the future is open

SIS Global Forum 2019

Reviving a Mature, Watered-Out Fractured Carbonate Reservoir: An Integrated Approach to Designing a Miscible EOR Scheme for the Bigoray Field in Alberta

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Bigoray Area of the Pembina Field

2 of about 50 naturally-fractured Devonian reefs in the Nisku formation in Alberta, Canada

Production started in 1978

Waterflooding started in 1979

Pools shut-in in 2014 due to high water cuts.
Targeted for EOR and acquired by Pulse Oil in 2017.

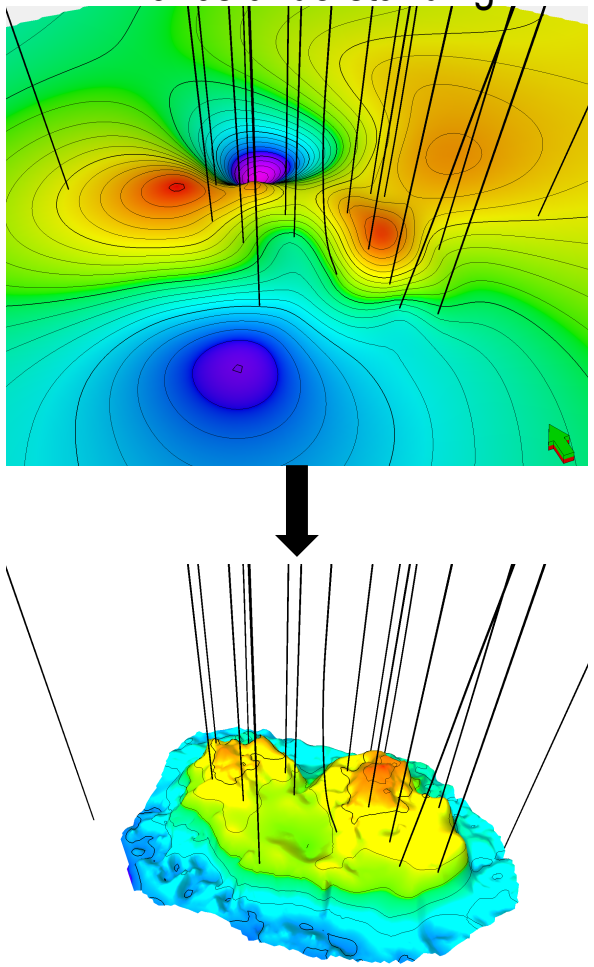
Project Phases

- Phase I – Reservoir Characterization: Petrophysical and Geological Study
- Phase II – Geomodelling: Static reservoir model (reservoir geometry/properties)
- Phase III – Numerical Reservoir Simulation

Multidisciplinary Integrated Approach

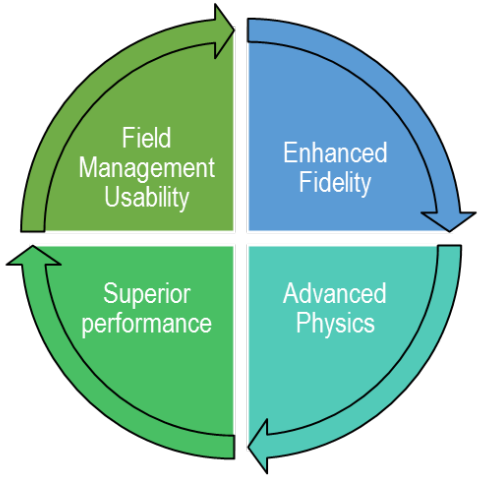
The outcome of each discipline affects the input of the other disciplines

1970s understanding



2019 characterization

Technology

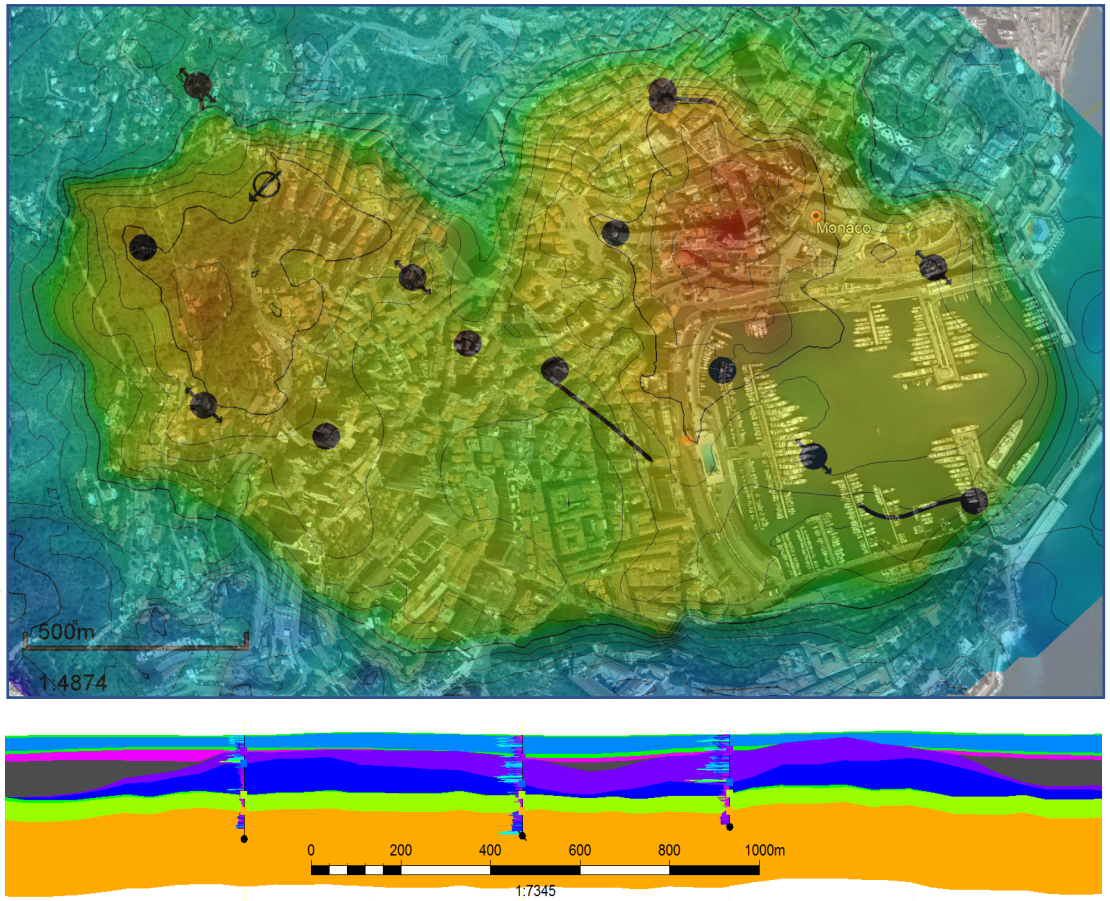


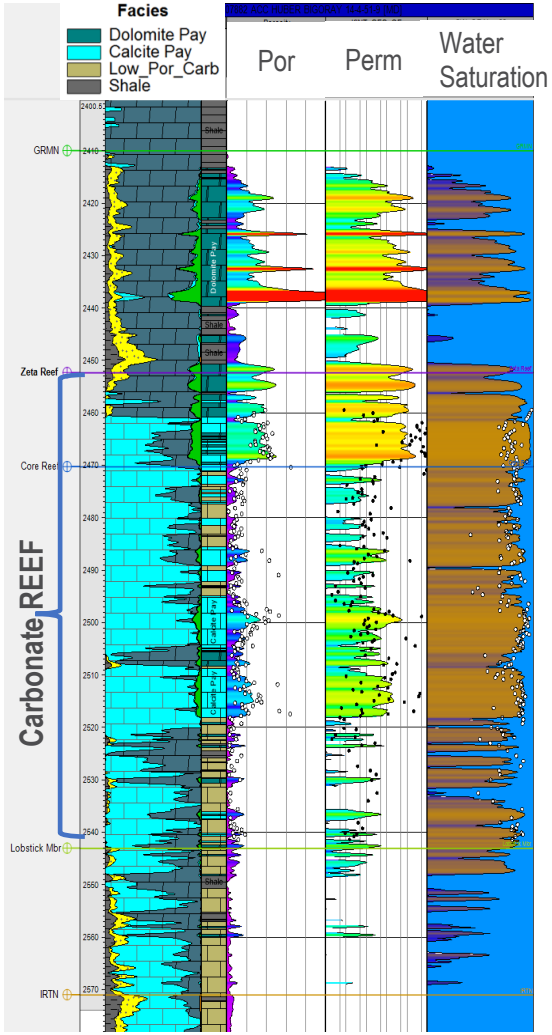
Domain Expertise

Petrophysical Analysis

ELAN analysis provided a discrete facies distribution and characterization

Petrophysical model consistent with core analysis and poro/perm measurements



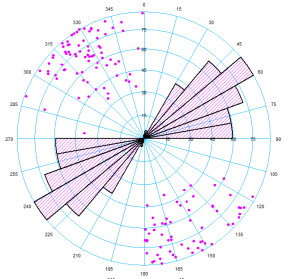


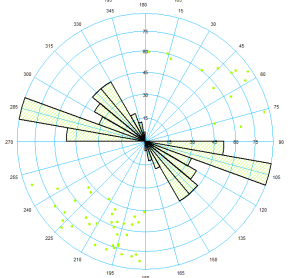
Geological Analysis

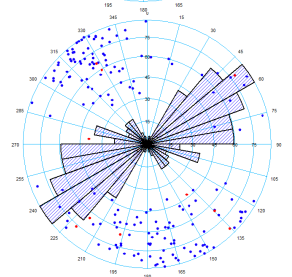
Complex triple porosity system: matrix, fractures and vugs

