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Solving the Puzzle: Completion Evolution to Optimize Production and Offshore Operations

Anastasia Bird

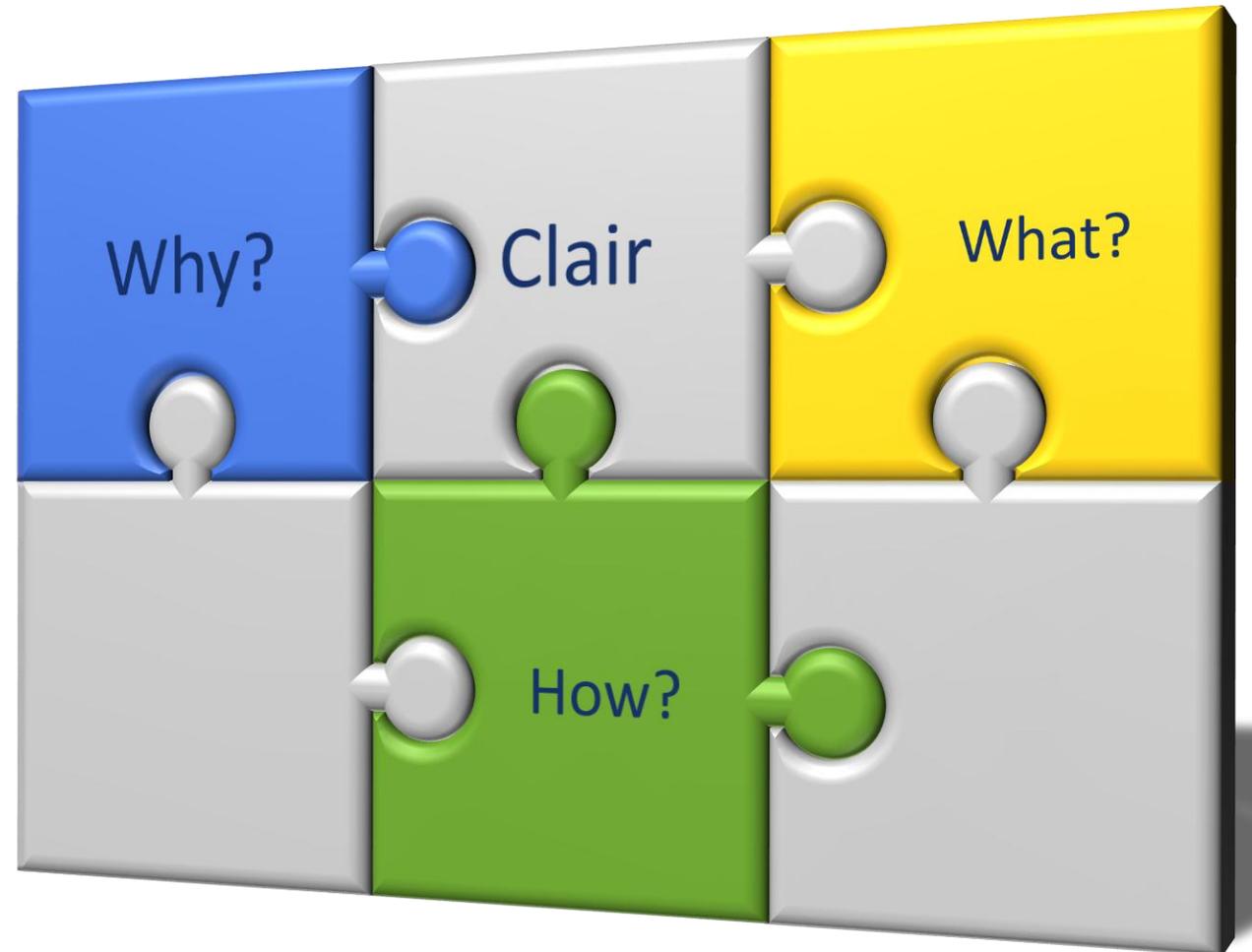


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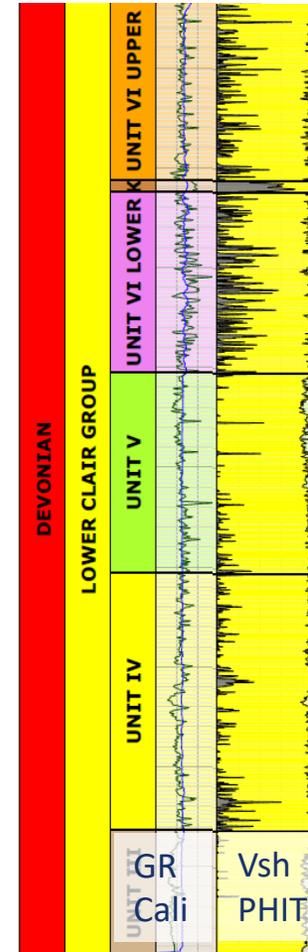
Outline

- Field Description
- **Why.** The Prize
- **What.** The Tools
- **How.** The Concept
- Conclusions

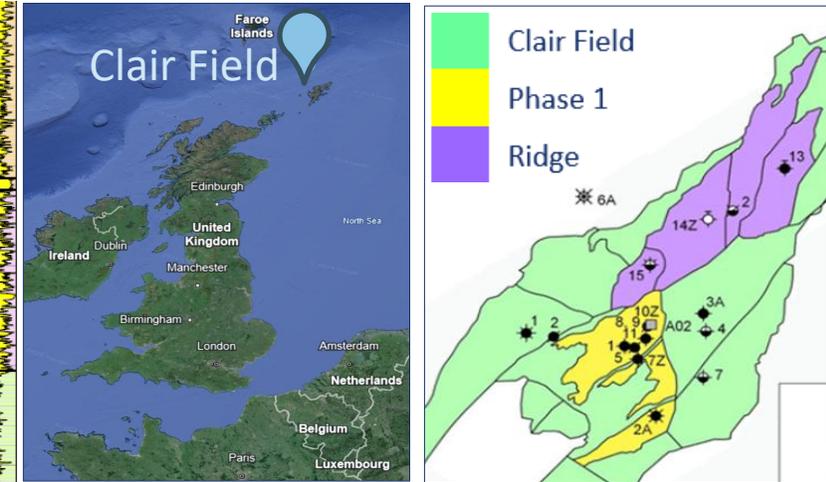


Clair Field Description

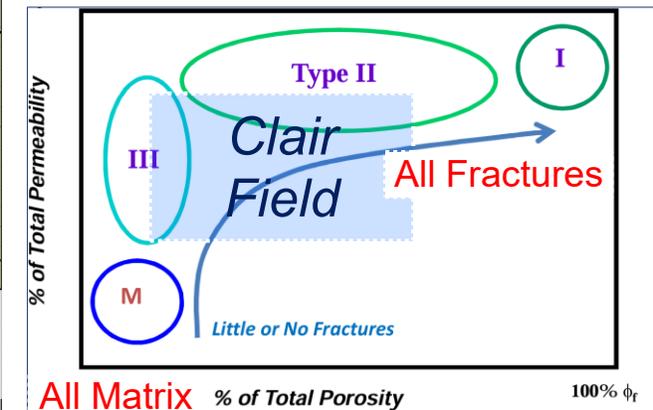
- Discovery 1977. Clair Phase 1 (2005) and Ridge (2018)
- 700m thick fluvial clastic reservoir
- Lower Clair Group (LCG) with 6 x sub-units
- Permeability 3 – 25 mD, low kv/kh
- Porosity 12-15%
- Dual porosity-permeability system
- Horizontal wells (2000 mTVD, up to 5000 mMD)



