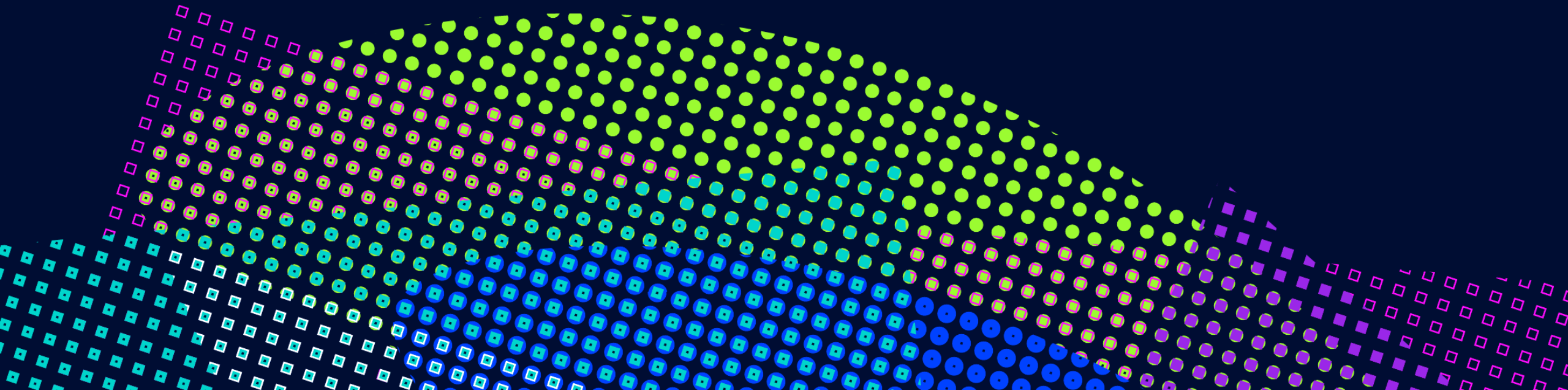


# Diagnosing flow challenges in horizontal wells with smart completions

Vener Nagimov, Principal Domain Champion, TGT  
Artur Giniyatullin, Snr Well Log Analyst



# Presenter



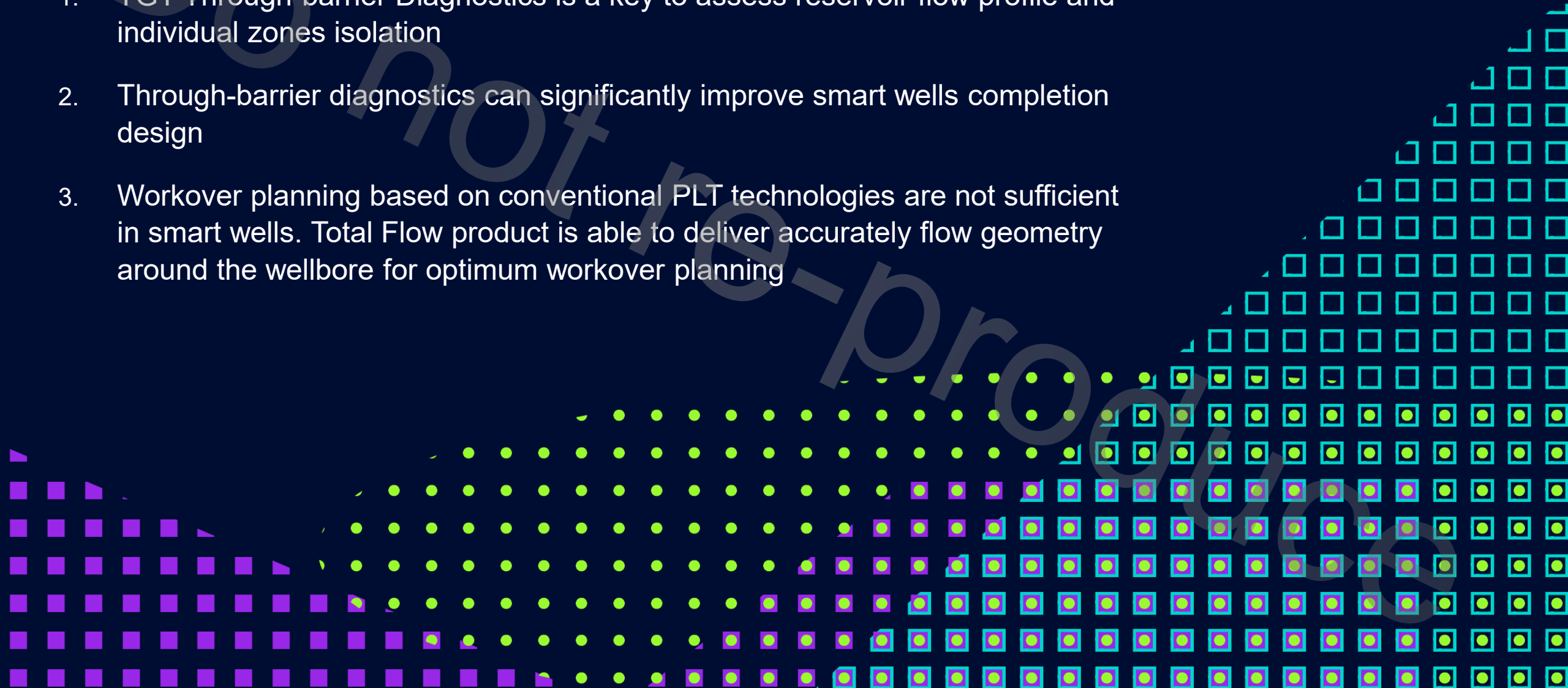
*Vener Nagimov, Principal Domain Champion*



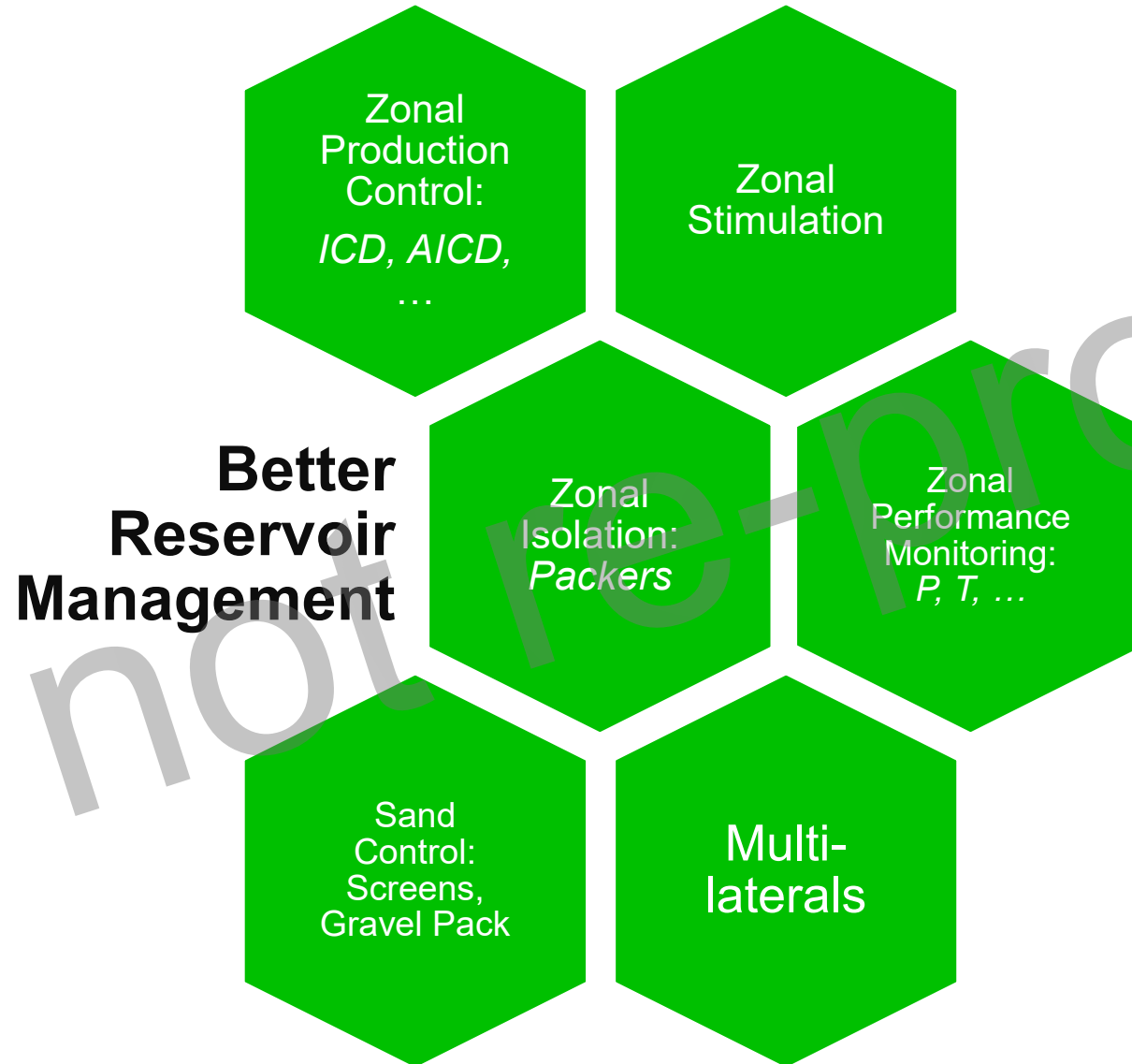
*Artur Giniyatullin, Snr Well Log Analyst*

# Learning outcomes

1. TGT Through-barrier Diagnostics is a key to assess reservoir flow profile and individual zones isolation
2. Through-barrier diagnostics can significantly improve smart wells completion design
3. Workover planning based on conventional PLT technologies are not sufficient in smart wells. Total Flow product is able to deliver accurately flow geometry around the wellbore for optimum workover planning

