



Oil & Gas  
Authority

# Exploration Well Failures from the Moray Firth & Central North Sea (UK)

21<sup>st</sup> Century Exploration Road Map Project  
Christian Mathieu



Oil & Gas  
Authority

# 1. Project Objectives, Time-Line and Status

2. A few statistics...

3. Reasons for failure

4. Selected interpretation pitfalls

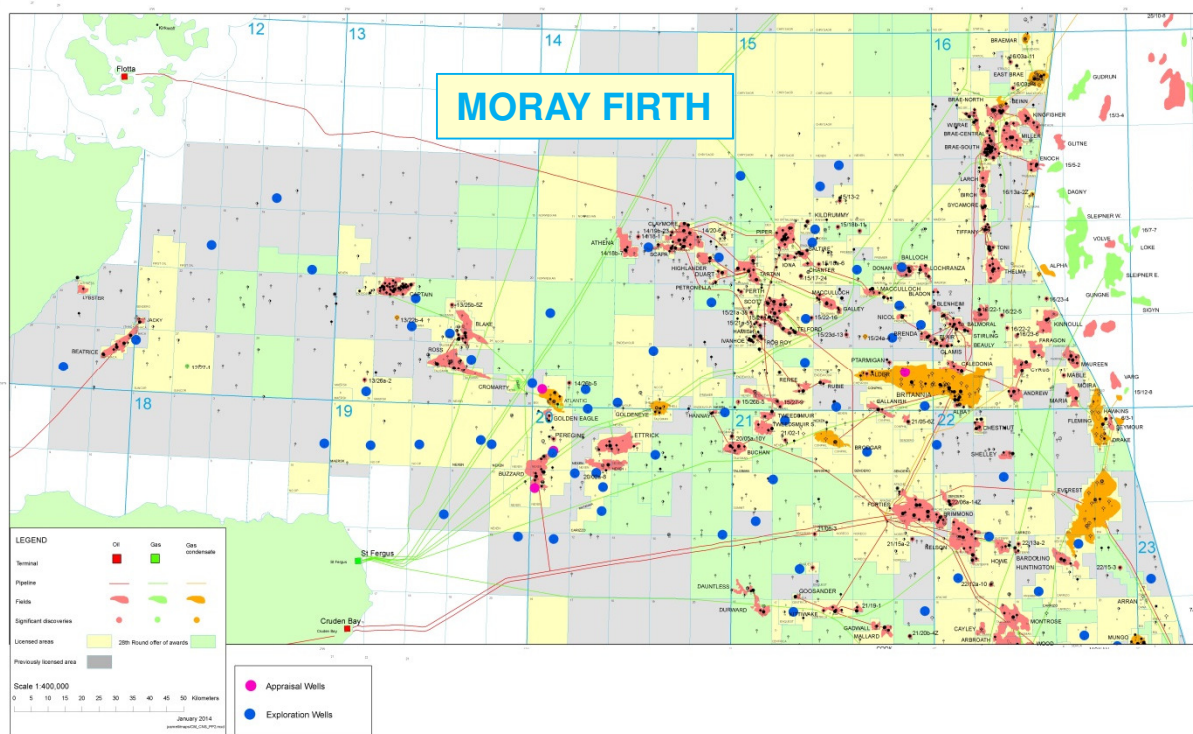
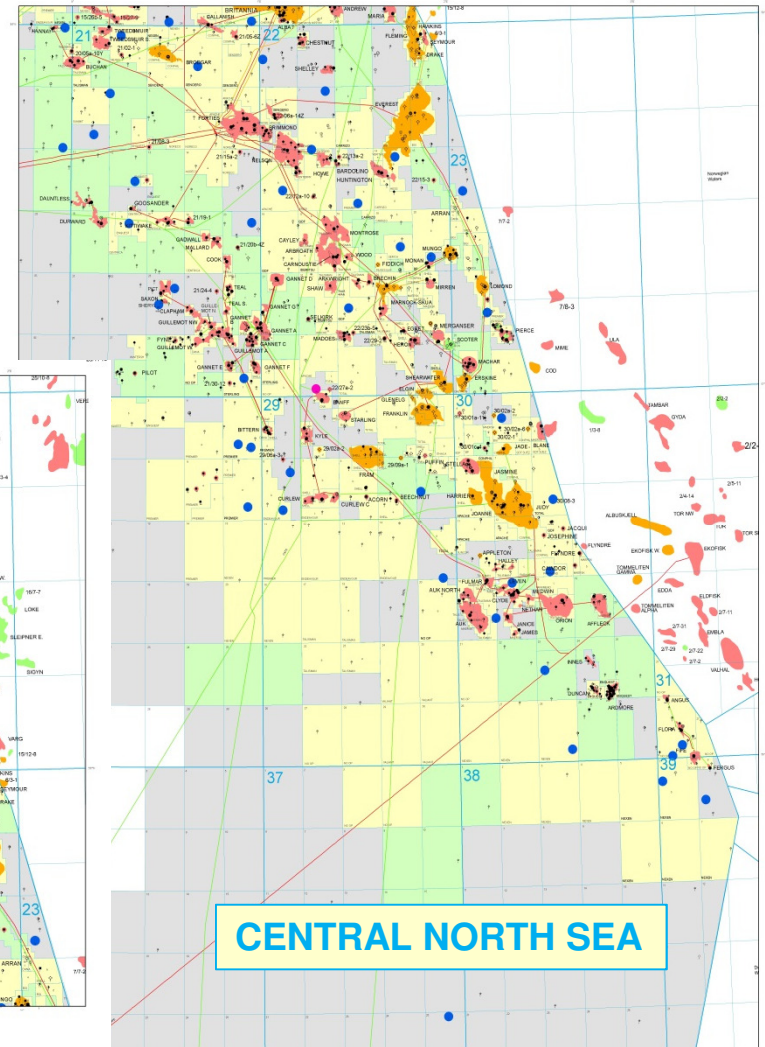
5. Conclusions



# Moray Firth – Central North Sea Post well analyses

## 2003 – 2013 Wells (E&A) to be looked at:

- 150 Exploration main bores + Exploration Side-tracks have been drilled over this 10 years period by 42 Operating Companies.
- Project tried and understood the reasons for failure of the dry wells and a few “technical” successes.
- 98 such wells (currently owned by 24 companies) have been reviewed >>> 104 segments successfully analysed.