Clair Log



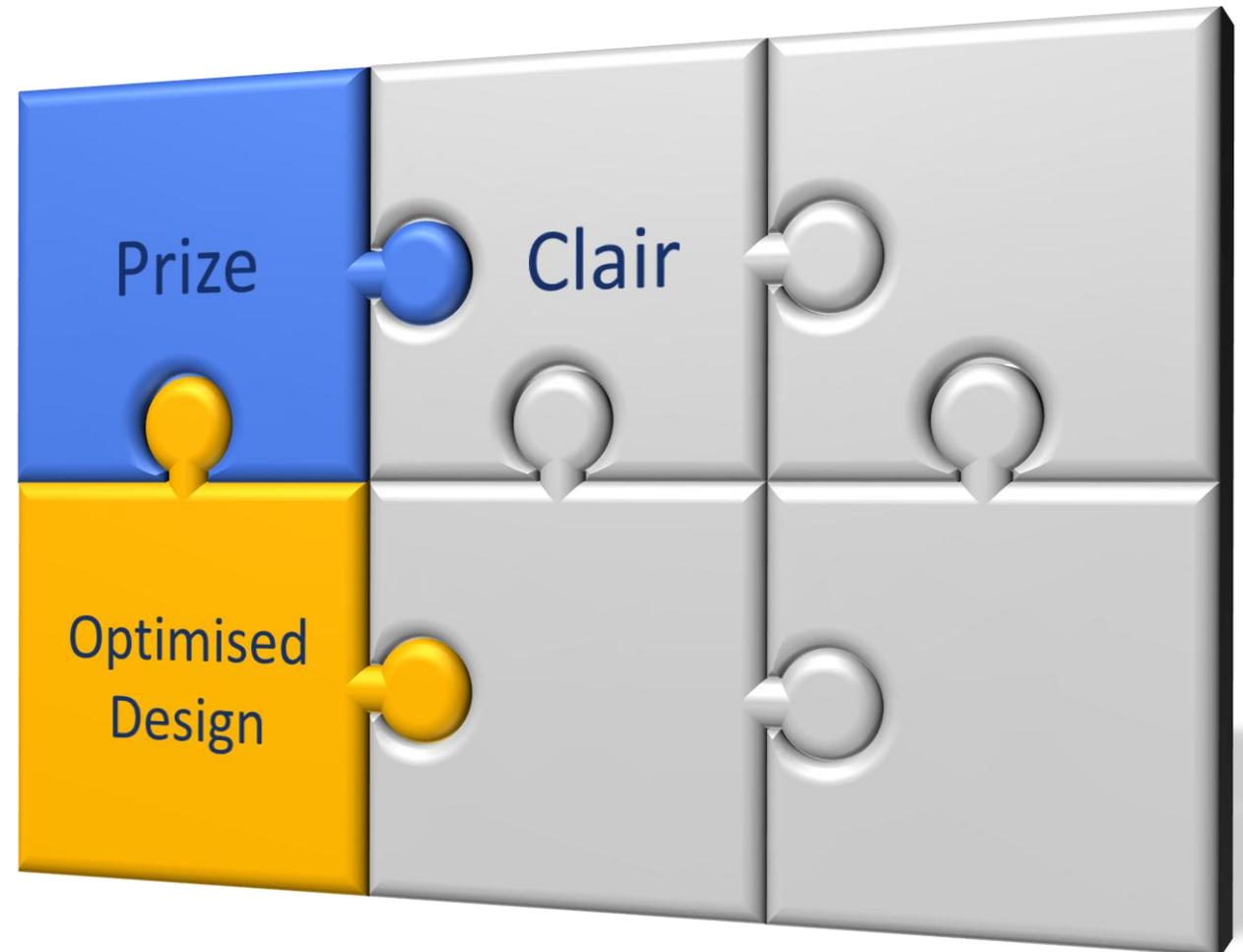
Clair Field Area – Phase 1 and Ridge



Clair Field in Nelson's Classification

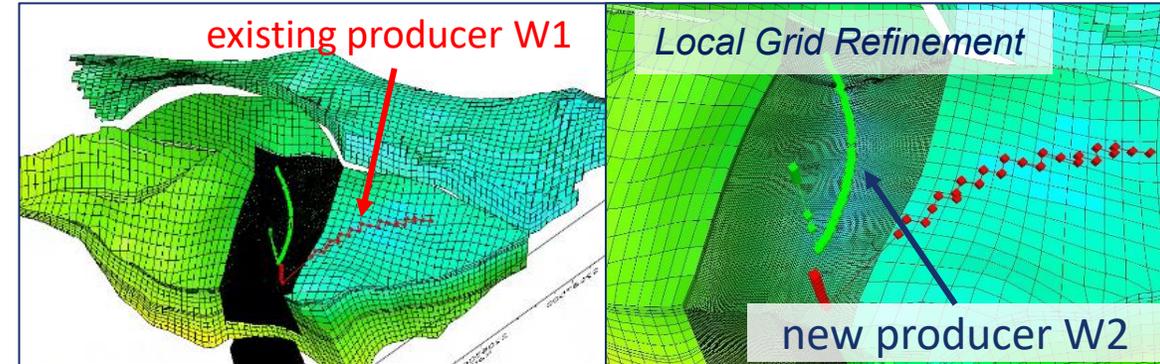
Outline

- Field Description
- **Why.** The Prize
 - fracturing design to optimise production
- **What.** The Tools
- **How.** The Concept
- Conclusions

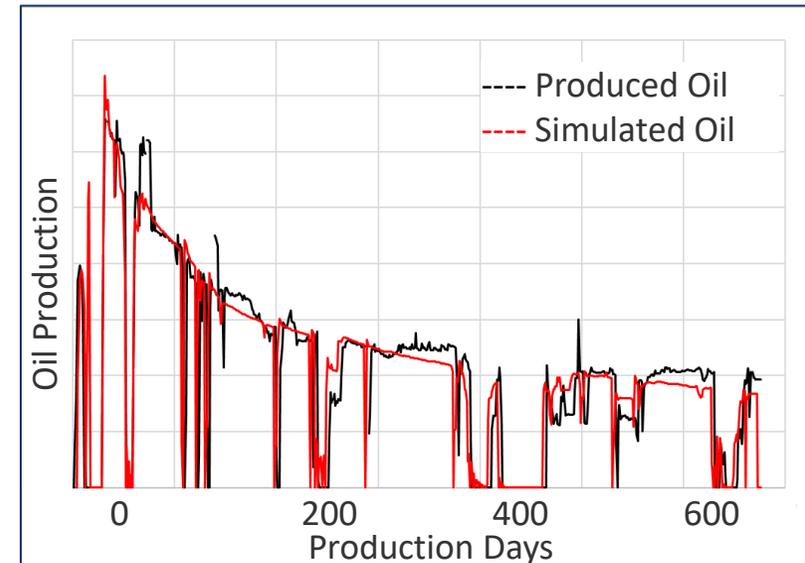


Reservoir Model

- Fault block extracted from full field model
- Multi-well model:
 - an existing producer W1
 - new producer W2
- Local Grid Refinement (LGR)
- Production match to existent producer
- Fracture calibration to stimulated well



