

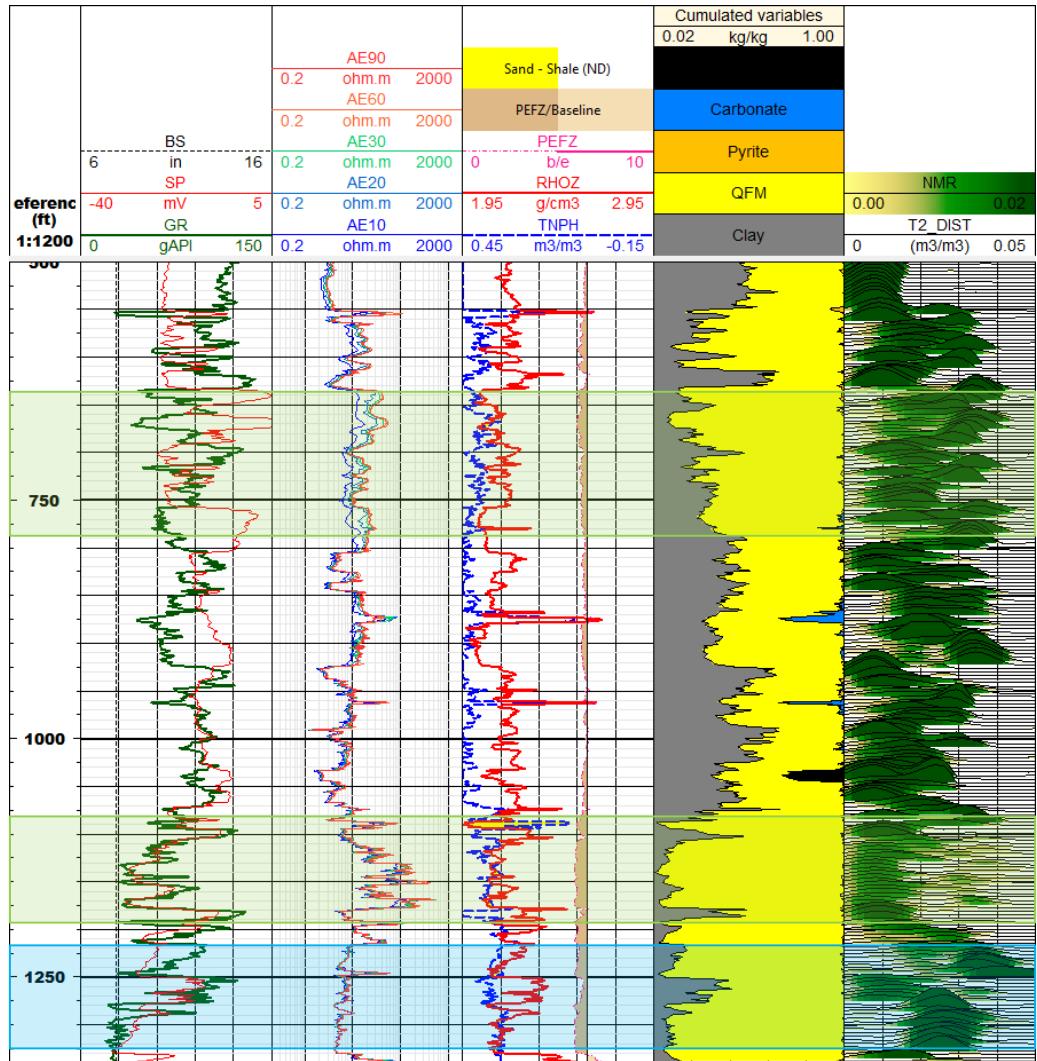
# Volumetric inversion method with integration of advanced log measurements (NMR, Dielectric, Spectroscopy)

*Mounir Belouahchia*



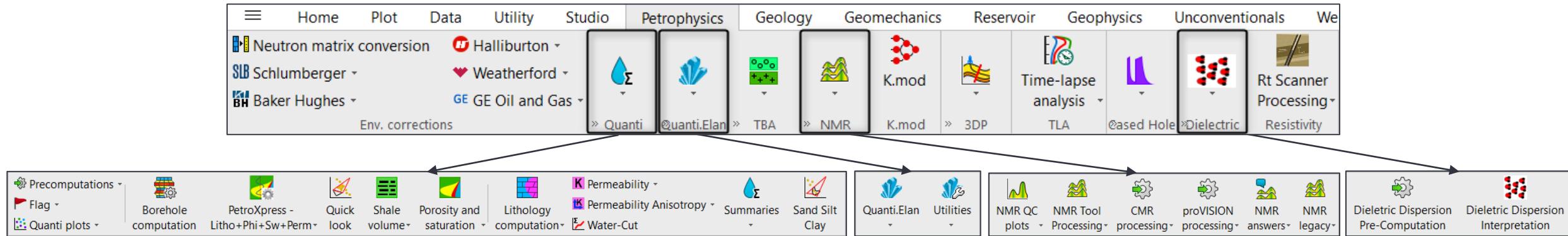
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# Well Overview



- Triple Combo
  - Induction Resistivity
  - NMR
  - Spectroscopy
  - Dielectric

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- Quick Look: Quanti
- NMR Processing & interpretation
- Dielectric
- Quanti Elan

