

FASTrak HD - LWD Fluid Analysis Sampling and Testing



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LWD Sampling and Testing

Agenda

- FASTrak
- FASTrak HD
- Cost savings through LWD & Wireline combinations
- Case study



FASTrak Capabilities

Pressure Testing

- Information of fluid dynamics within reservoir
- Mobility
- Pressure gradients-fluid type and density
- Predict the productivity of zone
- Safety and Drilling Optimization – Control Overbalance/ECD

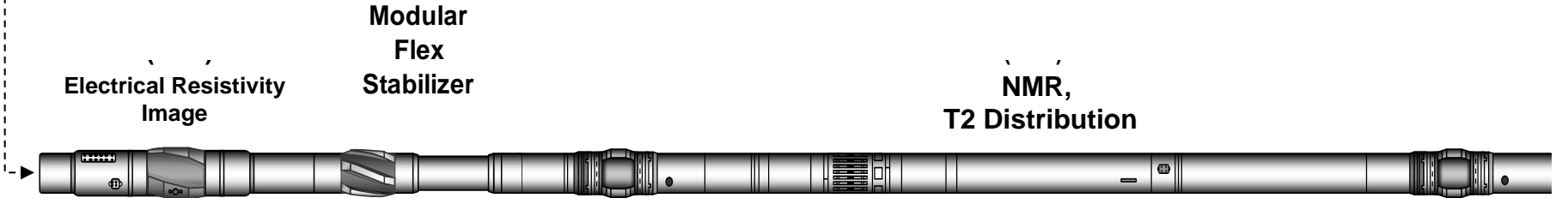
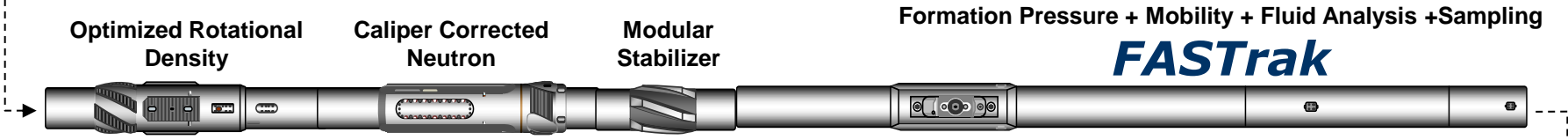
Fluid Sampling

- Representative and minimal contamination
- Provide info on production potential of reservoir
- Information on design and development of production facilities
- Info. on completion & development costs

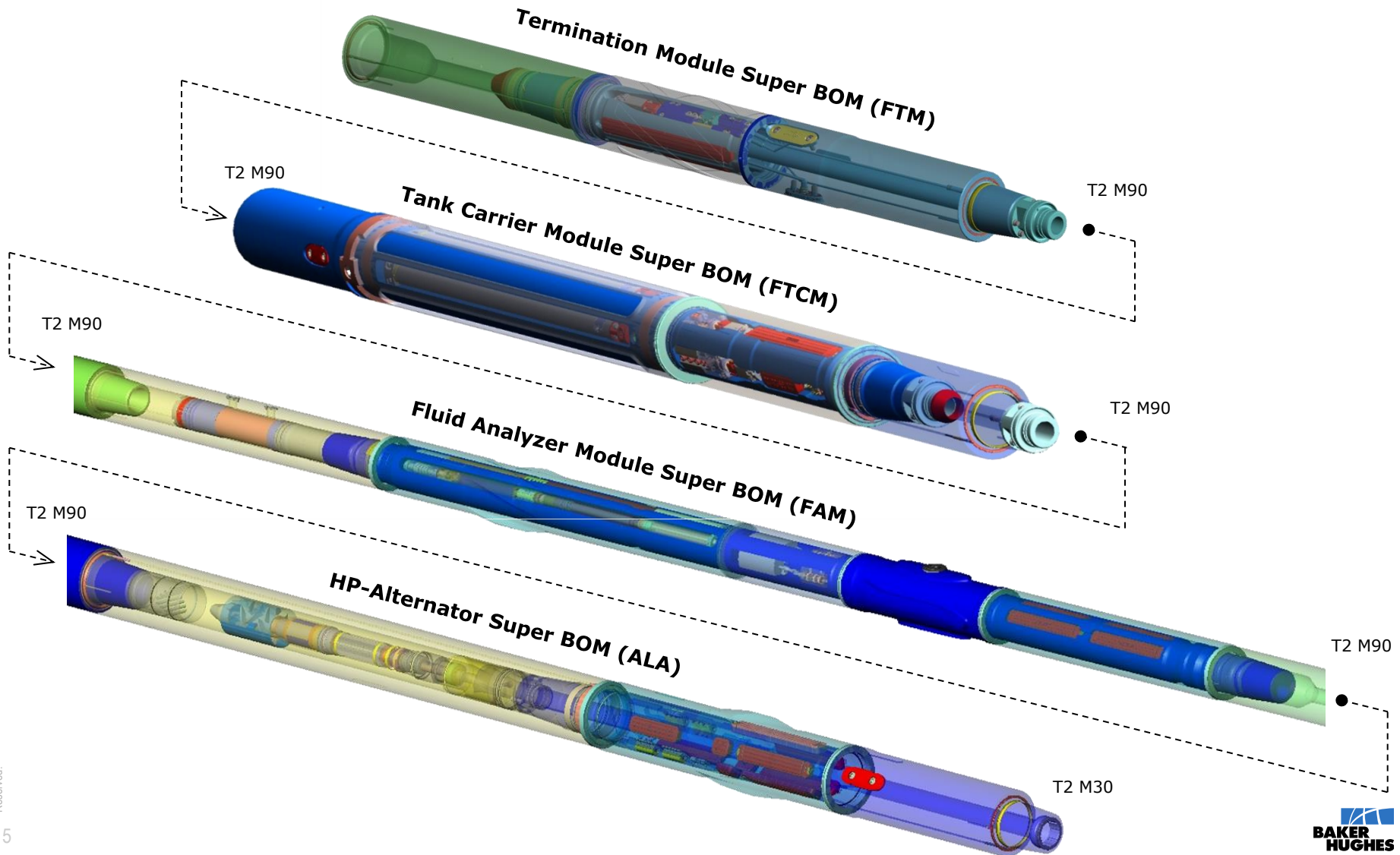
Downhole Fluid Characterization

- Density, Viscosity, Refractive Index and Soundspeed, GOR and Compressibility
- Real-time Clean up Monitoring
- Fluid Typing

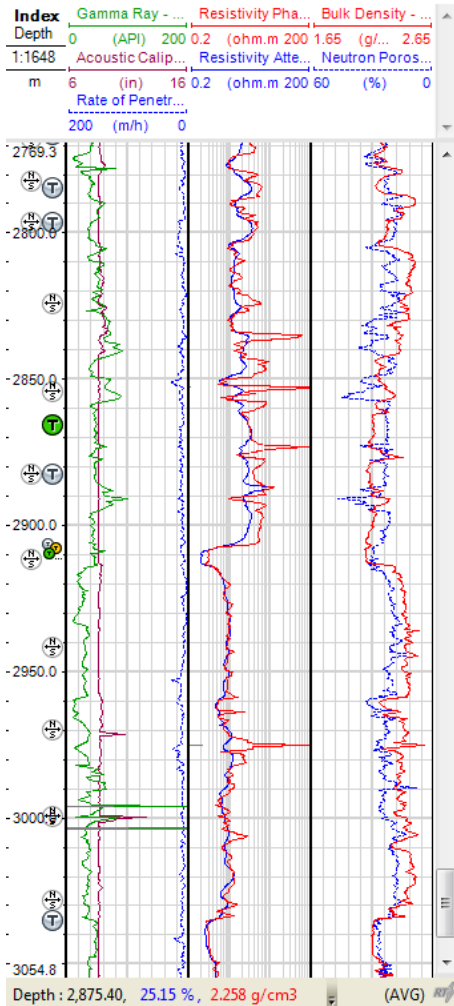
LWD Bottom Hole Assembly



FASTrak Modules



Real-Time Pressure Testing



Real-Time Pressure Test Summary

17 Feb 2013, 20:24:00

Annular Pressure

Before 316.853 bar
After 317.347 bar

Formation Tests

	Pressure 1	Pressure 2	Pressure 3
Formation	255.233 bar	255.217 bar	255.221 bar
Drawdown	249.150 bar	244.481 bar	244.481 bar
Delta	67.703 bar	72.372 bar	72.372 bar

