

Integrated Formation Evaluation using the Techlog Platform in a Complex Clastic Reservoir

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What's Next?

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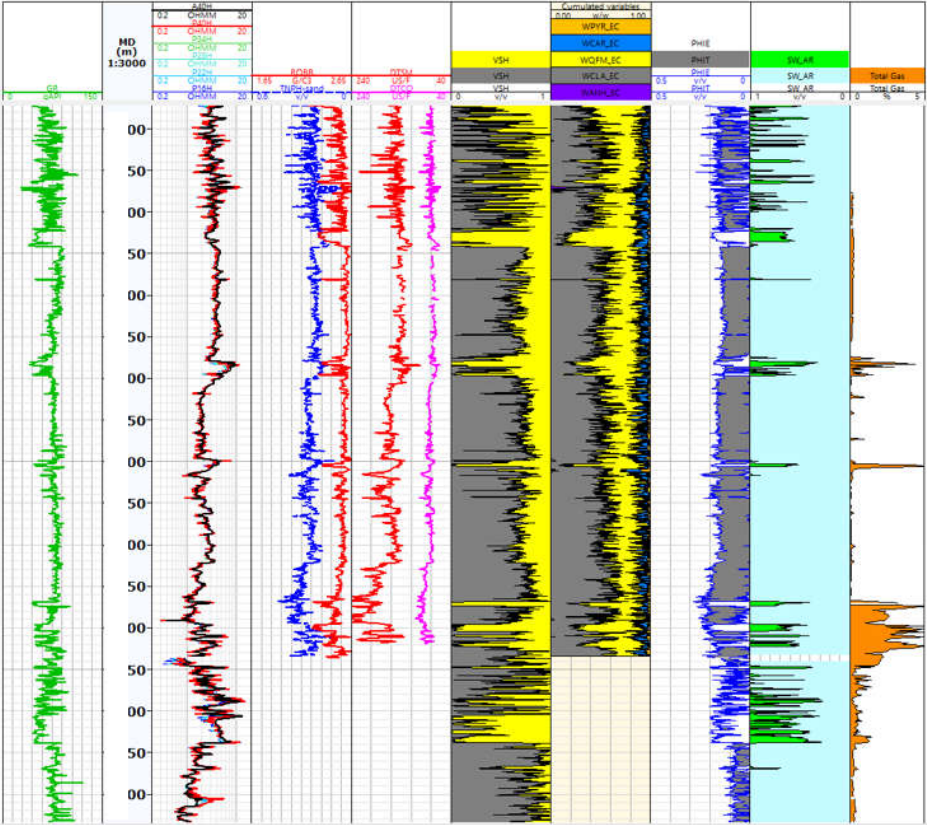
Le Palais des Congrès de Paris

Schlumberger

Agenda

- Formation evaluation with LWD / WL logging methods
- Fluid typing with Modular Dynamic Tester / NMR fluid mapping
- Well correlation in compartmentalized environment
- Pore Pressure regimes determination using OH logs
- Geomechanics / Acoustics
- Summary

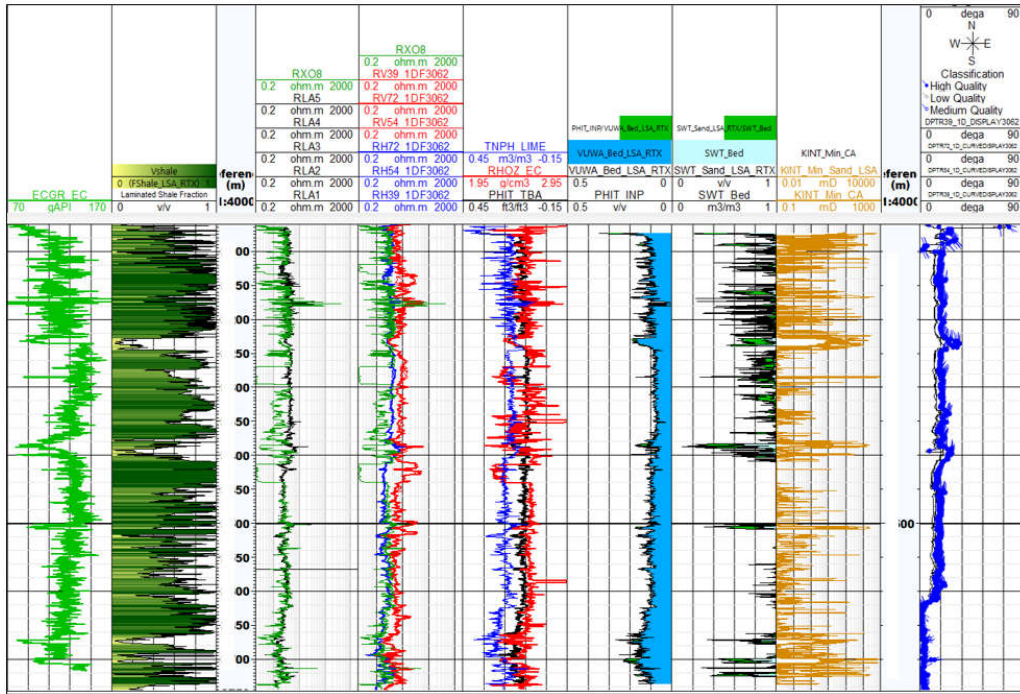
Open hole logging (Logging while drilling)



Interpretation output

- CPI interpretation
 - Shale volume
 - Porosity
 - Water saturation
- Borehole image interpretation
 - (structural)
- Formation Sigma
- Spectroscopy
- Well correlation

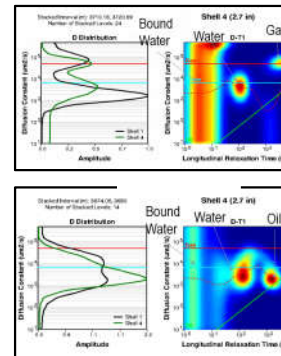
Open hole logging (Wireline logging)



Interpretation output

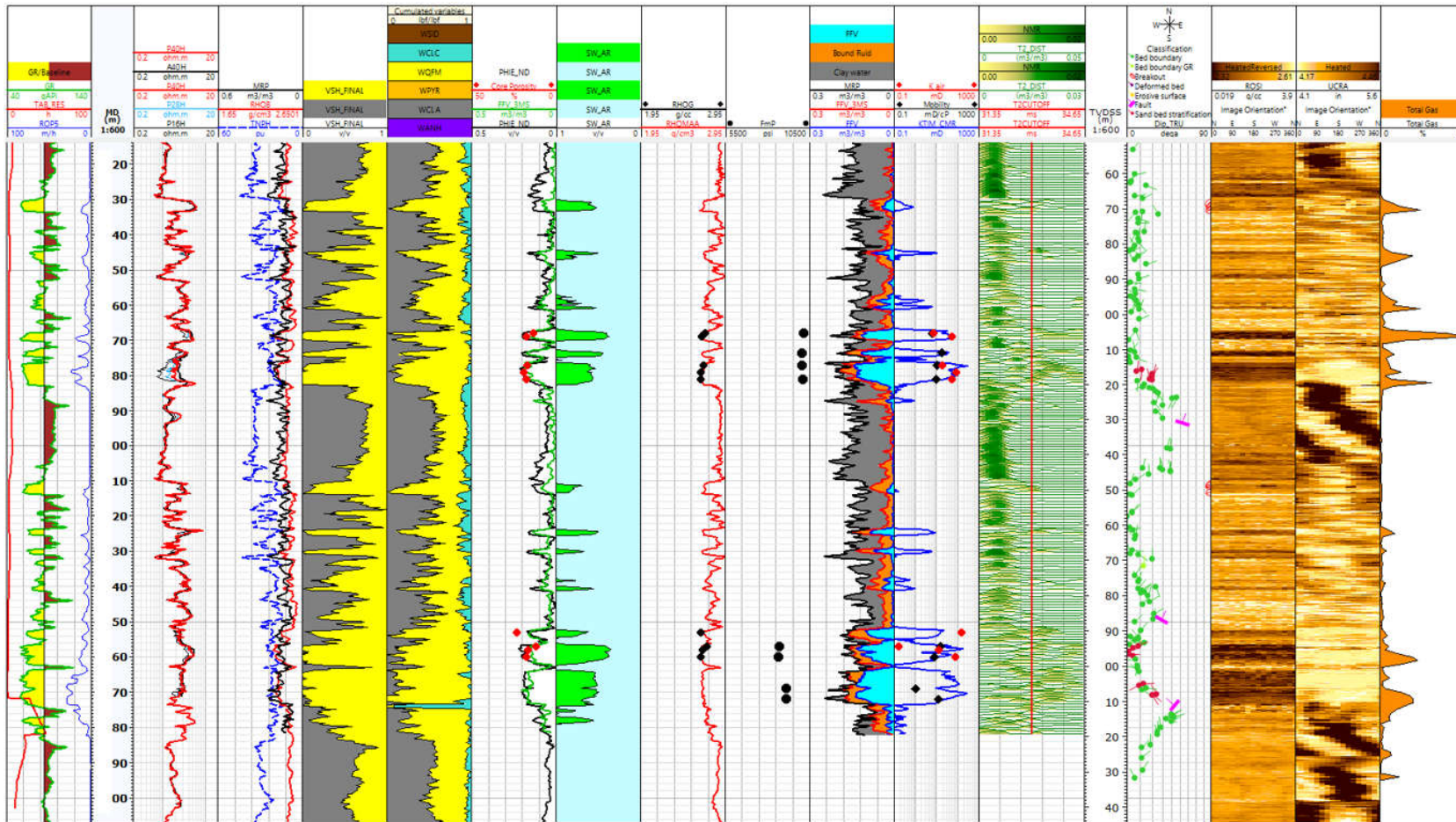
- RT Scanner (anisotropy)
 - Rv, Rh / Thin bed analysis
 - Low Resistivity Pay (LRP)
- FMI Image interpretation
- MDT Formation pressure & Sampling
- MDT Downhole fluid analyzer (DFA)
- MSCT sidewall coring
- NMR fluid typing, Poro-Perm
- Acoustic measurements
- Geomechanics

