IDENTIFICATION OF BREAKOUT BEHIND CASING:

METHODOLOGY TO OBTAIN OPENHOLE EQUIVALENT CALIPER MEASUREMENTS THROUGH SLOTTED LINER USING THE DENSITY TOOL

Laurent Mosse, Schlumberger,

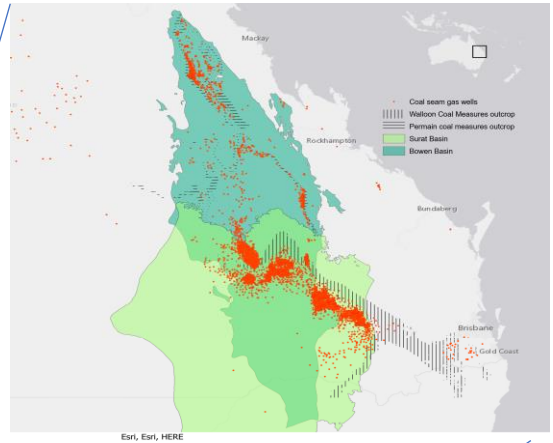
Stephen Pell, Santos Ltd,

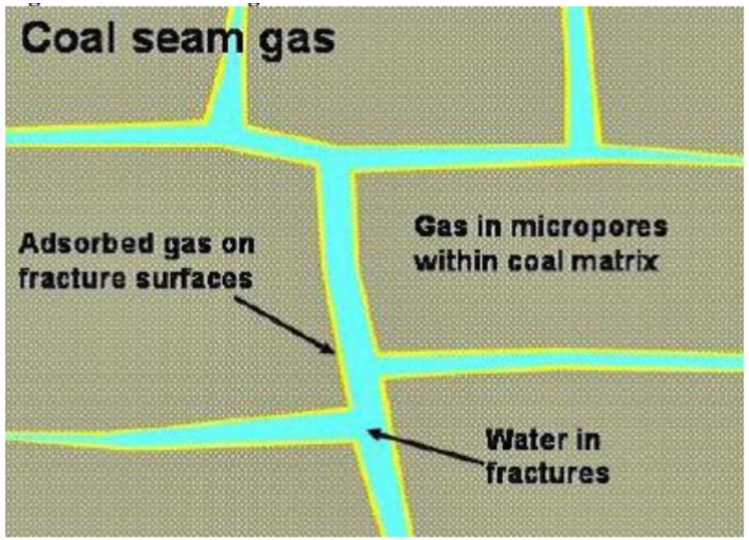
Thomas J. Neville, Asia-Pacific Formation Evaluation Services Pty Ltd

Paper SPWLA-923

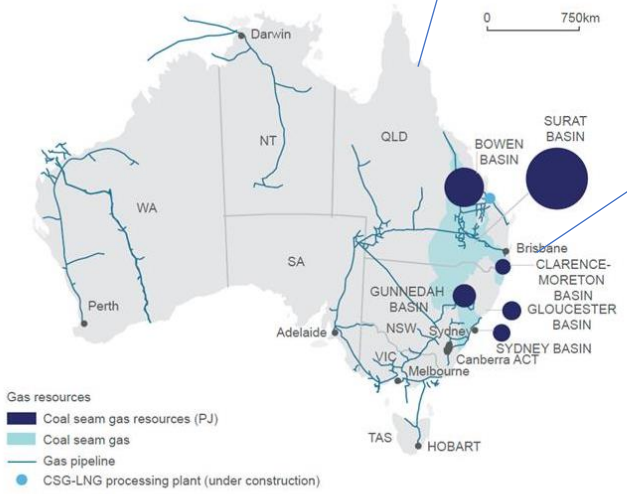
Distinguished Speaker Serie

Context of the Case Study : Coal Seam Gas Production



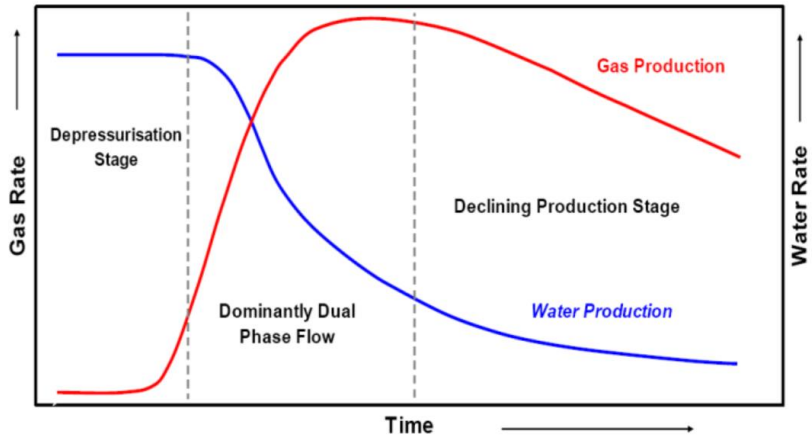


Source: Geoscience Australia.



Source: Office of the Chief Economist, *Review of the socioeconomic impacts of coal seam gas in Queensland 2015*

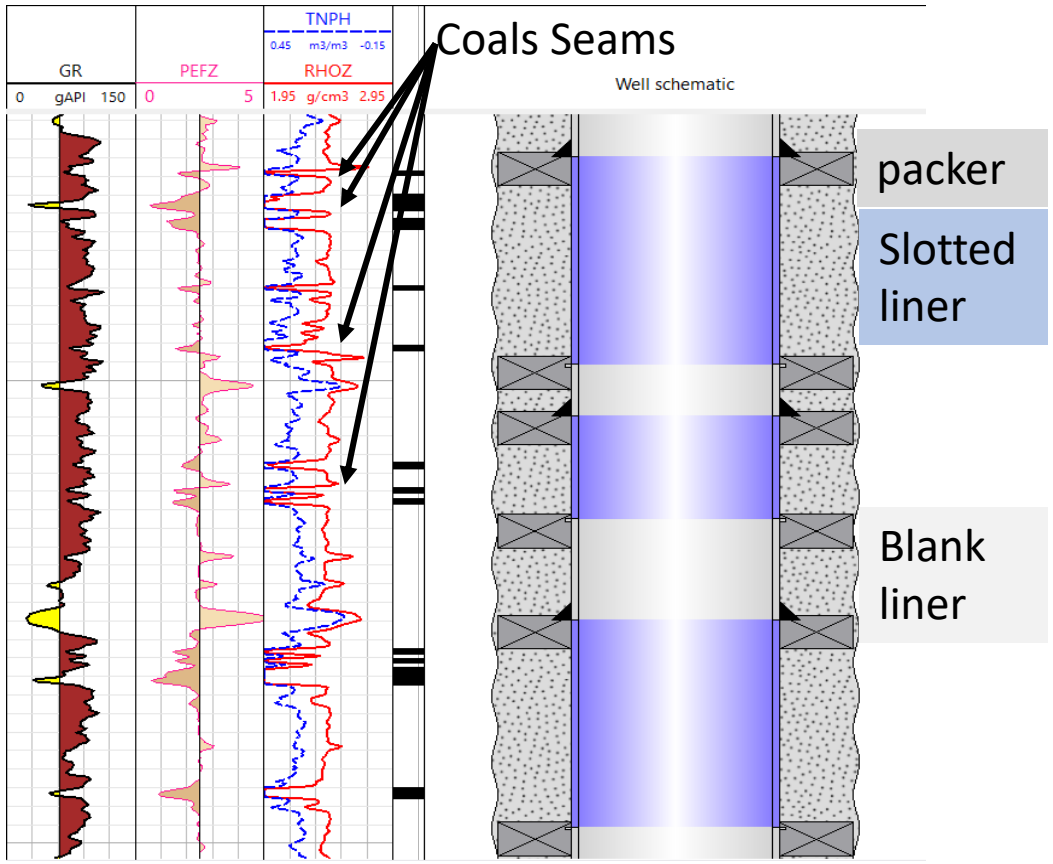
Specific Production Profile



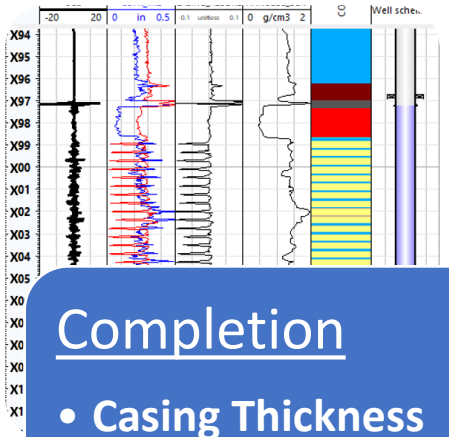
Source: QWC 2012.

Surat Basin – CSG Production Challenges and Mitigation

- **Reservoir characteristics**
  - 10 to 20 m of net coal over a 200 to 300 m interval
  - Interburden extremely fluid sensitive – smectite rich
  - Completion strategy maximizes access to gas bearing coals while isolating fluid sensitive interburden
- **Fines production significant**
  - Failure of artificial lift systems – expensive workovers or lost wells
  - Major economic impact
- **Locating zones of breakout**
  - Completion strategy – precludes use of mechanical calipers
  - Need alternate way to locate and quantify
  - Variable fluid type

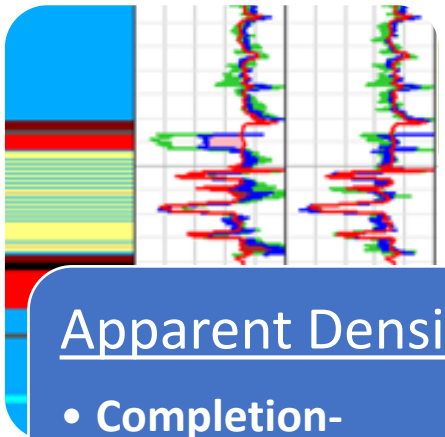


A New Application of 3-Detector Density Tool



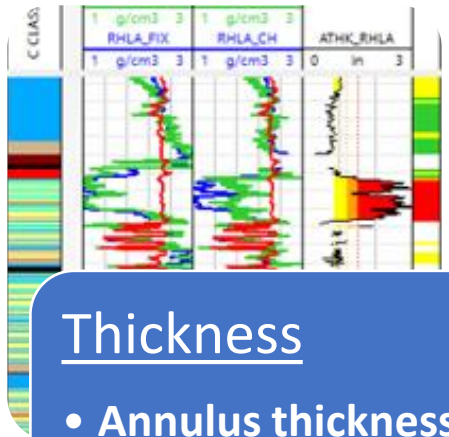
Completion

- **Casing Thickness**
- **Annulus Density**
- **Completion Class**



Apparent Density

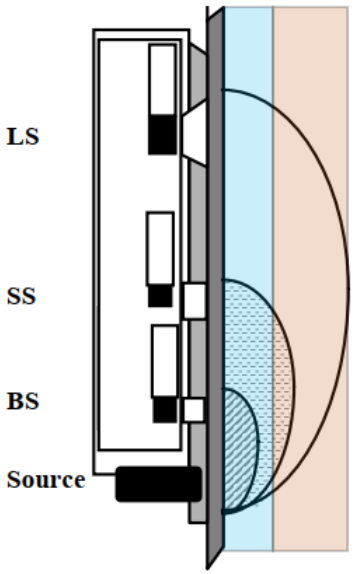
- **Completion-corrected Apparent Formation Density**



