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Live Webinar

Plugging Efficiency and Emerging Technology in Cement/Cement Bond Log Evaluation

Interstate Oil & Gas Compact Commission

Environmental Defense Fund

WEDNESDAY, 28 JANUARY

1100 CST (UTC-6)

MODERATOR

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BAKER HUGHES

SPEAKER

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CONSULTANT

SPEAKER

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SPEAKER

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NET-ZERO GEOSYSTEMS

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Nail P&A, No Questions Asked: P-W-C and Creeping Formations

Matteo Loizzo

Jan 28, 2026

Forever Hold Your Peace

Set "eternal" barriers, using only rock and cement

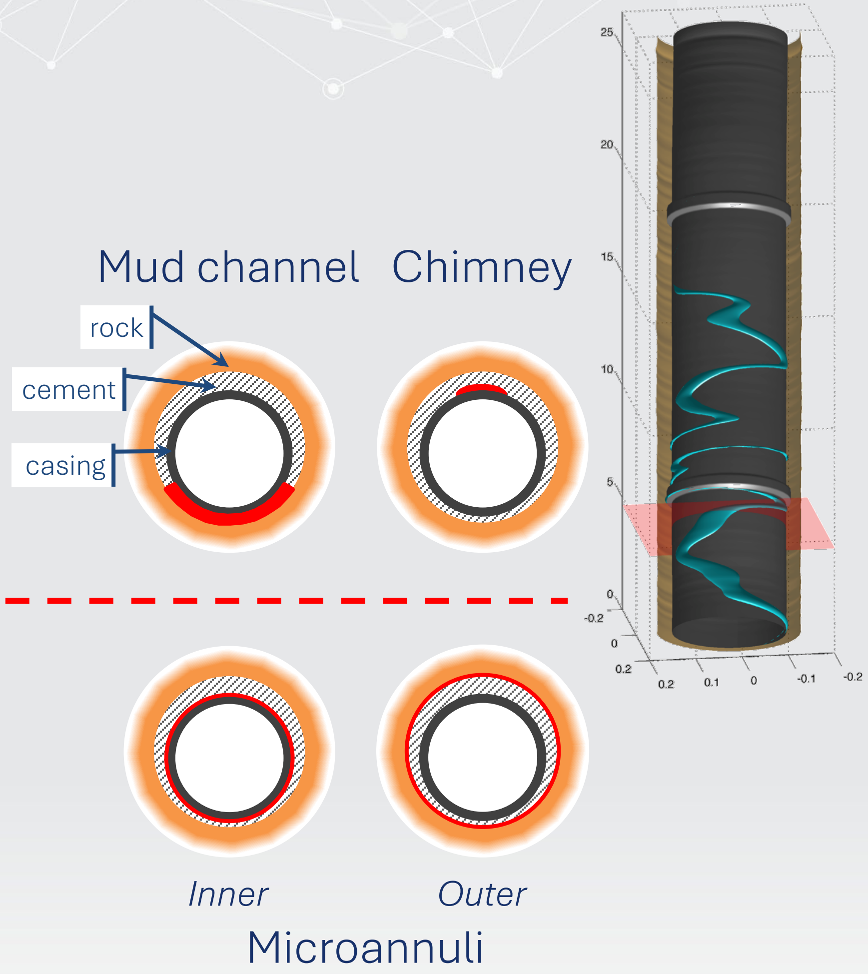
- Short eternity → 1,000 years or 1M days
  - Steel will be gone in 20-60 years
  - Idle and orphan wells vs. permanent P&A
- Rock has pressure rating, cement doesn't
  - Frac pressure, PPFG
  - So, how does cement fail?

Chernobyl New Safe Confinement, Cls14 at English Wikipedia, via Wikimedia Commons

Failure Modes of Cement

Major Accident Hazard vs. annoyance

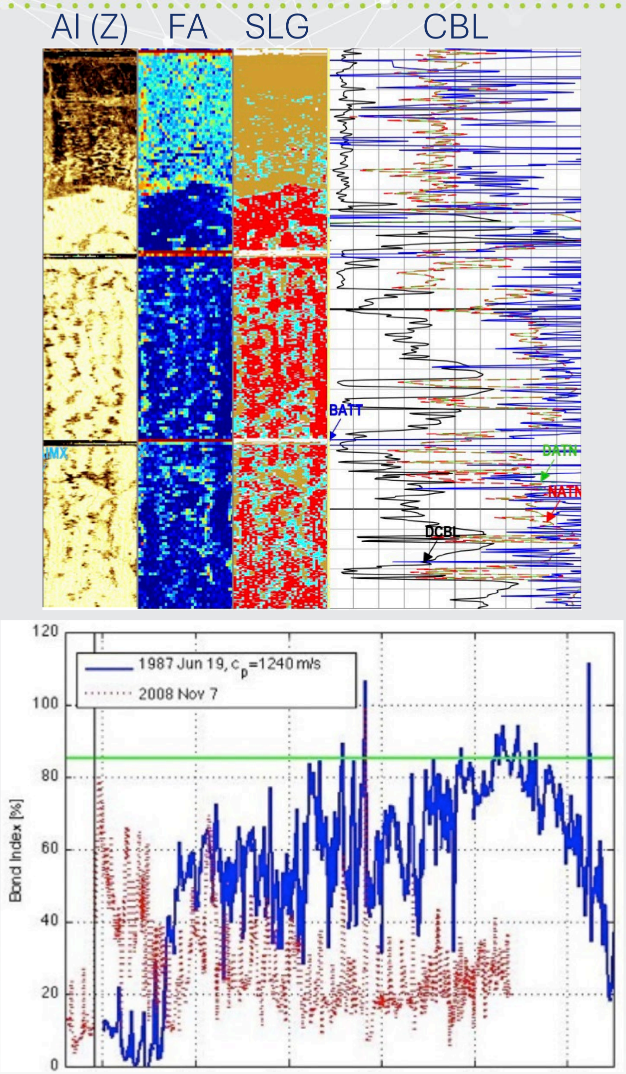
- Large pathway → major accident scenario
  - "*Catastrophic release*", 29 CFR 1910.119(b)
  - >10,000 tons per year
  - No cement, mud channels (think centralizers), chimneys
    - A.k.a. microchanneling, ¼" pipe
- Narrow pathway → annoyance
  - Microannulus (debonding)
  - ~100 tons per year, or <1 ton per year as gas bubbles
    - A few cows
  - Can appear at any time, but why?



Types of Microannuli

The good, the bad and the ugly

- Dry microannulus
  - <10 μm (0.4 mils), empty
  - Mostly a positive sign of integrity → would be wider
  - Casing shrinkage (including thermal) or cement expansion
- Liquid microannulus
  - 0.1-0.5 mm, full of water (or oil)
    - Water may have condensed from leaking gas
  - Leak, or pressure test
- Water layer separated during cement setting
  - 0.1 mm, a hybrid between the two – sometimes unconnected



Source: Loizzo, Lecampion, Mogilevskaya. (2017)

Fix It Before You Leave

How big is a tolerable leak?

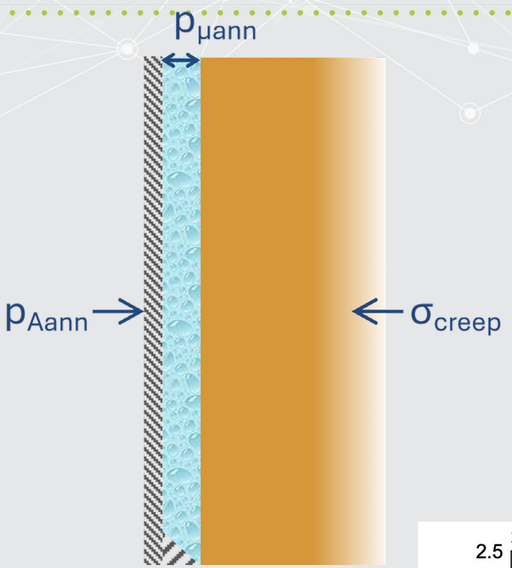
- You'll know a major accident when you see one → blowout
  - Unless it's subsurface
  - Can be hydrocarbons but most often brine → PWRI
- Do we repair a microannulus?
  - Liquid rates less than API RP 14B
  - Gas bubbles through a water layer
    - 2024 EU Methane Regulation Leak Detection and Repair (LDAR)
    - 5 g h^{-1} (0.7 cows) underground components, 17 g h^{-1} (2.3 cows) subsea
  - Small, unless you have a cellar in LA
    - Methane Seepage Regulations (LAMC Division 71)

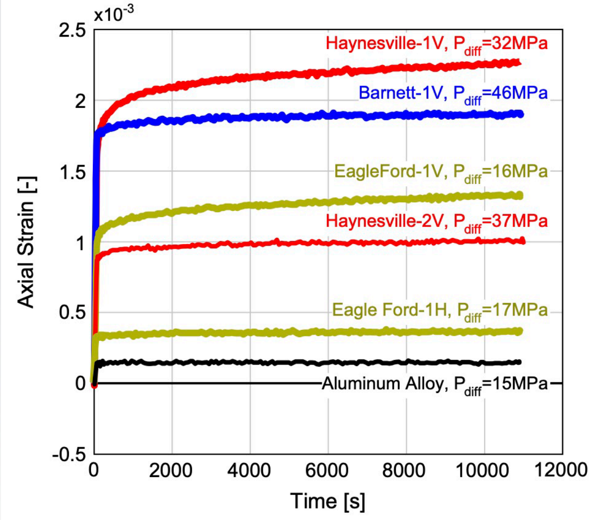
Source: TexasMonthly, 2022 Jan 12

Restoring Bond

Microannulus is the result of a tug-of-war

- Pressure inside the casing p_{Aann}
  - Not effective → half is taken up by the steel pipe
  - No use after P&A
- Pressure in the microannulus $p_{\mu ann}$
  - Set by the reservoir
- Formation clamping stress σ_{creep}
  - Creeping formations → shale and salt
  - Combination of mineralogy and tectonic stress
    - Marcellus creeps, Eagle Ford not so much
- Cannot squeeze water <~50 μm → cow-size gas leaks





