PROCEEDINGS
JOINT CONVENTION YOGYAKARTA 2019, HAGI – IAGI – IAFMI- IATMI (JCY 2019)
Tentrem Hotel, Yogyakarta, November 25th – 28th, 2019

Unlocking Hidden Opportunity in Tango Formation: Significant Incremental Recovery Through Practical Application of Reservoir Management and Characterization

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Abstract

Field Bravo started production in 1972 and has been maturing and declining over the last few decades. Most of production comes from the Delta formation currently under the waterflood, with several areas of additional production coming from Tango reservoirs, commonly under primary recovery mechanism.

Waterflood optimization efforts were done to arrest aging field decline, while at the same time looking for production improvement opportunities in non-waterflooded reservoirs.

This paper presents a success story in unlocking a hidden opportunity found in the T reservoir through production history and surveillance data revisit.

The use of comprehensive production history and surveillance analysis provided an integrated review to investigate reservoir performance and to develop most appropriate reservoir optimization strategy.

One key success factor in the application of this strategy was to perform an analysis by utilizing specific mapping methodology to capture the size of opportunity combined with pressure analysis and historical sand production allocation. Further reservoir management strategy was developed from reservoir characterization using basic production data (water-cut), high resolution stratigraphic analysis, y-plot analysis, and capacitance-resistance modeling.

The result of the approach is significant incremental recovery from a reservoir that has had already recovered high volumes of oil since its production.

Introduction

Tango-A is one of the reservoirs of the Tango Formation in the Bravo field. Unlike the other Tango reservoirs in the area that is synonymous with low quality, the Tango-A is a Darcy quality reservoir. The calculated permeability can reach up to 2 Darcy in some part of the reservoir.

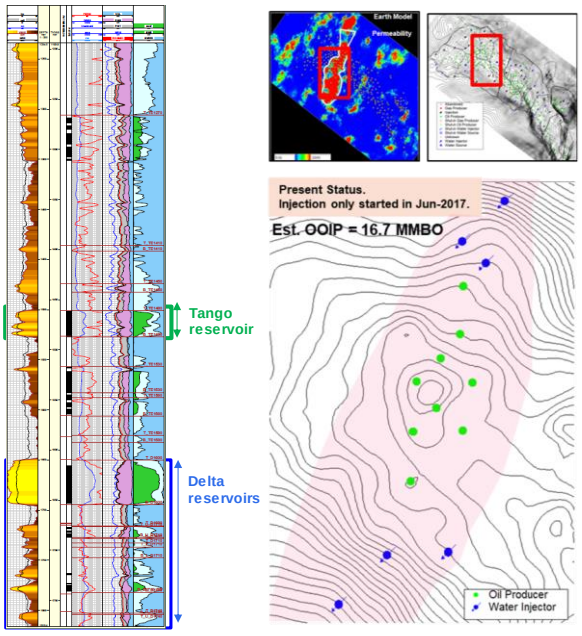

Figure 1 Tango-A location in Bravo field

The Tango-A reservoir is found in several areas within the field, with a main incised channel body located in the north of Bravo field.

Data and Method

The Tango-A reservoir has a long history of production since 1977, mostly commingled with the Delta formation, the main group of reservoirs of the field.

Initial production had 0% WC allocated to this sand for several years. In 1997, the fluid production was ramping up with additional wells completed in the Tango-A. However, in the year 2000, despite additional completion, the fluid kept dropping, with a bit of flattening in 2005, after reduction in completions. In

around 2010, activities were much reduced in this reservoir that no oil was allocated from the producing wells, due to the focus on producing the Delta reservoirs group.

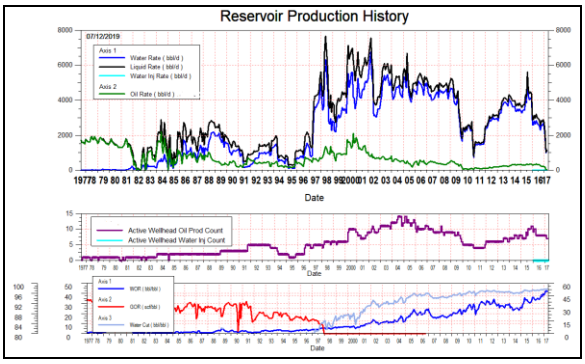

Figure 2 Tango-A full production and activities history

In 2012, an attempt to go back to production from the Tango-A was done for several years but the previous production level was not achieved, with water cut was increasing to about 80%, especially since 2015. Along this production history, the recorded reservoir pressure data showed a declining trend to less than half of the original pressure of about 530 psi.

