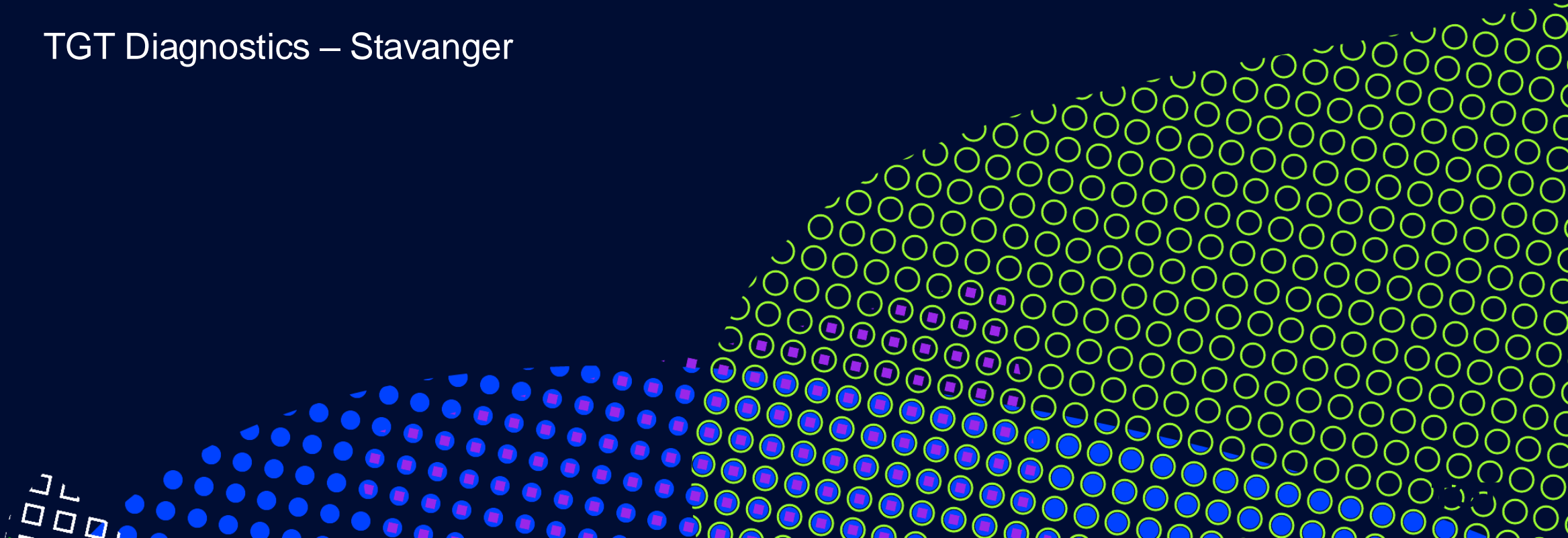


Barrier verification – Pre P&A

Mohammad Abshenas

TGT Diagnostics – Stavanger



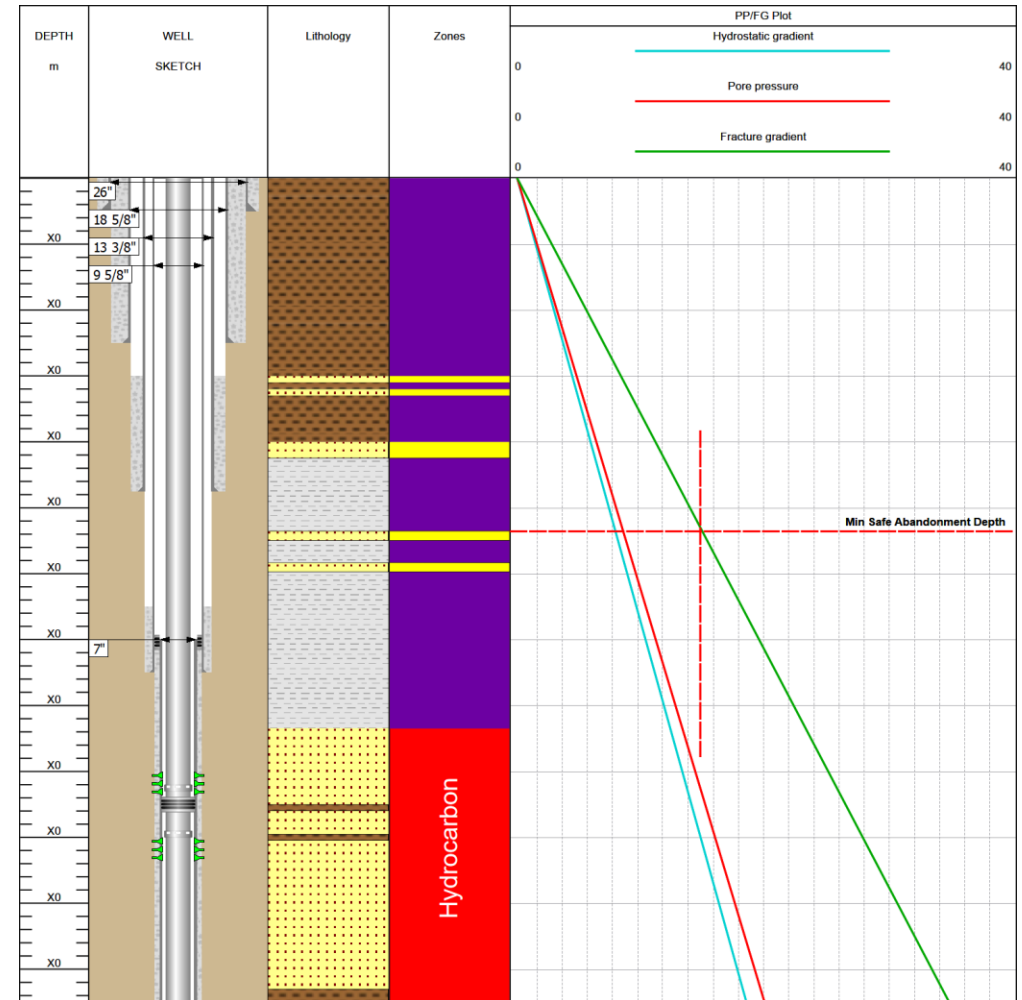
Pre abandonment planning

Main purpose of P&A is to **isolate** the **zones with flow potential** (i.e. zones with sufficient *permeability* and *pressure*).

