Experience with dual string barrier logging

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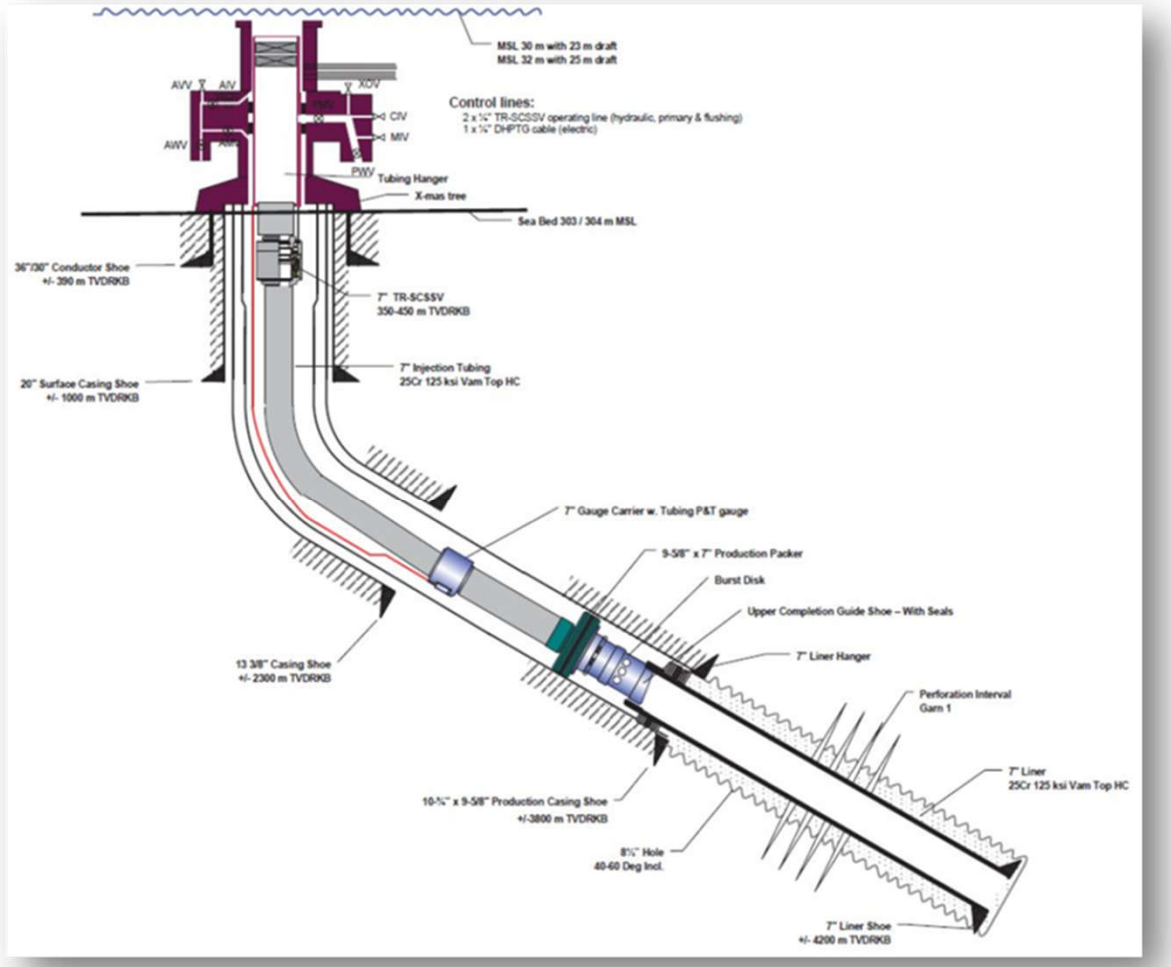
Reference publication: *OTC-31302: Acoustic Evaluation of Annulus B Barriers Through Tubing for Plug And Abandonment Job Planning*

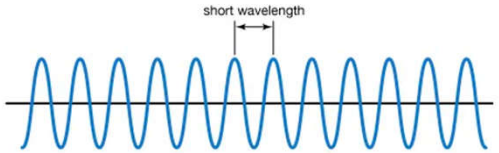
Why industry wants dual string bond evaluation?