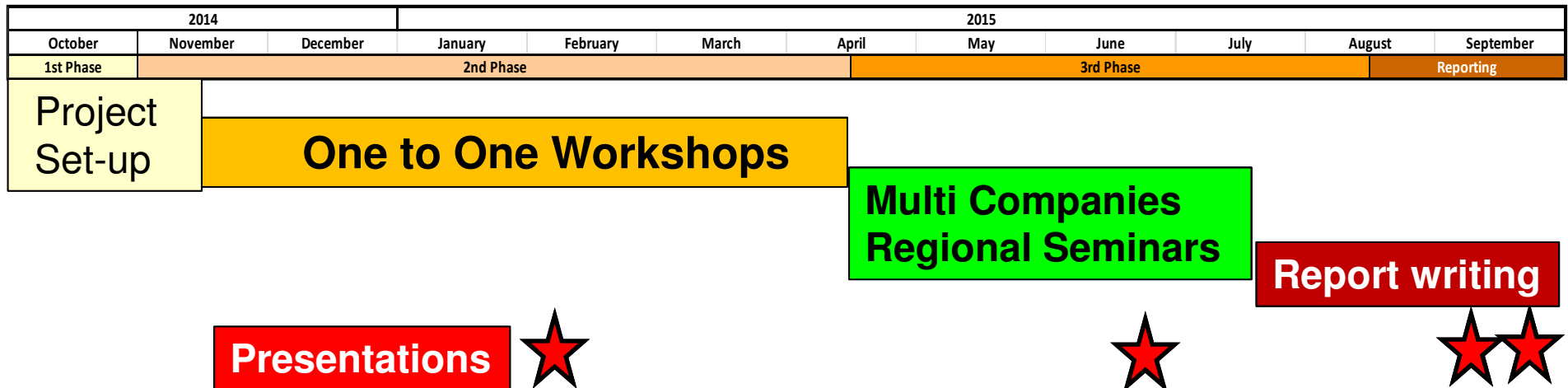


# Project Objectives

- **Part of the 21st Century Exploration Road Map recommended by ETF (“Exploration Task Force”) and aligned with Sir Ian Wood Review**
- **Project entirely sponsored by DECC / OGA.**
- **Project focused on Dry Holes and a few Technical Successes drilled 2003-2013 in Moray Firth (MF) and Central North Sea (CNS)**
- **150 Exploration main bores + Exploration Side-tracks with overall Technical Success rate = 40%**
- **Rigorous well failure analysis conducted by DECC / OGA together with Industry**
- **Objectives:**
  - **To fully understand the reasons why a prospect was drilled (i.e. Geological and Petroleum settings)**
  - **To better understand the reasons for success and failure in Exploring MF and CNS during the last 10 years**
  - **To share the main findings with the Industry**
  - **To test the “Collaborative Model”.**



# Project Time Line and Status



- 22 Companies (over 24) opened their “books” during “1 to 1” workshops
- Summary results for each well / each explored segment gathered into a Post Well Analysis Sheet
- Number of Post Well Analysis Sheets completed = 104 belonging to 97 wells (compared to 98 wells initially targeted)
- Preliminary findings have been presented at the [O&GUK 2<sup>nd</sup> Pitfalls in Exploration Conference](#) (London, 05<sup>th</sup> February 2015). Overall findings presented at [O&G Industry Conference](#) (Aberdeen, 17<sup>th</sup> June 2015) and [PGC VIII](#) (London, 29<sup>th</sup> September 2015)
- Multi-companies workshops gathering companies having drilled in the same Geological Basin / Entity held (London & Aberdeen video link: 16<sup>th</sup> and 29<sup>th</sup> June – 09<sup>th</sup> July 2015).
- Final report + Final presentations to be delivered September - November 2015.



Oil & Gas  
Authority

1. Project Objectives, Time-Line and Status
2. A few statistics...
3. Reasons for failure
4. Selected interpretation pitfalls
5. Conclusions



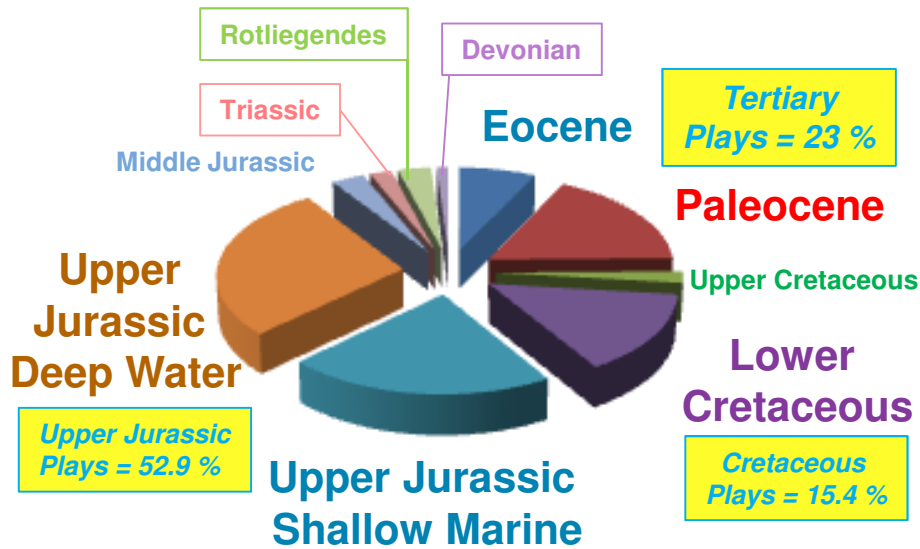
# Setting the scene (1/2)

