

A SUCCESS CASE OF WIDURI AREA REJUVENATION, ASRI BASIN, OFFSHORE SE SUMATRA BLOCK, INDONESIA

PEMUTAKHIRAN KONSEP PENGEMBANGAN AREA WIDURI, CEKUNGAN ASRI, LEPASPANTAI BLOK TENGGARA SUMATRA, INDONESIA

Dwandari Ralanarko^{1,2}, Ildrem Syafri², Abdurrokhim², Andi Agus Nur²

¹ Pertamina Hulu Energi OSES, Menara Standard Chartered, Jl. Prof. Dr. Satrio No.26, Karet Semanggi, Setiabudi, Jakarta Selatan, DKI Jakarta 12950

² Post-Graduate Program, Faculty of Geological Engineering – Universitas Padjadjaran, Jl. Raya Bandung – Sumedang KM 21, Jatinangor, Jawa Barat 45363

Corresponding author: dwandari.ralanarko@pertamina.com / dwandari20001@mail.unpad.ac.id

(Received 18 May 2021; in revised from 23 August 2021; accepted 05 November 2021)

ABSTRACT: INTA/B Field is one of the most producing mature fields in Widuri Area, Asri Basin, Offshore SE Sumatera, Indonesia, therefore it is subjected to rejuvenation to enhance hydrocarbon production. INTA/B Field is distinguished from other fields from its featured anticlinal structures that have the northeast-southwest trending. This structure is heavily faulted mainly in the up-thrown south side of a major normal fault. Two structural configurations with various oil-water contact have successfully been identified within the field. The most of oil reserves are preserved in the western lobe in which Intan-1 sands. One of the most important reservoirs in this field is Talangakar (TAF) sand deposited as a meandering river system that streamed from the northwest to the southeast within the basin. Two main reservoirs, Gita-34A and Gita-34B are correlated throughout the field and interpreted as Miocene fluvio-channel sands. These two channels are thickened moderately from southwest to northeast which has descriptions as follows: fine-to-coarse grains, unconsolidated to friable, and low cementing materials.

INTA/B Field has been produced for 25 years and currently undergoing a watered-out phase. Therefore, an integrated study is subjected to overcome this issue for mature field rejuvenation. The integrated study ranged from geology (e.g., depositional environment and facies analysis), geophysics (e.g., revisiting and reprocessing of seismic attributes), petrophysical calculation, and reservoir engineering (e.g., water conformance plot and volumetric calculation).

This integrated study has successfully rejuvenated a mature field resulting and added a significant number in oil production with an average of 300 BPOD/well. The extended project is estimated to have a similar result to the forward pilot.

Keywords: mature field rejuvenation, integrated study, offshore SE Sumatra, water out phase

ABSTRAK: Lapangan INTA/B merupakan salah satu diantara lapangan tua yang masih produktif di Area Widuri, Cekungan Asri, Lepas Pantai Tenggara Sumatra, Indonesia, yang tentunya memerlukan peremajaan konsep pengembangan untuk terus memproduksi hidrokarbon. Lapangan INTA/B dapat dipisahkan dari lapangan lainnya dari keberadaan struktur antiklin berarah Timurlaut - Tenggara. Struktur ini terpatahkan sangat kuat terutama pada sisi naik bagian Selatan dari Sesar Normal utama. Dua konfigurasi struktur dengan beberapa variasi kontak minyak dengan air sudah berhasil diidentifikasi di lapangan ini. Cadangan minyak tersisa sebagian besar berada pada area Barat dimana lokasi pengendapan Intan-1 terjadi.

Salah satu reservoir utama di lapangan ini adalah Batupasir Formasi Talangakar (TAF) yang diendapkan sebagai sistem sungai bermeander yang mengalir dari arah barat laut menuju bagian tenggara dari cekungan. Dua reservoir utama, yaitu Gita-34A dan Gita-34B berkorelasi pada lapangan ini dan diinterpretasikan sebagai fluvial-channel sands yang terendapkan kala Miosen. Kedua interval tersebut menebal secara moderat dari baratdaya ke arah timurlaut yang memiliki karakteristik fine - coarse grains, unconsolidated - friable, dan low cementing materials.

