Reducing uncertainty in fracture modeling using dynamic data: McElroy field case

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Agenda

- McElroy field basic introduction
- McElroy depositional model
- Static fracture characterization
- Streamline simulation and feedback
- Towards a static solution using dynamic data
- Deliverables
- Lessons learned
McElroy field basic introduction

- Discovered in 1926
- 50 mi south of Midland
- Carbonate reservoir (dolomite)
- 2700+ wells drilled
McElroy depositional model
Carbonate Ramp Model

- Evaporites & Mudstones
- Wackestones - Packstones
- Grainstones / Ooid Shoals
- Wackestones - Packstones

- Low Perm Area
- High Quality Area
- Low Press. Area
- East Flank Area
McElroy depositional model
Prograding carbonate ramp

- 2018 wells w/ formation tops
Reservoir Characterization

Pre-simulation static porosity

Pre-simulation static permeability

Initial characterization handles OOIP effectively
Fracture permeability is just an overprint at 400 mD
Simulation Results at field level via GTTI

Oil Production Rate (STB/day)

Water Cut (fraction)

Conclusions:
• Production can be history matched using heavy hitter wells (80+ wells)
• We get the energy of the reservoir right, but input data needs to be refined to match individual well performance
Calibrate Geologic Model via History Matching

Permeability – Before and After Water Cut Matching via GTTI
Calibrate Geologic Model via History Matching
Permeability Change Made via Water Cut Matching

Feedback:
- Diagnose the geologic model
- Need more permeability in LPA
- Need less fractures and vugs in HQA and LKA
Towards a static solution using dynamic data
Did we get lucky the first time around?
Two different characterizations to be tested
Simulation Results
Water Cut Match - Field

Oil Production Rate (STB/day)

Water Cut (Fraction)

- Production History
- : Before Water Cut Match
- : After Water Cut Match
Permeability Change required for History Matching
LONG case - Layer 5 (E-D5)

Mostly increased permeability in LPA (Low Pressure Area)
Permeability Change required for History Matching

SHORT case - Layer 5 (E-D5)

Relatively small changes in permeability
Flood Efficiency Map
Flux Map

Colored by Flux
Colored by Producer
Colored by Injector
Deliverables
Flood Efficiency Map Filtered

- Leave the connection showing flux movement from HQA to LPA

- Filtered out
  - Producer/injector paring with negligible amount of flux
  - Well connections supporting producers nearby (well-patterned flooding)
Deliverables

• Production forecasting using different pattern alternatives
• Expected ultimate recovery for drilling campaign

• Allocation factors
Lessons learned

- The update of the McElroy earth model lowers the risk associated to the future oil production and strengthens the quality of its production forecast.

- The Central Permian AD team selected the SHORT model for pattern scenario testing. The forecast from the streamline simulation displayed that recovery associated with the one scenario was larger and the cost of drilling was smaller.

- Carbonate fields are extremely heterogeneous. Well based variograms cannot honor field heterogeneity. In order to account for it, heterogeneity needs to be forced into the model.

- The different permeability simulations in the earth model controls the well allocation factors in mature fields with dense well population, hence looking for common well allocation factors is not a value adding proposition.
Benefits of streamline simulation

- Validation of the reservoir energy
- Update of permeability field
- Testing of production scenarios/patterns
- Forecasting production
- Characterization of high swept areas
- Generation of development strategies per quarter section