

Another dimension in downhole barrier assessment

Maxim Volkov – Principal Domain Champion, TGT Oilfield services



TGT pedigree



6,000+
wells diagnosed

15%
Annual R&D spend

80
published papers

40
patents & pending

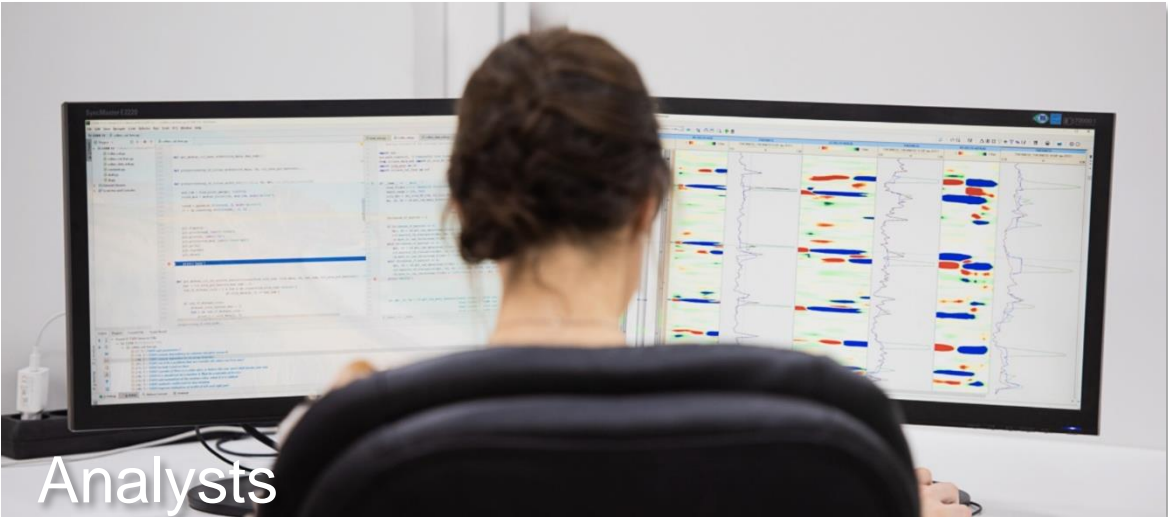
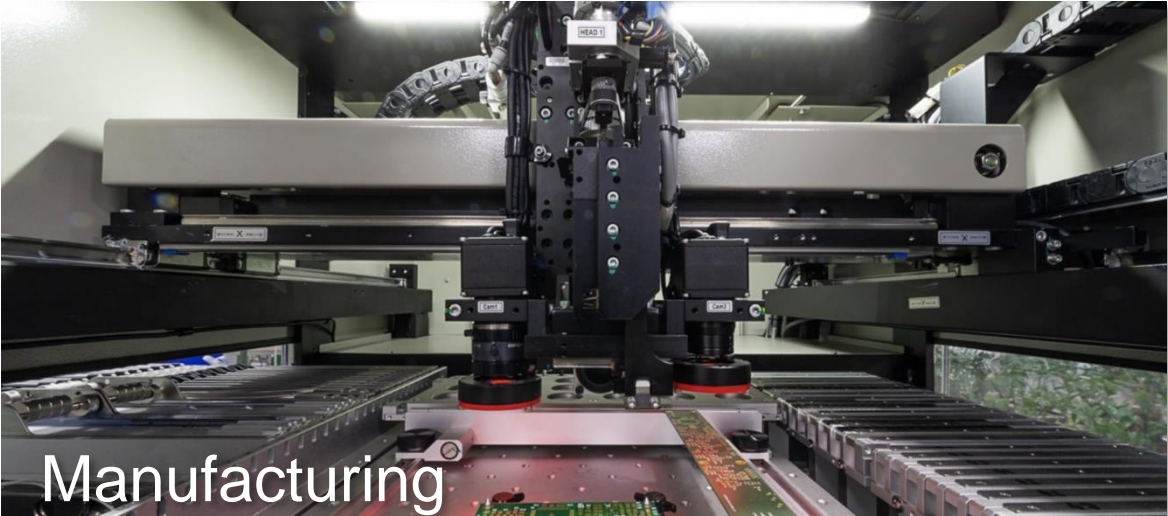
20
scientists with PhD's

