The Catcher Area Development

A Field Development Summary

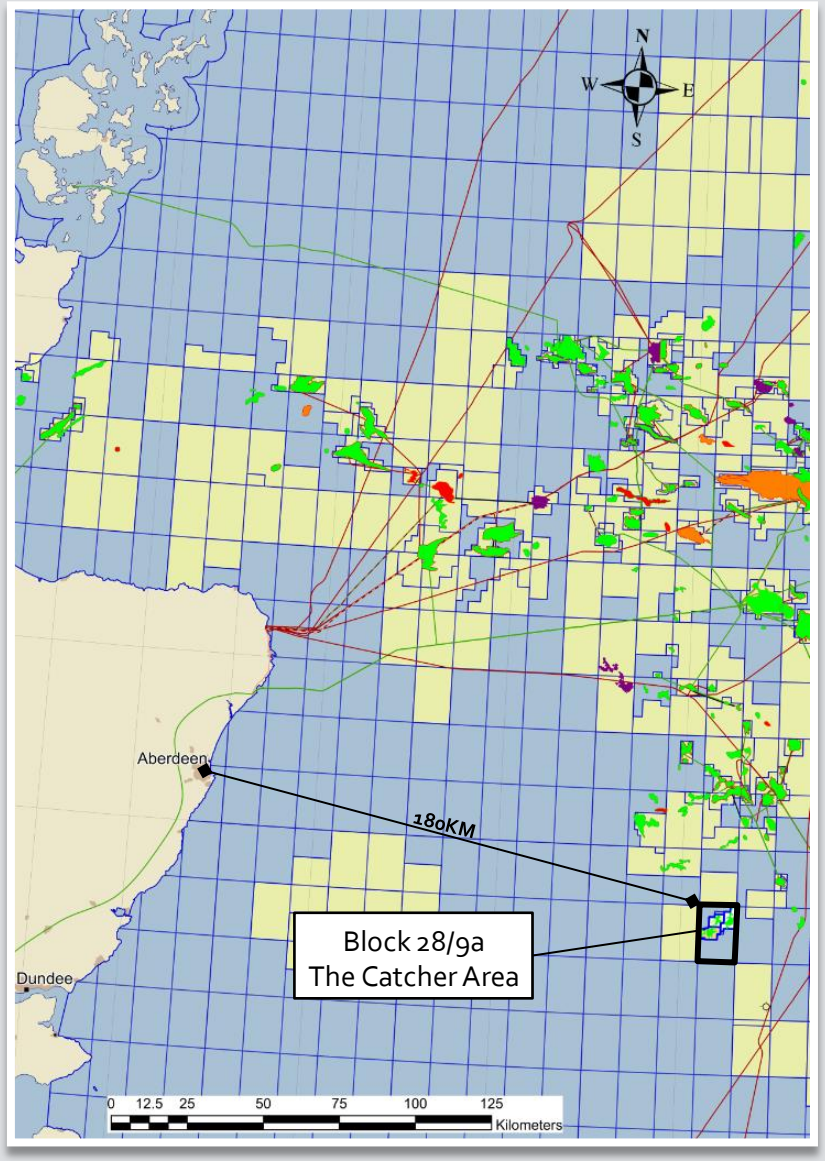
With Matt Gibson and Martin O'Donnell

Agenda

- Catcher Area Location
- Development Scheme
- Field Introduction
- Subsurface Introduction
- Well Design and Execution
  - Completion Design
  - Well Clean Up and Suspension
- Wrap Up

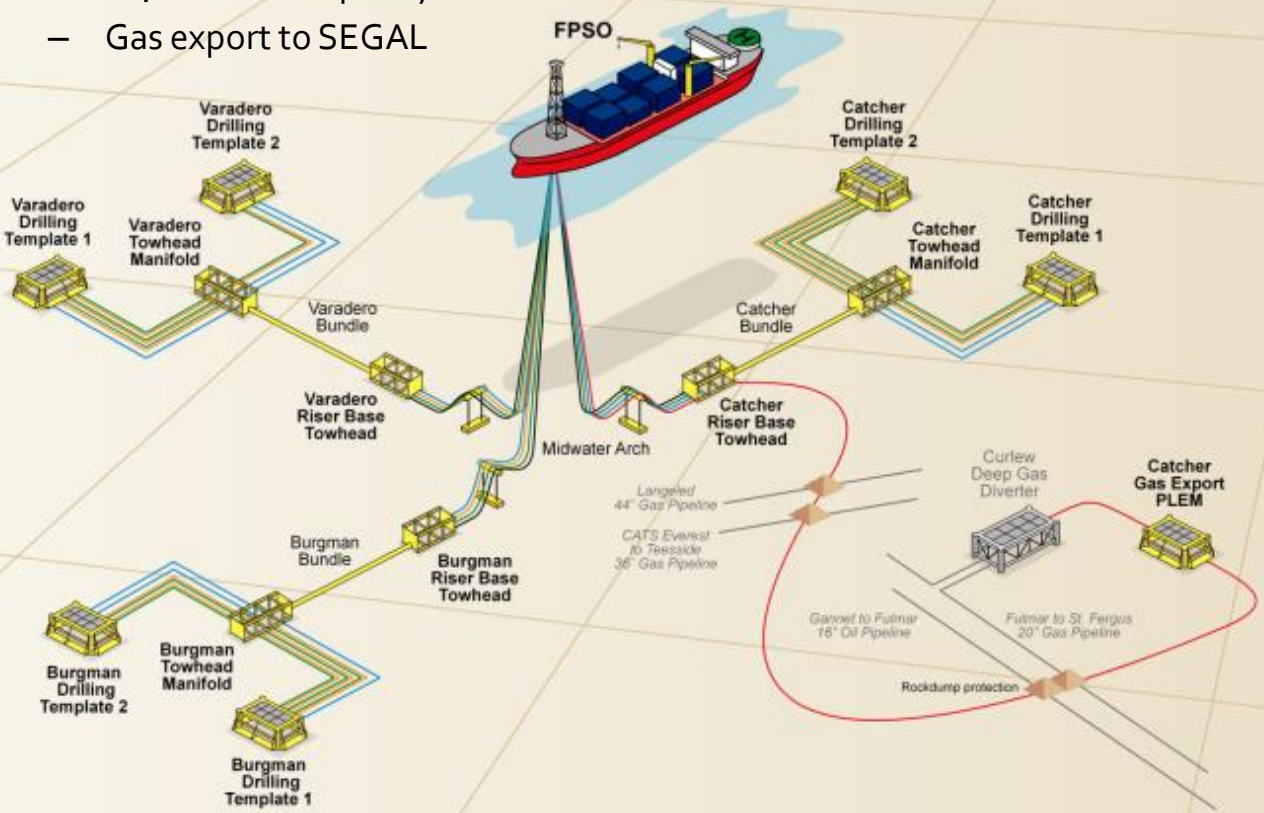
Catcher Area Introduction

- Block 28/9a
  - 180km ESE Aberdeen
- Central North Sea
- Western Terrace
- 11 E&A wells and side tracks
  - 6 field discoveries Catcher, Varadero, Burgman, Bonneville, Carnaby & Laverda
- Eocene Tay and Palaeocene Cromarty Reservoir
  - Spectrum of wholly injected reservoir sands through to remobilised and depositional
- Premier Oil 50%, Cairn 20%, MOL Group 20% and Dyas 10%



