



PETEX 2021
SHAPING THE FUTURE



OLD FIELD, NEW TRICKS : ALWYN OBN & IMPACT OF SUBSURFACE (2G & R) INTEGRATION



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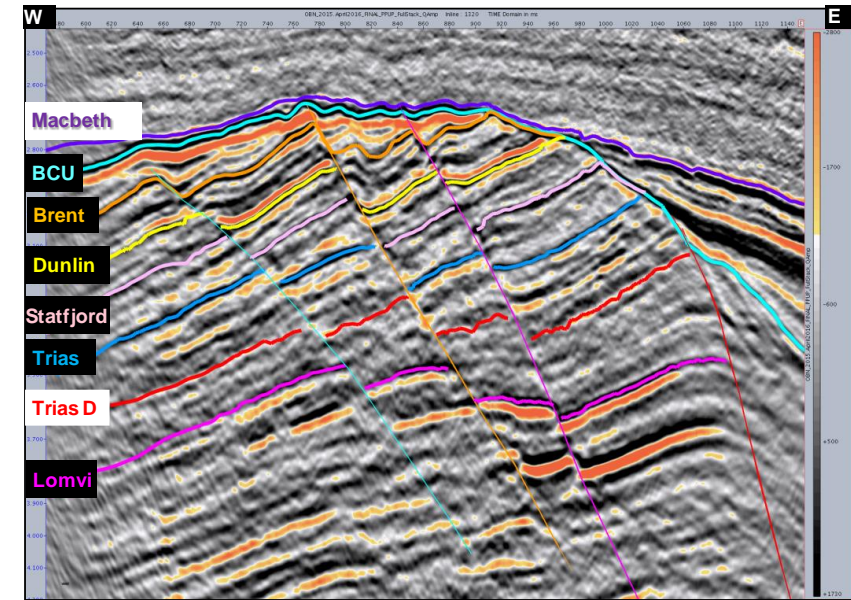
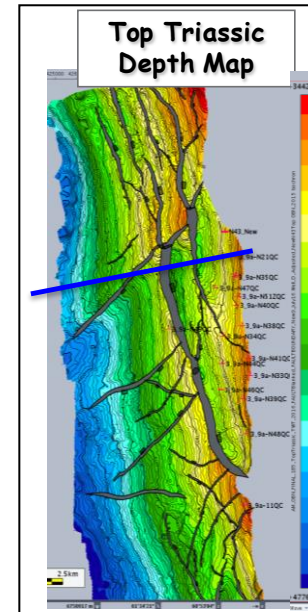
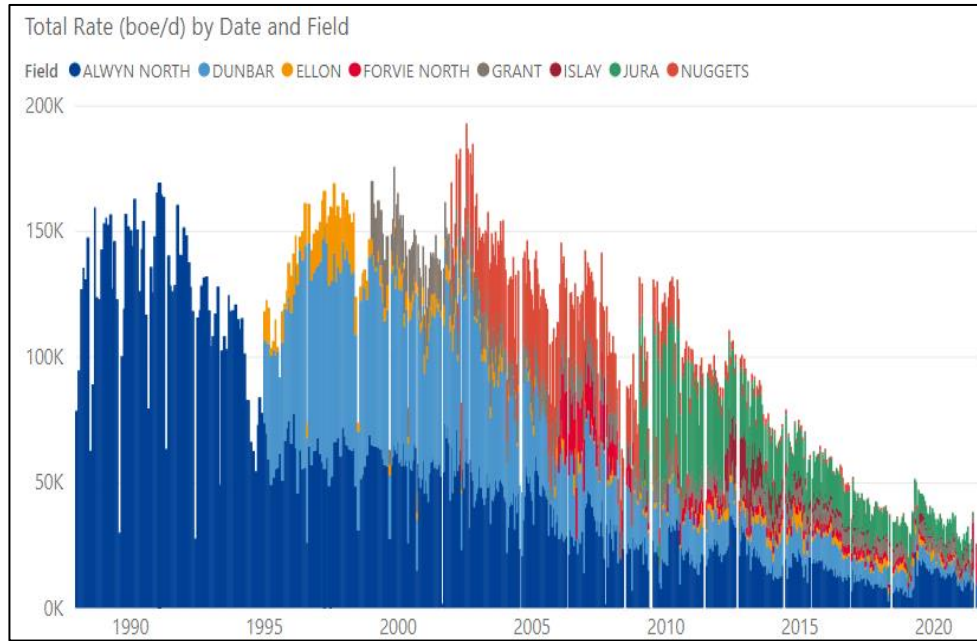
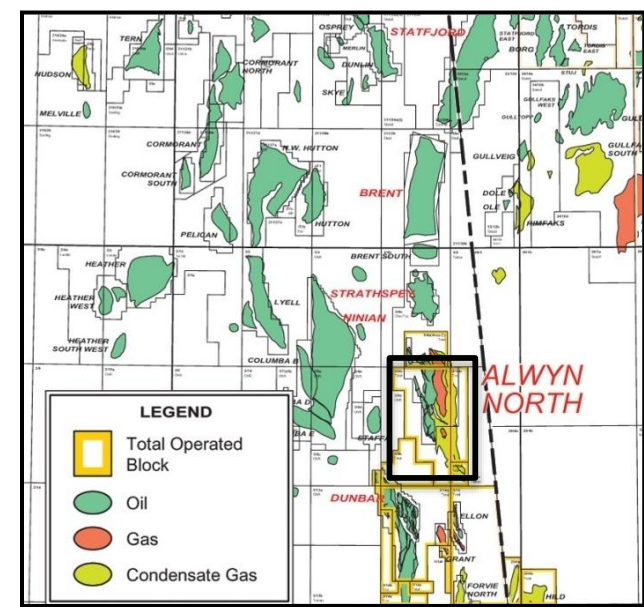
Outline & Overview

- Introduction to Alwyn field & Triassic reservoir
- 2G&R Integrated workflow, project outline & key milestones
- OBN uplift : Imaging improvement & Inversion, reservoir characterisation
- Inversion & Reservoir Characterization
 1. Static cross-validation
 2. Dynamic cross-validation
- TRN impact on well target placement & well-results
- Conclusions & future impacts

