

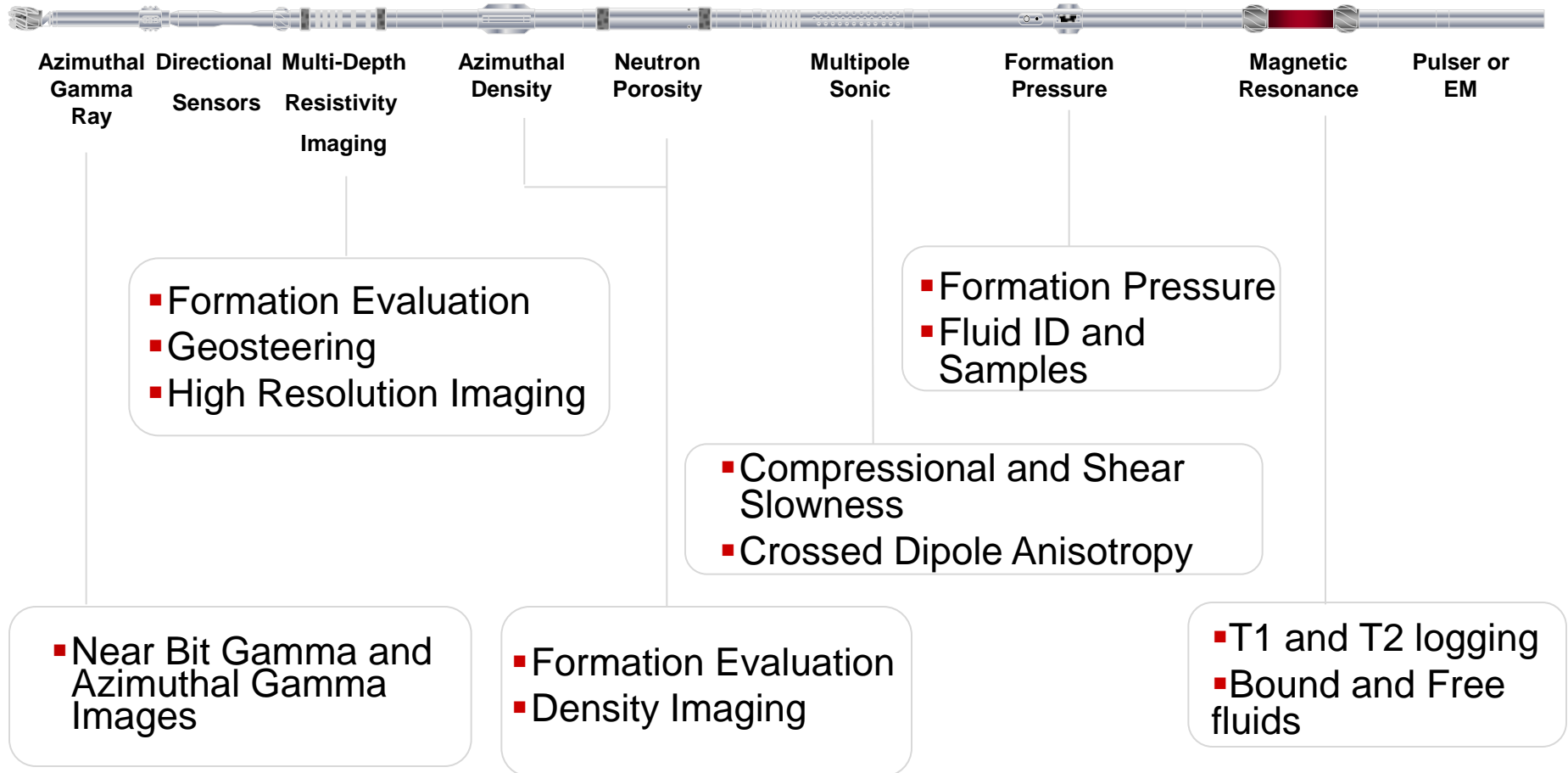


Sperry Drilling New LWD Technology

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Petrophysics Manager
Asia Pacific

HALLIBURTON

Complete LWD Formation Evaluation



New LWD Technologies

- GeoTap IDS
 - Fluid Identification and Sampling
- XBAT
 - Crossed Dipole Azimuthal Sonic
- GeoSharp
 - All Mud Imager

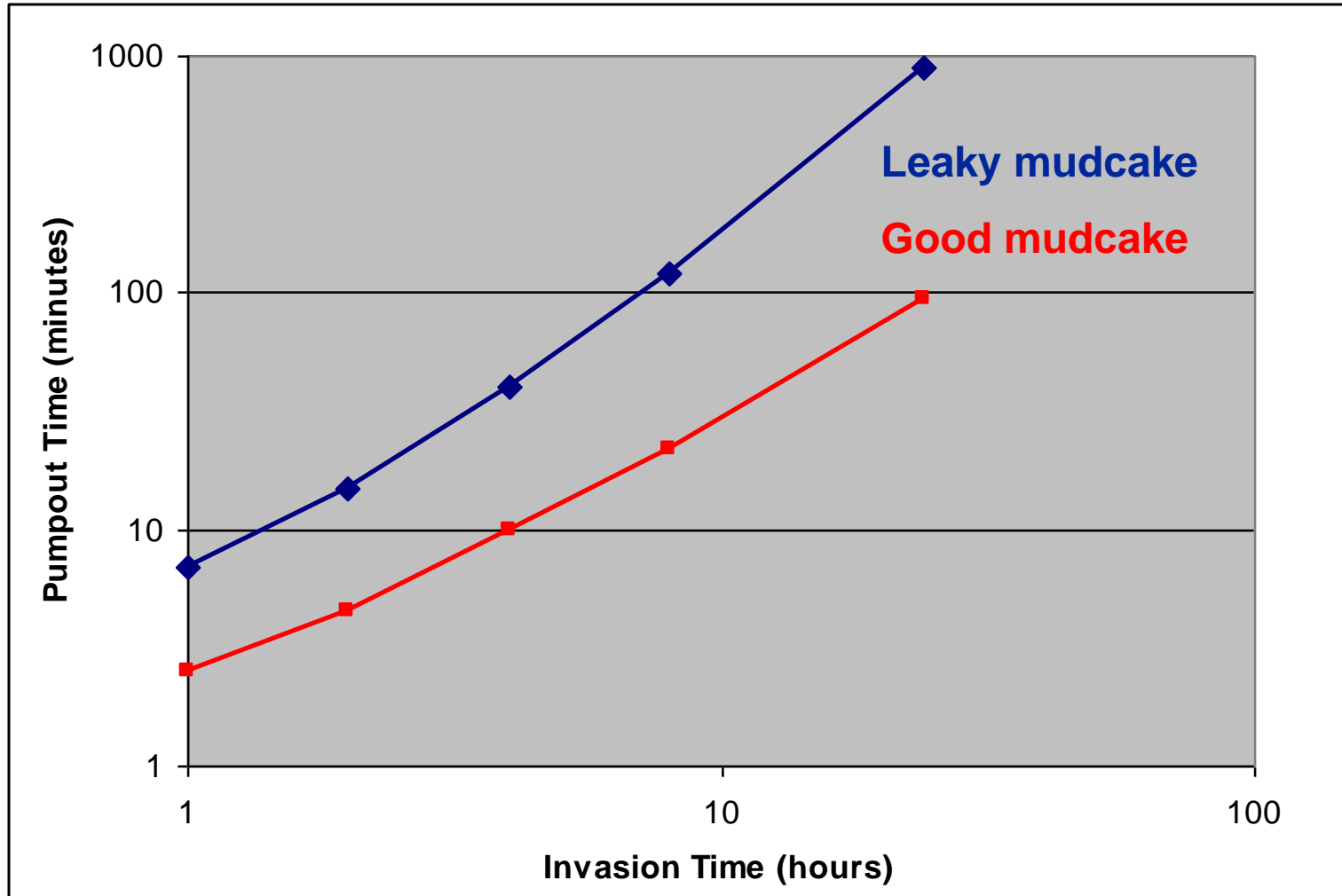


GeoTap IDS – Fluid ID and Sampling

GeoTap IDS Benefits

- Replace WL runs
- Obtain samples sooner
- Reduced pumpout times
 - Less invasion
- Obtain high quality samples
 - Real-time Fluid ID
- Obtain samples or FID in high angle / horizontal wells
 - WL conveyance difficult or impossible
 - Eliminate pilot holes
- Large time and cost savings in high spread rate operations

Rig Time Savings - Pumpout Time



GeoTap IDS

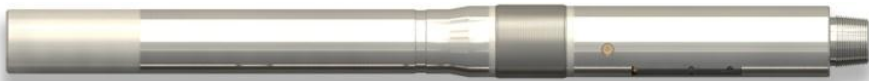
- 6 ¾” tool for 8 ⅜” - 10 ¾” hole
 - 11.2m - no sample collar
 - 14.8m - 1 sample collar
- Single Oval Pad Probe
- 150°C, 30kpsi
- Fluid ID Sensors
 - Pressure, Temperature, Resistivity, Density
 - Optical coming
- Multiple bubble points while pumping out

GeoTap IDS

- 100cc draw down chamber
- Use existing wireline RDT bottles
 - 1 liter PVT quality, N₂ charged option
 - 5 bottles / collar, 3 collars
 - IATA and DOT approved
- Integrated collar; sample bottles field removable
- Pumps on for fluid pump out and sampling
- 4000 and 8000 psi pumps
 - 60 and 30 cc/sec

GeoTap IDS Hardware

Terminator Collar



Sample Collar (Optional)



Power Collar



Probe Collar



Oval Pad Extended



GeoSpan Down Link

- 2 way communications with tool
- Change test parameters downhole
- Same unit used with GeoPilot Rotary Steerable drilling system



Real-time tool control

RtManager

File Layout Downlink EM FID Help

FID Downlink Control | **FID Display**

Interactive | Advanced

Pretest Control

Set FID Pretest Parameters [Send]

DD Rate: 1.0 sec | BuildUp time: 96 sec | DD volume: 10 cc | Min Pressure: 500 psi

Pump Control
Bubble Point Control
Fluid Sampling
Misc. Downlink commands

FID Data

General | Pretest | Pump

General

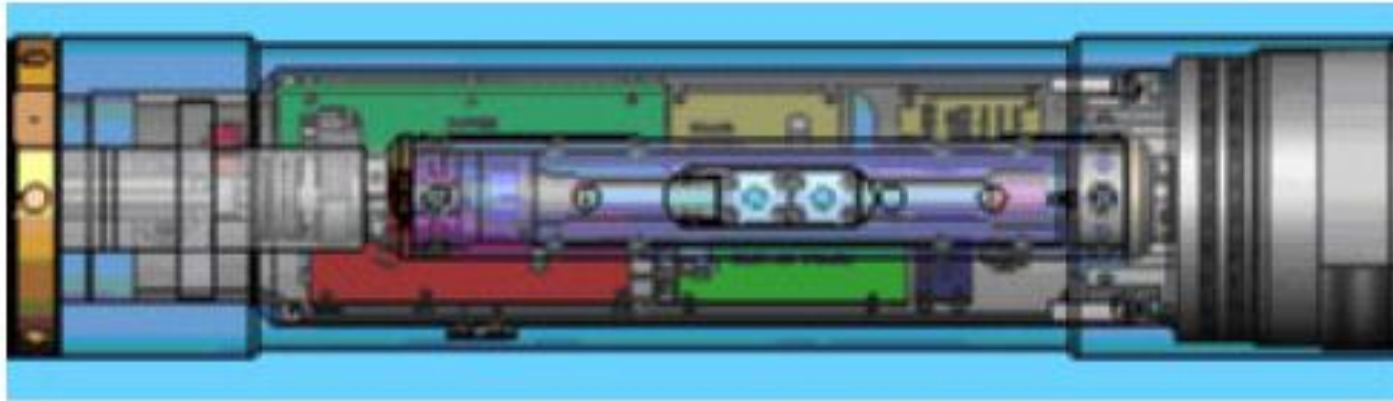
Tool Size: 6.75
Tool Configuration: Telescoping
Test Number: 3
Current Stage: Fluid Sampling

