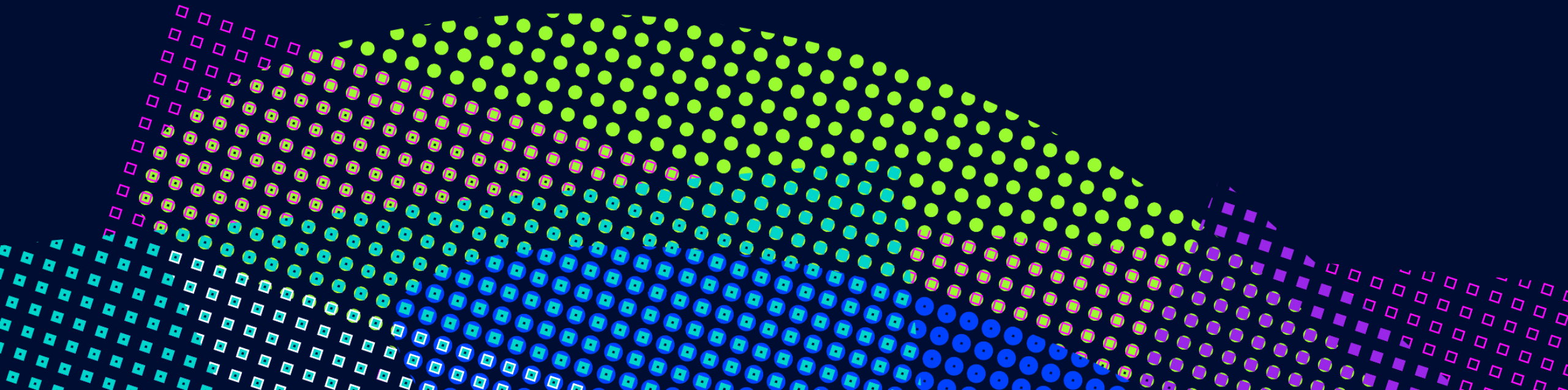


Diagnosing conventional & alternative well barriers to enable rigless abandonment

Maxim Volkov, Principal Domain Champion, TGT

Mar 2021



Presenter

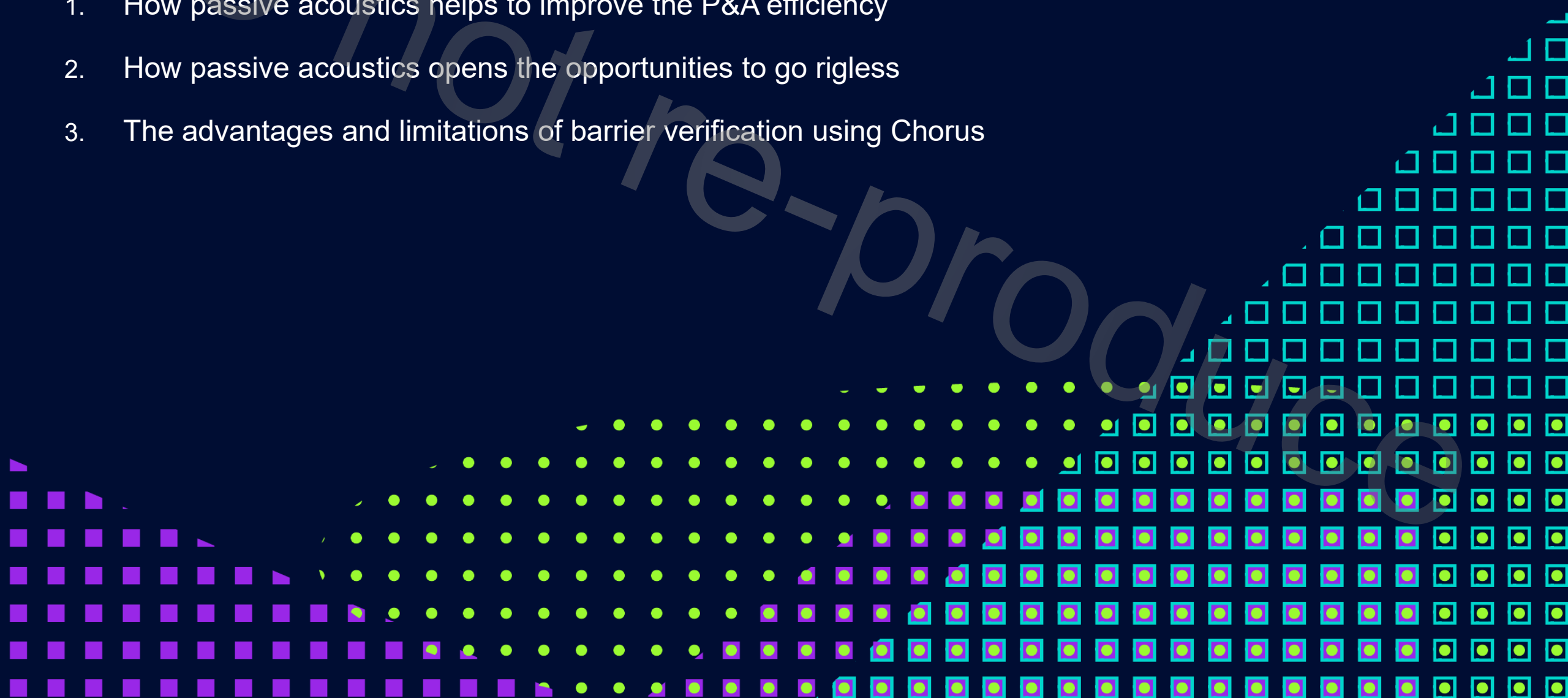


*Maxim Volkov
Principal Domain Champion
TGT, based in Stavanger*

Learning outcomes

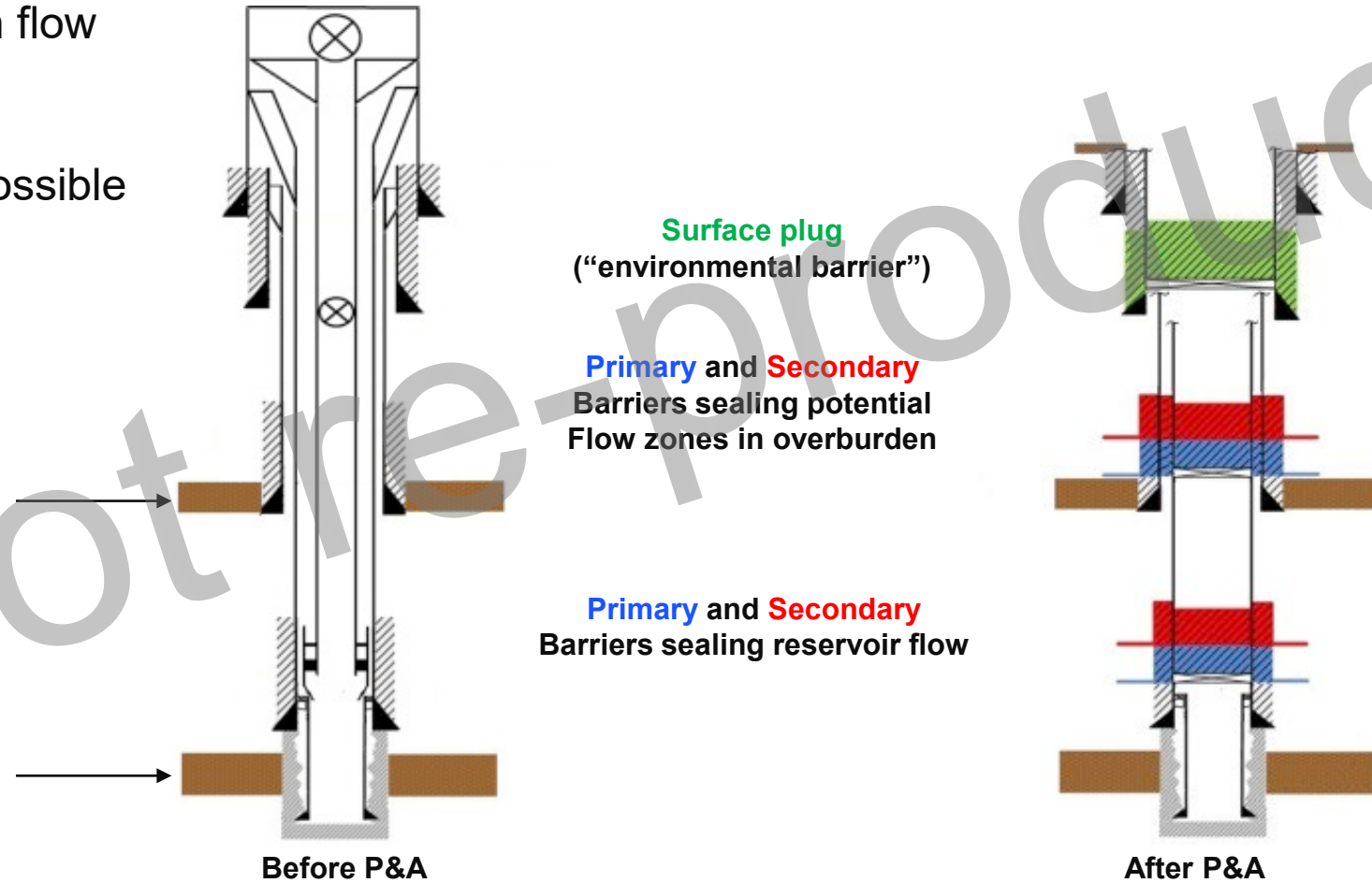
TGT

1. How passive acoustics helps to improve the P&A efficiency
2. How passive acoustics opens the opportunities to go rigless
3. The advantages and limitations of barrier verification using Chorus



