Hierarchical 3D Facies Model Capturing Conceptual Geology of Fluvial-Deltaic Environment in Zawtika Gas Field, Offshore Myanmar*

Peerapong Ekkawong[1], Sureena Matha[2], Rangsan Bhengbhun[2], and Ellya Saudale[3]

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Abstract

Zawtika Field is located in Block M9 in the Union of Myanmar. The field comprises multi-layered reservoirs characterized by the unique geology of its depositional environment. The first development phase was completed in 2014 with three production platforms. Information acquired from these development wells has sufficiently improved our understanding of the depositional environment, regional geology, sand development, and fluid characteristics so that we could construct a static model to quantify the gas volume in place and develop reservoir simulation models for further field development and production optimization.

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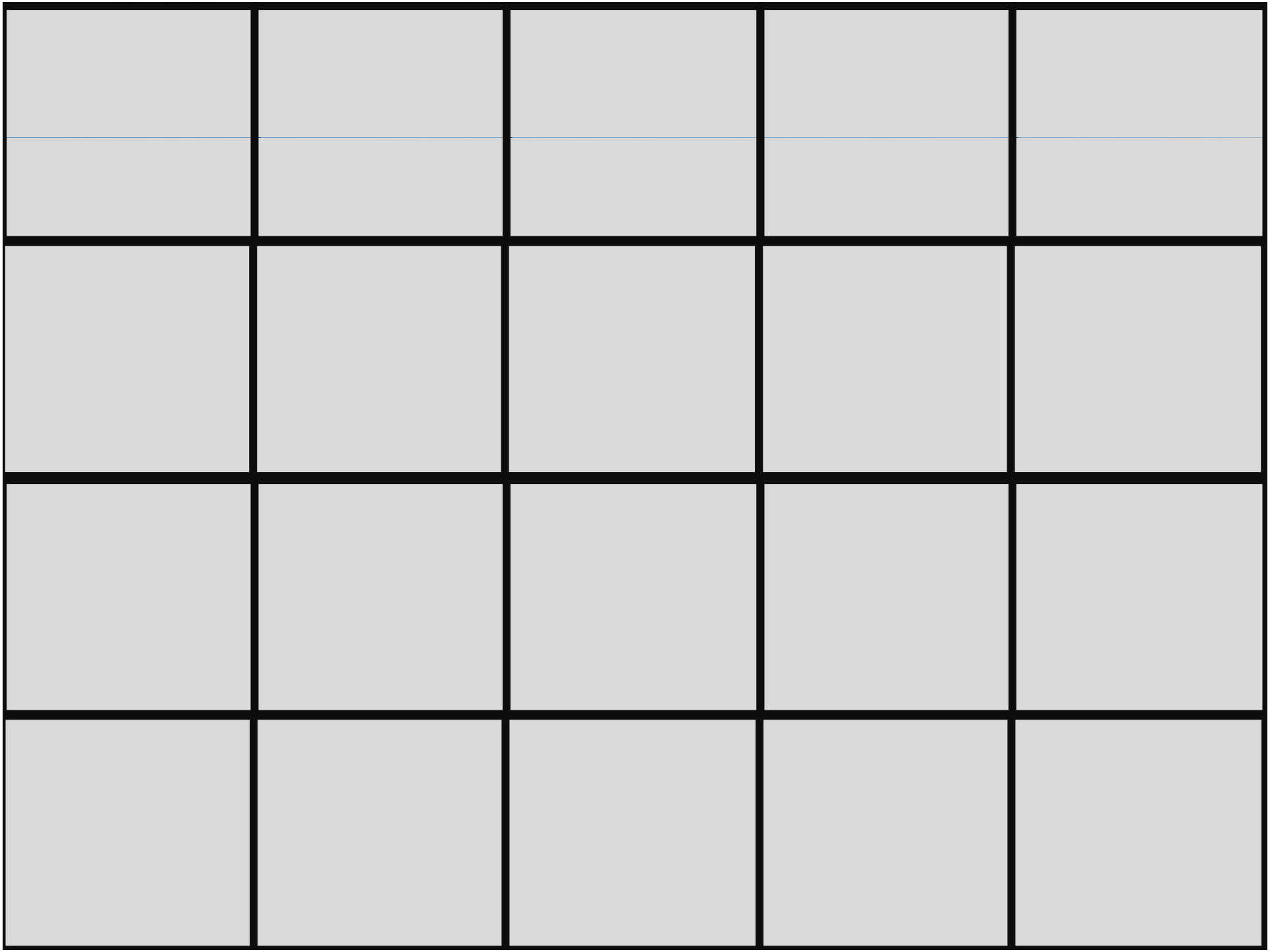
19 November 2015

Reservoir Characterization

As
Detective





Key points from this analogy

- Every piece of information always gives some clues
- Collect all available information then analyze with knowledge and tool to understand more about the reservoir

The objective from this work

- To construct static model using limited subsurface information (hard evidence), interpreted information (ANN), and regional geological knowledge.

- Logging
- Core

- Artificial Neural Network (ANN)

- Conceptual Regional Geology

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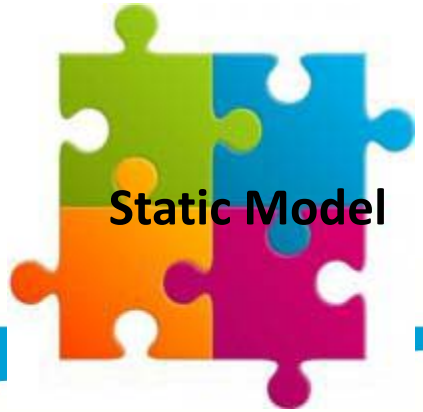
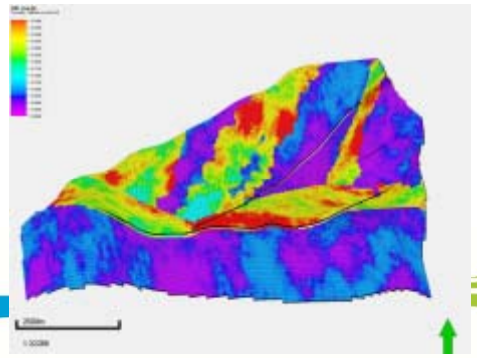
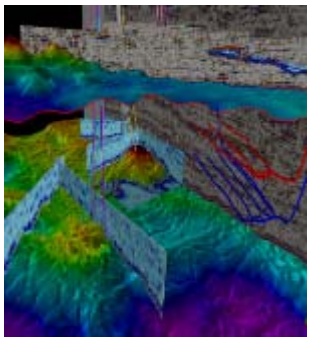