- 104 segments have been analysed, corresponding to 97 wells: 9 lacking overall Chance of Success (CoS) and/or detailed risking assessment.
- **93% Exploration wells** – 7% Appraisal wells. **33% were firm Commitment wells.**
- 62.5 % of these segments belong to post 20<sup>th</sup> Round licenses; 28.8 % were drilled on licenses awarded during the Rounds 1<sup>st</sup> to 7<sup>th</sup>.
- **90.4% were dry holes**; 8.6% Technical successes; 1% Commercial success
- Objectives:
  - **38 % above BCU**
  - **56 % Jurassic**
  - **2 % Triassic**
  - **4 % below Zechstein Salt**
- **33 % of the 104 analysed segments have been drilled because of some sort of “DHI”**: AVO, amplitude, gas cloud, “impedance indicator”...etc...
- Chance of Success
  - 34% of the 98 segments with available pre-drill risking fall within the 21 to 30% CoS (i.e. what you would expect in such mature Basins).
  - But 40% of these segments have CoS > 31%: this highlights a trend towards over-confidence in the risking assessment.
- Number of causes for failure: **3 main reasons = 38.8%**; 2 reasons = 48.6%; 1 reason = 12.6%
- **The main risk was not adequately predicted in 36 %**



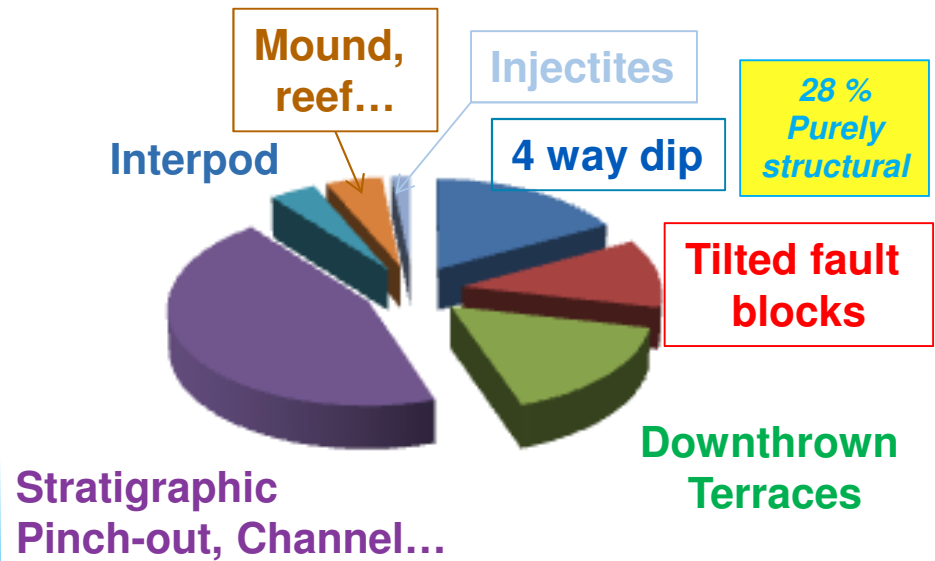
# Setting the scene (2/2)

## Objectives



- 38 % above BCU
- 56 % Jurassic
- 2 % Triassic
- 4 % below Zechstein Salt

## Trap types



- NB: Sum (>104 as several traps are Combined 4 way dip closure / stratigraphic upside)*
- 55 % Stratigraphic traps
  - 45 % Structural traps



