



# Arundel Field, Central North Sea

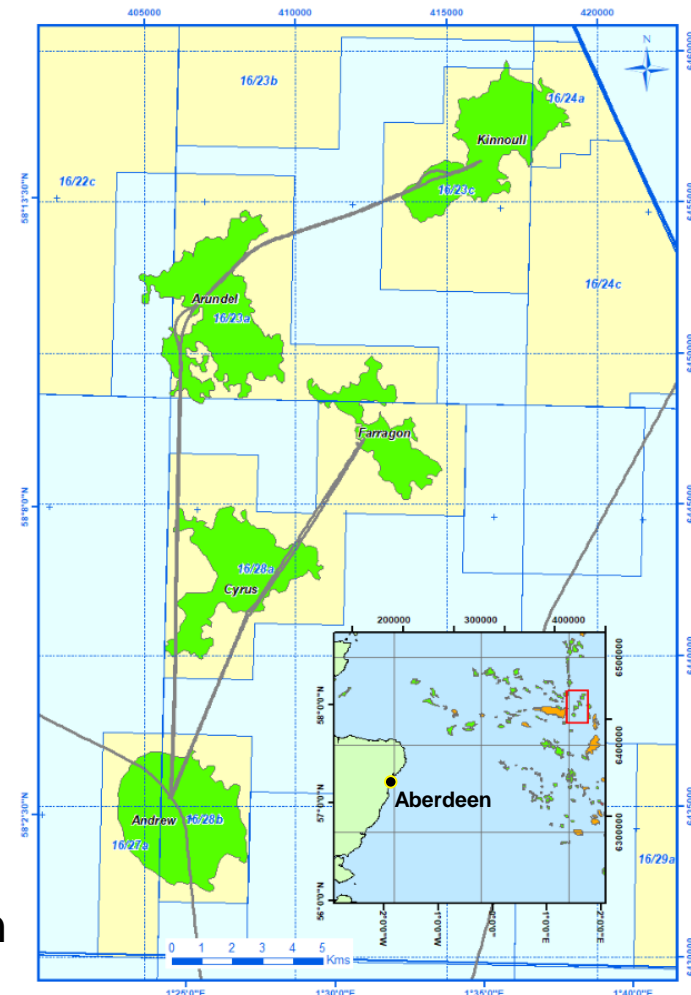
## - A Single Well Development on a Complex Small Field

**Primary Author:** Rory Leslie

**Co Authors:** Rosemary Anthony, Chris Hill, Lex Love, Mairi Nelson, Sara Newns, Simon Whiteman, Niek van den Beukel, Zoë Sayer

# Project Summary

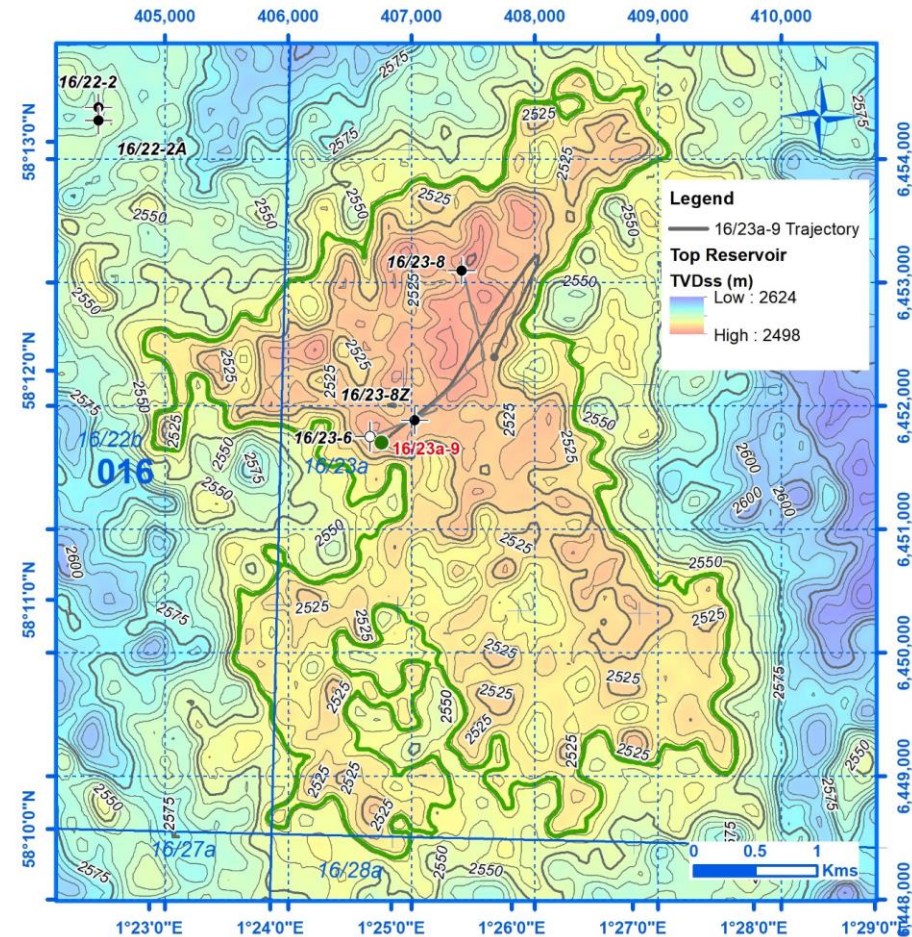
- Arundel is a small oilfield 12 km north of BP Andrew Platform containing 22 mmbbls STOIIIP (BP 100%)
- One of 4 Paleocene (Lista Formation) turbidite satellite fields tied into Andrew
- Developed by a single subsea well tied into the Kinnoull to Andrew pipeline
- Key to BP's strategy in the Central North Sea of extending the life of production hubs
- 1<sup>st</sup> oil in September 2017, 18 months after sanction
- Upside reservoir result and production rate



