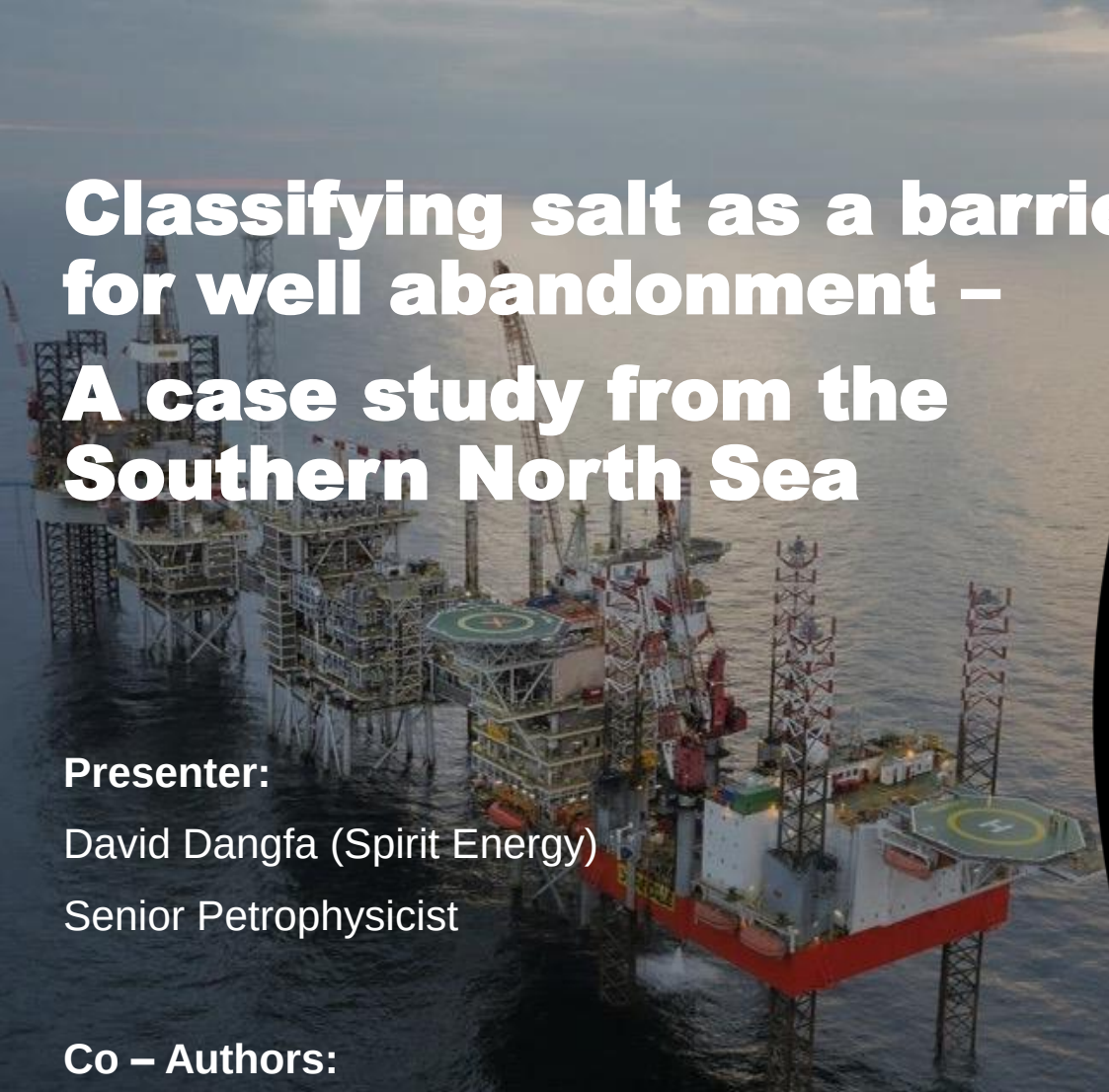
Classifying salt as a barrier for well abandonment – A case study from the Southern North Sea



Presenter:

David Dangfa (Spirit Energy)

Senior Petrophysicist

Co – Authors:

Hozefa Godhrawala, Rashid Sharafutdinov (Spirit Energy)

Kamaljeet Singh, David Small (Schlumberger)

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Agenda

- A-Fields introduction
- Geology
- Abandonment overview and challenges
- Case study
- Conclusion
- Acknowledgements

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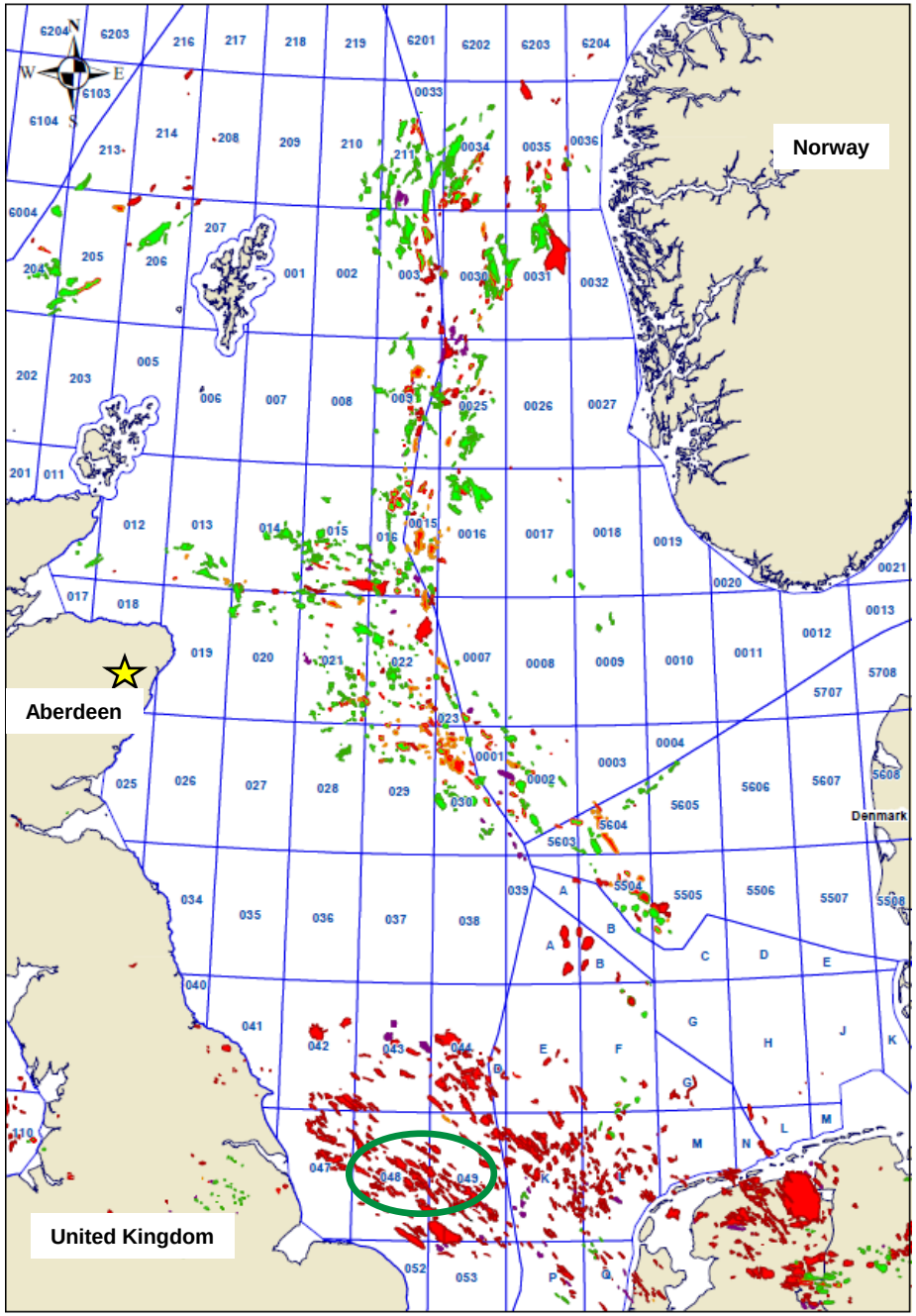
A-Fields - Overview

Fields:	*Ann* *Annabel* *Audrey* *Alison*
Location:	UKCS Southern Gas Basin
Partnership:	100% Spirit Energy
Hydrocarbons:	Gas , Condensate
Reservoir Formation:	Rotliegend Leman Sandstone
Source Formation:	Westphalian Coal Measure
Start of production:	1988
Production wells:	21
Total Production:	> 955 BCF
Total GIIP:	1.2 TCF
CoP:	2016