FID: Active Commands | **FID: Command History**

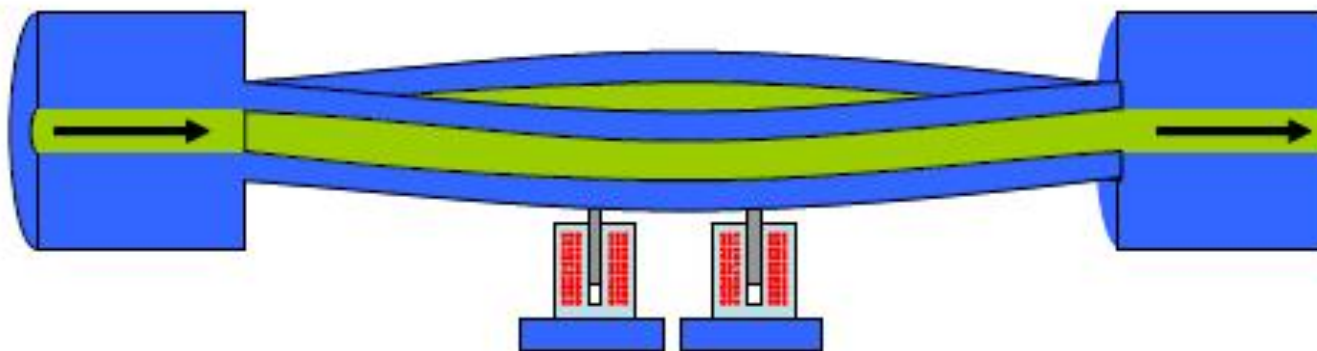
Tool	Command	Data	Status	Time	User

DB: -LOCAL- Well,Run: Dao, 301

Fluid Density Sensor



Vibrating Tube Density Sensor



Voice Coils

Driver

Detector

$$\rho_n = \mathbf{A} / f_n^2 - \mathbf{B}$$

Sample Chamber QC

- Non invasive QC at rig site
 - Same as RDT
- Ensure sample integrity
 - Pressure
 - Volume
 - Estimate contamination
- Fluid ID
 - Density
 - Compressibility
 - Compare with downhole Fluid ID



Sample Chamber QC



Sample Chamber QC

SAMPLE QC

Input	
Well Name	Exampler
Bottle Serial Number	1
Depth of Sample (ft)	A63
Sample number (#)	1 OF 2
Formation Pressure (psi)	
Formation Temp (deg F)	118.5
Sample Shutin (psi)	6000
Flushed Volume (L)	266
MCS # Pos	
Date of Job	
Type of Chamber	Standard
Buffer	Water
Mud Type	Water Based Mud
Expected Fluid	Water
Pre run (kg)	16.559
Post run (kg)	16.563
Piston Position (mm)	103.30
Post Pressure (kg)	16.593 @ 10000 psi
Piston Position End (mm)	134.00
Opening Pressure (psi)	600
Chamber Temp (deg F)	80.0

OUTPUTS

Working Volume (cc)	1004
Density (gm/cc)	1.003
Diff Weight (gm)	2.5
Comp Volume (cc)	976
Comp Vol (cc)	28
Density (gm/cc) Compressed	1.030 @ 10000 psi

Compressibility		Fluid Type
Average	2.91 ppm/psi	Water
Std Dev	0.37 ppm/psi	
Std Dev	13 %	
Density		
	1.003 gm/cc	Water

QC Sample Data Summary

Contamination Analysis		
Formation Water	97	%
Filtrate	3	%

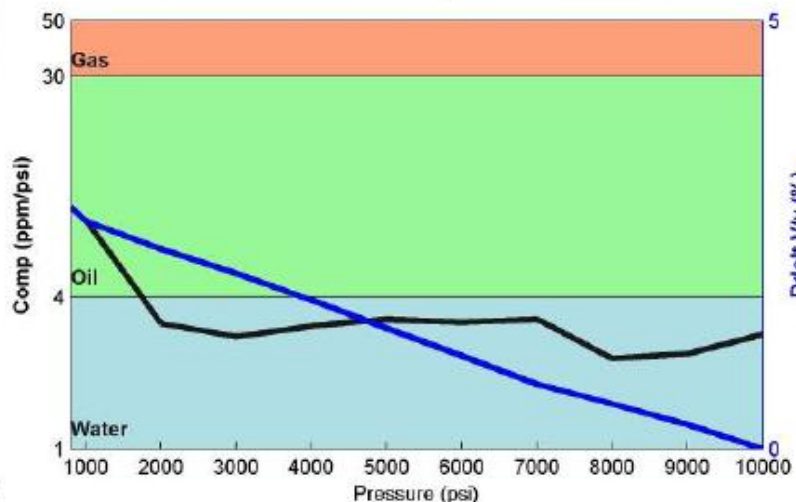
Fluid Type Inputs

Compressibility		
Oil-Gas Transition	30.00	ppm/psi
Water/Oil Transition	4.00	ppm/psi

Density Inputs

Density		
Filtrate	1.10	Filtrate gm/cc max
Formation Water	1.00	Water gm/cc min
Formation Oil	0.85	Oil gm/cc min
Gas	0.30	Gas gm/cc min
	0.01	gm/cc Accuracy

Calculate Save



INPUTS for compressibility calculation

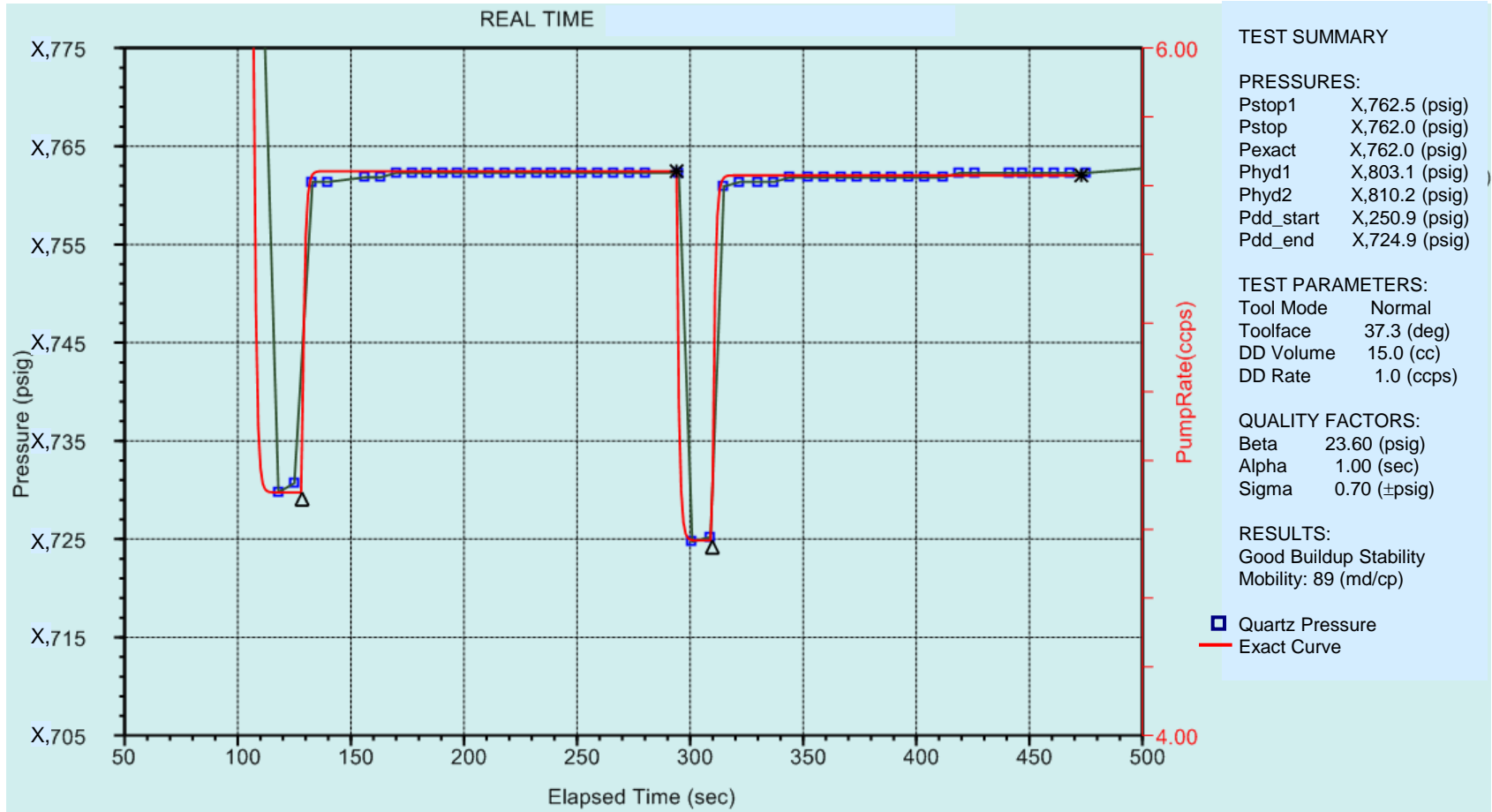
Pressure of Pump (psi)	800	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
Piston Position (mm)	103.30	105.10	108.60	111.70	115.10	118.70	122.20	125.80	128.30	130.90	134.00
Compression (ppm/psi)	0.00	8.06	3.14	2.79	3.07	3.26	3.18	3.26	2.28	2.38	2.85