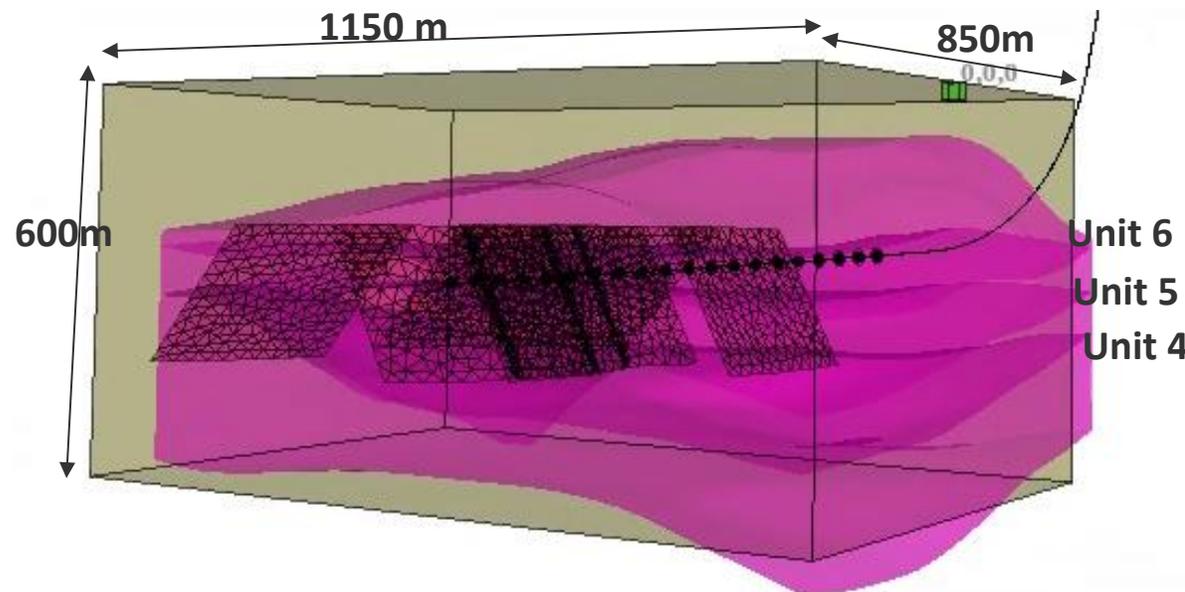
Fault Block Simulation Model with around W2



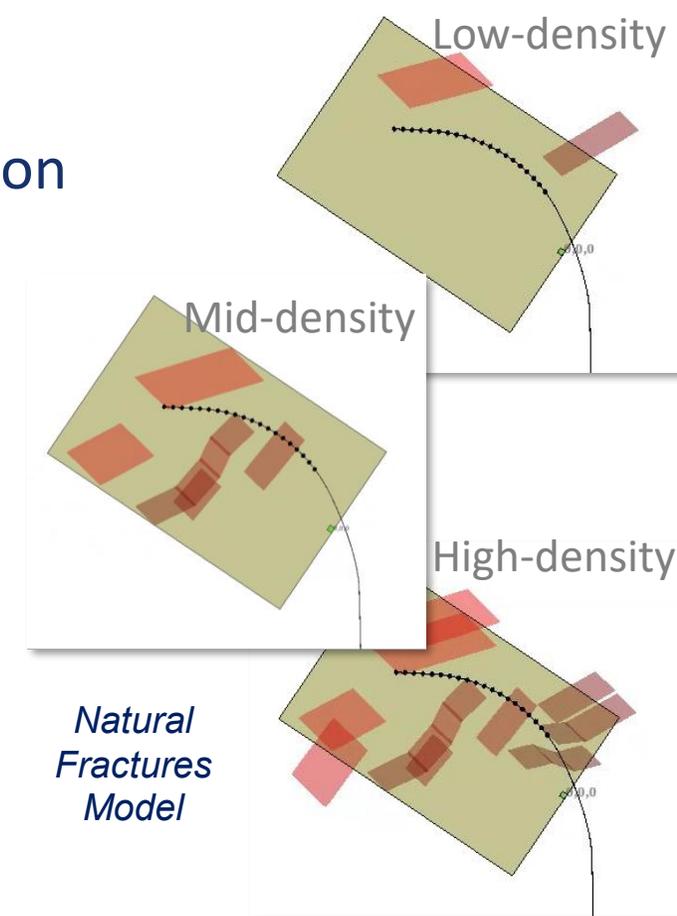
W2 Hydraulic Fracture Calibration

Natural and Hydraulic Fractures

- Model block across multiple reservoir units
- Visualisation of hydraulic (HF) and natural fractures (NF) interaction
- 4 Discrete Fracture Network (DFN) scenarios