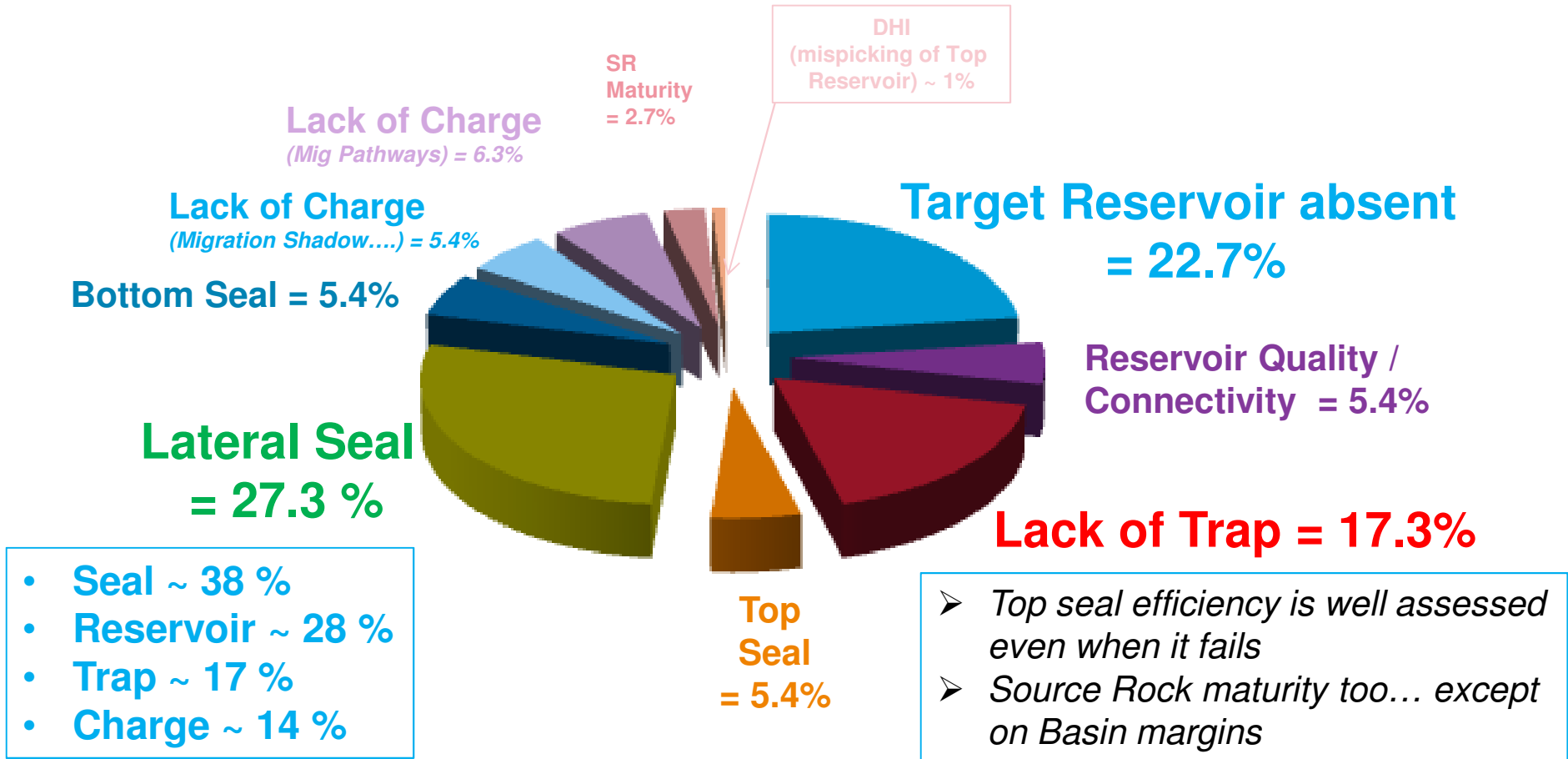


Oil & Gas  
Authority

1. Project Objectives, Time-Line and Status
2. A few statistics...
- 3. Reasons for failure**
4. Selected interpretation pitfalls
5. Conclusions



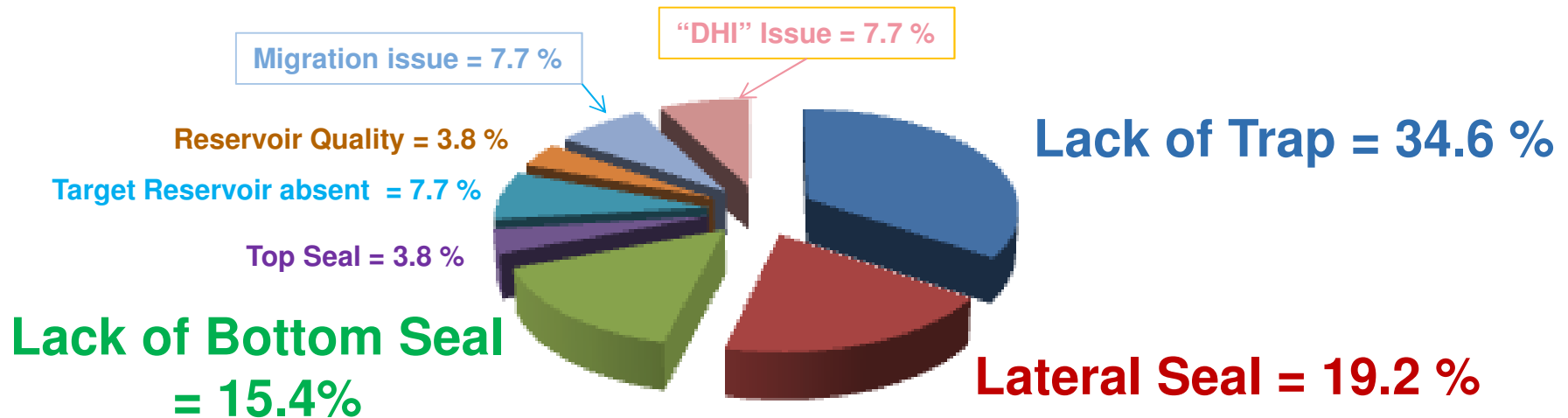
# Main Reason for Failure (1/4) Overall Main Reason for Failure



➤ Absence of Target Reservoir and Top Seal Failure are acting effectively as “killing parameters”



# Main Reason for Failure (2/4) Tertiary Plays (Eocene-Palaeocene)



- Sample size = 24 segments
- However, 20 (i.e. 77 %) have been drilled because of some sort of DHI (AVO, amplitude, gas cloud, "impedance indicator"...etc...)
- Another 2 were drilled despite AVO indicated the sands would be wet.

- "When looking at prospects that are solely dependent on AVO it is necessary to examine the pre-conditioned gathers.
- Match amplitude response to shear log recorded in near by wells.
- **Produce and risk the geological model unsupported by AVO. Does the play make sense without AVO support?**
- AVO responses are modelled outcomes, not unique solutions. They do not eliminate risk."



