Decommissioning and Restoration – Fostering Excellence through Regulations, Innovation, and Sustainable Practices

30–31 JULY 2024 | BANDAR SERI BEGAWAN, BRUNEI

Cement Evaluation Through Two Tubulars for Plug and Abandonment of a Deepwater Well at Malaysia

KC Khong, Kamaljeet Singh – SLB

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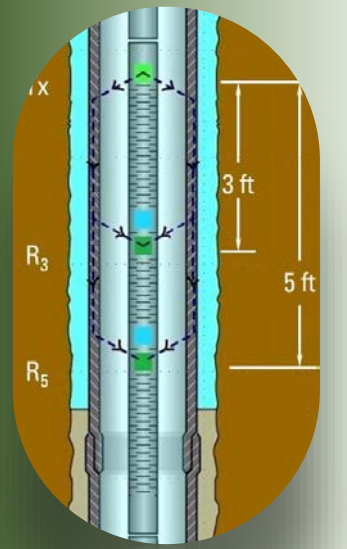
Agenda

- Cement Evaluation Through Two Tubulars
  - Technology Evolution
  - Challenges – Pipe Eccentricity and Annulus A Material
  - Correction – Pipe Eccentricity and Annulus A Material
- Level of Answer Products
- Case Study Example
- Value of Measurement

Traditional Single-String Barrier Evaluation

Acoustic

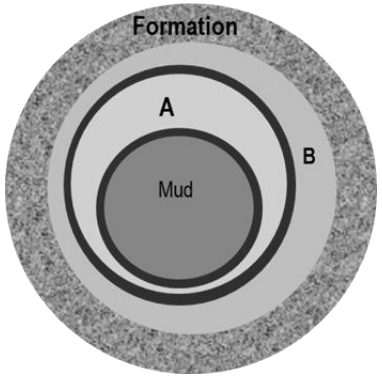


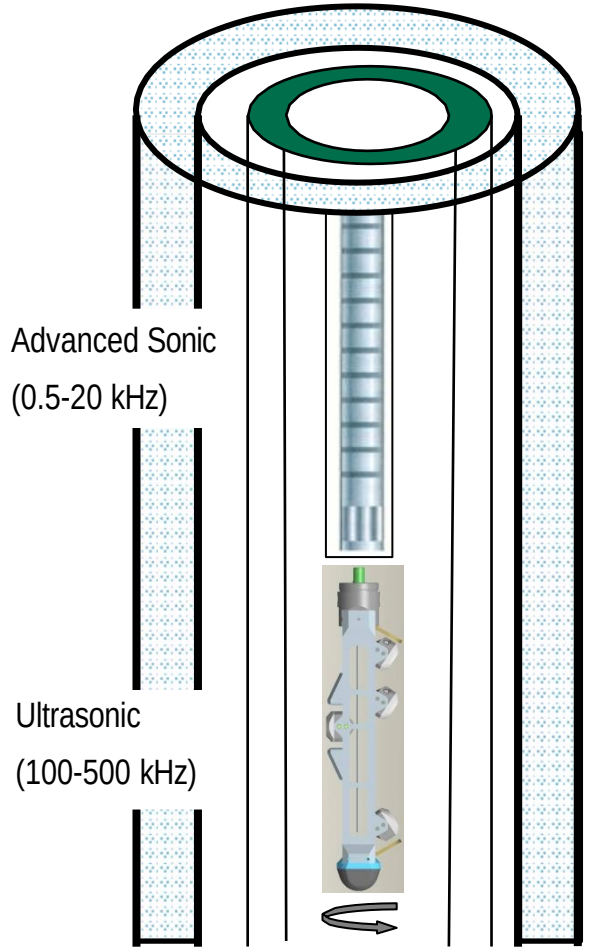
Ultrasonic

1960 — 1993 — 2006 — 2017 — 2022

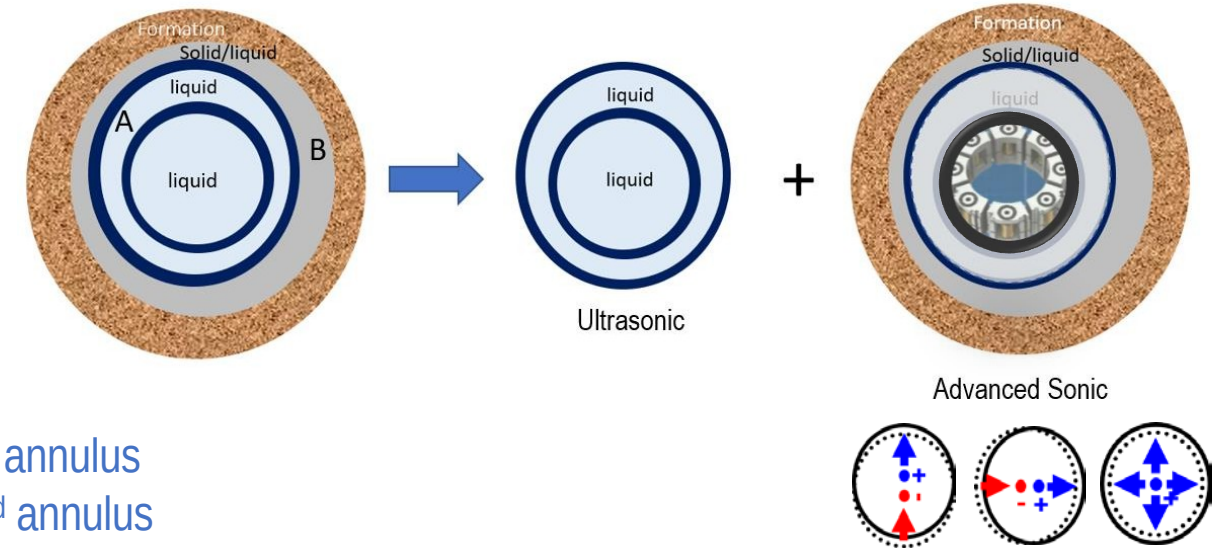
Dual-String Barrier Evaluation – An Approach

- Challenges
  - Two pipes
  - Two wellbore fluids
  - Pipe to Pipe positing (Geometry)





