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Application of Fluid Contact Analysis for Well Optimization and Field Development Strategy in Kerning Field, Central Sumatera

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Abstract

Determination of a fluid contact in brown field is essential for production optimization and well development strategies. In the last four years, production optimization in Kerning Field has been focused to drain Charlie and Delta Reservoir intervals which characterized by very clean sand, high quality and high fluid rate with strong water drive mechanism. However, water coning phenomena occurred in the existing production intervals, thus the identification of fluid contact is very essential to seek another potential reservoir to optimize and identify sweet spot area for new well placement.

This paper presents a technique to determine a fluid contact by integrating static and dynamic data such as well logs, oil allocation from fingerprint analysis, production test and completion history data. The fluid contact analysis performed for 44 active wells and eight reservoirs in end of 2020. Fluid contact interpretation indicates thick remaining oil column in Alpha and Beta that was attractive to optimize due to unproduced for more than 10 years. Eight workovers and four infill wells executed along 2021 – 2022, it resulted total 3,076 BOPD of initial production gain with 83% of success ratio. Application of this fluid contact methodology has proved strong capability to identify potential by passed oil. It can be applied to common problems of fluid contact determination in other field areas.

Keyword(s): fluid contact, reservoir, production optimization

Introduction

Kerning Field is one of small field located in the northern border of Rokan Block, Central Sumatera. The field discovered in 1976 with estimated initial oil in place around a hundred million stock tank barrels. Geologically, Kerning Field is a three way-dip closure anticline bounded by Northwest – Southeast trending of thrust fault at the West. The structure is plunging to the Southeastern and it compartmentalized into three local structures (North, Central and South) (**Figure 1**). Reservoir stratigraphy of the field consists of eight main reservoirs, such as Alpha, Beta, Charlie, Delta, Enstein, Frankfurt, Gold and Honest (**Figure 2**). The reservoirs deposited in tidal estuary environment and pre-dominantly characterized by strong water drive mechanism, thus well completion design, perforation plan and appropriate pump estimation is the key to avoid water coning while production.

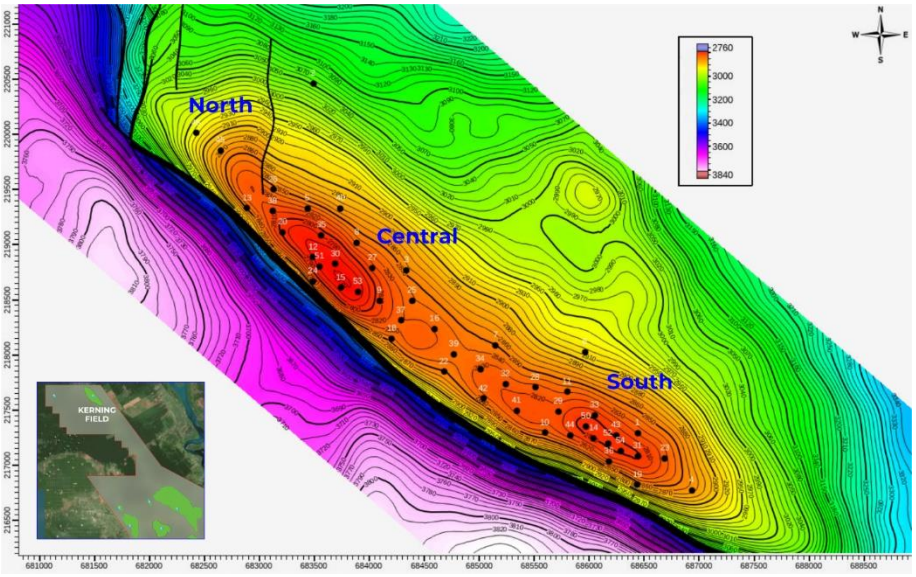


Figure 1. Top depth structure map of Beta Reservoir in Kerning Field showing three local structural compartments (North, Central, and South. Index map indicated location of the field in the northern border of Rokan Block, Central Sumatera.