40+
analysts

220+
employees

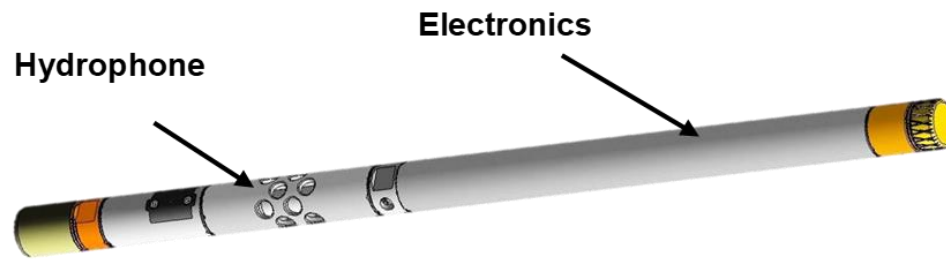
15+
international locations

TGT facilities

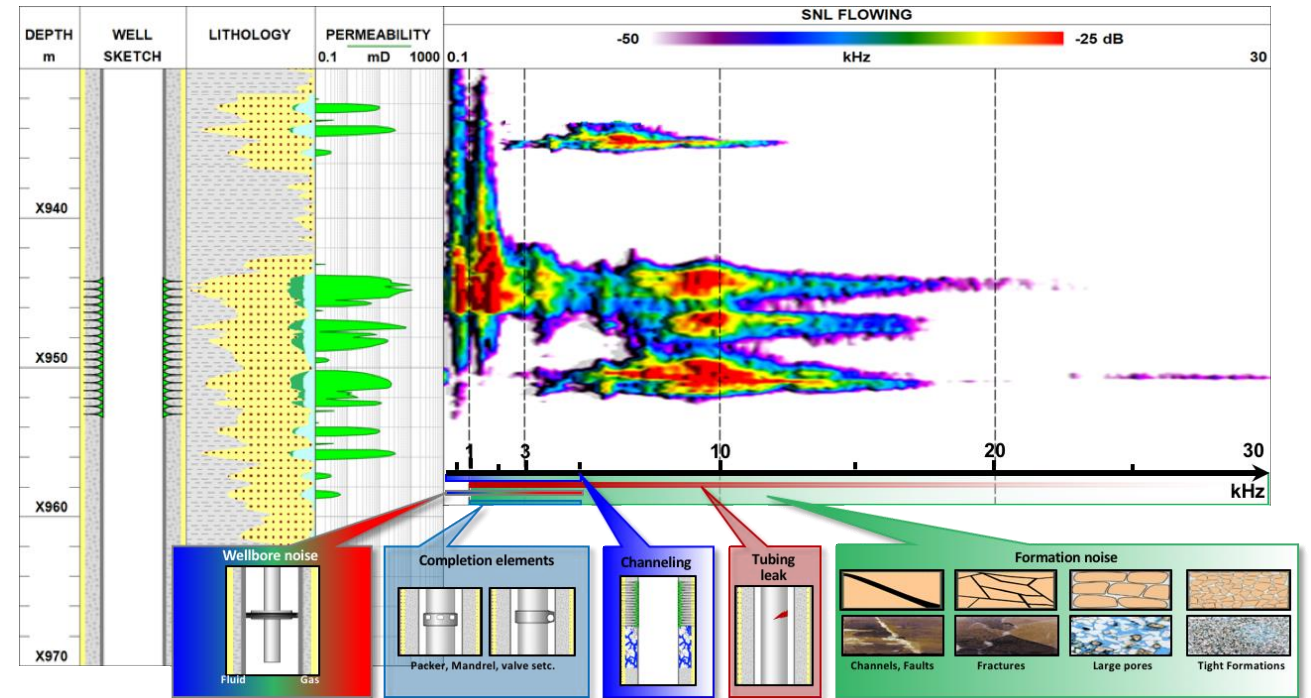


Downhole Passive Acoustic Monitoring

Passive hydrophone



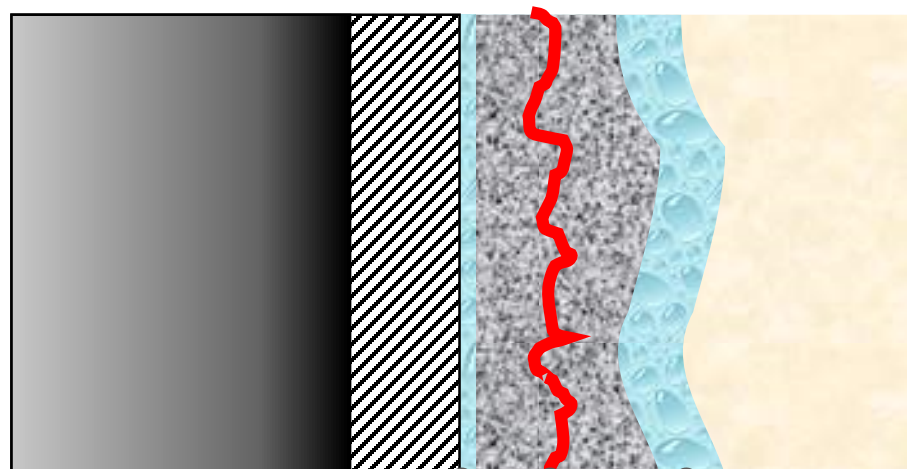
Frequency range	8-60 000 Hz
Dynamic range	100 dB
Tool OD	38/42mm
Length	80cm
Thresholds (SAP)	0.5 Bar/day
Thresholds (ml/min)	9.7 / 22