Catcher Area Development

- Catcher, Varadero and Burgman Fields under development
- Production and Water Injection wells to be drilled from 3 drill centres
- FPSO production hub
  - Oil export by shuttle tanker
  - 125 bfpd liquid handling & injection capacity
  - 60,000 stb/d capacity
  - Gas export to SEGAL



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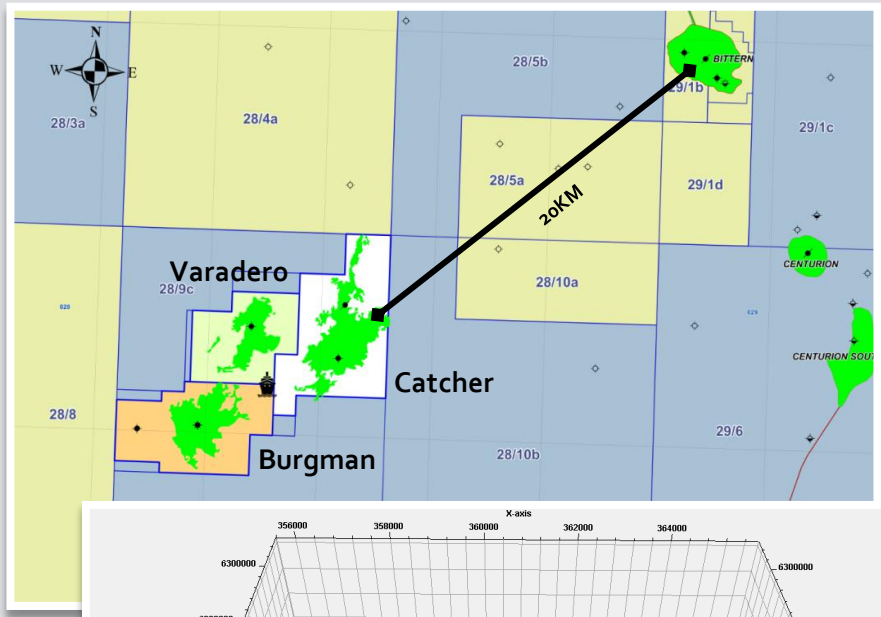
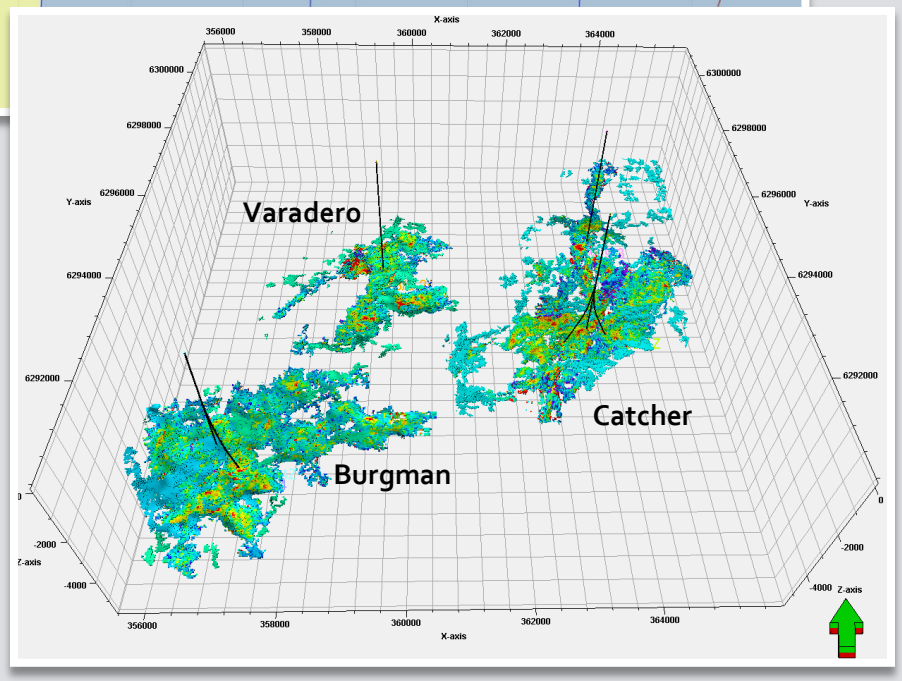
Purpose built FPSO – Module Installation in Singapore

BW Catcher – Module Installation

The Catcher Development - Oil Fields

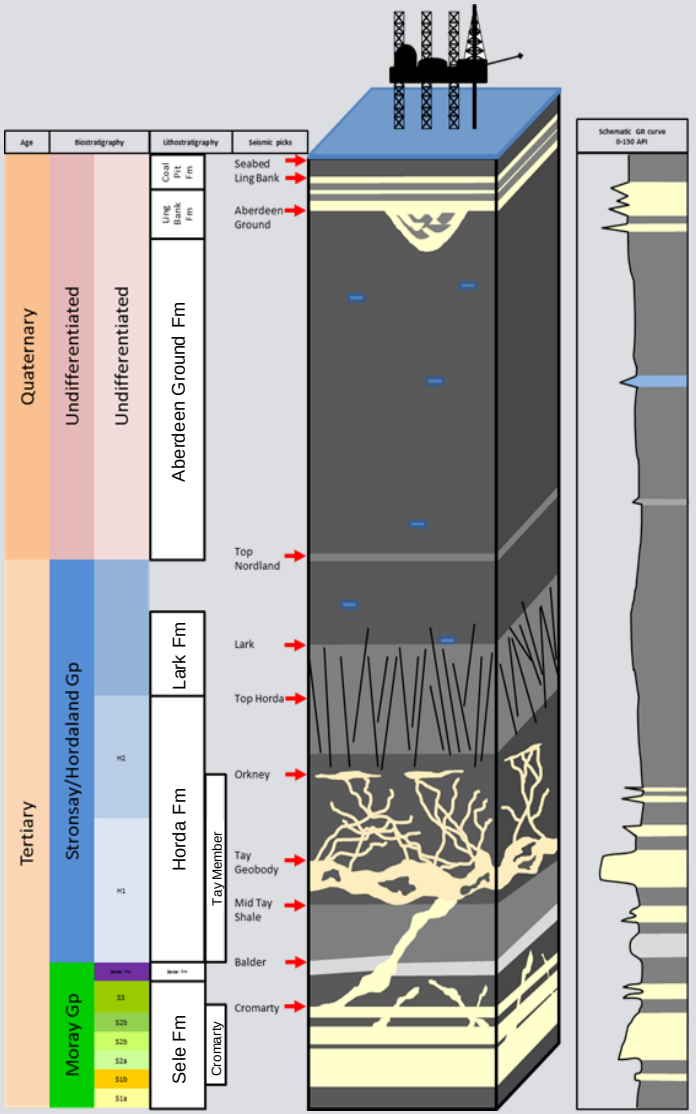
- Catcher
  - Tay and Cromarty reservoir
  - Juxtaposed across central NE-SW fault
  - Deepest Field @ c 4,700 ft tvdss
- Varadero
  - Tay reservoir
  - Fault bound to west
- Burgman
  - Tay Reservoir
  - Fault bound to west
  - Shallowest Field @ c. 3,500 ft tvdss
- Underlain by Cromarty aquifer
  - Probable source of injectites
- Reservoir properties
  - Oil Density 25-31 API
  - Oil Viscosity 2-12cP
  - GOR 200 – 300 scf/stb
  - Normal pressured reservoir
- Reservoir Management
  - Injection for voidage replacement