**Workflow manager**

**Workflow overview**

Controller	Input data	Favorite parameters	Outputs
Workflow / Methods		Enabled	Apply Mode
1_Dielectric		<input checked="" type="checkbox"/>	disp...
DielectricSigma_Interp		<input checked="" type="checkbox"/>	save...
2_Quanti		<input checked="" type="checkbox"/>	disp...
Borehole computation		<input checked="" type="checkbox"/>	save
Shale volume		<input checked="" type="checkbox"/>	save...
Effective Porosity and Saturation - neutron-density		<input checked="" type="checkbox"/>	save...
3a_CMRCQC		<input checked="" type="checkbox"/>	disp...
Signal phase QC		<input checked="" type="checkbox"/>	disp...
Echo stacking QC		<input checked="" type="checkbox"/>	disp...
3b_CMRIInversion		<input checked="" type="checkbox"/>	save
Window sums		<input checked="" type="checkbox"/>	save...
Inversion		<input checked="" type="checkbox"/>	save...
3c_CMRCStandardAnswers		<input checked="" type="checkbox"/>	disp...
Bound fluid, free fluid and permeability		<input checked="" type="checkbox"/>	save...
Bin porosity		<input checked="" type="checkbox"/>	save...
4_QuantElan		<input checked="" type="checkbox"/>	disp...
Quant Elan initialization		<input checked="" type="checkbox"/>	save
Quant Elan_ECS_ADT		<input checked="" type="checkbox"/>	disp...

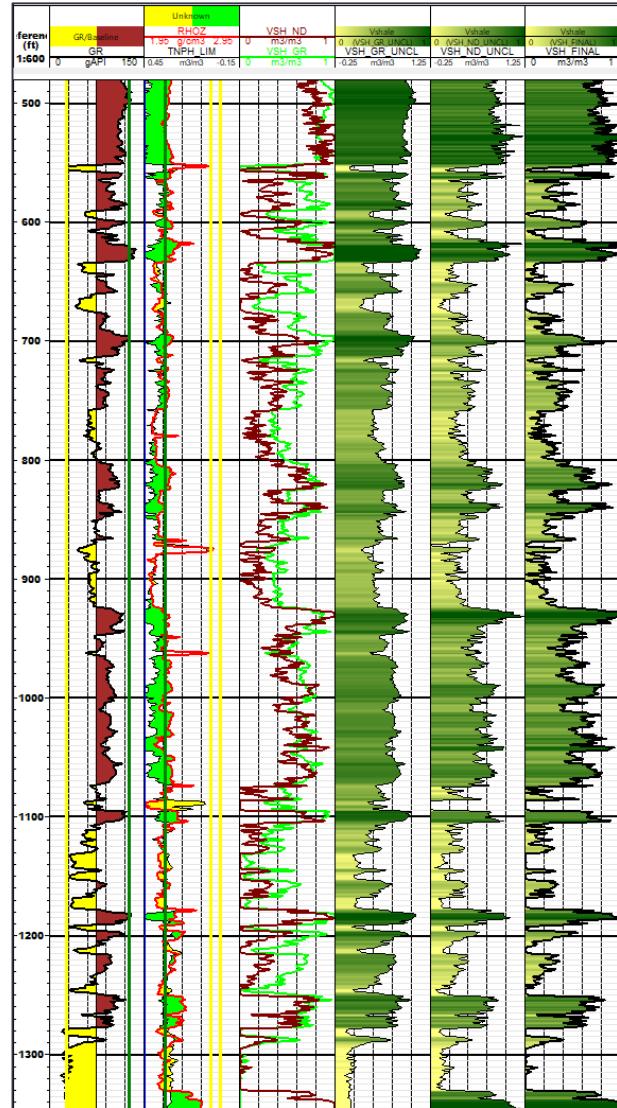
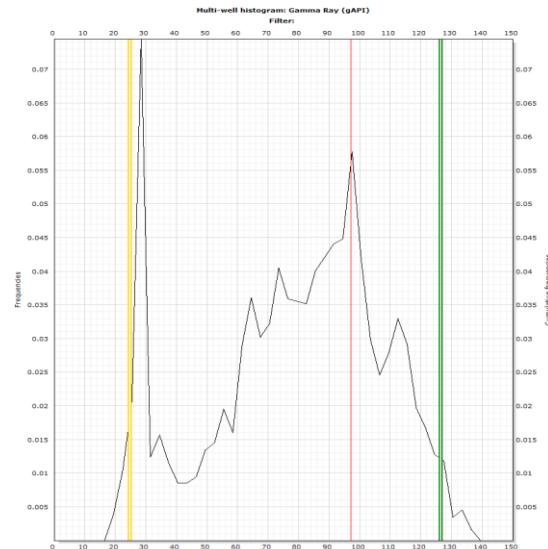
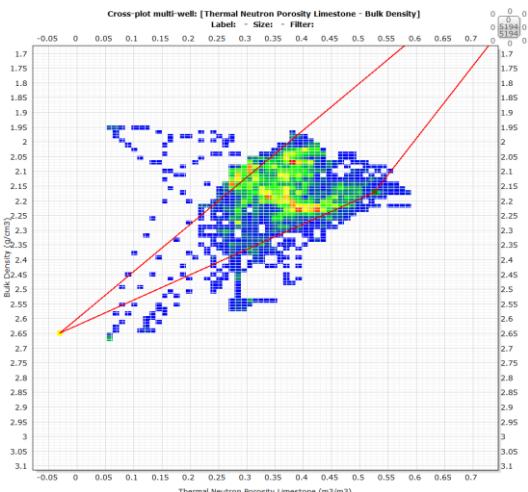
**Method settings**

