CHASING HIDDEN POTENTIAL BY 2G & R SYNTHESIS USING OBN DATA IN THE ALWYN NORTH FIELD

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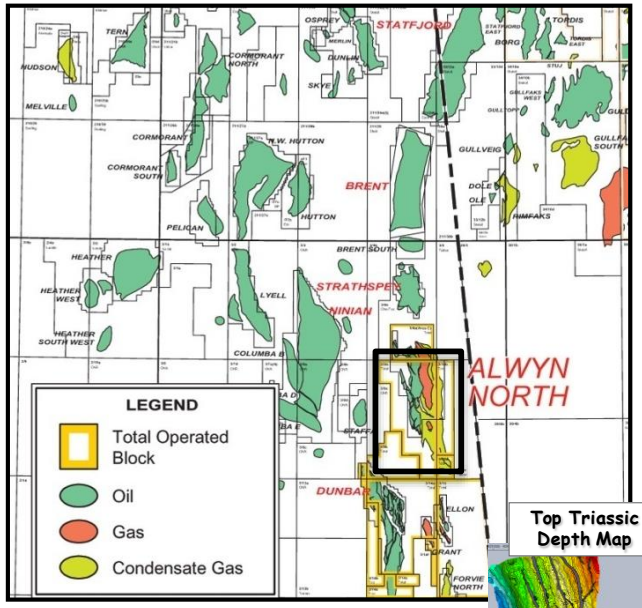
Total E&P UK

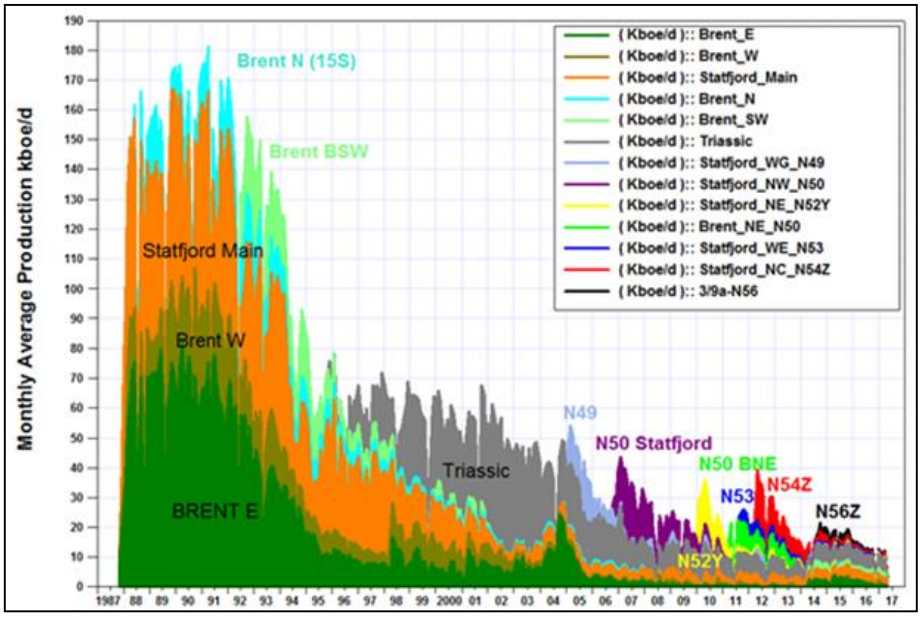
OUTLINE

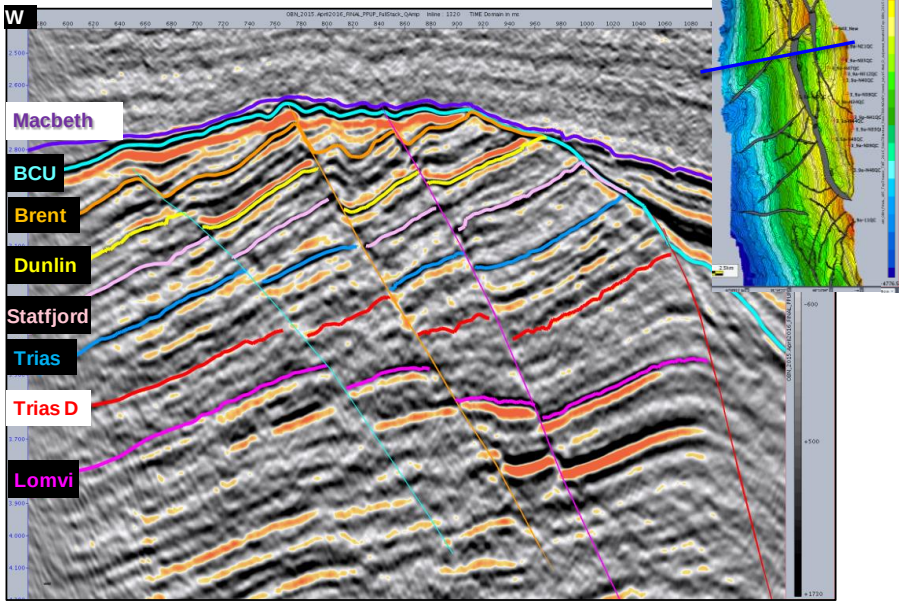
- Introduction to field
- Imaging improvement of OBN over Vintage
- 2G & R approach : Inversion & Reservoir Characterization
  - OBN Elastic Inversion results
  - Reservoir characterisation
  - Comparison with Static data
- Triassic Production overview
- Integrated workflow / methodology for resource estimation
- Summary & Conclusions
- Acknowledgement

ALWYN NORTH: INTRODUCTION & DESCRIPTION

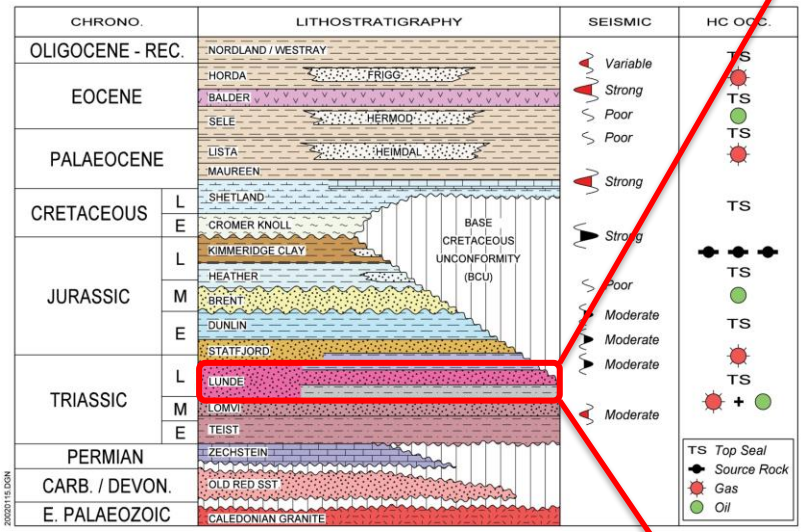
- Discovered in 1975 in Northern North Sea UK (blocks 3/9 & 3/4), on production since 1987
- Eroded and tilted fault blocks, separate HC pools within Jurassic & Triassic
- Actual Average Production ~ 10 kboed
- Cum. Prod. = 618 Mboe
- 3 developed reservoirs:
  - Brent (RF-50%) → Blowdown phase with CGL activation
  - Statfjord (RF-60%) → Gas pool with PWRI
  - Triassic (RF-18%) → Future drilling target focused on Triassic
- Total 4 seismic acquisitions : 1981/1996/2001 Streamer, 2014 OBN

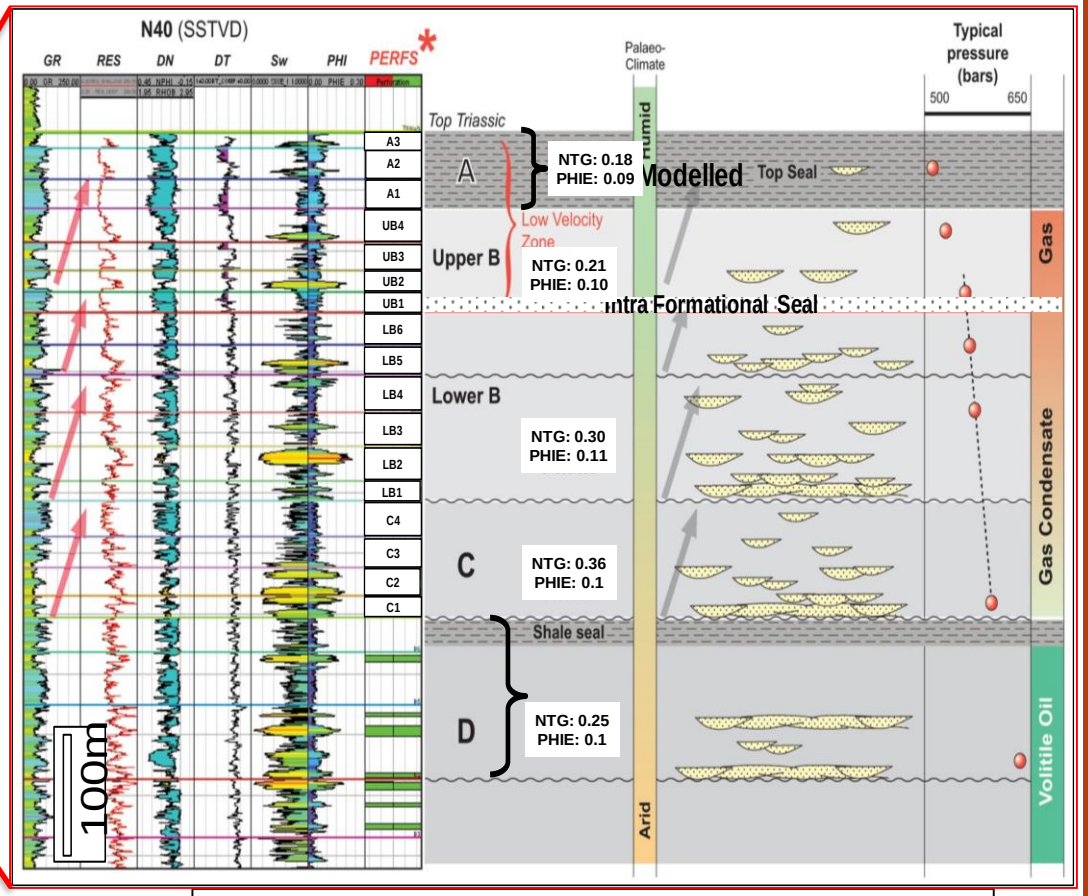






ALWYN NORTH TRIASSIC STRATIGRAPHY





•*Sub divided to 5 zones :* ***A, UB, LB, C & D***
• ***LB and C*** *are the most prolific*

