Reliance On Post-Production Data, Modelling And Infill Results For Building Stratigraphic Framework In Brownfield Development
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Abstract

Objectives: Initial reservoir compartmentalizations due to lack of understanding in reservoir connectivity in stratigraphic-trap field pose challenges in production life whereby vertical and lateral communications has occurred. Such threats include deviation of reservoir behaviours from forecasted which leads to ineffective RMP and high risk for future development plan. Production data, modelling and post-drilling results can be utilized as inputs for geological understanding revision which has to include observed reservoir connectivity prior to employing different approach for 3D static model construction through post-production data. This is further enhanced by standardization of lithofacies which was inconsistent across the reservoirs of interest and refined depositional environment through core study in tidal-influenced fluvial channel based on latest core study which allows for a framework for building an integrated reservoir model.

Methods, Procedures, Process: 2 methods are utilized to identify reservoir connectivity and facilitate the integrated stratigraphic concept which are post-production data and unified lithofacies and geological concept across the reservoirs.

1. Production data cross-checking by leveraging on reservoir pressure, production rate, water cut trend and water tracer results, 4 compartments in the southern area of Field A display connectivity based on various surveillance plots. For example, reservoir I35Upper South West (I35USW) and reservoir I35Upper Southern Channel (I35U SC) pressure trends converging and similar trends are observed for reservoir I27 South C (I27 SC) and reservoir I27 South D (I27 SD) pre-2016.

Figure 1: Compartments in south of field A namely I27 SD, I27 SC, I35U SW and I35U SC. Only I27 SD is under natural depletion recovery drive (NDR) while others are under water injection recovery drive (WIR).
Figure 2: General reservoir pressure trend seen in 1) I35U SW and I35U SC convergence, and 2) I27 SC and I27 SD pre-2016. Well C1S1 in I35U SC mimics pressure trend from I27 SC which may indicate partial connectivity/support from I27 SC.

2. In I27 SC and I35U SC dynamic models, pore volume (PV) multiplier and additional sand population were required to match production and water cut trend, in addition to reduce recovery factor (RF) in I27 SC from 50% to 30% as per current WIR mechanism. These artificial adjustments are indicators that initial reservoir volume in-place is insufficient to reflect the production data and recovery factor. Pilot capacitance resistance modelling (CRM) was also conducted based on water injection coefficient response to targeted oil producers which shows that vertical connectivity occurs in I27SC and I35U SC.

3. 2017 infill campaign targeting 3 oil producers in reservoir I35Upper North (I35U N) reached almost 100% water cut within a few months of production although initial reservoir pressure was 300psi higher than expected. Interference test concluded that injectors in reservoir I35Lower North (I35L N) are communicating with I35U N based on interference pulse test.
Previous compartmentalized understanding of reservoirs led to different lithotypes assigned to each reservoir as core studies were done independently. This led to inconsistency in integrating reservoirs geological concept which is fundamental in relating the facies to numerical rock properties such as porosity and permeability. A standardized core description, lithofacies and EOD was conducted for the reservoirs to ensure the same nomenclature and geological properties are uniform across the reservoirs. The EOD will be further refined based on well correlation and spectral decomposition in future static model rebuilding.

**Results, Observations & Conclusions:** Seismic amplitude shows that reservoirs I27 and I35U share the same reflector which fails to delineate the reservoir correlation and I35L attribute is masked by I35U. However, the attributes able to qualitatively explain possible barriers or pathways that permit connectivity to happen vertically.
or laterally, in addition to constraining the reservoir boundaries where applicable. Revisiting correlation is vital for stratigraphic framework as in some wells, both sands are stacked vertically with no apparent shale barrier which allows connectivity to occur. This is seen in well C03 and C1S1 which is producing from reservoir I35U SC. Water injector C12 injecting to I35U SC may have allow fluid to travel laterally to C03 and/or C1S1 before migrating vertically within the same wellbore as indicated by CRM result. Rebuilding of an integrated static model needs to heavily guided by incorporating inventory of post-production data, previous results of dynamic models, novel technology through CRM and infill findings as these reflects the latest understanding of the reservoirs which had been poorly understood or resolved through tunnel vision of the field. Through the fundamental of standardization of geological concept that translates across the reservoirs, a holistic model can be built with multiple scenarios within the data constraints that will able dynamic model to simulate the reservoirs connectivity extensively and predict the necessary prudent reservoir management interventions. The integration of the 2 methods provides a well characterized connectivity lateral and vertical across the reservoirs that should be incorporated as part of the stratigraphic framework.

Figure 5: Relative acoustic impedance (RAI) cross section across I27 to I35U does not distinguish both sands but the qualities vary according to bright/dim yellow variation. Seismic amplitude (top left) demonstrates baffle areas in I35U SW and I35U SC. Well correlation across the same RAI section postulates that some wells ie C03 and C1S1 in which both sands are stacked vertically without barrier may act as main fluid conduit for connectivity.