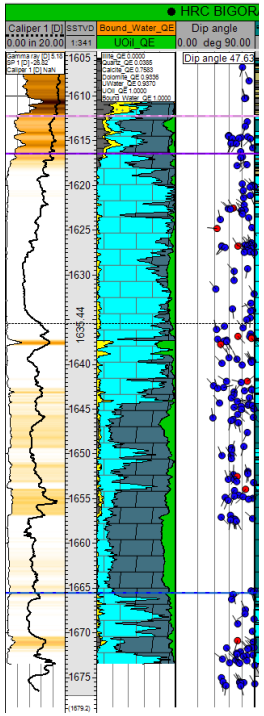
Core evaluation correlated to spectral analysis

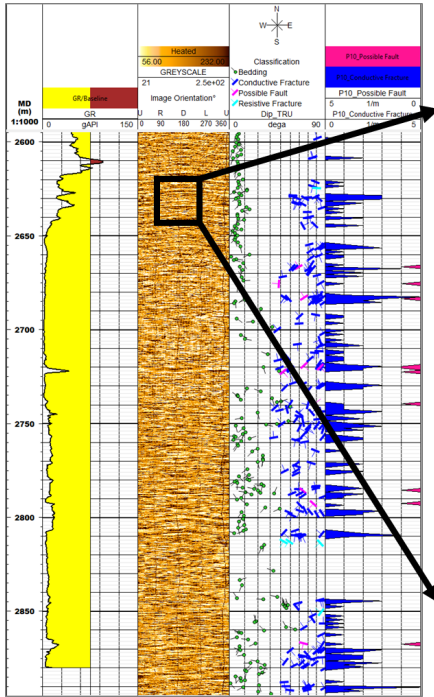
Image logs used to obtain fracture intensity/spacing and orientation

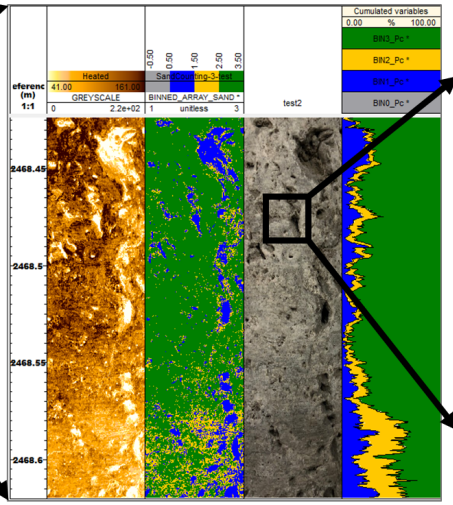


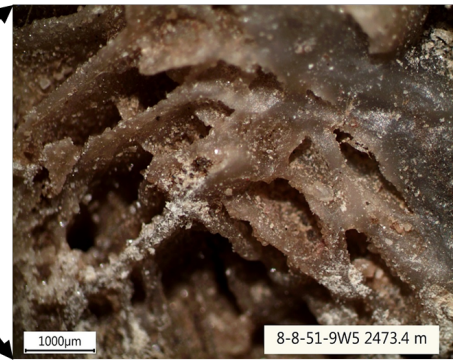






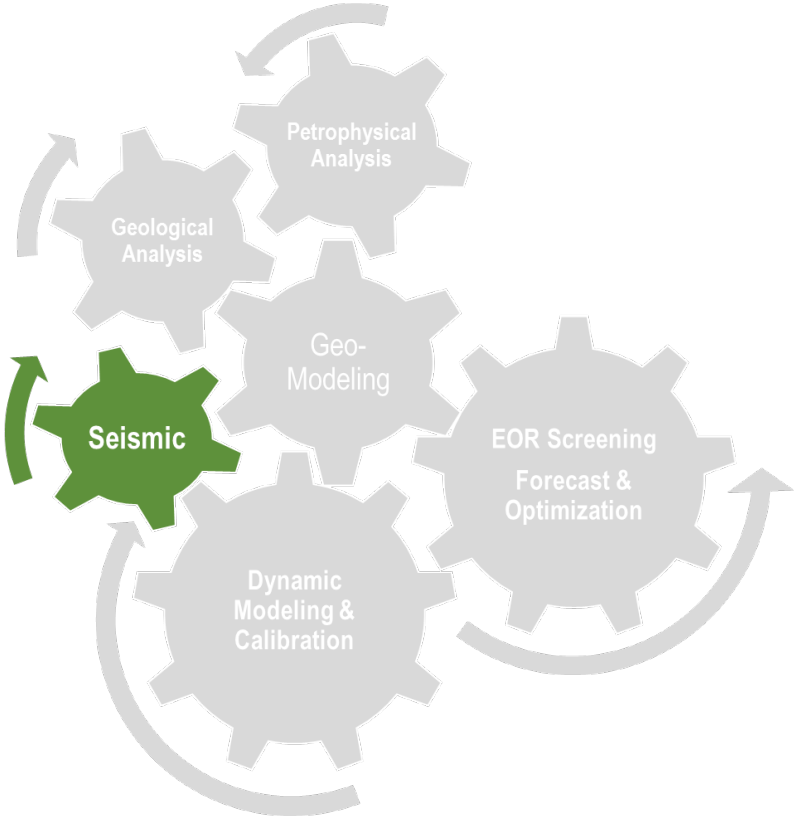


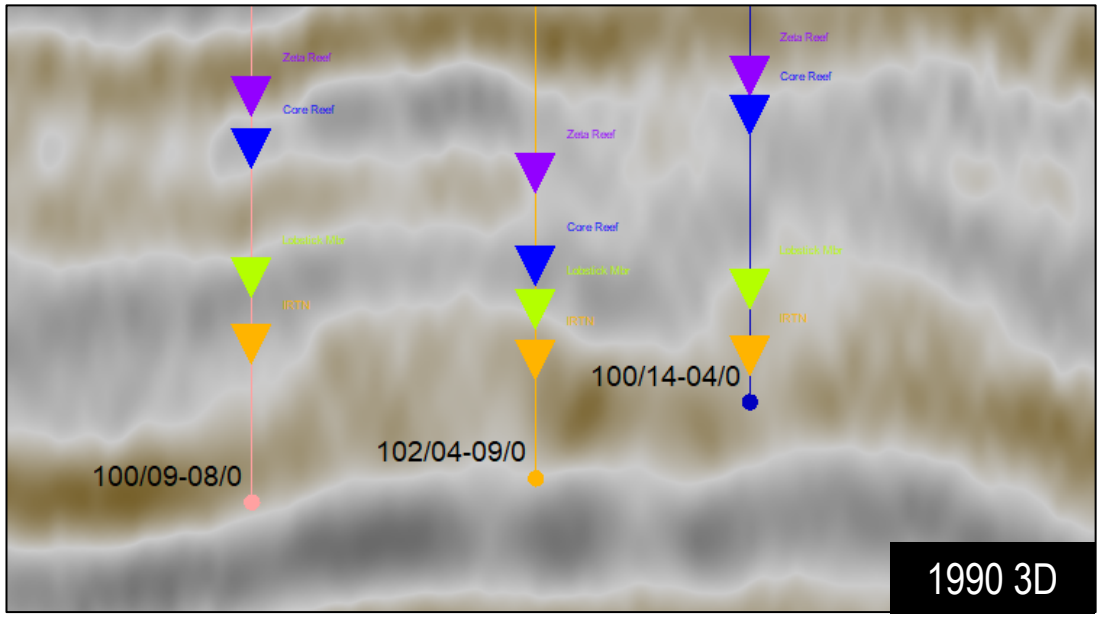


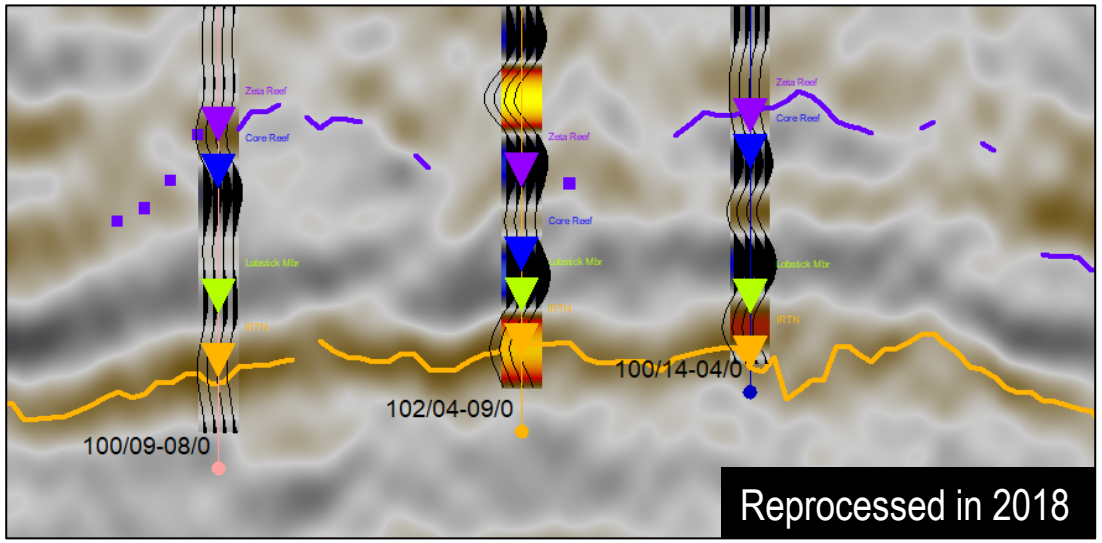


Seismic Analysis

3D seismic program was reinterpreted and combined with petrophysics derived well tops to obtain an updated geometry of the reefs