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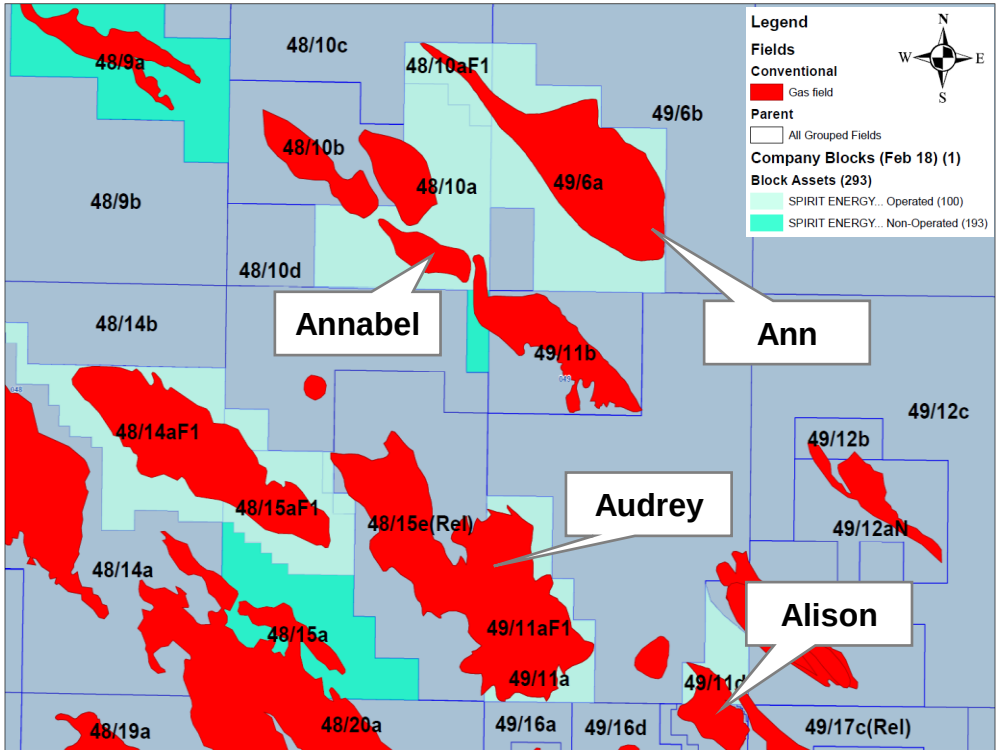
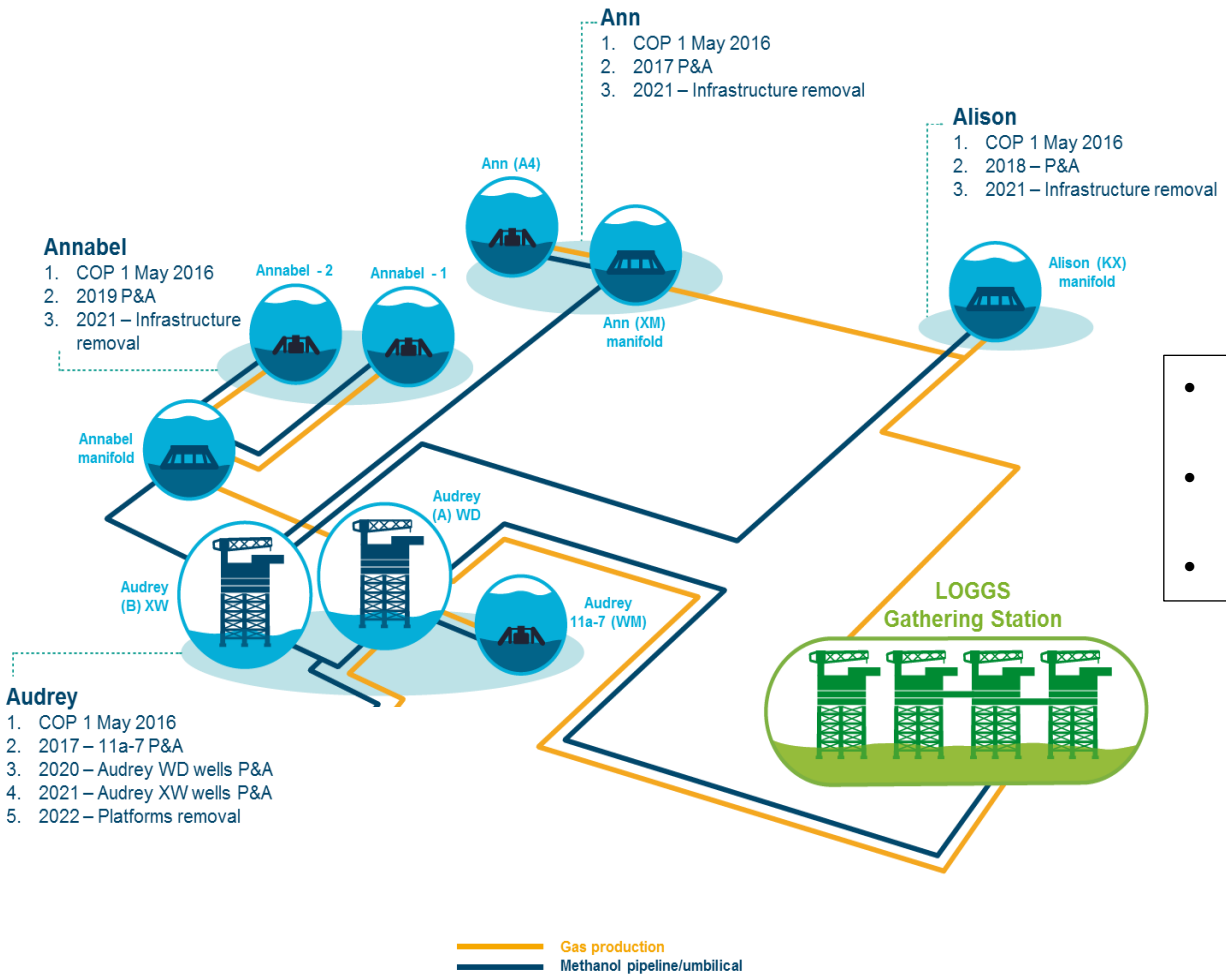


A-Fields - Decommissioning overview



- 14 platform wells
- 7 subsea wells
- 2 open water suspended wells

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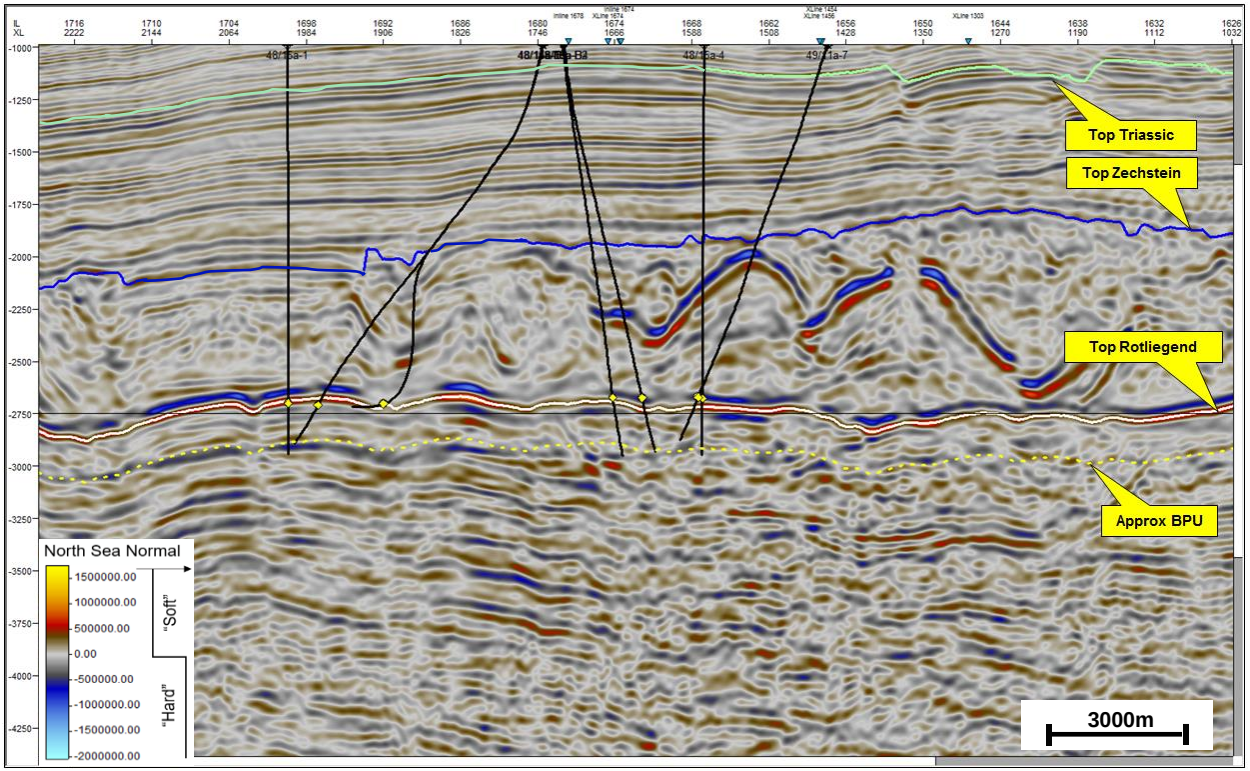
Spirit Energy has 52 wells to be abandoned by 2023