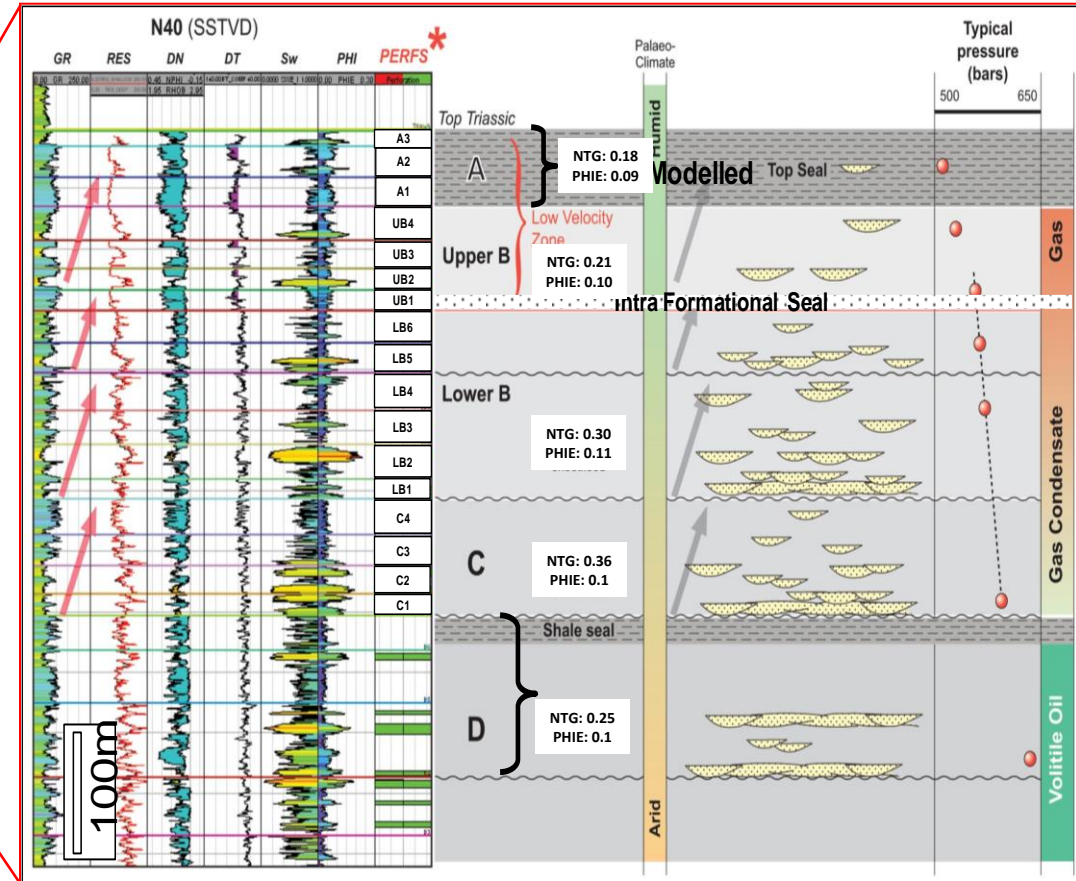
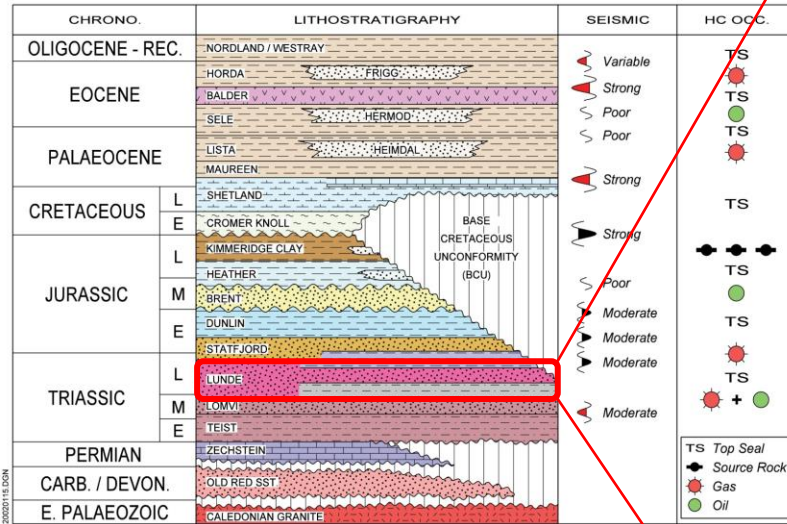
Alwyn North: Introduction



- 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 ~ 14 kboed
- Cum. Prod. = 640 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



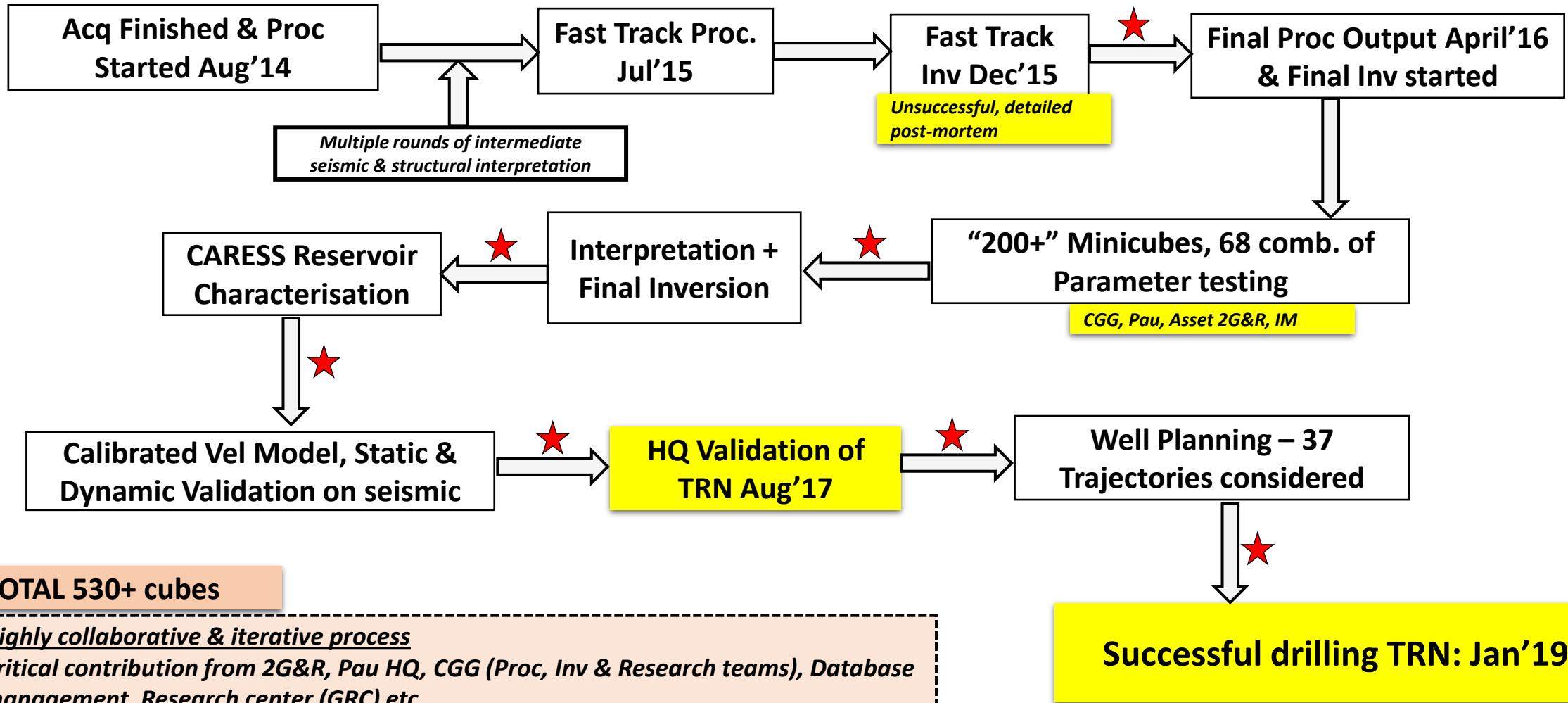
Low NTG → Channel & sheet sands deposited in a semi-arid alluvial plain