Inputs	Zonation	Invaded zone	Virgin zone	Limits	Saturation	Shale	Optional
Use	1						
Group							
Well	AdvancedMeasurements						
Dataset	Working						
Neutron Porosity	TNPH_LIM						
Bulk Density	RHOZ						
Shale Volume	VSH_FINAL						
True Formation Resistivity	AE90						
Flushed Zone Resistivity	AE10						
Formation Temperature	MTEM_ADT						

# Quanti Workflow: Deterministic Approach



- Allows you to pick your parameters graphically
- Allows you to specify the equation you wish to use for the combination

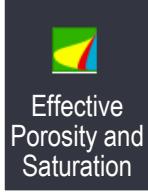


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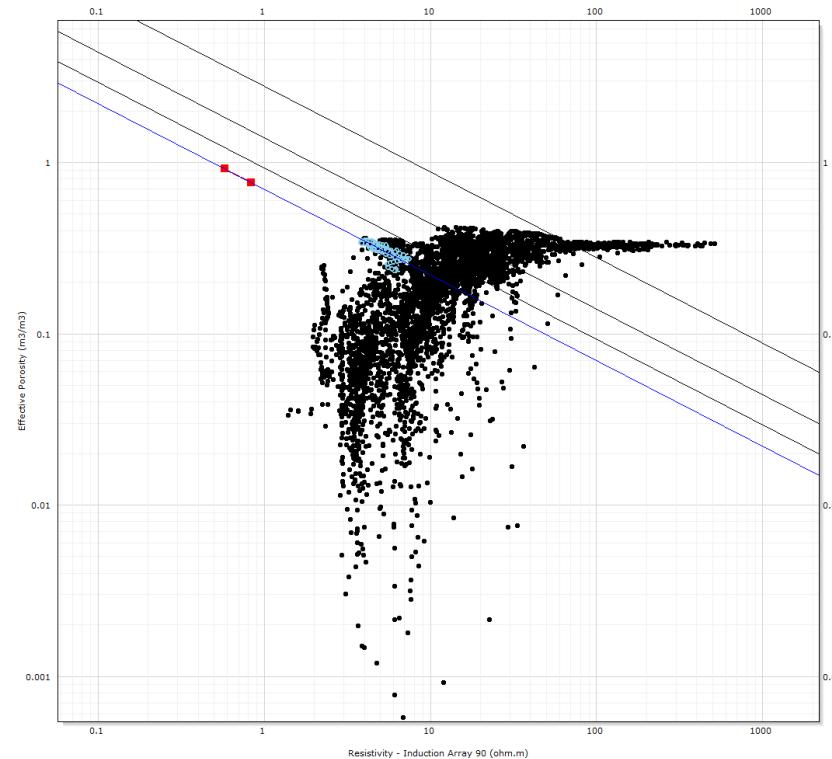
# Quanti Workflow: Deterministic Approach