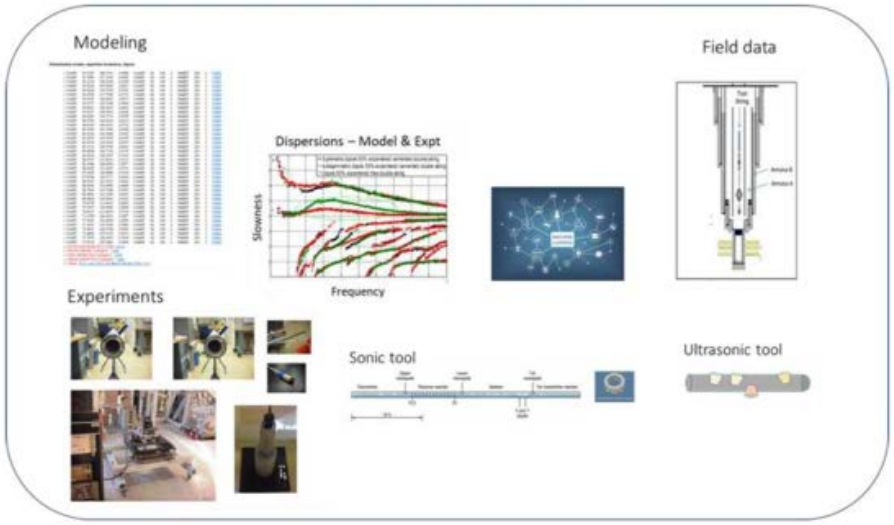
- Approach



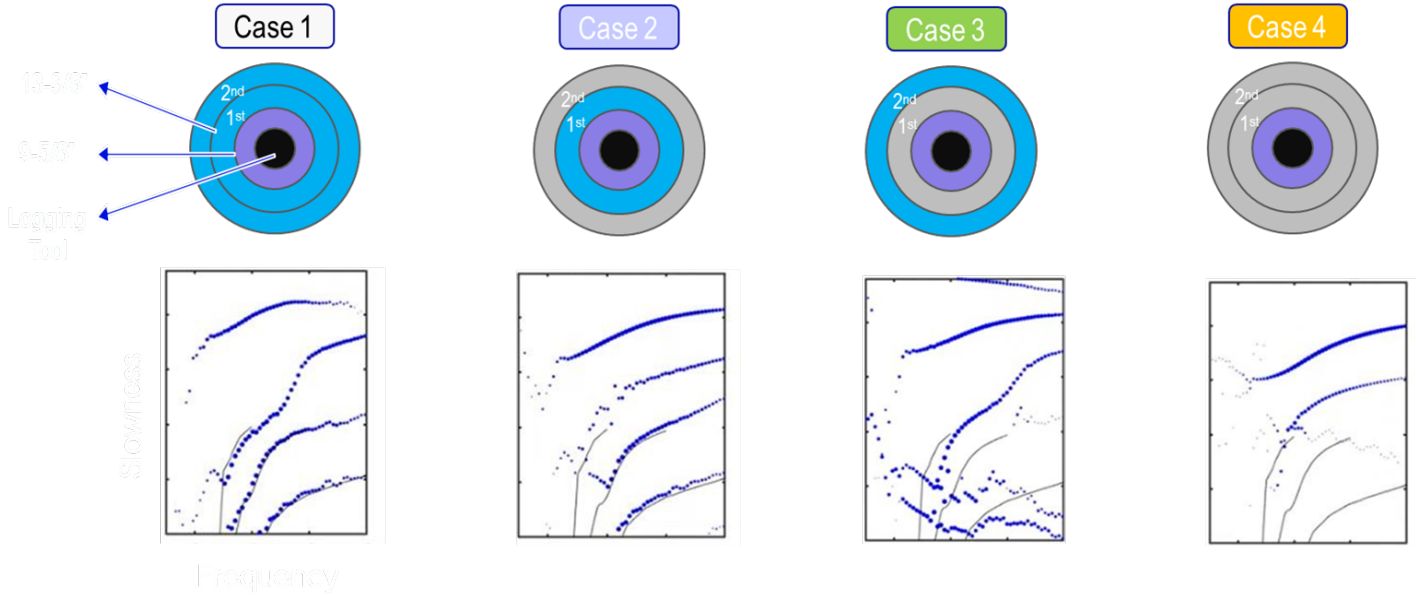
A – 1st annulus
B – 2nd annulus

Technology Deployment - Journey

Field Trial 2018-2022



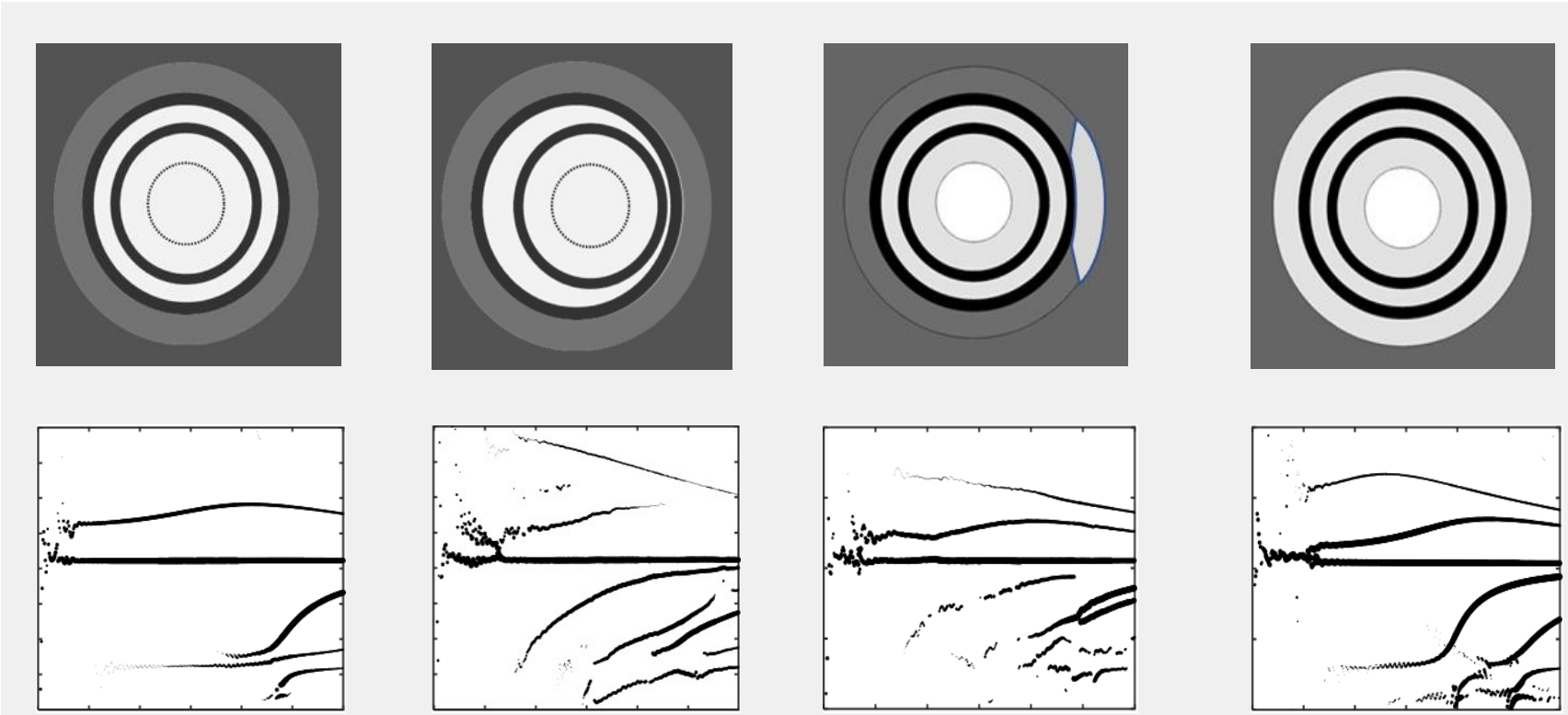
Modeling Example



Pipe-to-Pipe Position makes any Difference?

A Liquid, B Solid | **A Liquid**

Centered | Eccentered | B Solid w/channel | B Liquid



The figures above illustrate the importance of pipe-to-pipe position in the 2nd annulus evaluation, and not knowing the position may cause uncertainty in the answer. The position is determined using ultrasonic TIE (Third Interface Echo) physics

Understanding Annulus A behaviour and Inner Pipe standoff

SPE-210699-MSRedefining Well Abandonment Strategy: Tipping the Scale Towards Greater Cost and Operational Efficiency Through a Novel Multi-Layer Steel Barriers Cement Bond Logging

Sonic Based Tool is affected by Tubing Eccentricity Effect – M Field Example

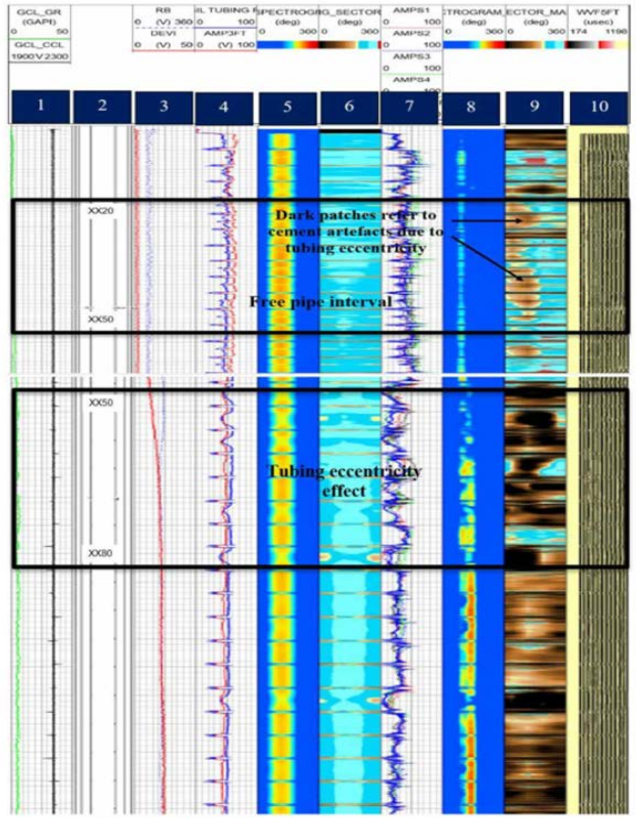
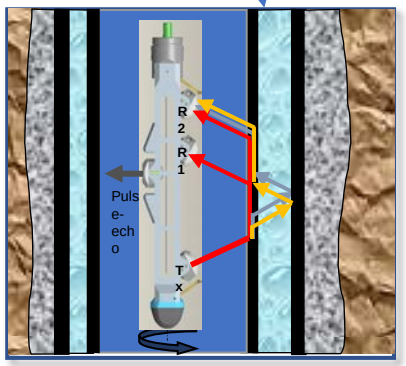
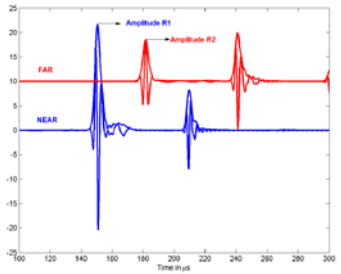