GeoTap IDS Deepwater Example

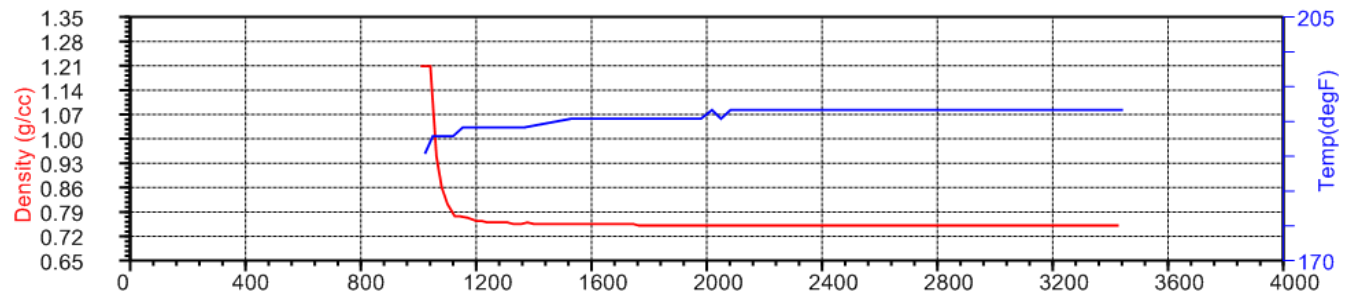
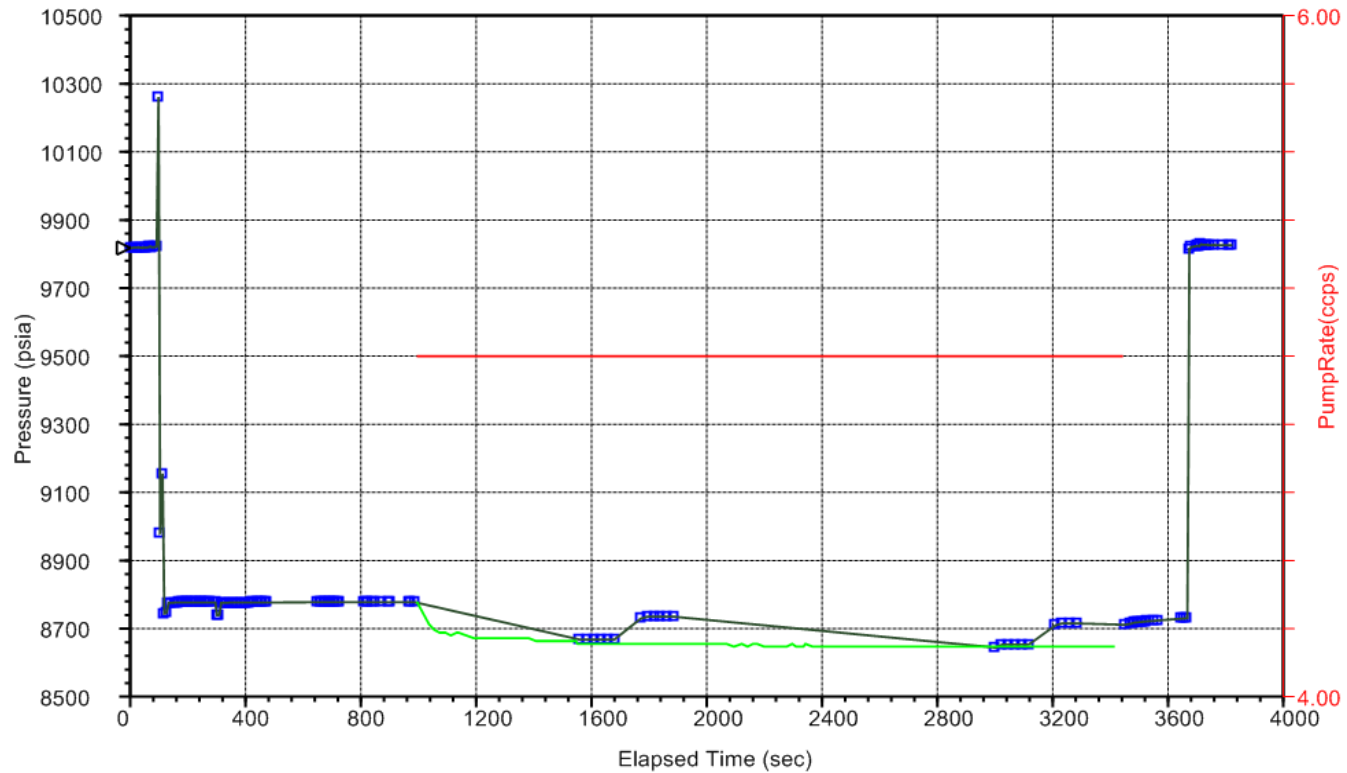
- BG Norway
 - Exploration well
- Drilled with LWD and GeoTap FTWD
 - OBM
- Hole conditions limited WL runs
- GeoTap IDS run on a wiper trip
 - Long invasion time

