Mature Field Potential Assessment through Integrated and Accelerated Field Development Plan workflows: Colombia

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Objective & High-Level Results

• Objective:
  • Characterizing a mature compartmentalized tight carbonate reservoir with a combination of natural fractures, expandable clays, and complex mineralogy with low-to-medium porosity values.

• Challenge:
  • Handle uncertainty in the characterization process through a semi-automated workflow considering 50 years of production and limited subsurface data.

• Solution:
  • Integrated and accelerated semi-automated workflow to evaluate the remaining potential of the target reservoir accelerated by On Demand Reservoir Simulation.
Petrophysical Characteristics

Tight carbonate reservoir with a combination of natural fractures, expandable clays, and complex mineralogy with low-to-medium porosity values.
Static Model

La Luna

Simiti

Rosablanca

Fm. La Luna

Phie

Swe

Digital Forum 2022
DFN, Fracture Modeling Workflow
DFN, Fracture Drivers – Seismic Attributes

- Fault Likelihood
- Ant-Tracking - Gradient
- Chaos
- Variance
- Sweetness
- Ant-Tracking Max Curvature
- Dip Angle
- Ant-Tracking Dip
DFN, Fracture Drivers – Seismic Attributes

Supervised Neural Net Estimation (Intensity)

Fractures Set 1
Fractures Set 3

Fracture Set 2
Fracture Set 4

NN Fracture Intensity based on Seismic drivers
DFN, Fracture Drivers – Distance from faults

Distance from faults ~100m

Faults Corridor, NW/SE direction

Distance from faults ~120m

Faults Corridor, NE/SW direction
Predictions with Automated Workflows

Integrated & Automated Workflow for FDP evaluation (from months to weeks), including Seismic Data to support reservoir characterization in green fields, best reservoir areas identification, probabilistic well types design, evaluation and ranking (profitability, production and risk criteria)

- Geological Models & DFN
- Reservoir Quality Index and Sweet Spot Screening
- Well Placement and Trajectory Evaluation
- Probabilistic Well Ranking
Integrate uncertainty workflows for sampling geological models

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Grid Base

Grid P10

Grid P50

Grid P90

P10 = 45 MMSTB
P50 = 73 MMSTB
P90 = 126 MMSTB

P10 = 1.6 MMSTB
P50 = 4.7 MMSTB
P90 = 12 MMSTB

P10 = 45 MMSTB
P50 = 73 MMSTB
P90 = 126 MMSTB

P10 = 1.6 MMSTB
P50 = 4.7 MMSTB
P90 = 12 MMSTB
Discrete Fracture network to support reservoir characterization
Calculate RQI (targets: sweet spots)

Productivity = f (Kf, Km, HCVPm, Sigma, Pm)

Type | Rating | Range
--- | --- | ---
1 | Bad | 0.0-0.25
2 | Not Bad | 0.25-0.5
3 | Good | 0.5-0.75
4 | Performer | 0.75-1

Productivity impact

Supervised Neural Net Classification

Here? or Here?

Performers well

SPE-181584-MS Innovative Approach for Building and Calibrating Multiple Fracture Network Models for Fractured Carbonate Reservoirs

SPE-175708-MS Development of Heterogeneous Immature Brownfield with Waterdrive Using Dynamic Opportunity Index: A Case Study from Iraqi Oilfields
Create and run several cases on cloud to perform uncertainty analysis

Automated well construction task
✓ Pad placement and Pad well design on the targets
✓ Resources Management and completion Schedule
Probabilistic well ranking by specified criteria (NPV or Np)
Success probability from uncertainty analysis

10 / 585 Horz. Wells
1.7% Success
Without NTG

6 / 969 Vert. Wells
0.6% Success
Without NTG

3 / 677 Vert. Wells
0.4% Success
With NTG
Risk Identification

- Special Logging (FMI, Porosity)
- Compressibility Analysis
- Pressure Tests
- Selective Well Test Discretized by unit
- Assign Weight Factor Combining Uncertainty Areas with Well Ranking (NP/NPV)
Conclusions & Recommendations

✓ Integrated Uncertainty Analysis within an Agile Customized Workflow enabled to run hundreds of simulation cases to evaluate 5,000 well possibilities and its combinations in a record time (20 days) using digital capabilities: On Demand Reservoir Simulation.

✓ Risk & Uncertainty Assessment through a probabilistic approach identified 6 new well locations in addition to the existing Field Development Plan. The main variables with a direct effect on new wells EUR are: porosity, fractures conductivity, matrix compressibility.

✓ The characterization process showed unconventional stimulation techniques are needed to boost the recovery factor from the target formations. Conventional techniques can provide a RF of up to 10% with the current FDP.

✓ From current data availability, it is recommended to acquire the following data: Image logs, Sonic logs, Spectroscopy Logs.