- Early information of annular barrier status to help P&A planning
- Indications / confirmation of annular barriers in wells where barrier status is uncertain in wells not planned for P&A
- Determining annular well barriers in old wells without the use of a rig
- Rig-less P&A

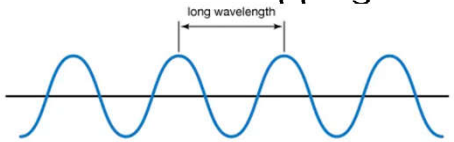


Through-Tubing Evaluation of B-Annulus

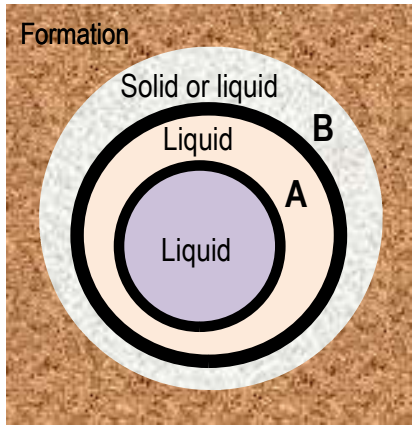
- Ultrasonic imaging to explain
  - A-annulus
  - Geometry of tubing within outer casing



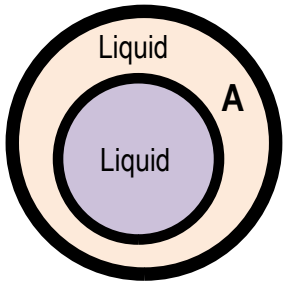
- Sonic to explain B-annulus
  - Axial coverage
  - Azimuthal mapping

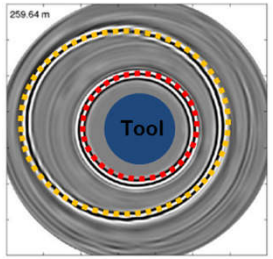


Dual-string configuration

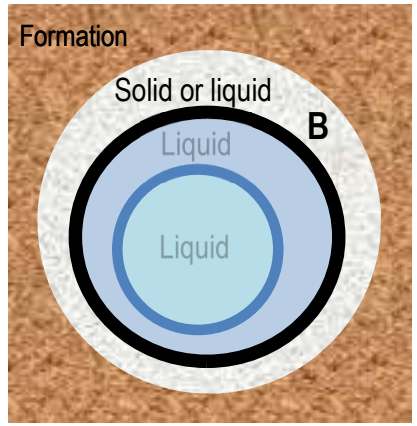


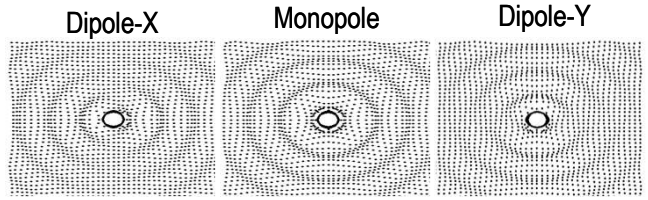
Ultrasonic measurement for shallow imaging