Barrier Verification. Challenges

Ultra-sound logging interpretation challenges

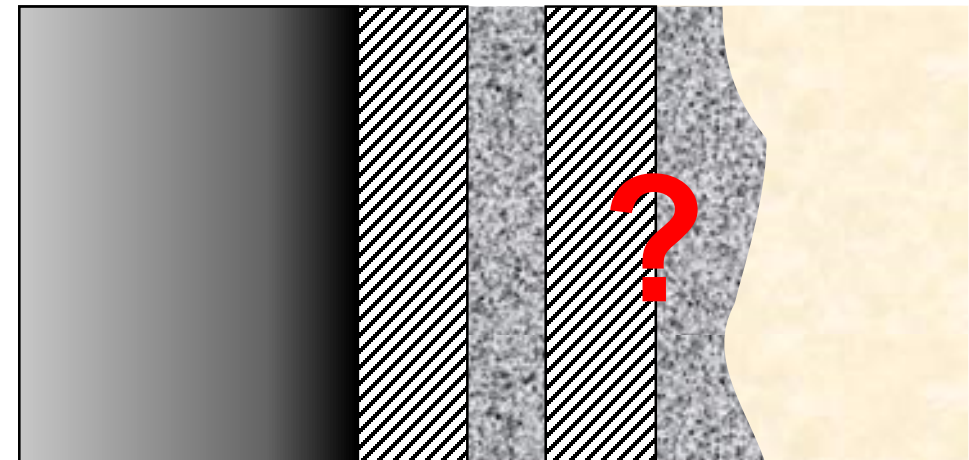
- Casing-cement bonding mapping only (VDL for Cement-formation)
- Average minimum detectable channel size is 0.6"
- Cement map is affected by Casing/wellbore condition
- Dual casing solutions are still at evaluation stage...