Best Test

Mobility	85.7 mD/cP
Quality	7
Number	2

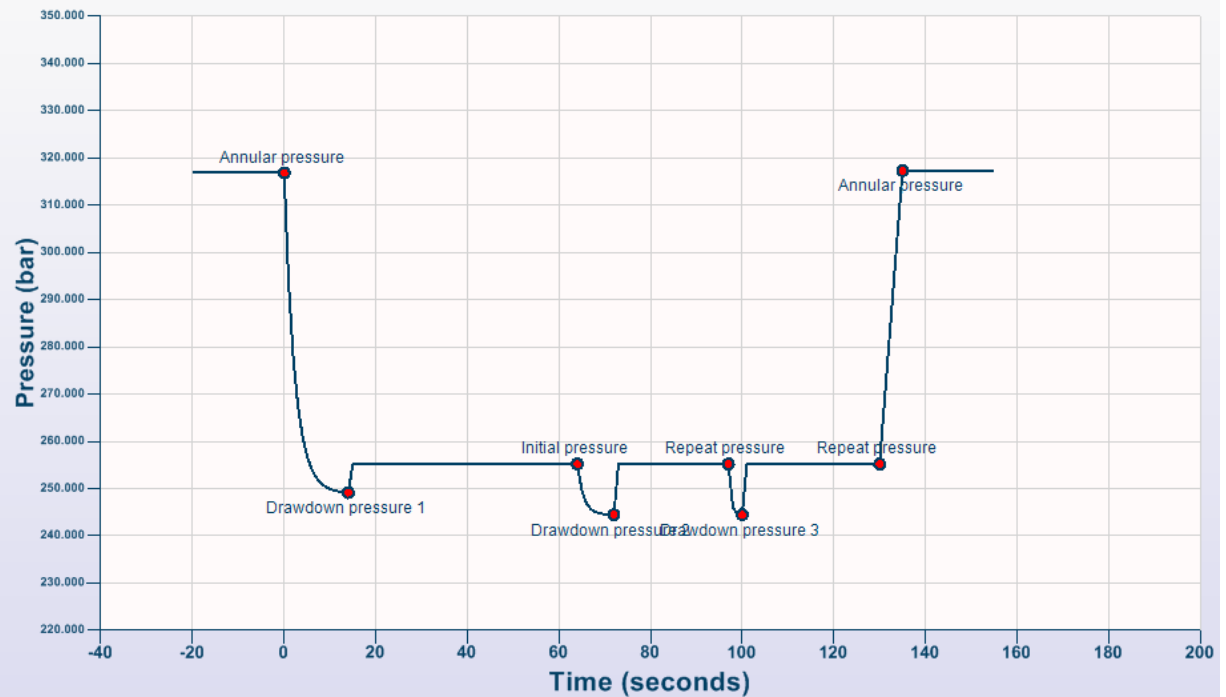
Other

Test Time	00:02:10
Toolface	56 dega
Time Since Drilled	489.19 h

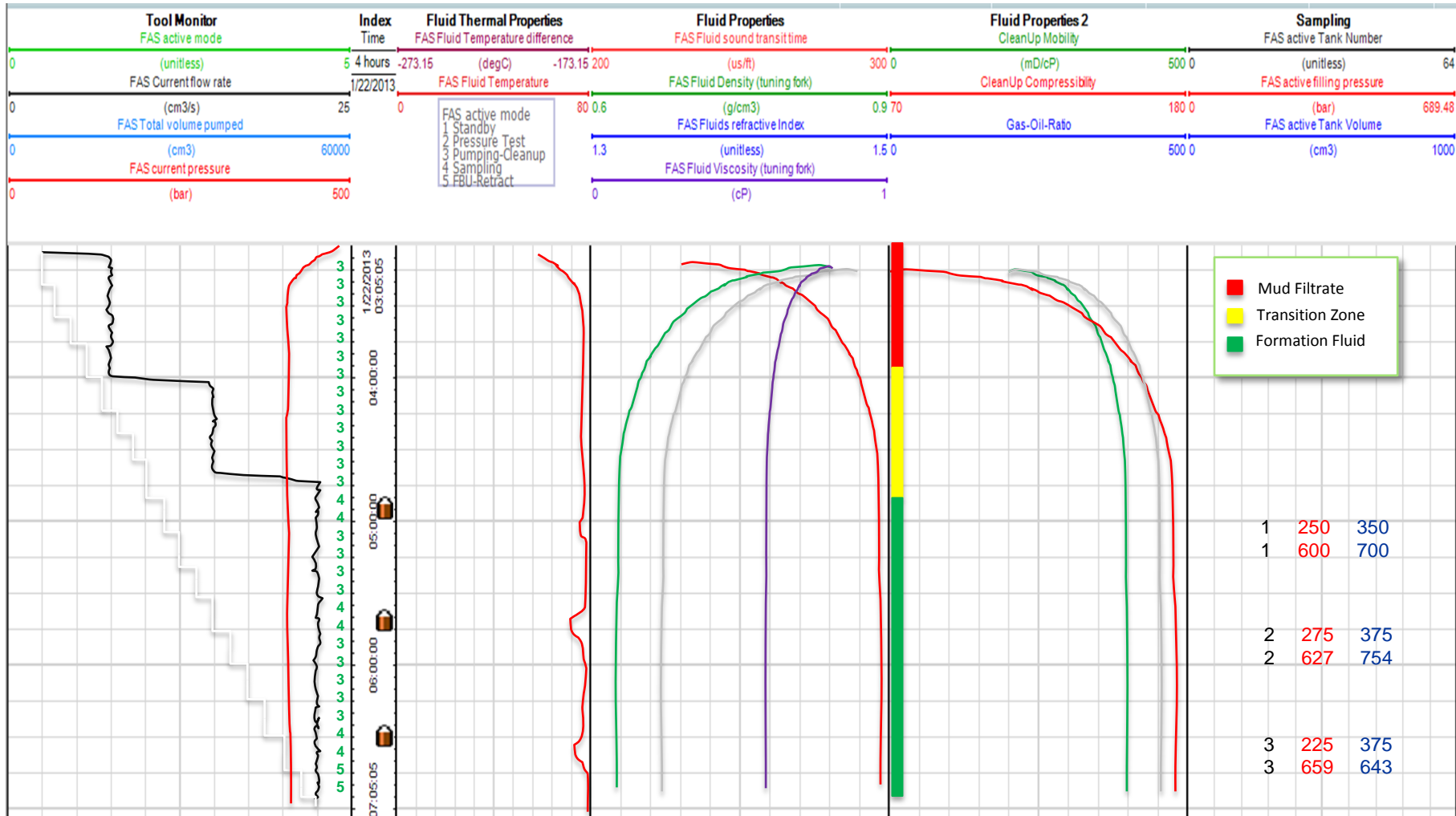
Station # 57
Sensor Depth (corrected)
MD 2866.00 m
TVD 2321.78 m

ECD 1.39 g/cm3
EMW 1.12 g/cm3

Remarks / Comments



Real Time Fluid Analysis (WLRT)



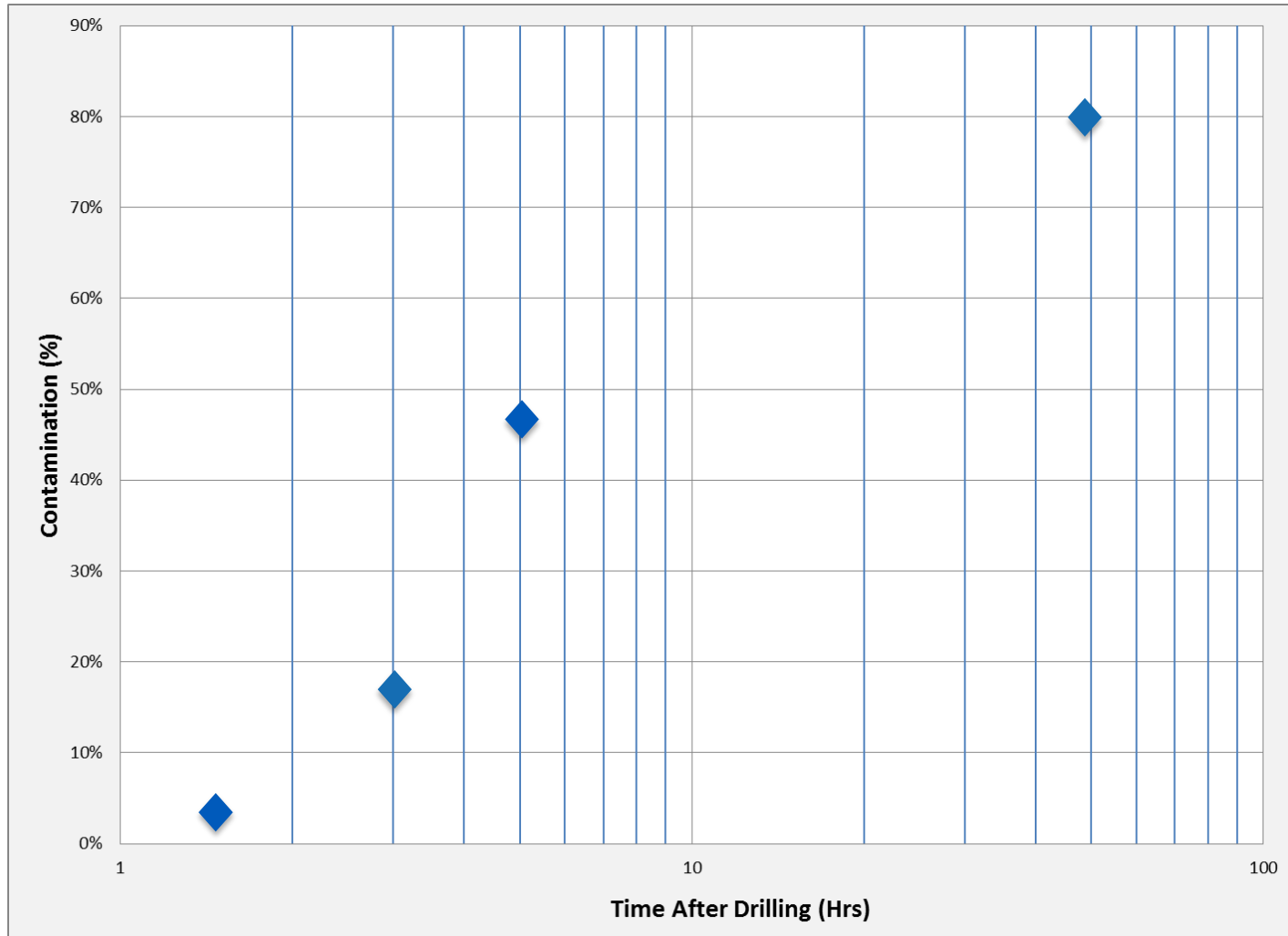
FASTrak Statistics

Number Runs	124
Total Number of Pressure Tests	>4100
Total Number of Samples Recovered	329 (165 Oil, 64 Gas, 100 Water)
Contamination Results (While Drilling)	<2% - 10%
Average clean up time (While Drilling)	2.5 hrs
Contamination Results (MAD Pass)	5% - 25%
Average clean up time (MAD Pass)	5.5 hrs
Most Samples recovered in one run	14
Most Pressures tests in one run	180
Longest Stationary Time	15 hrs.
Sealing Efficiency	96 %