BP Andrew Area map

# Discovery & Appraisal

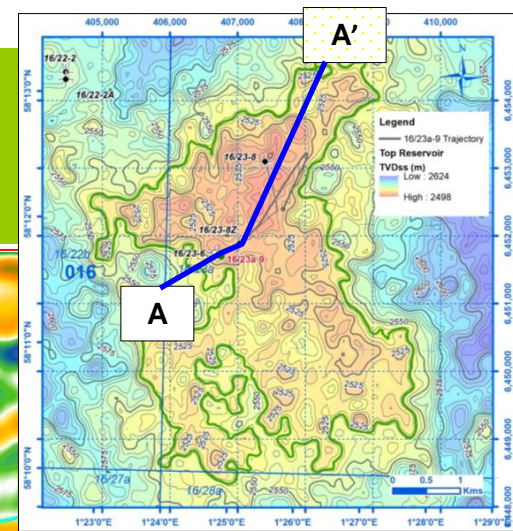
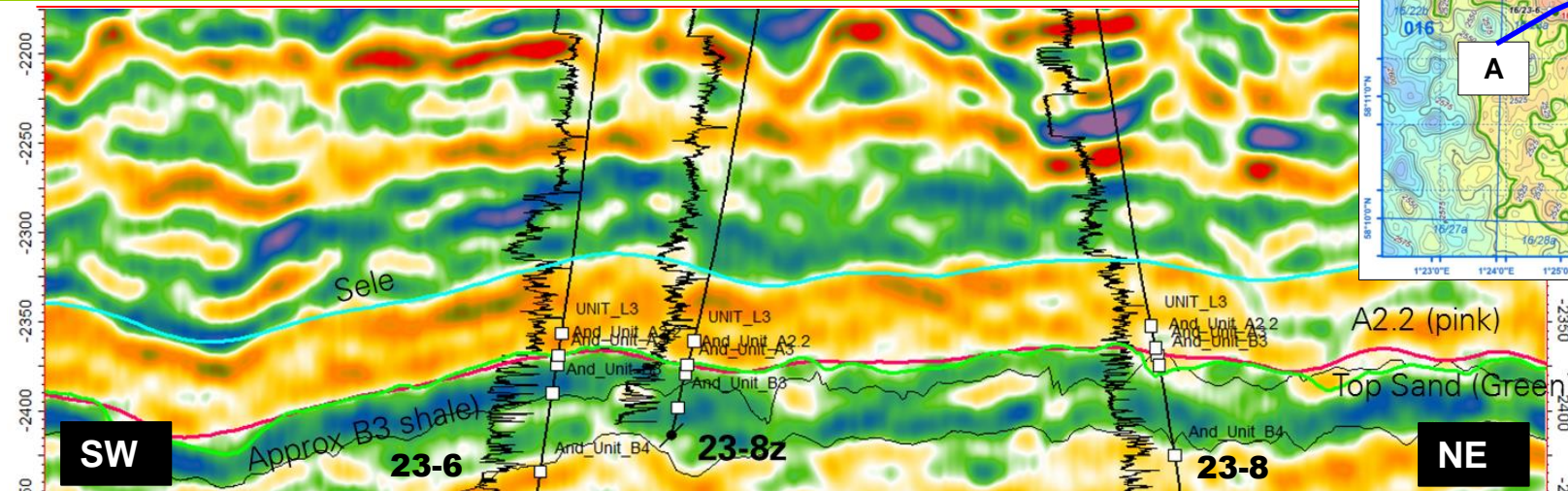
- Discovered in 2000 by Chevron well 16/23-6
  - Encountered thin, 20 m oil column
  - High N:G Lista L3 sands (A2.2 Unit)
- Appraised in 2008 by BP with 16/23-8 and 16/23-8Z
  - Poor N:G in 16/23-8
  - Intermediate N:G in 16/23-8Z
- Most recent seismic acquired in 2013
  - High density ocean bottom cable (HDOBC)
  - Improvement in reservoir imaging