A-Fields – Seismic section and stratigraphy



Seismic section of A-fields

Flow potential zones

Age	Group	Formation / Member
	Seabed	
TERTIARY	North Sea	*Quaternary*
CRETACEOUS	Chalk	
	Cromer Knoll	
		Top Speeton Clay
JURASSIC	Lias	
TRIASSIC		*Winterton*
	Haisborough	*Triton Anydrite*
		Dudgeon Saliferous
		Muschelkalk
		Rot Halite
	Bacton	*Bunter Sandstone*
		Bunter Shale
		Brockelshiefer
PERMIAN	Zechstein	*Aller Halite*
	Z4	*Pegmatitanhydrit*
		Roter Salzton
	Z3	*Leine Potash/ Leine Halite*
		Plattendolomit
	Z2	*Stassfurt Halite*
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		Basal Anhydrit
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	Z1	*Werraanhydrit*
		Zechsteinkalk
		Kupferschiefer
	Rotliegend	*Leman Sandstone Units A, B, C*
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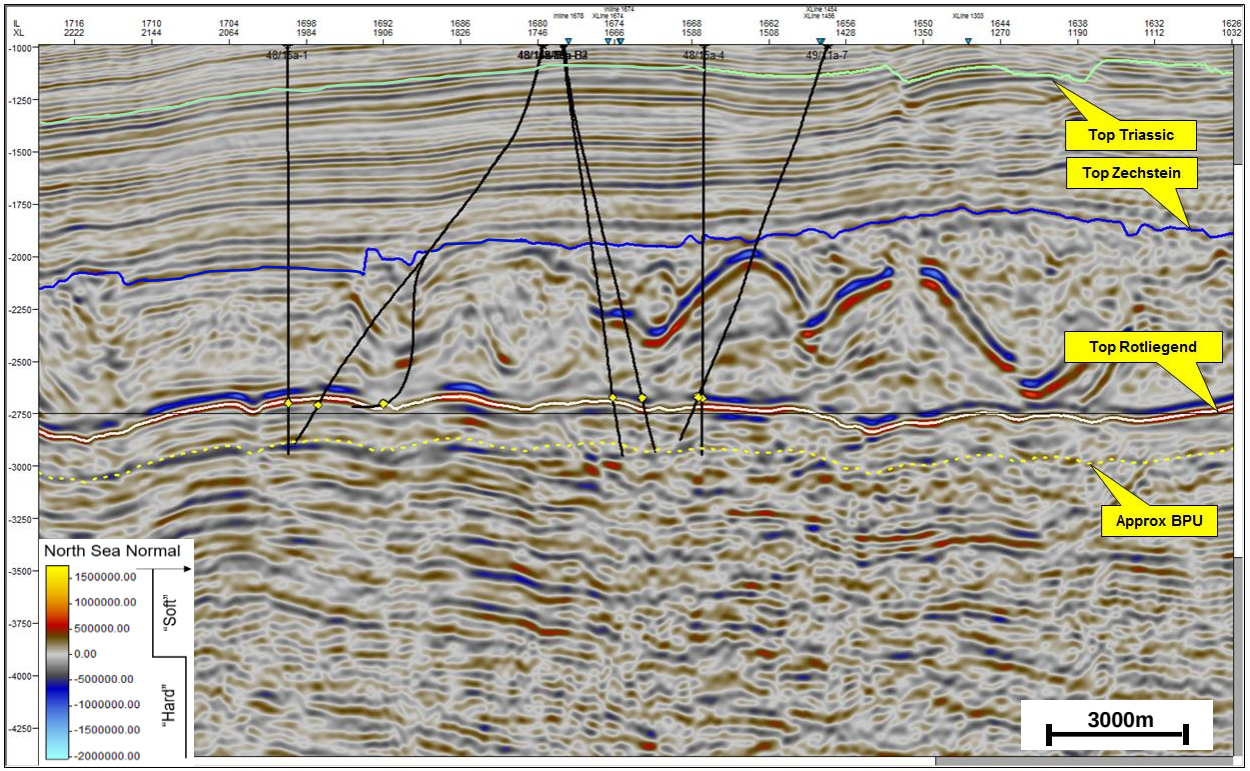
Multiple flow zones and drilling hazards

A-Fields – Seismic section and stratigraphy



Seismic section of A-fields

Soluble and mobile salts

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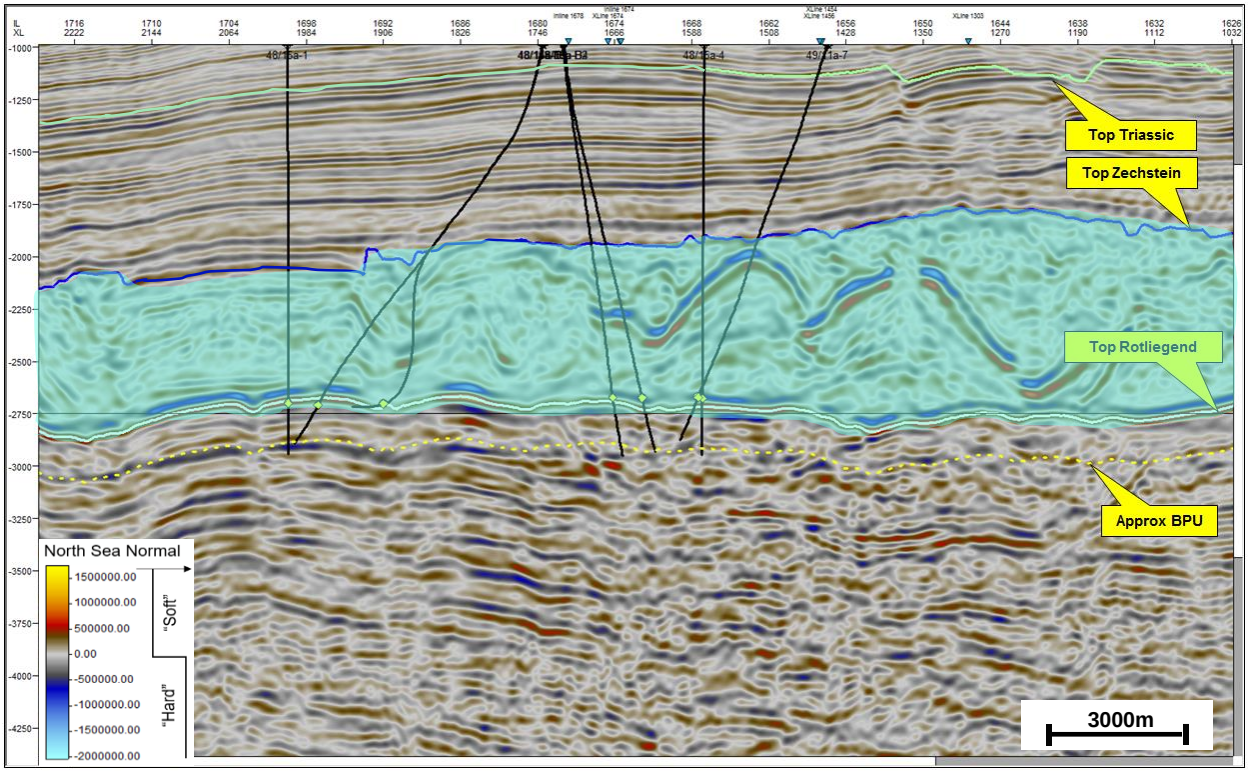
Multiple flow zones and drilling hazards

A-Fields – Seismic section and stratigraphy



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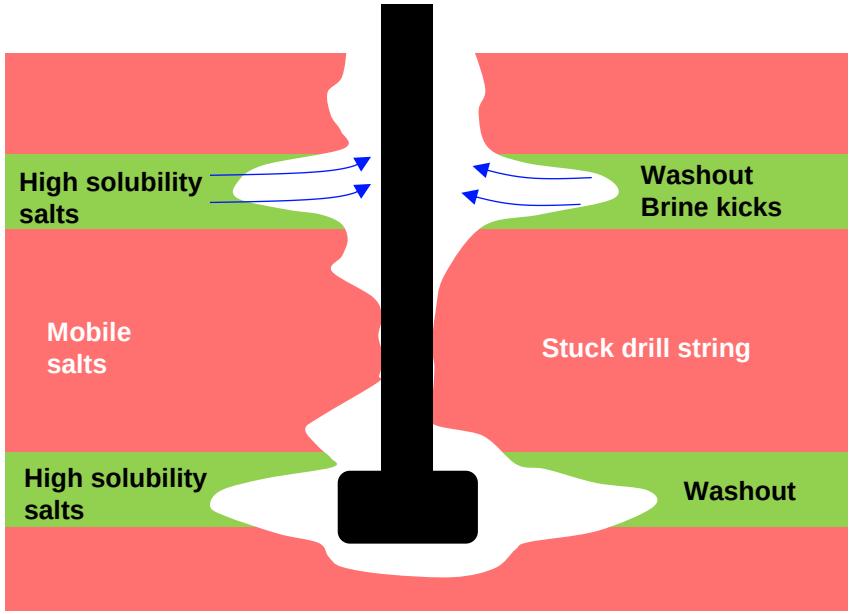
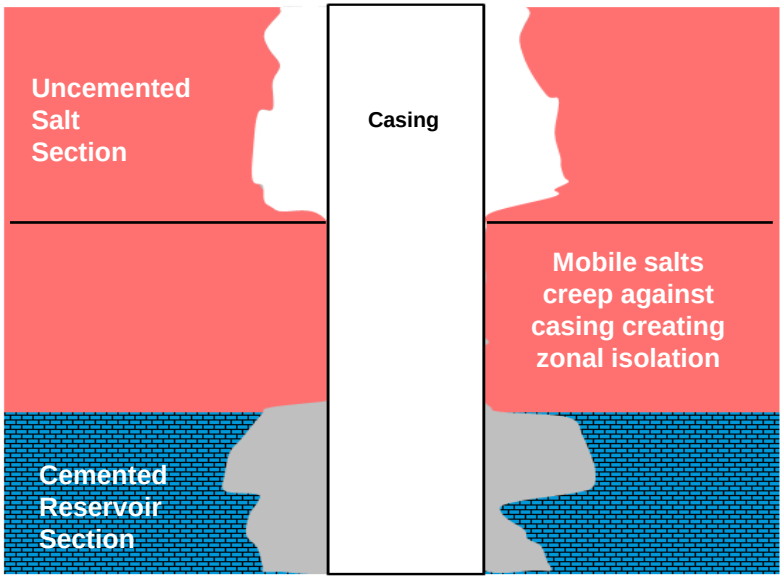
Multiple flow zones and drilling hazards

Zechstein - Squeezing salts

- Predominantly evaporite (anhydrite and salt) and carbonate formations
- Complex sequence of soluble salts with high potassium and magnesium content.
- Drilling challenges associated with highly soluble and mobile salts