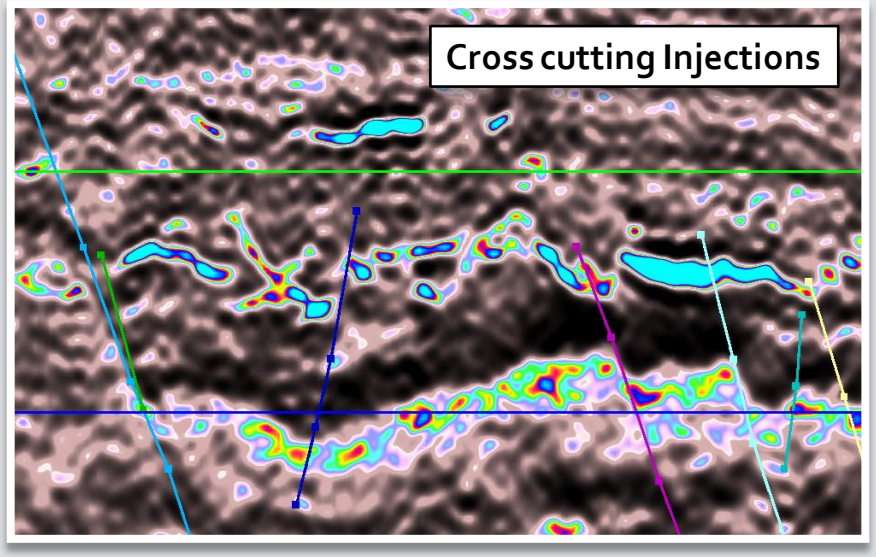


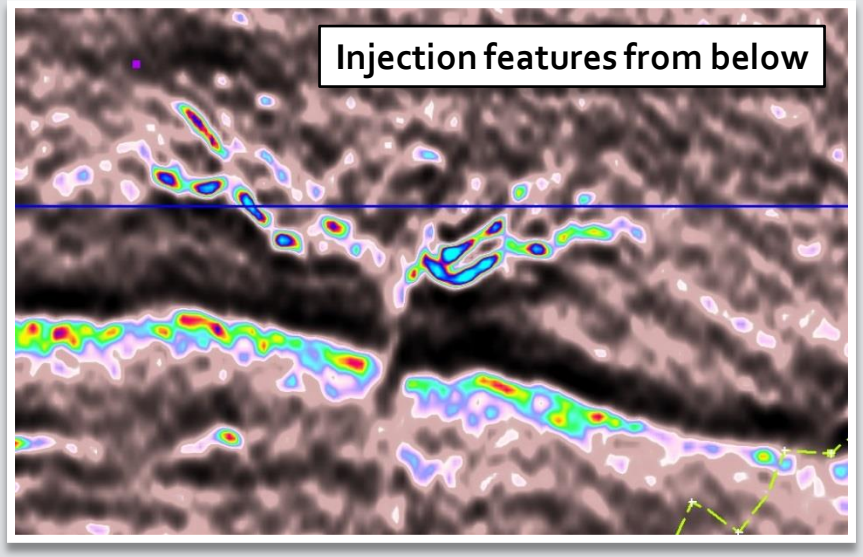
The Catcher Area Fields – Geology Overview

- Initially deposited as turbidites, significant remobilisation and injection upwards to shallower levels subsequently
  - Encasing Shale hydro fractured in the process
- Tay Formation is largely injected sands and forms main reservoir across all 3 fields, Cromarty significant in Catcher Field
  - Typically reservoir thickness 20-40ft, locally up to approx 60-80ft
- Complex and unresolvable 3D architecture with sands present in all orientations with varieties of scales



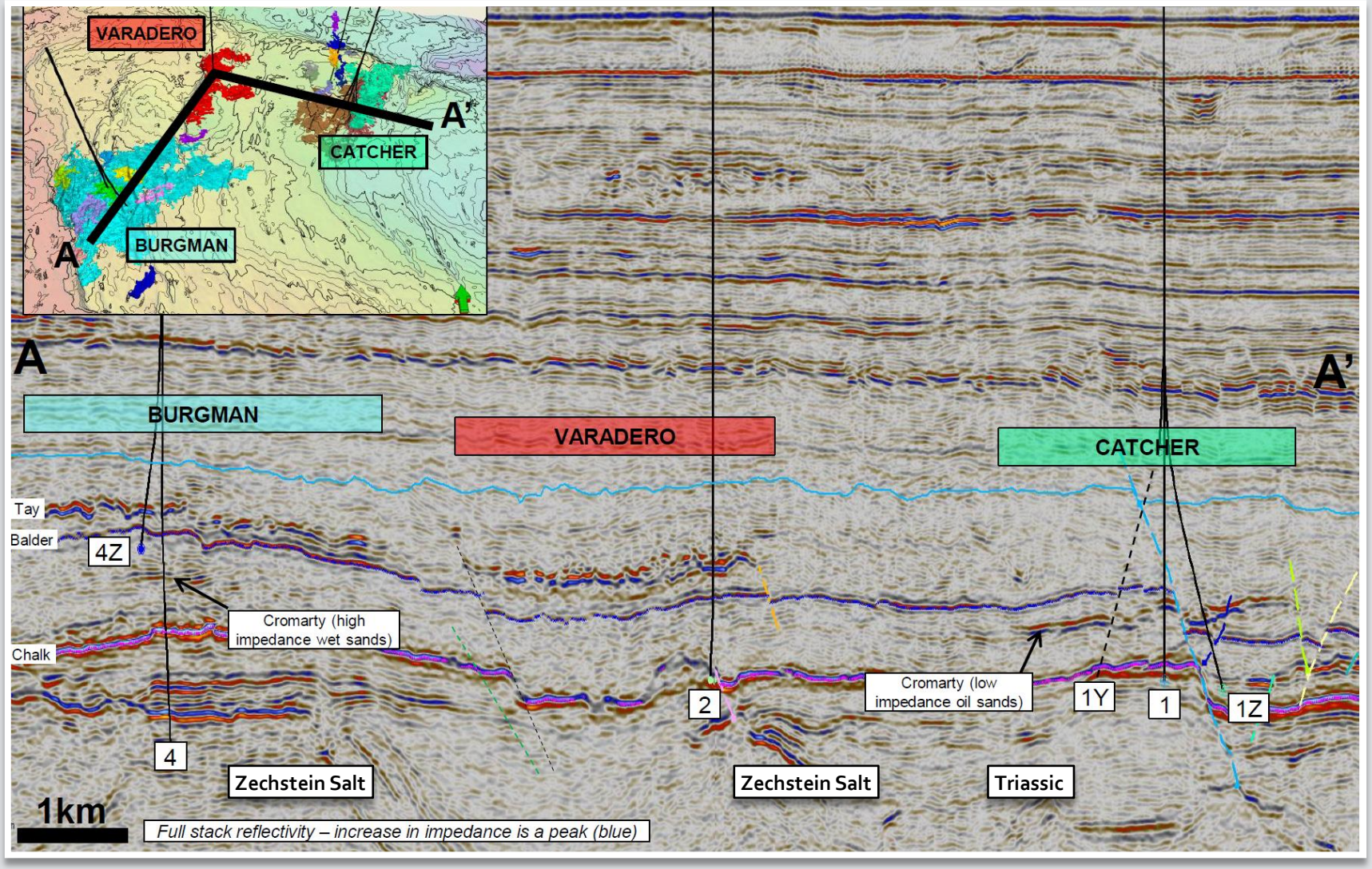
The Catcher Area Fields – Geophysics Overview