NMR fluid map

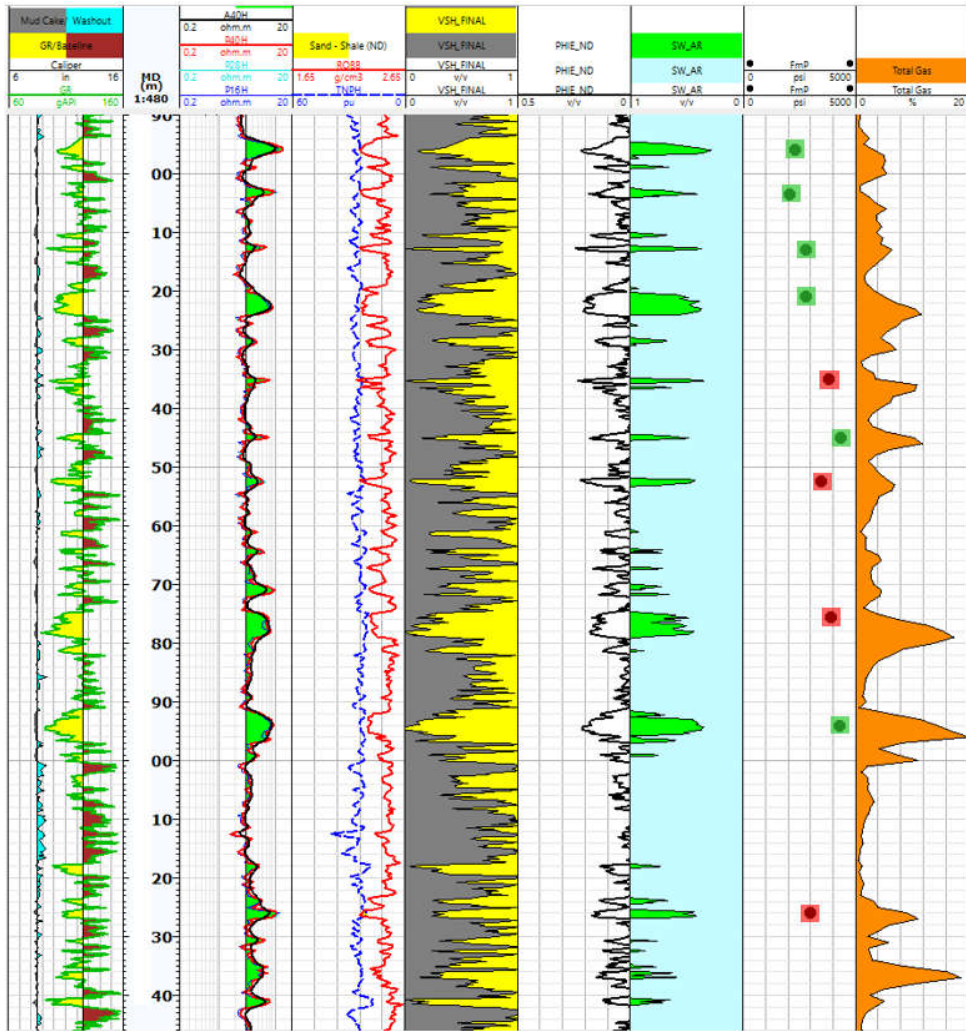


Sidewall core plugs

Integrated formation evaluation using LWD & Wireline data

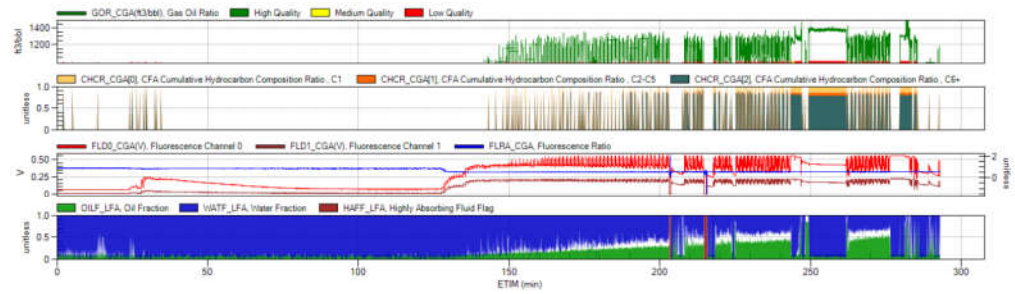
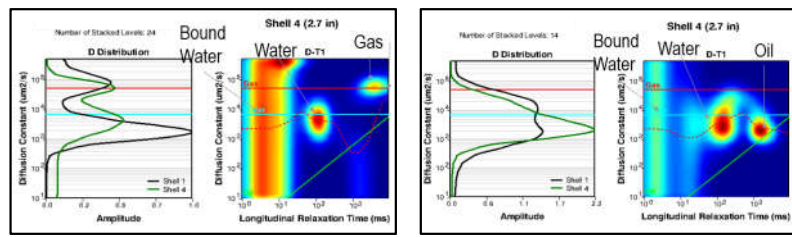


Fluid typing with Modular Dynamic Tester / NMR fluid mapping



Difficulty of Gas vs Oil differentiation in shaly sand environment

- Challenge:
 - High clay content masks the conventional density-neutron crossover
 - Possible solutions:
 - Formation tester (DFA)
 - NMR fluid typing
 - PLT



