Marginal and Mature Field Development and Operation

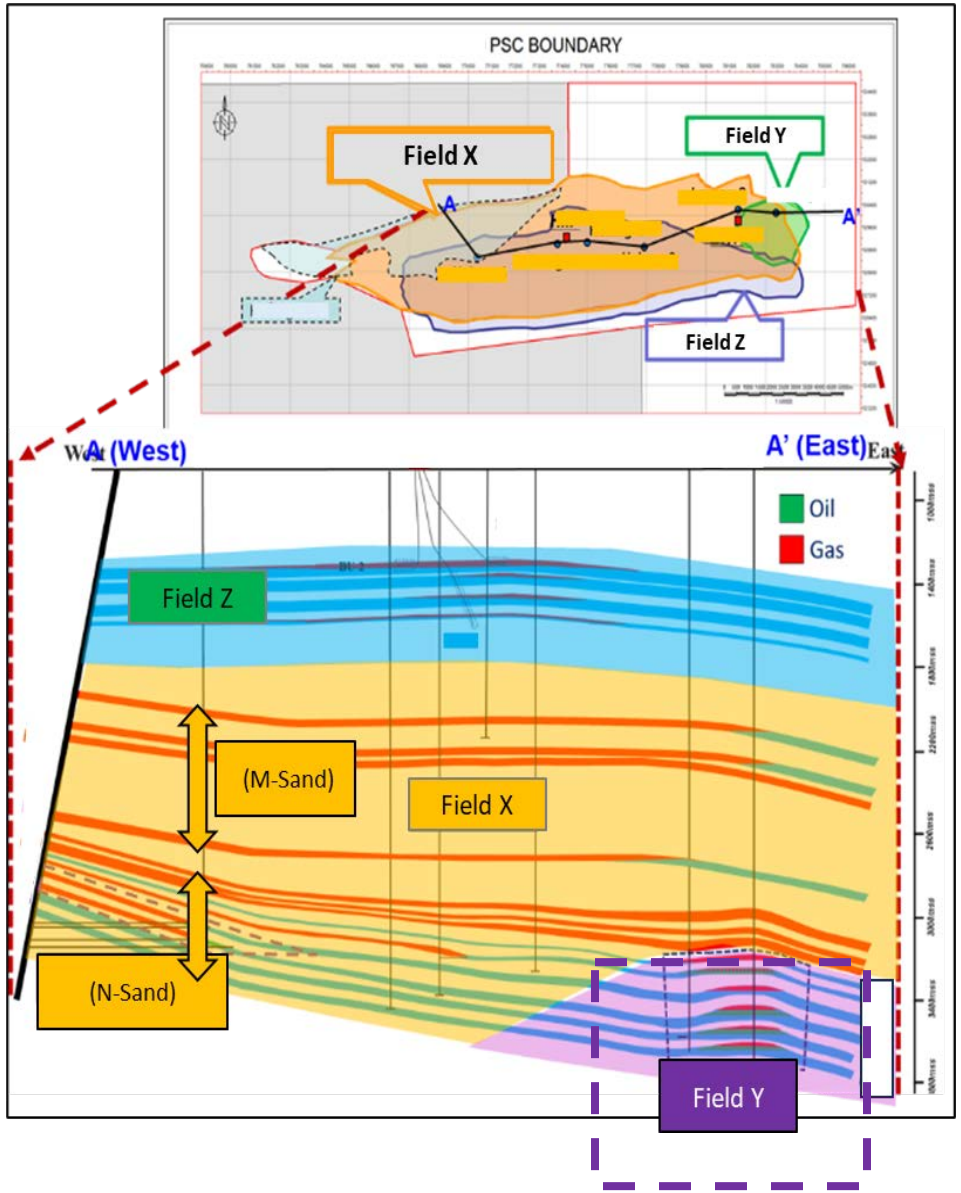
6 – 7 August 2024| KUALA LUMPUR, MALAYSIA

Managing Matured Field Production with an Accurate Production Allocation Determination

Azzad Hafiz Abdul Latif, Artur Giniyatullin (TGT Oilfield Services) Abd Hafriz Abd Wahid, Kamal Amri Bin Rosli (JX Nippon Oil & Gas)

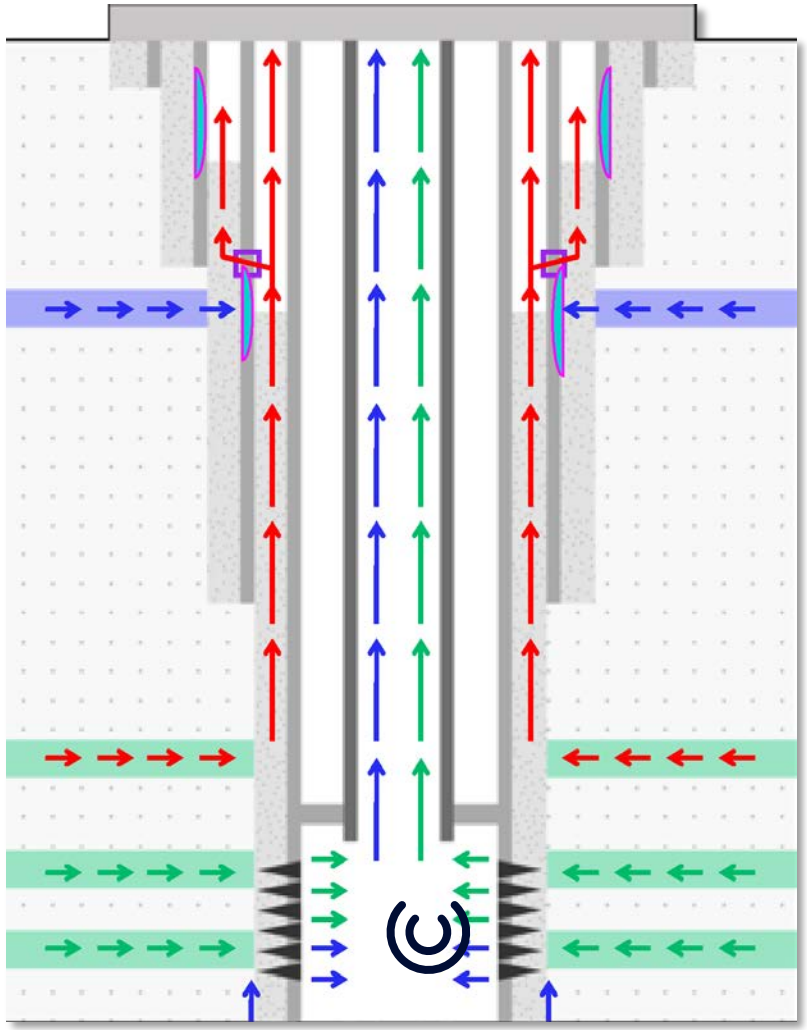
JX Nippon Oil & Gas Exploration (Malaysia) Limited