- Seismic data shows the gross container, the seismic amplitudes indicate the net pay
- Reservoir response is affected by tuning
  - Top reservoir / base reservoir / thickness uncertainty
  - Internal architecture poorly defined
  - Interference between different reservoir injections where present
  - Can't see shale clasts or rafts, and uncertainty over where reservoir bifurcates
- Often unable to see reservoir where it's thin, steep or water filled

The Catcher Area Fields – In The Seismic



Horizontal Development Wells

Challenges

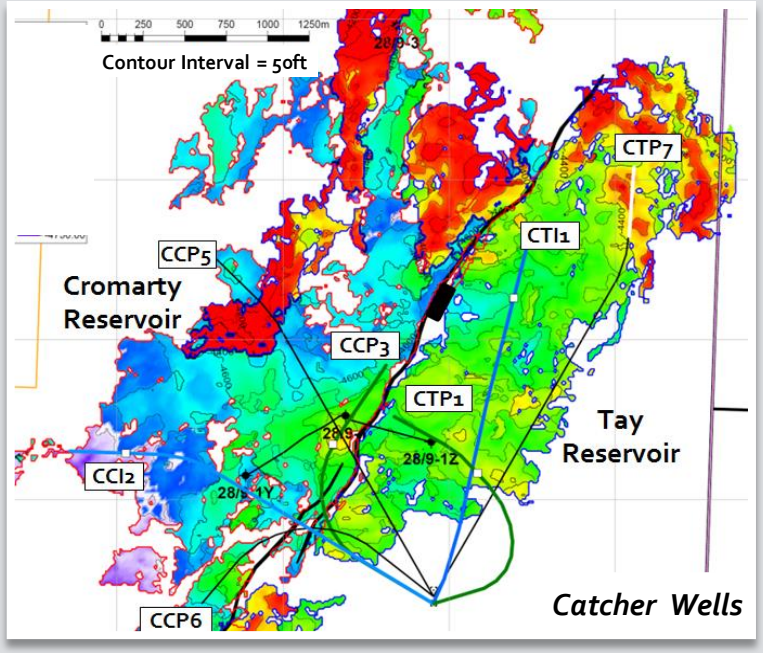
- Shallow reservoir <4500ft TVDSS
- Significant directional work
  - Inclination change 0° to 90 °
  - Up to 130° azimuth change
  - Maximum completion length 3,000ft TVDSS
- Attempting to land into a gross reservoir targets with inherent depth uncertainty
- Unknown internal net sand architecture

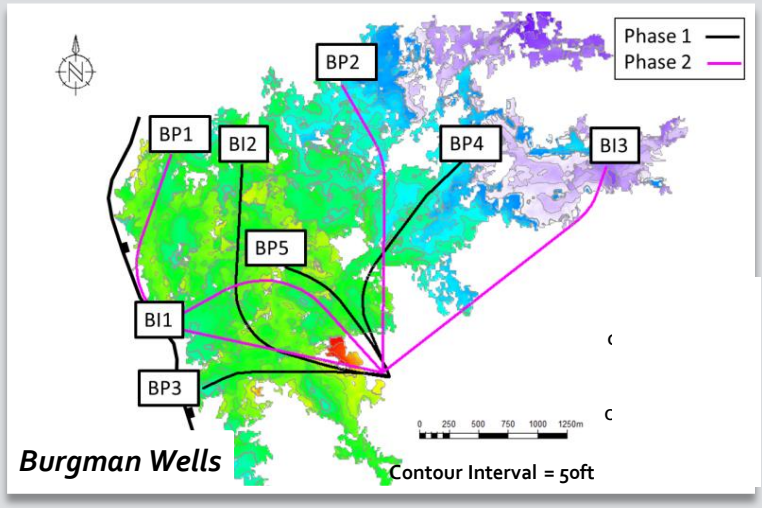
Solutions

- Point-the-bit RSS
- Top spec well position survey equipment
- Geosphere – deep reading Azimuthal Resistivity
- Res-At-Bit proven extremely valuable
- Methodical pre-drill break down of well steering decisions

