Integration of Geological Understanding with Geophysical Techniques for Better Reservoir Characterization
A Case Study in Ravva Block, India*

Arnab Ghosh[1], Harsh Vardhan[1], Shashank Singh[1], Siddharth Kejriwal[1], Harshul Khandelwal[1], Kaladhar Sharma[1], Bhawesh C. Jha[1], and Monosvita Chaliha[1]

Search and Discovery Article #51557 (2019)**
Posted March 25, 2019

*Adapted from oral presentation given at 2018 International Conference and Exhibition, Cape Town, South Africa, November 4-7, 2018
 DOI:10.1306/51557Ghosh2019

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Abstract

Ravva Block is one of the most prolific hydrocarbon areas in the Krishna Godavari Basin, on the eastern coast of India. The main reason for this is the location of the block which acted as the depocenter for thick Miocene sediments. The depositional environment for these sediments vary from shoreface to deep marine setting driven by the fluctuation in the sea level. The Middle Miocene (MM) sands are the main reservoirs with an exploration, development, and production history of nearly three decades in this block. The MM interval consists of excellent quality shoreface and distributary channel sands. Multiple local and regional unconformities along with listric and antithetic faults in the growth fault regime create excellent strati-structural hydrocarbon traps but at the same time brings in complexity within these reservoirs. With more than 80 wells, multiple 3D seismic and a huge wealth of production data there are still some unresolved questions especially with regards to the reservoir characterization and connectivity. This opens an opportunity to identify potentially unswept and disconnected reservoirs and exploit them to arrest the production decline. The workflow adopted for this study is the integration of geological concepts including core and well data with different seismic attributes like spectral decomposition and inversion and then using the pressure data to complete the understanding. With good quality seismic data and the concepts of sequence stratigraphy used extensively at each stage the workflow can be broadly divided into four stages. First, the well log data are used to derive 1D depositional model, the same is then calibrated with the core sedimentology and environment of deposition. Second, the complex well correlation across the MM sequence is done and then validated with pressure data. Third, the horizons,

unconformities and faults are picked in seismic and tied to the well markers and lastly the various seismic attributes are used to derive the sand fairways. The fairways are then back validated with the well information. This study improves the reservoir distribution and characterization understanding and are being immensely used in reservoir modelling, infill well placement, and understanding areas devoid of wells with more certainty.

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AAPG

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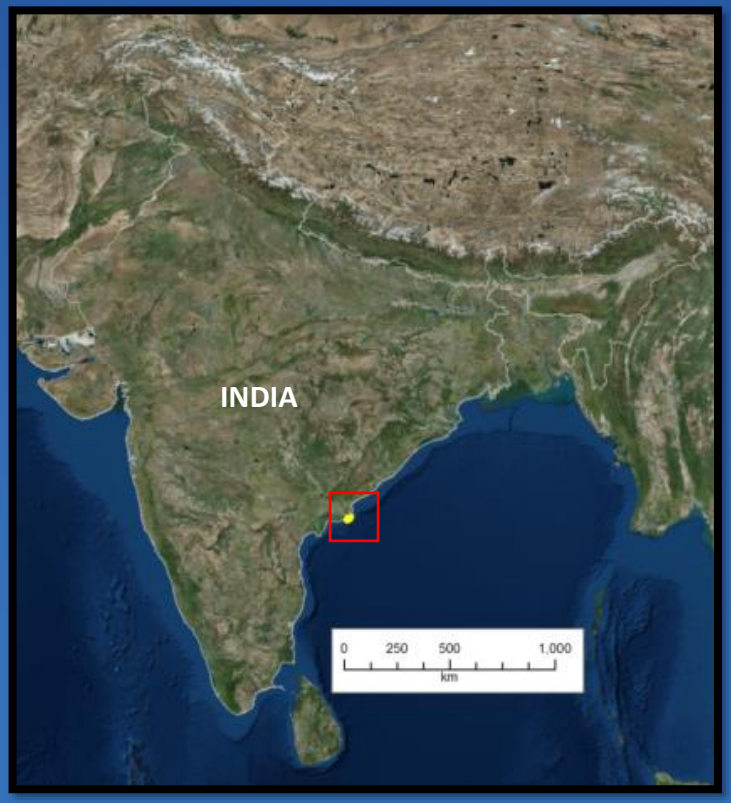
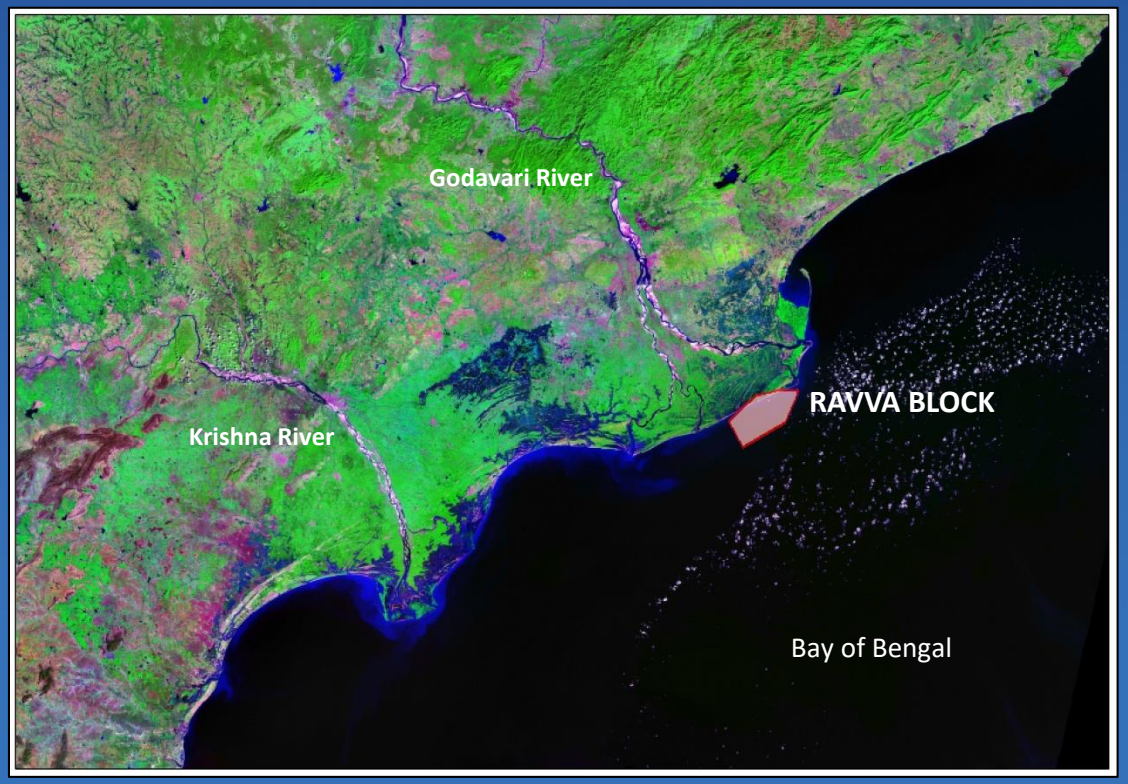
RAVVA BLOCK - INTRODUCTION





- Lies in Krishna-Godavari Basin on the eastern coast of India in the shallow waters of Bay of Bengal. Total area of the block is 331.26 km2 of which 21 km2 is onshore.
- Production started from 1993. Produced more than 286 MMBBL & 352 BSCF sales gas (Recovery – 50%). Currently producing around 18 kboepd.
- Field developed from 8 un-manned platforms in water depths of 10-15 m.

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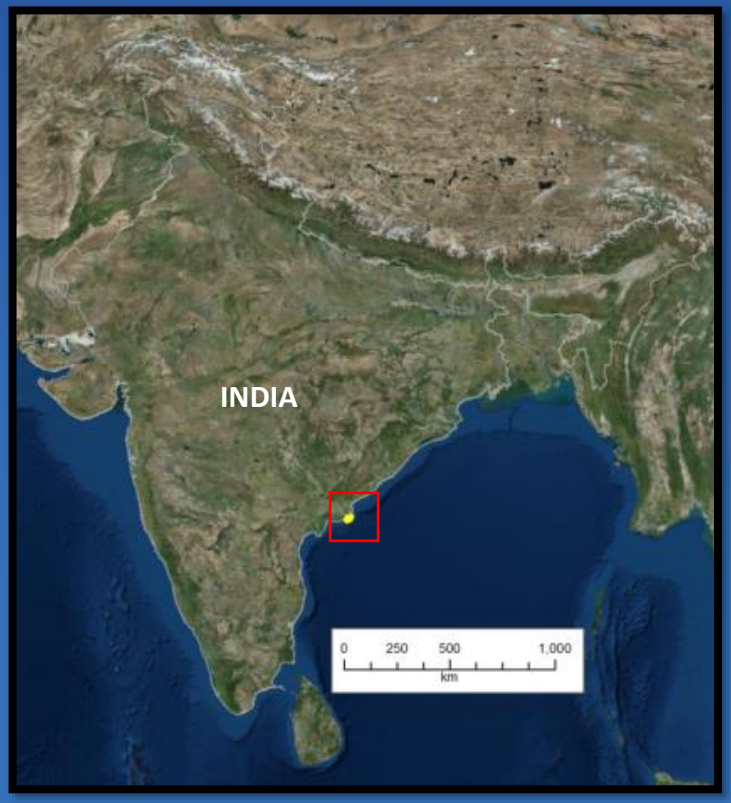