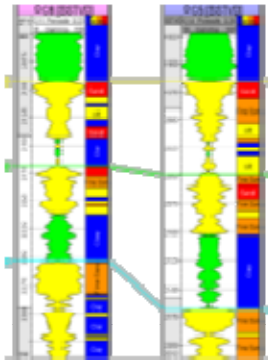
Overall Workflow

From Seismic to Simulation

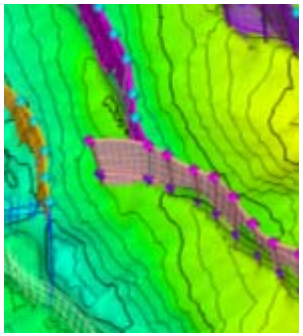
Seismic for surface map



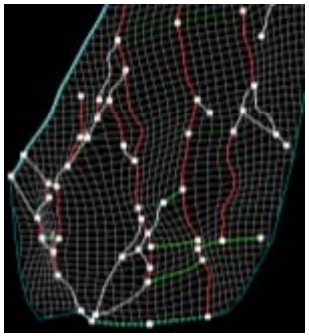
Well Correlation



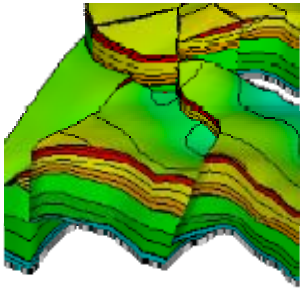
Fault Modeling



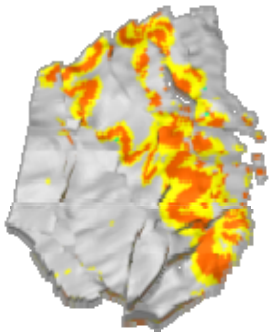
Pillar Gridding



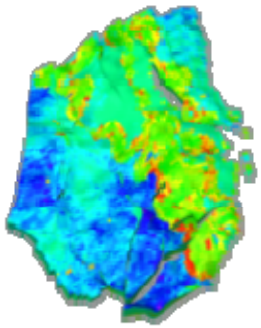
Zonation and Layering



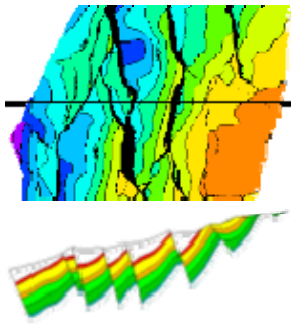
Facies Modeling



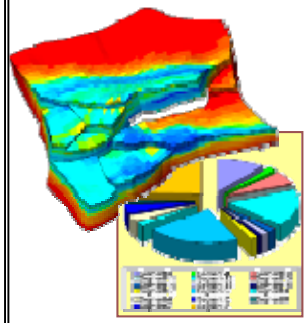
Petrophysical Modeling



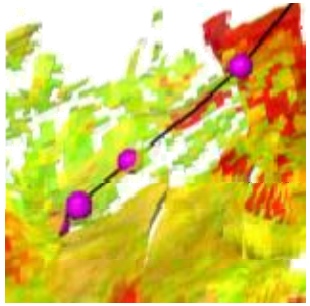
Plotting



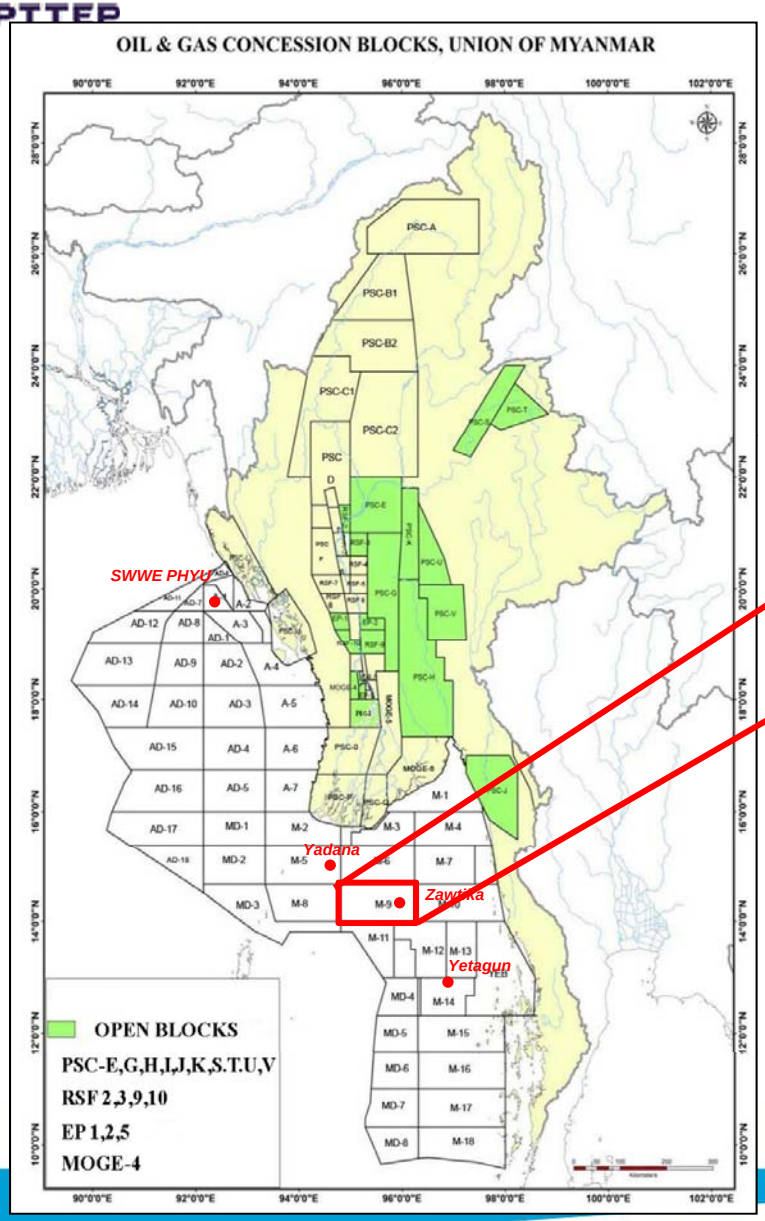
Volume Calculation

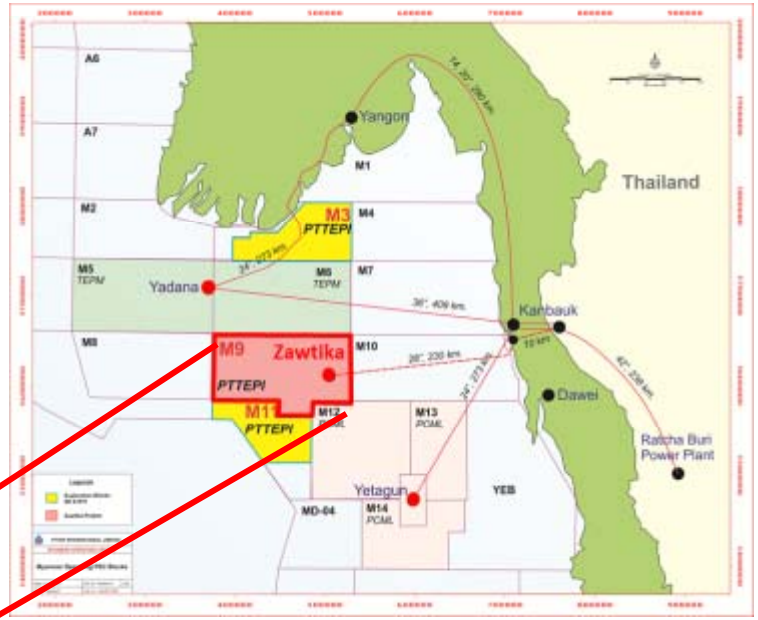