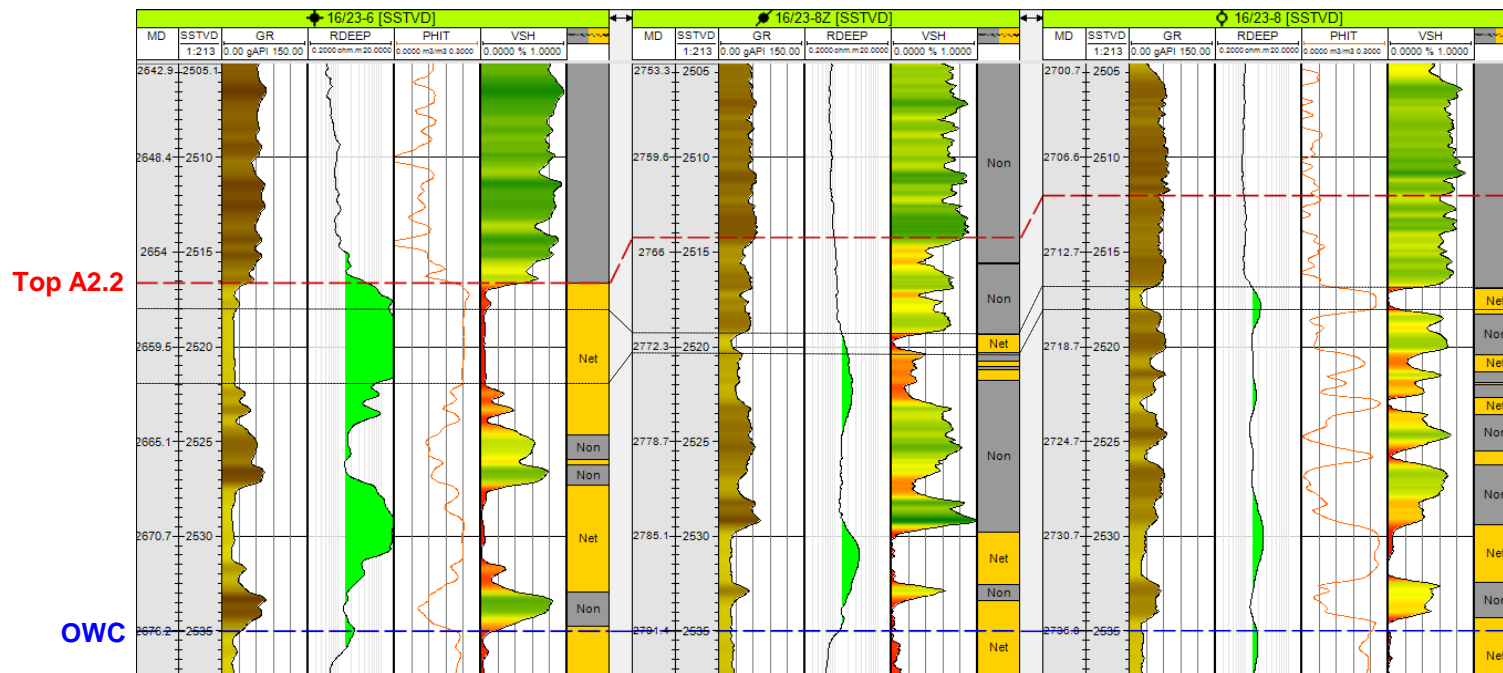
Arundel Top Structure Depth Map



# Seismic & Well Data