Well1

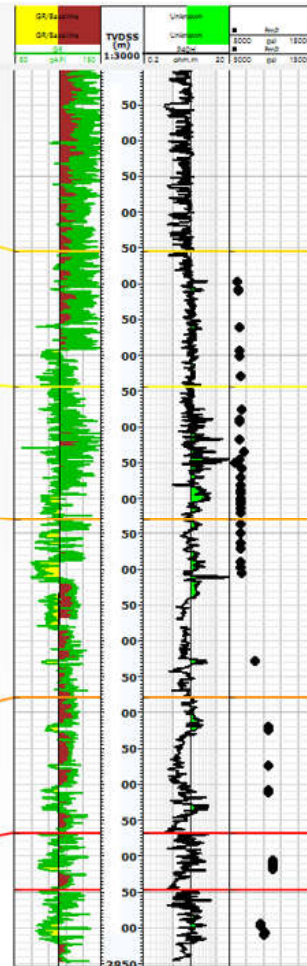
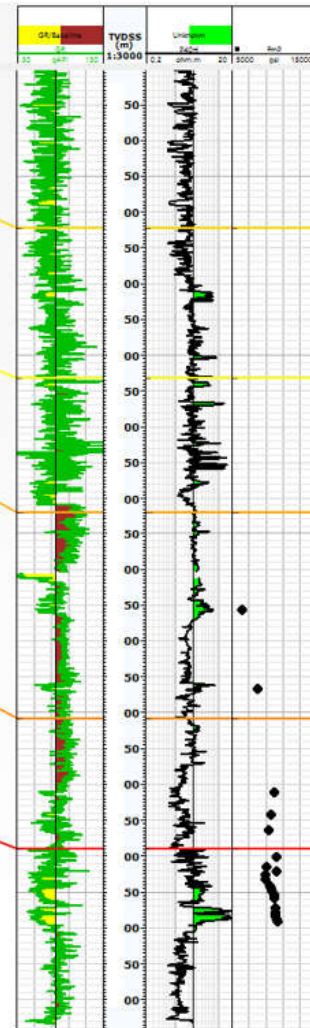
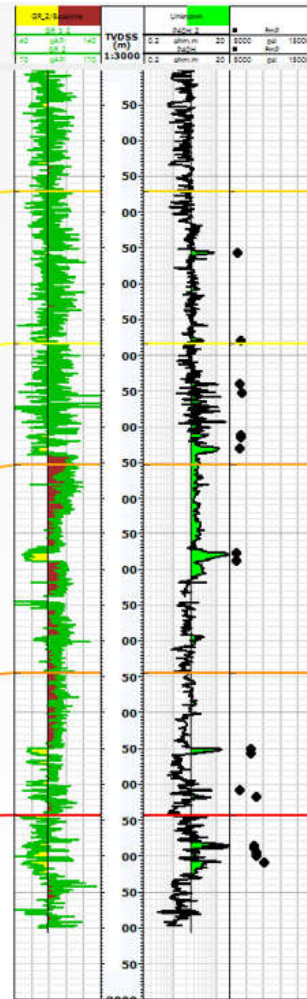
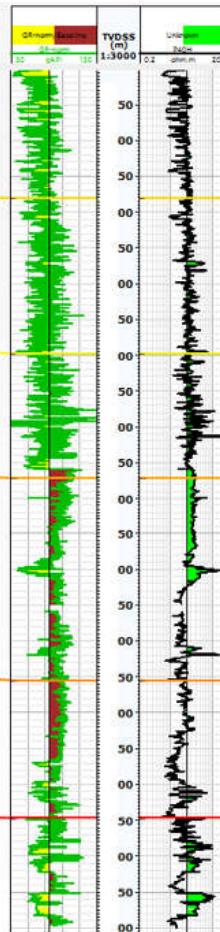
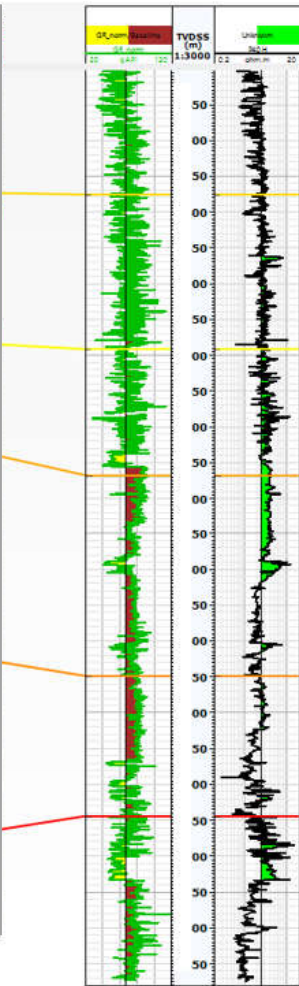
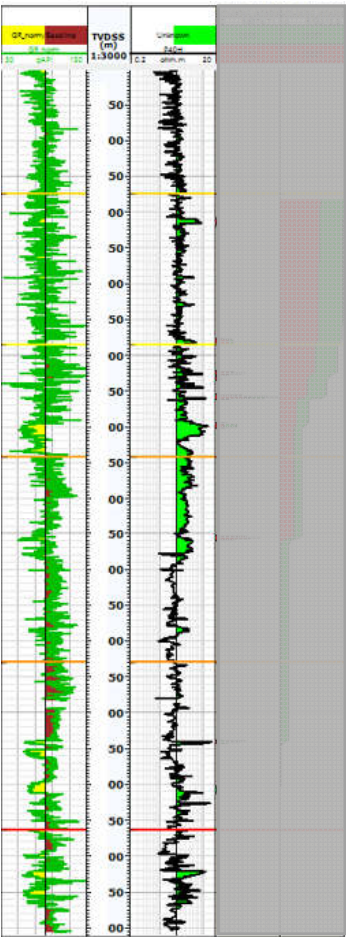
Well2

Well3

Well4

Well5

Well6



Well1

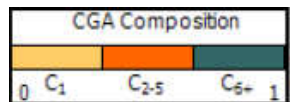
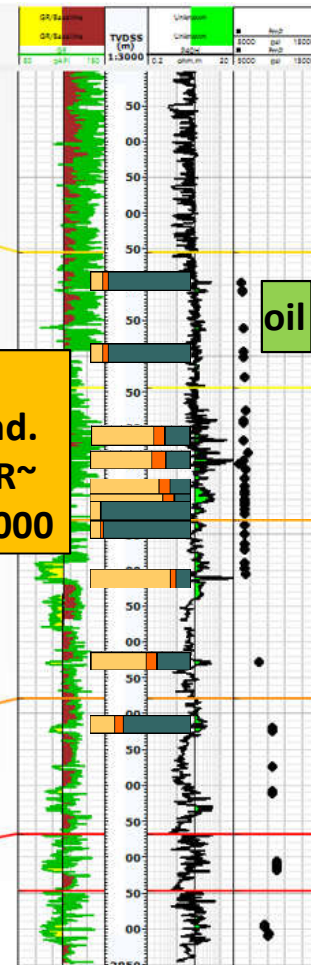
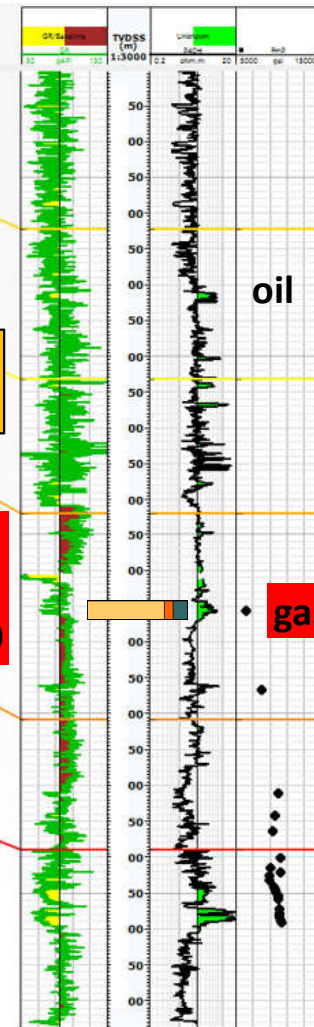
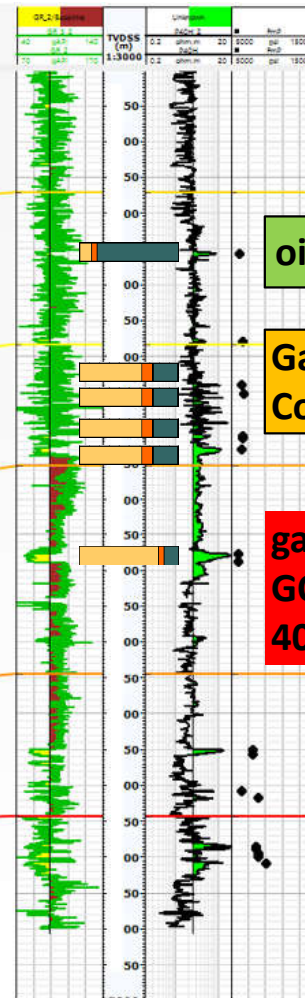
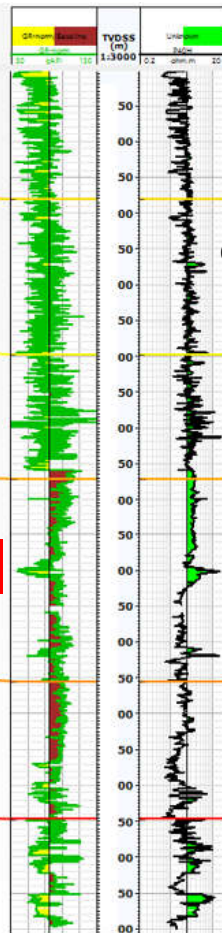
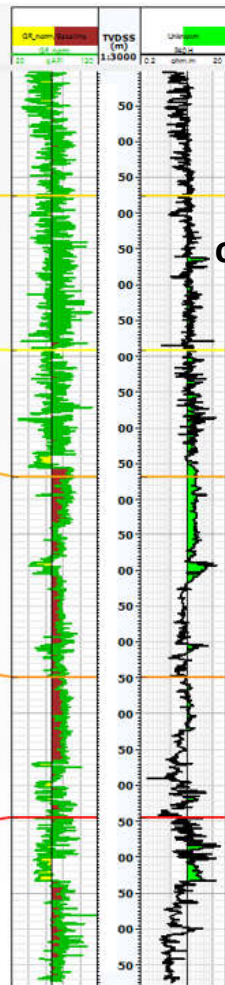
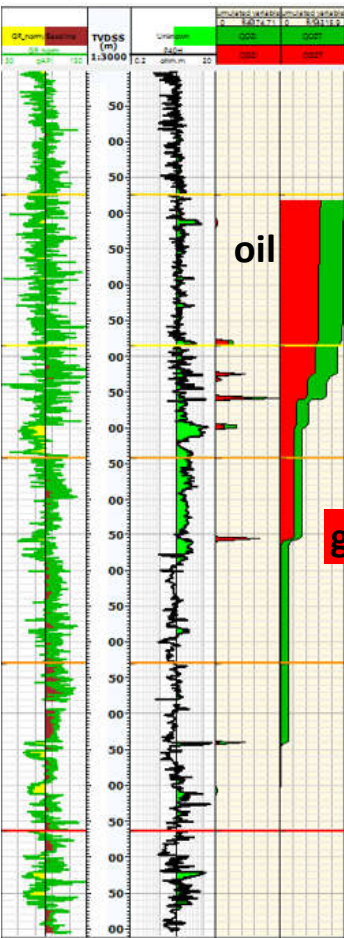
Well2

