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Unlocking New Potential From Weathered Basement Reservoir at South Sumatra Basin, Study Case Jabung Block and Pertamina Aset 2 Area

Ageng Warasta [*1], Alfandra Ihsan [1], Heri Safrizal [1], Randy Perfibita [1], and Satria Panji Kauripan [1]
[1]SKK Migas
* Email: awarasta@skkmigas.go.id

Abstract

Nowadays, the hydrocarbon potential of the reservoir basement is focused on the fracture zone. If there are no massive fault and fracture zone at the basement, it is believed that the basement reservoir has no hydrocarbon potential. Based on the evaluation and successful of the perforation program in the Jabung Block and Pertamina Asset 2 Area, a new understanding and opportunity was obtained in unlocking the potential in the weathered basement. Referring to this success, it is understood that a weathered basement reservoir can be a good reservoir even though it does not have an intensive natural fracture.

Analysis has been done using well log data and petrophysical evaluation for the characteristics of weathered basement zone. Also refer to successful fracturing program and production for this potential reservoir. The research area has a basement of granite and granodiorite. The weathered zone is characterized by high gamma ray and resistivity, which is as fresh basement zone, but the density value is lower than the fresh basement zone. In the previous method, the weathered basement reservoir was considered to be a basement part and did not have an intensive fracture. DST results from several wells obtained a small rate, than it was decided not to continue producing from basement and moved to the deltaic reservoir that has better reservoir property and more than 200 wells have been drilled to produce the deltaic zone. There are only a dozen wells that have log data up to a weathered basement. Based on the new concept, weathered basement can be separated from fresh basement. The weathered basement has better matrix property than fresh basement. In Jabung Block, it was decided to try hydraulic fracturing at this zone. The result of fracturing at INA-1 well in 2018 obtained gas rate of 3 MMSCFD, which is significantly increased compared with previous conventional perforation 0.6 MMSCFD gas rate. Through flow channel fracturing on oil well INA-2 and INA-3 in 2018 at the neighbor structure, gives oil rate 146 BOPD and 300 BOPD, respectively. Following those results, more detailed evaluation of electric logs, mud logs, and seismic attributes using AVO have been done to know hydrocarbon potential in weathered basement. In the Pertamina Asset 2 area, in one of the fields, there are 10 wells that penetrate the weathered basement zone. Perforation efforts have been made on 3 wells in 2004 & 2011 but only get a low flow rate of 0.3 - 1 BOPD.

A more detailed evaluation of the potential and completion methods include technology that could be implemented to produce a more massive weathered basement is still being carried out. It is believed that this reservoir potential also occurred at other structures in South Sumatera Basin and the other Basins in Indonesia.

Keyword(s): Weathered Basement; Low Quality Reservoir; Fracturing; South Sumatra Basin.

INTRODUCTION

Jabung Block and Pertamina Aset 2 located in South Sumatera Basin (Figure 1). Main reservoir in this working area is Talang Akar, Baturaja and Air Benakat formation. That reservoirs are already massively developed and some structure was left with low remaining reserves. Based on continuation of the evaluation study on several existing fields, discovered a large enough upside potential on weathered basement reservoir. Some area for this potential already drilled by amount of wells but not be produced massively.

Weathered basement theoretically is basement rocks which already going through alteration process, and fragmentation rock with soil material on and/or nearby surface caused by physical, chemical and biological process. Material product of this process is the source of the sedimentary rocks and soil. Weathering process will disintegrating rocks, or even dissolve some of the mineral thus become soil or will transported and re-deposited as clastical sedimentary rocks. In case, the weathered material is not transported, then it will be deposited on top of the un-weathered rock with coarse grains characteristics. Minerals contain will be similar with fresh basement itself (Benyamin, 2018).