Objective & Background



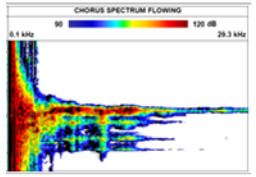
- Block A is of offshore Sarawak consists of Field X, Field Y and Field Z which is located 70 km offshore Sarawak at water depth of 90 m. First gas from Field Y is in **2003**.
- Field Y is highly compartmentalized **multi-stacked reservoirs with commingle production** poses a great challenge for subsurface data acquisition when it comes to determining production allocation, managing flow assurance issues, understanding reservoir connectivity, surveillance of individual well performance & generating total field production forecasting.
- **Conventional production logging result conducted in 2020 was unsatisfactory** to explain some of the wellbore & reservoir flow peculiarities.
- Since it was important to know which zonal contribution, diagnostic of wellbore/reservoir flows & validate well integrity issues, **Spectral Acoustic Logging with Thermo-Hydrodynamic Modeling was conducted in 2022**.

Through-barrier Diagnostics



Traditional diagnostics	Through-barrier diagnostics
Measure flow dynamics in wellbore only	Measure flow dynamics in wellbore & reservoir
Unable to track fluid movement behind production casing	Can accurately track fluid movement behind production casing
Limited sensitivity to fluid movements in outer annuli	High sensitivity to fluid movements in outer annuli
Restricted view of the well & reservoir	Complete, holistic view of the well & reservoir

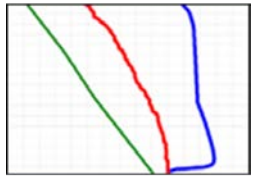
Chorus
Passive Acoustic



Senses all flow

Scanning radius: 3-5 meters
High sensitivity and wide dynamic range
Operates in any well conditions
Operates in any fluid media

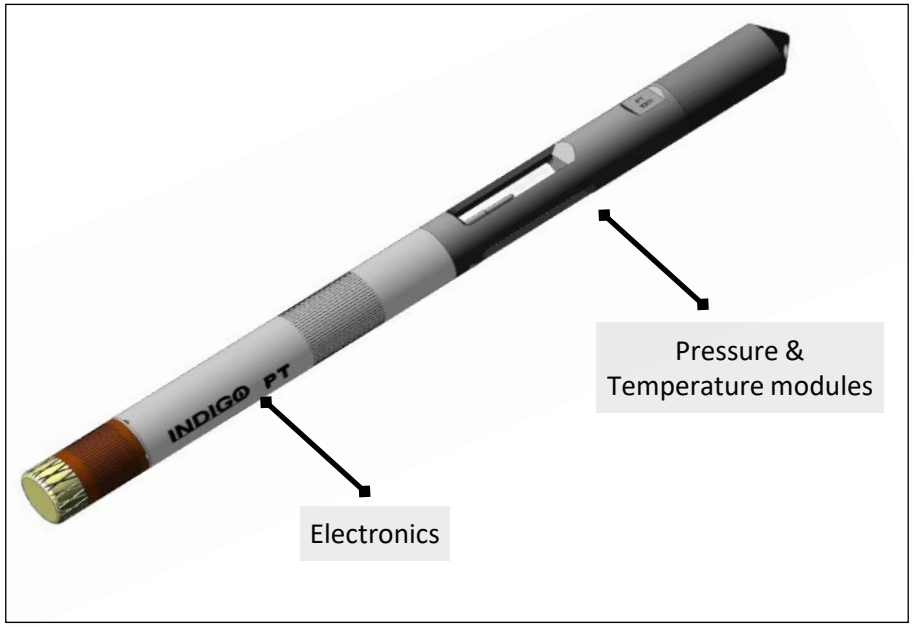
Cascade
Thermal



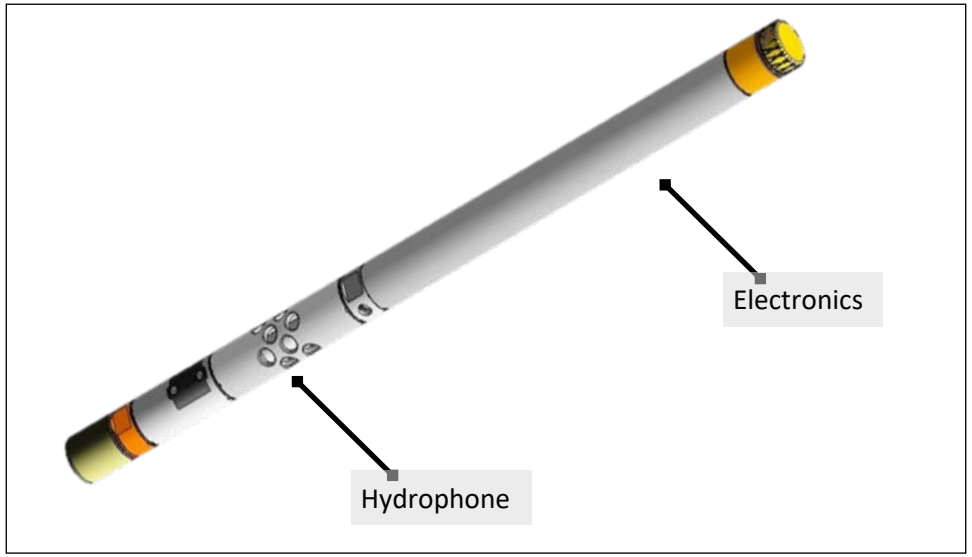
Quantifies flow

Comprehensive thermo-hydrodynamics solver
Quantifying flow profiles in the well system
Cross flows in wellbore & channeling
Quantifying of behind casing flow