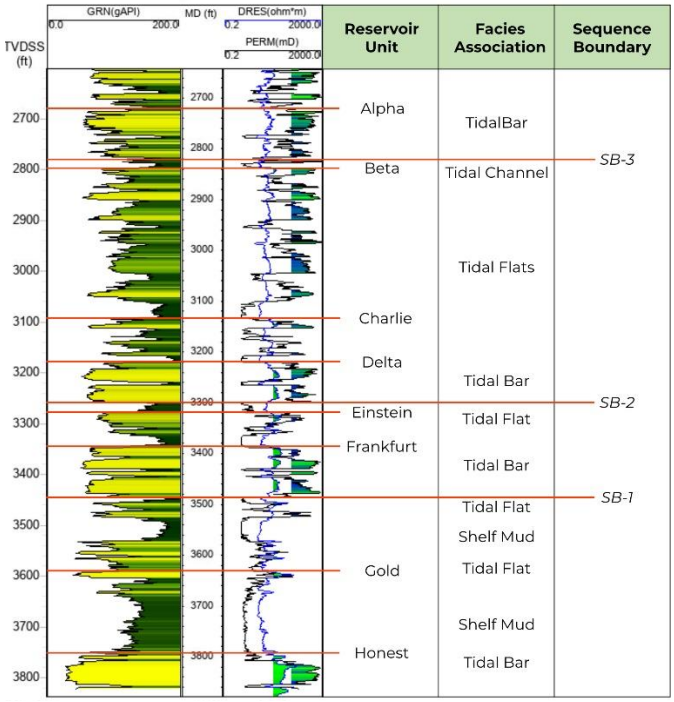


Figure 2. Kerning Field reservoir stratigraphy showing the vertical succession of tidal estuary facies

Methodology

The methods used for determining the fluid contacts include completion history and production test review, water cut estimation derived from oil finger printing geochemistry and conventional well-log analyses (**Figure 3**). It performed for 44 active wells to all main reservoirs in Kerning Field in end of 2020. For the accurate interpretation some petrophysical parameters applied using cut-off, such as porosity (0.125 v/v), shale volume (0.5 GAPI) and resistivity (10-30 ohmm). The well interval must be zoned by fluid type, to estimate for differences in fluid content. Color coded for open intervals based on historical swab test data or single production history was applied in interpretation, e.g., proven oil (dark green), possible to probable oil (light green), depleted oil (pale green) and water (blue) or flagged as grey to describe low-quality rock.