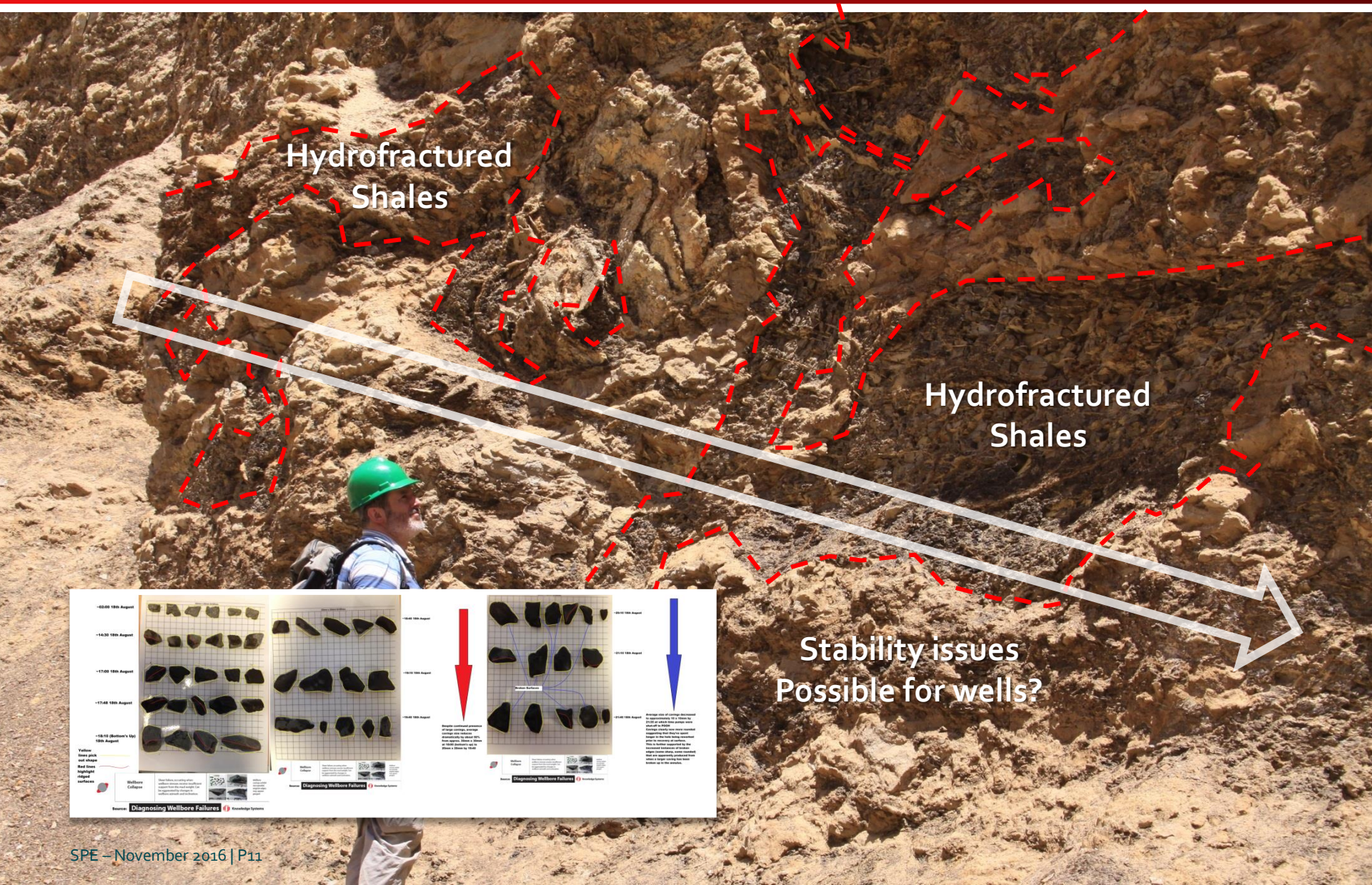
Results so far

- 7 wells on prognosis





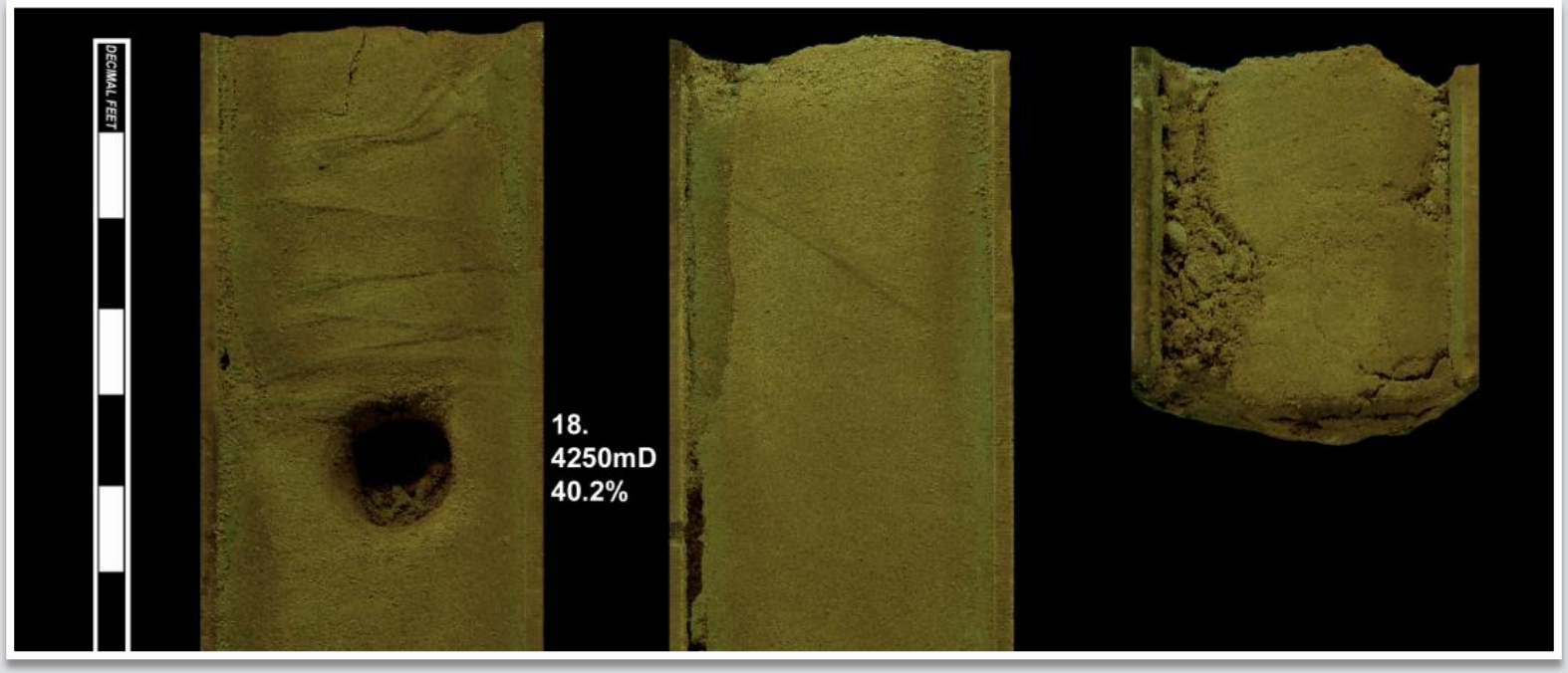
Hole stability issue example – CTI1



Sand Face Completion Design

Completion Design Challenges

- Prevent sand production
- Deliver high productivity
- Preserve both for up to 2 year suspension