Well Design



Zawtika Field Overview





Share PTTEP 80%, MOGE 20%

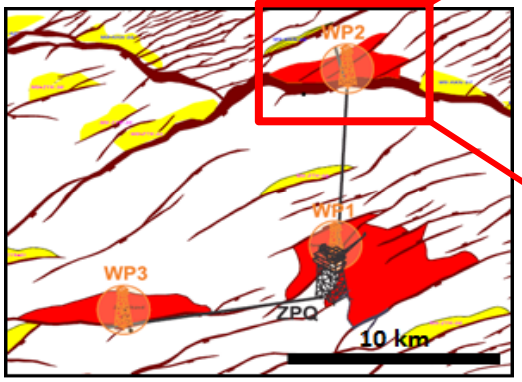
Current Production 345 MMscf/D

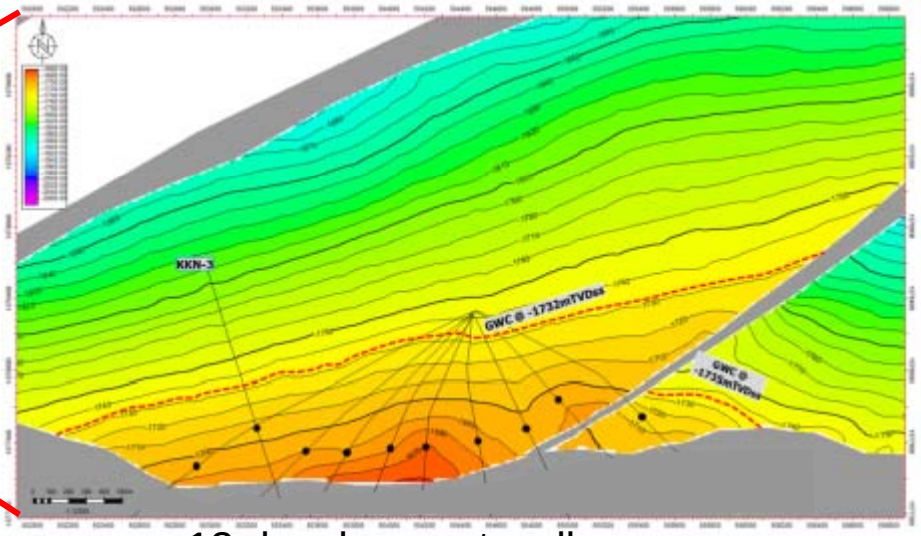
- Thailand ~ 75 %
- Myanmar ~ 25 %

Production from 3 wellhead platforms

Total number of producers: 36

Study Area: ZWP-02

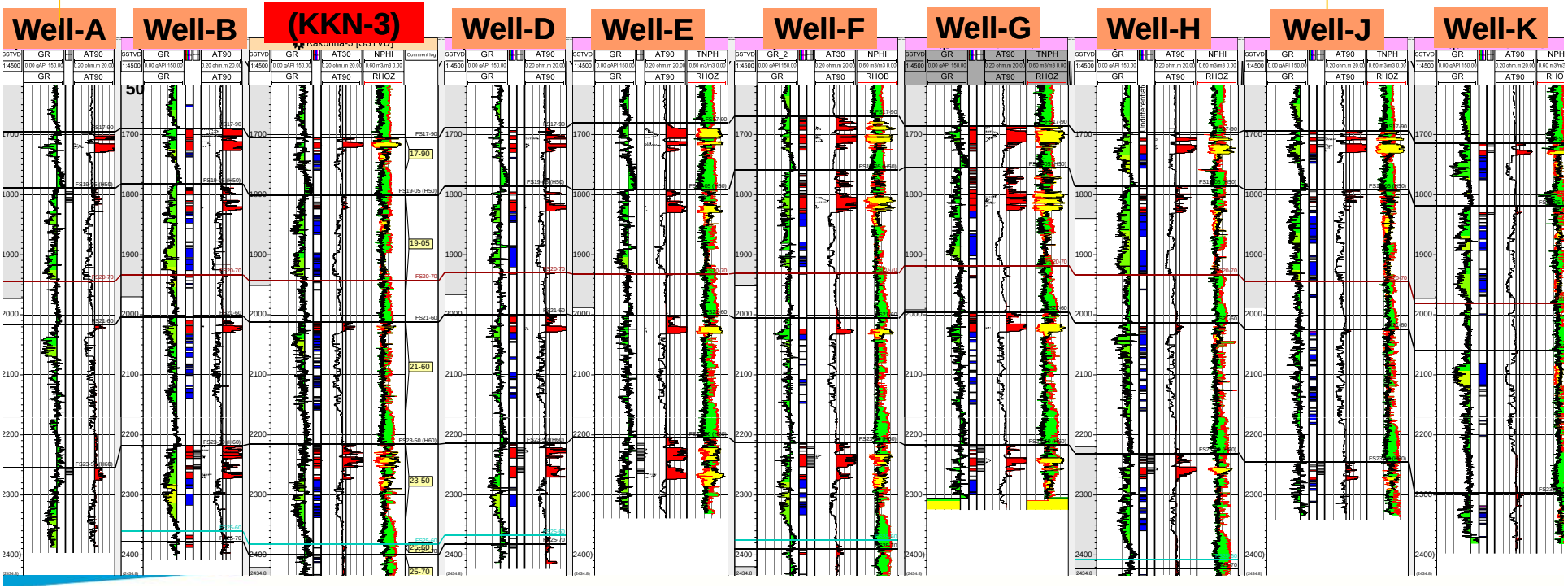




- 13 development wells
- 1 Reference well
- Layers of shale/sand sequence

W

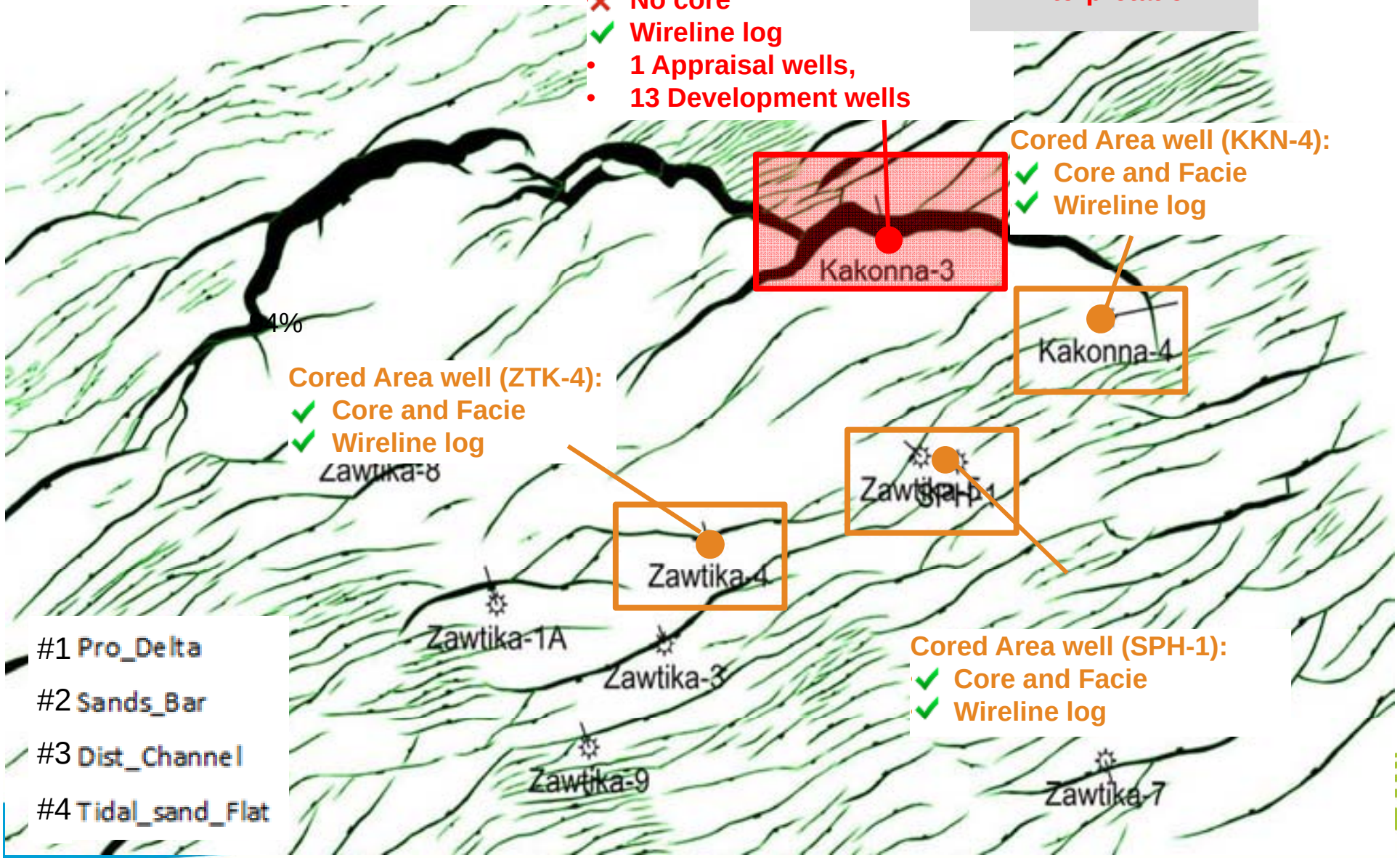
E



No Core, No Problem:
Validation the Neural Network From Nearby Wells

Study area, ZWP-02 (KKN-3)
- ✗ No core
- ✓ Wireline log
- 1 Appraisal wells,
- 13 Development wells