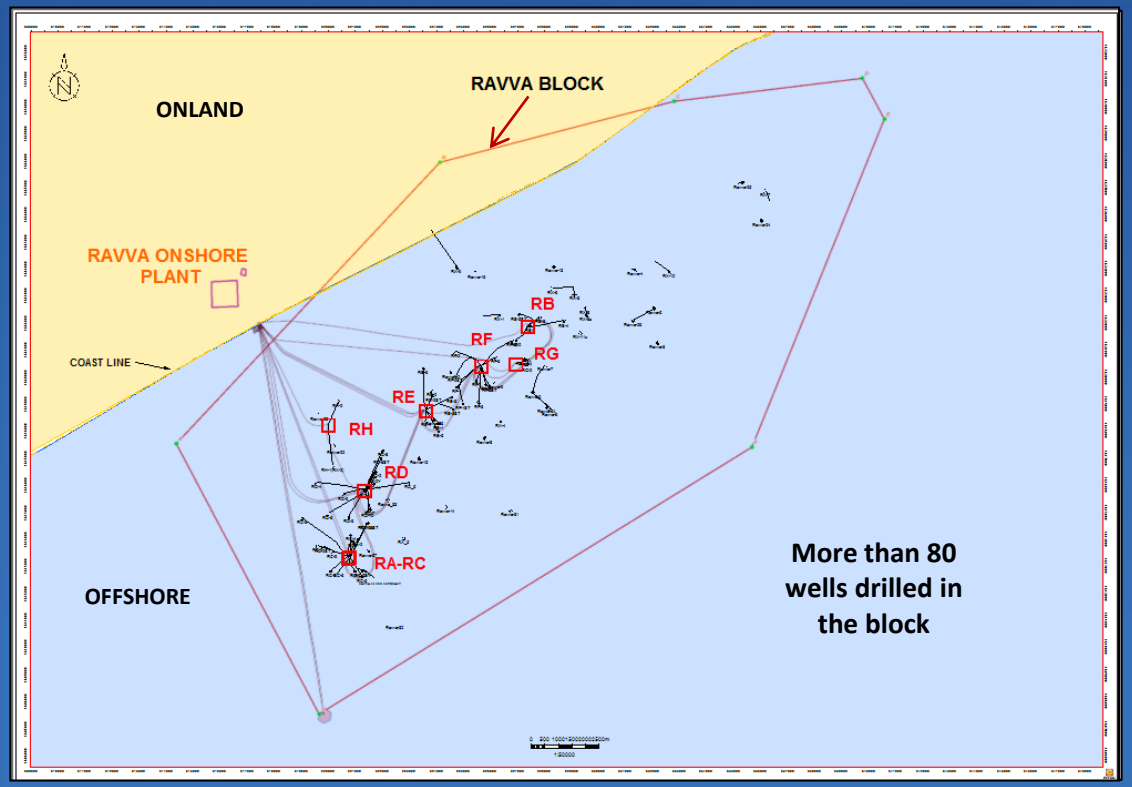

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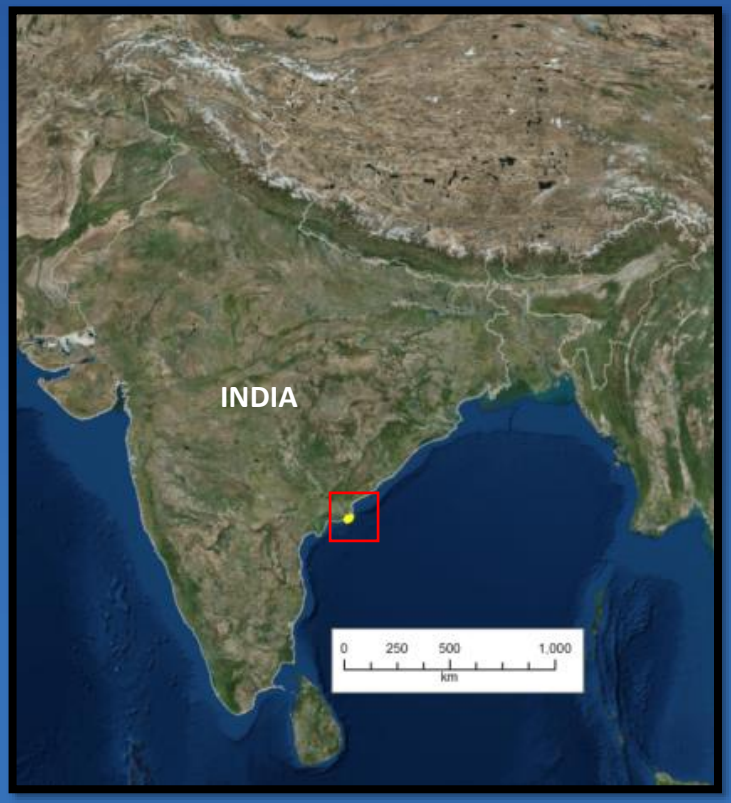
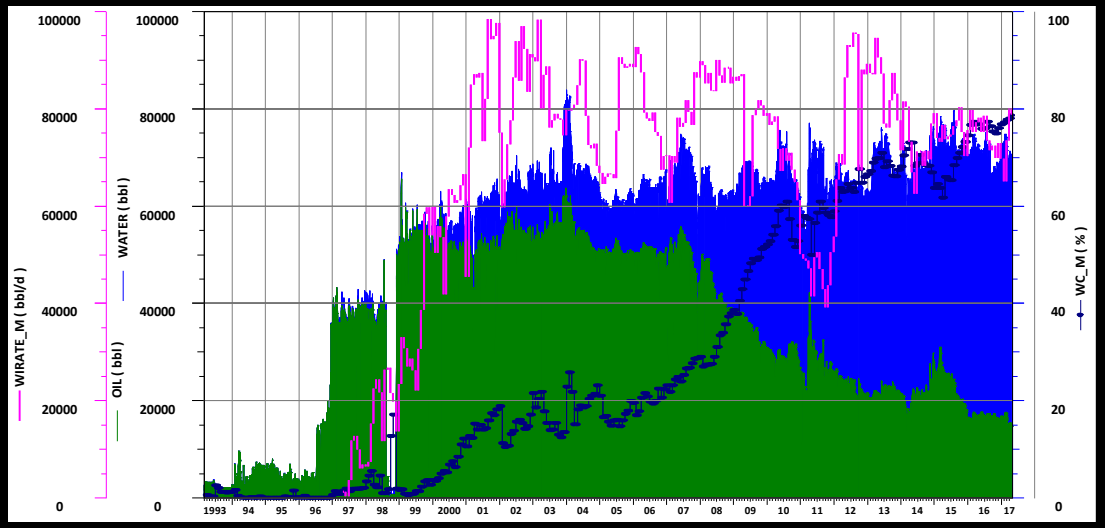


Production History of Ravva



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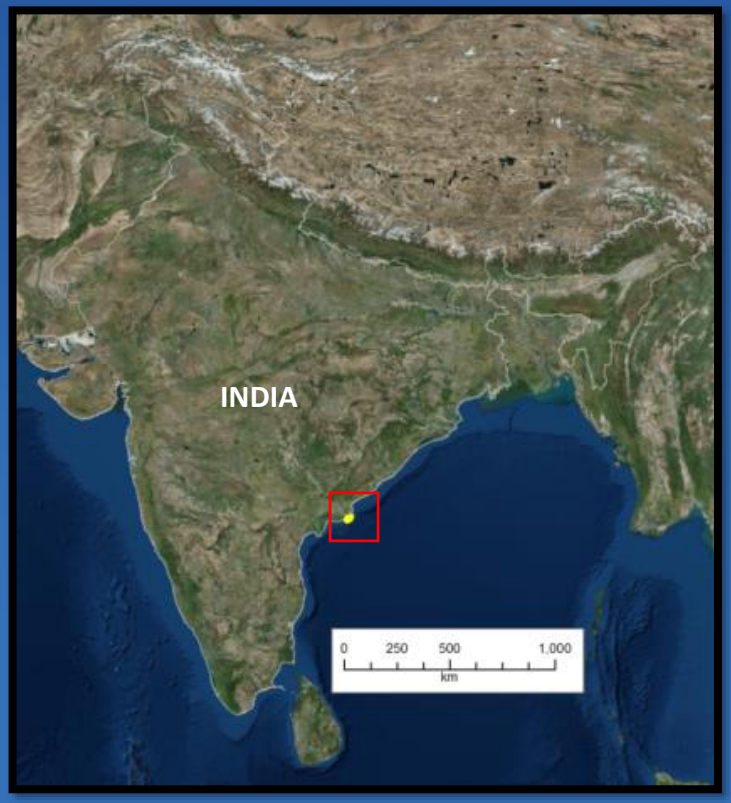


RAVVA OFFSHORE PLATFORM: RA-RC

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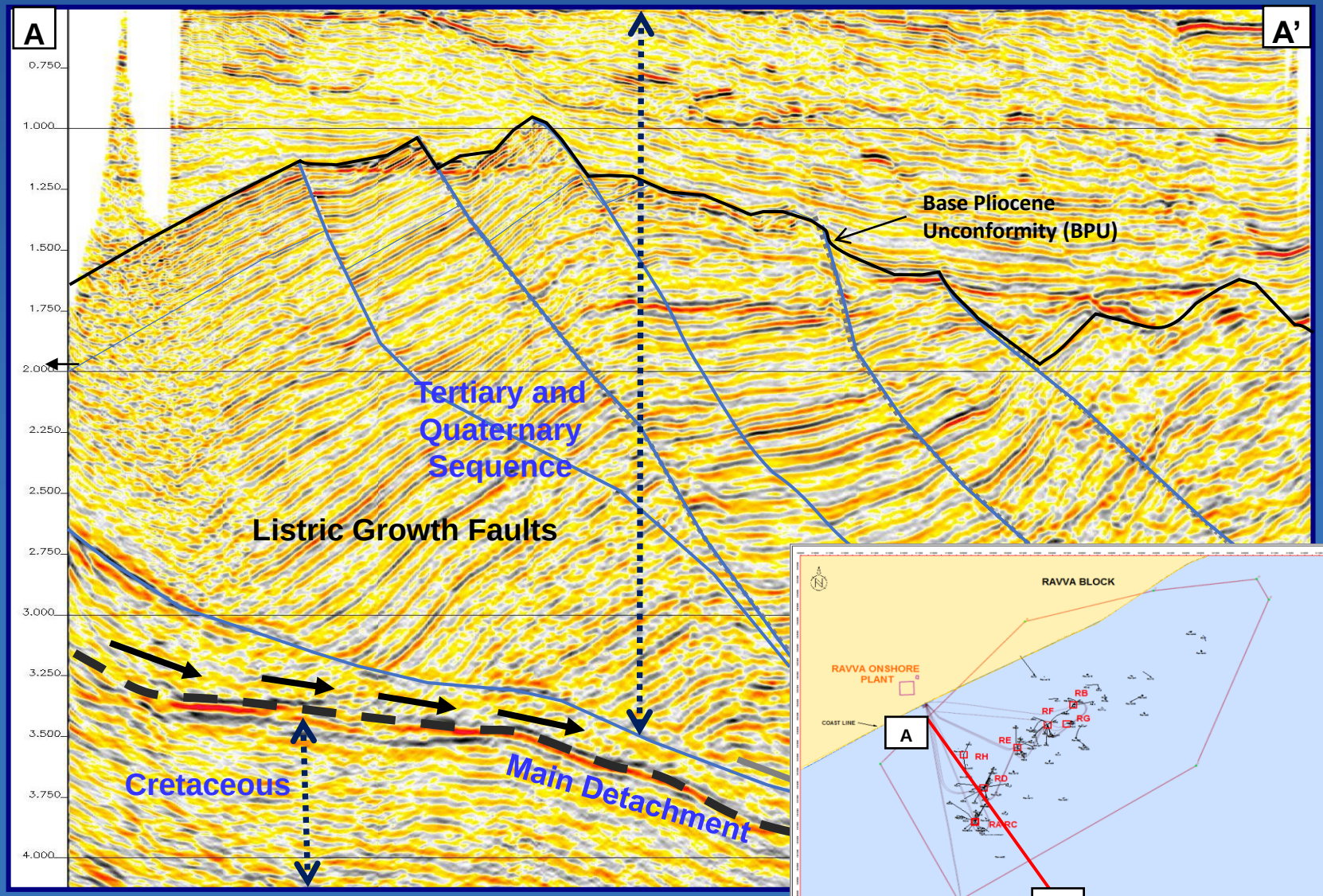
RAVVA BLOCK – STRUCTURE AND STRATIGRAPHY