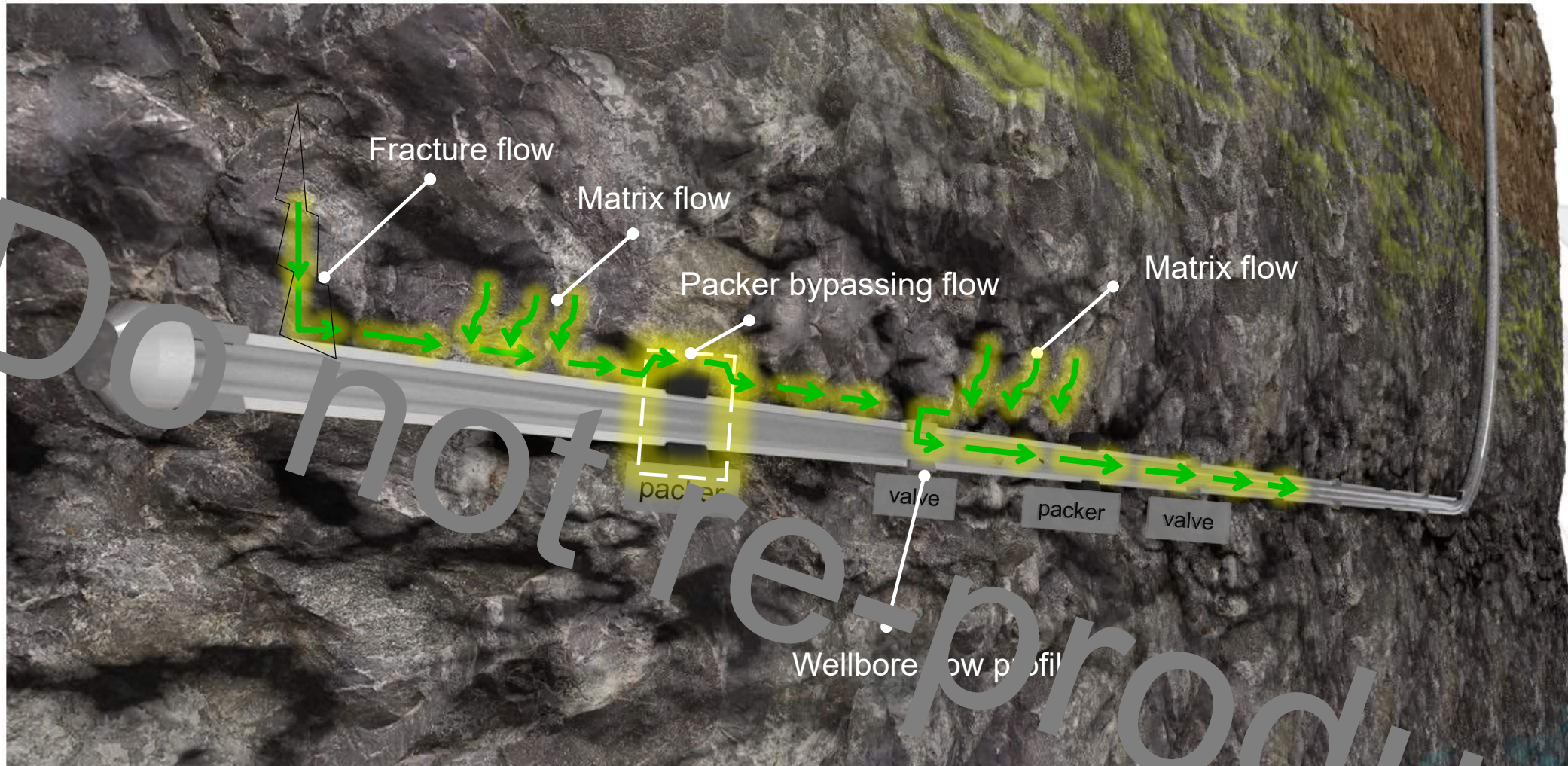


# Smart Completion

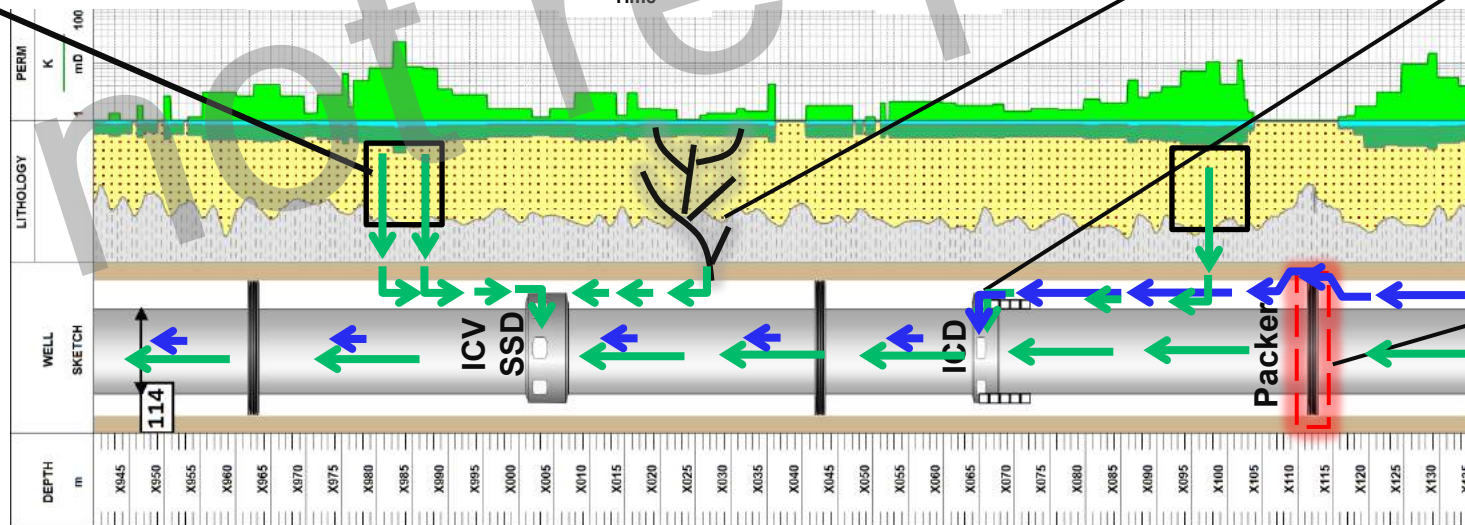
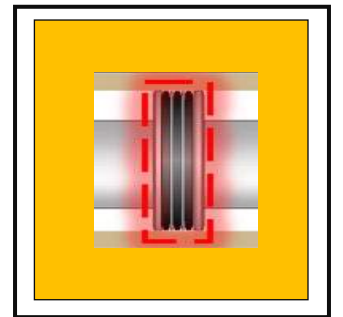
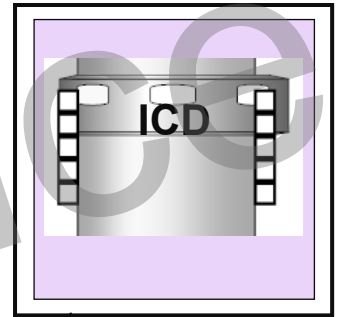
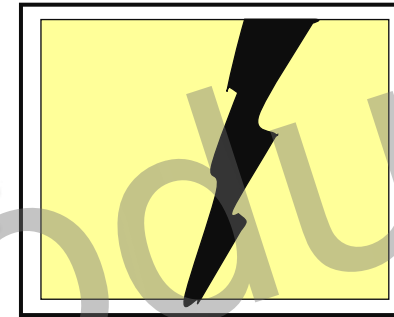
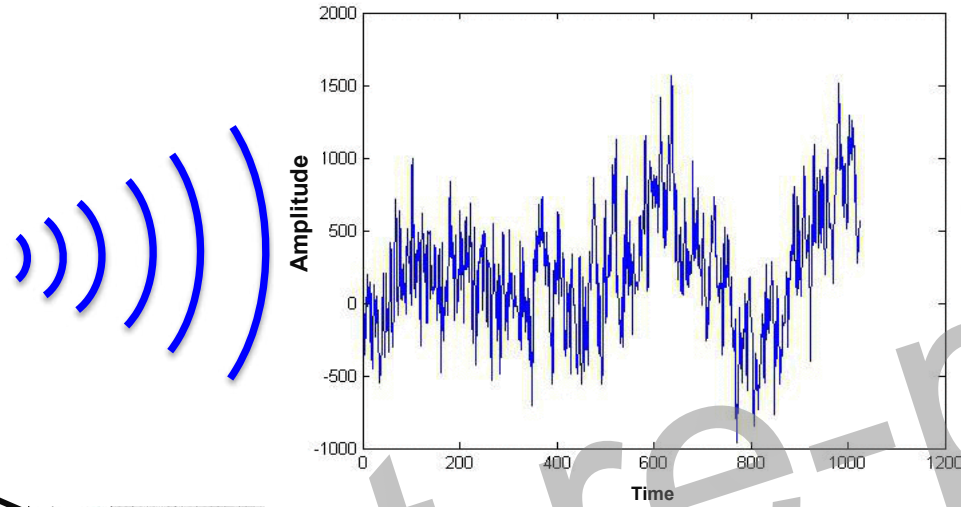
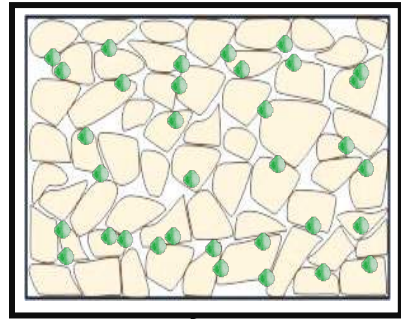