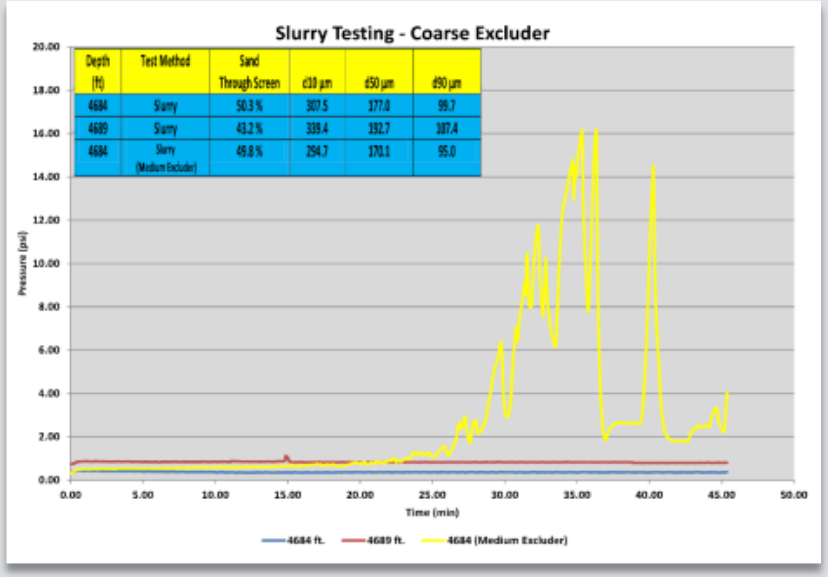


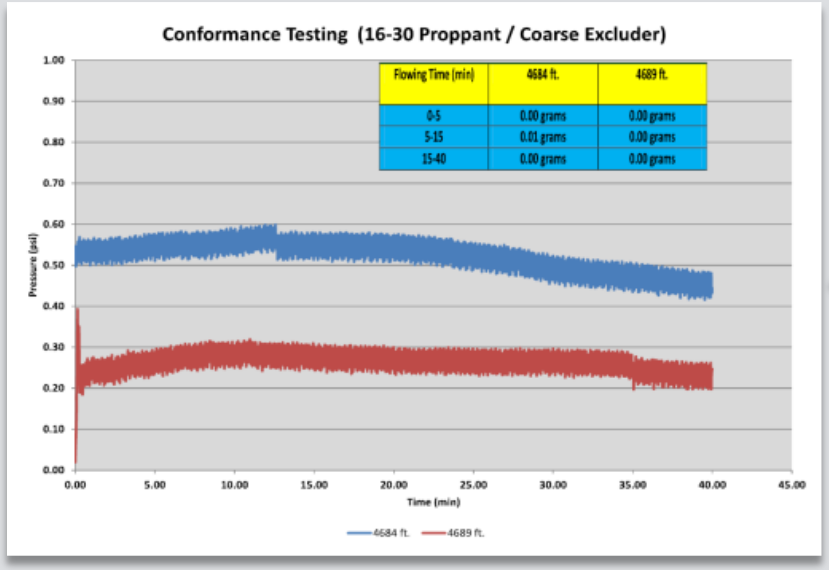
Sand Face Completion Design Process

- Statement of Requirements
  - Production & Inj Target Rates, Design life, Inflow monitoring (PDHG, Tracers)
- Core Testing
  - Strength measurements, Particle size distribution, Sand Retention Testing
- Fluids Testing
  - Shale sensitivity , Suspension issues, Oil leg Injection
- Desk top assessment of available technology
  - Open Hole Gravel Packs (OHGP)
  - Stand Alone Screens (SAS)
  - Expandable screens (ES)
  - Cased / perf & Frac pack
  - New technology

Sand Retention Testing

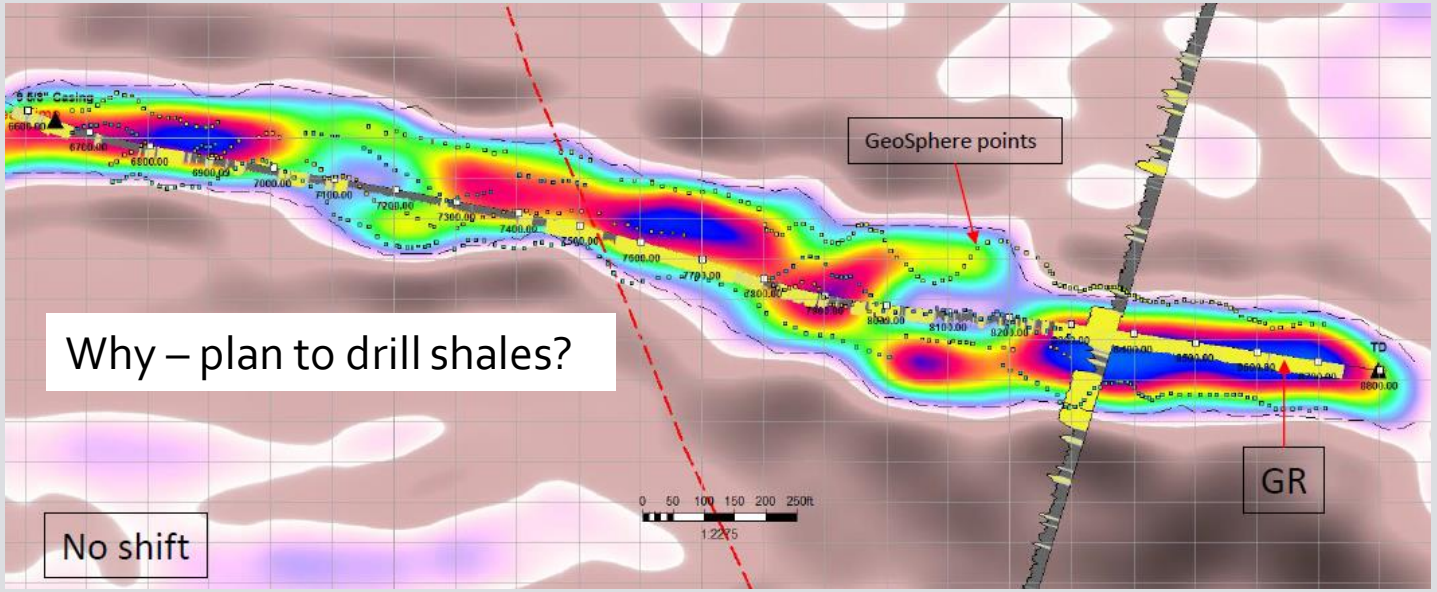
- Slurry testing = Non-compliant testing
- Coarse excluder screen shows no retention. c.50% of sand passes through screen.
- Medium excluder forms unstable pack. c.50% of sand passes through screen.
- In a cross flow or water hammer event expect sand to flow back into completion.





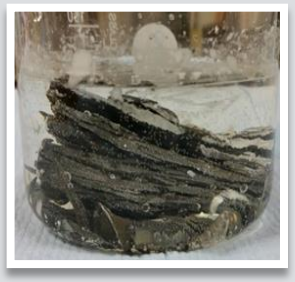
- Pack testing = Compliant Technology Test
- Confinement with 16:30 gravel and coarse (300 micron) excluder screen suggests very low potential for solids production.
- Results suggest compliant technology appropriate.
- Selected OHGP
- Also avoids resorting (of sand with c. 10 - 15% fines content).

Catcher Fluid Testing -Shale Sensitivity Testing



- Below images illustrate potential for shale delamination during well completion operations