Well3

Well4

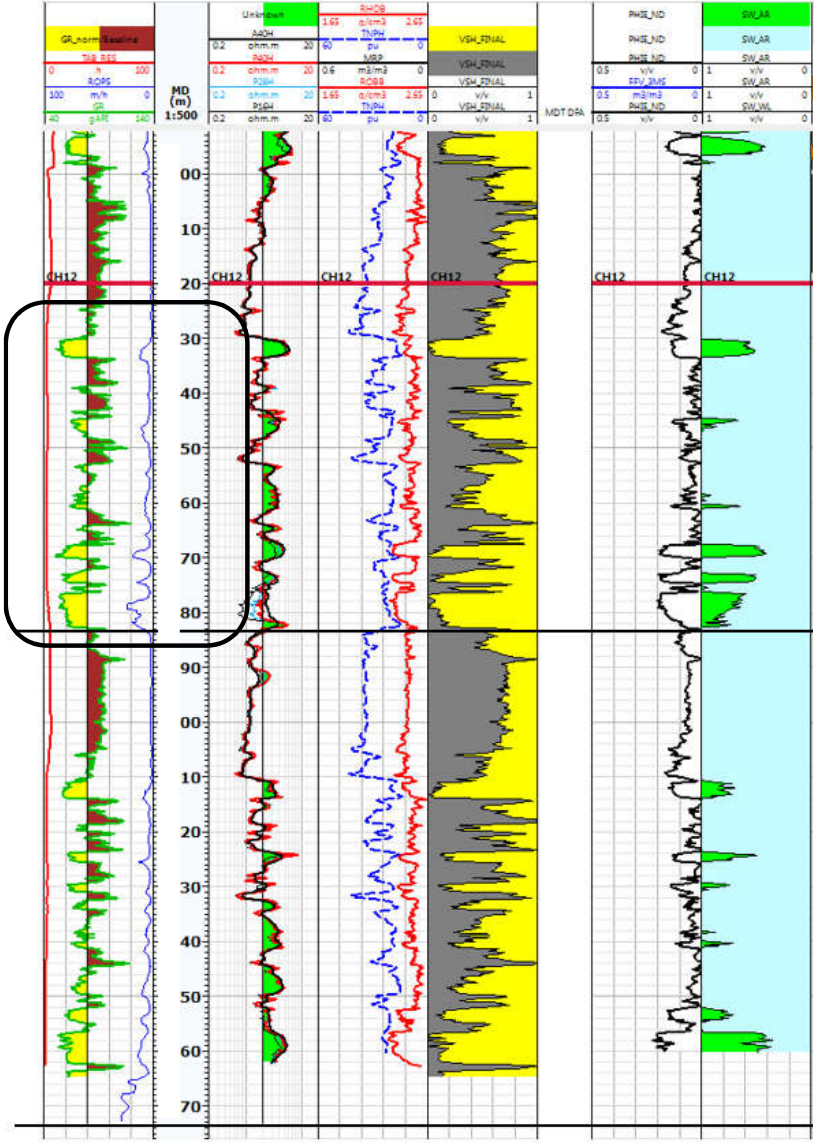
Well5

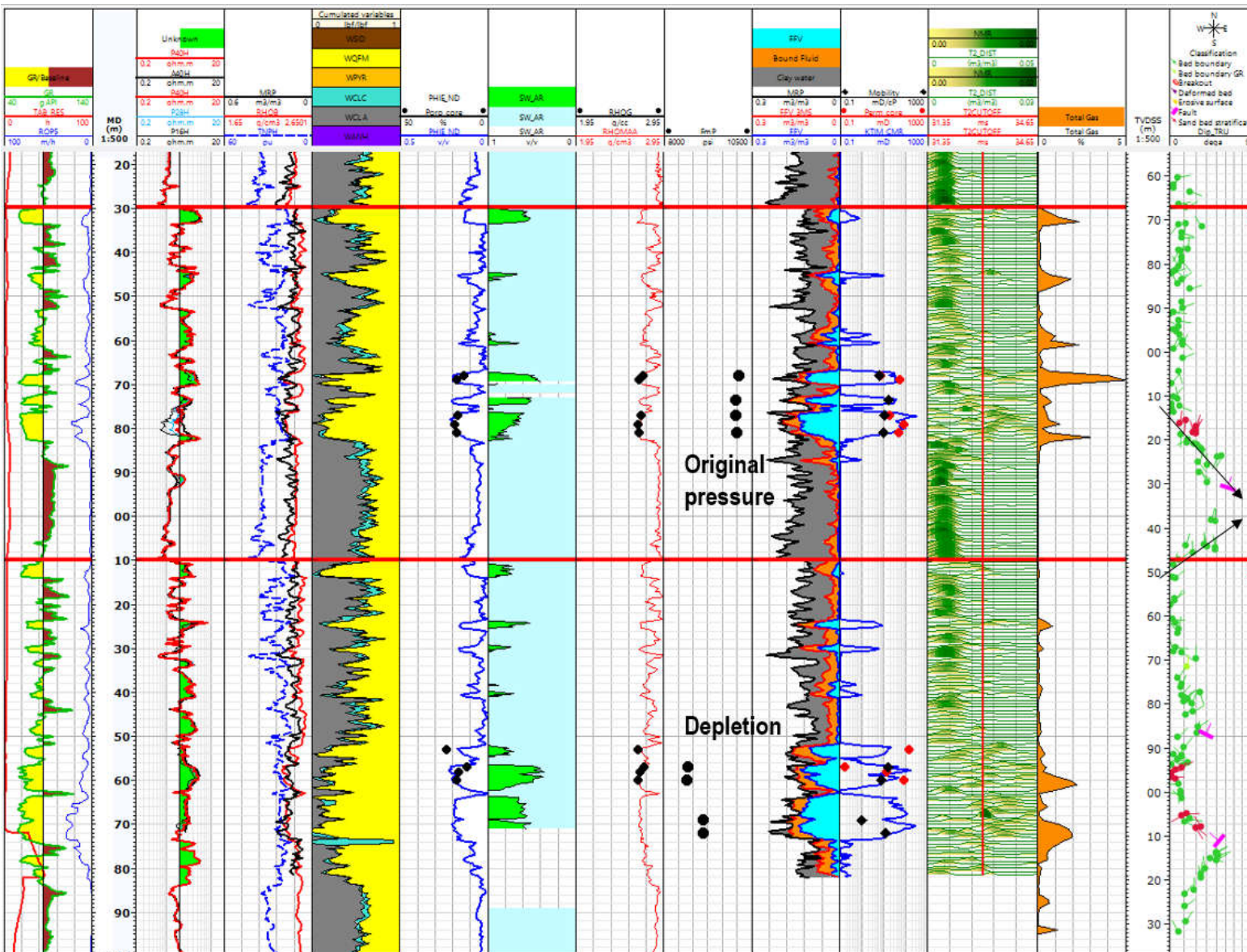
Well6



MDT CFA (Compositional Fluid Analyzer)