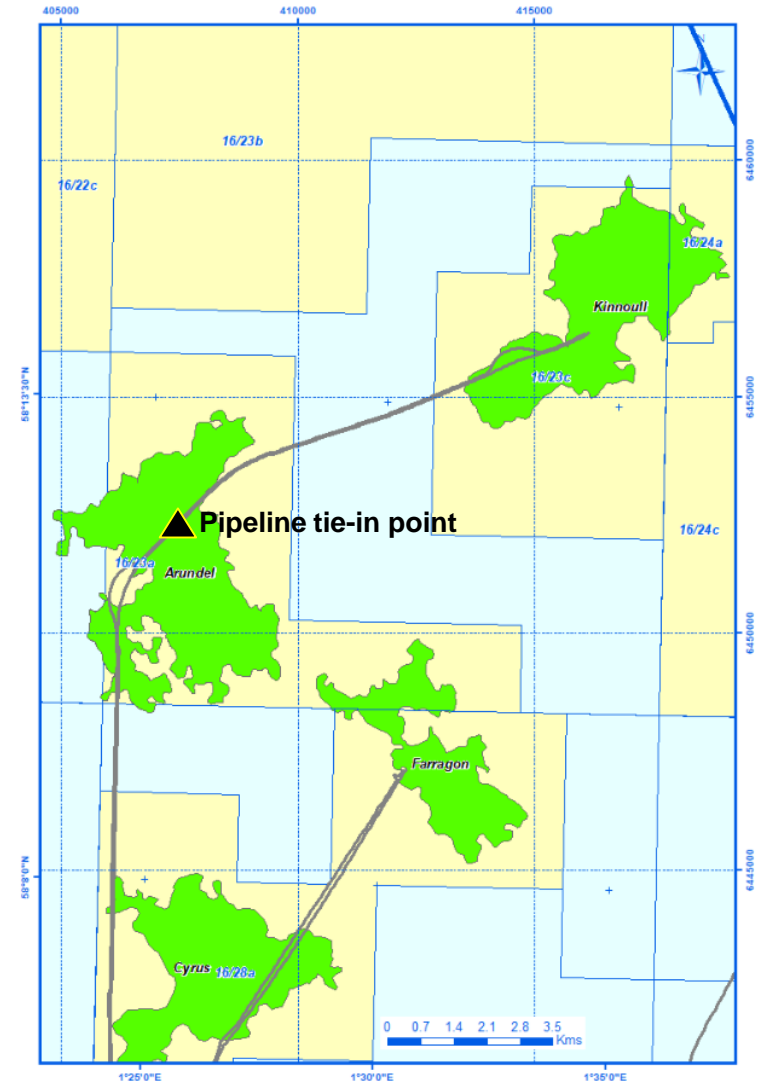
HDOBC Colour  
Inverted TWT  
seismic with offset  
wells and main  
stratigraphic  
horizons



