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Reservoir Pressure Evaluation using Multi-rate SNL

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- TGT Oilfield Services

Agenda

1. Introduction
2. Theory and Lab Tests
3. Calculation procedure
4. Case Study

Introduction

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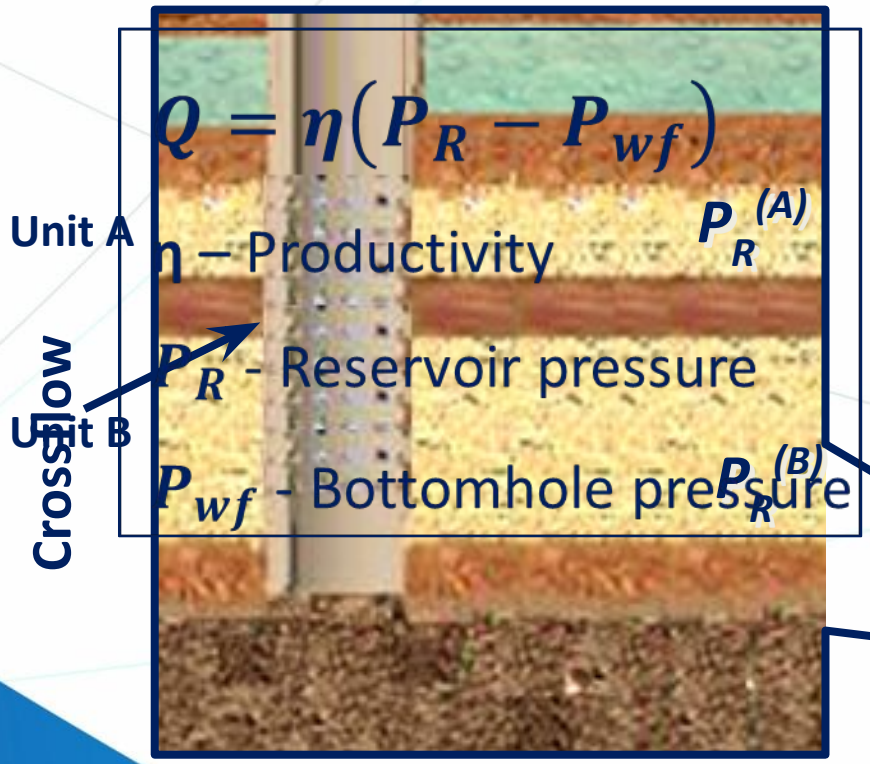
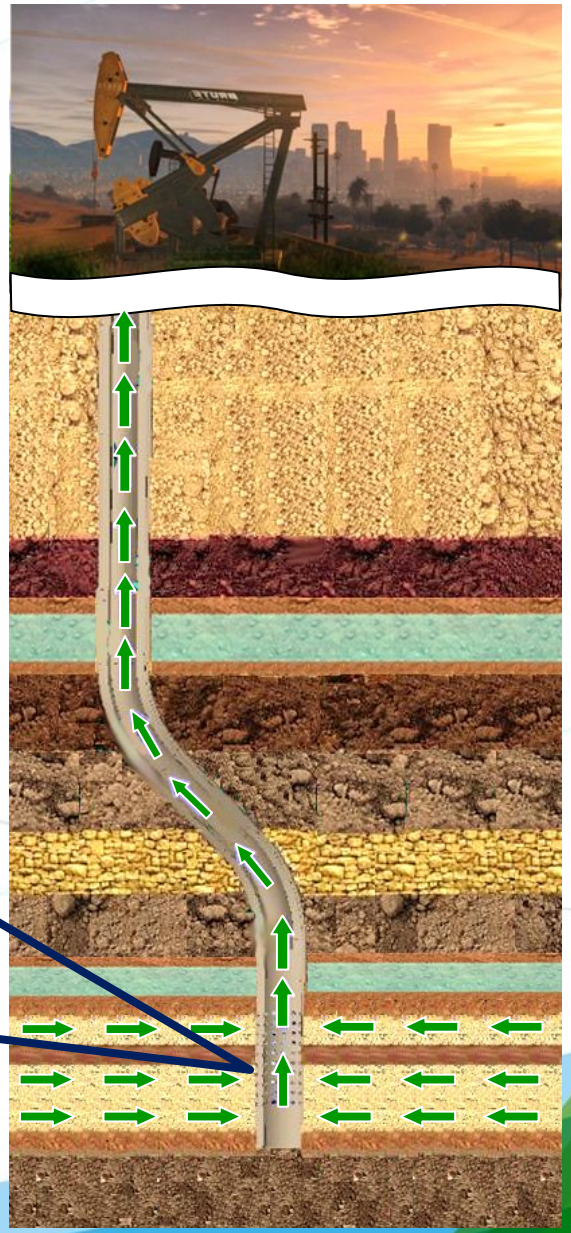
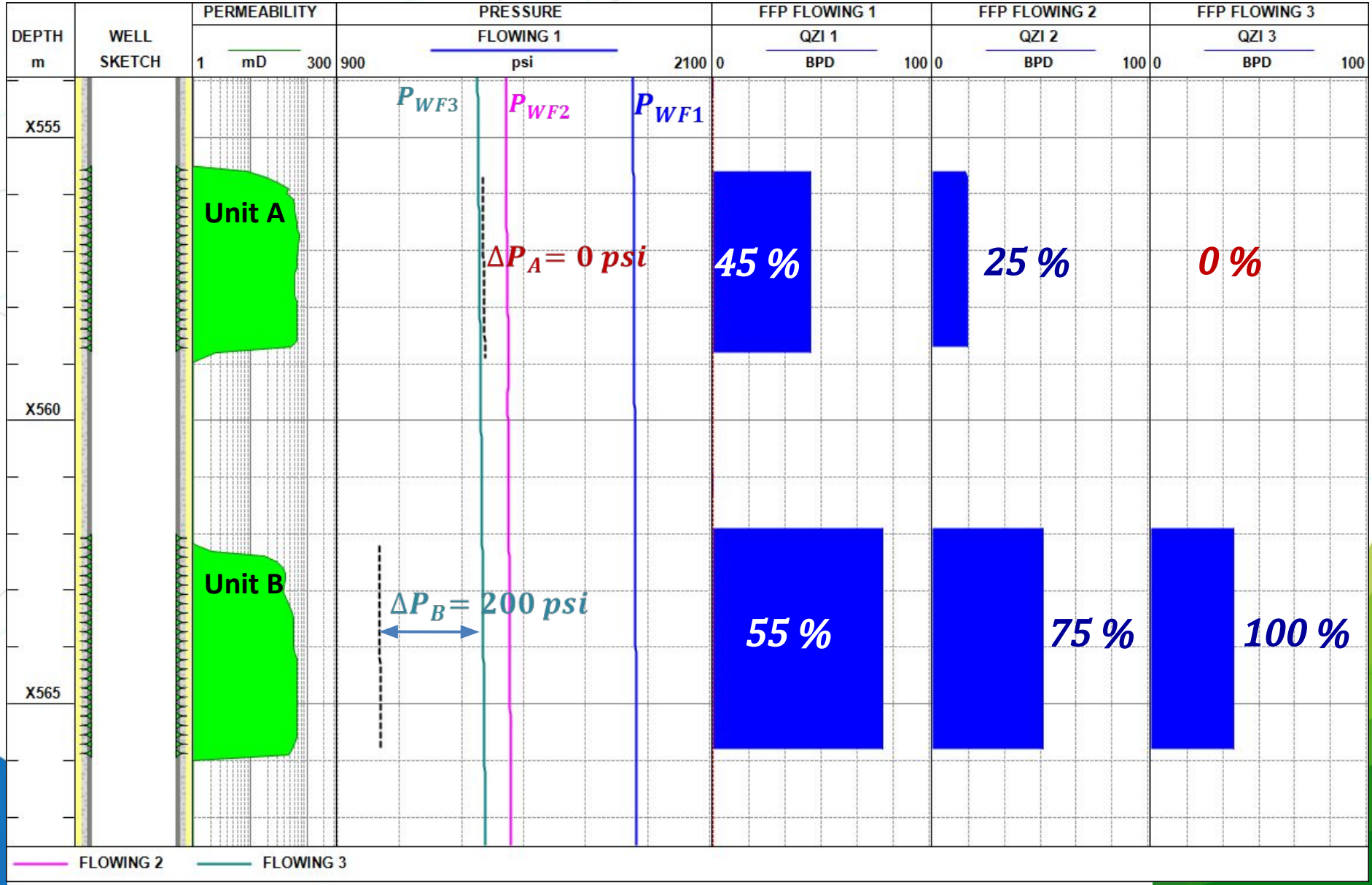
P_R – Reservoir Pressure