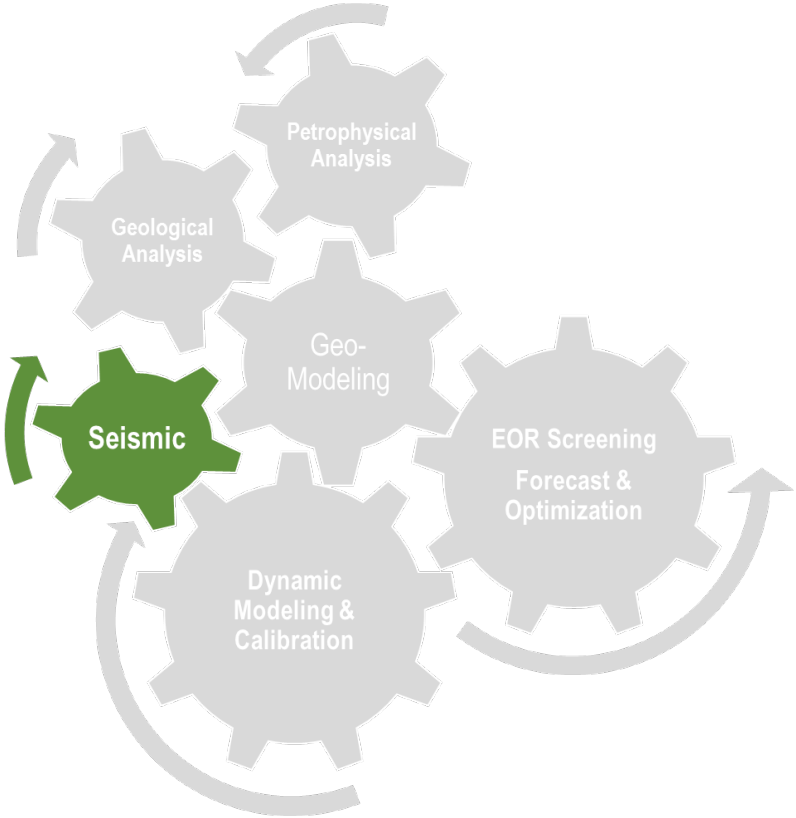


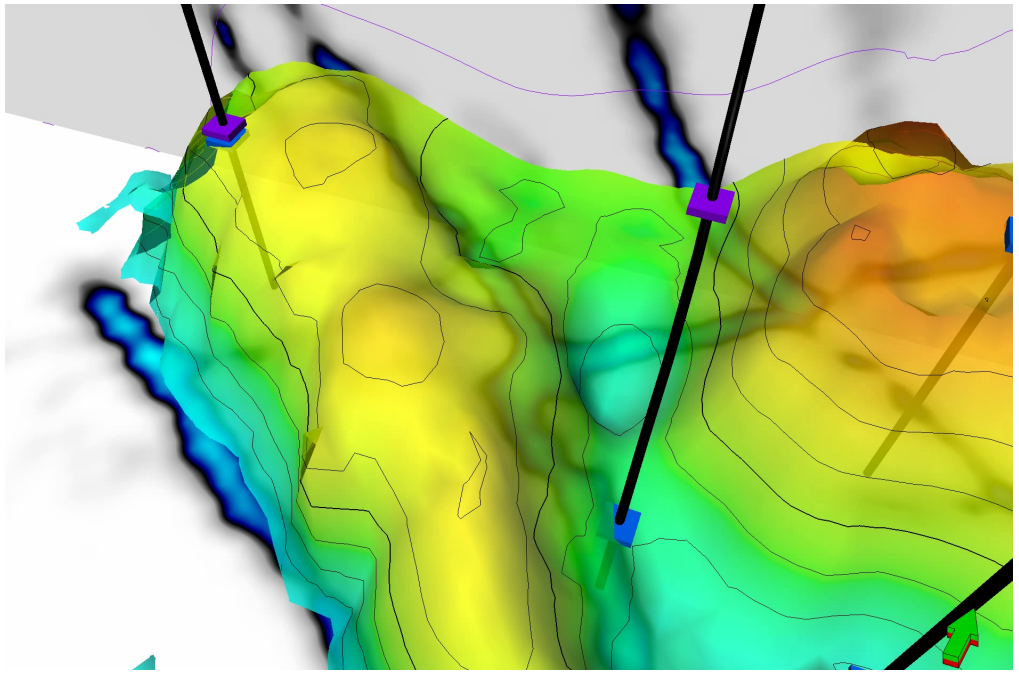


Seismic Analysis

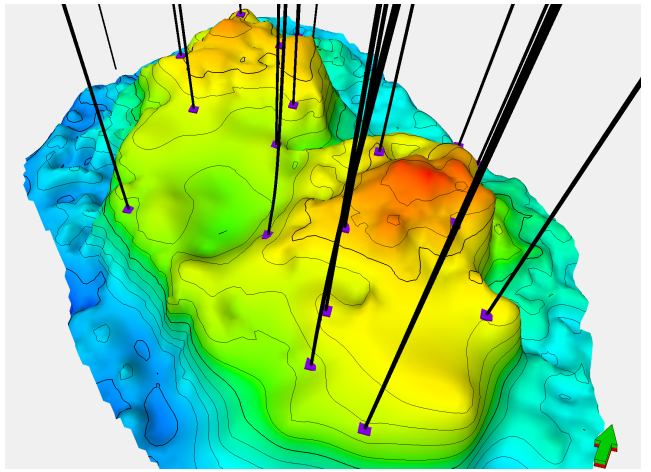
Ant tracking seismic attributes improved the definition of internal structure

Fracture intensity from image logs was correlated with an ant tracking seismic attribute and was propagated into a discrete fracture network (DFN)