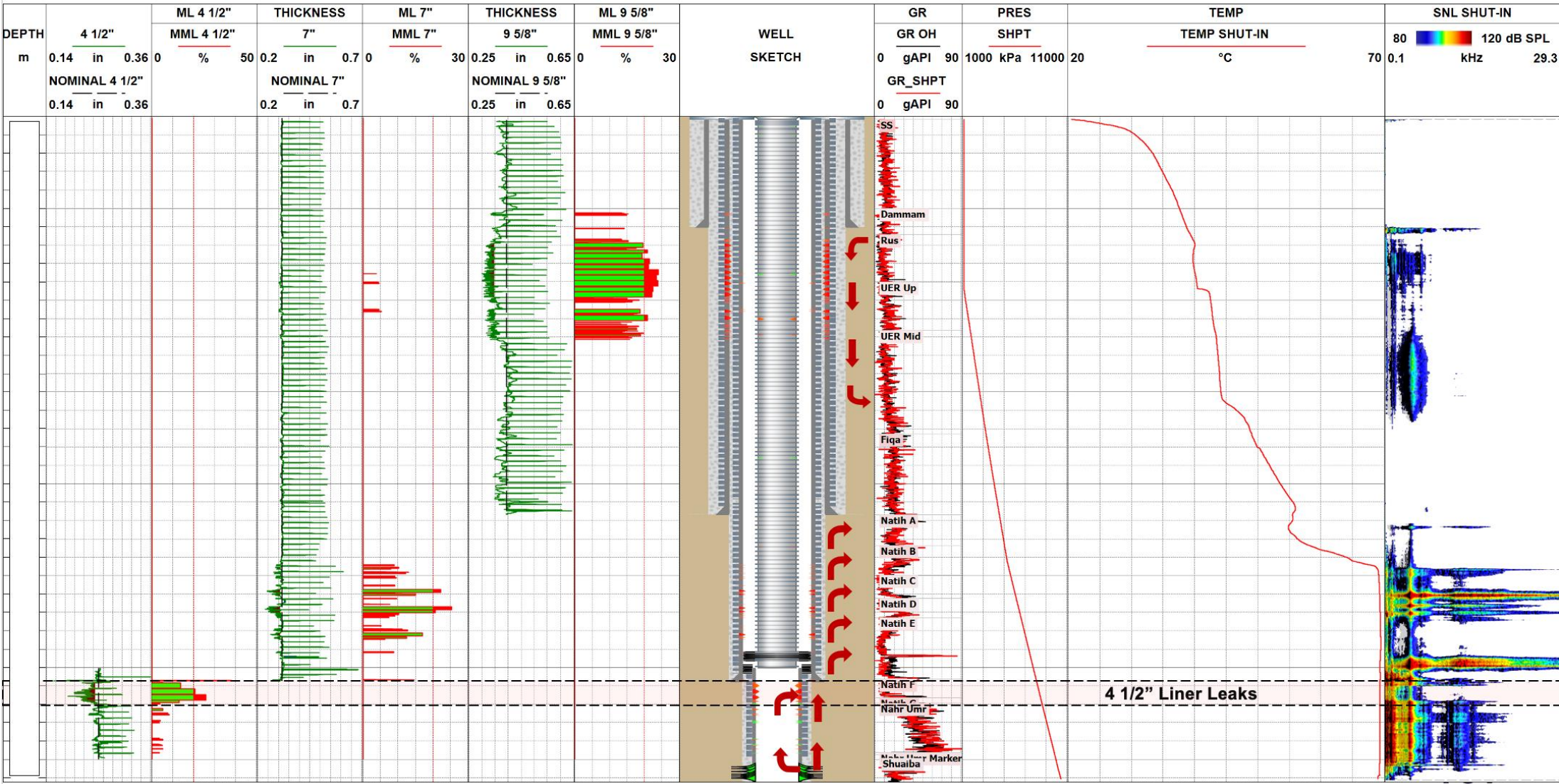
We tend to (rightly so) rely on subsurface / reservoir / geological data to identify these zones

What if there are communications between:

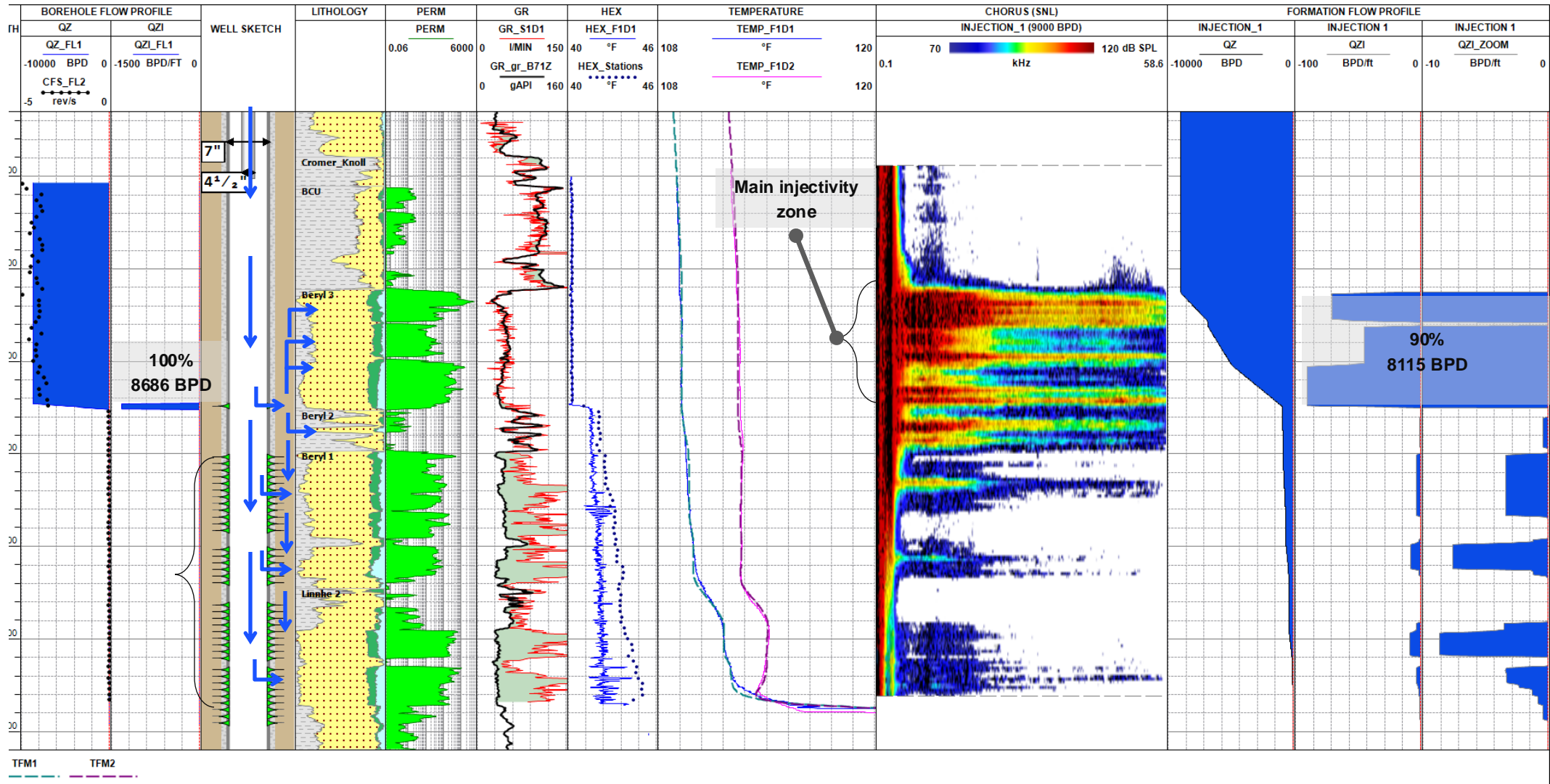
- Reservoir layers, Reservoir to overburden
- Overburden layers
- Over-pressured zones due to out of zone injection throughout the life of the well
- fractured formation due to injections,...
- The **presence** or **absence** of flows / communication will drastically change the abandonment design: **How do we verify?** Can we **pressure test the barriers**?



