Schlumberger

Sonic Scanner

Shear Anisotropy Analysis
with DT Compresional

Processed Interval: 6900 ft - 8400 ft

COMPANY: North East Natural Energy LLC
WELL: Boggess 17H
FIELD: Wildcat
COUNTY: Monongalia
STATE: West Virginia
COUNTRY: USA

API:47-061-01812-00-00

Location
39:40:12.6 N; 80:5:35.8 W
Longitude: -80.090600 degrees; Latitude: 39.687030 degrees

Elevations:
K.B. 1293 ft
D.F. 1293 ft
G.L. 1268 ft

Date	16-Apr-2019
Run No.	1D
Bottom Log Interval	8400 ft
Top Log Interval	6900 ft
Casing-Logger	9.625 in @2543 ft
Bit Size	8.5 in
Drilling Fluid Type	WATER
Mud Resistivity @ BHT	0.027 ohm m @ 158 degF
Drilling Fluid Density | Viscosity	9.5 lbm/gal | N/A
Drilling Fluid pH | Loss	N/A | N/A
Maximum Recorded Temperature	158 deg F
Equipment | Location	3703 | Bradford, PA
Recorded by	Elizabeth Morrone
Witnessed by	BJ Varney

FOLD HERE

The well name, location and borehole reference data were furnished by the customer

SIS Software:Techlog 2018.1	Process Date: 4/22/2019	SIS Center: Houston	Log Analyst Chandni MISHRA

Log Analyst Remarks:

AVAILABLE INPUT DATA:
Full Configuration; Concise Mode
DTCO: DT-Compressional from Far Monopole waveforms.
DTSM: DT-Shear from Dipole Source (Chirp Drive) Including the X and Y Dipole
CALIPERS: 2 PCD Calipers HD1 & HD2 and HCAL from PEX log.
NEUTRON/DENSITY: NPHI or TNPH and RHOZ from Triple Combo (PEX-HRLA) .
RESISTIVITY DATA: AT10-AT90
DIRECTIONAL DATA: GPIT was recorded on this logging run.
LITHOLOGY VOLUMES, POROSITY, PERM: Shale Gas Quanti using (PEX-HRLA)

Processing Parameters:

GENERAL - Processing parameters summary is attached to the bottom of this graphical file

BOREHOLE: OPEN

BOREHOLE FLUID: WATER

HOLE DIAMETER: 8.5 in
BOTTOM HOLE TEMPERATURE: 158 DegF @ 8400 ft MD

PROCESSING DETAILS:
Four sets of dipole waveforms (XD_inline, XD_offline, YD_inline and YD_offline) are rotated into the fast and slow shear directions using the modified Alford Rotation technique (four component rotation) in the presence of shear wave anisotropy. The rotated Fast and Slow shear waveforms are further processed to obtain the corresponding slowness (DTSH_FAST, DTSH_SLOW). They are determined either through flexural dispersion curves inversion technique (SPI method) or from traditional DSTC processing. This is followed by Anisotropy post processing which determines the different anisotropy indicators in terms of slowness (SLOANI), energy (MINXEN/ MAXXEN) and arrival time difference (TIMANI). A discriminated Fast Shear azimuth log is created from these anisotropy indicators to highlight the zones having significant anisotropy.

INTERPRETATION METHOD:
There are no Anisotropy observed in the given interval.

LOG ANALYST CONTACT INFORMATION:
Log Analyst: Chandni MISHRA
Log Analyst Email: CMishra2@slb.com

DIPOLE PROCESSING:

TOOL AZIMUTH: P1NO_MAST

Track Descriptions

Track 1: Depth
Depth numbers - depth scale
Minxene_Overall - overall minimum cross energy
Maxxene_overall- overall maximum cross energy
OffEne area shading - indicates the difference between MinEne and MaxEne
Tens - Tension

Track 2: Gamma Ray
GR_EDTC 0 - 150 - standard gamma ray
BS - bit size
HD1_PPC1 - Caliper1 from PPC
HD2_PPC1 - Caliper2 from PPC
SDEVM - borehole deviation
HAZIM - borehole inclination
P1NO_MAST - Pad 1 North memorized to MAST

Track 3: Porosity
DPHZ - density porosity
TNPH - neutron porosity
SPHI - sonic porosity
PEF - photoelectric Factor

Track 4: Fast Shear Azimuth
FSA_NAZ (red) - overall fast shear azimuth
FSA_NAZ_ERRPLUS - Fast shear azimuth error plus
FSA_NAZ_ERRMINUS - Fast shear azimuth error minus
Azimuth Uncertainty area shading - indicates uncertainty of fast shear azimuth direction
SENSOR_AZIM_QCI- sensor azimuth.
FSA_DIR- Fast Shear azimuth Direction

Track 5: Delta-T/ Anisotropy Indicators
DTCO_MF_R - delta-t compressional
DTCO values - delta-t compressional at that depth
DTSH_FAST - delta-t FAST shear

Track 6: Poisson's Ratio & VPVS ratio
PR_FAST: Poisson's Ratio from Fast Shear
VPVS_FAST: VPVS Ratio from Fast Shear

Track 7: Sonic Waveforms
Level7 : FAST (Red) - FAST shear waveform arrival time
Level7 : SLOW (Blue) - SLOW shear waveform arrival time
Time Processing Window

Track 8: Monopole Sonic Coherence
SPR_MF_R - monopole sonic coherence projection
DTCO_MF_R - delta-t compressional

Track 9: FAST Shear Sonic Coherency
SPR_FAST - FAST shear sonic coherence projection
DTSH_FAST - delta-t FAST shear

Track 10: FAST Shear Frequency Analysis
SFA_FAST - FAST shear sonic frequency analysis projection
DTSH_FAST - delta-t FAST shear

Track 11: SLOW Shear Sonic Coherency
SPR_SLOW - SLOW shear sonic coherence projection
DTSH_SLOW - delta-t SLOW shear

Track 12: SLOW Shear Frequency Analysis
SFA_SLOW - SLOW shear sonic frequency analysis projection
DTSH_SLOW - delta-t SLOW shear

DTSH_FAST values - delta-t FAST shear at that depth
DTSH_SLOW - delta-t SLOW shear
DTSH_SLOW values - delta-t SLOW shear at that depth
DT-based Aniso - indicates slowness based anisotropy (FAST < SLOW)
Time-based Aniso - indicates arrival time based anisotropy (FAST < SLOW)
Purple->Red area shading - indicates a percentage difference for both slowness based and time based anisotropy purple =low percentage red = high percentage

SLOANI/TIMANI- slowness/time based anisotropy

SLOANI = (DTSM_SLOW – DTSM_FAST) / ((DTSM_SLOW + DTSM_FAST) / 2) x 100

TIMANI = TDIF / TTFast x 100

Anisotropic Interpretation and Fast Shear Azimuth direction

SONIC WAVEFORM DISPERSION ANALYSIS (SWDA) and DIPOLE RADIAL PROFILE (DRP) plots will be used in this section to interpret the different types of Anisotropy.

GENERAL CHARACTERISTICS OF SWDA-DRP INDICATED ANISOTROPY

Homogeneous Isotropic - HI Intervals

** The SWDA shows the Fast Shear (red) is identical to the Slow Shear (blue) across the frequency spectrum from low frequency (Far Field) to high frequency (near wellbore) and both shears match their HI Models .

** The DRP shows the Fast and Slow Shears are identical as the shear waves move radially away from the borehole and deeper into the formation (Far Field). In an ideal HI interval, the Stoneley wave should also match the two shears.

Stress Induced Anisotropy

** The SWDA shows the Fast Shear (Red) is faster than the Slow Shear (Blue) at low frequencies (Far Field) but slower at high frequencies (Near Wellbore). One of the shears will match the Homogeneous Isotropic model.

** The DRP shows the Fast Shear (Red) is slower than the Slow Shear (Blue) when near wellbore and crossover such that it is faster than the Slow Shear in the Far Field. The Stoneley wave is generally slower than both shears .

Intrinsic Anisotropy - TIV Laminated Shale Anisotropy

** The SWDA shows the Fast Shear (red) and Slow Shear (blue) are identical across the frequency spectrum, from low frequency (Far Field) to high frequency (near wellbore). They are both depressed below their respective HI Models indicating this interval has TIV Anisotropy .

** The DRP shows the Fast and Slow Shear waves are identical as they move radially away from the borehole and deeper into the formation (Far Field). The Stoneley wave is faster than either the Fast or Slow Shear indicating TIV.

TIH Stress Induced Anisotropy

**The SWDA shows the Fast Shear is faster than the Slow Shear at low frequencies (Far Field) and slower at high frequencies (near wellbore). This crossover signature is indicating Stress Induced Anisotropy.

** The DRP shows the Fast and Slow Shear crossover as the shear waves move radially away from the borehole and deeper into the formation (Far Field). Fast Shear is faster than Slow in the Far Field. The Stoneley waveform usually is equal to the Fast Shear .

Orthorhombic Anisotropy - Stress + TIV Laminated Shale

**The SWDA shows the Fast Shear (Red) is faster than the Slow (Blue) at low frequency (Far Field) and slightly slower at high frequencies (near wellbore). Both shears are also below their HI models (TIV). This combined signature indicates Orthorhombic Anisotropy.

**The DRP shows the Fast Shear is faster than the Slow Shear as the shear waves move radially away from the borehole and deeper into the formation (Far Field). The Stoneley data will generally be faster than both shears in Orthorhombic Anisotropy, but it can also be slower in many cases.