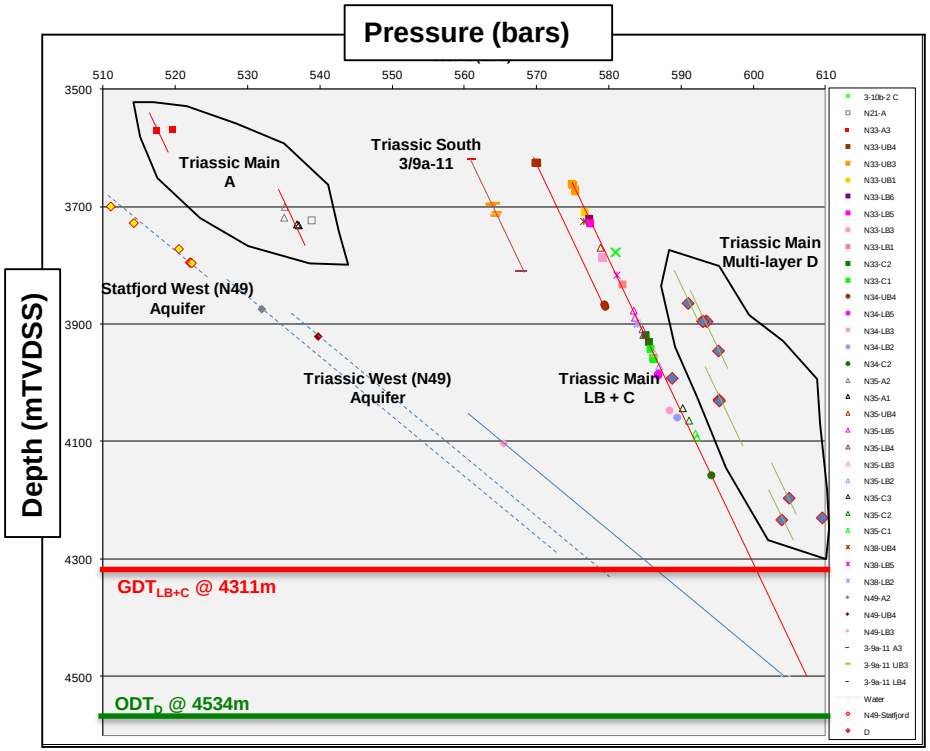
Low NTG → Channel & sheet sands deposited in a semi-arid alluvial plain

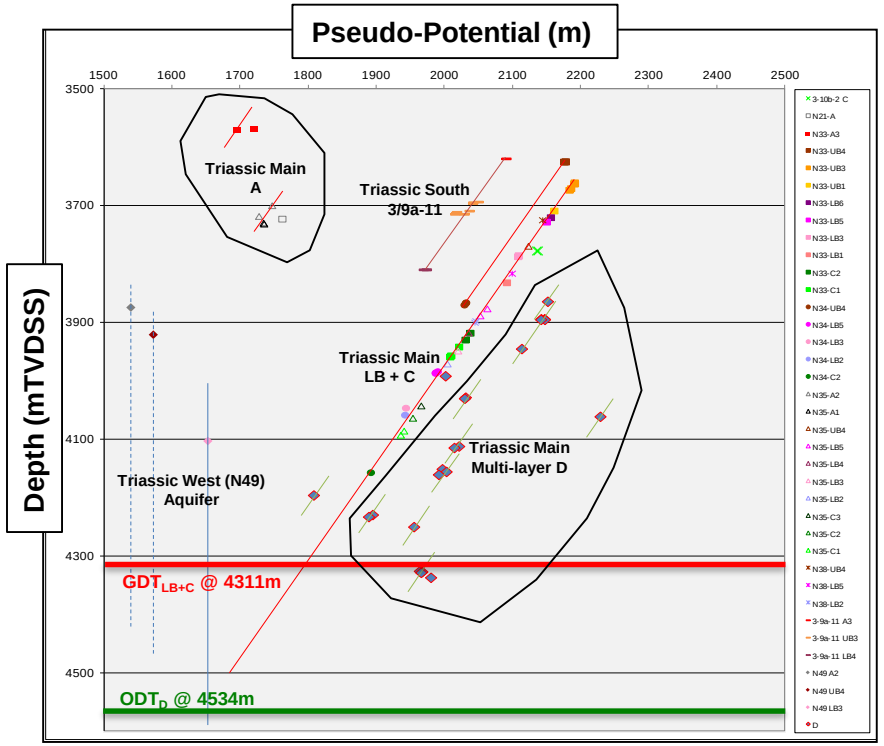
Vertical heterogeneity observed at production time scales

Common static pressure gradient in LB and C zones

Gas in A, UB, LB and C; Oil in D

ALWYN NORTH INITIAL PRESSURE & FLUIDS





No water encountered nor produced by Triassic Main panel wells

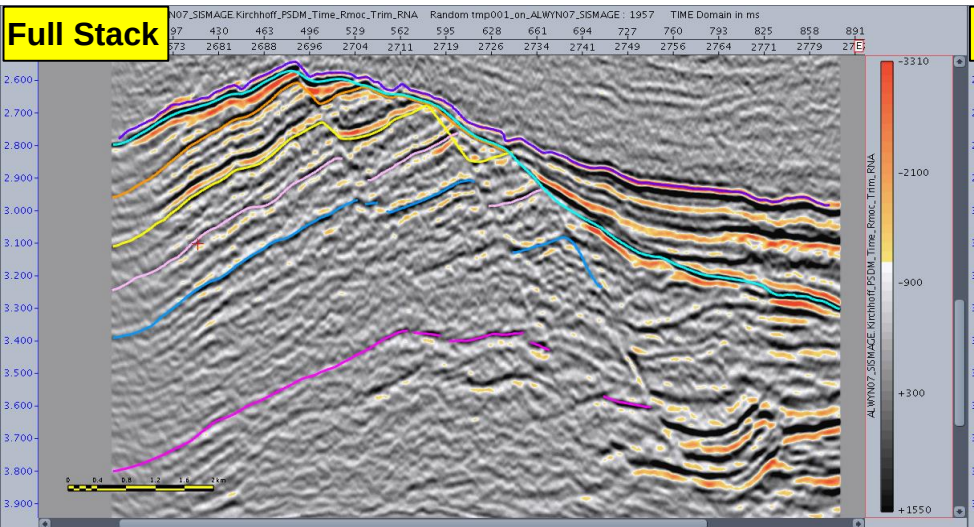
Lower B + C layers gas column in same initial trend

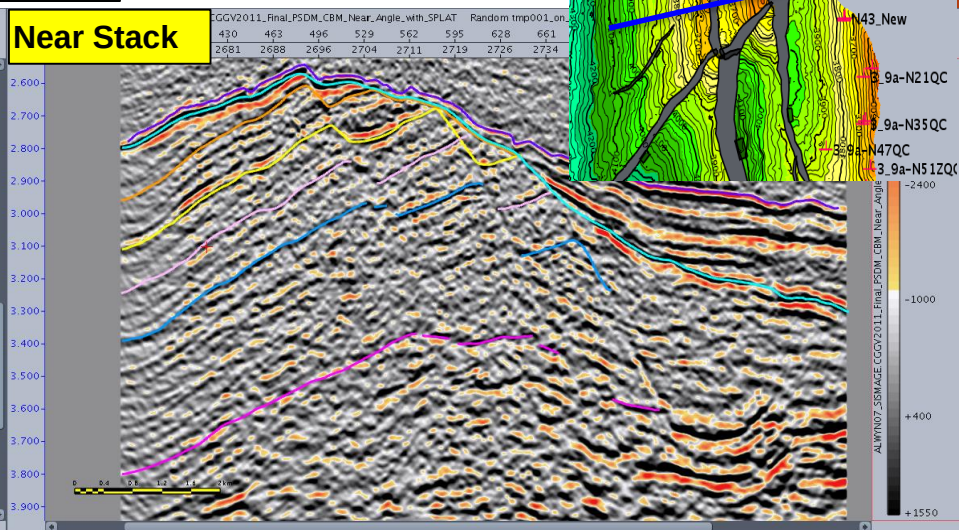
A (gas) and D (oil) layers in different trends

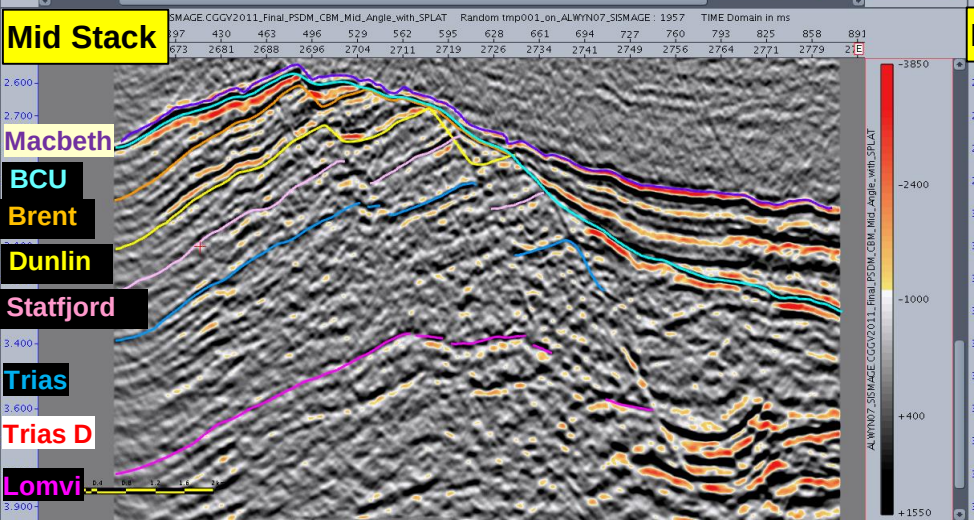
Initial Pressure = 585 bars @ 3900 mTVDSS