Objectives of P&A

- Permanent isolation of each flow potential zone
- Perform P&A as much as possible in Rigless mode



Traditional Well Barrier Verification Techniques

- Cement Bond Evaluation for well barrier elements (WBE)

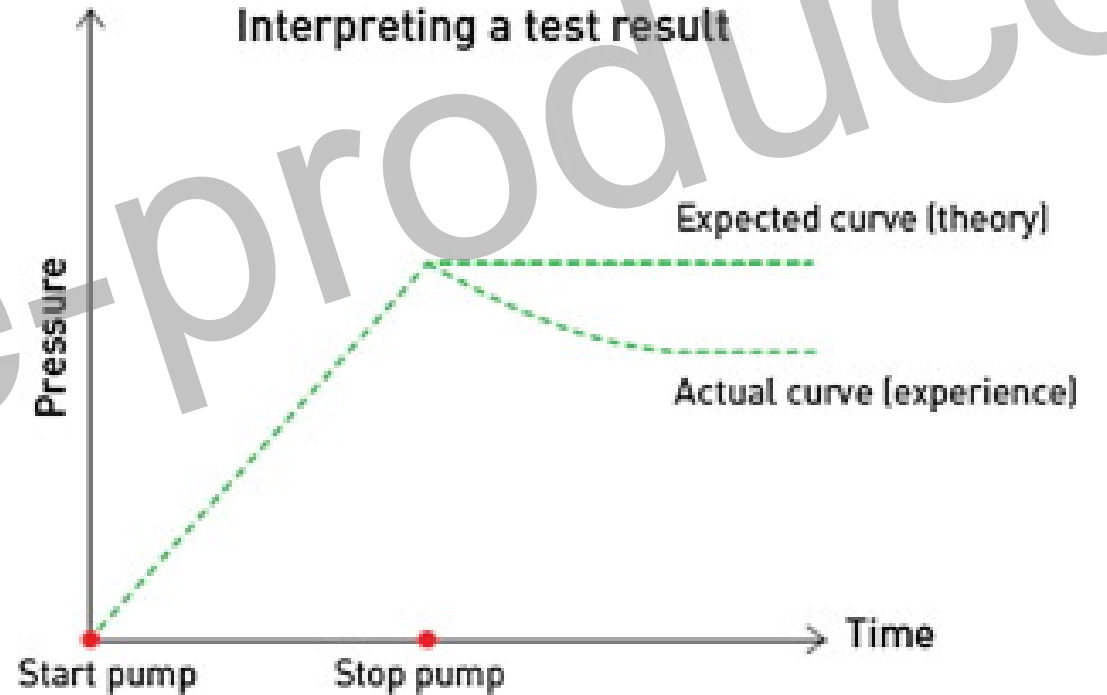


Low Attenuation



High Attenuation

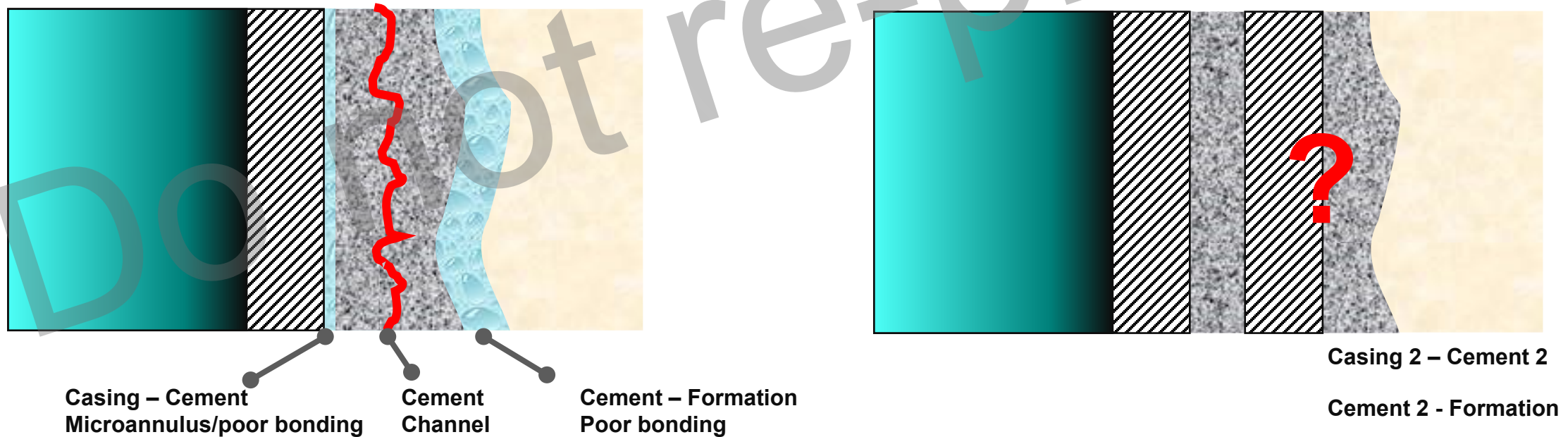
- Pressure test



Plug & Abandonment - Cement Bond Evaluation

Challenges

- Current evaluation techniques assess casing to cement bond mainly
- Minimum detectable channel in cement approx. 1"
- Limited assessment of cement to formation bond
- Cement map is affected by casing/wellbore condition
- Single casing only