FASTrak Reservoir Environments

Reservoir Testing Environments	Values
Types of Muds	OBM / WBM
Highest Temperature / Pressure	148 C / 19,800 psi
Lithology Tested	Sandstones & Carbonates
Permeability Range	.1 mD – 5000 mD
Viscosity Range	up to 140cP
Highest Mudweight / Solids	24 ppg / 30%
Max Overbalance	3146.5 psi
Depth Ranges	2,000 ft – 25100 ft
Hole Deviation	Vertical to horizontal

Contamination vs. Time after Drilling



- Volumes and times matched

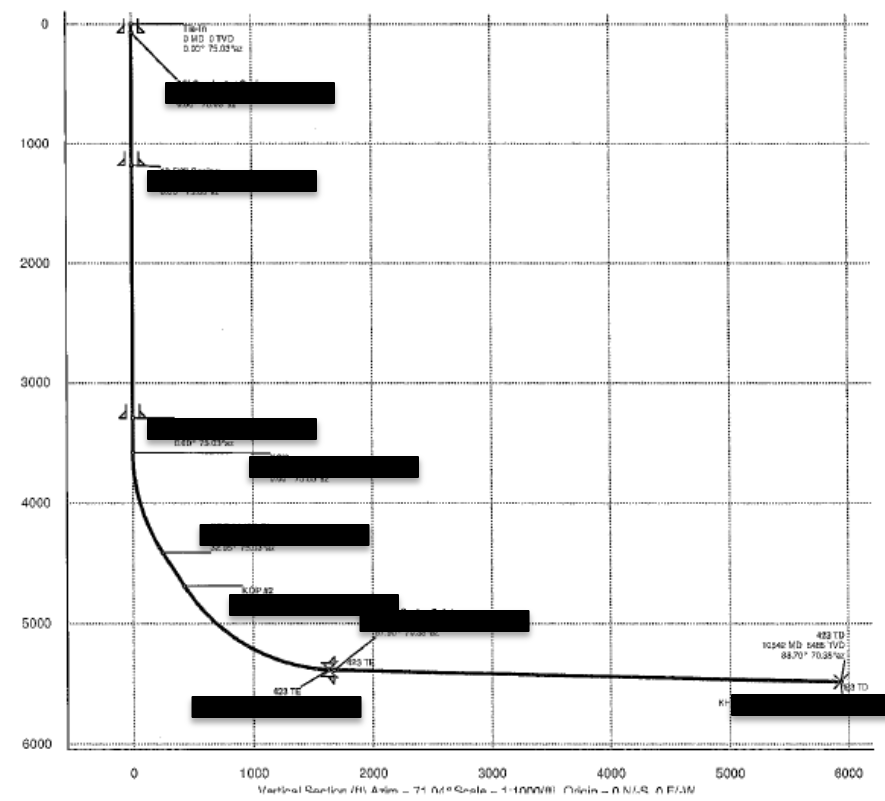
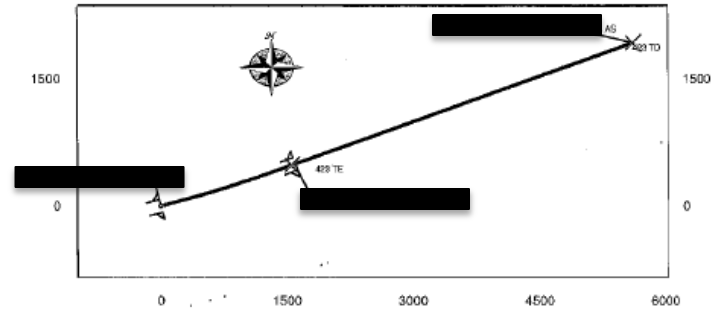
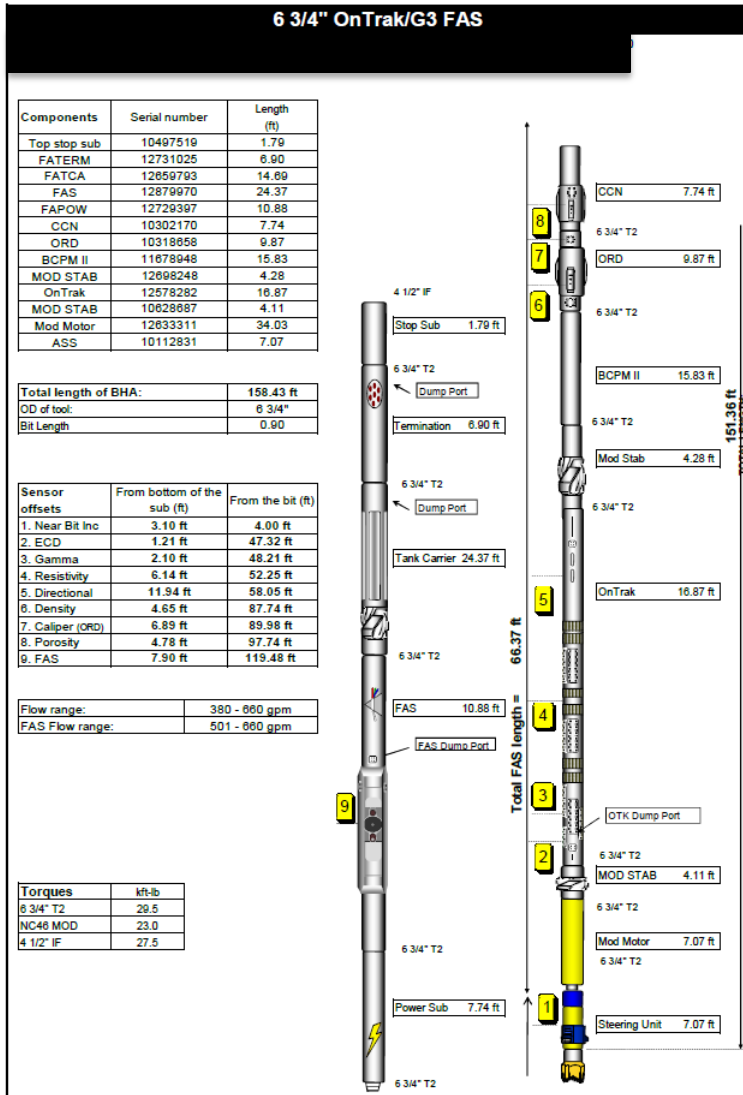
Case Study – Saudi Arabia

Client Objectives:

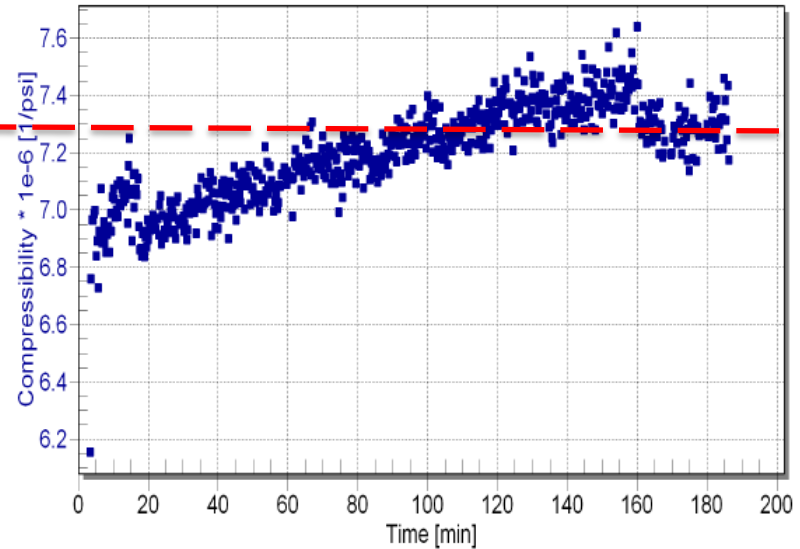
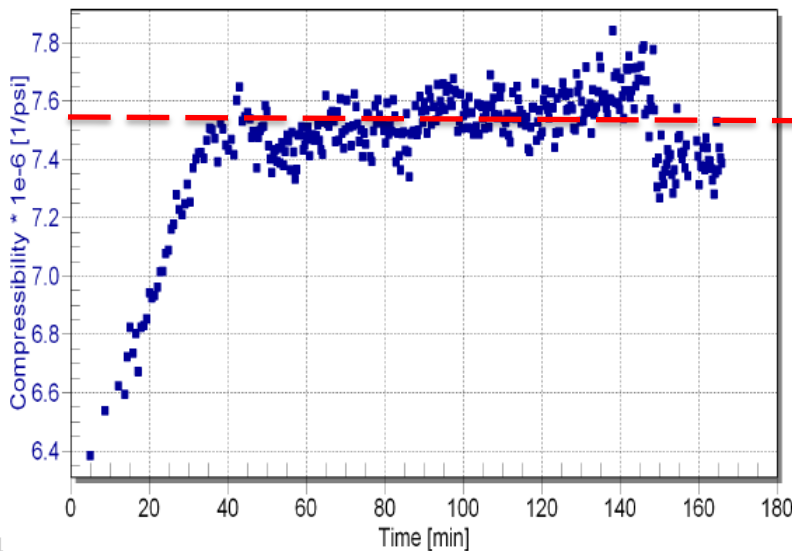
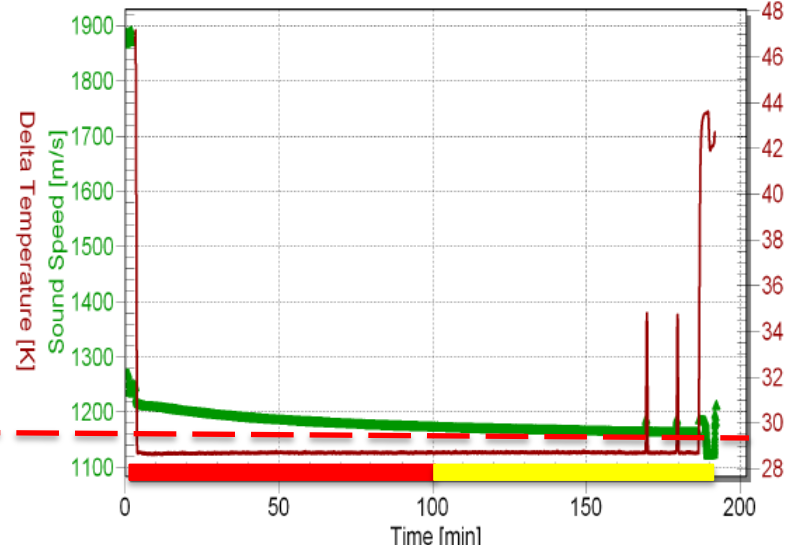
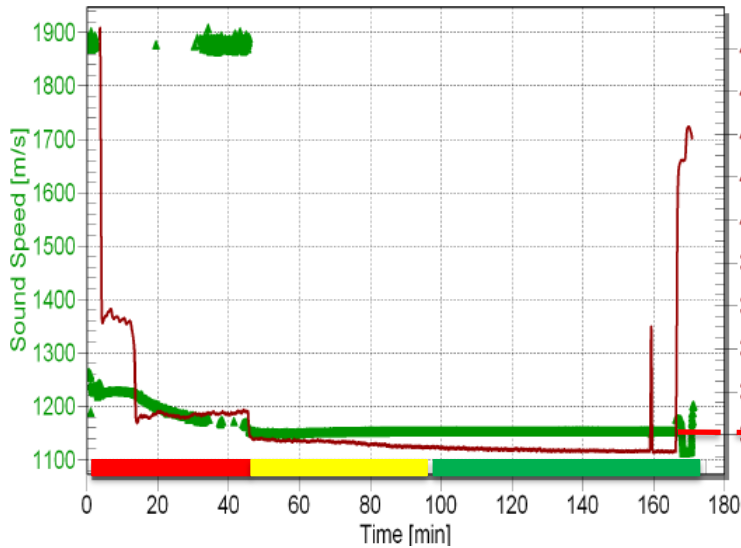
- Study the effect of time since drilling on the clean out time 2 samples at the same depth station (X560 FT-MD) with a significant time difference
- Verify the functionality of the LWD Sampling and Testing service for future deployments
- Obtain formation fluid samples at 2 depth stations (X675 Ft -MD & X560 FT-MD)