CSG-CMNT microannulus

CMNT
Channel

CMNT-FORMATION microannulus



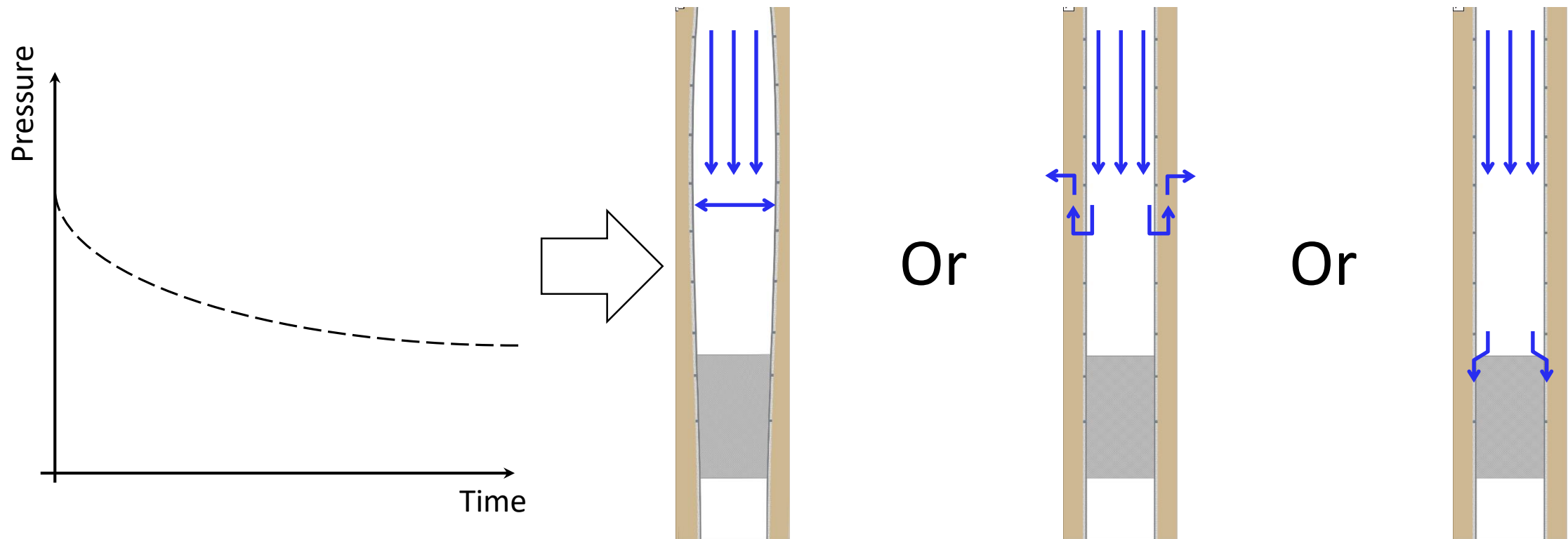
CSG2-CMNT2

CMNT2-FORMATION

Barrier Verification. Challenges








Surface (perf and) pressure test interpretation challenges

- Impact of casing ballooning
- Completion leaks in non-targeted zones
- Missed minor leakage



Developing a quantification model

IRIS (Norce) test 2017

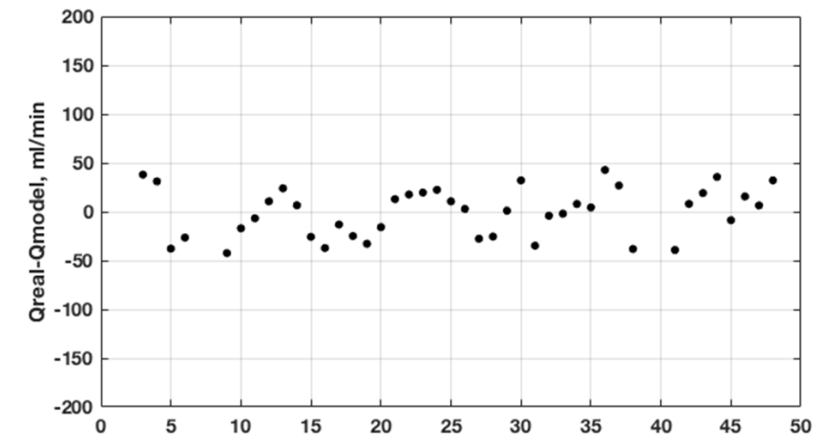
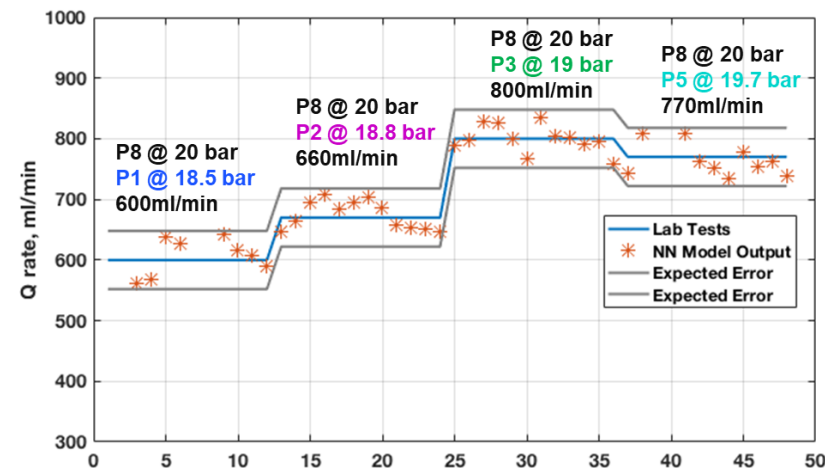
<p>No cement</p> <ul style="list-style-type: none"> 7" tubing + 9 5/8 casing Tubing eccentricity: 10.4mm (9.6%) 	 <p>Test Section Length: 284cm Make-up Length: 330cm</p>	
<p>Cemented - free of defects</p> <ul style="list-style-type: none"> 7" tubing + 9 5/8 casing Tubing eccentricity: 10.4mm (9.6%) Class 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