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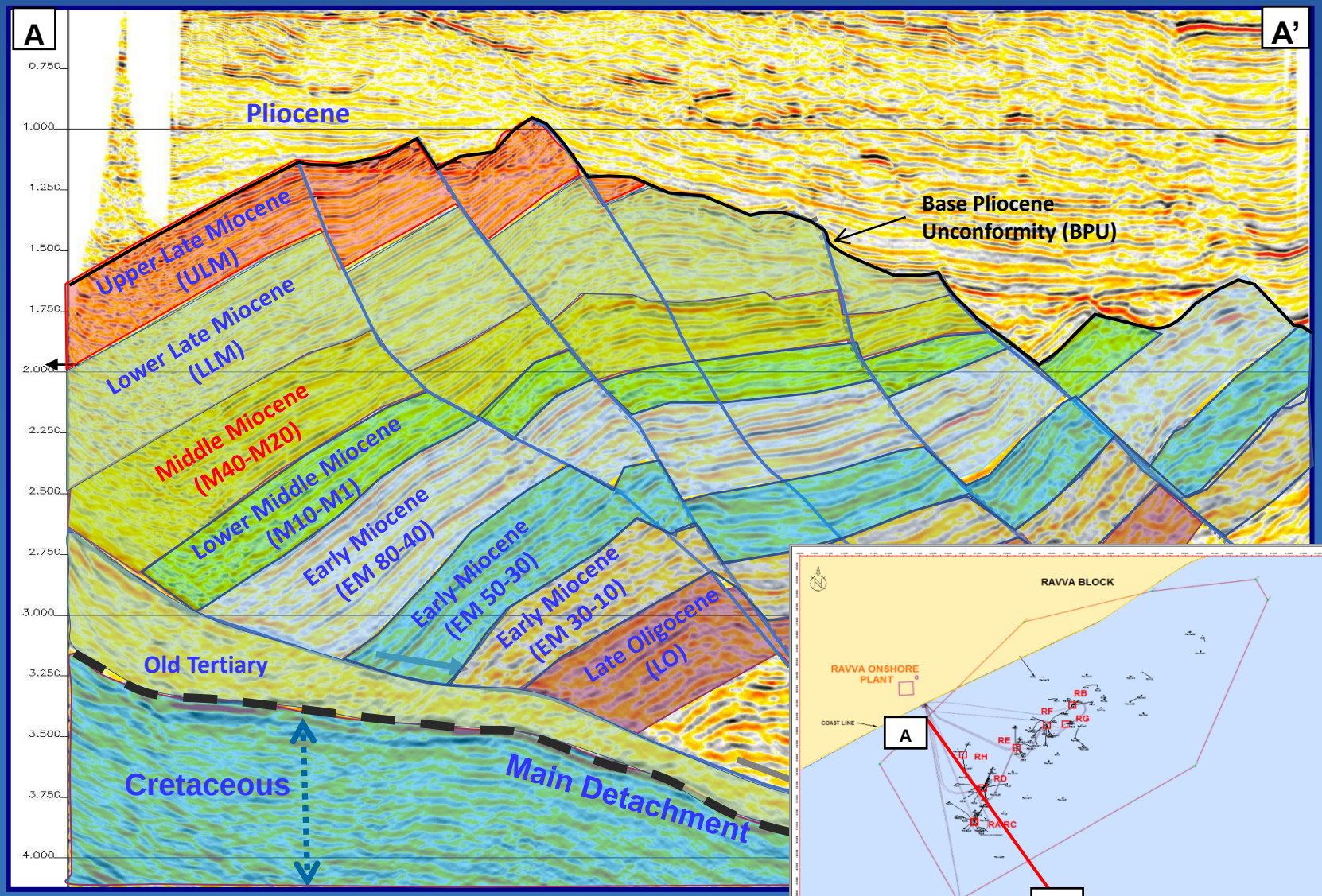

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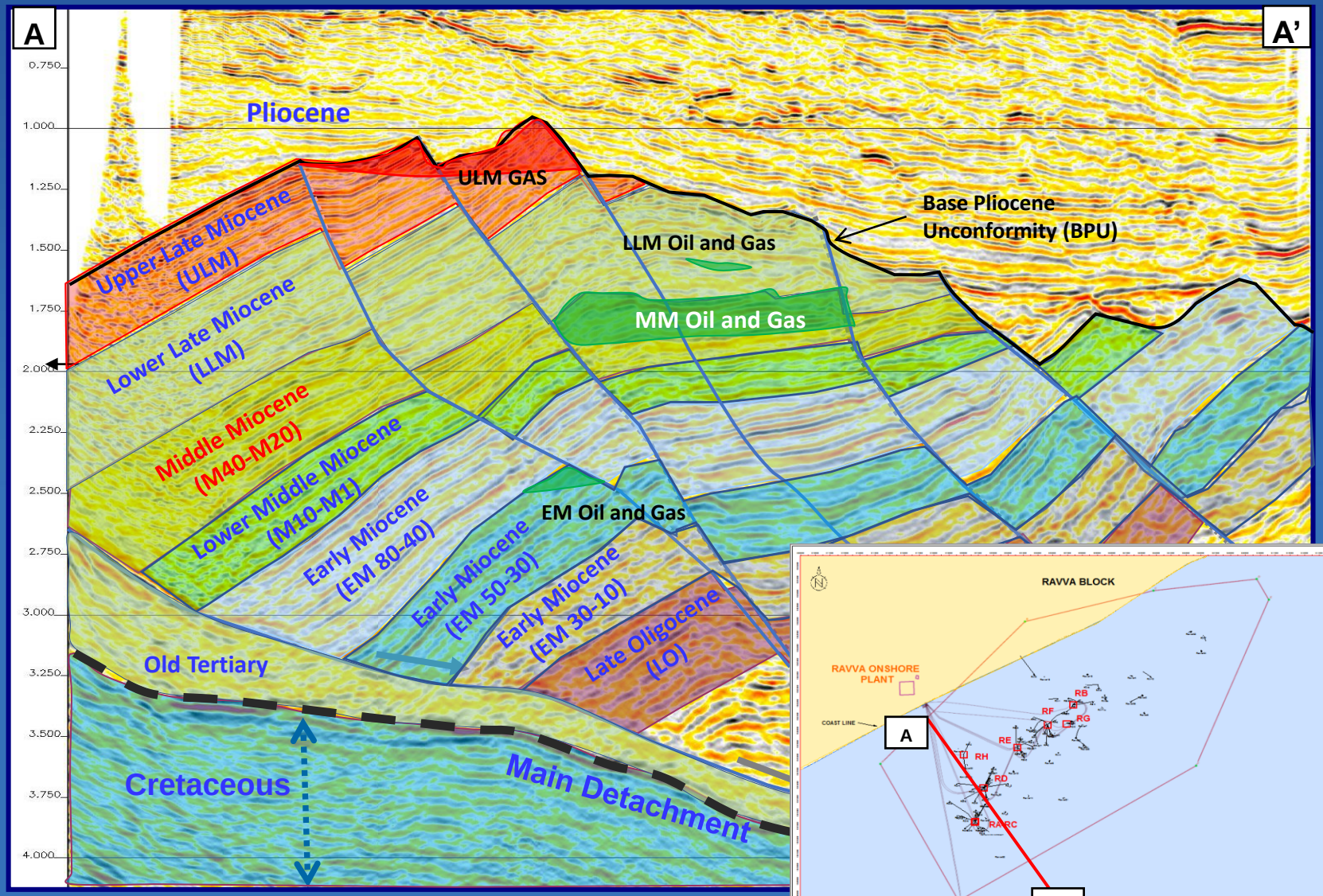
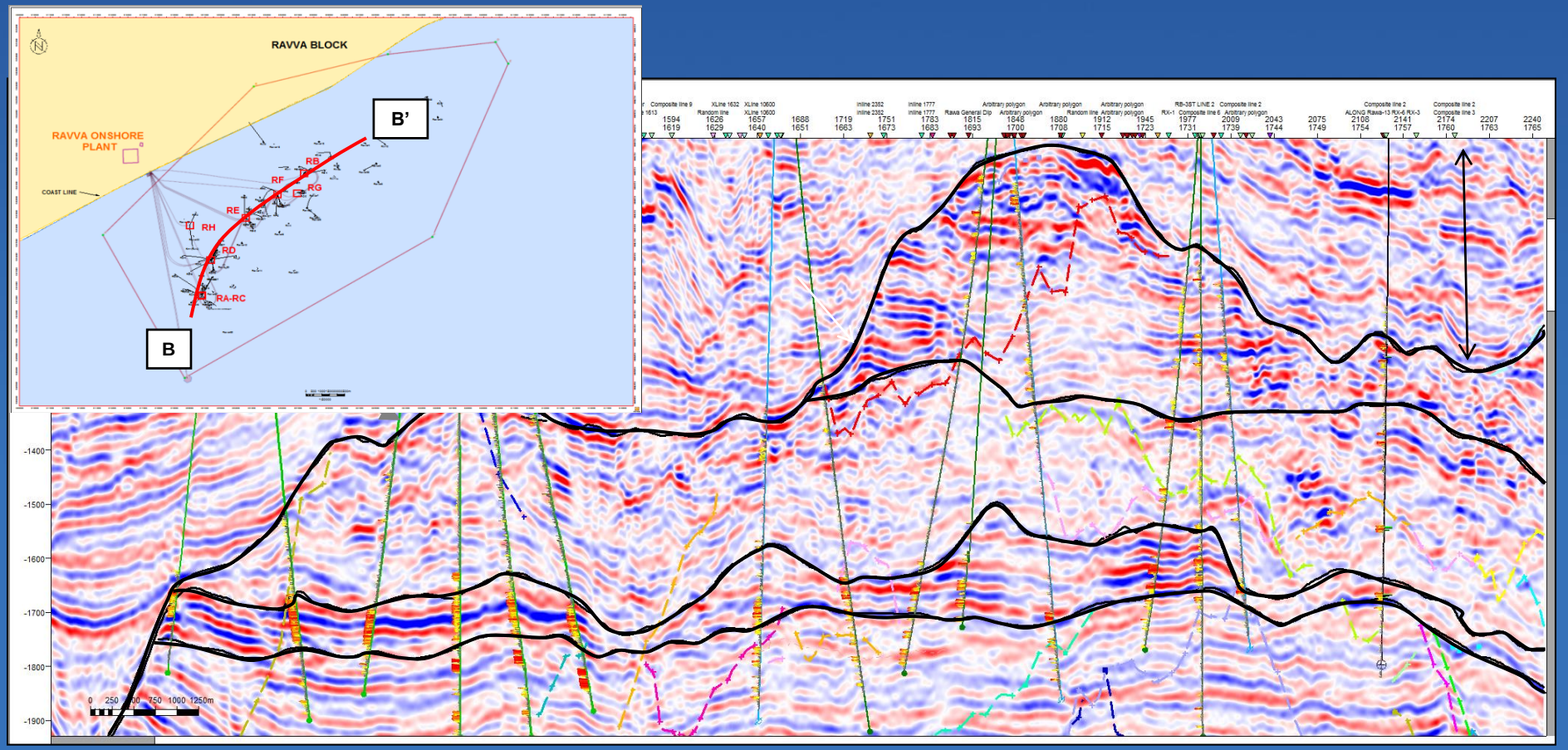


Middle Miocene Reservoirs

Structural and Stratigraphic control



- *Middle Miocene Reservoirs overlies an Angular Unconformity (M20SB)*
- *The Overlying Erosional cut (LLMSB) along with faults form the important entrapment element for hydrocarbon in these reservoirs*

