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

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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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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.

Hard Evidence + Synthetic Evidence + Geological Knowledge = Static Model

- Hard Evidence: Logging, Core
- Synthetic Evidence: Artificial Neural Network (ANN)
- Geological Knowledge: Conceptual Regional Geology
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

Hard Evidence
Synthetic Evidence (ANN)
Geological Knowledge
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

|--------|--------|---------|--------|--------|--------|--------|--------|--------|--------|

[Diagram showing well locations and geological layers]

[Well logs and geological cross-sections showing data for each well]
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

#1 Pro_Delta
#2 Sands_Bar
#3 Dist_Channel
#4 Tidal_sand_Flat
Artificial Neural Network

Input

Development wells
Logs / Petrophysics
Properties

Reference wells
logs/petrophysics
properties

Reference wells
facies interpretation
from core data

Artificial Neural
Network Training

Preliminary
Well Facies interpretation

Manually modified facies
by geologist

Output

Well Facies
Cross Validation The Trained Neural Network With Nearby Wells: Result

Study area

Closest well

94% 71% 80% 65%

Kakonna-2

Kakonna-3

Kakonna-4

Zawtika-1

Zawtika-2

Zawtika-3

Zawtika-9

Zawtika-4

Closest well

94% 71% 80% 65%

Kakonna-4

Kakonna-3

Kakonna-2

Study area

#1 Pro_Delta
#2 Sands_Bar
#3 Dist_Channel
#4 Tidal_sand_Flat

93% 73% 73% 34%

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93% 73% 73% 34%
Artificial Neural Network Manual Modification

Development well

ANN Edited

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

Development well

Delta Frame

Facies

Delta Frame Model

Delta plain

Delta front

ProDelta
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

1. Well Facies Preparation
2. Regional Delta Frame
3. Facies Modeling
4. Petrophysical Modeling
Petrophysical modeling

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

Sw modeling

- 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

- Facie Model
- Monte Carlo Simulation
- Sw
- Porosity Model
- Bg
- OGIP

Post Drill Dynamic OGIP

- P/z VS Gp
- Validation

Probabilistic OGIP

- Res-A_ZWP-02
- Res-B_ZWP-02
- Res-C_ZWP-02

Cumulative Gas Production

% OGIP Error from PSO Static Model
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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