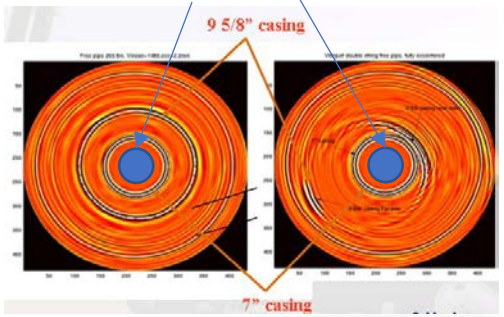
Figure 8—Overall results of CBL trial tool in well X (1-Gamma Ray, 2-measured depth in feet, 3-well deviation (DEVI) and relative bearing (RB), 4- tubing time domain (AMP3FT) and frequency domain (TUBING_THREE_FEET) amplitude, 5- tubing frequency spectrum, 6- tubing sector map, 7-casing amplitude, 8- casing frequency spectrum, 9- casing sector map, 10- variable density log (VDL).

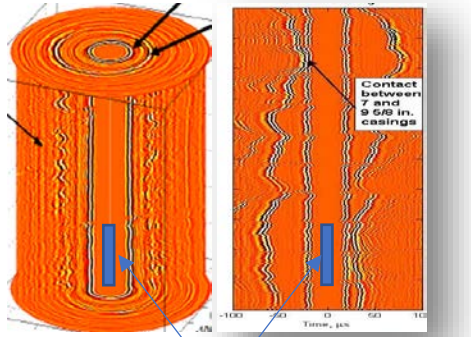
annulus A





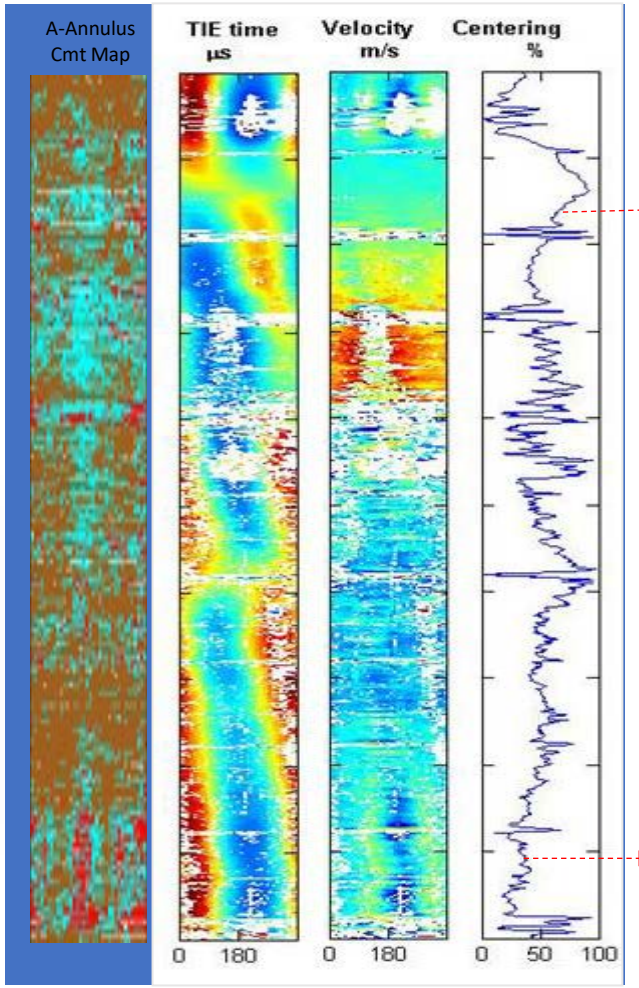
Logging Tool



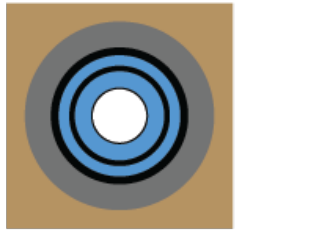


Logging Tool

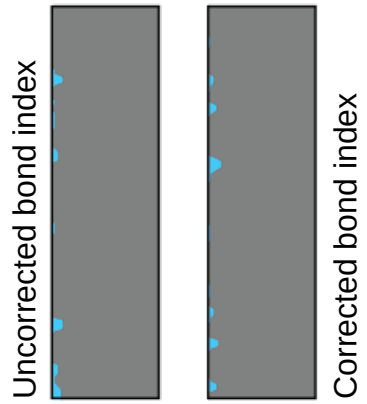
Annulus A Material and 1st Tubing Eccentricity