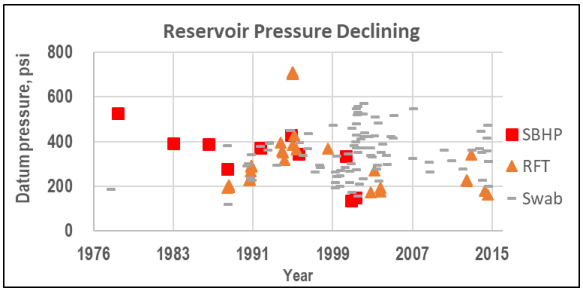

Figure 3 Pressure declining as reservoir produced

Approximately a recovery factor of 44% from the volumetric OOIP achieved from initial production up to 2017.

The reservoir producing water cut was still 80% before losing its capability to produce, however no pressure drawdown could be created to drive the oil to the wells.

In early 2017, water injection to improve the pressure was proposed and executed. The injection into the Tango-A reservoir was through additional perforation in three existing injectors, starting in Jun 2017. These injectors are in the north and south flank of the Tango-A structure.
The fluid above pump for existing completion was monitored for the impact of the injection, as well as a collection of swab data.

Finally, an increase in the reservoir pressure by an SBHP survey in one of the producers was confirmed in February 2018.

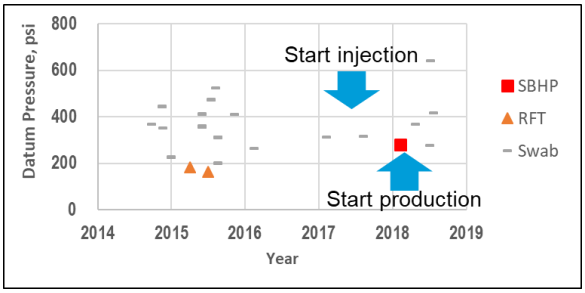

Figure 4 Re-activation enabled as pressure increased

Having the reservoir pressure back, an initial series of workovers was developed to complete the producers as single completion, dedicated to produce the Tango-A reservoir. These workovers were executed in April 2018. An additional injection through another injector in the north was included in these workovers.

Result and Discussion

A peak of 2,400 BOPD total monthly production from the Tango-A reservoir was added to the field production.

Up to May 2019, an estimated cumulative additional oil of 830 MBO had been produced from this reservoir.

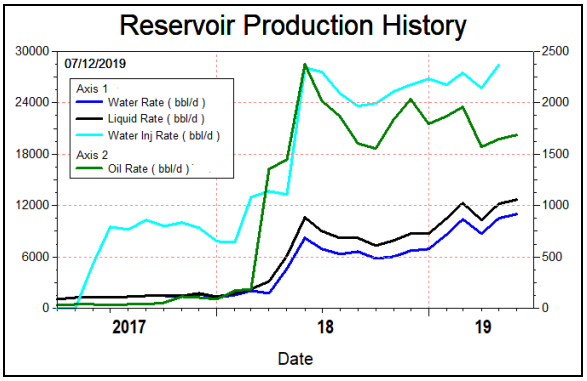

Figure 5 Additional production from Tango-A

An initial lookback suggested a possibility of an oil/water segregation in the reservoir during the limited production period. Few of the wells that were still producing from Tango-A in early 2017 were in the mid flank of the structure. During that time, the production from the reservoir was limited, and oil had been accumulated in the top of the structure.

The injection to the reservoir helped increasing the reservoir pressure, allowing the creation of the drawdown required when the reservoir was produced in April 2018.

Following these successful workovers, a reservoir characterization study was conducted to further understand the depositional environment and the dynamics of the reservoir.

A high-resolution stratigraphic analysis suggested two depositional system, an upper and lower lobe of the Tango-A reservoir, which are connected in the middle of the incised channel, based on RFT pressure data. The injectors are all injecting into the lower lobe.