Operational Summary	Run 1
Drilling run:	4078 feet
Circ. Hrs. / Drilling Hrs	75 hrs / 35 hrs
Mud Type / Formation Fluid	OBM / Oil
Formation Type / Permeability	Carbonate / 50 mD
Pressure Tests	4
Number of Samples	4
Sampling Stations	3
Total Volume Pumped	450 Liters
Time on Stations	3.33 Hours / station (Average)
Overbalance	~600psi
Sealing Efficiency	100%
Contamination	<5% early sample and <10% on later samples

BHA and Wellpath



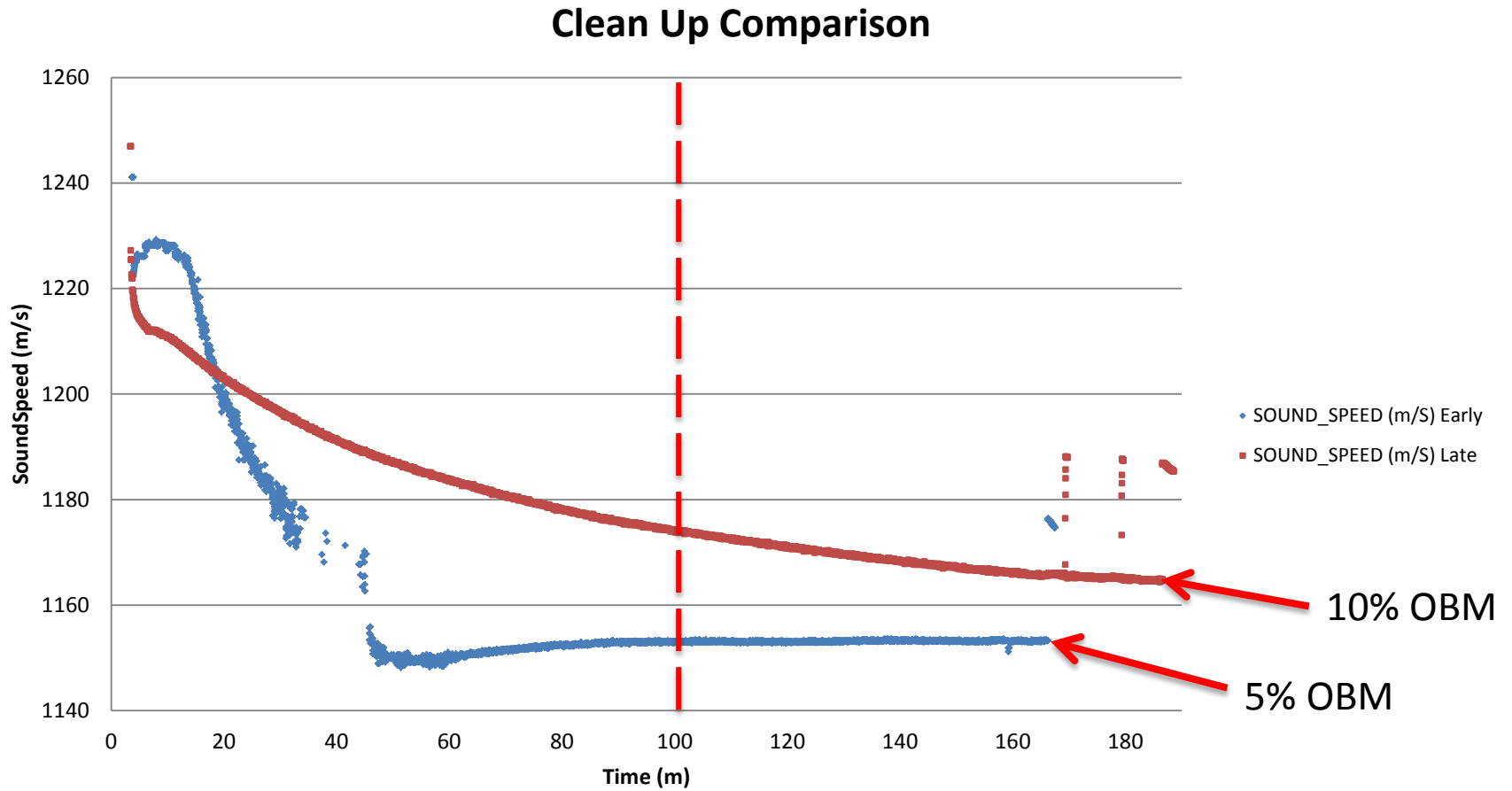
Clean Up Comparison



6.5 Hours since drilled

43 Hours since drilled

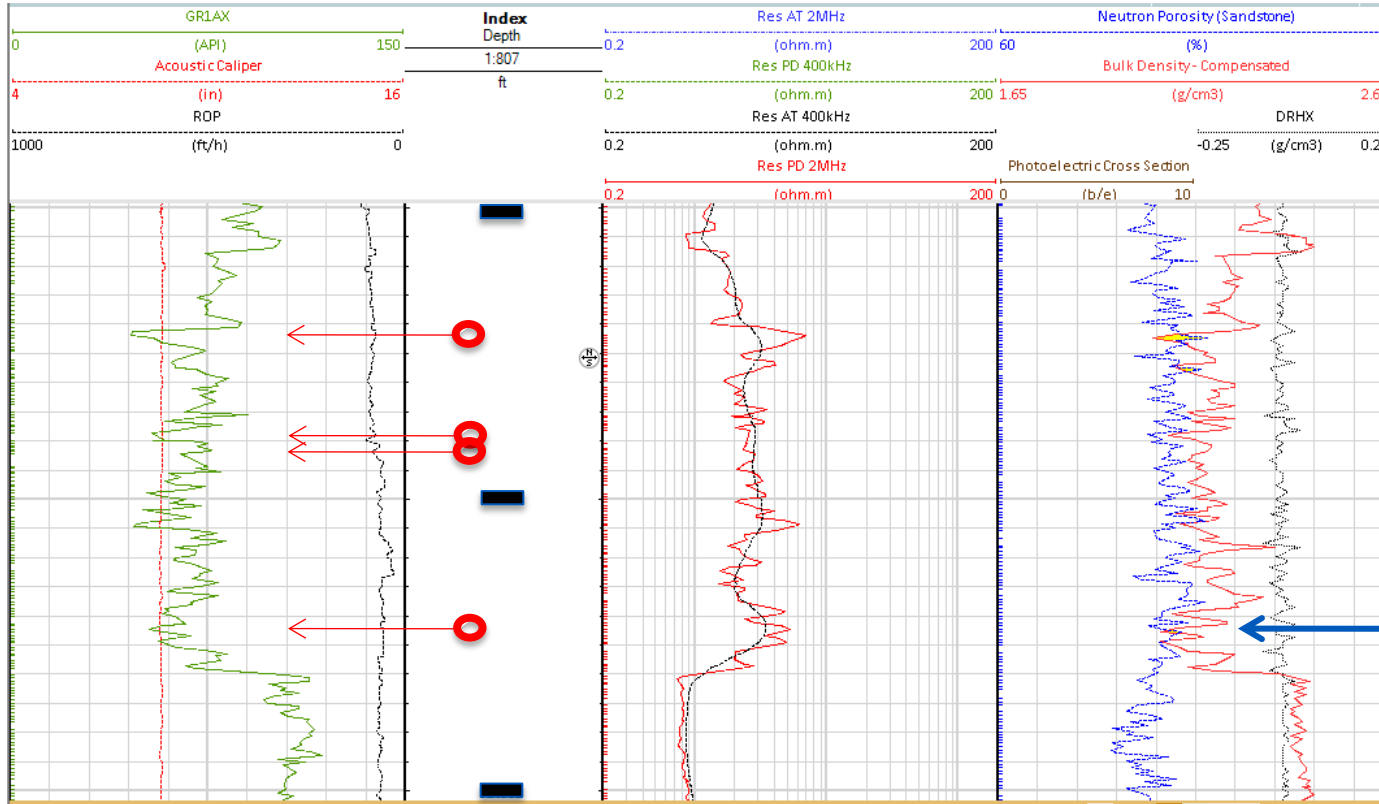
Clean Up Comparison



Deep Water Gulf of Mexico

Operational Summary	Run 1
Drilling run:	26000 ft
Circ. Hrs. / Drilling Hrs	76.5 / 40
Mud Type / Formation Fluid	OBM/ Oil & H ₂ O
Pressure Tests	20
Number of Samples	6
Sampling Stations	4
Total Volume Pumped	165 Liters
Time on Stations	90 mins / station (Average)
Overbalance	~1000psi
Sealing Efficiency	100%
PVT Analysis	<2% - 10%