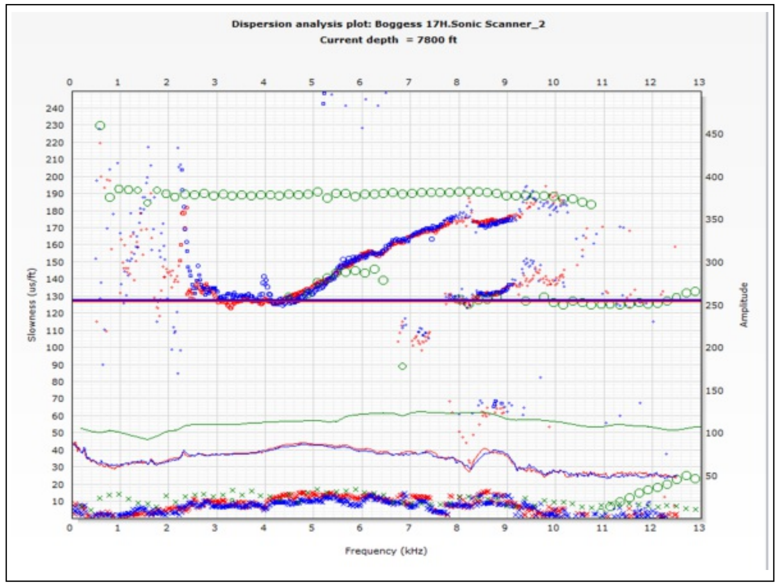
Sonic Model - Homogeneous Isotropic Zone (HI)

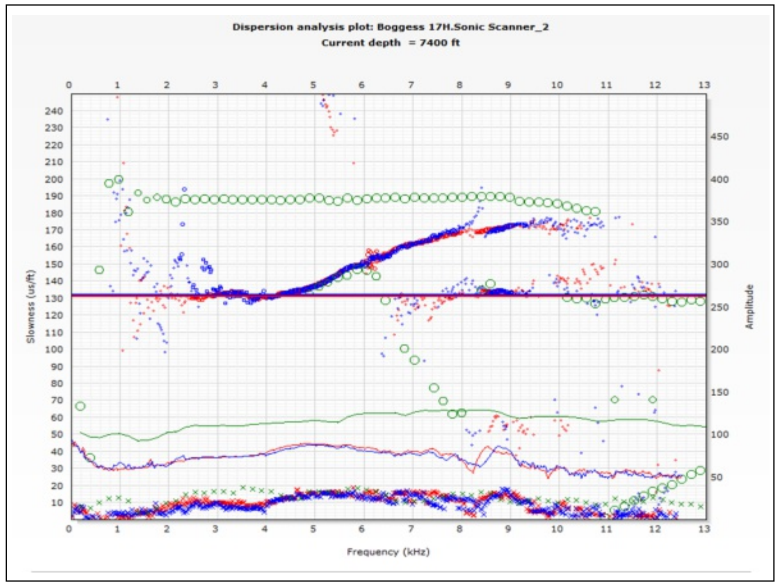
The flexural dispersion is modeled in a Homogeneous Isotropic interval using DT-Compressional, Orthogonal DT-Shears, DT-Stoneley, Bulk Density, DT-Mud and Caliper information. The Dispersion Plot shows that the two Shear Flexural waves are identical and overlay each other throughout the frequency range and they also match their respective HI models .The Radial Profile shows that the two Shear Flexural waves are identical and overlay each other as they move radially from near wellbore into the Far Field part of the rock. The Stoneley derived shear (Lt blue) will usually be equal to or slightly slower than the two orthogonal shear waves in ideal HI rock.

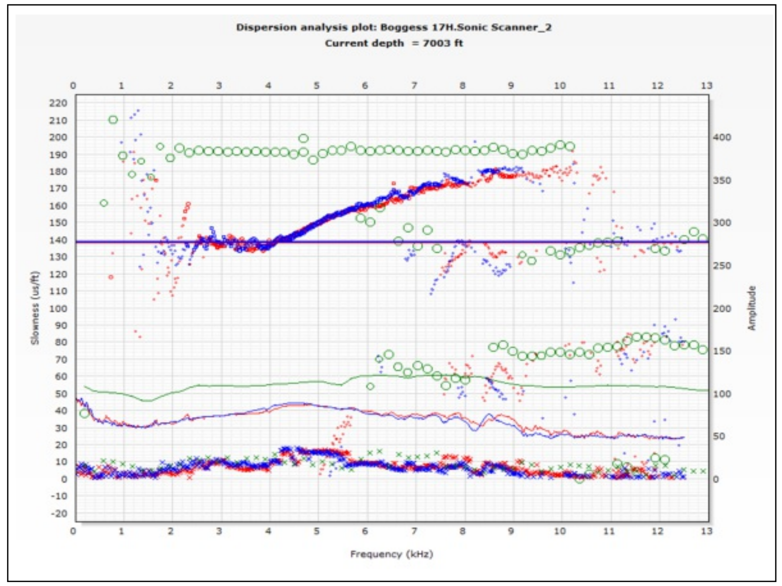
There is no anisotropy found in the given interval.

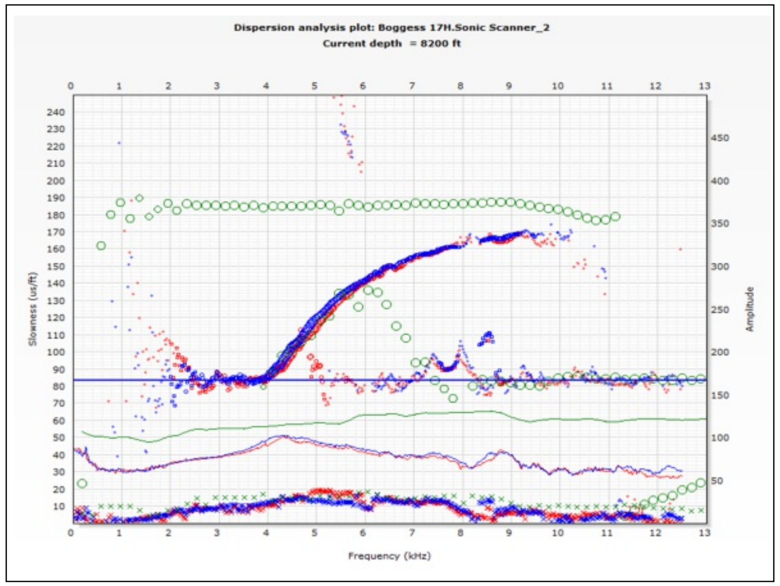
The anisotropy flag calculation uses two anisotropy indicators - Energy and Slowness-Based. If Anisotropy is identified, a flag will appear in the depth track: for stress induced anisotropy - **FSA_FINAL_SI** for intrinsic anisotropy - **FSA_FINAL_TI.** If the type of anisotropy is unclear - **FSA_NAZ_IN**
Type of anisotropy is determined based on dispersion plot pattern (cross-over or parallel) and cross validated using auxiliary information (images, oriented caliper analysis) . In addition, auxiliary image interpretation can be used to identify type of anisotropy using bedding and fracture dip information, break-out and tensile fracture direction.
Stereonet plot above shows Fast Shear azimuth direction in anisotropic rock and in case of vertical well in normal stress regime is indicative of the maximum horizontal stress direction.
Intrinsic anisotropy caused by the dipping bed or fractures is usually shows parallel dispersion pattern. To confirm this type of anisotropy image interpretation is required.

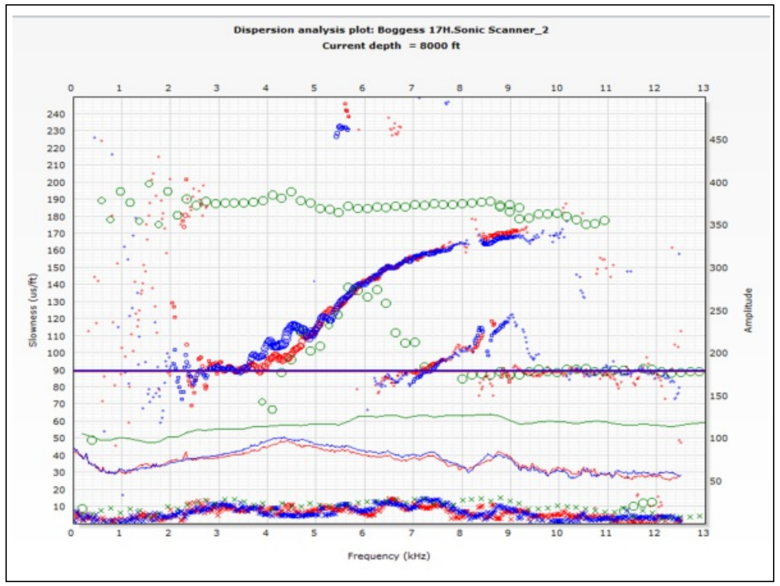
Dispersion plots

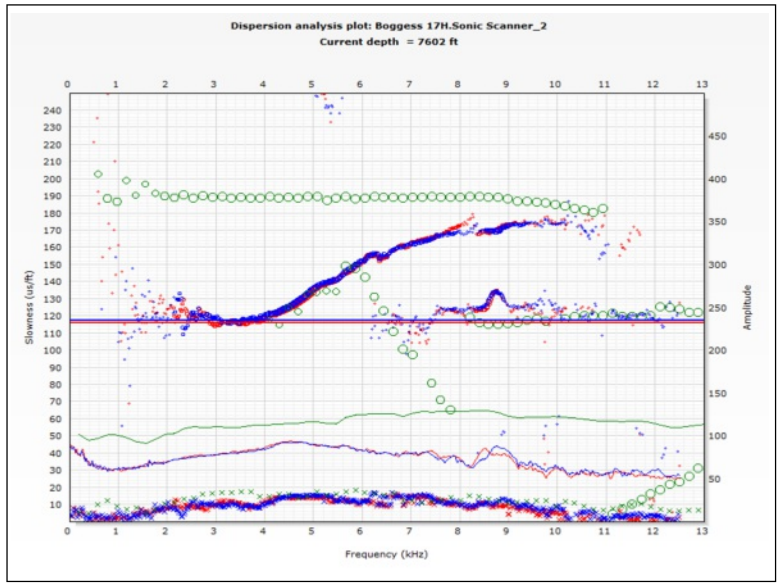












Remarks

Sonic data have been depth matched withTNPH neutron porosity. Sonic Porosity has been calculated using Wyllie's equation where DT Matrix = 47.5 us/ft and DT Fluid = 189us/ft.