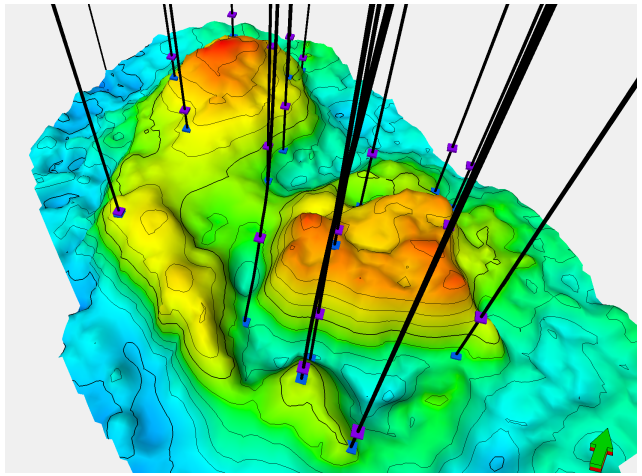




Zeta Reef Top



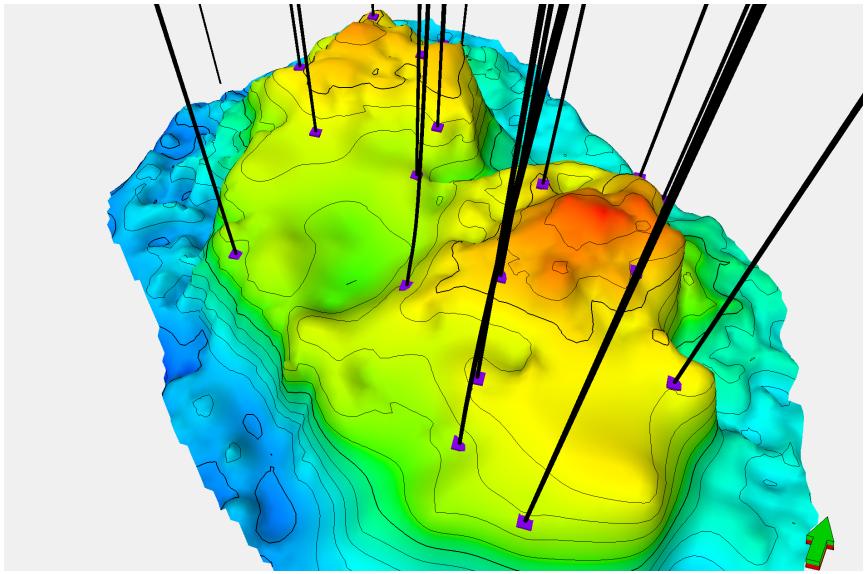
Core Reef Top

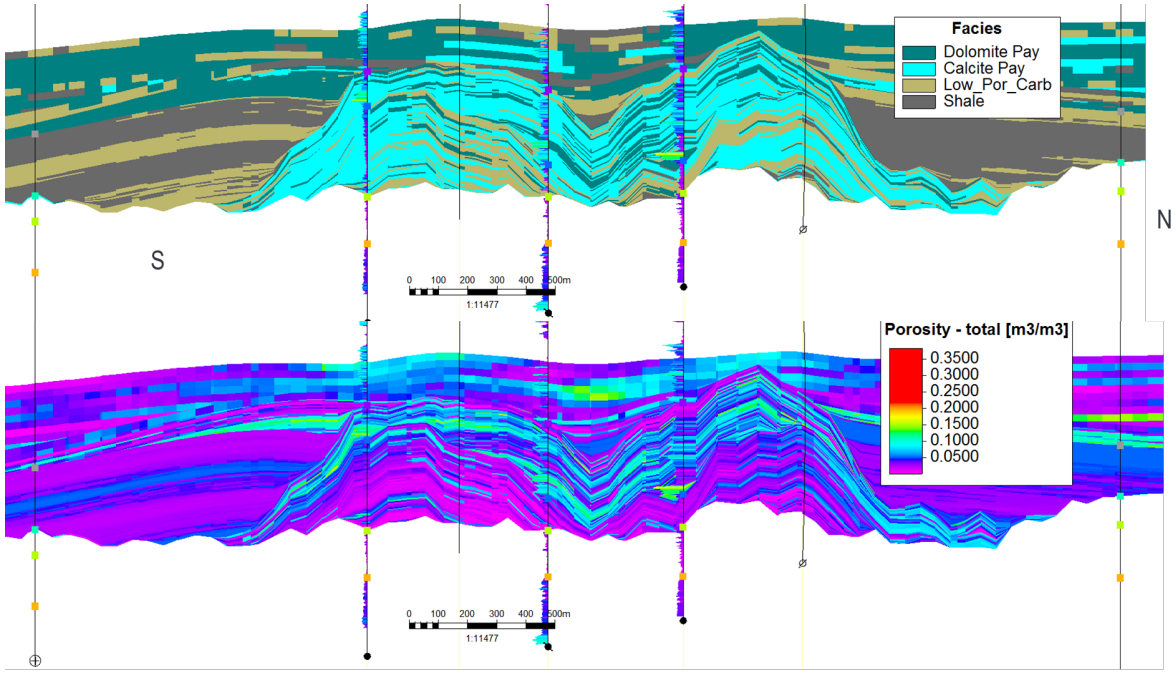


Geomodelling

Seismic-driven structure

Geostatistically-distributed properties



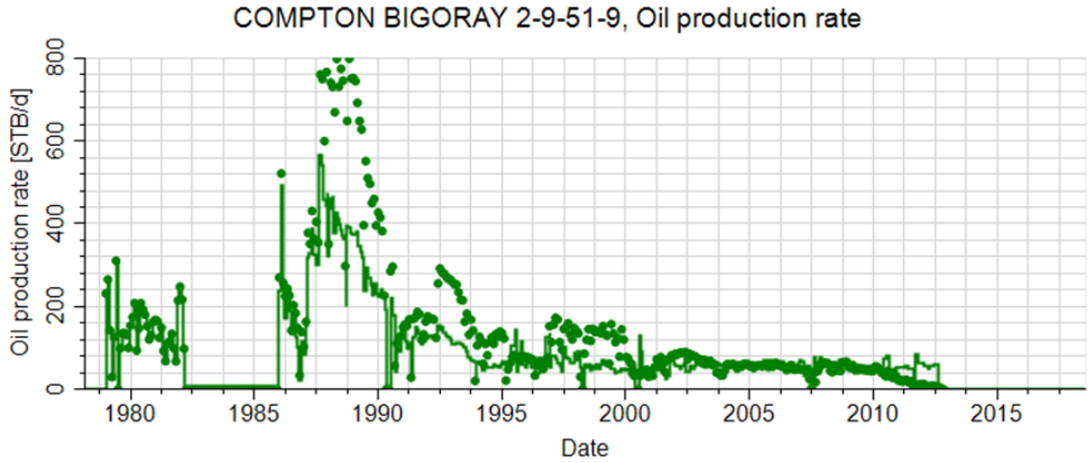


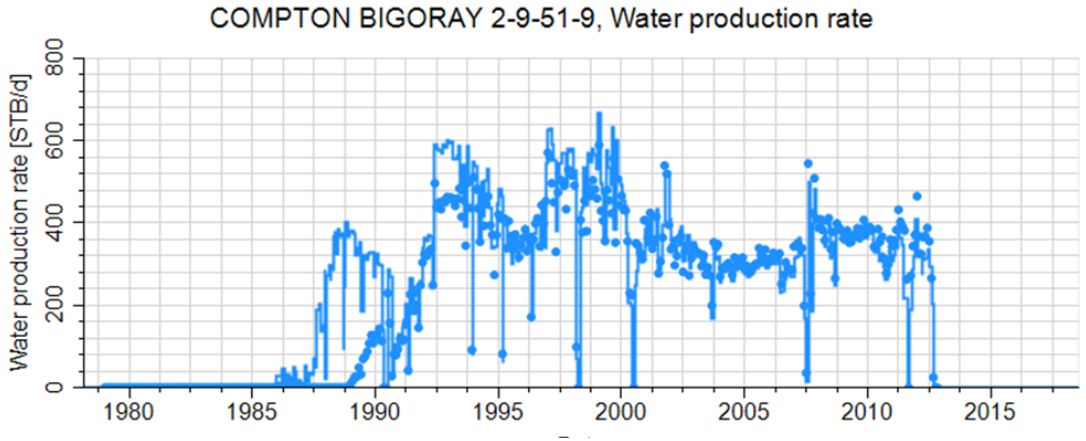
Dynamic Modelling / History-matching

A dual-porosity/dual-permeability **DP/DP** model

Model reproduces 40 years of production/water injection

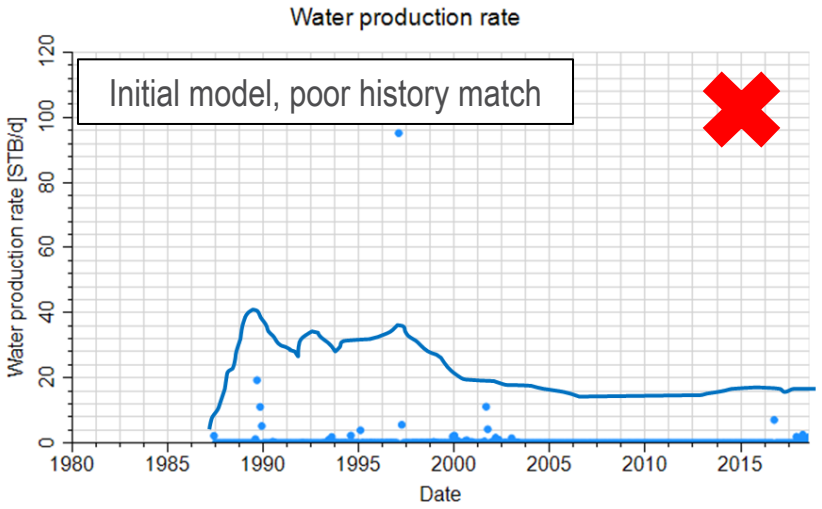
Oil, water and gas rates as well as pressures and breakthrough times are matched to historical observations