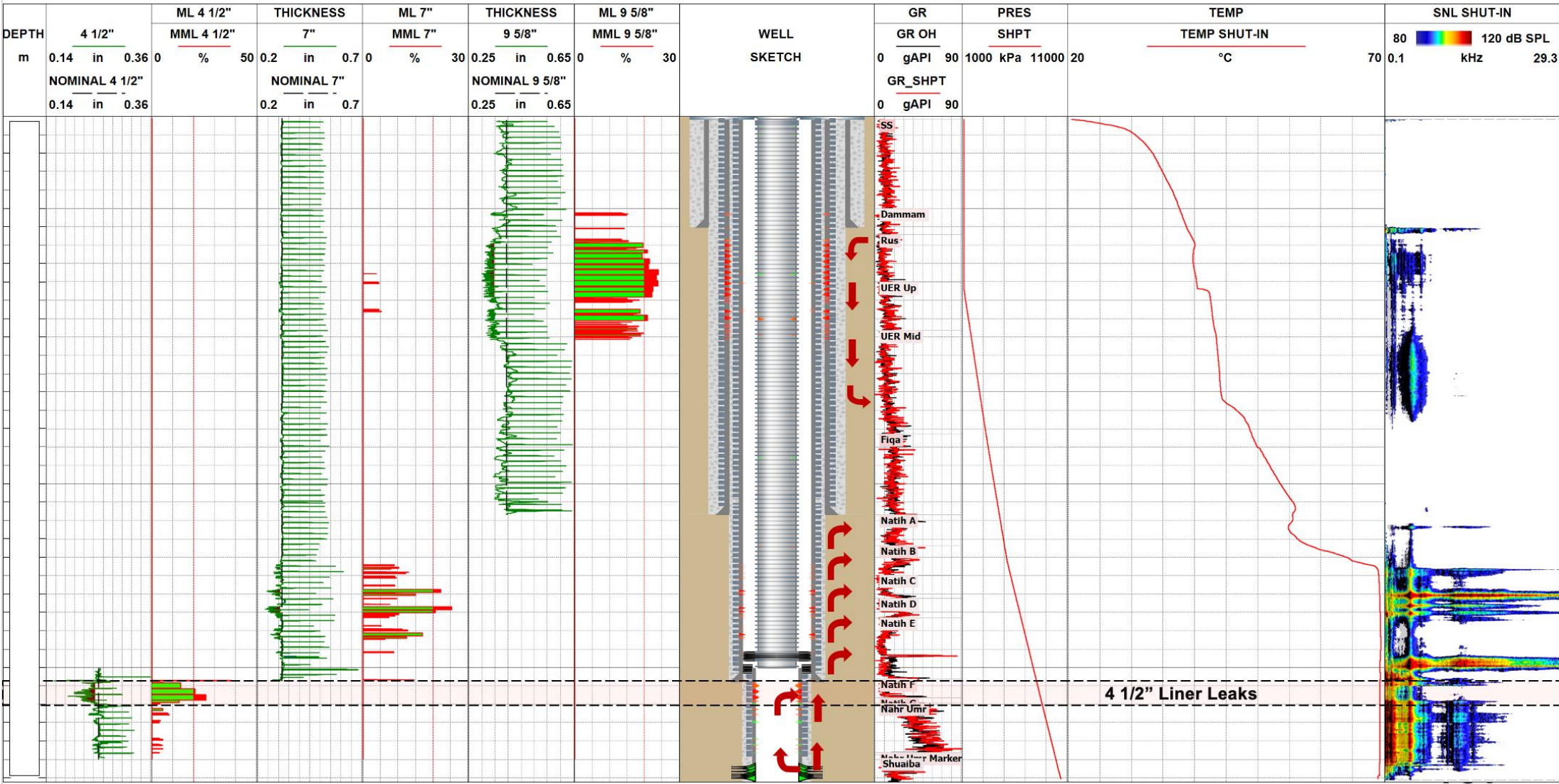
Cross-flows – behind casings



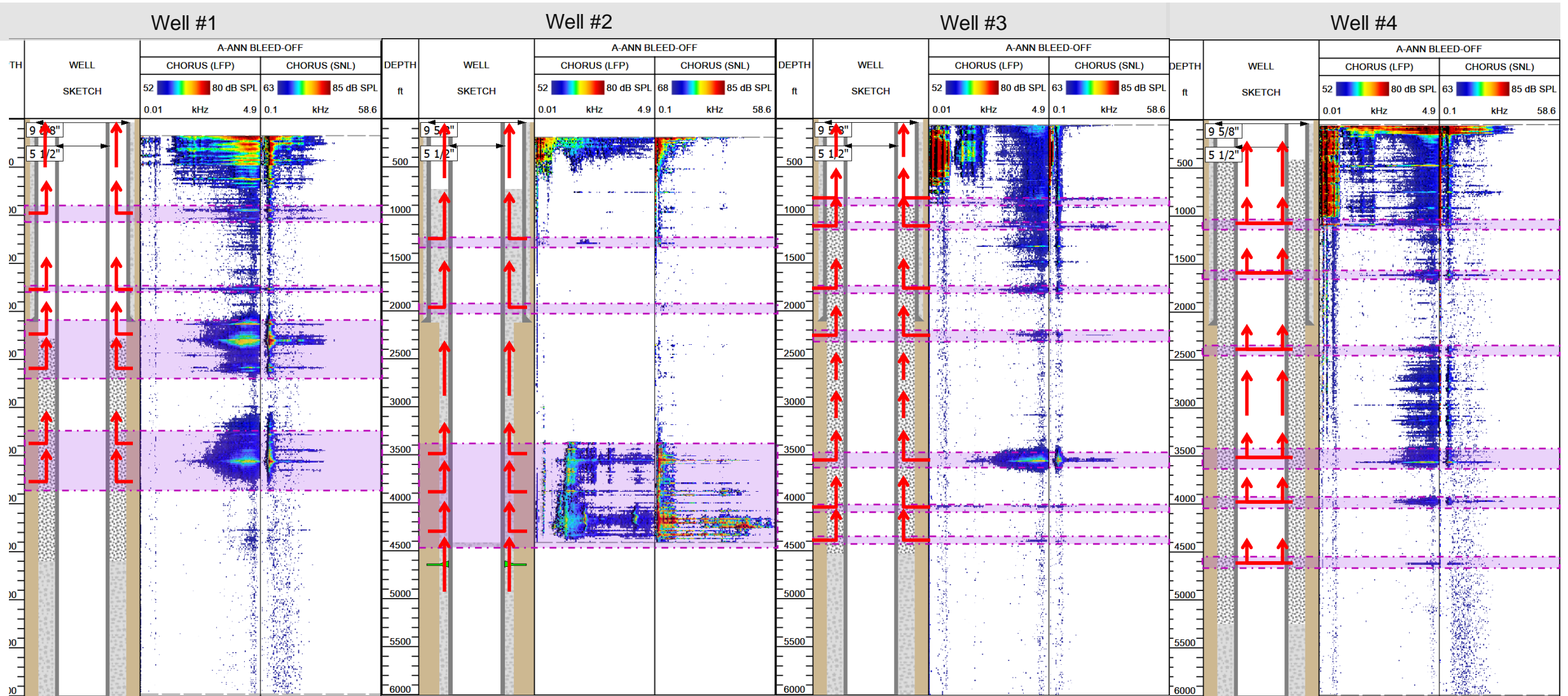
Out of Zone Injection: charged formations