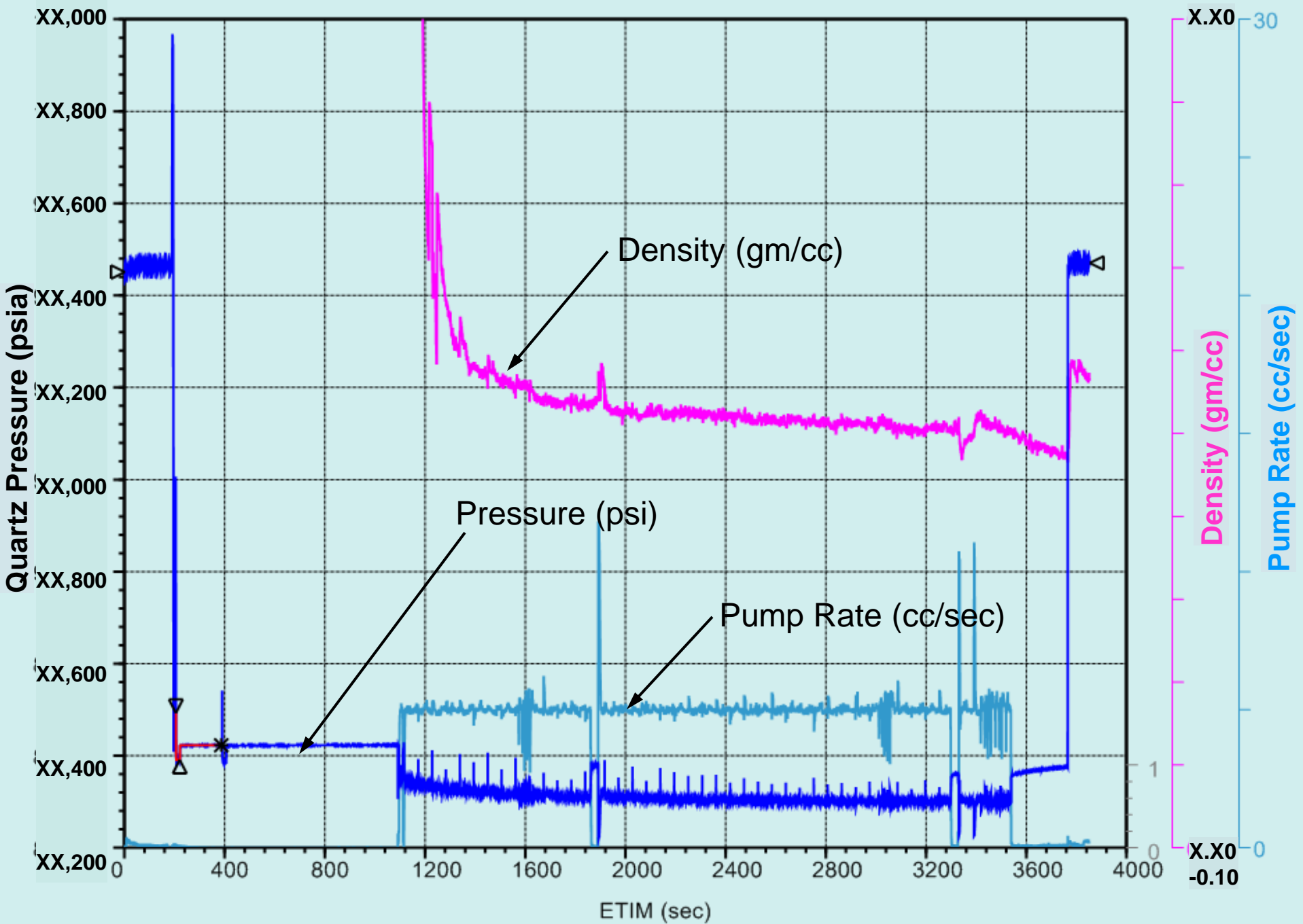


Real-time Pretests



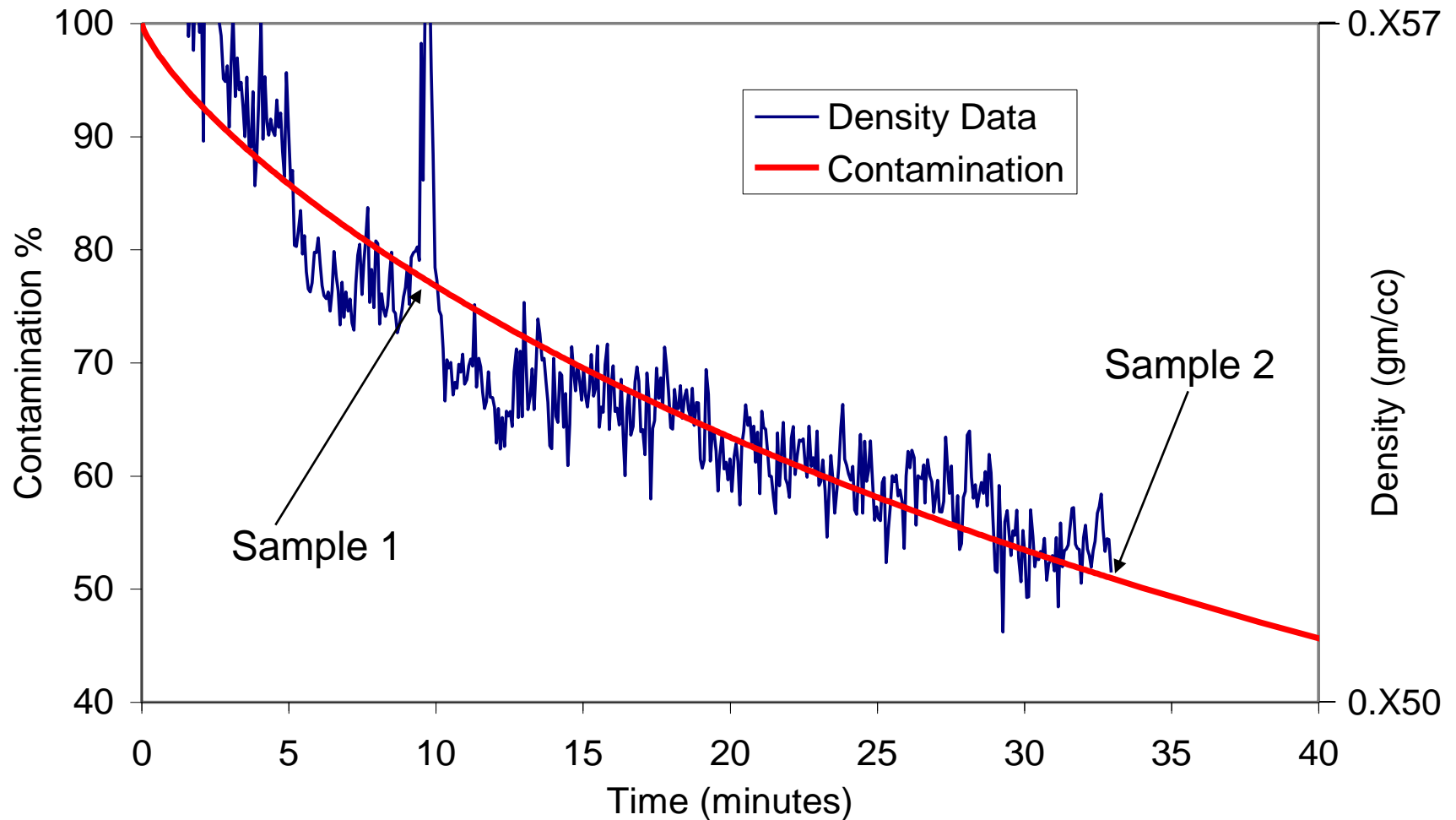
Real-time Pump Out and Fluid Samples





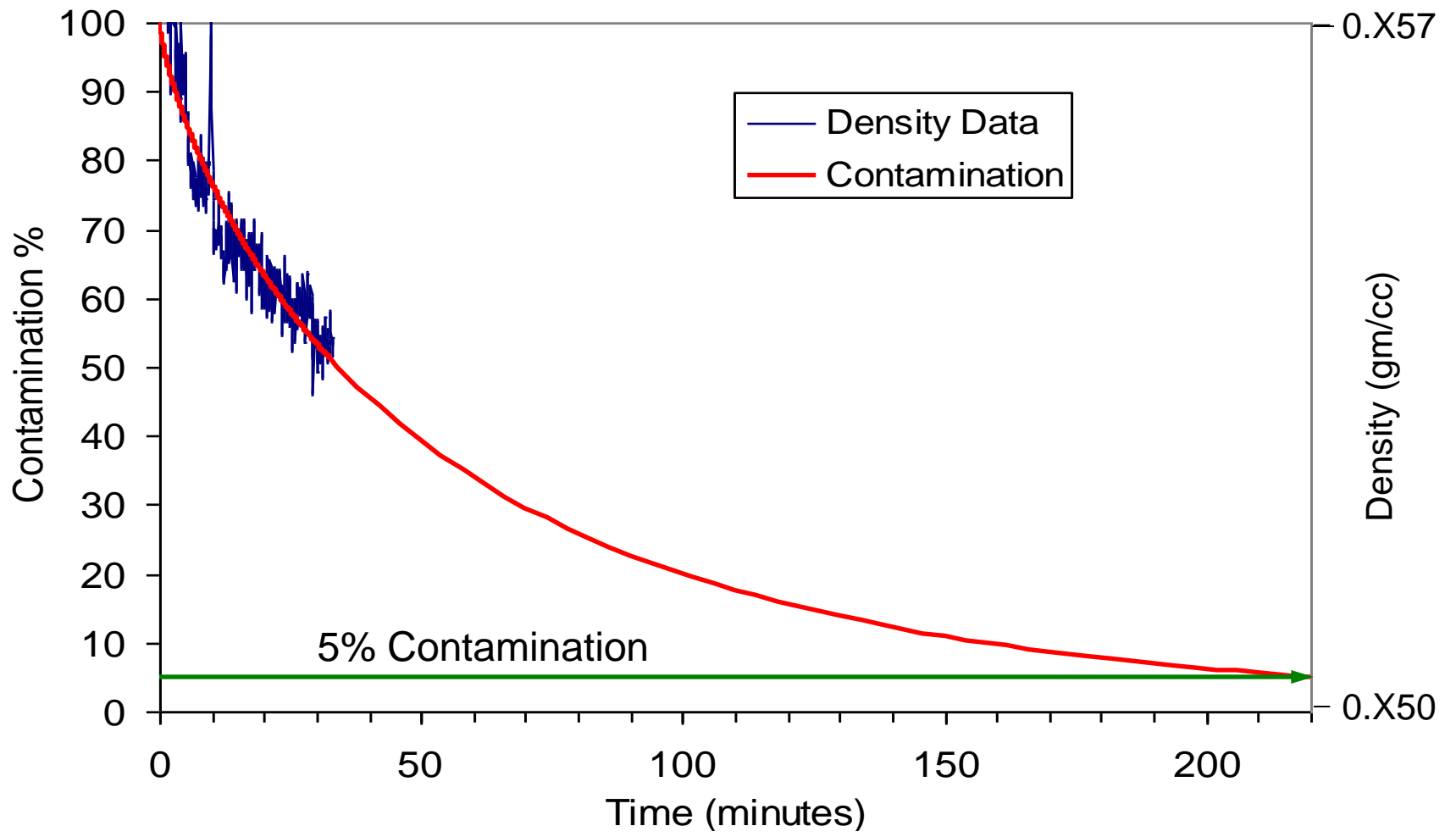
Real-Time Contamination Estimate

33 minutes for 50% Contamination



Real-Time Contamination Estimate

3 hours additional pumping needed for 5%





XBAT Azimuthal Sonic

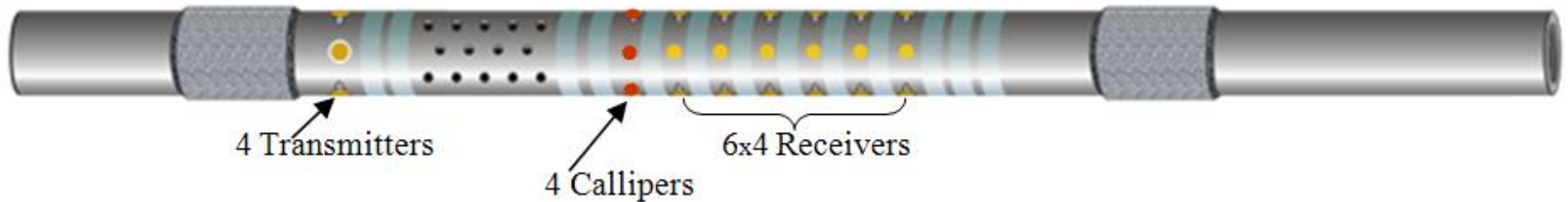
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QBAT Overview

- Provides wireline-quality compressional and shear measurements in fast and slow formations
- Hole sizes from 6" to 36"
- Used for porosity determination, seismic correlation, and wellbore stability applications
- Provides cased hole logs and identify fractures
- Monopole, dipole and quadrupole modes
 - 2 firings
 - Programmable source frequencies



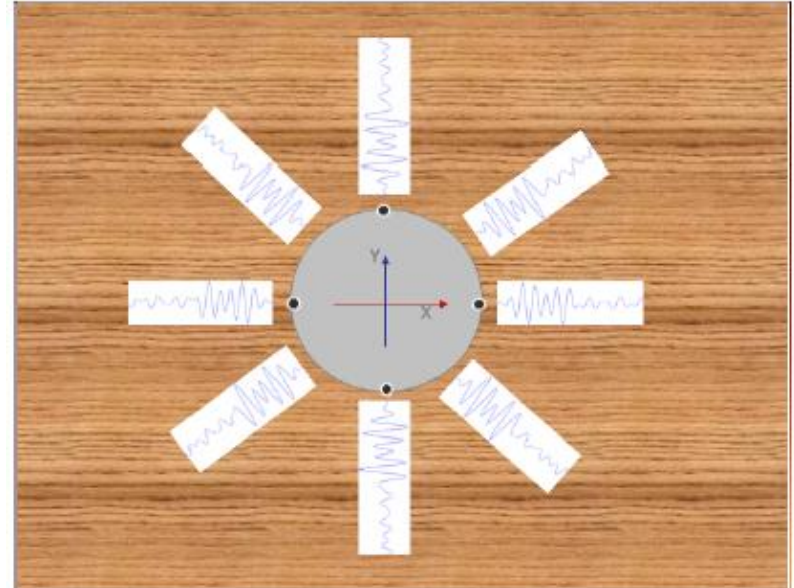
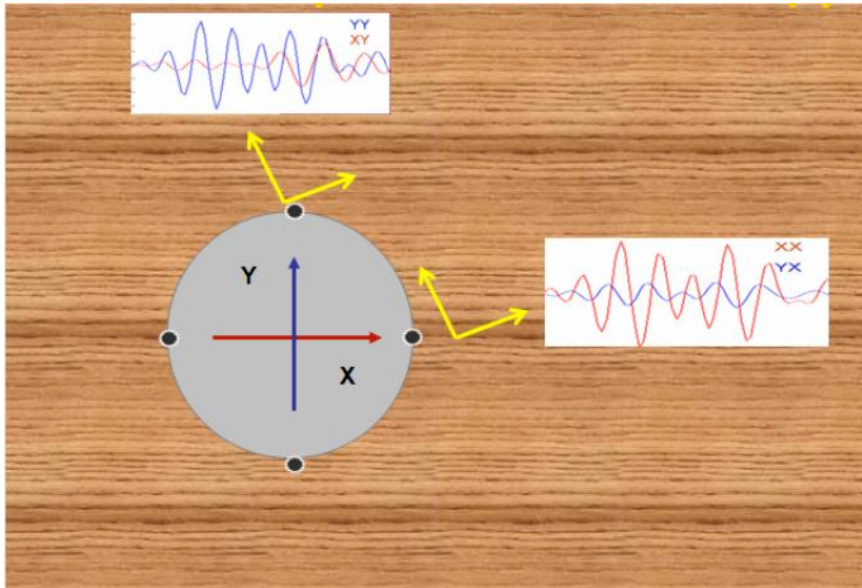
XBAT Azimuthal Sonic



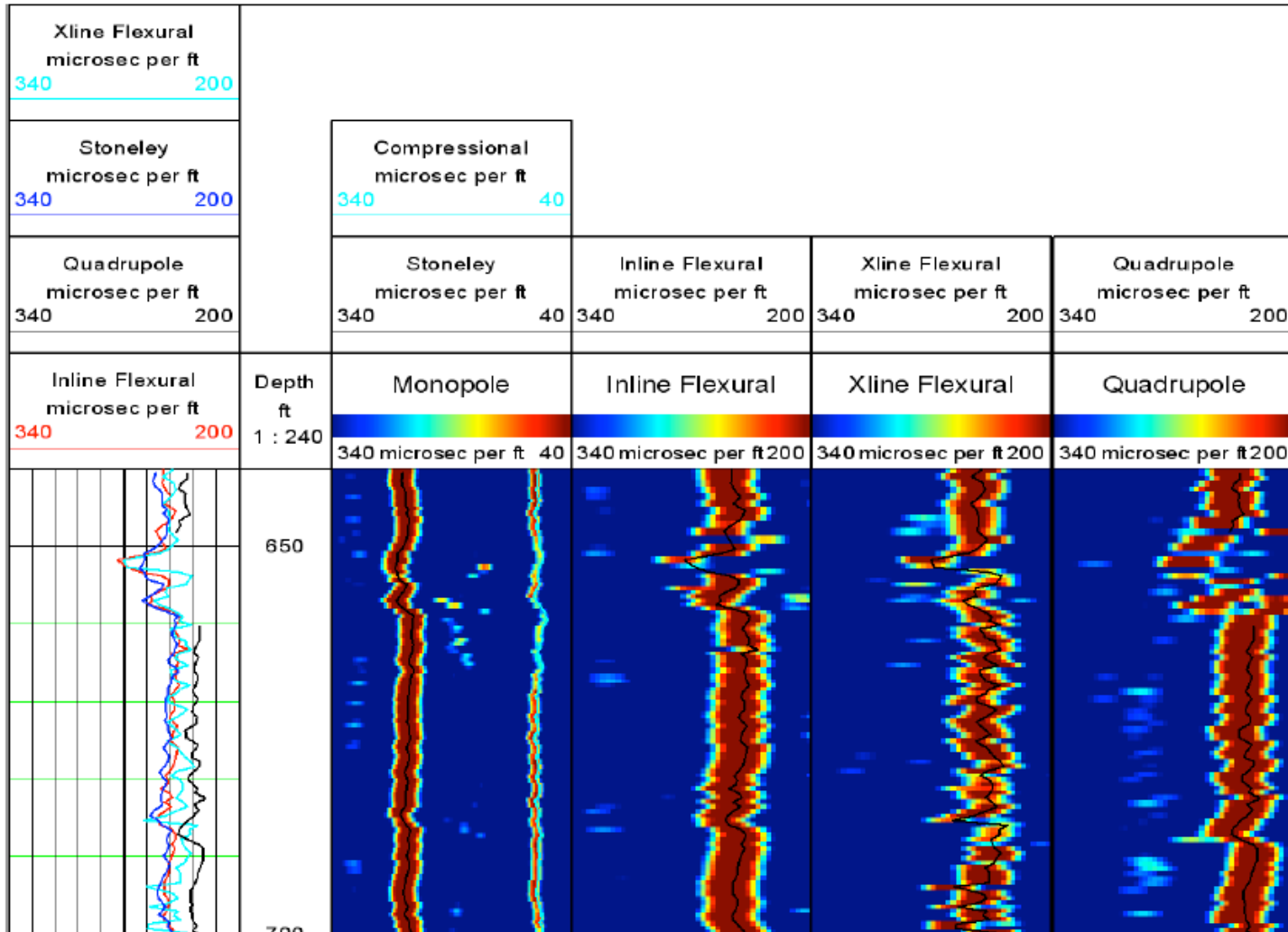
- Azimuthally sensitive – creates azimuthal images for geosteering and acoustic anisotropy
 - Fast and Slow Shear Slowness and anisotropy azimuth
- 4 azimuthal transmitters, 4 azimuthal arrays of receivers (6 in each array)
- 4 azimuthal acoustic calipers
- Up to 8 firing modes
- Broad Band Source
- 6 $\frac{3}{4}$ " and 8" tools available; 4 $\frac{3}{4}$ " and 9 $\frac{1}{2}$ " in testing