Technology Specification



Parameter	Value
Temperature rating	0 to 150◦C (32 to 302°F)
Pressure rating	100 MPa (14 500 psi)
Pressure resolution	0.00005 MPa (0.072 psi)
Temperature resolution	0.001 °C (0.0018 °F)
OD	42mm (1 11/16”)
Length	50.7cm (1.66ft)

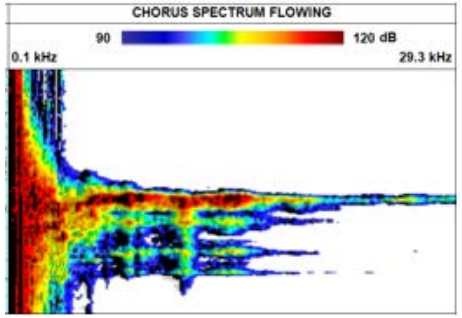


Parameter	Value
Temperature rating	0 to 150◦C (32 to 302°F)
Pressure rating	100 MPa (14 500 psi)
H_2S resistance	<30%
Frequency range	8-60 000 Hz
Dynamic range	90 dB
Recording time (mem. mode)	70h
Tool OD	38/42mm (1.5 / 1 11/16”)
Length	80cm (2.6’)
Weight	7 kg (15.4 pounds)