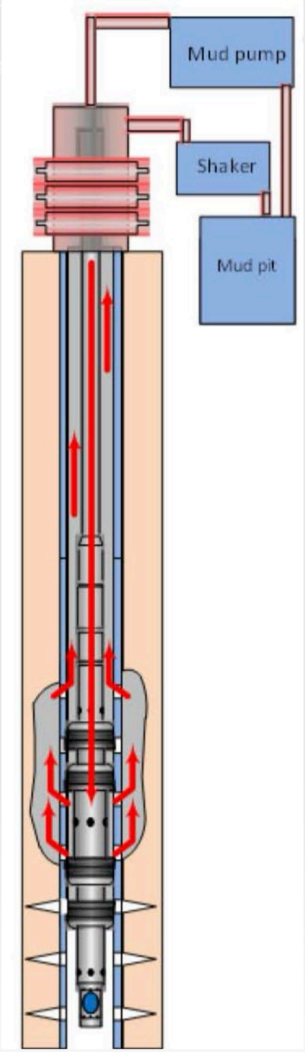
Source: Sone & Zoback (2014)

Perforate, Wash, and Cement

The silver bullet

- Run on drill pipe with TCP guns at the bottom
  - Lots of holes → typically, 45° phase spacing and 12 shots per foot
- Downward washing pass then upwards cementing
  - Old mud → use soapy water (surfactants)
- Two types
  - Jetting → high-velocity nozzles
  - Cup-type → swab cups isolating a chamber
    - ~3,000 psi pressure operating pressure → bypass above the cups
    - Positive indication of pumping in the annulus

Disclaimer: PWC is a trademark of HydraWell, and currently there is only one supplier of cup-type tools

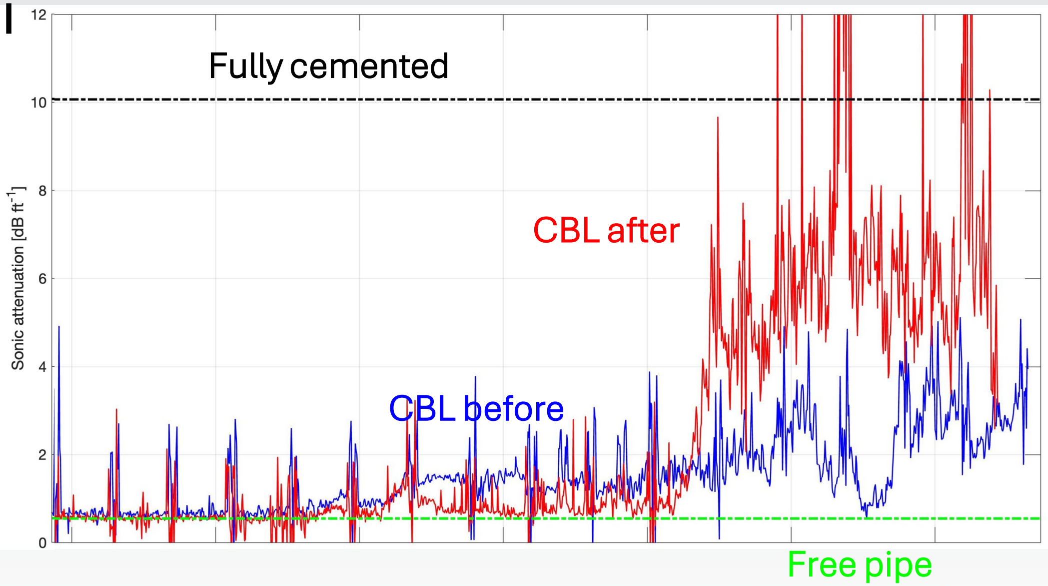


Source: Lucas et al. (2018) SPE 191528

Cups vs. Microannuli

Squeezing cement in a sub-millimeter gap

- Abrams' rule suggests opening w>3·D(50) to avoid bridging
  - D(50) median particle size → 10-20 μm for class G cement, w>60 μm
- Shortest distance between perfs either side of the cups → 2/3 ft
- Minimum squeeze pressure → 1,300-2,800 psi
  - Can reach chimneys
- Sometimes perfs are enough to let shales squeeze water in
  - Jetting-type can work, but only because of the "P"



P-W-C and Creeping Formations

Together we stand

Defect	Cup-type P-W-C	Jetting type P-W-C	Creeping formations
No cement (losses)	✓	✓	✓
Mud channel	✓	?	✓
Chimney	✓	?	?
(Liquid) microannulus	✓	? (with a hand)	✓ (with a hand)

Conclusions

Repair, if you must

- Is there an integrity failure?
  - Do not remediate based on logs alone, unless they show you the leak
    - Watch for crossflow, be alert for weak signals
  - If there is a leak to surface of USDW and the leak is unacceptable, then fix it
- Do I need decision points?
  - Perf, wash and cement is faster than section milling (the other silver bullet)
  - Watch how you qualify it in a new field → logs can show dry debonding
- What if I have a small leak and I'm broke?
  - Best time to fix a microannulus is yesterday, using lube & bleed
  - Use creeping formations and try perforating

THANK YOU

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Cement Squeeze for Total Loss Zone Treatment – Case Study from Indonesia

Rakhmahwidiati

Jan 28, 2026

Outline

- ❑ Background
- ❑ Normal Squeeze Cementing
- ❑ Challenge in Loss Zone
- ❑ Three Methods
- ❑ Mitigation Risk
- ❑ Advantage & Conclusion

Background

Why we do it:

- ❑ Many fields **experience total loss** zone
- ❑ Squeeze cementing has to be performed **more than 6-8 times**.
- ❑ Squeeze cementing in loss zone becomes **unpredictable** in term of cost and cure assurance
- ❑ There is a need in **self benchmarking** in each field for squeeze cementing

Normal Squeeze Cementing

What to Consider:

- R/U cementing unit, Pressure Test

  Prior to the operation, lab test should be carried out.
- Wellbore cleanout
- Injectivity test
- Mixing cement slurry, sampling.
- Squeeze cementing, mostly hesitation squeeze
- POOH, vacuumed and WOC min 12 hours