2 hrs Immersion in $CaCl_2$ Brine

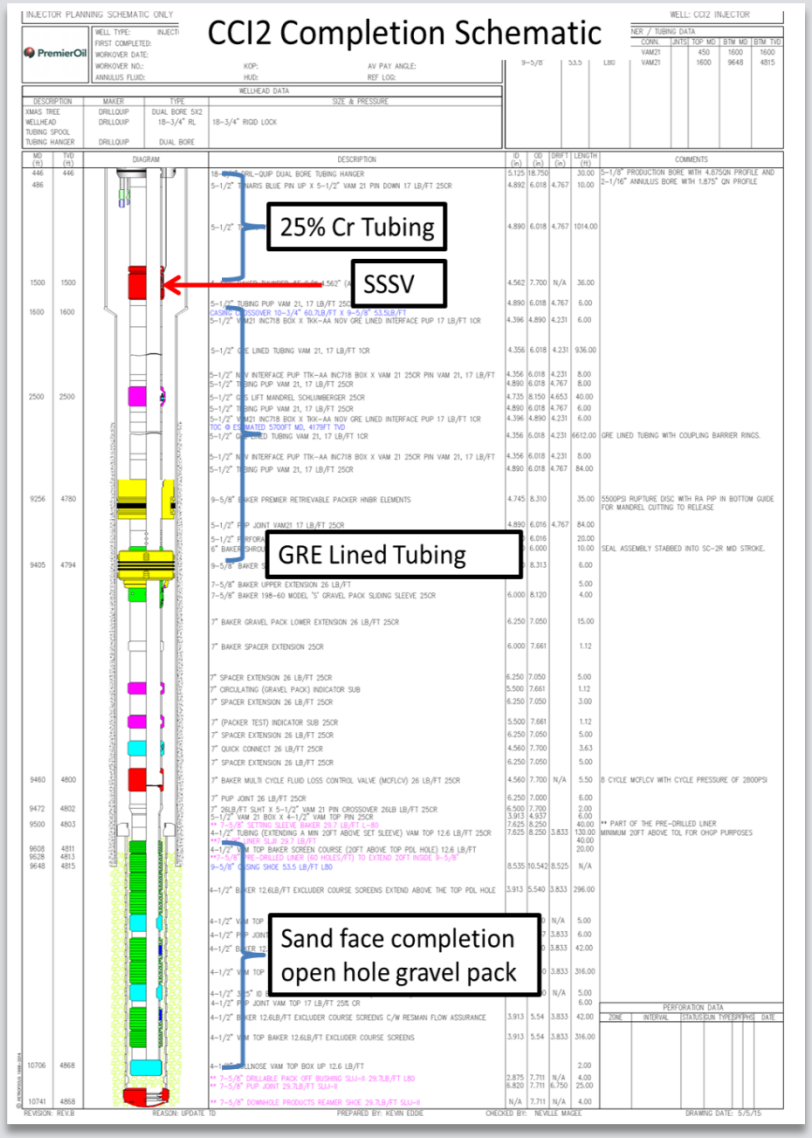


Catcher shale sample after 24hrs CaCl brine

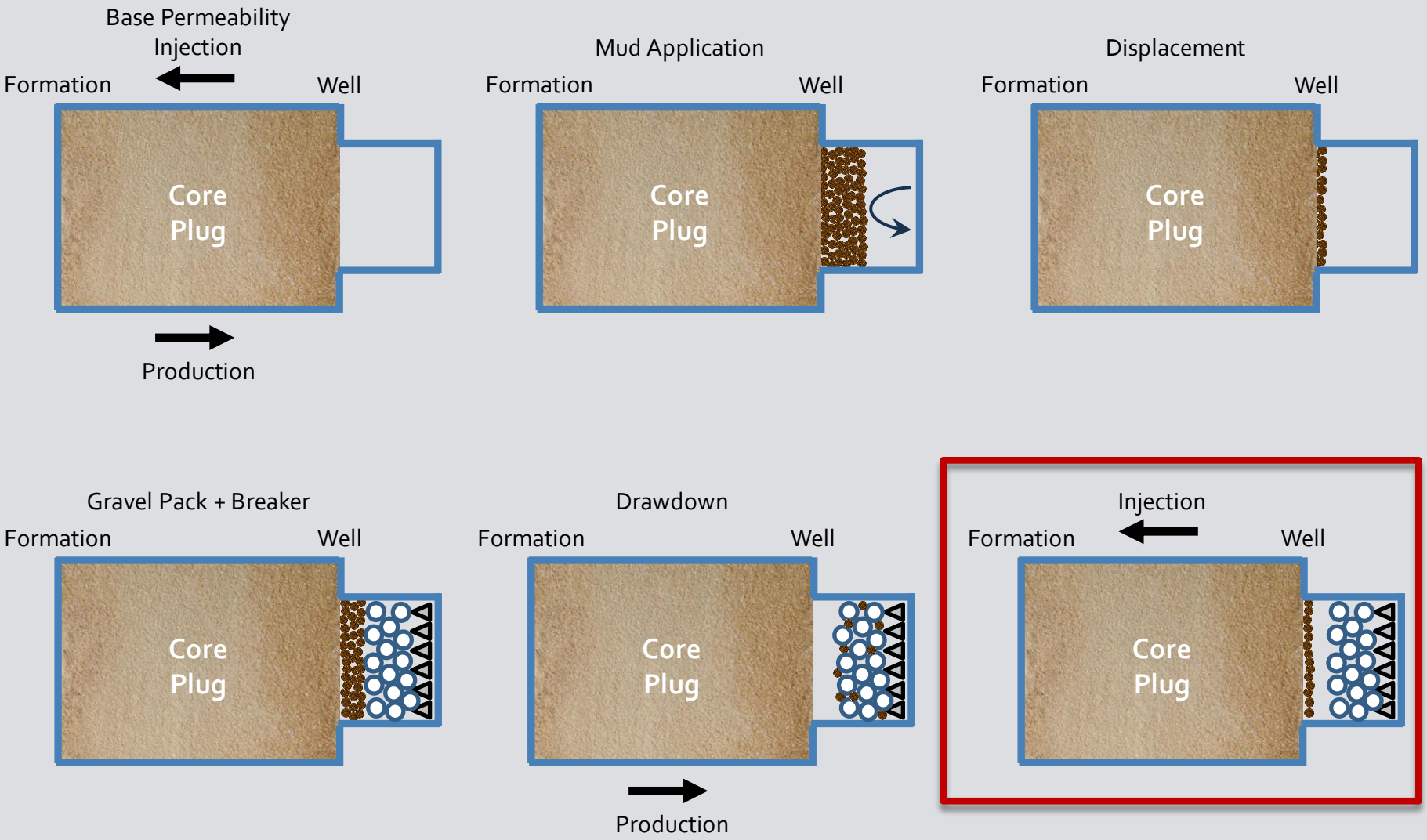
- Solution - Run Pre Drilled Liner (PDL) to mitigate against shale swelling
- Screens run in brine

Well completion selection

- Selected OHGP & PDL
  - Compliant w/low solids risk + minimise shale risk
  - Run PDL in mud – screens then run in brine
- Lwr completion includes inflow tracers
- Upper Completion
  - 13 cr / 25 cr+ GRE for producers / injectors
  - Gas lift in both
  - Chemical Injection
  - PDHG in producers, WHP/T in injectors
  - Fluid loss control valve to isolate SF completion whilst running upper
- OHGP Challenges:
  - 3,000 ft installations in PDL a world first
  - High skin risk
  - Perceived as unconventional for injectors
- Alternative well concepts:
  - Production history + 4D - help understand production and injection performance.
  - Low angle C&P – need large sump
  - Frac & Pack - Long Horizontals, multiple geobody targets etc