Lapangan INTA/B sudah diproduksi selama 25 tahun dan saat ini sudah memasuki fase watered-out. Studi terintegrasi mutlak diperlukan untuk mengatasi permasalahan ini dengan peremajaan dan

pemutakhiran lapangan tua. Studi ini melingkupi aspek geologi (lingkungan pengendapan dan analisis fasies), geofisika (semisal memproses ulang atribut seismic), perhitungan petrofisika, dan reservoir engineering (semisal water conformance plot dan perhitungan volumetrik)

Studi terintegrasi ini telah berhasil meremajakan dan memutakhirkan konsep pengembangan lapangan tua. Kelanjutan dari proyek ini tentunya perlu terus dilakukan dan diharapkan dapat juga memberikan hasil yang signifikan.

Kata Kunci: *peremajaan lapangan tua, studi terintegrasi, lepas pantai Tenggara Sumatra, watered out phase*

INTRODUCTION

Southeast Sumatra production sharing contract is located in Offshore Sumatra, operated by Pertamina Hulu Energi OSES. Three basins of Sunda, Asri, and Hera lie in an area of 11,046 sq. km of concession. Asri Basin was once thought to have low maturity of source rocks resulted in a low interest to be explored, during the early stage, from 1983 to 1987 (Wight *et. al.*, 1997). Approximately 9.7 km north of WIDA platform, INTA/B Field lies between VITA and NEIA field. The discovery well Intan-

from Paleocene to Pleistocene up to 16,000 ft thickness. It is bordered by a downthrown to the west, N-S trending faults to the East, and an NW-SE trending wrench system to the south (Ralanarko *et. al.*, 2020).

Three major tectonics are recognized: pre-rift, syn-rift, post-rift, which affected the structural style and depositional systems in the Asri Basin (Ralanarko *et. al.*, 2020). The basin acknowledged oil fields have a stratigraphic aspect that is influenced by moderate intra-basinal faulting and folding. Structural control on major

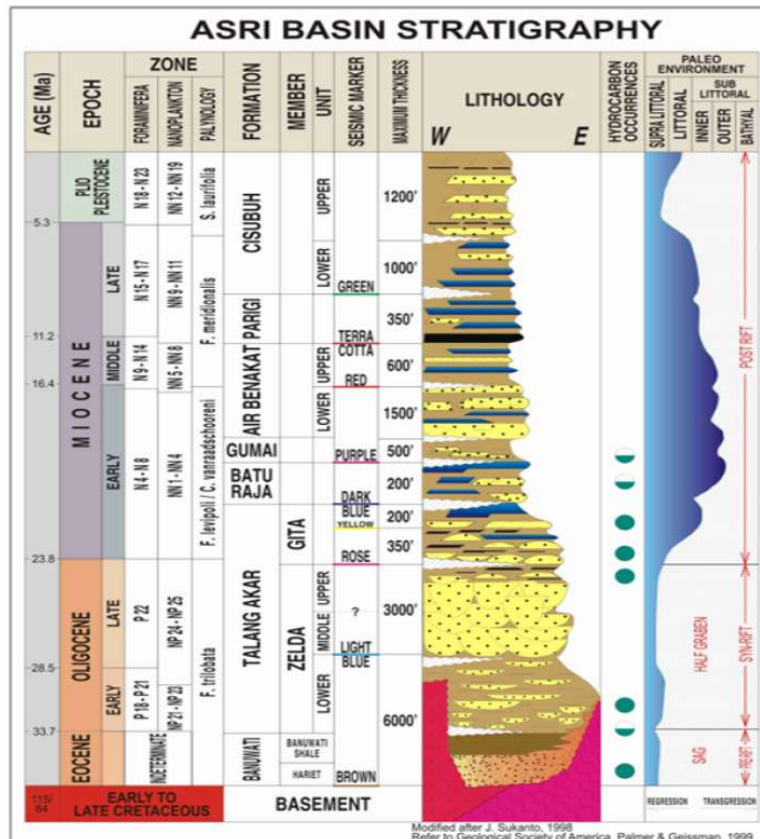


Figure 1. Asri Basin Regional Stratigraphy (modified after Sukanto, 1998)

01 was drilled in 1987, up to 42 ft and 34.5 ft net oil pay from two sandstone units (namely Gita-34A and Gita-34B sand) from Early Miocene TAF. Oil-bearing sands in the Intan-1 well are stratigraphically similar to Gita-34 interval sandstone in surrounding structures, according to a correlation with the INDA and WIDA fields, which is well-defined by 3D seismic mapping. This extensive study in developing this reservoir type suggests no further delineation wells are necessary.