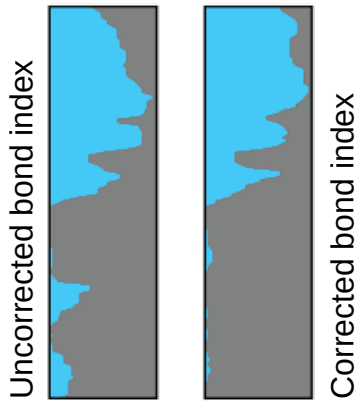
Addressing Measurement Challenges



B-annulus solid,
centered tubing

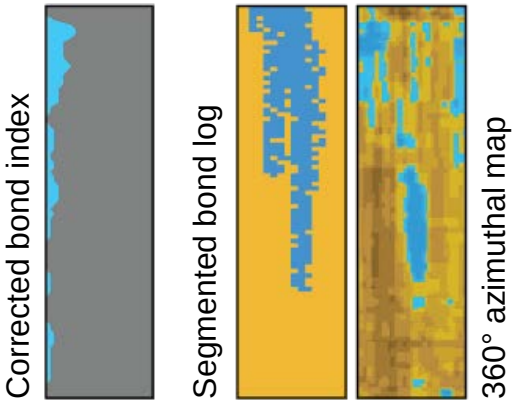


B-annulus solid,
eccentered tubing



Level 1
Answer

B-annulus
with liquid channel

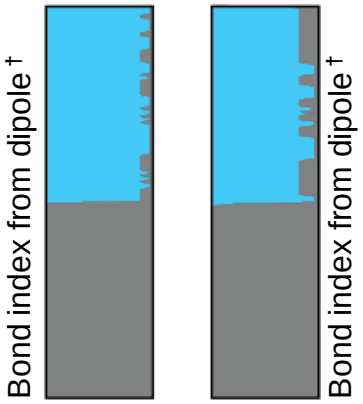


Level 2
Answer

Level 3
Answer

Level 4
Answer

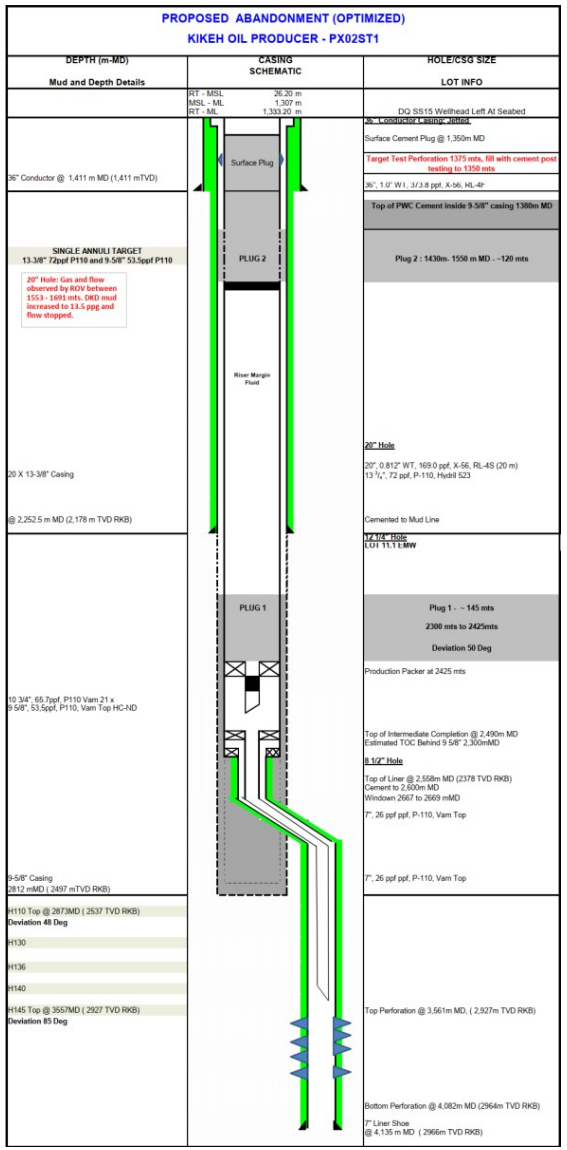
B-annulus solid,
A-annulus liquid change



8.5 lbm/galUS

13 lbm/galUS

Case Study - Cement Evaluation Objectives



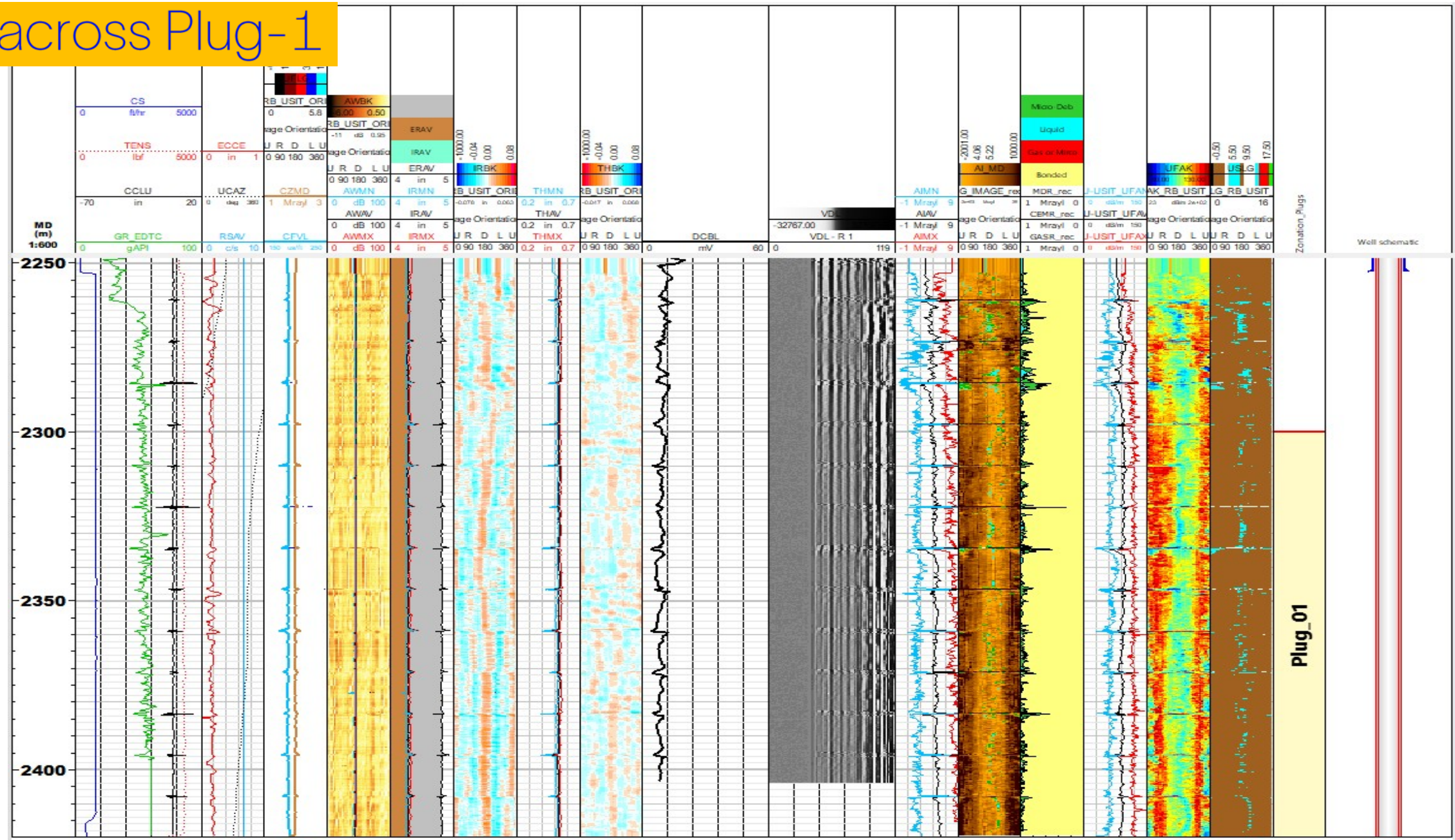
Plug # 1- 2150 m- 2420m MD

- → TAT: between 5 hrs of log data transfer
- → Areas of study cement bond behind 9-5/8″ casing. Targeting to confirmation of a continuous column of 60 mts
- → Fluid between 12-1/4″ hole and 9-5/8″ casing below the 13-3/8″ shoe
- → Fluid between the 13-3/8″ casing ID and the 9-5/8″ casing on this interval
- → Centralization between the 13-3/8″ casing ID and the 9-5/8″ casing OD on this interval