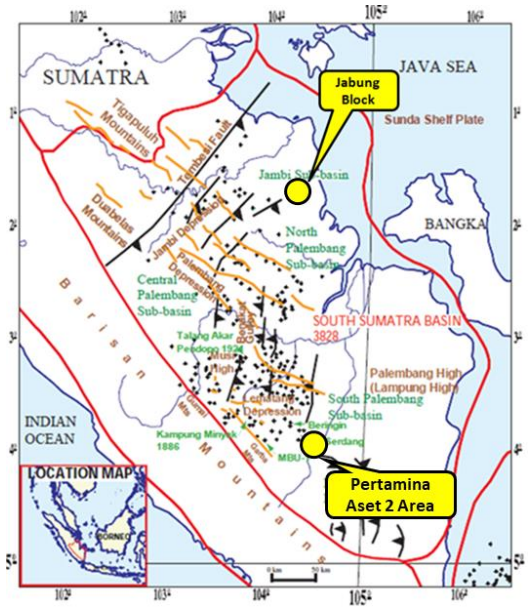

Figure 1. Index map of South Sumatra Basin Province. Research area shown by yellow circle (Modified from Bishop, 2000)

METHODOLOGY

Generally, composition of this weathered basement reservoir layer is a result of weathering process of the basement rocks. Therefore it has a similar characteristic of log with basement rocks itself. In order to indentify this weathered basement reservoir, this study used mud logs and well logs data, then supported by seismic and seismic attribute data.

1. Mud log. Around 45 wells in this study area, which are penetrated the weathered basement reservoir, have this mud log data. Increasing value of gas unit when entering this reservoir zone, becomes a one of distinctive characteristics to determinate the reservoir interval.

2. Log data. Weathered zone are characterized by high value of Gamma Ray and Resistivity, and high value of density but not as high as fresh basement. Well-to-well correlation is the main key to determine perforation interval and completion to achieve optimum production.
3. Seismic data. In Jabung Block and Pertamina Aset 2 Area, 3D seismic data is used in this study. Based on the seismic characteristic, this weathered basement zone is picked as basement with strong amplitude value compare to younger formation.
4. Seismic attribute. In Jabung Block, The P-Impedance and AVO attribute shows a corresponding correlation trend with the well log data. Therefore, this attribute seismic can be used for potential HC estimation on weathered basement zone. Meanwhile, in Pertamina Aset 2, the focus of seismic attribute only at younger formation then weathered basement.

RESULTS AND DISCUSSION

Identification of potential weathered basement reservoir zone

There have not been many detailed evaluations regarding the potential for weathered basements in the research area. Efforts made in this study used the main data in the form of well log data, mud logs and seismic data. Based on these data, the potential zone of this weathered basement is the result of weathering process on granite basement, while weathering on meta-sediment and metamorphic basement rock only deposited a thin layer of weathered zone and un-potential hydrocarbon zone. Therefore, this study is only focused on granite weathered basement.

Weathered granite rocks characteristics are conglomeratic sandstone with fine to coarse grain size, and sub-angular to sub-round of shaped grains. The occurrence of quartz, mica and pyrite mineral will affect the record of gamma ray and resistivity log. From log data evaluation, this weathered reservoir zone can be distinguished by high value of gamma ray. In Jabung Block and Pertamina Aset 2 Area, the gamma ray value range in this reservoir zone is around 270 – 380 API. High gamma ray value are caused by the occurrence of high amount of k-feldspars mineral and there is an opportunity of uranium presence.

The resistivity value ranges from 4 – 12 Ω.m, with proven resistivity value that contain oil reservoir is 4 – 8 Ω.m and gas reservoir is 8 – 12 Ω.m. Resistivity value of the weathered reservoir zone is similar with the underlying basement, so it is hard to separate the weathered basement zone with fresh basement zone. If there is an occurrence of HC, the resistivity value will become much higher.

