LWD data QC and processing memo of C0002P

20th February, 2014

LSS Yoshinori Sanada, Yukari Kido, and Yohei Hamada

Depth index

mBRT: meter below the rotary table (rig floor)

mbsf: meter below sea floor

MSL: mean sea level

MD: Measured depth, linear length from the rig floor

TVDSS: True Vertical Depth SubSea, vertical depth from MSL

Well summary

Expedition: 348

Hole: C0002P (sidetrack of C0002N, which is sidetrack of C0002F)

Longitude / Latitude = 136_38.2029 E / 33_18.0507 N (Well top of C0002F)

X / Y= 652382.4 / 3685834.6 (Coordinates: WGS84-N53)

3D seismic location: Inline = 2533, Xline = 6229

Magnetic field information (calculated by BGGM2013)

- Total magnetic force: 46029 nT
- Horizontal component: 31463 nT
- Vertical component: 33597 nT
- Grid North: 0.8988 deg
- Inclination: 46.878 deg
- Declination: -6.7586 deg

Water Depth: 1939.0m (sea floor from rig floor: 1967.5m)

Rig floor to MSL Elevation: 28.5 m

Last casing : 20" till 2827.8 mBRT (860.30 mbsf)

Top of sidetrack window: 3904.0mBRT (1936.33mbsf)

Bottom of sidetrack window: 3912.63mBRT (1845.13mbsf)

Bit size: 12-1/4"-PDC

Total depth: 5025.6 m BRT *(3058.1mbsf)*

Max hole deviation: 5.36 deg @3084.17mBRT (1116.67mbsf) (directional drilling)

Last hole deviation: 2.85 deg @4190.77mBRT (2223.27mbsf)

Measured interval:

4130-5026 mBRT (2162.5-3058.5mbsf)

Mud type: KNPP

Mud weight: 1.28, 1.30, 1.32

Mud resistivity: 0.10 Ohm-m @24.0 DegC
Mud filtrate: 0.08 Ohm-m @24.0 DegC
Mud cake: 0.14 Ohm-m @ 24.0 DegC
KCL concentration: ~117-124%wt

LWD BHA: AFR(resistivity image)+M5(AGR(gamma)+EWR(resistivity)+PWD(annular pressure)+HCIM(processor)+XBAT(Sonic)+MWD

- Sampling rate:
  - Real time data: 57 sec
  - Memory data: AGR: 10 sec, EWR-M5: 12 sec, PWD: 2 sec, AFR: 4 sec, XBAT: 20 sec

Operation and logging summary

26-Dec

18:50 Run in hole to 1924mBRT

22:15 Cut and slip drilling line

27-Dec

04:45 Resume run in hole

12:00 Start reaming down from 4129mBRT (2161.5mbsf)

18:00 Start drill down from 4186mBRT to 4228mBRT (2218.5mbsf - 2260.5mbsf)

28-Dec

00:45 No real time signal-detected @4228mBRT (2260.5mbsf). Troubleshooting.

02:15 Resume drilling down without realtime data

29-Dec

06:15 Circulation and bottoms up (to clean up hole)

09:00 Short trip (to clean up hole)

11:30 Resume drilling down

30-Dec

Continue drill ahead

31-Dec

04:15 Pull out of hole for short trip from 5026mRBT (3058.5msf)

08:45 Circulation and increase mud weight 1.28 to 1.30

22:00 Stack pipe at 5009mBRT (3041.5mbsf)

1-Jan

07:00 Mud weight up to 1.32

12:15 Pull out of hole

2-Jan

06:00 BHA at surface, download data

24-Jan

AFR was sent back to the Halliburton workshop in Thailand and recovered memory data.

Logging data quality control

Data quality control was performed by monitoring real time data till 4228mBRT (2260.5mbsf) and memory data. Logging Staff Scientists (here after LSS) assessed real time drilling parameters and data from the downhole tools in terms of realistic values for the lithology of drilling interval and comparing with the logs in C0002 in the previous IODP expeditions. MWD realtime signal was not detected from 4228mBRT (2260.5mbsf) due to the tool failure. We continued drilling down without realtime data. The AFR memory data could not downloaded due to damaged its data port. AFR was sent back to the Halliburton workshop in Thailand and recovered memory data on 24th January finally.