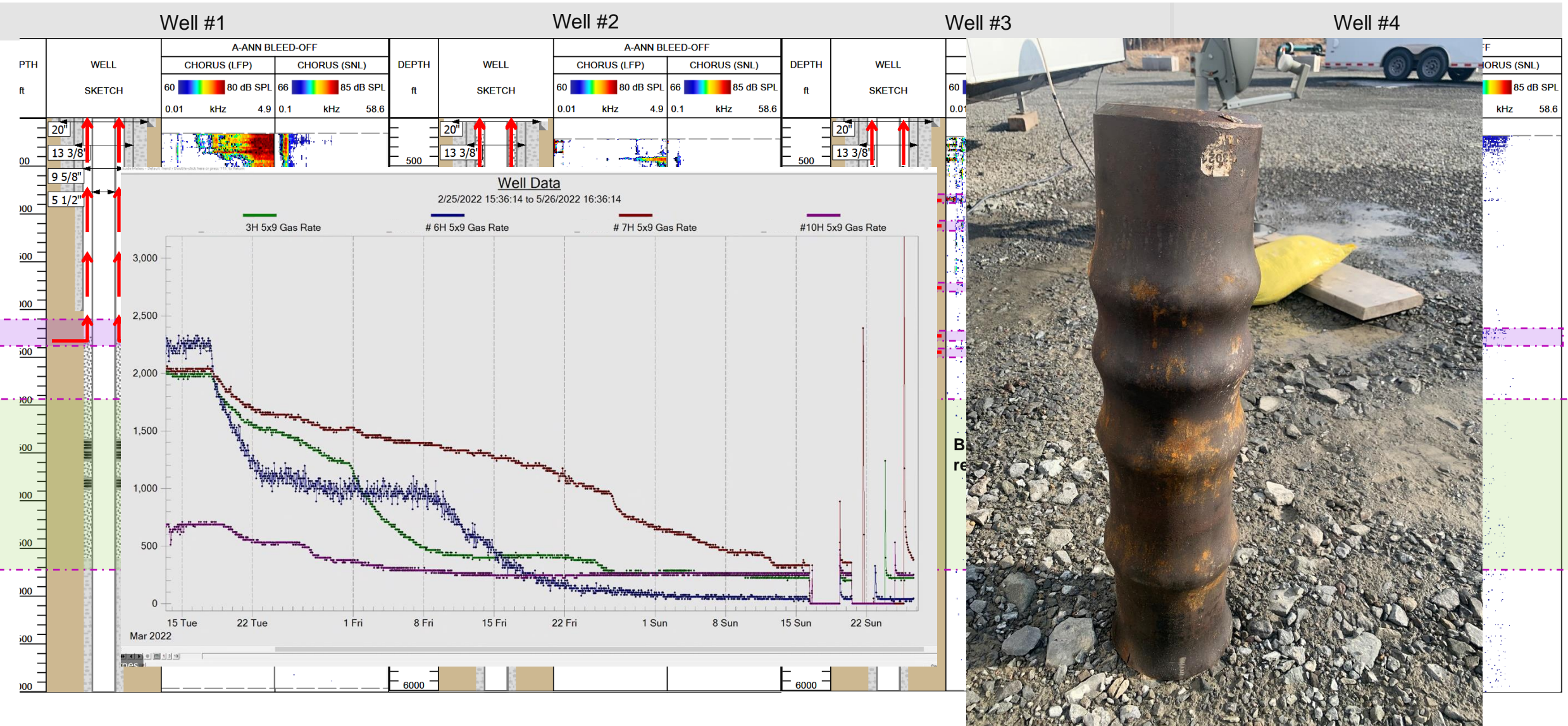
Cross-flows – behind casings



Cross well analysis (pre workover)



Cross well analysis (post workover)