Require well facies interpretation

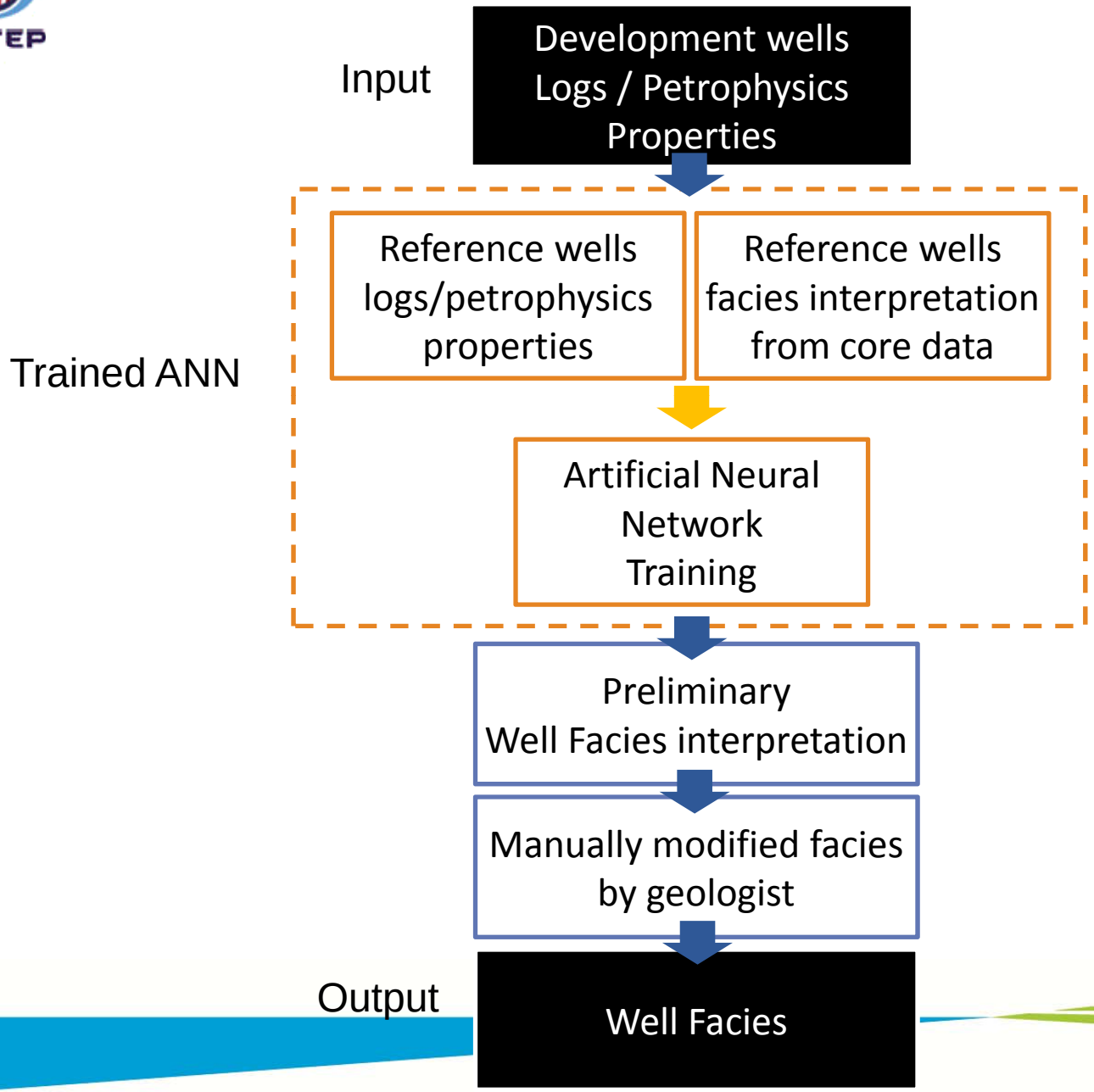


Cored Area well (KKN-4):
- ✓ Core and Facie
- ✓ Wireline log

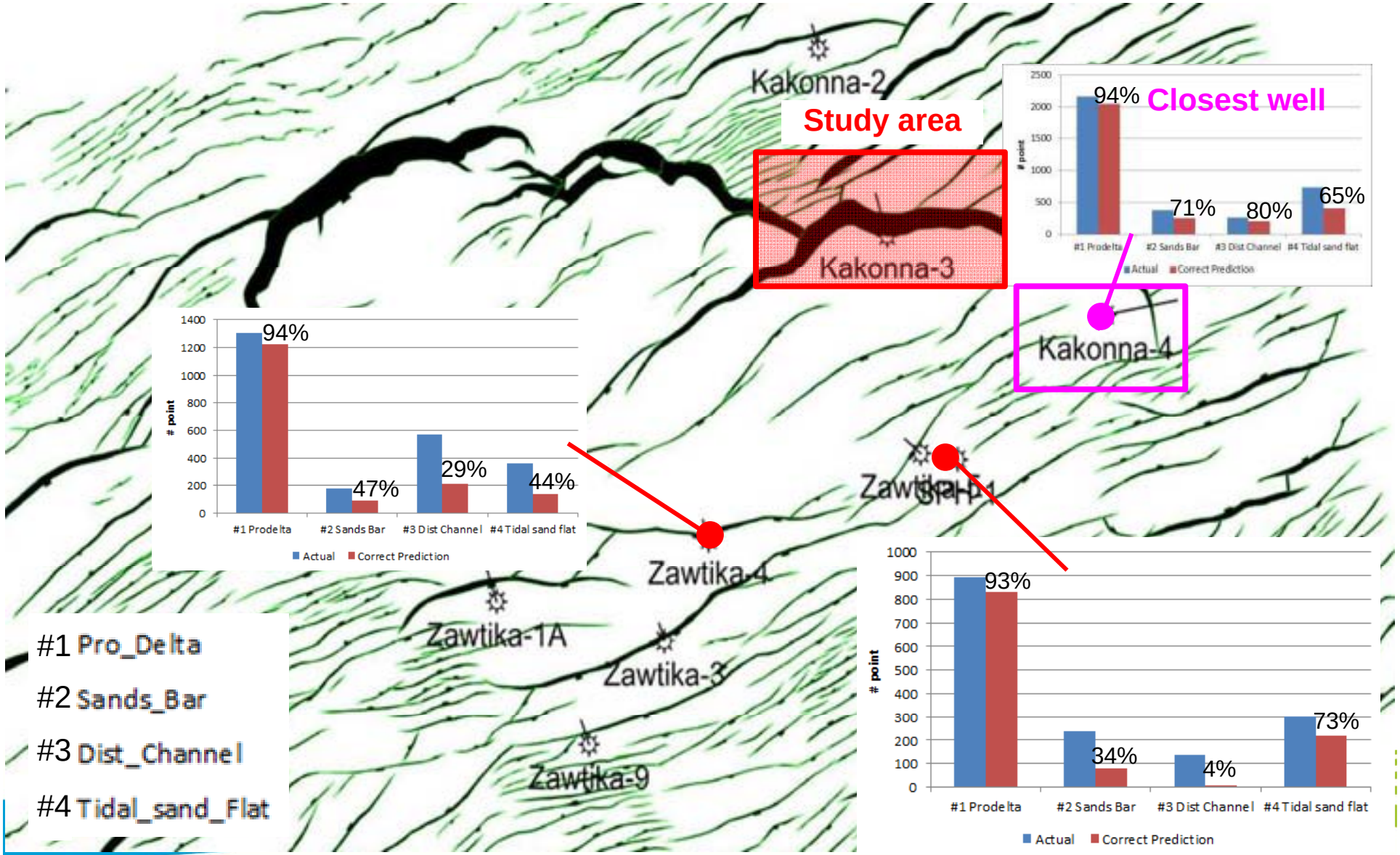
Cored Area well (ZTK-4):
- ✓ Core and Facie
- ✓ Wireline log