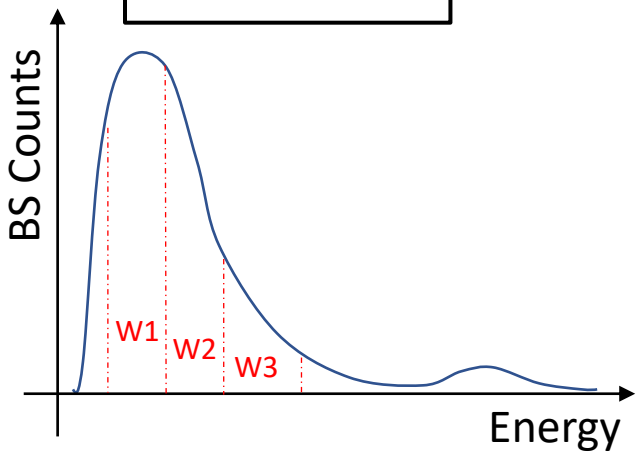
Thickness

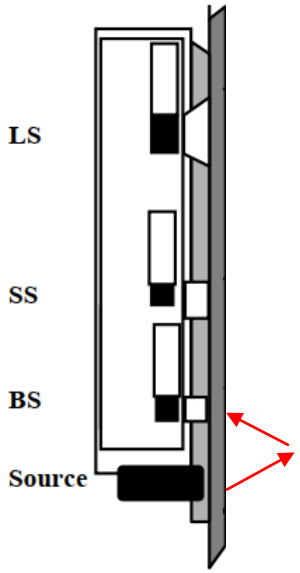
- **Annulus thickness**
- Hole Caliper

3-Detector Density Tool : Energy Window, DOI, Casing & Annulus



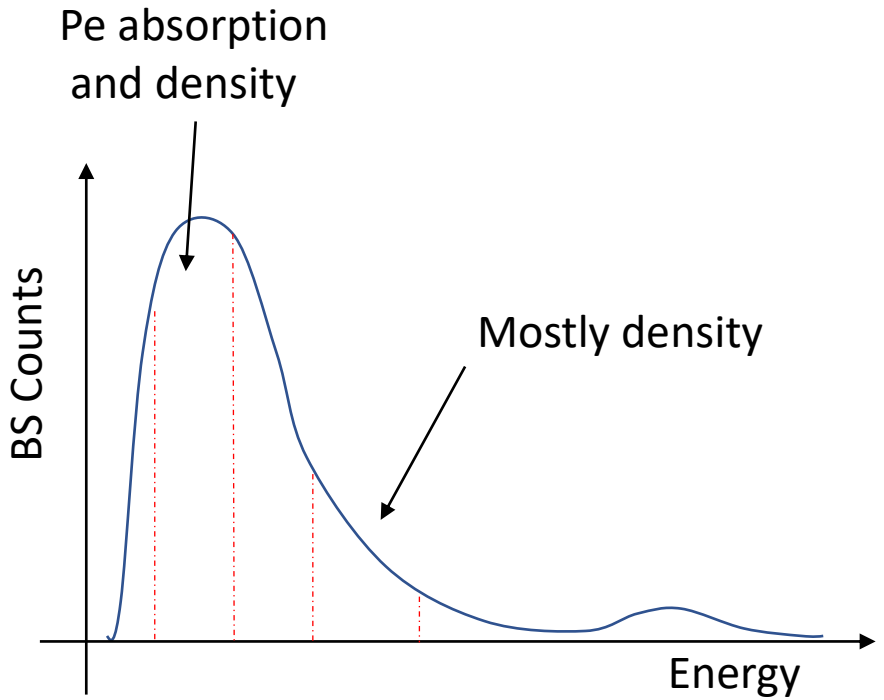
Back-scatter



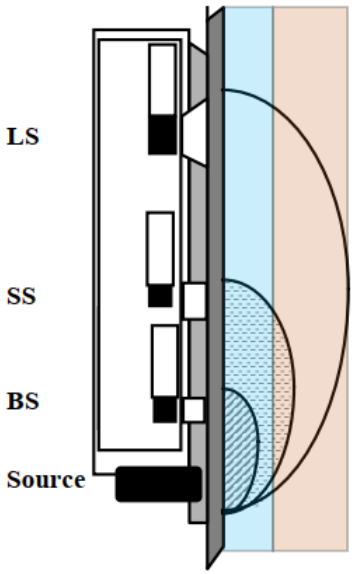


Density ↗ , counts ↗

Pe ↗ , counts ↘



3-Detector Density Tool : Energy Window, DOI, Casing & Annulus



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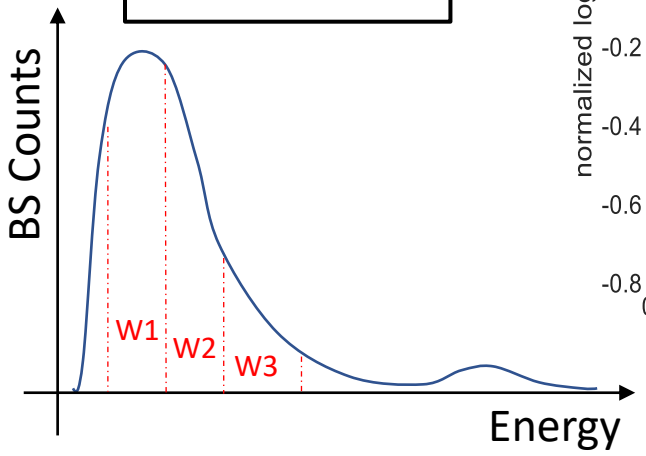
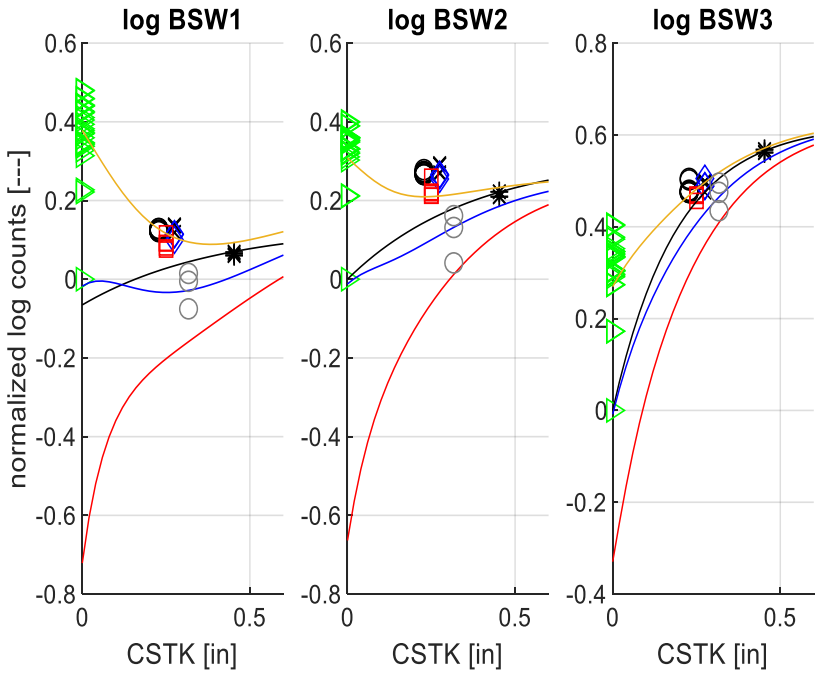
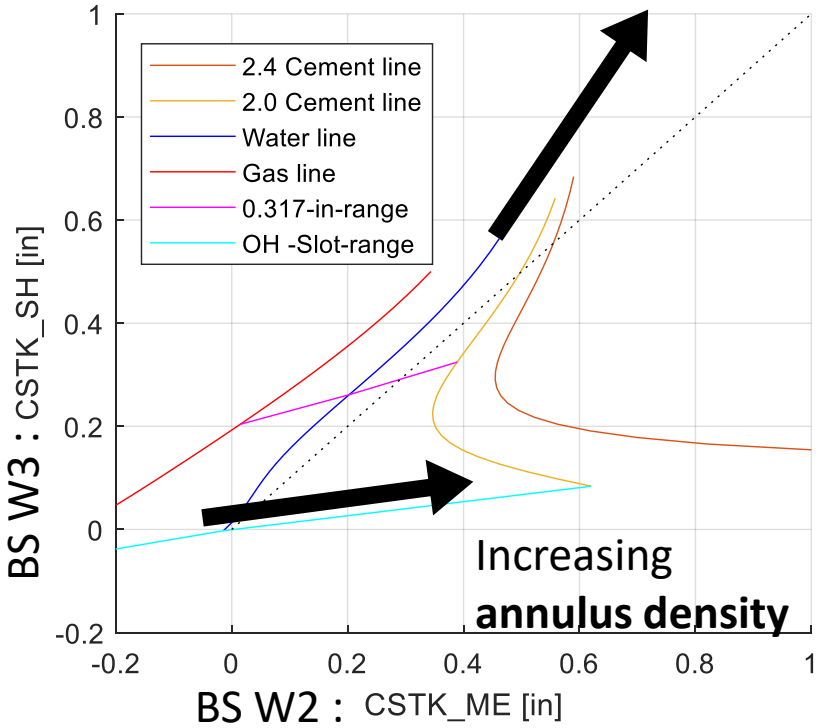