Vertical heterogeneity observed at production time scales

Gas in A, Upper B, Lower B and C; Oil in Triassic D

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

“2G&R+” (incl. Drilling & Ops) integrated workflow



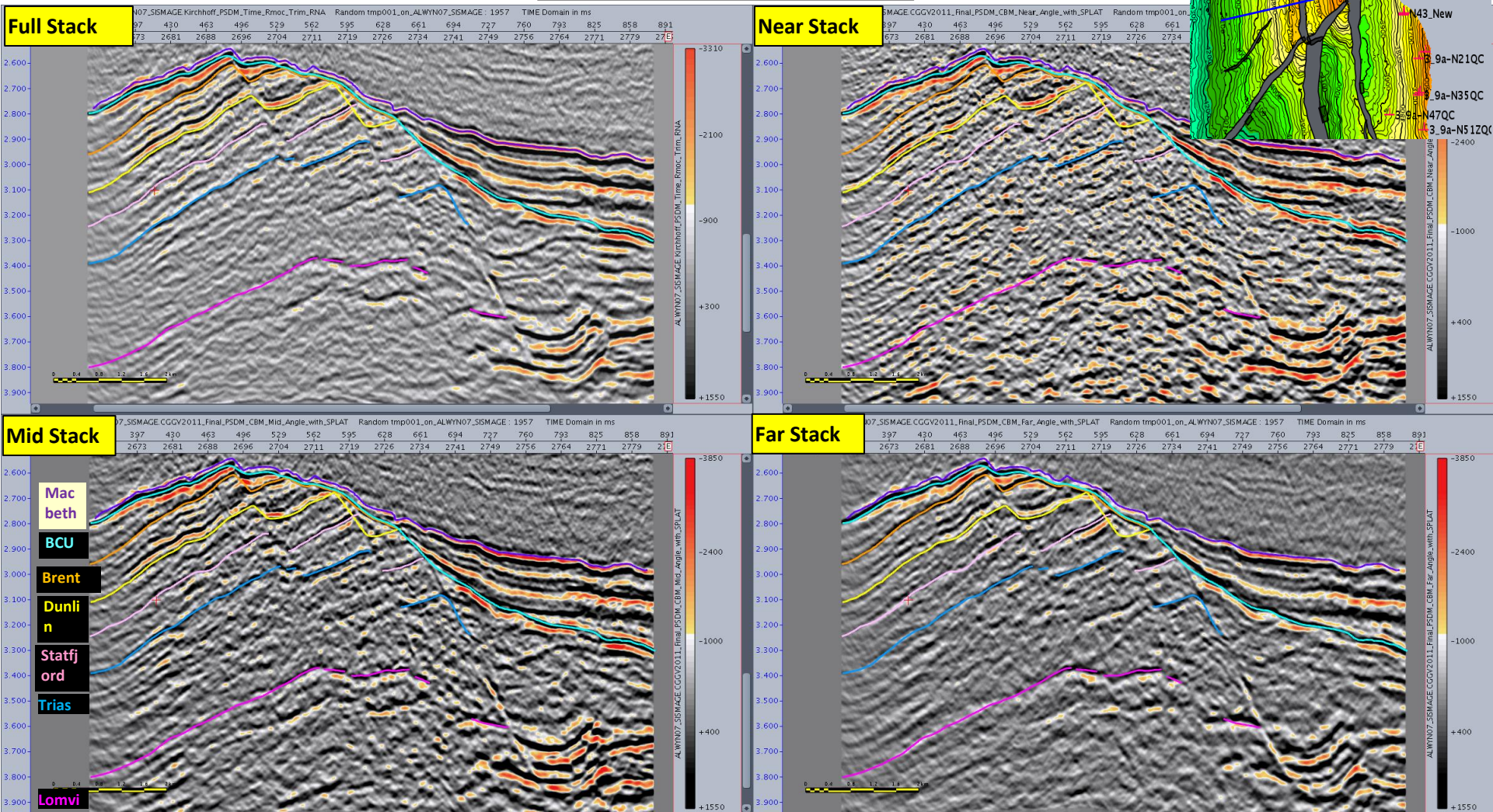
TOTAL 530+ cubes

★ *Highly collaborative & iterative process*
 ★ *Critical contribution from 2G&R, Pau HQ, CGG (Proc, Inv & Research teams), Database management, Research center (GRC) etc.*