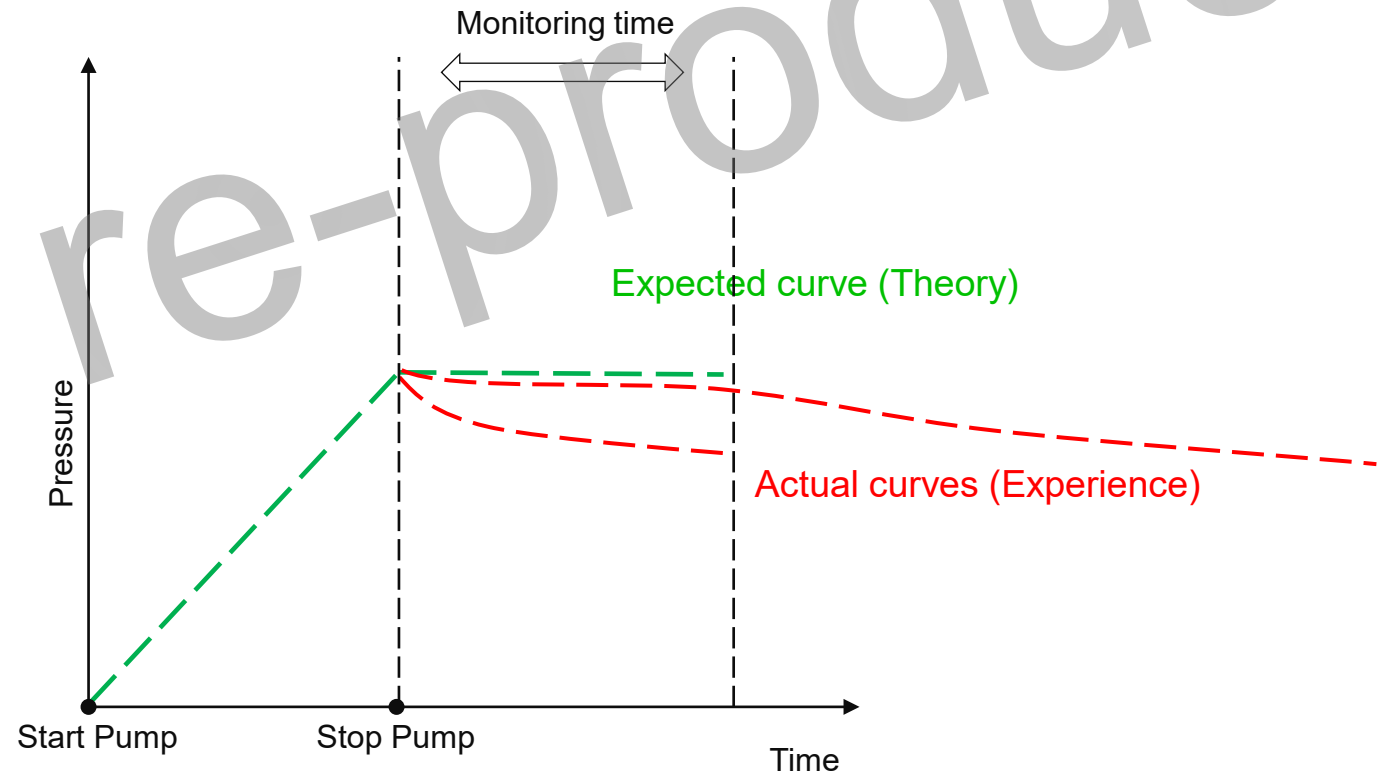


Plug & Abandonment - Pressure Test Technique.

Challenges

- Casing(s) ballooning
- Leaks into non-targeted zones
- Missed minor leaks
- Short monitoring time

Interpreting a test result



New Offering

- 1) The verification of wellbore and behind casing well barriers including unconventional ones (shale creep, salt dome, bismuth / thermite)
- 2) Verification of zonal isolation of unconventional barriers
- 3) Characterisation of the well barrier failures (leak path, induced / existing fracs, bottom hole assemblies' failures etc.)
- 4) How can you go Rigless using new approach

Downhole Passive Acoustic Monitoring

Chorus
Acoustic

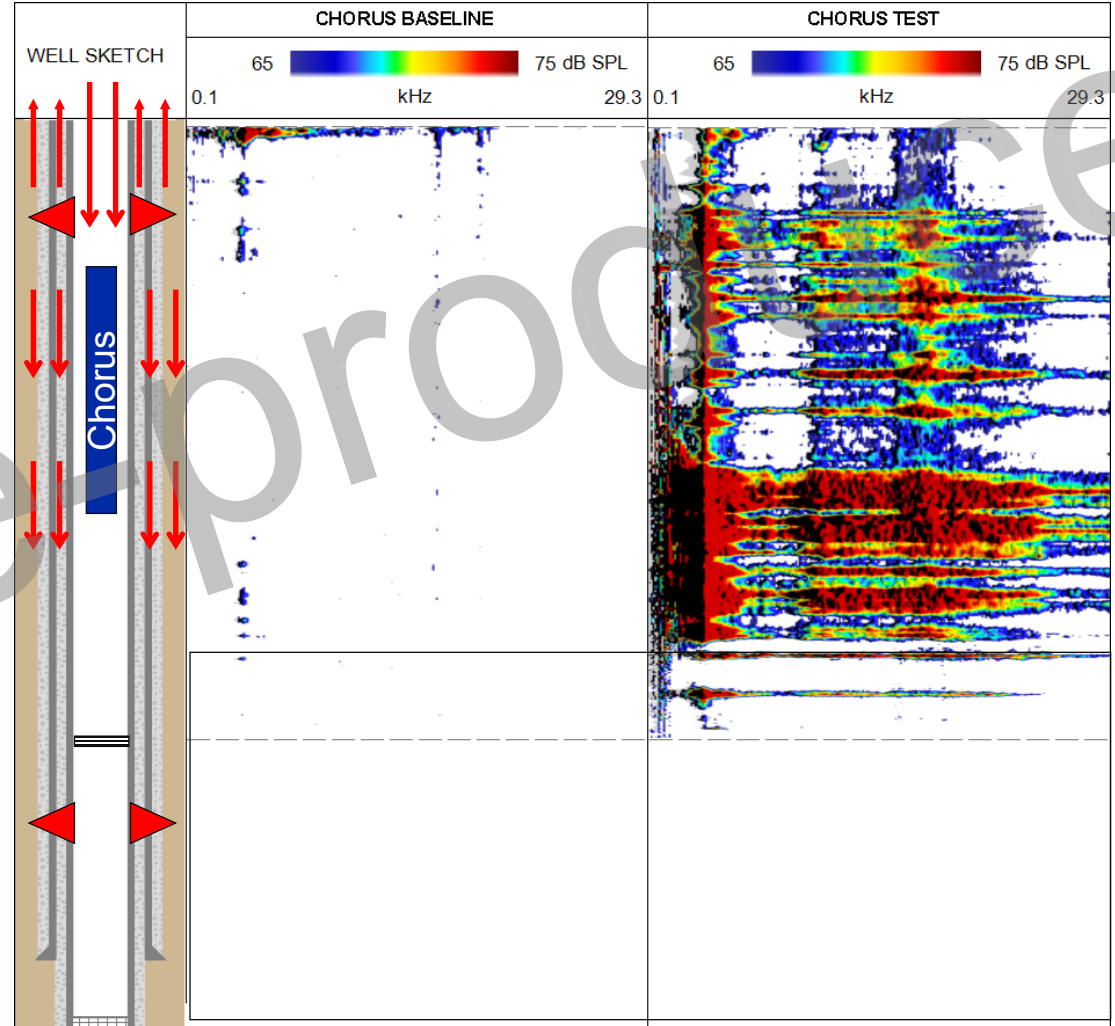



Senses all flow

Pulse
Electromagnetic




Quantifies tube thickness



- *At delta pressure of 90 Bars
- **

Independent Barrier Verification Test

Norce test 2017*

<p>No cement</p> <ul style="list-style-type: none"> • 7" tubing + 9 5/8 casing • Tubing eccentricity: 10.4mm (9.6%) 	 <p>Test Section Length: 284cm Make-up Length: 330cm</p>	
<p>Cemented - free of defects</p> <ul style="list-style-type: none"> • 7" tubing + 9 5/8 casing • Tubing eccentricity: 10.4mm (9.6%) • Class G cement (expanding), 1.92 s.g. 	 <p>Test Section Length: 148cm Make-up Length: 187cm</p>	
<p>Cemented - microannulus</p> <ul style="list-style-type: none"> • 7" tubing + 9 5/8 casing • Effective micro-annulus: 56µm • Tubing eccentricity: 10.4mm (9.6%) • Class G cement (regular), 1.92 s.g. 	 <p>Test Section Length: 172cm Make-up Length: 263cm</p>	
<p>Cemented - hole mid cement</p> <ul style="list-style-type: none"> • 7" tubing + 9 5/8 casing • 5 mm axial hole • Tubing eccentricity: 10.4mm (9.6%) • Class G cement (expanding), 1.92 s.g. • Sealed control lines 	 <p>Test Section Length: 150cm Make-up Length: 180cm</p>	



Norce test 2019



*IADC/SPE-194075-MS

Barrier Verification during Plug and Abandonment Using Spectral Noise Logging Technology, Reference Cells Yard Test


Behind Casing Flow Thresholds

- The resolution of Chorus technology was investigated over a range of leakage rates of water and gas for different casing cement sheath defects
- For the conditions tested, leakage was detected for rates of water and gas lower than the accepted criteria defined by API RP14B
- Where differential pressure is present across a well barrier, passive acoustics can be used to detect whether flow generated acoustic signatures are present

Reference cell	Rate threshold	
	Water	Gas
Micro-annulus (56 microns)	80 mL/min	1.2 mL/min
Good cement (induced microannulus)	9.7 mL/min	N/A
5mm channel	300 mL/min	11 L/min
API 14B	400 mL/min	420 L/min