Cored Area well (SPH-1):
- ✓ Core and Facie
- ✓ Wireline log

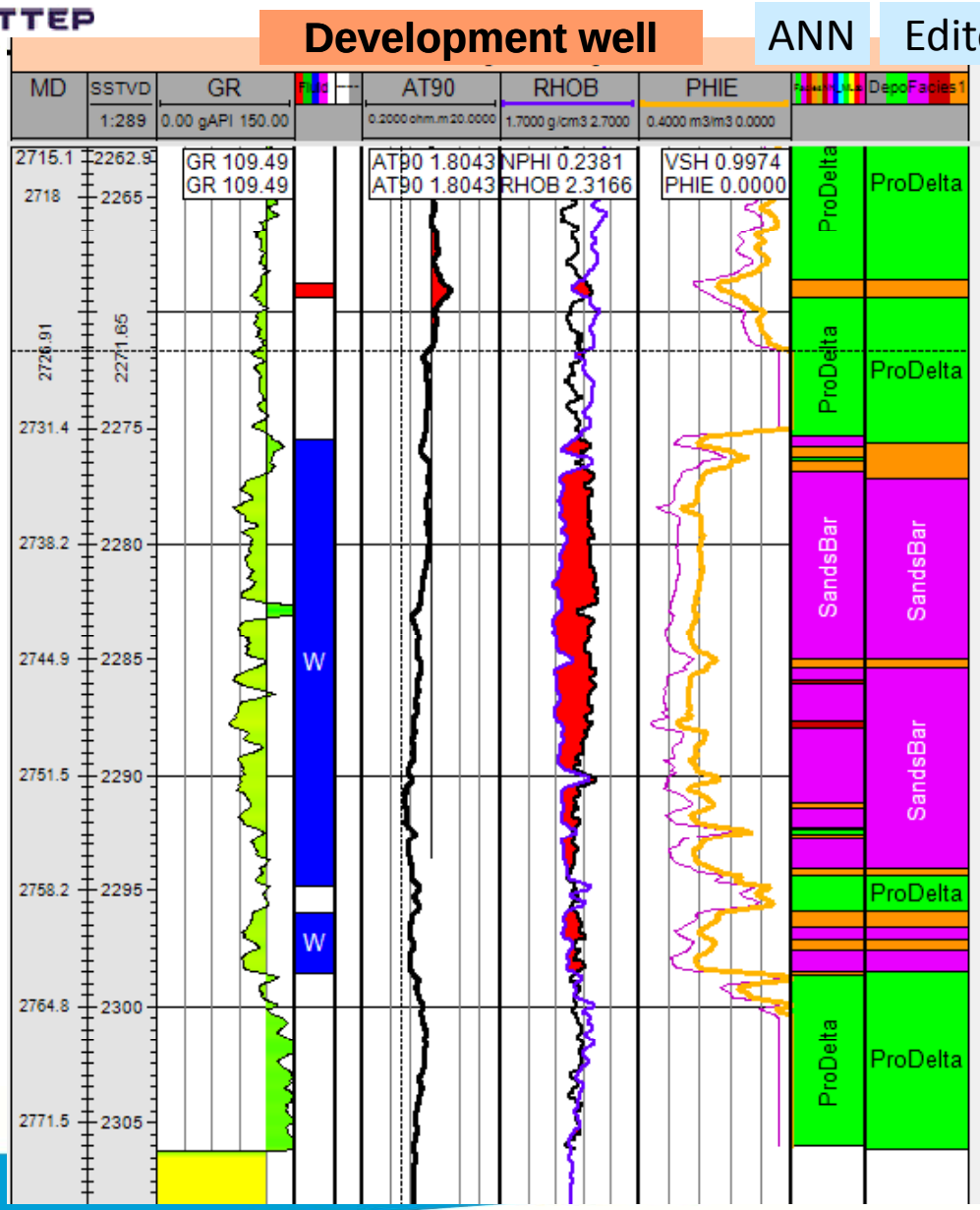
Artificial Neural Network

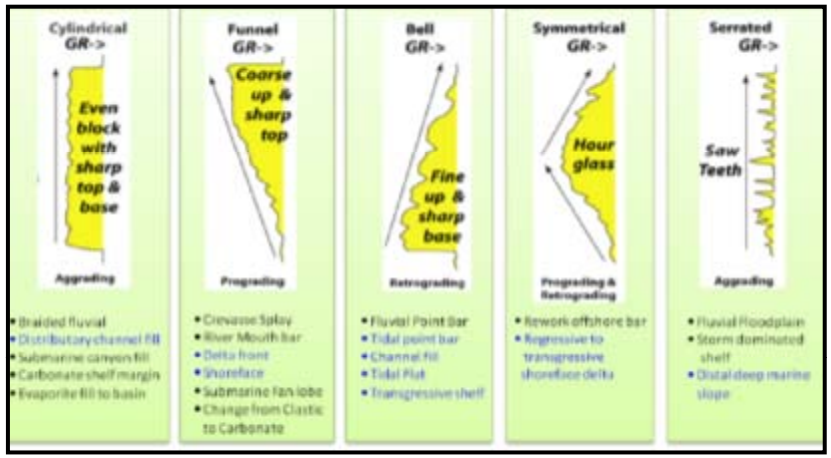


Cross Validation The Trained Neural Network With Nearby Wells: Result



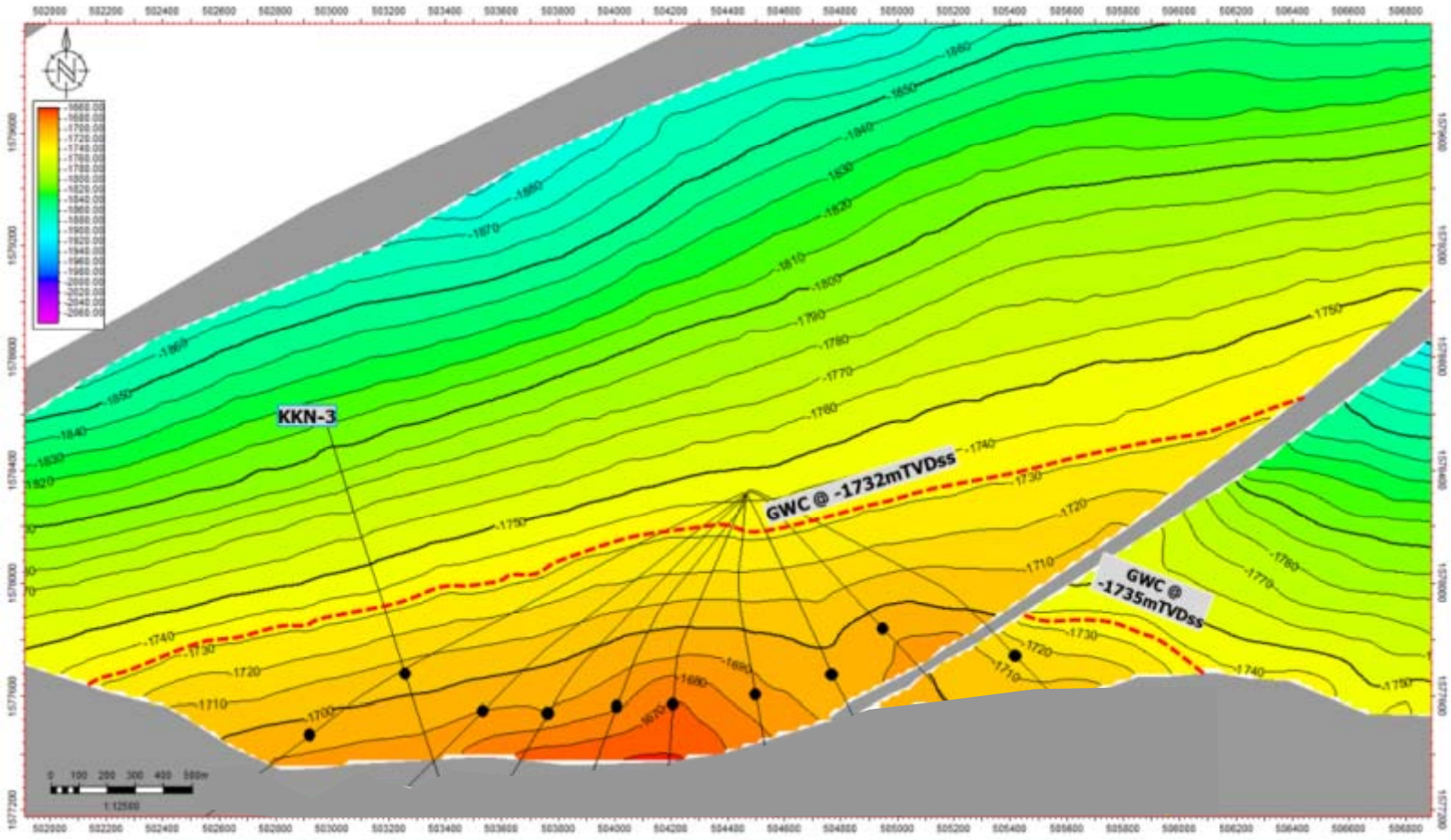
Artificial Neural Network Manual Modification