Challenges in Loss Zone

Method

- Conventional Technique
- Conventional Material

People

- Knowledge benchmarking
- Knowledge upgrading

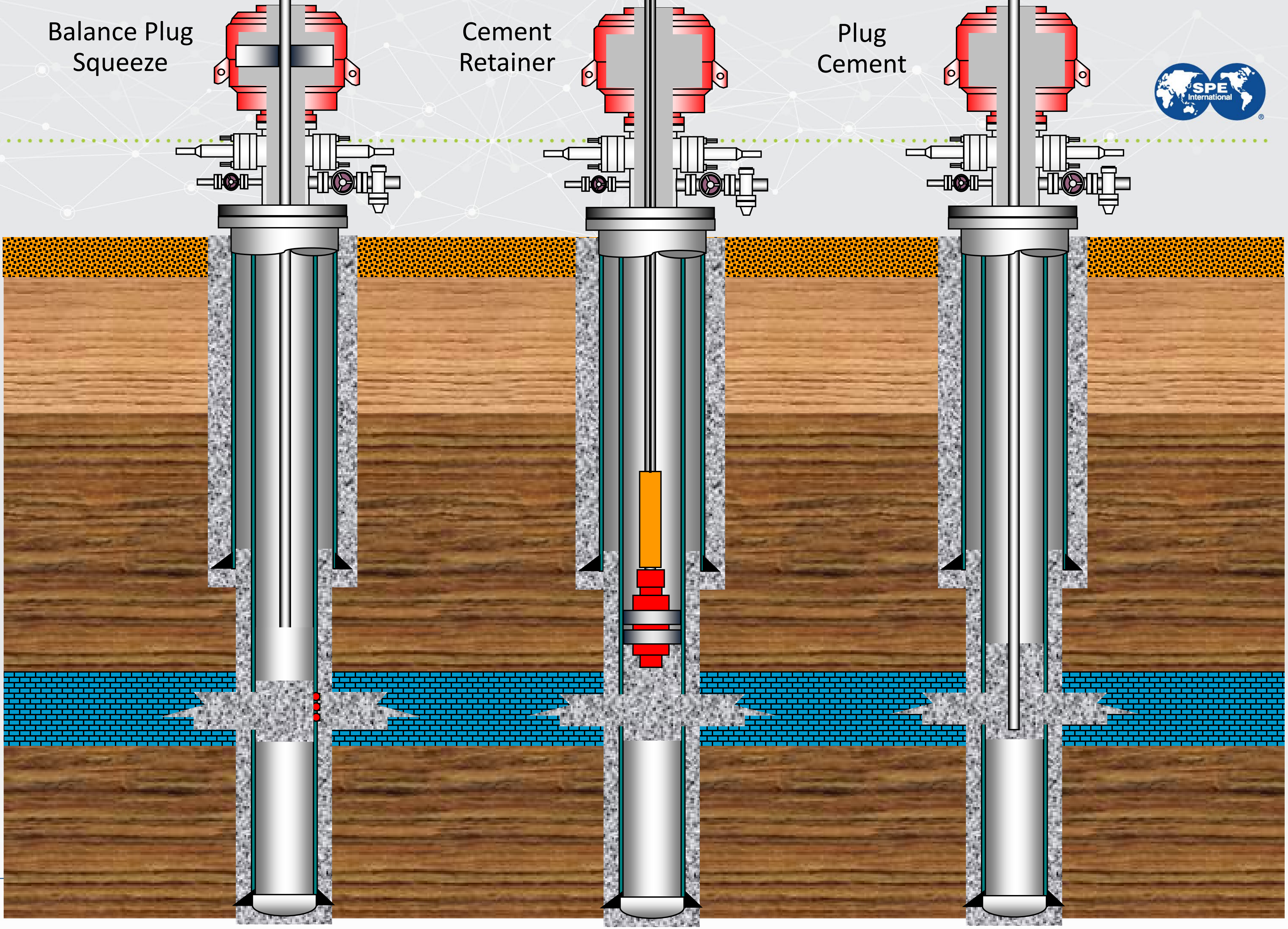
Bonding Quality

- Bad bonding
- High water cut

Methods on Remedial Cementing for Loss Zone

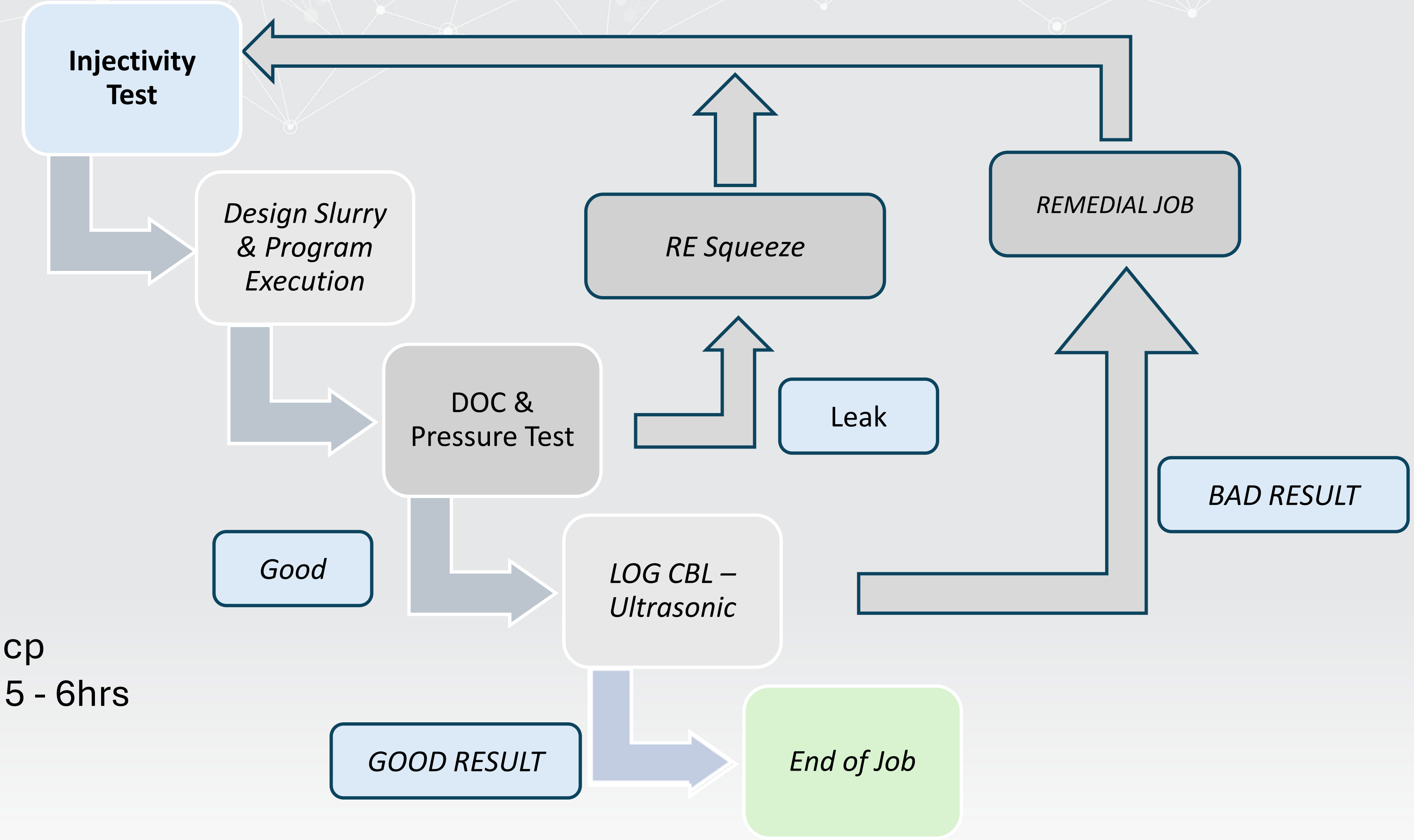
Method 1 2005-2006	Method 2a 2017	Method 2b 2019	Method 3 2020 - present
Polymer + slurry	**Sandwich**	**Sandwich**	**2 Stages Slurry**
1. Combination of Polymer + Catalysator. Polymer inside CT, catalysator by bullheading 2. Spacer+Cement Slurry + Spacer 3. Utilizing Coiled tubing. In Mahakam Field	1. Slurry with 3 elements (LCM polymer, Thixotropic cement + sugar water) to cover the loss zone. 2. By Jack Up Rig. In Natuna Field	1. Slurry with 3 elements (LCM polymer, uncontrolled fluid loss cement and neat cement) to cover the loss zone. 2. By Rig. In Sukowati Field	1. Lead Slurry (Uncontrolled slurry with no additives) 2. Tail Slurry (Slurry with additives) 3. By Rig**,** in Sukowati Field followed by other fields

Basic Cementing



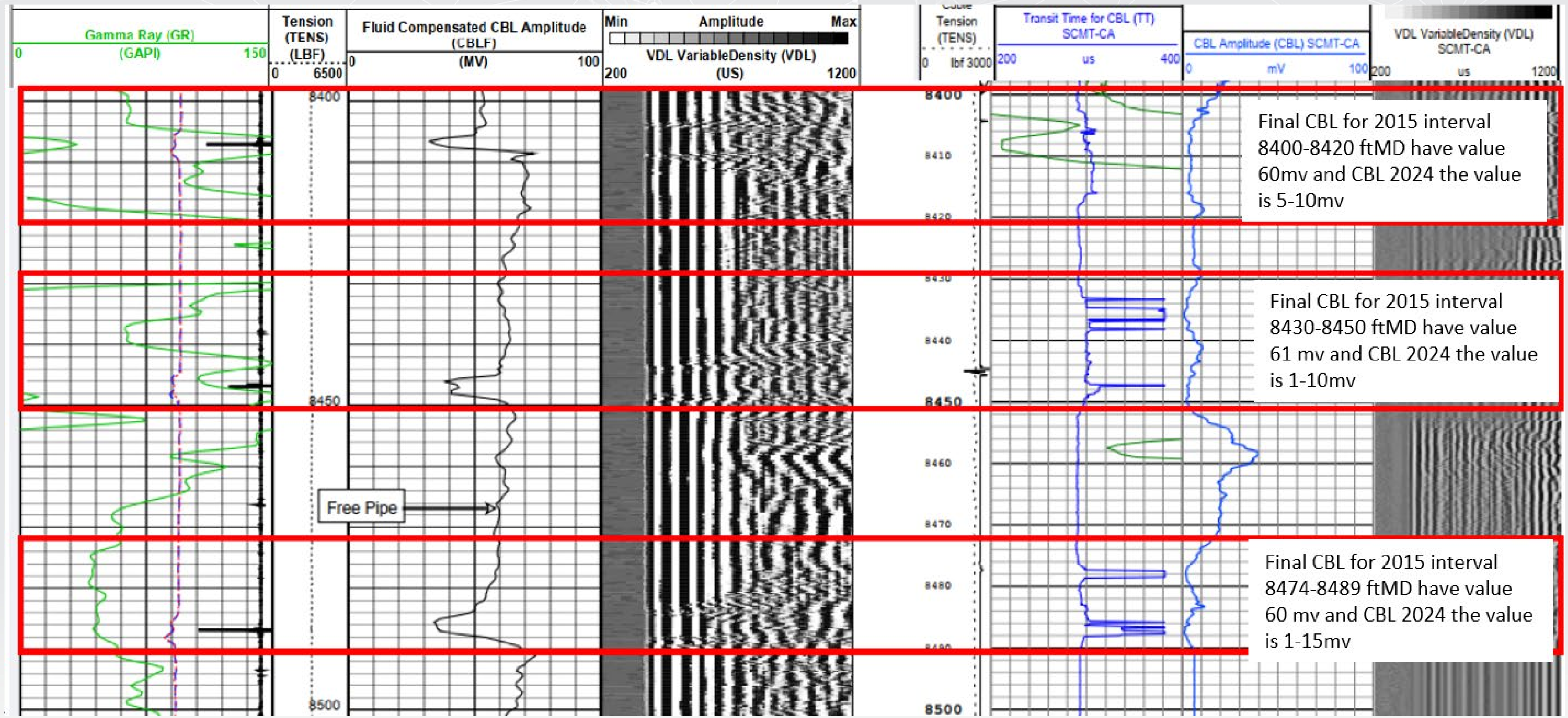
** Source: Well Intervention Pertamina EP - Sukowati Field*