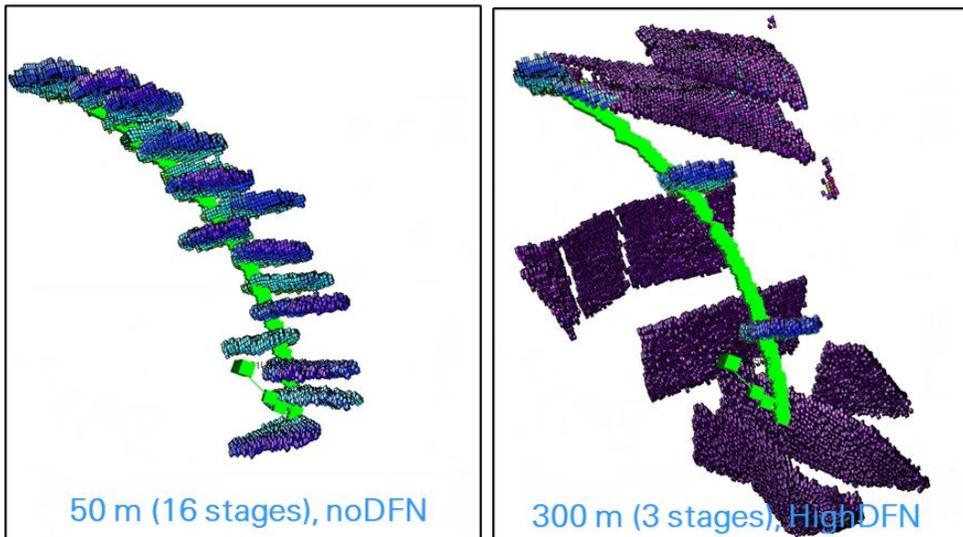


Fracturing Model

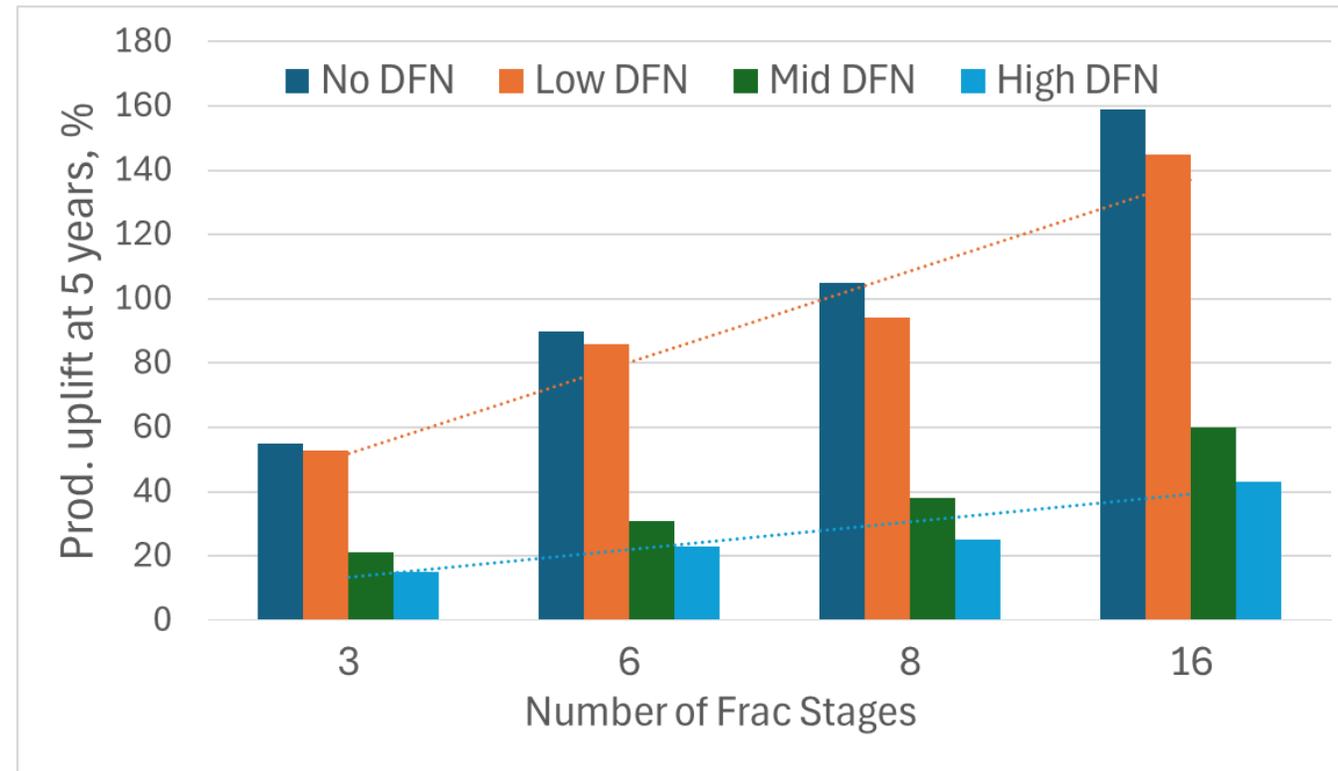


Production Value – the Prize

- Is there a value to frac? **YES**
- From fracture to reservoir simulator
- Production simulation – 5 years
- Positive impact on well performance – all DFN



Variation of HF Stage Spacing with Different DFN Intensities



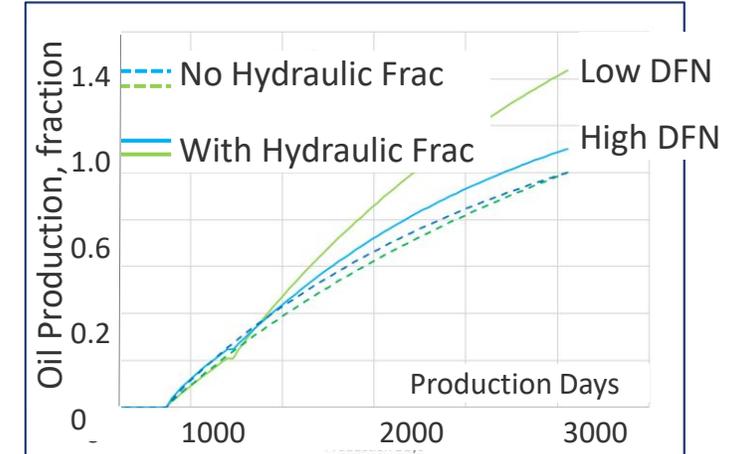
Production Uplift vs. Number of Stages and DFN Case

Fracturing Design Optimisation

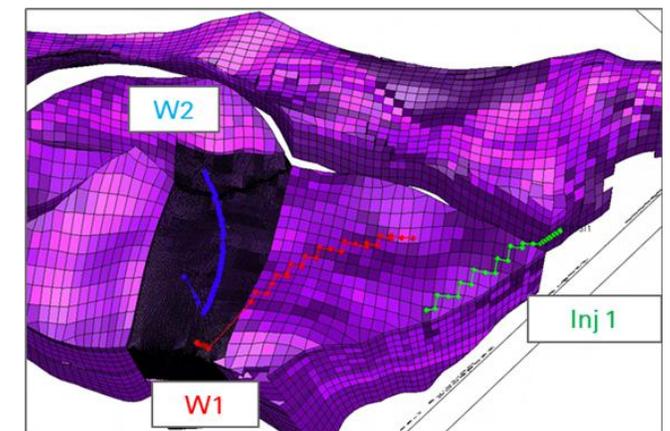
- Base case of fracturing design

Case	# Stages	Frac Inj Rate	Proppant / stage	Frac Orientation	Overflush	Injector Support	Oil Production	
							Low DFN	High DFN
Base	3	30 bpm	300 klbm	Transverse	0 bbl	No	1.00	1.00

- Associated production
- Design sensitivities:
 - Number of stages
 - Lower injection rate
 - Frac orientation
 - Overflush
 - Water injector support



Production Profile for Base Case



Location of Water Injector in Fault Block

Fracturing Design Optimisation

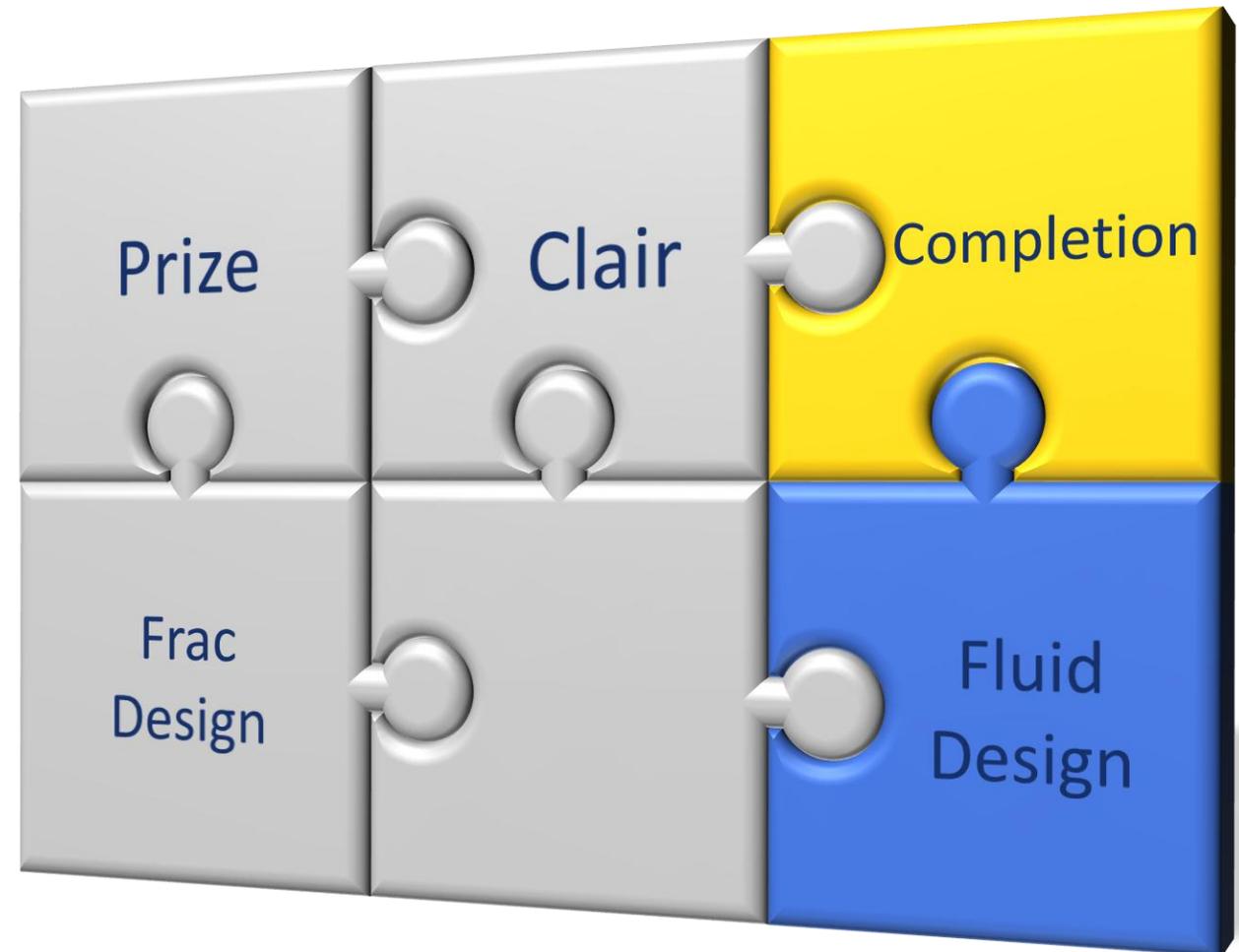
- Higher uplift with more stages
 - Proportional increase until < 100m stage spacing
- Lower injection rate – ability to stimulate longer wells
- Longitudinal fractures outperform transverse for higher perm
- Overflush does not affect production performance
- Water injection is vital for stimulated wells