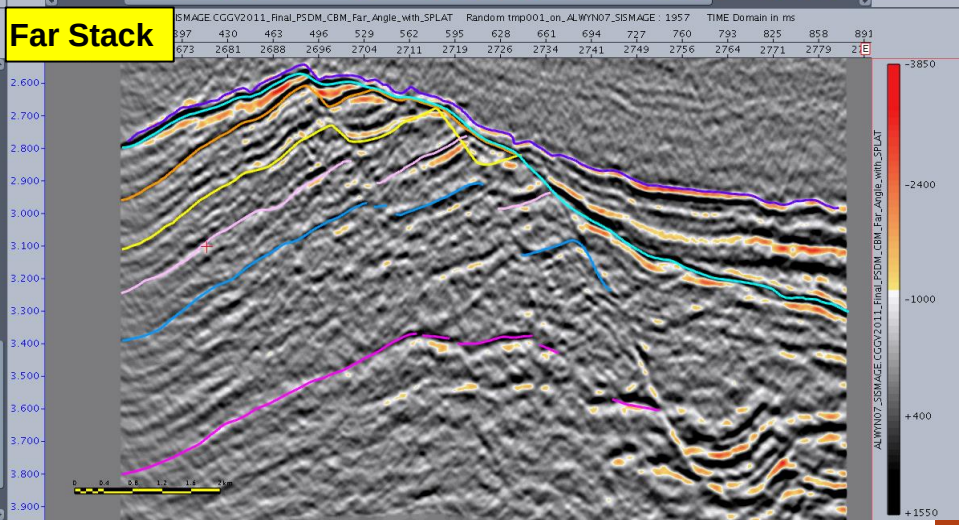
SEISMIC DATA QUALITY COMPARISON

Vintage Streamer



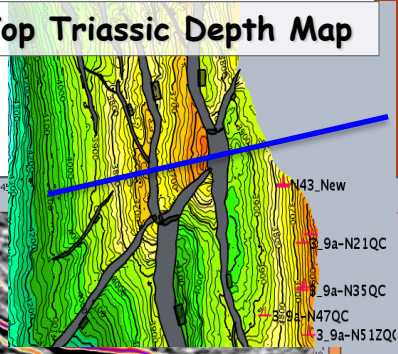


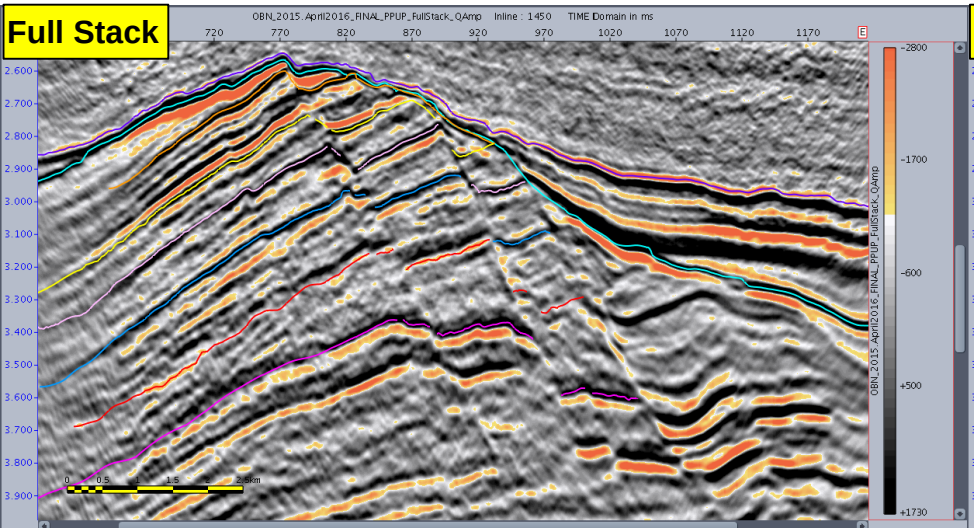


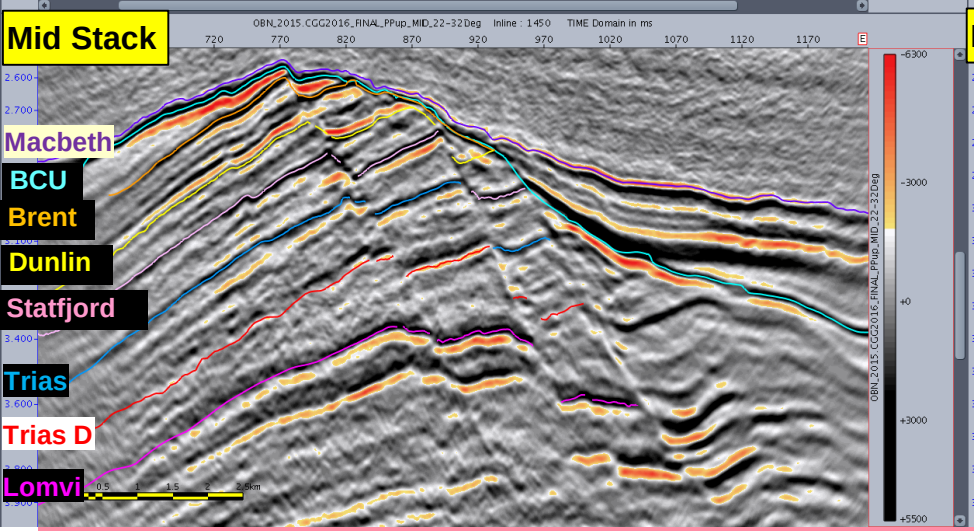


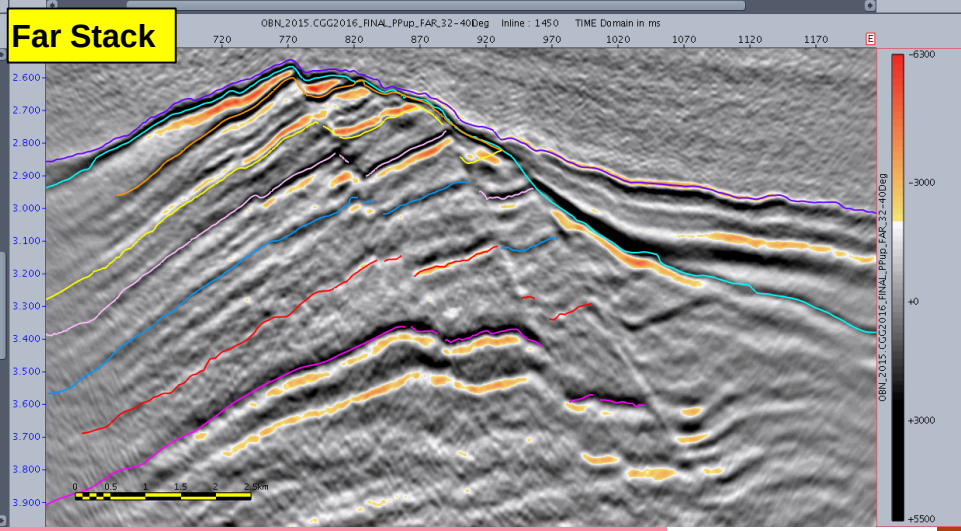
SEISMIC DATA QUALITY COMPARISON

OBN -PP



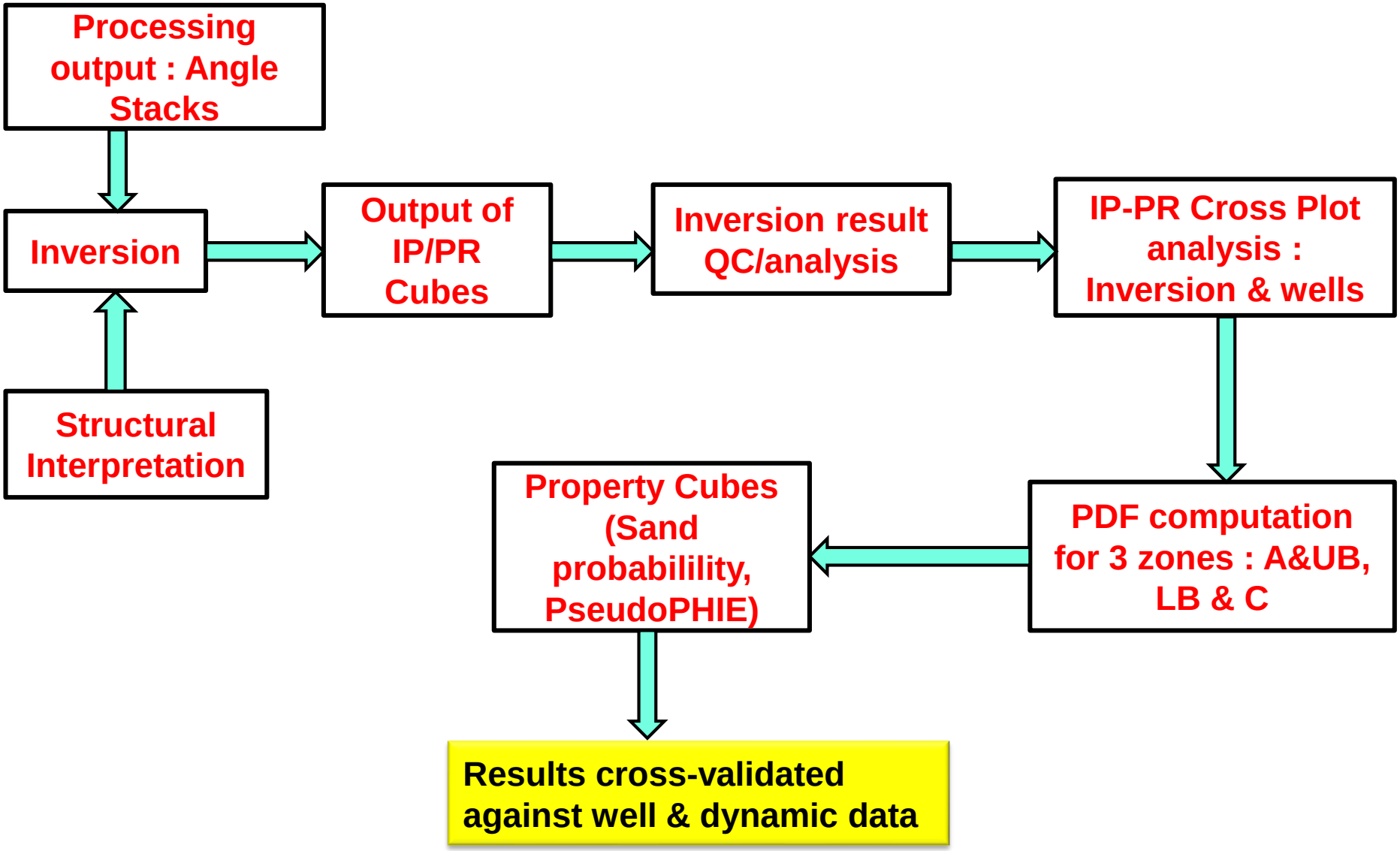




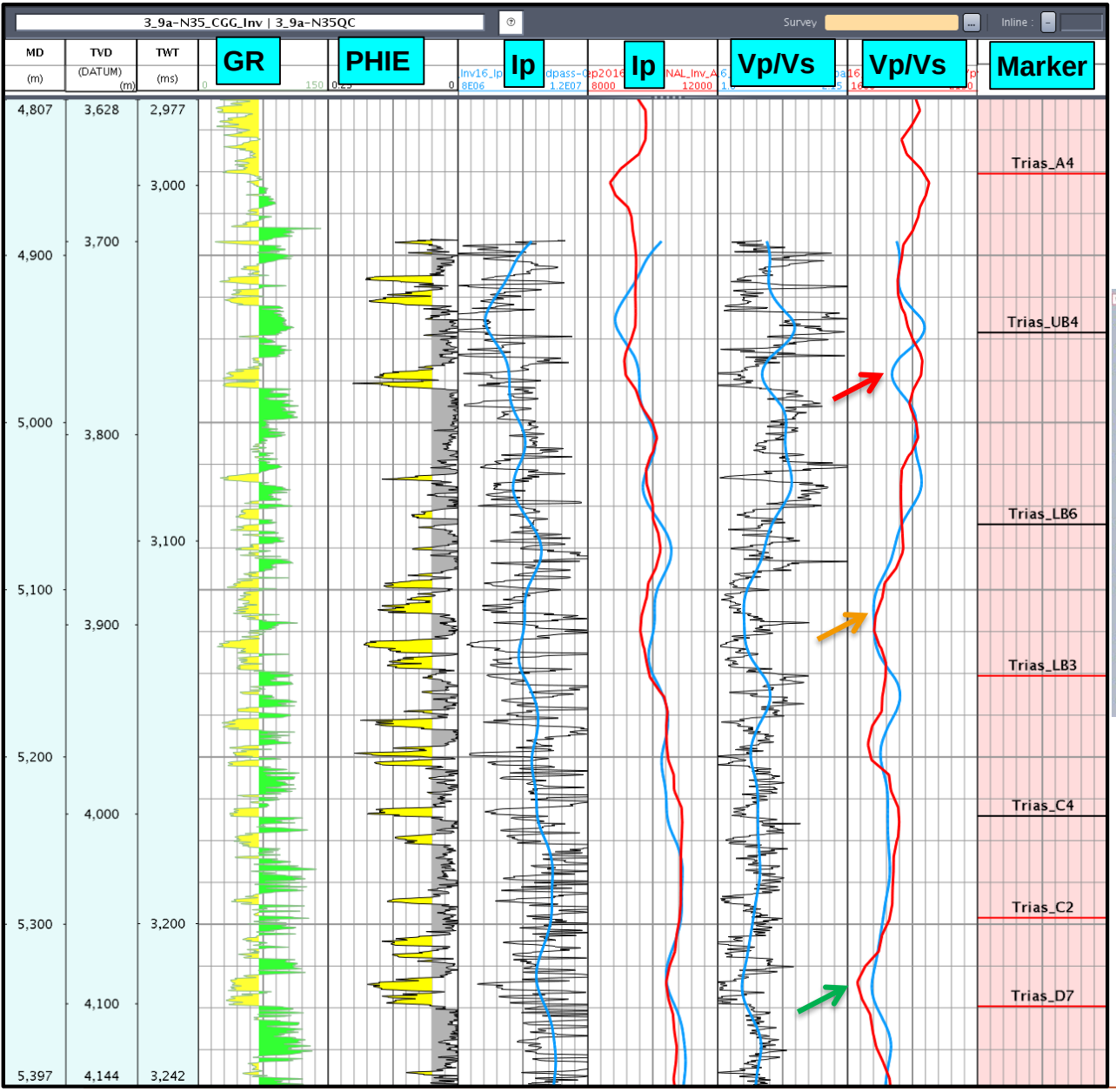


Improved Imaging (<u>at all levels including deep</u>) & quality of angle stacks.
Broader Bandwidth & Higher Signal/Noise ratio.

METHODOLOGY: INVERSION & RESERVOIR CHARACTERIZATION

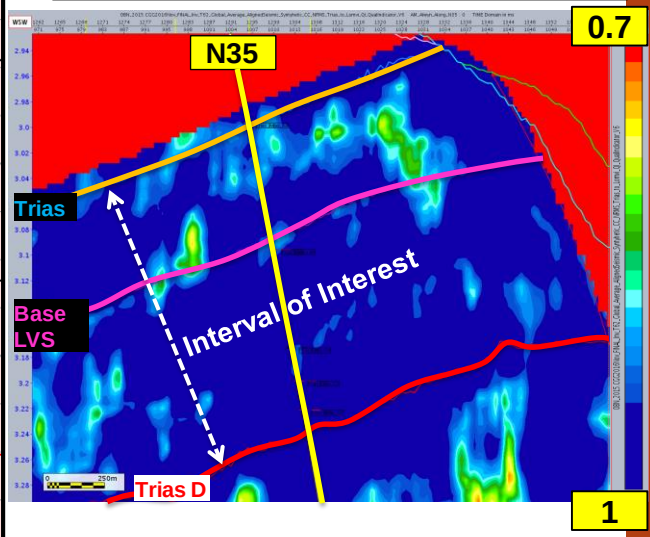