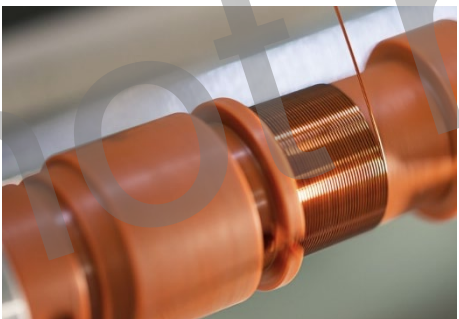

Pulse Electromagnetic Platform

Chorus
Acoustic



Senses all flow

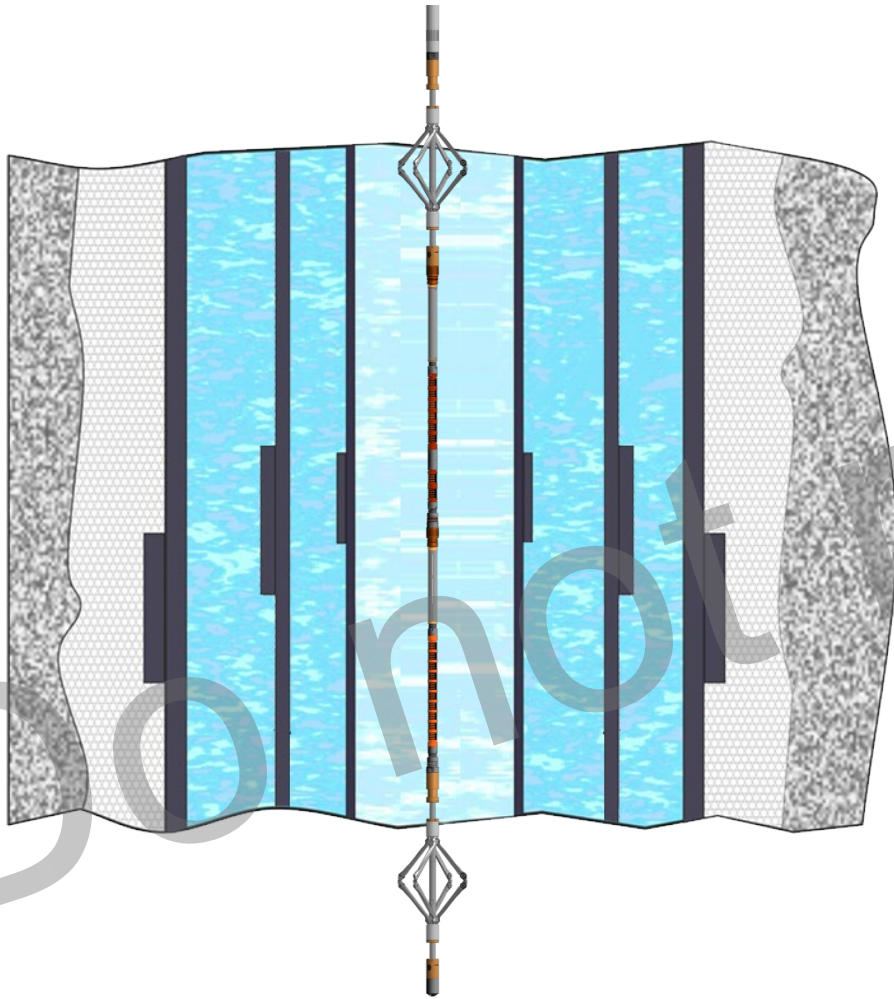
Pulse
Electromagnetic



Quantifies tube thickness

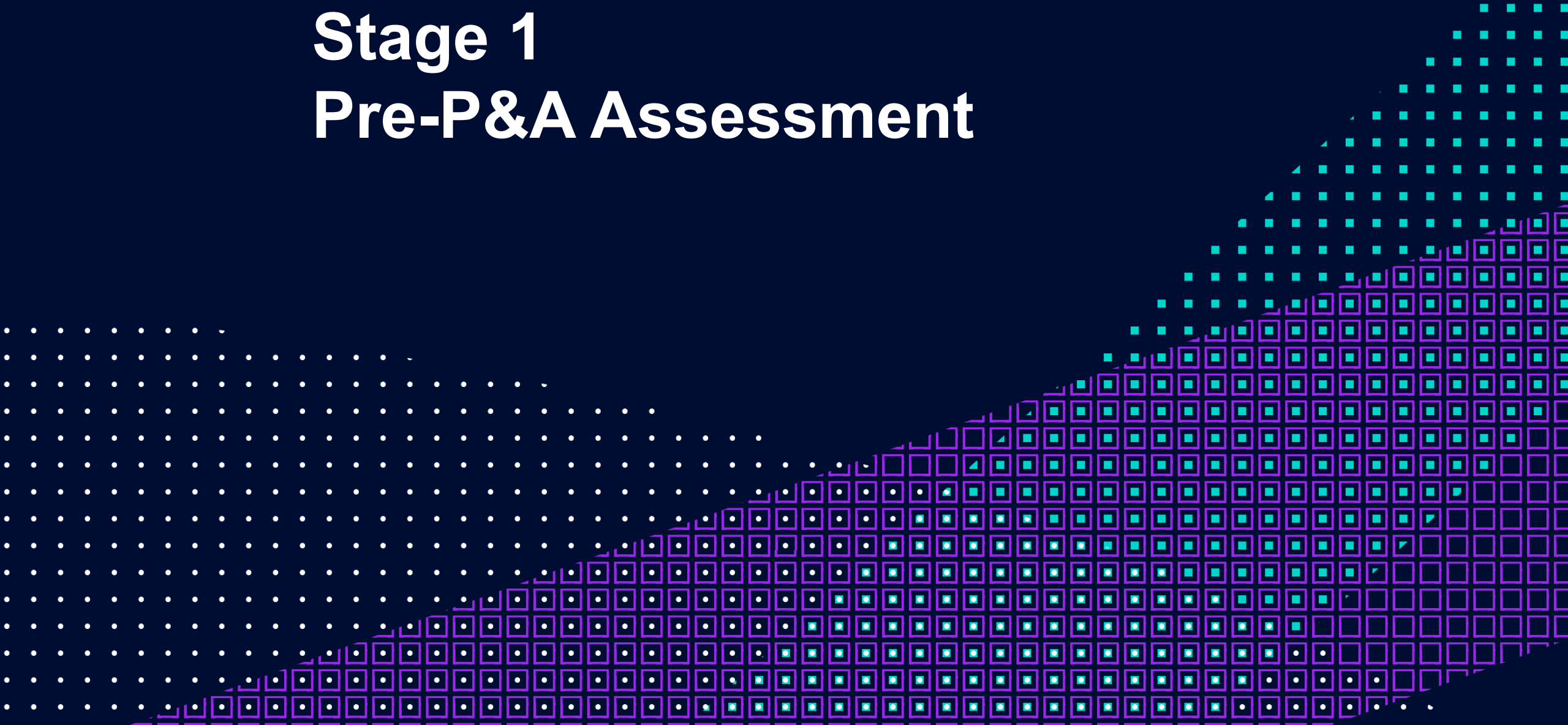


Tube Integrity Diagnostics - Pulse

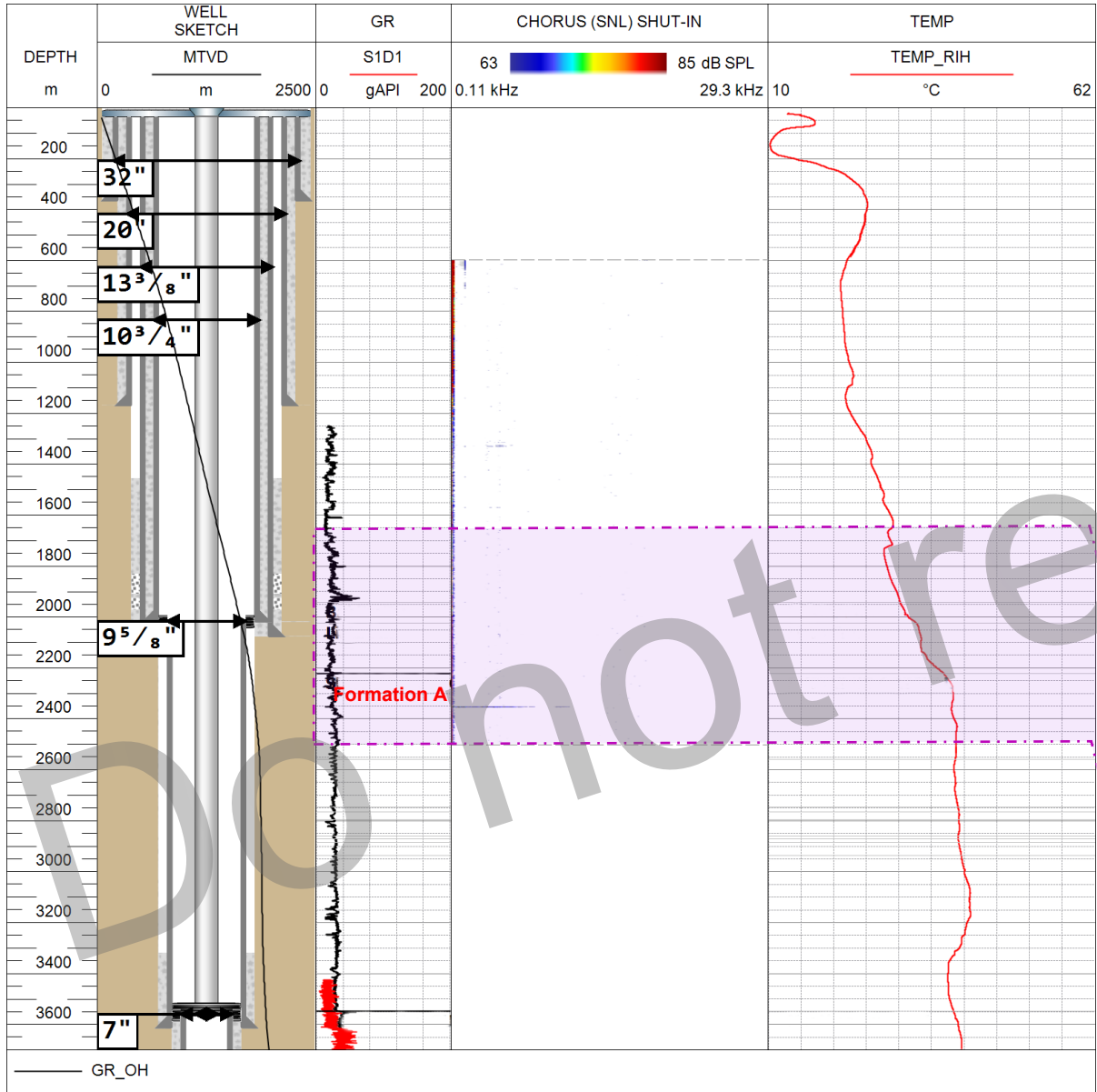


- Sensitive to the metal only – free from scale influence .
- No requirement for the well to be shut-in.
- Internal / external corrosion assessment for the primary tube.
- Location of tubing to casing decentralization (severe).
- Location of completion jewelry in first 4 casing strings.