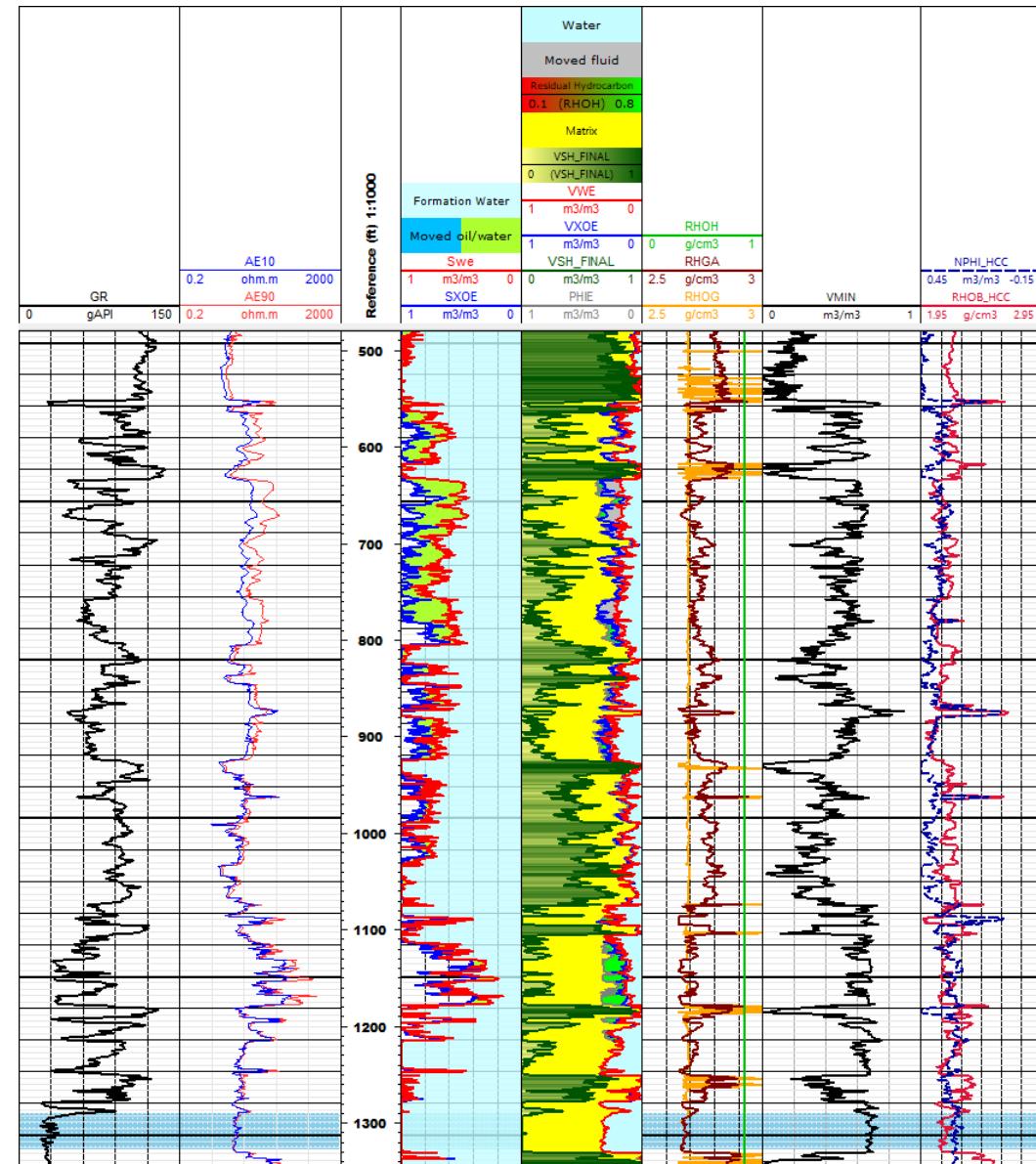
 Borehole computation



## Effective Porosity and Saturation

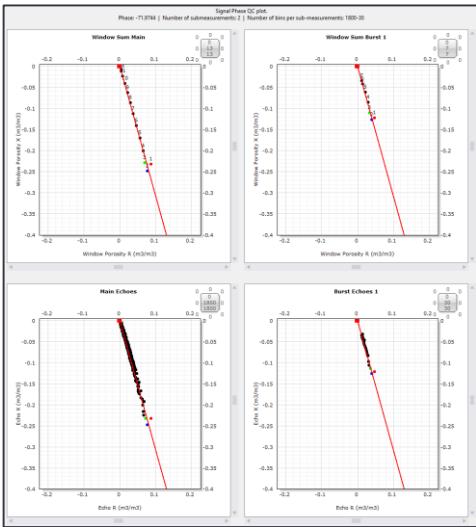


$$\begin{aligned}R_w &= 0.5 \text{ ohm.m} \\m &= n = 2 \\a &= 1\end{aligned}$$

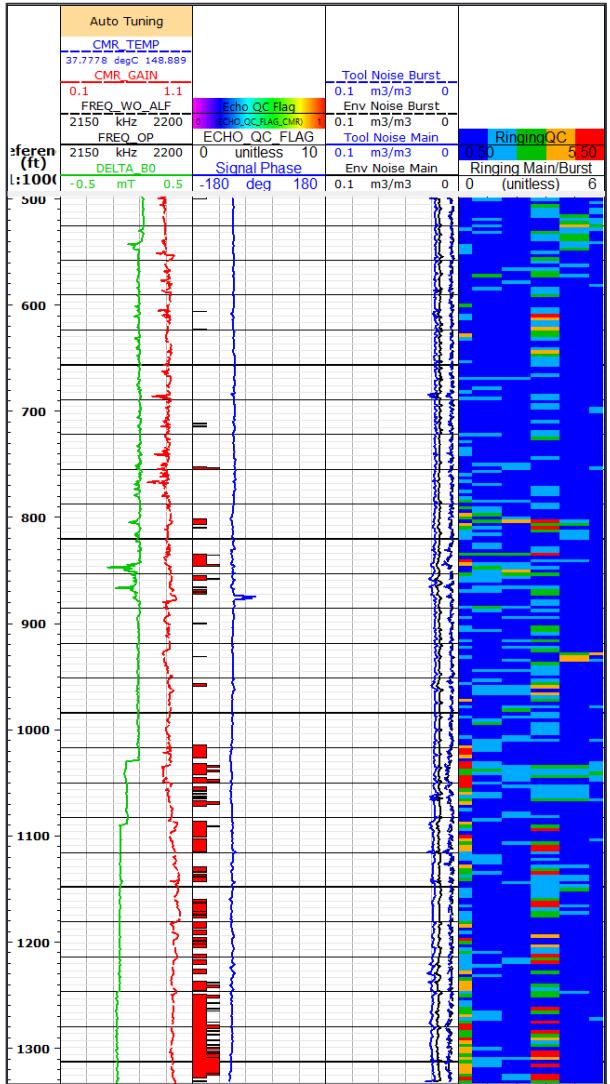