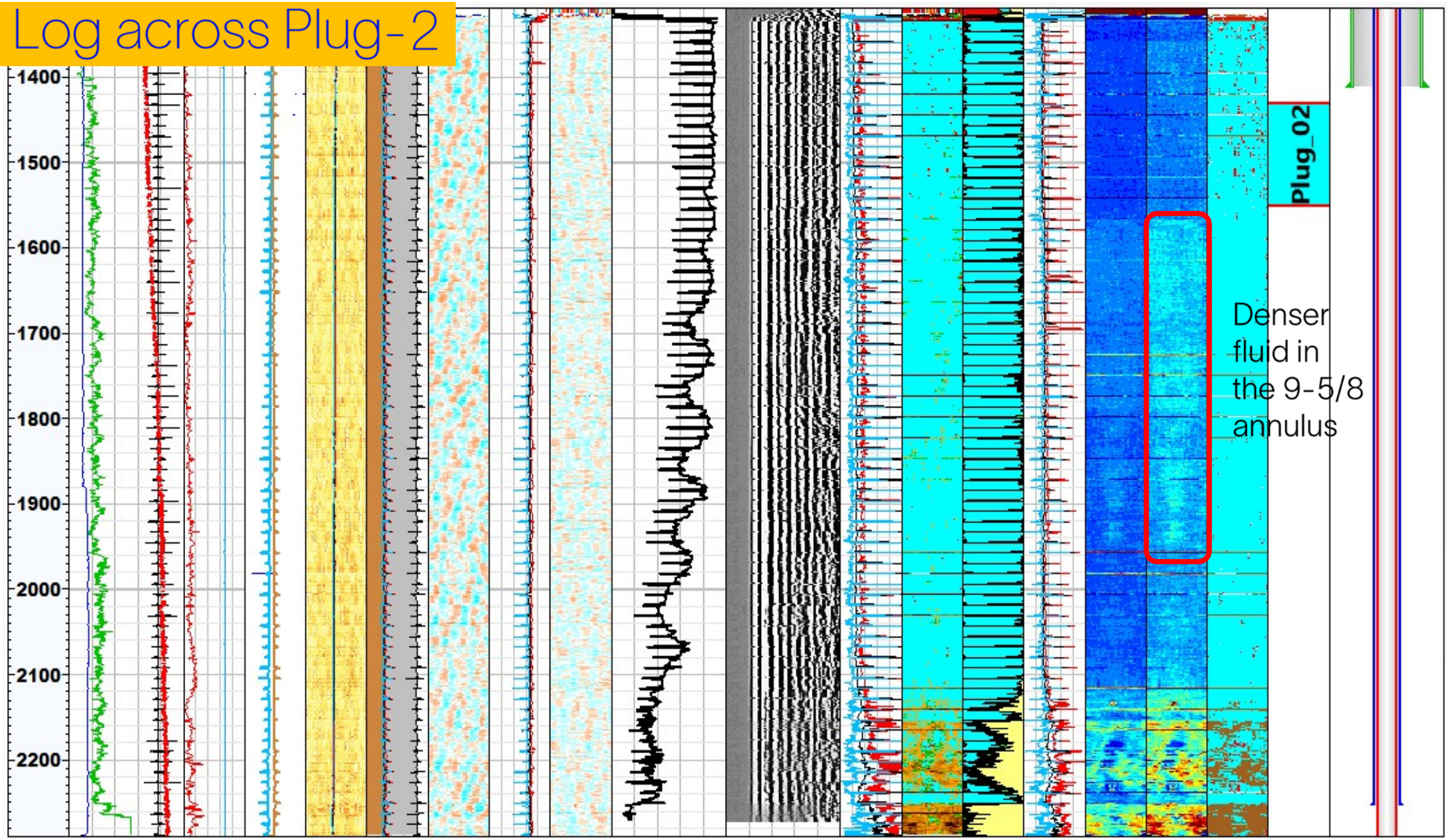
Plug #2- 1380m- 1700m MD

- → TAT<24 hrs
- → Fluid between the 13-3/8″ casing ID and the 9-5/8″ casing on this interval
- → Centralization between the 13-3/8″ casing ID and the 9-5/8″ casing OD on this interval
- → Bond quality of the 13-3/8″ annulus
- → Confirm if there is any gas trapped below the wellhead/hanger