Stage 1 Pre-P&A Assessment

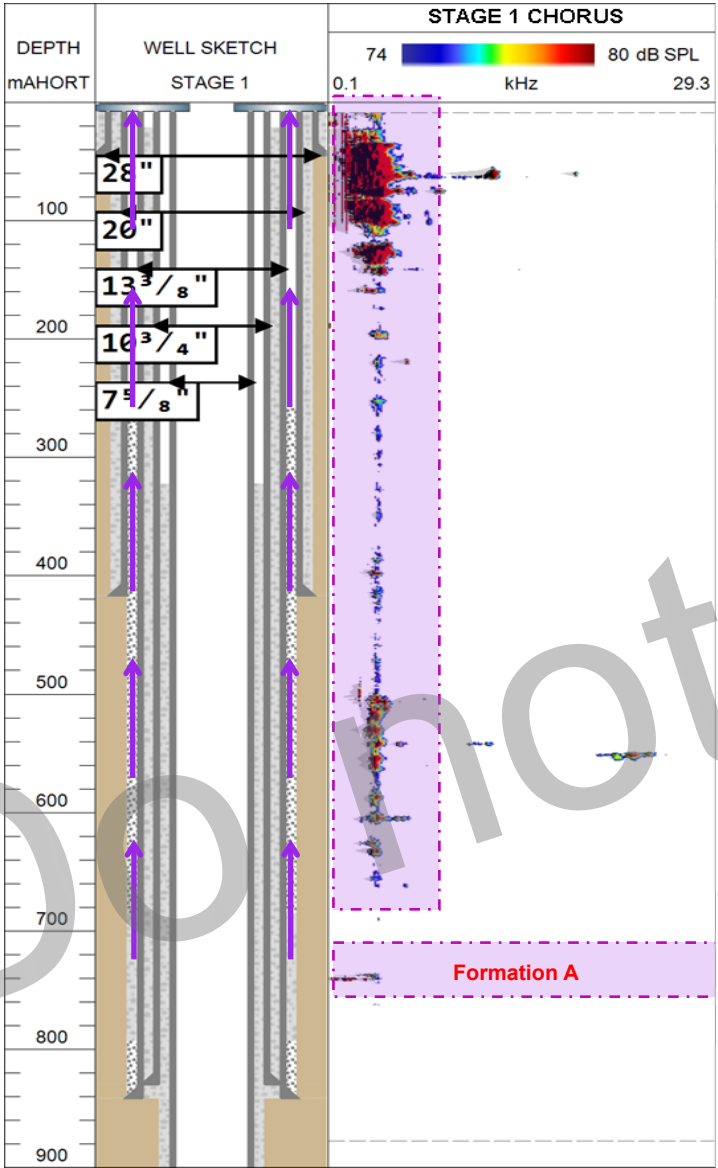


Verifying the Cement Barrier Through Tubing



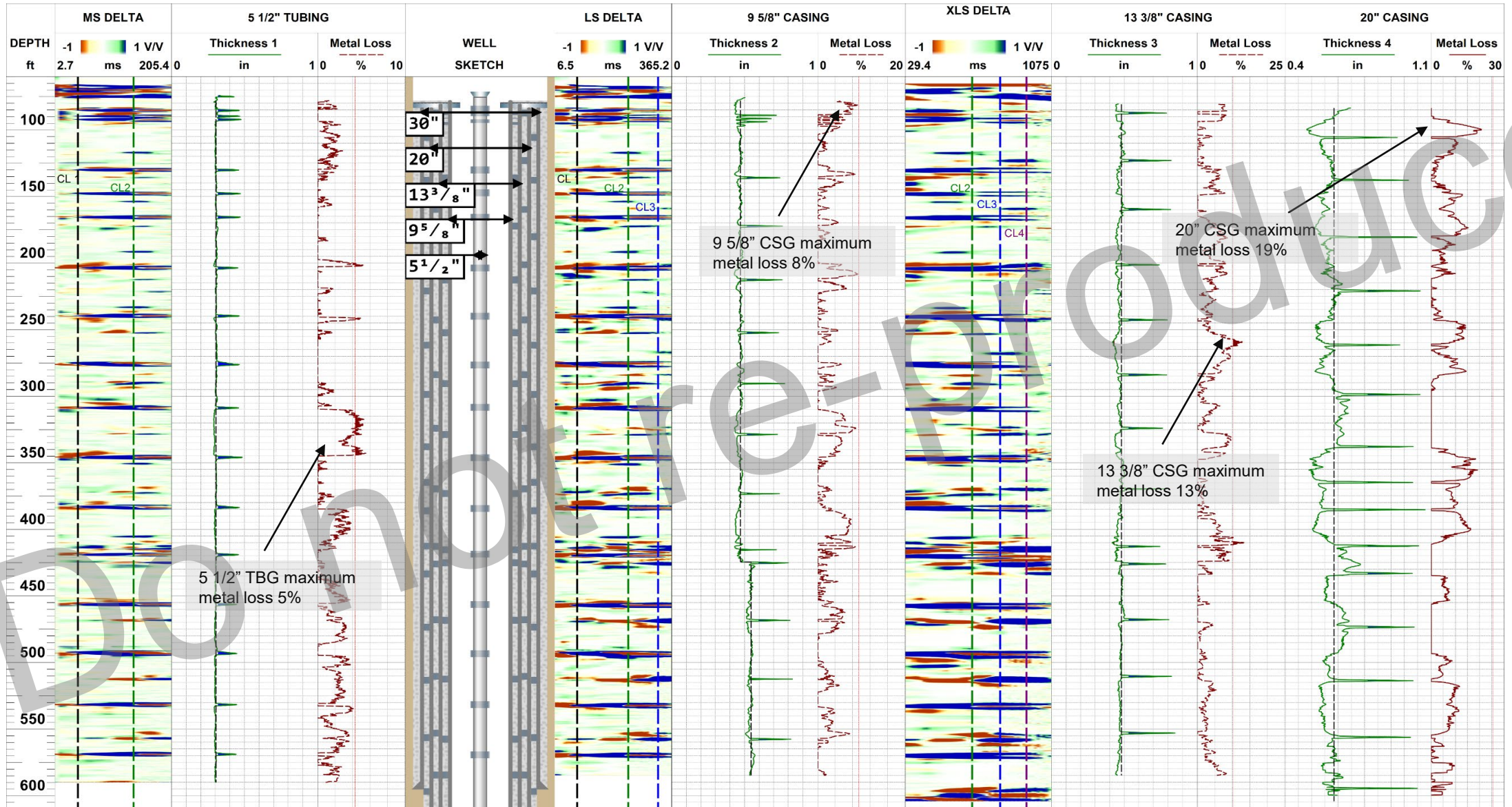
Cement /
Shale creep
sealing
failure

Locating & Isolating Flow Potential Zones During P&A



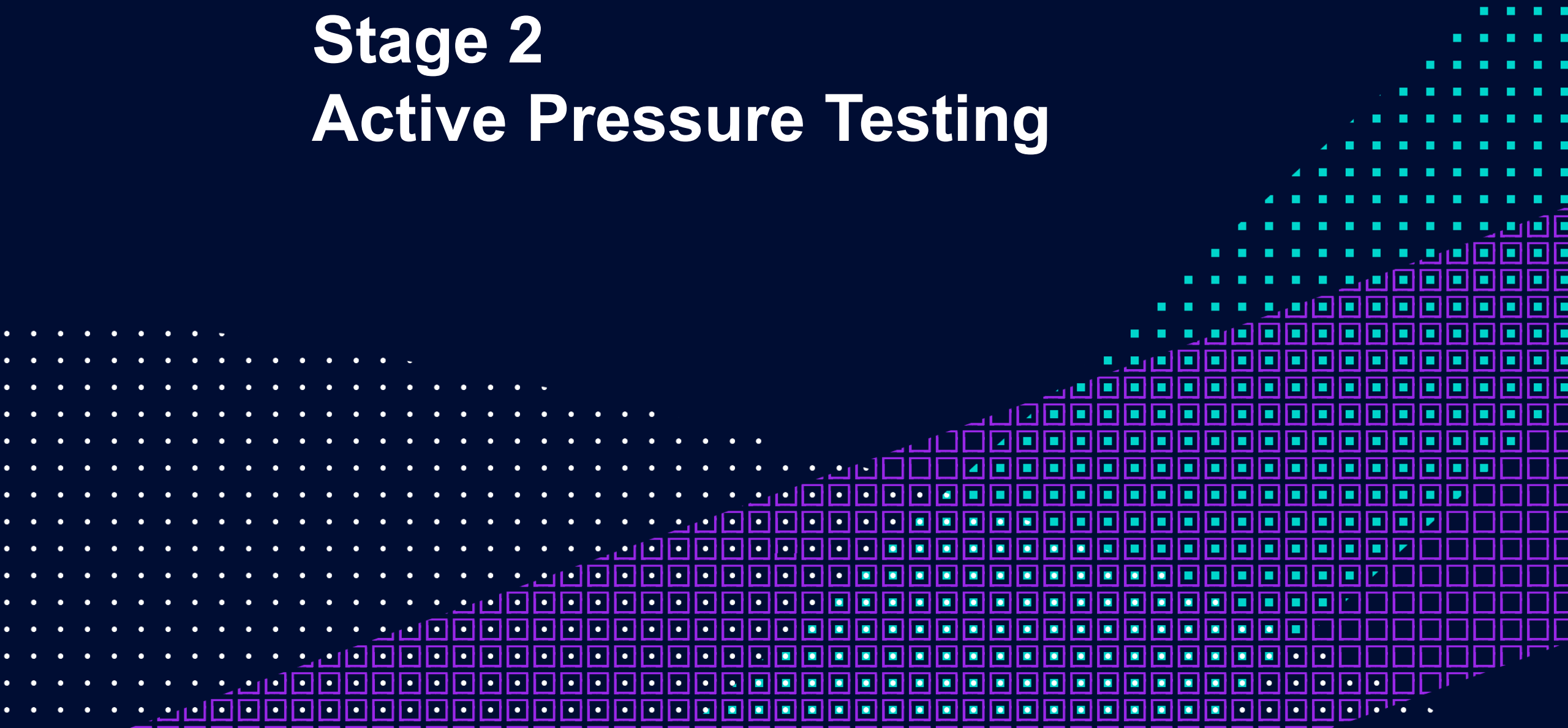
Do not re-produce

Pulse - Individual 4 Metal Barriers Integrity Verification



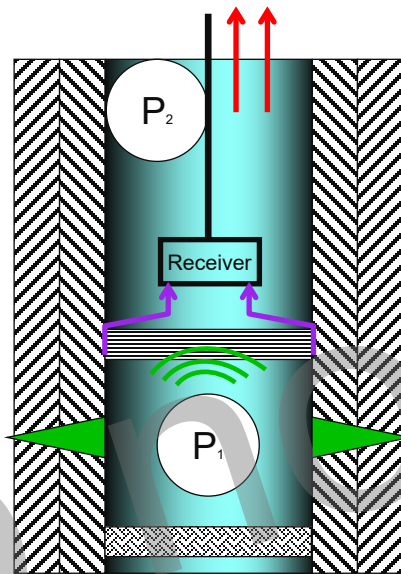
Stage 2

Active Pressure Testing

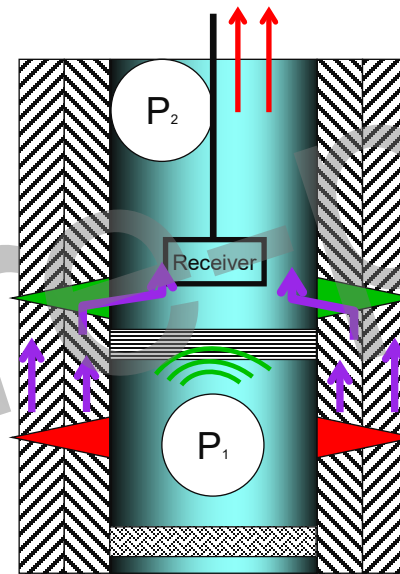


Plug & Abandonment - Pressure Test Technique

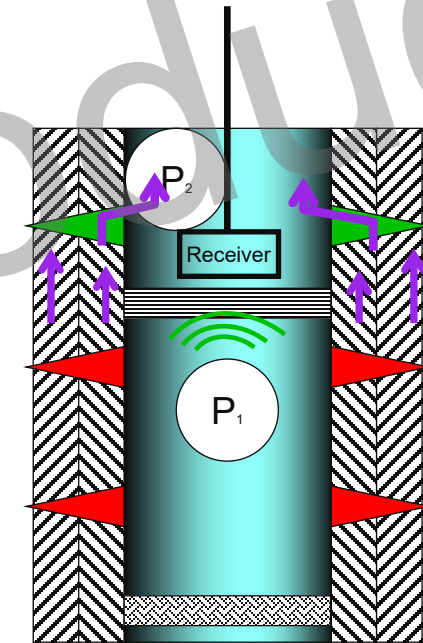
Perf and pressure test (Leak off test)