Processing parameters summary

Monopole Far STC#1

Borehole status: Open hole	**Bit size:** 8.5 in	**Caliper:** HD1_PPC1 in
Filter length: 49	**Filter band high:** 16000 Hz	**Filter band low:** 5000 Hz
Filter type: Static filter	**Formation type:** Intermediate	**Average hole size:** 8.5 in
Leaky-P: No	**Dispersion file mode:** None	**Receiver/transmitter/DDBHC mode:** Receiver mode
Mud slowness: 200 us/ft	**Mud density:** 9.5 lbm/gal	**Mud type:** WBM
Multishot NRSA: 5	**Search band offset:** 340 us	**Search band width:** 2880 us
Semblance threshold: 0.35	**Slowness lower limit:** 20 us/ft	**Slowness step:** 2 us/ft
STC stacking: No	**Slowness upper limit:** 240 us/ft	**Slowness width:** 20 us/ft
Compute SFA: Yes	**Max frequency:** 12000 Hz	**Min frequency:** 0 Hz
Normalization factor: 1	**Model order:** 3	**Matching tolerance:** 50
Time lower limit: 600 us	**Compressional lower limit:** 56.7 us/ft	**Compressional upper limit:** 127.5 us/ft
Shear lower limit: 80 us/ft	**Shear upper limit:** 540 us/ft	**Time step:** 100 us
Time upper limit: 5100 us	**Time width:** 2160 us	**Integration time window:** 300 us
Waveform: WF_MPS_FAR	**Reference receiver:** 7	**Receiver selection:** R1;R2;R3;R4;R5;R6;R7;R8;R9;R10;R11;R12;R13

Anisotropy pre-processing#4

Hole Diameter: HD1_PPC1 in	**Shear Slowness:** DTSH_XD_MS5_R_2 us/ft	**Filter length:** 101
Filter band high: 4000 Hz	**Filter band low:** 3000 Hz	**Formation type:** Intermediate
Mud Slowness: 200 us/ft	**Mud type:** WBM	**Processing time window length:** 1300 us
Processing time window offset: 1200 us	**Waveform X-Dipole Inline:** WF_XDP_IN	**Waveform X-Dipole Crossline:** WF_XDP_OFF
Waveform Y-Dipole Inline: WF_YDP_IN	**Waveform Y-Dipole Crossline:** WF_YDP_OFF	

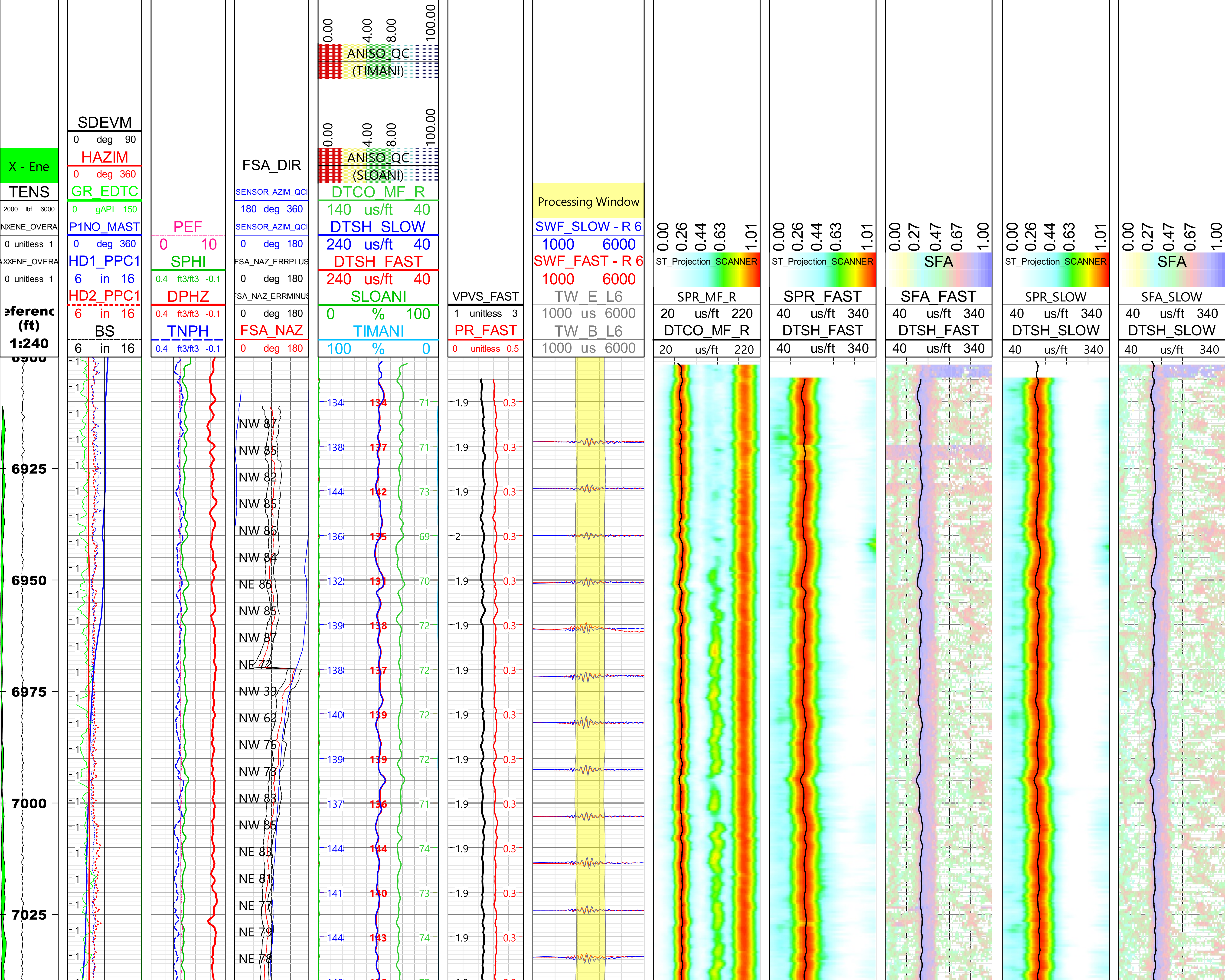
Slow Shear Dipole DSTC#7

Slow Shear Dipole DSTC#7

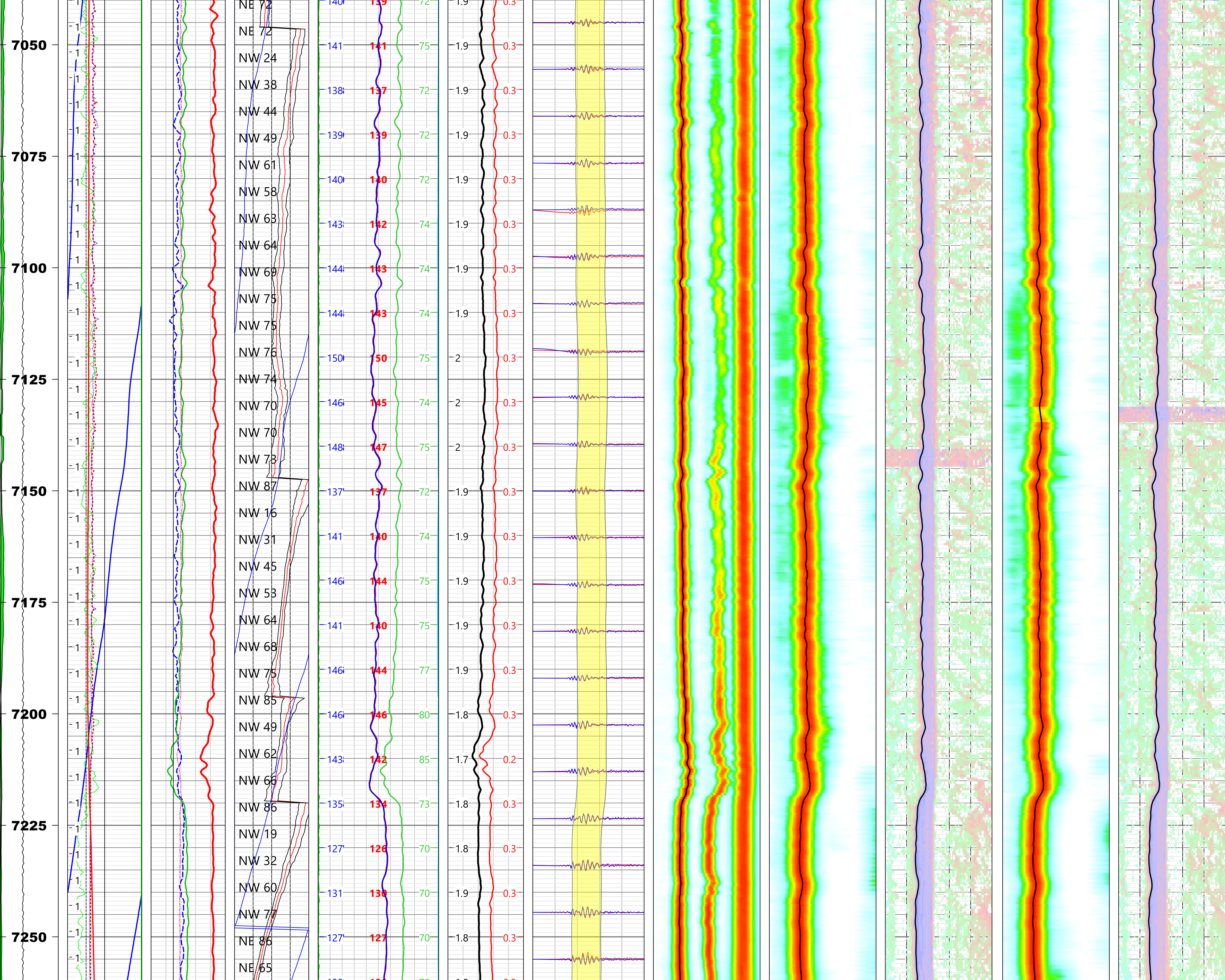
Borehole status: Open hole	**Bit size:** 8.5 in	**Caliper:** HD1_PPC1 in
Compressional slowness: DTCO_MF_MS5_R_1 us/ft	**Filter length:** 47	**Filter band high:** 4000 Hz
Filter band low: 3000 Hz	**Filter type:** Static filter	**Formation type:** Intermediate
Average hole size: 8.5 in	**Dispersion file mode:** None	**Receiver/transmitter/DDBHC mode:** Receiver mode
Mud slowness: 200 us/ft	**Mud density:** 9.5 lbm/gal	**Mud type:** WBM
Multishot NRSA: 5	**Search band offset:** 5520 us	**Search band width:** 11760 us
Semblance threshold: 0.35	**Slowness lower limit:** 40 us/ft	**Slowness step:** 4 us/ft
STC stacking: No	**Slowness upper limit:** 540 us/ft	**Slowness width:** 60 us/ft
Compute SFA: Yes	**Max frequency:** 12000 Hz	**Min frequency:** 0 Hz
Normalization factor: 1	**Model order:** 3	**Matching tolerance:** 50
Time lower limit: 1080 us	**Compressional lower limit:** 56.7 us/ft	**Compressional upper limit:** 127.5 us/ft
Shear lower limit: 80 us/ft	**Shear upper limit:** 540 us/ft	**Time step:** 360 us
Time upper limit: 18000 us	**Time width:** 8820 us	**Integration time window:** 1440 us
Waveform: WF_SLOW_IN_BCR_5_SWAP_6 unitless	**Reference receiver:** 6	**Receiver selection:** R1;R2;R3;R4;R5;R6;R7;R8;R9;R10;R11