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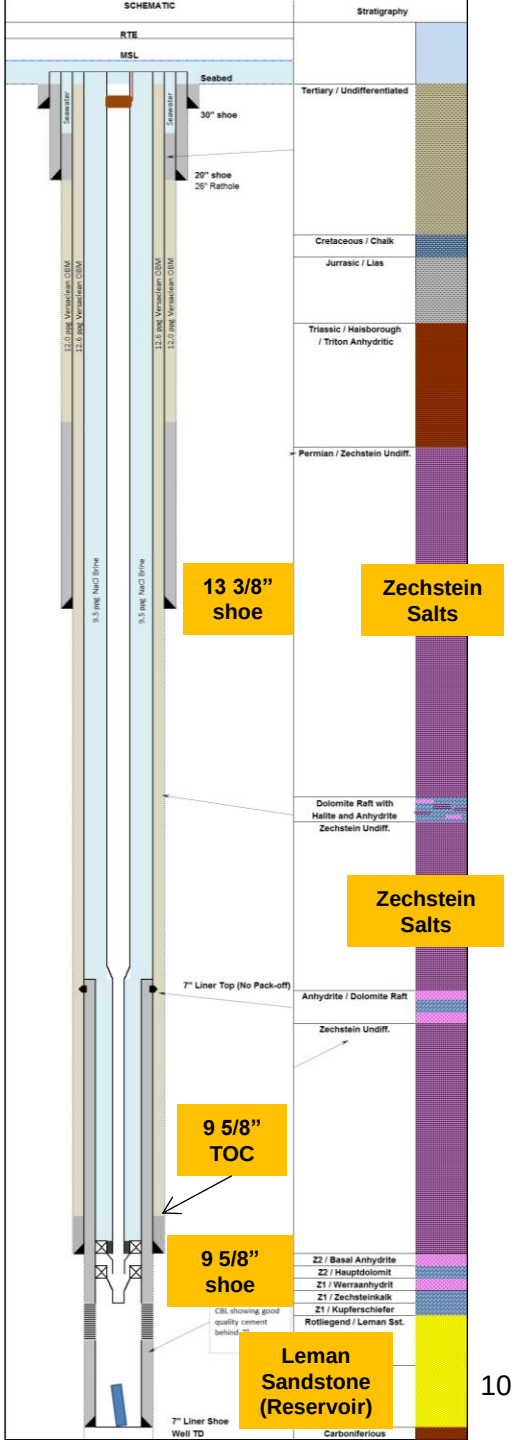
Mobile salts - drilling challenge but abandonment opportunity

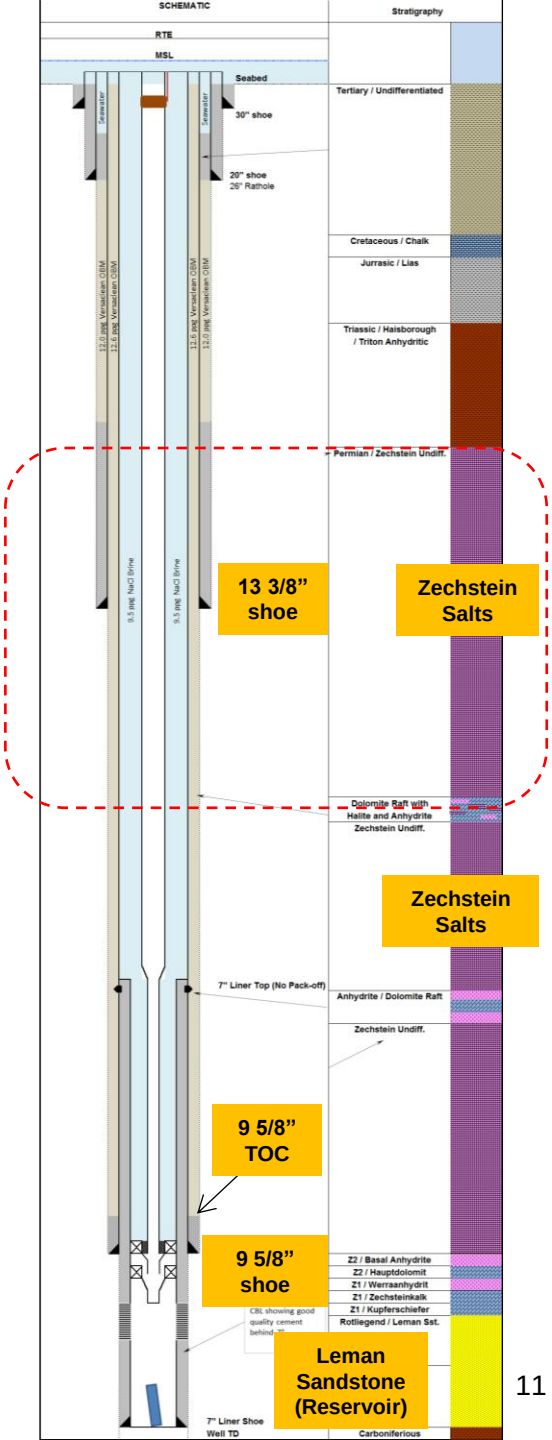
Case Study - Audrey 49/11a-7

- Subsea gas producer
- Drilled late 1987 and completed in August 1988
- Production abruptly ceased in March 1997 due to well related issues
- Well abandoned in April 2017
- Subsurface objectives to establish:-
  - Zones with flow potential
  - Cement / salt bond behind 9 5/8” casing



Case Study - Work plan

- Review old CBL log
- Cut and retrieve tubing
- Acquire conventional CBL and Pulse Echo / Flexural Attenuation logs for cement evaluation
- If good casing bond observed in zone(s) of interest, conduct AIT test and set balance cement plug along annular bond
- If poor/no casing bond observed or failed AIT, perform remedial perf and wash cement job at 13 3/8” shoe



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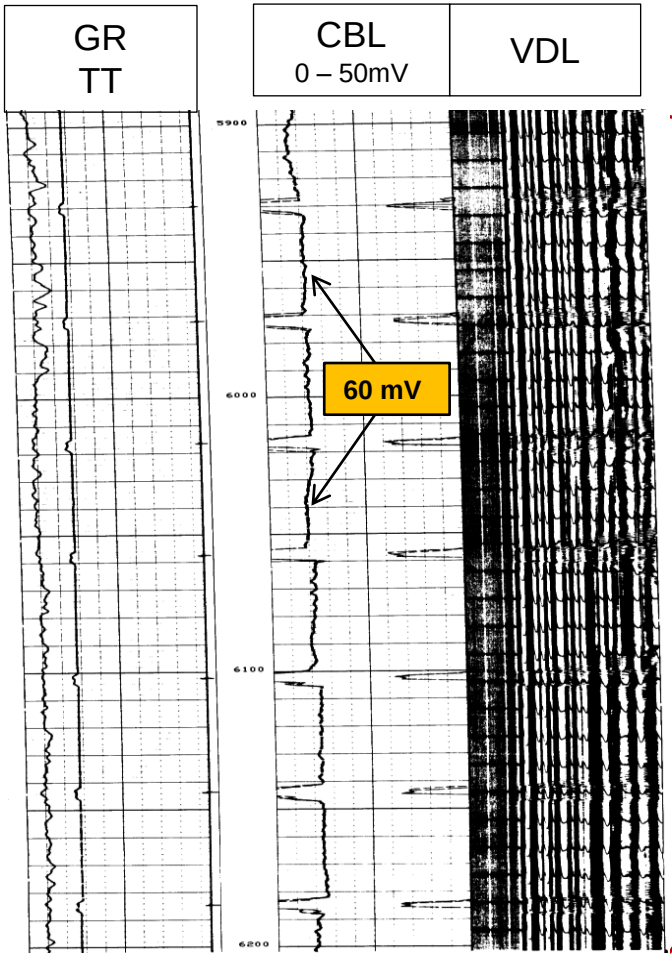
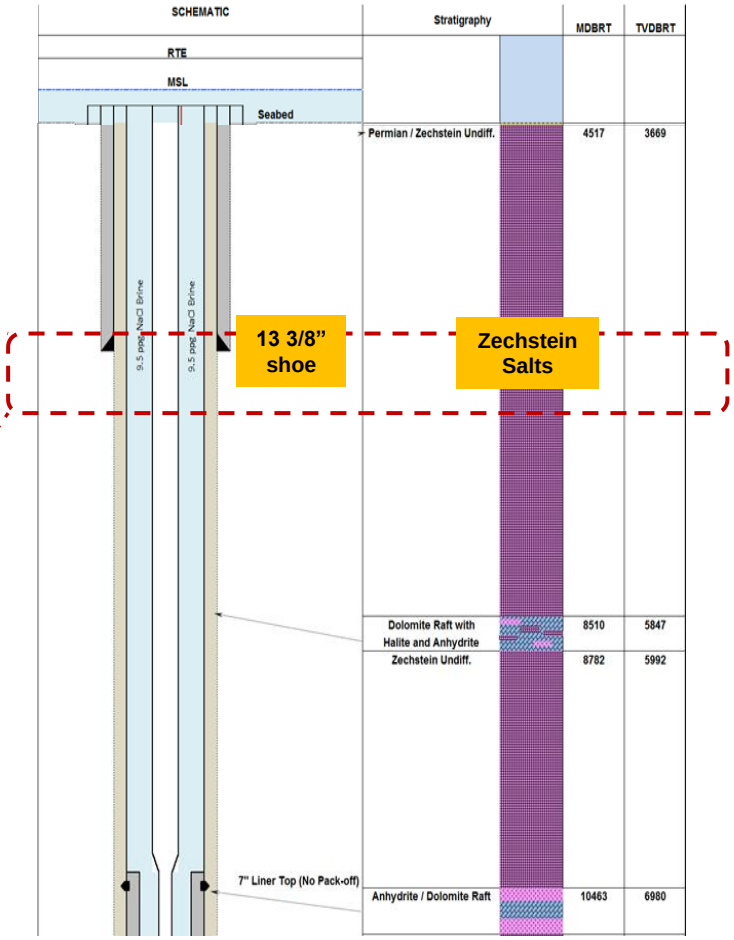
Case Study – 1987 vs 2017 log