Pressure Testing and Sampling points

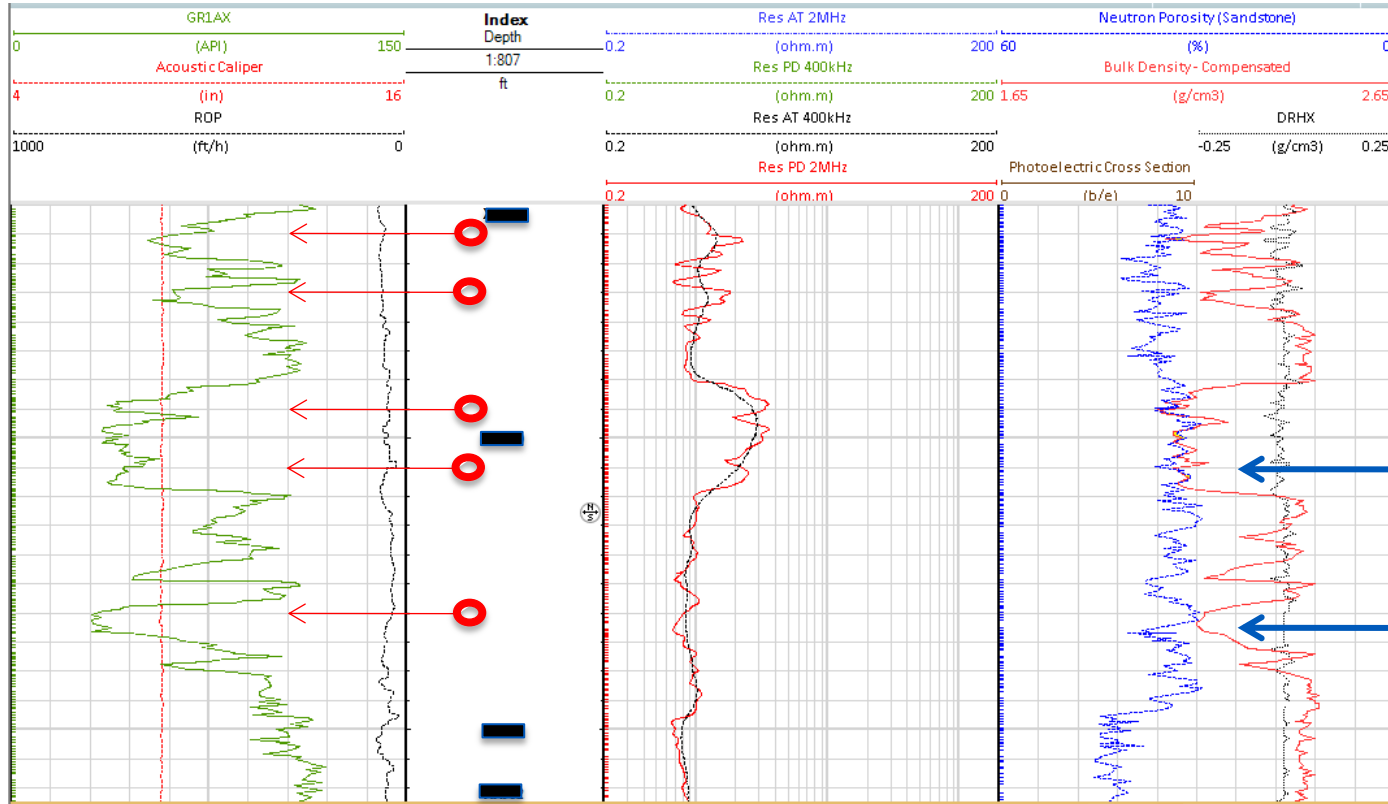


Sample 1 & 2
31.4 mD/cP

Sample Point

Pressure Point

Pressure Testing and Sampling points



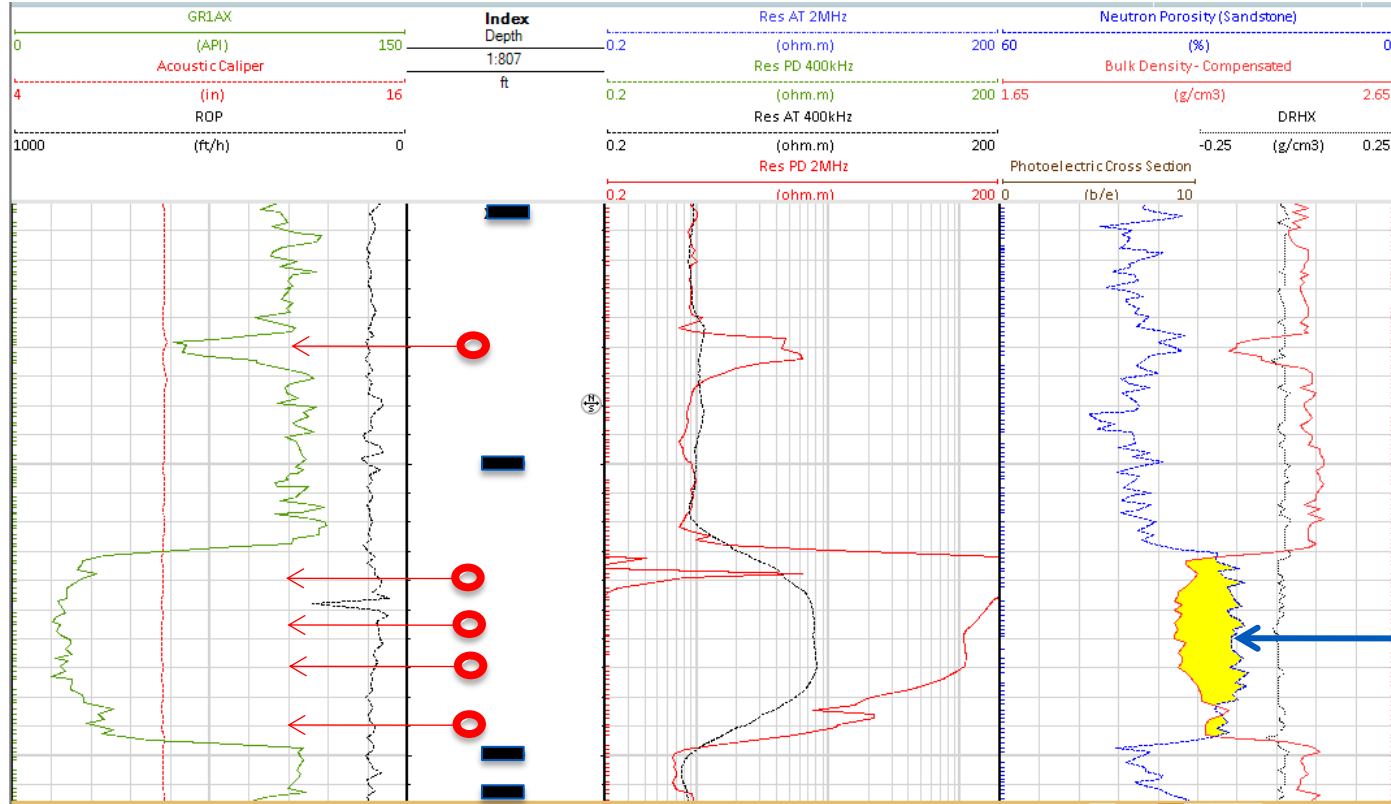
Sample 3 & 4
117.8 mD/cP

Sample 5
442.3 mD/cP

Sample Point

Pressure Point

Pressure Testing and Sampling points

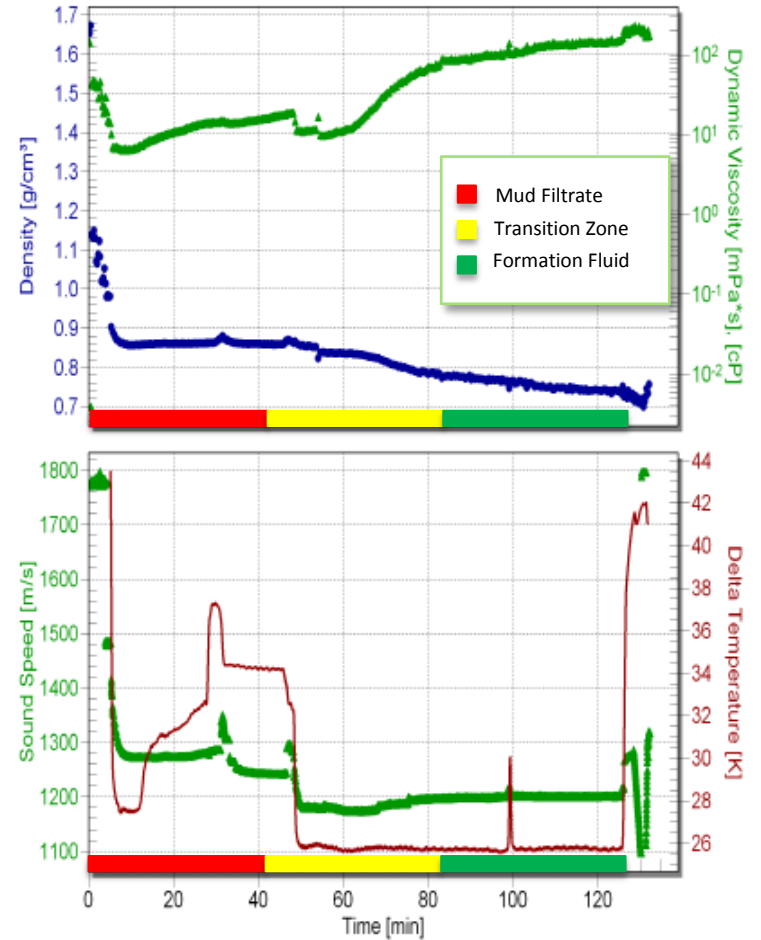
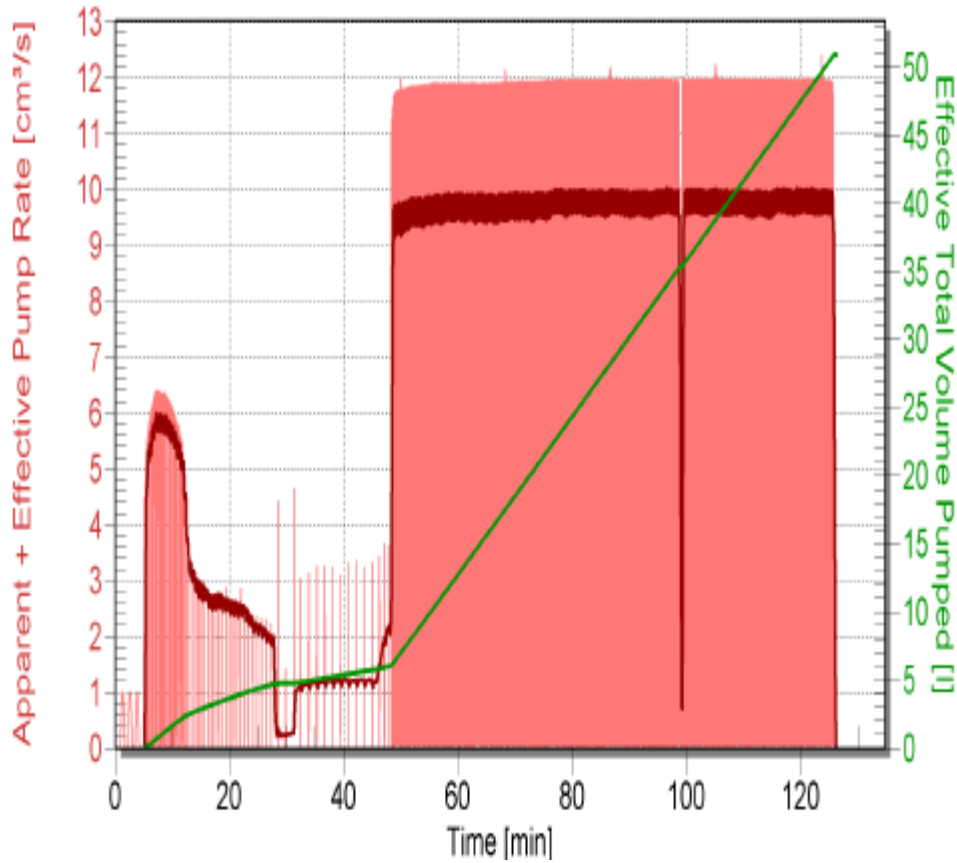


Sample 6
546.7 mD/cP

Sample Point

Pressure Point

Sample 1 & 2



Downhole vs Laboratory

Sample	Sampling time hrs	Density from FASTrak g/cc	Density from PVT Laboratory g/cc	GOR Baker Hughes SCF/STB	GOR Laboratory SCF/STB	% OBM Contamination
1	1.6	0.74	0.712	1150	1189	<2%
2	2	0.74	0.719	1600	1156	<2%
3	1	0.715	0.688	1600	1412	<8%
4	1.33	0.715	0.688	1600	1545	<8%
5 **	.9	0.92	0.779	350	101	N/A
6	1.16	0.72	0.743	1450	1353	<10%

** PVT Lab will retest



- FASTrak helps quantify Mercury content in gas samples for facilities design
- XOM Australia Janz Field saved 18 days and \$30M
- XOM Australia received VP Capital Efficiency Award due to FASTrak deployment

RCX Sentinel and FASTrak Services Teamed up in Deepwater GoM

LWD and wireline fluid sampling services captured high purity samples

Background

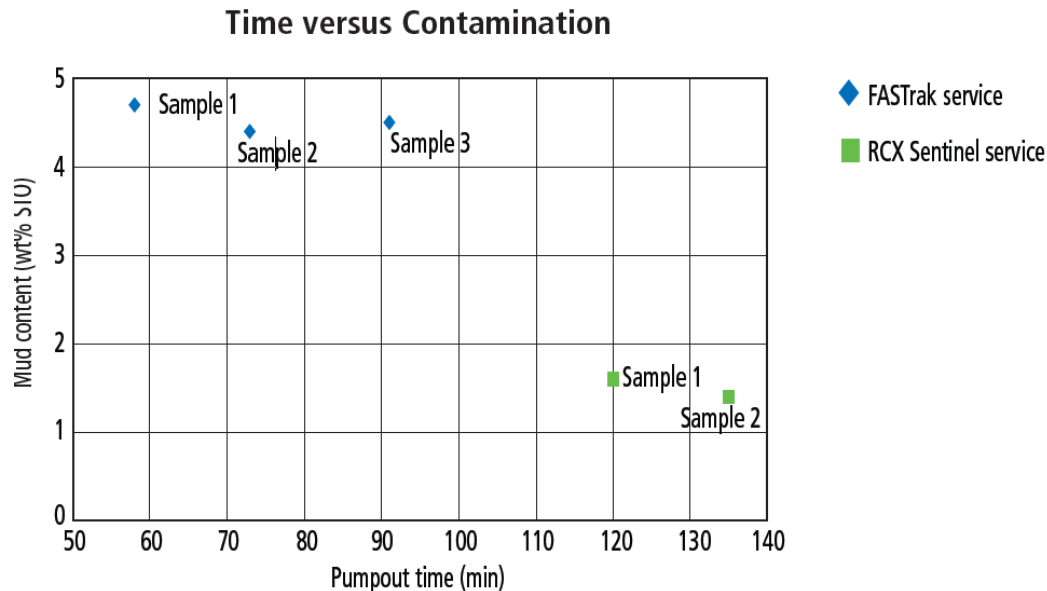
- Deepwater GoM development well
- Low permeability
- Laminated sand/shale sequences