Technology Details - Acoustic

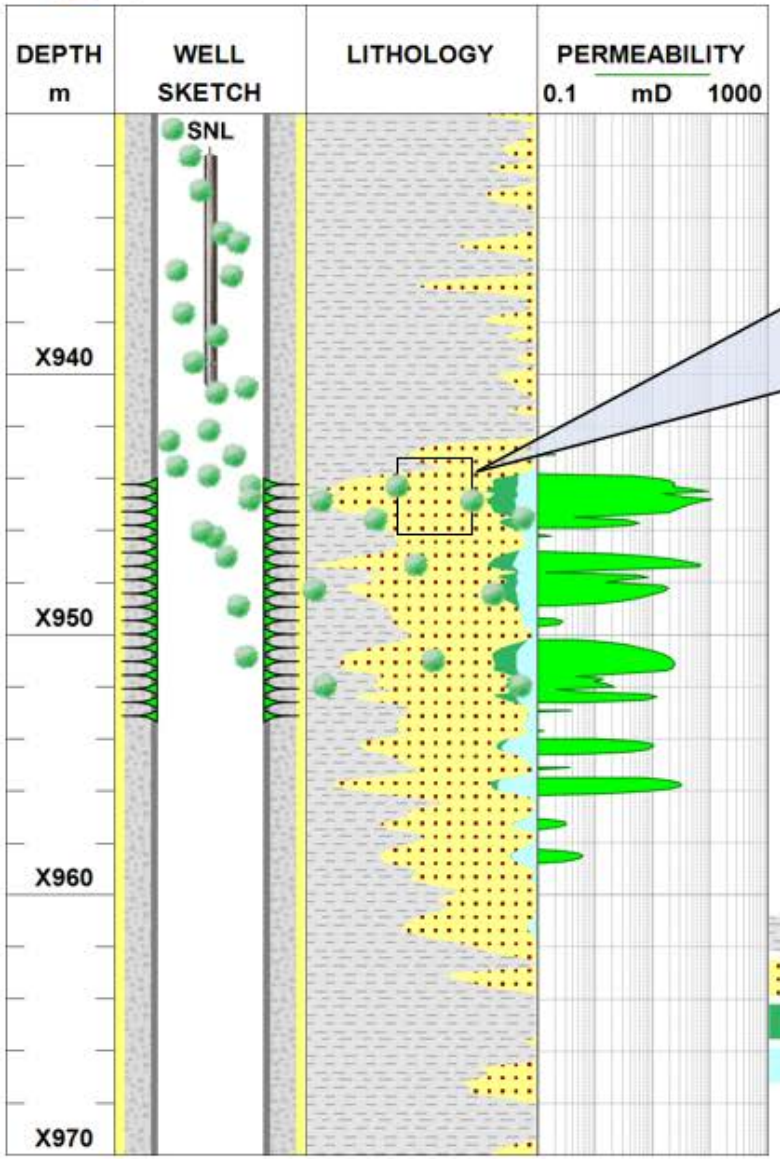
Chorus

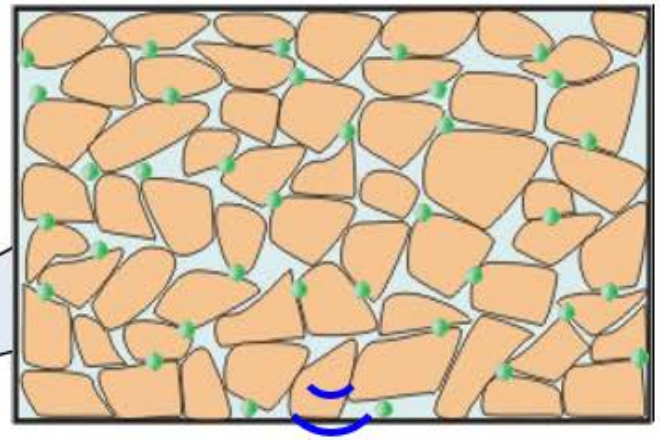
Passive Acoustic

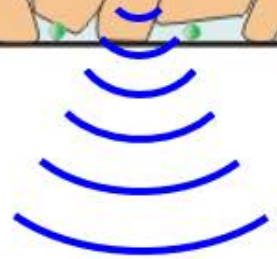


Senses all flow

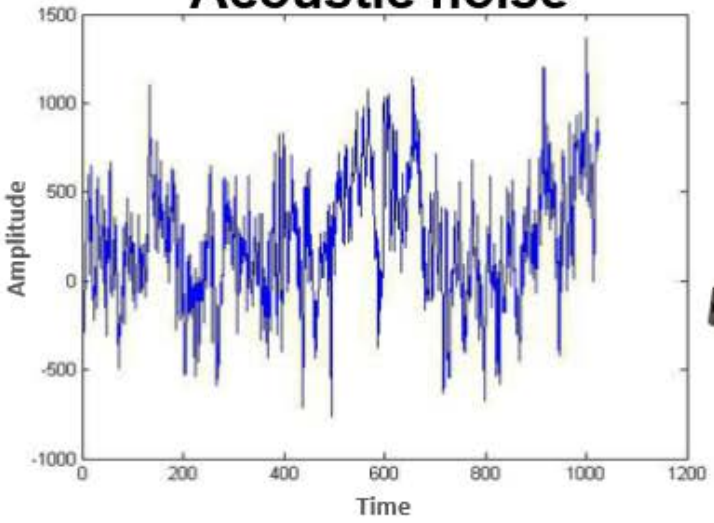
Physics of Measurement



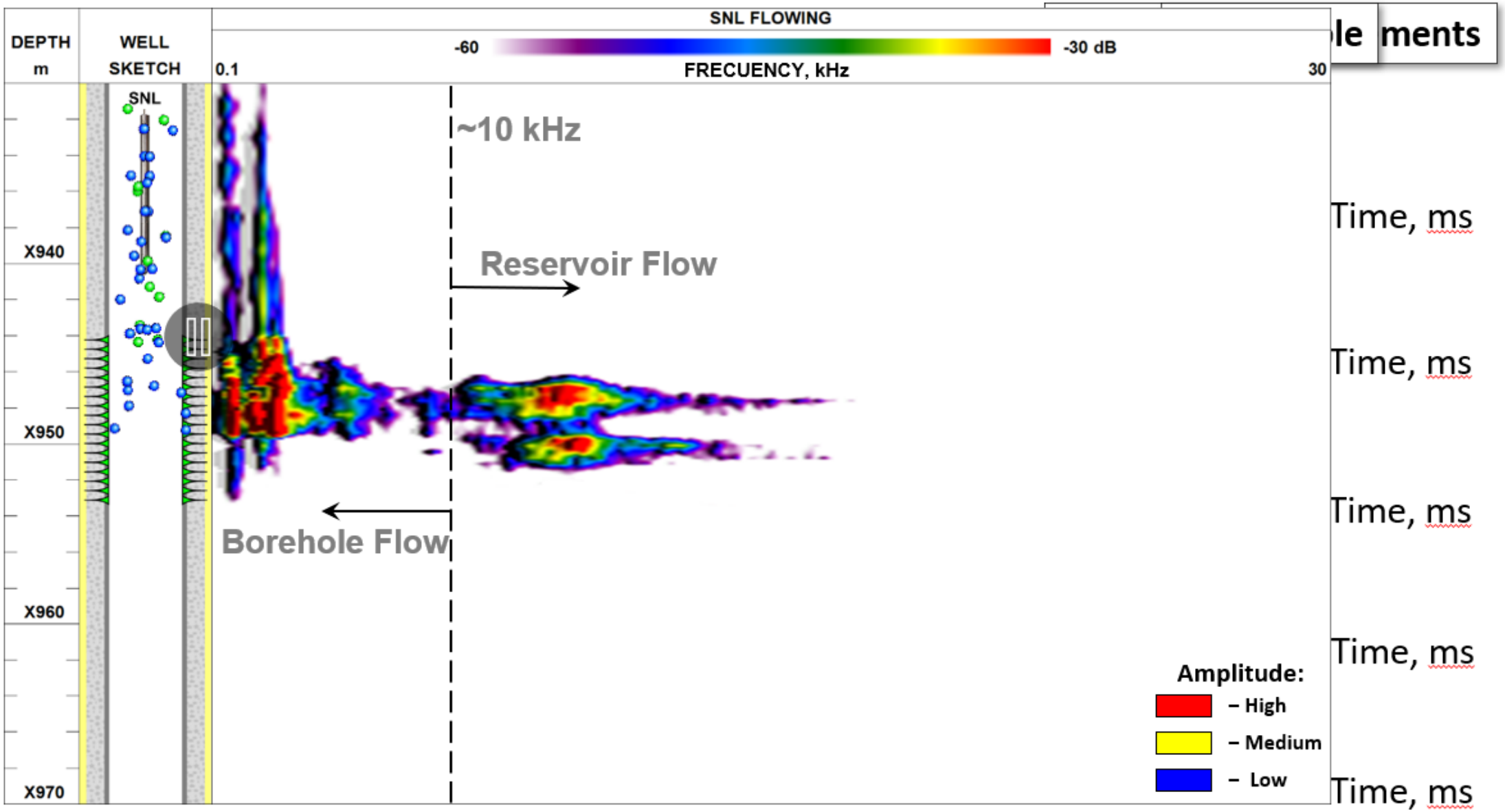




Acoustic noise

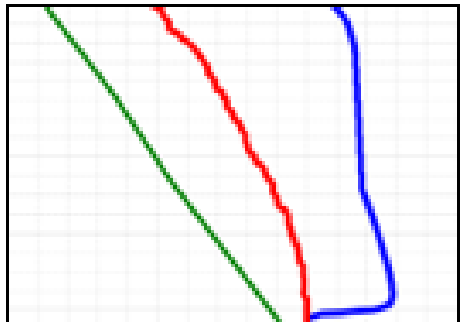


Chorus


SNL FLOWING
DEPTH
m
WELL
SKETCH
-60
-30 dB
0.1
FRECUENCY, kHz
30
SNL
~10 kHz
X940
X950
X960
X970
Reservoir Flow
Borehole Flow
Time, ms
Time, ms
Time, ms
Time, ms
Time, ms
Amplitude:
– High
– Medium
– Low