- Cement log at time of well completion showing free pipe (not cemented)
- CBL > 50mV (free pipe)
- CBL < 10mV (good cement)

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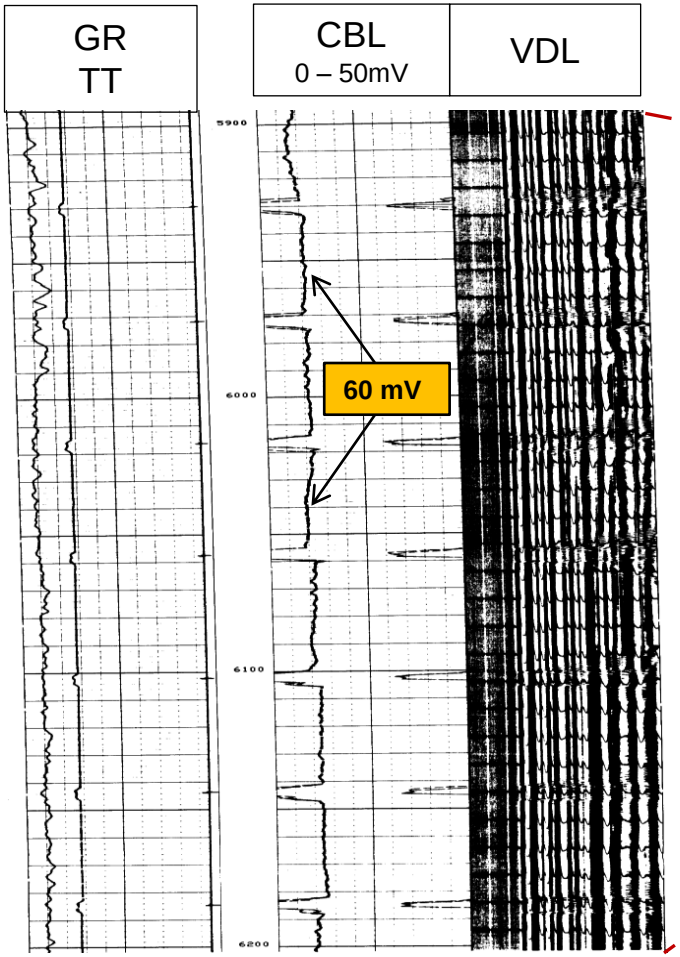
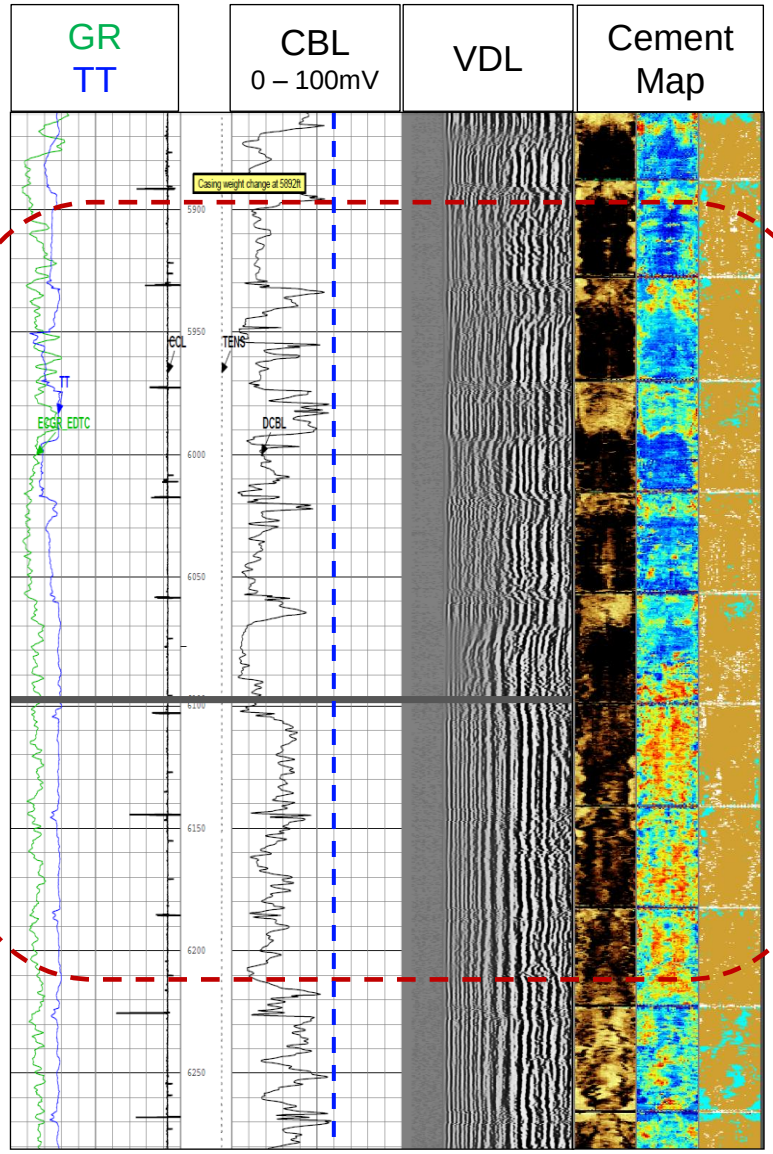
Case Study – 1987 vs 2017 log





The same interval logged in 2017 (30yrs later) shows the presence of solids and some degree of good casing bond suggesting formation has crept in against 9 5/8” casing

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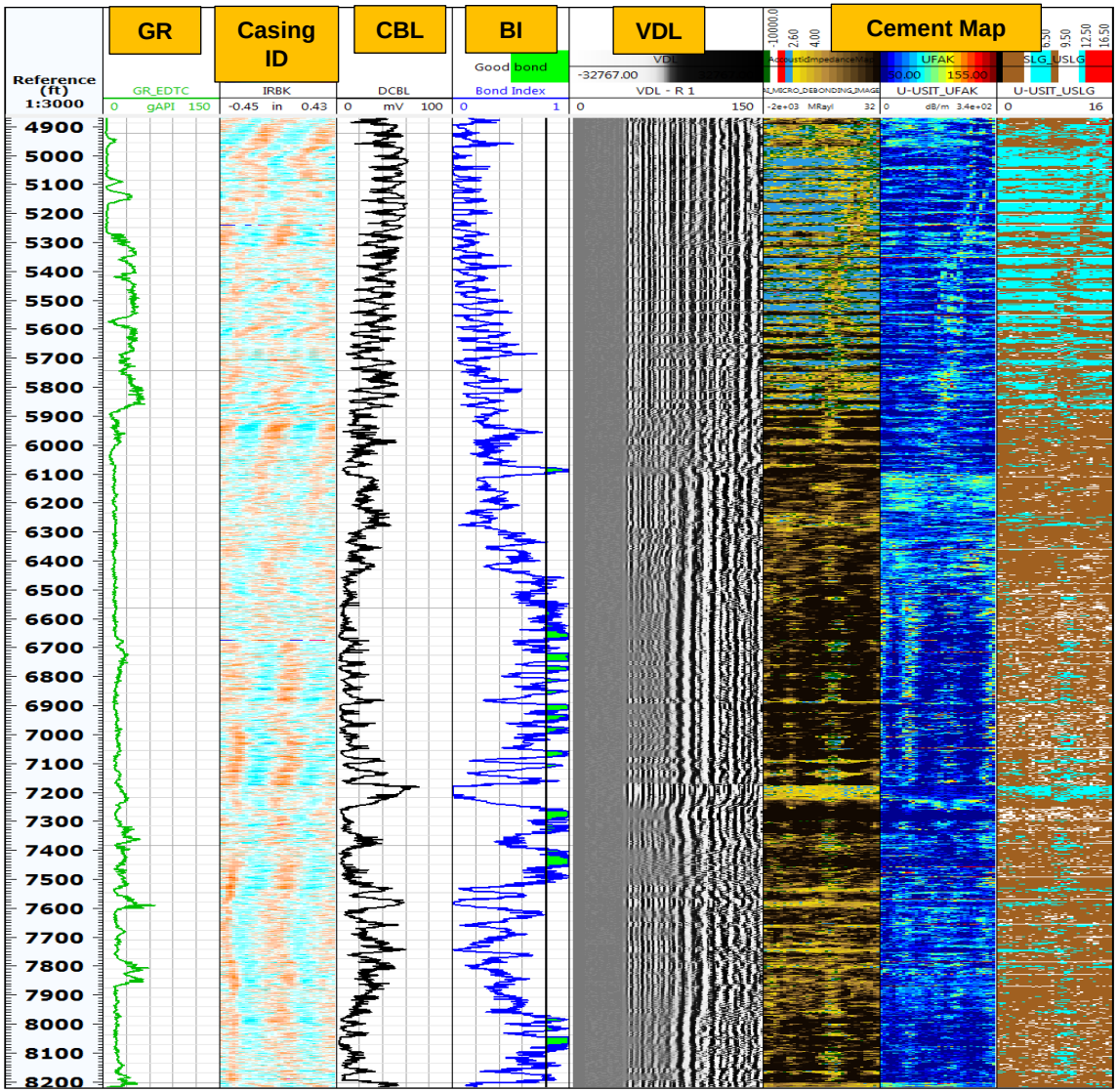
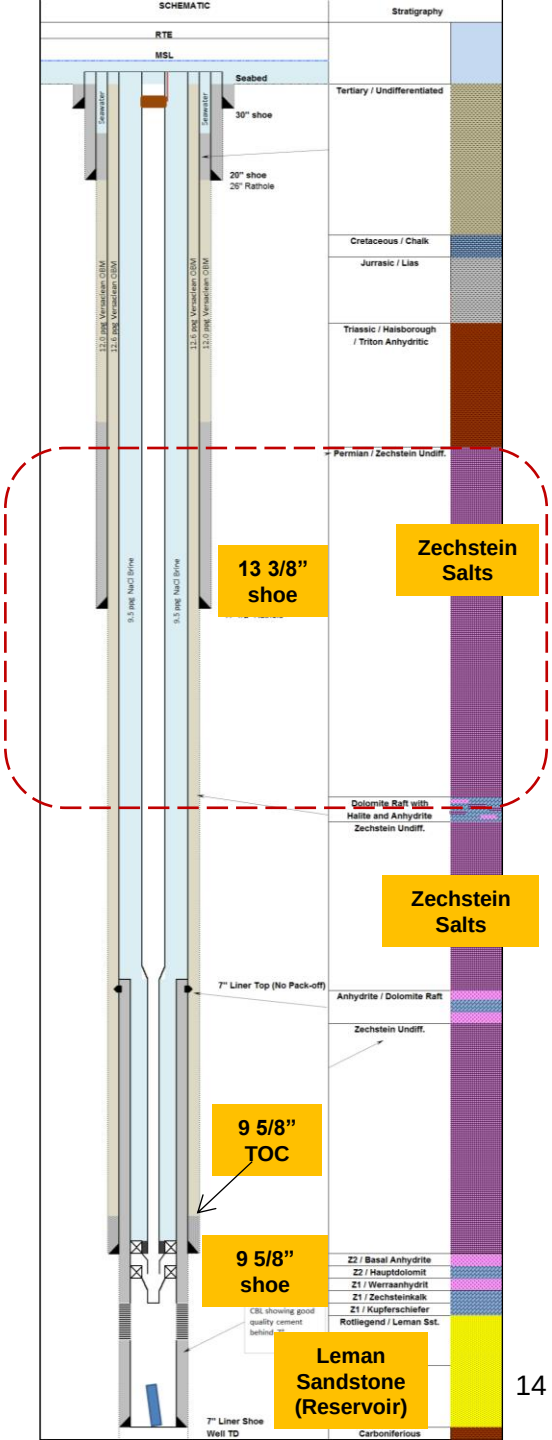
Case Study - Results