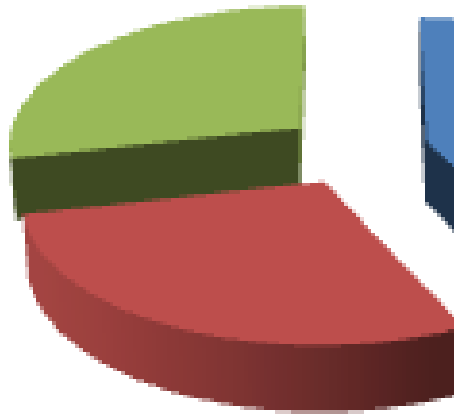
# Main Reason for Failure (3/4)

## Upper Jurassic: Fulmar Fm. in an interpod setting

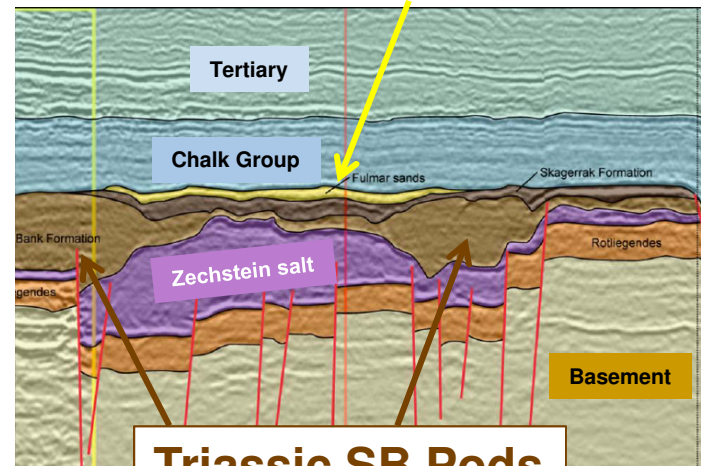
**Lateral Seal**  
= 28.5 %

**Target Reservoir absent**  
~ 43 %

**Lack of Charge**  
*(Migration Pathways)*  
= 28.5 %



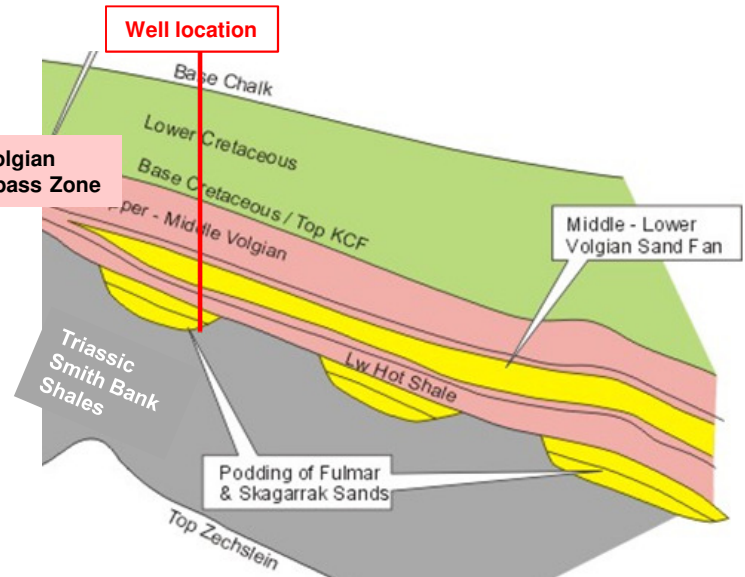
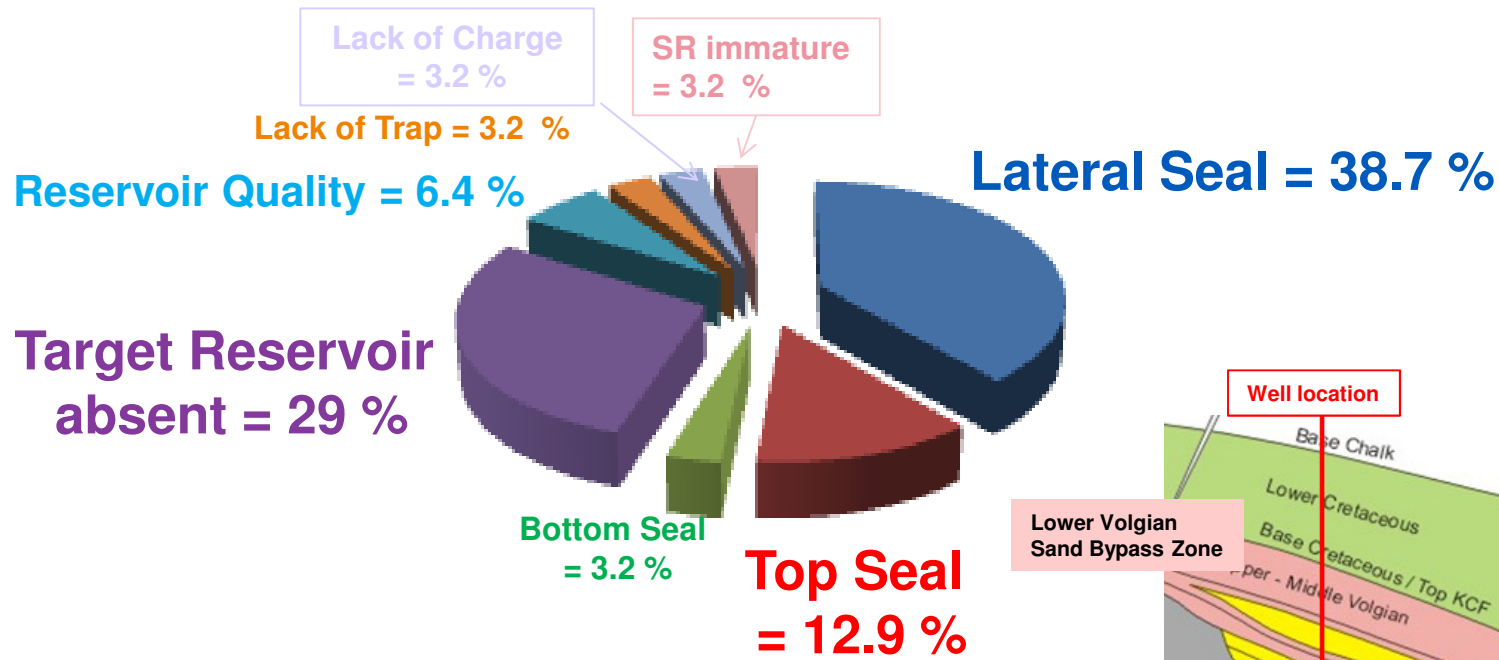
**Fulmar segment**