The interesting case is with the record of density logs. Density value on this weathered reservoir zone is 2.1 – 2.3 gr/cc, which is much lower than the fresh basement zone density value of 2.5 – 2.6 gr/cc. Based on those density log, the separation of weathered basement reservoir zone and fresh basement zone can be conducted. Additional value from density record is that it represents the matrix porosity in which HC accumulated. With the occurrence of matrix porosity, combined with considerably thickness and extensive distribution, it will be a huge potential HC zone. It is already proven in Jabung area based on drilled well and future potential from seismic attribute.

Based on the seismic data, picked seismic horizon in weathered basement reservoir zone is similar with fresh basement that shown high amplitude value (figure 2). By this time, it is impossible to separate the horizon picking for this zone with fresh basement.

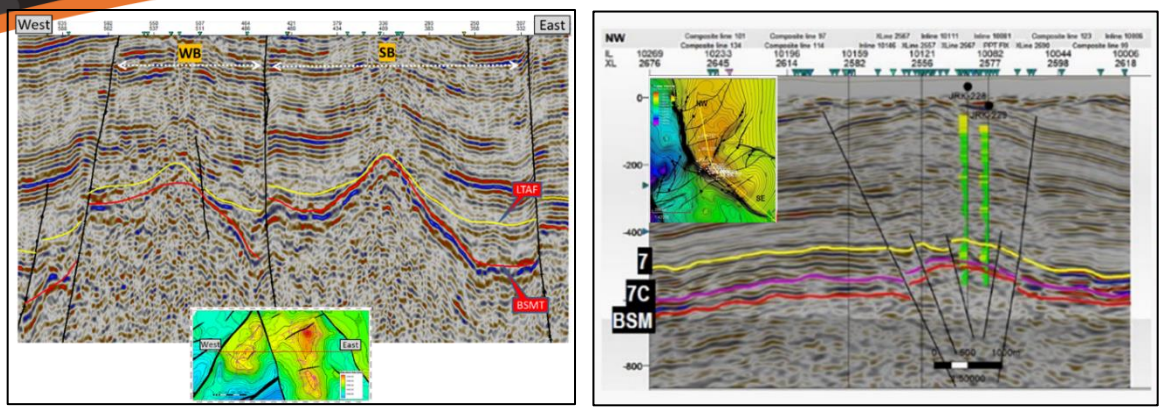

Figure 2. Seismic Cross section throught Jabung Blok (left) and Pertamina Aset 2 Area (right). The Yellow line is Talang Akar Formation (TAF) & the Red line is Top of Basement. Weathered basement cannot be separated from fresh basement in seismic picking.

Another possible approach can be used are the P-Impedance and AVO attribute in Jabung Block. P-Impedance attribute can define the area that has good property, especially on the top structure (figure 3). This case is correlated with the possibility of intensive weathered basement, that is located on higher area and yet to be transported to the lower area. Based on AVO analysis, the potential hydrocarbon area is also located in the top structure, and it corresponds with available reservoir thickness data. From gas chromatograph and well log data, the potential area is also located on top of structure (figure 3).