Open-hole database
+
Cased-hole database
+
Window-to-apparent casing thickness

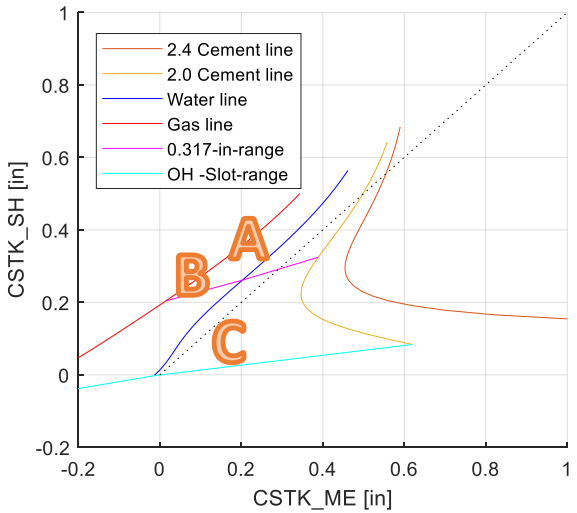


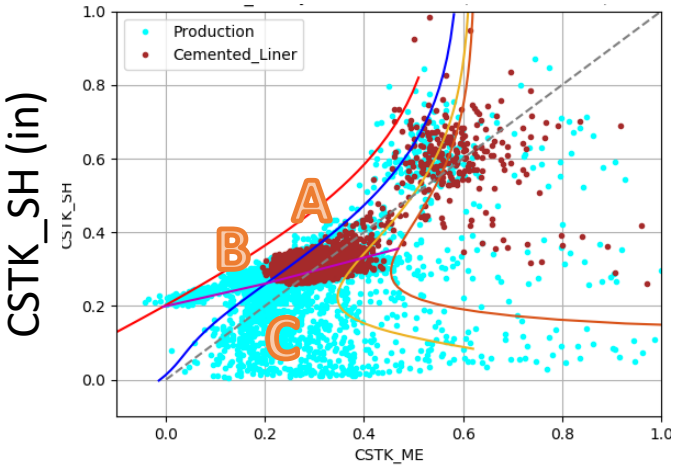
Increasing
casing thickness

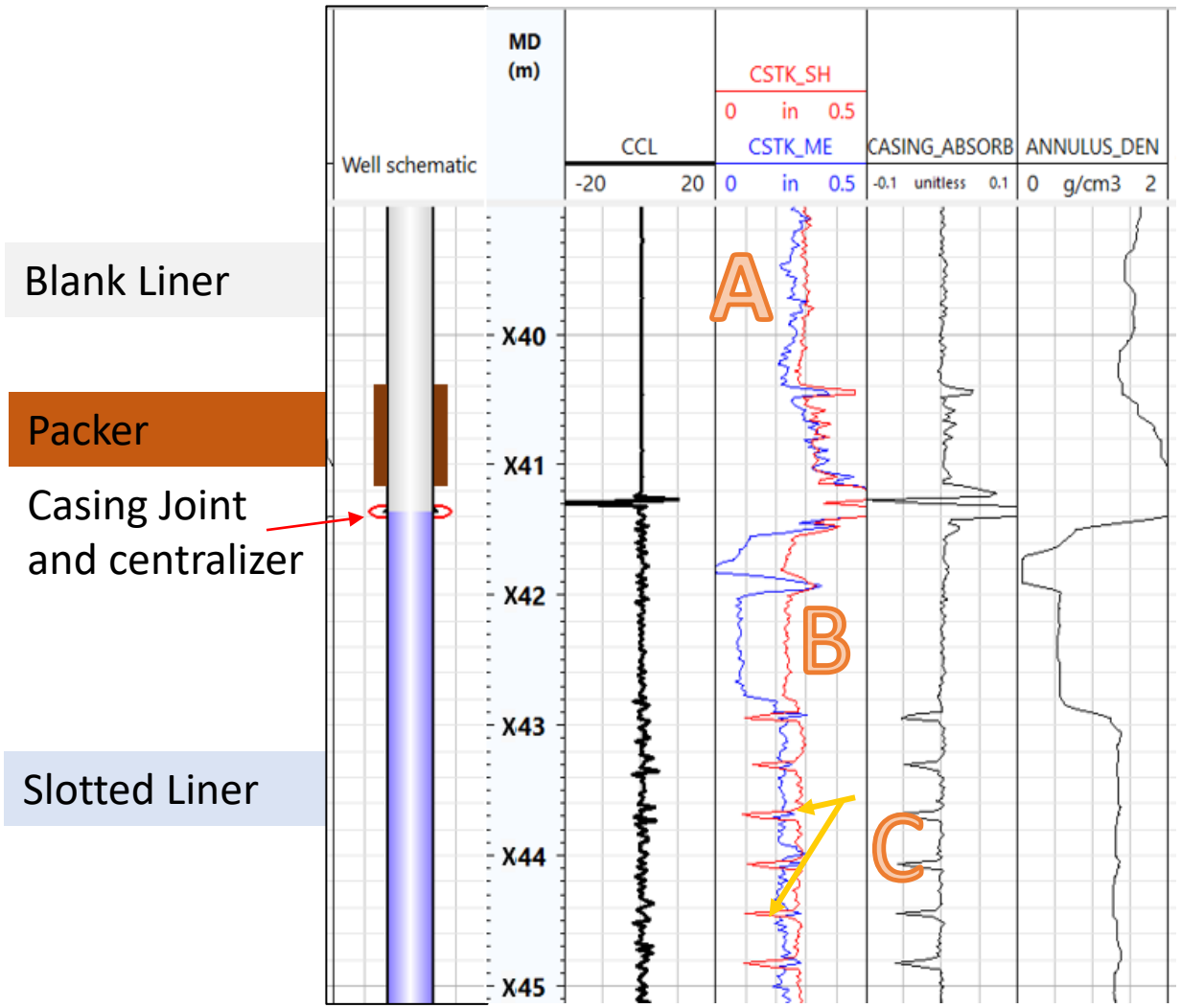


Cement in Annulus
Water in Annulus
Gas in Annulus

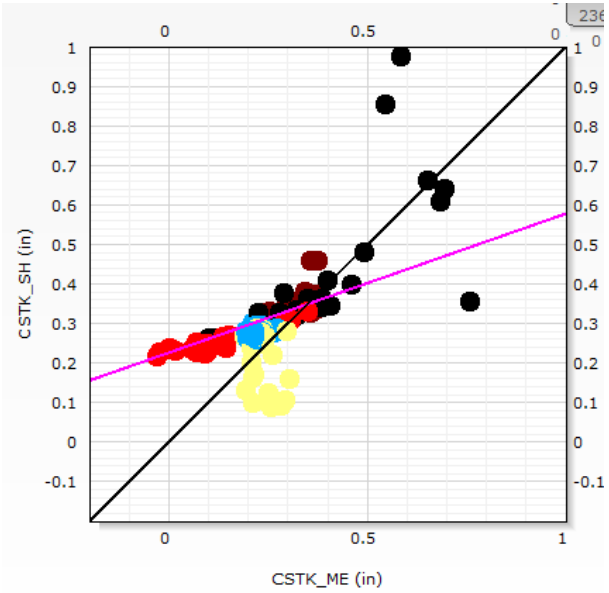
Liner Profile and Annulus Density



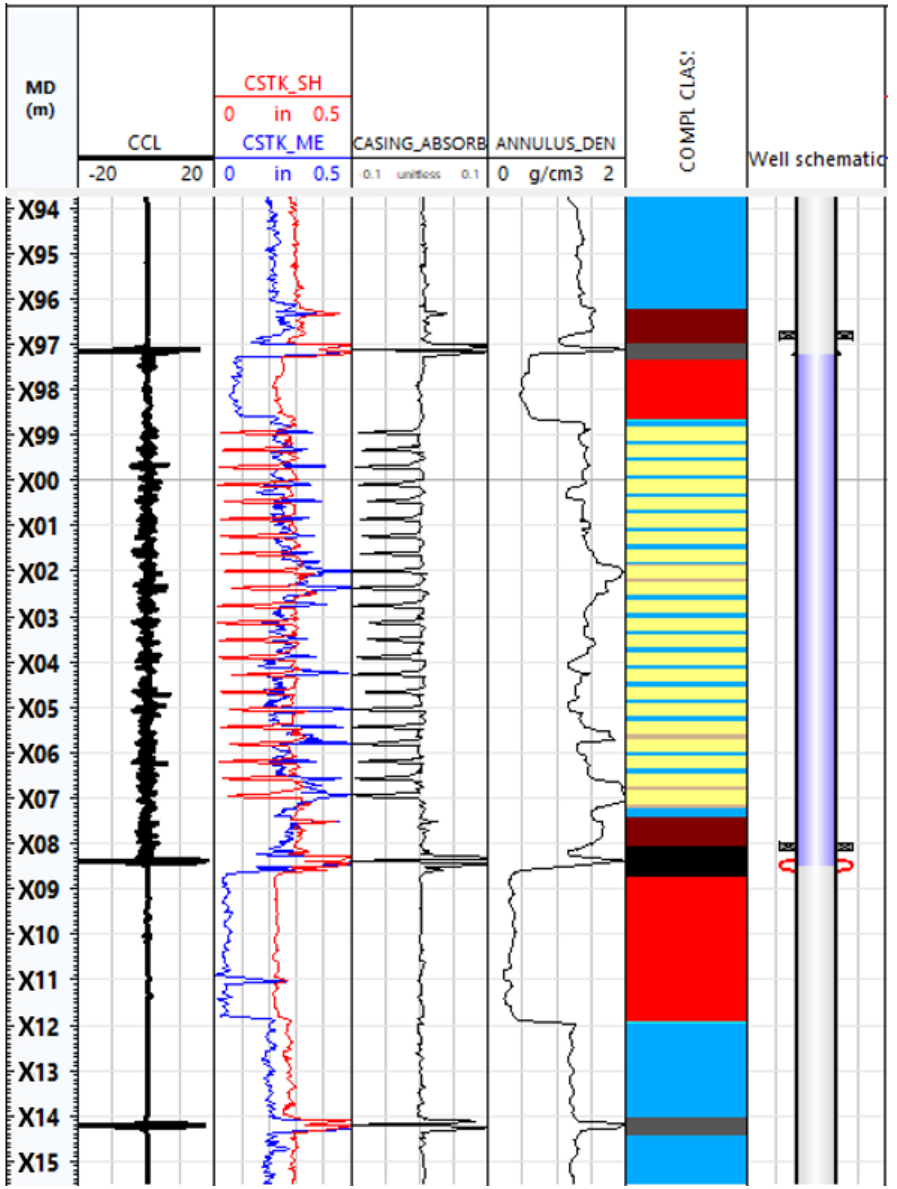




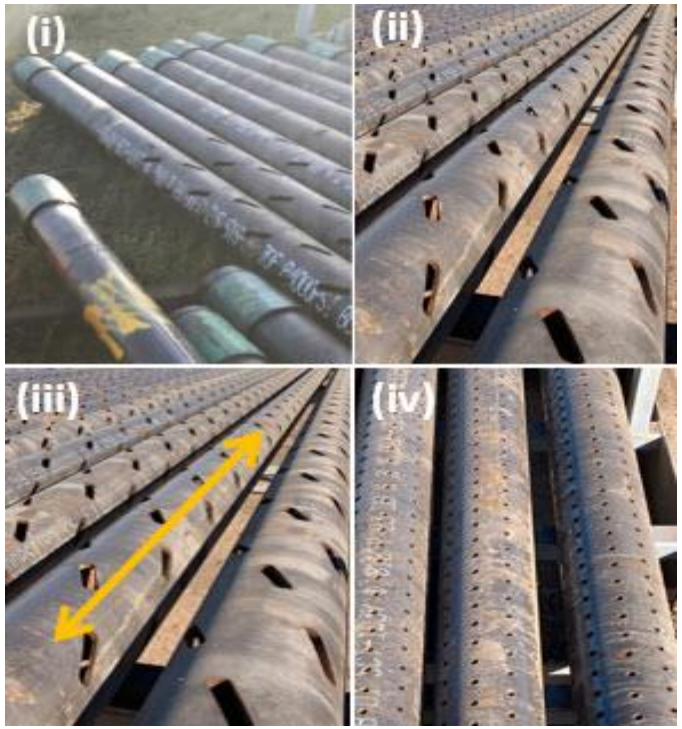
Completion Characteristics Classification