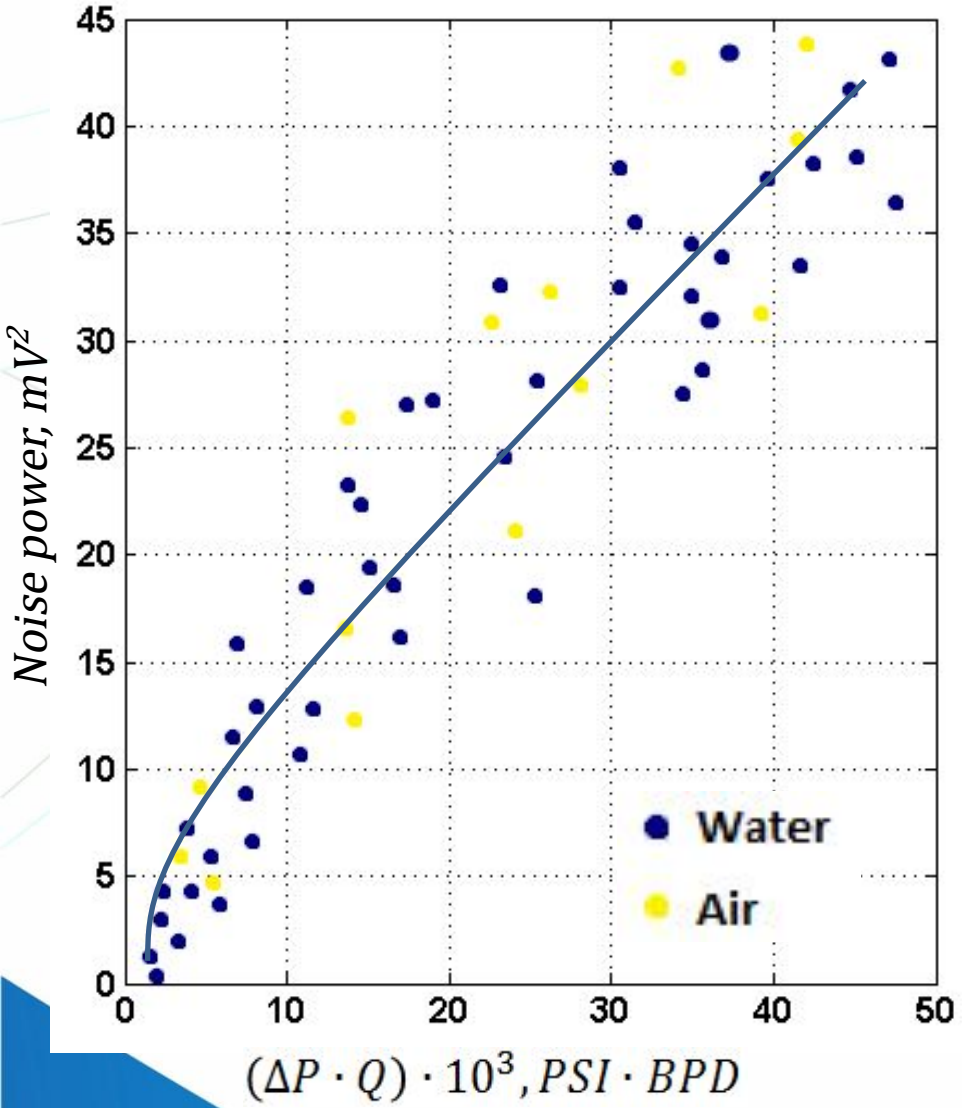


Simulated Multi - Layered Injector



Theory

McKinley (1994):