Well correlation with  
GR, resistivity, PHI,  
VShale and Net flag

# Development Decision

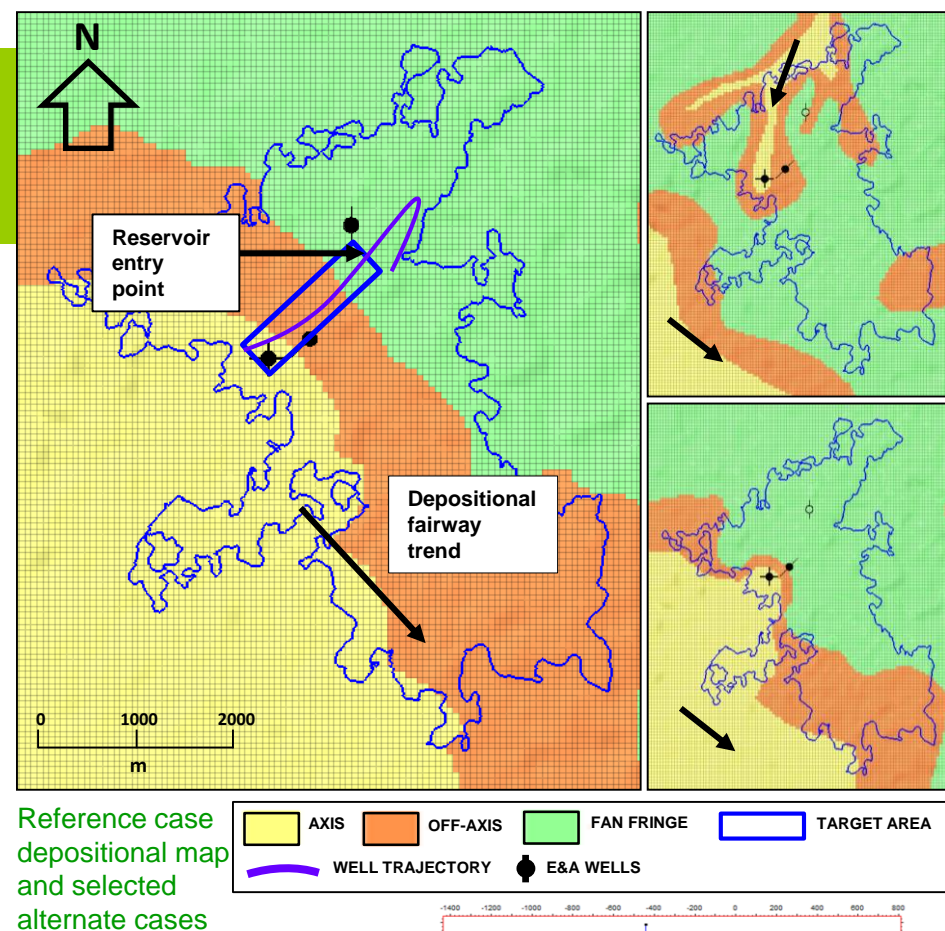
- Undeveloped due to:
  - Very thin column
  - Variable N:G in E&A wells
  - Poor seismic image
- Tie-in point over Arundel was built into the Kinnoull to Andrew pipeline during Andrew Area Development project (2013)
- Changes leading to project sanction:
  - HDOBC seismic improved definition of structure
  - Ullage available on Kinnoull to Andrew pipeline
  - Extend life of Andrew Platform benefitting other existing tie-ins
- One well development sanctioned



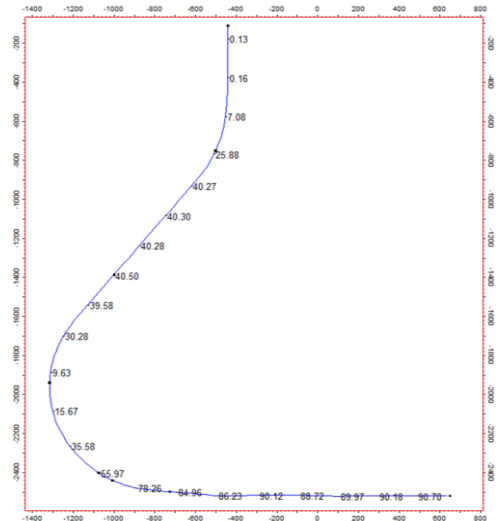
Area map with pipeline and tie-in point

# Well Concept

- Long horizontal reservoir section to maximise pay penetration and oil rate
- Different well lengths tested in simulation (1300 - 1400 m optimal)
- Well drilled perpendicular to trend of turbidite system to cross-cut sand bodies
- Top hole position and overburden drilling constraints required complex “fish hook” trajectory and reservoir land-out in NE of field
- Cased and perforated completion to enable future water shut-off