Testing BHA

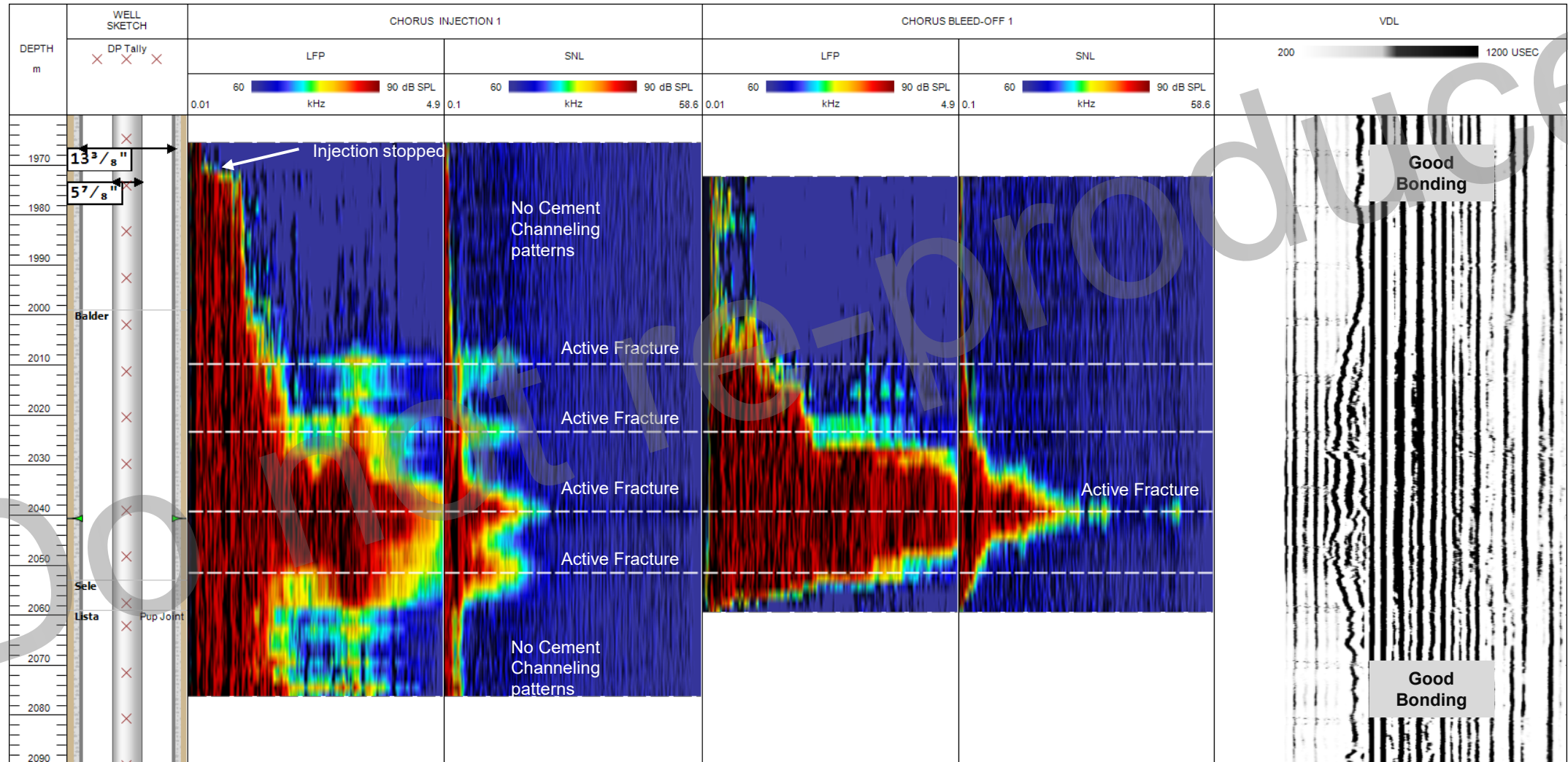


Testing communication
Bottom to middle perf

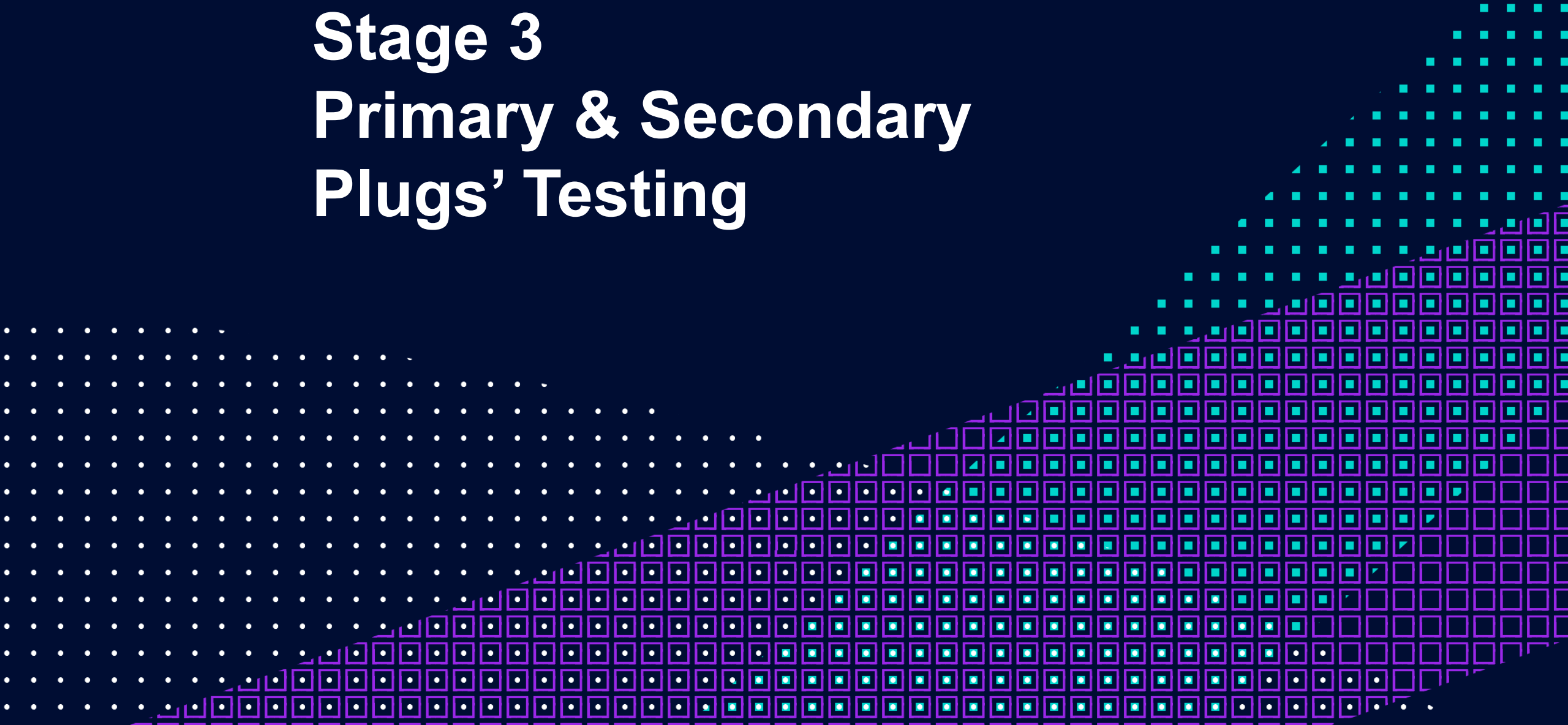


Testing communication