OBN INVERSION QC : EXAMPLE N35



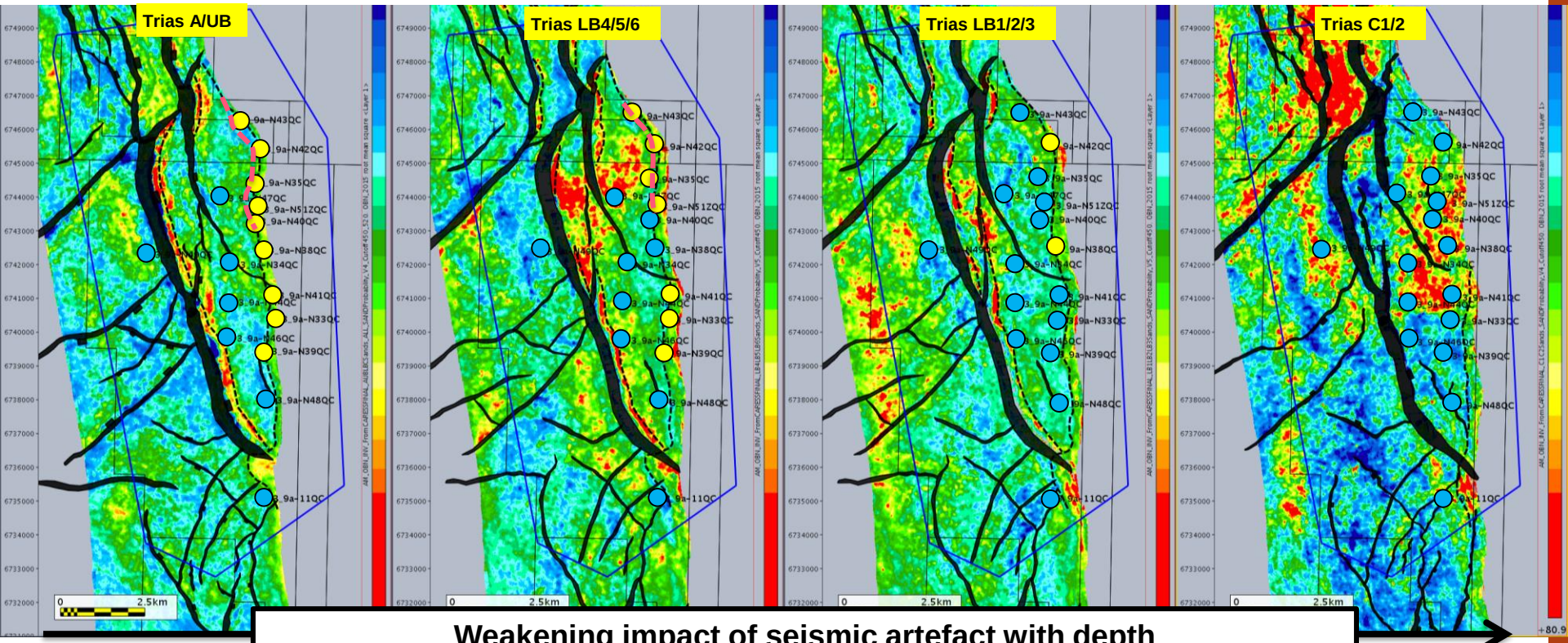
OBN Inversion
Upscaled Well logs
Fine-Scale Well Logs

Inversion quality indicator



Inversion results QC'd in details for all 15 Triassic wells. Globally good to moderate match with well results. Reasons for areas of poor match well understood.

WHERE CAN WE TRUST SEISMIC RESPONSE ?

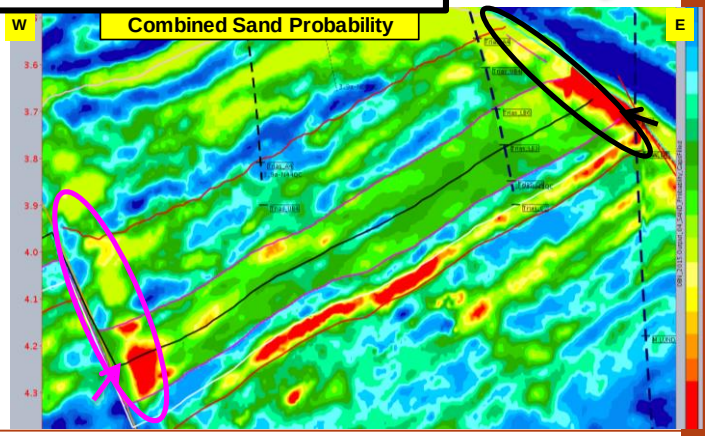


- **2 areas of seismic artefacts:**
  1. **Close to crest / Main Bounding Fault (MBF).**
  2. **Close to major faults.**
- **Higher impact in Shallow (A&UB), smallest impact in deep (C1/C2).**