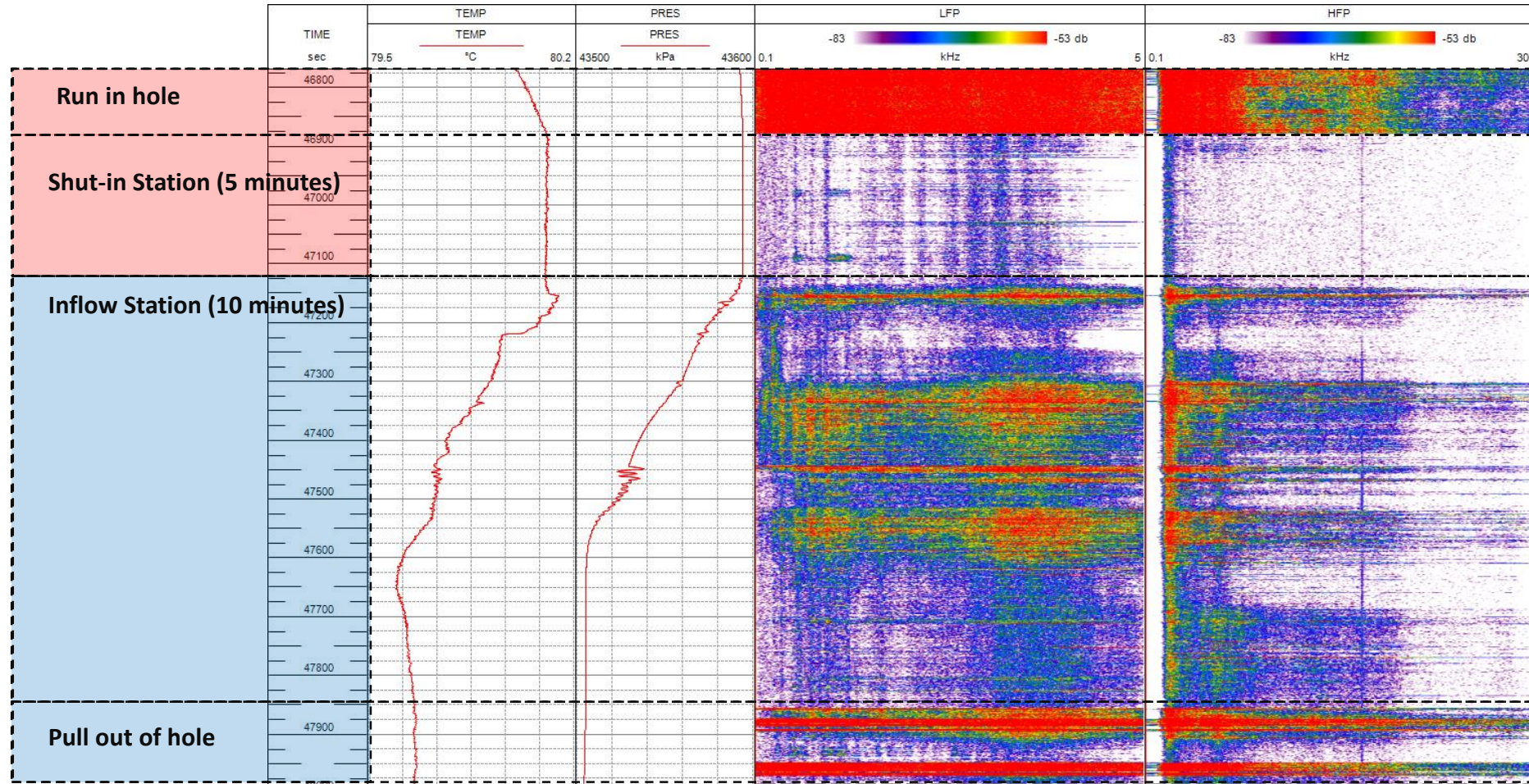
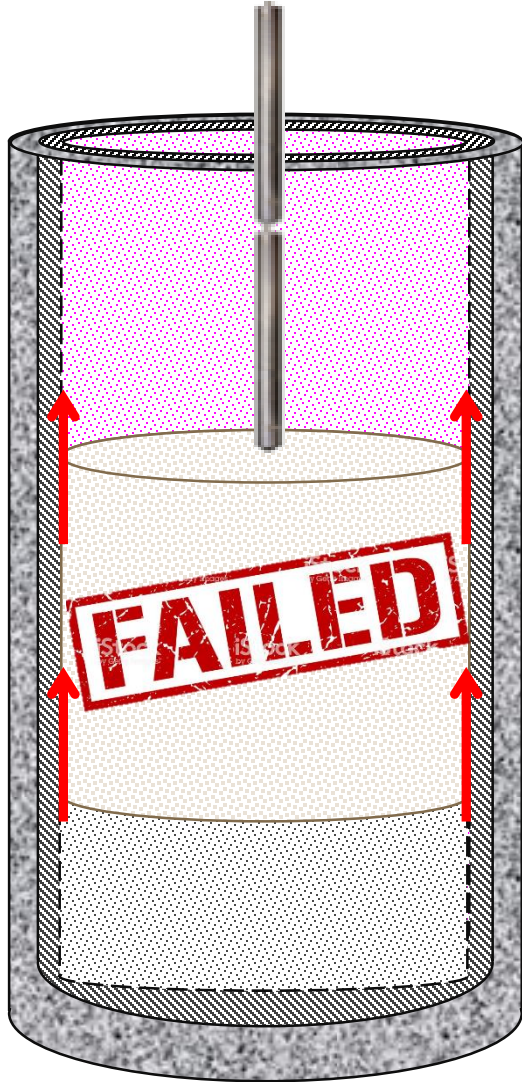