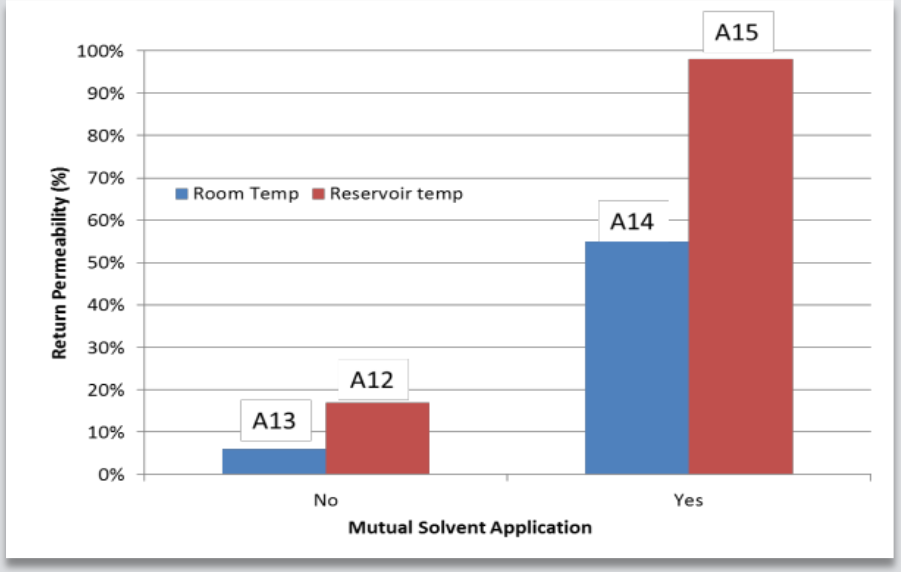


Full Sequence Return Perm Testing

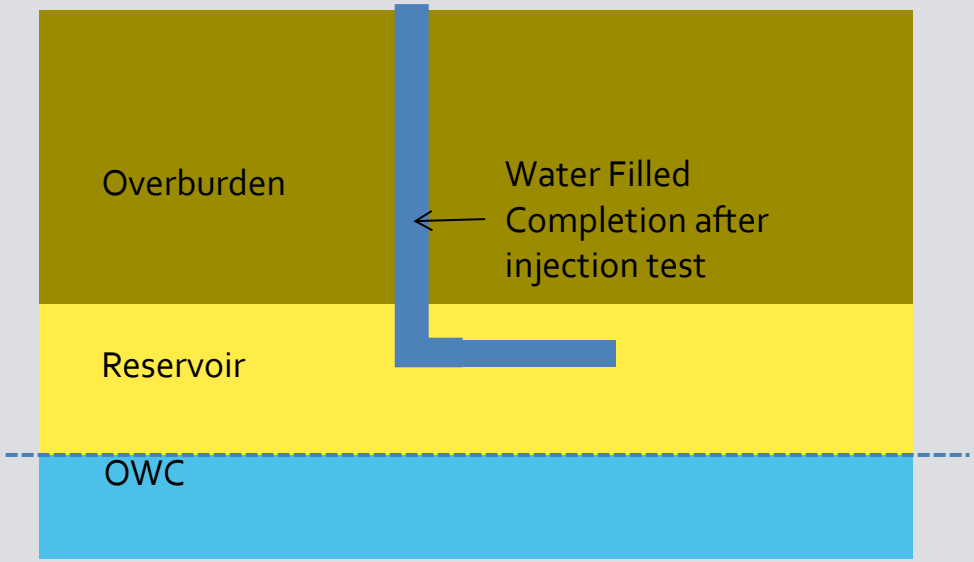


Oil Leg Water Injection Challenge

- How can we best assure good injectivity at field start up?
  - Lab test the effectiveness of mutual solvent prior to well ops
  - Effectiveness of mutual solvent demonstrated in both in the lab and field



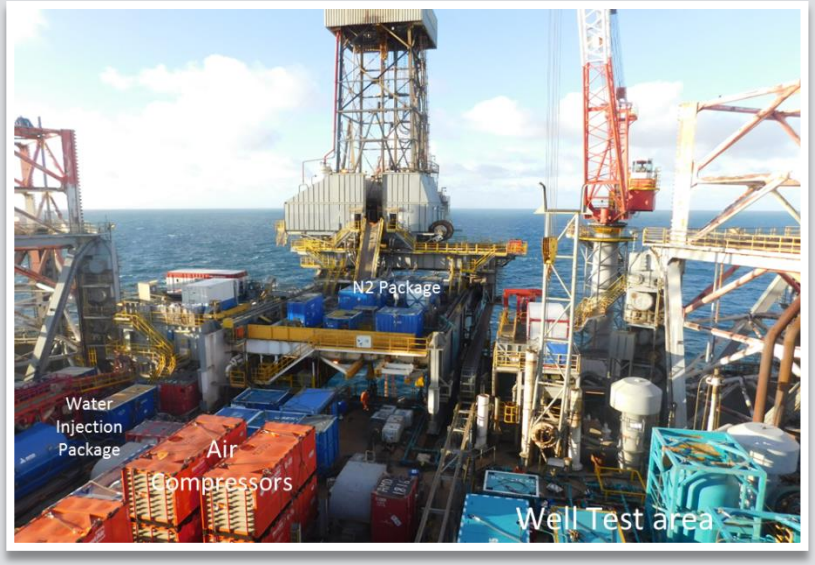
- Possible wax formation in injection tubing during suspension
  - Swap out results in 'cold' oil column.
  - May restrict injection at start up.

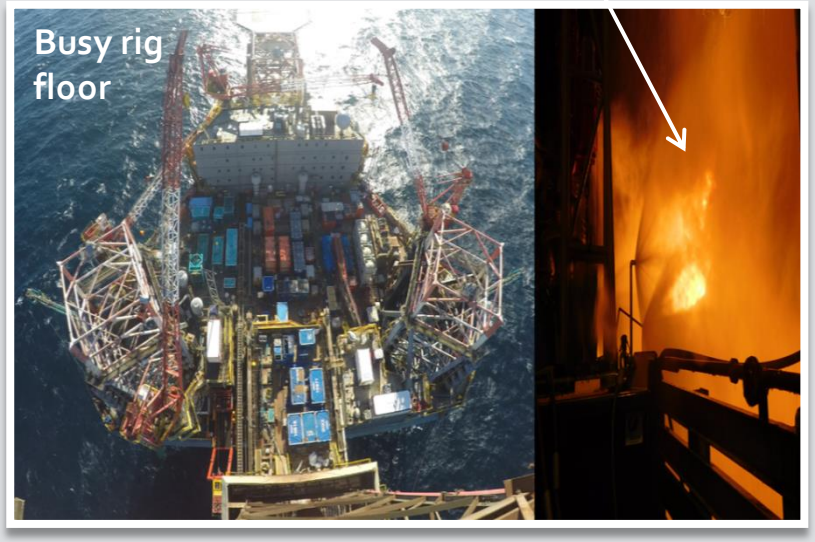


Well Suspension Strategy

- Oil Leg Injection Wells
  - Use mutual solvent to assure high injectivity at start up
- Injection Well Suspension strategy
  - Risk of wax formation in injection tubing
  - Displace to base oil
  - Also reduces hydrate risk
- Producer suspension – leave hydrocarbons below tree

Well Clean Up Operations





Summary

Successfully Delivering Across All Areas

- Fully integrated international project delivering on schedule
  - FPSO construction in South Korea and Japan – assembled in Singapore
- Subsea infrastructure installation complete:
  - Bundled subsea lines + risers installed
- Ongoing delivery of development wells:
  - Successful geosteering using latest technology in challenging formations
  - All wells achieving or exceeding well objectives
  - Installation of 3,000 ft OHGPs successful
- Well testing / clean up and suspension:
  - Proven high quality sands
  - Suspension programme as planned to preserve well PI / II

Questions?

Premier Oil acknowledge the Catcher Area Development JV Partners and thanks them for their permission to present to the SPE group