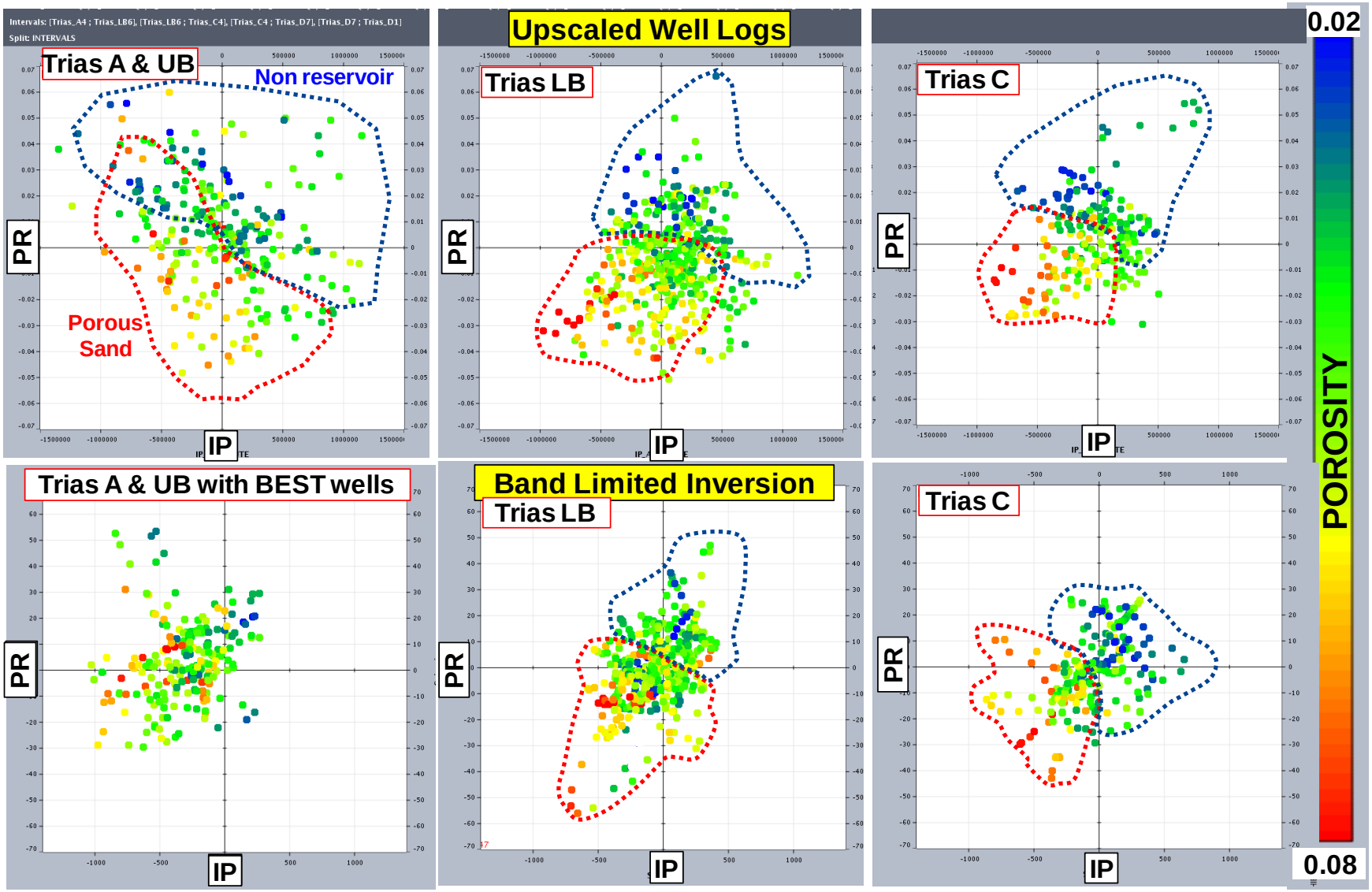
Areas affected by artefacts

Wells unaffected by artefacts

Wells affected by identified artefacts



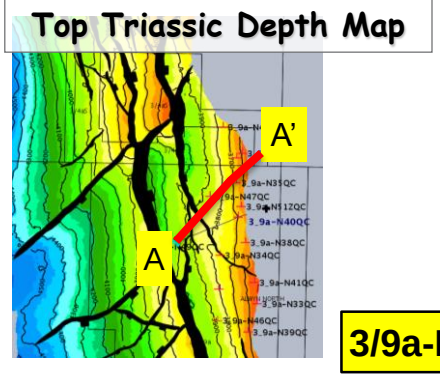
IP - PR CROSSPLOTS : WELLS / OBN INVERSION



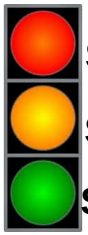
Good confidence in LB and C layers. Poor confidence in A/UB layers.

STATIC CROSS-VALIDATION

Pseudo PHIE & Probability of Sand Cube, *with Upscaled PHIE log along well*



3/9a-N35



Sand not seen

Sand partly seen

Sand resolved

A

3/9a-N35

A'

BCU

Statfjord

Trias

Base LVS

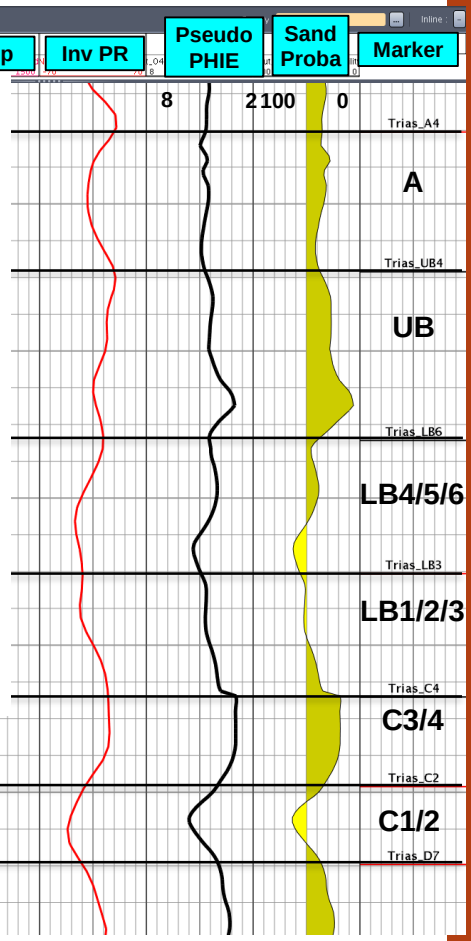
LB3

C4

C2

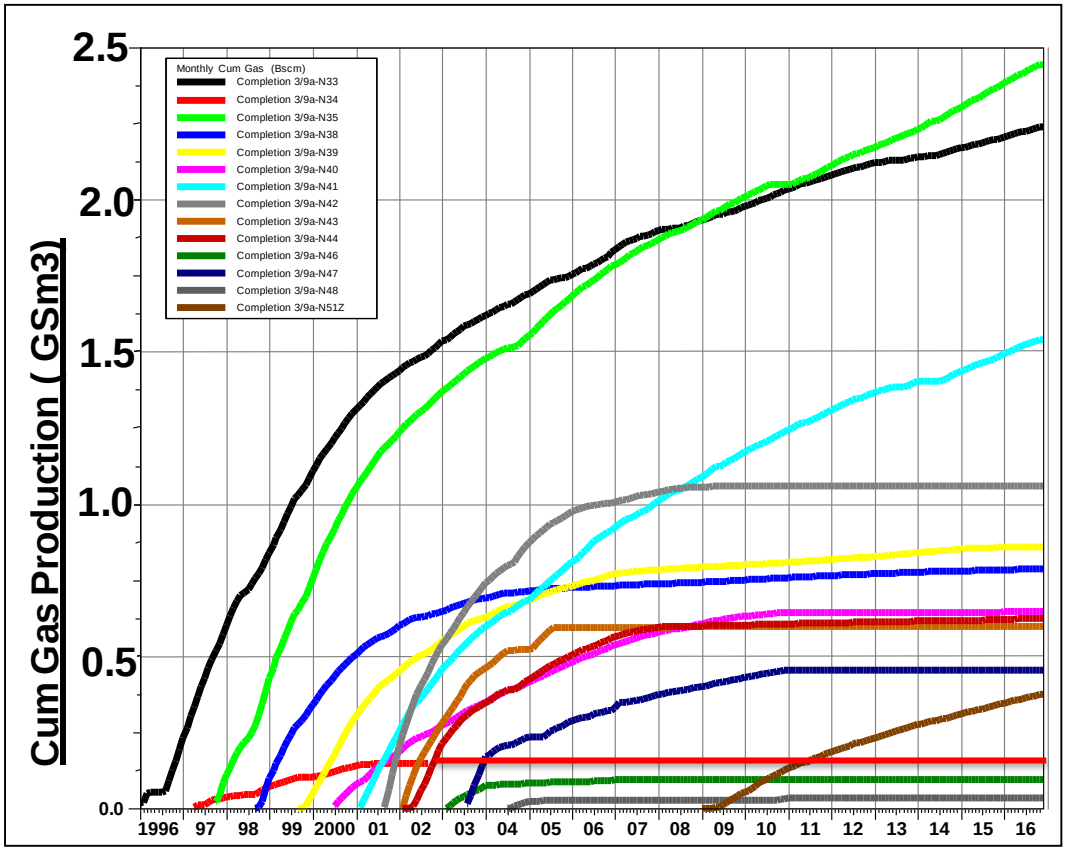
Trias D

Layers	Sands seen on Inversion	Weak Inversion response	Sands not seen on Inversion
A	7%	7%	86%
UB	20%	7%	73%
LB4/5/6	60%	20%	20%
LB1/2/3	33%	20%	47%
C1/C2	36%	36%	28%



Globally over 15 wells, better match for C & LB, poor match for A/UB → Key factors : thickness beyond resolution & artefacts

TRIASSIC PRODUCTION OVERVIEW



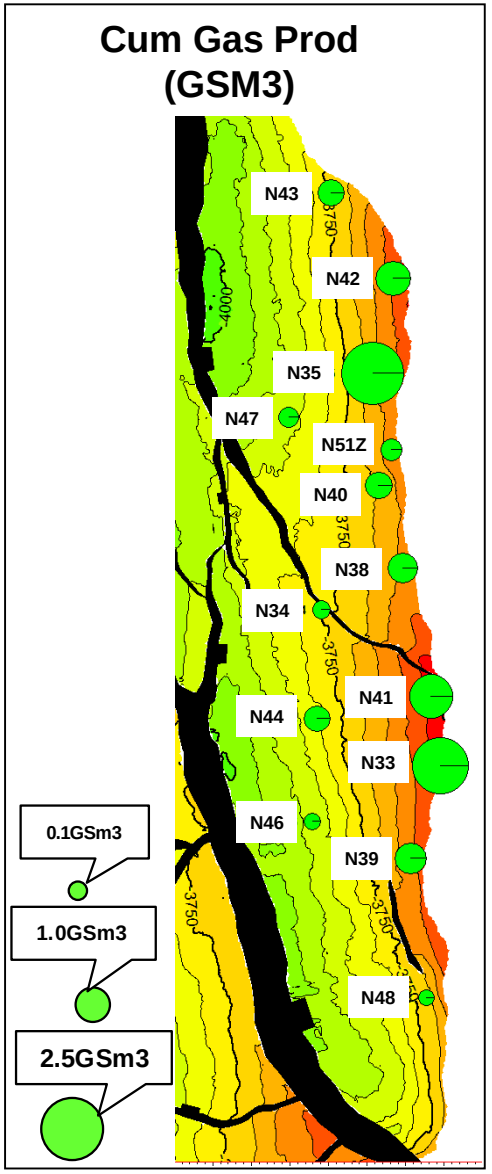
Average Cumulative Production = 7.8 Mboe

Production Mechanism = Depletion

43% of Cum prod came from N33 & N35

Main producers located at the crest

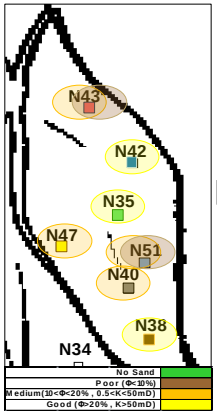
Down-dip wells (N44, N46, N47) impacted by depletion



Triassic Cumulative Production
10.9 GSm3 (~110Mboe)

DYNAMIC ANALYSIS

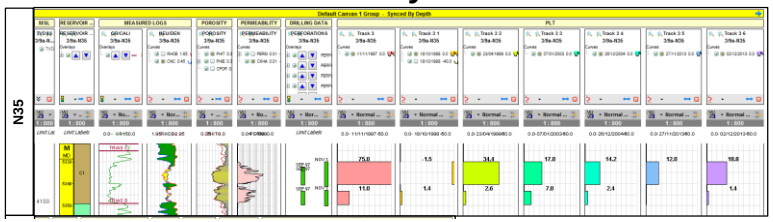
1.