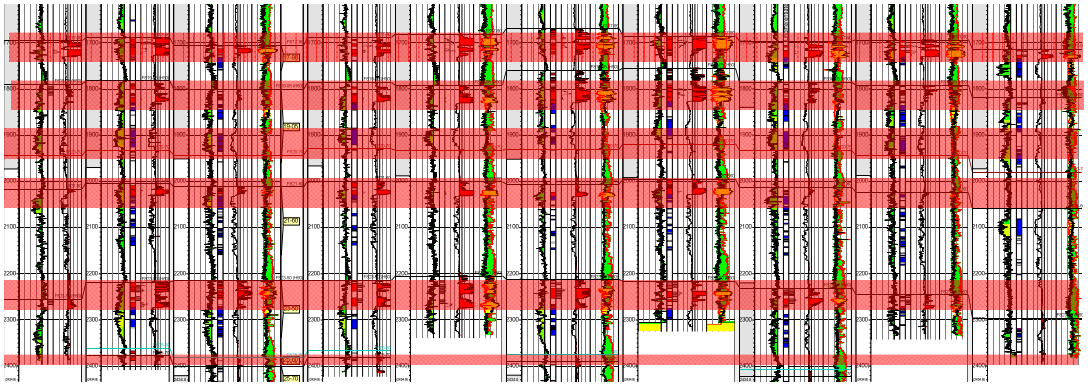
- ANN gives initial interpretation as a guideline for well facie interpretation
- Final interpretation will be manually modified with justification from development geologist

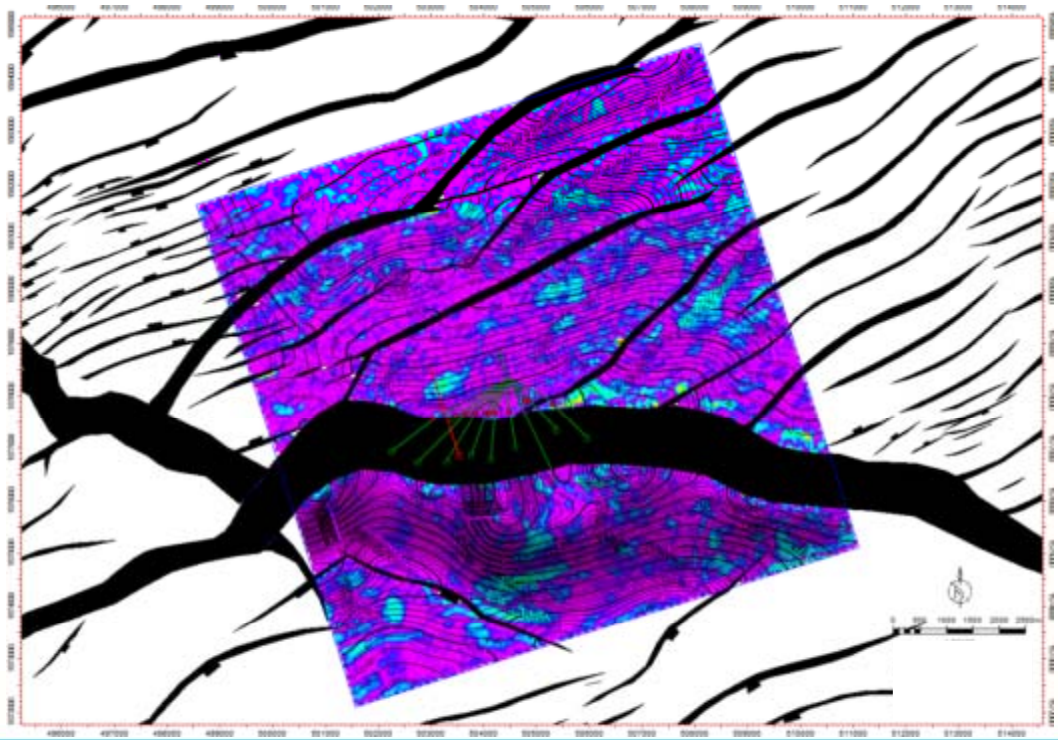
Regional Facie Model



- Facies interpretation is now available at each well
- Expand the facies to construct regional facies model for the whole study area

Difficulty of Using Seismic for Reservoir Characterization in The Study Area

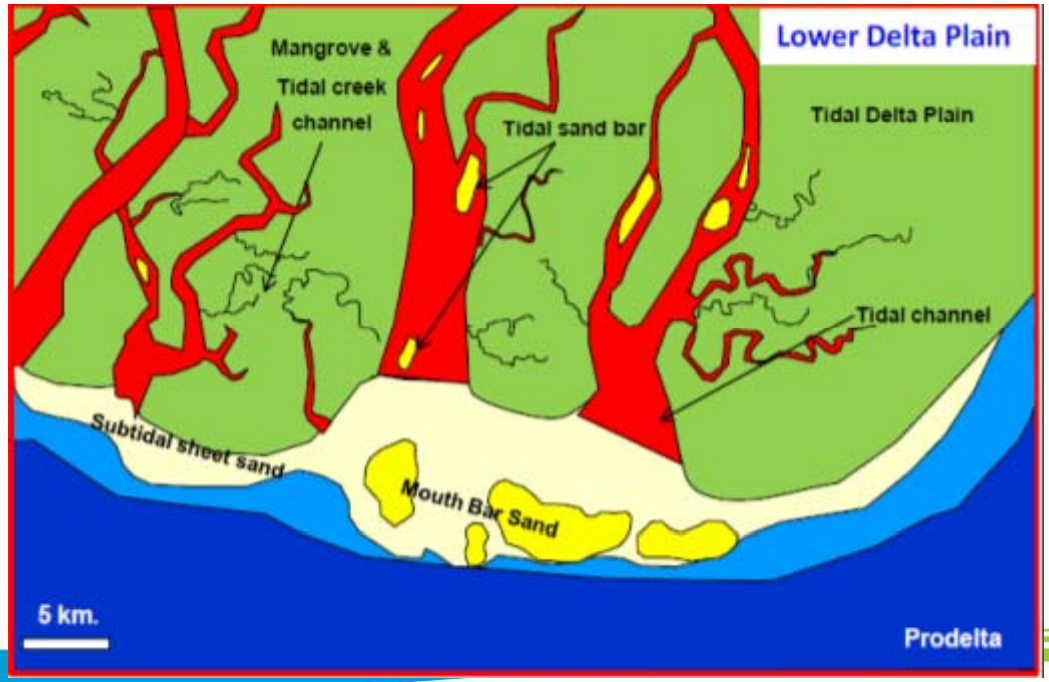




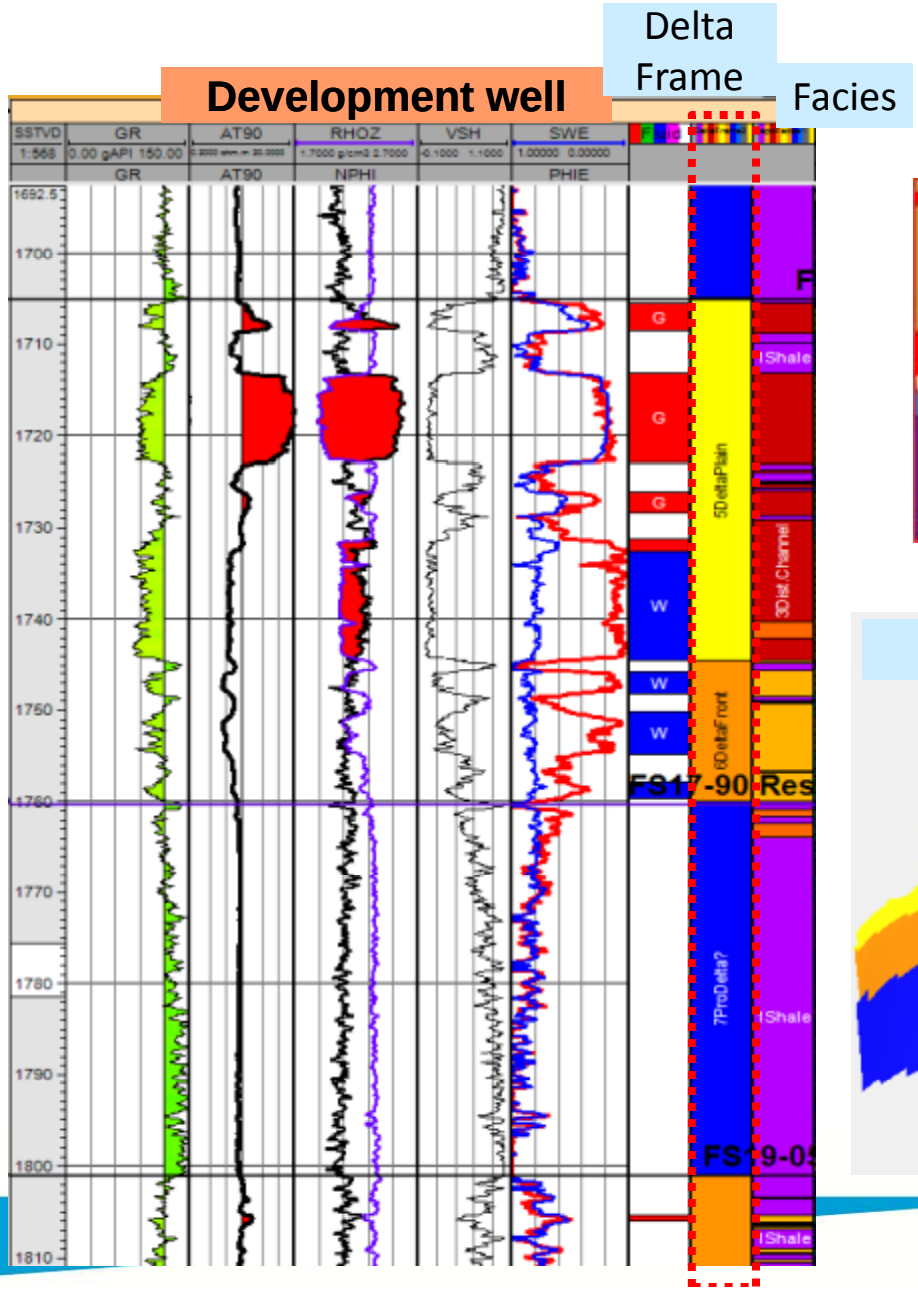
- Seismic data was analyzed it's capability to use for reservoir characterization
- Problems
  - Very thin reservoir layer
  - Shallow gas effect
- Not suitable for reservoir characterization