Case	Details	Oil Production, fraction
# Stages	10	1.15
	15	1.21
Lower Inj. Rate	20 bpm	0.99
Frac Orientation	Longitudinal	1.12
Overflush	10 bbl	1
	20 bbl	1
Water Injector Support	Yes	1.23



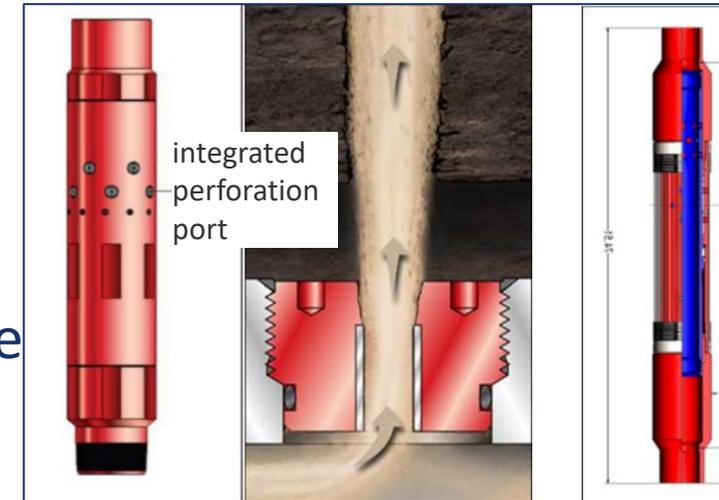
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- **Why.** The Prize
- **What.** The Tools
 - Completion evolution
- **How.** The Concept
- Conclusions

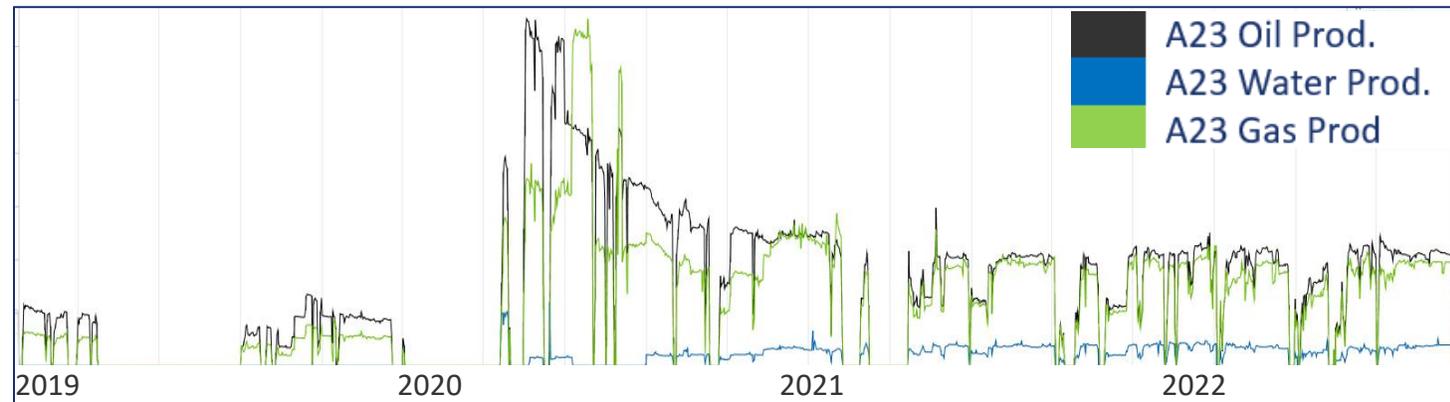


First Steps. Standalone Intervention

- Case 1 – Clair Phase 1 A23 (2019)
- Preproduced. Frac rigged up from drill floor
- The first multistage fracturing completion in the Clair Field
- 4 zones with Open Hole packers - 12 coil tubing shifted sleeve
- Plugging nozzles during initial injections >> plug & perf
- Proppant retention sleeves – redundant
- 5 folds of increase production