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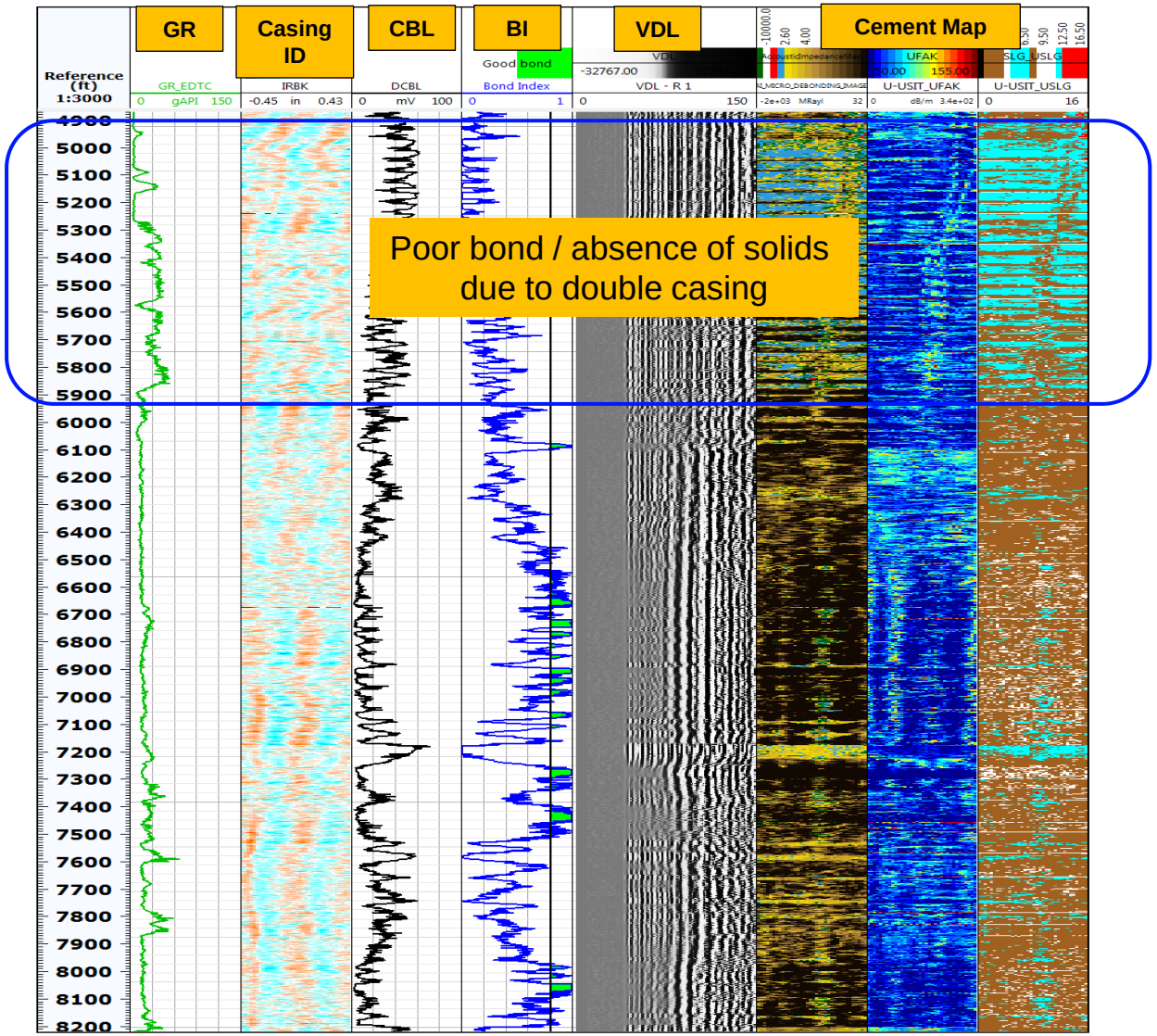