Main observations:

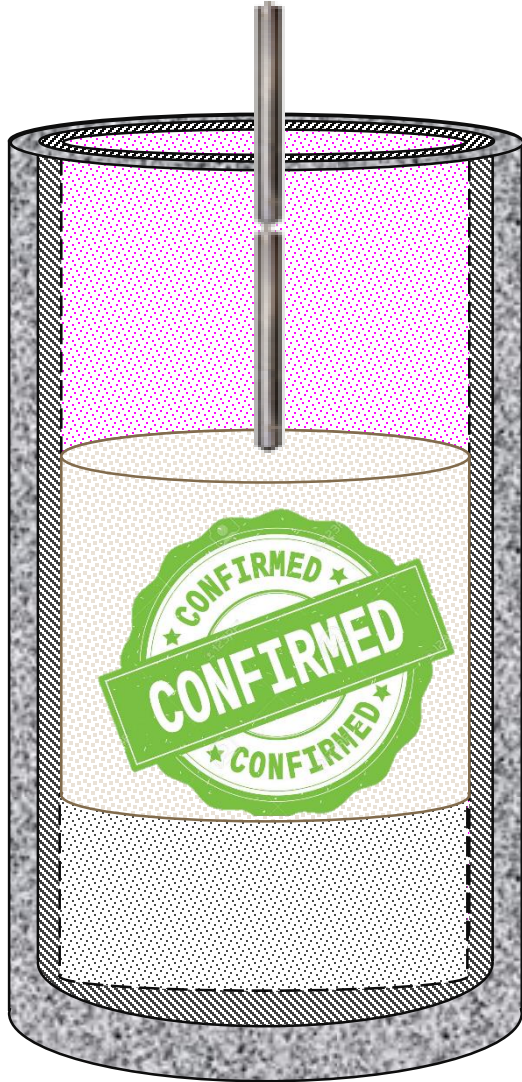
1. Annular space 100% cemented
2. Visual signs of debonding? – inner and outer casing
3. Apparent debonding visually appears worst on narrow side
4. Minor defects in cement bulk – few mm in depth
5. Debonding material and defects filled with material - might be mud solids
6. 9 5/8 casing collar present



Cement plug inflow Test (failure)