Cross Dipole Firing

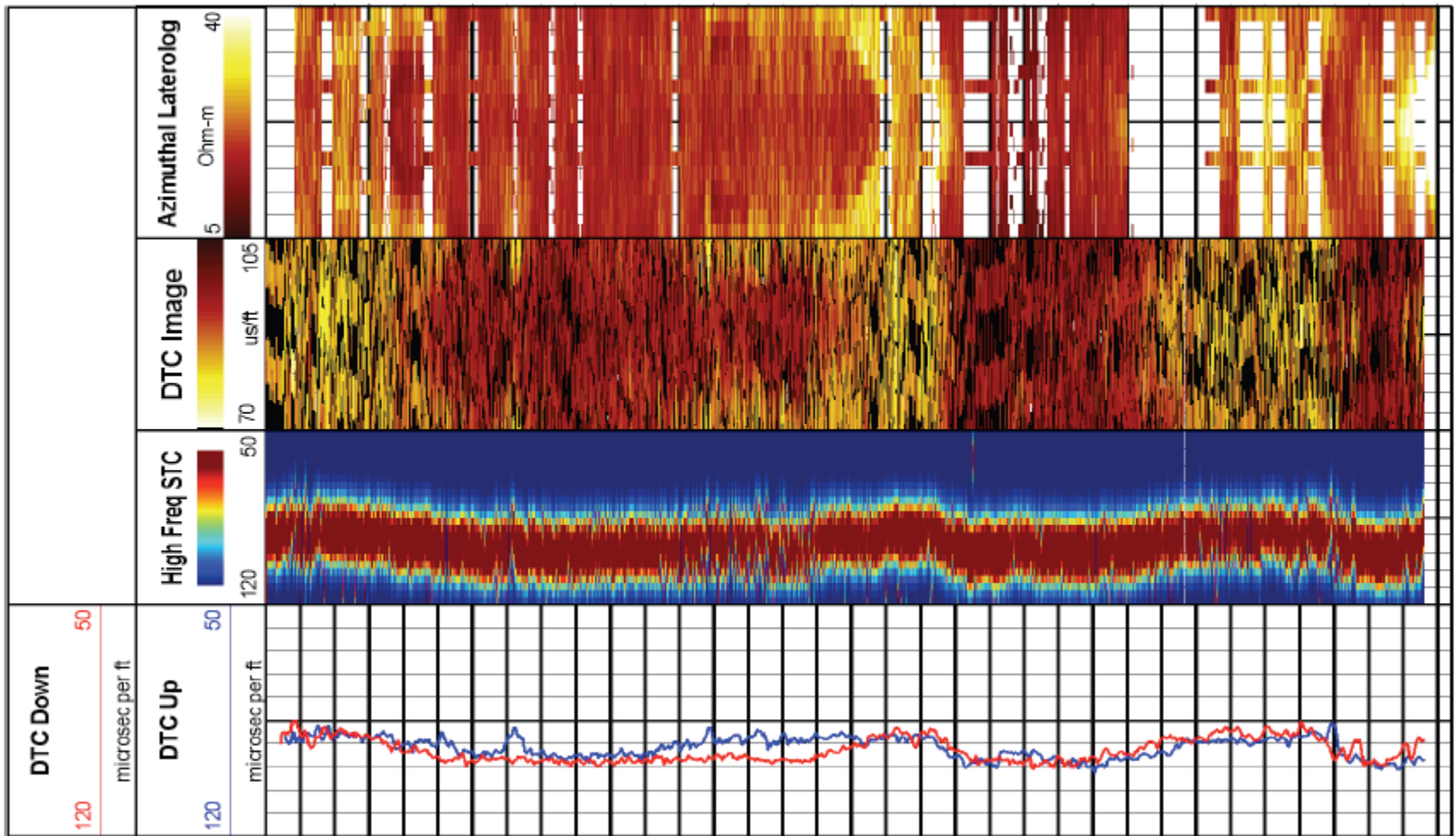
$$w(\theta) = \cos^2(\theta)XX + \cos(\theta)\sin(\theta)[XY + YX] + \sin^2(\theta)YY$$



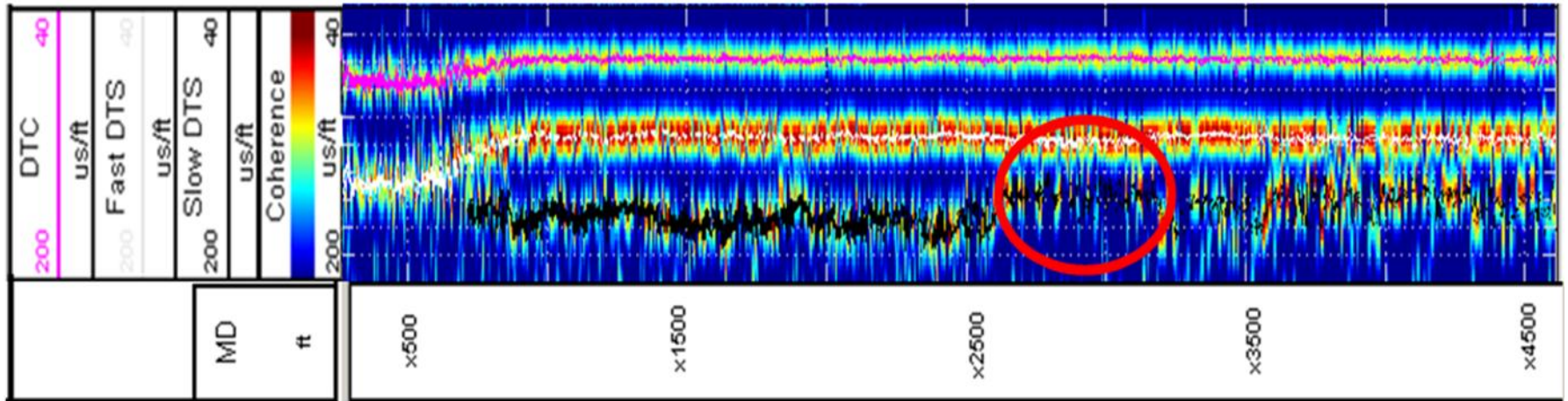
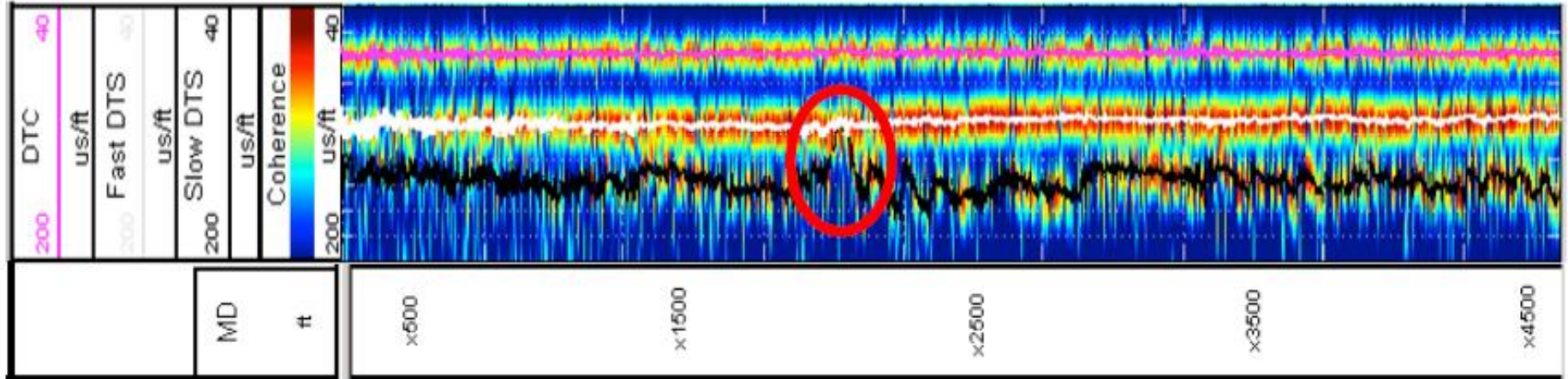
LWD Cross Dipole