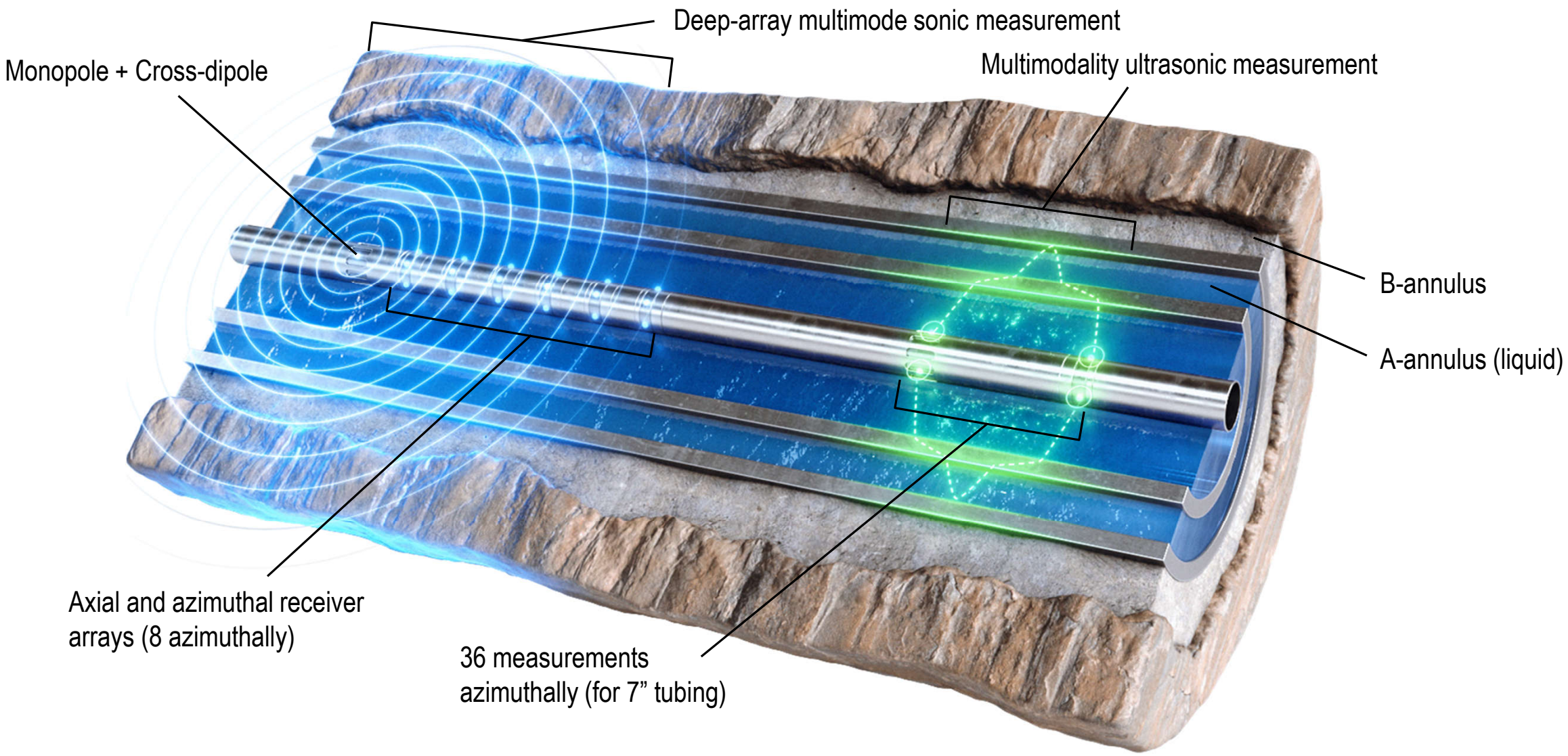


Sonic measurement for deep probing





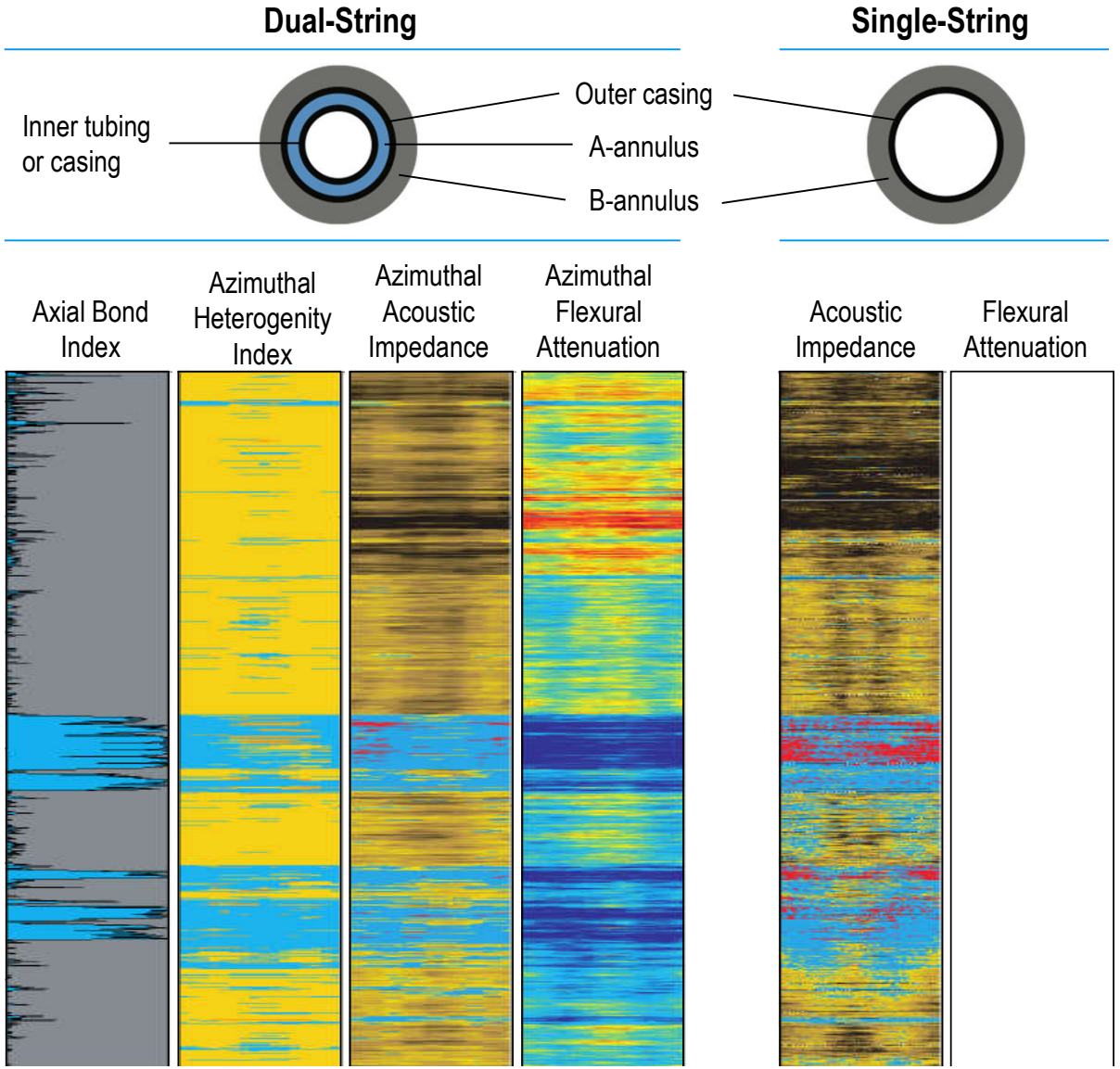
Dual-String Barrier Evaluation



Example-1

- 7-in tubing in 9 $^{5}/_{8}$-in casing
- Logging Interval: 1400 m
- Removal of inner 7-in tubing
- Comparison run in single 9 $^{5}/_{8}$-in casing

- NORSOK D-010:
  "The measurements shall provide azimuthal/segmented data. The logs shall be verified by qualified personnel and documented"