Squeeze Cementing Flowchart



Typical PV >100 cp
Thickening time 5 - 6hrs

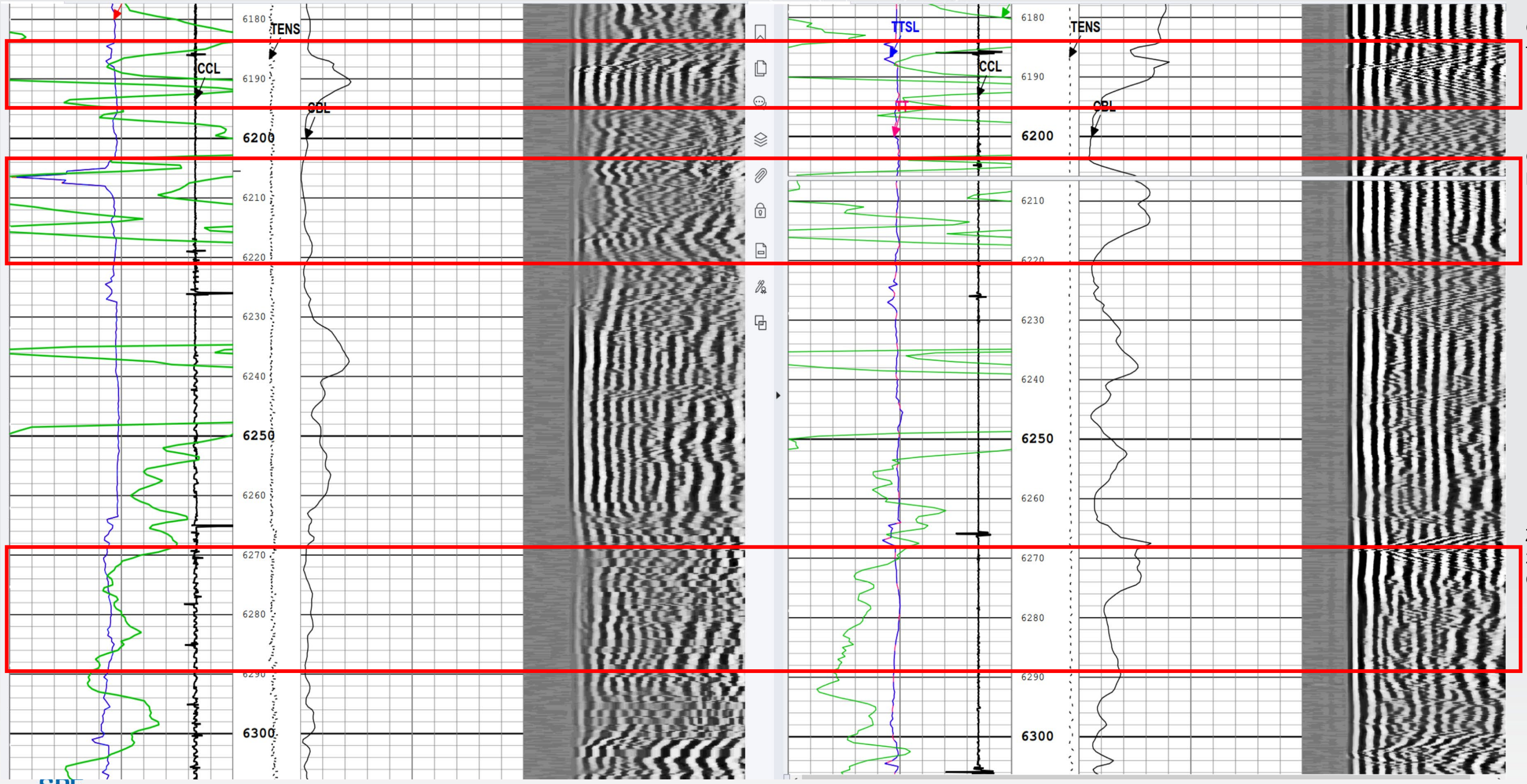
XX-33


Gamma Ray (GR)
(GAPI)
0
150
Tension (TENS) (LBF)
0
6500
Fluid Compensated CBL Amplitude (CBLF)
(MV)
0
100
Min
Amplitude
Max
VDL VariableDensity (VDL)
(US)
200
1200
Tension (TENS)
0
lbf 3000
Transit Time for CBL (TT) SCMT-CA
200
us
400
CBL Amplitude (CBL) SCMT-CA
0
mV
100
VDL VariableDensity (VDL) SCMT-CA
200
us
1200
8400
8450
8500
Free Pipe
Final CBL for 2015 interval 8400-8420 ftMD have value 60mv and CBL 2024 the value is 5-10mv
Final CBL for 2015 interval 8430-8450 ftMD have value 61 mv and CBL 2024 the value is 1-10mv
Final CBL for 2015 interval 8474-8489 ftMD have value 60 mv and CBL 2024 the value is 1-15mv

XX-29

After Remedial Cementing : CBL 2024

Before Remedial Cementing : CBL 2020



CBL Amplitude after squeeze 2024 approx 4-22mV (good to moderate bonding) compared to result CBL 2020

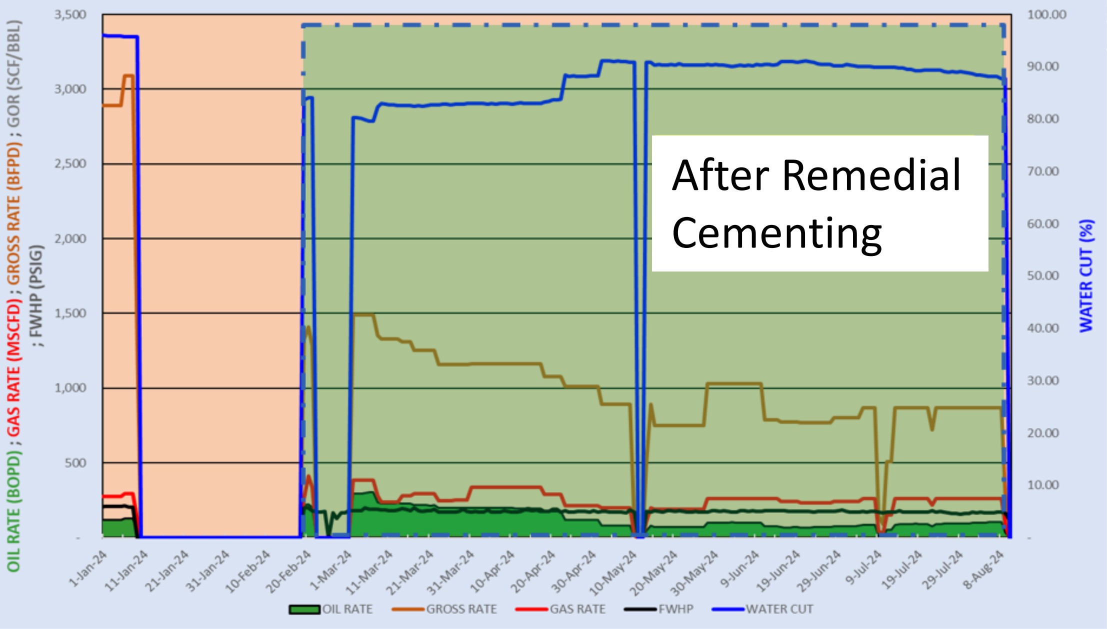
CBL Amplitude after squeeze 2024 approx. 1-5mV (good bonding) compared to CBL 2020

Zona Sqz 6269-6289 ftMD CBL Amplitude after squeeze 2024 berkisar 1-5mV (good bonding) dibandingkan hasil CBL 2020

Job Procedure in XX-33

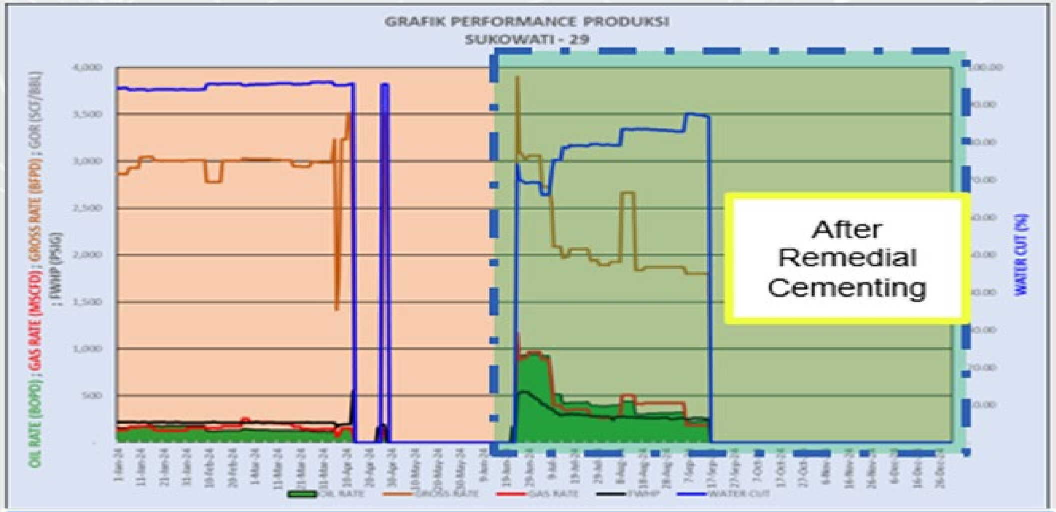
1. Compile the necessary HSE documentation before beginning any activities related to work in the well of region in alignment with regulations and/or business operations.
2. Set up every item in the well location according to the position that is determined by the business' representatives
3. Set up every treatment line from the pumping equipment and connect it to the work string above the rig floor. Apply a function test to every item.
4. Use certain volume of brine, or as needed in the water tank displacement and flush cementing unit. (for example +/- 200bbls)
5. Use brine to flush the line and make sure there are no obstacles inside. Apply a pressure test in a methodical manner for low pressure test and high pressure test for five minutes each, or in accordance with the company's procedures. If OK, bleed off pressure.
6. Pump brine (at a rate of 3 to 5 bpm) roughly equal to one string volume, or until a stable return is obtained. Perform injectivity test (starting at 0.5 bpm to 2.5 bpm or as company policy) . Record pump pressure, volume, velocity, and casing pressure
b. The volume of the slurry that is being prepared will be determined by the results of the injectivity test.
7. Discuss the final job program with the company's schedule based on injectivity results.
8. Hold a pre-job safety meeting with all employees involved in the day-to-day operations of the company.
9. RIH work string and place the string's end on the depth target for the cement job
10. To ensure full wellbore, fill up wellbore with a rig pump via a kill line until there is a return on the surface.
11. Mix tail slurry (volume includes 5 bbl of dead volume batch mixer) and mix lead slurry in different mixing tub. Mixing according to a program using chemical composition
• Mix cement slurry samples and place them in a water or bath.
12. Pump water ahead.
13. Pump Lead Slurry
14. Pump tail slurry.
15. Pump water. Close BOP
17. Use 12 bbl of displacement fluid at a rate of 2 bpm.
18. Add 40 bbl of displacement fluid at a rate of 1 bpm.
a. BOP starts to pay attention to casing pressure. According to the pump rate so that the casing pressure does not exceed 500 psi (or according to corporate policy) b. Before starting a work, use the table in the paper to record the volume of slurry that is put into the container vs the casing pressure during the job, especially after BOP is completed.
(c). Let's start applying pressure together and follow this contingency plan.