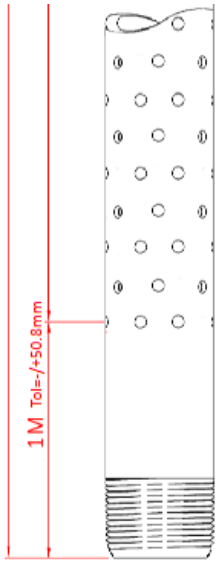
NAME	ANNULUS_DEN
Gas	-- <0.65 g/cc
Light Fluid	0.65< -- <1.0g/cc
Water	1.0< -- < 1.5 g/cc
High Density	1.5< -- < 2.0 g/cc
Heavy Cement	2.0 g/cc< --
Slot	
Collar Simple	
Collar & bow spring	
Packer	

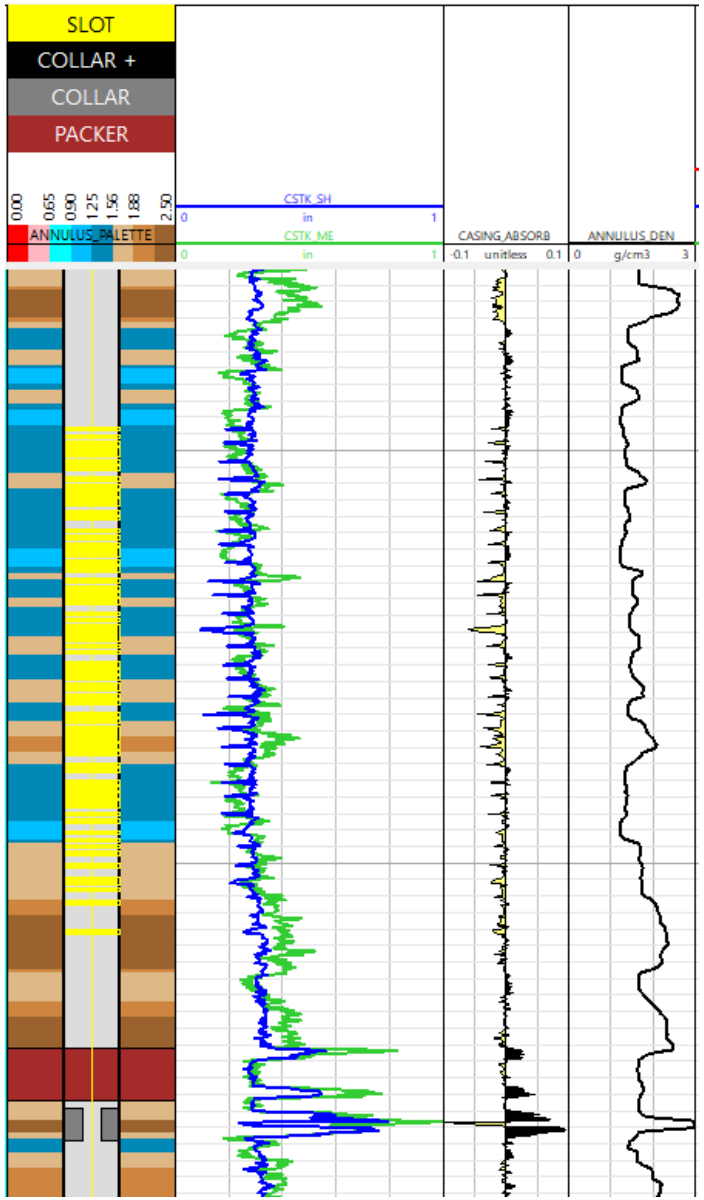


Example of Slots

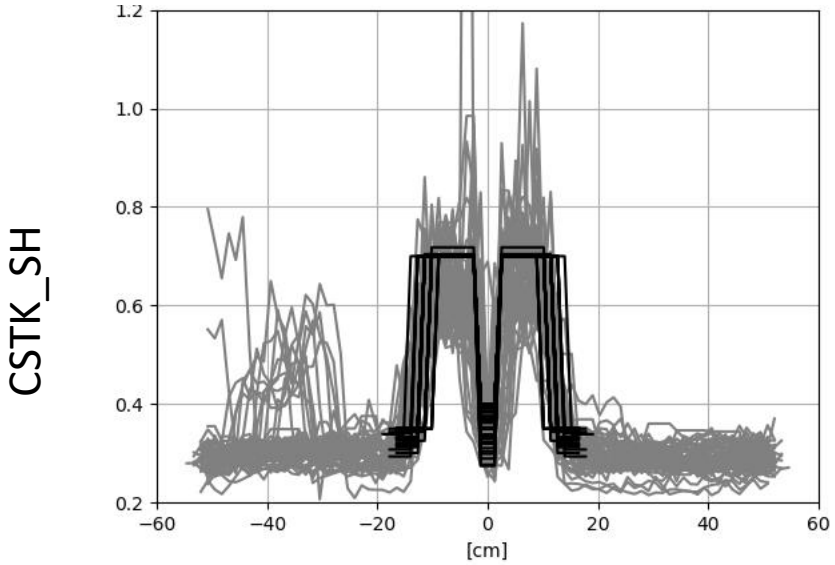


Different types of slots

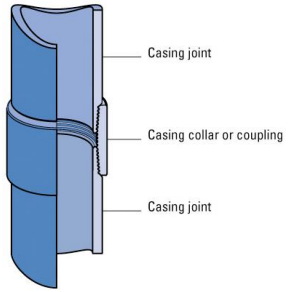


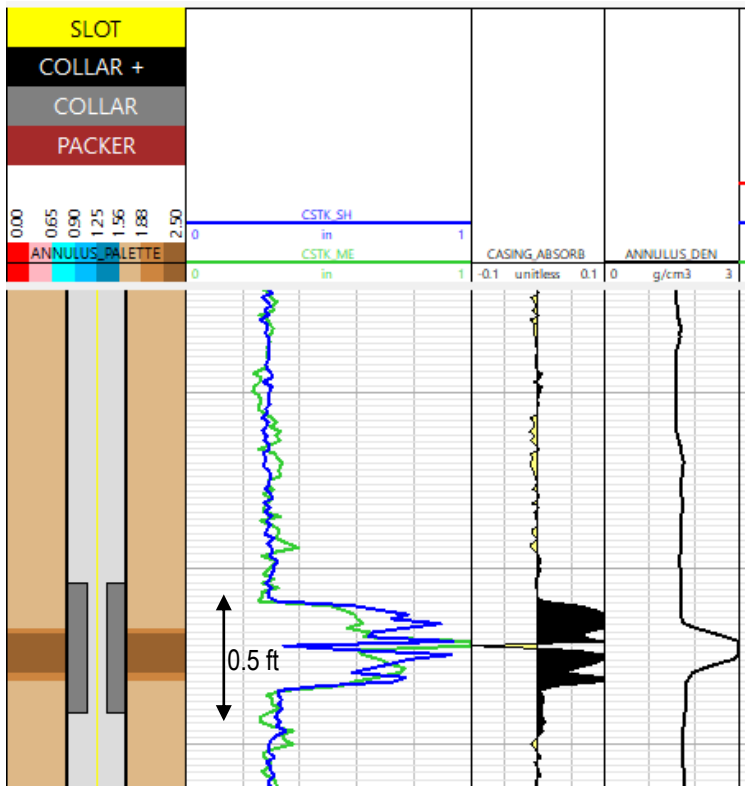


Example of Collar

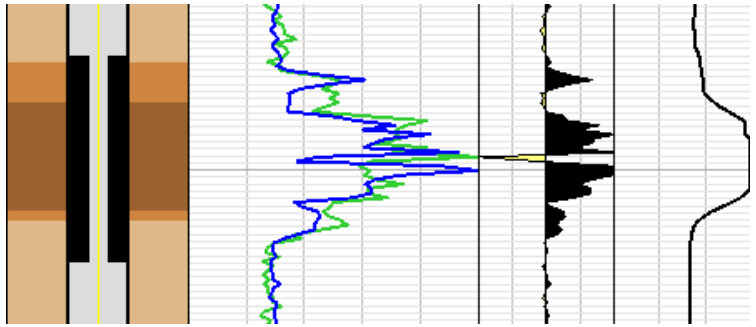


Cartoon of Casing Coupler



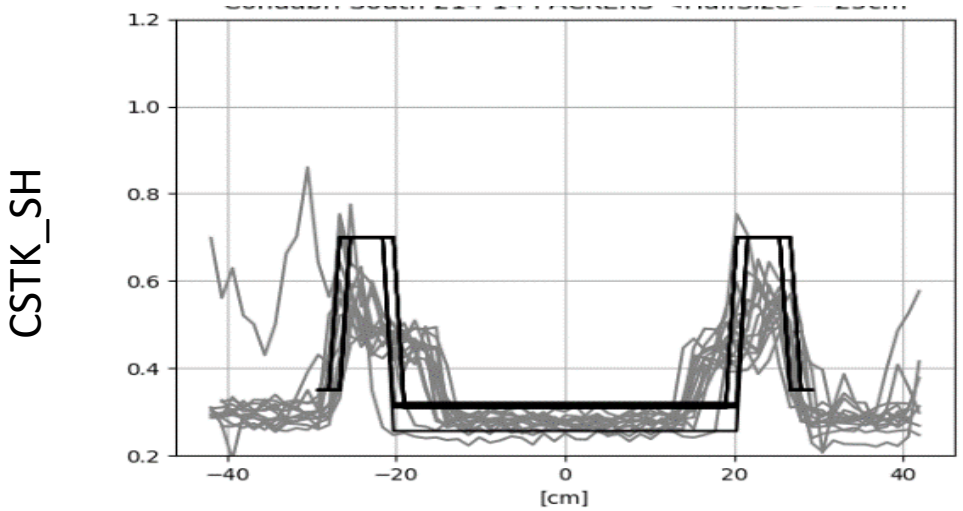


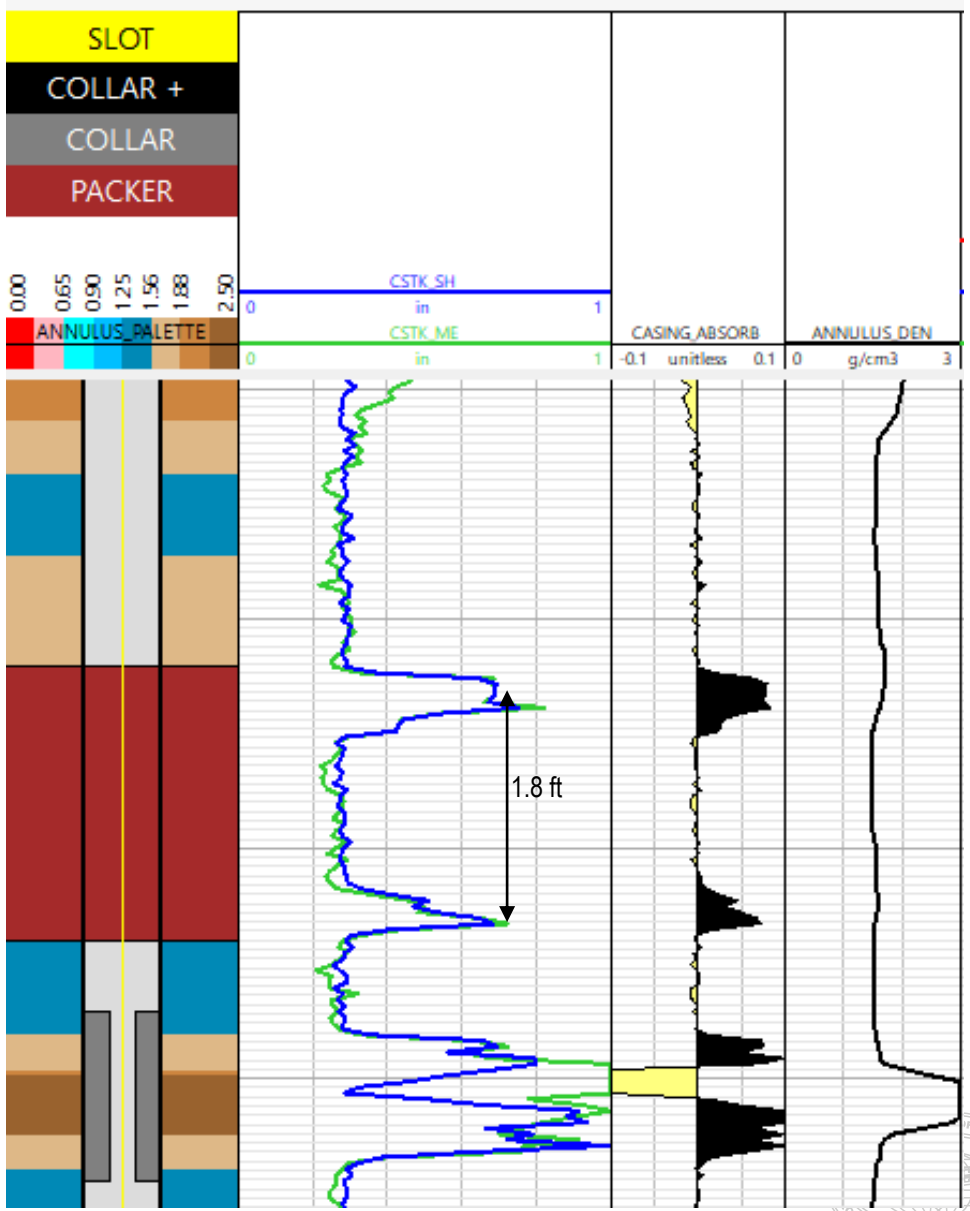
Collar + centralizer