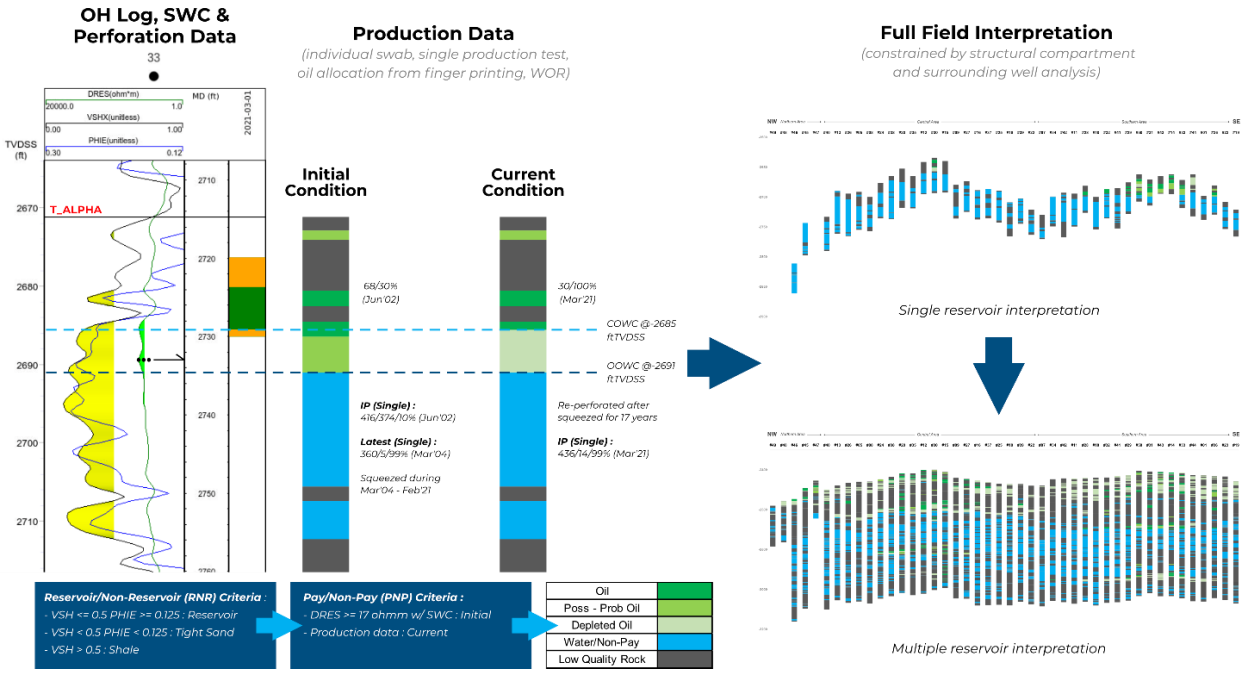


Figure 3. Integrated static and dynamic fluid contact interpretation in Kerning Field. The well interval must be zoned by fluid type, to estimate for differences in fluid content. Color coded for open intervals based on historical swab test data or single production history was applied in interpretation, e.g., proven oil (dark green), possible to probable oil (light green), depleted oil (pale green) and water (blue) or flagged as grey to describe low-quality rock.

Results

The Fluid contacts may vary over a reservoir either because of faults, semi or impermeable barriers, reservoir quality or heterogeneity, hydrocarbon filling history, and artificial lift/completion design from initial completion thru current condition (modified after Niculescu and Ciuperca, 2019). In Kerning Field, the last four controlled distribution of current oil existence in specific local compartment (**Figure 4**). The fluid contact analysis indicated thick remaining oil column in Alpha and Beta Reservoirs (**Figure 5** and **Figure 6**), it should be an attractive opportunity to revisit, because it has been neglected for more than 10 years due to production optimization strategy to prioritize other reservoirs.

Application of the concept validated by sequential workover and new drilled well execution along 2021 – 2022 from attic to flank structure areas. Eight workover jobs and four new infill wells have been successfully delivered cumulative production gain around 3,076 BOPD with 83% of success ratio (**Table 1**). Most of the wells produced using single completion strategy to obtain conclusive result and led better reservoir performance understanding.