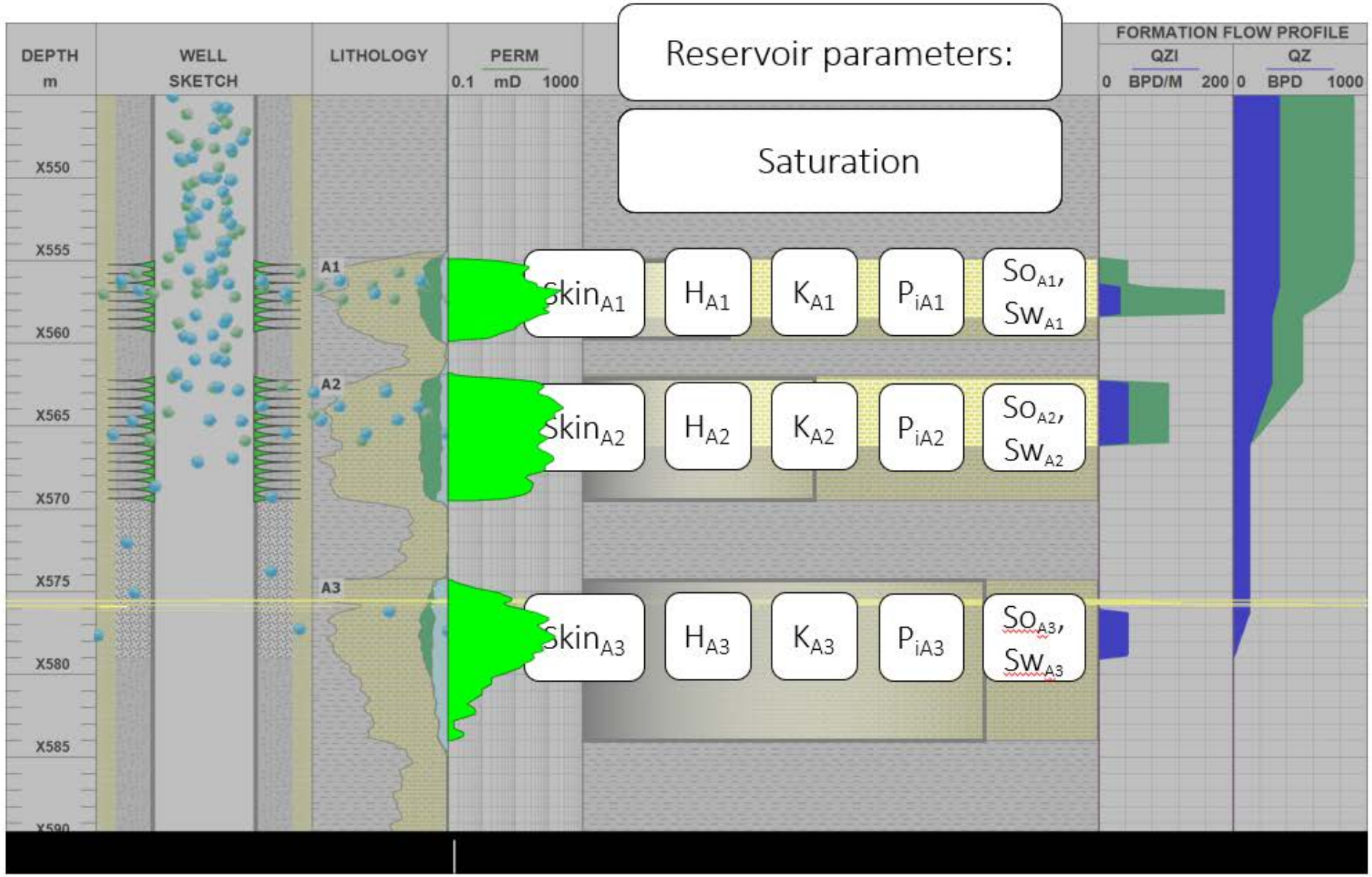
Technology Details - Thermal

Cascade
Thermal

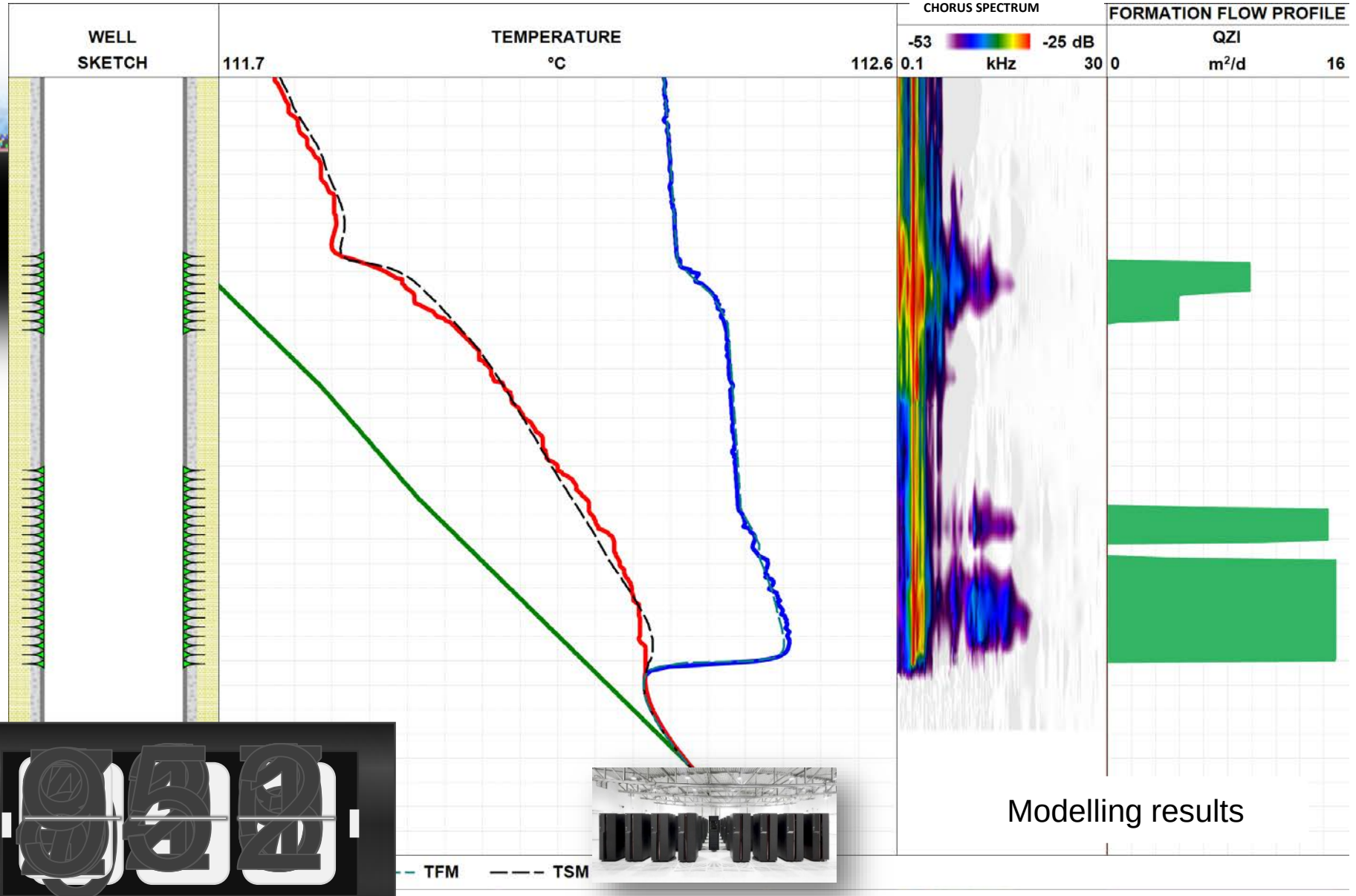


Quantifies flow

Temperature Modelling Input Parameters



Temperature Simulation Iteration



20% (20 m^3/d)

80% (80 m^3/d)

Modelling results

Key Benefits

Production logging (PL) is widely utilized in the industry as standard practice for production allocation measurement.

Wells in Malaysia tend to have multi reservoir production system, often completed