OBN uplift : Seismic quality comparison

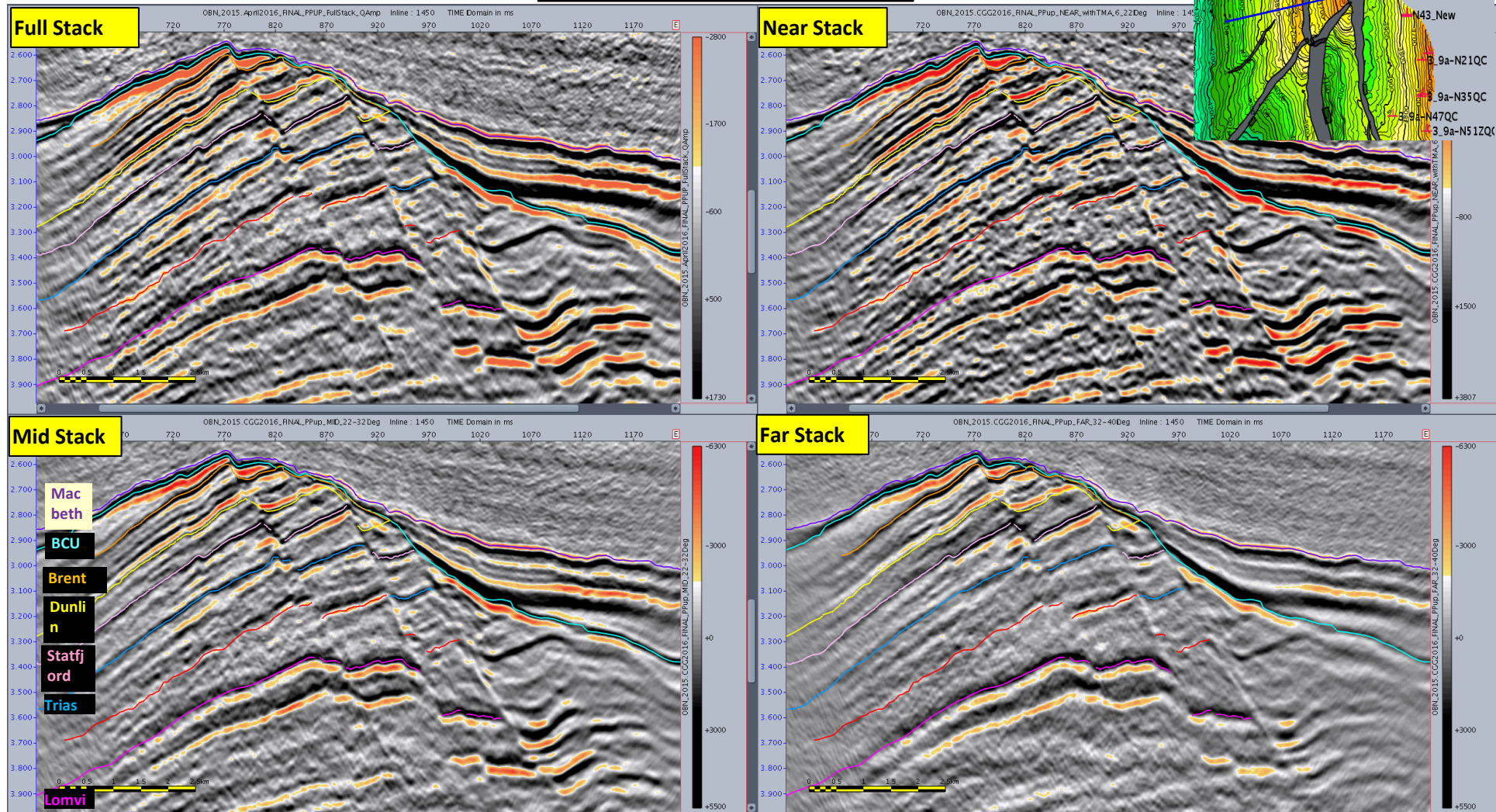


Vintage Streamer Final



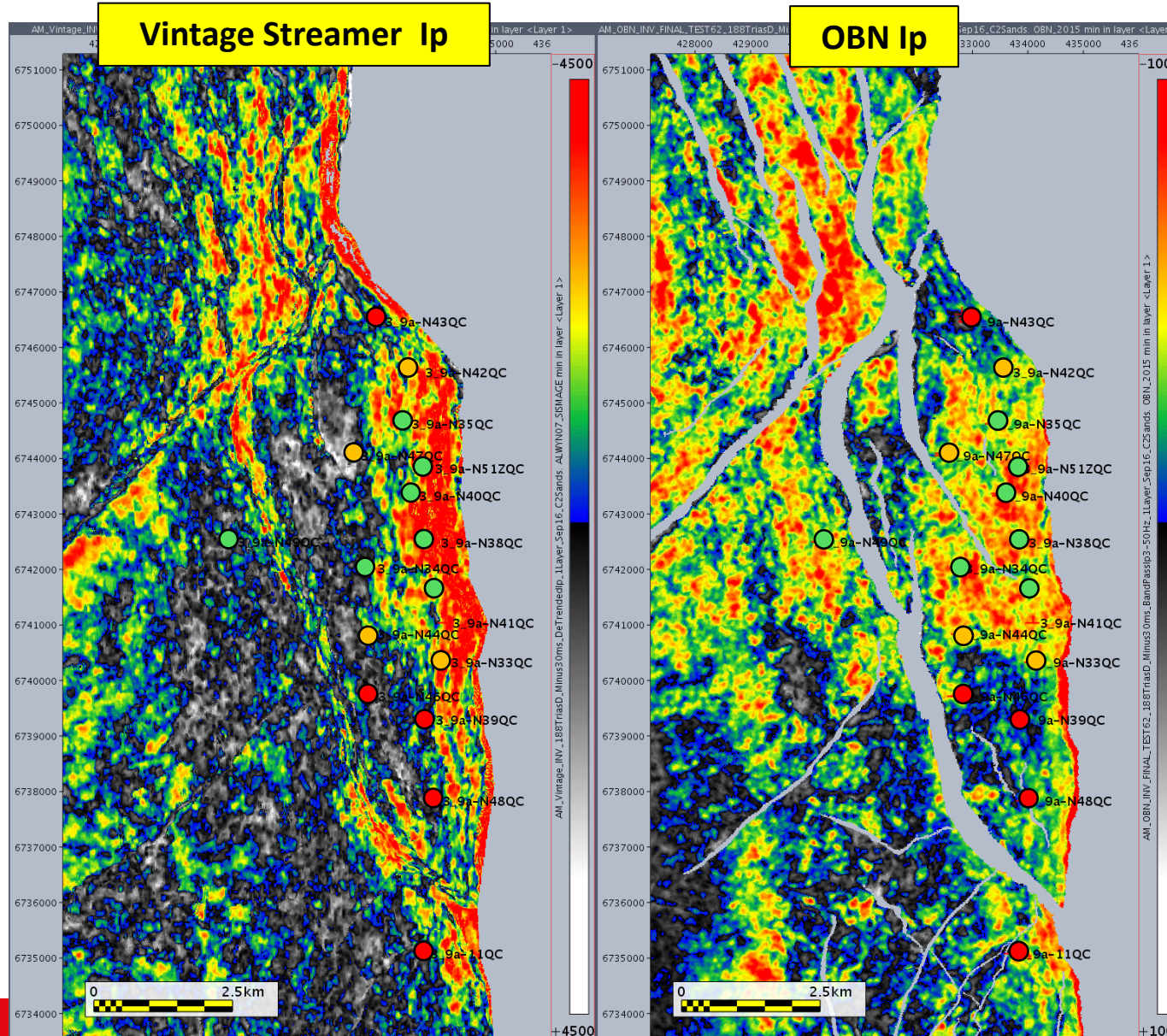
OBN uplift : Seismic quality comparison

OBN Final July 16






- Improved Imaging of angle stacks (input to Inversion) & full stacks