Middle to top perf

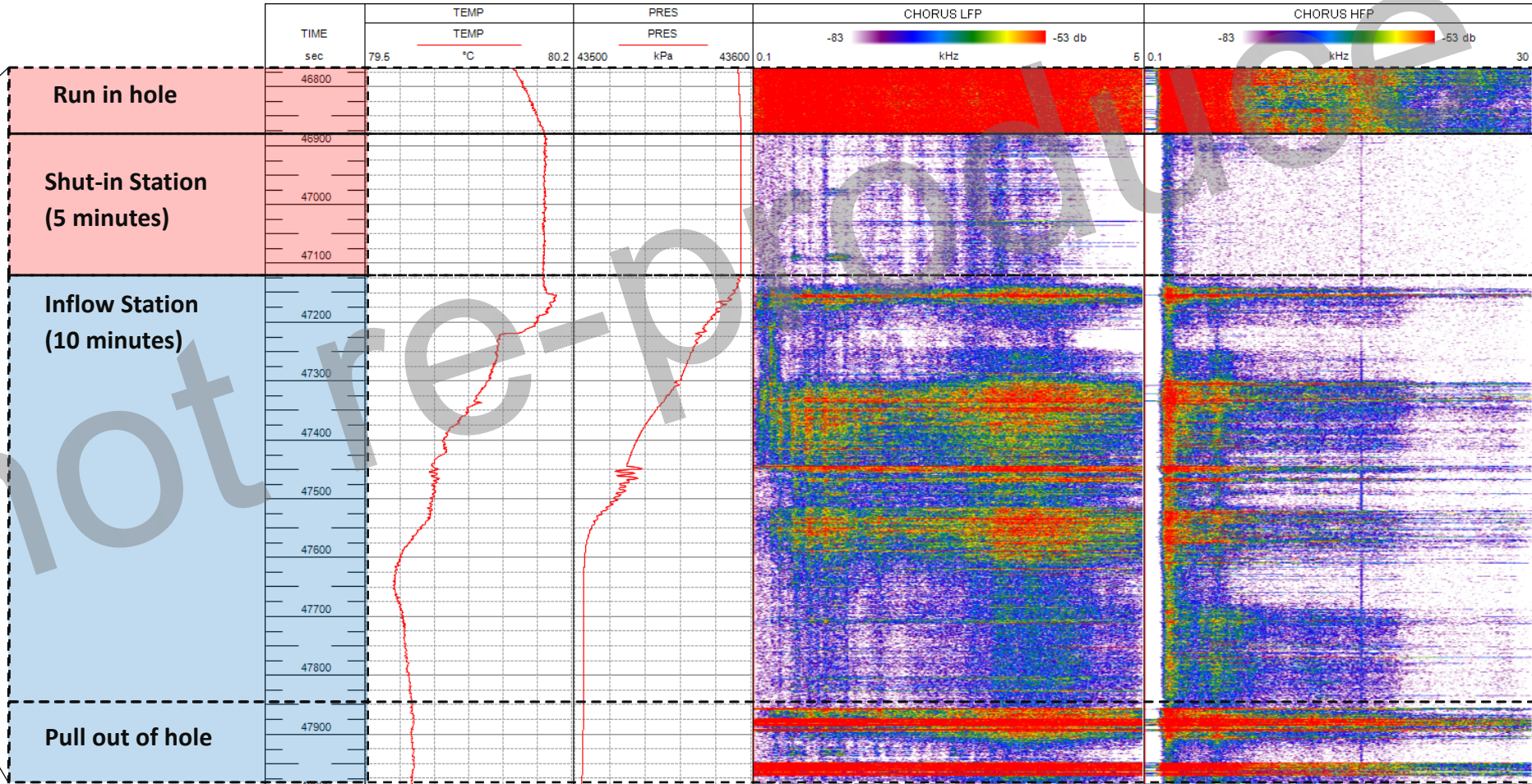
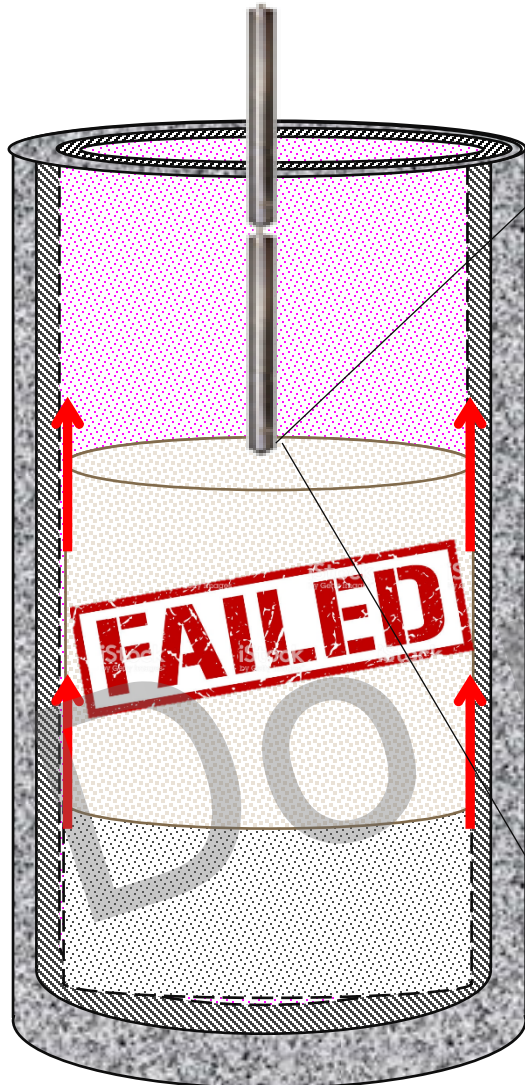
Chorus – During eXtended Leak Off Test (XLOT)