Log across Plug-1

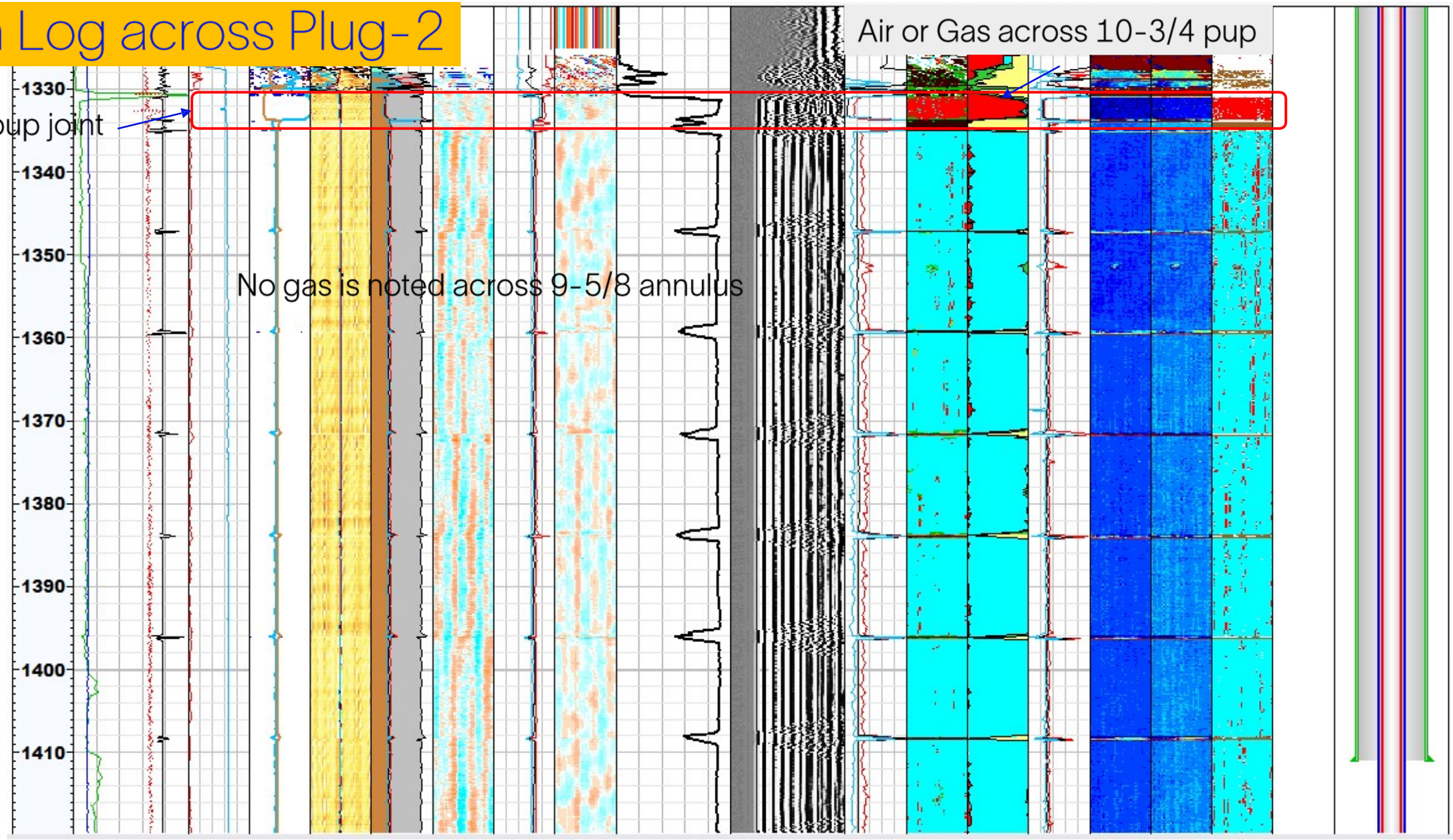


Main Log across Plug-2

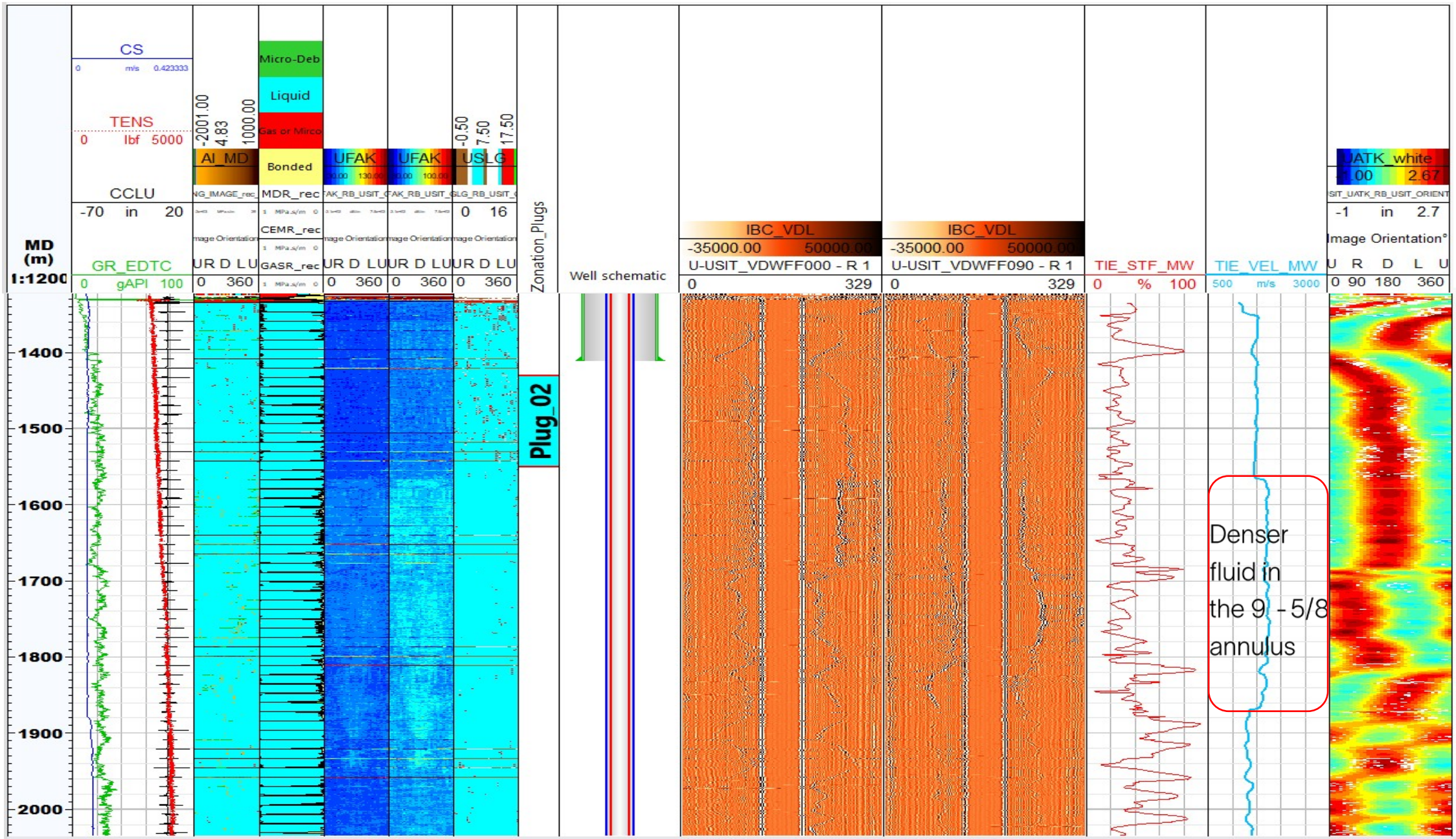


Plug 1

Main Log across Plug-2



Main Log – Pipe to Pipe Eccentricity Evaluation

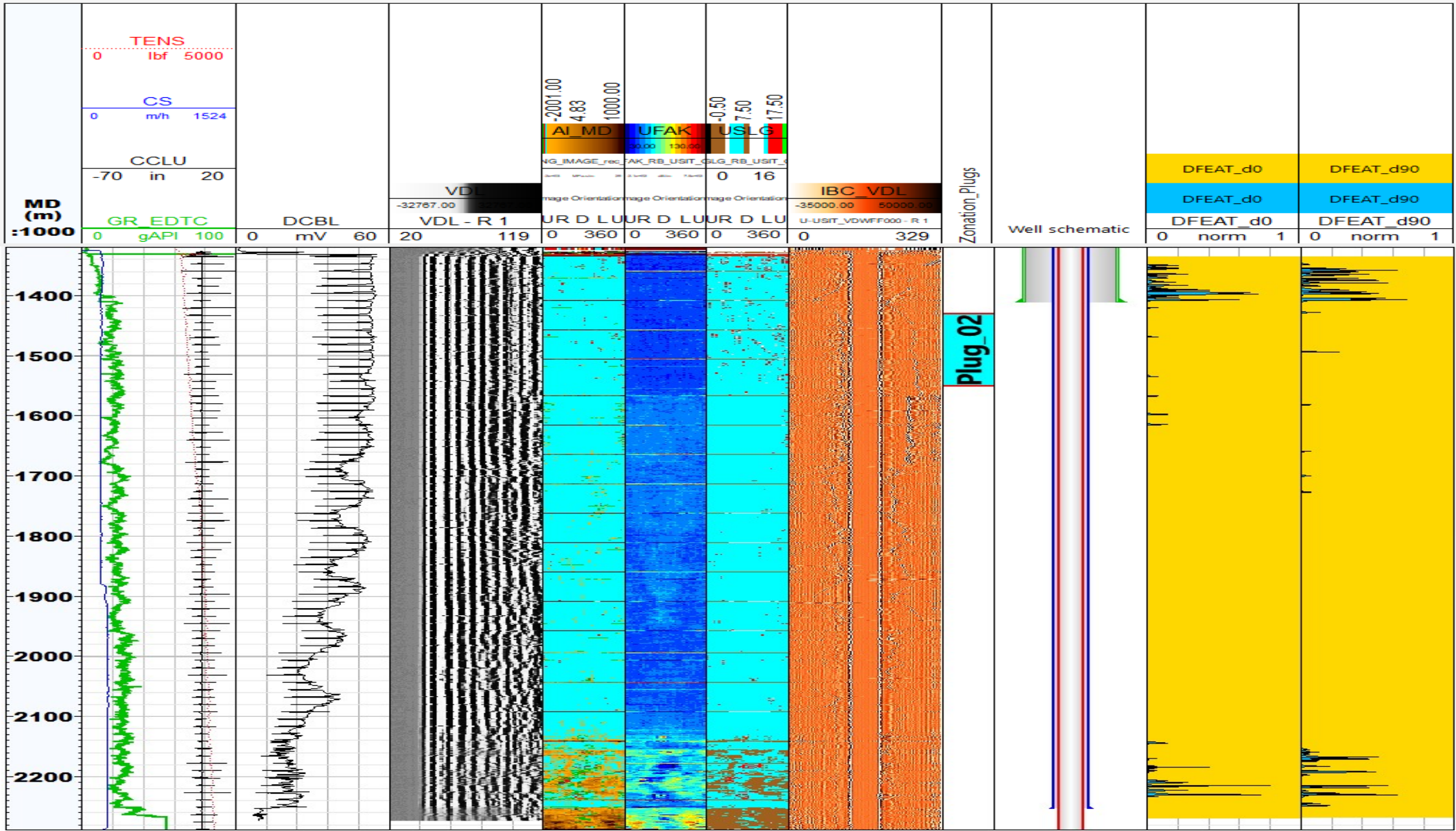


9-5/8 & 13-3/8 Results

9-5/8 Cement Map

13-3/8 Cement Map

X plane Y plane



Summary

Client
PTTEP DW Malaysia (SPE-219593-MS Aug-24)

Objective
- Set 3 plugs across the production zone,

the caprock, and at surface to safely P&A the well
- Detect trapped gas near surface in A-annulus

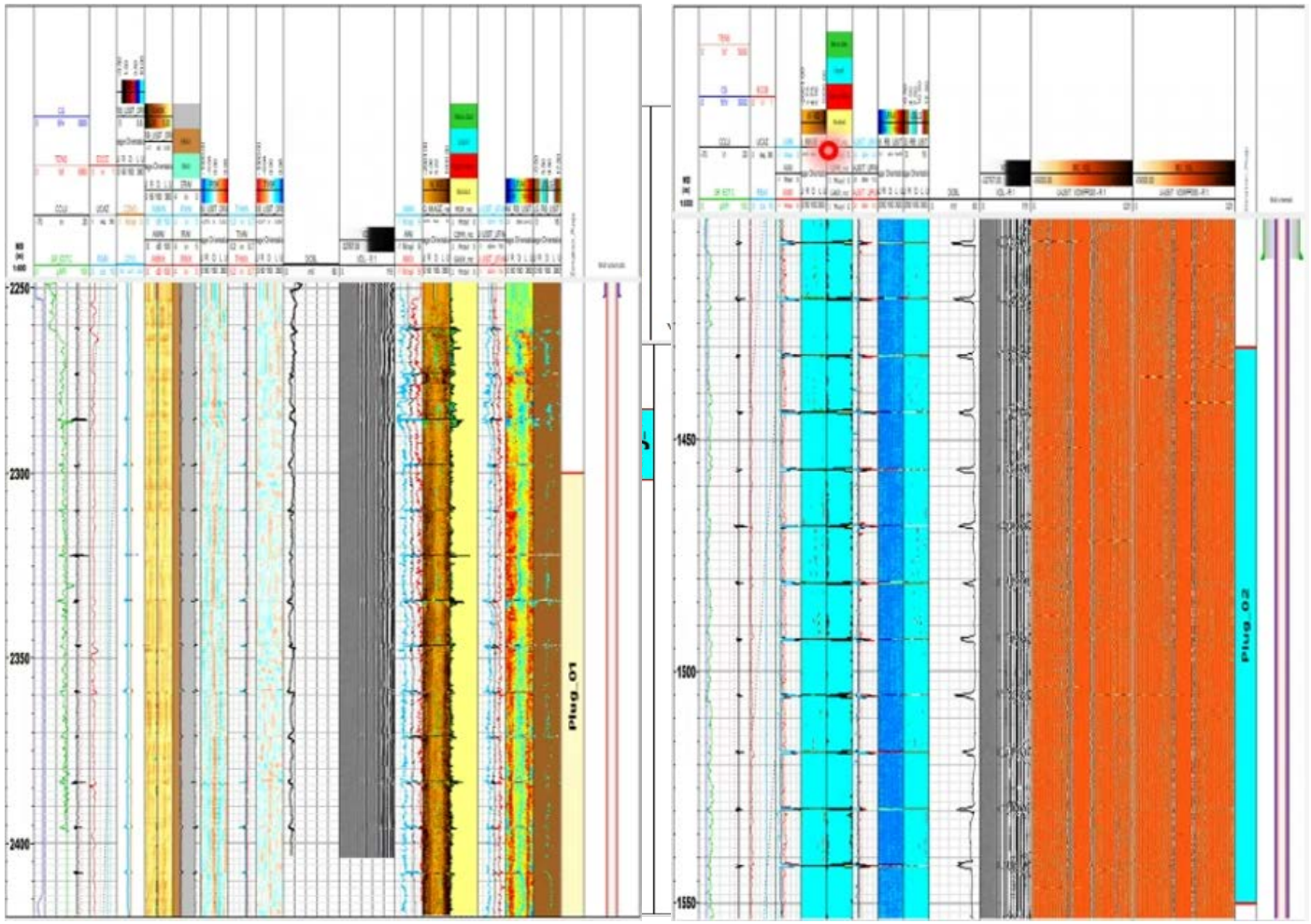
Challenges
- Unknown 13 3/8” barrier status, unknown 9 5/8”