Results After Remedial Cementing- XX 33



Production Rate		
	Before Remedial	After Remedial
FWHP	205 Psig	200 Psig
Gross	3111 BPD	1410 BPD
Oil	55 BOPD	225 BOPD
Water Cut	98 %	84 %

Results After Remedial Cementing- XX 29



Before Remedial Cementing				
Oil BOPD	Gas MSCFD	Water BWPD	Gross BLPD	WC %
159	155	3349	3508	96

After Remedial Cementing				
Oil BOPD	Gas MSCFD	Water BWPD	Gross BLPD	WC %
1241	1365	3625	4866	74.5

Risk Mitigation (1)

Problem with slurry

- If the slurry sets before the thickening time, stop the pump
  On-site, gather the cement, seawater, and mixing water samples, then transmit them to the laboratory.

- If the thickening time is not specified for the slurry, suggest:
  Extra time or ensure that the cement sample is dry on the surface
  Gather the mixing water, cement, and seawater sample on site and submit it to the laboratory if it is still soft after more than 24 hours.

Risk Mitigation (2)

Problem with pumping slurry

If there are equipment issues when pumping:

- Able to fix:
  As quickly as possible, fix the equipment.
  Make sure you have ample time to continue pumping.

- Unable to fix:
  Move all the slurry to the surface as quickly as you can before the thickening period expires.
  Do not move the slurry if the cement is in place (depending on the circumstances).

Advantage and Conclusion

Methods

- Polymer + Catalyst, followed by slurry cement
- Sandwich methods: LCM, Lead Slurry, Tail Slurry
- Lead Slurry+Tail Slurry. Utilizing Silica Flour to accelerate the thickening time

Cost Efficient

- Reducing operating days
- Reducing repetition of remedial cementing in total loss zone
- Reducing operating cost

Increasing Success Ratio

- Increasing success ratio through job assurance
- Water shut off and zonal isolation in total loss zone becomes feasible
- Widening opportunities in other areas

Our acknowledgement to:
SKK Migas
PT Pertamina EP
Harbour Energy

THANK YOU

SPE EnergyStream

Well Digital Twins for Integrity and Leakages

Clément JOULIN

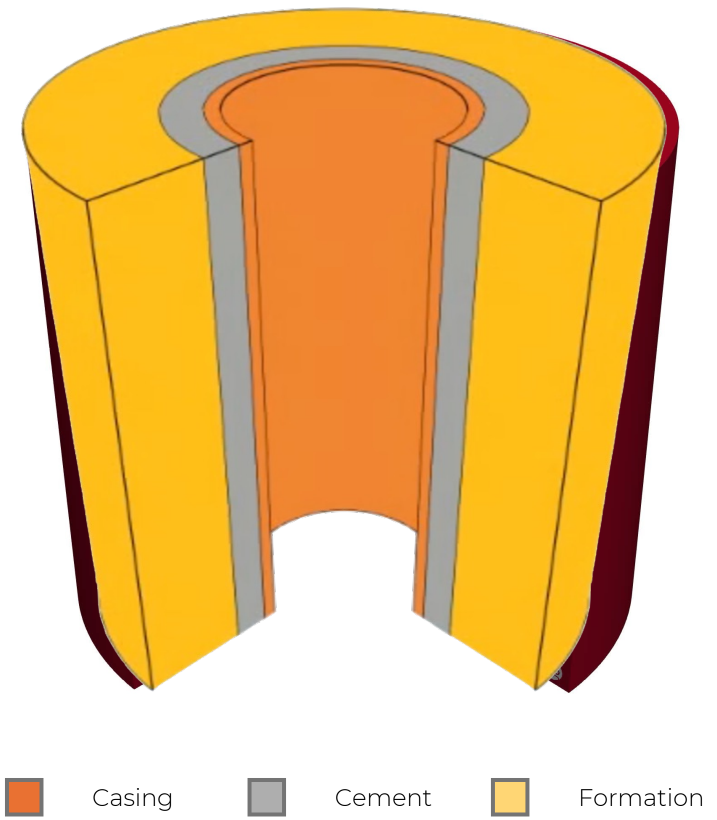
Net-Zero Geosystems (London,UK)

January 28th 2026

Presenter's company logo.
It is not mandatory. However, this is the only slide where their logo is allowed.

Well Digital Twins

Leveraging simulations to predict well integrity and leakages

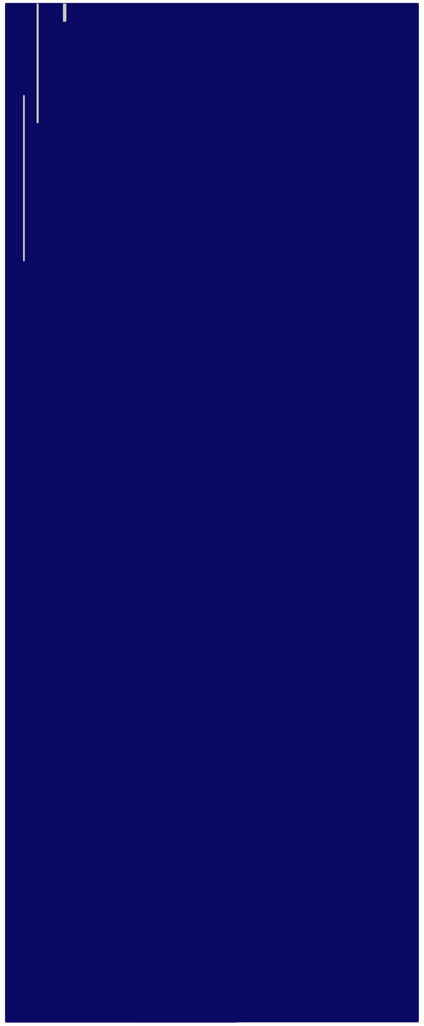


Well Integrity Simulations

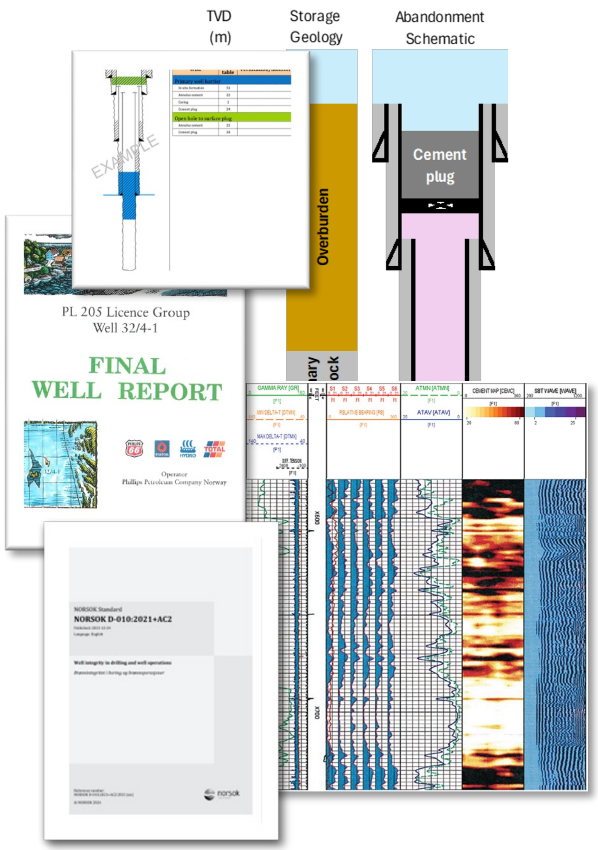
- Identify depth and nature of damage (cement fracturing & debonding)
- Provide accurate pressure and temperature envelopes
- Improve well designs, materials and loads

Well Leakage Simulations

- Identify leakage pathways and leakage rates
- Understand the cause of the problem and how to fix it
- Optimize plug placement
- Comply with regulations



