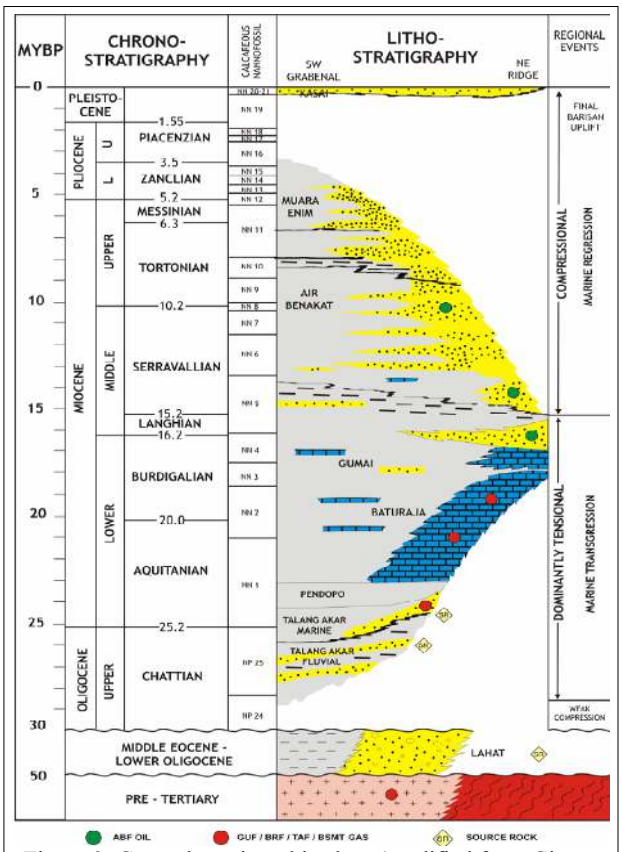

Figure 2. General stratigraphic chart (modified from Ginger and Fielding, 2005)

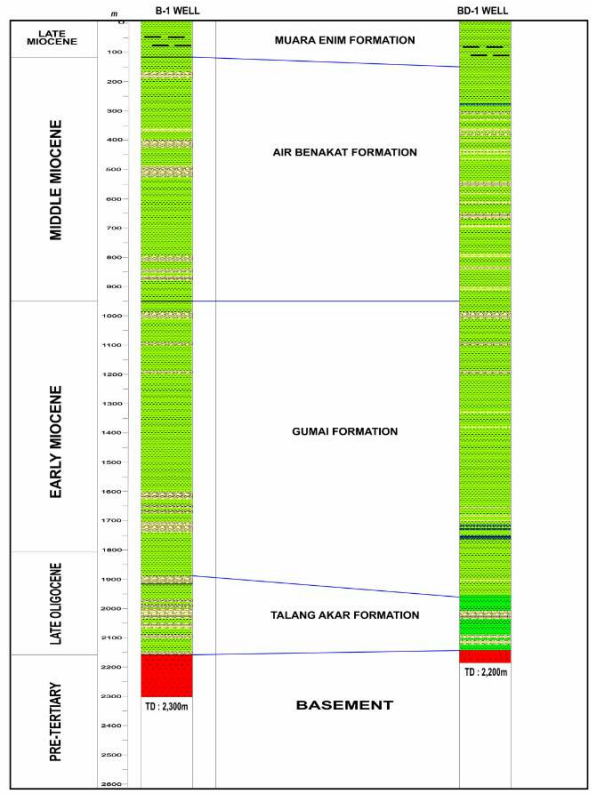

Figure 3. Stratigraphic columns of B1 and BD1 wells

Data and Method

Two wells that penetrated deeper formations, down to basement, i.e. B1 and BD1 wells, are used. The main log data are density, sonic, and resistivity logs. Because of difficulty in wireline logging in the shallow sections, logs of BD1 were not able to be acquired.

All logs are plotted along the depth and evaluated conventionally. Then cross plot between sonic and density logs is generated to analyze the characteristic of overpressure, based on Dutta (2002) and Katahara (2006).

Based on cuttings, stratigraphic columns of wells have been constructed as shown in Figure 3. Both wells penetrated pre-Tertiary basement of phyllite. Then Talang Akar, Gumai, Air Benakat, and Muara Enim Formations, from older to younger ages, are recognized. Limestone of Baturaja Formation was not growing well in the research area.

Result and Discussion

Plots of density, sonic, and resistivity logs, through the depth, could be seen in Figure 4. Down to about 1000 m depth, along the Air Benakat Formation, all logs follow a normal compaction trend (red line). After penetrating more than 100 m deep of Gumai Formation, in 1060 m depth, logs are stop to follow the normal compaction trend.

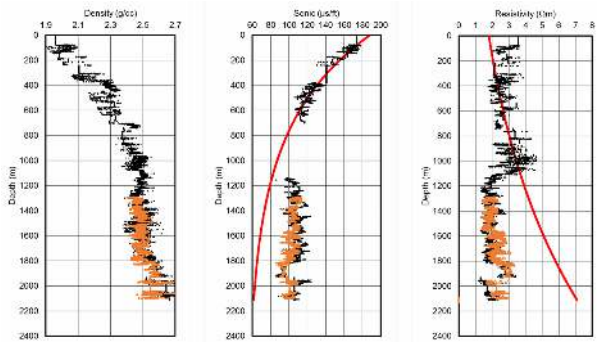
Figure 4. Wireline logs in shale section of B1 (black) and BD1 (brown) wells

Through the depth, density increases down to 1060 m depth. Then the density stops to increase and its value is constant while going deeper.

