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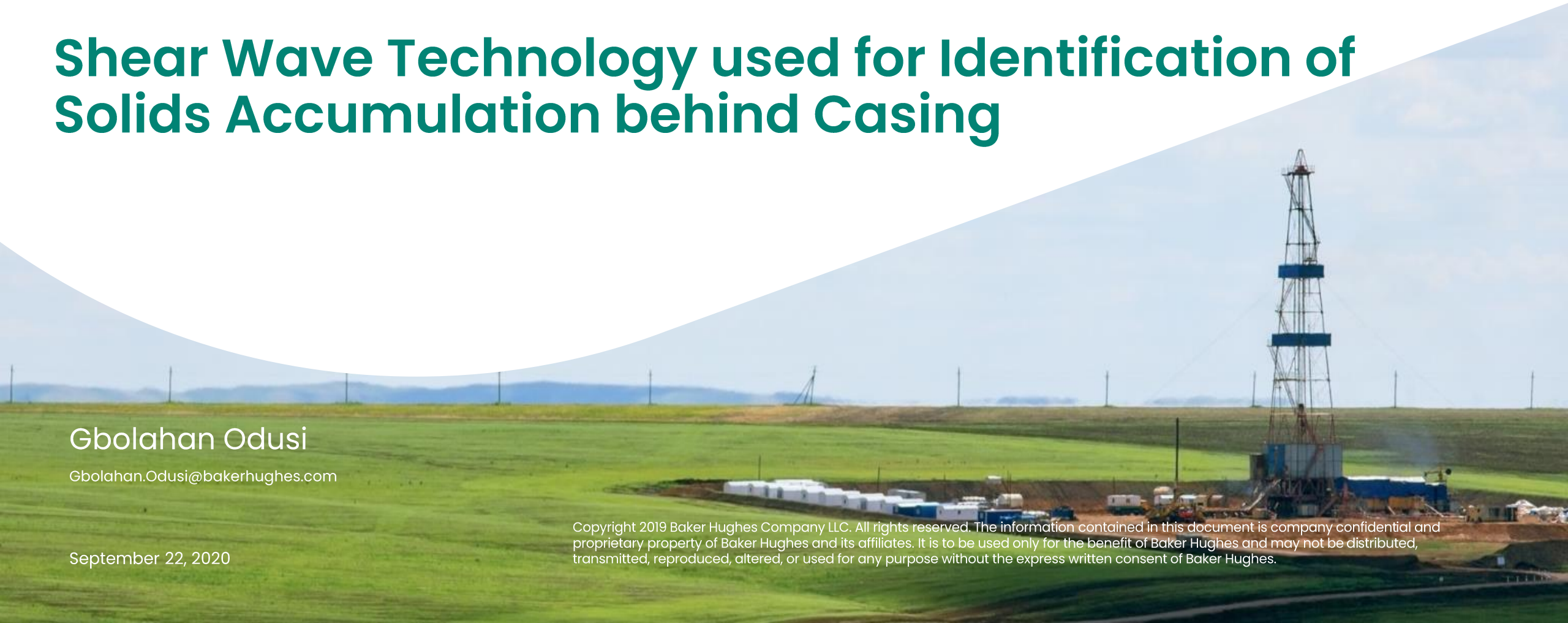
DEVEX 2020

Shear Wave Technology used for Identification of Solids Accumulation behind Casing



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Historical Evaluation

Compressive strength has been the oil & gas industry standard for evaluating cement quality for many years based on traditional CBL tools

Does cement in oil & gas wells really fail under compression?

