Facies interpretation and modelling - An integrated workflow

Liz Chellingsworth and Pete Kane (AGR TRACS)

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The yellow grid cell

• Defining ‘the best place’ to drill

• Uncertainties:
  – How good is our geological model?
  – How good is our facies prediction?
  – How well do we understand the depositional model?
  – How well do we understand our seismic data?
  – How good/representative is our well data?
Variation within a cell

• Cell dimensions:
  – 100m x 100m x 3ft

• Development well:
  – Aim for sand length of 1000m
  – 7-10 grid cells, depending on orientation of well

• How much does the geology vary within those cells?
Field studies

Coulomp Valley, Annot, France

Rambla de Lanujar, Tabernas, Spain

Facies model

300ft

500m

Facies model

200m

50m
Case study: Huntington Field

- Block 22/14
- Discovered in 2007
- Operated by Eon

- FPSO: Sevan Voyageur
- On stream in 2013
- Water flood

- Paleocene turbidite channel sands of Forties age
- Mixture of:
  - amalgamated sands
  - shaley sands
  - ‘heterolithics’
Purpose of the model

• Built on behalf of Premier Oil (non-operating partner)

• Assist with well planning:
  – Distribution of rock quality types
  – Placement/optimisation of the development wells
  – Producers and injectors

• What the model is not designed for...
  – Depth prognosis
  – STOIIP uncertainty analysis
  – Simulation
Integrated workflow

- Geologist meets geophysicist
- ‘What can we see?’
- ‘What can we do?’
- ‘How could it fit together?’
Seismic interpretation
General seismic character
Iso-slicing

~2km
Characterisation of water leg

- Intricate channel complex
  - 3D architecture
  - Hierarchy
Interpretation in water leg
Characterisation of oil leg

- Seismic facies interpretation along ‘near top Forties’

Observations:
- Stacked amalgamated sand in the middle of the channel.
- Some amalgamated sand towards the edge of the channel.
- More interbedded sands off the main channel axis.

Horizons:
- Near top Balder
- Top Sele
- Near top Forties
**Seismic facies interpretation**

**SHALE-PRONE facies 1:** acoustically dim, little to no character
*inferred geological facies:* shale-prone

**OVERBANK DEPOSITS facies 2:** acoustically dim background punctuated by small bursts of medium amplitude
*inferred geological facies:* overbank deposits: off main fairway, more silt/shale but occasional isolated channel

**SHEET SANDS facies 3:** moderate to high amplitudes, uniform/parallel reflector
*inferred geological facies:* sheet sands separated by thin shale beds

**AMALGAMATED SANDS facies 4:** channel shape and/or differential compaction with moderate or high amplitudes
*inferred geological facies:* amalgamated channel sands
Mechanics

- 1 map = 1 facies class
- Combine maps
Seismic facies map

- amalgamated sands
- sheet sands
- overbank deposits
- shale-prone
Meanwhile...
Facies

- **Inheritance:**
  - sand, shaley sand, heterolithics, shale, cement

- **Channel complex**
  - Long and narrow
  - Significant incision
  - Mainly sand and shaley sand

- **Laterally extensive reflectors:**
  - Flat, tabular bodies
  - Areally extensive
  - Higher shale content
Model dimensions

• Cell dimensions: 50m x 50m x 2ft
  – Sugar cube grid
  – Total cell count: 7.6 million (we are not simulating!!!!)

• Internal architecture:
  – Differences in facies/lithotype
  – No hard-wiring!
The water leg

- Discrete channel bodies

geo-bodies from seismic

~1700m
Facies organisation in channel complex

- Distance parameter $\rightarrow$ conditioning parameter for facies
- Facies proportions guided by well stats
Facies in the channel complex
The oil leg

- Seismic facies map $\rightarrow$ conditioning parameter for facies

- Facies proportions guided by well stats
Results

• Well results compared to well planning model
  – Success rate was high
  – Lessons learned

• What went well?
  – iteration and development of the method
  – calibration and validation of method
  – good communication and integration
    • before, during, after
Where next?

- Uncertainty analysis
  - Uncertainty bands
  - Variation of the conditioning property

- Facies definition
  - Meaningful facies definition in horizontal wells
    \(...to be continued\)
  - Re-definition of facies from log?
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