Middle Miocene Reservoirs

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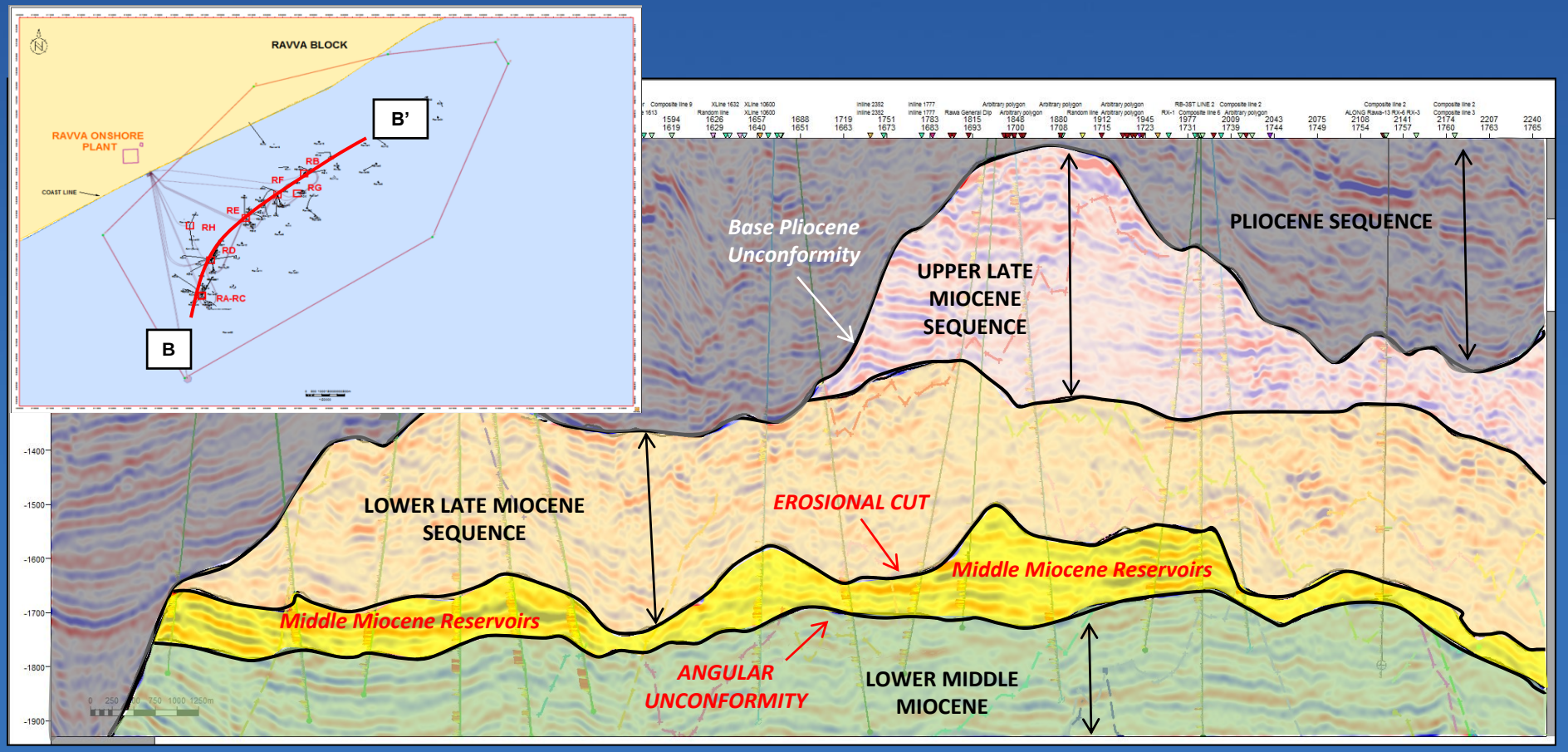

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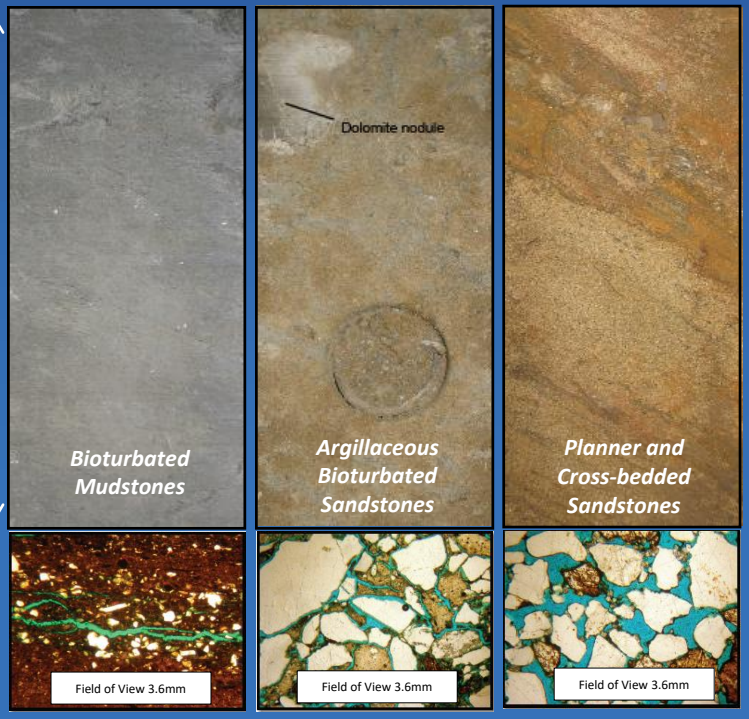
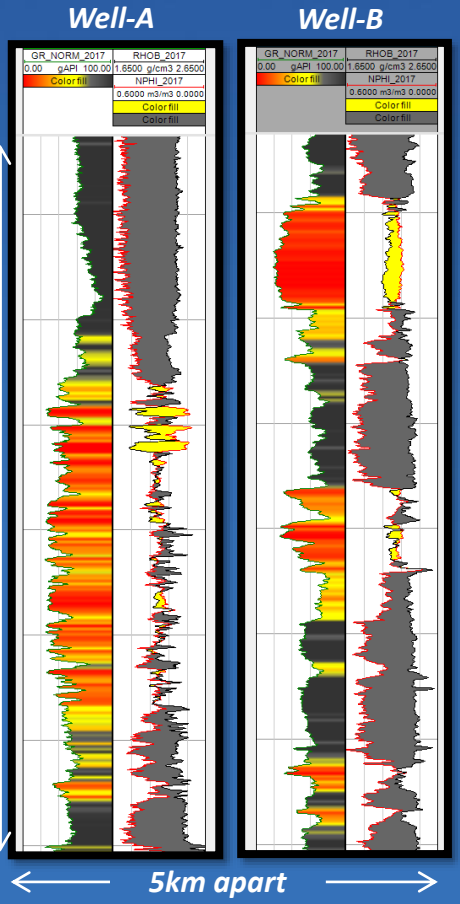
Middle Miocene Reservoirs

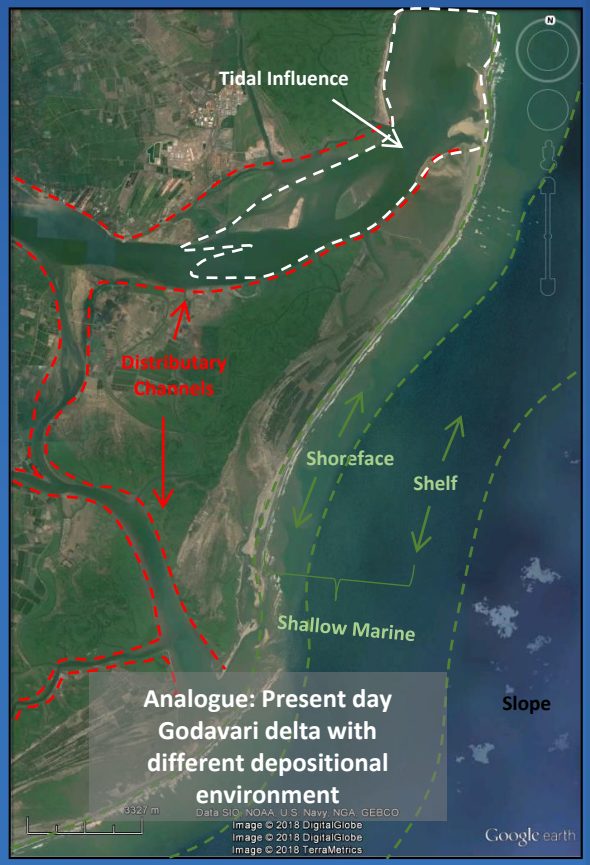
Geology

Broad Facies interpreted from core in Middle Miocene Deposits



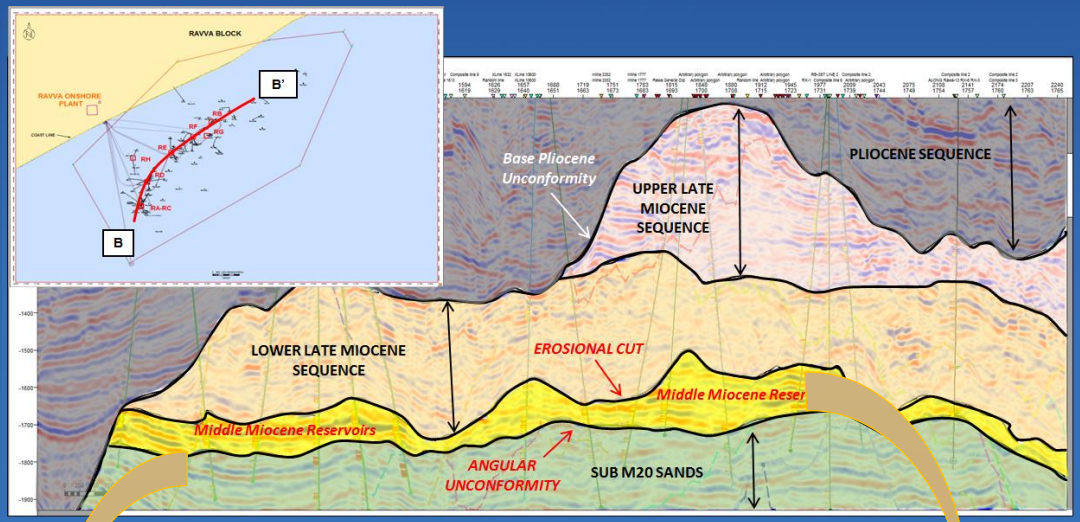
Shallow marine deposits with tidally influenced distributary channel fill