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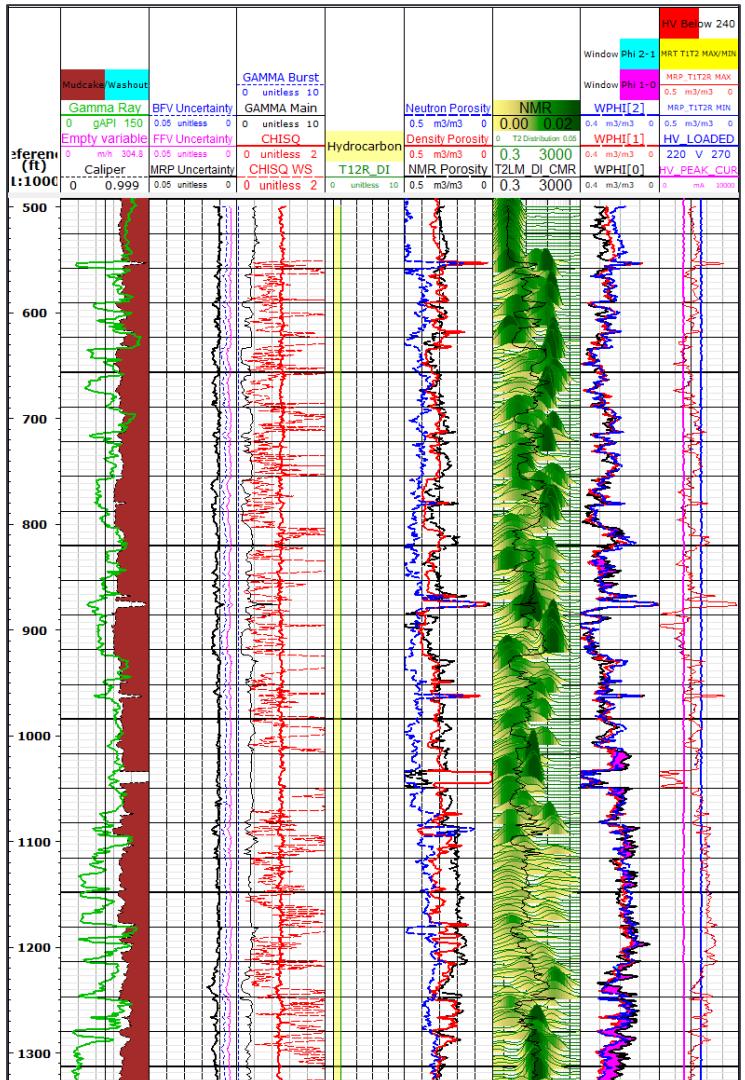
# CMR Processing



## Window sums



# Inversion

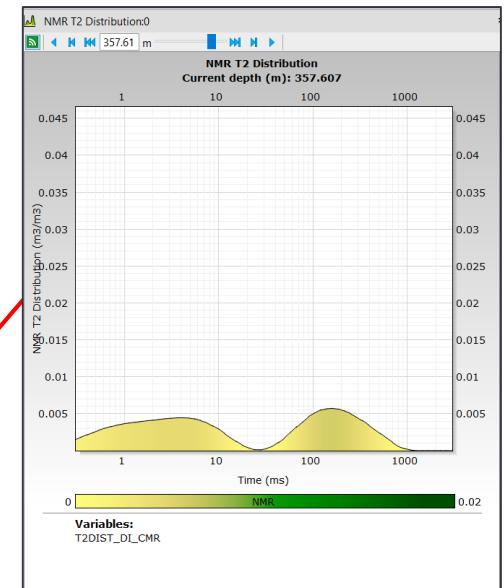
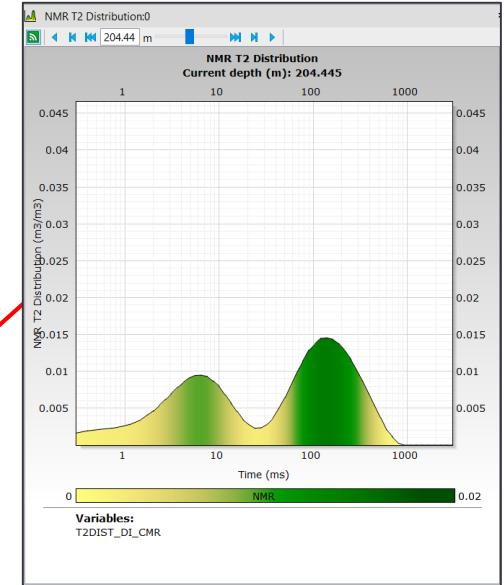
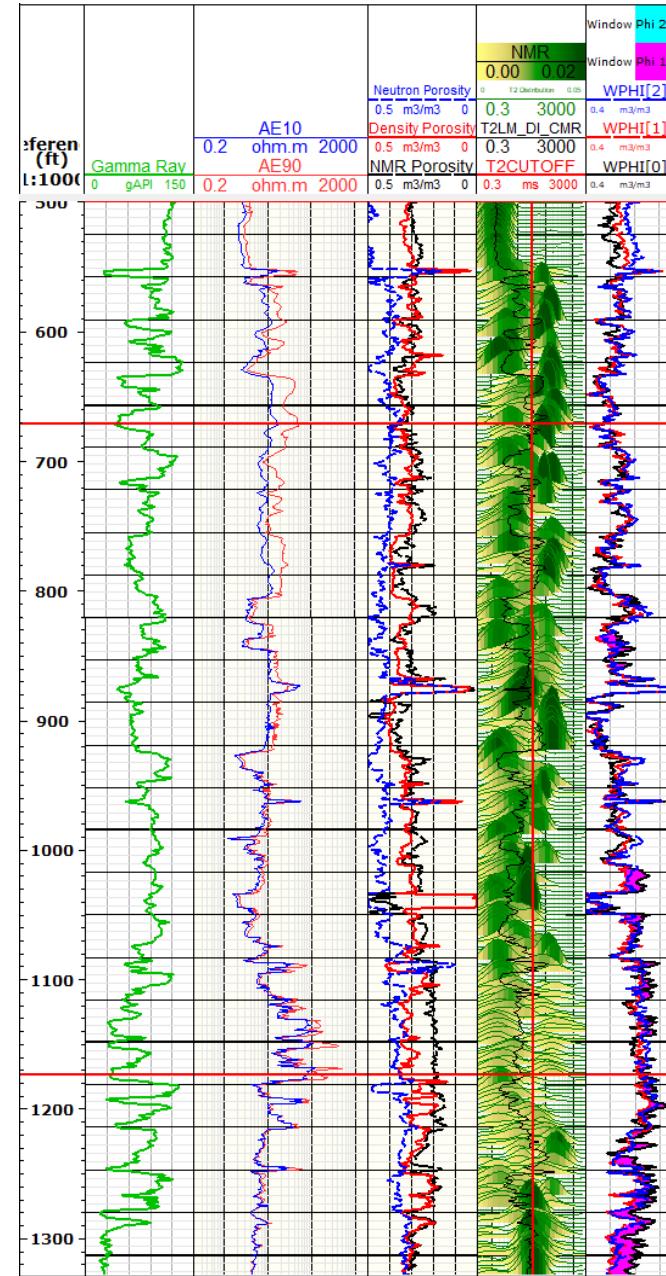