The XBAT caliper analysis by Halliburton shows the tool moved around ~2 inches in the borehole (Figure 2-A). The caliper values were corrected with the tool position by Halliburton. The borehole diameter was larger in 4130.5-4186.0m, the interval reamed down with 12-1/4" bit in 10-5/8" core interval (Figure 2-B). The hole would have collapsed by time lapse after coring.

The overall quality of the gamma and resistivites data with EWR-M5 were good. Resistivities are suddenly dropped at 5006mBRT (3038.5mbsf). It would not be sensor/data errors, because 1) all resistivities respond same, and 2) data was connected with several points. It would not be response of formation, because the gamma ray was not consistent with them.

The quality of the ring deep and shallow resistivity with AFR were good, consistent with resistivities with EWR-M5. The bit resistivity was invalid (Figure 3). It should have been like an average of others. The long BHA (a lot of metal below AFR) would cause the tool to find it difficult to read formation much forward into formation. Figure 4 shows from the left, ROPA (ratio of penetration average), AFR hi-resolution image with smoothed median filter, and the original AFR hi-resolution image. The AFR image resolution was excellent with 128 bins. The number of missing points of the AFR image was 8,446,077 (36.8%) out of 22,937,600 total points in the original data. The smoothed data is good enough for interpretation. The missing points resulted from instantaneous large ROP and/or RPM. The high sampling rate with sensitive sensors

could not catch up the irregular movement.

The quality of compressional slowness measured with a monopole source is good. The S/N is good as in the 3rd track in Figure 5-A. The quality of shear slowness measured with a dipole source is poor. The S/N is poor as in the 4th track in Figure 5-A. It is difficult to find the correlation between the compressional and shear slowness.

Data processing

The LWD data was downloaded from the tools (except with AFR) at the surface on 2nd January. The AFR memory data could not be downloaded due to the damaged data port. The EWR-M5 raw data were delivered by Halliburton field engineers on-site to LSS. The XBAT sonic data were sent to Halliburton data processing center in Kuala Lumpur by hand-carry and internet. The XABT caliper data were forwarded to Halliburton experts in Houston to apply advanced correction. The processed data was sent back to LSS aboard. The AFR data was recovered at Halliburton workshop in Thailand on 24th. LSS applied depth shift of -1967.5m from the rig floor to the sea floor to all data. The data was uploaded the share server to distribute to the scientists.

The plots of resistivity images with AFR, GR image with AGR, and caliper image with XBAT in "ORIGINAL" were processed by Halliburton. They applied them with 5x5 median filter to smoothing and with 1m moving window for dynamic image. The resulting image has been interpolated and written as 200 points azimuthally as opposed to the original 128-bin tool image.

LSS processed high-resolution (128bins) resistivity image in dynamic and static as standard workflow. To process image data with Schlumberger Techlog 2013, RB, P1AZ, P1NO, INC, and AZI as follows were added to the AFR DLIS file.

- RB= 1.40625 deg (a constant for 128 bins image)
  (The start of the 1st bin is at North - 0 deg. For the High Resolution 128 bin image the center of the 1st bin is 360/128/2 = 1.40625deg)
- INC: Hole inclination from the survey data
- AZI: Hole azimuth from the survey data
- P1AZ = AZI + atan(tan(RB)/cos(INC))
- P1NO = AZI + atan(tan(RB)/cos(INC))

1m window was used to generate dynamic images.

Contacts:

CDEX LSS: cdex.lss@gmail.com
Yoshinori Sanada: sanada@jamstec.go.jp

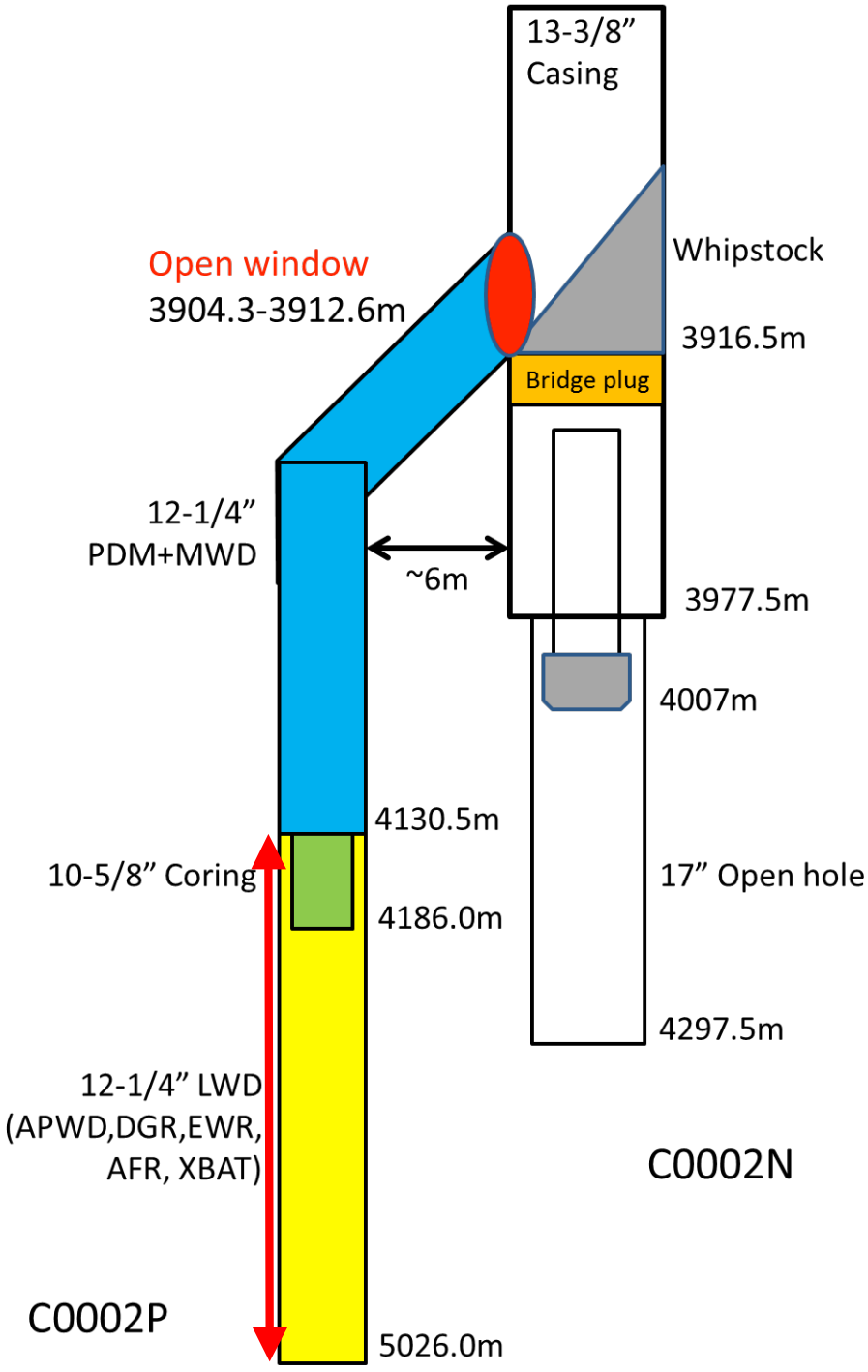

Figure 1 Schematic of sidetrack and logging interval in red arrow. LWD logged with reaming down in the coring interval and drilled down to TD.

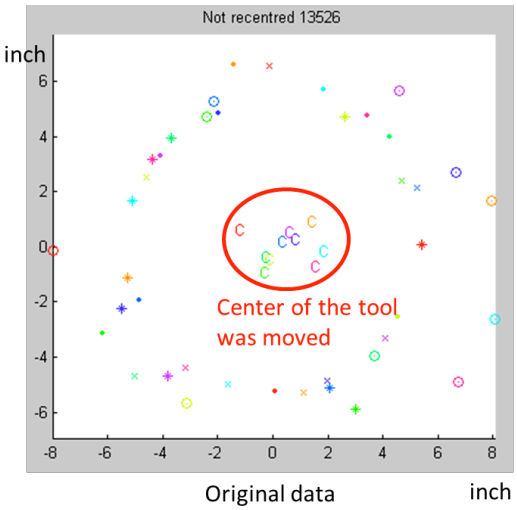

Figure 2-A. The plane view of the tool center (indicated as "C") analysis at 4123mBRT. The tool moved around ~2 inches.