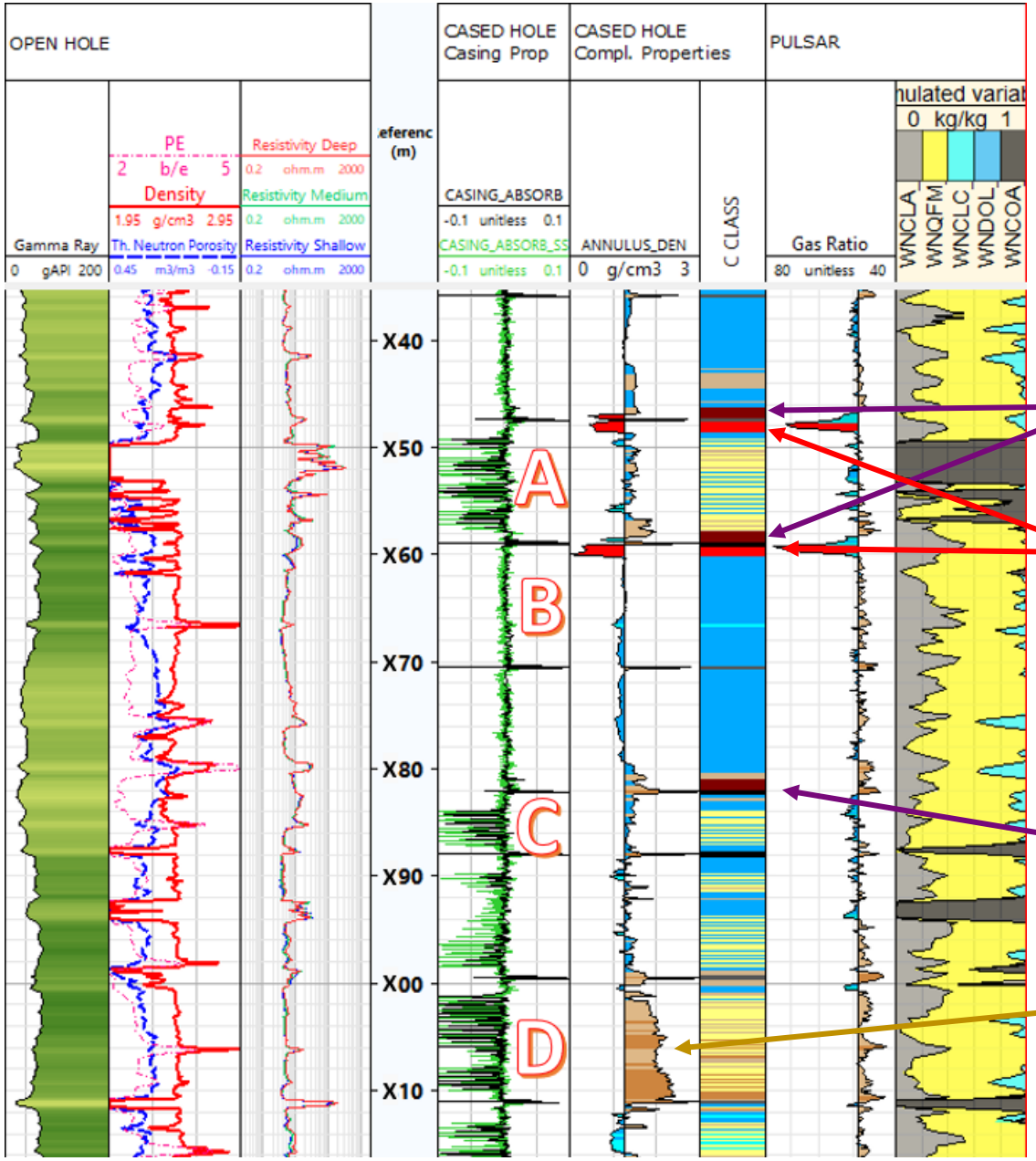
Example of swellable Packer

Swell Packer Type 2





Completion Properties



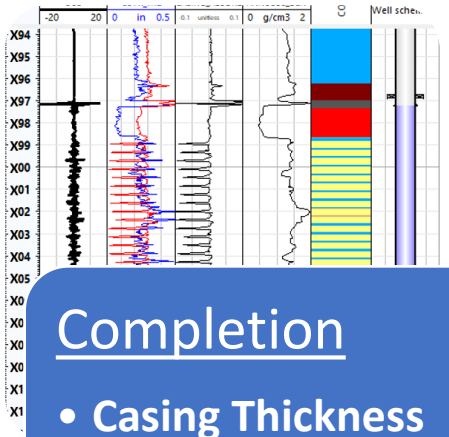
Isolating packers ;
gas accumulating below

Accumulation of gas in the annulus

Leaking packer ;
Origin of gas higher up in the annulus

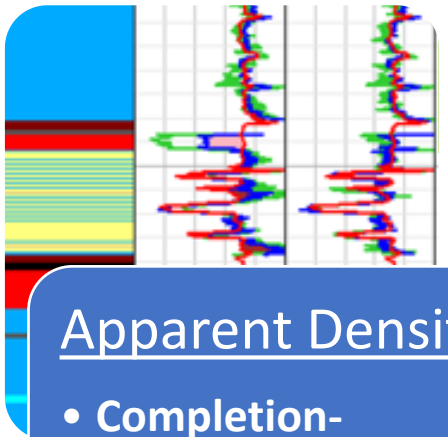
Accumulation of fines in the annulus

A New Application of 3-Detector Density Tool



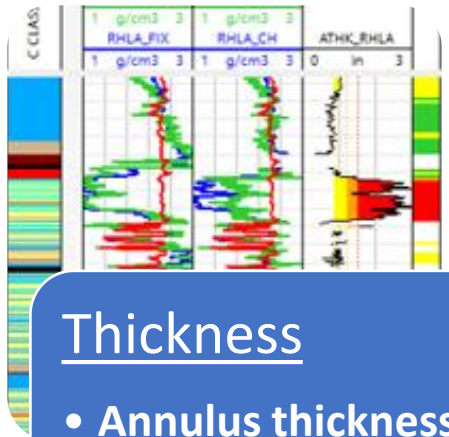
Completion

- **Casing Thickness**
- **Annulus Density**
- **Completion Class**



Apparent Density

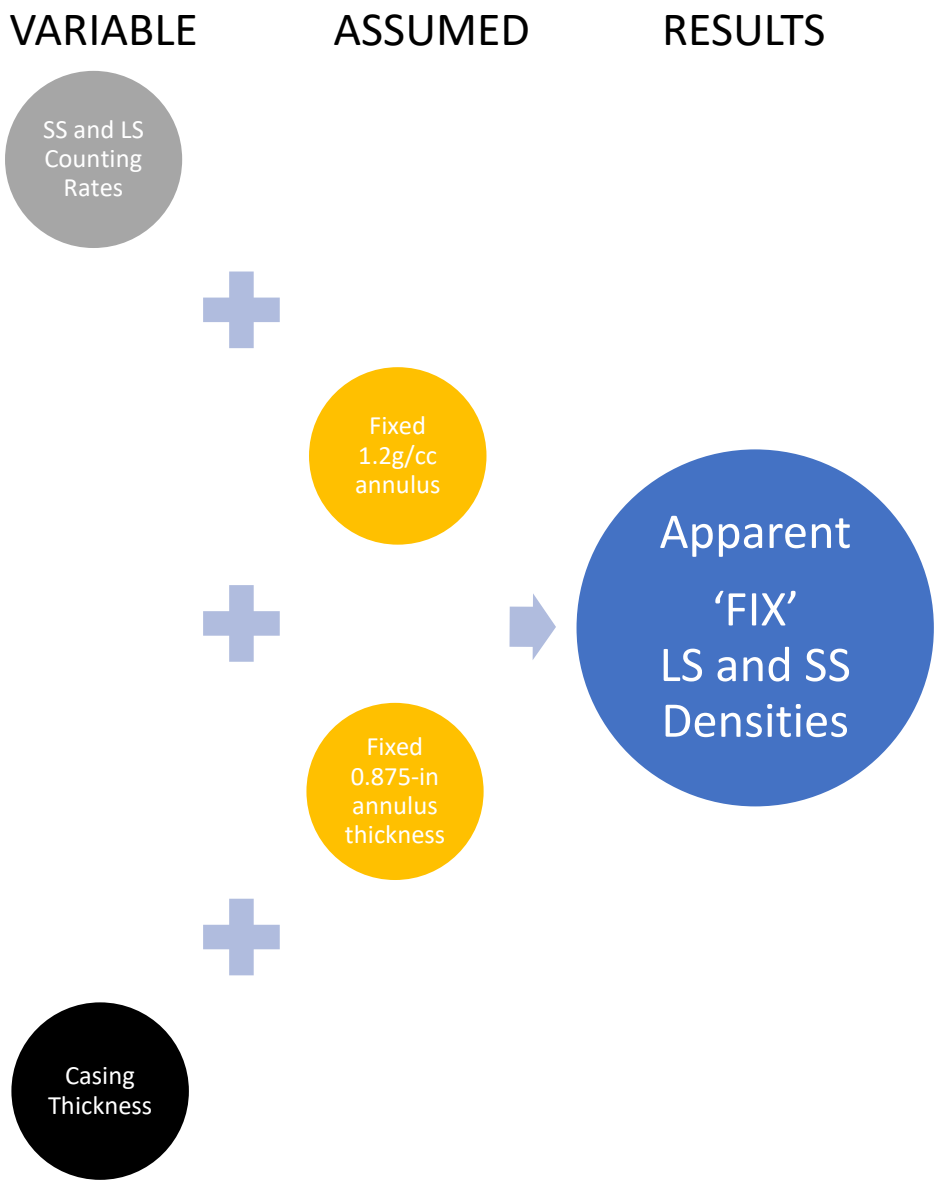
- **Completion-corrected Apparent Formation Density**