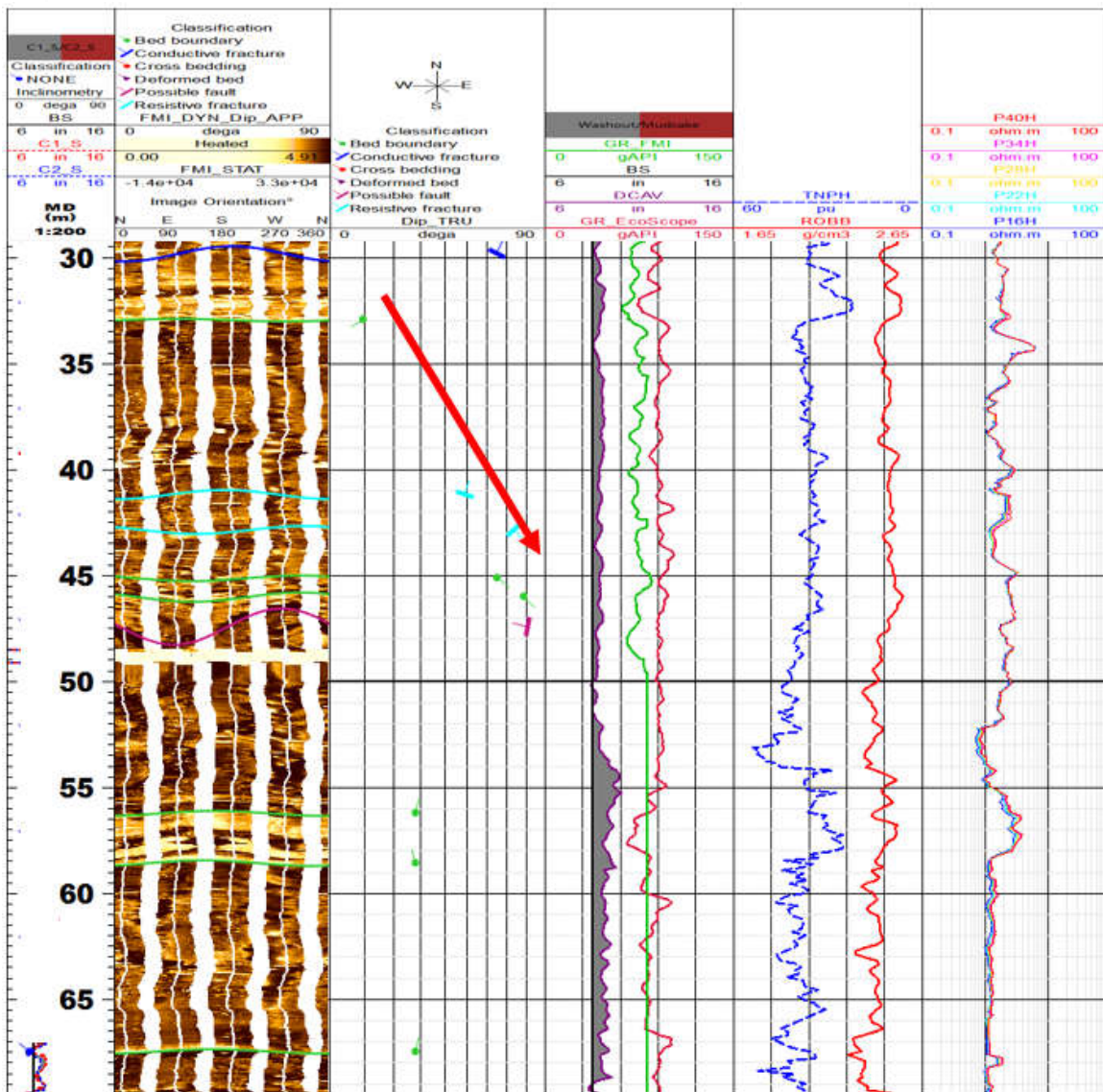
Well correlation in compartmentalized / faulted environment





Reverse faults were identified from LWD image interpretation

- 30m drag
- Logs response (minor density and neutron, resistivity) change along fault → formation displacement along fault
- Small washout as indirect fault sign. Usually formation is damaged (can be breccia) near fault → easier to be washed out
- Pore pressure results are different in the repeat section

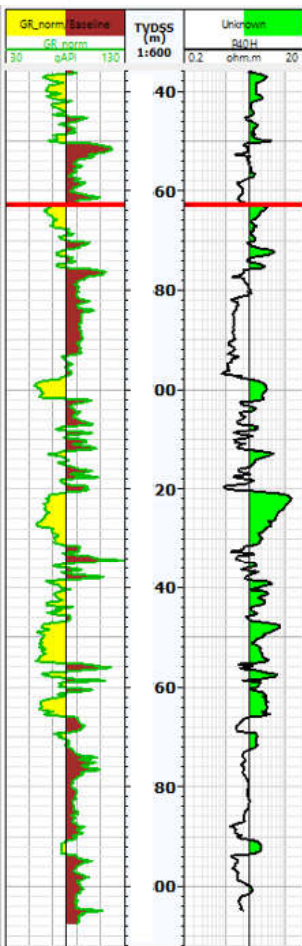


FMI Image interpretation

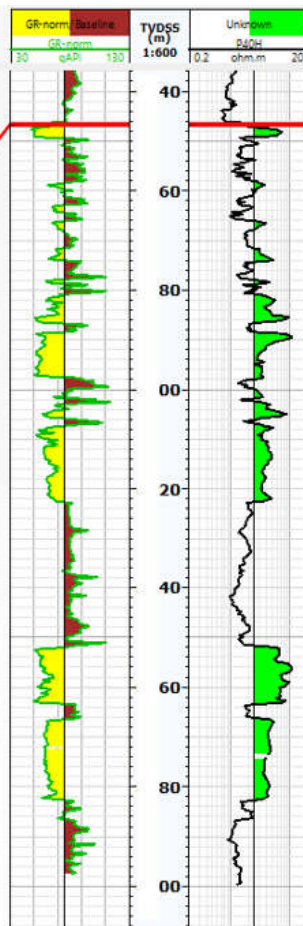
Fault interpretation (NNE-SSE strike):

- Drag (red arrow)
- Fracturing
- Tool severe sticking in washouts along fault zone possibly due to tectonic damaged rocks
- High dip angles of bed boundaries

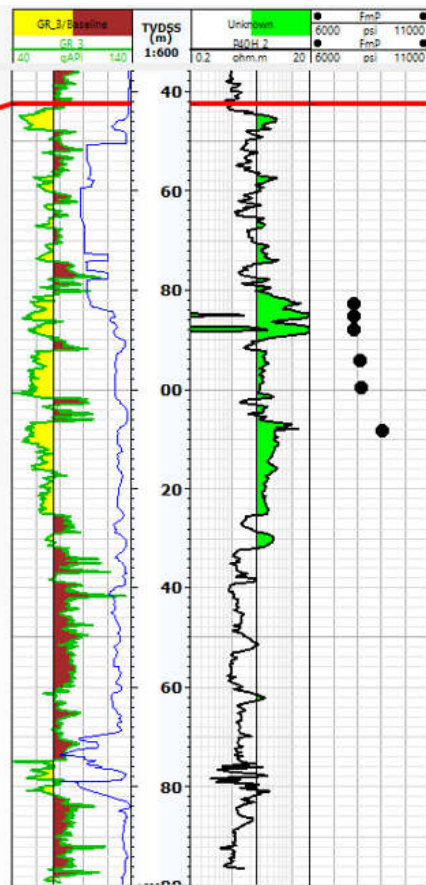
Well1



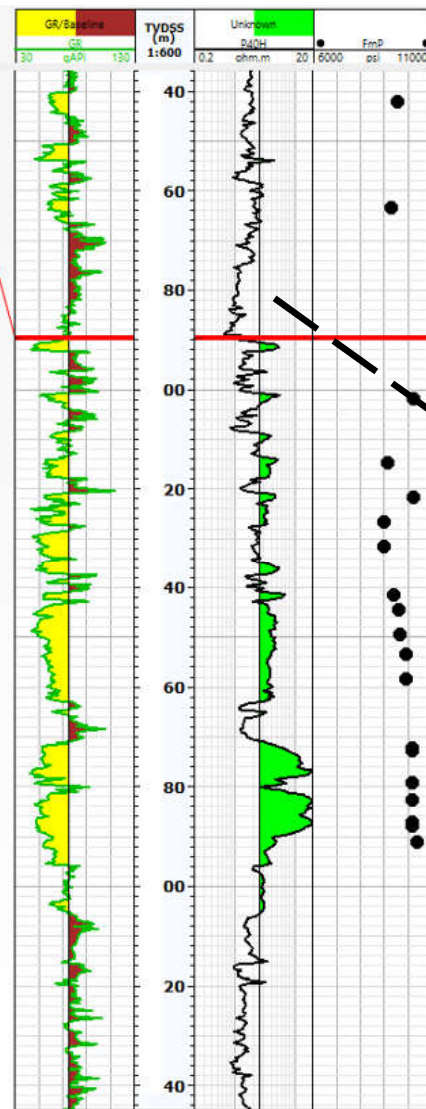
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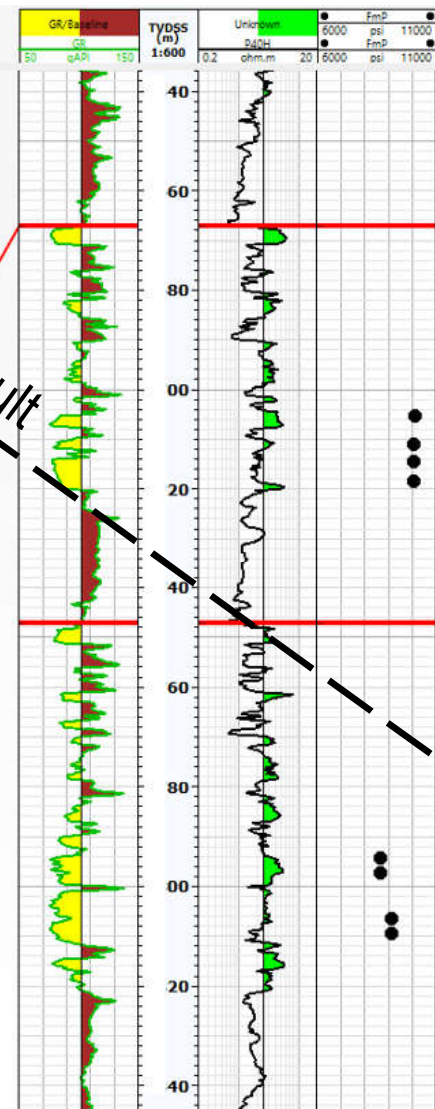
Well3