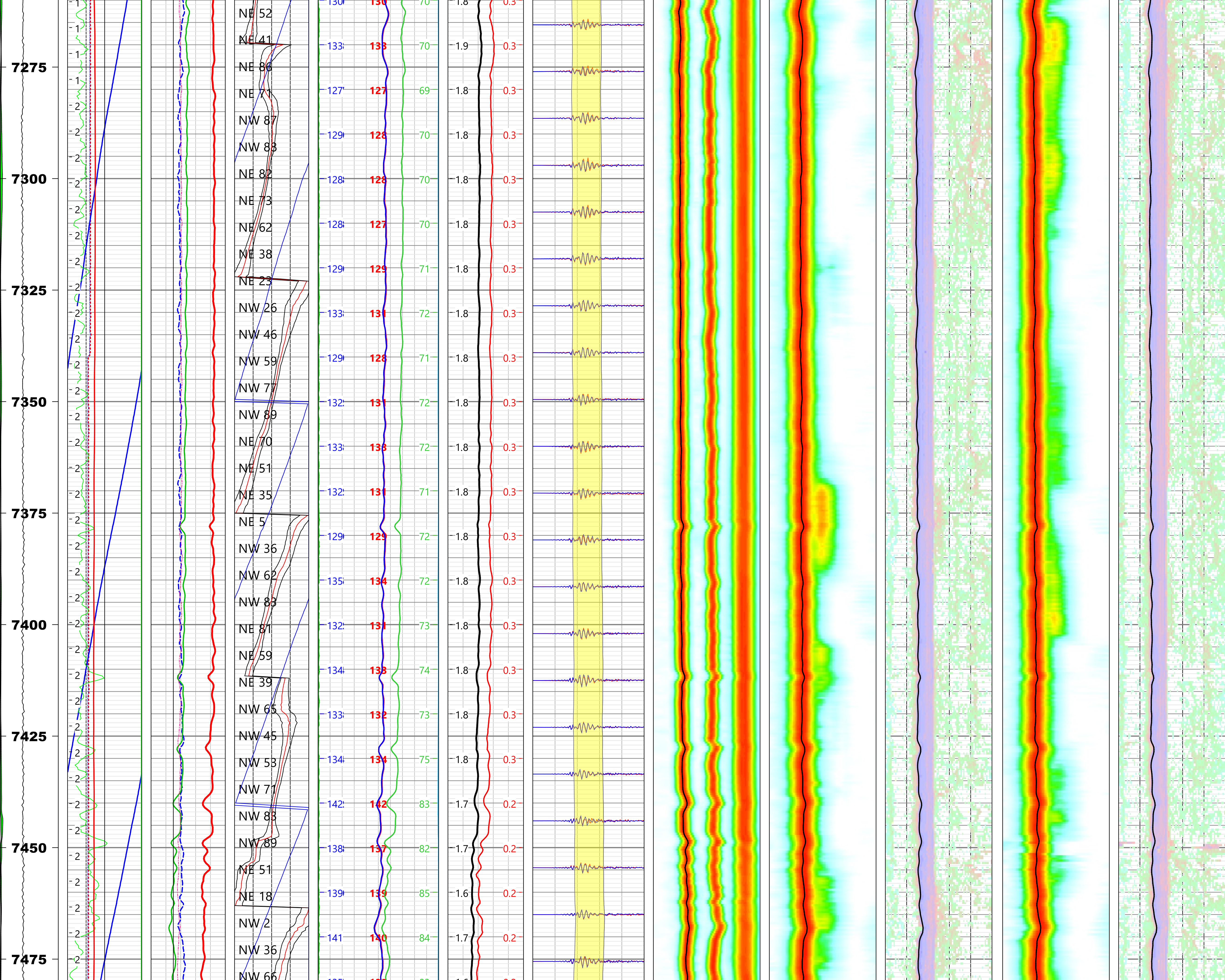
Fast Shear Dipole DSTC#8

Borehole status: Open hole	**Bit size:** 8.5 in	**Caliper:** HD1_PPC1 in
Compressional slowness: DTCO_MF_MS5_R_1 us/ft	**Filter length:** 47	**Filter band high:** 4000 Hz
Filter band low: 3000 Hz	**Filter type:** Static filter	**Formation type:** Intermediate
Average hole size: 8.5 in	**Dispersion file mode:** None	**Receiver/transmitter/DDBHC mode:** Receiver mode
Mud slowness: 200 us/ft	**Mud density:** 9.5 lbm/gal	**Mud type:** WBM
Multishot NRSA: 5	**Search band offset:** 5520 us	**Search band width:** 11760 us
Semblance threshold: 0.35	**Slowness lower limit:** 40 us/ft	**Slowness step:** 4 us/ft
STC stacking: No	**Slowness upper limit:** 540 us/ft	**Slowness width:** 60 us/ft
Compute SFA: Yes	**Max frequency:** 12000 Hz	**Min frequency:** 0 Hz
Normalization factor: 1	**Model order:** 3	**Matching tolerance:** 50
Time lower limit: 1080 us	**Compressional lower limit:** 56.7 us/ft	**Compressional upper limit:** 127.5 us/ft
Shear lower limit: 80 us/ft	**Shear upper limit:** 540 us/ft	**Time step:** 360 us
Time upper limit: 18000 us	**Time width:** 8820 us	**Integration time window:** 1440 us
Waveform: WF_FAST_IN_BCR_5_SWAP_6 unitless	**Reference receiver:** 6	**Receiver selection:** R1;R2;R3;R4;R5;R6;R7;R8;R9;R10;R11

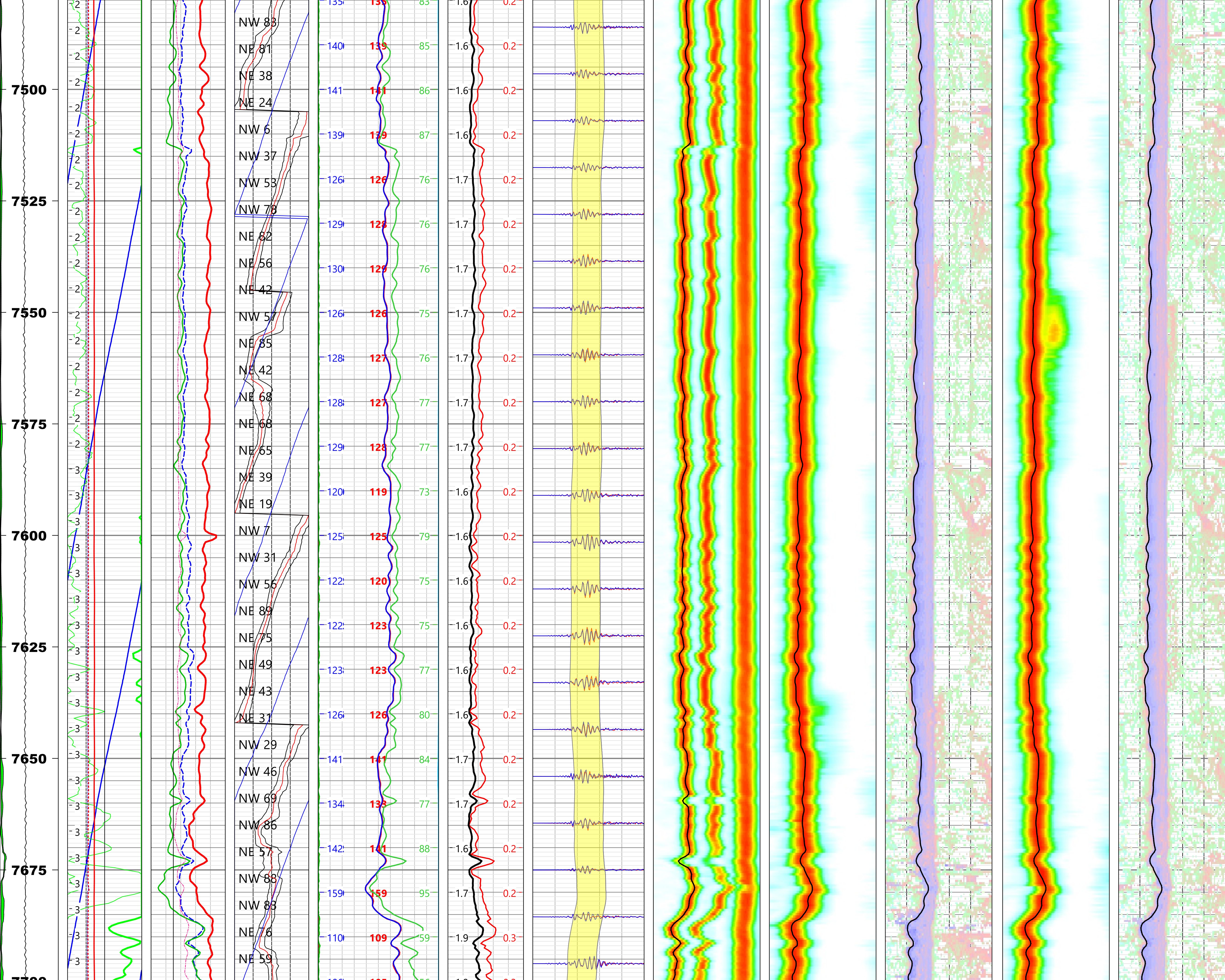


X - Ene
TENS
2000 lbf 6000
NXENE_OVERA
0 unitless 1
AXENE_OVERA
0 unitless 1
eferenc
(ft)
1:240
6925
6950
6975
7000
7025
SDEVM
0 deg 90
HAZIM
0 deg 360
GR_EDTC
0 gAPI 150
P1NO_MAST
0 deg 360
HD1_PPC1
6 in 16
HD2_PPC1
6 in 16
BS
6 in 16
PEF
0 10
SPHI
0.4 ft3/ft3 -0.1
DPHZ
0.4 ft3/ft3 -0.1
TNPH
0.4 ft3/ft3 -0.1
FSA_DIR
SENSOR_AZIM_QCI
180 deg 360
SENSOR_AZIM_QCI
0 deg 180
FSA_NAZ_ERRPLUS
0 deg 180
FSA_NAZ_ERRMINUS
0 deg 180
FSA_NAZ
0 deg 180
NW 87
NW 85
NW 82
NW 85
NW 86
NW 84
NE 85
NW 85
NW 87
NE 72
NW 39
NW 62
NW 75
NW 73
NW 83
NW 85
NE 83
NE 81
NE 77
NE 79
NE 78
0.00 4.00 8.00 100.00
ANISO_QC
(TIMANI)
0.00 4.00 8.00 100.00
ANISO_QC
(SLOANI)
DTCO_MF_R
140 us/ft 40
DTSH_SLOW
240 us/ft 40
DTSH_FAST
240 us/ft 40
SLOANI
0 % 100
TIMANI
100 % 0
VPVS_FAST
1 unitless 3
PR_FAST
0 unitless 0.5
Processing Window
SWF_SLOW - R 6
1000 6000
SWF_FAST - R 6
1000 6000
TW_E_L6
1000 us 6000
TW_B_L6
1000 us 6000
0.00 0.26 0.44 0.63 1.01
ST_Projection_SCANNER
SPR_MF_R
20 us/ft 220
DTCO_MF_R
20 us/ft 220
0.00 0.26 0.44 0.63 1.01
ST_Projection_SCANNER
SPR_FAST
40 us/ft 340
DTSH_FAST
40 us/ft 340
0.00 0.27 0.47 0.67 1.00
SFA
SFA_FAST
40 us/ft 340
DTSH_FAST
40 us/ft 340
0.00 0.26 0.44 0.63 1.01
ST_Projection_SCANNER
SPR_SLOW
40 us/ft 340
DTSH_SLOW
40 us/ft 340
0.00 0.27 0.47 0.67 1.00
SFA
SFA_SLOW
40 us/ft 340
DTSH_SLOW
40 us/ft 340