## QC Plots

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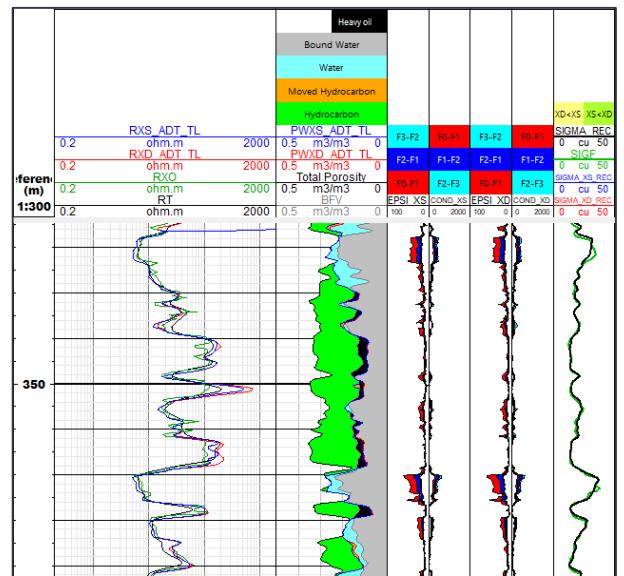
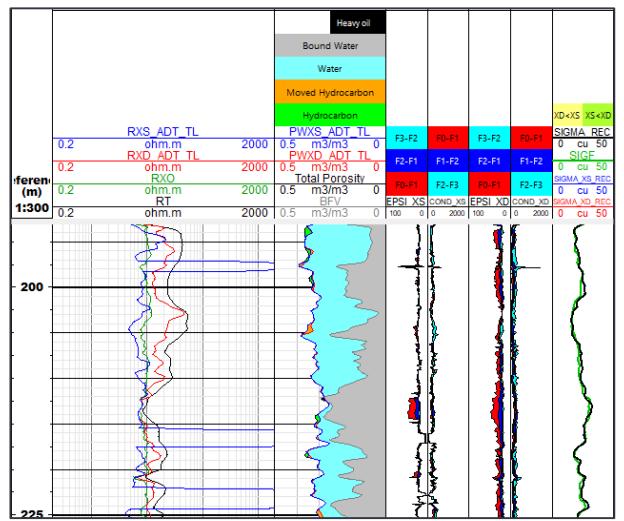
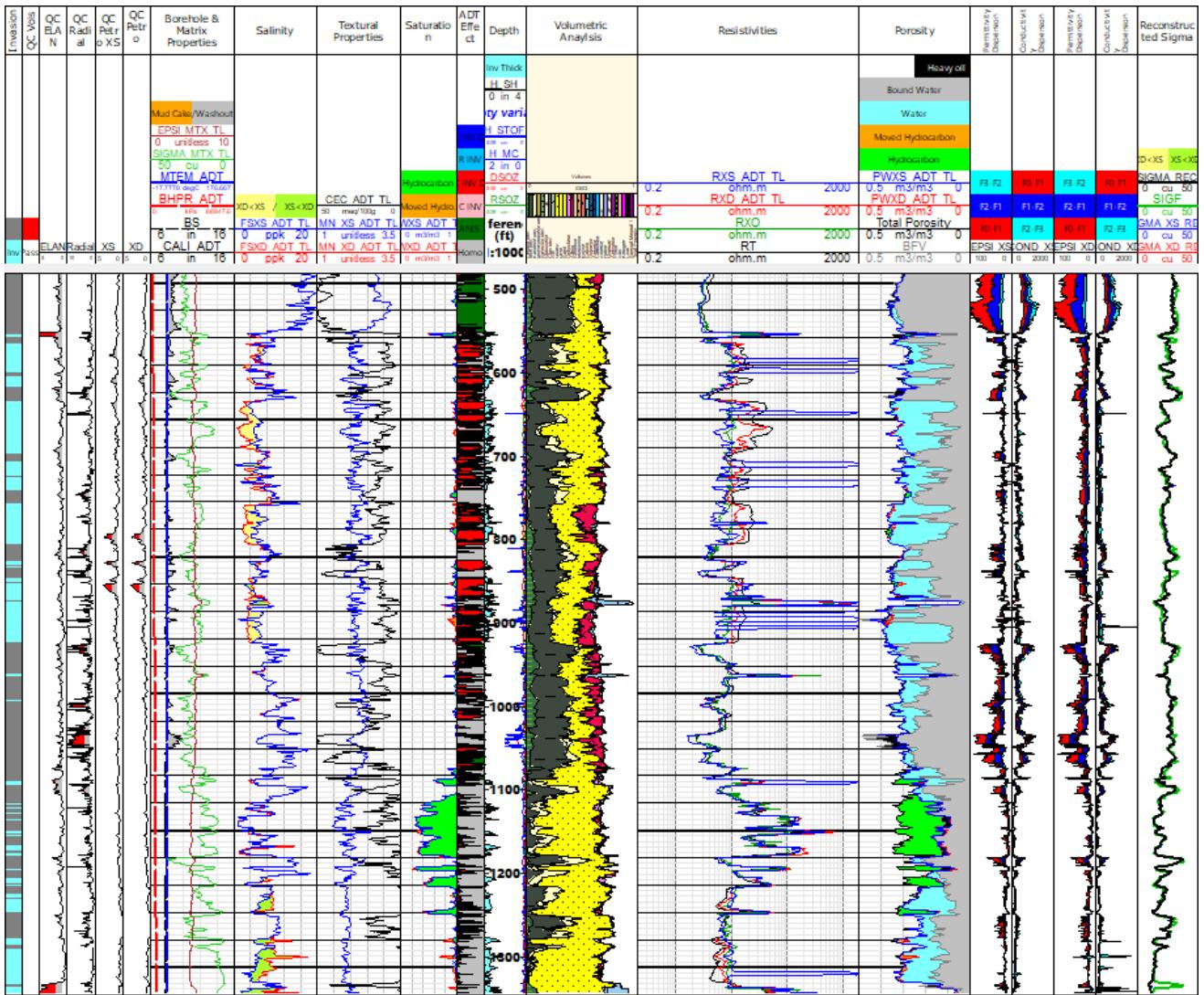
# NMR Porosity