- 2 very clean samples needed. Additional samples needed => joint WL and LWD optimal cost

Baker Hughes solution and results

- FASTrak LWD service: 3 samples < 5% contamination
- RCX Sentinel service: 2 samples < 2% contaminations

Cost saving

- \$1.5 M cost savings – Utilized FASTrak for preliminary samples and pressures, RCX Sentinel for acquisition of high volume low contamination samples



FASTrak LWD Service Acquires Formation-Fluid Samples and Formation Pressures in a 9½” Horizontal Well, Deep-Water Nigeria

Client's First Successful Formation Fluid Sampling while Drilling Worldwide

Background

- 3D horizontal well previously requiring Pipe-Conveyed Wireline Fluid Sampling.
- Wash out of the soft shallow formation during the planned 90 min's sampling stationary time was a concern for the Client.
- Differential sticking concern with the drilling BHA containing radioactive source.

Baker Hughes Solution and Results

- The trajectory was successfully drilled into the targets with AutoTrak and FASTrak FASTrak LWD fluid analysis sampling and testing service.
- Successfully acquired 6 formation pressure tests, collected 6 single-phase fluid samples and performed 1 PVT test in less than two hours
- Continuous circulation during sampling operation prevented any differential sticking

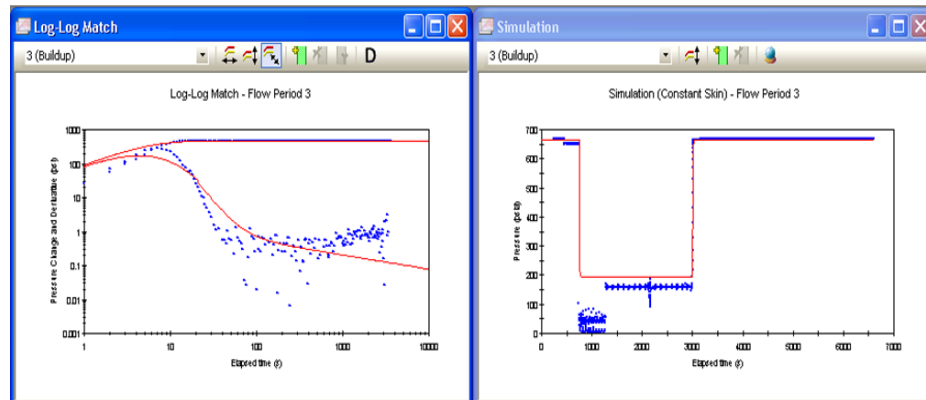
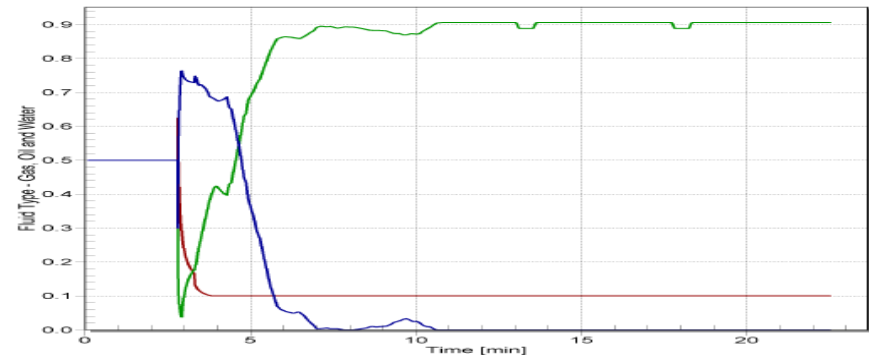
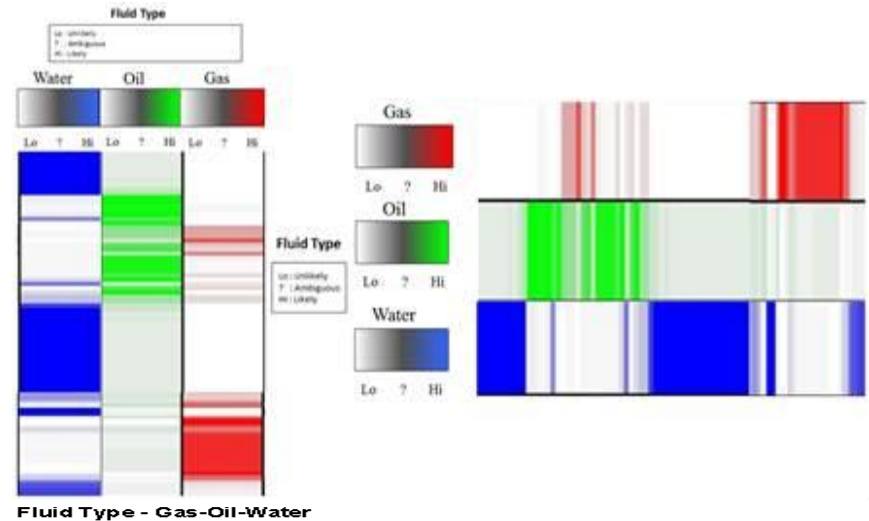
Cost Savings