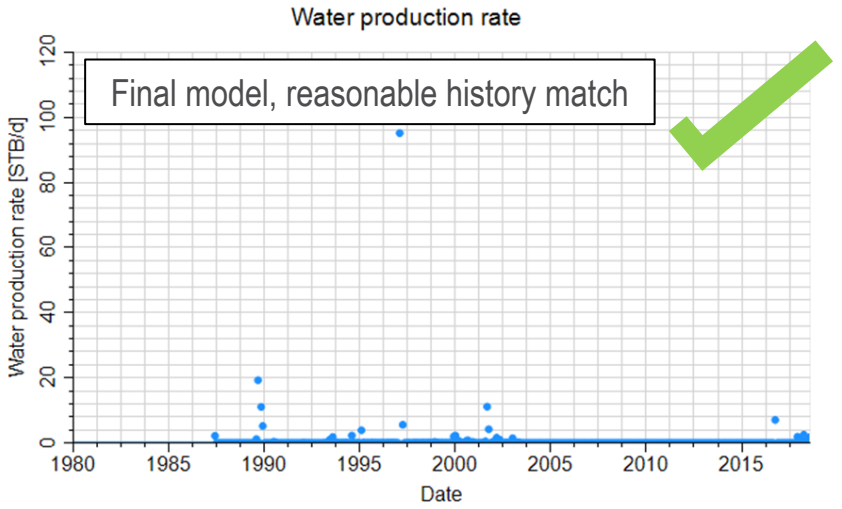


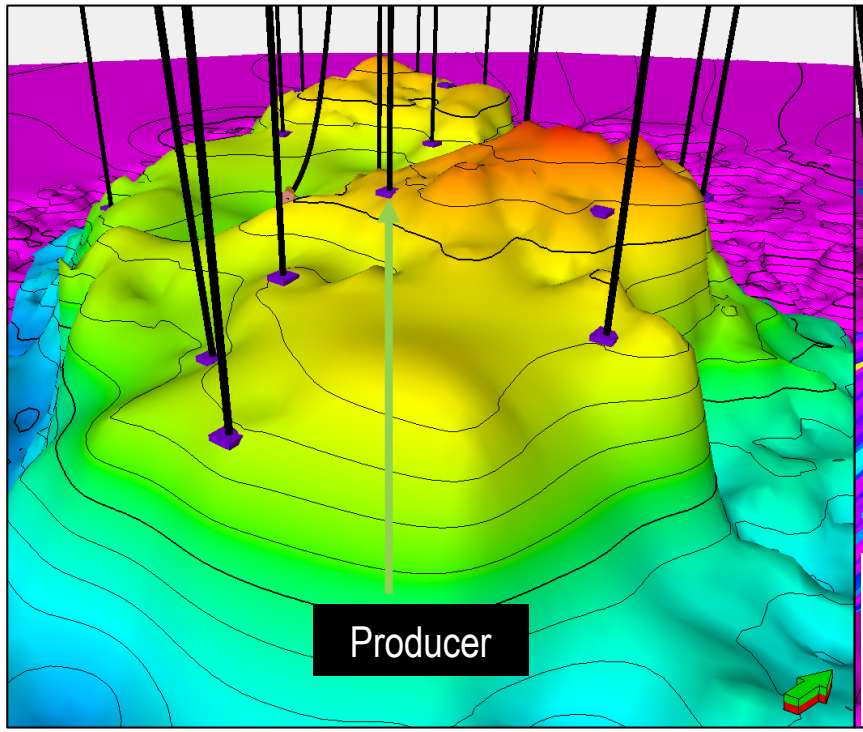


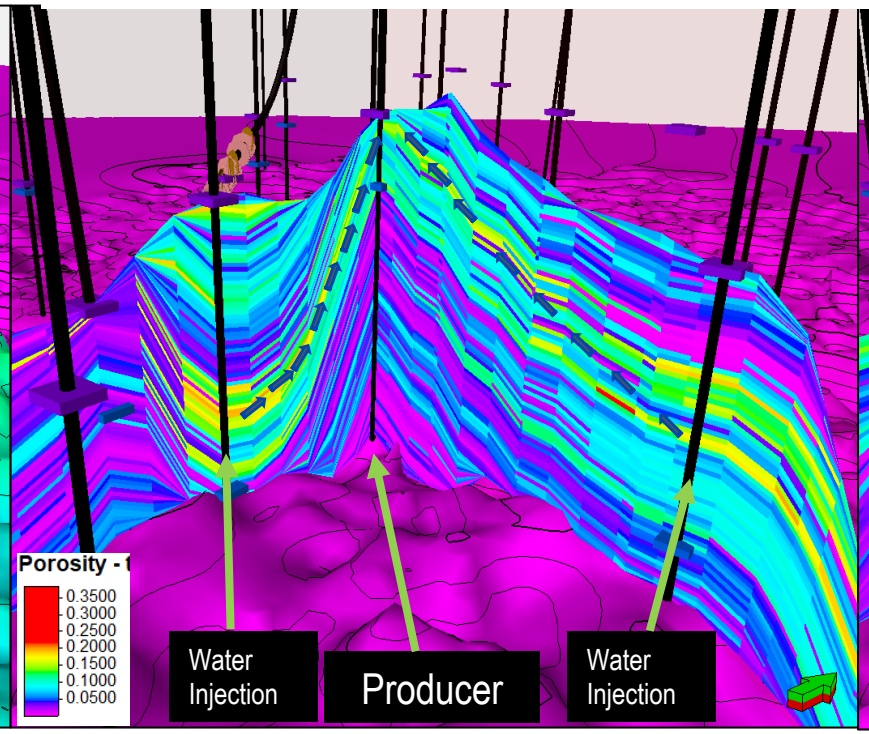
History-matching

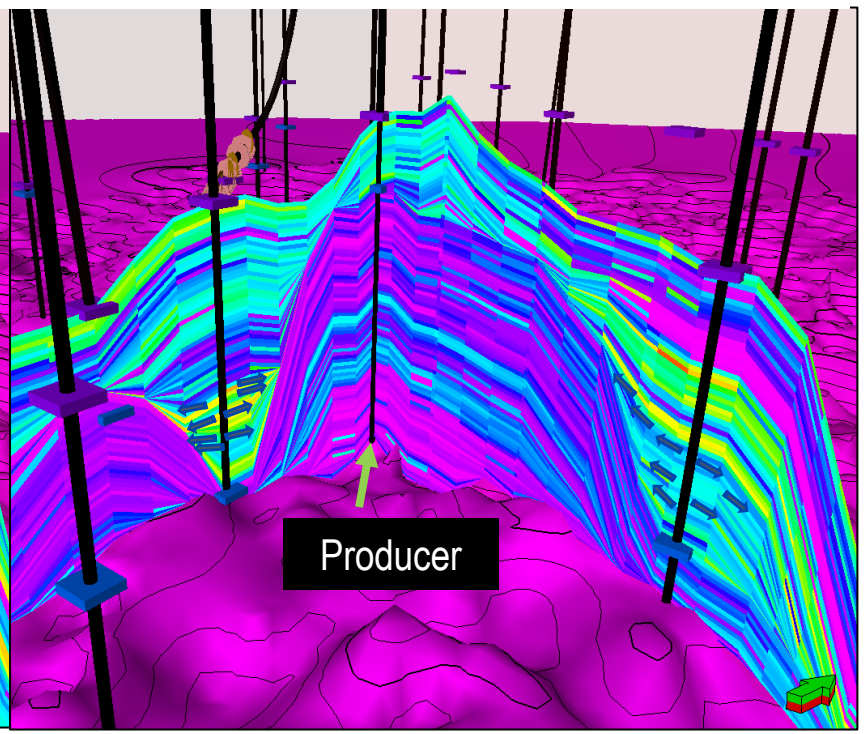
Static model was iteratively updated until the appropriate reservoir connectivity was established to honor historical production/injection