Well Digital Twins



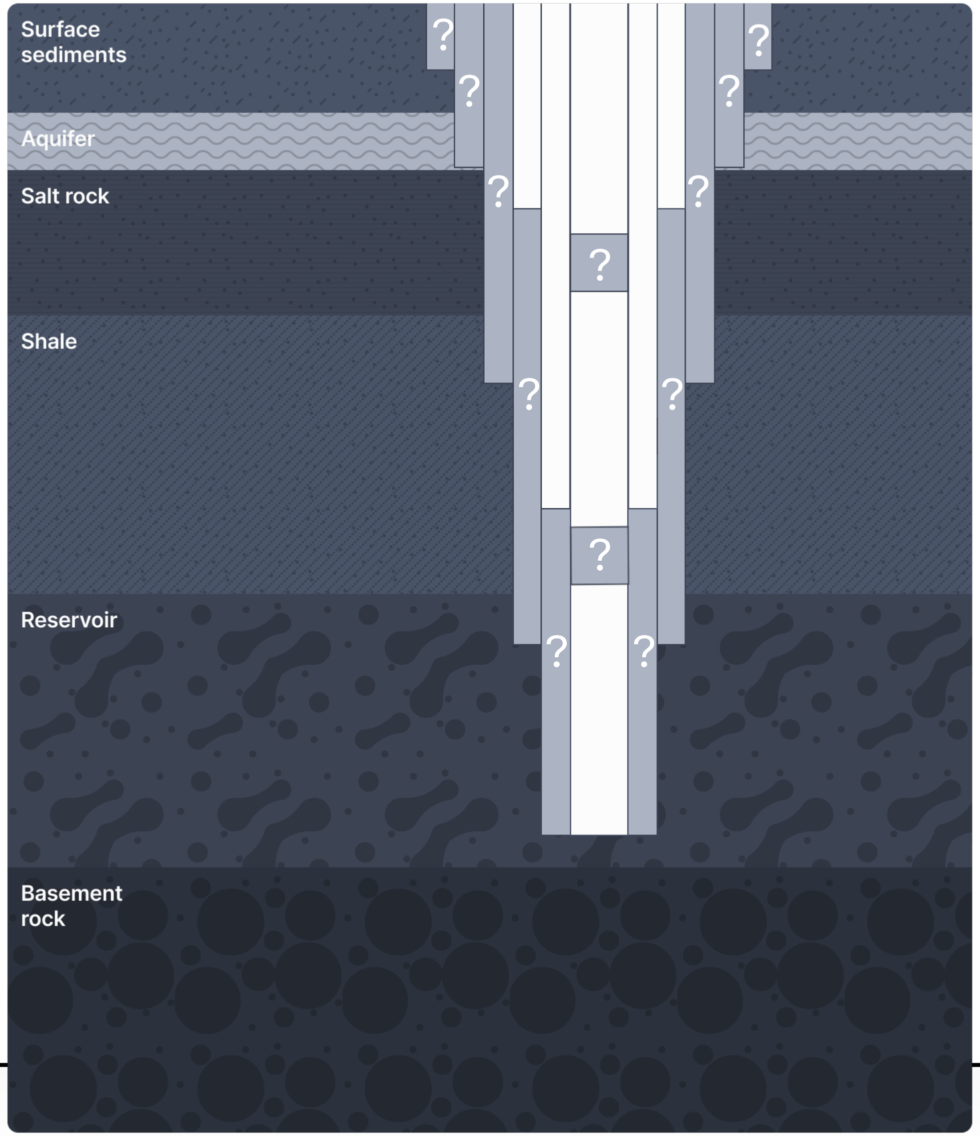
Well Data

↓

Integrity Simulations

↓

Leakage simulations

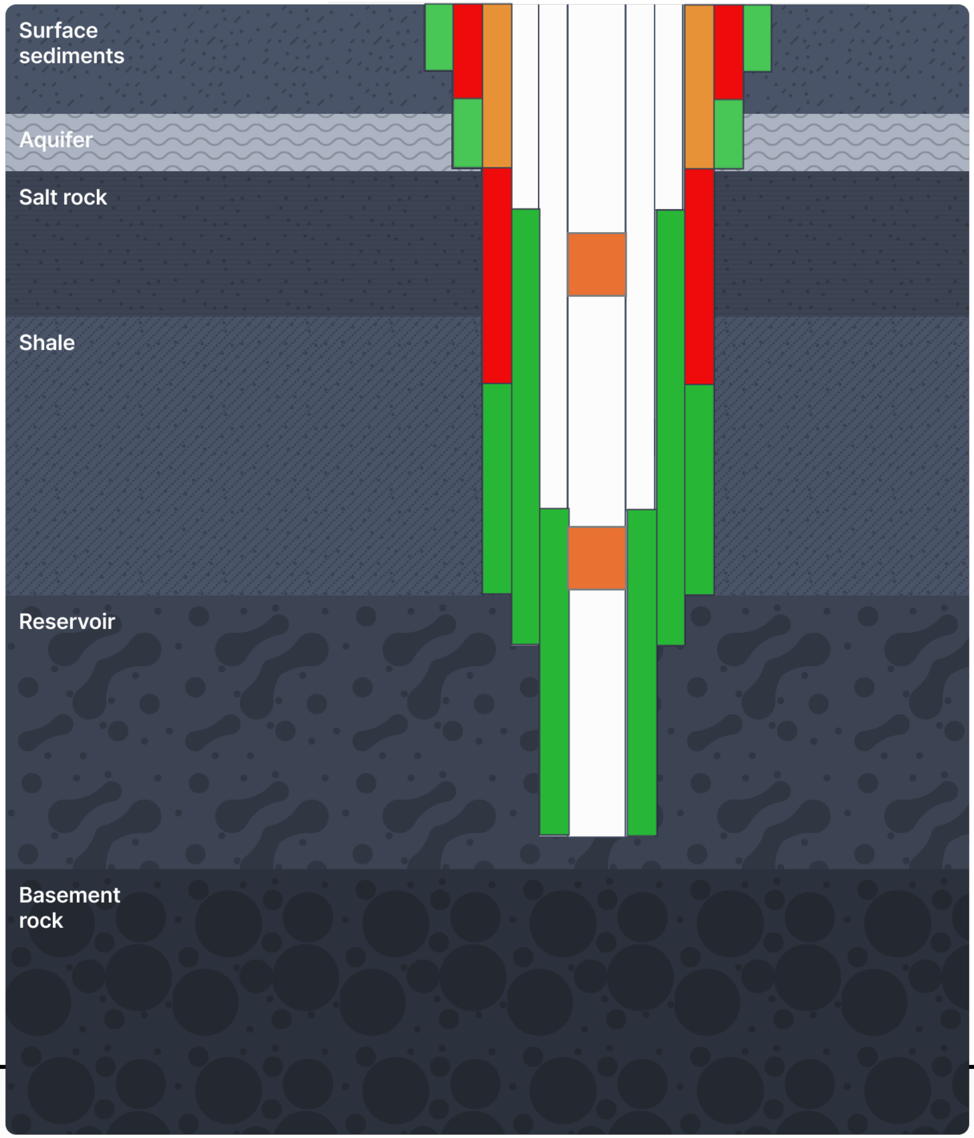


Well Digital Twins

Well Data

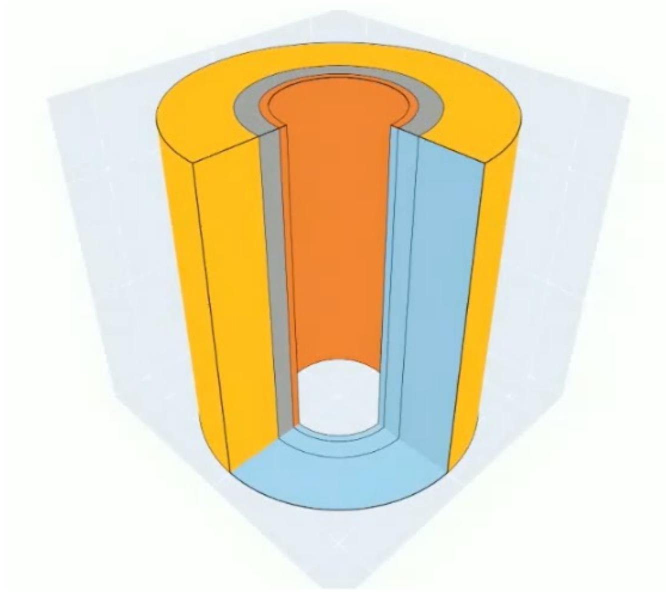
Integrity Simulations

Leakage simulations



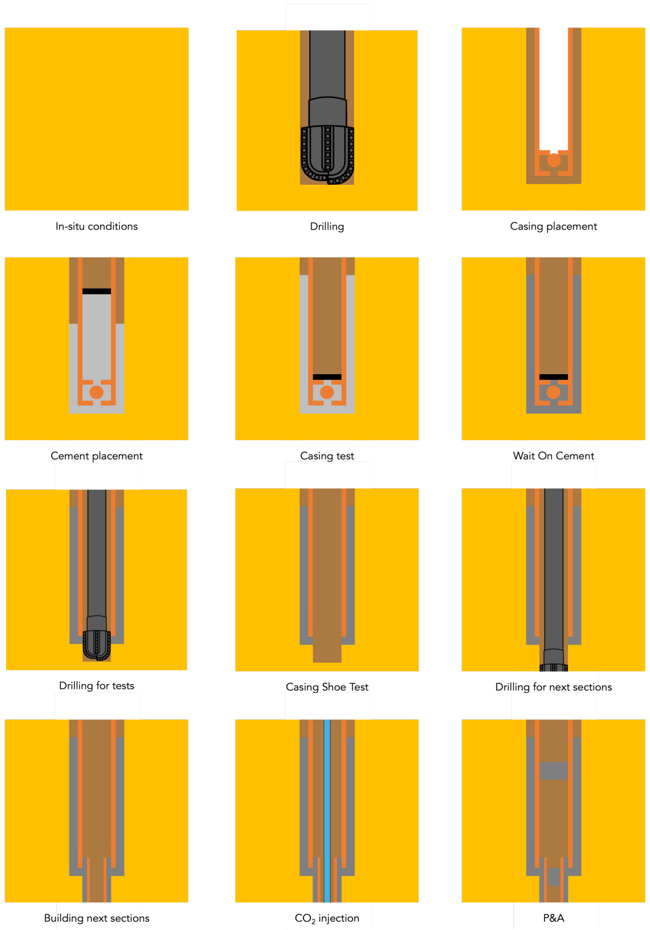
Predicting integrity over the life of the well