Well4



Well5



Pore pressure regime identification

Well1

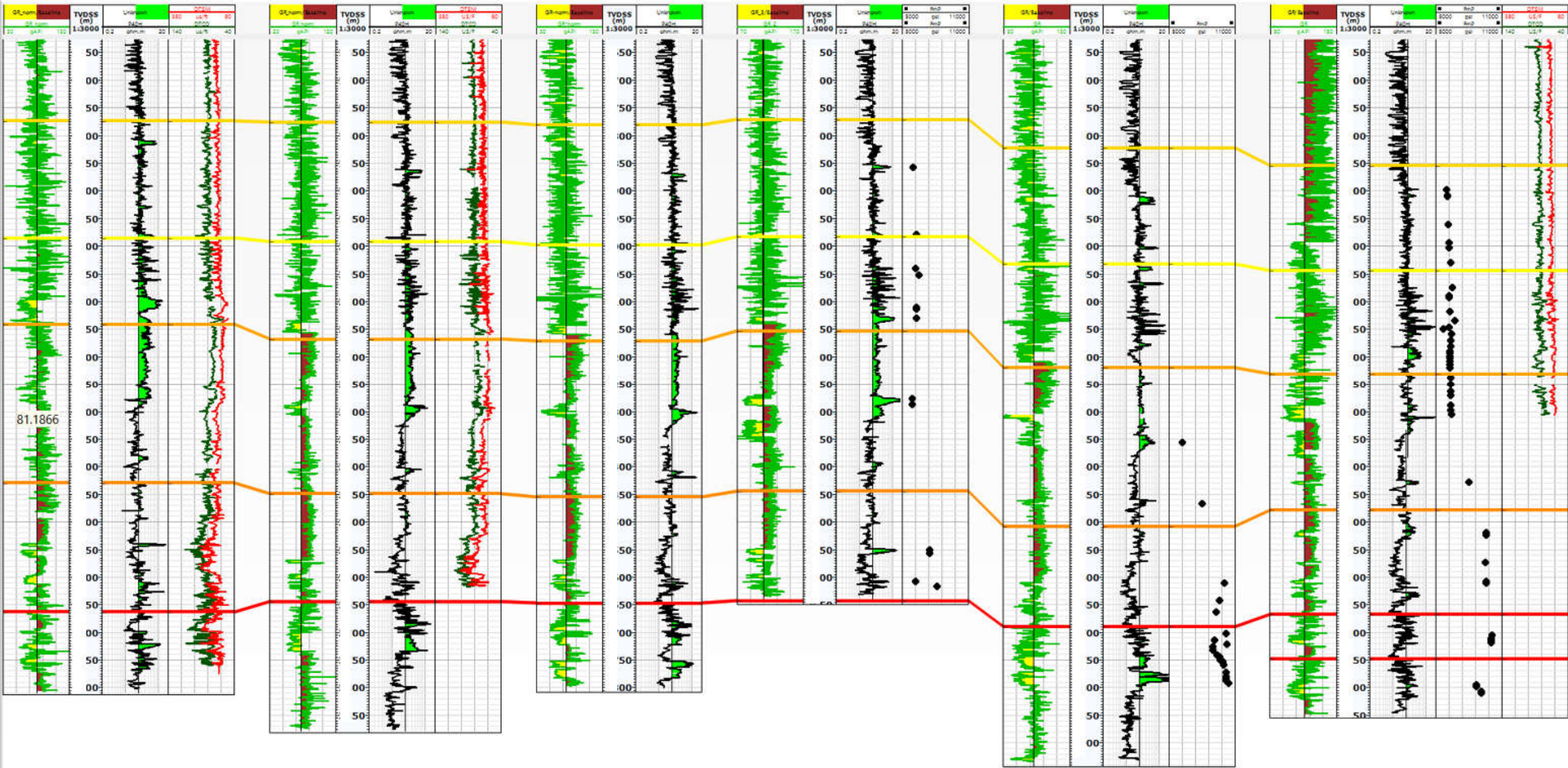
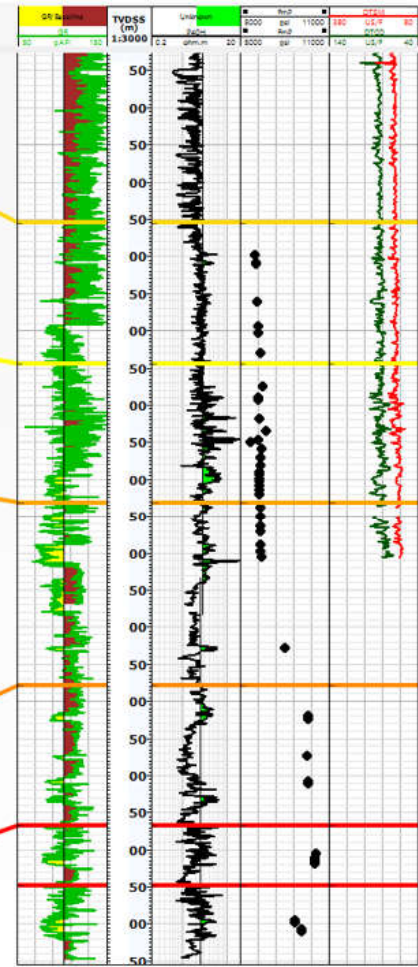
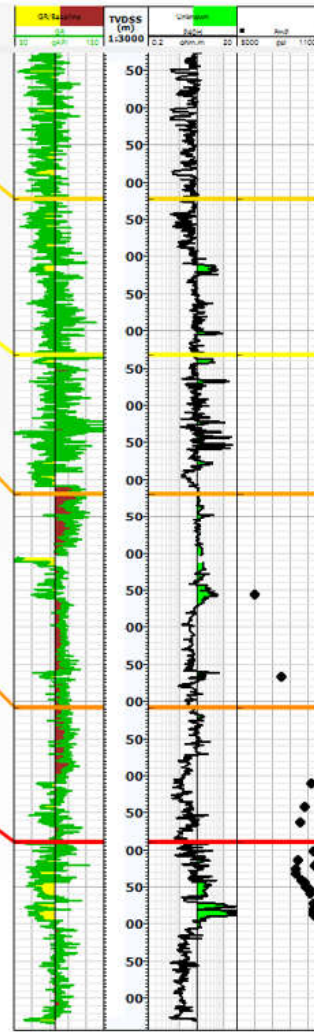
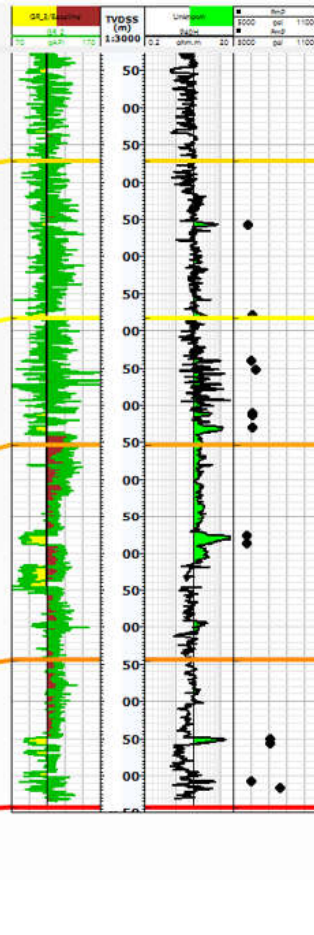
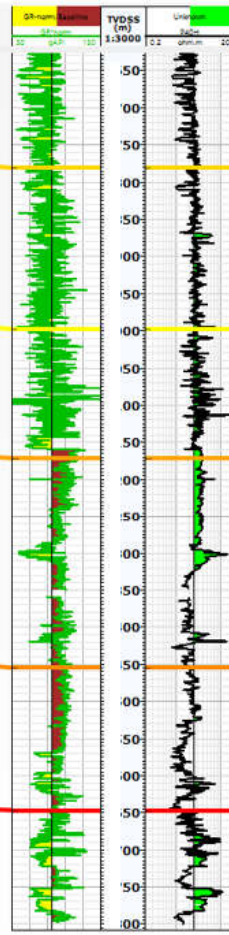
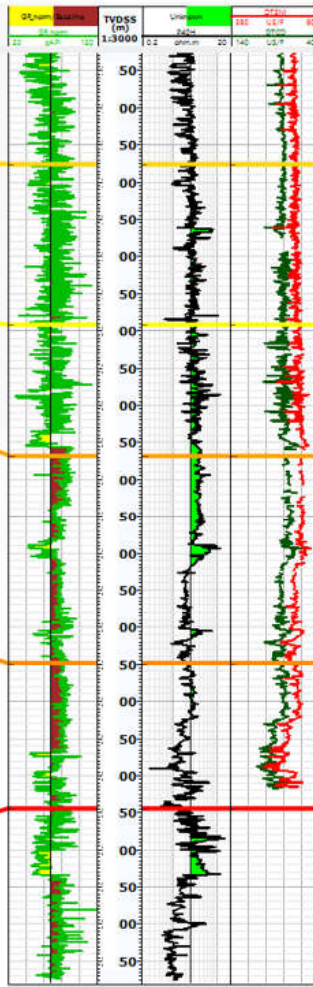
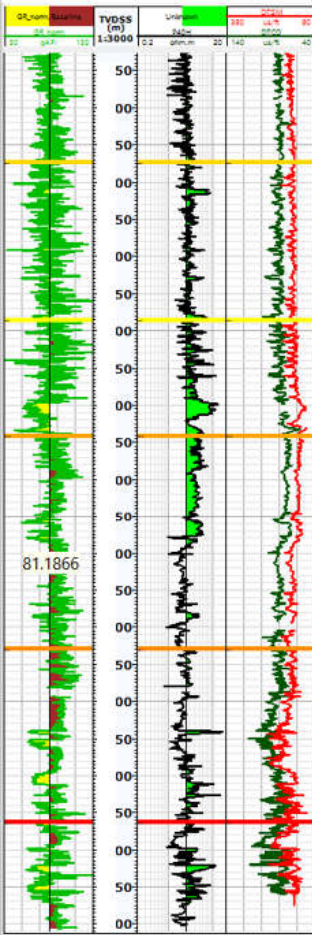
Well2