annulus status and eccentricity profile
- Multiple costly contingencies

Solution/Result
- Good single-string bond eliminating PWC
- Dual string evaluation eliminating 9 5/8” casing pull
- Good B-annulus bond eliminating 9 5/8” and 13 3/8”

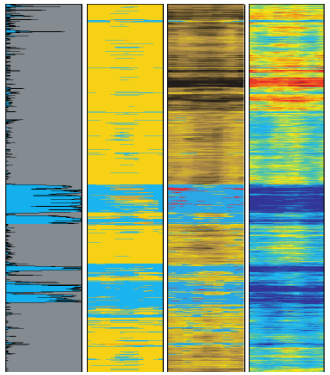
section milling
- Optimum depth for plug#2 with no barite sag and

minimal eccentricity enabling successful plug



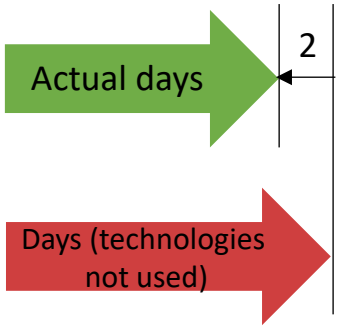
Value of Measurements

Barrier Insight



De-risk Project

Optimize Operations



Sustainable Execution

Provides bond quality for two strings simultaneously in a single run

Eliminated 1 section mill PWC depth refinement

Over 2 days of rig time were estimated to be saved

The total reduction in Scope 1 emissions 320 metric tons of CO_2e

STD Tool (OD depend on inner pipe logged)

Inner Pipe	5 ½, 6 5/8, 7, 9 5/8
Outer Pipe	7, 9 5/8, 10, 10 3/5, 13 3/8

Slim Tool	2 1/8-inch OD (On going field trial)
Inner Pipe	3 ½, 4, 4 1/2, 5
Outer Pipe	6 5/8, 7, 7 5/8, 9 5/8

World Oil AWARDS 2021 WINNER Best Well Integrity Technology Award

Winner of the 2021 World Oil Best Well Integrity Technology Award

ICoTA Intervention & Coiled Tubing Association

Winner of the 2022 ICoTA Intervention Technology Award

OWI 2022 AWARDS GLOBAL

Winner of the 2022 OWI Global Plug and Abandonment Excellence Award

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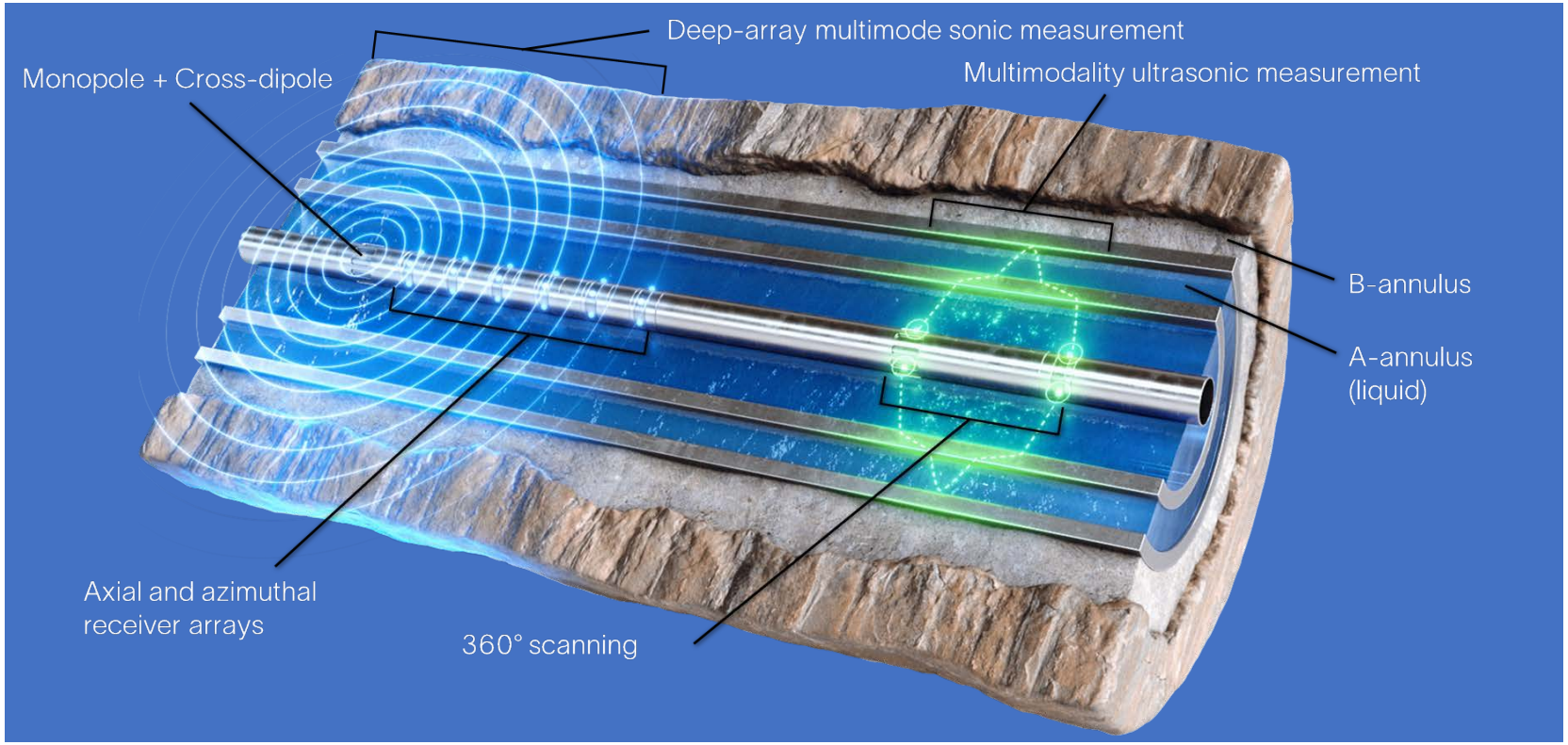