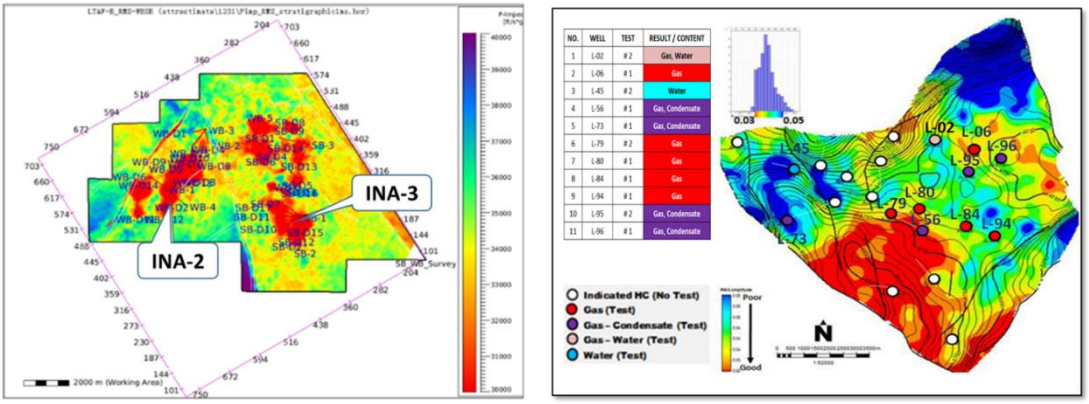

Figure 3. P-Impedance at SB-WB Field (left) and AVO analysis at NEB Field (right) for weathered basement in Jabung Block. Red colour in P-Impedance correlate with possible weathered basement accumulations. AVO analysis can identify gas potential. Almost all the wells show HC potential, only one well (L-45) tested water located at blue colour for AVO map. More than 35 well identified that are proven HC contain at weathered basement in Jabung Area.

Petrophysical analysis was run using well log data. Conventional coring activity is not acquired in this zone, but it is acquired in Talang Akar Formation and Fresh basement zone. Rock characteristic for weathered basement is following the TAF sandstone to accommodate the matrix porosity. The depth of reservoir is around 4,500 – 4,800 ftTVDSS in Jabung Block and 2,100 – 2,300 ftTVDSS in Pertamina Aset 2 Area, with reservoir thickness is around 30 – 150 ft. Based on petrophysical analysis, rock properties of the weathered basement reservoir area are shown by table below.

Table 1. Rock properties at NEB, WB and SB fields in Jabung Block and JRK filed in PEP Aset 2.

Area	Por (%)	Perm (mD)	Modulus Young (Psi)	Pressure (Psi)
NEB	5-11	6-11	$1.22X10^6$	1,896
WB	8-14	4-7	$2.2X10^6$	1,188
SB	11-17	20-64	$2.2X10^6$	1,824
JRK	6-12	7-20	No Data	860

From the properties above, the weathered basement reservoir porosity and permeability value are not considerably high. Therefore, fracturing stimulation method is needed to optimize production for this reservoir layer. This method are supported by a good value of modulus young and pressure reservoir.

Production Realization from Weathered Basement

In Jabung Block, pilot fracturing project is conducted to optimize production in this weathered basement reservoir. Pilot fracturing is held on 3 wells. Well INA-01 is located in NEB area. Based on well log and DST data, the weathered basement can produce up to 0.589 MMSCFD (figure 4). To optimize the production, conventional fracturing held on this well and resulted initial flow of 6 MMSCFD and 88 BCPD. This result shows a significant increasing compared to conventional perforation.

Second pilot held on WB area at INA-02 well. Based on well and mud log data, HC potential in weathered basement in this structure is oil. This zone is already produced from several surrounding wells by conventional perforation. Flow channel fracturing is conducted in this well and successfully produced HC from initial flow of 146 BOPD and 5 BPD of water.

Third pilot is conducted in INA-03 well at SB area (figure 4). Flow channel fracturing also conducted and successfully produced 300 BOPD from initial flow, compare with last test data 10 BOPD without fracturing. Interestingly, TAF sandstone in SB Field, which deposited above the weathered basement reservoir, is already massively produced and already wet. This is possible due to the unconformity layer between weathered basement and TAF, and acts as a barrier. Second possibility is that the occurrence of bypass oil on weathered basement that has a lower reservoir property compare to TAF sandstone.