Asri Basin Regional Context

A Cenozoic extensional back-arc and half-graben rift of Asri Basin (Young and Atkinson, 1993) is situated in Offshore Sumatra, Indonesia, and covers an area of approximately 3500 sq. km. It comprises thick sediment

axial drainage systems would exert tremendous influence on sand supply to any particular basin at any given time. Basin integration and its control on axial fluvial systems play an important role to fluvial deposition during basin evolution and fill.

The Lower Zelda and Upper Gita Members are the main components of the Oligocene TAF (Armon *et. al.*, 1995). In INTA/B Field, the Gita-33 series sand comprises the top sequence of Gita Member. One of those series is the Gita-33A sand consisting of sinuous meandering fluvial channel sandstones with northwest-southeast trending (Ralanarko *et. al.*, 2020). A fault with a throw of around 150 ft in the northwest juxtaposes sand against shale. It was collected in the same channel system as VITA field Gita-33 sand during a similar time.

METHODS

Earlier in 2015, review and analyses were conducted on all producer wells in the Asri Basin. After data gathered, it can be seen that watered out-wells potency from production well test before watered out reached about 1800 BPOD from 17 wells, where four wells of them

are from INTA/B Field. This study covers various subjects including completion history and well perforation, production performance plot of the well, well-cased hole logging, seismic attribute analysis, a structural cross-section with offset well, facies distribution map,