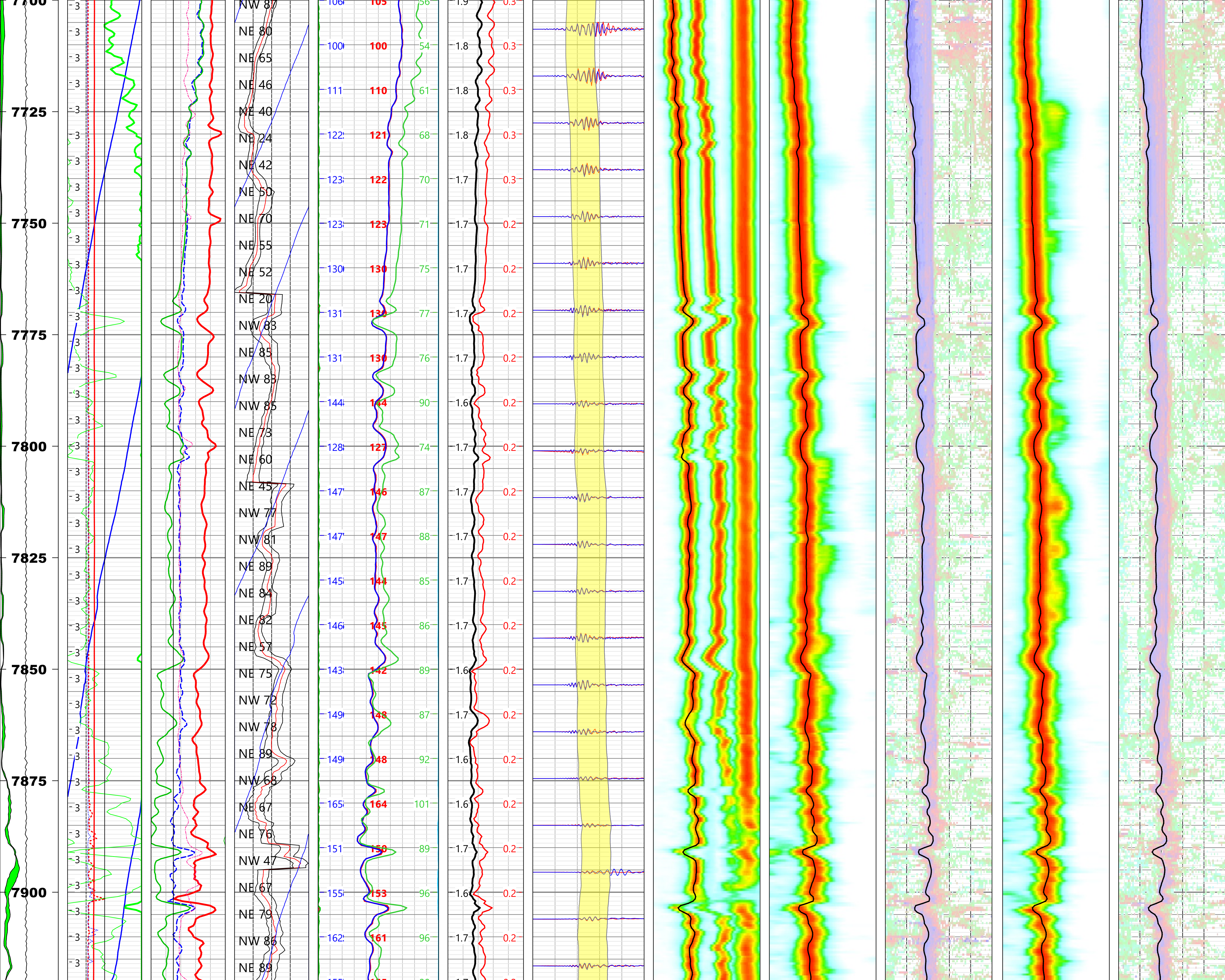

7050
7075
7100
7125
7150
7175
7200
7225
7250
NE 72
NW 24
NW 38
NW 44
NW 49
NW 61
NW 58
NW 63
NW 64
NW 69
NW 75
NW 75
NW 76
NW 74
NW 70
NW 70
NW 73
NW 87
NW 16
NW 31
NW 45
NW 53
NW 64
NW 68
NW 75
NW 85
NW 49
NW 62
NW 66
NW 86
NW 19
NW 32
NW 60
NW 77
NE 86
NE 65