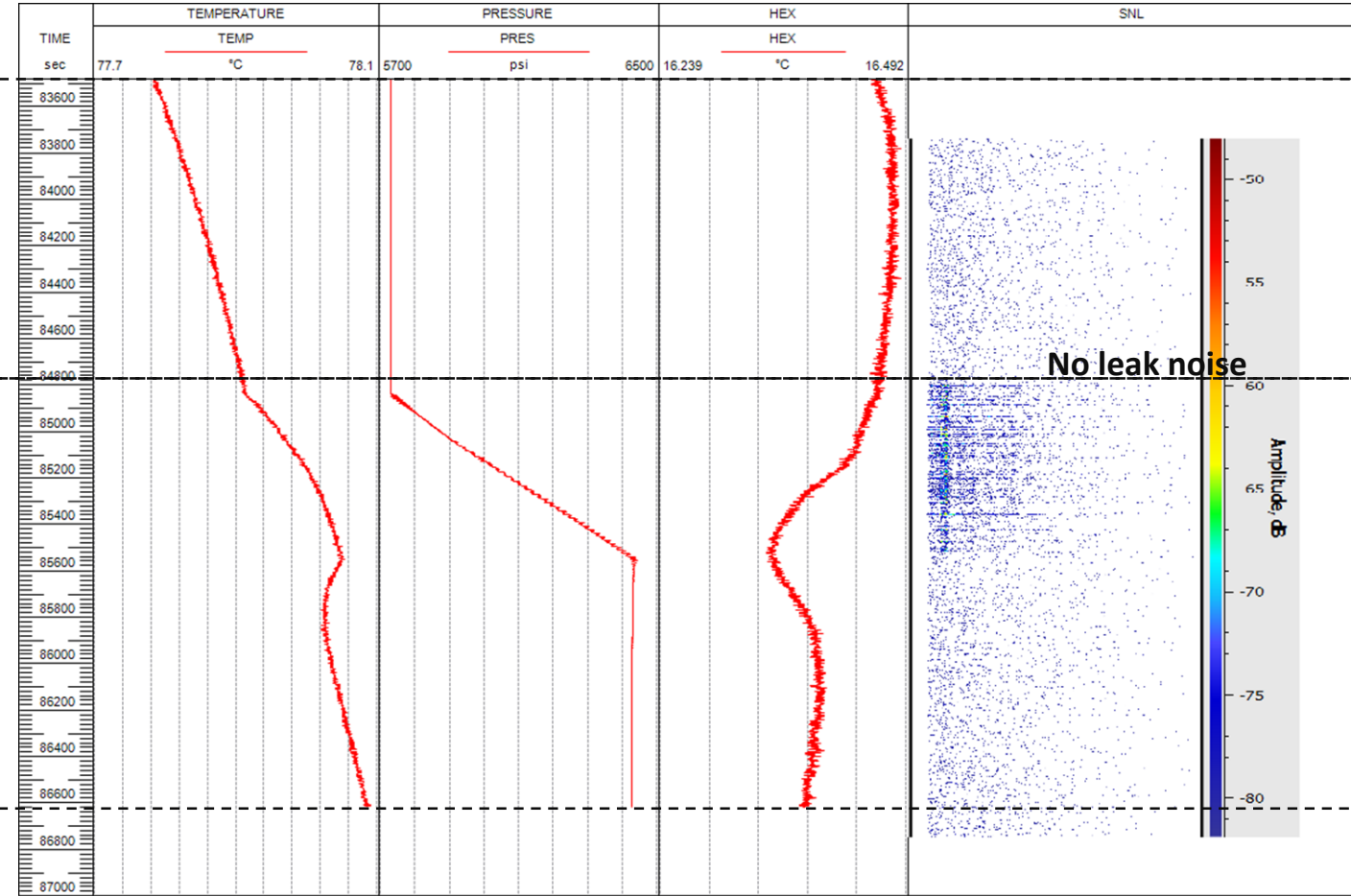


Cement plug pressure Test (success)



Shut-in Station (5 minutes)

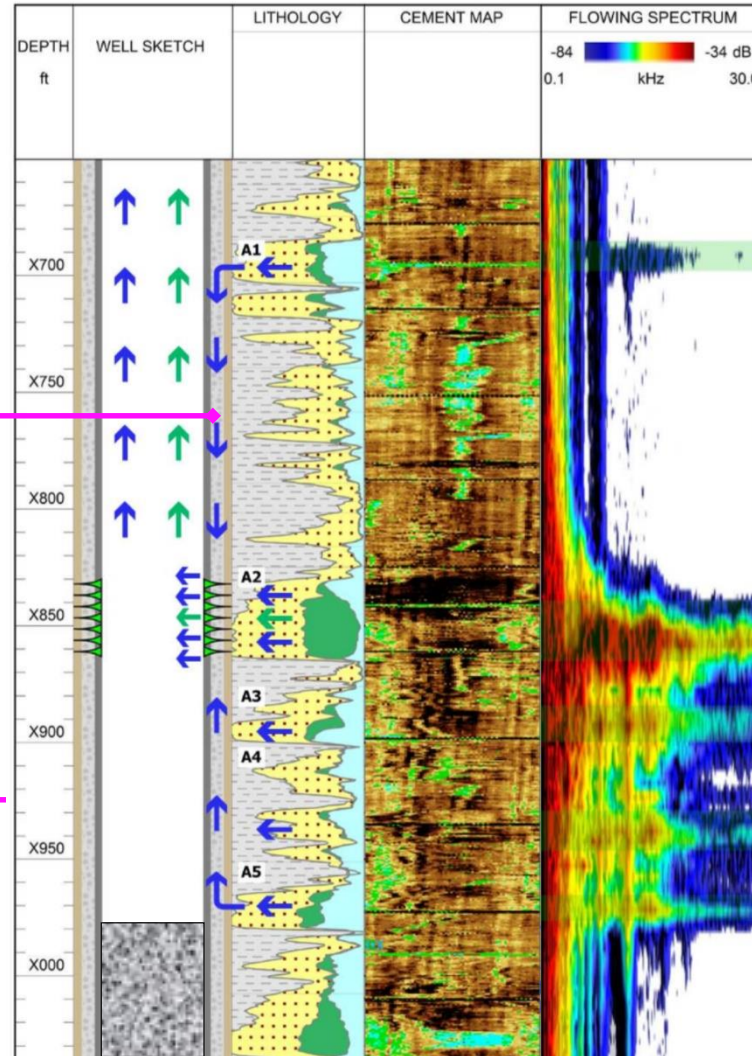
Pressure Test Station (30 minutes)