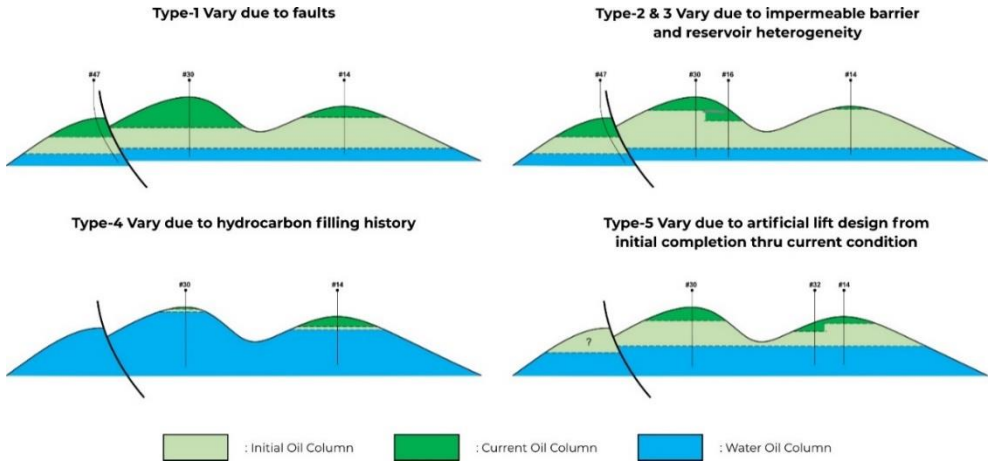
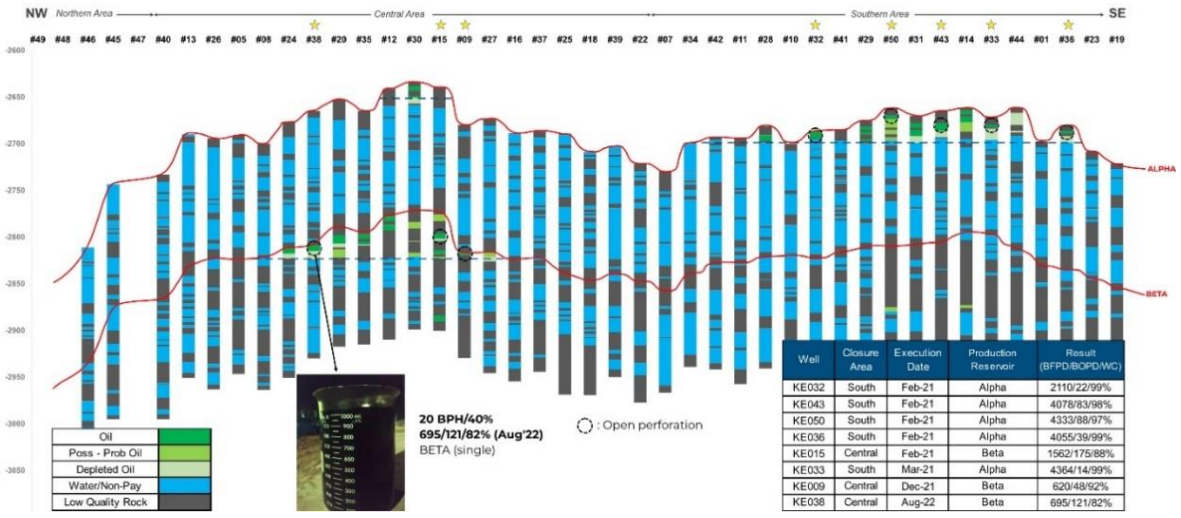


Figure 4. The Fluid contacts may vary over a reservoir either because of faults, semi or impermeable barriers, reservoir quality or heterogeneity, hydrocarbon filling history, and artificial lift/completion design from initial completion thru current condition (modified after Niculescu and Ciuperca, 2019). Last four controlled controlled distribution of current oil existence in specific local compartment in Kerning Field.



Well	Closure Area	Execution Date	Production Reservoir	Result (BFPD/BOPD/WC)
KE032	South	Feb-21	Alpha	2110/22/99%
KE043	South	Feb-21	Alpha	4078/83/98%
KE050	South	Feb-21	Alpha	4333/88/97%
KE036	South	Feb-21	Alpha	4055/39/99%
KE015	Central	Feb-21	Beta	1562/175/88%
KE033	South	Mar-21	Alpha	4364/14/99%
KE009	Central	Dec-21	Beta	620/48/92%
KE038	Central	Aug-22	Beta	695/121/82%

Figure 5. Fluid contact interpretation in Alpha and Beta Reservoirs section showing thick remaining oil column. Black dash circles and stars subsequently are current open production intervals and location of workover wells.