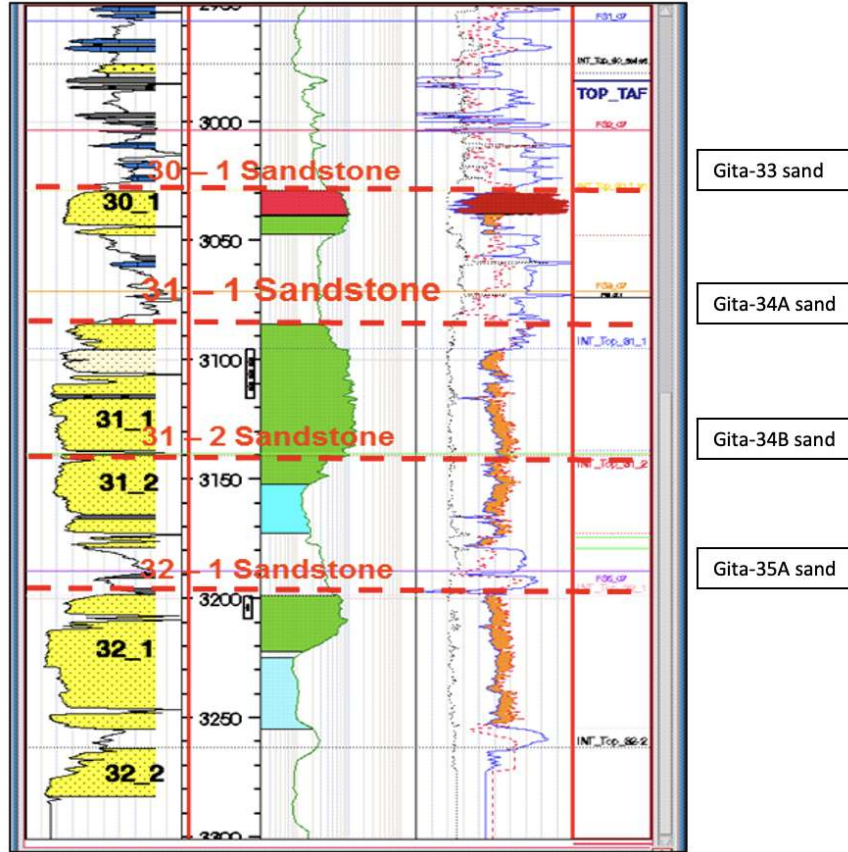


Figure 2. INTB-X Elan Log

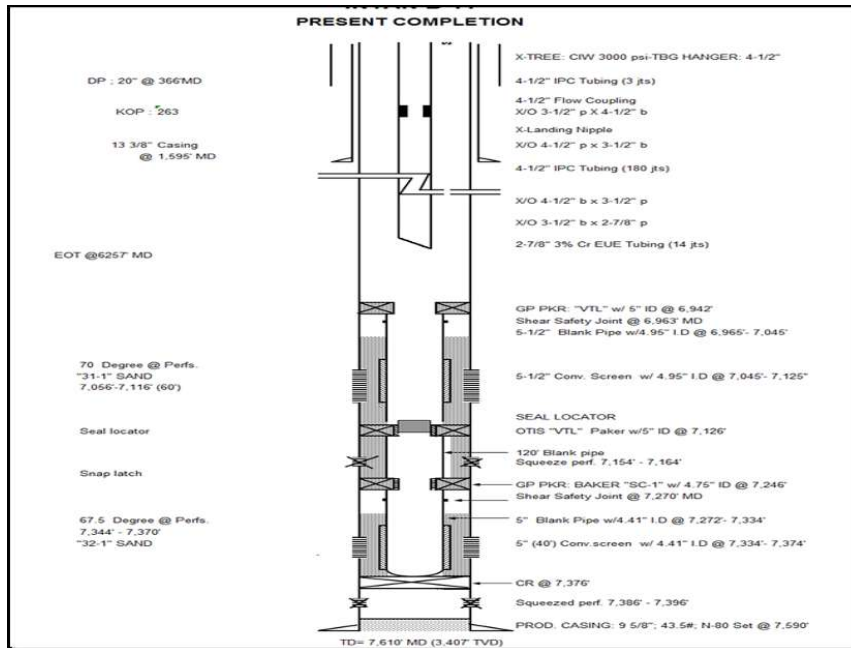


Figure 3. INTB-X Wellbore Diagram

production surveillance, and current recovery factor, and risk analysis.

One of the wells which successfully reactivated is INTB-X drilled in June 1995, encountered 21 ft net pay of Gita-35A sand, 52 ft net pay of Gita-34A sand, and 9.5 ft net pay of Gita-33A sand (Figure 2).

INTB-X was completed in June 1995 in Gita-35A sand with interval perforation 7344' – 7370' MD using production casing 9-5/8" production casing (Figure 3). The initial pressure of this well from Gita-35A sand is

1336 psi meanwhile initial production is 1200 BPOD. Due to production decline, the Gita-35A sand was closed in December 1995 using a seal locator. INTB-X continues to produce from Gita-34A sand, with interval perforation 7056' – 7116' MD.

A seismic attribute used to observe Gita-34 series sand continuity in the INTA/B field is a root mean square (RMS) amplitude (Figure 4), one of the most common and powerful statistical measures of the magnitude of variation over a dataset. In particular, the RMS is constructive if