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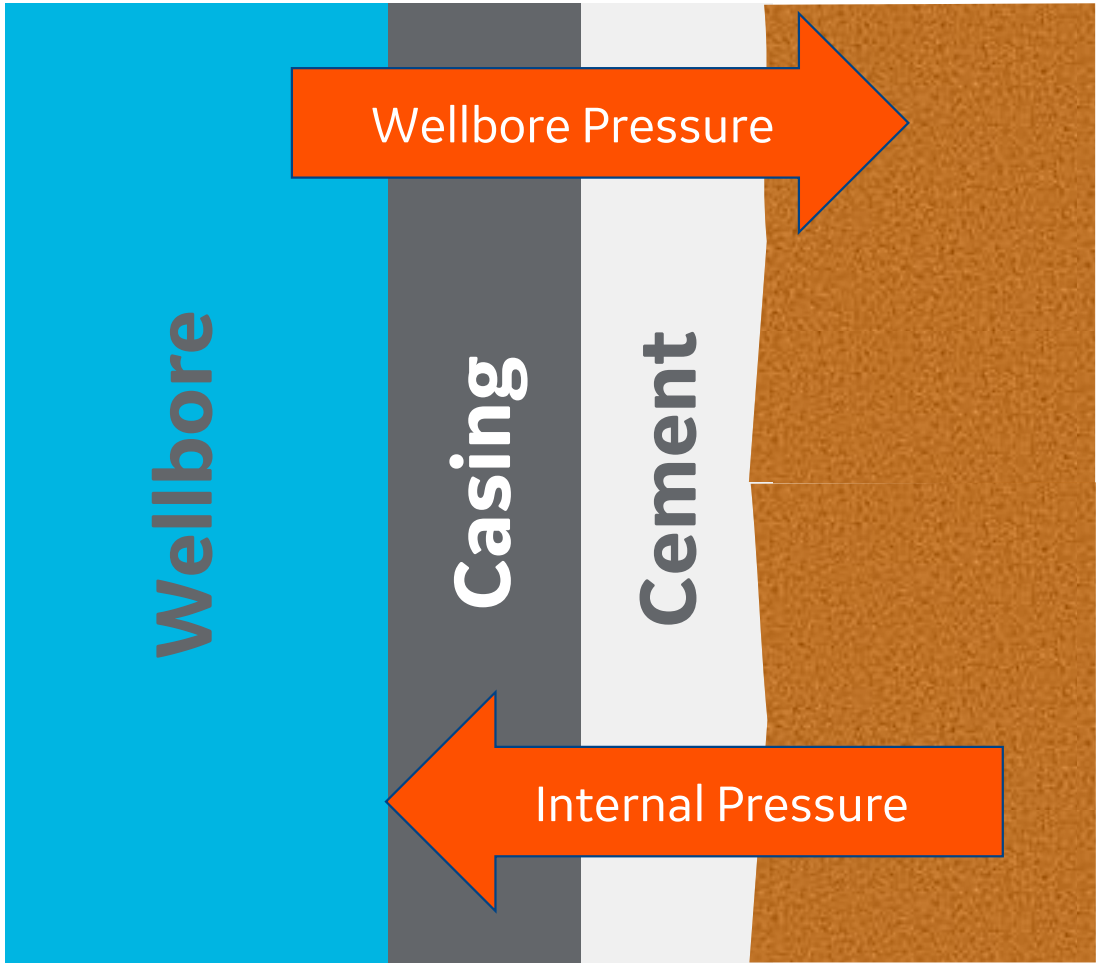
What Really Happens?

- Cement present in the annulus is “CONFINED” between casing and formation.
- Difference in pressures inside and outside the casing exert SHEAR forces on the cement.
- So what should we measure to evaluate potential SHEAR failures?



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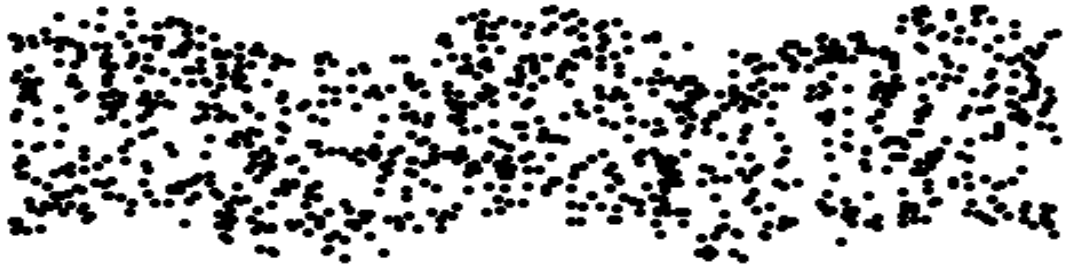
Shear Wave Technology

Shear Wave Attenuation Measurement

- True indicator of cement integrity in boreholes
- Wave propagation perpendicular to movement of particle
- Responds to in-situ shear modulus of the annular material
- Covers widest range of cements
- Only responds to **SOLIDS**



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The Best Solution to Exotic Cements and Solids?

Shear (S) waves will only travel through a solid – **responds to** the **Shear Modulus**

Compressional (P) waves will travel though any kind of material (solid or liquid) - **responds to** the **compressive strength or Acoustic Impedance**

Differentiating low Acoustic Impedance Solids from heavy liquids - Easy?

Material	Acoustic Impedance (Mrayl)
Fresh Water	1.5
Free Gas	0.1
Steel	46.0
12 ppg Drilling Mud	2.16
15 ppg Drilling Mud	2.70
17 ppg Drilling Mud	3.06
9 ppg Foam Class C (250 psi)	2.19
9 ppg Foam Class C (1000 psi)	2.69
13 ppg Cement (500 psi)	3.37
13 ppg Cement (2000 psi)	4.42
16.5 ppg Cement (500 psi)	4.38
16.5 ppg Cement (2000 psi)	5.62