# Smart Completion: Flow Challenges

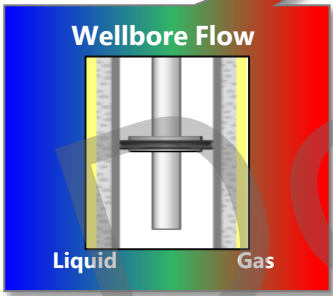
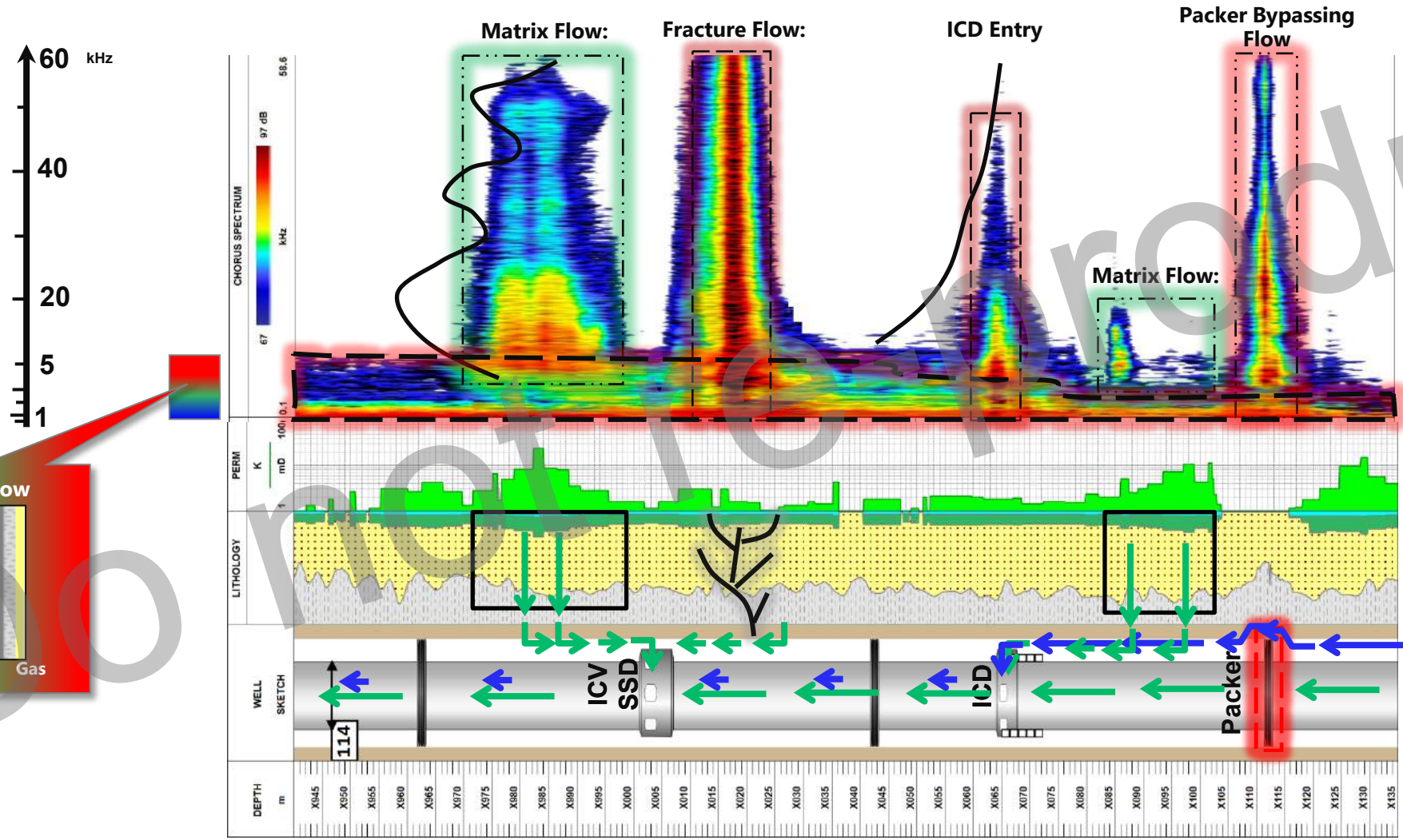


# What is the Acoustic Sound Heard in Horizontal Wells?

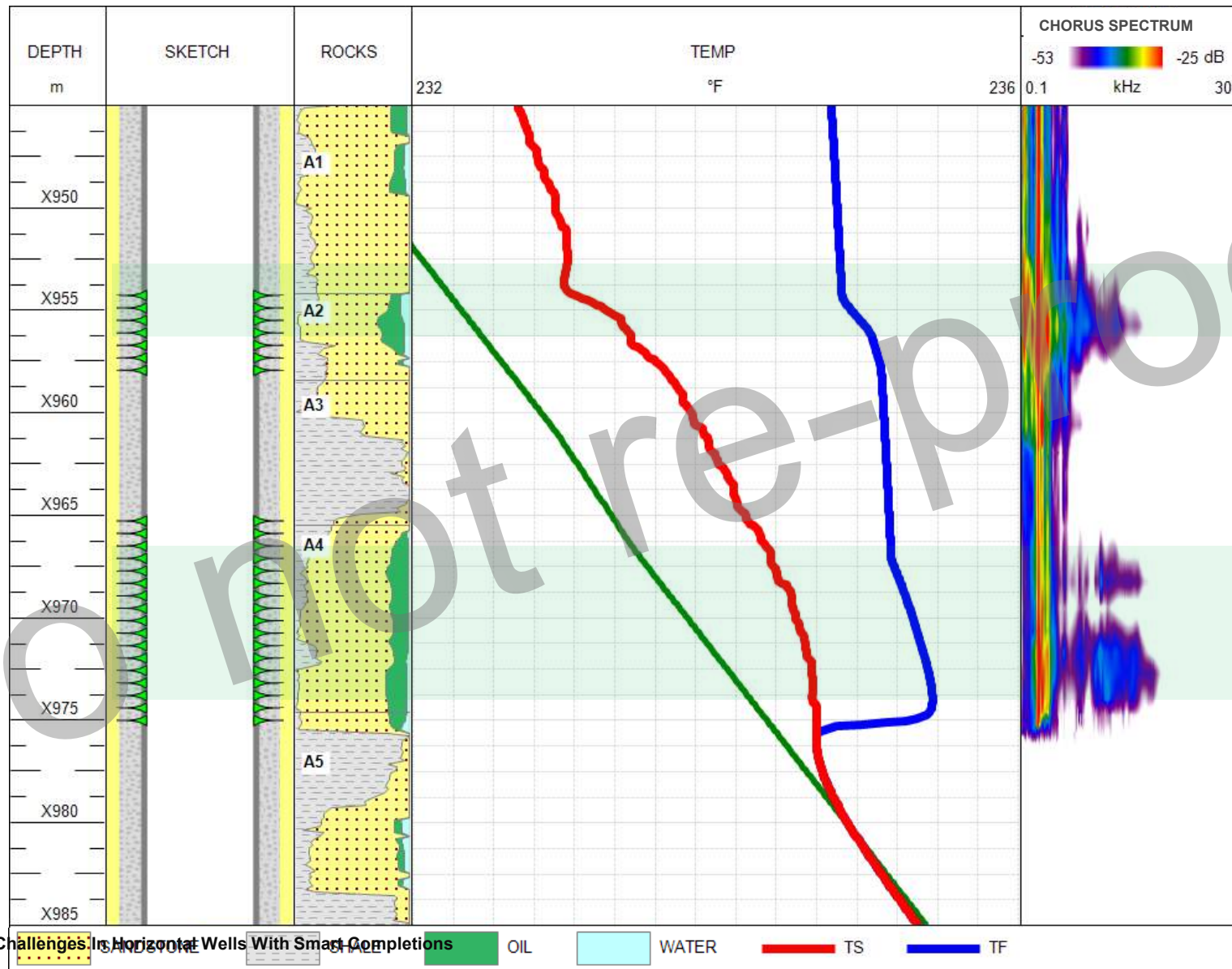




# Acoustic Data Interpretation



# Temperature Modelling Basics

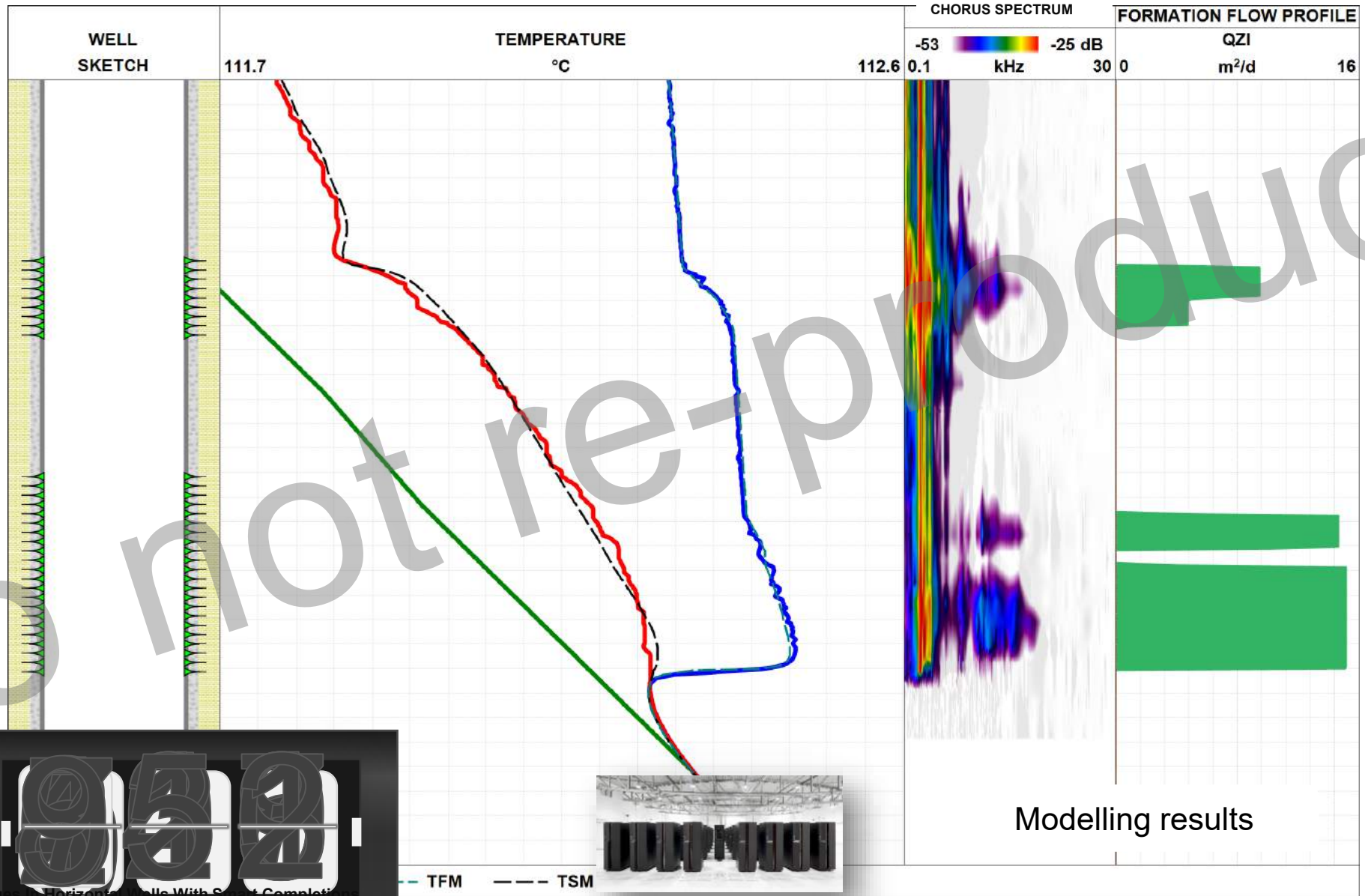


% = ?