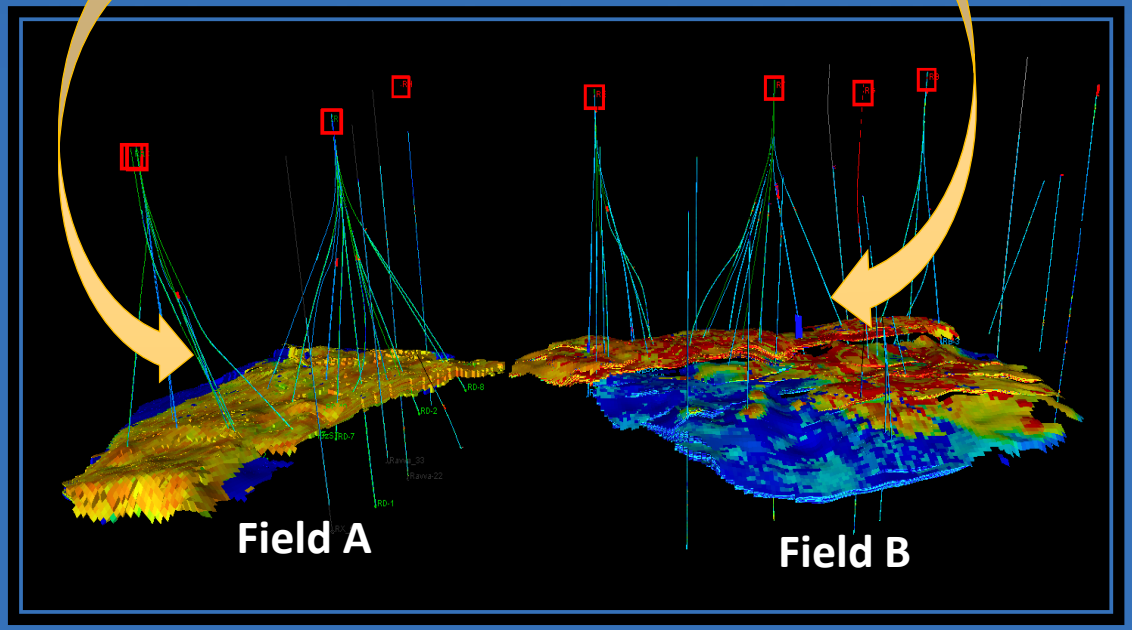


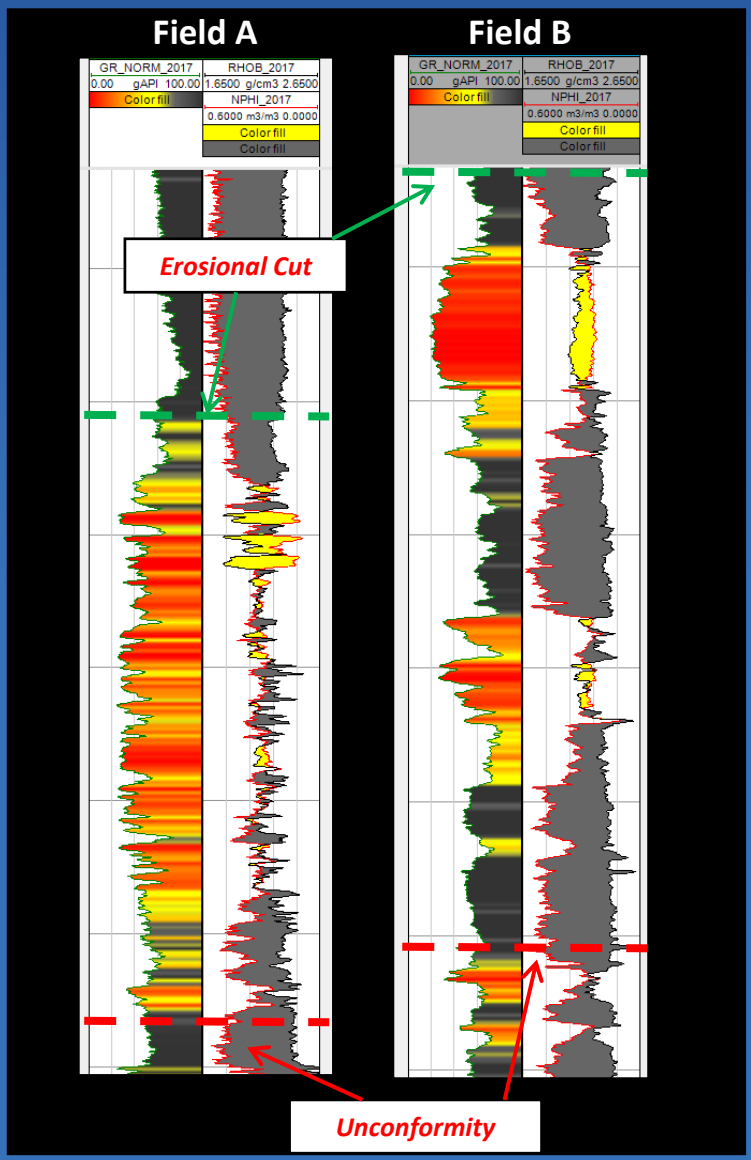


- *Sediments transported by rivers from the Indian subcontinent*
- *A progradational sequence with relative fall in sea level in Middle Miocene time*
- *The present day Godavari delta is a good analogue for these Middle Miocene sands*

What are the Challenges ?







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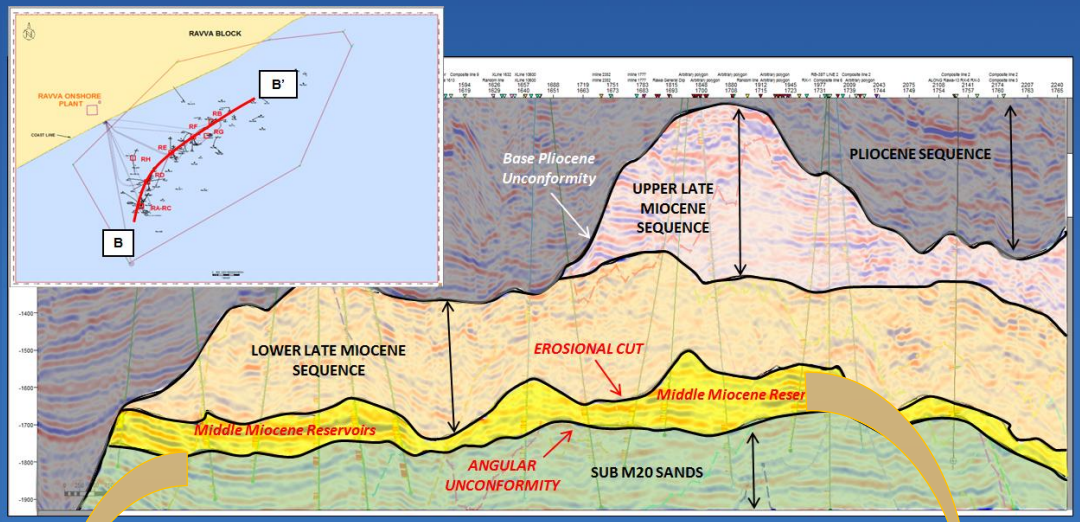
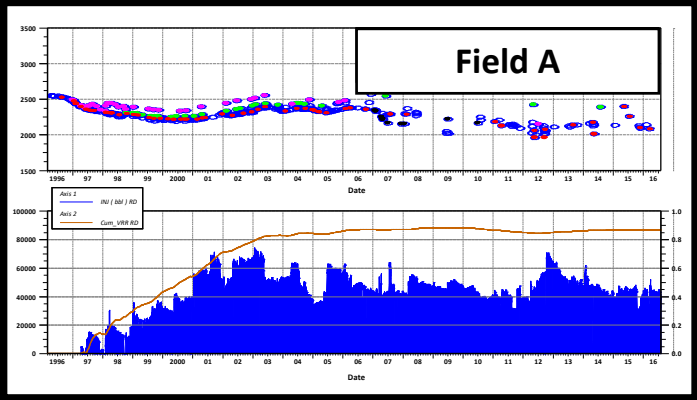
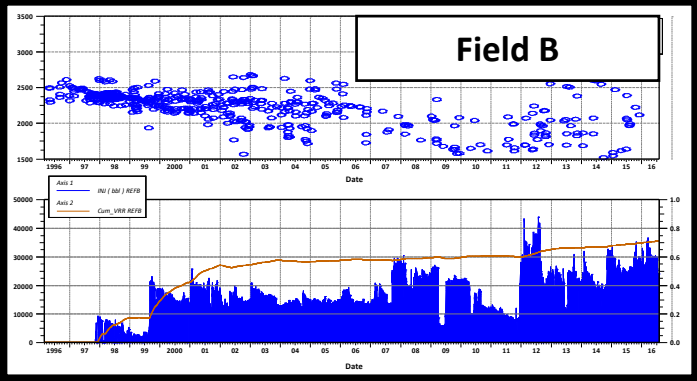
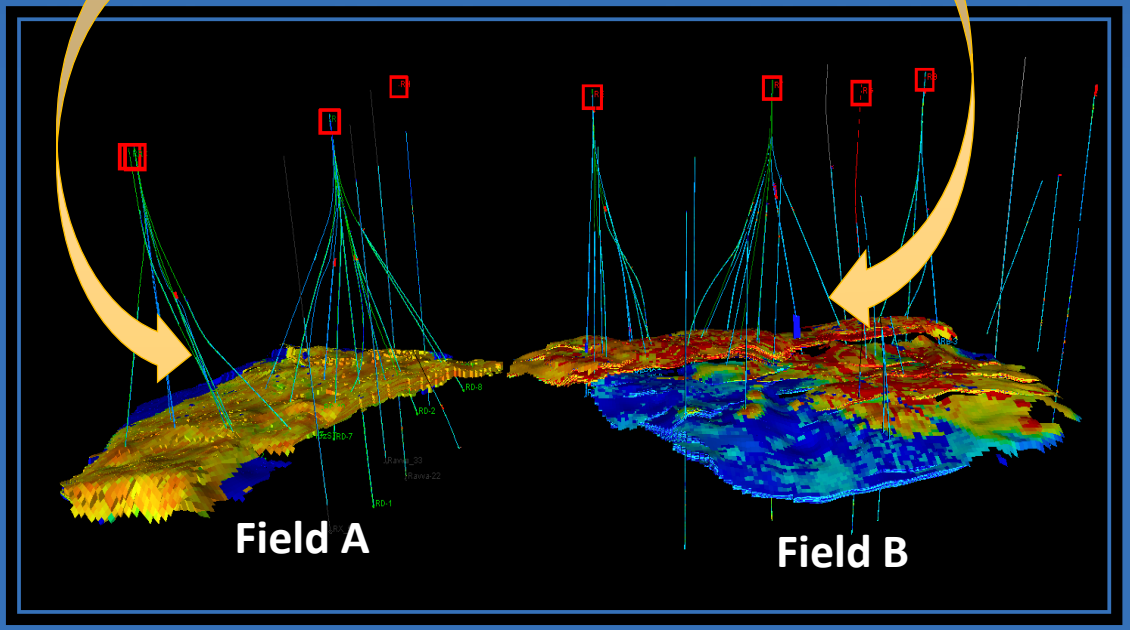