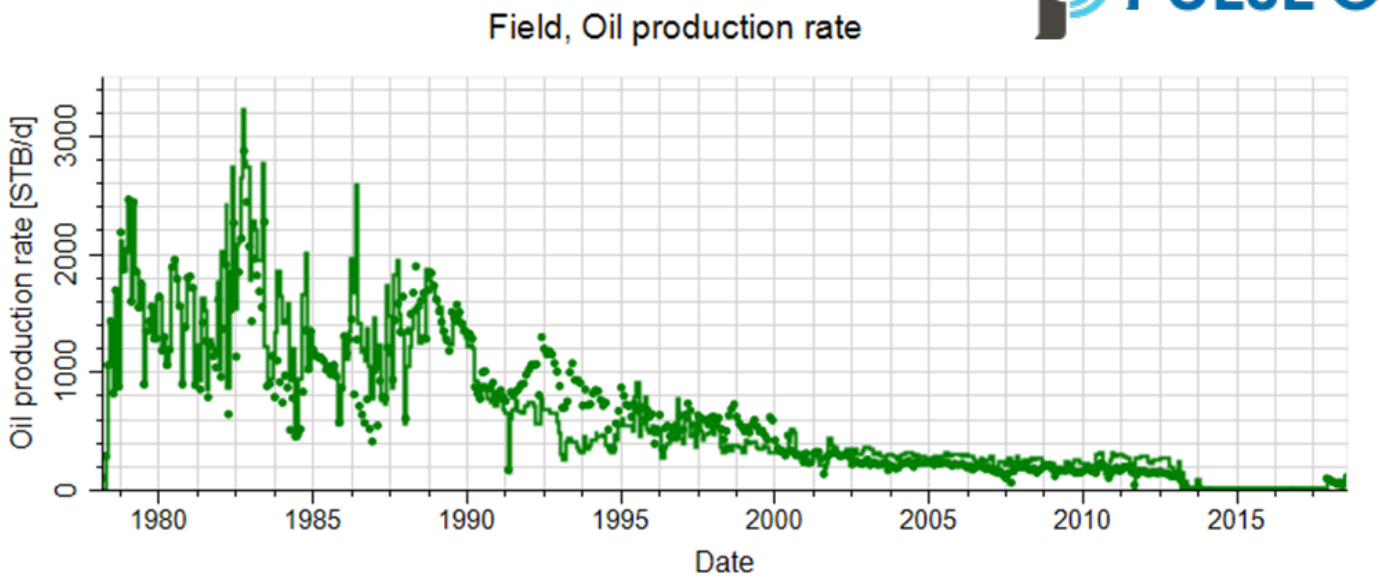


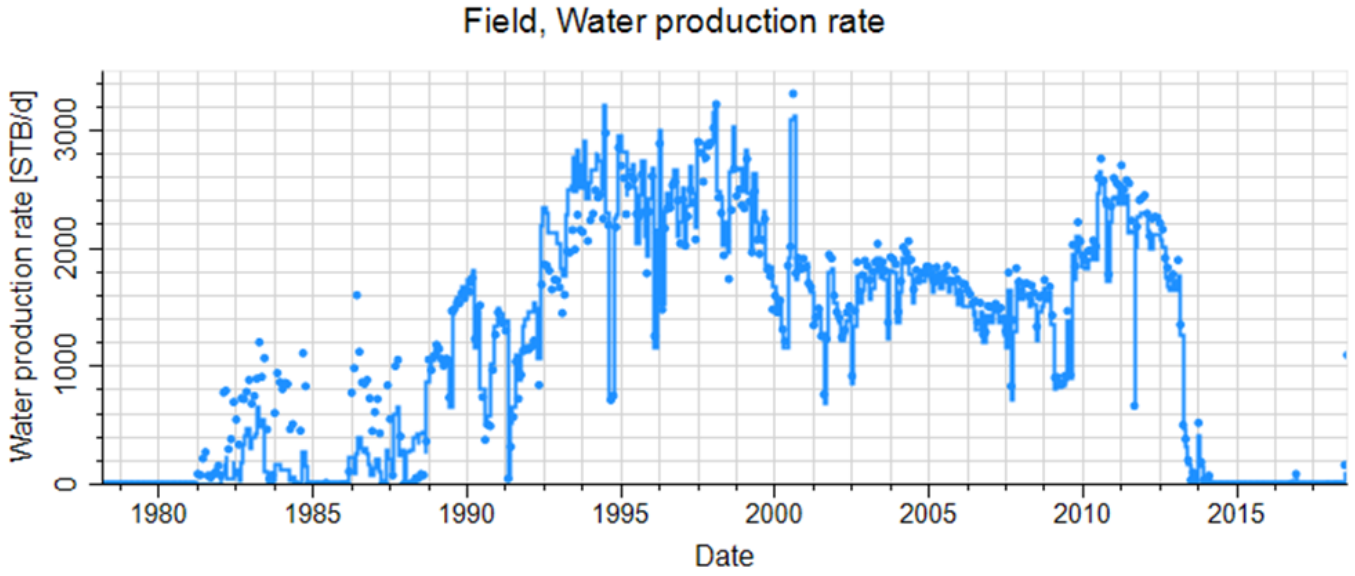




History-matching

Final field-wide match



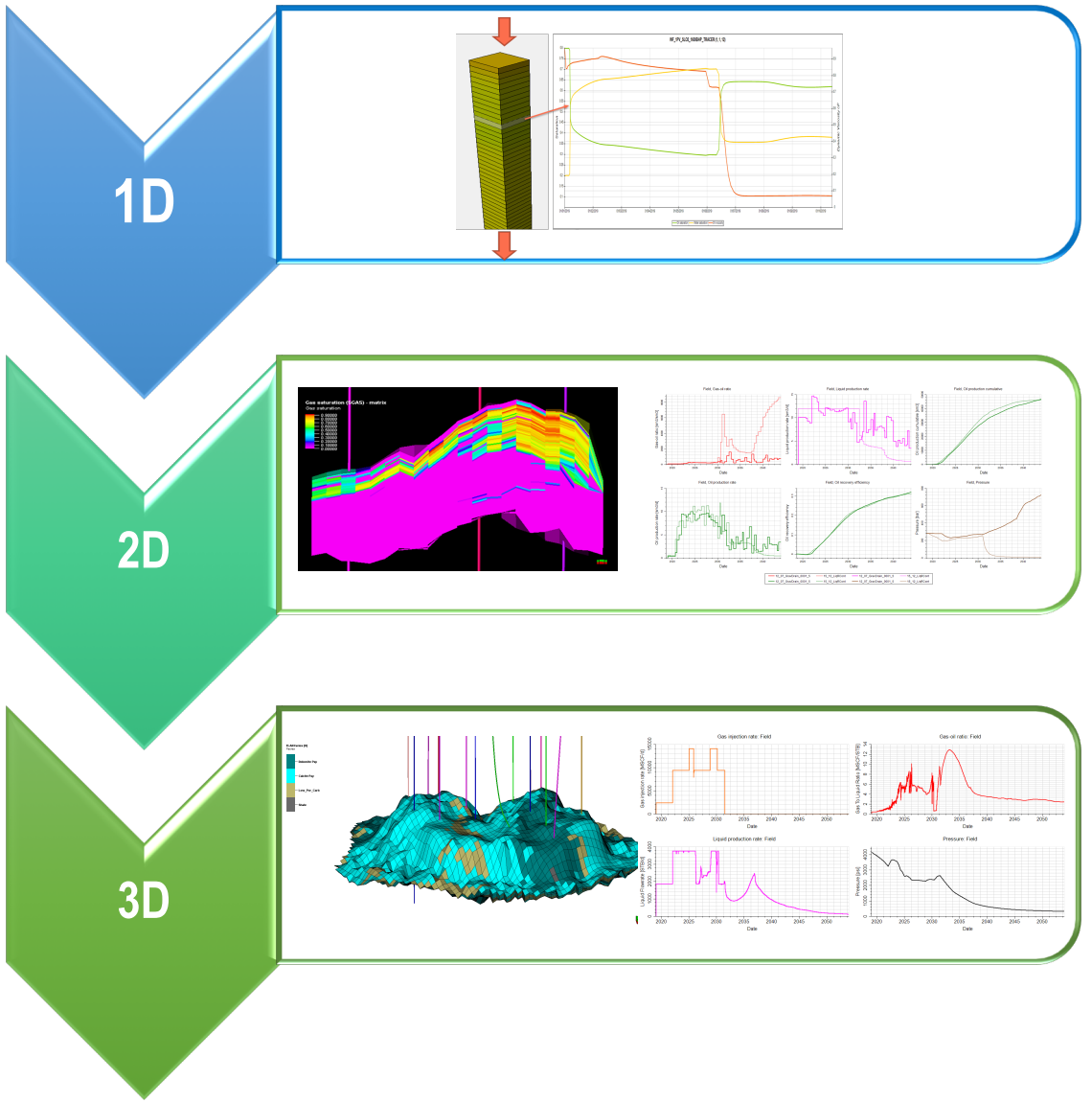


Forecasting Optimization

1D solvent injection runs

2D solvent/chase gas runs

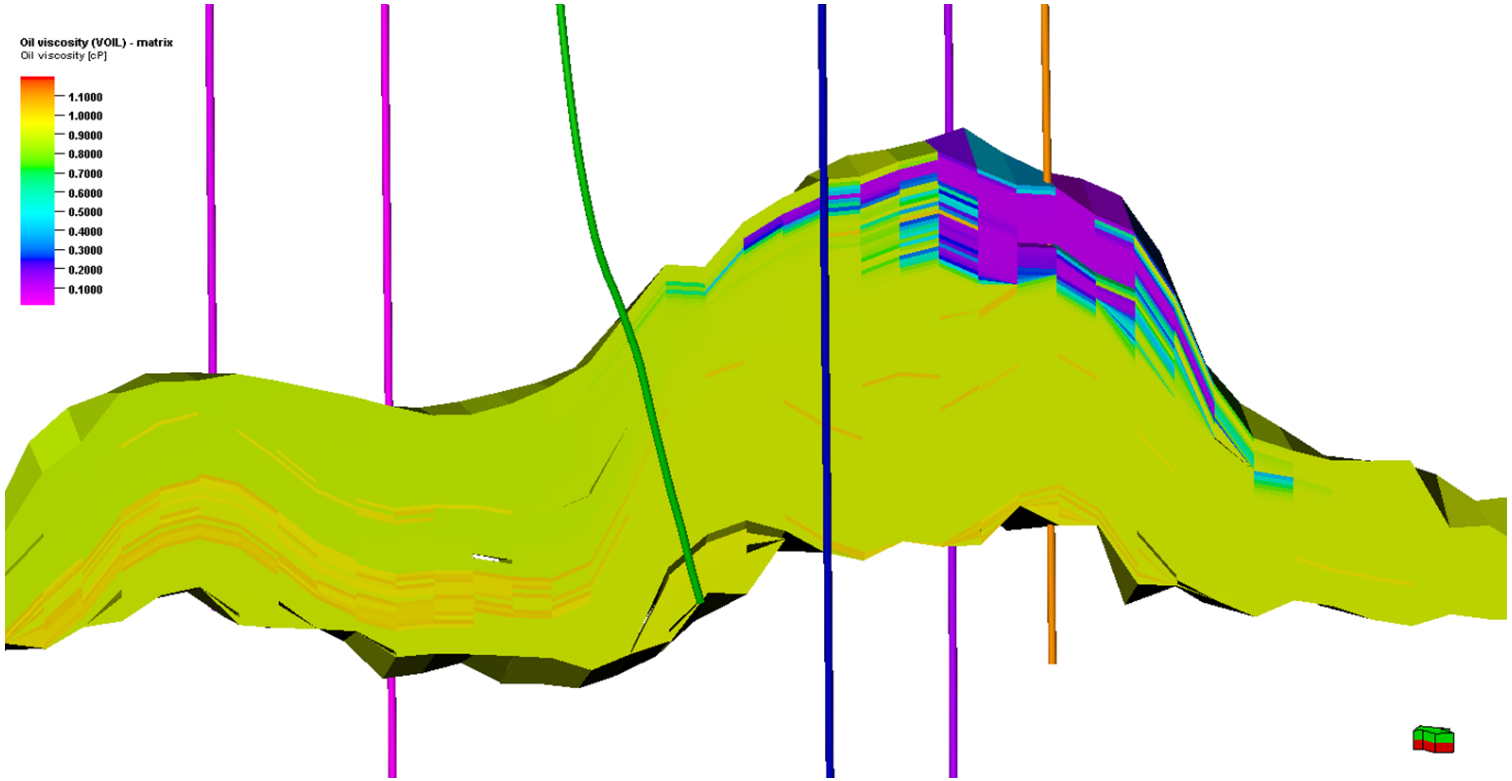
Optimize solvent scheduling, production and injection rates and controls