% = ?



# Modelling Procedure



# Cascade® Platform

The screenshot displays the Cascade Platform software interface. On the left is a navigation tree with the following items: Multiphase, Geotherma, Rocks, Well, Hydrodynamics, History, Grid, PVT (highlighted), Output, Advanced, Output Charts, and Fitting. At the bottom left, there are two radio buttons: 'No Cross Flow' (selected) and 'Cross Flow'. The main window is titled 'Fluids properties' and has three tabs: 'Advanced', 'Fluids properties', and 'Plots'. The 'Advanced' tab is active, showing a table of fluid properties for Oil, Gas, and Water. A large watermark 'Do not re-produce' is overlaid on the image.

Oil			
Pb_EX	21.2754	MPa	Bubble point pressure
bp	*****	1/C	Bubble point temperature dependency factor
ALPHA_RS	1.18955	-	Adjustable parameter
RHO_DEAD_OIL	910.259	kg/M3	Apparent dead oil density
BETA_OIL	0.000496053	1/C	Oil coefficients of thermal expansion
GAMMA_OIL	1.88412e-09	1/MPa	Oil compressibility
MU_OIL_EX	0.000775026	Pa*s	Oil viscosity at reservoir conditions
a_b_T	0.00810995	1/C	Adjustable parameter
a_b_P	0.00658682	1/MPa	Adjustable parameter
MU_DEAD_OIL_0	0.00277829	Pa*s	Dead oil viscosity at standard conditions
a_d_T	0.0146796	1/C	Adjustable parameter
a_d_P	-0.00492209	1/MPa	Adjustable parameter

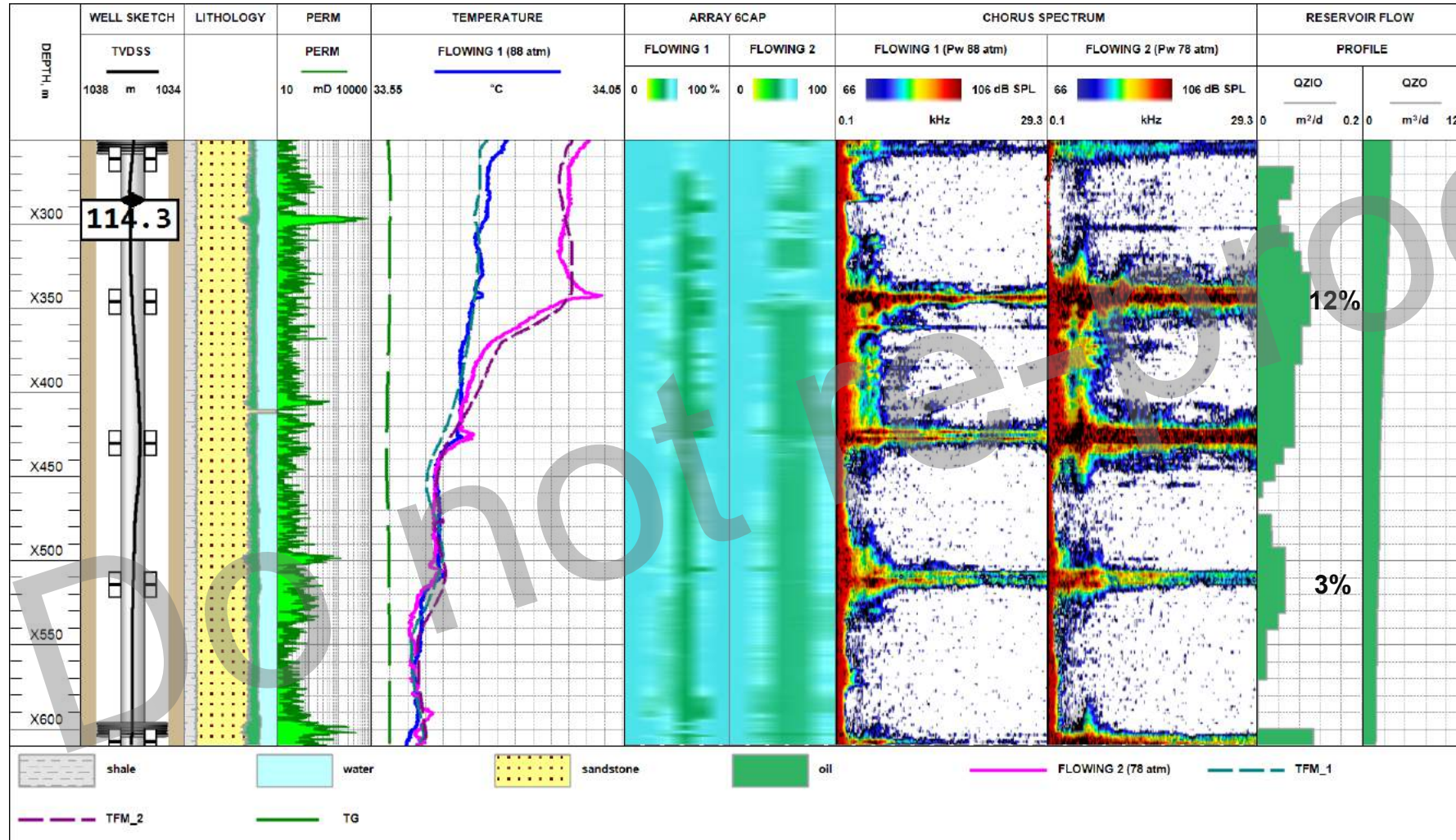
Gas			
Az	-2.82192e-06	C/Pa	Adjustable parameter
Bz	2.6226e-13	C/Pa	Adjustable parameter
Tz	-668.046	C	Adjustable parameter

Water			
RHO_WATER	989.09	kg/M3	Water density at reservoir conditions
BETA_WATER	0.000542272	1/C	Water coefficients of thermal expansion
GAMMA_WATER	0.000438606	1/MPa	Water compressibility