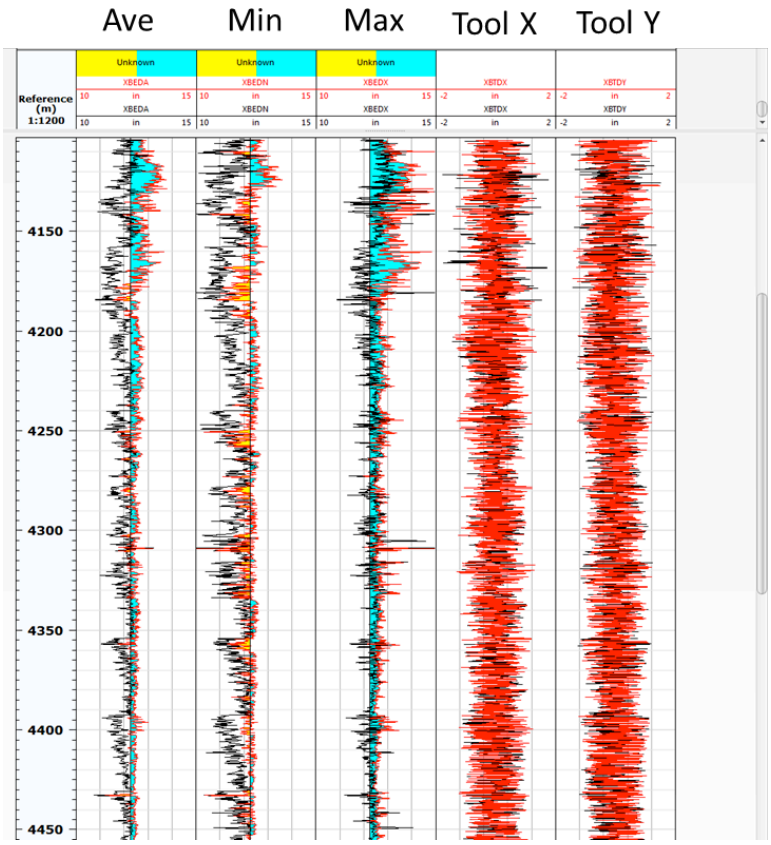

Figure 2-B. XBAT calipers. The lines in black are original data. The lines in red are correction with tool center position.

