Interactive Well Planning for The Appraisal of a Fractured Oil Field

An Example of Data Acquisition, Integration and Successful Testing of the Clair Ridge

Robin Cooke, May 2014
Clair Field Overview

- 75 km west of Shetland
- 150m water depths
- UK’s Largest known resource
  - 220 km² (55,000 acres)
  - STOIIP c.4 billion barrels

- **Complex Field:**
  - 500-800m of interbedded, fluvial sediments
  - diagenetically altered Devonian sandstones
  - Highly variable reservoir quality (moderate-poor)
  - Low API oil (24)

... and naturally fractured
Clair Field Regions - Structural
Taking ourselves back...

- c.30 wells had been drilled over the entire field
- Appraisal wells in the 1990s demonstrated that commercial rates could be achieved through natural fracture flow
- Still Considerable subsurface uncertainty on the Ridge
- 2 Clair Ridge Offset wells (1978)… flowed only 200 bbl/d on DST
Well Plan and Orientation

Poorly imaged and constrained interpretation

=> Plan to drill an inclined pilot hole and then sidetrack SW to run a DST
Critical Operational Decisions

• Should we **sidetrack** the pilot well and run a **DST**?
  …high enough reservoir quality (porosity / permeability)?
  …have we seen evidence of natural fractures?

• Inform **sidetrack placement**…
  …correct stratigraphy?
  …best well orientation?

Planned Data Acquisition…

Matrix: **Core** Analysis & Description; **Comprehensive FE Logs**

Fractures: Drilling Mud **losses**, Image **Log** and **Core** Description => orientation
Informing Operation Decisions

- Vital to **understand the core** as quickly as possible
  - Ship the core onshore ASAP. *Need a supply boat to be waiting*
  - Describe core. **Specialists to be available out of hours**

- Fracture orientation from core… probably qualitative but early

- **WL Image Logs** will be run at TD with little time to make decisions
  - mobile rig with poor connectivity & interpreters will be onshore (Aberdeen & Cornwall) *Satellite bandwidth?*
  - Re-process data and make full interpretations in quick order **Specialists to be available out of hours**

⇒ communicate **expectations** to all staff early
⇒ continually **notify** all staff of operational timings
⇒ detailed **planning** of technical work - prioritise and mitigate conflicts
Core Processing - Detailed Planning

- Complex processing, multiple objectives and stakeholders
  
  e.g.
  - General Best Practice
    => offshore processing for SCAL
  - Fracture understanding needed
    => onshore core processing
  - After planning, SCAL not significantly compromised by onshore processing
    - large diameter core
    - low perm matrix, low api oil
    - mitigated rapid transport to shore / quick sampling and by doped mud

Detailed Work Plan (processing flow diagram)
Difficult Logistics with Log data:
- Quick interpretation
- Large file sizes
- Mobile drilling rig

30m repeat image log pass took 30mins to send onshore. Main pass was 700m long.
Fracture Interpretation & Orientation

Core-Based
High Side to Bedding
Scribe Data

OBMI Image log (rpt section)

Red: Bedding
Blue: Open fractures
Brown: Faults
Pink: with correction
Yellow: Vuggy veins
Cross: Coring-induced breaks
Fracture Interpretation - Implications

Orientation of Main Bore

Original Sidetrack Orientation

>10m spacing

<1m spacing

N

N
Well Results – losses/PLT/seismic

- Major losses and flow zone at toe of well (PLT)
- Correlates with intense fracturing (logs)
- Fracture clusters appear to be associated with faulting but not predictable on seismic (yet!)
Well Project Overview

- Successful & comprehensive data acquisition
- Large fracture corridors seen

6057 bbls/d max. flow
(test spread constrained)

=> PI = 60

- True Fracture understanding was critical

=> Confidence to continue the appraisal project…

- 3 additional appraisal boreholes
- Full coverage OBC seismic acquisition
Ridge Development

• 2009: Subsurface description signed-off
• 2011: Project sanction
  => Bridge-linked platform (36 slots)
• 2012: Development drilling (2 Pre-drills)
• 2013: Jackets Installed
• 2014: Topsides construction in progress

First Oil ~2016
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