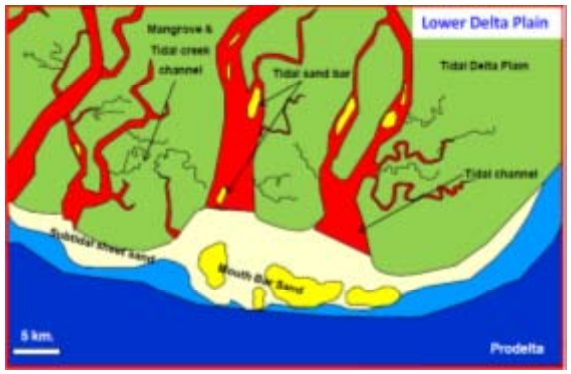
Brief Regional Geology

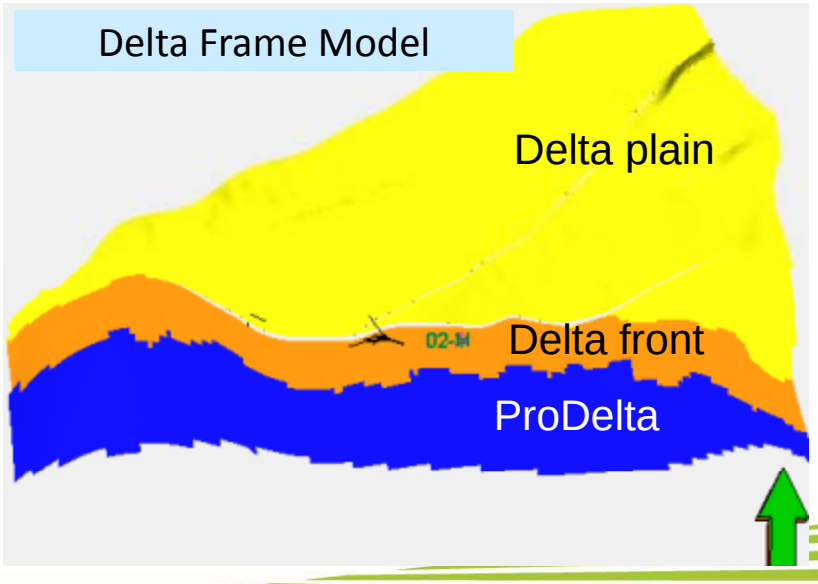
- Geological study have been done using wells in M9 area to understand more about depositional environment
- The main reservoir sands are interpreted as a deltaic to shallow marine depositional environment.
- Depositional Direction is N-S from Delta Plain -> Delta Front -> Pro Delta



Hierarchical Facies Interpretation to follow Regional Trend







Define Facies model

‘Hierarchical’ facies modeling

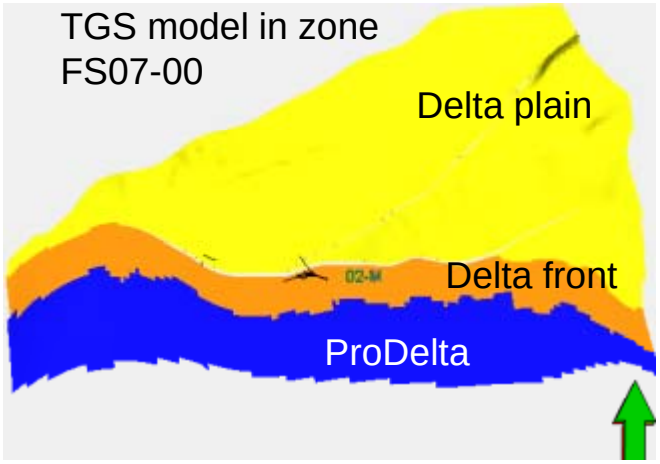
TGS with trend

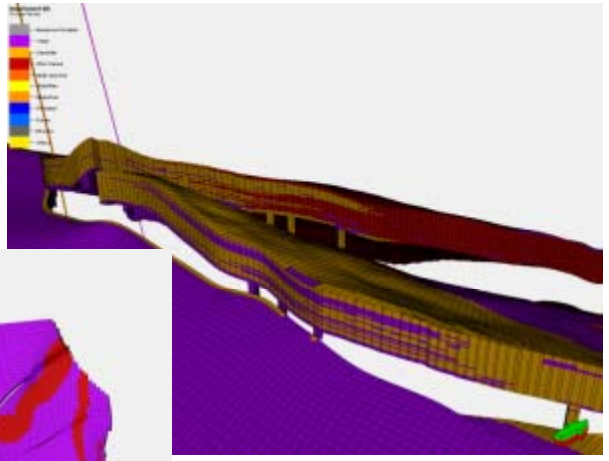
Object modeling

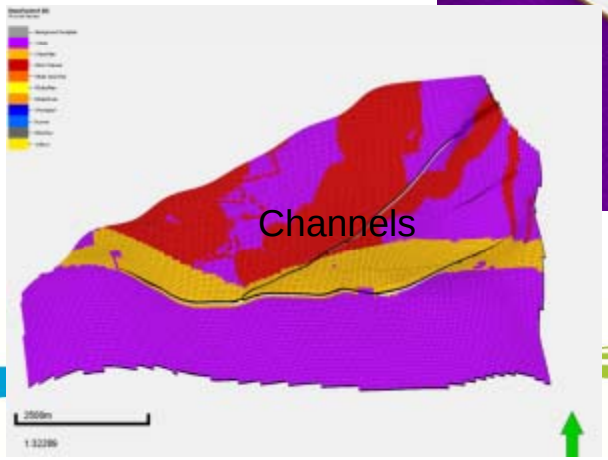
To address different sub delta environment which creates different facies association. → ‘Delta frame’

Creates the desired shapes/objects appropriate for the area being modeled. Defined some parameters.