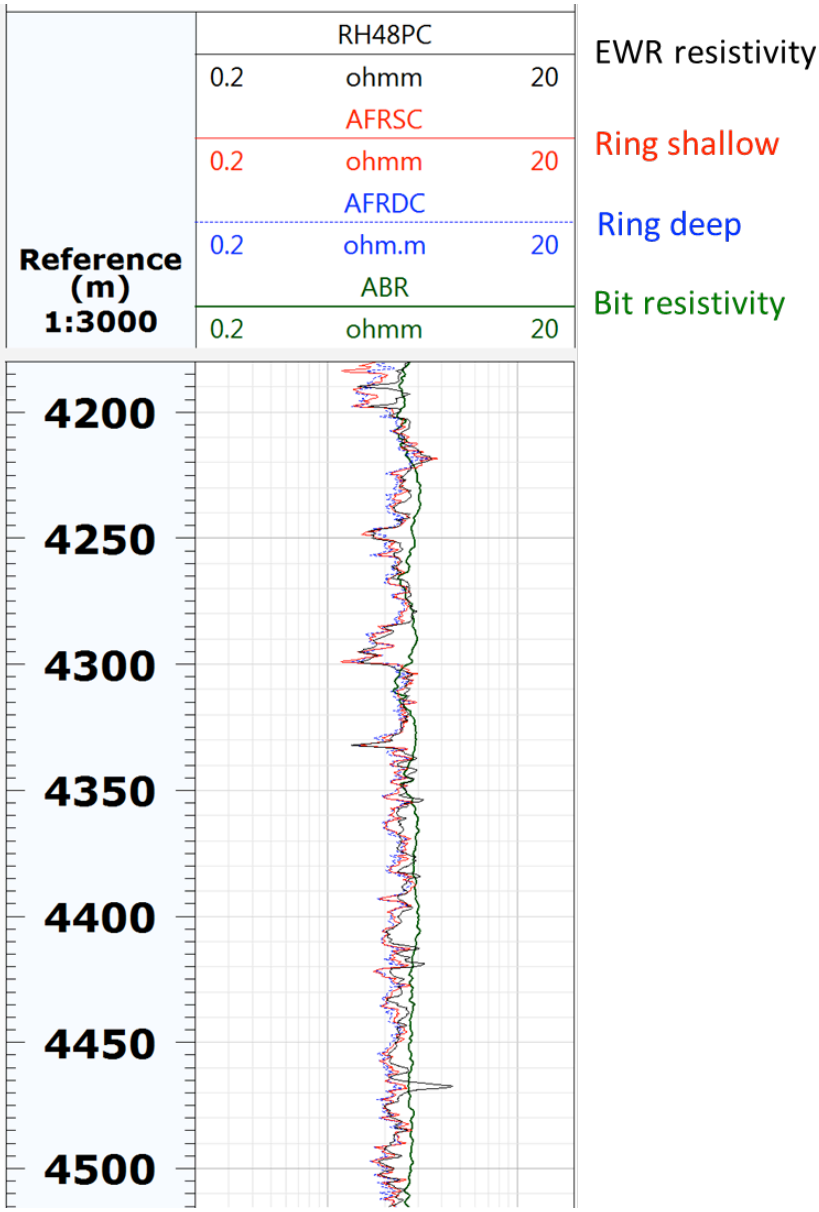

Figure 3. The line in black is the 48-inch phase resistivity with EWR-M5. The ring shallow, deep, and bit are resistivity with AFR.