at all levels with better velocity model & enhanced denoise (Higher Signal/Noise ratio)
- Broader bandwidth due to OBN acquisition

INVERSION Comparison: OBN Vs Vintage



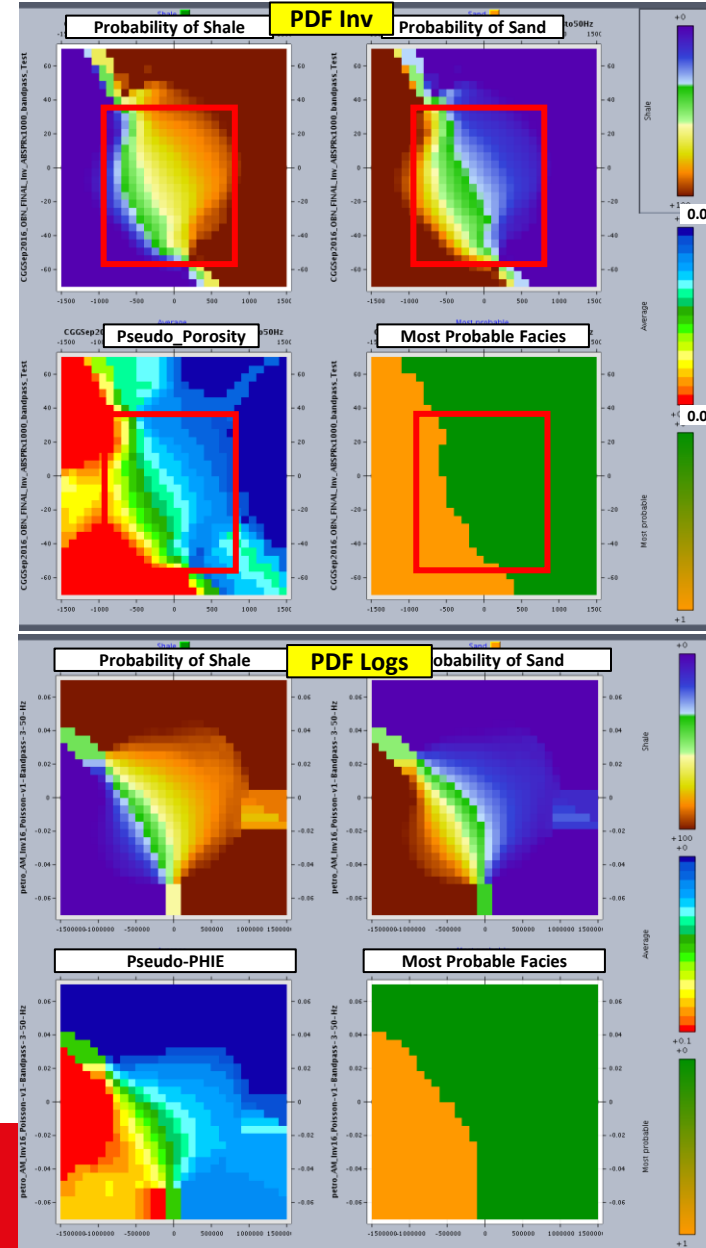
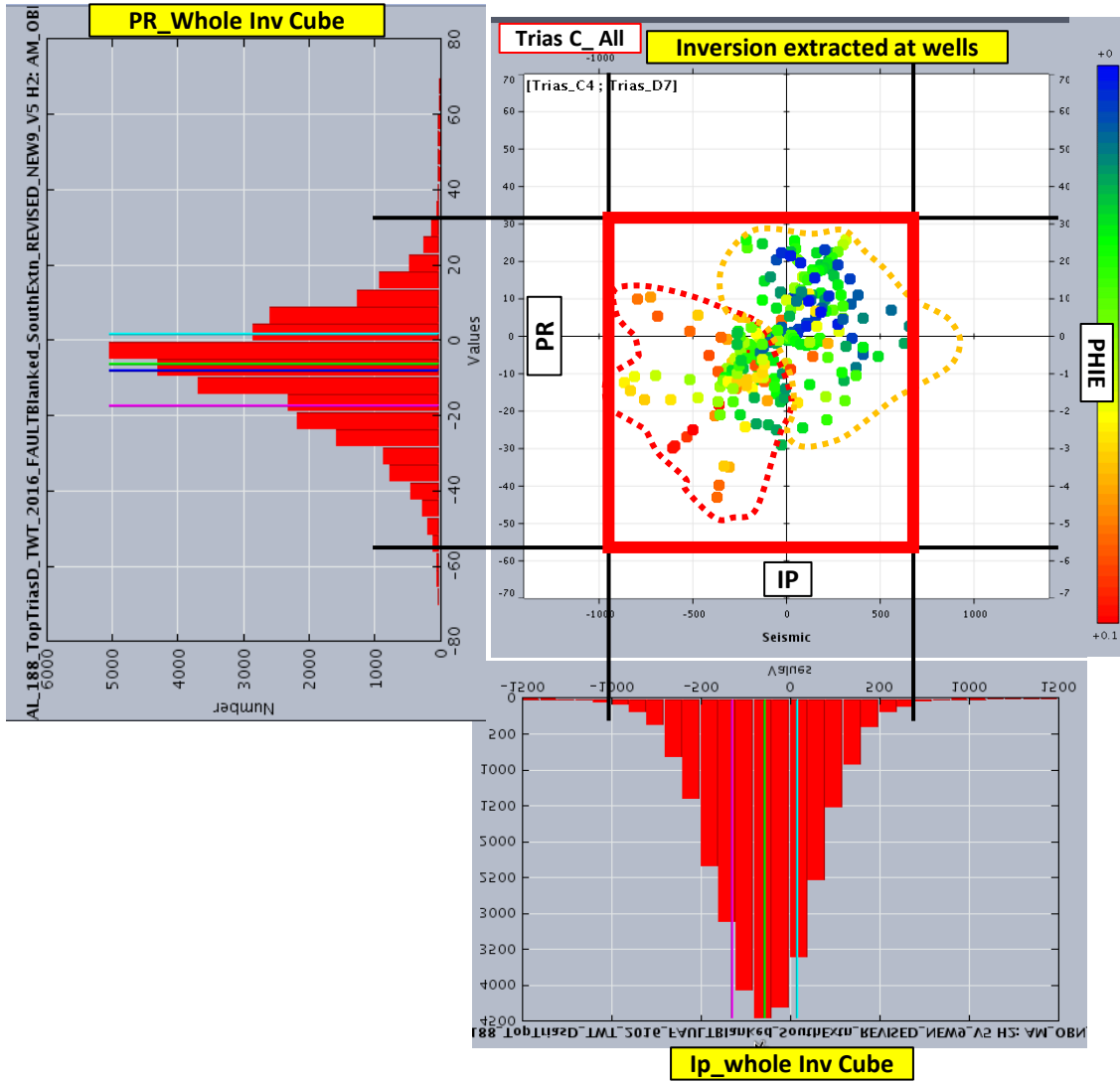
Maps extraction :
C1/C2 sands