Sand properties and presence

2.

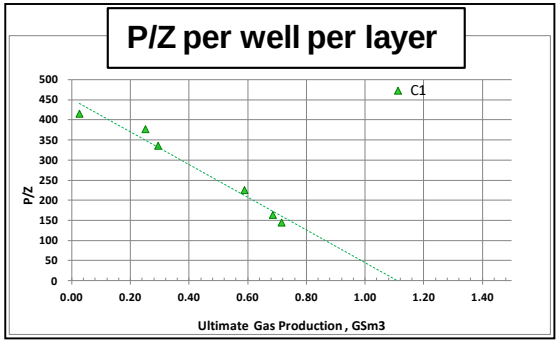
PLT analysis



SIP analysis
Production split per layer

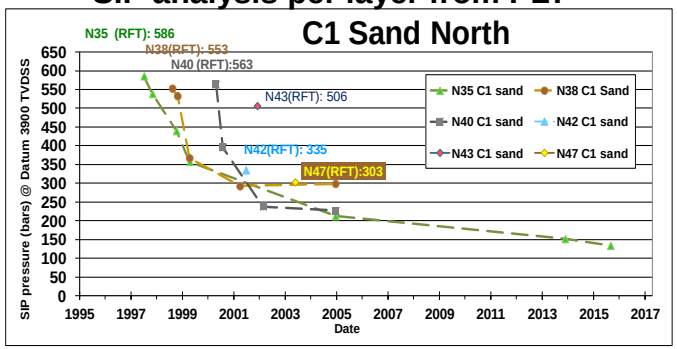
3.

P/Z per well per layer

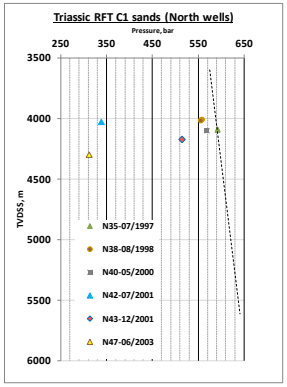


Connected Volume per layer

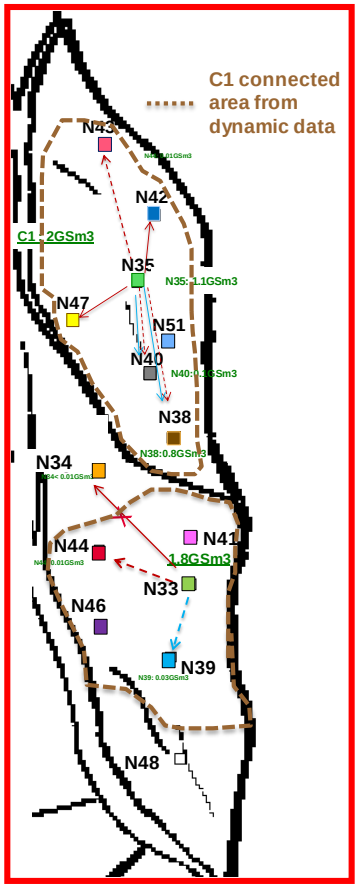
SIP analysis per layer from PLT



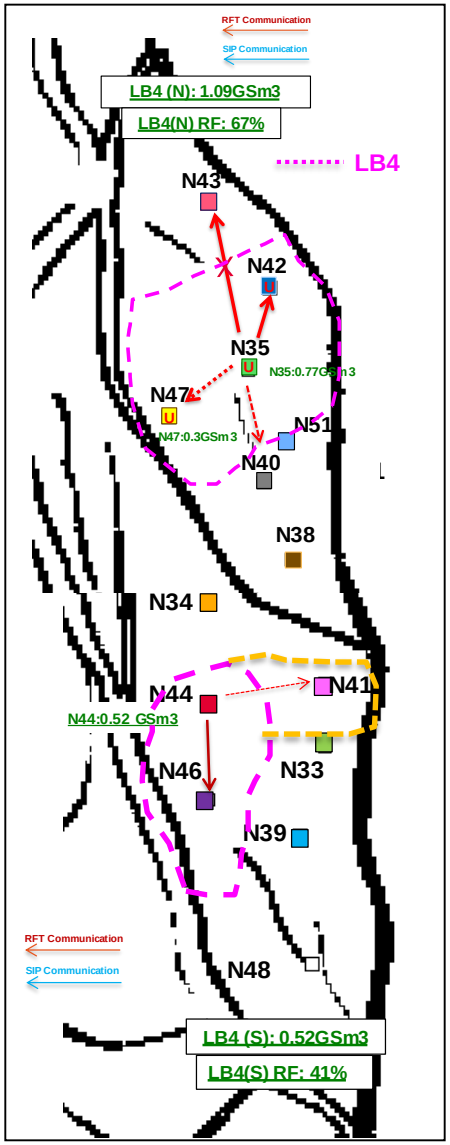
WFT analysis per layer

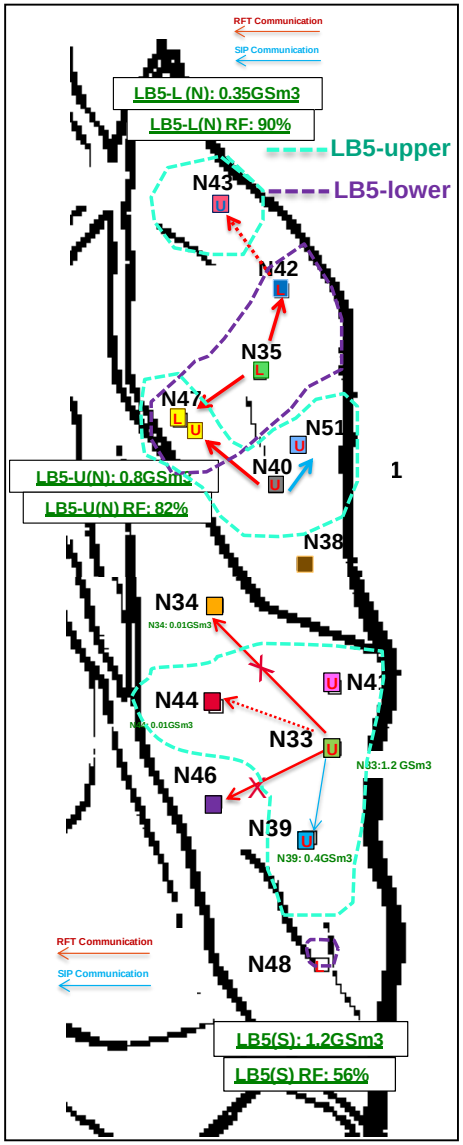


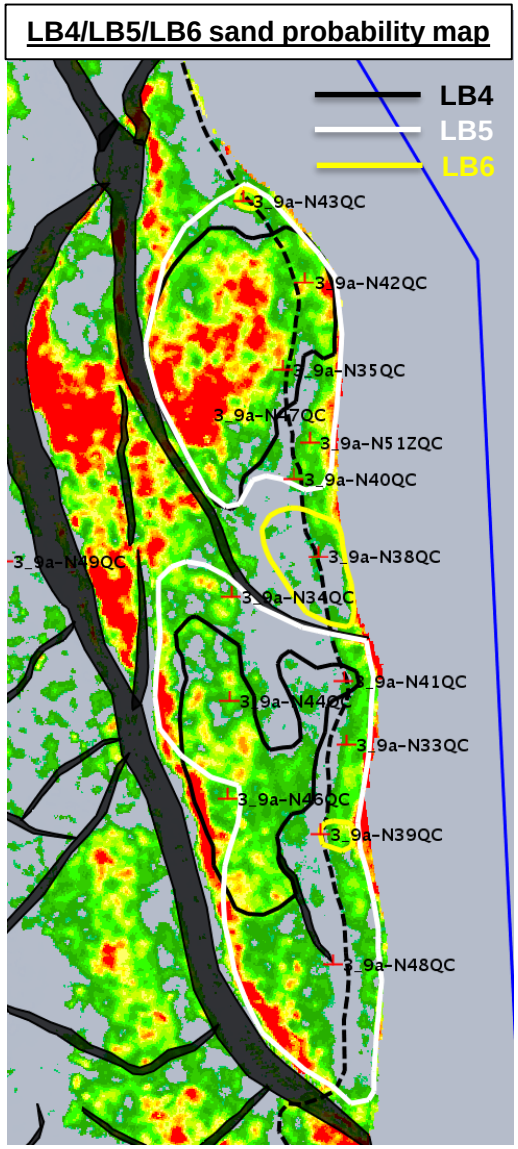
Communication map



LB4/LB5/LB6 SAND CONNECTED VOLUME







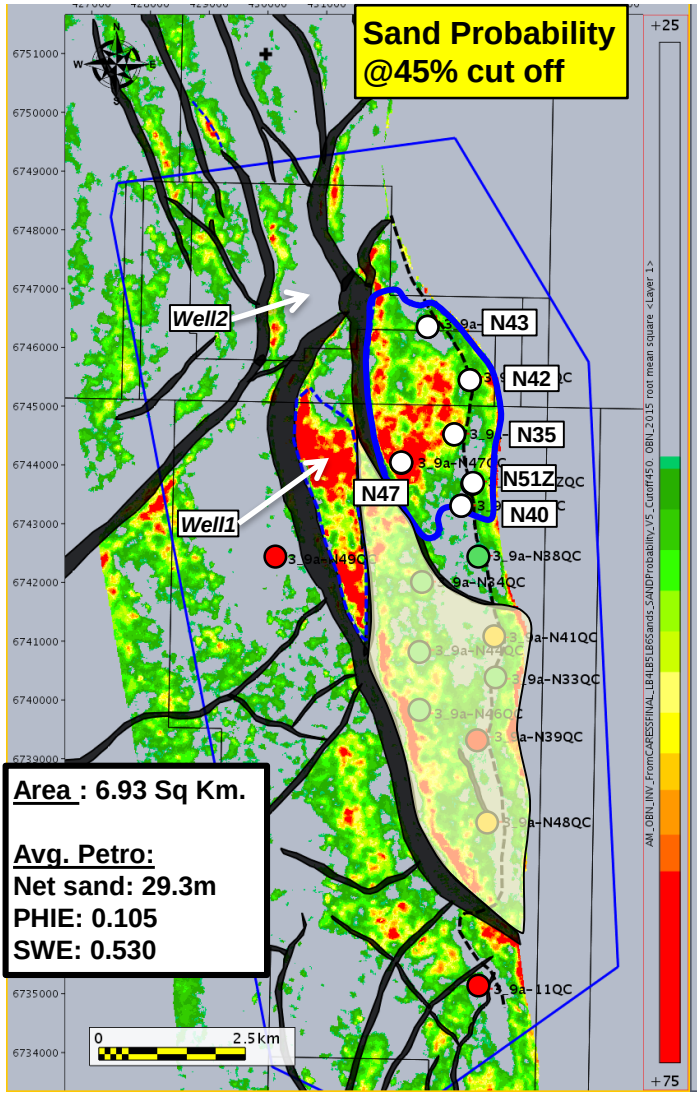
Polygon areas are based on connected GIP per layer from dynamic synthesis