Azimuthal LWD Sonic Image

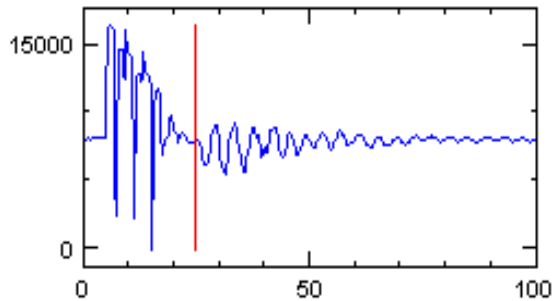


Fast and Slow Shear

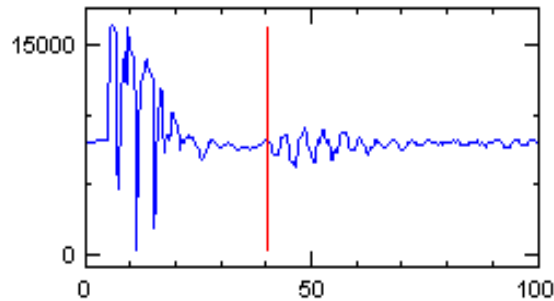


4-axis Ultrasonic Calliper

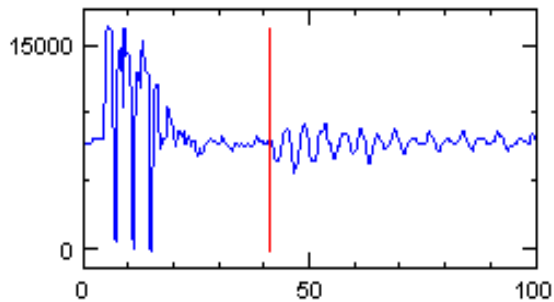
A



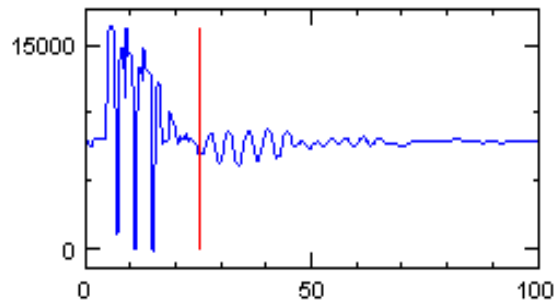
B



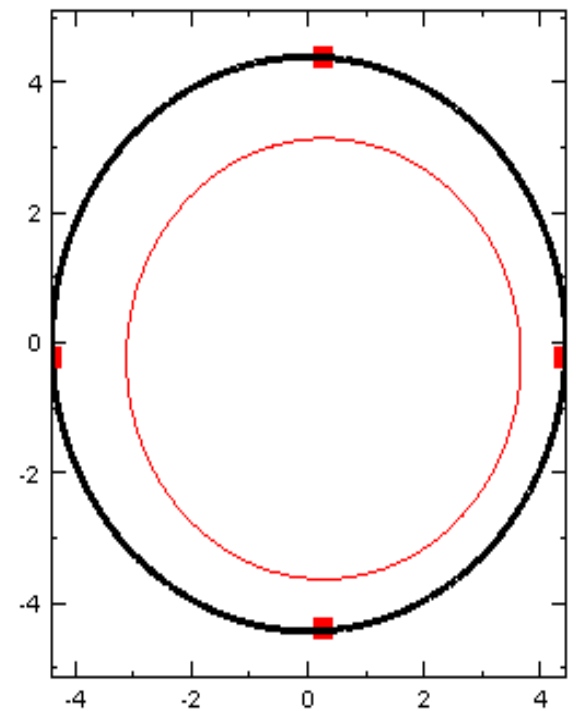
C



D



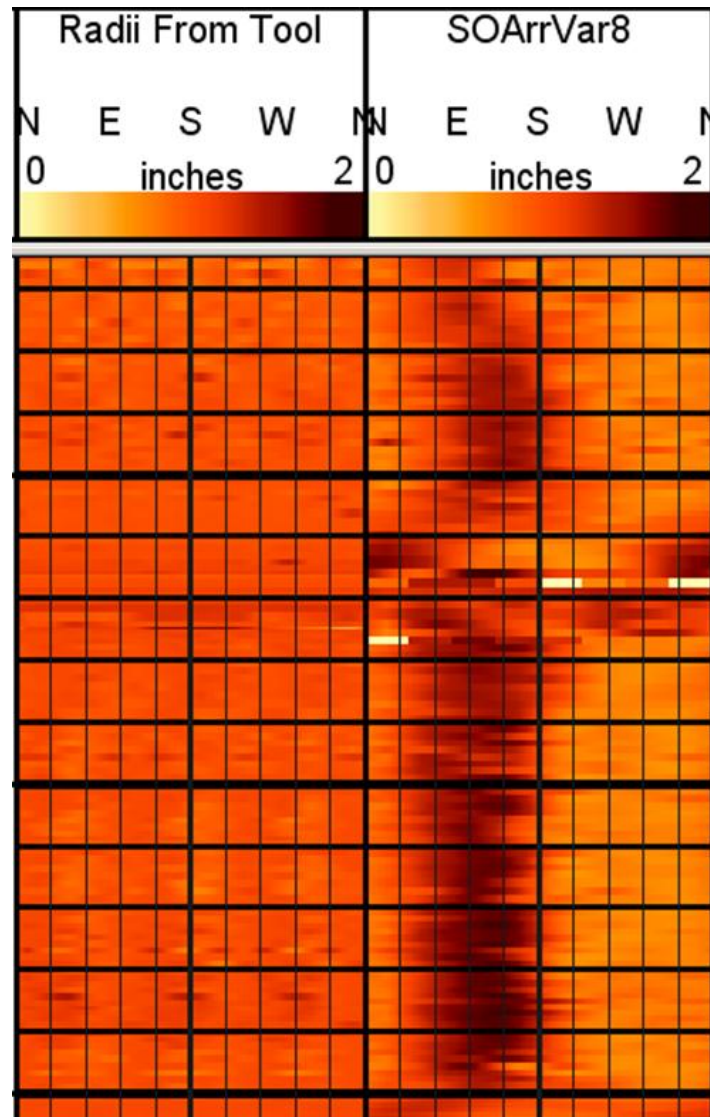
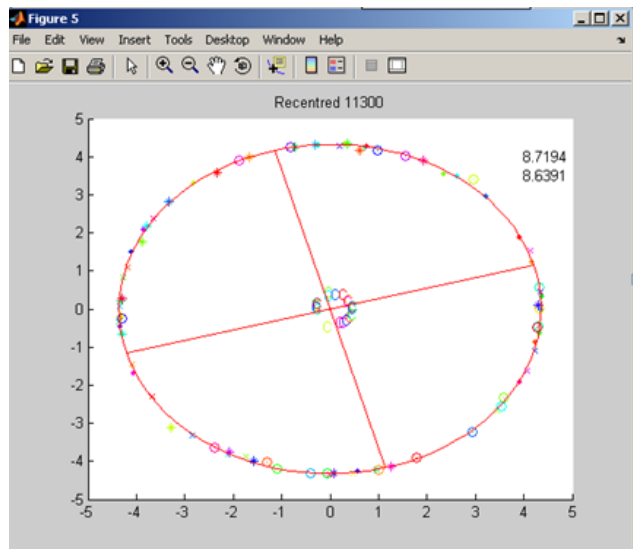
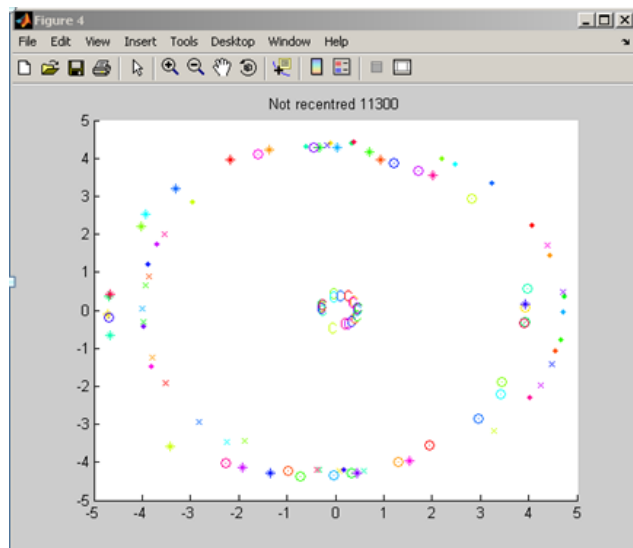
Hole Diameter: 8.83 inches, tool at (0.26, -0.23)



Mud Slowness (us/ft)

Current Record Index: 3485 out of total 4771. Current Depth: 4690.44

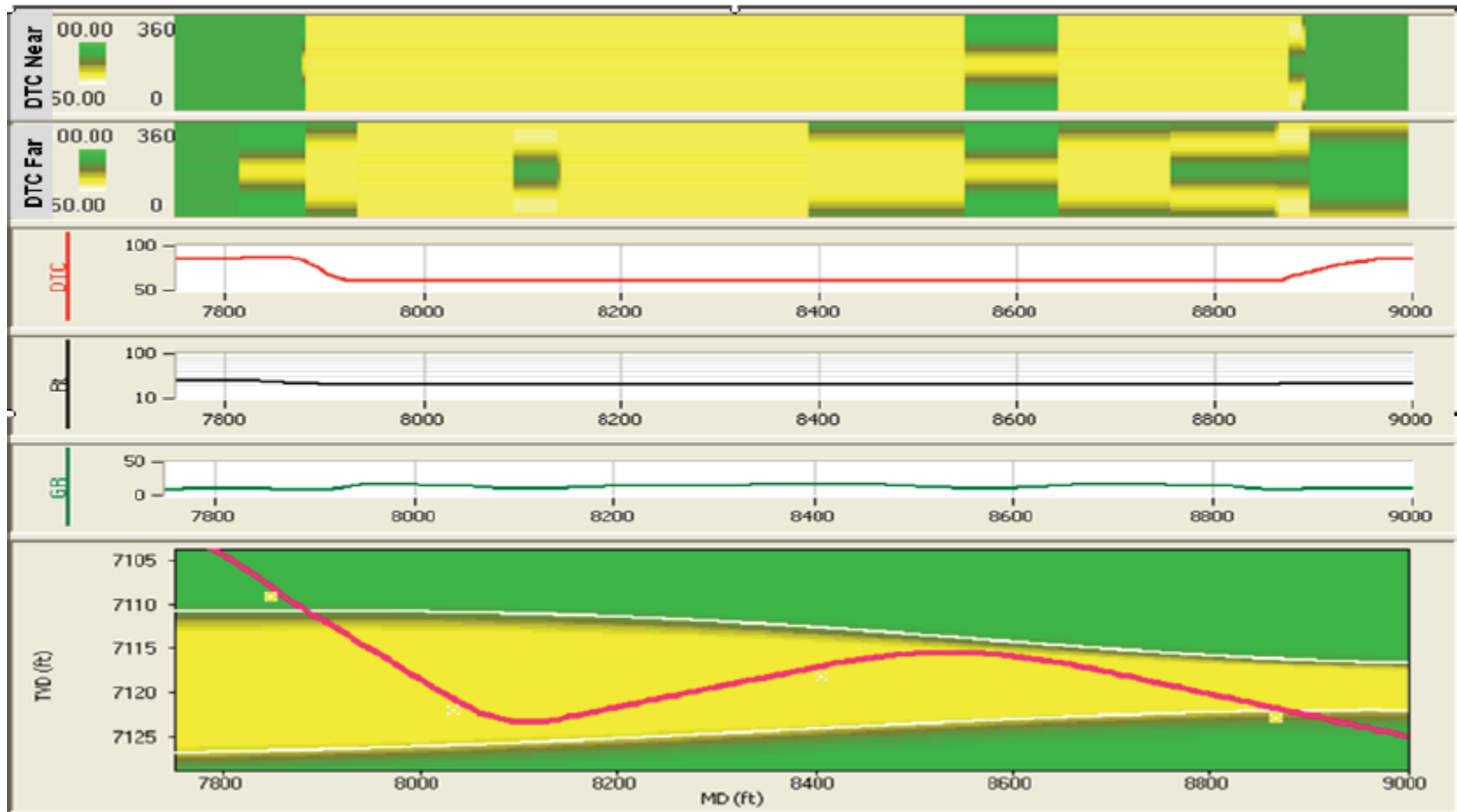
Accounting for tool position



Azimuthal Sonic Geosteering

85 usec/ft

60 usec/ft





GeoSharp All Mud Imager

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GeoSharp All Mud Imager

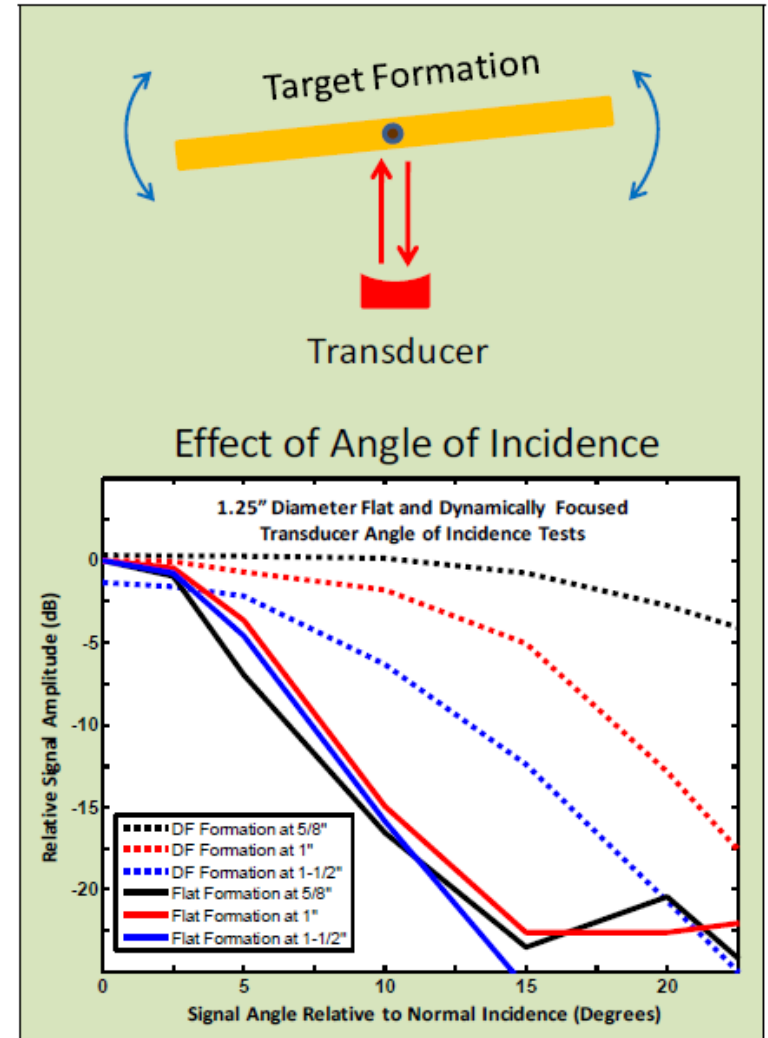
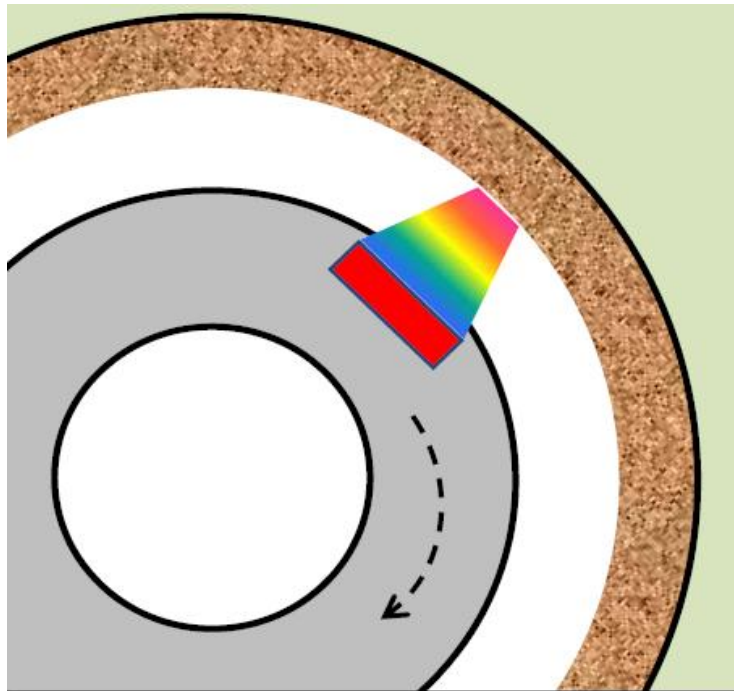