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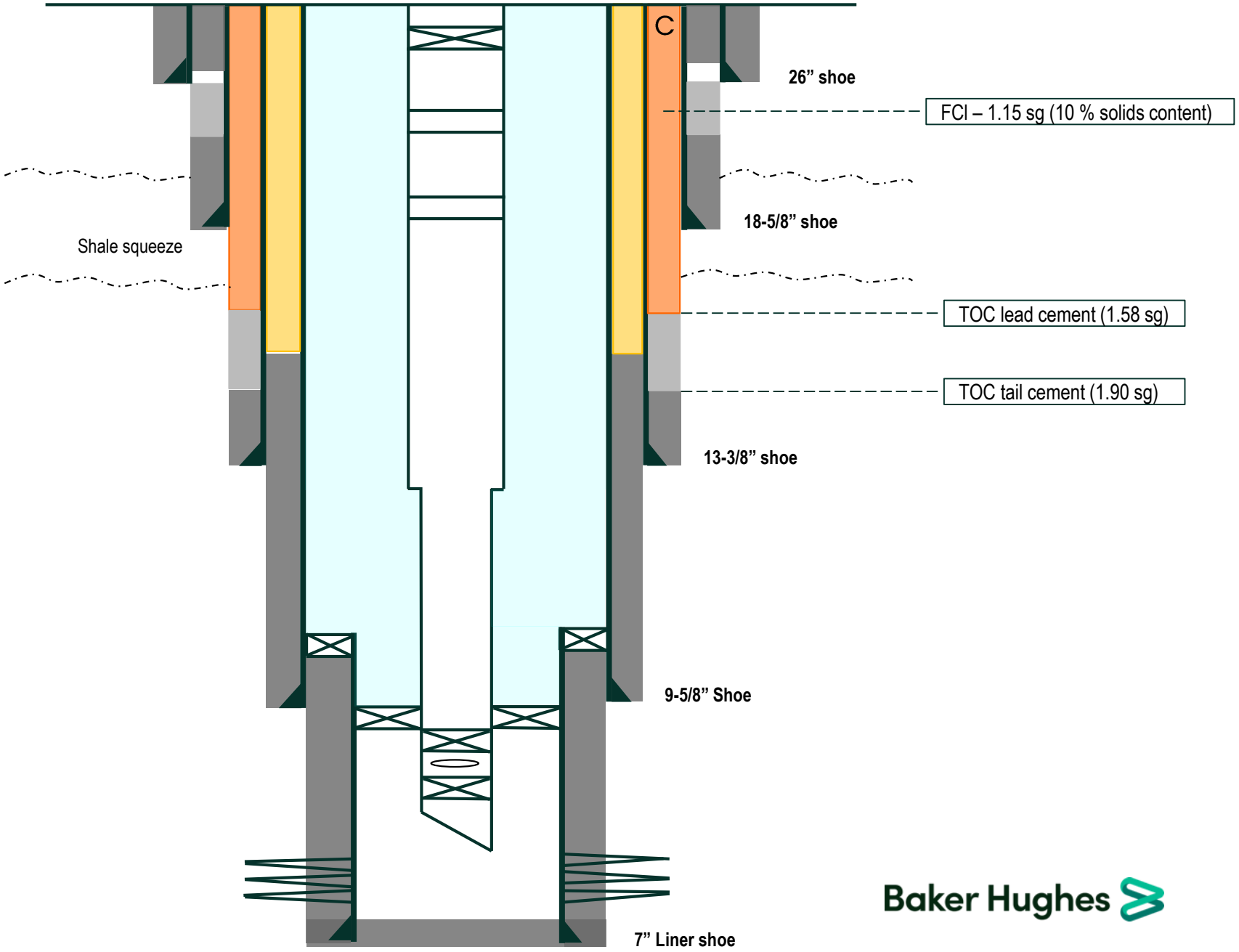
Case History