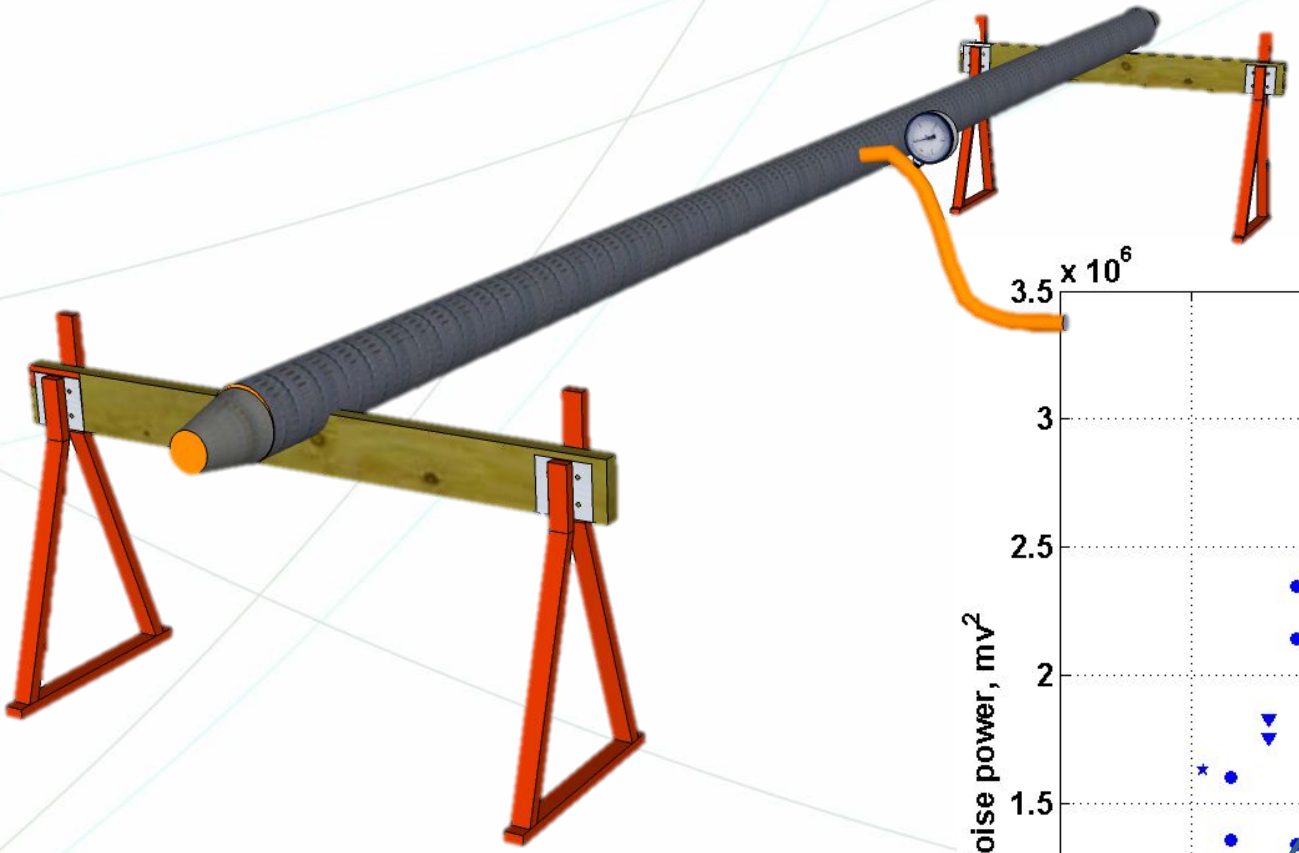
$$N \sim Q \cdot \Delta P$$

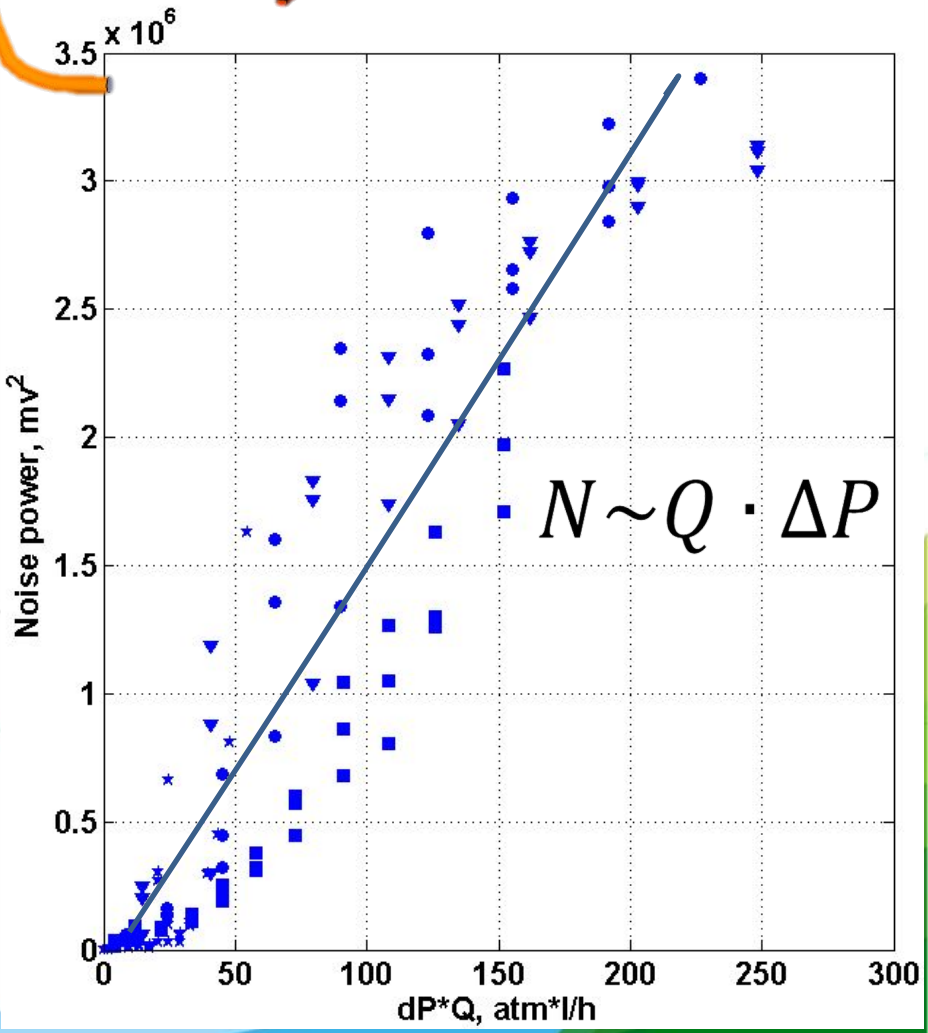
N - Noise Power

Q - Volumetric rate

ΔP - Pressure drop

Lab tests





Height	6 m
Ø Tube	3 ½”
Volume	0.029 m^3
Pressure drop	0 – 5 atm
Ø Hole	1– 10 mm

Calculation procedure. SNL Dual-rate

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Noise Power:

$$N = K(P_R - P_{wf})^2$$

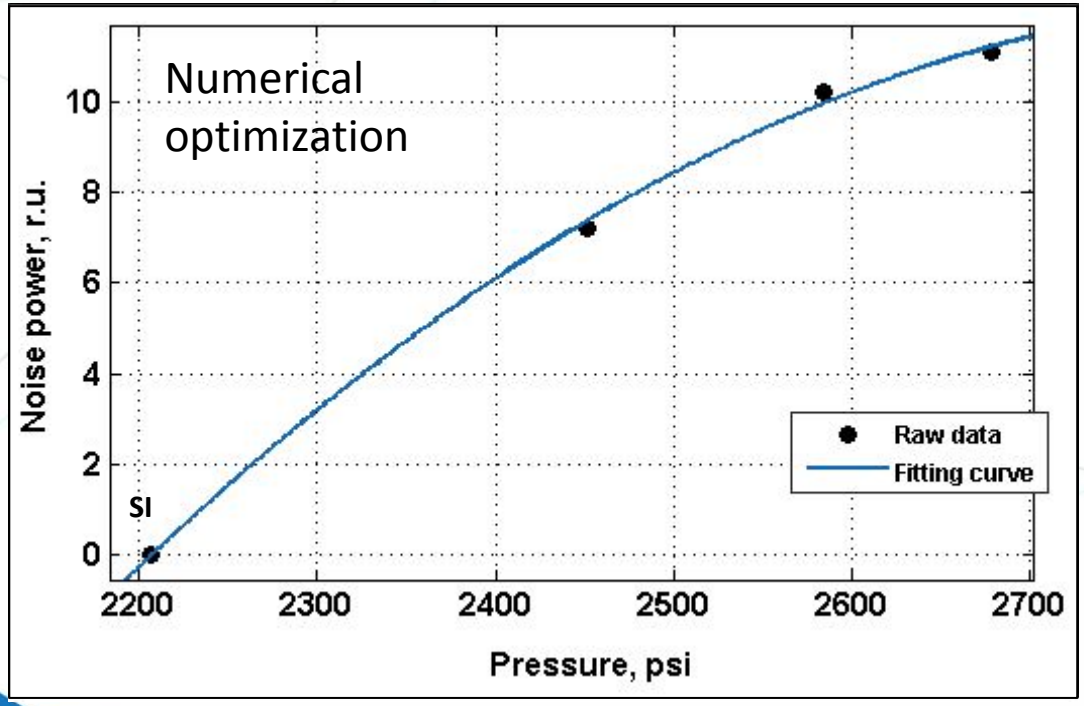
Dual-rate SNL a single-phase fluid:

$$Q = k \cdot \Delta P$$

$$\begin{cases} N^{(1)} = K(P_R - P_{wf1})^2 \\ N^{(2)} = K(P_R - P_{wf2})^2 \end{cases} \rightarrow P_R$$

Calculation procedure. SNL Multi-rate

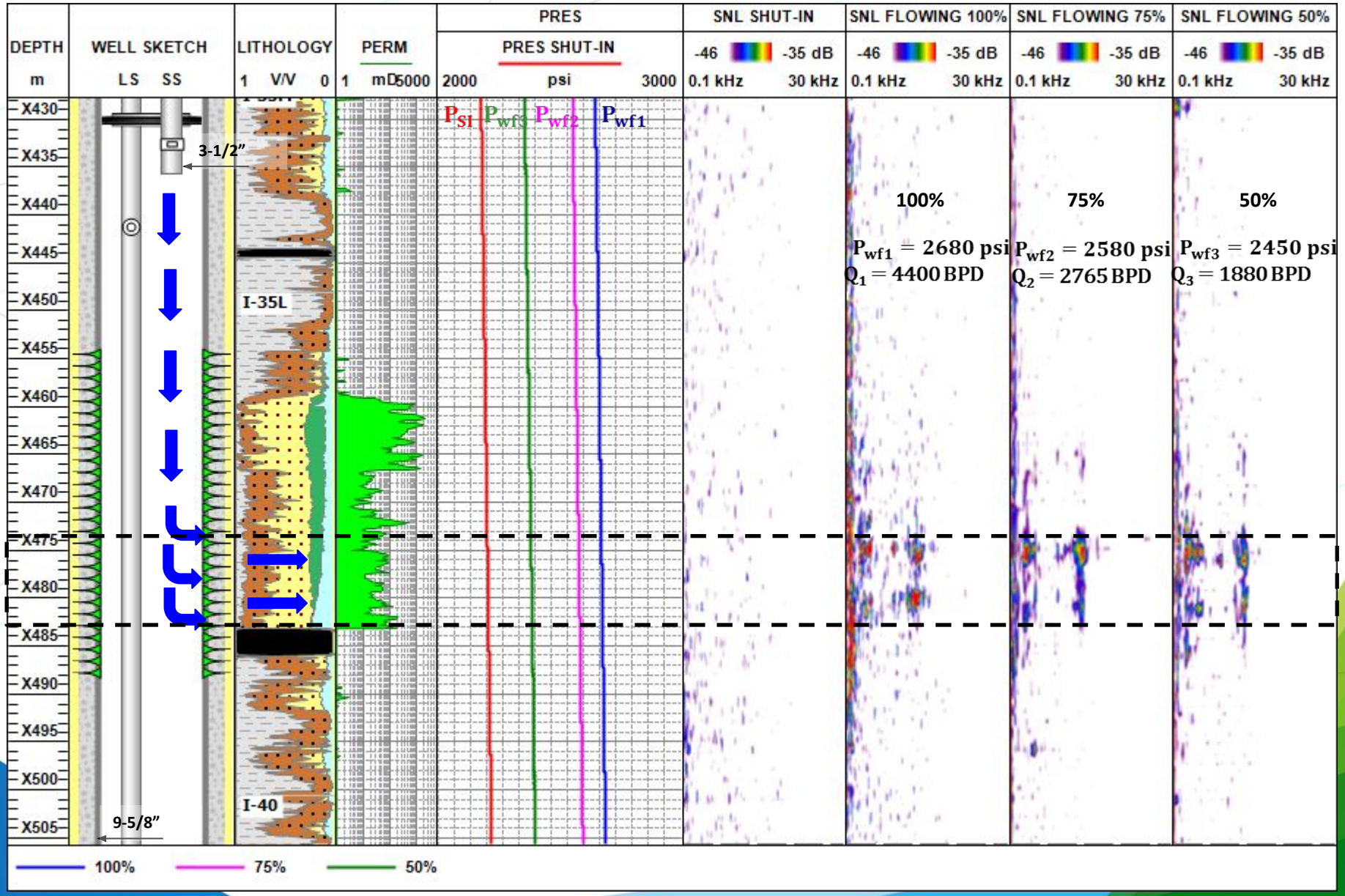
$$N_{pow} = a(P_{wf} - P_R)^2 + b(P_{wf} - P_R)$$