No data of sonic in interval of 650 m to 1150 m, thus the point or depth, when its value stops to follow the normal compaction trend, is not able to be recognized. Data in Gumai and Talang Akar Formations is very clear to tell us that its value is constant through the depth.

The resistivity in the shale also increases along the normal compaction trend, until in the depth of 1060 m; then decreasing while going deeper.

Therefore, top of overpressure in the research study is in 1060 m depth, within very upper part of Gumai Formation. This overpressure occurs along the Gumai Formation and down to Talang Akar Formation.

Understanding pressure regime in the research area, cross plot of density and sonic logs is constructed (Figure 5). Syukri et al (2019) has also applied this method in other wider part of South Sumatra Basin.

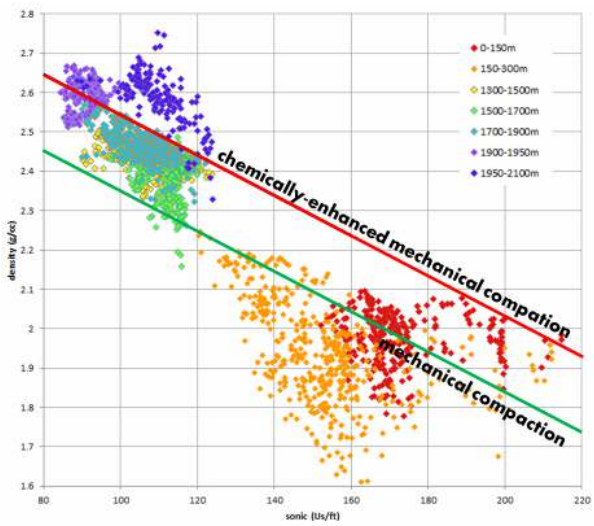

Figure 5. Cross plot of sonic and density in B1 well

Along Muara Enim and Air Benakat Formations, values of density vs sonic follow mechanical compaction line (green line). They follow a normal compaction, where density values increase and sonic values decrease.

Below 1300 m depth (should be below 1060 m depth), data started to follow transition line between green and red lines, until the depth about 1900 m. This is represented by pink arrows in Figure 6.

Going deeper below 1900 m depth, data plot follow the illitic line in the beginning. After that, it turns right, constant or decreasing of its density but increasing of its sonic.

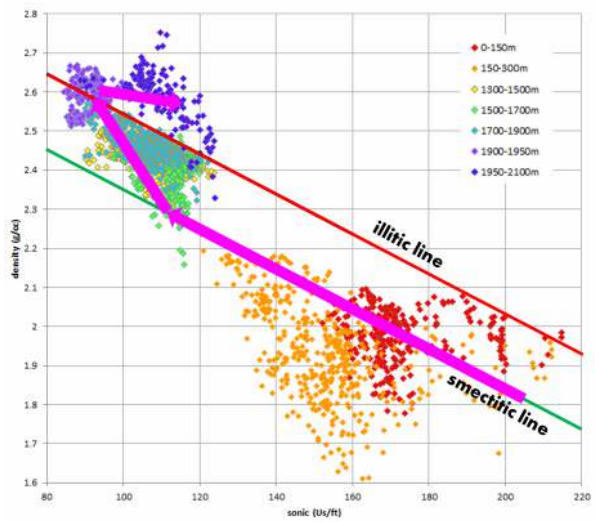

Figure 6. Trend of data showing overpressure that caused by disequilibrium compaction

Pattern of this plot suggests that the occurrence of overpressure in the research area is caused by disequilibrium compaction.

It should be noted, smectitic and illitic lines that are used here is similar to the lines which are used in the North Sumatra Basin (Syaiful, 2019). The origin lines by Dutta (2002) may not appropriate to be applied in younger Tertiary rocks of Indonesia.

Conclusions

Overpressure is existing in Budi Field, the research area. Normal hydrostatic pressure happens along the shallower rocks, Muara Enim and Air Benakat Formations. Top of overpressure is in the very upper part of Gumai Formation and occurring down to the deeper rocks of Talang Akar Formation.

Disequilibrium compaction is the reason of the overpressure. Further evaluation of data, including the additional ones by more wells drilling, would be helping in better understanding this overpressure.

Acknowledgements

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References

Dutta, N. C., 2002, Deepwater geohazard prediction using prestack inversion of large offset P-wave data and rock model, *The Leading Edge*, **21**, 193 – 198.

Ginger, D., and Fielding, K., 2005, The petroleum systems and future potential of the South Sumatra Basin, *Proceedings of Indonesian Petroleum Association 30th Annual Convention and Exhibition*, 67 – 89.

Katahara, K., 2006, Overpressure and shale properties: stress unloading or smectite-illite transformation?, *76th SEG Annual Meeting*, expanded abstracts, 1520 – 1524.

Syaiful, M., 2019, Relationship between mudstones compaction and overpressure magnitude: case study of North Sumatra Basin, doctoral dissertation, Bandung Institute of Technology.

Syukri, I.Y., Permana , B.P., Heppard, P.D., Ramdhan, A. M., dan Hutasoit, L.M., 2019, Pore-pressure analysis in the Corridor Block, South Sumatra Basin: distribution, origin, mechanism, and prediction, *Proceedings Indonesian Petroleum Association 43rd Annual Convention,* 18 pages.