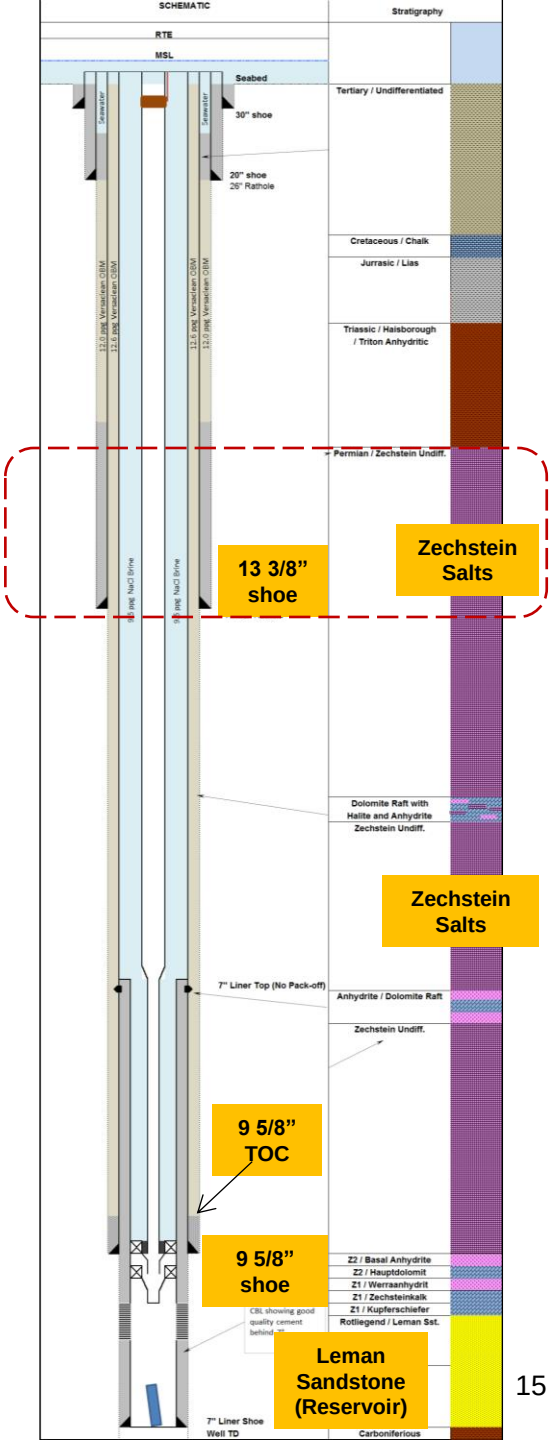

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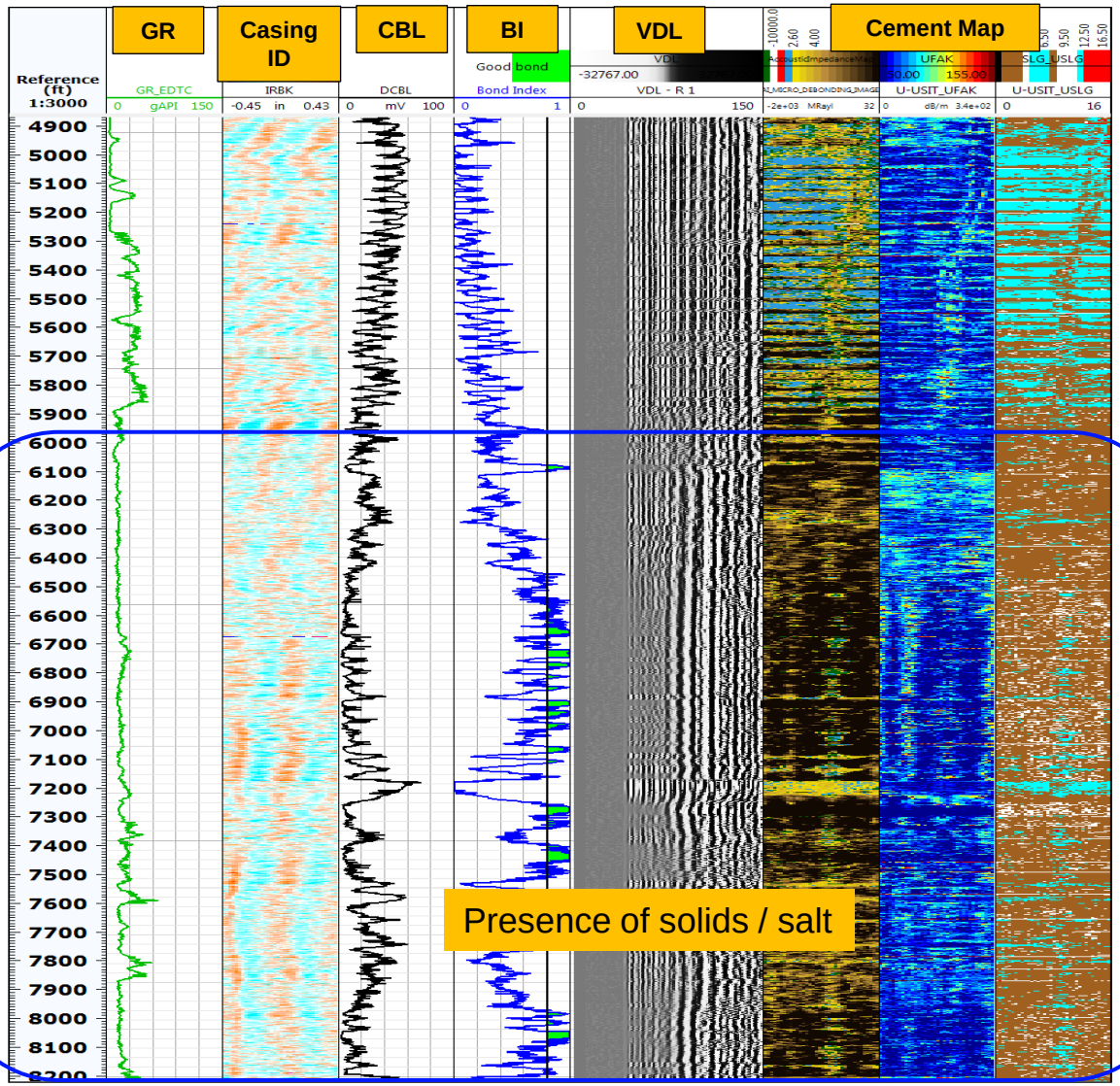

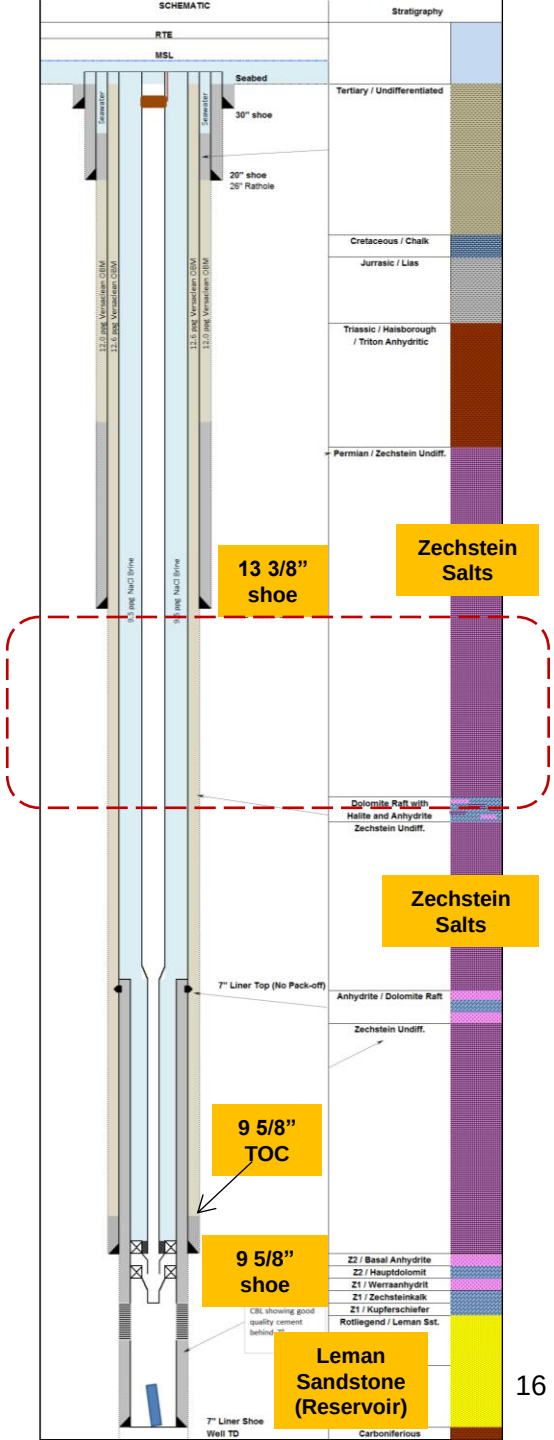

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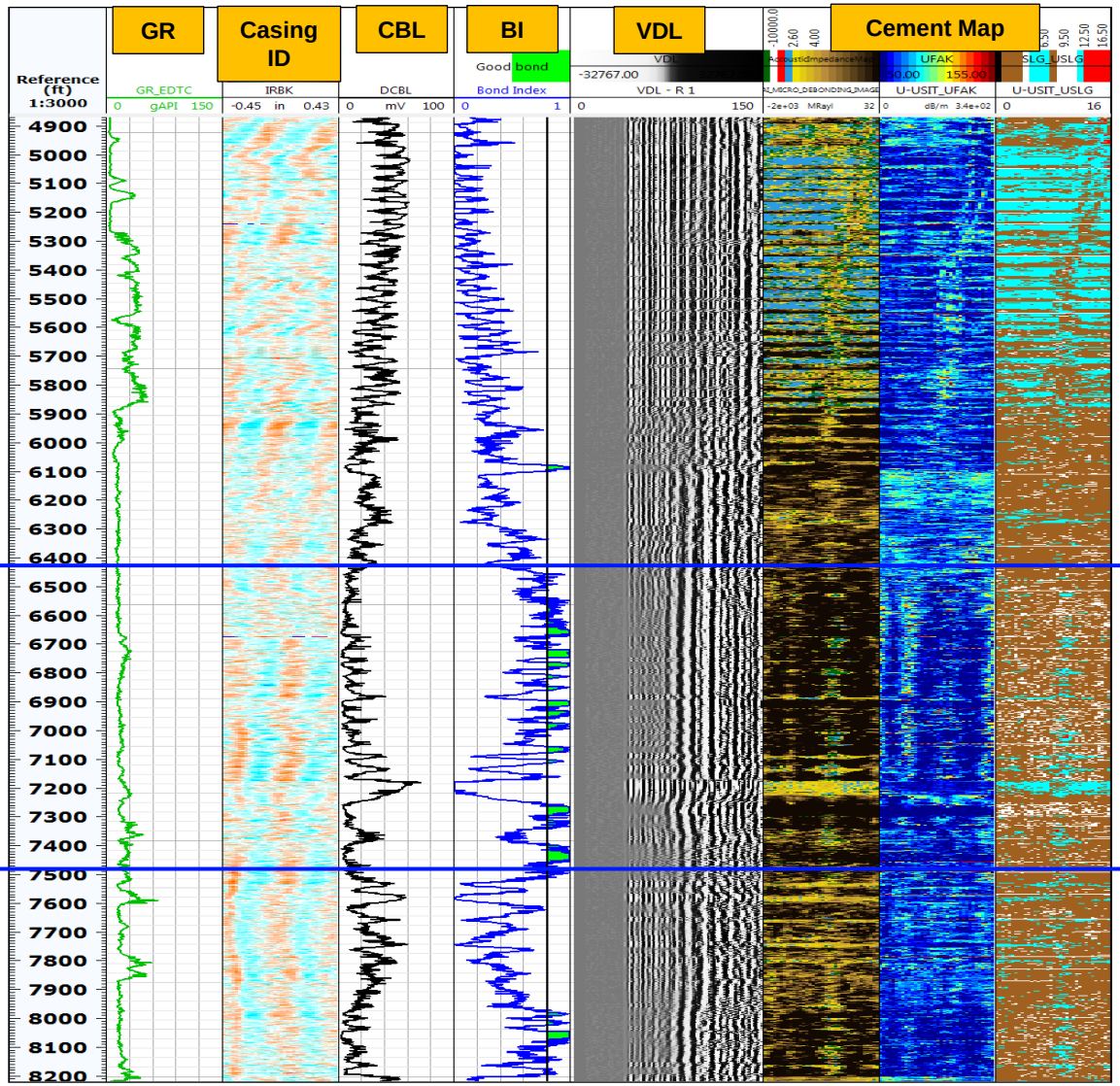