Well3

Well4

Well5

Well6



Well1

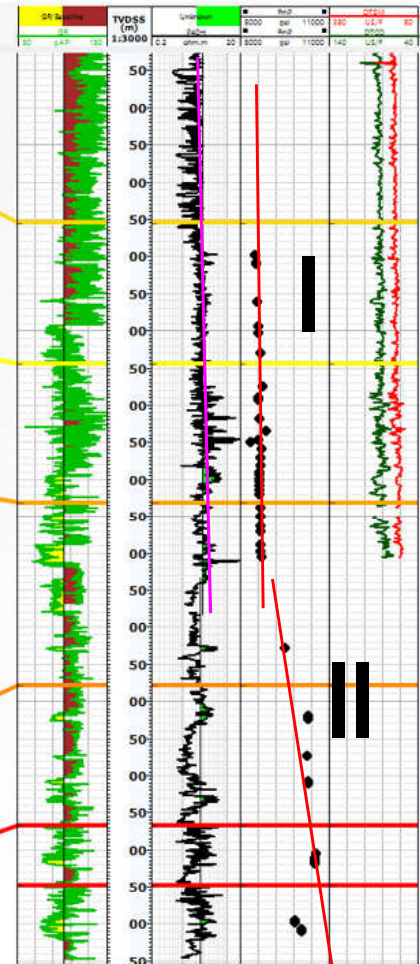
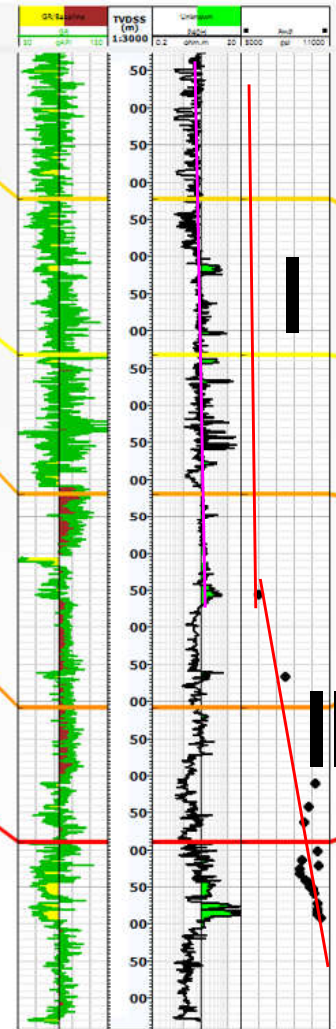
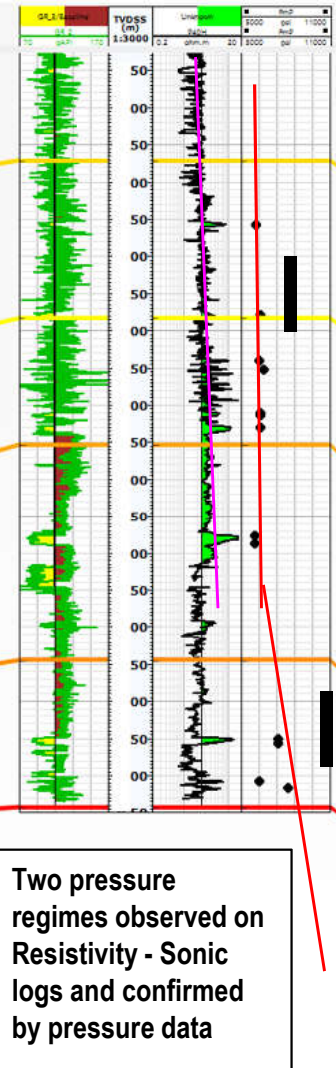
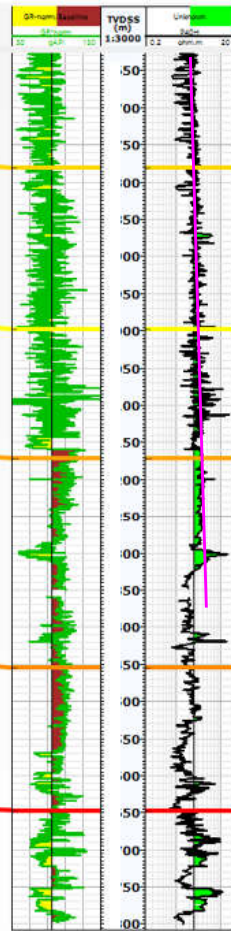
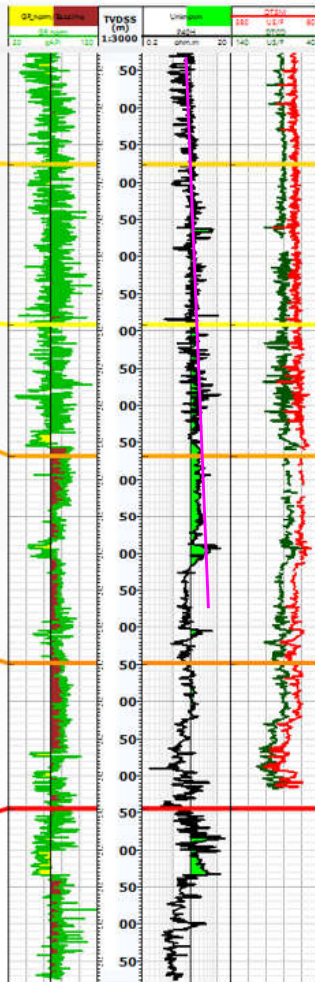
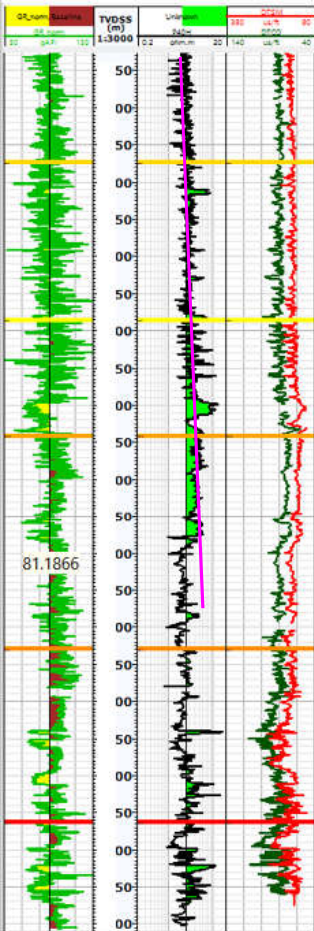
Well2