Well integrity simulations

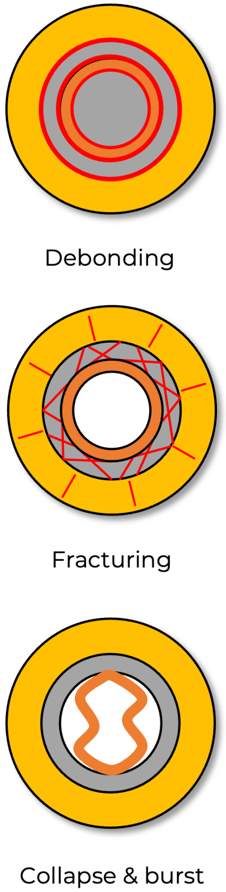


Casing | Cement | Formation

Reproduce all stages of the life of the well

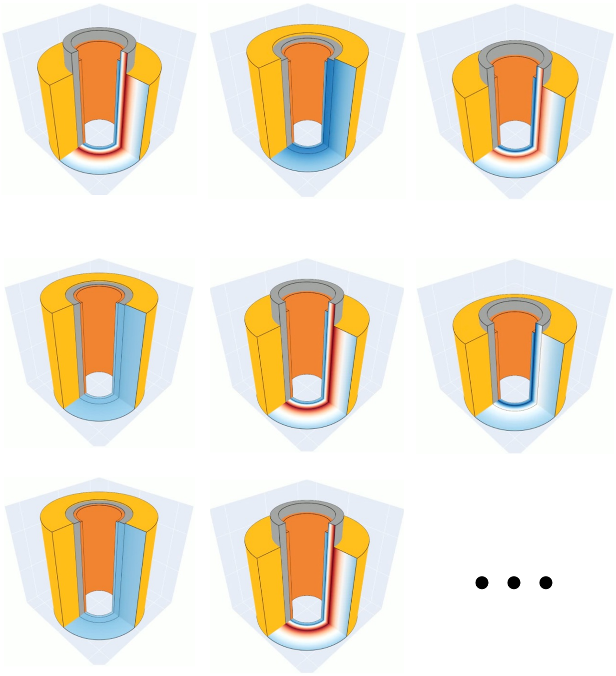


Predict failure and leak paths

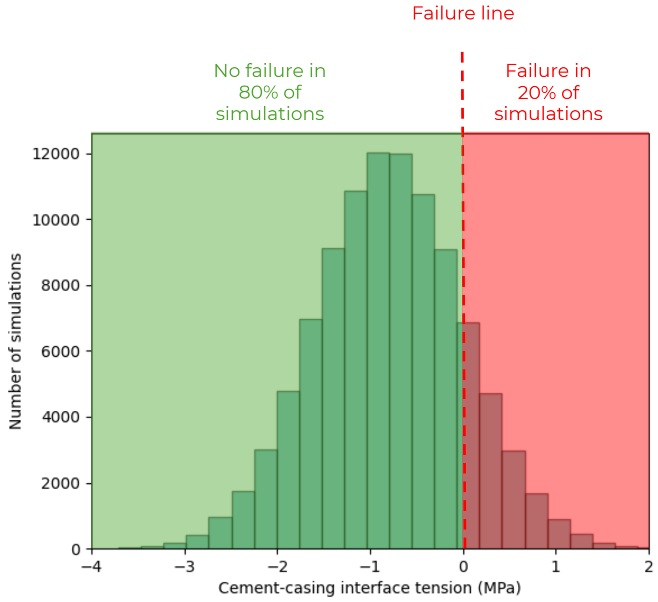


Handling Uncertainty

Performing simulations for many scenarios



Obtaining a probability of failure

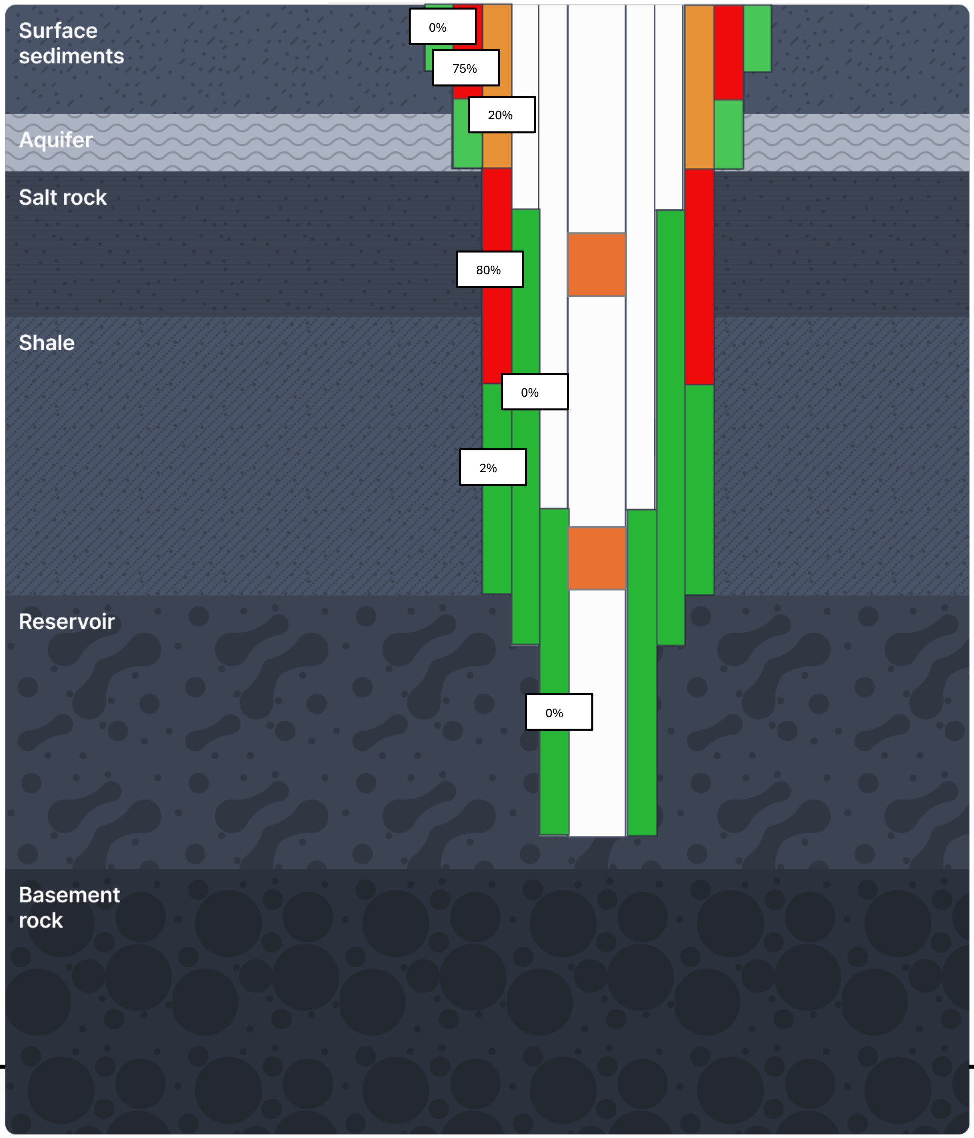


Well Digital Twins

Well Data

Integrity Simulations

Leakage simulations

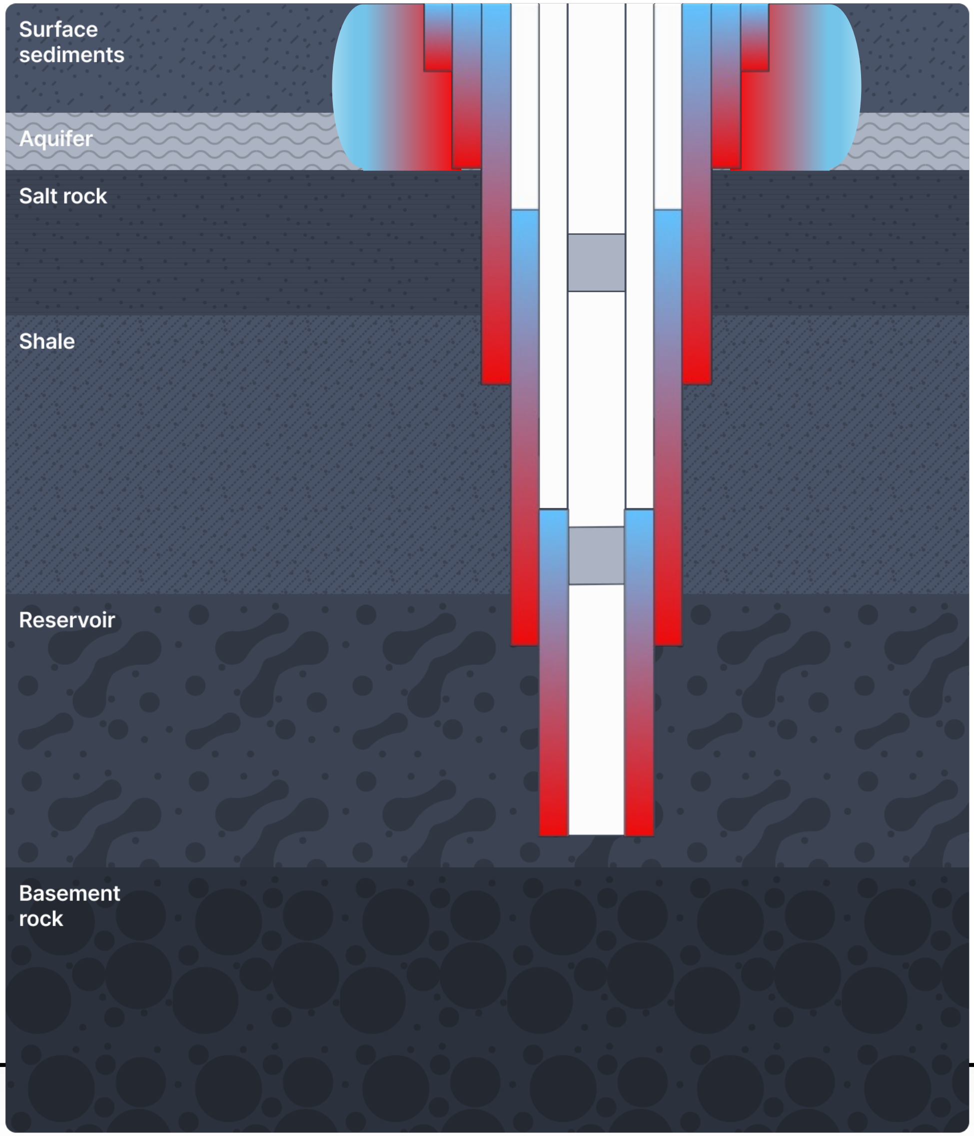


Well Digital Twins

Well Data

Integrity Simulations

Leakage simulations



Handling Uncertainty