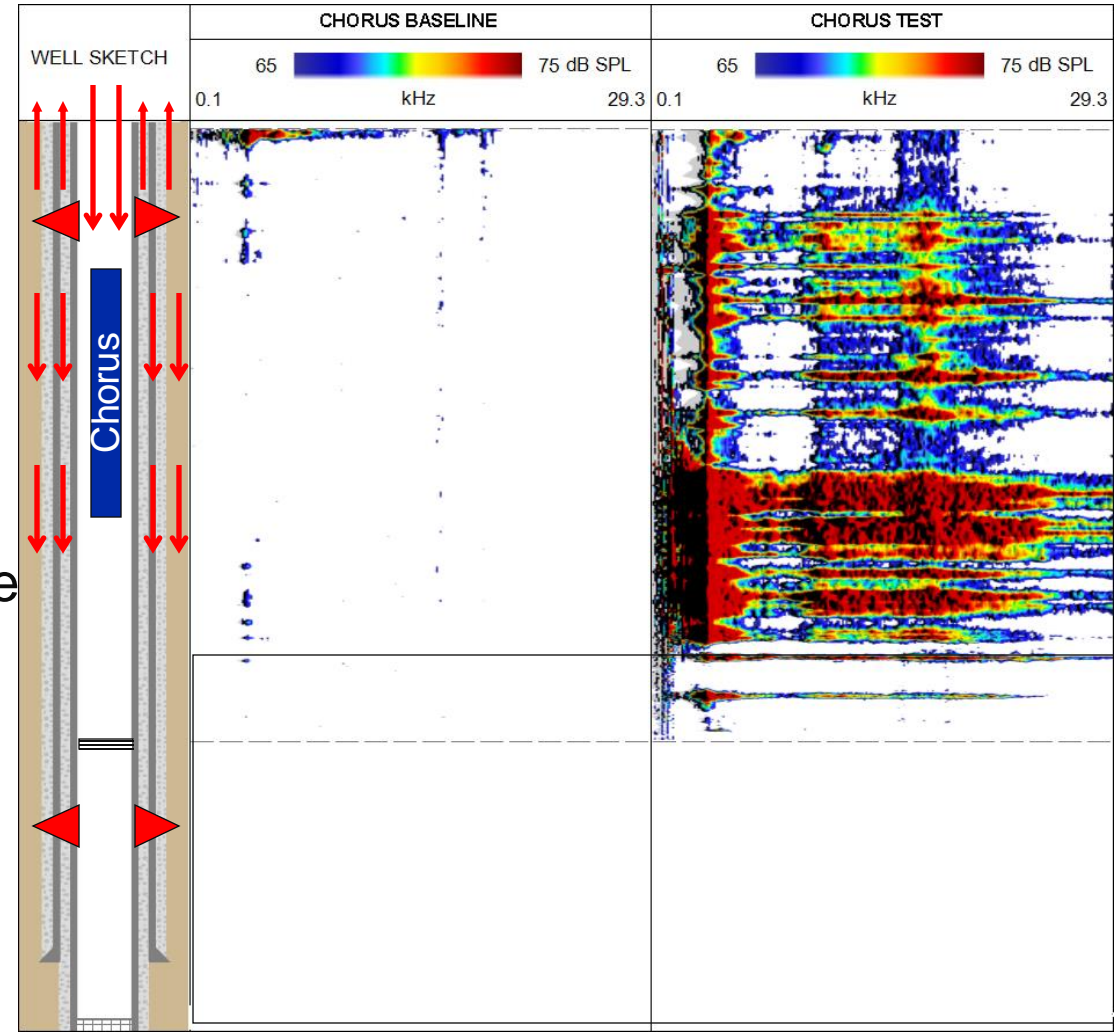


Barrier verification – Acoustic leak-off test

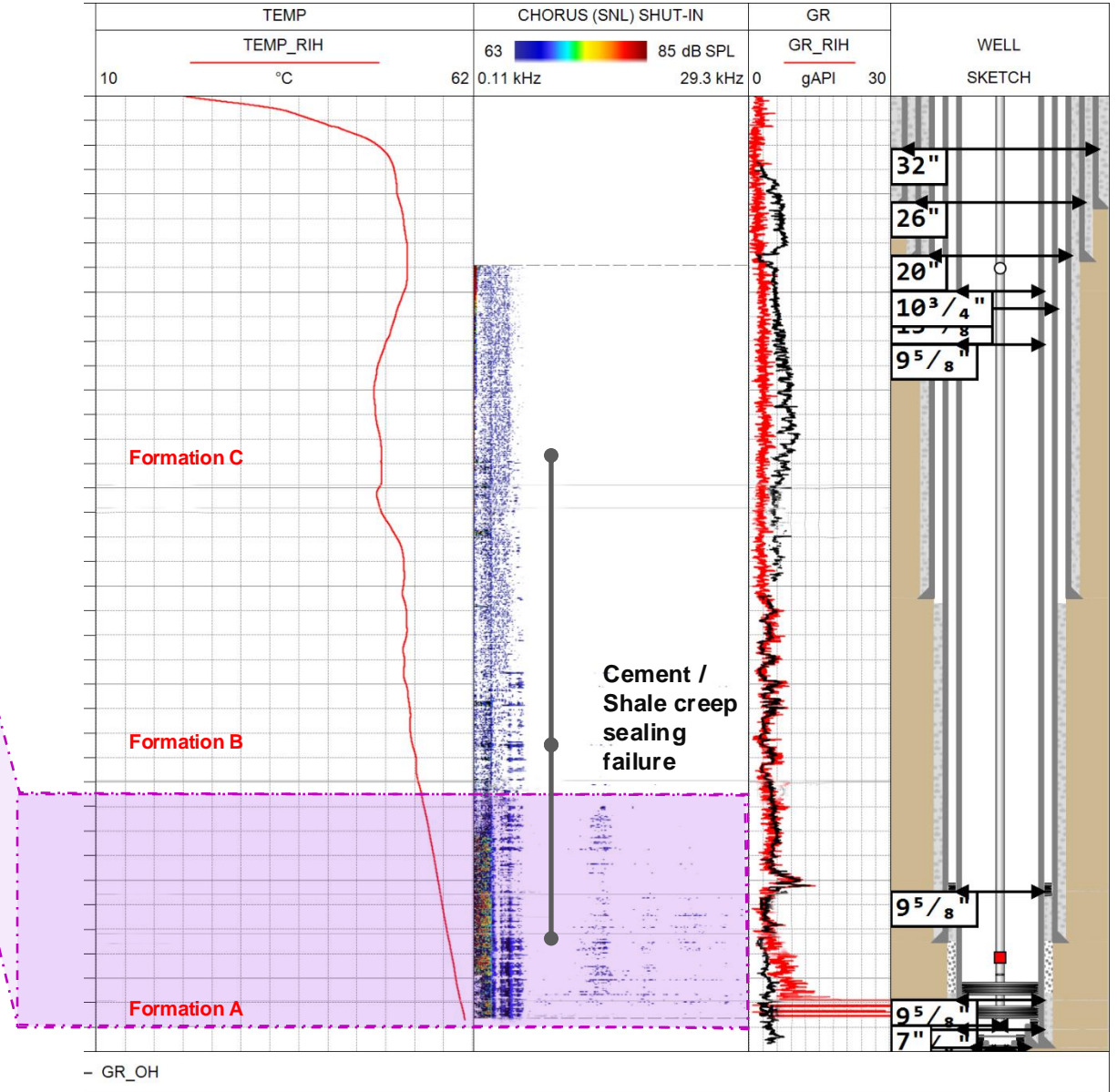
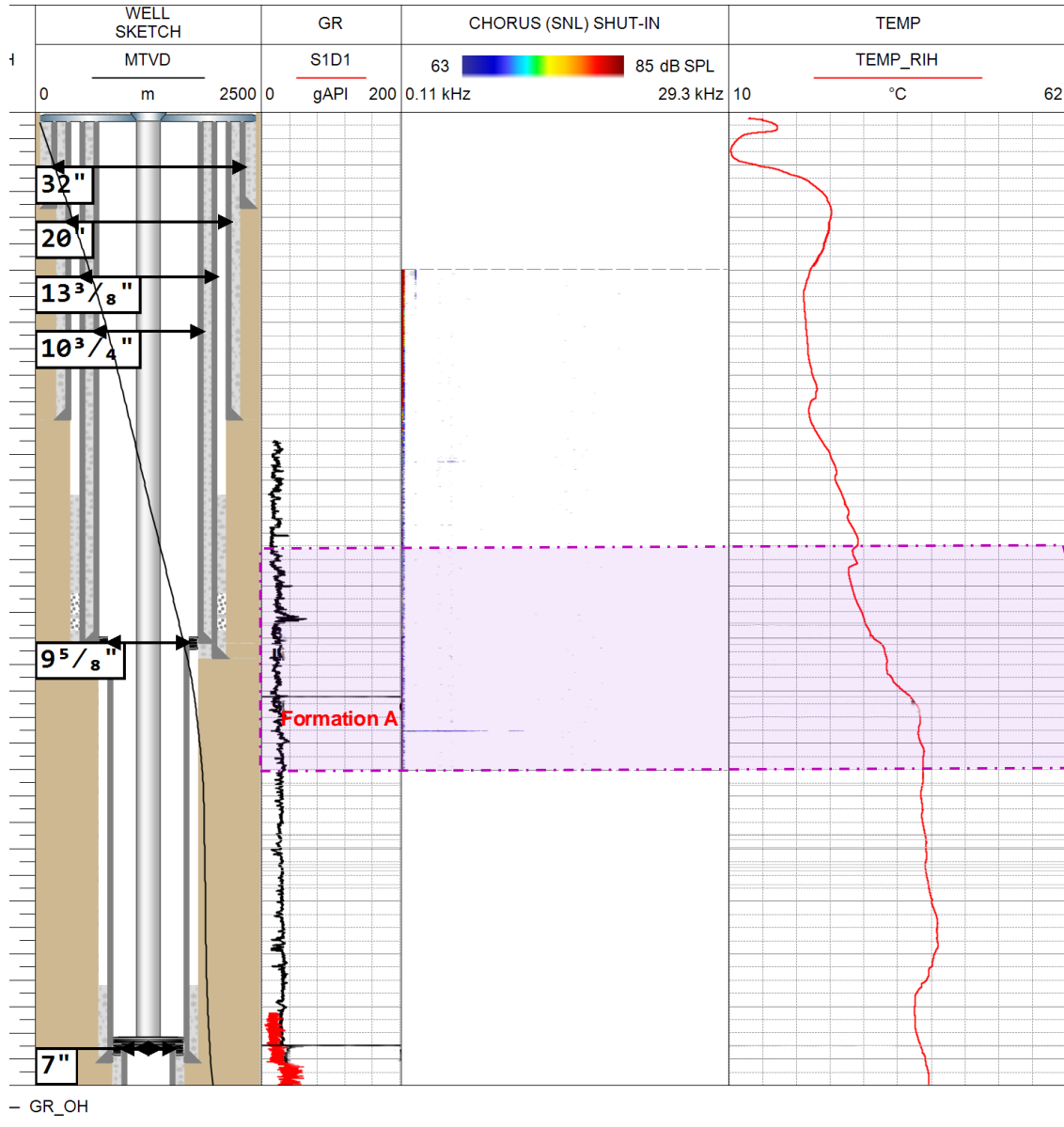
Method of testing the barrier:

Presence or **absence** of acoustic (proxy for Flow)

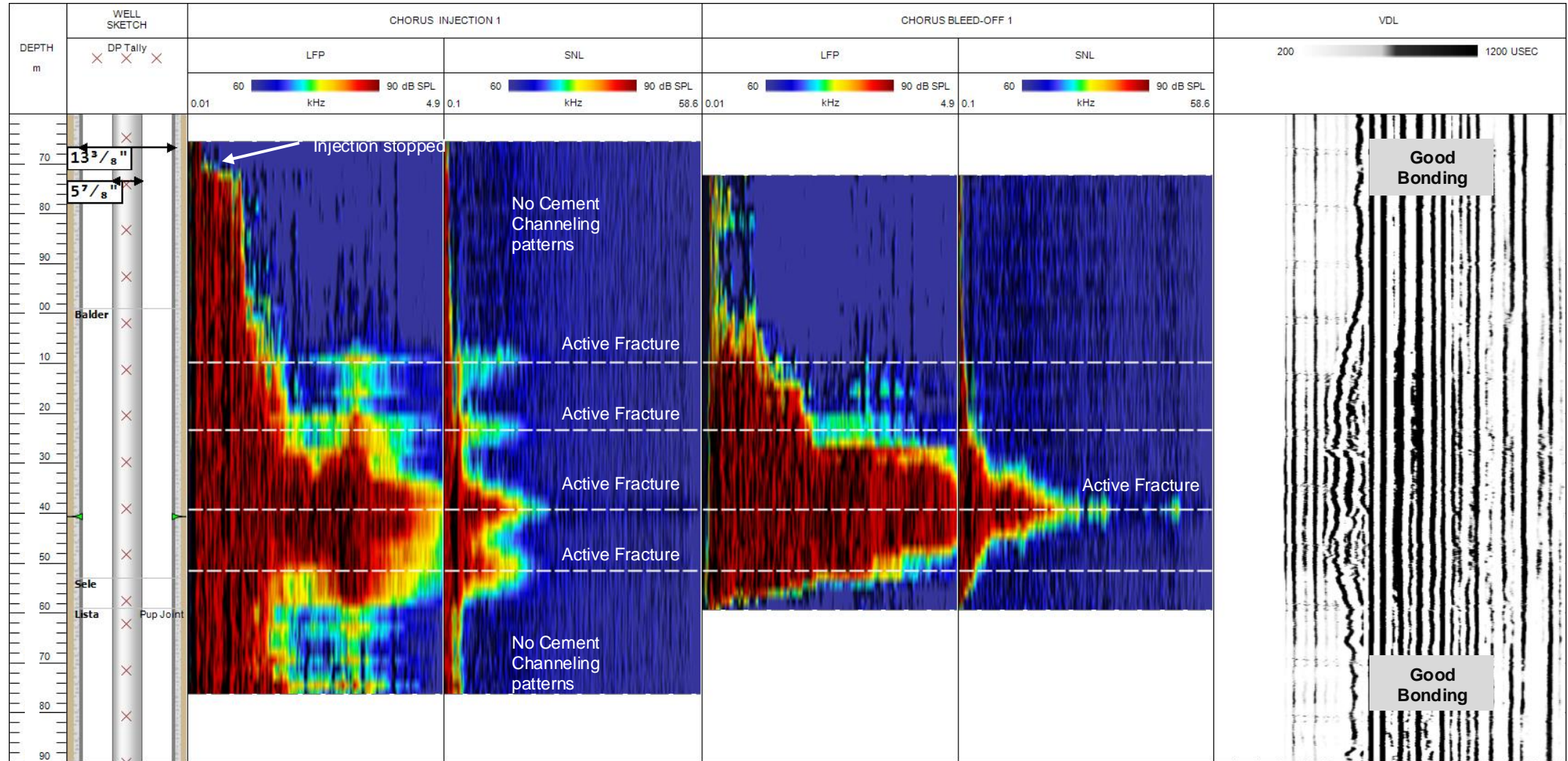
- Subsurface driving force (ΔP) in place
- No subsurface driving force across the zone of interest (shale / cement ..)



Verifying the cement barrier through tubing



Acoustic leak off test



Acoustic leak off test (NORSOK D010 rev5)