Offshore

- Plug and abandon well
- Multiple casing
- Production tubing



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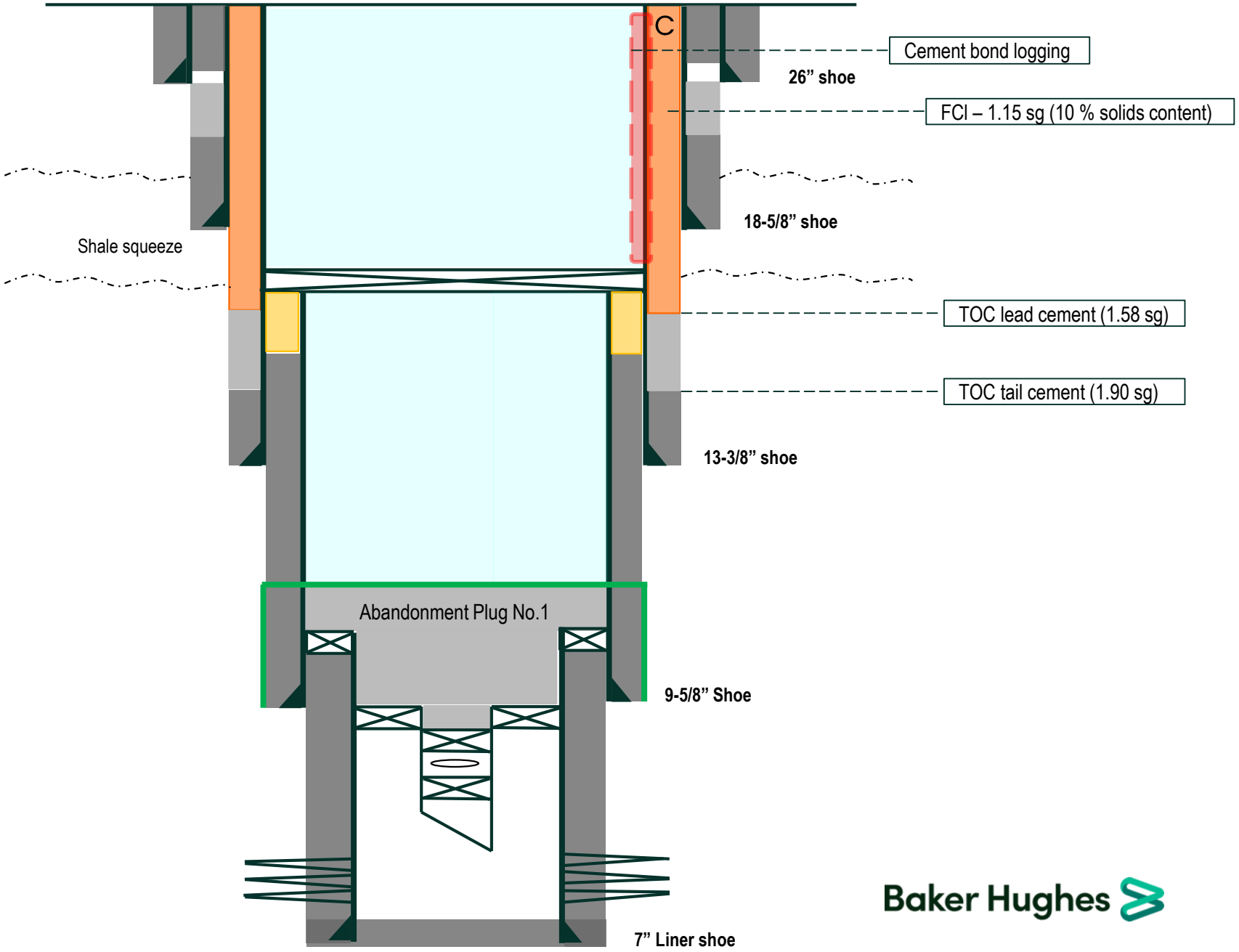
Case History

Offshore

- High solids content mud