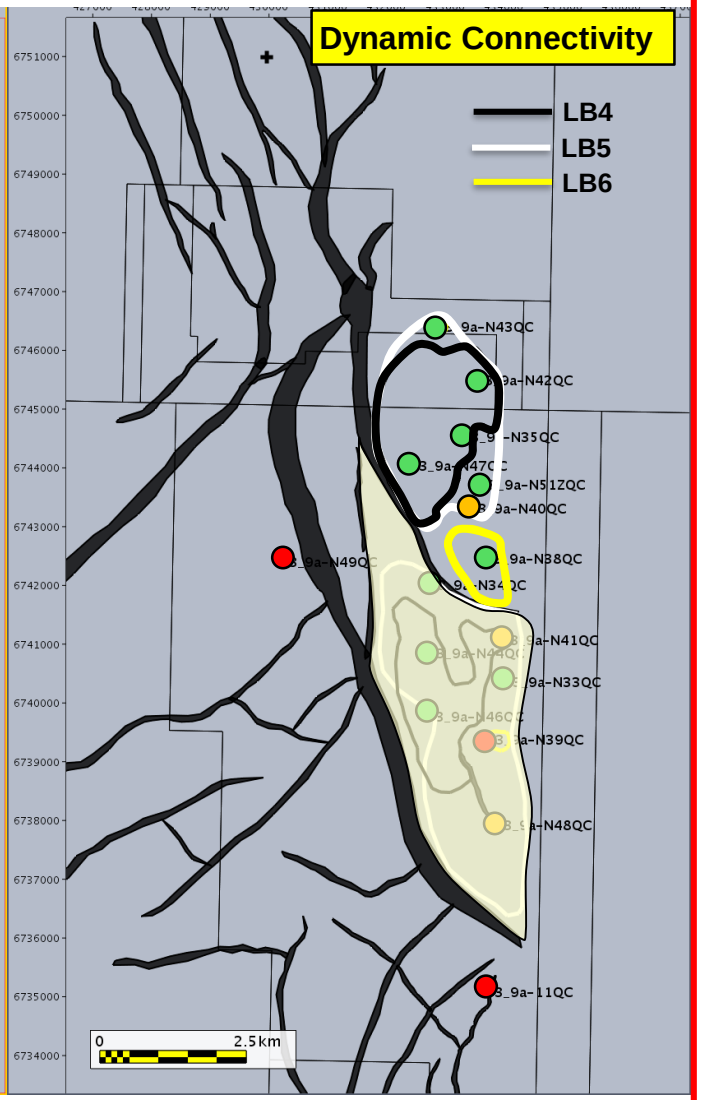
Sand probability map used as a guide to locate the polygons trying also to respect the well communication maps

Good agreement between seismic and dynamic for LB4/LB5 layers in the North

Agreement more difficult to find in the South due to poorer sand imaging (Not adequately stacked)

DYNAMIC CROSS-VALIDATION – LB4 /LB5 /LB6 SANDS





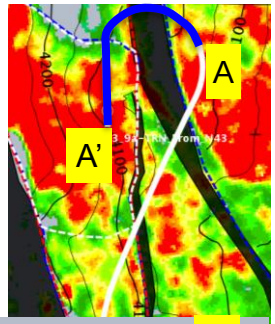
- Seismic delineates LB4/5/6 sands when adequately stacked.
- IGIP from seismic is slightly higher but
  - LB6 has no connected volume from dynamic data
  - Very high recovery factors observed in LB4/LB5 → Dynamic Connected volume under-estimated ?
- IGIP from seismic inline with connected gas volume.
- Good confidence to identify LB4/5/6 sands in main panel North → helps to validate sand presence in Well 1