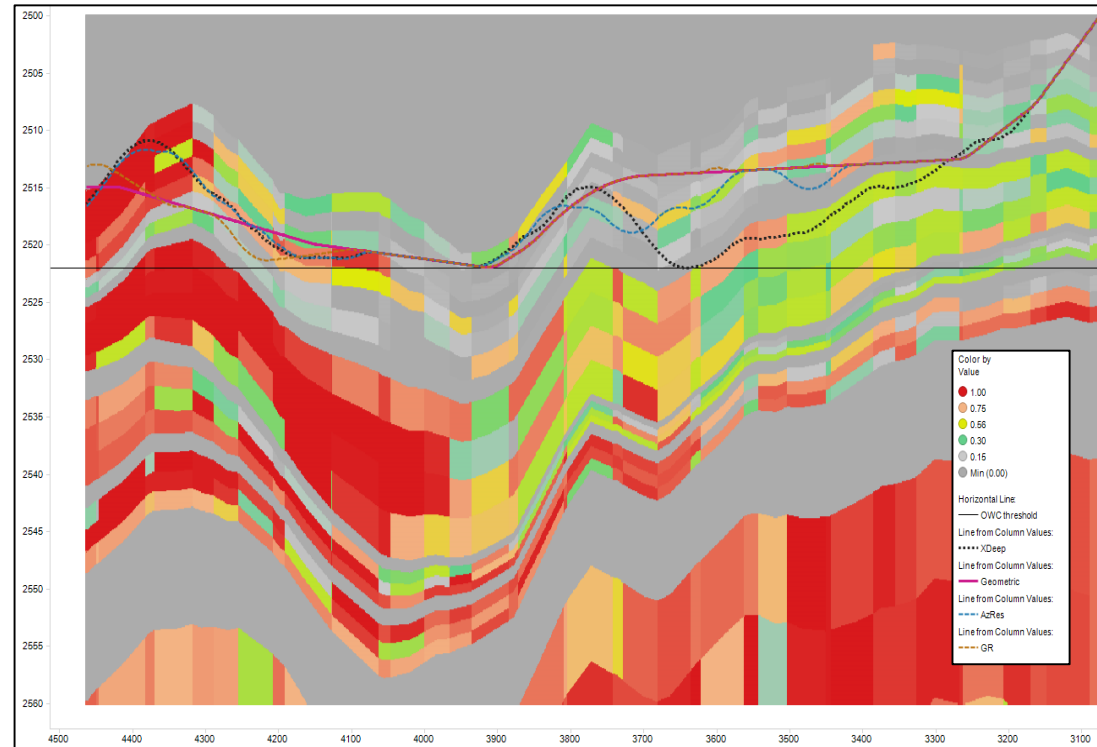


Well trajectory x-section view



# Reservoir Geosteering

- Geosteering toolkit
  - Deep & Extra Deep Azimuthal resistivity tools to “see” sands and maximise pay (**Baker Hughes AziTrak & VisiTrak**)
  - Density & Gamma Ray image logs for dip and stratigraphic direction
  - Wellsite biostratigraphy (palynology) for landing the well and confirming stratigraphy
- Predicted Net Sand Length: **430 m**
- Constraints
  - 3.5° per 30 m dogleg limit
  - 15 m TVD stand-off from OWC