- \$1M rig time savings compared to taking Pipe-Conveyed Wireline Samples.



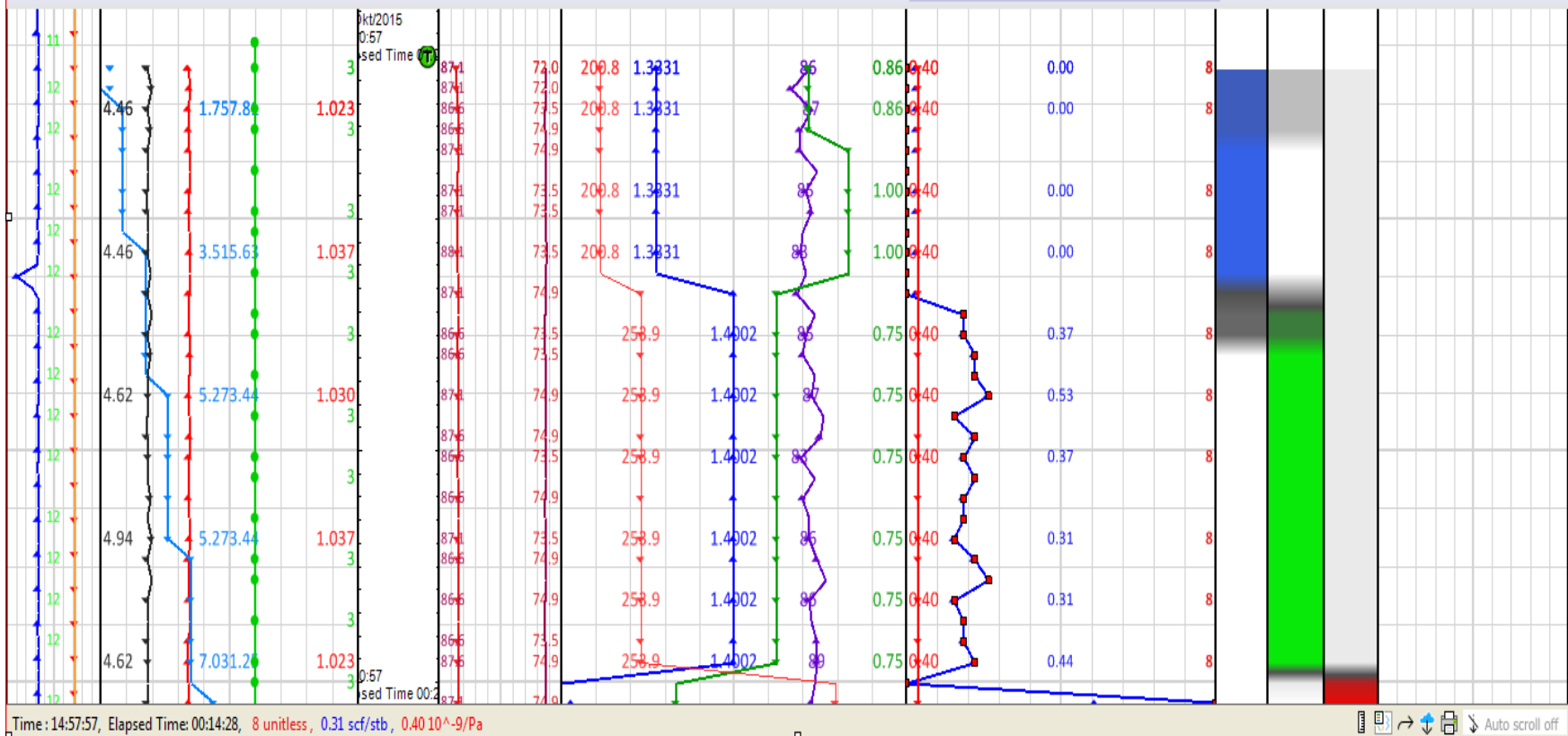
FASTrak HD

- New WLRT Visualization
 - Fluid type interpretation indicator
 - Sampling forecast to “terminal purity”
- JewelSuite Software for Real Time Answers and Post Job Deliverables
- New Measurements – Mini - DST
- Increased efficiency in sampling and testing
 - New BHA Options
 - New Sensors

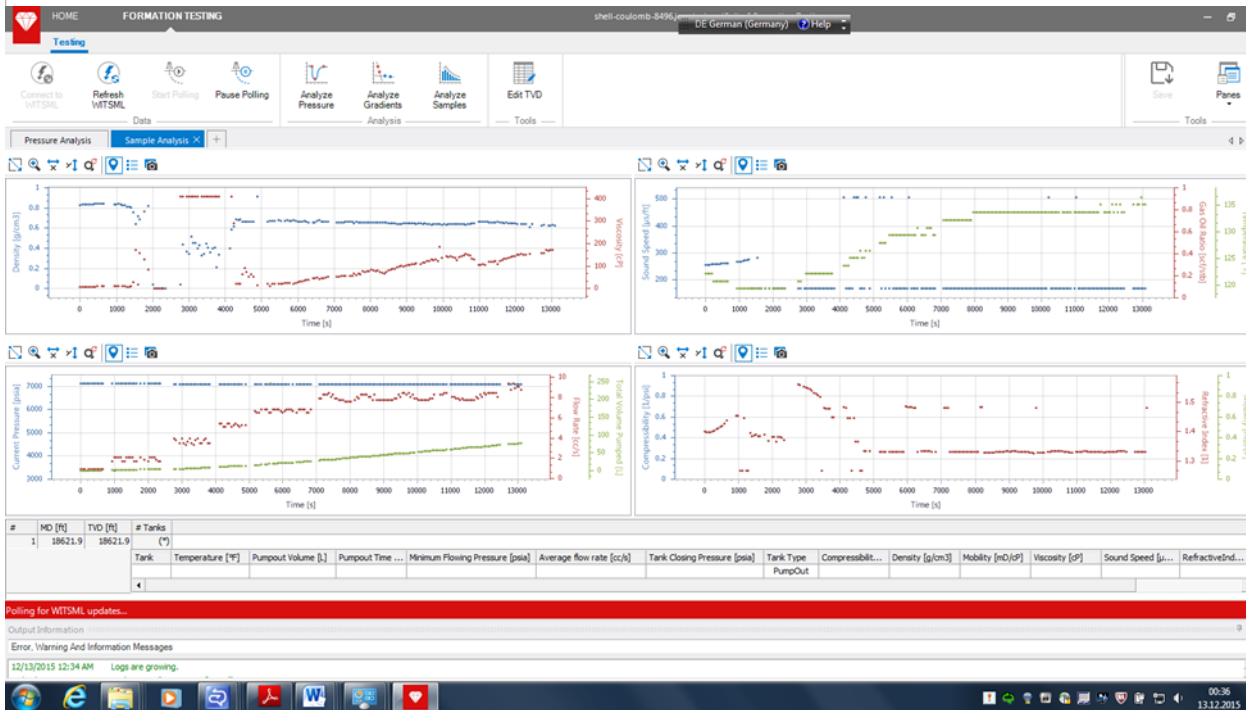
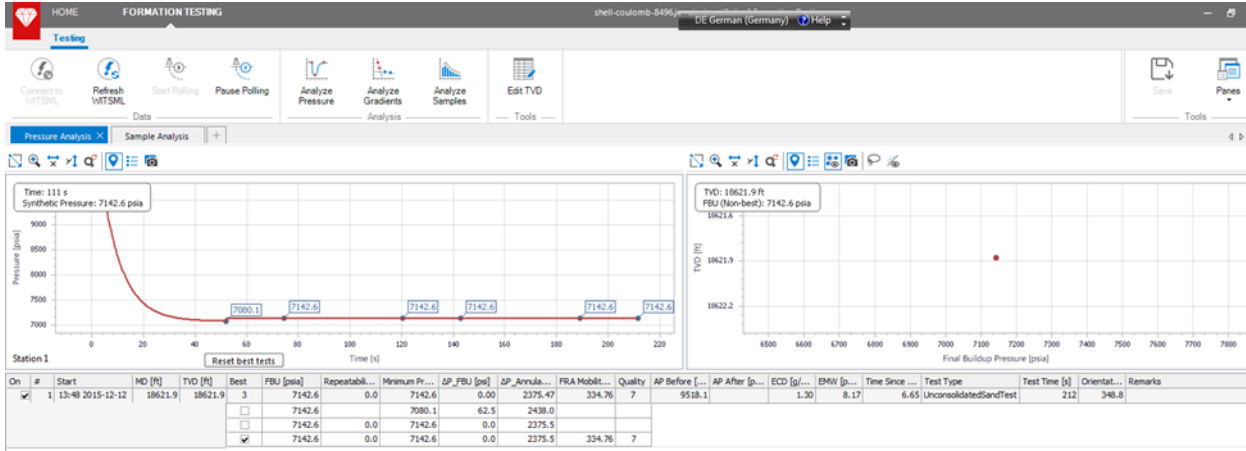