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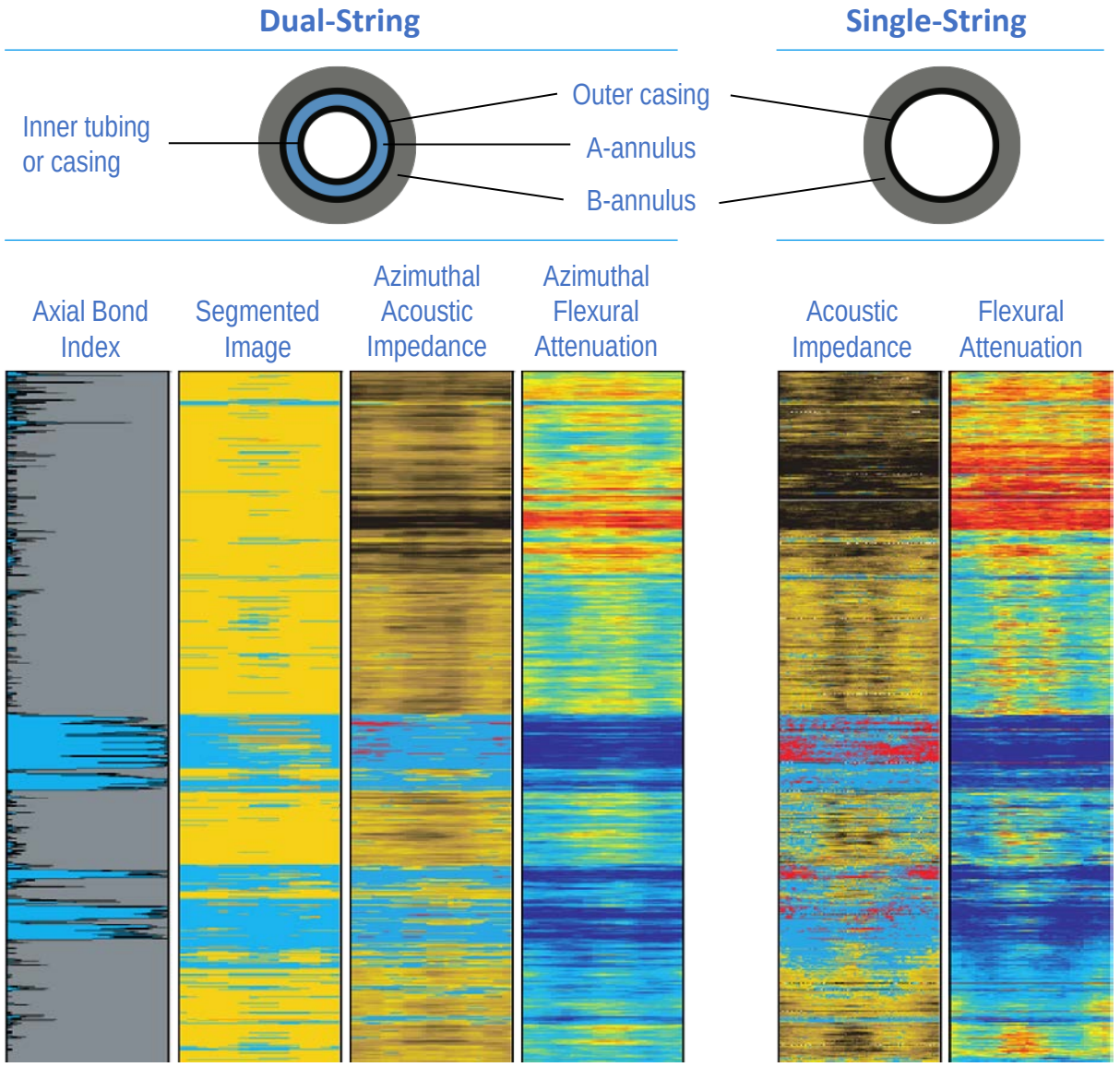
Track Record

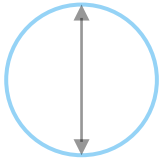
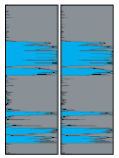
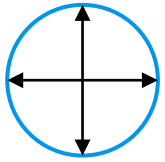
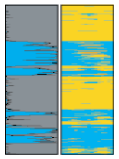
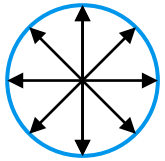
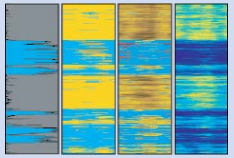
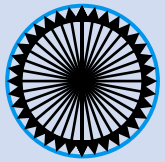
- Proven at ~120-130 wells Q2-24 in North Sea, GOM, Australia, South East Asia, Middle East
- Slim version field test ongoing, performed ~> 30 wells Q2-24

Validation Log & Level 4 Example

- Blind test run inside 7-in tubing in 9 5/8-in casing
- Removal of inner 7-in tubing
- Comparison run in single 95/8-in casing
- ORSOK D-010 standard requires segmented and azimuthal data



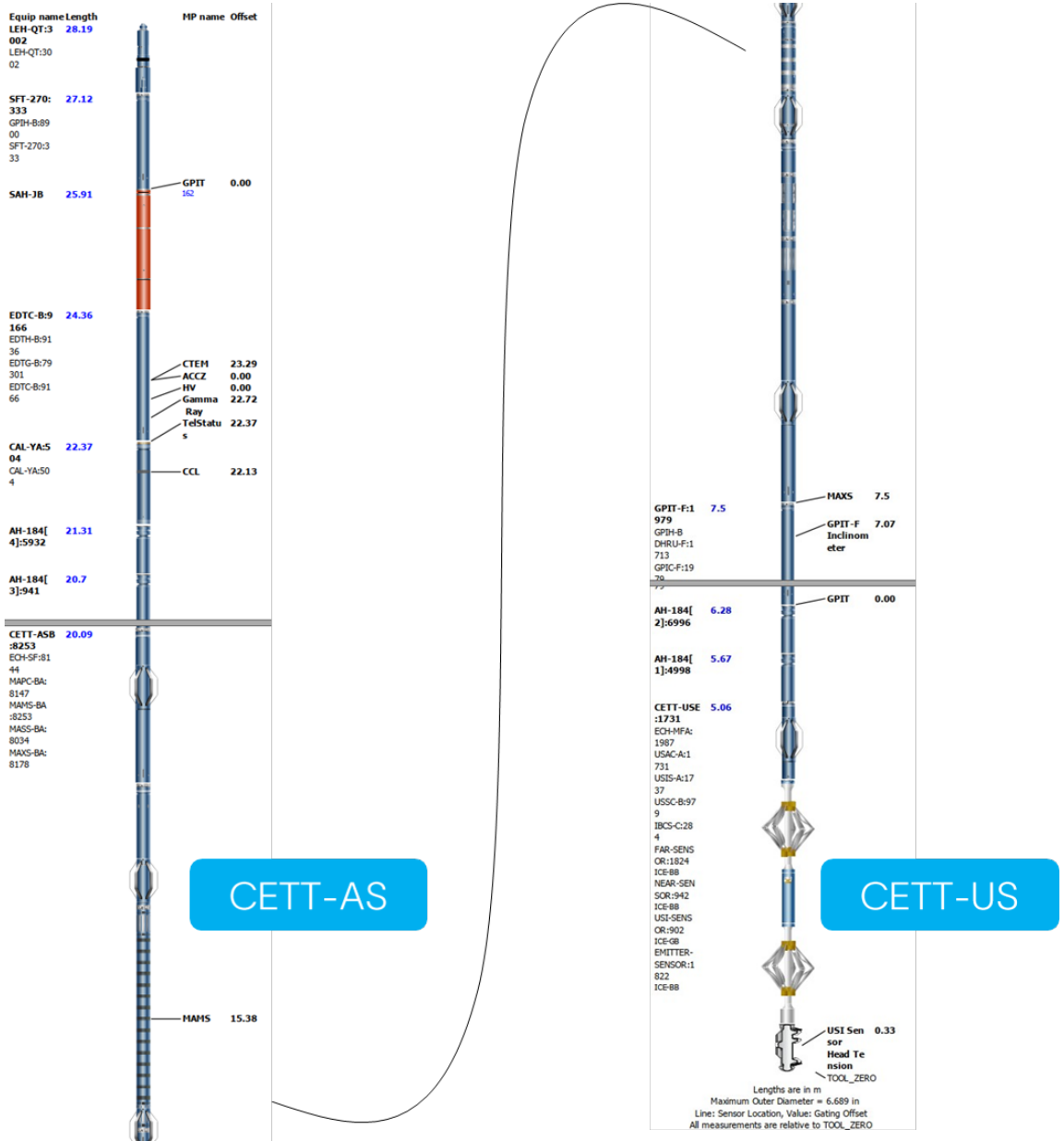
Answer Product Level

Level	B-Annulus Deliverables		Radial Direction	Correction Type
1	Basic bond index			—
2	Corrected bond index			 Environmental
3	Segmented bond log			 Environmental
4	360° azimuthal map			 Environmental, Formation

Dual Barrier Evaluation Toolstring

CETT-AS
(Array Sonic)

CETT-US
(Multimodality Ultrasonic)



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