- Integrated OBM and WBM Imager
- Resistivity
 - Geology and bedding
- Ultrasonic
 - Fractures, vugs, borehole geometry
 - Dynamic focussing
 - Motion compensation
- 6 $\frac{3}{4}$ " tool for 8 $\frac{1}{2}$ " hole

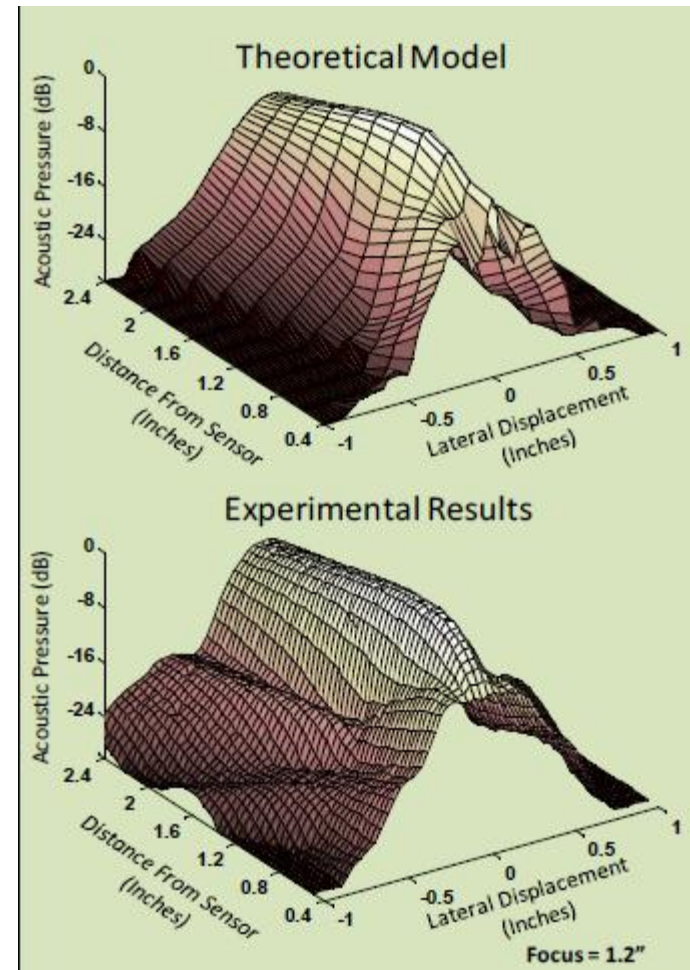
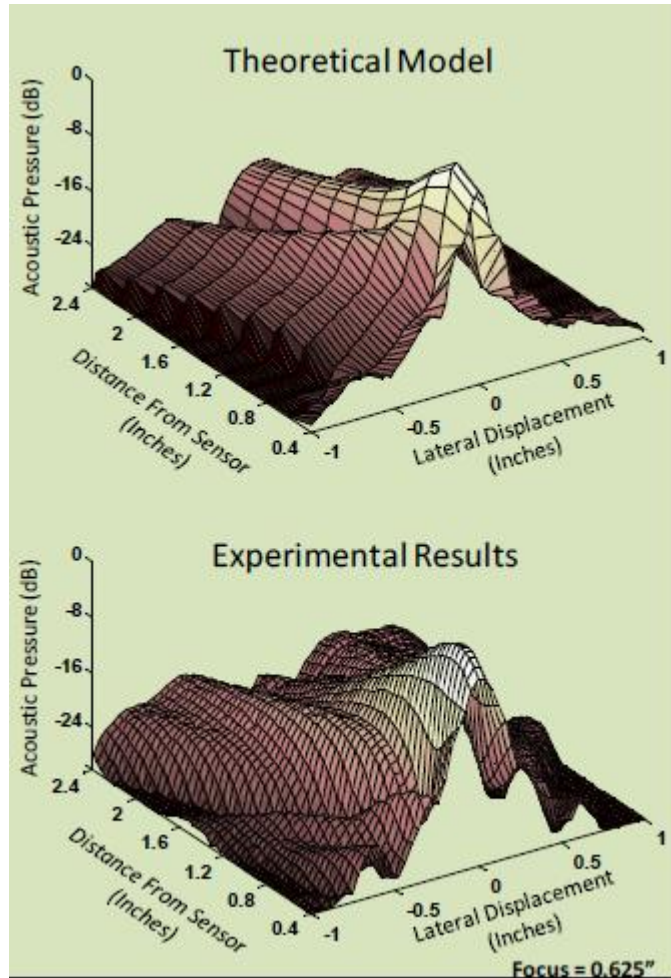
Acoustic and Resistivity Imaging

- Dual ultrasonic transducers (350 kHz)
- Acoustic image resolution ~0.15 inches
- Resistivity image resolution ~1.0 inches
- Requires 10:1 ratio between mud resistivity & formation resistivity
- Acoustic and resistivity images complement each other