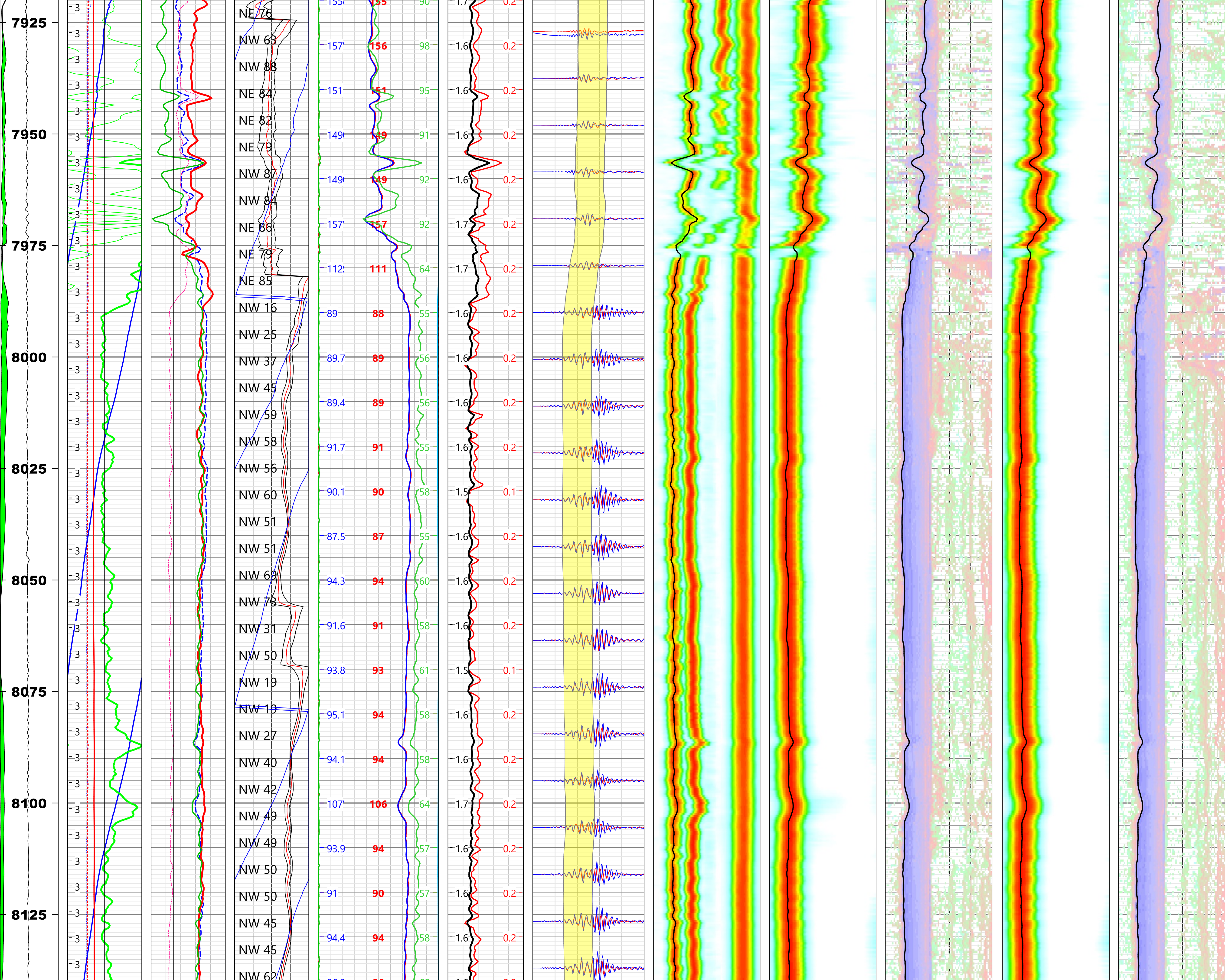


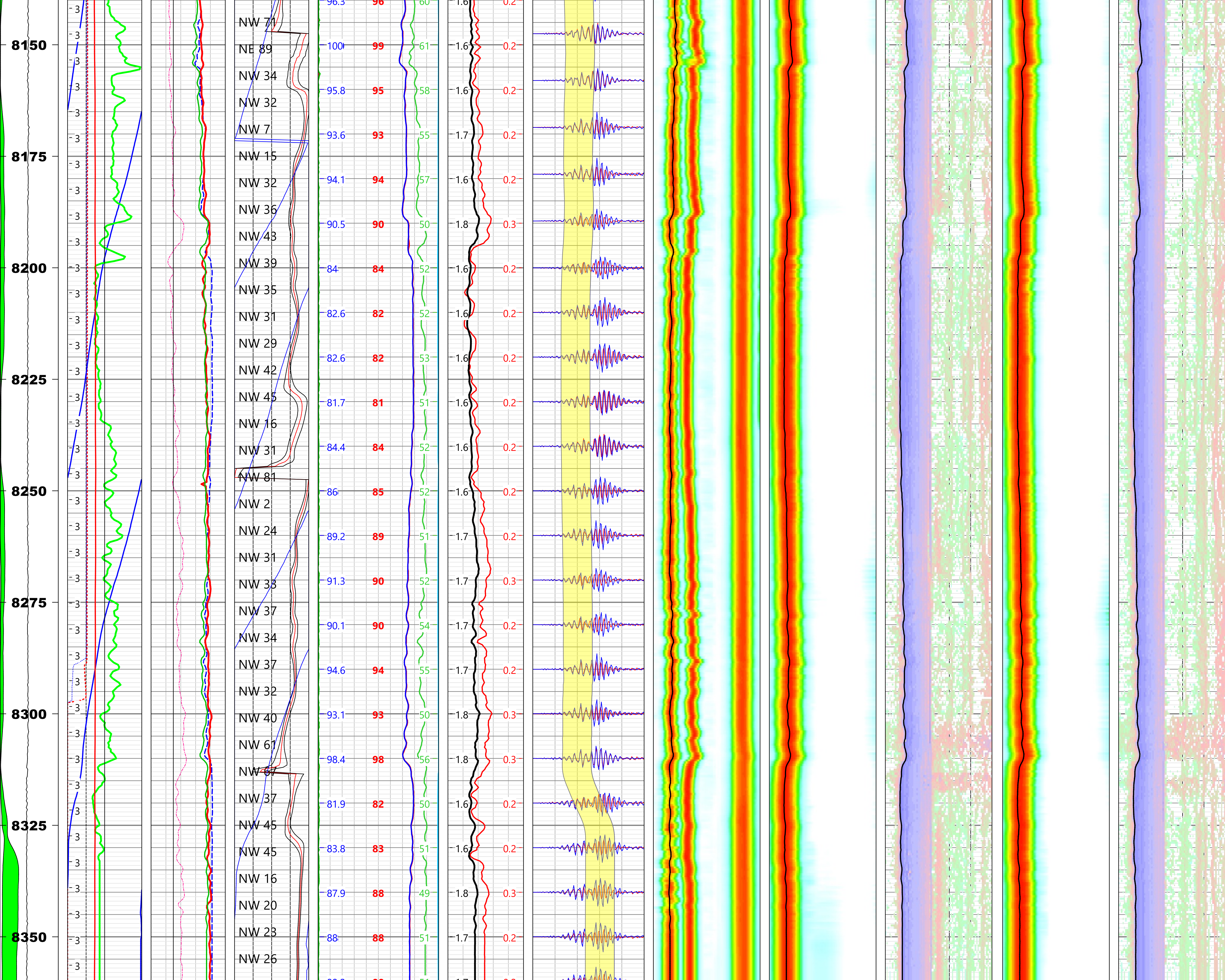
7275
7300
7325
7350
7375
7400
7425
7450
7475
NE 52
NE 41
NE 86
NE 71
NW 87
NW 88
NE 82
NE 73
NE 62
NE 38
NE 23
NW 26
NW 46
NW 59
NW 77
NW 89
NE 70
NE 51
NE 35
NE 5
NW 36
NW 62
NW 83
NE 81
NE 59
NE 39
NW 65
NW 45
NW 53
NW 71
NW 83
NW 89
NE 51
NE 18
NW 2
NW 36
NW 66

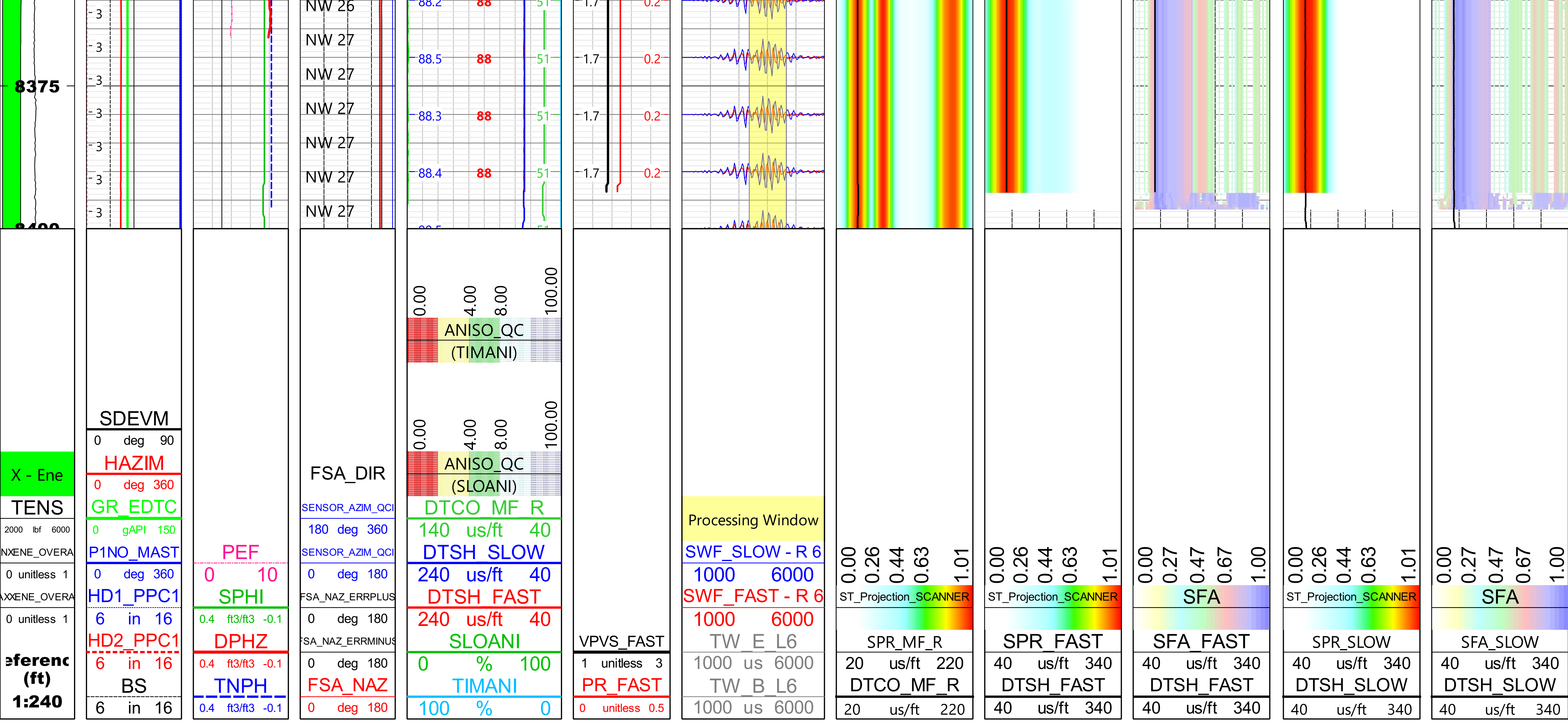


7500
7525
7550
7575
7600
7625
7650
7675
NW 83
NE 81
NE 38
NE 24
NW 6
NW 37
NW 53
NW 78
NE 82
NE 56
NE 42
NW 57
NE 85
NE 42
NE 68
NE 68
NE 65
NE 39
NE 19
NW 7
NW 31
NW 56
NE 89
NE 75
NE 49
NE 43
NE 31
NW 29
NW 46
NW 69
NW 86
NE 57
NW 88
NW 83
NE 76
NE 59

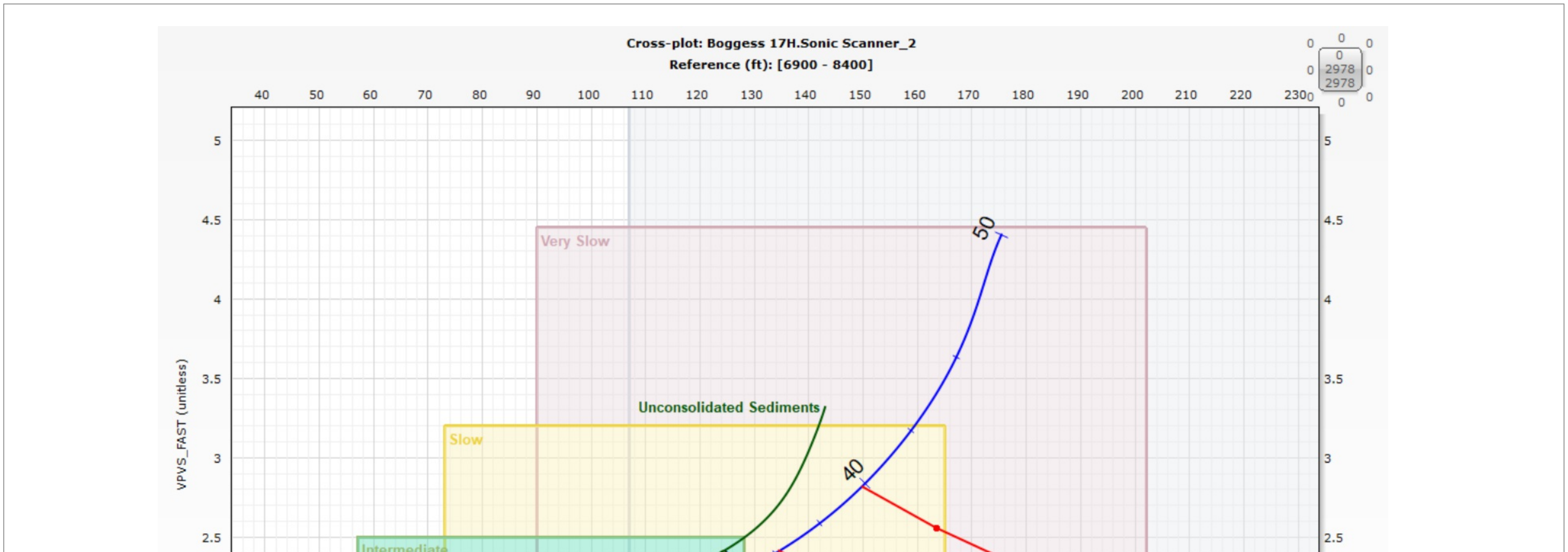

7725
7750
7775
7800
7825
7850
7875
7900
NE 80
NE 65
NE 46
NE 40
NE 24
NE 42
NE 50
NE 70
NE 55
NE 52
NE 20
NW 83
NE 85
NW 83
NW 85
NE 73
NE 60
NE 45
NW 77
NW 81
NE 89
NE 84
NE 82
NE 57
NE 75
NW 72
NW 78
NE 89
NW 68
NE 67
NE 76
NW 47
NE 67
NE 79
NW 86
NE 89