- Possible formation effect
- Wireline operations
  - Compressional and Shear cement bond logs



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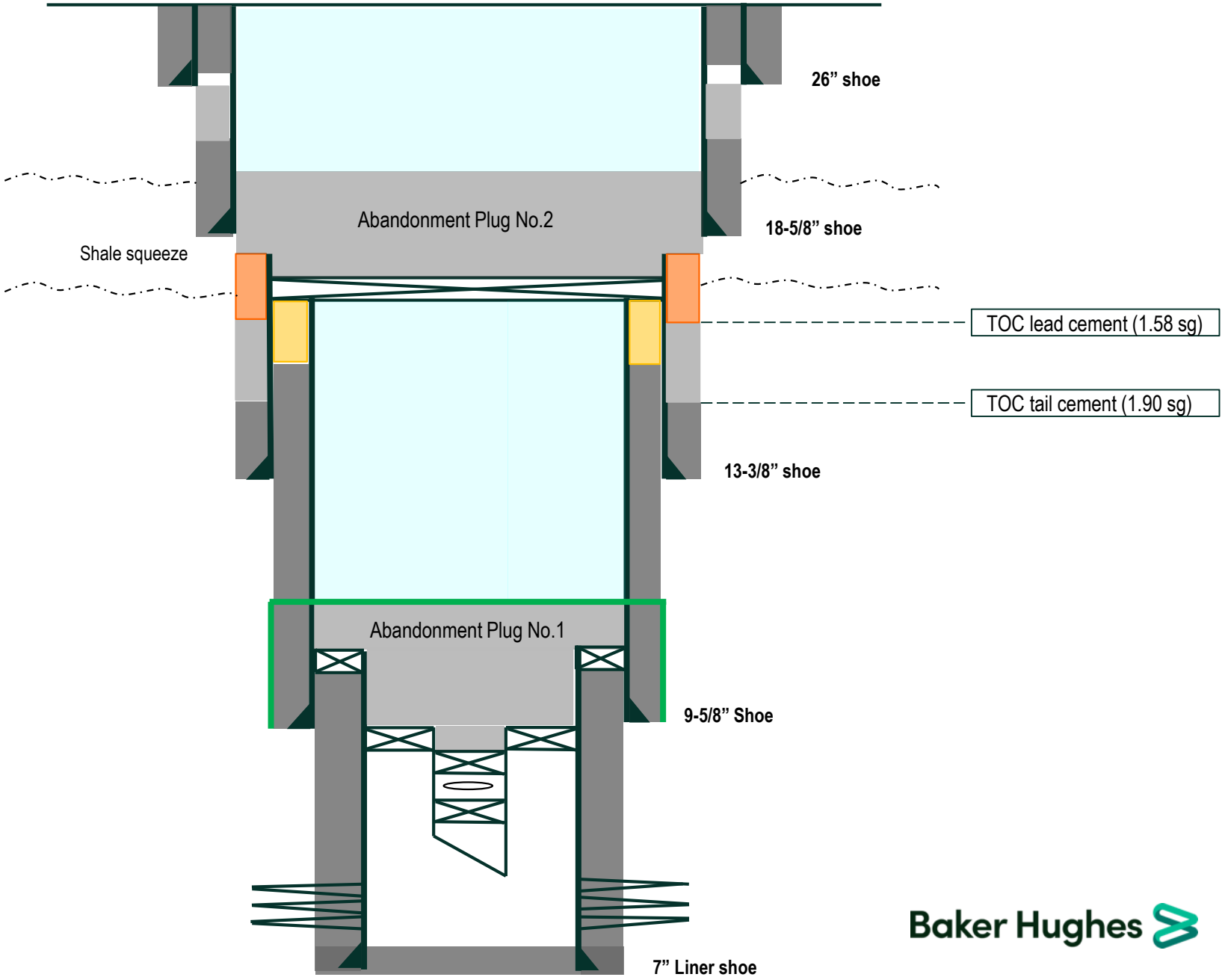
Case Well