- Single Depth Plot
- Logview Synchronization



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# Dielectric



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# Quanti Elan: Volumetric Inversion



Quanti Elan ECS\_NMR\_ADT

Inputs Zonation AdvancedMeasurements\_Working

	Input properties	Component Specification	Wet clays	Special Models	Additional constraints	Post-process parameters	Uncertainties		
	Family	Uncertainties	Uncertainty Type	Input Weight	Jnflushed factor	Equation type	Tool type	Constants	Activate
1	Bulk Density	0.027	Absolute	▼ 1	0.3807818	Linear		Bulk ...	▼ yes
2	Neutron Porosity	0.015	Absolute	▼ 1	0.4895766	Linear	▼ NPHI	Neutr...	▼ yes
3	Compressional Slowness	2.25	Absolute	▼ 0.75	0	Linear		Com...	▼ yes
4	Porosity	0.015	Absolute	▼ 0.5	0	Linear		Poros...	▼ no
5	U	0.225	Absolute	▼ 0.5	0	Linear		Volu...	▼ yes
6	UI_Gamma Ray	6	Absolute	▼ 0.3	0	Linear		Gam...	▼ yes
7	UI_Bound Water Volume Fraction	0.015	Absolute	▼ 1	0	Linear		Boun...	▼ no
8	UI_Silicon Weight Fraction	DWSI_SIG_WA...	Absolute	▼ 1	0	Dry Weight		Silico...	▼ yes
9	UI_Calcium Weight Fraction	DWCA_SIG_W...	Absolute	▼ 1	0	Dry Weight		Calci...	▼ yes
10	UI_Aluminum Weight Fraction	DWAL_SIG_WA...	Absolute	▼ 1	0	Dry Weight		Alum...	▼ yes
11	UI_Iron Weight Fraction	DWFE_SIG_WA...	Absolute	▼ 1	0	Dry Weight		Iron ...	▼ yes
12	UI_Titanium Weight Fraction	DWTI_SIG_WA...	Absolute	▼ 1	0	Dry Weight		Titani...	▼ yes
13	UI_Gadolinium Weight Fraction	DWGD_SIG_W...	Absolute	▼ 1	0	Dry Weight		Gado...	▼ yes
14	UI_PWXD_ADT_TL	0.015	Absolute	▼ 1	1	Linear			▼ yes
15	UI_PWXS_ADT_TL	0.015	Absolute	▼ 1	0	Linear			▼ yes