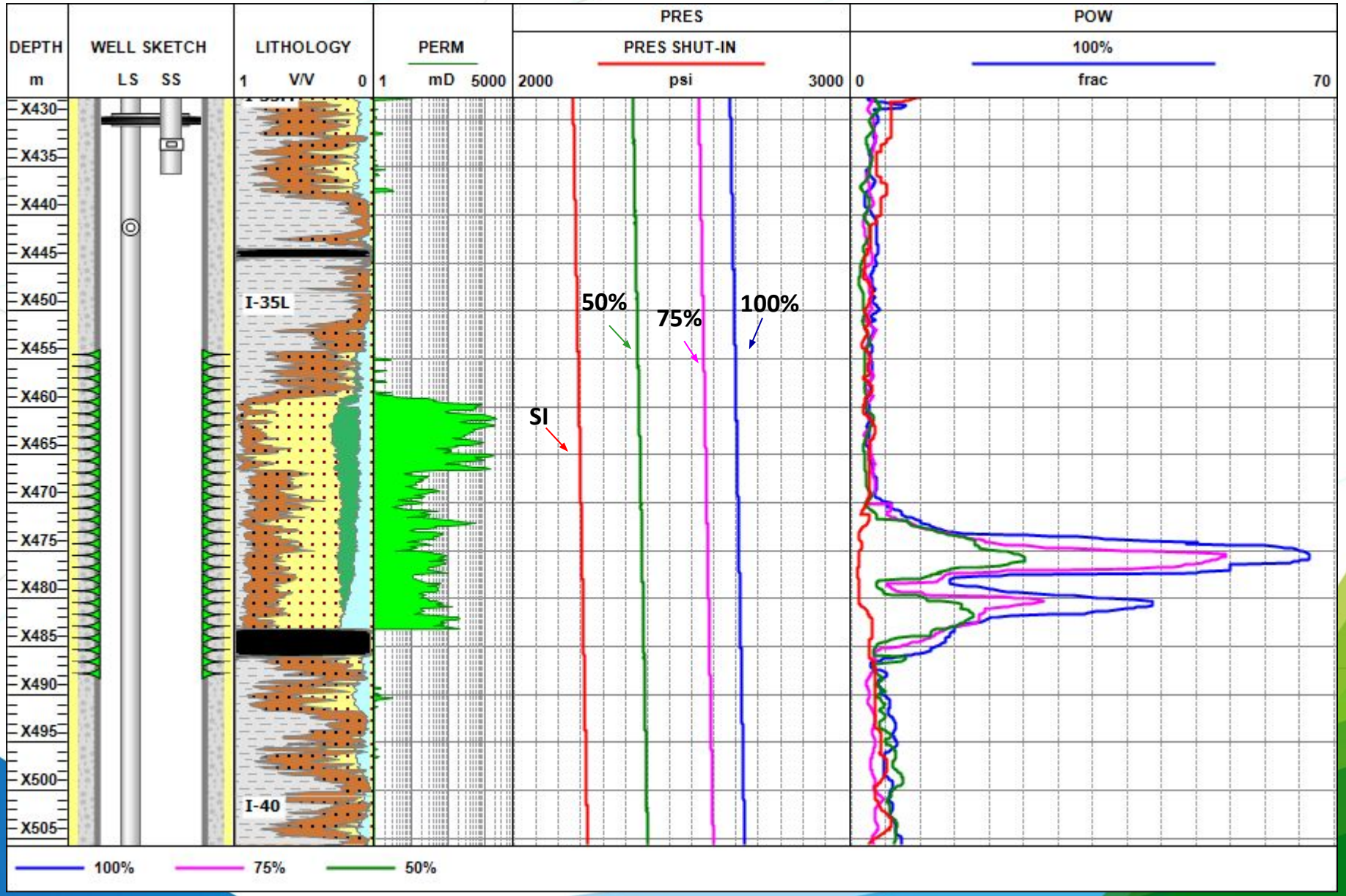
P_R

Case Study

Case 1. Smart completion (SS – Inj, LS – Shut-in)



Case 1. Noise power



Calculation procedure

Conditions	Target unit	Temperature °C	Pressure, psi	Noise power psi	Normalized noise power, psi
Shut-in	I-35 L	56.1	2205	8.2	0
Flowing (100 %)	I-35 L	59.0	2677	19.4	11.2
Flowing (75%)	I-35 L	60.5	2582	18.4	10.2
Flowing (50%)	I-35 L	63.0	2450	15.7	7.56

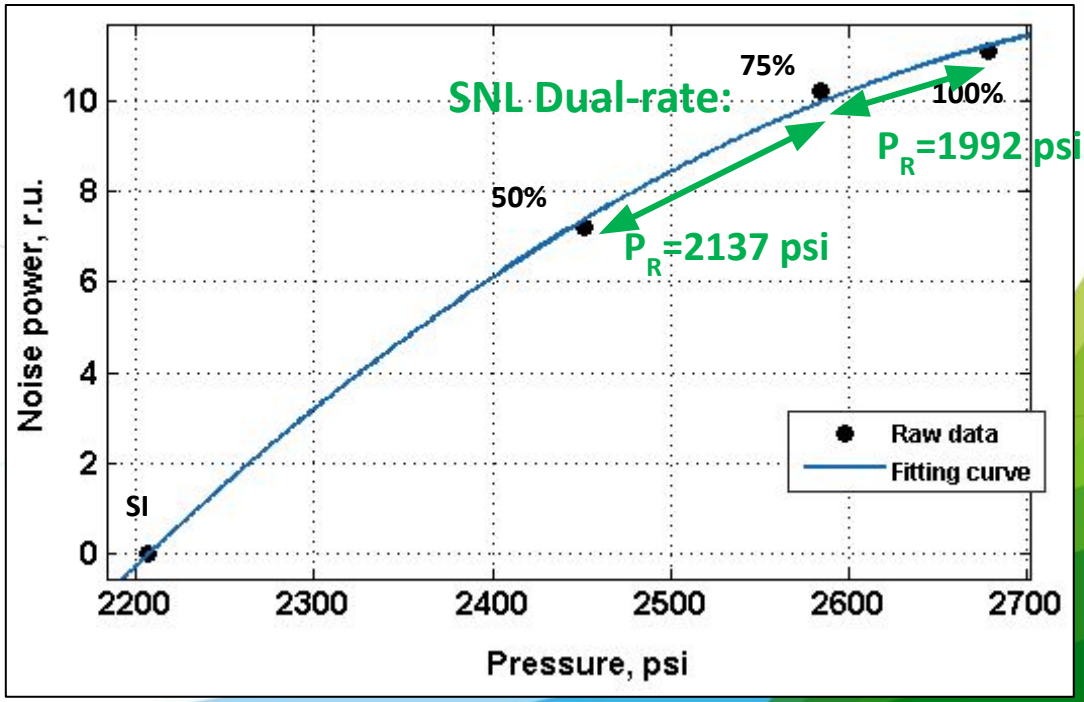
$$N_{pow} = a(P_{wf} - P_R)^2 + b(P_{wf} - P_R)$$

SNL Multi-rate:

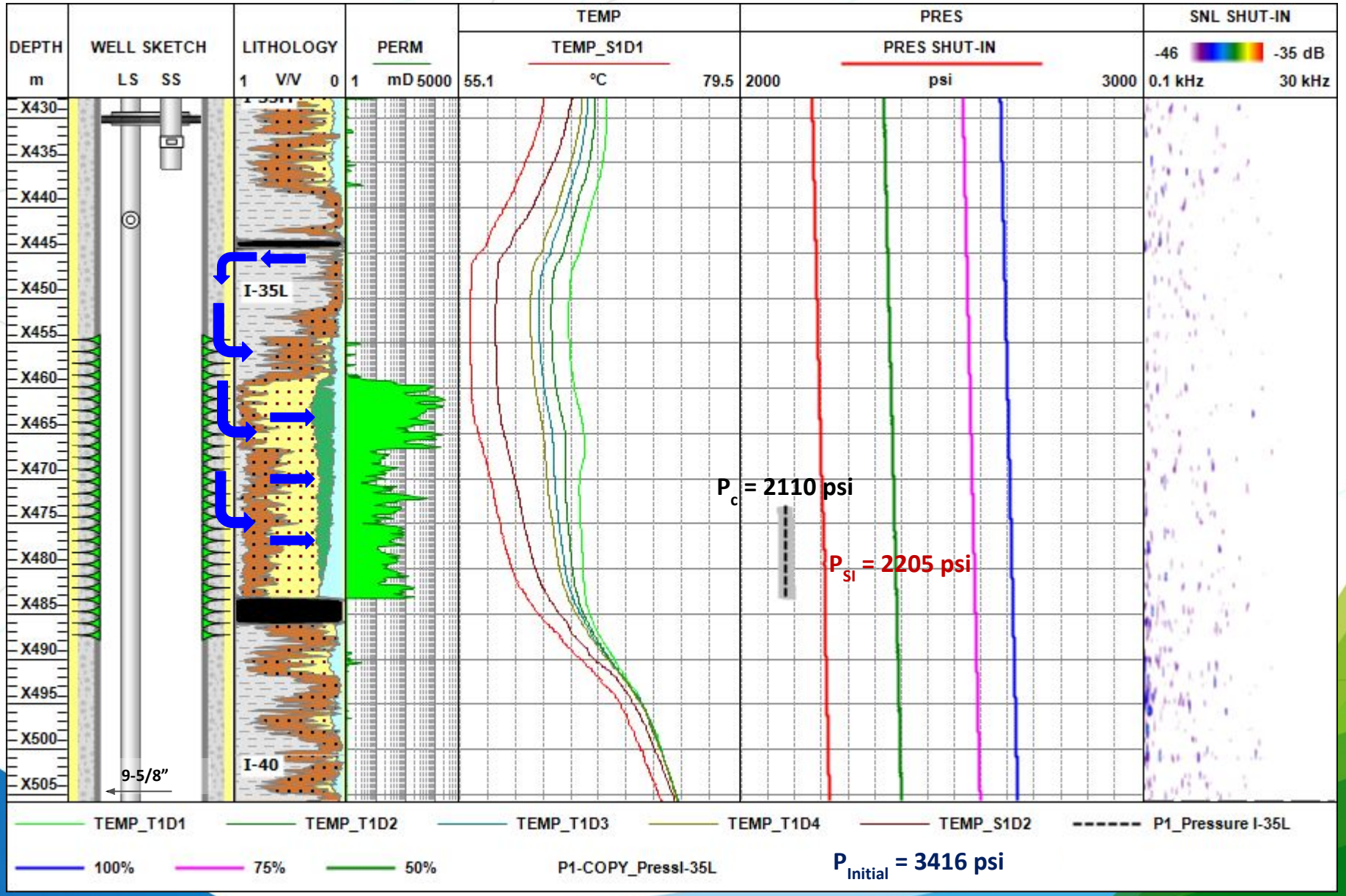
$P_R = 2110\ psi\ (\pm 20);$

$a = 0.0015\ (\pm 0.0001)\ ;$

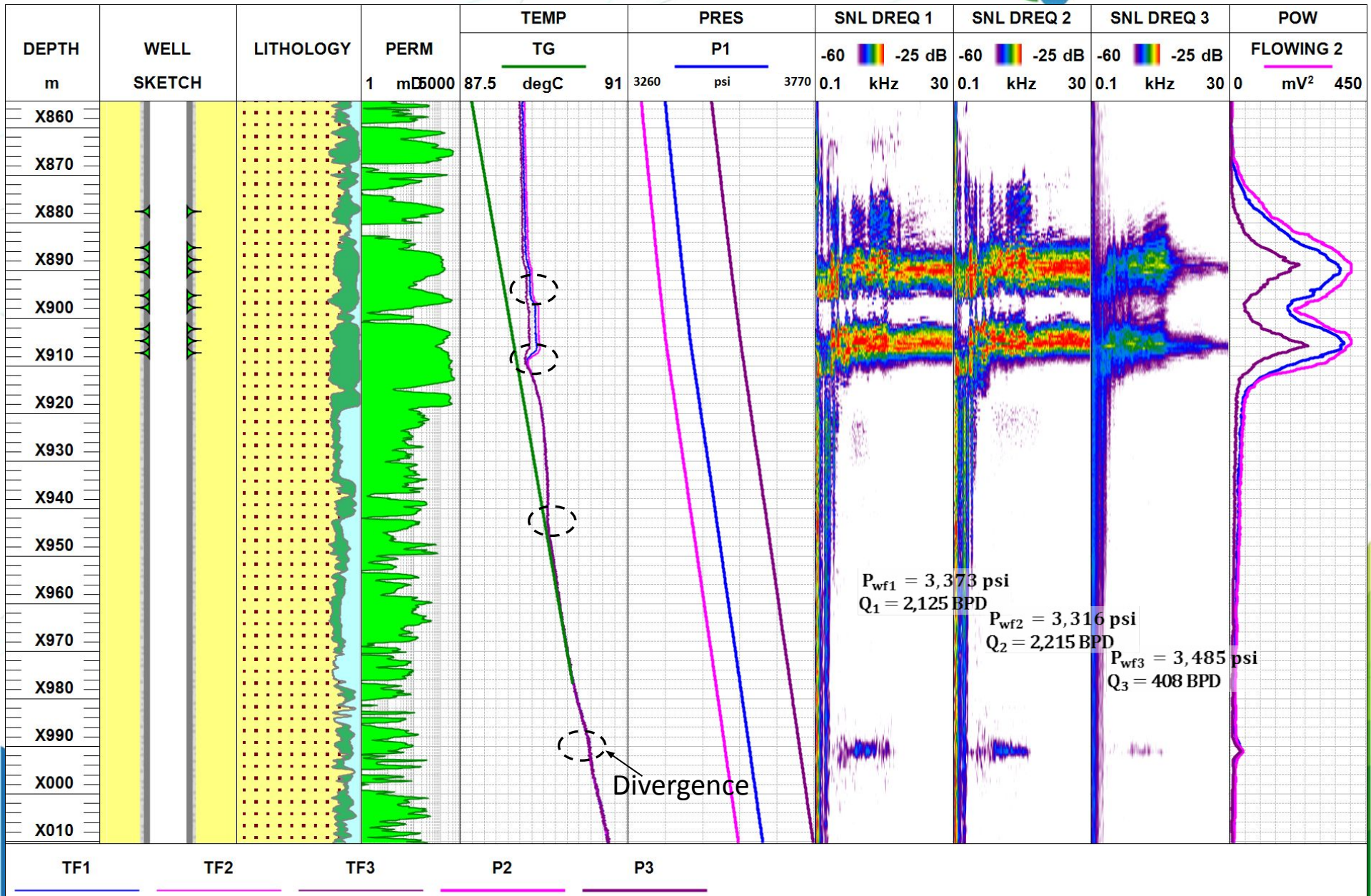
$b = -0.037\ (\pm 0.002)$



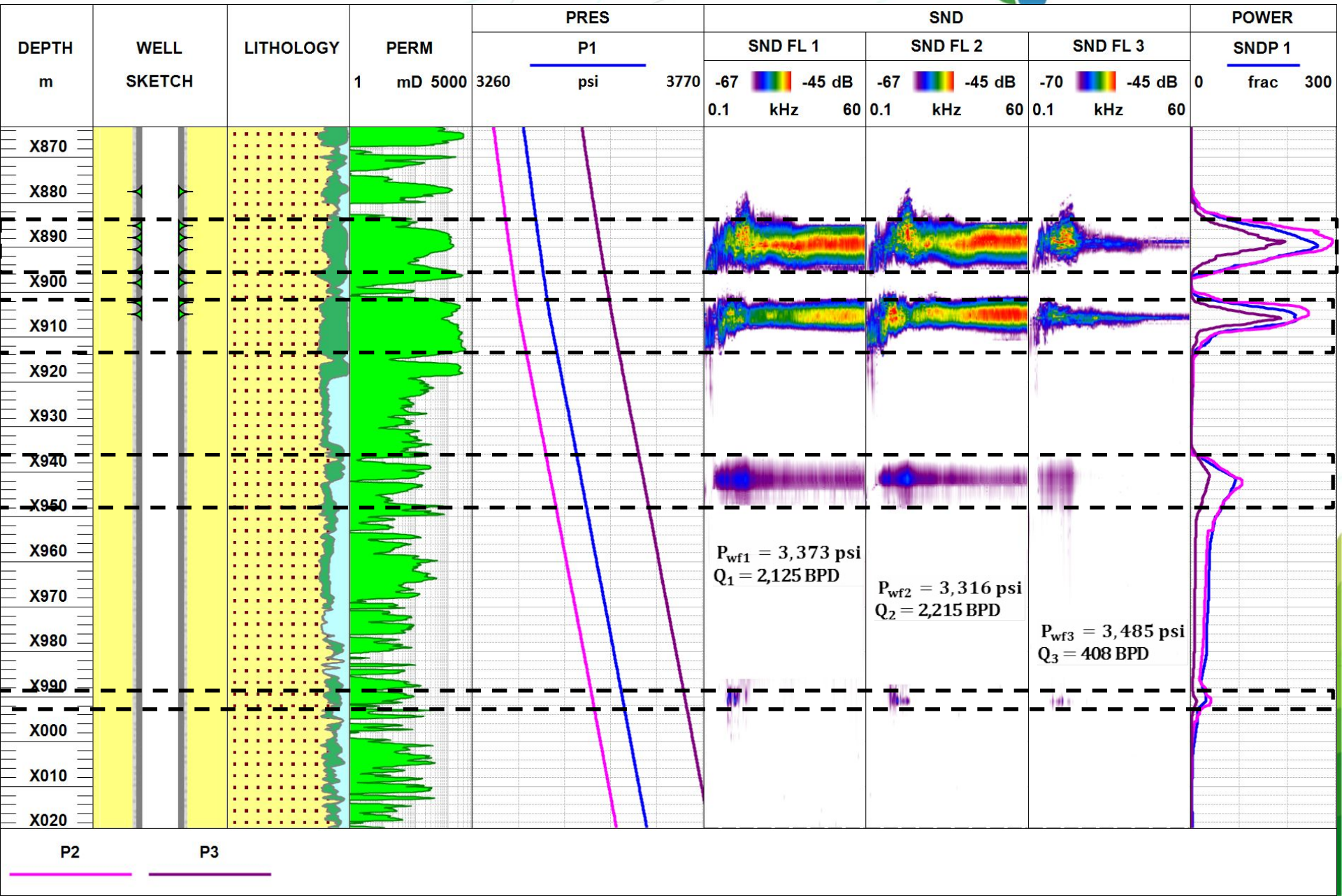