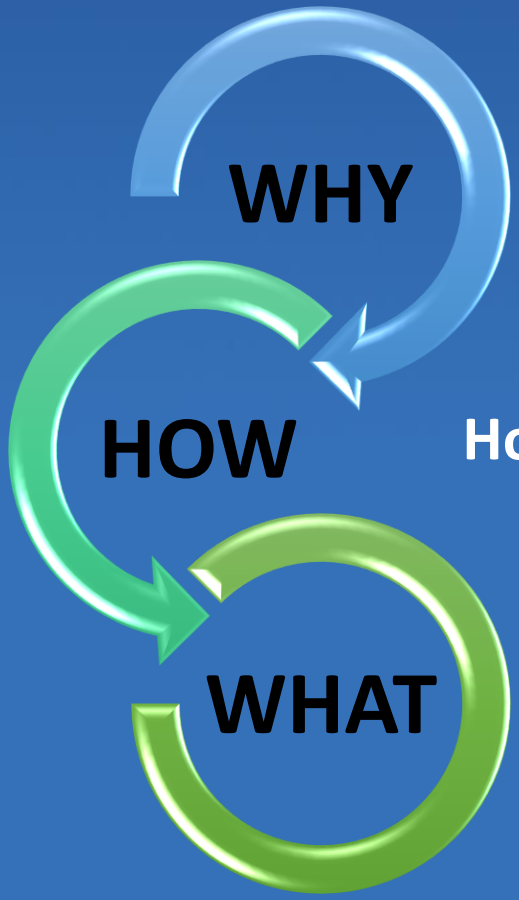






- ***Both the fields developed with down dip water injection***
- ***Field behavior very different from one another***

Questions on the Table

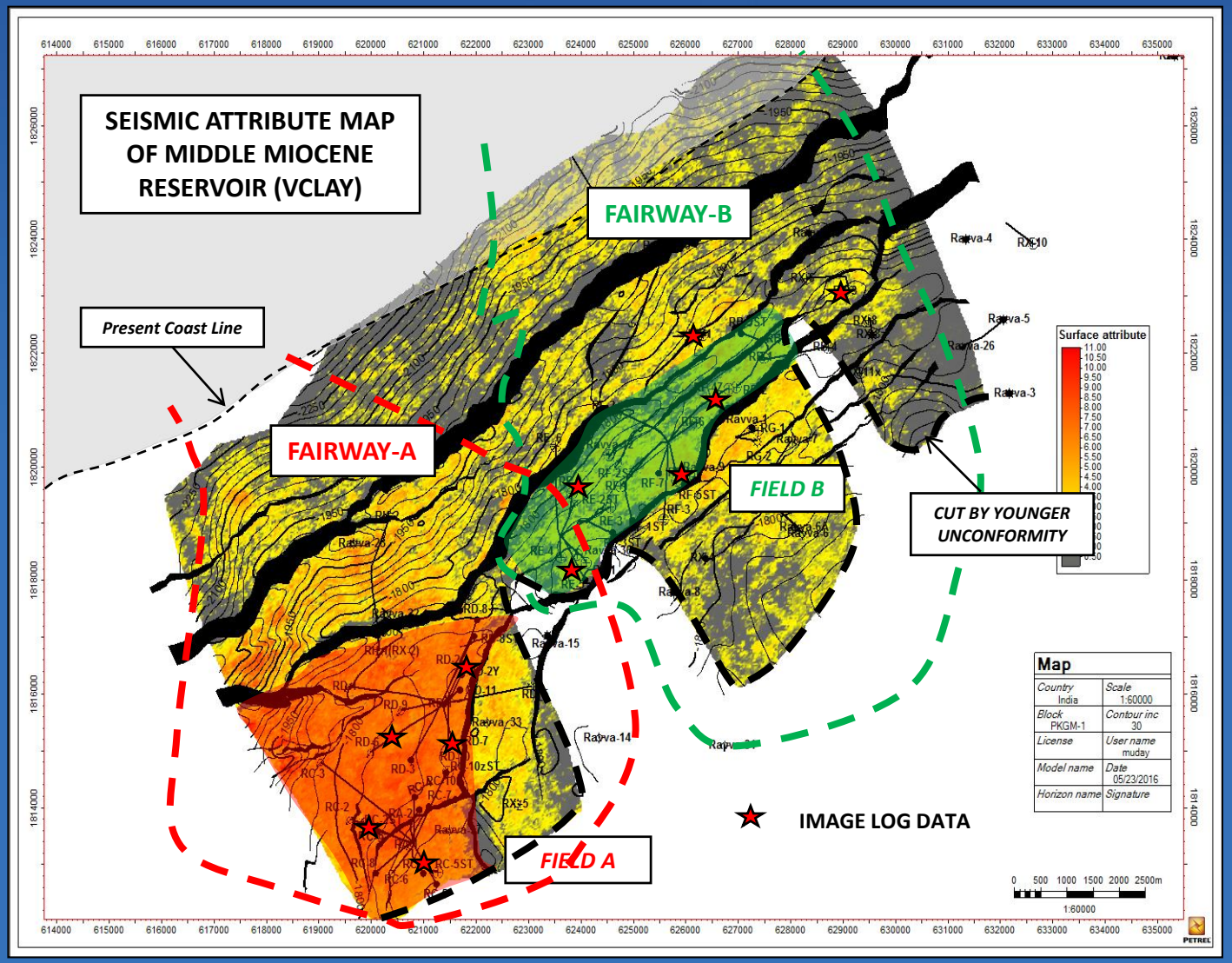


Why is Field B different from A ?

How do we approach to find a solution?

What are we going to get out of it?

Integration of Image Log + Core + Seismic Attribute



Helped in understanding why B is different from A

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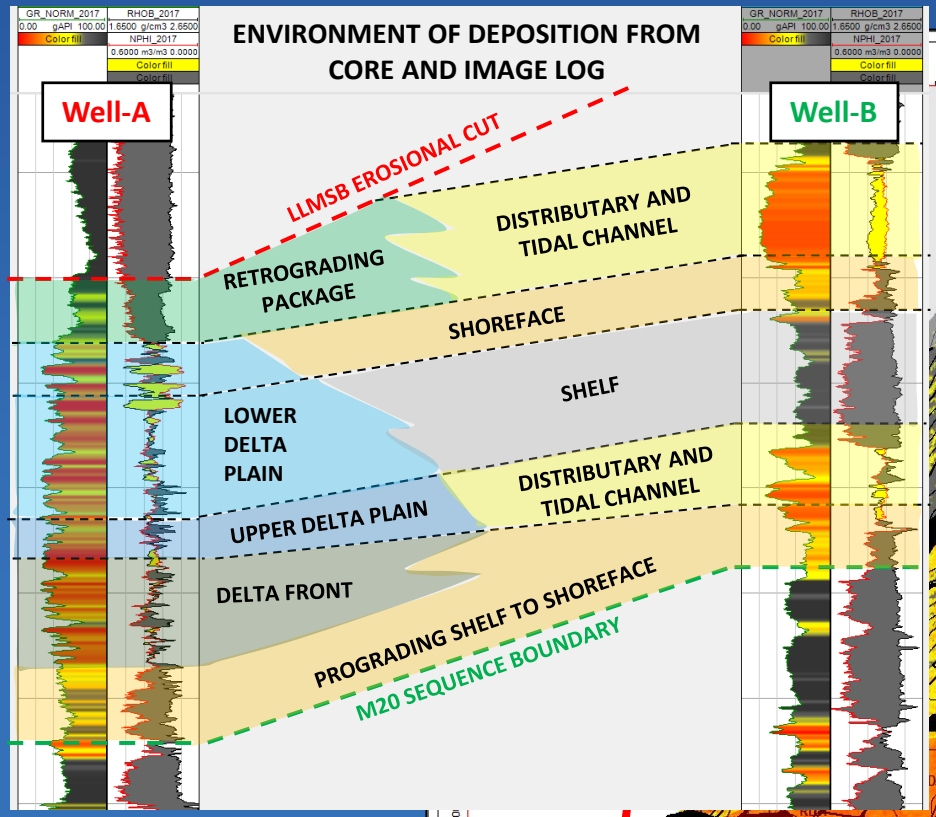