with dual strings. This severely limits the PL capabilities (flow behind tubing).

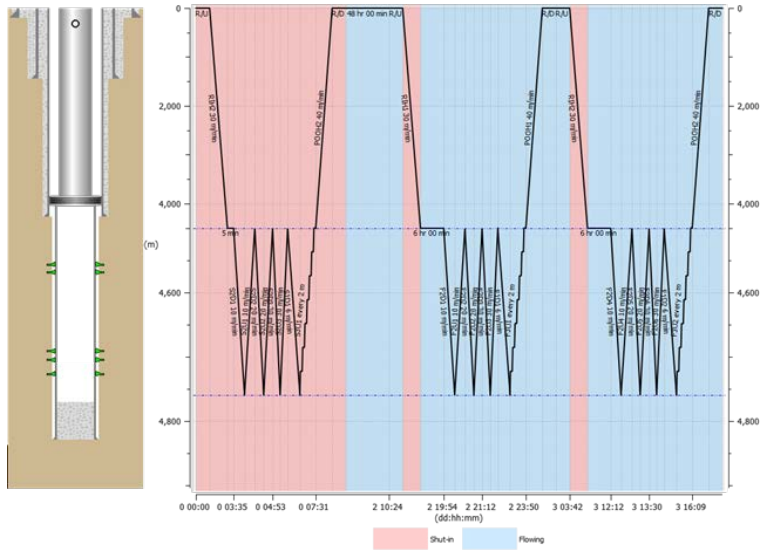
Completion integrity adds uncertainty which may lead to wrong allocation determination

PL measurement method can’t reveal the full picture, as the measurement is limited to borehole analyses.

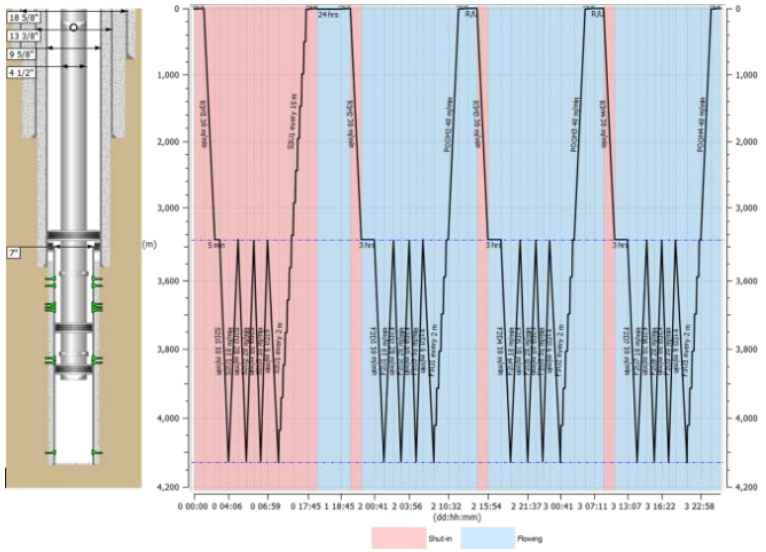
Addition of Spectral Noise Sensor and High Precision Temperature will greatly enhance the PLT value, enabling through-barrier diagnostics