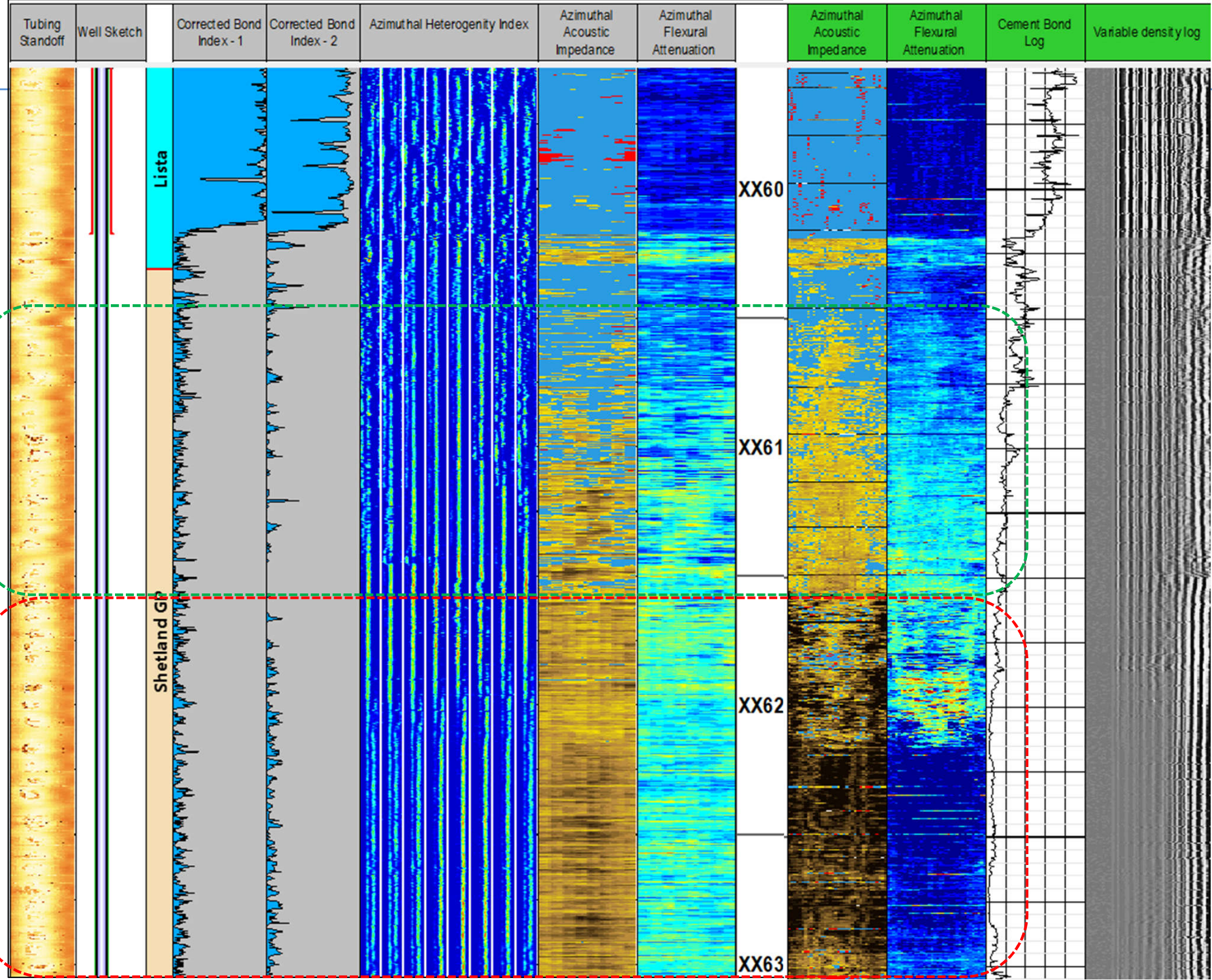
Data acquisition across 14 Fields / 28 sections / 14 validations

Customer	Inner pipe	Outer pipe	Annulus A	Number of jobs	Validation log (after tubing removal)
Equinor	7”	9 5/8”	Brine	18	12
Equinor	7”	10 ¾”	Brine	6	1
Equinor	5 ½”	9 5/8”	Brine	2	
Equinor	5 ½”	9 7/8”	Brine	1	
Equinor	5 ½”	10 ¾”	Brine	1	1
NORCE	7”	9 5/8”	Brine	1+1*	2
NORCE	5 ½”	9 5/8”	Brine	1+1*	2