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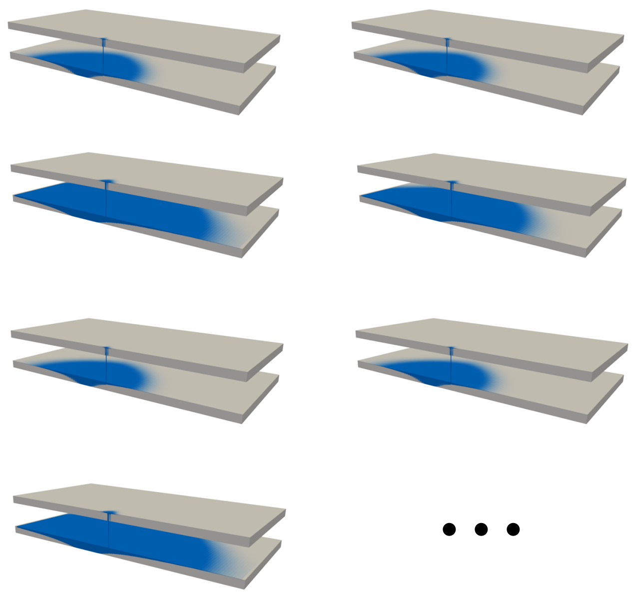
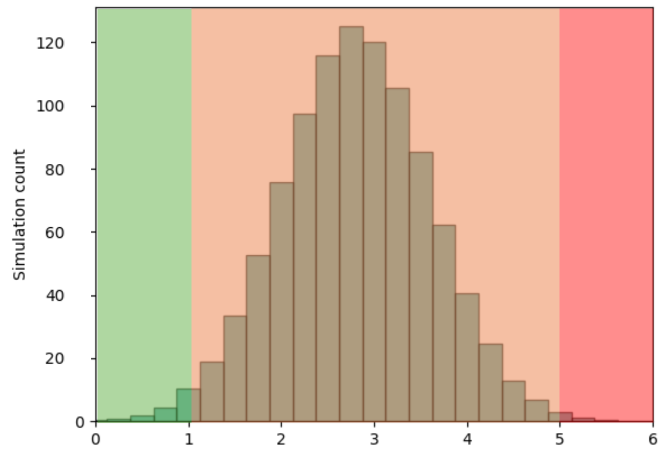
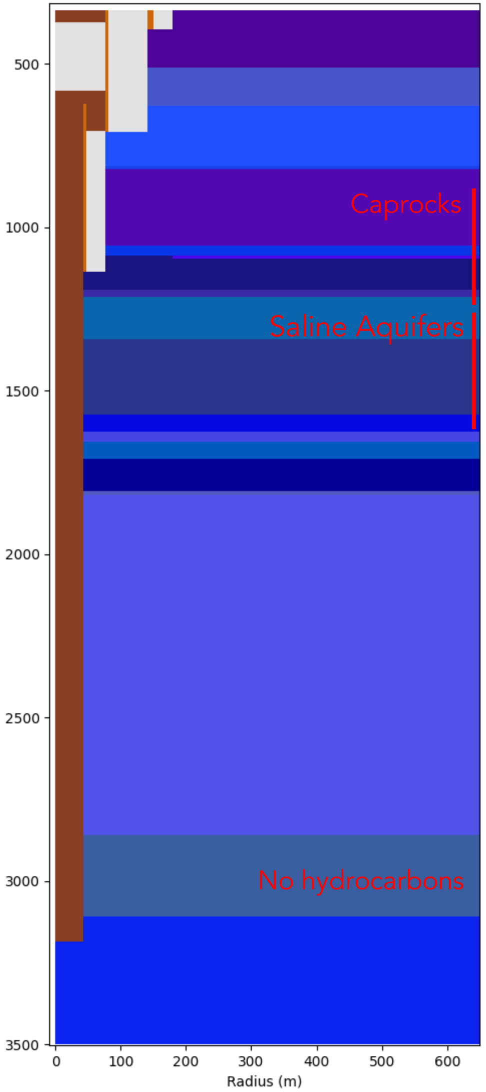


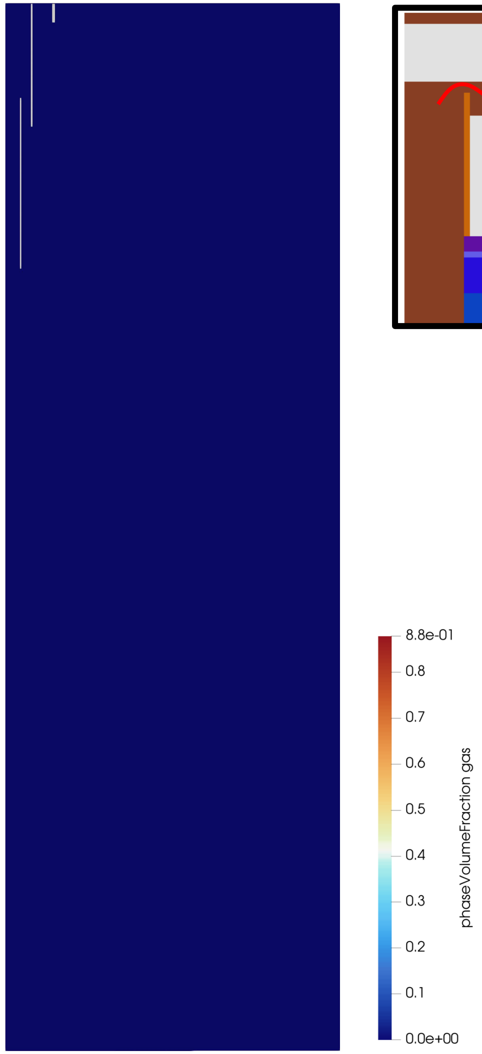
Obtaining a probability of leakage

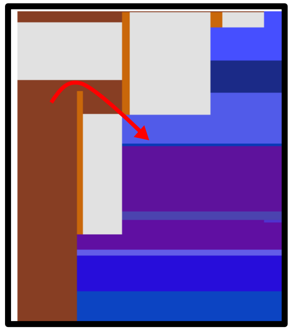


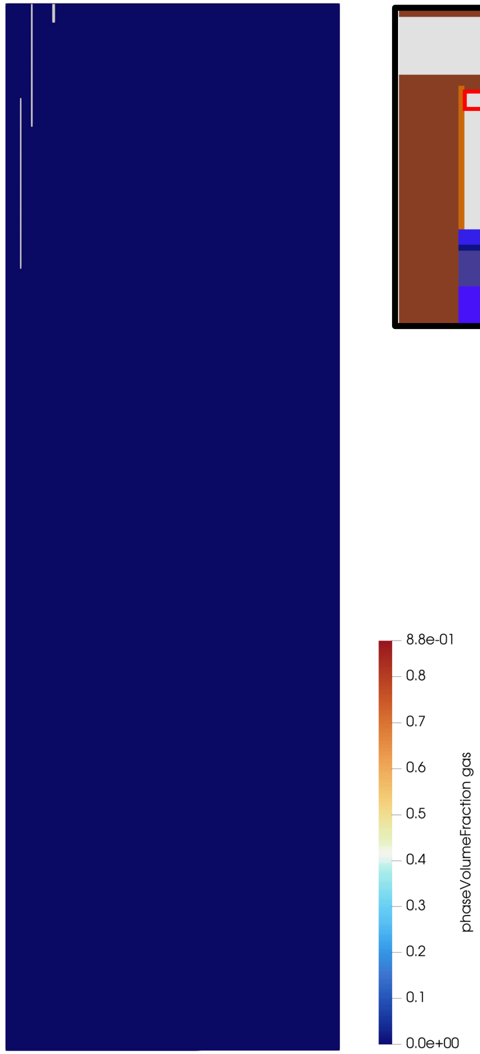
- 3% probability for the well to leak less than 1% of the stored CO_2
- 96% probability for the well to leak 1-5% of the stored CO_2
- < 1% probability for the well to leak more than 5% of the stored CO_2

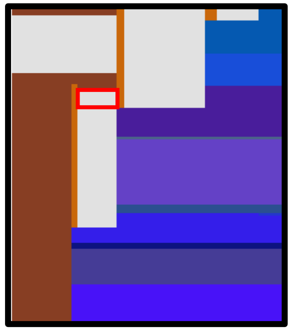
Well Leakage example











THANK YOU