Well trajectory

# Profile Accuracy



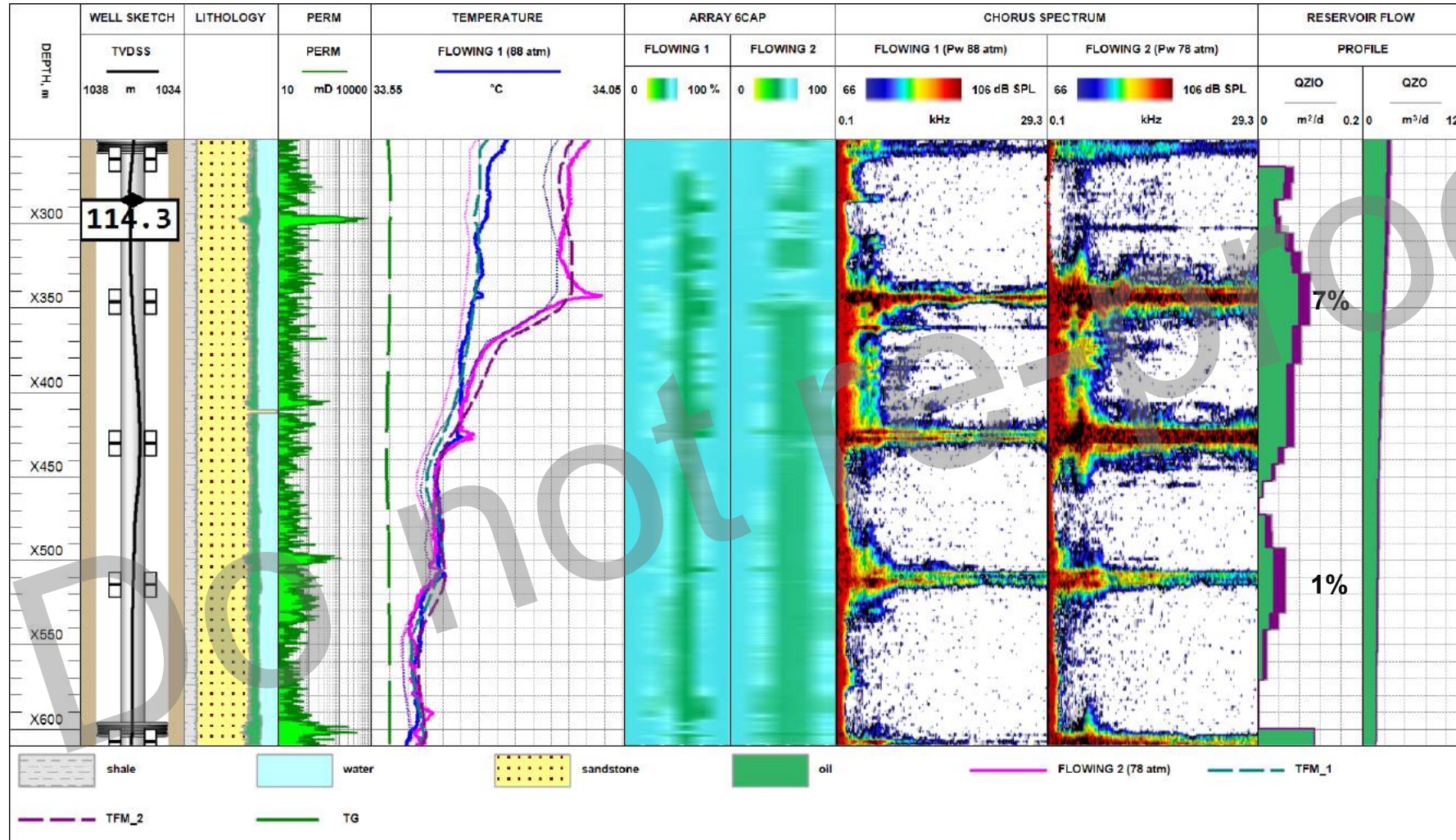
Variable parameters

Zonal productivity  $\sigma_1$

Zonal productivity  $\sigma_2$



# Profile Accuracy

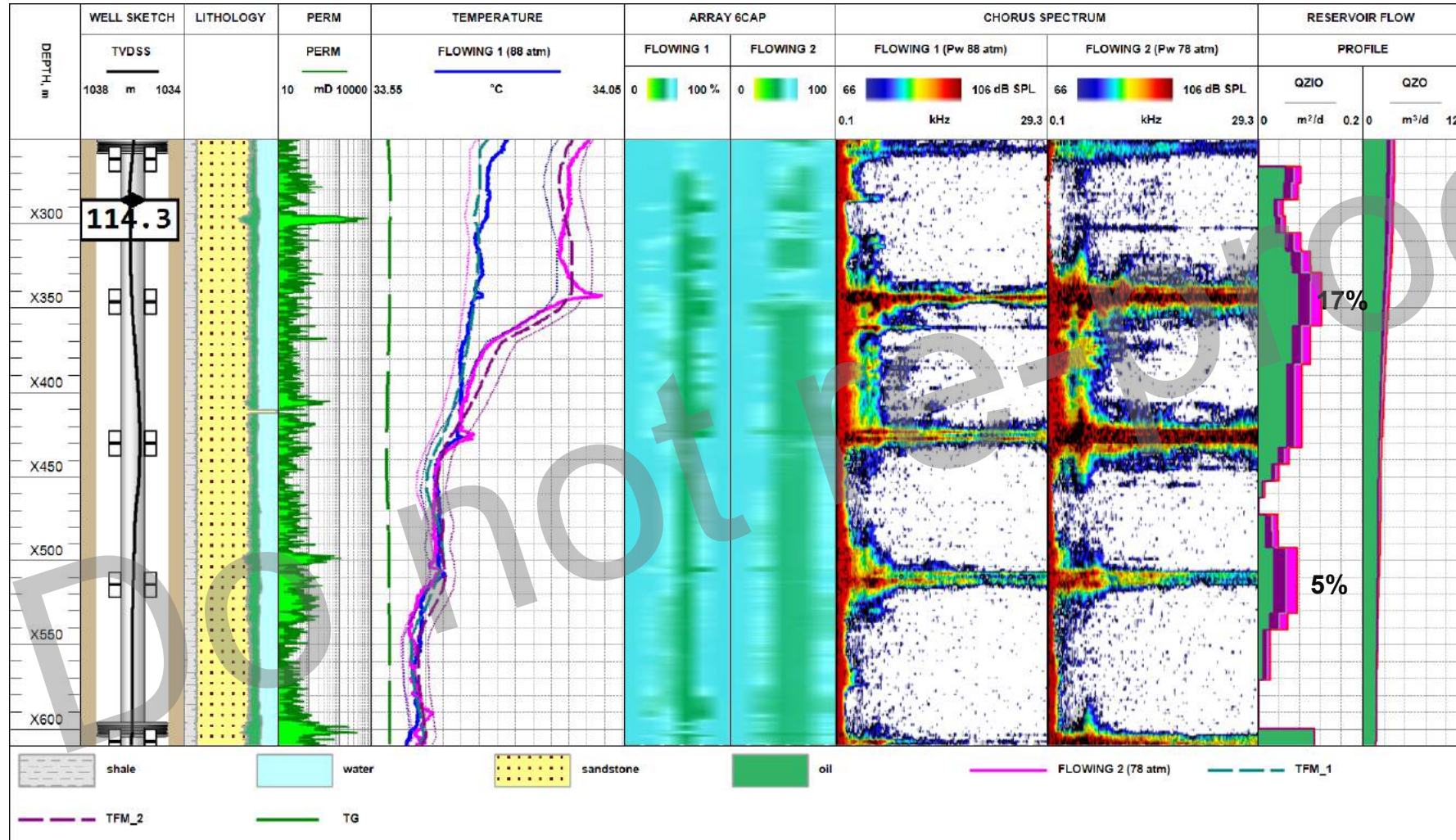


Variable parameters

Zonal productivity  $\sigma_1$  ↓

Zonal productivity  $\sigma_2$  ↓

# Profile Accuracy



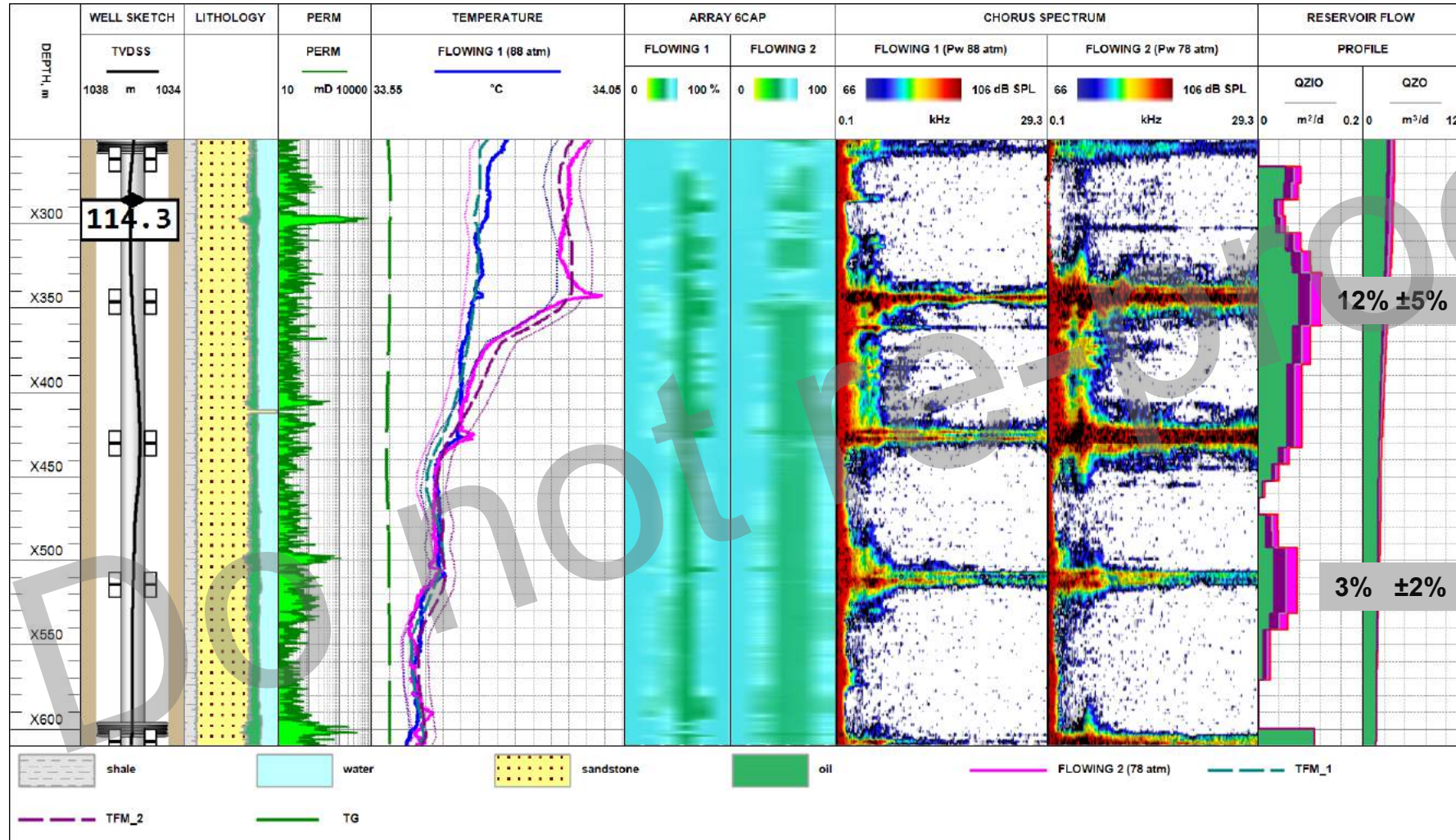
Variable parameters:

Zonal productivity  $\sigma_1$  ↑

Zonal productivity  $\sigma_2$  ↑



# Profile Accuracy



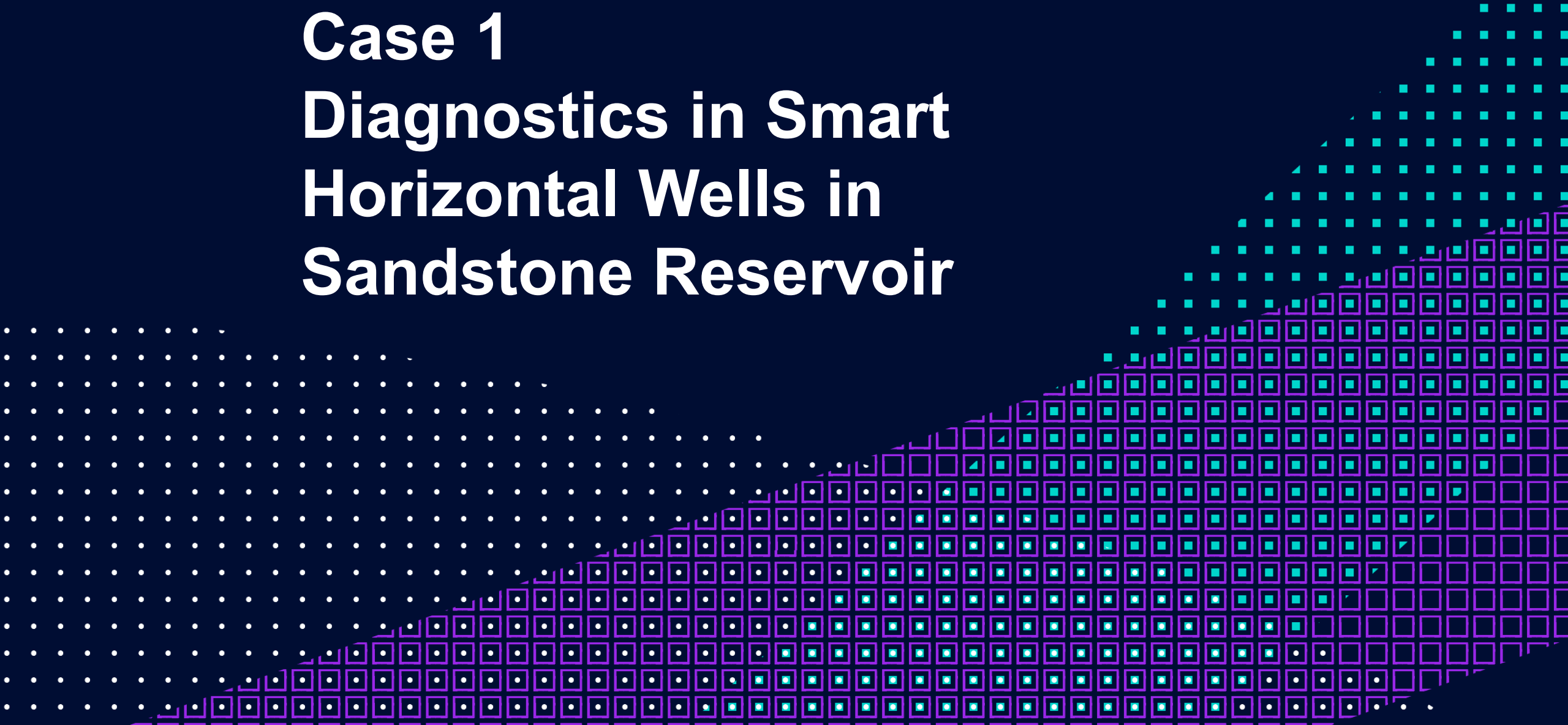
Zonal accuracy ±5%

Zonal accuracy ±2%

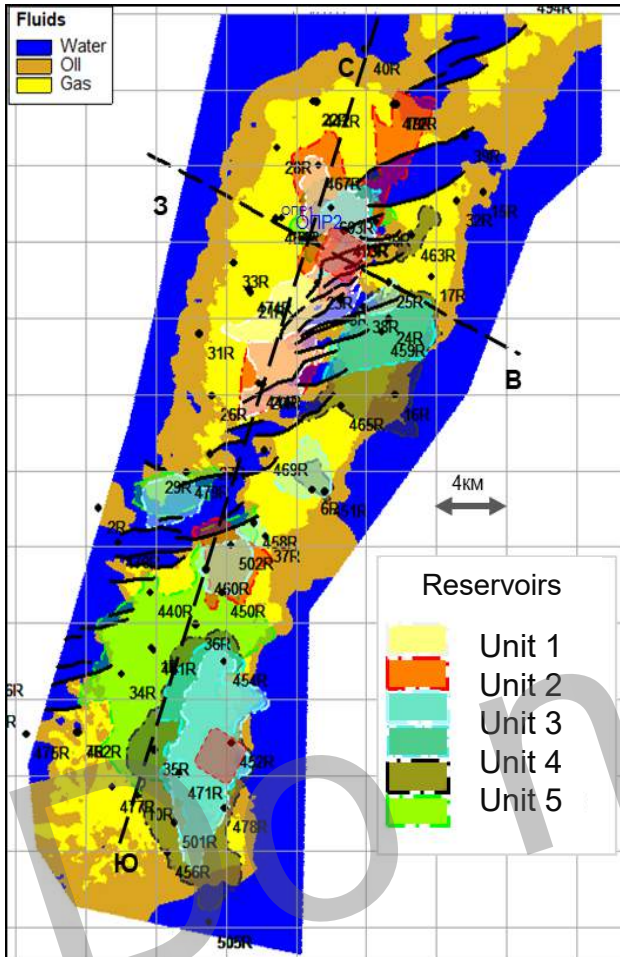


# Case 1

## Diagnostics in Smart Horizontal Wells in Sandstone Reservoir

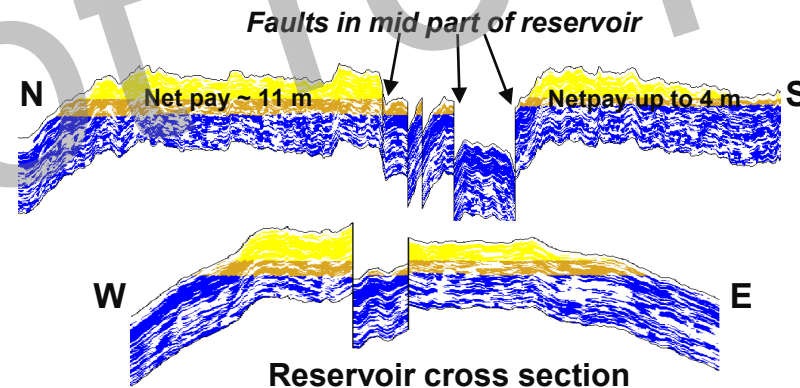


# Case 1: Reservoir Description and Geological Challenges



## Geological Challenges:

- Thin oil rim thickness (4-20 m)
- Gas cap (up to 35 m)
- Aquifer (more than 40 m)
- Variable and heterogeneous deposits
- Reservoir is represented by poorly consolidated sandstone
- High oil viscosity in reservoir condition (>50 cP)
- Permeability in heteroliths:
  - Tidal Flat (Delta) facies: ~500-1000 mD,
  - Channel facies: up to 10000 mD



Delta system

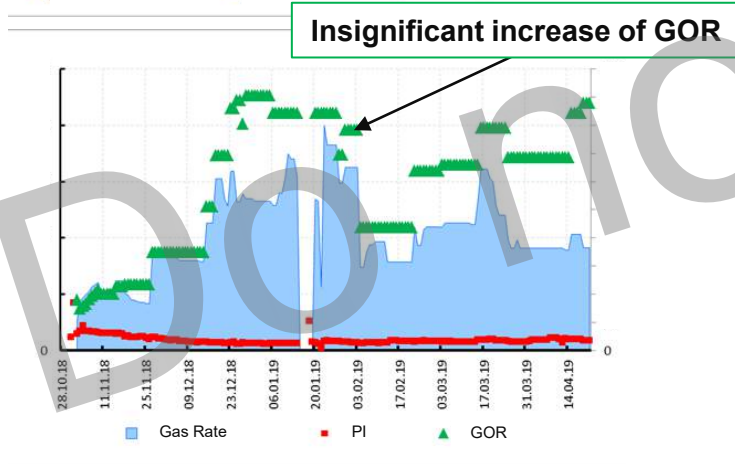
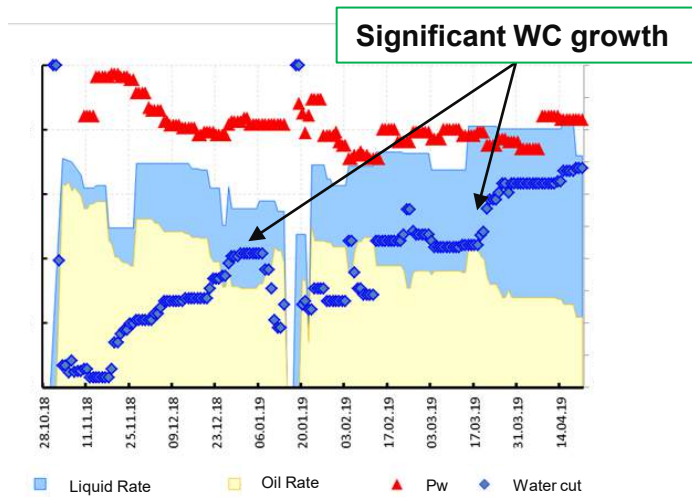


Channel facies (sandstone) up to 10000 mD

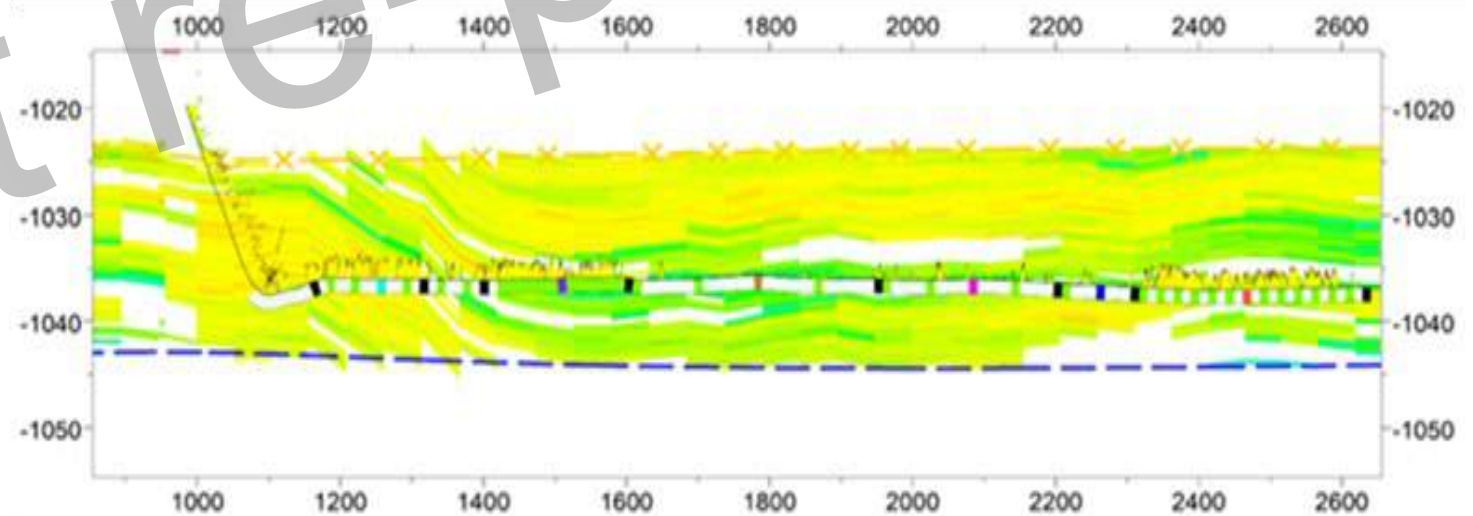


Tidal Flat (Delta) facies (clay sandstone) 100-1000 mD

# Case 1: Well Information



- Completion:
  - 7" casing and 4-1/2" liner
  - 7 separated zones
  - Swellable packers
  - Autonomous ICD (AICD)
  - Sand screens