Offshore

- Cut and pull 13-3/8” casing
- Section mill and set Abandonment Plug 2



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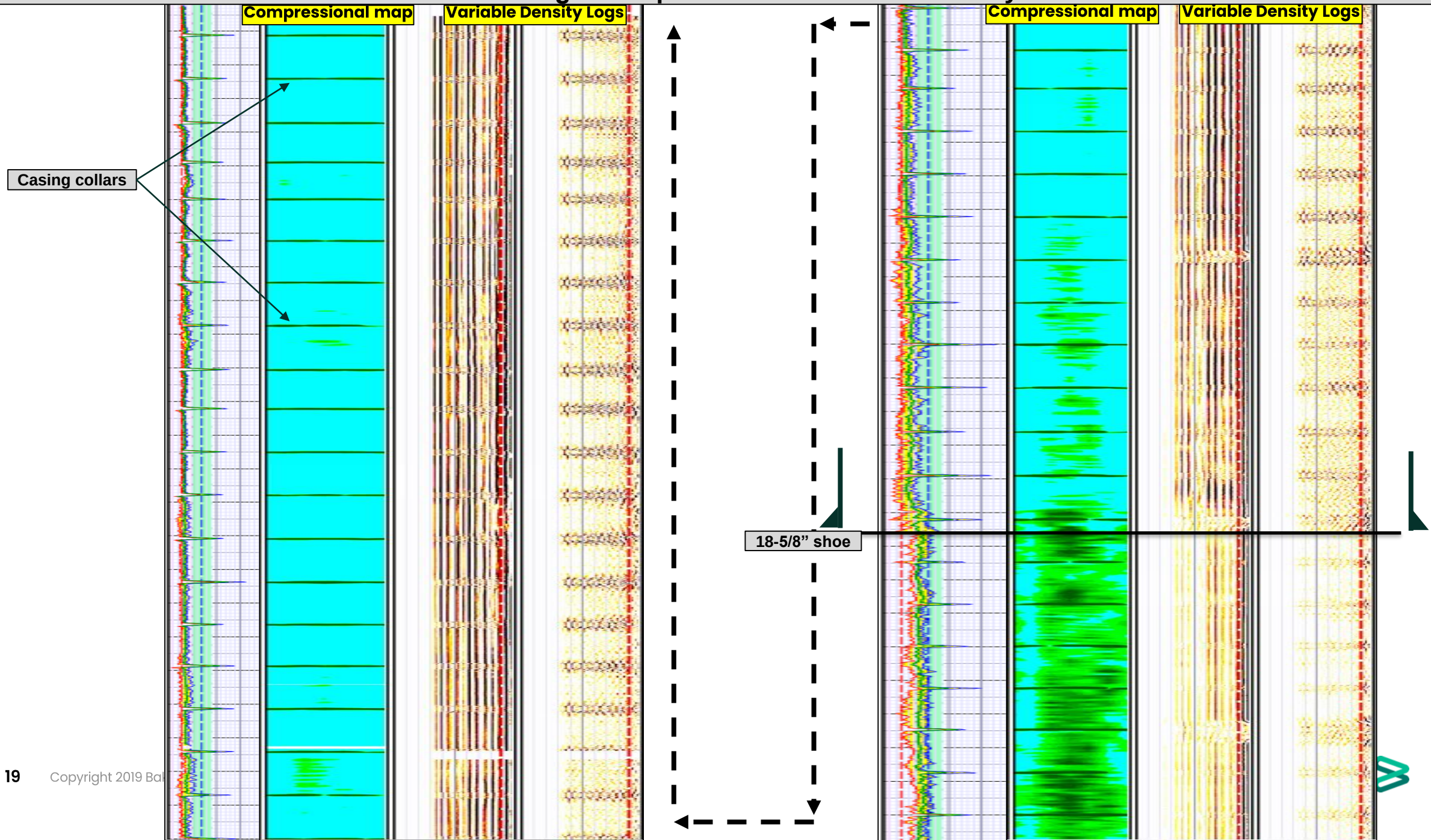
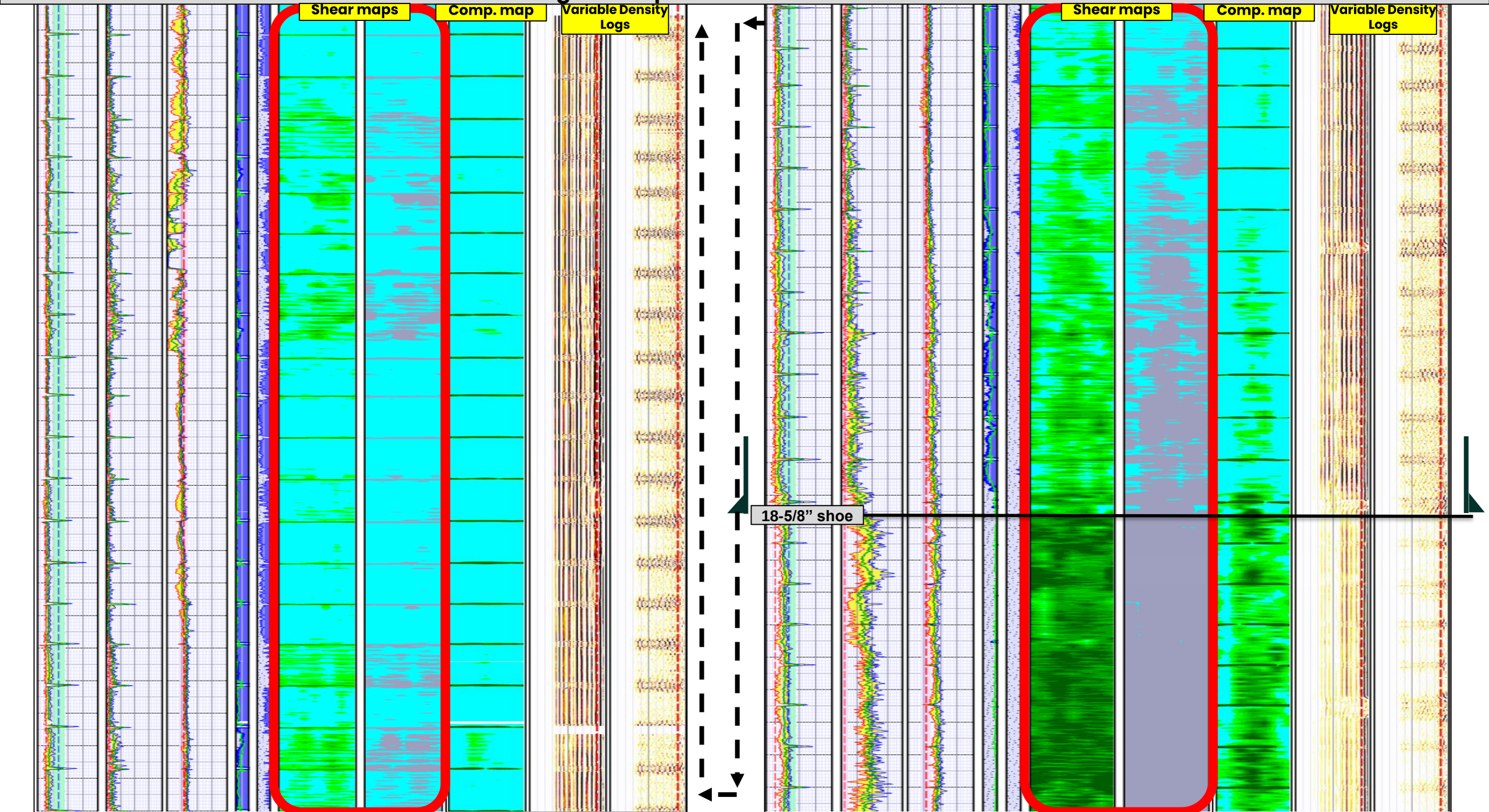
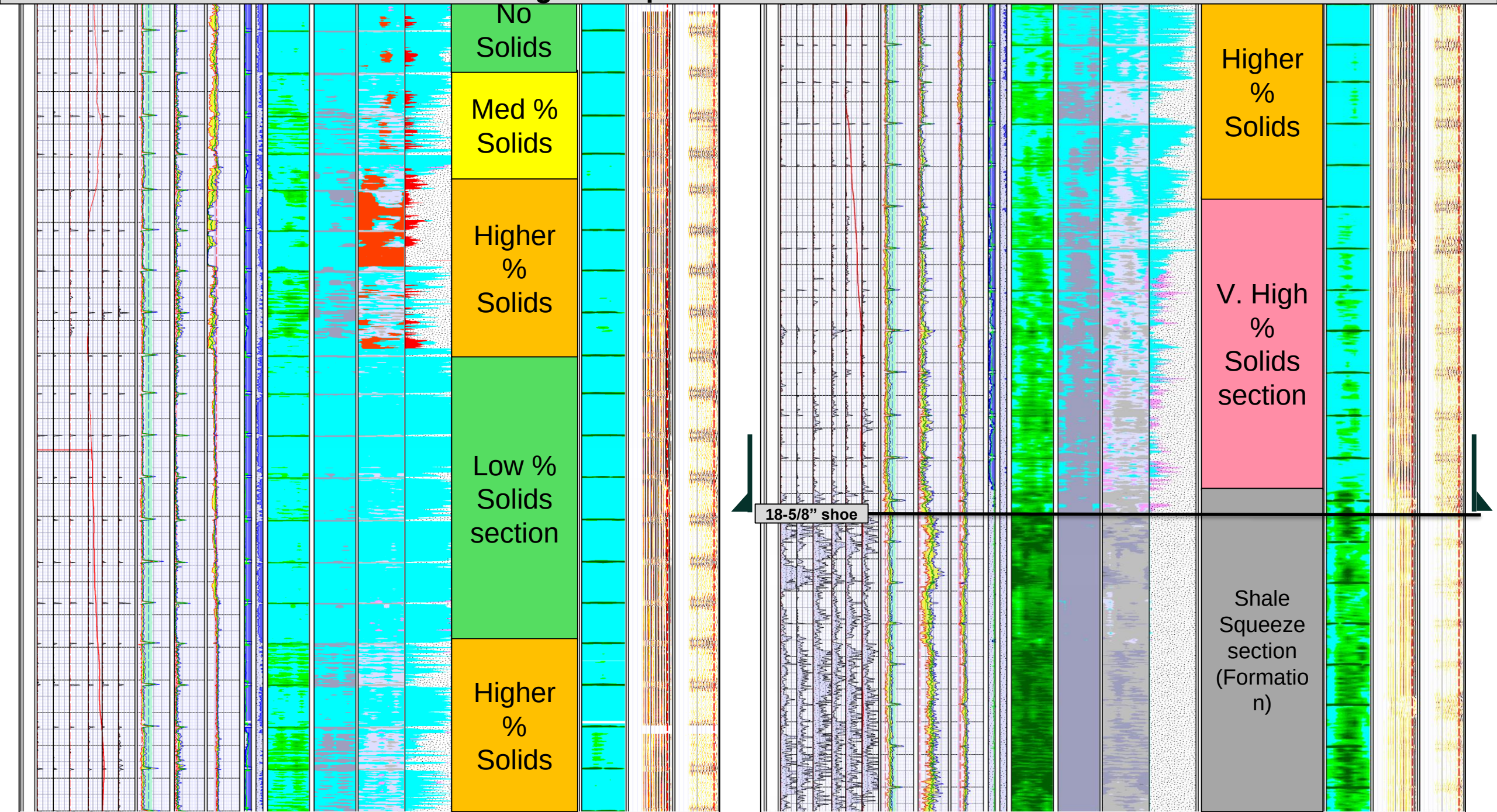
13-3/8” casing – Compressional measurement only