Well results legends

-  Thick Stacked Sands in wells
-  Very thin or no sands in wells
-  Marginally stacked Sands

Improved understanding of the distribution of C sands, later confirmed by TRN well results

QI analysis : C sands (Inv Ip/PR/Porosity)



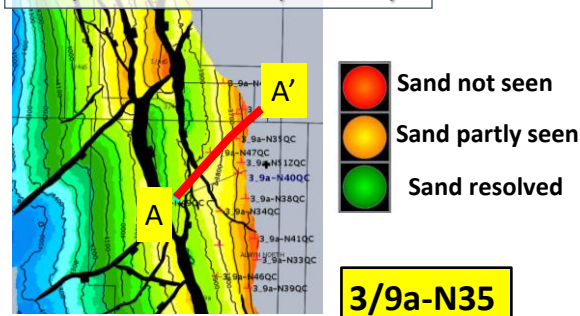
Majority of points lie within the area highlighted in RED. Very few points on the Top left quadrant.

Data management & HQ internal software teams provided round the clock support all along the studies, allowing us to valorize the OBN to the max - integrated complex workflow

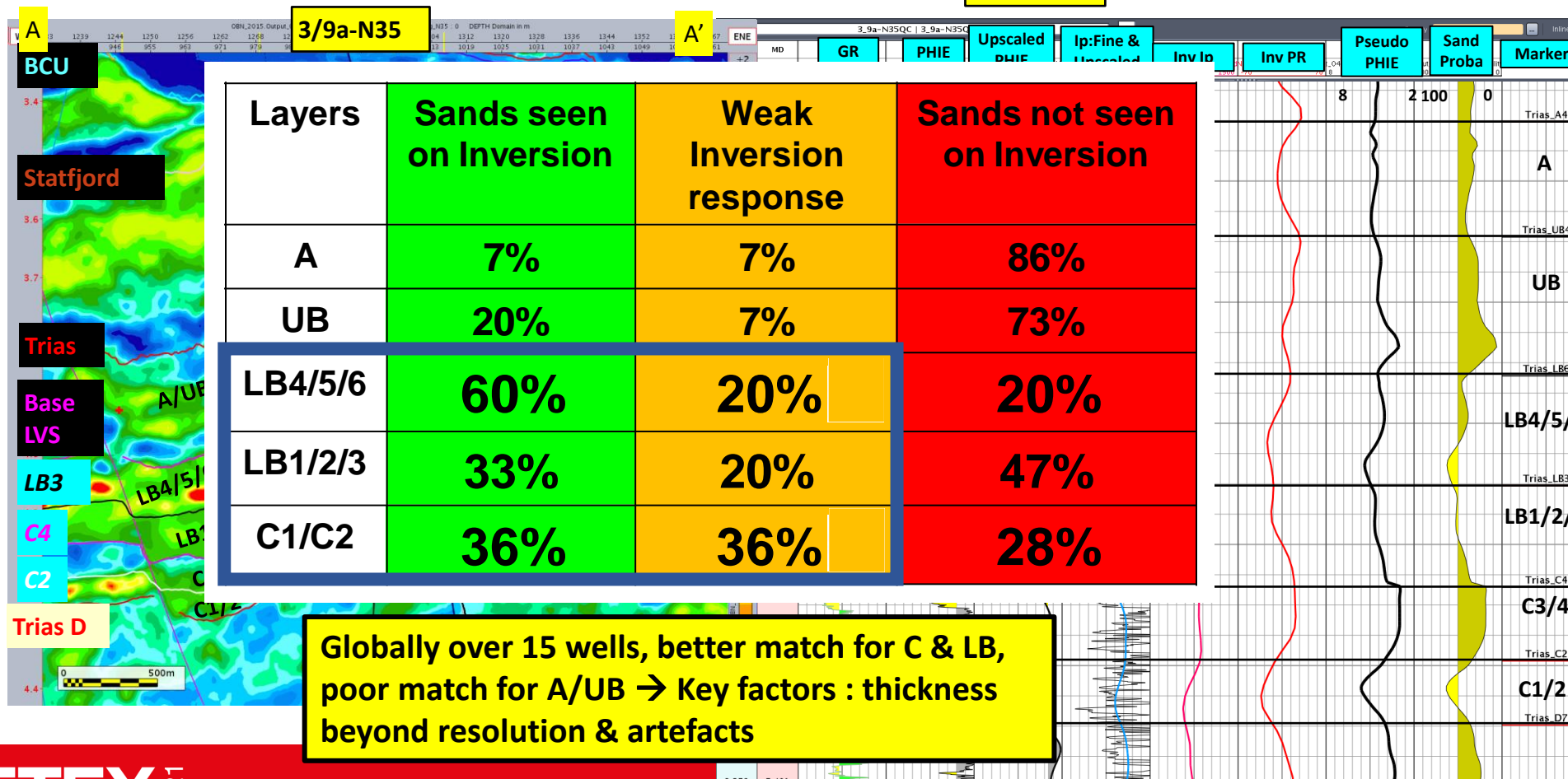
Static Cross-Validation

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

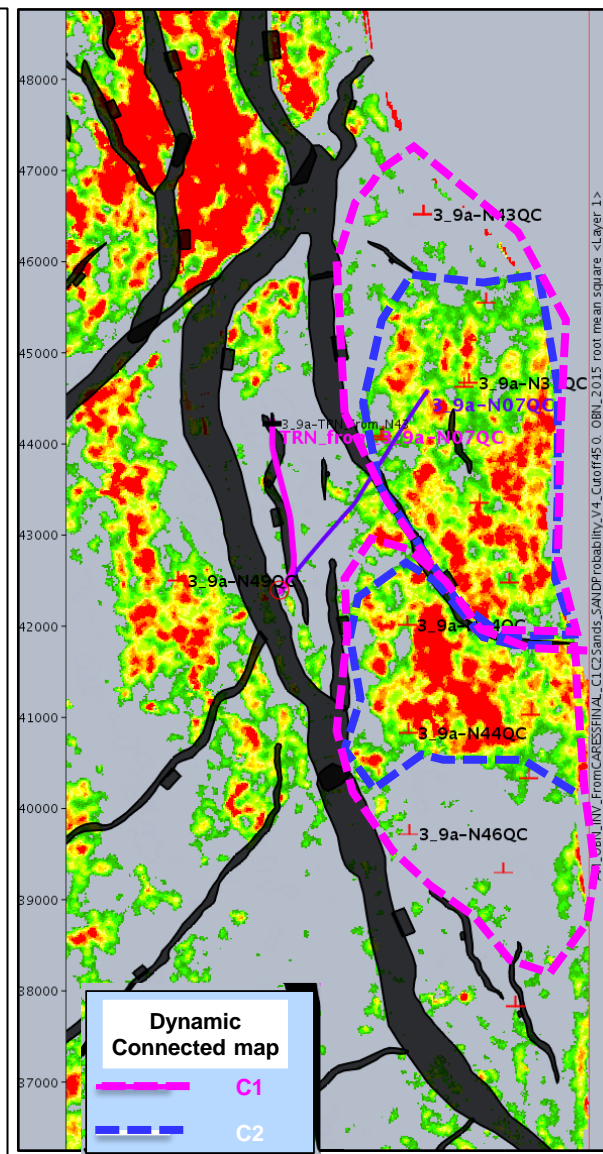
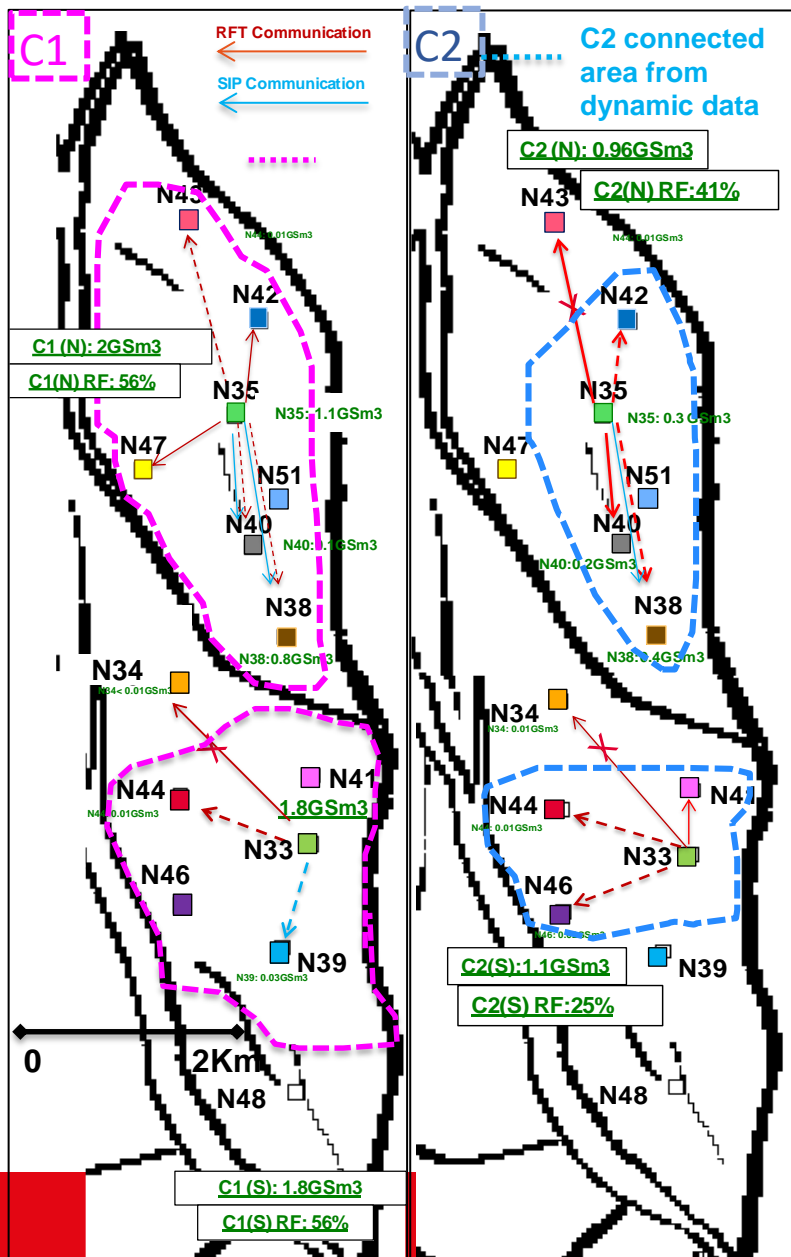
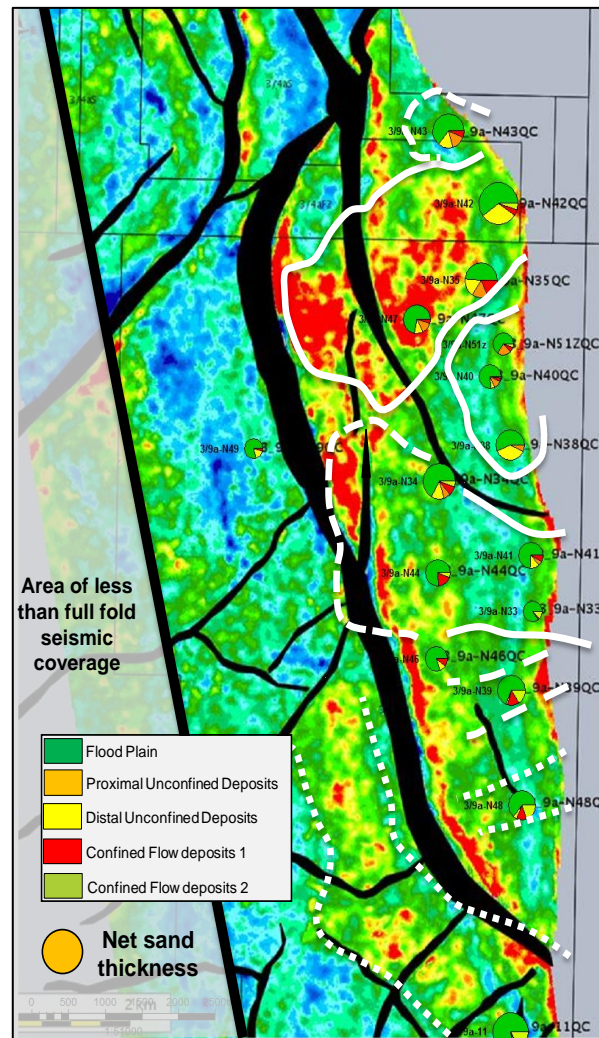
Top Triassic Depth Map



Layer	N35 (22 Mboe - Rank 1)	
	Sand Indicator	Prod. Split
A	Red	0% 😊
UB	Red	2% 😊
LB4/5/6	Yellow	34% 😊
LB1/2/3	Green	28% 😊
C3/4	Red	3% 😊
C1/2	Green	34% 😊
D		0%



Static & Dynamic Cross-Validation



C1-C2 CONNECTED VOLUME

Dynamic Synthesis connected volume IGIP - 5.9 GSm3

Seismically derived connected volume IGIP - 4.3 GSm3

- Seismic only sees where C1/C2 adequately stacked
- IGIP from seismic can be considered as a minimum connected gas vol