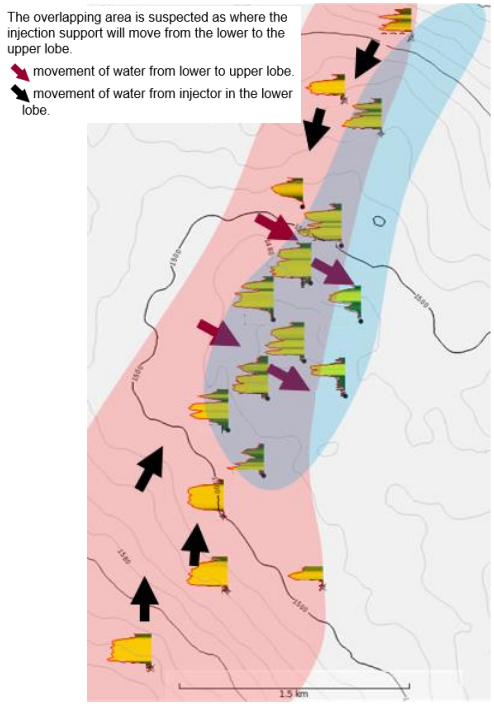

Figure 6 Injection support movement characteristic

By the end of 2018, the cumulative VRR was 0.16, provided an opportunity for additional injection to allow for production acceleration. This opportunity was implemented in two wells conversion to injectors, also located in the structure flank.

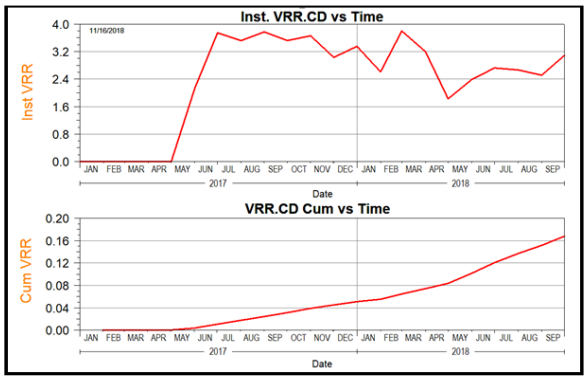

Figure 7 VRR history since injection

In effort to optimize the reservoir management, a capacitance-resistance modeling was done to understand the injector-producer connectivity.

Additionally, Y-plot analysis, an analysis to the displacement mechanism and efficiency using well production history was conducted in place of reservoir simulation.

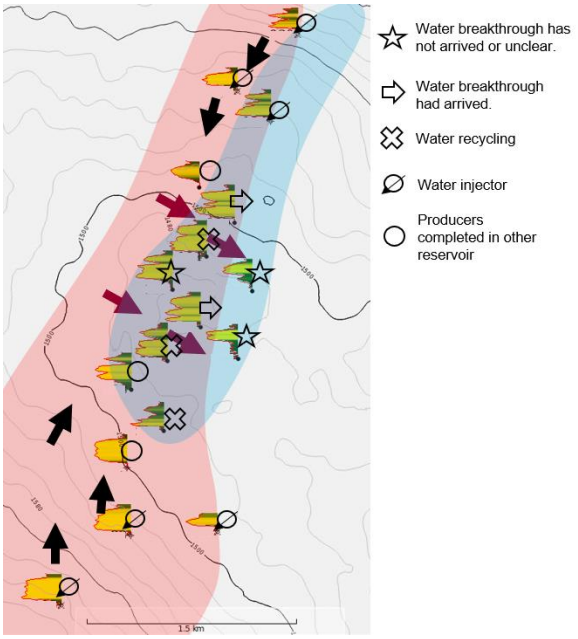

Figure 8 Wells behavior post-injection

The result of these analyses coupled with the stratigraphic analysis confirm the understanding to the reservoir characterization and dynamics.

Furthermore, the analyses allow the development of reservoir management and well level strategy. Specifically, the analyses helped pin-pointing if a well required a remedial completion to remove water cycling from the water injection, or if a well is best to increase fluid production. The execution of opportunities from the reservoir characterization study is being developed to further increase the oil production from the Tango-A reservoir.

Conclusions

A reservoir production history and surveillance/pressure data revisit provided an opportunity for increasing recovery in Tango-A reservoir. Reservoir characterization using a simpler analysis than a reservoir simulation study, for example the capacitance-resistance model and y-plot analysis, are adequate and faster to allow a reservoir management strategy to further maximize its recovery.

References

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Acknowledgements (Optional)

We thank Lidia K. Apriani (PT. Chevron Pacific Indonesia), Eric Flodin (Chevron), Eric Bhark (Chevron), Peter Nester (Chevron), Cahyo Bawono (PT. Chevron Pacific Indonesia) for the contribution to this work.
We thank Bangun Yulianto, M. Afton, Nikola Maricic, Peter R. Nesom (Chevron management) for permission to publish this work.