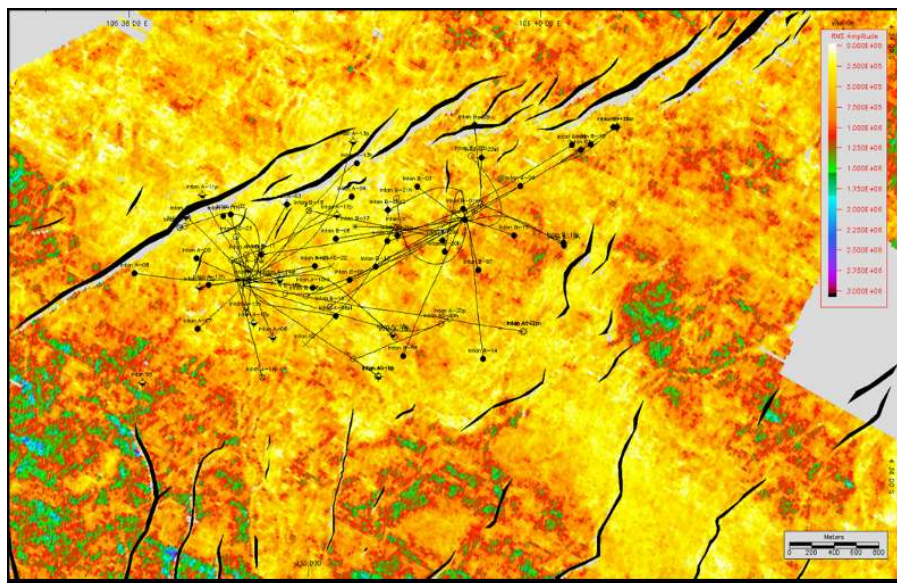


Figure 4. RMS Amplitude of Gita-34

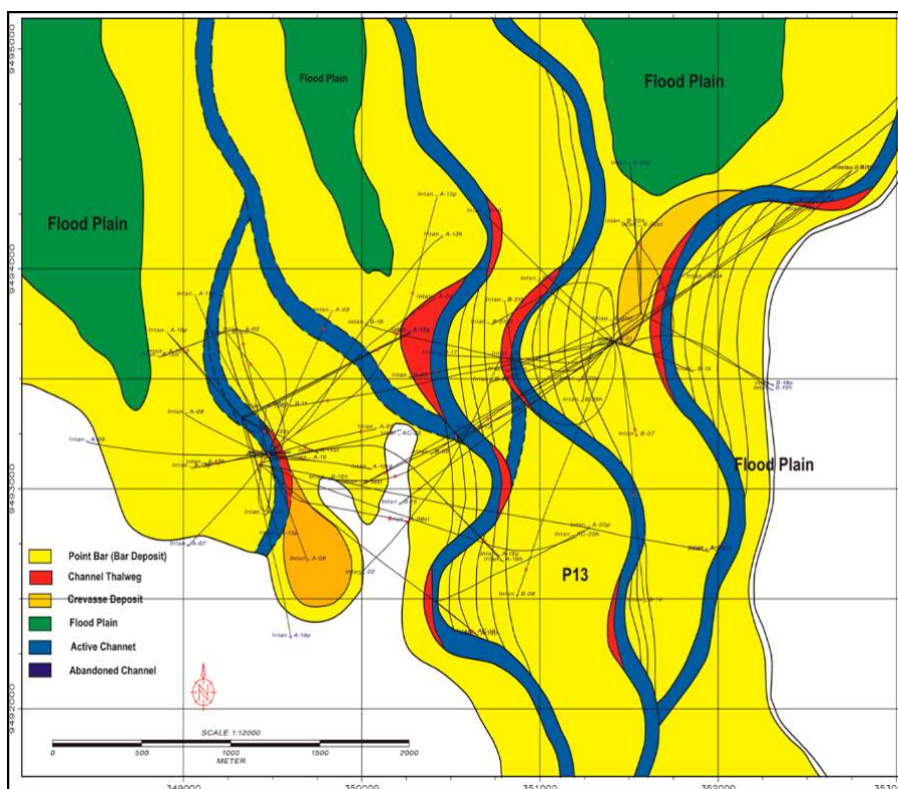


Figure 5. The Gita-34 Series Sand Facies Interpretation

positive and negative values such as sinusoids and seismic tracks are crossed. As a result, the RMS attribute emphasizes acoustic impedance variations over a given sample interval (Epegeology Website, 2015). This attribute's amplitude ranges from 0 to 1500000.

RESULTS

Intan - Widuri platform area forms the western flank of the Asri Basin which is cut by several series of NE-SW trending faults. This area became the focus of exploration after the Intan and Widuri discoveries in 1987 and 1988 (Young *et al.*, 1991). The structure on this platform is generally a three-way dip closure bounded by down-to basin-margin series of en-echelon faults i.e., Intan closure, and a four-way dip closure as seen in the Widuri (Widuri is 3 way – fault bounded to NW) and Indri closure (Young *et al.*, 1995).