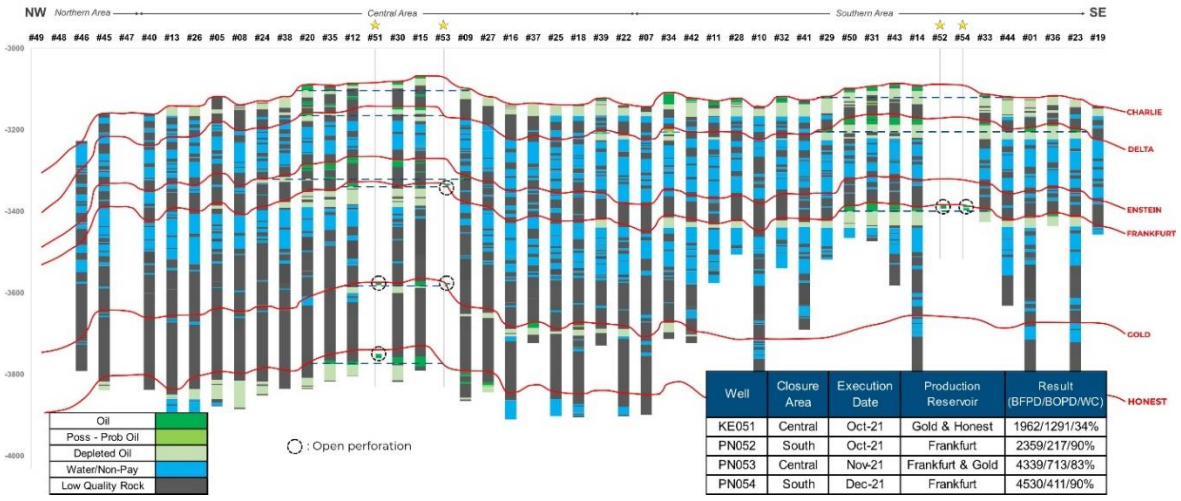


Figure 6. Fluid contact interpretation in Charlie, Delta, Enstein, Frankfurt, Gold and Honest Reservoir section. The infill wells (#51, #52, #53 and #54) deliver more than two-thousand-barrel of oils from those lower reservoir section. Black dash circles and stars subsequently are current open production intervals and location of new infill wells.

Table 1. Workover campaign and new infill production results during 2021 - 2022

Well	Compartment Area	Execution Date	Production Reservoir	Initial Production (BOPD)	Initial Oil Gain (BOPD)	Remark
KE032	South	Feb-21	Alpha	22	9	Workover
KE043	South	Feb-21	Alpha	83	66	Workover
KE050	South	Feb-21	Alpha	88	71	Workover
KE036	South	Feb-21	Alpha	39	32	Workover
KE015	Central	Feb-21	Beta	175	152	Workover
KE033	South	Mar-21	Alpha	14	10	Workover
KE051	Central	Oct-21	Gold & Honest	1291	1291	New Well
KE052	South	Oct-21	Frankfurt	217	217	New Well
KE053	Central	Nov-21	Frankfurt & Gold	713	713	New Well
KE009	Central	Dec-21	Beta	48	32	Workover
KE054	South	Dec-21	Frankfurt	411	411	New Well
KE038	Central	Aug-22	Beta	121	72	Workover
Cumulative Oil Production (BOPD)				**3,222**	**3,076**	

In term of reservoir management strategy, all new wells are focusing to drain main lower reservoirs (Frankfurt, Gold and Delta) while workover job campaign is producing from Alpha and Beta Reservoirs. Temporary isolation method applied to Charlie and Delta intervals using packer or squeeze cementing. Production sustainability achieved by implemented shorten perforation interval and appropriate pump utilization to avoid massive water coning.

Conclusions

The fluid contact analysis offers strong methodology to identify potential by passed oil. It is very crucial not only for production optimization strategy, but also very beneficial for well placement plan during infill project design. Integration of static and dynamic data resulted precise fluid contact interpretation, thus deliver significant direct impact to production.

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