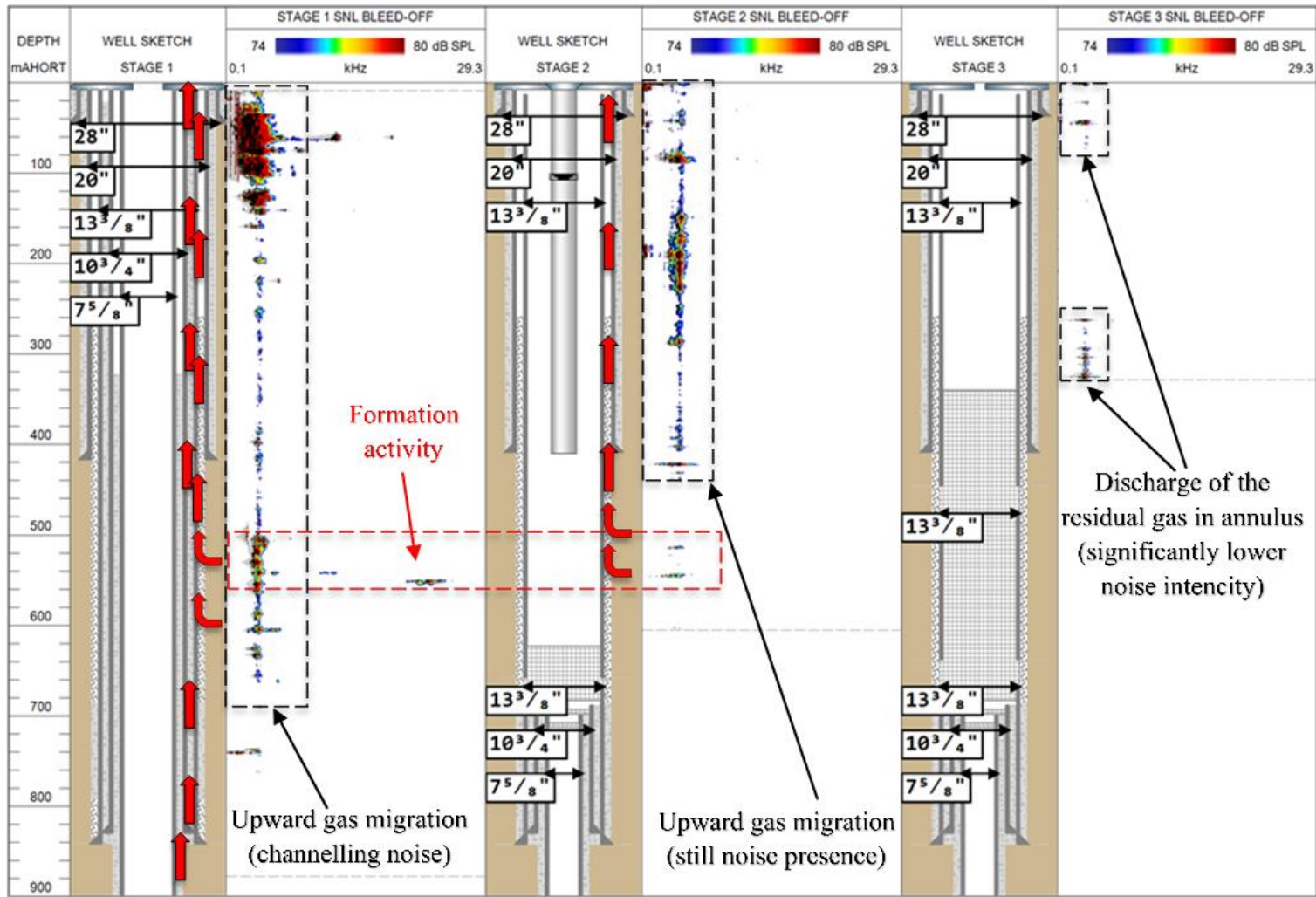
Perf and pressure test

Cement isolation failure

Cement isolation failure



Cement Seal Failure causing SAP



Conclusions

Passive acoustic logging and its spectrum interpretation can be considered today as direct measurement of hydraulic sealing of cement barrier.

Adding passive acoustic logging into the current barrier verification approach allows to identify most well barrier barriers failure scenarios more confidently and to confirm the established well barriers after cementing operations.

Quantitative barrier assessment while pressure test.