Abrasive fracture sleeve



A23 - production history

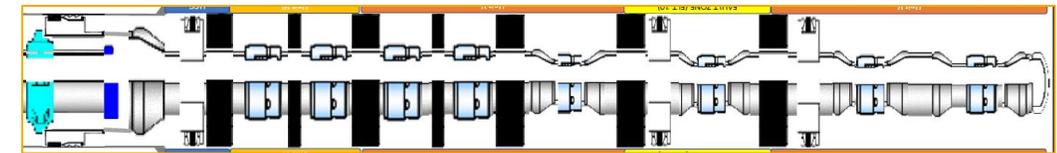


Next Step. SIMOPS Intervention

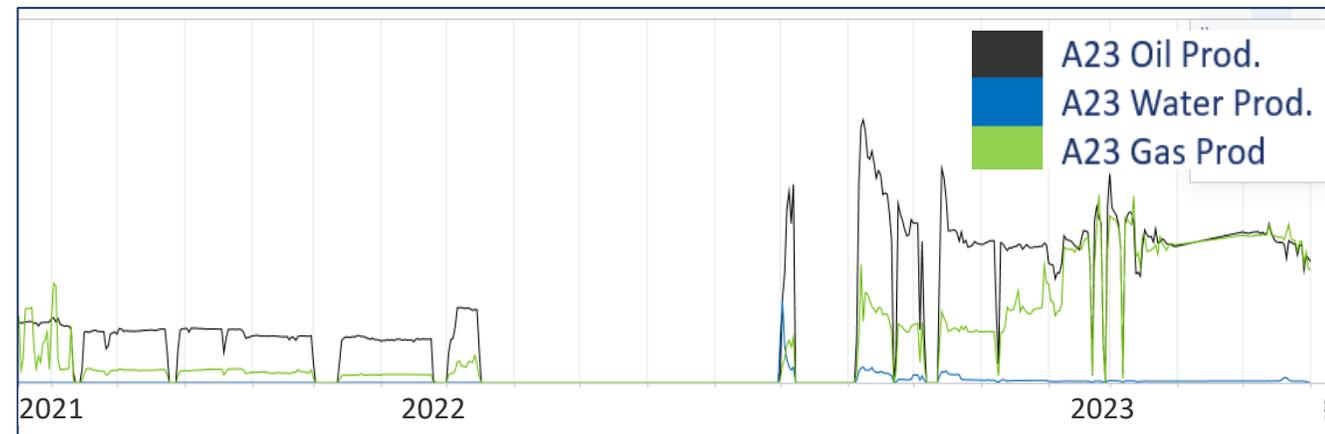
- Case 2 – Clair Ridge B09 (2022)
- The first fracturing completion on Clair Ridge
- Simplified: 1 sleeve/zone. Total 7 zones
- Mechanical sliding sleeves and OH packers
- No issue in operating sleeves
- SIMOPS – simultaneous operations
- 3 folds of increase instant production



Mechanical coiled tubing shifted fracturing sleeve in B09



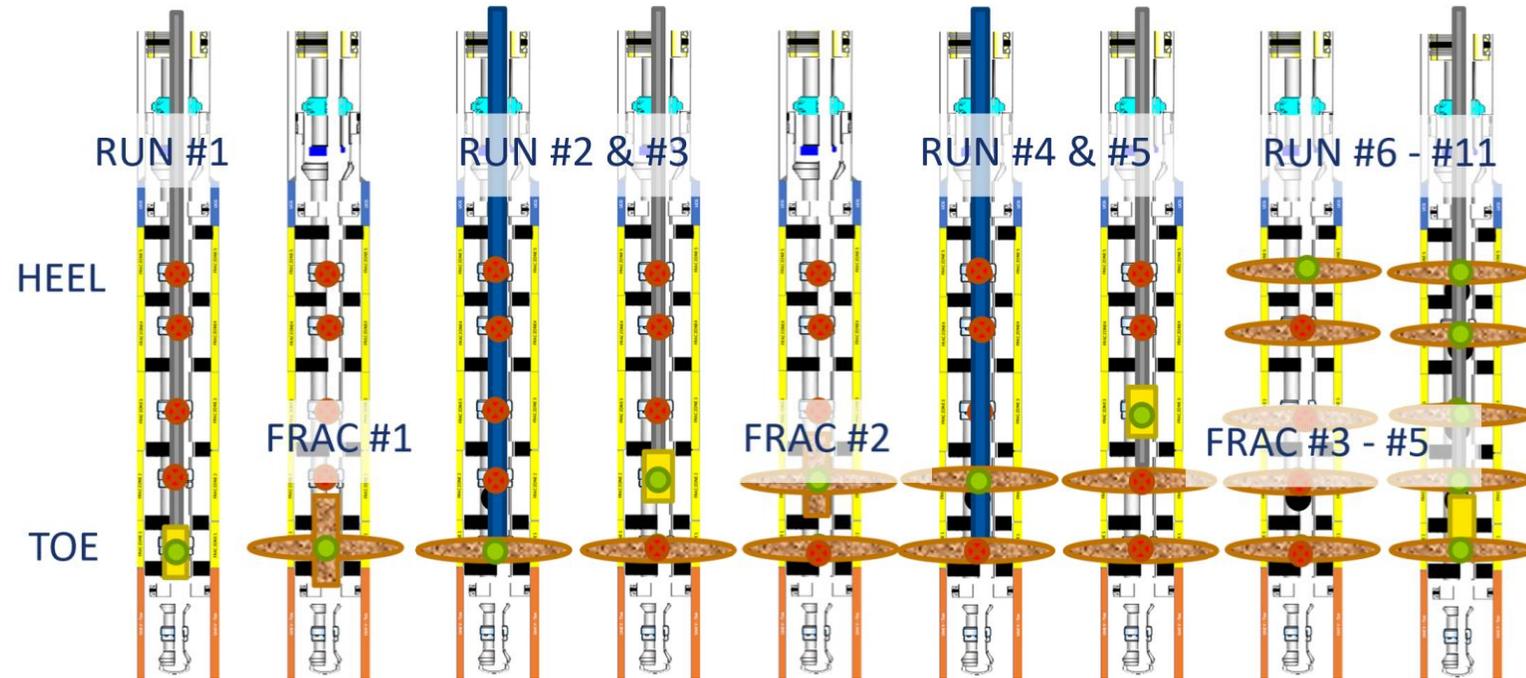
Clair Ridge B09 completion schematic



B09 production history

Conventional Multistage Completion

- Coiled tubing (CT) shifted sleeves
- Separate BHAs (Bottomhole assembly) to shift and clean out
- Conventional sequence of multistage fracturing:
 - 11 CT runs for 5 zones well