Solvent Injection Forecasting

PULSE OIL

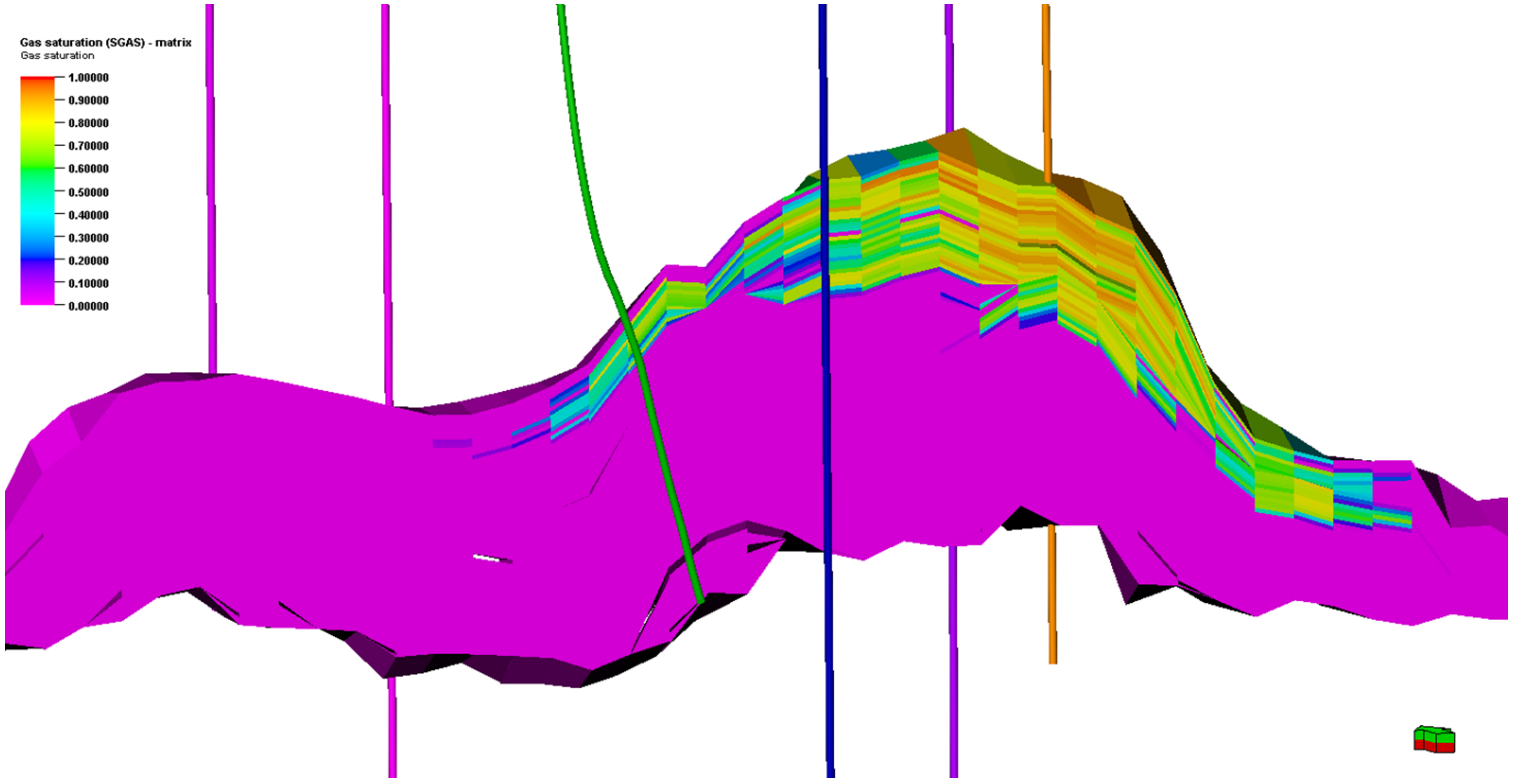
Oil viscosity – liquid solvent injection (2021)



Solvent Injection Forecasting

PULSE OIL

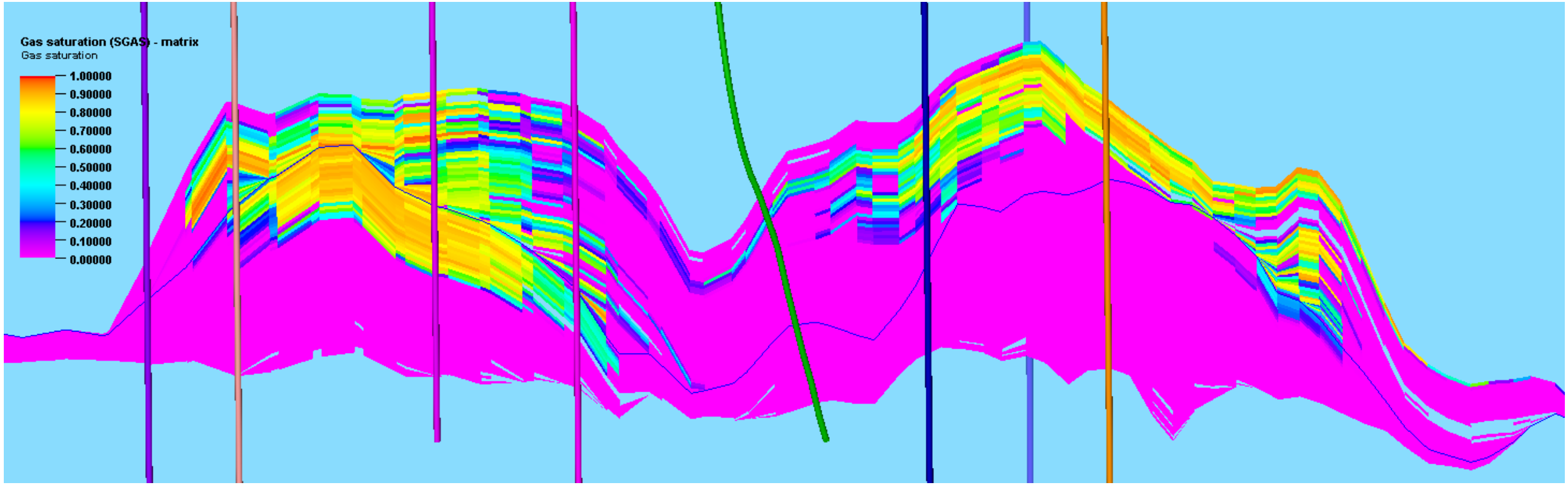
Gas saturation – chase gas injection (2029)



Solvent Injection Forecasting

PULSE OIL

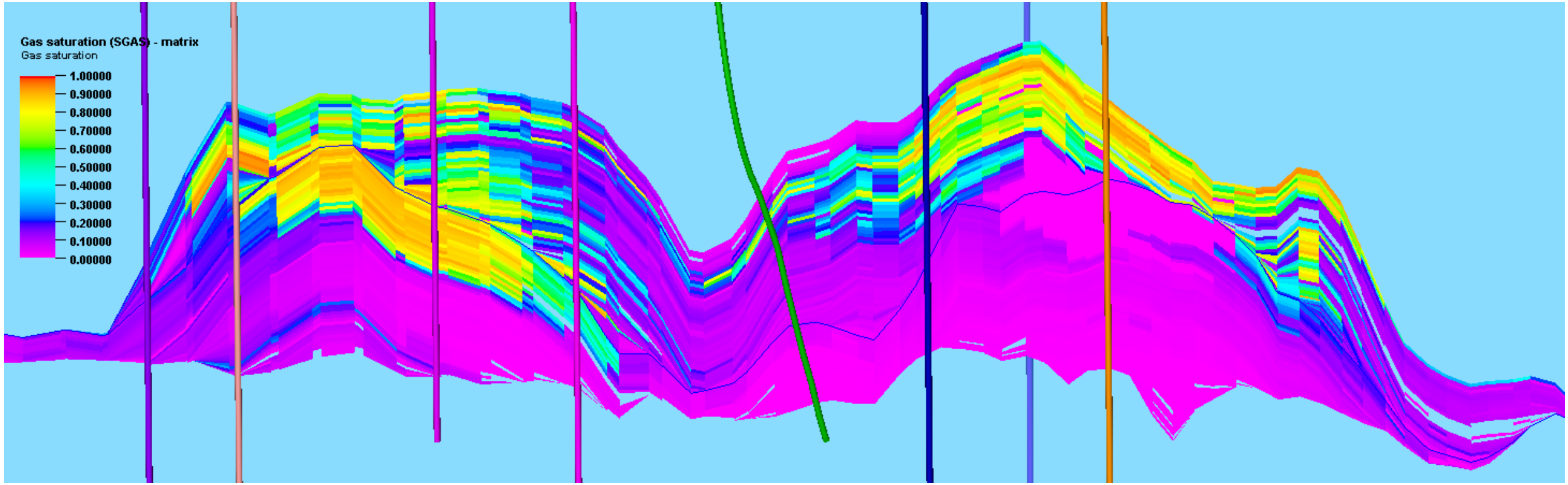
Gas saturation – blowdown period (2032)