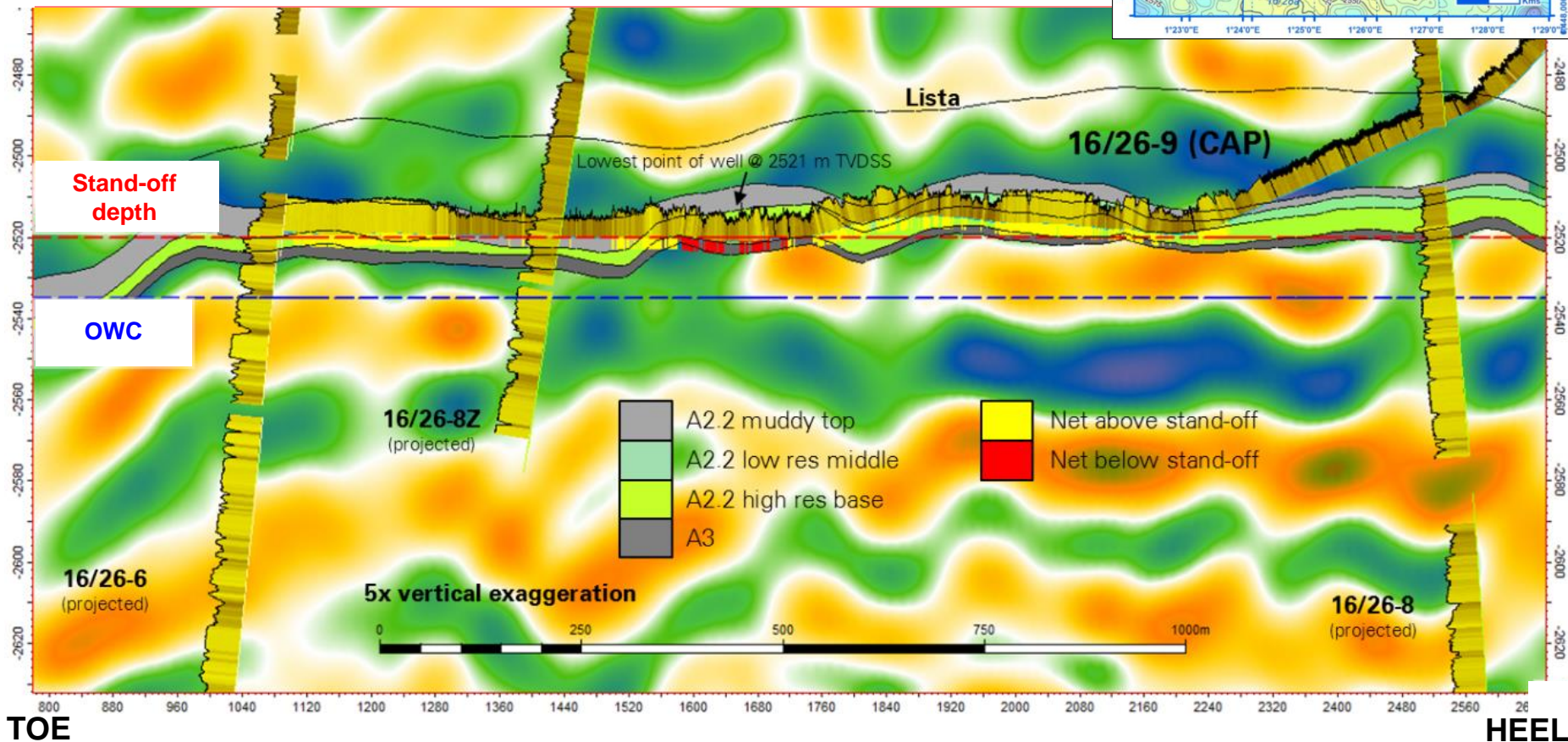
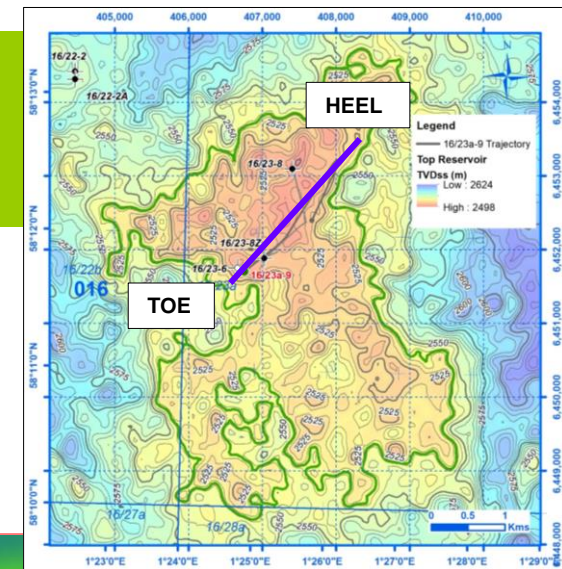