The only productive area found to date in the Asri Basin is the Intan and Widuri platform on the NW flank of the basin (Primadani *et al.*, 2018). All oilfields are currently producing from the syn-rift sandstones (Zelda Member) and early sag sandstones (Gita Member)

reservoirs. The trapping mechanism in these fields is a large three-way dip-faulted closure (Intan and NE Intan) and four-way dip closures (Indri) except for the Widuri oil accumulation, which is a combination structural-stratigraphic trap (Ralanarko *et al.*, 2020).

Reservoir distributions and properties in the Gita-34 sands has not been optimally defined and determined in previous field development campaigns. The Gita-34A and Gita-34B updated facies distribution maps are established using the RMS amplitude, combined with log and core data (Figure 5). The depositional environment of this Gita-34 series sand is interpreted as a meandering river system deposit, where some areas are associated with a crevasse splay deposit.

Structurally, the Gita-34A sand in INTB-X is 40 ft higher than INTA-S (248 m from INTB-X) and 55 ft higher INTB-E (397 m from INTB-X) (Figure 6).

DISCUSSION

The Initial production of the Gita-34A sand in INTB-X is 2873 BOPD, 4719 BFPD, 39% water cut with initial pressure 1357 psi. On June 7, 2004, INTB-X was watered

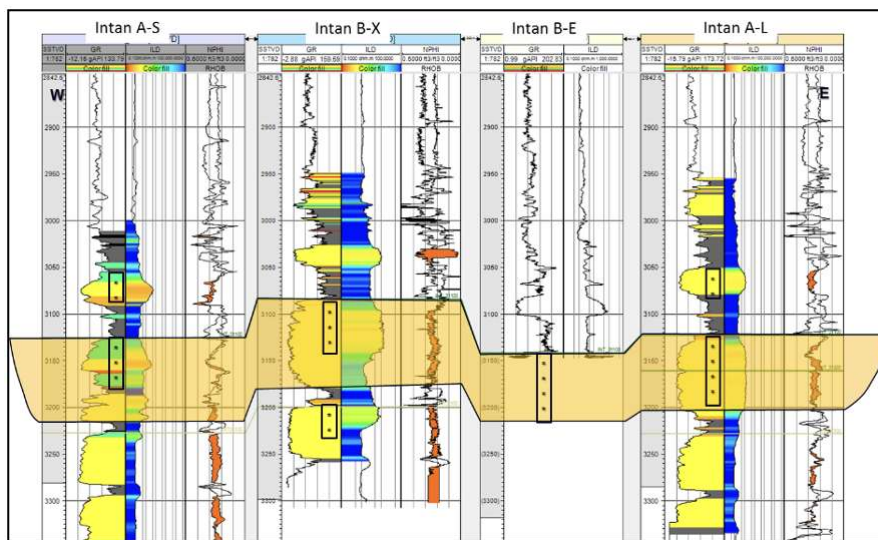


Figure 6. West to East Gita-34A Sand Structural Cross

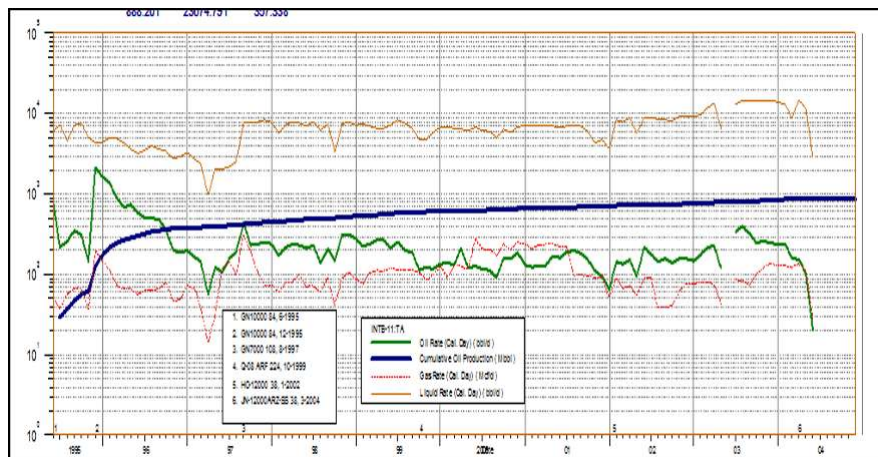


Figure 7. INTB-X Production Plot (1995-2004)