The Approach - Logging Program

Well #1



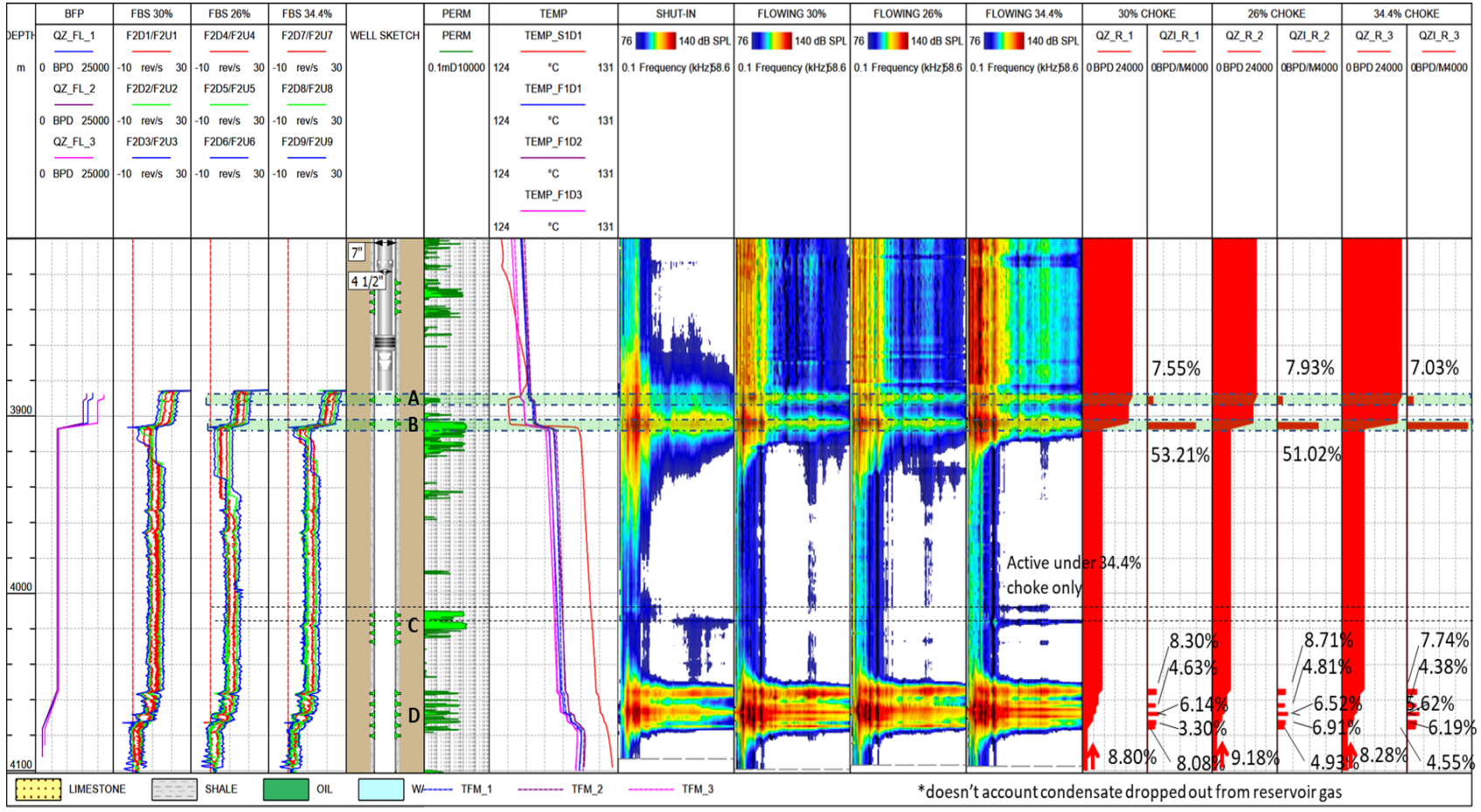
Well #2



- Development wells Well#1 & Well#2 was drilled & completed in 2009 and 2017 as comingle gas and oil producers with 7” x 4-1/2” cemented liner across the reservoirs.
- Main purpose of the logging program is **quantification of fluid flow at each reservoirs** to justify production allocation assumption, especially for minimally produced reservoirs.
- Fluid flow behavior will also be observed at different flowing conditions to validate the wellbore & reservoir flow peculiarities (e.g. crossflow).

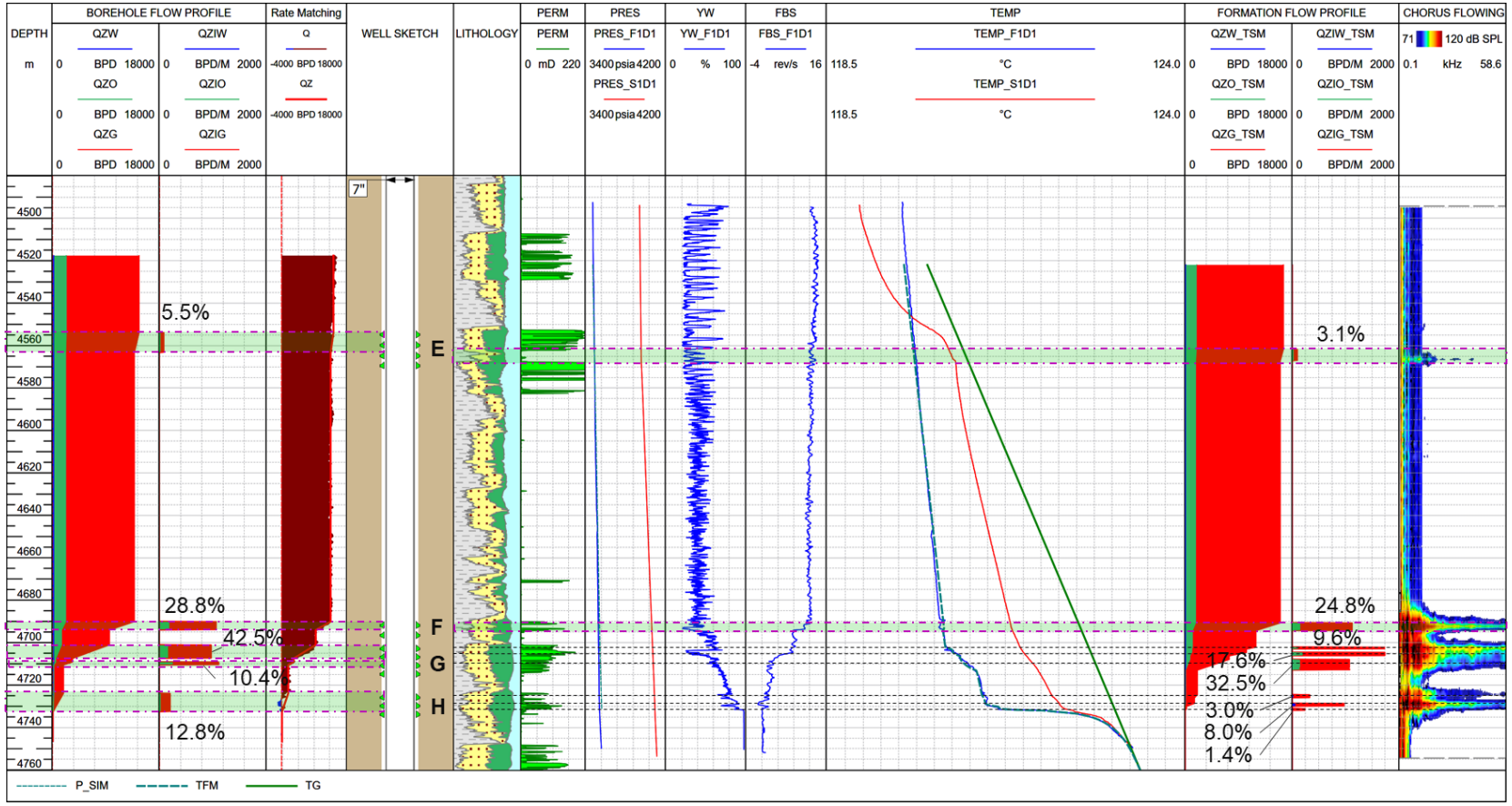
Case Study Well #1

- Objective of the logging is to evaluate flow allocation and focusing on minimal contribution from Zone C
- From logging result, Zone C is not producing during low rate passes.
- No indication of reservoir noise across C reservoir, gave concrete justification for operator.