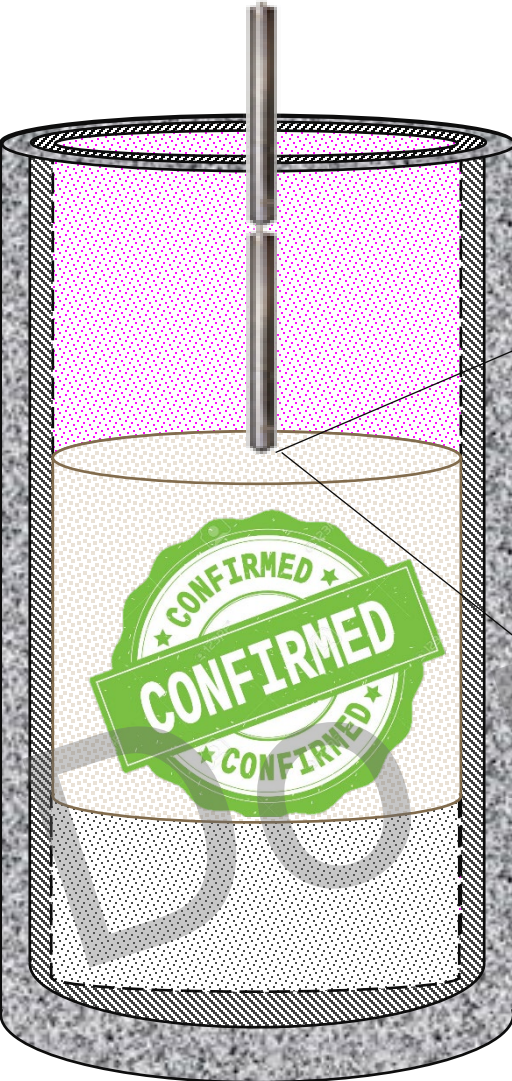
Stage 3 Primary & Secondary Plugs' Testing



Cement Plug Inflow Test (failure)

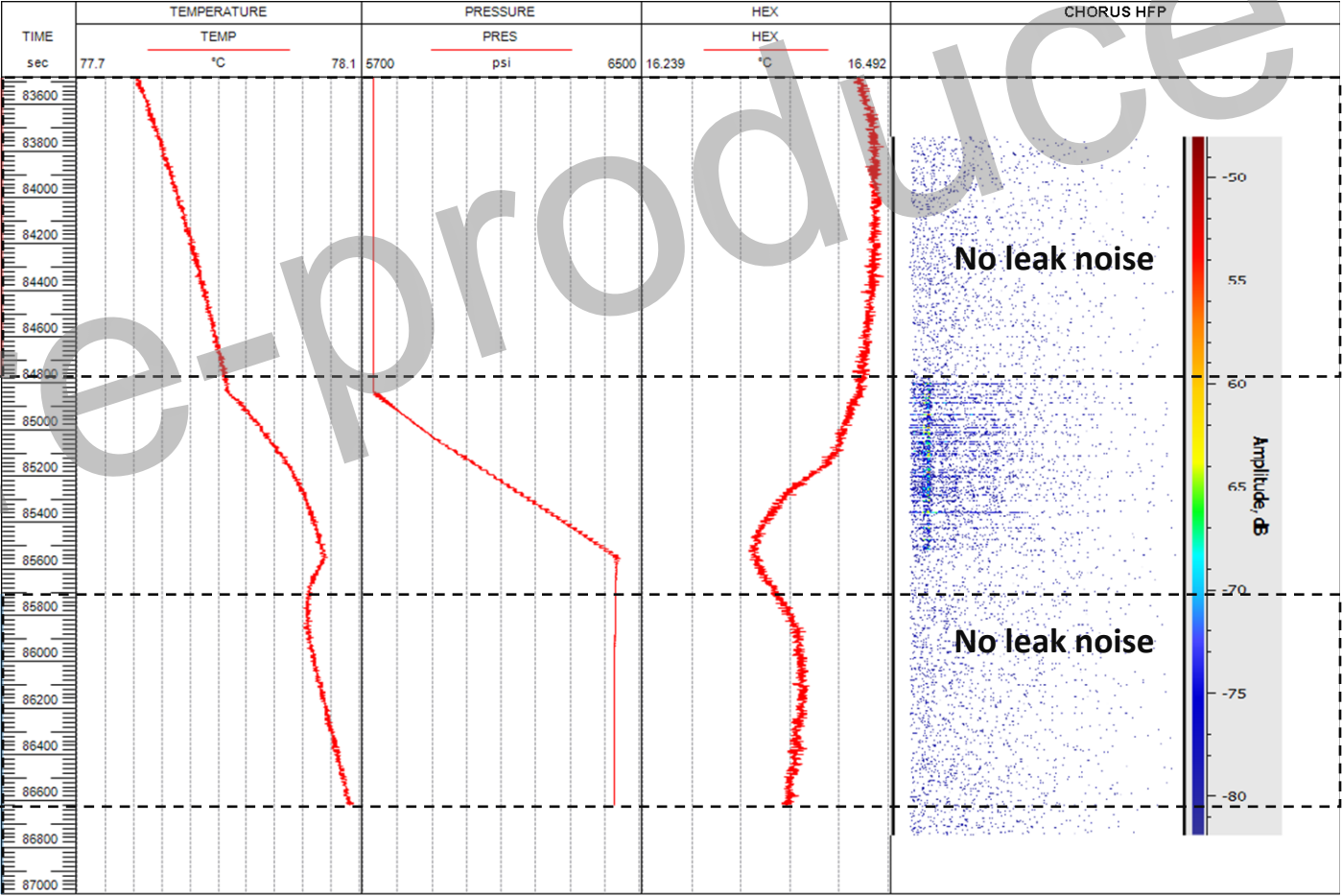


Cement Plug Pressure Test (success)



Shut-in Station
(5 minutes)

Pressure Test Station
(30 minutes)



Conclusion

- Chorus acoustic platform is an independently verified technique for assessing the sealing performance of well barriers
- Well barrier verification can be performed through tubing / casing
- Chorus acoustic sensitivity and dynamic range outperforms current barrier verification techniques
- P&A effectiveness can be improved to the level of complete or partial Rigless P&A

Thank you

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