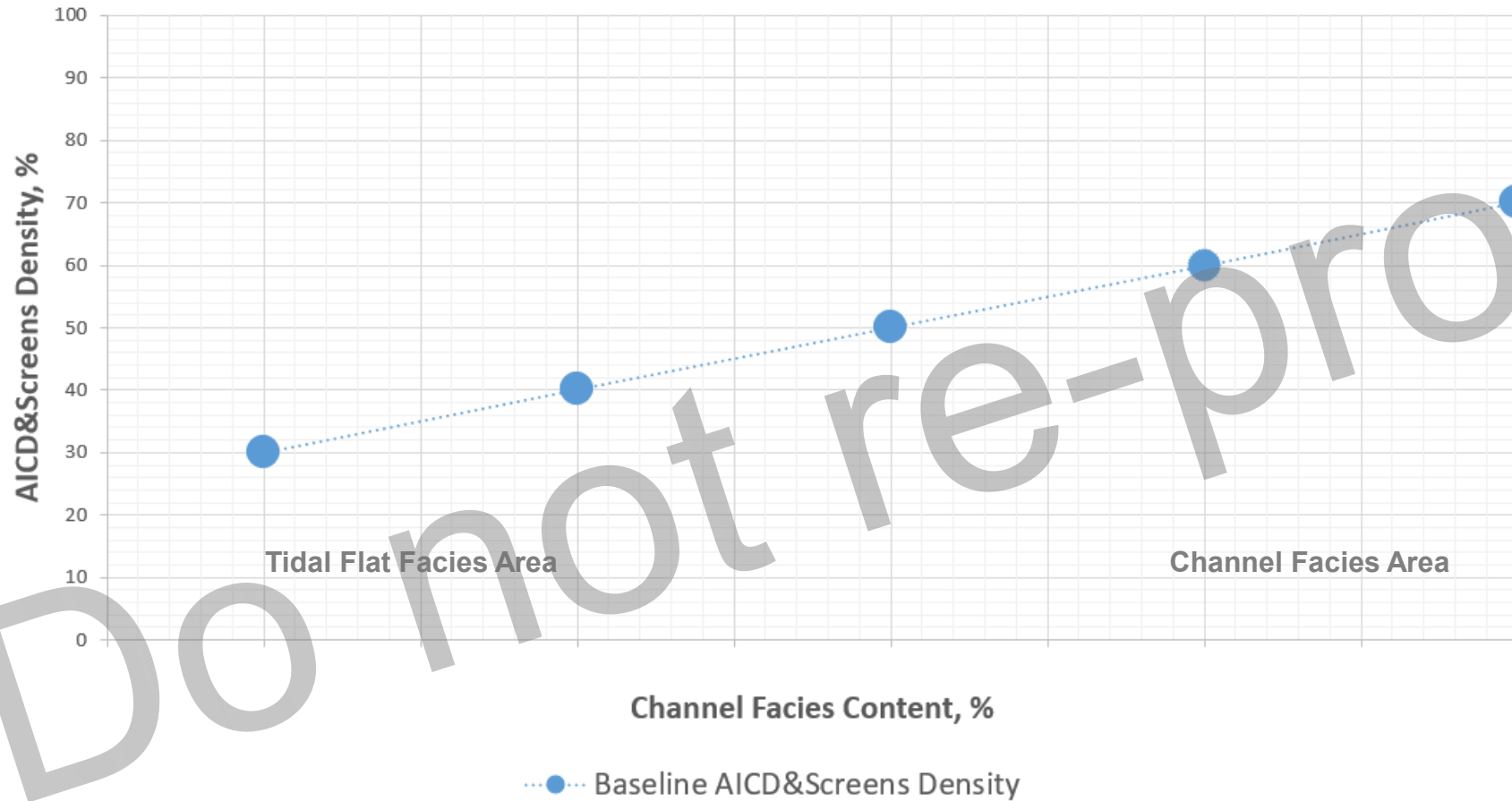




# Case 1: Through-barrier Diagnostics Results



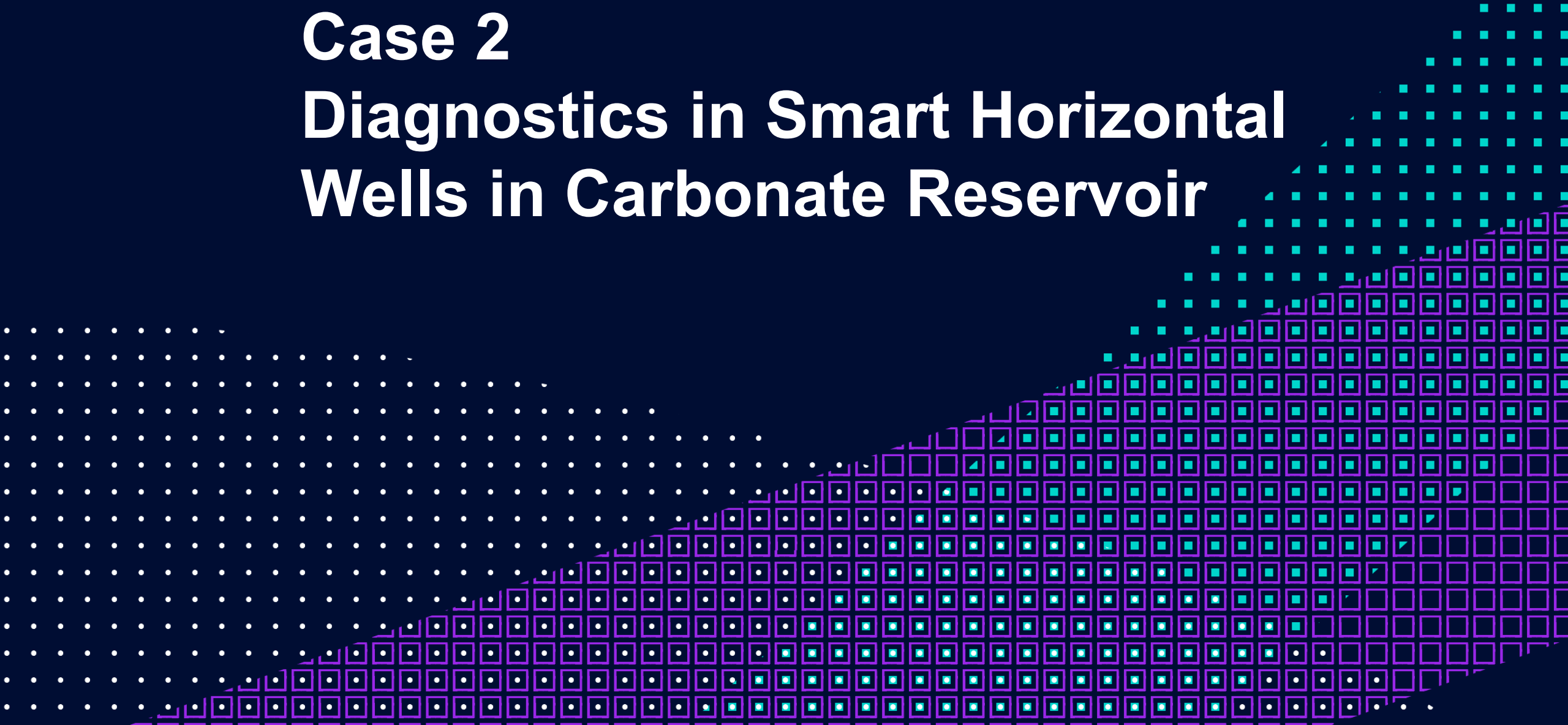
# Completion Strategy Improvement



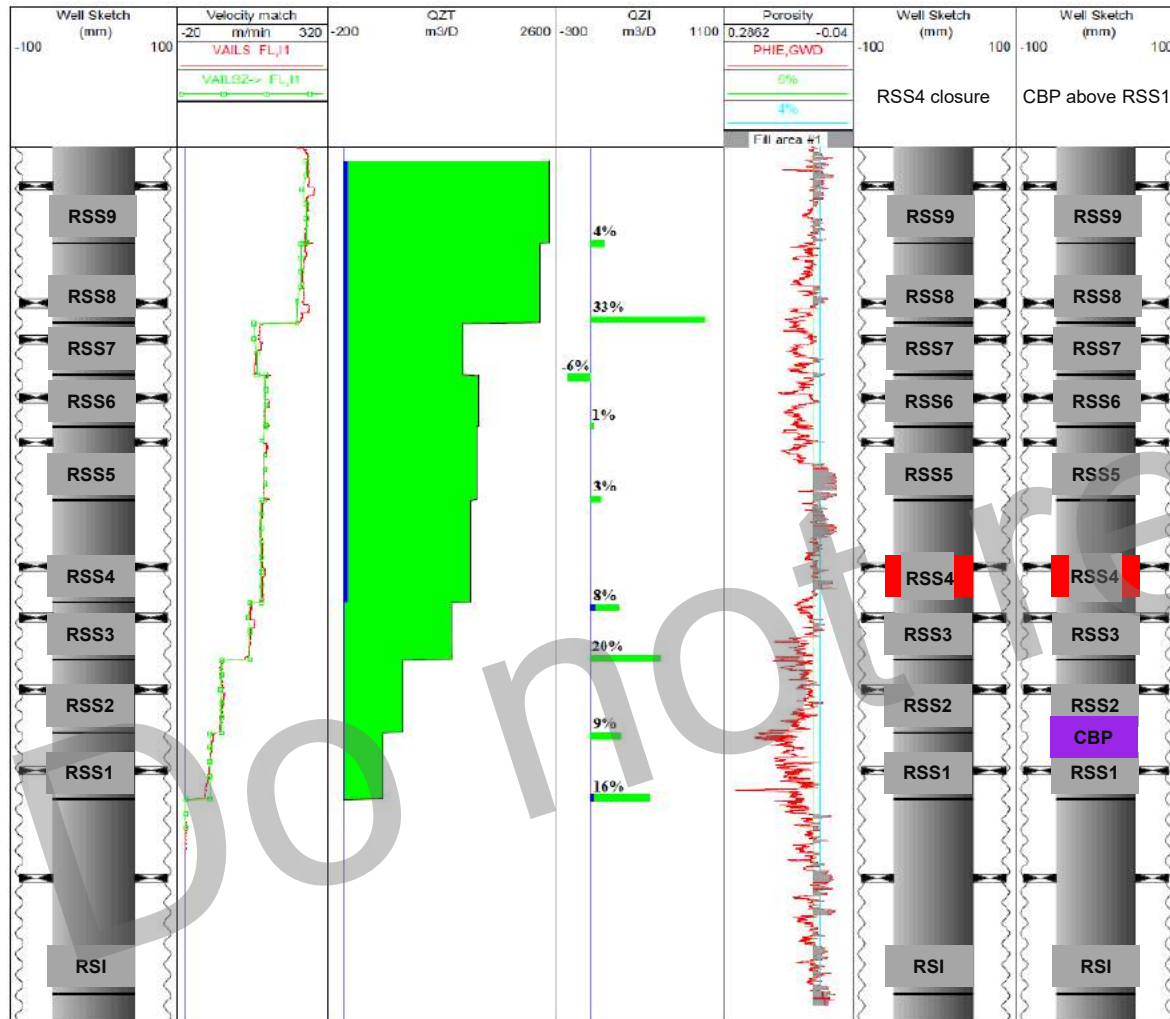


# Case 2

## Diagnostics in Smart Horizontal Wells in Carbonate Reservoir



# Introduction to Case 2 - Water Shut-off Based on Conventional PLT

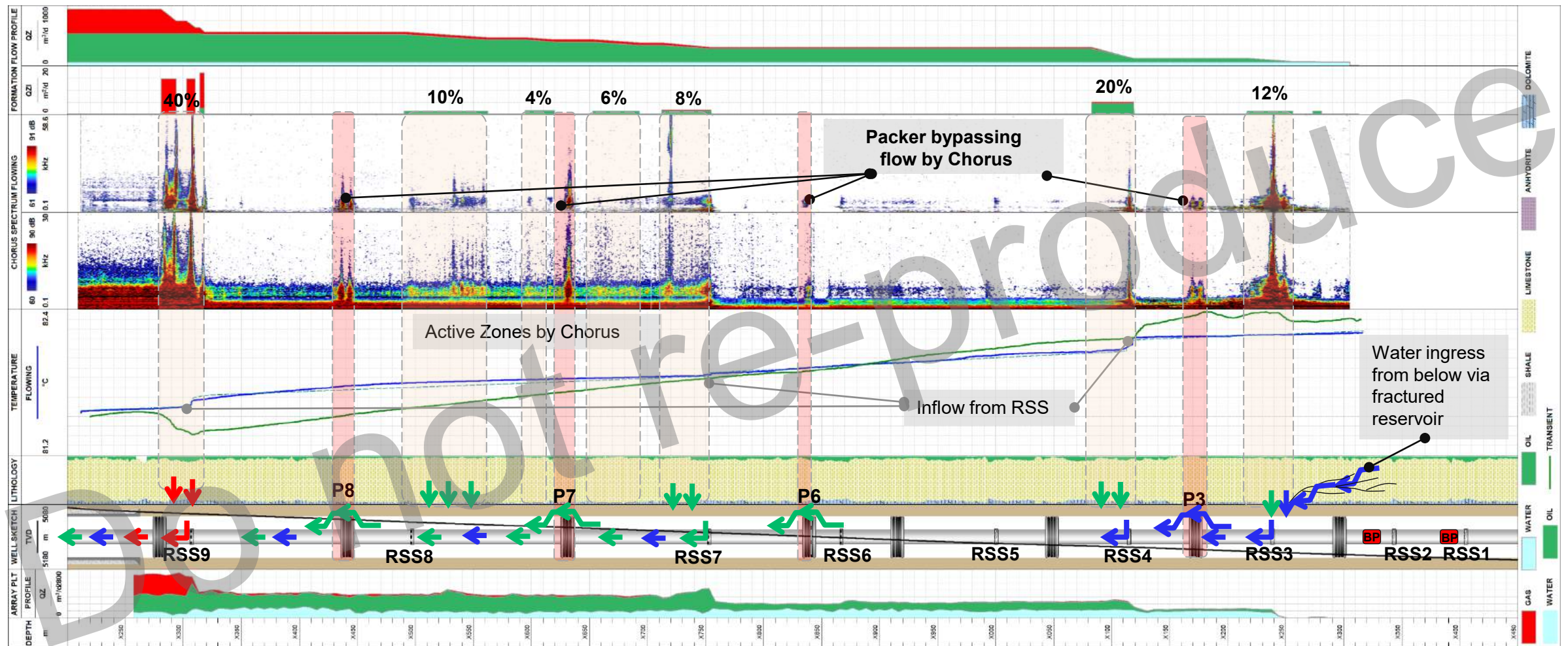


- Water from RSS4 and RSS1 by PLT
- Mechanical water shut-off by closing RSS4 (due to its high WC and low oil contribution): no change in either the water or oil production.
- Further steps: setting a composite bridge plug above RSS1: WC remained the same, but a drop in oil productivity was observed.
- Conclusion: mechanical water shut-off was considered a **failure**, due to a combination of inaccurate diagnostics of the water ingress and complex near wellbore fluid movement.