Thickness

- **Annulus thickness**
- Hole Caliper

FIX Apparent Densities : Casing Thickness and Nominal Annulus Corrections



1- Correct deeper-reading Short spacing and Long Spacing windows for :

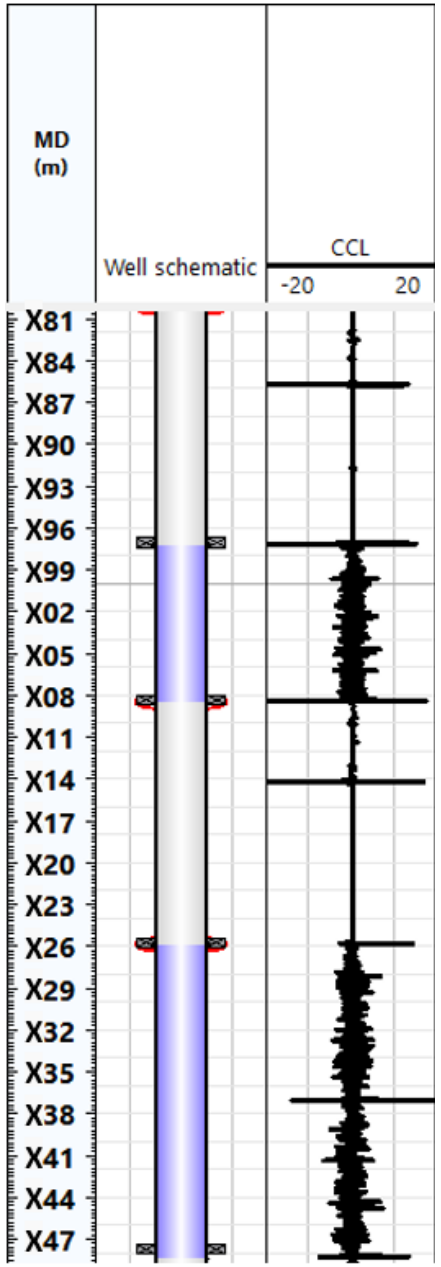
- Variable casing thickness
- 1.2 g/cc annulus
- Nominal size annulus

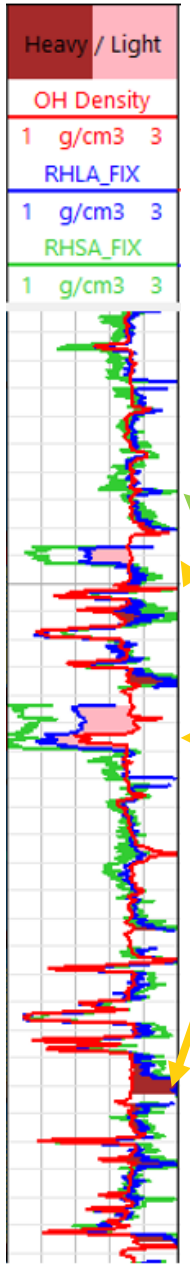
Does not input variable annulus density

2- compare with OH reference density

→ Test of "blind" approach

FIX Apparent Densities : Casing Thickness and Nominal Annulus Corrections





NO annulus density correction

--- Open hole density

--- Short Spacing density

--- Long Spacing density

Fixed 1.2g/cc annulus

Fixed 0.875-in annulus thickness

Good match :

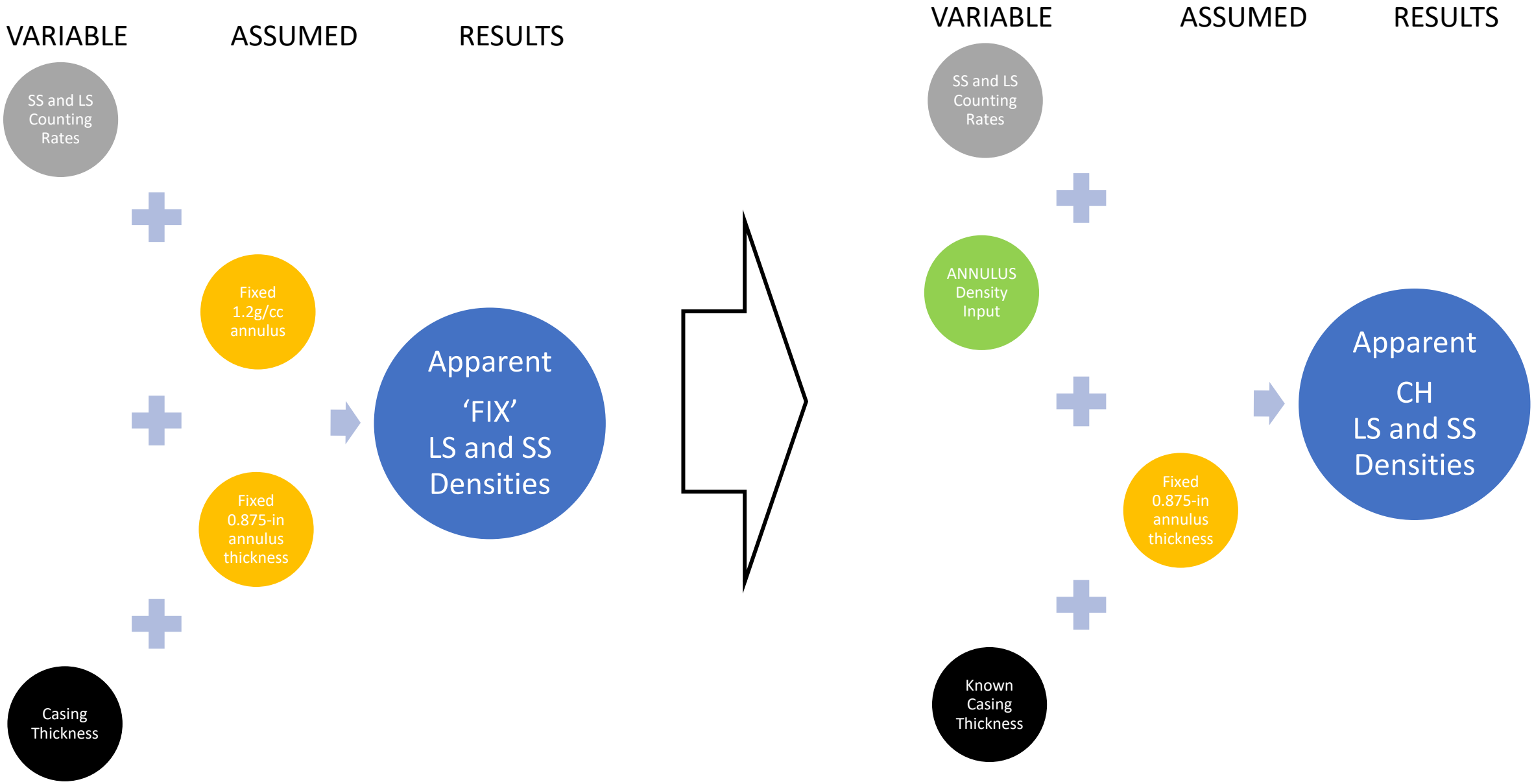
- Annulus fluid is water
- Annulus thickness is nominal

Poor match : ??

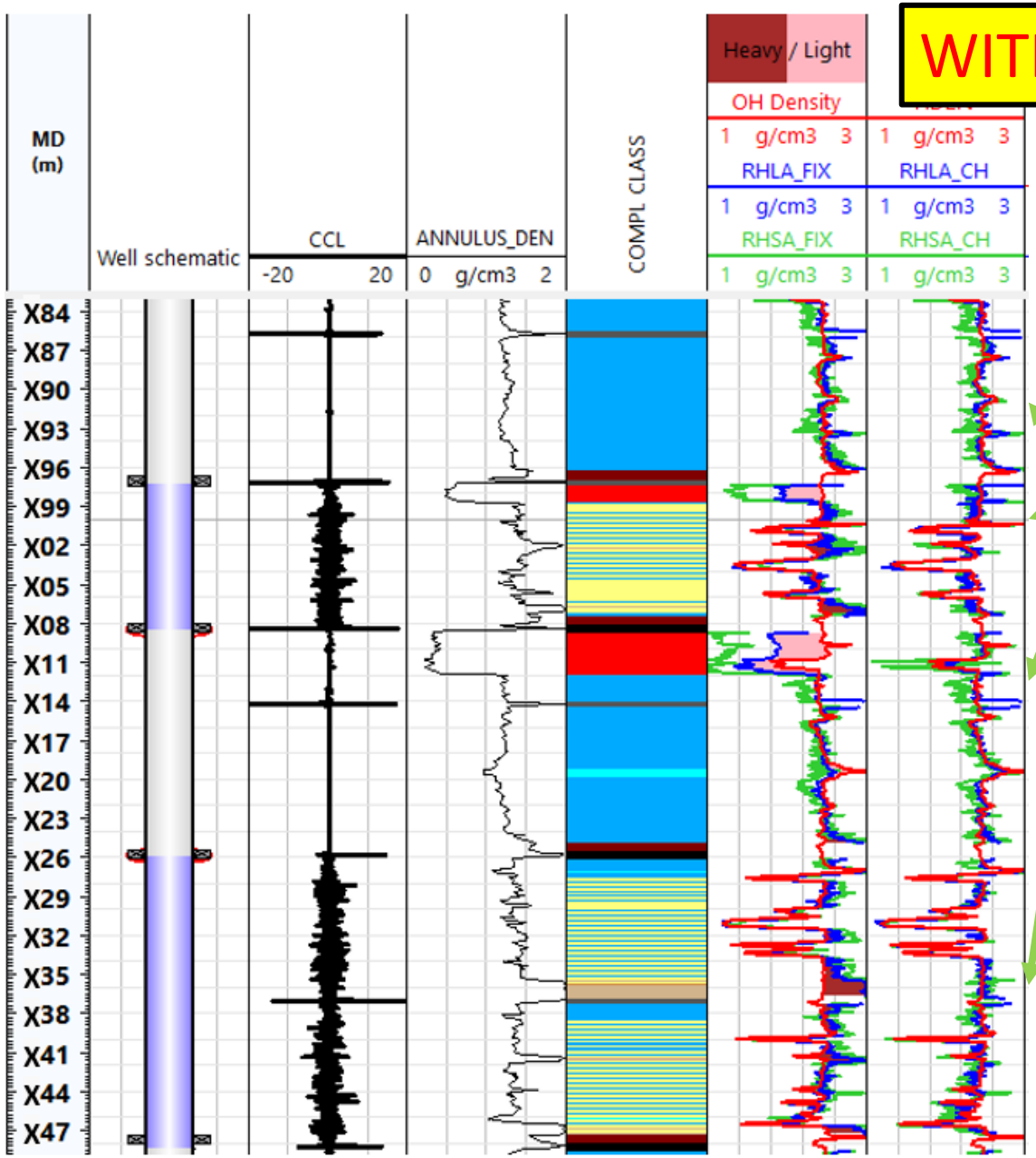
- Annulus fluid is NOT water
- Annulus thickness NOT nominal

In gauge or washouts ??