7925
7950
7975
8000
8025
8050
8075
8100
8125
NE 76
NW 63
NW 88
NE 84
NE 82
NE 79
NW 87
NW 84
NE 86
NE 79
NE 85
NW 16
NW 25
NW 37
NW 45
NW 59
NW 58
NW 56
NW 60
NW 51
NW 51
NW 69
NW 73
NW 31
NW 50
NW 19
NW 19
NW 27
NW 40
NW 42
NW 49
NW 49
NW 50
NW 50
NW 45
NW 45
157 156 98
151 151 95
149 149 91
149 149 92
157 157 92
112 111 64
89 88 55
89.7 89 56
89.4 89 56
91.7 91 55
90.1 90 58
87.5 87 55
94.3 94 60
91.6 91 58
93.8 93 61
95.1 94 58
94.1 94 58
107 106 64
93.9 94 57
91 90 57
94.4 94 58

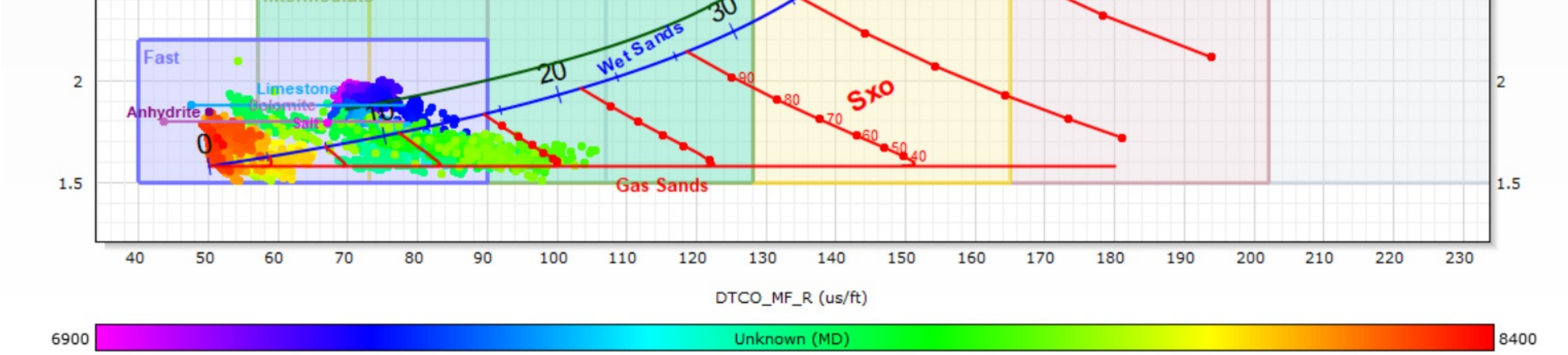

8150
8175
8200
8225
8250
8275
8300
8325
8350
NW 71
NE 89
NW 34
NW 32
NW 7
NW 15
NW 32
NW 36
NW 43
NW 39
NW 35
NW 31
NW 29
NW 42
NW 45
NW 16
NW 31
NW 81
NW 2
NW 24
NW 31
NW 33
NW 37
NW 34
NW 37
NW 32
NW 40
NW 61
NW 67
NW 37
NW 45
NW 45
NW 16
NW 20
NW 23
NW 26



8375
X - Ene
TENS
2000 lbf 6000
NXENE_OVERA
0 unitless 1
AXXENE_OVERA
0 unitless 1
Reference (ft)
1:240
SDEVM
0 deg 90
HAZIM
0 deg 360
GR_EDTC
0 gAPI 150
P1NO_MAST
0 deg 360
HD1_PPC1
6 in 16
HD2_PPC1
6 in 16
BS
6 in 16
PEF
0 10
SPHI
0.4 ft3/ft3 -0.1
DPHZ
0.4 ft3/ft3 -0.1
TNPH
0.4 ft3/ft3 -0.1
NW 26
NW 27
FSA_DIR
SENSOR_AZIM_QCI
180 deg 360
SENSOR_AZIM_QCI
0 deg 180
FSA_NAZ_ERRPLUS
0 deg 180
FSA_NAZ_ERRMINUS
0 deg 180
FSA_NAZ
0 deg 180
0.00 4.00 8.00 100.00
ANISO_QC (TIMANI)
ANISO_QC (SLOANI)
DTCO_MF_R
140 us/ft 40
DTSH_SLOW
240 us/ft 40
DTSH_FAST
240 us/ft 40
SLOANI
0 % 100
TIMANI
100 % 0
VPVS_FAST
1 unitless 3
PR_FAST
0 unitless 0.5
Processing Window
SWF_SLOW - R 6
1000 6000
SWF_FAST - R 6
1000 6000
TW_E_L6
1000 us 6000
TW_B_L6
1000 us 6000
ST_Projection_SCANNER
SPR_MF_R
20 us/ft 220
DTCO_MF_R
20 us/ft 220
SPR_FAST
40 us/ft 340
DTSH_FAST
40 us/ft 340
SFA
SFA_FAST
40 us/ft 340
DTSH_FAST
40 us/ft 340
SPR_SLOW
40 us/ft 340
DTSH_SLOW
40 us/ft 340
SFA_SLOW
40 us/ft 340
DTSH_SLOW
40 us/ft 340



Cross-plot: Boggess 17H.Sonic Scanner_2
Reference (ft): [6900 - 8400]
40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230
5 4.5 4 3.5 3 2.5
VPVS_FAST (unitless)
Very Slow
Slow
Intermediate
Unconsolidated Sediments
50
40
2978



Charts:

Schlumberger, Compressional Slowness vs VPVS, Formation Type

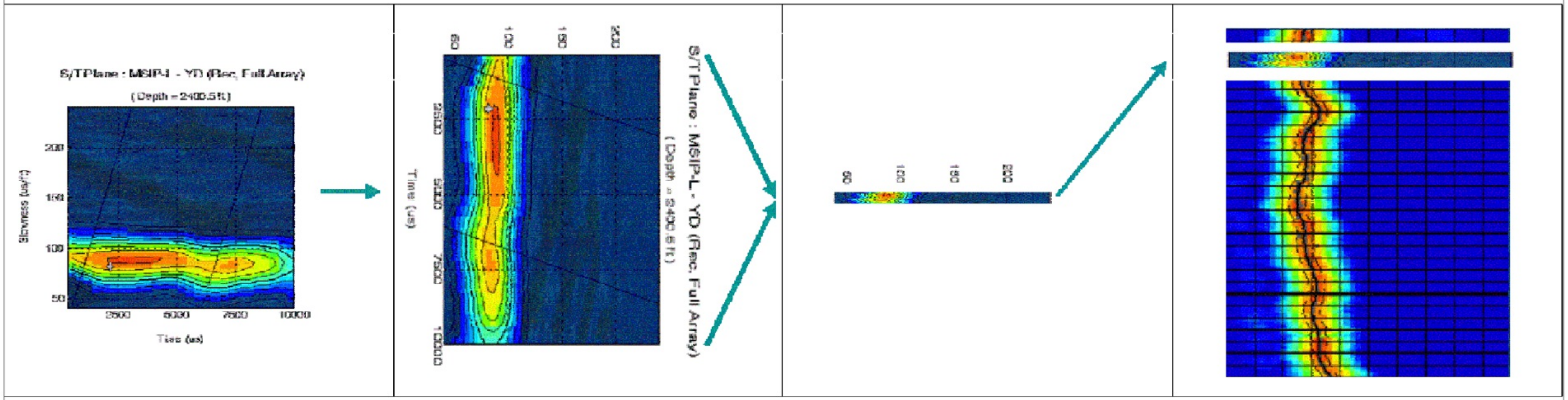
Schlumberger, Compressional vs VPVS

Scale:

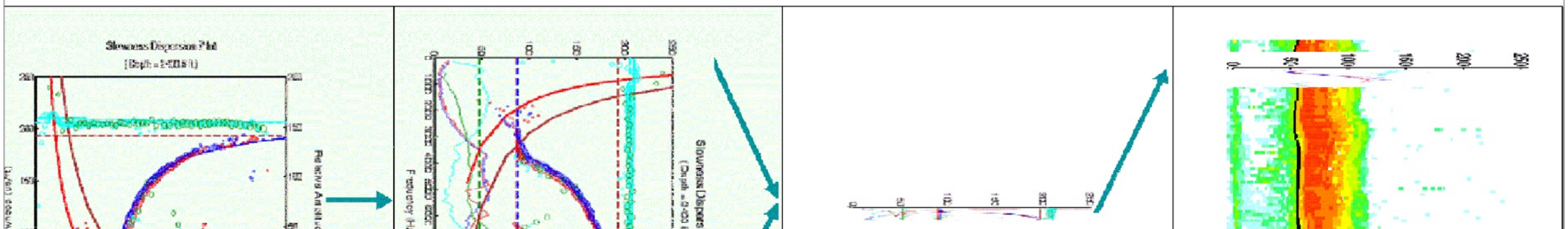
● Scale 1: [DTCO_MF_R - VPVS_FAST]