IGIP – 2.9 GSm3

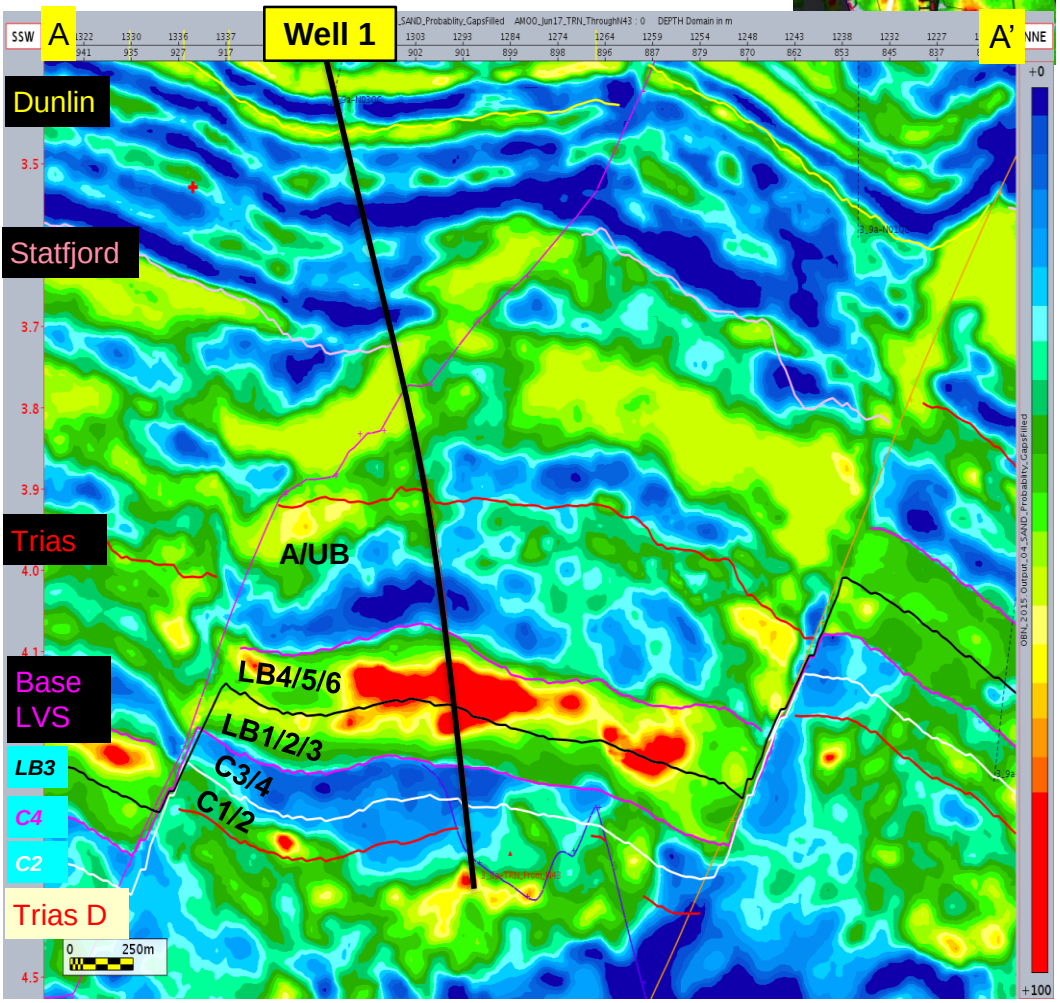
Connected GIP – 2.3 GSm3

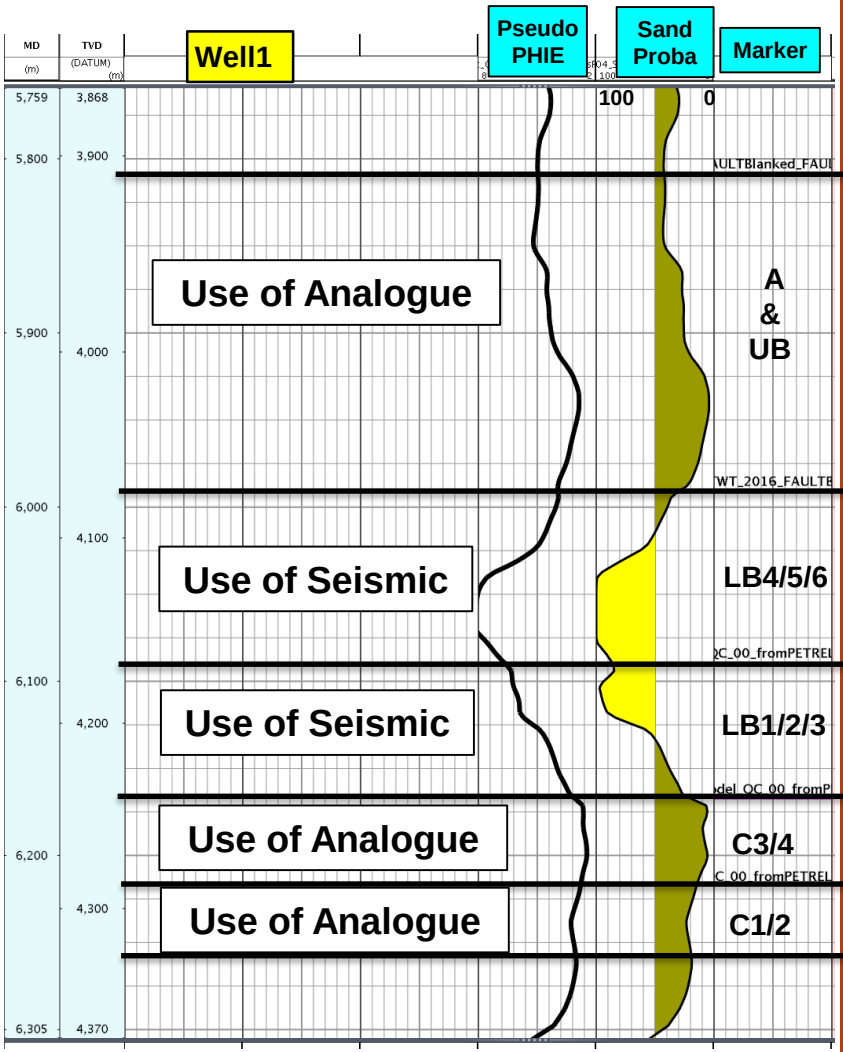
INFILL TARGET RESOURCES

INTEGRATED Probability of Sand Cube - Output from Caress PDF & Combined together



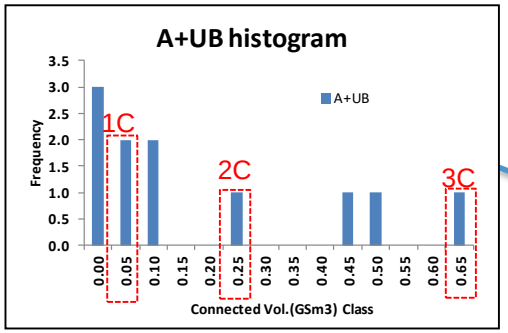
Primary targets – LB sands

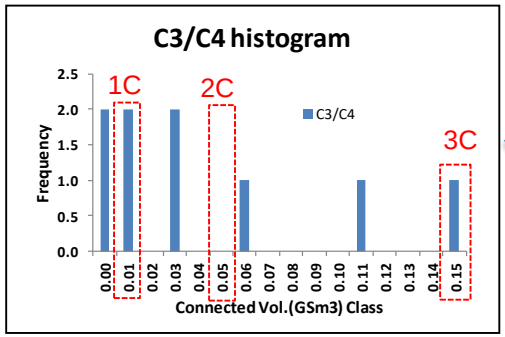


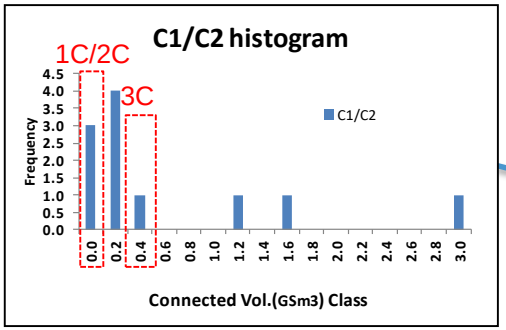


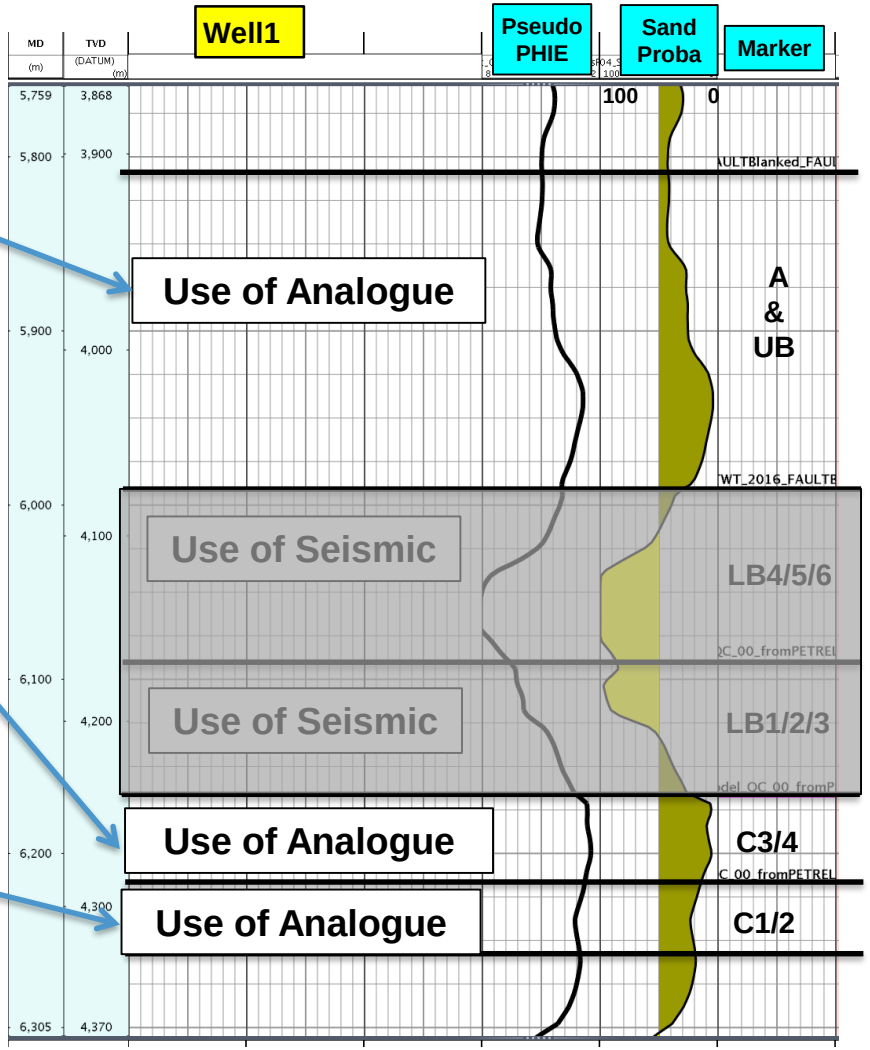
WELL 1 RANGE OF RECOVERY WITH ANALOGUES

Only wells with perforated intervals and PLT data are included



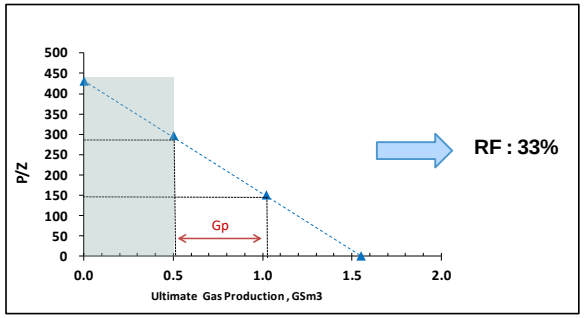




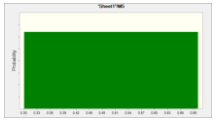


WELL 1 RESOURCES: RECOVERY FACTOR ASSUMPTIONS

1. Surface area from seismic : LB4/5/6 & LB1/2/3

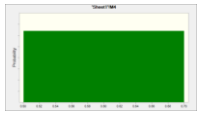


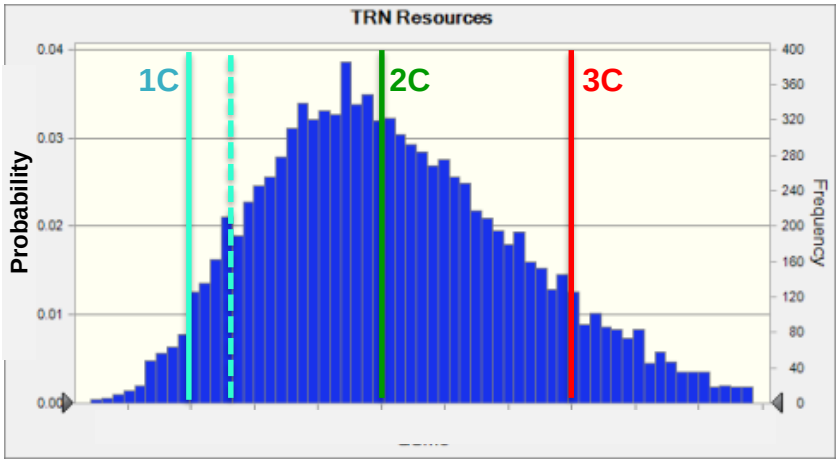
- Uniform distribution with parameters
  - Min: 0.3
  - Max: 0.7

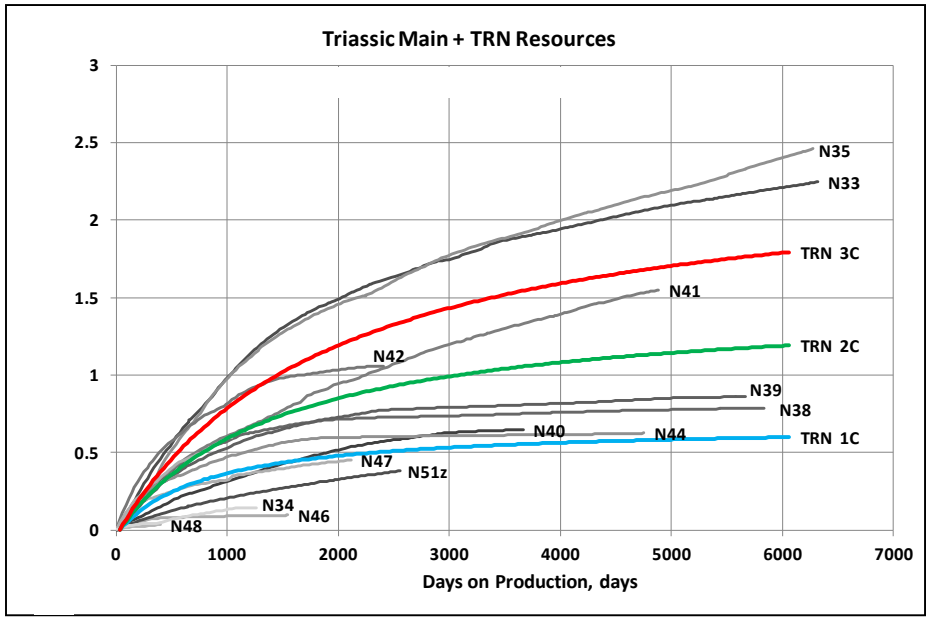


2. From analogues: A/UB + C1/C2 + C3/C4 :

- RF range is higher as the volume is smaller than LB layers then less likely to be depleted
- Uniform distribution with parameters
  - Min: 0.5
  - Max: 0.7







SUMMARY & CONCLUSIONS :

- **OBN provided a step change improvement in image quality, leading to improved reservoir characterisation, consistent with global geological understanding and dynamic synthesis of Triassic.**

- **Good confidence on the ability of the PP Elastic Inversion to predict stacked porous sands.**

- **Imaging / inversion uncertainty & limitation :**
  - **Close to the crest due to BCU erosion**
  - **Close to big faults due to strong fault plane reflection**

- **Adapted workflow managed to establish correlations between inversion & well results. Confidence in seismic :**
  - **HIGH : C1/C2 in Main panel (both North & South) & LB4/5/6 in Main-Northern panel**
  - **LOW : LB1/2/3 in the Main panel (both North & South) but good response in Well 1 panel**
  - **NO : for A/UB layers**

- **Gas in Place Volume estimated from the seismic is considered as minimum connected gas volume**

- **Confidence gained in main panel helps to predict sand presence towards potential future target & it's resource estimation.**

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