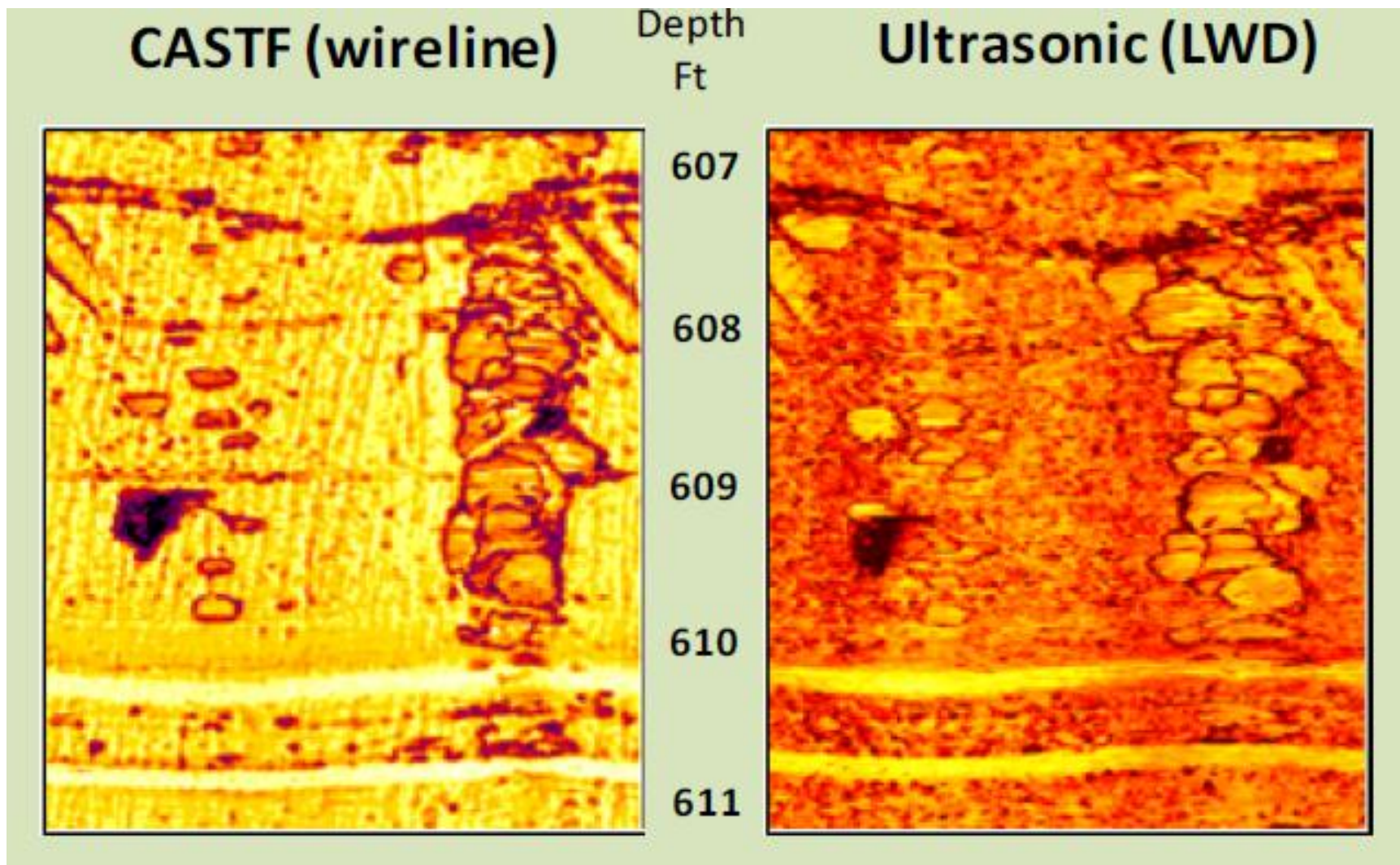
Dynamic Transducer Focusing



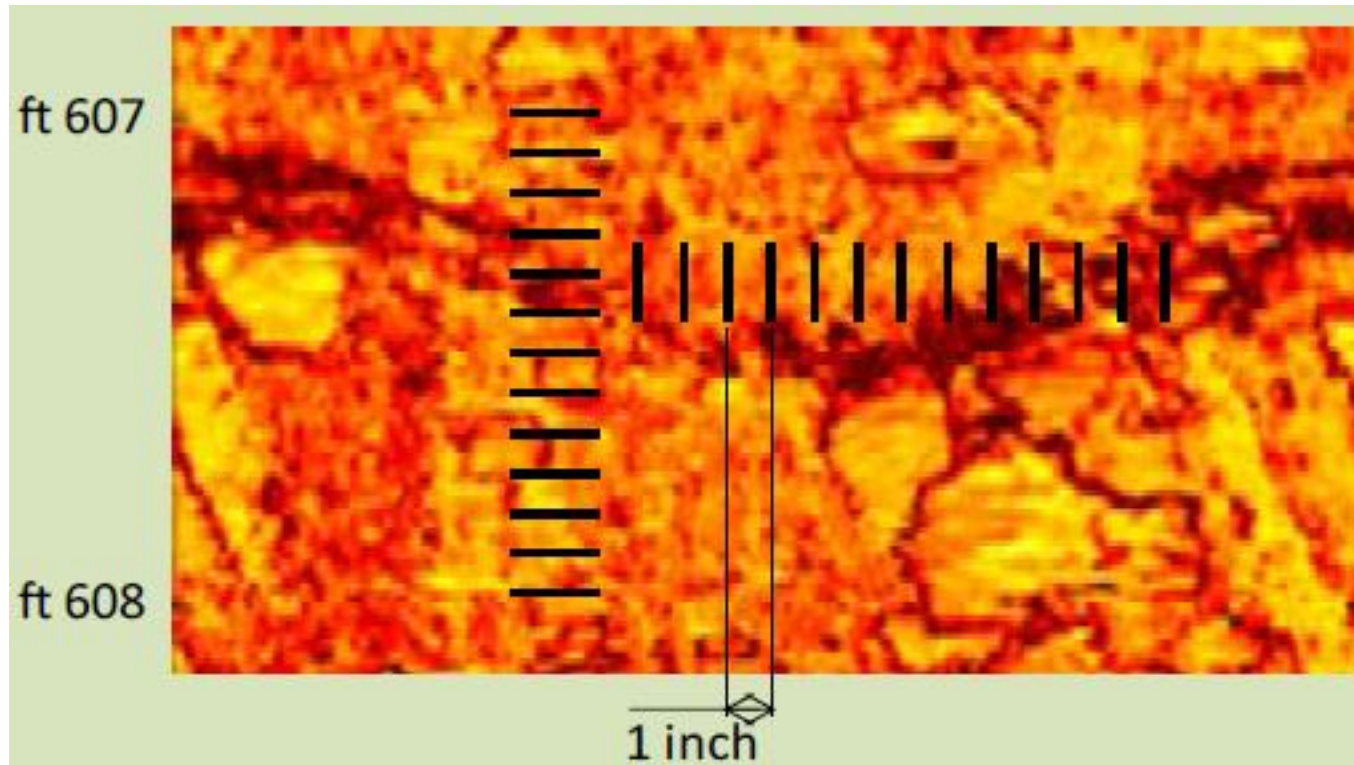
Dynamic Transducer Focusing



LWD vs. WL Ultrasonic Images



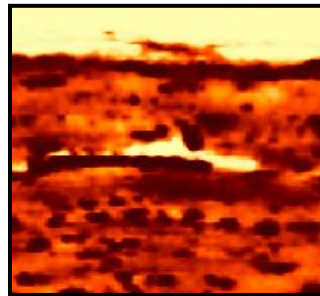
High Resolution Ultrasonic Image



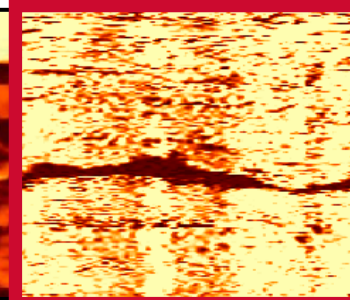
GeoSharp Ultrasonic Image



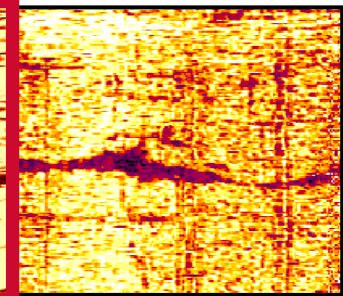
Open Fracture



AFR



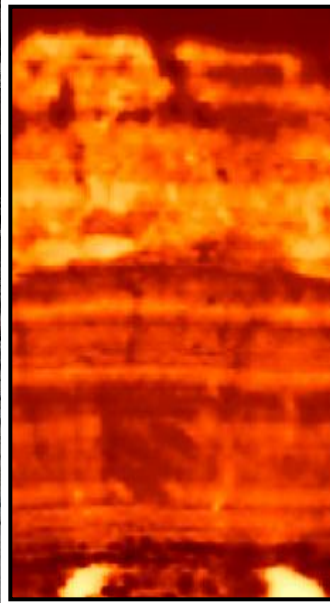
GeoSharp AMI



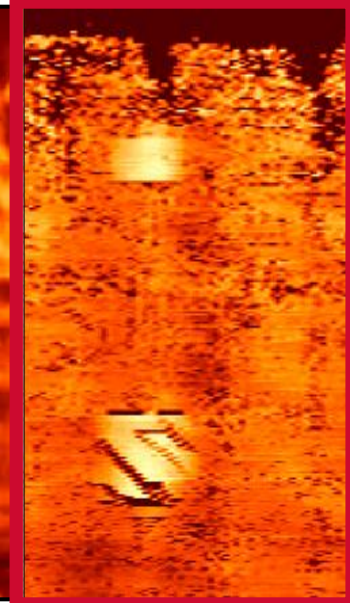
CAST-F

ft 873
1 inch
ft 874

Stabilizer impression in borehole wall



AFR



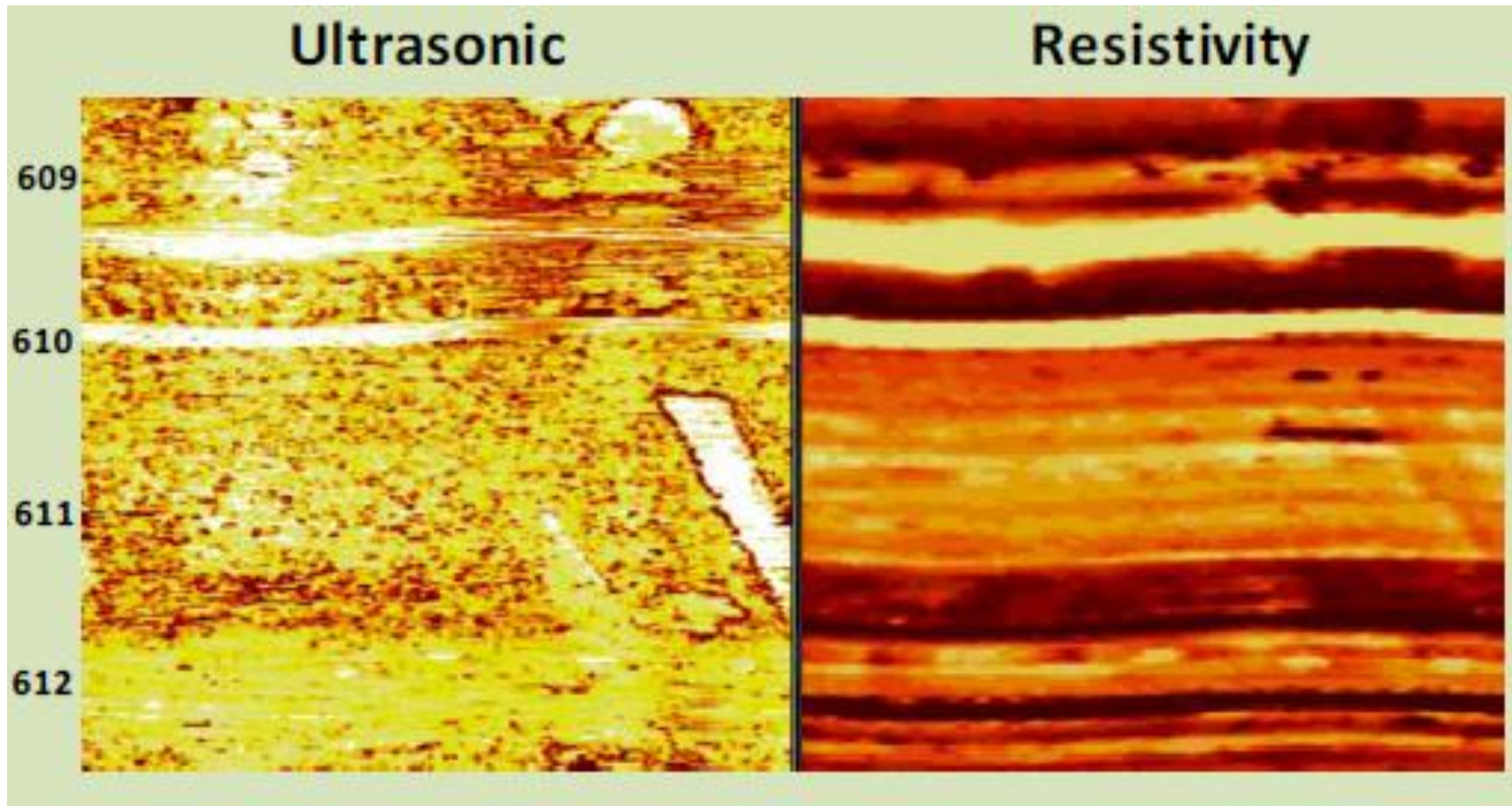
GeoSharp AMI



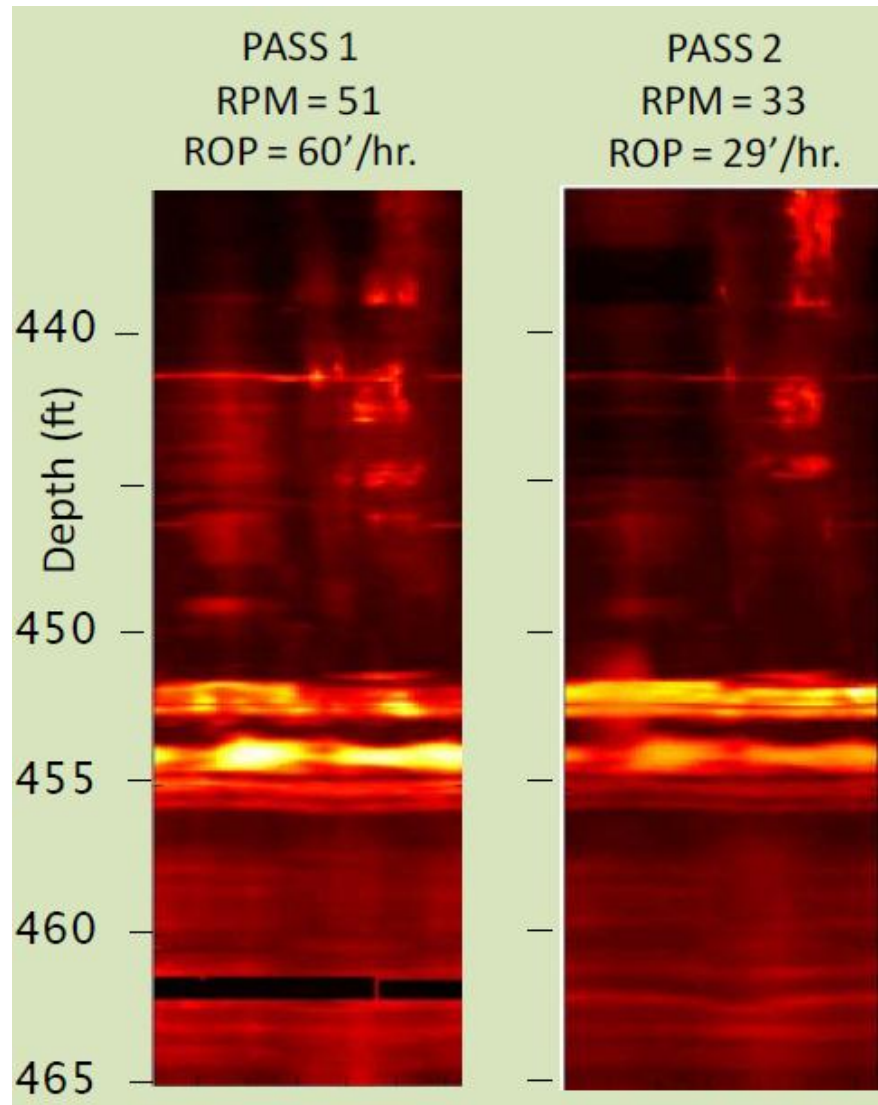
CAST-F

ft 864
1 inch
ft 865

LWD Ultrasonic and Resistivity



OBM Resistivity Image





Thank You

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