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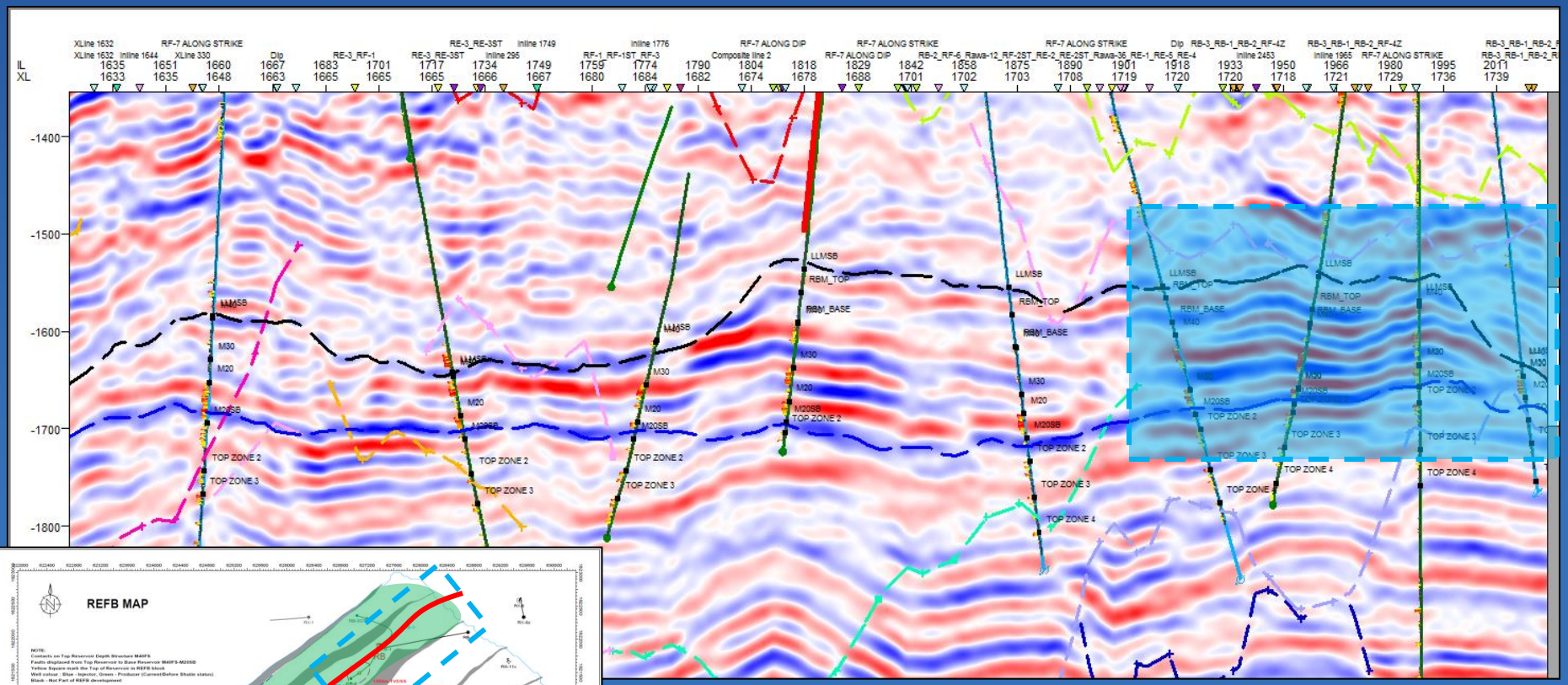
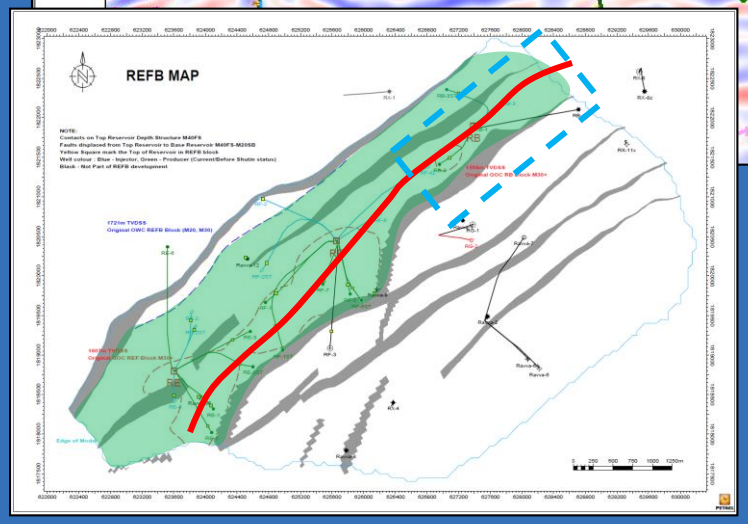
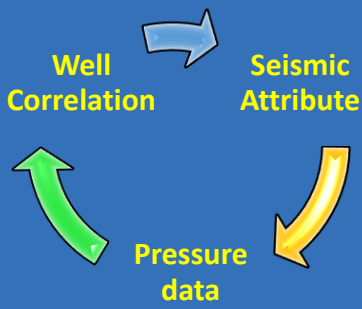
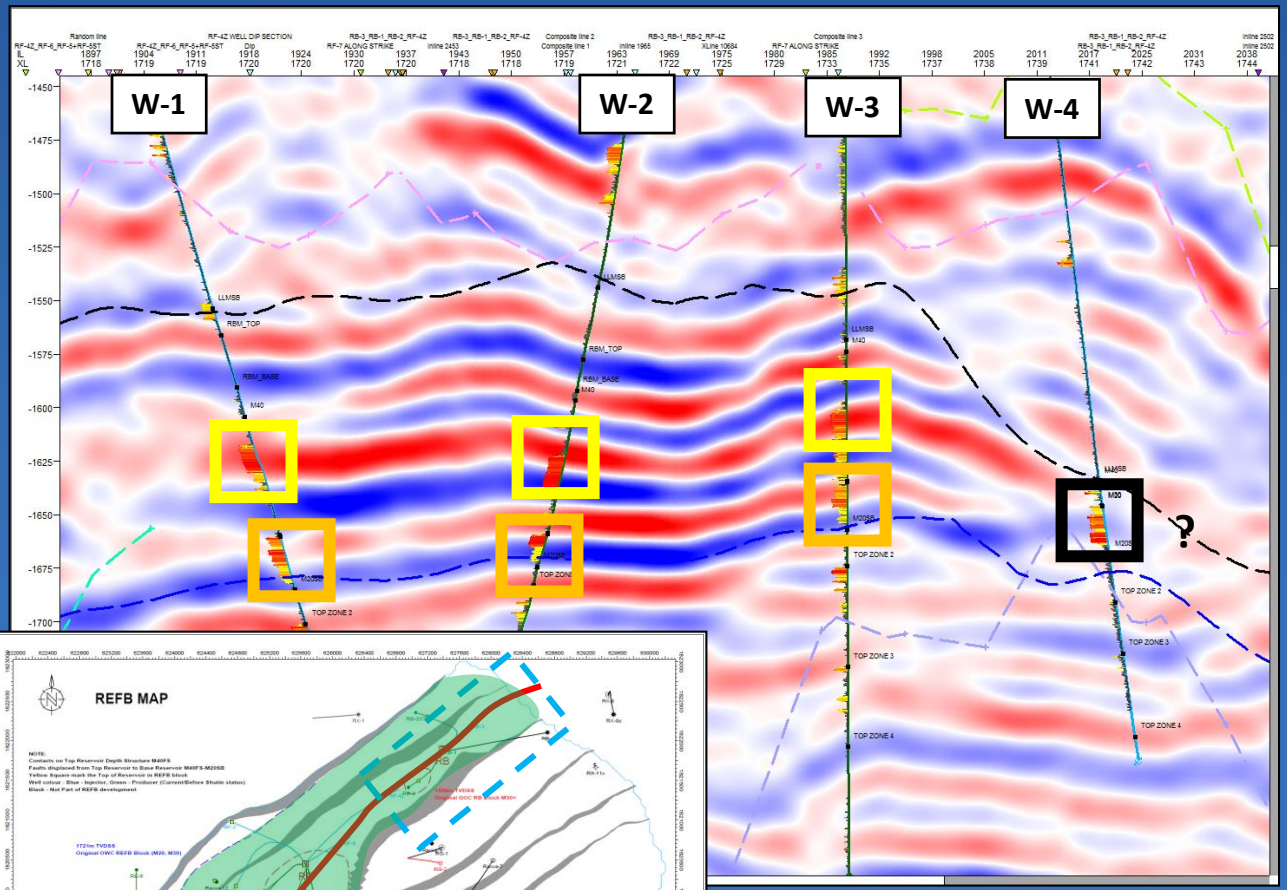
Integration of Well Logs + Seismic +Pressure

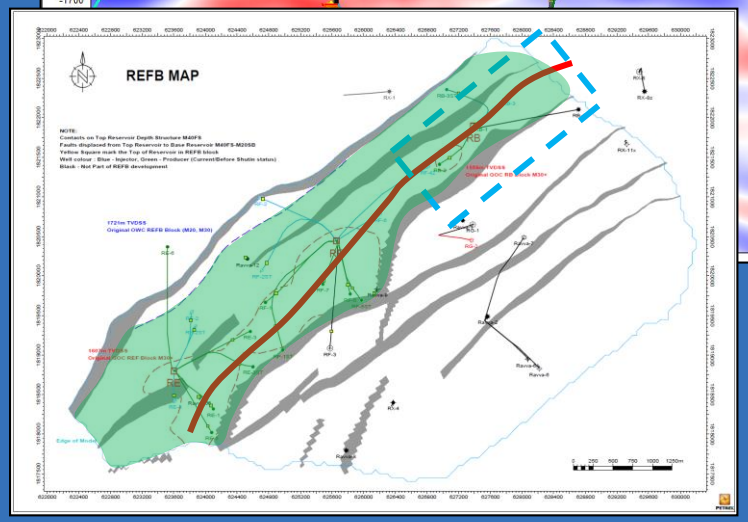






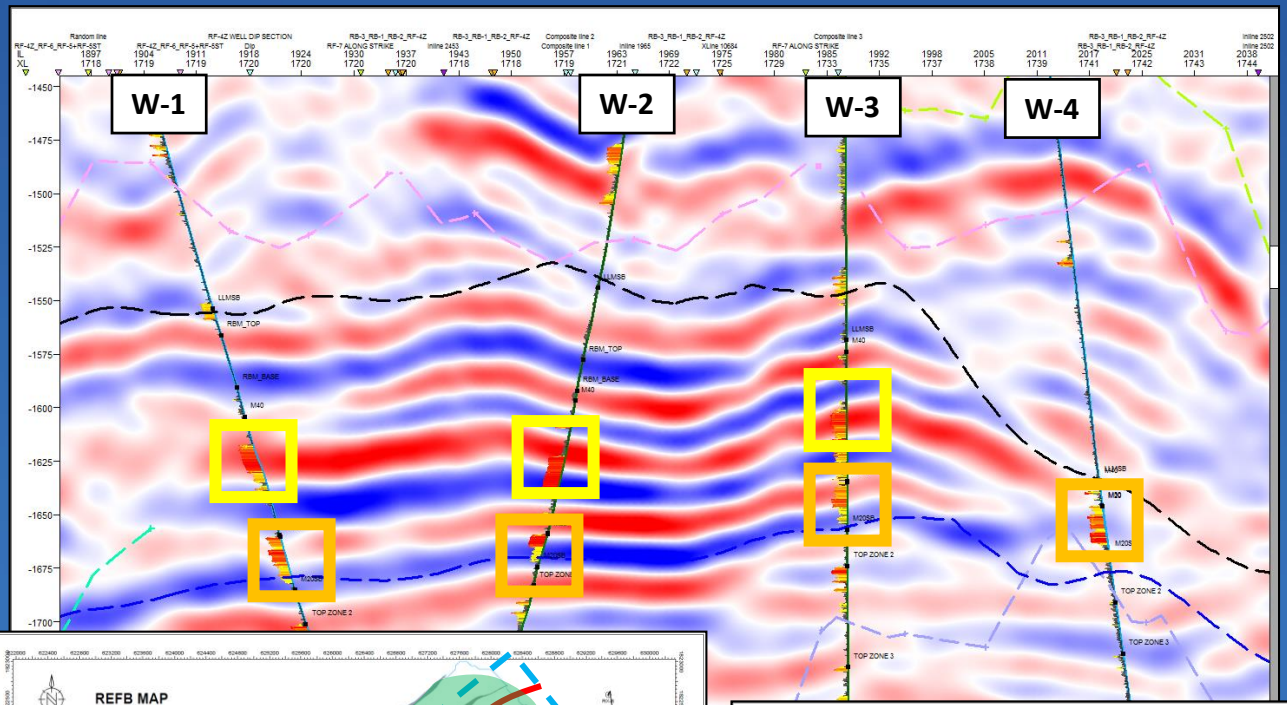
Integration of Well Logs + Seismic +Pressure

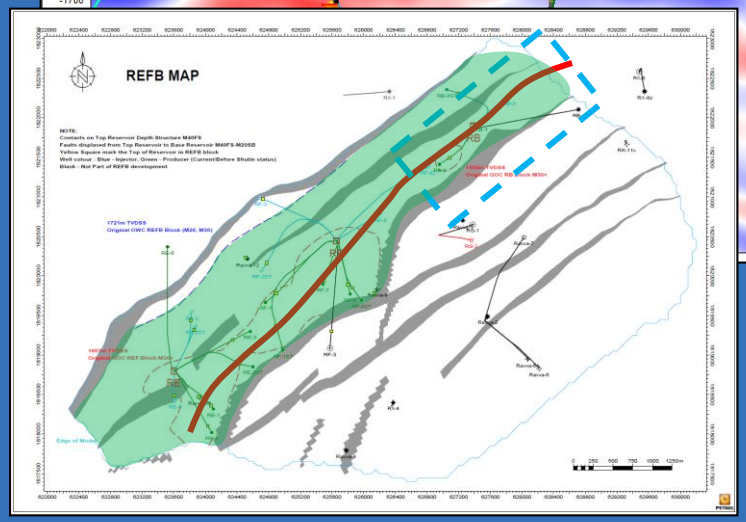


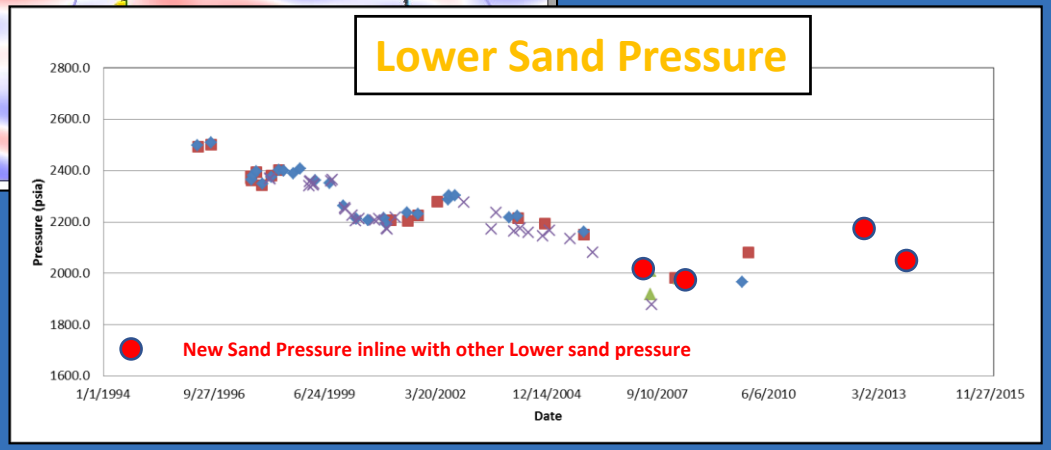


Integration of Pressure data (RFT, Pulse Test and Production data) helped in improving the well correlation