Cased-Hole Apparent Density : Annulus Density Correction



Cased-Hole Apparent Density : With Annulus Density Correction



WITH annulus density correction

--- Open hole density

--- Short Spacing density

--- Long Spacing density

Fixed 0.875-in annulus thickness

Good match :

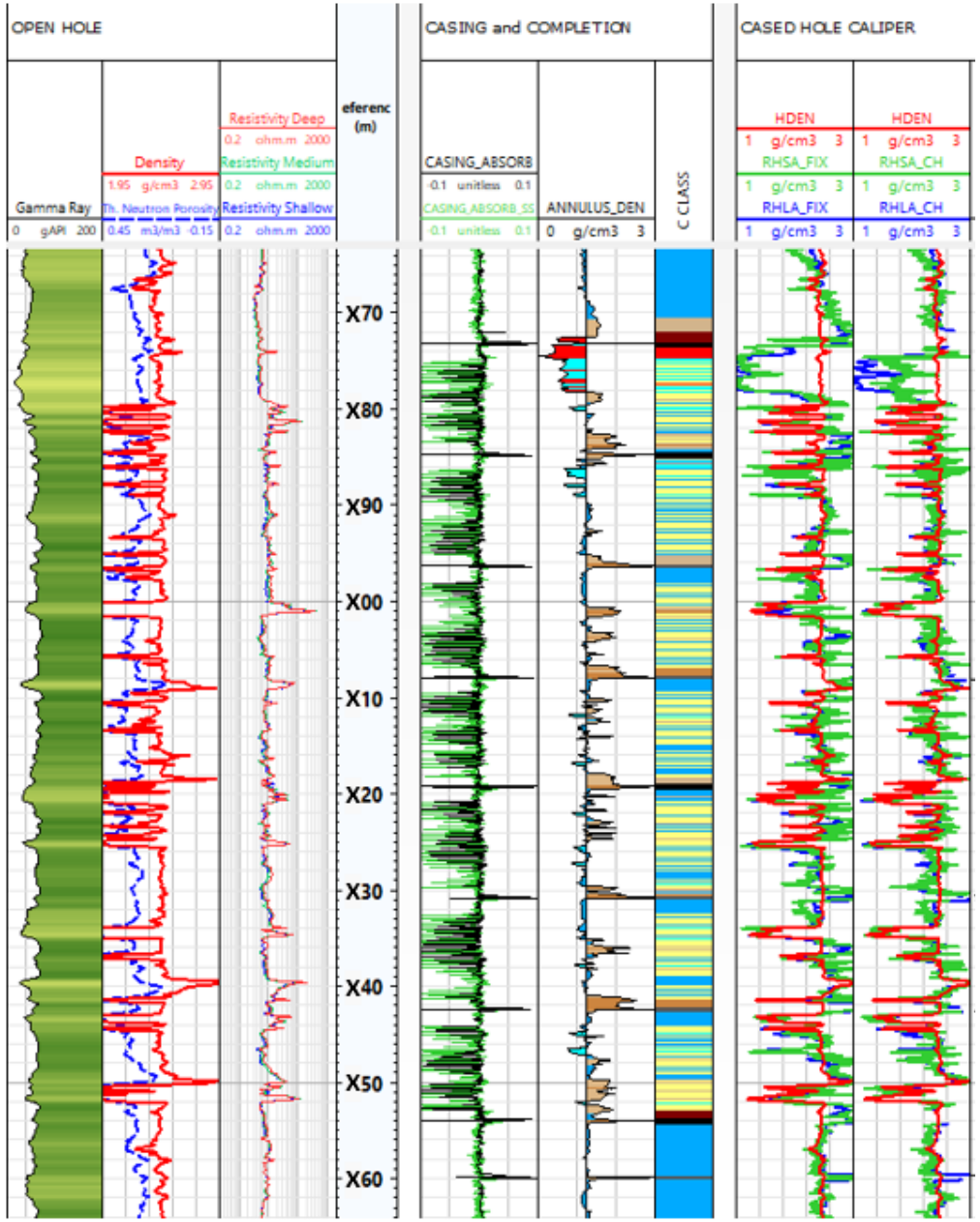
- Annulus thickness is nominal

Poor match :

- Annulus thickness NOT nominal

→ **In gauge, no washouts**

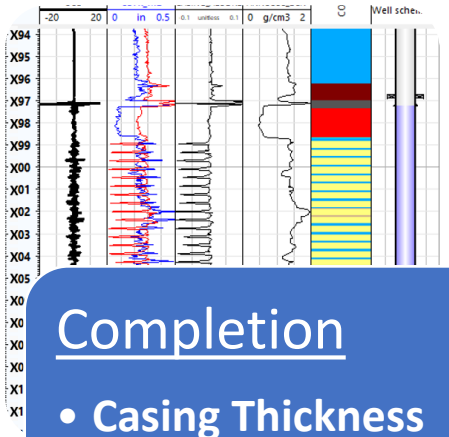
Case Study 1



Still differences after applying variable annuus density correction

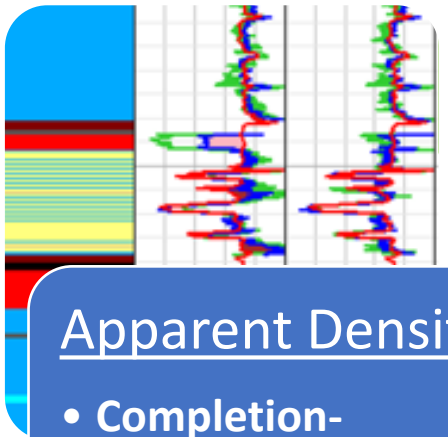
How to quantify extent of hole enlargement ?