Case 1. Shut-in



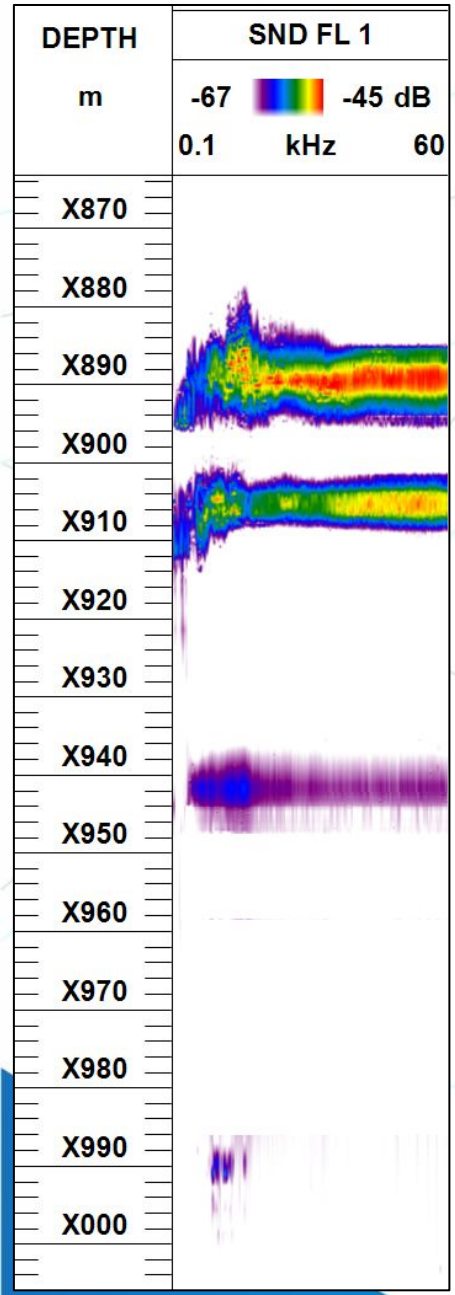
Case 2. Oil Producer



Case 2. Oil Producer



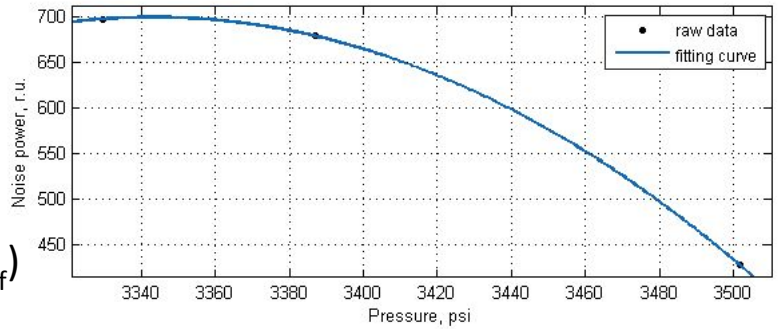
Calculation procedure



Depth X475 ft:

$N_{pow} = -0.001*(P_R-P_{wf})^2+0.072*(P_R-P_{wf})$

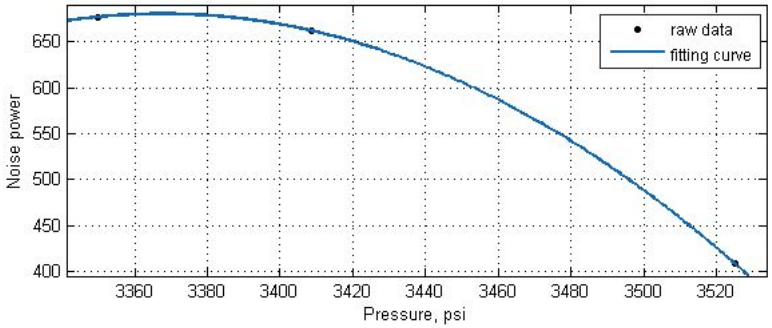
P_R = 3598 psi



Depth X532 ft:

$N_{pow} = -0.001*(P_R-P_{wf})^2+0.073*(P_R-P_{wf})$

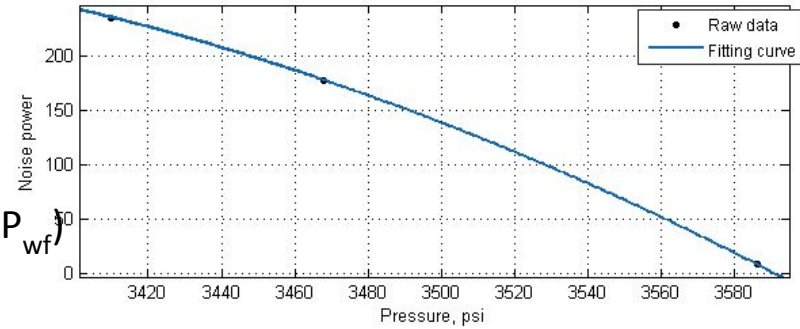
P_R = 3617 psi



Depth X948 ft:

$N_{pow} = -0.002*(P_R-P_{wf})^2+-0.0016*(P_R-P_{wf})$

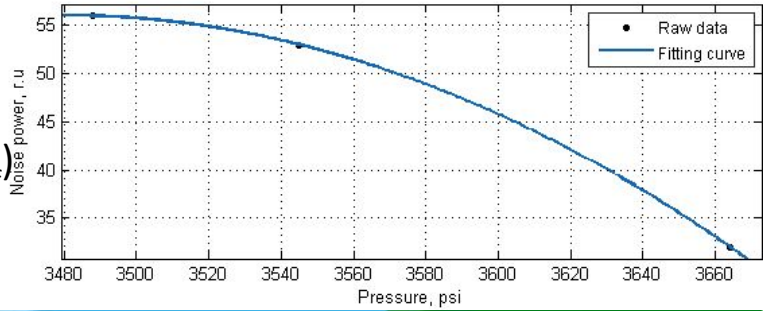
P_R = 3660 psi



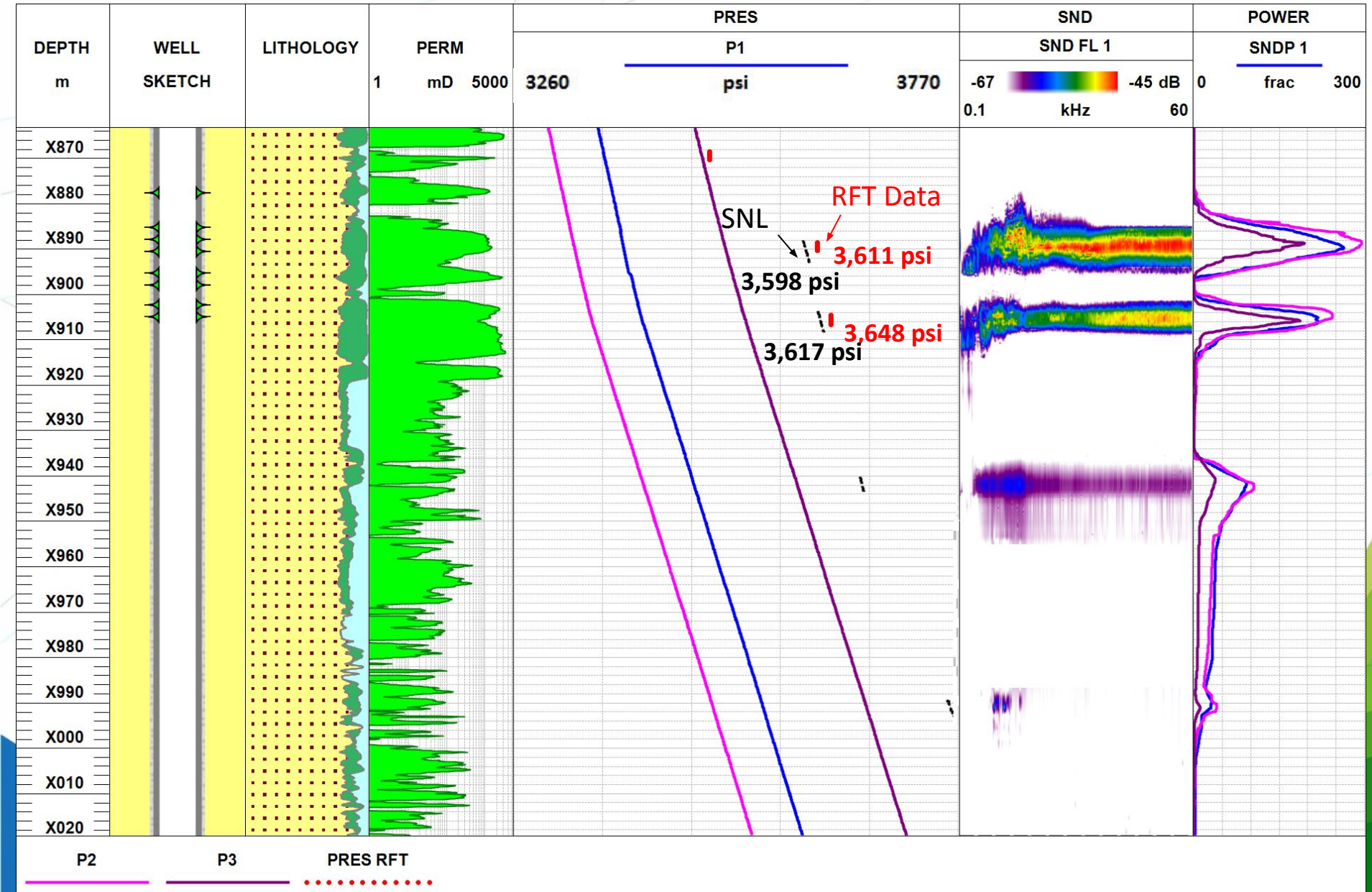
Depth X812 ft:

$N_{pow} = -0.0007*(P_R-P_{wf})^2+0.004*(P_R-P_{wf})$

P_R = 3761 psi



SNL Multi-rate & RFT



Conclusion

1. Multi-rate SNL is more accurate than Dual-rate SNL;
2. Shut-in survey is not mandatory;
3. Multi-rate SNL is applicable for multi-phase fluid;

Thank you!