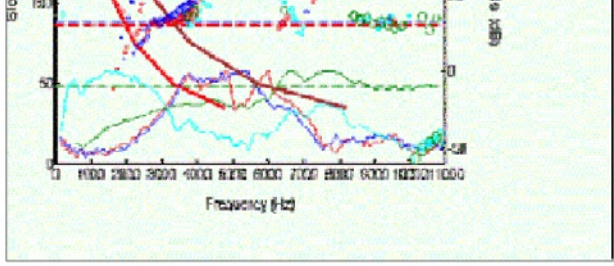
Quality Control Projection Logs

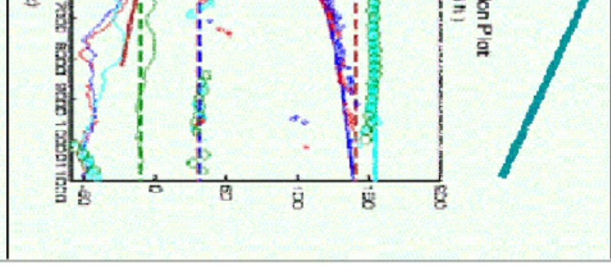
Slowness Time Coherency Log

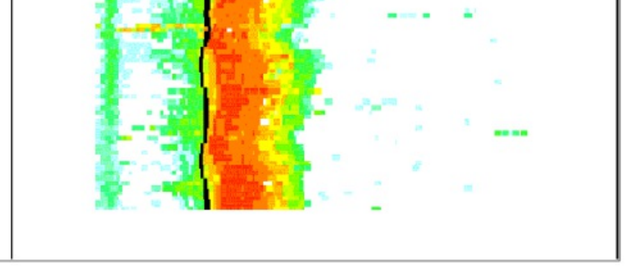


Slowness Frequency Analysis Log

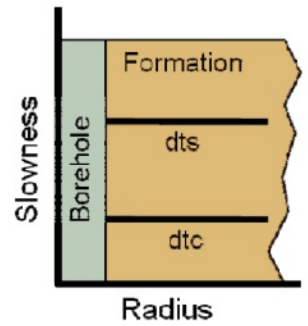




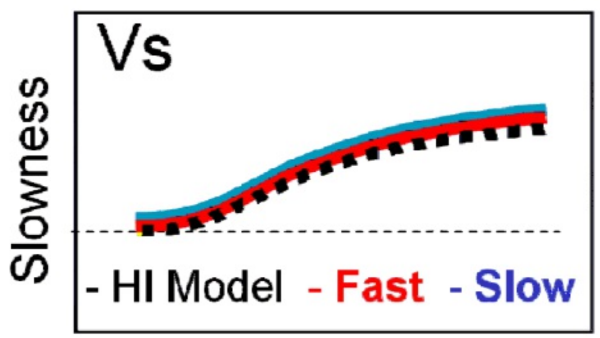




Homogeneous Isotropic Model

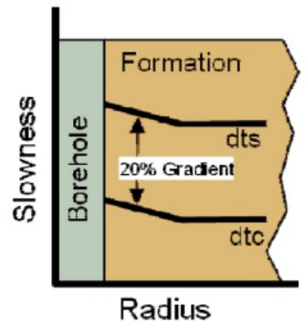


Vp,s

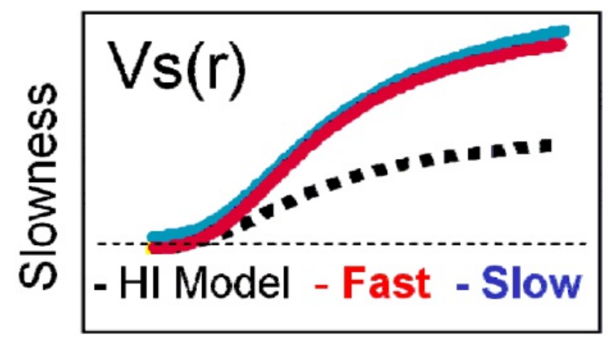


Shear slowness is the same in all directions, which is the basis of the Homogeneous Isotropic (HI) formation model.

Inhomogeneous Isotropic Model



Vp(r),Vs(r) change with distance



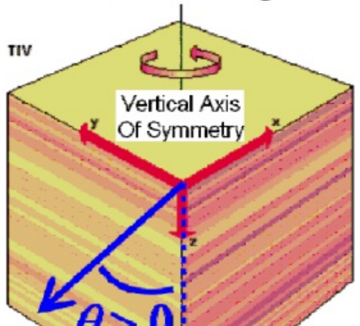
Shear slowness changes with distance from the borehole. On dispersion plots, fast and slow shear curves will overlay and be higher than the HI model at higher frequencies.

Homogeneous Anisotropic Formation Model

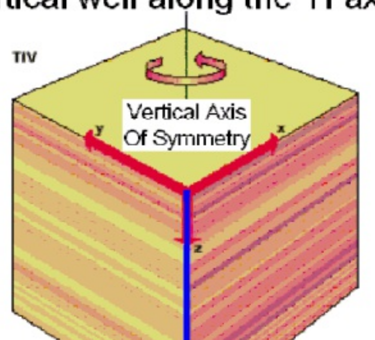
Transverse Isotropic Vertical – TIV

Shales & Bedding or Layering - $V_s(\theta)$

Deviated well at angle to TI axis

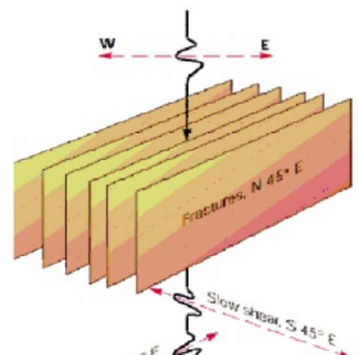


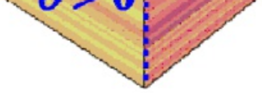
Vertical well along the TI axis

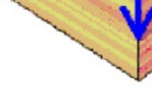


Transverse Isotropic Horizontal – TIH

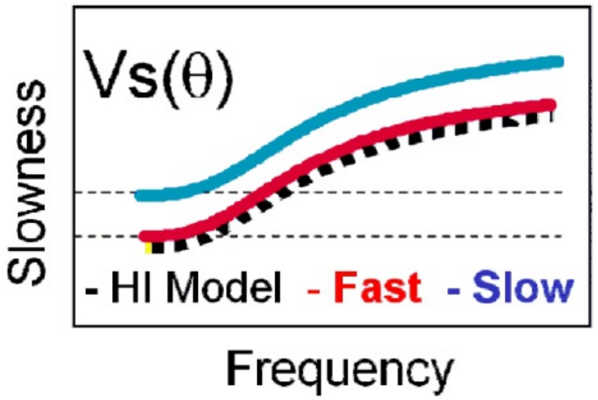
Fractures - $V_s(\theta)$



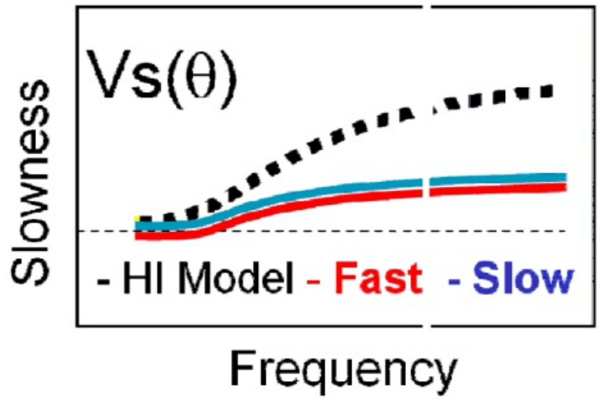




Intrinsic Anisotropy

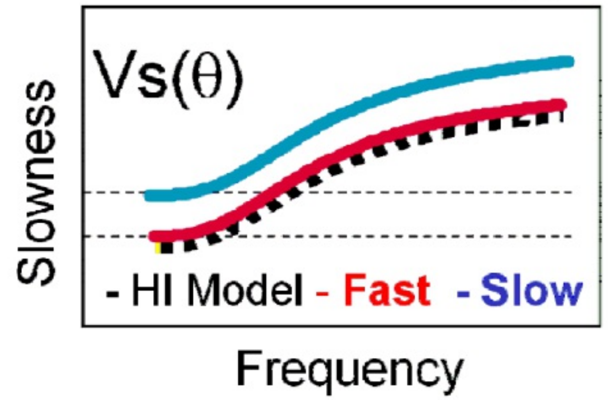


Intrinsic Anisotropy



Shear velocity is function of angle in shales. On dispersion plots, the fast and slow shear are parallel to each other, and their relationship to the HI model is a function of angle.

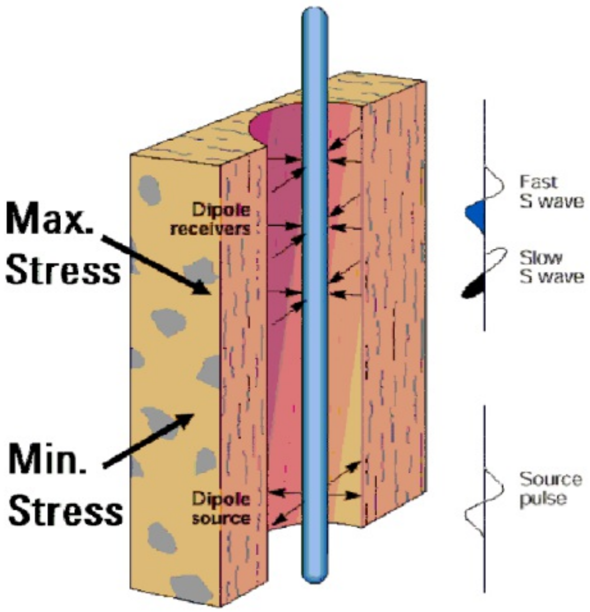
Intrinsic Anisotropy

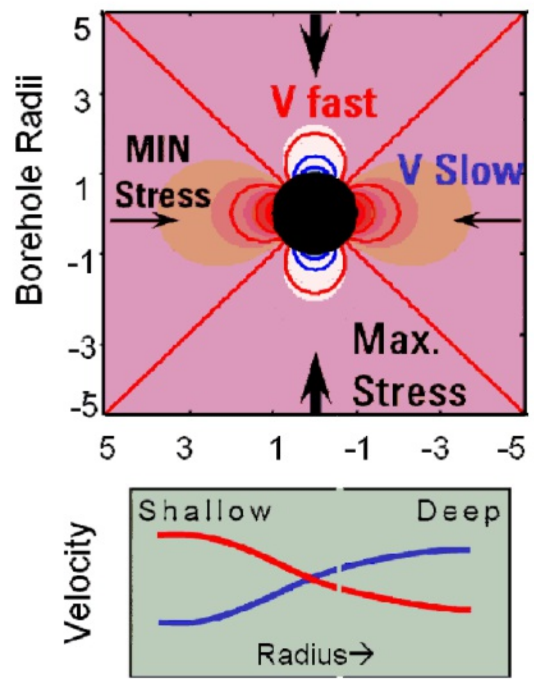


Shear travels slower across fractures. On dispersion plots, the fast and slow shear are parallel to each other, with the slow shear shape close to that of the HI model.

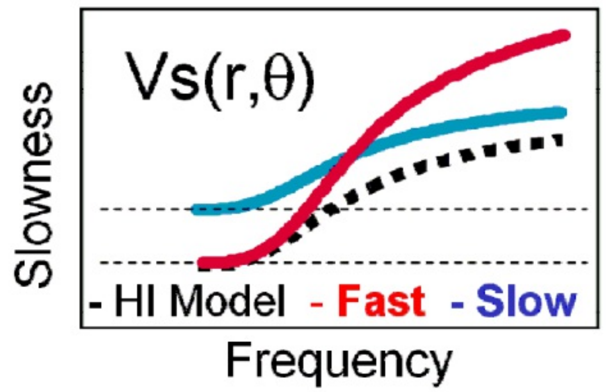
Inhomogeneous Anisotropic Formation Model

Intrinsic Anisotropy – Stress Induced – $V_s(r,\theta)$





Inhomogeneous Anisotropic (Stress) Induced



Shear velocity is a function of radius and angle, with the slowest shear velocity in the direction of minimum stress. On a dispersion plot, this is characterized as a crossover of the fast and slow shear as frequency increases.

Sonic Scanner

Schlumberger

COMPANY:	North East Natural Energy LLC
WELL:	Boggess 17H
FIELD:	Wildcat
COUNTY:	Monongalia
STATE:	West Virginia
COUNTRY:	USA

API No.: 47-061-01812-00-00

Date Processed: 4/22/2019