Conventional Multistage Fracturing Sequence

● Open Sleeve

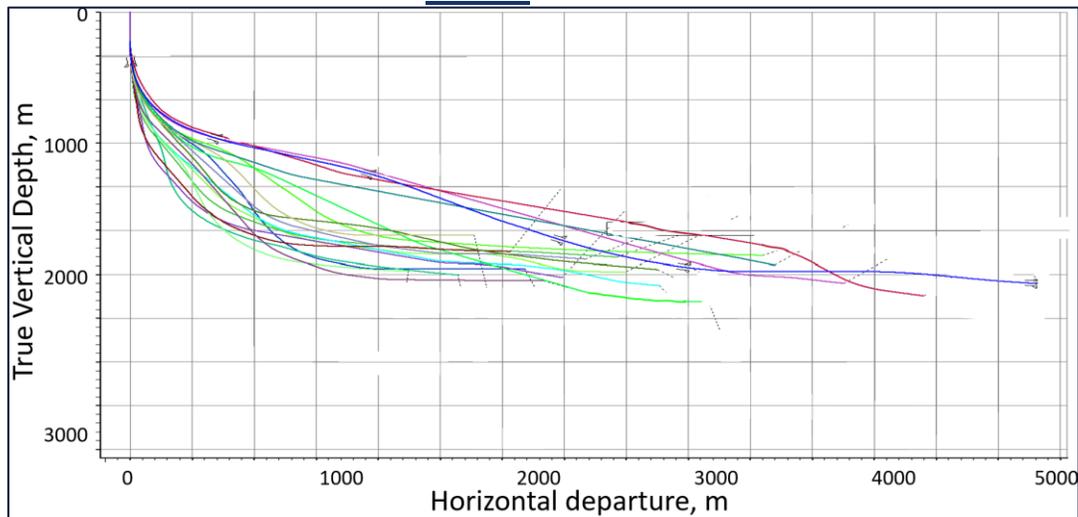
● Closed Sleeve

■ CT with clean out nozzle

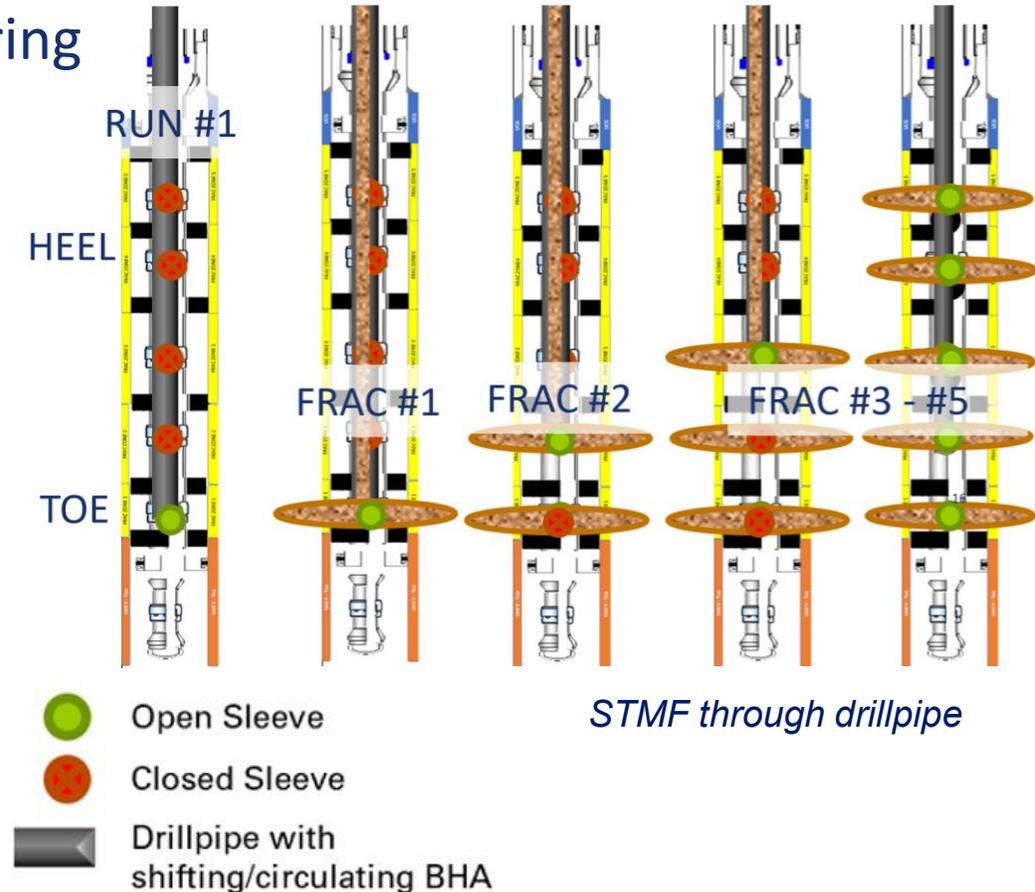
■ CT with shifting tool

Change to Single Trip Completion

- Adopted from unconventional land fracturing
- Single trip multistage frac (STMF):
 - Drill pipe shifted sleeves
 - BHA combines shifting and pumping
- Increased efficiency
 - From 11 to **1 run** for 5 zones well



Clair Well Trajectories



Logistics and Fluid Design

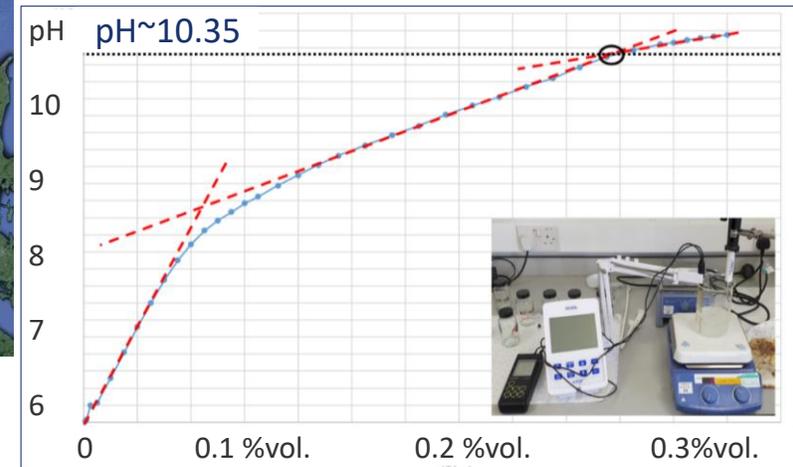
- Logistics to support new completion
 - Relocating base port
 - Proppant capacity
- Fluid design – continuous supply
 - Based on sea water
 - Reverse osmosis desalinating units