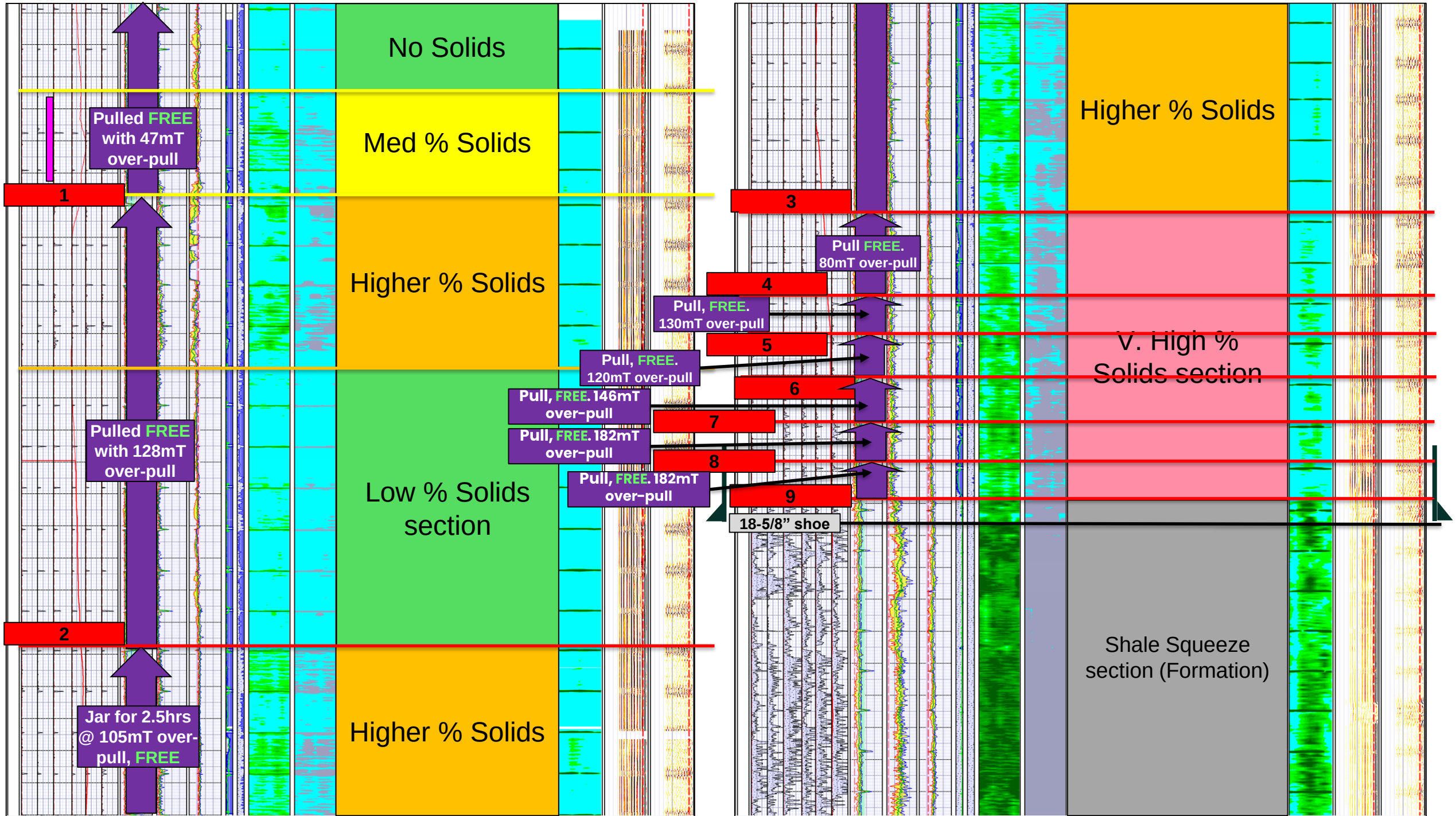


13-3/8” casing – Compressional and Shear measurements



13-3/8” casing – Compressional and Shear measurements




No Solids
Med % Solids
Higher % Solids
Low % Solids section
Higher % Solids
Higher % Solids
V. High % Solids section
Shale Squeeze section (Formation)
Pulled FREE with 47mT over-pull
Pulled FREE with 128mT over-pull
Jar for 2.5hrs @ 105mT over-pull, FREE
Pull FREE. 80mT over-pull
Pull, FREE. 130mT over-pull
Pull, FREE. 120mT over-pull
Pull, FREE. 146mT over-pull
Pull, FREE. 182mT over-pull
Pull, FREE. 182mT over-pull
18-5/8" shoe
1
2
3
4
5
6
7
8
9

Observed clay-like material on the outside of the 13-3/8” casing at surface

Pulled FREE with 47mT over-pull

Pulled FREE with 128mT over-pull

Jar for 2.5hrs @ 105mT over-pull, FREE

Pull FREE. 80mT over-pull

, FREE. over-pull

Pull, FREE. 182mT over-pull

Pull, FREE. 182mT over-pull

18-5/8” shoe

1

2

3

4

5

6

7

8

9

Low % Solids section

Higher % Solids

Higher % Solids

V. High % Solids section

Shale Squeeze section (Formation)

Summary

- Compressional wave attenuation showed minimal solids presence in the annulus
- Shear wave technology identified solids with low acoustic impedance in the annulus
- Build up of solids were graded using the Shear wave measurement
- Cut and pull decision based on the Shear wave data
- Percentage of solids correlates with the pulling force applied
- Shear attenuation showed azimuthal bond due to Shale squeeze
- No barite presence in this case

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