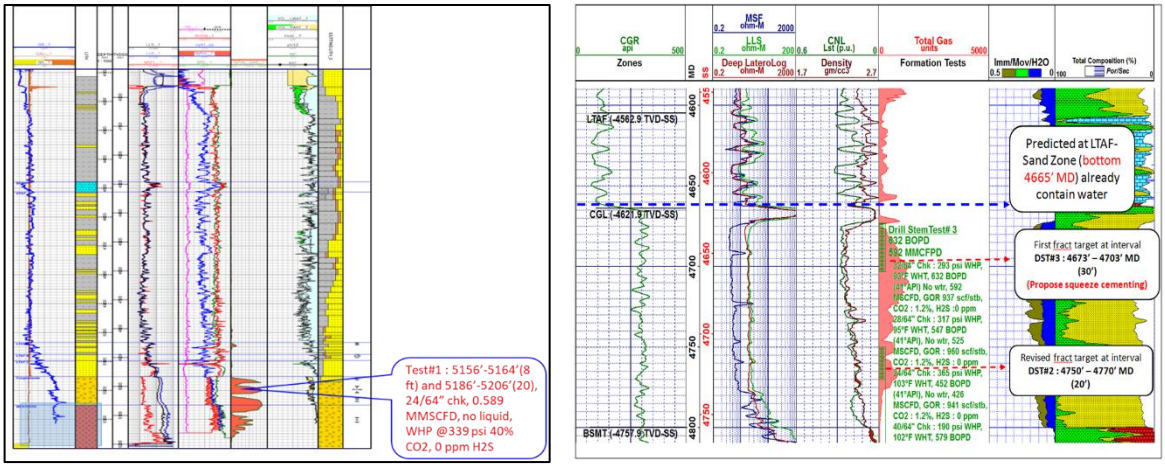

Figure 4. INA-01 (left) and INA-03 (right) well log data and DST data. When the fracturing is conducted at INA-03, perforation is lowered farther from TAF sandstone zone and fract design is built so that TAF sandstone is not affected. The results is production of oil and low water cut.

In the Pertamina Asset 2 area, the potential from weathered basement has been produced through the perforation method from 2 wells and open hole from 1 well (figure 6). The production performance obtained is not optimal, with an oil flow rate only 14 – 20 BOPD and a cumulative 0.3 – 19 MBO from the perforation method and the result is water in open hole wells. Referring to these results, it shows that there is still an opportunity to optimize the production of weathered basement through more detailed identification and application of fracturing as was successfully done in the Jabung Block.

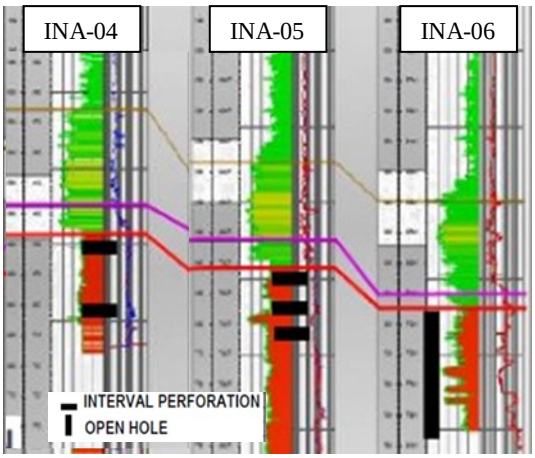

Figure 6. Producing wells at weathered basement intervals in Pertamina Asset 2 Area. For petroleum system, it has been proven that the potential of hydrocarbons in this interval. Further evaluation and proper completion efforts are needed to produce this potential

Conclusion

Weathered basement reservoir is already proven to be a big HC potency. It is proven from the activity that conducted on 3 pilot fracturing wells and also further evaluation from well and seismic data. For now, the optimal method to development this reservoir is with fracturing, whether conventional or flow channel fracturing. This study is intended so that the next fracturing activity should be massive and optimally conducted. This is interesting because it will need a great amount of investment, but the production gain will be quite high. It shows a differentiation of fluid contact from weathered basement reservoir with TAF sandstone reservoir above. This is supported by the result of fracturing activity that produce oil with very low water cut, even though the upper reservoir is already massively produce and believed to be wet.

Hopefully this successfully story in Jabung Block and Pertamina EP Aset 2 Area can be transmitted to other KKKS. Geological condition of basement high with granite composition has a potency to become a reservoir. Another added value is that if the upper sand contain a HC, it may increase the confidence that weathered basement reservoir bellow could be quite potential

Acknowledgment

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