NMR

NMR

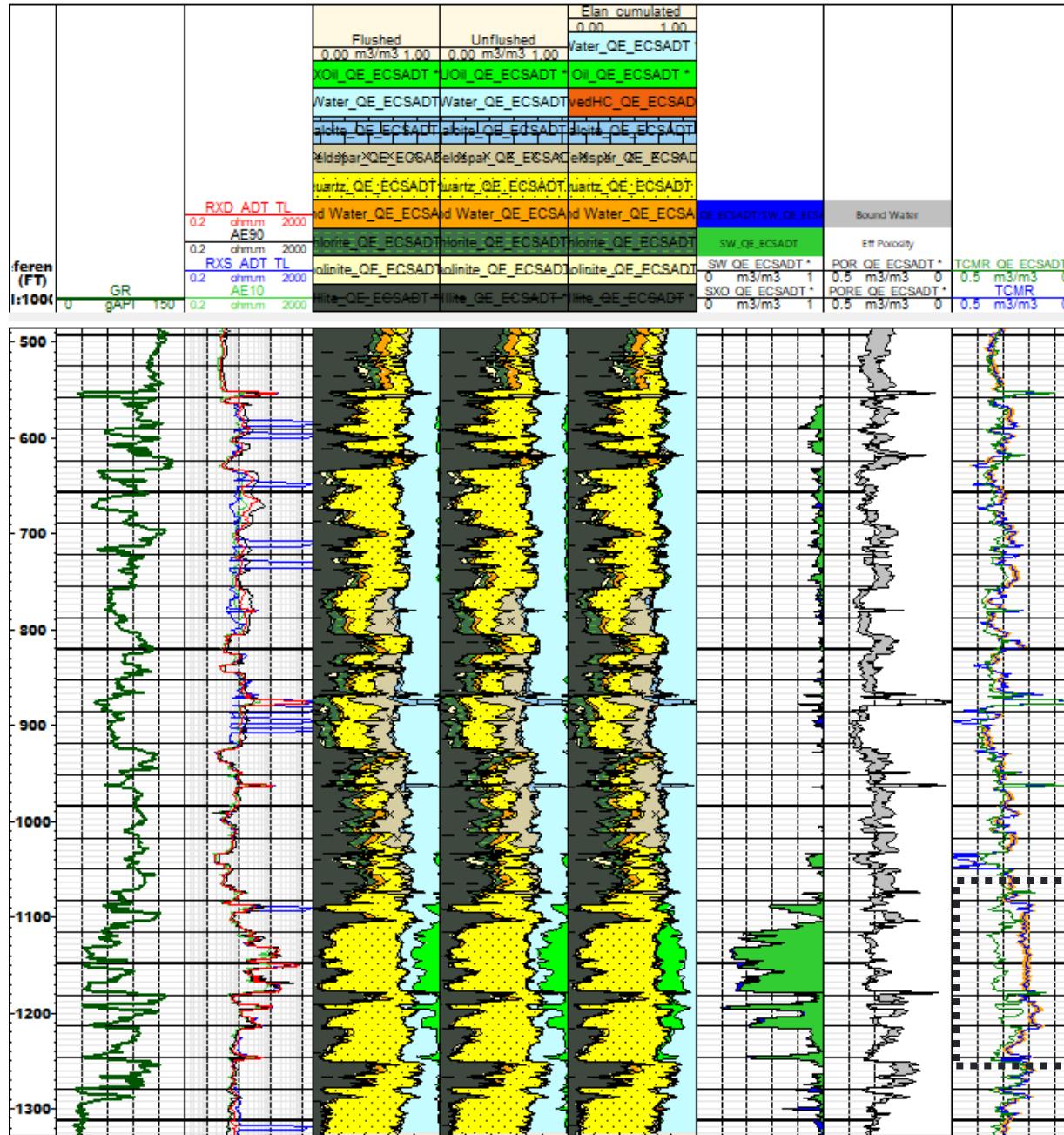
Spectroscopy

Dielectric

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# Quanti Elan

- Solves for flushed and unflushed systems
- Derives porosity

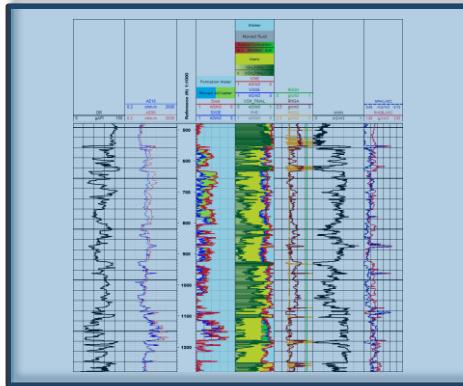


Heavy Oil

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# Conclusion

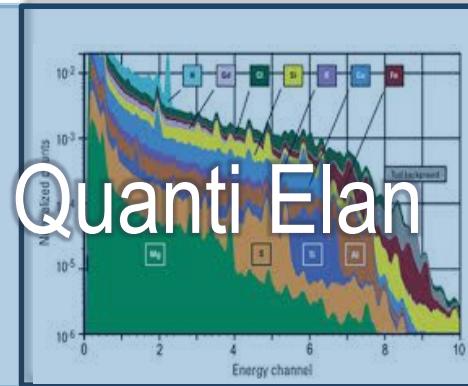
Triple-Combo



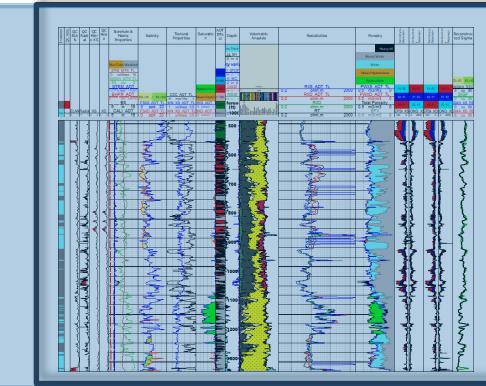
NMR



Elemental Spectroscopy  
Integrated – Quanti Elan



Dielectric



- Formation properties (Vsh,  $\Phi$ , Sw...)

- Porosity
- Bound Fluid, Free Fluid

- Matrix
- Clay volumes

- Water-filled porosity
- Formation water
- Salinity



Techlog Wellbore Software Platform

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