out (Figure 7). INTB-X cumulative production as of June 2004 is 811 MBO. In early 2015, INTA-S still produces 107 BPOD, 7667 BFPD with 98.6% water cut. INTB-E, another offset well of INTB-X, produces 101 BPOD, 20235 BFPD, and 99.5% water cut.

INTB-X reactivation is also analysed using MMRA development well chance success. Source components (quantity, quality, and maturation) have already been proven as the well has been already drilled and produced. Various factors including timing/ migration components (e.g., timing of the closure, timing of expulsion, and effective migration pathway), reservoir components (e.g., the reservoir presence, quality, and performance), and closure components (e.g., map reliability, presence, and

CONCLUSIONS

Among the many challenges of managing a mature oil field is the need to obtain as accurate as possible an understanding of its remaining recovery potential. Greater accuracy in assessing characteristics that influence recovery—geologic changes, rate of saturation, water cut; will enabling subsurface teams to make better decisions regarding mature field production optimization. With the right methods that take advantage of the wealth of reservoir data, geoscientists and reservoir engineers can more easily determine when, where, and how to improve well performance.

Mature fields have the inherent benefit of a long history of geologic and operational data, complemented by

Table 1. INTB-X Reactivation Chance Success

DEVELOPMENT WELL(S) Chance Success	Ratings (0.01-1.00)
SOURCE COMPONENTS	Confidence of P99 Reserves: 118.13 MBO
Quantity/Volume (include Monetizable Product)	1.00
Quality/Richness	1.00
Maturation	1.00
MINIMUM FACTOR	1.00
TIMING/ MIGRATION COMPONENTS	Confidence of P99 Reserves: 118.13 MBO
Timing of Closure / Trap	1.00
Timing of Expulsion	1.00
Effective Migration Pathway	1.00
MINIMUM FACTOR	1.00
RESERVOIR COMPONENTS	Confidence of P99 Reserves: 118.13 MBO
Presence	1.00
Quality	1.00
Reservoir Performance	1.00
MINIMUM FACTOR	1.00
CLOSURE COMPONENTS	Confidence of P99 Reserves: 118.13 MBO
Map Reliability & Control	1.00
Presence	1.00
Data Quality	1.00
MINIMUM FACTOR	1.00
CONTAINMENT COMPONENTS	Confidence of P99 Reserves: 118.13 MBO
Top / Base Seal Effectiveness	1.00
Lateral Seal Effectiveness	1.00
Preservation from Spillage or Depletion	0.90
Preservation from Degradation	0.90
MINIMUM FACTOR	0.90
DEVELOPMENT WELL(S) Chance Success	0.90

data quality) have similarity with the source components. The risk for Intan B-X reactivation will be preservation from spillage, depletion, and degradation (Table 1).

The integrated analysis has successfully reactivated the INTB-X well in February 2020, after considering its resource availability. The initial production of INTB-X after reactivation is 345 BPOD, 23021 BFPD, 98.5 water cut. After reactivation, INTB-X still has productivity index (PI) 634 BFPD/ psi. This PI indicates an excellent performance of the Gita-34A sand. The liquid rate of INTB-X has also been stable. This successful project later triggering rejuvenation concept opener for similar case studies in other mature oil fields in Widuri Area, Asri Basin, and Offshore SE Sumatra Block.

even larger volumes of recent surveillance data made available through increased oilfield instrumentation. When these data (seismic, cores, geology analyses, reservoir simulations, completion plans, production data, tracers, and well stimulations) are integrated, visualized, and analysed subsurface teams could be more accurately determine how much ultimate recovery potential has already been achieved and how much remains.

