Ensign,
Unravelling the Enigma

DEVEX 2016
Introduction

- Sole Pit area of UK SNS
- Discovered 1986, developed 2012
- View and understanding evolved over time
The ‘Facts’

- **Structure**
  - Fault bound 3-way dip closure
  - Compartmentalized by ‘de Keyser’ fault zones
  - Heterogeneous distribution of fractures, faults and micro-faults

- **Reservoir**
  - Rotliegendes Leman sandstones
  - Sabkha, fluvial and aeolian facies
  - Tight ~0.1md needs stimulation to flow
  - Deep burial – diagenesis – illite

- **Mapped Gas Initially In Place**
  - 0.5 Tcf
Appraisal – Achieving Economic Rates

1986
Vertical well
1 frac
15 mmscf/d
Appraisal – Achieving Economic Rates

1986
Vertical well
1 frac
15 mmscf/d

1988
Vertical well
1 frac
unsustainable rate

2006
Vertical well
1 frac
12 mmscf/d
Appraisal – Achieving Economic Rates

- Decision to develop based on 2007 appraisal
- Remaining uncertainty around exact controls on well deliverability ‘the Ensign enigma’ (Purvis et al. 2010)
Development Phase

• **Development**
  - Installation of unmanned production facilities
  - 2 development wells – similar concept as appraisal well

• **Challenging completions**
  - Not all fracture stages contributing to flow
  - Inconsistent well deliverability

• **First gas 2012**
Production Phase – the Enigma continues

- Production rates lower and decline steeper than expected
- Low recovery per well compared to other analogue tight gas fields
- Exact reasons unclear
  - Hydraulic fractures?
  - Well location/orientation?
  - Permeability too low?
  - No natural fractures?
  - No high perm streaks?
  - Compartmentalization
  - Lower GIIP?

Ensign vs Analogue Recovery

- High 40-60%
- Mid 20-40%
- Low <20%
• **2015 study remaining potential**
  - Back to basics approach
  - Separate facts from fiction
  - Integration of:
    - Geological data
    - Geophysical data
    - Production data
    - Completion data

• **Result:** **3 key reasons** for experienced well behaviour
  1. Compartmentalization/baffling by faults parallel to wells
  2. Productivity loss with time
  3. Not all frac stages contributing
Unravelling the Enigma – 1. Compartmentalization

Production data nearby boundaries

Seismic
NW-SE low offset faults

FMI log
NW-SE resistive fractures

Core
cemented fractures
Unravelling the Enigma – 1. Compartmentalization

2012 top reservoir depth map
Unravelling the Enigma – 1. Compartmentalization

2016 top reservoir depth map
Unravelling the Enigma – 2. Productivity Loss

Completion related?
- Reduction of fracture half-length?

Reservoir related?
- Natural fractures closing?
- Consecutive depletion of small compartments?
Unravelling the Enigma – 3. Completions

- Not all fracture stages in EN01 well contributing
  - Reduced productivity
  - Reduced drainage area
  - Compartmentalization effect amplified

- Completion systems in Ensign
  - Cased cemented perforated
  - Open-hole ball-drop, sleeve

- Future wells
  - Balance speed vs reliability
  - Plan for spare hydraulic fractures
  - New technology
Changing view with time

1986

Vertical appraisals
- Too tight to produce at economic rates

2007

Horizontal appraisal
- Economic rates can be achieved with horizontal multi-fractured wells

2012

Production
- Wells not achieving expected rates and recovery

2016

Current understanding
- 3 key factors identified that have affected well productivity
Ensign Potential – what’s next?

- Potential to drill up to 5 new wells
- Large volume of gas remaining
- Improved understanding
- Drill across internal faults
- Improve completion design

Can we improve recovery???
Questions?

Ensign core workshop!