Alwyn OBN – Impact on TRN well target

TRN before OBN

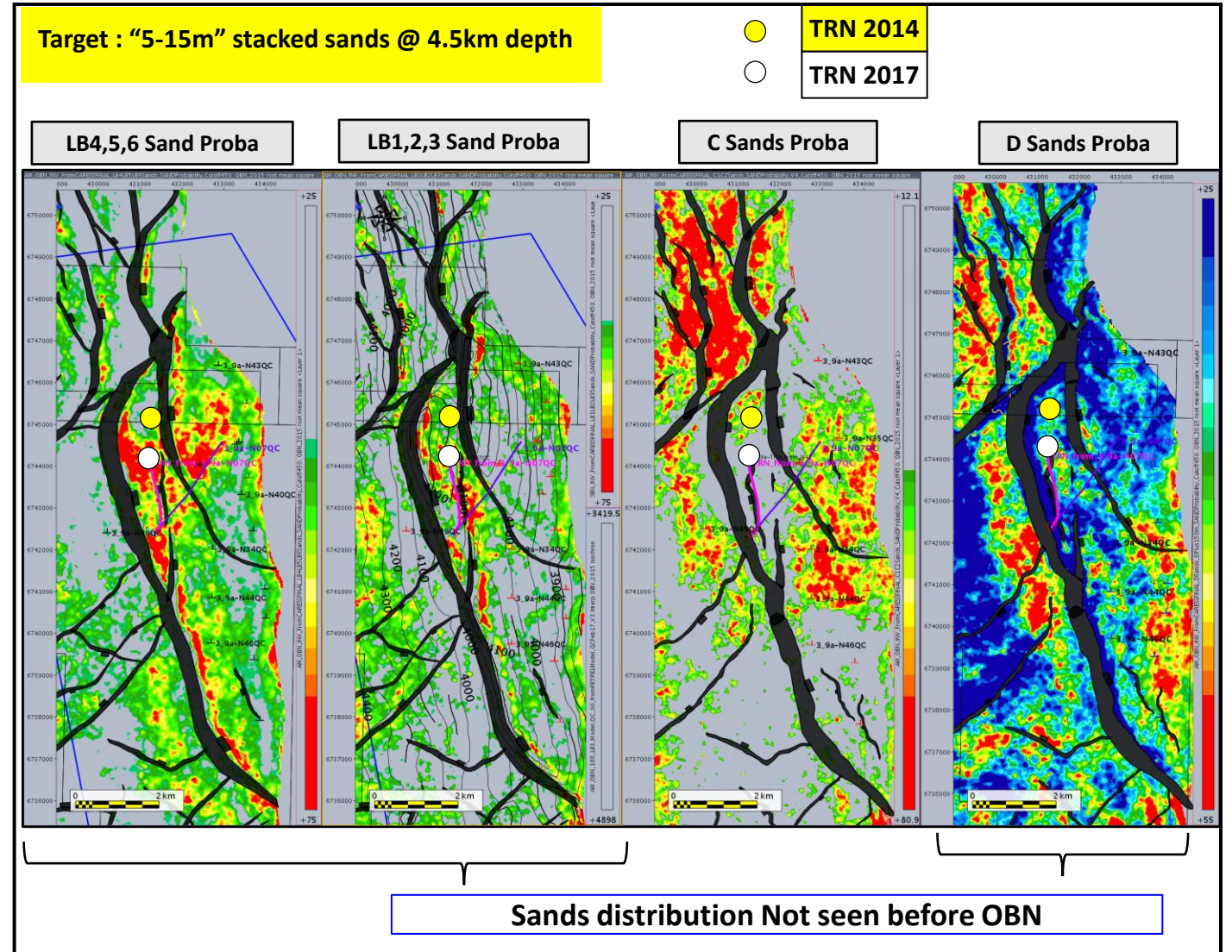
- Static and dynamic model approach (ECLIPSE)
- Multi-Eclipse realizations to capture uncertainties of sand prediction over TR panel

TRN post-OBN

- Based on OBN seismic, both in terms of Static behaviour & dynamic connectivity
- **Target moved approximately ~800 m towards SOUTH**