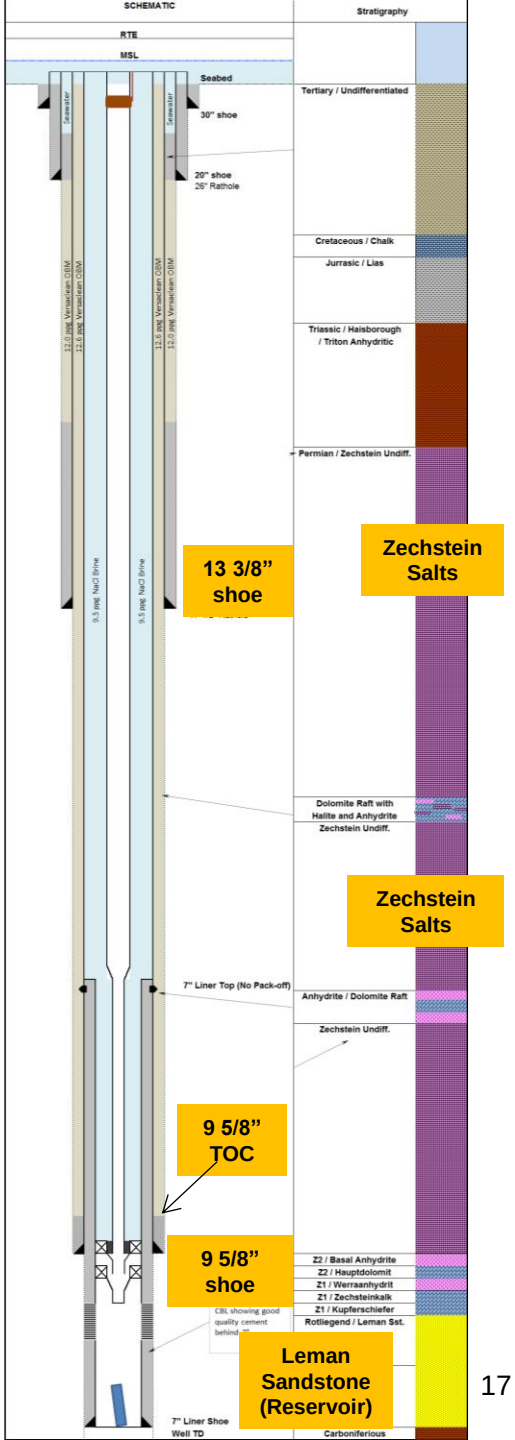

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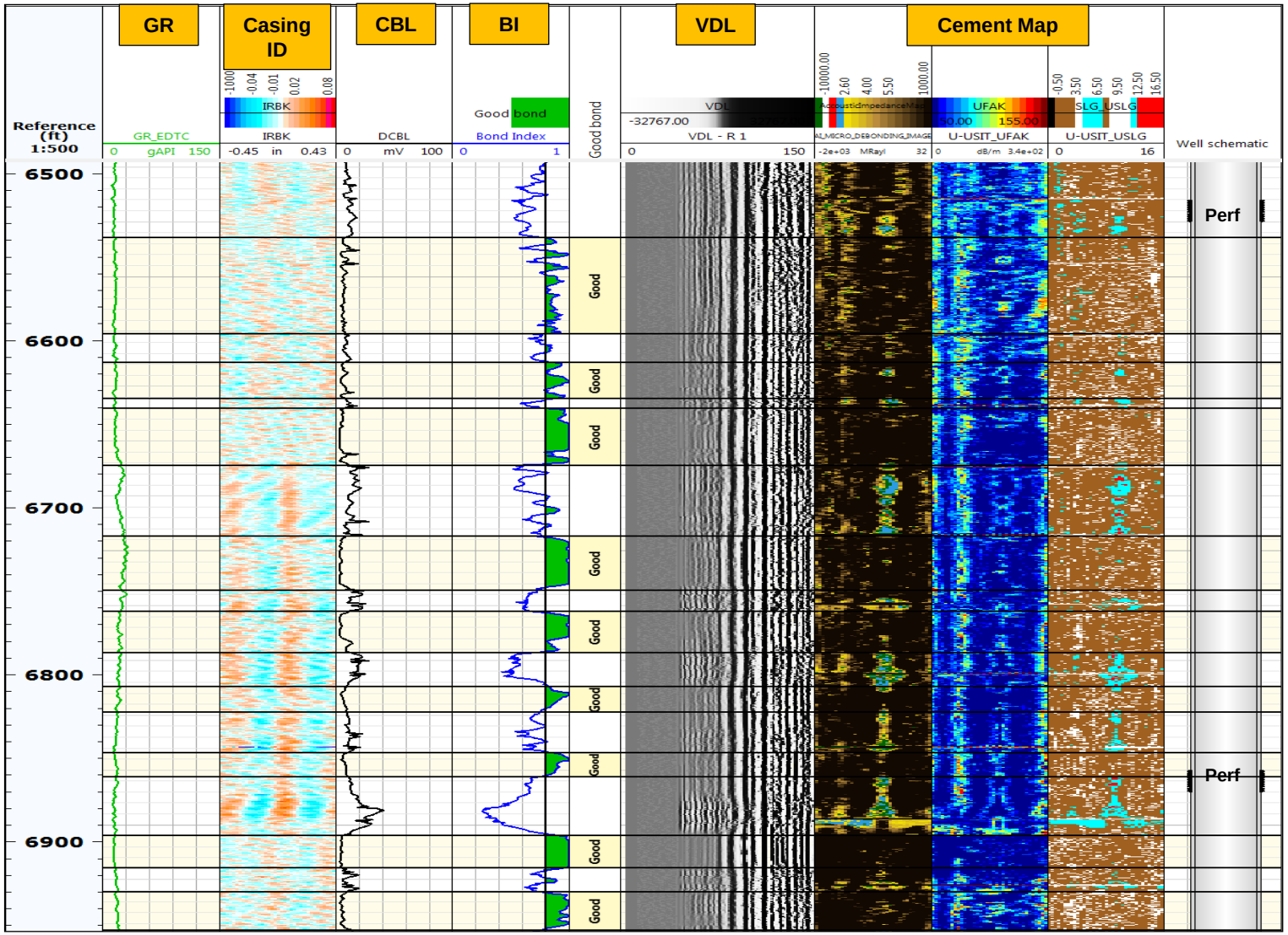
Need to identify > 200ft of cumulative good bond to satisfy Oil and Gas UK abandonment guidelines

Case Study - Results



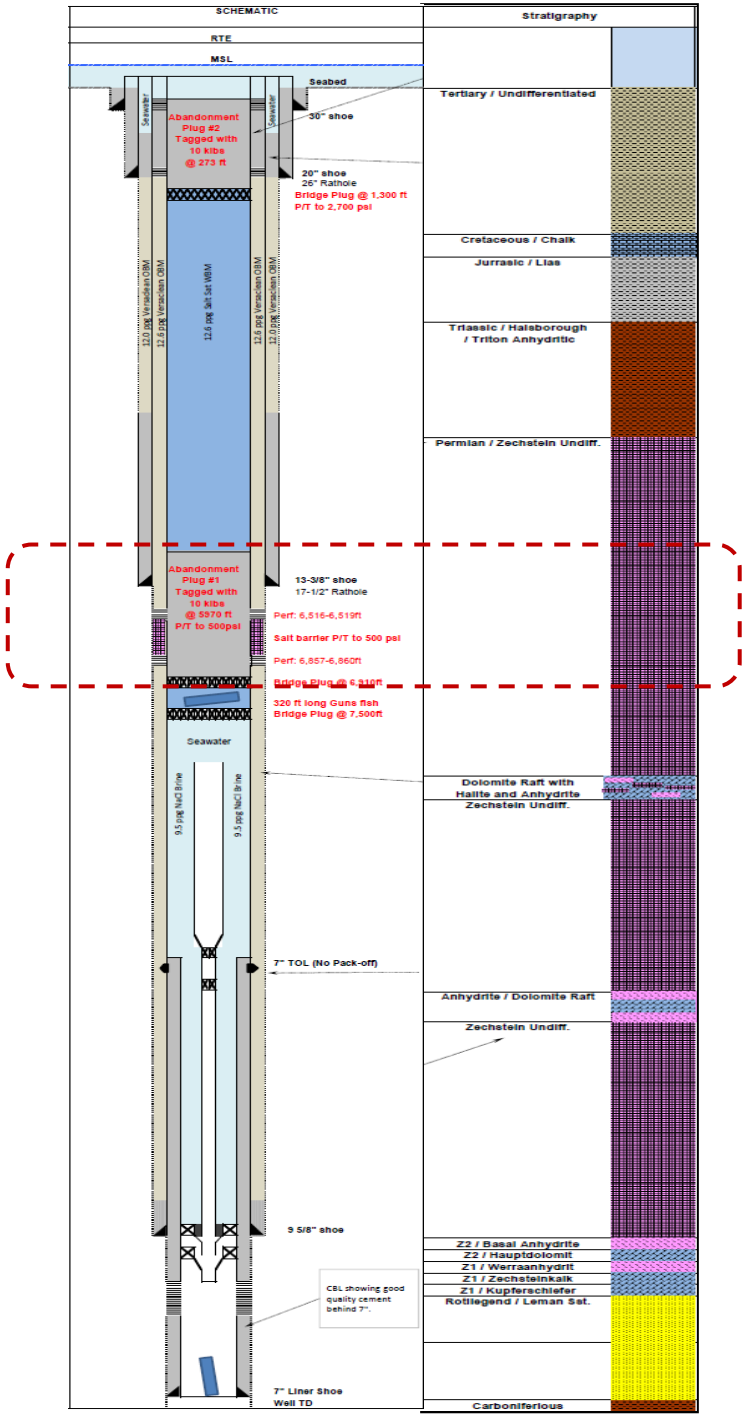
Successful Annular Integrity Test @ 500psi

> 200ft of good annular salt bond was achieved over 340ft long interval tested

Creeping salts can act as annular barrier for abandonment

Case Study - Summary

- Set 940ft balanced cement plug adjacent to annular salt bond
- Well successfully abandoned with salt as annular sealing barrier
- Significant cost savings made by not performing remedial cement job



Conclusion

Creeping salts are not always your enemies. They could actually be your buddies ……..

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Acknowledgements

The authors would like to thank the management of Spirit Energy for permission to share this document/knowledge

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Thank you

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