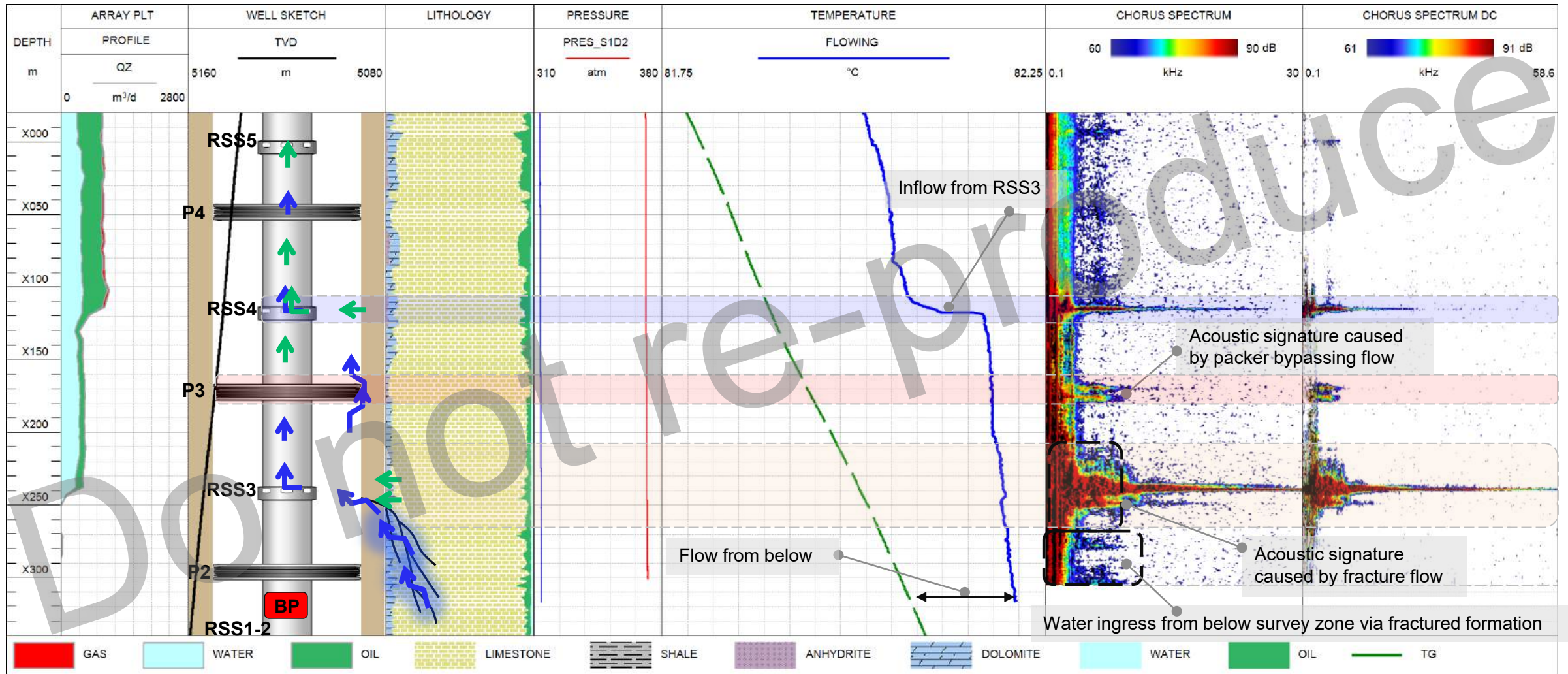
SPE 182587 Production Logging and Spectral Noise Logging Tools in Optimising Water Shut-off in a Carbonate Environment // SPE Caspian, Nov 2016



# Case 2: Smart Well in Carbonate Reservoir



# Case 2: Smart Well in Carbonate Reservoir





# Conclusions

- TGT's True Flow System provides a complete assessment of reservoir flow dynamics and zonal isolation, in horizontal wells
- TGT Through-barrier diagnostics can significantly improve smart well completion designs
- Workover strategy based on conventional PLT is not sufficient in smart wells
- Horizontal well workovers can be complex and costly. 'Total Flow' diagnostics provide the insights you need to plan and execute them efficiently and effectively.

# Thank you

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