- Limited sample = 7 segments
- However all 3 reasons for failure highlight pretty well what is requested to find such a trap being hydrocarbon bearing.
- **Migration effectiveness is the 2<sup>nd</sup> reason for failure in 5 over 7 cases >> detailed pre-drill Basin modelling should be carried out**



# Main Reason for Failure (4/4) Upper Jurassic Deep water turbidites (Buzzard, Ettrick, Peterhead...all kind of traps)



- Sample size = 27 segments
- The search for Buzzard look alike in adjacent Grabens failed; it was mostly driven by conceptual analogy and on “notional” prospects.
- 76.7 % were interpreted as Stratigraphic Traps

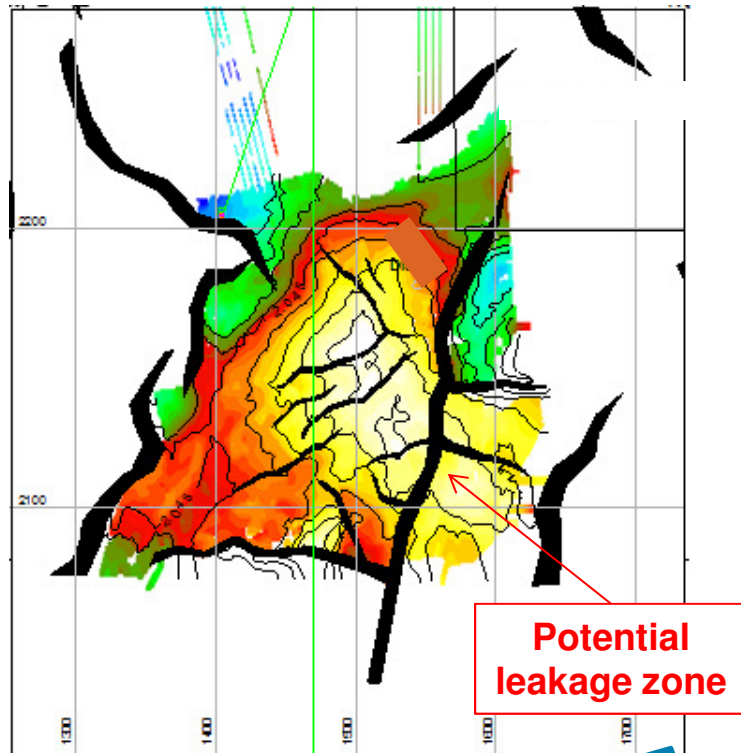


Oil & Gas  
Authority

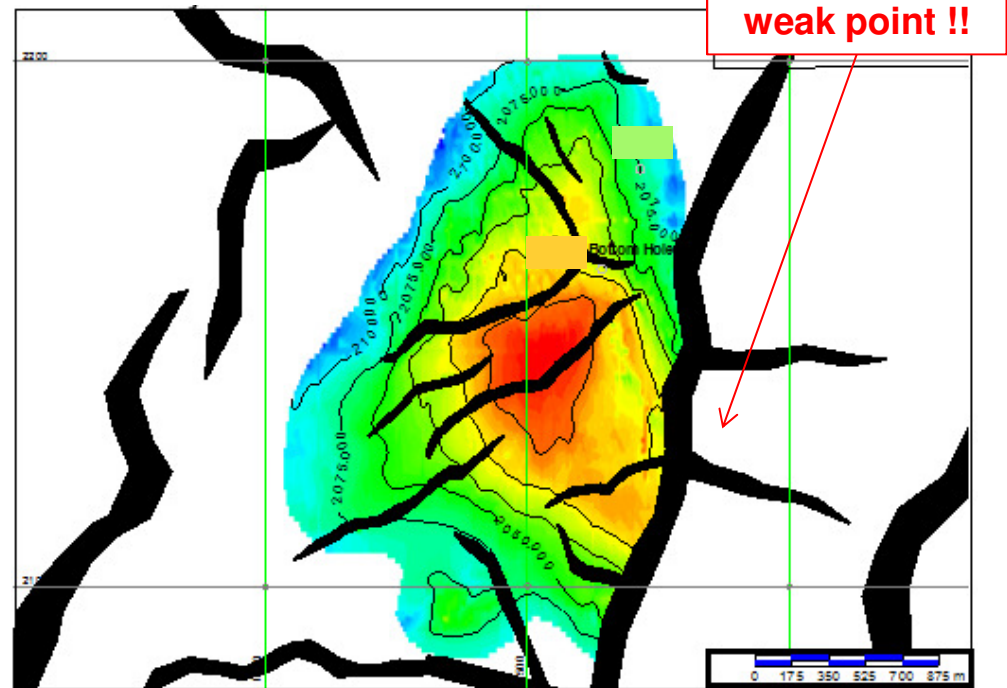
1. Project Objectives, Time-Line and Status
2. A few statistics...
3. Reasons for failure
4. Selected interpretation pitfalls
5. Conclusions