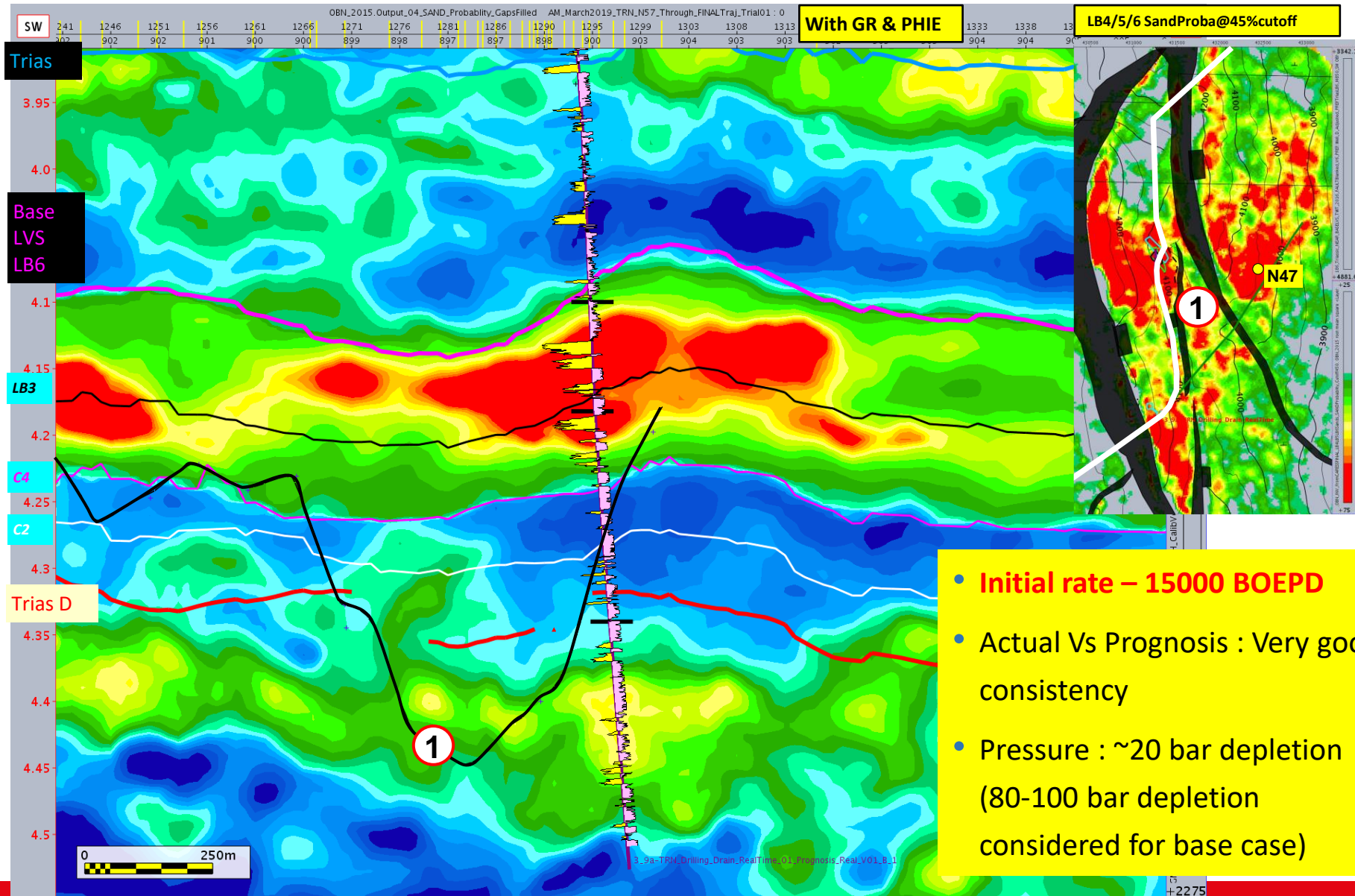
• Pre-OBN: Primary target C

• Post-OBN: Primary target Lower B, no frac



TRN actual results

Data displayed - Combined Sand Probability in Calibrated depth domain

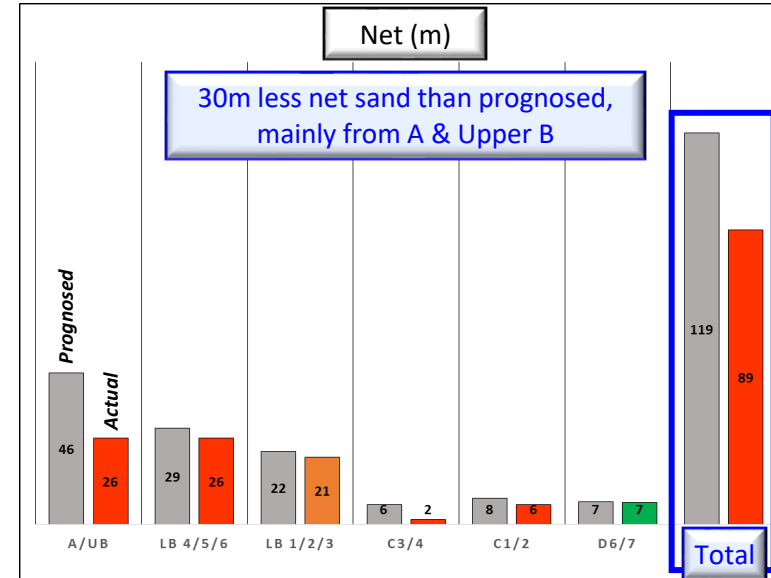
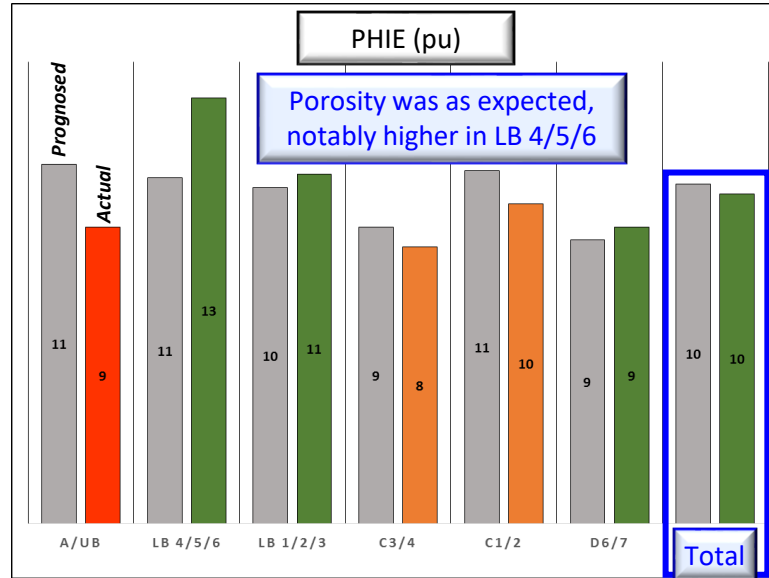


① → Fault -1

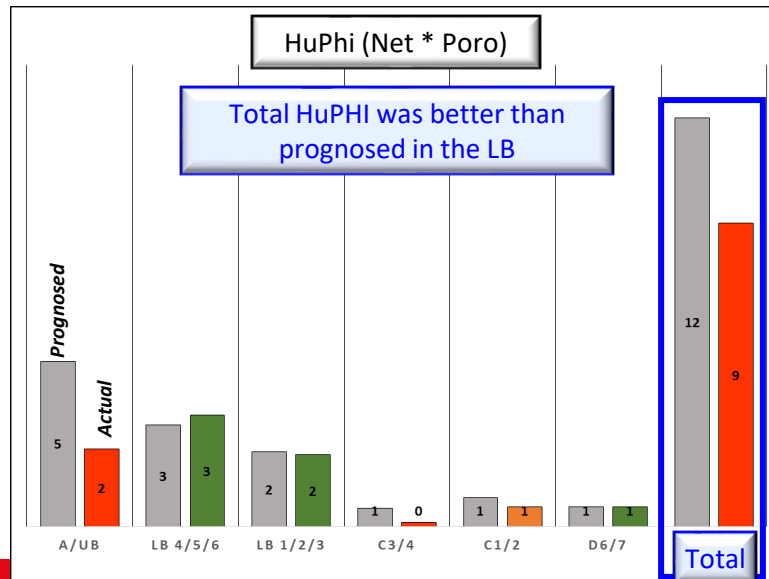
- Initial rate – 15000 BOEPD
- Actual Vs Prognosis : Very good consistency
- Pressure : ~20 bar depletion (80-100 bar depletion considered for base case)

AGE FORM MEMB	PROG	Main Markers m MD (-m TVDSS)	m TVD	Actual (-m TVDSS) m MD	ACTUAL	SHOWS
EOCENE to RECENT	Nordfordland	177.6m (-130m) Nordland/Hordaland	0	Nordland/Hordaland(-130m) 177.6m		
		1631m (-140m) Balder	2.2	Balder (-1493.3m) 1633.3m Sele (-1515.7m) 1659m		
CRETACEOUS	Jorsalfare	2324m (-2002m) Jorsalfare	4.4	Jorsalfare (-2007.4m) 2288m		
		2643m (-2394m) Kyrre	2	Kyrre (-2392m) 2648m		
JURASSIC	Dunlin	4091m (-3446m) Dunlin	8.9	Dunlin (-3454.9m) 4044.5m		
		4262m (-3672m) Stafford C 4311m (-3720m) Stafford D	40 0.2	E2 Fault / Stafford B (-3622m) 4215.4m Stafford C (-3645.1m) 4227.9m Stafford D (-3720.2m) 4314.5m		
TRIASSIC	Base LVS	4517m (-3921m) Triassic A	23	Triassic A (-3897.5m) 4495m		
		4684.3m (-4085.1m) Base LVS	14.8 0.6	Base LVS (-4090.9m) 4590.1m Triassic LB3 (-417.1m) 4770.7m Triassic LB4 (-263.1m) 4964.1m Triassic LB5 (-287.4m) 4988.9m Triassic LB6 (-430.2m) 4962.5m Triassic D5 (-4381.6m) 4984.8m		
TRIASSIC	TD	5073.2m (-4468m) Triassic D2	11.2 0.2	Triassic D2 (-4475.2m) 5060.5m		
		5124.8m (-4518m) TD	10.8	TD (-4528.6m) 5135m		

TRN prognosed vs actual properties



Cut-offs	
PHIT	≥ 0.07 V/V
VCL	≤ 0.4 V/V



- The gross thickness of the Triassic interval was close to prognosis
- The net sand thickness was in line with prognosis for the reservoir units seen on seismic.
- The realization was lower compared to that of A & Upper B which used conceptual model for pre-drill estimate.
- The porosity was in line with prognosis – however higher in the LB intervals

Conclusions & future impacts

- OBN provided a step change improvement in image quality & reservoir characterisation. Good confidence on the ability of the PP Elastic Inversion to predict stacked porous sands, was key for the well sanction.
 - TRN & additional targets finalized based on static & dynamic validation using Seismic.
 - TRN well results confirms that OBN can reliably predict sand presence
- “OPTIMAL” and Multi-disciplinary (drilling OPS R&D...) adapted workflow was implemented :
 - Same workflow can be used in other mature fields => will save years of man-hours & time (e.g. Dunbar).
- “2G & R PLUS” integration is the Key to the success of OBN. Value lies in detailed analysis & working together.
COLLABORATION critical => a multi-way traffic.
- TOTALENERGIES - Alwyn hub production increased from **34 000 BOEPD to 49 000 BOEPD => 1 well 45% increase.**

OBN / TRN has a critical impact on future of NNS

- COP (Cessation of Production) pushed back.
- Next prospect TNE already validated.
- Future additional targets identified.
- Inversion work for Brent & Statfjord.
- Dunbar OBN sanctioned & acquired.

The Journey & Acknowledgement



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