Further analysis can help determine the appropriate mature field optimization methods. The ability to identify and evaluate bypassed hydrocarbons and monitor fluid movement is vital in improving recovery in mature fields. Fortunately, the volume and details of reservoir data acquired in recent years can make it easier to identify bypassed pay. Time-lapse seismic surveys, reservoir fluid

saturations, tracer data, and updated geocellular models can reveal previously undetected promising zones. Utilizing data that changes over time can see the extent and effectiveness of previous steam injections, as well as uncover zones that have not been swept and drained by current production wells.

Risk analysis and resource arrangement play a crucial role before reactivation execution. The probability of success is an important input parameter during the economic evaluation and profitability studies of mapped prospects. It is also an important tool in exploration and development strategy, especially when assessing the ranking of prospects and/or well candidates, i.e. which of a portfolio is most favourable with respect to the predicted volume of oil or gas, its chance of success and economic value.

ACKNOWLEDGEMENTS

The authors would like to thank the management of Pertamina Hulu Energi OSES, Pertamina EP, Pertamina Subholding Upstream (PHE), and SKK MIGAS, for their permission to publish this paper. Thank you to all Geosciences & Reservoir Team of the Subsurface Development Planning Department, PHE OSES and all lecturers of Post-Graduate Program, Faculty of Geological Engineering, Universitas Padjadjaran for several beneficial and constructive discussions.

REFERENCES

- Aldrich, J.B., Pinehart, G.P., Ridwan, S., and Schuepbach. M.A., 1995. Paleogene basin architecture of the Sunda and Asri basins and associated non marine sequence stratigraphy, Proc. International Symposium on Sequence Stratigraphy, IPA, Jakarta, May 1995, 261-287.
- Armon, J., Harmony, W. E., Smith, S., Thomas, B., Himawan R., Harmon B., Lukito, P., Gilmore, L., and Syarkawi I., 1995. *Complementary role of seismic and well data in identifying upper Talangakar stratigraphic sequences— Widuri Area, Asri Basin*, in: C.A. Caughey, D.C. Carter, J. Clure, M. J. Primadani, G.S., I.M. Watkinson, Gunawan H., and Ralanarko D., 2018. *Tectonostratigraphy of the Asri Basin, SE Sumatera, Indonesia: Unlocking the Hidden Potential of Oligo-Miocene Reservoirs and Implications for Hydrocarbon Prospectivity*. Proc. 42nd Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, IPA18-19-G, 14p.
- Ralanarko, D., Syafri, I., Abdurrokhim, and Nur, A.A., 2020. Seismic Expression of Paleogene Talangakar Formation, Asri & Sunda Basins, Java Sea, Indonesian Journal of Sedimentary Geology, ISSN 0853-9413, No. 46, 21-43.
- Wight, A., Friestad, H., Anderson, I., Wicaksono, P., and Remington, C.H., 1997. *Exploration History of the Offshore Southeast Sumatra PSC, Java Sea, Indonesia*, in: Petroleum Geology of Southeast Asia, Fraser, Matthews, and Murphy (eds.), Geol.Soc. Sp. Pub. No. 126,p. 121-142.
- Young, R., Harmony, W.E., Juniarto, Gunawan., Thomas, B., 1991. *Widuri Field, Offshore Southeast Sumatra: Sandbody Geometries and The Reservoir Model*. Jakarta, Prceeding 20th Annual Convention Indonesian Petroleum Association.
- Young, R. and Atkinson, C.D., 1993. A Review of Talangakar Formation (Oligo-Miocene) Reservoirs in the Offshore Areas of Southeast Sumatra and Northwest Java. Clastic Core Workshop, Spec. Publication of the Indonesian Petroleum Association, 177-210.
- Young, R., Harmony, W.E., and Thomas B., 1995. *The Evolution of Oligo-Miocene Fluvial Sand-Body Geometries and the Effect on Hydrocarbon Trapping: Widuri field, West Java Sea*, in A. G. Plint, ed., *Sedimentary facies analysis*: Oxford, Blackwell Science, Special Publication of the International Association of Sedimentologists 22, p. 355 – 380.
- www.epgeology.com, Seismic Attribute root-mean-square, accessed date July 28, 2015.