Rev04 revision

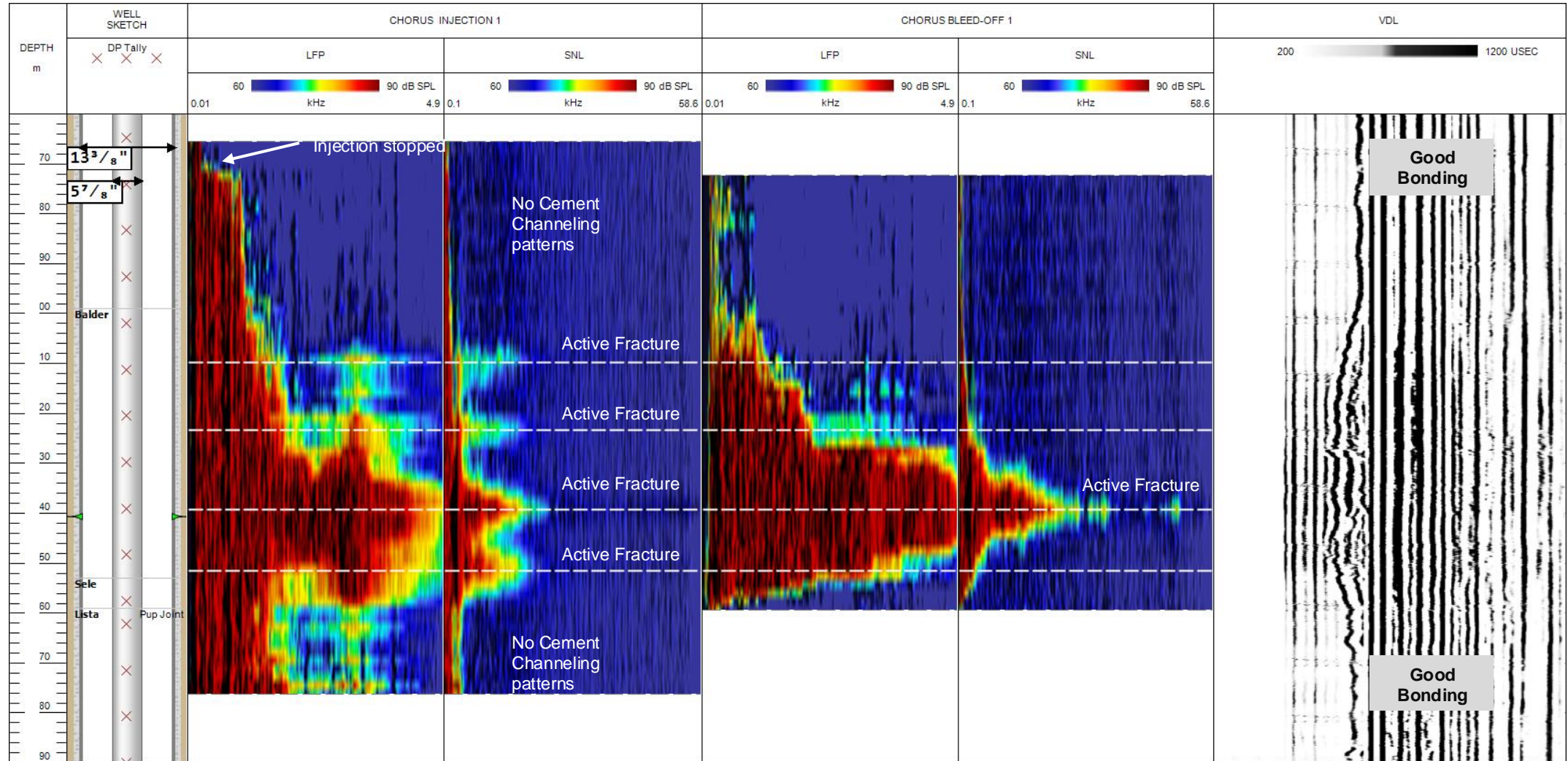
| Features | Acceptance criteria | See |
|---|---|-----|
| D. Initial test and verification | <p>The material should be left undisturbed until it has met sufficient compressive strength.</p> <ol style="list-style-type: none"> 1. The material sealing ability shall be verified through a formation integrity test when the casing shoe/window is drilled out. 2. The material length shall be verified by one of the following: <ol style="list-style-type: none"> a) Bonding logs: Logging methods/tools shall be selected based on ability to provide data for verification of bonding. The measurements shall provide azimuthal/segmented data. The logs shall be verified by qualified personnel and documented. b) 100 % displacement efficiency based on record from the pumping operation (volumes pumped, returns during pumping, etc.). Actual displacement pressure/volumes should be compared with simulations using industry recognized software. In case of losses, the loss zone shall be above the planned TOM, this shall be documented. Acceptable documentation is job record comparison with similar loss case(s) on a reference well(s) that has achieved sufficient length verified by logging. c) In the event of losses, it is acceptable to use the PIT/FIT or LOT as the verification method, only if the casing material shall be used as a WBE for drilling the next hole section. (This method shall not be used for verification of casing material as a WBE for production or abandoned wells). 3. Critical casing material shall be logged and is defined by the following scenarios: <ol style="list-style-type: none"> a) the production casing / liner when set into/through a source of inflow with hydrocarbons; b) the production casing / liner when the same casing material is a part of the primary and secondary well barriers; c) wells with injection pressure which exceeds the formation integrity at the cap rock. 5. Actual material length for a qualified WBE shall be: <ol style="list-style-type: none"> a) above a potential source of inflow/ reservoir; b) 50m MD verified by displacement calculations. The formation integrity shall exceed the maximum expected pressure at the base of the interval. | |
| E. Use | None | |



Rev05 (Jan 2021)

| Features | Acceptance criteria | See |
|---|---|-----|
| D. Initial test and verification | <ol style="list-style-type: none"> 1. Internal WBE shall be verified using at least one of the methods below: <ol style="list-style-type: none"> a) Pressure test, either in the direction of flow or from above. If the WBE is set on a pressure tested foundation, a pressure test is not required. It shall be verified by tagging; b) Tag/load test with drill pipe or wireline; c) Any other alternative verification method that is documented and proven to be suitable for the particular type of alternative barrier material being used. 2. External WBE shall be verified using at least one of the methods below: <ol style="list-style-type: none"> d) Bonding logs. Logging methods/tools shall be selected based on ability to provide data for verification of bonding. The measurements shall provide azimuthal/segmented data. The logs shall be verified by qualified personnel and documented; e) Application of a pressure differential across the interval; f) Downhole acoustic leak-off test; g) Any other alternative verification method that is documented and proven to be suitable for the particular type of alternative barrier material being used 3. The installation of the alternative material WBE shall be verified through evaluation of job execution | |
| E. Use | None | |
| F. Monitoring | <p>Monitoring required in the following scenarios:</p> <ol style="list-style-type: none"> a) First use of a new alternative barrier material b) Temporary Abandonment (wells with monitoring) and suspension | |
| G. Common well barrier | To be evaluated on a case by case basis after performing an engineering review and a risk assessment. | |

Acoustic leak off test



Summary

Main purpose of P&A is to isolate the zones with *flow potential* (i.e. zones with sufficient *permeability* and *pressure*).

What if there are communications between:

- Reservoir layers, Reservoir to overburden
- Overburden layers
- Over-pressured zones due to out of zone injection throughout the life of the well
- fractured formation due to injections,..

Downhole logging methods including Acoustic logging to determine the ***presence*** or ***absence*** of flow

Acoustic leak off test as a verification method

Beware of ***future impact of CCUS on pressure regimes***

Thank You

Mohammad Abshenas

TGT Diagnostics – Stavanger