Outputs from azimuthal resistivity value of information algorithm



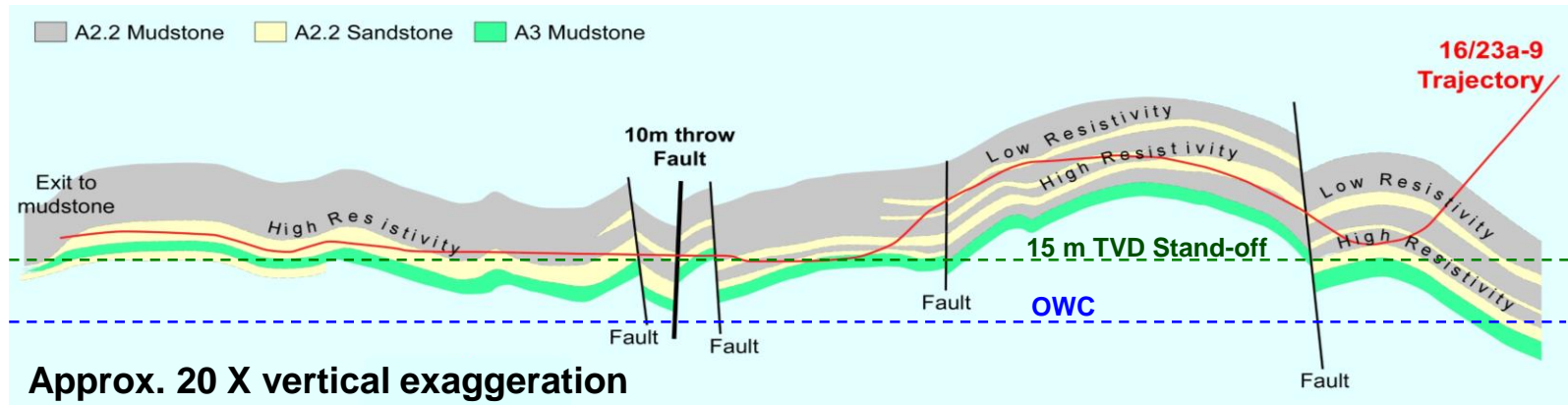
# Well Execution

Seismic reflectivity (depth) with development well (16/23a-9) and offset wells  
GR logs in yellow/brown  
Cross-section location shown on map



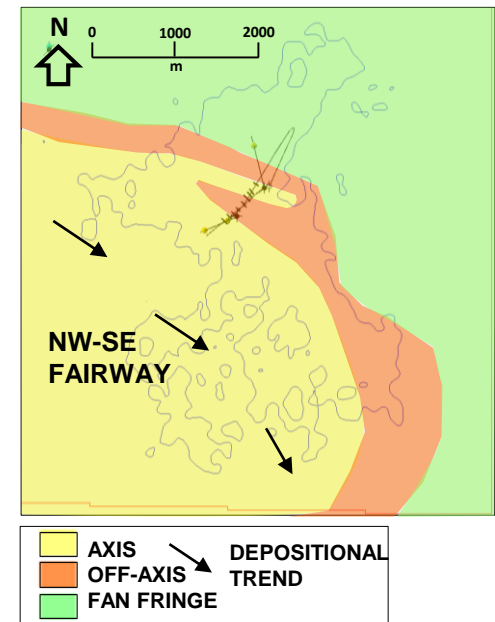


# Results



Reservoir geology cartoon (not to scale)

Parameter	Actual	Predicted Most Likely	Difference (+/-)
Gross Length (m MD)	1404	1300	+104
Net Sand Length (m MD)	696	430	+266
Net Sand Length above stand-off (m MD)	619	430	+189
Perforated Length (m MD)	608	430	+178
Net : Gross	0.5	0.4	+0.1
Net Porosity	0.23	0.19	+0.04
Oil saturation	0.76	0.75	+0.01
Maximum Oil Rate (mbbls / day)	11.7	9.9	+1.8



Updated depositional scenario map

# Summary

- Appropriate well design to address the subsurface uncertainty – able to chase the upside as well as deliver reference case
- Strong case made for Azimuthal Resistivity tools – resulted in 40% perforated pay increase compared to geometric trajectory
- Careful planning and successful execution of geosteering helped attain the upside outcome
- Realised value from pre-invested pipeline and tie-in point
- Maximise recovery from Andrew Area – later CoP helps other existing tie-backs



# Acknowledgements



- I would like to thank BP for their permission to give this talk
- The Arundel Development was a collaborative project between BP subsurface, drilling, operations, projects, commercial and a number of 3<sup>rd</sup> party companies
- I would like to particularly acknowledge colleagues in the BP CNS Team: Rosemary Anthony, Chris Hill, Lex Love, Mairi Nelson, Sara Newns, Simon Whiteman, Niek van den Beukel, Zoë Sayer and the Baker Hughes Reservoir Navigation Team