Base port relocation



Scale inhibitor for fluid design

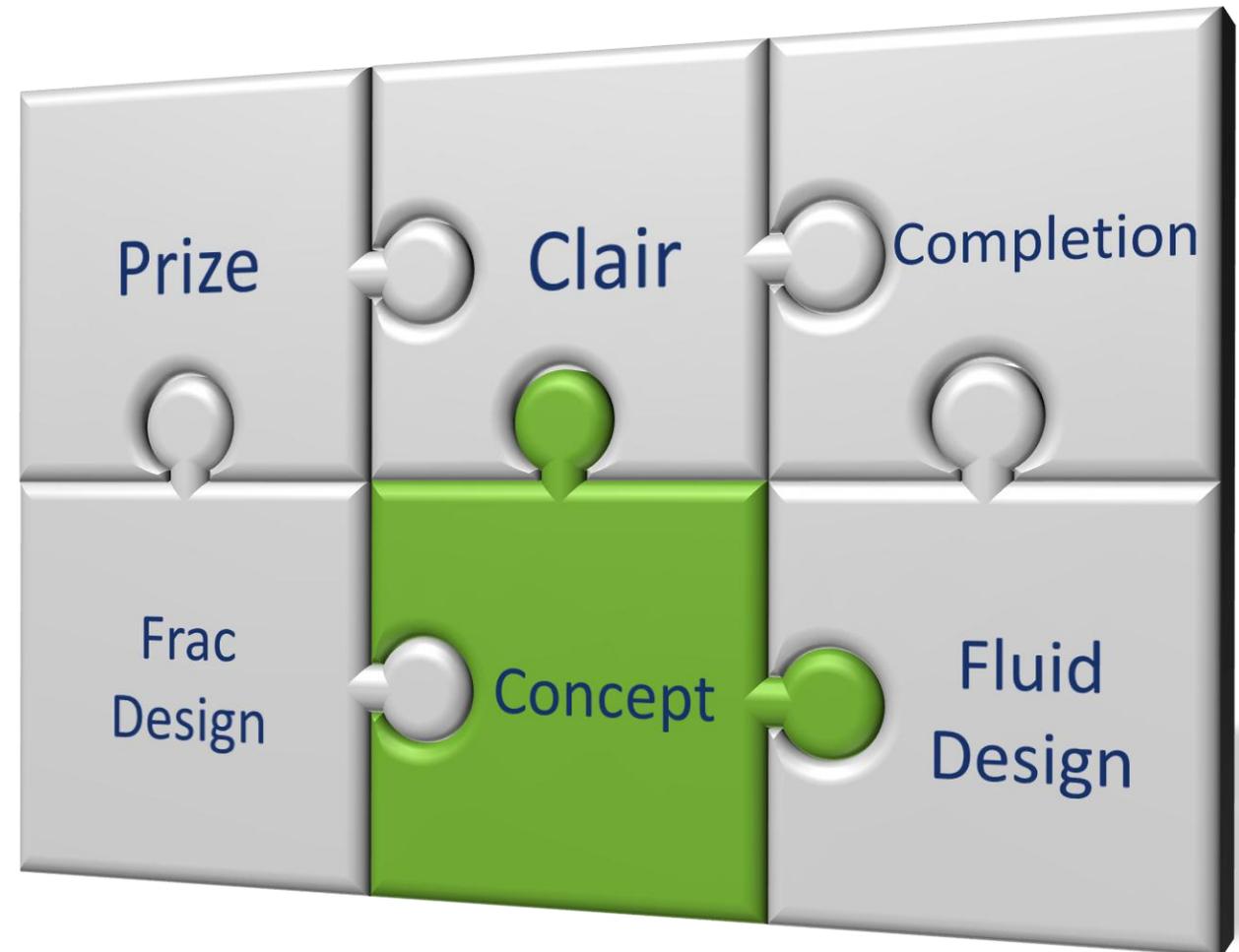


Defining fluid pH envelope



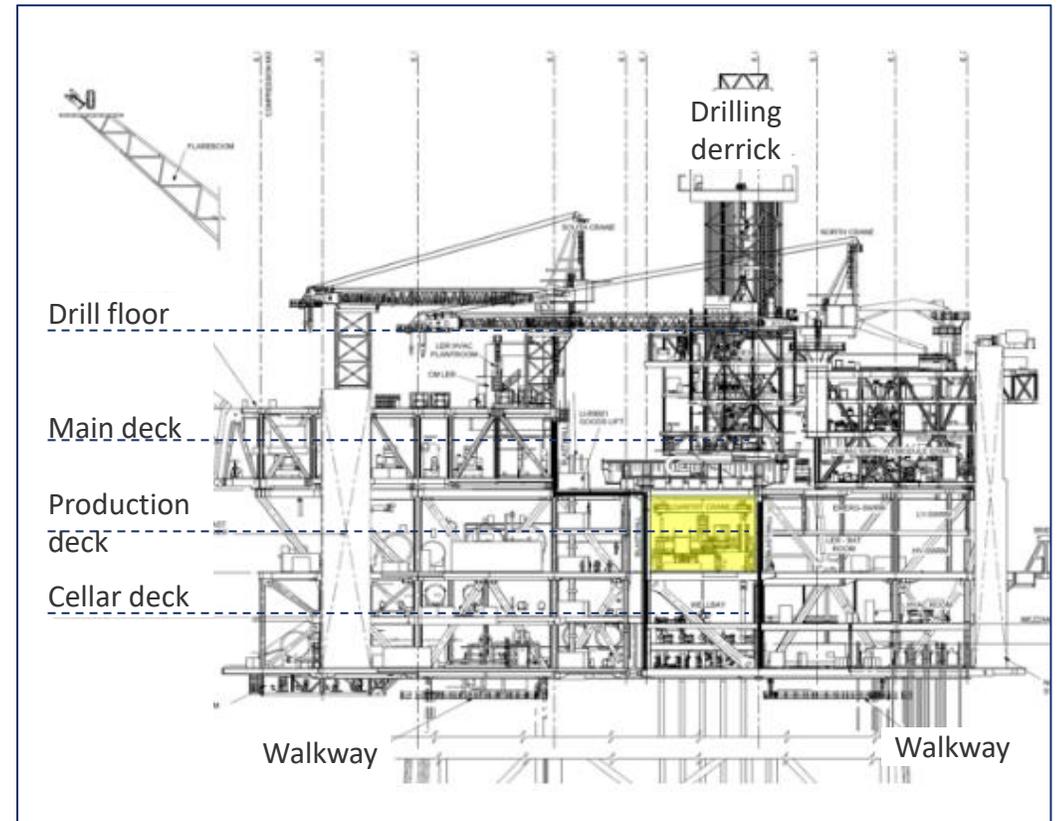
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 - from wellwork to well construction
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Offshore Constraints

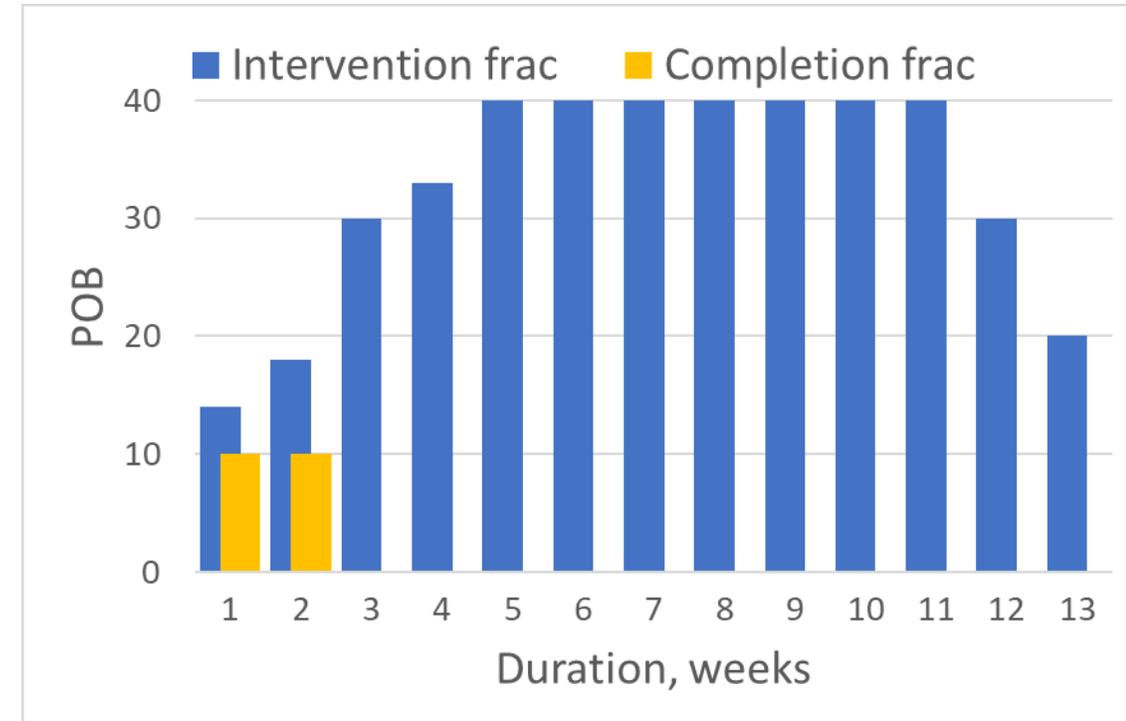
- Preproduced well
- Requirement for multiple services
 - Wireline
 - Coil tubing
 - Clean up package
- 40 POB – personnel on board
- Intervention deck vs. the drill floor
- Well 2 ops constrained to production deck:
 - Deck area and load limitations
 - Available height
- Highly disruptive to platform activities



Clair Ridge intervention deck (highlighted yellow)

Concept Evolution – Strategy Change

- Intervention fracturing:
 - Case 1: 92 days
 - Case 2: 169 days
 - 40 POB (personnel on board, i.e. beds)
- Completion fracturing:
 - 14 days
 - 10 POB
 - Fracturing performed through the rig “online”



The Clair field fracturing concepts comparison

Conclusions

- Understanding production value to measure Why
- Fracturing design – optimised, not maximised
- Completion change to increase efficiency (KISS)
- Fluid design and logistics – to support completion
- From intervention to completion fracturing
- 2x wells done: new completion, design and concept



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THANK YOU

References:

- SPE 212356 – Fracturing & Production Modelling
- SPE 215632 – Case 1 Intervention Standalone Frac
- SPE 215632 – Case 2 Intervention Frac SIMOPS
- SPE 215625 – Frac Fluid Design (Sea water)
- SPE 216632 – Completion Evolution & Selection
- SPE 226610 – New Completion & Concept Case Study