Fluid Type Indicator

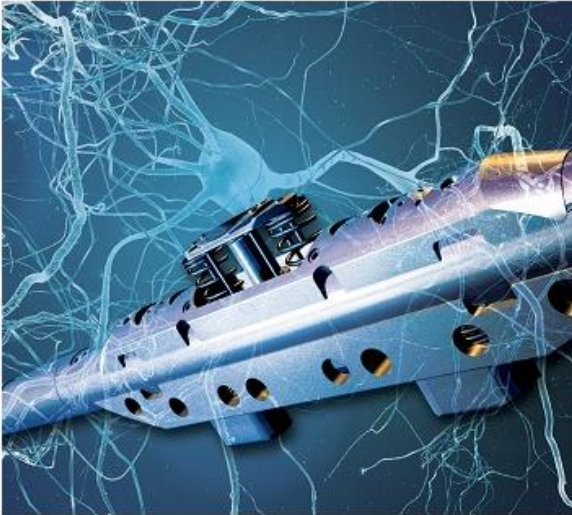
Block and Pump	Tool Monitor	Index	Fluid Thermal	Fluid Properties 1	Fluid Properties 2	Fluid Type	Sampling
Block Position 0 (ft) 130	FAS active mode 0 (unitless)	Time 30 min	FAS Fluid Temper... 0 (K) 100	FAS Fluid sound transit time 150 (us/ft)	CleanUp Compressibility 0 (10^-9/Pa)	Lo : Unlikely ? : Ambiguous Hi : Likely	FAS active Tank Number 0 (unitless)
Stand Pipe P... 0 (psi) 5000	FAS Current flow rate 0 (cm3/s)	29/Okt/2015	FAS Fluid Temper... 32 (degF) 302	FAS Fluid Density (tuning fork) 0 (g/cm3)	Gas-Oil-Ratio 0 (scf/stb)	Water Oil Gas	FAS active filling pressure 0 (psi)
FID 0 unitl...1000	FAS Total volume pumped 0 (cm3) 20000		FAS active mode 1 Standby 2 Pressure Test 3 Pumping-Cleanup 4 Sampling 5 FBU-Retract	FAS Fluids refractive Index 1.25 (unitless)	Number of available tank bottles 0 (unitless)		FAS active Tank Volume 0 (cm3)
BitDepth 0 (ft) 1000	FAS current pressure 0 (psi) 3000			FAS Fluid Viscosity (tuning fork) 0 (cP)	FAS remaining time of Clean Up No Data h		FAS Bubble Point pressure 0 (psi) 10000



JewelSuite Software Deliverables



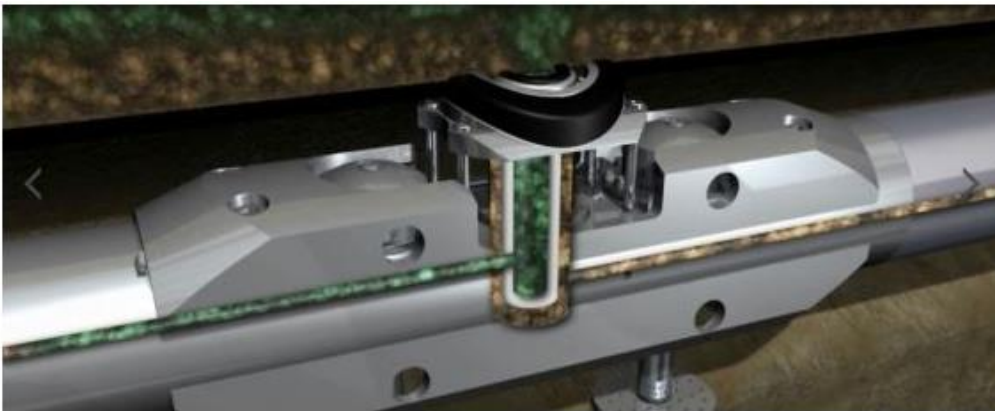
Latest Technology



FTeX

Advanced wireline formation pressure testing service, combines state-of-the-art downhole automation with real-time control.

Time saving: $\leq 60\%$ rig operations for pressure testing



RCX- Sentinel

Wireline Focused Sampling service enables our customer to acquire cleaner, faster and ultimately safer formation fluid samples

Time saving: $\leq 75\%$ faster sampling clean-up time

FASTrak^{HD}

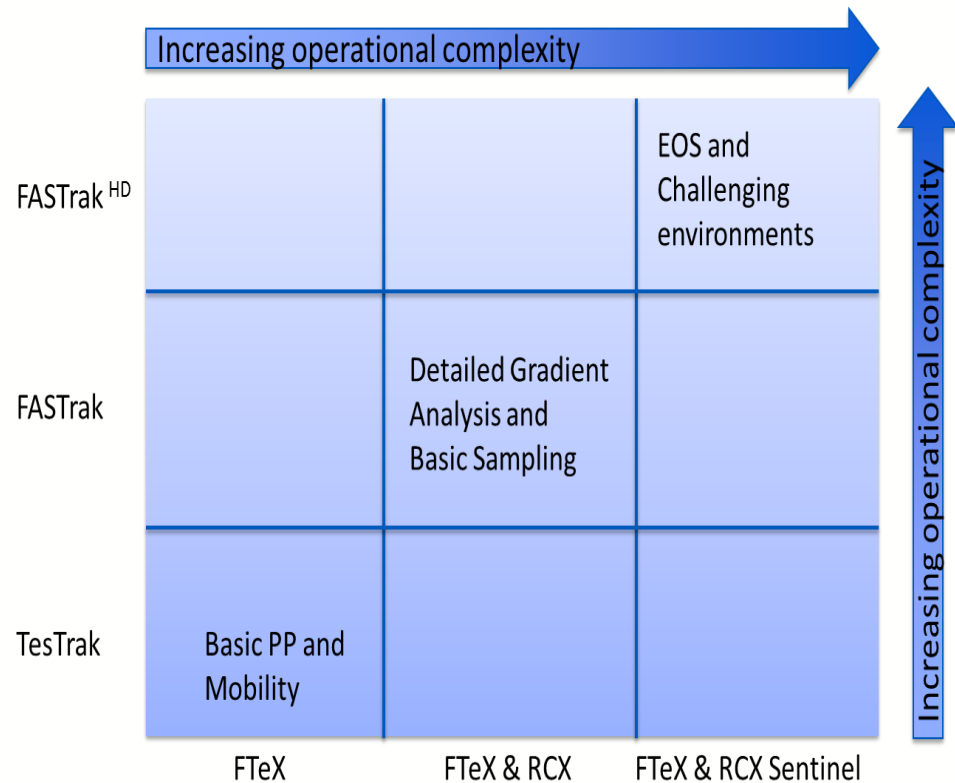
LWD Fluid sampling and pressure testing with enhanced fluid analysis interpretation

Time saving: Rig days



Maximum Costs Savings for Application Specific Combinations

Application	Technology
Pressure Testing	FTEX – WL
	RCX / RCX Sentinel – WL
	TesTrak – LWD
	FASTrak / FASTrak ^{HD} - LWD
Downhole Fluid Characterization	RCX /RCX Sentinel – WL
	FASTrak / FASTrak ^{HD} - LWD
Fluid Sampling	RCX Sentinel – WL
	FASTrak / FASTrak ^{HD} - LWD
Mini DST	RCX Straddle Packer - WL
Micro Hydraulic Fracturing	
Mini DST – Probe Based	FASTrak ^{HD} – LWD
	RCX - WL



Goal is to focus on the objectives of your asset needs

RCX Sentinel and FASTrak Services Teamed up in Deepwater GoM

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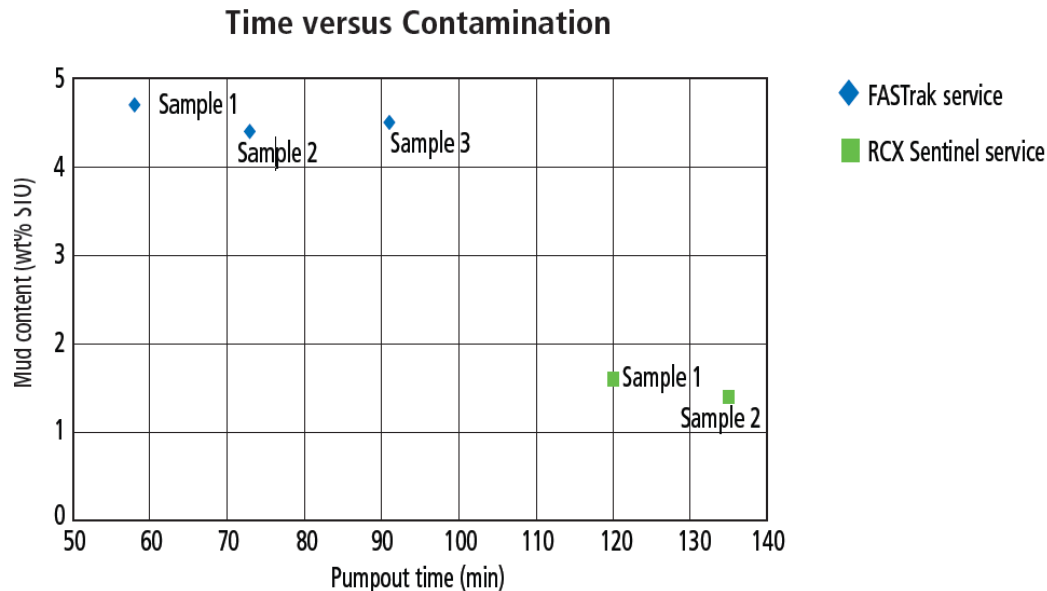
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■ Thank You