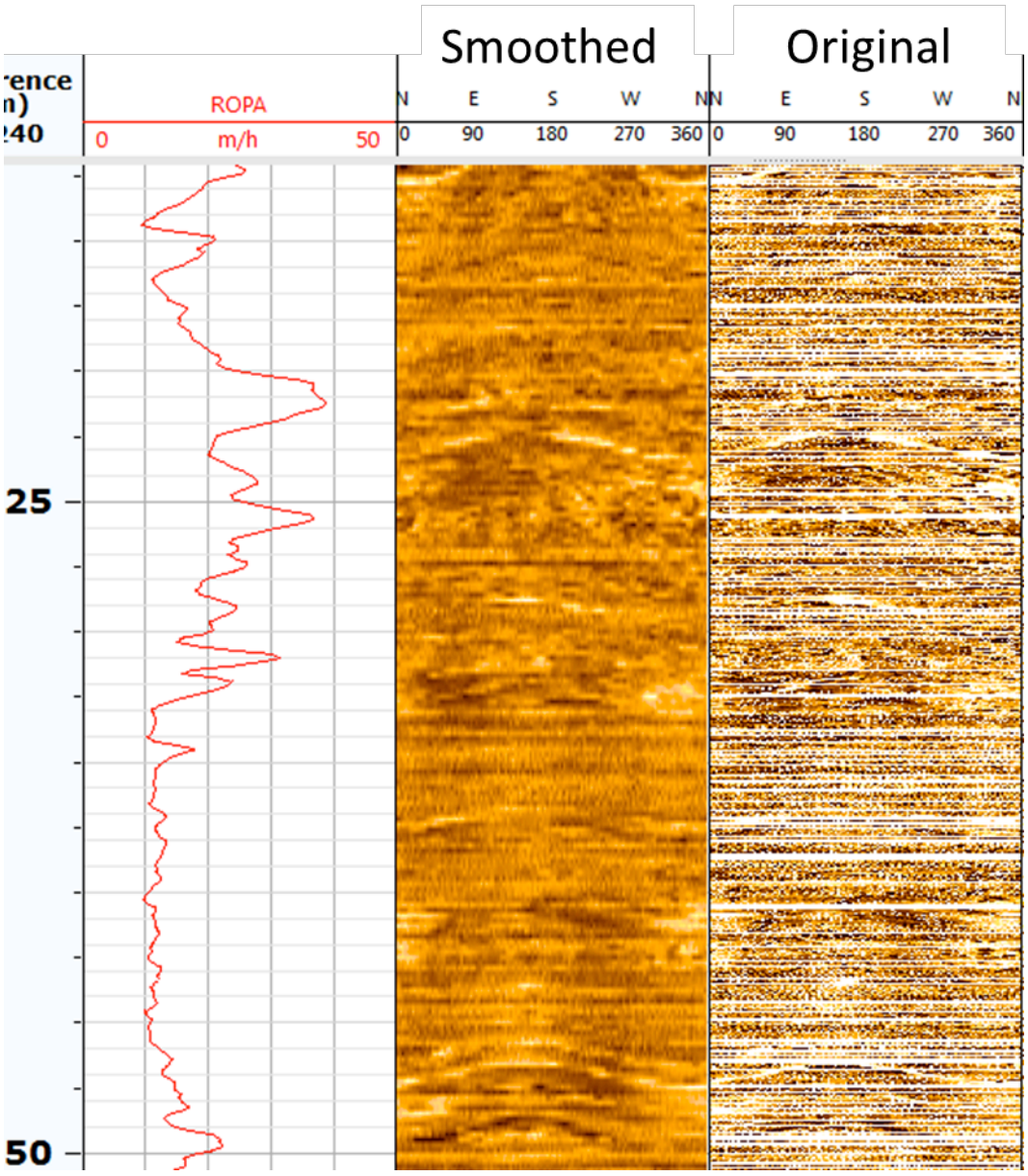

Figure 4. From the left, ROPA (ratio of penetration average), AFR high-resolution image smoothed with median filter, and the original AFR high-resolution image (blank dots are missing data points).