OTC-31302 : Acoustic Evaluation of Annulus B Barriers Through Tubing for Plug And Abandonment Job Planning
SPE-208699: Construction of a Reference Well to Support the Qualification of Cement Evaluation Logging Tools and Data Processing
** Logging in engineered well at NORCE*

Example-2

- 7-in tubing in 9 $^{5}/_{8}$-in casing
- Logging Interval: 800 m
- Removal of inner 7-in tubing
- Comparison run in 9 $^{5}/_{8}$-in casing



Predicted formation

Predicted cement

Theoretical top of cement ~ XX62m

Equinor Take-Aways

- **Present:**
- An annular interpretation of a 7” x 9⅝” TTL data set is qualified to be used for planning purposes in Equinor
- These data are being used by several rig groups as a guide in P&A planning – where the TTL data has been collected by Well Intervention, well in advance of the arrival of the rig

- **Future work:**
- Improve understanding of uncertainty regarding:
  – Processing (tubing positioning, ML models)
  – Interpretation (resolution, formation / cement, qualified formation barriers etc.)
- Model for Barite sag
- 5½” x 9⅝” (10¾”): waiting for single casing data to define ML model(s)

- **Please note**: no info regarding casing properties (wear groove / ovality) for the casing available at a resolution usable to define minimum remaining wall thickness etc..

Industry Recognition

World Oil® AWARDS
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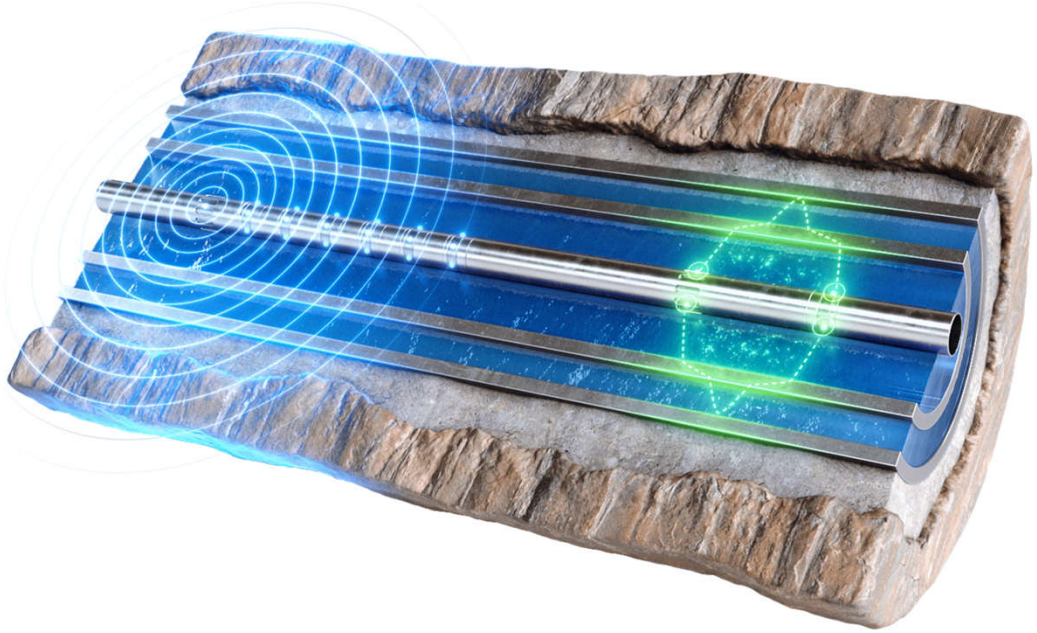

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Intervention & Coiled Tubing Association

Winner of the 2022 ICoTA Intervention Technology Award