- Orientation & width with geological analogy
- Thickness : facies log







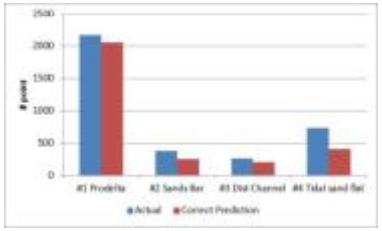
Overall Modeling Workflow

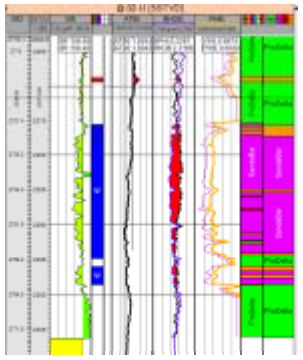
Well Facies Preparation

Regional Delta Frame

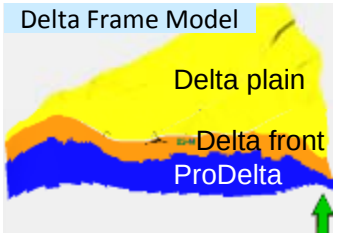
Facies Modeling

Petrophysical Modeling

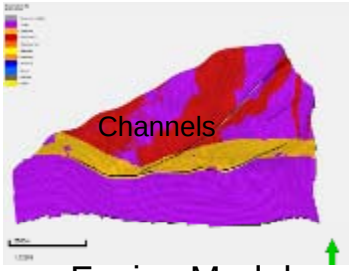




Artificial Neural Network with manual adjustment



Regional Delta Frame



Facies Model

Petrophysical modeling

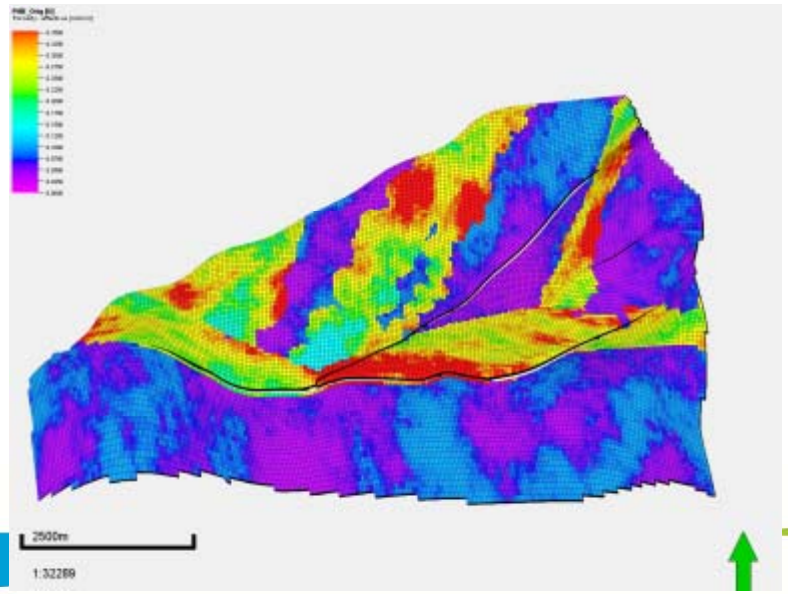
Petrophysical modeling

Porosity modeling

Sw modeling

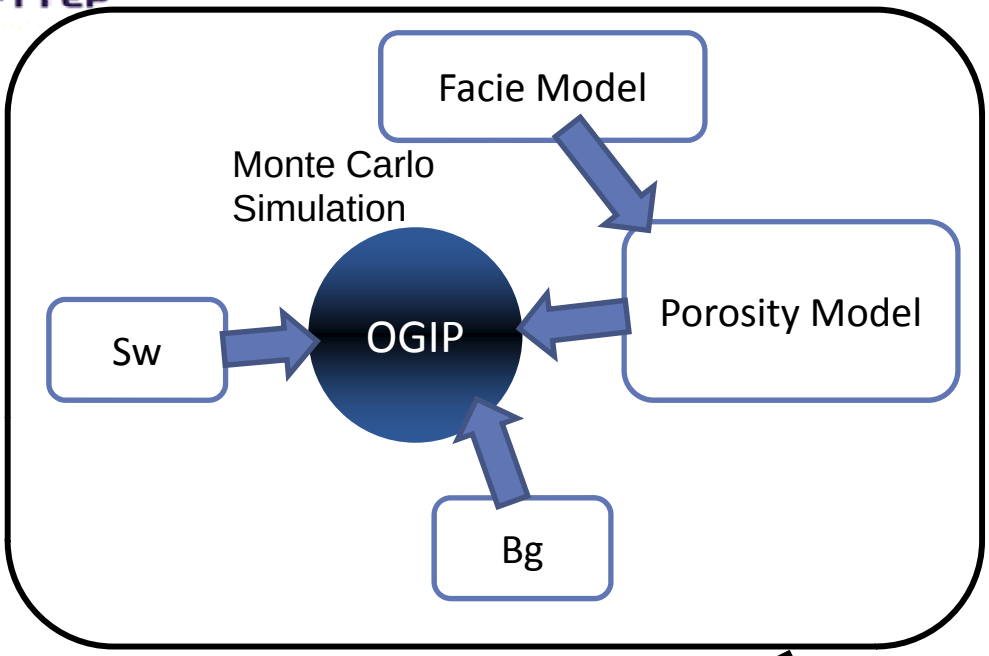
- SGS algorithm
- Related to facies model : High porosity in Sand Bar / Channel, low porosity in Shale.

- SW was calculated from the regional gas saturation equation
- PHIE & SW model were generated for various case for probabilistic estimation

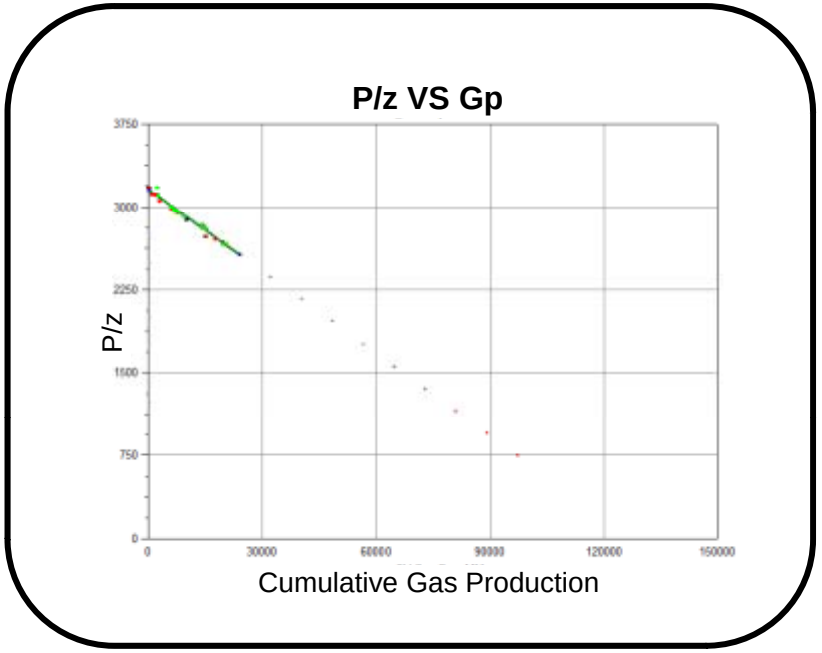


Result: Comparison between Static and Dynamic OGIP

Probabilistic OGIP

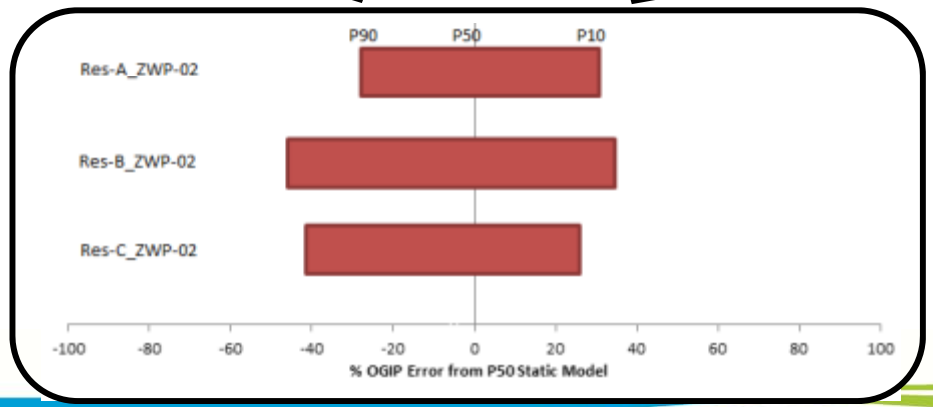


Post Drill Dynamic OGIP



Probabilistic OGIP

Validation



Conclusion

- Integrating geological knowledge and ANN can fulfil the limited subsurface information for static model construction
- Facie model could honor regional geological feature
- Range of probabilistic OGIP consistent with dynamic OGIP
- The model is expected to imitate actual behavior for the future reservoir simulation work

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