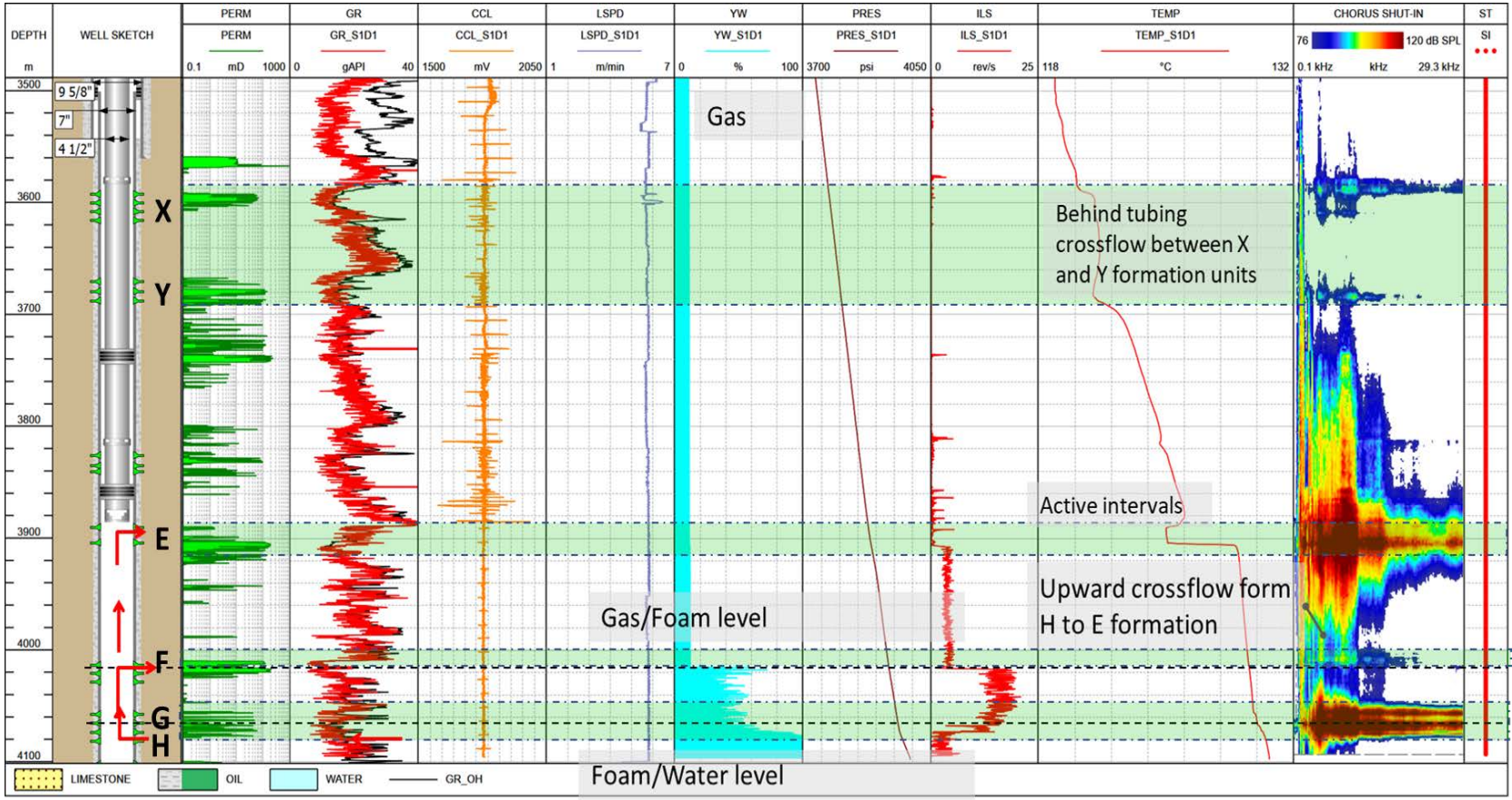
Case Study Well #2

- Objective of the logging is to evaluate flow allocation and focusing on justification from E Reservoir
- Previous conventional logging concludes no contribution from E Zone
- Based on Acoustic response and thermohydrodynamic evaluation, confirms approximate 3% of contribution from E Reservoir.



Shut In Well #2

- Additional information was observed during Shut In Pass
- Upward wellbore crossflow was identified under shut-in condition. According to multiphase data gas is bubbling through water column from outside logging interval below 4009 m.
- Additional behind tubing crossflow between X and Y Formation Units



Value Creation

For Well #1

- Due to minor channeling / liquid inflow observed from the highest drawdown from Chorus, operator advised the production team to control the well choke not to exceed 25% DD and the well is currently producing water-free for 2 years plus which is significantly improved compared to analogue well which has no drawdown control.
- With no production from **Zone C**, operator conduct re-evaluation on the connected volume between well 2 and analogue well (potential more compartmentalization etc.)
- Correct production allocation to reservoir for correct reserves reporting.

For Well #2

- **E-Zone** is contributing as per expectation which initially guessed as potential formation damage which may cause unnecessary remedies such as acid stimulation.
- Correct production allocation to reservoir for correct reserves reporting.

Summary

- Effective management of matured oil and gas fields involves integrating advanced diagnostic technologies with strategic planning and operational excellence.
- By addressing measurement limitations through innovative approaches like spectral noise logging and temperature diagnostics, operators can ensure accurate reservoir management.