Integration of Well Logs + Seismic +Pressure







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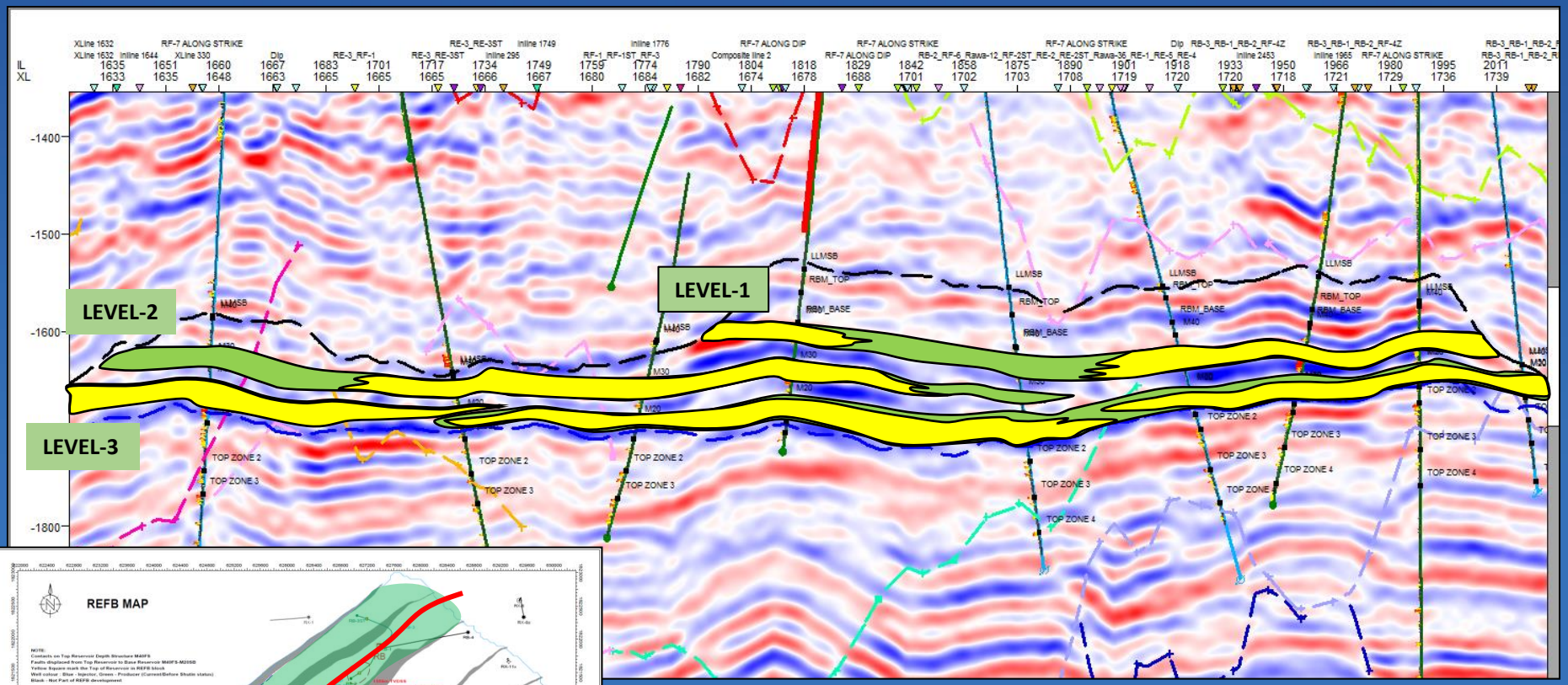
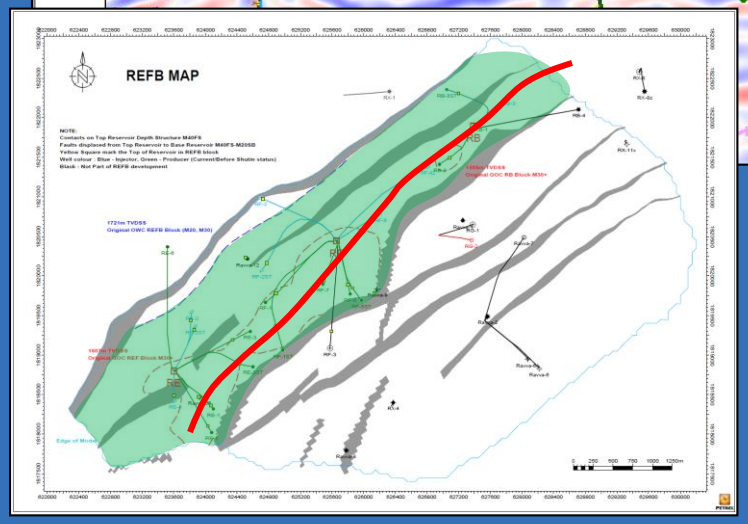




- *Identification of Time equivalent Packages*
- *Using Well Logs and Pressure data establish connectivity of sands*
- *Seismic attribute to validate the same where ever possible*

How do we use this Understanding

Production Optimization activity

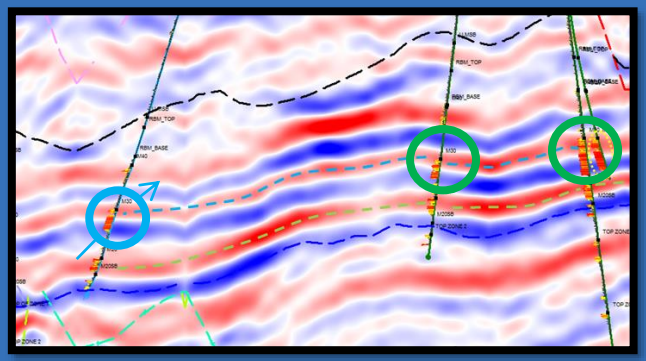
- Improving injector support where required
- Opening zones earlier thought to connected or produced by other wells

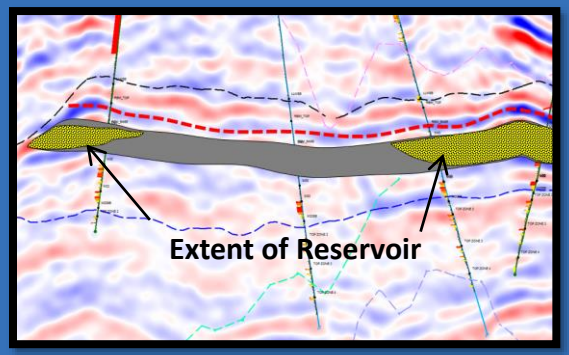
Reservoir Modelling

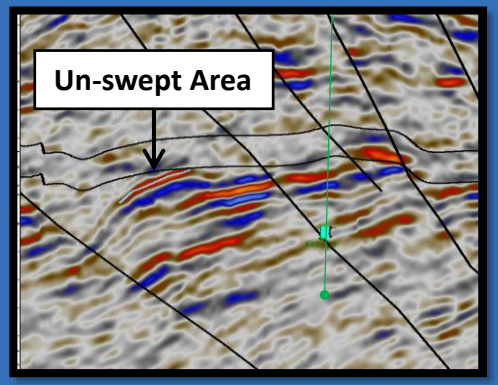
- A robust rock model is the fundamental base of any reservoir modelling
- Incorporation of a better understanding improves the end result

Undrained- Untapped potential

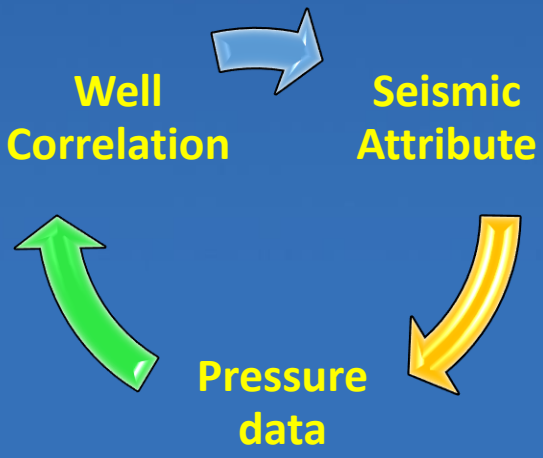
- Field B sand deposition and connectivity raises question if there are areas which have not been penetrated by any well?
- Pools identified and kept for optimization in the next drilling campaign.

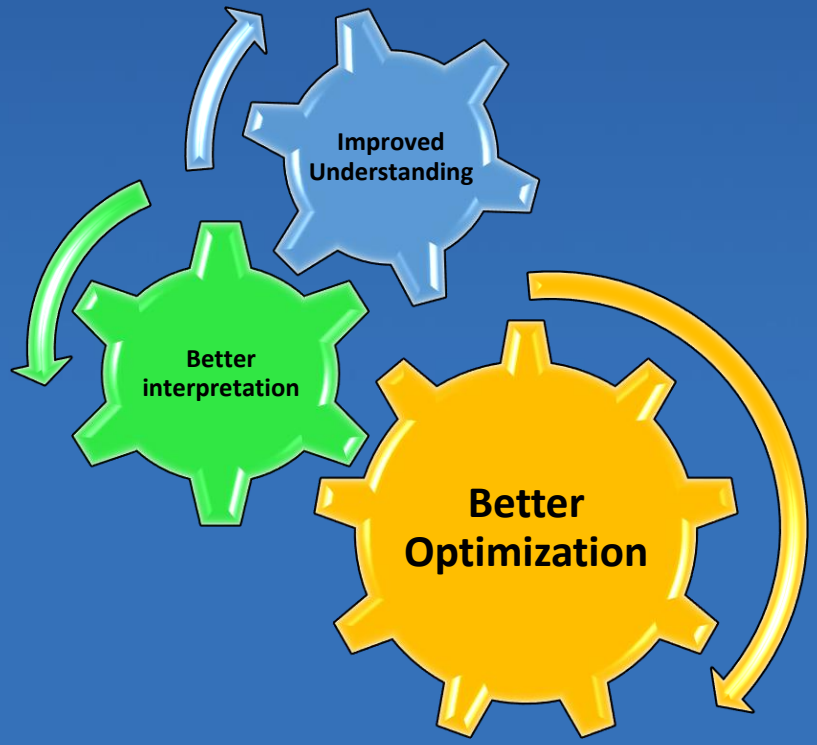






WHY INTEGRATE ?





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Thank you

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