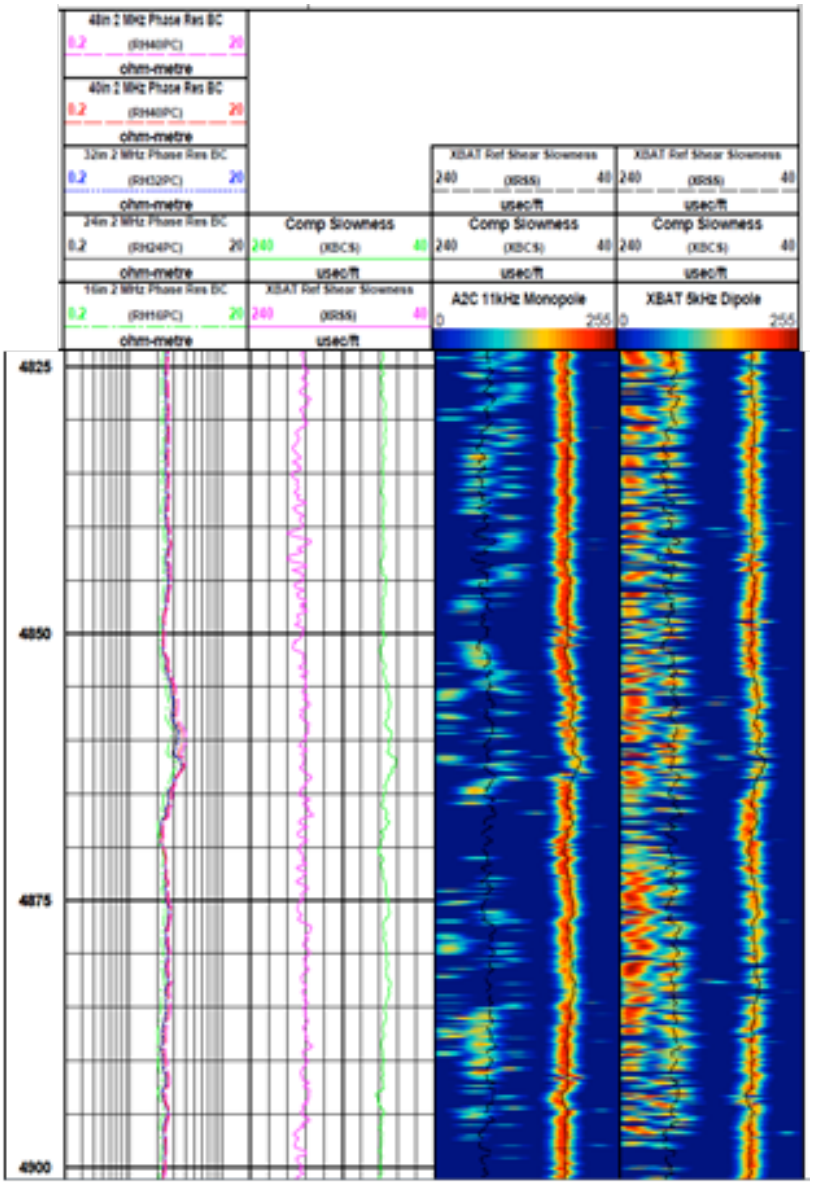

Figure 5-A. 16/24/32/40/48" phase resistivities in the 1st track, Compressional slowness in green and shear slowness in pink in the 2nd track, coherent log of monopole source for compressional slowness in the 3rd track, and coherent log of dipole source for shear slowness in the 4th track.

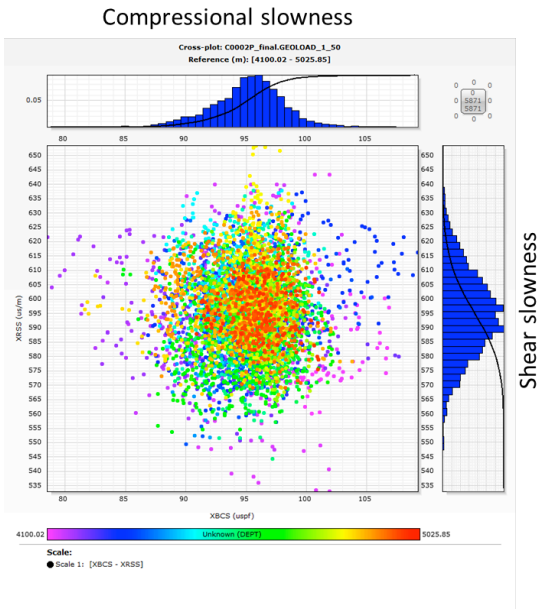

Figure 5-B. Crossplot of compressional and shear slowness. The color indicates the depth (shallower in blue and deeper in red).

Acronyms:

- Surface data

  ROPA.m/hr ：Avg Rate of Penetration

- EWR-M5

  RH16PC.ohmm : 16in 2 MHz Phase Res BC
  RH24PC.ohmm : 24in 2 MHz Phase Res BC
  RH32PC.ohmm : 32in 2 MHz Phase Res BC
  RH40PC.ohmm : 40in 2 MHz Phase Res BC
  RH48PC.ohmm : 48in 2 MHz Phase Res BC
  RH16AC.ohmm : 16in 2 MHz Atten Res BC
  RH24AC.ohmm : 24in 2 MHz Atten Res BC
  RH32AC.ohmm : 32in 2 MHz Atten Res BC
  RH40AC.ohmm : 40in 2 MHz Atten Res BC
  RH48AC.ohmm : 48in 2 MHz Atten Res BC
  M5XT.min : M5 Formation Exp Time
  M5TEMP.degC : EWR-M5 Temperature

- AFR

  AGRCC.api : AGR Comb Gamma Ray BCorr
  AGXT.hr : AGR Formation Exp Time
  AGTEMP.degC : AGR Temperature
  ABR.ohmm : ABR/At-Bit Resistivity
  AFRDC.ohmm : AFRDC/AFR Deep Resistivity BC
  AFRSC.ohmm : AFRSC/AFR Shallow Resistivity BC
  AFXT.hr : AFR Formation Exp Time

- XBAT

  XBCS.uspf : XBAT Compressional
  XRSS.us/m : XBAT Refracted Shear
  VPVS.NONE : XBAT VP/VS
  XBEDA.in : XCAL Ellipse Avg Diameter
  XBEDN.in : XCAL Min Ellipse Diameter
  XBEDX.in : XCAL Max Ellipse Diameter
  XBMAO.deg : XCAL Maj Axis Orientation
  PWPA.psig : PWD Annular Pressure
  PWEA.ppg : PWD Annular EMW