Well3

Well4

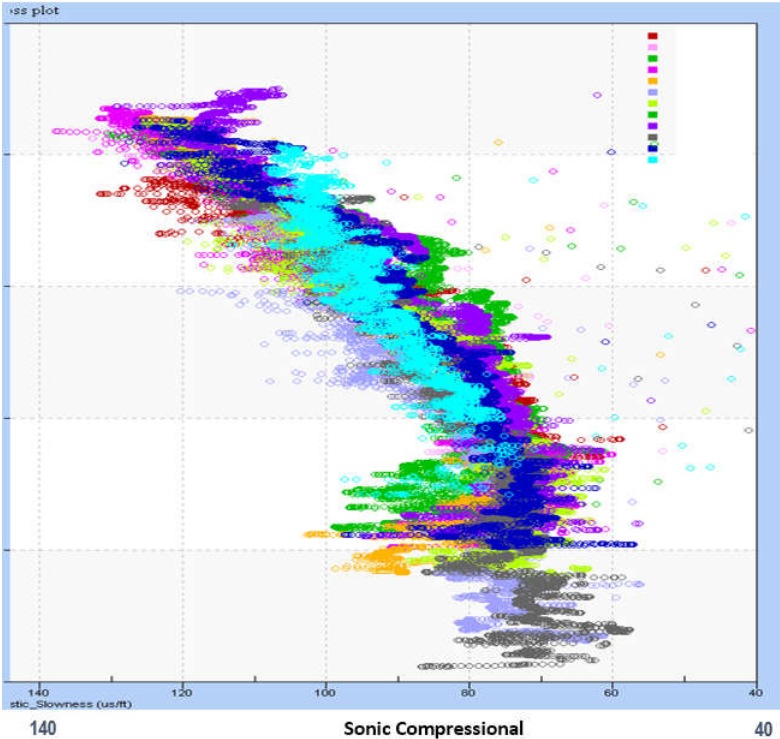
Well5

Well6

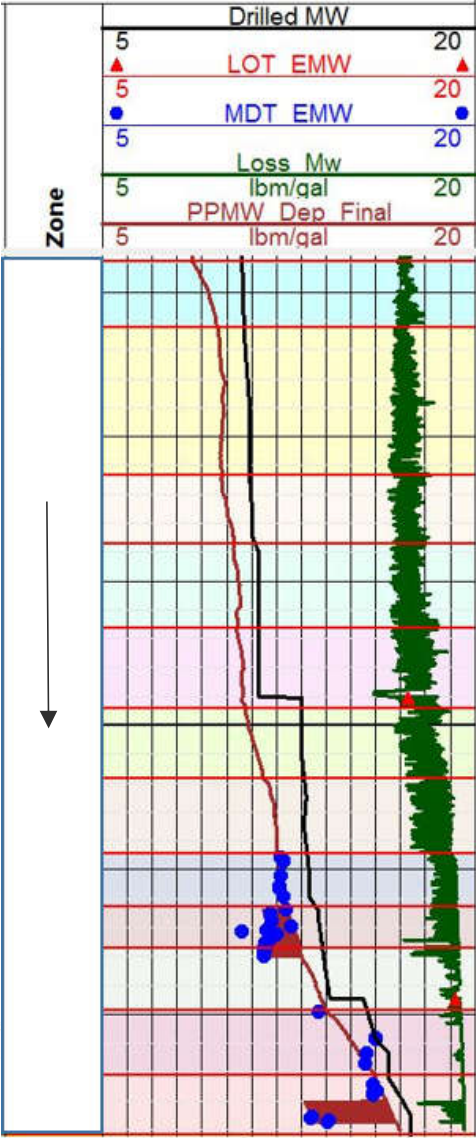
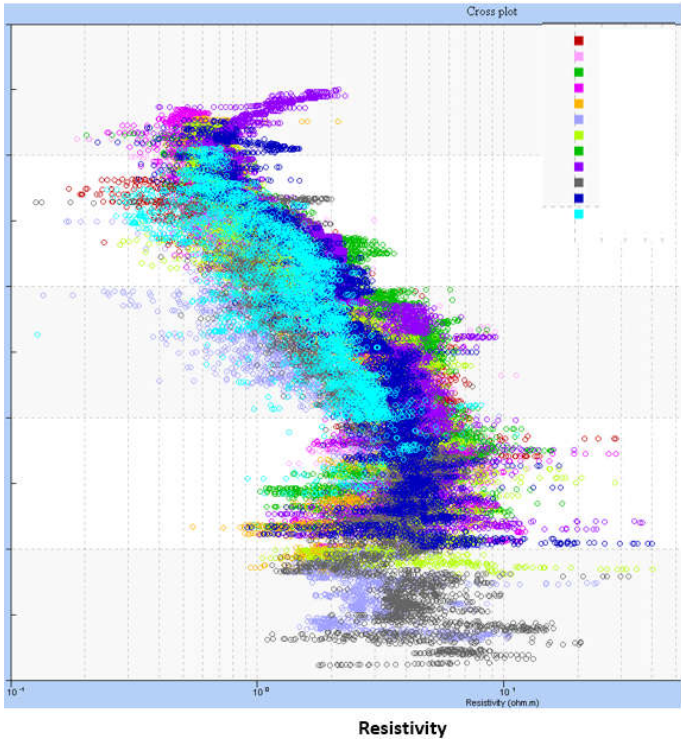


Resistivity and Sonic data have been used to generate pre-production Pore Pressure Profiles (shale points)

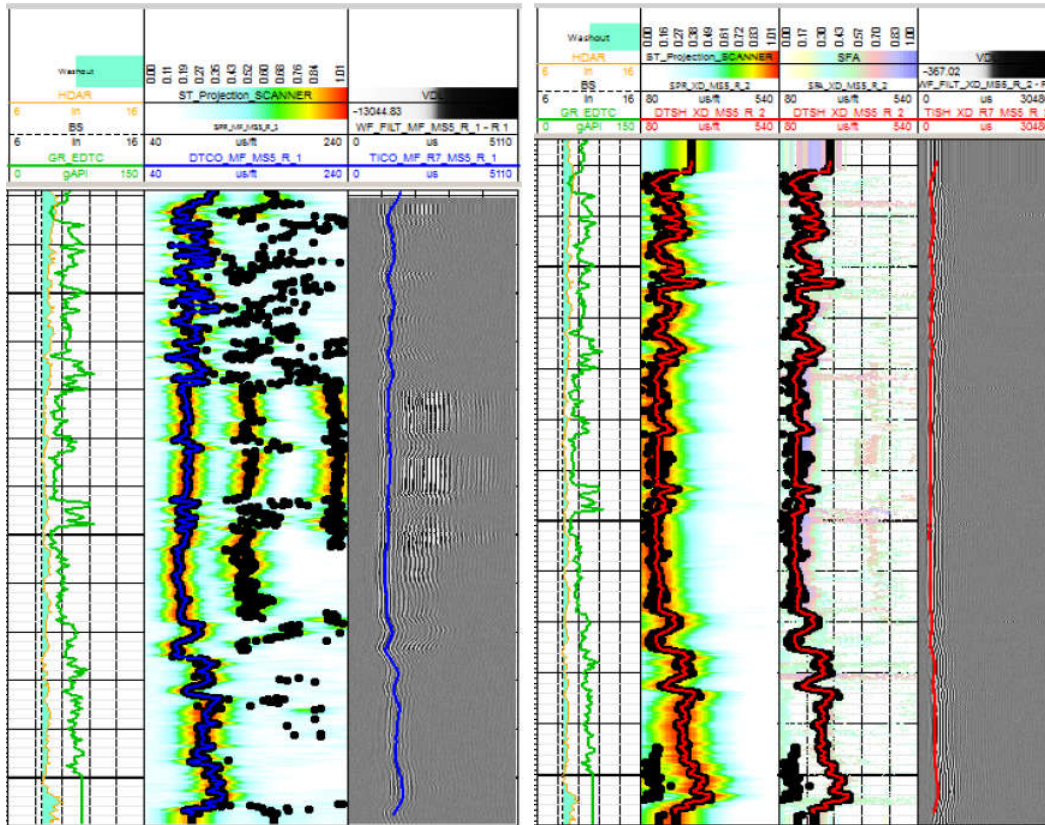
Sonic



Resistivity

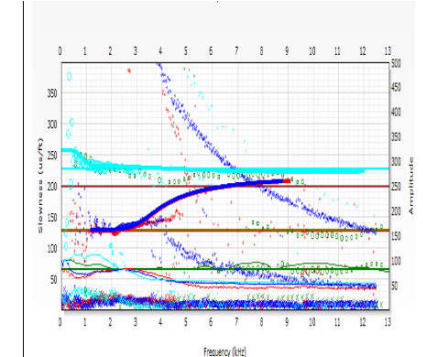
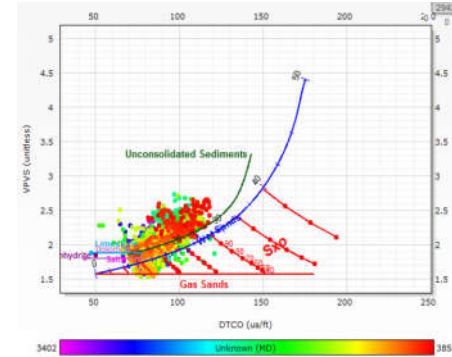


Acoustic processing on Techlog platform



Compressional from Monopole

Shear from X/Y Dipoles



- Compressional and Shear processing
- Shear Anisotropy analysis
- Shear Radial Variation Profiling
- 3D Anisotropy analysis

Summary

TECHLOG platform is used in multiple log interpretation:

- Real time LWD log interpretation
- Wireline log interpretation (Open hole and Cased hole)
- Well log correlation panel
- Formation tester analysis (pretest, DFA, sampling, VIT)
- NMR analysis
- Image interpretation (LWD density image and FMI images)
- Fault identification using OH logs and image data
- Geomechanics / Acoustics
- **Integration** of all above information provide robust understanding of the complex compartmentalized shaly-sand reservoir