A New Application of 3-Detector Density Tool



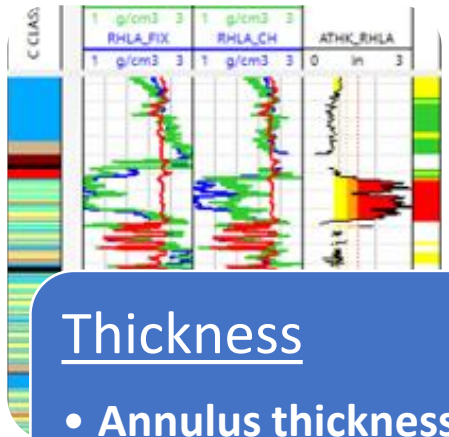
Completion

- **Casing Thickness**
- **Annulus Density**
- **Completion Class**



Apparent Density

- **Completion-corrected Apparent Formation Density**



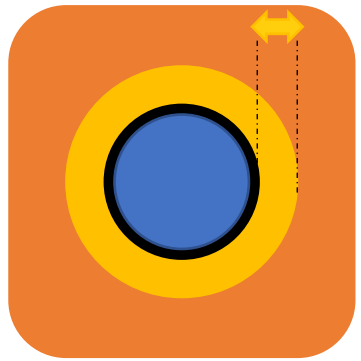
Thickness

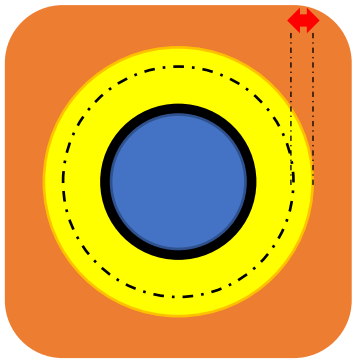
- **Annulus thickness**
- Hole Caliper

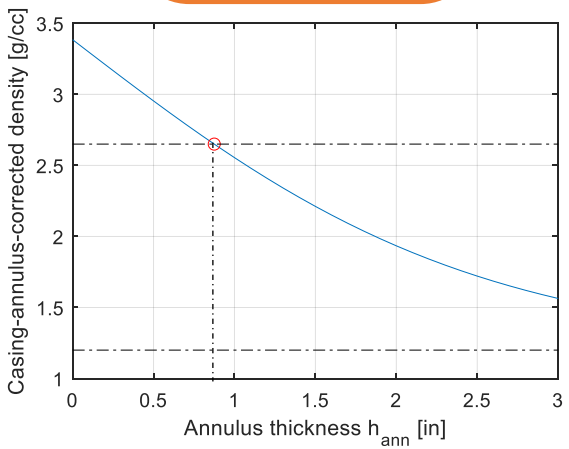
Quantifying Actual Annulus Thickness

Nominal casing-annulus correction

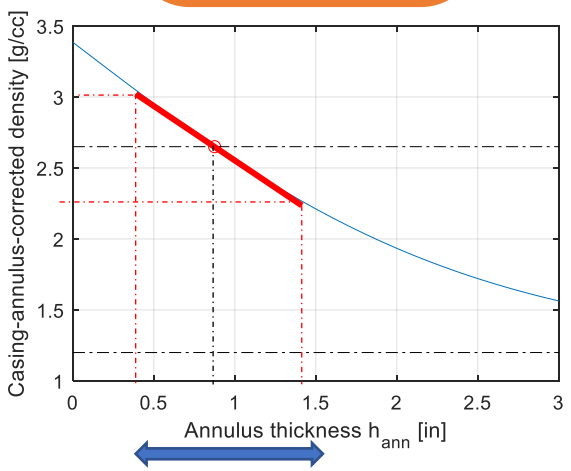
Estimating thickness from deviation





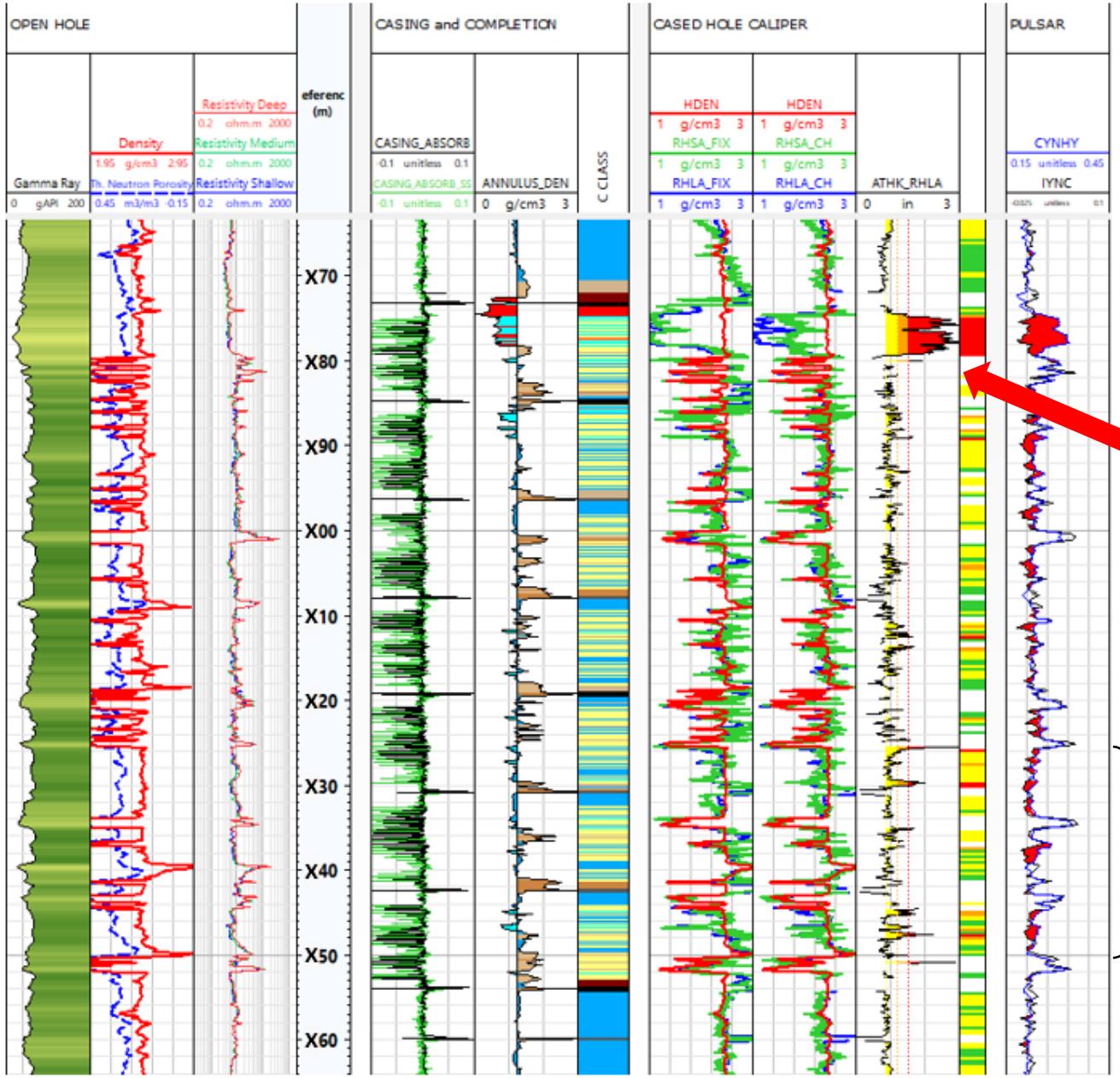


Density deviation



Annulus thickness deviation

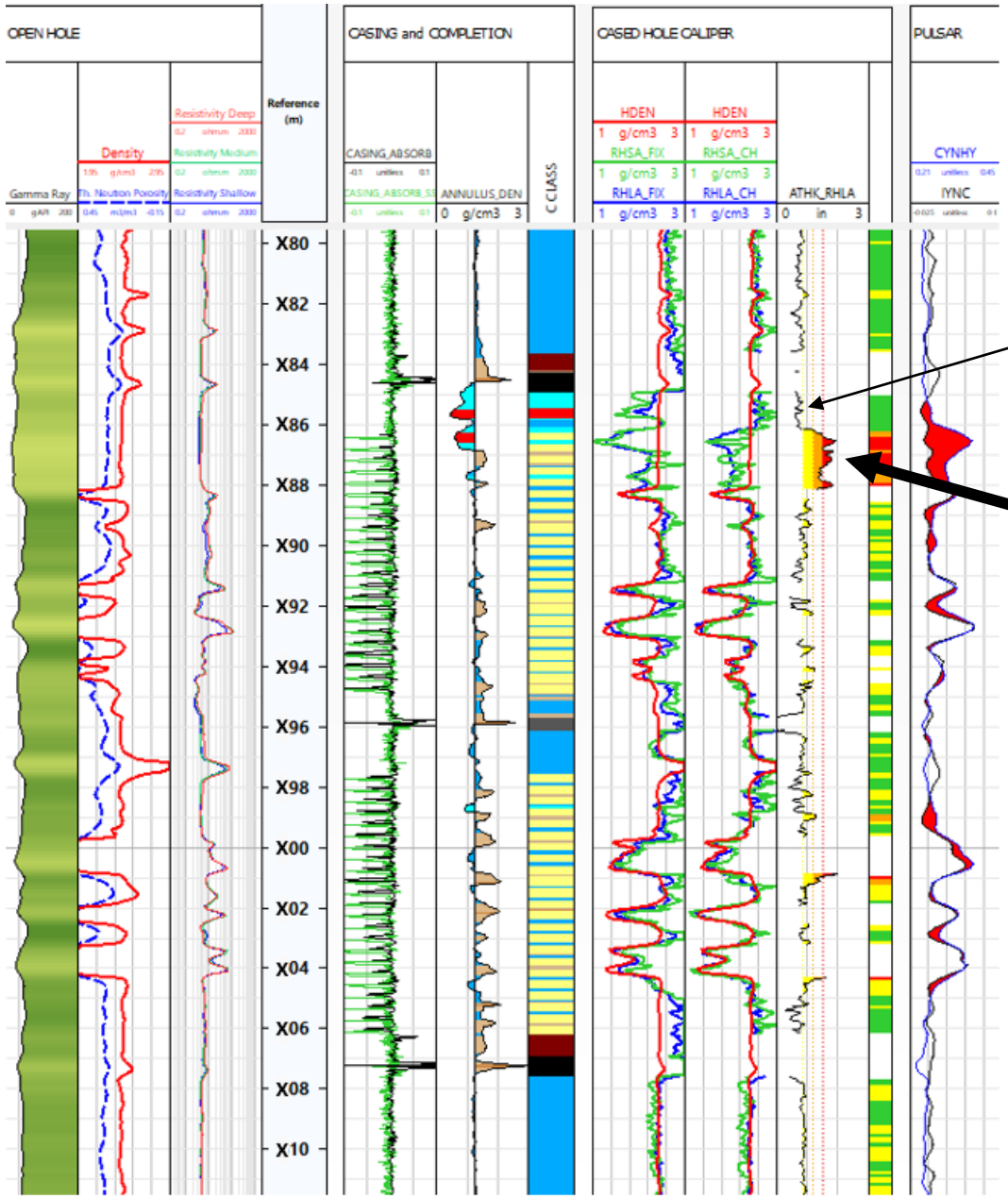
Case Study 1



Large washout

Some washouts

Case Study 2



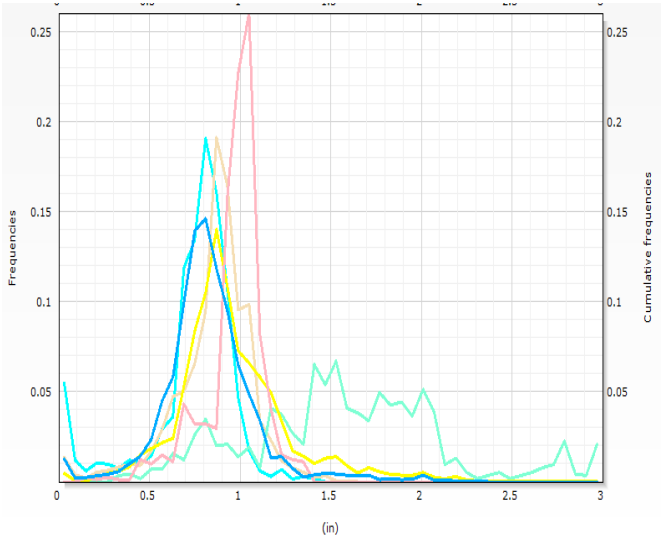
No washout

Large washout

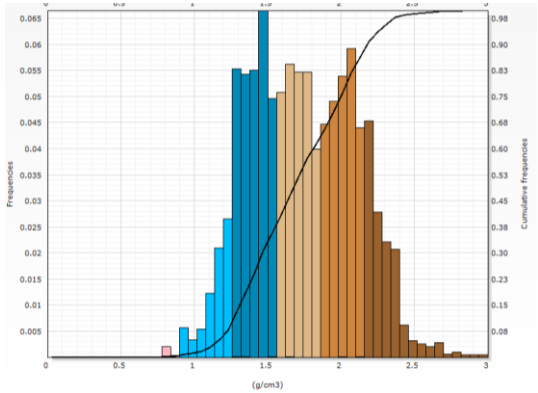
Examples of how to use this information

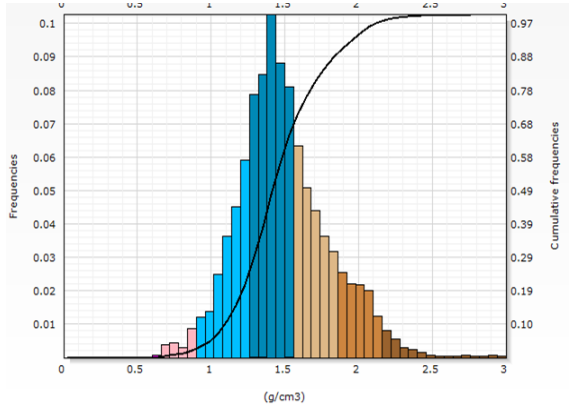
- Drives improvements in the design of in-wellbore completion programs
- Drives recompletion decisions
- Can triggers proactive workovers

Annulus thickness distribution per zone



Annulus density distribution





Conclusions

- A new methodology to estimate casing and annulus properties, in particular annulus thickness, based on a 3-detector density tool, is proposed

- The performance of this new methodology is illustrated in several wells completed in the Walloon Coal Measures.

- Results demonstrate the ability to:
  - **identify downhole completion elements**
  - **identity fluid/material filling the annular**
  - **identify leaking packer**
  - **identify zones of borehole enlargement behind slotted liner**.

- The application of this solution :
  - **Drives improvements in the design of in-wellbore completion programs**
  - **Drives recompletion decisions**
  - **Can triggers proactive workovers.**