Solvent Injection Forecasting

PULSE OIL

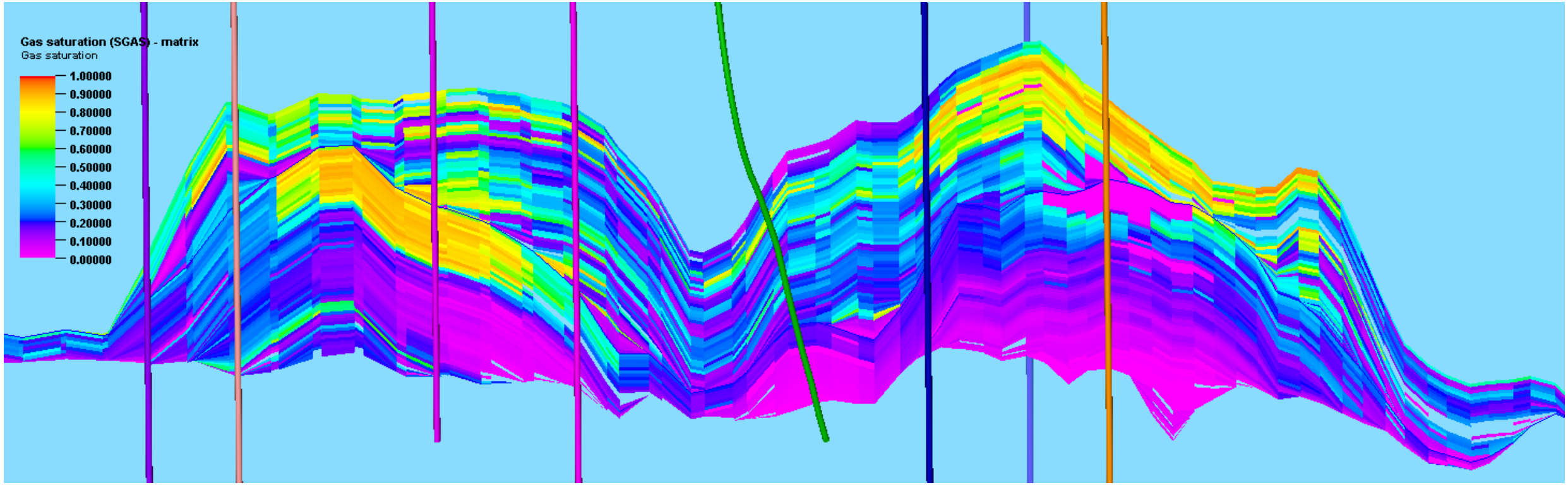
Gas saturation – blowdown period (2035)



Solvent Injection Forecasting

PULSE OIL

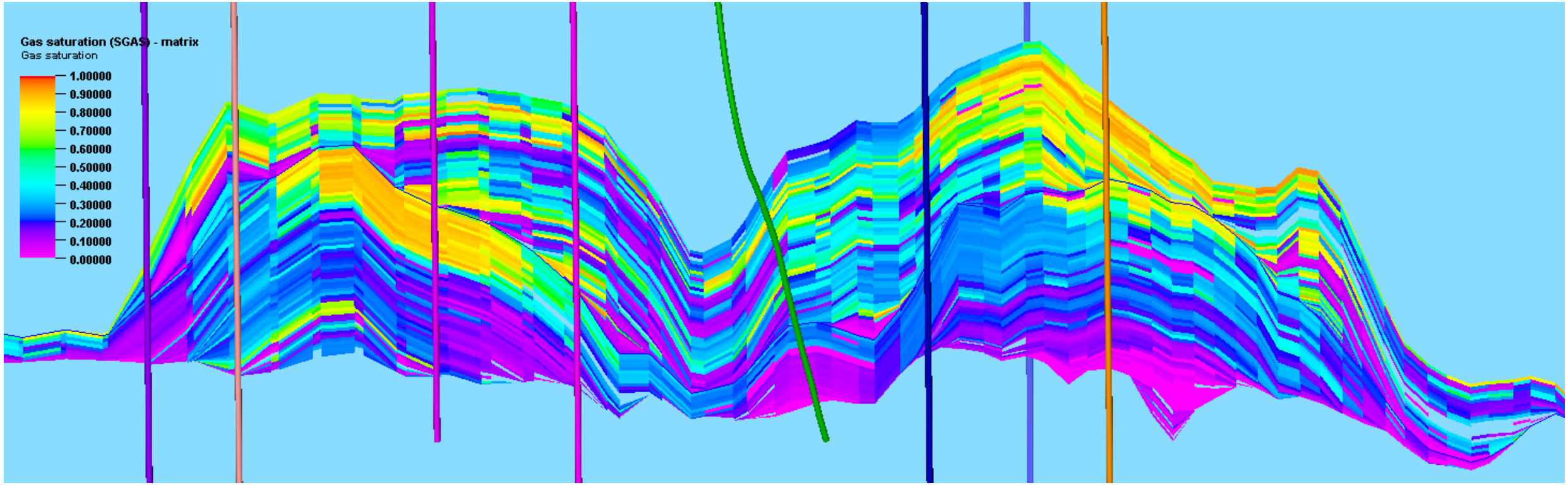
Gas saturation – blowdown period (2038)



Solvent Injection Forecasting

PULSE OIL

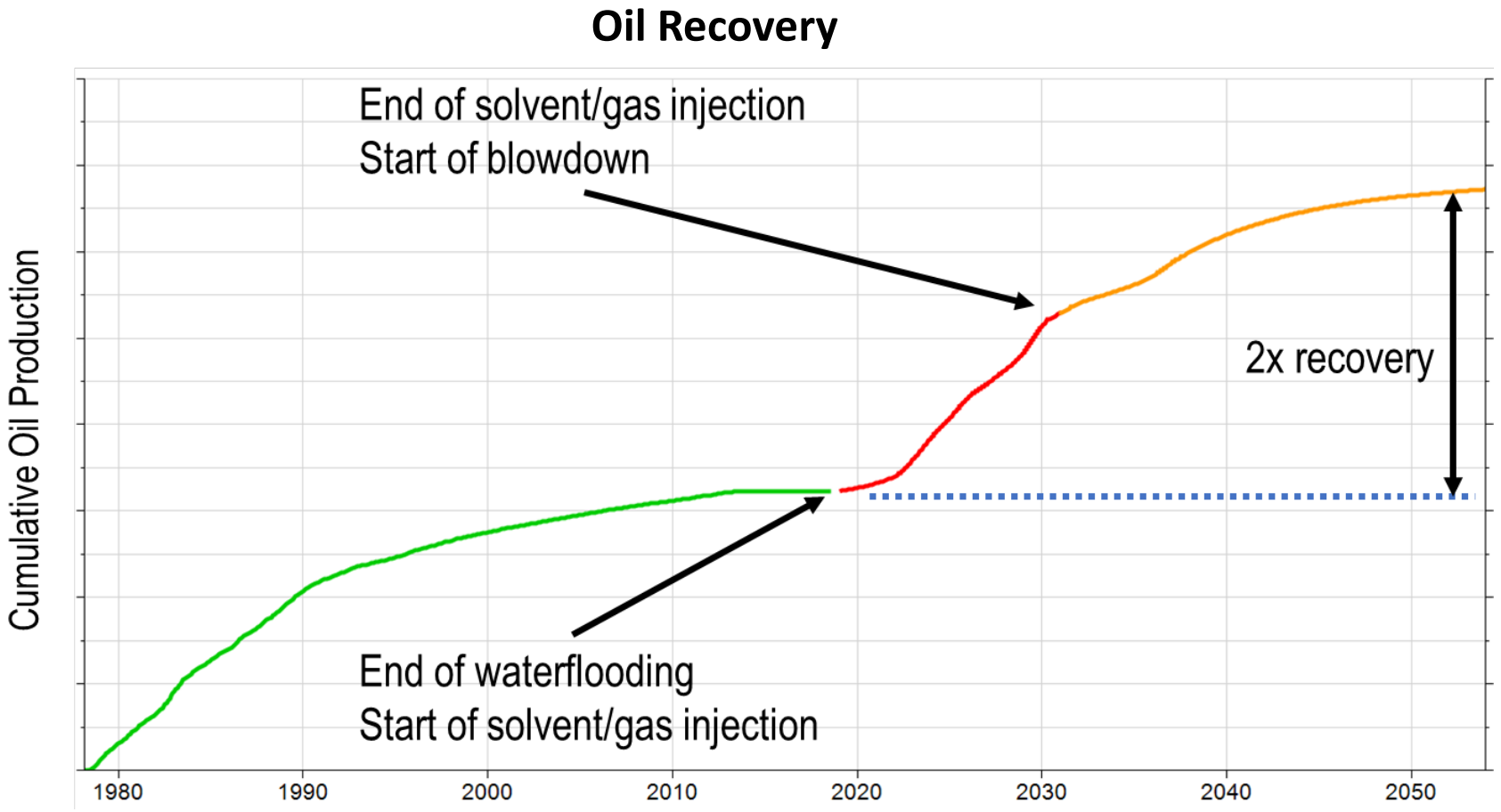
Gas saturation – blowdown period (2042)



Solvent Injection Forecasting

PULSE OIL

Optimized field-wide predicted incremental oil recovery



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