# 1) Map cut short >> does not allow optimal understanding of the trap (1/2)



Top Fulmar Depth Map  
Partners meeting  
24<sup>th</sup> January 2006

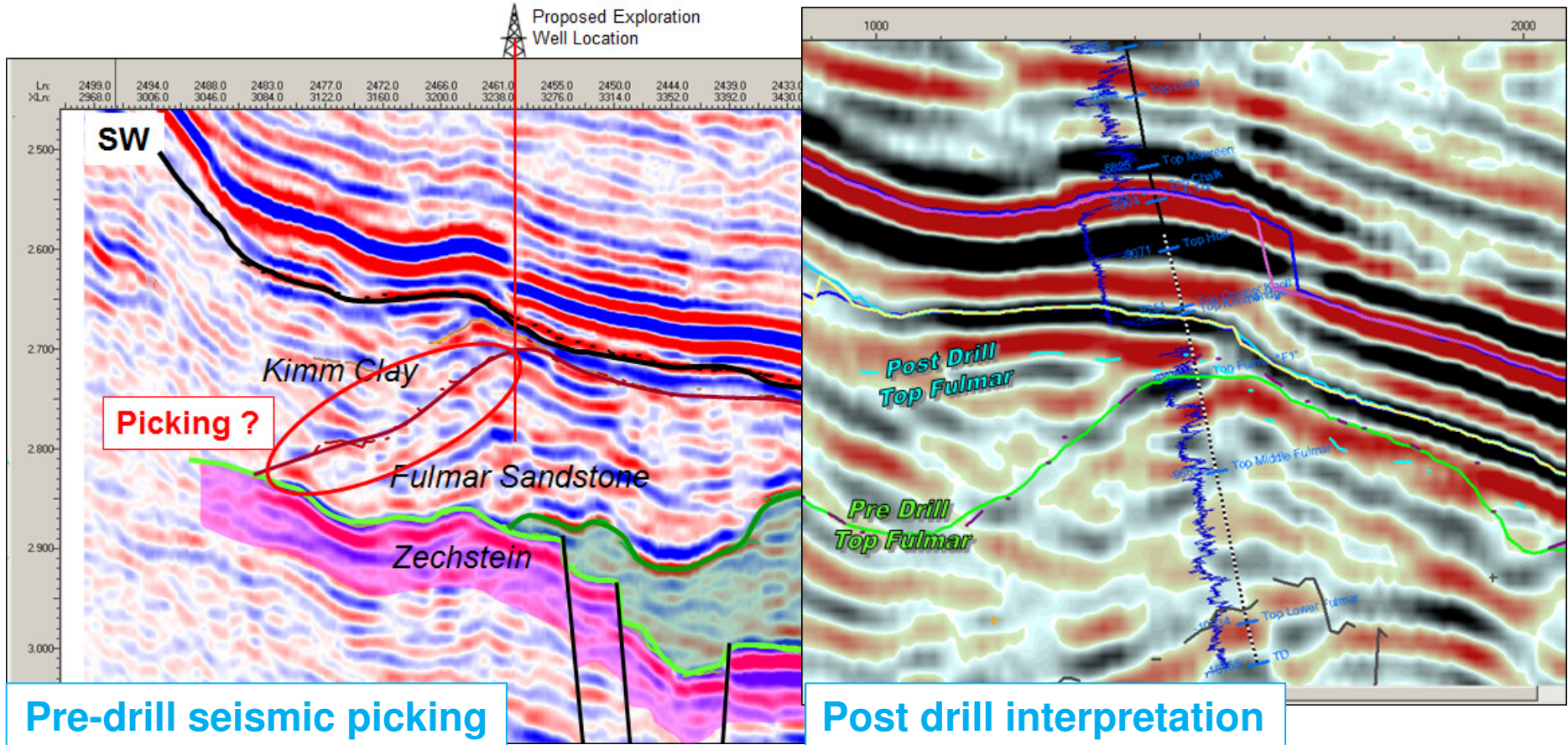


Top Fulmar Depth Map (m TVDss)  
TCM 31<sup>st</sup> March 2006  
i.e. @ technical decision point



## 2) Seismic picking questionable

- >> need for other advice (Peer review?)
- >> need to improve QC (1/5)

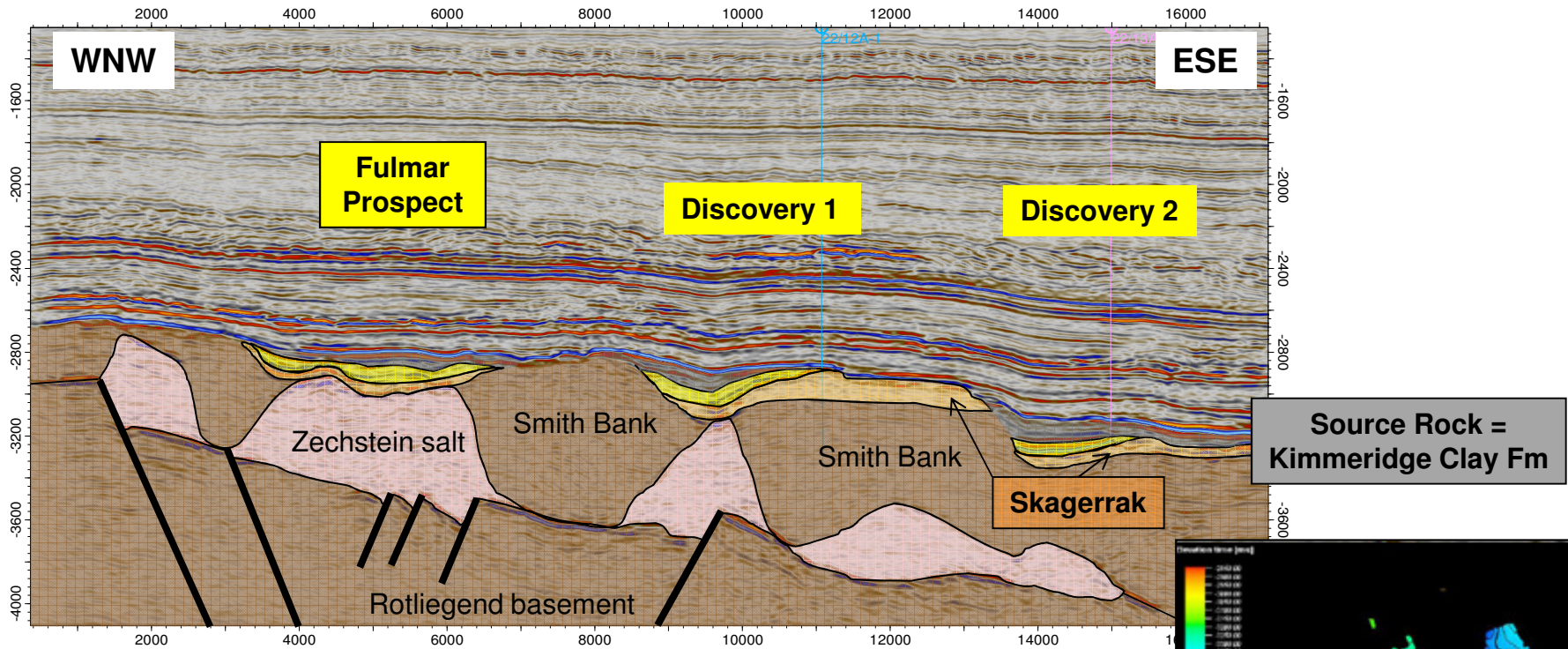


> Keep using analogues, but beware of respecting the data



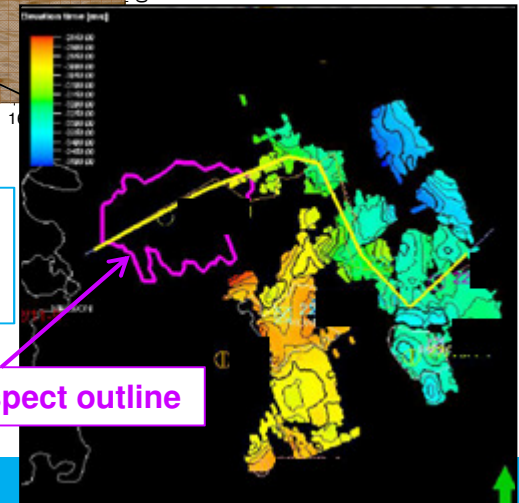


### 3) Efficient seal and / or efficient sourcing pathway ?



Thickness map of the Source Rock >

Fulmar prospect outline





Oil & Gas  
Authority

1. Project Objectives, Time-Line and Status
2. A few statistics...
3. Reasons for failure
4. Selected interpretation pitfalls
5. Conclusions



# Conclusions – 1/2

- **Underestimation of the physical content of the seismic response:**
  - Well to seismic ties must be properly done >> impact on choice of the relevant horizon to be picked and / or on reservoir polarity
  - DHI type and robustness must be double checked
  - When looking at prospects that are solely dependent on AVO:
    - seismic data must be properly processed prior to any AVO study
    - **Produce and risk the geological model unsupported by AVO. Does the play makes sense without AVO support?**
  - **Seismic picking must not cut through valid seismic reflectors.** Dual polarity displays should help more rigorous picking particularly in Tertiary or relatively shallow Plays.
  - Prognosis of sand presence cannot only rely on “rules of thumb”, particularly when seismic data are poor /fair quality. Re-processing, acquiring new fit for purpose 3D data and rock physics modelling should be undertaken before locating wildcats on poor quality data
- **Cognitive bias:** Since the “X” discovery was just made, was there some kind of "cognitive bias" which led to a too fast move to drill what was deemed to be an analogue amplitude feature / an analogue stratigraphic trap?
- **Drilling quality prospects should prevail against drilling as many wells as possible** >> food for thought for the OGA?
- **In some instances, the operator was the sole licensee:** being not far enough away to assess the prospect this resulted in over-confidence. >> food for thought for the OGA?
- **Access to information:** In some instance the lack of access to a well recently drilled up dip of the prospect lead to the drilling of another dry well >> food for thought for the OGA?



# Conclusions – 2/2

## What shall we do to become more successful?

### ➤ Geology

- Better regional understanding using Play Fairway maps
- Improve quality and expand scope of well data in CDA (biostratigraphic & geochemical...etc...)
- Understanding trap integrity / fault and top seal key issues; prospects being under-risked.

### ➤ Geophysics

- Data quality of seismic for prospect generation must be up to the task
- Reprocessing together with data scaling and conditioning
- More accurate depth conversion required, more sophisticated velocity modelling
- Potential seismic anomalies e.g. bright and flat spots, need to be carefully analysed

### ➤ Interpretation skills

- Prospects evaluation needs integrated technical input from geophysicists, geologists and reservoir engineers
- Prospect evaluation teams need to ensure there is good linkage with field teams
- Post-Well Analysis is key element of Exploration Quality Insurance process
- Staff movement and turnover can lead to disconnects in prospect generation, post well analysis and regional knowledge



Oil & Gas Authority

# Thank you for your attention !

Thank you to all those who have been sharing with me on these post well assessments:



assessments:



CNR International



and cooperation from:

