APPENDIX C

Geophysical Investigation Data

APPENDIX C.1

Downhole Geophysical Data

SR-710 TUNNEL TECHNICAL STUDY
BORING GEOPHYSICS

BORINGS Z1-B3, Z1-B5, Z1-B6, Z1-B7, Z2-B1, Z2-B4, Z3-B1, Z3-B3, Z3-B4, Z3-B6, Z3-B8, Z3-B12 AND Z4-B4

Report 9014-01 rev 0

October 5, 2009

SR-710 TUNNEL TECHNICAL STUDY
BORING GEOPHYSICS

BORINGS Z1-B3, Z1-B5, Z1-B6,
Z1-B7, Z2-B1, Z2-B4, Z3-B1, Z3-B3, Z3-B4,
Z3-B6, Z3-B8, Z3-B12 AND Z4-B4

Report 9014-01 rev 0

October 5, 2009

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TABLE OF CONTENTS

Table of Figures

Table of Tables

APPENDICES

INTRODUCTION

Boring geophysical measurements were collected in thirteen uncased borings located within four zones of the SR-710 tunnel technical study. Geophysical data acquisition was performed between January 14 and March 31, 2009 by Robert Steller, Charles Carter and Lauren Annis of **GEO***Vision*. Data analysis was performed by Robert Steller and reviewed by John Diehl of **GEO***Vision*. Report preparation was performed by Robert Steller and reviewed by John Diehl of **GEO***Vision*. The work was performed under subcontract with Cascade Drilling for CH2M Hill, Inc. (CH2M) with Ravee Raveendra serving as the point of contact for CH2M.

This report describes the field measurements, data analysis, and results of this work.

SCOPE OF WORK

This report presents the results of boring geophysical measurements collected between January 14 and March 31, 2009, in thirteen borings, as detailed in Table 1. The purpose of these studies was to supplement stratigraphic information obtained during CH2M's soil and rock sampling program and to acquire shear wave velocities and compressional wave velocities as a function of depth, as a component of the SR-710 tunnel study.

The OYO/Robertson Suspension PS Logging System (Suspension System) was used to obtain in-situ horizontal shear (S_H) and compressional (P) wave velocity measurements in all borings, except Z3-B8, at 1.6-foot intervals. Measurements followed **GEO***Vision* Procedure for P-S Suspension Seismic Velocity Logging, revision 1.3. The acquired data was analyzed and a profile of velocity versus depth was produced for both compressional and horizontally polarized shear waves.

A detailed reference for the suspension PS velocity measurement techniques used in this study is:

> Guidelines for Determining Design Basis Ground Motions, Report TR-102293, Electric Power Research Institute, Palo Alto, California, November 1993, Sections 7 and 8.

The Robertson 3ACS probe was used to collect 3-arm mechanical caliper and natural gamma data at 0.05-foot intervals in all borings to aid in identification of stratagraphic transitions. Measurement procedures followed these ASTM standards:

- ASTM D5753, “Planning and Conducting Borehole Geophysical Surveys
- ASTM D6274, “Conducting Borehole Geophysical Logging – Gamma ASTM D6274-98 (Re-approved 2004), Conducting Borehole Geophysical Logging - Gamma”
- ASTM D6167-97 (Re-approved 2004) “Conducting Borehole Geophysical Logging – Mechanical Caliper”

The acquired data was combined and a profile of these parameters versus depth was produced.

The Robertson High Resolution Acoustic Televiewer (HiRAT) was used to collect deviation data and acoustic televiewer images of the rock at 0.008-foot intervals in all borings except Z3-B8. Measurements followed the **GEO***Vision* HiRAT Field Procedure, revision 1.0. In addition, the boring images were analyzed and planar features such as bedding planes and fractures were identified for dip, azimuth and stereonet processing to identify dominant fracture and bedding planes.

INSTRUMENTATION

Suspension Velocity Instrumentation

Suspension velocity measurements were performed using the suspension PS logging system, manufactured by OYO Corporation, and their subsidiary, Robertson Geologging. This system directly determines the average velocity of a 3.28-foot high segment of the soil column surrounding the boring of interest by measuring the elapsed time between arrivals of a wave propagating upward through the soil column. The receivers that detect the wave, and the source that generates the wave, are moved as a unit in the boring producing relatively constant amplitude signals at all depths.

The suspension system probe consists of a combined reversible polarity solenoid horizontal shear-wave source (S_H) and compressional-wave source (P), joined to two biaxial receivers by a flexible isolation cylinder, as shown in Figure 1. The separation of the two receivers is 3.28 feet, allowing average wave velocity in the region between the receivers to be determined by inversion of the wave travel time between the two receivers. The total length of the probe as used in these surveys is 19 feet, with the center point of the receiver pair 12.1 feet above the bottom end of the probe.

The probe receives control signals from, and sends the digitized receiver signals to, instrumentation on the surface via an armored 4 conductor cable. The cable is wound onto the drum of a winch and is used to support the probe. Cable travel is measured to provide probe depth data, using a 3.28-foot circumference sheave fitted with a digital rotary encoder.

The entire probe is suspended in the boring by the cable, therefore, source motion is not coupled directly to the boring walls; rather, the source motion creates a horizontally propagating impulsive pressure wave in the fluid filling the boring and surrounding the source. This pressure wave is converted to P and S_H-waves in the surrounding soil and rock as it passes through the casing and grout annulus and impinges upon the wall of the boring. These waves propagate through the soil and rock surrounding the boring, in turn causing a pressure wave to be generated in the fluid surrounding the receivers as the soil waves pass their location. Separation of the P and S_H-waves at the receivers is performed using the following steps:

1. Orientation of the horizontal receivers is maintained parallel to the axis of the source, maximizing the amplitude of the recorded S_H -wave signals.
2. At each depth, S_H-wave signals are recorded with the source actuated in opposite directions, producing S_H-wave signals of opposite polarity, providing a characteristic S_H-wave signature distinct from the P-wave signal.
3. The 7.0-foot separation of source and receiver 1 permits the P-wave signal to pass and damp significantly before the slower S_H-wave signal arrives at the receiver. In faster soils or rock, the isolation cylinder is extended to allow greater separation of the P- and S_H-wave signals.
4. In saturated soils, the received P-wave signal is typically of much higher frequency than the received S_H-wave signal, permitting additional separation of the two signals by low pass filtering.
5. Direct arrival of the original pressure pulse in the fluid is not detected at the receivers because the wavelength of the pressure pulse in fluid is significantly greater than the dimension of the fluid annulus surrounding the probe (foot versus inch scale), preventing significant energy transmission through the fluid medium.

In operation, a distinct, repeatable pattern of impulses is generated at each depth as follows:

1. The source is fired in one direction producing dominantly horizontal shear with some vertical compression, and the signals from the horizontal receivers situated parallel to the axis of motion of the source are recorded.
2. The source is fired again in the opposite direction and the horizontal receiver signals are recorded.
3. The source is fired again and the vertical receiver signals are recorded. The repeated source pattern facilitates the picking of the P and S_H-wave arrivals; reversal of the source changes the polarity of the S_H-wave pattern but not the P-wave pattern.

The data from each receiver during each source activation is recorded as a different channel on the recording system. The Suspension PS system has six channels (two simultaneous recording channels), each with a 1024 sample record. The recorded data are displayed as six channels with a common time scale. Data are stored on disk for further processing. Up to 8 sampling sequences can be summed to improve the signal to noise ratio of the signals.

Review of the displayed data on the recorder or computer screen allows the operator to set the gains, filters, delay time, pulse length (energy), sample rate, and summing number to optimize the quality of the data before recording. Verification of the calibration of the Suspension PS digital recorder is performed every twelve months using a NIST traceable frequency source and counter, as outlined in Appendix D.

Caliper / Natural Gamma Instrumentation

Caliper and natural gamma data were collected using a Model 3ACS 3-arm caliper probe, serial number 5368, manufactured by Robertson Geologging, Ltd. With the short arm configuration used in these surveys, the probe permitted measurement of boring diameters between 1.6 and 16 inches. With this tool, caliper measurements were collected concurrent with measurement of natural gamma emission from the boring walls. The probe is 6.82 feet long, and 1.5 inches in diameter.

This probe is useful in the following studies:

- Measurement of boring diameter and volume
- Location of hard and soft formations
- Location of fissures, caving, pinching and casing damage
- Bed boundary identification
- Strata correlation between borings

The probe receives control signals from, and sends the digitized measurement values to, a Robertson Micrologger II on the surface via an armored 4 conductor cable. The cable is wound onto the drum of a winch and is used to support the probe. Cable travel is measured to provide probe depth data, using a 3.28-foot circumference sheave fitted with a digital rotary encoder. The probe and depth data are transmitted by USB link from the Micrologger unit to a laptop computer where it is displayed and stored on hard disk.

The caliper consists of three arms, each with a toothed quadrant at their base, pivoted in the lower probe body. A toothed rack engages with each quadrant, thus constraining the arms to move together. Linear movement of the rack is converted to opening and closing of the arms. Springs hold the arms open in the operating position. A motor drive is provided to retract the arms, allowing the probe to be lowered into the boring. The rack is coupled to a potentiometer which converts movement into a voltage sensed by the probe's microprocessor.

Natural gamma measurements rely upon small quantities of radioactive material contained in all soil and rocks to emit gamma radiation as they decay. Trace amounts of Uranium and Thorium are present in a few minerals, where potassium-bearing minerals such as feldspar, mica and clays will include traces of a radioactive isotope of Potassium. These emit gamma radiation as they decay with an extremely long half-life. This radiation is detected by scintillation - the production of a tiny flash of light when gamma rays strike a crystal of sodium iodide. The light is converted into an electrical pulse by a photomultiplier tube. Pulses above a threshold value of 60 thousand electron Volts (KeV) are counted by the probe's microprocessor. The measurement is useful because the radioactive elements are concentrated in certain soil and rock types e.g. clay or shale, and depleted in others e.g. sandstone or coal.

Acoustic Televiewer / Boring Deviation Instrumentation

An acoustic image and boring deviation data were collected using a High Resolution Acoustic Televiewer probe (HiRAT), serial number 5174, manufactured by Robertson Geologging, Ltd. The probe is 5.2 feet long, 1.6 inches in diameter, and may be fitted with upper and lower four-band centralizers.

In this application, this probe is useful in the following studies:

- Measurement of boring inclination and deviation from vertical
- Determination of need to correct soil and geophysical log depths to true vertical depths
- Acoustic imaging of the boring wall to identify fractures, dikes, and weathered zones, and determine dip and azimuth of these features

The probe receives control signals from, and sends the digitized measurement values to, a Robertson Micrologger II on the surface via an armored 4 conductor cable. The cable is wound onto the drum of a winch and is used to support the probe. Cable travel is measured to provide probe depth data, using a 3.28-foot circumference sheave fitted with a digital rotary encoder. The probe and depth data are transmitted by USB link from the Micrologger unit to a laptop computer where it is displayed and stored on hard disk.

This system produces images of the boring wall based upon the amplitude and travel time of an ultrasonic beam reflected from the formation wall. The ultrasonic energy is generated by a piezoelectric transducer at a frequency of 1.4 MHz. A periodic acoustic energy wave is emitted by the transducer and travels through the acoustic head and boring fluid until it reaches the interface between the boring fluid and the boring wall. Here a portion of the energy is reflected back to the transducer, the remainder continuing on into the formation. By careful time sequencing, the piezoelectric transducer acts as both the transmitter of the ultrasonic pulse and receiver of the reflected wave. The travel time of the energy wave is the period between transmission of the source energy pulse and the return of the reflected wave measured at the point of maximum wave amplitude. The magnitude of the wave energy is measured in dB, a unit-less ratio of the detected echo wave amplitude divided by the amplitude of the transmitted wave. The strength of the reflected signal depends primarily upon the impedance contrast of the boring fluid and the boring wall formation. In a number of these borings, there was significant clay “wall cake” which attenuated the acoustic signal, and created a low impedance contrast at the boring wall.

The acoustic wave propagates along the axis of the probe and then is reflected perpendicular to this axis by a reflector that focuses the beam to a 0.1-inch diameter spot about 2 inches from the central axis of the probe. This reflector is mounted on the shaft of a stepper motor enabling the position of the measurement to be rotated through 360°. Sampling rates of 90, 180 and 360 measured points per revolution are available. During these surveys, data were collected at 360 samples per revolution, providing an equivalent horizontal pixel size of approximately 0.05 inches on the boring wall. It should be noted that during logging the probe is moving in the boring, so that the measured points describe a very fine pitch spiral.

The probe contains a fluxgate magnetometer to monitor magnetic north, and all raw televiewer data are referenced to magnetic north. The processed data is referenced to true north, using a declination of 12.9 degrees east for these sites and dates, obtained from the NOAA declination web site (http://www.ngdc.noaa.gov/geomagmodels/Declination.jsp). Also, a three-axis accelerometer is enclosed in the probe, and boring deviation data are recorded during the logging runs, to permit correction of structure dip angle from apparent dip, (referenced to boring axis), to true dip (referenced to a vertical axis) in non-vertical borings.

The data are presented on a computer screen for operator review during the logging run, and stored on hard disk for later processing.

MEASUREMENT PROCEDURES

Suspension Velocity Measurement Procedures

Twelve borings (excluding Z3-B8) were logged while filled with bentonite or polymer based drilling mud. Measurements followed the **GEO***Vision* Procedure for P-S Suspension Seismic Velocity Logging, revision 1.31, as presented in Appendix E. These procedures were supplied and approved in advance of the work. Prior to each logging run, the probe was positioned with the top of the probe at the top of the surface casing, and the electronic depth counter was set to 8.2 feet, the distance between the mid-point of the receiver and the top of the probe, minus the height of the casing stick-up, as verified with a tape measure, and recorded on the field logs. The probe was lowered to the bottom of the boring, stopping at 1.6-foot intervals to collect data, as summarized in Table 2.

At each measurement depth the measurement sequence of two opposite horizontal records and one vertical record was performed, and the gains were adjusted as required. The data from each depth were viewed on the computer display, checked, and recorded on disk before moving to the next depth.

Upon completion of the measurements, the probe zero depth indication at the depth reference point was verified prior to removal from the boring, and after survey depth error (ASDE) was calculated, as listed in Table 3.

Caliper / Natural Gamma Procedures

The borings were filled with bentonite or polymer based drilling mud and logged from the bottom of the boring up until the caliper entered the bottom of the surface casing or reached the surface, as listed in Table 2. Measurements followed ASTM D6167-97 (Re-approved 2004) Conducting Borehole Geophysical Logging – Mechanical Caliper.

Prior to and following each logging run, the caliper tool was verified, using the manufacturer's supplied three point calibration jig. The three point jig is a circular plate with a series of holes in the top surface into which the tips of the caliper arms fit. This has circles of diameters from 2 to 12 inches. The calibration jig is placed over a bucket with the probe standing upright with its nose section passing through the jig's central hole. The caliper probe arms are opened under program control, and a log is recorded as the tips of the arms are placed in the holes on the calibration jig. The measured dimensions, as displayed on the recording computer screen was recorded on the field log sheet, as well as in the digital files, and compared with the calibration jig dimensions. These files are presented in LAS 2.0 format in the boring specific sub-directories of the data directory on the data disk (CD-R) labeled Report 9014-02 that accompanies this report. If the verification records did not fall within +/- 0.05 inches of the calibration jig values, the caliper tool was re-calibrated, using the three point calibration jig, and the log repeated. As with the verification, the tips of the caliper arms are placed in the holes marked with the required diameter. During calibration, the value of the current calibration point, as stamped on the jig, is entered via the control computer. The system counts for 15 seconds to make an average of the response. The procedure is repeated for the second and third required openings. The computation and generation of the calibration coefficient file is entirely automatic. The calibration file is simply the set of coefficients of a quadratic curve which fits the three data points.

Natural gamma was not calibrated in the field, as it is a qualitative measurement, not a quantitative value, and is used only to assist in picking transitions between stratigraphic units, as described in ASTM D6274-98 (Re-approved 2004), Conducting Borehole Geophysical Logging - Gamma.

In each boring, the probe was positioned with the top of the probe at the top of the casing, and the electronic depth counter was set to the specified length of the probe, minus the height of the casing stick-up, as verified with a tape measure, and recorded on the field logs. The probe was lowered to the bottom of the boring, where the caliper legs were opened, and data collection begun. The probe was then returned to the surface at 10 feet/minute, collecting data continuously at 0.05-foot spacing, as summarized in Table 2.

Upon completion of the measurements, the probe zero depth indication at the depth reference point was verified prior to removal from the boring, and after survey depth error (ASDE) was calculated, as listed in Table 3.

Acoustic Televiewer / Boring Deviation Measurement Procedures

Twelve borings (excluding Z3-B8) were logged while filled with bentonite or polymer based drilling mud. Measurements followed the **GEO***Vision* standard field procedures, as presented in Appendix E.

Prior to use, the HiRAT probe tiltmeter and compass functions were checked by comparison with a Brunton surveyors' compass, and the results recorded on the field logs.

In each boring, the HiRAT probe was positioned with the top of the probe at the top of the casing, and the electronic depth counter was set to the specified length of the probe, minus the height of the casing stick-up, as verified with a tape measure, and recorded on the field logs. The probe was lowered to the bottom of the boring, and data collection begun. The rotational scan resolution was set to 360 samples per revolution, giving a horizontal pixel size of approximately 0.05 inches. The probe was returned to the surface at a nominal rate of 3 feet/minute, with an acquisition rate of 125 samples/foot, giving an equivalent vertical pixel size of 0.008 feet (approximately 0.1 inches).

Upon completion of the measurements, the probe zero depth indication at grade was verified prior to removal from the boring, and after survey depth error (ASDE) was calculated, as listed in Table 3.

DATA ANALYSIS

Suspension Velocity Analysis

Using the proprietary OYO program PSLOG.EXE version 1.0, the recorded digital waveforms were analyzed to locate the most prominent first minima, first maxima, or first break on the vertical axis records, indicating the arrival of P-wave energy.

The difference in travel time between receiver 1 and receiver 2 (R1-R2) arrivals was used to calculate the P-wave velocity for that 3.28-foot segment of the soil column. When observable, P-wave arrivals on the horizontal axis records were used to verify the velocities determined from the vertical axis data. The time picks were then transferred into an EXCEL template (EXCEL version 2003 SP2) to complete the velocity calculations based upon the arrival time picks made in PSLOG. The EXCEL analysis files are included in the boring specific directories on the data disk (CD-R) labeled Report 9014-02 that accompanies this report.

The P-wave velocity over the 7.0-foot interval from source to receiver 1 (S-R1) was also picked using PSLOG, and calculated and plotted in EXCEL, for quality assurance of the velocity derived from the travel time between receivers. In this analysis, the depth values as recorded were increased by 5.2 feet to correspond to the mid-point of the7.0-foot S-R1 interval. Travel times were obtained by picking the first break of the P-wave signal at receiver 1 and subtracting 0.3 milliseconds, the calculated and experimentally verified delay from source trigger pulse (beginning of record) to source impact. This delay corresponds to the duration of acceleration of the solenoid before impact.

As with the P-wave records, the recorded digital waveforms were analyzed to locate clear S_H-wave pulses, as indicated by the presence of opposite polarity pulses on each pair of horizontal records. Ideally, the S_H-wave signals from the 'normal' and 'reverse' source pulses are very nearly inverted images of each other. Digital Fast Fourier Transform – Inverse Fast Fourier Transform (FFT – IFFT) lowpass filtering was used to remove the higher frequency P-wave signal from the S_H-wave signal. Different filter cutoffs were used to separate P- and S_H-waves at different depths, ranging from 600 Hz in the slowest zones to 3000 Hz in the regions of highest velocity. At each depth, the filter frequency was selected to be at least twice the fundamental frequency of the S_H-wave signal being filtered.

Generally, the first maxima were picked for the 'normal' signals and the first minima for the 'reverse' signals, although other points on the waveform were used if the first pulse was distorted. The absolute arrival time of the 'normal' and 'reverse' signals may vary by +/- 0.2 milliseconds, due to differences in the actuation time of the solenoid source caused by constant mechanical bias in the source or by boring inclination. This variation does not affect the R1-R2 velocity determinations, as the differential time is measured between arrivals of waves created by the same source actuation. The final velocity value is the average of the values obtained from the 'normal' and 'reverse' source actuations.

As with the P-wave data, S_H-wave velocity calculated from the travel time over the 7.0-foot interval from source to receiver 1 was calculated and plotted for verification of the velocity derived from the travel time between receivers. In this analysis, the depth values were increased by 5.2 feet to correspond to the mid-point of the 7.0-foot S-R1 interval. Travel times were obtained by picking the first break of the S_H-wave signal at the near receiver and subtracting 0.3 milliseconds, the calculated and experimentally verified delay from the beginning of the record at the source trigger pulse to source impact.

These data and analysis were reviewed by John Diehl as a component of **GEO***Vision*'s in-house Quality assurance program.

Figure 2 shows an example of R1 - R2 measurements on a sample filtered suspension record. In Figure 2, the time difference over the 3.28-foot interval of 1.88 milliseconds for the horizontal signals is equivalent to an S_H-wave velocity of 1745 feet/second. Whenever possible, time differences were determined from several phase points on the S_H-waveform records to verify the data obtained from the first arrival of the S_H-wave pulse. Figure 3 displays the same record before filtering of the S_H-waveform record with a 1400 Hz FFT - IFFT digital lowpass filter, illustrating the presence of higher frequency P-wave energy at the beginning of the record, and distortion of the lower frequency S_H-wave by residual P-wave signal.

Caliper / Natural Gamma Analysis

No analysis is required with the caliper or natural gamma data; however depths to identifiable boring features on the acoustic televiewer and suspension logs were compared to verify compatible depth readings on all logs. Using Robertson Geologging Winlogger software version 1.5, build 401J, these data were converted to LAS 2.0 and PDF formats for transmittal to the client.

Acoustic Televiewer / Boring Deviation Analysis

The acoustic televiewer data were processed using Robertson's RGLDIP software, version 6.2. Sinusoidal projections of fractures observed in the boring walls were interactively picked on the un-wrapped televiewer image, and are presented on the logs as red sinusoids superimposed over the televiewer image. Bedding features, where identifiable, were picked on the same images, and are presented on the logs as green sinusoids. The sinusoidal projections were processed using the mechanical caliper diameter data to calculate apparent dip angle. True dip was calculated, correcting for the plunge of the borings using the recorded data from the accelerometer located in the probes, and presented in arrow format, with true dip indicated by the arrow position across the plot. Azimuth of dip (not strike), is indicated by the direction of the arrow tail, with true north being "up". These values are presented with the comments to the right of the arrow plots, as dip azimuth followed by dip angle.

The televiewer images were also processed to create a simulated core image of the borings. It must be noted that the simulated core image represents a core that would have the full diameter of the boring, not the diameter of the cores removed during drilling, so that direct comparison between the two is not possible. Also, the unwrapped image is viewed from the perspective of an observer in the center of the boring looking outward. The simulated core image is viewed form the "outside" of the boring looking inward, so there is a reversal of the position of east and west relative to north between the two images.

The televiewer data were also processed to extract the deviation data and produce an ASCII file and plots of boring deviation. Stereonet analysis of the identified features was performed with Robertson's RGLDIP software, version 6.2, to assist in identifying dominant fracture and bedding planes in the borings. Concentrations of similarly oriented features were enclosed in three to five small circles on the stereonet image, and the vector mean dip and azimuth for each small circle was calculated.

RESULTS

Suspension Velocity Results

Suspension R1-R2 P- and S_H-wave velocities are plotted in Figures 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 45, and 49. The suspension velocity data presented in these figures are presented in Tables 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, and 27. The EXCEL analysis file for each boring are included in the boring specific directories on the data disk (CD-R) labeled Report 9014-02 that accompanies this report.

P- and S_H-wave velocity data from R1-R2 analysis and quality assurance analysis of S-R1 data are plotted together in Figures A-1 through A-12 to aid in visual comparison. It should be noted that R1-R2 data are an average velocity over a 3.28-foot segment of the soil column; S-R1 data are an average over 7.0 feet, creating a significant smoothing relative to the R1-R2 plots. S-R1 data are presented in Tables A-1 through A-12, and included in the EXCEL analysis files for each boring on the data disk (CD-R) labeled Report 9014-02 that accompanies this report. The EXCEL analysis files include Poisson's Ratio calculations, tabulated data and plots.

Calibration procedures and records for the suspension PS measurement system are presented in Appendix D.

The **GEO***Vision* standard field procedures, as provided to CH2M for approval prior to field work, are reproduced in Appendix E.

Caliper / Natural Gamma Results

Caliper and natural gamma data are presented as single page logs in Figures 5, 9, 13, 17, 21, 25, 29, 33, 37, 41, 44, 46 and 50, as well as multi-page logs in Appendix B. LAS 2.0 data and Acrobat files for each boring are included in the boring specific sub-directories in the data directory on the data disk (CD-R) labeled Report 9014-02 that accompanies this report.

Acoustic Televiewer / Boring Deviation Results

Acoustic televiewer amplitude images and picked sinusoids are presented in Appendix C. The same logs are presented in .pdf format in the boring specific sub-directories of the data disk (CD-R) labeled Report 9014-02 that accompanies this report. Fracture and bedding depth, dip and azimuth of dip data are provided on the multi-page log sheets in Appendix C, and in Tables 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26 and 28 as well as in .txt and EXCEL format.

Upper hemisphere stereonet plots are presented in Figures 6, 10, 14, 18, 22, 26, 30, 34, 38, 42, 47, and 51, as well as in PDF format. These borings did not exhibit different zones of feature orientation; the feature orientations appeared to be fairly evenly distributed over the boring depths, so they were processed as single zone models.

The mean dips for each of the stereonet small circles are presented in Figures 6, 10, 14, 18, 22, 26, 30, 34, 38, 42, 47, and 51, and in ASCII format. Feature distribution histograms and Rose diagrams are presented in the boring specific sub-directories of the data disk (CD-R).

Boring deviation data is presented graphically in Figures 7, 11, 15, 19, 23, 27, 31, 35, 39, 43, 48 and 52, and summarized in Table 4. Deviation data plots in Acrobat format and deviation data at 1.0-foot stations are presented in text format in the boring specific sub-directories of the data disk (CD-R).

SUMMARY

Discussion of Suspension Velocity Results

Suspension PS velocity data are ideally collected in an uncased fluid filled boring, drilled with rotary mud (rotary wash) methods. The borings at these sites were well suited for collection of suspension PS velocity data, though in some cases the shallow portions of the borings were eroded out to large diameters, which degraded the quality of the velocity data.

Suspension PS velocity data quality is judged based upon 5 criteria:

1. Consistent data between receiver to receiver (R1 – R2) and source to receiver (S – R1) data.
2. Consistent relationship between P-wave and S_H -wave (excluding transition to saturated soils)
3. Consistency between data from adjacent depth intervals.
4. Clarity of P-wave and S_H-wave onset, as well as damping of later oscillations.
5. Consistency of profile between adjacent borings, if available.

Generally, these data show excellent correlation between R1 – R2 and S – R1 data, as well as excellent correlation between P-wave and S_H-wave velocities. P-wave and S_H-wave onsets are very clear, and later oscillations are well damped, with the exception of the borings that showed larger diameters due to erosion, Z1-B6, Z1-B7, Z2-B1 and Z3-B12, some which had diameters approaching 12 inches.

Discussion of Caliper / Natural Gamma Results

Caliper and natural gamma data were collected in each boring. The caliper logs for these borings generally show nominal bit diameters of below about 100 feet, with the softer material above 100 feet eroded out to almost 12 inches in some locations. Natural gamma data were collected with this tool in all the borings, and shows a number of thin layers that correspond to features on the acoustic televiewer logs. One such example is at 361 – 362 feet in Z1-B6, where there is a significant drop in natural gamma, and an apparent hard sandstone layer on the acoustic televiewer image. A significant velocity increase can be seen at the same depth.

Discussion of Acoustic Televiewer / Boring Deviation Results

Despite the large nominal diameter (5.5 inches) of the Cascade Drilling borings, the acoustic televiewer data quality in borings with good diameter control and clean walls, like Z1-B3, Z1-B5 are quite clear, showing contacts between soft and harder rock units, fractures in the rock, and even spiral marks form the coring bit.

Boring Z1-B6 has good diameter control below 100 feet, but the images are not as clear due to a thick wall cake. This is illustrated by the presence of interference patterns caused by standing acoustic waves in the wall cake, similar to optical moiré patterns. These can be seen clearly in Z1-B6 at 333 – 334 feet. Heavy wall cake was a regular problem, with the probe completely covered in clay at the end of logging runs.

Boring Z2-B1 is eroded out to 8 inches or more for the entire depth, and yields almost no acoustic image. Z3-B1 does not show many planar features, but the image quality is good. This boring shows a number of hard inclusions in a softer matrix, but few planar features.

The twelve borings in which deviation data were collected were inclined at 2.0 degrees, or less, from vertical, and the maximum error in depth value was 0.3 feet in 319 feet, or less than 0.1 percent, as presented in Table 4. This error is less than depth errors from other causes, and no adjustment of log depths is indicated.

Quality Assurance

These boring geophysical measurements were performed using industry-standard or better methods for measurements and analyses. All work was performed under **GEO***Vision* quality assurance procedures, which include:

- Use of NIST-traceable calibrations, where applicable, for field and laboratory instrumentation
- Use of standard field data logs
- Use of independent verification of velocity data by comparison of receiver-to-receiver and source-to-receiver velocities
- Independent review of calculations and results by a registered professional engineer, geologist, or geophysicist.

Suspension Velocity Data Reliability

P- and S_H-wave velocity measurement using the Suspension Method gives average velocities over a 3.28-foot interval of depth. This high resolution results in the scatter of values shown in the graphs. Individual measurements are very reliable with estimated precision of +/- 5%. Standardized field procedures and quality assurance checks contribute to the reliability of these data.

CERTIFICATION

All geophysical data, analysis, interpretations, conclusions, and recommendations in this document have been prepared under the supervision of and reviewed by a **GEO***Vision* California Professional Geophysicist.

7/31/09

Antony J. Martin — Date
California Professional Geophysicist GP989
GEO*Vision* Geophysical Services

* This geophysical investigation was conducted under the supervision of a California Professional Geophysicist using industry standard methods and equipment. A high degree of professionalism was maintained during all aspects of the project from the field investigation and data acquisition, through data processing interpretation and reporting. All original field data files, field notes and observations, and other pertinent information are maintained in the project files and are available for the client to review for a period of at least one year.

  A professional geophysicist's certification of interpreted geophysical conditions comprises a declaration of his/her professional judgment. It does not constitute a warranty or guarantee, expressed or implied, nor does it relieve any other party of its responsibility to abide by contract documents, applicable codes, standards, regulations or ordinances.

BORING DESIGNATION	DATES LOGGED	COORDINATES (FEET, ZONE 5, NAD83) [1] NORTH	EAST	ELEVATION [1] (FEET NAVD88)
Z1-B3	1/30/2009	1855594.07	6492810.43	343.23
Z1-B5	2/25/2009	1850576.02	6499981.20	442.15
Z1-B6	2/10/2009	1852836.59	6503970.85	447.22
Z1-B7	1/26/2009	1849941.30	6506175.09	480.52
Z2-B1	1/21/2009	1866308.10	6492663.29	451.02
Z2-B4	3/31/2009	1858027.66	6507350.57	558.11
Z3-B1	3/19/2009	1873601.92	6507232.68	885.14
Z3-B3	2/11/2009	1870194.48	6514774.44	801.99
Z3-B4	3/6/2009	1870813.73	6516733.49	768.04
Z3-B6	3/5/2009	1868062.70	6516722.28	750.00
Z3-B8	3/23/2009	1860993.95	6514198.81	594.27
Z3-B12	1/14/2009	1856063.15	6513380.17	501.00
Z4-B4	3/17/2009	1851895.71	6514496.46	454.42

[1] Coordinates and elevation provided by CH2M dated 6/17/09

Table 1. Boring locations and logging dates

BORING NUMBER	TOOL AND RUN NUMBER	DEPTH RANGE (FEET)	BOTTOM OF BOREHOLE CASING	SAMPLE OR MEASUREMENT INTERVAL (FEET)	DATE LOGGED
Z1-B3	CALIPER/GAMMA 1	300.7 – 71.0	86	0.05	1/30/2009
Z1-B3	ACOUSTIC TELEVIEWER 1	300.9 – 82.3	86	0.008	1/30/2009
Z1-B3	SUSPENSION PS 1	88.6 – 288.7	86	1.6	1/30/2009
Z1-B5	CALIPER/GAMMA 1	500.1 – 4.1	8	0.05	2/25/2009
Z1-B5	ACOUSTIC TELEVIEWER 1	499.4 – 35.0	8	0.008	2/25/2009
Z1-B5	SUSPENSION PS 1	11.8 – 487.2	8	1.6	2/25/2009
Z1-B6	CALIPER/GAMMA 1	400.1 – 1.0	4	0.05	2/10/2009
Z1-B6	ACOUSTIC TELEVIEWER 1	400.0 – 65.0	4	0.008	2/10/2009
Z1-B6	SUSPENSION PS 1	6.6 – 390.4	4	1.6	2/10/2009
Z1-B7	CALIPER/GAMMA 1	299.0 - 0	11	0.05	1/26/2009
Z1-B7	ACOUSTIC TELEVIEWER 1	299.0 – 145.0	11	0.008	1/26/2009
Z1-B7	SUSPENSION PS 1	13.1 – 290.4	11	1.6	1/26/2009
Z2-B1	CALIPER/GAMMA 1	149.0 – 1.0	19	0.05	1/21/2009
Z2-B1	ACOUSTIC TELEVIEWER 1	149.0 – 18.5	19	0.008	1/21/2009
Z2-B1	SUSPENSION PS 1	21.3 – 137.8	19	1.6	1/21/2009
Z2-B4	CALIPER/GAMMA 1	358.3 – 6.0	6	0.05	3/31/2009
Z2-B4	CALIPER/GAMMA 2	374.5 – 325.0	6	0.05	3/31/2009
Z2-B4	ACOUSTIC TELEVIEWER 1	358.7 – 1.8	6	0.008	3/31/2009
Z2-B4	ACOUSTIC TELEVIEWER 2	374.2 – 347.0	6	0.008	3/31/2009
Z2-B4	SUSPENSION PS 1	3.3 – 305.1	6	1.6	3/31/2009
Z2-B4	SUSPENSION PS 2	306.8 – 360.9	6	1.6	3/31/2009
Z3-B1	CALIPER/GAMMA 1	300.2 – 14.8	26	0.05	3/19/2009
Z3-B1	ACOUSTIC TELEVIEWER 1	300.2 – 22.2	26	0.008	3/19/2009
Z3-B1	SUSPENSION PS 1	4.0 – 287.1	26	1.6	3/19/2009

- PROBE DID NOT TOUCH BOTTOM OF BORING

Table 2. Logging dates and depth ranges

BORING NUMBER	TOOL AND RUN NUMBER	DEPTH RANGE (FEET)	BOTTOM OF BOREHOLE CASING	SAMPLE OR MEASUREMENT INTERVAL (FEET)	DATE LOGGED
Z3-B3	CALIPER/GAMMA 1	273.0 – 165.1	174.5	0.05	2/11/2009
Z3-B3	CALIPER/GAMMA 2	273.0 – 50.0	55	0.05	2/11/2009
Z3-B3	ACOUSTIC TELEVIEWER 1	274.0 – 173.0	174.5	0.008	2/11/2009
Z3-B3	SUSPENSION PS 1	177.2 – 262.5	174.5	1.6	2/11/2009
Z3-B3	SUSPENSION PS 2	57.4 – 183.7	55	1.6	2/11/2009
Z3-B4	CALIPER/GAMMA 1	274.9 – 2.1	3.5	0.05	3/6/2009
Z3-B4	ACOUSTIC TELEVIEWER 1	275.3 – 2.5	3.5	0.008	3/6/2009
Z3-B4	SUSPENSION PS 1	2.8 – 262.5	3.5	1.6	3/6/2009
Z3-B6	CALIPER/GAMMA 1	325.0 - 5.3	10.5	0.05	3/5/2009
Z3-B6	ACOUSTIC TELEVIEWER 1	320.4 – 308.9	10.5	0.008	3/5/2009
Z3-B6	ACOUSTIC TELEVIEWER 2	318.7 – 28.3	10.5	0.008	3/5/2009
Z3-B6	SUSPENSION PS 1	43.0 – 311.7	10.5	1.6	3/5/2009
Z3-B8	CALIPER/GAMMA 1	275.7 – 4.2	4	0.05	3/23/2009
Z3-B12	CALIPER/GAMMA 1	273.0 – 50.0	57.5	0.05	1/14/2009
Z3-B12	CALIPER/GAMMA 2	273.0 – 245.5	57.5	0.05	1/14/2009
Z3-B12	CALIPER/GAMMA 3	258.0 – 54.0	57.5	0.05	1/14/2009
Z3-B12	ACOUSTIC TELEVIEWER 1	67.5 – 186.8	57.5	0.008	1/14/2009
Z3-B12	ACOUSTIC TELEVIEWER 2	182.6 – 57.0	57.5	0.008	1/14/2009
Z3-B12	SUSPENSION PS 1	59.0 – 185.4	57.5	1.6	1/14/2009
Z3-B12	SUSPENSION PS 2	173.9 – 251.0 8.2 – 62.3	5	1.6	1/14/2009
Z4-B4	CALIPER/GAMMA 1	275.0 – 2.0	7	0.05	3/17/2009
Z4-B4	ACOUSTIC TELEVIEWER 1	275.1 – 270.3	7	0.008	3/17/2009
Z4-B4	ACOUSTIC TELEVIEWER 2	275.1 – 4.7	7	0.008	3/17/2009
Z4-B4	SUSPENSION PS 1	4.7 – 262.5	7	1.6	3/17/2009

- PROBE DID NOT TOUCH BOTTOM OF BORING

Table 2, continued. Logging dates and depth ranges

BORING NUMBER	MEAN DEVIATION AND AZIMUTH (DEGREES TN)	SURVEY DEPTH (FEET)	VERTICAL DEPTH (FEET)	DEPTH ERROR (FEET)	HORIZONTAL OFFSET (FEET)
Z1-B3	0.7 – N213	300.8	300.7	0.1	3.8
Z1-B5	0.5 – N292	499.3	499.3	0	4.7
Z1-B6	1.3 – N031	400.0	399.8	0.2	9.0
Z1-B7	1.5 – N226	299.0	298.9	0.1	7.6
Z2-B1	1.2 – N178	148.9	148.0	0	3.0
Z2-B4	0.9 – N000	374.6	374.5	0.1	6.0
Z3-B1	1.8 – N307	300.2	300.0	0.2	9.3
Z3-B3	0.5 – N265	273.9	273.9	0	2.2
Z3-B4	0.2 – N033	275.2	275.2	0	1.1
Z3-B6	2.0 – N081	318.7	318.4	0.3	11.3
Z3-B12	0.3 – N264	182.5	182.5	0	0.9
Z4-B4	0.6 – N000	275.1	275.0	0.1	2.6

Table 3. Boring Deviation Data Summary

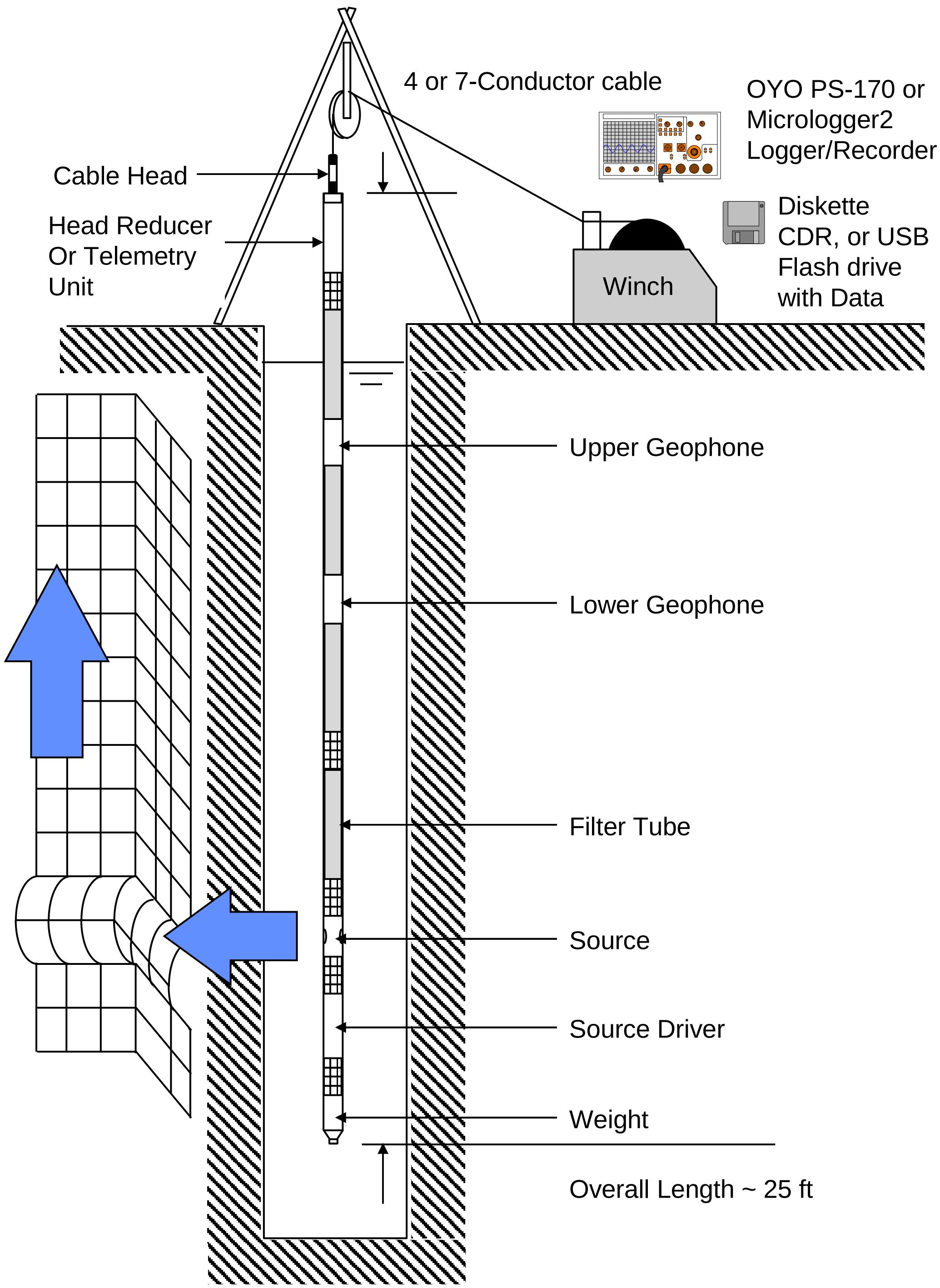


Figure 1: Concept illustration of Suspension P S logging system

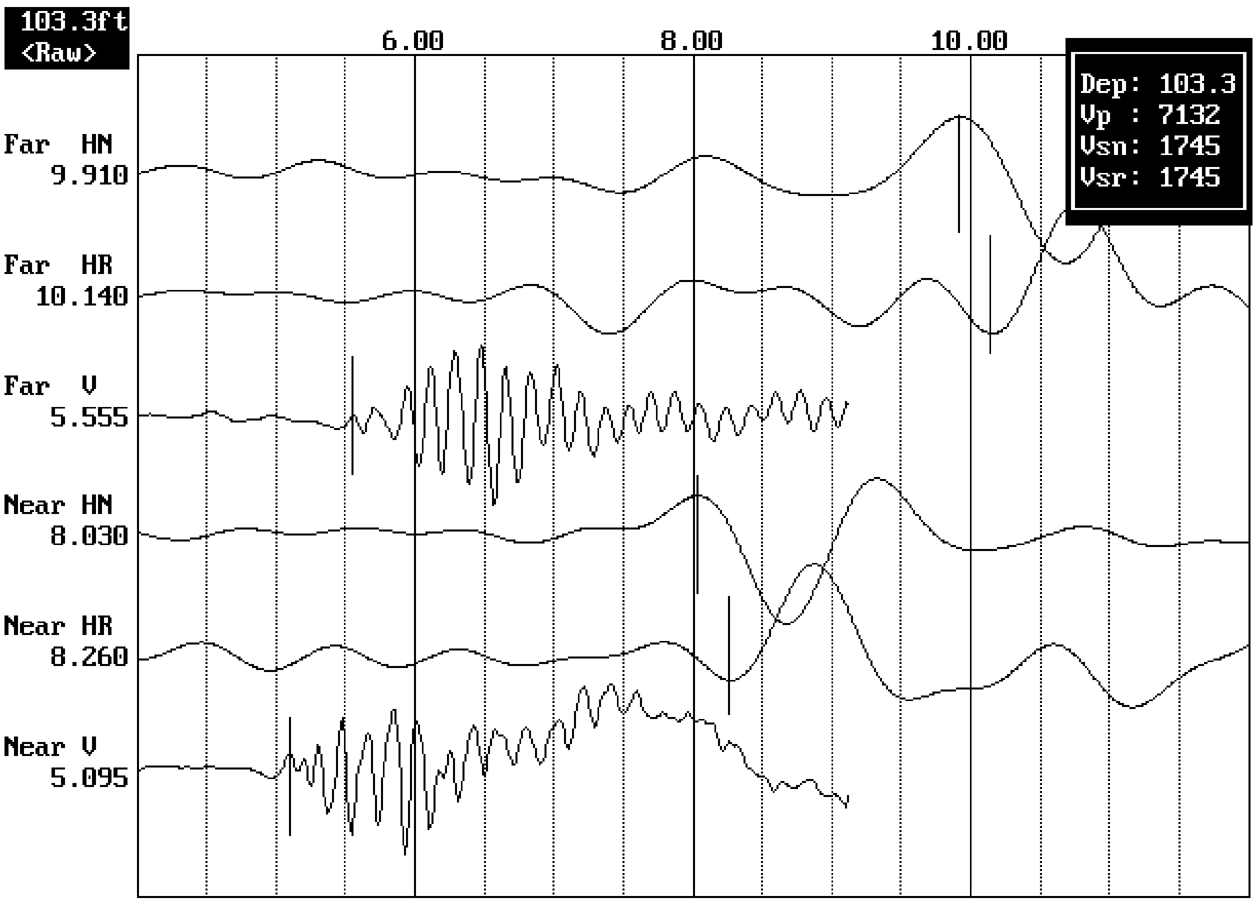


Figure 2: Example of filtered (1400 Hz lowpass) suspension record

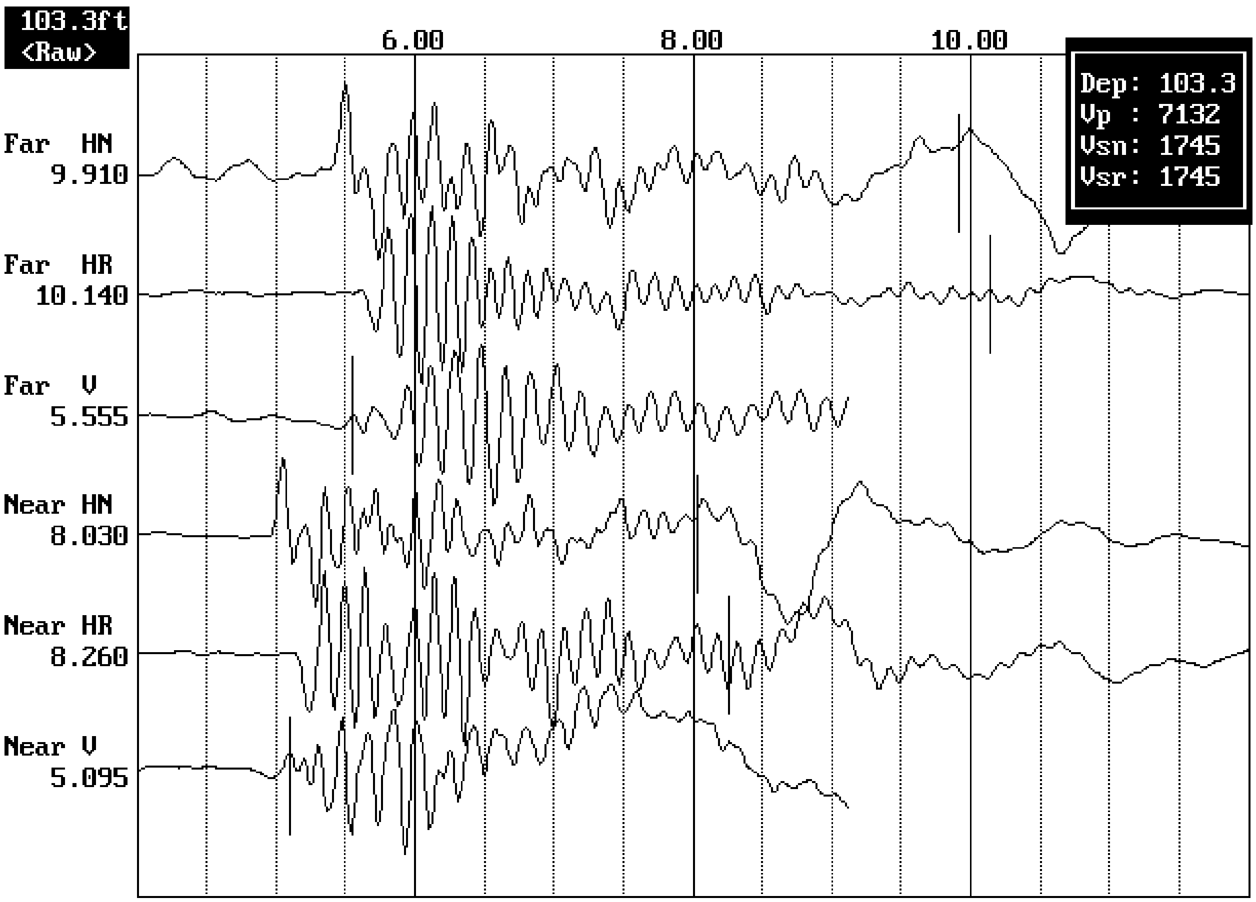


Figure 3. Example of unfiltered suspension record

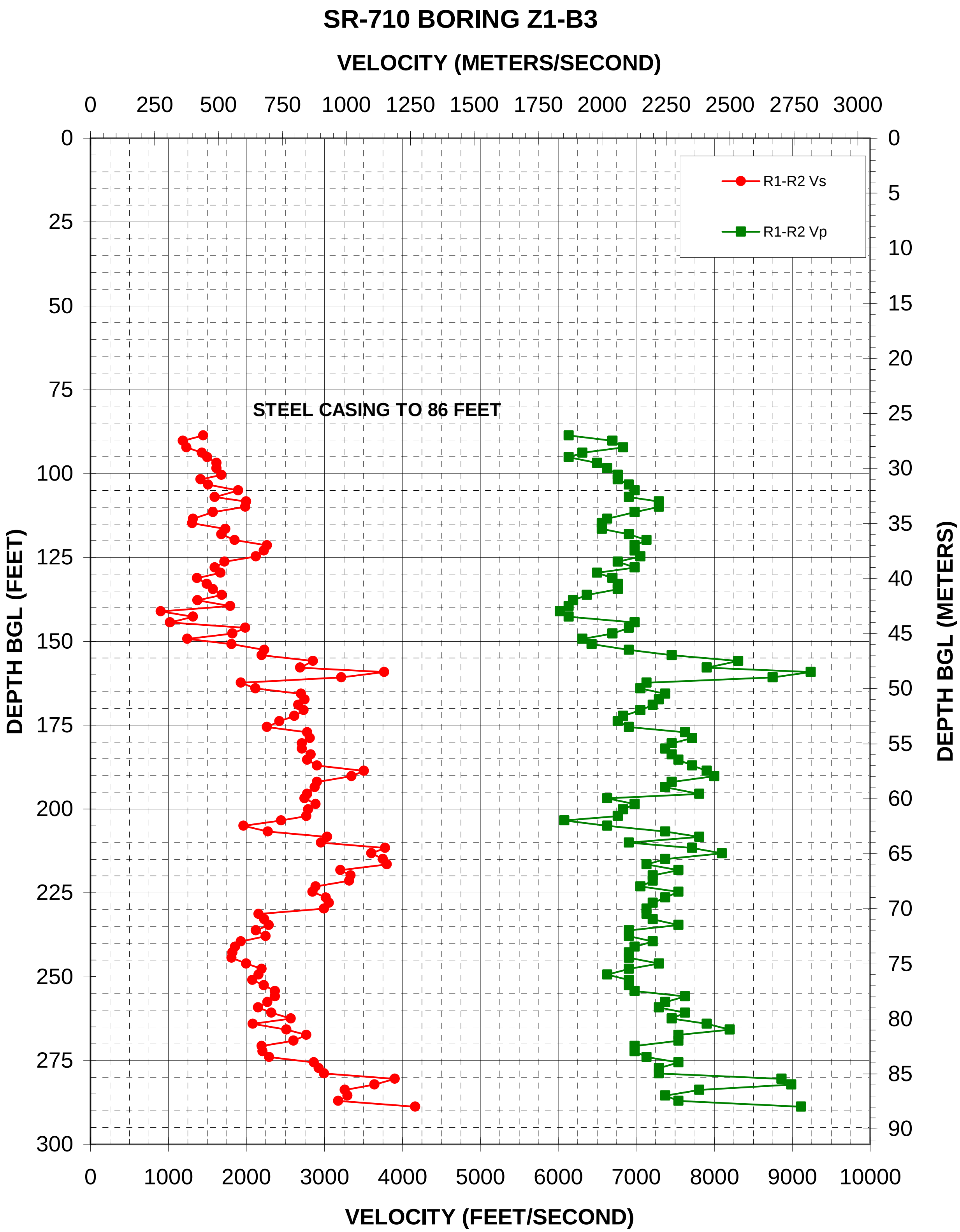


Figure 4: Boring Z1-B3, Suspension R1-R2 P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
88.58	1445	6132
90.22	1189	6696
92.19	1229	6835
93.83	1433	6309
95.14	1498	6132
96.78	1616	6497
98.43	1616	6628
100.39	1682	6765
101.71	1414	6765
103.35	1512	6907
104.99	1896	6981
106.96	1593	6907
108.27	2001	7291
109.91	1988	7291
111.55	1570	6981
113.52	1318	6628
114.83	1307	6562
116.47	1731	6562
118.11	1678	6907
119.75	1848	7132
121.39	2263	6981
123.03	2224	6981
124.67	2124	7056
126.31	1722	6765
127.95	1597	6981
129.59	1670	6497
131.23	1367	6696
132.87	1491	6765
134.51	1570	6765
136.15	1687	6371
137.80	1373	6190
139.44	1793	6132
141.08	901	6020
142.72	1318	6132
144.36	1022	6981
146.00	1988	6907
147.64	1823	6696
149.28	1243	6309
150.92	1813	6433
152.56	2232	6907
154.20	2195	7456
155.84	2853	8306
157.81	2689	7906
159.12	3771	9242
160.76	3217	8749
162.40	1930	7132
164.04	2117	7056
165.68	2700	7373
167.32	2745	7291
168.96	2667	7211
170.60	2734	7056
172.24	2614	6835
173.88	2421	6765
175.52	2263	6907
177.17	2780	7630
178.81	2816	7720
180.45	2711	7456
182.09	2711	7373
183.73	2828	7456
185.37	2780	7542
187.01	2903	7720
188.65	3509	7906
190.29	3348	8002
191.93	2903	7456
193.57	2878	7373
195.54	2780	7812
196.85	2745	6628
198.49	2891	6981
200.13	2792	6835
202.10	2769	6765
203.41	2448	6076
205.05	1965	6628
206.69	2278	7373
208.33	3038	7812
209.97	2956	6907
211.61	3782	7720
213.25	3605	8101
214.90	3750	7373
216.54	3804	7132
218.18	3209	7542
219.82	3339	7211
221.46	3322	7211
223.10	2891	7056
224.74	2847	7542
226.38	3017	7373
228.02	3059	7211
229.66	2996	7132
231.30	2158	7132
232.94	2232	7211
234.58	2286	7542
236.22	2124	6907
237.86	2247	6907
239.50	1930	7211
241.14	1854	6981
242.78	1823	6907
244.42	1813	6907
246.06	2001	7291
247.70	2195	6907
249.34	2158	6628
250.98	2076	6907
252.62	2224	6907
254.27	2369	6981
255.91	2369	7630
257.55	2270	7373
259.19	2151	7291
260.83	2319	7630
262.47	2573	7456
264.11	2083	7906
265.75	2514	8202
267.39	2769	7542
269.03	2604	7542
270.67	2195	6981
272.31	2209	6981
273.95	2294	7132
275.59	2865	7542
277.23	2929	7291
278.87	2996	7291
280.51	3906	8867
282.15	3645	8989
283.79	3265	7812
285.43	3297	7373
287.07	3178	7542
288.71	4166	9113

Table 4. Boring Z1-B3, Suspension R1-R2 depths and P- and S_H-wave velocities

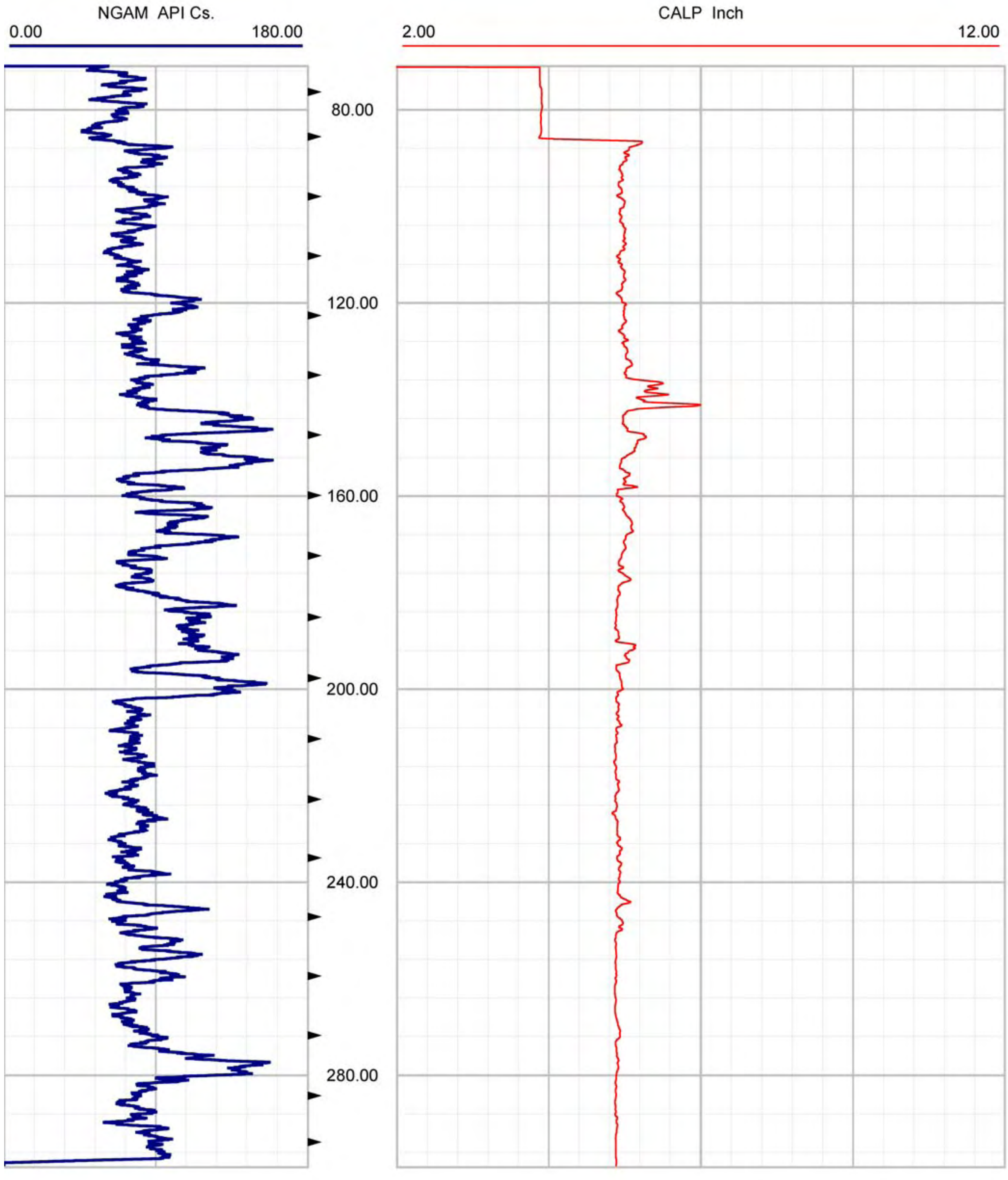


Figure 5. Boring Z1-B3, Caliper and Natural Gamma logs

DIP DATA INTERPRETATION
RGLDIP vsn 6.2
FRACTURE ANALYSIS STEREOGRAMS

CASCADE DRILLING

Borehole: Z1-B3

SR-710 TUNNEL INVESTIGATION

top of borehole.....
East:_
North:_
Elev:_

North ref: true
Depth units are feet

Zone from 298.260 to 90.806ft
Mean dip format: dip-azimuth and dip

Interpretation 1

Dip data sets .....
BHTV dips

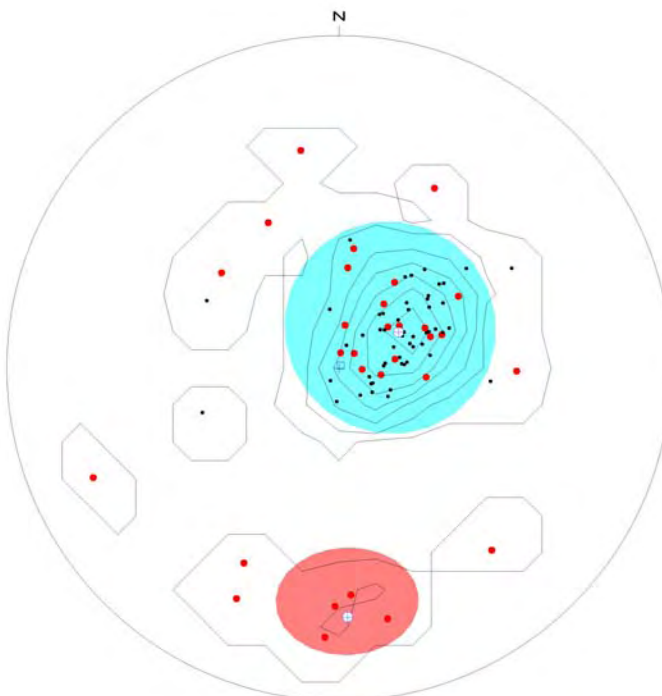
Z1-B3
Zone 0. 90.806 - 298.260ft
Deviation 0.80 N211.10

dipdata sets.....
BHTV dips
• Highlighted dips: Fracture Planar Hairline-fracture

	mean dip	n	f
N059 17	N059 17	67	0.34
N178 64	N178 64	4	(0.04)

intersections

	N059 17	N178 64
N059 17		14 N095
N178 64	14 N095	



mean dip
well axis

equal-area upper-hemisphere 0-90
contour-levels 1,3,6,10,15,21,28,

Z1-B3, Interpretation 1 298.260 to 90.806ft 1

Figure 6. Boring Z1-B3, Stereonet Plot

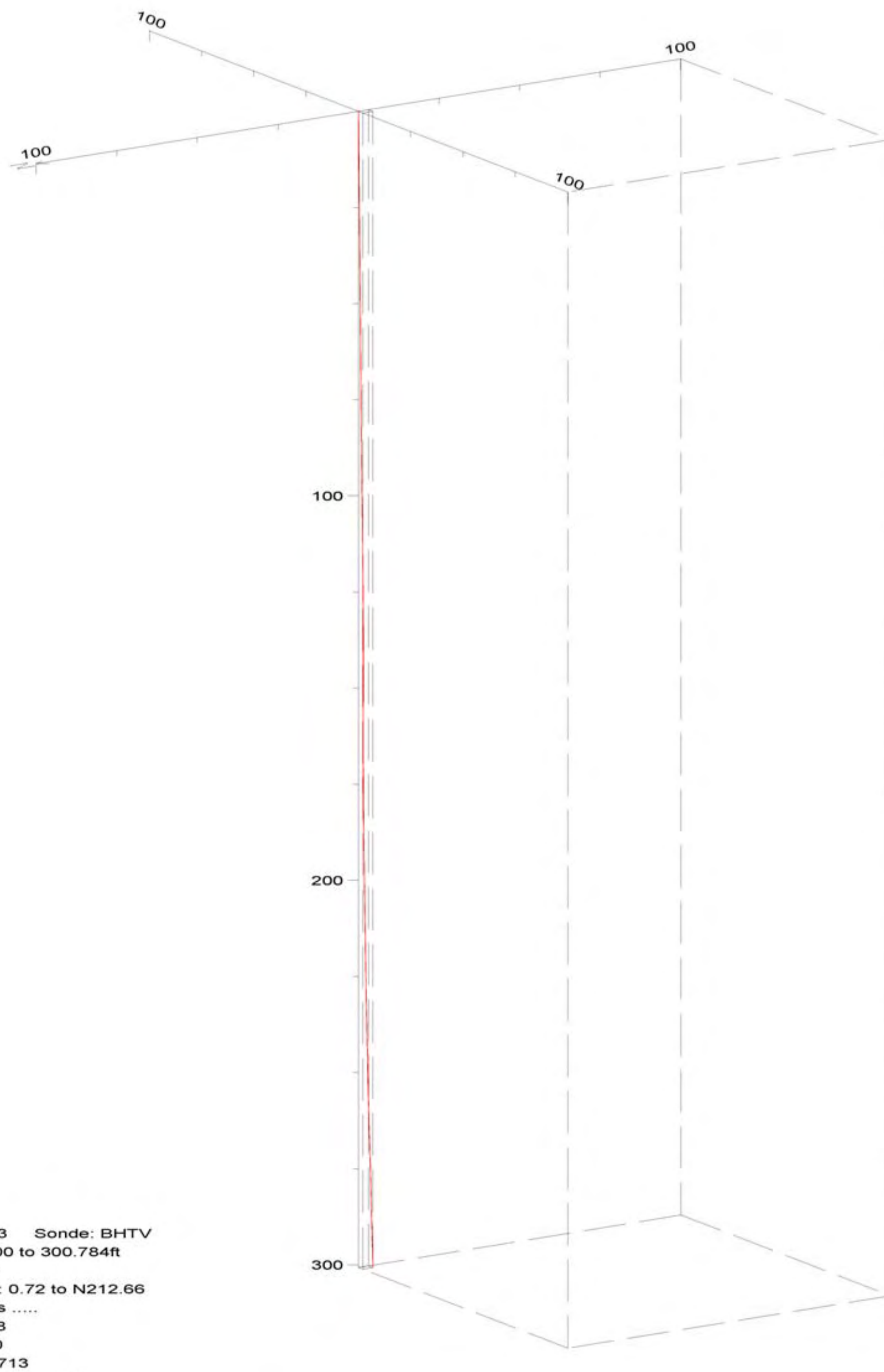
Depth (feet)	Dip azimuth	Dip	Structure description
297.76	N039	17	Primary-structure Planar Bedding
296.77	N036	28	Primary-structure Planar Bedding
295.70	N120	14	Primary-structure Planar Bedding
294.66	N018	6	Primary-structure Planar Bedding
293.70	N142	8	Primary-structure Planar Bedding
292.24	N047	14	Primary-structure Planar Bedding
291.36	N113	14	Primary-structure Planar Bedding
290.90	N046	5	Fracture Planar Hairline-fracture
289.29	N087	11	Primary-structure Planar Bedding
283.19	N116	9	Primary-structure Planar Bedding
282.98	N080	15	Primary-structure Planar Bedding
282.62	N184	8	Primary-structure Planar Bedding
281.07	N068	24	Primary-structure Planar Bedding
280.42	N114	9	Primary-structure Planar Bedding
280.25	N081	14	Fracture Planar Hairline-fracture
279.48	N006	4	Fracture Planar Hairline-fracture
279.21	N093	6	Fracture Planar Hairline-fracture
277.41	N099	10	Fracture Planar Hairline-fracture
275.05	N070	29	Primary-structure Planar Bedding
273.23	N297	37	Primary-structure Planar Bedding
272.58	N069	14	Primary-structure Planar Bedding
265.19	N046	23	Primary-structure Planar Bedding
265.00	N038	29	Primary-structure Planar Bedding
263.87	N086	15	Primary-structure Planar Bedding
263.68	N061	18	Primary-structure Planar Bedding
259.97	N084	11	Primary-structure Planar Bedding
259.70	N071	18	Primary-structure Planar Bedding
259.27	N059	35	Fracture Planar Hairline-fracture
258.98	N065	23	Fracture Planar Hairline-fracture
254.67	N351	15	Primary-structure Planar Bedding
251.99	N106	8	Primary-structure Planar Bedding
251.65	N085	17	Primary-structure Planar Bedding
246.14	N058	18	Primary-structure Planar Bedding
245.71	N063	17	Primary-structure Planar Bedding
241.14	N037	17	Primary-structure Planar Bedding
203.70	N036	10	Primary-structure Planar Bedding
203.06	N126	10	Primary-structure Planar Bedding
200.15	N050	15	Primary-structure Planar Bedding
197.26	N087	16	Primary-structure Planar Bedding
178.99	N071	27	Primary-structure Planar Bedding
177.90	N214	4	Primary-structure Planar Bedding
169.87	N050	32	Primary-structure Planar Bedding
167.22	N056	27	Primary-structure Planar Bedding
166.67	N051	33	Primary-structure Planar Bedding
164.03	N052	40	Primary-structure Planar Bedding
161.49	N041	32	Primary-structure Planar Bedding
161.00	N033	25	Fracture Planar Hairline-fracture
160.46	N051	28	Primary-structure Planar Bedding
160.05	N206	55	Fracture Planar Hairline-fracture
159.65	N052	28	Primary-structure Planar Bedding

Table 5. Boring Z1-B3, Structure depth, dip azimuth, dip and description

Depth (feet)	Dip azimuth	Dip	Structure description
159.56	N204	65	Fracture Planar Hairline-fracture
159.42	N008	11	Fracture Planar Hairline-fracture
159.36	N177	58	Fracture Planar Hairline-fracture
159.23	N350	56	Fracture Planar Hairline-fracture
158.73	N007	30	Fracture Planar Hairline-fracture
158.50	N067	20	Primary-structure Planar Bedding
156.68	N309	38	Fracture Planar Hairline-fracture
156.03	N005	32	Primary-structure Planar Bedding
155.16	N055	18	Fracture Planar Hairline-fracture
154.75	N035	19	Fracture Planar Hairline-fracture
154.07	N334	40	Fracture Planar Hairline-fracture
152.96	N091	45	Fracture Planar Hairline-fracture
151.88	N050	16	Fracture Planar Hairline-fracture
143.95	N005	25	Fracture Planar Hairline-fracture
134.74	N028	51	Fracture Planar Hairline-fracture
131.98	N074	19	Primary-structure Planar Bedding
129.24	N181	61	Fracture Planar Hairline-fracture
123.13	N183	70	Fracture Planar Hairline-fracture
121.61	N072	27	Fracture Planar Hairline-fracture
120.20	N050	22	Primary-structure Planar Bedding
119.74	N051	19	Primary-structure Planar Bedding
119.24	N068	23	Primary-structure Planar Bedding
118.96	N071	24	Fracture Planar Hairline-fracture
118.83	N068	26	Primary-structure Planar Bedding
118.26	N074	21	Primary-structure Planar Bedding
117.97	N169	66	Fracture Planar Hairline-fracture
117.66	N082	23	Primary-structure Planar Bedding
110.46	N246	70	Fracture Planar Hairline-fracture
110.34	N058	30	Primary-structure Planar Bedding
109.77	N140	61	Fracture Planar Hairline-fracture
96.08	N252	36	Primary-structure Planar Bedding
96.08	N060	50	Primary-structure Planar Bedding
95.06	N095	38	Primary-structure Planar Bedding
91.31	N096	22	Fracture Planar Hairline-fracture

Table 5, continued. Boring Z1-B3, Structure depth, dip azimuth, dip and description

Deviated borehole in orthographic projection, viewed from N303



Borehole: Z1-B3 Sonde: BHTV
Zone from: 0.000 to 300.784ft
North ref is true
Mean deviation: 0.72 to N212.66
End coordinates .....
North: -3.168
East : -2.030
Down : 300.713
Azimuth of end: N212.65
Distance start-end: 3.763ft
Viewpoint: N303
Data extrapolated to the surface from 82.288ft

Figure 7. Boring Z1-B3, Deviation Projection

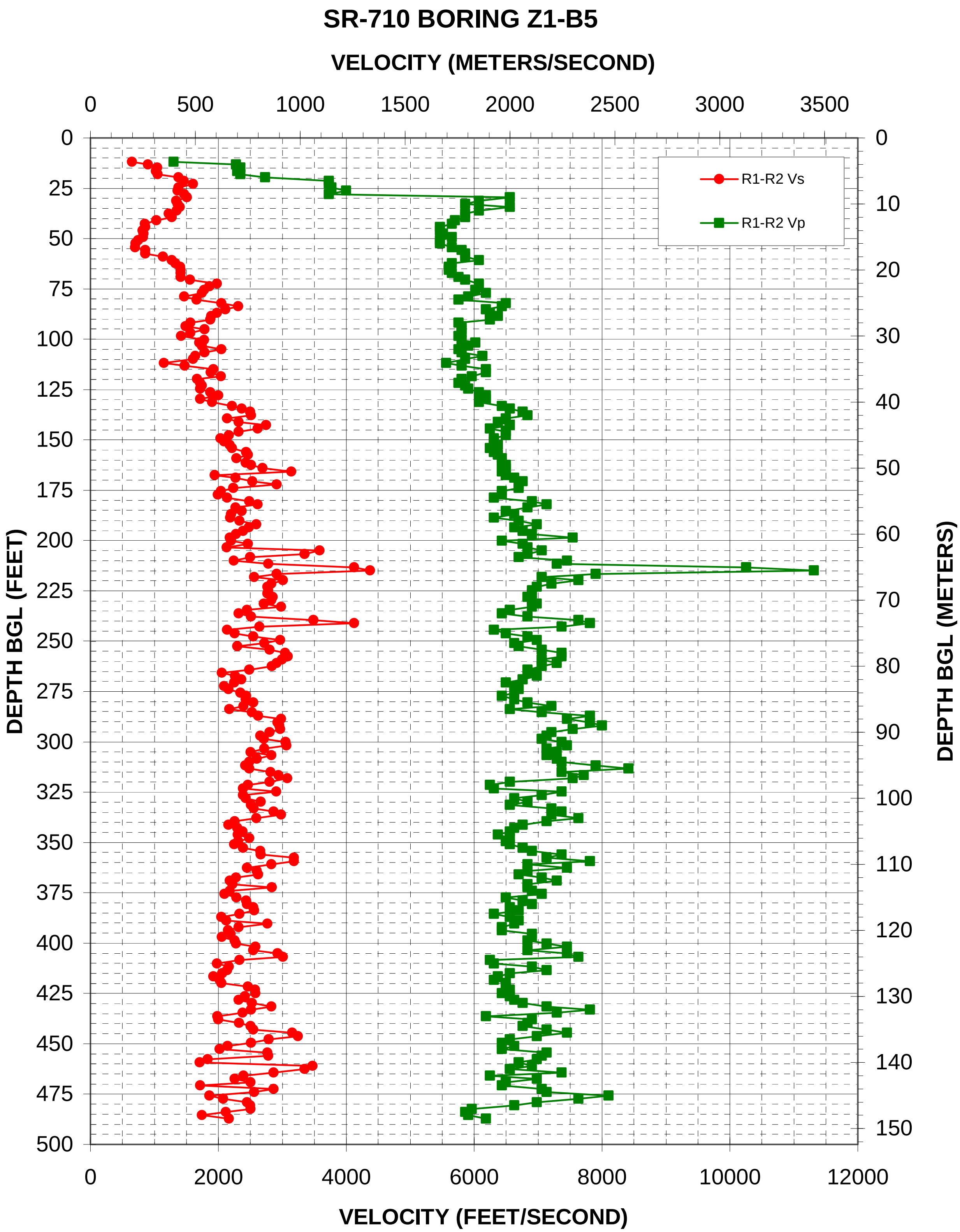


Figure 8: Boring Z1-B5, Suspension R1-R2 P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)	Depth (feet)	V_s (feet/sec)	V_p (feet/sec)	Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
11.81	651	1302	93.50	1485	5807	175.52	2044	6433
13.12	899	2278	95.14	1783	5807	177.17	1994	6433
14.76	1048	2343	96.78	1566	5807	178.81	2137	6309
16.40	1025	2294	98.43	1417	5756	180.45	2485	6907
18.04	1052	2343	100.39	1778	5807	182.09	2614	7132
19.69	1379	2734	101.71	1704	6020	183.73	2270	6835
21.33	1458	3728	103.35	1745	5911	185.37	2369	6497
22.97	1608	3728	104.99	2051	5756	187.01	2202	6628
24.61	1379	3771	106.63	1783	5807	188.65	2187	6309
26.25	1361	4001	108.27	1640	6132	190.29	2335	6696
27.89	1465	3728	109.91	1608	5859	191.93	2594	6981
29.53	1512	6562	111.88	1151	5561	193.57	2476	6628
31.17	1339	6076	113.19	1475	5807	195.21	2386	6765
32.81	1361	5859	114.83	1924	6190	196.85	2278	6907
34.45	1396	6562	116.47	1880	6190	198.49	2180	7542
36.09	1350	6076	118.44	2044	5965	200.13	2202	6433
37.73	1224	5859	119.75	1670	5807	201.77	2467	6765
39.37	1272	5859	121.72	1718	5756	203.41	2130	6835
41.01	1032	5706	123.03	1745	5859	205.05	3586	7056
42.65	854	5657	124.67	1713	5911	206.69	3348	6835
44.29	857	5468	126.31	1875	6076	208.33	2495	6696
45.93	814	5468	127.95	2001	6190	209.97	2239	7456
47.57	833	5514	129.59	1713	6190	211.61	2780	7291
49.21	822	5657	131.23	1902	6076	213.25	4127	10253
50.85	744	5468	133.20	2217	6433	214.90	4374	11313
52.49	706	5468	134.51	2369	6562	216.54	2916	7906
54.46	700	5657	136.15	2495	6765	218.18	2563	7056
55.77	857	5807	137.80	2514	6835	219.82	3010	7630
57.41	859	5859	139.44	2137	6497	221.46	2828	7211
59.06	1135	5859	141.08	2319	6371	223.10	2769	6981
60.70	1272	6076	142.72	2745	6562	224.74	2780	6907
62.34	1328	5657	144.36	2614	6249	226.38	2769	6907
63.98	1408	5608	146.00	2319	6497	228.02	2853	6835
65.62	1414	5608	147.64	2166	6497	229.66	2828	6907
67.26	1414	5657	149.28	2038	6309	231.30	2711	6981
69.23	1414	5756	150.92	2090	6309	232.94	2983	6907
70.54	1555	5859	152.56	2180	6371	234.58	2448	6562
72.51	1982	6076	154.20	2217	6249	236.22	2319	6433
73.82	1859	6076	156.17	2439	6309	237.86	2514	6835
75.46	1778	6020	157.48	2467	6371	239.50	3490	7630
77.10	1740	6190	159.12	2286	6433	241.14	4127	7812
78.74	1468	5911	161.42	2430	6433	242.78	2646	7373
80.38	1661	5756	162.40	2514	6497	244.42	2137	6309
82.02	2051	6497	164.04	2689	6497	246.06	2255	6497
83.66	2310	6433	165.68	3140	6433	247.70	2543	6835
85.30	2110	6190	167.65	1941	6497	249.34	2969	6981
86.94	1976	6249	168.96	2270	6628	250.98	2723	6628
88.58	1891	6371	170.60	2533	6765	252.62	2294	6696
90.22	1875	6249	172.24	2916	6696	254.27	2804	7056
91.86	1562	5756	173.88	2232	6696	255.91	3045	7373

Table 6. Boring Z1-B5, Suspension R1-R2 depths and P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
257.55	3088	7373
259.19	2996	7056
260.83	2916	7291
262.47	2841	7056
264.11	2485	6835
265.75	2057	6907
267.39	2263	6981
269.03	2360	6765
270.67	2247	6497
272.31	2090	6628
273.95	2158	6696
275.59	2343	6628
277.23	2439	6433
278.87	2430	6628
280.51	2543	6835
282.15	2395	7211
283.79	2173	6562
285.43	2524	7056
287.07	2625	7812
288.71	2983	7456
290.35	2929	7812
291.99	2956	8002
293.64	2969	7542
295.28	2804	7211
296.92	2657	7132
298.56	2711	7056
300.20	3052	7373
301.84	3066	7456
303.48	2723	7132
305.12	2504	7291
306.76	2828	7132
308.40	2604	7291
310.04	2485	7373
311.68	2421	7906
313.32	2485	8412
314.96	2816	7373
316.60	2942	7720
318.24	3081	7542
319.88	2804	6562
321.52	2467	6249
323.16	2386	6309
324.80	2903	7373
326.44	2386	7056
328.08	2430	6628
329.72	2667	6835
331.36	2514	6562
333.01	2553	7211
334.65	2865	7373
336.29	2983	7211
337.93	2594	7630
339.57	2255	7132
341.21	2158	6765
342.85	2294	6628
344.49	2377	6562
346.13	2302	6371
347.77	2485	6562
349.41	2310	6497
351.05	2247	6562
352.69	2386	6765
354.33	2657	6907
355.97	2667	7373
357.61	3185	7132
359.25	3185	7812
360.89	2828	6835
362.53	2448	7456
364.17	2604	6835
365.81	2625	6696
367.45	2278	7056
369.09	2180	7291
370.73	2224	6835
372.38	2841	6835
374.02	2180	6907
375.66	2096	7056
377.30	2286	6497
378.94	2439	6765
380.58	2448	6907
382.22	2543	6562
383.86	2563	6696
385.50	2335	6309
387.14	2051	6562
388.78	2124	6696
390.42	2769	6628
392.06	2319	6433
393.70	2151	6433
395.34	2195	6907
396.98	2057	6907
398.62	2255	6835
400.26	2278	7132
401.90	2583	7456
403.54	2543	6835
405.18	2929	7456
406.82	3010	7630
408.46	2335	6249
410.10	1982	6309
411.75	2166	6907
413.39	2137	7132
415.03	2063	6562
416.67	1924	6371
418.31	2019	6309
419.95	2051	6497
421.59	2467	6497
423.23	2573	6562
424.87	2583	6433
426.51	2412	6562
428.15	2319	6628
429.79	2524	6765
431.43	2828	7132
433.07	2514	7812
434.71	2377	7291
436.35	1988	6190
437.99	2001	6907
439.63	2327	6835
441.27	2504	6765
442.91	2543	7132
444.55	3155	7456
446.19	3248	6981
447.83	2792	6562
449.48	2514	6433
451.12	2144	6628
452.76	2019	6433
454.40	2769	7132
456.04	2780	7056
457.68	1833	6981
459.32	1709	6696
460.96	3472	6907
462.60	3348	6562
464.24	2865	7373
465.88	2395	6249
467.52	2255	6981
469.16	2504	6497
470.80	1713	6433
472.44	2865	7056
474.08	2563	7132
475.72	1859	8101
477.36	2076	7630
479.00	2448	6981
480.64	2495	6628
482.28	2504	5965
483.92	2117	5859
485.56	1740	5911
487.20	2166	6190

Table 6, continued. Boring Z1-B5, Suspension R1-R2 depths and P- and S_H-wave velocities

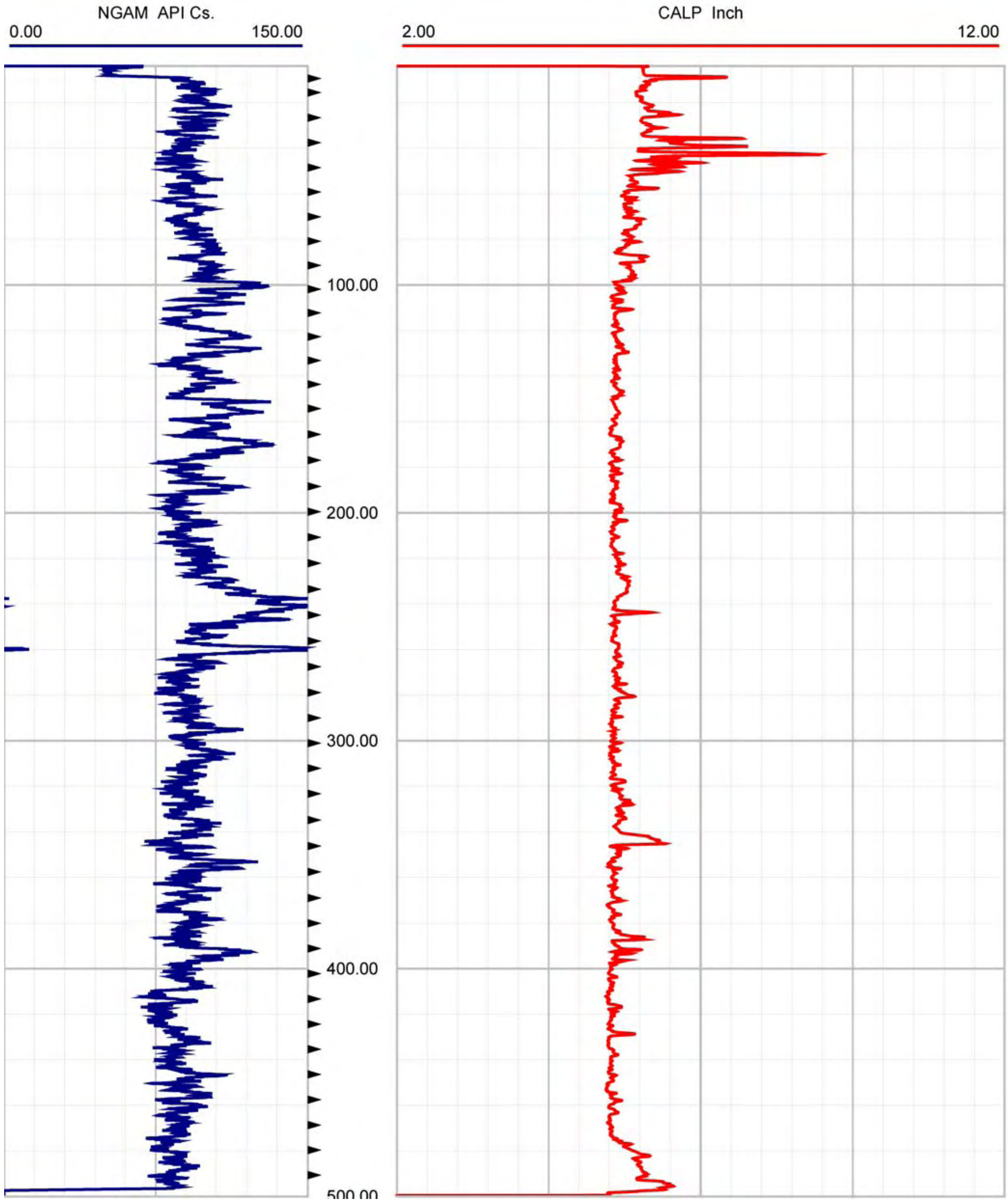


Figure 9. Boring Z1-B5, Caliper and Natural Gamma logs

DIP DATA INTERPRETATION
RGLDIP vsn 6.2
FRACTURE ANALYSIS STEREOGRAMS

CASCADE DRILLING

Borehole: Z1-B5

SR-710 TUNNEL INVESTIGATION

top of borehole.....
East:_
North:_
Elev:_

North ref: true
Depth units are feet

Zone from 492.992 to 63.799ft
Mean dip format: dip-azimuth and dip

Interpretation 1

Dip data sets .....
BHTV dips

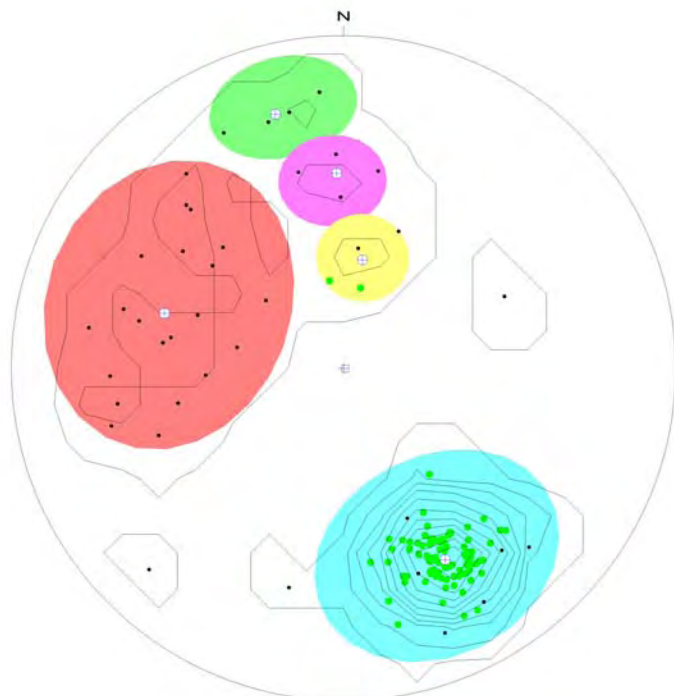
Z1-B5
Zone 0. 63.799 - 492.992ft
Deviation 0.50 N286.60

dipdata sets.....
BHTV dips
• Highlighted dips: Primary-structure Planar Bedding

	mean dip	n	f
N152 55	N152 55	101	0.41
N287 47	N287 47	21	(0.07)
N345 68	N345 68	4	(0.03)
N358 49	N358 49	4	(0.01)
N010 27	N010 27	4	(0.01)

intersections

	N152 55	N287 47	N345 68	N358 49	N010 27
N152 55		25 N223	12 N070	16 N074	14 N072
N287 47	25 N223		47 N280	42 N320	26 N350
N345 68	12 N070	47 N280		25 N064	15 N069
N358 49	16 N074	42 N320	25 N064		10 N079
N010 27	14 N072	26 N350	15 N069	10 N079	



mean dip
equal-area upper-hemisphere 0-90
well axis
contour-levels 1,3,6,10,15,21,28,36,45,55,66,

Figure 10. Boring Z1-B5, Stereonet Plot

Depth (feet)	Dip azimuth	Dip	Structure description
492.49	N256	61	Fracture Planar Hairline-fracture
491.76	N139	62	Fracture Planar Hairline-fracture
491.09	N316	56	Fracture Planar Hairline-fracture
484.48	N308	42	Fracture Planar Hairline-fracture
482.56	N007	30	Fracture Planar Hairline-fracture
456.00	N351	22	Primary-structure Planar Bedding
455.47	N012	20	Primary-structure Planar Bedding
448.58	N154	72	Primary-structure Planar Bedding
444.73	N168	68	Primary-structure Planar Bedding
433.82	N157	66	Primary-structure Planar Bedding
409.76	N155	62	Primary-structure Planar Bedding
397.58	N151	72	Primary-structure Planar Bedding
394.65	N163	55	Primary-structure Planar Bedding
394.00	N224	73	Fracture Planar Hairline-fracture
389.37	N154	47	Primary-structure Planar Bedding
378.66	N152	60	Primary-structure Planar Bedding
378.28	N149	61	Primary-structure Planar Bedding
371.18	N153	63	Primary-structure Planar Bedding
370.51	N152	65	Primary-structure Planar Bedding
365.21	N164	55	Primary-structure Planar Bedding
364.16	N278	46	Fracture Planar Hairline-fracture
363.66	N281	27	Fracture Planar Hairline-fracture
363.60	N153	57	Primary-structure Planar Bedding
356.88	N137	52	Primary-structure Planar Bedding
355.81	N134	67	Fracture Planar Hairline-fracture
352.82	N147	49	Primary-structure Planar Bedding
339.13	N146	58	Primary-structure Planar Bedding
338.78	N290	39	Fracture Planar Hairline-fracture
338.67	N283	53	Fracture Planar Hairline-fracture
337.40	N147	60	Primary-structure Planar Bedding
336.92	N151	61	Primary-structure Planar Bedding
329.84	N160	55	Fracture Planar Hairline-fracture
329.12	N311	25	Fracture Planar Hairline-fracture
328.82	N066	44	Fracture Planar Hairline-fracture
328.61	N258	42	Fracture Planar Hairline-fracture
316.93	N146	55	Primary-structure Planar Bedding
316.22	N144	54	Primary-structure Planar Bedding
309.20	N140	58	Primary-structure Planar Bedding
306.25	N147	59	Primary-structure Planar Bedding
305.66	N146	57	Primary-structure Planar Bedding
302.64	N146	60	Primary-structure Planar Bedding
295.64	N148	61	Primary-structure Planar Bedding
294.97	N149	64	Primary-structure Planar Bedding
294.46	N146	64	Primary-structure Planar Bedding
292.59	N142	51	Primary-structure Planar Bedding
289.01	N152	57	Primary-structure Planar Bedding
287.53	N156	56	Primary-structure Planar Bedding
287.25	N157	57	Primary-structure Planar Bedding
282.11	N159	58	Primary-structure Planar Bedding
274.89	N359	43	Fracture Planar Hairline-fracture

Table 7. Boring Z1-B5, Structure depth, dip azimuth, dip and description

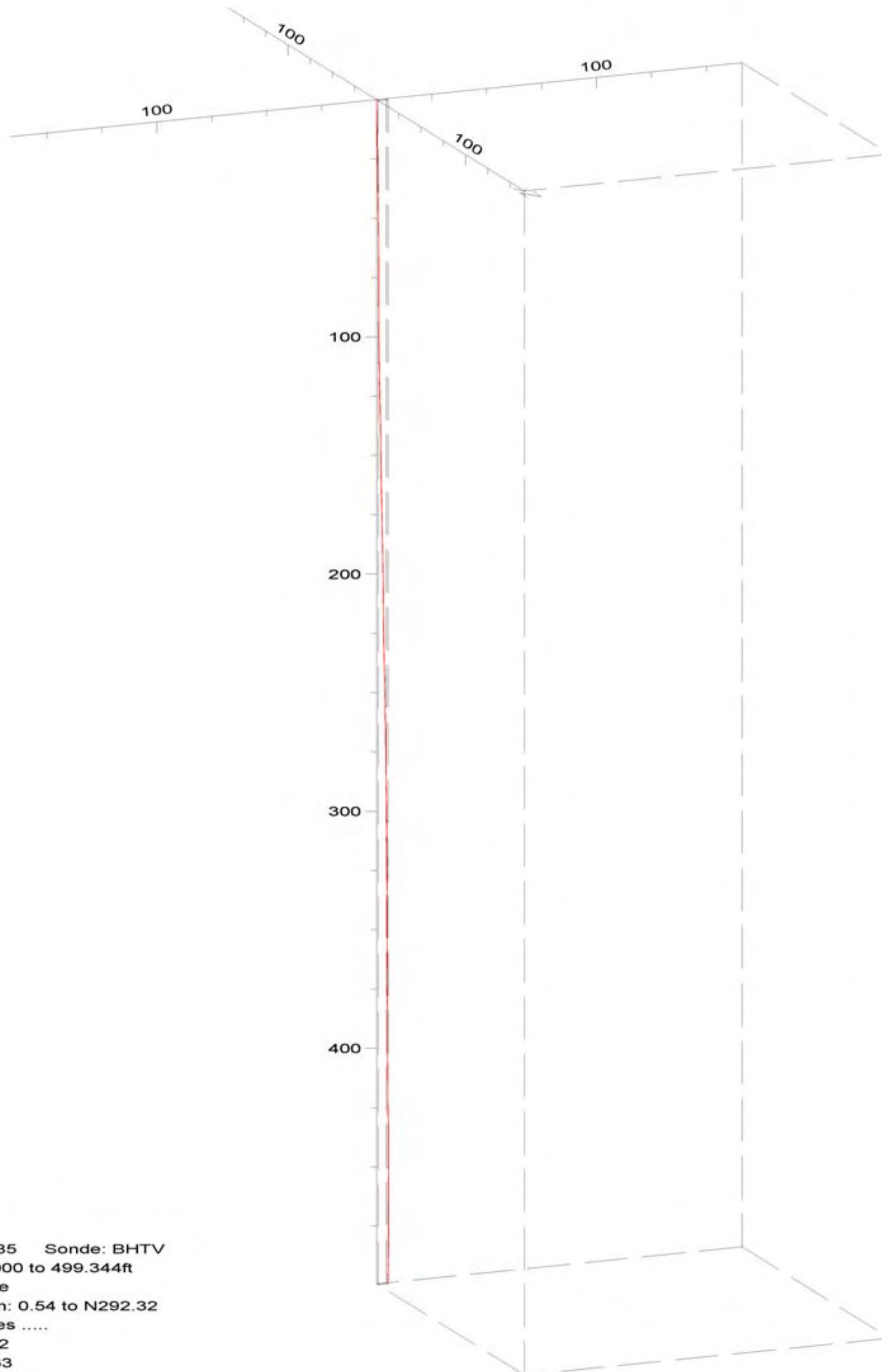
Depth (feet)	Dip azimuth	Dip	Structure description
269.78	N155	53	Primary-structure Planar Bedding
268.51	N155	53	Primary-structure Planar Bedding
264.22	N153	56	Primary-structure Planar Bedding
263.93	N152	57	Primary-structure Planar Bedding
261.91	N148	50	Primary-structure Planar Bedding
260.81	N151	57	Primary-structure Planar Bedding
260.58	N147	58	Primary-structure Planar Bedding
260.25	N136	57	Primary-structure Planar Bedding
259.01	N149	71	Fracture Planar Hairline-fracture
258.88	N172	49	Primary-structure Planar Bedding
257.37	N358	54	Fracture Planar Hairline-fracture
256.37	N169	61	Primary-structure Planar Bedding
255.42	N156	58	Primary-structure Planar Bedding
254.28	N147	57	Primary-structure Planar Bedding
253.48	N161	46	Primary-structure Planar Bedding
252.10	N145	57	Primary-structure Planar Bedding
251.25	N144	61	Primary-structure Planar Bedding
248.24	N299	59	Fracture Planar Hairline-fracture
248.00	N145	57	Primary-structure Planar Bedding
247.11	N010	50	Fracture Planar Hairline-fracture
247.09	N147	59	Primary-structure Planar Bedding
246.40	N148	59	Primary-structure Planar Bedding
241.94	N150	61	Primary-structure Planar Bedding
241.17	N154	60	Primary-structure Planar Bedding
240.07	N155	59	Primary-structure Planar Bedding
239.63	N156	58	Primary-structure Planar Bedding
237.91	N157	56	Primary-structure Planar Bedding
234.35	N267	34	Fracture Planar Hairline-fracture
232.74	N135	59	Primary-structure Planar Bedding
231.87	N150	59	Primary-structure Planar Bedding
228.24	N145	60	Primary-structure Planar Bedding
226.51	N159	74	Fracture Planar Hairline-fracture
225.75	N153	56	Primary-structure Planar Bedding
219.45	N355	72	Fracture Planar Hairline-fracture
213.65	N261	58	Fracture Planar Hairline-fracture
206.34	N280	44	Fracture Planar Hairline-fracture
203.73	N250	50	Fracture Planar Hairline-fracture
186.04	N306	50	Fracture Planar Hairline-fracture
183.20	N022	37	Fracture Planar Hairline-fracture
176.36	N141	34	Primary-structure Planar Bedding
176.05	N156	49	Primary-structure Planar Bedding
173.19	N160	49	Primary-structure Planar Bedding
171.44	N151	50	Primary-structure Planar Bedding
169.50	N167	50	Primary-structure Planar Bedding
168.40	N154	53	Primary-structure Planar Bedding
167.45	N152	52	Primary-structure Planar Bedding
164.20	N155	54	Primary-structure Planar Bedding
162.79	N147	57	Primary-structure Planar Bedding
162.58	N285	58	Fracture Planar Hairline-fracture
161.20	N157	41	Fracture Planar Hairline-fracture

Table 7, continued. Boring Z1-B5, Structure depth, dip azimuth, dip and description

Depth (feet)	Dip azimuth	Dip	Structure description
160.43	N165	47	Primary-structure Planar Bedding
156.33	N321	64	Fracture Planar Hairline-fracture
155.36	N156	52	Primary-structure Planar Bedding
153.83	N147	50	Primary-structure Planar Bedding
152.87	N152	45	Primary-structure Planar Bedding
151.94	N165	44	Primary-structure Planar Bedding
146.64	N152	49	Primary-structure Planar Bedding
144.99	N154	55	Primary-structure Planar Bedding
143.68	N156	54	Primary-structure Planar Bedding
143.32	N268	60	Fracture Planar Hairline-fracture
143.30	N279	67	Fracture Planar Hairline-fracture
143.28	N194	58	Fracture Planar Hairline-fracture
142.09	N159	47	Primary-structure Planar Bedding
133.86	N153	49	Primary-structure Planar Bedding
132.41	N150	50	Primary-structure Planar Bedding
129.57	N156	56	Primary-structure Planar Bedding
126.02	N150	51	Primary-structure Planar Bedding
125.38	N151	53	Primary-structure Planar Bedding
123.31	N315	43	Fracture Planar Hairline-fracture
123.22	N316	58	Fracture Planar Hairline-fracture
122.58	N157	48	Primary-structure Planar Bedding
121.16	N333	68	Fracture Planar Hairline-fracture
120.21	N347	51	Fracture Planar Hairline-fracture
120.11	N155	57	Primary-structure Planar Bedding
117.51	N348	68	Fracture Planar Hairline-fracture
117.26	N343	66	Fracture Planar Hairline-fracture
105.33	N164	57	Primary-structure Planar Bedding
101.18	N152	49	Primary-structure Planar Bedding
98.64	N150	52	Primary-structure Planar Bedding
95.72	N158	51	Primary-structure Planar Bedding
94.93	N160	48	Primary-structure Planar Bedding
94.55	N158	51	Primary-structure Planar Bedding
81.13	N151	41	Primary-structure Planar Bedding
79.88	N150	50	Primary-structure Planar Bedding
71.20	N146	58	Primary-structure Planar Bedding
64.61	N154	49	Primary-structure Planar Bedding
64.30	N153	48	Primary-structure Planar Bedding

Table 7, continued. Boring Z1-B5, Structure depth, dip azimuth, dip and description

Deviated borehole in orthographic projection, viewed from N22



Borehole: Z1-B5   Sonde: BHTV
Zone from: 0.000 to 499.344ft
North ref is true
Mean deviation: 0.54 to N292.32
End coordinates .....
North: 1.792
East : -4.363
Down : 499.287
Azimuth of end: N292.33
Distance start-end: 4.716ft
Viewpoint: N22
Data extrapolated to the surface from 35.024ft

Figure 11. Boring Z1-B5, Deviation Projection

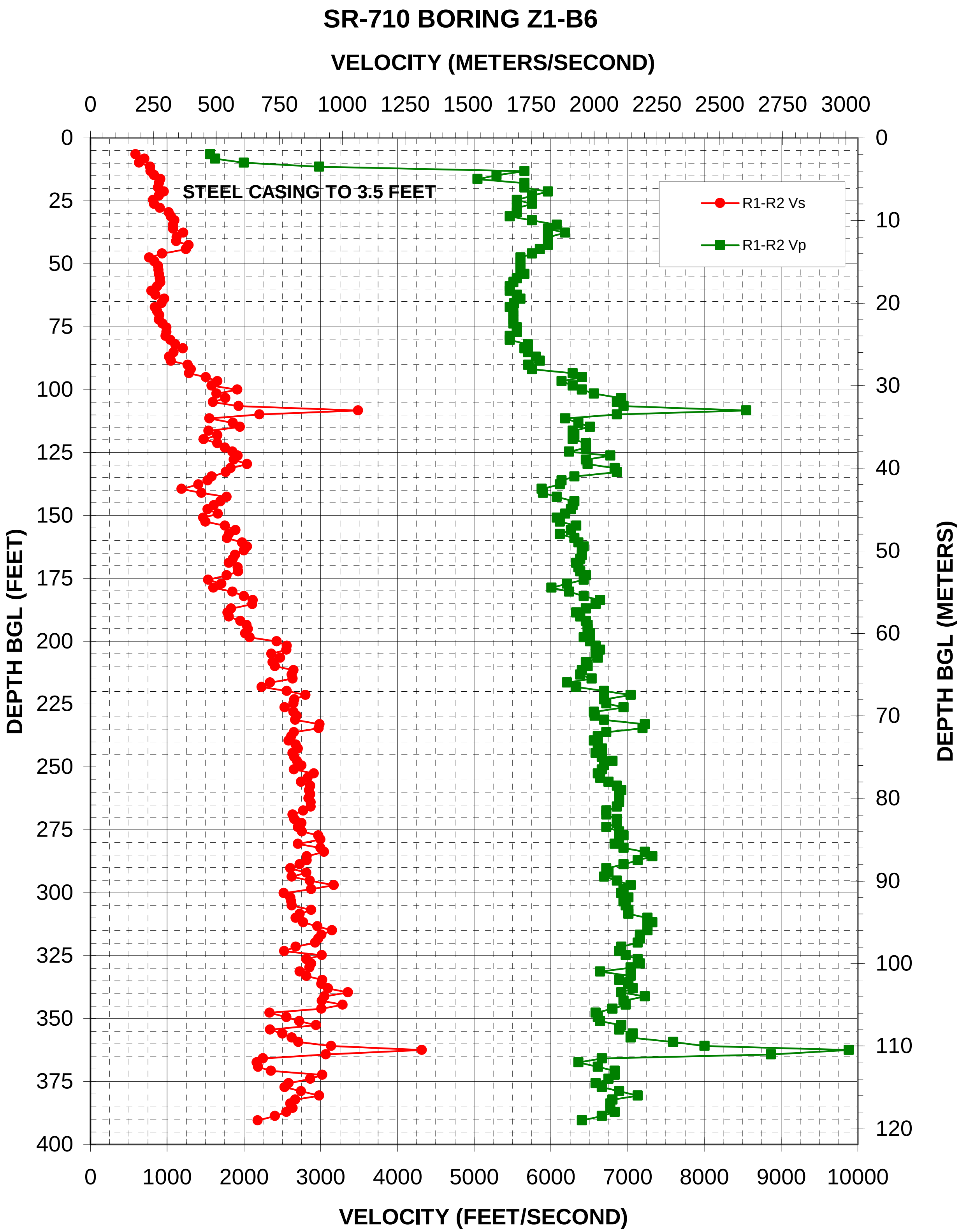


Figure 12: Boring Z1-B6, Suspension R1-R2 P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
6.56	586	1562
8.20	702	1624
9.84	634	2001
11.48	777	2983
13.12	787	5657
14.76	828	5292
16.40	909	5047
18.04	894	5657
19.69	882	5657
21.33	957	5965
22.97	896	5756
24.61	818	5561
26.25	828	5756
27.89	904	5561
29.53	1022	5561
31.17	1048	5468
32.81	1094	5756
34.45	1076	6076
36.09	1079	5965
37.73	1211	6190
39.37	1127	5965
41.01	1116	5965
42.65	1282	5965
44.29	1247	5859
45.93	935	5756
47.57	767	5608
49.21	839	5608
50.85	880	5608
52.49	889	5608
54.13	896	5657
55.77	904	5561
57.41	911	5514
59.06	873	5468
60.70	798	5468
62.34	848	5561
63.98	962	5608
65.62	929	5523
67.26	843	5468
68.90	870	5514
70.54	899	5514
72.18	894	5514
73.82	943	5514
75.46	991	5561
77.10	994	5561
78.74	982	5468
80.38	1042	5468
82.02	1105	5706
83.66	1206	5657
85.30	1086	5706
86.94	1028	5807

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
88.58	1052	5859
90.22	1267	5706
91.86	1307	5756
93.50	1284	6285
95.14	1505	6408
96.78	1653	6144
98.43	1581	6285
100.07	1913	6408
101.71	1645	6562
103.35	1759	6922
104.99	1597	6864
106.63	1930	6951
108.27	3490	8544
109.91	2202	6864
111.55	1551	6190
113.19	1859	6358
114.83	1947	6510
116.47	1540	6285
118.11	1653	6309
119.75	1475	6285
121.39	1653	6458
123.03	1754	6458
124.67	1848	6237
126.31	1919	6779
127.95	1869	6458
129.59	2044	6484
131.23	1828	6835
132.87	1764	6864
134.51	1577	6309
136.15	1526	6144
137.80	1408	6121
139.44	1189	5880
141.08	1445	5901
142.72	1773	6076
144.36	1696	6309
146.00	1608	6285
147.64	1530	6261
149.28	1661	6190
150.92	1468	6076
152.56	1498	6121
154.20	1754	6334
155.84	1891	6261
157.48	1803	6121
159.12	1783	6309
160.76	1976	6358
162.40	2044	6433
164.04	2001	6408
165.68	1886	6408
167.32	1859	6383
168.96	1803	6334

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
170.60	1919	6358
172.24	1924	6383
173.88	1773	6458
175.52	1537	6433
177.17	1704	6214
178.81	1604	6009
180.45	1848	6237
182.09	2001	6433
183.73	2117	6641
185.37	2110	6588
187.01	1833	6458
188.65	1788	6334
190.29	1803	6383
191.93	1953	6458
193.57	2038	6484
195.21	2051	6484
196.85	2019	6510
198.49	2076	6433
200.13	2430	6510
201.77	2563	6588
203.41	2553	6641
205.05	2360	6588
206.69	2476	6615
208.33	2377	6458
209.97	2404	6484
211.61	2646	6408
213.25	2625	6383
214.90	2635	6536
216.54	2343	6214
218.18	2232	6334
219.82	2563	6696
221.46	2804	7040
223.10	2657	6696
224.74	2646	6723
226.38	2533	6951
228.02	2646	6562
229.66	2689	6575
231.30	2667	6696
232.94	2989	7227
234.58	2976	7195
236.22	2651	6723
237.86	2619	6615
239.50	2583	6562
241.14	2678	6615
242.78	2706	6668
244.42	2635	6588
246.06	2657	6668
247.70	2695	6807
249.34	2751	6696
250.98	2651	6668

Table 8. Boring Z1-B6, Suspension R1-R2 depths and P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
252.62	2910	6615
254.27	2834	6641
255.91	2745	6751
257.55	2865	6864
259.19	2847	6922
260.83	2865	6893
262.47	2841	6893
264.11	2872	6893
265.75	2872	6864
267.39	2774	6723
269.03	2635	6723
270.67	2657	6864
272.31	2751	6864
273.95	2706	6723
275.59	2757	6893
277.23	2969	6951
278.87	2996	6893
280.51	2706	6835
282.15	2996	6951
283.79	3045	7227
285.43	2822	7323
287.07	2822	7132
288.71	2728	6951
290.35	2604	6723
291.99	2816	6751
293.64	2625	6696
295.28	2859	6864
296.92	3170	7040
298.56	2878	6951
300.20	2519	6922
301.84	2604	7010
303.48	2619	6951
305.12	2625	6981
306.76	2878	7010
308.40	2728	7010
310.04	2678	7258
311.68	2774	7323
313.32	2956	7258
314.96	3147	7258
316.60	3010	7163
318.24	2969	7163
319.88	2929	7132
321.52	2678	6922
323.16	2524	6893
324.80	3017	6981
326.44	2816	7132
328.08	2878	7163
329.72	2853	7040
331.36	2728	6641
333.01	2816	7040

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
334.65	3024	6893
336.29	3010	7010
337.93	3095	7071
339.57	3356	6922
341.21	3052	7227
342.85	3017	6951
344.49	3289	6981
346.13	3010	6807
347.77	2335	6588
349.41	2553	6615
351.05	2723	6641
352.69	2942	6922
354.33	2343	6893
355.97	2504	7071
357.61	2625	7040
359.25	2711	7595
360.89	3140	8002
362.53	4317	9882
364.17	3066	8867
365.81	2247	6668
367.45	2166	6358
369.09	2187	6615
370.73	2352	6835
372.38	3024	6835
374.02	2865	6751
375.66	2583	6588
377.30	2533	6668
378.94	2745	6893
380.58	2983	7132
382.22	2667	6807
383.86	2604	6779
385.50	2635	6779
387.14	2553	6835
388.78	2404	6668
390.42	2180	6408

Table 8, continued. Boring Z1-B6, Suspension R1-R2 depths and P- and S_H-wave velocities

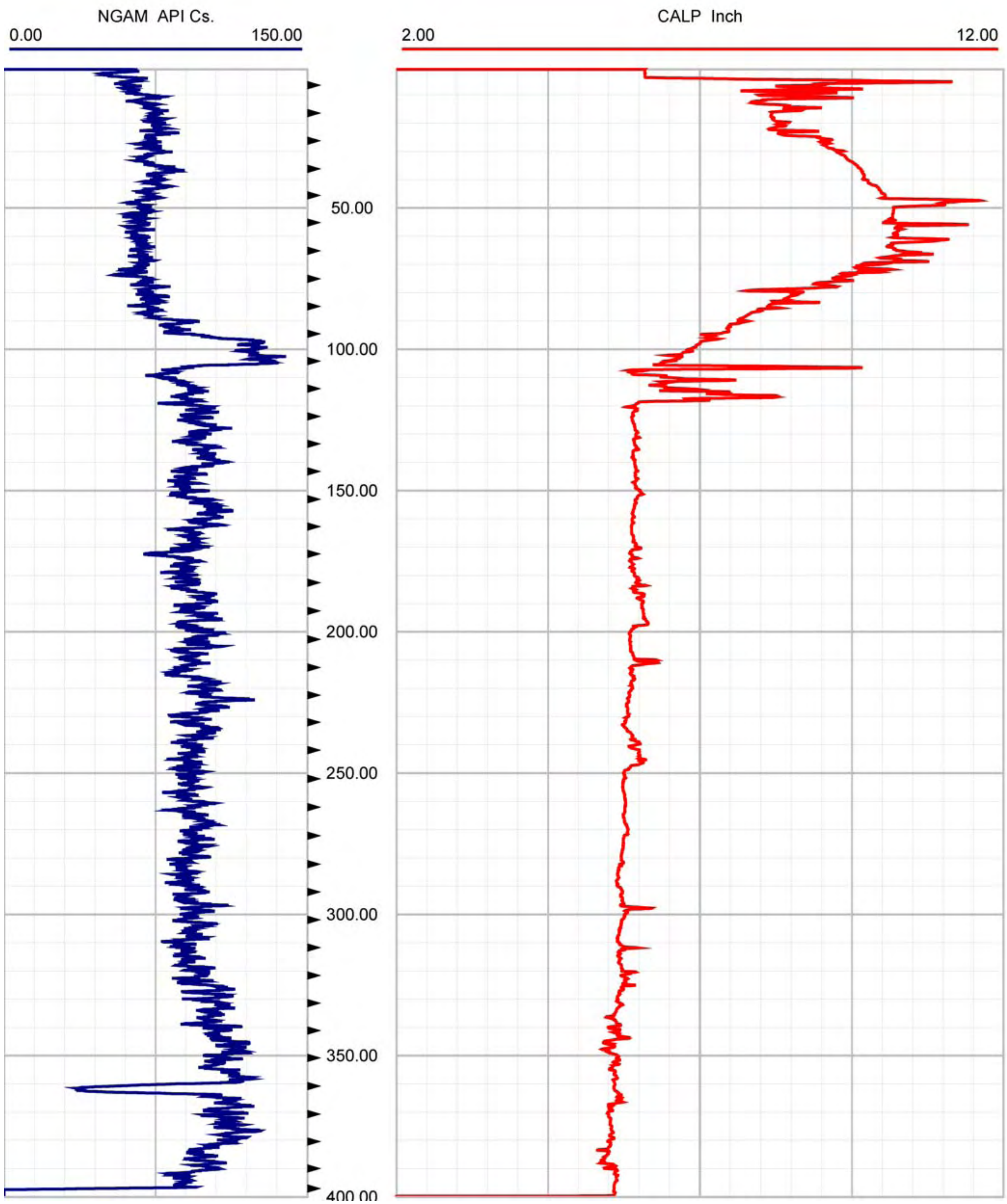


Figure 13. Boring Z1-B6 Caliper and Natural Gamma logs

DIP DATA INTERPRETATION
RGLDIP vsn 6.2
FRACTURE ANALYSIS STEREOGRAMS

CASCADE DRILLING

Borehole: Z1-B6

SR-710 TUNNEL INVESTIGATION

top of borehole.....
East:_
North:_
Elev:_

North ref: true
Depth units are feet

Zone from 399.902 to 99.381ft
Mean dip format: dip-azimuth and dip

Interpretation 1

Dip data sets .....
BHTV dips

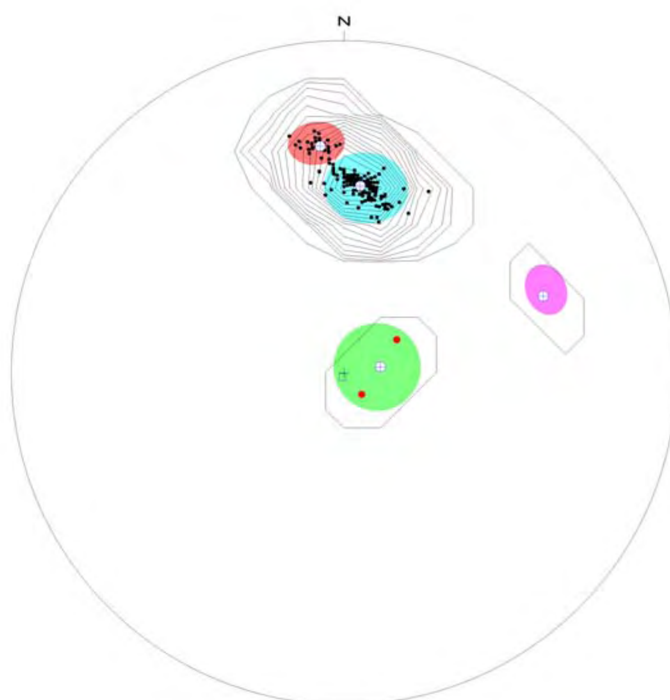
Z1-B6
Zone 0. 99.381 - 399.902ft
Deviation 1.20 N 19.70

dipdata sets.....
BHTV dips
• Highlighted dips: Fracture Planar Hairline-fracture

	mean dip	n	f
N005 47	N005 47	166	0.83
N354 58	N354 58	30	(0.20)
N081 9	N081 9	2	(0.01)
N069 54	N069 54	1	(0.00)

intersections

	N005 47	N354 58	N081 9	N069 54
N005 47		29 N064	09 N087	45 N026
N354 58	29 N064		09 N078	49 N037
N081 9	09 N087	09 N078		02 N157
N069 54	45 N026	49 N037	02 N157	



mean dip
equal-area upper-hemisphere 0-90
well axis
contour-levels 1,3,6,10,15,21,28,36,45,55,66,78,91,105,
120,136,153,

Z1-B6, Interpretation 1 399.902 to 99.381ft 1

Figure 14. Boring Z1-B6, Stereonet Plot

Depth (feet)	Dip azimuth	Dip	Structure description
399.40	N014	43	Primary-structure Planar Bedding
398.62	N014	43	Primary-structure Planar Bedding
395.15	N016	43	Primary-structure Planar Bedding
394.89	N015	42	Primary-structure Planar Bedding
394.54	N015	44	Primary-structure Planar Bedding
394.24	N018	45	Primary-structure Planar Bedding
366.92	N022	43	Primary-structure Planar Bedding
360.52	N018	49	Primary-structure Planar Bedding
359.49	N010	51	Primary-structure Planar Bedding
351.68	N011	53	Primary-structure Planar Bedding
341.58	N010	46	Primary-structure Planar Bedding
340.43	N013	38	Primary-structure Planar Bedding
339.94	N012	40	Primary-structure Planar Bedding
339.16	N013	46	Primary-structure Planar Bedding
337.68	N010	44	Primary-structure Planar Bedding
336.75	N008	45	Primary-structure Planar Bedding
334.58	N354	45	Primary-structure Planar Bedding
332.26	N000	47	Primary-structure Planar Bedding
329.73	N002	47	Primary-structure Planar Bedding
329.28	N008	44	Primary-structure Planar Bedding
328.49	N069	54	Fracture Planar Hairline-fracture
327.66	N001	42	Primary-structure Planar Bedding
327.08	N005	41	Primary-structure Planar Bedding
325.88	N013	43	Primary-structure Planar Bedding
323.85	N007	43	Primary-structure Planar Bedding
322.62	N009	46	Primary-structure Planar Bedding
320.69	N013	45	Primary-structure Planar Bedding
320.46	N010	49	Primary-structure Planar Bedding
318.21	N008	44	Primary-structure Planar Bedding
316.24	N008	45	Primary-structure Planar Bedding
315.11	N009	44	Primary-structure Planar Bedding
314.34	N011	42	Primary-structure Planar Bedding
312.82	N012	45	Primary-structure Planar Bedding
311.07	N012	45	Primary-structure Planar Bedding
310.73	N008	44	Primary-structure Planar Bedding
309.98	N014	42	Primary-structure Planar Bedding
309.15	N012	42	Primary-structure Planar Bedding
308.20	N010	45	Primary-structure Planar Bedding
305.46	N006	43	Primary-structure Planar Bedding
303.83	N025	50	Primary-structure Planar Bedding
303.31	N010	39	Primary-structure Planar Bedding
300.74	N141	7	Fracture Planar Hairline-fracture
300.61	N008	48	Primary-structure Planar Bedding
300.02	N009	50	Primary-structure Planar Bedding
299.23	N006	45	Primary-structure Planar Bedding
298.28	N005	49	Primary-structure Planar Bedding
297.61	N006	48	Primary-structure Planar Bedding
297.02	N008	47	Primary-structure Planar Bedding
296.21	N006	45	Primary-structure Planar Bedding
295.97	N006	45	Primary-structure Planar Bedding

Table 9. Boring Z1-B6, Structure depth, dip azimuth, dip and description

Depth (feet)	Dip azimuth	Dip	Structure description
294.81	N005	46	Primary-structure Planar Bedding
294.37	N005	48	Primary-structure Planar Bedding
293.88	N005	47	Primary-structure Planar Bedding
293.51	N009	47	Primary-structure Planar Bedding
292.76	N006	46	Primary-structure Planar Bedding
291.99	N006	47	Primary-structure Planar Bedding
291.38	N002	47	Primary-structure Planar Bedding
290.83	N003	48	Primary-structure Planar Bedding
289.95	N007	47	Primary-structure Planar Bedding
288.90	N006	46	Primary-structure Planar Bedding
288.22	N009	44	Primary-structure Planar Bedding
287.54	N010	47	Primary-structure Planar Bedding
287.02	N008	45	Primary-structure Planar Bedding
285.48	N008	49	Primary-structure Planar Bedding
284.73	N008	46	Primary-structure Planar Bedding
284.34	N004	49	Primary-structure Planar Bedding
284.00	N008	47	Primary-structure Planar Bedding
282.91	N009	47	Primary-structure Planar Bedding
281.99	N007	48	Primary-structure Planar Bedding
281.70	N006	48	Primary-structure Planar Bedding
281.45	N008	45	Primary-structure Planar Bedding
281.00	N005	46	Primary-structure Planar Bedding
280.56	N008	47	Primary-structure Planar Bedding
278.88	N005	46	Primary-structure Planar Bedding
278.38	N005	46	Primary-structure Planar Bedding
277.00	N010	46	Primary-structure Planar Bedding
276.52	N008	47	Primary-structure Planar Bedding
275.60	N009	47	Primary-structure Planar Bedding
273.86	N006	48	Primary-structure Planar Bedding
272.07	N005	45	Primary-structure Planar Bedding
271.49	N009	47	Primary-structure Planar Bedding
270.23	N006	48	Primary-structure Planar Bedding
269.09	N009	48	Primary-structure Planar Bedding
268.95	N007	49	Primary-structure Planar Bedding
268.30	N007	49	Primary-structure Planar Bedding
267.98	N006	47	Primary-structure Planar Bedding
267.52	N007	47	Primary-structure Planar Bedding
266.81	N007	48	Primary-structure Planar Bedding
264.73	N007	49	Primary-structure Planar Bedding
264.49	N008	48	Primary-structure Planar Bedding
264.23	N004	49	Primary-structure Planar Bedding
262.88	N004	46	Primary-structure Planar Bedding
262.29	N006	47	Primary-structure Planar Bedding
261.89	N004	48	Primary-structure Planar Bedding
260.18	N008	47	Primary-structure Planar Bedding
259.22	N005	47	Primary-structure Planar Bedding
258.76	N005	47	Primary-structure Planar Bedding
258.32	N007	45	Primary-structure Planar Bedding
255.61	N002	49	Primary-structure Planar Bedding
254.61	N003	47	Primary-structure Planar Bedding

Table 9, continued. Boring Z1-B6, Structure depth, dip azimuth, dip and description

Depth (feet)	Dip azimuth	Dip	Structure description
253.28	N003	45	Primary-structure Planar Bedding
252.66	N003	48	Primary-structure Planar Bedding
251.34	N006	48	Primary-structure Planar Bedding
251.02	N000	45	Primary-structure Planar Bedding
249.76	N004	48	Primary-structure Planar Bedding
248.71	N004	50	Primary-structure Planar Bedding
247.72	N006	48	Primary-structure Planar Bedding
246.84	N008	48	Primary-structure Planar Bedding
246.11	N007	51	Primary-structure Planar Bedding
245.01	N006	47	Primary-structure Planar Bedding
243.33	N006	50	Primary-structure Planar Bedding
241.37	N008	48	Primary-structure Planar Bedding
239.96	N002	48	Primary-structure Planar Bedding
238.23	N010	49	Primary-structure Planar Bedding
237.50	N003	50	Primary-structure Planar Bedding
235.34	N006	47	Primary-structure Planar Bedding
234.85	N005	46	Primary-structure Planar Bedding
232.74	N356	46	Primary-structure Planar Bedding
232.39	N006	48	Primary-structure Planar Bedding
229.86	N003	50	Primary-structure Planar Bedding
229.00	N002	49	Primary-structure Planar Bedding
228.70	N002	49	Primary-structure Planar Bedding
226.87	N002	48	Primary-structure Planar Bedding
225.00	N003	48	Primary-structure Planar Bedding
221.60	N003	46	Primary-structure Planar Bedding
221.31	N000	48	Primary-structure Planar Bedding
219.50	N002	49	Primary-structure Planar Bedding
216.63	N001	47	Primary-structure Planar Bedding
216.11	N002	48	Primary-structure Planar Bedding
214.95	N360	49	Primary-structure Planar Bedding
214.32	N001	49	Primary-structure Planar Bedding
212.63	N001	50	Primary-structure Planar Bedding
209.61	N005	47	Primary-structure Planar Bedding
207.20	N004	48	Primary-structure Planar Bedding
206.57	N001	48	Primary-structure Planar Bedding
204.89	N001	49	Primary-structure Planar Bedding
201.54	N001	49	Primary-structure Planar Bedding
197.68	N005	49	Primary-structure Planar Bedding
196.80	N360	51	Primary-structure Planar Bedding
194.95	N003	51	Primary-structure Planar Bedding
192.84	N001	50	Primary-structure Planar Bedding
191.22	N002	49	Primary-structure Planar Bedding
189.90	N003	49	Primary-structure Planar Bedding
189.05	N001	50	Primary-structure Planar Bedding
188.07	N360	50	Primary-structure Planar Bedding
186.45	N001	48	Primary-structure Planar Bedding
184.33	N357	50	Primary-structure Planar Bedding
182.87	N357	52	Primary-structure Planar Bedding
181.27	N001	49	Primary-structure Planar Bedding
179.84	N001	49	Primary-structure Planar Bedding

Table 9, continued. Boring Z1-B6, Structure depth, dip azimuth, dip and description

Depth (feet)	Dip azimuth	Dip	Structure description
178.52	N002	50	Primary-structure Planar Bedding
176.20	N358	50	Primary-structure Planar Bedding
175.51	N350	49	Primary-structure Planar Bedding
174.39	N002	49	Primary-structure Planar Bedding
172.42	N357	51	Primary-structure Planar Bedding
171.55	N357	50	Primary-structure Planar Bedding
170.48	N354	48	Primary-structure Planar Bedding
169.66	N001	50	Primary-structure Planar Bedding
168.25	N058	15	Fracture Planar Hairline-fracture
166.95	N003	50	Primary-structure Planar Bedding
165.58	N002	49	Primary-structure Planar Bedding
164.51	N001	49	Primary-structure Planar Bedding
163.60	N360	51	Primary-structure Planar Bedding
162.54	N358	49	Primary-structure Planar Bedding
160.88	N003	48	Primary-structure Planar Bedding
159.74	N357	50	Primary-structure Planar Bedding
158.43	N360	50	Primary-structure Planar Bedding
157.47	N002	49	Primary-structure Planar Bedding
156.46	N357	51	Primary-structure Planar Bedding
154.82	N359	51	Primary-structure Planar Bedding
154.00	N357	53	Primary-structure Planar Bedding
152.88	N357	51	Primary-structure Planar Bedding
152.36	N356	53	Primary-structure Planar Bedding
149.94	N004	49	Primary-structure Planar Bedding
148.61	N360	49	Primary-structure Planar Bedding
146.74	N353	51	Primary-structure Planar Bedding
143.94	N356	54	Primary-structure Planar Bedding
142.99	N353	51	Primary-structure Planar Bedding
142.29	N354	55	Primary-structure Planar Bedding
140.89	N356	56	Primary-structure Planar Bedding
140.54	N356	57	Primary-structure Planar Bedding
140.19	N356	56	Primary-structure Planar Bedding
137.53	N358	58	Primary-structure Planar Bedding
136.31	N354	60	Primary-structure Planar Bedding
135.80	N356	58	Primary-structure Planar Bedding
134.95	N351	60	Primary-structure Planar Bedding
134.77	N353	60	Primary-structure Planar Bedding
133.64	N349	58	Primary-structure Planar Bedding
133.49	N351	58	Primary-structure Planar Bedding
132.63	N354	58	Primary-structure Planar Bedding
132.25	N351	56	Primary-structure Planar Bedding
131.67	N352	58	Primary-structure Planar Bedding
131.27	N349	60	Primary-structure Planar Bedding
130.64	N352	59	Primary-structure Planar Bedding
130.00	N355	59	Primary-structure Planar Bedding
129.39	N356	60	Primary-structure Planar Bedding
129.17	N353	61	Primary-structure Planar Bedding
128.88	N354	60	Primary-structure Planar Bedding
126.96	N352	58	Primary-structure Planar Bedding
125.48	N354	57	Primary-structure Planar Bedding

Table 9, continued. Boring Z1-B6, Structure depth, dip azimuth, dip and description

Depth (feet)	Dip azimuth	Dip	Structure description
125.12	N353	58	Primary-structure Planar Bedding
123.49	N354	60	Primary-structure Planar Bedding
122.27	N359	58	Primary-structure Planar Bedding
120.71	N355	57	Primary-structure Planar Bedding
117.50	N353	62	Primary-structure Planar Bedding
108.96	N348	59	Primary-structure Planar Bedding
107.77	N354	62	Primary-structure Planar Bedding
99.88	N347	62	Primary-structure Planar Bedding

Table 9, continued. Boring Z1-B6, Structure depth, dip azimuth, dip and description

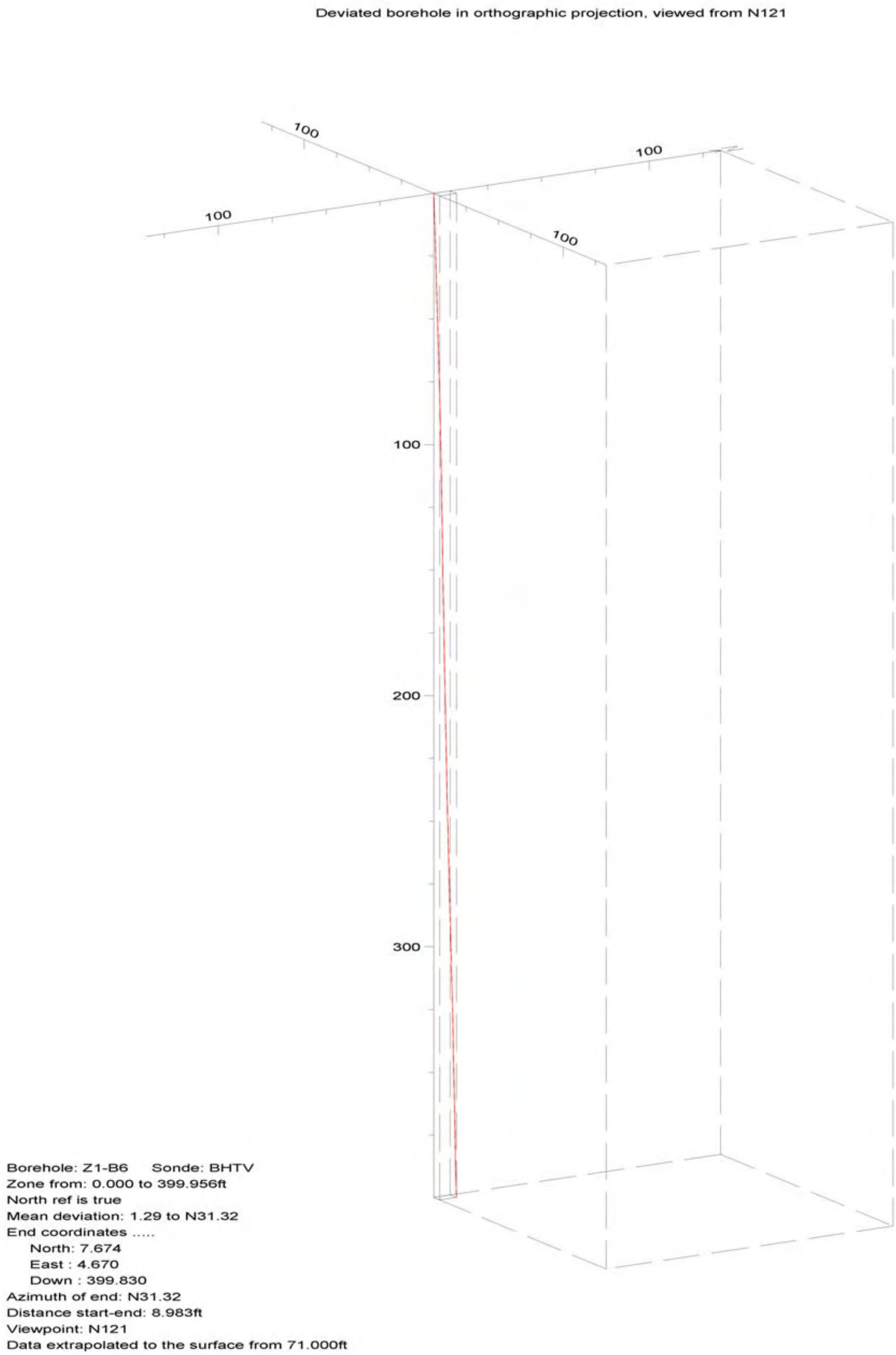


Figure 15. Boring Z1-B6, Deviation Projection

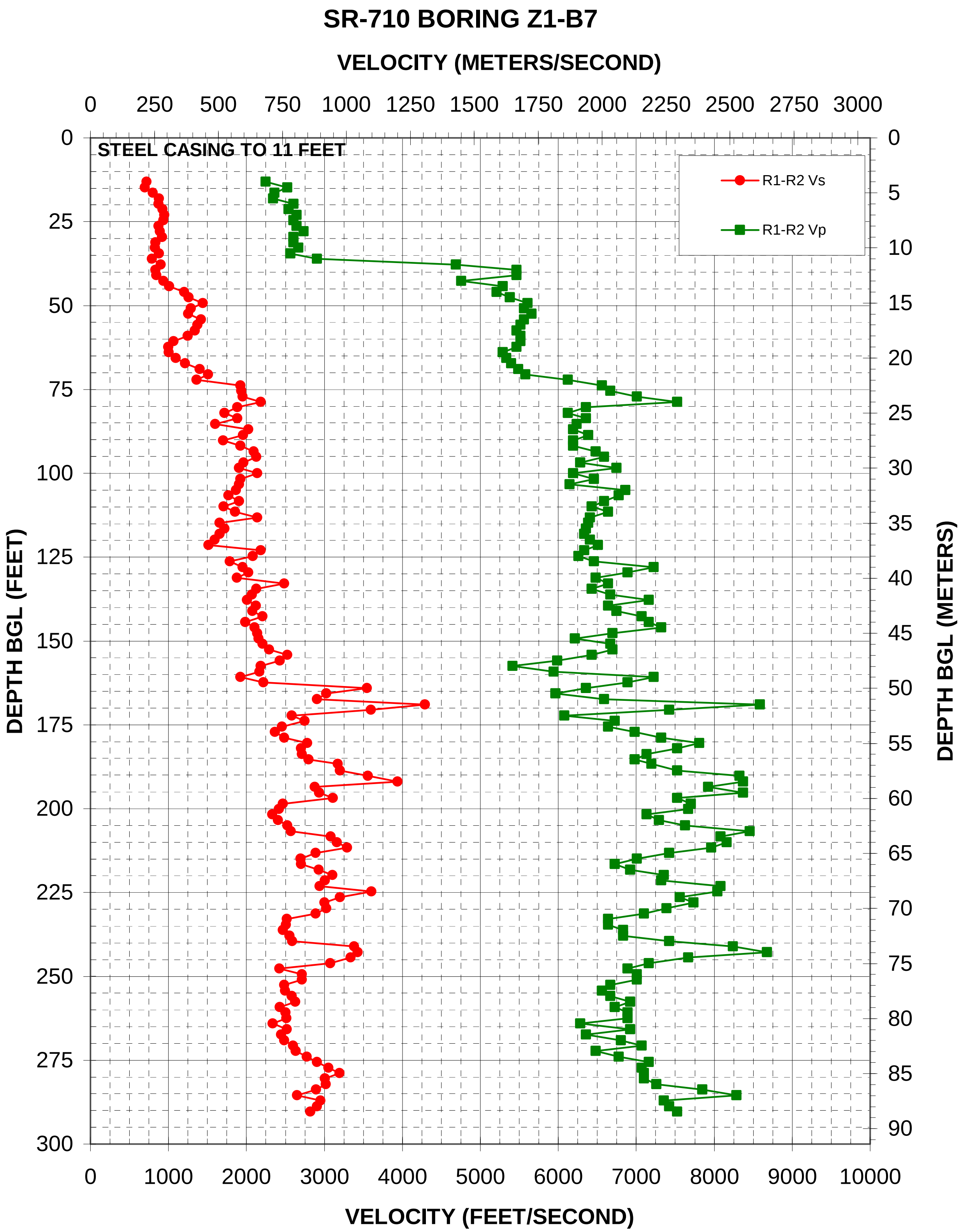


Figure 16: Boring Z1-B7, Suspension R1-R2 P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
13.12	721	2247
14.76	697	2524
16.40	802	2360
18.04	882	2343
19.69	875	2604
21.33	924	2543
22.97	948	2646
24.61	937	2604
26.25	875	2646
27.89	889	2734
29.53	922	2604
31.17	833	2604
32.81	831	2667
34.45	877	2563
36.09	789	2903
37.73	904	4687
39.37	837	5468
41.01	846	5468
42.65	935	4755
44.29	1009	5292
45.93	1202	5208
47.57	1262	5378
49.21	1442	5608
50.85	1289	5561
52.49	1252	5657
54.13	1417	5561
55.77	1376	5514
57.41	1339	5468
59.06	1247	5514
60.70	1069	5514
62.34	999	5468
63.98	1005	5292
65.62	1097	5335
67.26	1213	5396
68.90	1399	5486
70.54	1512	5580
72.18	1364	6121
73.82	1924	6562
75.46	1936	6668
77.10	1953	7010
78.74	2187	7525
80.38	1886	6358
82.02	1722	6121
83.66	1886	6358
85.30	1600	6237
86.94	2025	6190
88.58	1959	6383
90.22	1704	6190
91.86	1924	6190
93.50	2096	6484

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
95.14	2130	6588
96.78	1965	6285
98.43	1907	6751
100.07	2137	6190
101.71	1924	6458
103.35	1907	6144
104.99	1869	6864
106.63	1773	6779
108.27	1907	6588
109.91	1709	6433
111.55	1854	6641
113.19	2137	6408
114.83	1657	6383
116.47	1722	6358
118.11	1657	6334
119.75	1593	6408
121.39	1515	6510
123.03	2187	6334
124.67	2083	6261
126.31	1788	6458
127.95	1953	7227
129.59	2025	6893
131.23	1880	6484
132.87	2485	6641
134.51	2130	6433
136.15	2070	6668
137.80	2007	7163
139.44	2124	6641
141.08	2076	6751
142.72	2209	7071
144.36	1988	7163
146.00	2103	7323
147.64	2137	6696
149.28	2158	6214
150.92	2209	6668
152.56	2294	6696
154.20	2524	6433
155.84	2430	5987
157.48	2187	5414
159.12	2166	5944
160.76	1921	7227
162.40	2221	6893
164.04	3547	6358
165.68	3024	5965
167.32	2903	6588
168.96	4289	8589
170.60	3595	7423
172.24	2583	6076
173.88	2745	6723
175.52	2458	6641

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
177.17	2369	6981
178.81	2485	7323
180.45	2780	7812
182.09	2700	7525
183.73	2711	7132
185.37	2798	6981
186.68	3170	7195
188.65	3201	7525
190.29	3556	8327
191.93	3941	8369
193.57	2878	7925
195.21	2936	8369
196.85	3110	7525
198.49	2471	7701
200.13	2417	7666
201.77	2335	7132
203.41	2404	7291
205.05	2524	7630
206.69	2573	8456
208.33	3081	8081
209.97	3162	8161
211.61	3289	7963
213.25	2891	7423
214.90	2695	7010
216.54	2700	6723
218.18	2929	6922
219.82	3102	7356
221.46	3010	7323
223.10	2942	8081
224.74	3605	8041
226.38	3201	7560
228.02	3003	7738
229.66	3024	7389
231.30	2891	7101
232.94	2519	6641
234.58	2509	6641
236.22	2471	6835
237.86	2552	6835
239.50	2588	7423
241.14	3382	8243
242.78	3426	8679
244.42	3339	7666
246.06	3073	7163
247.70	2421	6893
249.34	2711	7010
250.98	2711	7010
252.62	2485	6668
254.27	2495	6562
255.91	2583	6668
257.55	2630	6922

Table 10. Boring Z1-B7, Suspension R1-R2 depths and P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
259.19	2430	6723
260.83	2504	6893
262.47	2514	6893
264.11	2339	6285
265.75	2519	6922
267.39	2444	6358
269.03	2485	6807
270.67	2599	7071
272.31	2635	6484
273.95	2774	6779
275.59	2903	7163
277.23	3052	7071
278.87	3193	7101
280.51	3010	7101
282.15	3017	7258
283.79	2897	7849
285.43	2649	8285
287.07	2949	7356
288.71	2903	7423
290.35	2822	7525

Table 10, continued. Boring Z1-B7, Suspension R1-R2 depths and P- and S_H-wave velocities

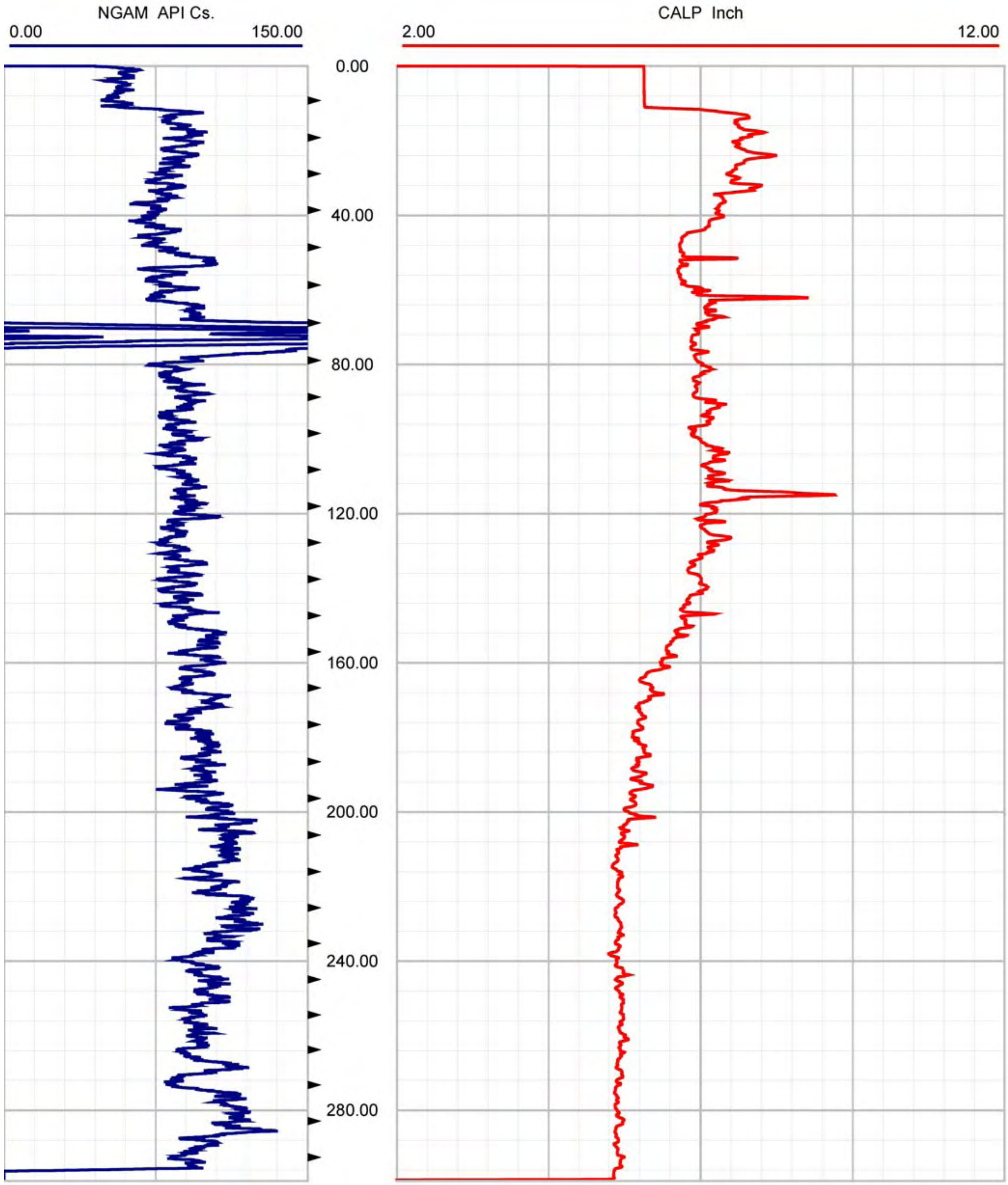


Figure 17. Boring Z1-B7, Caliper and Natural Gamma logs

DIP DATA INTERPRETATION
RGLDIP vsn 6.2
FRACTURE ANALYSIS STEREOGRAMS

CASCADE DRILLING

Borehole: Z1-B7

SR-710 TUNNEL INVESTIGATION

top of borehole.....
East:_
North:_
Elev:_

North ref: true
Depth units are feet

Zone from 290.606 to 162.911ft
Mean dip format: dip-azimuth and dip

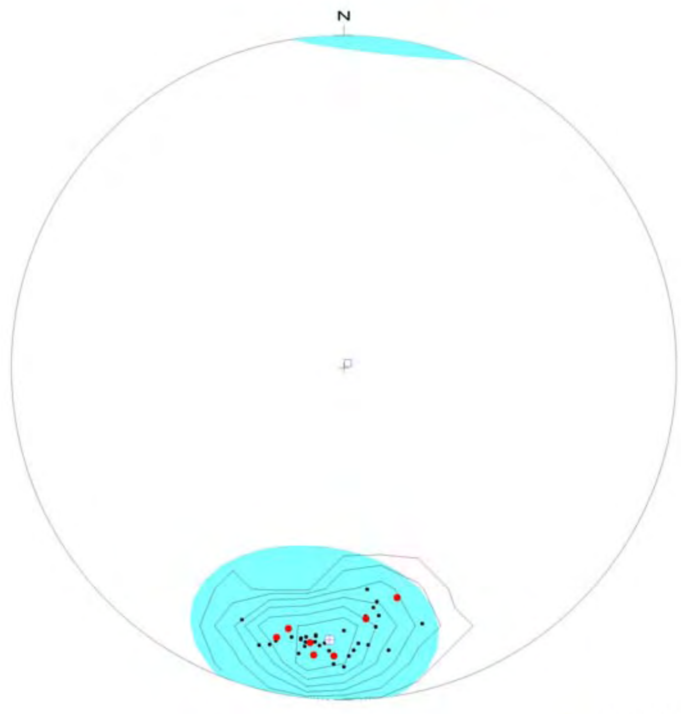
Interpretation 1

Dip data sets .....
BHTV dips

Z1-B7
Zone 0. 162.911 - 290.606ft
Deviation 1.50 N221.40

dipdata sets.....
BHTV dips
• Highlighted dips: Fracture Planar Open-fracture

	mean dip	n	f
N183 71	N183 71	41	1.04



mean dip
well axis

equal-area upper-hemisphere 0-90
contour-levels 1,3,6,10,15,21,

Figure 18. Boring Z1-B7, Stereonet Plot

Depth (feet)	Dip azimuth	Dip	Structure description
290.11	N202	71	Primary-structure Planar Bedding
282.71	N189	76	Fracture Planar Hairline-fracture
282.42	N195	75	Fracture Planar Hairline-fracture
280.36	N180	68	Fracture Planar Hairline-fracture
279.66	N175	65	Fracture Planar Open-fracture
278.85	N192	69	Fracture Planar Open-fracture
278.03	N167	60	Fracture Planar Open-fracture
276.57	N174	57	Fracture Planar Hairline-fracture
276.19	N172	60	Fracture Planar Hairline-fracture
275.75	N172	65	Fracture Planar Hairline-fracture
275.56	N175	64	Fracture Planar Hairline-fracture
275.06	N173	62	Primary-structure Planar Bedding
268.22	N171	75	Primary-structure Planar Bedding
267.36	N189	71	Primary-structure Planar Bedding
262.11	N182	78	Primary-structure Planar Bedding
261.05	N175	73	Primary-structure Planar Bedding
255.56	N163	70	Primary-structure Planar Bedding
254.78	N173	68	Primary-structure Planar Bedding
245.34	N183	74	Primary-structure Planar Bedding
235.53	N188	71	Primary-structure Planar Bedding
232.08	N186	70	Fracture Planar Hairline-fracture
231.10	N186	70	Fracture Planar Hairline-fracture
230.79	N186	70	Fracture Planar Hairline-fracture
230.32	N189	72	Fracture Planar Hairline-fracture
229.95	N191	72	Fracture Planar Hairline-fracture
228.85	N188	72	Fracture Planar Hairline-fracture
227.30	N189	72	Fracture Planar Hairline-fracture
222.05	N194	73	Fracture Planar Open-fracture
212.15	N177	72	Fracture Planar Hairline-fracture
211.98	N185	73	Fracture Planar Hairline-fracture
211.37	N184	72	Fracture Planar Hairline-fracture
210.95	N186	72	Fracture Planar Hairline-fracture
209.03	N187	72	Fracture Planar Open-fracture
202.06	N182	76	Fracture Planar Open-fracture
196.97	N186	76	Fracture Planar Open-fracture
195.89	N179	76	Fracture Planar Hairline-fracture
194.99	N178	74	Fracture Planar Hairline-fracture
194.36	N188	74	Primary-structure Planar Bedding
184.79	N180	79	Primary-structure Planar Bedding
165.17	N197	76	Primary-structure Planar Bedding
163.41	N194	74	Primary-structure Planar Bedding

Table 11. Boring Z1-B7, Structure depth, dip azimuth, dip and description

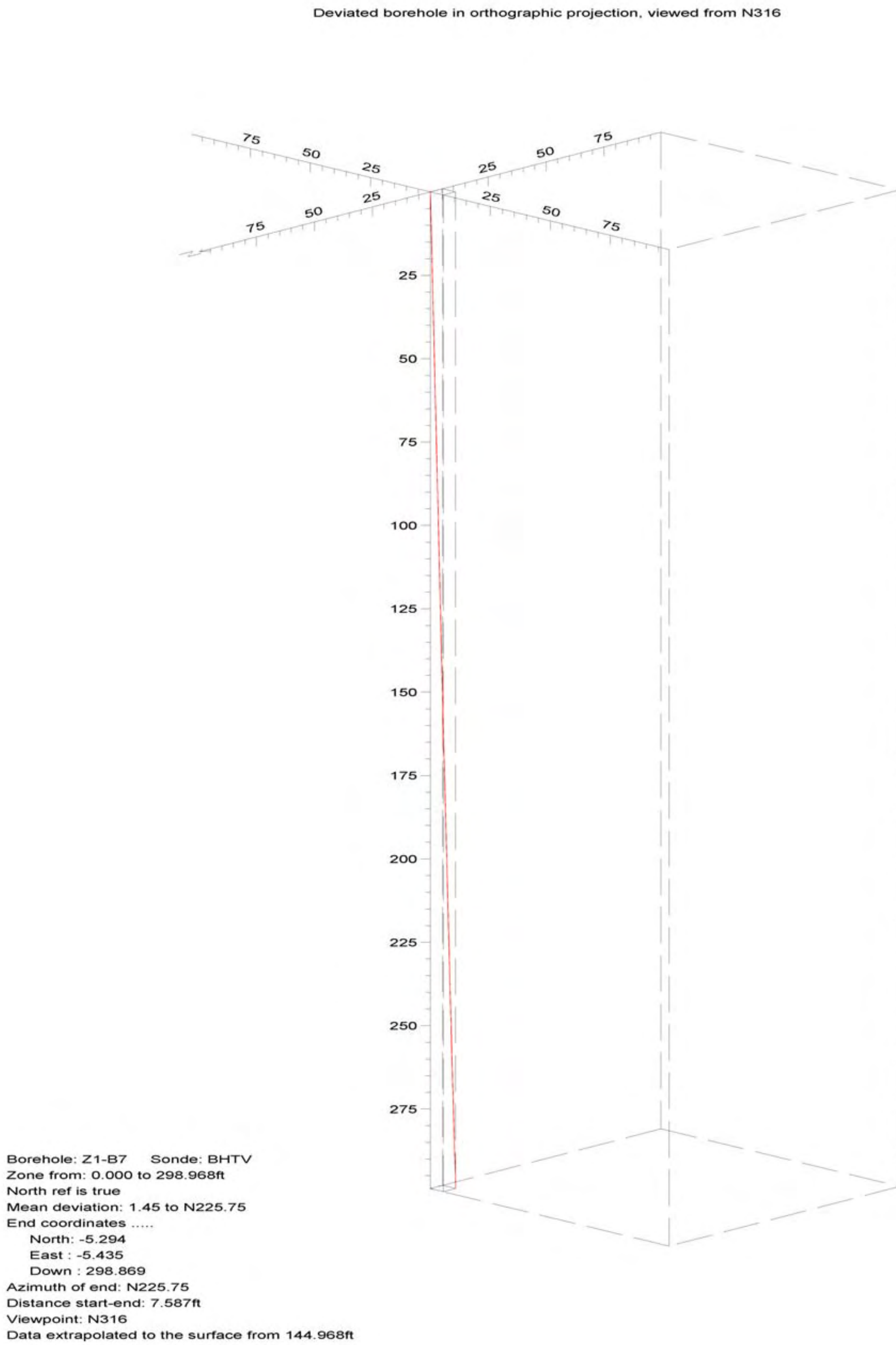


Figure 19. Boring Z1-B7, Deviation Projection

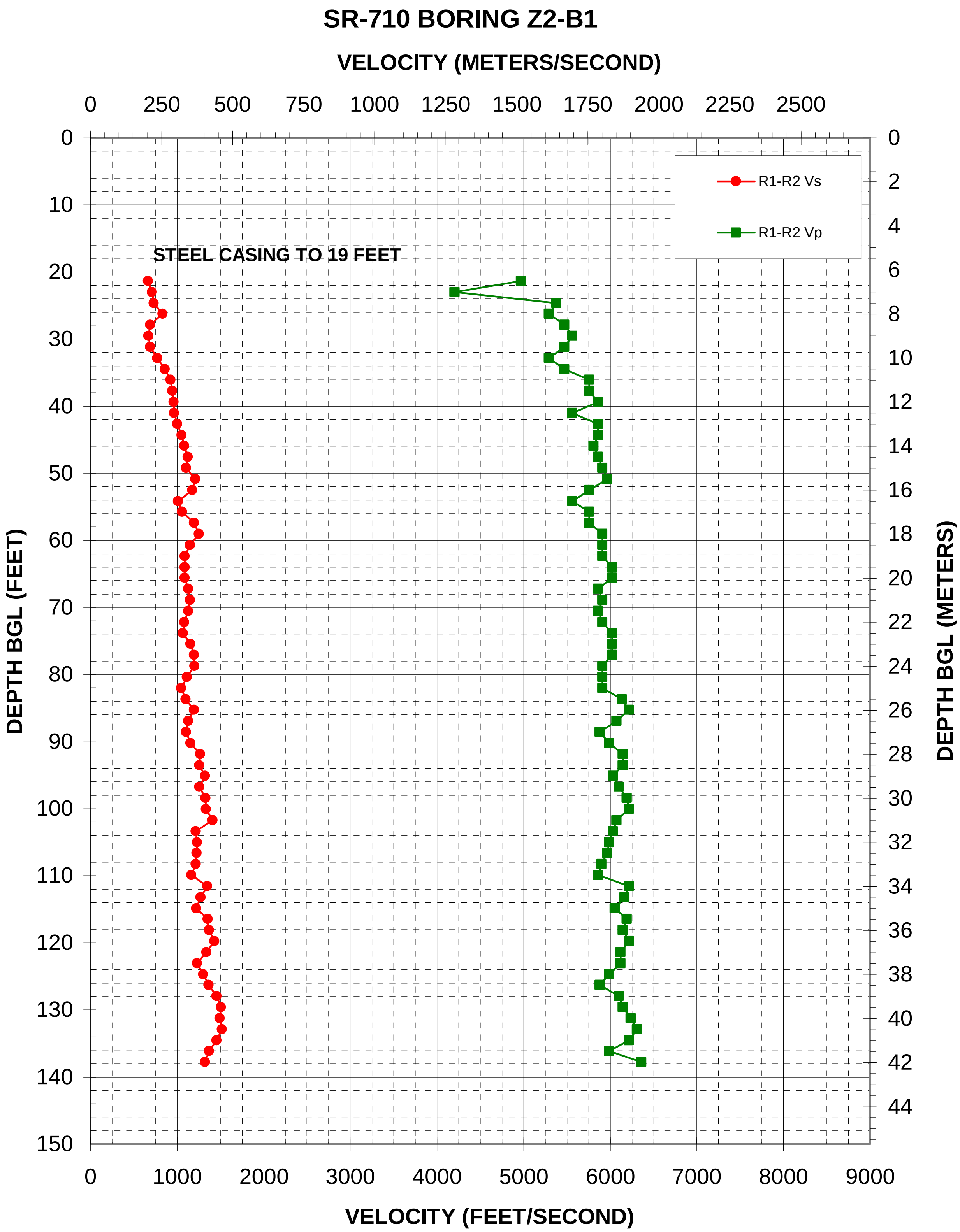


Figure 20: Boring Z2-B1, Suspension R1-R2 P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
21.33	666	4971
22.97	712	4206
24.61	732	5378
26.25	835	5292
27.89	691	5468
29.53	671	5561
31.17	691	5468
32.81	770	5292
34.45	859	5468
36.09	927	5756
37.73	943	5756
39.37	962	5859
41.01	968	5561
42.65	1000	5859
44.29	1052	5859
45.93	1085	5807
47.57	1124	5859
49.21	1105	5911
50.85	1211	5965
52.49	1176	5756
54.13	1009	5561
55.77	1055	5756
57.41	1193	5756
59.06	1252	5911
60.70	1147	5911
62.34	1086	5911
63.98	1086	6020
65.62	1086	6020
67.26	1131	5859
68.90	1147	5911
70.54	1131	5859
72.18	1083	5911
73.82	1069	6020
75.46	1155	6020
77.10	1197	6020
78.74	1202	5911
80.38	1112	5911
82.02	1045	5911
83.66	1097	6132
85.30	1193	6214
86.94	1131	6076
88.58	1101	5880
90.22	1155	5987
91.86	1267	6144
93.50	1257	6144
95.14	1323	6031
96.78	1257	6098
98.43	1328	6190
100.07	1334	6214
101.71	1408	6076
103.35	1215	6031
104.99	1229	5987
106.63	1224	5965
108.27	1215	5901
109.91	1163	5859
111.55	1350	6214
113.19	1272	6167
114.83	1220	6053
116.47	1356	6190
118.11	1367	6144
119.75	1433	6214
121.39	1339	6121
123.03	1229	6121
124.67	1302	5987
126.31	1361	5880
127.95	1458	6098
129.59	1505	6144
131.23	1491	6237
132.87	1519	6309
134.51	1458	6214
136.15	1367	5987
137.80	1323	6358

Table 12. Boring Z2-B1, Suspension R1-R2 depths and P- and S_H-wave velocities

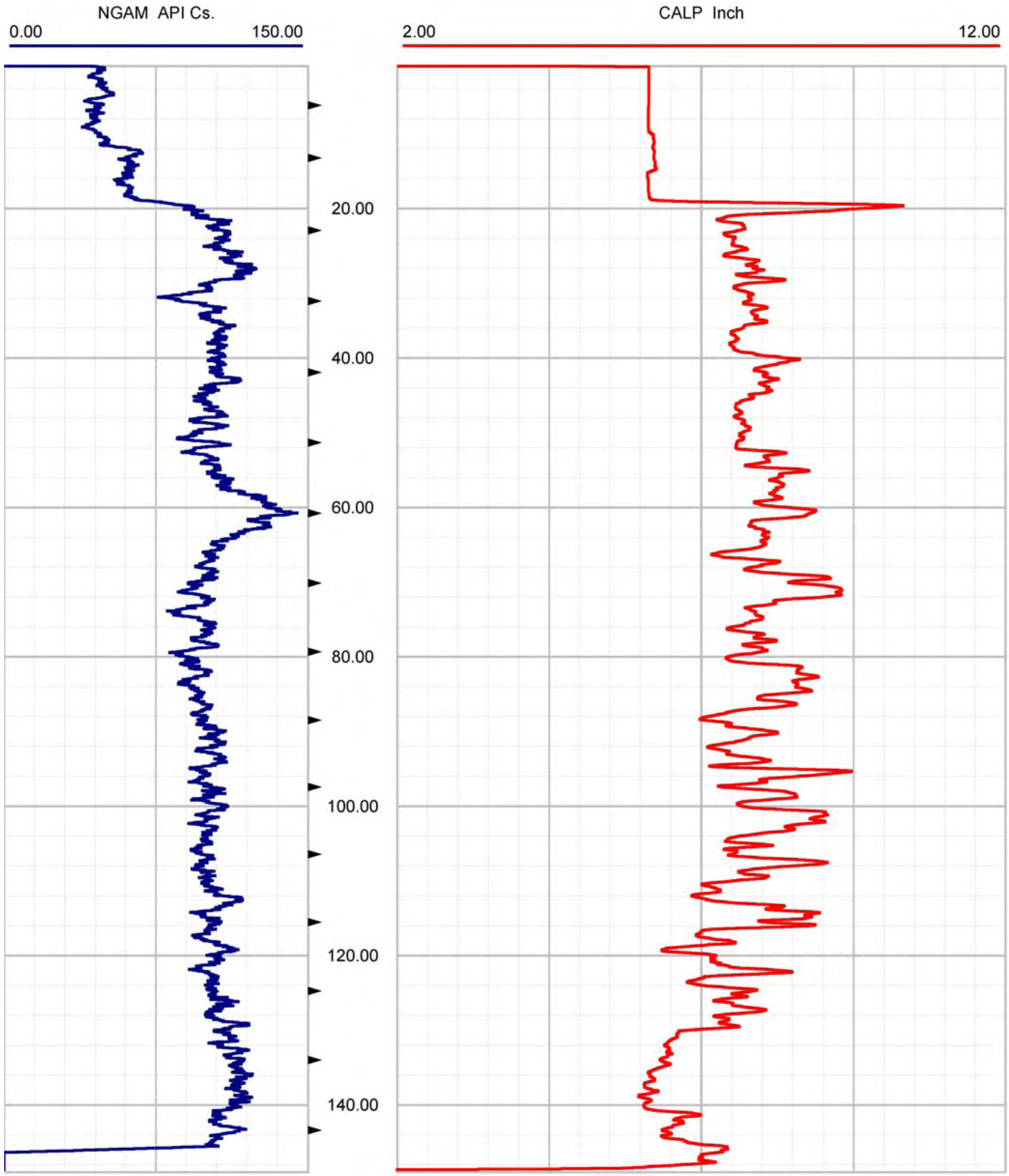


Figure 21. Boring Z2-B1, Caliper and Natural Gamma logs

DIP DATA INTERPRETATION
RGLDIP vsn 6.2
FRACTURE ANALYSIS STEREOGRAMS

CASCADE DRILLING

Borehole: Z2-B1

SR-710 TUNNEL INVESTIGATION

top of borehole.....
East:_
North:_
Elev:_

North ref: true
Depth units are feet

Zone from 142.728 to 141.728ft
Mean dip format: dip-azimuth and dip

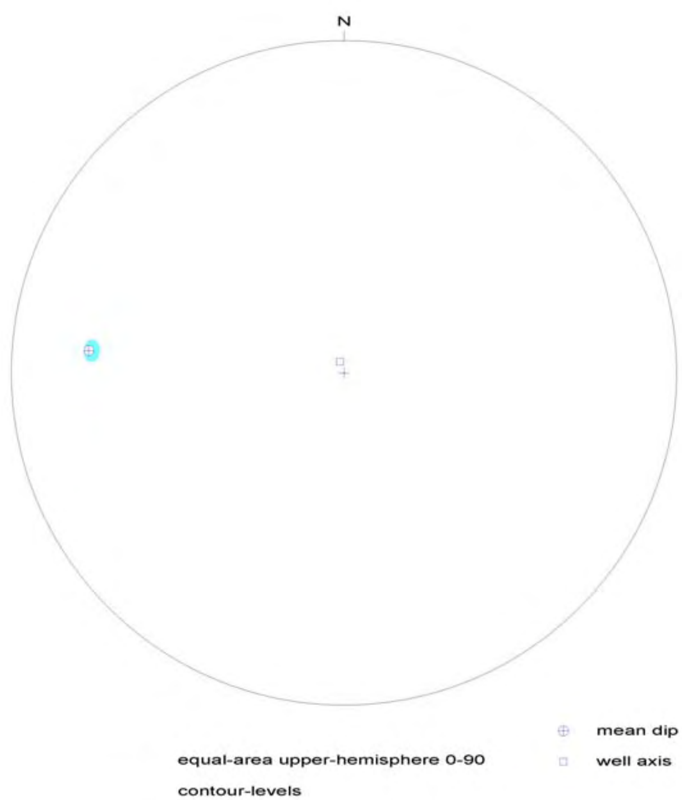
Interpretation 1

Dip data sets .....
BHTV dips

Z2-B1
Zone 0. 141.728 - 142.718ft
Deviation 2.90 N159.20

dipdata sets.....
BHTV dips
• Highlighted dips: Fracture Planar Hairline-fracture

	mean dip	n	f
N275 66	N275 66	1	0.00



Z2-B1, Interpretation 1 142.718 to 141.728ft 1

Figure 22. Boring Z2-B1, Stereonet Plot

Depth (feet)	Dip azimuth	Dip	Structure description
142.23	N275	66	Primary-structure Planar Bedding

Table 13. Boring Z2-B1, Structure depth, dip azimuth, dip and description

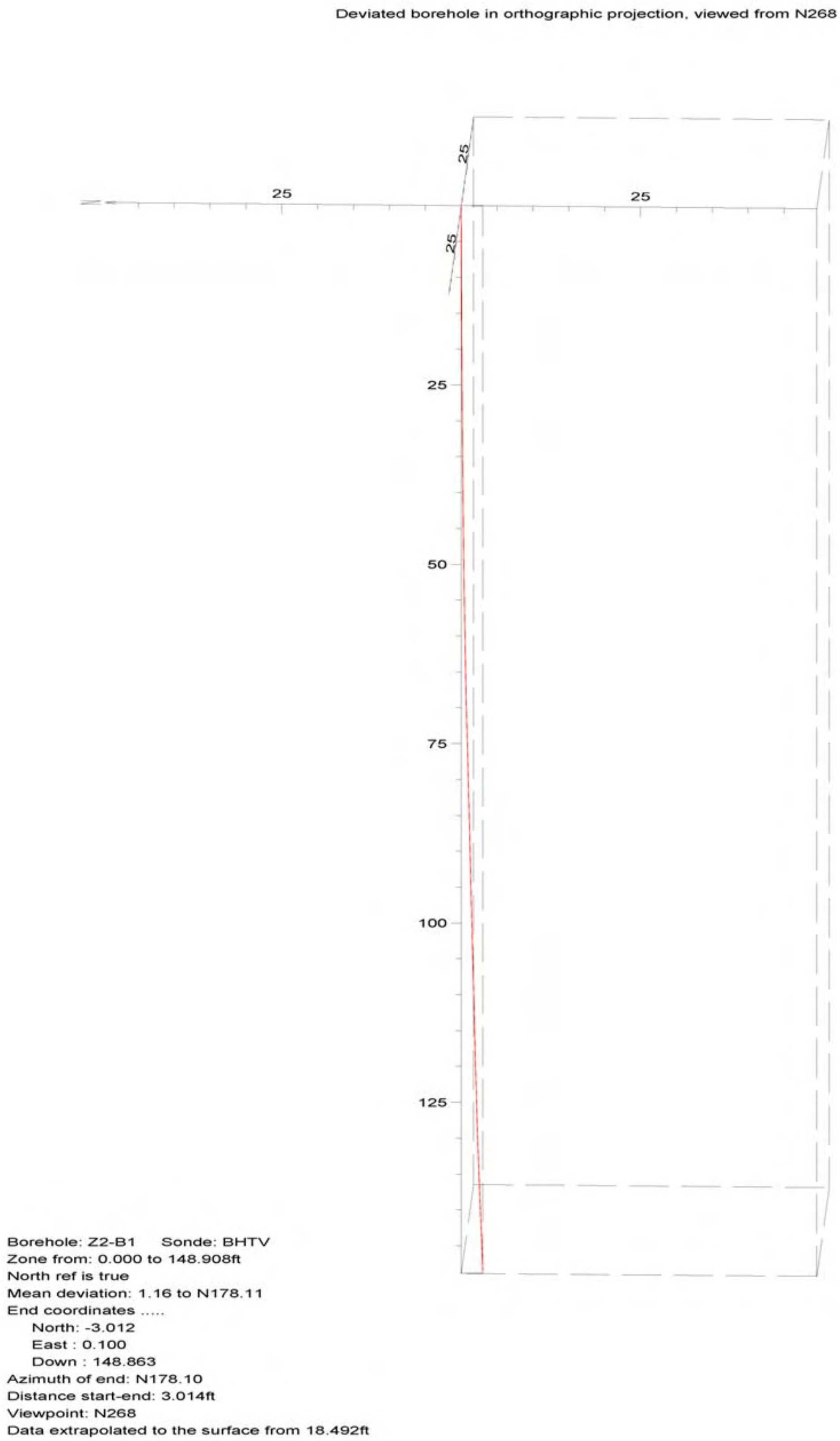


Figure 23. Boring Z2-B1, Deviation Projection

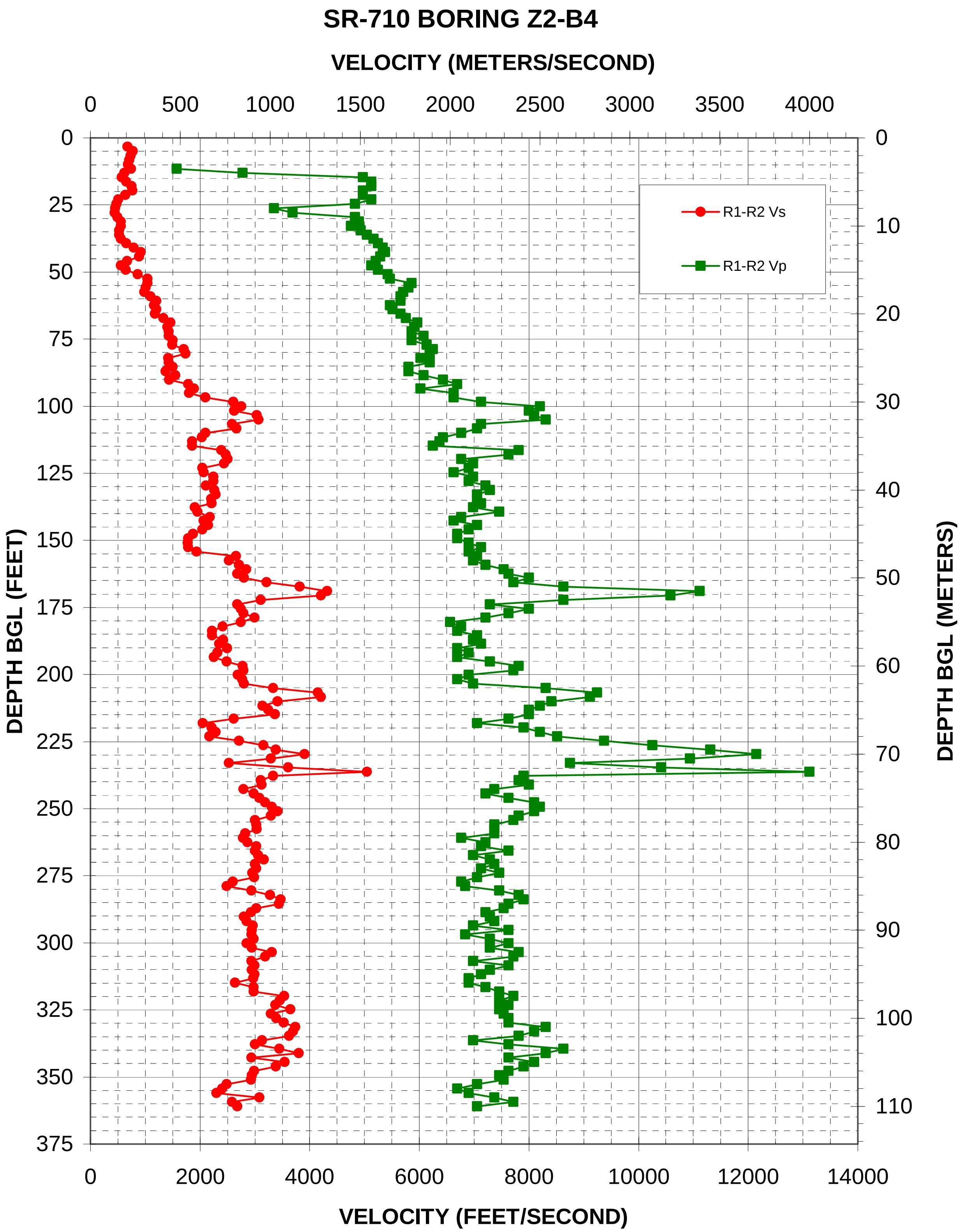


Figure 24: Boring Z2-B4, Suspension R1-R2 P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
3.28	676	
4.92	772	
6.56	737	
8.20	713	
9.84	687	
11.48	741	1577
13.12	622	2780
14.76	571	4971
16.40	656	5126
18.04	754	5126
19.69	763	4971
21.33	640	4971
22.97	513	5126
24.61	475	4825
26.25	456	3348
27.89	448	3686
29.53	492	4825
31.17	554	4897
32.81	558	4755
34.45	523	4934
36.09	527	5047
37.73	554	5167
39.37	656	5249
41.01	791	5335
42.65	924	5378
44.29	887	5292
45.93	672	5208
47.57	556	5126
49.21	645	5249
50.85	861	5423
52.49	1042	5468
54.13	1038	5859
55.77	1006	5807
57.41	982	5706
59.06	1101	5657
60.70	1206	5657
62.34	1163	5468
63.98	1202	5514
65.62	1180	5657
67.26	1334	5756
68.90	1465	5965
70.54	1408	5911
72.18	1433	5859
73.82	1426	6076
75.46	1498	5859
77.10	1491	6132
78.74	1700	6249
80.38	1736	6190
82.02	1420	6020
83.66	1433	6190
85.30	1505	5807
86.94	1373	5807
88.58	1548	6076
90.22	1439	6433
91.86	1783	6696
93.50	1886	6020
95.14	1803	6628
96.78	2103	6628
98.43	2604	7132
100.07	2757	8202
101.71	2625	8002
103.35	3038	8101
104.99	3066	8306
106.63	2583	7132
108.27	2667	7056
109.91	2103	6765
111.55	2038	6433
113.19	1859	6371
114.83	1854	6249
116.47	2386	7812
118.11	2467	7630
119.75	2504	6765
121.39	2439	6981
123.03	2044	6907
124.67	2063	6628
126.31	2247	6981
127.95	2247	6907
129.59	2110	7211
131.23	2263	7291
132.87	2286	7056
134.51	2202	7056
136.15	2209	7132
137.80	1907	6981
139.44	1953	7456
141.40	2180	6765
142.72	2070	6628
144.36	2151	7056
146.00	2044	6907
147.64	1875	6696
149.28	1788	6696
150.92	1773	6907
152.56	1783	7132
154.20	1941	6907
155.84	2657	7056
157.48	2524	6981
159.12	2711	7211
160.76	2841	7542
162.40	2678	7630
164.04	2804	8002
165.68	3217	7720
167.32	3815	8634
168.96	4317	11121
170.60	4206	10583
172.24	3110	8634
173.88	2678	7291
175.52	2745	8002
177.17	2792	7630
178.81	2996	7211
180.45	2745	6562
182.09	2412	6765
183.73	2224	6696
185.37	2217	7056
187.01	2421	6981
188.65	2352	7132
190.29	2495	6696
191.93	2319	6907
193.57	2255	6696
195.21	2485	7291
196.85	2780	7812
198.49	2792	7720
200.13	2689	6907
201.77	2769	6696
203.41	2804	6981
205.05	3331	8306
206.69	4153	9242
208.33	4206	9113
209.97	3418	8412
211.61	3140	8202
213.25	3248	8002
214.90	3365	8002
216.54	2614	7630
218.18	2051	7056
219.82	2209	7906
221.46	2286	8202
223.10	2173	8522
224.74	2711	9374
226.38	3155	10253
228.02	3382	11313
229.66	3906	12151
231.30	3297	10936
232.94	2524	8749
234.58	3605	10415
236.22	5047	13123
237.86	3331	7906
239.50	3110	7812
241.14	3125	8002
242.78	2792	7373
244.42	2983	7211
246.06	3081	7630
247.70	3185	8101

NOTE: “blank” space indicates data of insufficient quality for good pick.

Table 14. Boring Z2-B4, Suspension R1-R2 depths and P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
249.34	3314	8202
250.98	3418	8101
252.62	3297	7812
254.27	3003	7720
255.91	3024	7373
257.55	3038	7373
259.19	2828	7373
260.83	2786	6765
262.47	2865	7211
264.11	3024	7132
265.75	3003	7630
267.39	3059	6981
269.03	3162	7291
270.67	3003	7373
272.31	3024	7132
273.95	2956	7456
275.59	2989	7056
277.23	2599	6765
278.87	2485	6835
280.51	2942	7456
282.15	3281	7812
283.79	3472	7906
285.43	3435	7630
287.07	3024	7542
288.71	2929	7211
290.35	2804	7291
291.99	2853	7373
293.64	2962	6981
295.28	2949	7630
296.92	2942	6835
298.56	2976	7291
300.20	2847	7630
301.84	2949	7291
303.48	3314	7812
305.12	3193	7720
306.76	2942	6981
308.40	2996	7630
310.04	2949	7291
311.68	2996	7132
313.32	2969	6907
314.96	2641	6907
316.60	2976	7211
318.24	2976	7456
319.88	3537	7720
321.52	3454	7456
323.16	3374	7630
324.80	3645	7456
326.44	3297	7542
328.08	3391	7630
329.72	3528	7630

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
331.36	3739	8306
333.01	3697	8101
334.65	3625	7812
336.29	3132	6981
337.93	3003	7630
339.57	3444	8634
341.21	3804	8306
342.85	2936	7630
344.49	3547	8101
346.13	3382	7906
347.77	2989	7630
349.41	2949	7456
351.05	2929	7542
352.69	2485	7056
354.33	2404	6696
355.97	2302	6907
357.61	3081	7373
359.25	2583	7720
360.89	2678	7056

Table 14, continued. Boring Z2-B4, Suspension R1-R2 depths and P- and S_H-wave velocities

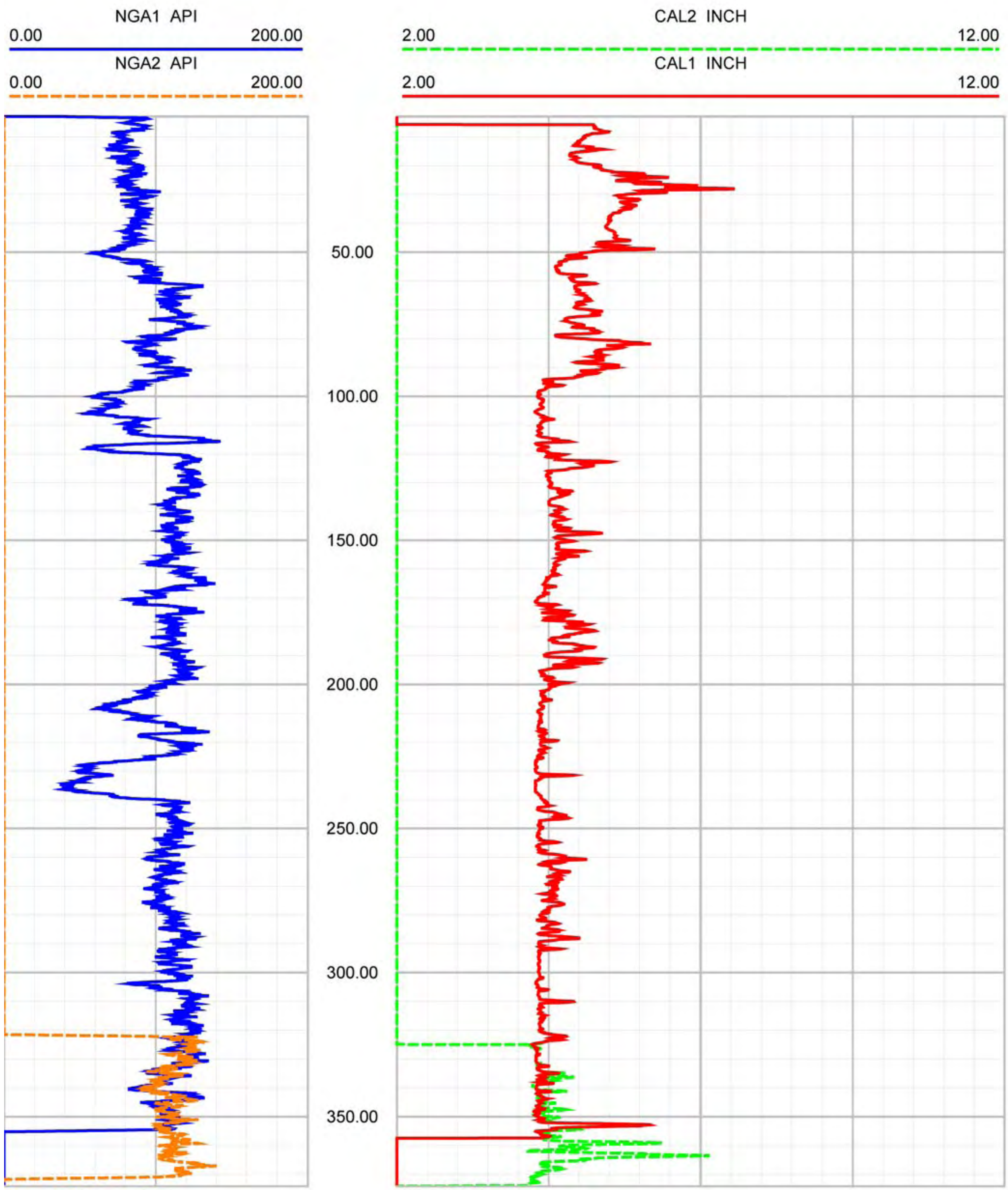


Figure 25. Boring Z2-B4, Caliper and Natural Gamma logs

DIP DATA INTERPRETATION
RGLDIP vsn 6.2
FRACTURE ANALYSIS STEREOGRAMS

CASCADE DRILLING

Borehole: Z2-B4

SR-710 TUNNEL INVESTIGATION

top of borehole.....
East:_
North:_
Elev:_

North ref: true
Depth units are feet

Zone from 372.508 to 63.101ft
Mean dip format: dip-azimuth and dip

Interpretation 1

Dip data sets .....
BHTV dips

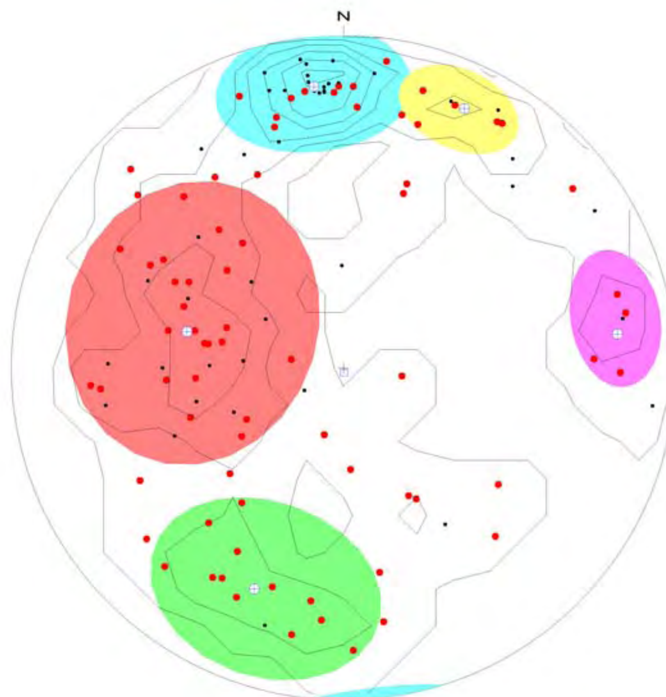
Z2-B4
Zone 0. 63.101 - 372.498ft
Deviation 1.20 N355.10

dipdata sets.....
BHTV dips
• Highlighted dips: Fracture Planar Hairline-fracture

	mean dip	n	f
N354 74	N354 74	30	(0.38)
N283 40	N283 40	37	0.16
N202 61	N202 61	13	(0.08)
N083 72	N083 72	5	(0.05)
N025 75	N025 75	7	(0.09)

intersections

	N354 74	N283 40	N202 61	N083 72	N025 75
N354 74		40 N278	30 N273	67 N042	74 N003
N283 40	40 N278		39 N266	13 N357	38 N307
N202 61	30 N273	39 N266		49 N151	04 N114
N083 72	67 N042	13 N357	49 N151		71 N064
N025 75	74 N003	38 N307	04 N114	71 N064	



mean dip
well axis

equal-area upper-hemisphere 0-90
contour-levels 1,3,6,10,15,21,

Z2-B4, Interpretation 1 372.498 to 63.101ft 1

Figure 26. Boring Z2-B4, Stereonet Plot

Depth (feet)	Dip azimuth	Dip	Structure description
372.01	N310	70	Fracture Planar Hairline-fracture
371.64	N297	48	Fracture Planar Hairline-fracture
358.32	N229	68	Fracture Planar Hairline-fracture
355.82	N344	60	Primary-structure Planar Bedding
353.21	N335	60	Primary-structure Planar Bedding
351.36	N019	46	Fracture Planar Hairline-fracture
347.18	N301	53	Fracture Planar Hairline-fracture
346.92	N298	56	Fracture Planar Hairline-fracture
340.12	N345	67	Fracture Planar Hairline-fracture
335.30	N354	73	Primary-structure Planar Bedding
333.92	N356	74	Primary-structure Planar Bedding
332.78	N356	72	Primary-structure Planar Bedding
332.48	N355	72	Primary-structure Planar Bedding
332.28	N356	72	Primary-structure Planar Bedding
331.62	N354	73	Primary-structure Planar Bedding
329.41	N353	76	Primary-structure Planar Bedding
326.88	N357	75	Primary-structure Planar Bedding
324.88	N359	75	Primary-structure Planar Bedding
322.72	N002	74	Fracture Planar Hairline-fracture
321.26	N003	68	Fracture Planar Hairline-fracture
319.15	N075	74	Fracture Planar Hairline-fracture
318.02	N298	65	Fracture Planar Hairline-fracture
317.58	N171	66	Fracture Planar Hairline-fracture
316.66	N282	45	Fracture Planar Hairline-fracture
316.23	N280	35	Fracture Planar Hairline-fracture
315.75	N294	43	Fracture Planar Bedding
315.28	N312	49	Fracture Planar Bedding
312.60	N270	45	Fracture Planar Open-fracture
311.03	N291	43	Fracture Planar Hairline-fracture
309.49	N284	38	Fracture Planar Hairline-fracture
308.08	N321	40	Fracture Planar Hairline-fracture
306.82	N240	11	Fracture Planar Open-fracture
306.55	N313	31	Fracture Planar Open-fracture
304.96	N302	23	Fracture Planar Open-fracture
301.89	N310	38	Fracture Planar Hairline-fracture
301.36	N282	31	Fracture Planar Hairline-fracture
300.88	N318	47	Fracture Planar Hairline-fracture
300.21	N178	74	Fracture Planar Hairline-fracture
300.05	N317	60	Fracture Planar Hairline-fracture
299.48	N289	31	Fracture Planar Hairline-fracture
299.05	N280	34	Fracture Planar Hairline-fracture
297.35	N222	69	Fracture Planar Hairline-fracture
297.11	N248	29	Primary-structure Planar Bedding
296.16	N151	37	Fracture Planar Hairline-fracture
296.09	N274	25	Primary-structure Planar Bedding
294.36	N313	77	Fracture Planar Hairline-fracture
293.43	N266	44	Fracture Planar Hairline-fracture
292.43	N294	54	Fracture Planar Open-fracture
291.74	N299	44	Fracture Planar Hairline-fracture
290.23	N212	64	Fracture Planar Hairline-fracture

Table 15. Boring Z2-B4, Structure depth, dip azimuth, dip and description

Depth (feet)	Dip azimuth	Dip	Structure description
287.54	N265	63	Fracture Planar Hairline-fracture
278.90	N016	76	Fracture Planar Hairline-fracture
278.82	N033	77	Fracture Planar Hairline-fracture
277.31	N127	49	Fracture Planar Hairline-fracture
276.54	N138	58	Fracture Planar Hairline-fracture
262.81	N147	47	Primary-structure Planar Bedding
260.29	N031	80	Fracture Planar Open-fracture
258.50	N032	76	Fracture Planar Hairline-fracture
257.53	N326	59	Fracture Planar Hairline-fracture
252.83	N221	52	Fracture Planar Hairline-fracture
252.20	N349	72	Fracture Planar Hairline-fracture
250.80	N336	54	Fracture Planar Hairline-fracture
250.61	N339	77	Fracture Planar Hairline-fracture
248.47	N039	70	Primary-structure Planar Bedding
245.68	N097	83	Fracture Planar Open-fracture
243.08	N043	64	Primary-structure Planar Bedding
242.02	N197	70	Primary-structure Planar Bedding
239.17	N279	13	Fracture Planar Hairline-fracture
235.45	N153	36	Fracture Planar Hairline-fracture
234.66	N242	27	Fracture Planar Hairline-fracture
233.82	N271	33	Primary-structure Planar Bedding
230.68	N236	30	Fracture Planar Hairline-fracture
230.67	N210	54	Fracture Planar Hairline-fracture
230.37	N227	39	Fracture Planar Hairline-fracture
228.17	N266	37	Fracture Planar Hairline-fracture
227.88	N252	40	Fracture Planar Hairline-fracture
227.81	N266	65	Fracture Planar Hairline-fracture
226.68	N022	75	Primary-structure Planar Bedding
224.18	N013	67	Fracture Planar Hairline-fracture
223.83	N017	66	Fracture Planar Hairline-fracture
222.73	N098	14	Fracture Planar Hairline-fracture
221.57	N079	76	Fracture Planar Hairline-fracture
220.56	N188	60	Fracture Planar Hairline-fracture
219.40	N217	42	Fracture Planar Hairline-fracture
218.07	N170	53	Fracture Planar Hairline-fracture
217.72	N205	65	Fracture Planar Hairline-fracture
217.23	N052	77	Fracture Planar Hairline-fracture
216.54	N196	17	Fracture Planar Hairline-fracture
214.54	N091	72	Fracture Planar Hairline-fracture
210.95	N176	25	Fracture Planar Hairline-fracture
208.84	N088	65	Fracture Planar Hairline-fracture
207.87	N348	74	Primary-structure Planar Bedding
205.72	N345	75	Primary-structure Planar Bedding
204.29	N185	65	Fracture Planar Hairline-fracture
203.48	N358	72	Fracture Planar Hairline-fracture
203.02	N352	73	Fracture Planar Hairline-fracture
200.58	N345	81	Primary-structure Planar Bedding
198.71	N354	74	Primary-structure Planar Bedding
197.32	N353	78	Primary-structure Planar Bedding
197.04	N198	59	Fracture Planar Hairline-fracture

Table 15, continued. Boring Z2-B4, Structure depth, dip azimuth, dip and description

Depth (feet)	Dip azimuth	Dip	Structure description
196.55	N210	62	Fracture Planar Hairline-fracture
192.65	N019	49	Fracture Planar Hairline-fracture
191.15	N344	64	Fracture Planar Hairline-fracture
182.49	N058	78	Primary-structure Planar Bedding
172.51	N191	71	Fracture Planar Hairline-fracture
170.53	N008	82	Fracture Planar Hairline-fracture
167.26	N359	74	Fracture Planar Hairline-fracture
153.62	N358	82	Primary-structure Planar Bedding
150.93	N353	81	Primary-structure Planar Bedding
142.63	N006	78	Primary-structure Planar Bedding
134.65	N352	83	Primary-structure Planar Bedding
120.06	N327	68	Primary-structure Planar Bedding
116.80	N359	25	Primary-structure Planar Bedding
116.14	N023	75	Fracture Planar Hairline-fracture
114.10	N354	75	Primary-structure Planar Bedding
104.93	N080	74	Primary-structure Planar Bedding
99.39	N248	46	Primary-structure Planar Bedding
96.06	N261	62	Primary-structure Planar Bedding
79.11	N257	38	Primary-structure Planar Bedding
72.91	N271	60	Primary-structure Planar Bedding
63.60	N241	59	Fracture Planar Hairline-fracture

Table 15, continued. Boring Z2-B4, Structure depth, dip azimuth, dip and description

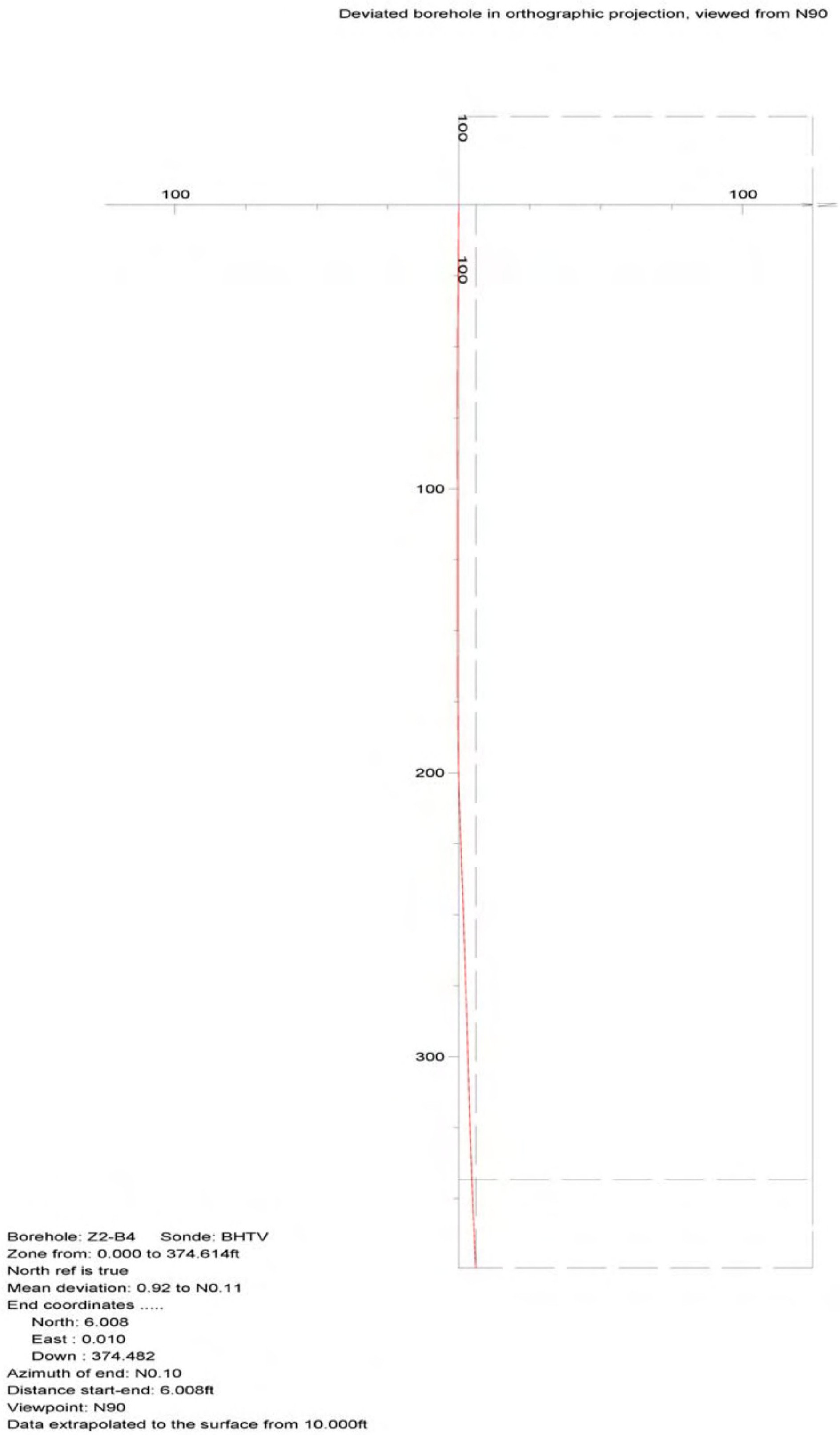


Figure 27. Boring Z2-B4, Deviation Projection

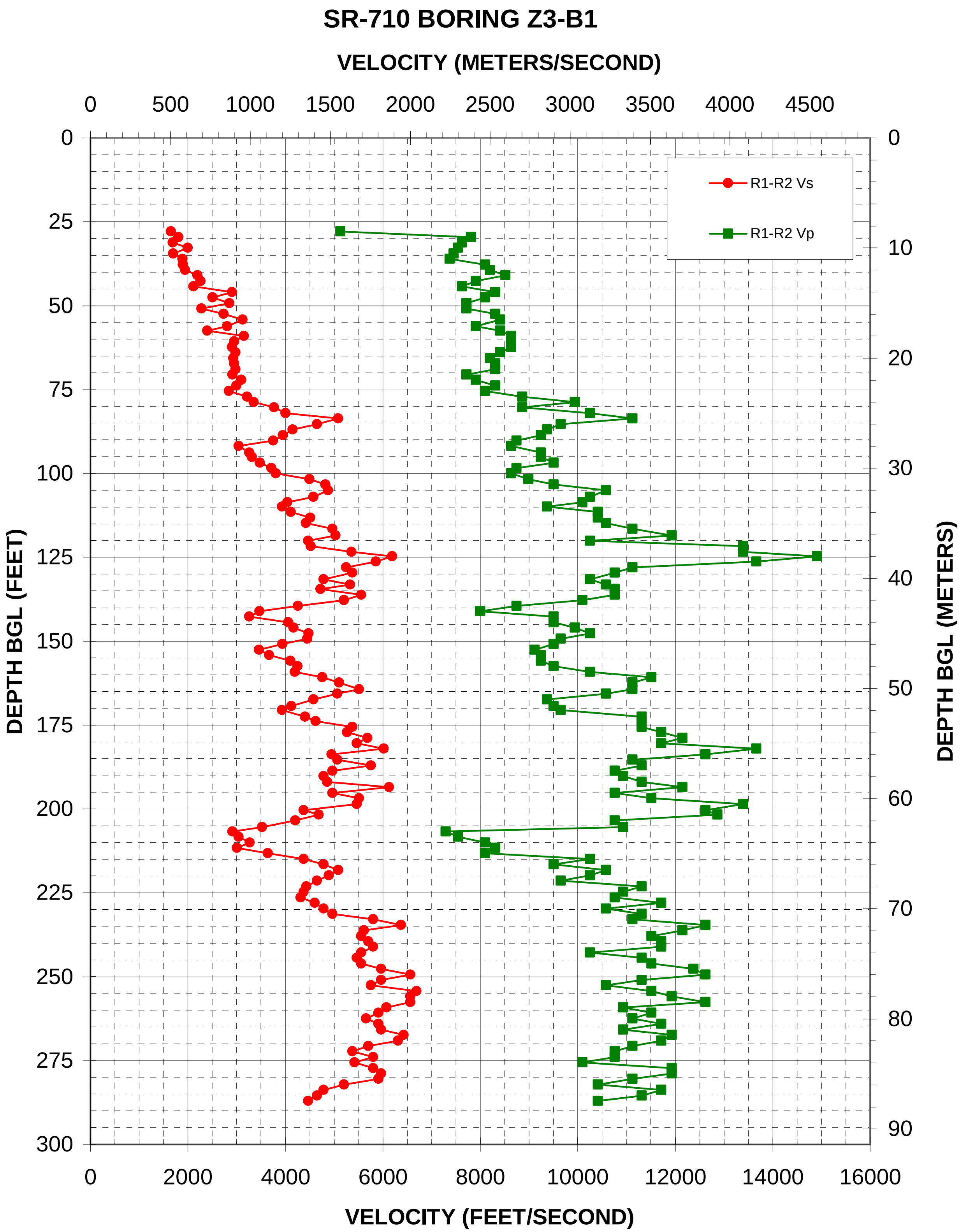


Figure 28: Boring Z3-B1, Suspension R1-R2 P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
27.89	1649	5126
29.53	1803	7812
31.17	1691	7630
32.81	2001	7542
34.45	1700	7456
36.09	1886	7373
37.73	1896	8101
39.37	1941	8202
41.01	2202	8522
42.65	2263	7906
44.29	2117	7630
45.93	2903	8306
47.57	2504	8101
49.21	2853	7720
50.85	2278	7720
52.49	2734	8306
54.13	3125	8412
56.10	2804	7906
57.41	2395	8412
59.06	3155	8634
60.70	2956	8634
62.34	2903	8634
63.98	2983	8412
65.62	2929	8202
67.26	2956	8306
68.90	2983	8306
70.54	2916	7720
72.18	3095	7906
73.82	2996	8306
75.46	2841	8101
77.10	3217	8867
78.74	3348	9942
80.38	3771	8867
82.02	4001	10253
83.66	5087	11121
85.30	4654	9650
86.94	4153	9374
88.58	3953	9242
90.22	3750	8749
91.86	3038	8634
93.83	3256	9242
95.14	3314	9242
96.78	3481	9510
98.43	3718	8749
100.07	3804	8634
101.71	4494	8989
103.35	4825	9510
104.99	4879	10583
106.96	4573	10253
108.60	4038	10095

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
109.91	3929	9374
111.55	4114	10415
113.19	4510	10415
114.83	4419	10583
116.47	4971	11121
118.44	5028	11930
120.08	4464	10253
121.72	4525	13391
123.36	5356	13391
124.67	6190	14913
126.31	5859	13670
127.95	5249	11121
129.59	5378	10757
131.56	4790	10253
133.20	5335	10583
134.51	4721	10757
136.15	5561	10757
137.80	5208	10095
139.44	4261	8749
141.08	3472	8002
142.72	3256	9510
144.36	4063	9510
146.00	4166	9942
147.64	4479	10253
149.28	4449	9650
150.92	3941	9510
152.56	3463	9113
154.20	3666	9242
155.84	4101	9242
157.48	4247	9510
159.12	4193	10253
160.76	4755	11512
162.40	5106	11121
164.37	5514	11121
165.68	5067	10583
167.32	4573	9374
169.29	4127	9510
170.60	3929	9650
172.57	4404	11313
173.88	4621	11313
175.52	5378	11313
177.17	5270	11717
178.81	5681	12151
180.45	5468	11717
182.09	6020	13670
183.73	4952	12619
185.37	5067	11121
187.01	5756	11313
188.65	4971	10757
190.29	4790	10936

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
191.93	4861	11313
193.57	6132	12151
195.21	4971	10757
196.85	5514	11512
198.49	5468	13391
200.46	4374	12619
201.77	4687	12866
203.41	4206	10757
205.38	3528	10936
206.69	2916	7291
208.33	3038	7542
209.97	3265	8101
211.61	3010	8306
213.25	3645	8101
214.90	4374	10253
216.54	4790	9510
218.18	5087	10583
219.82	4897	10253
221.46	4654	9650
223.10	4434	11313
224.74	4374	10936
226.38	4317	10757
228.02	4605	11717
229.66	4790	10583
231.30	4971	11313
232.94	5807	11121
234.58	6371	12619
236.22	5608	12151
237.86	5561	11512
239.50	5706	11717
241.14	5807	11717
242.78	5561	10253
244.42	5468	11313
246.06	5561	11512
247.70	5965	12381
249.34	6562	12619
250.98	5965	11313
252.62	5756	10583
254.27	6696	11512
255.91	6562	11930
257.55	6562	12619
259.19	6076	10936
260.83	5911	11512
262.47	5657	11121
264.11	5911	11717
265.75	5965	10936
267.39	6433	11930
269.03	6309	11717
270.67	5706	11121
272.31	5378	10757

Table 16. Boring Z3-B1, Suspension R1-R2 depths and P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
273.95	5807	10757
275.59	5423	10095
277.23	5807	11930
278.87	5965	11930
280.51	5911	11121
282.15	5208	10415
283.79	4790	11717
285.43	4654	11313
287.07	4464	10415

Table 16, continued. Boring Z3-B1, Suspension R1-R2 depths and P- and S_H-wave velocities

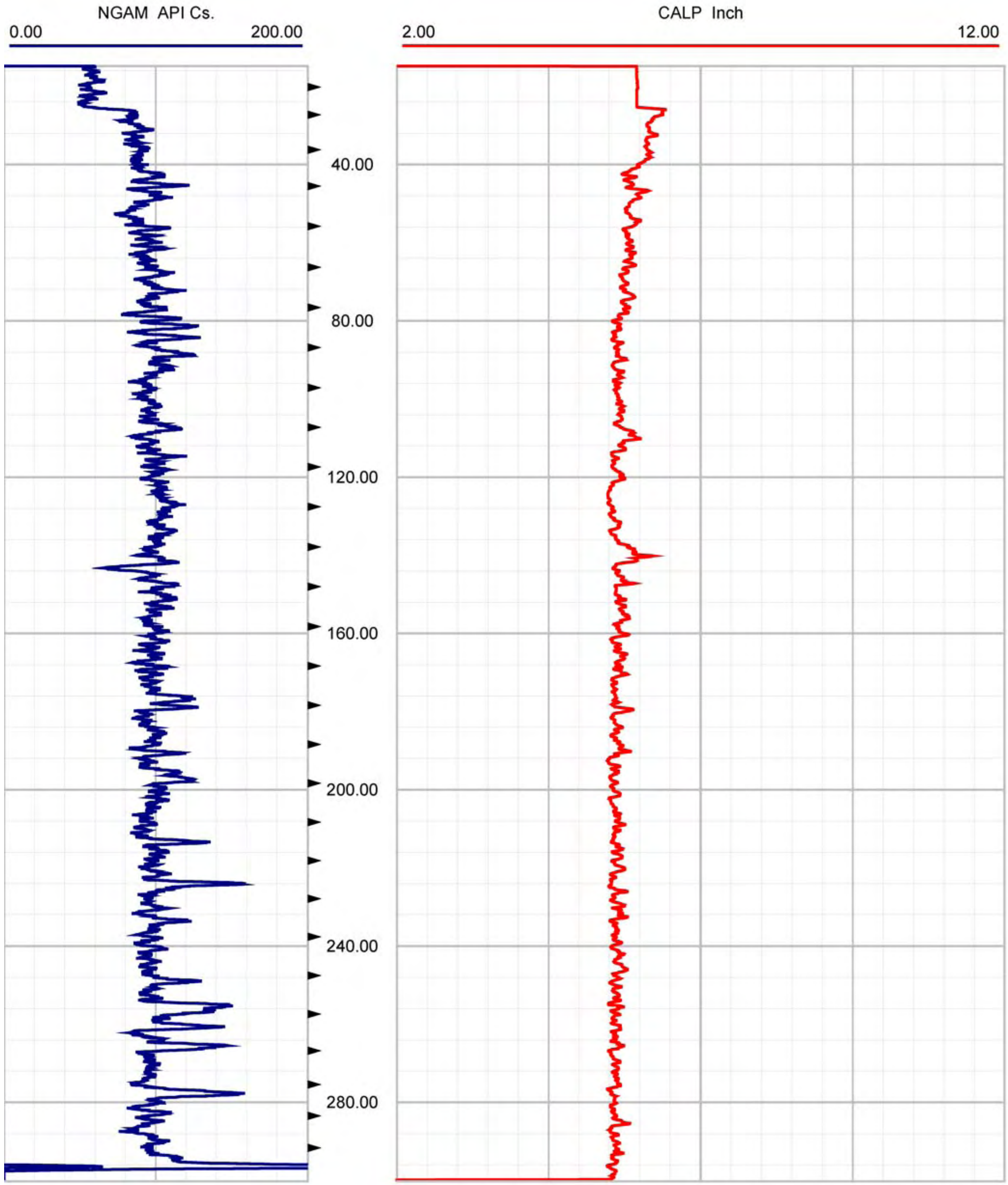


Figure 29. Boring Z3-B1, Caliper and Natural Gamma logs

DIP DATA INTERPRETATION
RGLDIP vsn 6.2
FRACTURE ANALYSIS STEREOGRAMS

CASCADE DRILLING

Borehole: Z3-B1

SR-710 TUNNEL INVESTIGATION

top of borehole.....
East:_
North:_
Elev:_

North ref: true
Depth units are feet

Zone from 274.689 to 36.716ft
Mean dip format: dip-azimuth and dip

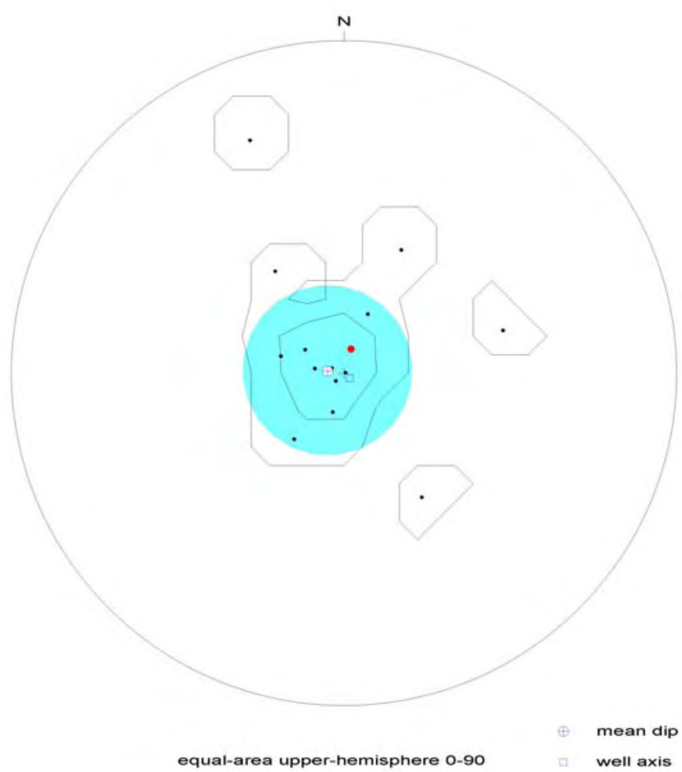
Interpretation 1

Dip data sets .....
BHTV dips

Z3-B1
Zone 0. 36.716 - 274.679ft
Deviation 1.90 N310.30

dipdata sets.....
BHTV dips
• Highlighted dips: Fracture Planar Hairline-fracture

	mean dip	n	f
N277 4	N277 4	10	(0.04)



equal-area upper-hemisphere 0-90
contour-levels 1,3,

Z3-B1, Interpretation 1 274.679 to 36.716ft 1

Figure 30. Boring Z3-B1, Stereonet Plot

Depth (feet)	Dip azimuth	Dip	Structure description
274.19	N226	3	Primary-structure Planar Bedding
267.32	N025	34	Primary-structure Planar Bedding
266.61	N196	10	Primary-structure Planar Bedding
255.39	N285	16	Primary-structure Planar Bedding
254.45	N217	20	Primary-structure Planar Bedding
230.38	N279	7	Primary-structure Planar Bedding
230.06	N292	3	Primary-structure Planar Bedding
206.30	N075	41	Primary-structure Planar Bedding
193.65	N326	30	Primary-structure Planar Bedding
192.12	N148	36	Primary-structure Planar Bedding
146.99	N338	65	Primary-structure Planar Bedding
125.67	N301	11	Primary-structure Planar Bedding
123.19	N022	16	Primary-structure Planar Bedding
55.52	N075	0	Primary-structure Planar Bedding
37.22	N016	6	Fracture Planar Hairline-fracture

Table 17. Boring Z3-B1, Structure depth, dip azimuth, dip and description

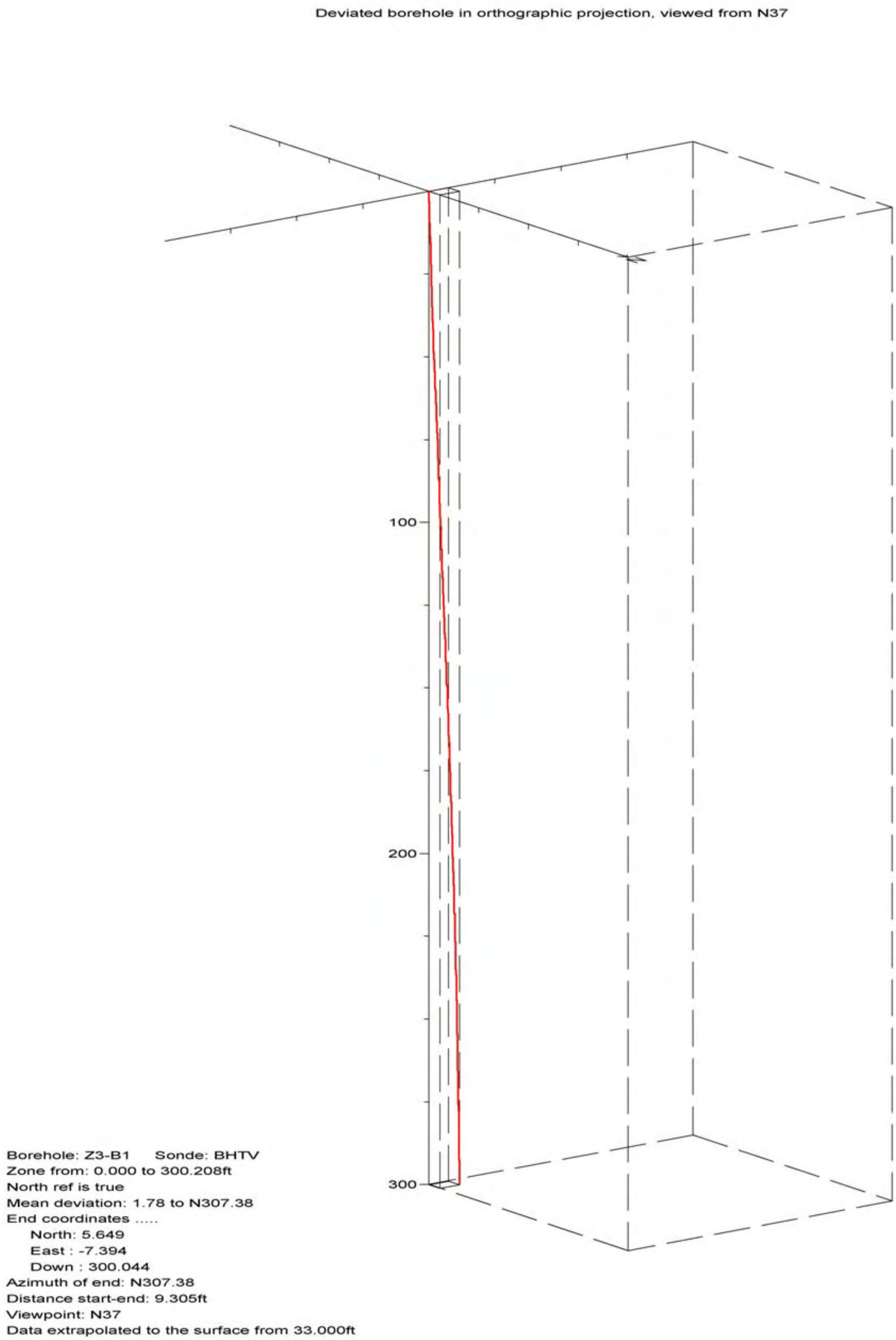


Figure 31. Boring Z3-B1, Deviation Projection

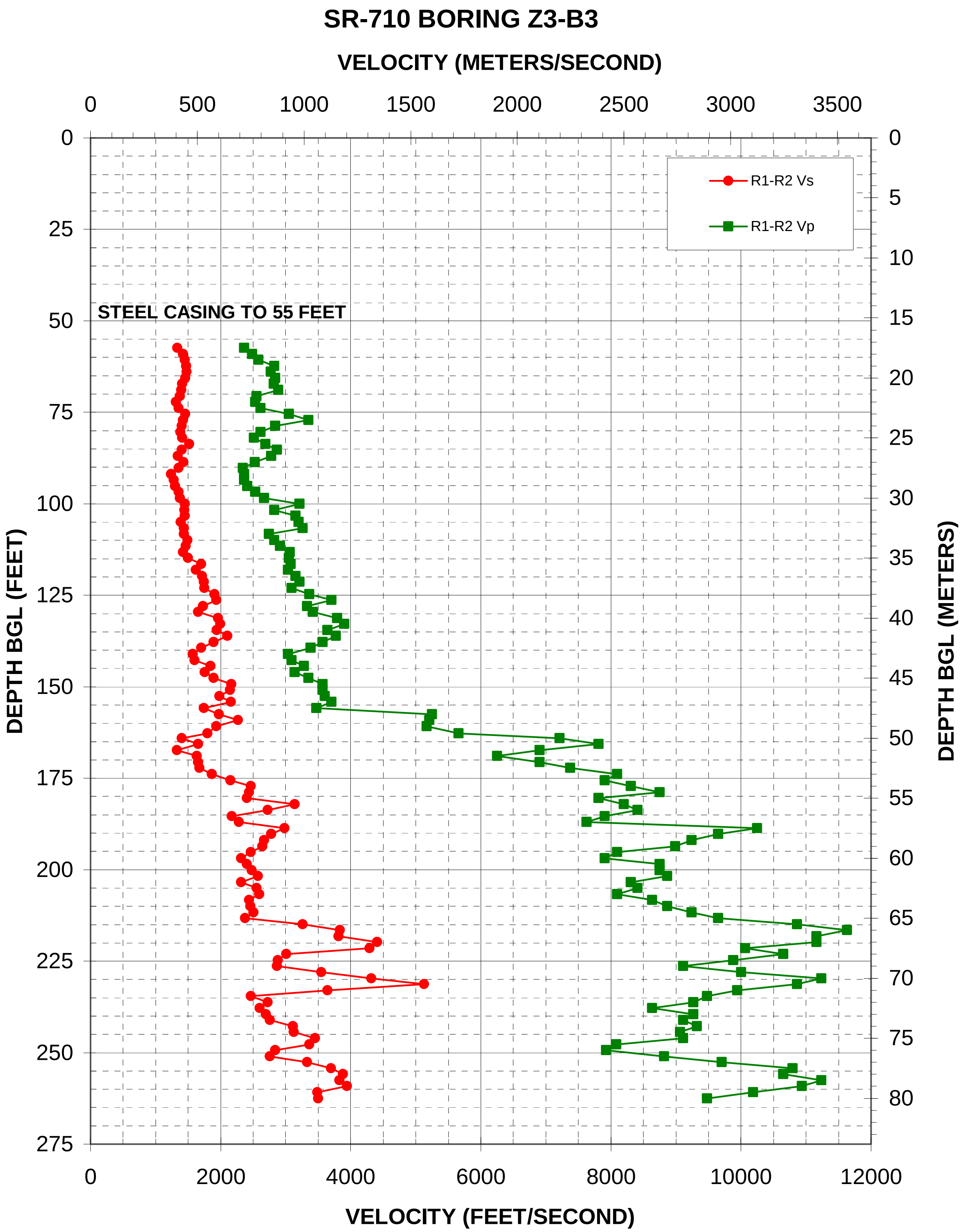


Figure 32: Boring Z3-B3, Suspension R1-R2 P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
57.41	1334	2360
59.06	1426	2485
60.70	1448	2583
62.34	1468	2828
63.98	1481	2769
65.62	1458	2841
67.26	1408	2816
68.90	1393	2891
70.54	1379	2553
72.18	1312	2533
73.82	1353	2614
75.46	1455	3052
77.10	1423	3348
78.74	1402	2841
80.38	1384	2614
82.02	1411	2514
83.66	1515	2689
85.30	1405	2865
86.94	1345	2780
88.58	1433	2524
90.22	1353	2343
91.86	1240	2360
93.50	1282	2360
95.14	1299	2412
96.78	1356	2533
98.43	1379	2667
100.07	1452	3217
101.71	1445	2828
103.35	1448	3155
104.99	1387	3201
106.63	1439	3265
108.27	1439	2745
109.91	1491	2828
111.55	1465	2916
113.19	1426	3066
114.83	1498	3052
116.47	1704	3081
118.11	1624	3038
119.75	1713	3155
121.39	1740	3217
123.03	1750	3095
124.67	1907	3365
126.31	1936	3707
127.95	1731	3331
129.59	1657	3418
131.23	1959	3793
132.87	1994	3906
134.51	1941	3645
136.15	2103	3771
137.80	1896	3566
139.44	1700	3382
141.08	1574	3038
142.72	1600	3095
144.36	1848	3281
146.00	1759	3140
147.64	1896	3348
149.28	2166	3566
150.92	2144	3566
152.56	1982	3605
154.20	2158	3707
155.84	1745	3472
157.48	1976	5249
159.12	2270	5208
160.76	1936	5167
162.73	1798	5657
164.04	1402	7211
165.68	1657	7812
167.32	1331	6907
168.96	1632	6249
170.60	1657	6907
172.24	1674	7373
173.88	1864	8101
175.52	2151	7906
177.17	2467	8306
178.81	2439	8749
180.45	2404	7812
182.09	3140	8202
183.73	2723	8412
185.37	2173	7906
187.01	2278	7630
188.65	2983	10253
190.29	2780	9650
191.93	2667	9242
193.57	2646	8989
195.21	2467	8101
196.85	2319	7906
198.49	2404	8749
200.13	2476	8749
201.77	2573	8867
203.41	2319	8306
205.05	2553	8412
206.69	2594	8101
208.33	2439	8634
209.97	2458	8867
211.61	2504	9242
213.25	2377	9650
214.90	3265	10864
216.54	3837	11634
218.18	3815	11159
219.82	4404	11159
221.46	4289	10064
223.10	3010	10652
224.74	2878	9882
226.38	2865	9113
228.02	3547	10003
229.66	4317	11236
231.30	5126	10864
232.94	3645	9942
234.58	2467	9482
236.22	2723	9268
237.86	2604	8634
239.50	2700	9268
241.14	2757	9113
242.78	3110	9321
244.42	3125	9063
246.06	3454	9113
247.70	3365	8081
249.34	2841	7925
250.98	2757	8819
252.62	3331	9707
254.27	3697	10792
255.91	3883	10652
257.55	3826	11236
259.19	3941	10936
260.83	3490	10189
262.47	3500	9482

Table 18. Boring Z3-B3, Suspension R1-R2 depths and P- and S_H-wave velocities

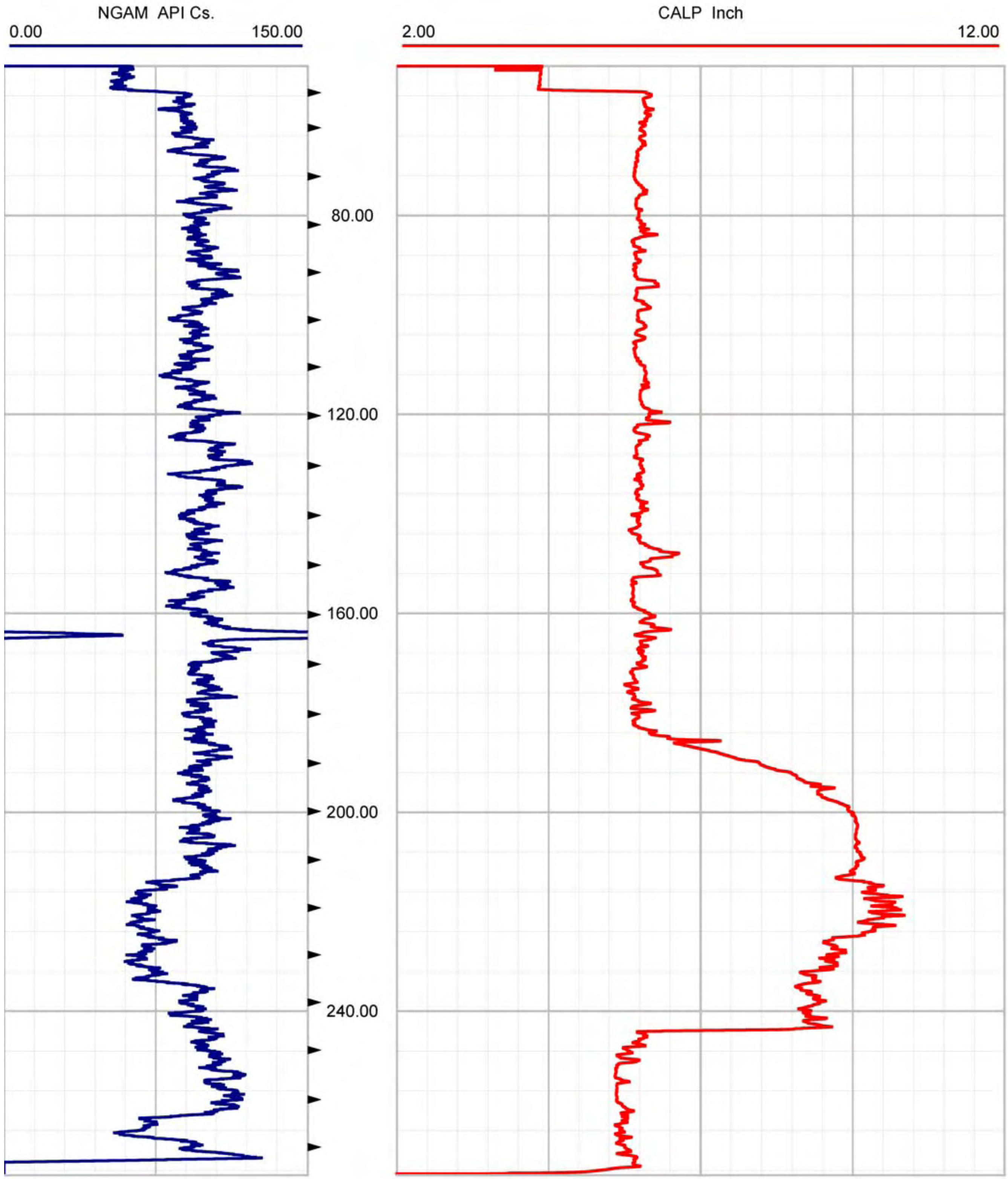


Figure 33. Boring Z3-B3, Caliper and Natural Gamma logs

DIP DATA INTERPRETATION
RGLDIP vsn 6.2
FRACTURE ANALYSIS STEREOGRAMS

CASCADE DRILLING

Borehole: Z3-B3

SR-710 TUNNEL INVESTIGATION

top of borehole.....
East:_
North:_
Elev:_

North ref: true
Depth units are feet

Zone from 273.652 to 271.984ft
Mean dip format: dip-azimuth and dip

Interpretation 1

Dip data sets .....
BHTV dips

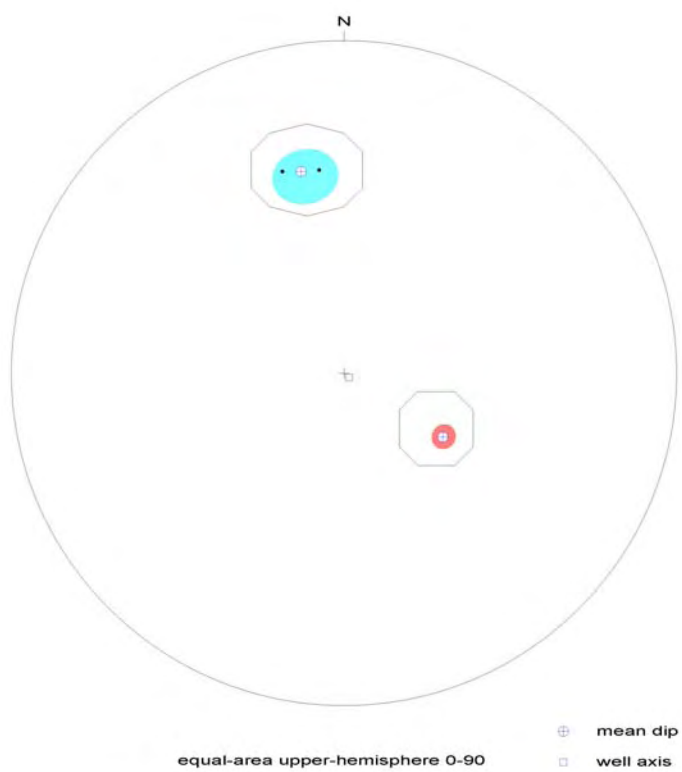
Z3-B3
Zone 0. 271.984 - 273.642ft
Deviation 1.60 N308.50

dipdata sets.....
BHTV dips
• Highlighted dips: Fracture Planar Hairline-fracture

	mean dip	n	f
N348 52	N348 52	2	2.04
N123 29	N123 29	1	(0.00)

intersections

	N348 52	N123 29
N348 52		16 N065
N123 29	16 N065	



equal-area upper-hemisphere 0-90
contour-levels 1,

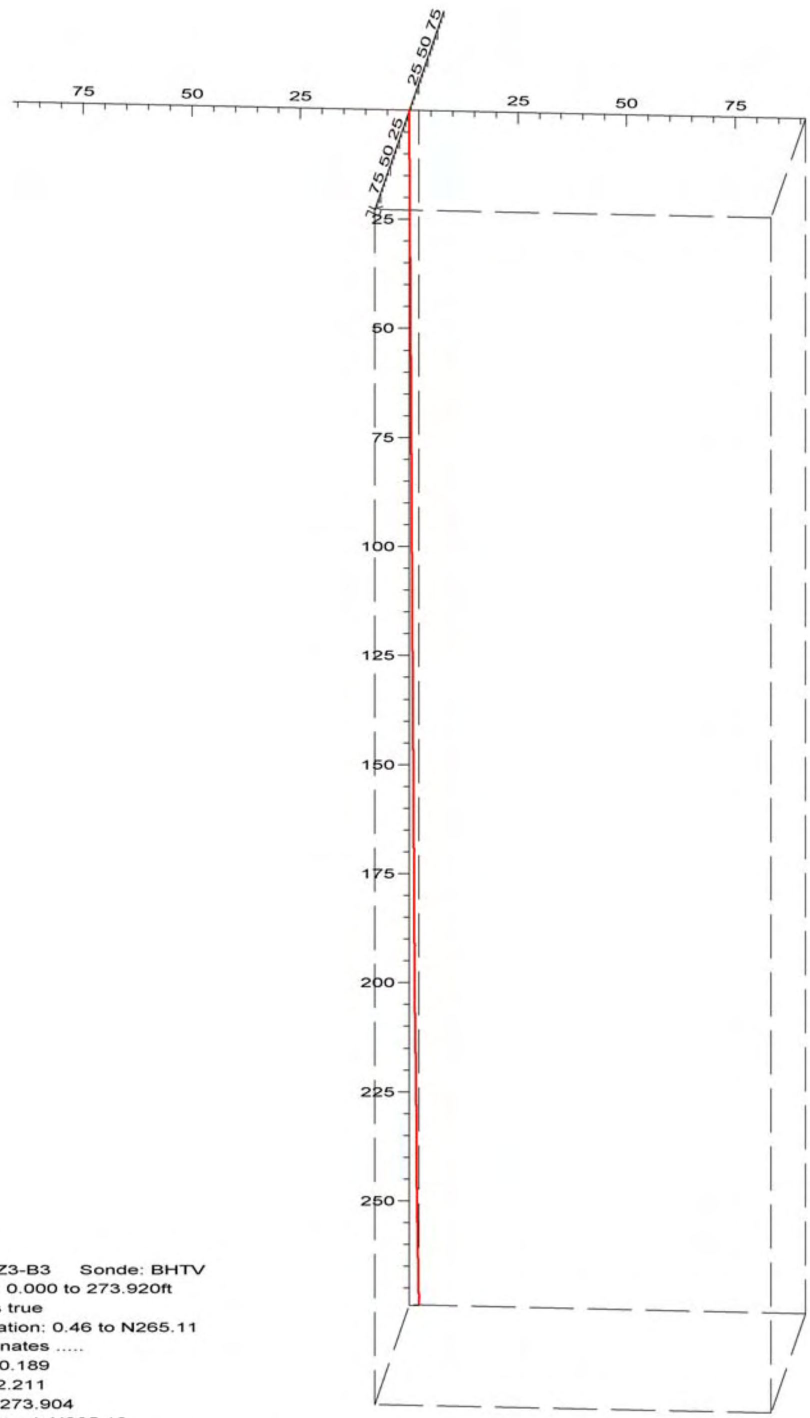
Z3-B3, Interpretation 1 273.642 to 271.984ft 1

Figure 34. Boring Z3-B3, Stereonet Plot

Depth (feet)	Dip azimuth	Dip	Structure description
273.15	N343	53	Primary-structure Planar Bedding
272.68	N353	52	Primary-structure Planar Bedding
272.48	N123	29	Fracture Planar Hairline-fracture

Table 19. Boring Z3-B3, Structure depth, dip azimuth, dip and description

Deviated borehole in orthographic projection, viewed from N355



Borehole: Z3-B3   Sonde: BHTV
Zone from: 0.000 to 273.920ft
North ref is true
Mean deviation: 0.46 to N265.11
End coordinates .....
North: -0.189
East : -2.211
Down : 273.904
Azimuth of end: N265.12
Distance start-end: 2.219ft
Viewpoint: N355
Data extrapolated to the surface from 173.024ft

Figure 35. Boring Z3-B3, Deviation Projection

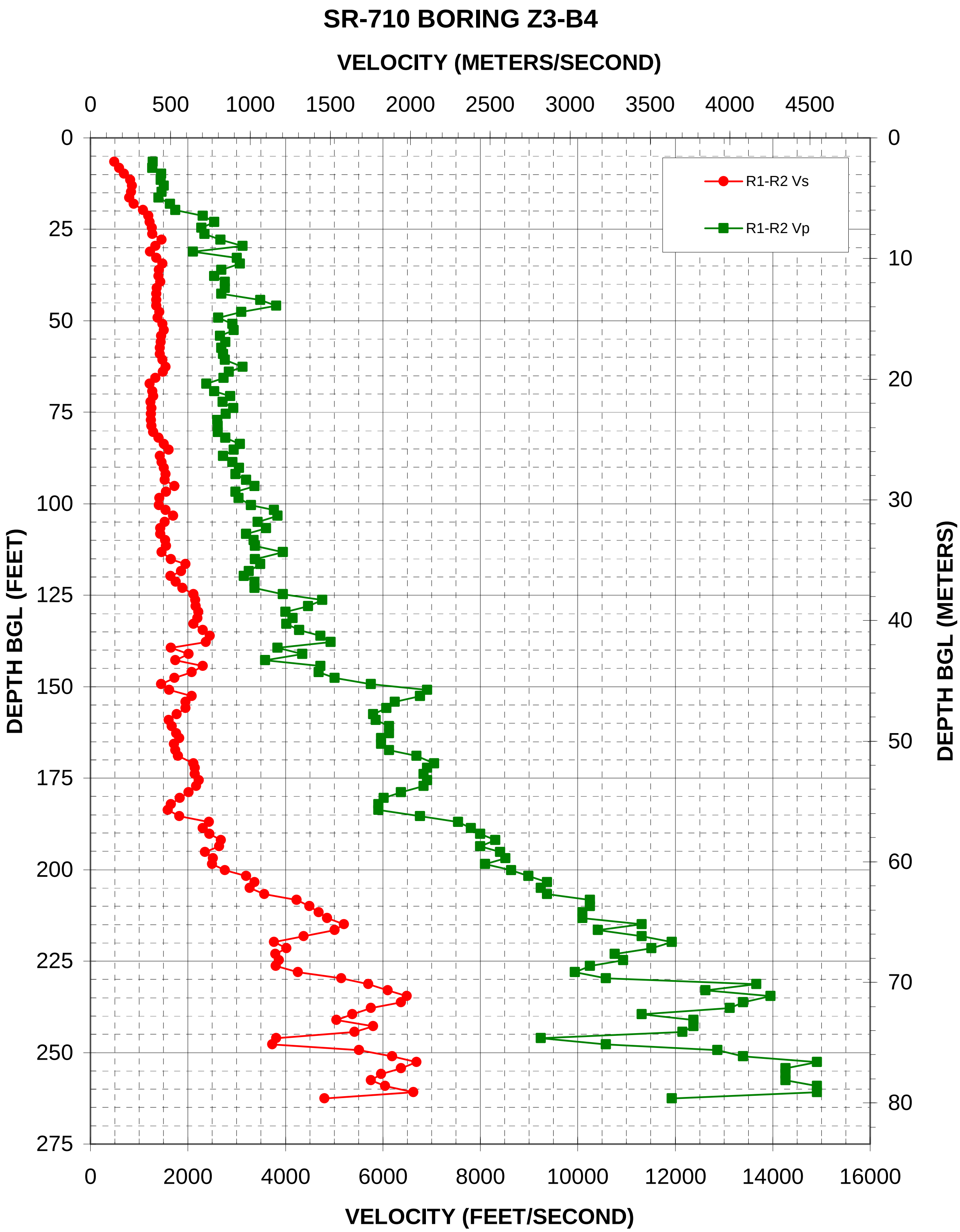


Figure 36: Boring Z3-B4, Suspension R1-R2 P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
6.56	489	1277
8.20	594	1272
9.84	689	1452
11.48	814	1445
13.12	857	1505
14.76	833	1458
16.40	800	1402
18.04	894	1632
19.69	1079	1745
21.33	1189	2310
22.97	1215	2543
24.61	1267	2278
26.25	1272	2343
27.89	1458	2667
29.53	1334	3125
31.17	1224	2103
32.81	1356	3010
34.45	1485	3066
36.09	1408	2689
37.73	1396	2543
39.37	1433	2757
41.01	1361	2757
42.65	1356	2689
44.29	1350	3490
45.93	1356	3815
47.57	1420	3095
49.21	1384	2625
50.85	1478	2916
52.49	1505	2942
54.13	1452	2657
55.77	1445	2769
57.41	1426	2689
59.06	1426	2723
60.70	1478	2757
62.66	1540	3125
63.98	1491	2841
65.62	1334	2734
67.26	1215	2377
69.23	1272	2543
70.54	1287	2865
72.18	1233	2711
73.82	1252	2929
75.46	1247	2780
77.10	1247	2604
78.74	1252	2614
80.38	1292	2614
82.02	1402	2769
83.66	1512	3066
85.30	1608	2942
86.94	1426	2723
88.58	1465	2916
90.22	1512	3052
91.86	1548	2983
93.50	1526	3201
95.14	1727	3365
96.78	1555	2983
98.43	1414	3038
100.39	1408	3297
101.71	1540	3771
103.35	1700	3837
104.99	1526	3435
106.63	1433	3605
108.27	1433	3201
109.91	1533	3348
111.55	1555	3382
113.19	1458	3953
115.16	1649	3382
116.47	1953	3490
118.44	1864	3248
119.75	1640	3155
121.39	1754	3365
123.03	1886	3365
124.67	2117	3953
126.31	2151	4755
127.95	2158	4464
129.59	2217	4001
131.23	2202	4153
132.87	2117	4026
134.51	2310	4289
136.15	2448	4721
137.80	2369	4934
139.44	1649	3837
141.08	2013	4345
142.72	1745	3586
144.36	2310	4721
146.00	2076	4687
147.64	1727	5009
149.28	1452	5756
150.92	1620	6907
152.56	2083	6765
154.20	1953	6249
155.84	1953	6076
157.48	1773	5807
159.12	1608	5859
160.76	1674	6132
162.73	1759	6132
164.04	1828	5965
165.68	1713	5965
167.32	1745	6132
168.96	1798	6696
170.93	2117	7056
172.24	2144	6907
173.88	2144	6835
175.52	2224	6907
177.17	2173	6835
178.81	2019	6371
180.45	1838	6020
182.09	1657	5911
183.73	1589	5911
185.37	1823	6765
187.01	2430	7542
188.65	2310	7812
190.29	2439	8002
191.93	2678	8306
193.57	2646	8002
195.21	2352	8412
196.85	2514	8522
198.49	2495	8101
200.13	2757	8634
201.77	3201	8989
203.41	3365	9374
205.05	3265	9242
206.69	3566	9374
208.33	4233	10253
209.97	4494	10253
211.61	4687	10095
213.25	4861	10095
214.90	5208	11313
216.54	5009	10415
218.18	4374	11313
219.82	3771	11930
221.46	4026	11512
223.10	3793	10757
224.74	3871	10936
226.38	3804	10253
228.02	4261	9942
229.66	5146	10583
231.30	5706	13670
232.94	6104	12619
234.58	6497	13961
236.22	6371	13391
237.86	5756	13123
239.50	5378	11313
241.14	5047	12381
242.78	5807	12381
244.42	5423	12151
246.06	3815	9242
247.70	3728	10583
249.34	5514	12866
250.98	6190	13391

Table 20. Boring Z3-B4, Suspension R1-R2 depths and P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
252.62	6696	14913
254.27	6371	14265
255.91	5965	14265
257.55	5756	14265
259.19	6048	14913
260.83	6628	14913
262.47	4807	11930

Table 20, continued. Boring Z3-B4, Suspension R1-R2 depths and P- and S_H-wave velocities

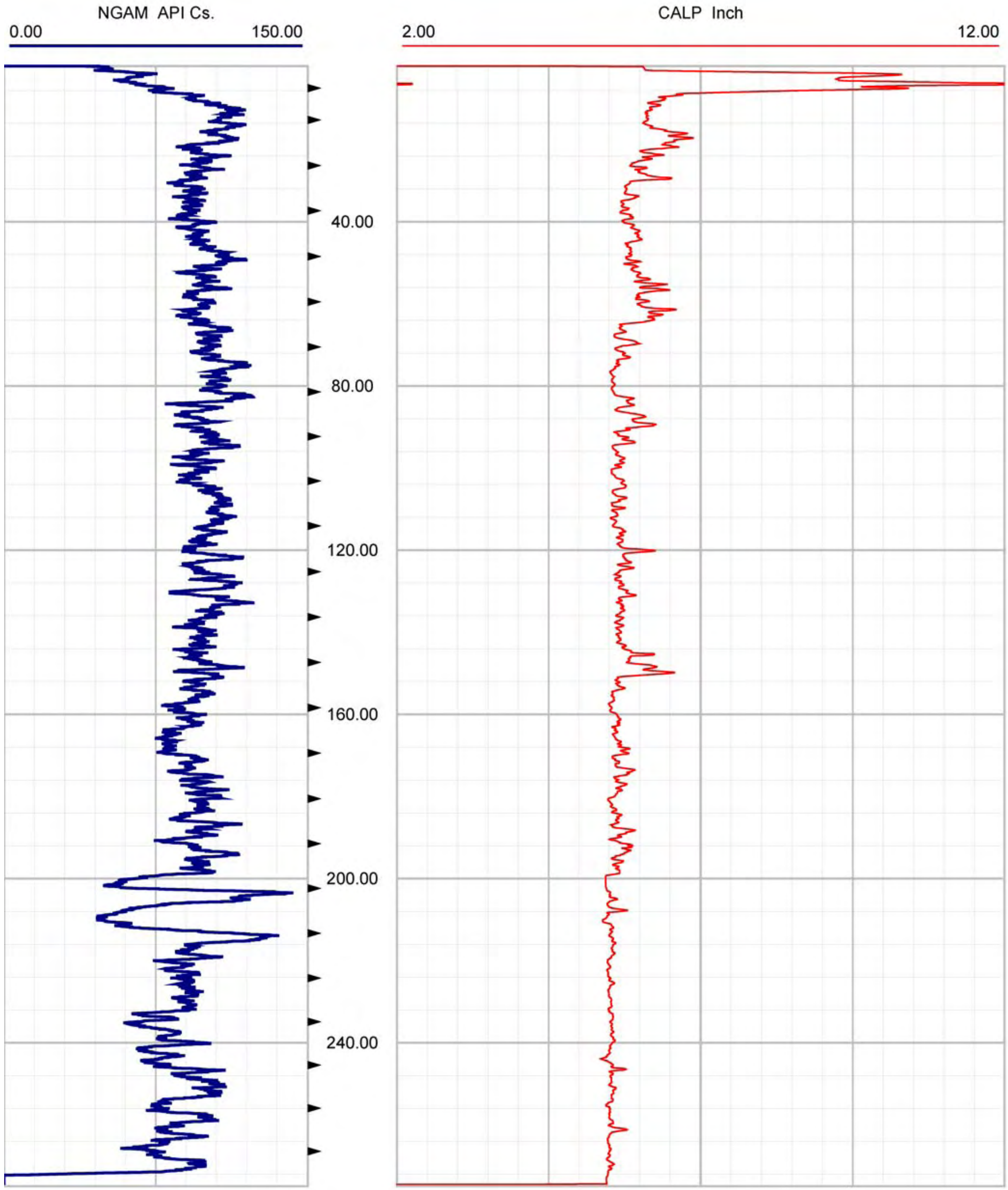


Figure 37. Boring Z3-B4, Caliper and Natural Gamma logs

DIP DATA INTERPRETATION
RGLDIP vsn 6.2
FRACTURE ANALYSIS STEREOGRAMS

CASCADE DRILLING

Borehole: Z3-B4

SR-710 TUNNEL INVESTIGATION

top of borehole.....
East:_
North:_
Elev:_

North ref: true
Depth units are feet

Zone from 275.196 to 64.540ft
Mean dip format: dip-azimuth and dip

Interpretation 1

Dip data sets .....
BHTV dips

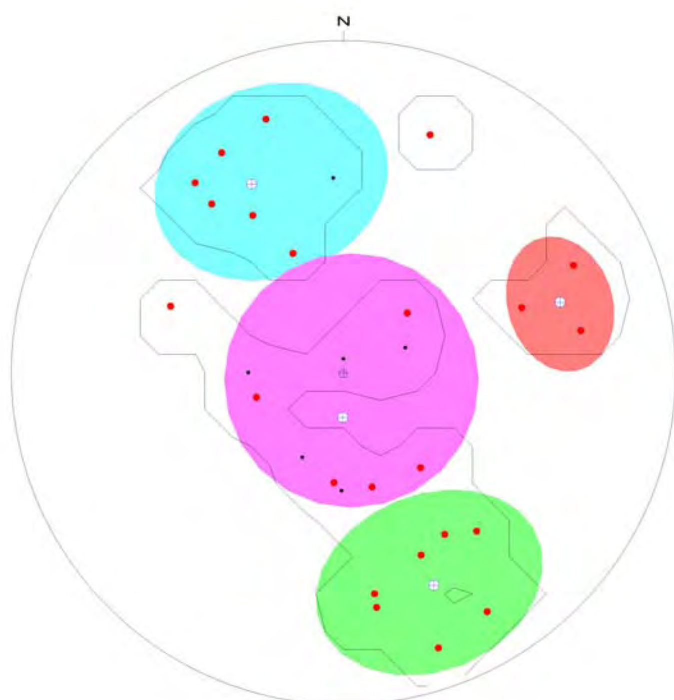
Z3-B4
Zone 0. 64.540 - 275.196ft
Deviation 0.30 N 25.80

dipdata sets.....
BHTV dips
• Highlighted dips: Fracture Planar Hairline-fracture

	mean dip	n	f
N334 53	N334 53	7	(0.06)
N072 58	N072 58	3	(0.03)
N157 59	N157 59	7	(0.06)
N181 11	N181 11	10	(0.05)

intersections

	N334 53	N072 58	N157 59	N181 11
N334 53		43 N018	02 N246	04 N247
N072 58	43 N018		50 N113	10 N156
N157 59	02 N246	50 N113		05 N244
N181 11	04 N247	10 N156	05 N244	



mean dip
well axis

equal-area upper-hemisphere 0-90
contour-levels 1,

Z3-B4, Interpretation 1 275.196 to 64.540ft 1

Figure 38. Boring Z3-B4, Stereonet Plot

Depth (feet)	Dip azimuth	Dip	Structure description
274.74	N141	30	Fracture Planar Hairline-fracture
274.42	N065	65	Fracture Planar Hairline-fracture
274.33	N020	65	Fracture Planar Hairline-fracture
273.39	N331	65	Fracture Planar Hairline-fracture
273.13	N080	62	Fracture Planar Hairline-fracture
271.88	N185	27	Fracture Planar Hairline-fracture
271.42	N157	50	Fracture Planar Hairline-fracture
271.18	N148	48	Fracture Planar Hairline-fracture
270.43	N161	77	Fracture Planar Hairline-fracture
270.26	N181	29	Primary-structure Planar Bedding
267.93	N149	73	Fracture Planar Hairline-fracture
265.43	N166	29	Fracture Planar Hairline-fracture
265.05	N343	69	Fracture Planar Hairline-fracture
259.99	N330	45	Fracture Planar Hairline-fracture
258.86	N322	54	Fracture Planar Hairline-fracture
258.15	N291	47	Fracture Planar Hairline-fracture
257.82	N047	21	Fracture Planar Hairline-fracture
252.67	N070	48	Fracture Planar Hairline-fracture
250.25	N254	22	Fracture Planar Hairline-fracture
248.28	N172	61	Fracture Planar Hairline-fracture
247.64	N359	3	Primary-structure Planar Bedding
245.30	N322	62	Fracture Planar Hairline-fracture
236.66	N172	57	Fracture Planar Hairline-fracture
215.95	N140	52	Fracture Planar Hairline-fracture
199.28	N337	32	Fracture Planar Hairline-fracture
191.94	N357	49	Primary-structure Planar Bedding
190.56	N206	23	Primary-structure Planar Bedding
133.02	N270	23	Primary-structure Planar Bedding
65.04	N068	16	Primary-structure Planar Bedding

Table 21. Boring Z3-B4, Structure depth, dip azimuth, dip and description

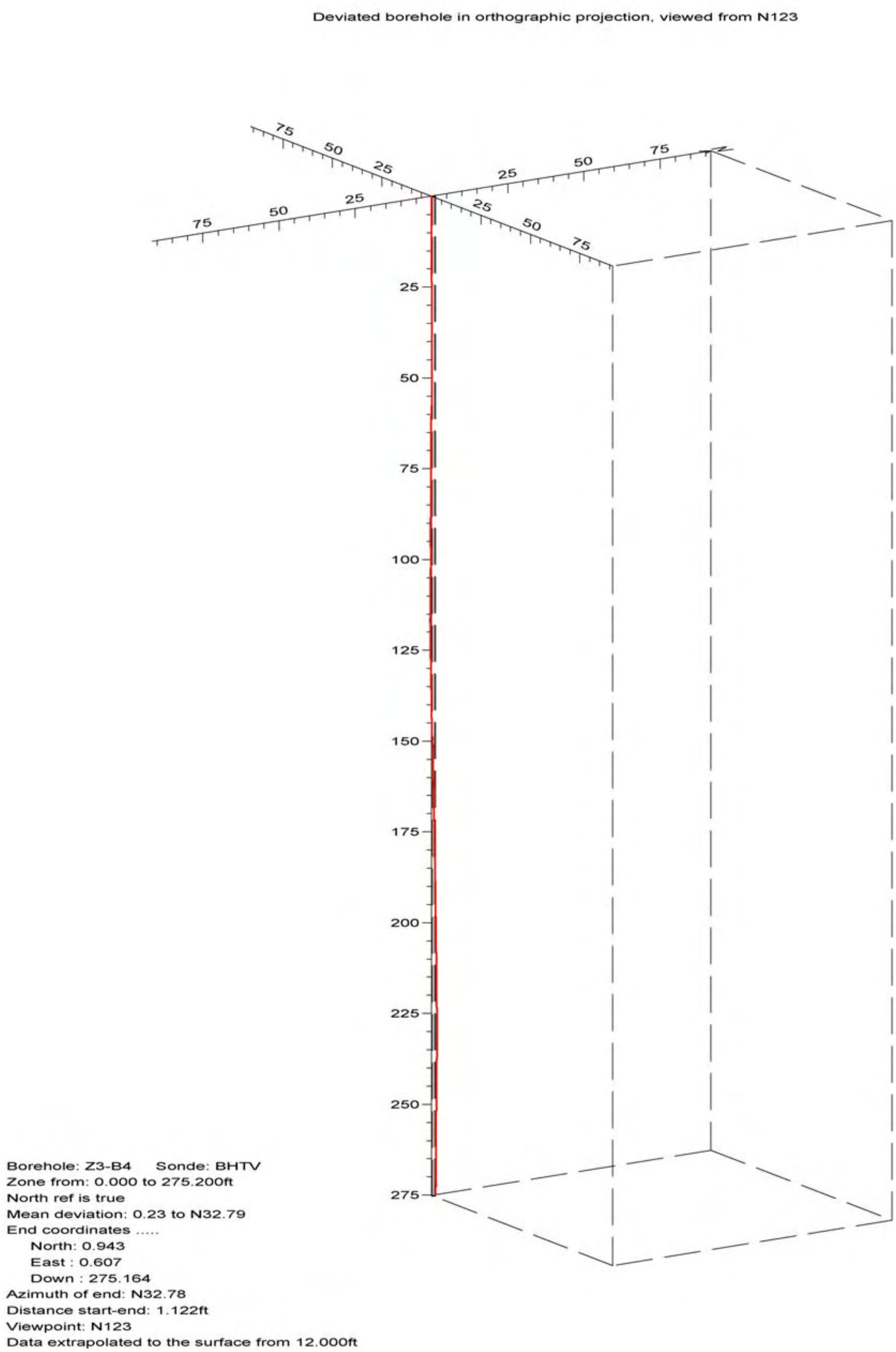


Figure 39. Boring Z3-B4, Deviation Projection

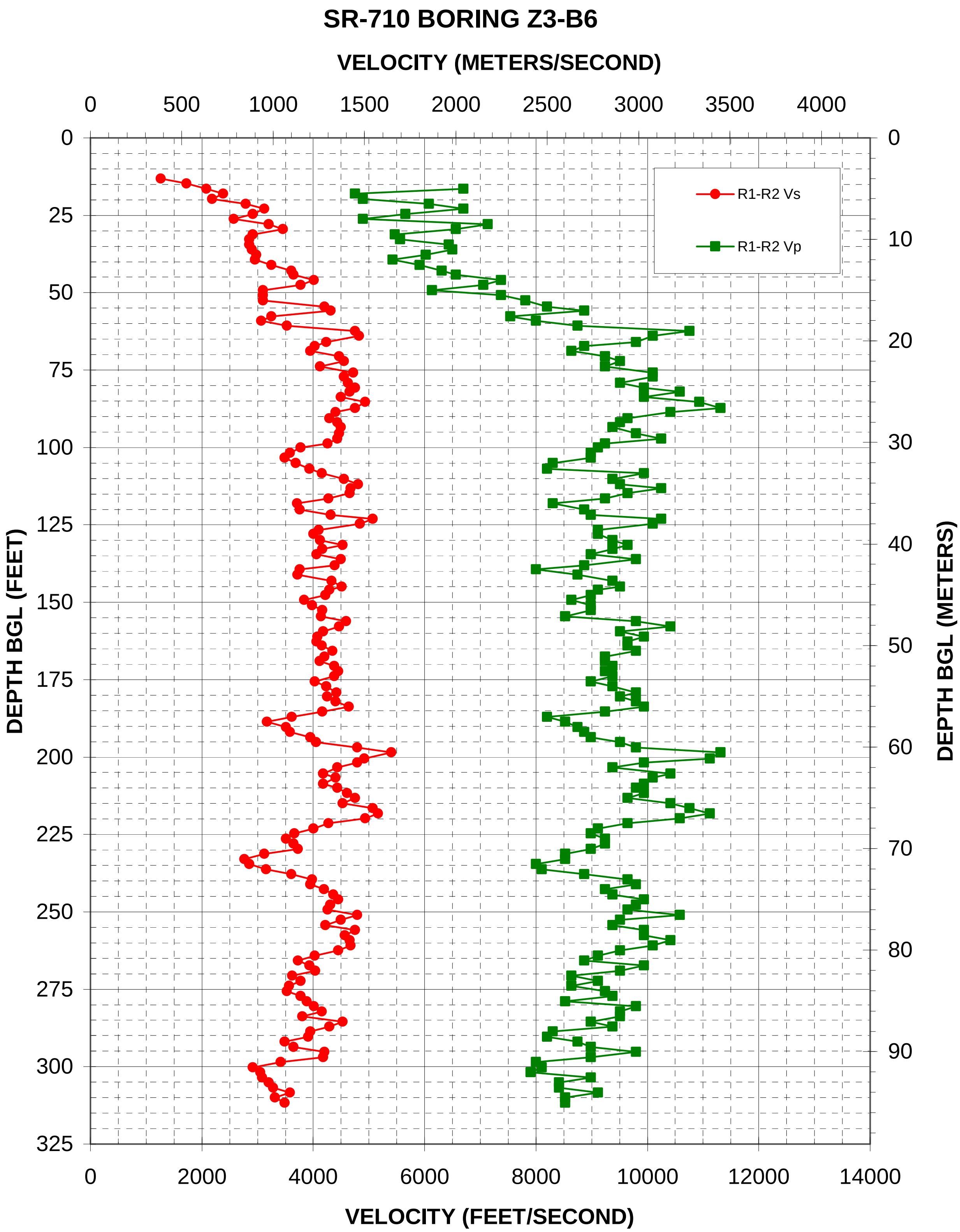


Figure 40: Boring Z3-B6, Suspension R1-R2 P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
13.12	1262	
14.76	1727	
16.40	2083	6696
18.04	2386	4755
19.69	2187	4897
21.33	2792	6076
22.97	3125	6696
24.61	2916	5657
26.25	2573	4897
27.89	3201	7132
29.53	3454	6562
31.17	2916	5468
32.81	2853	5561
34.45	2853	6433
36.09	2903	6497
37.73	2983	6020
39.37	2956	5423
41.01	3248	5911
42.98	3605	6309
44.29	3645	6562
45.93	4013	7373
47.57	3771	7056
49.21	3095	6132
50.85	3095	7373
52.49	3095	7812
54.46	4206	8202
55.77	4317	8867
57.74	3248	7542
59.06	3066	8002
60.70	3528	8749
62.34	4755	10757
63.98	4825	10095
65.94	4233	9794
67.26	4026	8867
68.90	3953	8634
70.54	4464	9242
72.18	4557	9510
73.82	4127	9242
75.79	4721	10095
77.10	4557	10095
79.07	4621	9510
80.71	4755	9942
82.02	4654	10583
83.66	4494	9942
85.30	4934	10936
87.27	4755	11313
88.58	4404	10415
90.55	4289	9650
91.86	4434	9510
93.50	4494	9374
95.47	4464	9794
97.11	4434	10253
98.75	4261	9242
100.07	3771	9113
101.71	3586	8989
103.35	3490	8989
104.99	3686	8306
106.96	3929	8202
108.27	4153	9942
110.24	4557	9374
111.88	4807	9510
113.19	4670	10253
114.83	4654	9650
116.47	4275	9242
118.11	3707	8306
120.08	3760	8867
121.72	4317	8989
123.03	5067	10253
124.67	4843	10095
126.64	4101	9113
127.95	4001	9113
129.92	4127	9374
131.56	4525	9650
132.87	4166	9374
134.51	4063	8989
136.15	4494	9794
138.12	4389	8867
139.44	3760	8002
141.08	3718	8749
143.04	4331	9374
145.01	4510	9510
146.00	4289	9113
147.64	4220	8989
149.28	3837	8634
150.92	3977	8989
152.56	4166	8989
154.53	4140	8522
156.17	4589	9794
157.81	4464	10415
159.45	4179	9510
161.09	4076	9942
162.73	4063	9650
164.04	4153	9650
165.68	4345	9794
167.65	4206	9242
168.96	4114	9242
170.60	4374	9374
172.24	4449	9242
173.88	4374	9374
175.52	4026	8989
177.17	4233	9374
179.13	4419	9794
180.45	4247	9510
182.09	4404	9794
183.73	4637	9942
185.37	4166	9242
187.01	3615	8202
188.65	3170	8522
190.29	3509	8749
191.93	3586	8867
193.57	3953	8989
195.21	4050	9510
196.85	4790	9794
198.49	5401	11313
200.46	4915	11121
201.77	4790	9942
203.41	4434	9374
205.38	4179	10415
206.69	4404	10095
208.66	4179	9942
209.97	4434	9794
211.61	4605	9942
213.25	4755	9650
214.90	4525	10415
216.54	5067	10757
218.18	5167	11121
219.82	4934	10583
221.46	4275	9650
223.10	4001	9113
224.74	3666	8989
226.38	3509	9242
228.02	3645	9242
229.66	3728	8989
231.30	3125	8522
232.94	2769	8522
234.58	2853	8002
236.22	3155	8101
237.86	3605	8867
239.50	3977	9650
241.14	3953	9794
242.78	4193	9242
244.42	4360	9374
246.06	4449	9942
247.70	4303	9794
249.34	4261	9650
250.98	4790	10583
252.62	4494	9510
254.27	4220	9374
255.91	4755	9942
257.55	4573	9942

Table 22. Boring Z3-B6, Suspension R1-R2 depths and P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
259.19	4654	10415
260.83	4670	10095
262.47	4449	9510
264.11	4026	9113
265.75	3728	8867
267.39	3929	9942
269.03	4038	9510
270.67	3625	8634
272.31	3771	9113
273.95	3566	8634
275.59	3528	9242
277.23	3771	9374
278.87	3883	8522
280.51	4013	9794
282.15	4153	9510
283.79	3804	9510
285.43	4525	8989
287.07	4289	9374
288.71	3953	8306
290.35	3906	8202
291.99	3490	8749
293.64	3645	8989
295.28	4206	9794
296.92	4179	8989
298.56	3418	8002
300.20	2916	8101
301.84	3052	7906
303.48	3081	8989
305.12	3201	8412
306.76	3281	8412
308.40	3586	9113
310.04	3314	8522
311.68	3490	8522

Table 22, continued. Boring Z3-B6, Suspension R1-R2 depths and P- and S_H-wave velocities

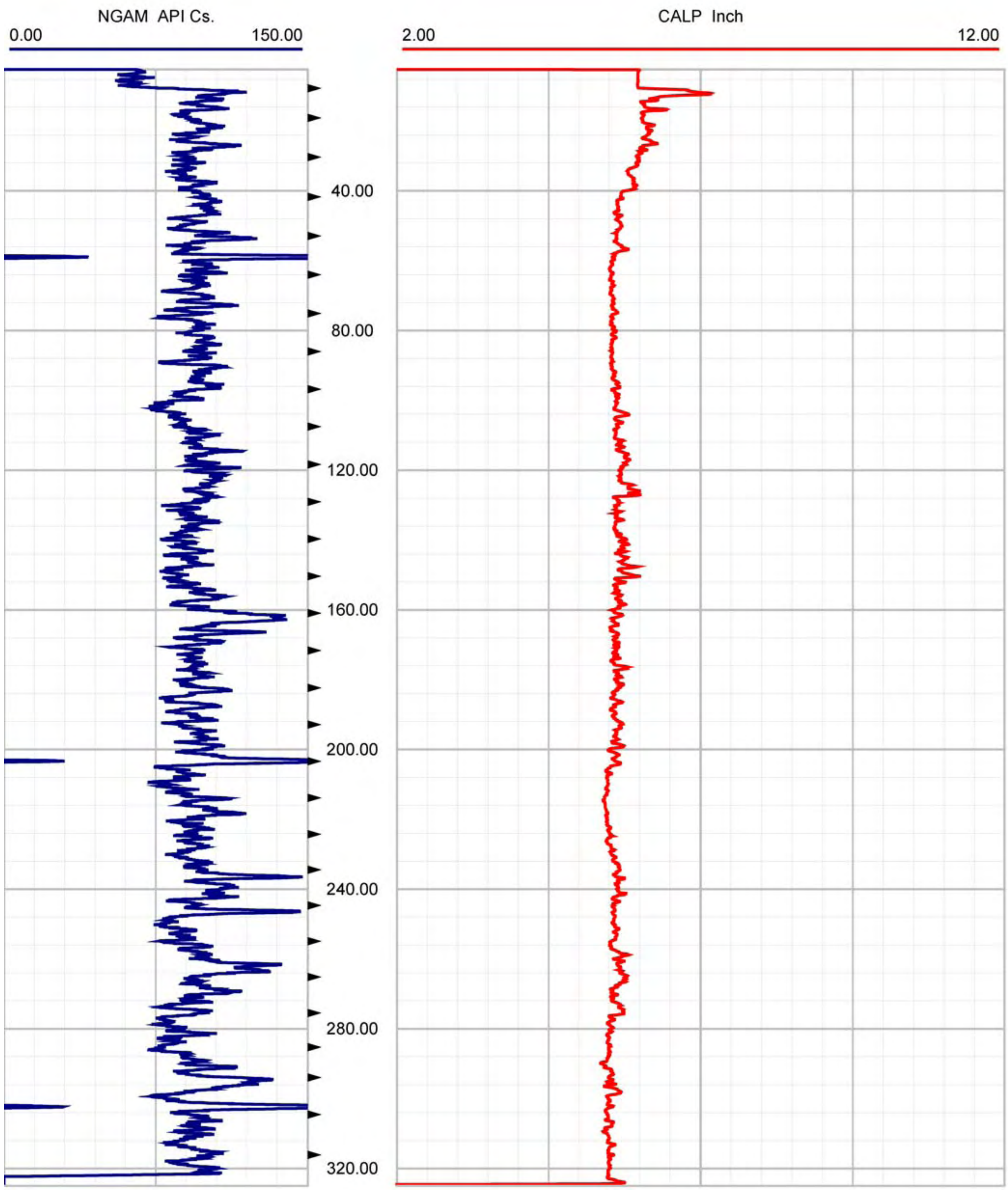


Figure 41. Boring Z3-B6, Caliper and Natural Gamma logs

DIP DATA INTERPRETATION
RGLDIP vsn 6.2
FRACTURE ANALYSIS STEREOGRAMS

CASCADE DRILLING

Borehole: Z3-B6

SR-710 TUNNEL INVESTIGATION

top of borehole.....
East:_
North:_
Elev:_

North ref: true
Depth units are feet

Zone from 285.973 to 45.665ft
Mean dip format: dip-azimuth and dip

Interpretation 1

Dip data sets .....
BHTV dips

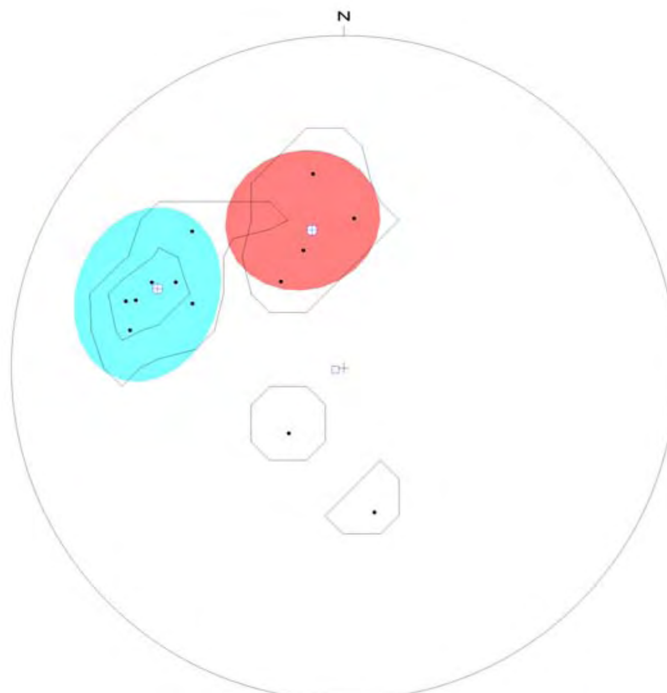
Z3-B6
Zone 0. 45.665 - 285.973ft
Deviation 2.10 N 78.30

dipdata sets.....
BHTV dips
• Highlighted dips: Fracture Planar Hairline-fracture

	mean dip	n	f
N293 51	N293 51	7	(0.04)
N347 35	N347 35	4	(0.02)

intersections

	N293 51	N347 35
N293 51		35 N348
N347 35	35 N348	



mean dip
equal-area upper-hemisphere 0-90
well axis
contour-levels 1,3,

Z3-B6, Interpretation 1 285.973 to 45.665ft 1

Figure 42. Boring Z3-B6, Stereonet Plot

Depth (feet)	Dip azimuth	Dip	Structure description
285.47	N351	49	Primary-structure Planar Bedding
267.80	N324	26	Primary-structure Planar Bedding
256.46	N004	37	Primary-structure Planar Bedding
255.27	N341	31	Primary-structure Planar Bedding
219.30	N312	52	Primary-structure Planar Bedding
108.50	N280	55	Primary-structure Planar Bedding
108.43	N288	56	Primary-structure Planar Bedding
97.24	N294	53	Primary-structure Planar Bedding
97.13	N287	58	Primary-structure Planar Bedding
63.31	N168	37	Primary-structure Planar Bedding
61.26	N220	21	Primary-structure Planar Bedding
46.68	N293	41	Primary-structure Planar Bedding
46.17	N297	47	Primary-structure Planar Bedding

Table 23. Boring Z3-B6, Structure depth, dip azimuth, dip and description

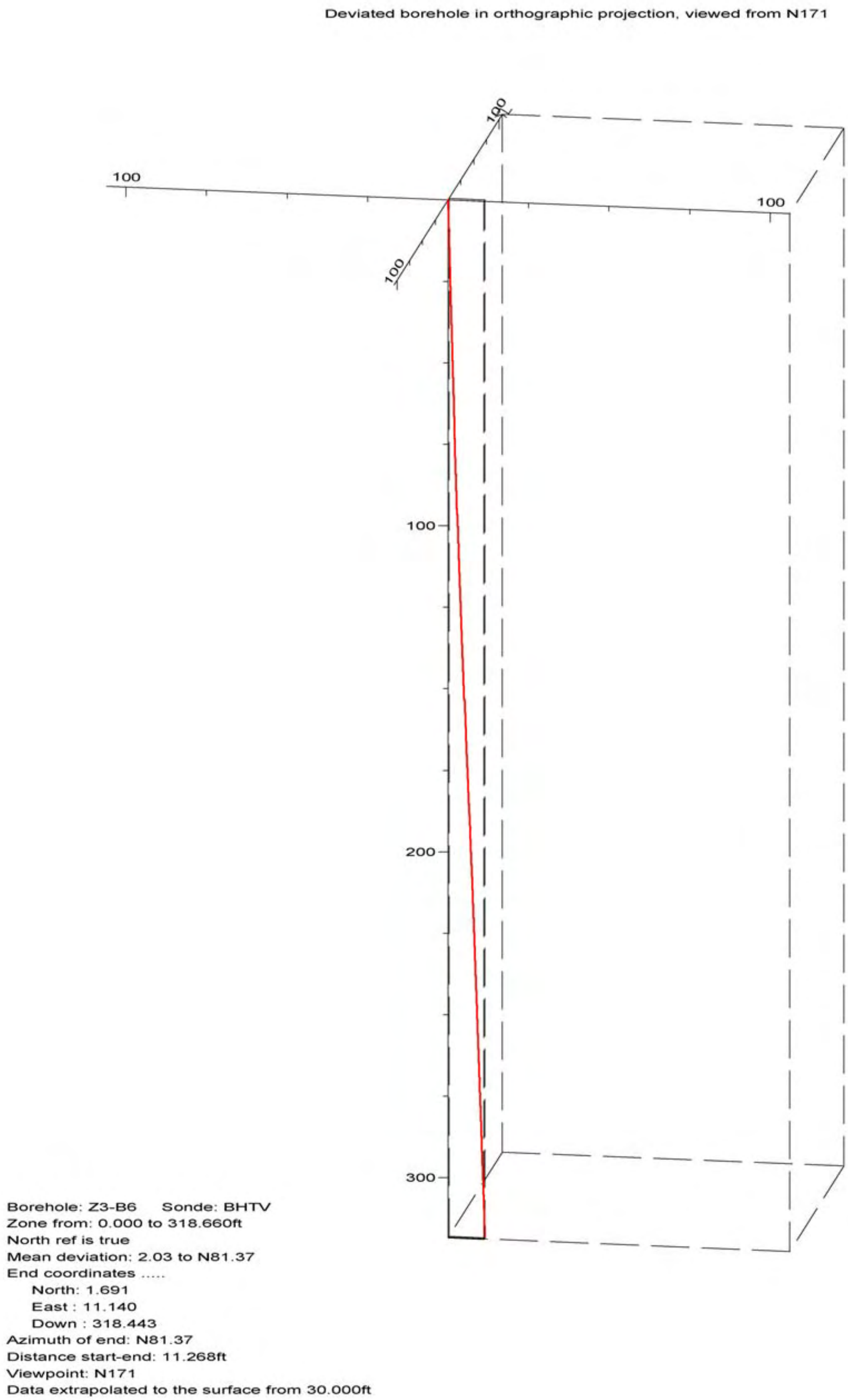


Figure 43. Boring Z3-B6, Deviation Projection

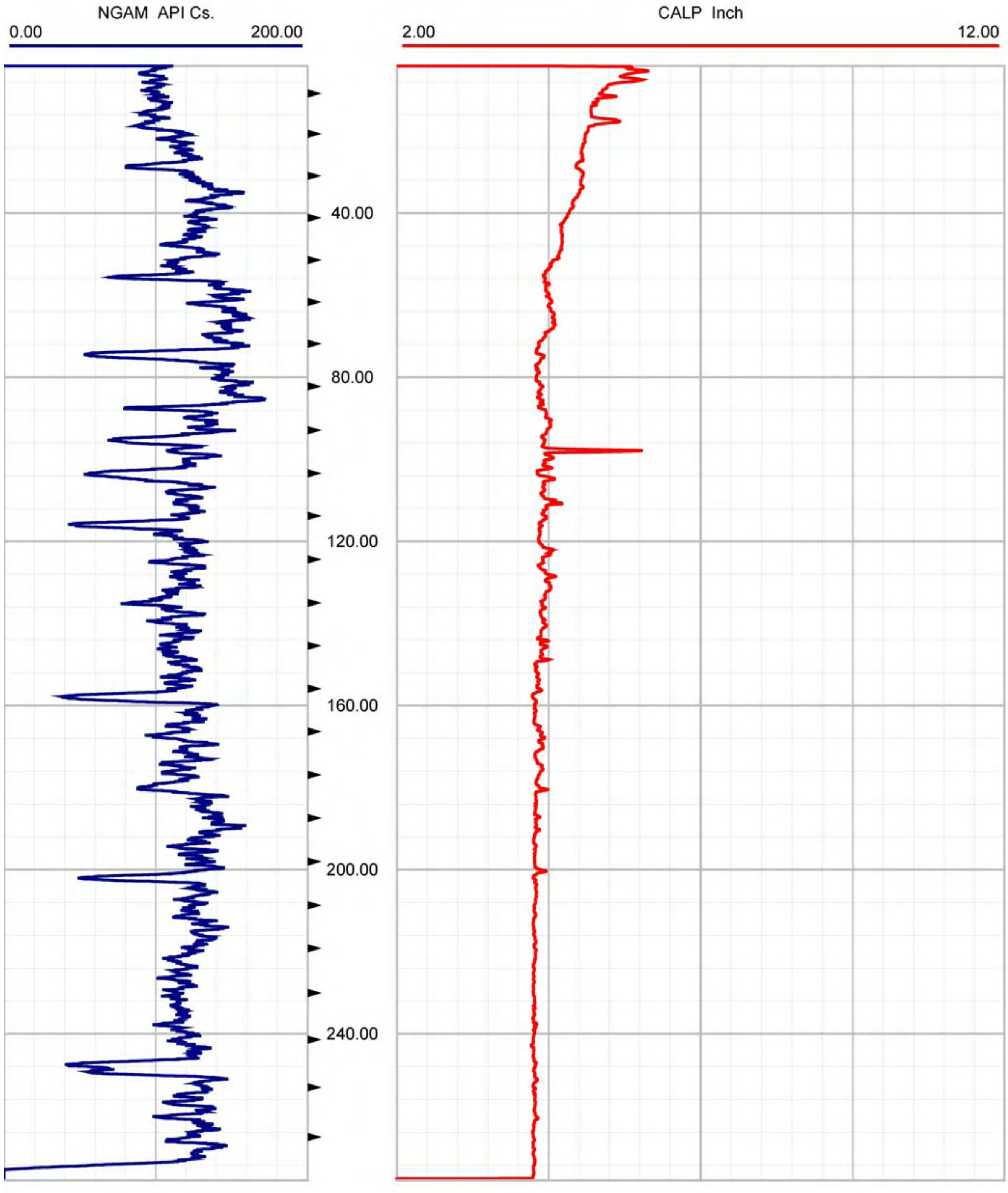


Figure 44. Boring Z3-B8, Caliper and Natural Gamma logs

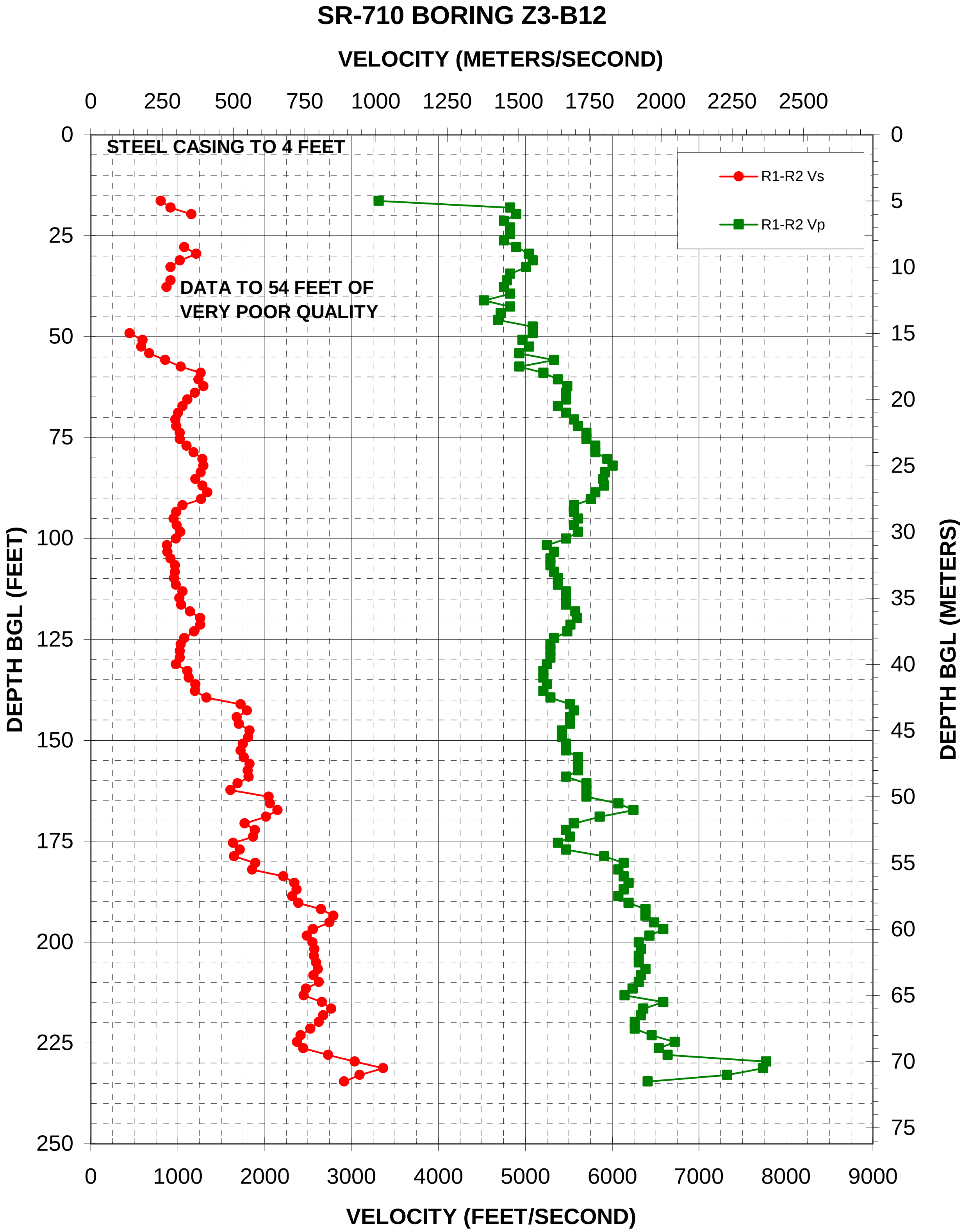


Figure 45: Boring Z3-B12, Suspension R1-R2 P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
8.20		
16.40	805	3314
18.04	918	4825
19.69	1161	4897
21.33		4755
22.97		4825
24.61		4825
26.25		4755
27.89	1076	4897
29.53	1215	5047
31.17	1025	5087
32.81	918	5009
34.45		4825
36.09	918	4790
37.73	875	4755
39.37		4825
41.01		4525
42.65		4825
44.29		4721
45.93		4687
47.57		5087
49.21	449	5087
50.85	599	4971
52.49	583	5047
54.13	676	4934
55.77	859	5335
57.41	1038	4934
59.06	1267	5208
60.70	1243	5378
62.34	1297	5486
63.98	1202	5468
65.62	1116	5468
67.26	1055	5378
68.90	1006	5468
70.54	976	5561
72.18	988	5608
73.82	1028	5706
75.46	1025	5706
77.10	1105	5807
78.74	1184	5807
80.38	1289	5944
82.02	1299	6009
83.66	1267	5922
85.30	1206	5901
86.94	1287	5911
88.58	1345	5807
90.22	1272	5756
91.86	1058	5561
93.50	988	5561
95.14	954	5608
96.78	991	5561
98.43	1032	5608
100.07	982	5468
101.71	877	5249
103.35	882	5335
104.99	922	5292
106.63	971	5292
108.27	971	5335
109.91	959	5378
111.55	979	5378
113.19	1058	5468
114.83	1020	5468
116.47	1043	5468
118.11	1143	5580
119.75	1262	5599
121.39	1259	5523
123.03	1191	5486
124.67	1079	5335
126.31	1035	5292
127.95	1025	5292
129.59	1028	5292
131.23	982	5249
132.87	1112	5208
134.51	1131	5208
136.15	1206	5249
137.80	1202	5208
139.44	1334	5292
141.08	1727	5514
142.72	1798	5561
144.36	1682	5514
146.00	1704	5514
147.64	1828	5423
149.28	1813	5423
150.92	1750	5468
152.56	1727	5468
154.20	1764	5608
155.84	1828	5608
157.48	1808	5608
159.12	1818	5468
160.76	1691	5706
162.40	1608	5706
164.04	2051	5706
165.68	2063	6076
167.32	2151	6249
168.96	2019	5859
170.60	1773	5561
172.24	1891	5468
173.88	1869	5514
175.52	1640	5378
177.17	1718	5468
178.81	1649	5911
180.45	1896	6132
182.09	1859	6076
183.73	2217	6132
185.37	2343	6190
187.01	2369	6132
188.65	2319	6076
190.29	2390	6190
191.93	2651	6383
193.57	2792	6383
195.21	2745	6484
196.85	2558	6588
198.49	2485	6433
200.13	2553	6309
201.77	2573	6334
203.41	2568	6309
205.05	2594	6309
206.69	2614	6383
208.33	2563	6334
209.97	2625	6309
211.61	2476	6237
213.25	2453	6144
214.90	2662	6588
216.54	2769	6358
218.18	2678	6334
219.82	2625	6261
221.46	2529	6261
223.10	2417	6458
224.74	2377	6723
226.38	2448	6536
228.02	2734	6641
229.66	3038	7774
231.30	3365	7738
232.94	3095	7323
234.58	2916	6408

NOTE: “blank” space indicates data of insufficient quality for good pick. See Appendix A for Source-to-Receiver measurement.

Table 24. Boring Z3-B12, Suspension R1-R2 depths and P- and S_H-wave velocities

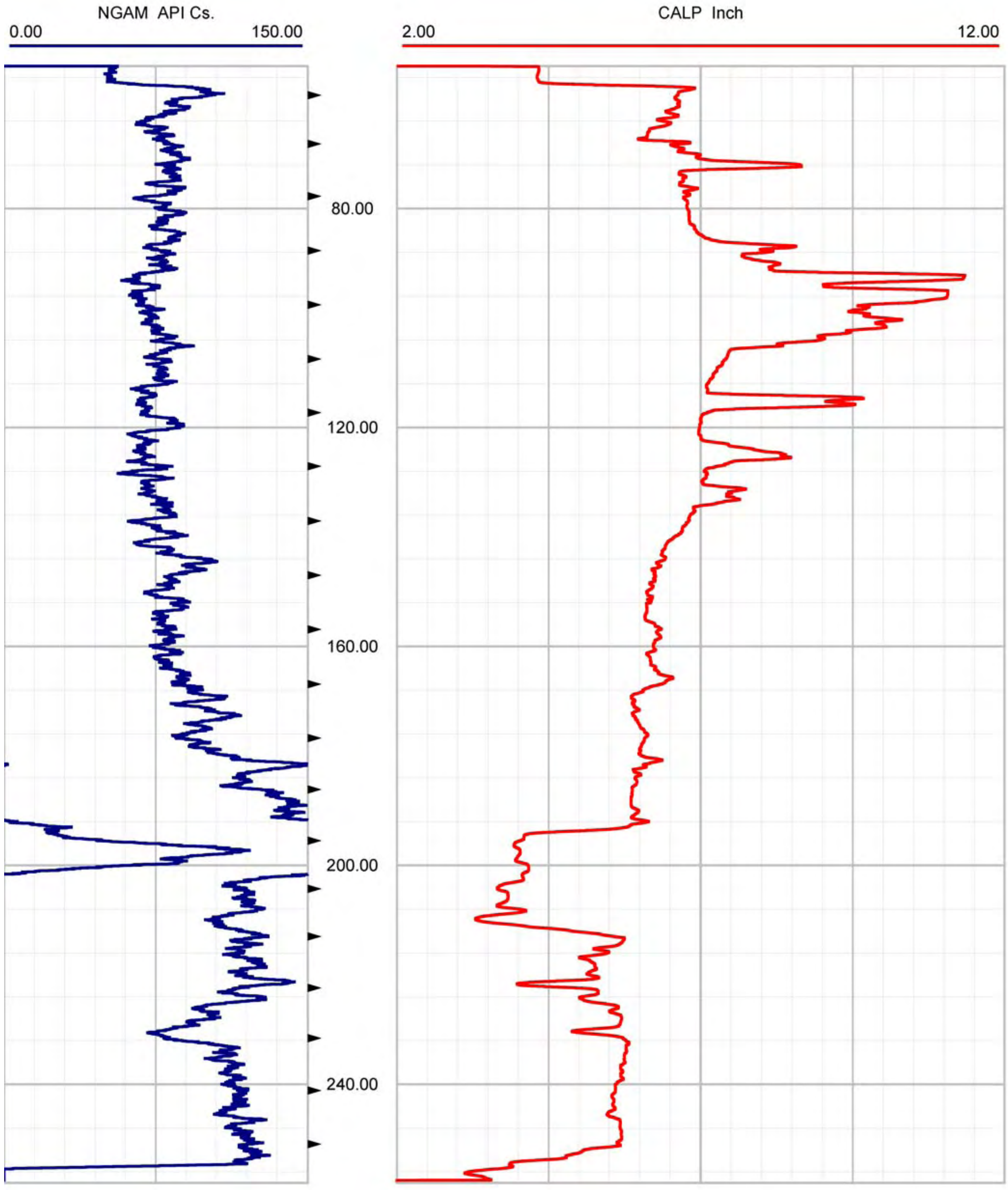


Figure 46. Boring Z3-B12, Caliper and Natural Gamma logs

DIP DATA INTERPRETATION
RGLDIP vsn 6.2
FRACTURE ANALYSIS STEREOGRAMS

CASCADE DRILLING

Borehole: Z3-B12

SR-710 TUNNEL INVESTIGATION

top of borehole.....
East:_
North:_
Elev:_

North ref: true
Depth units are feet

Zone from 179.361 to 113.631ft
Mean dip format: dip-azimuth and dip

Interpretation 1

Dip data sets .....
BHTV dips

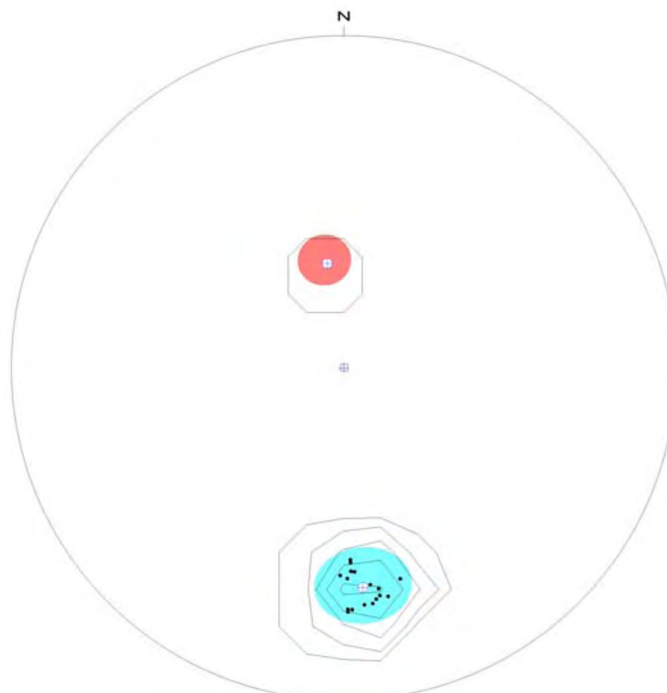
Z3-B12
Zone 0. 113.631 - 179.351ft
Deviation 0.20 N234.00

dipdata sets.....
BHTV dips
• Highlighted dips: Fracture Planar Open-fracture

	mean dip	n	f
N175 56	N175 56	17	0.47
N351 26	N351 26	1	(0.00)

intersections

	N175 56	N351 26
N175 56		01 N264
N351 26	01 N264	



equal-area upper-hemisphere 0-90
contour-levels 1,3,6,10,15,

mean dip
well axis

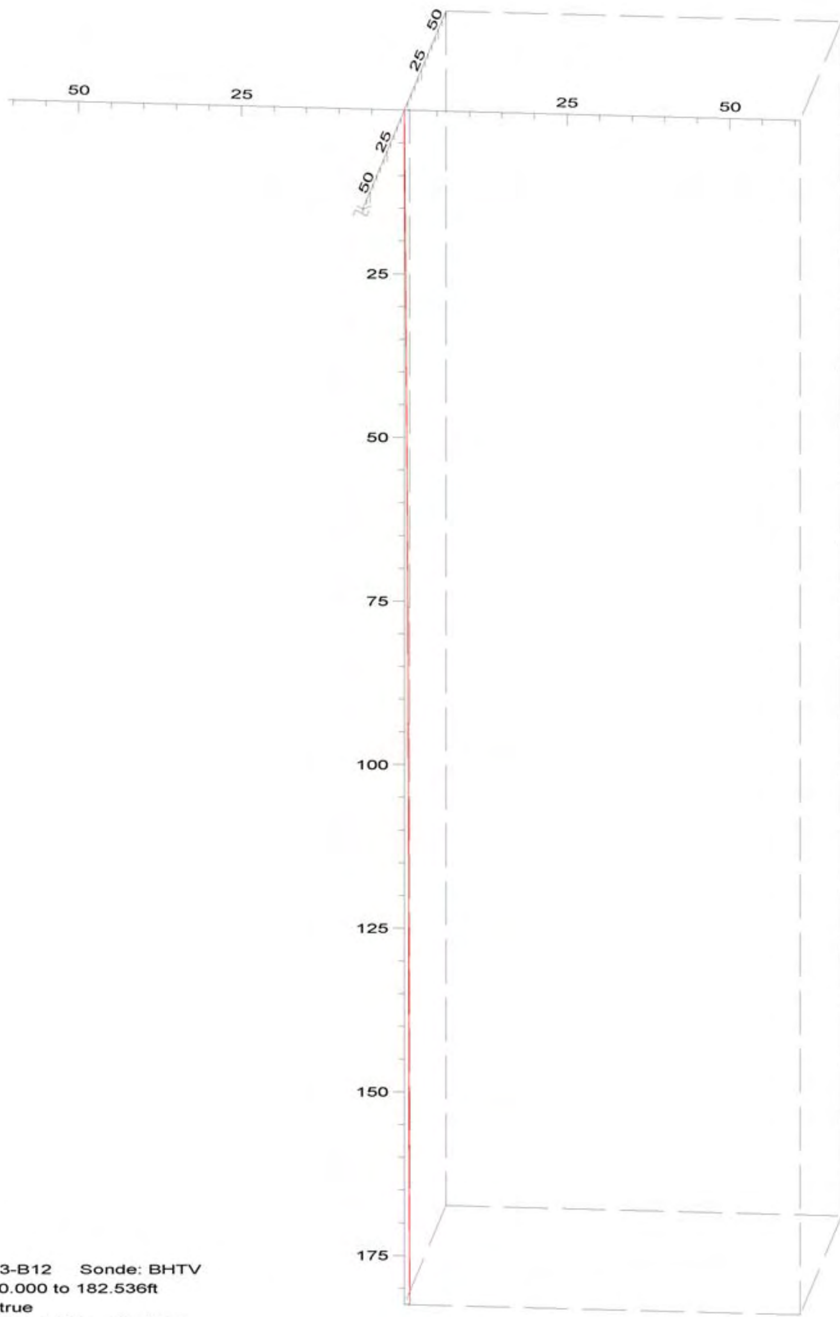
Z3-B12, Interpretation 1 179.351 to 113.631ft 1

Figure 47. Boring Z3-B12, Stereonet Plot

Depth (feet)	Dip azimuth	Dip	Structure description
178.86	N179	62	Primary-structure Planar Bedding
178.55	N179	63	Primary-structure Planar Bedding
177.99	N178	62	Primary-structure Planar Bedding
176.93	N175	61	Primary-structure Planar Bedding
176.29	N173	61	Primary-structure Planar Bedding
174.71	N172	60	Primary-structure Planar Bedding
162.82	N171	57	Primary-structure Planar Bedding
162.36	N169	59	Primary-structure Planar Bedding
161.74	N165	55	Primary-structure Planar Bedding
159.94	N171	59	Primary-structure Planar Bedding
157.05	N179	53	Primary-structure Planar Bedding
156.16	N173	55	Primary-structure Planar Bedding
152.02	N178	49	Primary-structure Planar Bedding
150.86	N178	48	Primary-structure Planar Bedding
148.50	N178	51	Primary-structure Planar Bedding
146.45	N181	53	Primary-structure Planar Bedding
131.08	N177	52	Primary-structure Planar Bedding
114.13	N351	26	Primary-structure Planar Bedding

Table 25. Boring Z3-B12, Structure depth, dip azimuth, dip and description

Deviated borehole in orthographic projection, viewed from N354



Borehole: Z3-B12 Sonde: BHTV
Zone from: 0.000 to 182.536ft
North ref is true
Mean deviation: 0.27 to N263.66
End coordinates .....
North: -0.094
East : -0.846
Down : 182.516
Azimuth of end: N263.66
Distance start-end: 0.852ft
Viewpoint: N354
Data extrapolated to the surface from 57.000ft

Distances in feet, Deviation and Azimuths in degrees

Figure 48. Boring Z3-B12, Deviation Projection

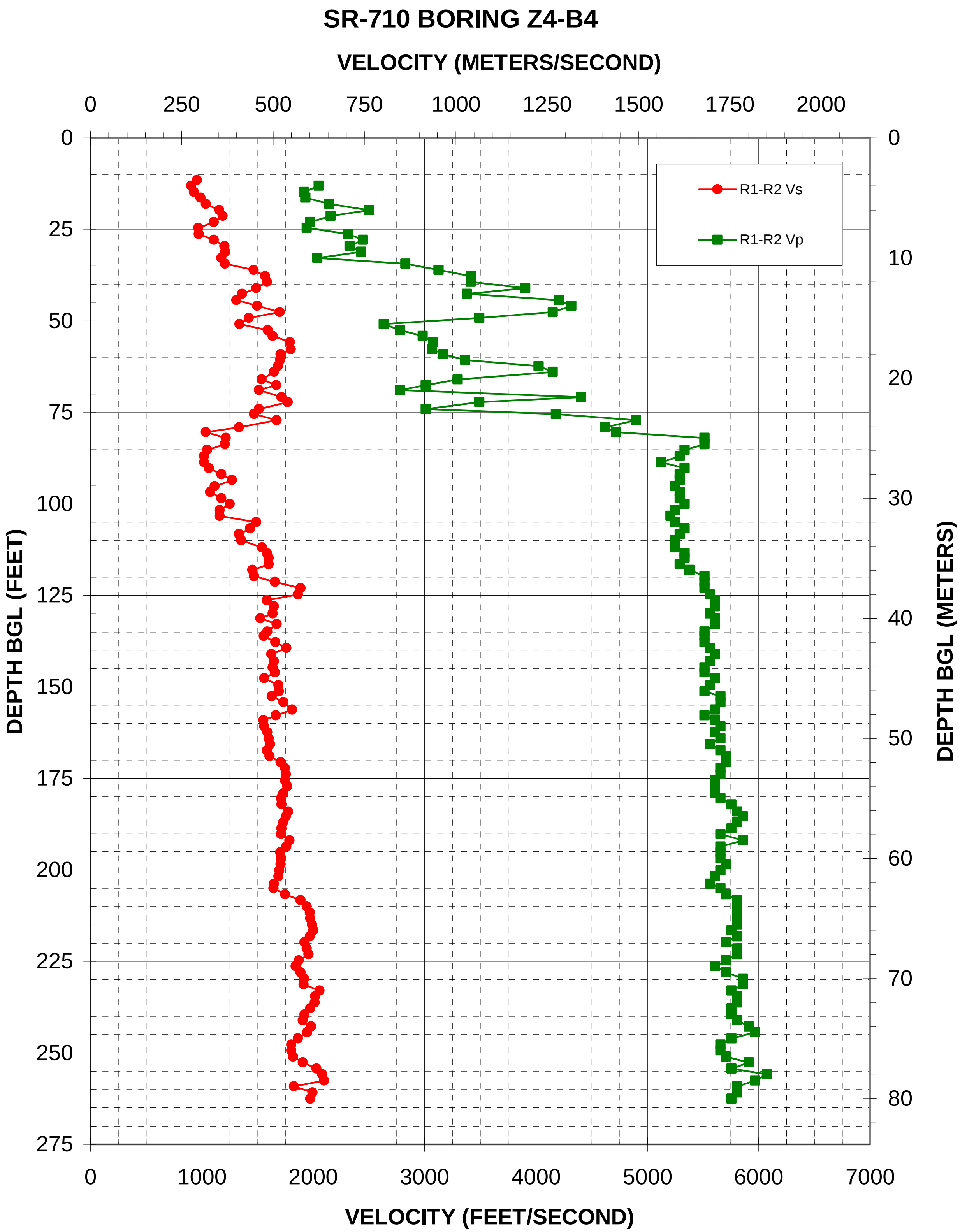


Figure 49: Boring Z4-B4, Suspension R1-R2 P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
11.48	958	
13.12	904	2051
14.76	929	1919
16.40	991	1930
18.04	1035	2144
19.69	1155	2504
21.33	1189	2158
22.97	1108	1976
24.61	968	1941
26.25	974	2310
27.89	1108	2448
29.53	1202	2327
31.17	1211	2430
32.81	1176	2038
34.45	1206	2828
36.09	1465	3125
37.73	1570	3418
39.37	1585	3418
41.01	1491	3906
42.65	1361	3382
44.29	1312	4206
45.93	1498	4317
47.57	1700	4153
49.21	1420	3490
50.85	1339	2635
52.49	1593	2780
54.13	1636	2983
55.77	1793	3081
57.74	1798	3066
59.06	1709	3170
60.70	1704	3365
62.34	1682	4026
63.98	1649	4153
65.94	1537	3297
67.59	1670	3010
68.90	1512	2780
70.87	1718	4404
72.18	1773	3490
74.15	1512	3010
75.46	1471	4179
77.10	1674	4897
79.07	1334	4621
80.38	1038	4721
82.02	1215	5514
83.66	1206	5514
85.30	1048	5335
86.94	1022	5292
88.58	1022	5126
90.22	1065	5335
91.86	1176	5292

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
93.50	1272	5292
95.14	1116	5249
96.78	1076	5292
98.43	1176	5292
100.07	1252	5335
101.71	1159	5249
103.35	1159	5208
104.99	1491	5249
106.63	1433	5335
108.27	1334	5292
109.91	1356	5249
111.88	1540	5249
113.52	1585	5335
114.83	1600	5335
116.47	1600	5292
118.11	1455	5378
119.75	1468	5514
121.39	1657	5514
123.03	1886	5514
124.67	1864	5561
126.31	1585	5608
127.95	1649	5608
129.92	1636	5561
131.23	1526	5608
132.87	1674	5608
134.84	1589	5514
136.15	1559	5514
137.80	1661	5514
139.44	1759	5561
141.08	1624	5608
143.04	1649	5561
144.69	1636	5514
146.00	1657	5514
147.64	1562	5608
149.61	1687	5561
151.25	1691	5514
152.56	1628	5657
154.20	1731	5657
156.17	1813	5608
157.81	1665	5514
159.12	1555	5608
160.76	1562	5657
162.40	1589	5608
164.04	1600	5657
165.68	1612	5561
167.32	1585	5657
168.96	1608	5706
170.60	1709	5706
172.24	1750	5657
173.88	1754	5657

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
175.52	1750	5608
177.17	1769	5608
179.13	1731	5608
180.45	1713	5657
182.09	1718	5756
184.06	1776	5807
185.37	1754	5859
187.01	1731	5807
188.65	1718	5756
190.29	1713	5657
191.93	1788	5859
193.57	1759	5657
195.21	1704	5657
196.85	1713	5657
198.49	1709	5706
200.13	1696	5657
201.77	1687	5608
203.74	1649	5561
205.05	1645	5657
206.69	1750	5706
208.33	1886	5807
209.97	1941	5807
211.61	1970	5807
213.25	1976	5807
214.90	1988	5807
216.54	2001	5756
218.18	1970	5807
219.82	1924	5706
221.46	1941	5807
223.10	1959	5807
224.74	1869	5706
226.38	1843	5608
228.02	1886	5706
229.66	1919	5859
231.30	1913	5859
232.94	2057	5756
234.58	2019	5807
236.22	2013	5807
237.86	1976	5756
239.50	1924	5756
241.14	1907	5807
242.78	1982	5911
244.42	1947	5965
246.06	1864	5756
247.70	1803	5657
249.34	1803	5657
250.98	1818	5706
252.62	1907	5911
254.27	2031	5756
255.91	2083	6076

Table 26. Boring Z4-B4, Suspension R1-R2 depths and P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
257.55	2096	5965
259.19	1828	5807
260.83	1994	5807
262.47	1976	5756

Table 26, continued. Boring Z4-B4, Suspension R1-R2 depths and P- and S_H-wave velocities

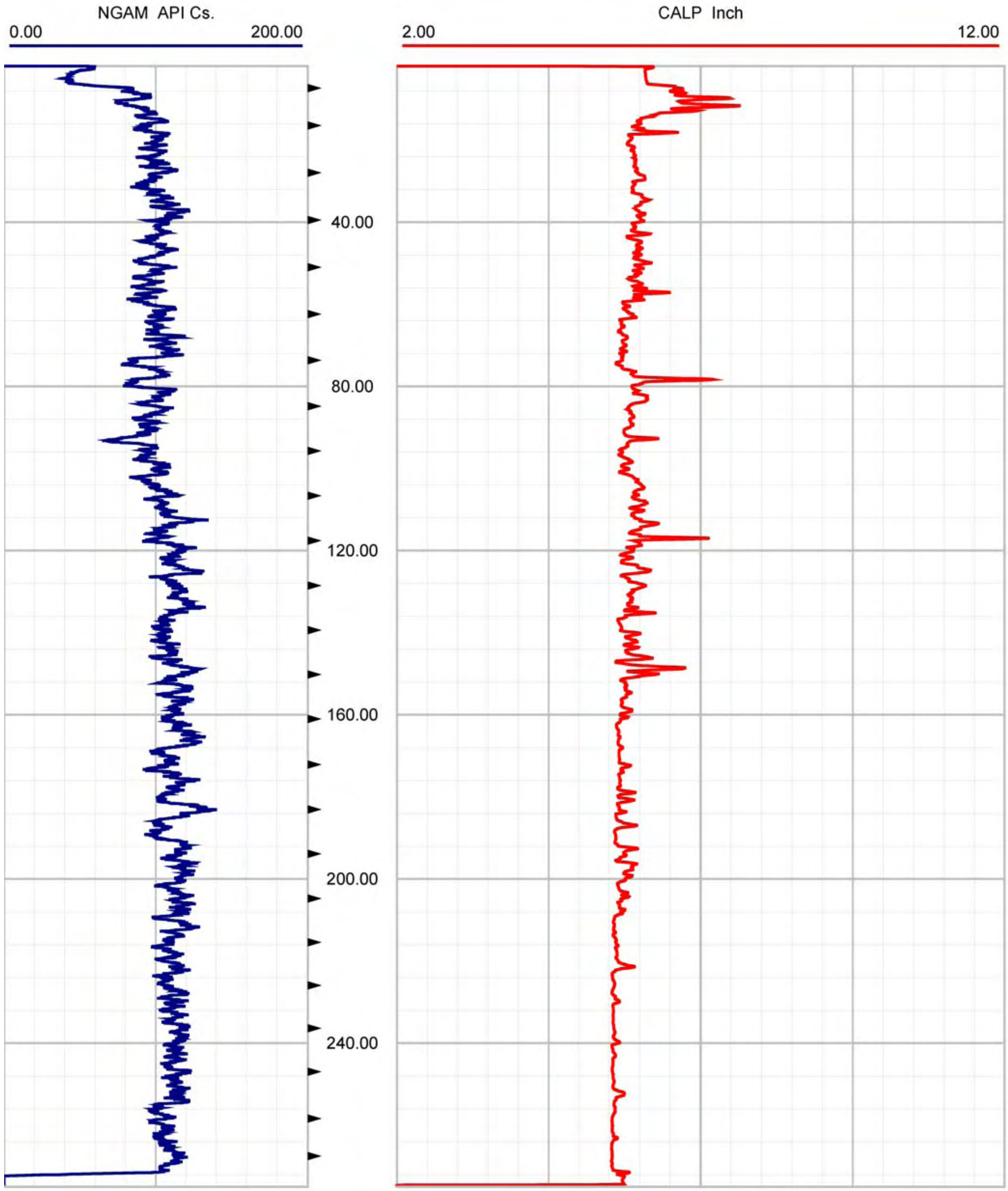


Figure 50. Boring Z4-B4, Caliper and Natural Gamma logs

DIP DATA INTERPRETATION
RGLDIP vsn 6.2
FRACTURE ANALYSIS STEREOGRAMS

CASCADE DRILLING

Borehole: Z4-B4

SR-710 TUNNEL INVESTIGATION

top of borehole.....
East:_
North:_
Elev:_

North ref: true
Depth units are feet

Zone from 274.222 to 17.723ft
Mean dip format: dip-azimuth and dip

Interpretation 1

Dip data sets .....
BHTV dips

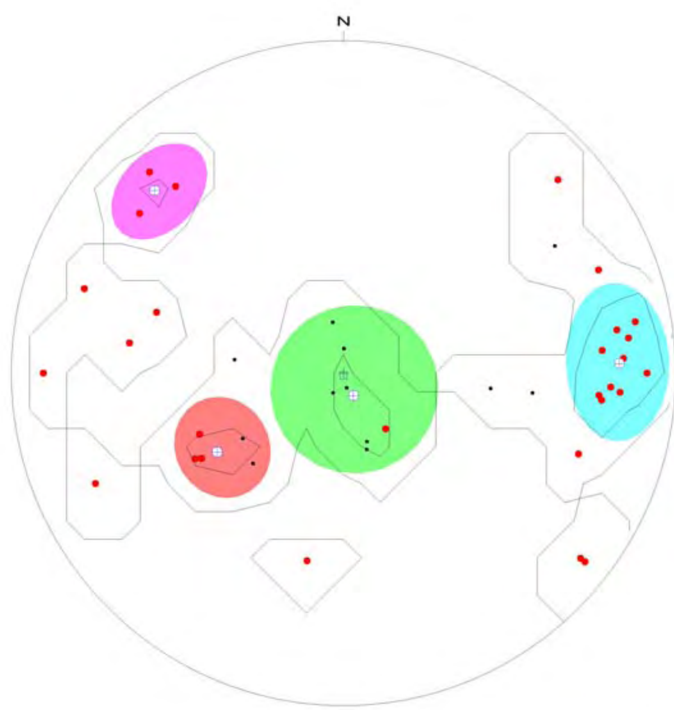
Z4-B4
Zone 0. 17.723 - 274.222ft
Deviation 0.60 N356.10

dipdata sets.....
BHTV dips
• Highlighted dips: Fracture Planar Hairline-fracture

	mean dip	n	f
N088 72	N088 72	10	(0.13)
N238 37	N238 37	5	(0.02)
N156 6	N156 6	7	(0.03)
N314 68	N314 68	3	(0.03)

intersections

	N088 72	N238 37	N156 6	N314 68
N088 72		17 N172	06 N176	47 N018
N238 37	17 N172		06 N156	37 N242
N156 6	06 N176	06 N156		02 N225
N314 68	47 N018	37 N242	02 N225	



mean dip
well axis

equal-area upper-hemisphere 0-90
contour-levels 1,3,

Z4-B4, Interpretation 1 274.222 to 17.723ft 1

Figure 51. Boring Z4-B4, Stereonet Plot

Depth (feet)	Dip azimuth	Dip	Structure description
273.72	N318	65	Fracture Planar Hairline-fracture
273.28	N316	73	Fracture Planar Hairline-fracture
269.47	N308	67	Fracture Planar Hairline-fracture
257.47	N239	41	Fracture Planar Hairline-fracture
245.93	N109	64	Fracture Planar Hairline-fracture
208.70	N143	17	Fracture Planar Hairline-fracture
187.06	N001	6	Primary-structure Planar Bedding
182.56	N128	81	Fracture Planar Hairline-fracture
173.49	N128	80	Fracture Planar Hairline-fracture
172.05	N068	72	Fracture Planar Hairline-fracture
168.70	N208	6	Primary-structure Planar Bedding
168.04	N168	4	Primary-structure Planar Bedding
159.96	N083	75	Fracture Planar Hairline-fracture
159.55	N240	43	Fracture Planar Hairline-fracture
155.97	N247	39	Fracture Planar Hairline-fracture
152.85	N288	50	Fracture Planar Hairline-fracture
152.03	N191	48	Fracture Planar Hairline-fracture
150.23	N094	72	Fracture Planar Hairline-fracture
146.46	N085	67	Fracture Planar Hairline-fracture
145.99	N081	72	Fracture Planar Hairline-fracture
144.45	N246	71	Fracture Planar Hairline-fracture
142.84	N087	73	Fracture Planar Hairline-fracture
140.85	N288	71	Fracture Planar Hairline-fracture
121.97	N080	78	Fracture Planar Hairline-fracture
121.13	N095	66	Fracture Planar Hairline-fracture
120.84	N096	67	Fracture Planar Hairline-fracture
120.50	N093	69	Fracture Planar Hairline-fracture
118.41	N090	81	Fracture Planar Hairline-fracture
118.05	N278	55	Fracture Planar Hairline-fracture
117.53	N225	32	Primary-structure Planar Bedding
117.11	N096	37	Primary-structure Planar Bedding
114.88	N277	27	Primary-structure Planar Bedding
113.08	N270	80	Fracture Planar Hairline-fracture
112.28	N048	76	Fracture Planar Hairline-fracture
98.48	N059	63	Primary-structure Planar Bedding
78.32	N096	48	Primary-structure Planar Bedding
43.39	N237	30	Primary-structure Planar Bedding
35.14	N348	13	Primary-structure Planar Bedding
18.61	N161	18	Primary-structure Planar Bedding
18.22	N163	20	Primary-structure Planar Bedding

Table 27. Boring Z4-B4, Structure depth, dip azimuth, dip and description

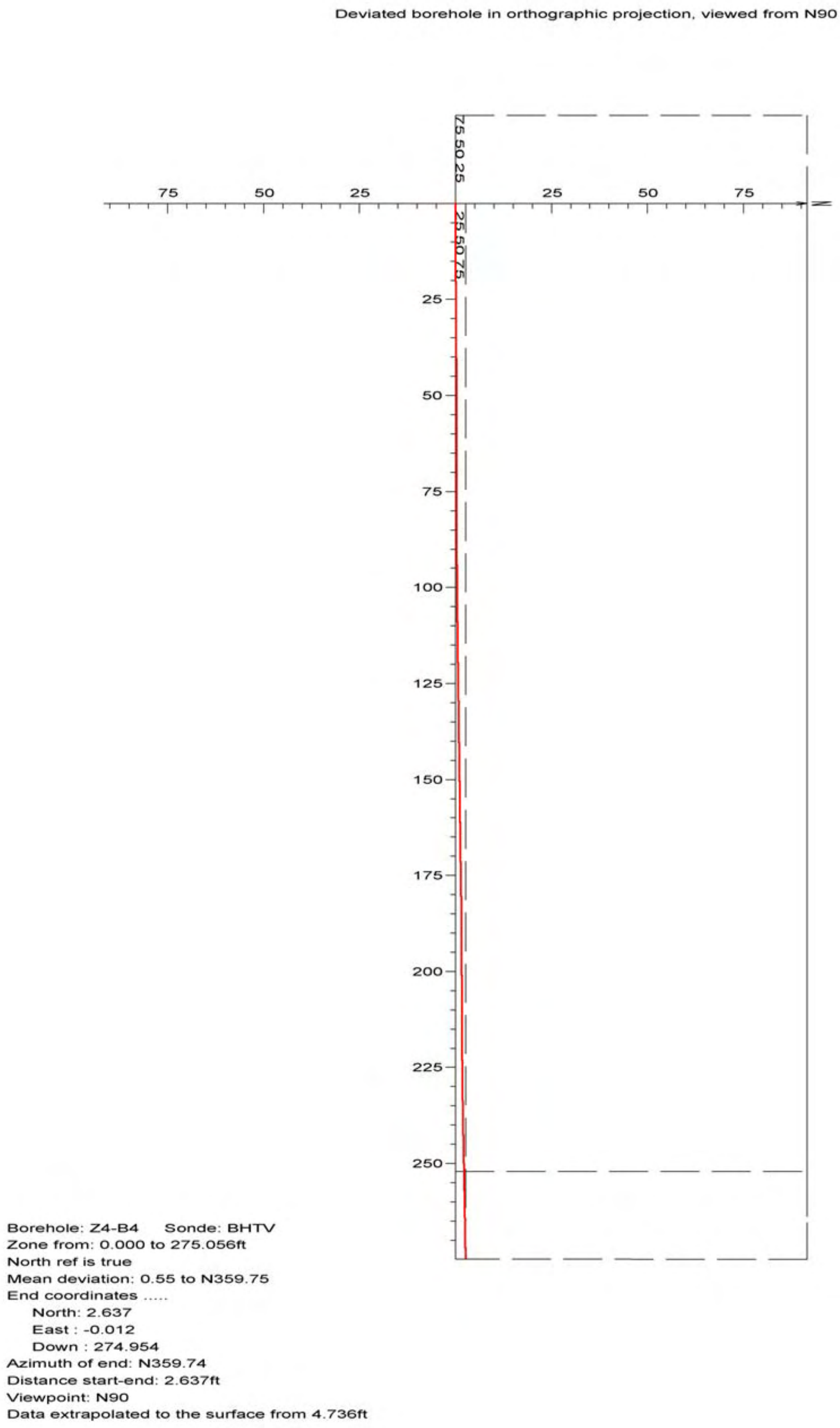


Figure 52. Boring Z4-B4, Deviation Projection

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APPENDIX A

SUSPENSION VELOCITY MEASUREMENT QUALITY ASSURANCE SUSPENSION SOURCE TO RECEIVER ANALYSIS RESULTS

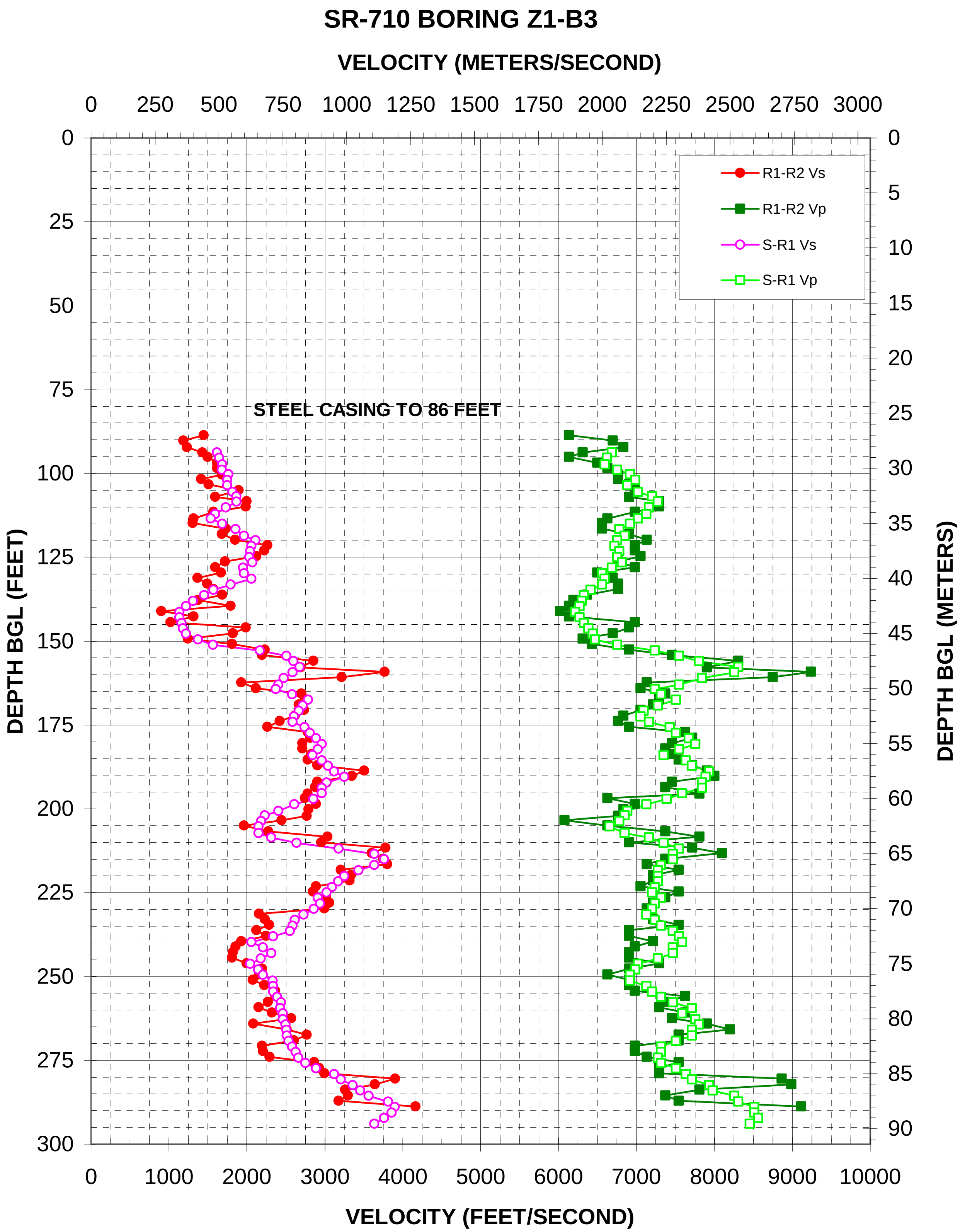


Figure A-1. Boring Z1-B3, R1 - R2 high resolution analysis and S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
93.73	1618	6687
95.37	1648	6624
97.34	1688	6592
98.98	1680	6751
100.30	1764	6917
101.94	1747	6986
103.58	1747	6883
105.54	1819	7021
106.86	1867	7201
108.50	1867	7276
110.14	1729	7164
112.11	1596	7128
113.42	1540	7021
115.06	1688	6917
116.70	1857	6784
118.67	1961	6850
119.98	2108	6751
121.62	2059	6719
123.26	2044	6784
124.90	2032	6751
126.54	2071	6817
128.18	1950	6687
129.82	1961	6562
131.46	2059	6592
133.10	1796	6562
134.74	1571	6412
136.38	1451	6325
138.02	1310	6297
139.67	1220	6269
141.31	1132	6213
142.95	1134	6269
144.59	1166	6325
146.23	1182	6383
147.87	1219	6441
149.51	1371	6471
151.15	1567	6751
152.79	2167	7238
154.43	2507	7549
156.07	2600	7801
157.71	2680	8309
159.35	2591	8260
160.99	2472	7845
162.96	2404	7549
164.27	2372	7238
165.91	2581	7314
167.55	2786	7509
169.19	2721	7276
170.83	2670	7092
172.47	2605	7056
174.11	2591	7164
175.75	2743	7430
177.40	2808	7509
179.04	2889	7673
180.68	2962	7758
182.32	2913	7549
183.96	2843	7352
185.60	2962	7632
187.24	3039	7715
188.88	3120	7933
190.52	3250	7889
192.16	3026	7845
193.80	2962	7845
195.44	2962	7590
197.08	2854	7391
198.72	2610	7128
200.69	2404	6883
202.00	2229	6850
203.64	2187	6784
205.28	2154	6655
207.25	2154	6850
208.56	2317	7164
210.20	2639	7352
211.84	3177	7549
213.48	3638	7469
215.12	3765	7469
216.77	3638	7314
218.41	3433	7276
220.05	3250	7276
221.69	3170	7276
223.33	3093	7238
224.97	3026	7201
226.61	2913	7314
228.25	2938	7238
229.89	2860	7201
231.53	2732	7128
233.17	2615	7238
234.81	2591	7314
236.45	2553	7469
238.09	2340	7549
239.73	2059	7590
241.37	2208	7469
243.01	2317	7469
244.65	2180	7276
246.29	2041	7021
247.93	2147	6986
249.57	2208	6917
251.21	2333	6917
252.85	2336	7128
254.49	2336	7201
256.14	2388	7314
257.78	2438	7469
259.42	2429	7715
261.06	2464	7590
262.70	2464	7758
264.34	2499	7801
265.98	2507	7715
267.62	2516	7715
269.26	2535	7509
270.90	2581	7314
272.54	2630	7314
274.18	2659	7276
275.82	2753	7314
277.46	2889	7509
279.10	3120	7632
280.74	3206	7715
282.38	3359	7933
284.02	3459	7978
285.66	3564	8260
287.30	3816	8309
288.94	3901	8510
290.58	3858	8510
292.22	3765	8562
293.86	3638	8459

Table A-1. Boring Z1-B3, S - R1 quality assurance analysis P- and S_H-wave data

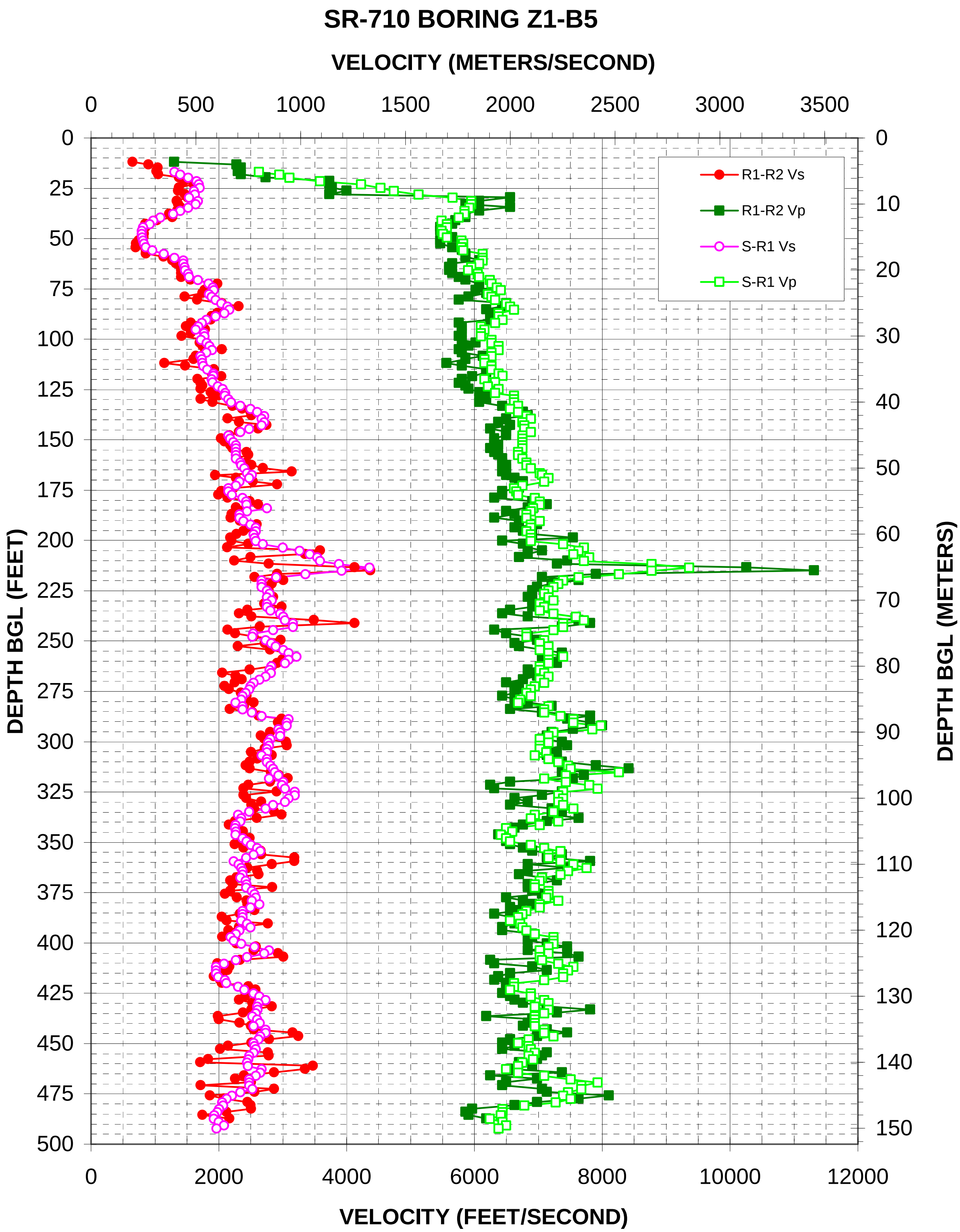


Figure A-2. Boring Z1-B5, R1 - R2 high resolution analysis and S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
16.96	1305	2630
18.27	1399	2950
19.91	1523	3107
21.56	1656	3582
23.20	1688	4230
24.84	1704	4530
26.48	1610	4744
28.12	1625	5125
29.76	1533	5662
31.40	1672	5950
33.04	1640	5950
34.68	1520	5925
36.32	1399	5851
37.96	1286	5851
39.60	1083	5755
41.24	975	5485
42.88	919	5572
44.52	818	5572
46.16	796	5485
47.80	796	5507
49.44	803	5572
51.08	818	5802
52.72	834	5827
54.36	858	5802
56.00	964	5827
57.64	1142	6132
59.61	1305	6132
60.93	1445	6132
62.57	1445	6079
64.21	1470	5950
65.85	1475	5900
67.49	1520	6053
69.13	1540	6079
70.77	1672	6241
72.41	1838	6269
74.38	1908	6354
75.69	1924	6412
77.66	1848	6213
78.97	1887	6269
80.61	1950	6325
82.25	2041	6501
83.89	2141	6562
85.53	2167	6624
87.17	2090	6383
88.81	1950	6383
90.45	1810	6441
92.09	1734	6325
93.73	1680	6105
95.37	1639	6159
97.01	1773	6105
98.65	1782	6105
100.30	1725	6269
101.94	1814	6269
103.58	1853	6383
105.54	1898	6383
106.86	1805	6269
108.50	1717	6269
110.14	1738	6159
111.78	1747	6159
113.42	1755	6269
115.06	1819	6269
117.03	1918	6383
118.34	1918	6441
119.98	1892	6159
121.62	1903	6325
123.59	1989	6213
124.90	2065	6383
126.87	2102	6325
128.18	2096	6624
129.82	2154	6624
131.46	2194	6624
133.10	2340	6687
134.74	2499	6562
136.38	2600	6687
138.35	2711	6817
139.67	2670	6883
141.31	2711	6751
142.95	2670	6784
144.59	2481	6784
146.23	2340	6883
147.87	2154	6751
149.51	2180	6751
151.15	2229	6751
152.79	2272	6751
154.43	2272	6751
156.07	2272	6687
157.71	2272	6687
159.35	2272	6751
161.32	2340	6817
162.63	2356	6817
164.27	2404	6883
166.57	2446	7021
167.55	2516	7056
169.19	2481	7164
170.83	2325	7092
172.80	2272	6751
174.11	2154	6624
175.75	2154	6655
177.40	2208	6687
179.04	2372	6951
180.68	2429	7021
182.32	2438	7021
183.96	2753	6917
185.60	2446	6883
187.24	2325	6817
188.88	2325	6817
190.52	2388	7021
192.16	2499	6883
193.80	2581	6883
195.44	2581	6817
197.08	2544	6883
198.72	2562	6883
200.36	2581	6883
202.00	2690	7391
203.64	3000	7715
205.28	3266	7632
206.92	3425	7549
208.56	3546	7801
210.20	3582	7715
211.84	3879	8776
213.48	4361	9361
215.12	3922	8776
216.77	3359	8260
218.41	2901	7632
220.05	2670	7391
221.69	2670	7314
223.33	2670	7238
224.97	2753	7164
226.61	2797	7092
228.25	2753	7164
229.89	2831	7238
231.53	2753	7021
233.17	2753	7092
234.81	2808	7021
236.45	2962	7238
238.09	3013	7590
239.73	3039	7715
241.37	3163	7391
243.01	3163	7391
244.65	2854	7238
246.29	2539	6817
247.93	2526	6817
249.57	2732	7092
251.21	2825	7021
252.85	2889	7164
254.49	3013	7021
256.14	3093	7164
257.78	3221	7391
259.42	3093	7164
261.06	3039	7164

Table A-2. Boring Z1-B5, S - R1 quality assurance analysis
P- and S_H-wave data

Depth (feet)	**V_s (feet/sec)**	**V_p (feet/sec)**
262.70	2825	7021
264.34	2797	7021
265.98	2820	7092
267.62	2732	7164
269.26	2639	7021
270.90	2544	7092
272.54	2499	6951
274.18	2481	6883
275.82	2421	6817
277.46	2372	6883
279.10	2356	6719
280.74	2265	6687
282.38	2372	7164
284.02	2372	7092
285.66	2516	7092
287.30	2670	7352
288.94	3093	7549
290.58	3066	7549
292.22	3066	7978
293.86	2938	7845
295.51	2962	7238
297.15	2962	7164
298.79	2808	7021
300.43	2775	7164
302.07	2786	7021
303.71	2753	7021
305.35	2753	7128
306.99	2670	6951
308.63	2753	7164
310.27	2753	7314
311.91	2808	7469
313.55	2854	7509
315.19	2877	8260
316.83	2938	7430
318.47	2786	7092
320.11	3013	7430
321.75	2988	7801
323.39	3039	7933
325.03	3191	7391
326.67	3191	7314
328.31	3093	7391
329.95	3039	7314
331.59	2854	7391
333.23	2732	7549
334.88	2481	7238
336.52	2302	6951
338.16	2356	6883
339.80	2340	7314
341.44	2265	7021
343.08	2258	6501

Depth (feet)	**V_s (feet/sec)**	**V_p (feet/sec)**
344.72	2272	6592
346.36	2265	6412
348.00	2372	6501
349.64	2438	6562
351.28	2507	6883
352.92	2600	7092
354.56	2649	7352
356.20	2544	7164
357.84	2429	7164
359.48	2236	7352
361.12	2310	7549
362.76	2356	7758
364.40	2372	7469
366.04	2372	7352
367.68	2340	7056
369.32	2421	7021
370.96	2438	6951
372.60	2429	6951
374.25	2516	7164
375.89	2562	7164
377.53	2581	7128
379.17	2516	7314
380.81	2639	7021
382.45	2499	7021
384.09	2372	6817
385.73	2372	6751
387.37	2372	6687
389.01	2356	6562
390.65	2446	6719
392.29	2499	6751
393.93	2325	6817
395.57	2272	6951
397.21	2187	7238
398.85	2236	7238
400.49	2356	7238
402.13	2562	7164
403.77	2786	7021
405.41	2711	7164
407.05	2446	7021
408.69	2272	7056
410.33	2083	7314
411.98	1956	7549
413.62	1956	7469
415.26	1956	7391
416.90	1995	7391
418.54	2096	7092
420.18	2115	6624
421.82	2302	6624
423.46	2404	6562
425.10	2544	6883

Depth (feet)	**V_s (feet/sec)**	**V_p (feet/sec)**
426.74	2639	6883
428.38	2732	7092
430.02	2620	7164
431.66	2600	6951
433.30	2610	7164
434.94	2581	7092
436.58	2526	6951
438.22	2600	6951
439.86	2644	6951
441.50	2544	6951
443.14	2732	7092
444.78	2732	7092
446.42	2649	7238
448.06	2620	6850
449.70	2544	6687
451.35	2562	6850
452.99	2581	6883
454.63	2544	6951
456.27	2481	6850
457.91	2464	6917
459.55	2446	6751
461.19	2455	6687
462.83	2670	6501
464.47	2649	6687
466.11	2581	7092
467.75	2481	7509
469.39	2481	7933
471.03	2481	7673
472.67	2526	7673
474.31	2340	7469
475.95	2208	7391
477.59	2121	7509
479.23	2053	7276
480.87	2071	6784
482.51	2006	6441
484.15	1978	6441
485.79	1934	6412
487.43	1924	6241
489.07	2000	6441
490.72	2083	6501
492.36	1967	6383

Table A-2, continued. Boring Z1-B5, S - R1 quality assurance analysis
P- and S_H-wave data

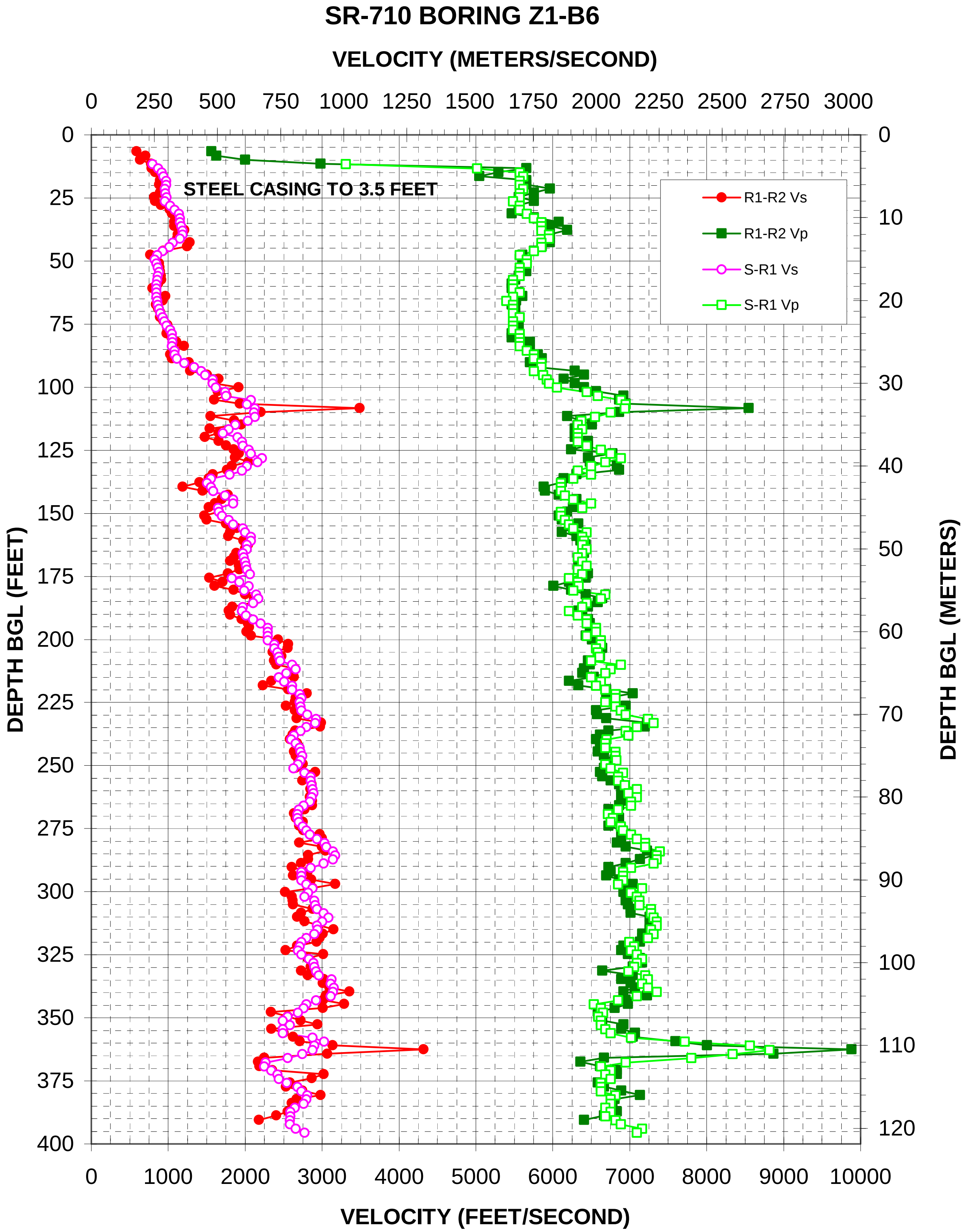


Figure A-3. Boring Z1-B6, R1 - R2 high resolution analysis and S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
11.71	798	3312
13.35	873	5015
14.99	919	5572
16.63	942	5617
18.27	974	5572
19.91	974	5572
21.56	957	5617
23.20	962	5572
24.84	978	5572
26.48	959	5485
28.12	1026	5572
29.76	1087	5572
31.40	1143	5662
33.04	1155	5755
34.68	1155	5851
36.32	1170	5851
37.96	1186	5851
39.60	1186	5950
41.24	1151	5950
42.88	1064	5851
44.52	1015	5851
46.16	931	5755
47.80	858	5572
49.44	826	5662
51.08	846	5662
52.72	865	5572
54.36	884	5572
56.00	863	5572
57.64	858	5485
59.28	848	5485
60.93	848	5485
62.57	848	5572
64.21	846	5485
65.85	860	5401
67.49	863	5485
69.13	882	5485
70.77	898	5485
72.41	926	5572
74.05	951	5485
75.69	981	5485
77.33	1026	5485
78.97	1048	5572
80.61	1057	5572
82.25	1057	5572
83.89	1051	5572
85.53	1087	5662
87.17	1087	5755
88.81	1114	5755
90.45	1212	5851
92.09	1340	5851

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
93.73	1433	5755
95.37	1484	5875
97.01	1578	5925
98.65	1581	5950
100.30	1618	6053
101.94	1742	6441
103.58	1751	6586
105.22	2077	6883
106.86	2023	6951
108.50	2128	6938
110.14	2115	6751
111.78	2128	6549
113.42	2035	6371
115.06	1872	6325
116.70	1787	6383
118.34	1712	6325
119.98	1903	6325
121.62	1961	6325
123.26	1972	6441
124.90	2047	6624
126.54	2076	6751
128.18	2218	6883
129.82	2160	6687
131.46	2023	6501
133.10	1962	6325
134.74	1800	6501
136.38	1557	6269
138.02	1503	6105
139.67	1557	6105
141.31	1585	6105
142.95	1742	6159
144.59	1848	6269
146.23	1848	6501
147.87	1652	6383
149.51	1660	6105
151.15	1704	6105
152.79	1787	6159
154.43	1848	6213
156.07	1972	6269
157.71	2000	6441
159.35	2077	6383
160.99	2077	6406
162.63	2023	6383
164.27	2023	6441
165.91	1974	6383
167.55	1987	6325
169.19	2000	6383
170.83	2012	6441
172.47	2023	6325
174.11	2065	6383

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
175.75	1828	6213
177.40	1929	6325
179.04	2047	6337
180.68	1989	6269
182.32	2147	6687
183.96	2174	6624
185.60	2102	6441
187.24	1972	6383
188.88	1961	6213
190.52	2012	6325
192.16	2102	6441
193.80	2201	6441
195.44	2294	6562
197.08	2294	6562
198.72	2294	6441
200.36	2294	6624
202.00	2380	6624
203.64	2380	6562
205.28	2421	6586
206.92	2438	6611
208.56	2455	6501
210.20	2610	6883
211.84	2659	6751
213.48	2535	6687
215.12	2438	6501
216.77	2507	6624
218.41	2610	6562
220.05	2610	6687
221.69	2711	6817
223.33	2732	6817
224.97	2711	6687
226.61	2721	6817
228.25	2732	6883
229.89	2808	6951
231.53	2925	7238
233.17	2913	7314
234.81	2797	7092
236.45	2721	6951
238.09	2635	6986
239.73	2600	6699
241.37	2659	6687
243.01	2711	6687
244.65	2721	6817
246.29	2743	6817
247.93	2721	6830
249.57	2690	6687
251.21	2630	6751
252.85	2775	6917
254.49	2854	6850
256.14	2854	6850

Table A-3. Boring Z1-B6, S - R1 quality assurance analysis
P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
257.78	2866	6938
259.42	2877	7092
261.06	2889	6986
262.70	2866	7092
264.34	2843	7021
265.98	2764	7021
267.62	2700	6850
269.26	2680	6719
270.90	2680	6784
272.54	2700	6751
274.18	2753	6883
275.82	2797	6917
277.46	2843	7021
279.10	2938	7092
280.74	3033	7201
282.38	3059	7201
284.02	3143	7391
285.66	3171	7352
287.30	3141	7352
288.94	3020	7314
290.58	2854	7021
292.22	2732	6917
293.86	2732	6917
295.51	2732	6917
297.15	2797	6850
298.79	2877	7164
300.43	2820	7021
302.07	2775	7092
303.71	2901	7128
305.35	2913	7128
306.99	2938	7276
308.63	3020	7276
310.27	3086	7314
311.91	3007	7352
313.55	2938	7352
315.19	2944	7276
316.83	2899	7314
318.47	2797	7238
320.11	2732	6993
321.75	2711	7056
323.39	2690	7021
325.03	2732	7092
326.67	2831	7164
328.31	2889	7092
329.95	2901	7056
331.59	2925	6986
333.23	2956	7201
334.88	3127	7238
336.52	3114	7164
338.16	3156	7238
339.80	3141	7352
341.44	3114	7092
343.08	2925	6850
344.72	2797	6531
346.36	2764	6624
348.00	2690	6655
349.64	2553	6592
351.28	2490	6624
352.92	2581	6624
354.56	2491	6687
356.20	2490	6751
357.84	2877	7021
359.48	3026	7715
361.12	2899	8562
362.76	2877	8820
364.40	2743	8338
366.04	2555	7801
367.68	2265	6951
369.32	2250	6624
370.96	2340	6751
372.60	2421	6687
374.25	2438	6751
375.89	2544	6624
377.53	2680	6624
379.17	2732	6624
380.81	2808	6817
382.45	2797	6751
384.09	2764	6751
385.73	2649	6687
387.37	2591	6751
389.01	2591	6687
390.65	2581	6817
392.29	2581	6883
393.93	2659	7164
395.57	2775	7092

Table A-3, continued. Boring Z1-B6, S - R1 quality assurance analysis
P- and S_H-wave data

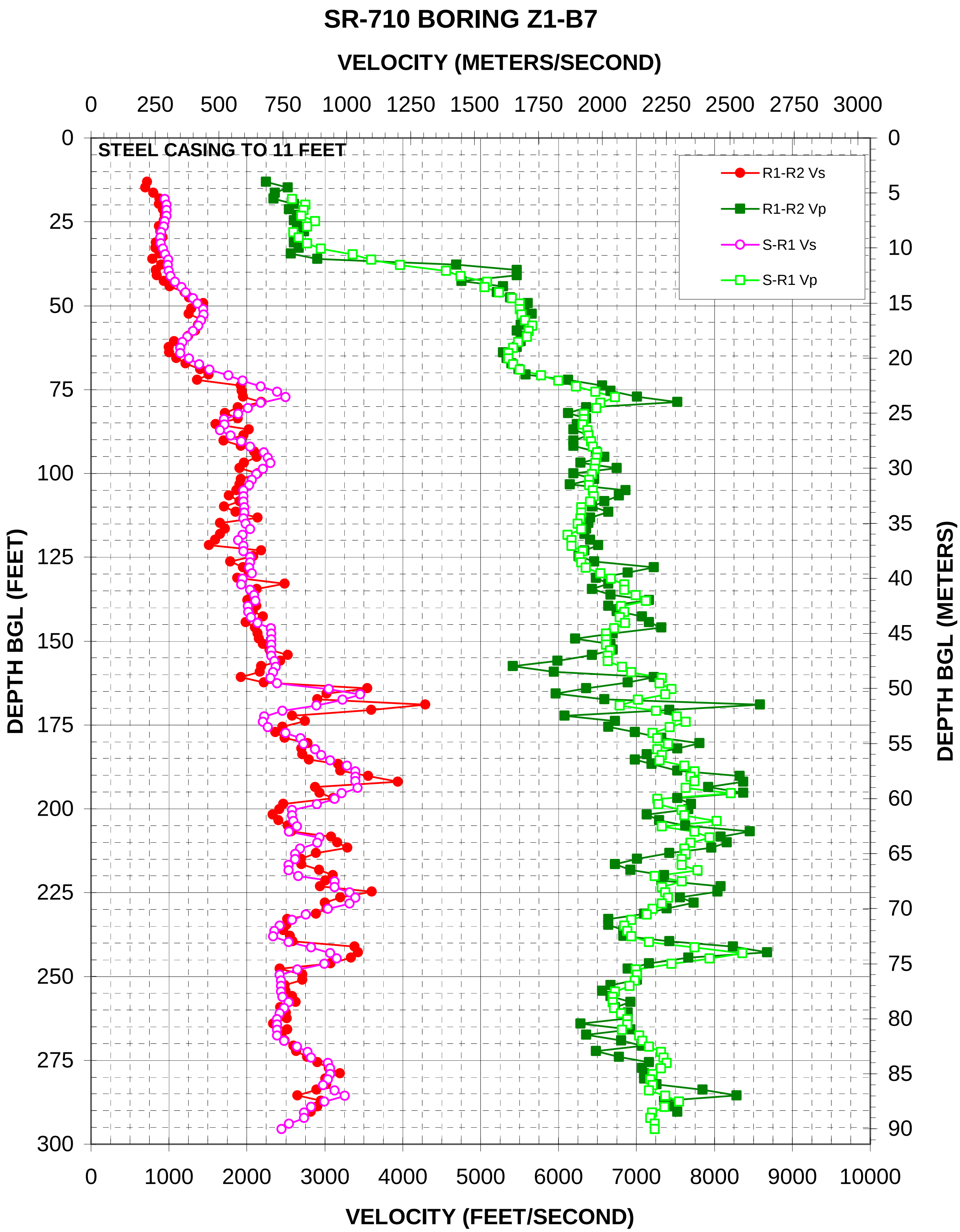


Figure A-4. Boring Z1-B7, R1 - R2 high resolution analysis and S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
18.27	945	2581
19.91	968	2753
21.56	968	2732
23.20	970	2700
24.84	948	2877
26.48	936	2775
28.12	904	2600
29.76	890	2670
31.40	894	2775
33.04	923	2950
34.68	955	3359
36.32	996	3601
37.96	985	3967
39.60	1002	4559
41.24	1022	4744
42.88	1078	5088
44.52	1164	5051
46.16	1217	5240
47.80	1312	5401
49.44	1366	5507
51.08	1442	5507
52.72	1448	5528
54.36	1416	5572
56.00	1379	5662
57.64	1312	5617
59.28	1236	5594
60.93	1174	5485
62.57	1149	5422
64.21	1149	5360
65.85	1261	5360
67.49	1390	5422
69.13	1523	5507
70.77	1764	5779
72.41	1945	6001
74.05	2180	6224
75.69	2388	6477
77.33	2499	6725
78.97	2180	6537
80.61	2018	6489
82.25	1887	6325
83.89	1708	6325
85.53	1717	6314
87.17	1656	6371
88.81	1791	6383
90.45	1929	6418
92.09	2041	6441
93.73	2222	6501
95.37	2272	6489
97.01	2302	6477
98.65	2208	6465
100.30	2121	6429
101.94	2067	6394
103.58	2029	6394
105.22	1956	6441
106.86	1956	6453
108.50	1956	6406
110.14	1967	6291
111.78	1967	6291
113.42	1956	6280
115.06	1989	6246
116.70	2041	6291
118.34	1945	6116
119.98	1887	6170
121.62	1956	6170
123.26	1956	6314
124.90	2041	6269
126.54	2041	6291
128.18	2029	6348
129.82	2065	6537
131.46	1945	6674
133.10	1929	6843
134.74	2041	6843
136.38	2096	6993
138.02	2108	7121
139.67	2014	6803
141.31	2020	6843
142.95	2053	6790
144.59	2138	6856
146.23	2310	6712
147.87	2317	6611
149.51	2317	6611
151.15	2317	6611
152.79	2317	6661
154.43	2317	6636
156.07	2356	6636
157.71	2372	6817
159.35	2340	6938
160.99	2302	7329
162.63	2388	7298
164.27	3053	7453
165.91	3455	7375
167.55	3228	7021
169.19	2895	6790
170.83	2455	7253
172.47	2225	7517
174.11	2208	7632
175.75	2272	7430
177.40	2499	7208
179.04	2690	7268
180.68	2732	7406
182.32	2877	7268
183.96	2956	7329
185.60	3073	7298
187.24	3289	7615
188.88	3392	7749
190.52	3392	7698
191.83	3392	7749
193.80	3425	7632
195.44	3221	8212
197.08	3127	7268
198.72	2901	7283
200.36	2581	7582
202.00	2581	7615
203.64	2600	8033
205.28	2644	7329
206.92	2544	7749
208.56	2932	7942
210.20	2904	7698
211.84	2685	7615
213.48	2620	7632
215.12	2620	7582
216.77	2538	7582
218.41	2539	7784
220.05	2665	7238
221.69	3127	7582
223.33	3127	7329
224.97	3320	7375
226.61	3392	7406
228.25	3320	7329
229.89	3039	7208
231.53	2759	7135
233.17	2583	6938
234.81	2421	6843
236.45	2356	6883
238.09	2339	6938
239.73	2535	7164
241.37	2825	7749
243.01	3073	8358
244.65	3156	7942
246.29	2994	7453
247.93	2649	6993
249.57	2425	7007
251.21	2442	6979
252.85	2442	6910
254.49	2443	6725
256.14	2459	6699
257.78	2539	6699
259.42	2481	6712
261.06	2425	6803
262.70	2388	6883

Table A-4. Boring Z1-B7, S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
264.34	2388	6883
265.98	2388	6817
267.62	2388	7035
269.26	2481	7078
270.90	2644	7164
272.54	2781	7314
274.18	2825	7352
275.82	3039	7391
277.46	3073	7314
279.10	3073	7208
280.74	3039	7179
282.38	2981	7208
284.02	3127	7164
285.66	3258	7375
287.30	2994	7549
288.94	2825	7360
290.58	2737	7201
292.22	2737	7179
293.86	2544	7238
295.51	2446	7238

Table A-4, continued. Boring Z1-B7, S - R1 quality assurance analysis P- and S_H-wave data

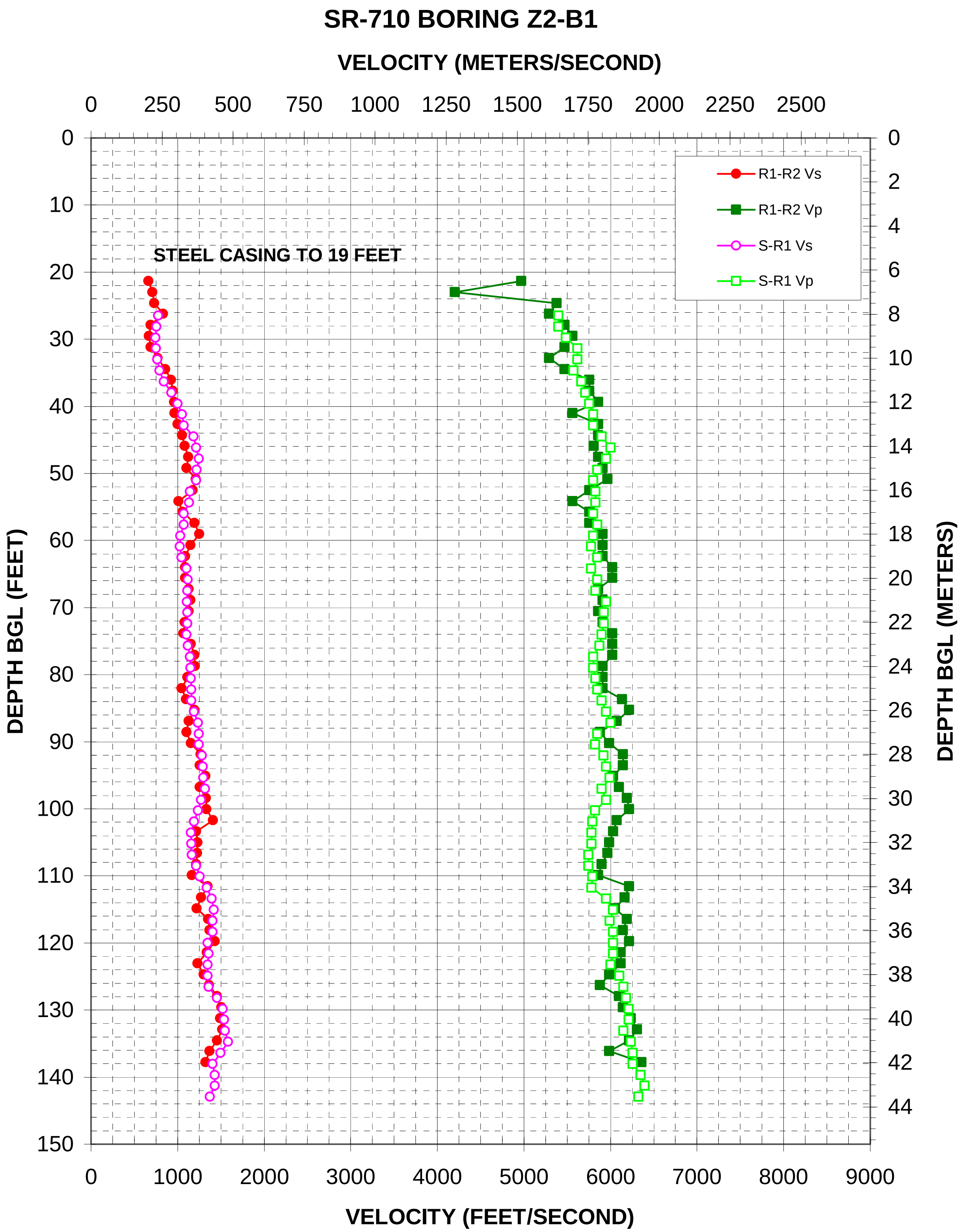


Figure A-5. Boring Z2-B1, R1 - R2 high resolution analysis and S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
26.48	774	5401
28.12	756	5401
29.76	746	5485
31.40	751	5617
33.04	767	5617
34.68	790	5572
36.32	843	5662
37.96	927	5708
39.60	1002	5755
41.24	1053	5802
42.88	1075	5802
44.52	1184	5900
46.16	1217	6001
47.80	1247	5950
49.44	1223	5851
51.08	1215	5802
52.72	1142	5827
54.36	1134	5827
56.00	1075	5802
57.64	1075	5851
59.28	1034	5802
60.93	1028	5779
62.57	1046	5851
64.21	1102	5779
65.85	1120	5851
67.49	1113	5827
69.13	1107	5950
70.77	1113	5925
72.41	1113	5925
74.05	1102	5900
75.69	1120	5875
77.33	1142	5802
78.97	1149	5802
80.61	1157	5827
82.25	1160	5851
83.89	1160	5900
85.53	1192	5950
87.17	1238	6001
88.81	1247	5851
90.45	1247	5822
92.09	1284	5920
93.73	1293	5950
95.37	1298	5991
97.01	1317	5900
98.65	1274	5950
100.30	1238	5822
101.94	1192	5793
103.58	1157	5783
105.22	1160	5783
106.86	1162	5745
108.50	1217	5745
110.14	1256	5793
111.78	1337	5783
113.42	1396	5950
115.06	1418	6032
116.70	1407	5991
118.34	1407	6032
119.98	1348	6032
121.62	1358	6032
123.26	1348	6001
124.90	1348	6105
126.54	1358	6148
128.18	1454	6180
129.82	1523	6213
131.46	1536	6213
133.10	1550	6148
134.74	1585	6235
136.38	1497	6258
138.02	1407	6258
139.67	1430	6348
141.31	1430	6394
142.95	1374	6325

Table A-5. Boring Z2-B1, S - R1 quality assurance analysis P- and S_H-wave data

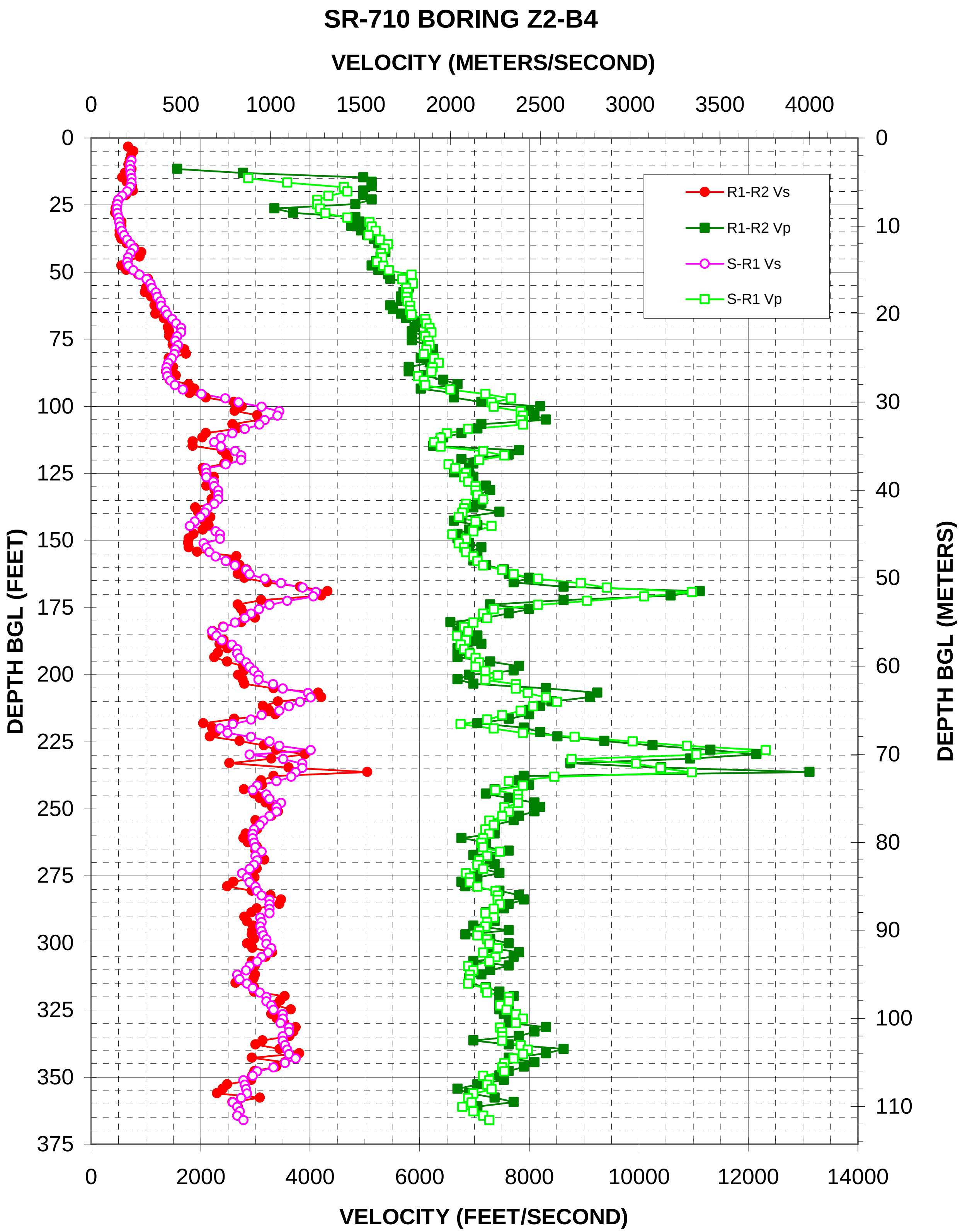


Figure A-6. Boring Z2-B4, R1 - R2 high resolution analysis and S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)	Depth (feet)	V_s (feet/sec)	V_p (feet/sec)	Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
8.43	742		90.45	1457	6079	172.47	3582	9059
10.07	719		92.09	1535	6105	174.11	3266	8164
11.71	721		93.73	1680	6562	175.75	3066	7352
13.35	727		95.37	2018	7201	177.40	2925	7164
14.99	742	2877	97.01	2455	7673	179.04	2808	7238
16.63	742	3582	98.65	2700	7314	180.68	2630	6986
18.27	719	4619	100.30	3120	7352	182.32	2421	6817
19.91	662	4681	101.94	3442	7845	183.96	2215	6883
21.56	573	4334	103.58	3408	7889	185.60	2294	6687
23.20	498	4130	105.22	3177	7845	187.24	2388	6850
24.84	482	4130	106.86	3079	7889	188.88	2572	6751
26.48	474	4179	108.50	2808	6883	190.52	2670	6817
28.12	484	4281	110.14	2581	6501	192.16	2670	6917
29.76	507	4681	111.78	2372	6383	193.80	2721	7021
31.40	516	5088	113.42	2250	6269	195.44	2831	7092
33.04	531	5125	115.06	2372	6383	197.08	2901	7021
34.68	568	5201	116.70	2635	7164	198.72	2981	7201
36.32	605	5069	118.34	2743	7549	200.36	3059	7430
37.96	659	5279	119.98	2743	7092	202.00	3059	7201
39.60	723	5422	121.62	2464	6531	203.64	3327	7758
41.24	784	5360	123.26	2096	6655	205.28	3502	7758
42.88	723	5299	124.90	2108	6850	206.92	3967	7978
44.52	681	5319	126.54	2108	6817	208.56	4012	8309
46.16	659	5220	128.18	2236	6883	210.20	3816	8510
47.80	686	5339	129.82	2250	7021	211.84	3619	8070
49.44	772	5443	131.46	2325	7021	213.48	3442	7845
51.08	889	5851	133.10	2325	7056	215.12	3120	7509
52.72	1020	5685	134.74	2325	7164	216.77	2925	7238
54.36	1094	5875	136.38	2250	6850	218.41	2591	6751
56.00	1114	5755	138.02	2134	6817	220.05	2356	7352
57.64	1186	5779	139.67	2083	6784	221.69	2499	7889
59.28	1215	5755	141.31	2006	6719	223.33	2925	8831
60.93	1272	5779	142.95	1898	7021	224.97	3266	9889
62.57	1281	5827	144.59	1805	7314	226.61	3442	10885
64.21	1355	5827	146.56	2280	6986	228.25	4012	12318
65.85	1399	5851	147.87	2356	6592	229.89	2901	11057
67.49	1487	6105	149.51	2356	6850	231.53	3510	8776
69.13	1560	6132	151.15	2059	6719	233.17	3858	9959
70.77	1648	6186	152.79	2108	6817	234.81	3858	10401
72.41	1648	6213	154.43	2160	6850	236.45	3735	10970
74.05	1574	6105	156.07	2280	6986	238.09	3657	8459
75.69	1540	6159	157.71	2464	7056	239.73	3392	7632
77.33	1588	6186	159.35	2630	7164	241.37	3039	7889
78.97	1540	6132	160.99	2831	7509	243.01	2956	7391
80.61	1526	6079	162.63	2901	7715	244.65	3206	7801
82.25	1475	6269	164.27	3177	8164	246.29	3266	7801
83.89	1410	6354	165.91	3476	8944	247.93	3476	7801
85.53	1382	6241	167.55	3868	9424	249.57	3392	7549
87.17	1377	6213	169.19	4106	10970	251.21	3392	7632
88.81	1399	5975	170.83	4058	10102	252.85	3266	7509

NOTE: “blank” space indicates data of insufficient quality for good pick.

Table A-6. Boring Z2-B4, S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
254.49	3148	7276
256.14	3086	7352
257.78	2981	7201
259.42	2956	7276
261.06	2956	7164
262.70	2981	7128
264.34	3007	7164
265.98	3120	7469
267.62	3007	7238
269.26	3033	7092
270.90	2981	7056
272.54	2901	7164
274.18	2759	6850
275.82	2854	6917
277.46	2901	6917
279.10	3007	7056
280.74	3033	7391
282.38	3120	7430
284.02	3266	7430
285.66	3266	7469
287.30	3266	7352
288.94	3266	7201
290.58	3093	7352
292.22	3120	7238
293.86	3093	7201
295.51	3120	7092
297.15	3148	7056
298.79	3206	7238
300.43	3206	7276
302.07	3296	7430
303.71	3235	7164
305.35	3120	7391
306.99	3033	7276
308.63	2901	6883
310.27	2831	6986
311.91	2675	6917
313.55	2716	6917
315.19	2854	6883
316.83	2956	7201
318.47	3086	7238
320.11	3206	7632
321.75	3206	7632
323.39	3296	7469
325.03	3335	7590
326.67	3502	7758
328.31	3502	7889
329.95	3467	7758
331.59	3619	7469
333.23	3619	7509
334.88	3502	7509

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
336.52	3502	7509
338.16	3546	7845
339.80	3582	7978
341.44	3619	7889
343.08	3735	7715
344.72	3546	7549
346.36	3335	7509
348.00	3033	7549
349.64	2956	7164
351.28	2786	7276
352.92	2808	7238
354.56	2831	7314
356.20	2854	6986
357.84	2743	6883
359.48	2591	6951
361.12	2670	6784
362.76	2721	6986
364.40	2670	7164
366.04	2786	7276

Table A-6, continued. Boring Z2-B4, S - R1 quality assurance analysis P- and S_H-wave data

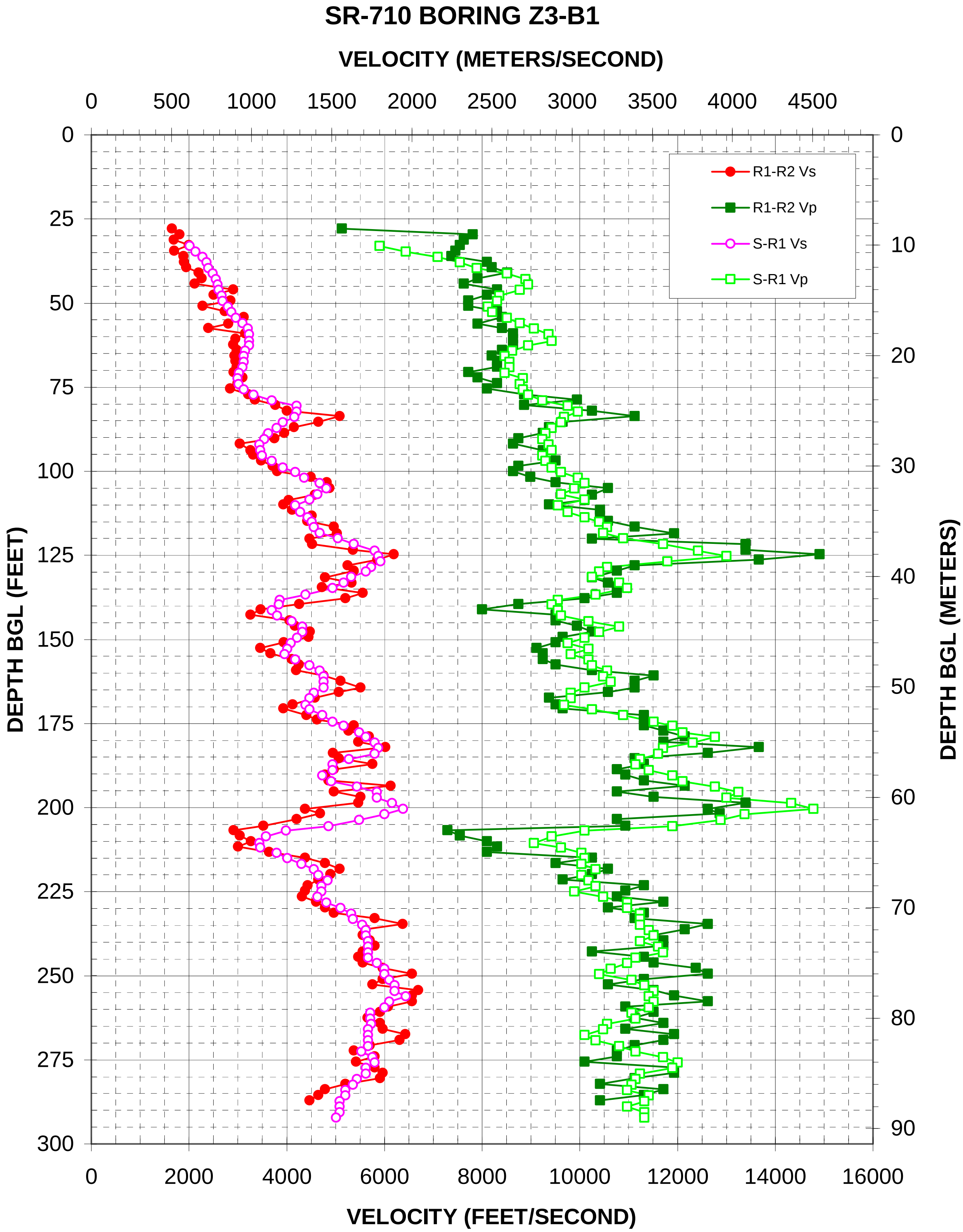


Figure A-7. Boring Z3-B1, R1 - R2 high resolution analysis and S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
33.04	2012	5900
34.68	2134	6441
36.32	2276	7092
37.96	2364	7549
39.60	2396	7889
41.24	2485	8510
42.88	2553	8887
44.52	2591	8944
46.16	2610	8776
47.80	2670	8358
49.44	2690	8309
51.08	2797	8117
52.72	2866	8212
54.36	2962	8510
56.00	3093	8776
57.64	3206	9059
59.28	3235	9361
61.25	3235	9424
62.57	3235	8944
64.21	3148	8615
65.85	3120	8459
67.49	3120	8562
69.13	3093	8562
70.77	3026	8459
72.41	3000	8831
74.05	3013	8776
75.69	3120	8831
77.33	3327	8944
78.97	3695	9238
80.61	4204	9751
82.25	4204	9959
83.89	4154	9684
85.53	3922	9618
87.17	3795	9424
88.81	3619	9299
90.45	3546	9238
92.09	3442	9361
93.73	3459	9424
95.37	3493	9238
97.01	3695	9299
98.98	3922	9424
100.30	4179	9618
101.94	4361	9959
103.58	4681	10102
105.22	4809	9889
106.86	4634	9618
108.50	4472	10102
110.14	4179	9552
112.11	4281	9751
113.75	4430	10102

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
115.06	4515	10401
116.70	4559	10558
118.34	4681	10479
119.98	5051	10885
121.62	5380	11702
123.59	5802	12427
125.23	5875	13002
126.87	5925	11800
128.51	5731	10558
129.82	5617	10401
131.46	5319	10250
133.10	5162	10802
134.74	4944	10970
136.71	4388	10325
138.35	3858	9552
139.67	3837	9424
141.31	3695	9552
142.95	3805	9618
144.59	4106	10175
146.23	4321	10802
147.87	4321	10401
149.51	4217	10102
151.15	4082	9751
152.79	4012	10175
154.43	3955	9820
156.07	4179	10175
157.71	4472	10250
159.35	4681	10558
160.99	4760	10479
162.63	4760	10638
164.27	4760	10102
165.91	4559	9820
167.55	4472	9820
169.52	4388	9684
170.83	4472	10250
172.47	4728	10885
174.44	4944	11510
175.75	5162	11900
177.72	5485	12105
179.04	5617	12765
180.68	5802	12318
182.32	5875	11702
183.96	5802	11605
185.60	5279	11234
187.24	4944	11144
188.88	4944	11416
190.52	4728	11900
192.16	4910	12105
193.80	5443	12765
195.44	5851	13247

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
197.08	5851	13002
198.72	6159	14329
200.36	6383	14781
202.00	6001	13373
203.64	5485	12883
205.61	4859	11900
206.92	3989	10102
208.56	3582	9424
210.53	3442	9059
211.84	3459	9618
213.48	3795	10030
215.12	4012	10102
216.77	4307	10030
218.41	4559	10325
220.05	4650	10030
221.69	4842	10175
223.33	4712	10325
224.97	4712	9889
226.61	4634	10479
228.25	4809	10970
229.89	5106	10970
231.53	5319	11234
233.17	5360	11234
234.81	5550	11234
236.45	5617	11416
238.09	5617	11510
239.73	5662	11234
241.37	5662	11605
243.01	5662	11702
244.65	5662	11144
246.29	5851	10970
247.93	6001	10638
249.57	6001	10401
251.21	6105	11057
252.85	6213	11324
254.49	6213	11510
256.14	6441	11416
257.78	6105	11510
259.42	6001	11416
261.06	5708	11057
262.70	5708	11144
264.34	5731	10558
265.98	5662	10479
267.62	5662	10102
269.26	5662	10325
270.90	5662	10802
272.54	5528	11144
274.18	5755	11702
275.82	5802	12002
277.46	5617	11900

Table A-7. Boring Z3-B1, S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
279.10	5617	11234
280.74	5443	11144
282.38	5360	11057
284.02	5201	10970
285.66	5201	11416
287.30	5088	11324
288.94	5088	10970
290.58	5088	11324
292.22	5015	11324

Table A-7, continued. Boring Z3-B1, S - R1 quality assurance analysis P- and S_H-wave data

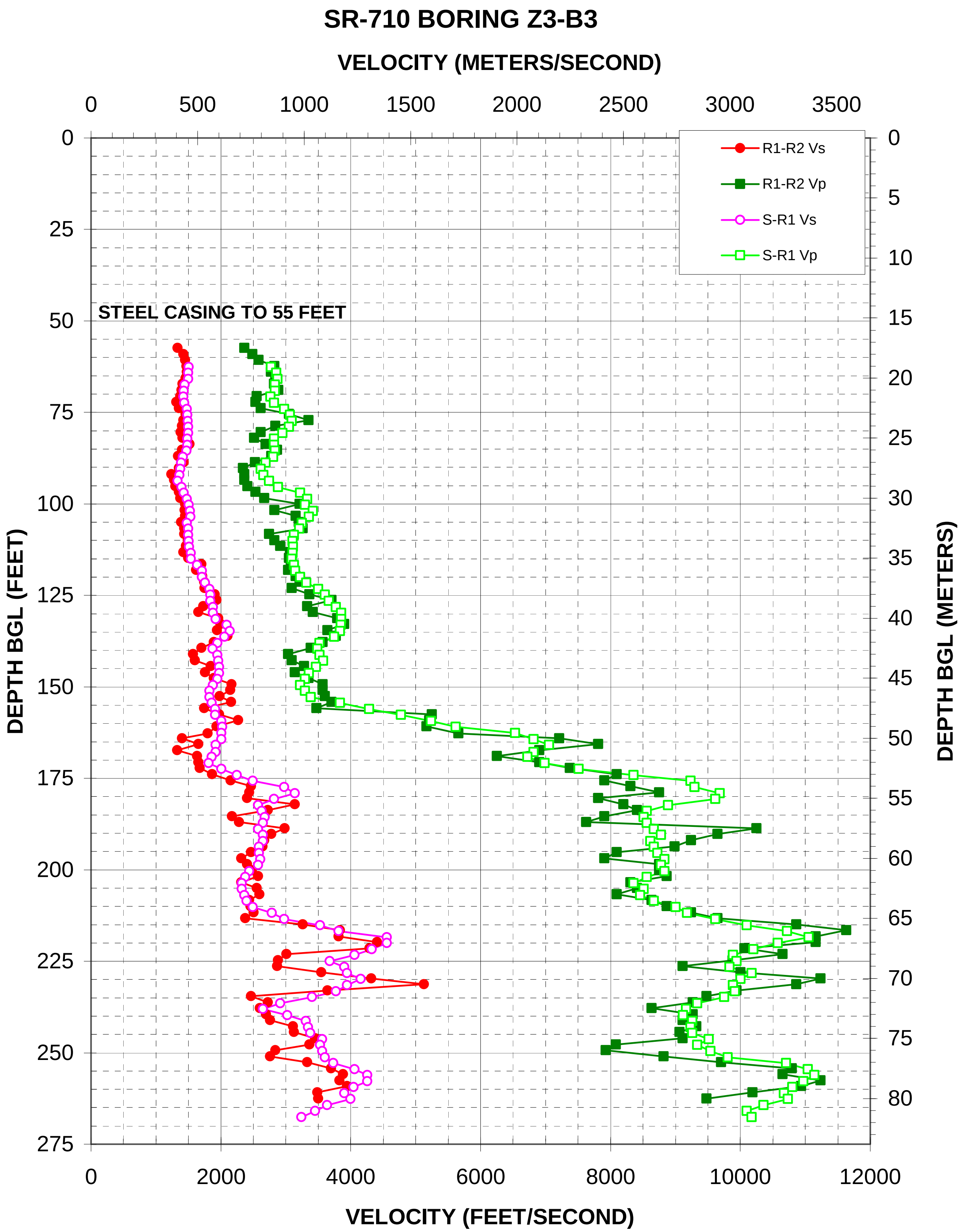


Figure A-8. Boring Z3-B3, R1 - R2 high resolution analysis and S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
62.57	1503	2775
64.21	1497	2854
65.85	1497	2872
67.49	1445	2831
69.13	1430	2831
70.77	1424	2764
72.41	1437	2820
74.05	1478	2975
75.69	1484	3066
77.33	1491	3093
78.97	1497	3053
80.61	1497	2950
82.25	1484	2820
83.89	1484	2820
85.53	1469	2831
87.17	1418	2803
88.81	1388	2690
90.45	1377	2615
92.09	1363	2654
93.73	1337	2743
95.37	1399	2877
97.01	1430	3221
98.65	1478	3327
100.30	1503	3296
101.94	1526	3417
103.58	1533	3359
105.22	1478	3250
106.86	1497	3206
108.50	1497	3127
110.14	1505	3107
111.78	1510	3114
113.42	1540	3107
115.06	1540	3093
116.70	1633	3127
118.34	1712	3148
119.98	1712	3221
121.62	1760	3320
123.26	1828	3502
124.90	1838	3601
126.54	1838	3666
128.18	1882	3775
129.82	1882	3858
131.46	1924	3858
133.10	2090	3847
134.74	2141	3837
136.38	2059	3745
138.02	1950	3519
139.67	1872	3484
141.31	1950	3519
142.95	1961	3573

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
144.59	1972	3467
146.23	1972	3359
147.87	1950	3296
149.51	1882	3221
151.15	1828	3296
152.79	1828	3384
154.43	1857	3837
156.07	1913	4281
157.71	1913	4776
159.35	2012	5240
160.99	2023	5617
162.63	2012	6531
164.27	2012	6817
165.91	1924	7056
167.88	1924	6817
169.19	1857	6719
170.83	1810	6986
172.47	2012	7509
174.11	2250	8358
175.75	2490	9238
177.40	2975	9299
179.04	3141	9684
180.68	2820	9618
182.32	2572	8887
183.96	2630	8562
185.60	2675	8510
187.24	2649	8562
188.88	2572	8668
190.52	2649	8776
192.16	2649	8615
193.80	2591	8668
195.44	2591	8722
197.08	2610	8831
198.72	2572	8776
200.36	2438	8831
202.00	2380	8562
203.64	2325	8358
205.28	2325	8510
206.92	2364	8459
208.56	2396	8668
210.20	2490	9001
211.84	2786	9178
213.48	2975	9618
215.12	3528	10102
216.77	3816	10719
218.41	4559	11057
220.05	4559	10574
221.69	4323	10205
223.33	4058	9889
224.97	3676	9945

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
226.61	3901	9833
228.25	3944	10175
229.89	4154	10001
231.53	3944	9889
233.17	3775	9917
234.81	3408	9751
236.45	2913	9336
238.09	2649	9166
239.73	3026	9118
241.37	3312	9263
243.01	3343	9238
244.65	3375	9263
246.29	3564	9514
247.93	3528	9336
249.57	3564	9539
251.21	3601	9806
252.85	3735	10703
254.49	4058	11039
256.14	4255	11144
257.78	4255	10970
259.42	4047	10802
261.06	3901	10670
262.70	4001	10735
264.34	3638	10355
265.98	3450	10102
267.62	3243	10175

Table A-8. Boring Z3-B3, S - R1 quality assurance analysis P- and S_H-wave data

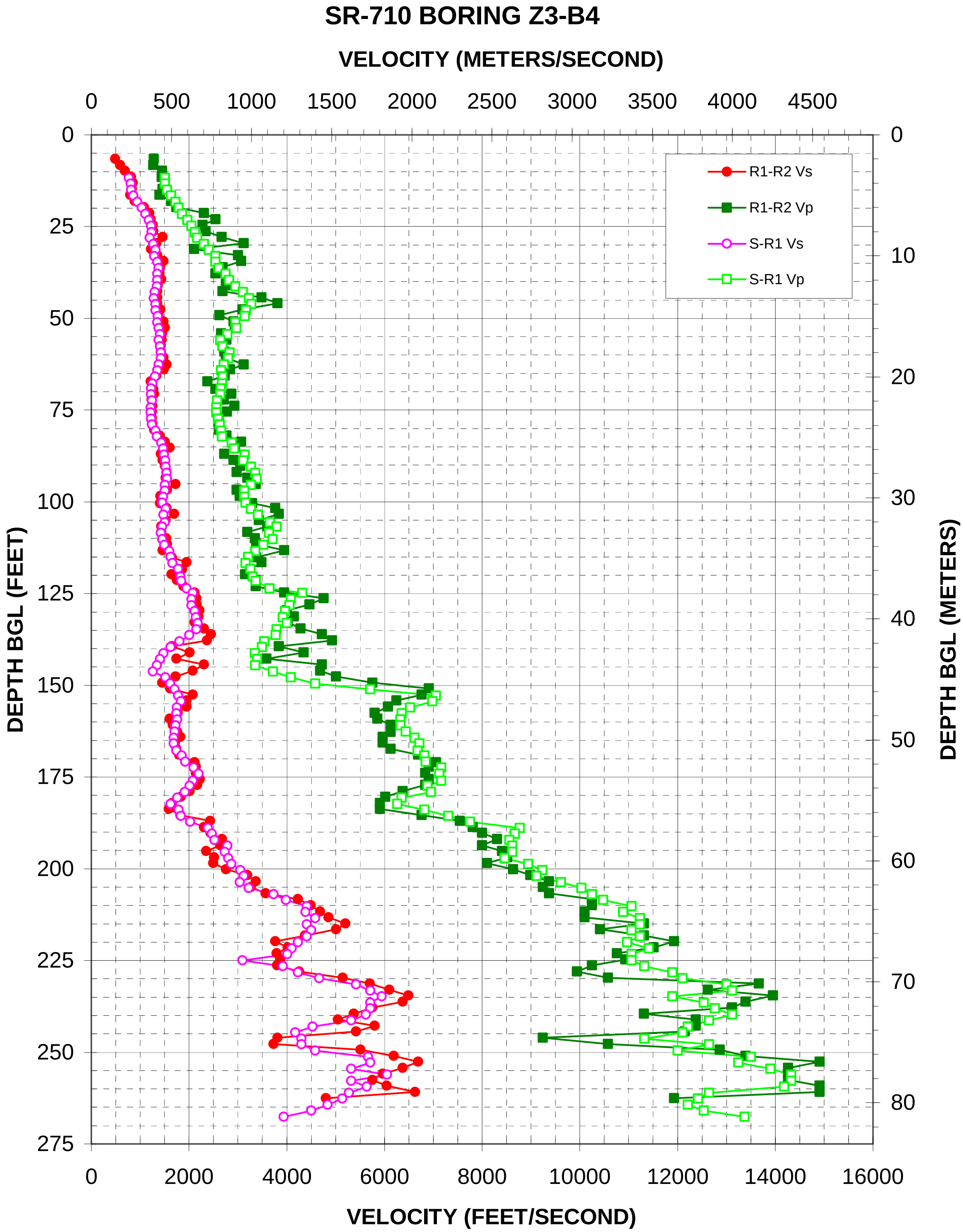


Figure A-9. Boring Z3-B4, R1 - R2 high resolution analysis and S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
11.71	767	1510
13.35	807	1510
14.99	815	1550
16.63	858	1633
18.27	941	1721
19.91	1034	1791
21.56	1111	1862
23.20	1182	1972
24.84	1227	2053
26.48	1236	2128
28.12	1198	2174
29.76	1272	2302
31.40	1315	2404
33.04	1286	2544
34.68	1350	2544
36.32	1382	2610
37.96	1355	2753
39.60	1355	2820
41.24	1340	2950
42.88	1295	3107
44.52	1281	3235
46.16	1315	3281
47.80	1315	3170
49.44	1361	3141
51.08	1355	2950
52.72	1377	2969
54.36	1410	2786
56.00	1377	2644
57.64	1410	2690
59.28	1427	2837
60.93	1427	2803
62.57	1377	2711
64.21	1350	2659
65.85	1305	2690
67.81	1254	2680
69.13	1227	2654
70.77	1227	2639
72.41	1240	2581
74.38	1219	2562
75.69	1219	2562
77.33	1227	2600
78.97	1245	2630
80.61	1315	2659
82.25	1345	2675
83.89	1433	2877
85.53	1469	2925
87.17	1487	3141
88.81	1513	3114
90.45	1526	3273
92.09	1540	3359
93.73	1553	3384
95.37	1507	3273
97.01	1507	3134
98.65	1469	3134
100.30	1451	3163
101.94	1526	3273
103.58	1481	3417
105.54	1507	3657
106.86	1457	3795
108.50	1427	3638
110.14	1451	3715
111.78	1500	3519
113.42	1596	3359
115.06	1625	3213
116.70	1664	3163
118.34	1782	3258
120.31	1828	3304
121.62	1848	3367
123.59	1950	3647
124.90	2077	4321
126.54	2053	4082
128.18	2053	4058
129.82	2115	3967
131.46	2141	3922
133.10	2180	4001
134.74	2154	3795
136.38	2006	3775
138.02	1810	3546
139.67	1625	3493
141.31	1478	3351
142.95	1404	3400
144.59	1348	3359
146.23	1258	3725
147.87	1513	4082
149.51	1618	4589
151.15	1704	5708
152.79	1782	7056
154.43	1838	6986
156.07	1755	6531
157.71	1747	6354
159.35	1760	6325
160.99	1721	6325
162.63	1708	6441
164.27	1688	6624
165.91	1692	6719
167.88	1747	6687
169.19	1853	6817
170.83	1924	6850
172.47	2102	7164
174.11	2194	7128
176.08	2077	7164
177.40	2012	6883
179.04	1918	6951
180.68	1764	6354
182.32	1621	6269
183.96	1791	6817
185.60	1833	7314
187.24	2023	7758
188.88	2388	8776
190.52	2472	8668
192.16	2526	8562
193.80	2786	8615
195.44	2732	8615
197.08	2808	8459
198.72	2866	8944
200.36	3053	9238
202.00	3120	9118
203.64	3039	9618
205.28	3221	10030
206.92	3735	10250
208.56	3989	10479
210.20	4416	11057
211.84	4388	10885
213.48	4589	11234
215.12	4416	11234
216.77	4501	11057
218.41	4416	11234
220.05	4230	10970
221.69	4106	11416
223.33	4012	11057
224.97	3093	11057
226.61	3922	11324
228.25	4230	11900
229.89	4665	12105
231.53	5422	13002
233.17	5708	13123
234.81	5950	11900
236.45	5708	12537
238.09	5708	12765
239.73	5617	13123
241.37	5319	12650
243.01	4530	12210
244.65	4179	12105
246.29	4307	11324
247.93	4307	12650
249.57	4589	12002
251.21	5662	13502
252.85	5708	13247
254.49	5319	13903
256.14	6053	14329

Table A-9. Boring Z3-B4, S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
257.78	5319	14329
259.42	5639	14184
261.06	5279	12650
262.70	5144	12427
264.34	4842	12210
265.98	4501	12537
267.62	3944	13373

Table A-9, continued. Boring Z3-B4, S - R1 quality assurance analysis
P- and S_H-wave data

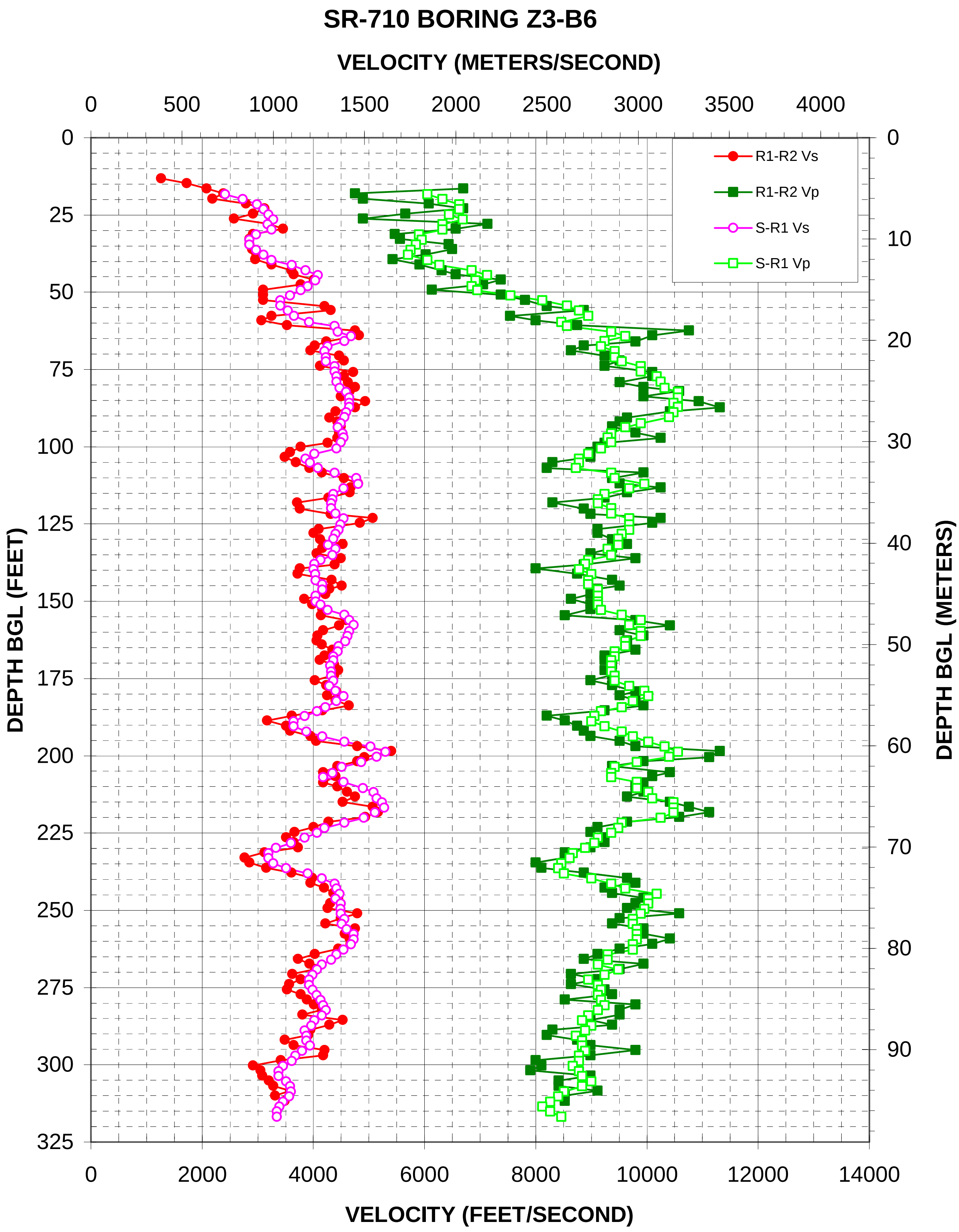


Figure A-10. Boring Z3-B6, R1 - R2 high resolution analysis and S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)	Depth (feet)	V_s (feet/sec)	V_p (feet/sec)	Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
18.27	2413	6053	100.62	4416	9178	182.32	4416	9751
19.91	2732	6325	102.26	4023	8944	184.28	4217	9552
21.56	2988	6624	103.90	3858	8776	185.60	4070	9178
23.20	3107	6624	105.22	3944	8776	187.24	3847	9059
24.84	3191	6441	106.86	4082	8722	188.88	3647	9001
26.48	3281	6687	108.50	4388	9361	190.52	3647	9238
28.12	3177	6325	110.14	4776	9424	192.16	3879	9552
29.76	3250	6325	112.11	4809	9959	193.80	4167	9751
31.40	2975	5900	113.42	4544	9684	195.44	4559	10030
33.04	2854	5950	115.39	4361	9238	197.08	5033	10325
34.68	2854	5851	117.03	4347	9118	198.72	5299	10558
36.32	2975	5755	118.34	4321	9118	200.36	5144	10401
37.96	3107	5708	119.98	4321	9361	202.00	4859	9820
39.60	3250	6053	121.62	4402	9361	203.64	4515	9424
41.24	3619	6269	123.26	4544	9684	205.61	4347	9361
42.88	3858	6850	125.23	4486	9684	206.92	4179	9361
44.52	4082	7128	126.87	4458	9684	208.56	4544	9820
46.16	4035	6917	128.18	4402	9552	210.53	4893	9820
48.13	3901	6850	129.82	4361	9488	211.84	5088	10030
49.44	3775	6951	131.79	4268	9488	213.81	5144	10102
51.08	3582	7549	133.10	4402	9299	215.12	5240	10479
52.72	3408	8117	135.07	4347	9361	216.77	5279	10479
54.36	3408	8562	136.71	4130	8944	218.41	5106	10479
56.00	3546	8776	138.02	4023	8887	220.05	4910	10250
57.64	3657	8944	139.67	4001	8776	221.69	4559	9552
59.61	3922	8459	141.31	4035	9001	223.33	4204	9488
60.93	4388	8562	143.27	4047	8944	224.97	4070	9361
62.89	4444	9361	144.59	4167	8944	226.61	3847	9118
64.21	4681	9618	146.23	4167	9118	228.25	3601	9059
65.85	4559	9238	148.20	4047	9118	229.89	3327	8887
67.49	4255	9178	150.16	4047	9118	231.53	3191	8668
69.13	4204	9424	151.15	4130	9118	233.17	3191	8615
71.10	4230	9424	152.79	4255	9178	234.81	3281	8459
72.41	4230	9552	154.43	4559	9552	236.45	3510	8408
74.05	4388	9889	156.07	4650	9889	238.09	3901	8510
75.69	4388	9889	157.71	4728	9684	239.73	4154	9001
77.33	4416	10175	159.68	4650	9889	241.37	4388	9361
78.97	4416	10250	161.32	4619	9889	243.01	4416	9618
80.94	4472	10325	162.96	4574	9618	244.65	4472	10175
82.25	4589	10558	164.60	4458	9618	246.29	4402	10030
84.22	4650	10558	166.24	4444	9424	247.93	4501	10030
85.86	4650	10479	167.88	4361	9424	249.57	4486	9959
87.17	4650	10558	169.19	4361	9361	251.21	4501	9889
88.81	4589	10479	170.83	4307	9361	252.85	4559	9751
90.45	4559	10401	172.80	4321	9361	254.49	4515	9751
92.42	4501	9889	174.11	4321	9424	256.14	4604	9820
93.73	4444	9618	175.75	4361	9424	257.78	4728	9820
95.70	4530	9361	177.40	4294	9684	259.42	4728	9820
97.01	4544	9299	179.04	4402	9959	261.06	4681	9751
98.65	4501	9361	180.68	4544	10030	262.70	4544	9751

Table A-10. Boring Z3-B6, S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
264.34	4416	9299
265.98	4321	9299
267.62	4154	9118
269.26	4070	9488
270.90	3989	9238
272.54	3922	8944
274.18	3922	9118
275.82	3989	9178
277.46	4058	9118
279.10	4130	9178
280.74	4179	9238
282.38	4230	9118
284.02	4154	8944
285.66	4023	8831
287.30	3967	9001
288.94	3847	8887
290.58	3879	8722
292.22	3879	8831
293.86	3944	8831
295.51	3795	8887
297.15	3676	8776
298.79	3619	8776
300.43	3459	8668
302.07	3375	8776
303.71	3375	8831
305.35	3510	9001
306.99	3582	8831
308.63	3601	8510
310.27	3564	8408
311.91	3459	8260
313.55	3392	8117
315.19	3343	8260
316.83	3343	8459

Table A-10, continued. Boring Z3-B6, S - R1 quality assurance analysis
P- and S_H-wave data

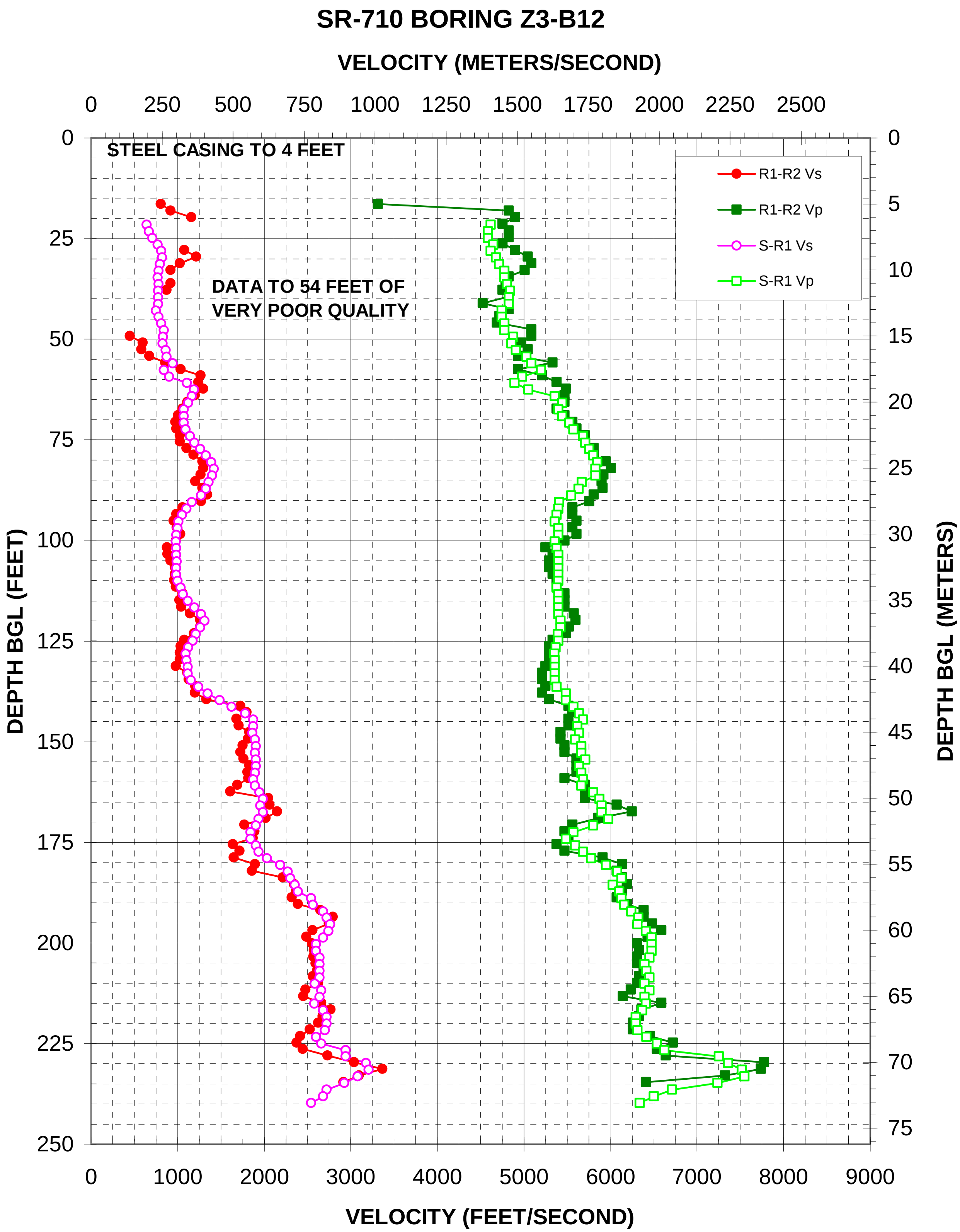


Figure A-11. Boring Z3-B12, R1 - R2 high resolution analysis and S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
13.35		
21.56	645	4619
23.20	669	4589
24.84	711	4589
26.48	769	4650
28.12	814	4619
29.76	823	4681
31.40	795	4712
33.04	782	4776
34.68	773	4776
36.32	782	4809
37.96	778	4842
39.60	778	4825
41.24	778	4825
42.88	749	4744
44.52	782	4744
46.16	814	4776
47.80	843	4776
49.44	833	4876
51.08	828	4859
52.72	864	4910
54.36	874	5033
56.00	945	5088
57.64	843	5201
59.28	906	4979
60.93	1111	4893
62.57	1188	5051
64.21	1164	5360
65.85	1122	5443
67.49	1072	5401
69.13	1072	5443
70.77	1072	5528
72.41	1092	5572
74.05	1142	5685
75.69	1196	5708
77.33	1261	5755
78.97	1327	5802
80.61	1390	5851
82.25	1418	5827
83.89	1401	5827
85.53	1358	5671
87.17	1327	5635
88.81	1272	5546
90.45	1164	5409
92.09	1102	5401
93.73	1053	5380
95.37	1010	5360
97.01	1002	5401
98.65	985	5401
100.30	979	5360
101.94	985	5380
103.58	985	5401
105.22	993	5401
106.86	985	5401
108.50	985	5401
110.14	1002	5401
111.78	1037	5380
113.42	1062	5401
115.06	1120	5401
116.70	1196	5401
118.34	1274	5401
119.98	1312	5426
121.62	1261	5426
123.26	1211	5392
124.90	1174	5401
126.54	1122	5368
128.18	1092	5351
129.82	1102	5360
131.46	1120	5360
133.10	1120	5360
134.74	1153	5360
136.38	1244	5380
138.02	1348	5485
139.67	1484	5485
141.31	1625	5572
142.95	1782	5639
144.59	1872	5685
146.23	1872	5617
147.87	1862	5639
149.51	1892	5594
151.15	1903	5662
152.79	1892	5662
154.43	1903	5708
156.07	1903	5639
157.71	1892	5662
159.35	1872	5685
160.99	1892	5662
162.63	1945	5802
164.27	1989	5875
165.91	1956	5900
167.55	1989	5900
169.19	1934	5975
170.83	1903	5802
172.47	1843	5572
174.11	1845	5485
175.75	1903	5594
177.40	1934	5685
179.04	2035	5779
180.68	2187	5950
182.32	2272	6079
183.96	2302	6132
185.60	2356	6027
187.24	2388	6105
188.88	2544	6132
190.52	2562	6159
192.16	2680	6241
193.80	2721	6325
195.44	2764	6314
197.08	2743	6412
198.72	2680	6477
200.36	2600	6477
202.00	2600	6477
203.64	2639	6453
205.28	2639	6394
206.92	2639	6418
208.56	2639	6453
210.20	2583	6394
211.84	2659	6453
213.48	2639	6394
215.12	2581	6412
216.77	2680	6371
218.41	2721	6291
220.05	2721	6291
221.69	2700	6314
223.33	2600	6418
224.97	2659	6537
226.61	2944	6624
228.25	2944	7253
229.89	3177	7360
231.53	3206	7517
233.17	3079	7549
234.81	2925	7238
236.45	2721	6712
238.09	2680	6501
239.73	2544	6337

Table A-11. Boring Z3-B12, S - R1 quality assurance analysis P- and S_H-wave data

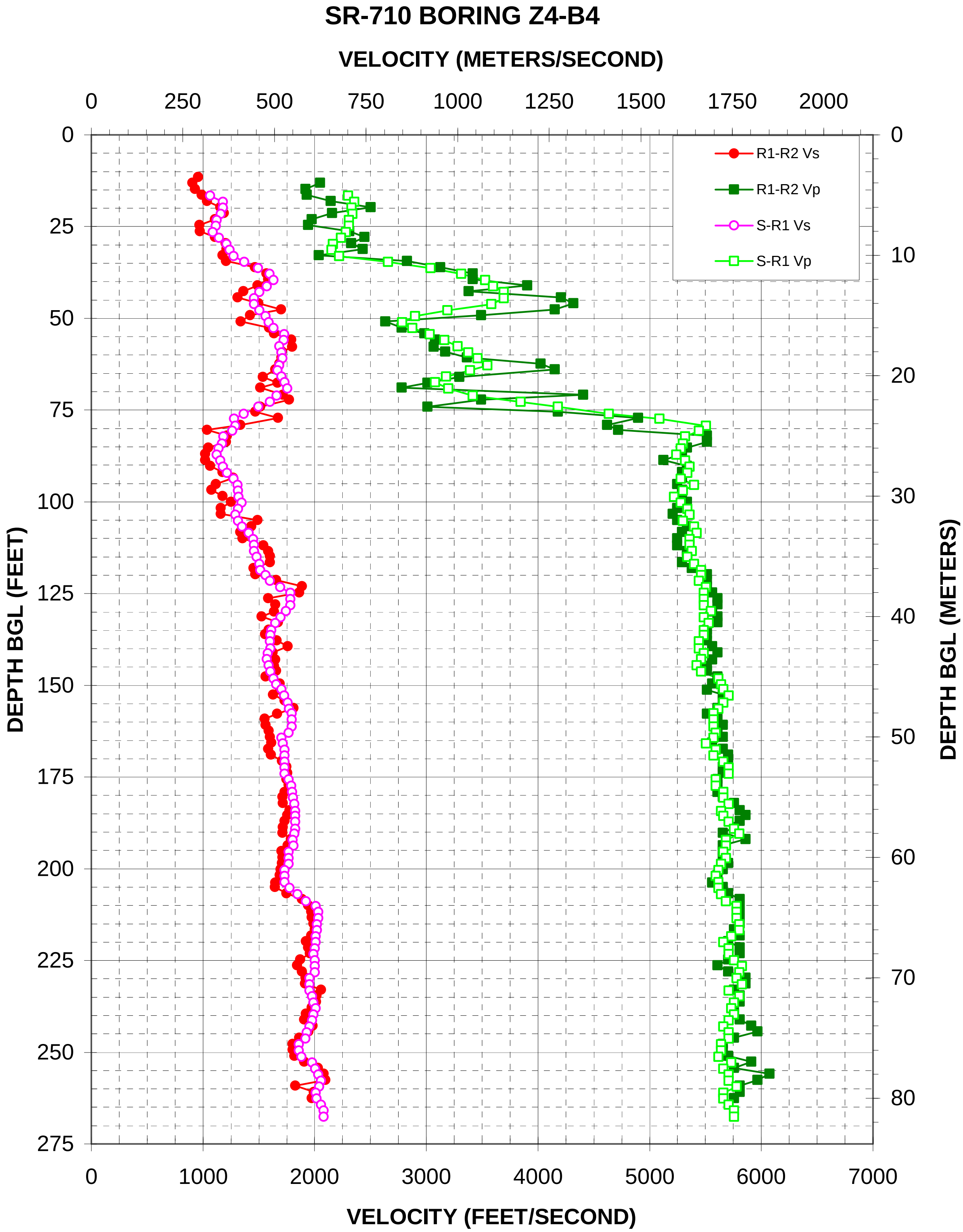


Figure A-12. Boring Z4-B4, R1 - R2 high resolution analysis and S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)	Depth (feet)	V_s (feet/sec)	V_p (feet/sec)	Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
16.63	1064	2302	98.65	1320	5220	180.68	1810	5662
18.27	1178	2356	100.30	1348	5279	182.32	1819	5708
19.91	1178	2333	101.94	1315	5339	184.28	1828	5639
21.56	1159	2340	103.58	1291	5360	185.60	1828	5662
23.20	1125	2310	105.22	1315	5299	187.24	1828	5708
24.84	1114	2310	106.86	1350	5401	189.21	1828	5755
26.48	1087	2280	108.50	1410	5422	190.52	1819	5802
28.12	1143	2236	110.14	1451	5360	192.16	1803	5685
29.76	1211	2167	111.78	1457	5360	193.80	1812	5685
31.40	1240	2154	113.42	1457	5380	195.44	1769	5662
33.04	1277	2222	115.06	1481	5339	197.08	1766	5685
34.68	1371	2659	117.03	1507	5401	198.72	1766	5639
36.32	1494	3039	118.67	1513	5464	200.36	1734	5617
37.96	1596	3312	119.98	1560	5464	202.00	1734	5594
39.60	1633	3528	121.62	1599	5443	203.64	1734	5617
41.24	1574	3601	123.26	1692	5507	205.28	1777	5617
42.88	1507	3695	124.90	1782	5485	206.92	1848	5639
44.52	1457	3695	126.54	1782	5485	208.89	1924	5685
46.16	1457	3582	128.18	1782	5485	210.20	2012	5779
47.80	1507	3191	129.82	1742	5550	211.84	2035	5779
49.44	1560	2901	131.46	1696	5485	213.48	2035	5779
51.08	1588	2786	133.10	1650	5528	215.12	2023	5802
52.72	1633	2877	135.07	1614	5485	216.77	2023	5802
54.36	1729	3033	136.38	1607	5485	218.41	2012	5731
56.00	1723	3163	138.02	1599	5443	220.05	2012	5662
57.64	1686	3281	139.99	1607	5443	221.69	2000	5708
59.28	1704	3375	141.31	1583	5485	223.33	1989	5708
60.93	1712	3459	142.95	1574	5464	224.97	2000	5755
62.89	1686	3546	144.59	1588	5422	226.61	2000	5827
64.21	1668	3392	146.23	1607	5464	228.25	2000	5802
65.85	1704	3177	148.20	1633	5617	229.89	1956	5779
67.49	1734	3079	149.84	1656	5639	231.53	1956	5827
69.13	1755	3199	151.15	1704	5662	233.17	1956	5708
71.10	1660	3417	152.79	1729	5708	234.81	1978	5802
72.74	1599	3847	154.76	1760	5662	236.45	1989	5755
74.05	1497	4179	156.40	1773	5617	238.09	2012	5731
76.02	1366	4634	157.71	1796	5572	239.73	1989	5755
77.33	1281	5088	159.35	1796	5572	241.37	1978	5708
79.30	1291	5507	161.32	1796	5572	243.01	1956	5662
80.61	1263	5443	162.96	1769	5594	244.65	1929	5708
82.25	1182	5319	164.27	1704	5572	246.29	1918	5708
84.22	1170	5299	165.91	1717	5507	247.93	1857	5639
85.53	1140	5279	167.55	1734	5594	249.57	1857	5639
87.17	1125	5240	169.19	1734	5572	251.21	1882	5617
88.81	1155	5319	170.83	1734	5662	252.85	1978	5731
90.45	1178	5360	172.47	1734	5708	254.49	2006	5662
92.09	1215	5339	174.11	1734	5708	256.14	2035	5708
93.73	1277	5279	175.75	1769	5594	257.78	2059	5708
95.37	1310	5401	177.40	1791	5594	259.42	2041	5779
97.01	1314	5299	179.04	1800	5662	261.06	2012	5662

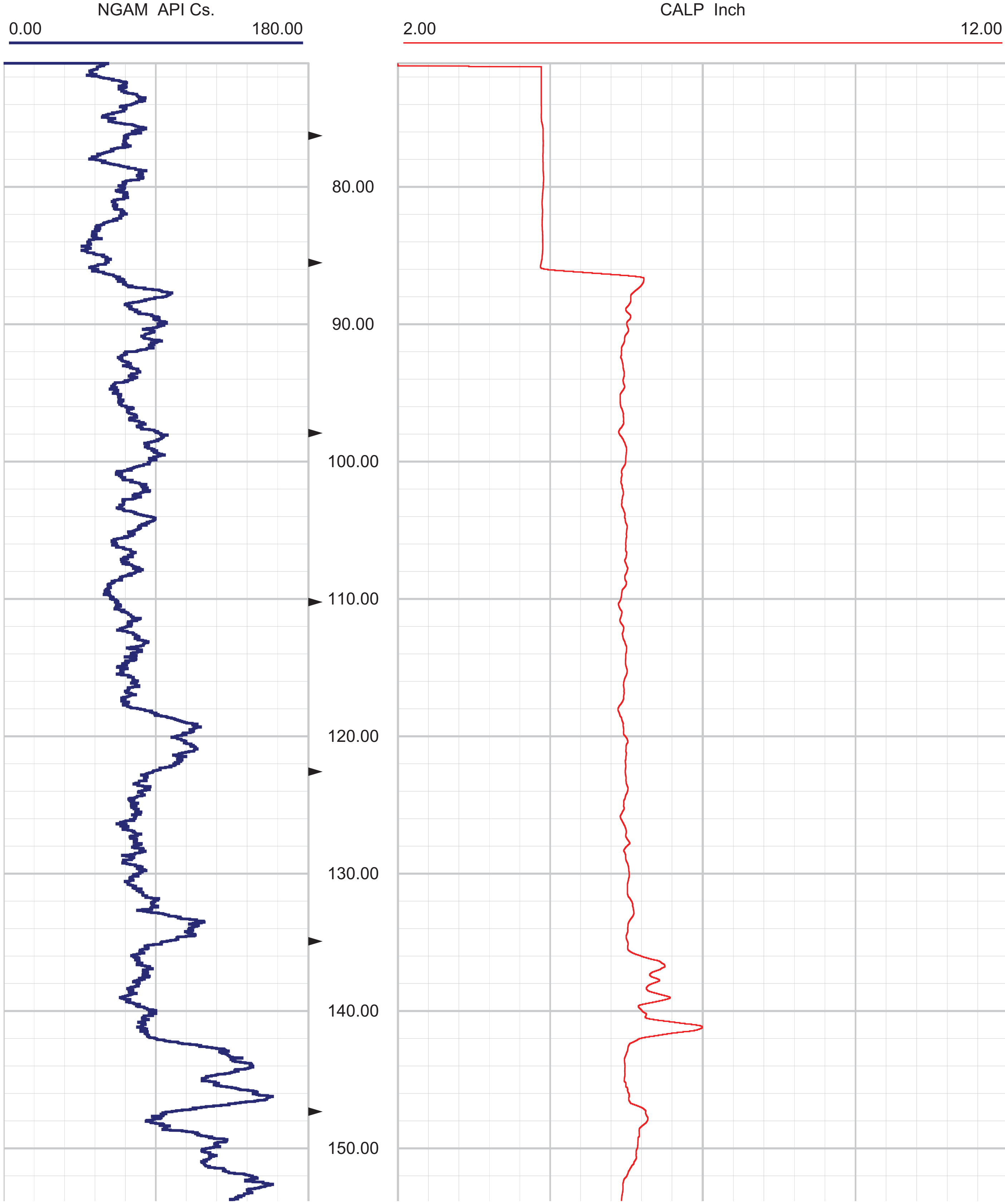
Table A-12. Boring Z4-B4, S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
262.70	2018	5662
264.34	2059	5708
265.98	2083	5755
267.62	2083	5755

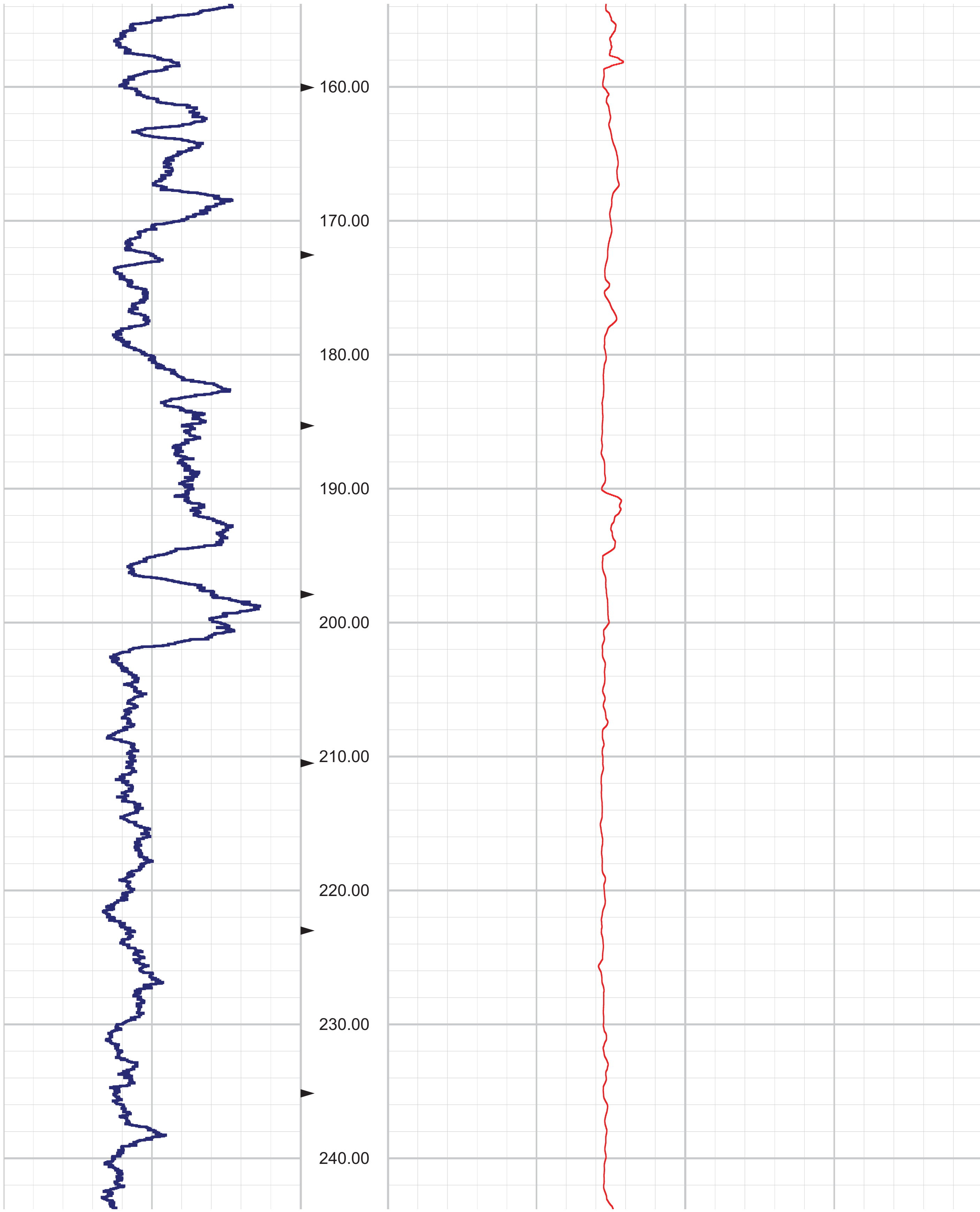
Table A-12, continued. Boring Z4-B4, S - R1 quality assurance analysis P- and S_H-wave data

APPENDIX B

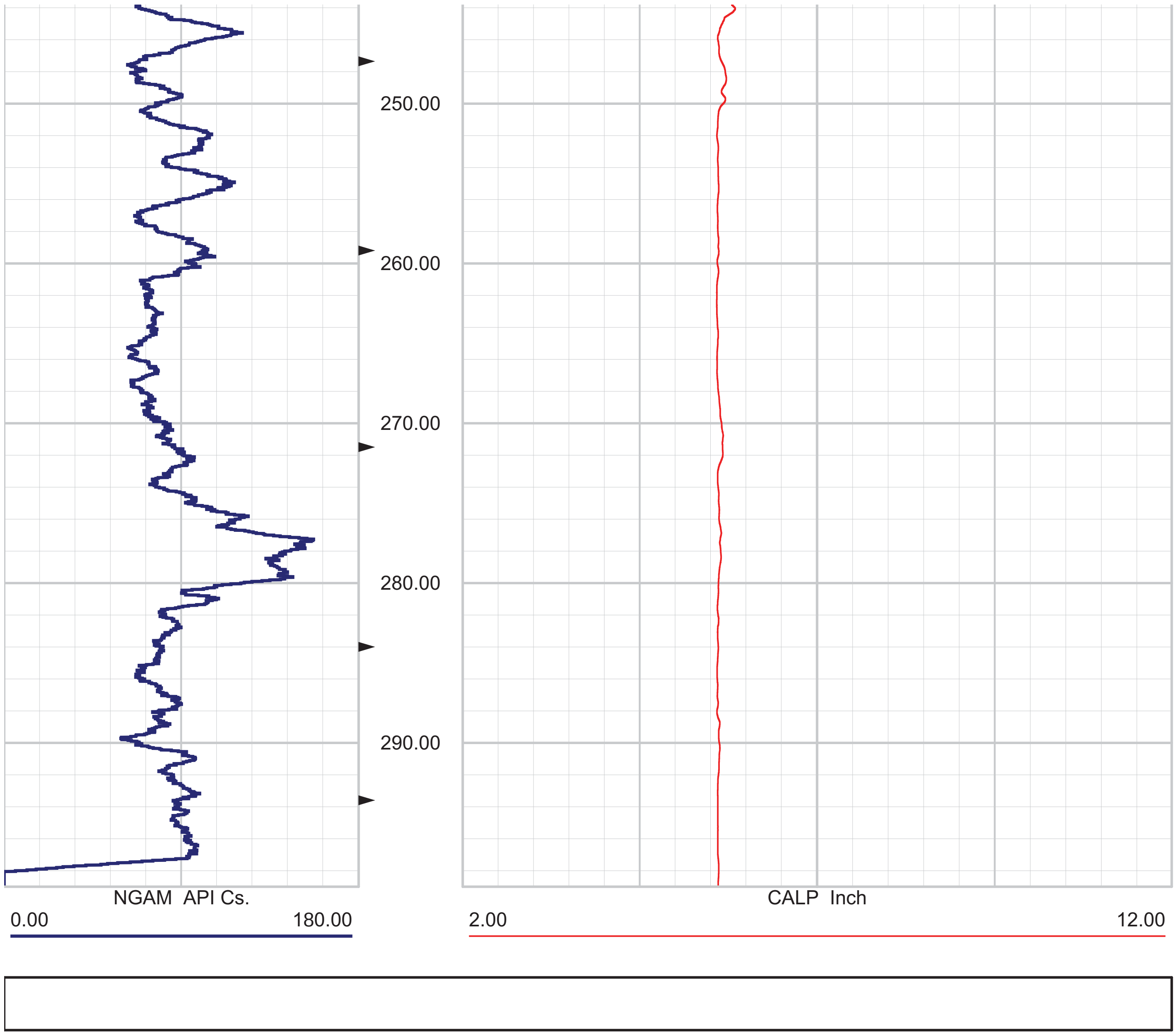
CALIPER AND NATURAL GAMMA LOGS



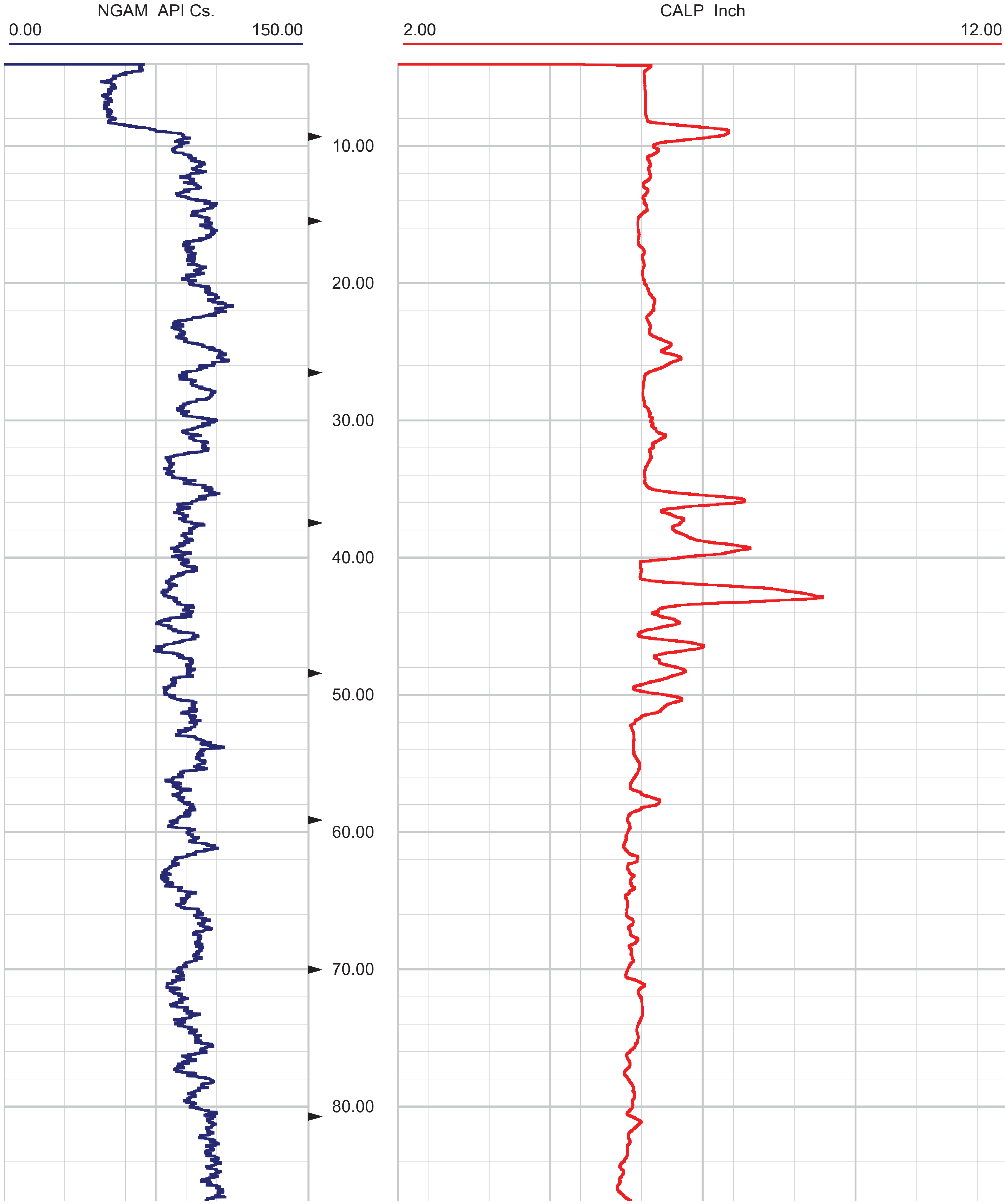
SR-710 Boring Z1-B3 Caliper and Natural Gamma rev 1.1 Sheet 1 of 3



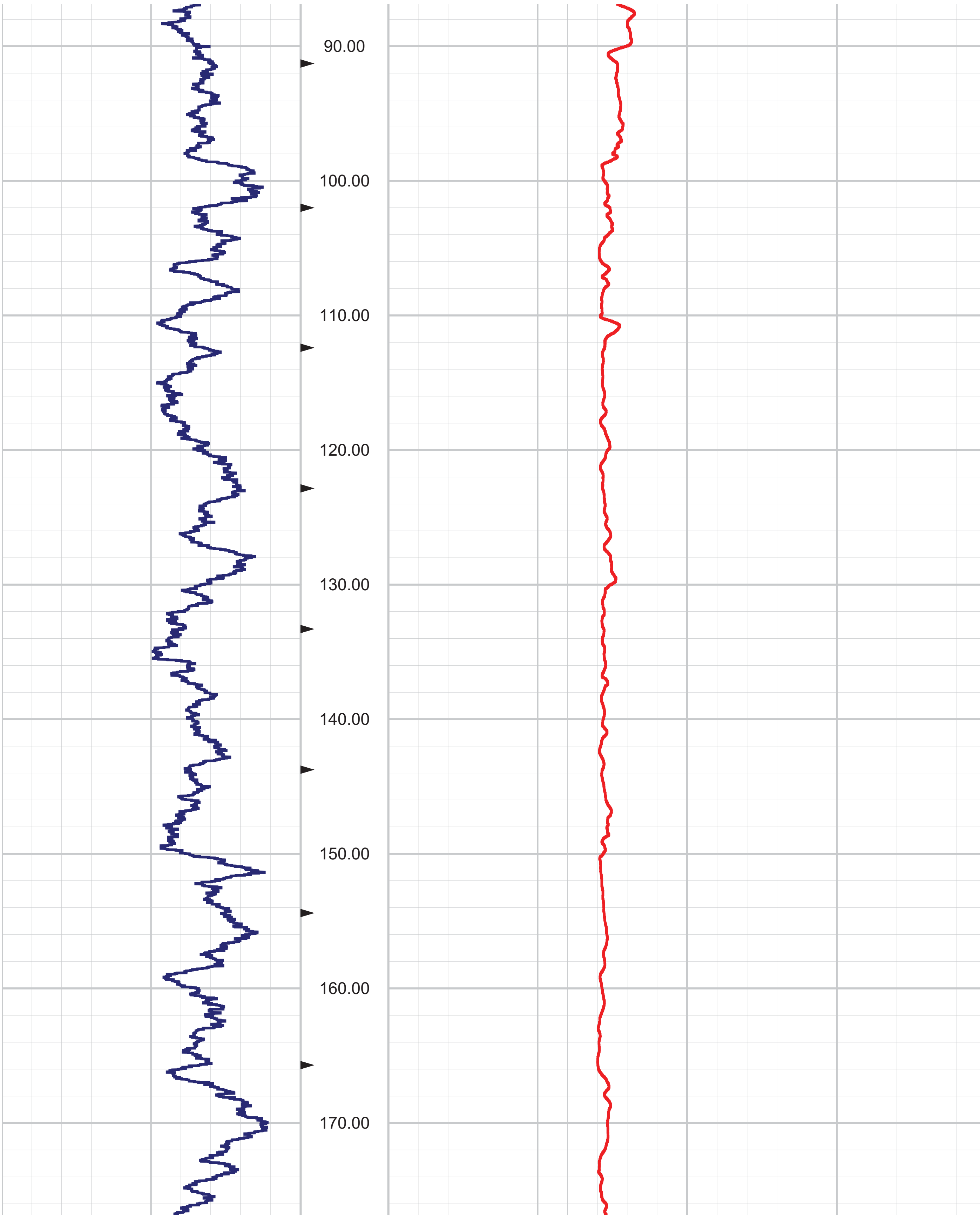
SR-710 Boring Z1-B3 Caliper and Natural Gamma rev 1.1 Sheet 2 of 3



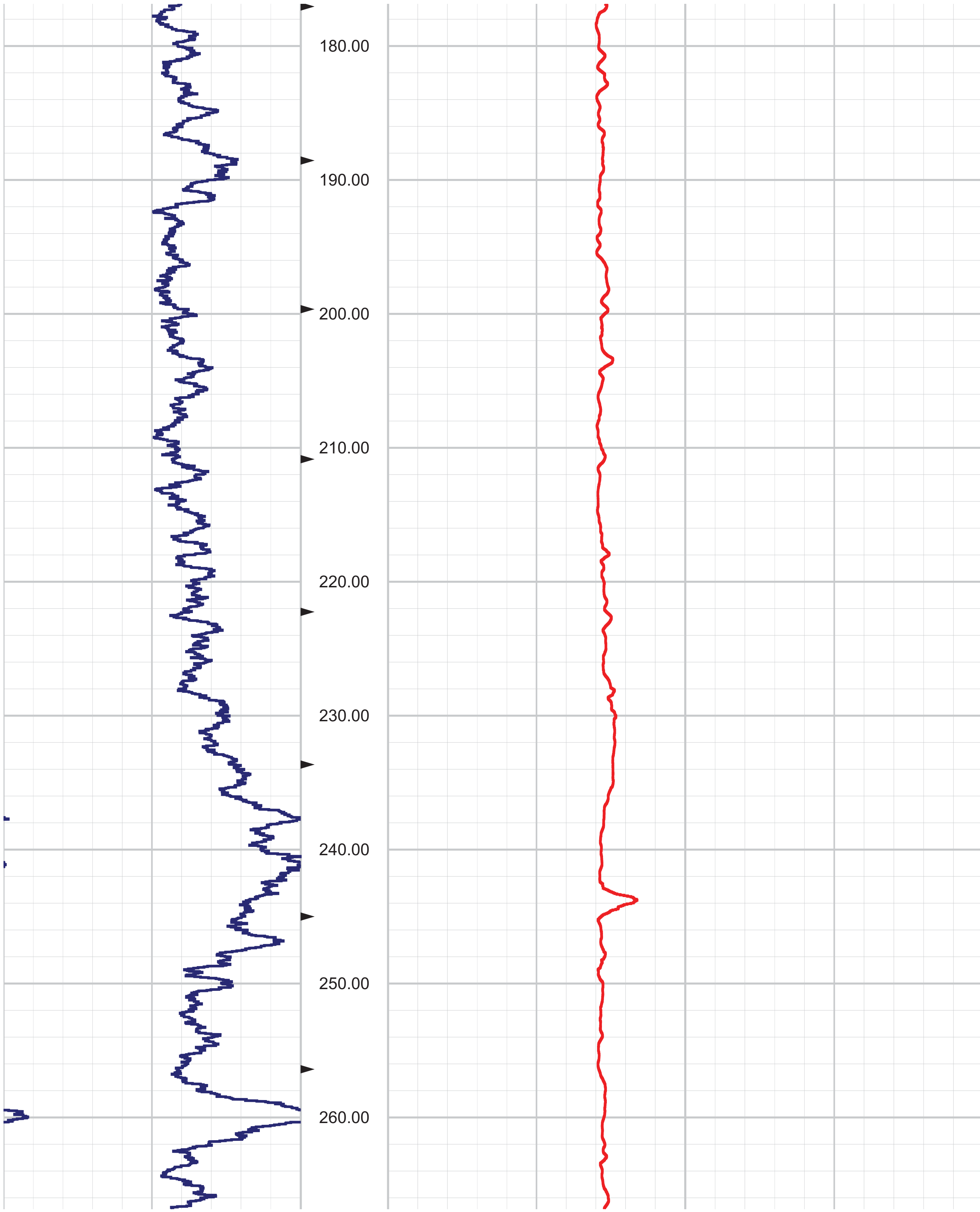
SR-710 Boring Z1-B3 Caliper and Natural Gamma rev 1.1 Sheet 3 of 3



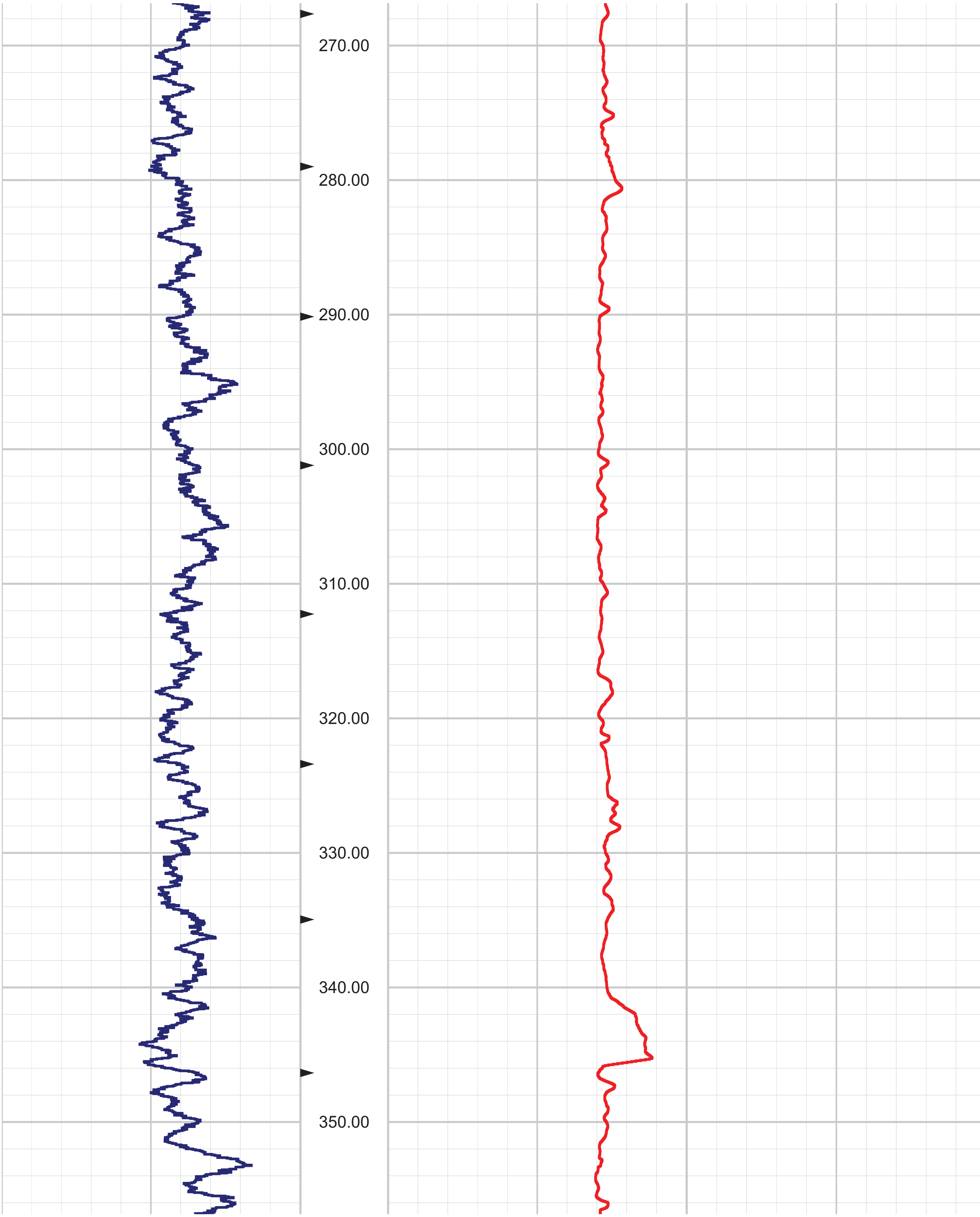
SR-710 Boring Z1-B5 Caliper and Natural Gamma rev 1.1 Sheet 1 of 6



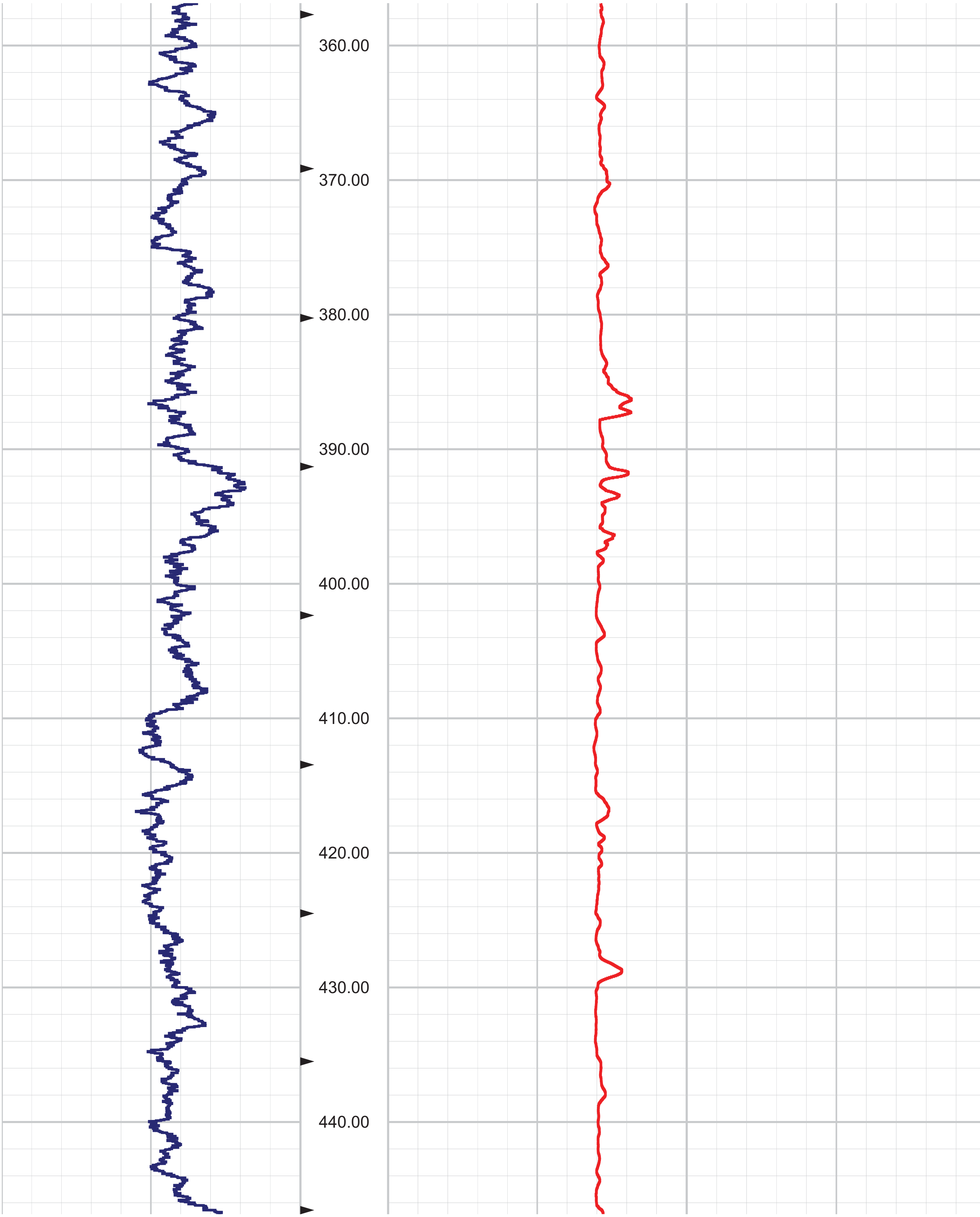
SR-710 Boring Z1-B5 Caliper and Natural Gamma rev 1.1 Sheet 2 of 6



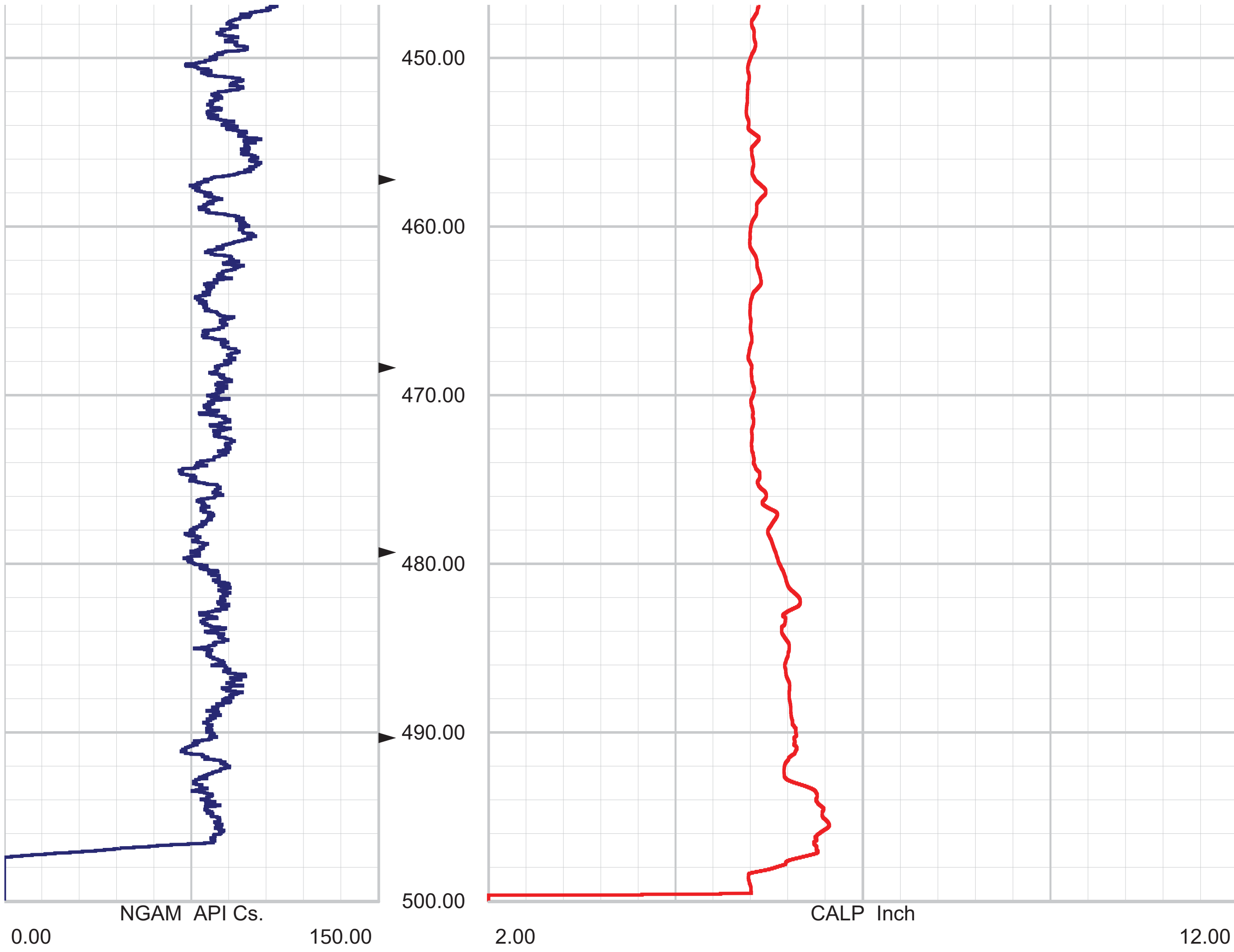
SR-710 Boring Z1-B5 Caliper and Natural Gamma rev 1.1 Sheet 3 of 6



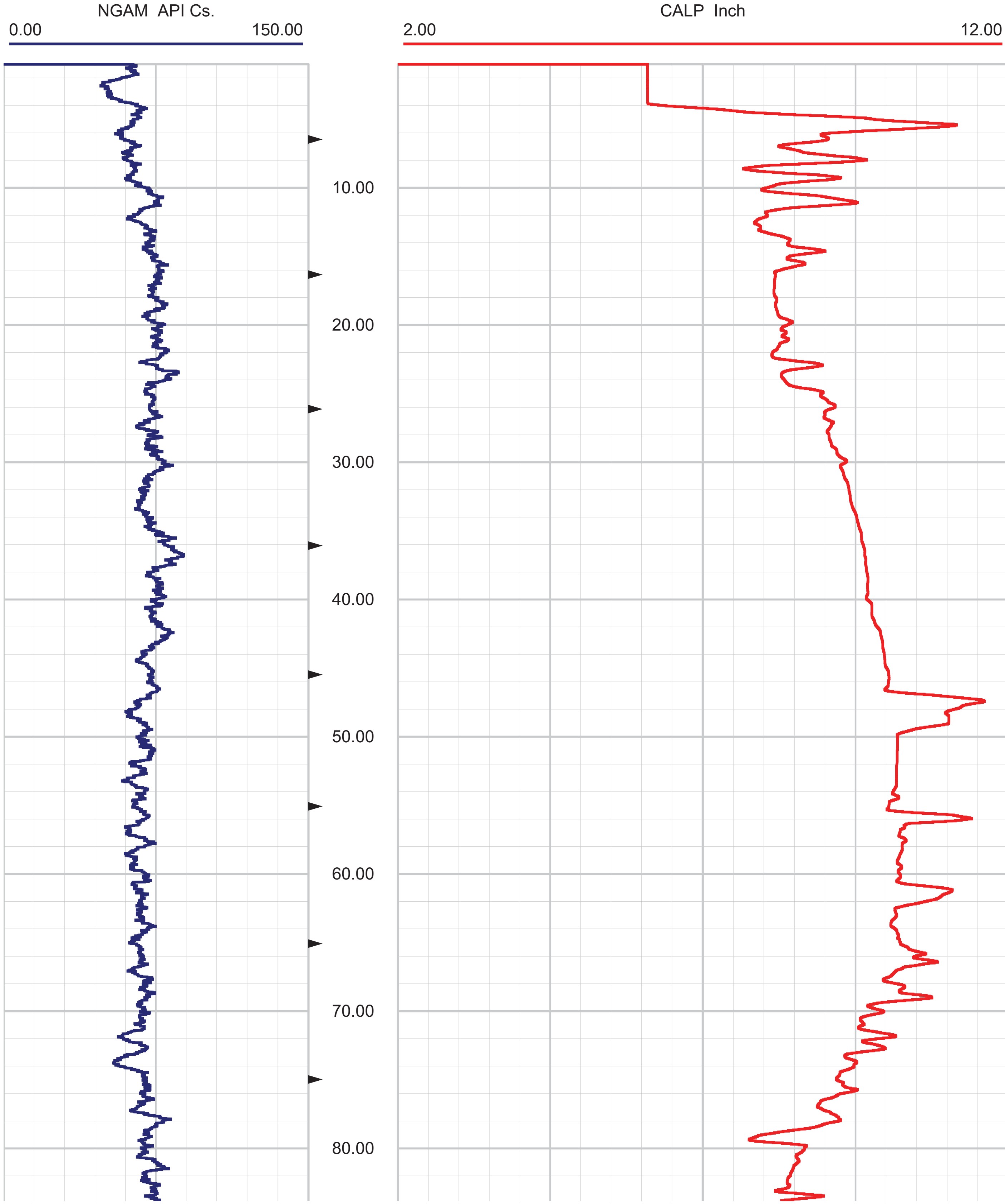
SR-710 Boring Z1-B5 Caliper and Natural Gamma rev 1.1 Sheet 4 of 6



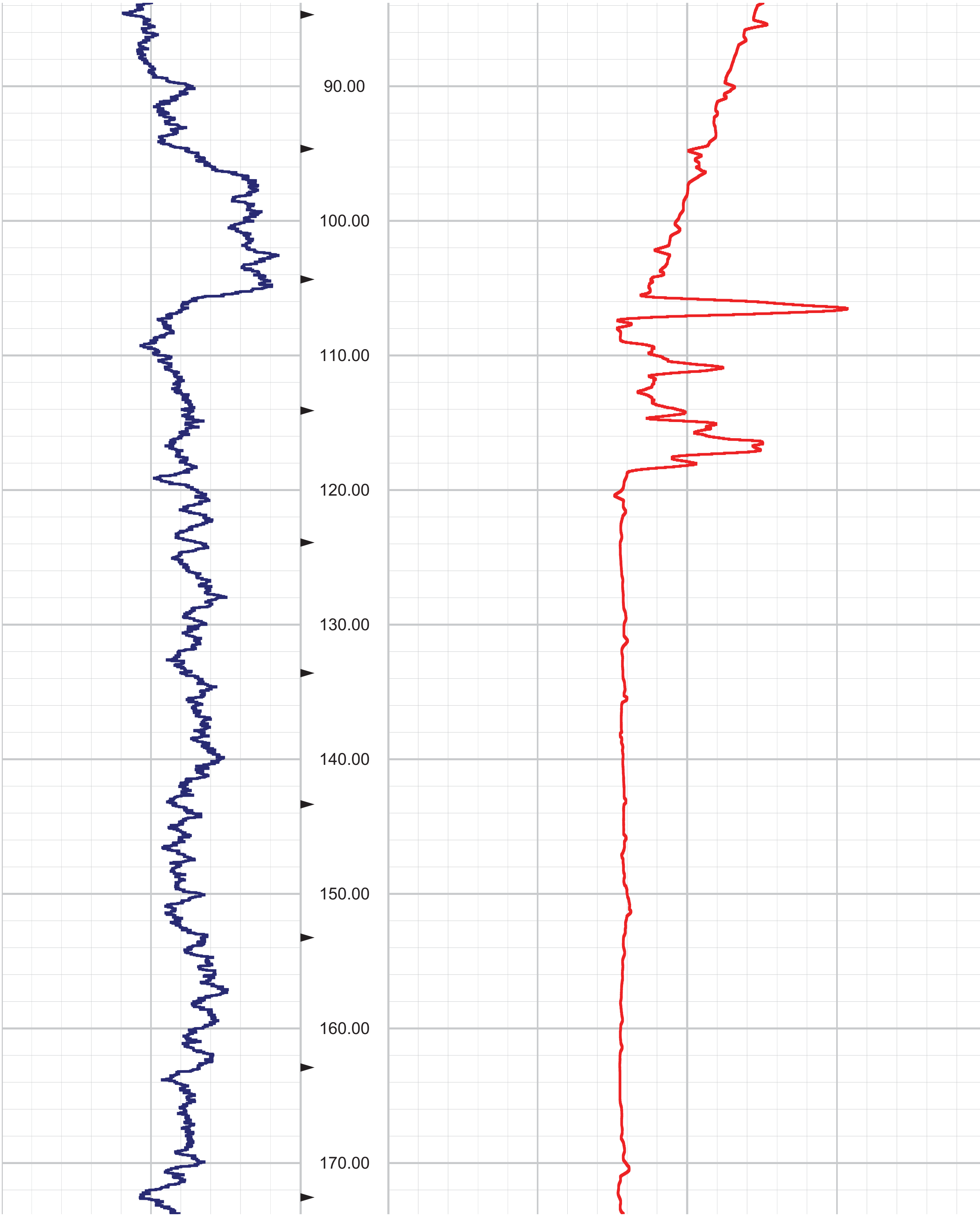
SR-710 Boring Z1-B5 Caliper and Natural Gamma rev 1.1 Sheet 5 of 6



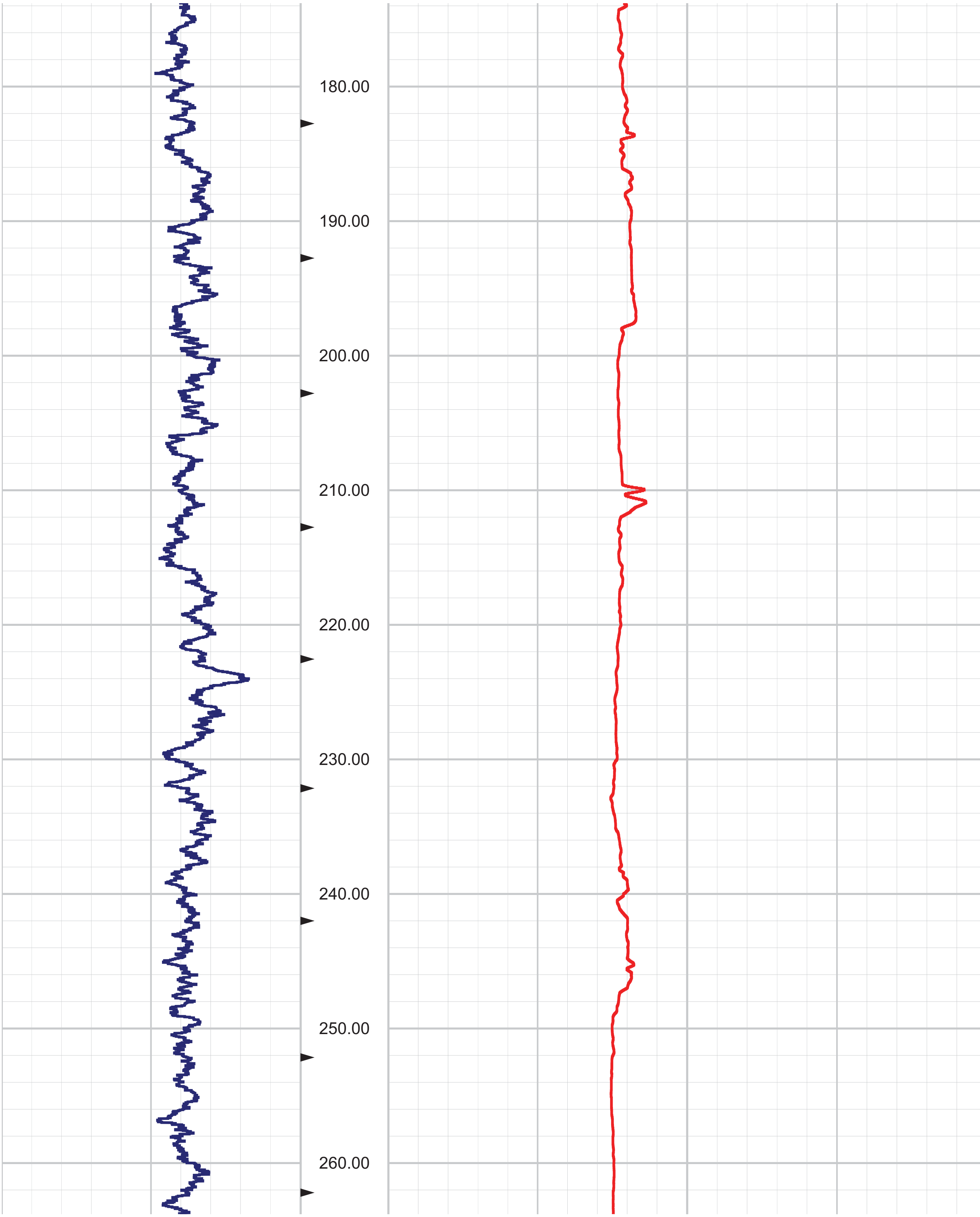
SR-710 Boring Z1-B5 Caliper and Natural Gamma rev 1.1 Sheet 6 of 6



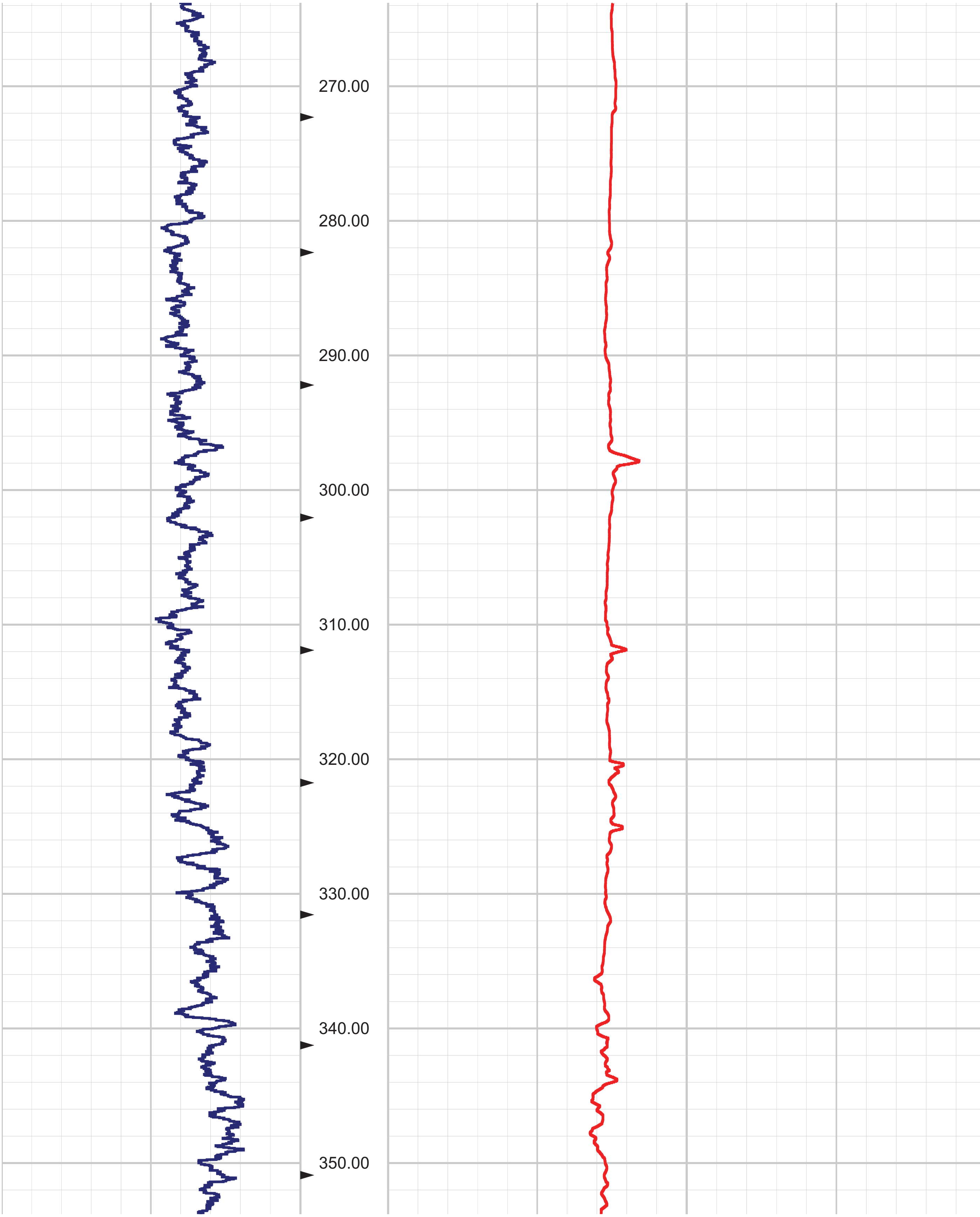
SR-710 Boring Z1-B6 Caliper and Natural Gamma rev 1.1 Sheet 1 of 5



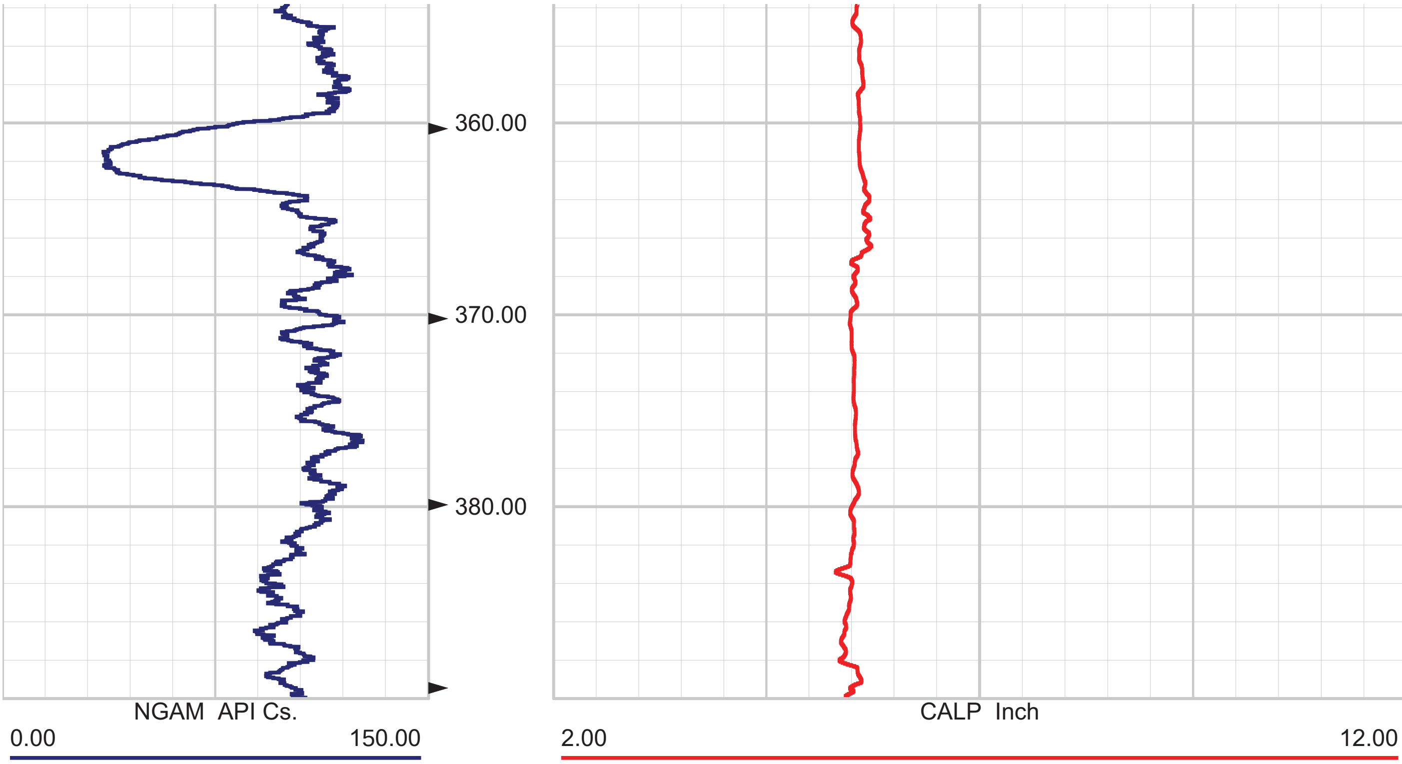
SR-710 Boring Z1-B6 Caliper and Natural Gamma rev 1.1 Sheet 2 of 5



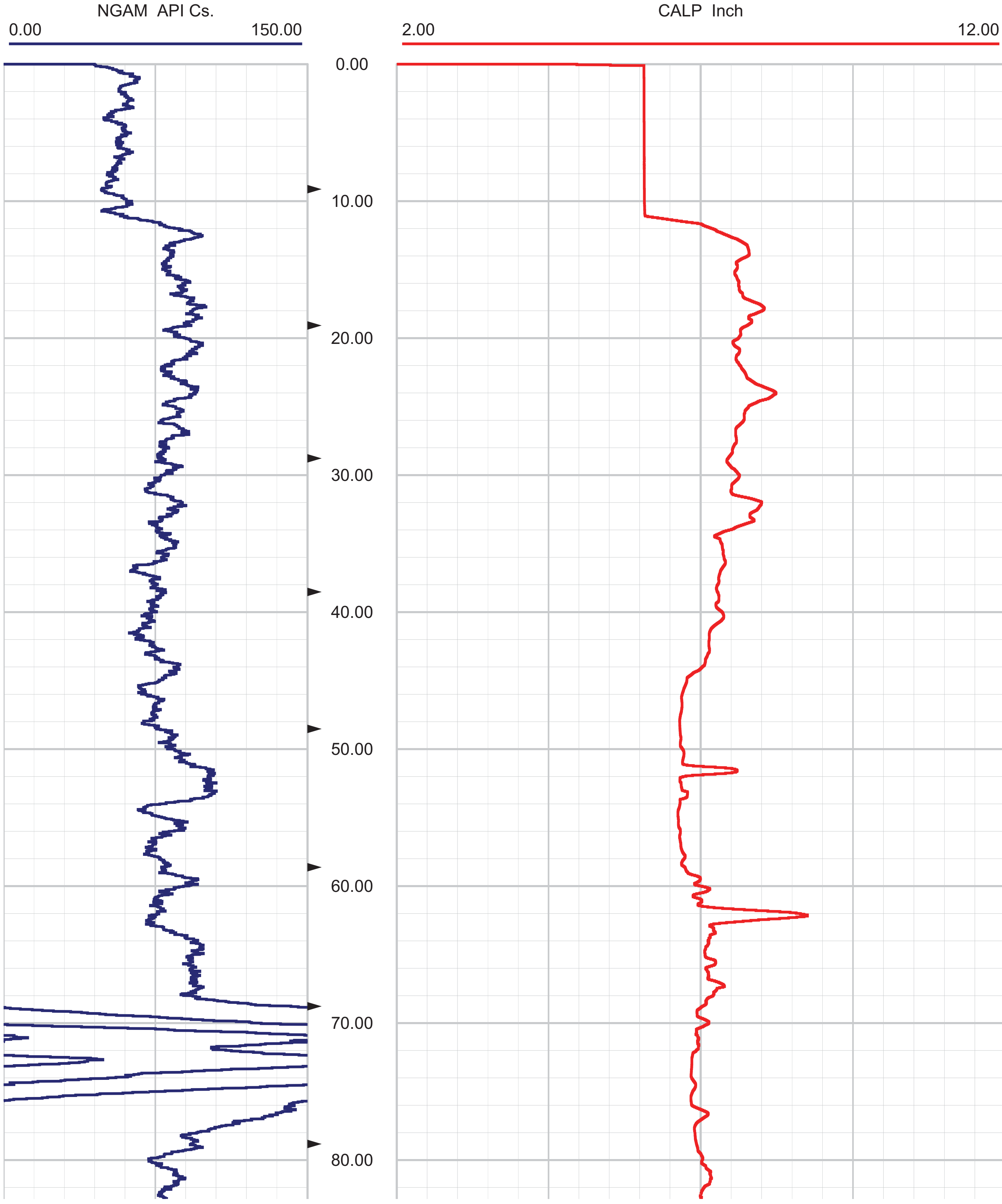
SR-710 Boring Z1-B6 Caliper and Natural Gamma rev 1.1 Sheet 3 of 5



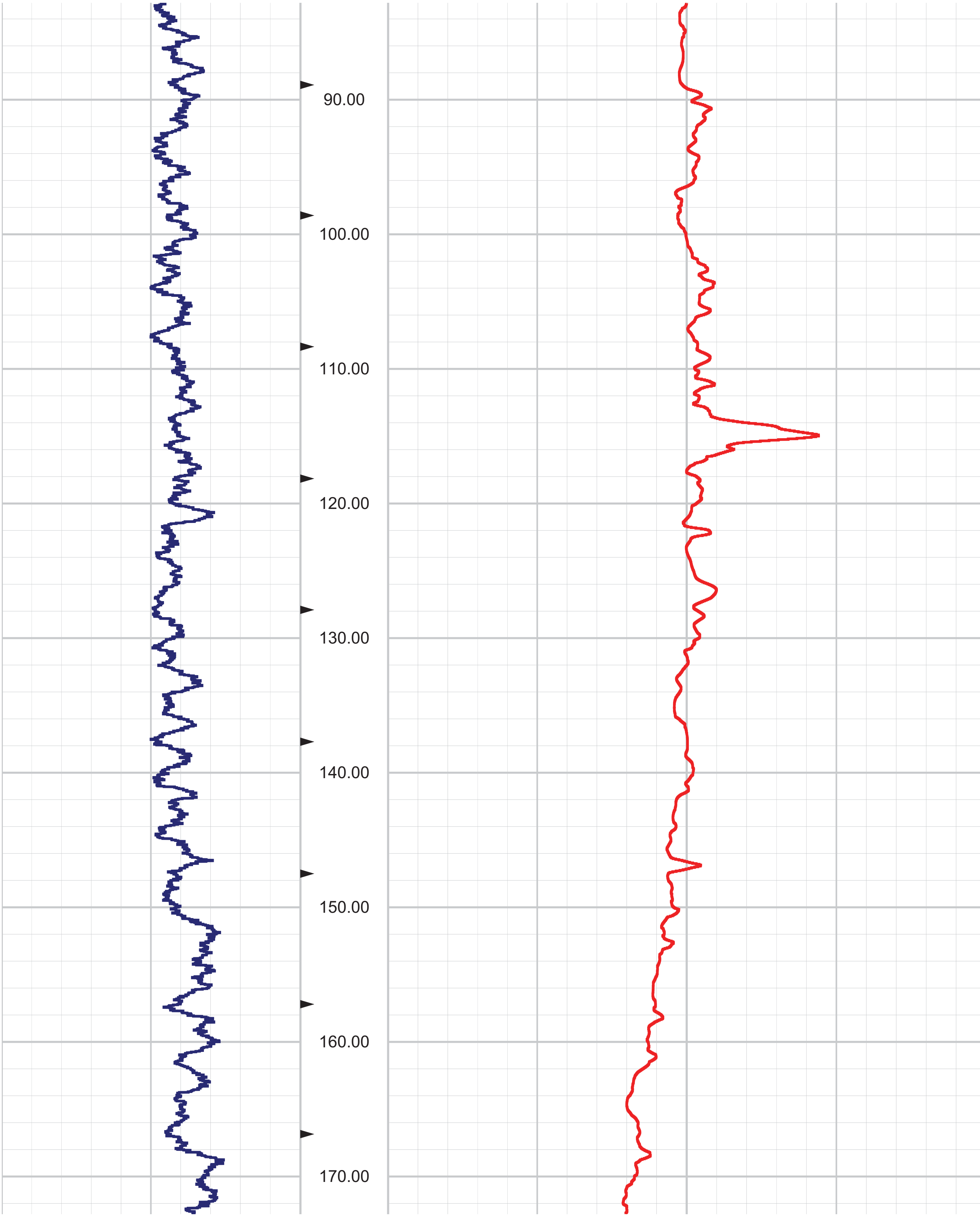
SR-710 Boring Z1-B6 Caliper and Natural Gamma rev 1.1 Sheet 4 of 5



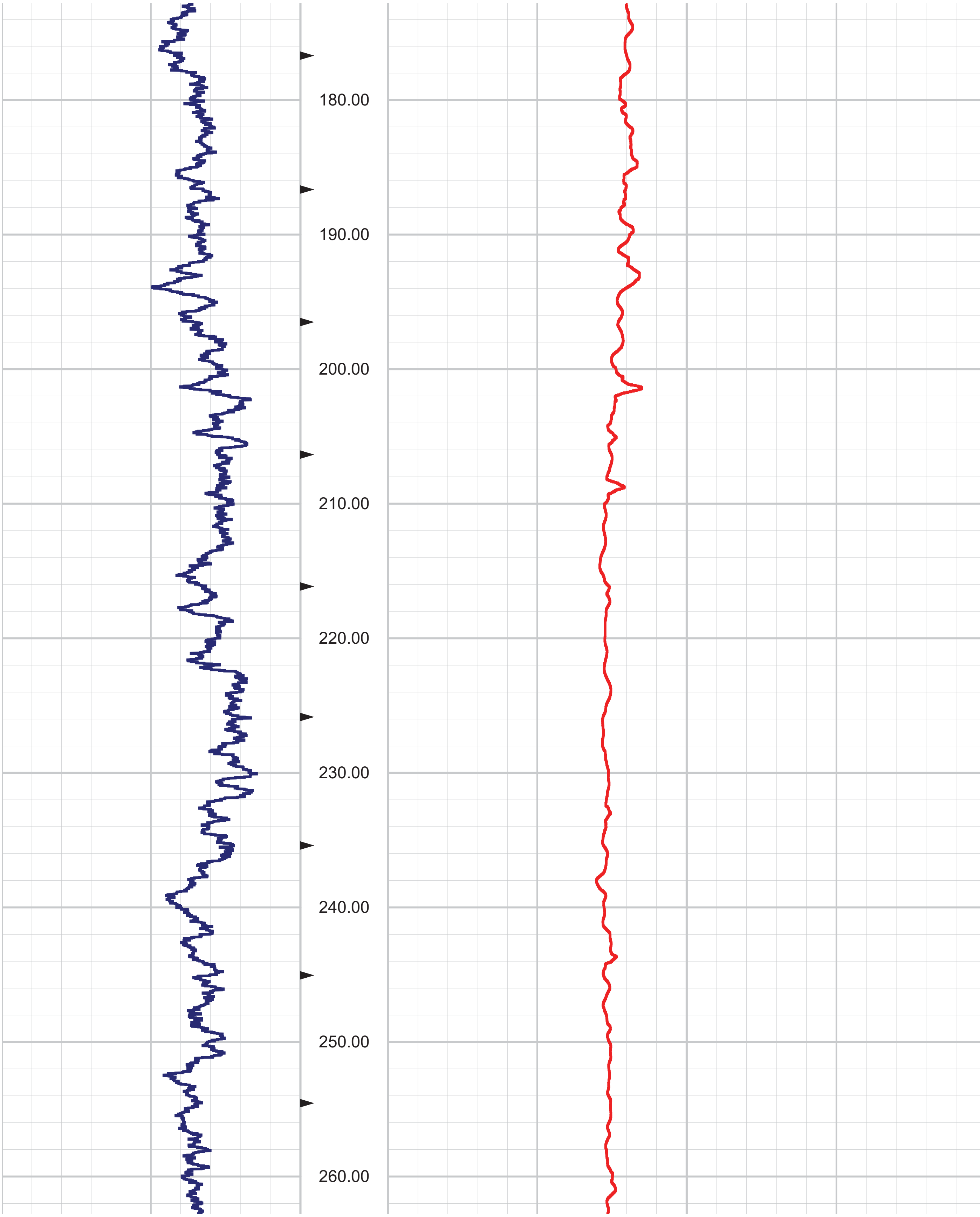
SR-710 Boring Z1-B6 Caliper and Natural Gamma rev 1.1 Sheet 5 of 5



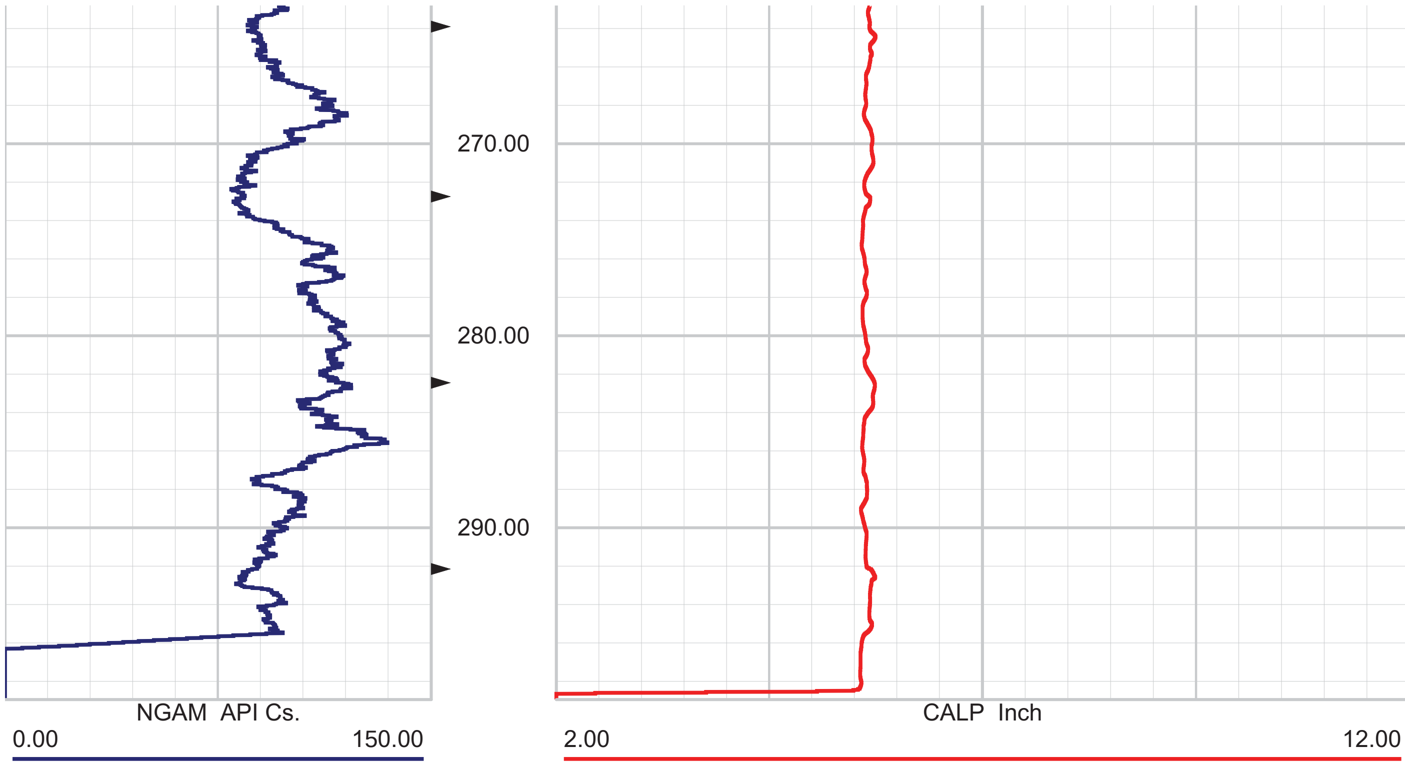
SR-710 Boring Z1-B7 Caliper and Natural Gamma rev 1.1 Sheet 1 of 4



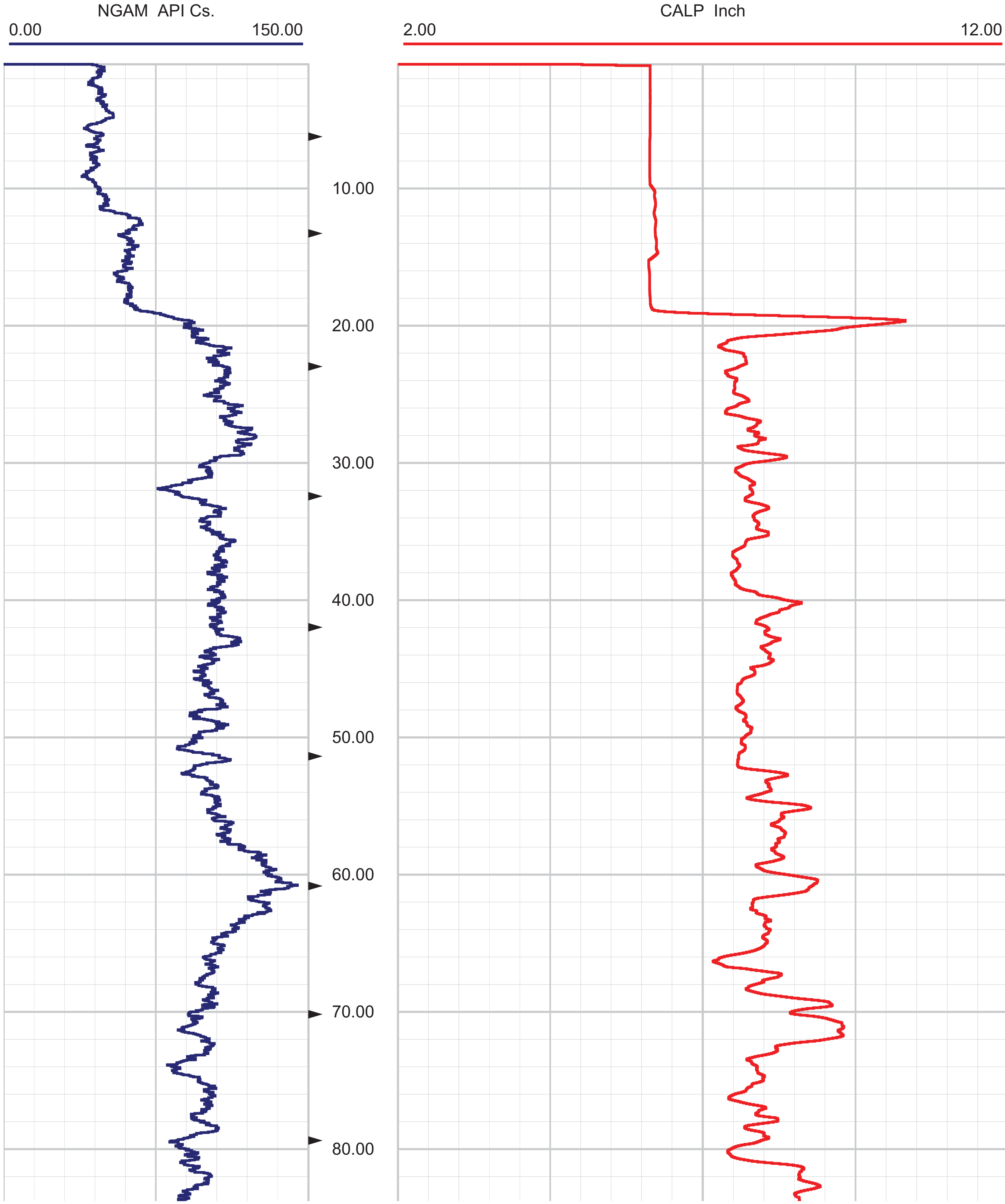
SR-710 Boring Z1-B7 Caliper and Natural Gamma rev 1.1 Sheet 2 of 4



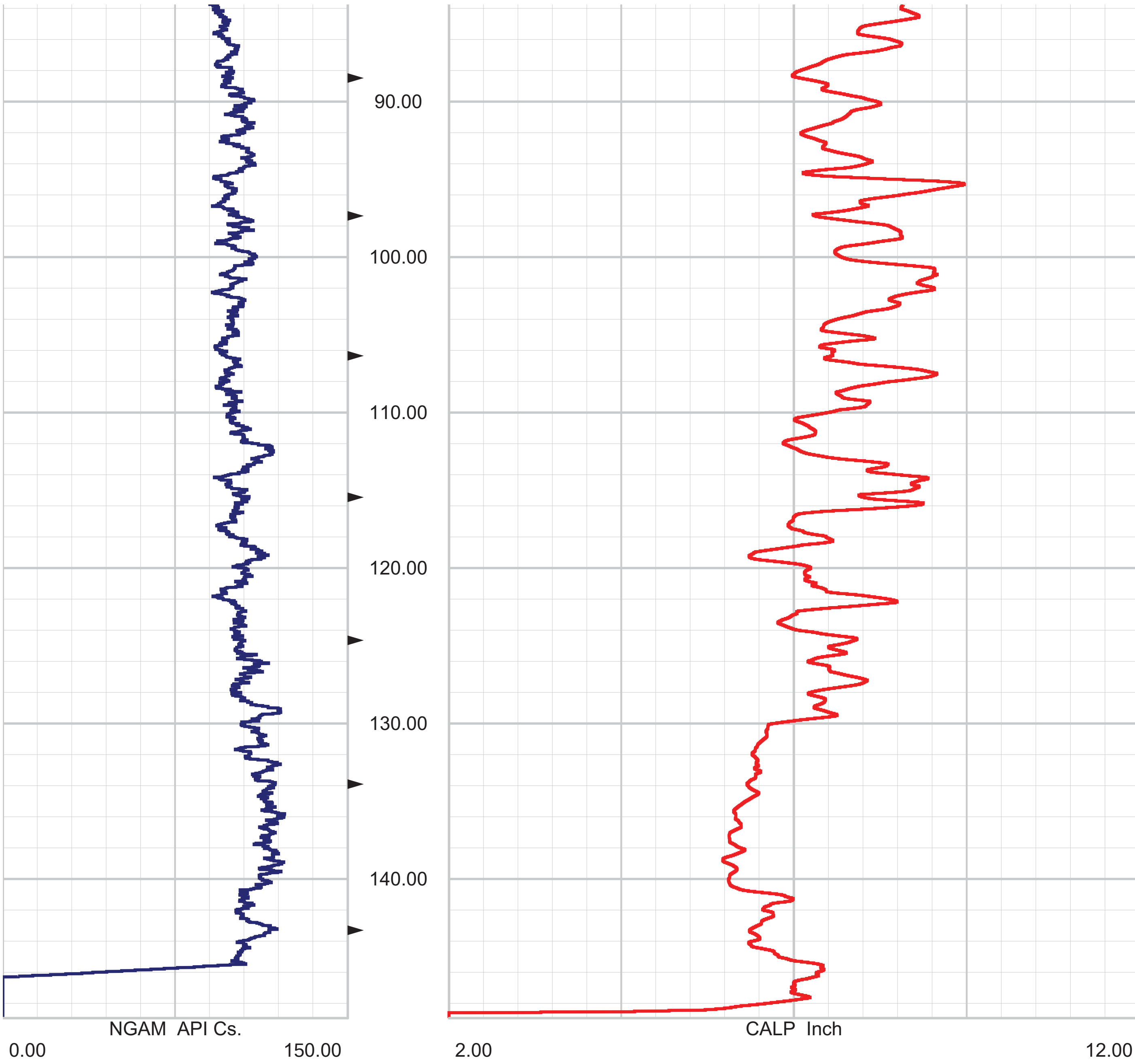
SR-710 Boring Z1-B7 Caliper and Natural Gamma rev 1.1 Sheet 3 of 4



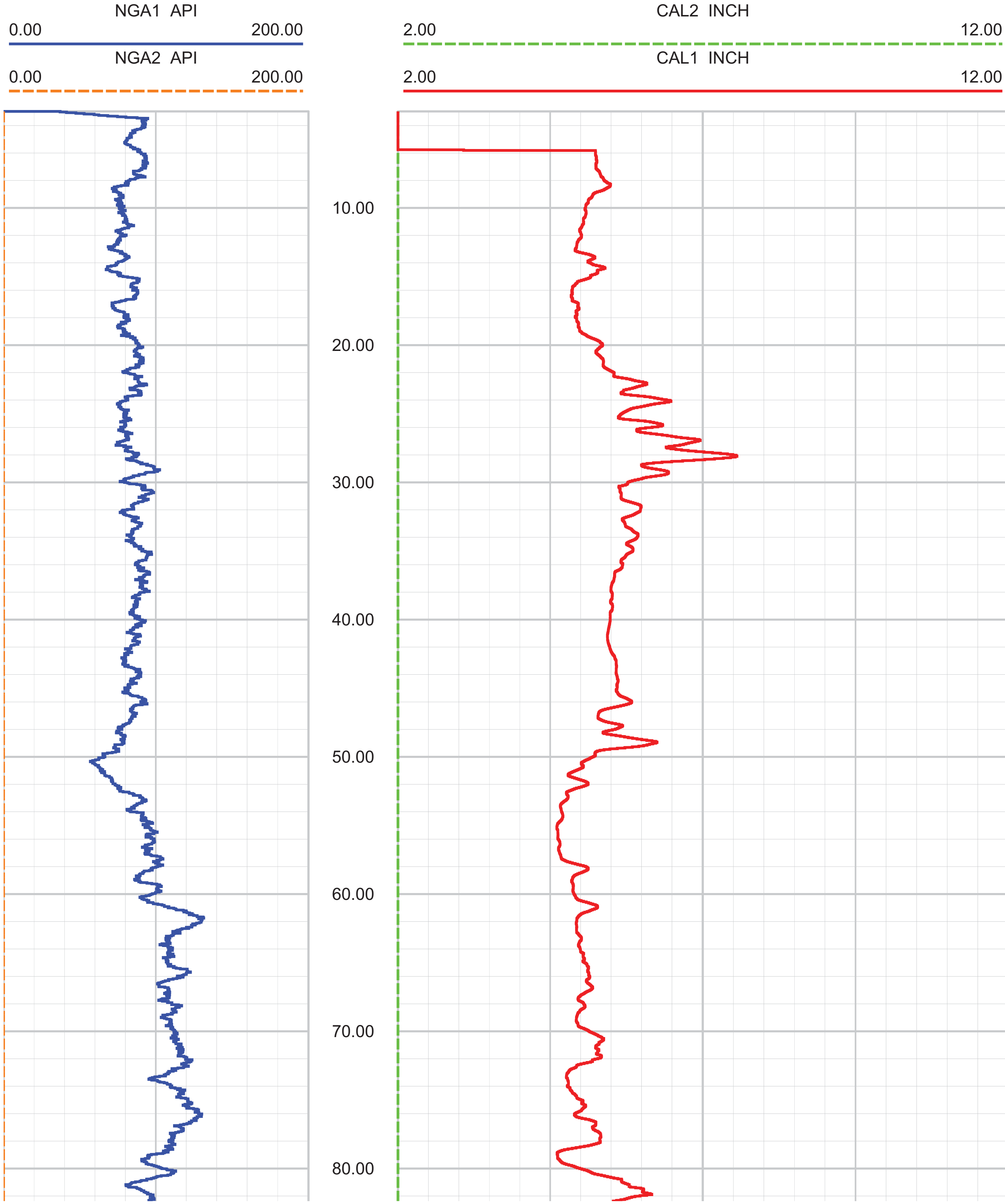
SR-710 Boring Z1-B7 Caliper and Natural Gamma rev 1.1 Sheet 4 of 4



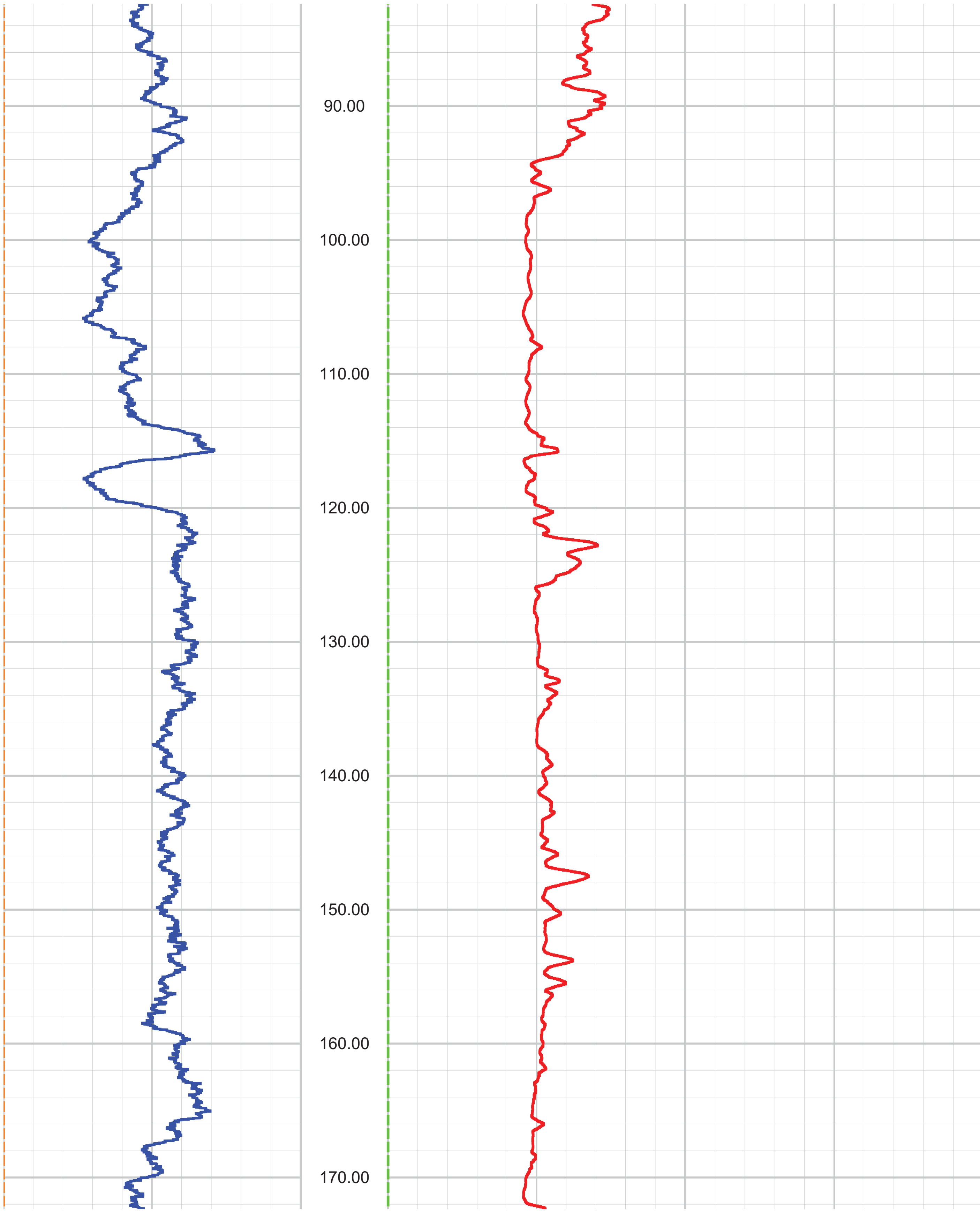
SR-710 Boring Z2-B1 Caliper and Natural Gamma rev 1.1 Sheet 1 of 2



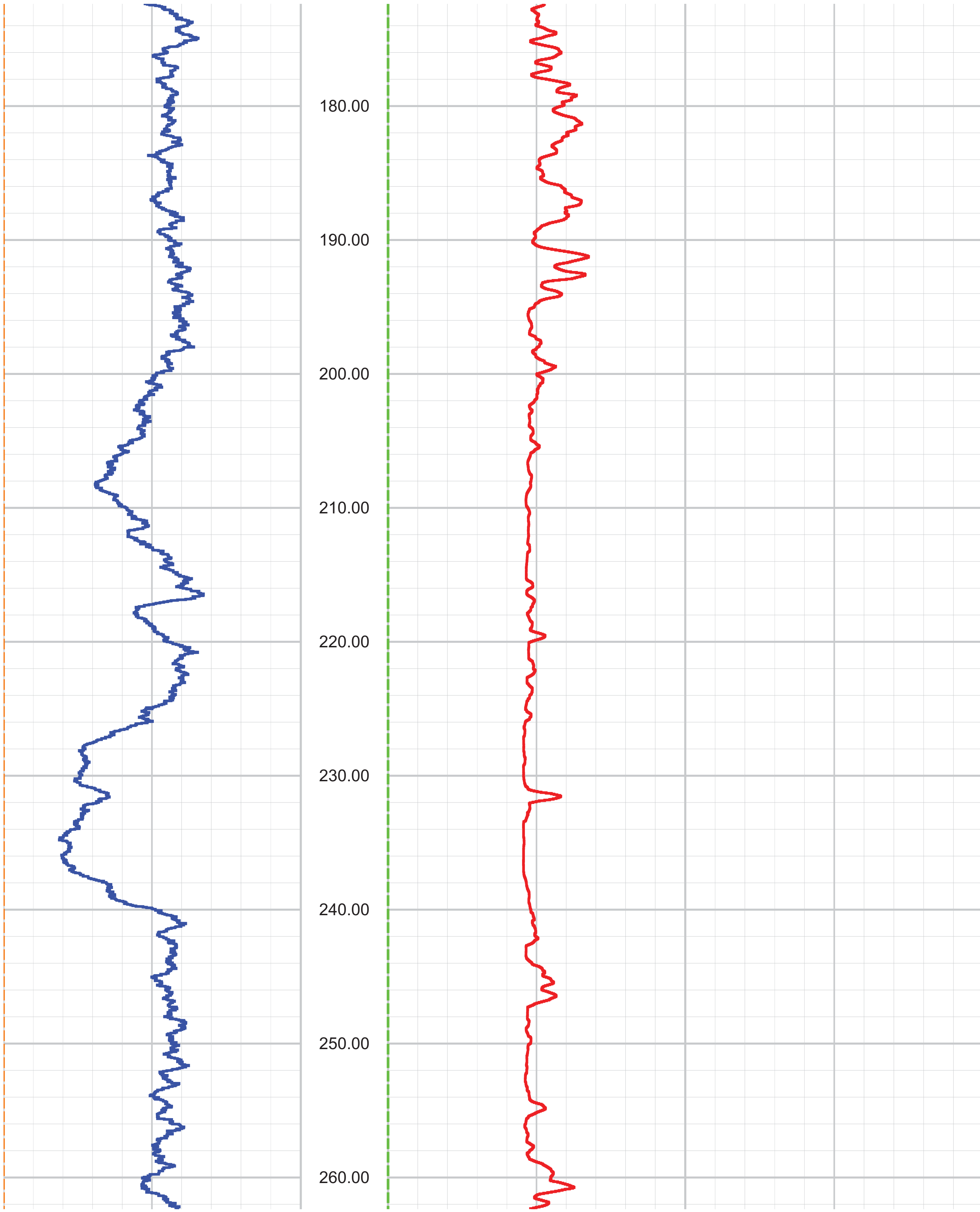
SR-710 Boring Z2-B1 Caliper and Natural Gamma rev 1.1 Sheet 2 of 2



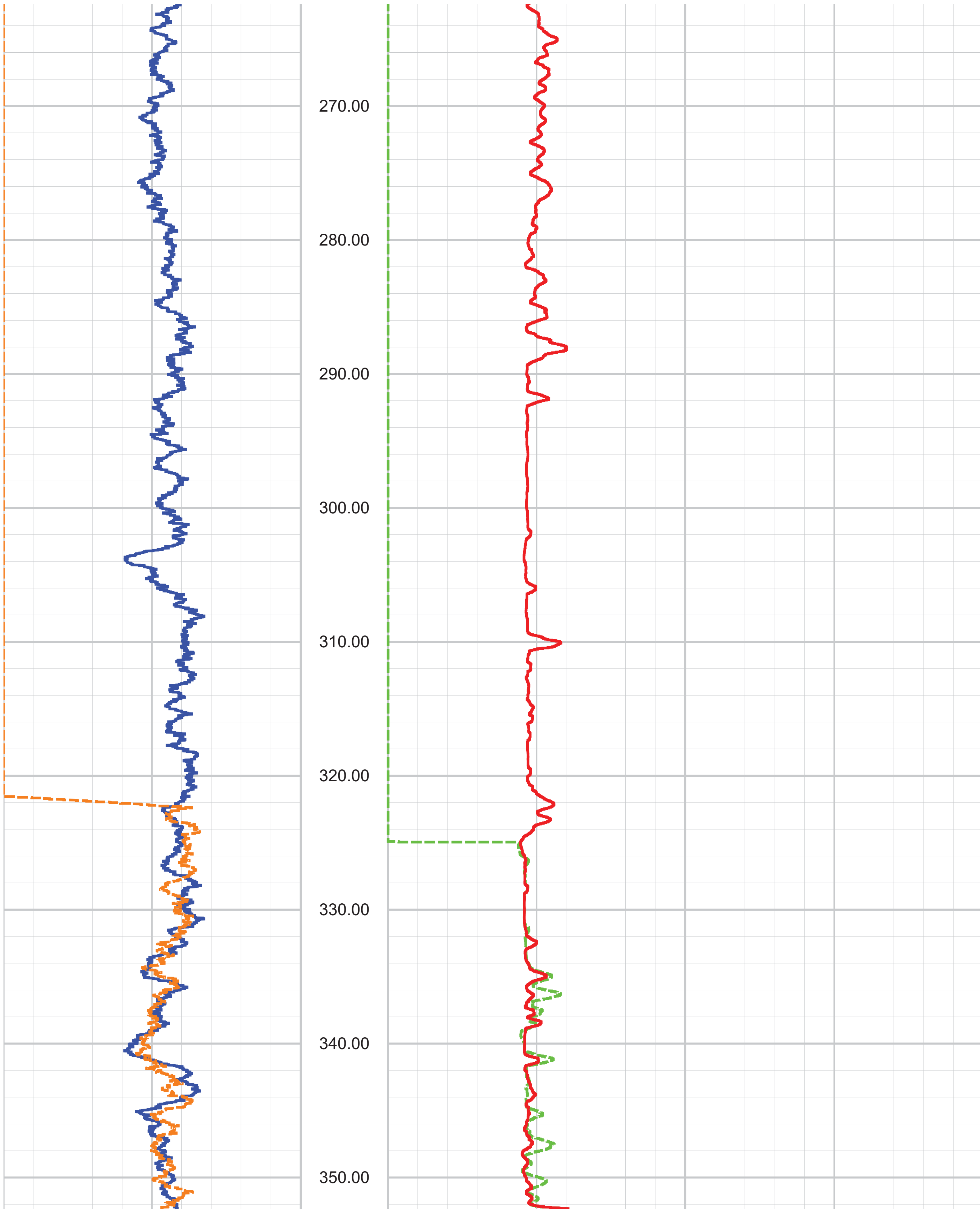
SR-710 Boring Z2-B4 Caliper and Natural Gamma rev 1.1 Sheet 1 of 5



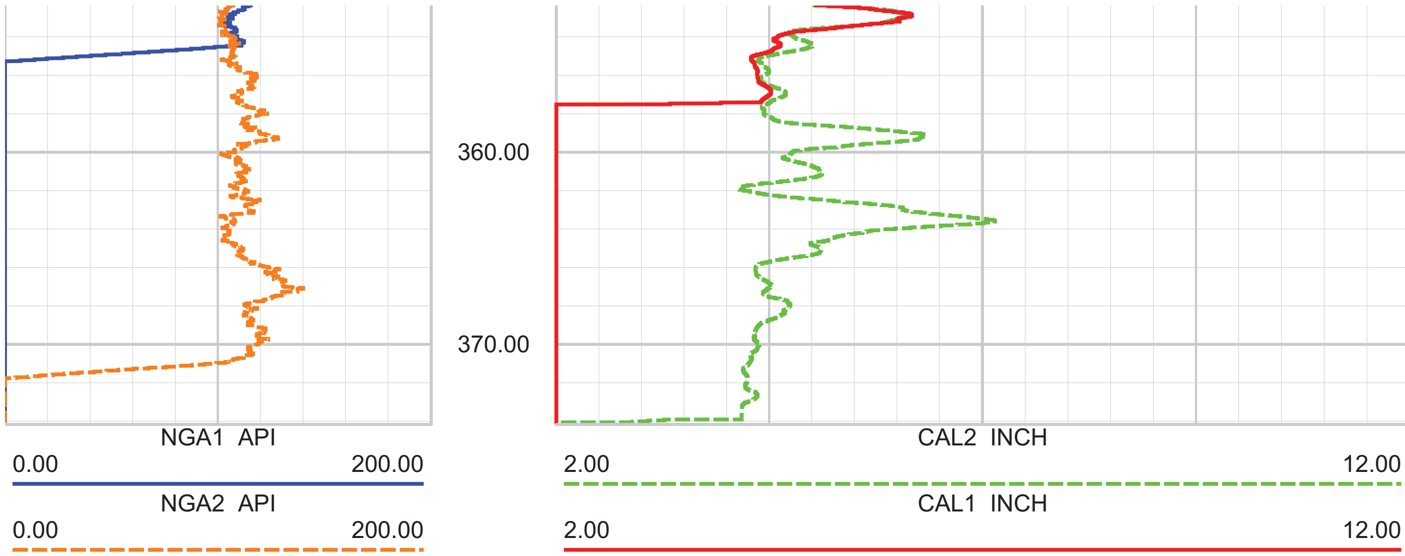
SR-710 Boring Z2-B4 Caliper and Natural Gamma rev 1.1 Sheet 2 of 5



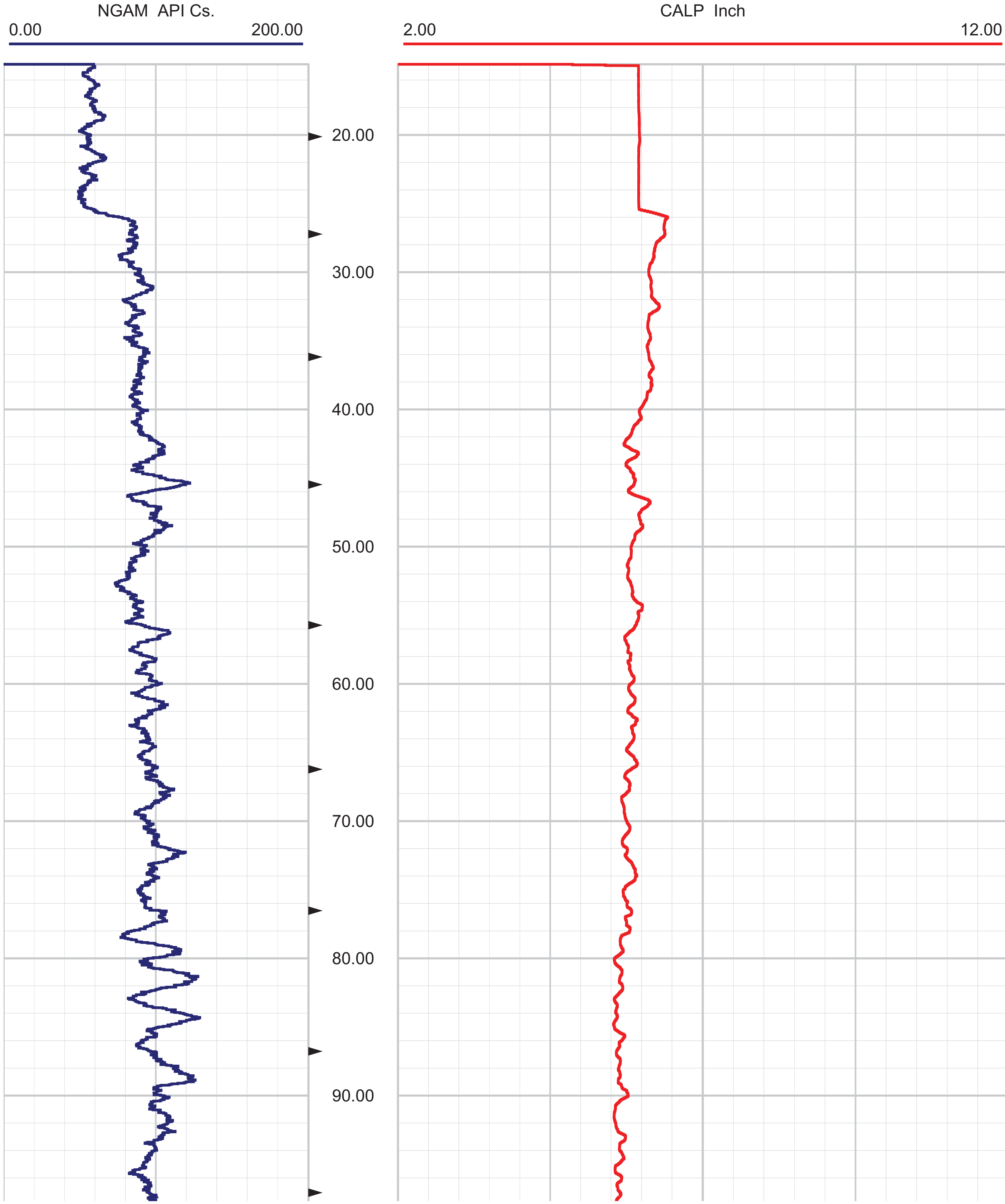
SR-710 Boring Z2-B4 Caliper and Natural Gamma rev 1.1 Sheet 3 of 5



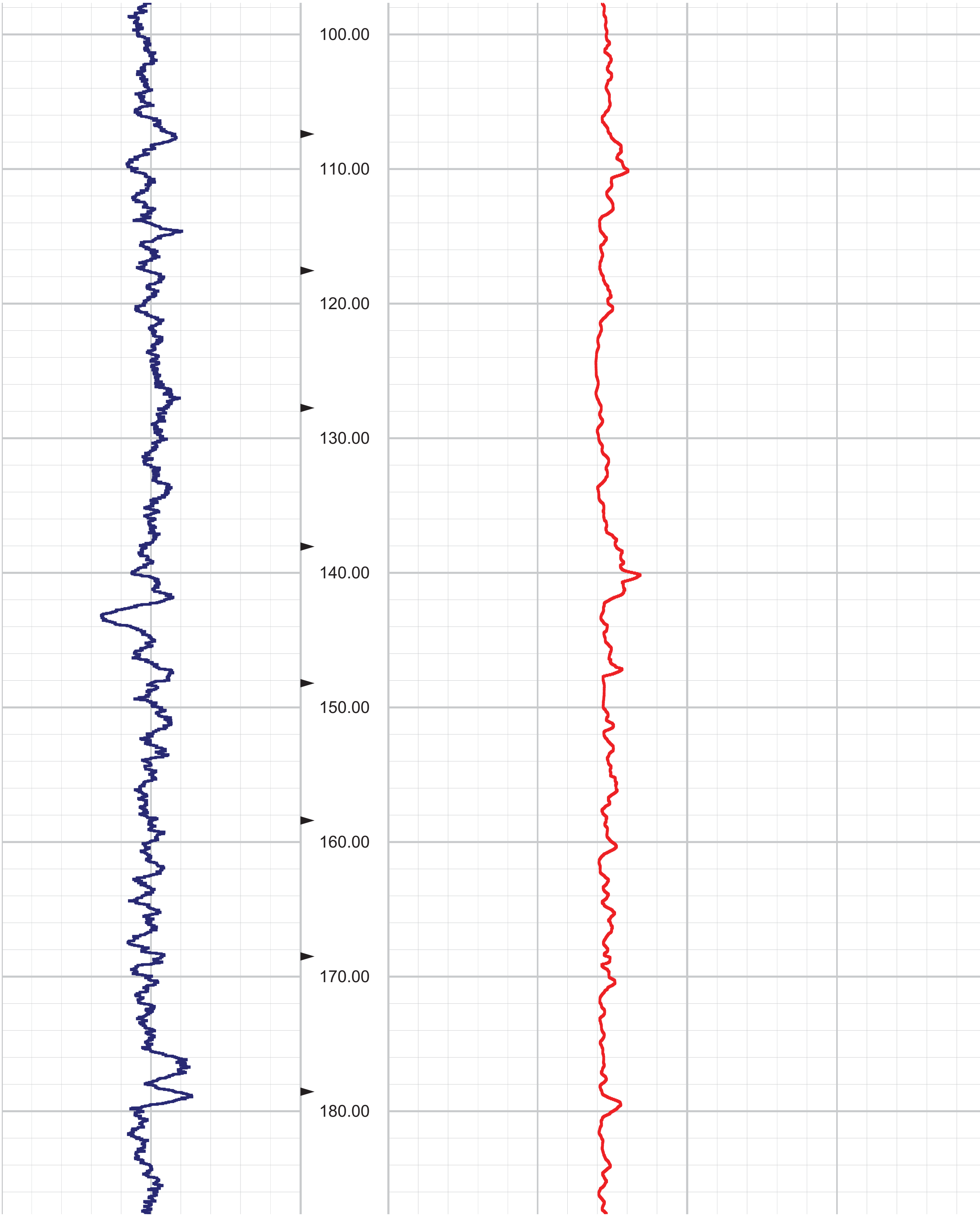
SR-710 Boring Z2-B4 Caliper and Natural Gamma rev 1.1 Sheet 4 of 5



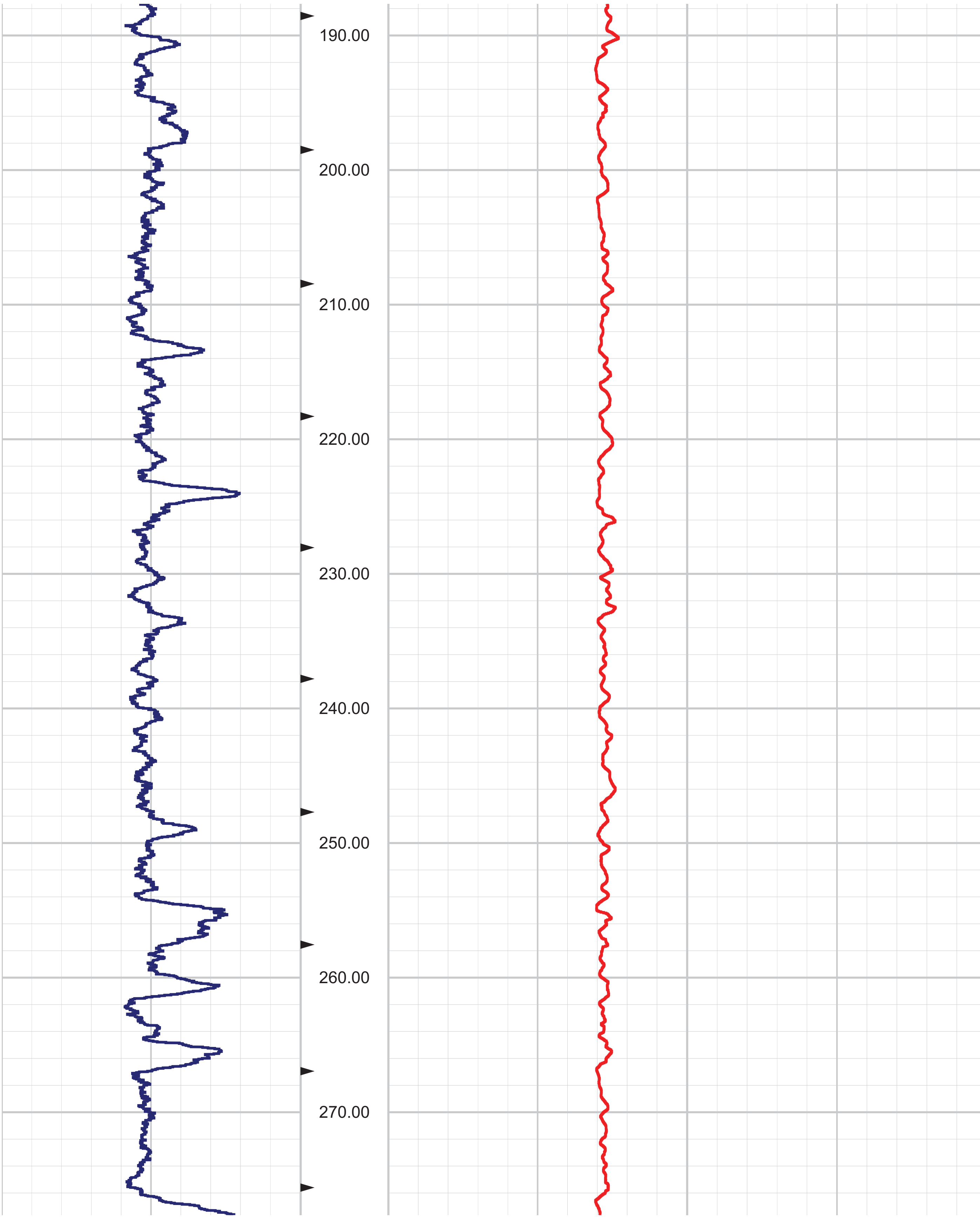
SR-710 Boring Z2-B4 Caliper and Natural Gamma rev 1.1 Sheet 5 of 5



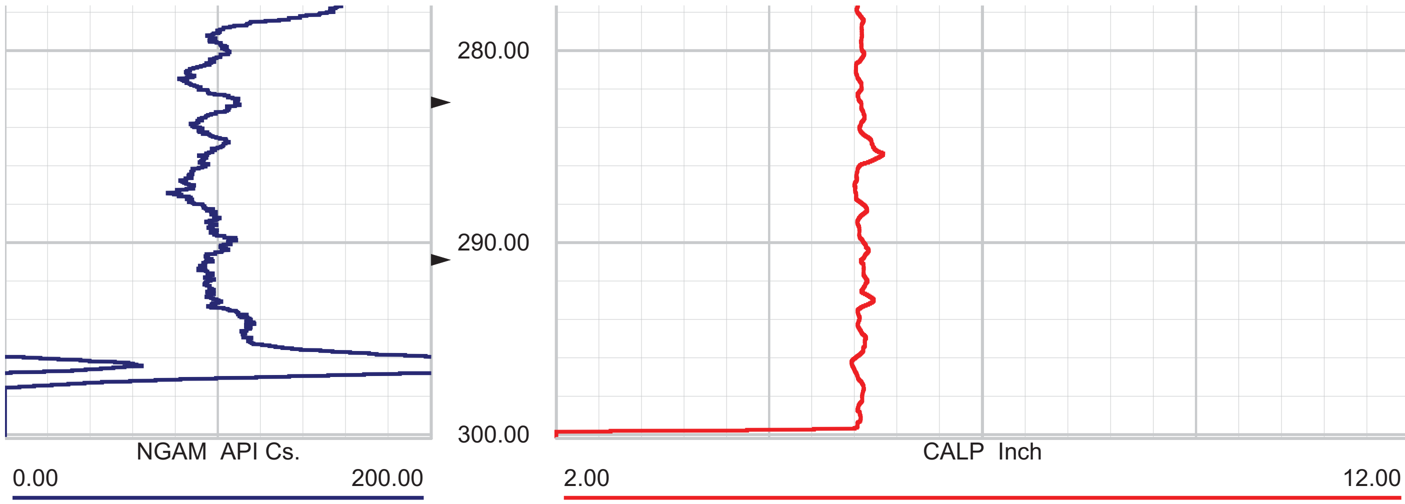
SR-710 Boring Z3-B1 Caliper and Natural Gamma rev 1.1 Sheet 1 of 4



SR-710 Boring Z3-B1 Caliper and Natural Gamma rev 1.1 Sheet 2 of 4



SR-710 Boring Z3-B1 Caliper and Natural Gamma rev 1.1 Sheet 3 of 4



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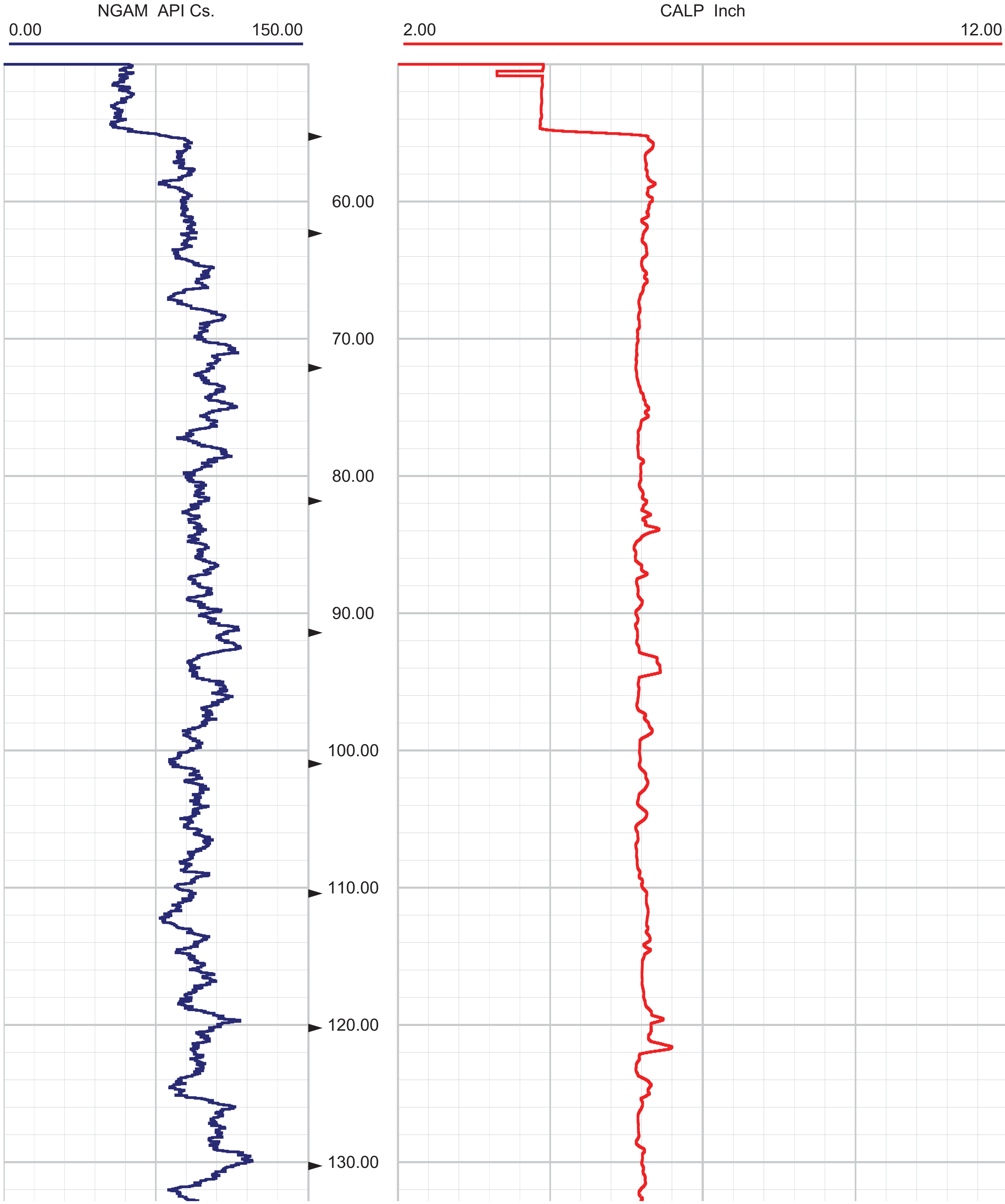
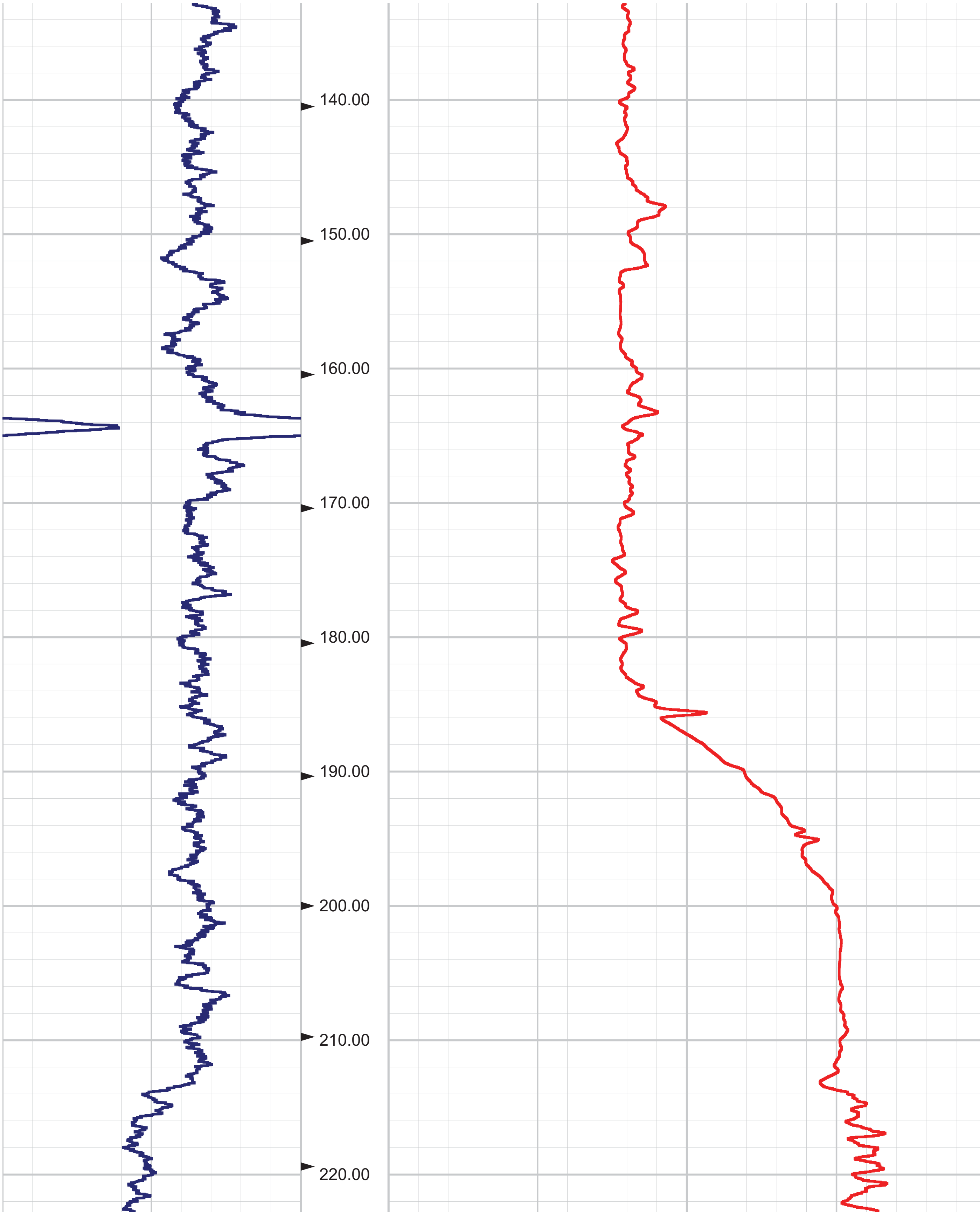
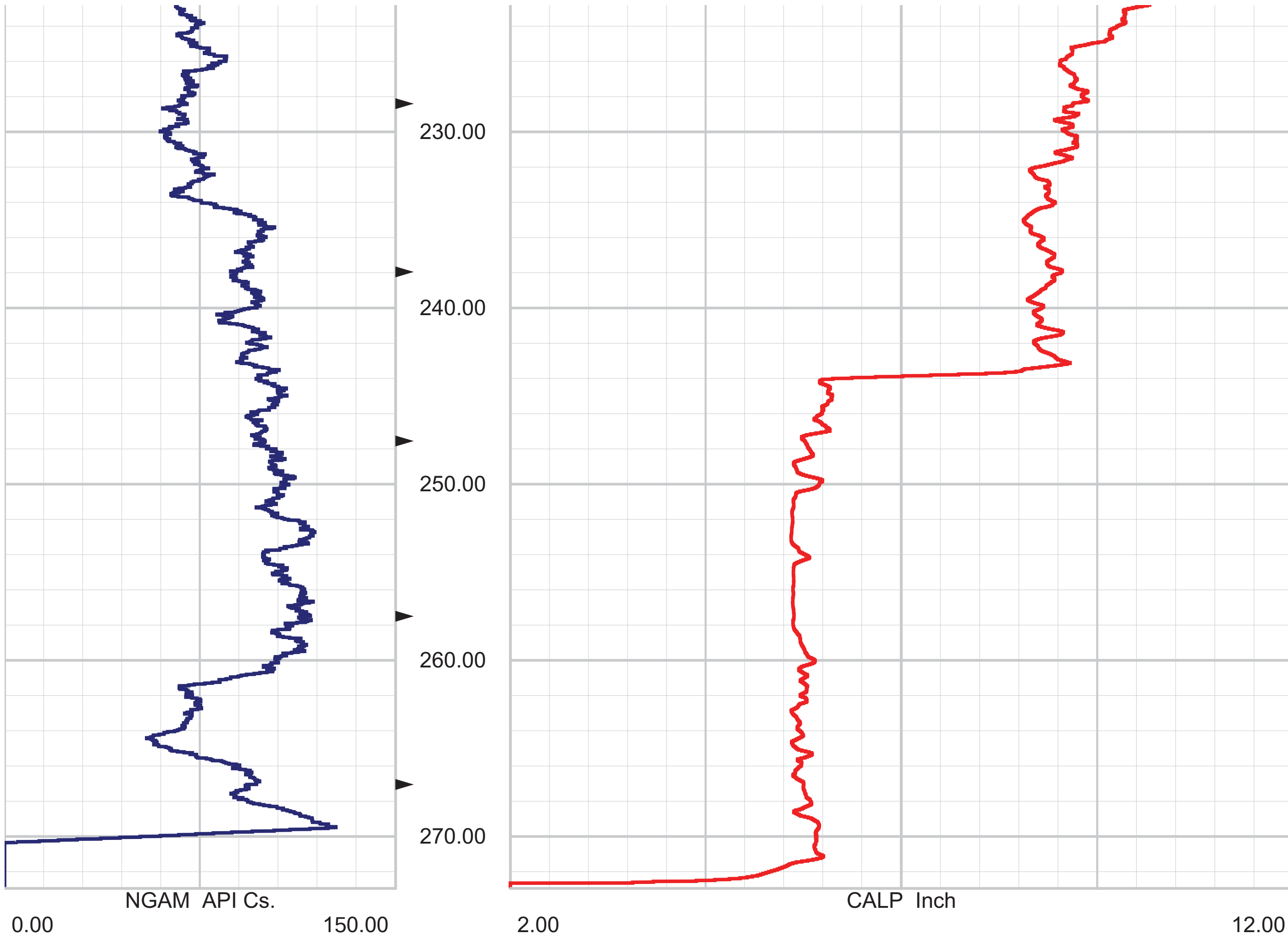
SR-710 Boring Z3-B1 Caliper and Natural Gamma rev 1.1 Sheet 4 of 4



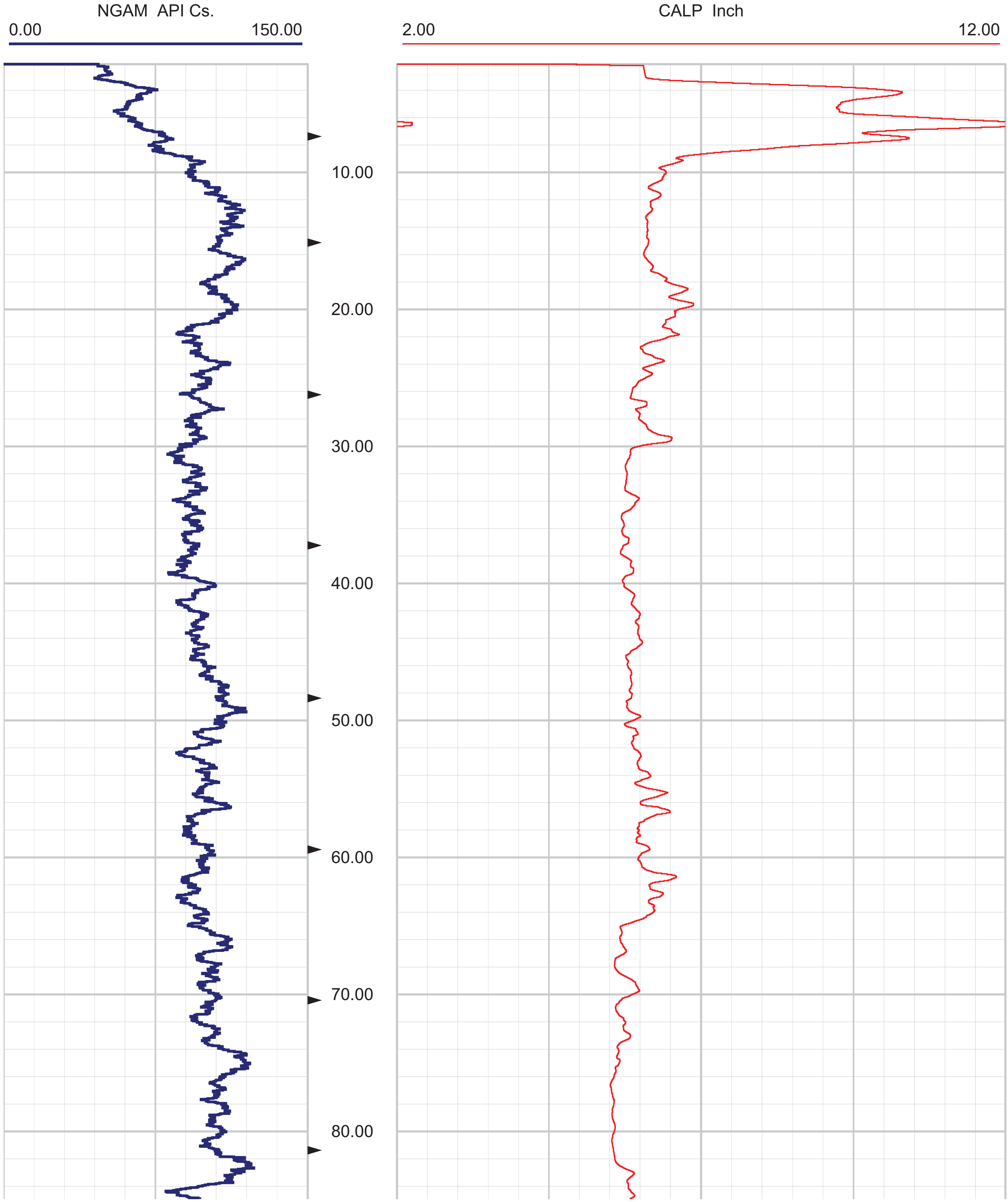
SR-710 Boring Z3-B3 Caliper and Natural Gamma rev 1.1 Sheet 1 of 3



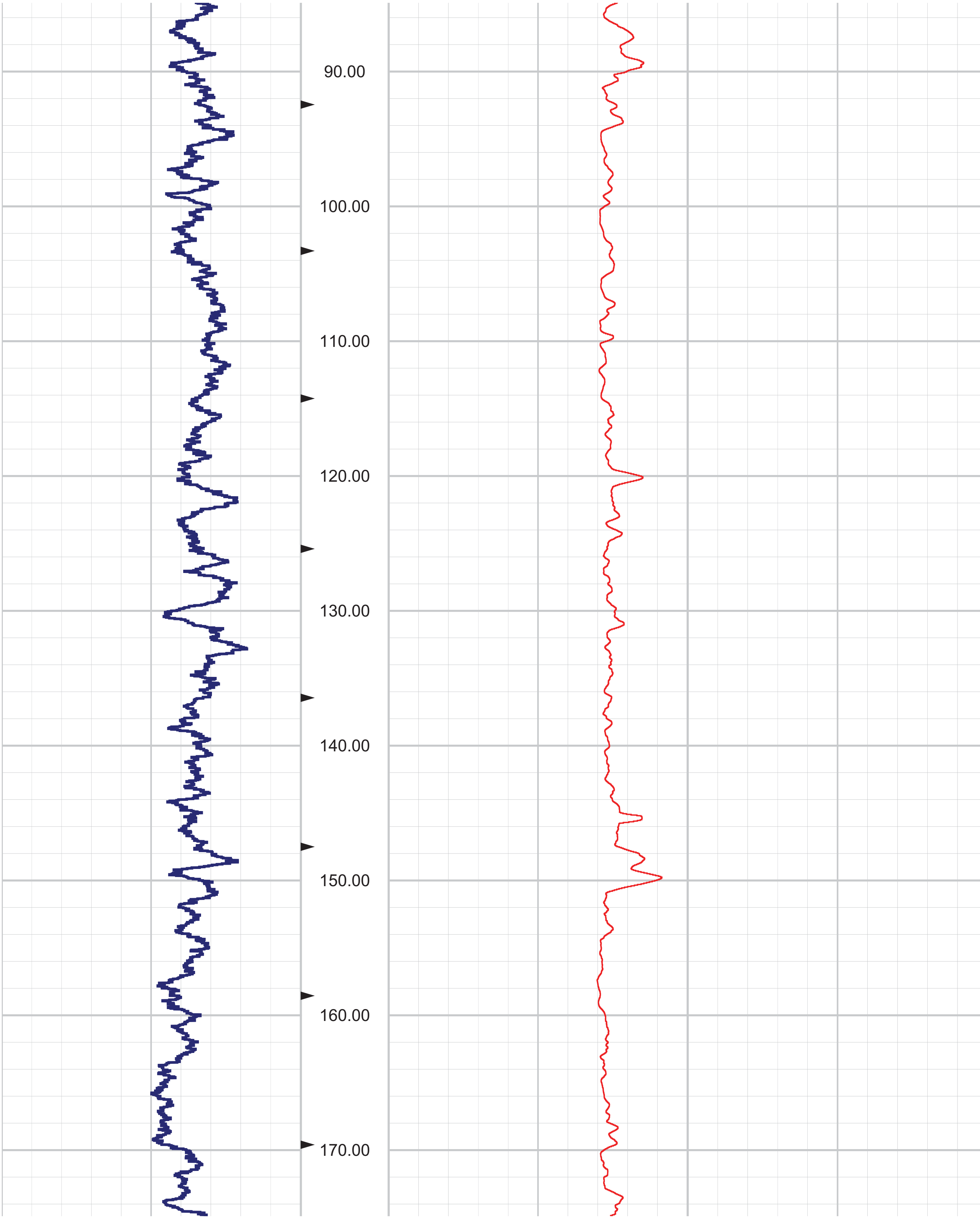
SR-710 Boring Z3-B3 Caliper and Natural Gamma rev 1.1 Sheet 2 of 3



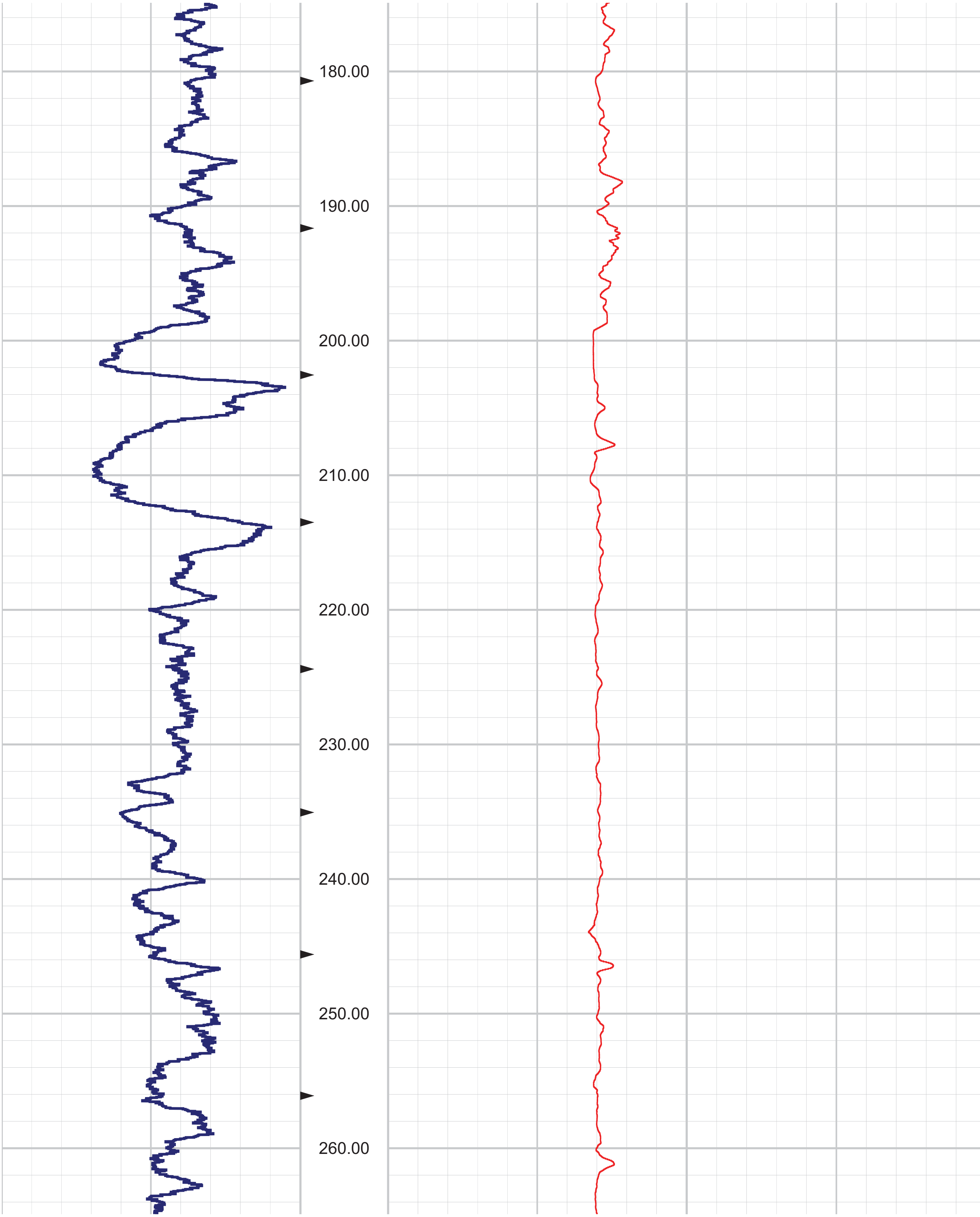
SR-710 Boring Z3-B3 Caliper and Natural Gamma rev 1.1 Sheet 3 of 3



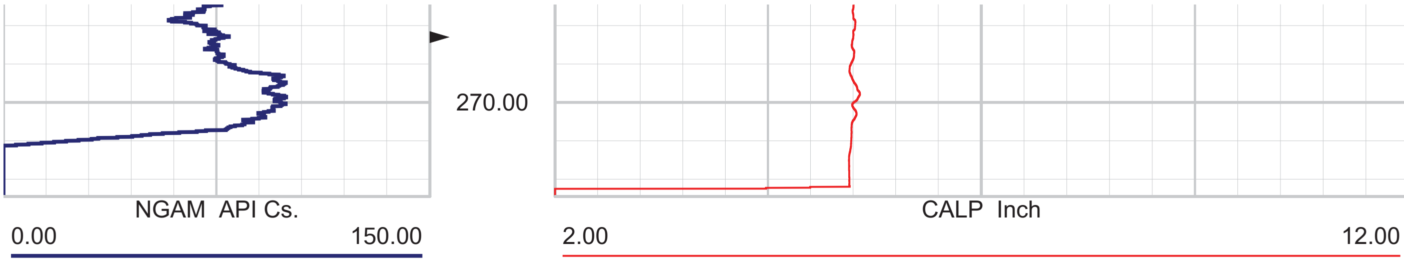
SR-710 Boring Z3-B4 Caliper and Natural Gamma rev 1.1 Sheet 1 of 4



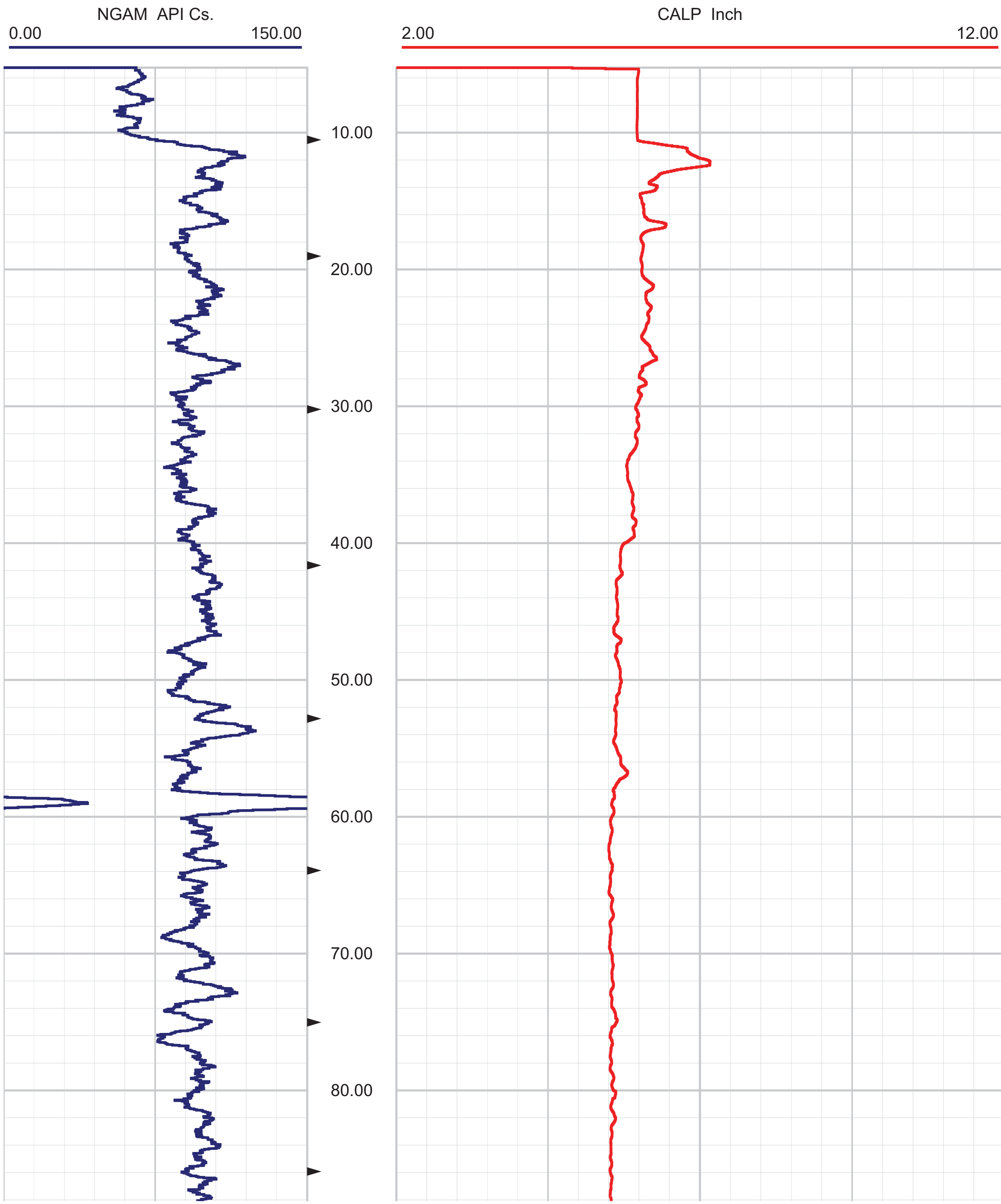
SR-710 Boring Z3-B4 Caliper and Natural Gamma rev 1.1 Sheet 2 of 4



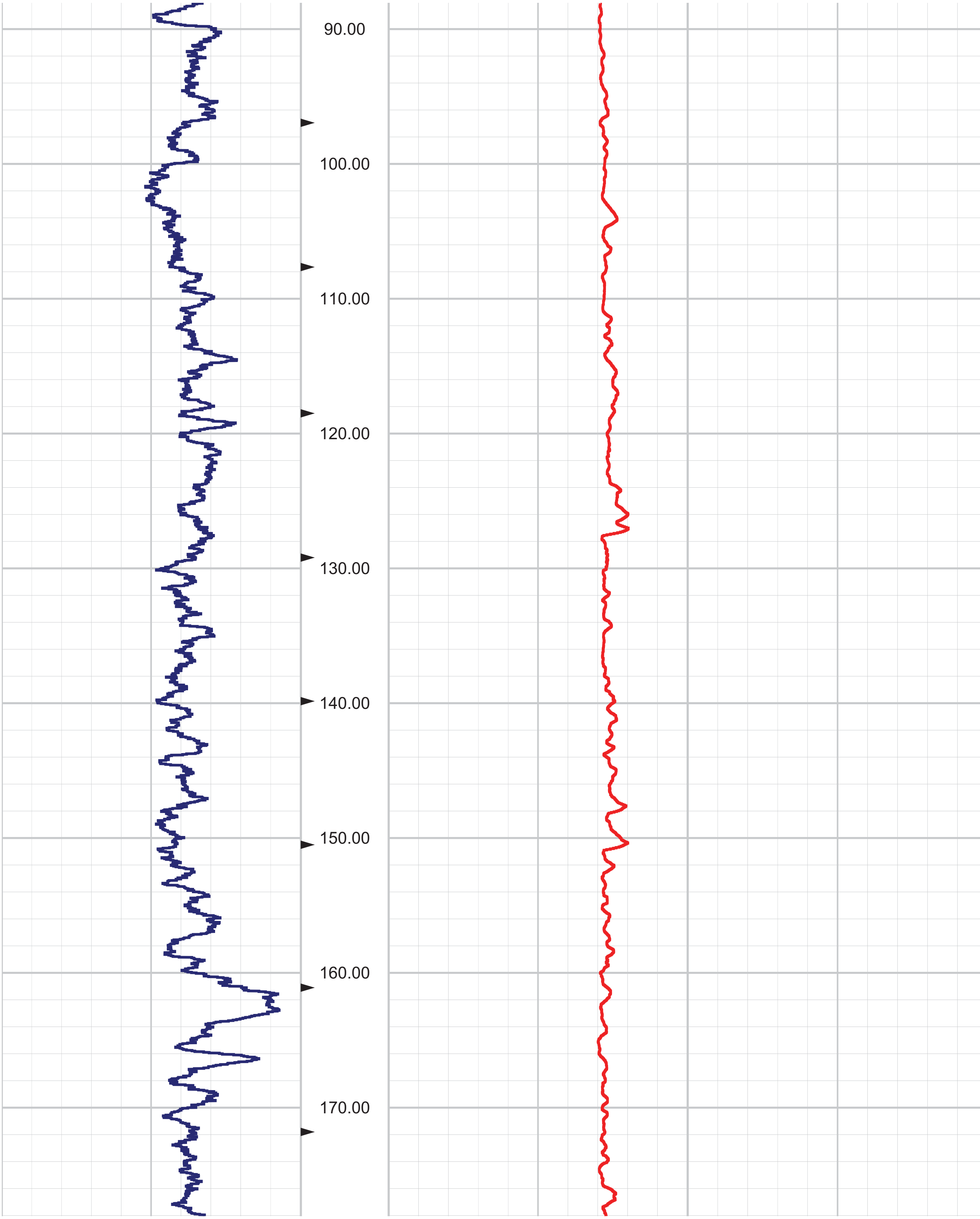
SR-710 Boring Z3-B4 Caliper and Natural Gamma rev 1.1 Sheet 3 of 4



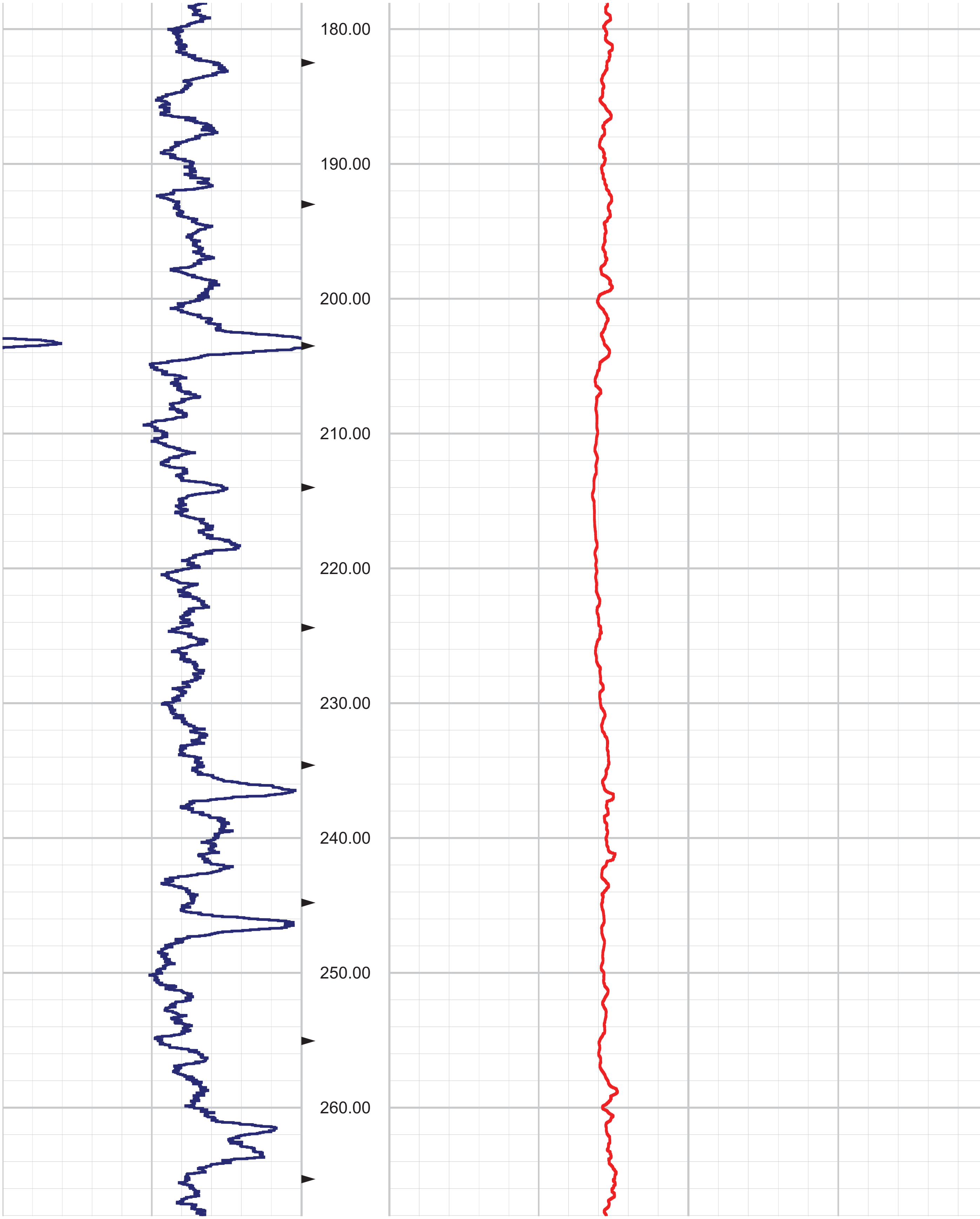
SR-710 Boring Z3-B4 Caliper and Natural Gamma rev 1.1 Sheet 4 of 4



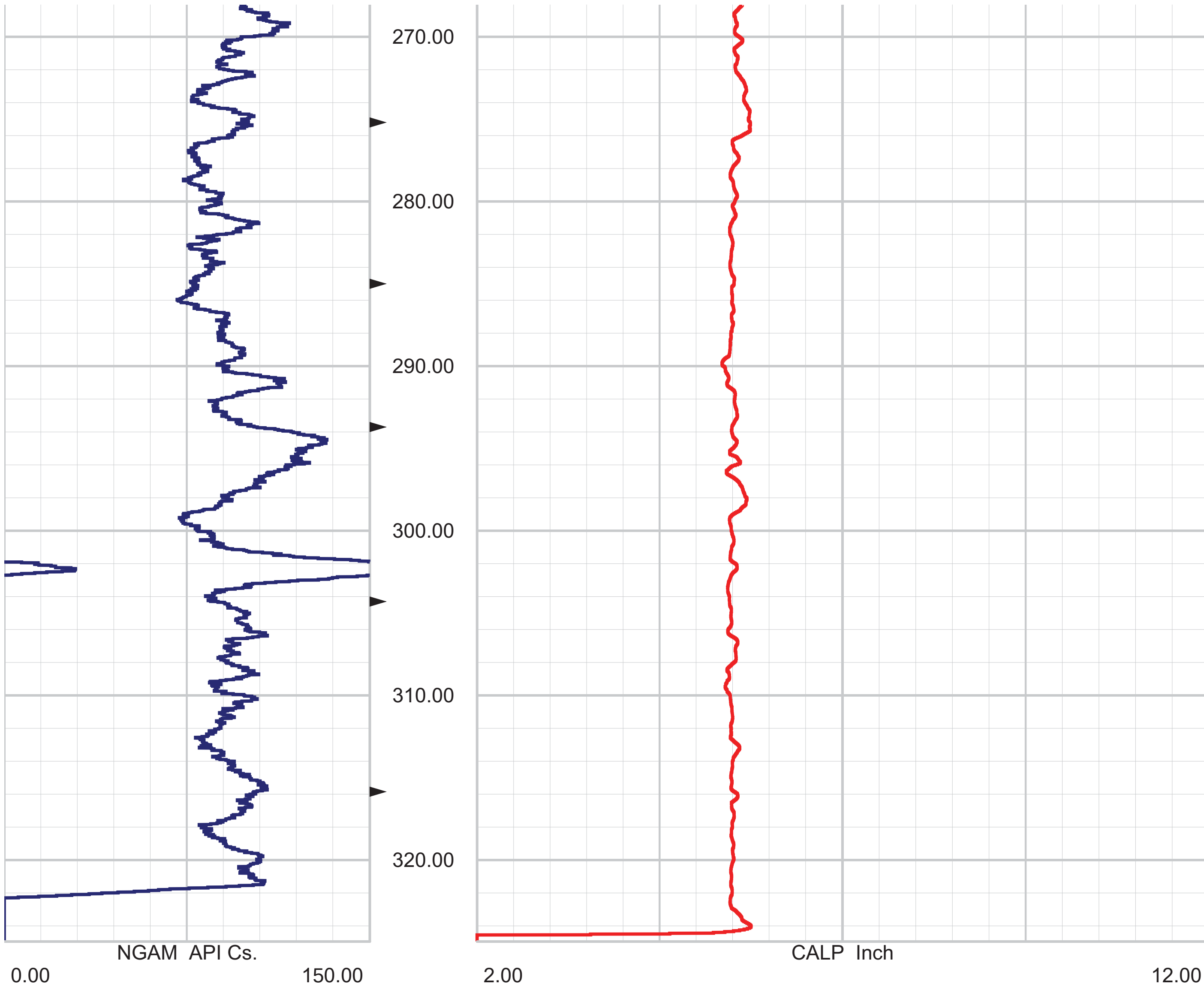
SR-710 Boring Z3-B6 Caliper and Natural Gamma rev 1.1 Sheet 1 of 4



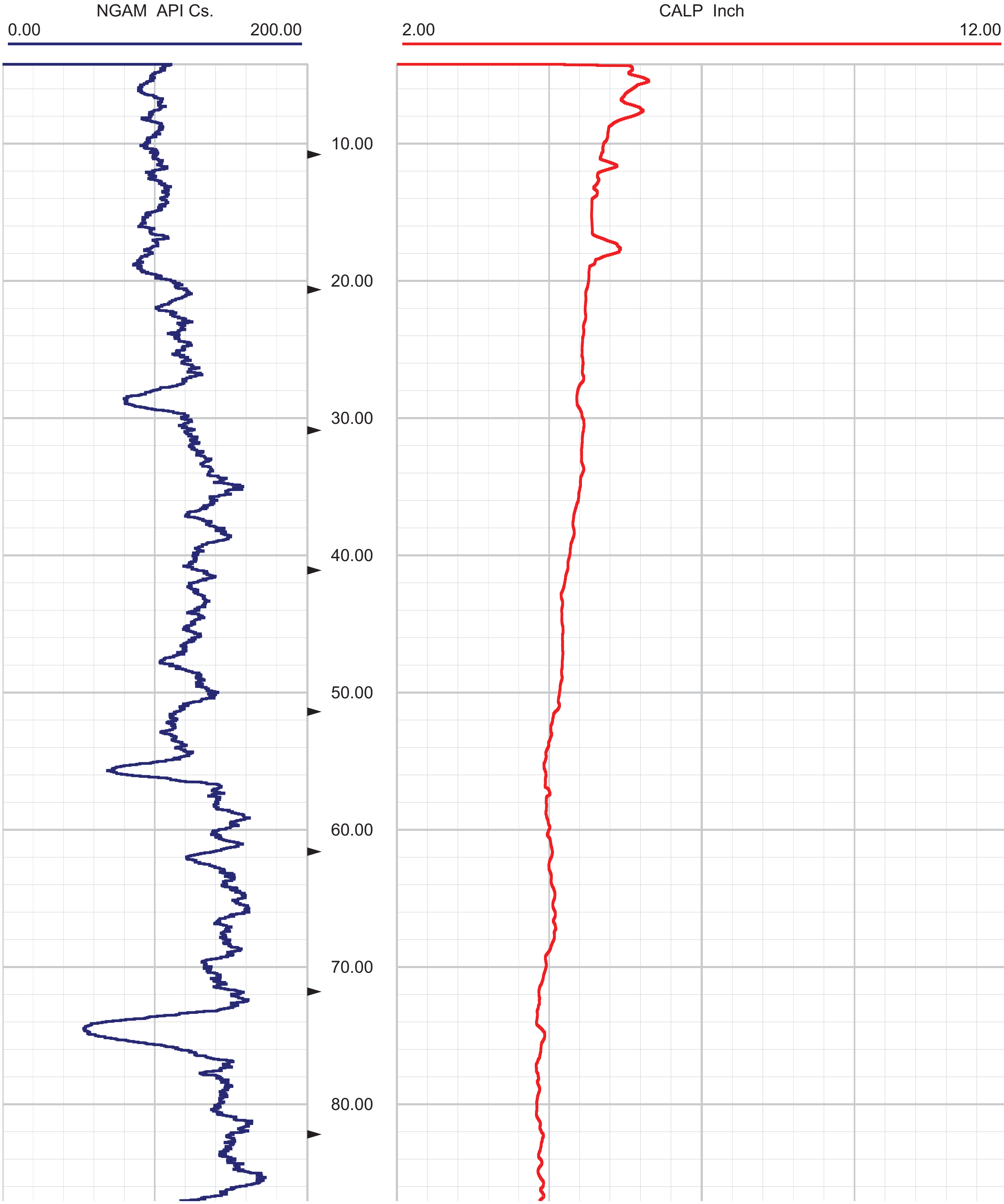
SR-710 Boring Z3-B6 Caliper and Natural Gamma rev 1.1 Sheet 2 of 4



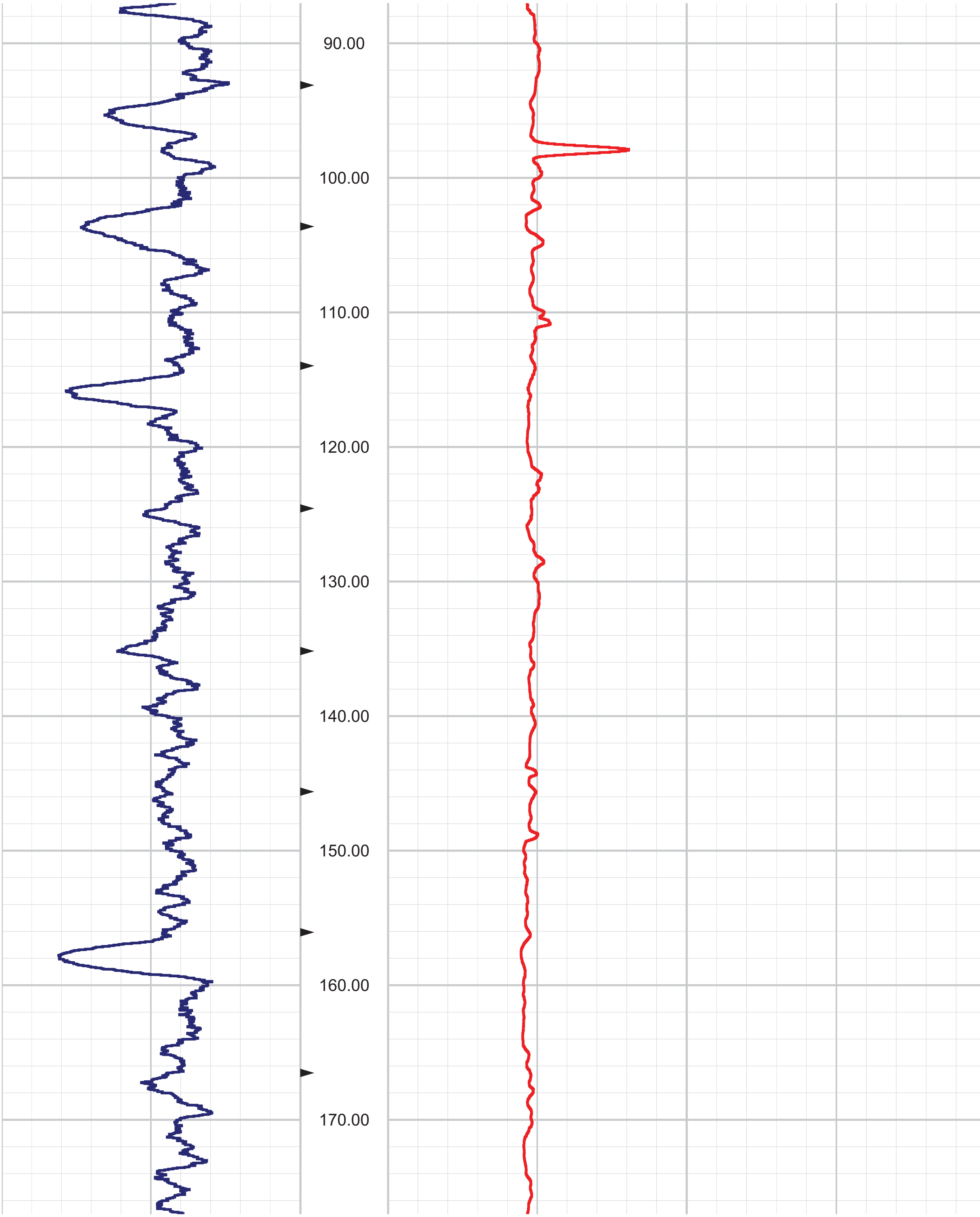
SR-710 Boring Z3-B6 Caliper and Natural Gamma rev 1.1 Sheet 3 of 4



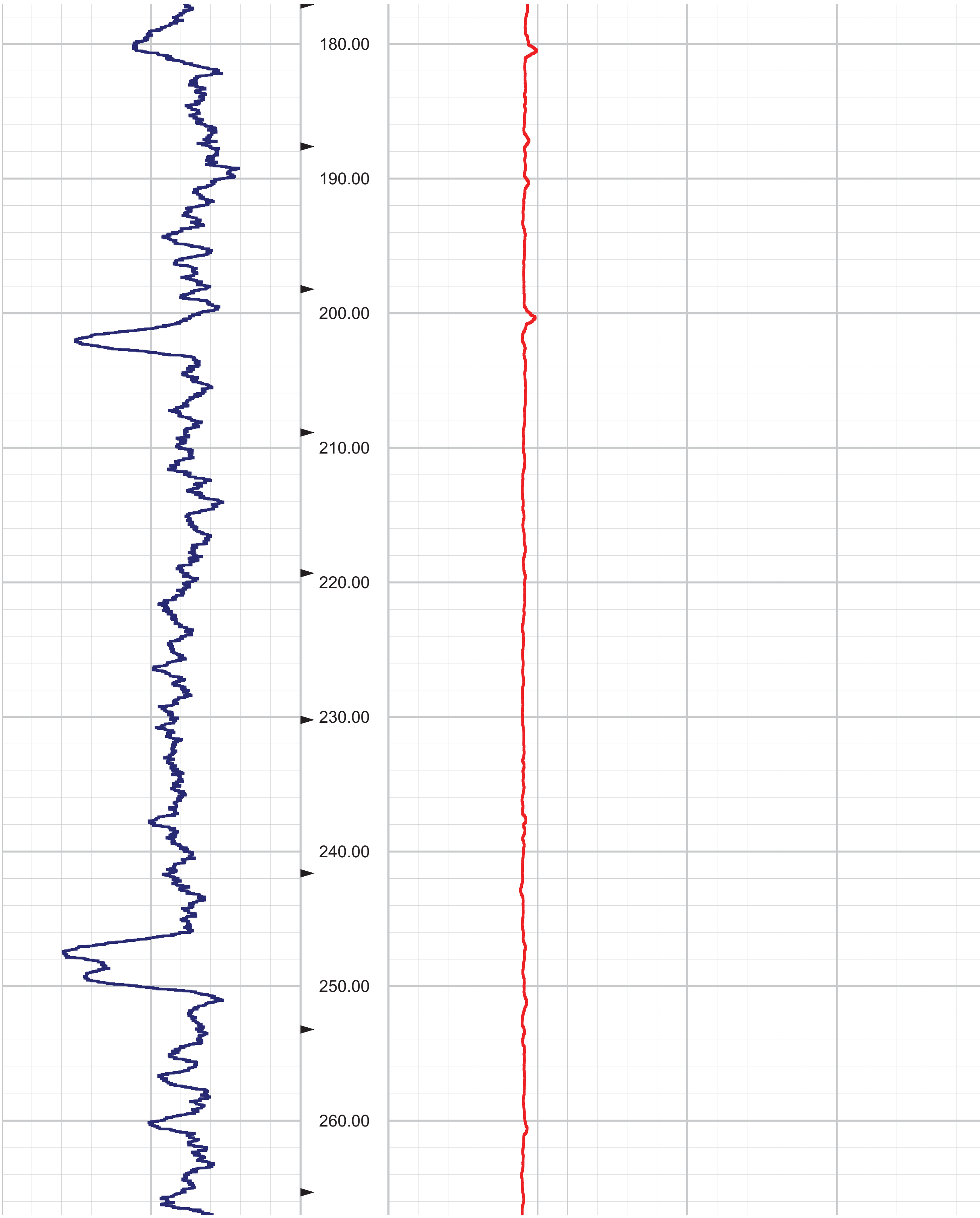
SR-710 Boring Z3-B6 Caliper and Natural Gamma rev 1.1 Sheet 4 of 4



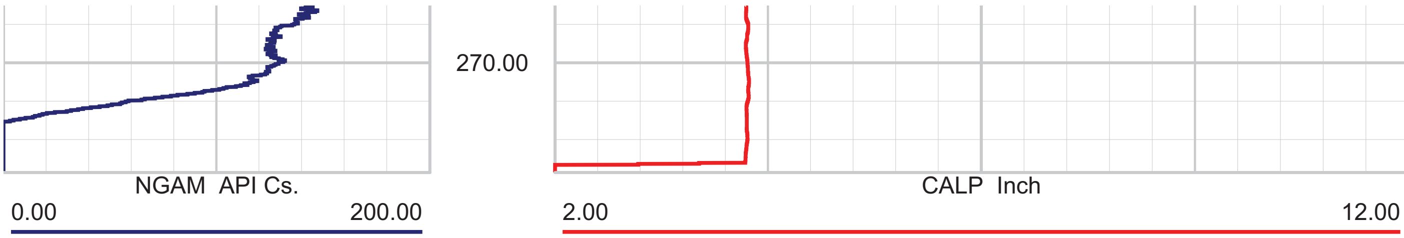
SR-710 Boring Z3-B8 Caliper and Natural Gamma rev 1.1 Sheet 1 of 4



SR-710 Boring Z3-B8 Caliper and Natural Gamma rev 1.1 Sheet 2 of 4



SR-710 Boring Z3-B8 Caliper and Natural Gamma rev 1.1 Sheet 3 of 4



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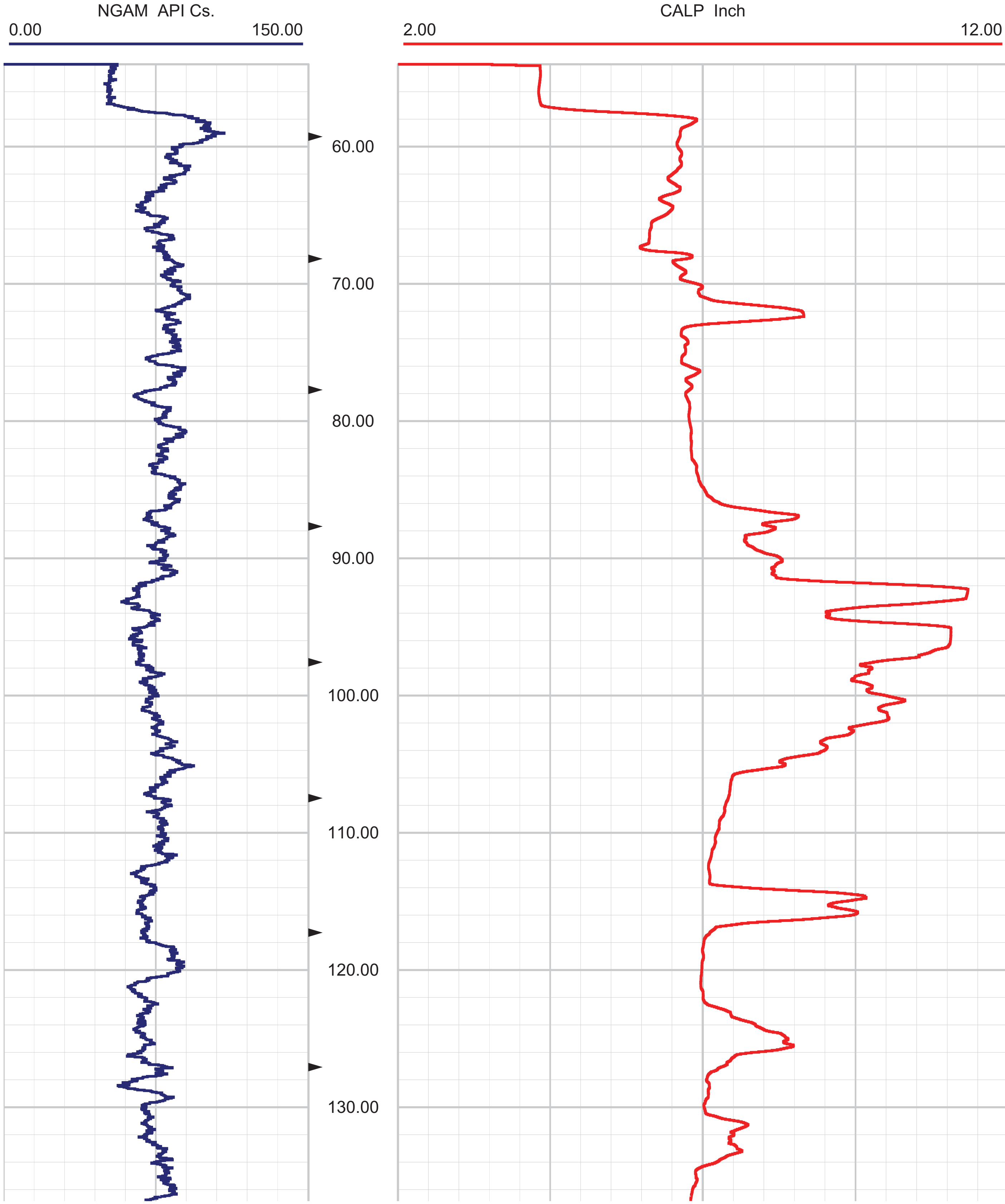
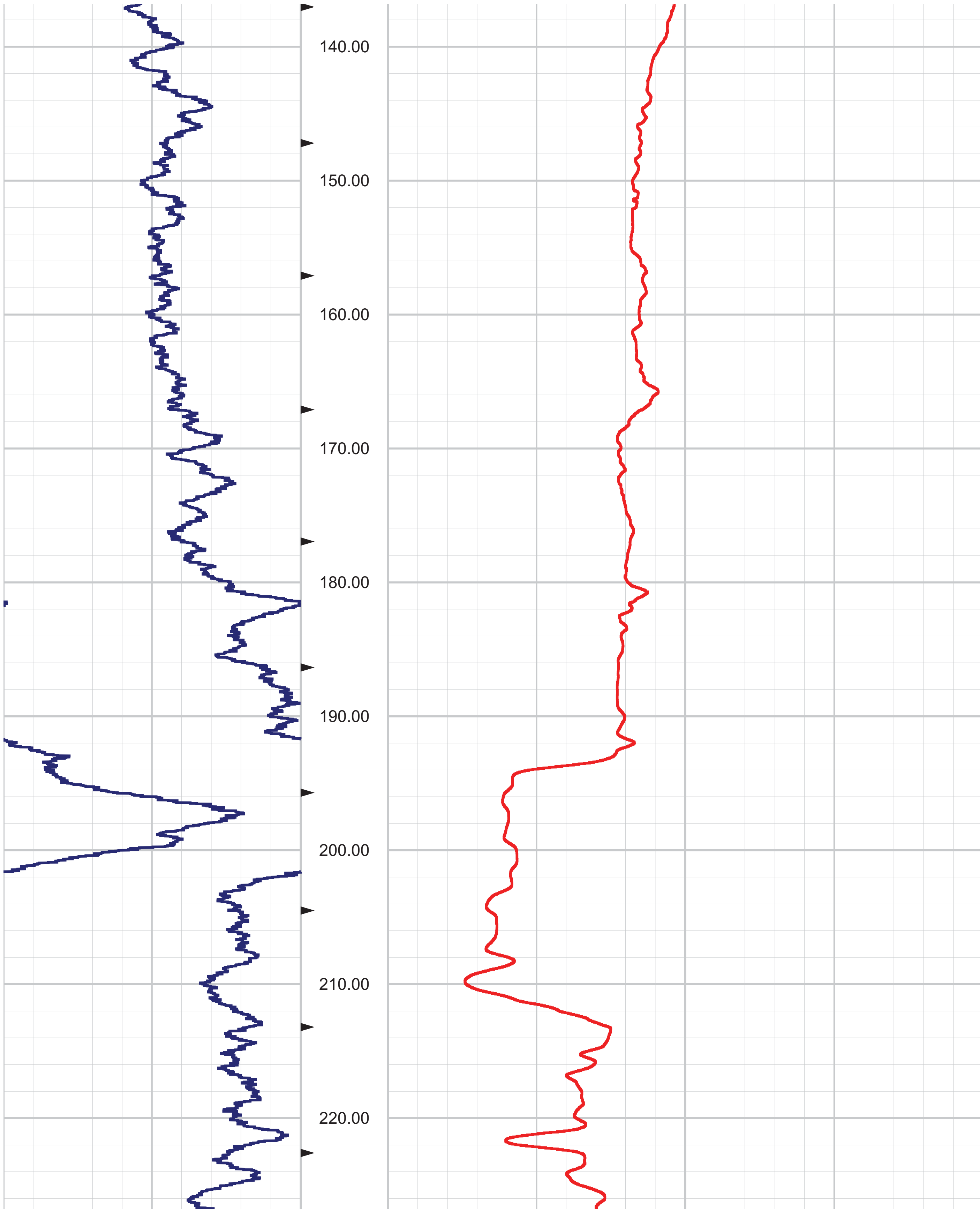
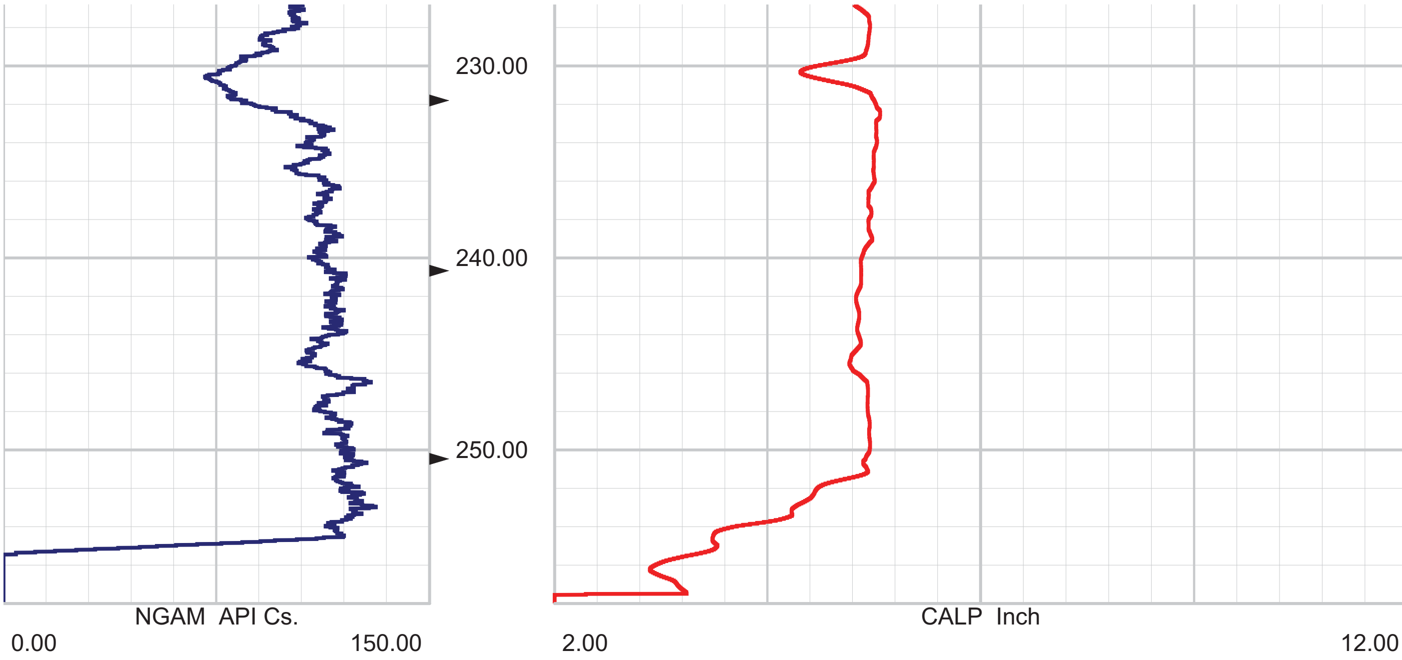


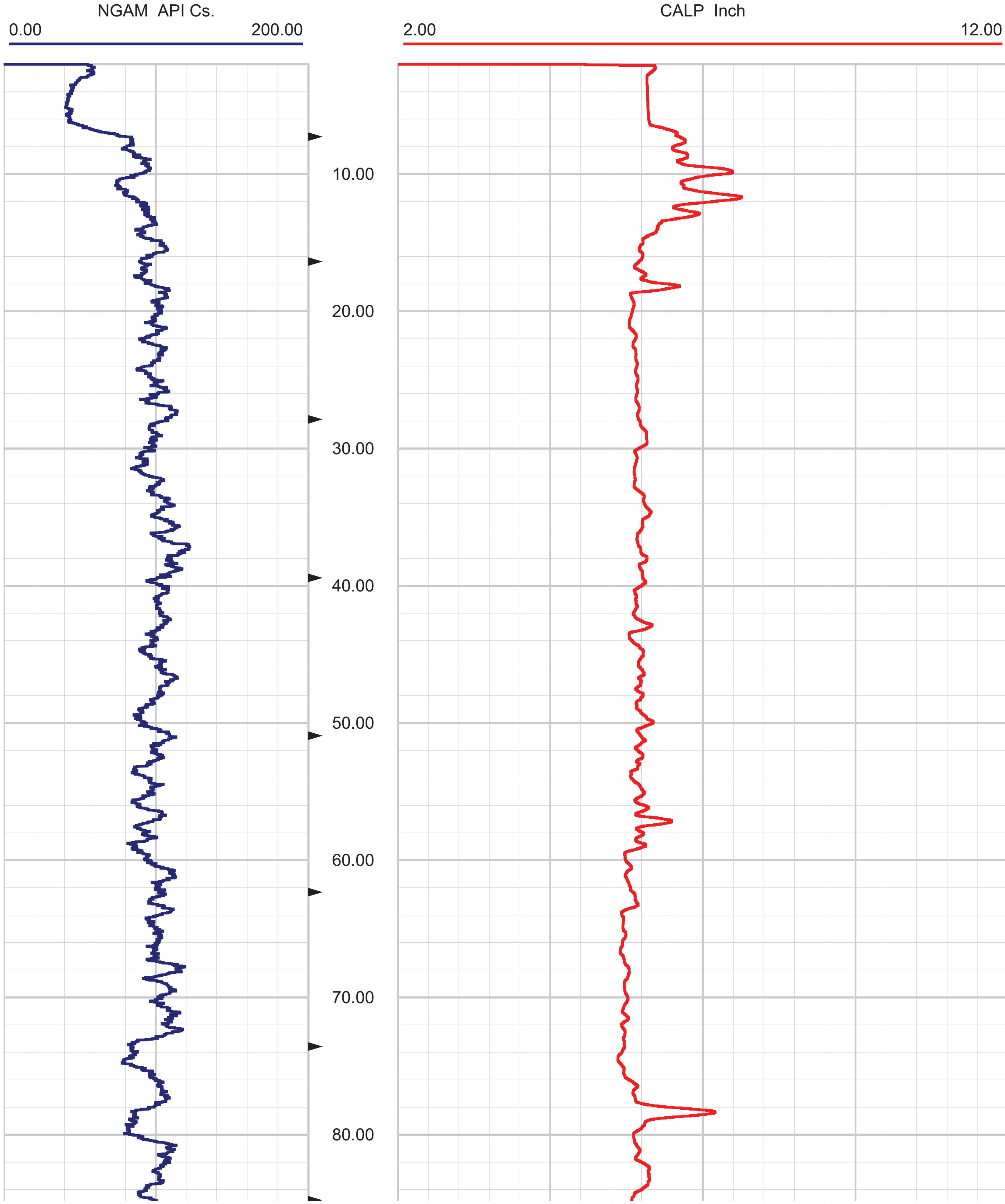
SR-710 Boring Z3-B12 Caliper and Natural Gamma rev 1.1 Sheet 1 of 3



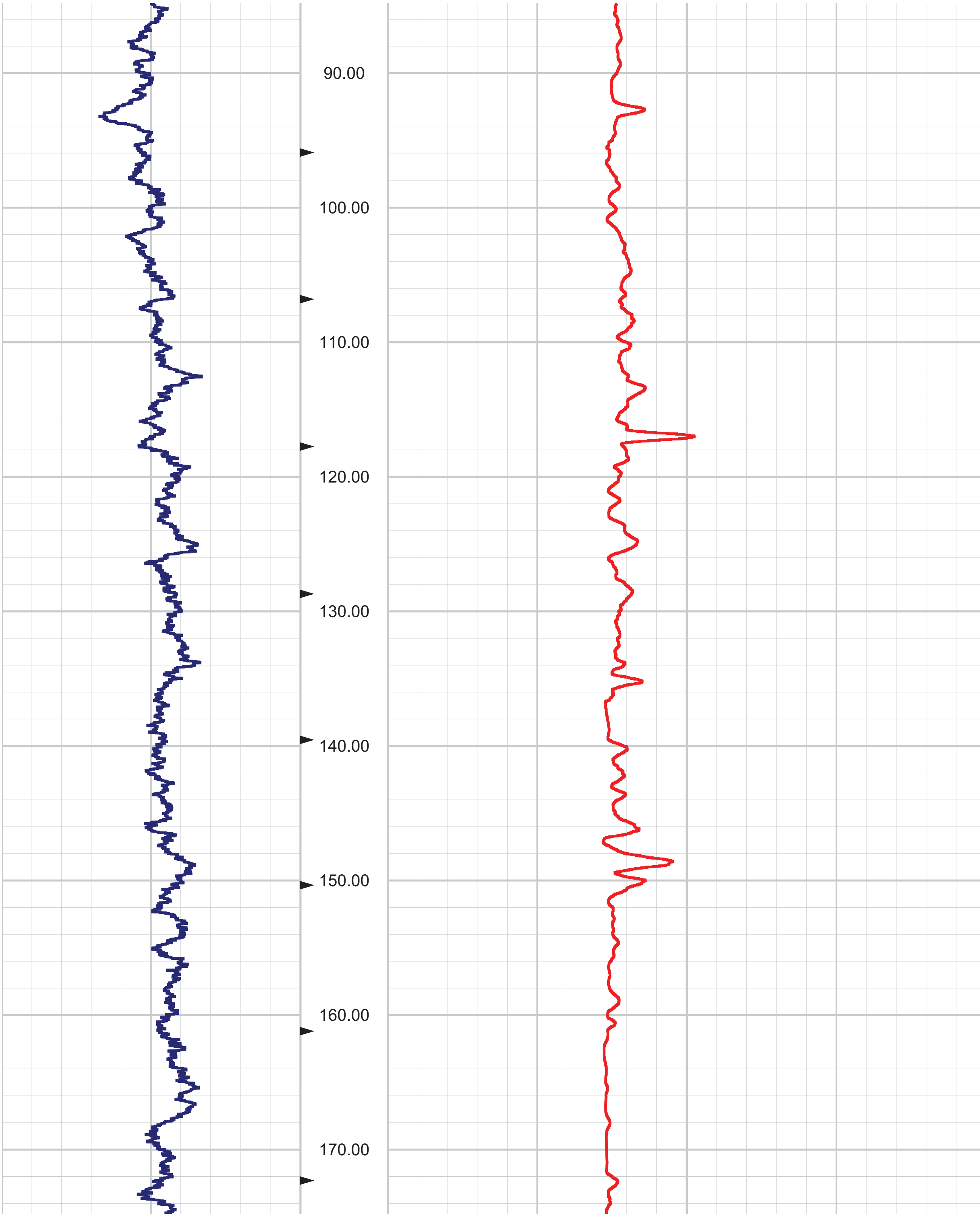
SR-710 Boring Z3-B12 Caliper and Natural Gamma rev 1.1 Sheet 2 of 3



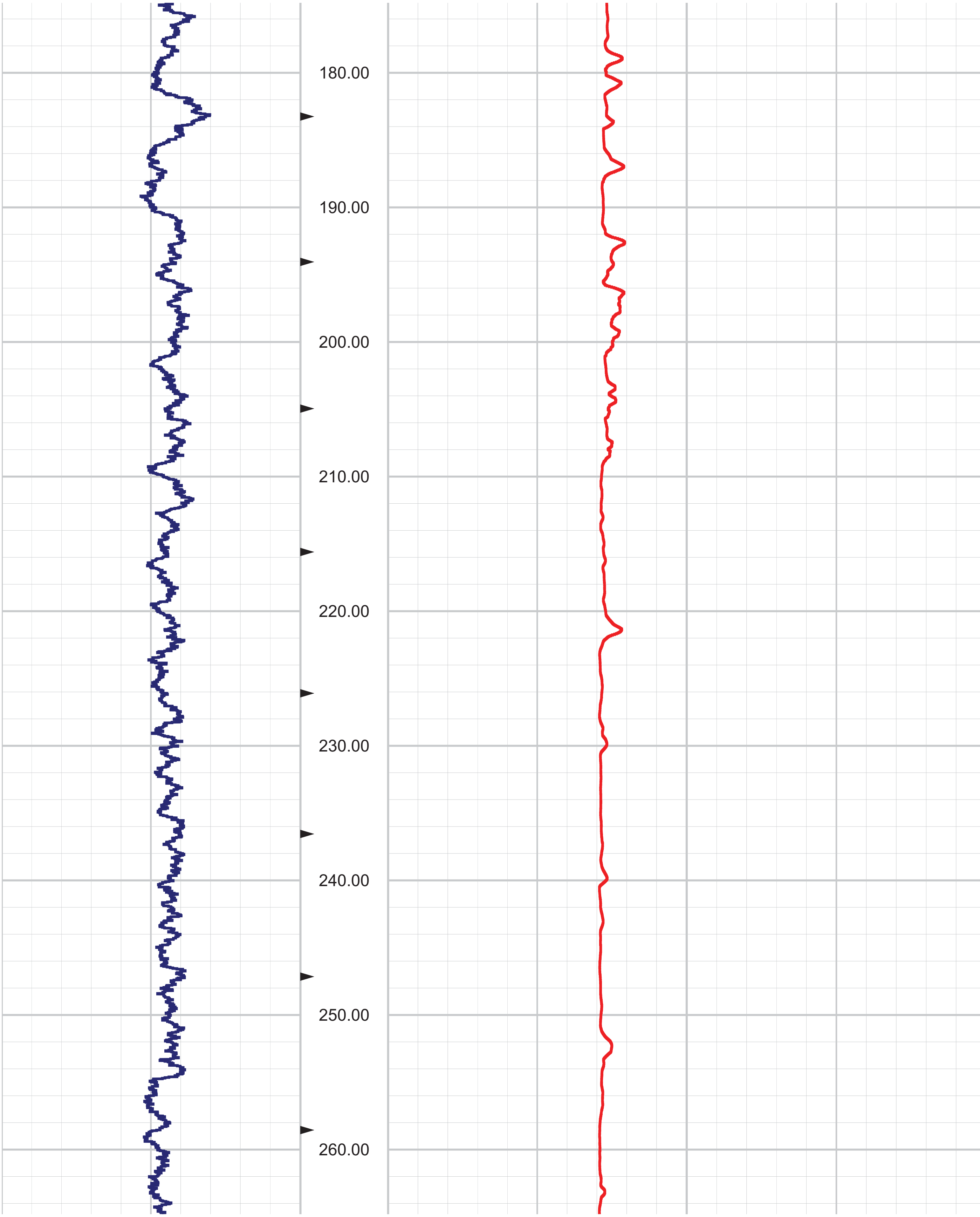
SR-710 Boring Z3-B12 Caliper and Natural Gamma rev 1.1 Sheet 3 of 3



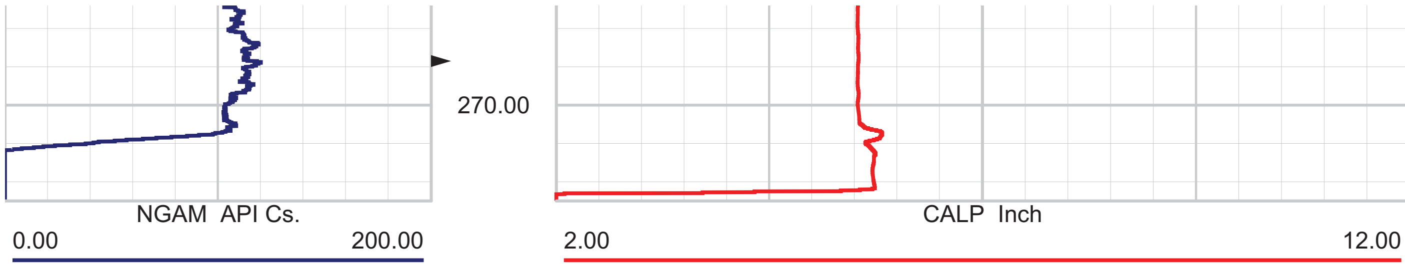
SR-710 Boring Z4-B4 Caliper and Natural Gamma rev 1.1 Sheet 1 of 4



SR-710 Boring Z4-B4 Caliper and Natural Gamma rev 1.1 Sheet 2 of 4



SR-710 Boring Z4-B4 Caliper and Natural Gamma rev 1.1 Sheet 3 of 4



SR-710 Boring Z4-B4 Caliper and Natural Gamma rev 1.1 Sheet 4 of 4

APPENDIX C

ACOUSTIC TELEVIEWER DIPS LOGS

BHTV DATA PROCESSING
RGLDIP vsn 6.2
INTERPRETED BHTV DIPS LOG

CASCADE DRILLING

Borehole: Z1-B3

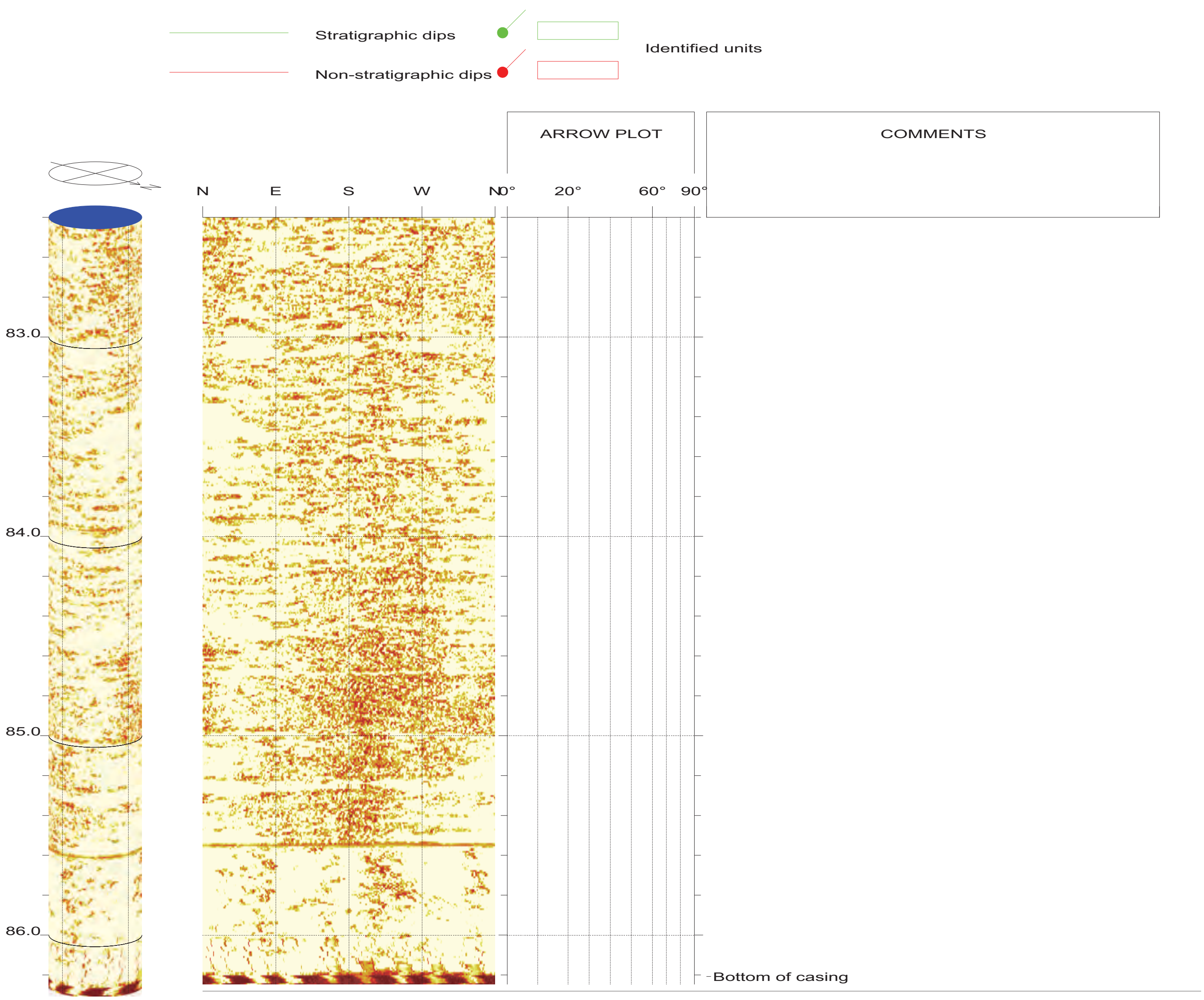
SR-710 TUNNEL INVESTIGATION

top of borehole.....
East: _
North: _
Elev: _

North ref. is true
Depth units are feet
Vertical scale: 1/10
Horiz scale = 1.00x Vert scale

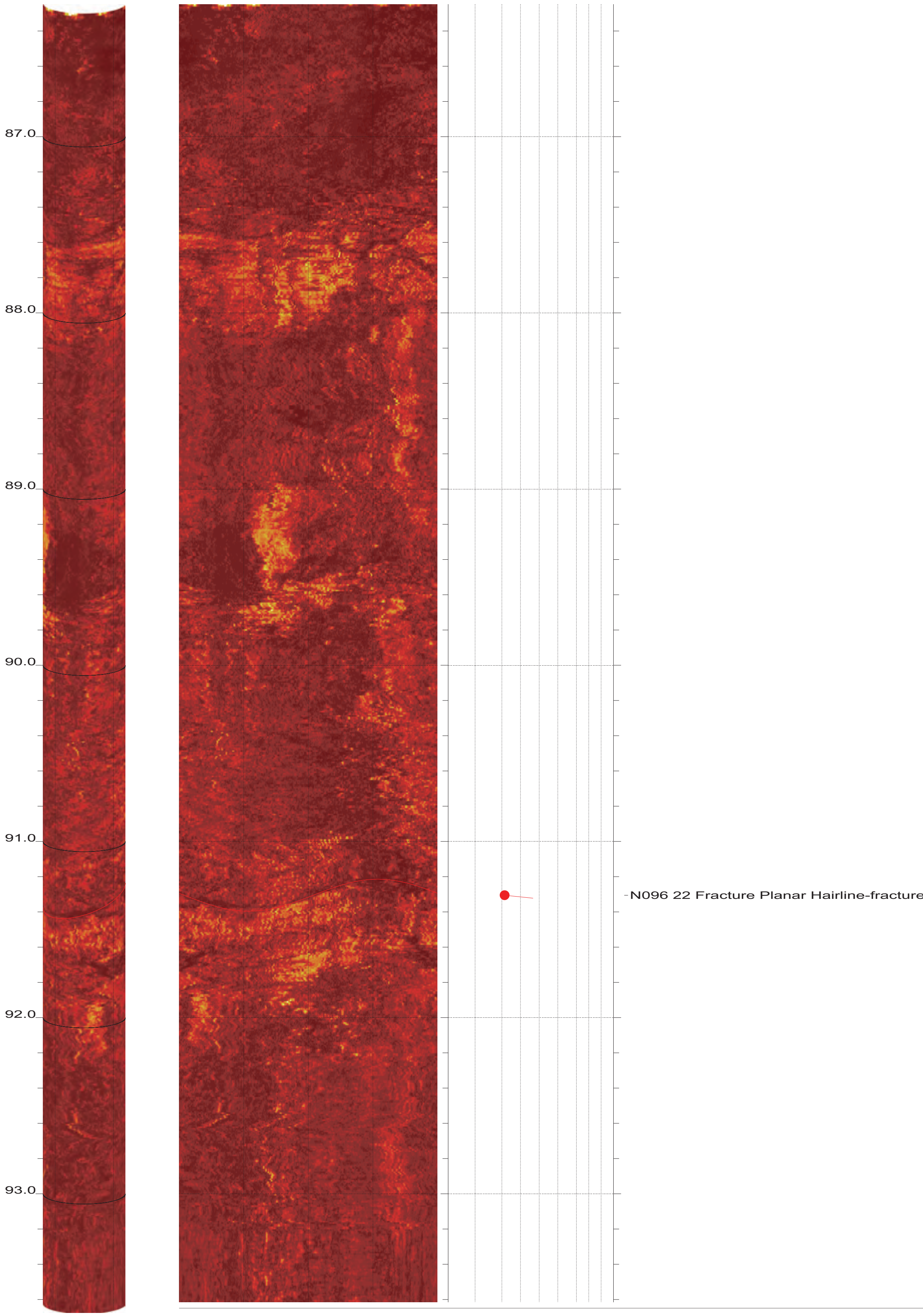
Zone from 300.600 to 82.400ft
Format: BHTV-NESWN

Borehole diam: 5.600inch
Vertical = borehole-axis
Image: Amplitude



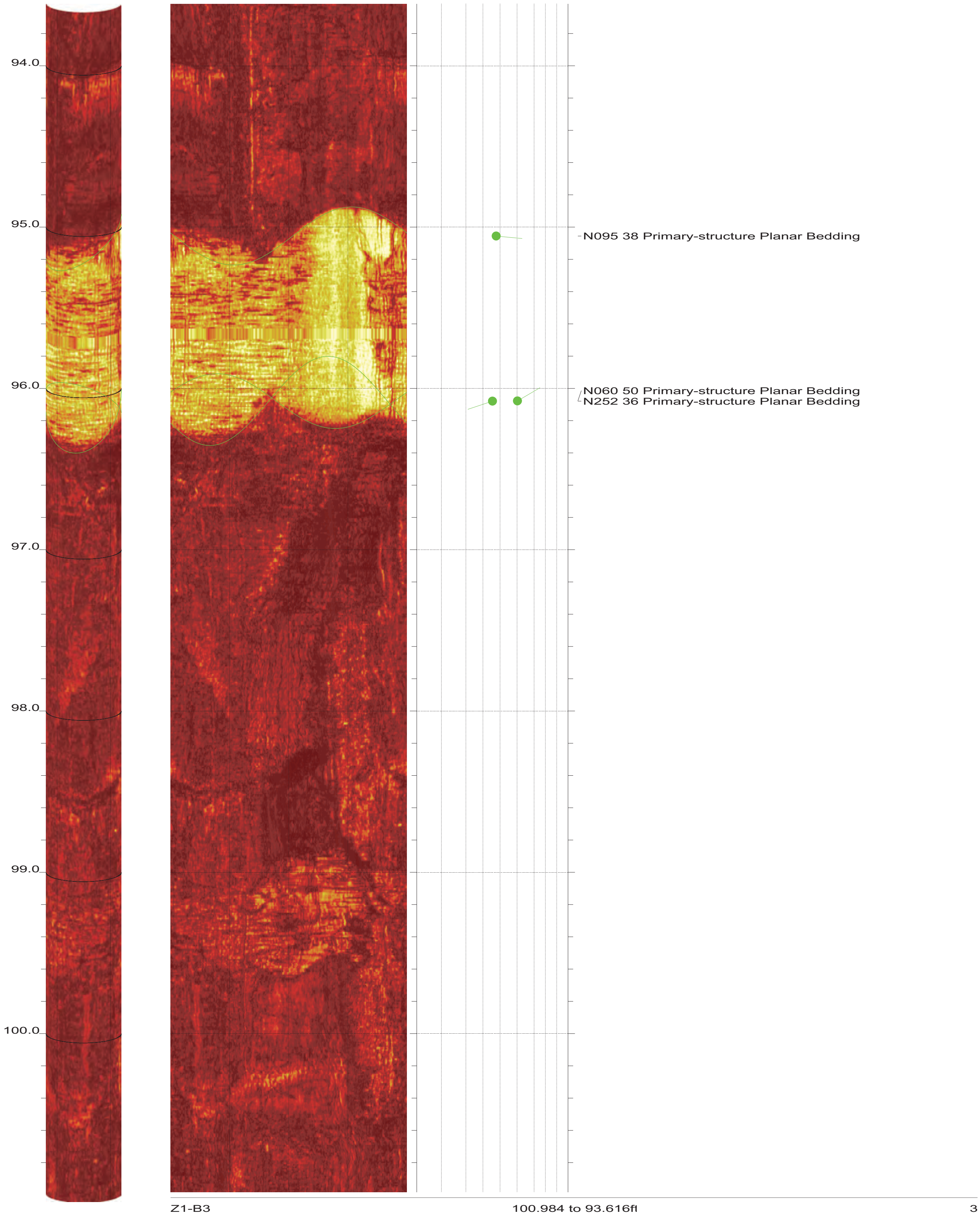
Z1-B3 86.248 to 82.400ft 1

SR-710 Boring Z1-B3 Acoustic Televiewer Dips rev 1 Sheet 1 of 31

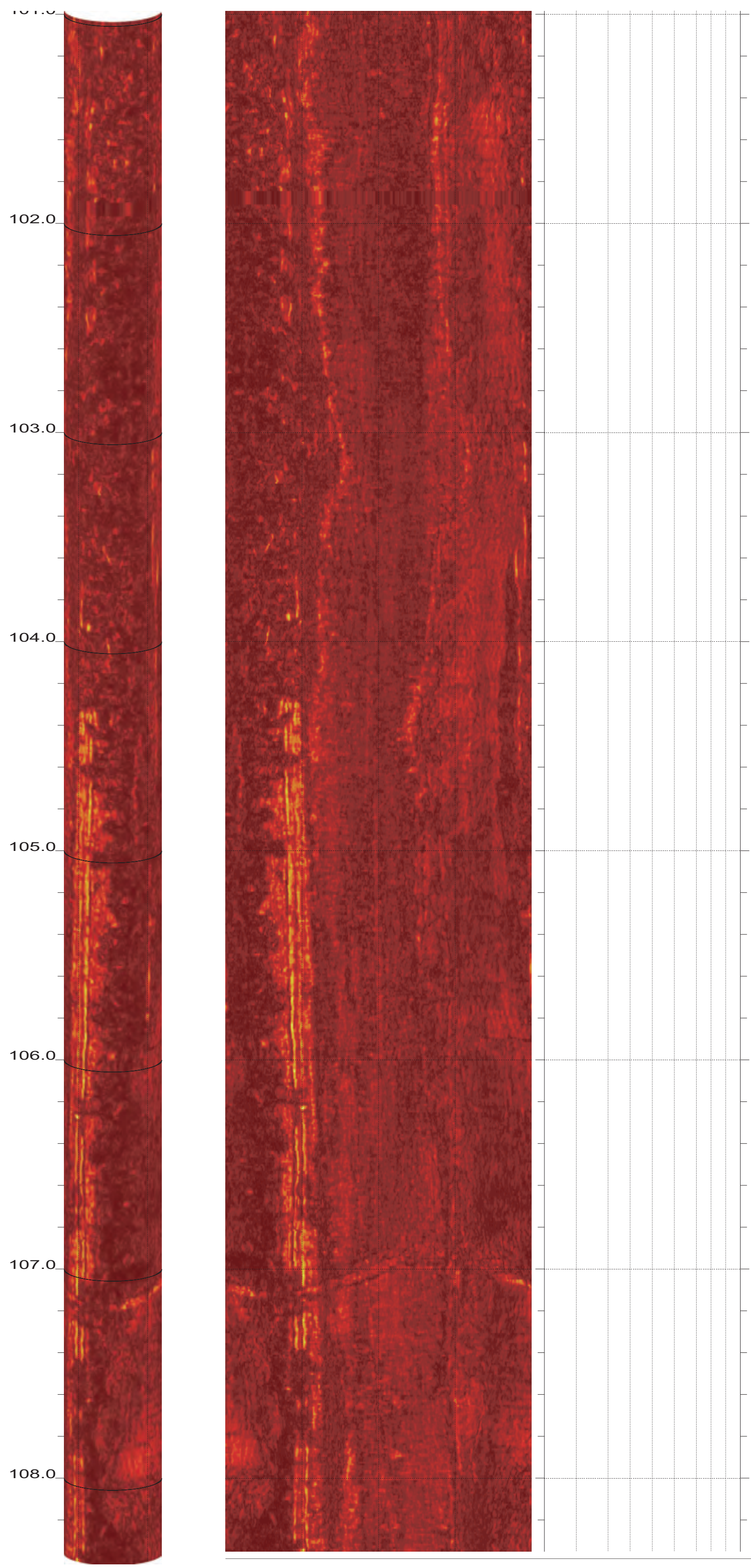


Z1-B3 93.616 to 86.248ft 2

SR-710 Boring Z1-B3 Acoustic Televiewer Dips rev 1 Sheet 2 of 31

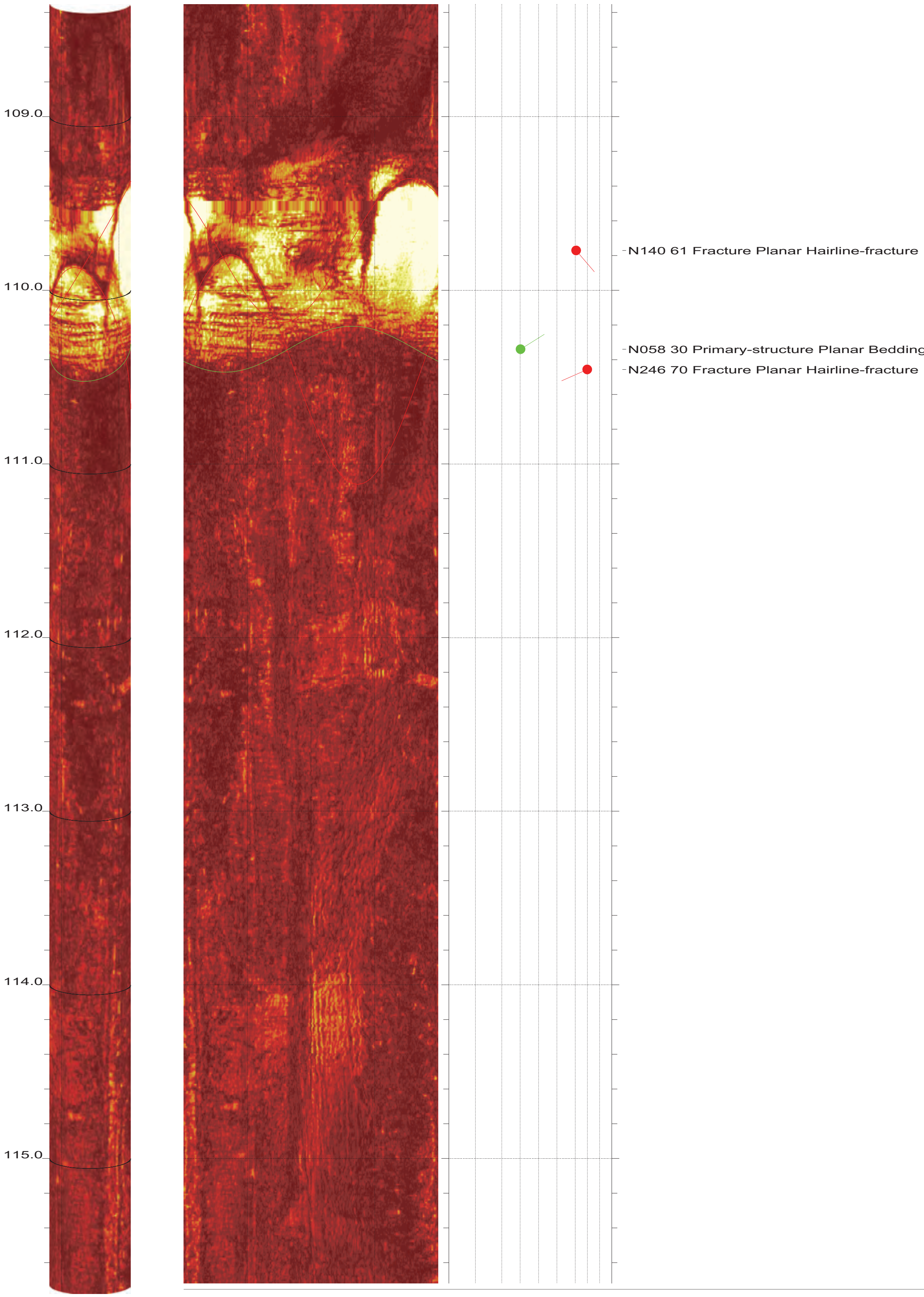


SR-710 Boring Z1-B3 Acoustic Televiewer Dips rev 1 Sheet 3 of 31



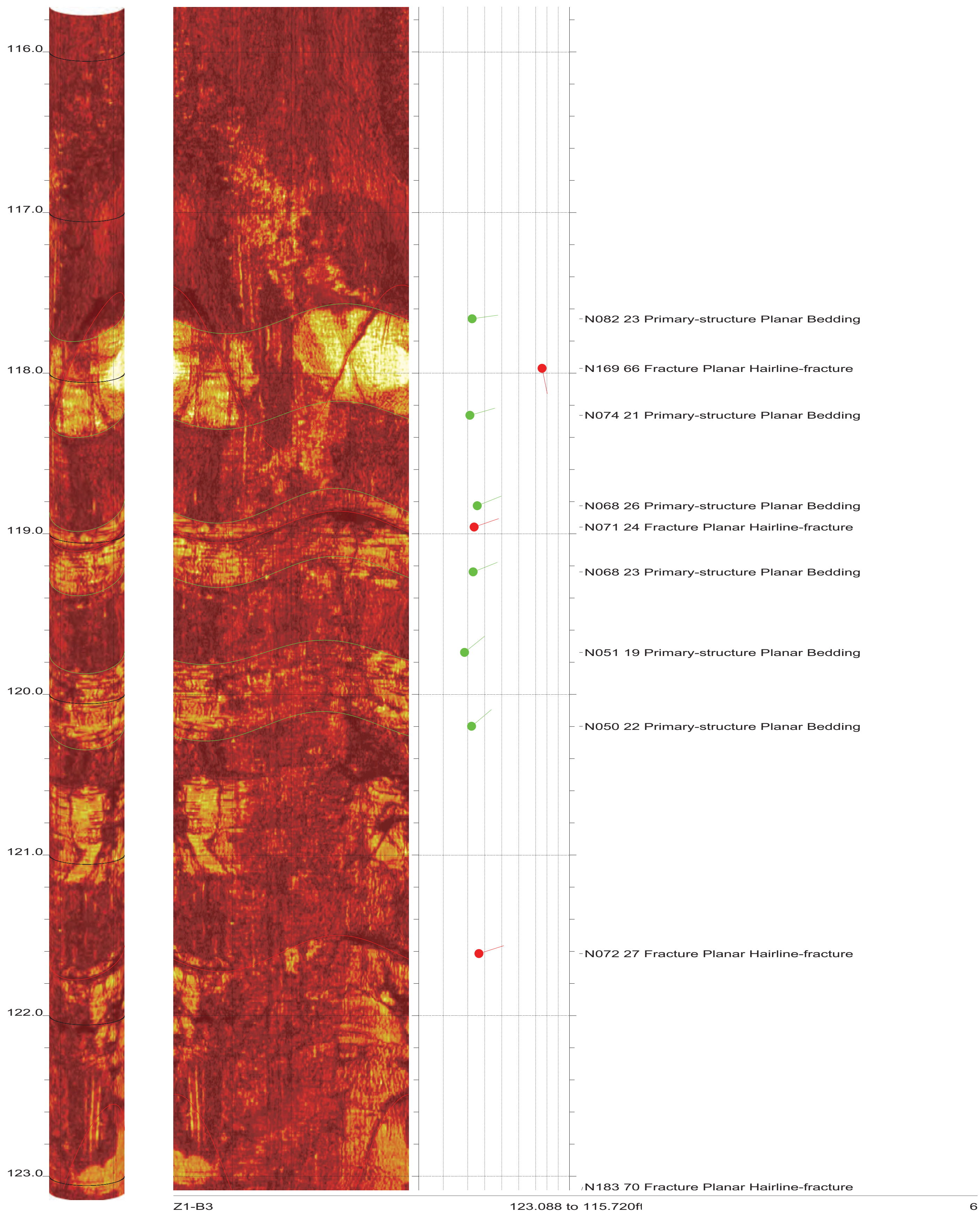
Z1-B3 108.352 to 100.984ft 4

SR-710 Boring Z1-B3 Acoustic Televiewer Dips rev 1 Sheet 4 of 31

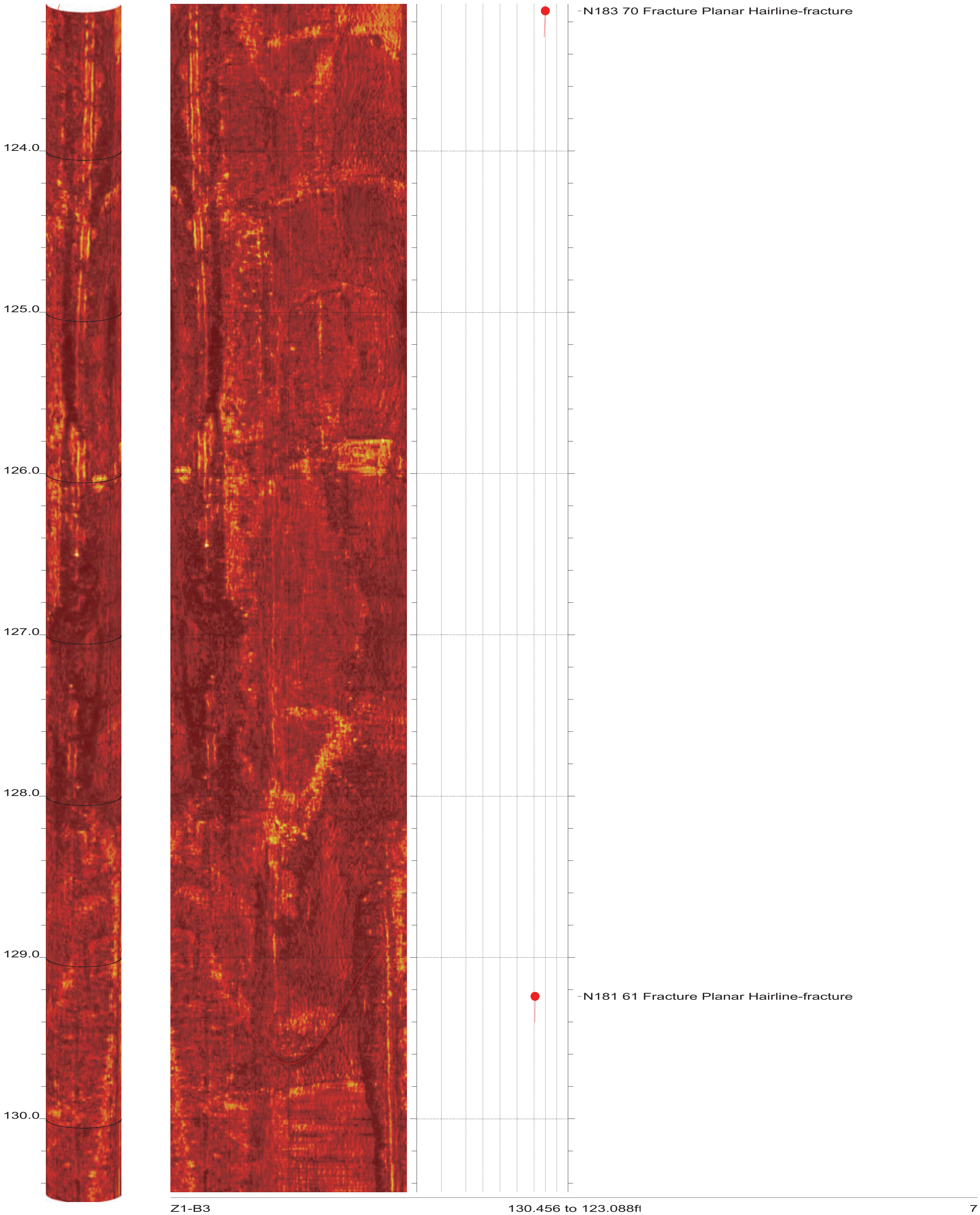


Z1-B3 115.720 to 108.352ft 5

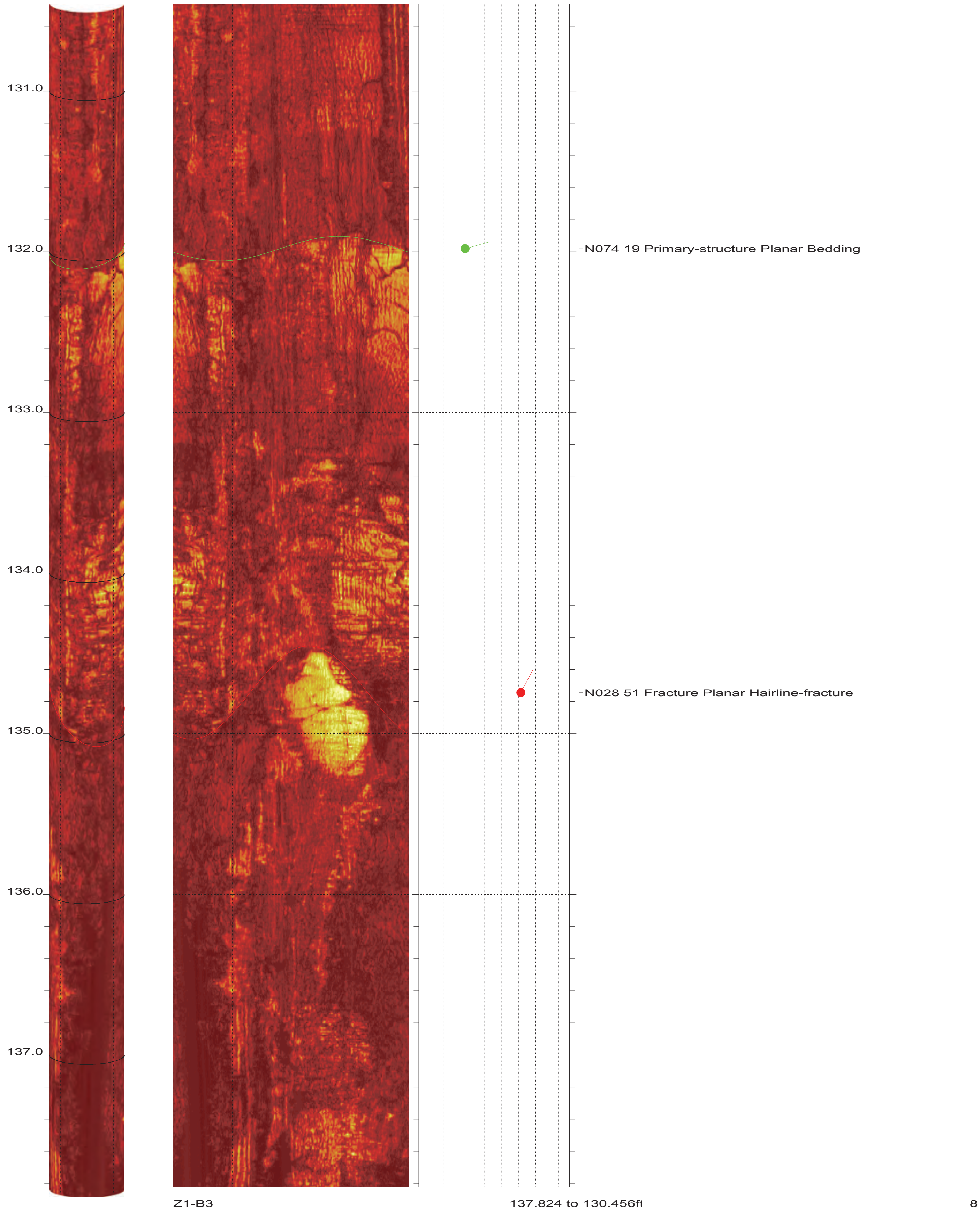
SR-710 Boring Z1-B3 Acoustic Televiewer Dips rev 1 Sheet 5 of 31



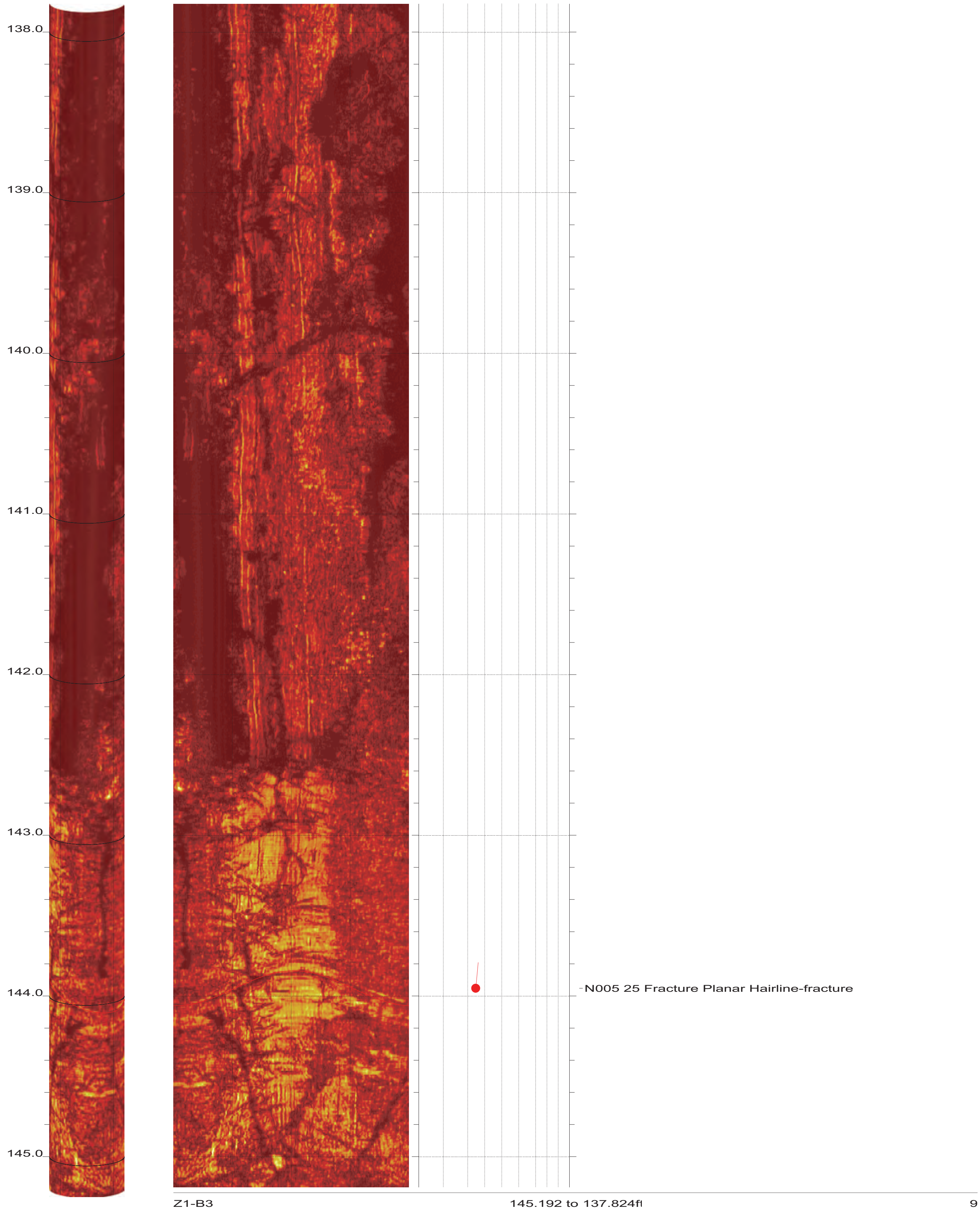
SR-710 Boring Z1-B3 Acoustic Televiewer Dips rev 1 Sheet 6 of 31



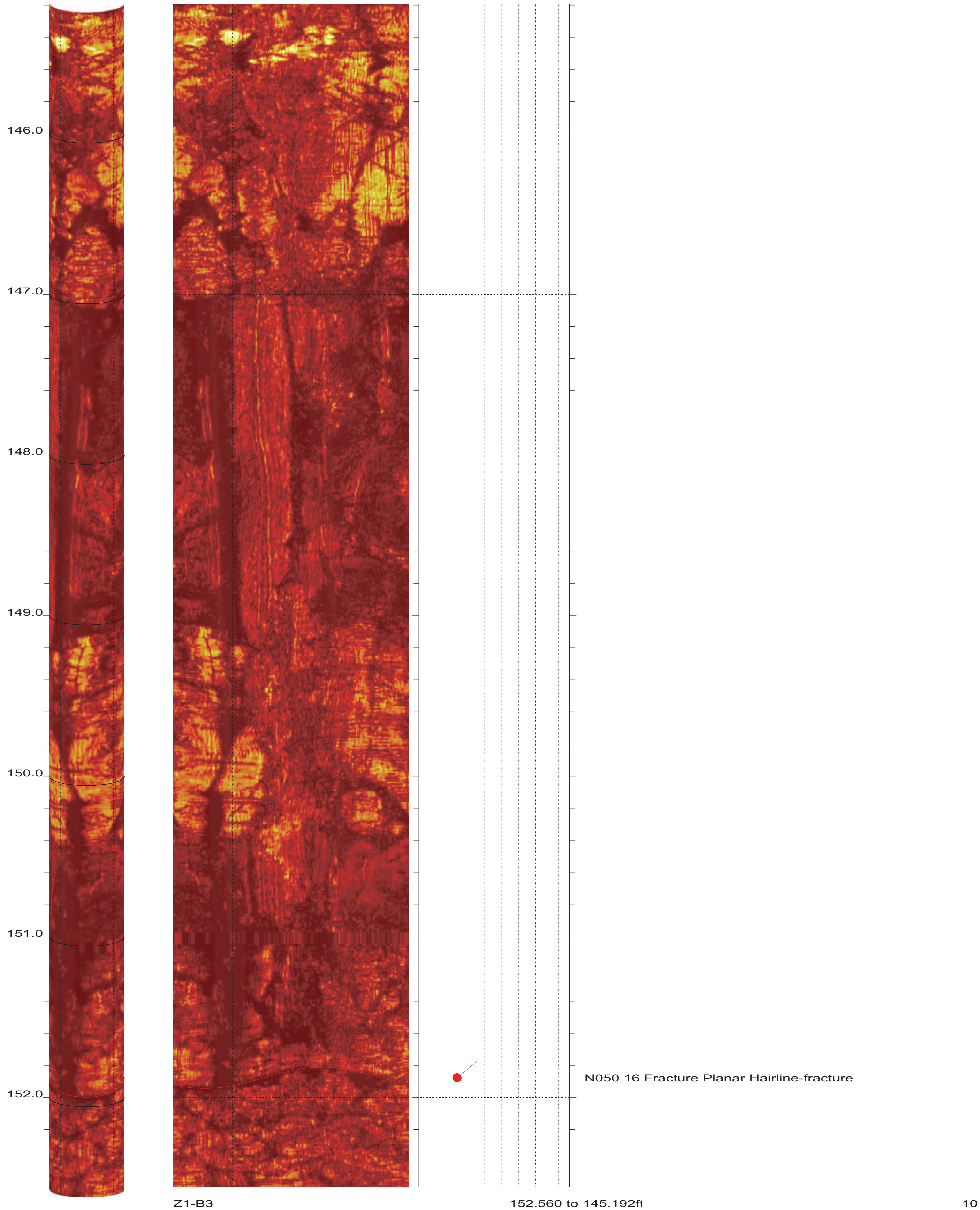
SR-710 Boring Z1-B3 Acoustic Televiewer Dips rev 1 Sheet 7 of 31



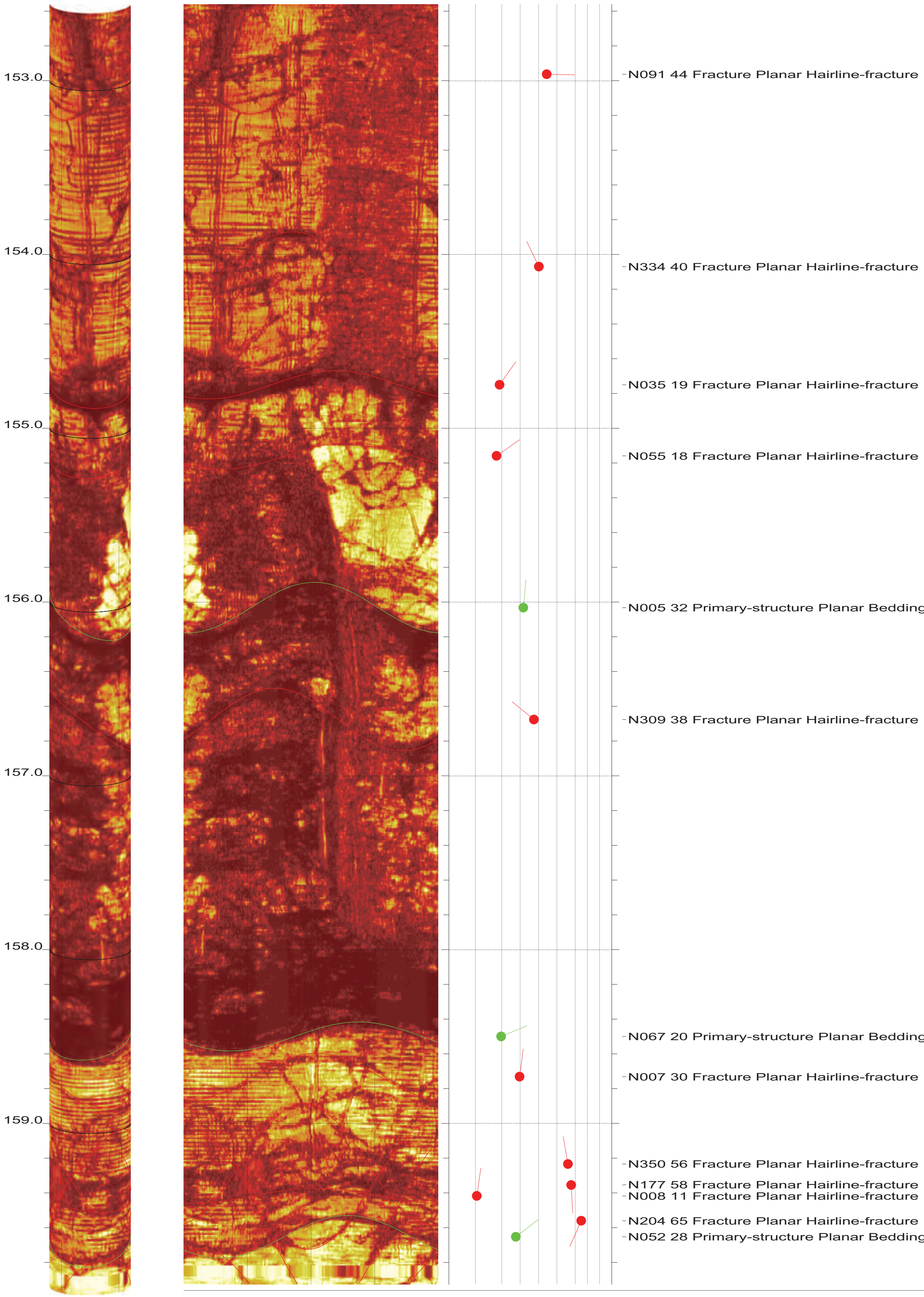
SR-710 Boring Z1-B3 Acoustic Televiewer Dips rev 1 Sheet 8 of 31



SR-710 Boring Z1-B3 Acoustic Televiewer Dips rev 1 Sheet 9 of 31

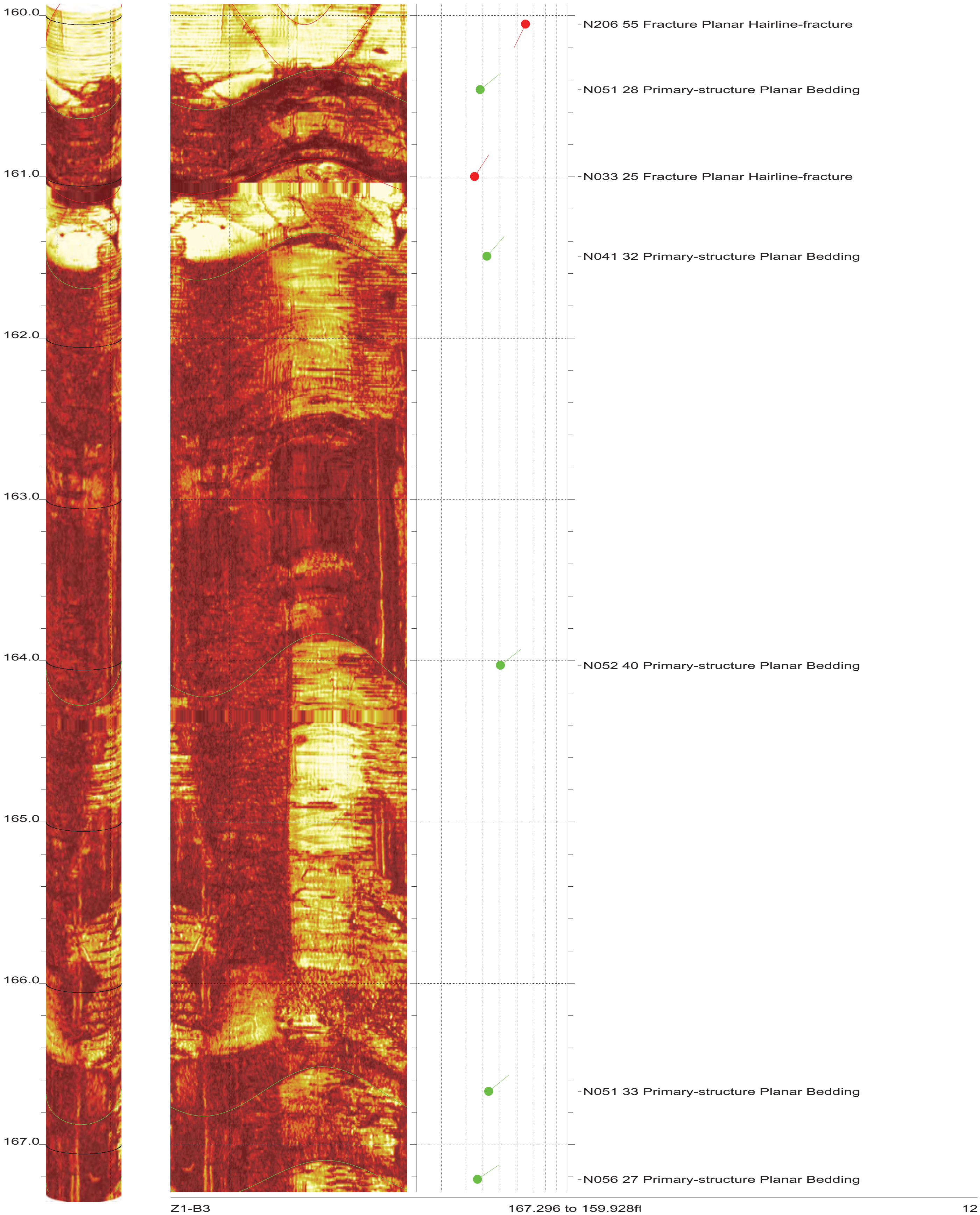


SR-710 Boring Z1-B3 Acoustic Televiewer Dips rev 1 Sheet 10 of 31

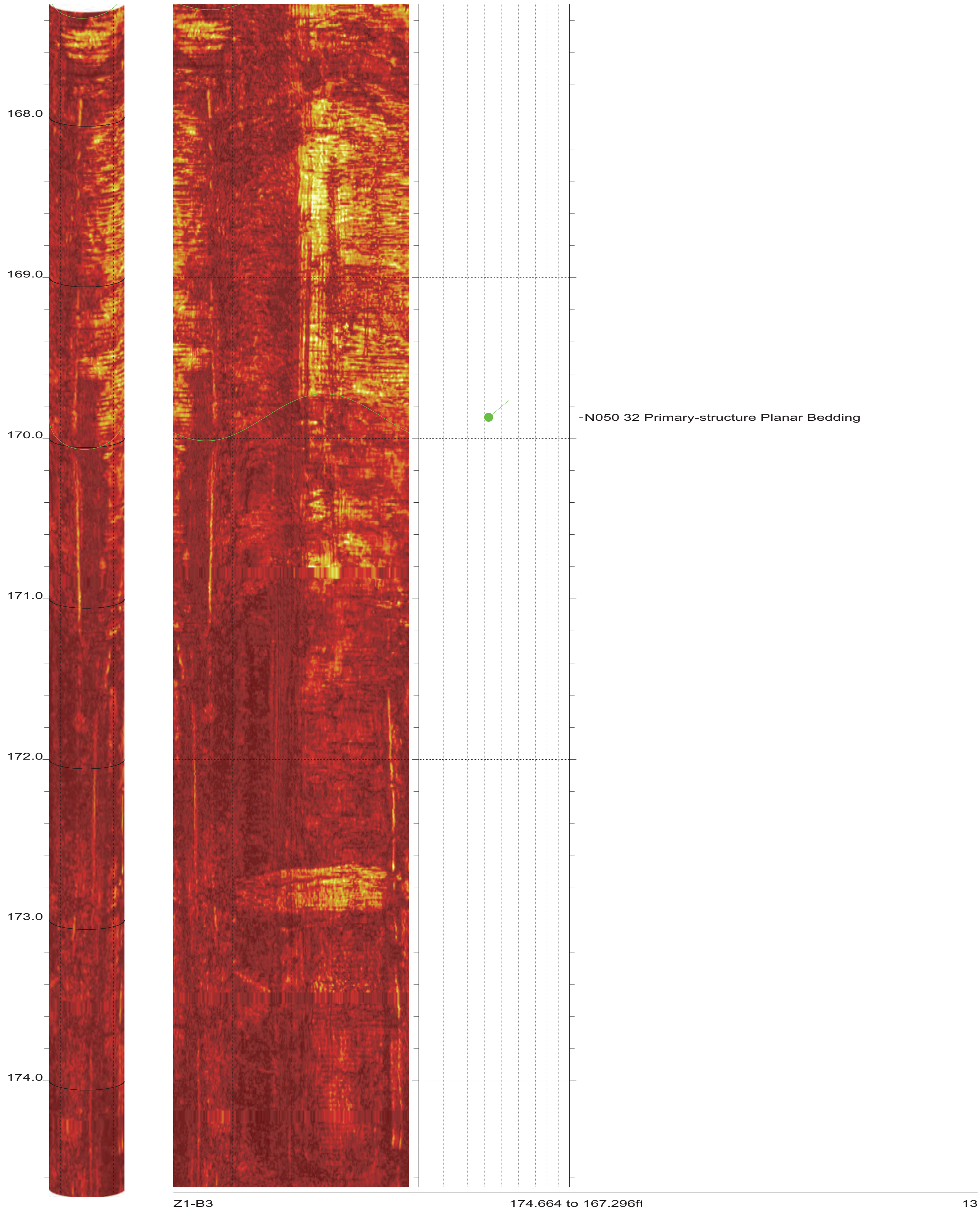


Z1-B3 159.928 to 152.560ft 11

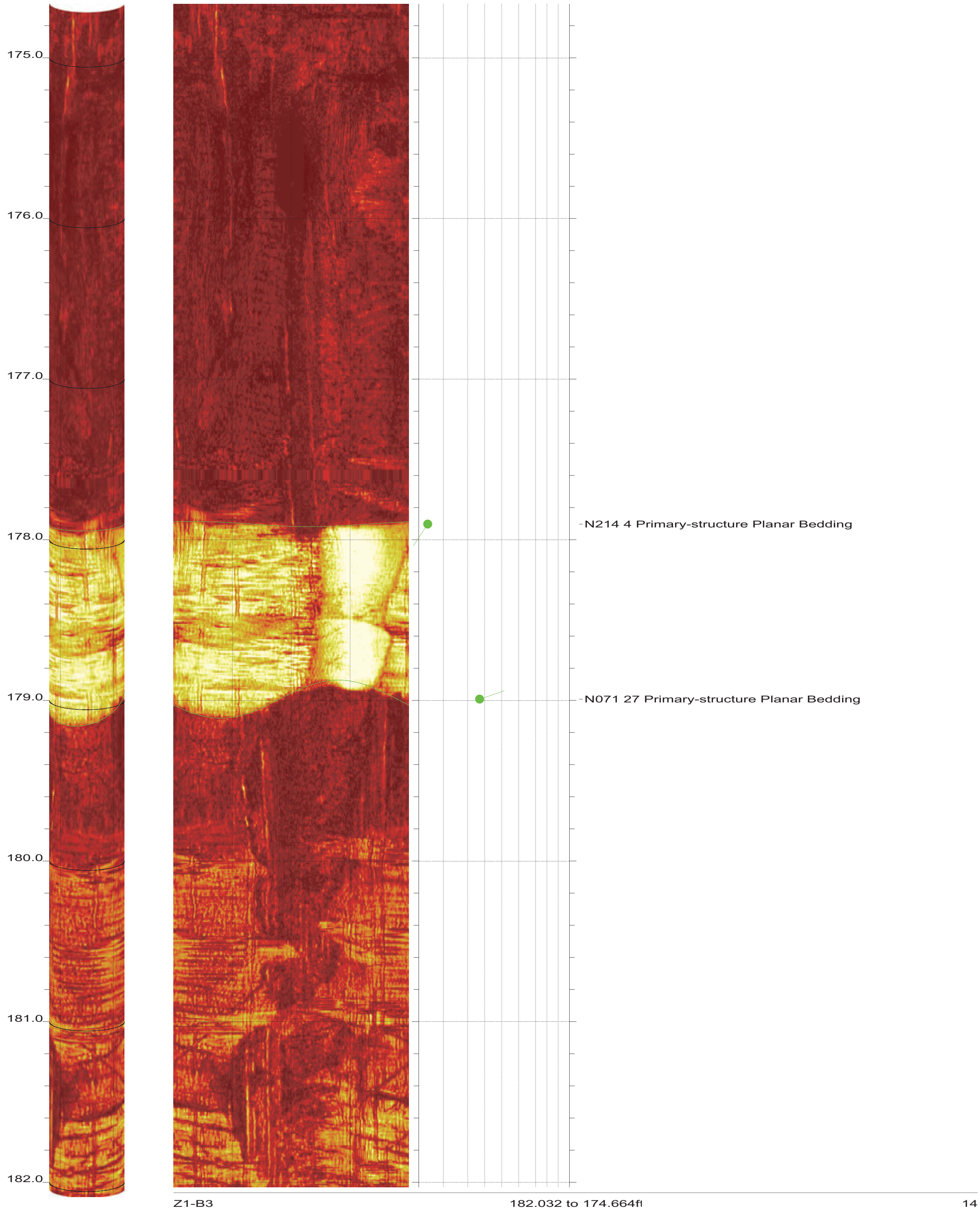
SR-710 Boring Z1-B3 Acoustic Televiewer Dips rev 1 Sheet 11 of 31



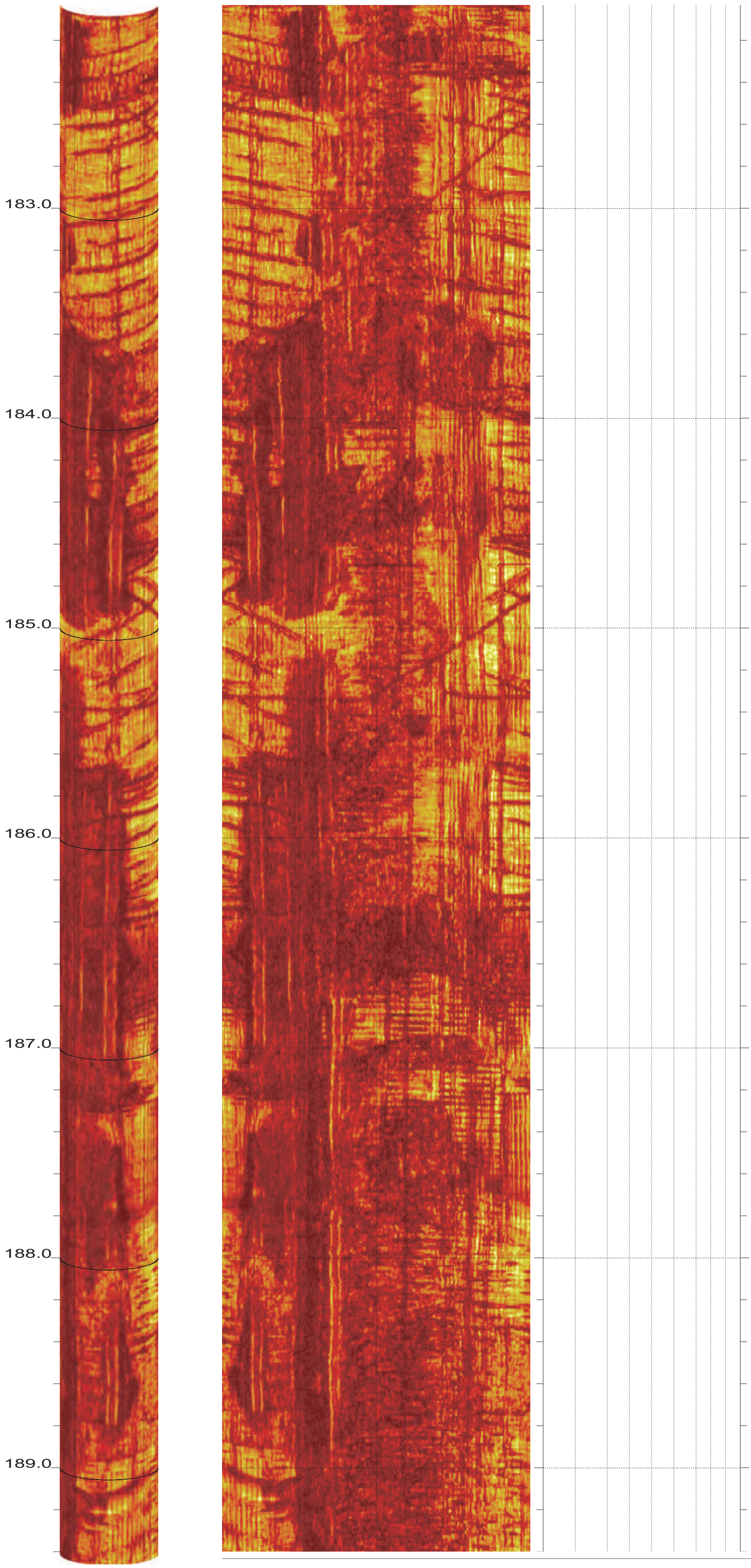
SR-710 Boring Z1-B3 Acoustic Televiewer Dips rev 1 Sheet 12 of 31



SR-710 Boring Z1-B3 Acoustic Televiewer Dips rev 1 Sheet 13 of 31

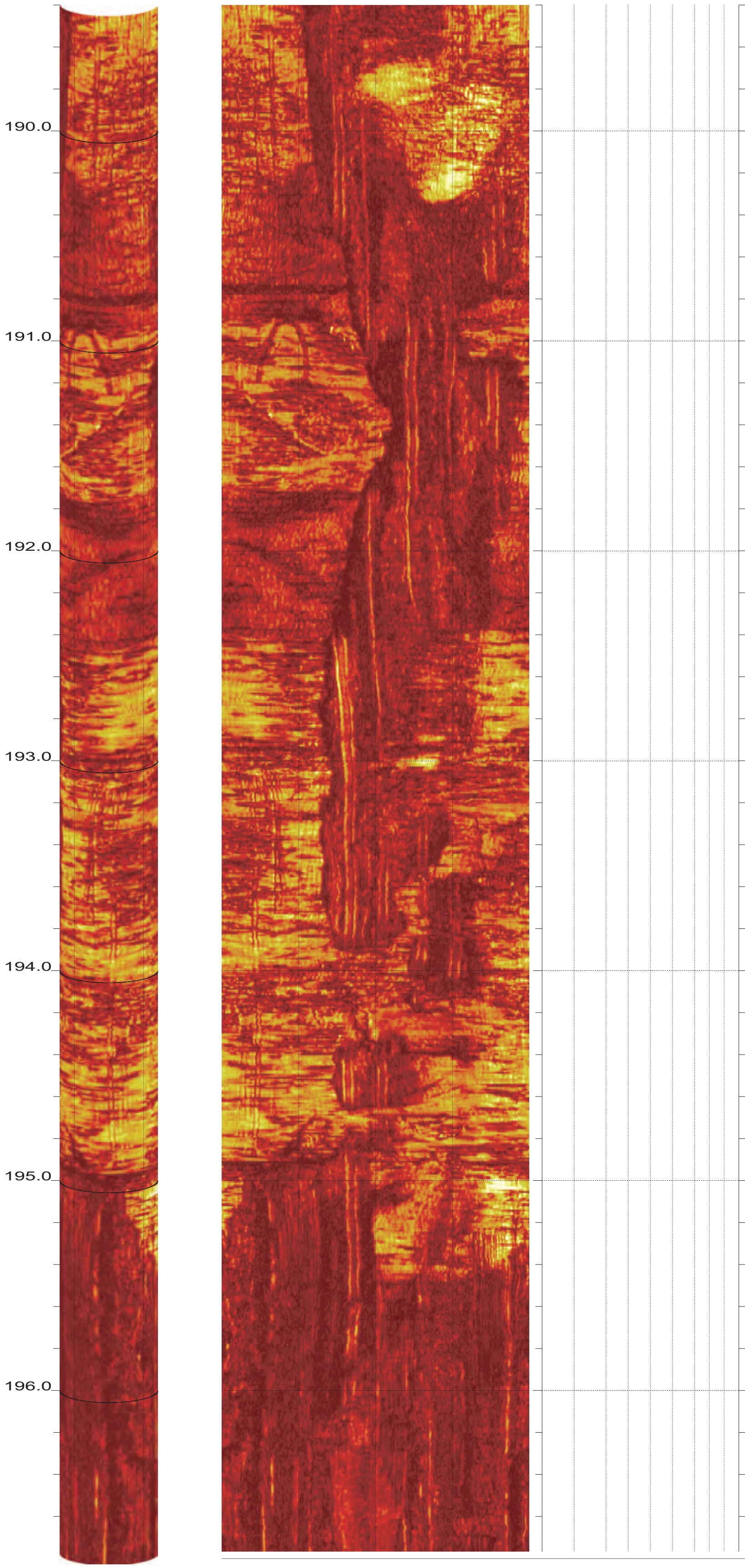


SR-710 Boring Z1-B3 Acoustic Televiewer Dips rev 1 Sheet 14 of 31



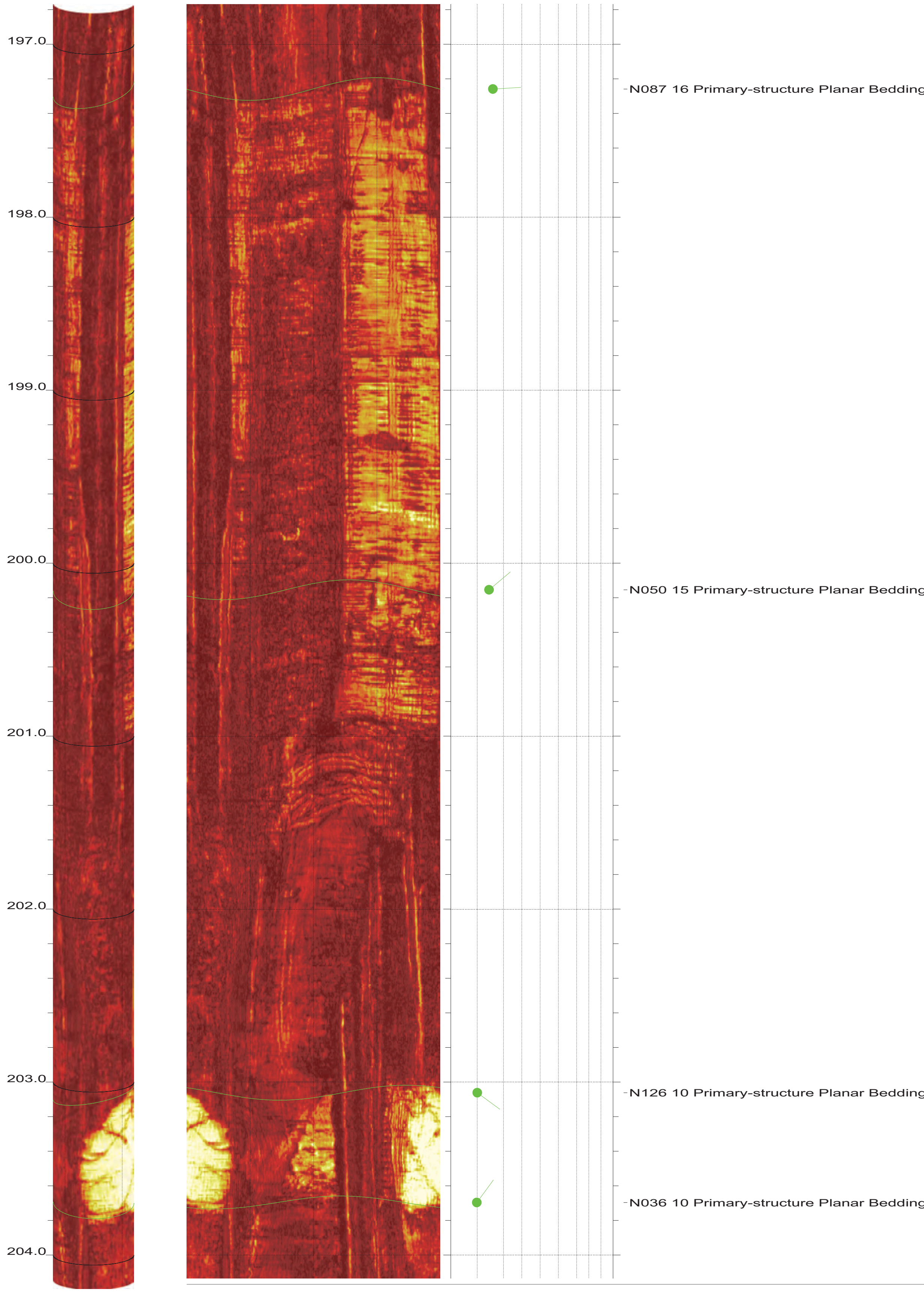
Z1-B3 189.400 to 182.032ft 15

SR-710 Boring Z1-B3 Acoustic Televiewer Dips rev 1 Sheet 15 of 31



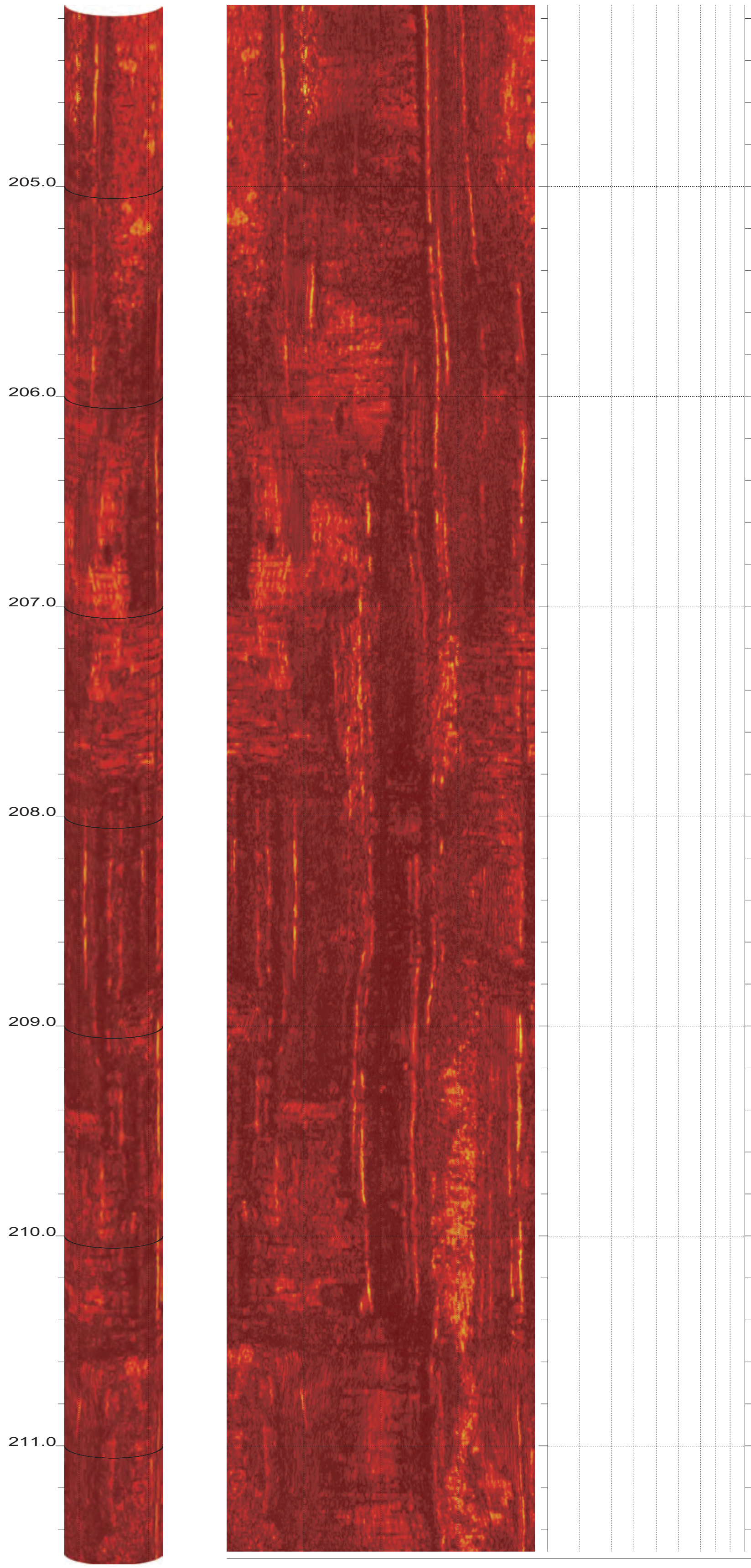
Z1-B3 196.768 to 189.400ft 16

SR-710 Boring Z1-B3 Acoustic Televiewer Dips rev 1 Sheet 16 of 31



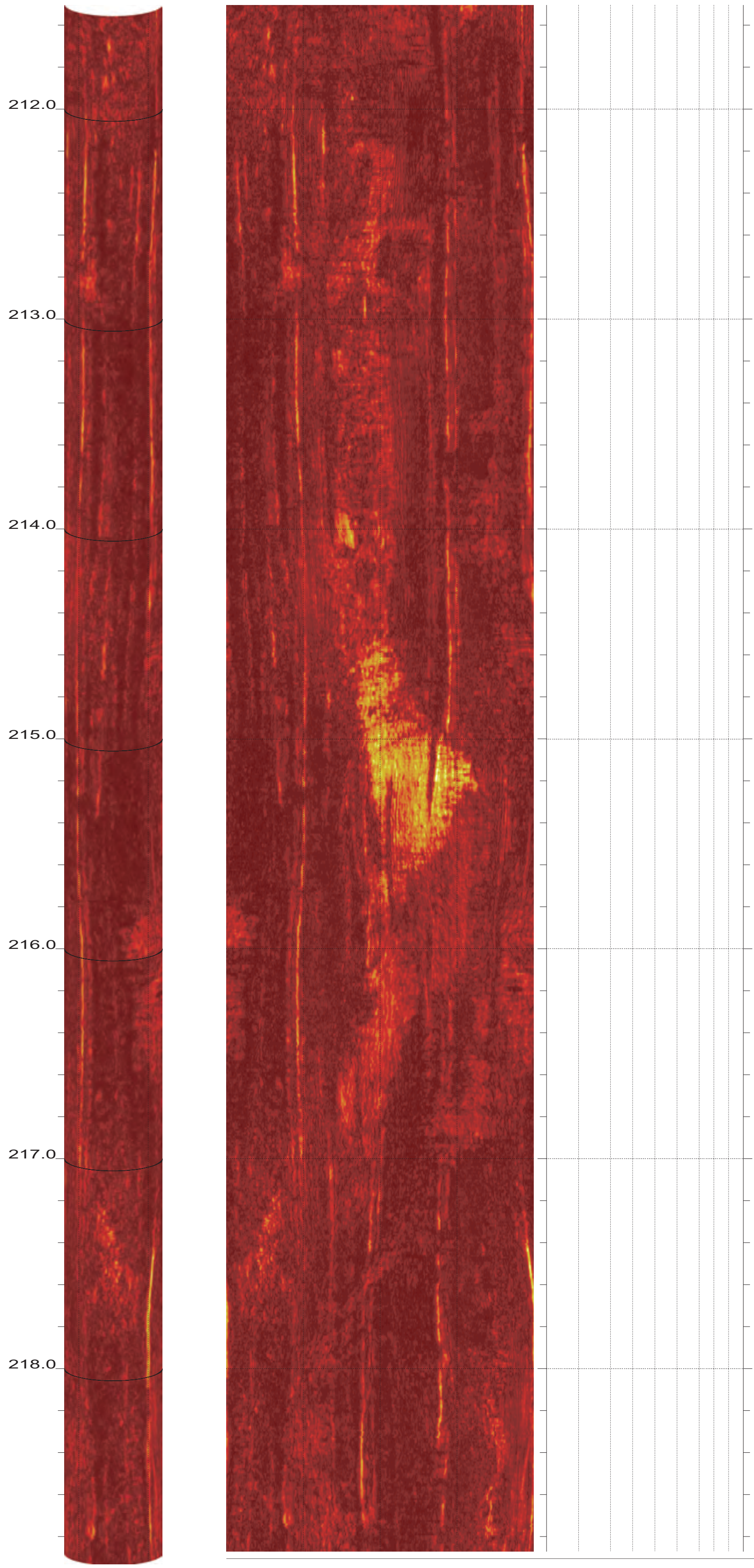
Z1-B3 204.136 to 196.768ft 17

SR-710 Boring Z1-B3 Acoustic Televiewer Dips rev 1 Sheet 17 of 31



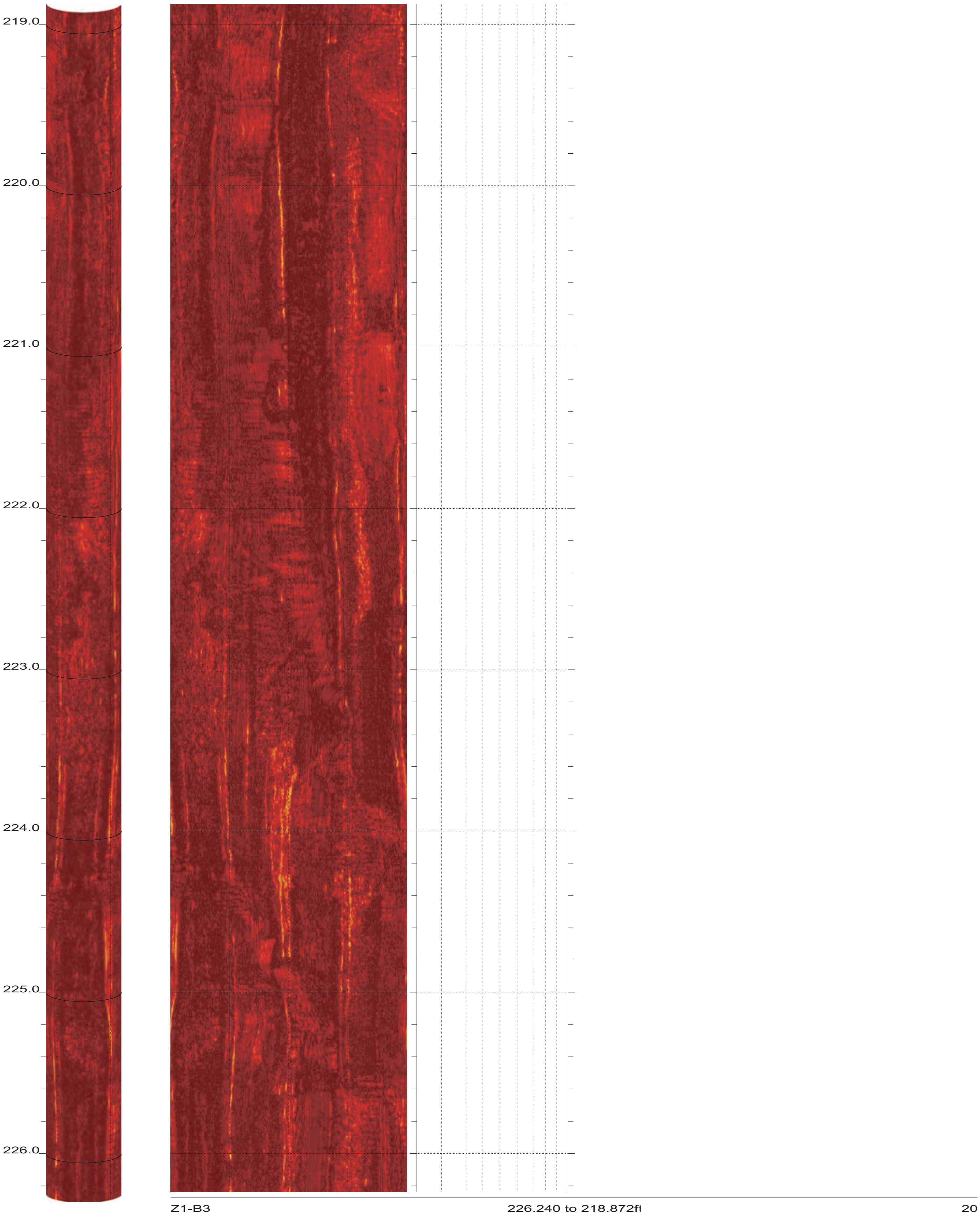
Z1-B3 211.504 to 204.136ft 18

SR-710 Boring Z1-B3 Acoustic Televiewer Dips rev 1 Sheet 18 of 31

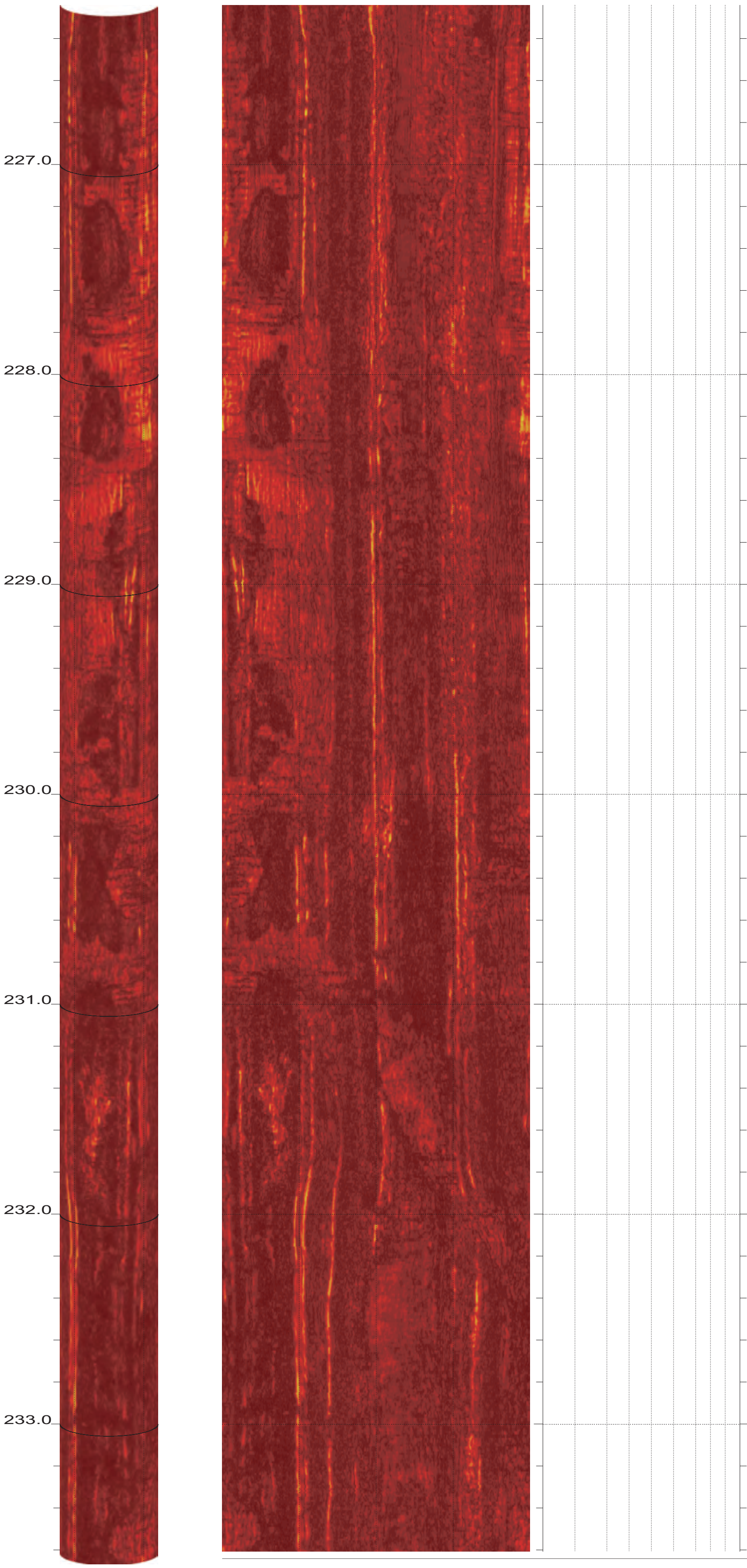


Z1-B3 218.872 to 211.504ft 19

SR-710 Boring Z1-B3 Acoustic Televiewer Dips rev 1 Sheet 19 of 31

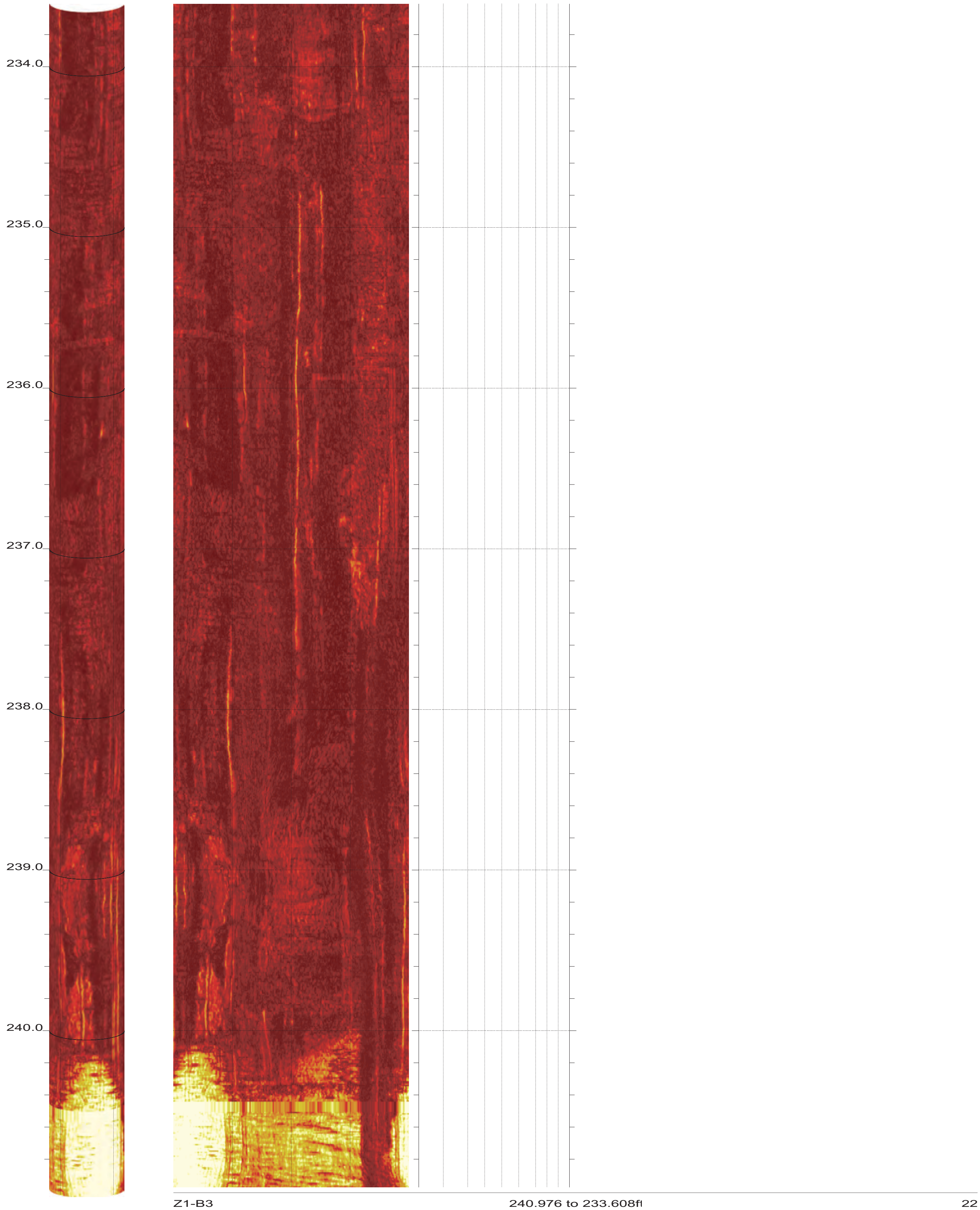


SR-710 Boring Z1-B3 Acoustic Televiewer Dips rev 1 Sheet 20 of 31

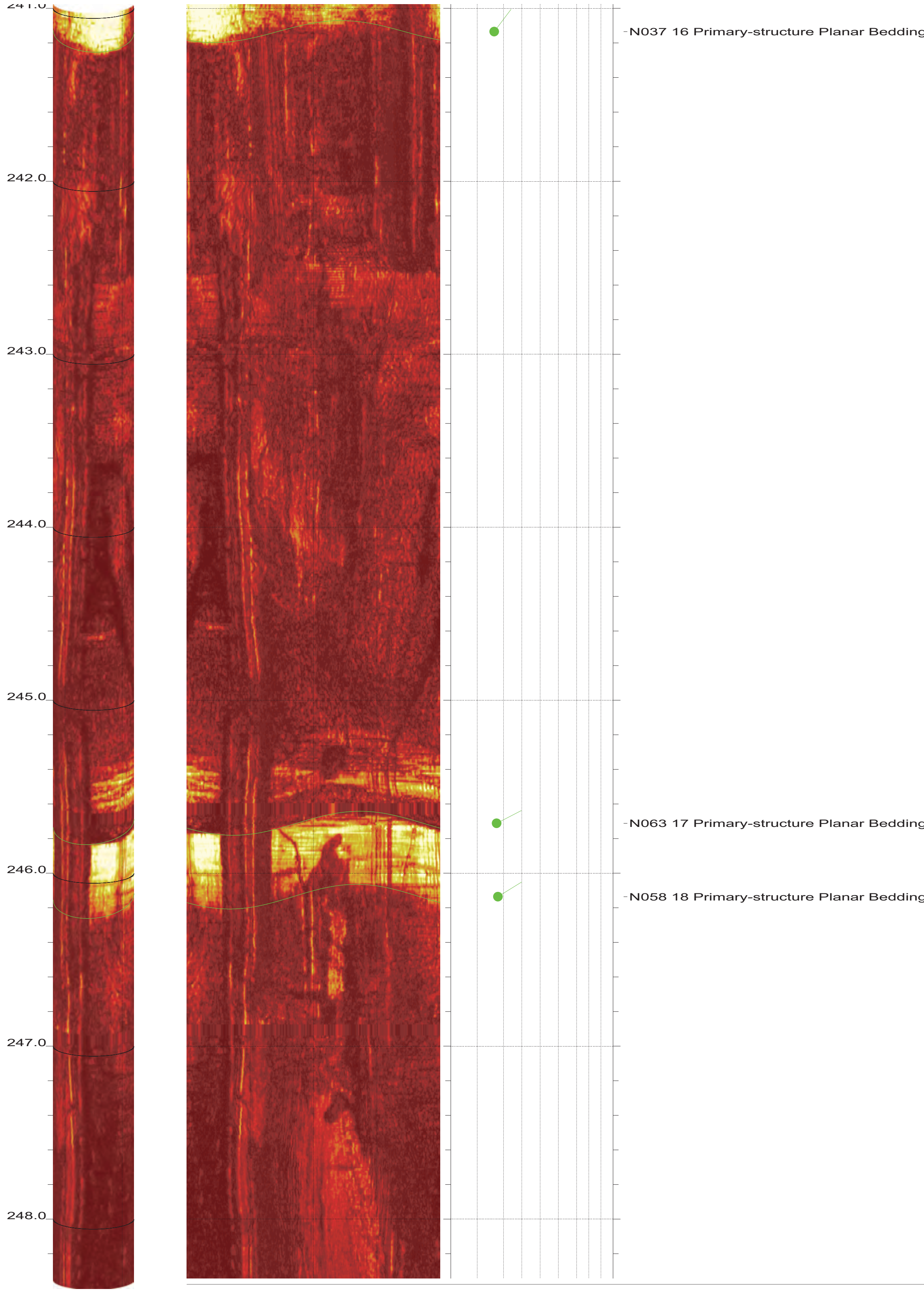


Z1-B3 233.608 to 226.240ft 21

SR-710 Boring Z1-B3 Acoustic Televiewer Dips rev 1 Sheet 21 of 31

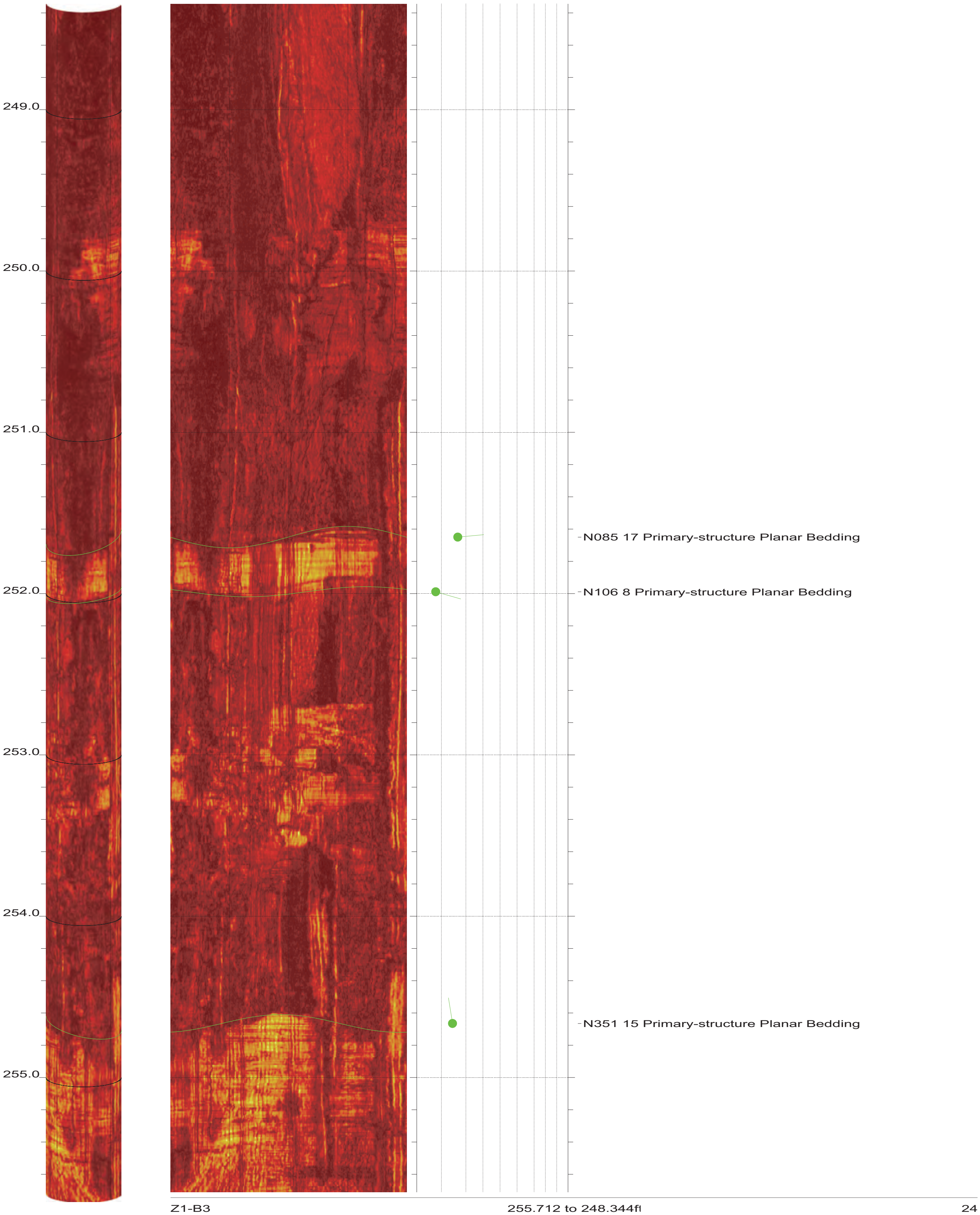


SR-710 Boring Z1-B3 Acoustic Televiewer Dips rev 1 Sheet 22 of 31

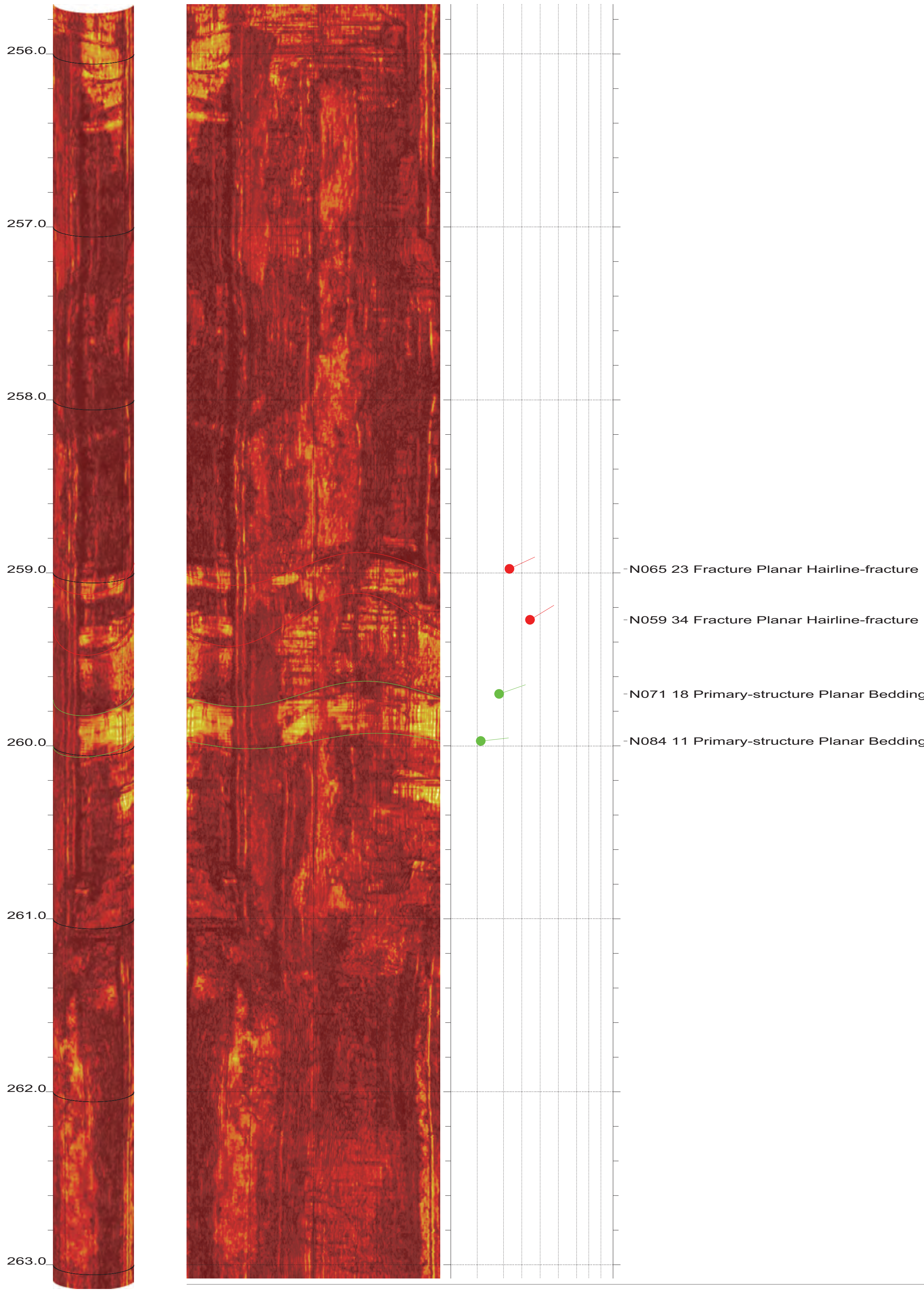


Z1-B3 248.344 to 240.976ft 23

SR-710 Boring Z1-B3 Acoustic Televiewer Dips rev 1 Sheet 23 of 31

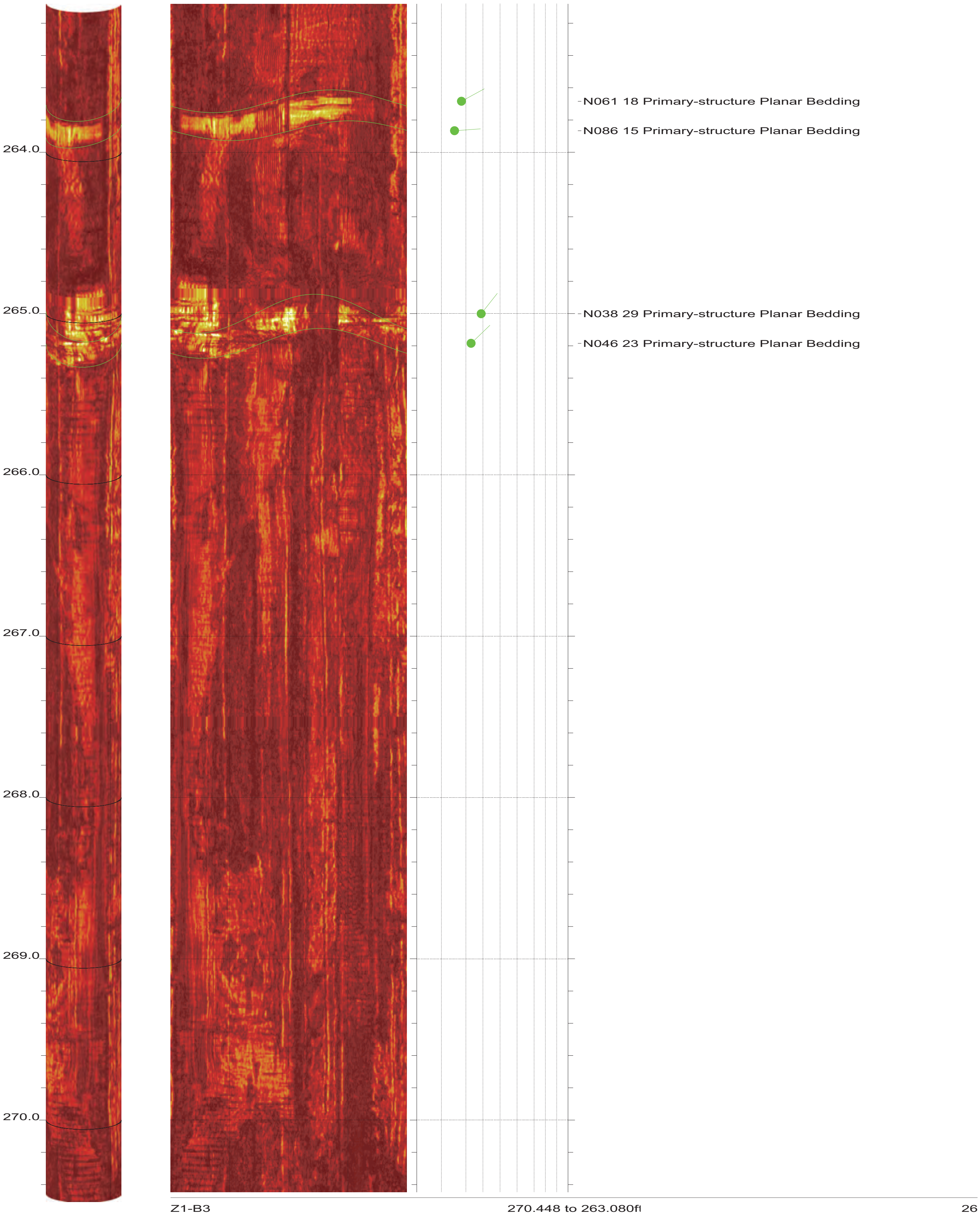


SR-710 Boring Z1-B3 Acoustic Televiewer Dips rev 1 Sheet 24 of 31

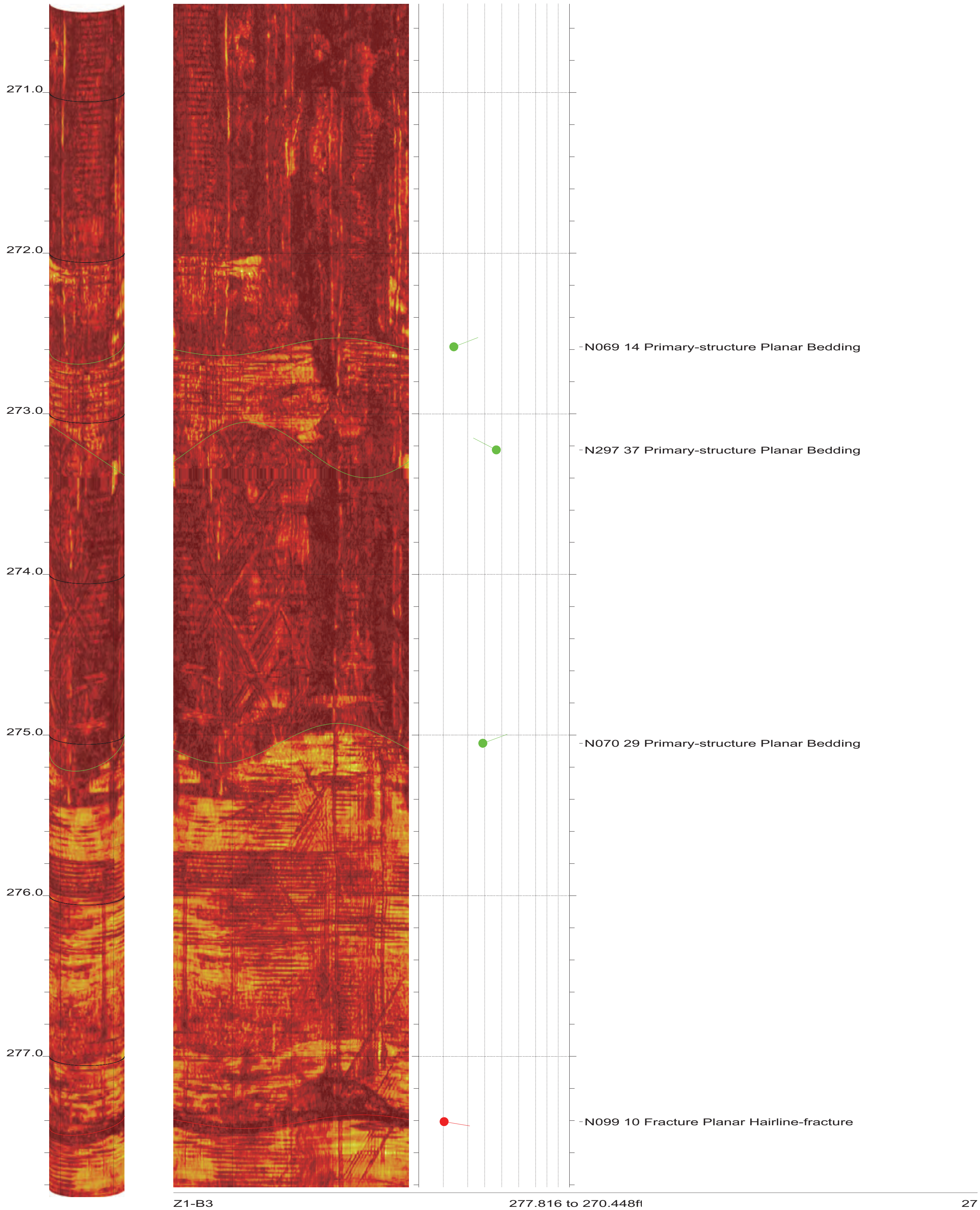


Z1-B3 263.080 to 255.712ft 25

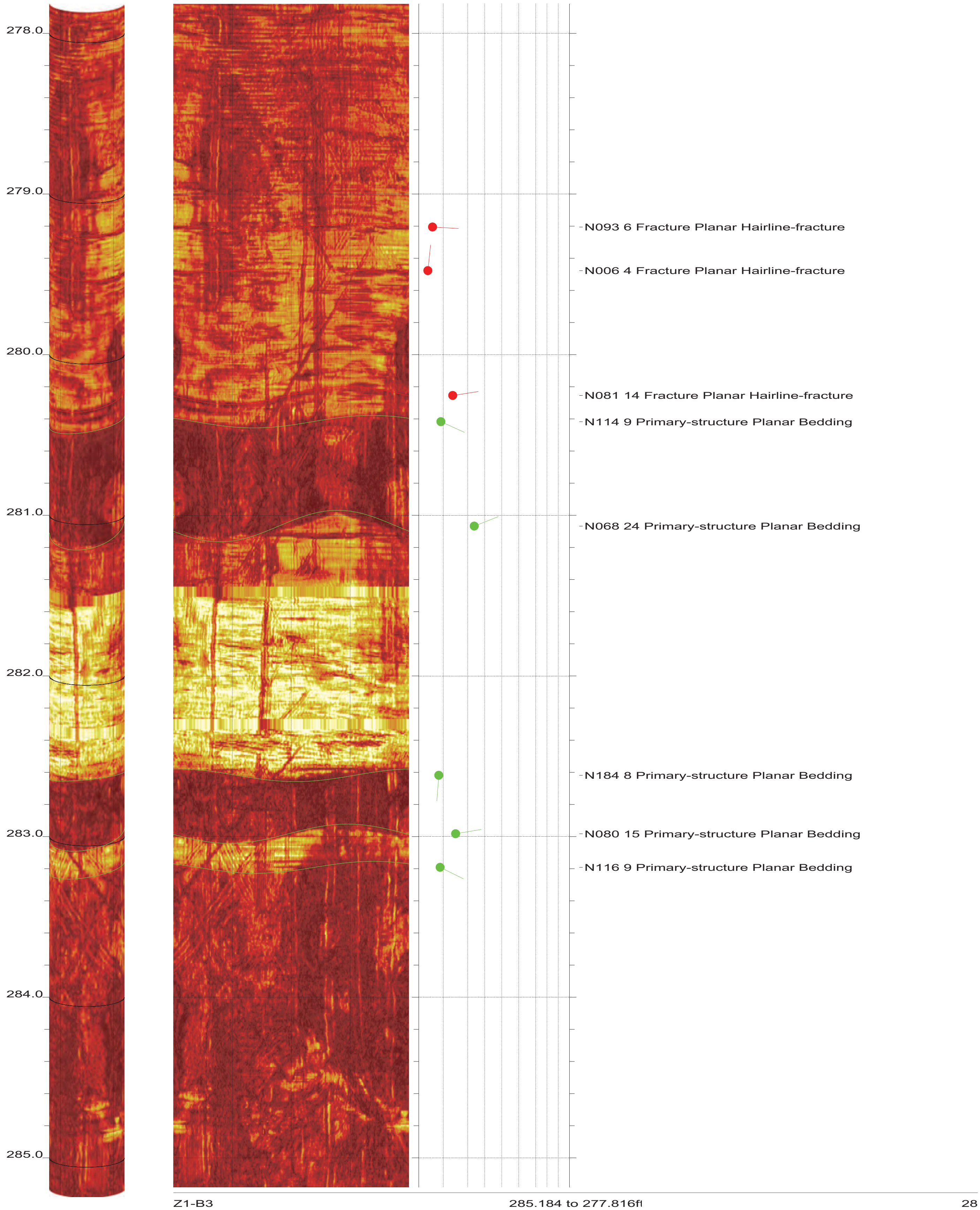
SR-710 Boring Z1-B3 Acoustic Televiewer Dips rev 1 Sheet 25 of 31



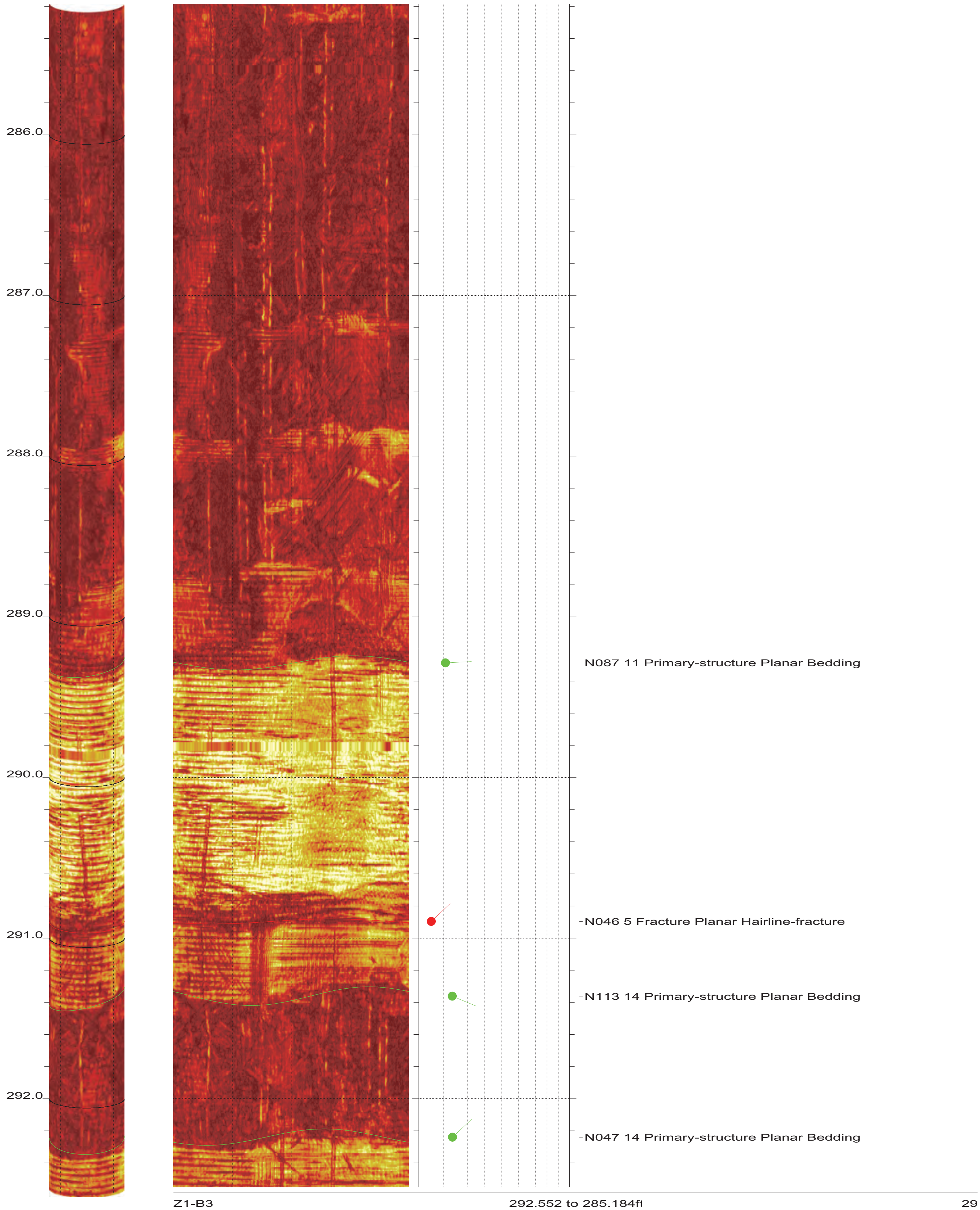
SR-710 Boring Z1-B3 Acoustic Televiewer Dips rev 1 Sheet 26 of 31



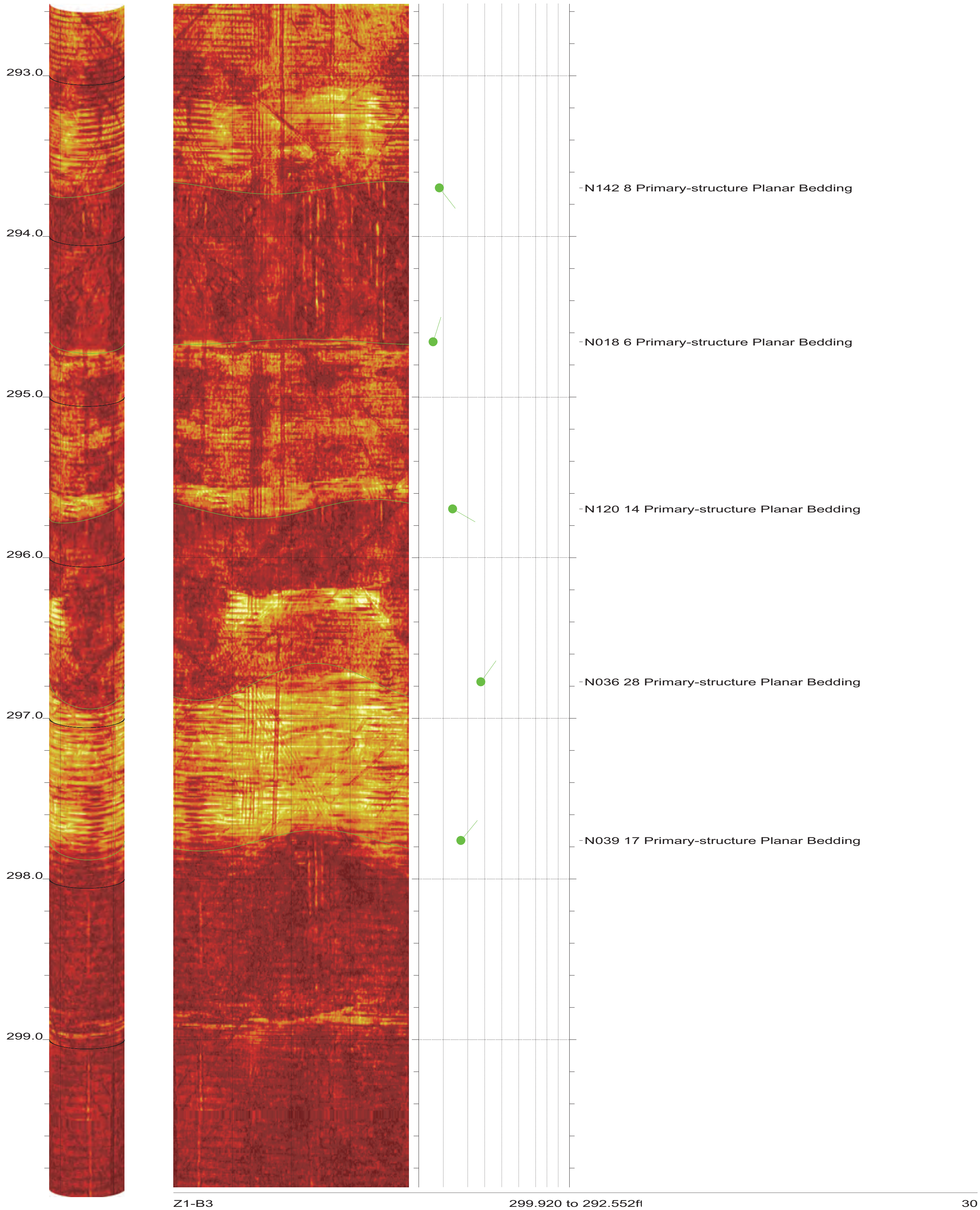
SR-710 Boring Z1-B3 Acoustic Televiewer Dips rev 1 Sheet 27 of 31



SR-710 Boring Z1-B3 Acoustic Televiewer Dips rev 1 Sheet 28 of 31



SR-710 Boring Z1-B3 Acoustic Televiewer Dips rev 1 Sheet 29 of 31



SR-710 Boring Z1-B3 Acoustic Televiewer Dips rev 1 Sheet 30 of 31

300.0

BHTV DATA PROCESSING
RGLDIP vsn 6.2
INTERPRETED BHTV DIPS LOG

CASCADE DRILLING

Borehole: Z1-B5

SR-710 TUNNEL INVESTIGATION

top of borehole.....	North ref. is true
East: _	Depth units are feet
North: _	Vertical scale: 1/10
Elev: _	Horiz scale = 1.00x Vert scale

Zone from 499.200 to 35.200ft	Borehole diam: 5.600inch
Format: BHTV-NESWN	Vertical = borehole-axis
	Image: Amplitude

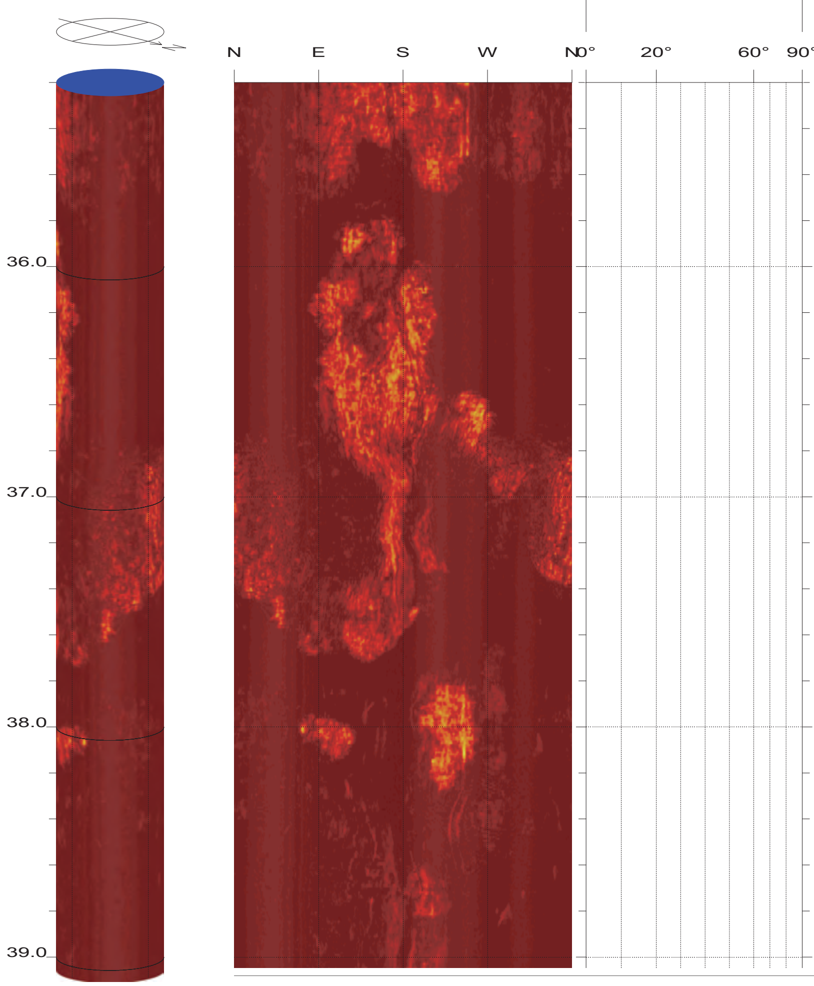
Stratigraphic dips

Non-stratigraphic dips

Identified units

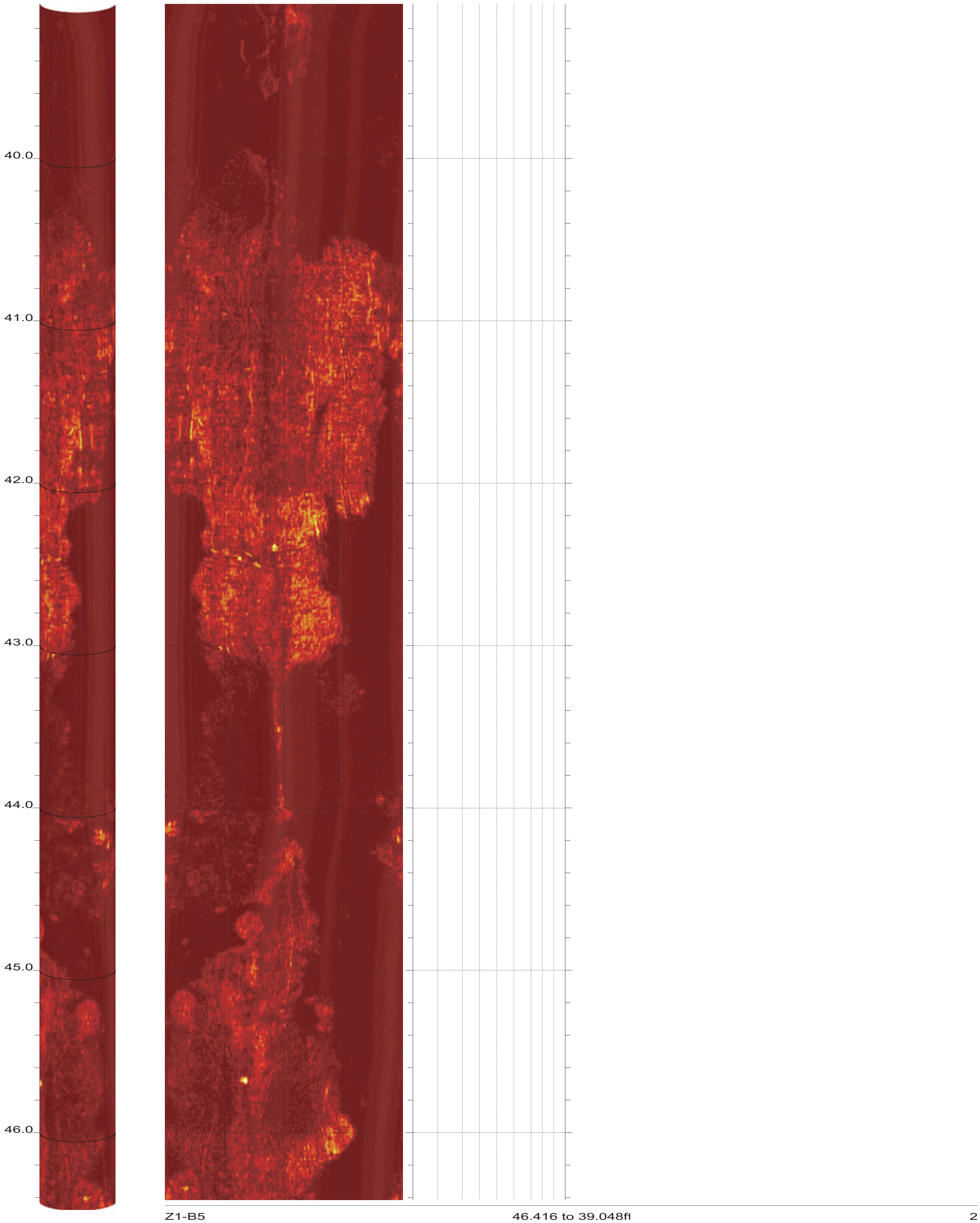
ARROW PLOT

COMMENTS

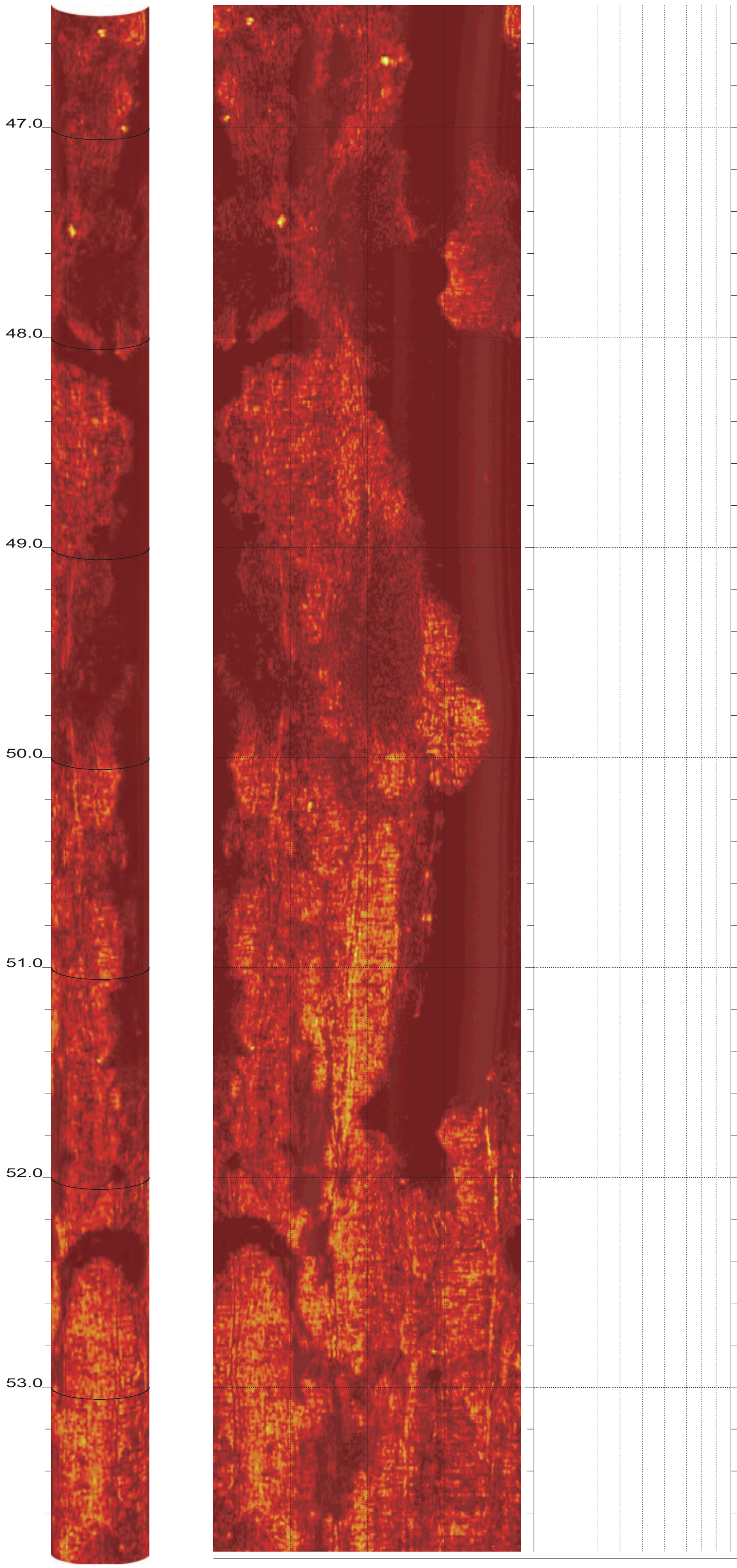


Z1-B5 39.048 to 35.200ft 1

SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 1 of 64

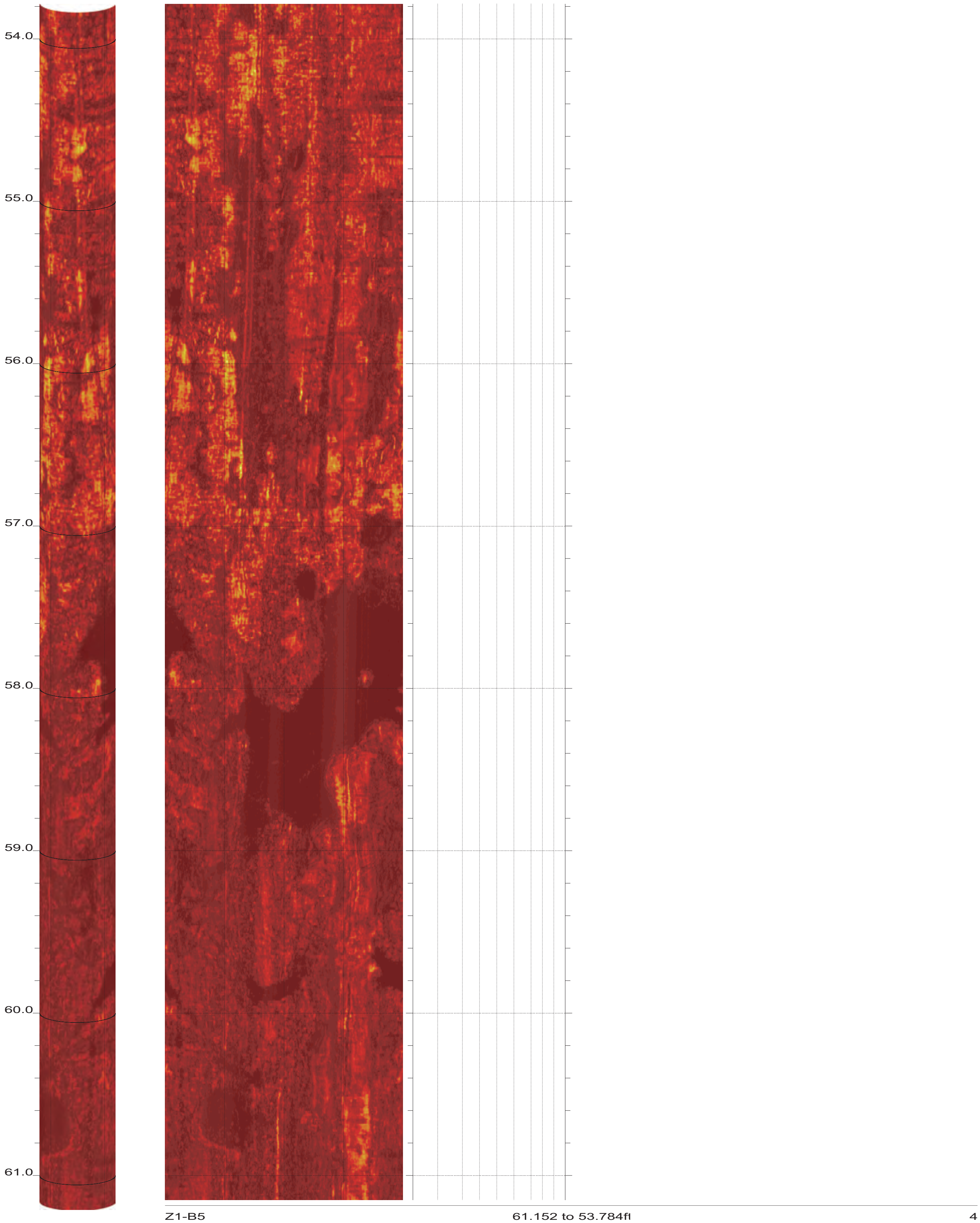


SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 2 of 64

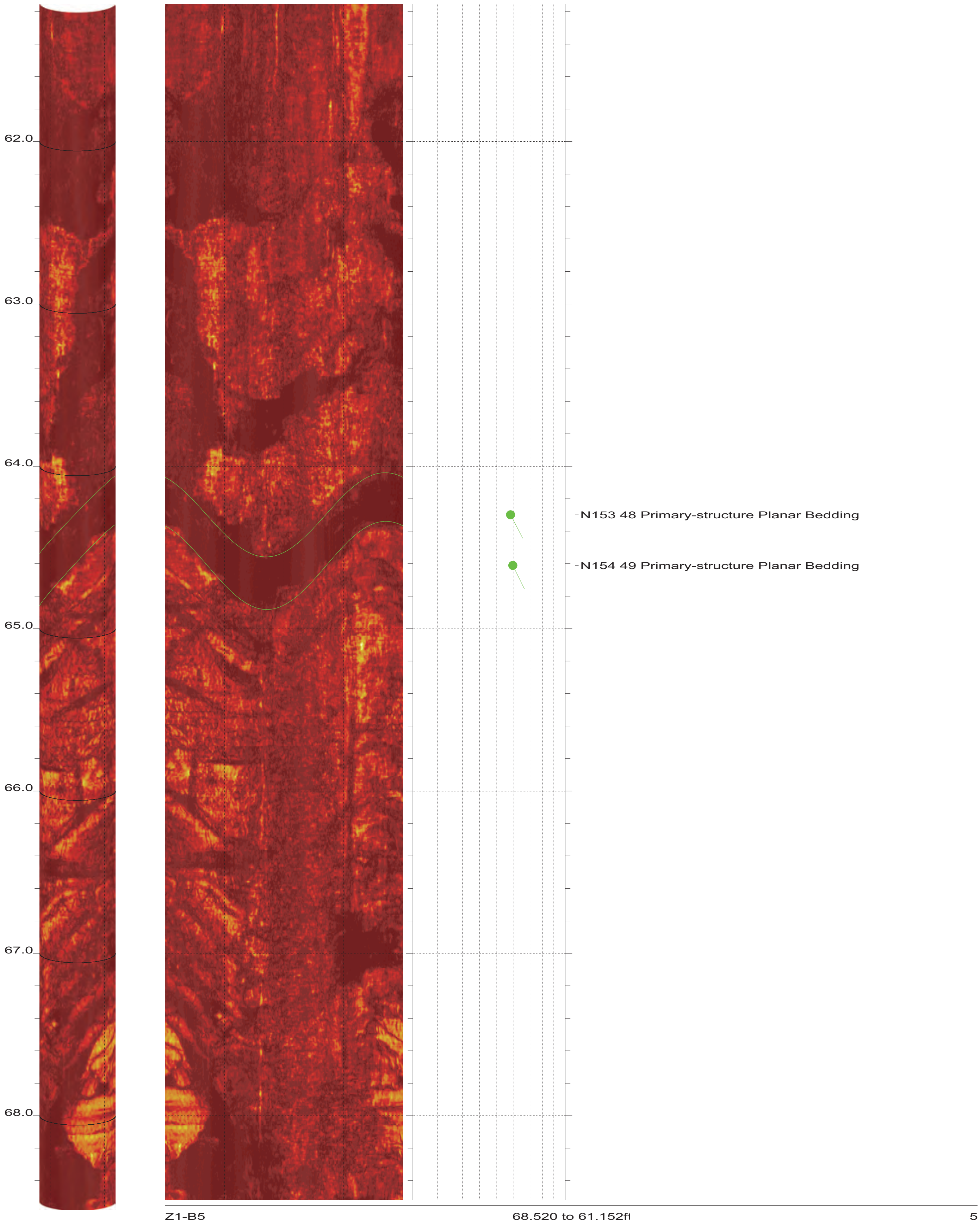


Z1-B5 53.784 to 46.416ft 3

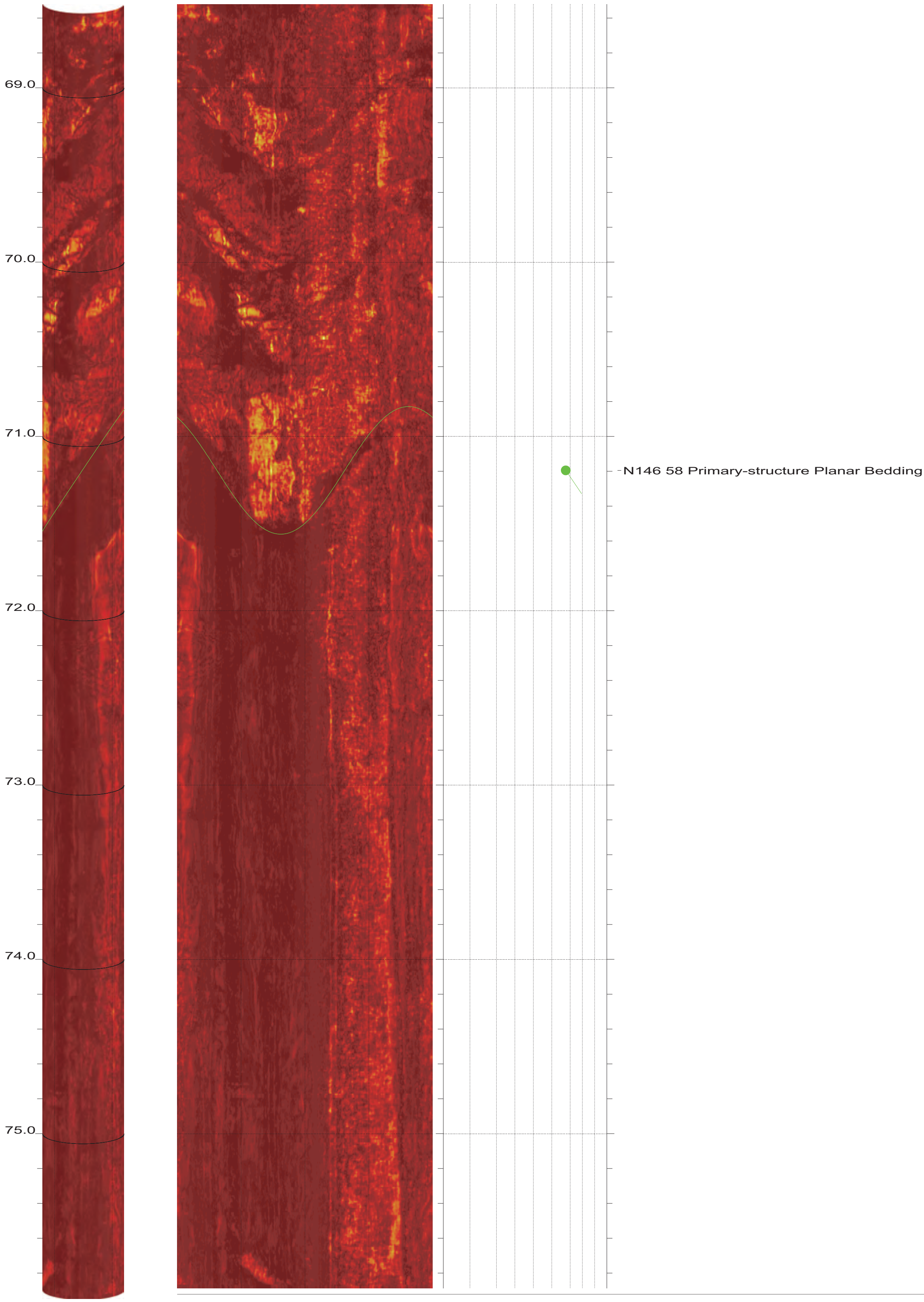
SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 3 of 64



SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 4 of 64

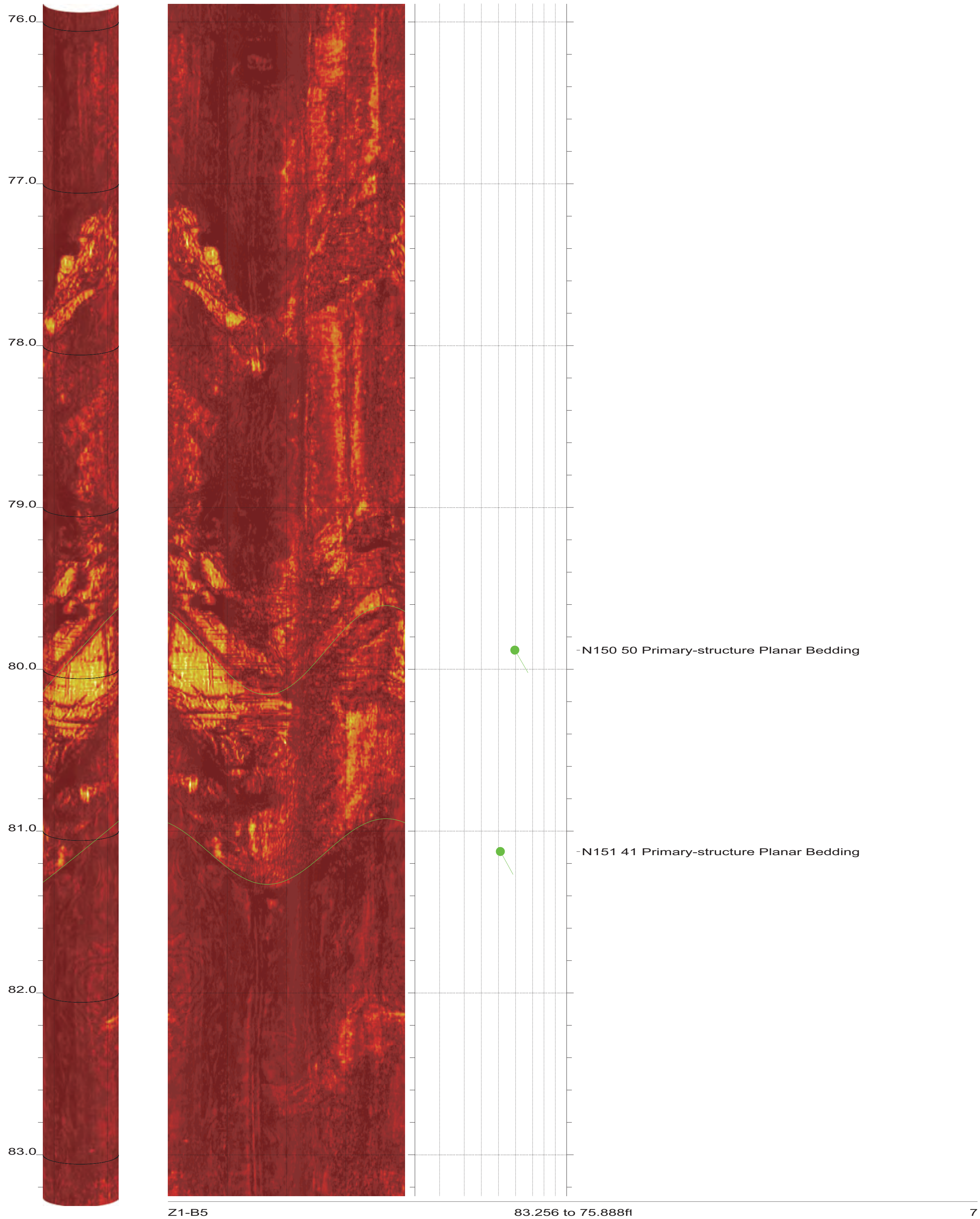


SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 5 of 64

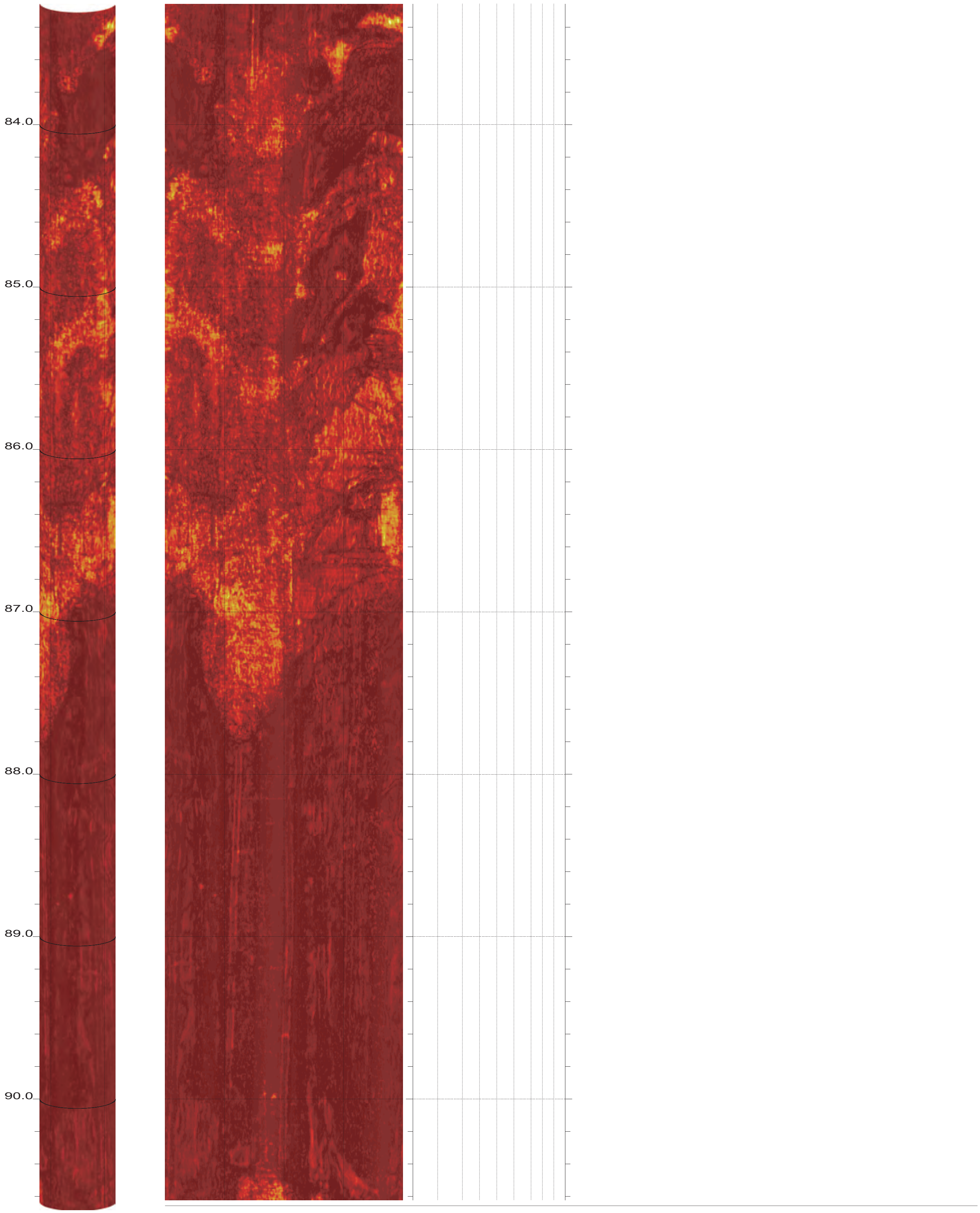


Z1-B5 75.888 to 68.520ft 6

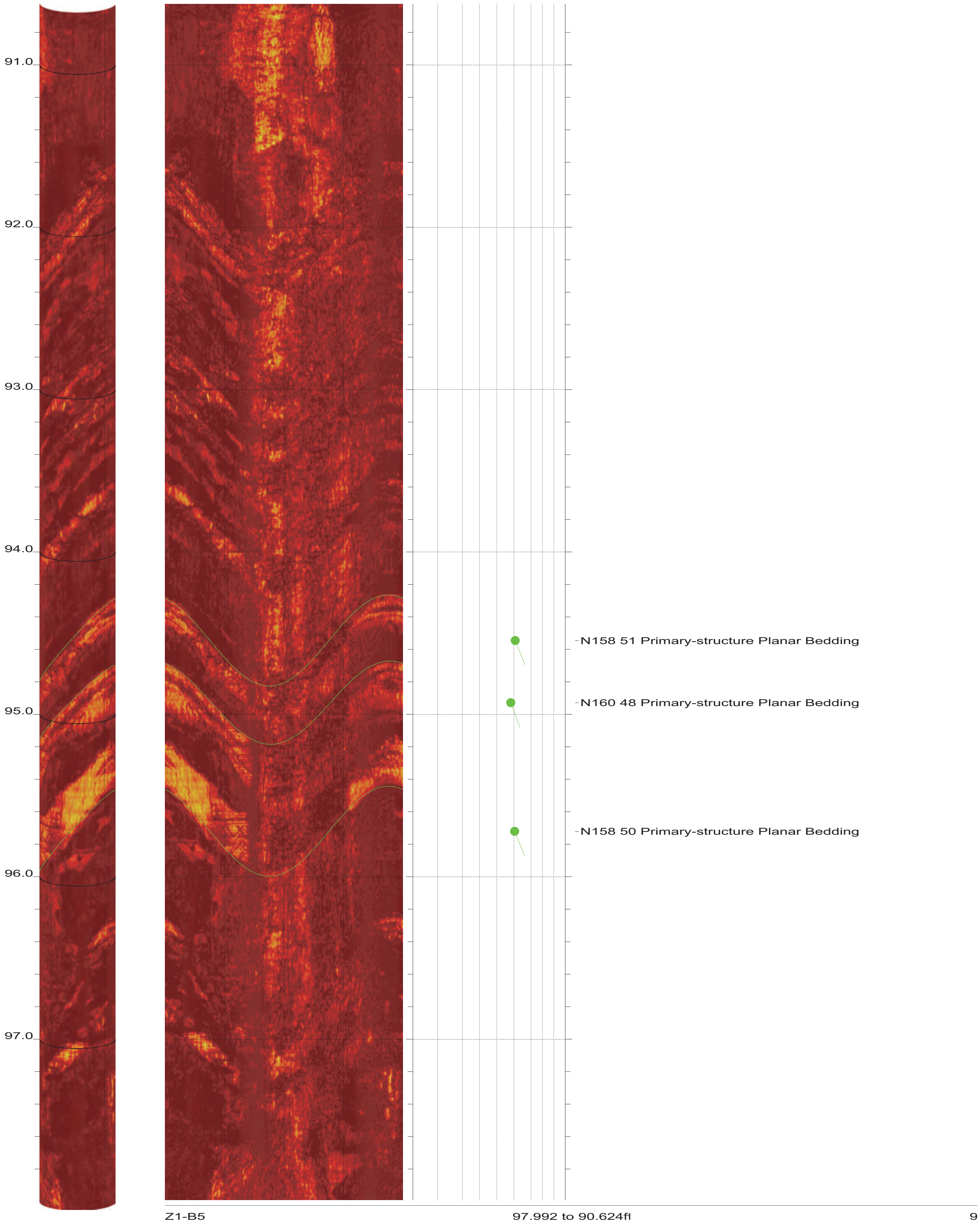
SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 6 of 64



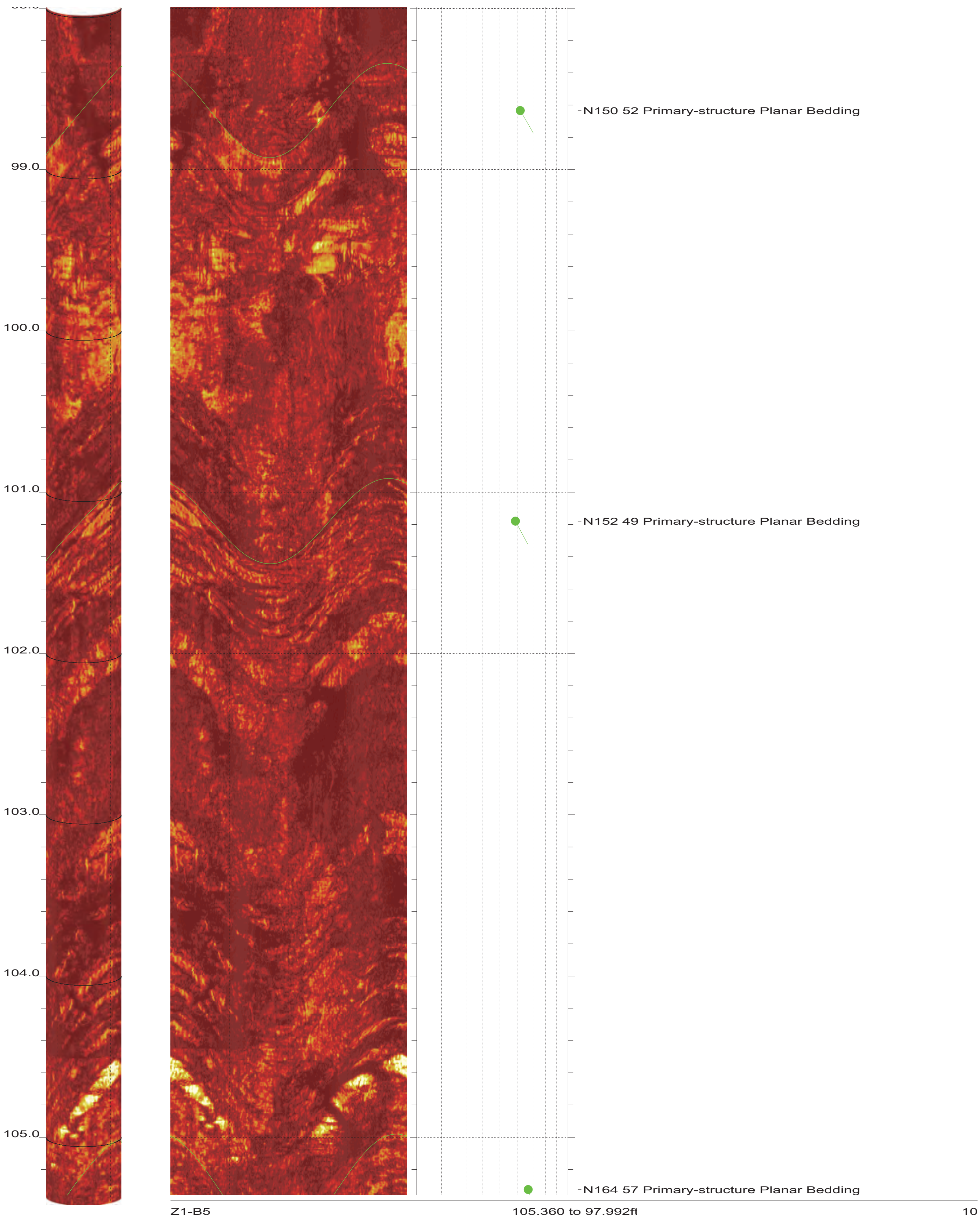
SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 7 of 64



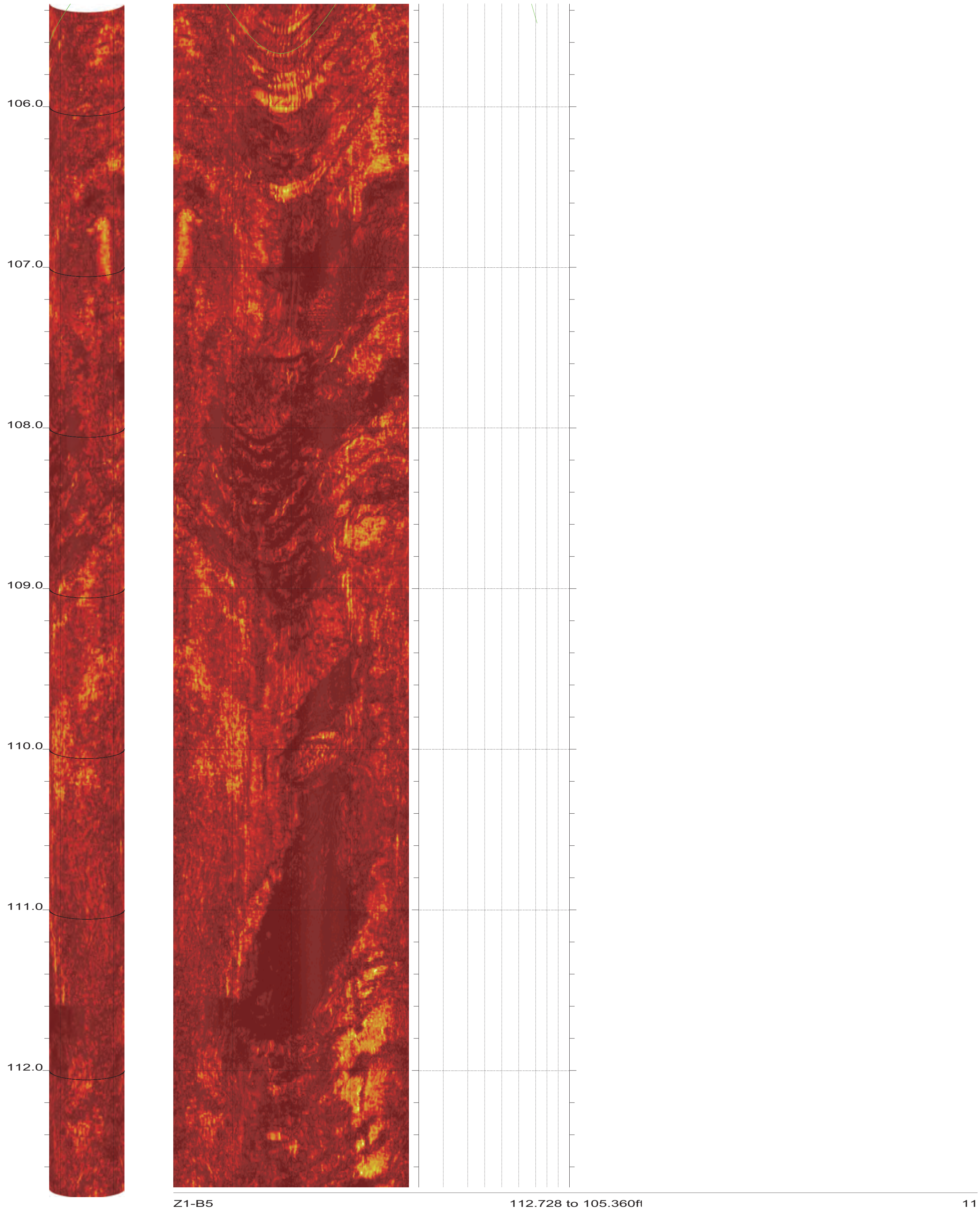
SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 8 of 64



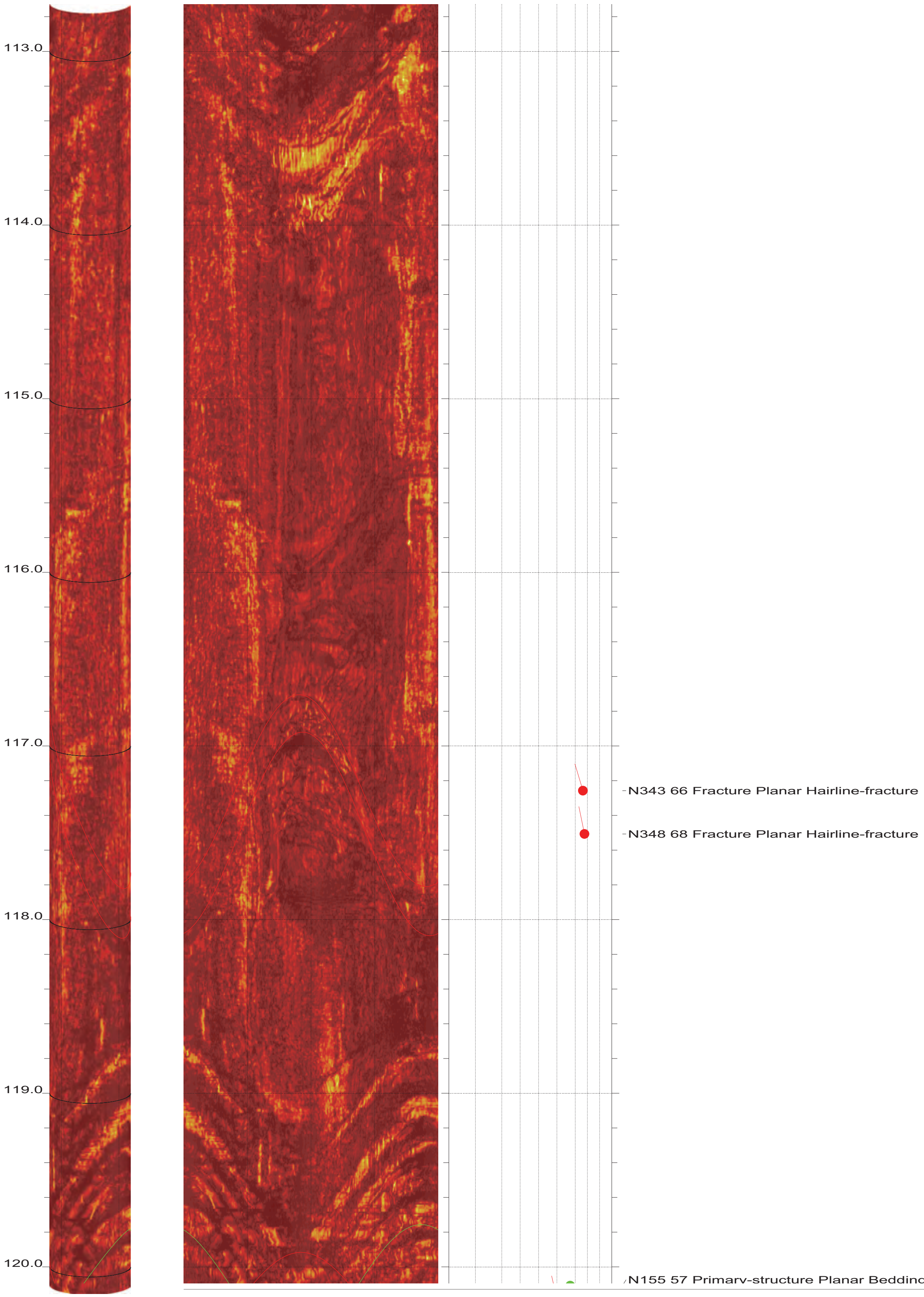
SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 9 of 64



SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 10 of 64

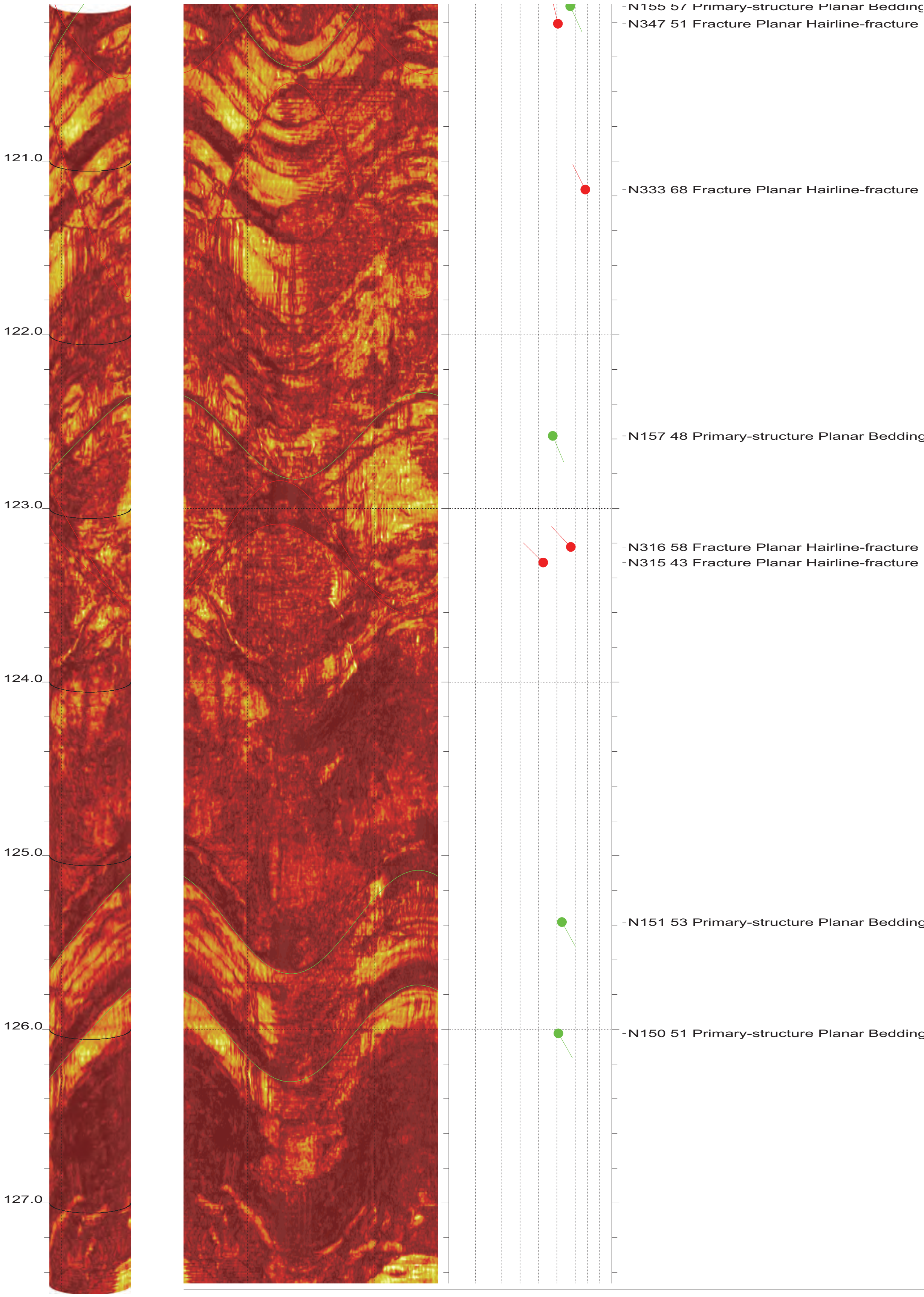


SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 11 of 64



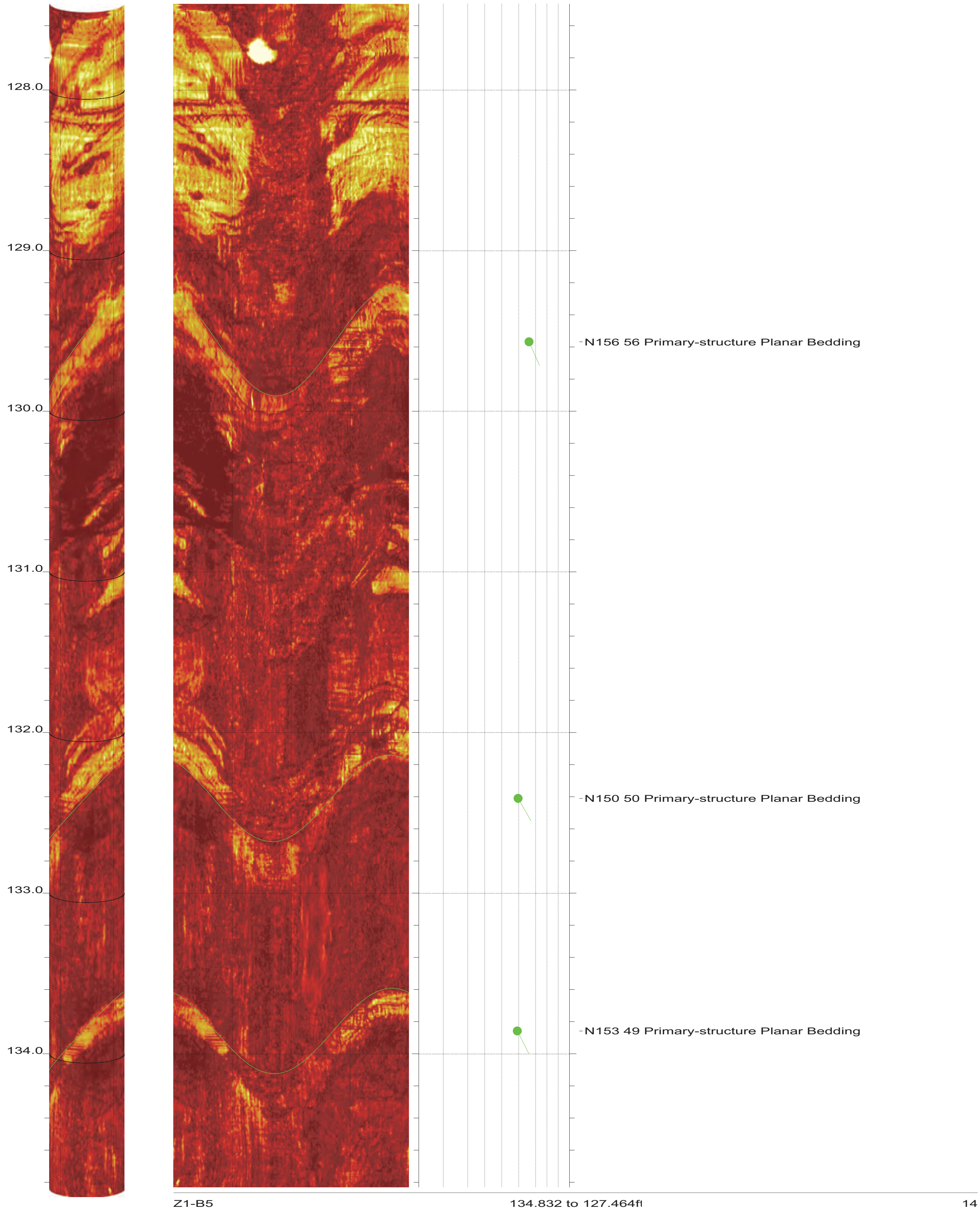
Z1-B5 120.096 to 112.728ft 12

SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 12 of 64

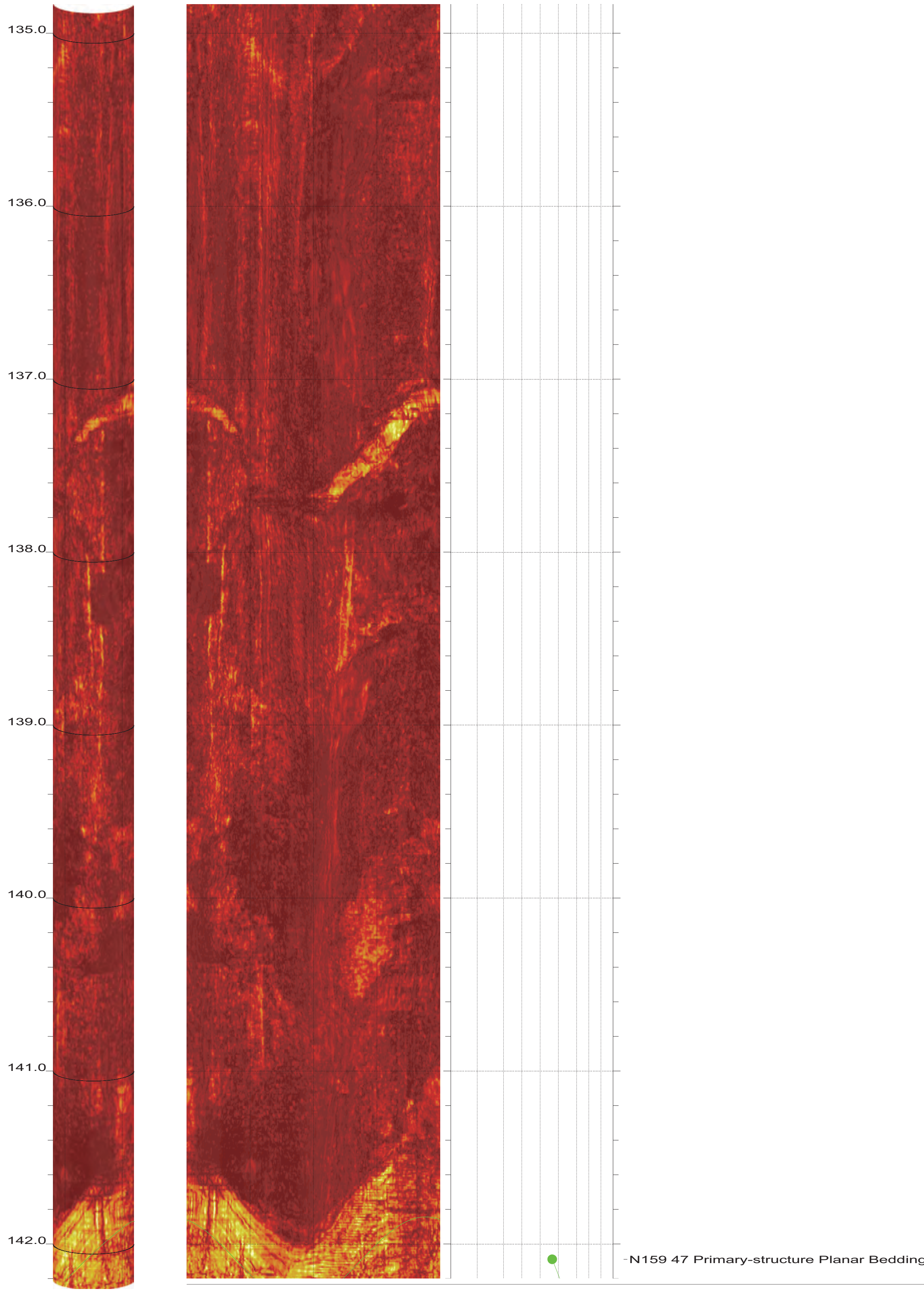


Z1-B5 127.464 to 120.096ft 13

SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 13 of 64

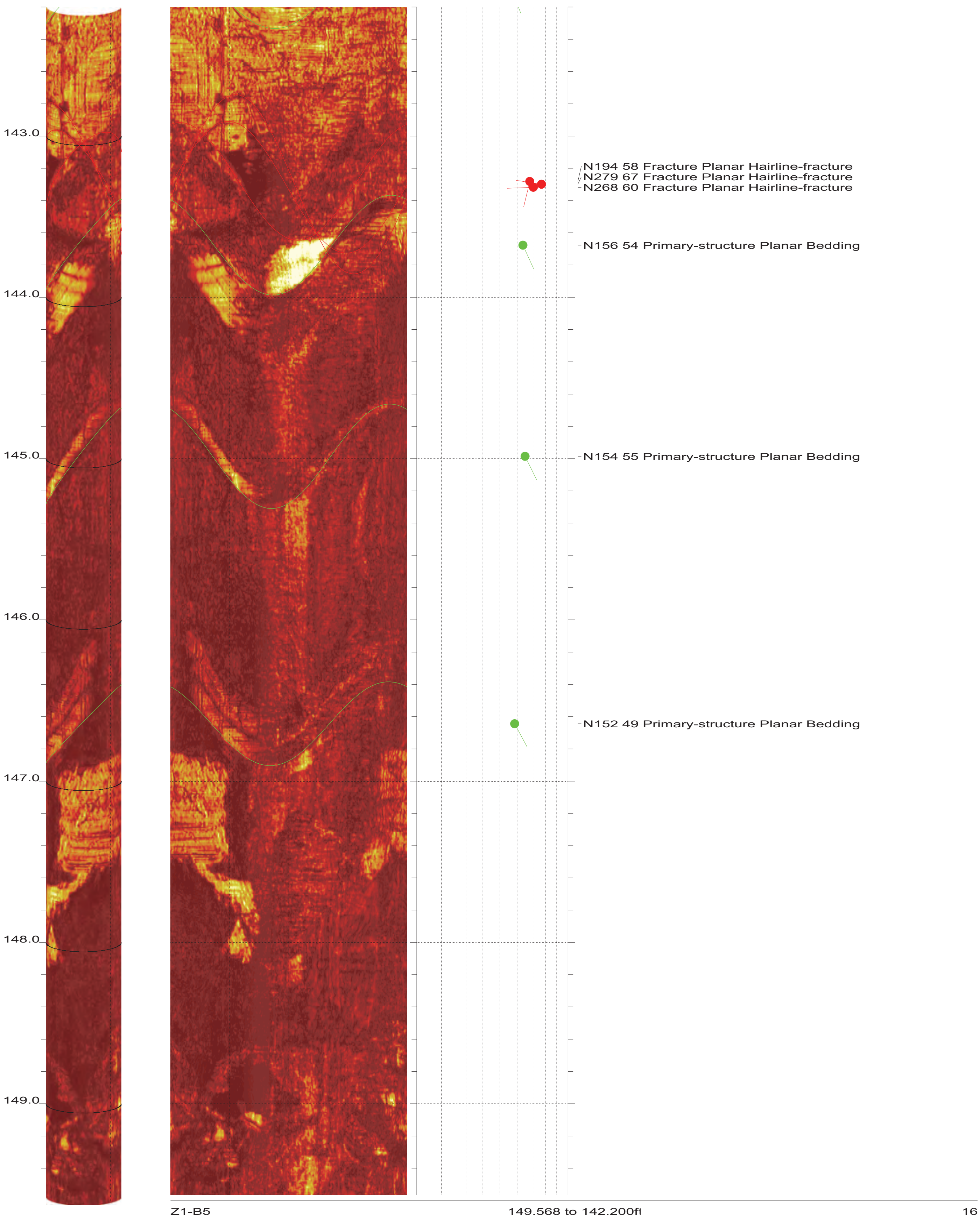


SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 14 of 64

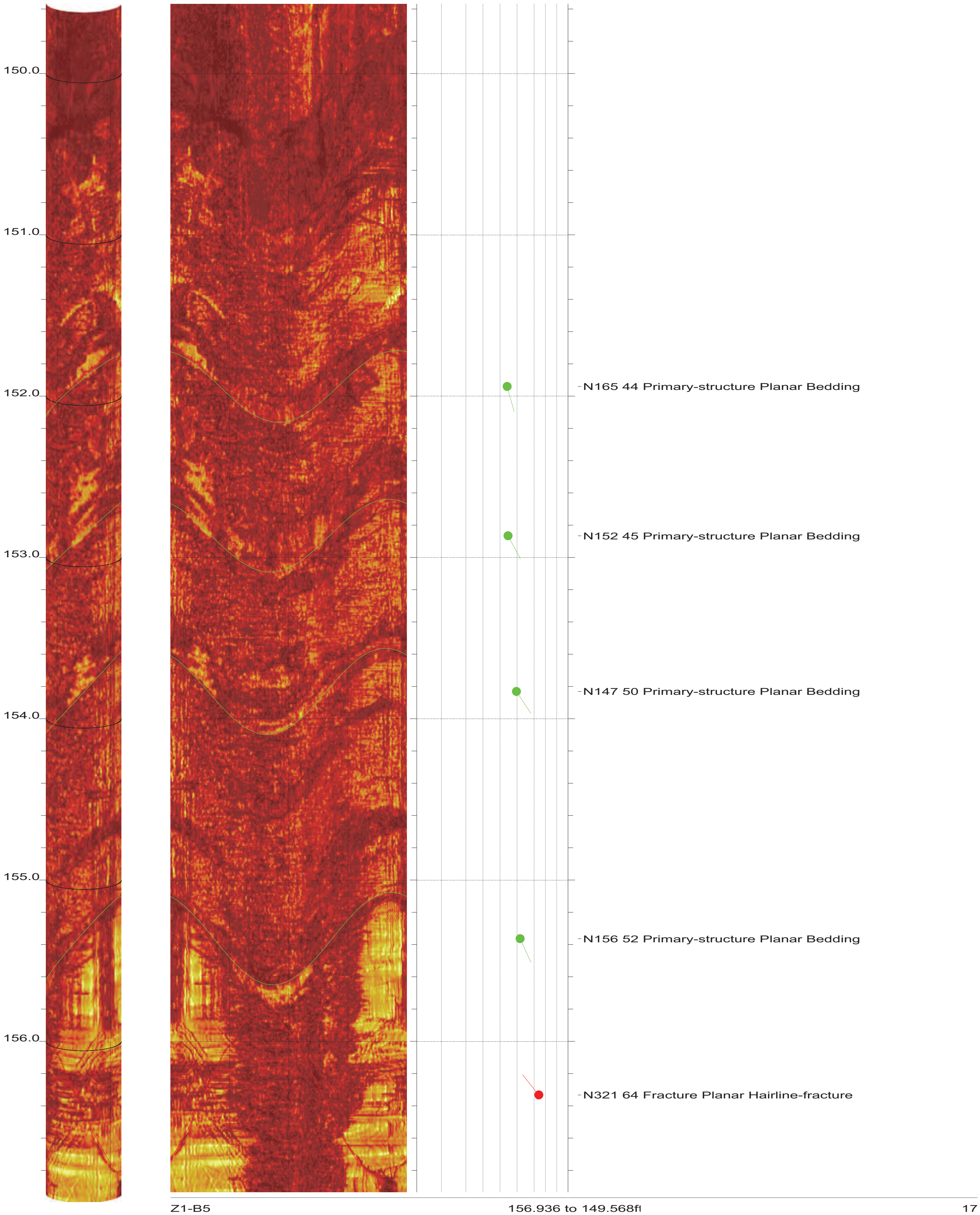


Z1-B5 142.200 to 134.832ft 15

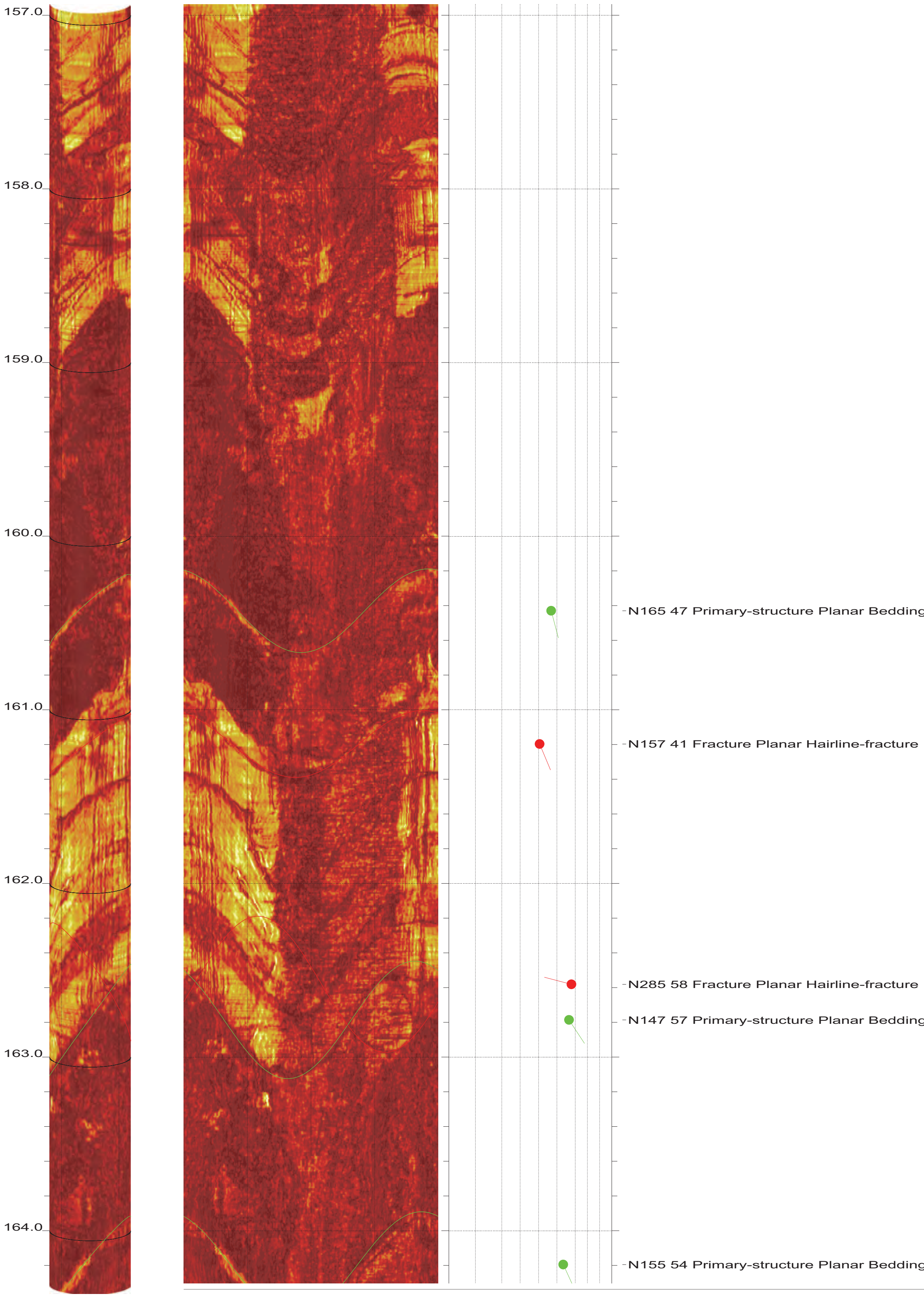
SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 15 of 64



SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 16 of 64

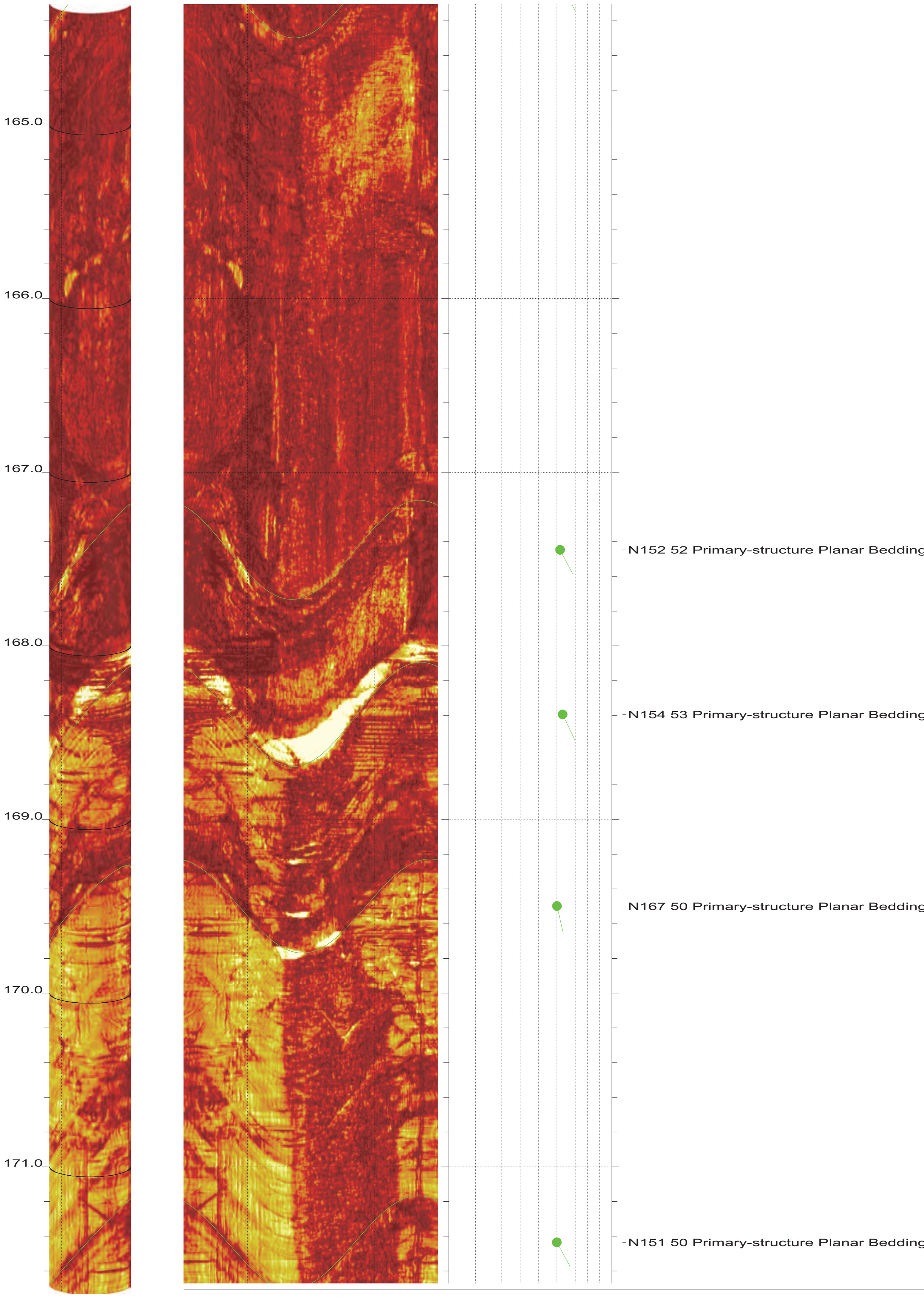


SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 17 of 64



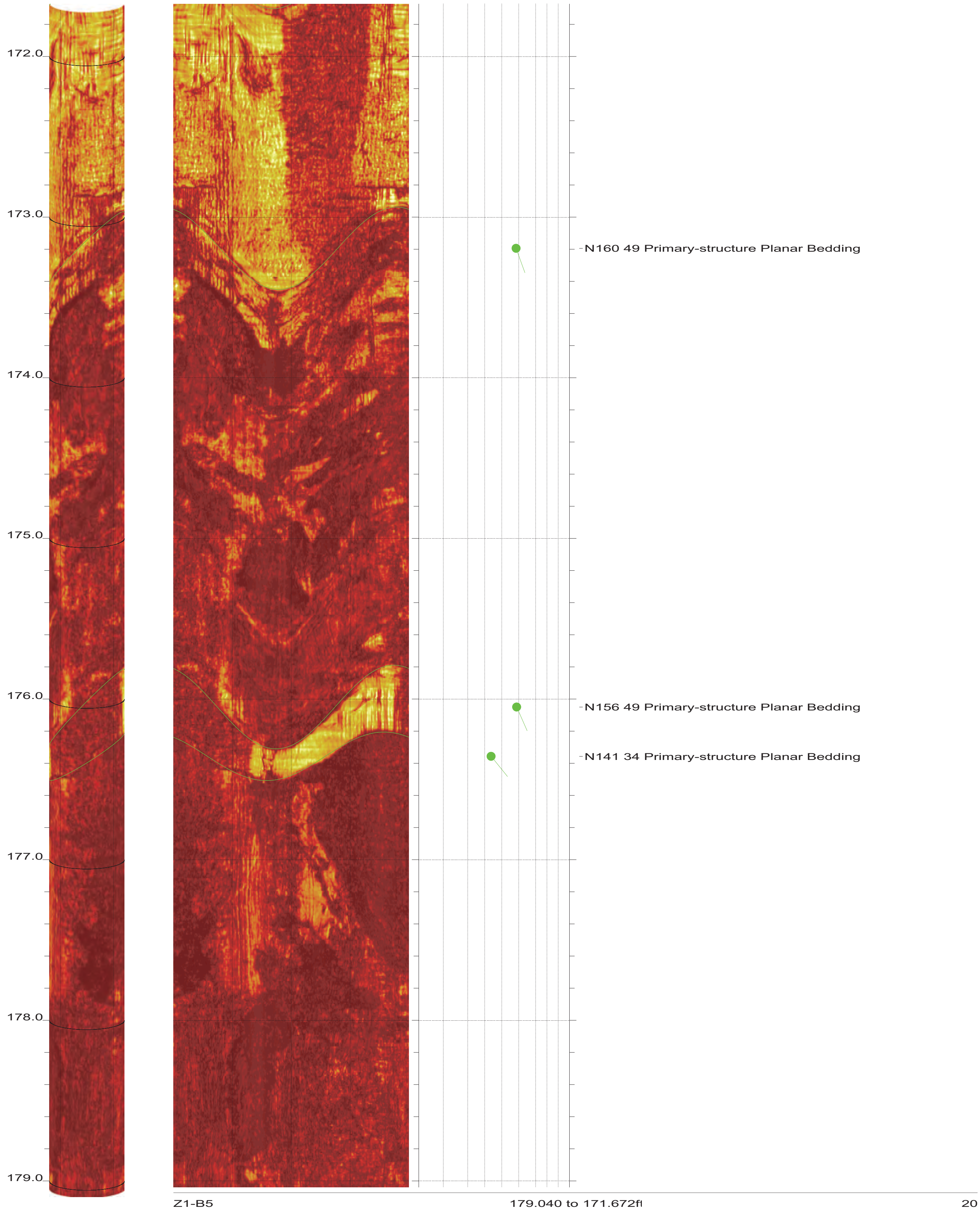
Z1-B5 164.304 to 156.936ft 18

SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 18 of 64

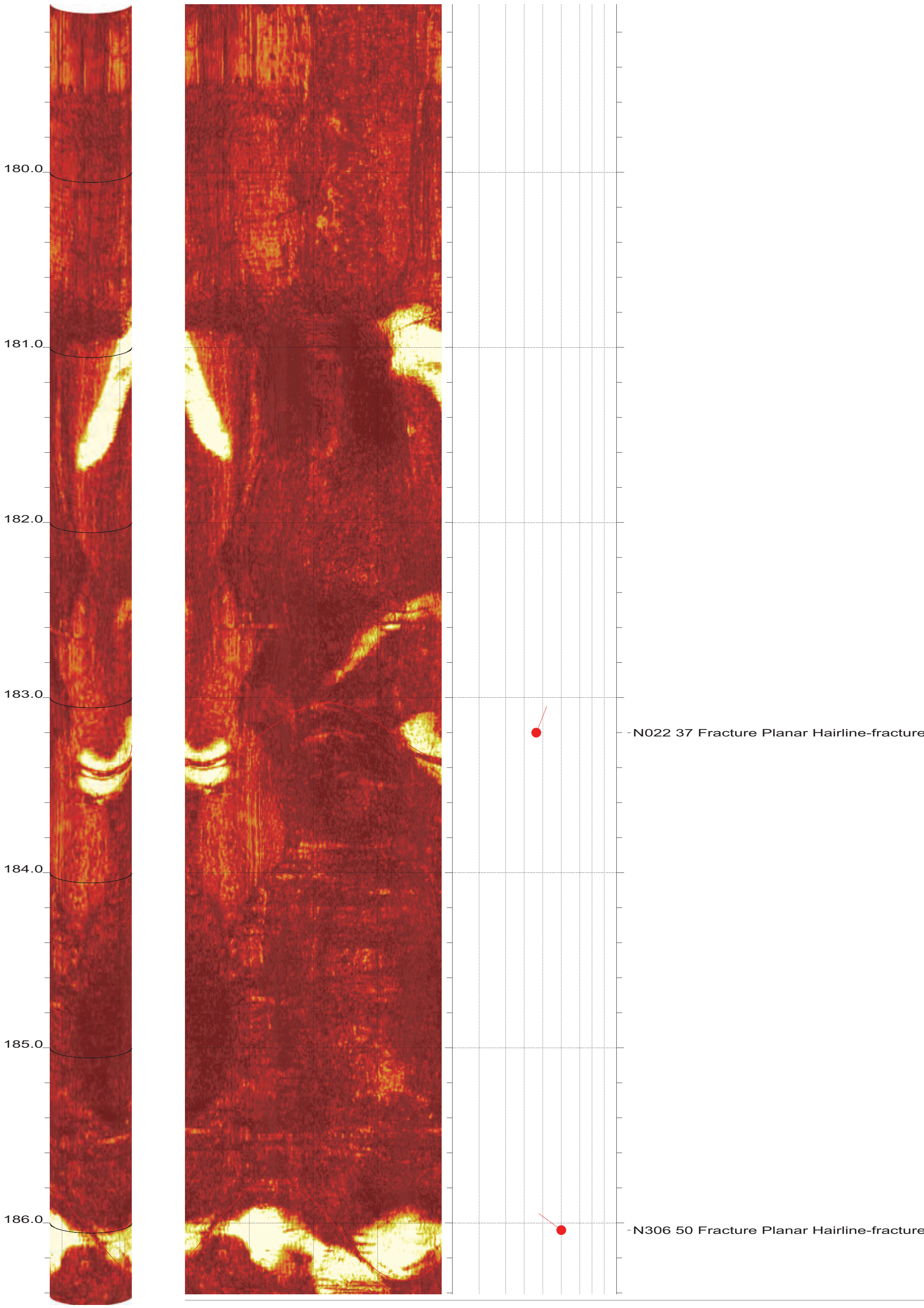


Z1-B5 171.672 to 164.304ft 19

SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 19 of 64

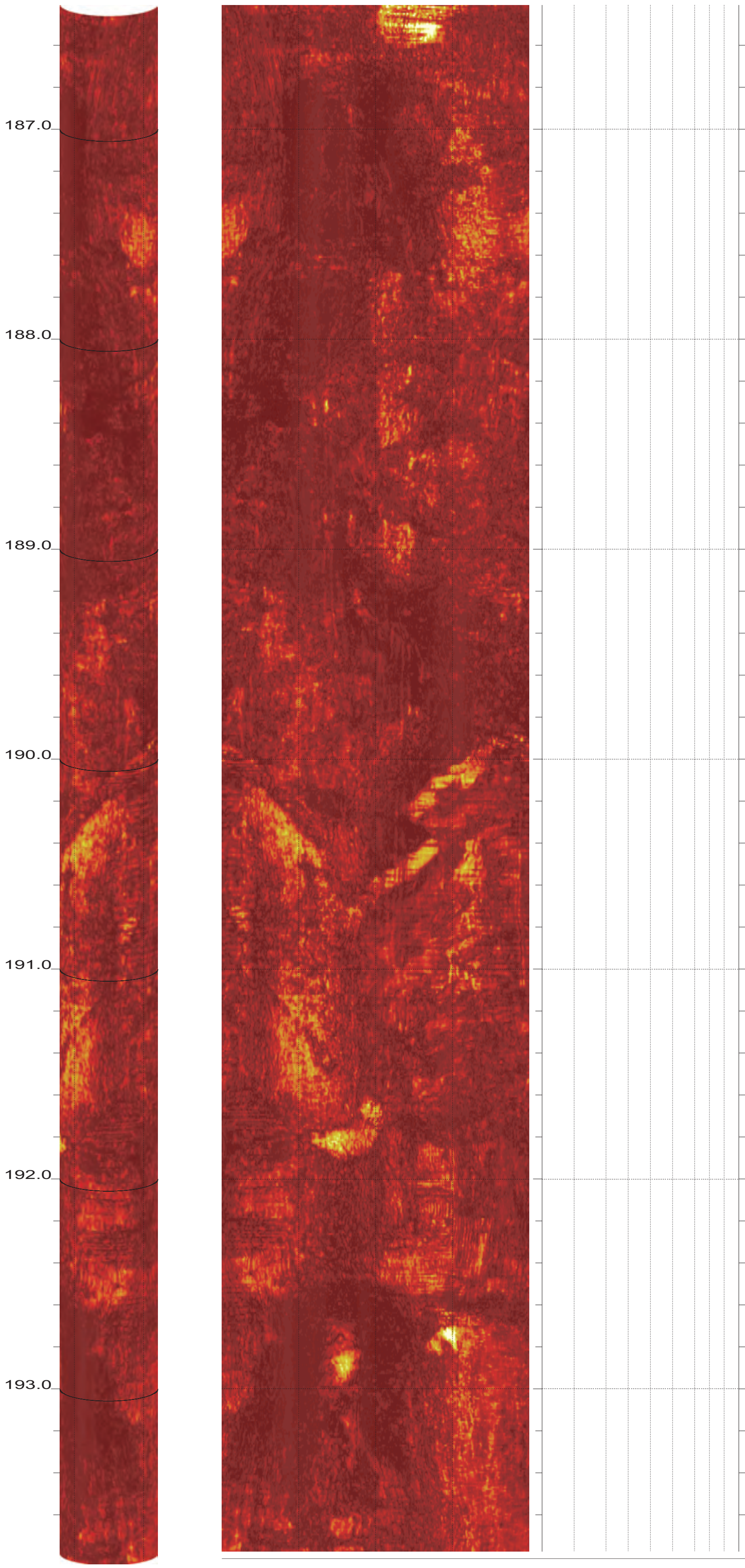


SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 20 of 64



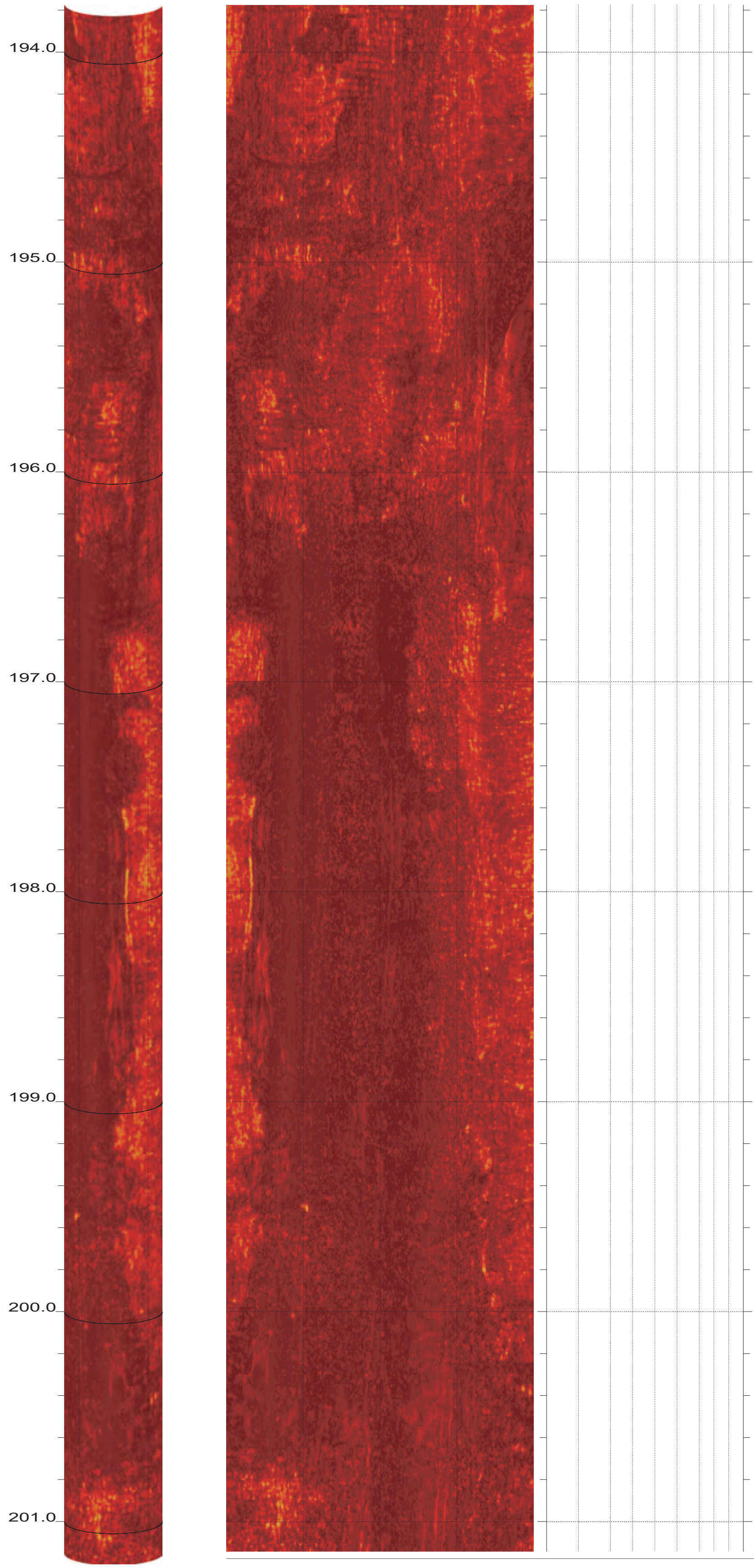
Z1-B5 186.408 to 179.040ft 21

SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 21 of 64



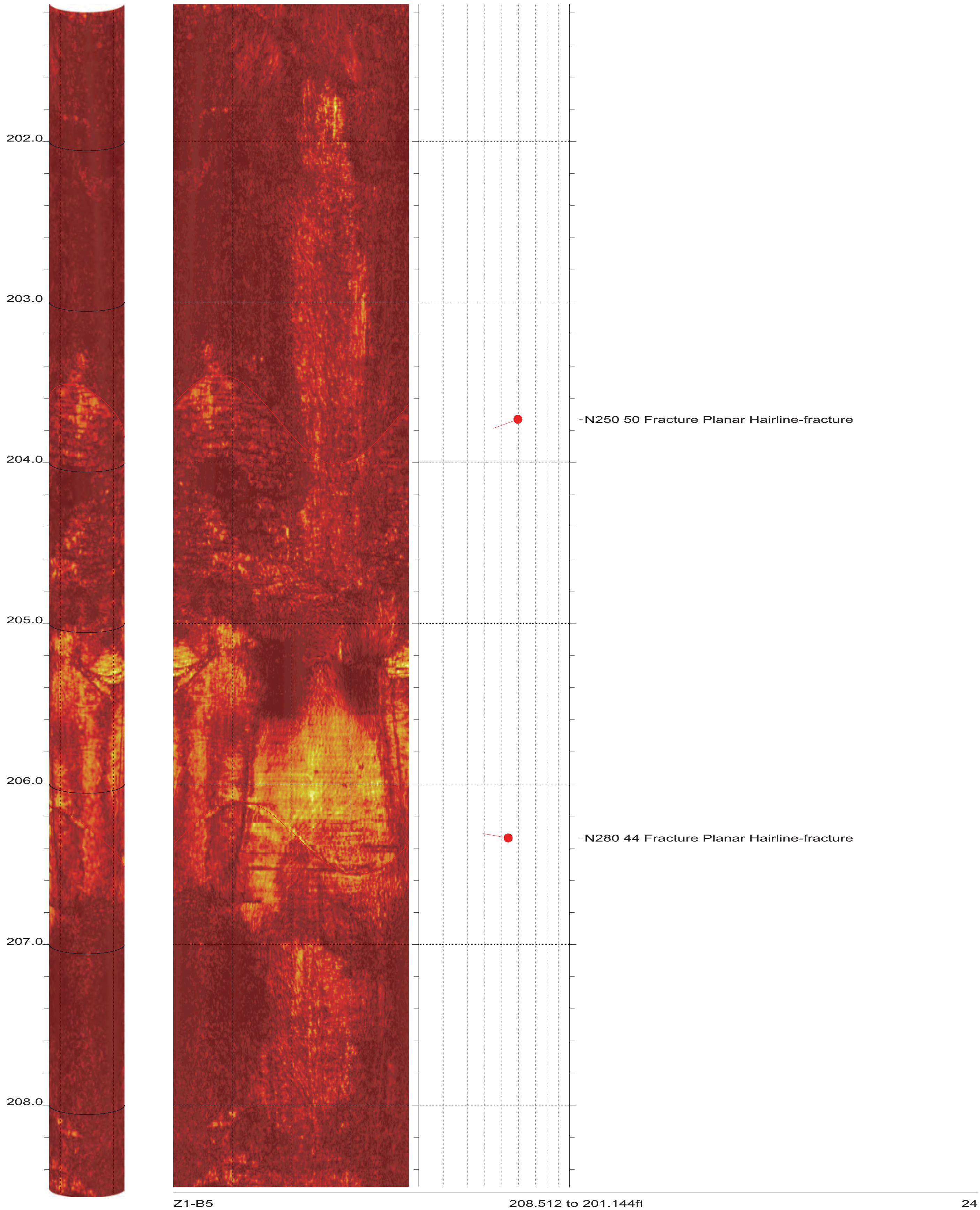
Z1-B5 193.776 to 186.408ft 22

SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 22 of 64

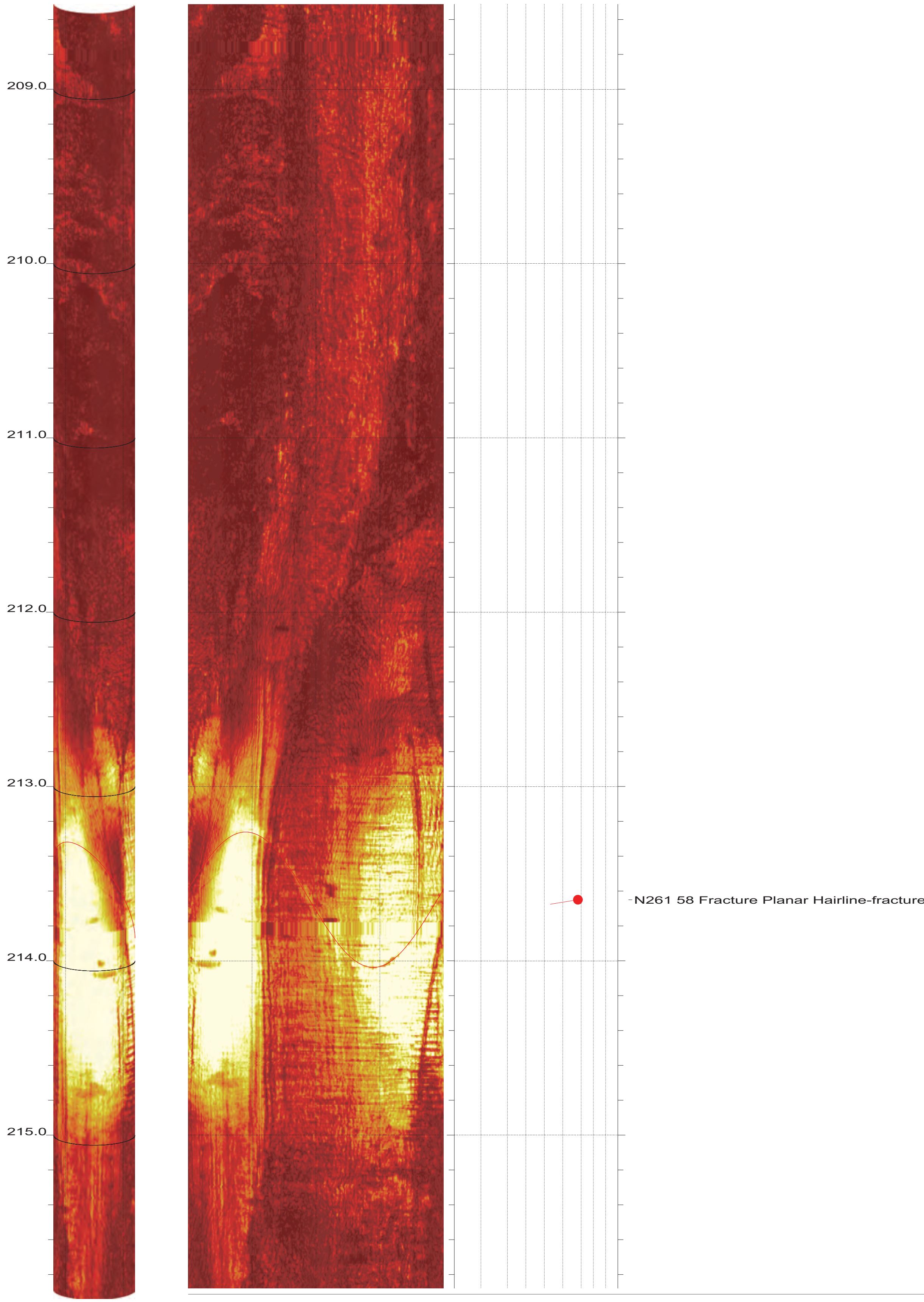


Z1-B5 201.144 to 193.776ft 23

SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 23 of 64

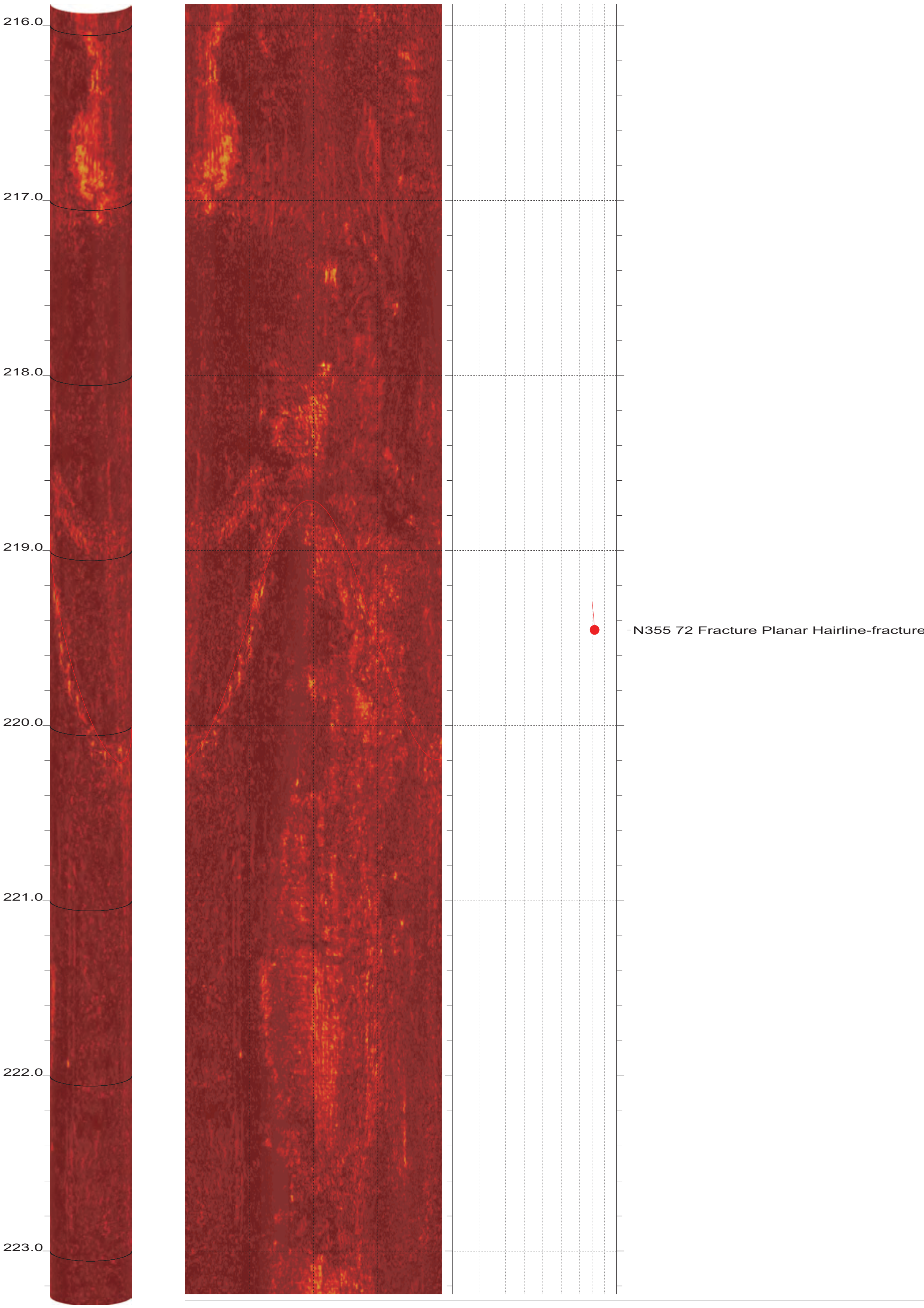


SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 24 of 64



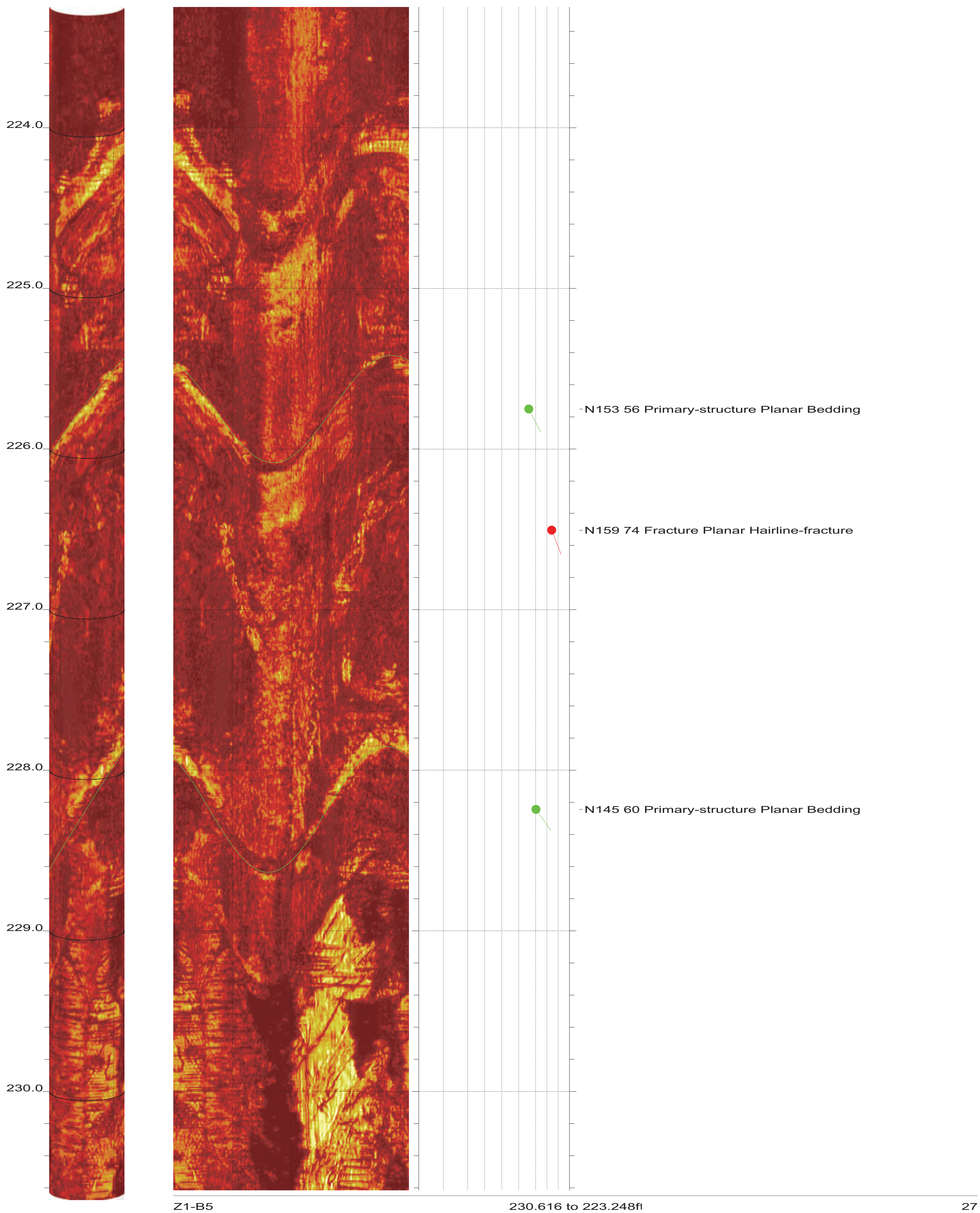
Z1-B5 215.880 to 208.512ft 25

SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 25 of 64

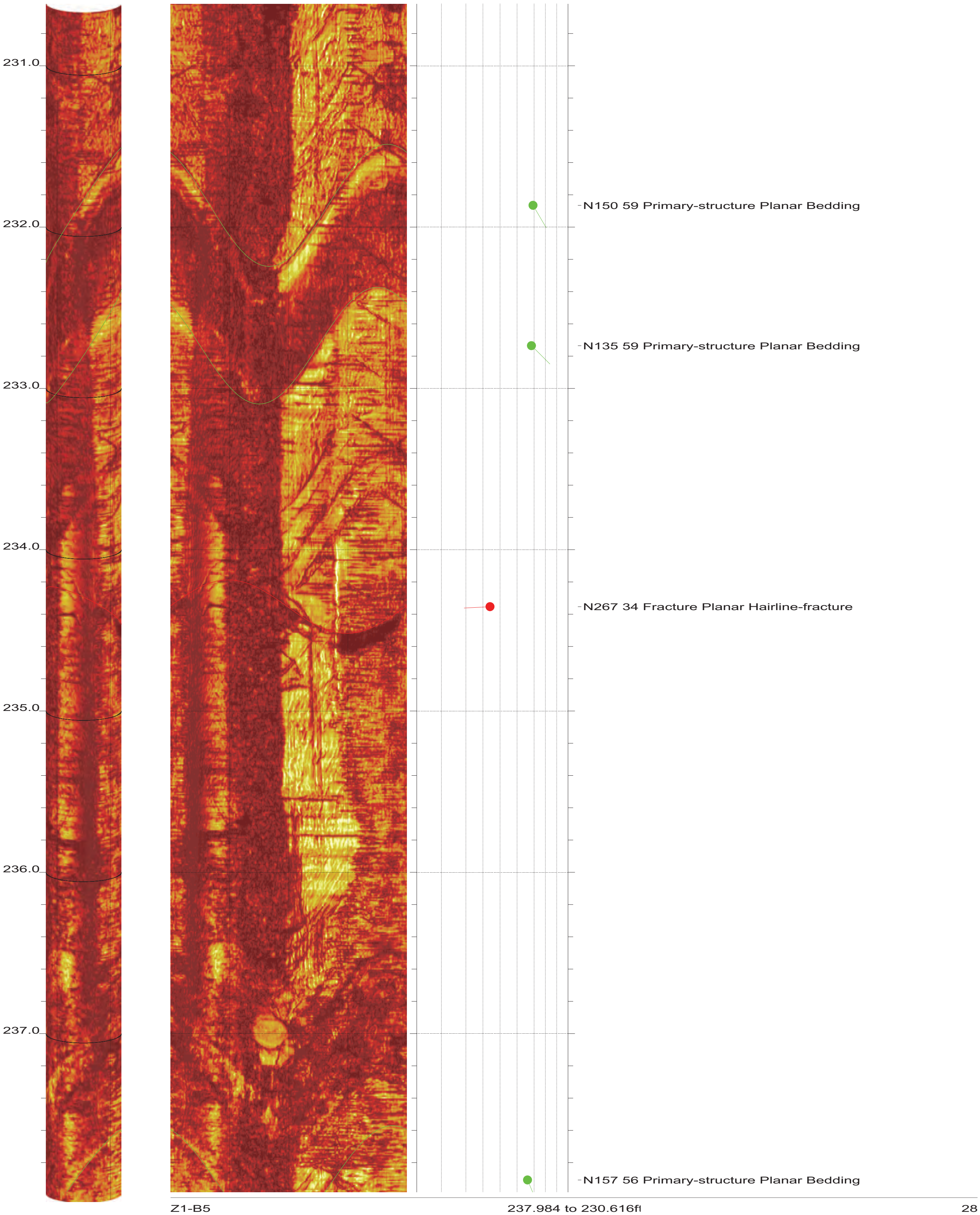


Z1-B5 223.248 to 215.880ft 26

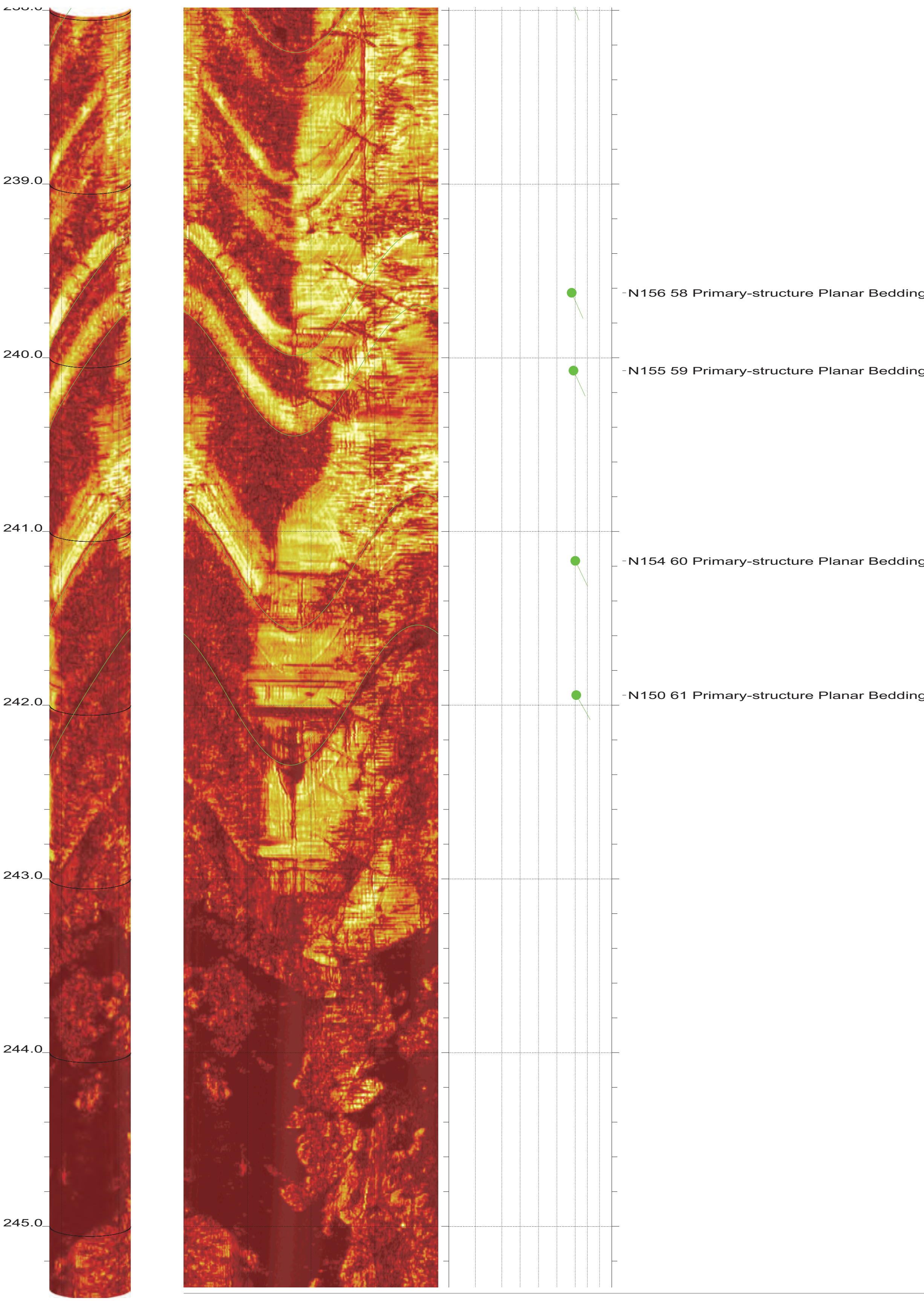
SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 26 of 64



SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 27 of 64

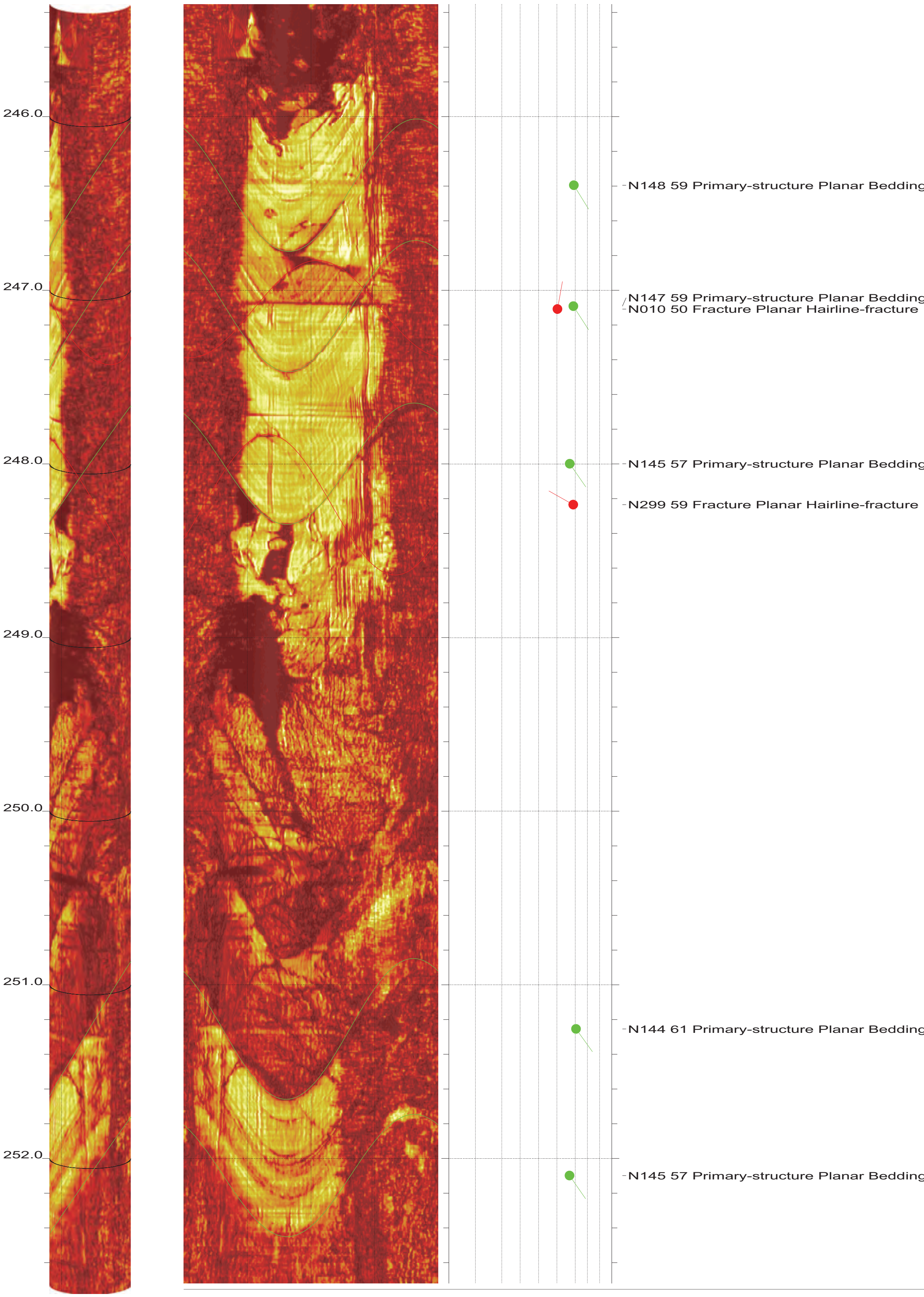


SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 28 of 64



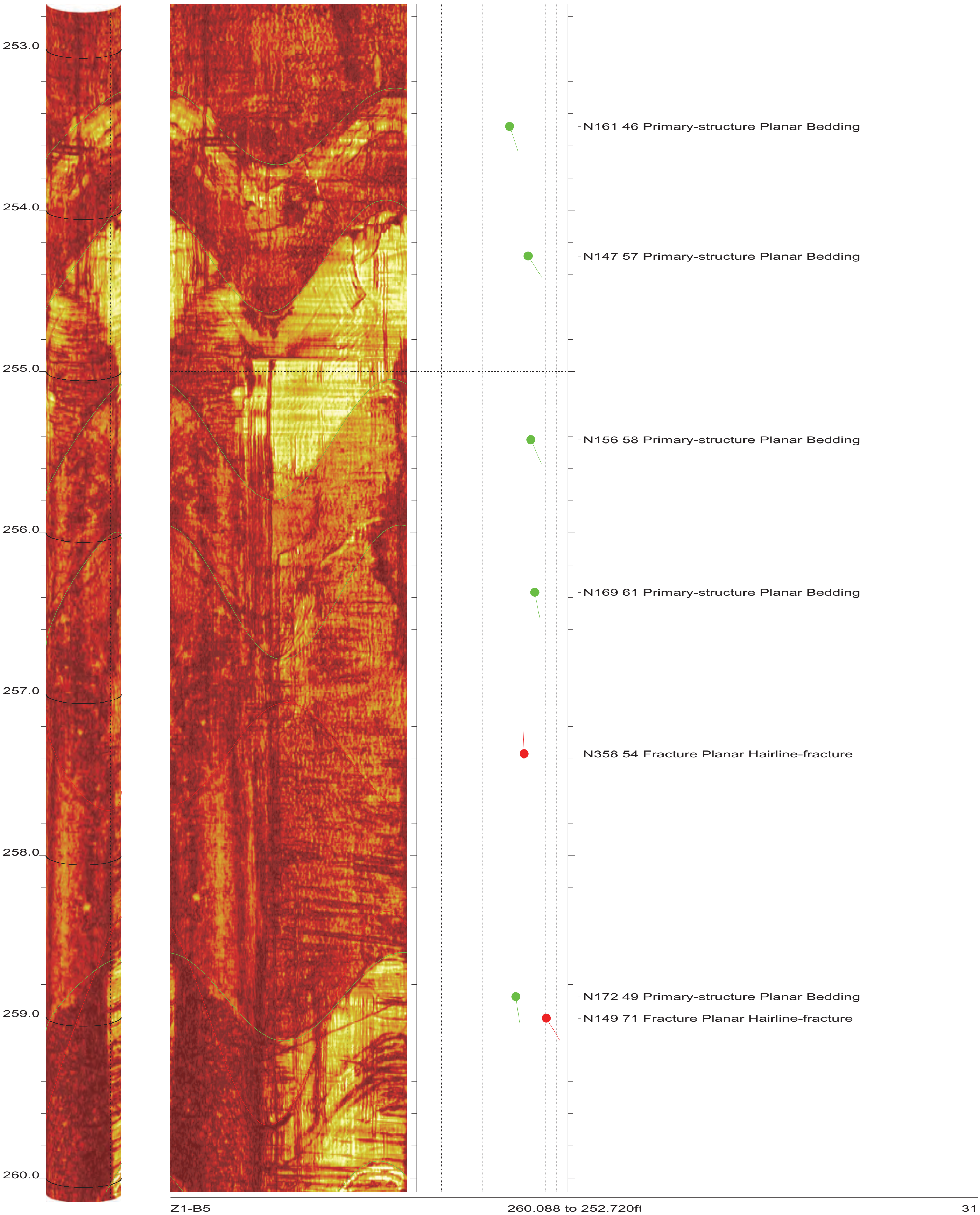
Z1-B5 245.352 to 237.984ft 29

SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 29 of 64

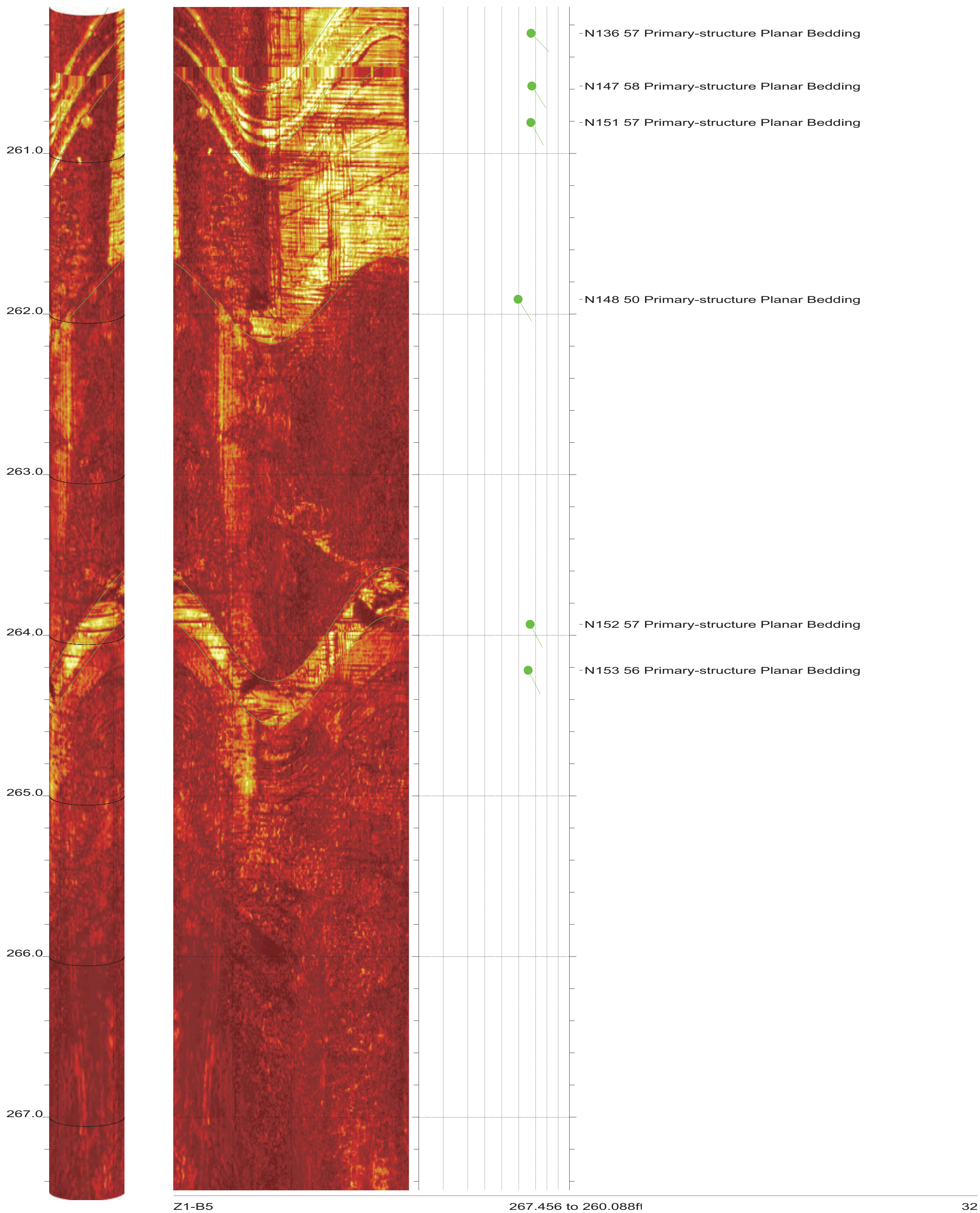


Z1-B5 252.720 to 245.352ft 30

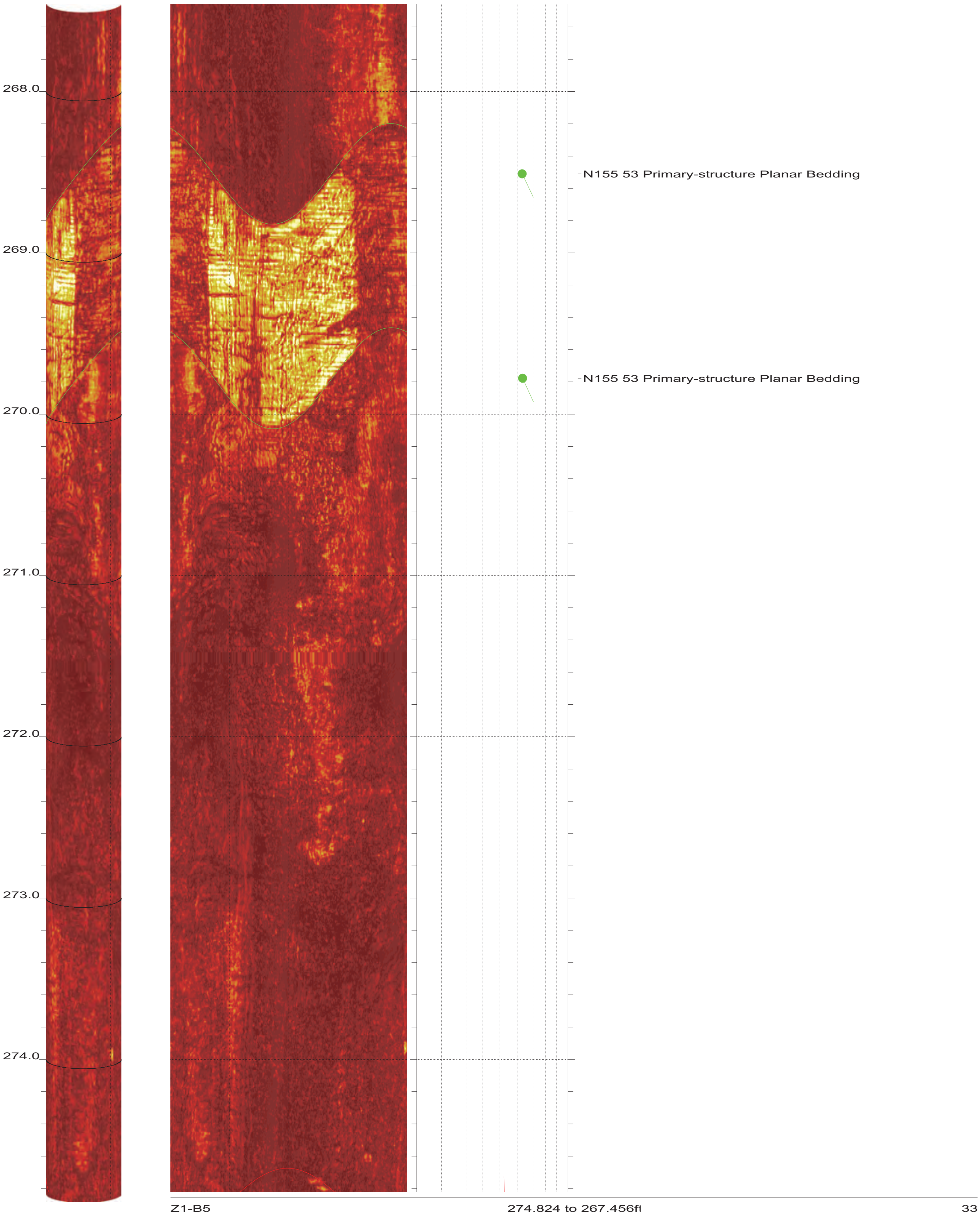
SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 30 of 64



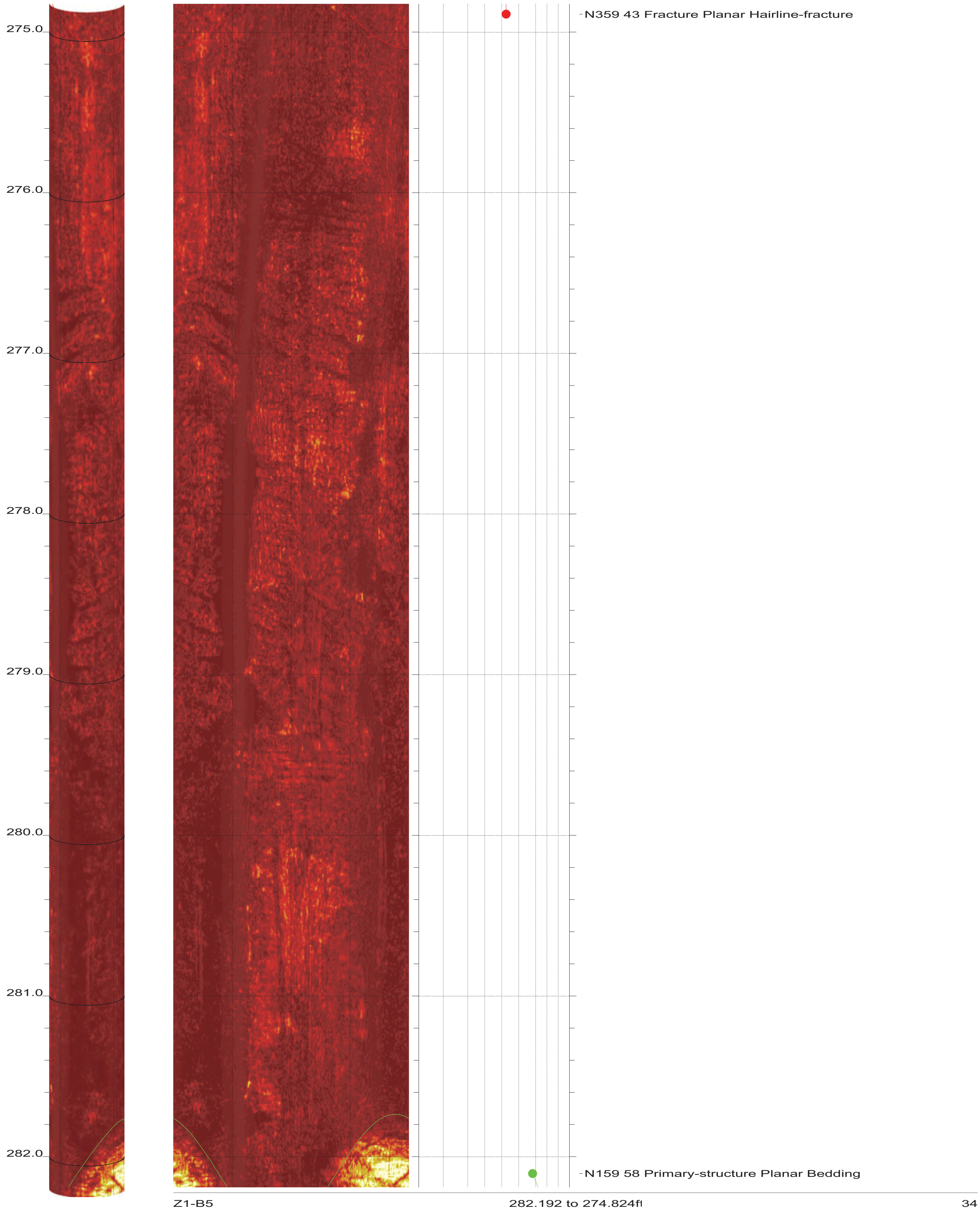
SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 31 of 64



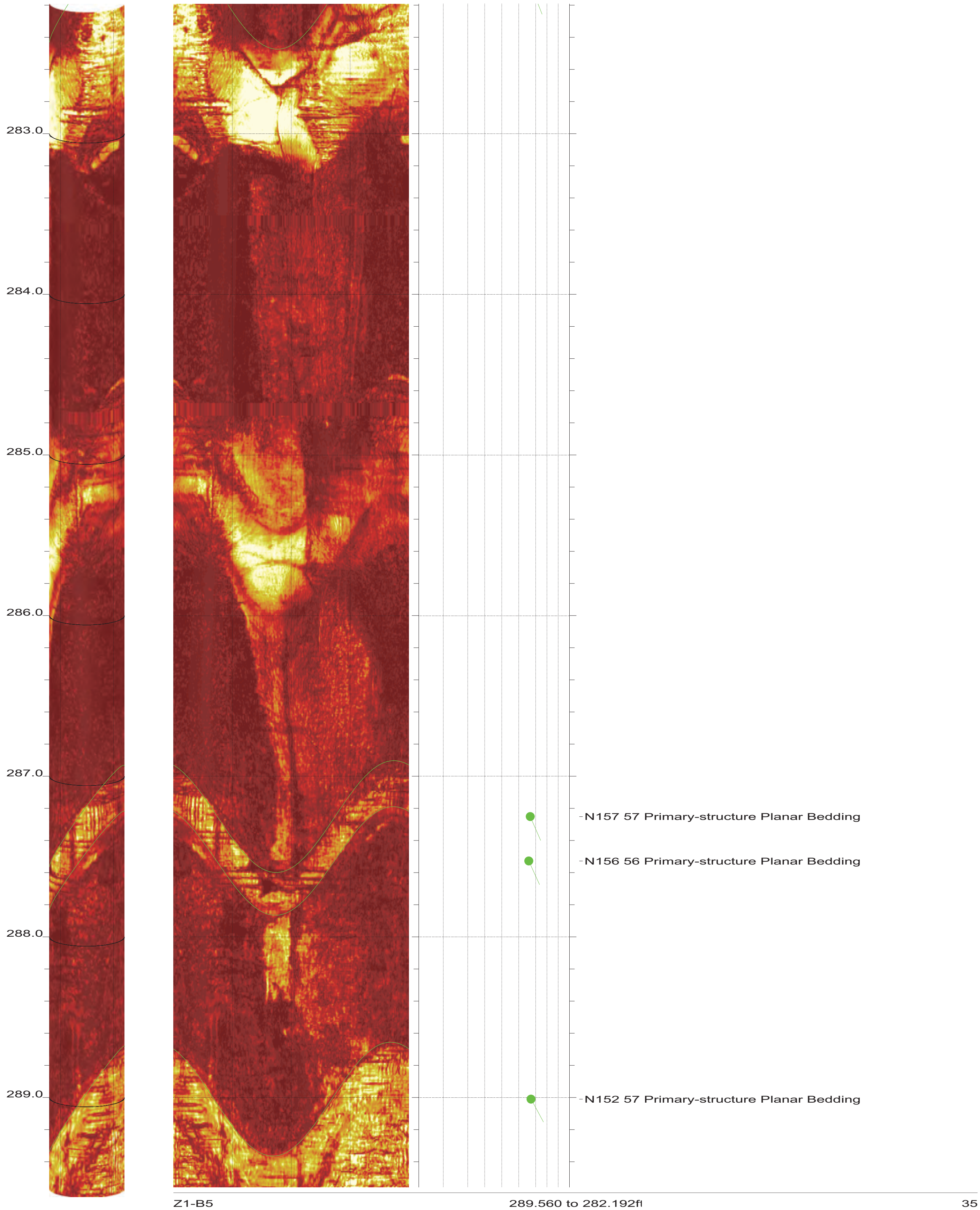
SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 32 of 64



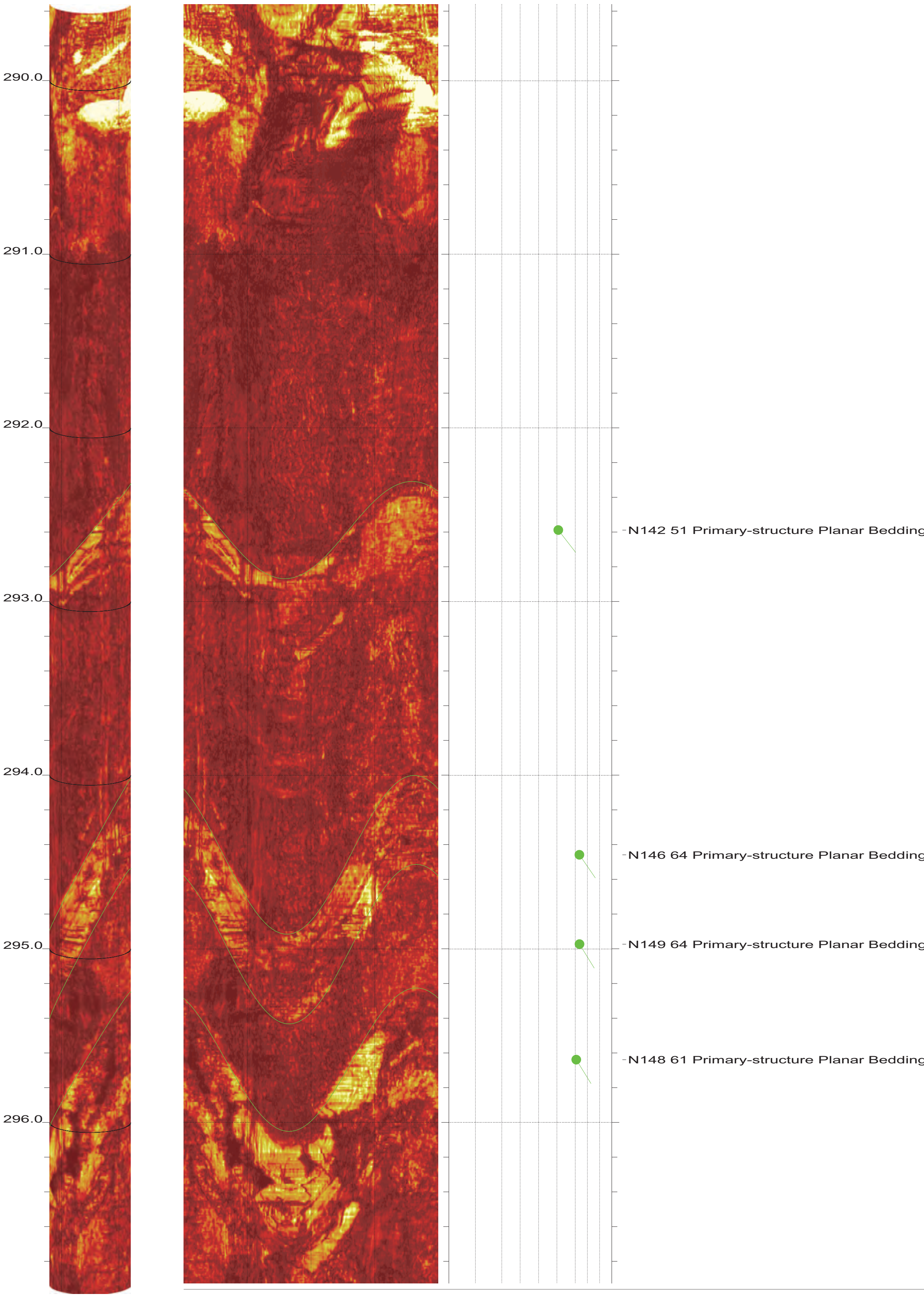
SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 33 of 64



SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 34 of 64

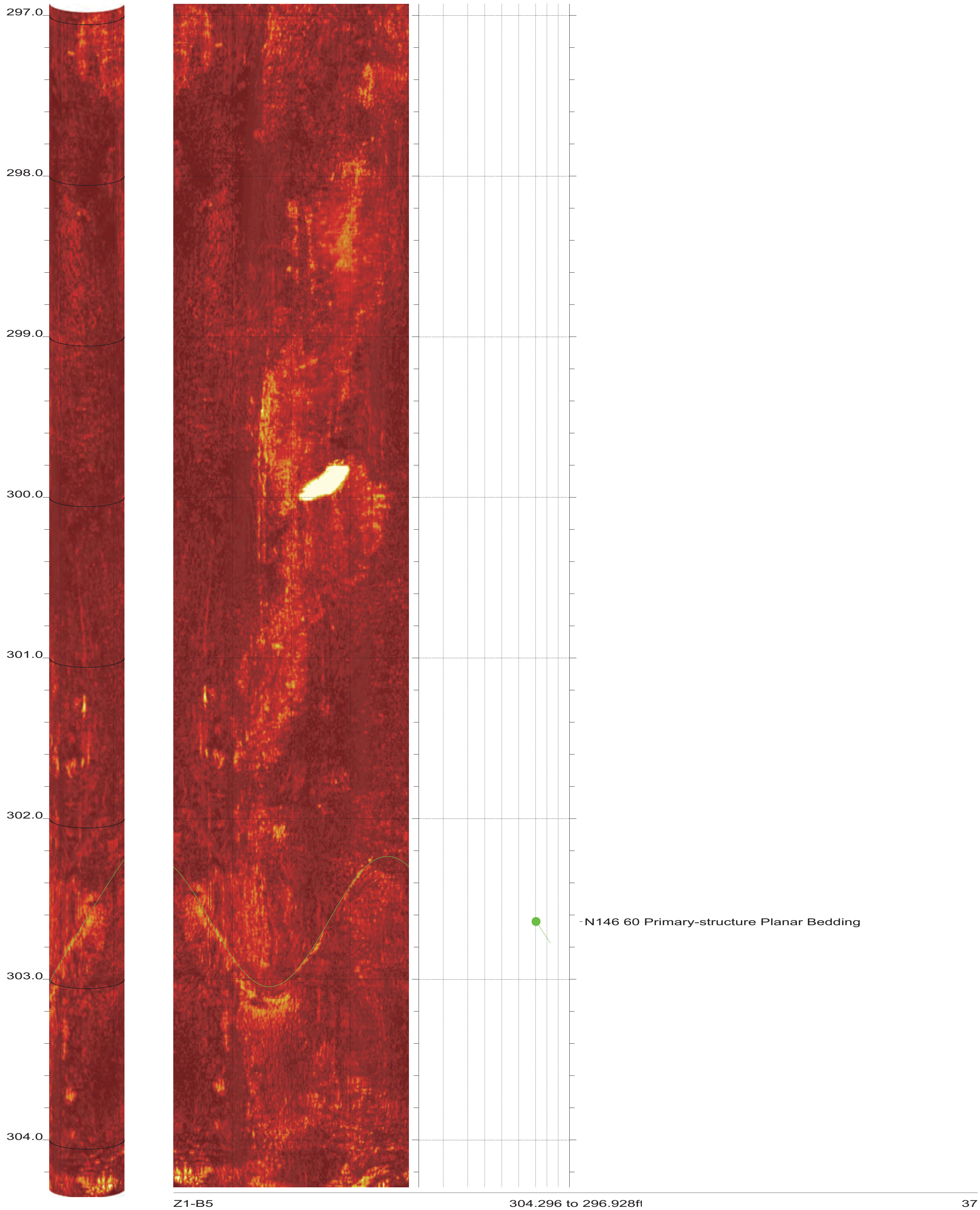


SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 35 of 64

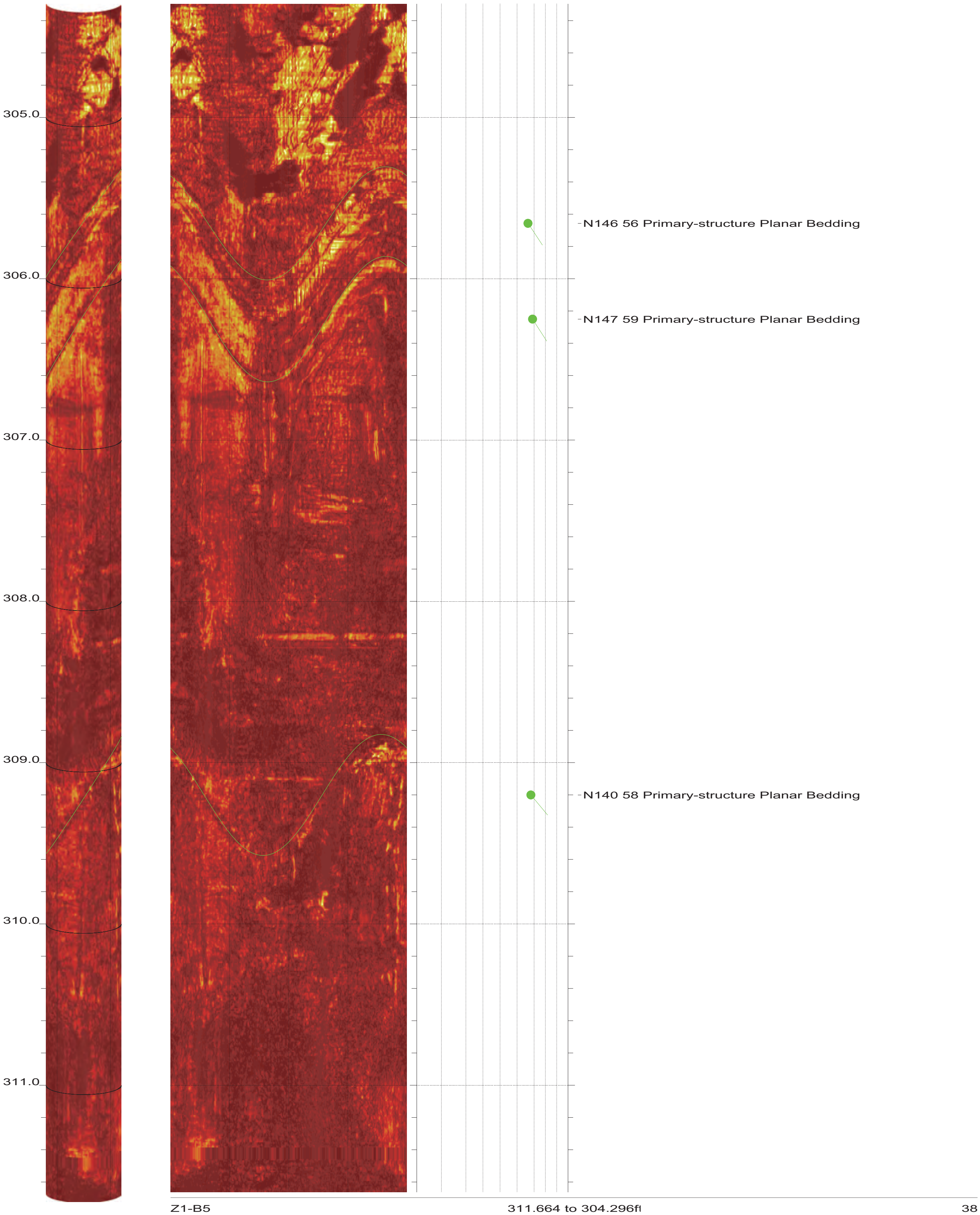


Z1-B5 296.928 to 289.560ft 36

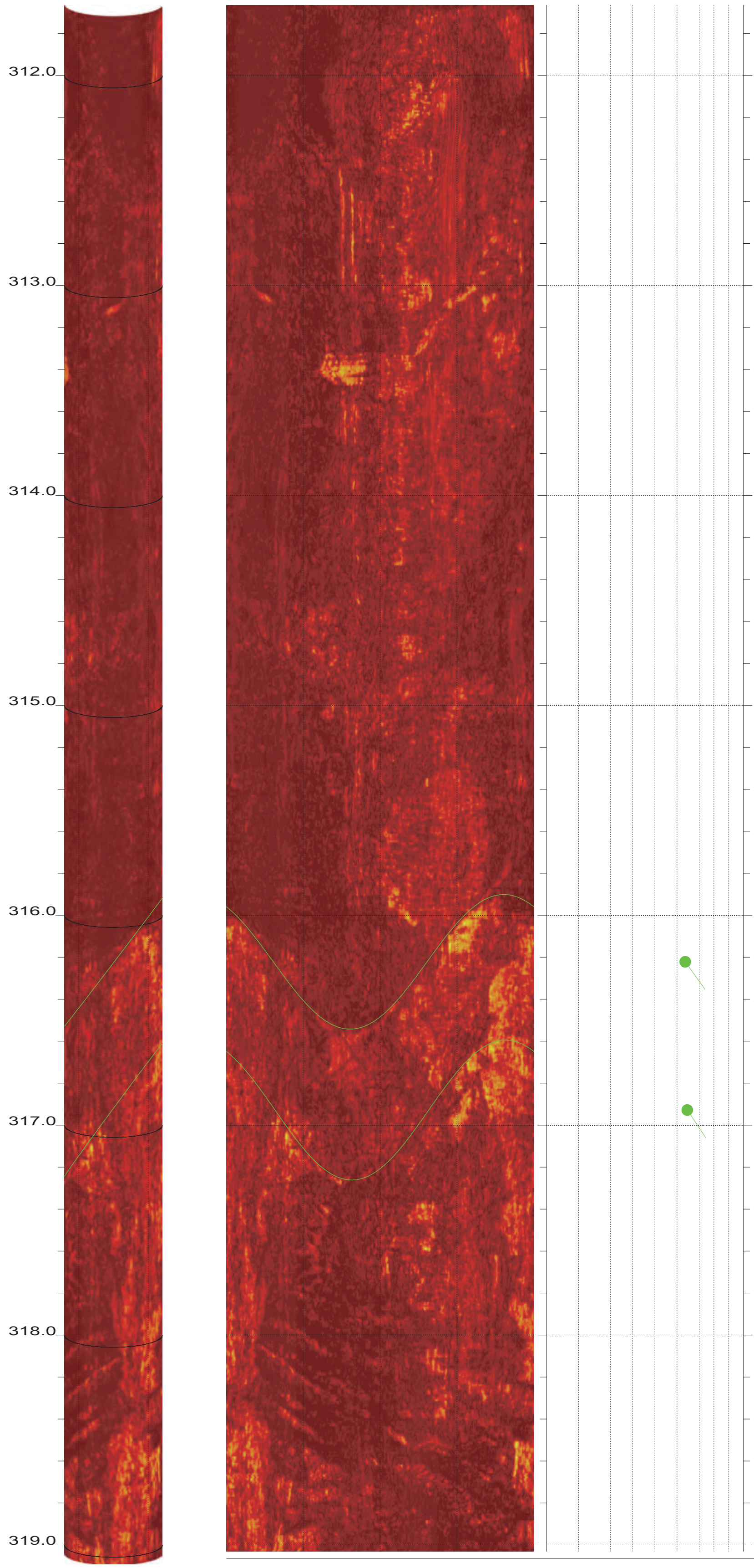
SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 36 of 64



SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 37 of 64



SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 38 of 64

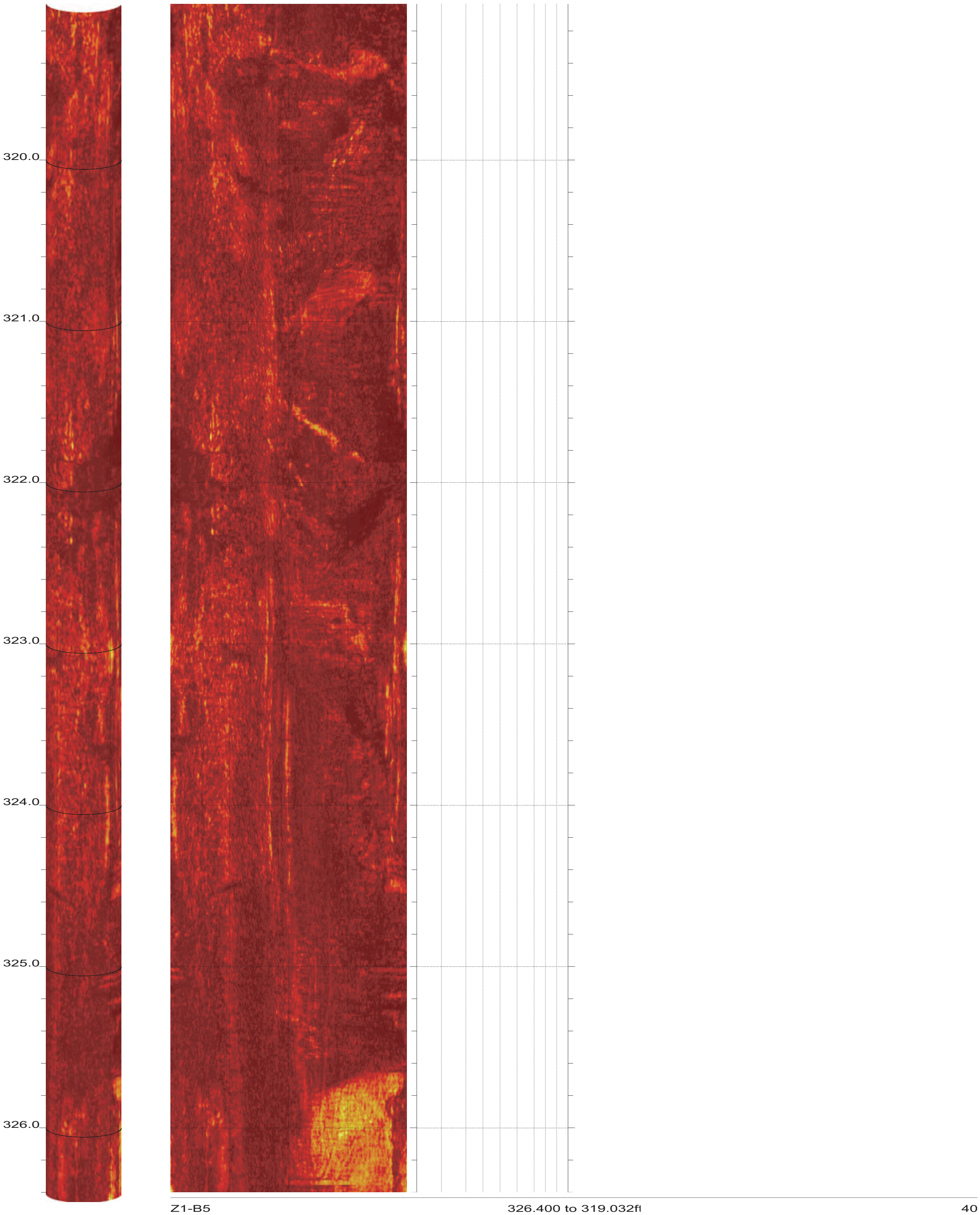


N144 54 Primary-structure Planar Bedding

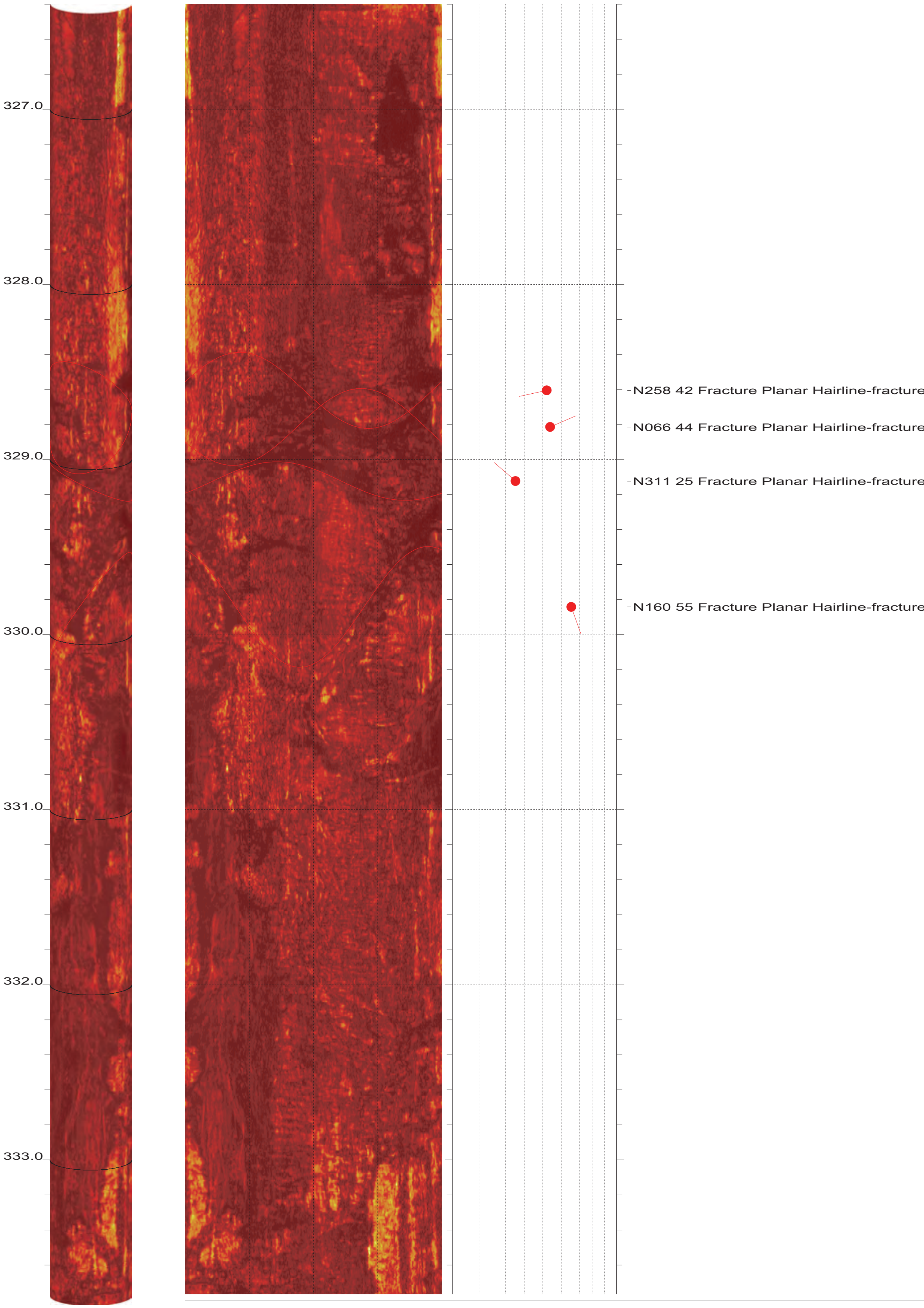
N146 55 Primary-structure Planar Bedding

Z1-B5 319.032 to 311.664ft 39

SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 39 of 64

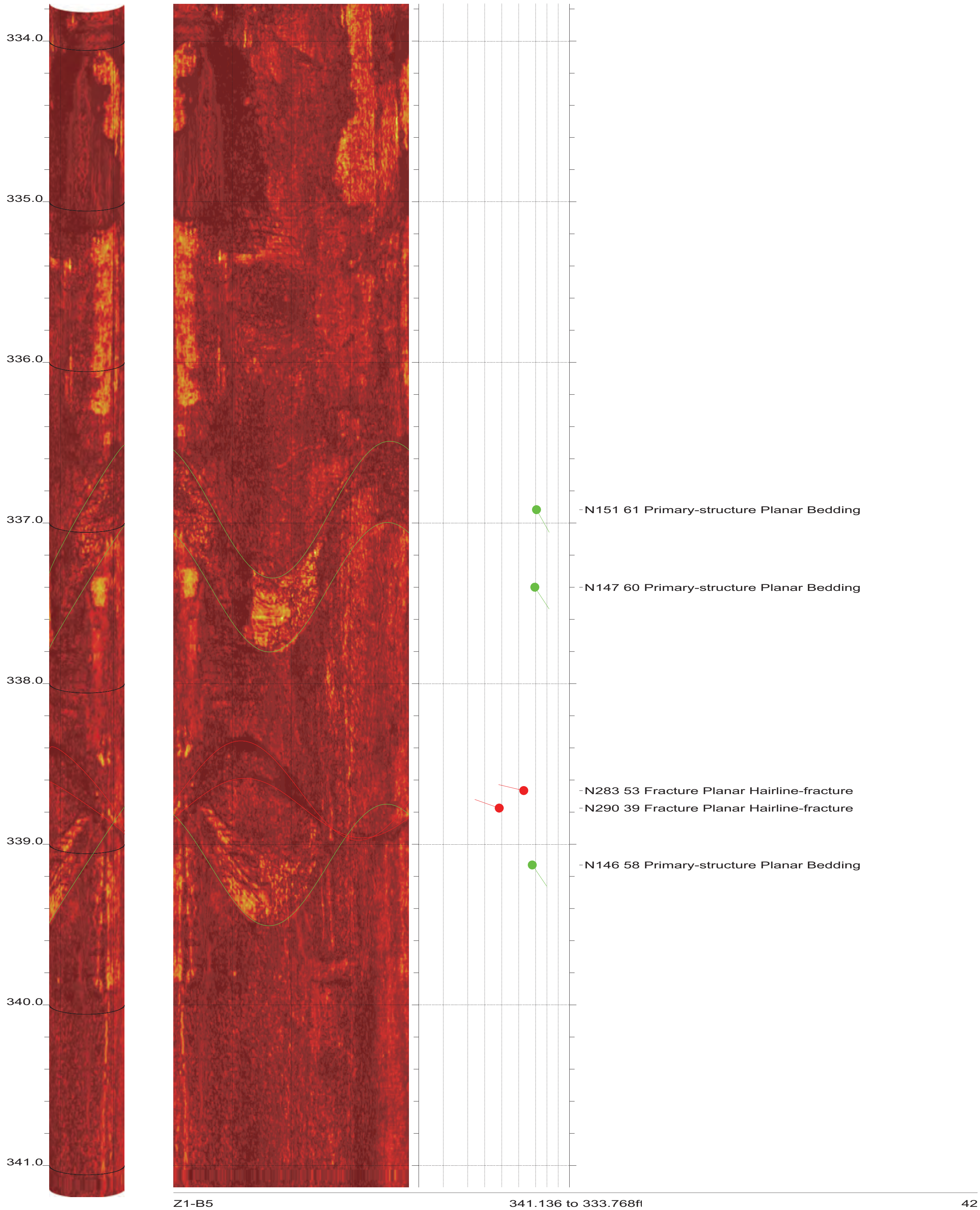


SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 40 of 64

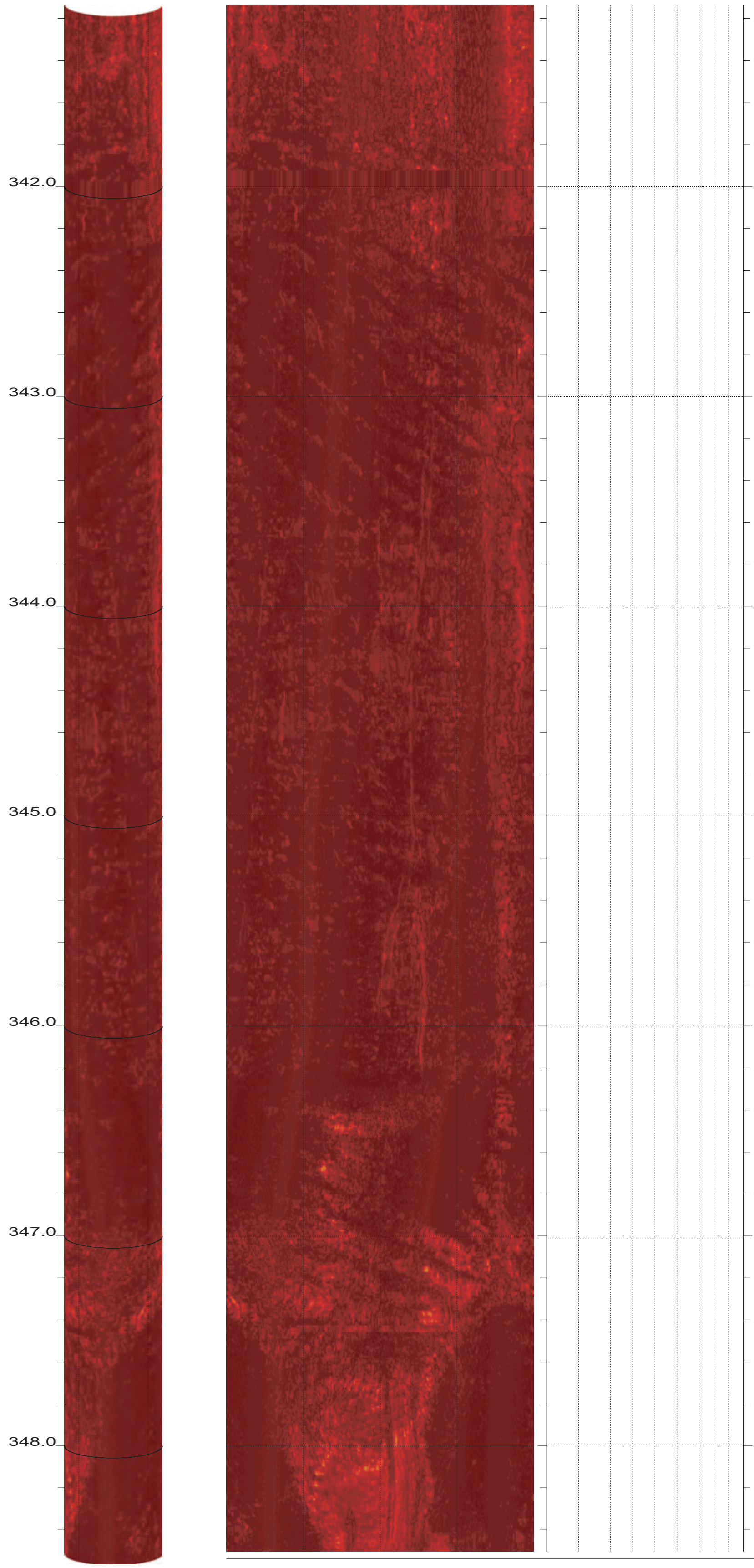


Z1-B5 333.768 to 326.400ft 41

SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 41 of 64

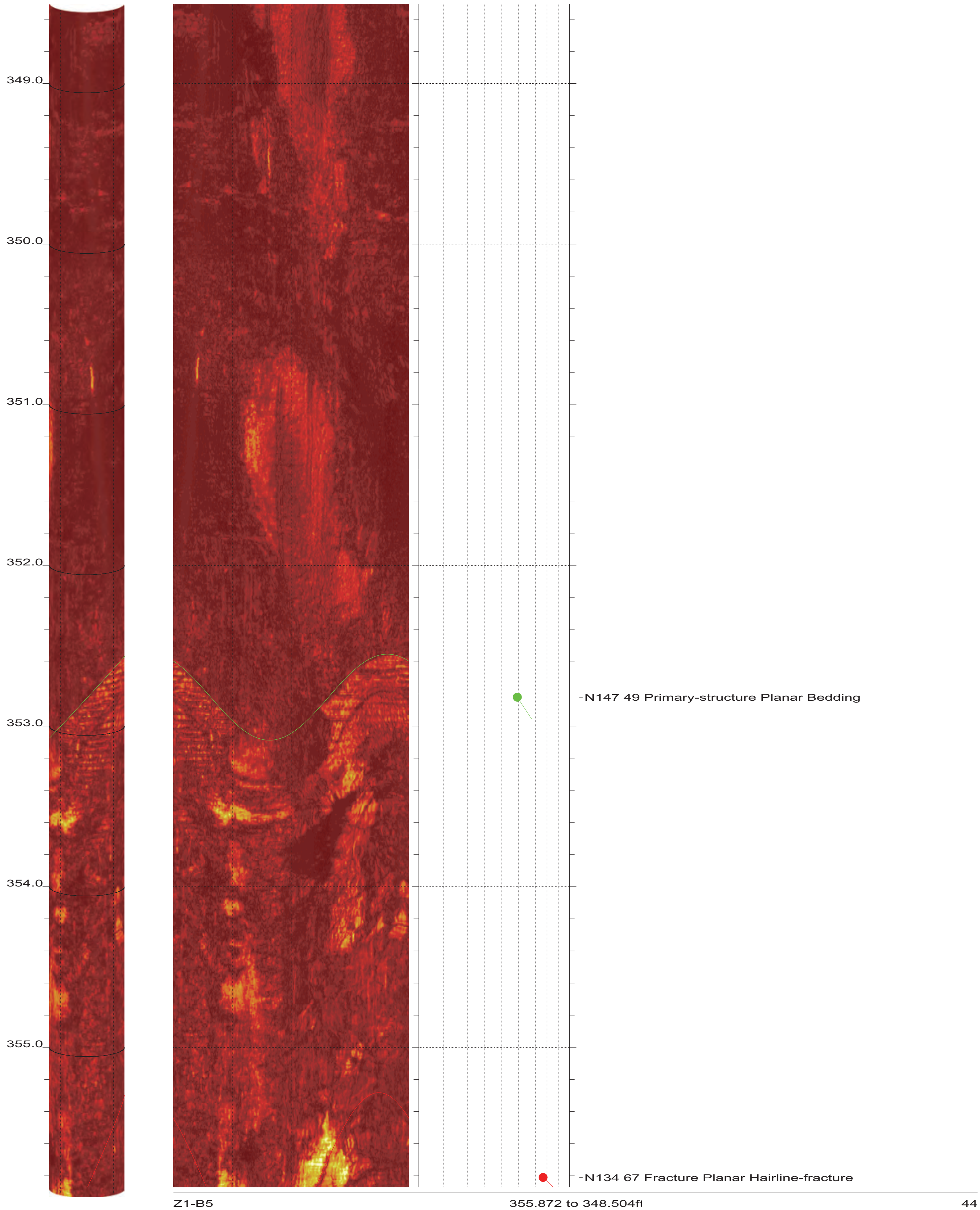


SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 42 of 64

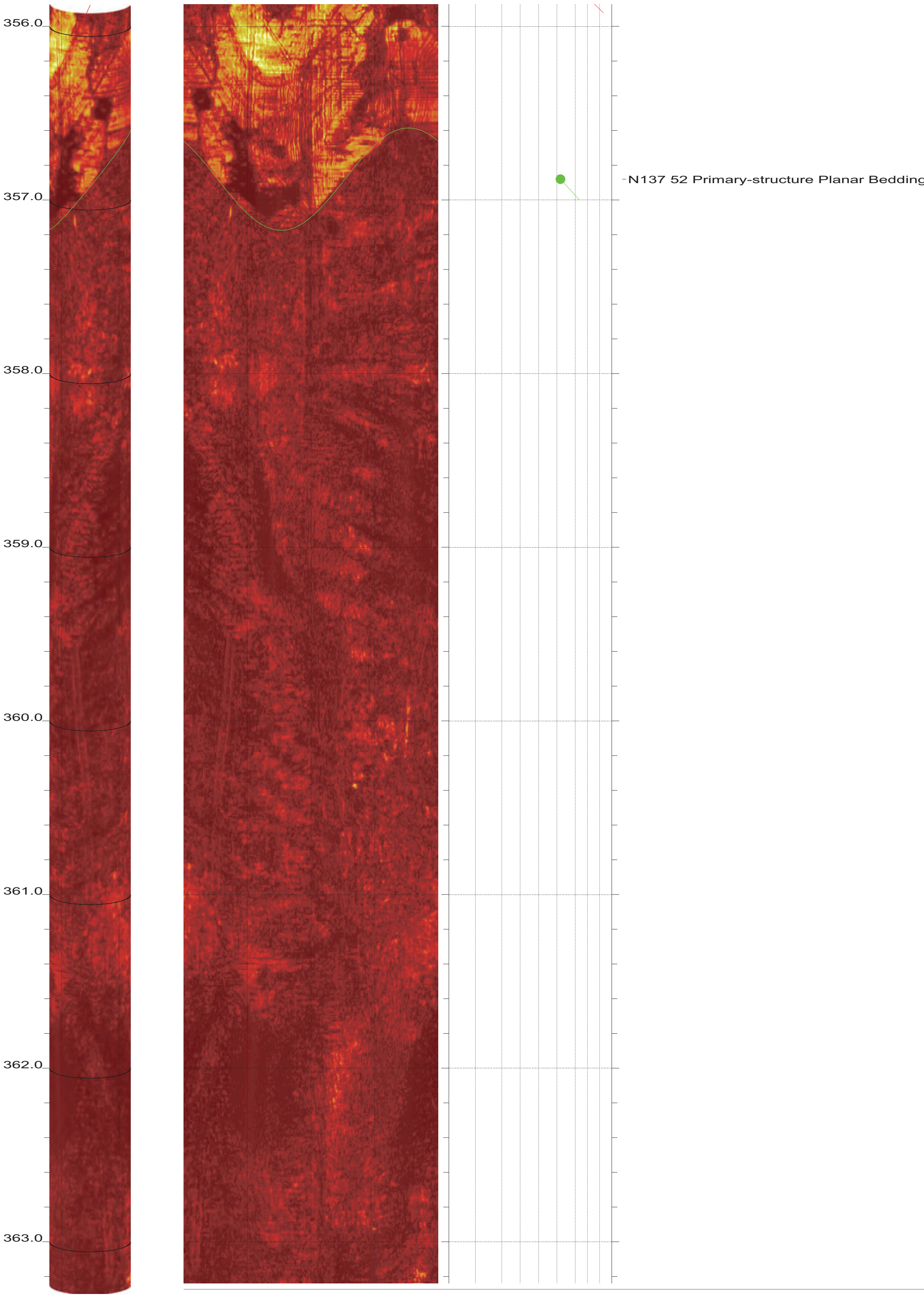


Z1-B5 348.504 to 341.136ft 43

SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 43 of 64

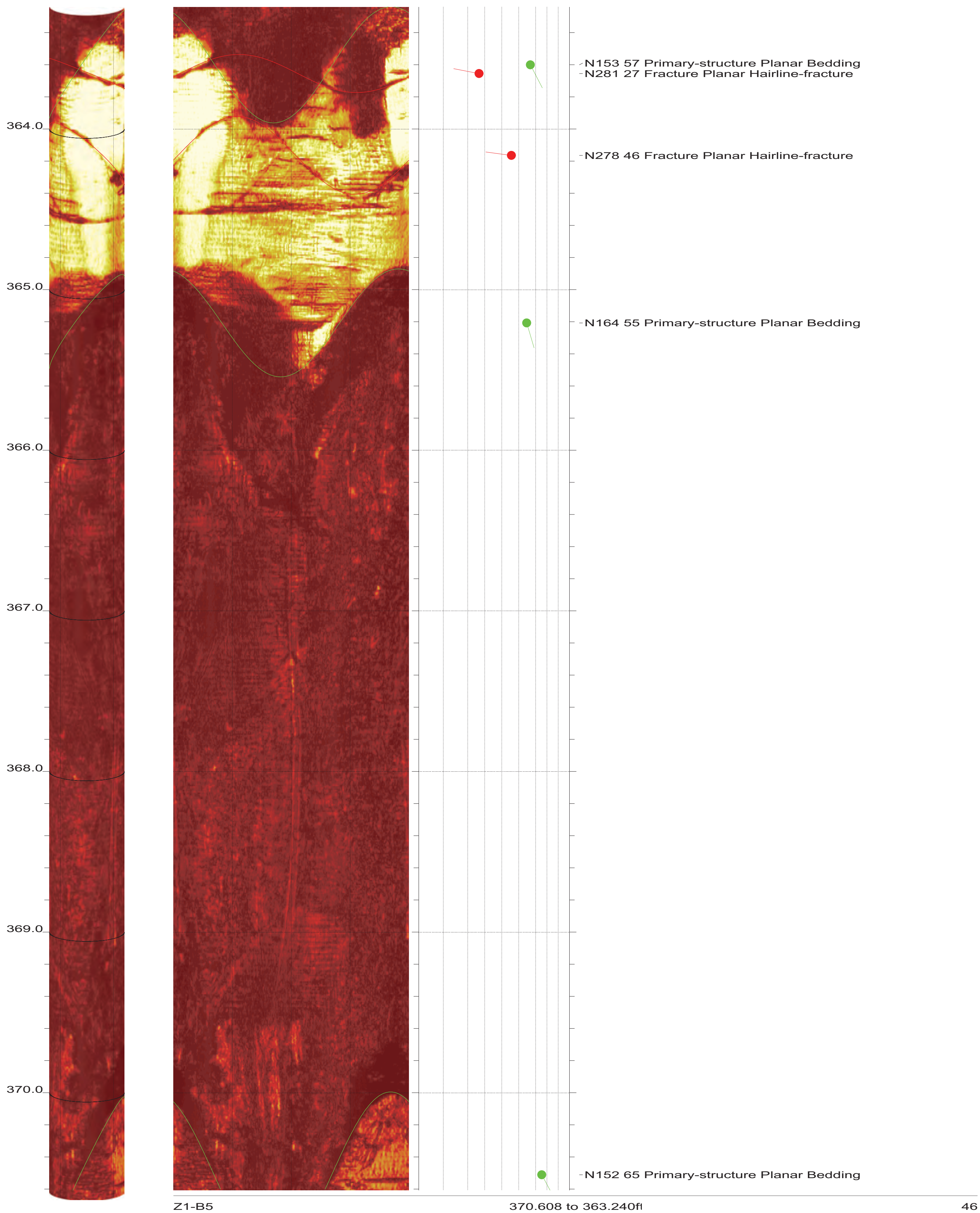


SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 44 of 64

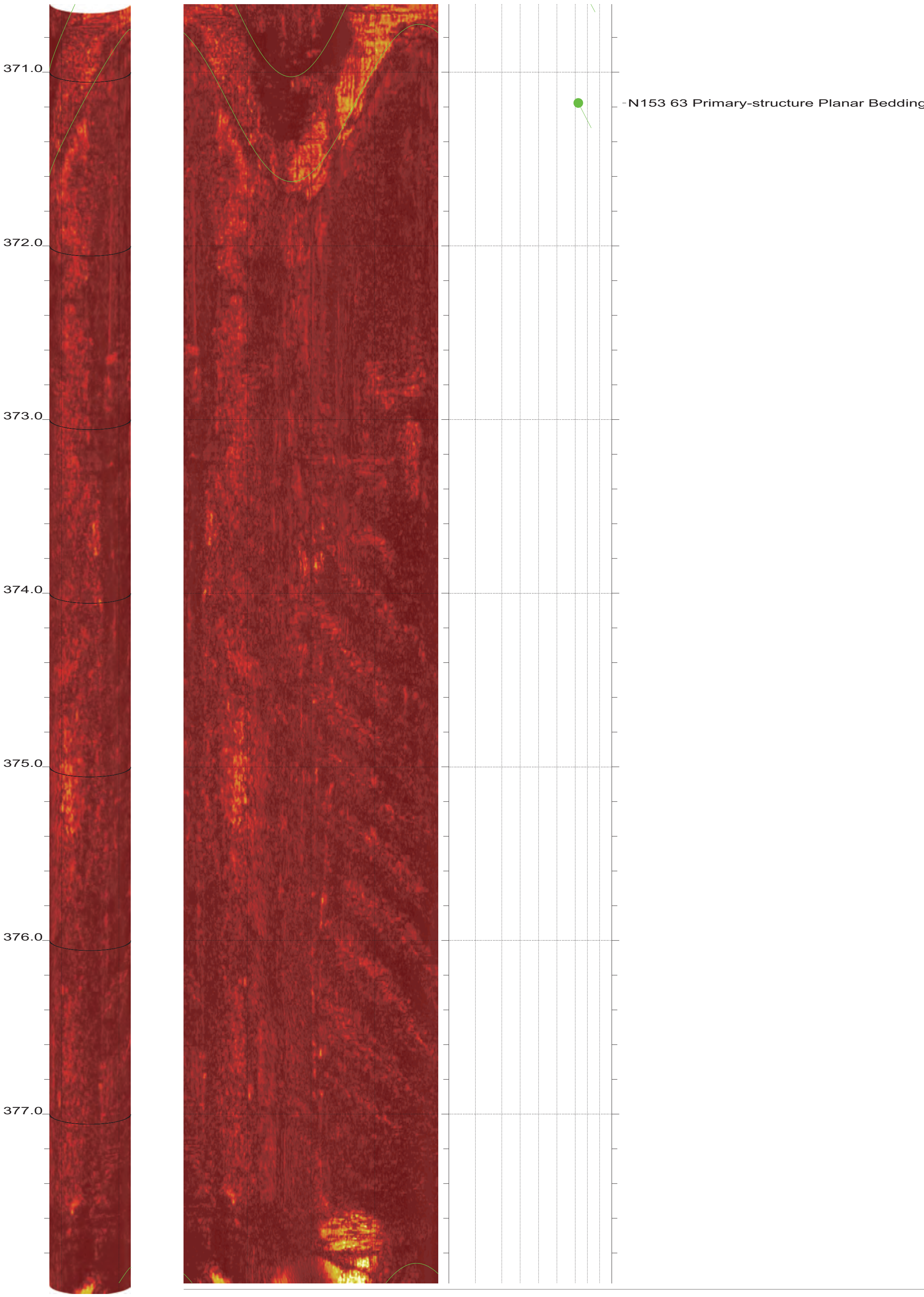


Z1-B5 363.240 to 355.872ft 45

SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 45 of 64

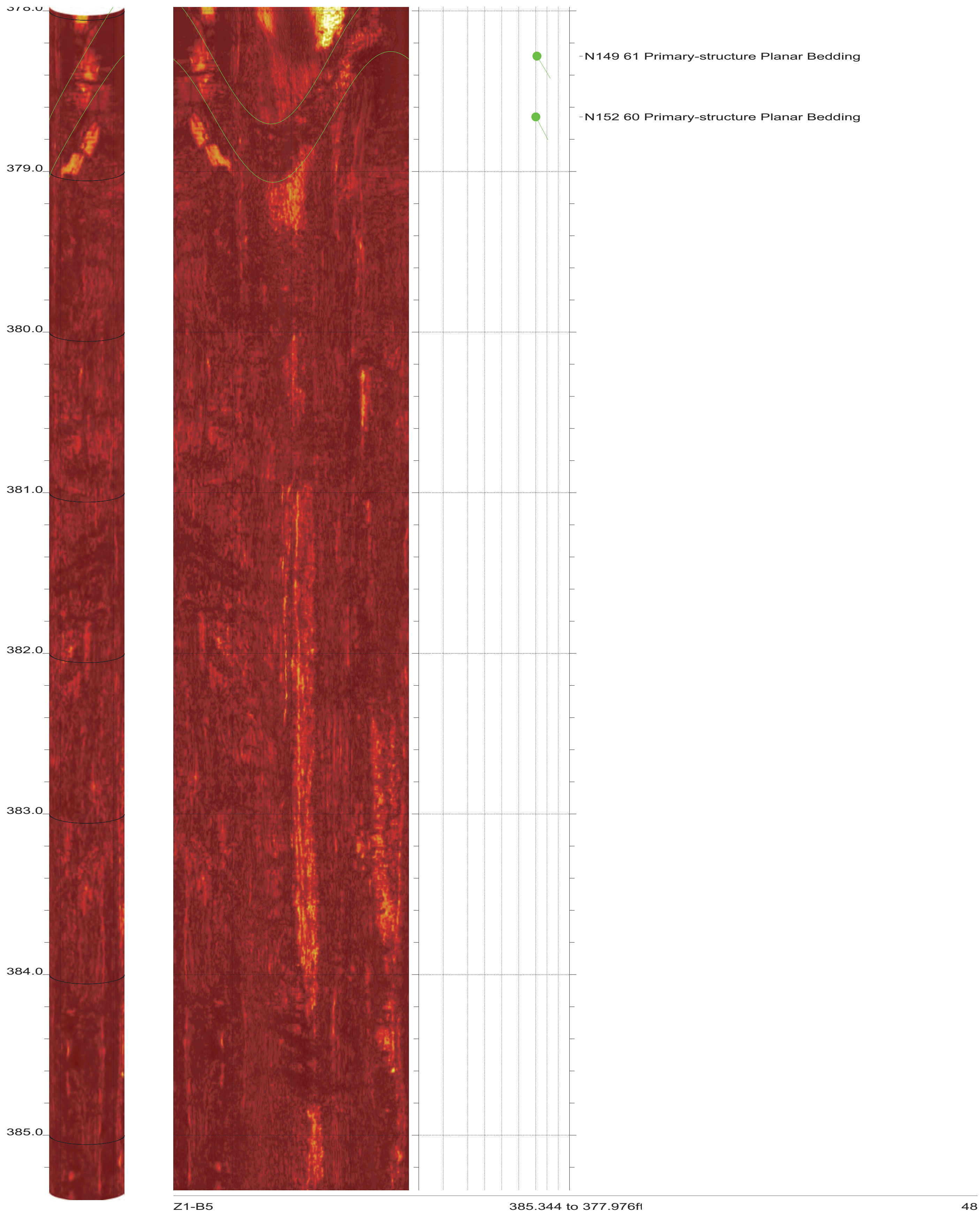


SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 46 of 64

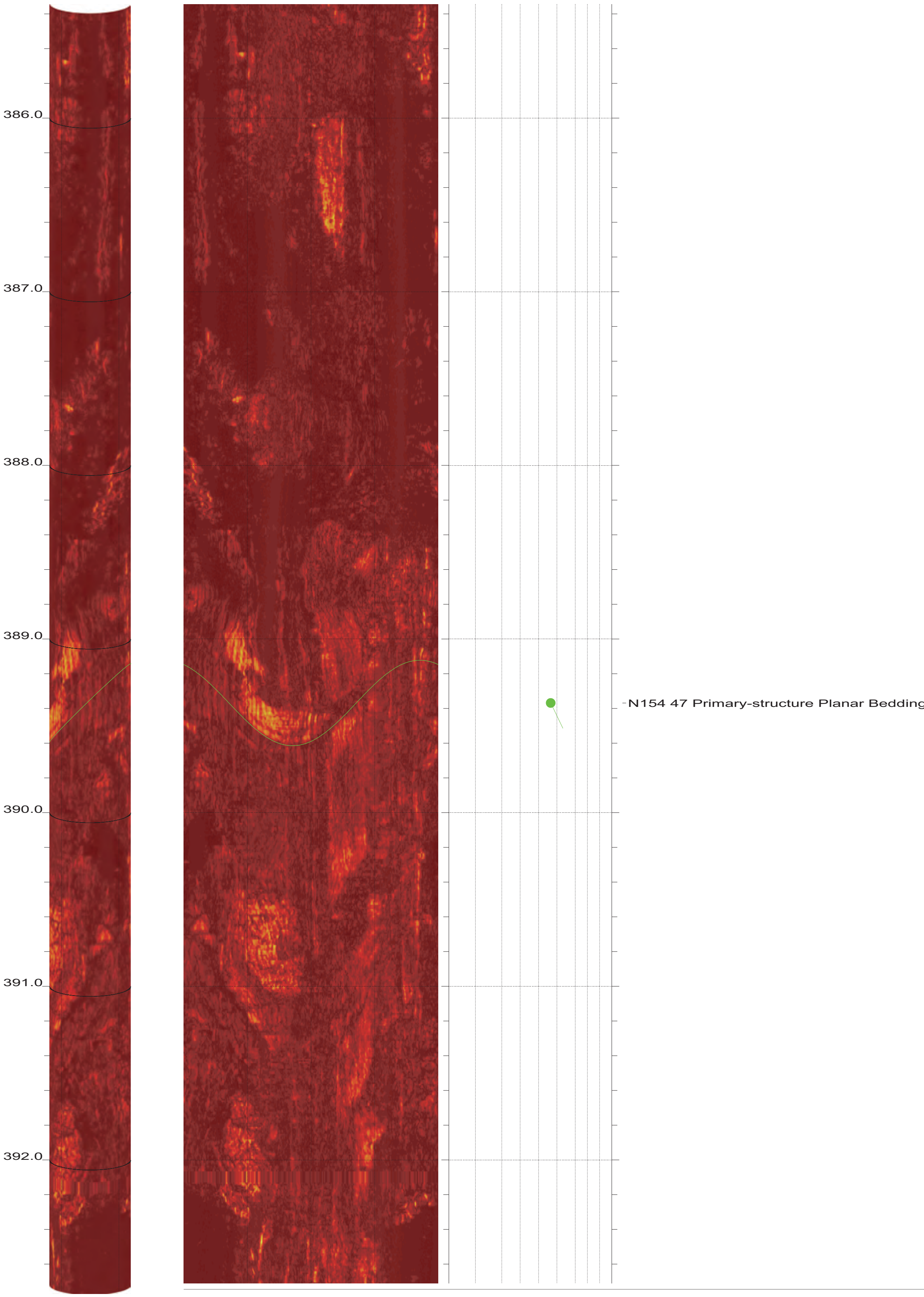


Z1-B5 377.976 to 370.608ft 47

SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 47 of 64

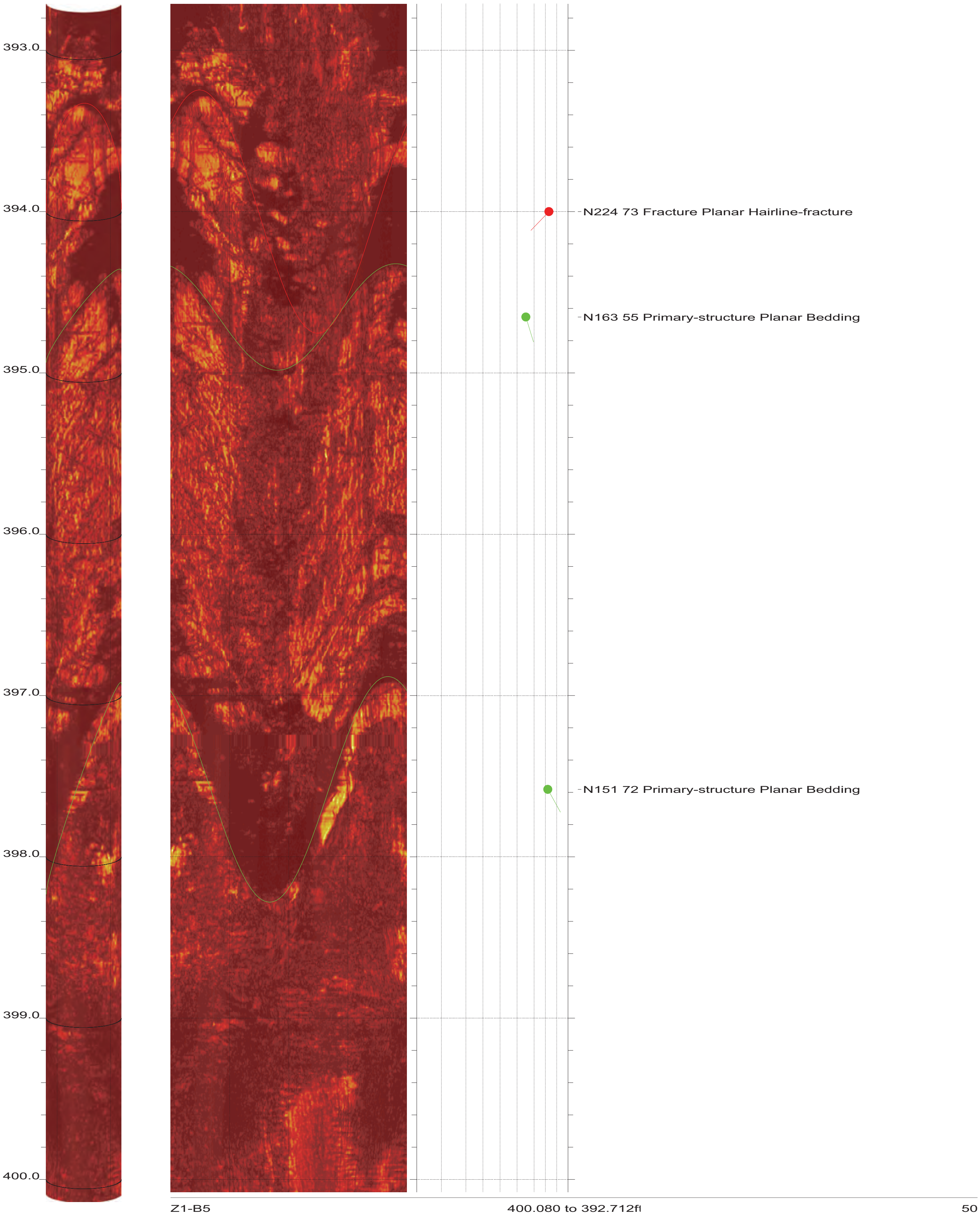


SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 48 of 64

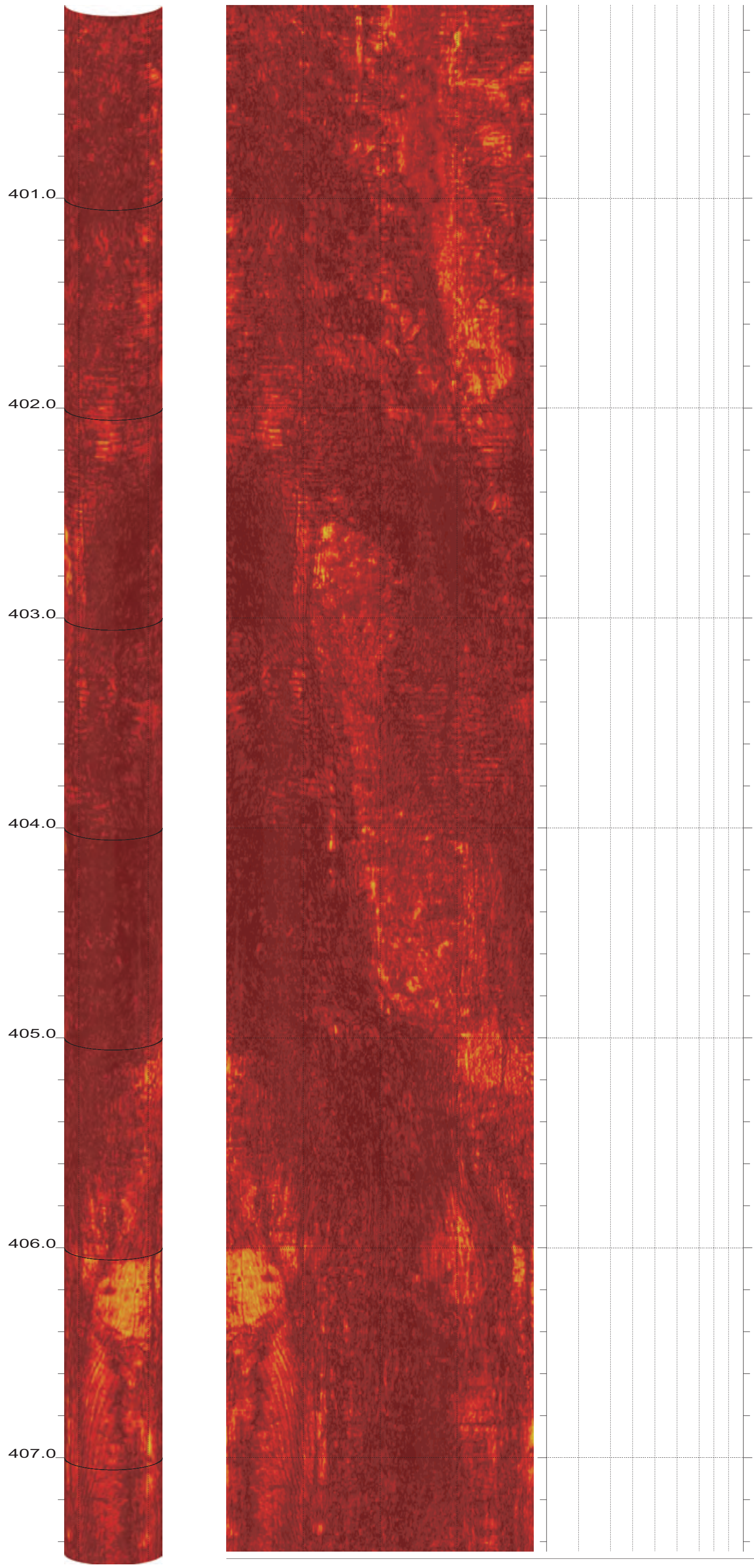


Z1-B5 392.712 to 385.344ft 49

SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 49 of 64

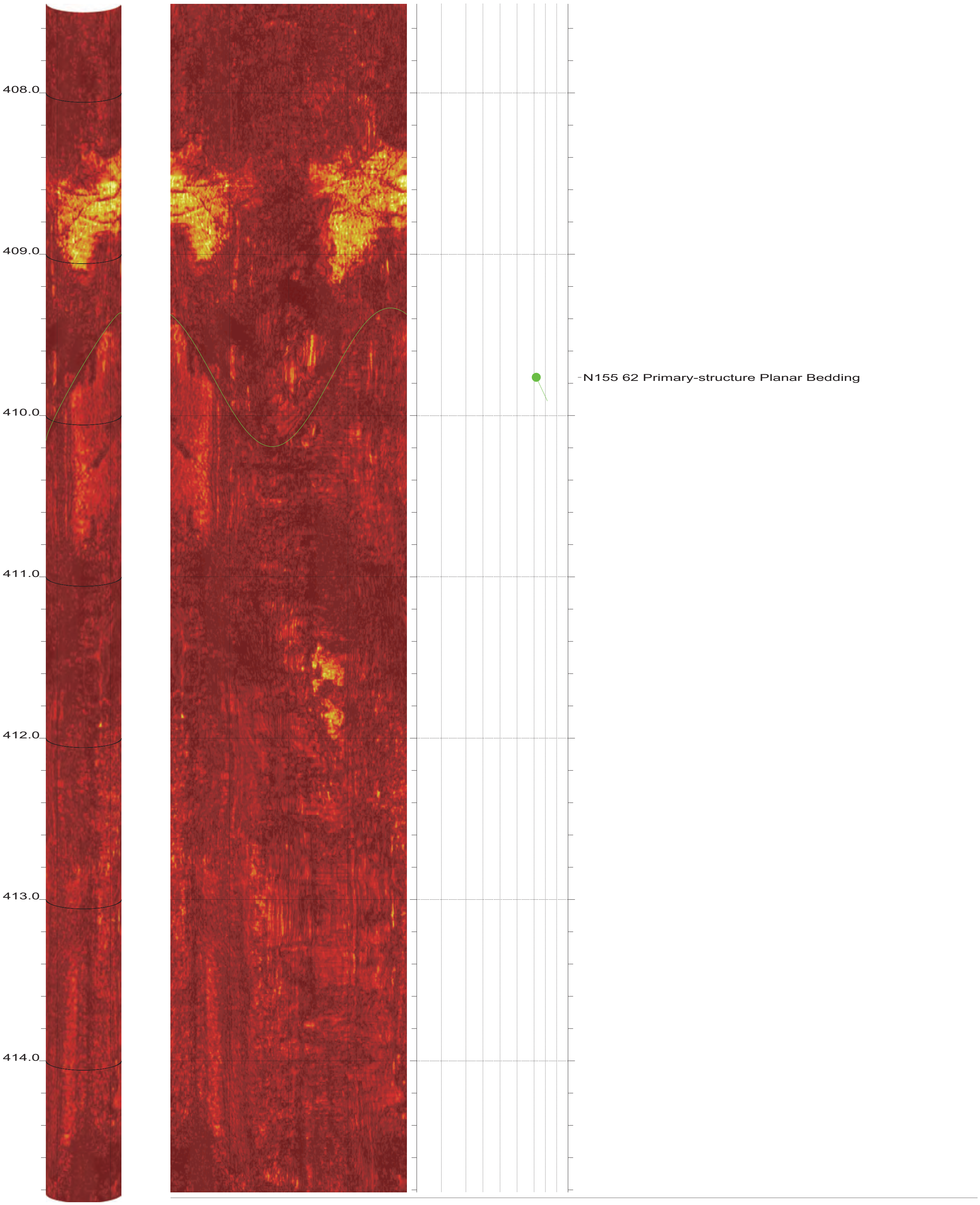


SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 50 of 64



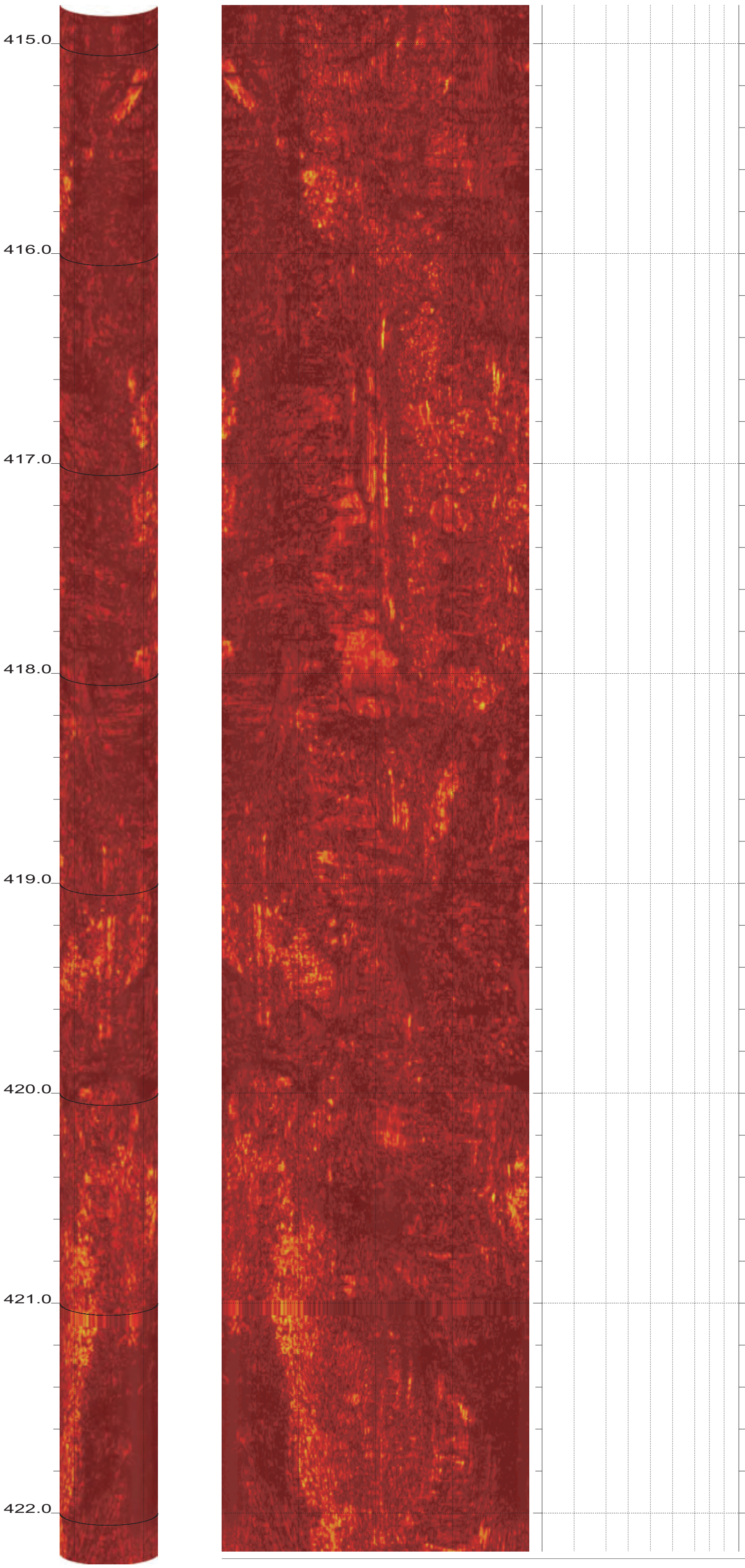
Z1-B5 407.448 to 400.080ft 51

SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 51 of 64



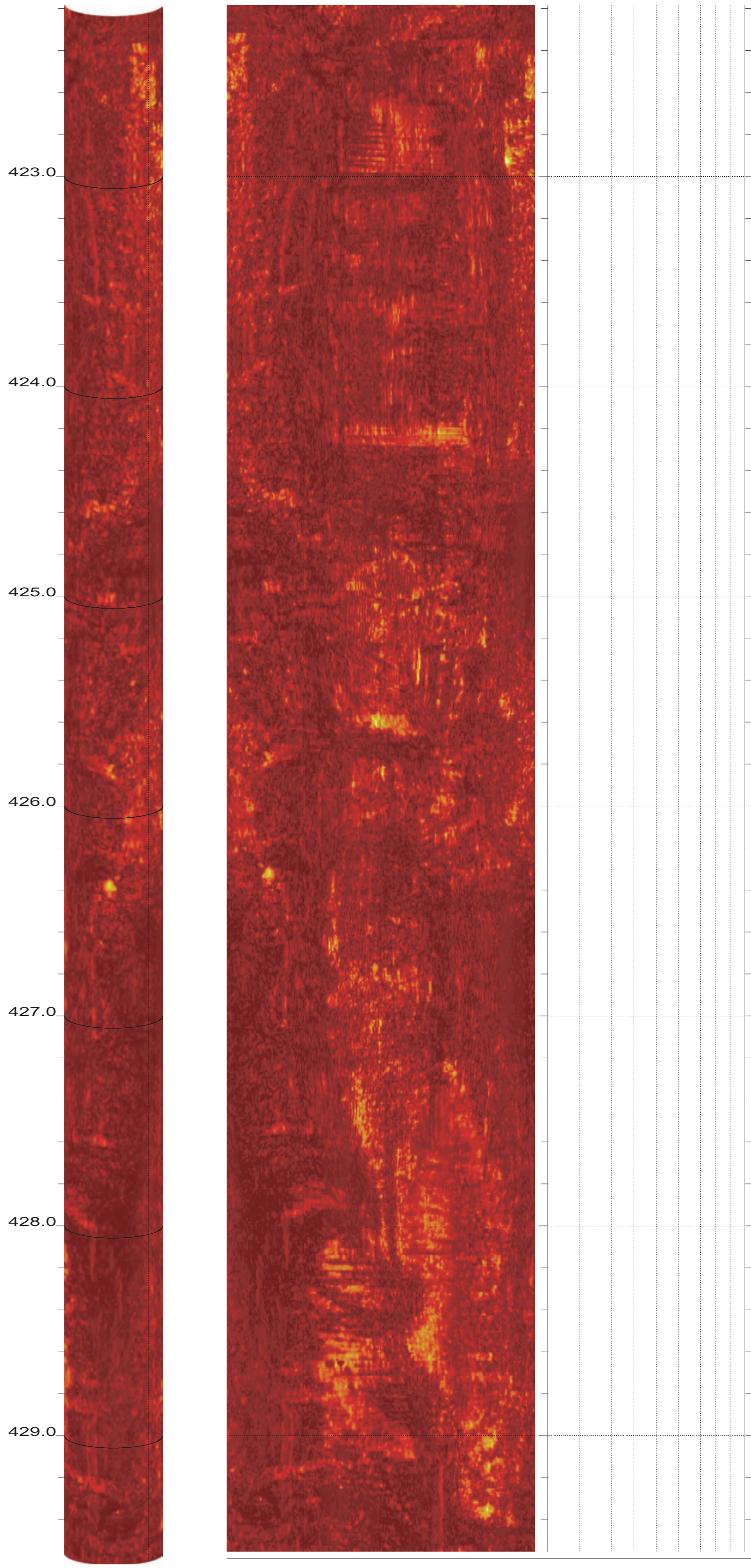
Z1-B5 414.816 to 407.448ft 52

SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 52 of 64



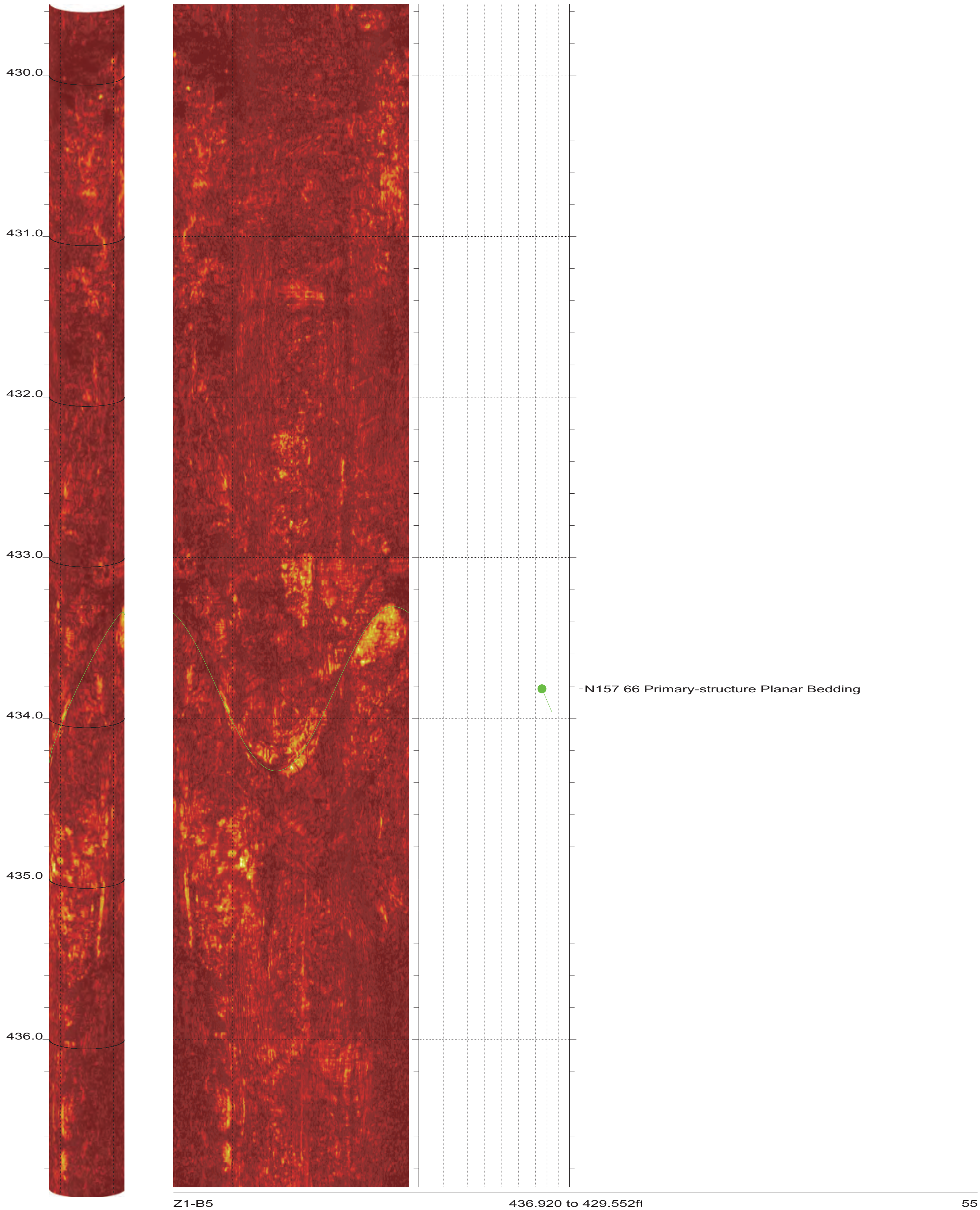
Z1-B5 422.184 to 414.816ft 53

SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 53 of 64

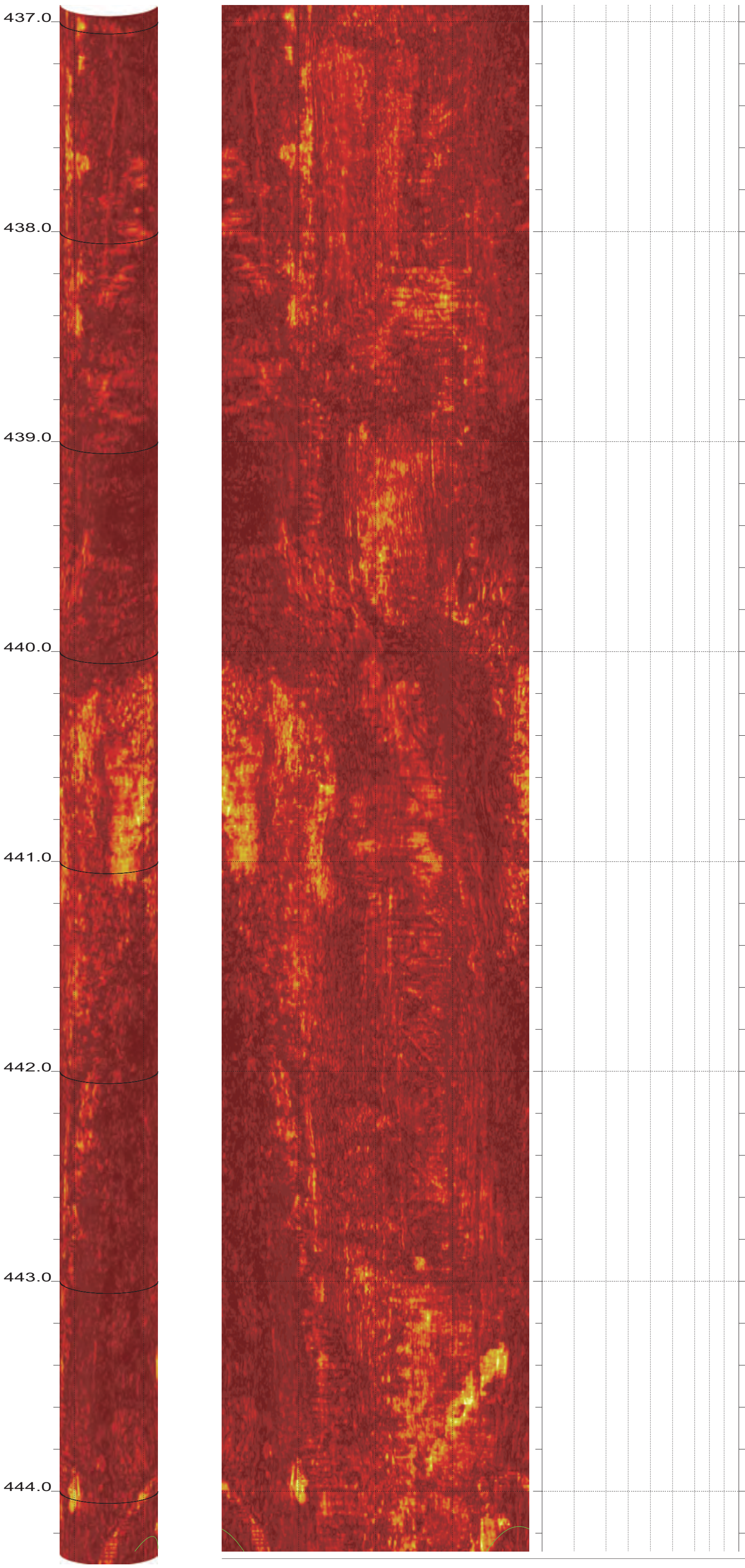


Z1-B5 429.552 to 422.184ft 54

SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 54 of 64

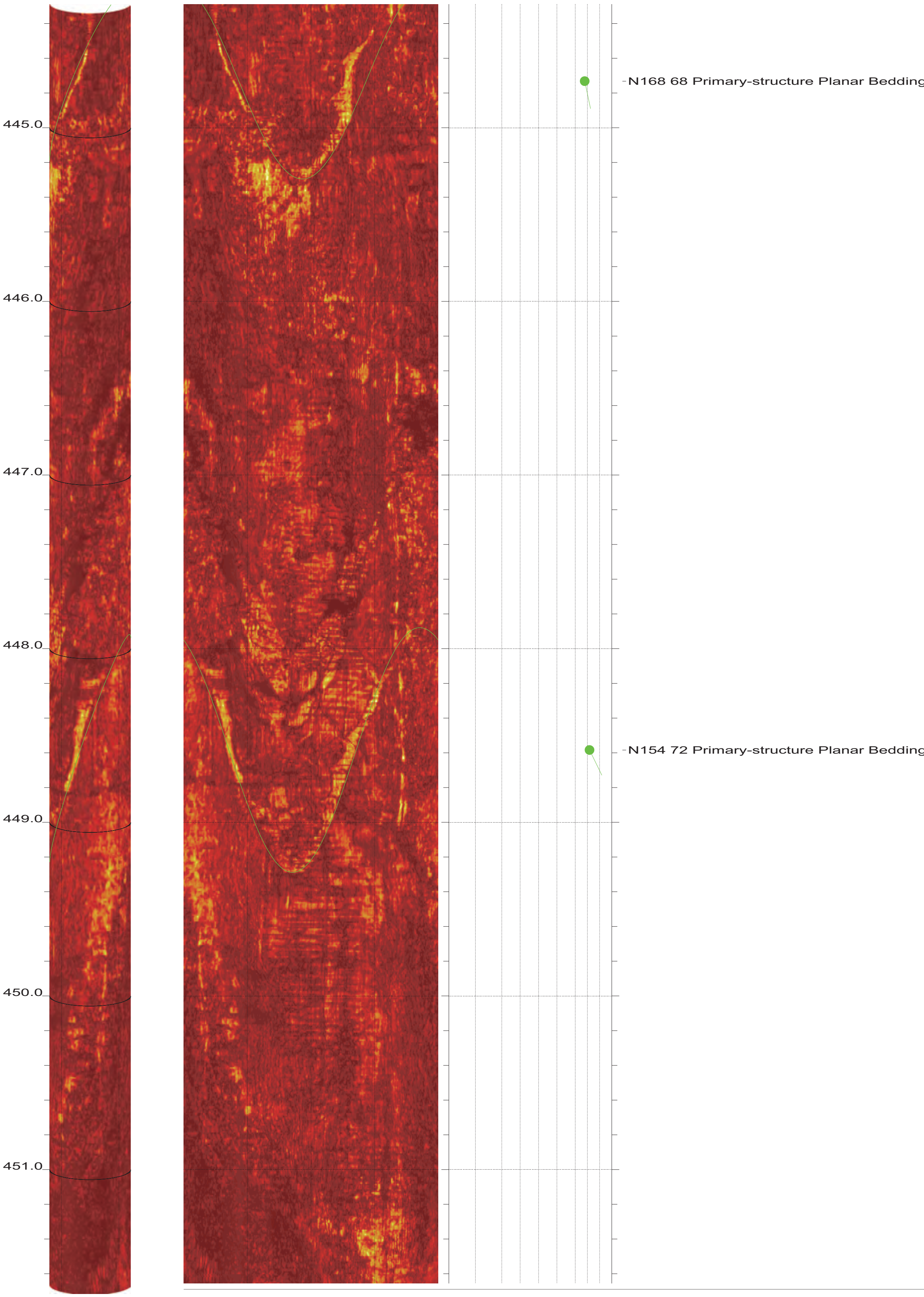


SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 55 of 64



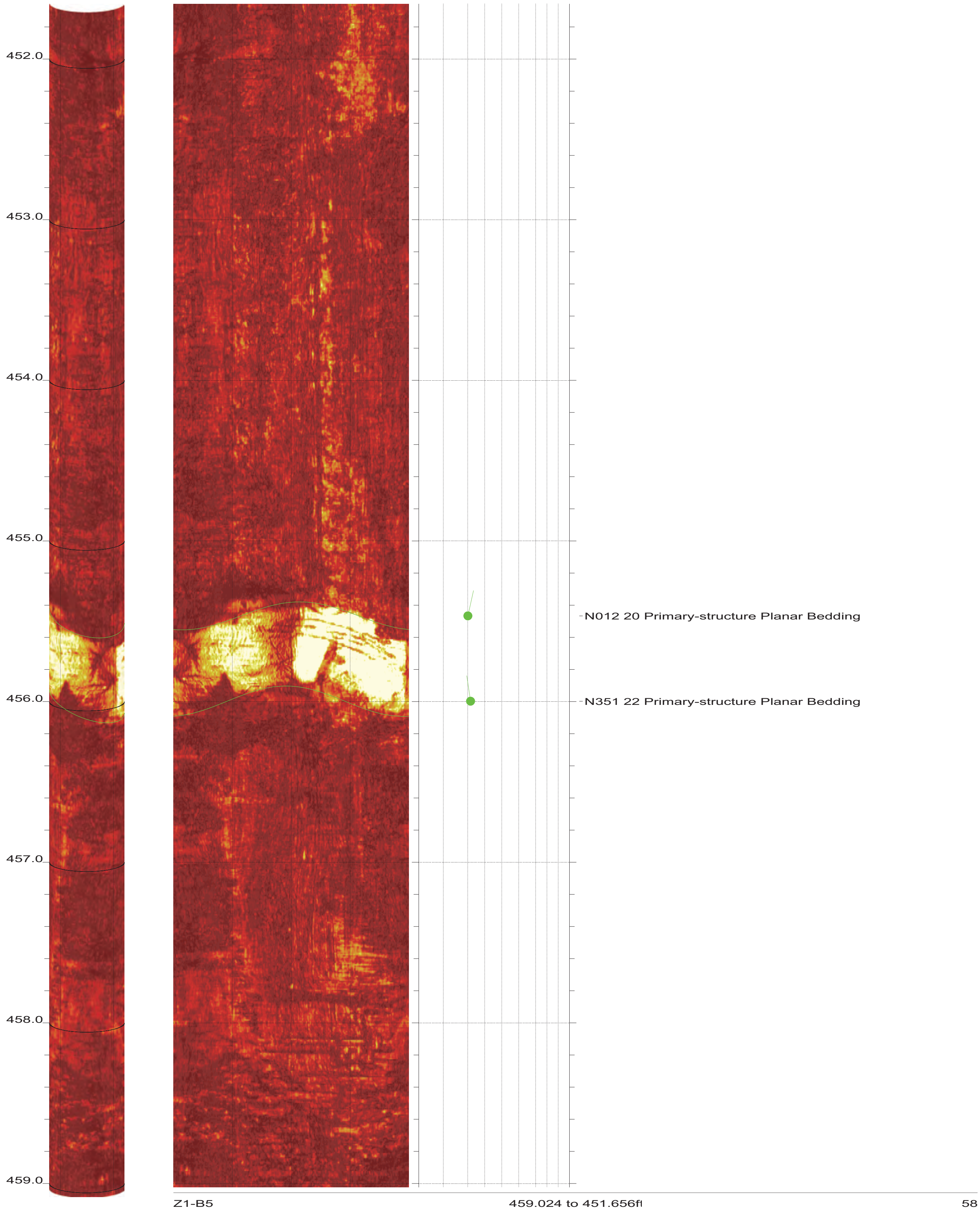
Z1-B5 444.288 to 436.920ft 56

SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 56 of 64

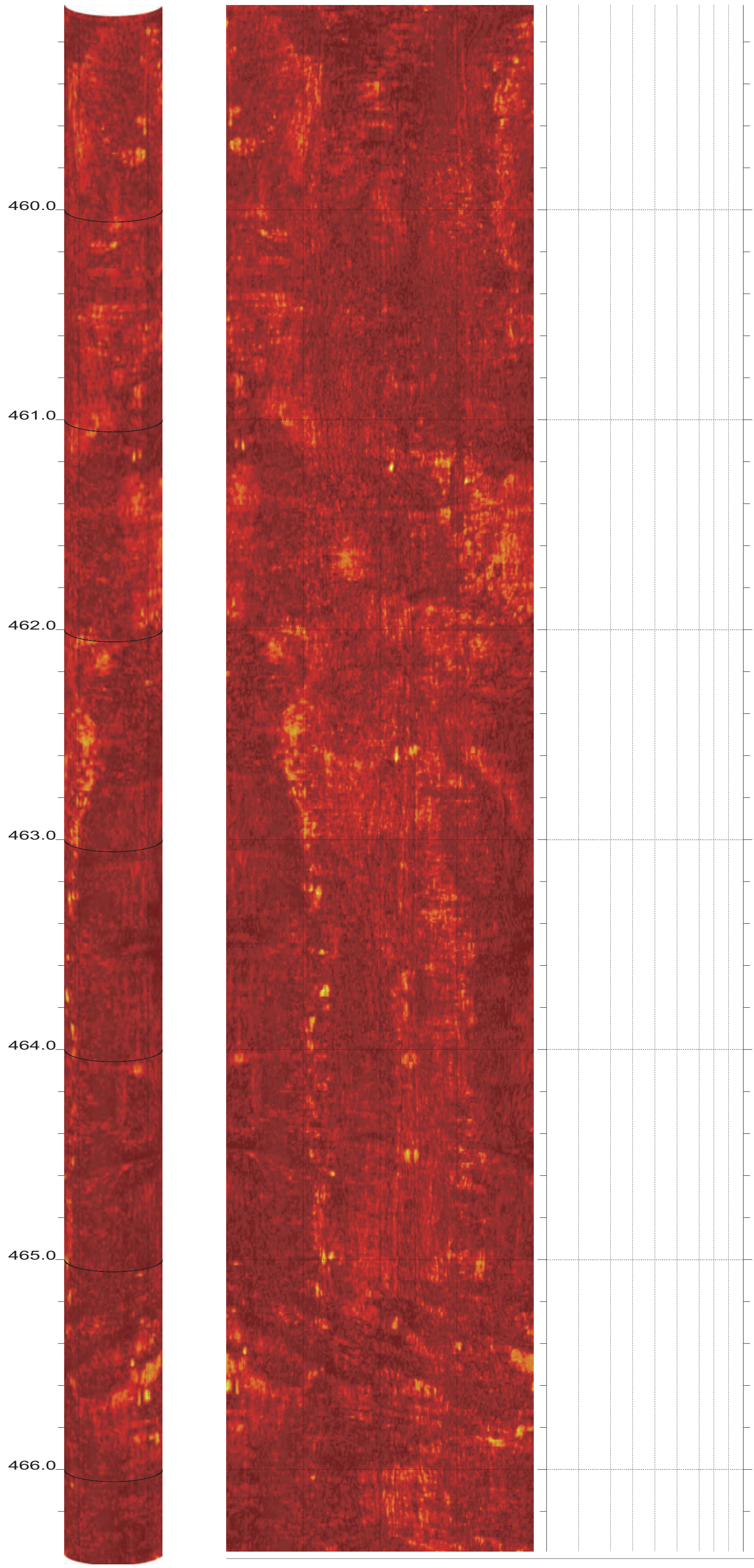


Z1-B5 451.656 to 444.288ft 57

SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 57 of 64

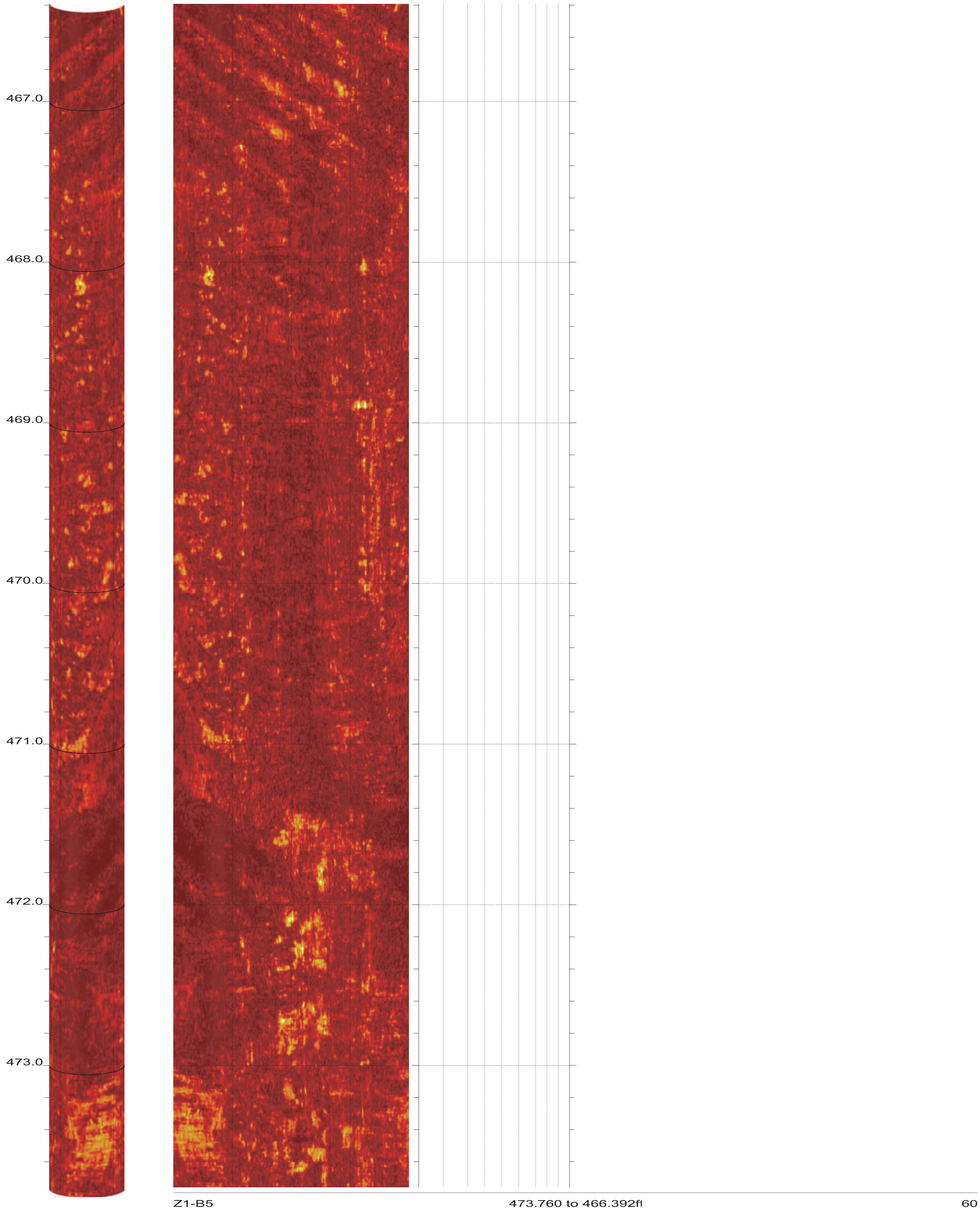


SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 58 of 64

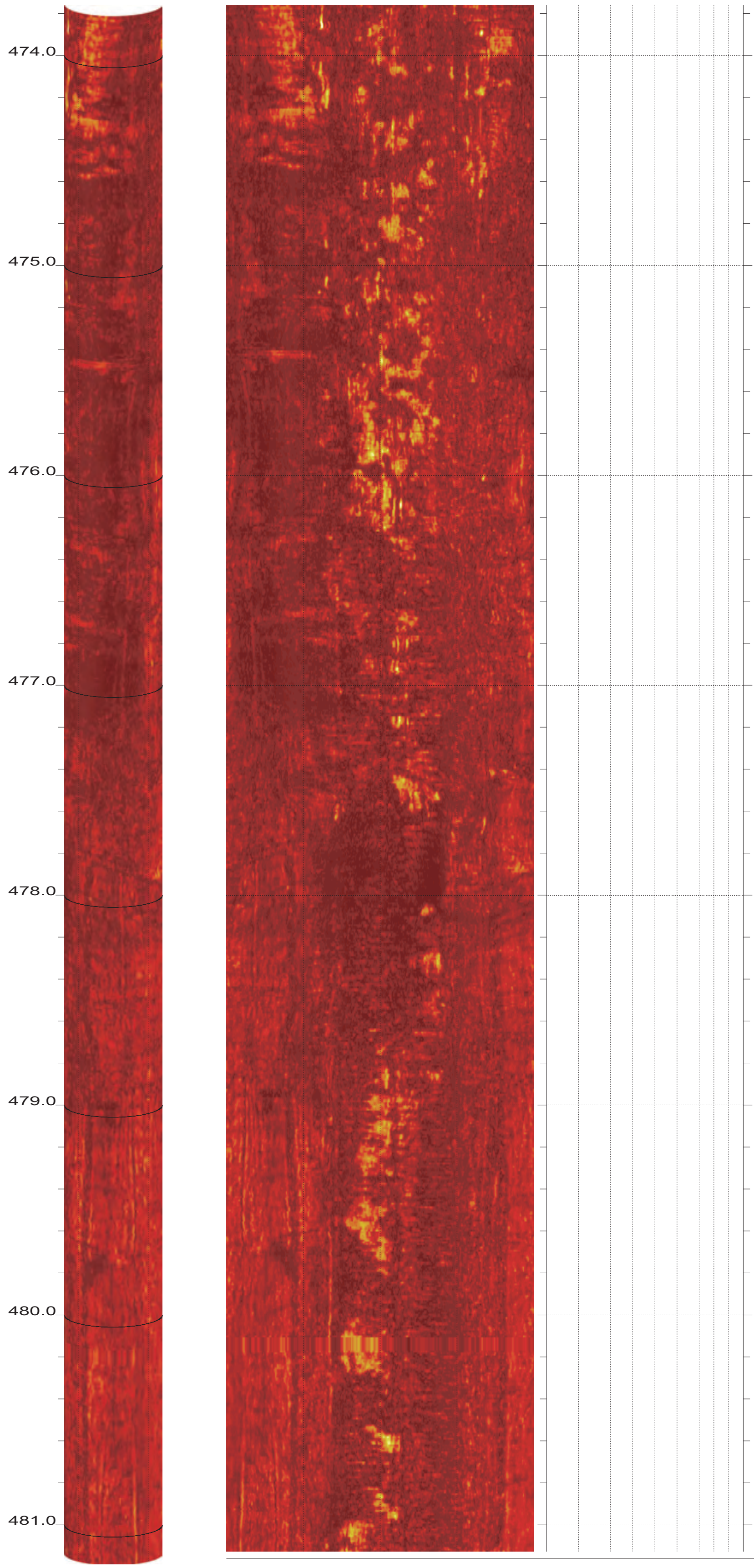


Z1-B5 466.392 to 459.024ft 59

SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 59 of 64

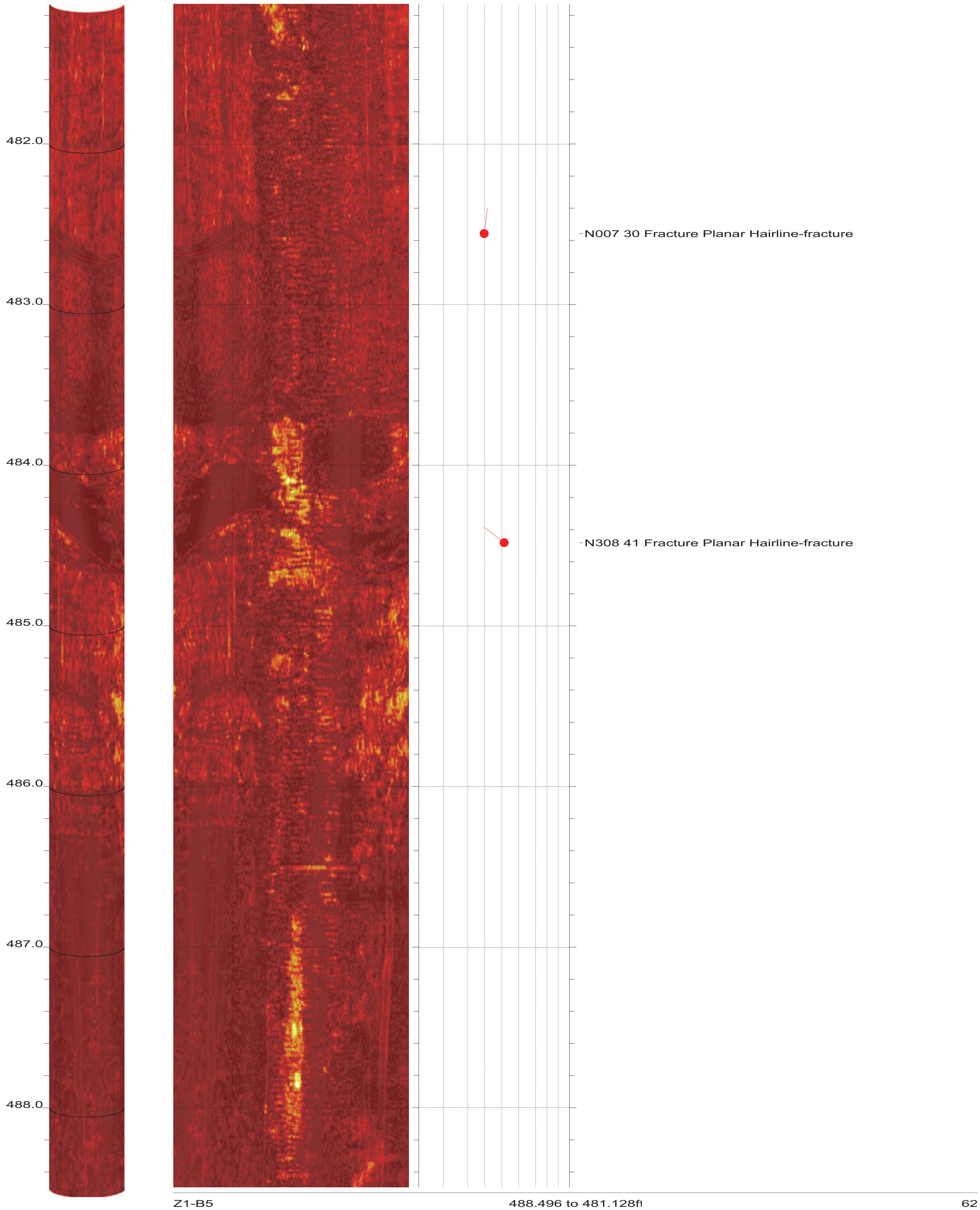


SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 60 of 64

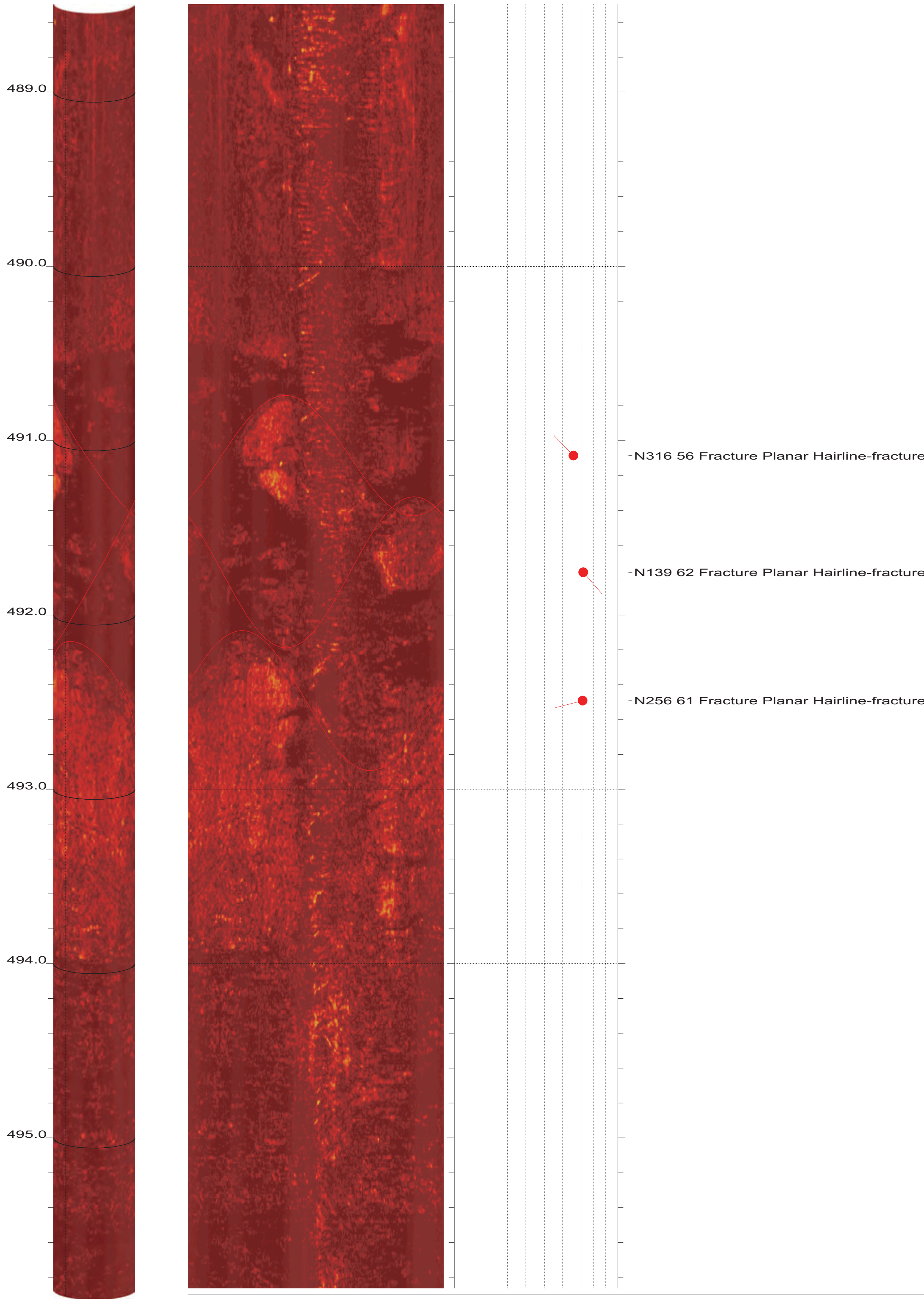


Z1-B5 481.128 to 473.760ft 61

SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 61 of 64

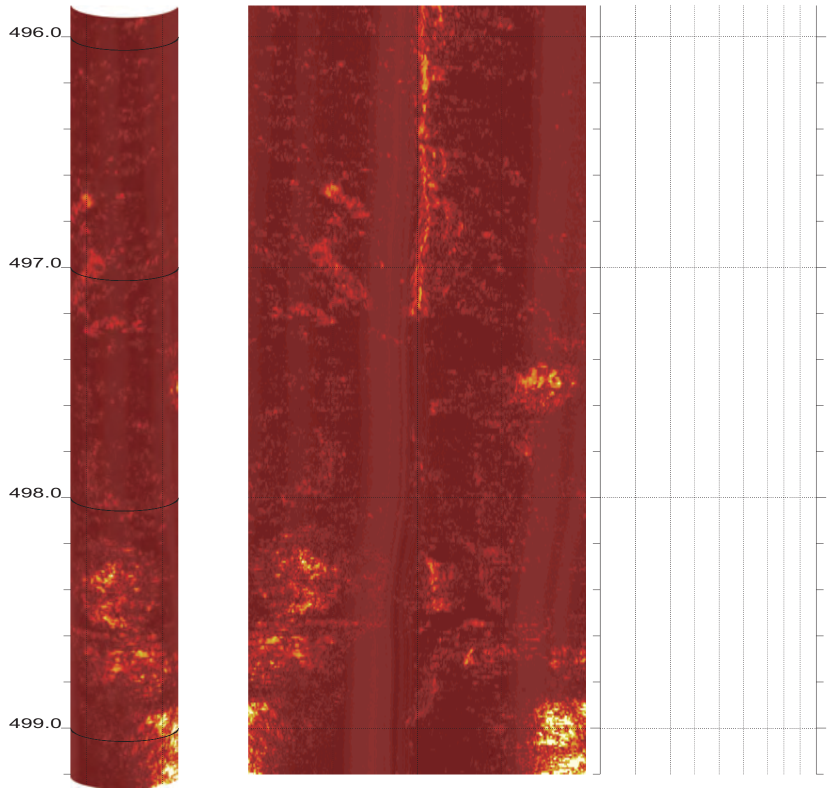


SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 62 of 64



Z1-B5 495.864 to 488.496ft 63

SR-710 Boring Z1-B5 Acoustic Televiewer Dips rev 1 Sheet 63 of 64


496.0
497.0
498.0
499.0

BHTV DATA PROCESSING
RGLDIP vsn 6.2
INTERPRETED BHTV DIPS LOG

CASCADE DRILLING

Borehole: Z1-B6

SR-710 TUNNEL INVESTIGATION

top of borehole.....	North ref. is true
East: _	Depth units are feet
North: _	Vertical scale: 1/10
Elev: _	Horiz scale = 1.00x Vert scale

Zone from 399.800 to 65.000ft	Borehole diam: 5.900inch
Format: BHTV-NESWN	Vertical = borehole-axis
	Image: Amplitude

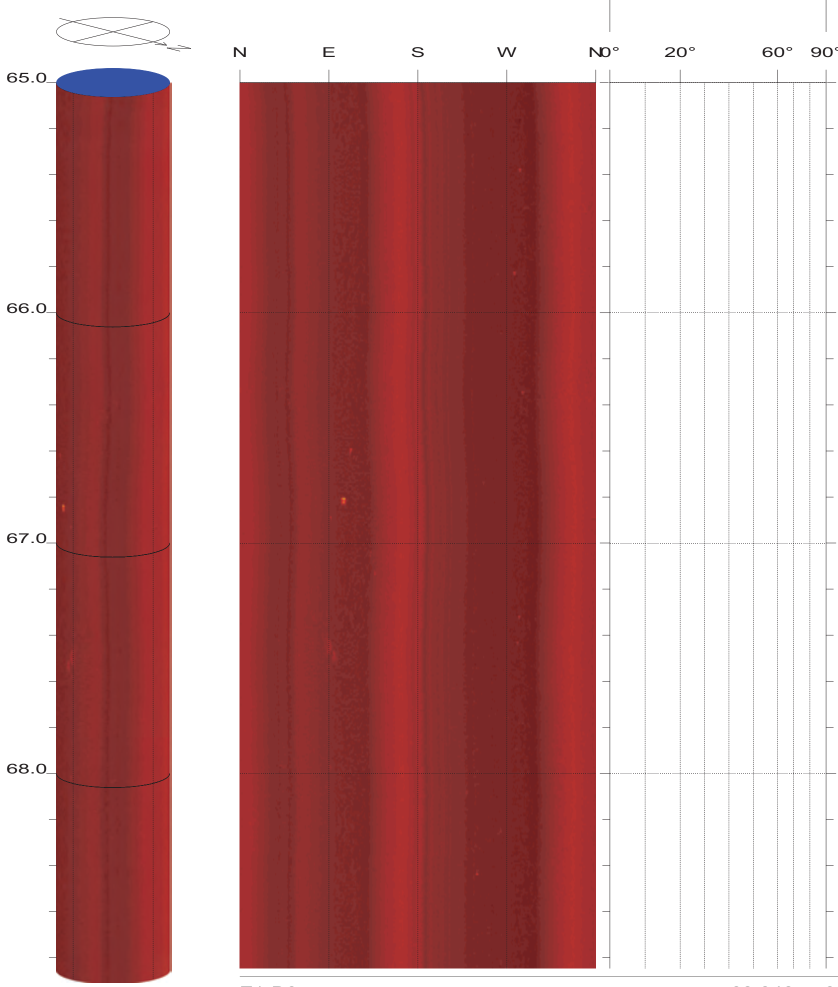
Stratigraphic dips

Non-stratigraphic dips

Identified units

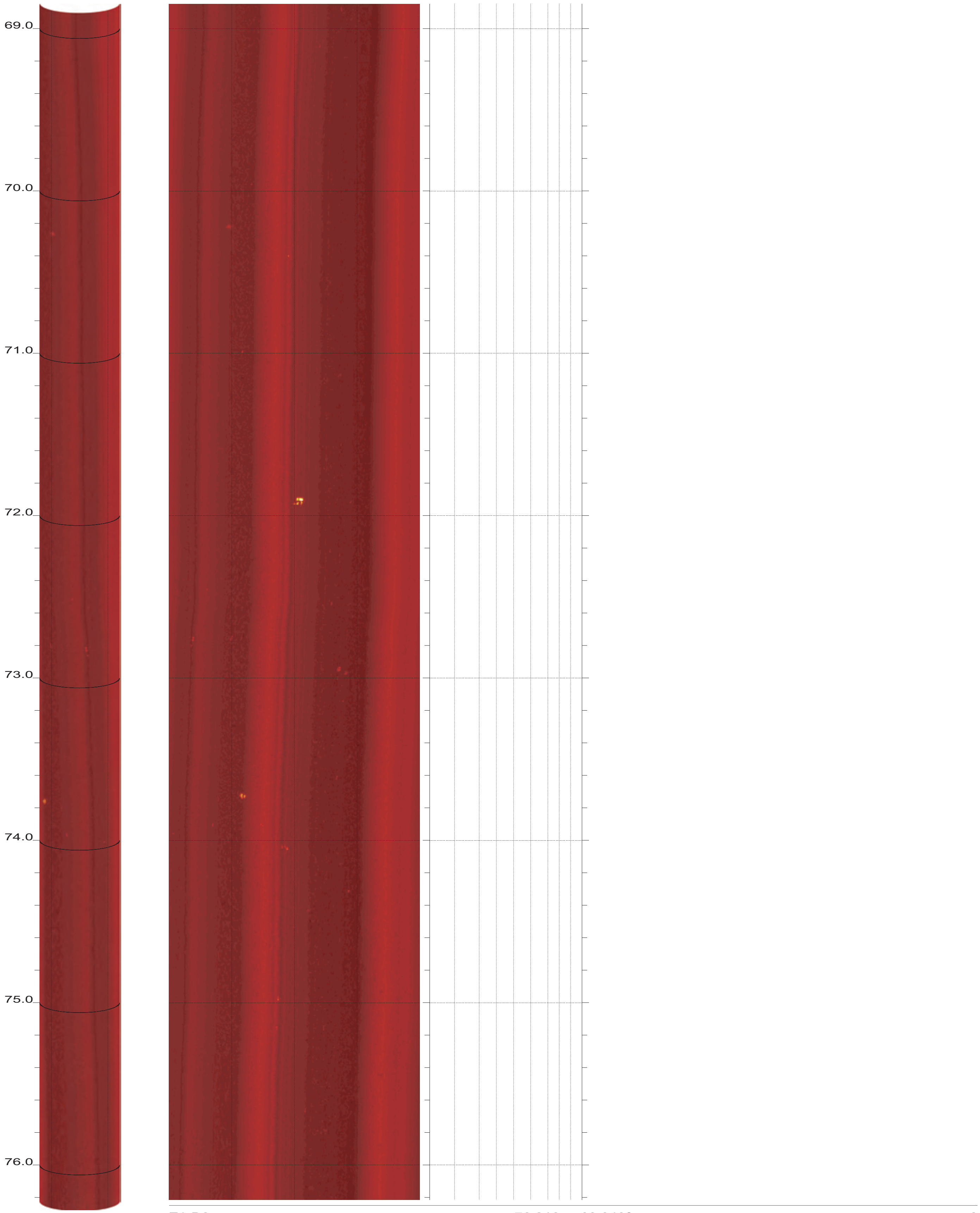
ARROW PLOT

COMMENTS

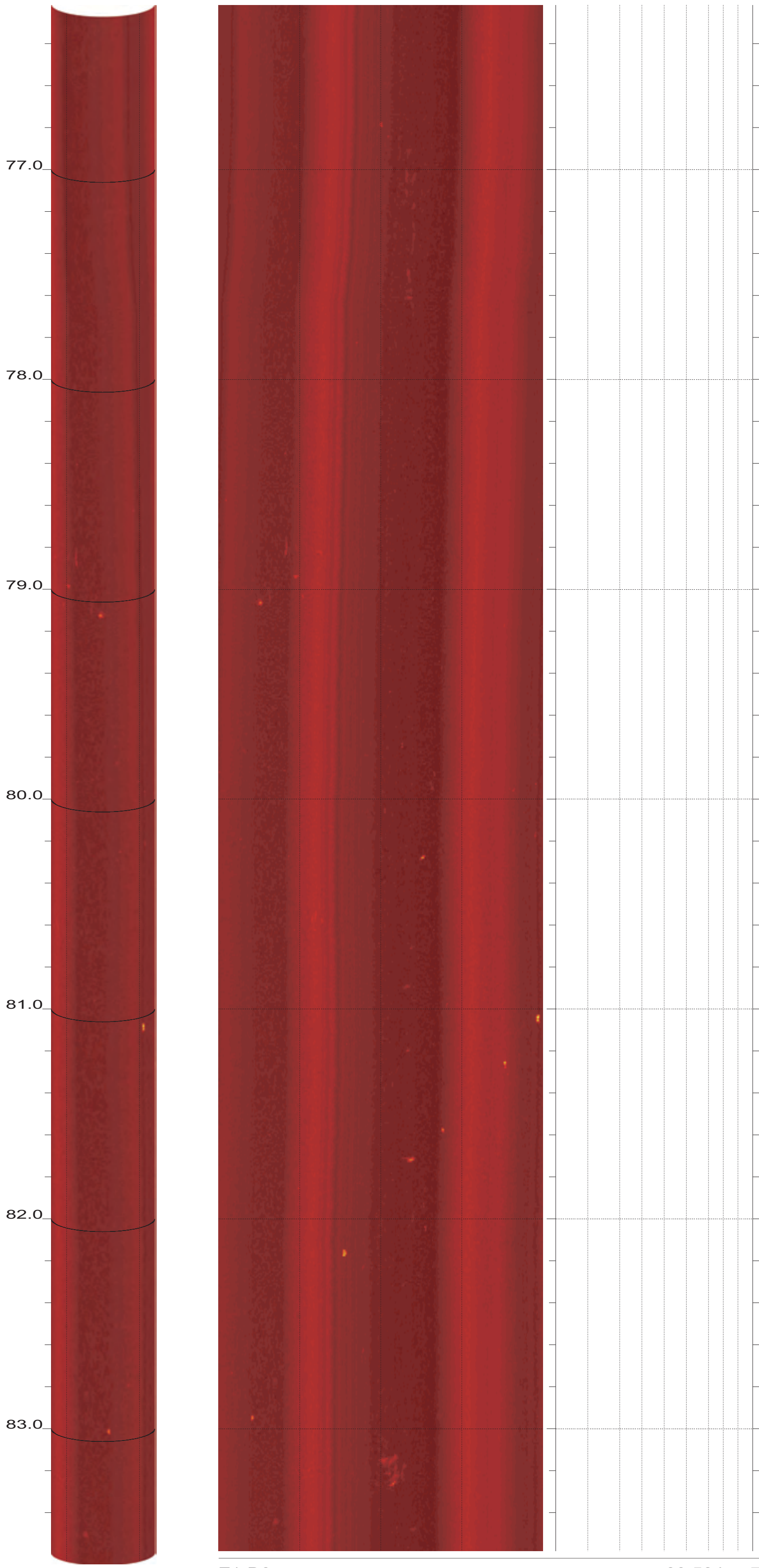


Z1-B6 68.848 to 65.000ft 1

SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 1 of 46

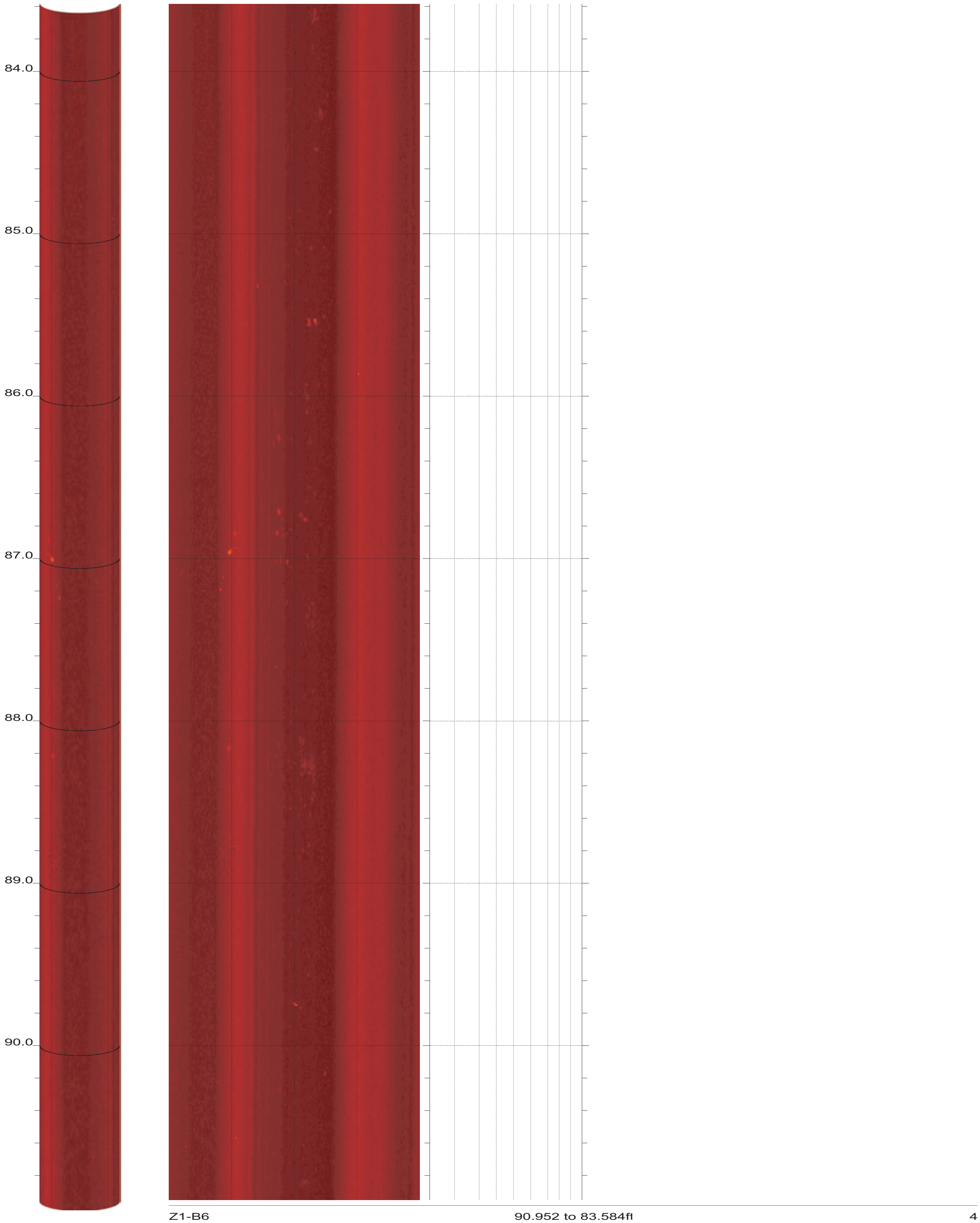


SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 2 of 46

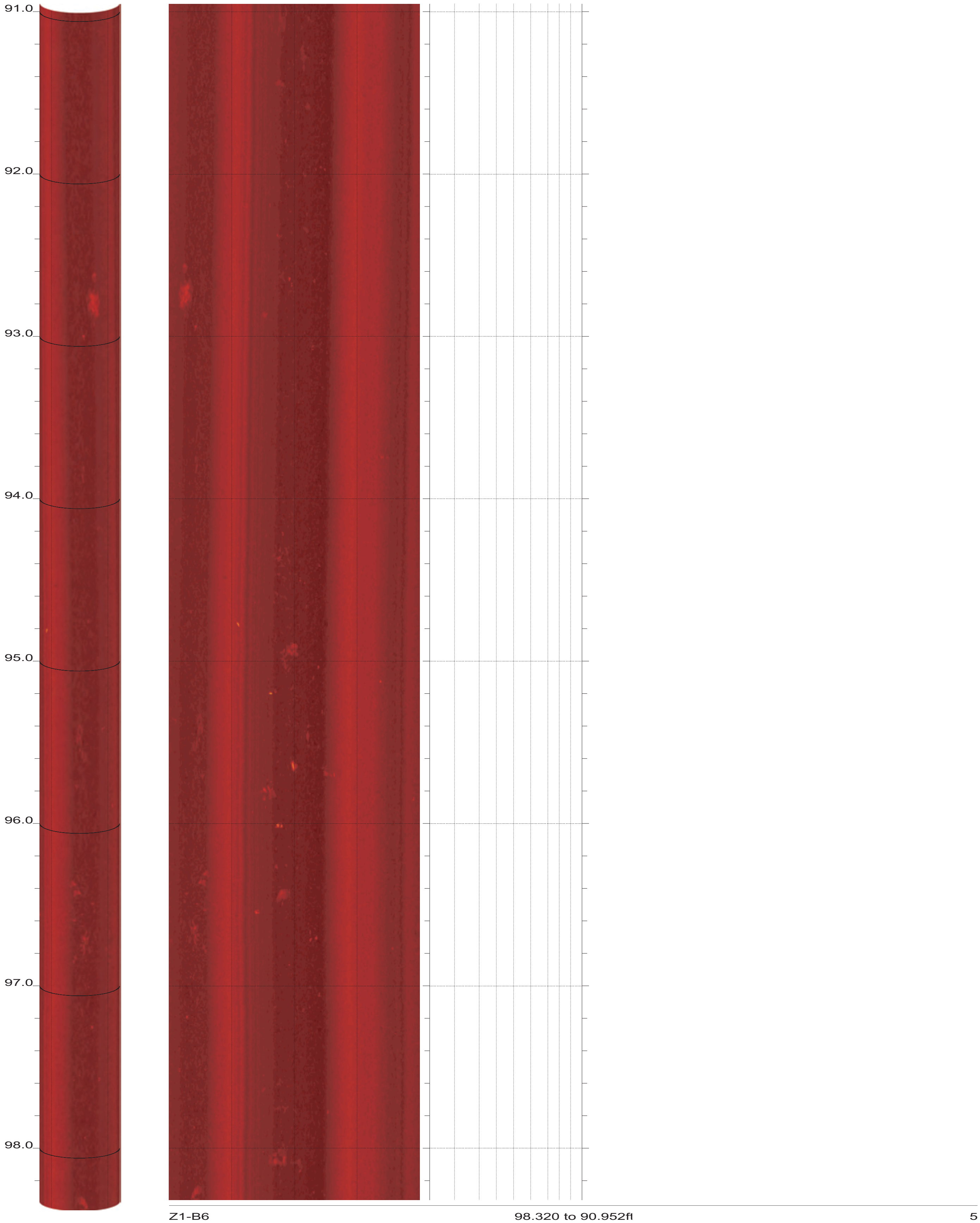


Z1-B6 83.584 to 76.216ft 3

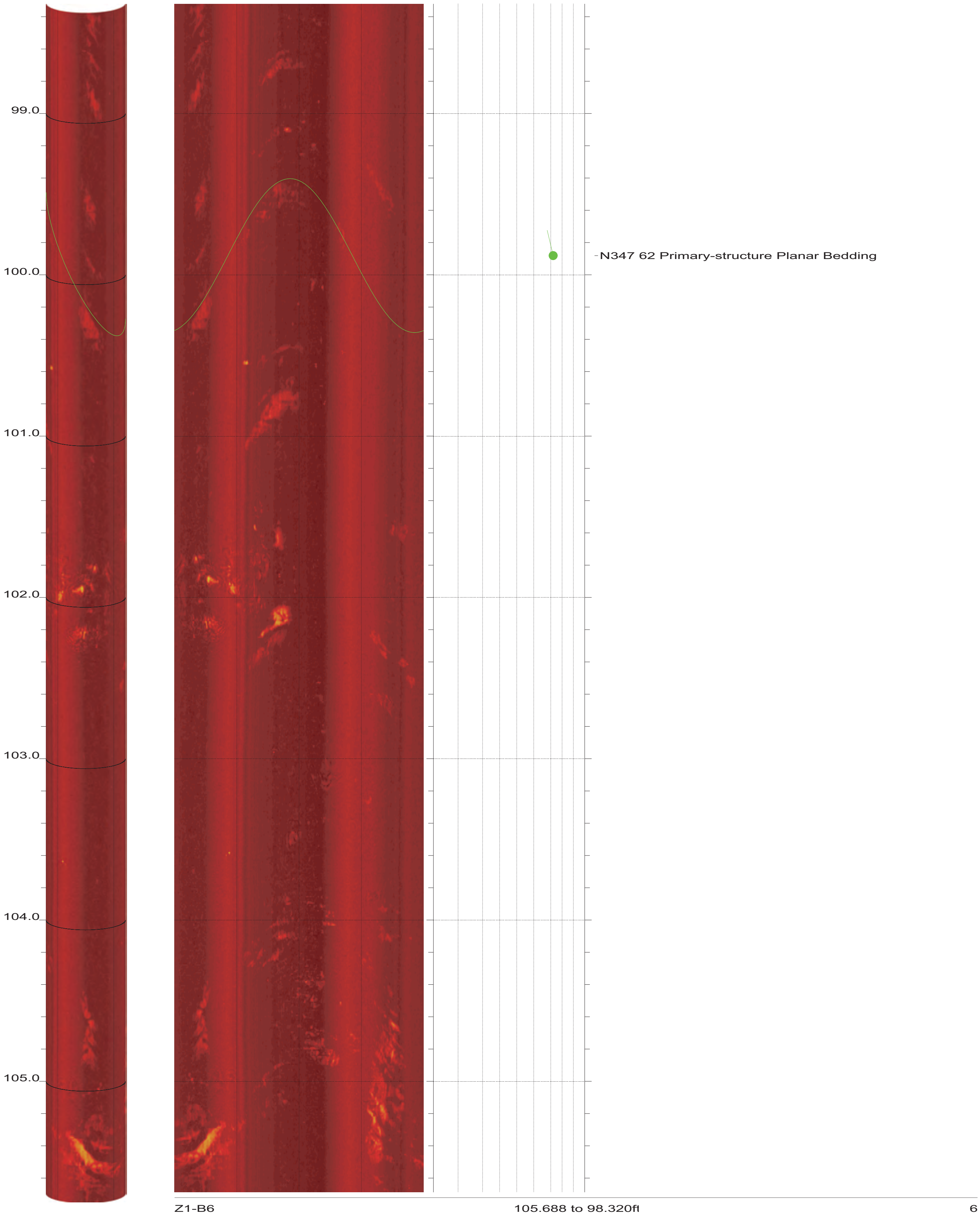
SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 3 of 46



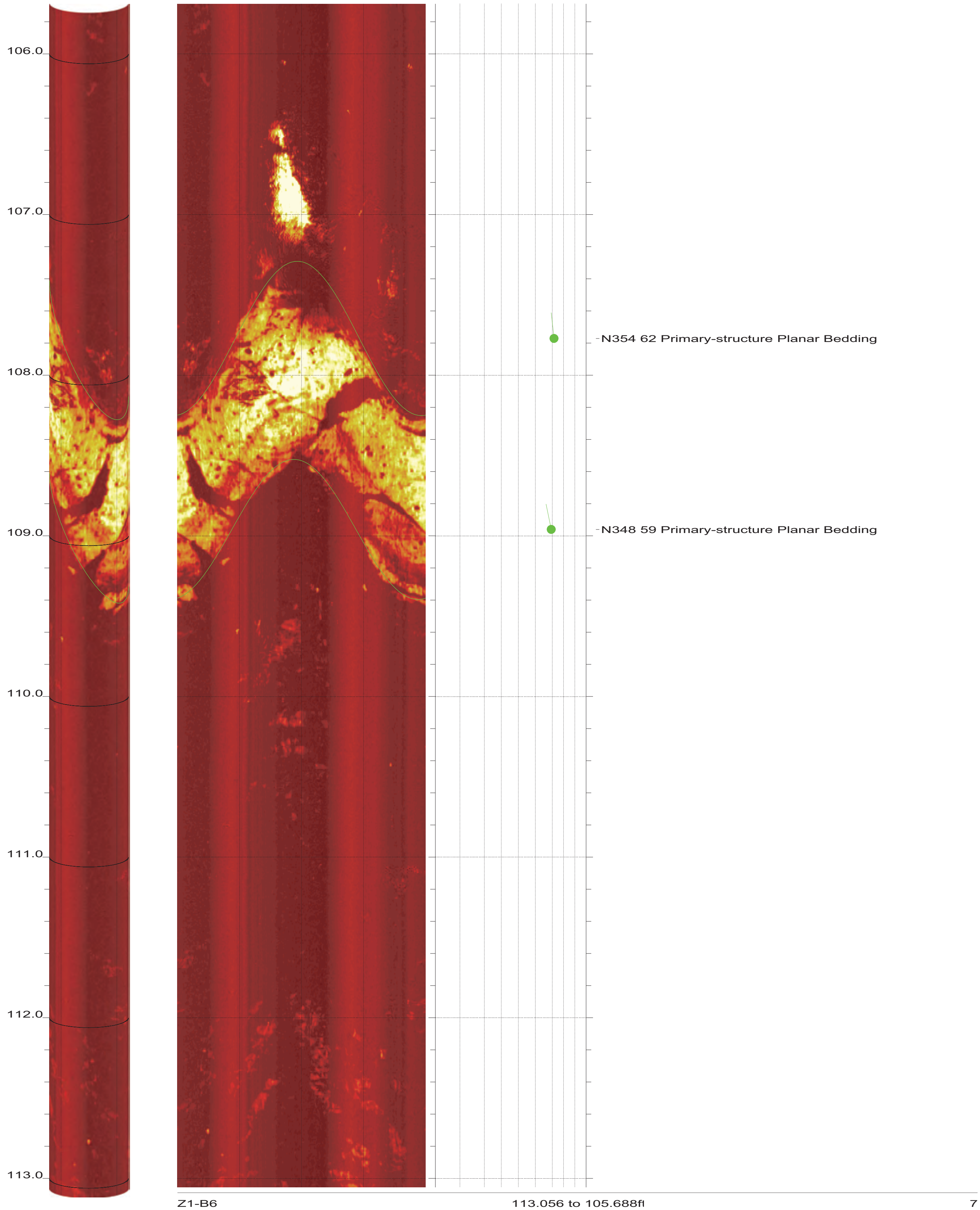
SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 4 of 46



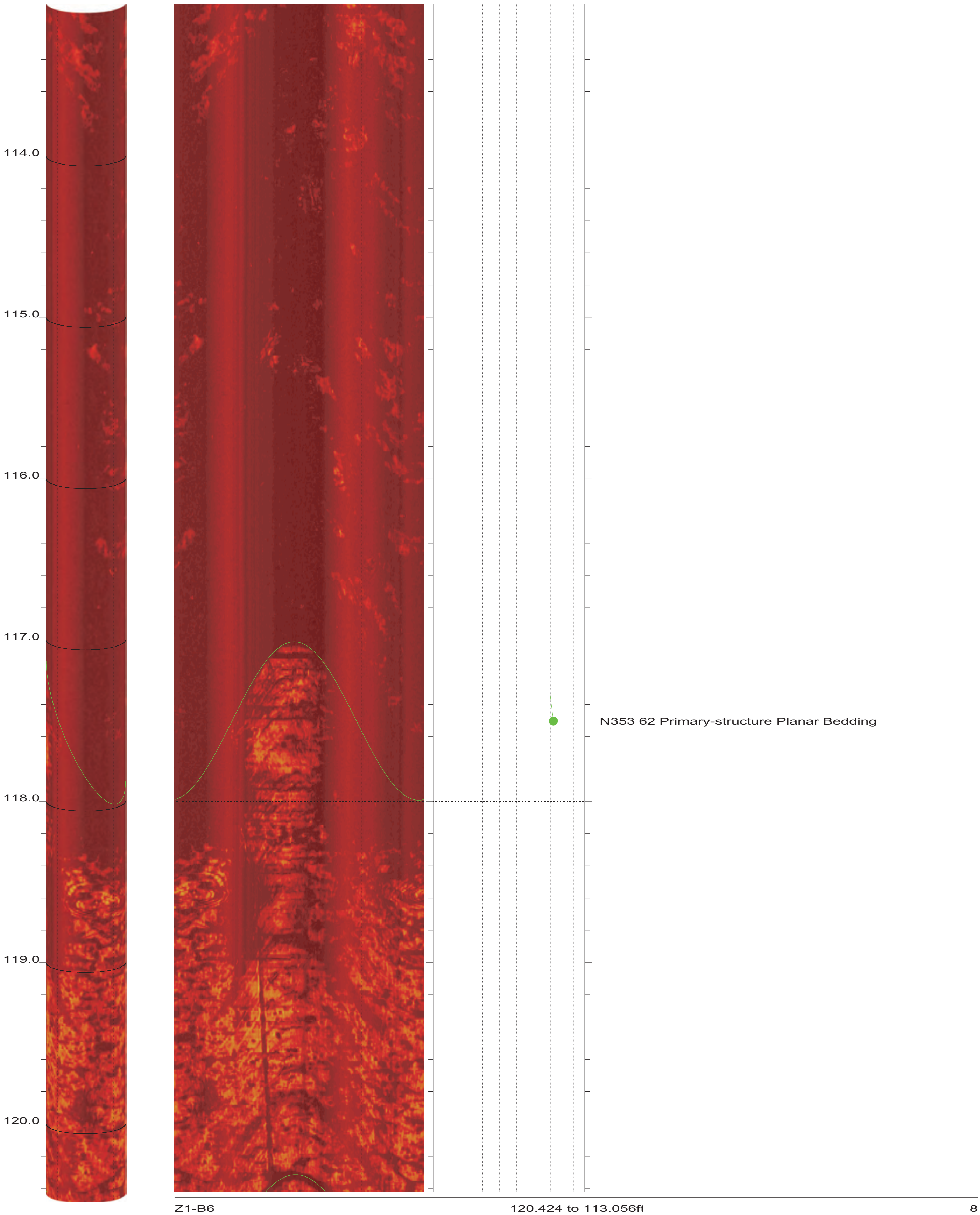
SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 5 of 46



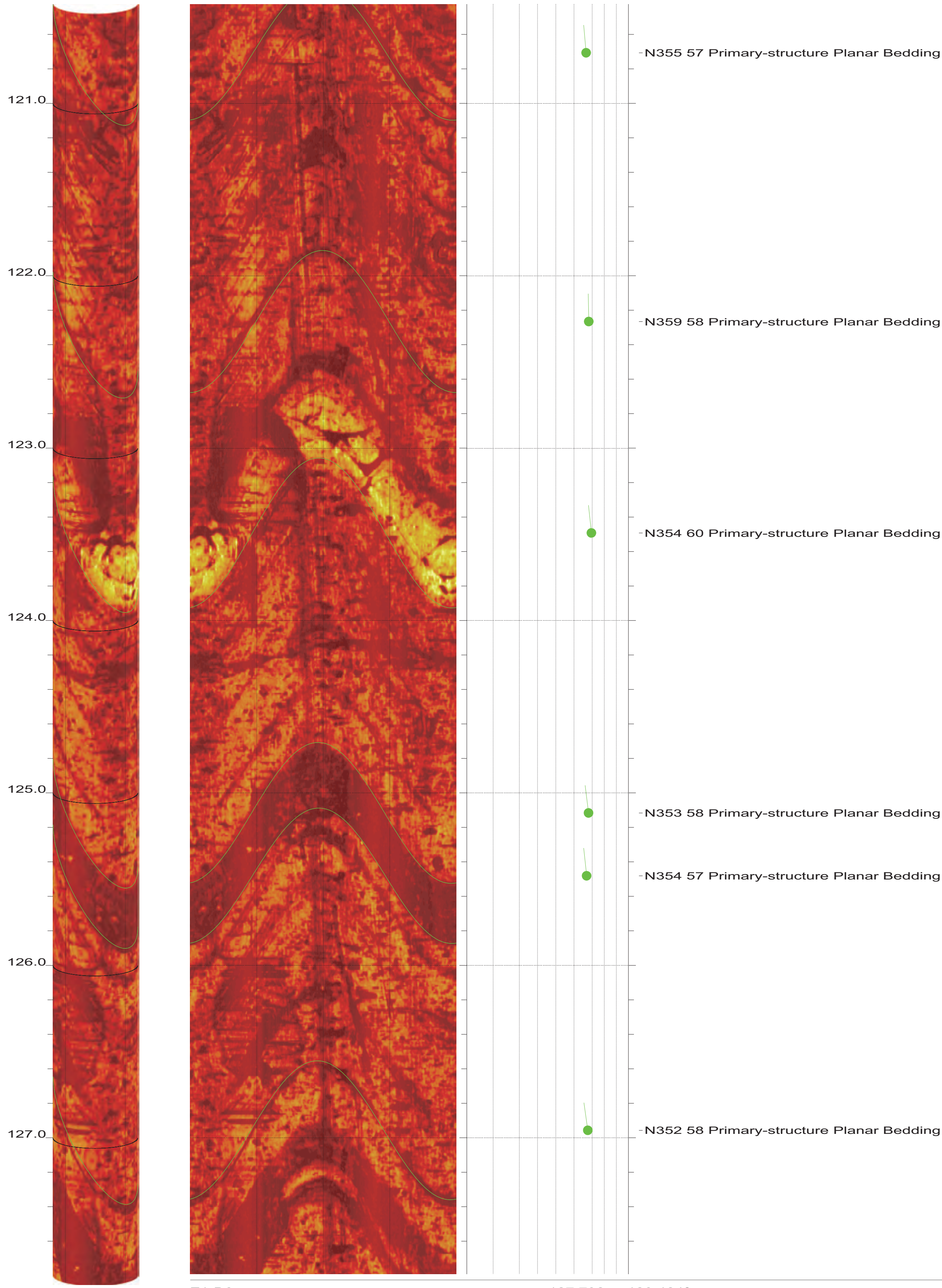
SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 6 of 46



SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 7 of 46

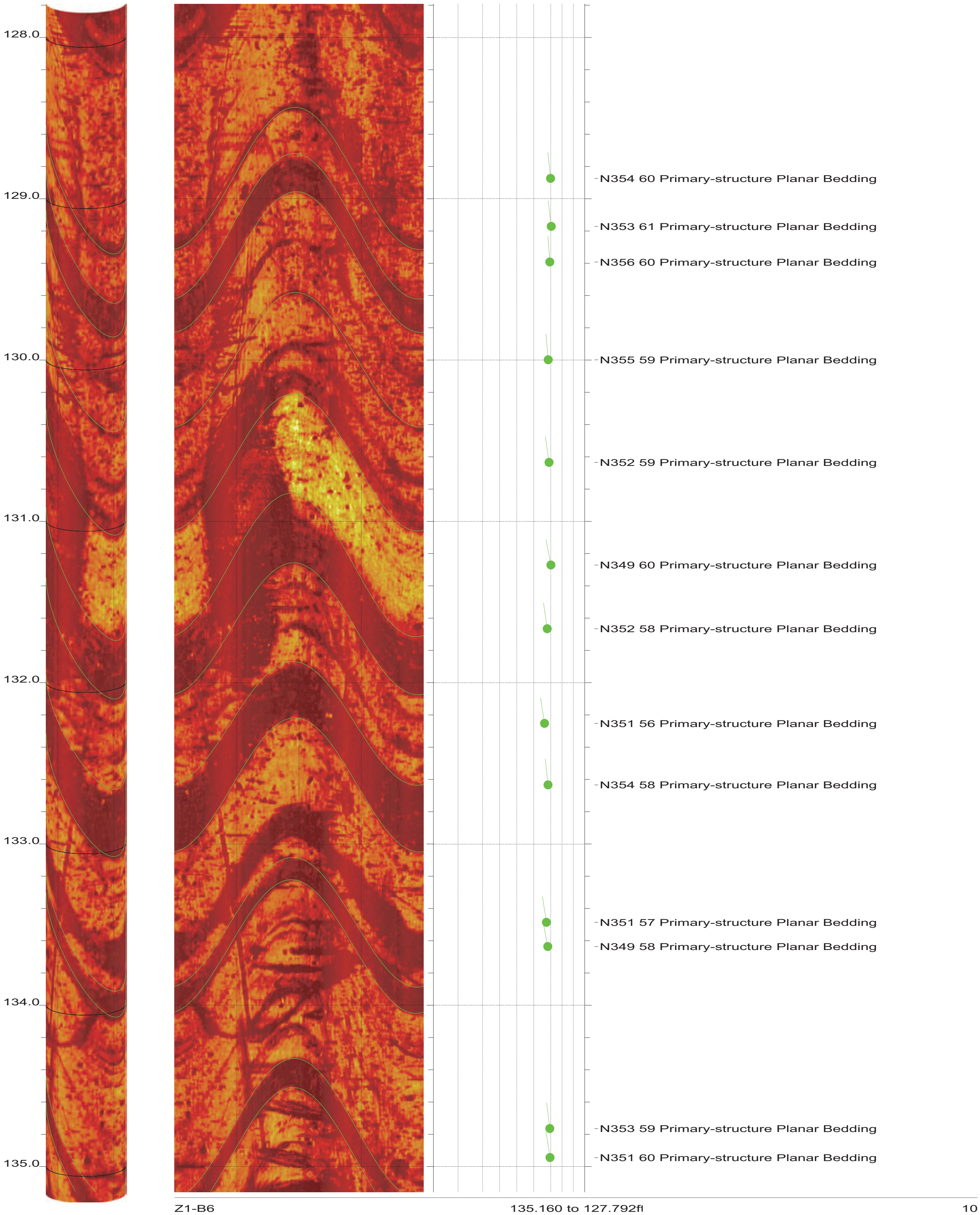


SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 8 of 46

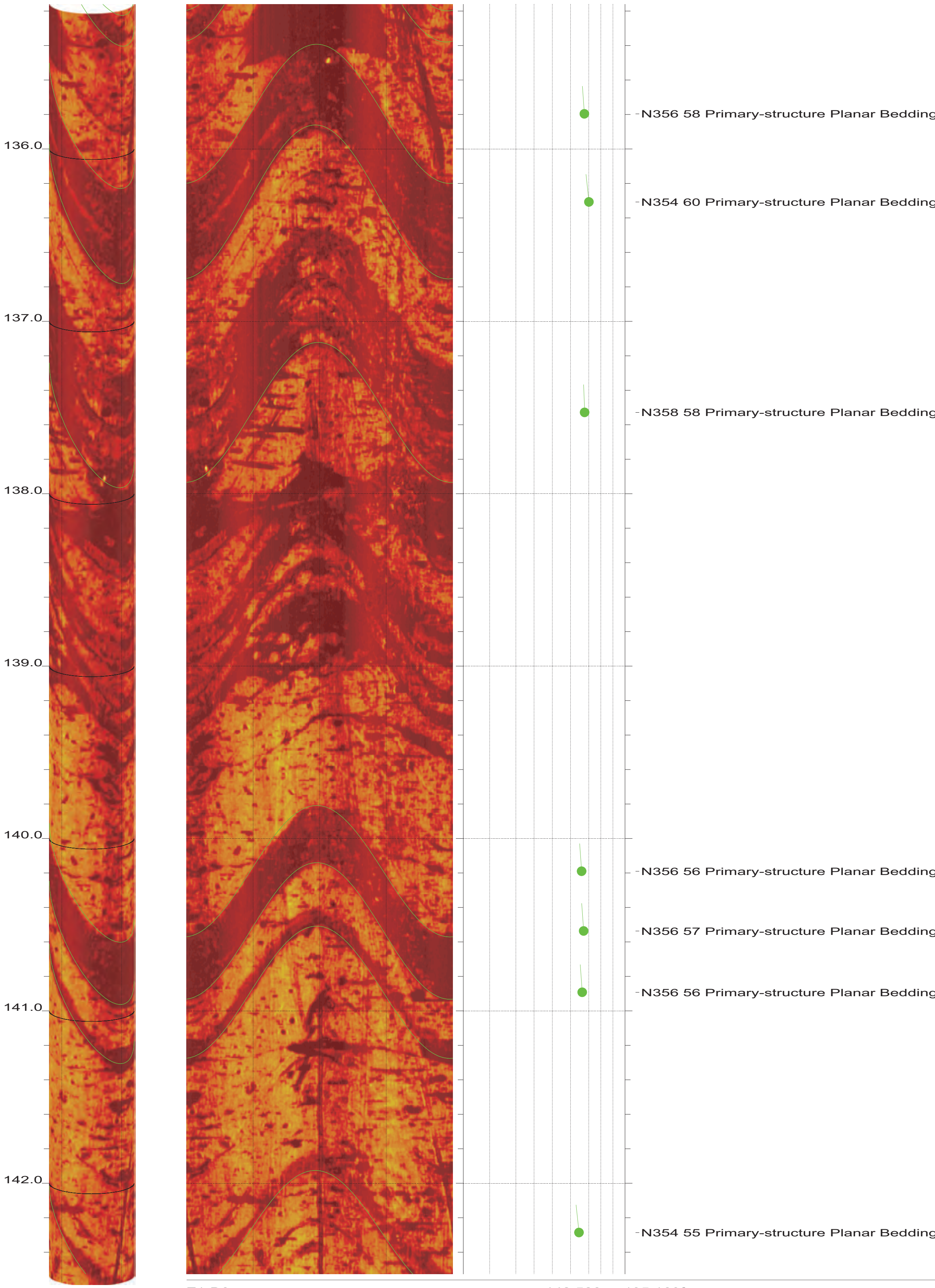


Z1-B6 127.792 to 120.424ft 9

SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 9 of 46

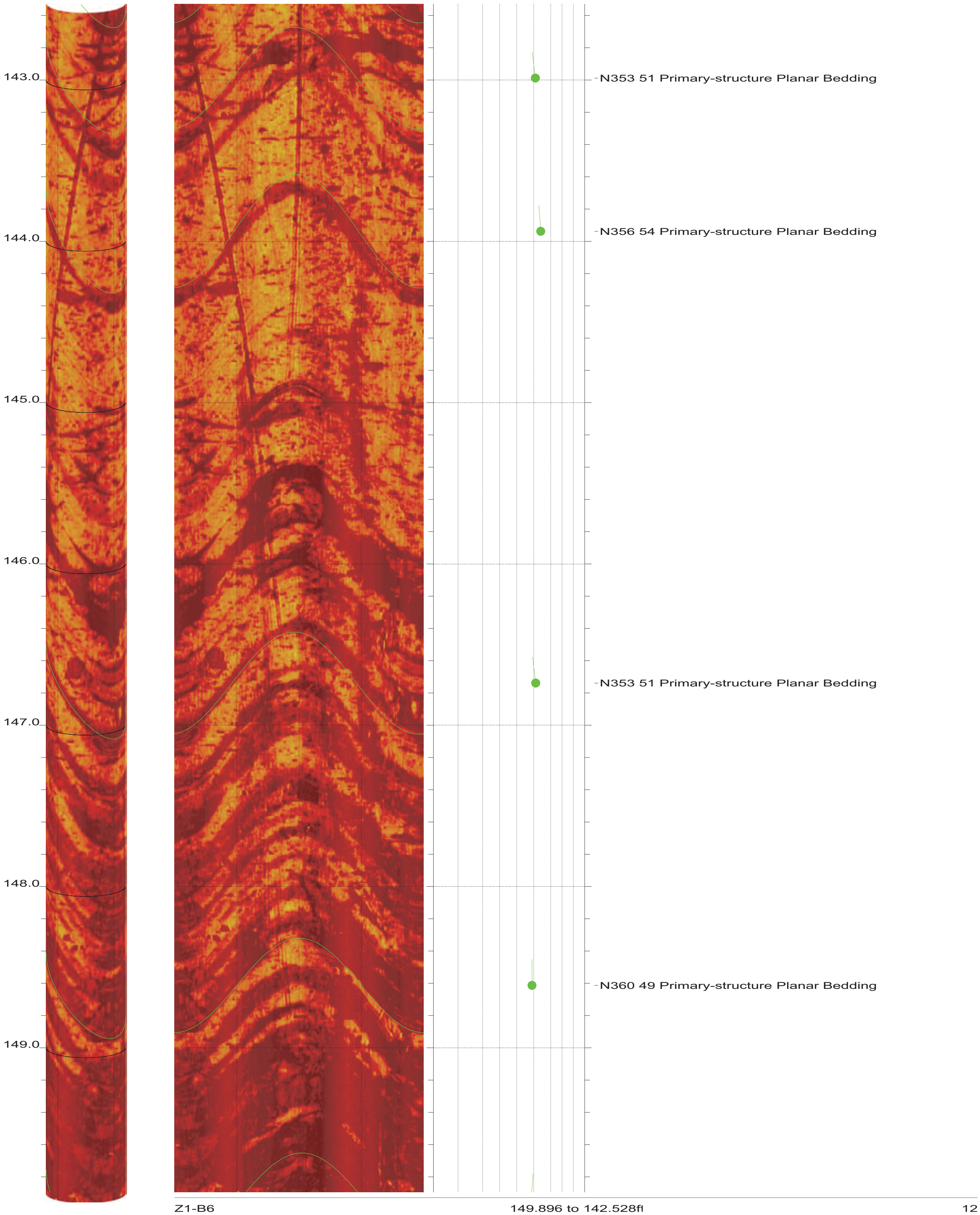


SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 10 of 46

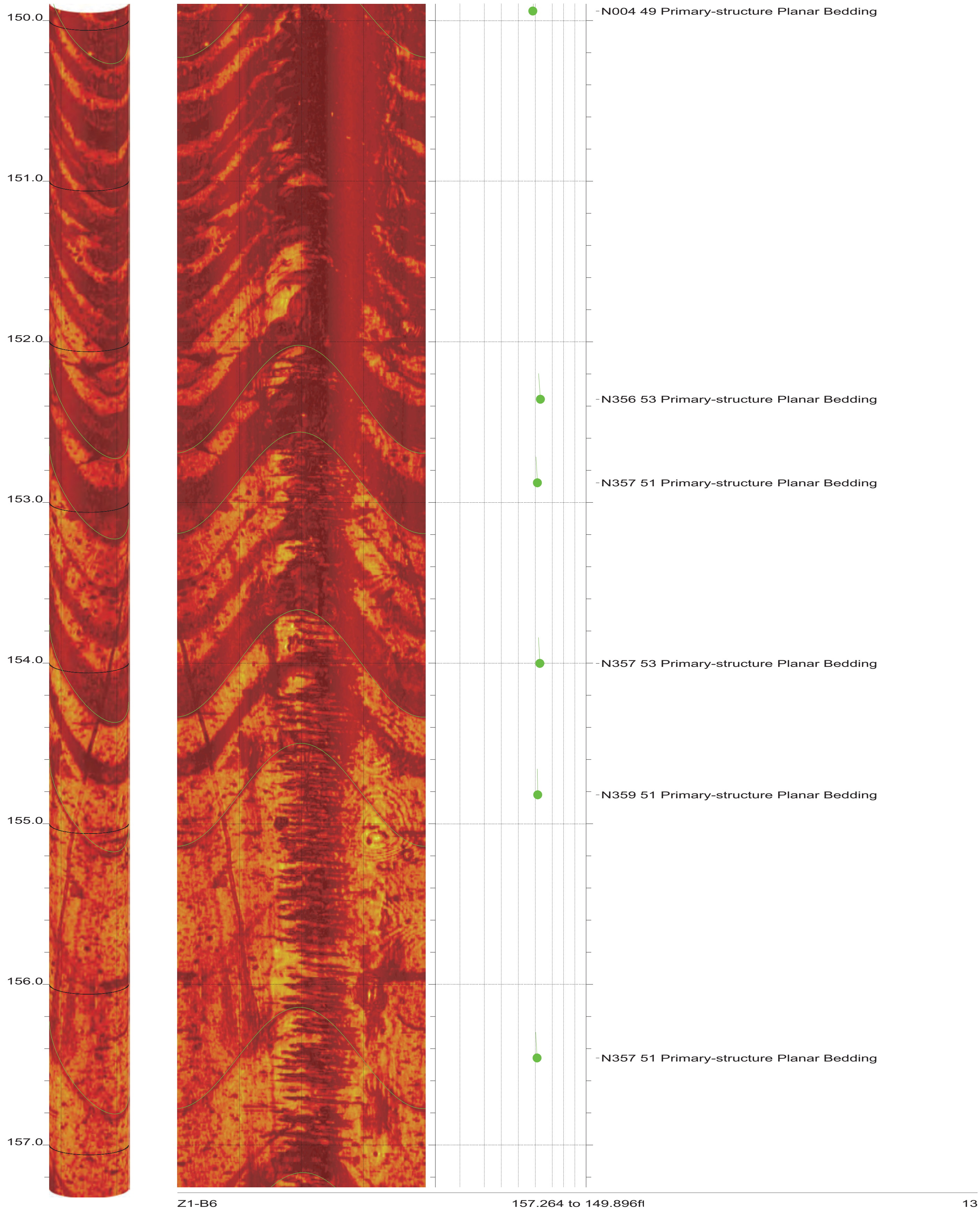


Z1-B6 142.528 to 135.160ft 11

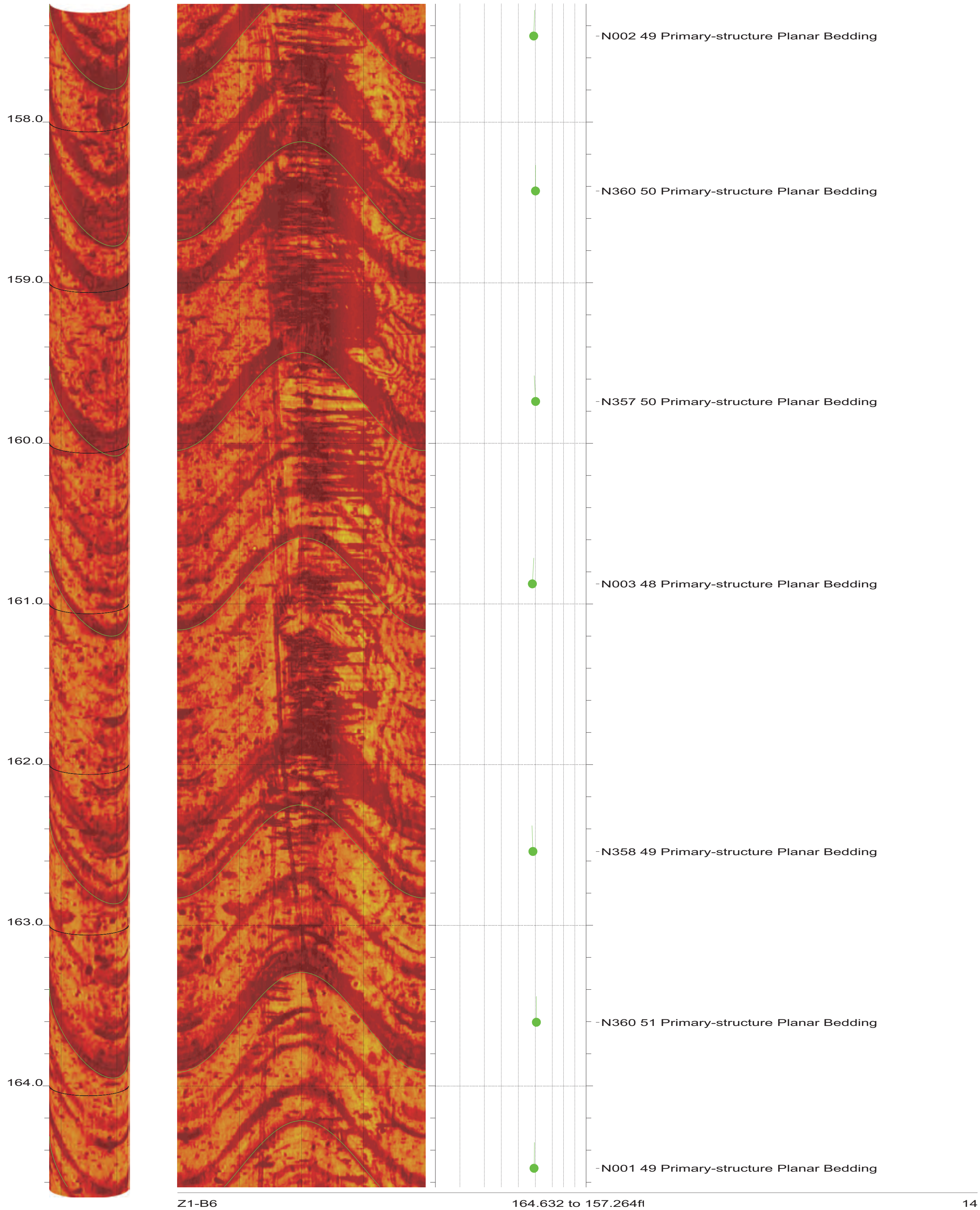
SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 11 of 46



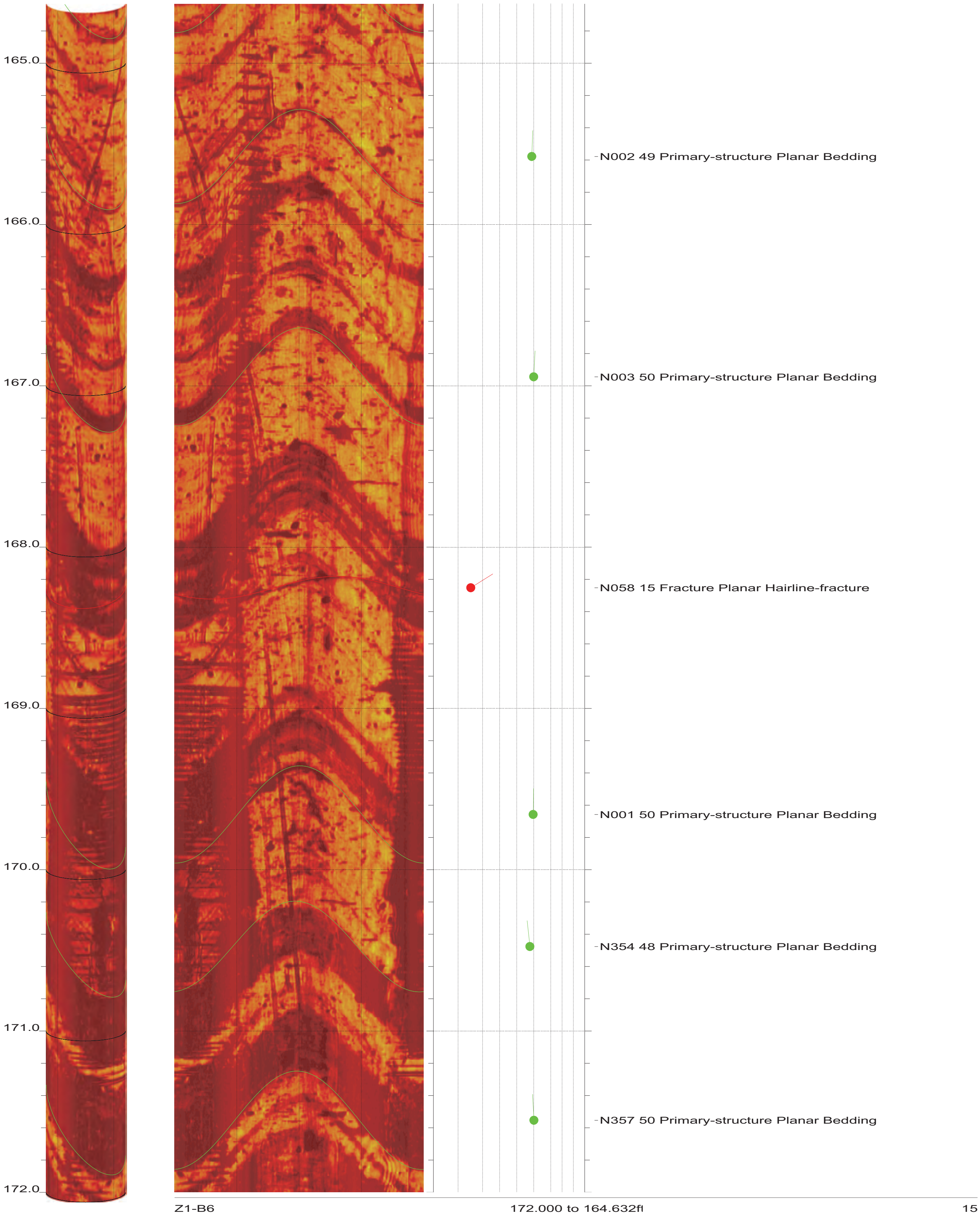
SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 12 of 46

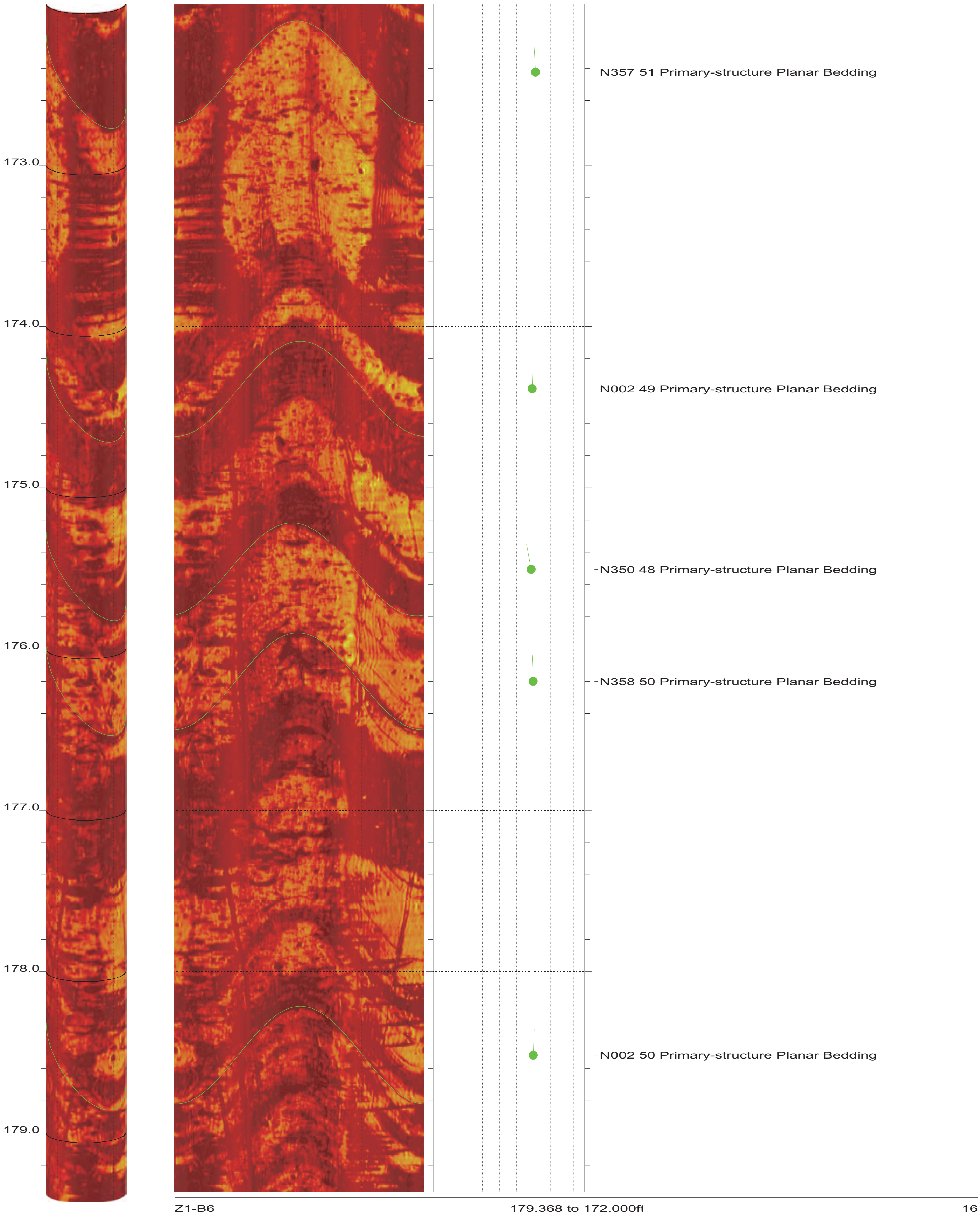


SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 13 of 46

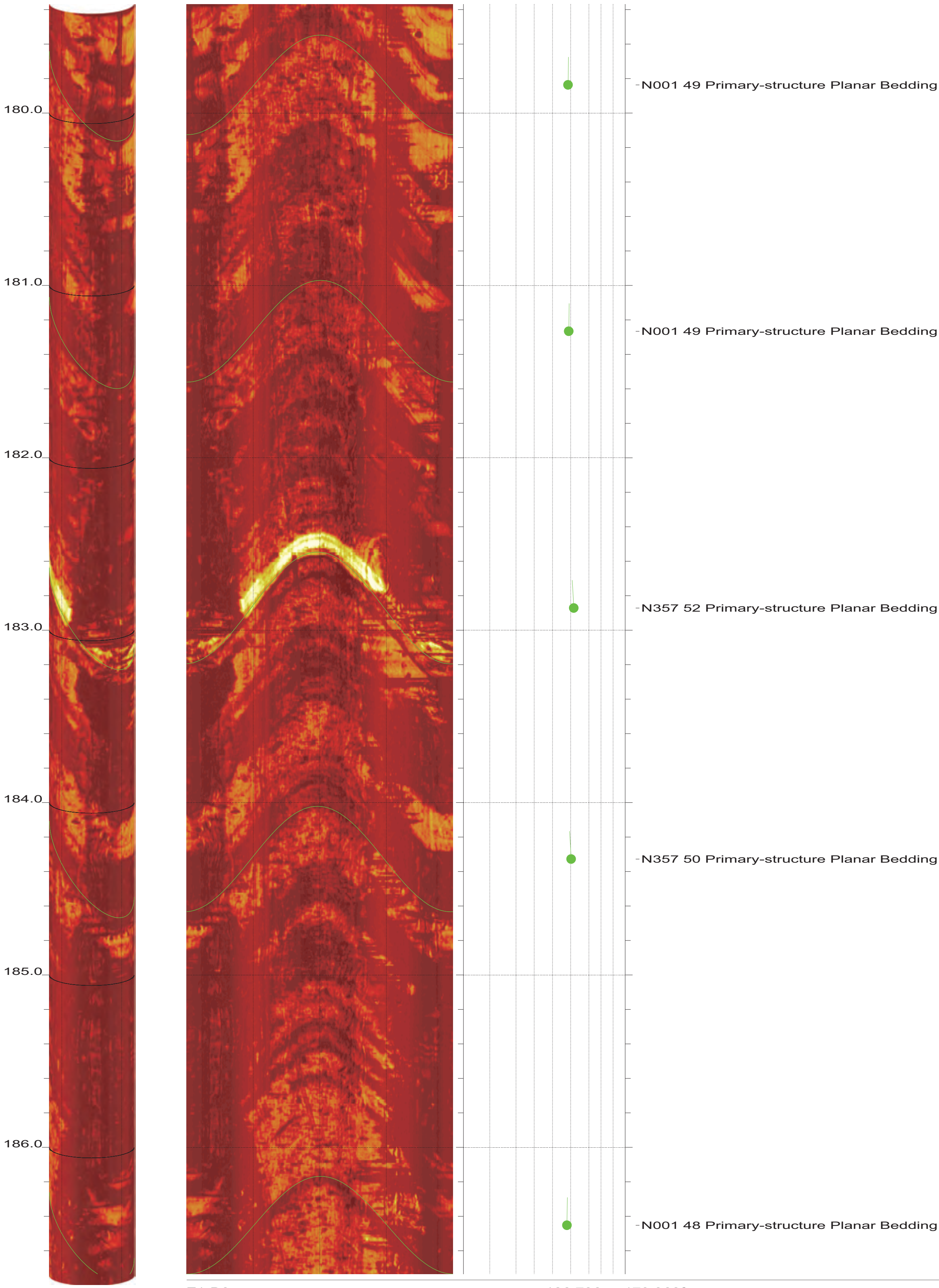


SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 14 of 46


165.0
166.0
167.0
168.0
169.0
170.0
171.0
172.0
N002 49 Primary-structure Planar Bedding
N003 50 Primary-structure Planar Bedding
N058 15 Fracture Planar Hairline-fracture
N001 50 Primary-structure Planar Bedding
N354 48 Primary-structure Planar Bedding
N357 50 Primary-structure Planar Bedding
Z1-B6
172.000 to 164.632ft
15

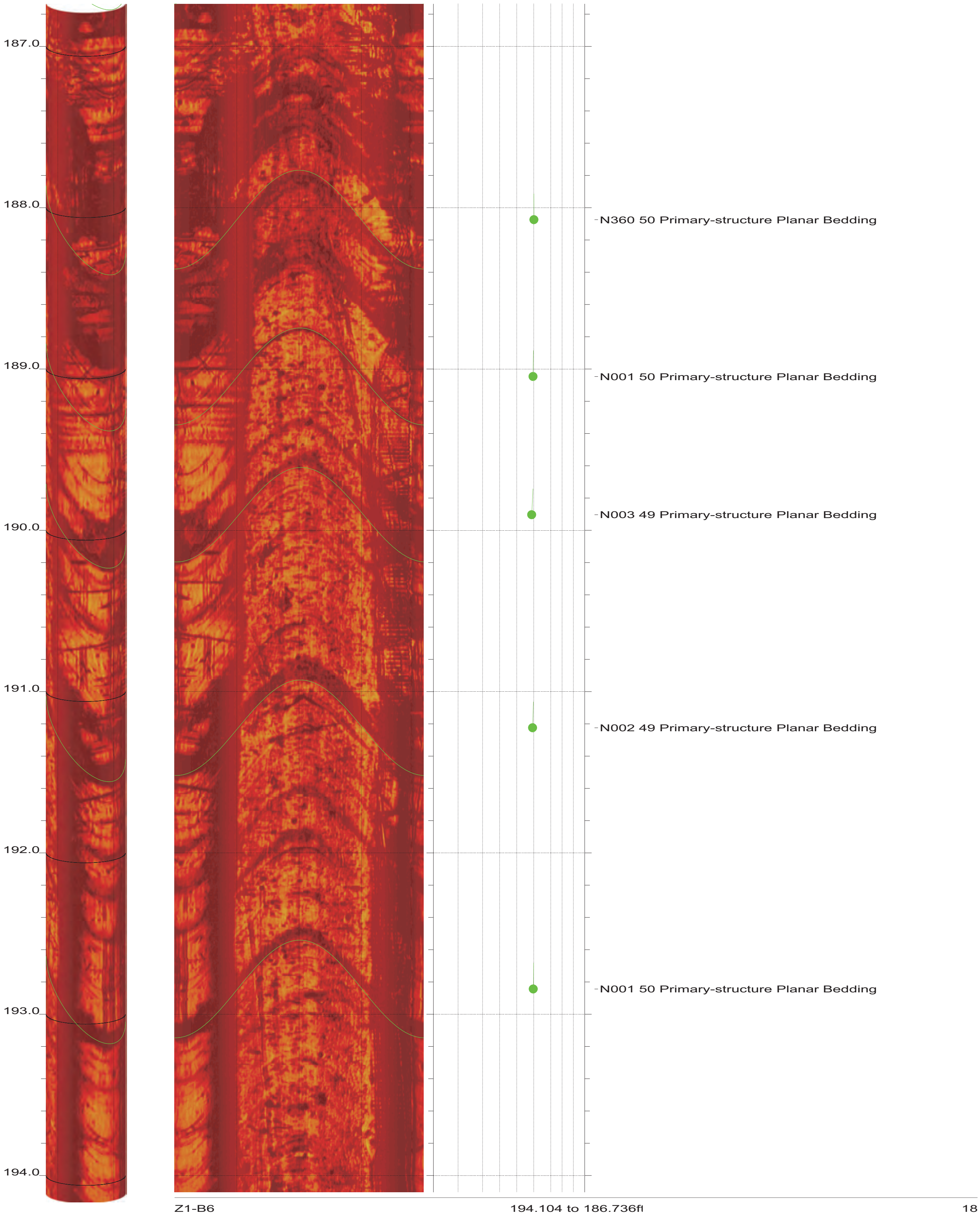


SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 16 of 46

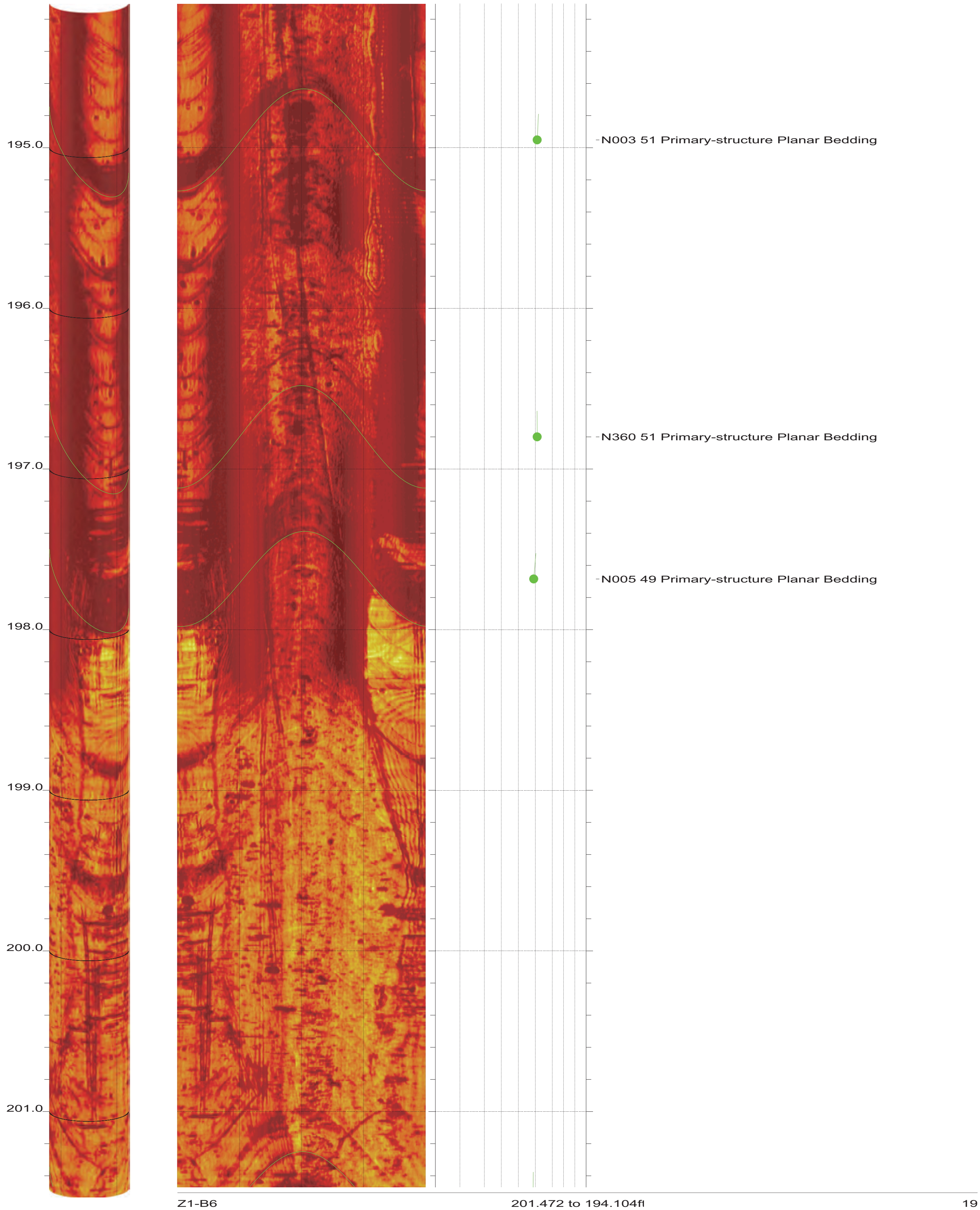


Z1-B6 186.736 to 179.368ft 17

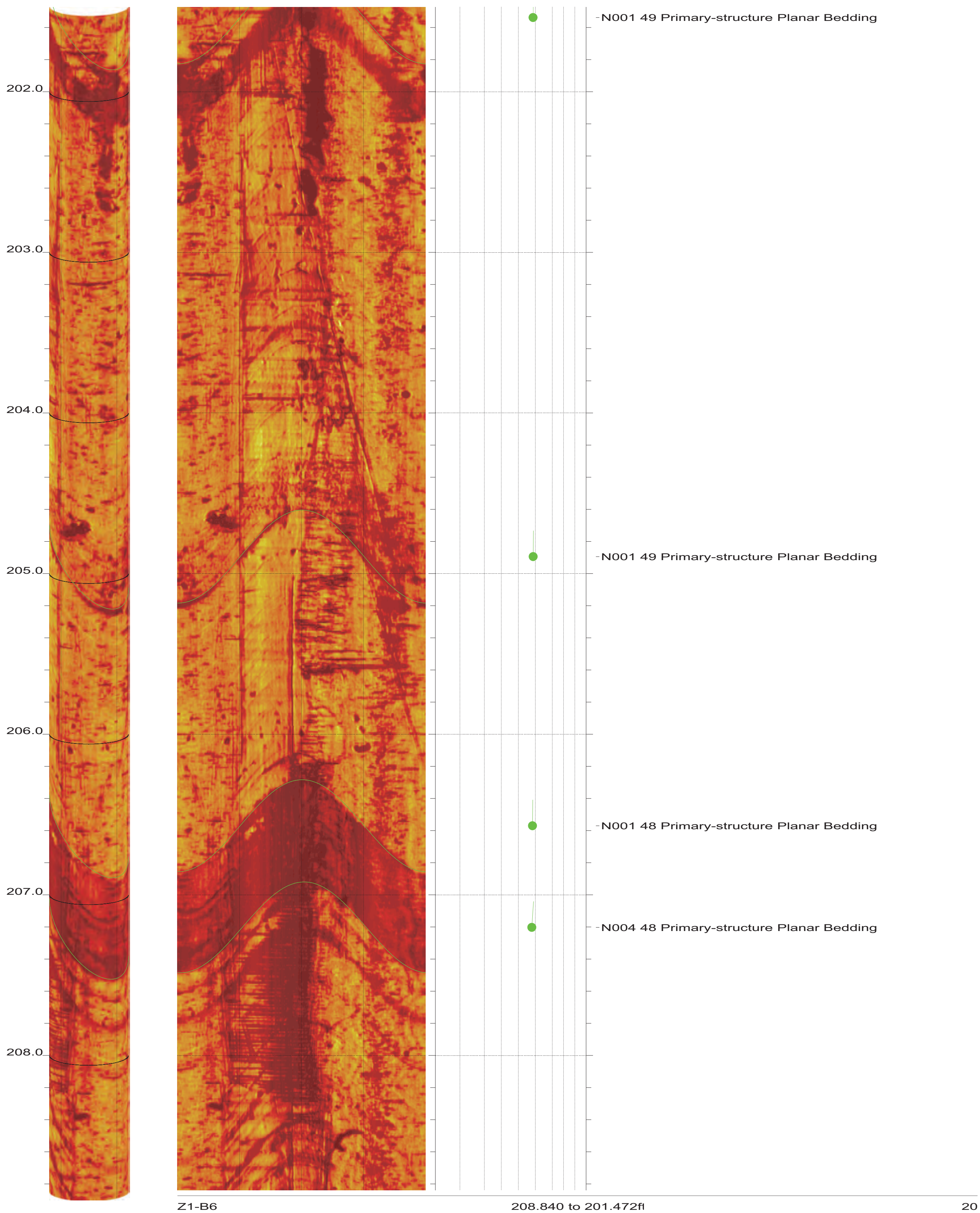
SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 17 of 46



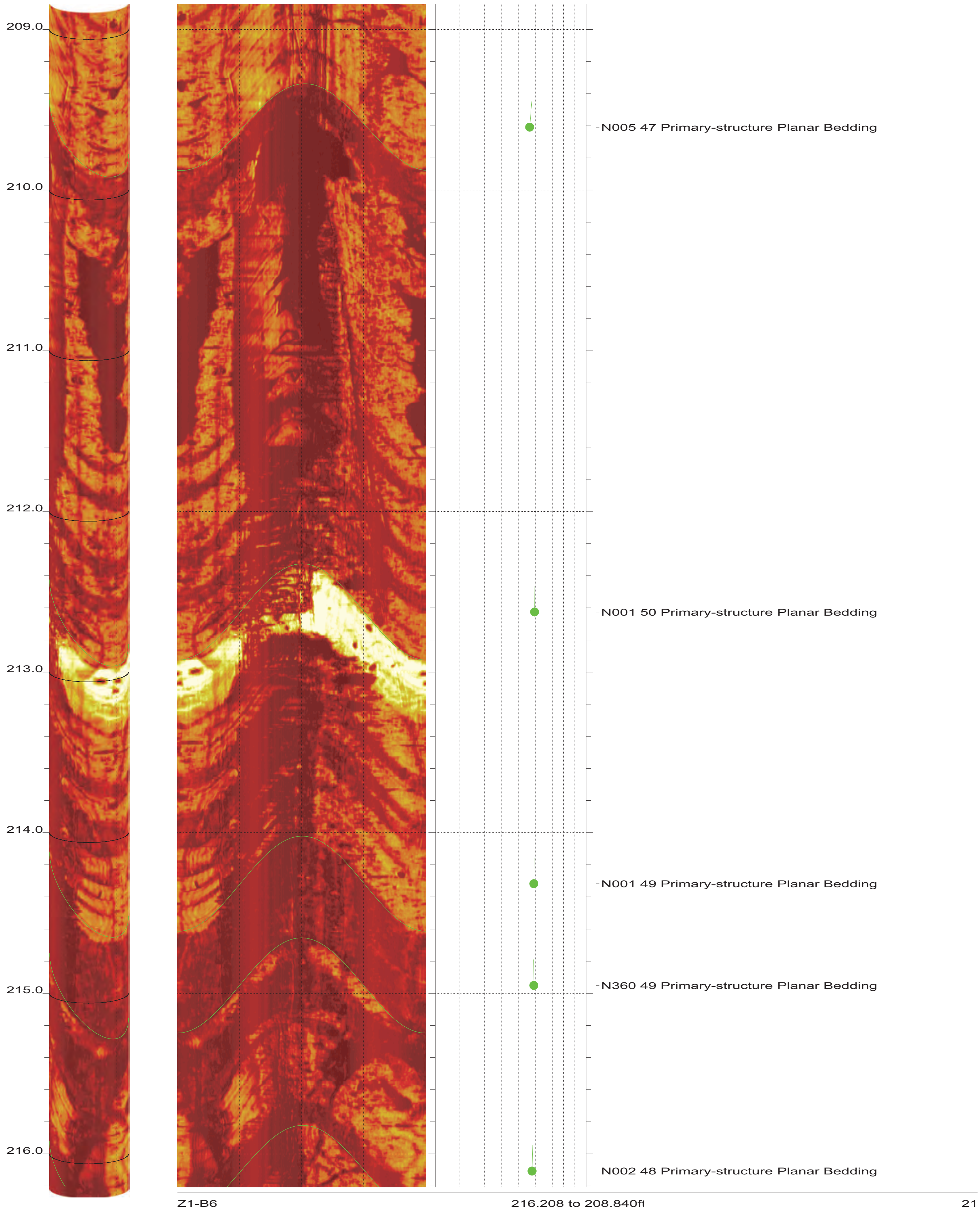
SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 18 of 46



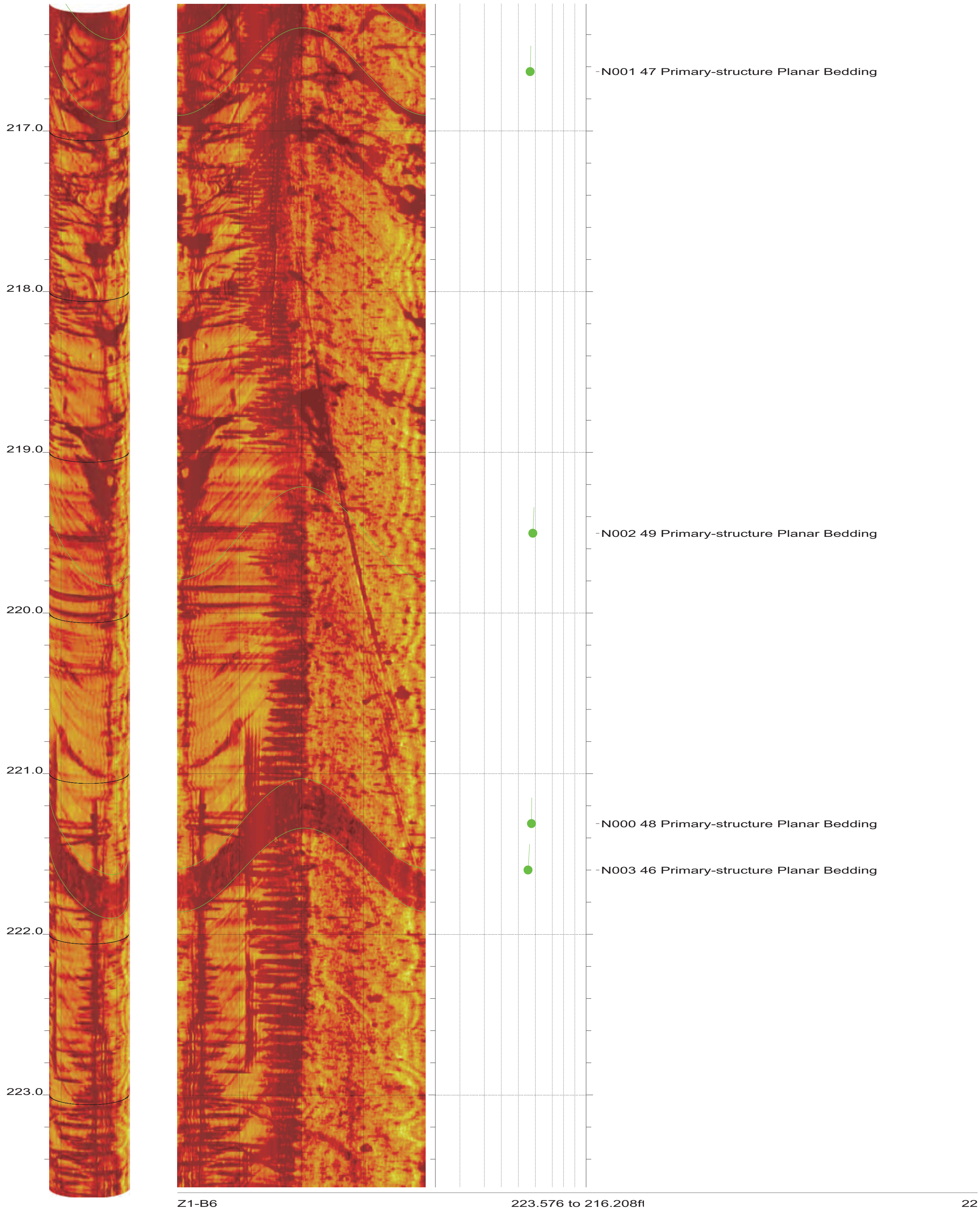
SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 19 of 46



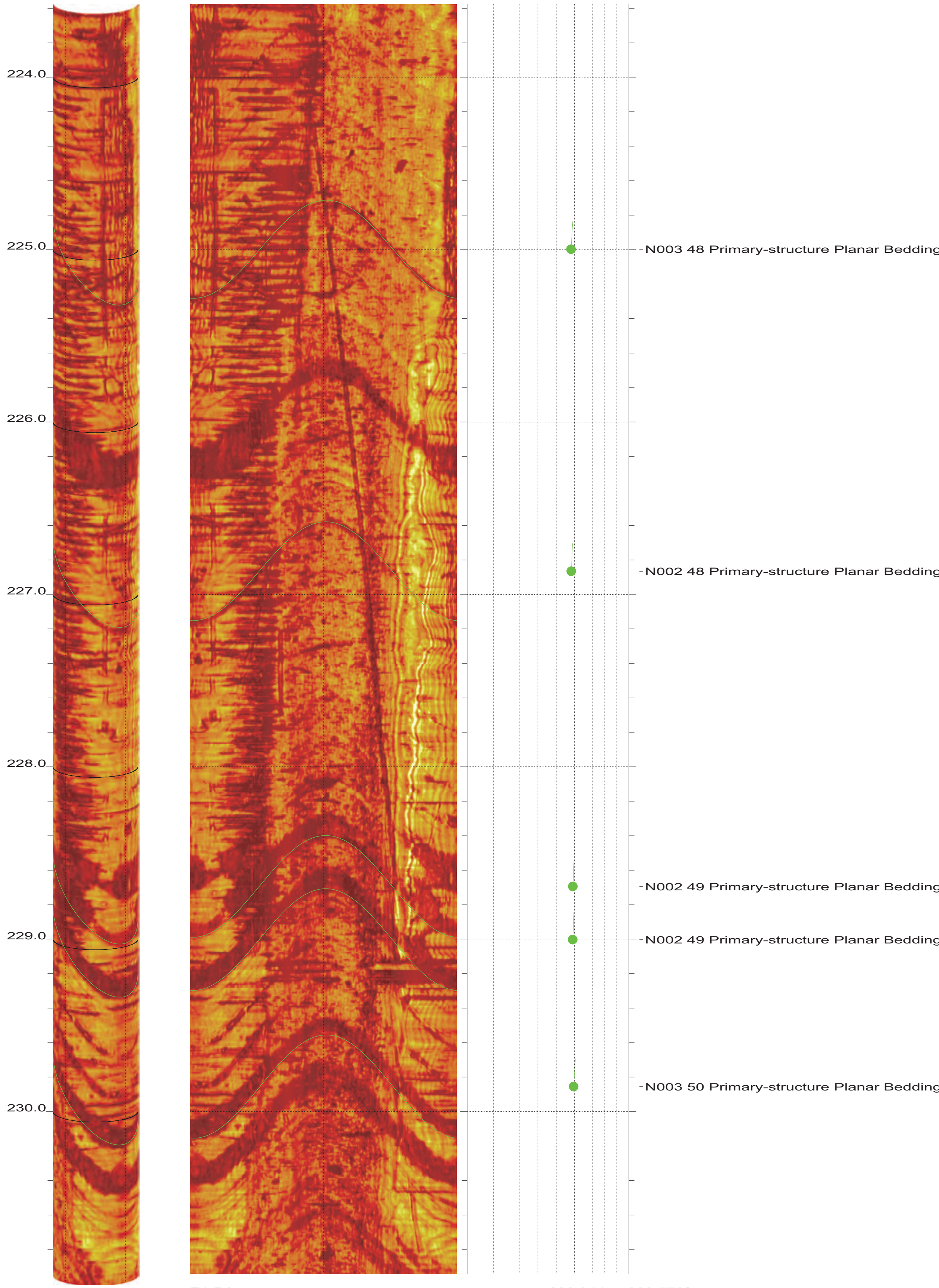
SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 20 of 46



SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 21 of 46

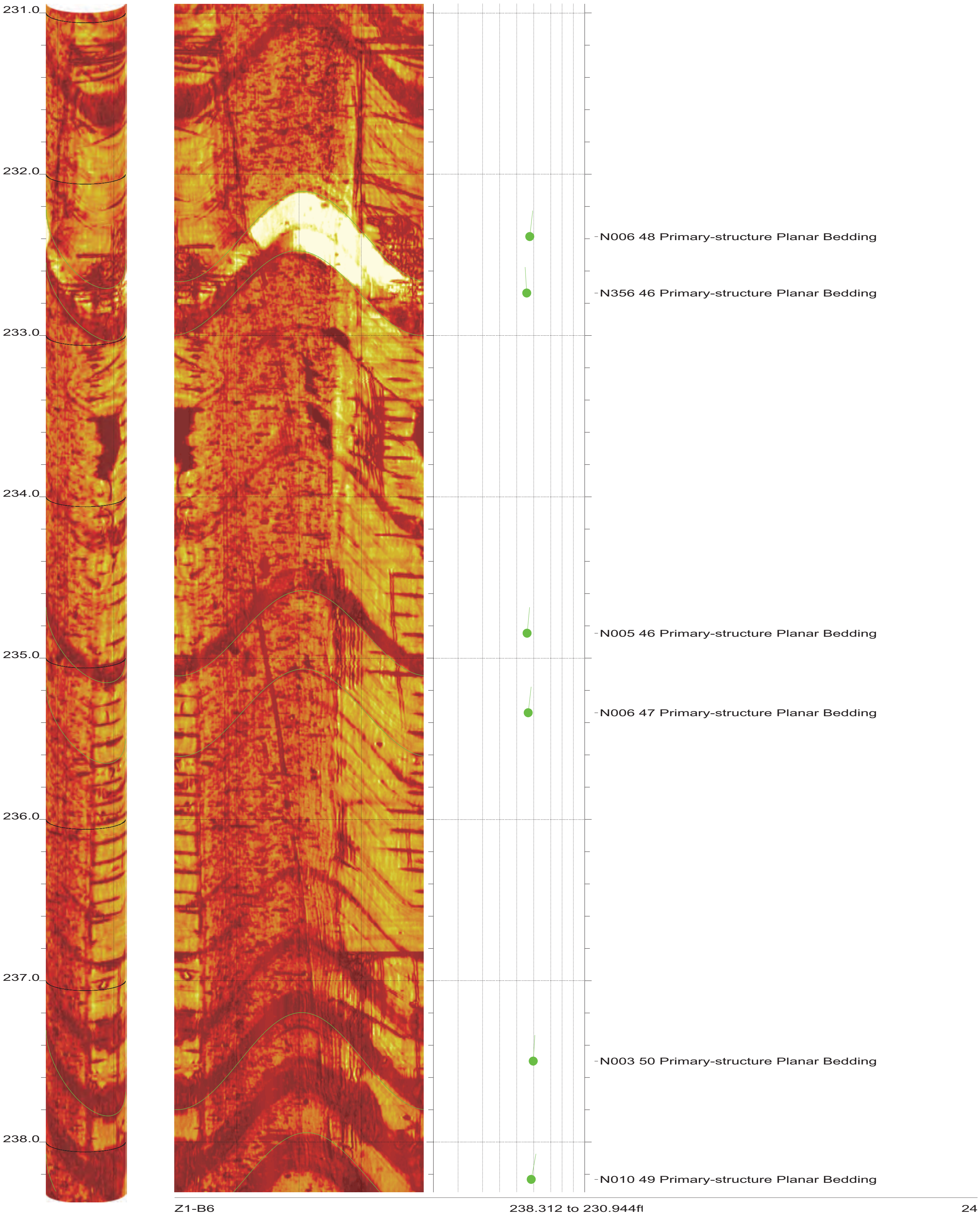


SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 22 of 46

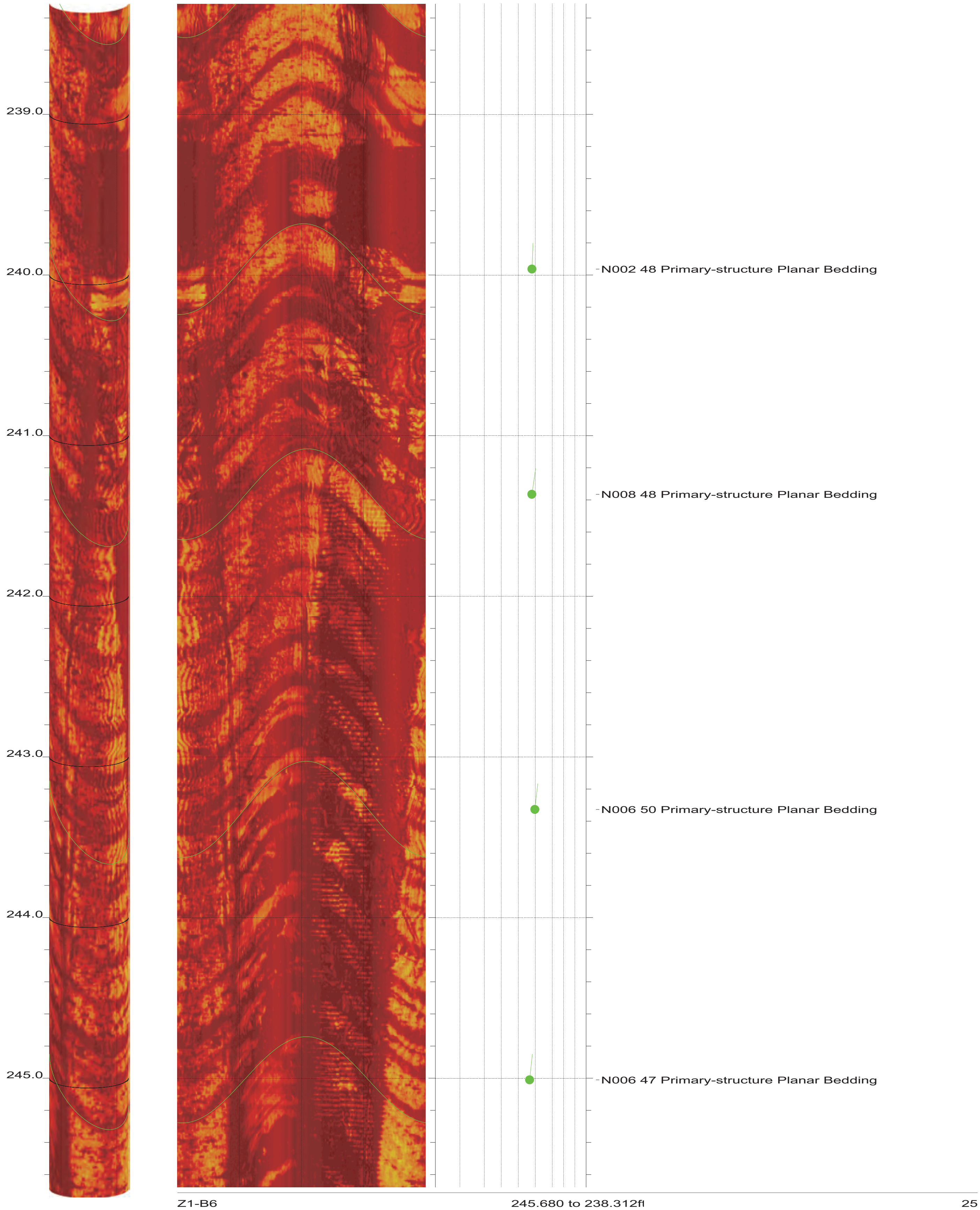


Z1-B6 230.944 to 223.576ft 23

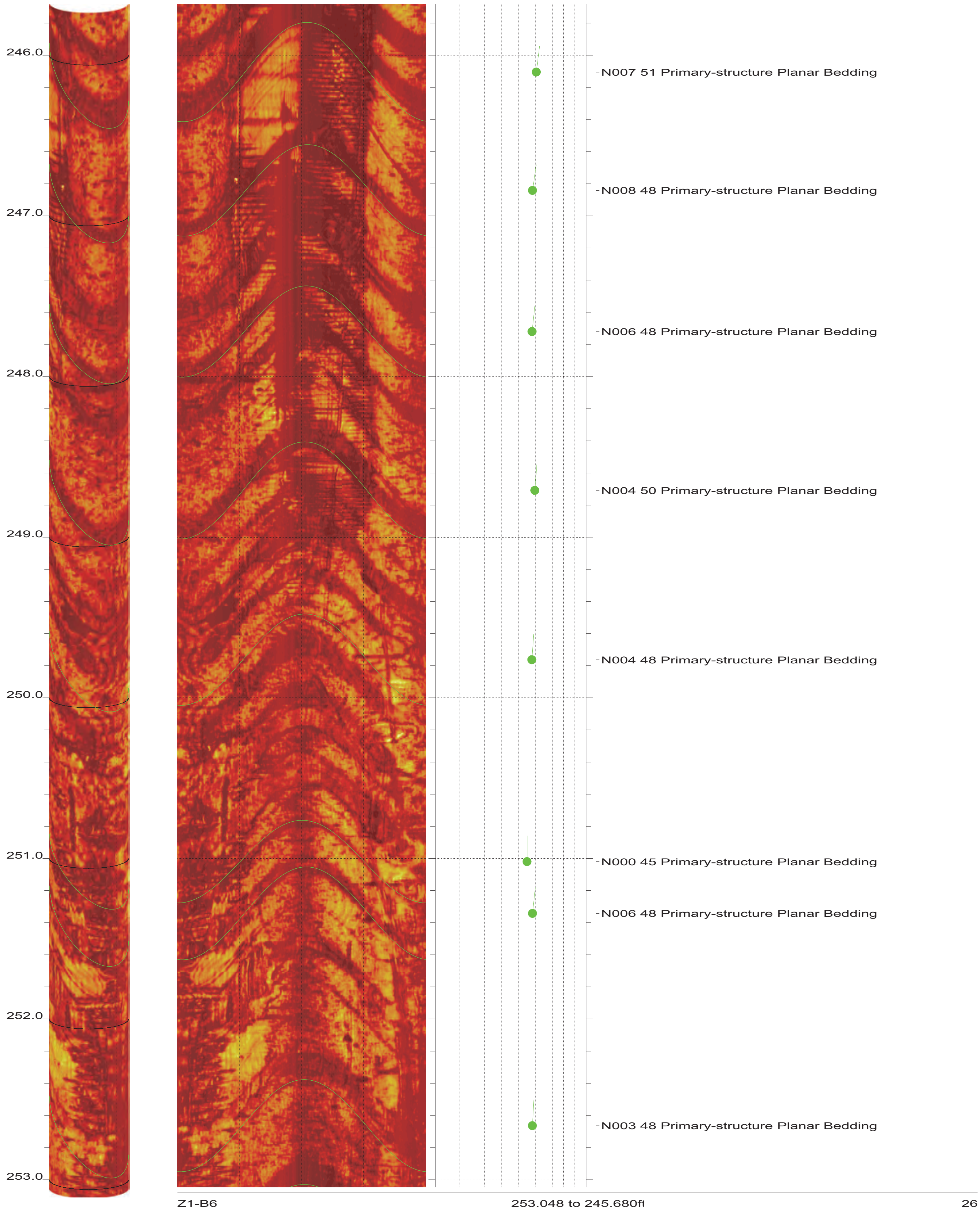
SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 23 of 46



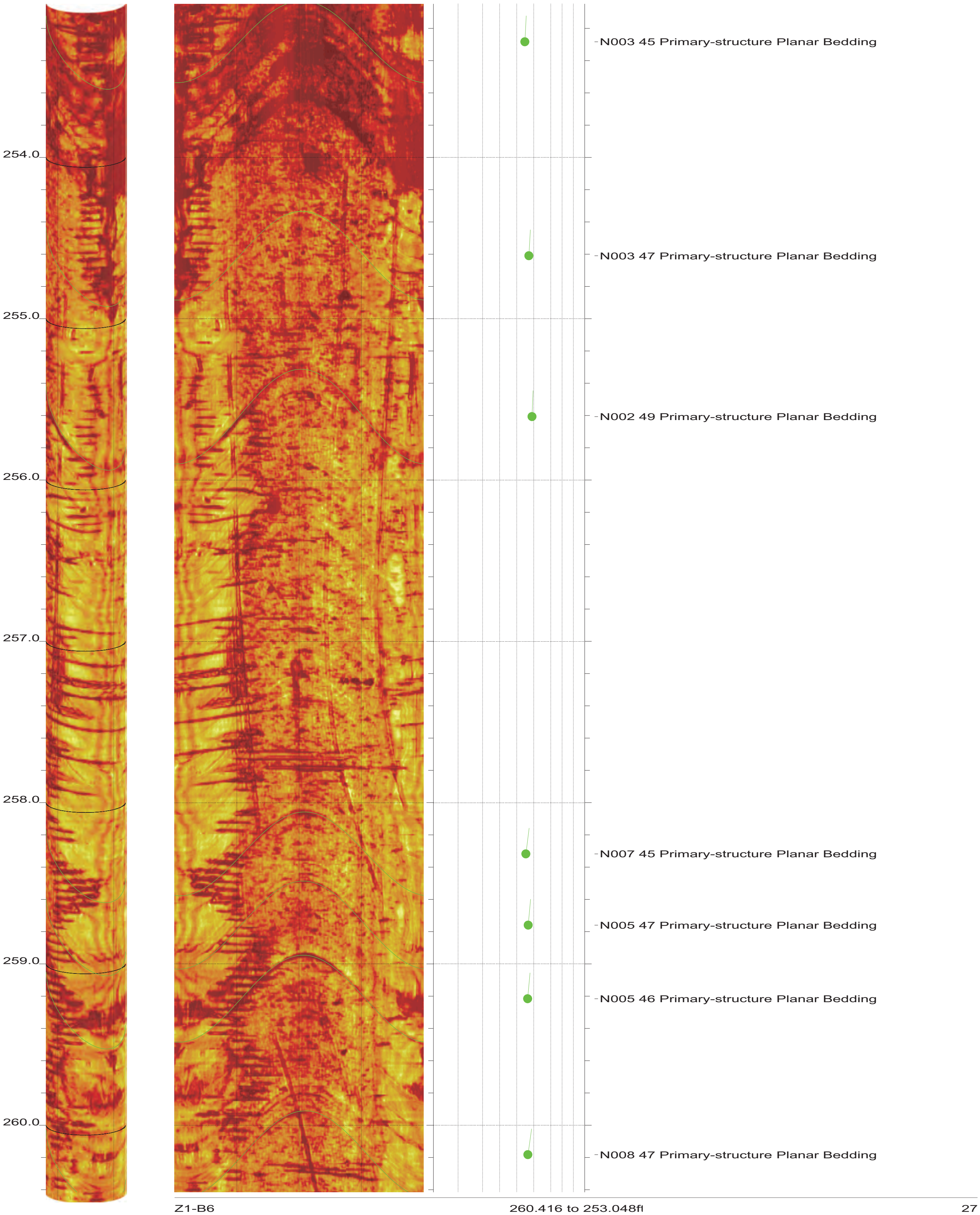
SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 24 of 46



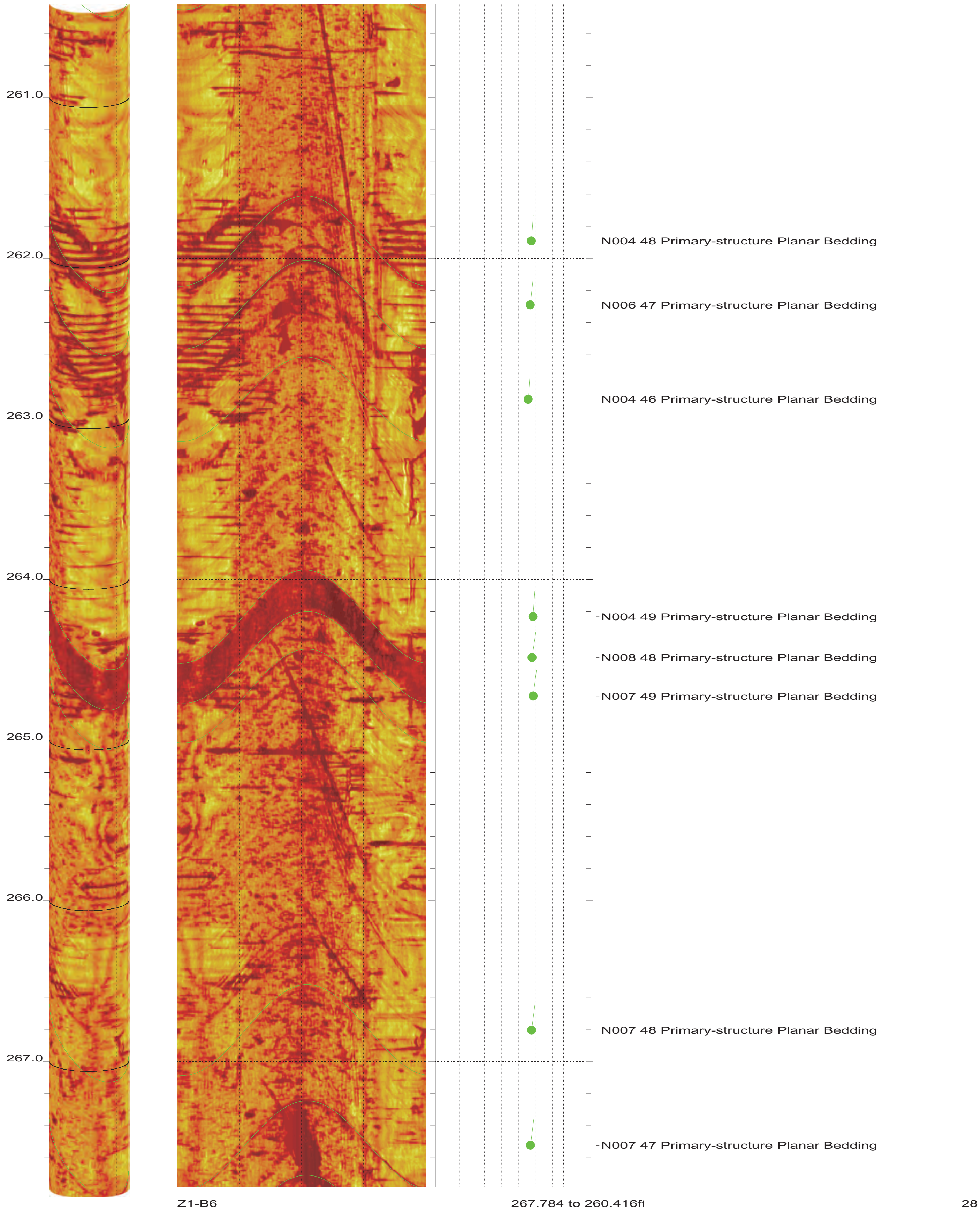
SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 25 of 46



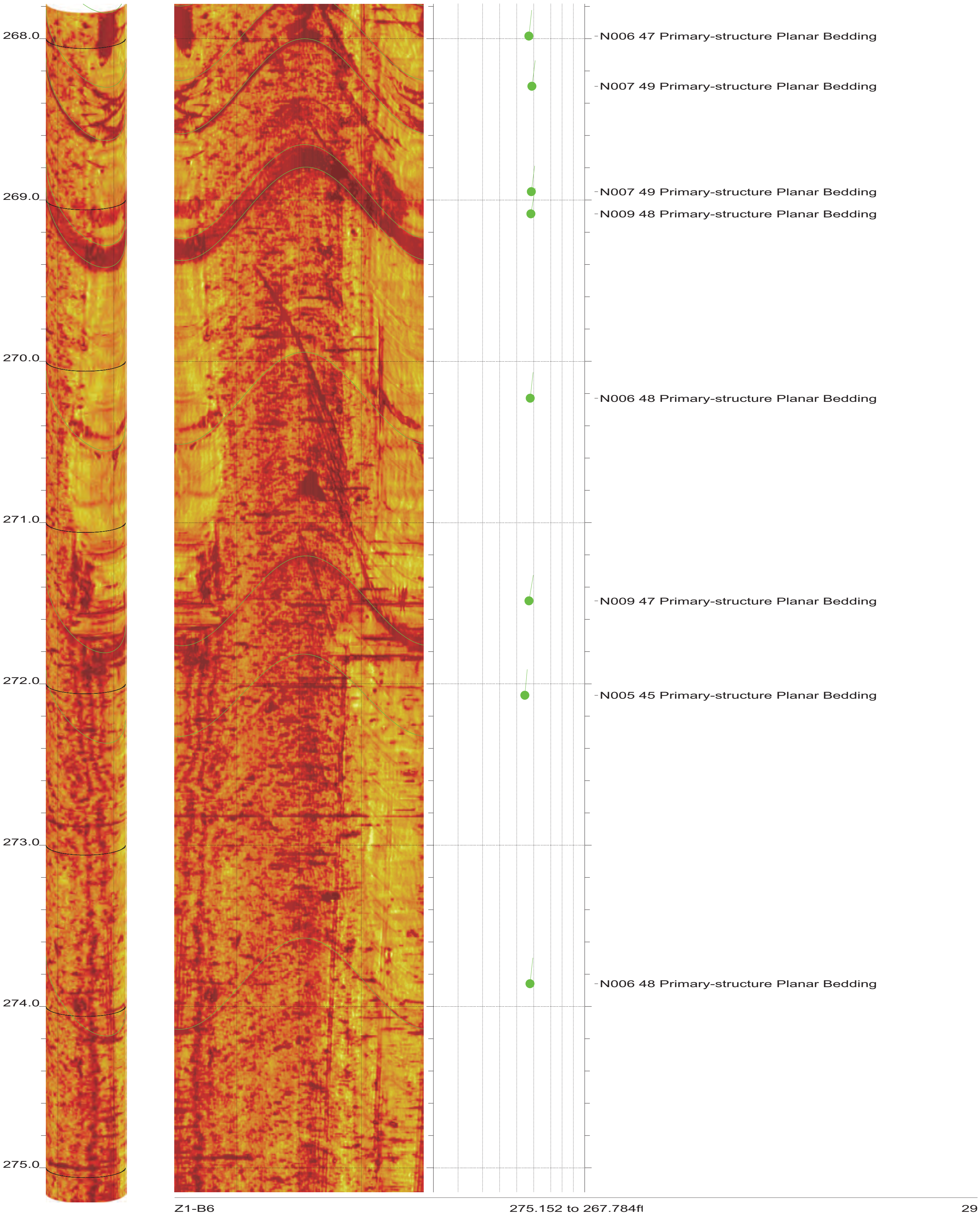
SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 26 of 46



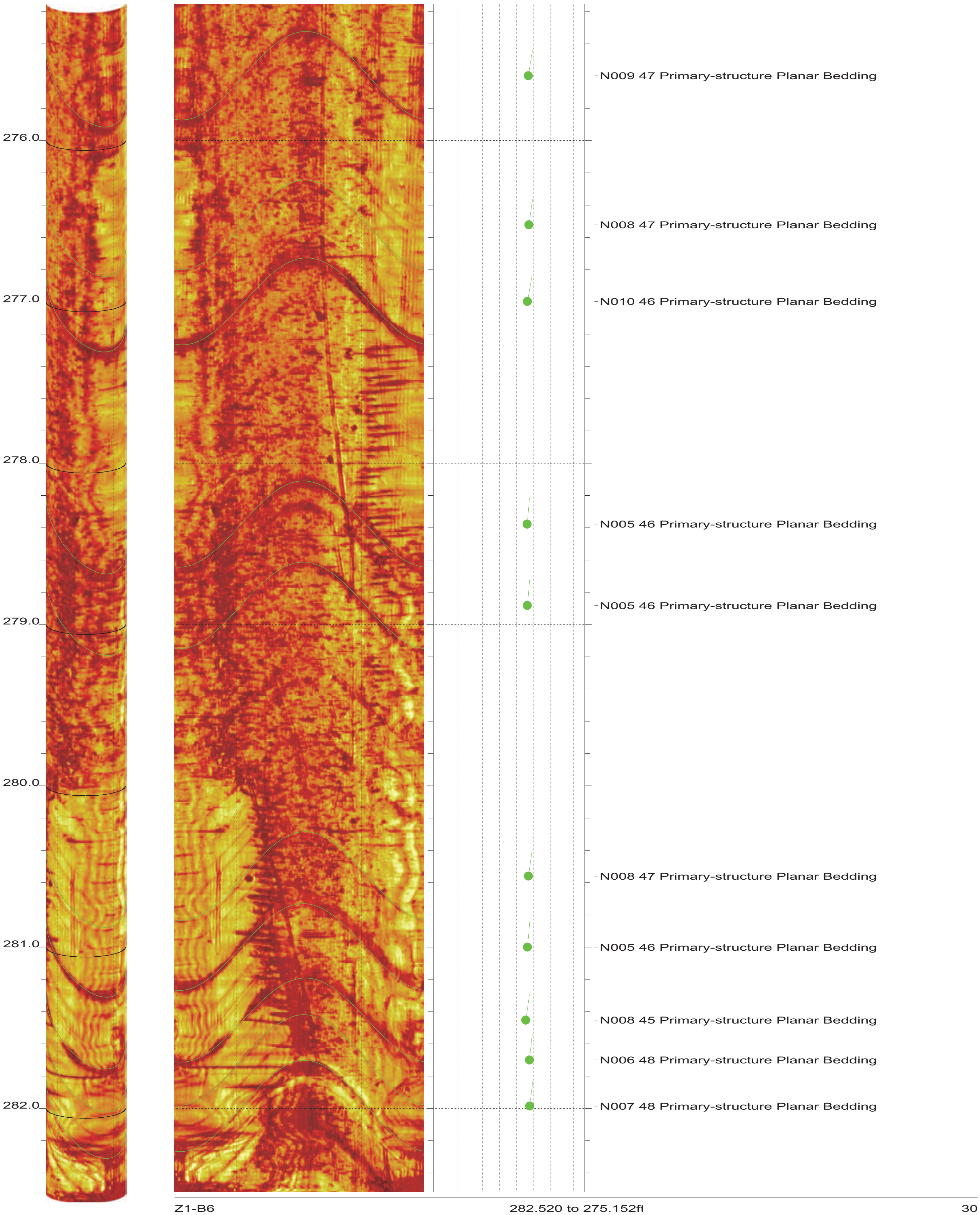
SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 27 of 46



SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 28 of 46

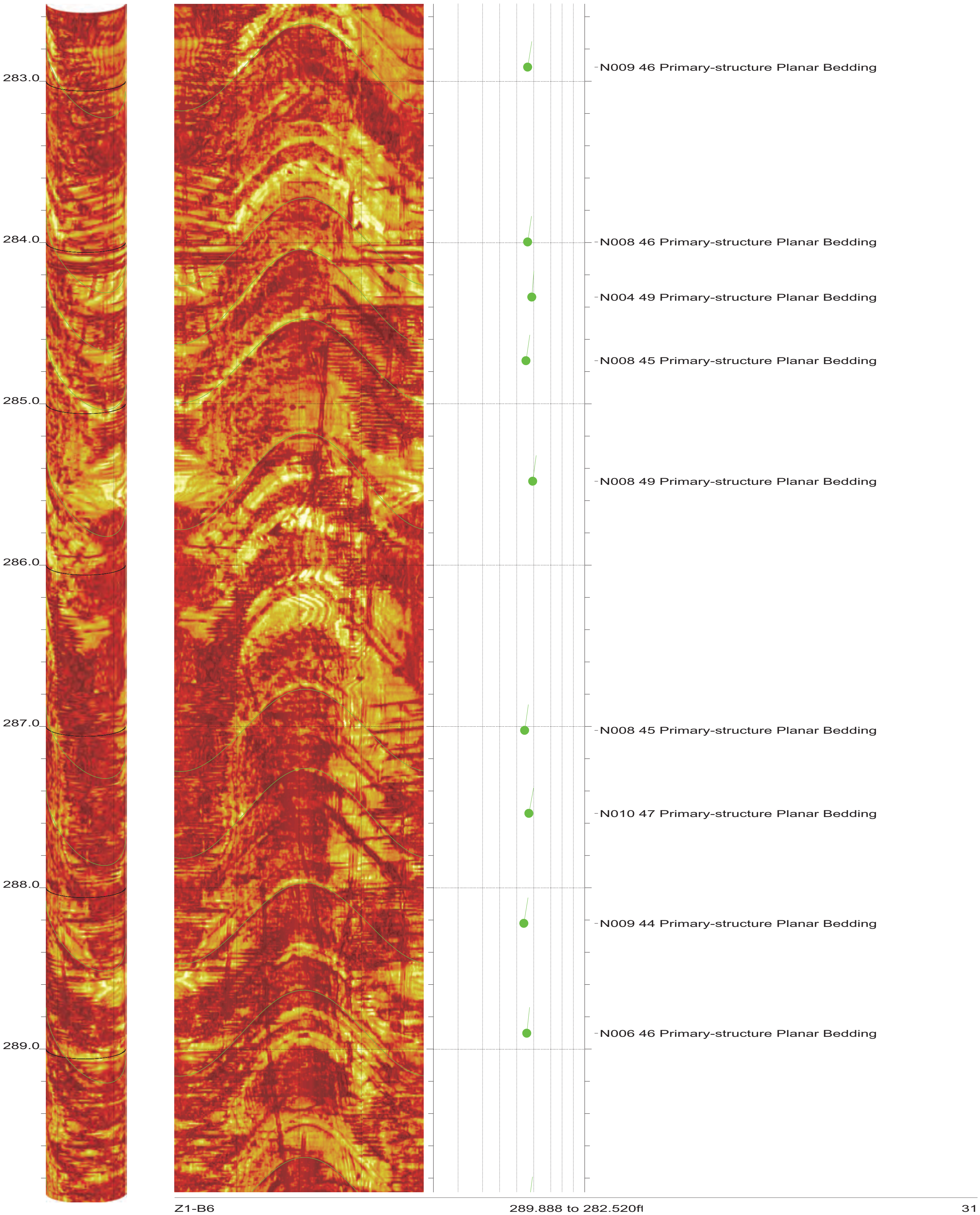


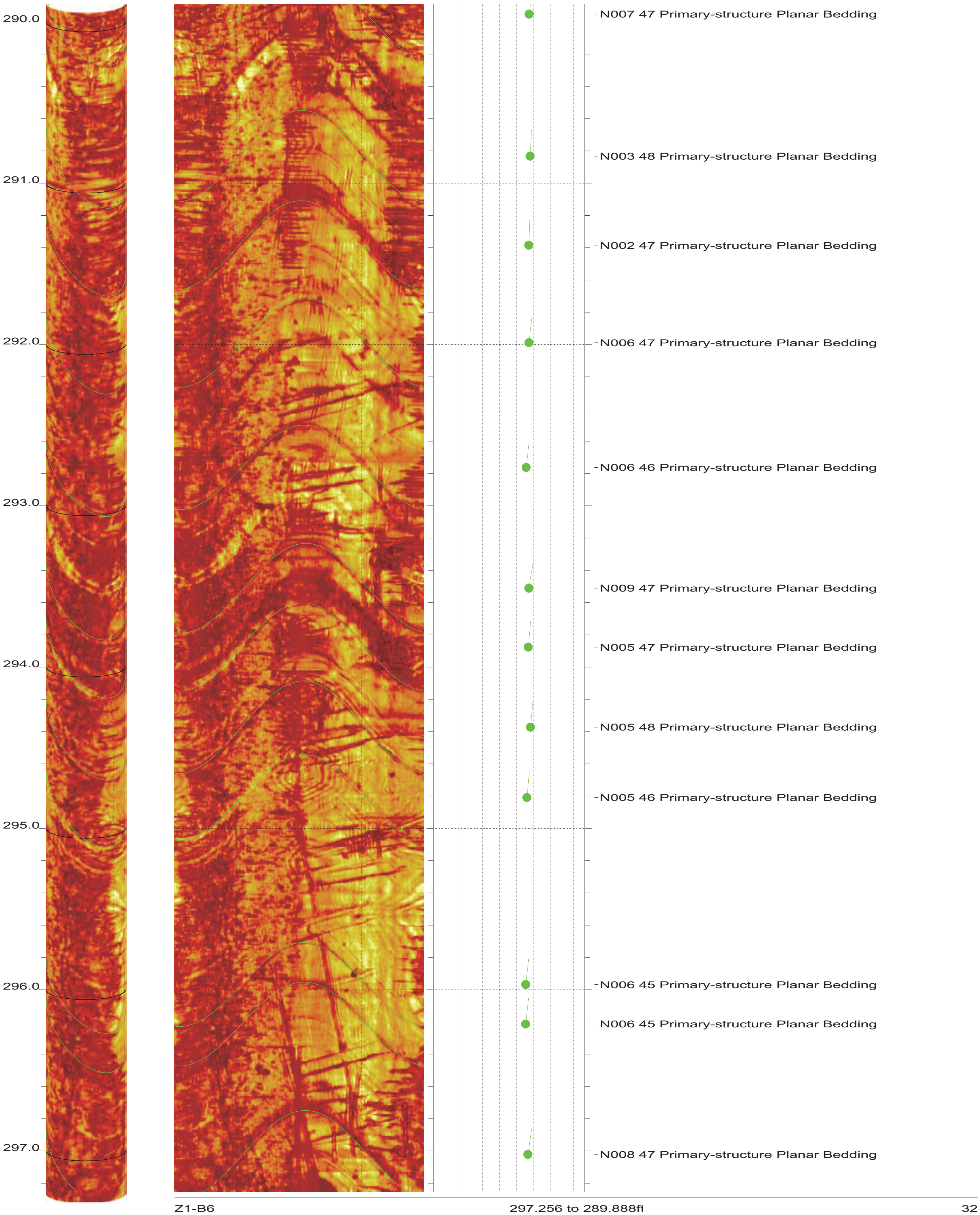
SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 29 of 46



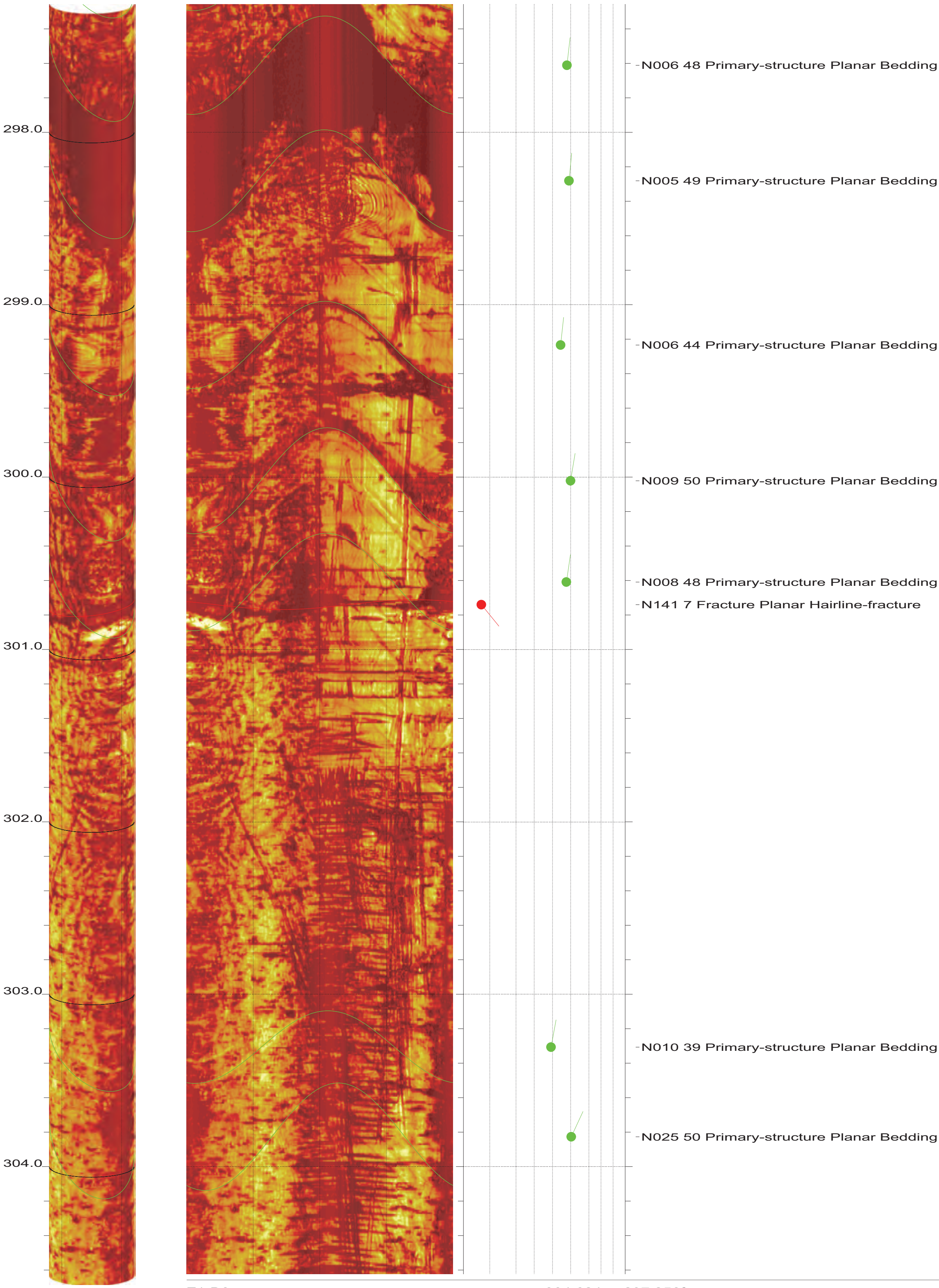
Z1-B6 282.520 to 275.152ft 30

SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 30 of 46


283.0
284.0
285.0
286.0
287.0
288.0
289.0
N009 46 Primary-structure Planar Bedding
N008 46 Primary-structure Planar Bedding
N004 49 Primary-structure Planar Bedding
N008 45 Primary-structure Planar Bedding
N008 49 Primary-structure Planar Bedding
N008 45 Primary-structure Planar Bedding
N010 47 Primary-structure Planar Bedding
N009 44 Primary-structure Planar Bedding
N006 46 Primary-structure Planar Bedding
Z1-B6
289.888 to 282.520ft
31

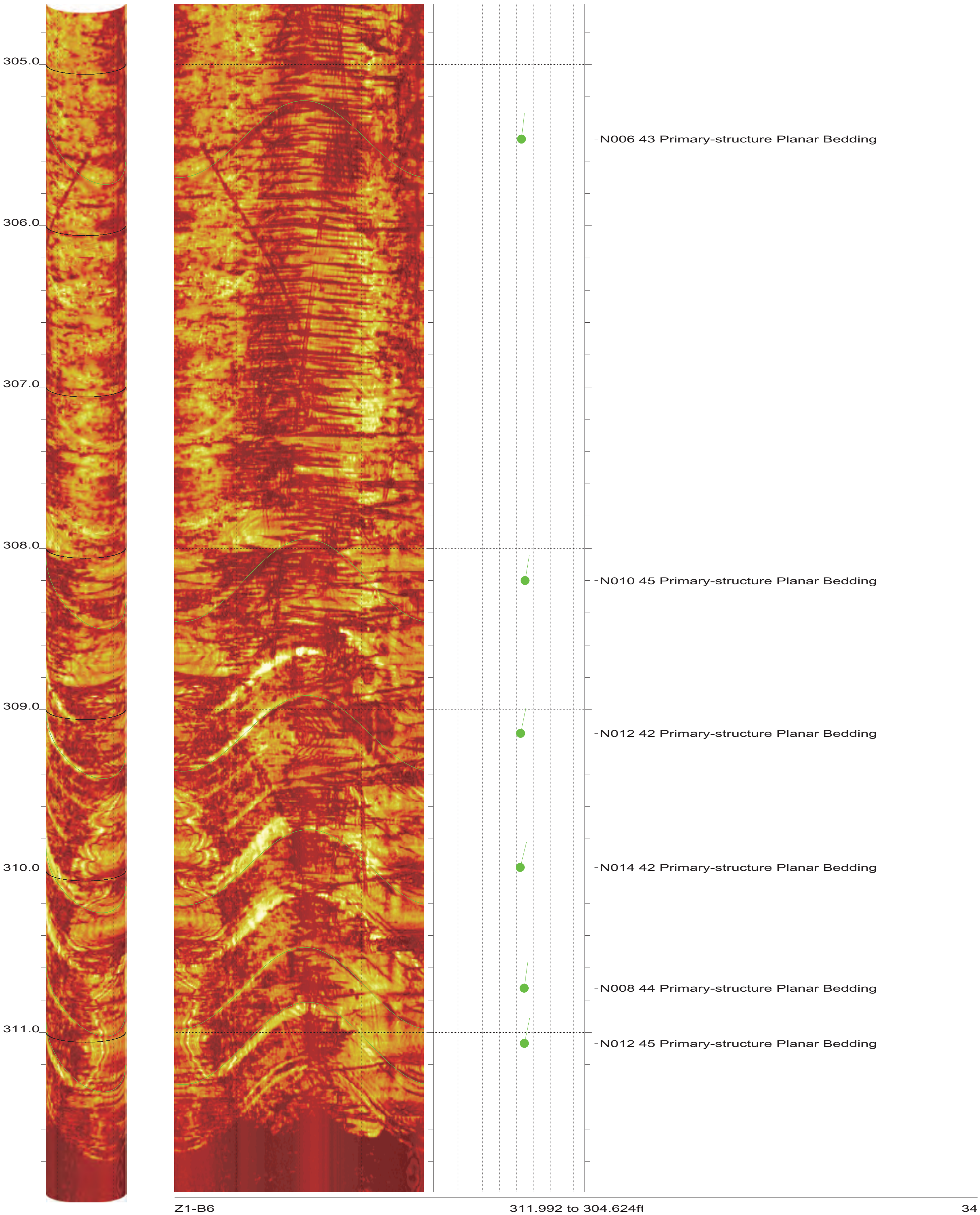


SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 32 of 46

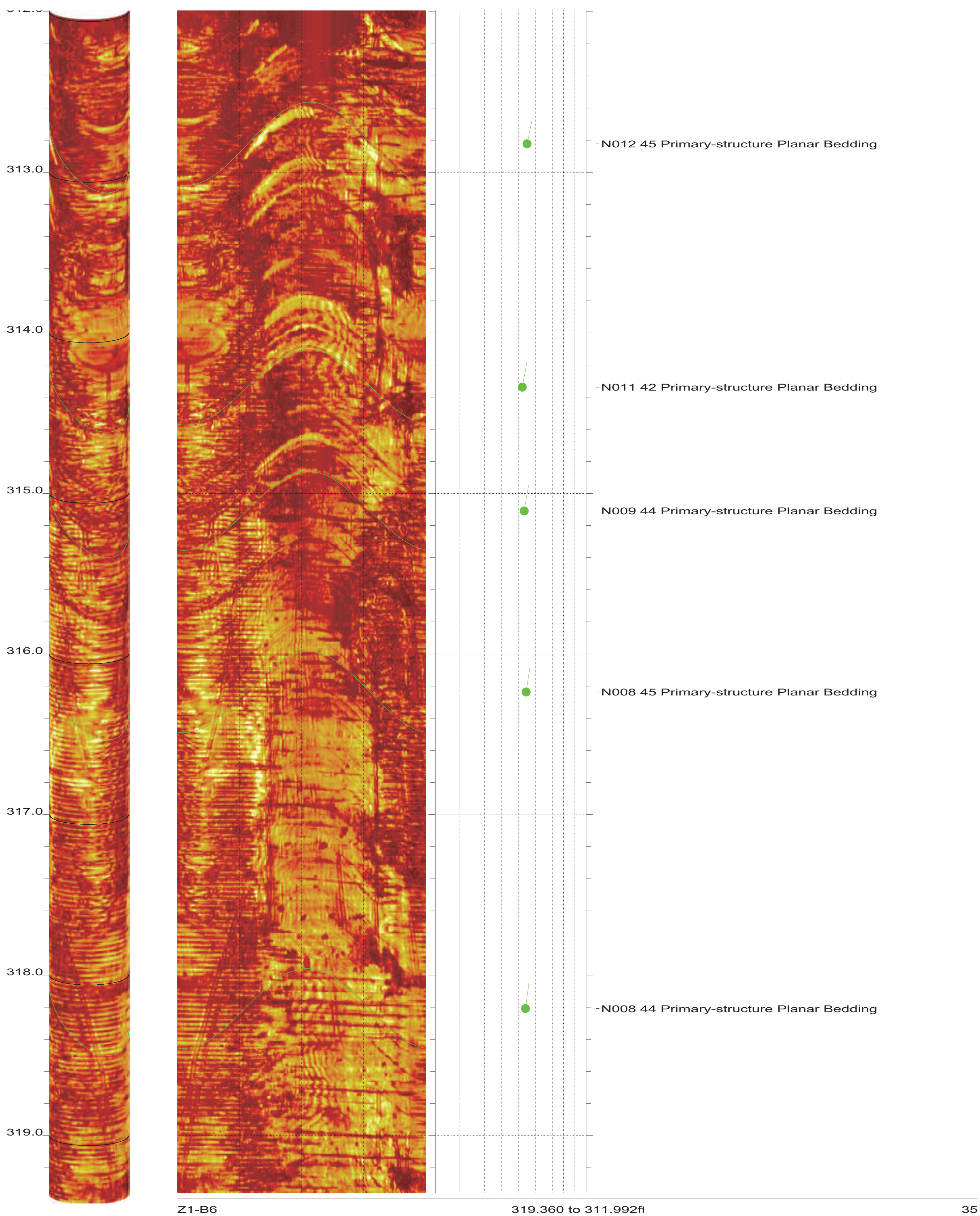


Z1-B6 304.624 to 297.256ft 33

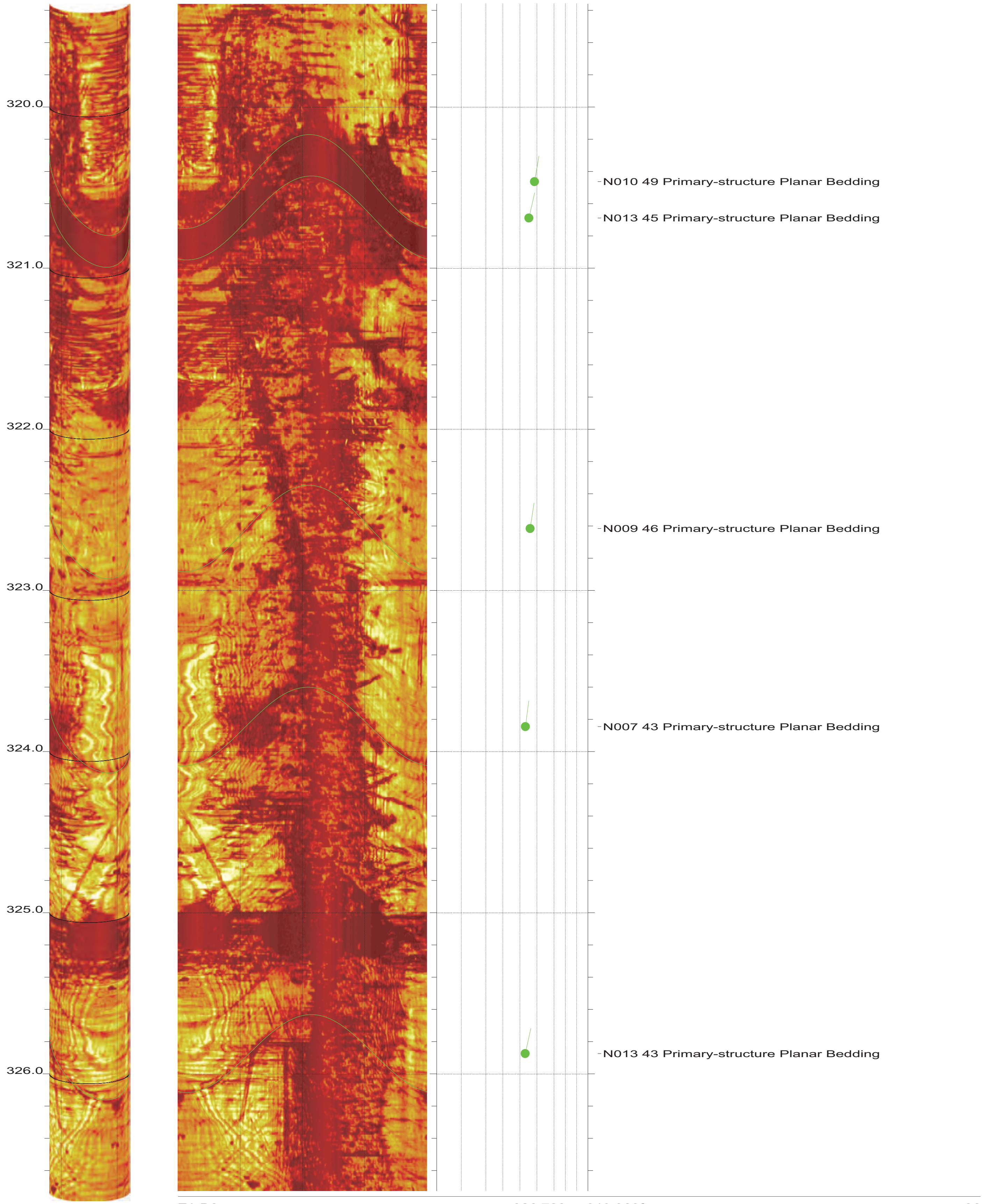
SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 33 of 46



SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 34 of 46

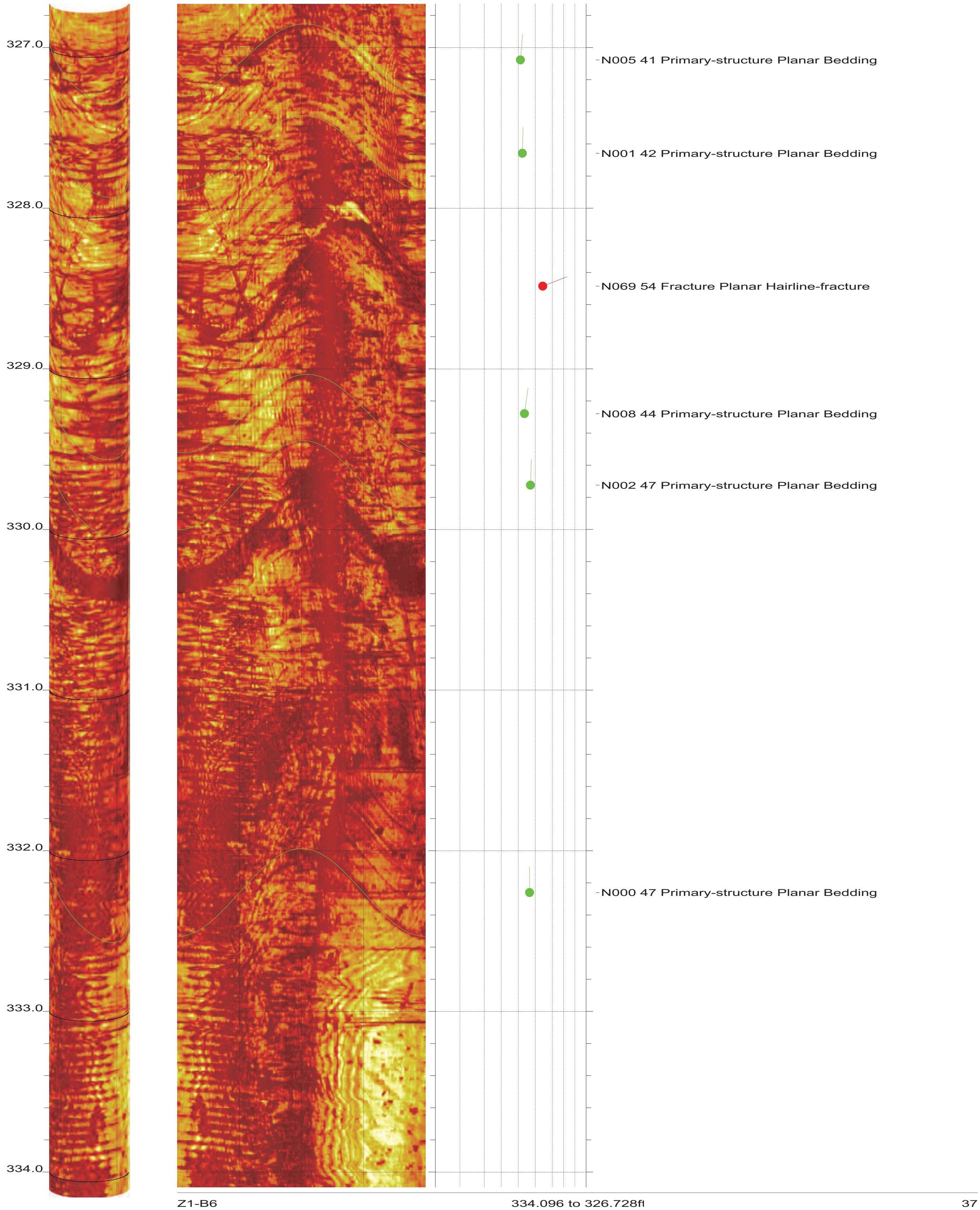


SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 35 of 46

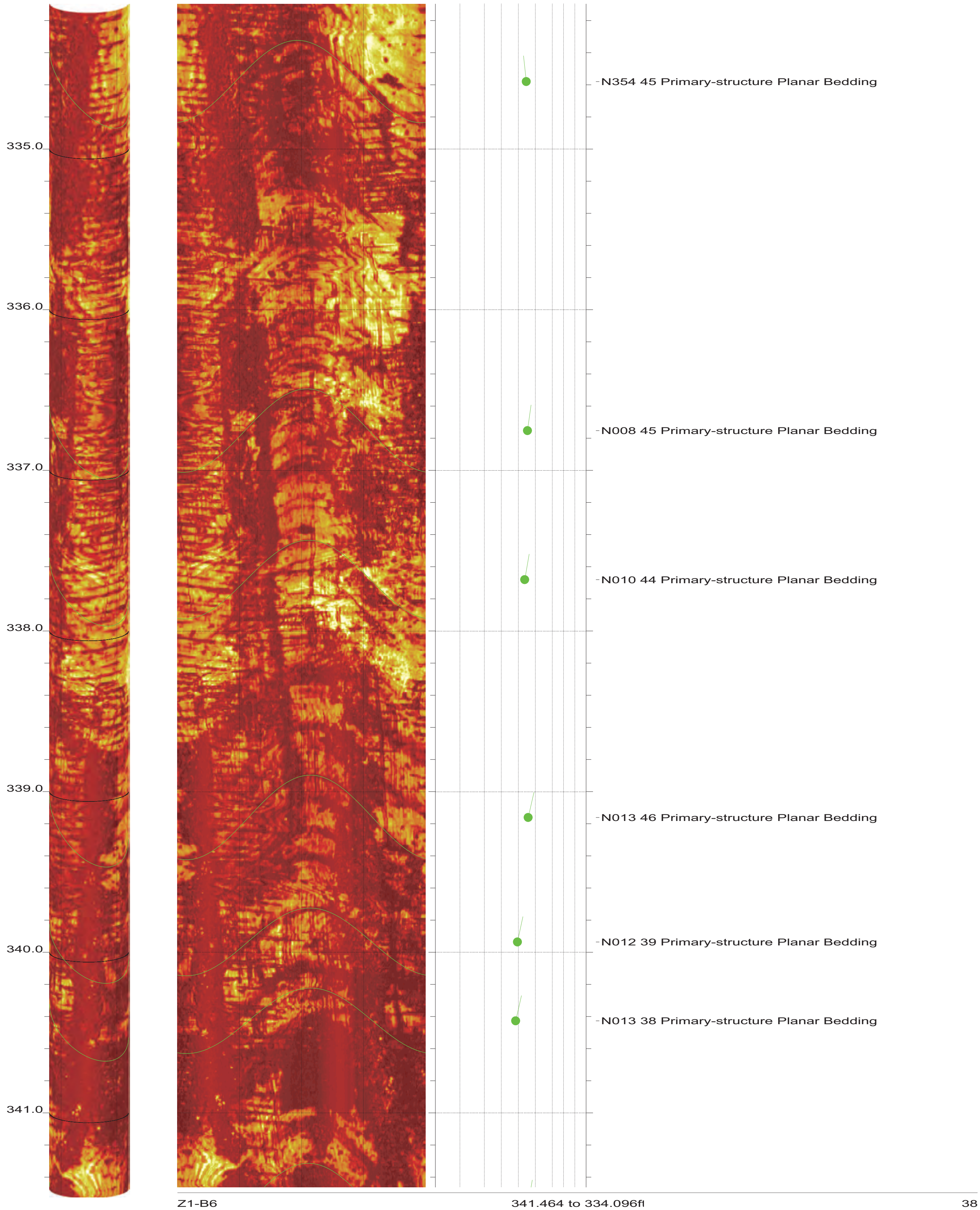


Z1-B6 326.728 to 319.360ft 36

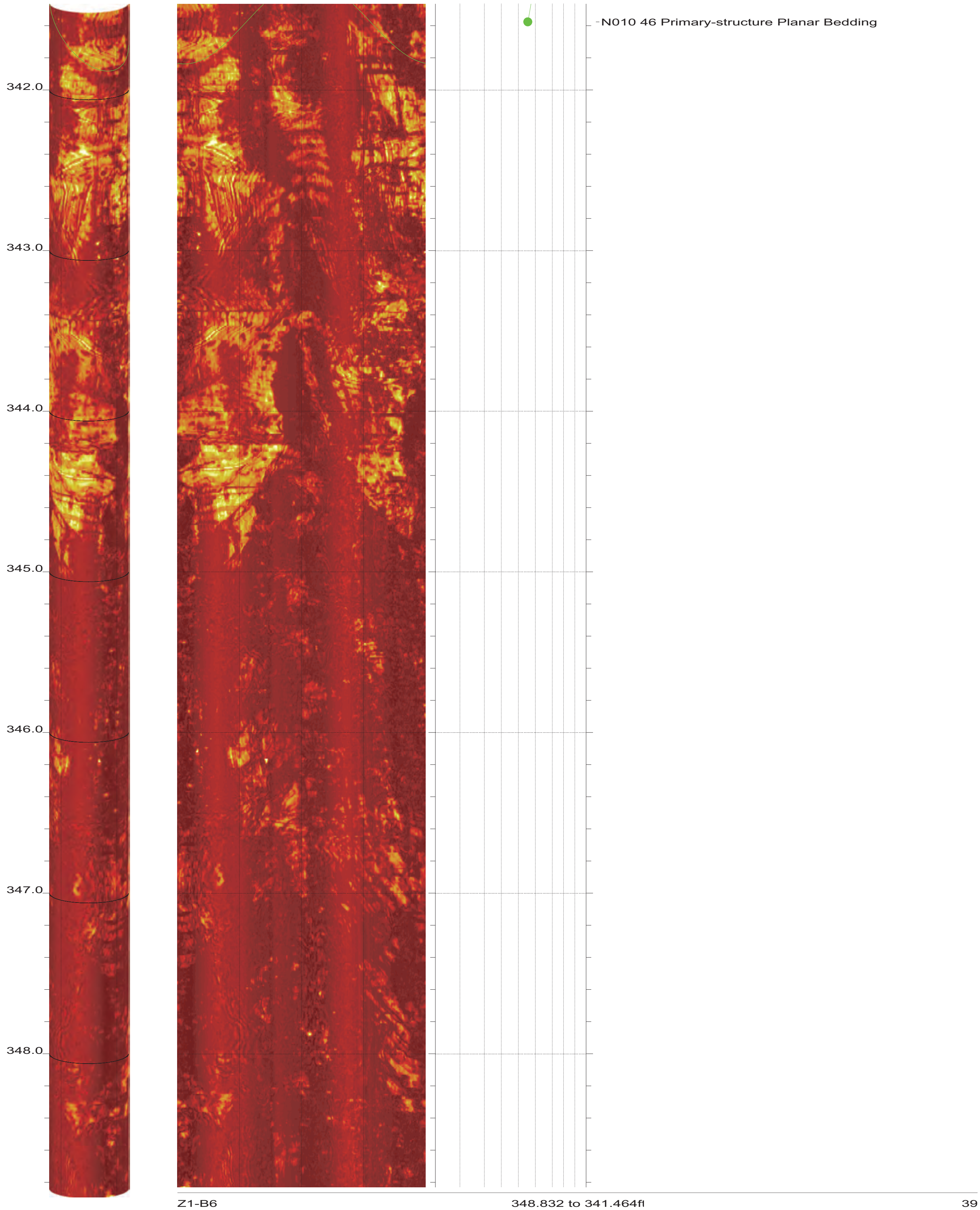
SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 36 of 46



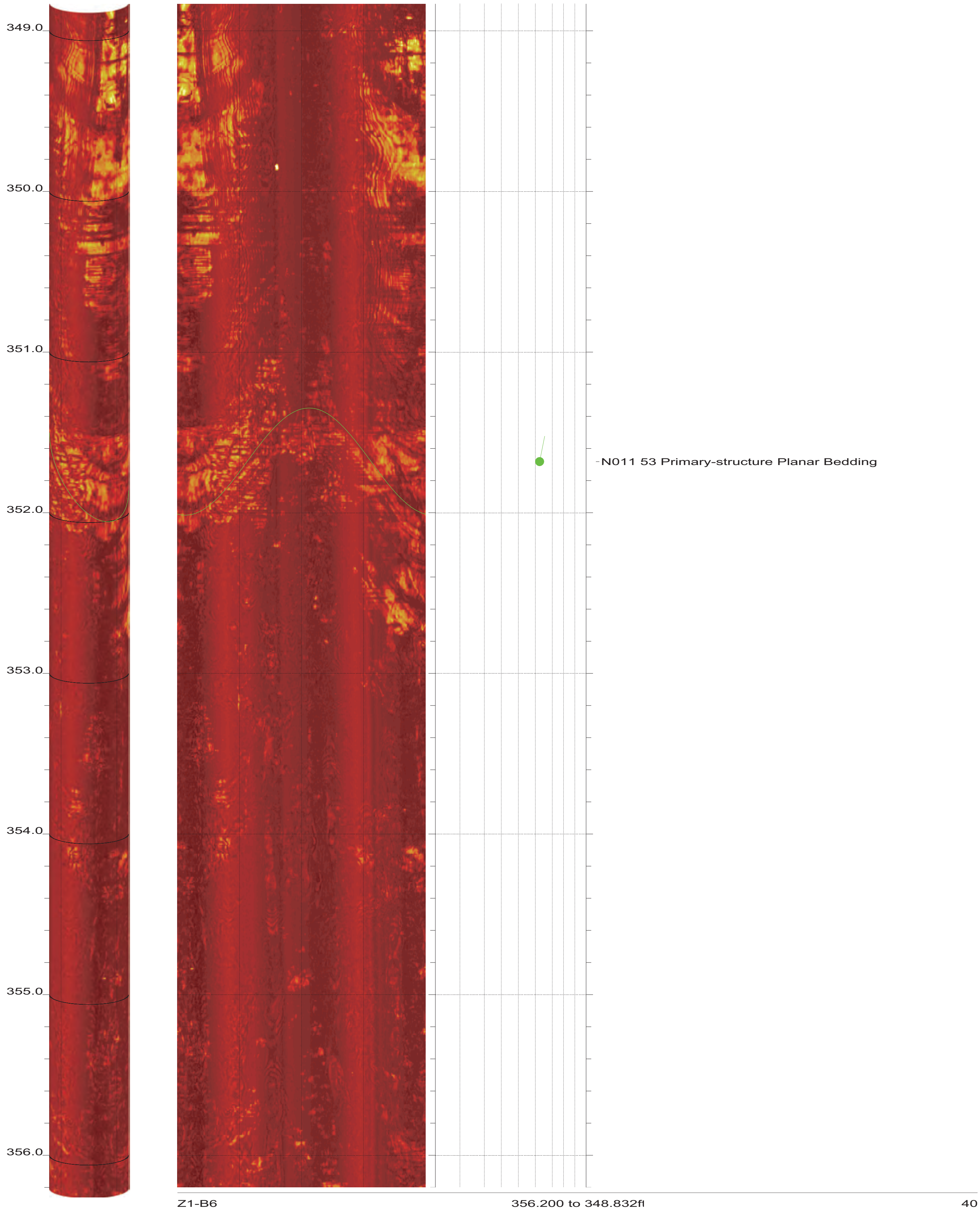
SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 37 of 46



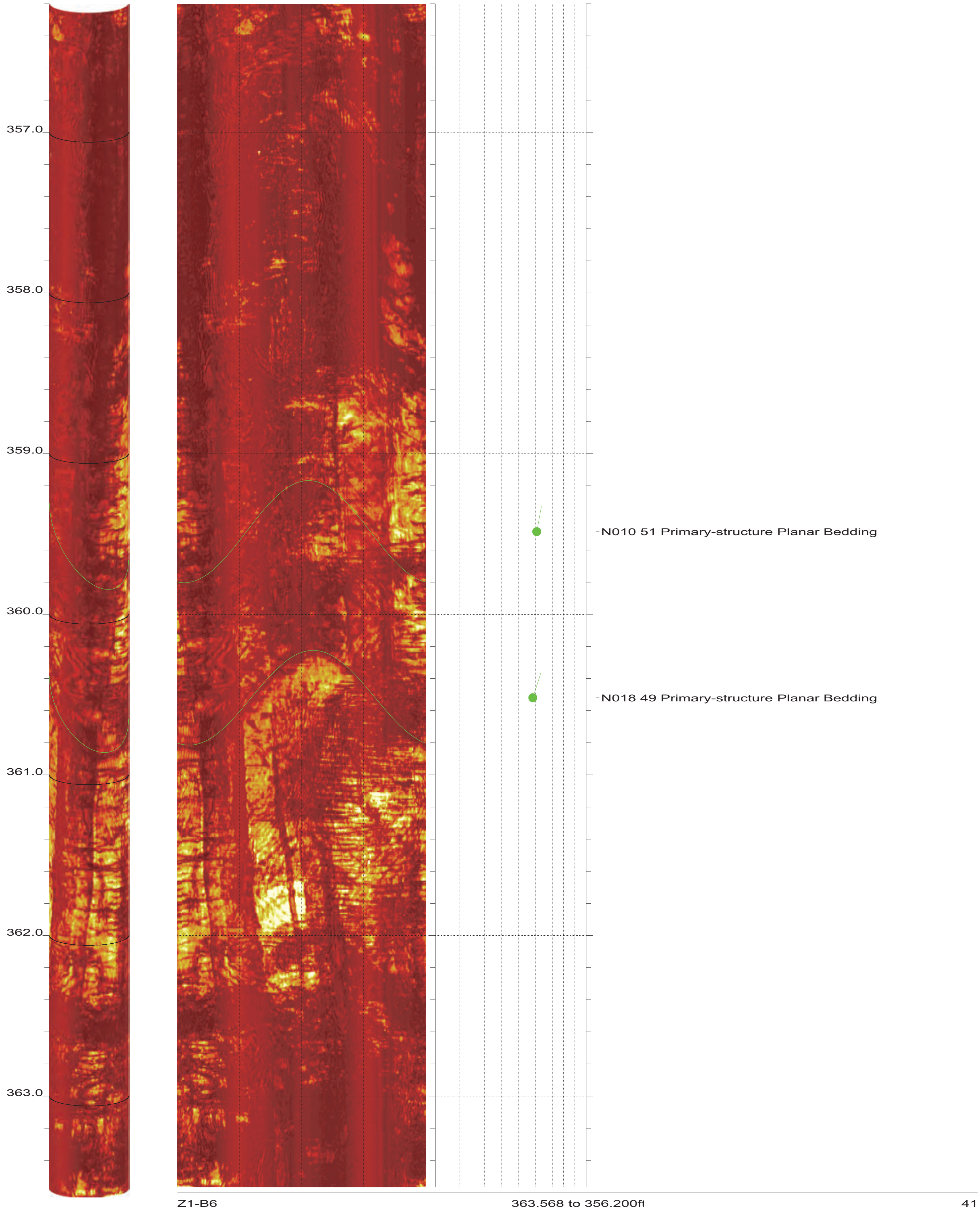
SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 38 of 46



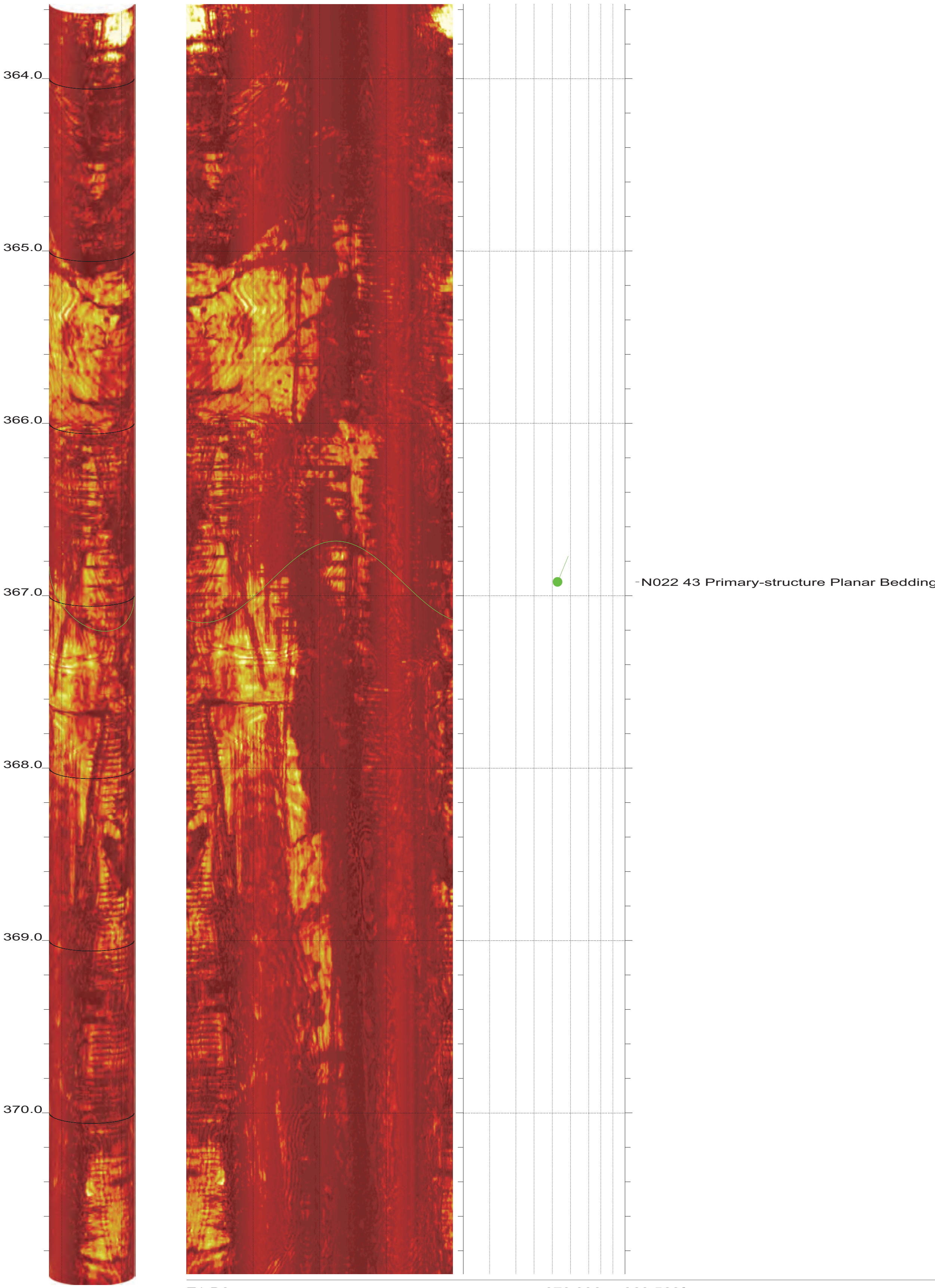
SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 39 of 46



SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 40 of 46

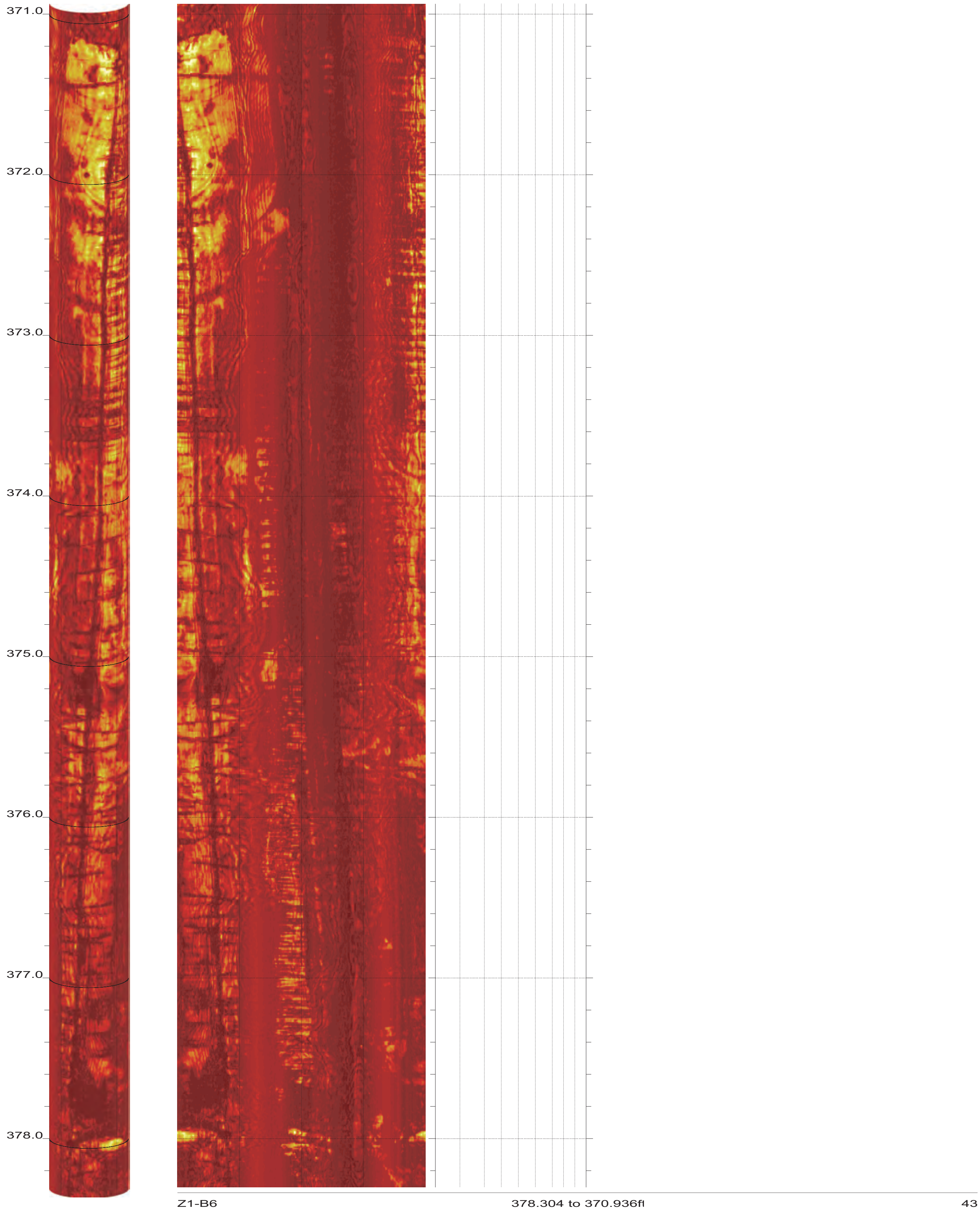


SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 41 of 46

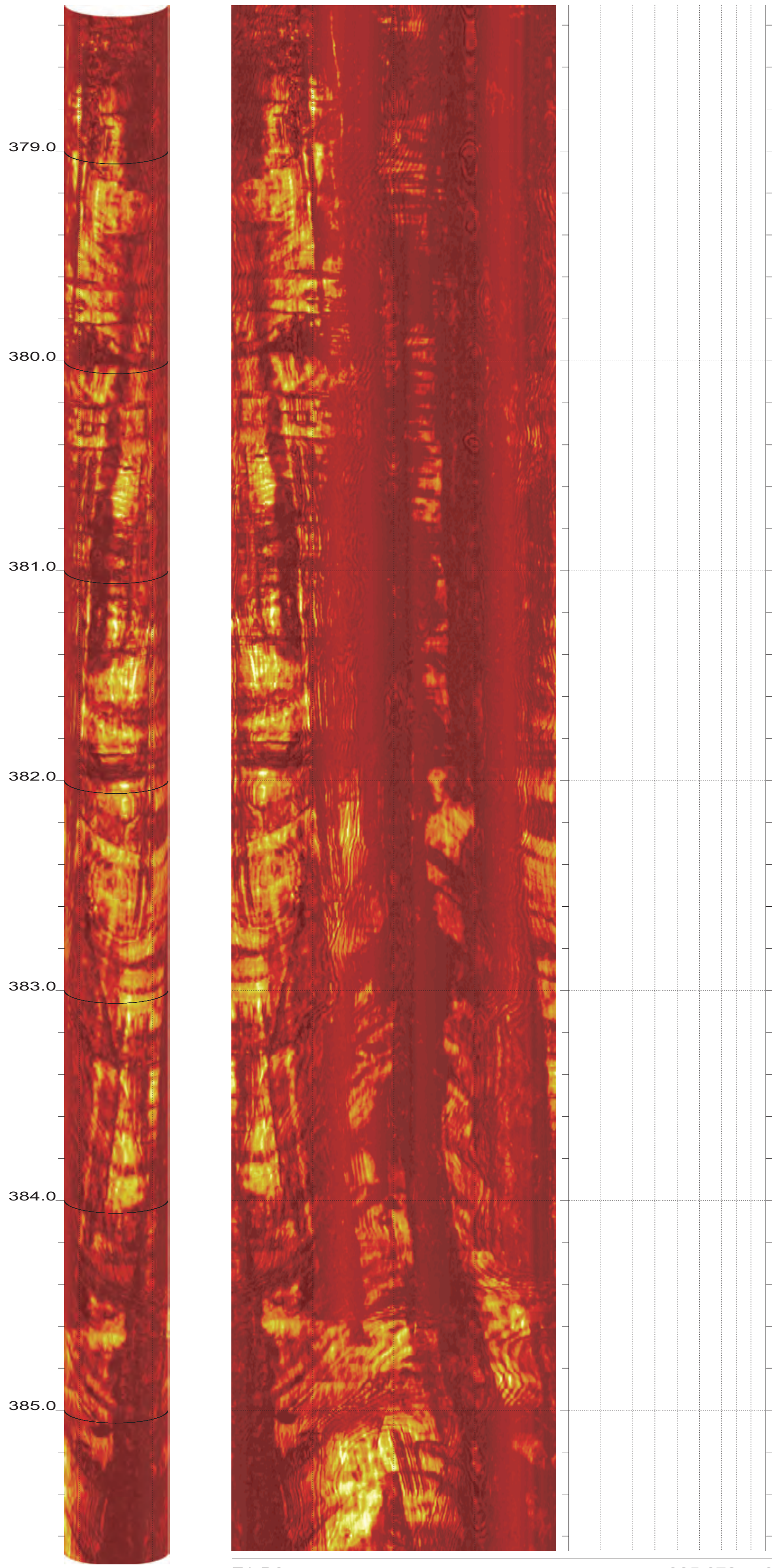


Z1-B6 370.936 to 363.568ft 42

SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 42 of 46

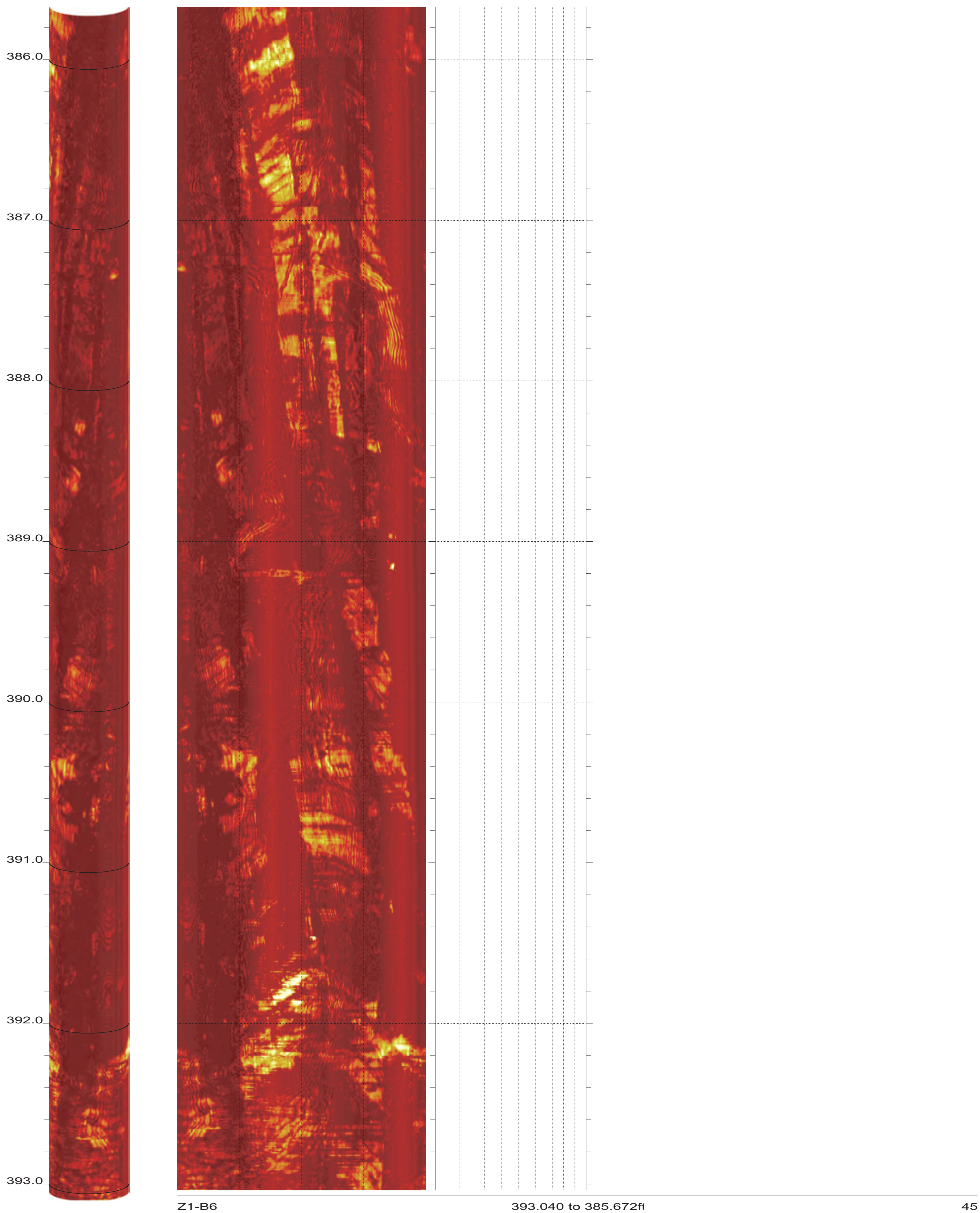


SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 43 of 46

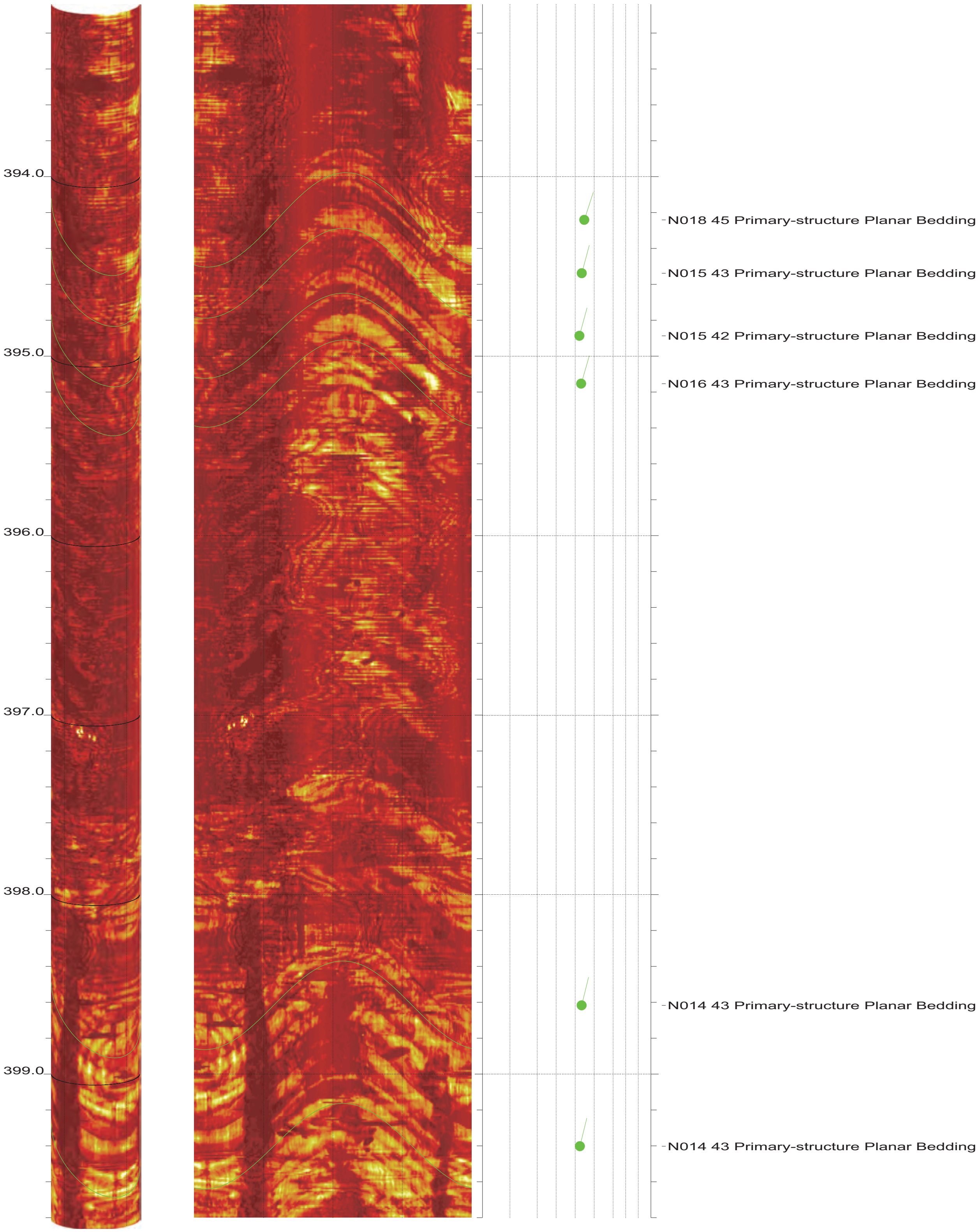


Z1-B6 385.672 to 378.304ft 44

SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 44 of 46



SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 45 of 46



Z1-B6 399.800 to 393.040ft 46

SR-710 Boring Z1-B6 Acoustic Televiewer Dips rev 1 Sheet 46 of 46

BHTV DATA PROCESSING
RGLDIP vsn 6.2
INTERPRETED BHTV DIPS LOG

CASCADE DRILLING

Borehole: Z1-B7

SR-710 TUNNEL INVESTIGATION

top of borehole.....
East: _
North: _
Elev: _

North ref. is true
Depth units are feet
Vertical scale: 1/10
Horiz scale = 1.00x Vert scale

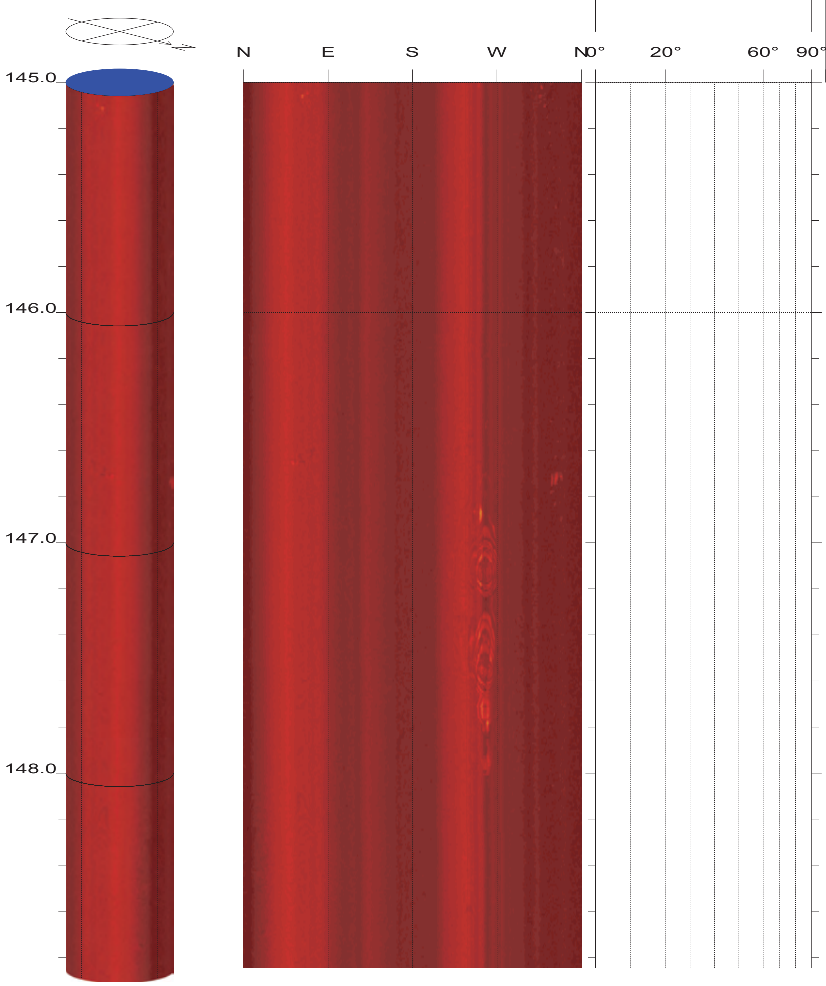
Zone from 298.800 to 145.000ft
Format: BHTV-NESWN

Borehole diam: 5.600inch
Vertical = borehole-axis
Image: Amplitude

Stratigraphic dips
Non-stratigraphic dips
Identified units

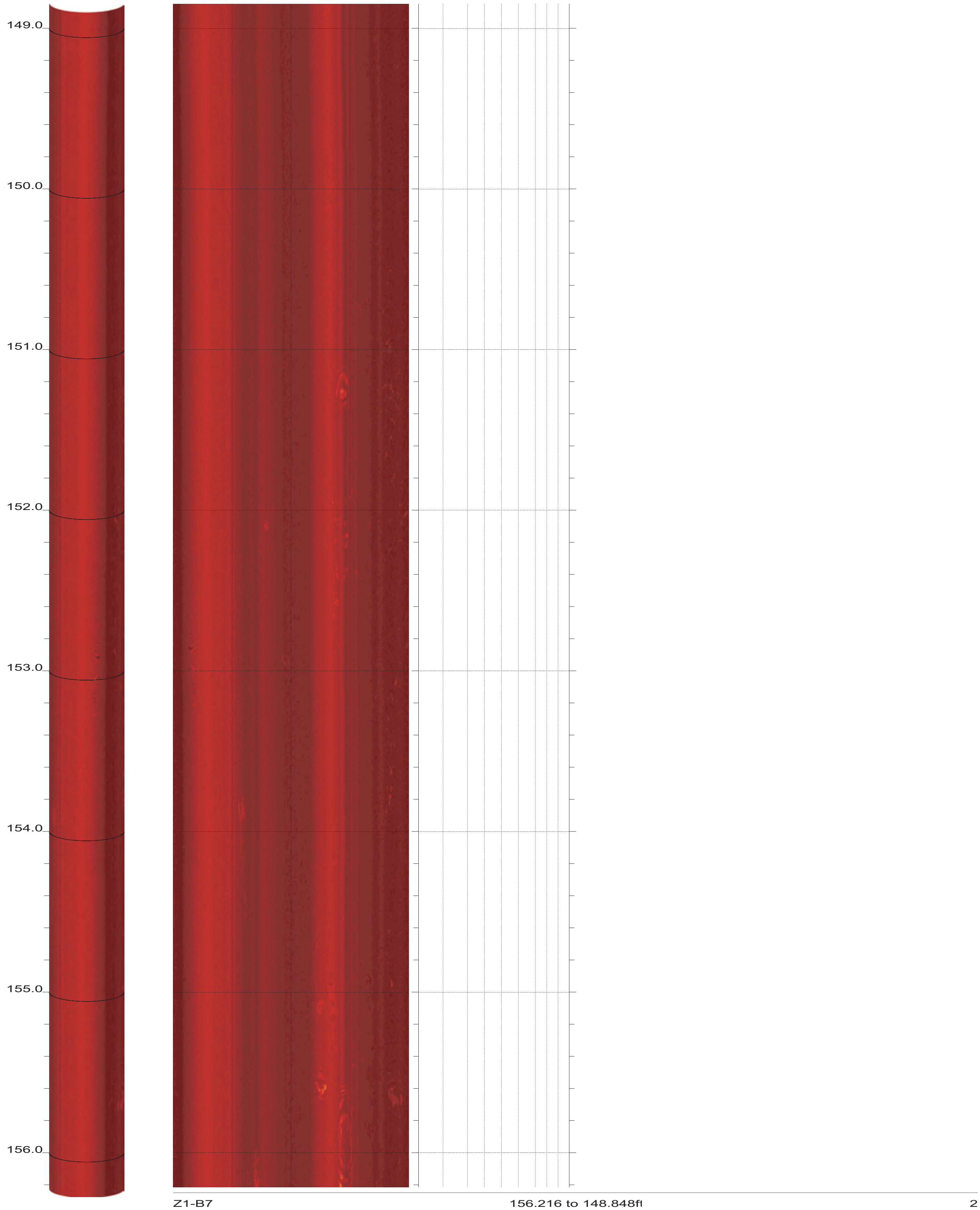
ARROW PLOT

COMMENTS

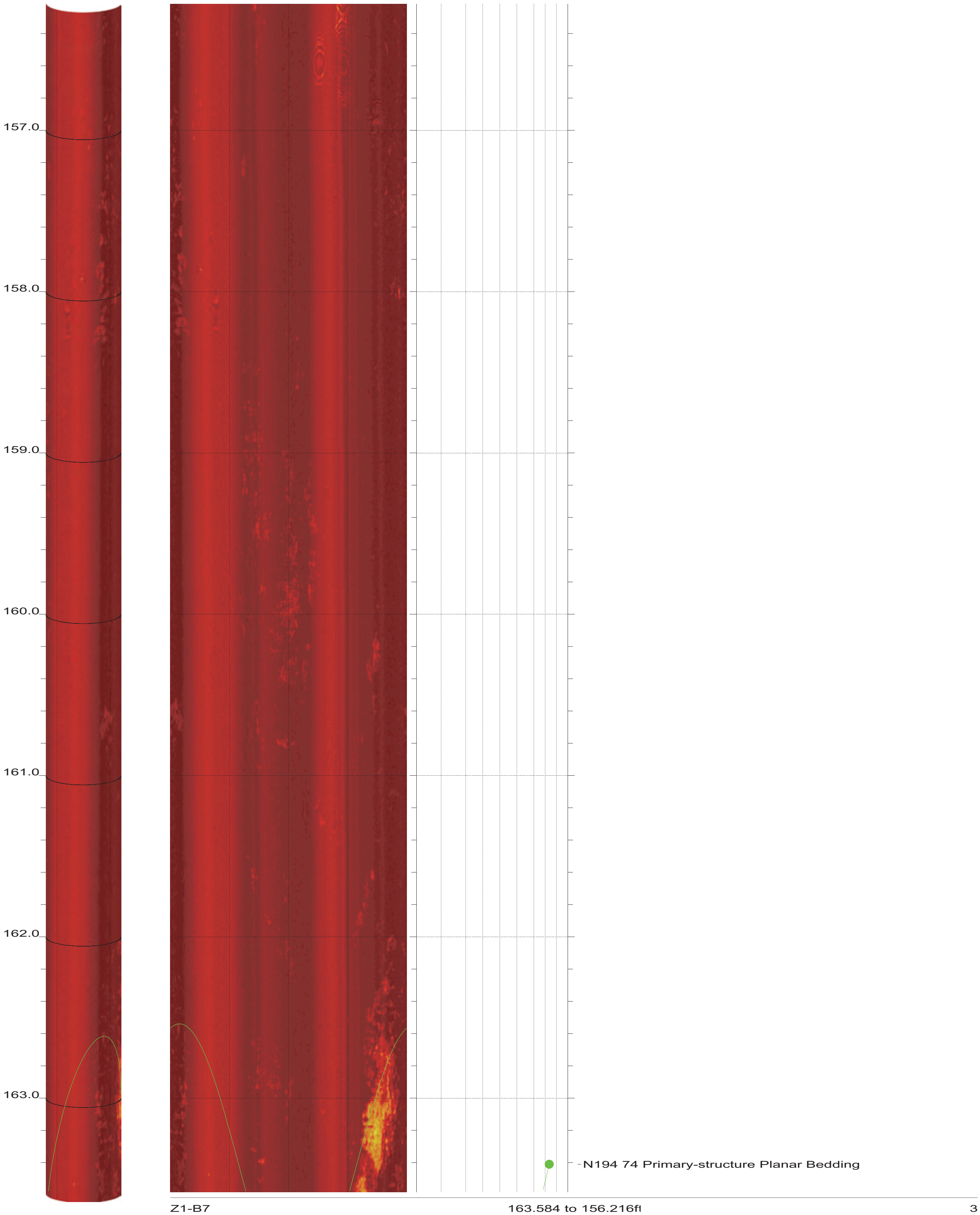


Z1-B7 148.848 to 145.000ft 1

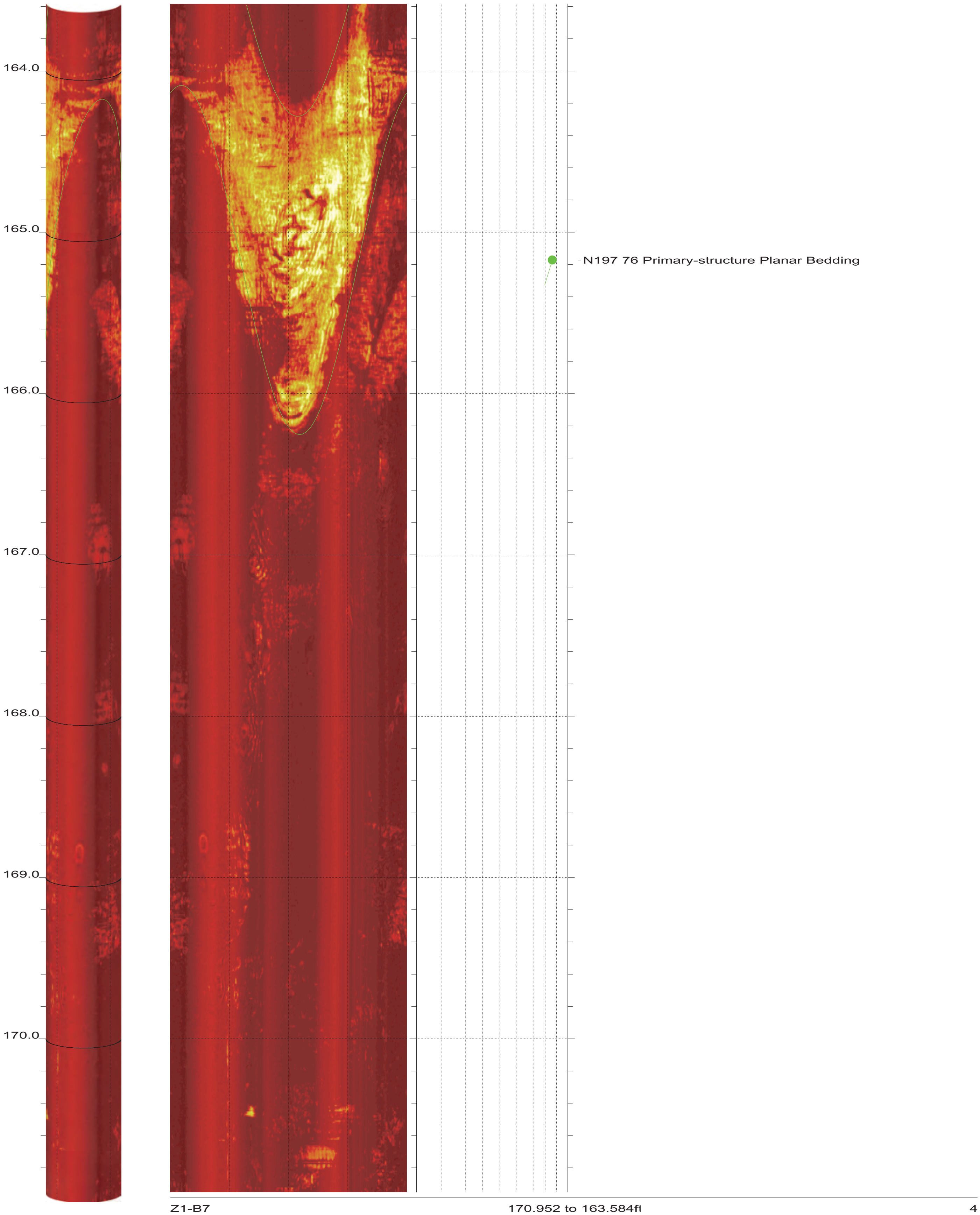
SR-710 Boring Z1-B7 Acoustic Televiewer Dips rev 1 Sheet 1 of 22



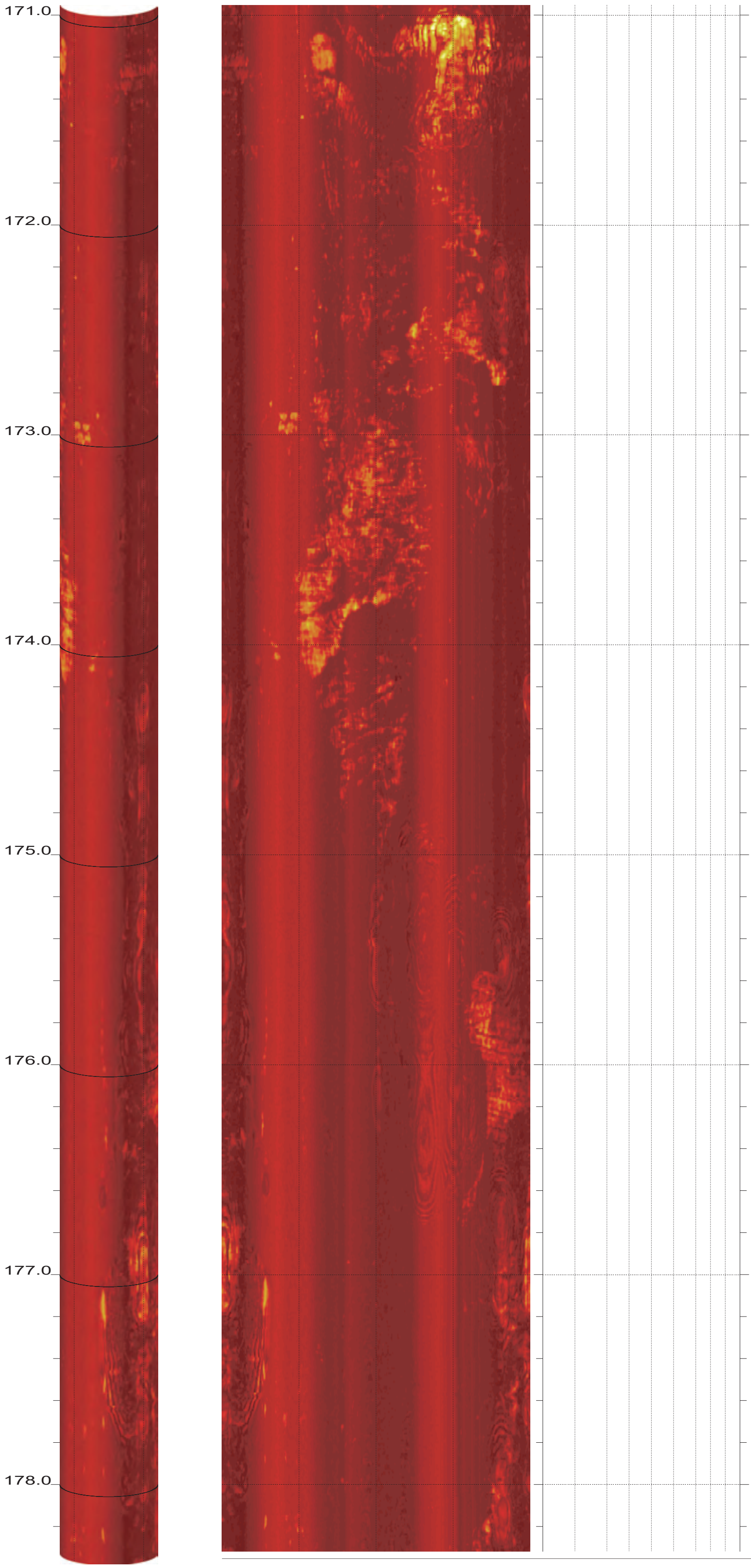
SR-710 Boring Z1-B7 Acoustic Televiewer Dips rev 1 Sheet 2 of 22



SR-710 Boring Z1-B7 Acoustic Televiewer Dips rev 1 Sheet 3 of 22

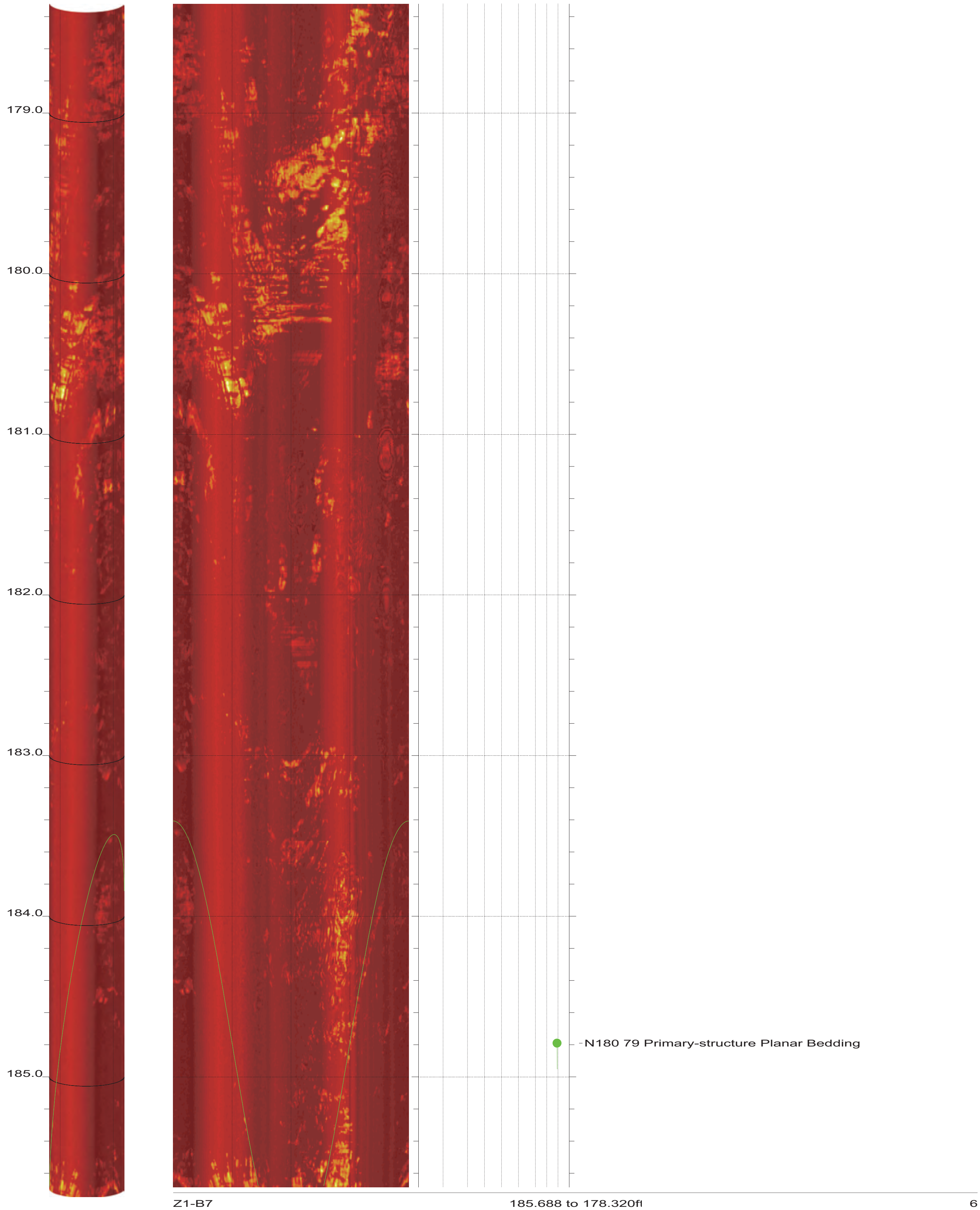


SR-710 Boring Z1-B7 Acoustic Televiewer Dips rev 1 Sheet 4 of 22

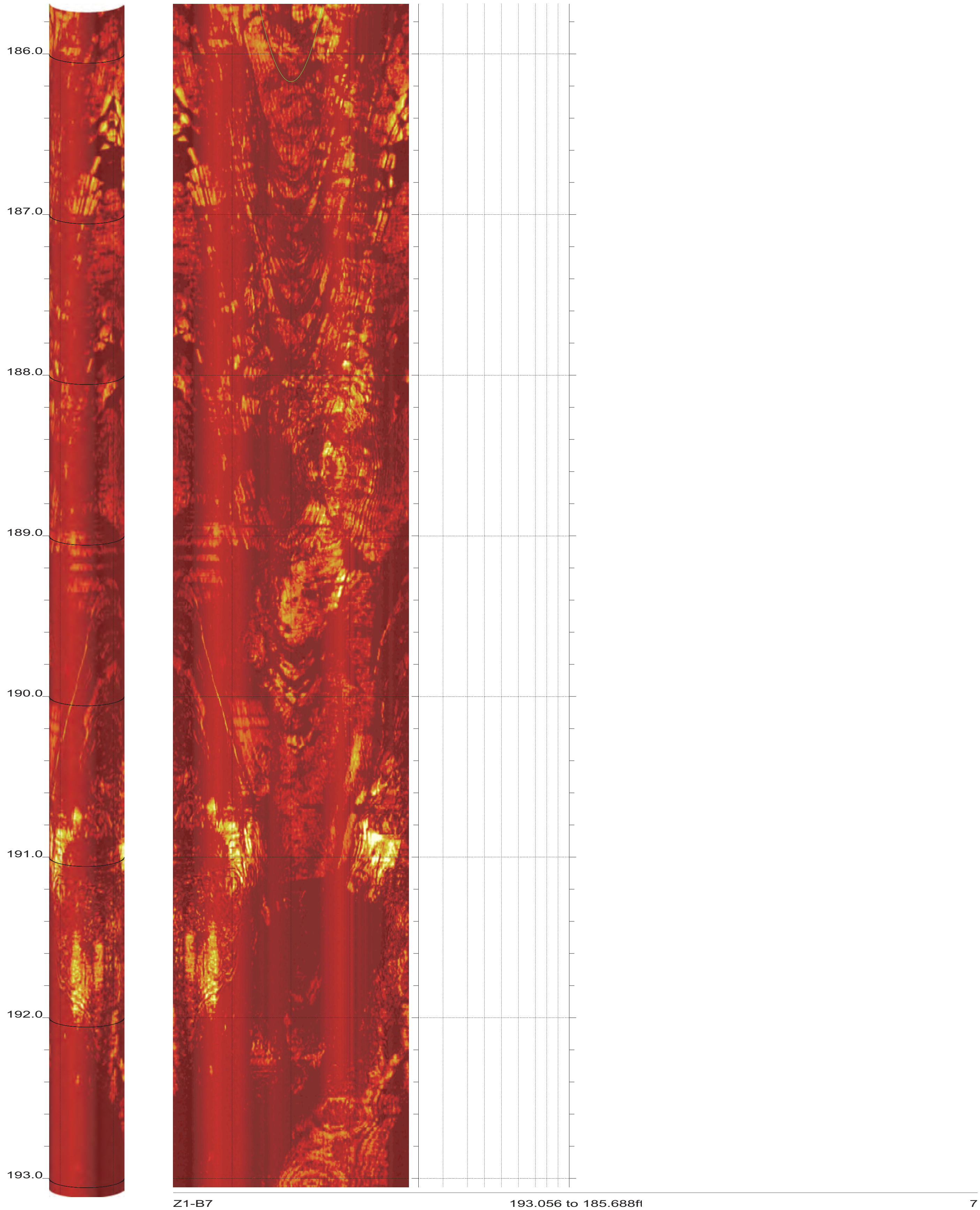


Z1-B7 178.320 to 170.952ft 5

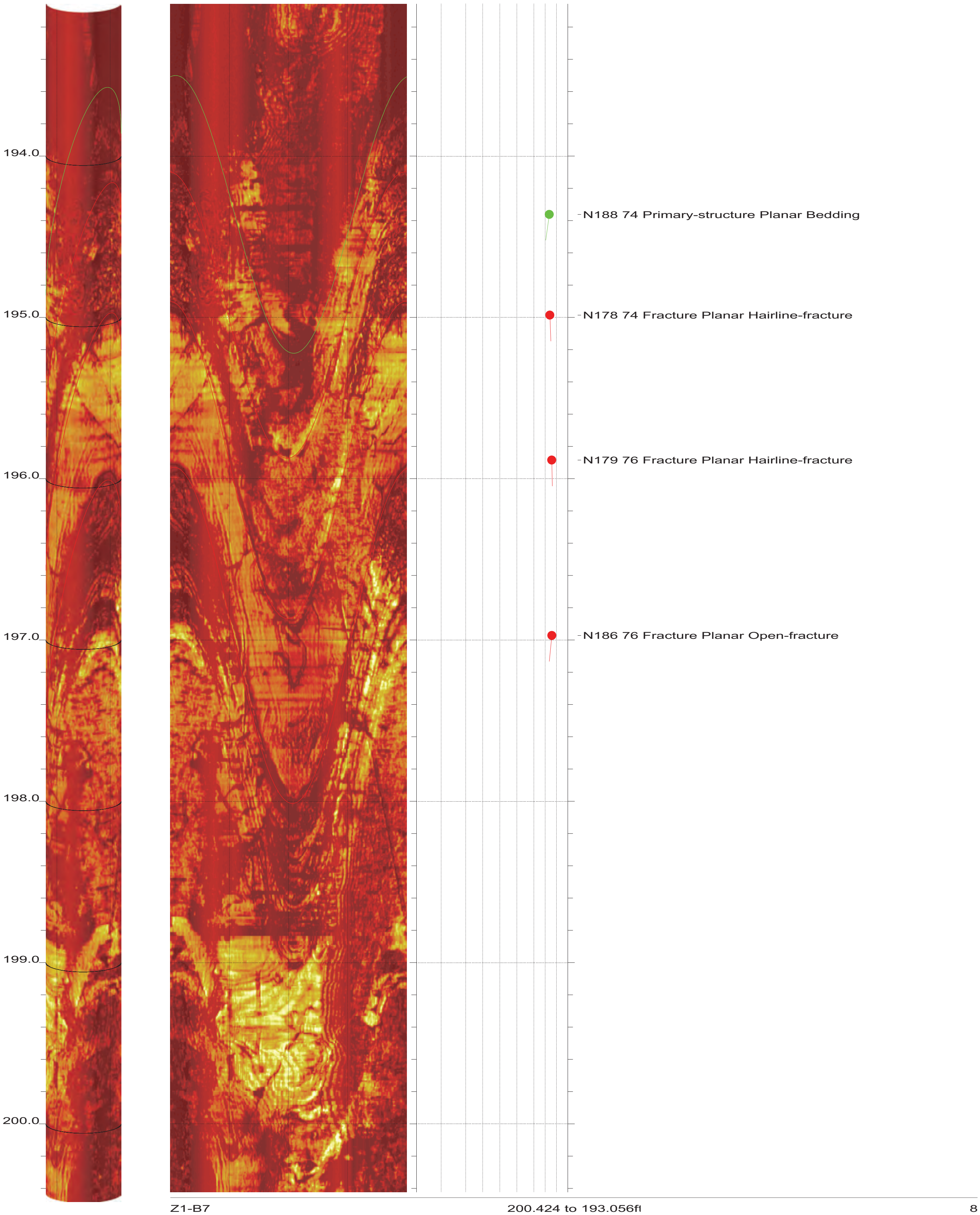
SR-710 Boring Z1-B7 Acoustic Televiewer Dips rev 1 Sheet 5 of 22



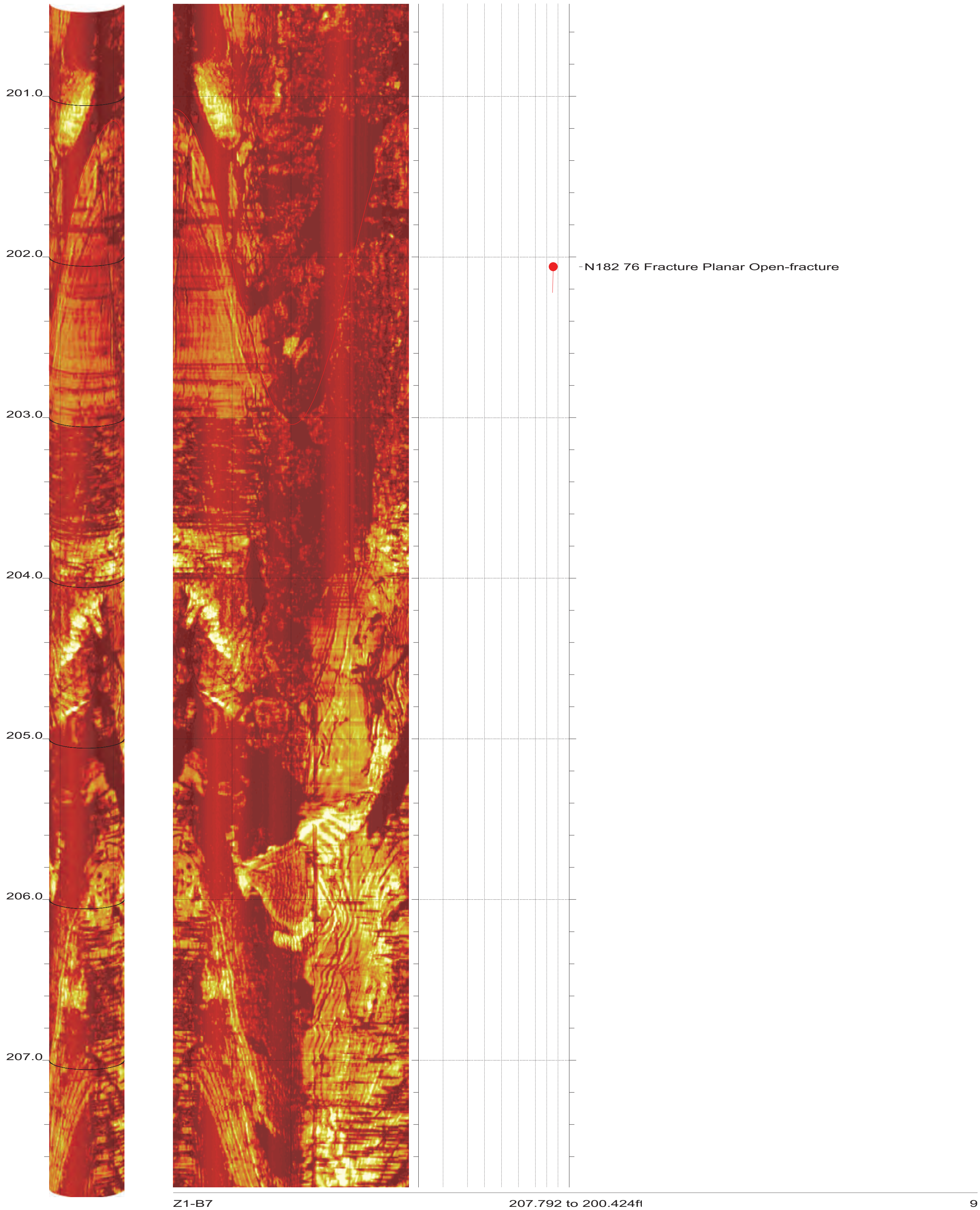
SR-710 Boring Z1-B7 Acoustic Televiewer Dips rev 1 Sheet 6 of 22



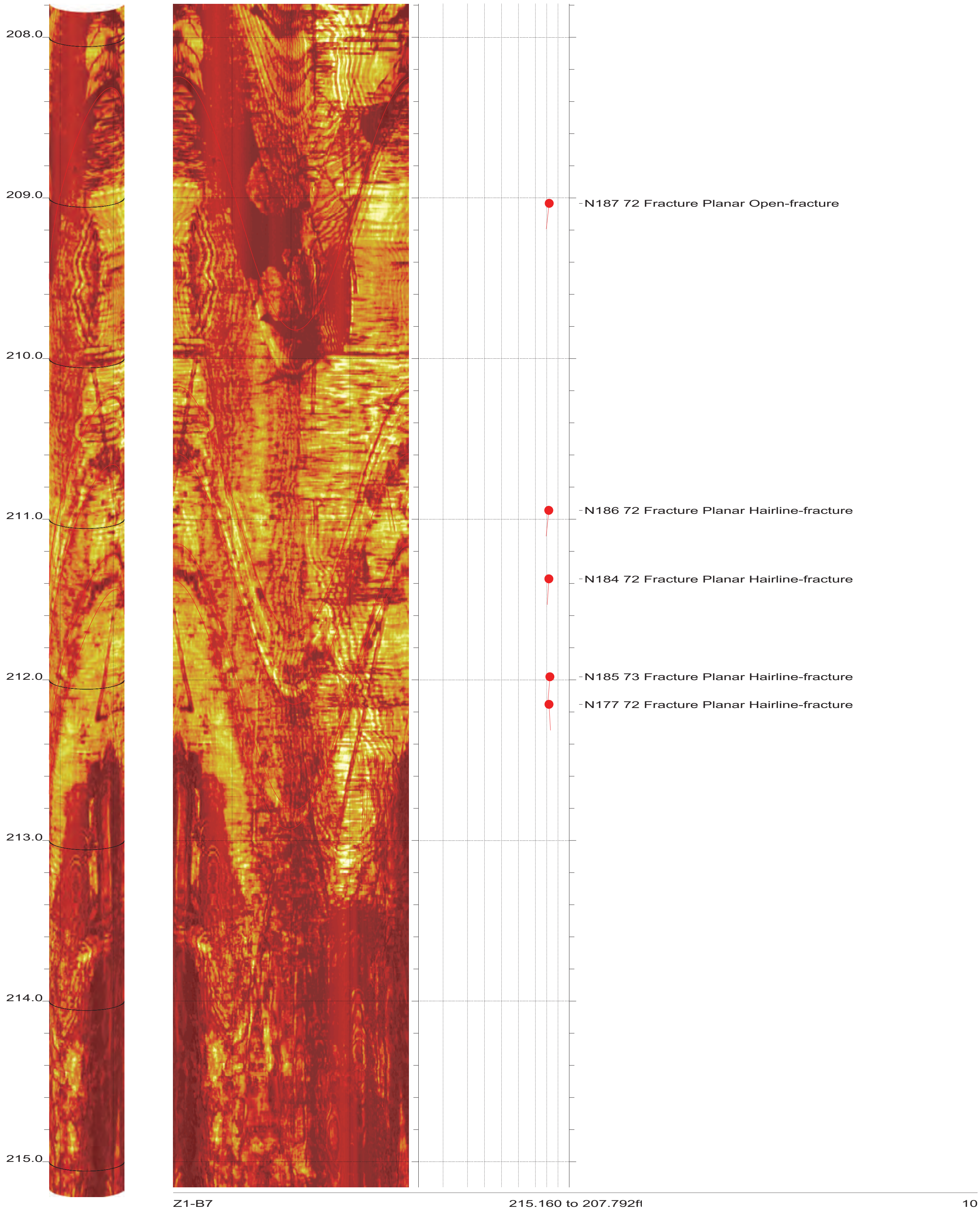
SR-710 Boring Z1-B7 Acoustic Televiewer Dips rev 1 Sheet 7 of 22



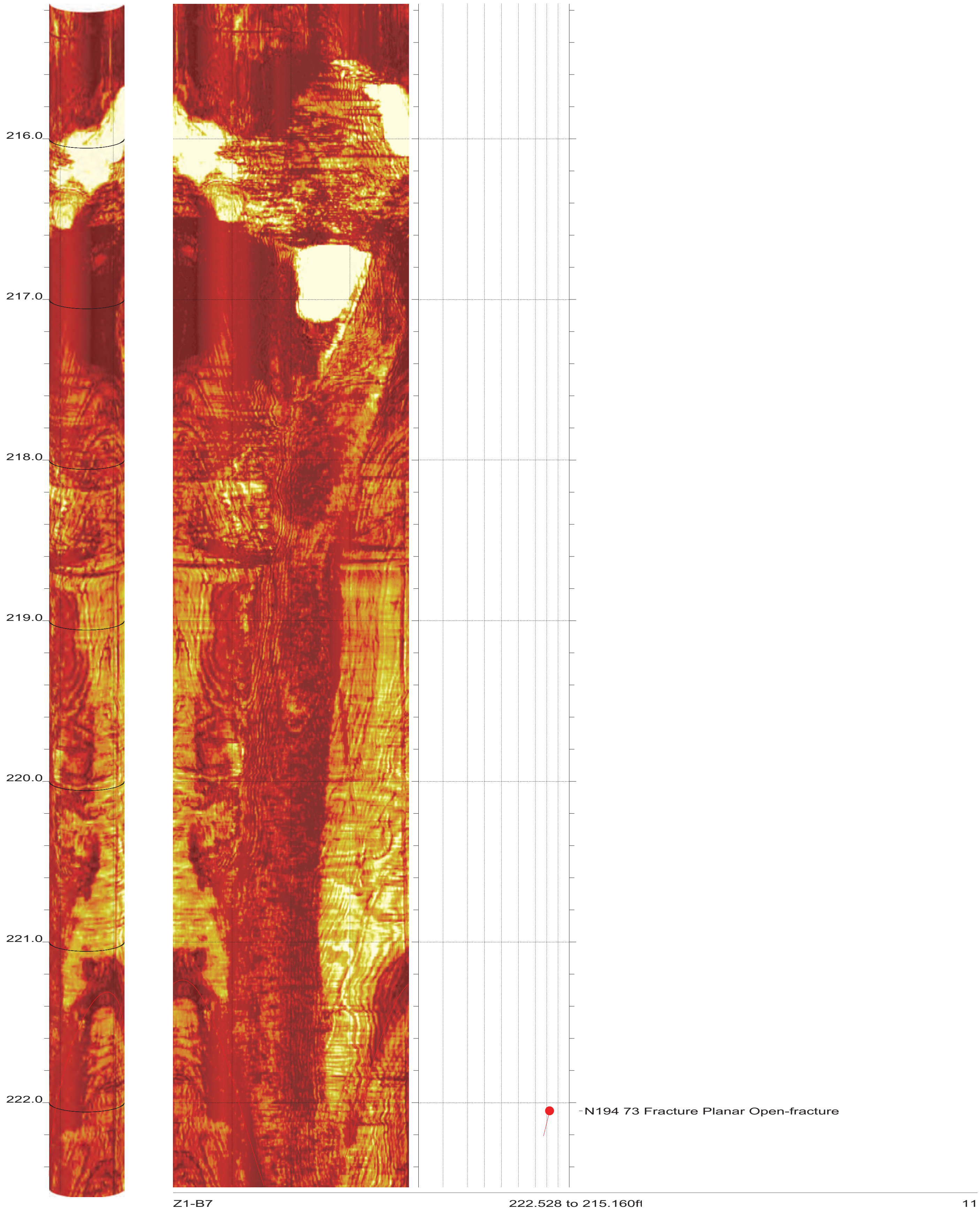
SR-710 Boring Z1-B7 Acoustic Televiewer Dips rev 1 Sheet 8 of 22



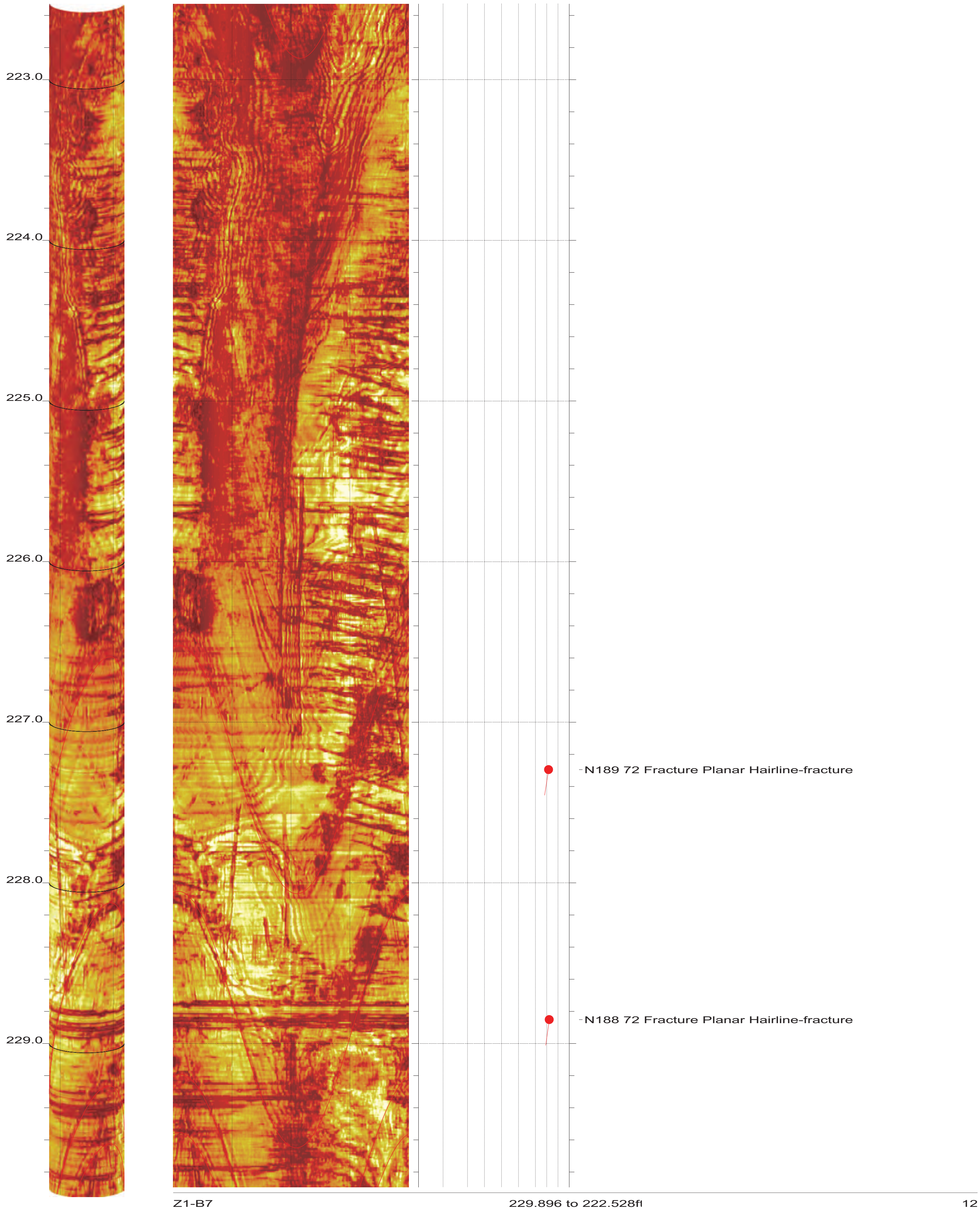
SR-710 Boring Z1-B7 Acoustic Televiewer Dips rev 1 Sheet 9 of 22



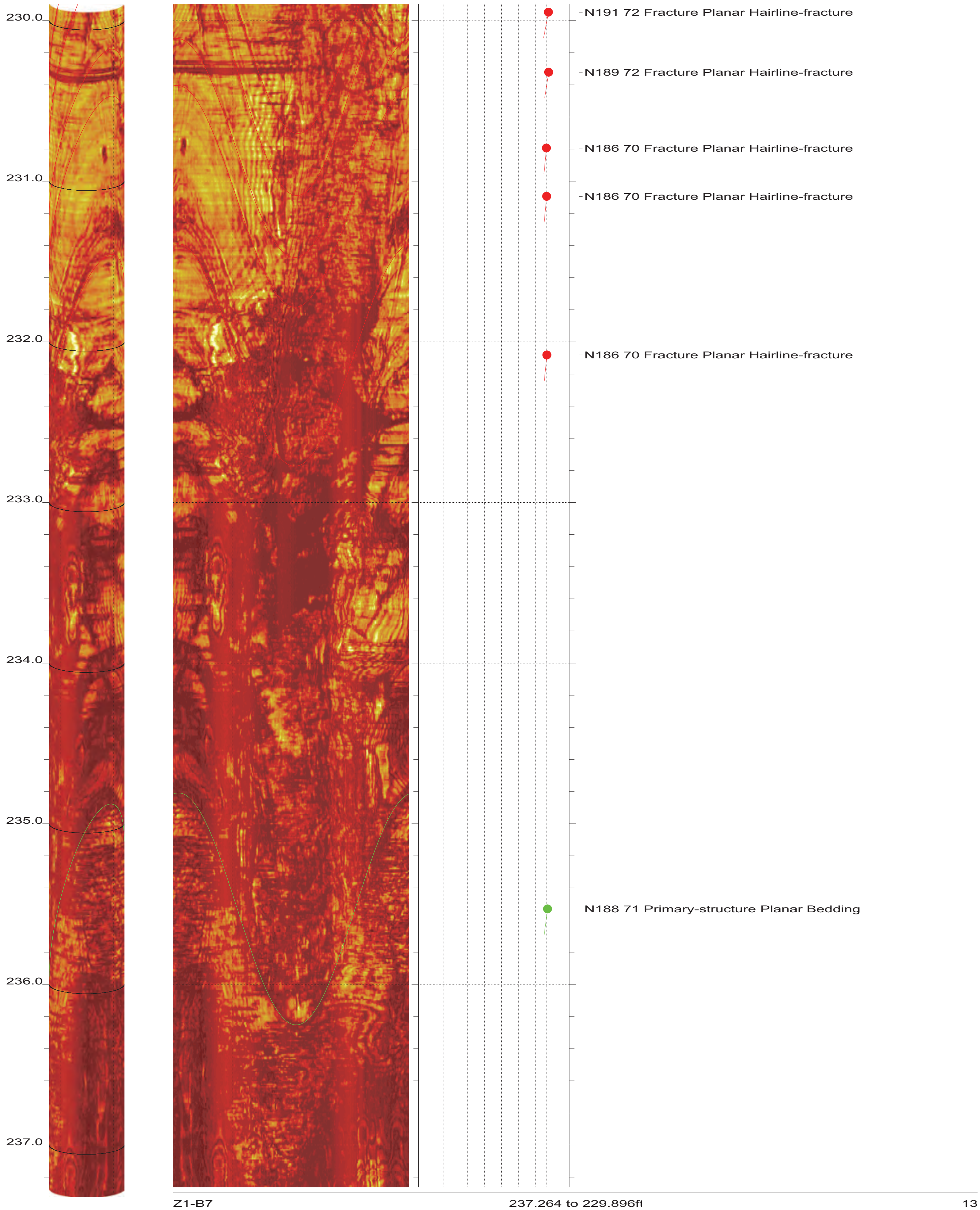
SR-710 Boring Z1-B7 Acoustic Televiewer Dips rev 1 Sheet 10 of 22



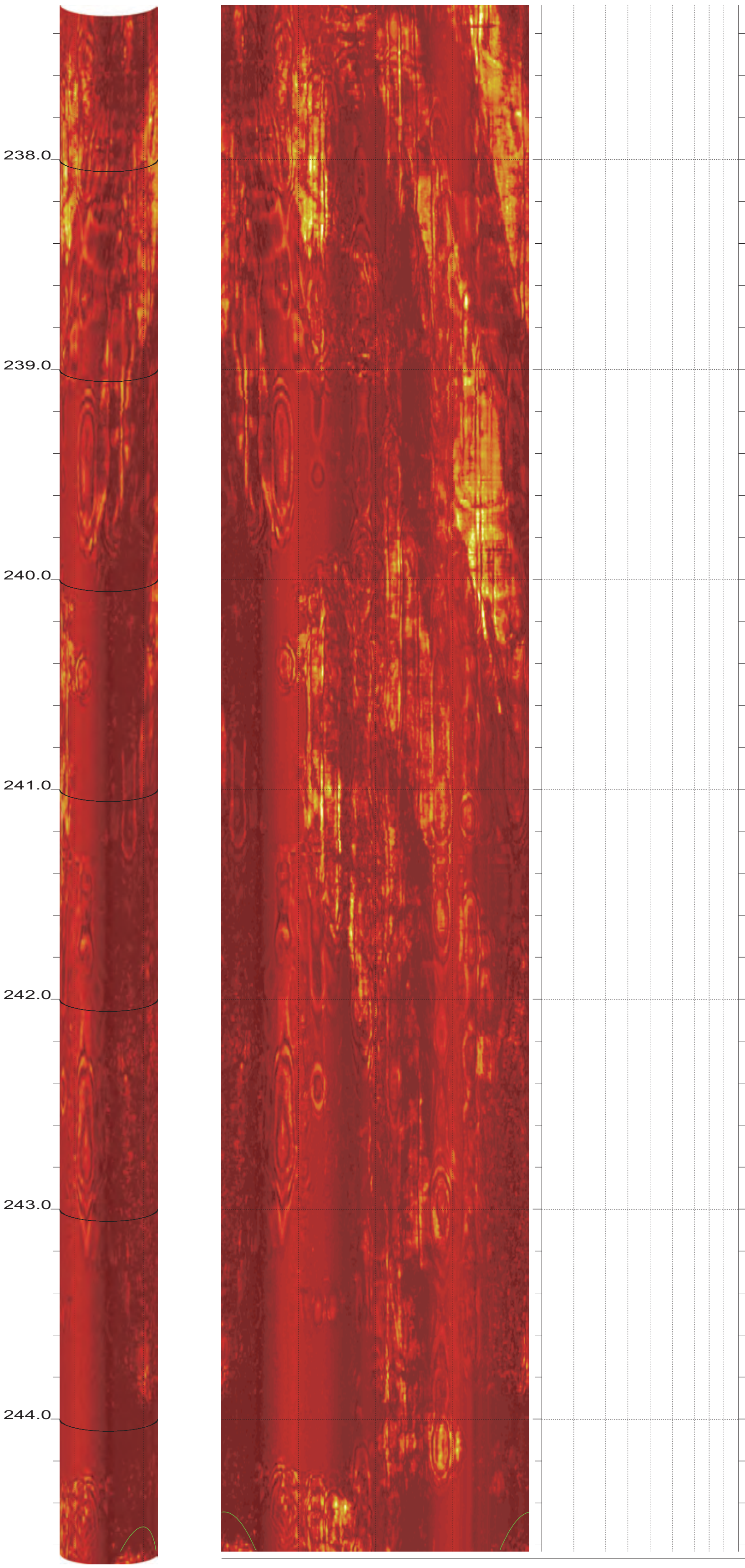
SR-710 Boring Z1-B7 Acoustic Televiewer Dips rev 1 Sheet 11 of 22



SR-710 Boring Z1-B7 Acoustic Televiewer Dips rev 1 Sheet 12 of 22

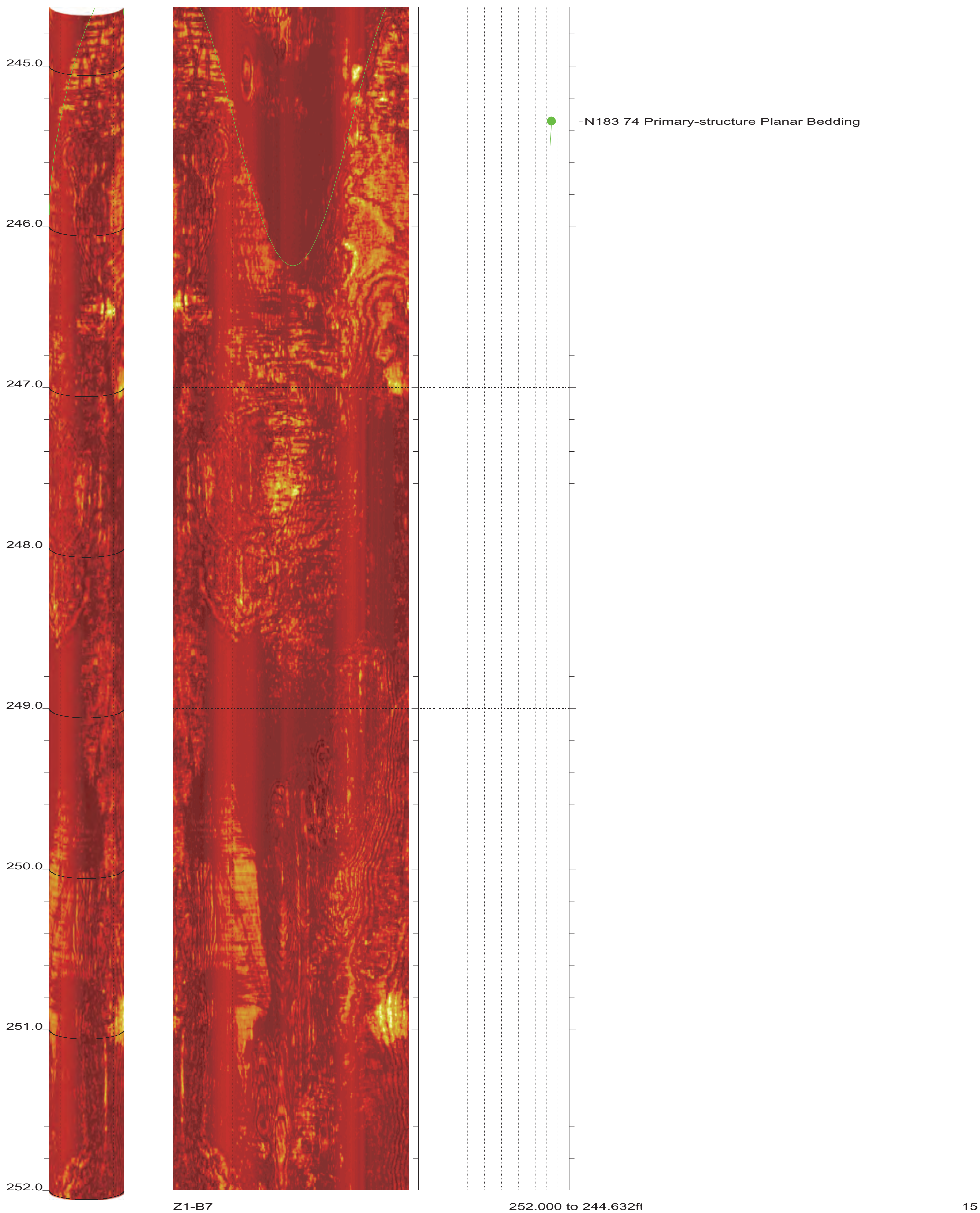


SR-710 Boring Z1-B7 Acoustic Televiewer Dips rev 1 Sheet 13 of 22

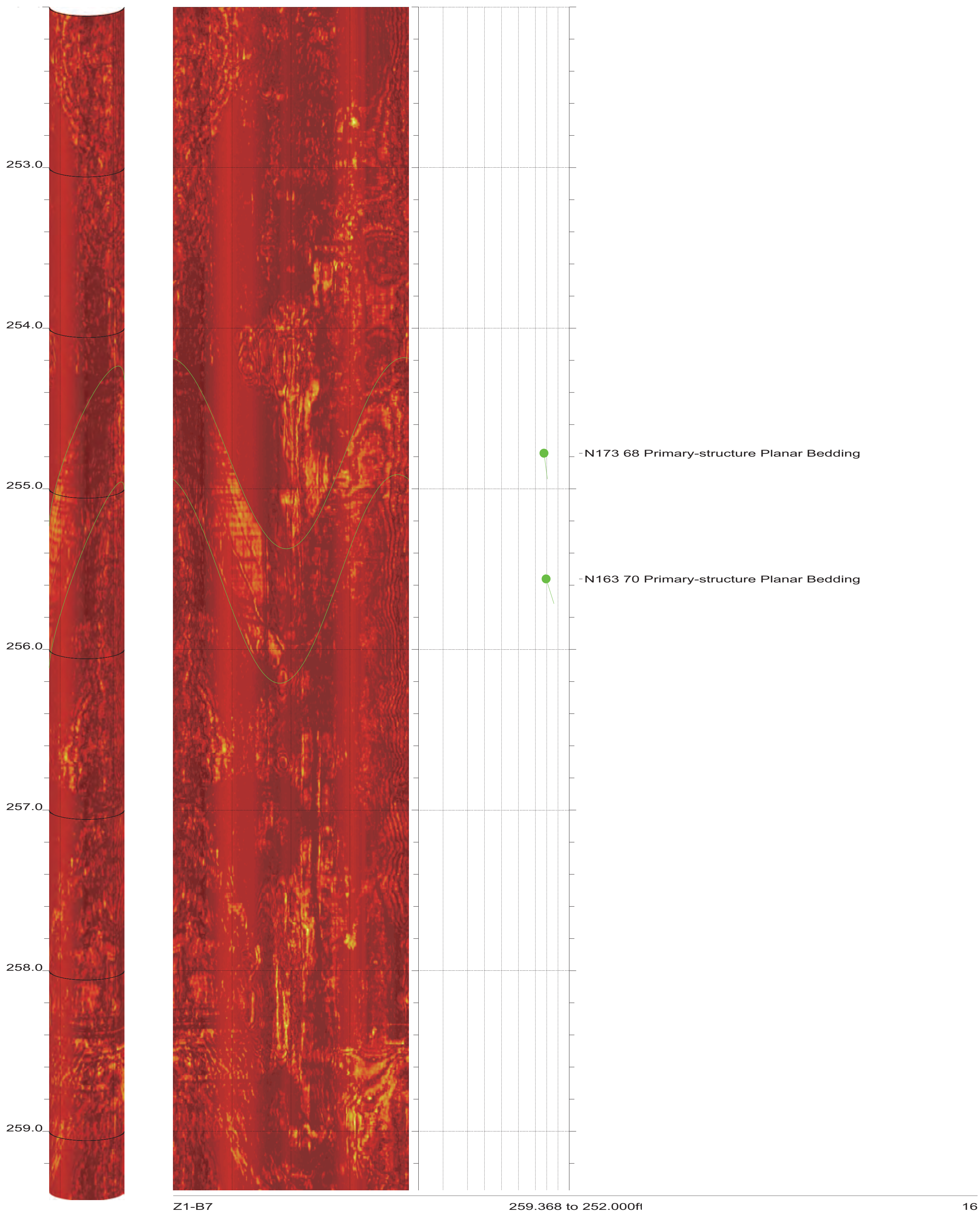


Z1-B7 244.632 to 237.264ft 14

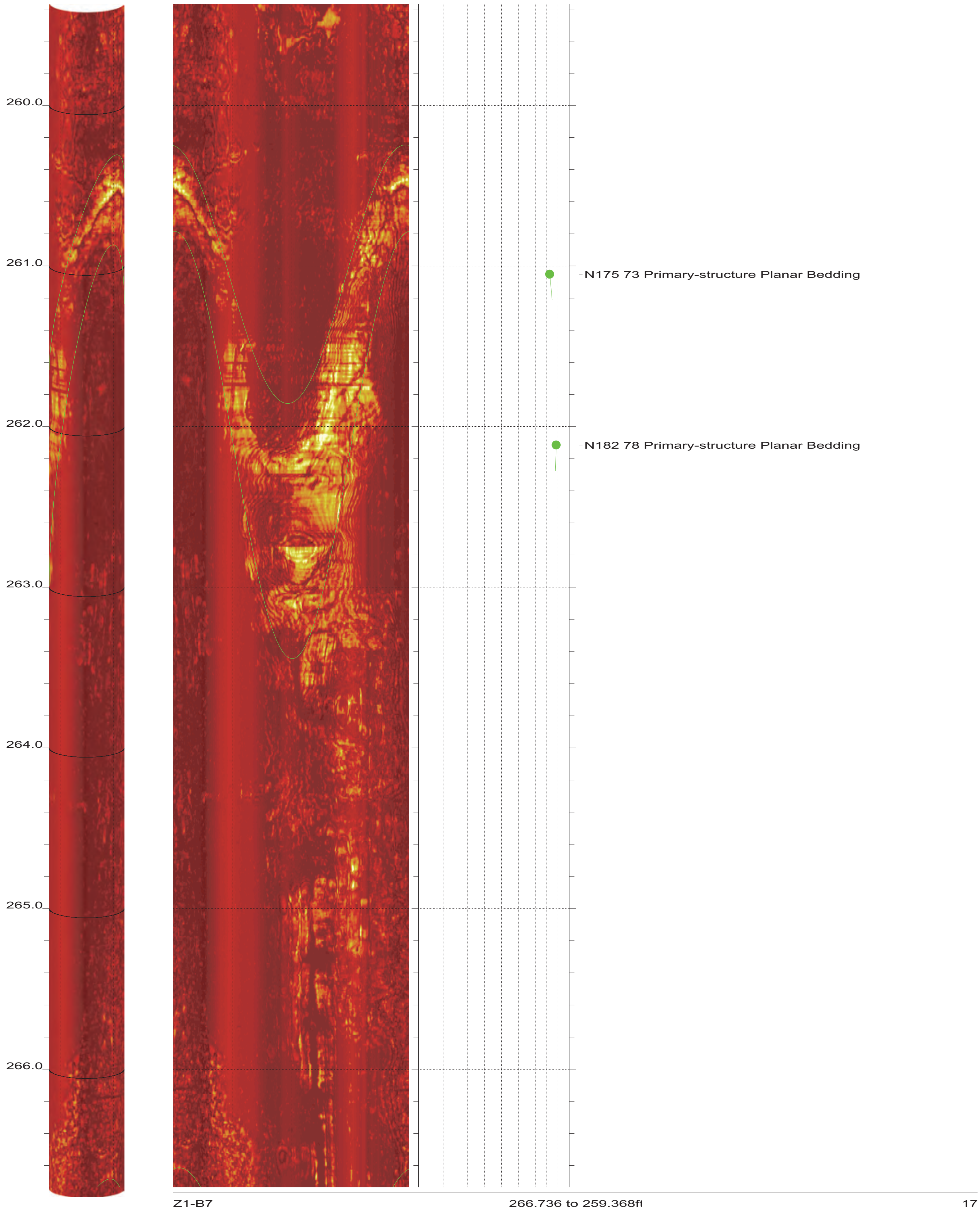
SR-710 Boring Z1-B7 Acoustic Televiewer Dips rev 1 Sheet 14 of 22



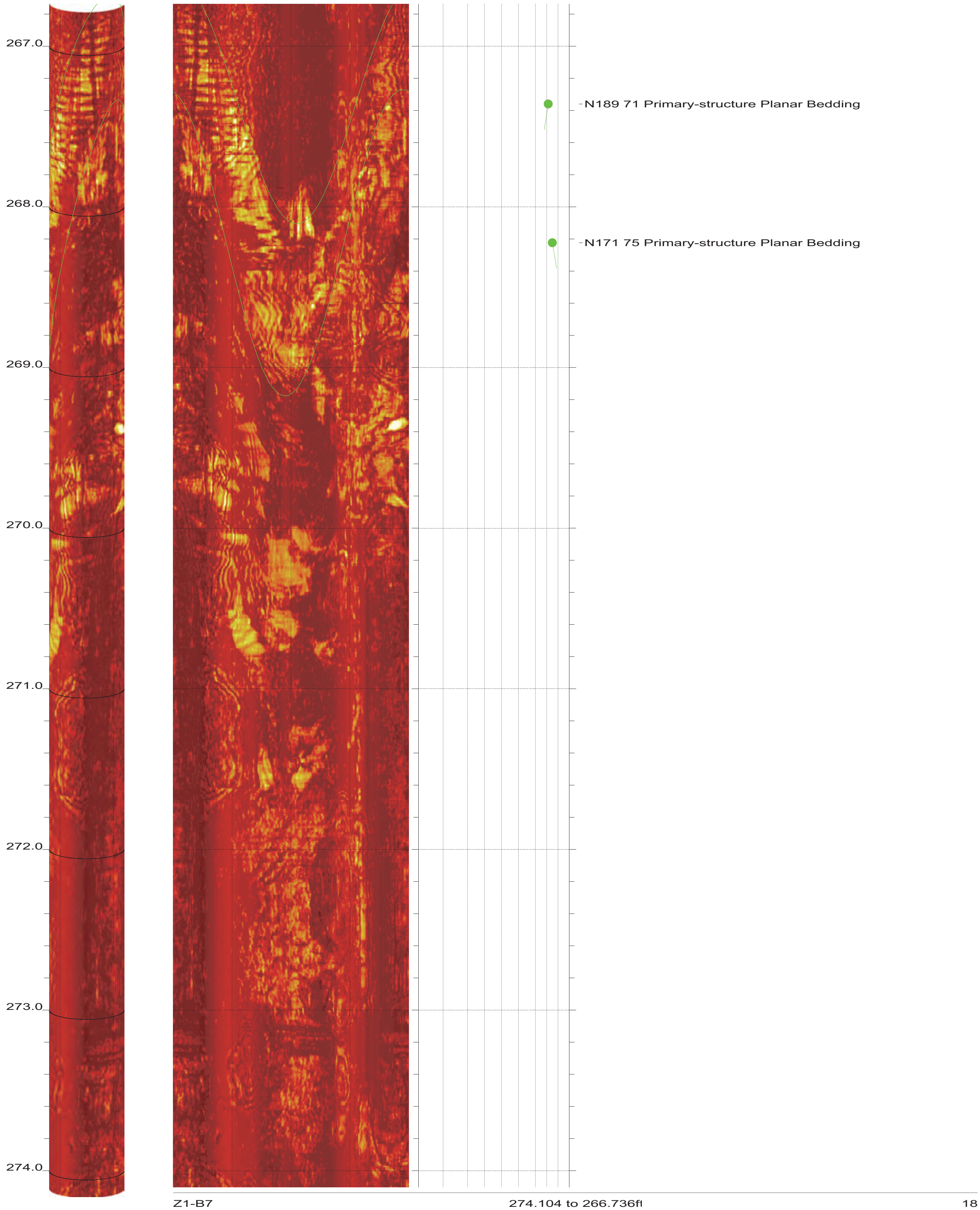
SR-710 Boring Z1-B7 Acoustic Televiewer Dips rev 1 Sheet 15 of 22



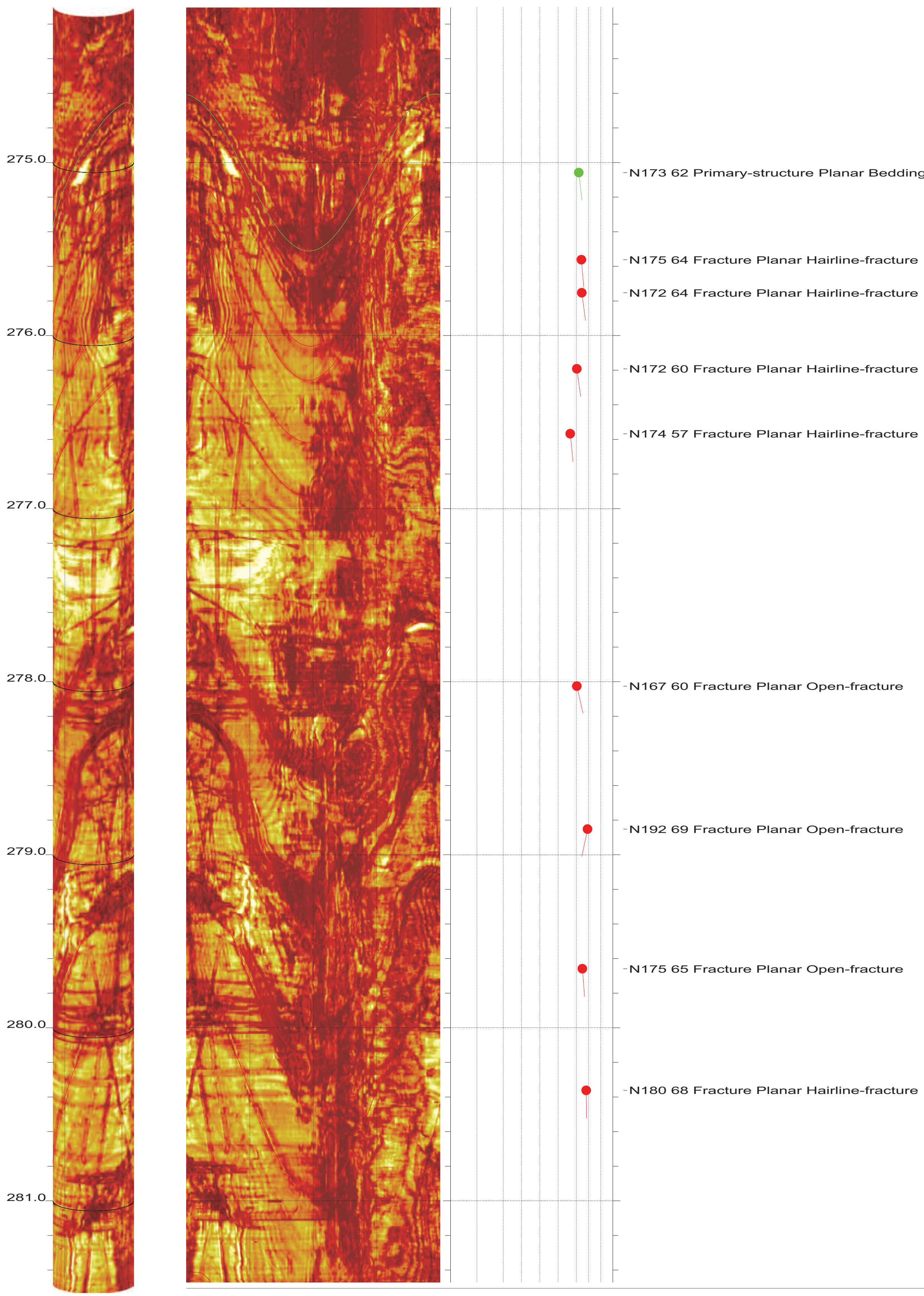
SR-710 Boring Z1-B7 Acoustic Televiewer Dips rev 1 Sheet 16 of 22



SR-710 Boring Z1-B7 Acoustic Televiewer Dips rev 1 Sheet 17 of 22

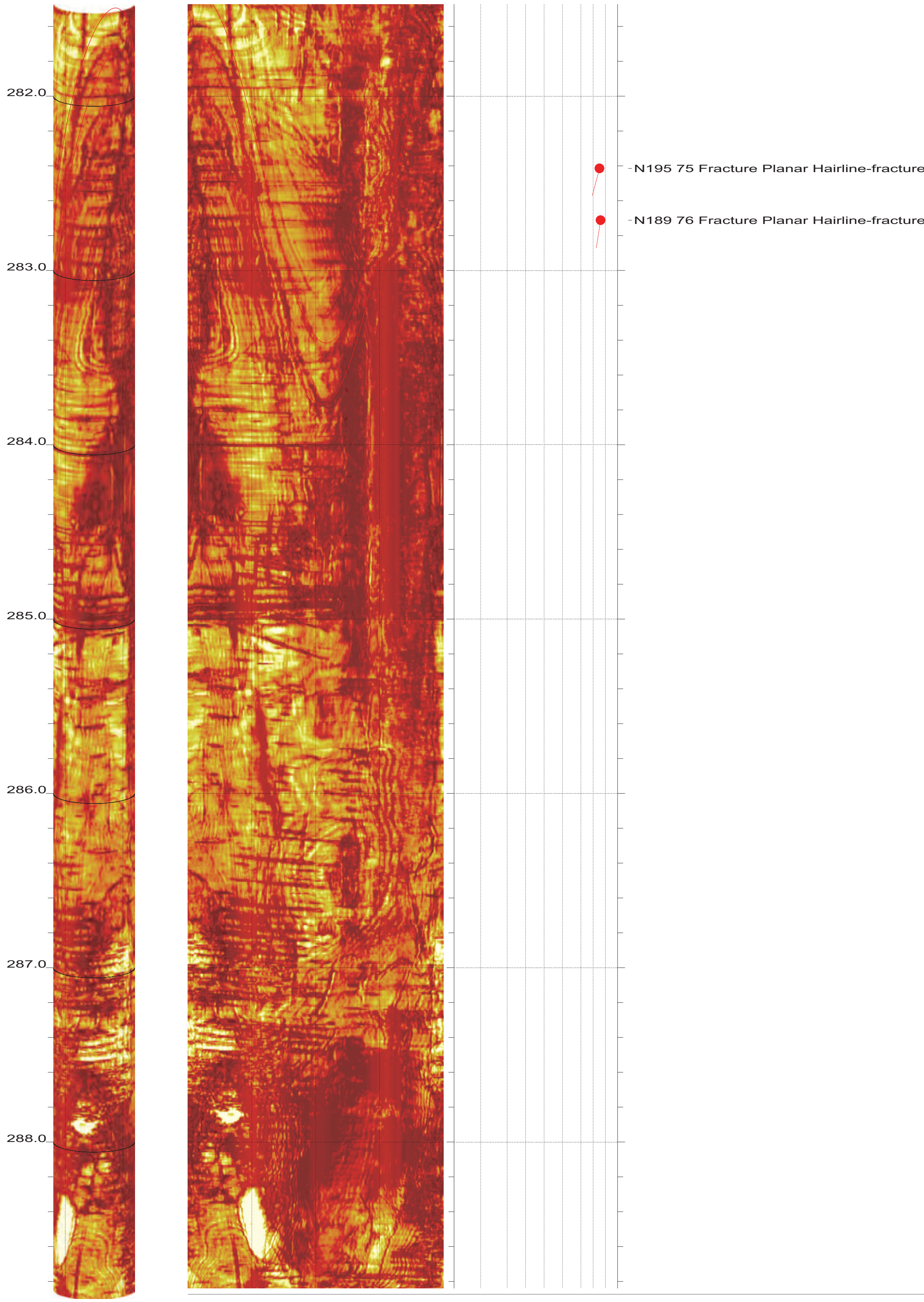


SR-710 Boring Z1-B7 Acoustic Televiewer Dips rev 1 Sheet 18 of 22



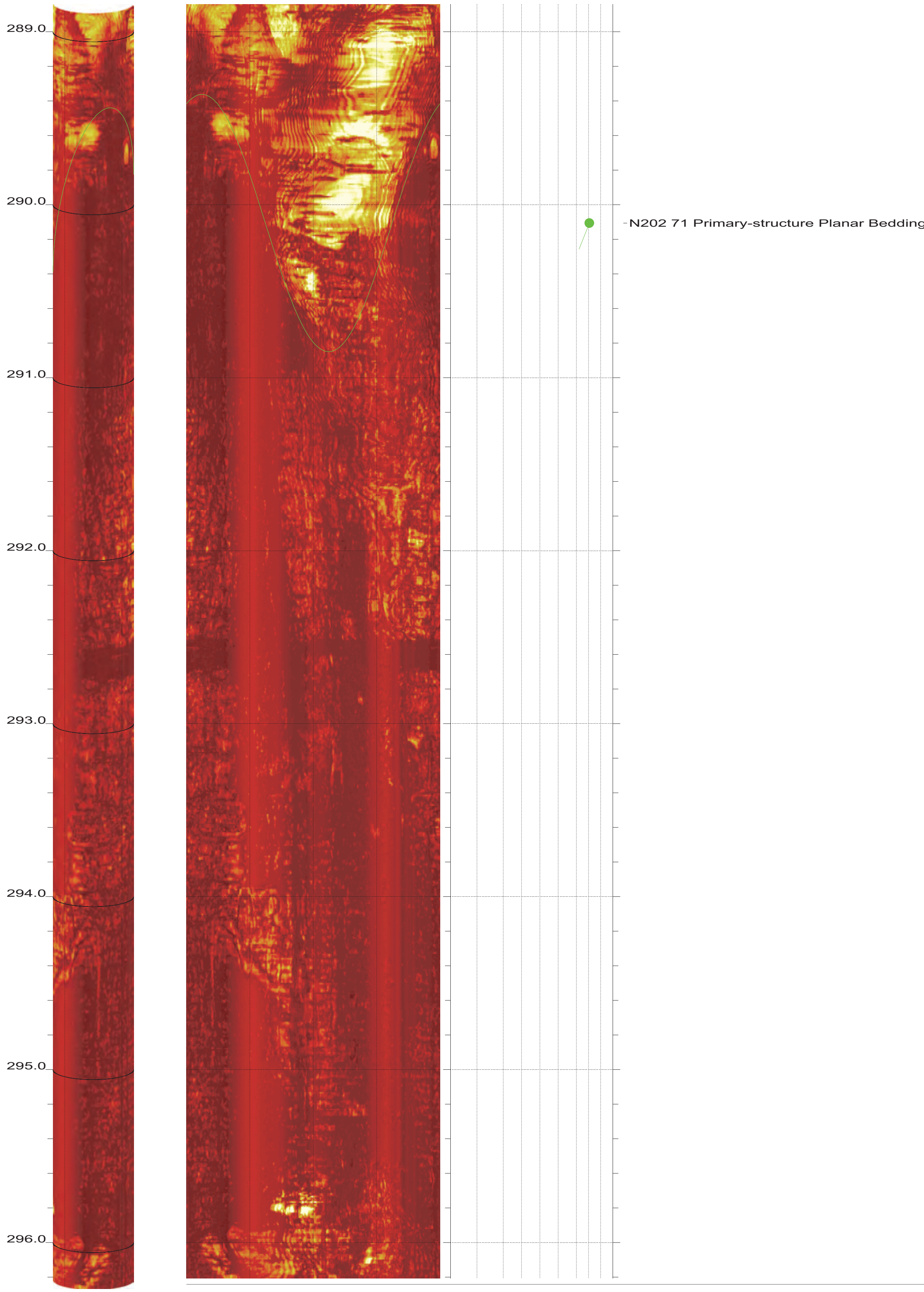
Z1-B7 281.472 to 274.104ft 19

SR-710 Boring Z1-B7 Acoustic Televiewer Dips rev 1 Sheet 19 of 22



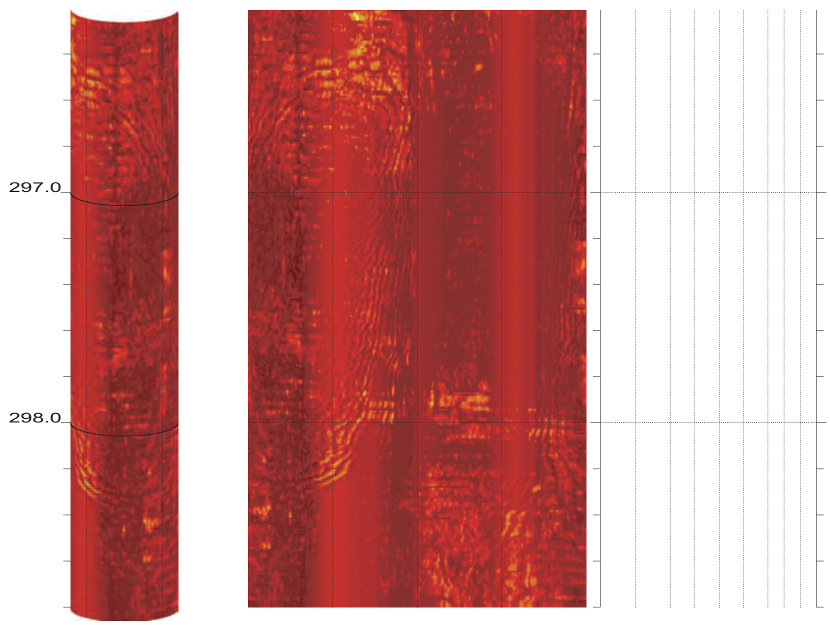
Z1-B7 288.840 to 281.472ft 20

SR-710 Boring Z1-B7 Acoustic Televiewer Dips rev 1 Sheet 20 of 22



Z1-B7 296.208 to 288.840ft 21

SR-710 Boring Z1-B7 Acoustic Televiewer Dips rev 1 Sheet 21 of 22



Z1-B7 298.800 to 296.208ft 22

SR-710 Boring Z1-B7 Acoustic Televiewer Dips rev 1 Sheet 22 of 22

BHTV DATA PROCESSING
RGLDIP vsn 6.2
INTERPRETED BHTV DIPS LOG

CASCADE DRILLING

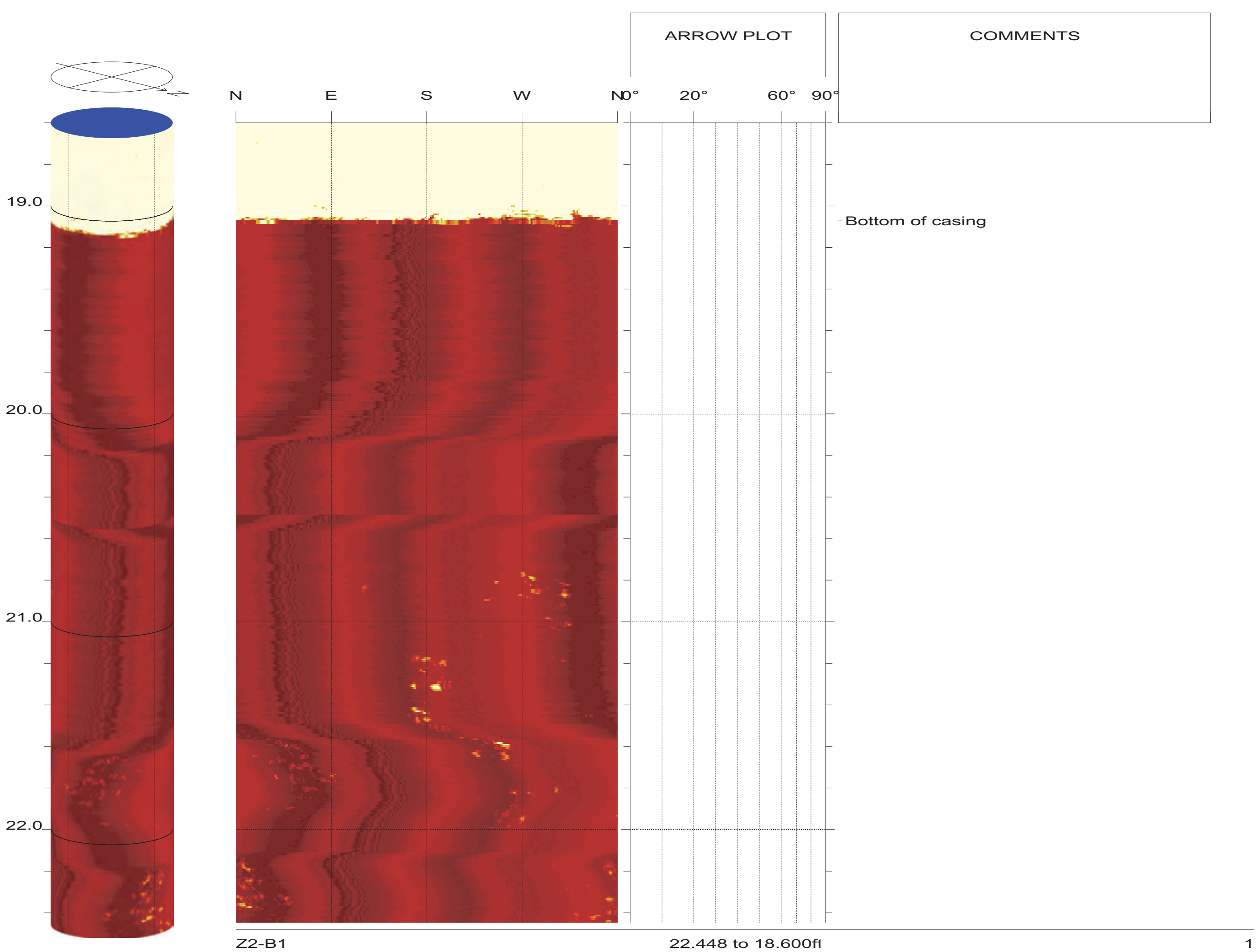
Borehole: Z2-B1

SR-710 TUNNEL INVESTIGATION

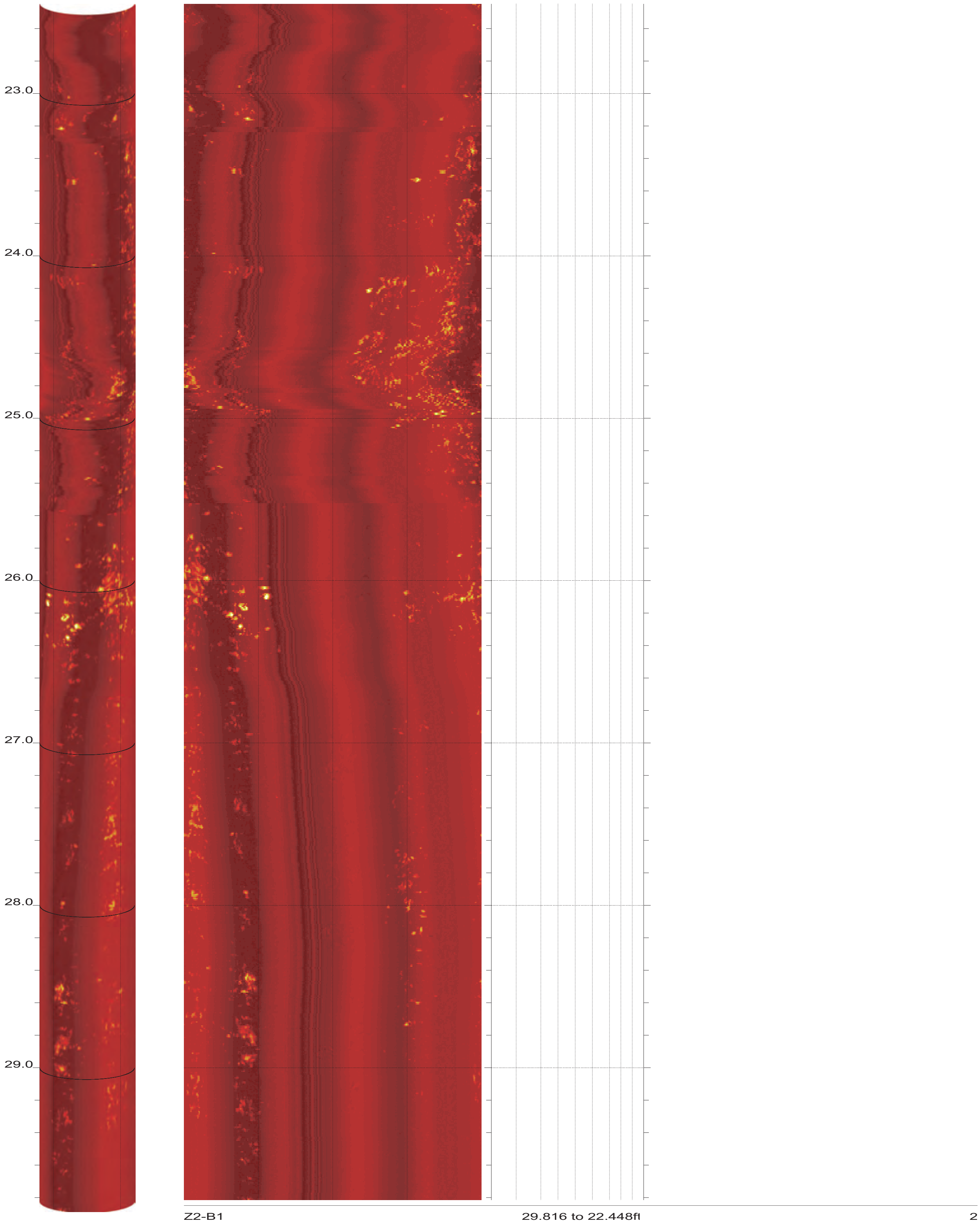
top of borehole.....	North ref. is true
East: _	Depth units are feet
North: _	Vertical scale: 1/10
Elev: _	Horiz scale = 1.00x Vert scale

Zone from 148.800 to 18.600ft	Borehole diam: 7.000inch
Format: BHTV-NESWN	Vertical = borehole-axis
	Image: Amplitude

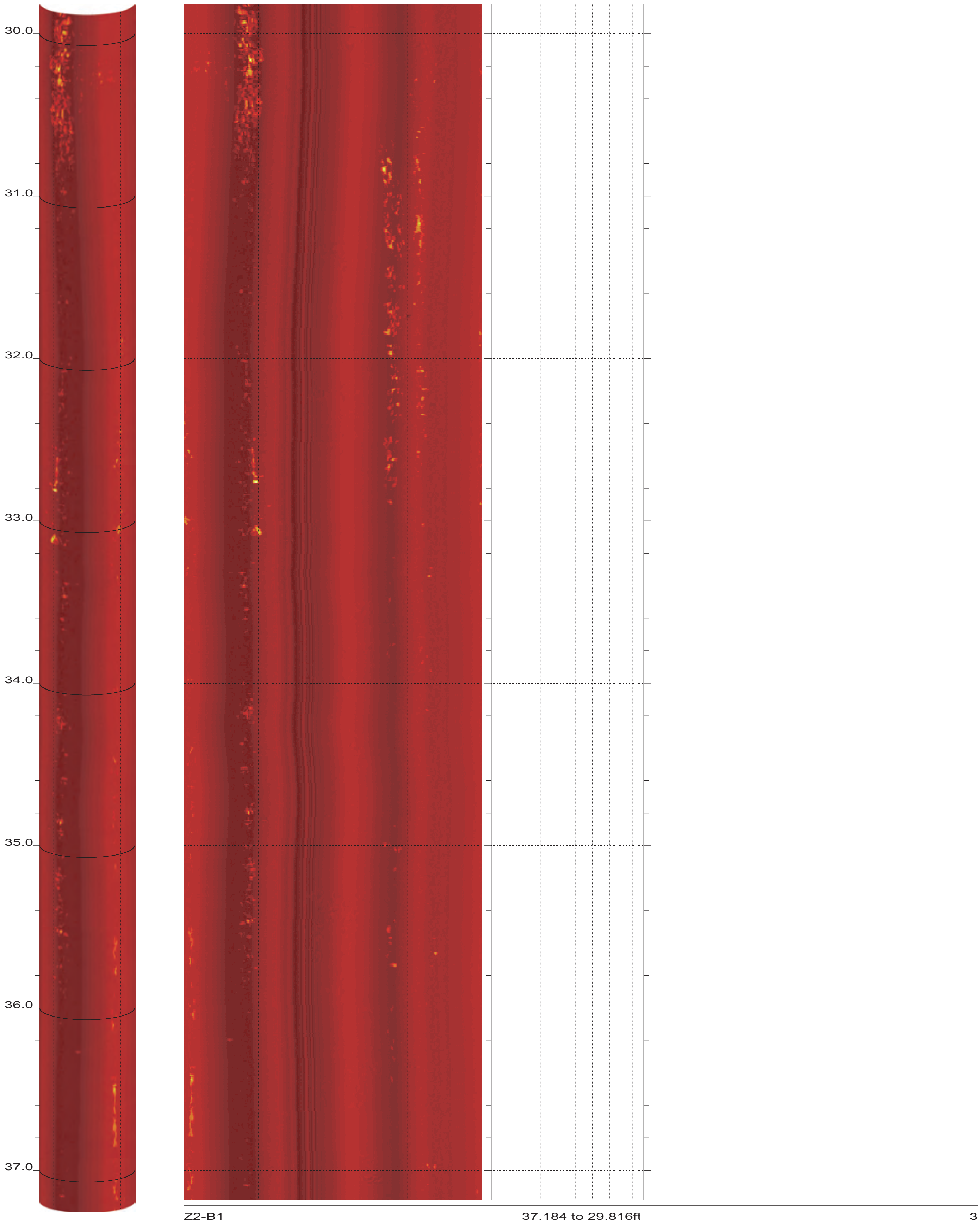
Stratigraphic dips
Non-stratigraphic dips
Identified units



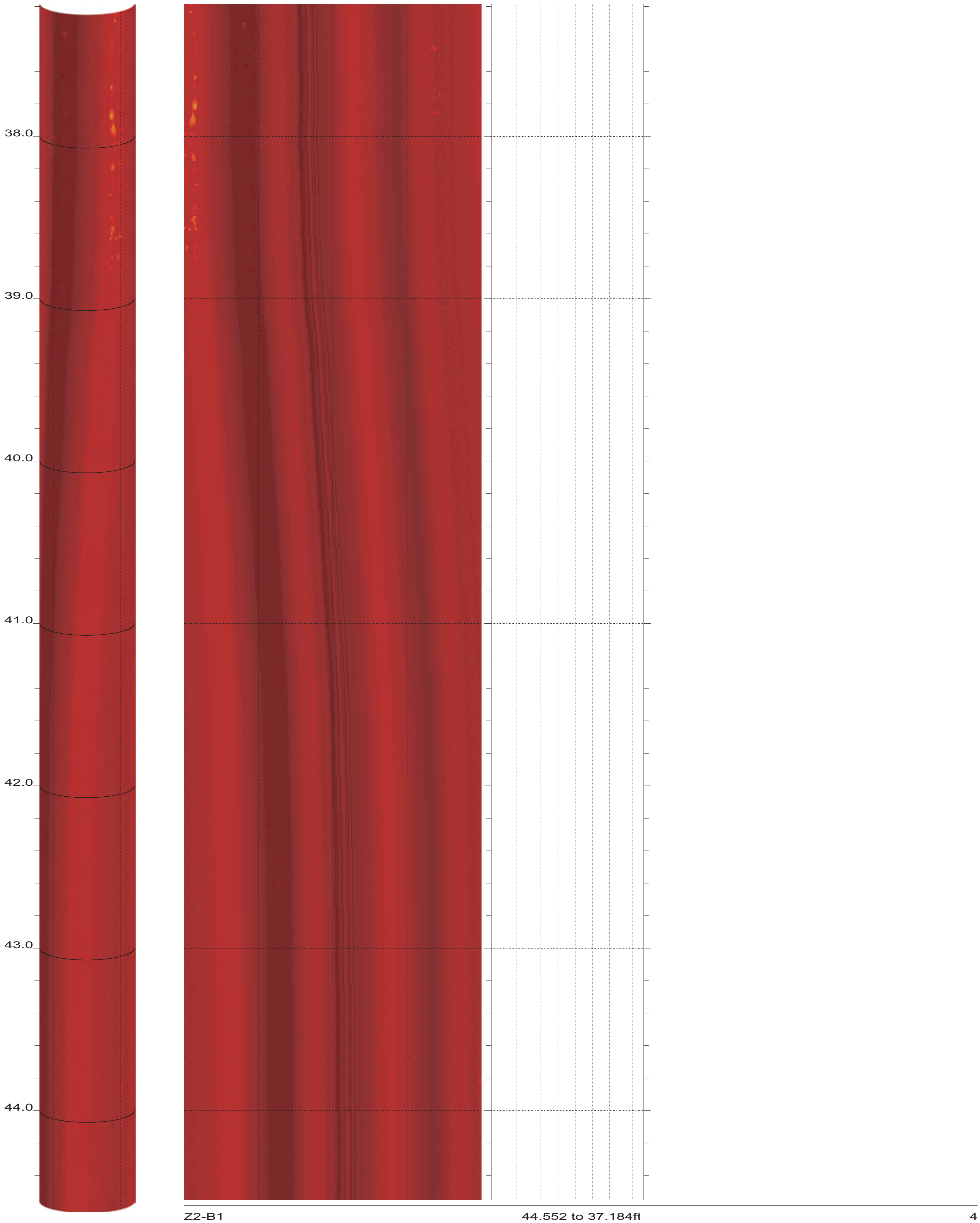
SR-710 Boring Z2-B1 Acoustic Televiewer Dips rev 1 Sheet 1 of 19



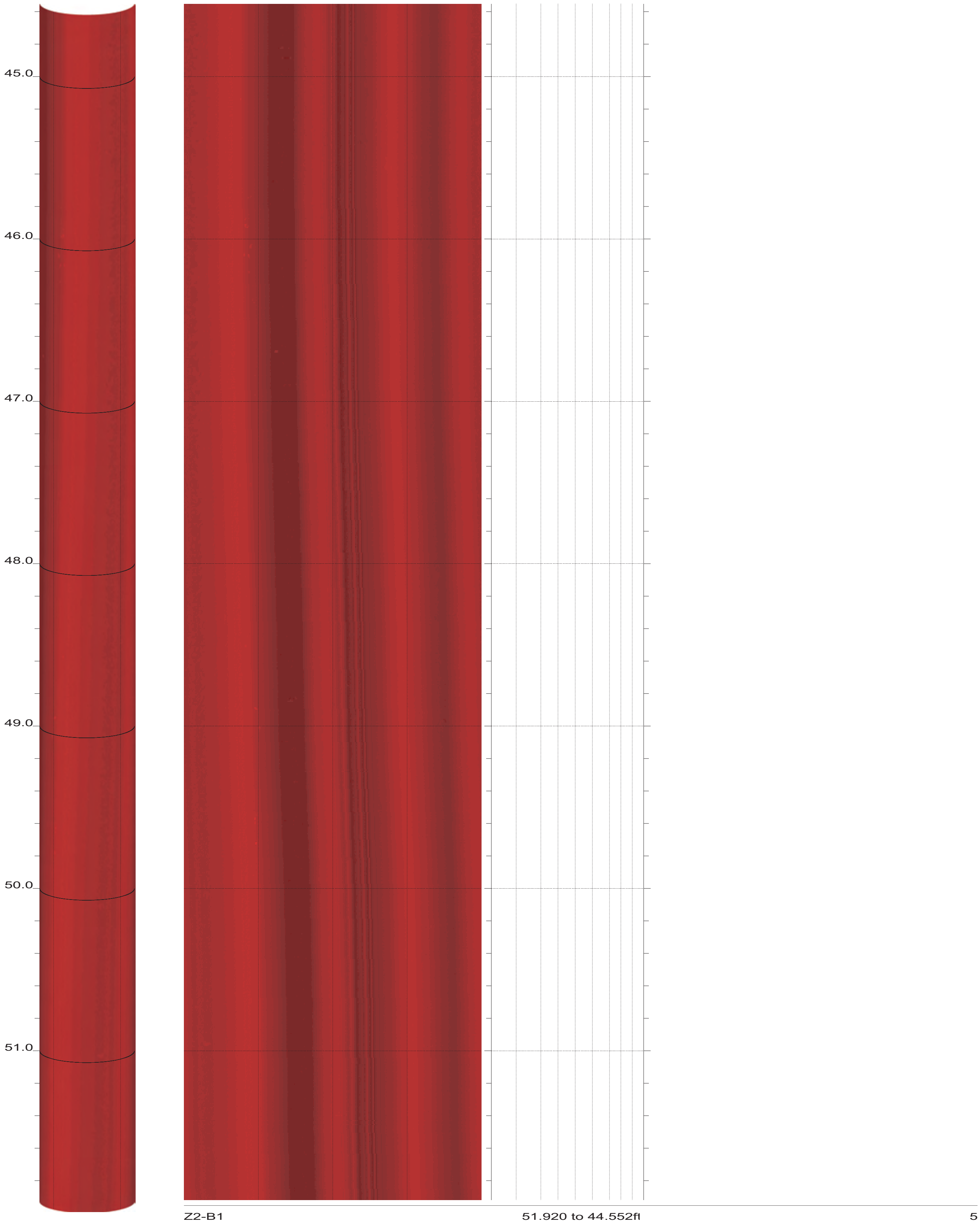
SR-710 Boring Z2-B1 Acoustic Televiewer Dips rev 1 Sheet 2 of 19



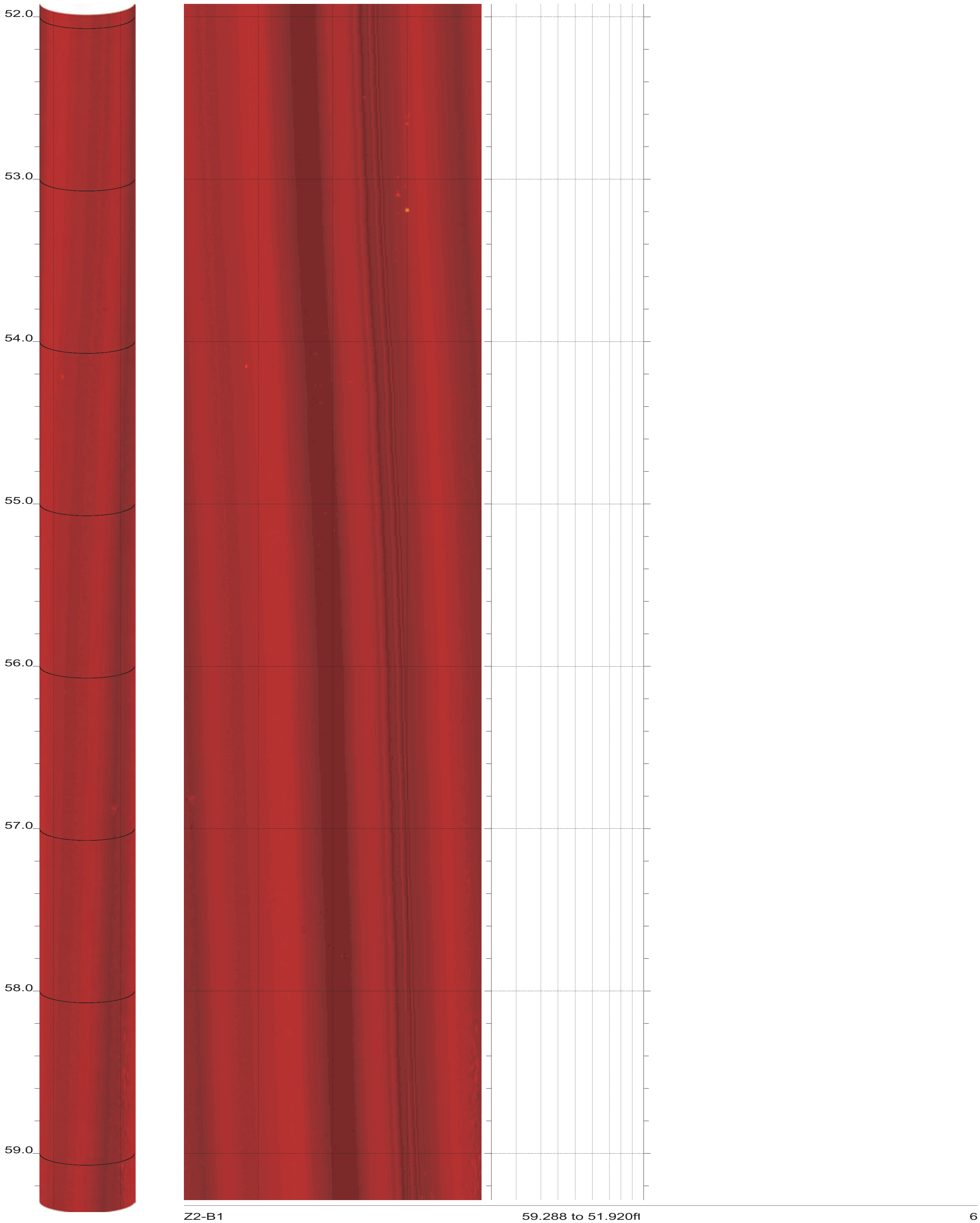
SR-710 Boring Z2-B1 Acoustic Televiewer Dips rev 1 Sheet 3 of 19



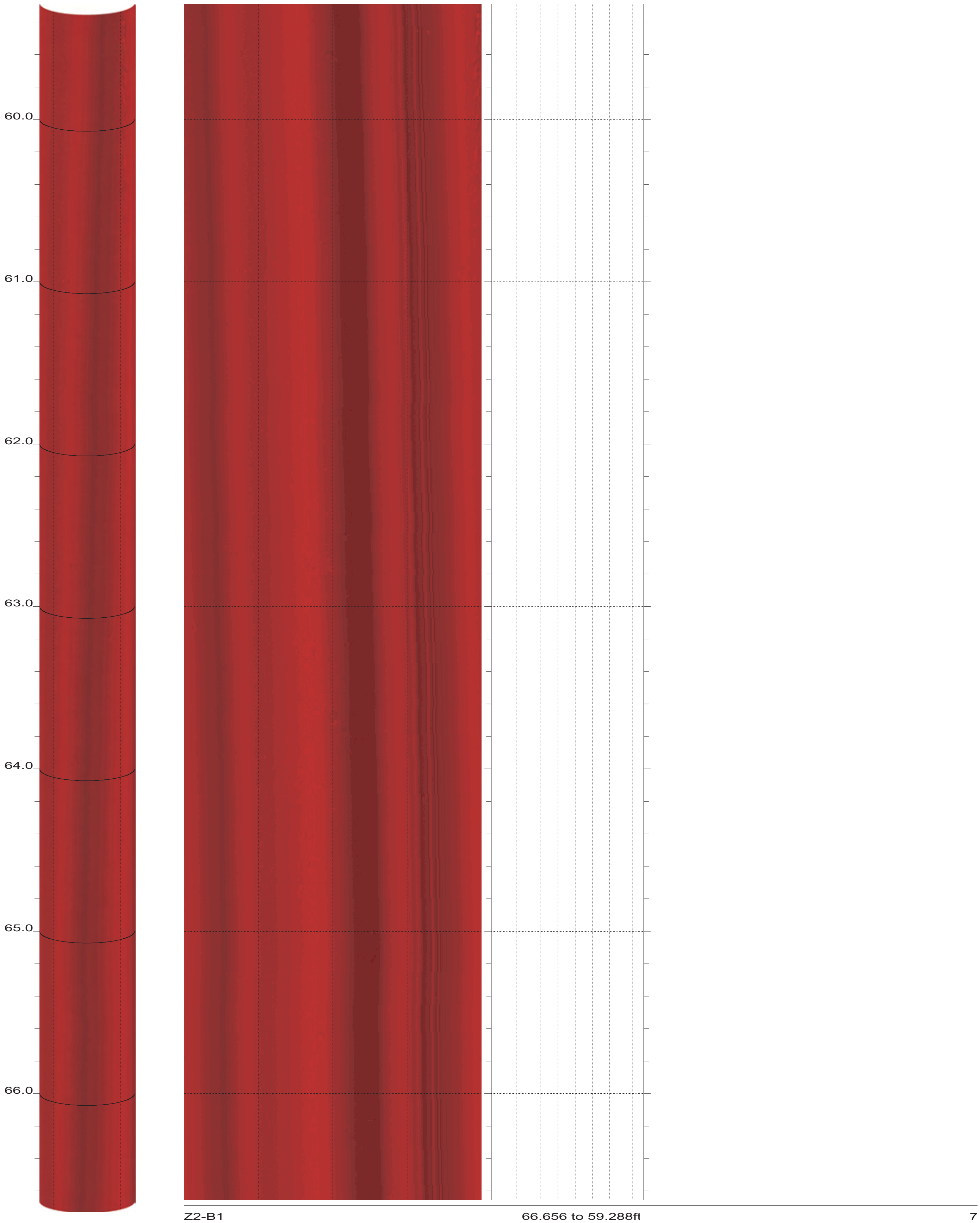
SR-710 Boring Z2-B1 Acoustic Televiewer Dips rev 1 Sheet 4 of 19



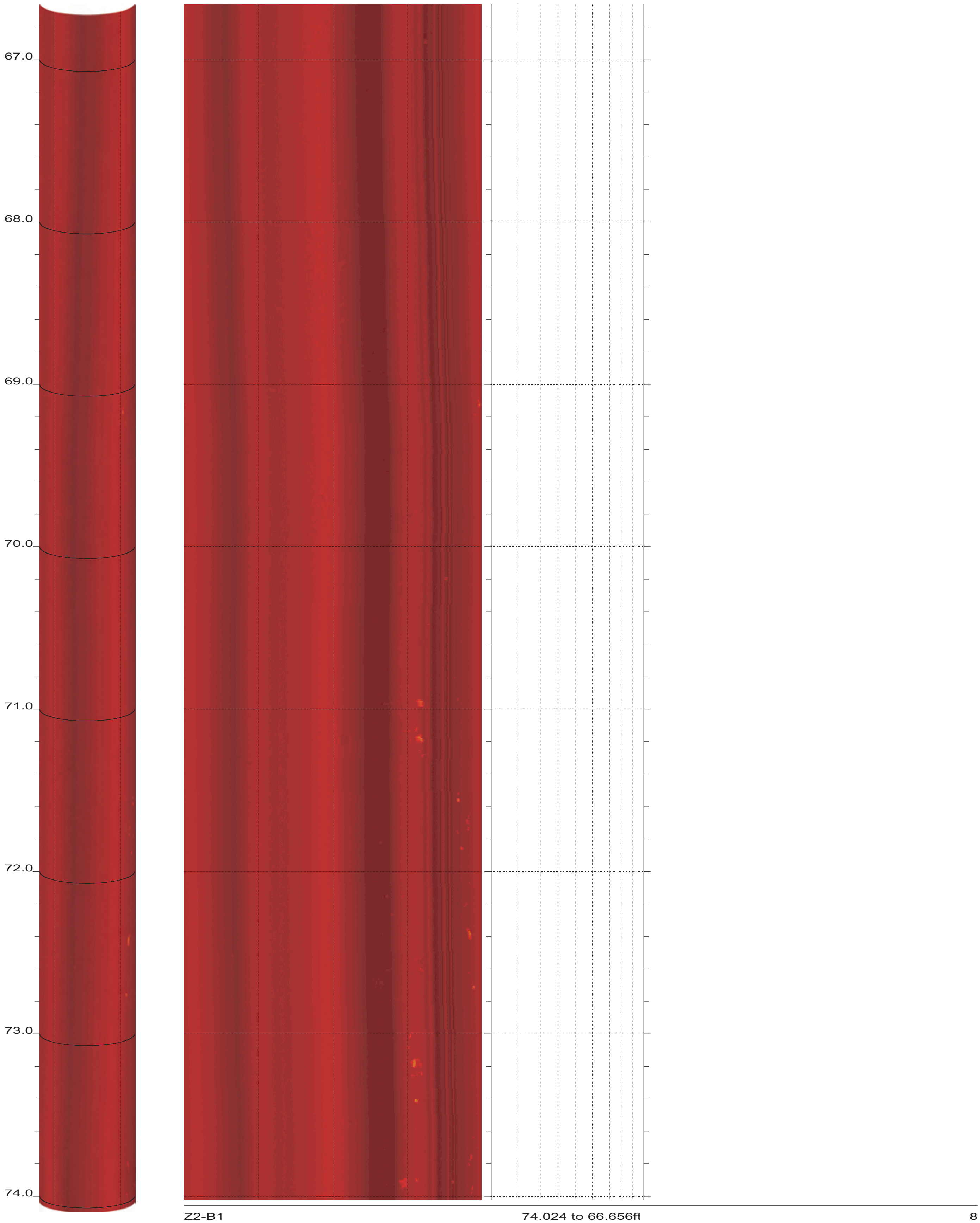
SR-710 Boring Z2-B1 Acoustic Televiewer Dips rev 1 Sheet 5 of 19



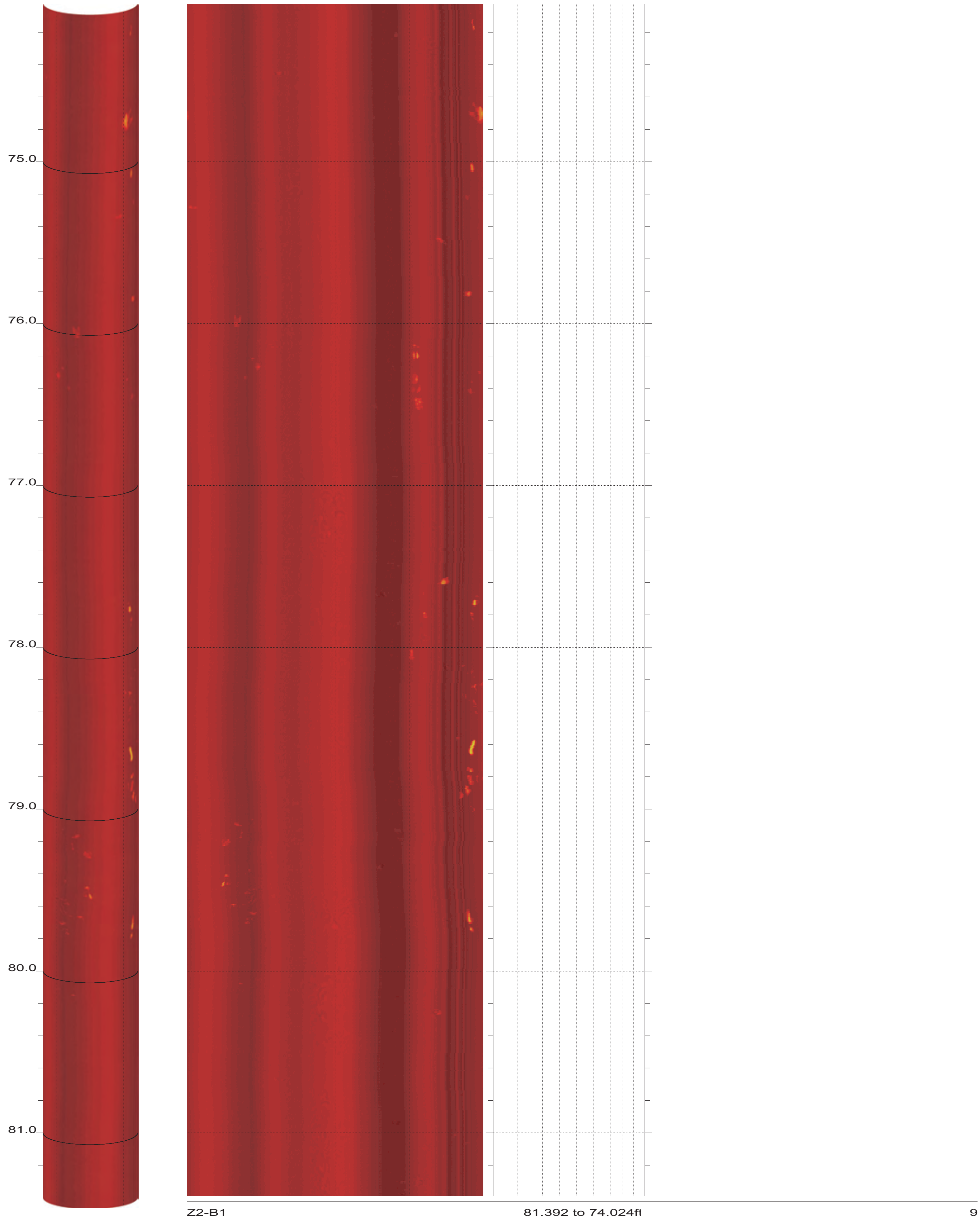
SR-710 Boring Z2-B1 Acoustic Televiewer Dips rev 1 Sheet 6 of 19



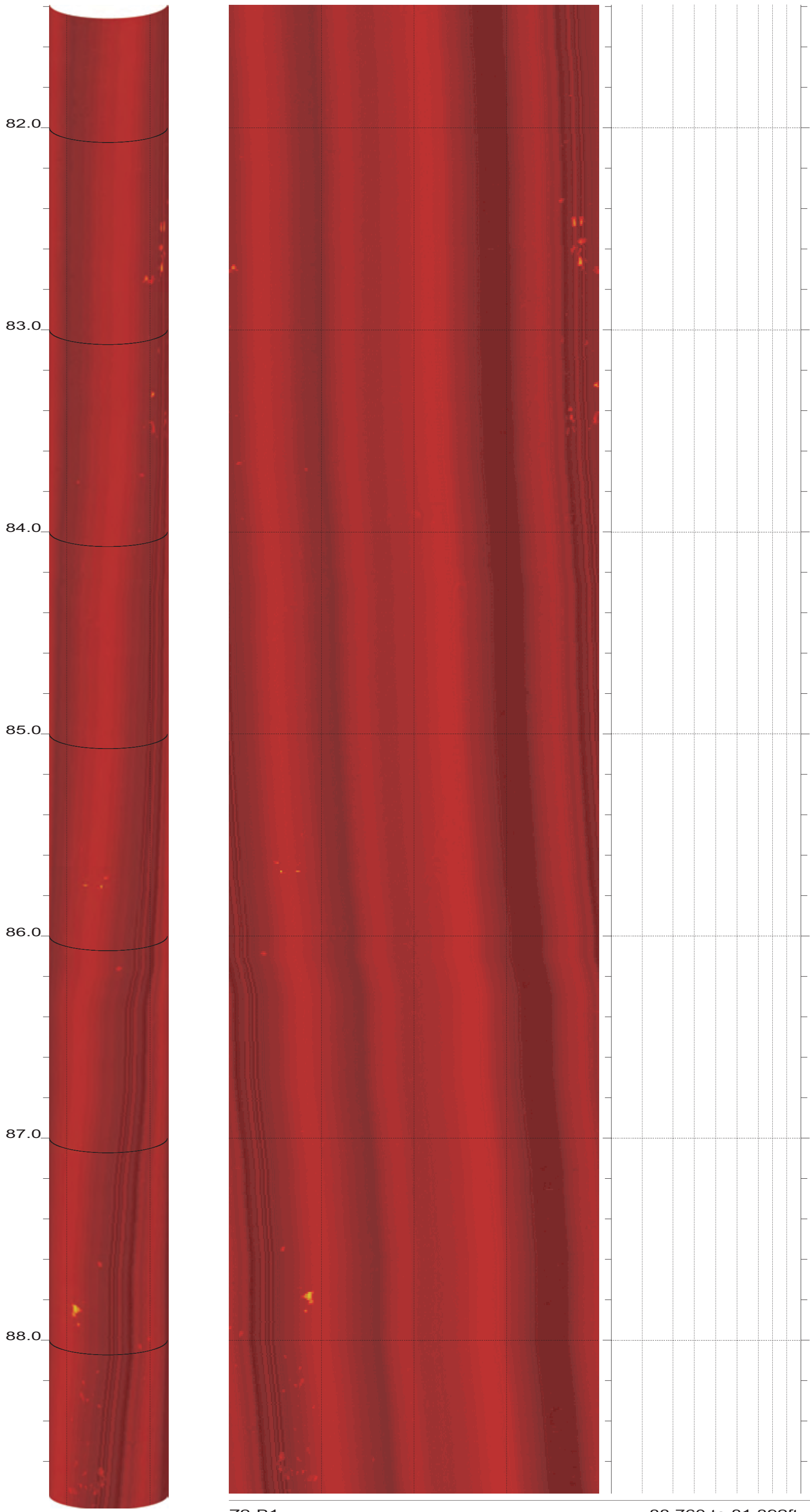
SR-710 Boring Z2-B1 Acoustic Televiewer Dips rev 1 Sheet 7 of 19



SR-710 Boring Z2-B1 Acoustic Televiewer Dips rev 1 Sheet 8 of 19

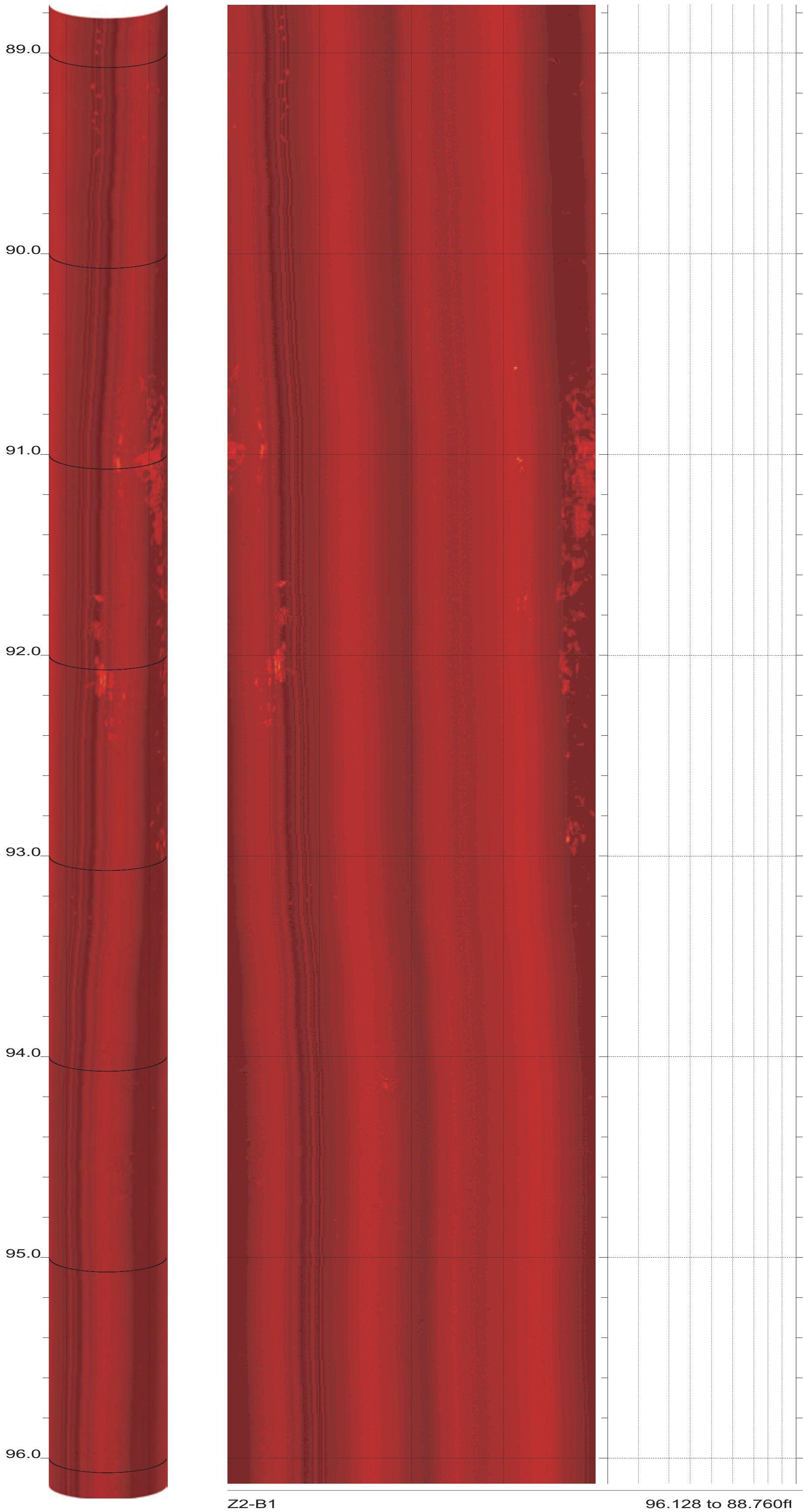


SR-710 Boring Z2-B1 Acoustic Televiewer Dips rev 1 Sheet 9 of 19



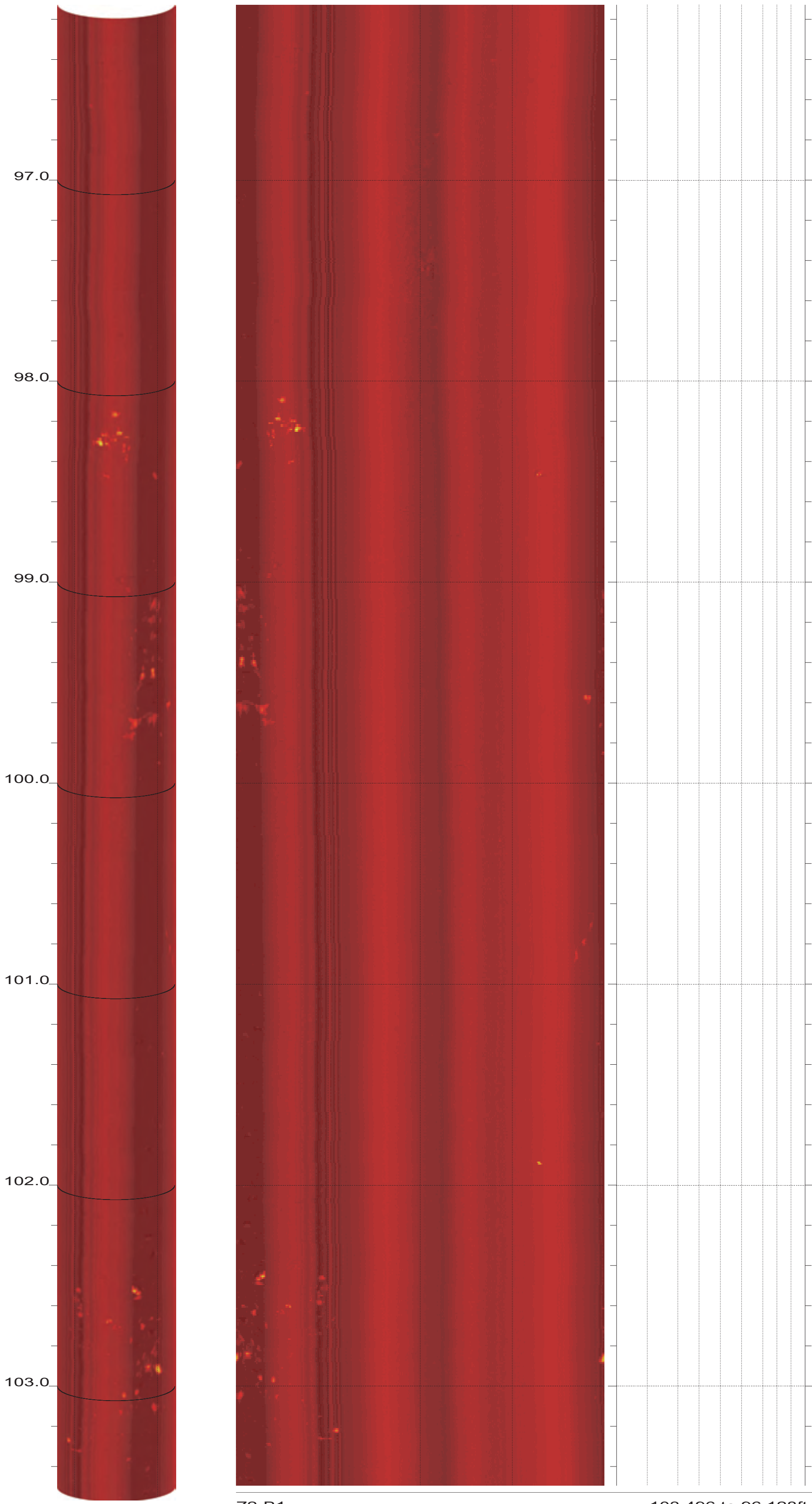
Z2-B1 88.760 to 81.392ft 10

SR-710 Boring Z2-B1 Acoustic Televiewer Dips rev 1 Sheet 10 of 19



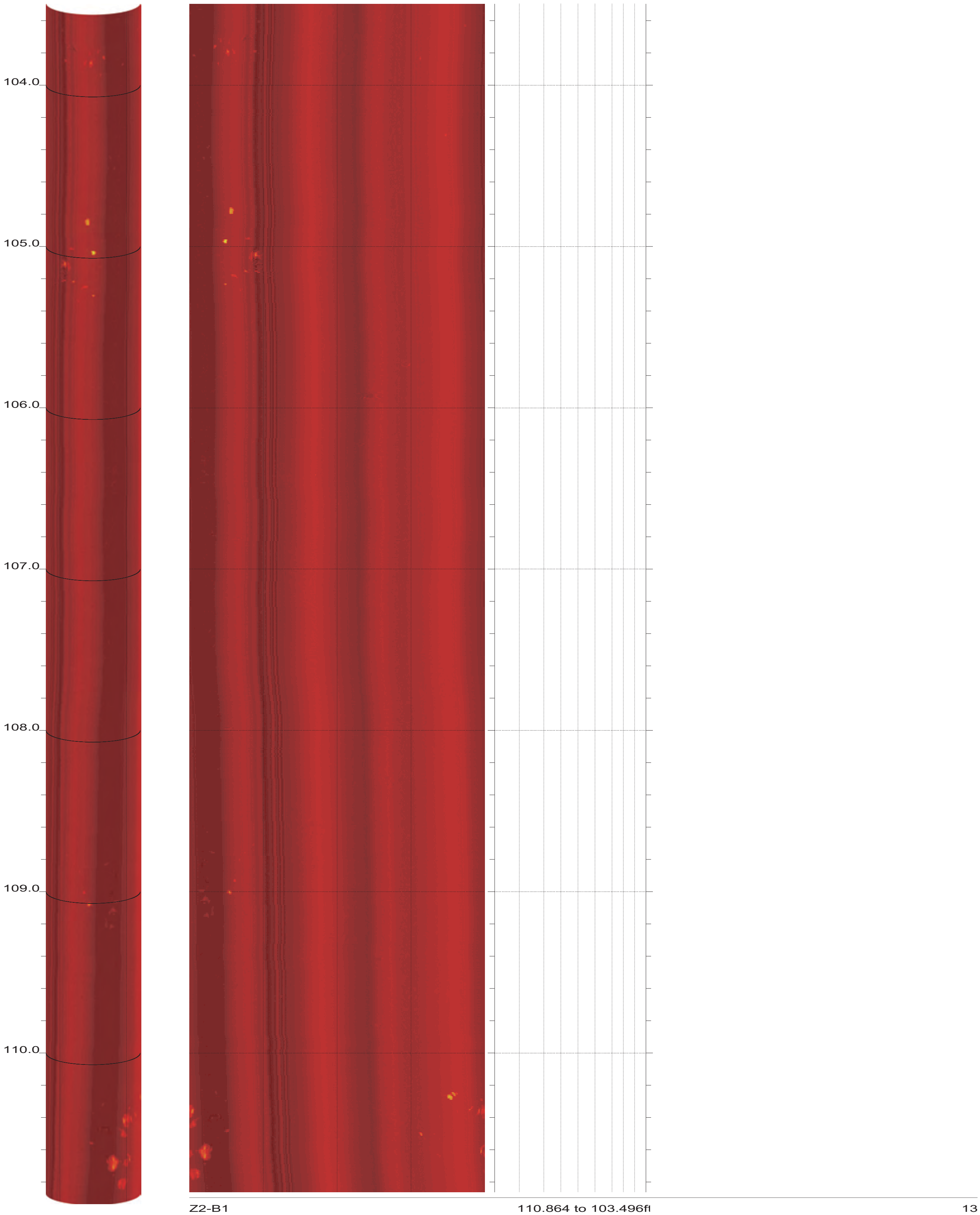
Z2-B1 96.128 to 88.760ft 11

SR-710 Boring Z2-B1 Acoustic Televiewer Dips rev 1 Sheet 11 of 19

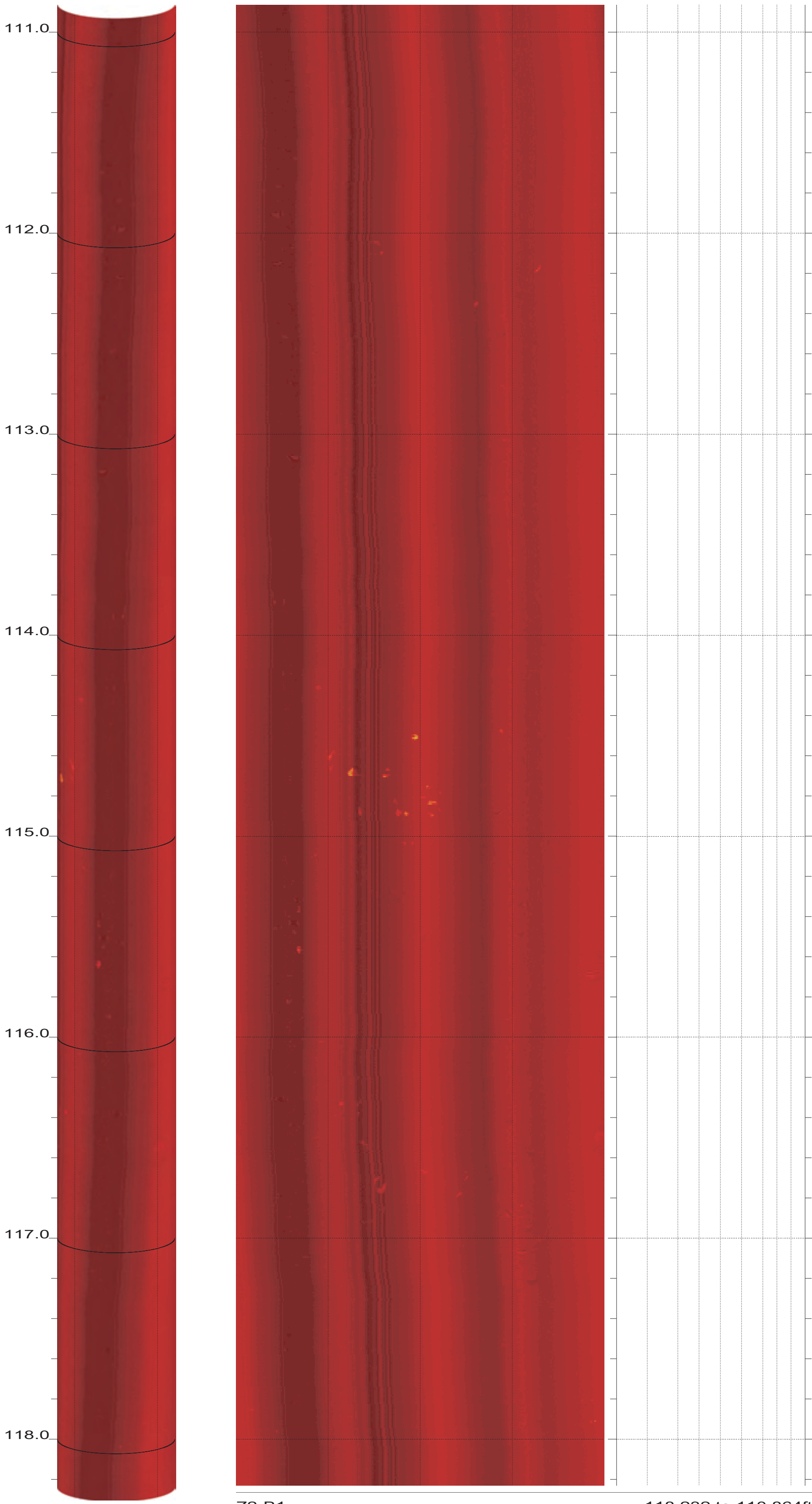


Z2-B1 103.496 to 96.128ft 12

SR-710 Boring Z2-B1 Acoustic Televiewer Dips rev 1 Sheet 12 of 19

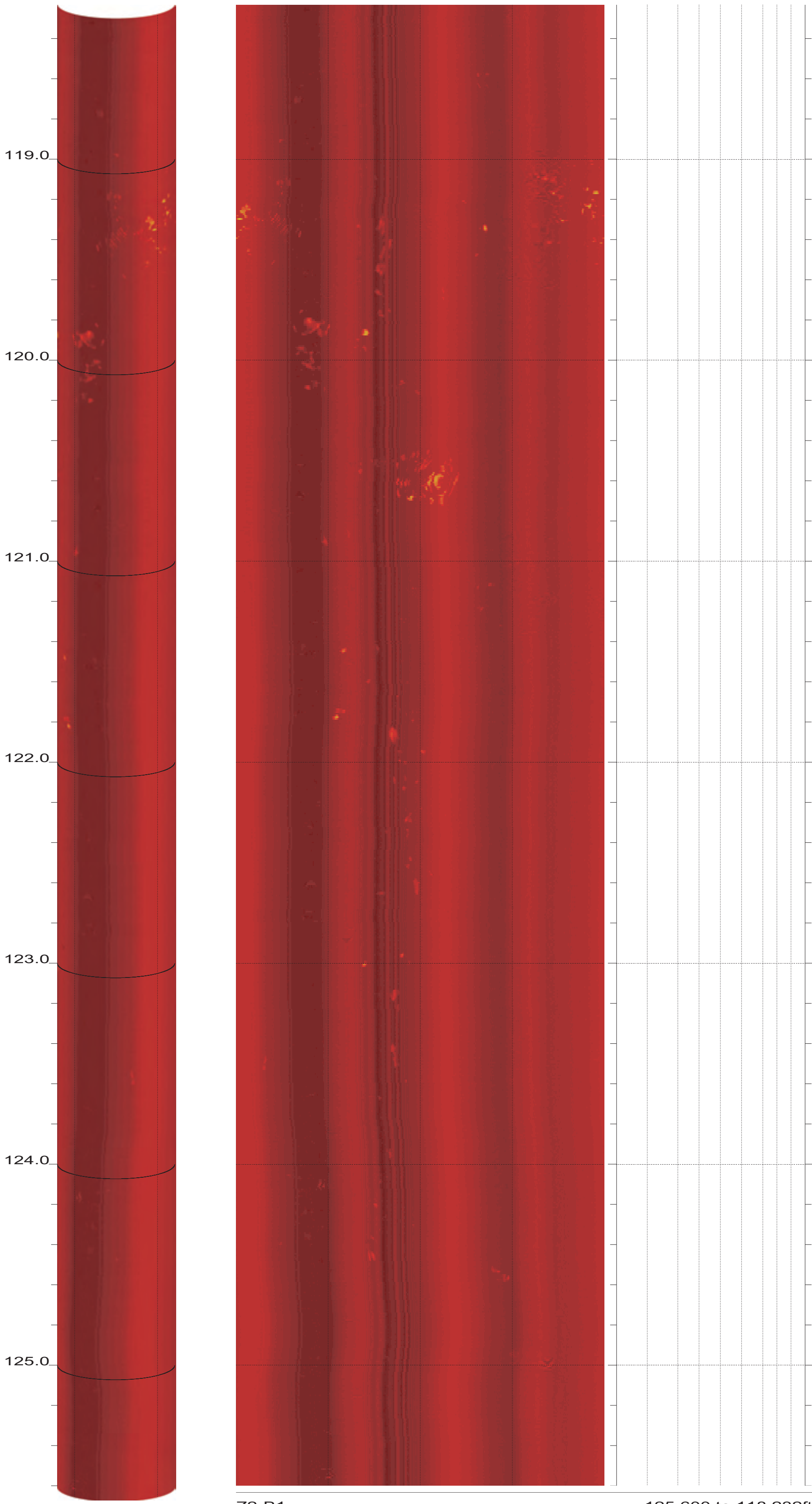


SR-710 Boring Z2-B1 Acoustic Televiewer Dips rev 1 Sheet 13 of 19



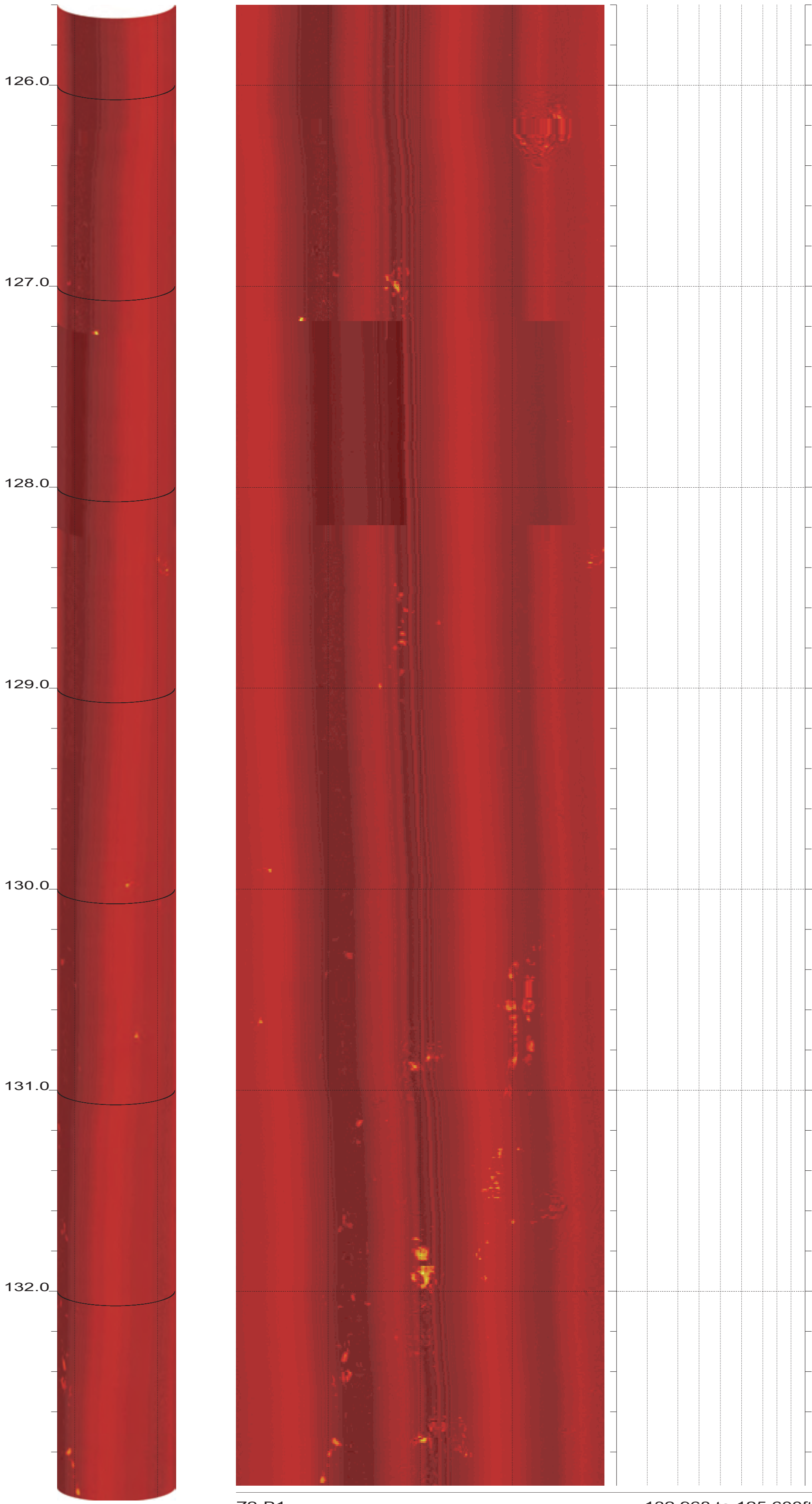
Z2-B1 118.232 to 110.864ft 14

SR-710 Boring Z2-B1 Acoustic Televiewer Dips rev 1 Sheet 14 of 19



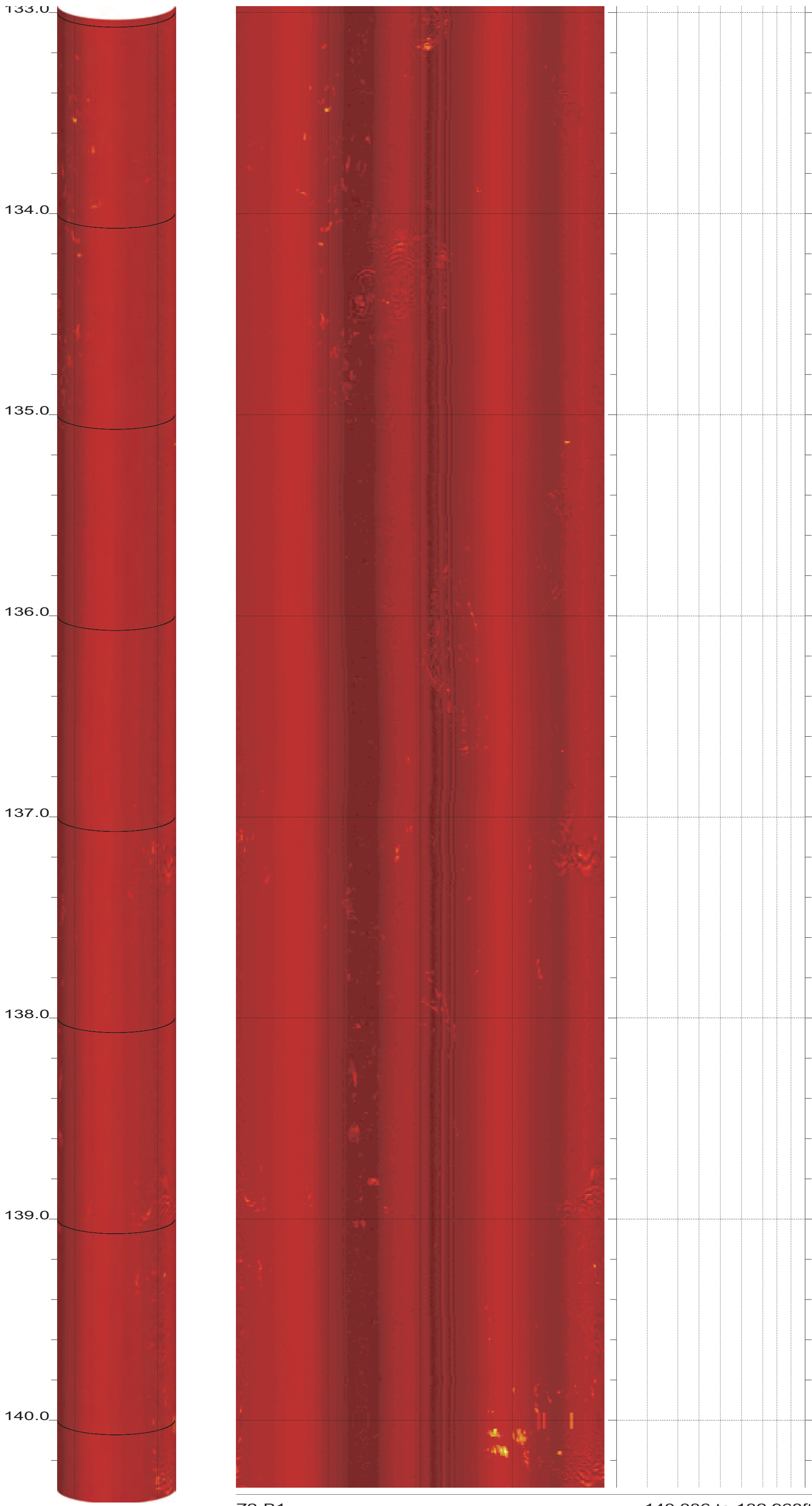
Z2-B1 125.600 to 118.232ft 15

SR-710 Boring Z2-B1 Acoustic Televiewer Dips rev 1 Sheet 15 of 19



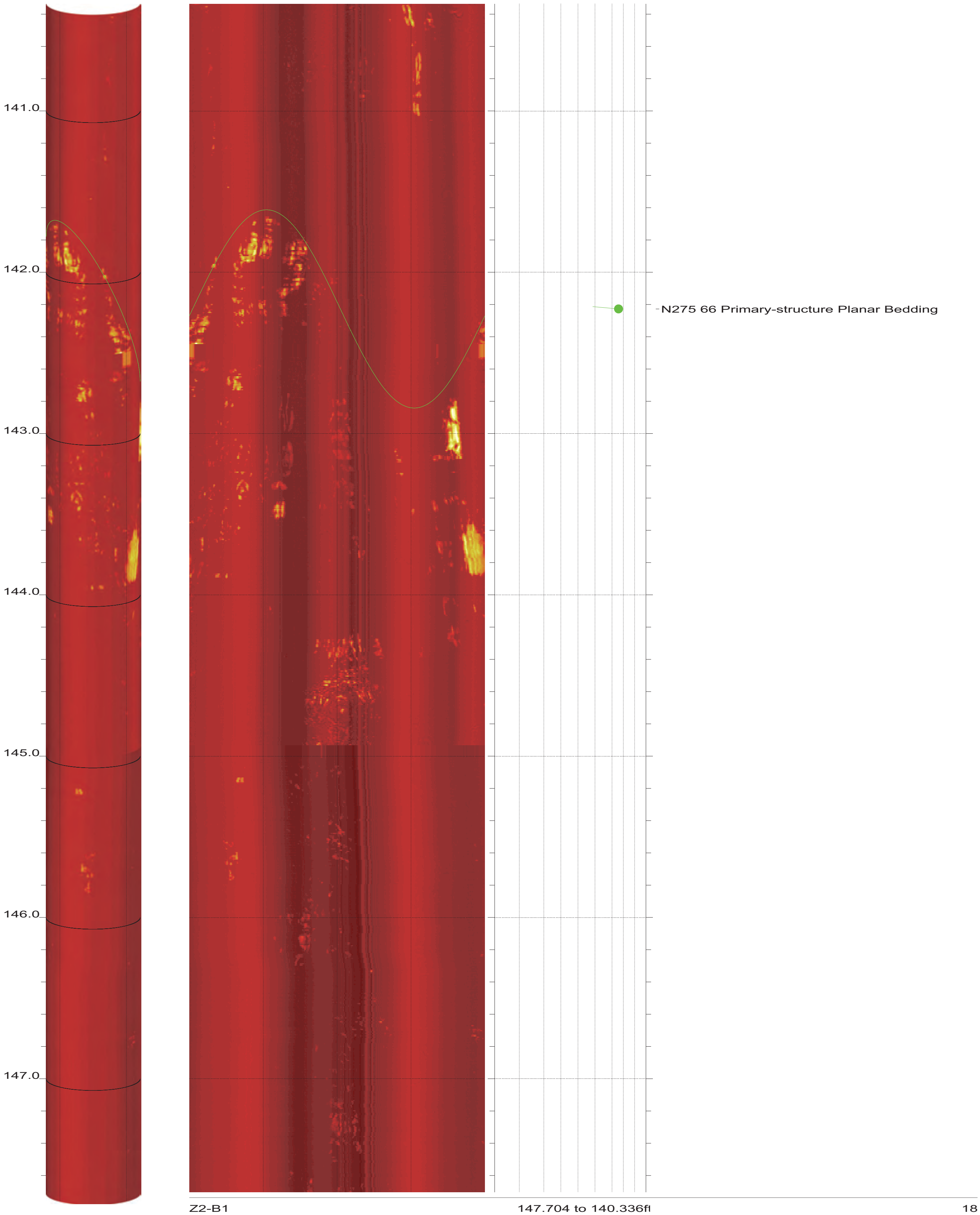
Z2-B1 132.968 to 125.600ft 16

SR-710 Boring Z2-B1 Acoustic Televiewer Dips rev 1 Sheet 16 of 19

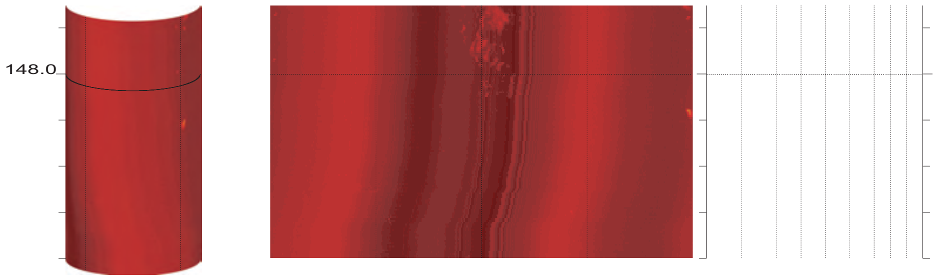


Z2-B1 140.336 to 132.968ft 17

SR-710 Boring Z2-B1 Acoustic Televiewer Dips rev 1 Sheet 17 of 19



SR-710 Boring Z2-B1 Acoustic Televiewer Dips rev 1 Sheet 18 of 19


148.0

BHTV DATA PROCESSING
RGLDIP vsn 6.2
INTERPRETED BHTV DIPS LOG

CASCADE DRILLING

Borehole: Z2-B4

SR-710 TUNNEL INVESTIGATION

top of borehole.....	North ref. is true
East: _	Depth units are feet
North:_	Vertical scale: 1/10
Elev: _	Horiz scale = 1.00x Vert scale
Zone from 374.600 to 1.800ft	Borehole diam: 4.100inch
Format: BHTV-NESWN	Vertical = borehole-axis
	Image: Amplitude

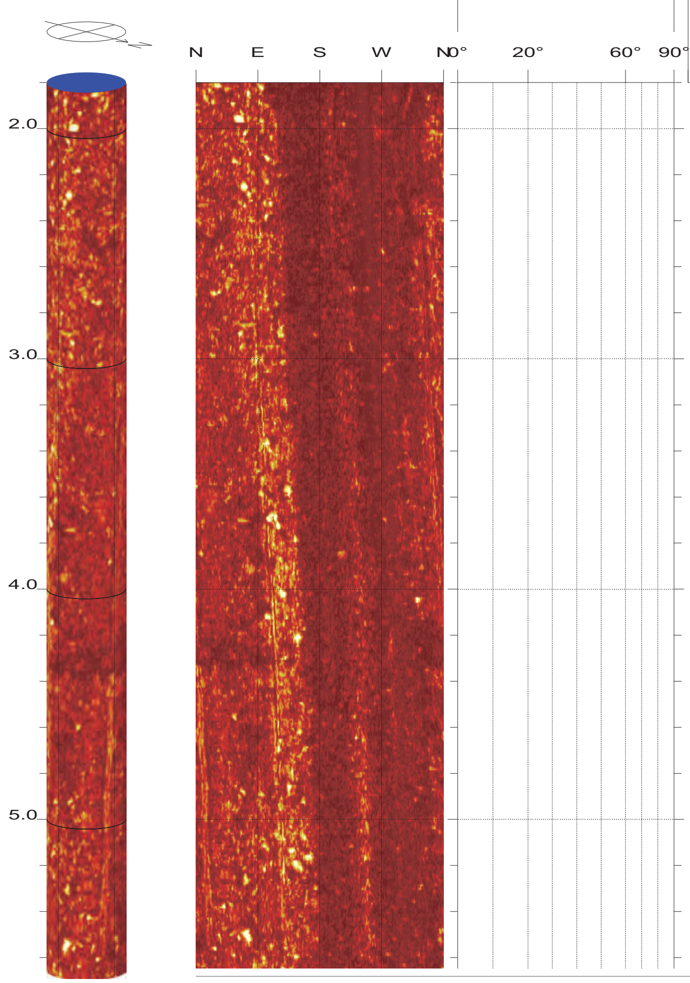
Stratigraphic dips

Non-stratigraphic dips

Identified units

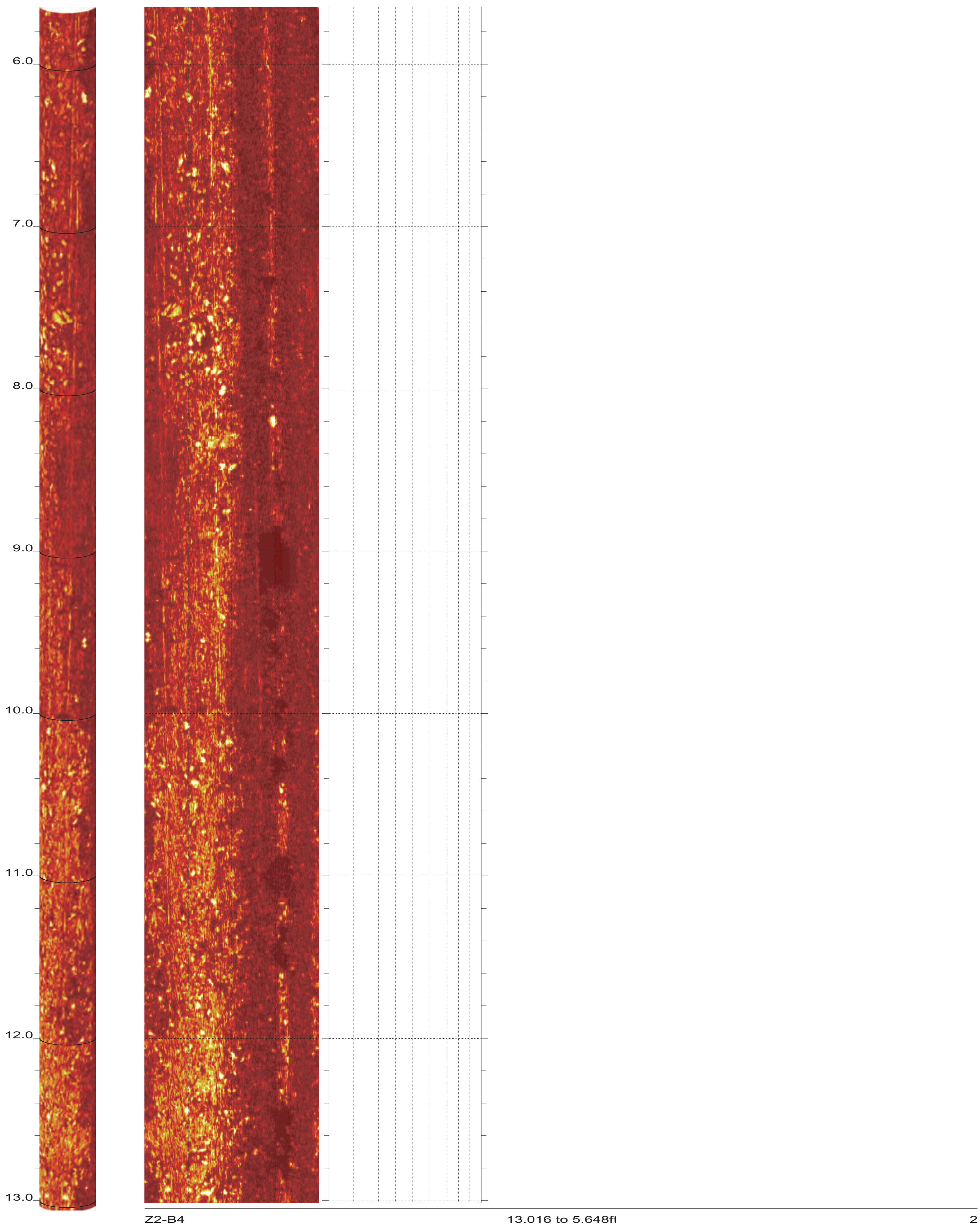
ARROW PLOT

COMMENTS

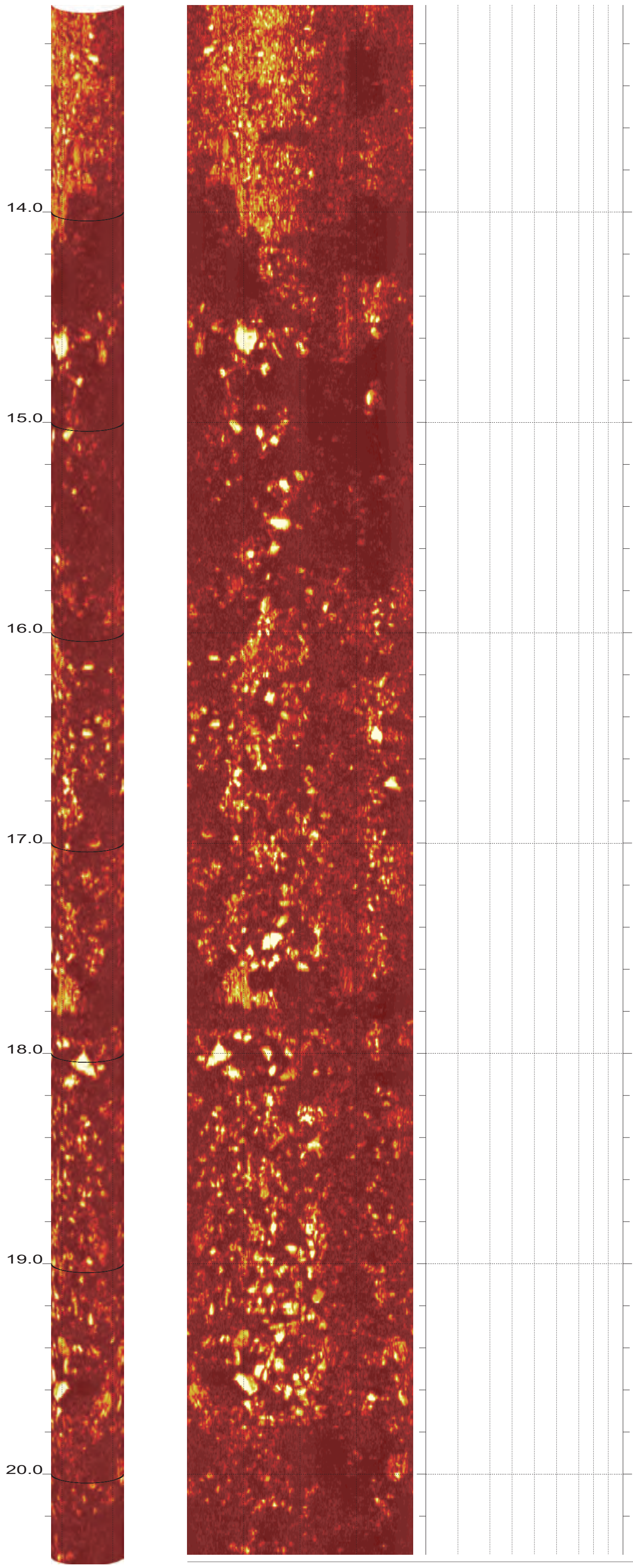


Z2-B4 5.648 to 1.800ft 1

SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 1 of 52

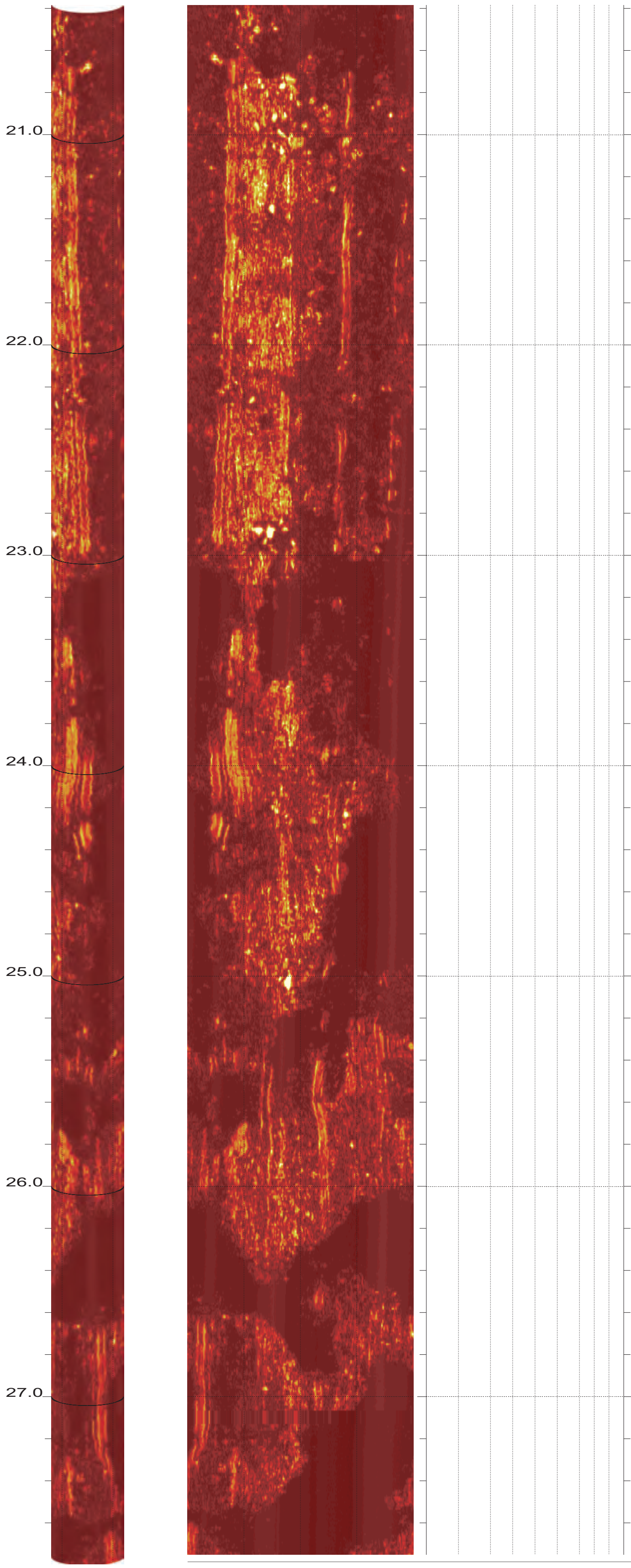


SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 2 of 52



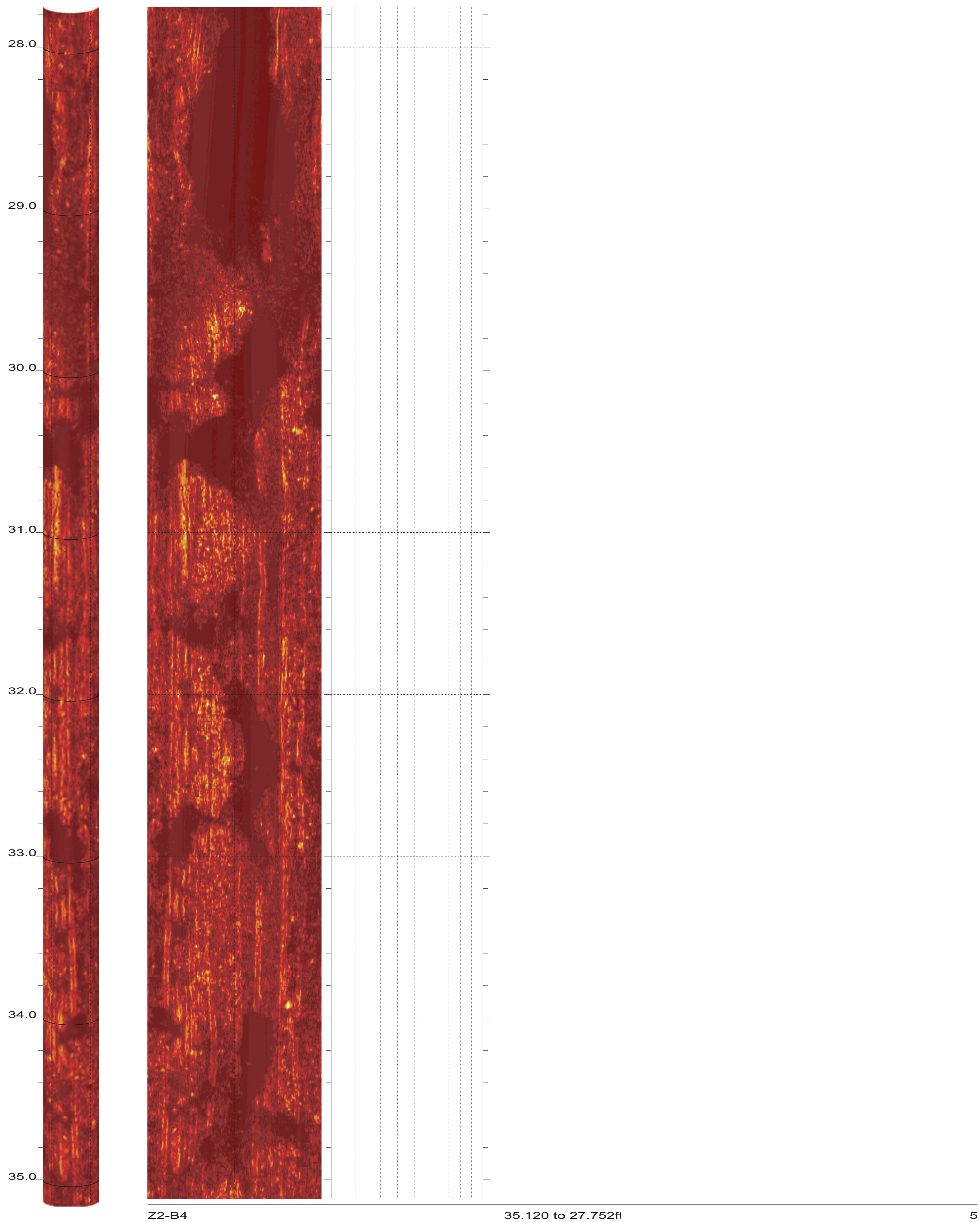
Z2-B4 20.384 to 13.016ft 3

SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 3 of 52

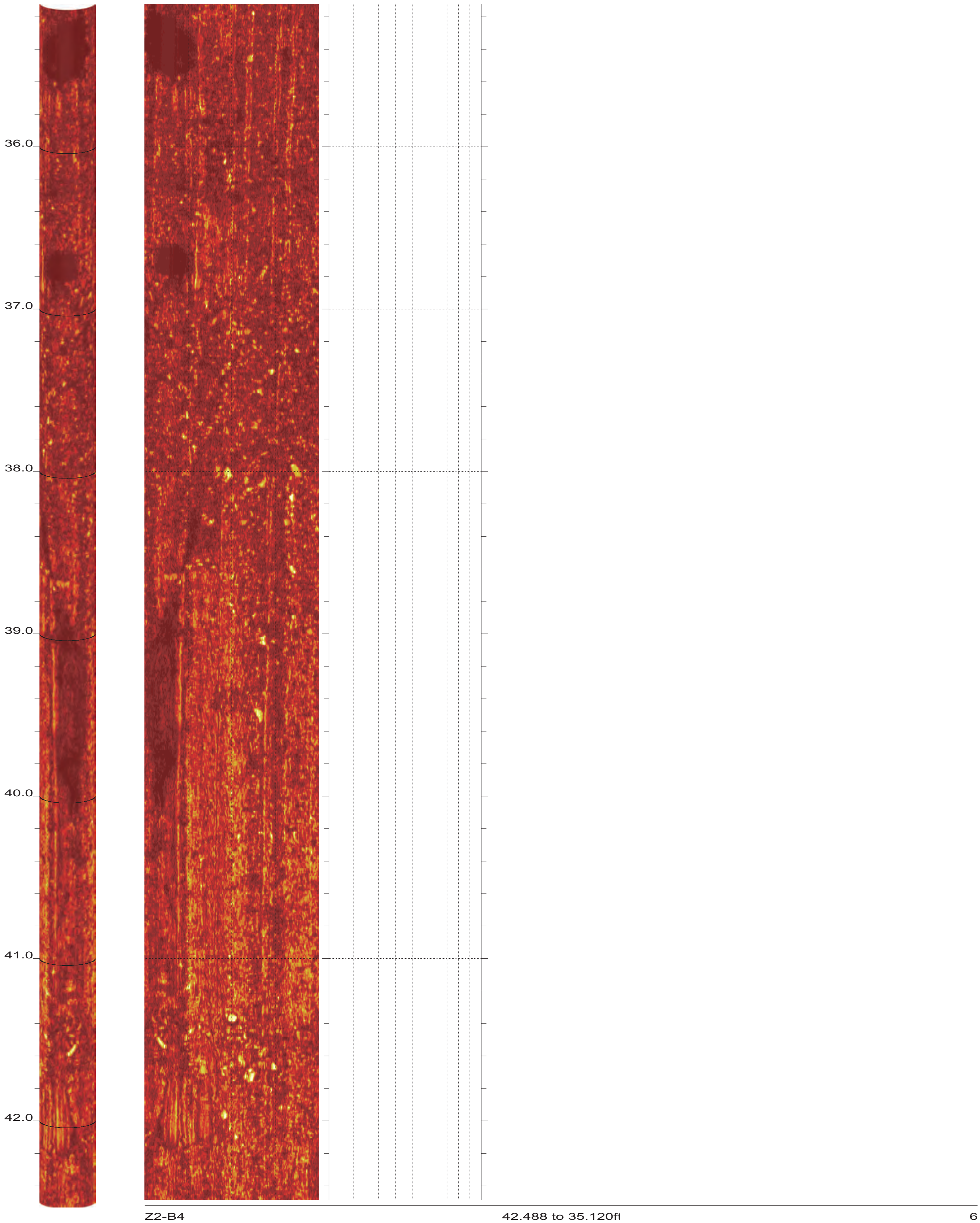


Z2-B4 27.752 to 20.384ft 4

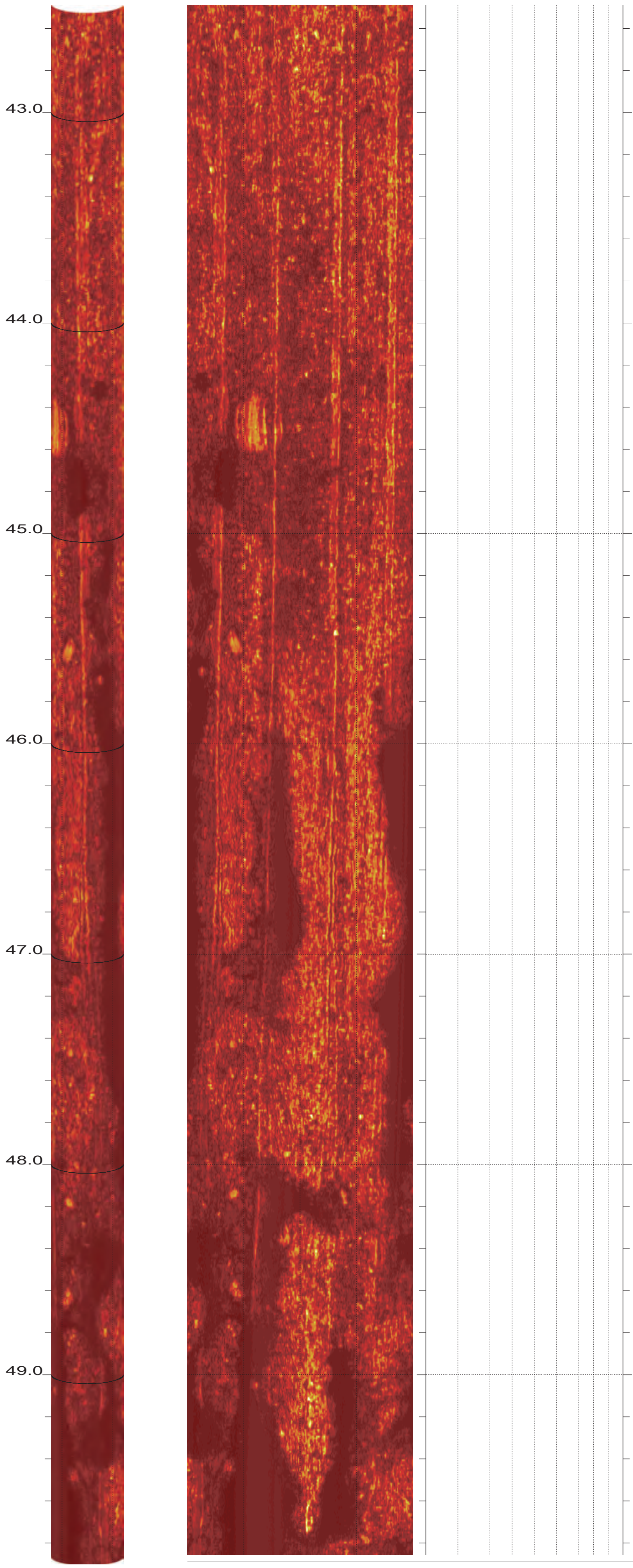
SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 4 of 52



SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 5 of 52

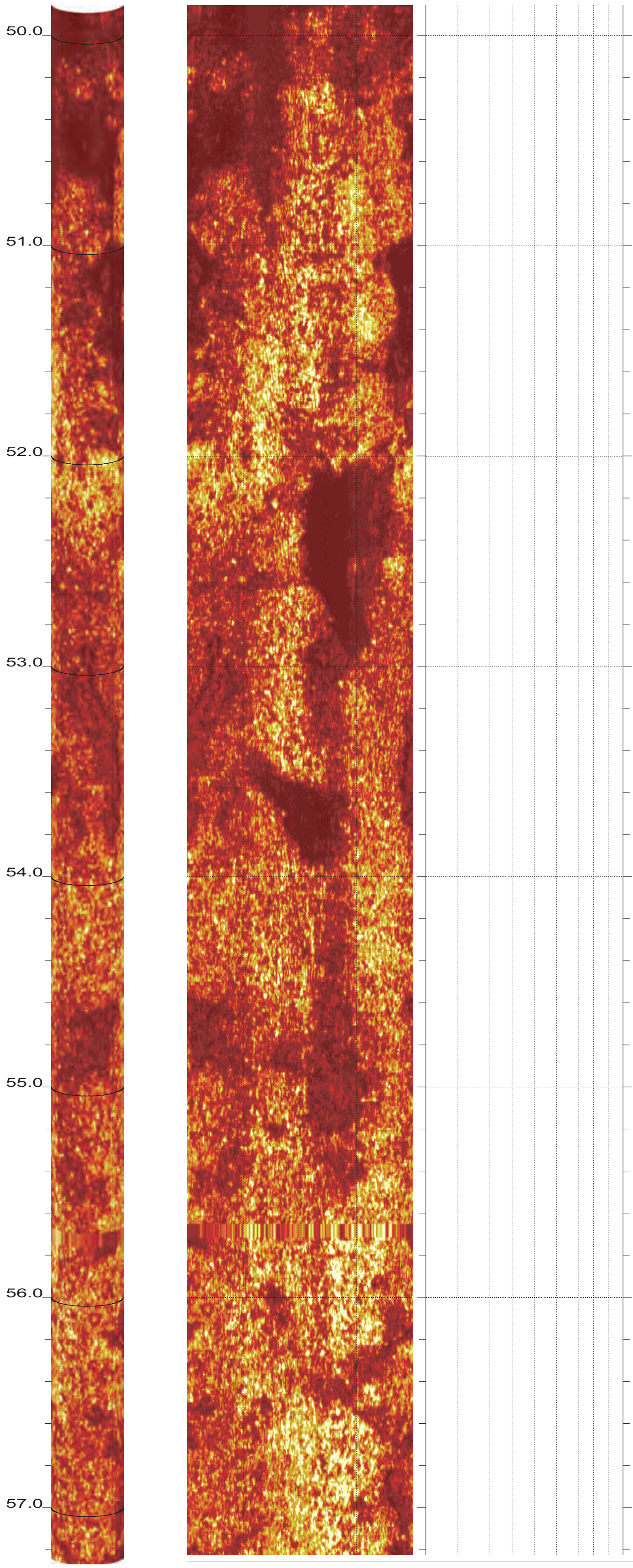


SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 6 of 52



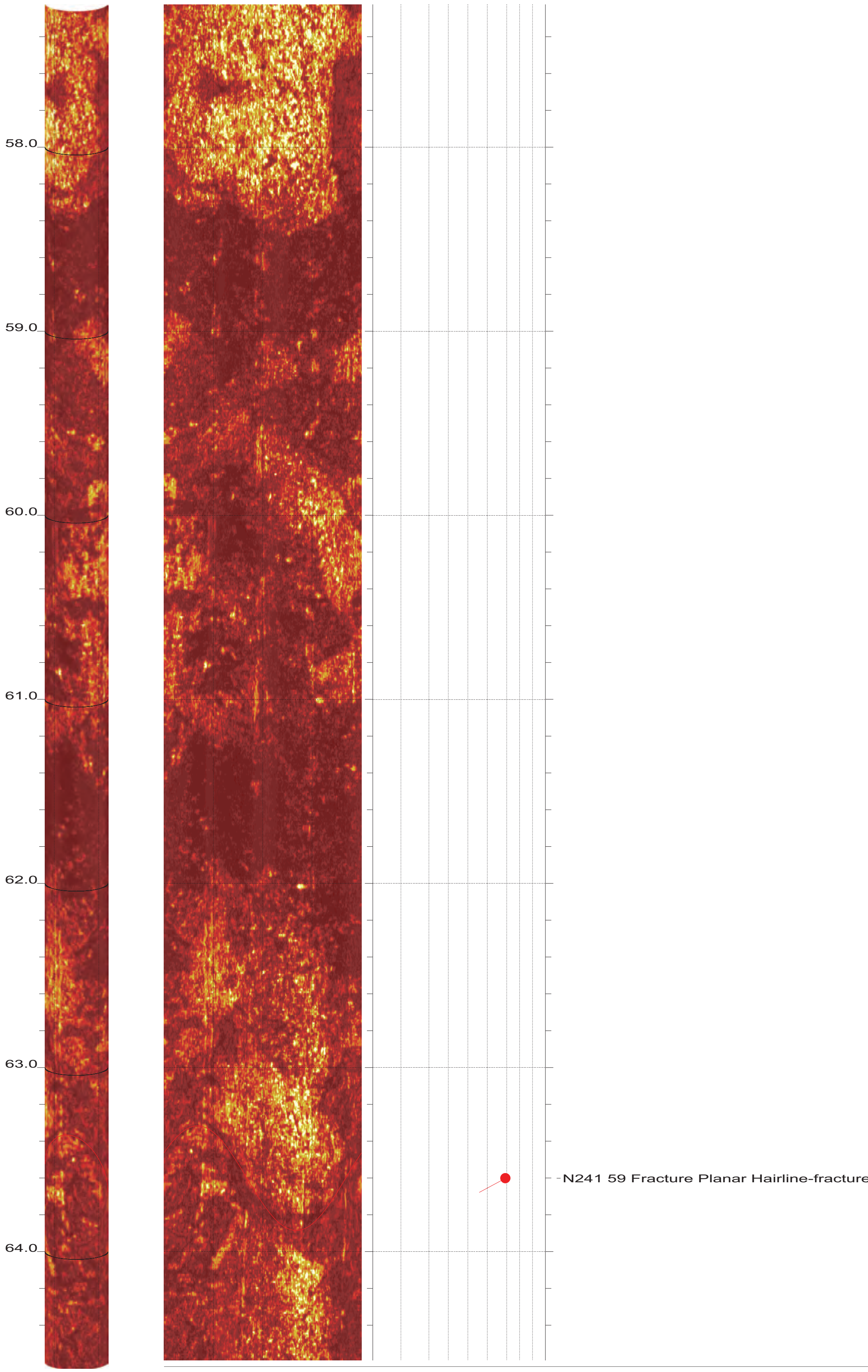
Z2-B4 49.856 to 42.488ft 7

SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 7 of 52



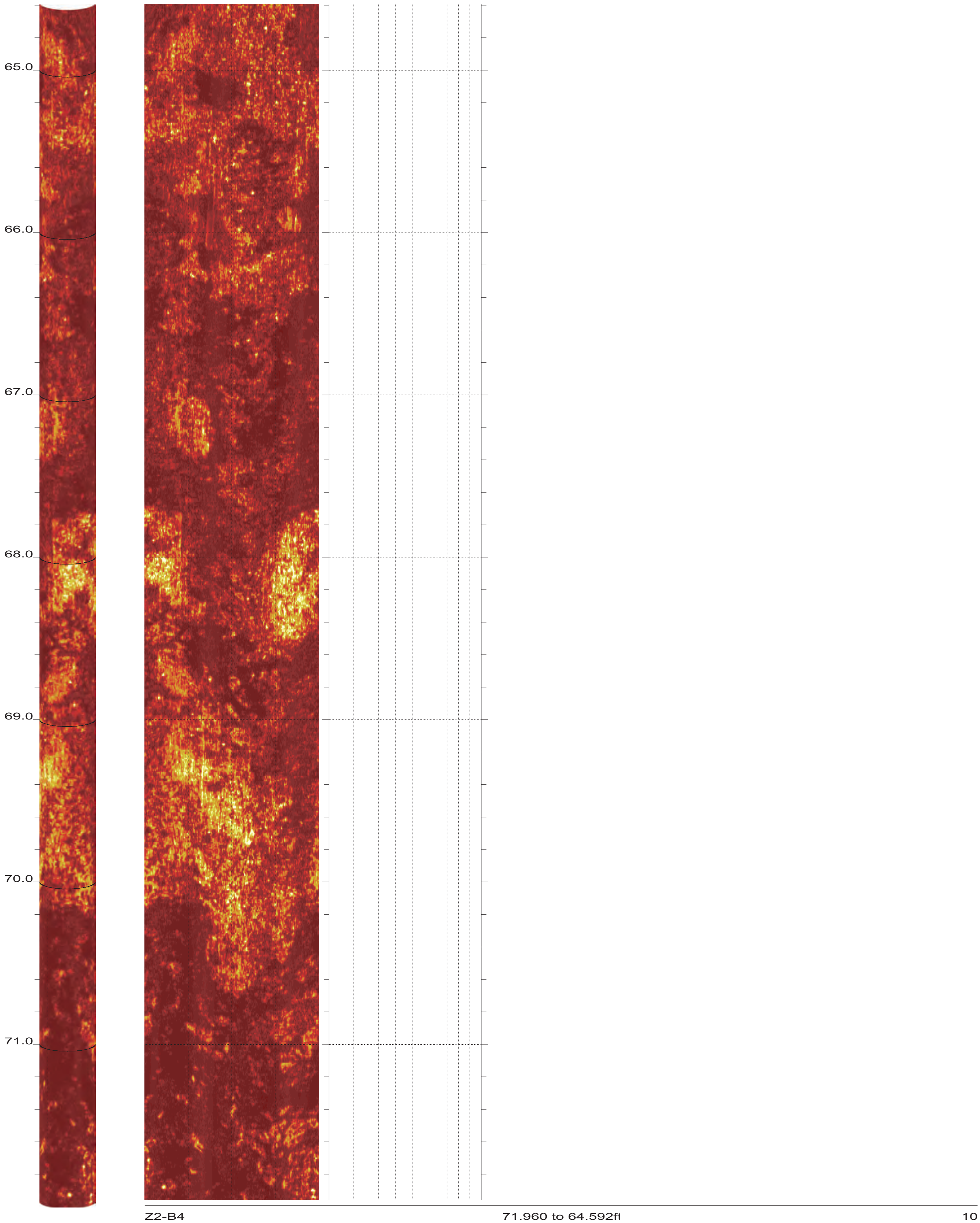
Z2-B4 57.224 to 49.856ft 8

SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 8 of 52

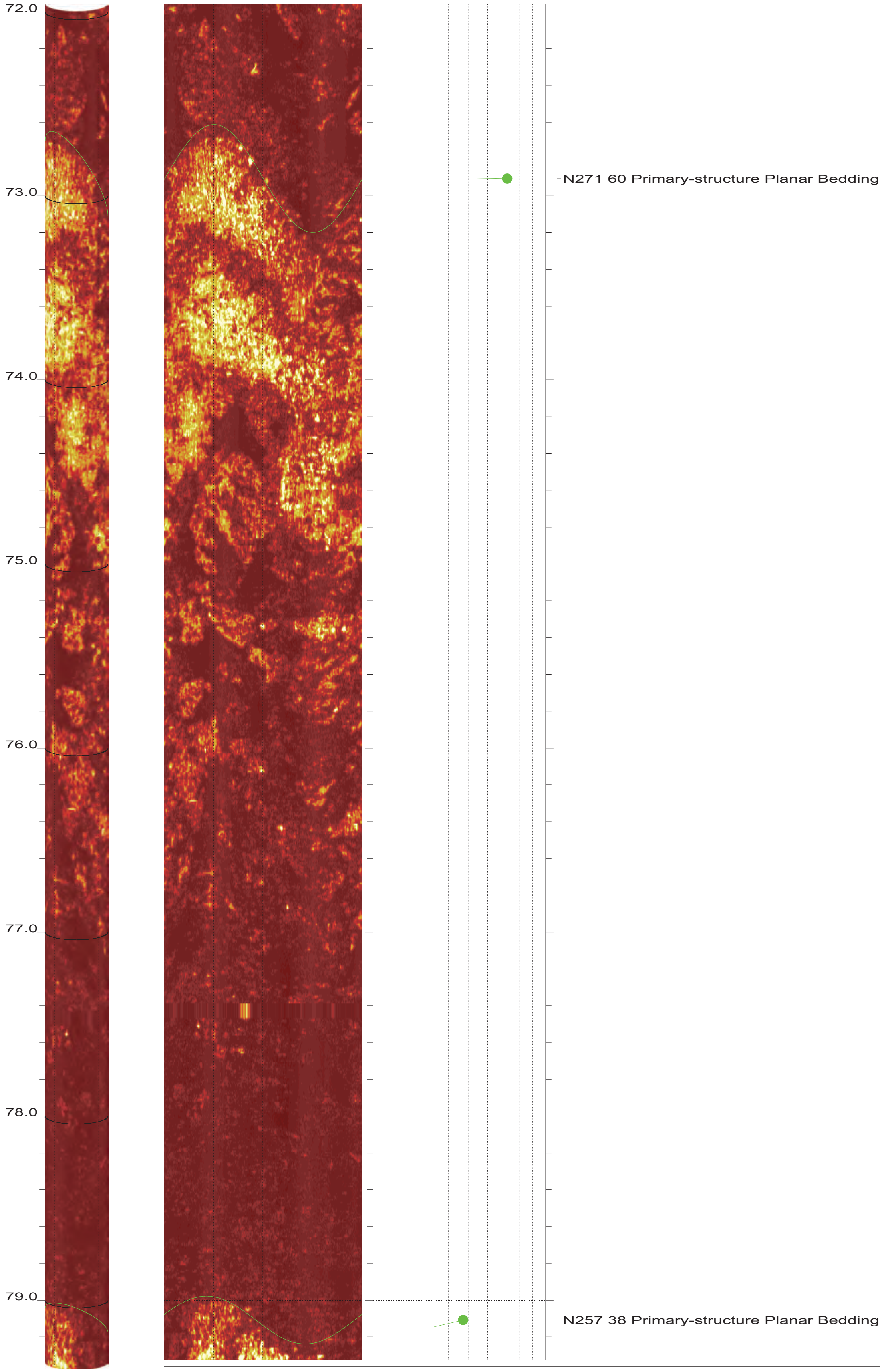


Z2-B4 64.592 to 57.224ft 9

SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 9 of 52

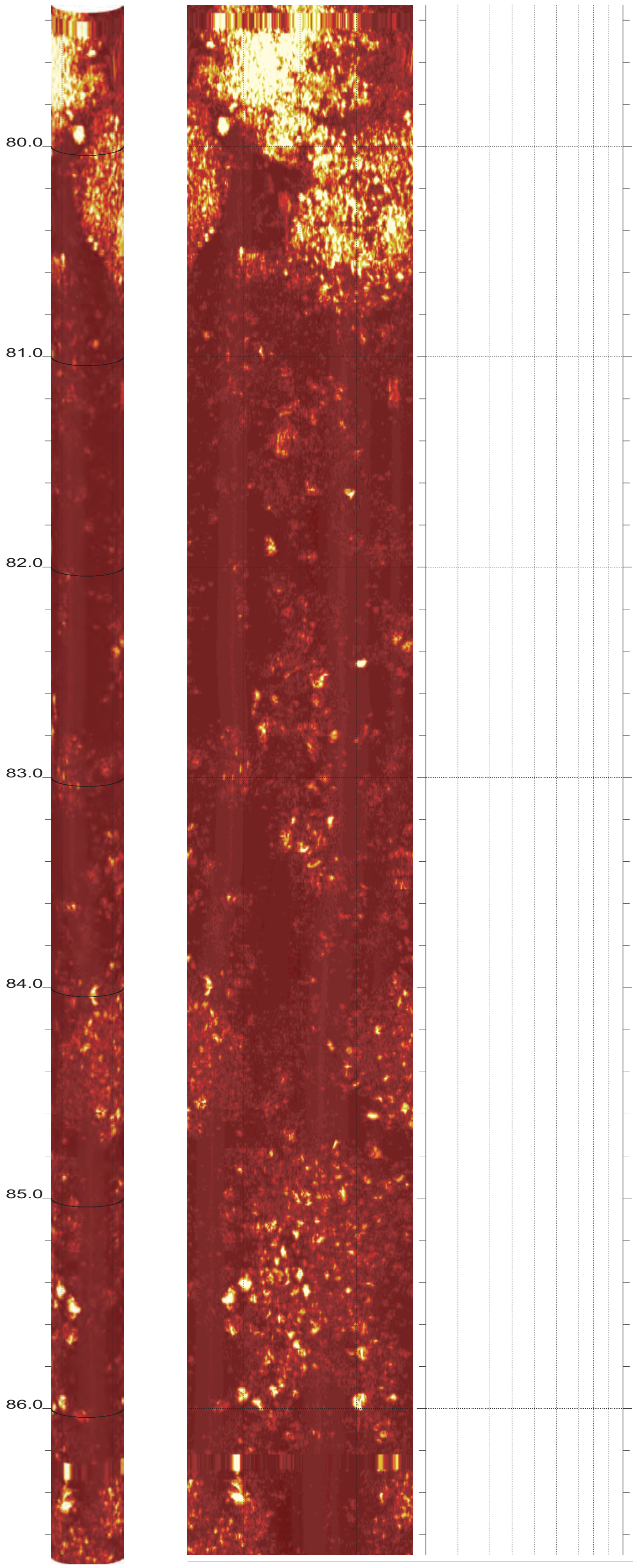


SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 10 of 52



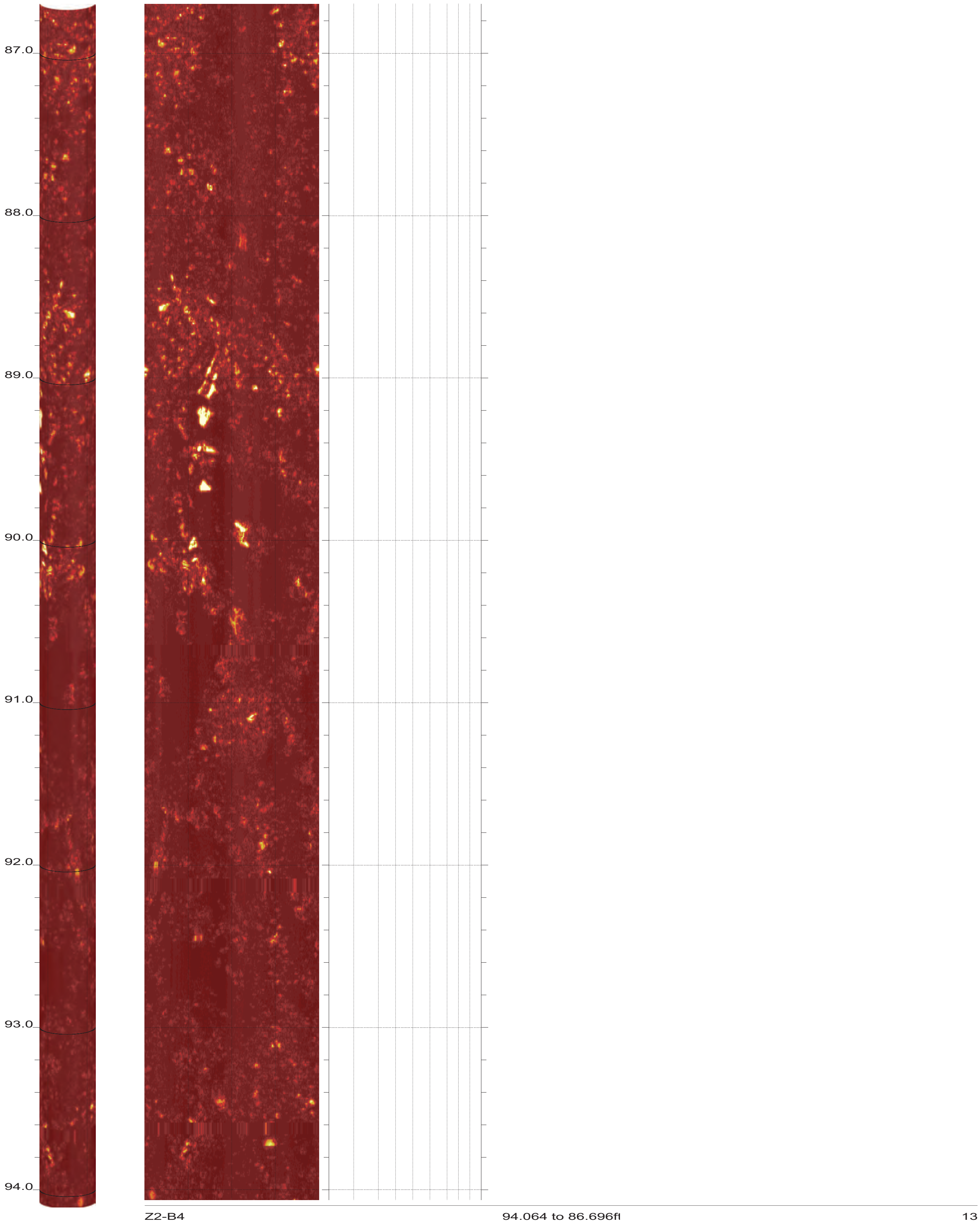
Z2-B4 79.328 to 71.960ft 11

SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 11 of 52

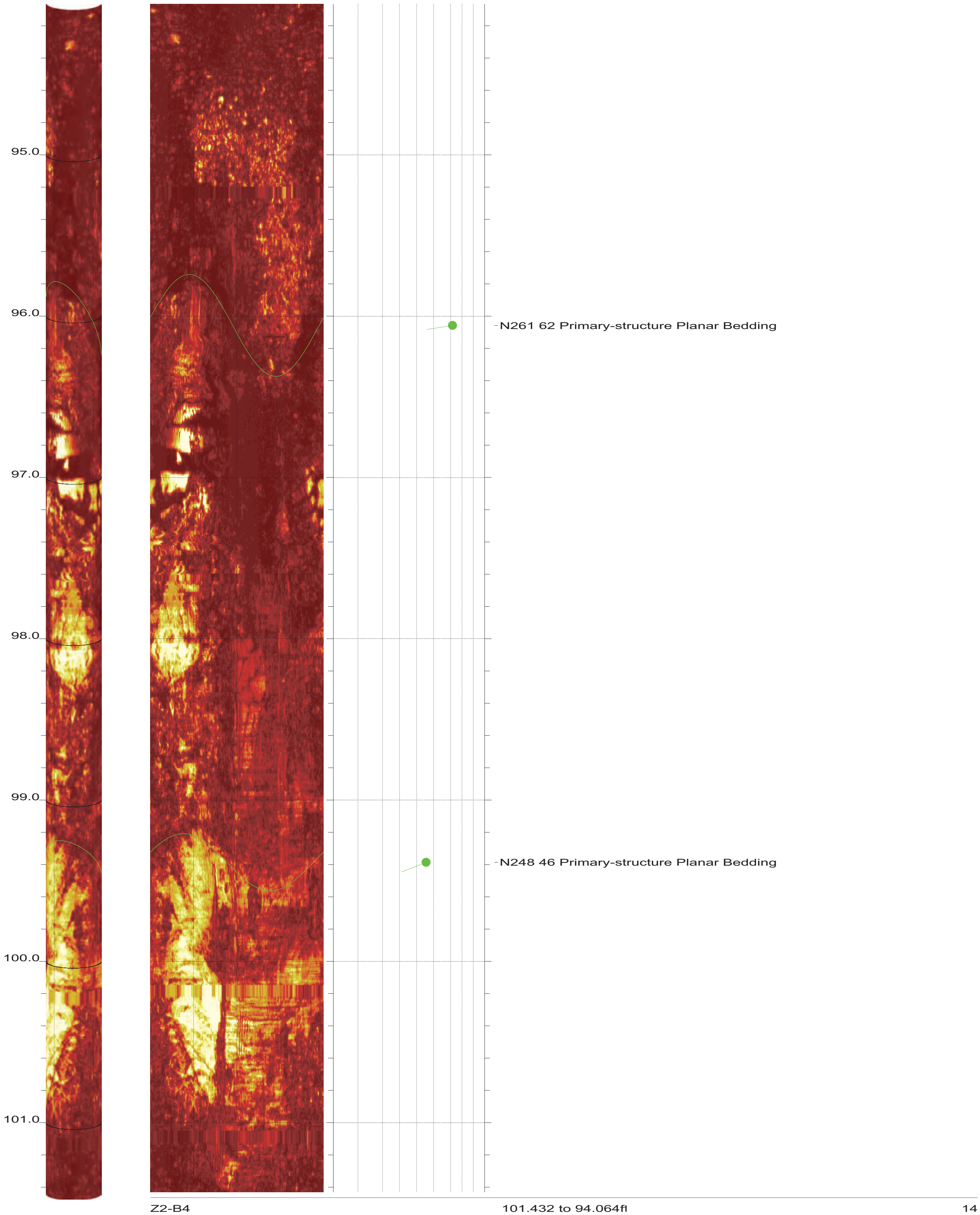


Z2-B4 86.696 to 79.328ft 12

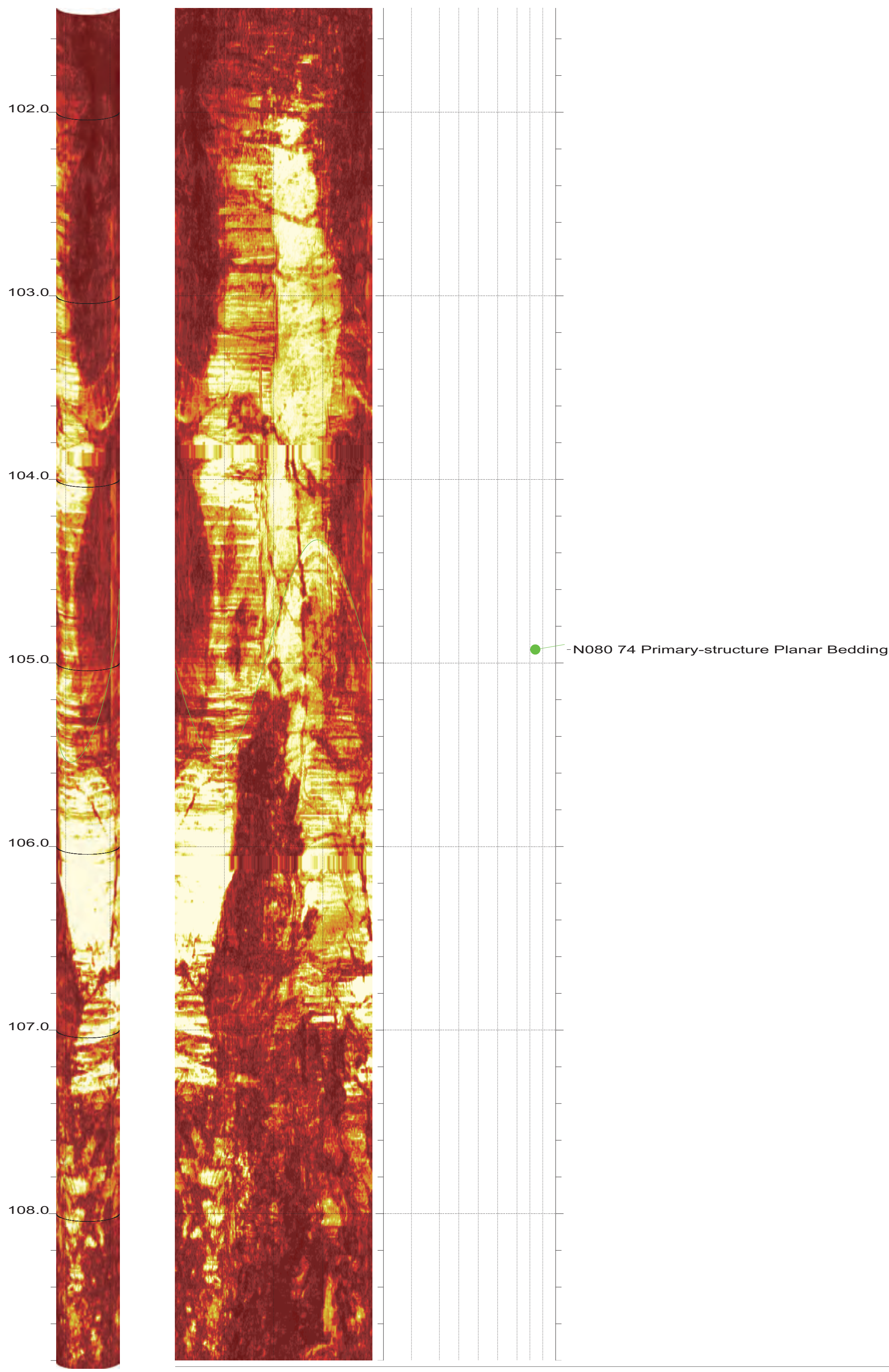
SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 12 of 52



SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 13 of 52

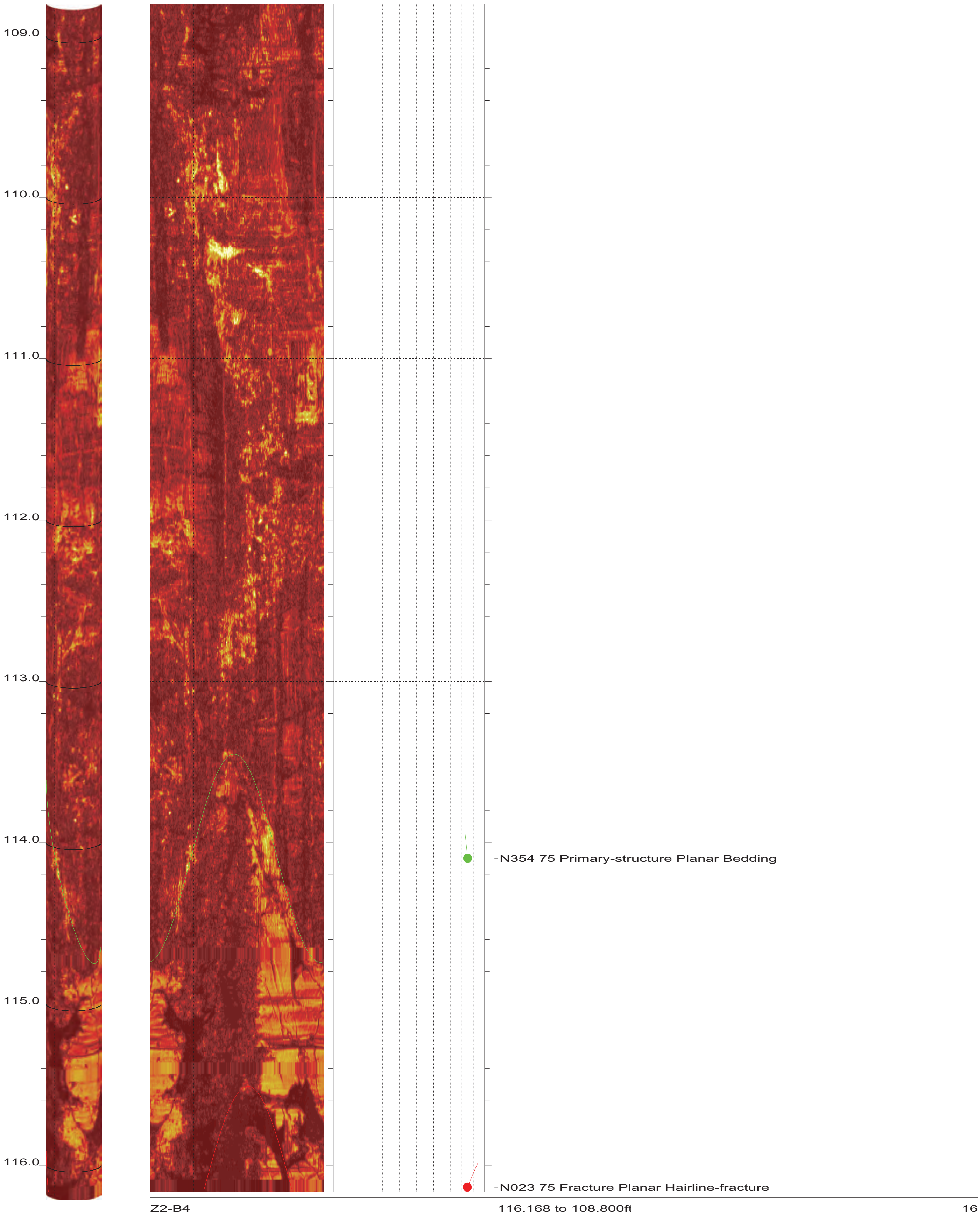


SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 14 of 52

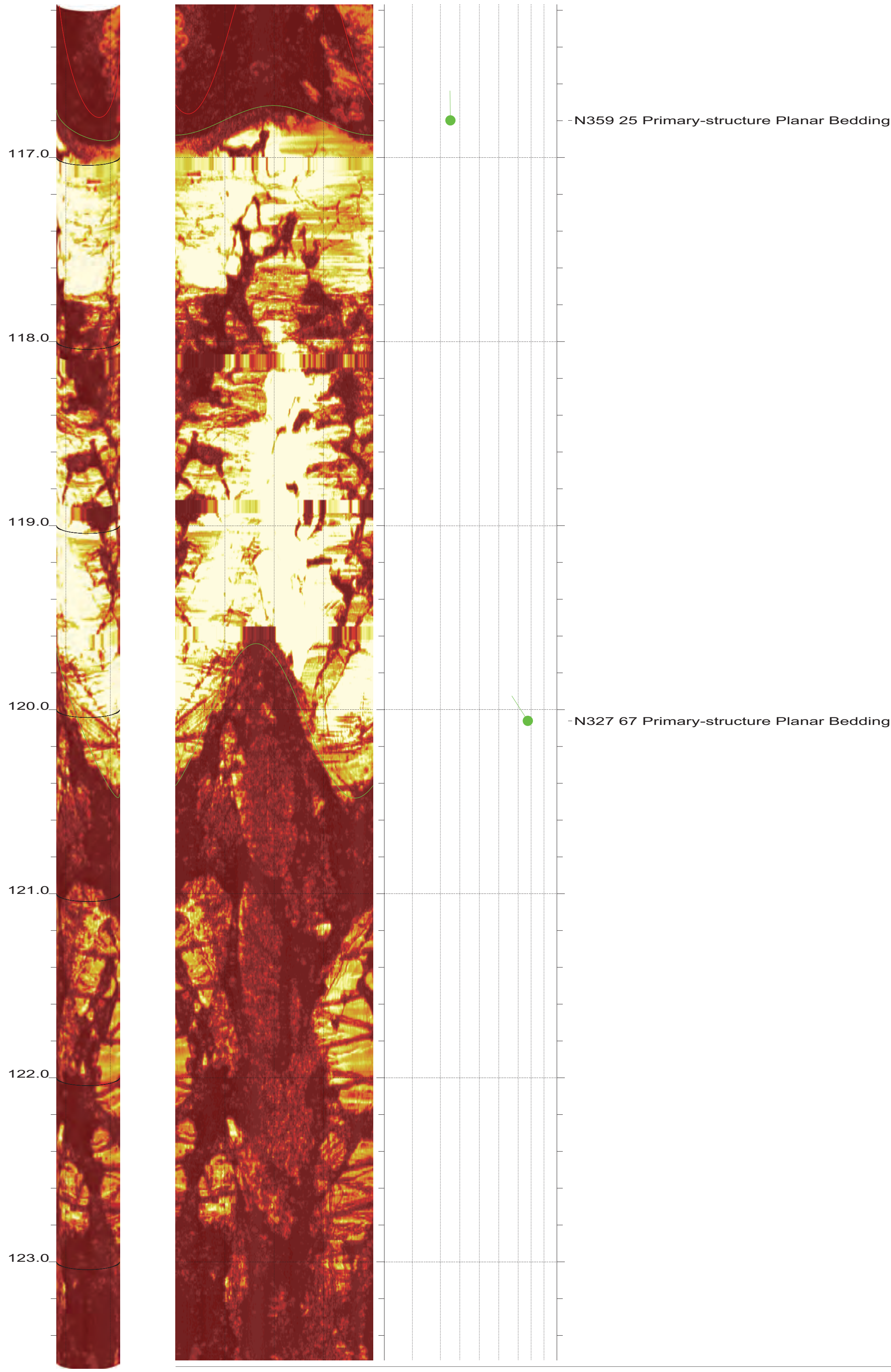


Z2-B4 108.800 to 101.432ft 15

SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 15 of 52

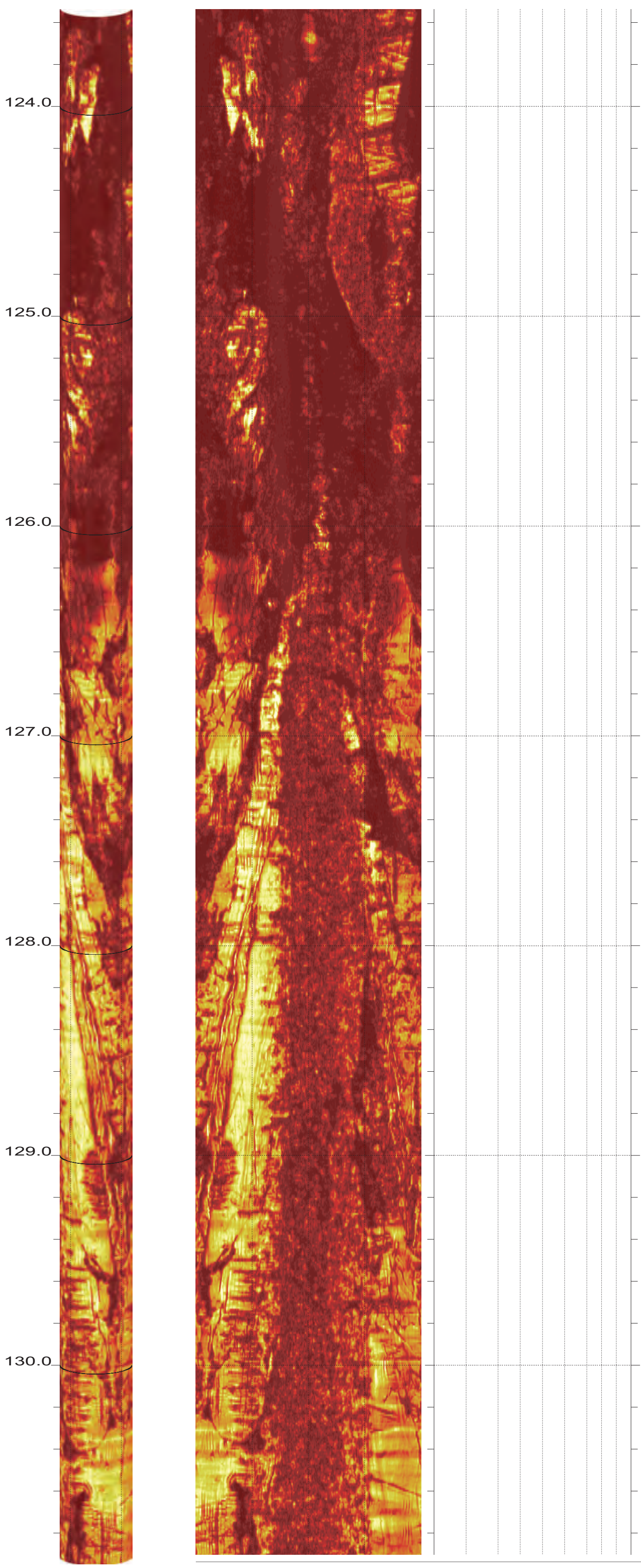


SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 16 of 52



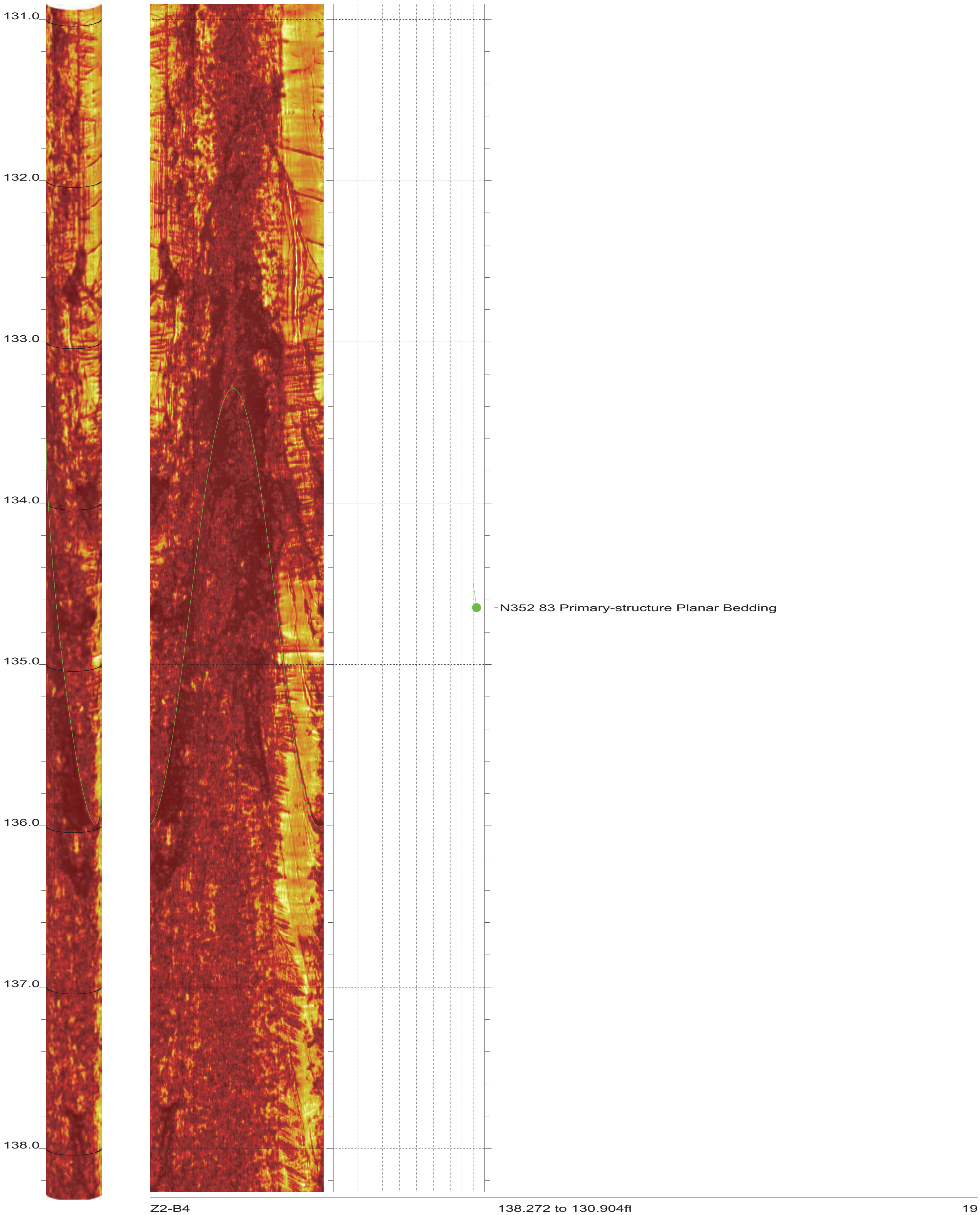
Z2-B4 123.536 to 116.168ft 17

SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 17 of 52

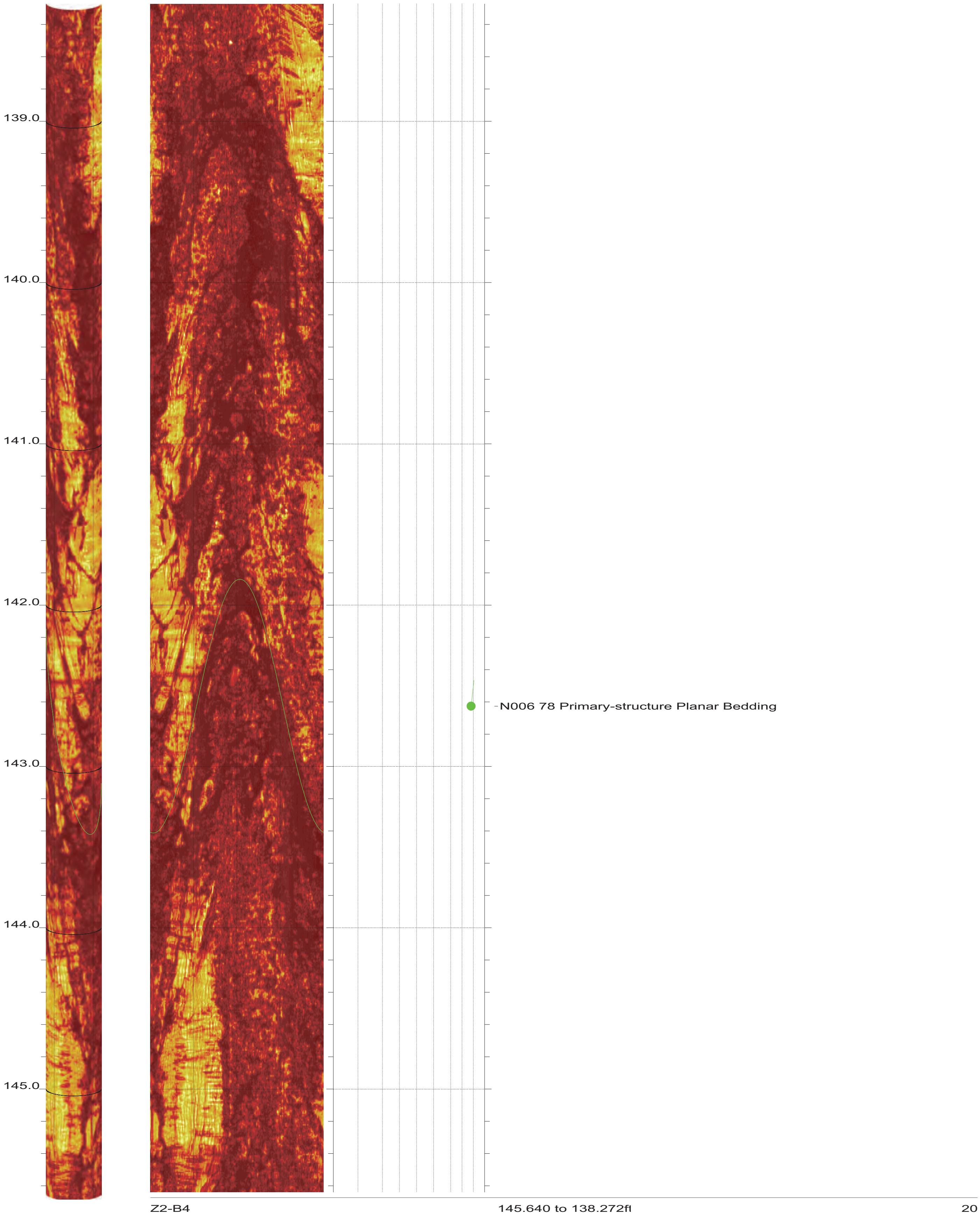


Z2-B4 130.904 to 123.536ft 18

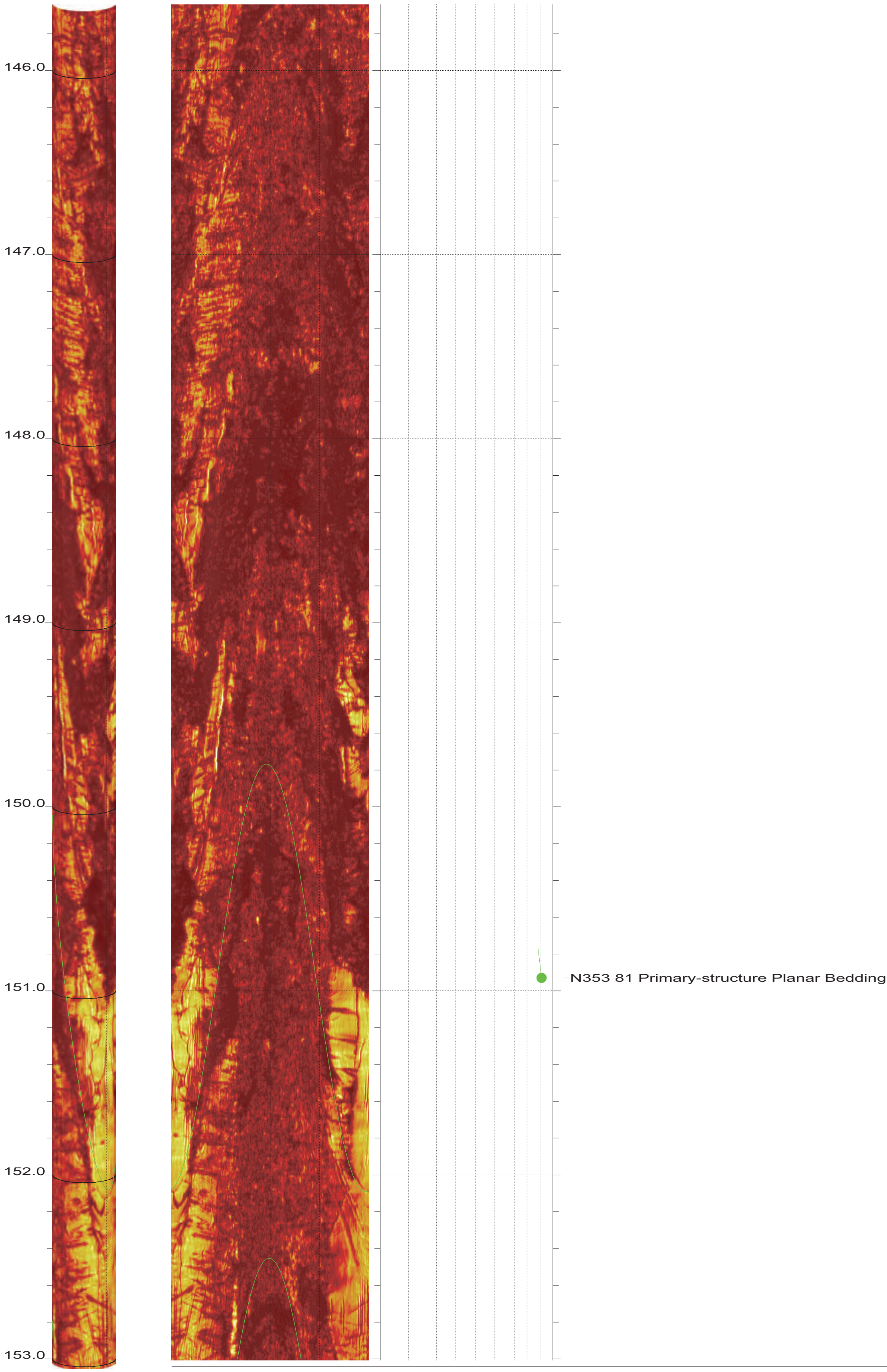
SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 18 of 52



SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 19 of 52

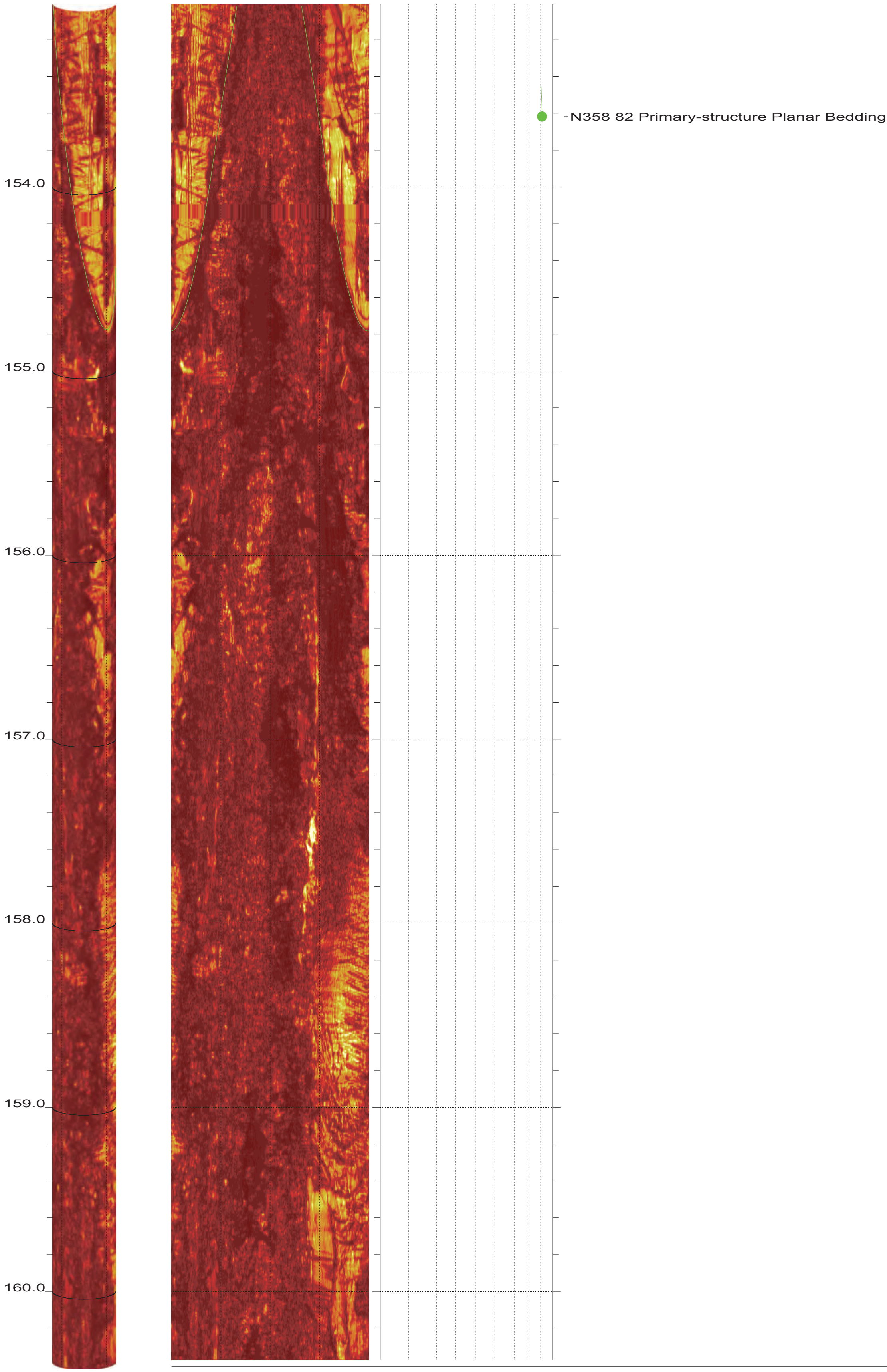


SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 20 of 52



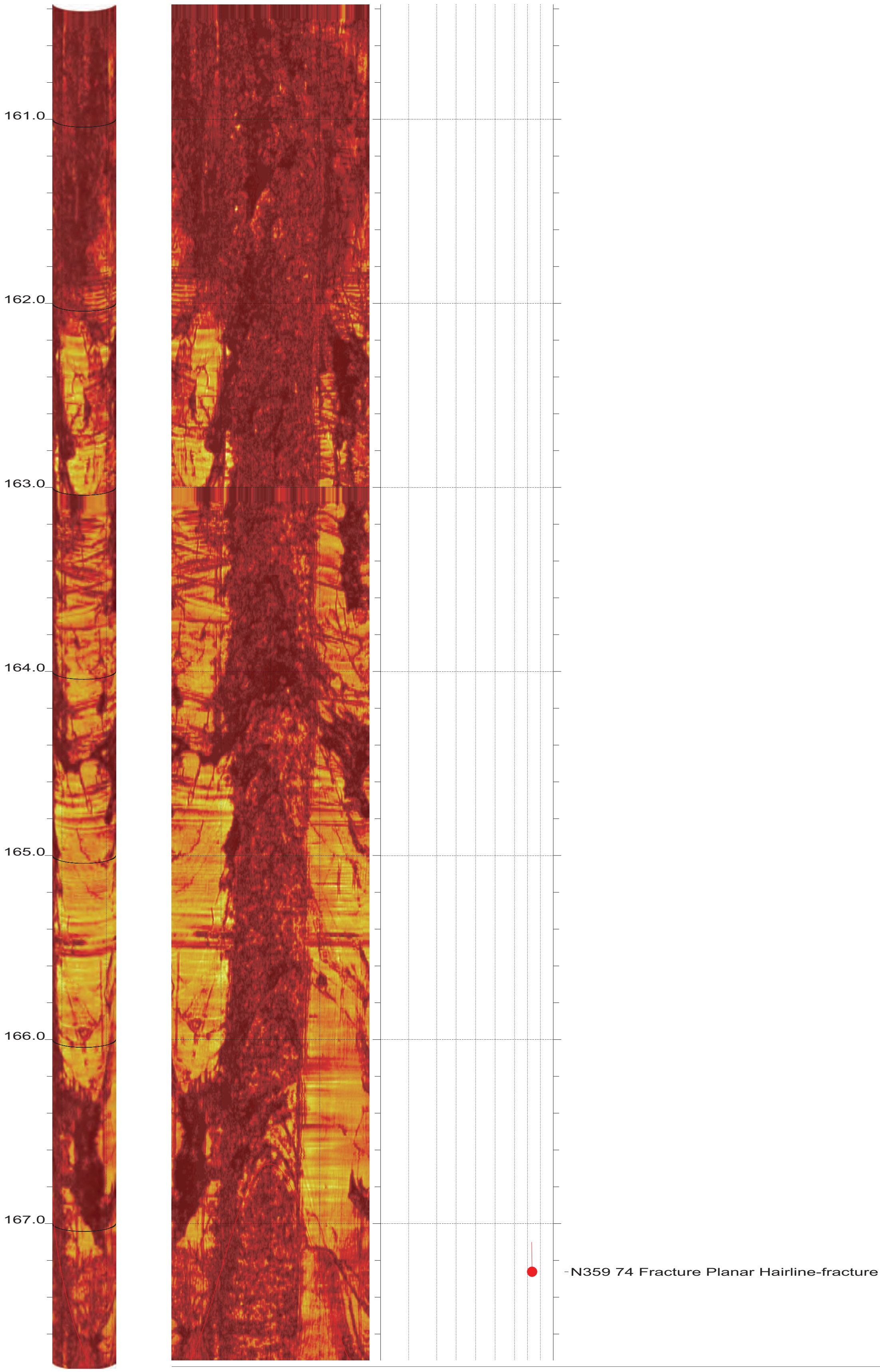
Z2-B4 153.008 to 145.640ft 21

SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 21 of 52



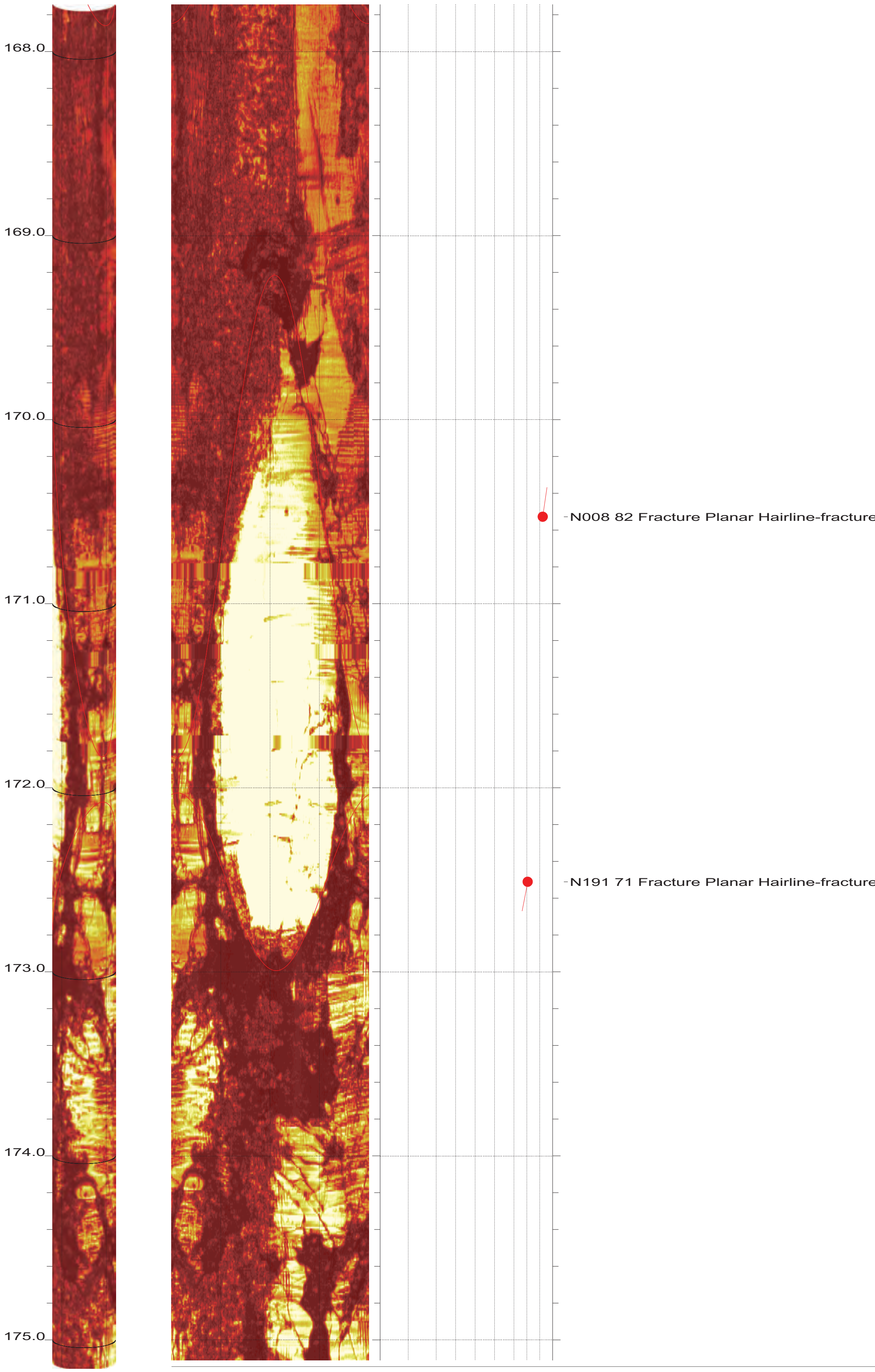
Z2-B4 160.376 to 153.008ft 22

SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 22 of 52



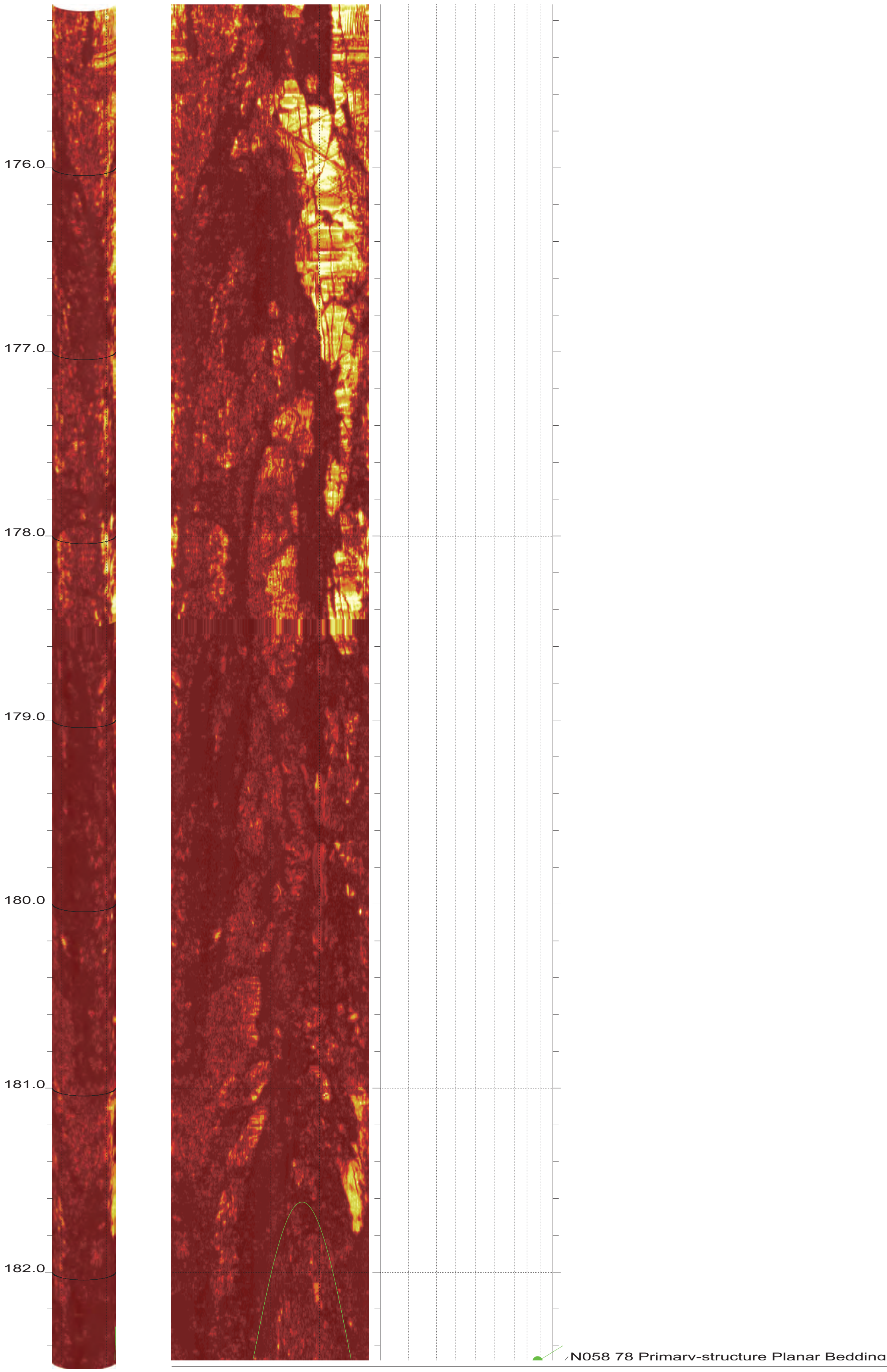
Z2-B4 167.744 to 160.376ft 23

SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 23 of 52



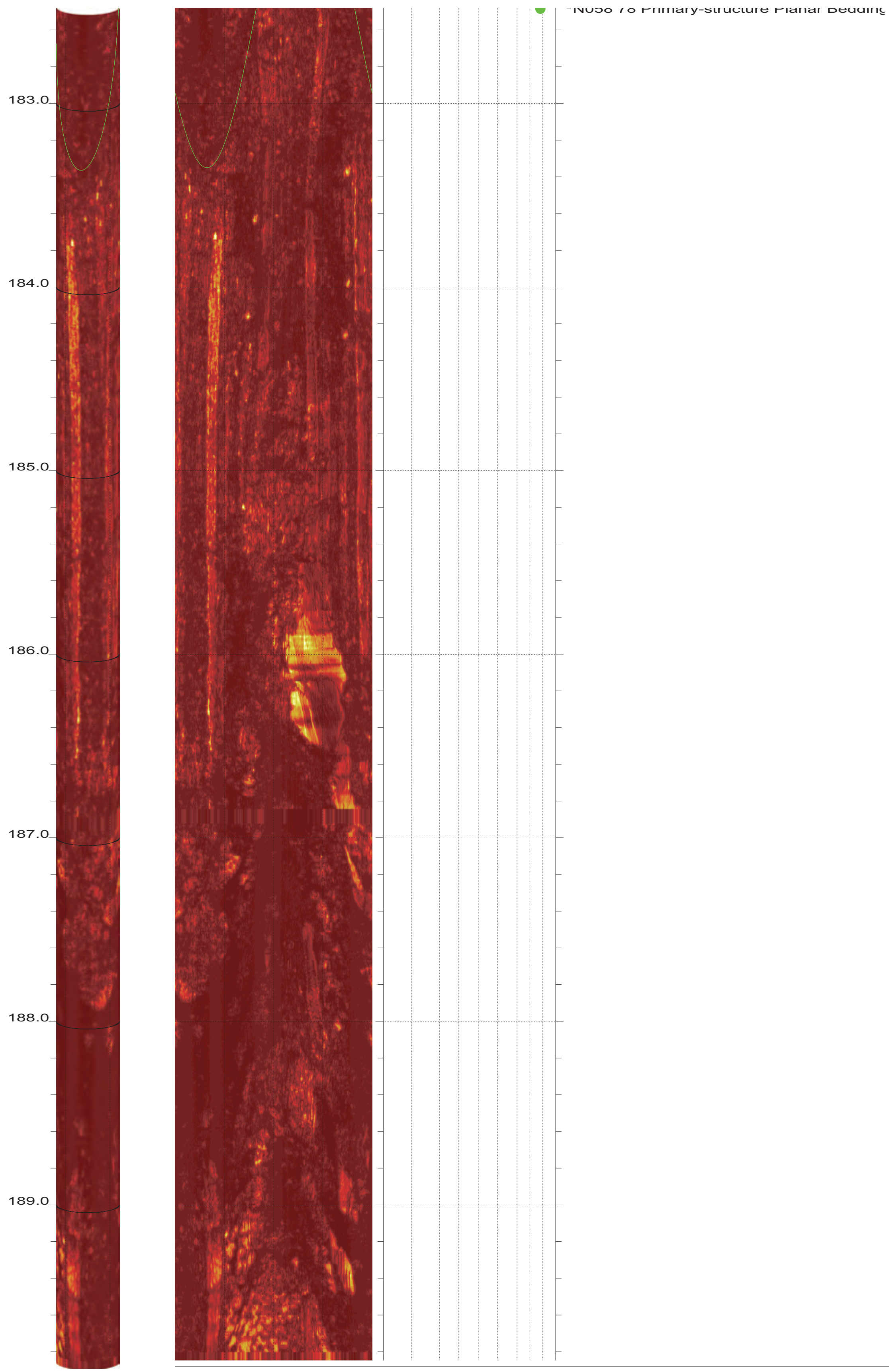
Z2-B4 175.112 to 167.744ft 24

SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 24 of 52



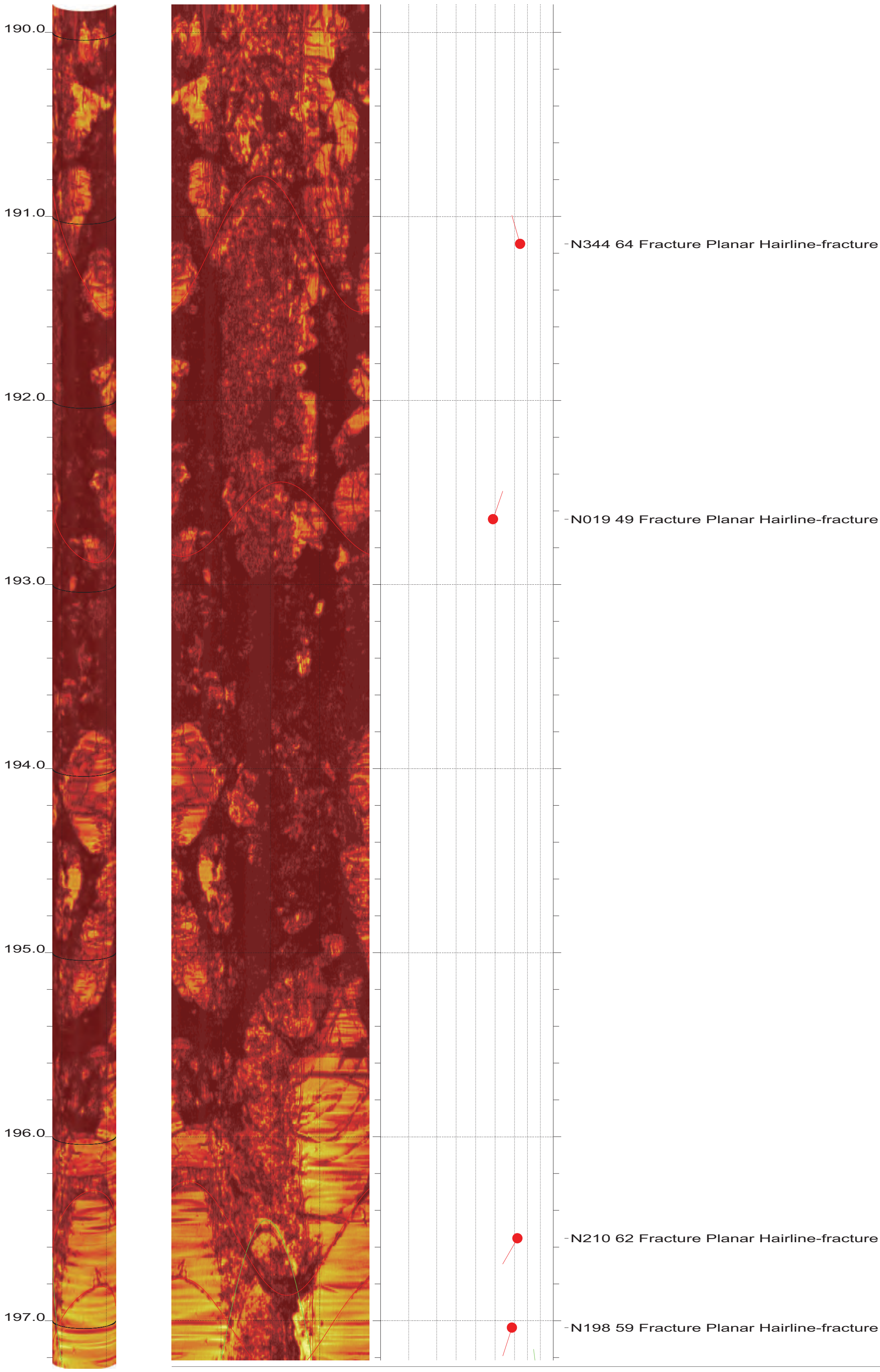
Z2-B4 182.480 to 175.112ft 25

SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 25 of 52



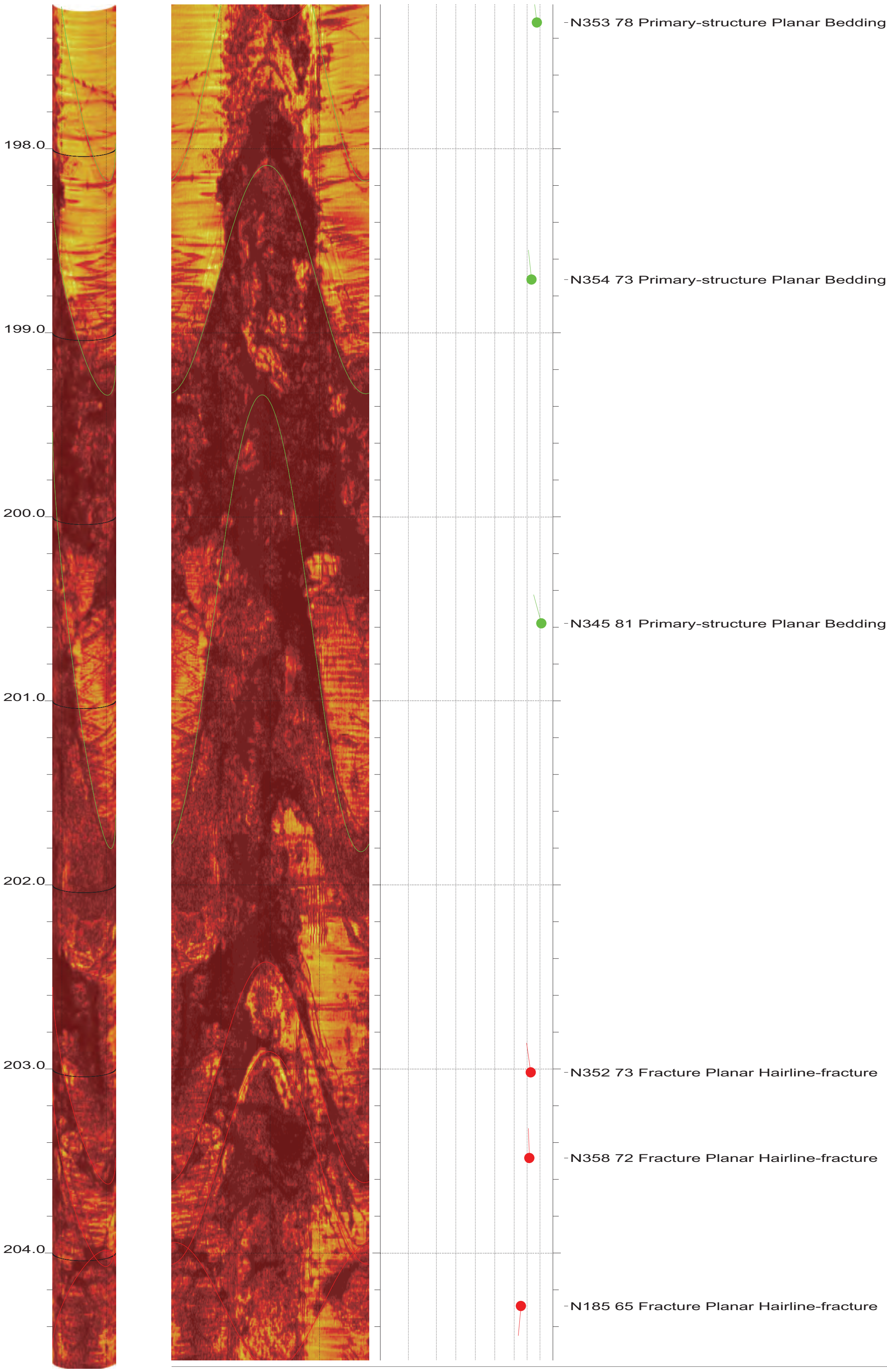
Z2-B4 189.848 to 182.480ft 26

SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 26 of 52



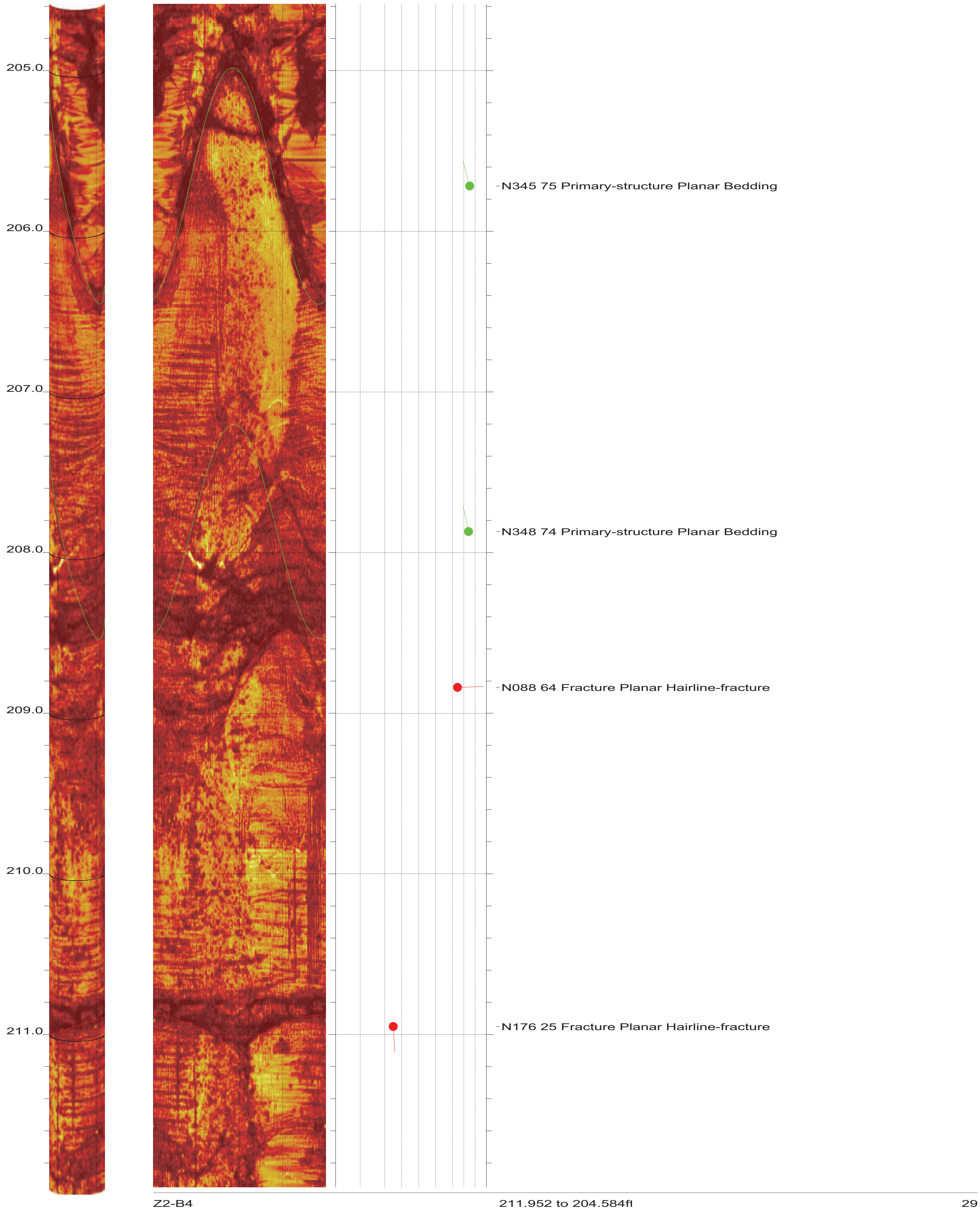
Z2-B4 197.216 to 189.848ft 27

SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 27 of 52

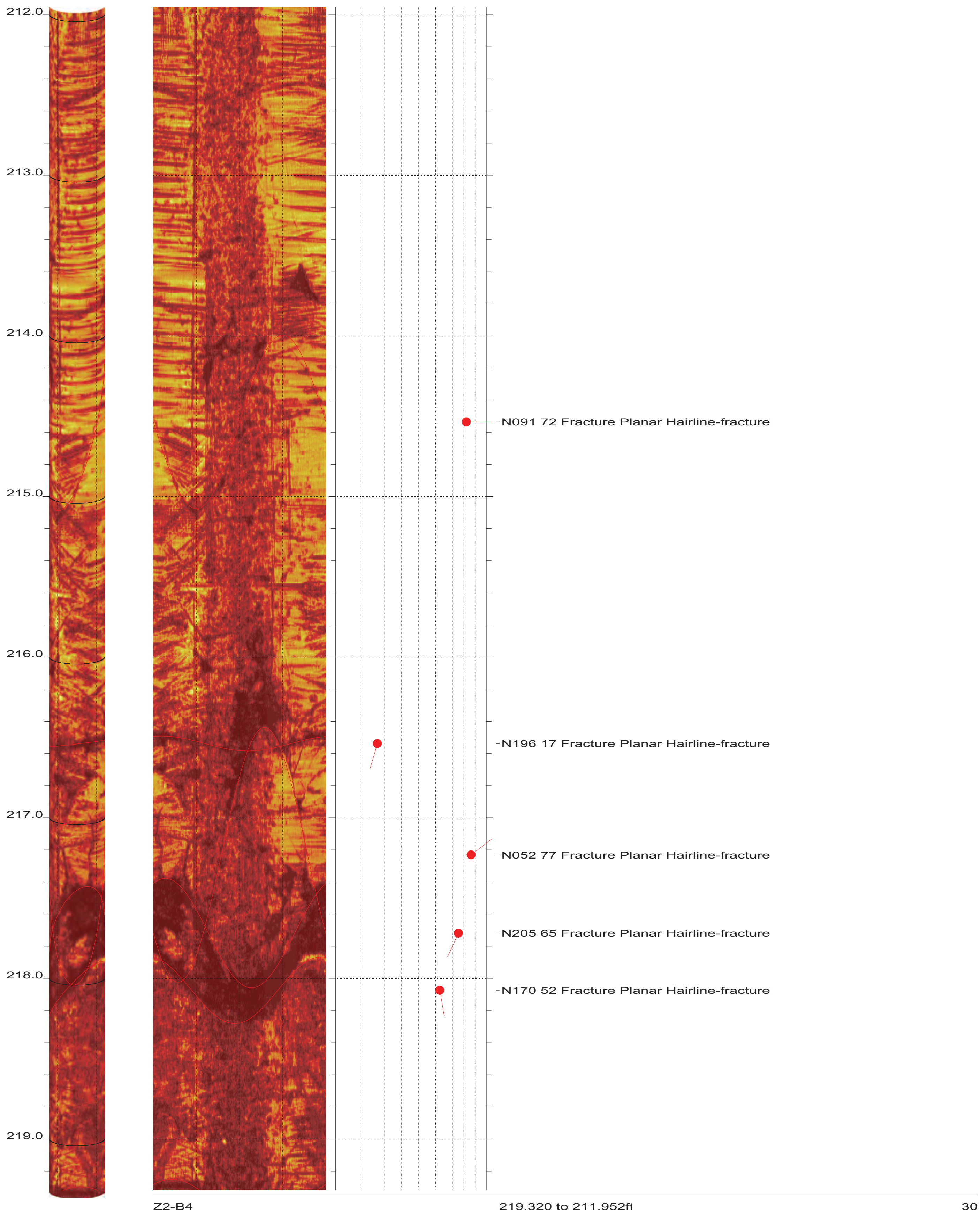


Z2-B4 204.584 to 197.216ft 28

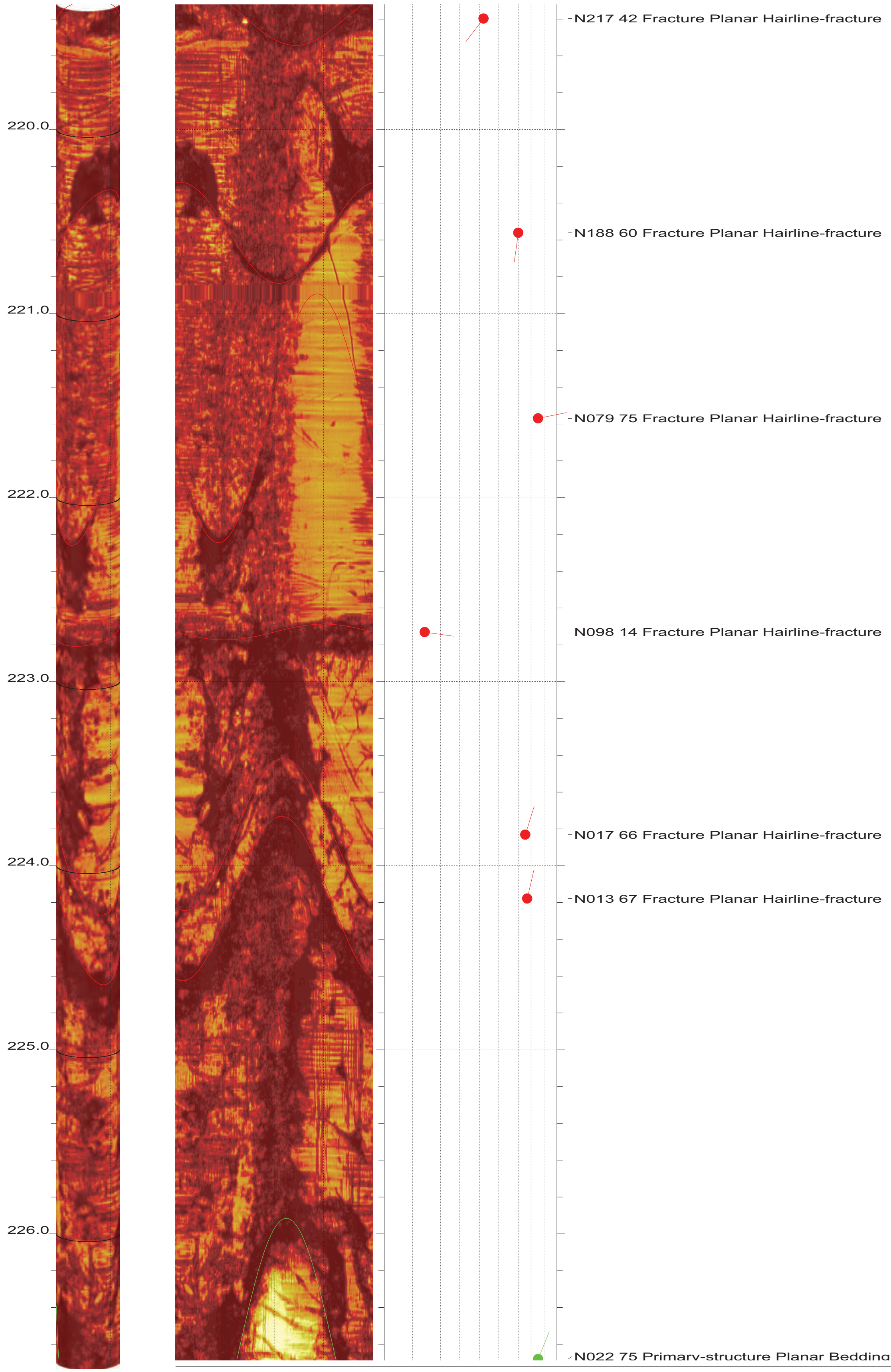
SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 28 of 52



SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 29 of 52

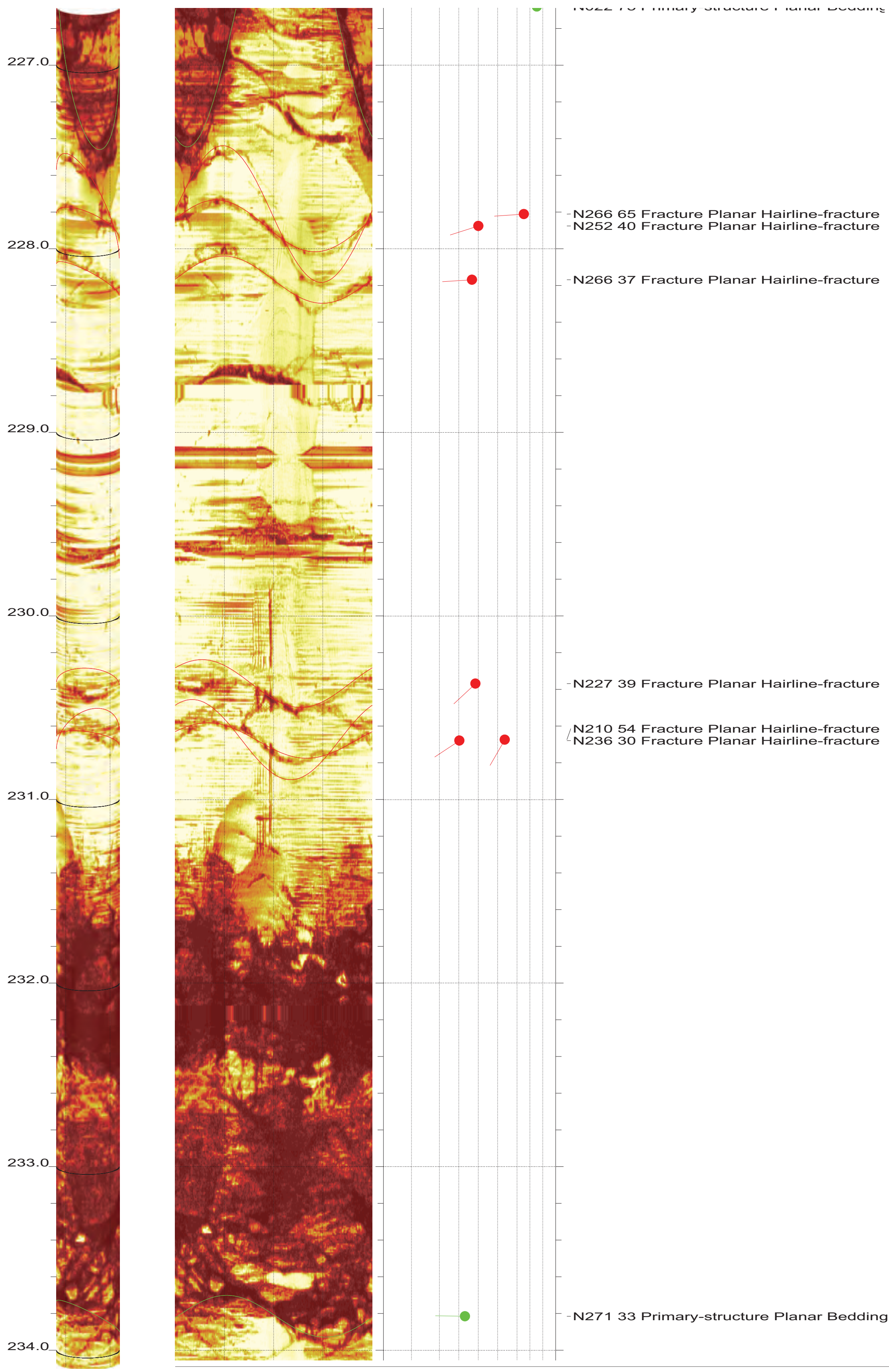


SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 30 of 52



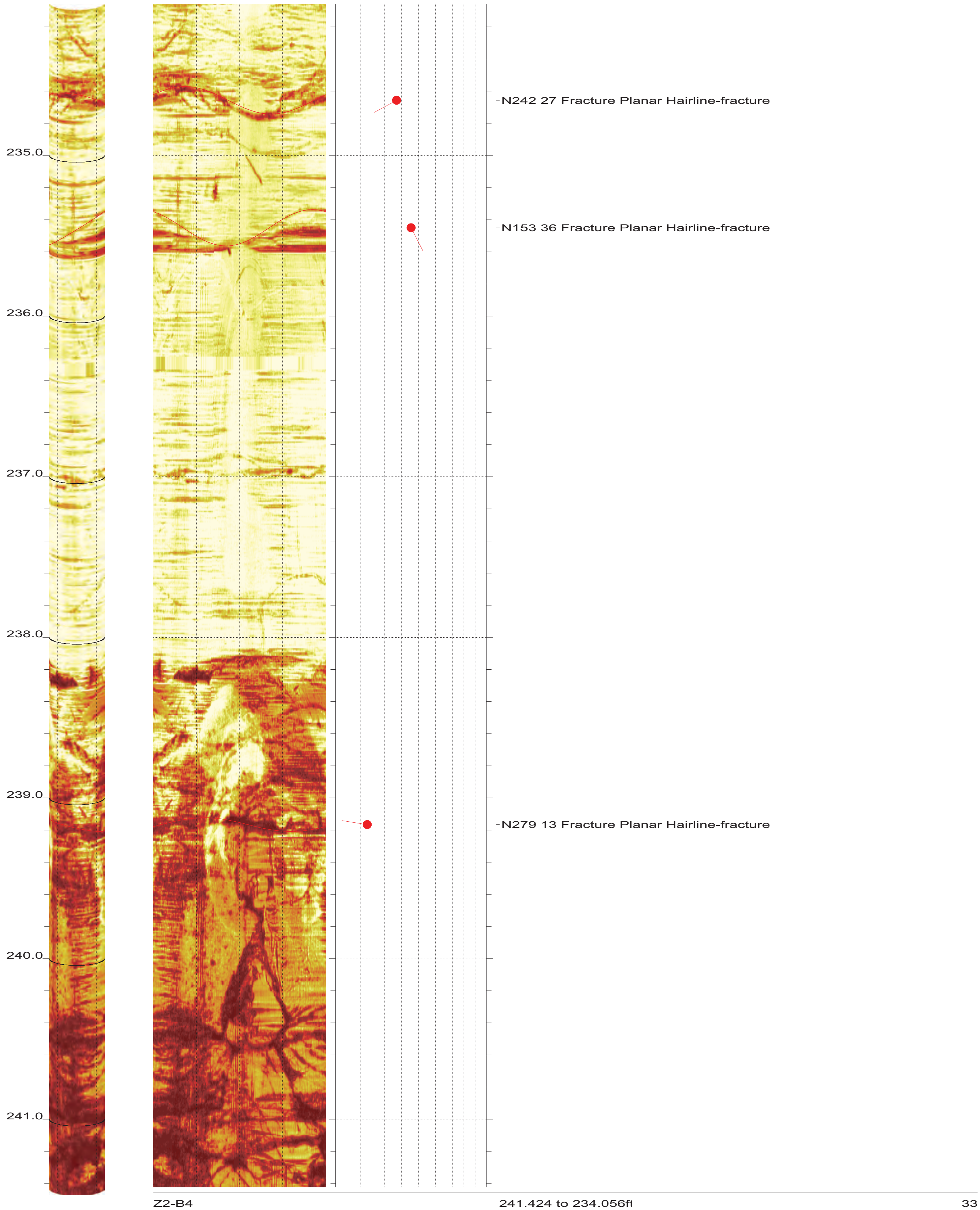
Z2-B4 226.688 to 219.320ft 31

SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 31 of 52

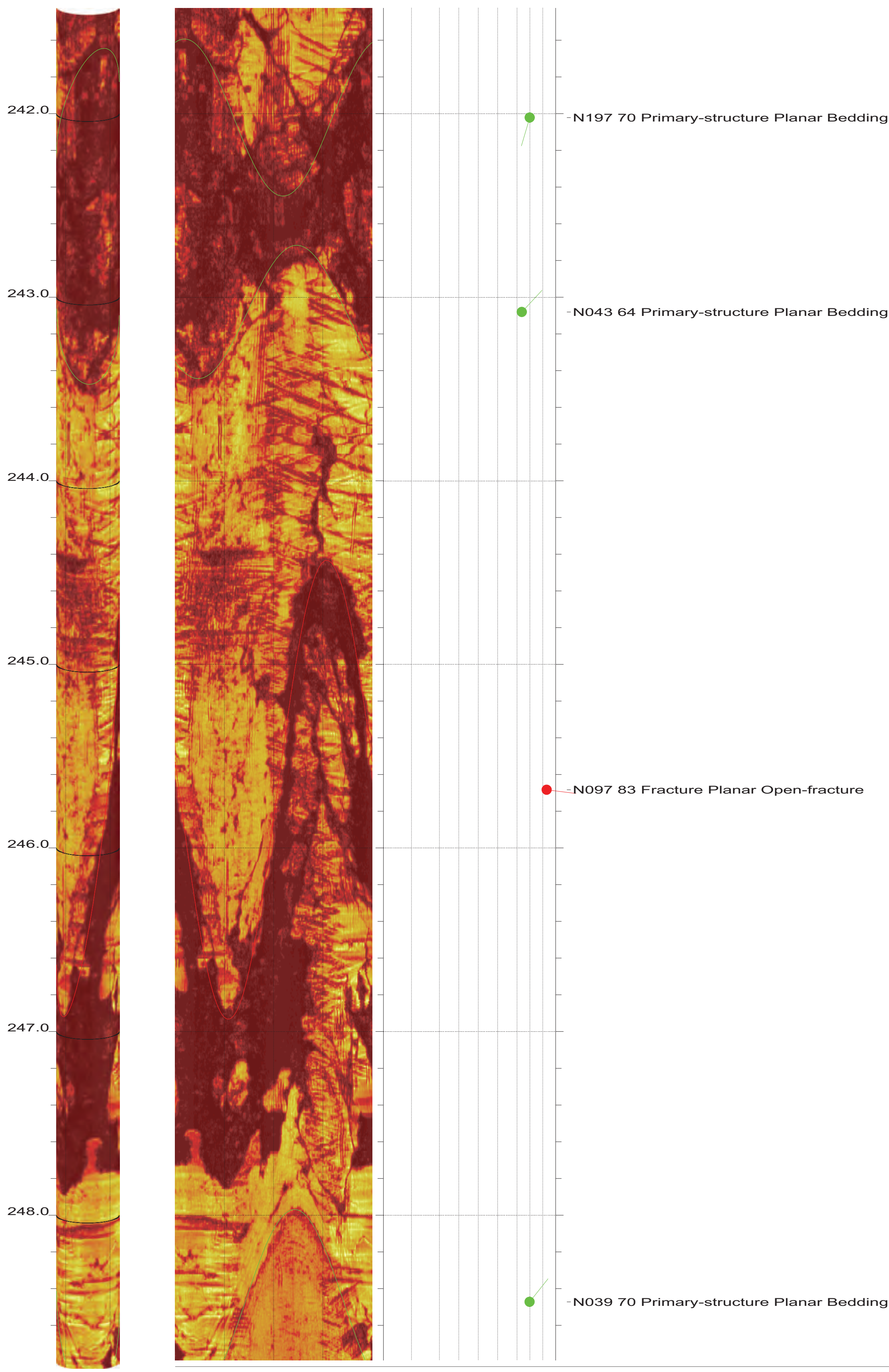


Z2-B4 234.056 to 226.688ft 32

SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 32 of 52

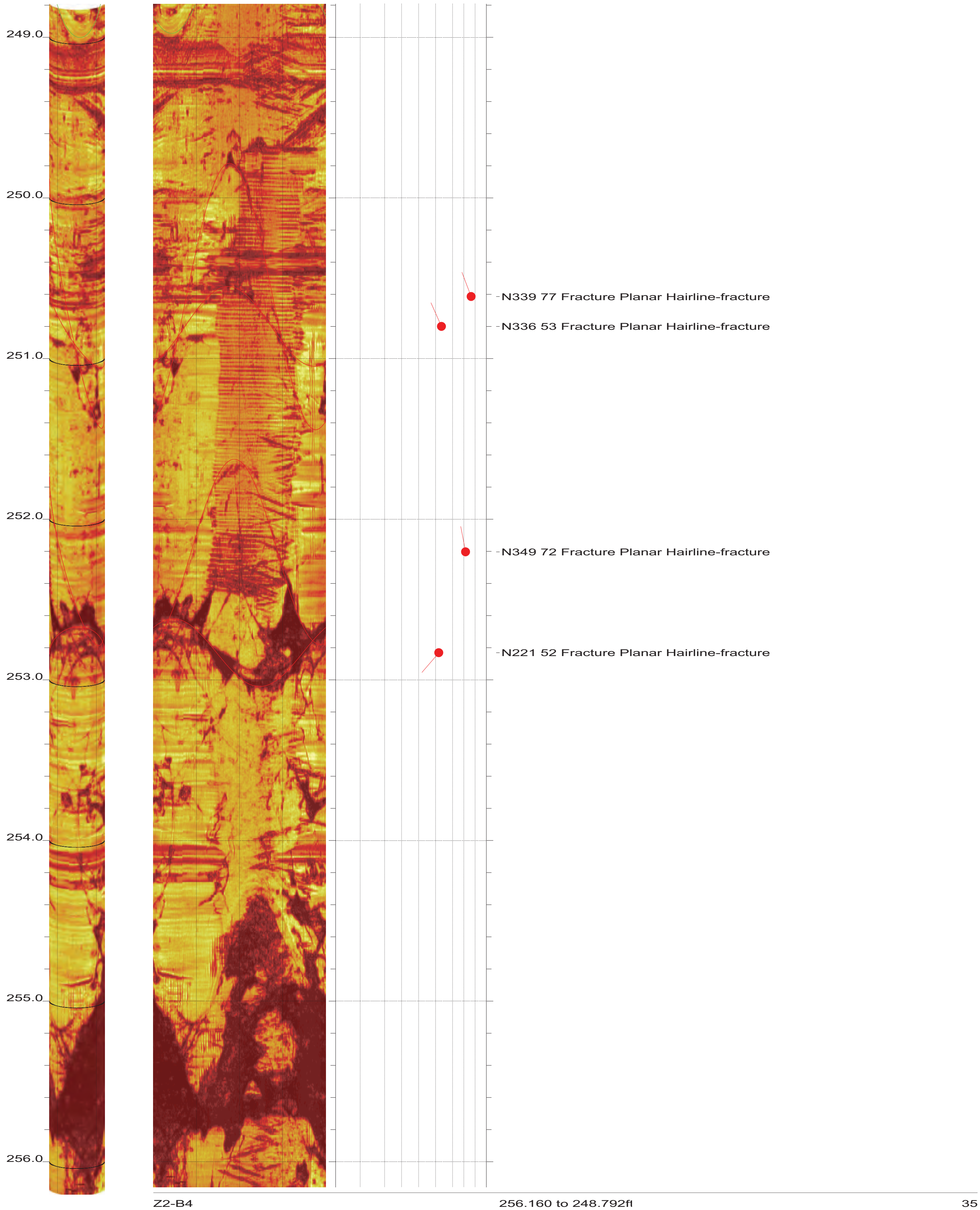


SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 33 of 52

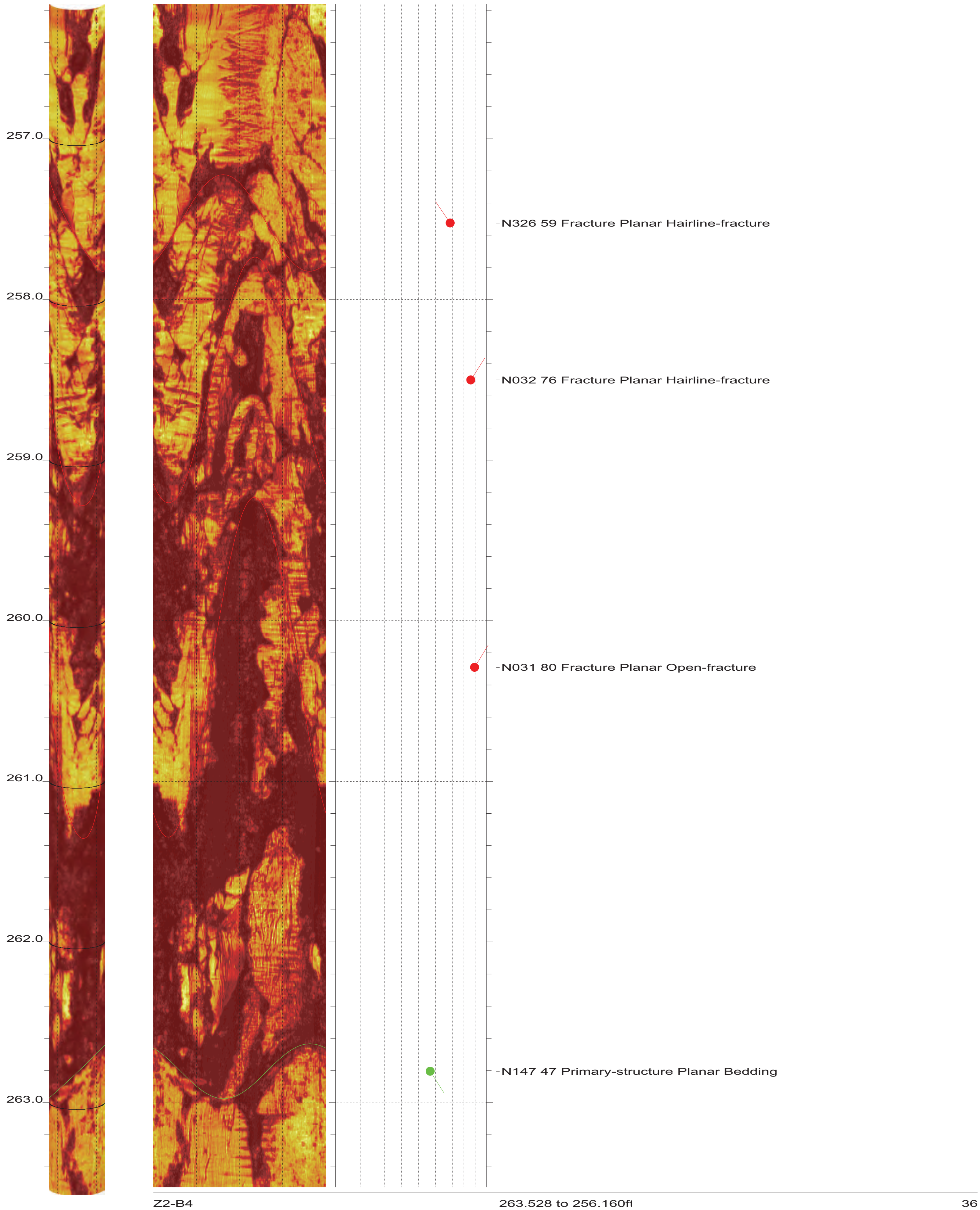


Z2-B4 248.792 to 241.424ft 34

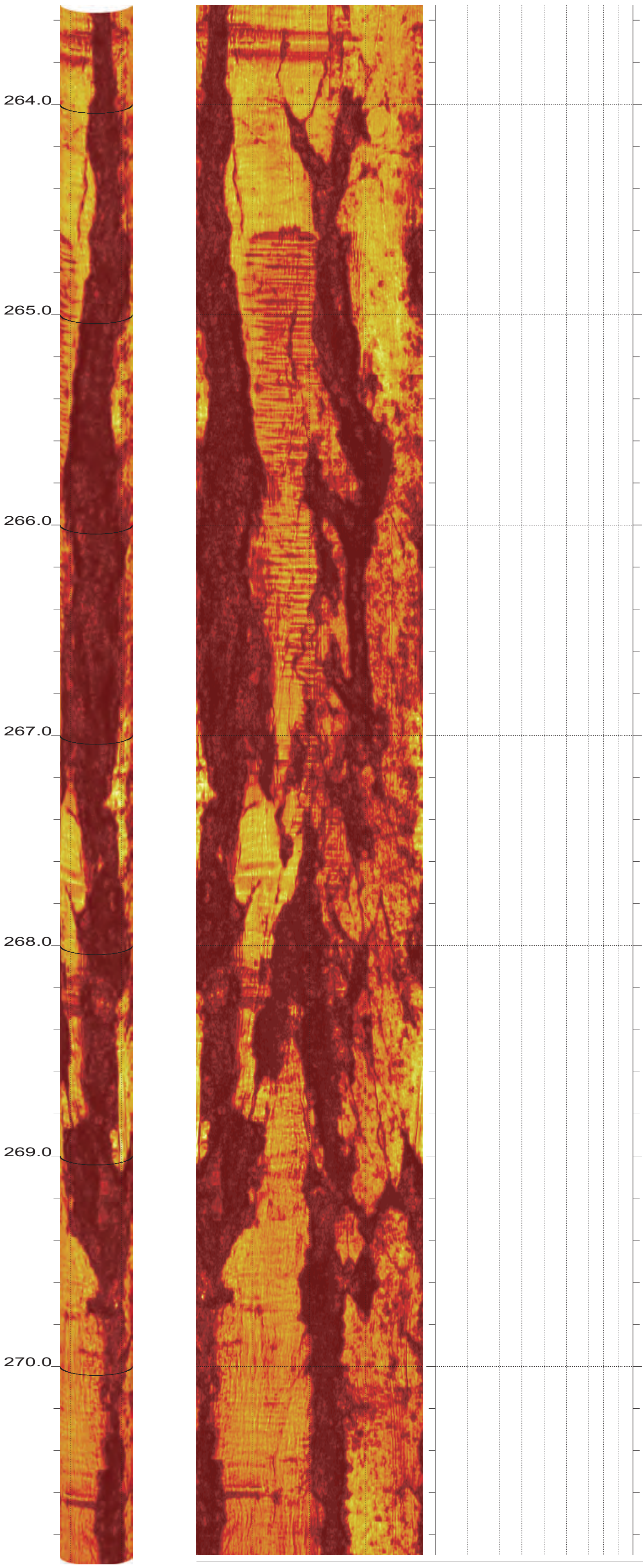
SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 34 of 52



SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 35 of 52

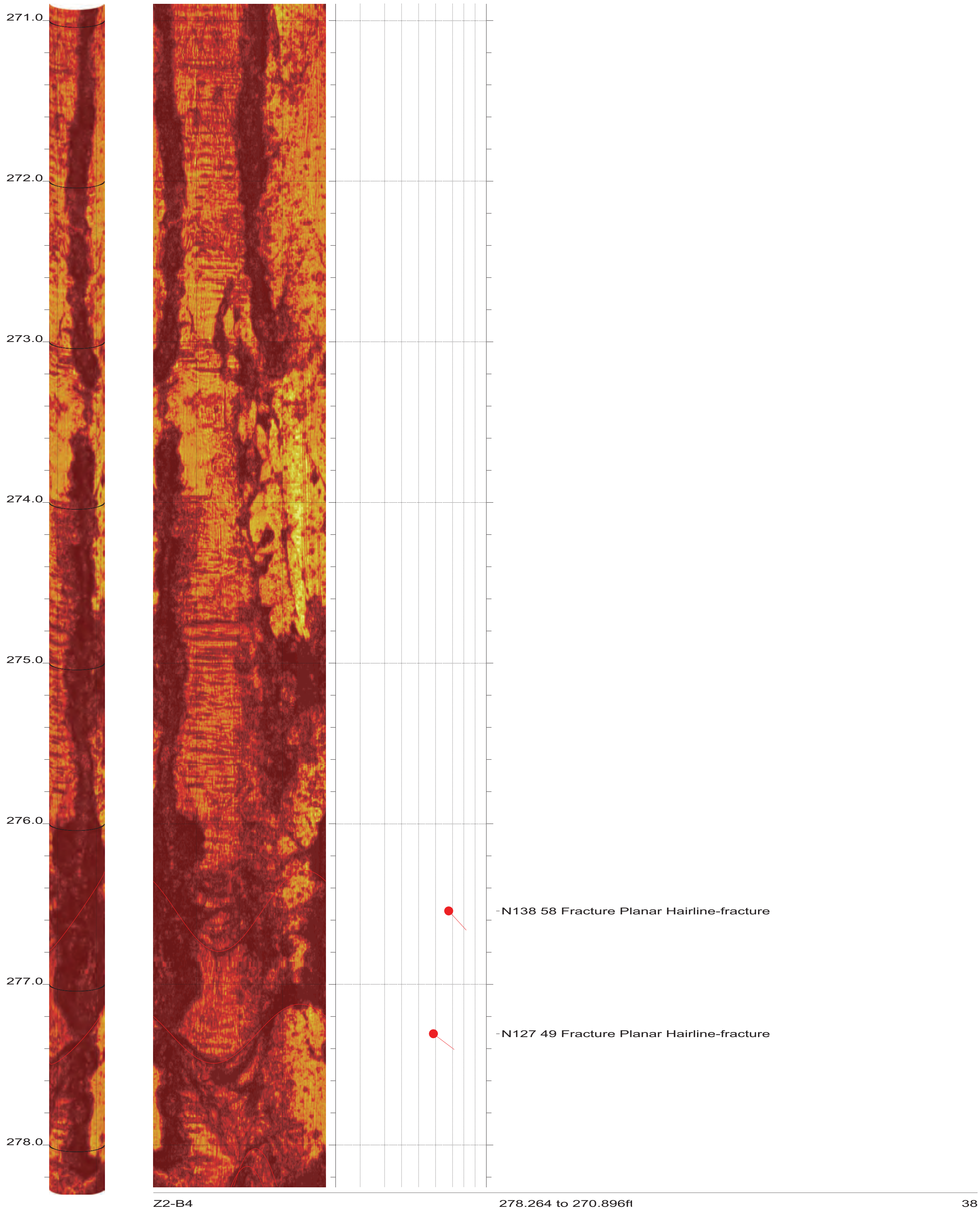


SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 36 of 52

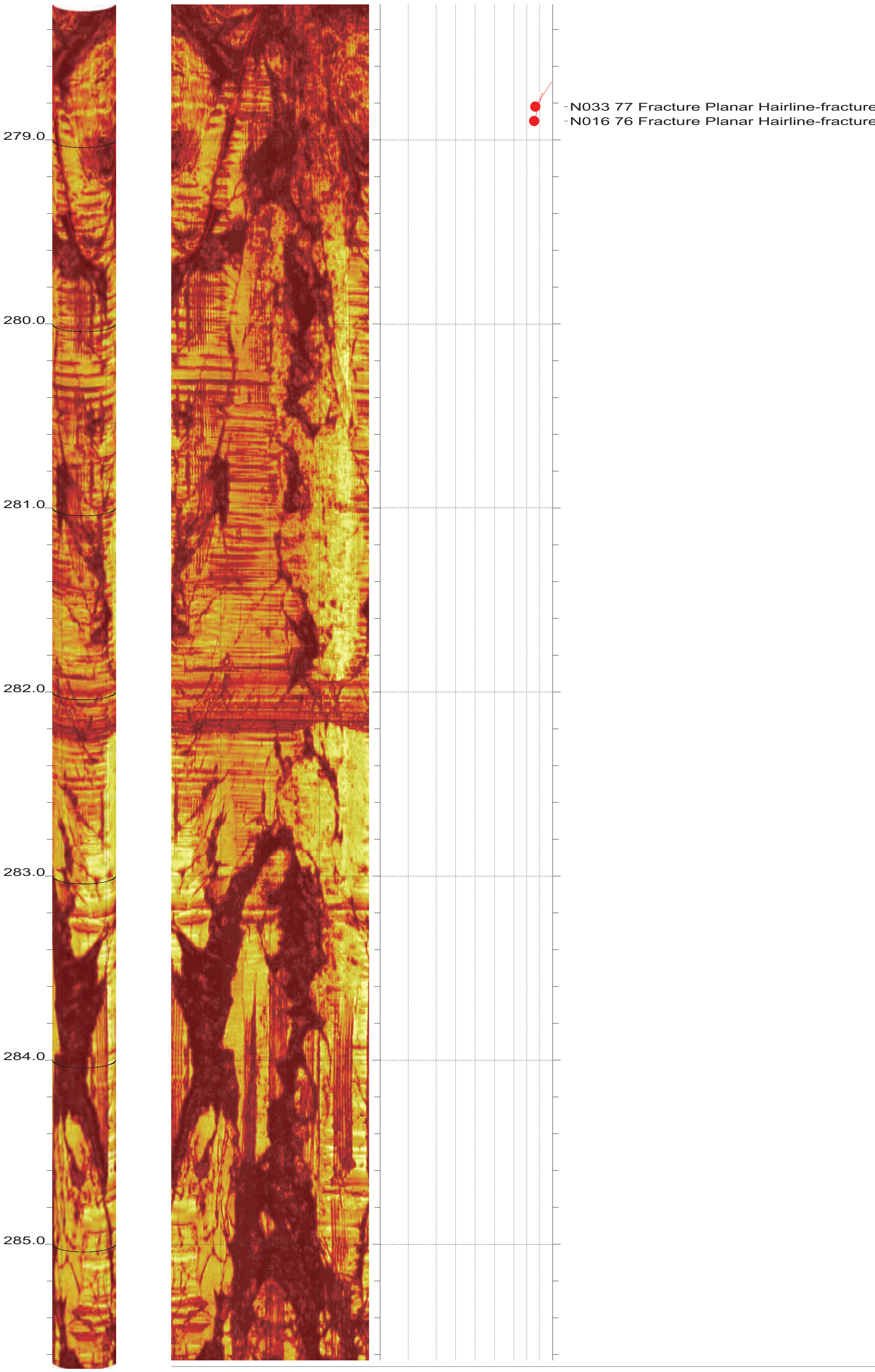


Z2-B4 270.896 to 263.528ft 37

SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 37 of 52

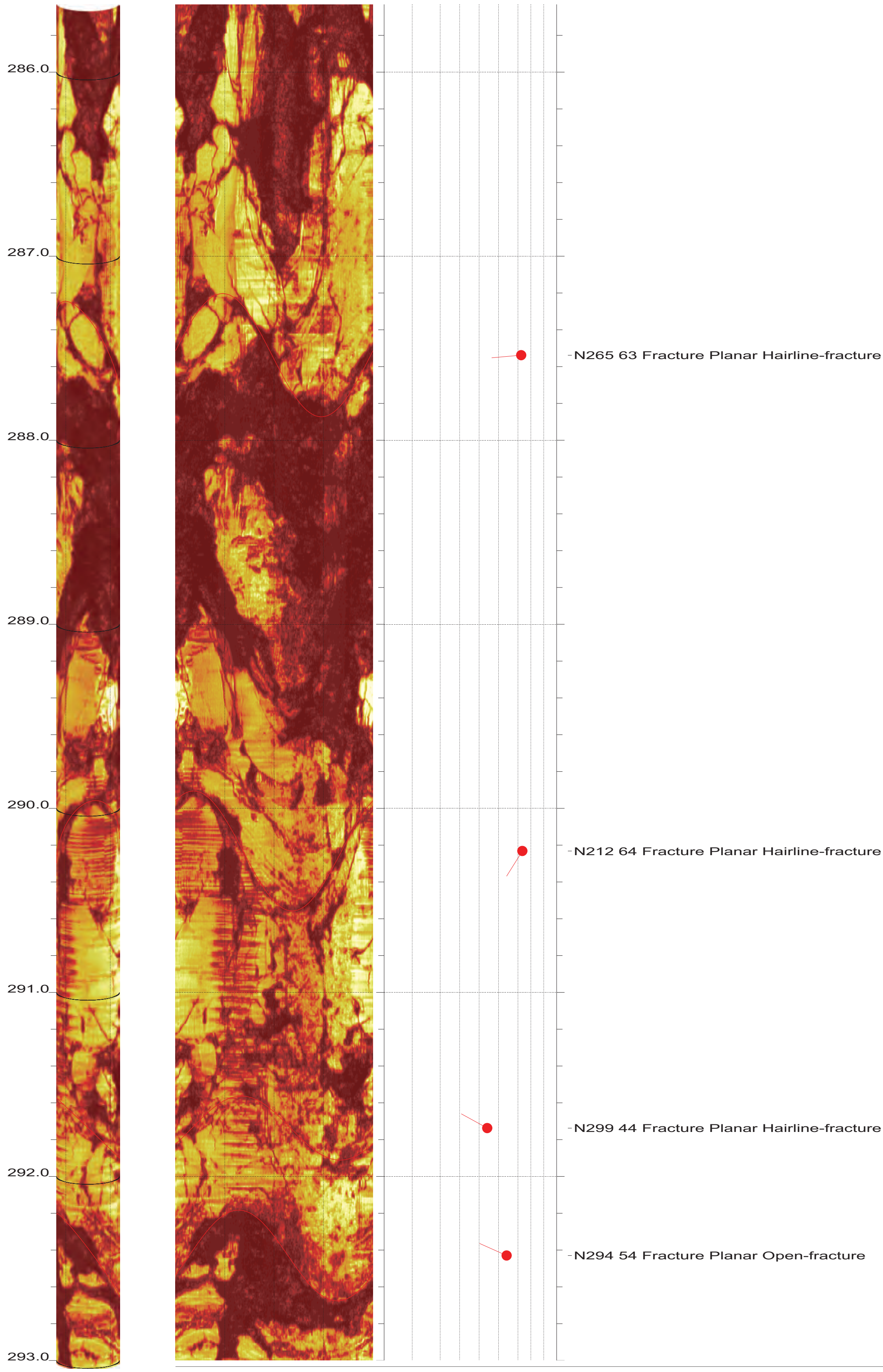


SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 38 of 52



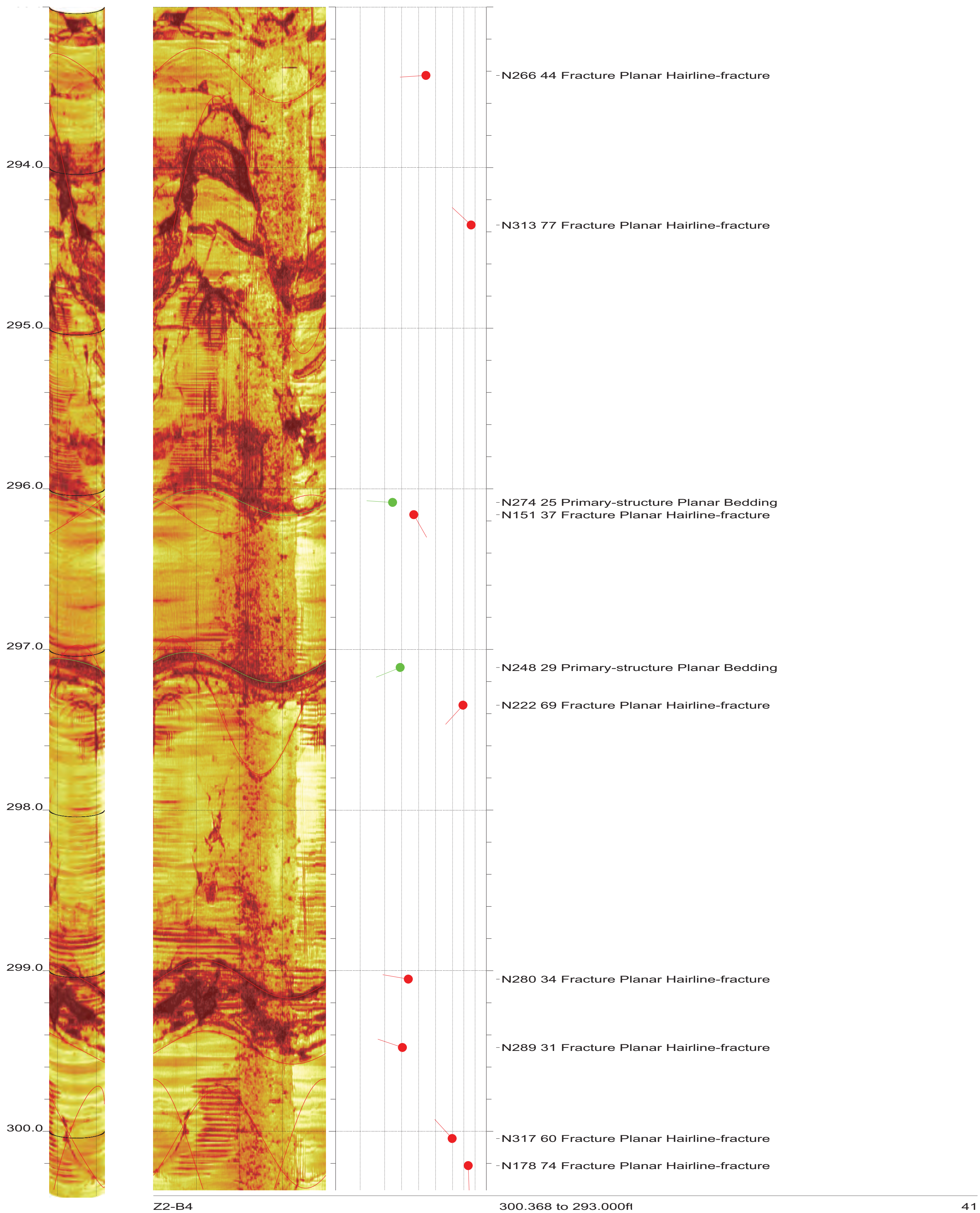
Z2-B4 285.632 to 278.264ft 39

SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 39 of 52

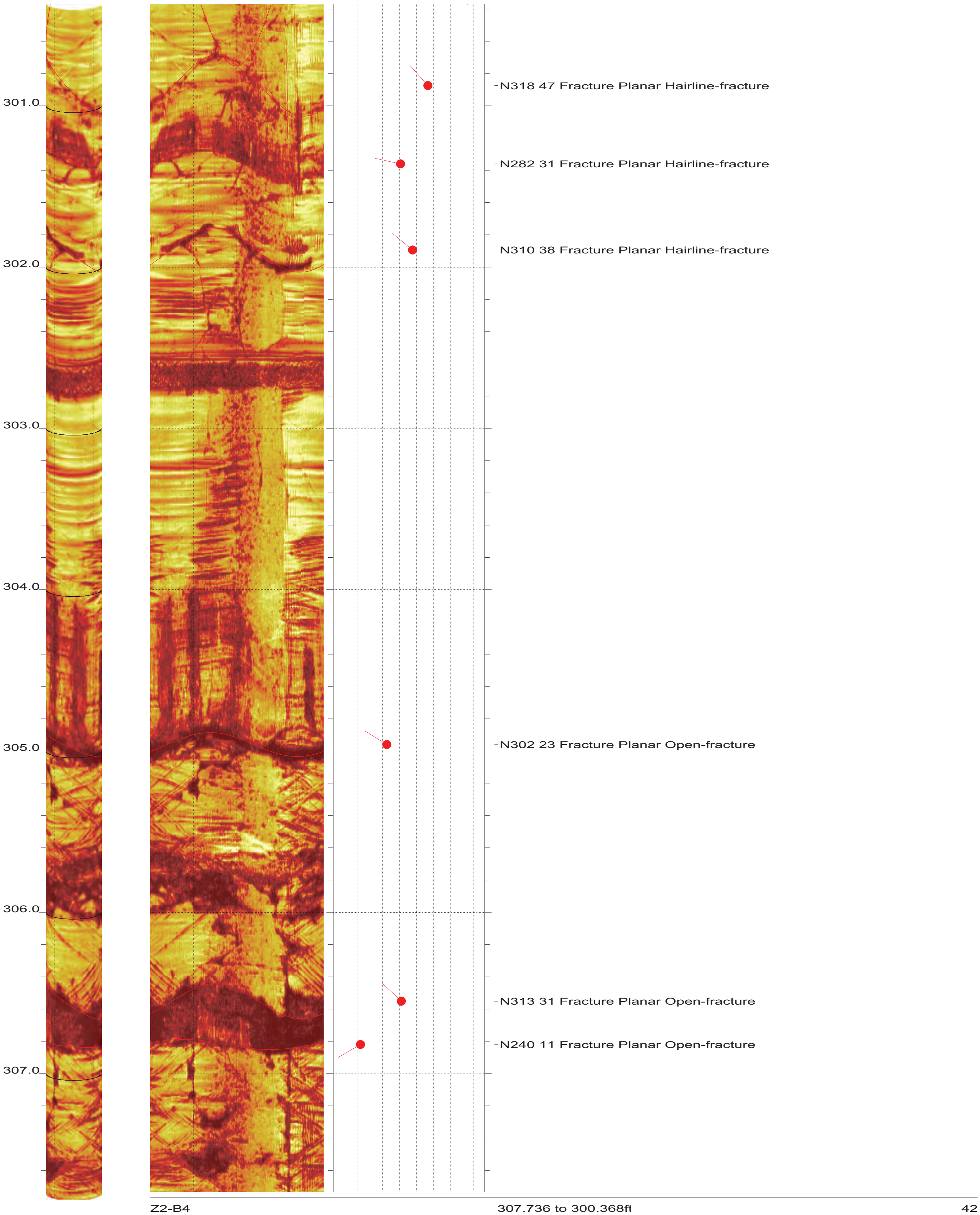


Z2-B4 293.000 to 285.632ft 40

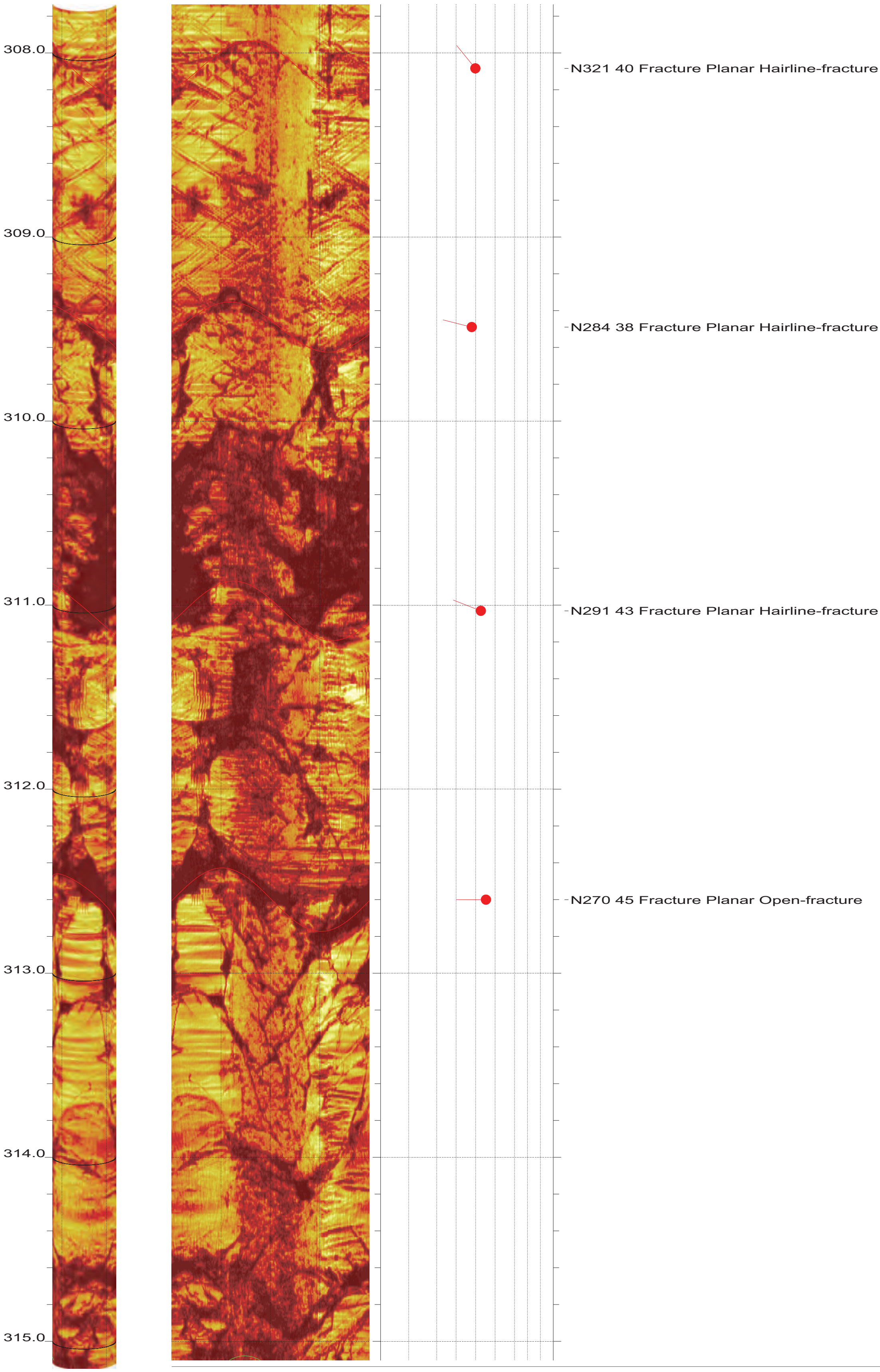
SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 40 of 52



SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 41 of 52

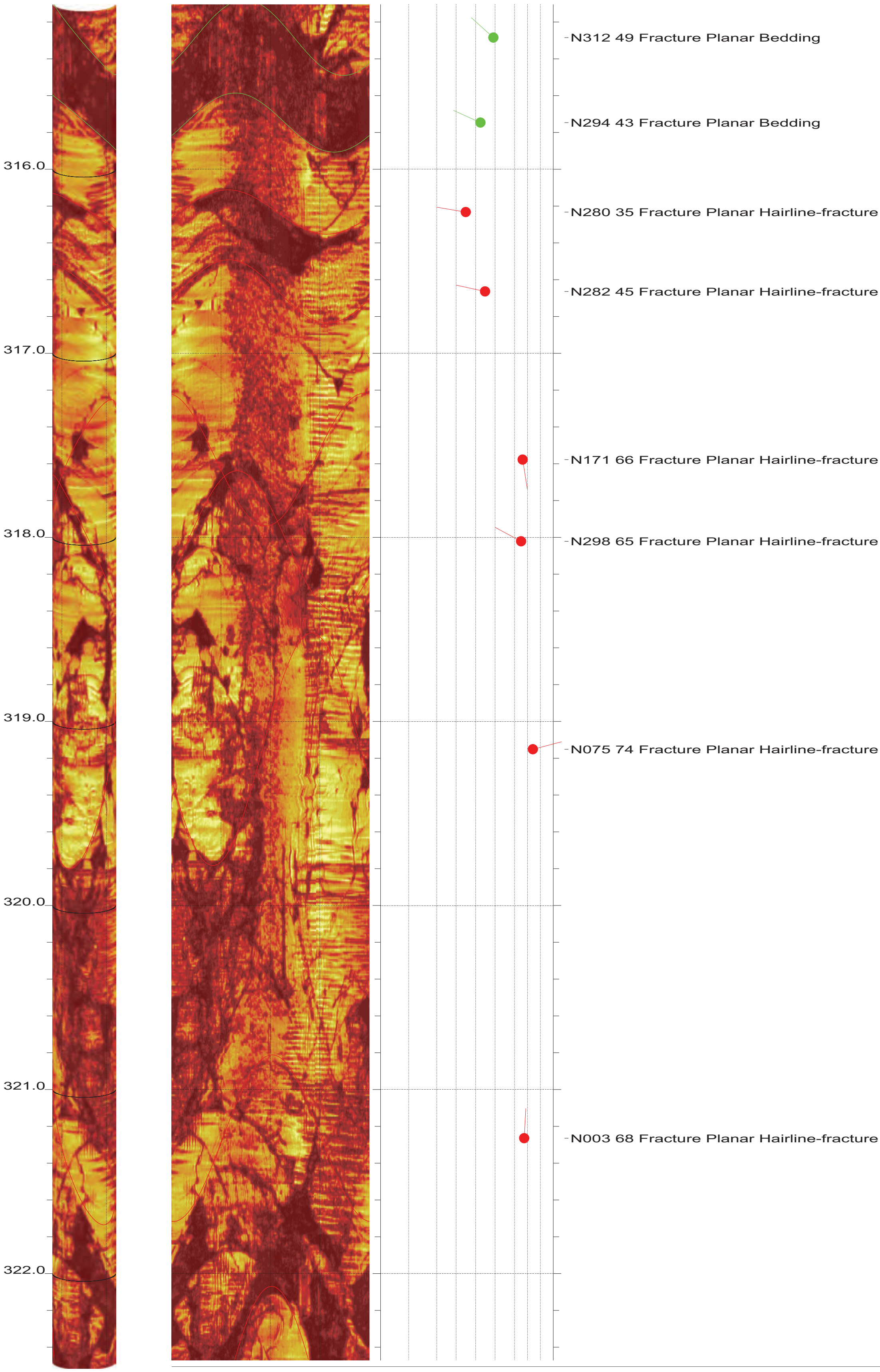


SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 42 of 52



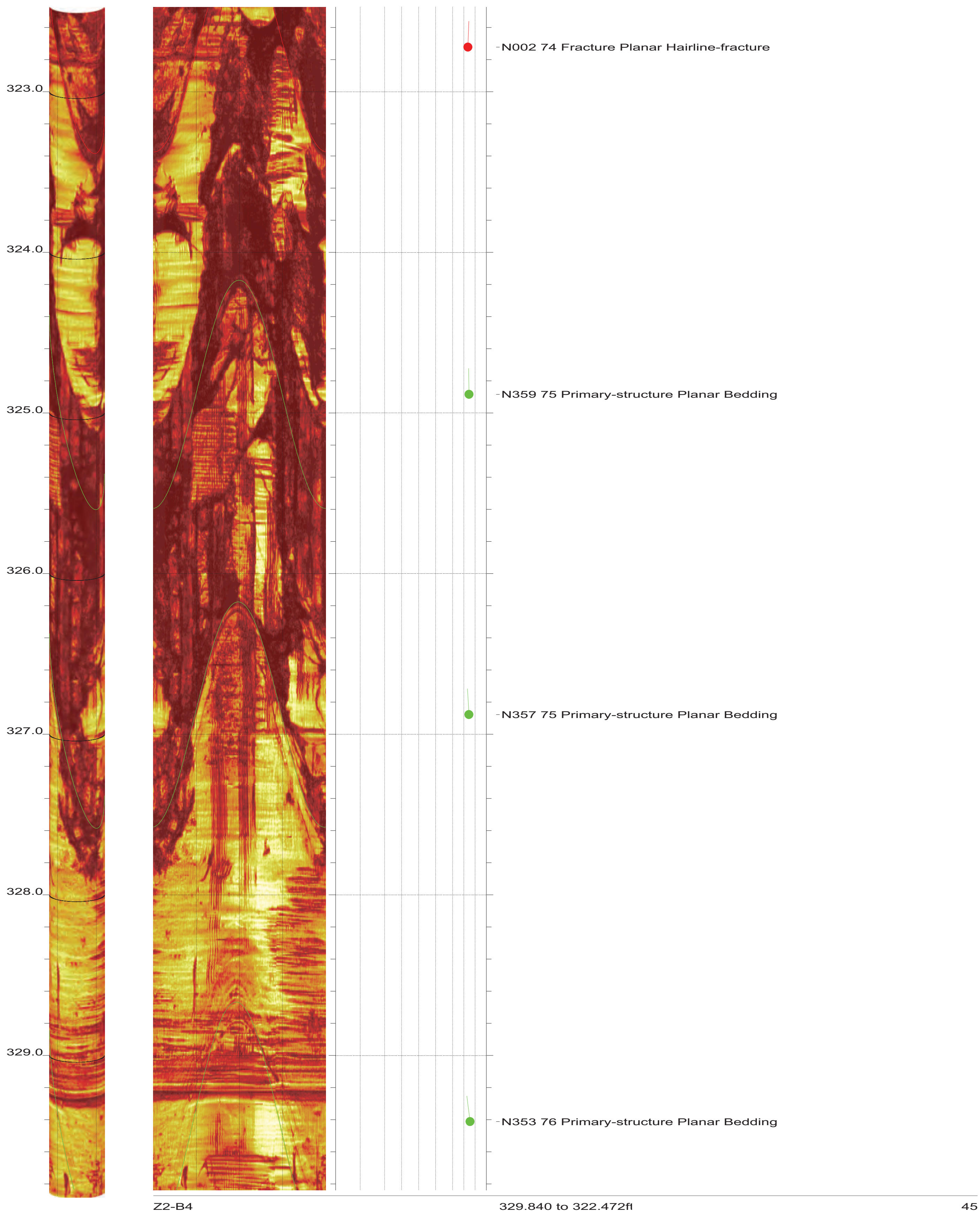
Z2-B4 315.104 to 307.736ft 43

SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 43 of 52

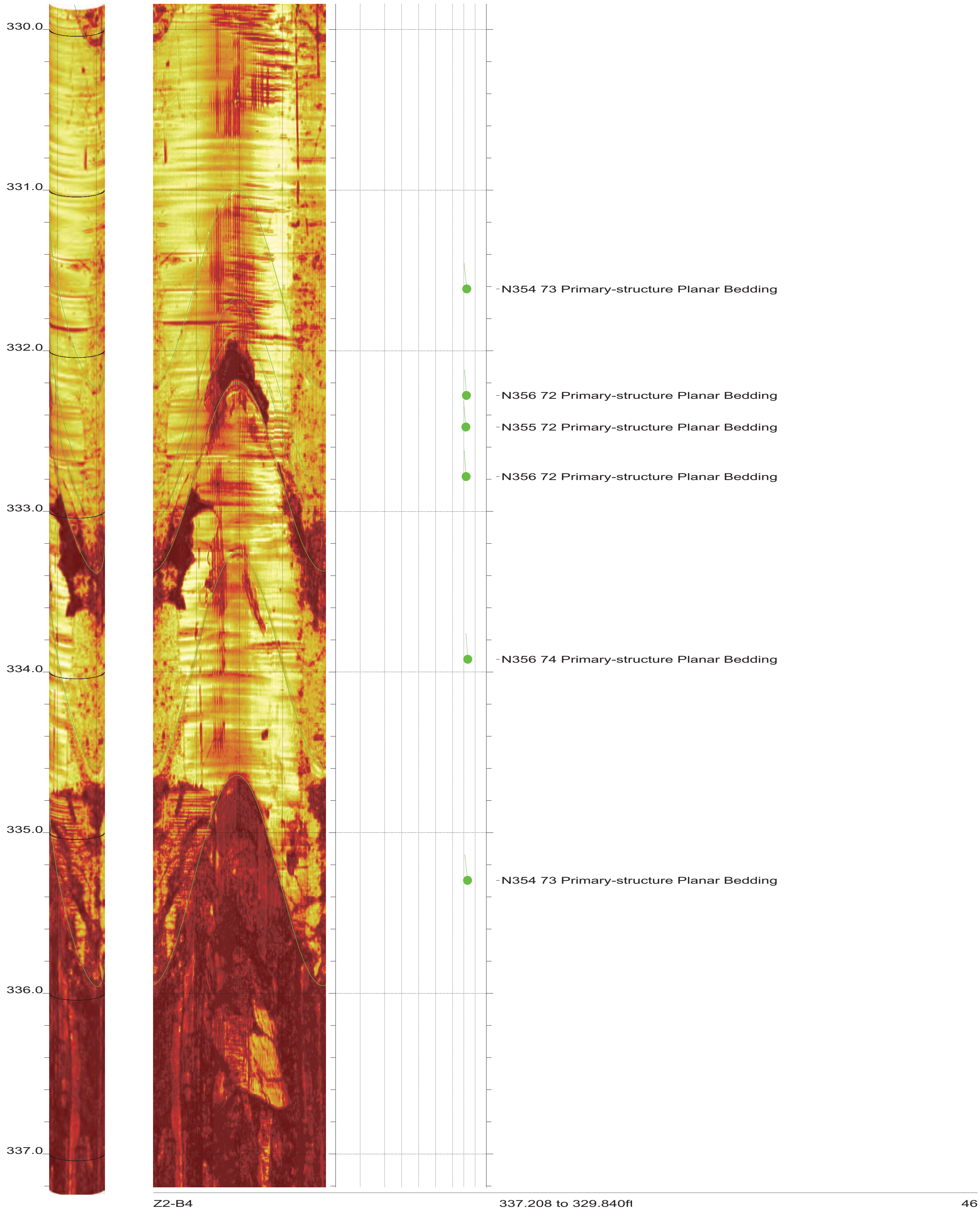


Z2-B4 322.472 to 315.104ft 44

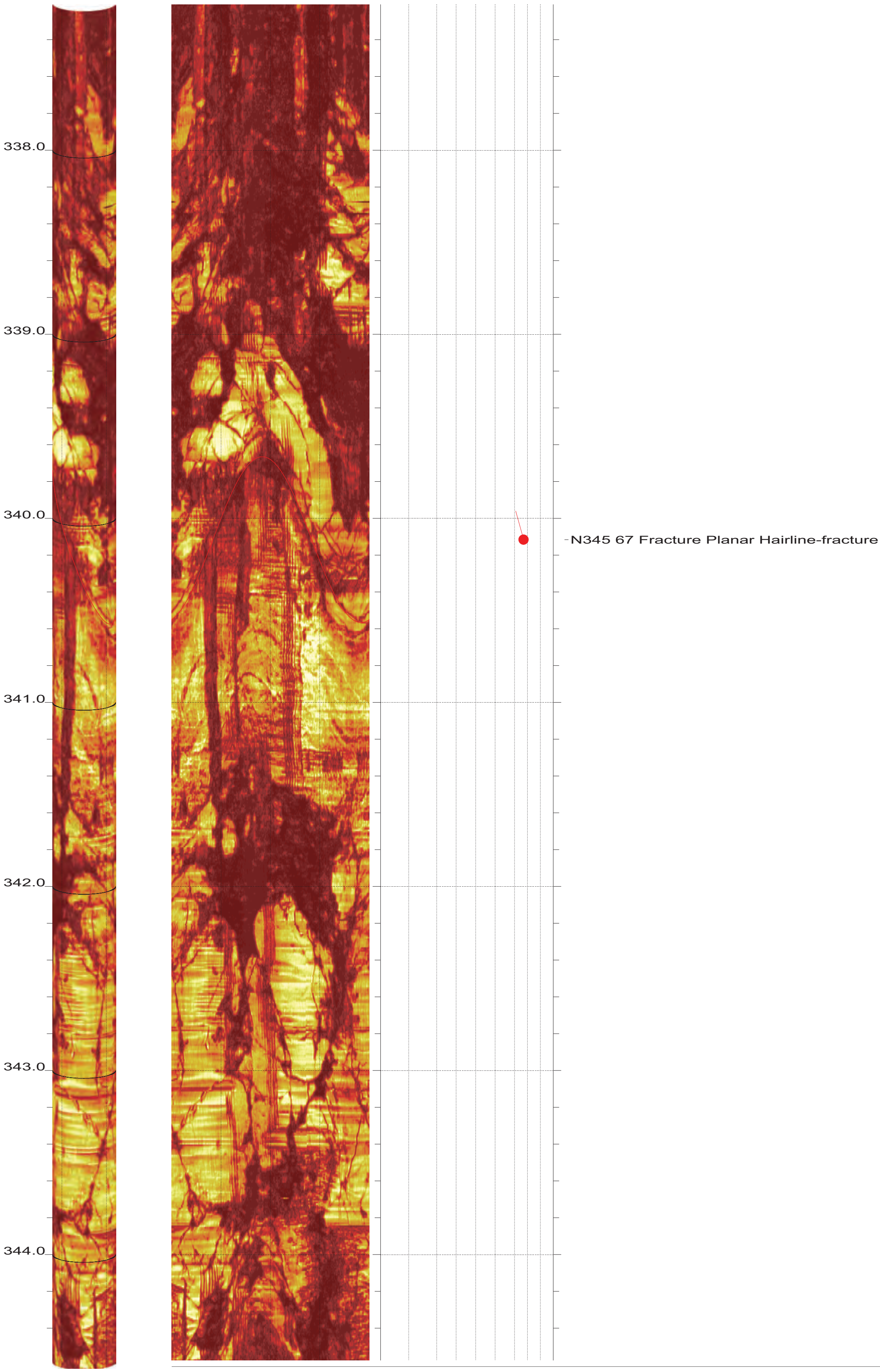
SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 44 of 52



SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 45 of 52

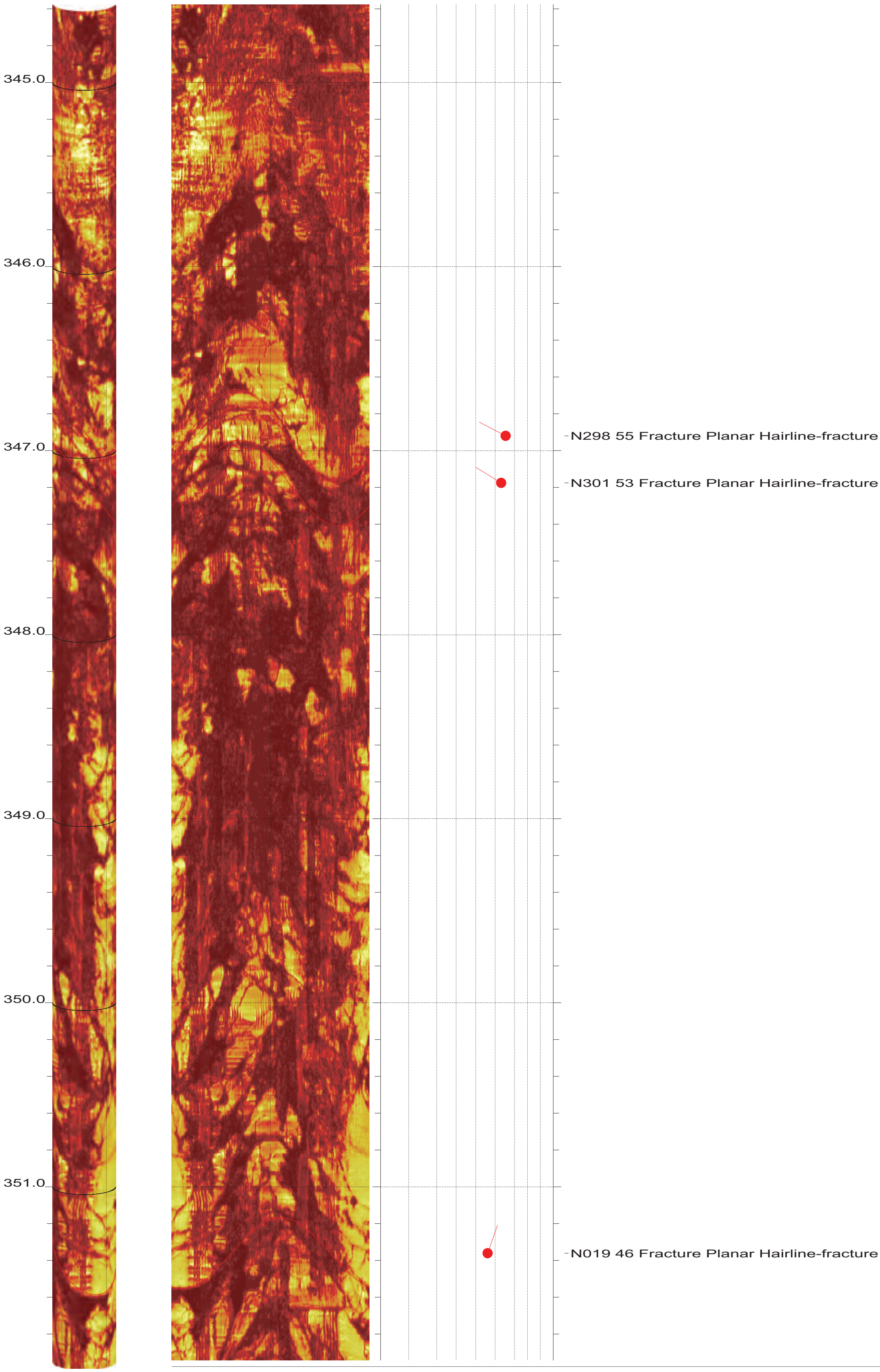


SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 46 of 52



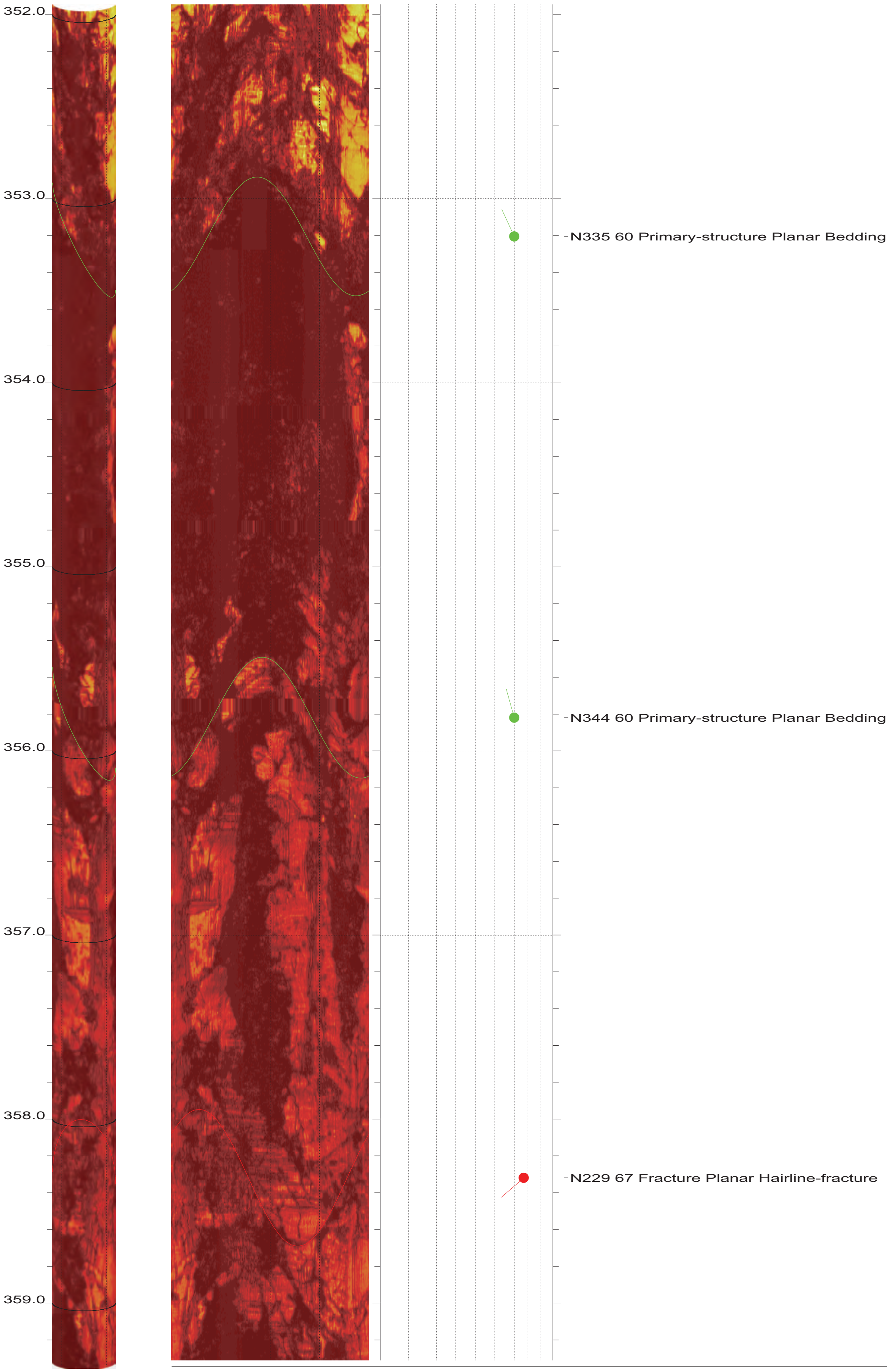
Z2-B4 344.576 to 337.208ft 47

SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 47 of 52



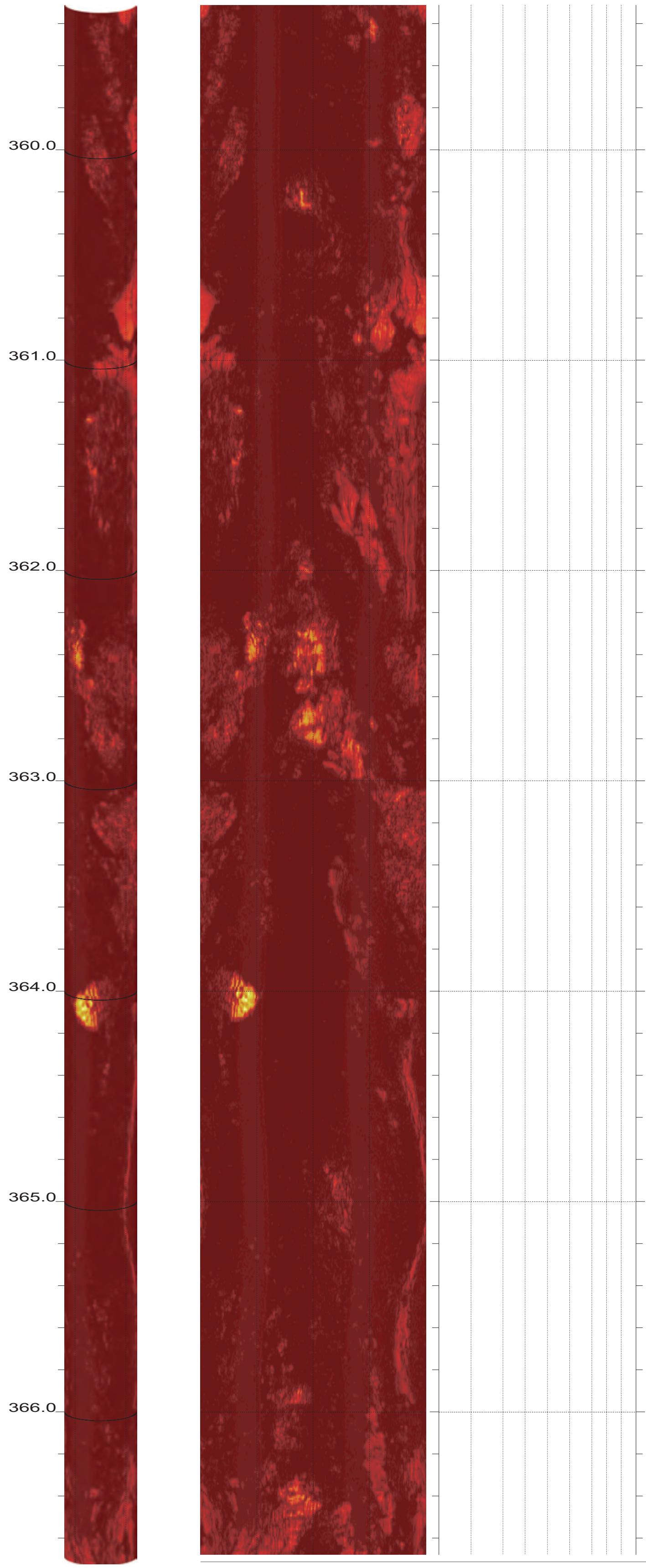
Z2-B4 351.944 to 344.576ft 48

SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 48 of 52



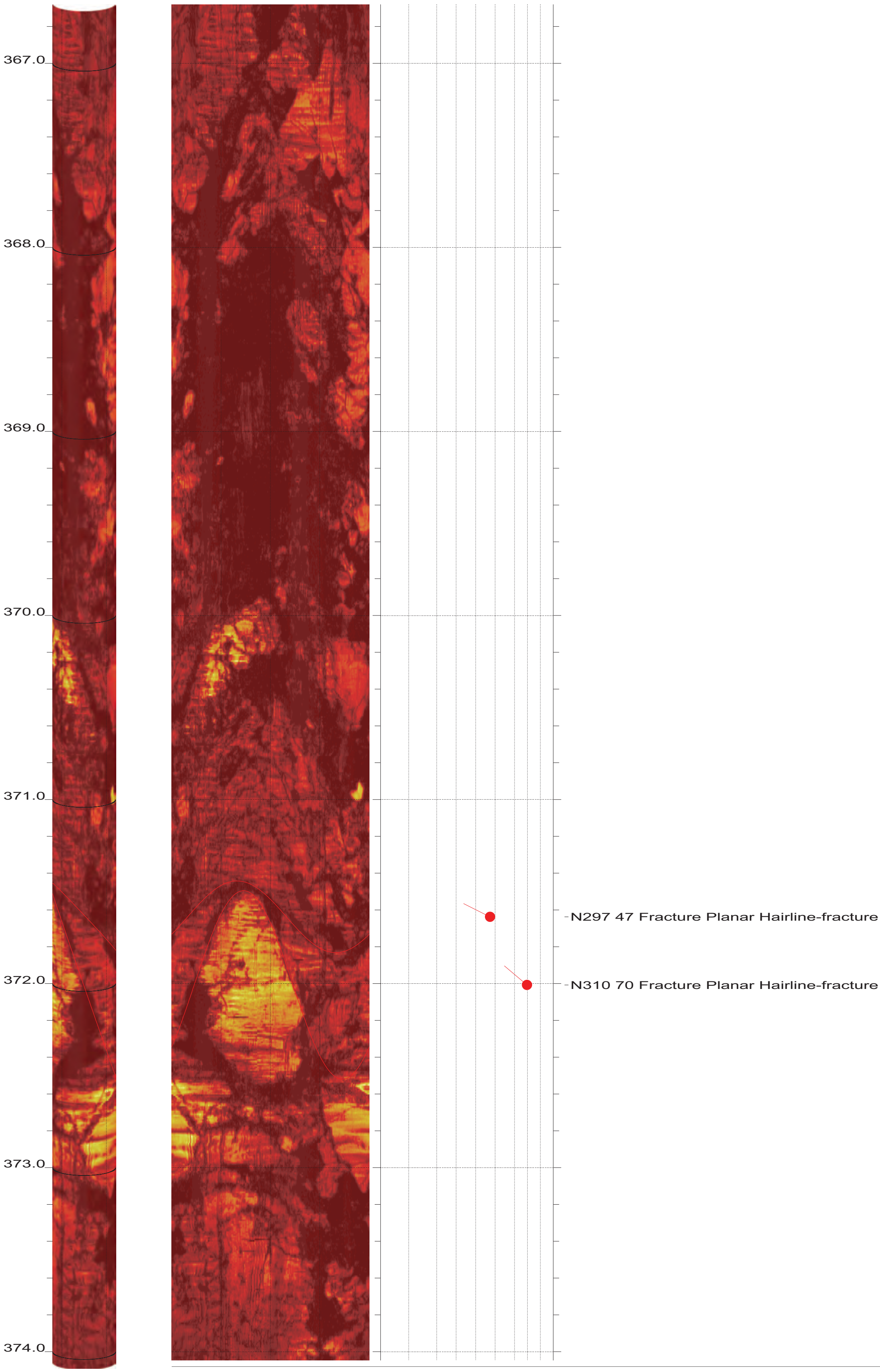
Z2-B4 359.312 to 351.944ft 49

SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 49 of 52



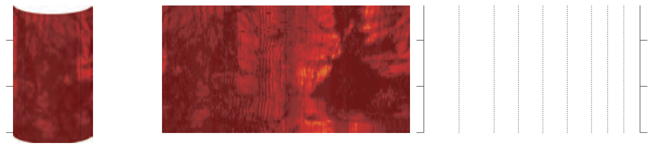
Z2-B4 366.680 to 359.312ft 50

SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 50 of 52



Z2-B4 374.048 to 366.680ft 51

SR-710 Boring Z2-B4 Acoustic Televiewer Dips rev 1 Sheet 51 of 52



BHTV DATA PROCESSING
RGLDIP vsn 6.2
INTERPRETED BHTV DIPS LOG

CASCADE DRILLING

Borehole: Z3-B1

SR-710 TUNNEL INVESTIGATION

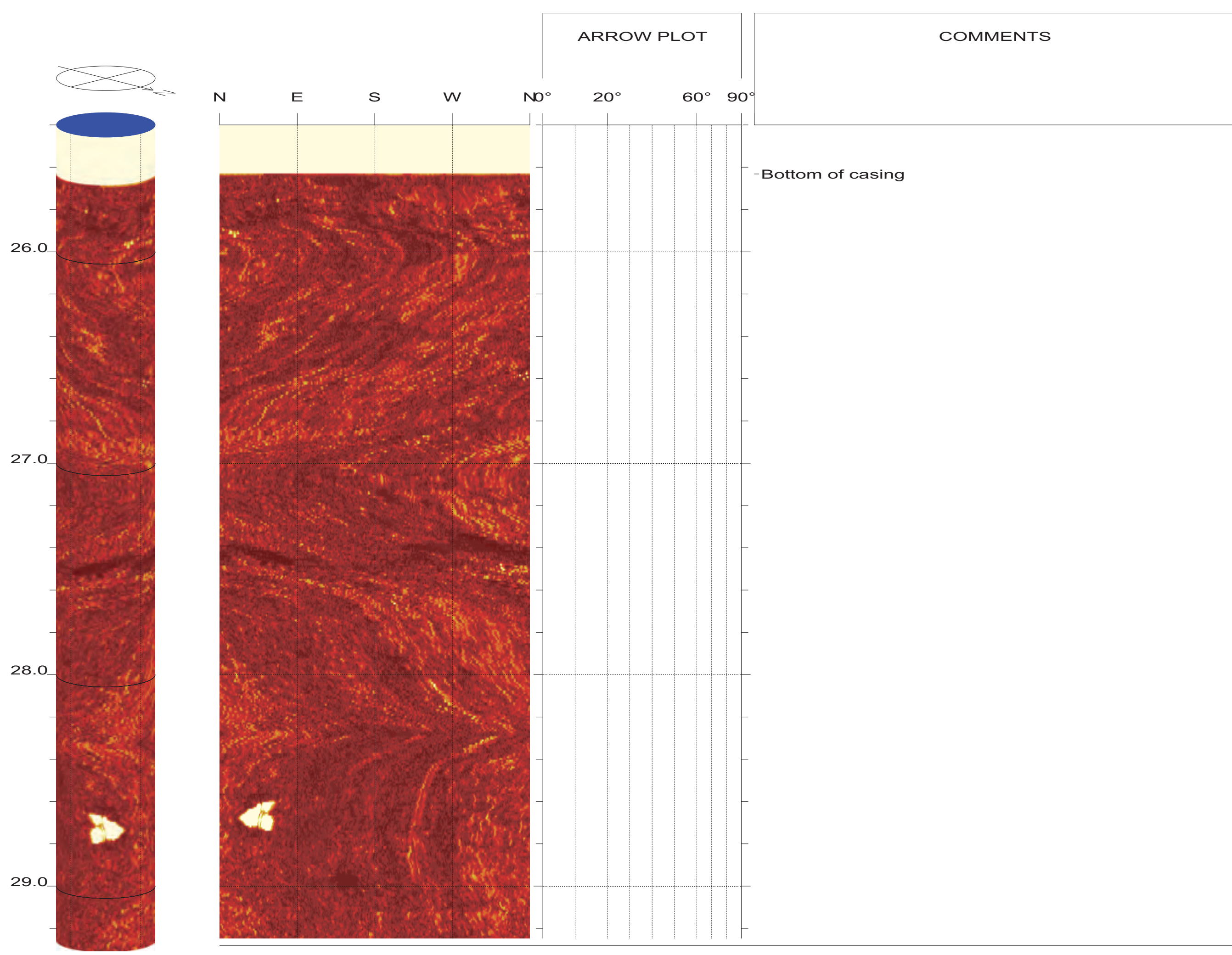
top of borehole.....
East: _
North: _
Elev: _

North ref. is true
Depth units are feet
Vertical scale: 1/10
Horiz scale = 1.00x Vert scale

Zone from 300.200 to 25.400ft
Format: BHTV-NESWN

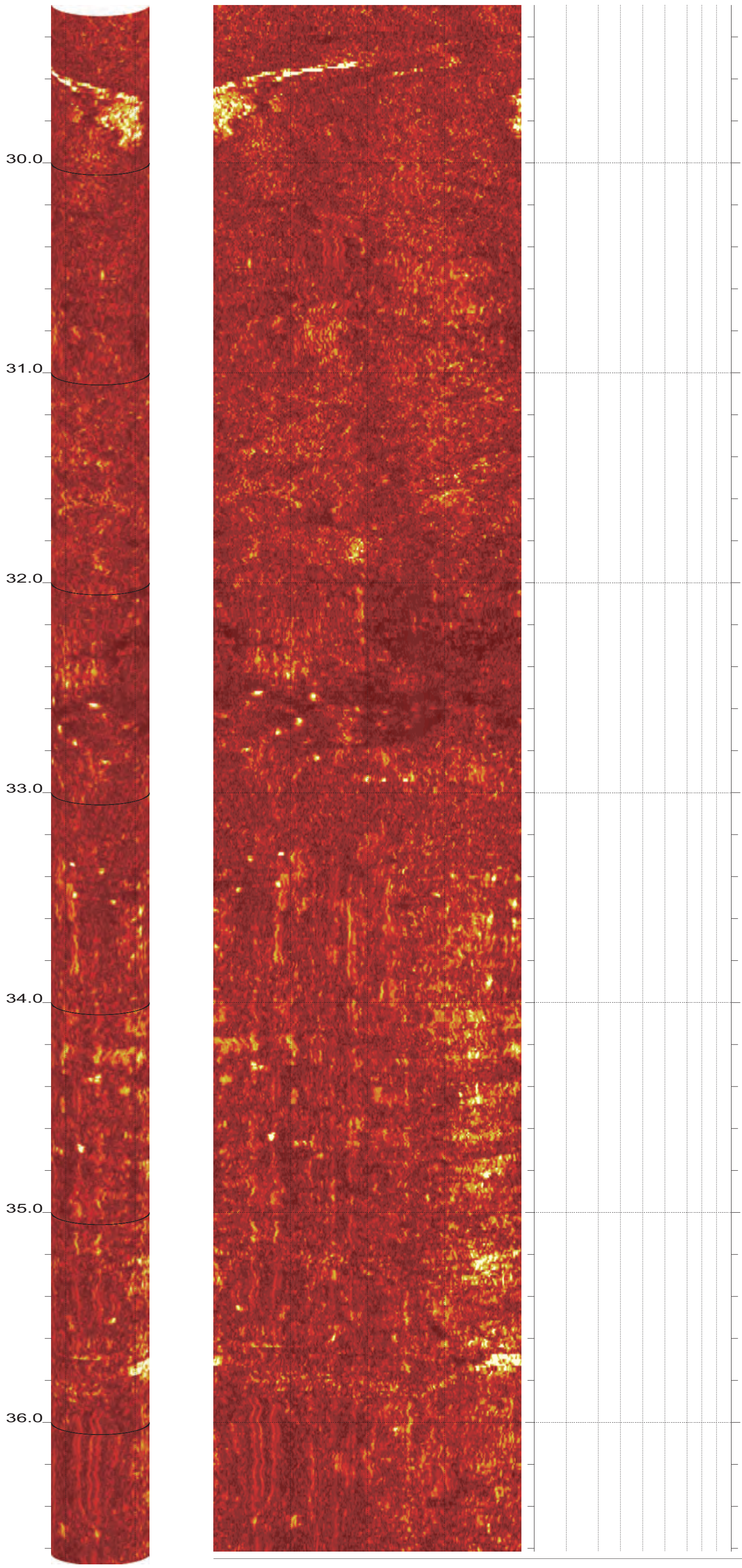
Borehole diam: 5.600inch
Vertical = borehole-axis
Image: Amplitude

Stratigraphic dips
Non-stratigraphic dips
Identified units



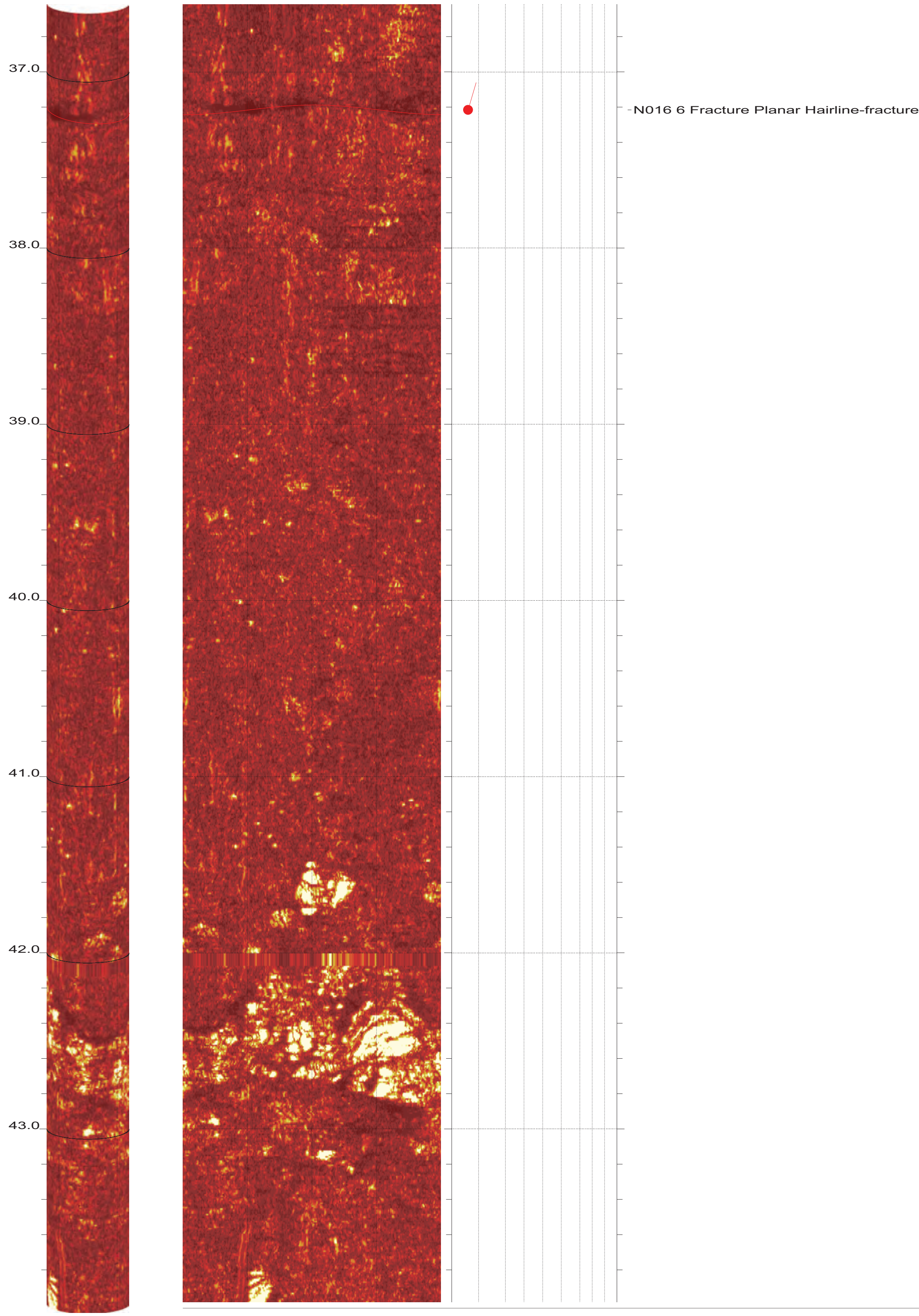
Z3-B1   29.248 to 25.400ft   1

SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 1 of 38



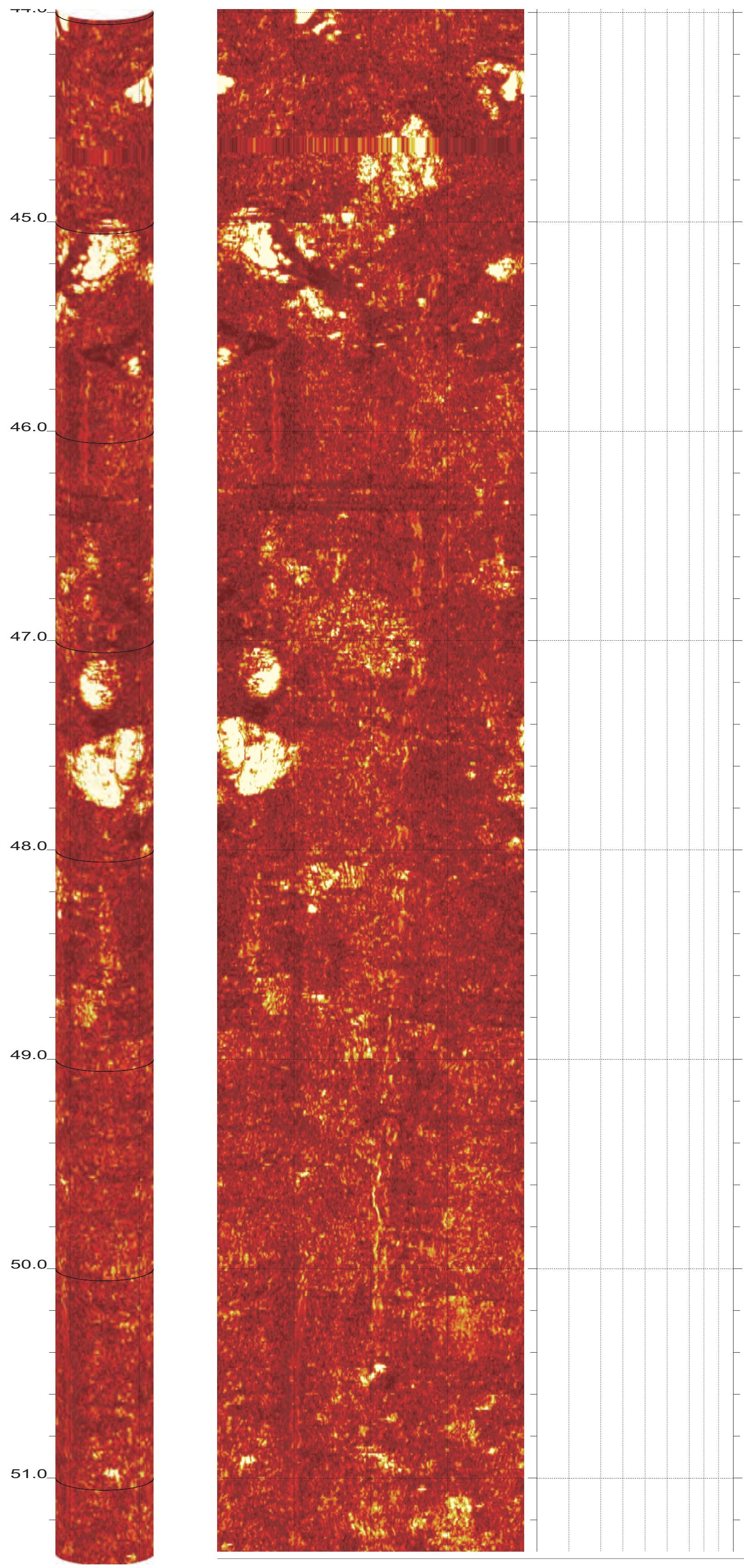
Z3-B1 36.616 to 29.248ft 2

SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 2 of 38



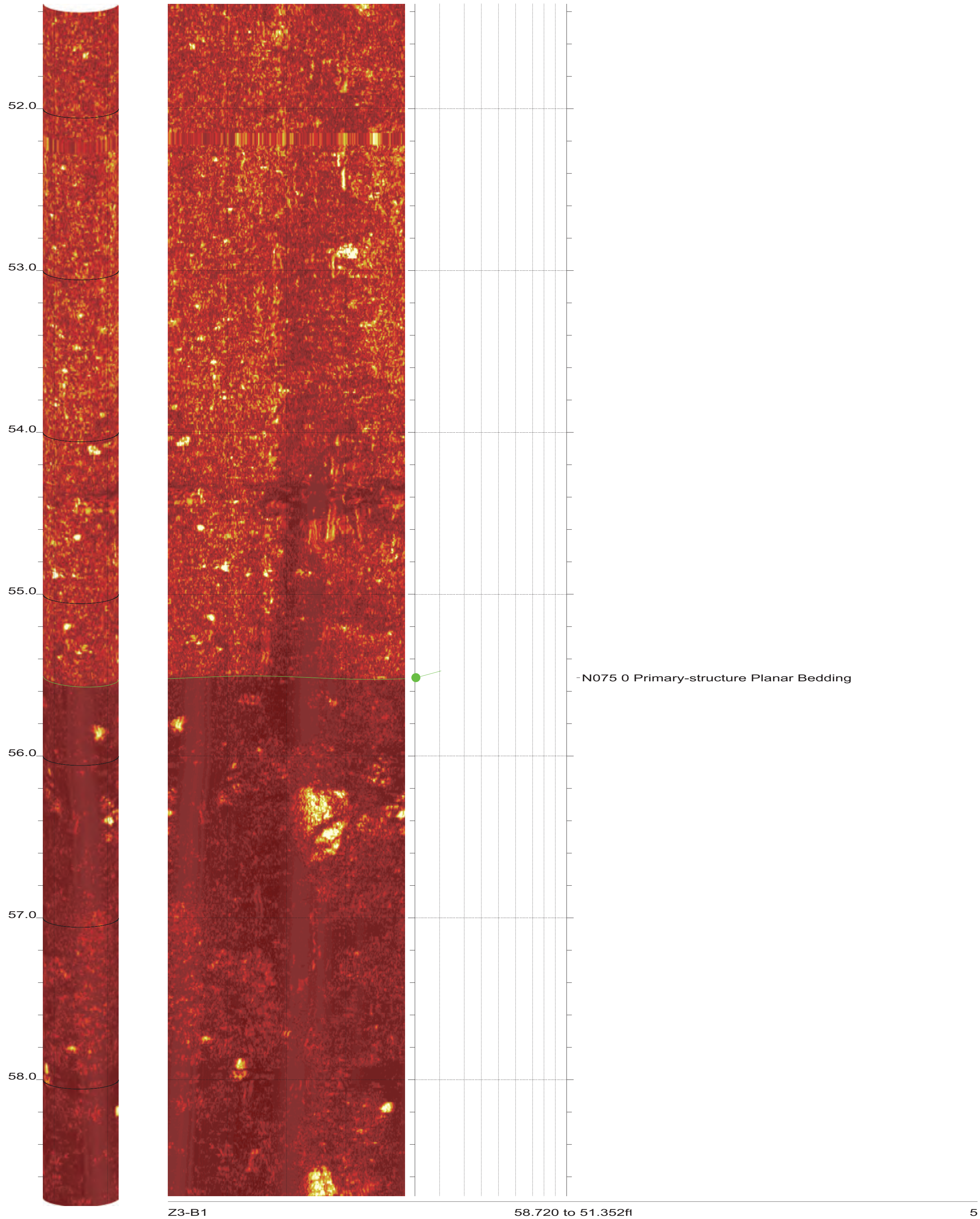
Z3-B1 43.984 to 36.616ft 3

SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 3 of 38

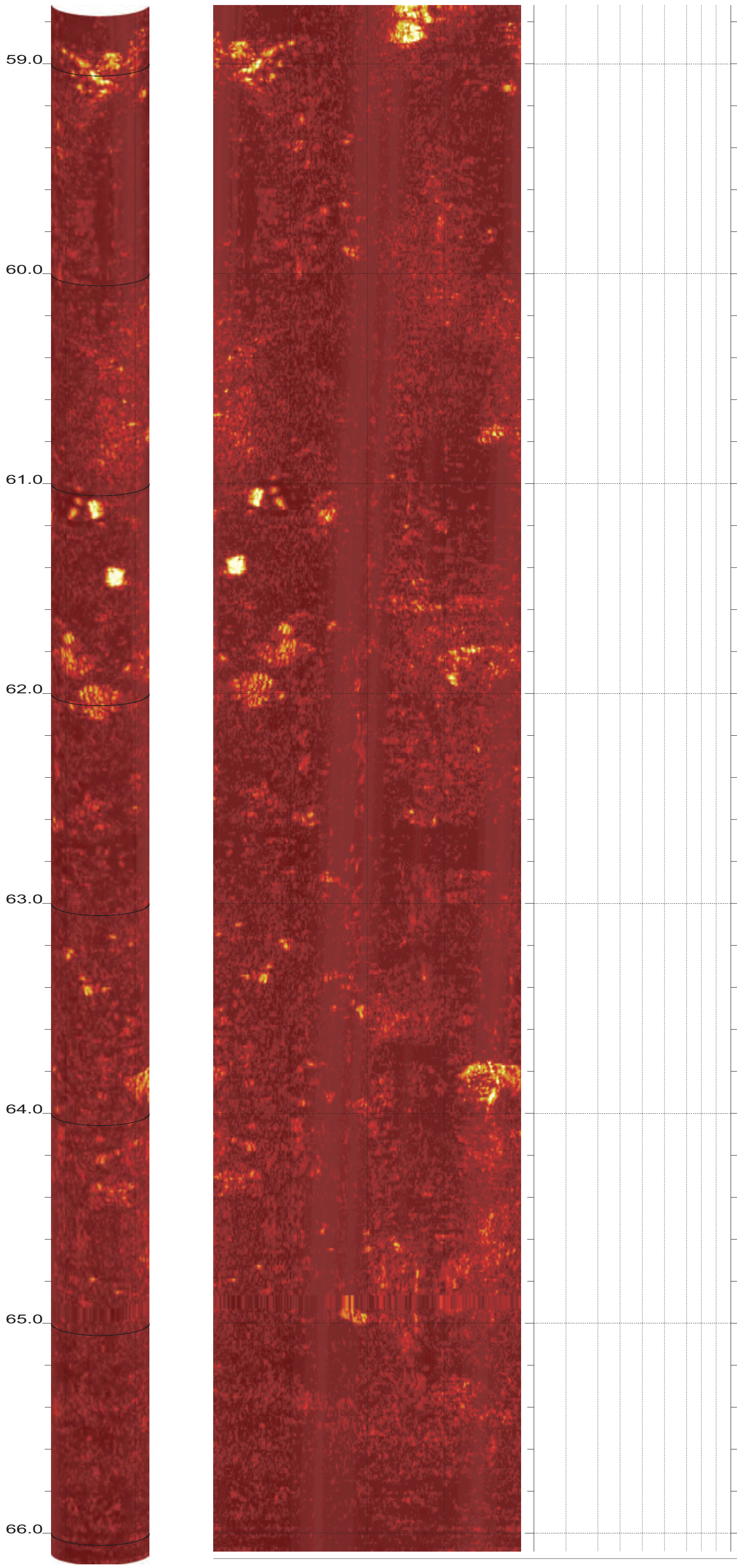


Z3-B1 51.352 to 43.984ft 4

SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 4 of 38

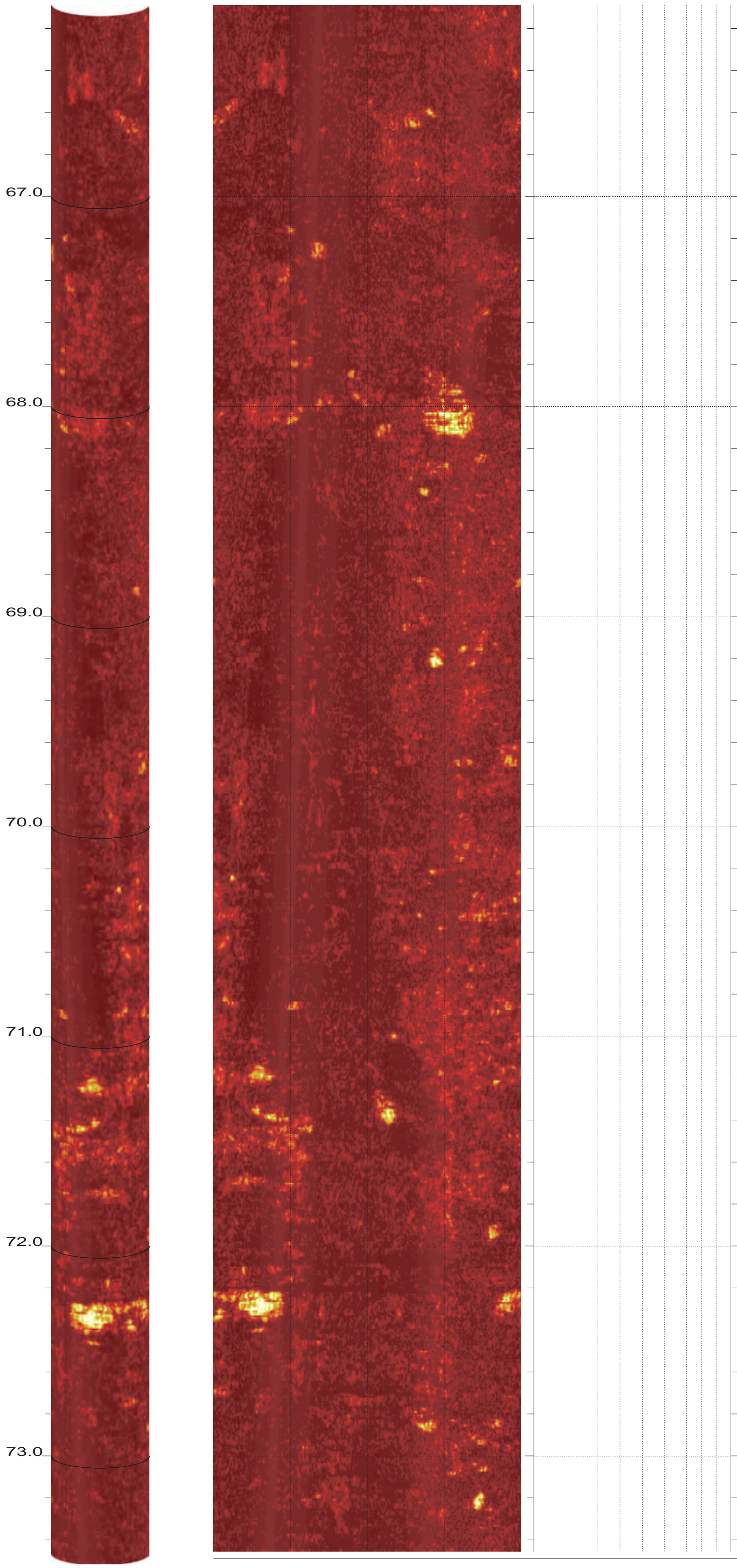


SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 5 of 38



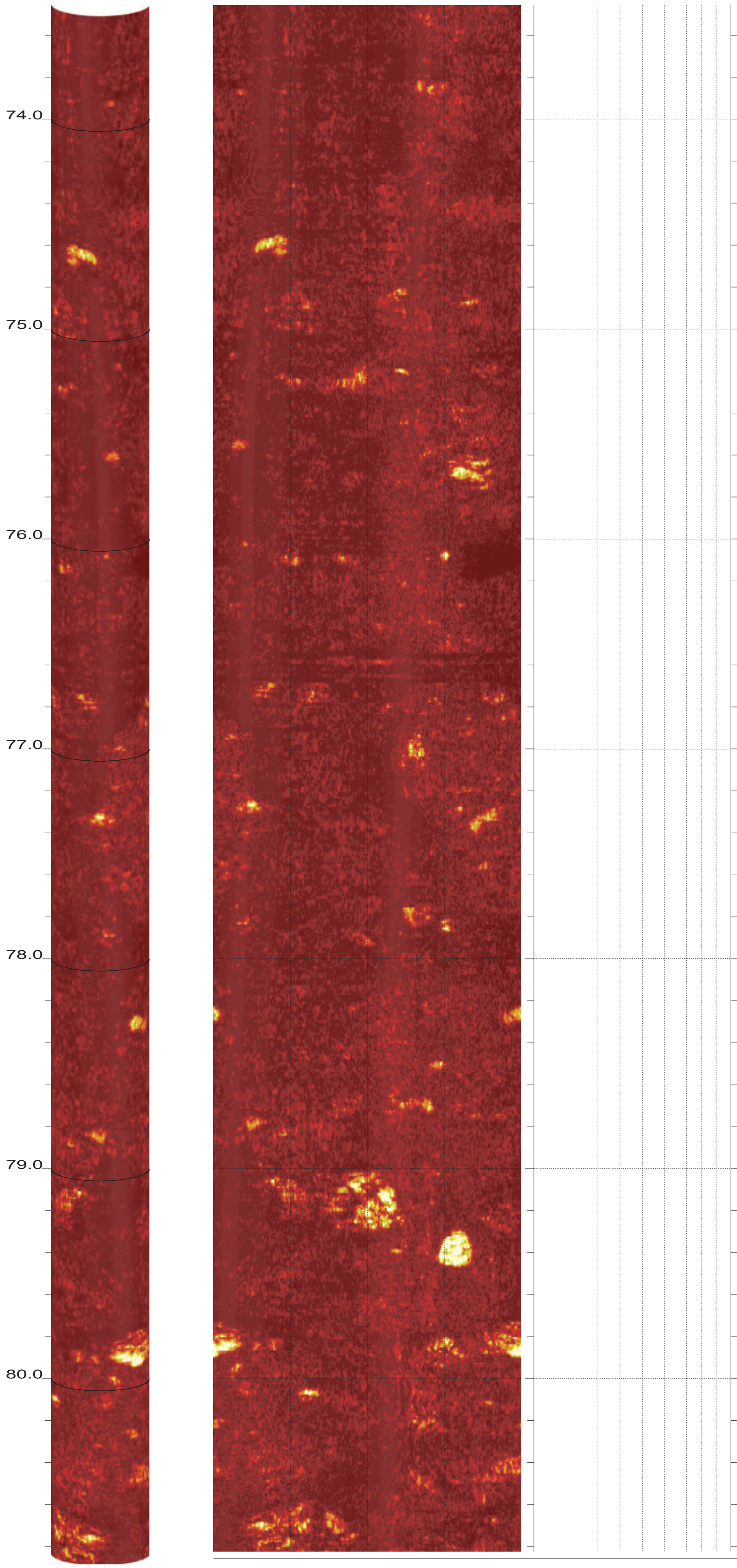
Z3-B1 66.088 to 58.720ft 6

SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 6 of 38



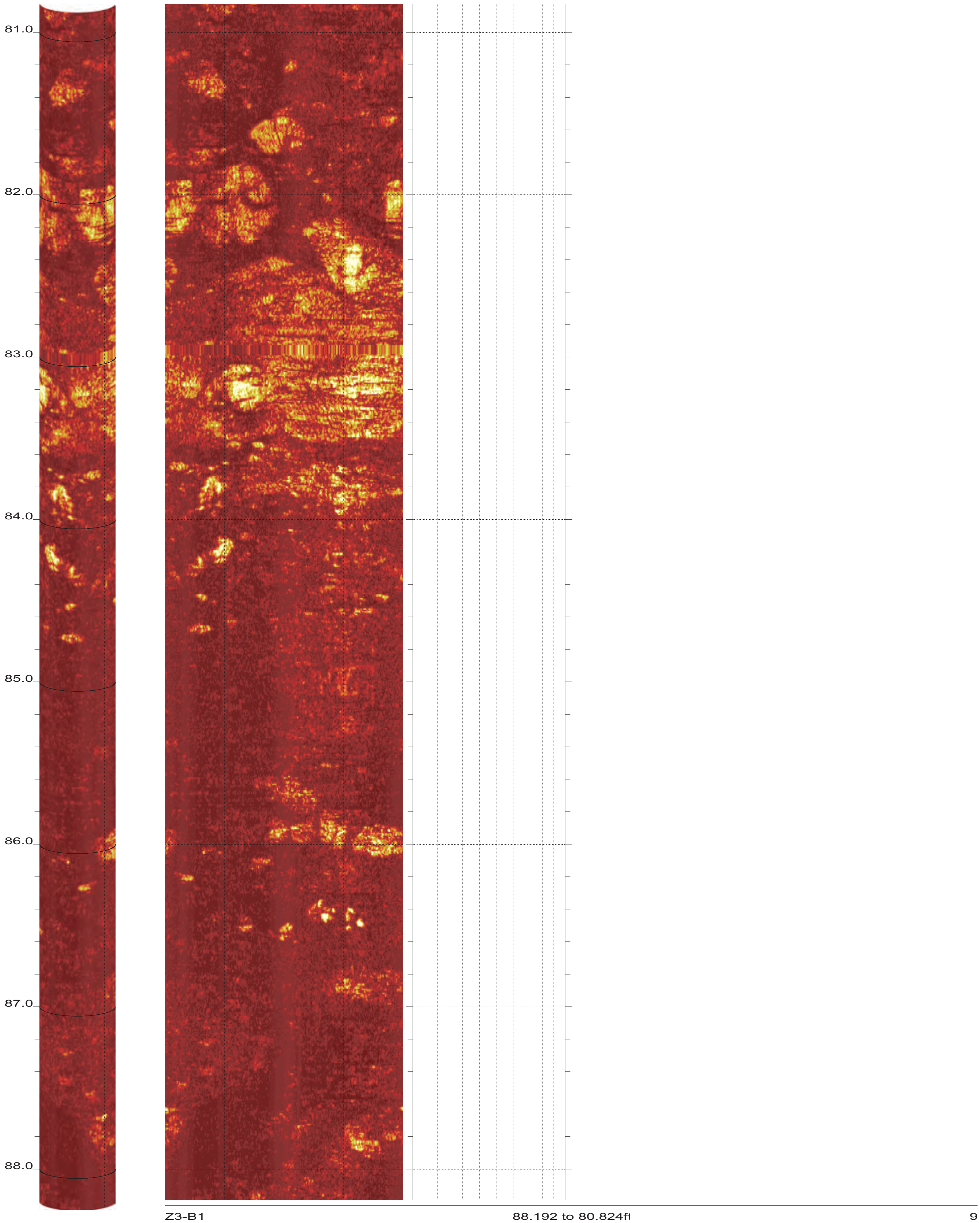
Z3-B1 73.456 to 66.088ft 7

SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 7 of 38

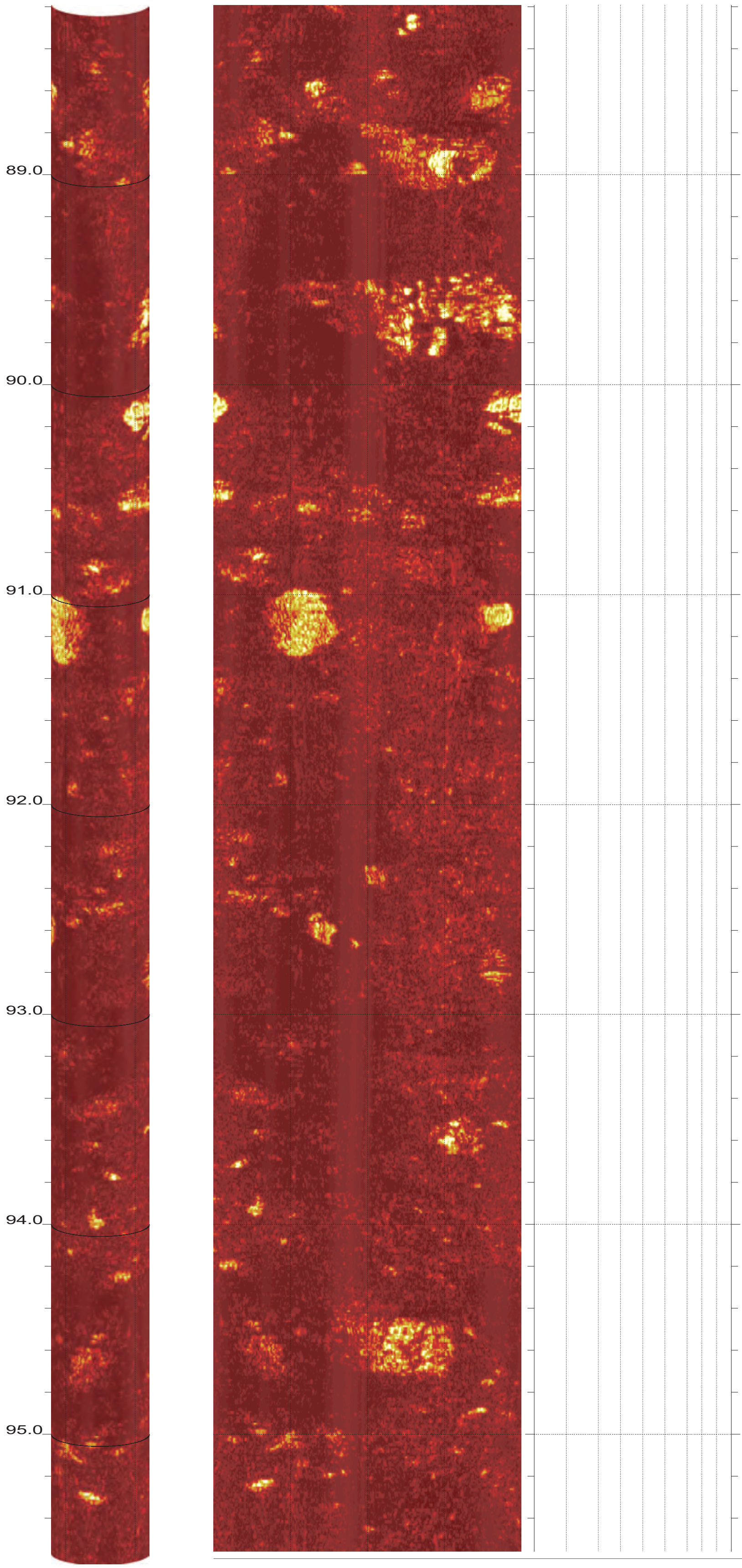


Z3-B1 80.824 to 73.456ft 8

SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 8 of 38

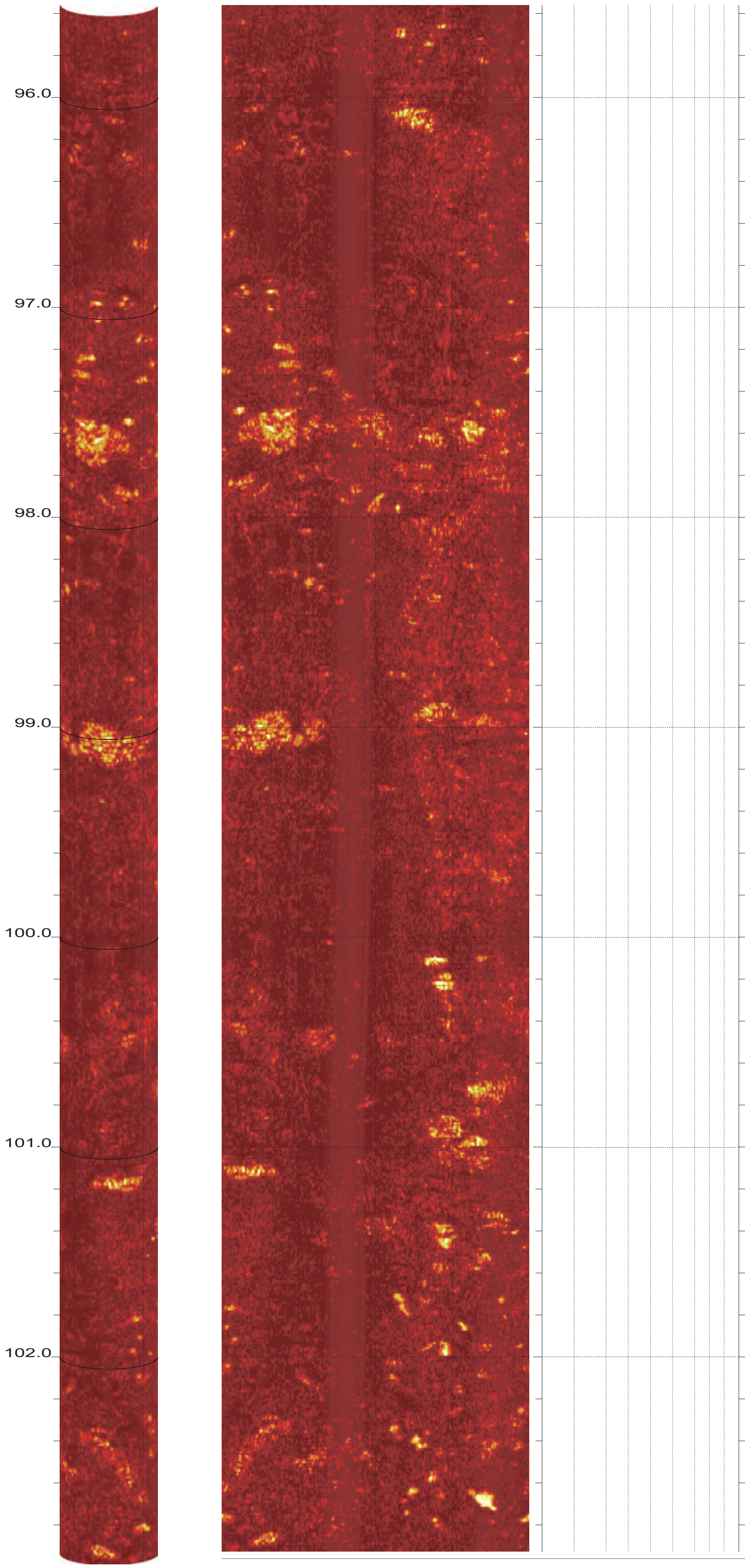


SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 9 of 38



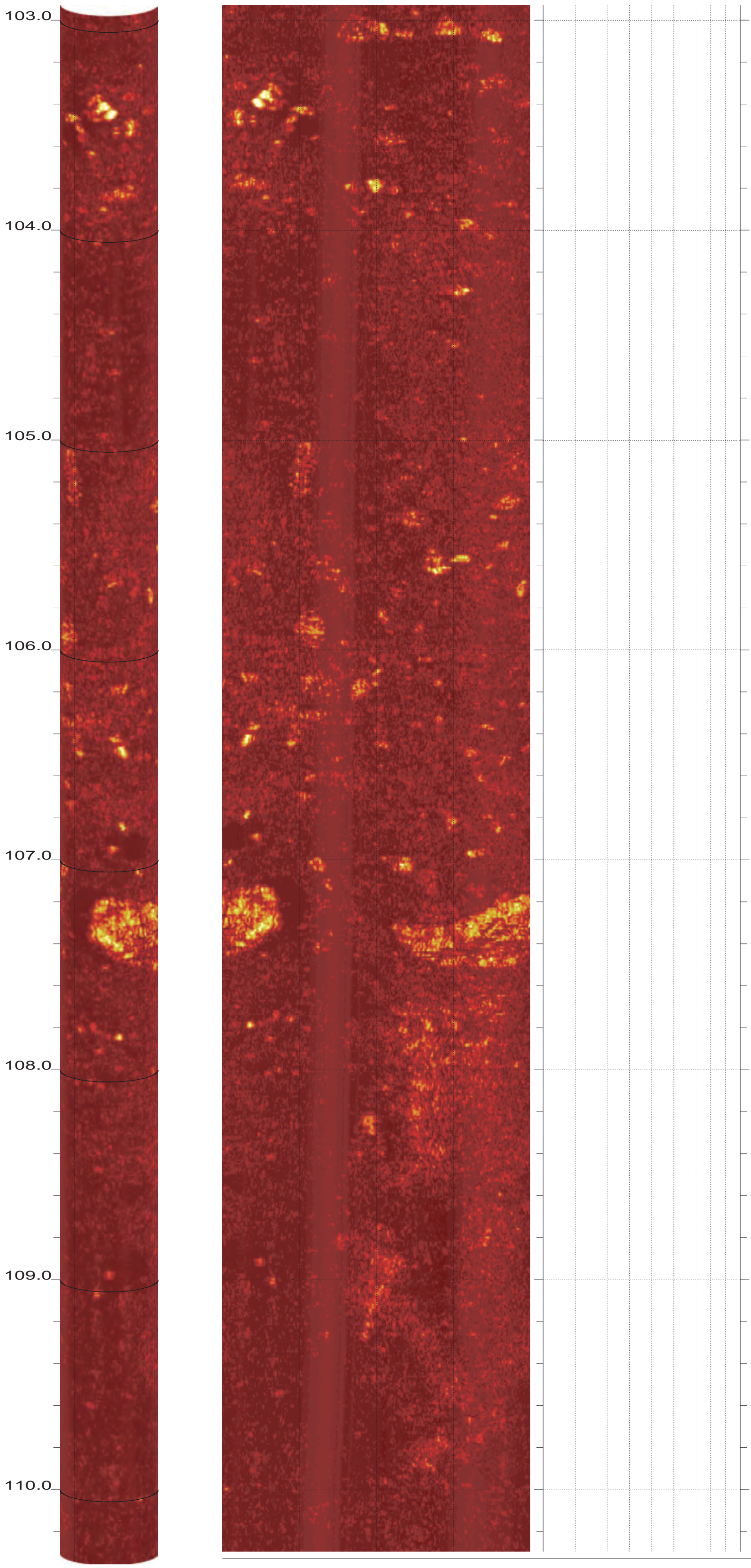
Z3-B1 95.560 to 88.192ft 10

SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 10 of 38



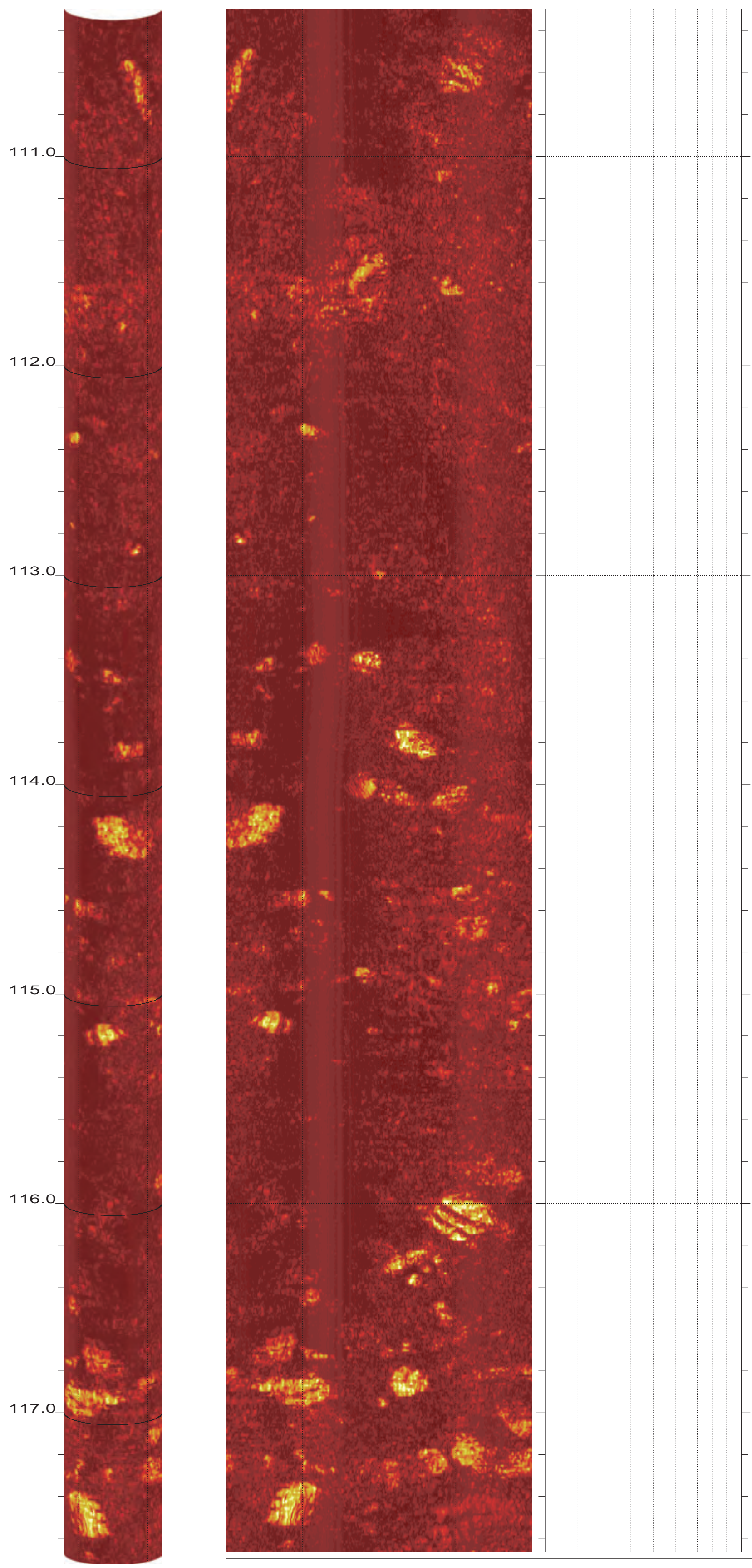
Z3-B1 102.928 to 95.560ft 11

SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 11 of 38



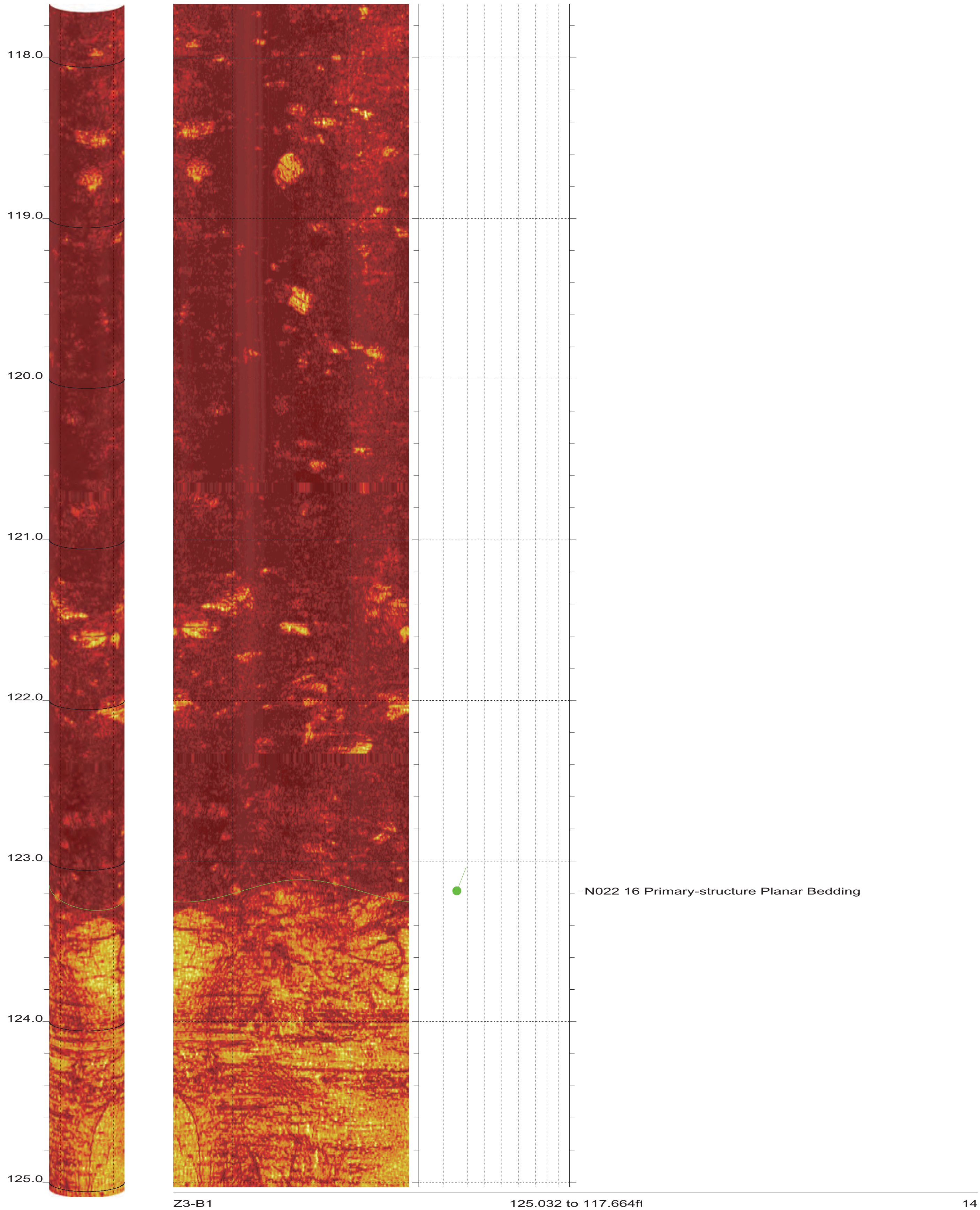
Z3-B1 110.296 to 102.928ft 12

SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 12 of 38

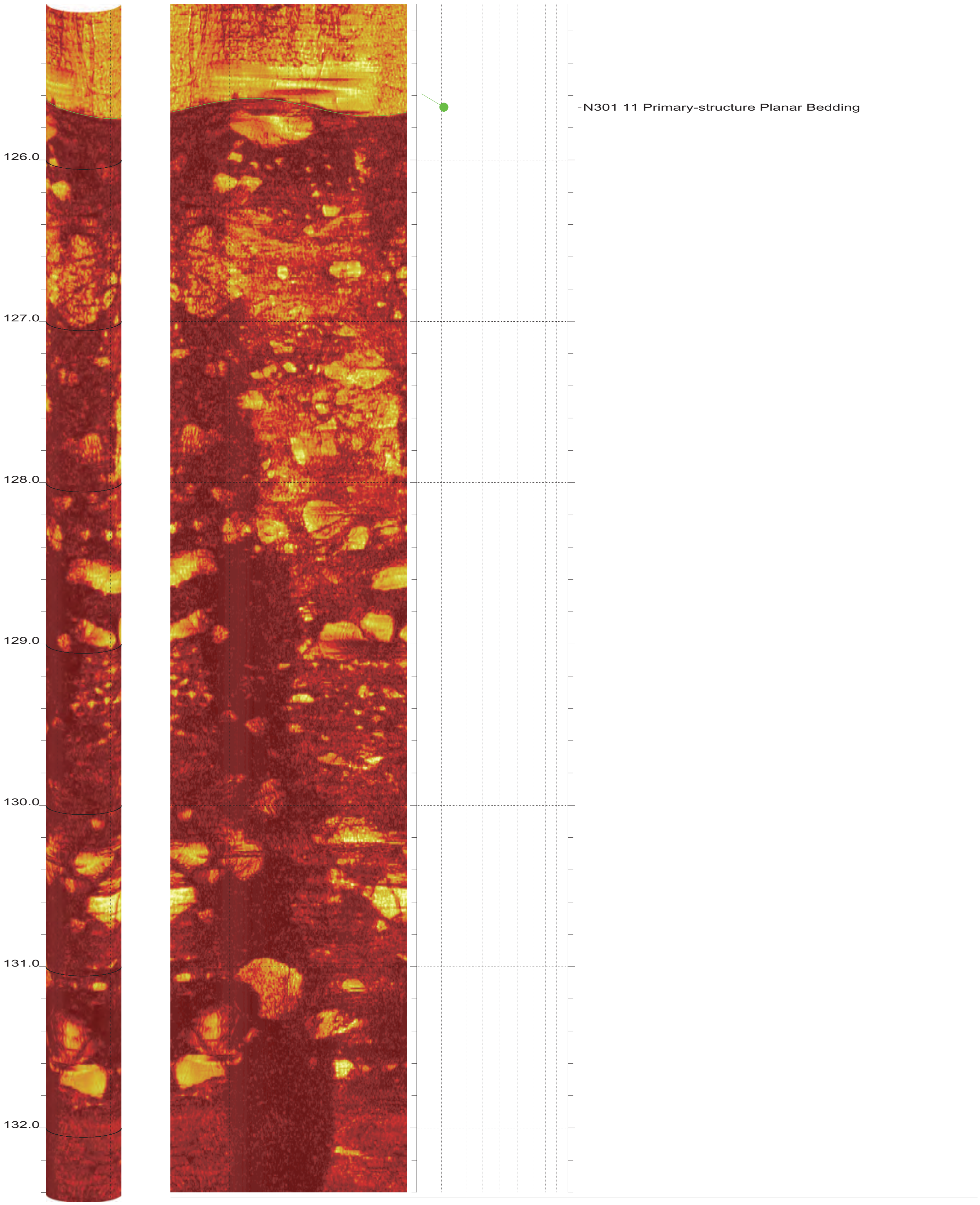


Z3-B1 117.664 to 110.296ft 13

SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 13 of 38

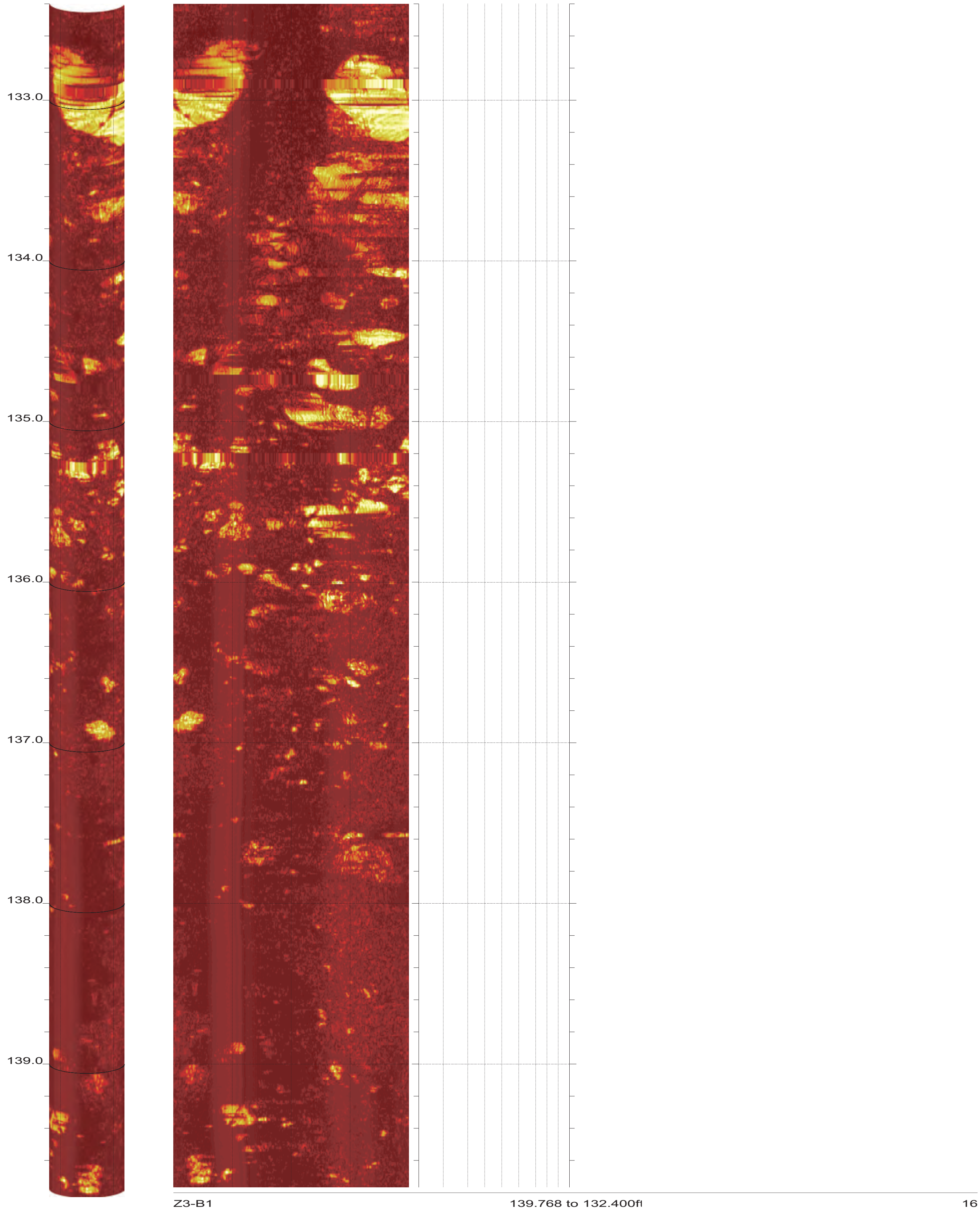


SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 14 of 38

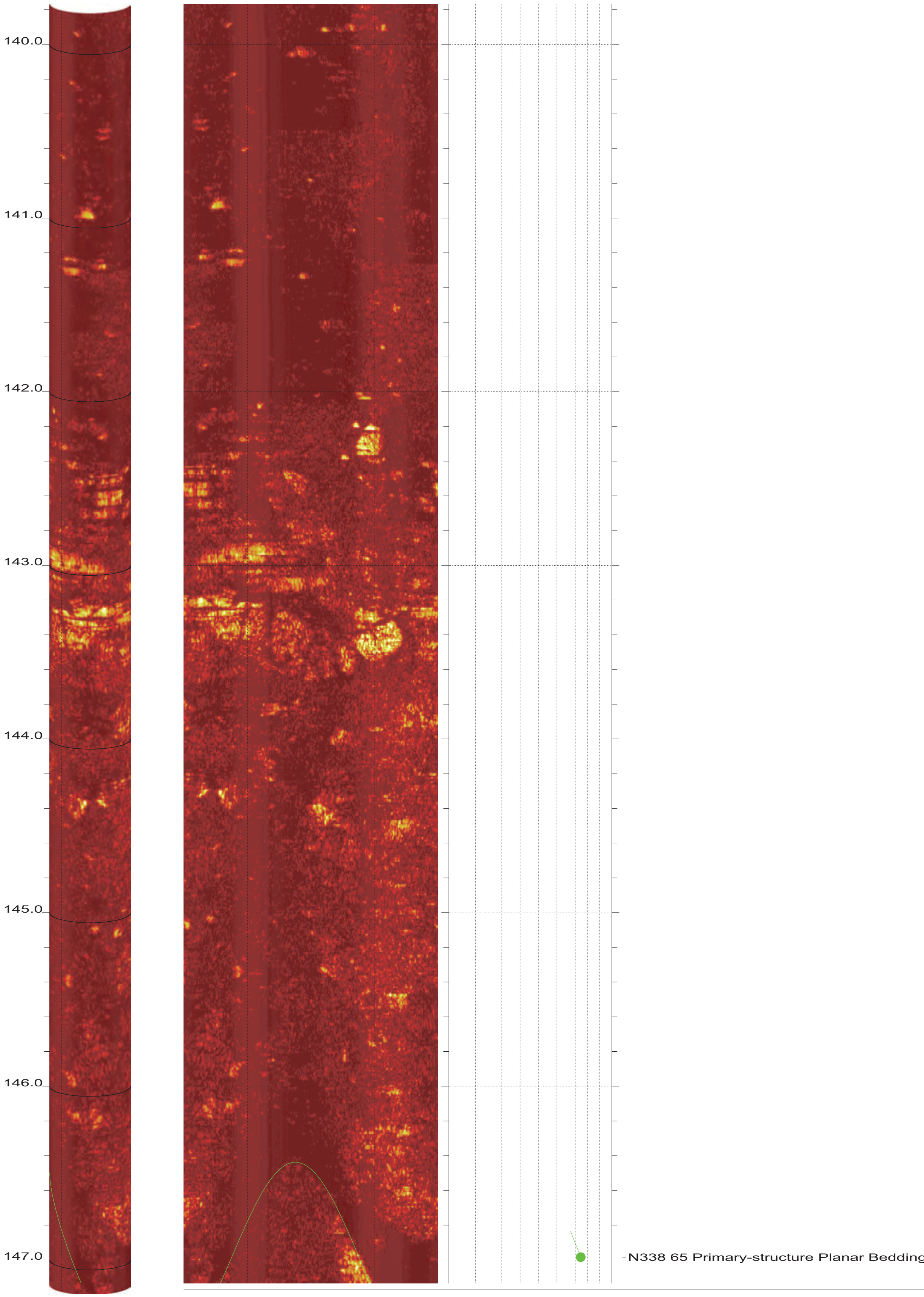


Z3-B1 132.400 to 125.032ft 15

SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 15 of 38

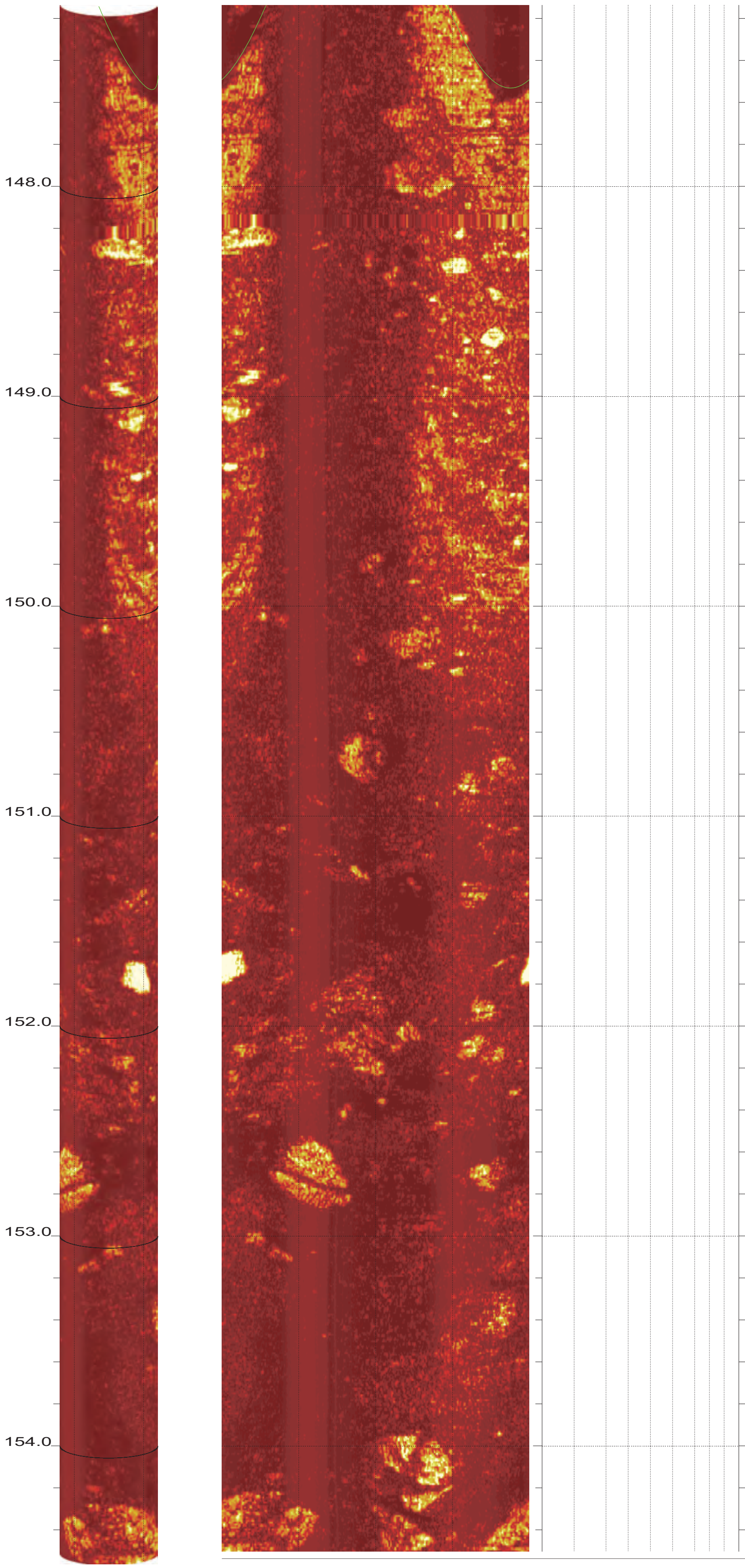


SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 16 of 38



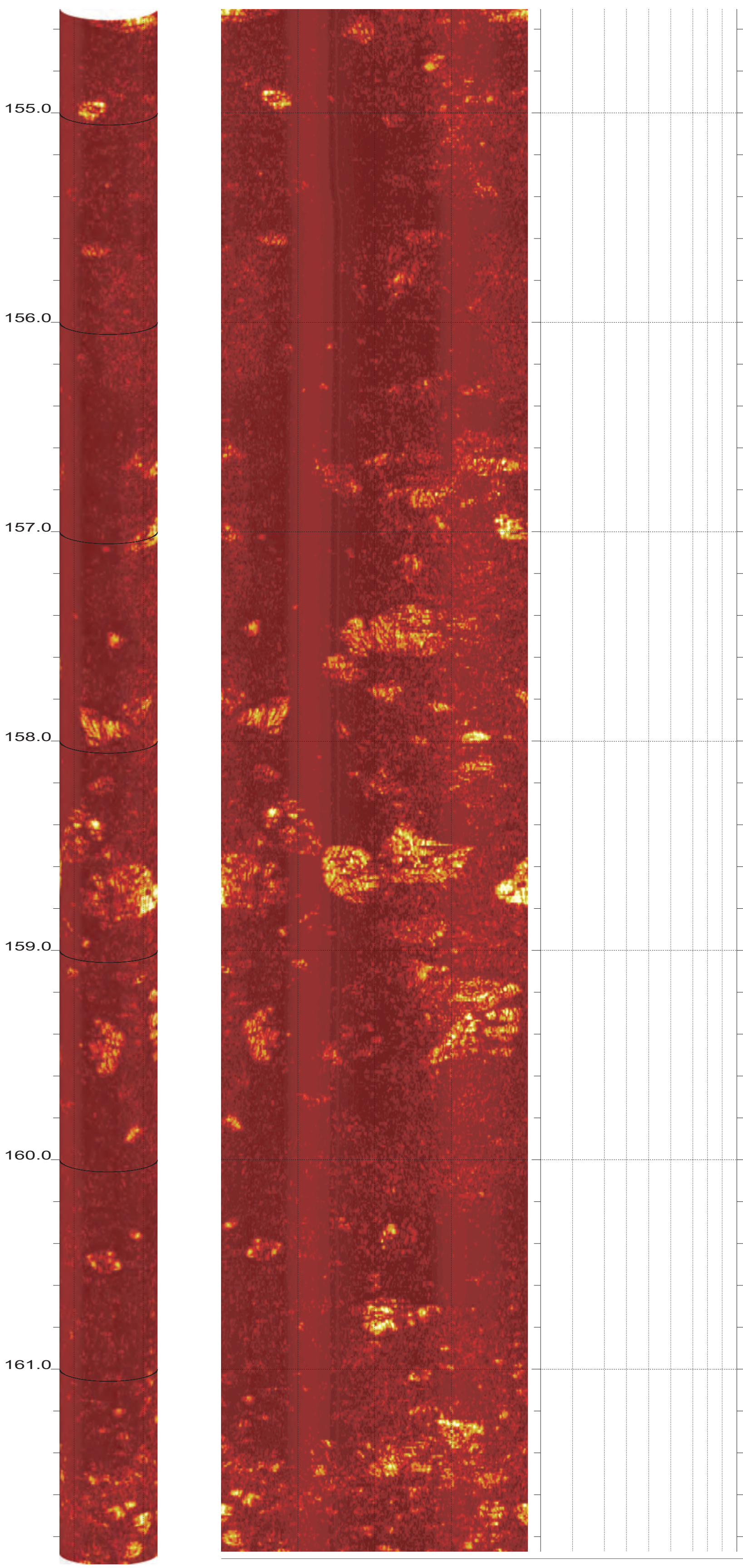
Z3-B1 147.136 to 139.768ft 17

SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 17 of 38



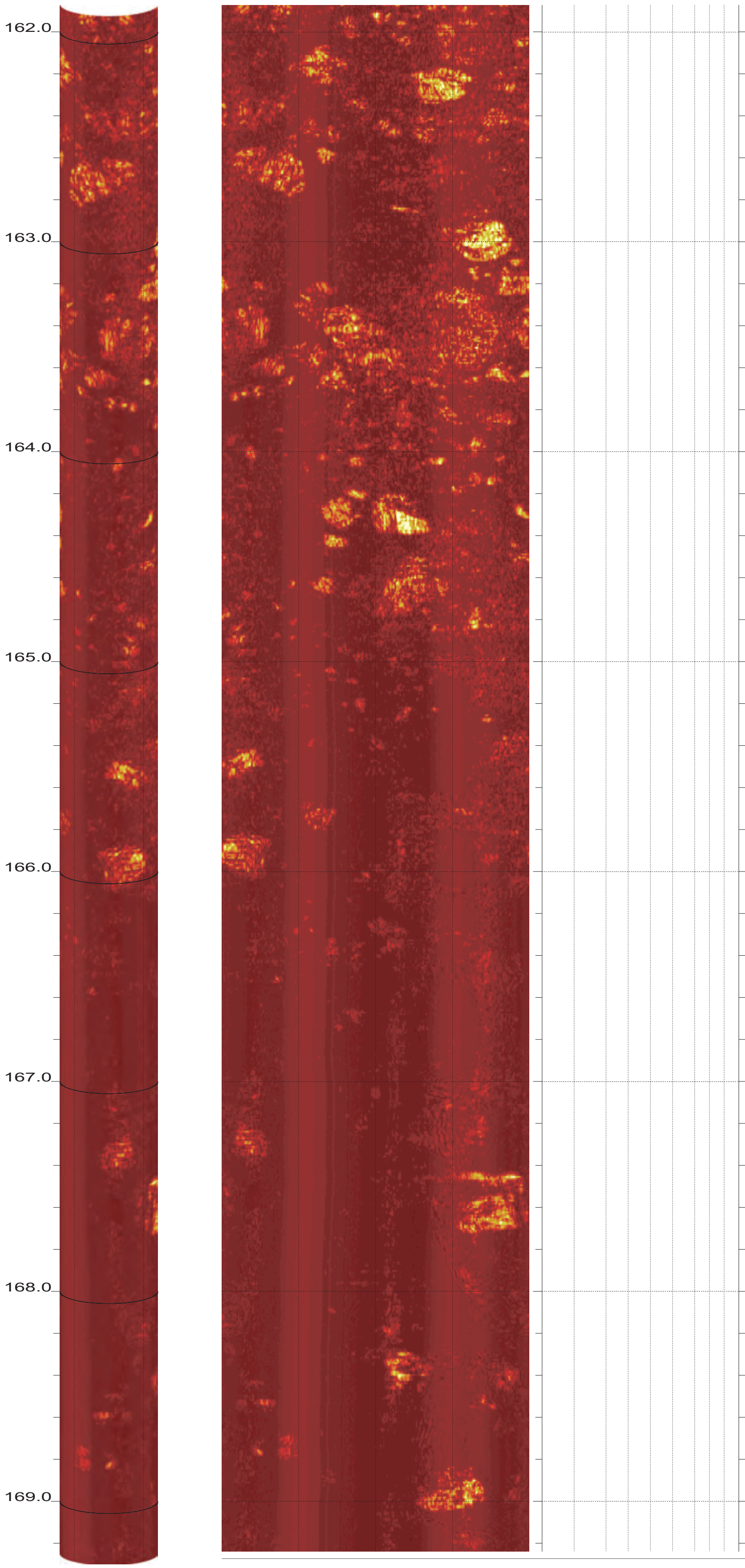
Z3-B1 154.504 to 147.136ft 18

SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 18 of 38



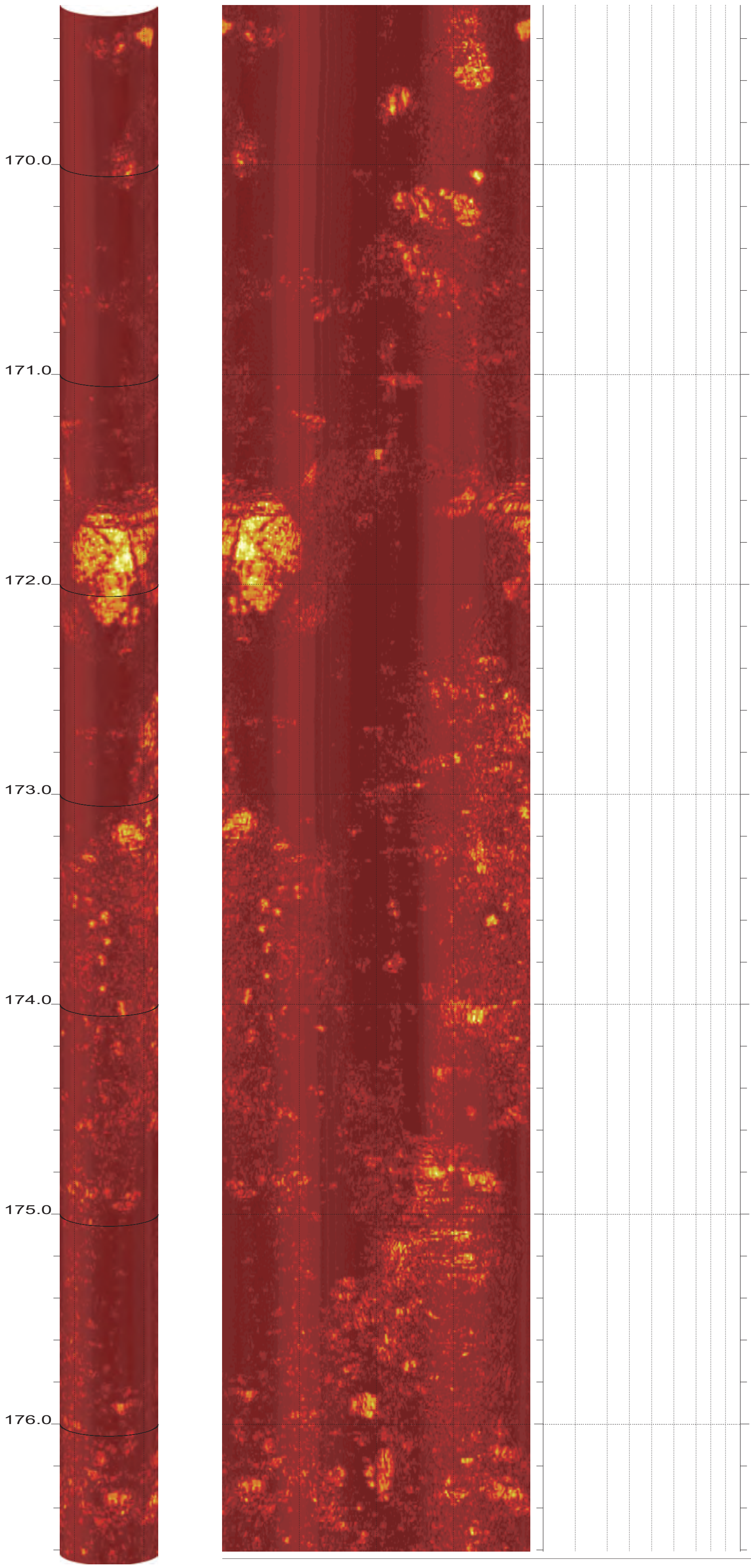
Z3-B1 161.872 to 154.504ft 19

SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 19 of 38



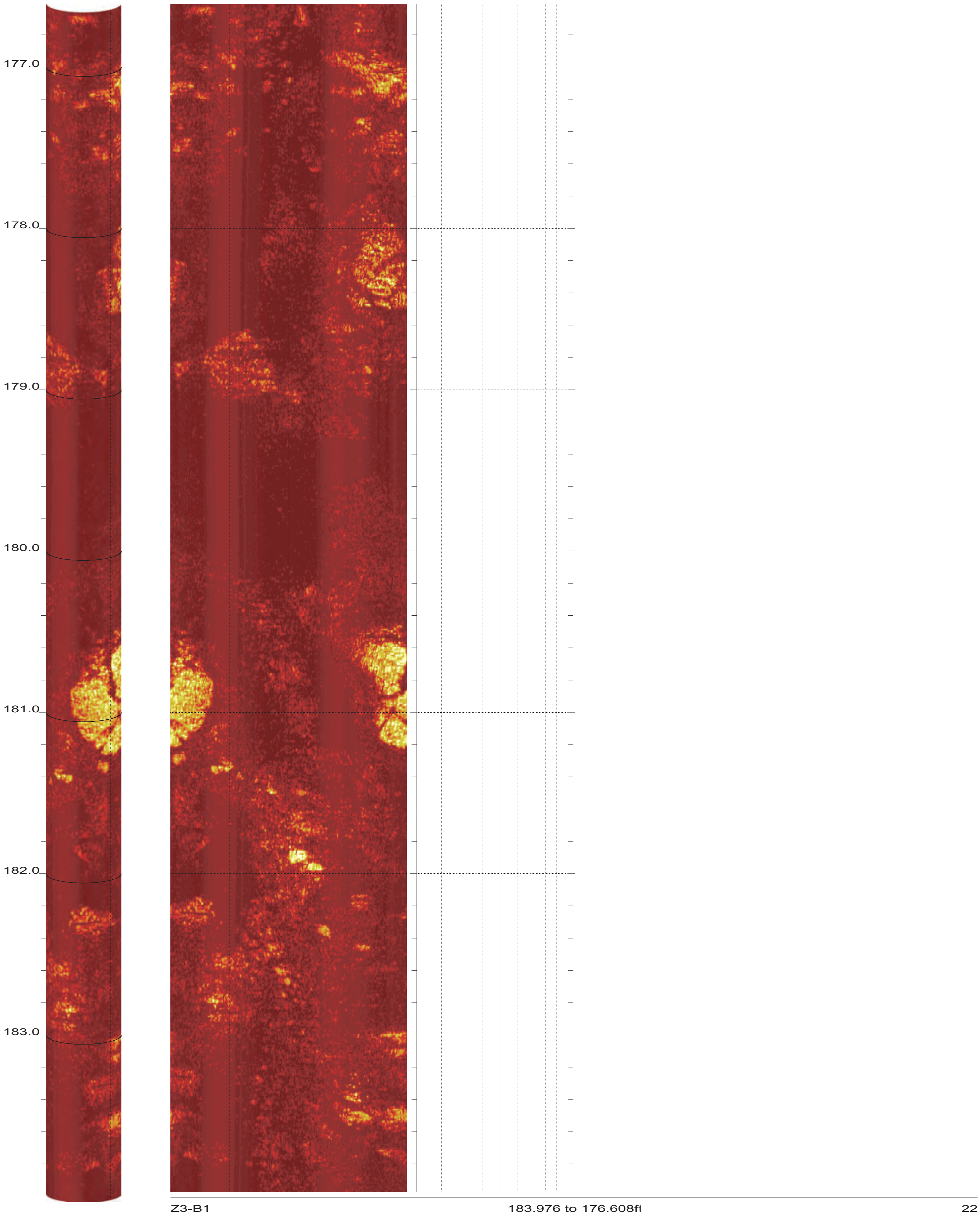
Z3-B1 169.240 to 161.872ft 20

SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 20 of 38

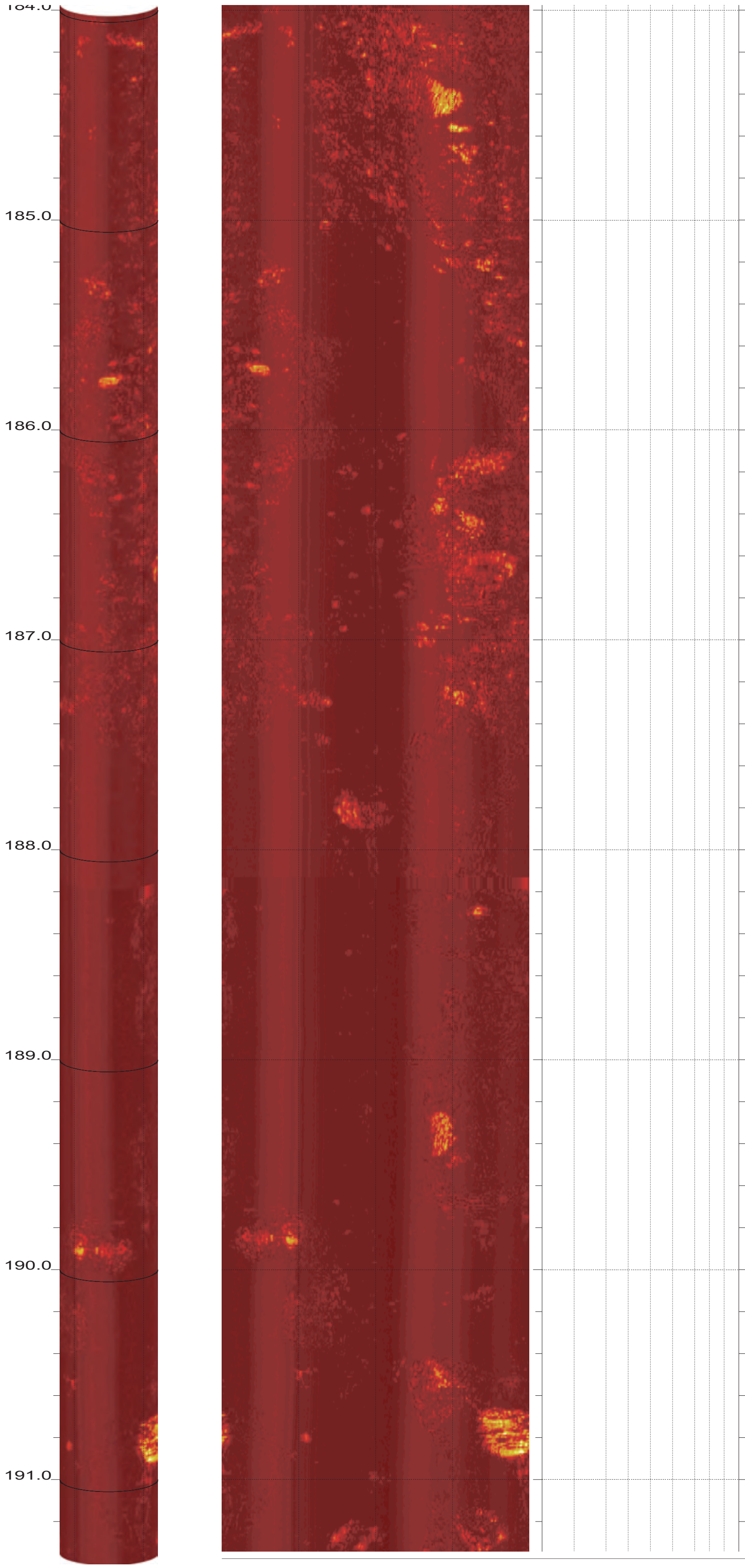


Z3-B1 176.608 to 169.240ft 21

SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 21 of 38

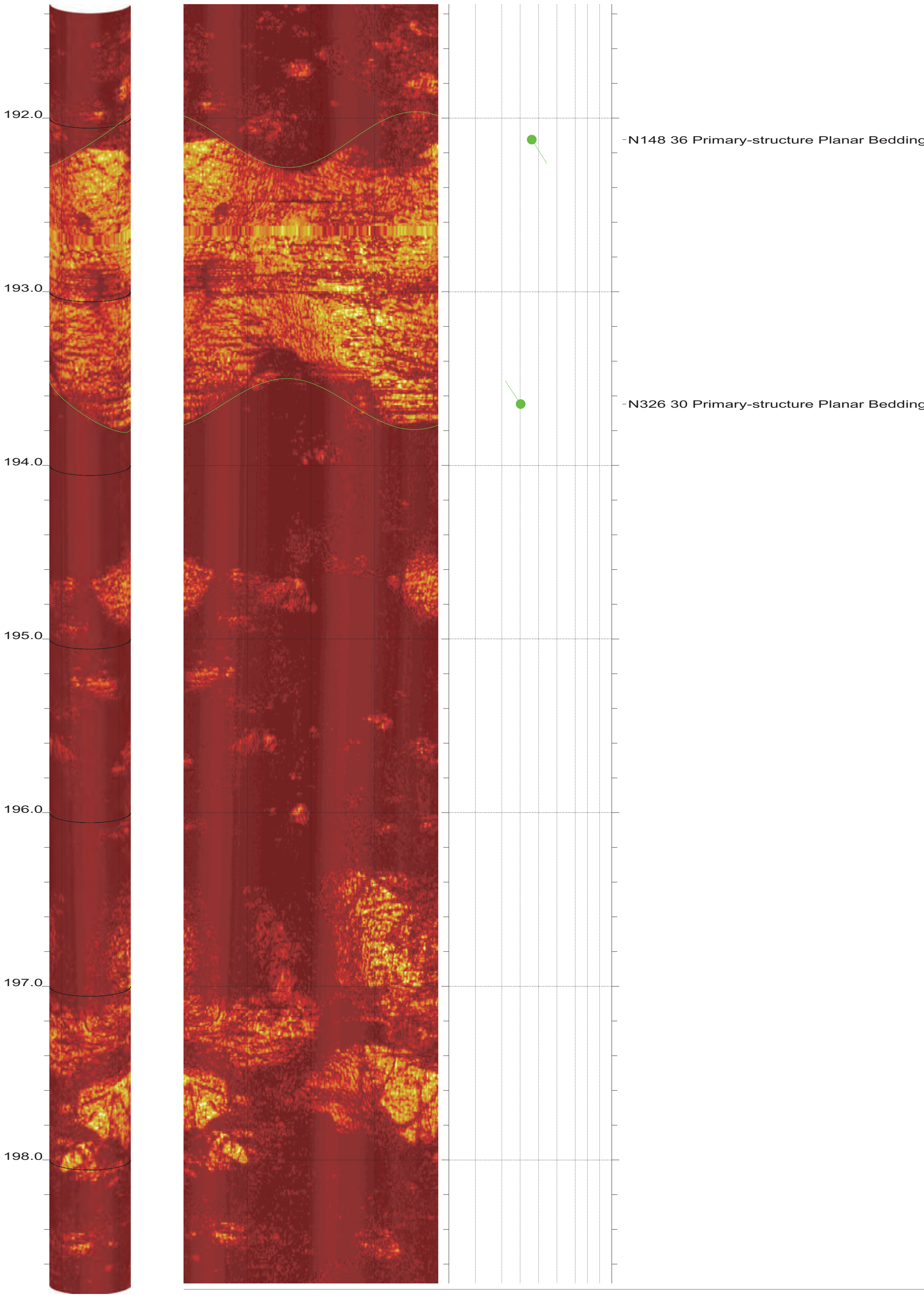


SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 22 of 38



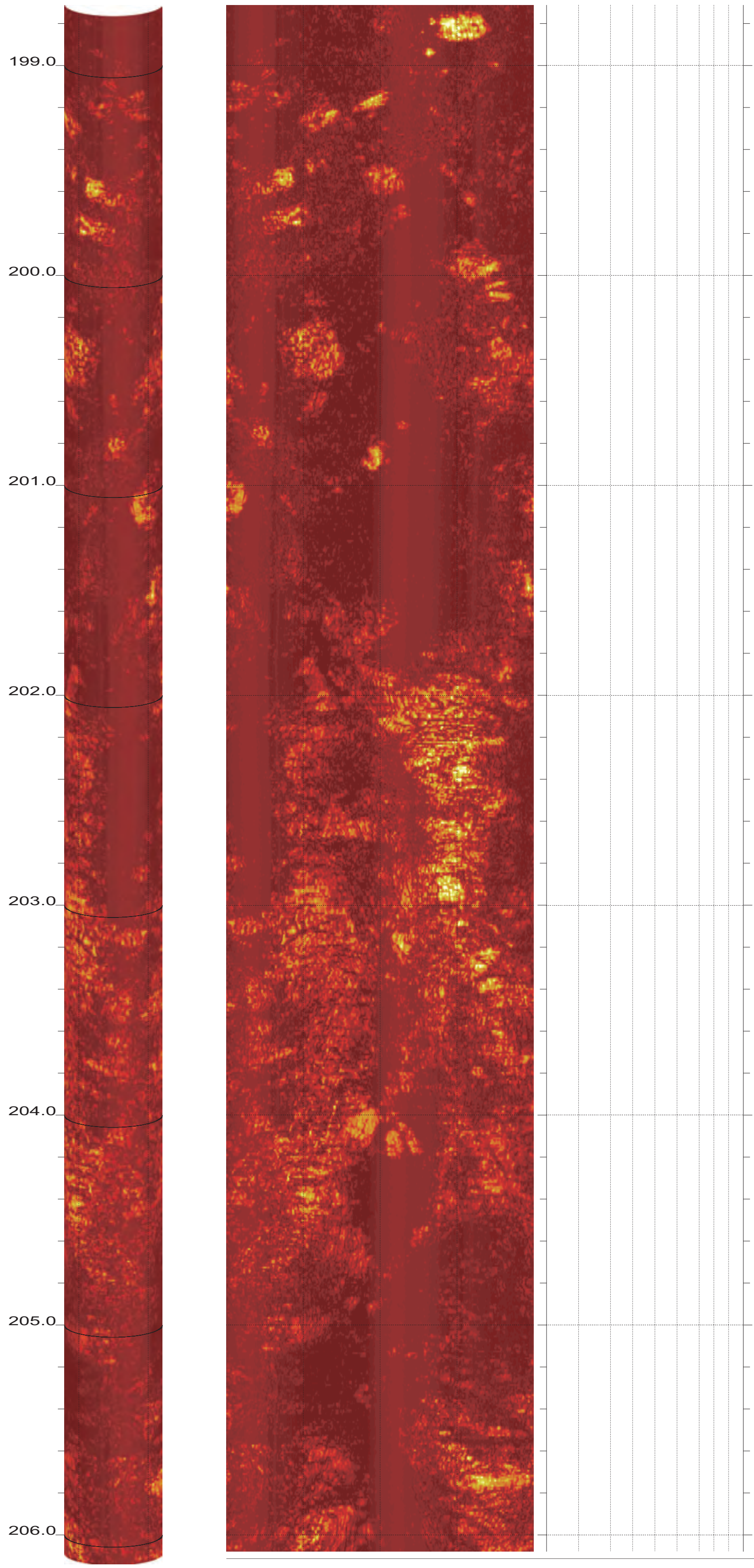
Z3-B1 191.344 to 183.976ft 23

SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 23 of 38



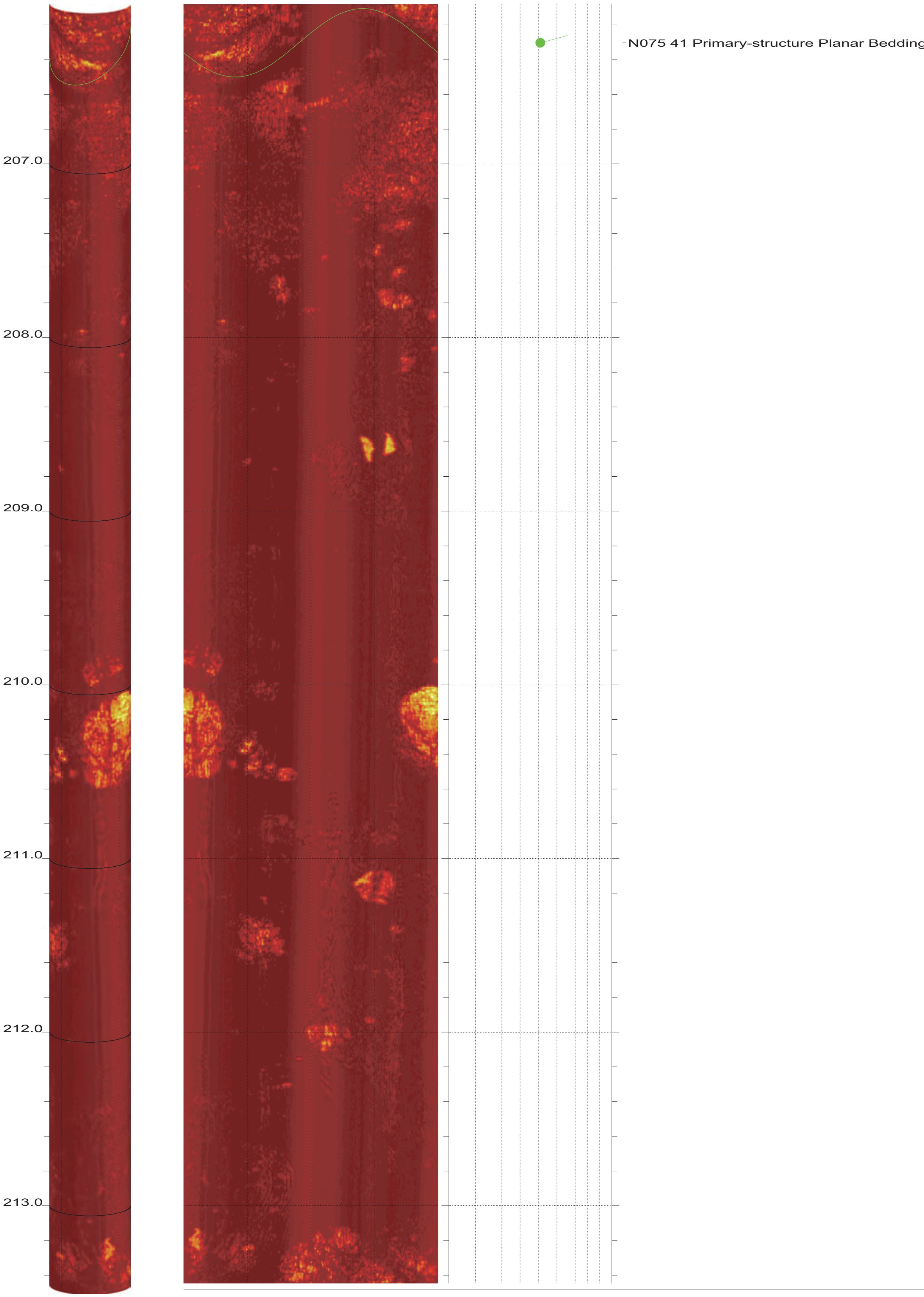
Z3-B1 198.712 to 191.344ft 24

SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 24 of 38



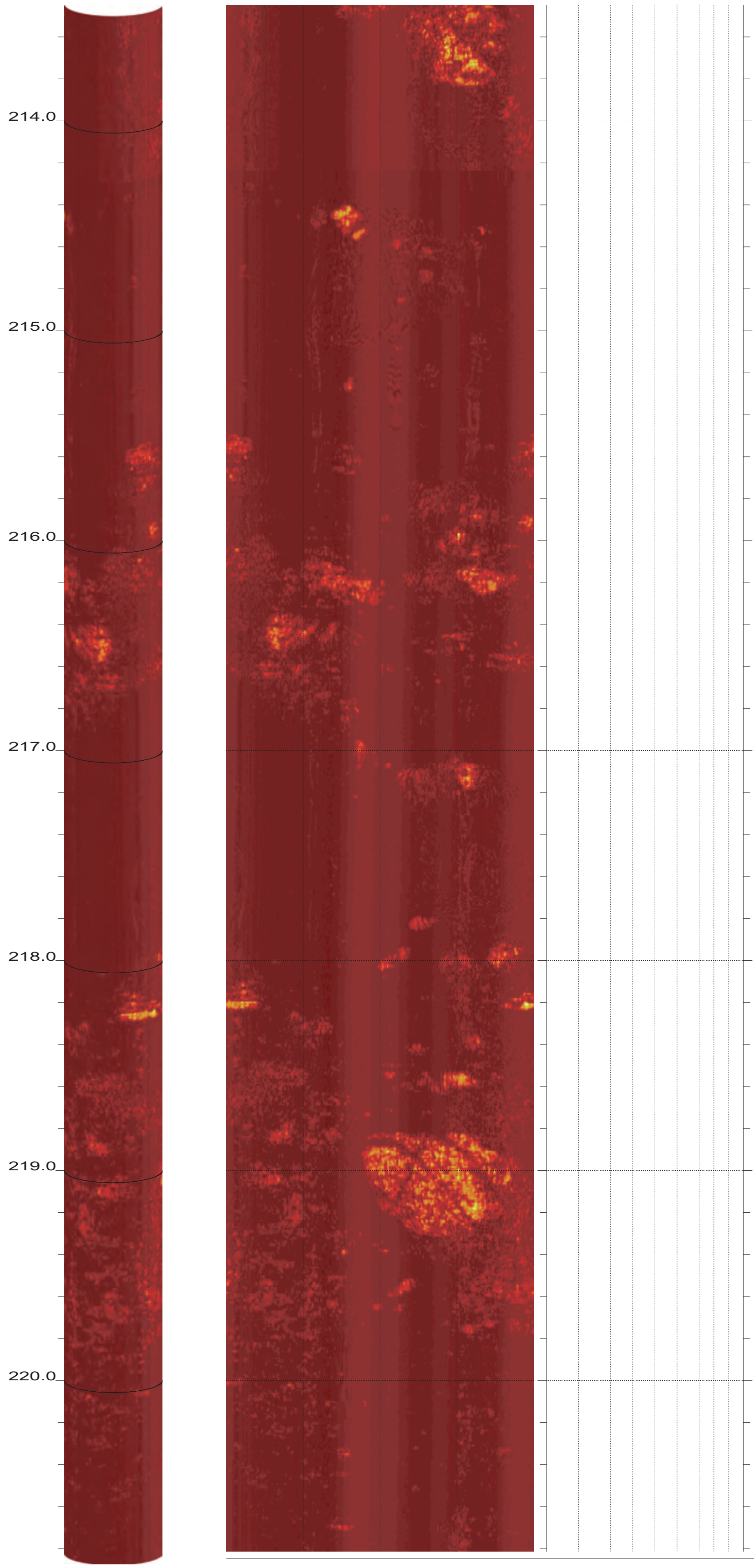
Z3-B1 206.080 to 198.712ft 25

SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 25 of 38



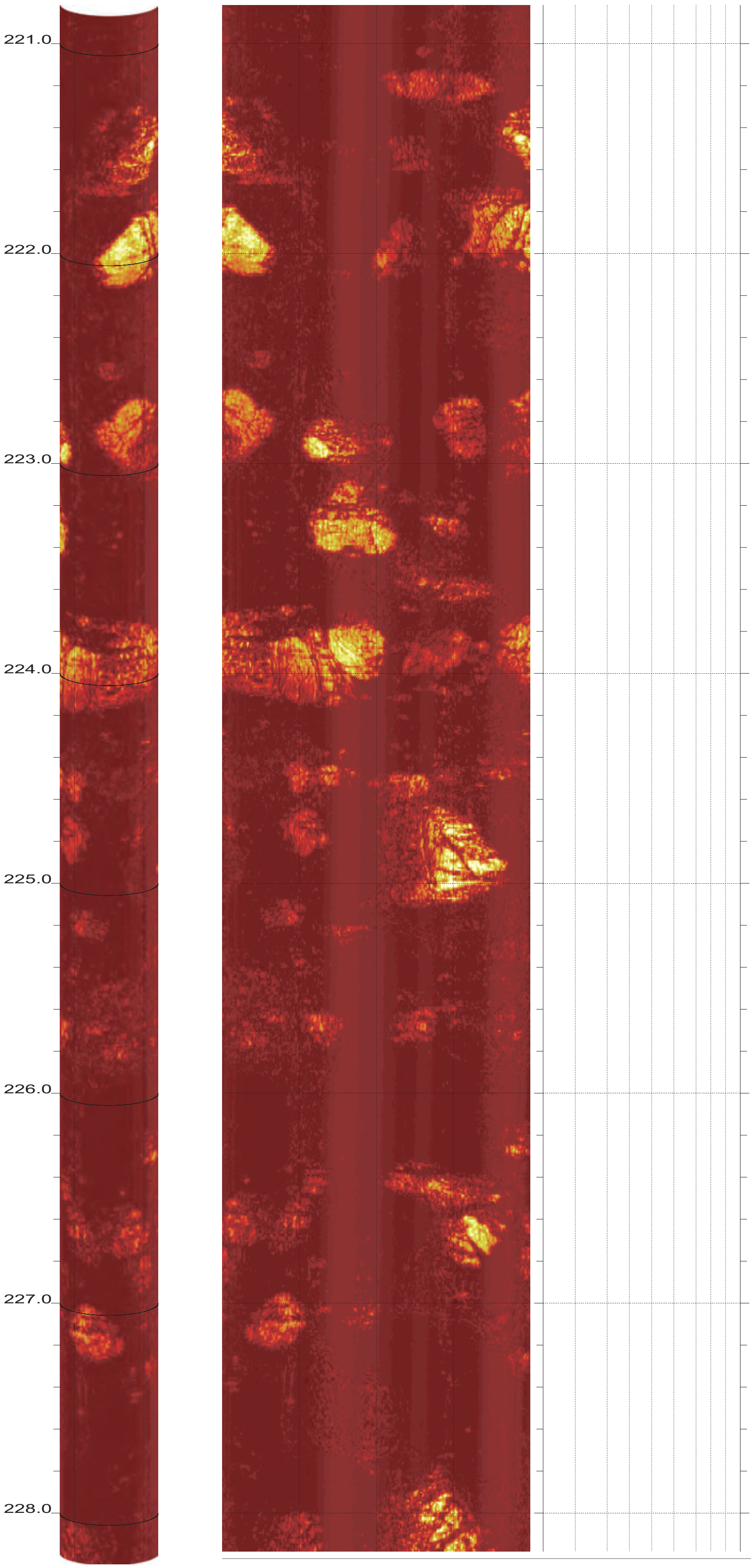
Z3-B1 213.448 to 206.080ft 26

SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 26 of 38



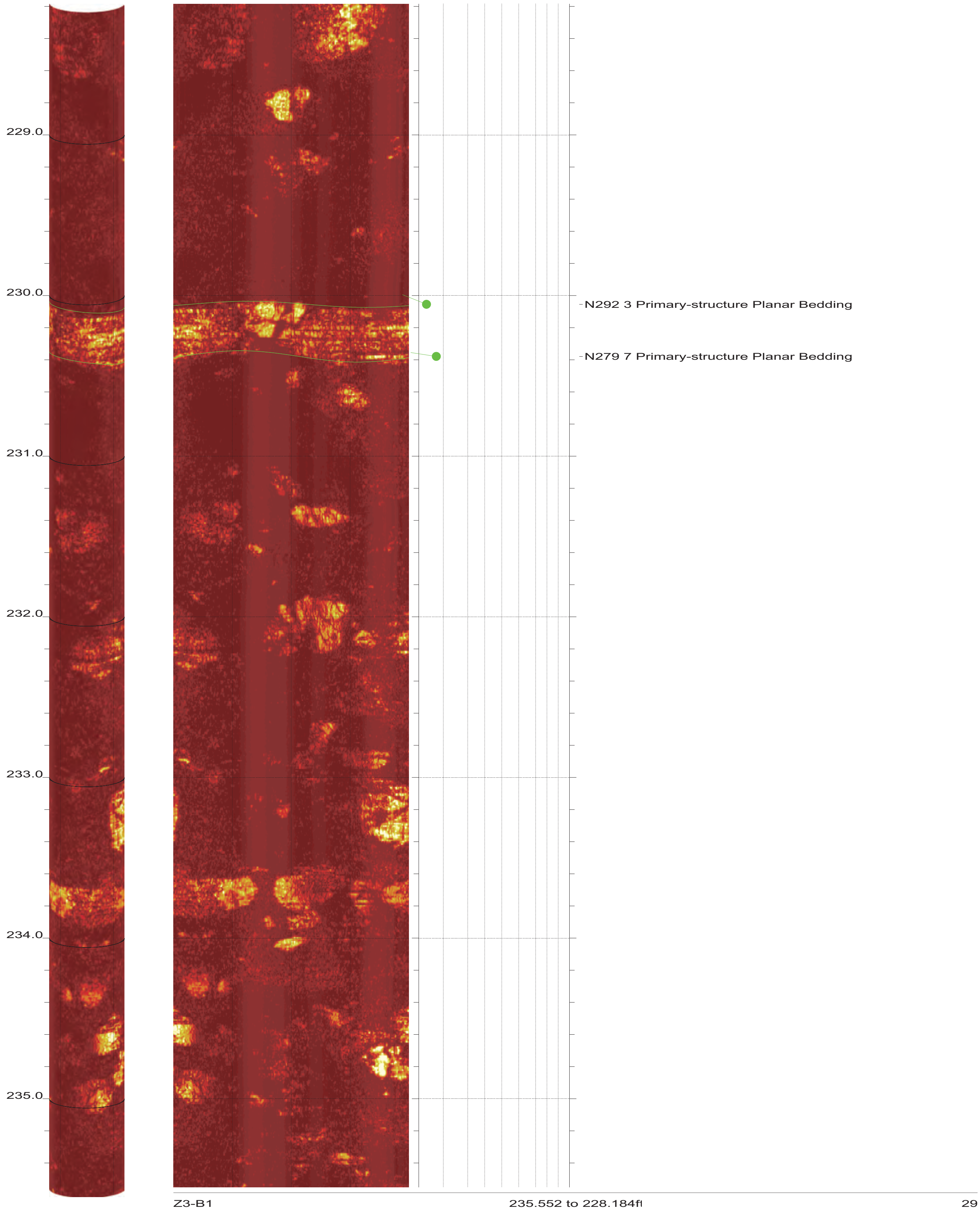
Z3-B1 220.816 to 213.448ft 27

SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 27 of 38

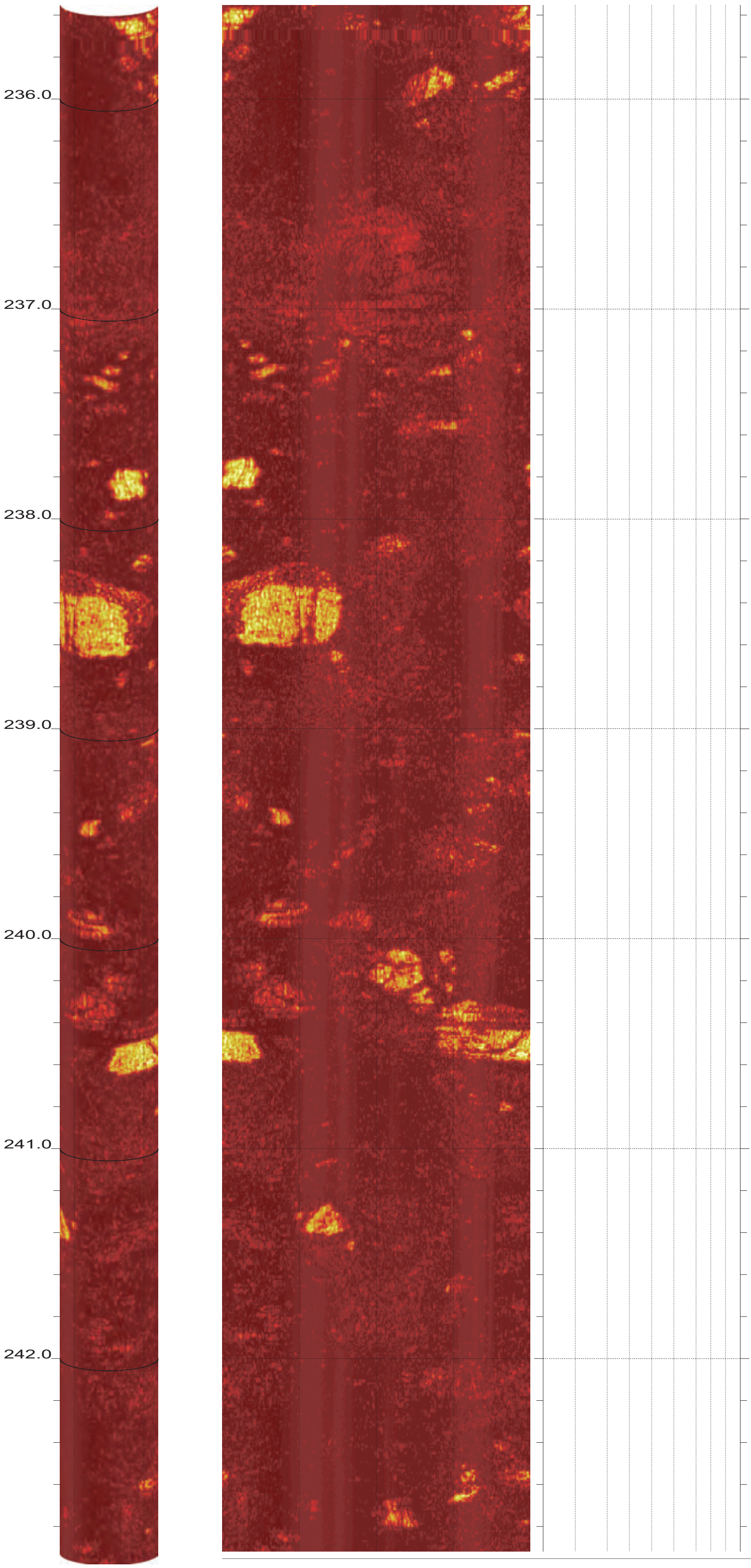


Z3-B1 228.184 to 220.816ft 28

SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 28 of 38

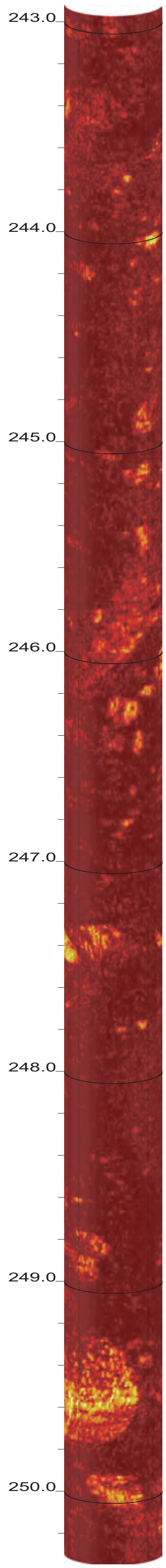


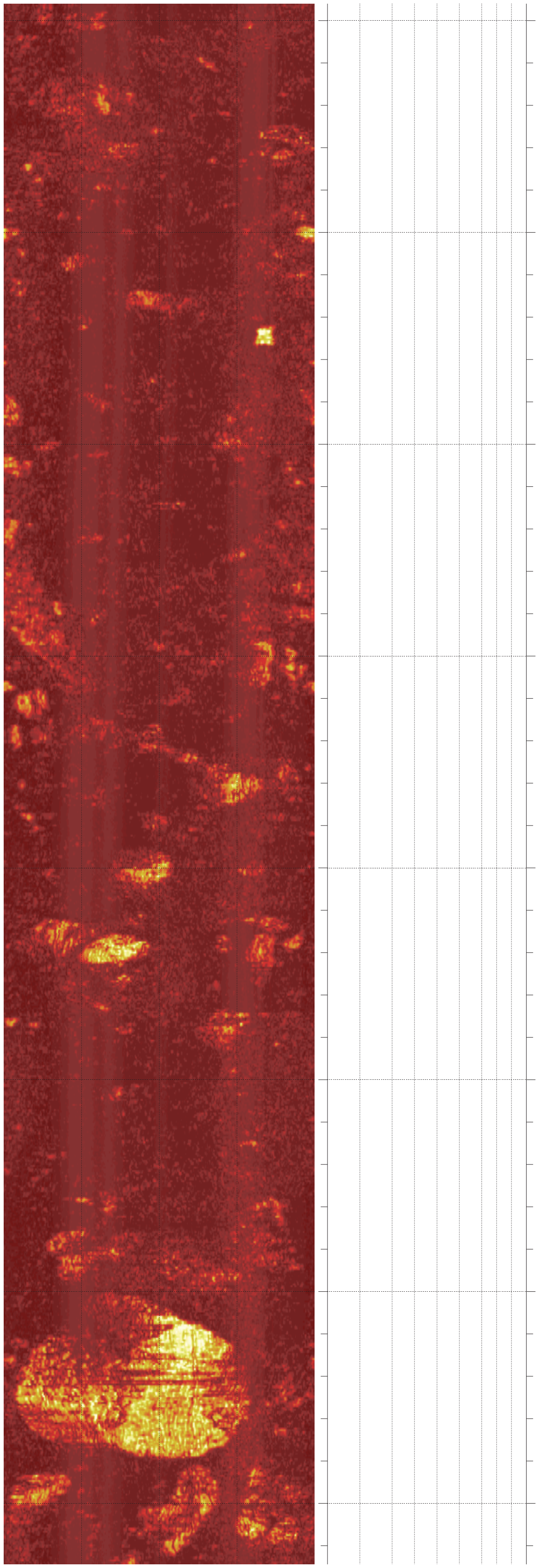
SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 29 of 38



Z3-B1 242.920 to 235.552ft 30

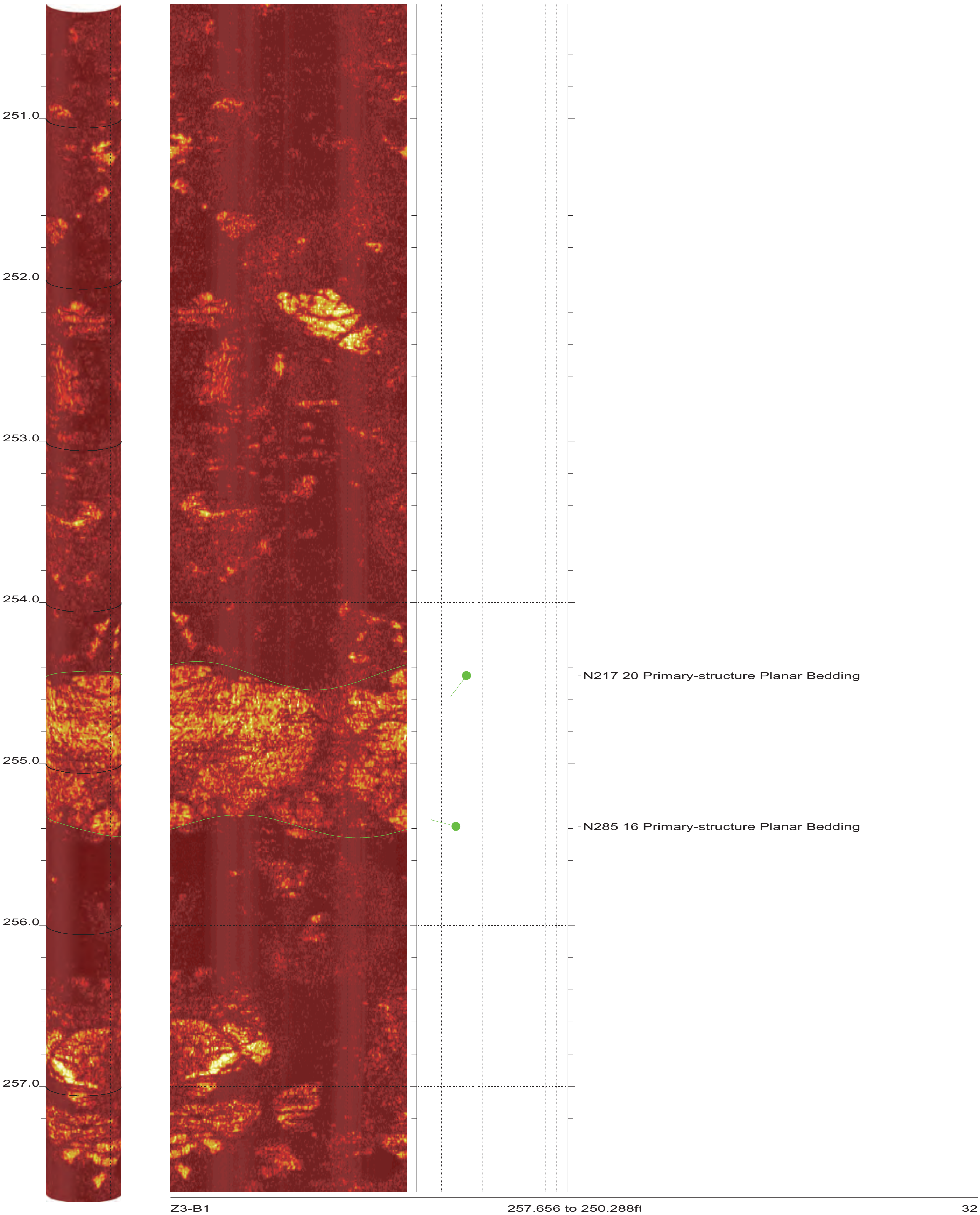
SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 30 of 38



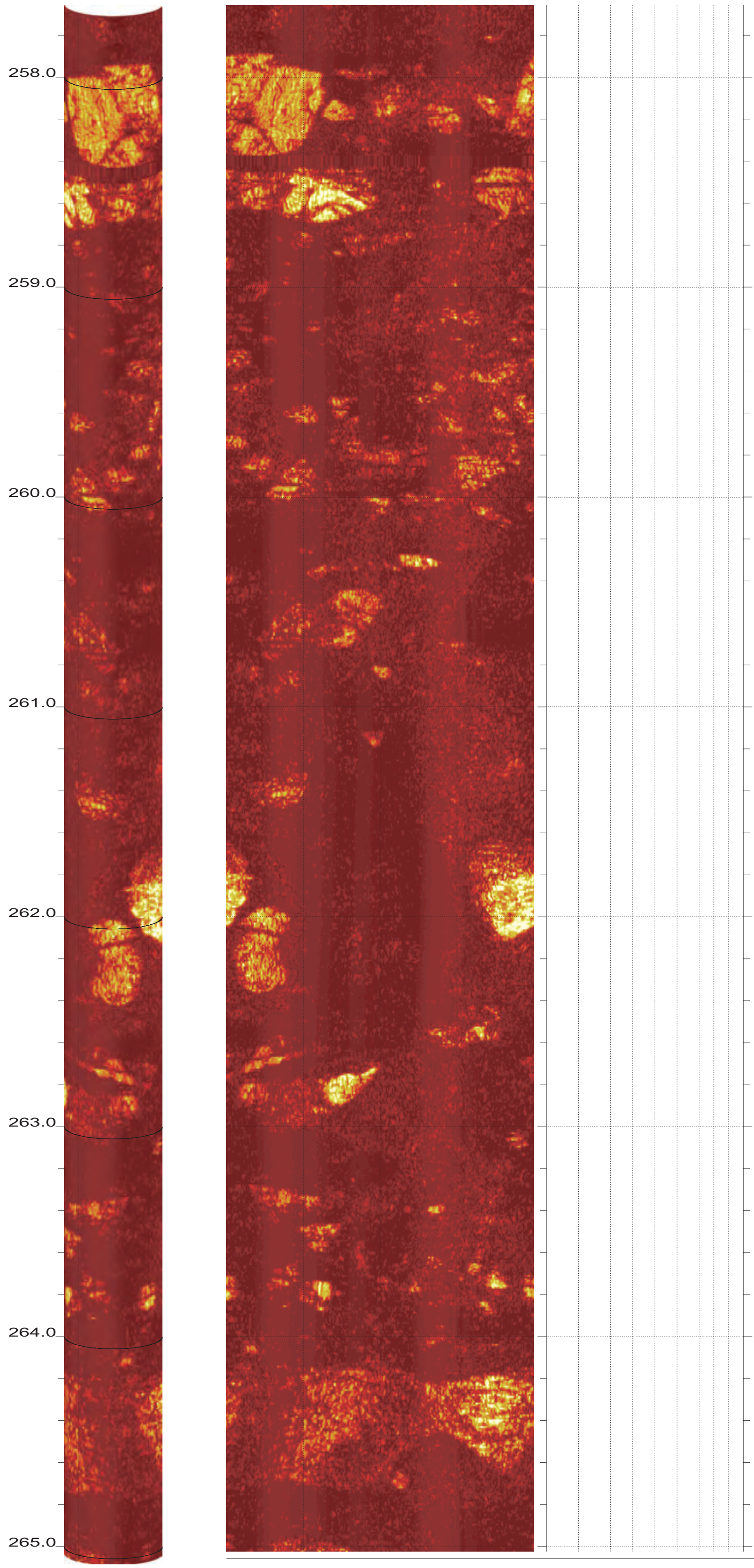


Z3-B1 250.288 to 242.920ft 31

SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 31 of 38

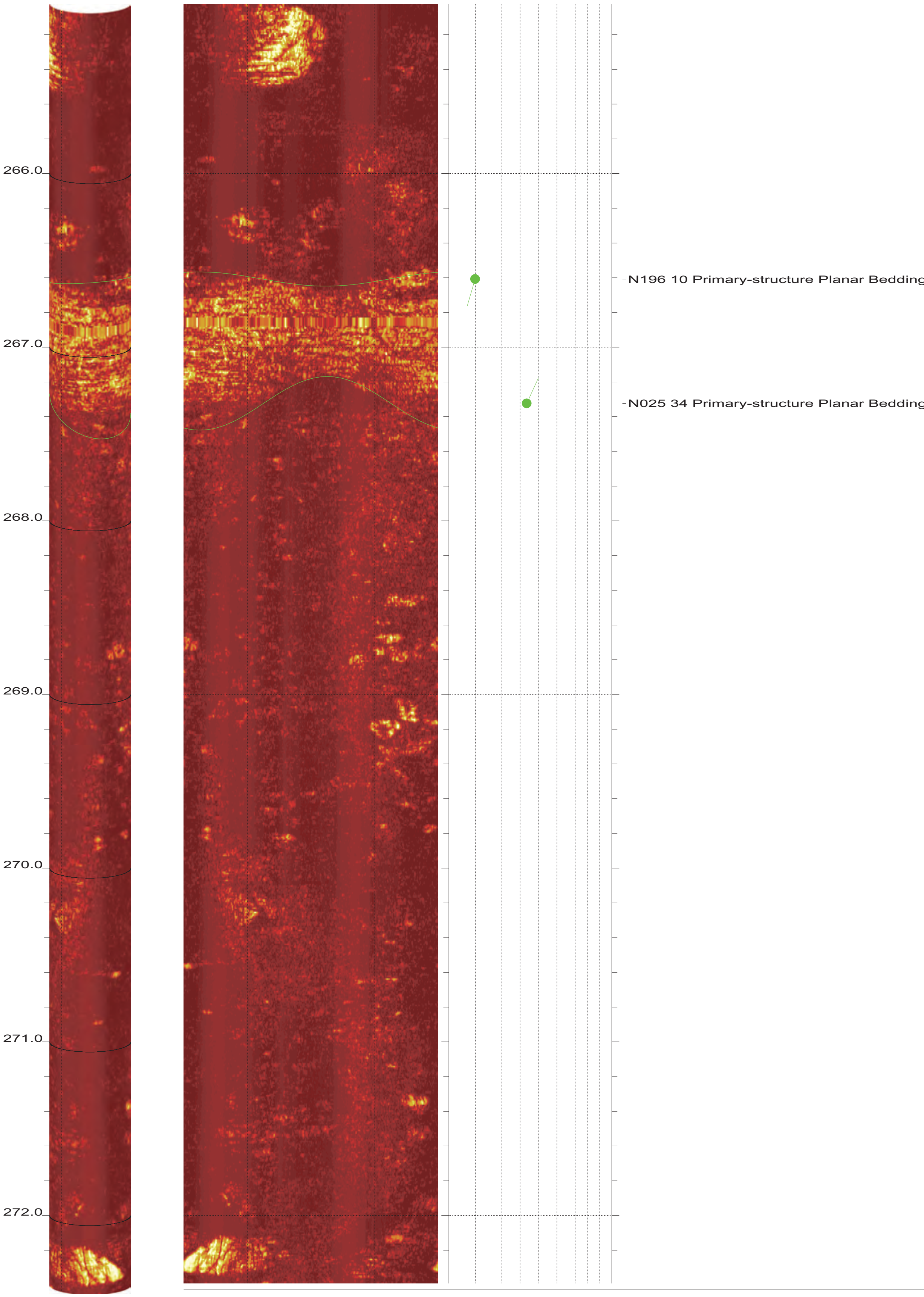


SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 32 of 38



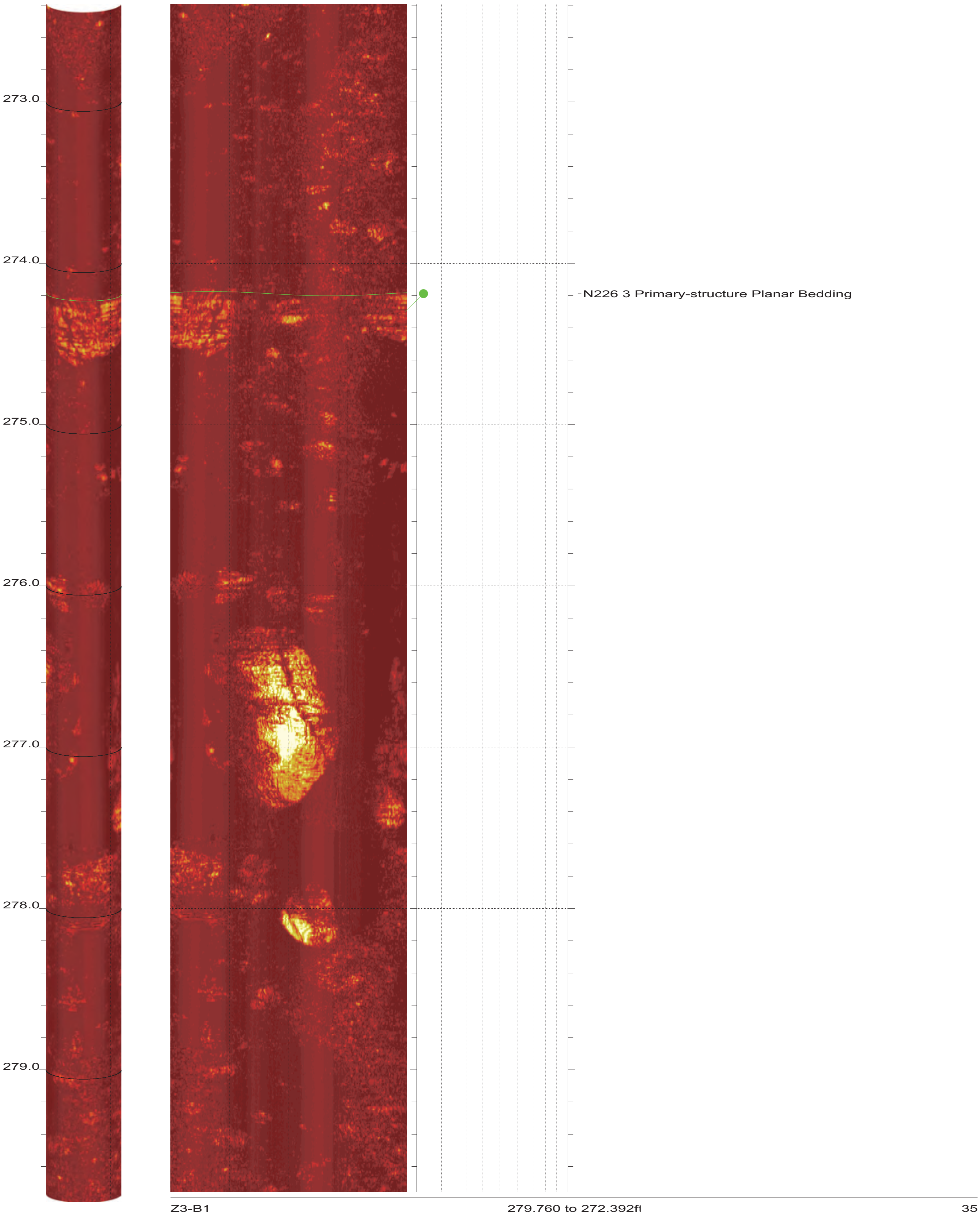
Z3-B1 265.024 to 257.656ft 33

SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 33 of 38

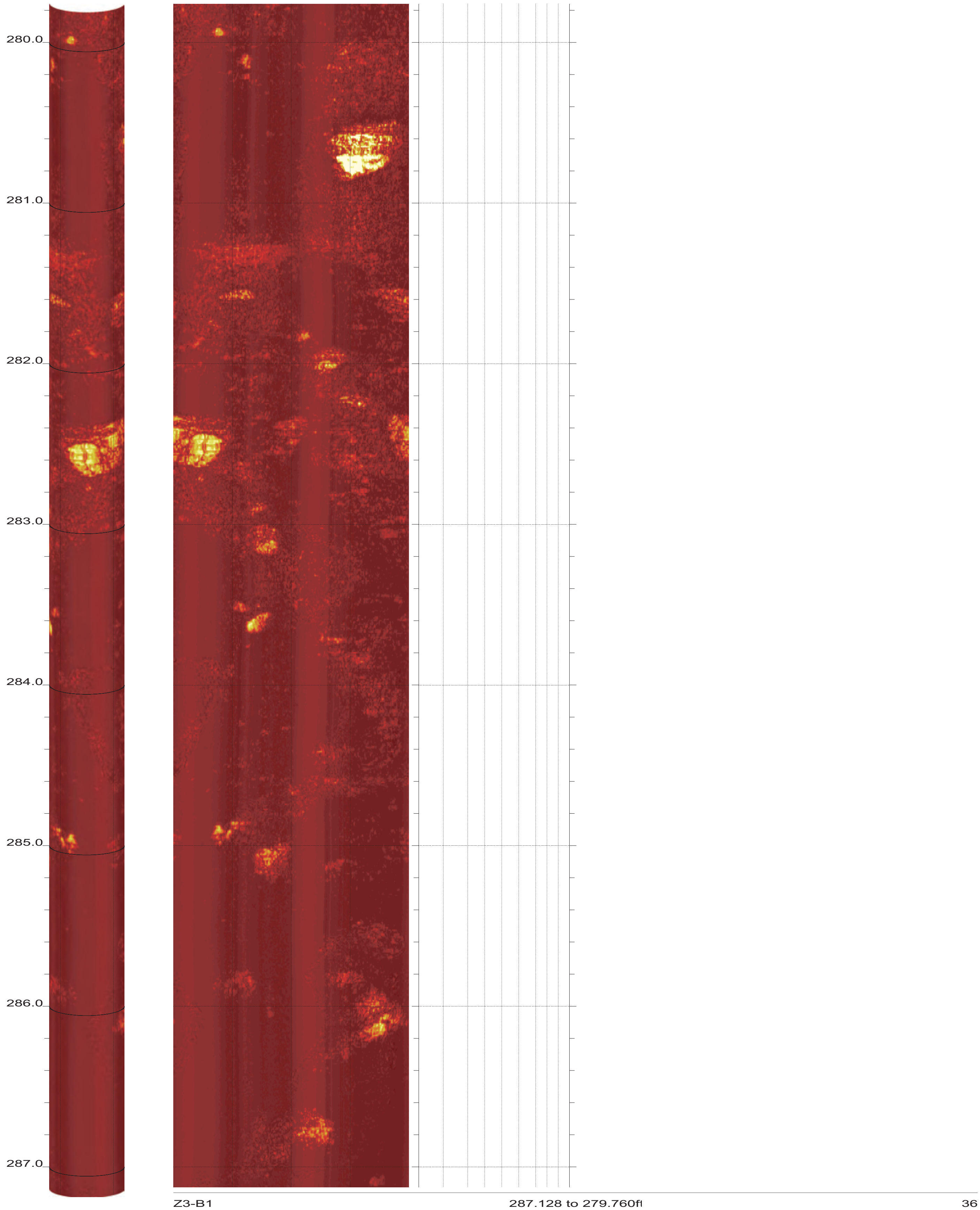


Z3-B1 272.392 to 265.024ft 34

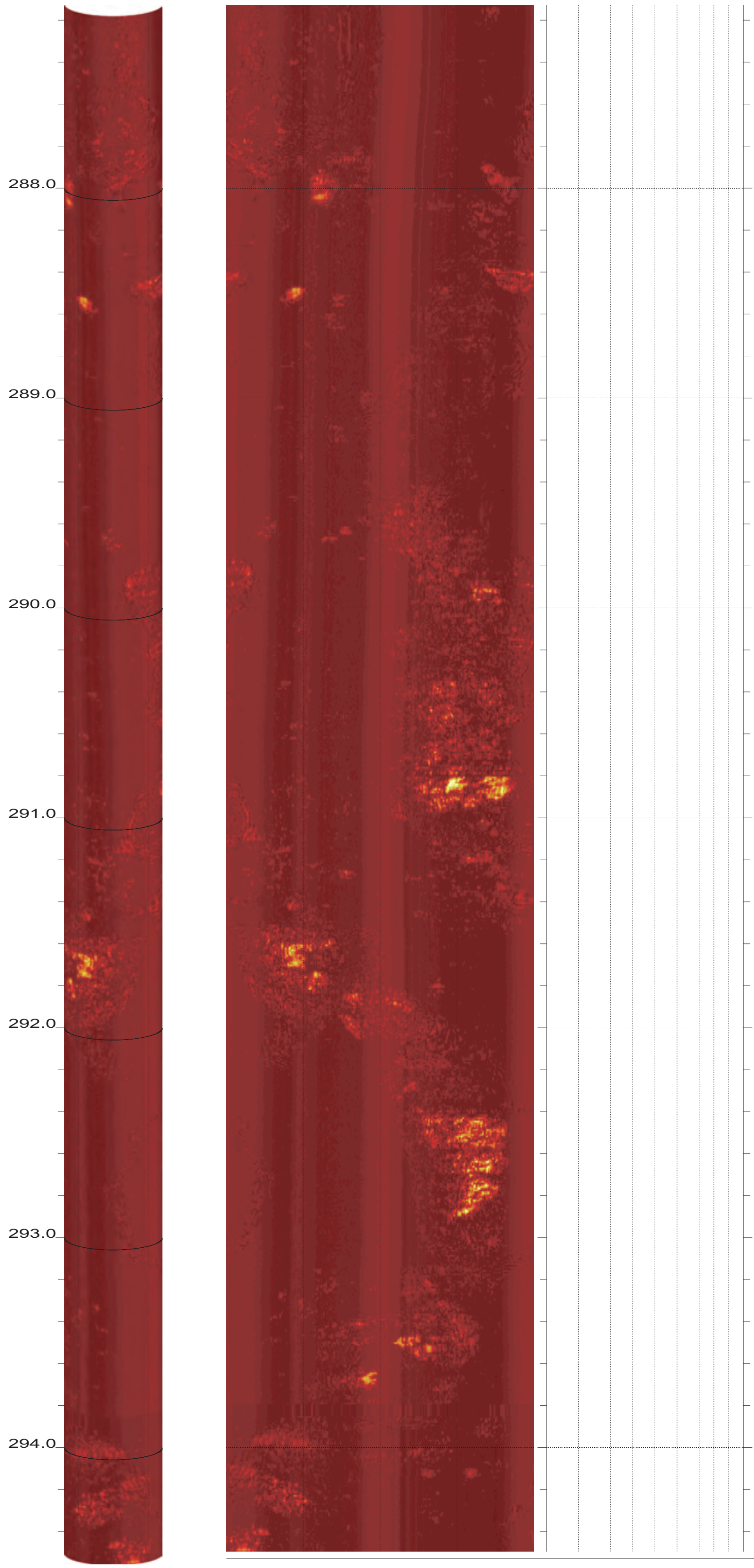
SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 34 of 38



SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 35 of 38

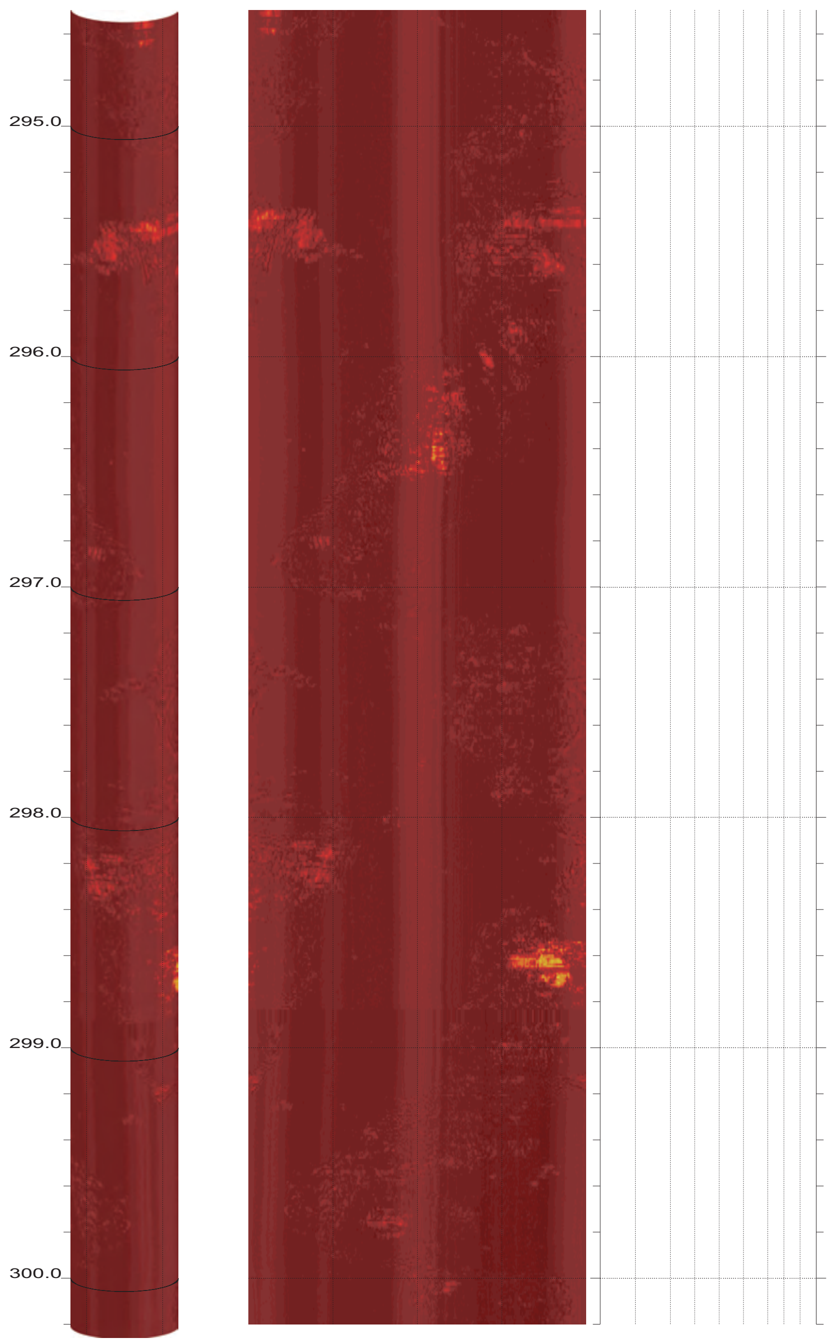


SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 36 of 38



Z3-B1 294.496 to 287.128ft 37

SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 37 of 38



SR-710 Boring Z3-B1 Acoustic Televiewer Dips rev 1 Sheet 38 of 38

BHTV DATA PROCESSING
RGLDIP vsn 6.2
INTERPRETED BHTV DIPS LOG

CASCADE DRILLING

Borehole: Z3-B3

SR-710 TUNNEL INVESTIGATION

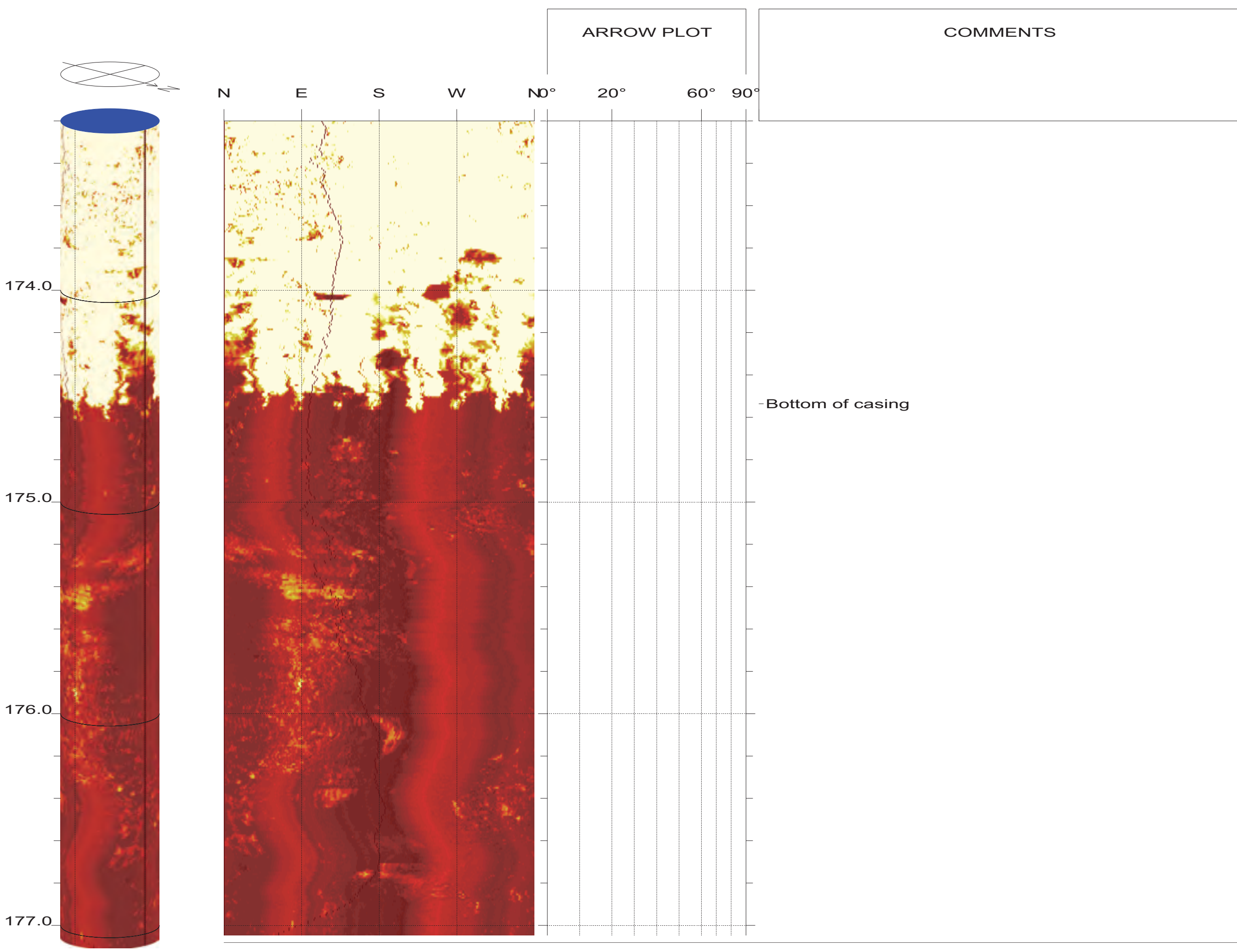
top of borehole.....	North ref. is true
East: _	Depth units are feet
North: _	Vertical scale: 1/10
Elev: _	Horiz scale = 1.00x Vert scale

Zone from 273.984 to 173.200ft	Borehole diam: 5.600inch
Format: BHTV-NESWN	Vertical = borehole-axis
	Image: Amplitude

Stratigraphic dips

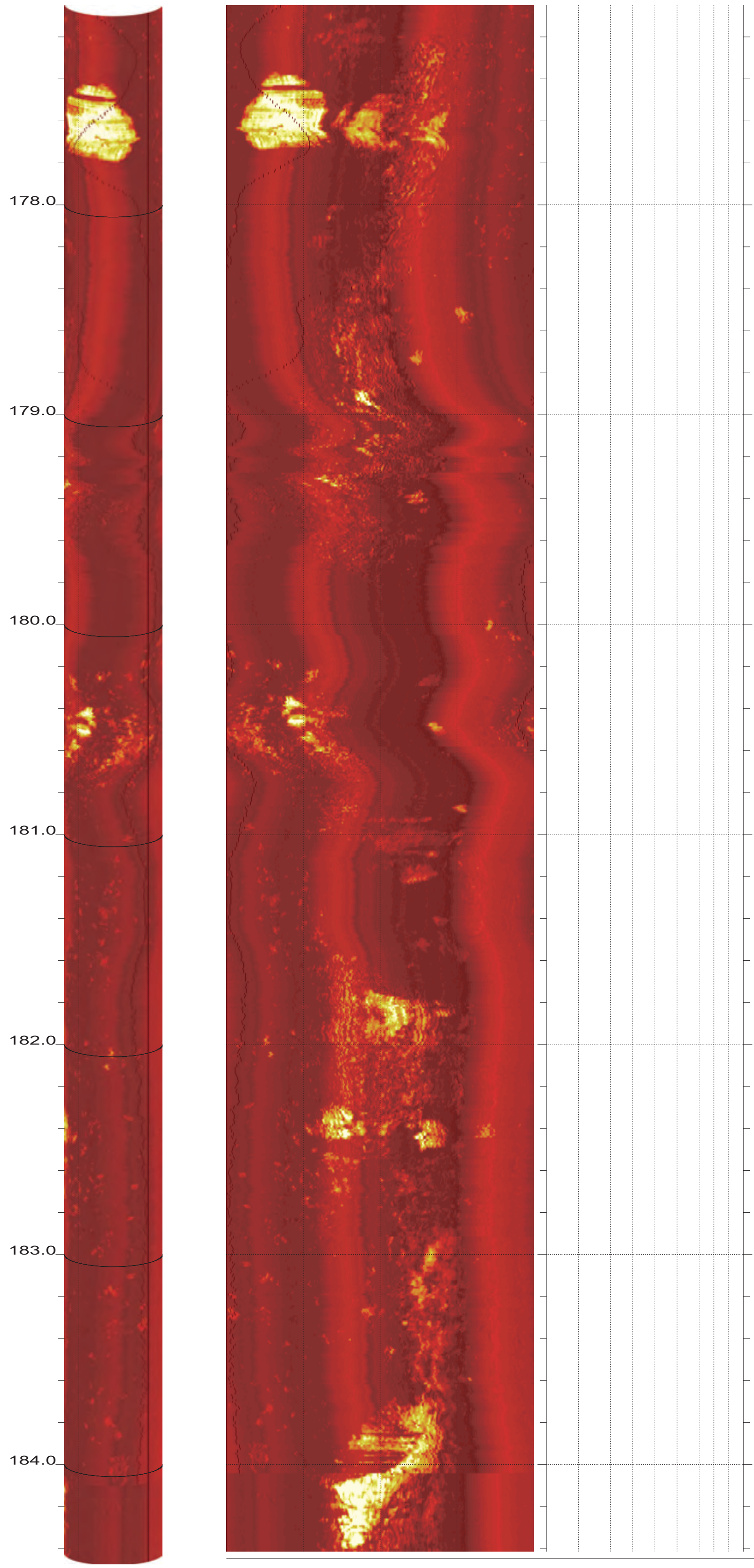
Non-stratigraphic dips

Identified units



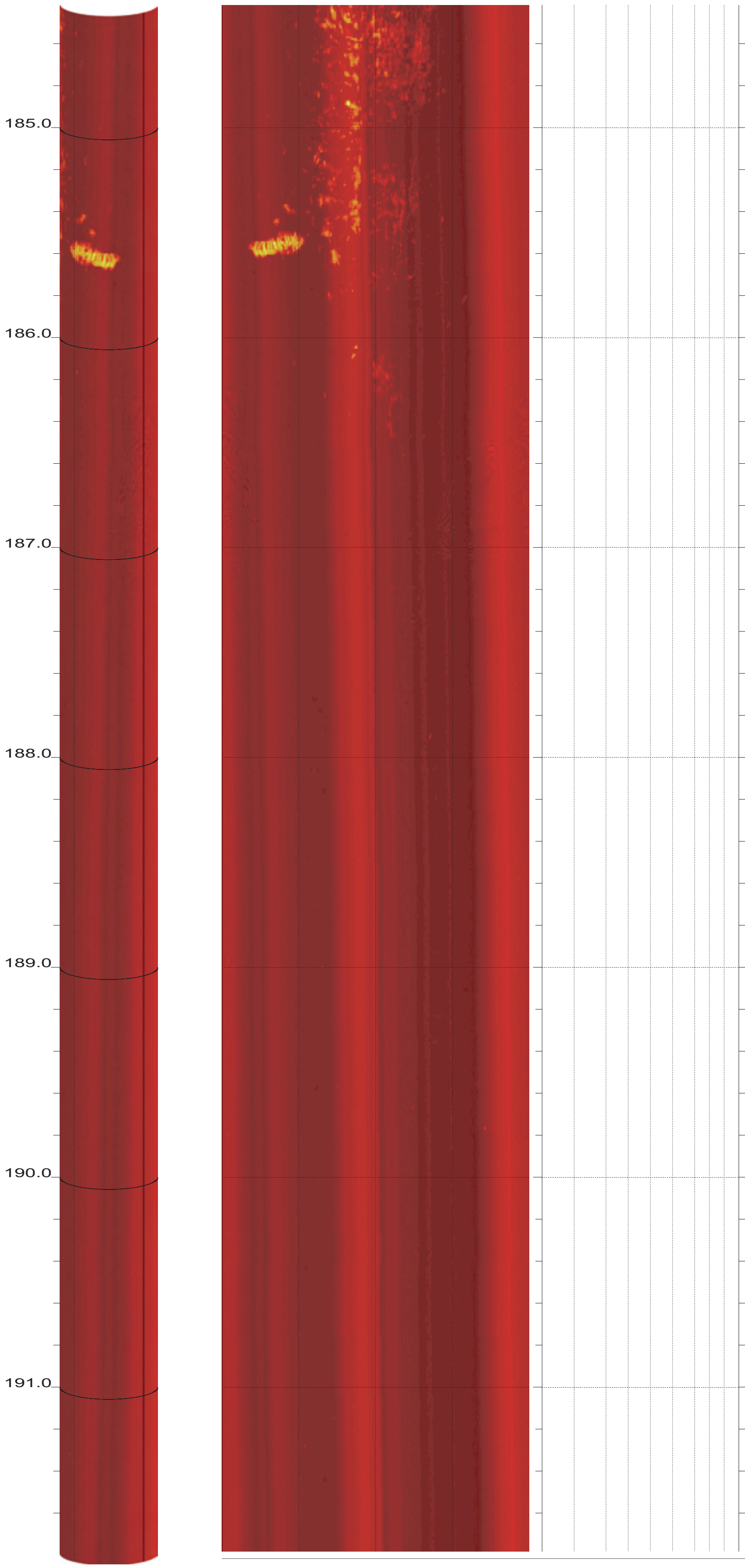
Z3-B3 177.048 to 173.200ft 1

SR-710 Boring Z3-B3 Acoustic Televiewer Dips rev 1 Sheet 1 of 15



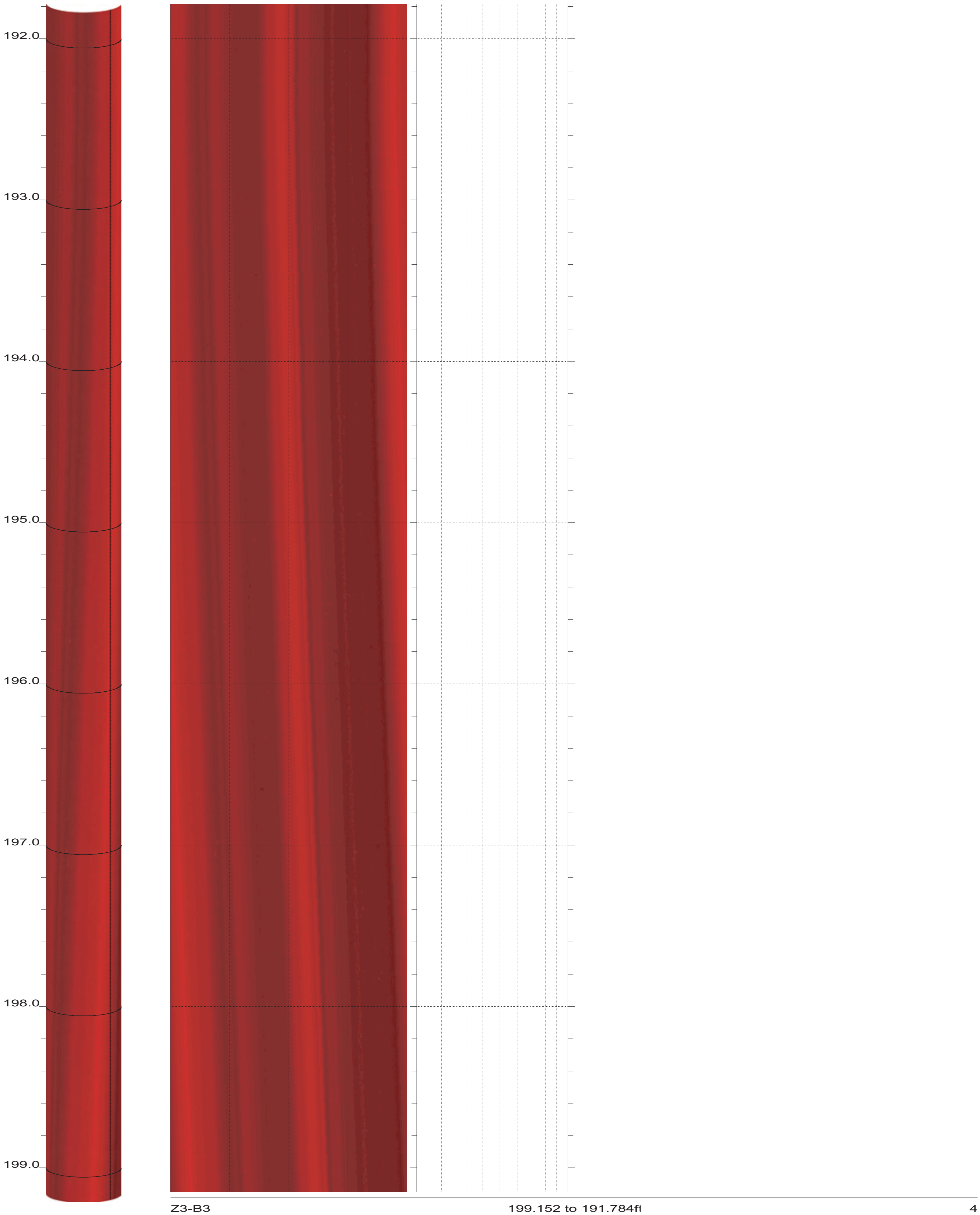
Z3-B3 184.416 to 177.048ft 2

SR-710 Boring Z3-B3 Acoustic Televiewer Dips rev 1 Sheet 2 of 15

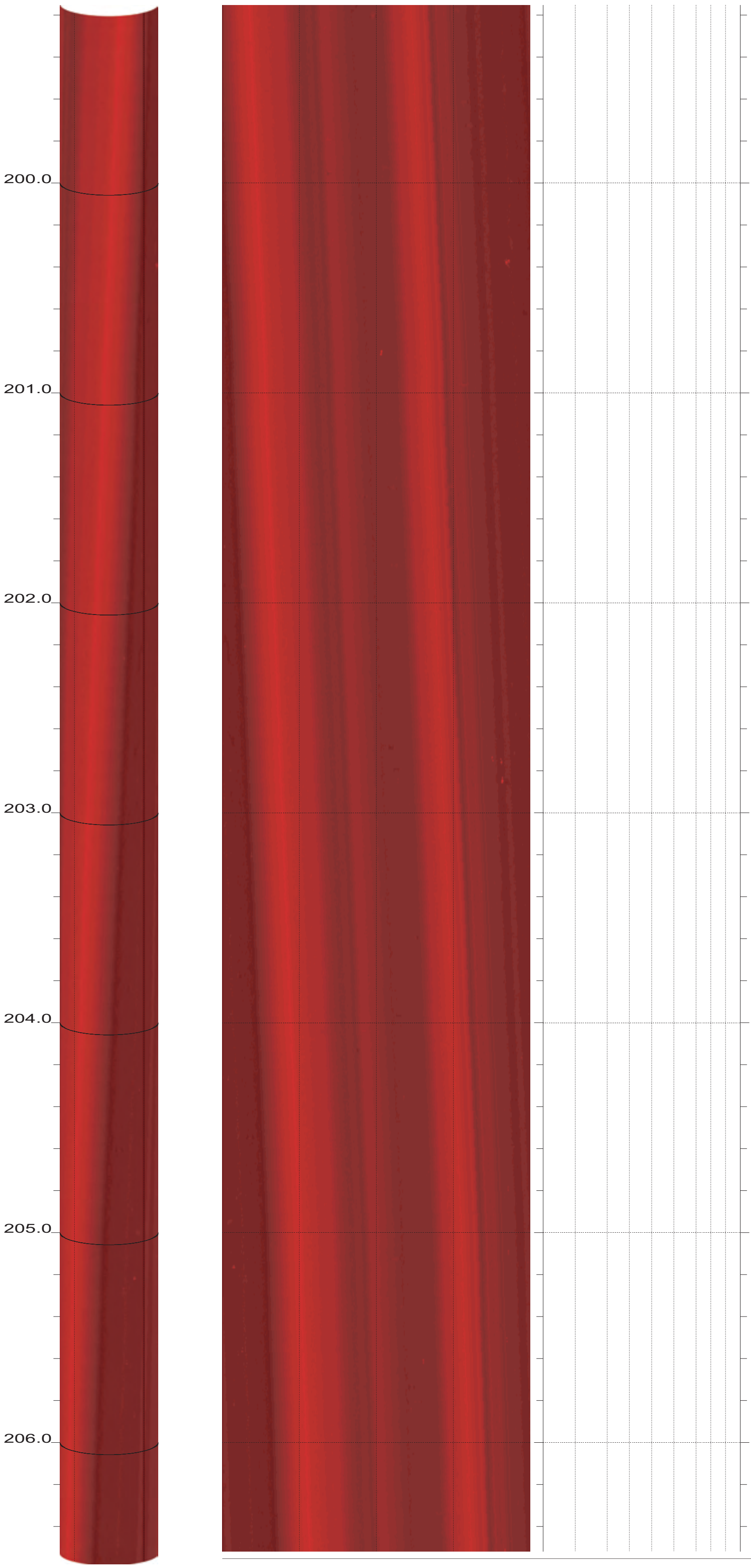


Z3-B3 191.784 to 184.416ft 3

SR-710 Boring Z3-B3 Acoustic Televiewer Dips rev 1 Sheet 3 of 15

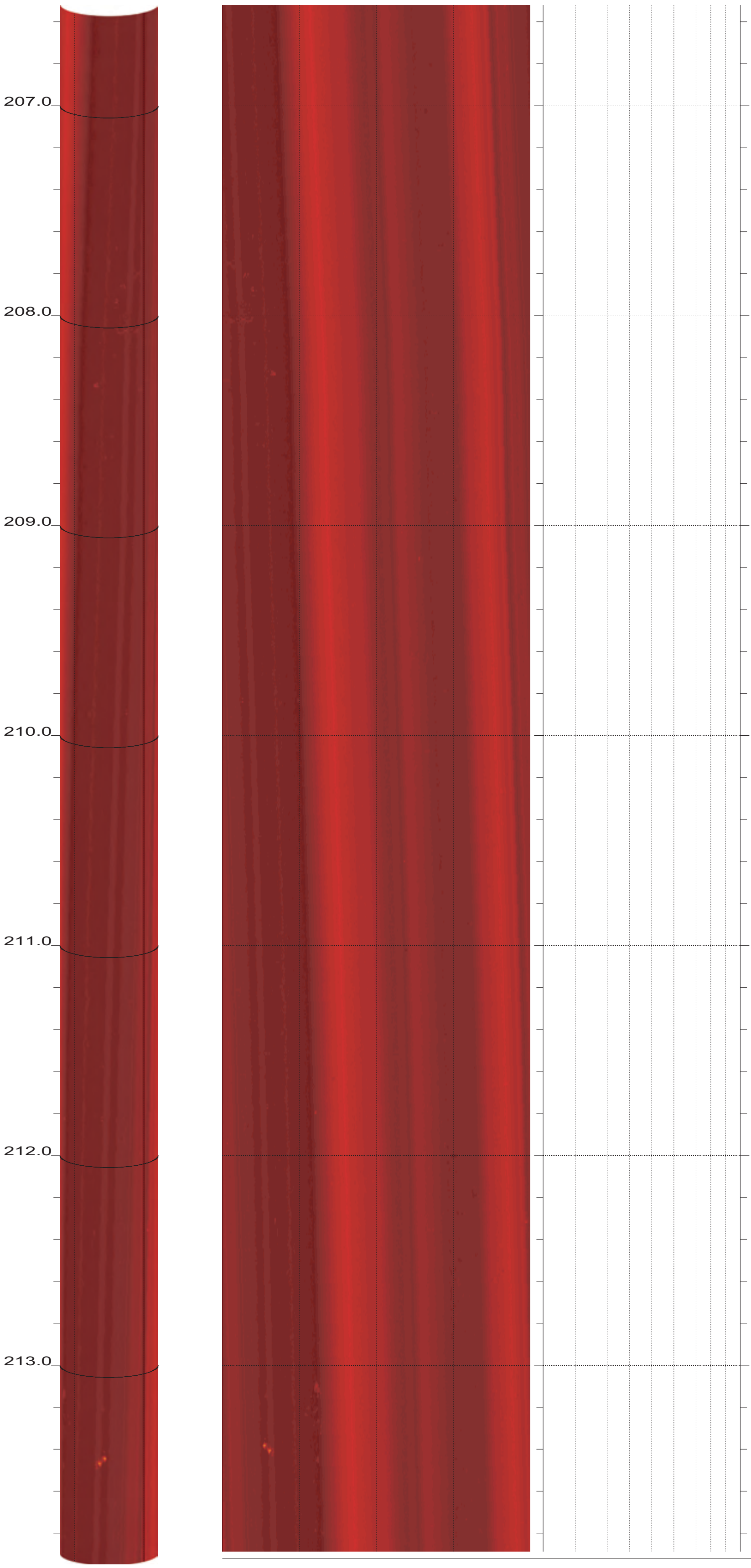


SR-710 Boring Z3-B3 Acoustic Televiewer Dips rev 1 Sheet 4 of 15



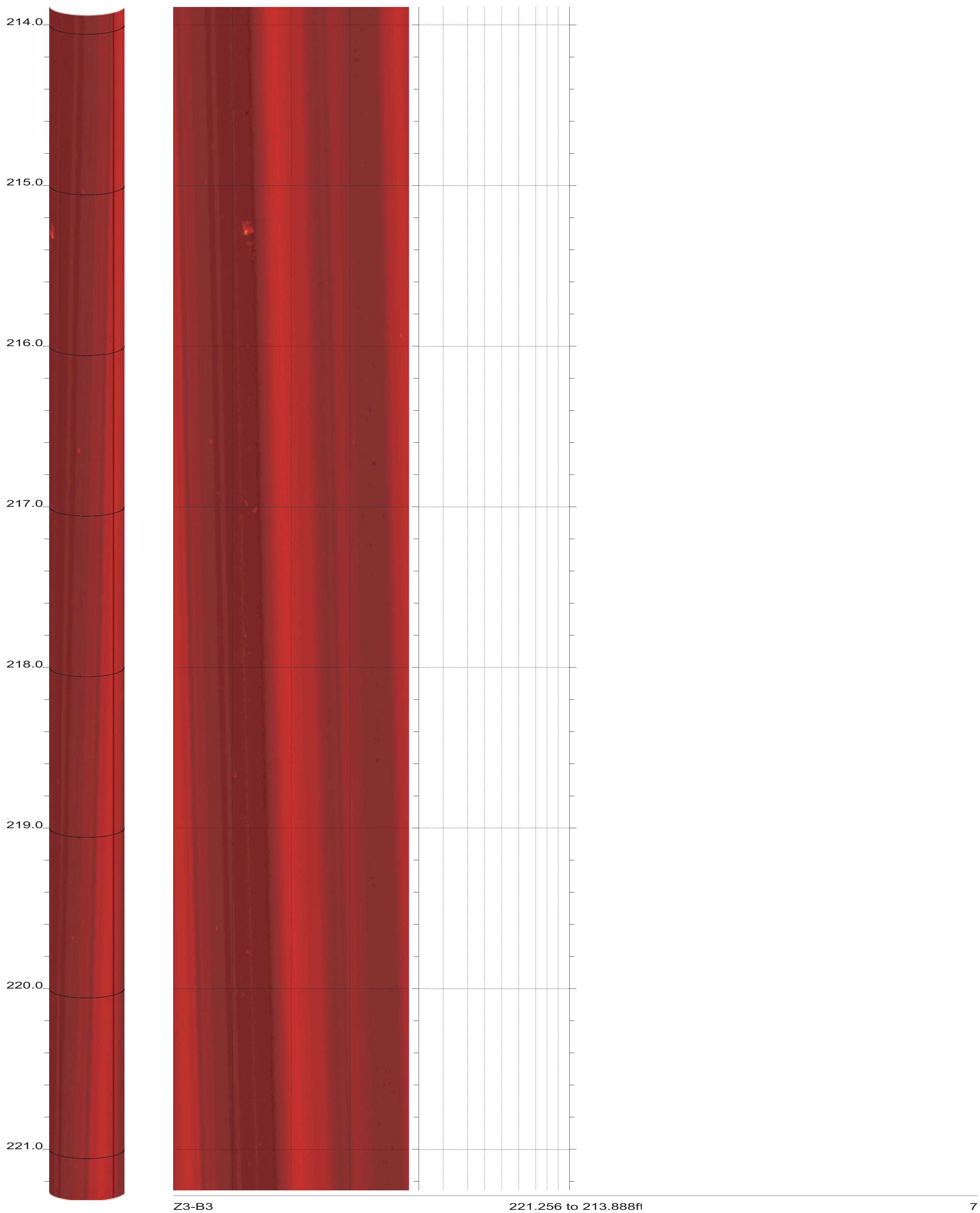
Z3-B3 206.520 to 199.152ft 5

SR-710 Boring Z3-B3 Acoustic Televiewer Dips rev 1 Sheet 5 of 15

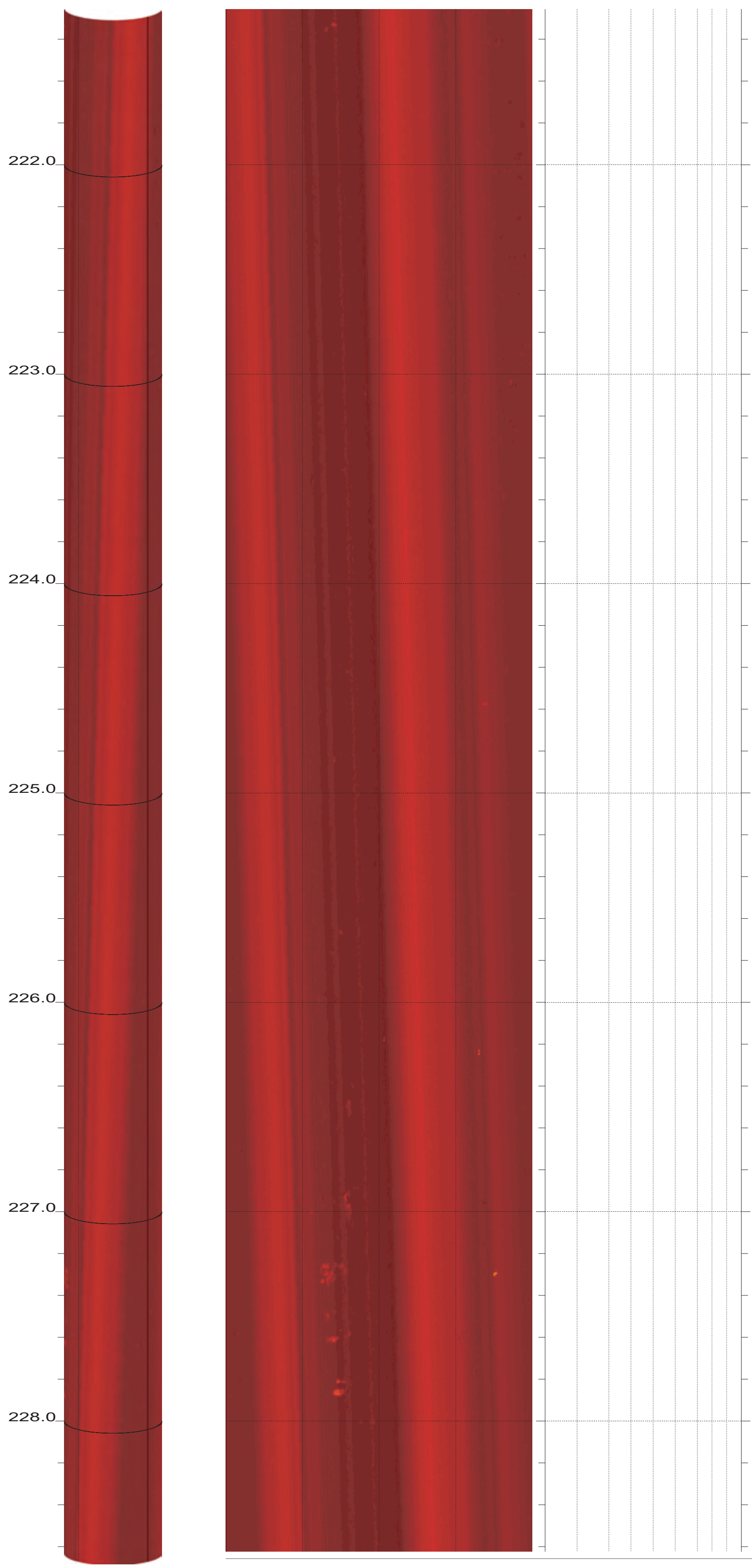


Z3-B3 213.888 to 206.520ft 6

SR-710 Boring Z3-B3 Acoustic Televiewer Dips rev 1 Sheet 6 of 15

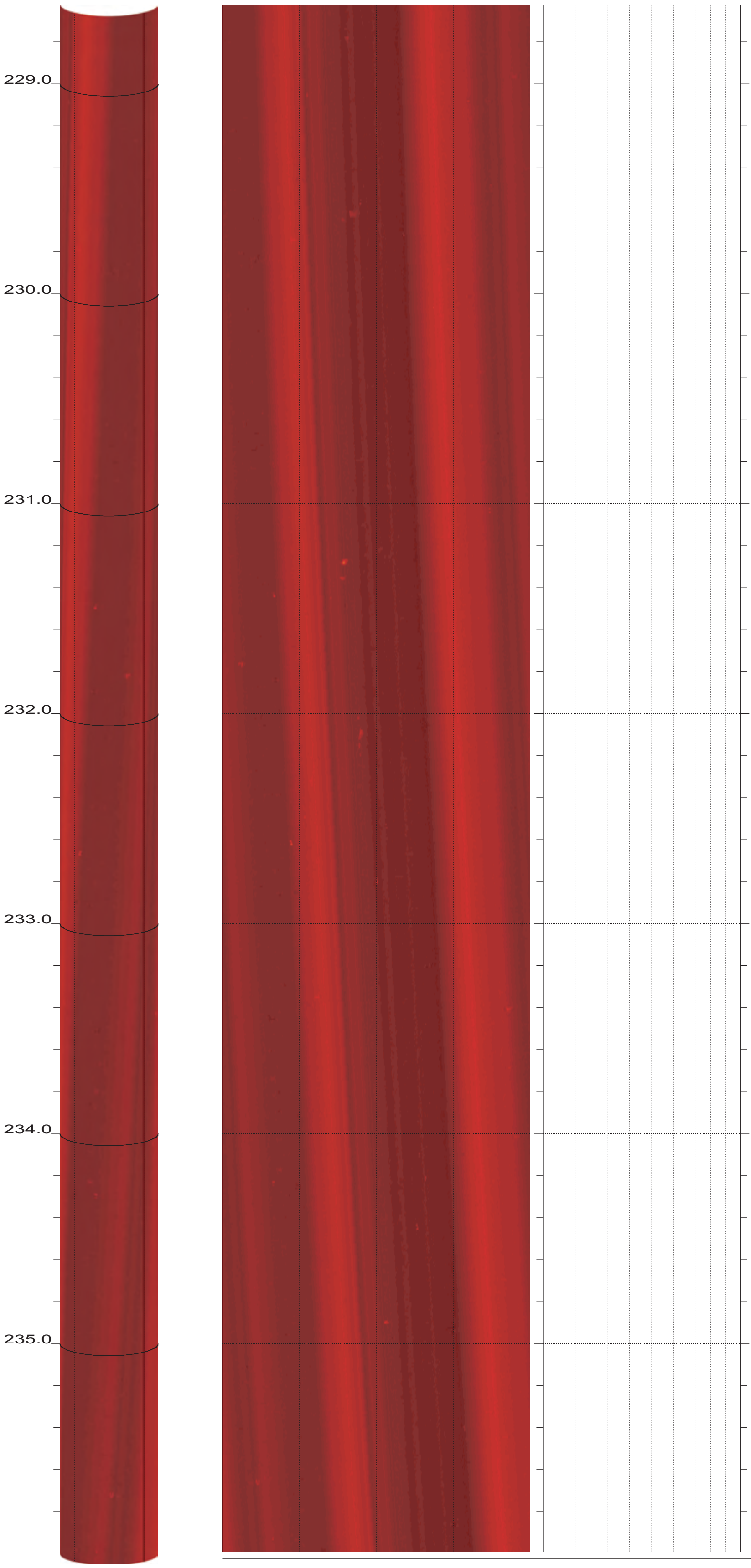


SR-710 Boring Z3-B3 Acoustic Televiewer Dips rev 1 Sheet 7 of 15



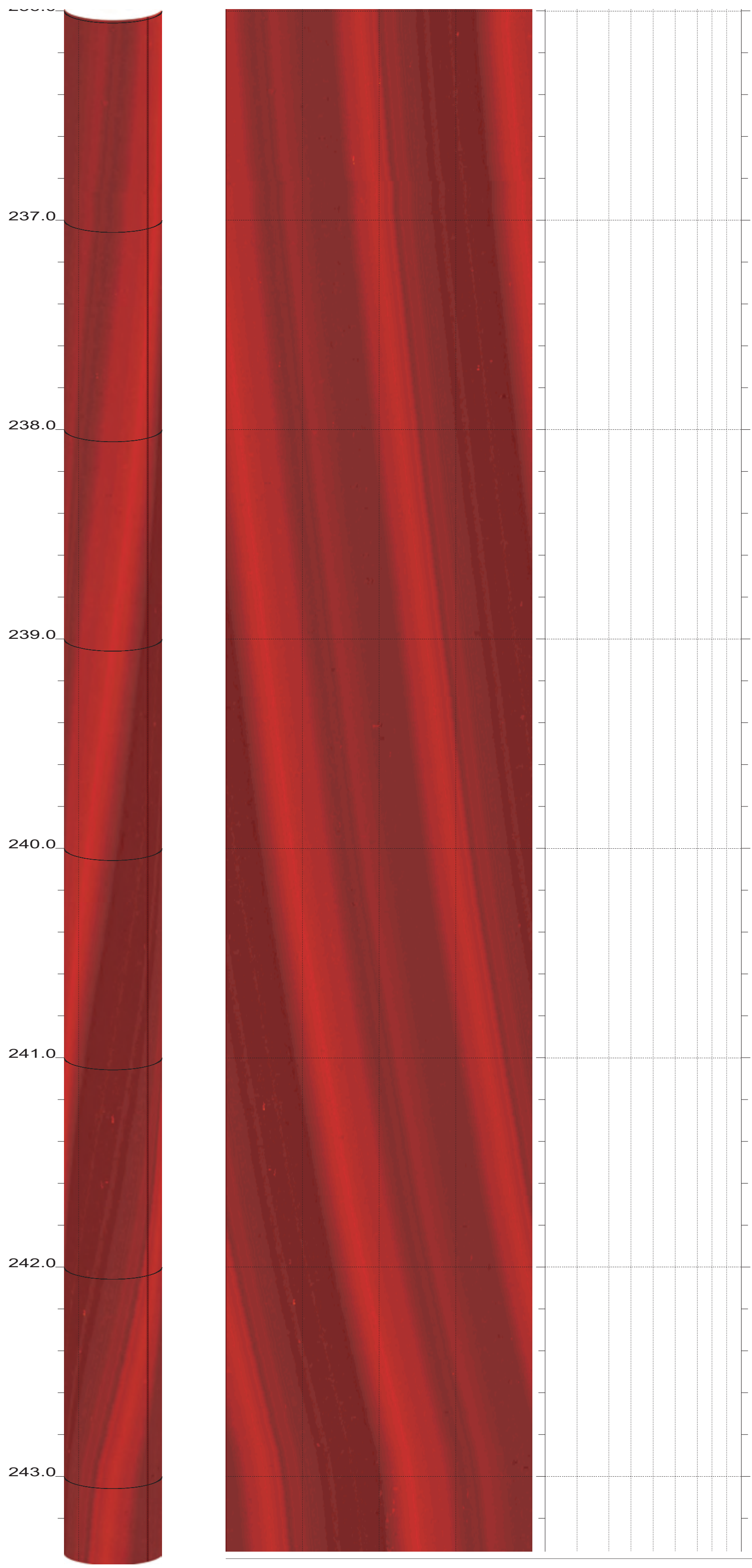
Z3-B3 228.624 to 221.256ft 8

SR-710 Boring Z3-B3 Acoustic Televiewer Dips rev 1 Sheet 8 of 15



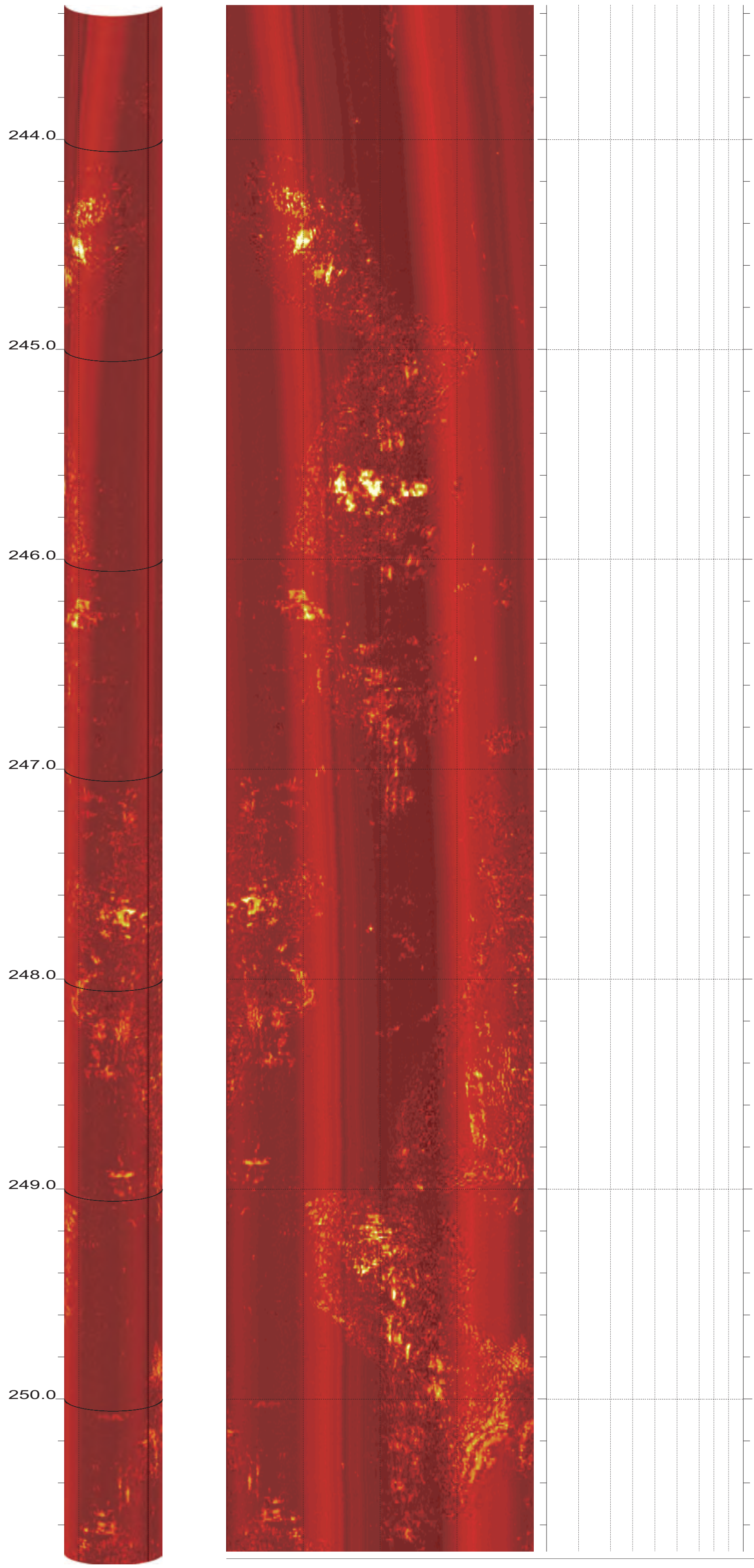
Z3-B3 235.992 to 228.624ft 9

SR-710 Boring Z3-B3 Acoustic Televiewer Dips rev 1 Sheet 9 of 15



Z3-B3 243.360 to 235.992ft 10

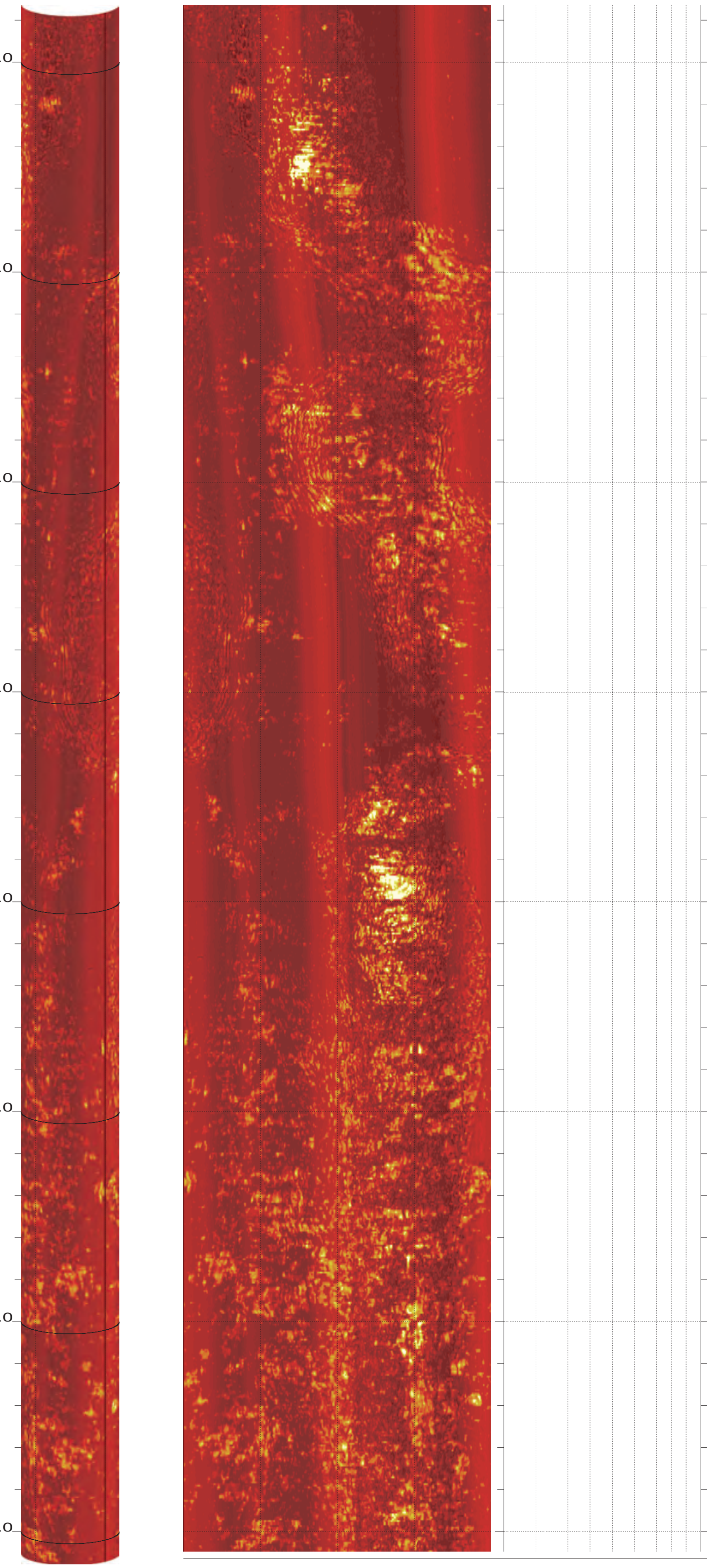
SR-710 Boring Z3-B3 Acoustic Televiewer Dips rev 1 Sheet 10 of 15



Z3-B3 250.728 to 243.360ft 11

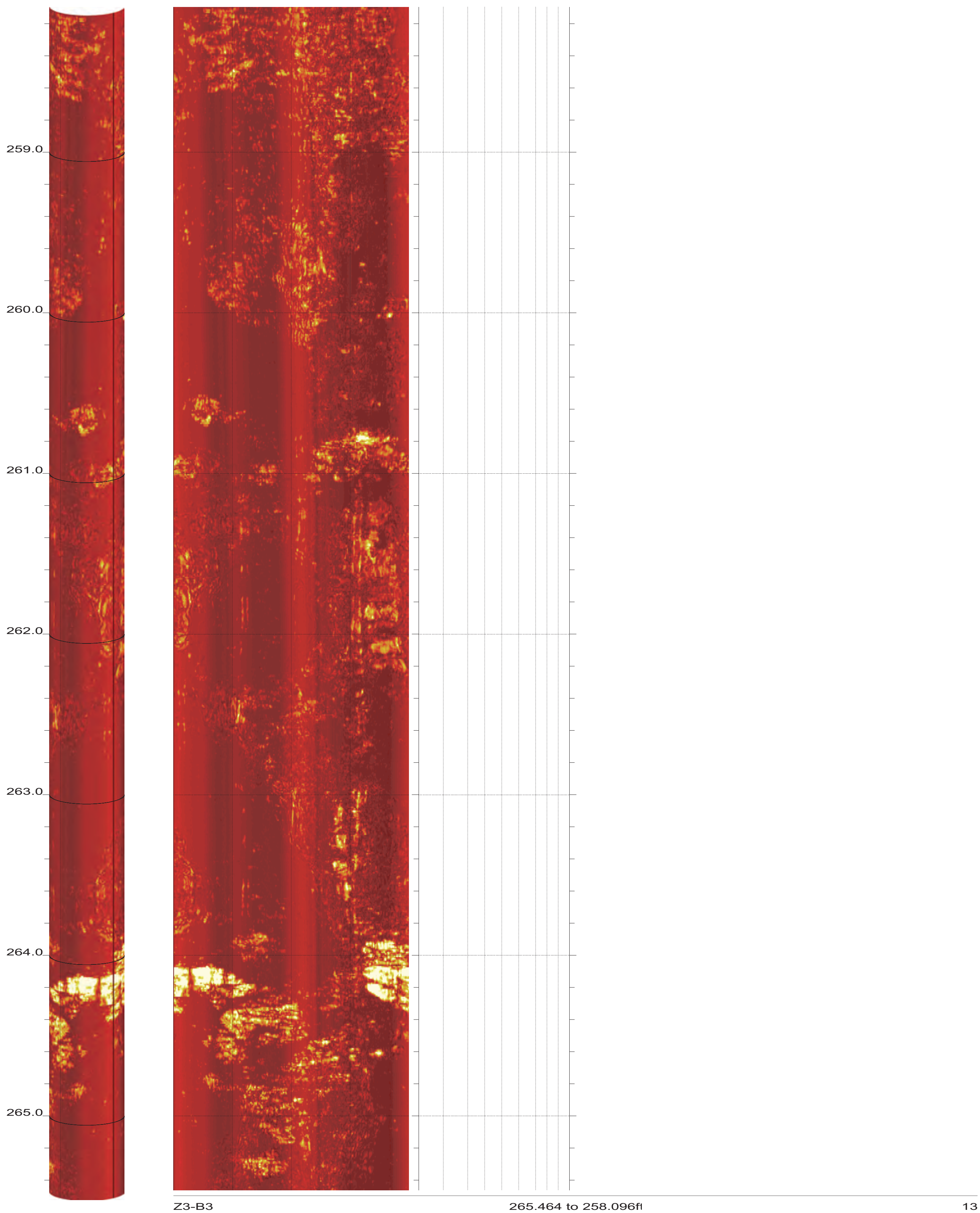
SR-710 Boring Z3-B3 Acoustic Televiewer Dips rev 1 Sheet 11 of 15

251.0
252.0
253.0
254.0
255.0
256.0
257.0
258.0

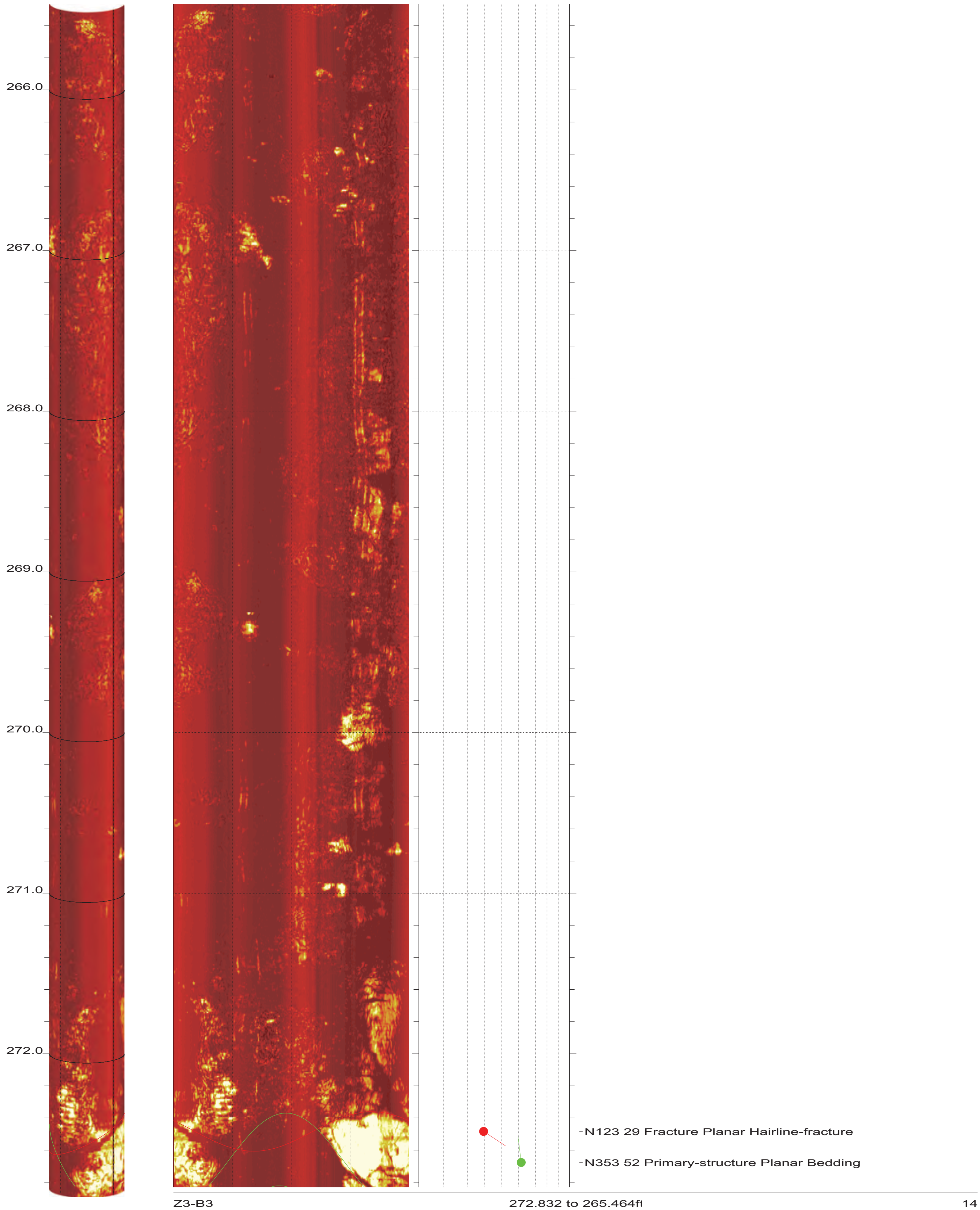


Z3-B3 258.096 to 250.728ft 12

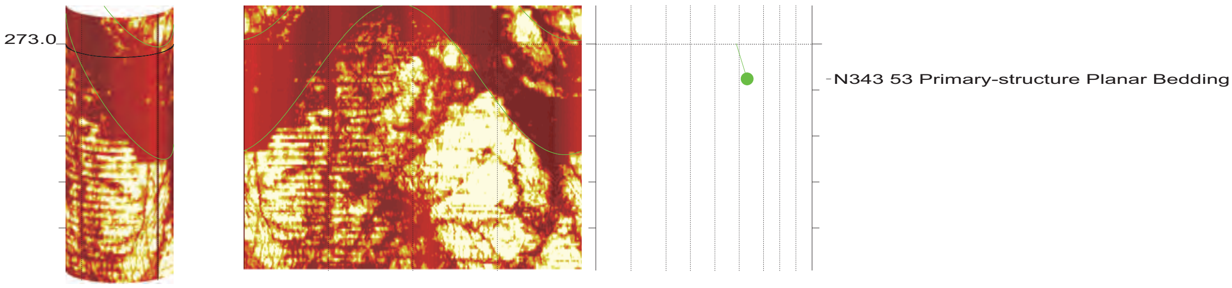
SR-710 Boring Z3-B3 Acoustic Televiewer Dips rev 1 Sheet 12 of 15



SR-710 Boring Z3-B3 Acoustic Televiewer Dips rev 1 Sheet 13 of 15



SR-710 Boring Z3-B3 Acoustic Televiewer Dips rev 1 Sheet 14 of 15


273.0
N343 53 Primary-structure Planar Bedding

BHTV DATA PROCESSING
RGLDIP vsn 6.2
INTERPRETED BHTV DIPS LOG

CASCADE DRILLING

Borehole: Z3-B4

SR-710 TUNNEL INVESTIGATION

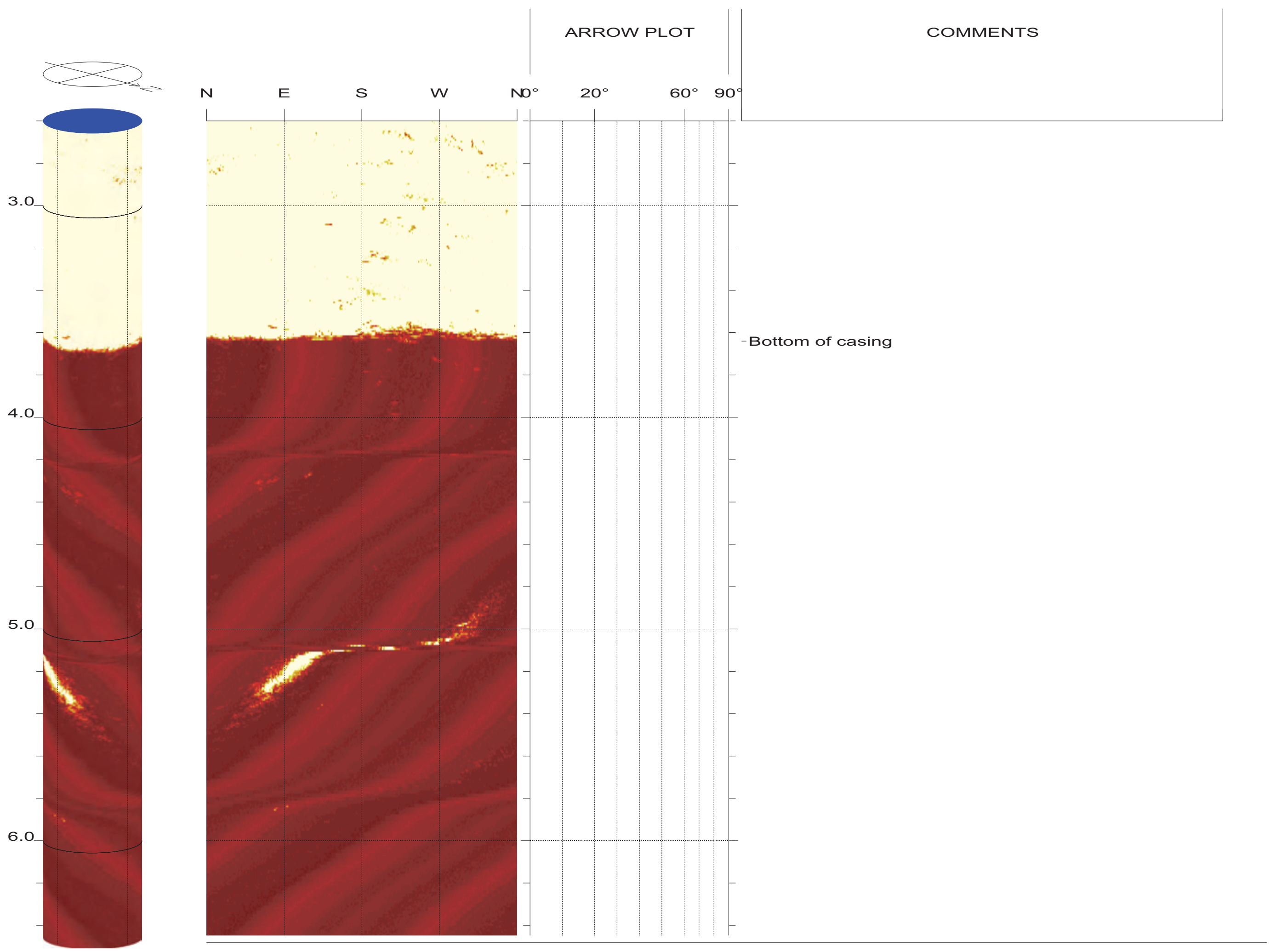
top of borehole.....	North ref. is true
East: _	Depth units are feet
North: _	Vertical scale: 1/10
Elev: _	Horiz scale = 1.00x Vert scale

Zone from 275.000 to 2.600ft	Borehole diam: 5.600inch
Format: BHTV-NESWN	Vertical = borehole-axis
	Image: Amplitude

Stratigraphic dips

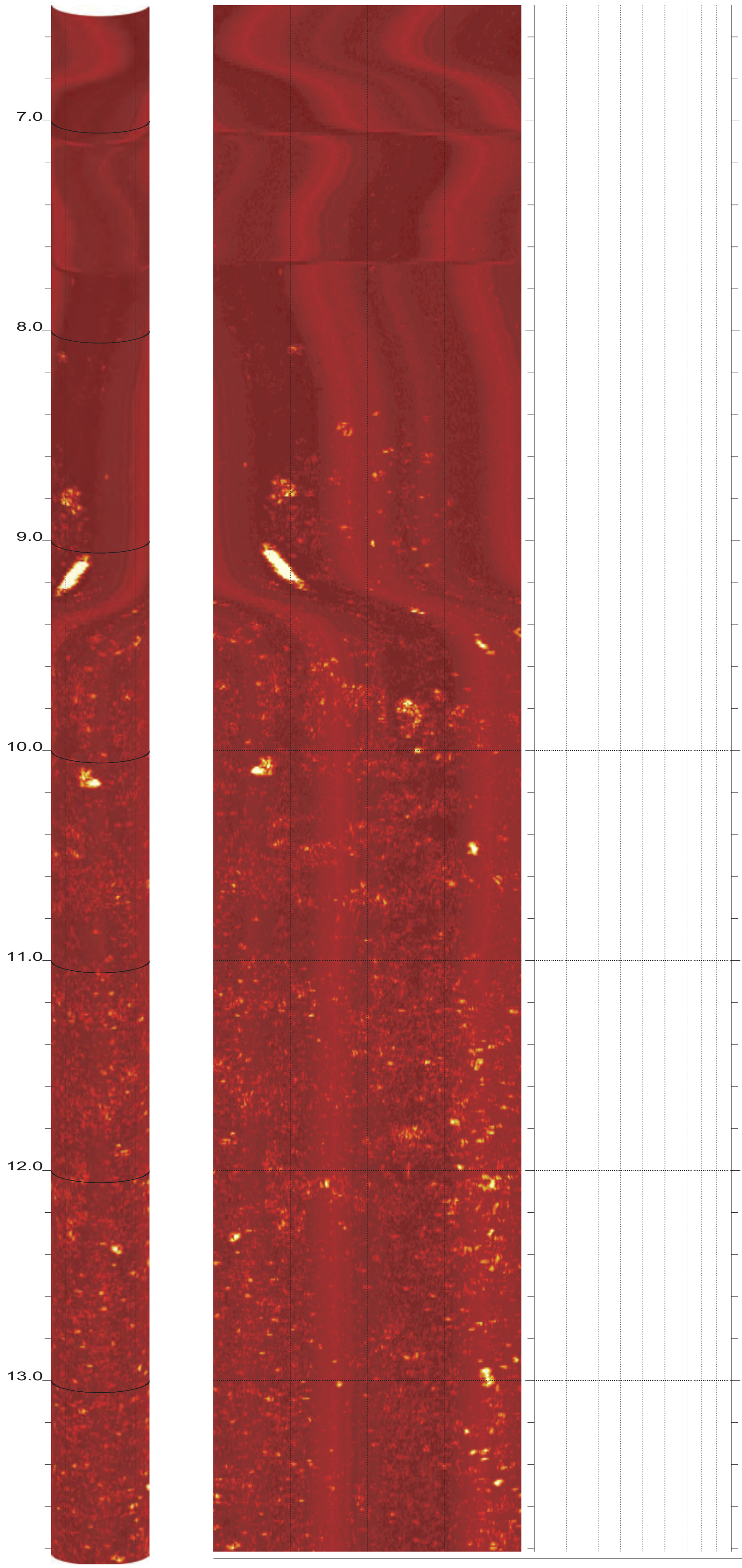
Non-stratigraphic dips

Identified units



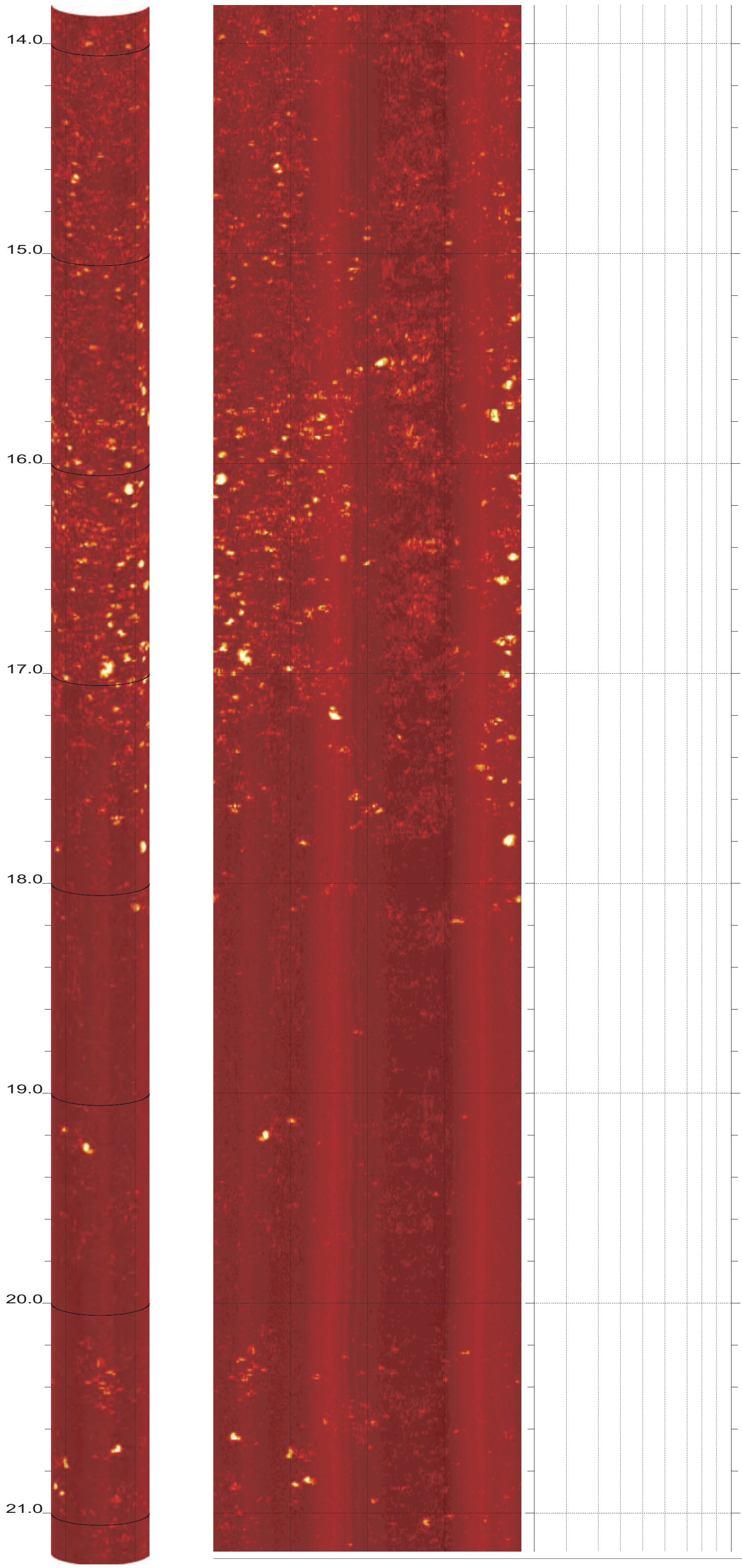
Z3-B4 6.448 to 2.600ft 1

SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 1 of 38



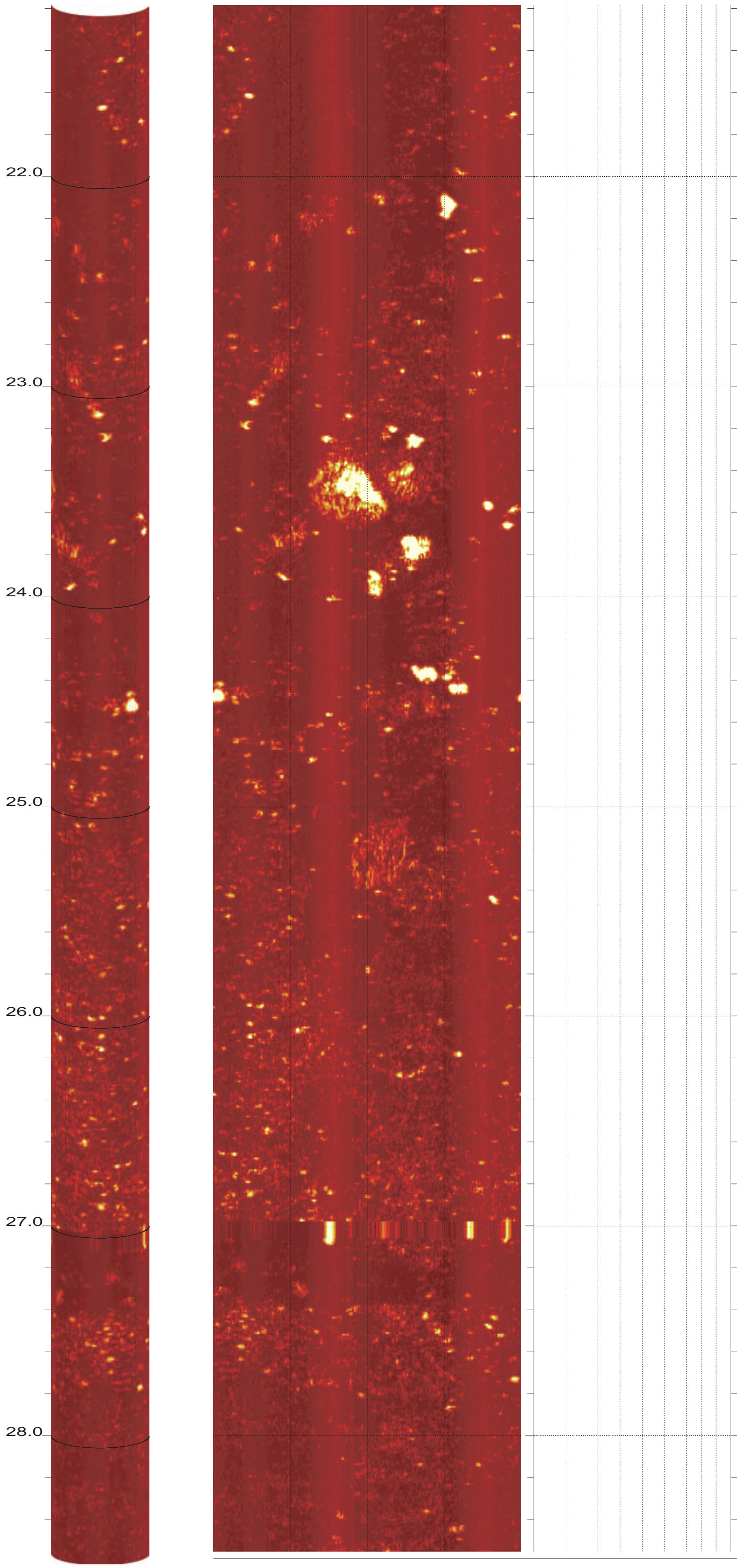
Z3-B4 13.816 to 6.448ft 2

SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 2 of 38



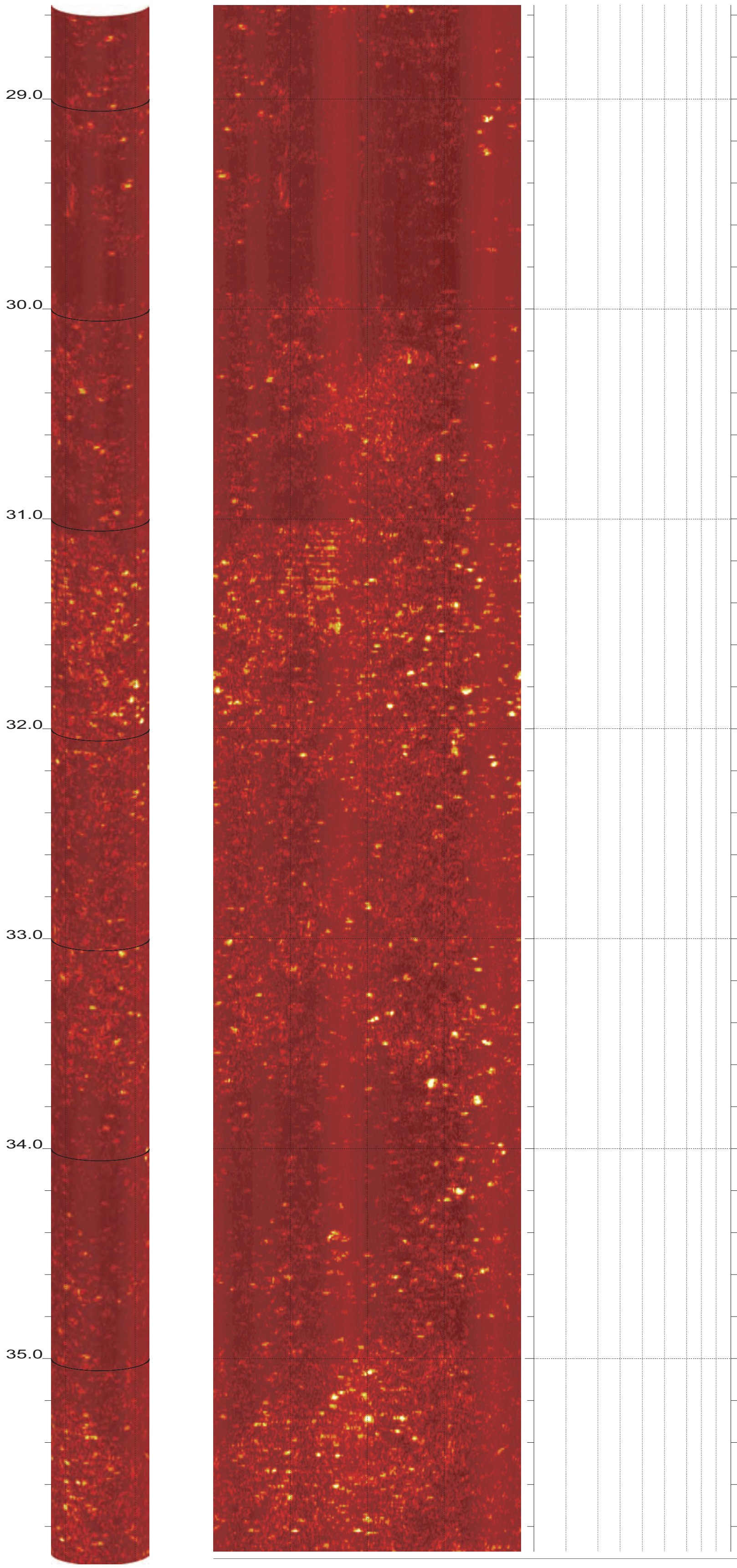
Z3-B4 21.184 to 13.816ft 3

SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 3 of 38



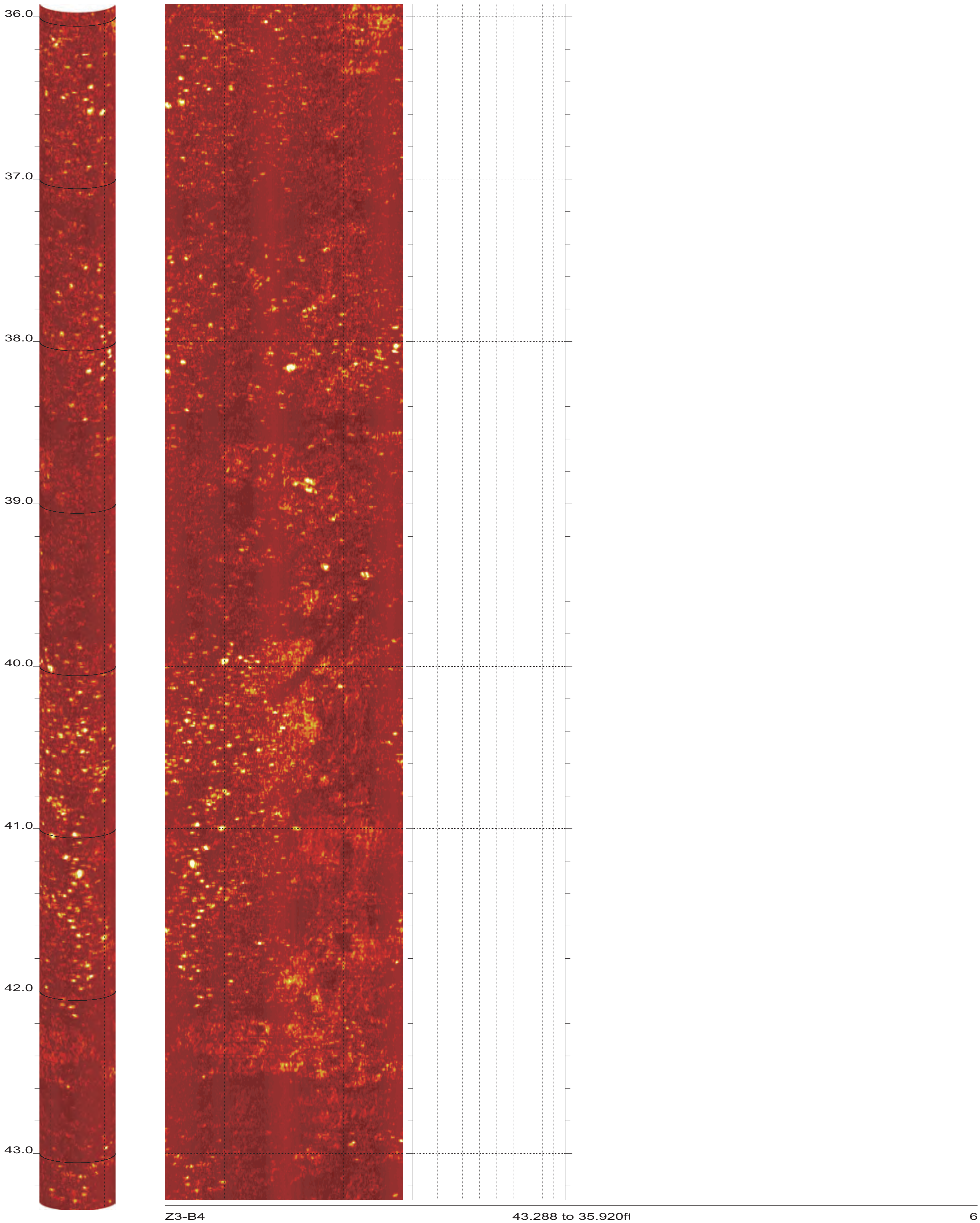
Z3-B4 28.552 to 21.184ft 4

SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 4 of 38

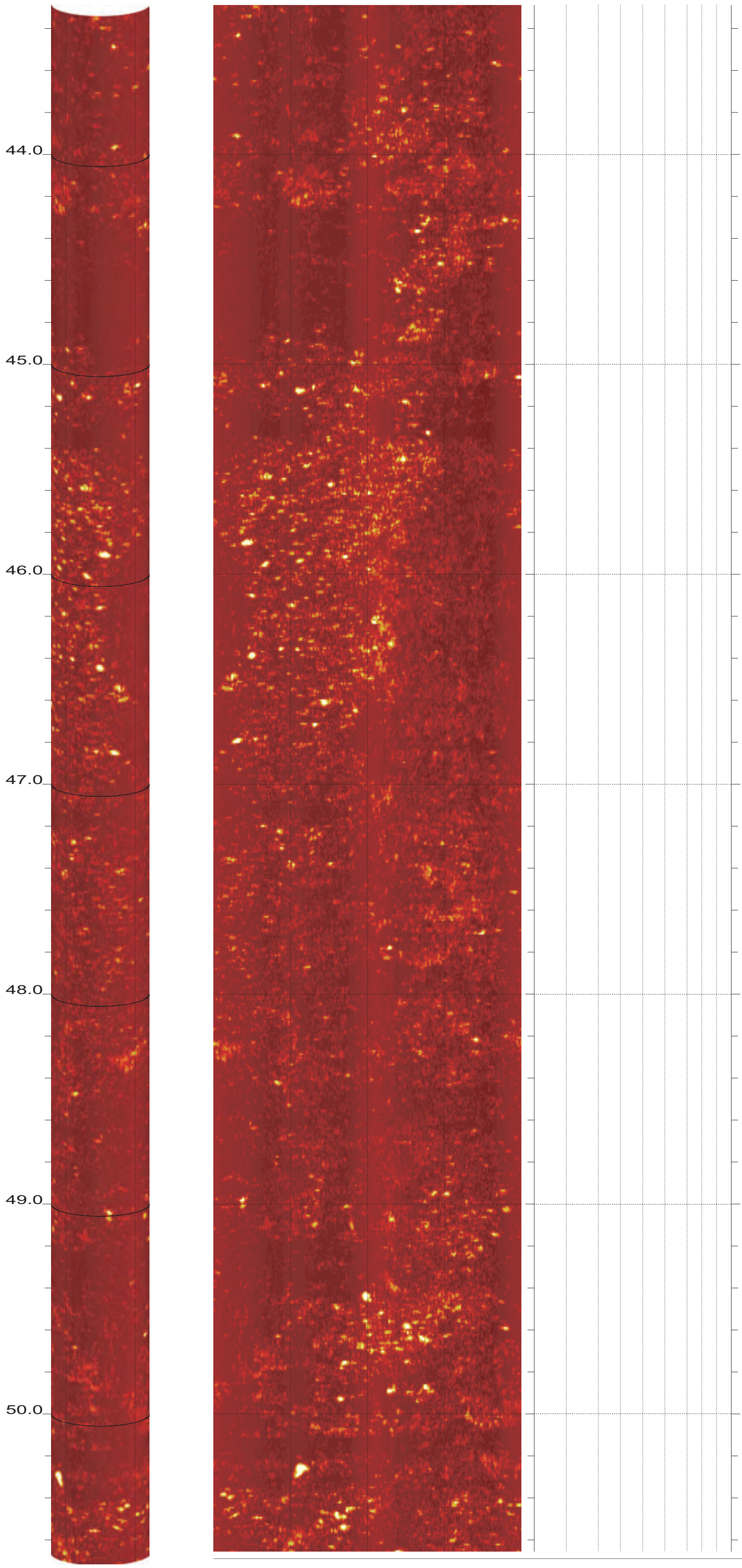


Z3-B4 35.920 to 28.552ft 5

SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 5 of 38

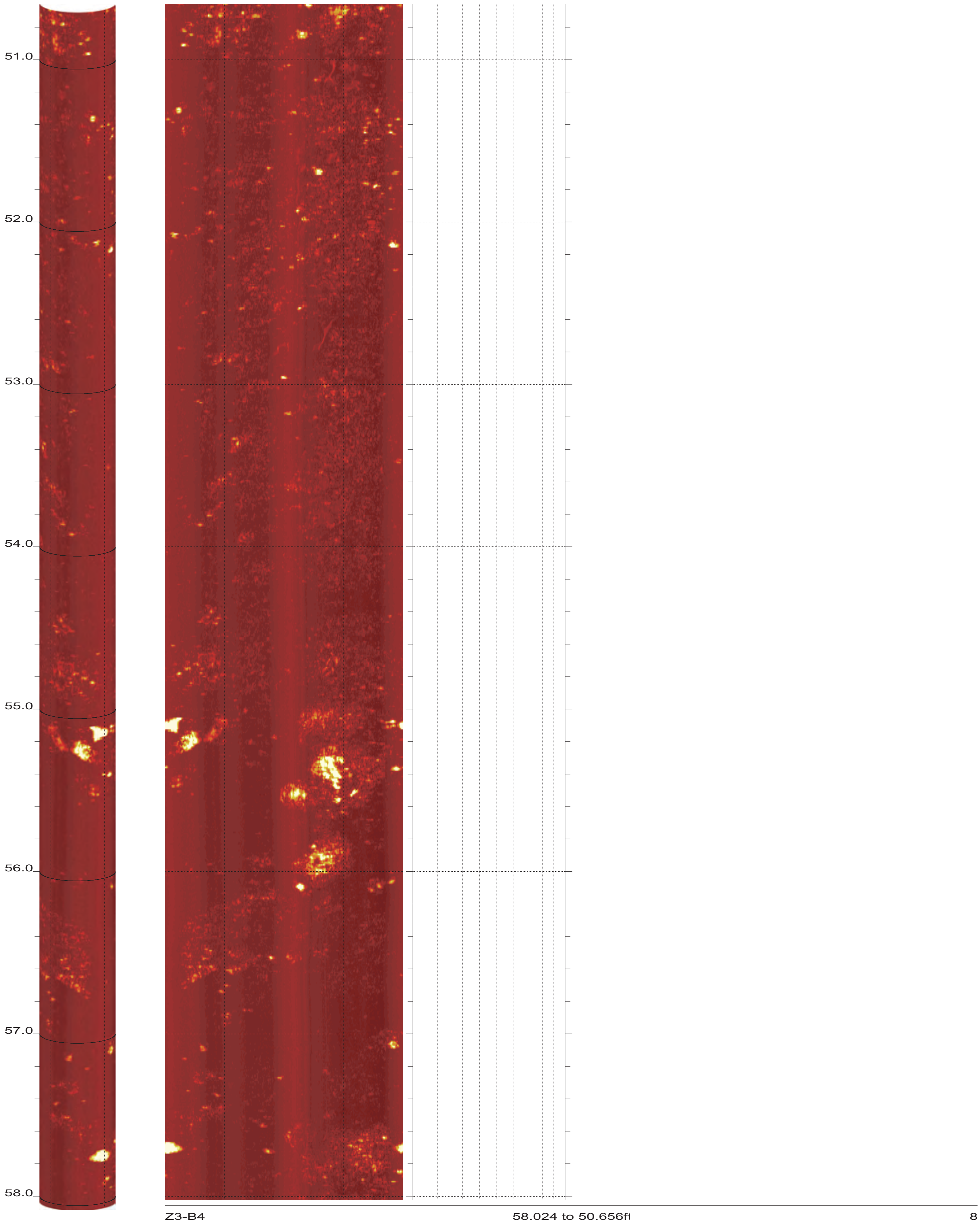


SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 6 of 38

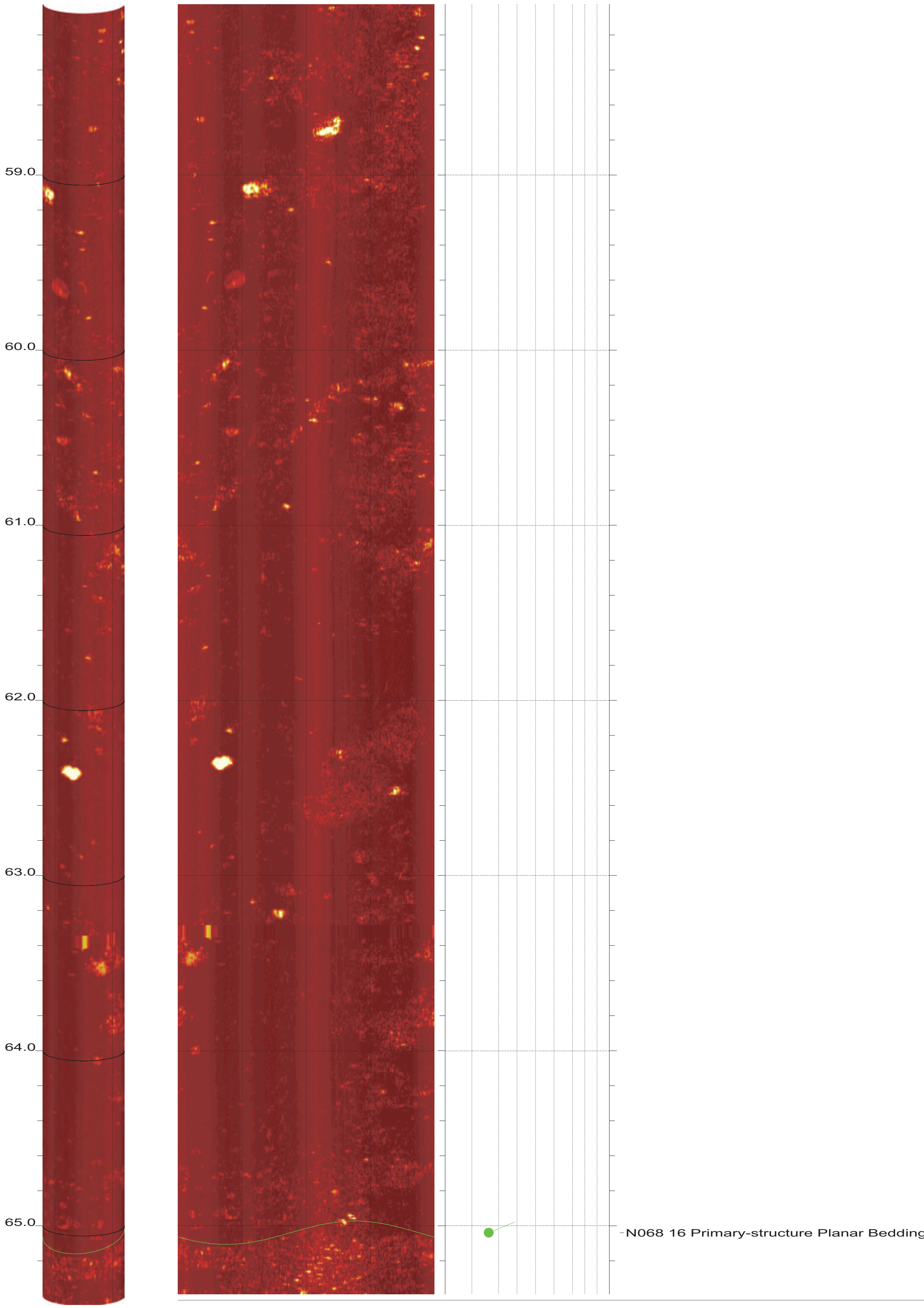


Z3-B4 50.656 to 43.288ft 7

SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 7 of 38

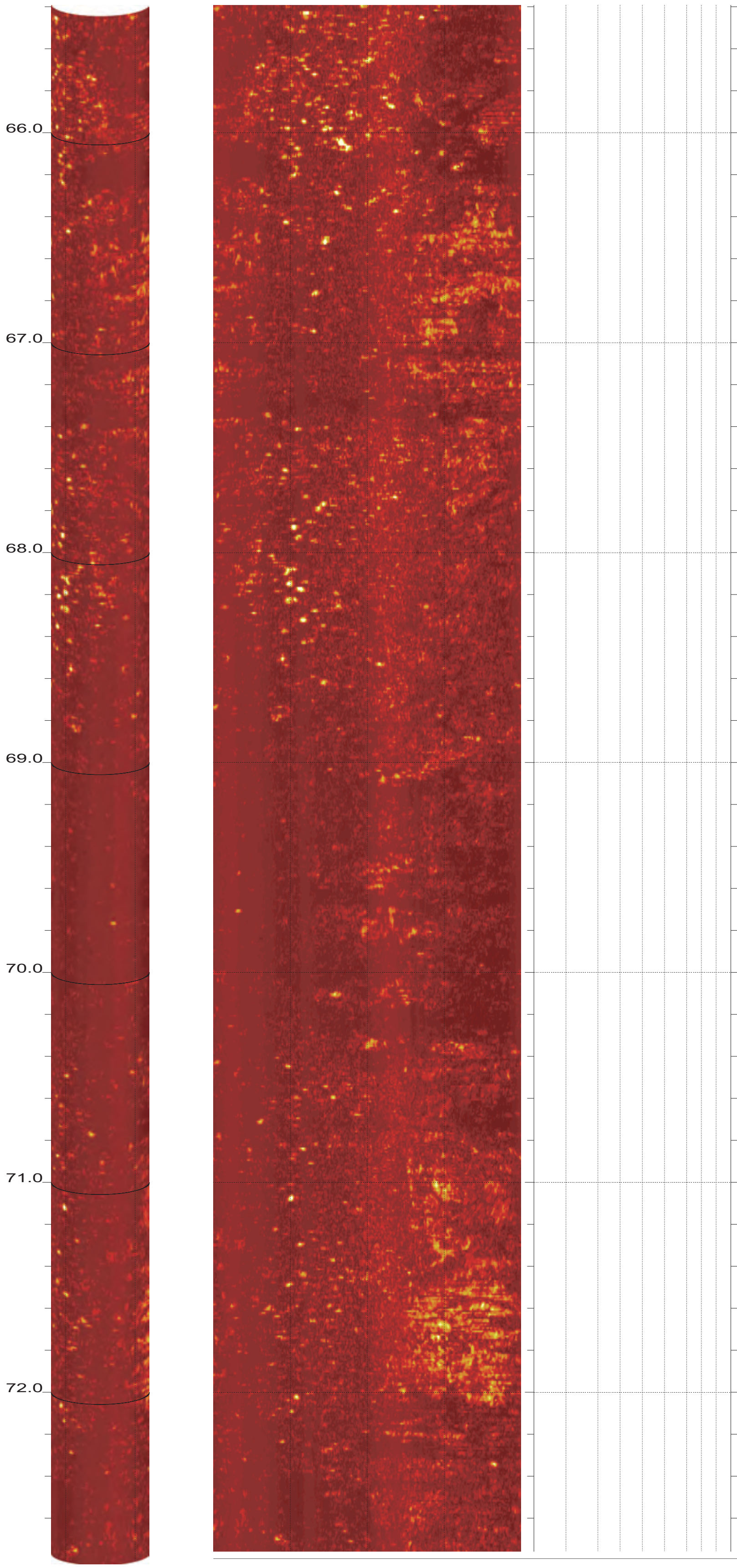


SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 8 of 38



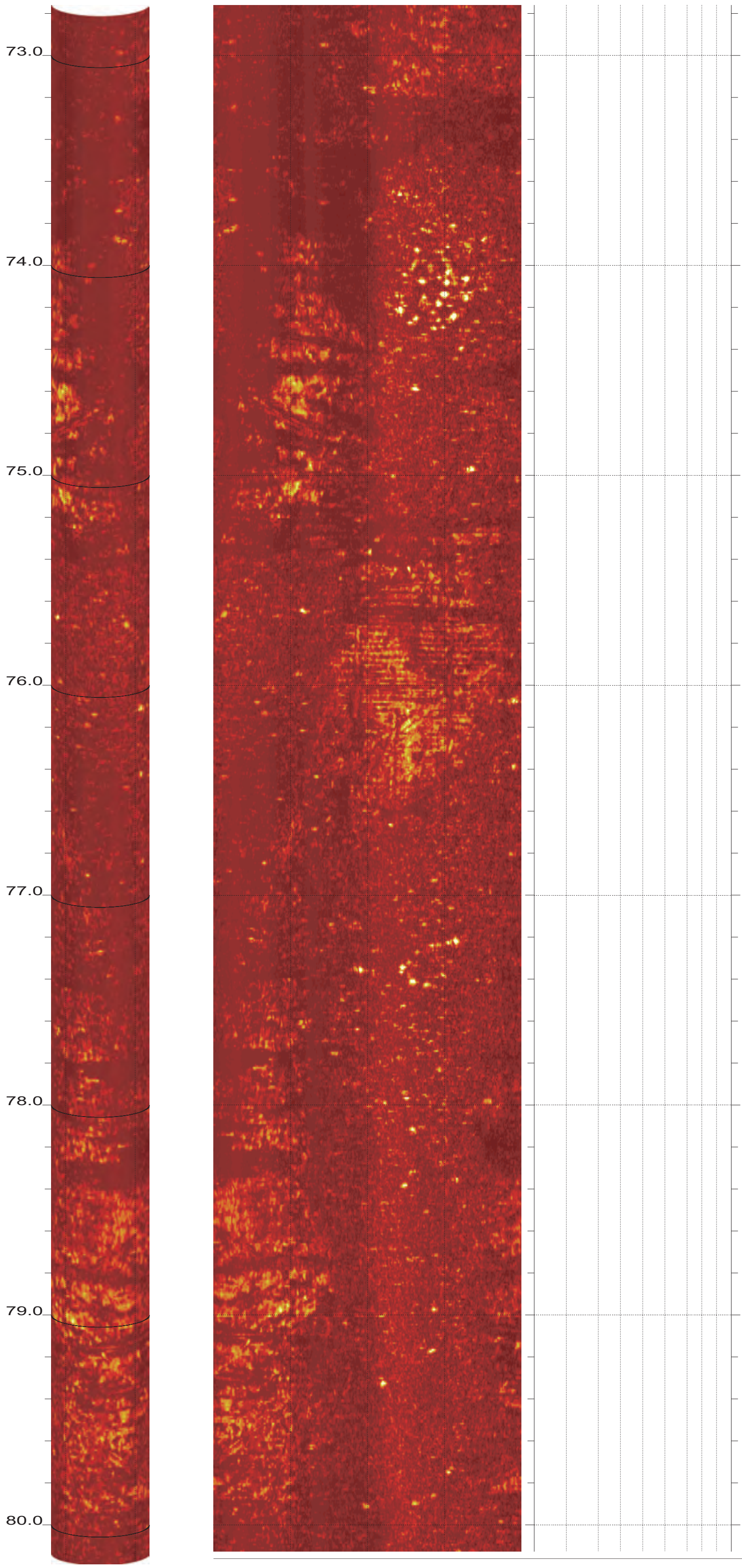
Z3-B4 65.392 to 58.024ft 9

SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 9 of 38



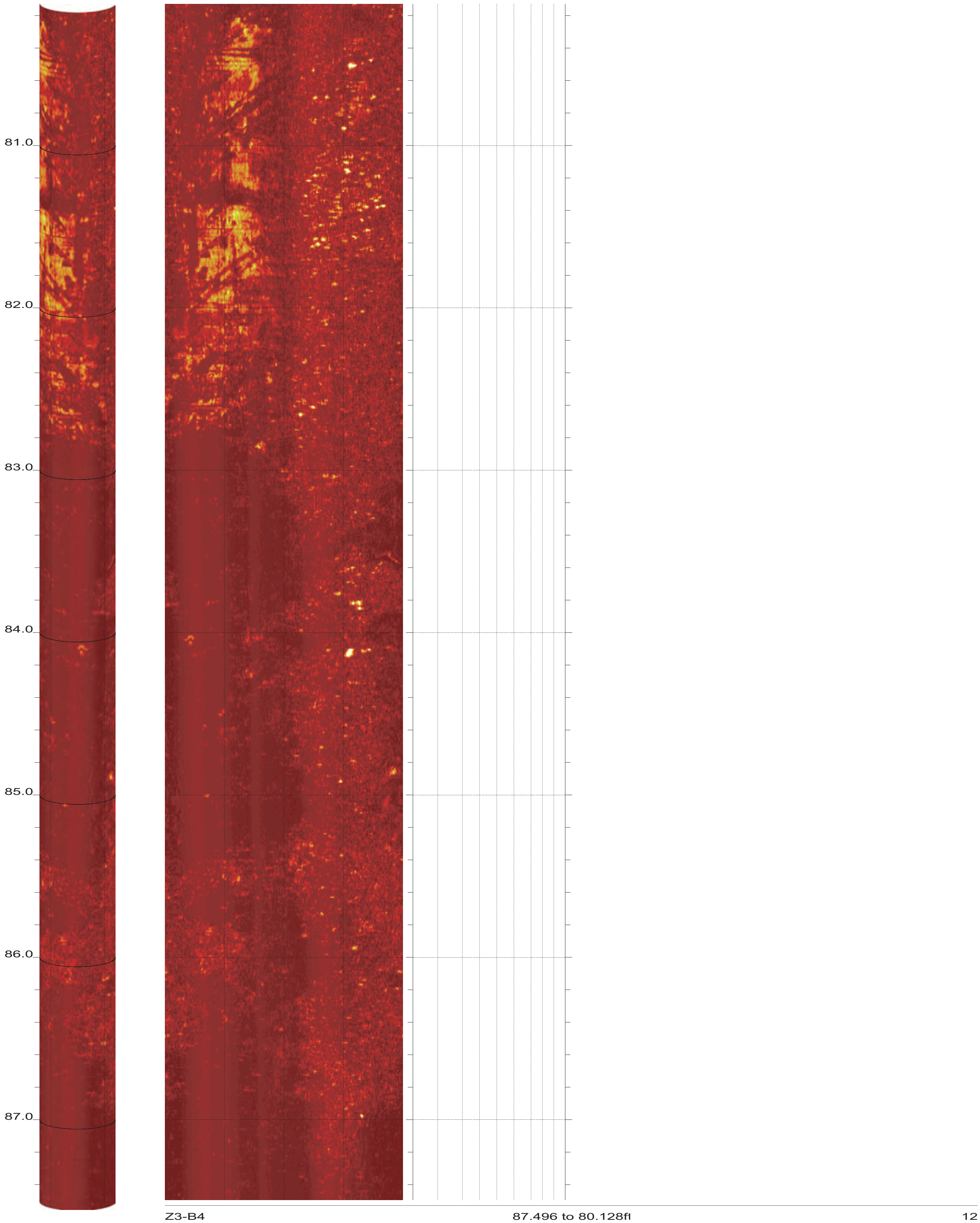
Z3-B4 72.760 to 65.392ft 10

SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 10 of 38

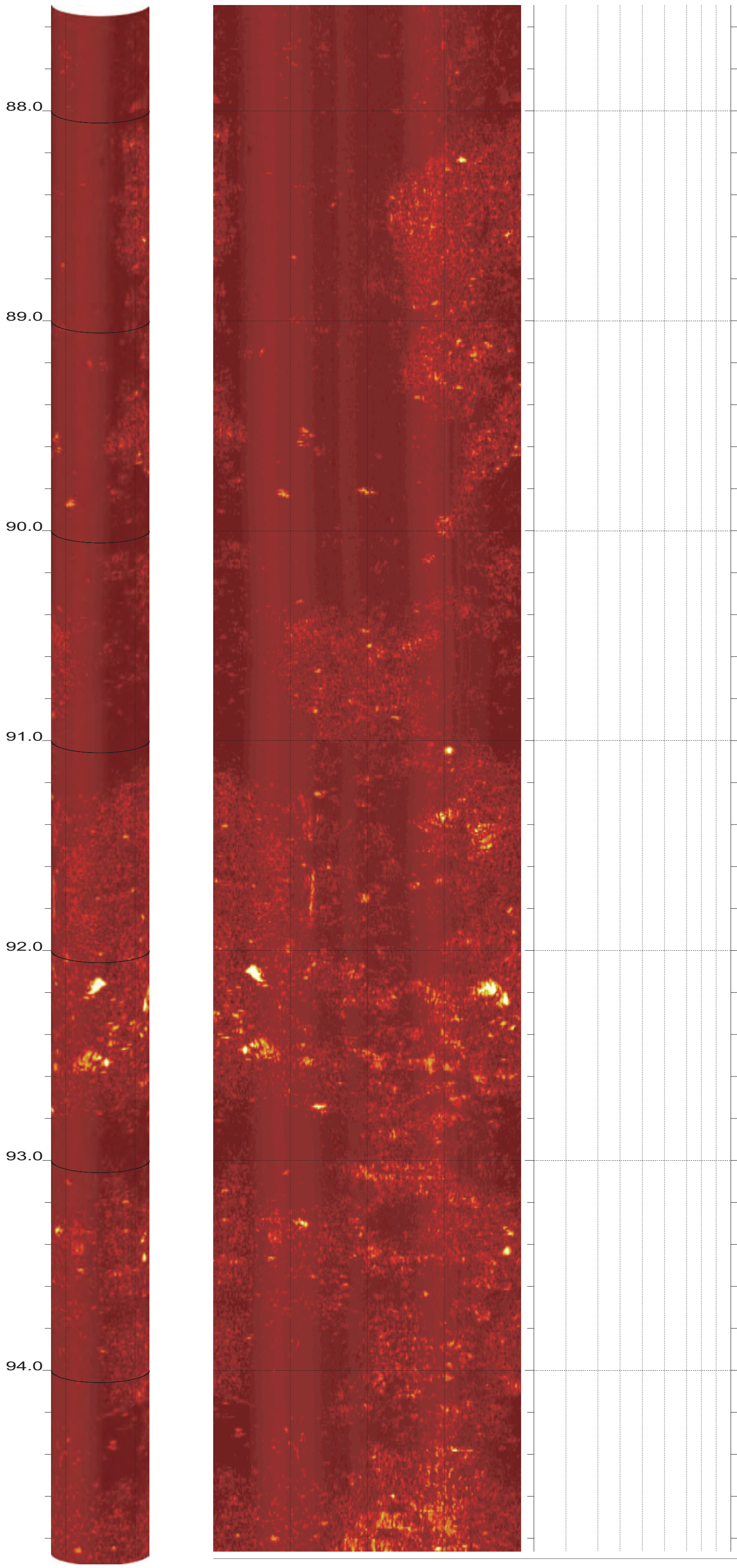


Z3-B4 80.128 to 72.760ft 11

SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 11 of 38

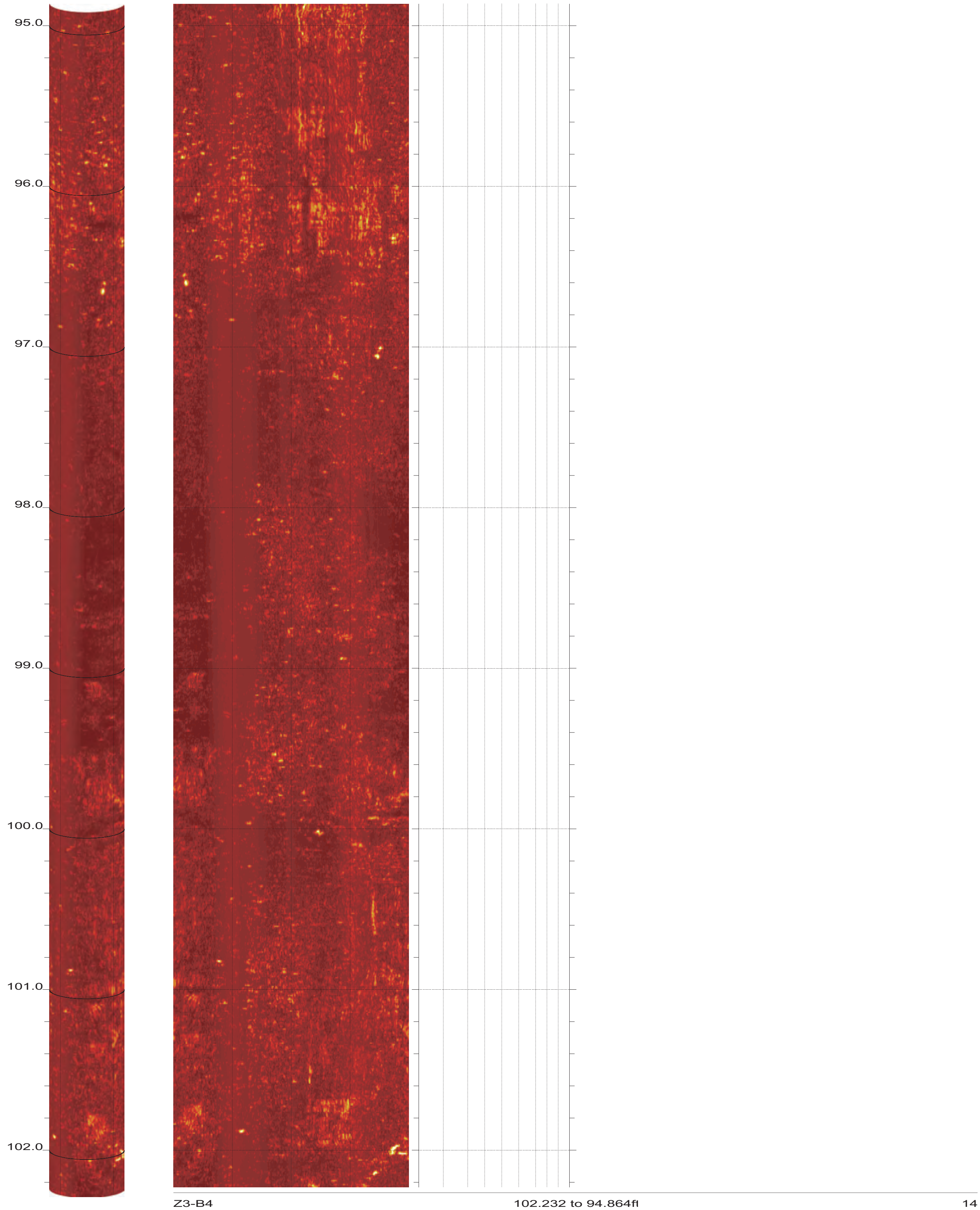


SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 12 of 38

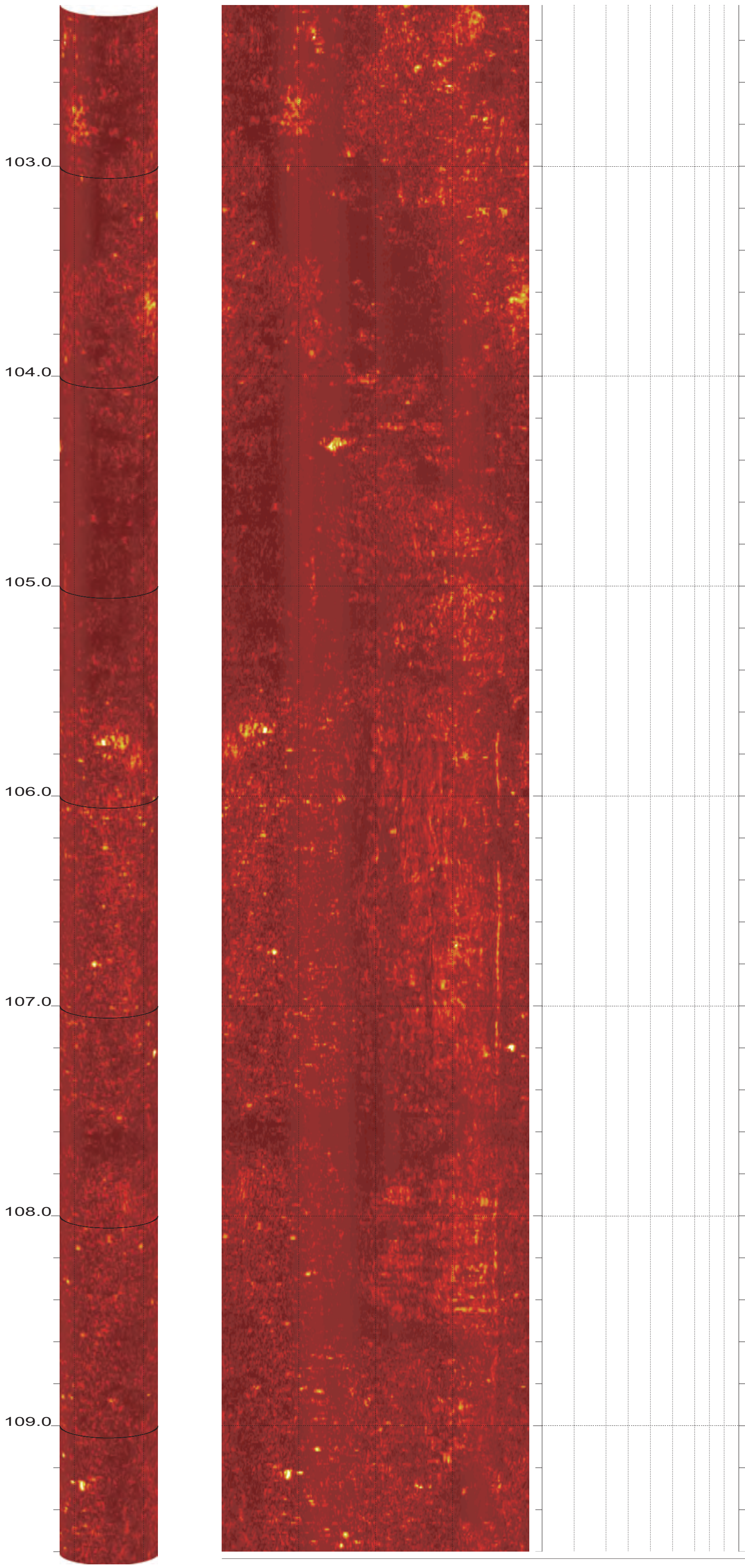


Z3-B4 94.864 to 87.496ft 13

SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 13 of 38

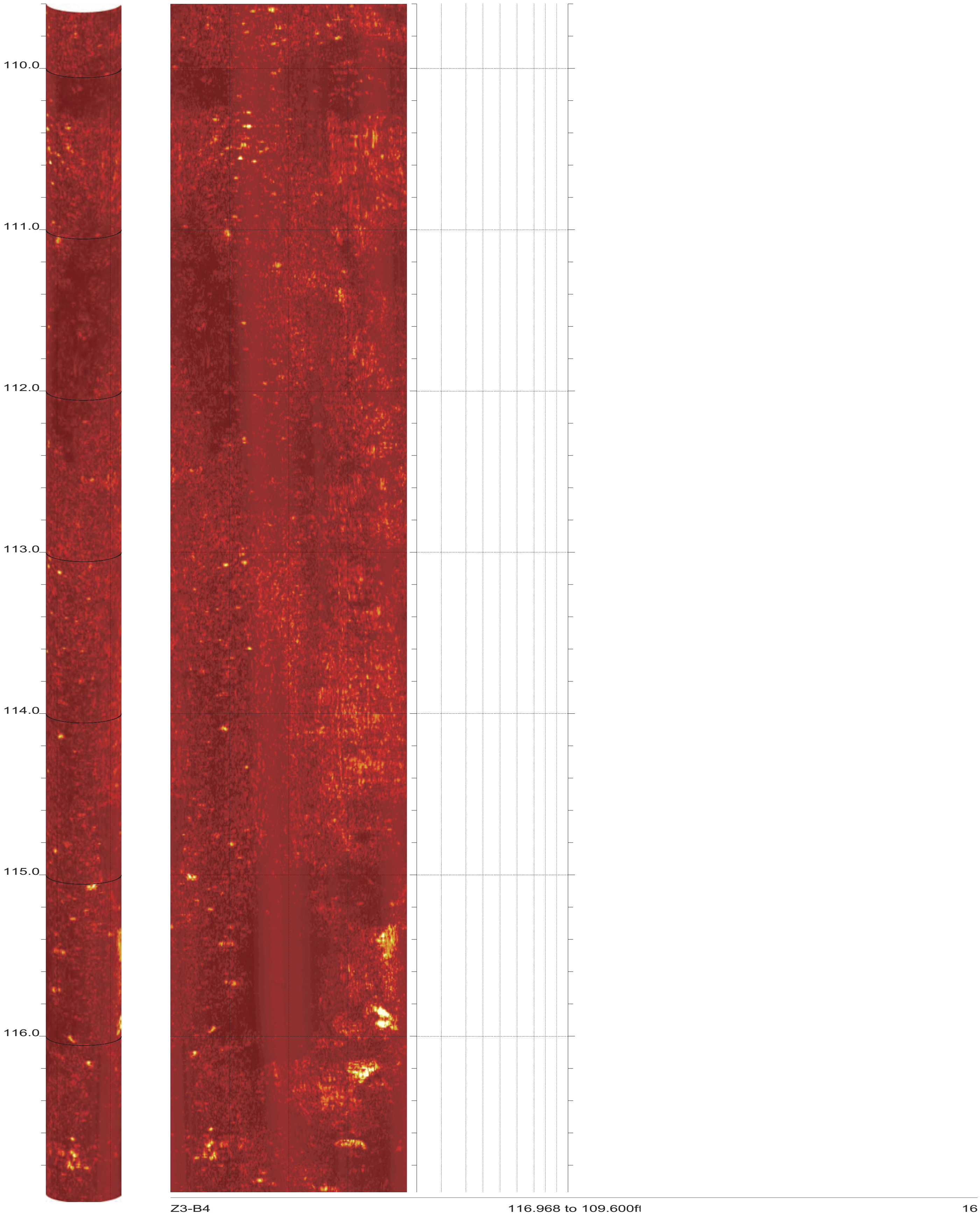


SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 14 of 38

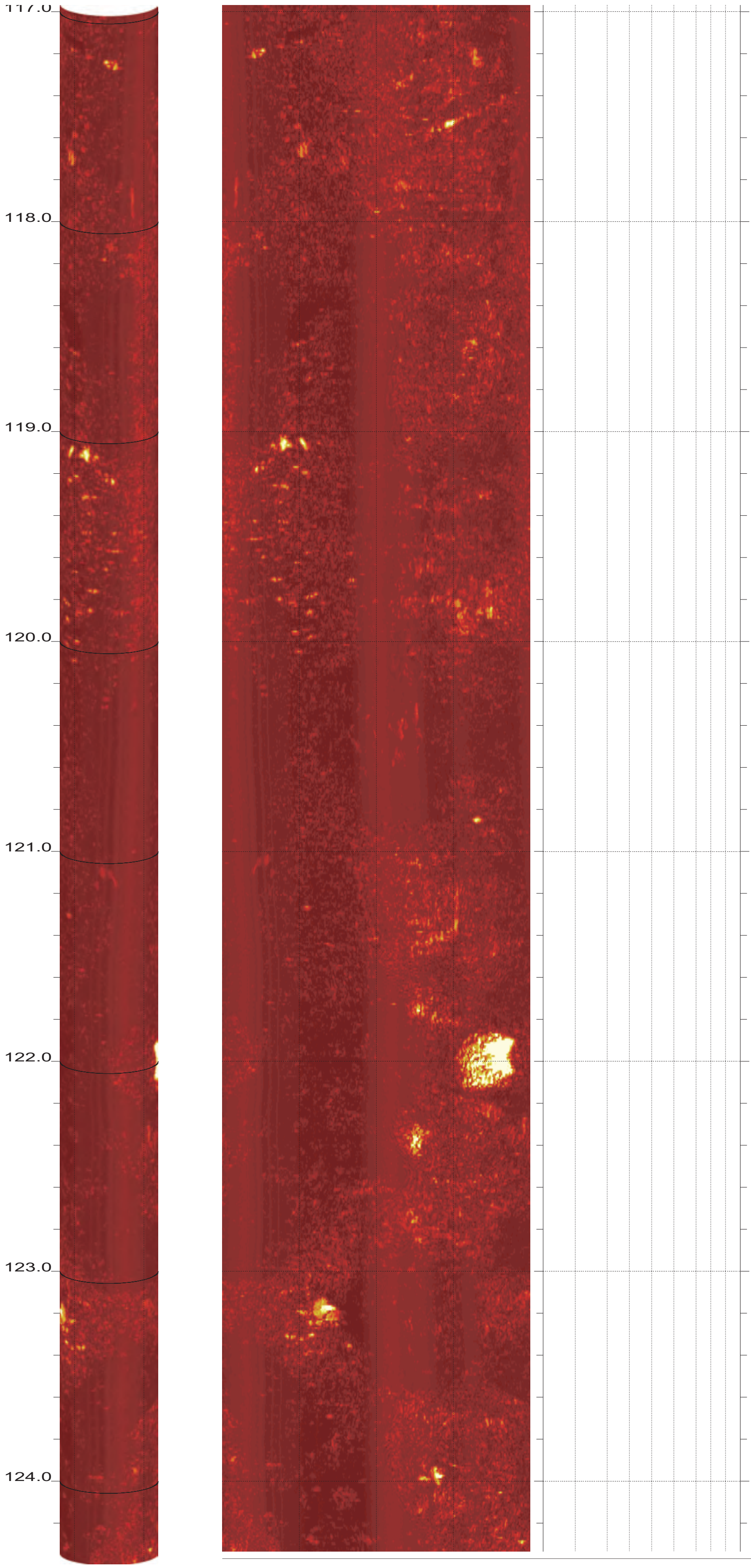


Z3-B4 109.600 to 102.232ft 15

SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 15 of 38

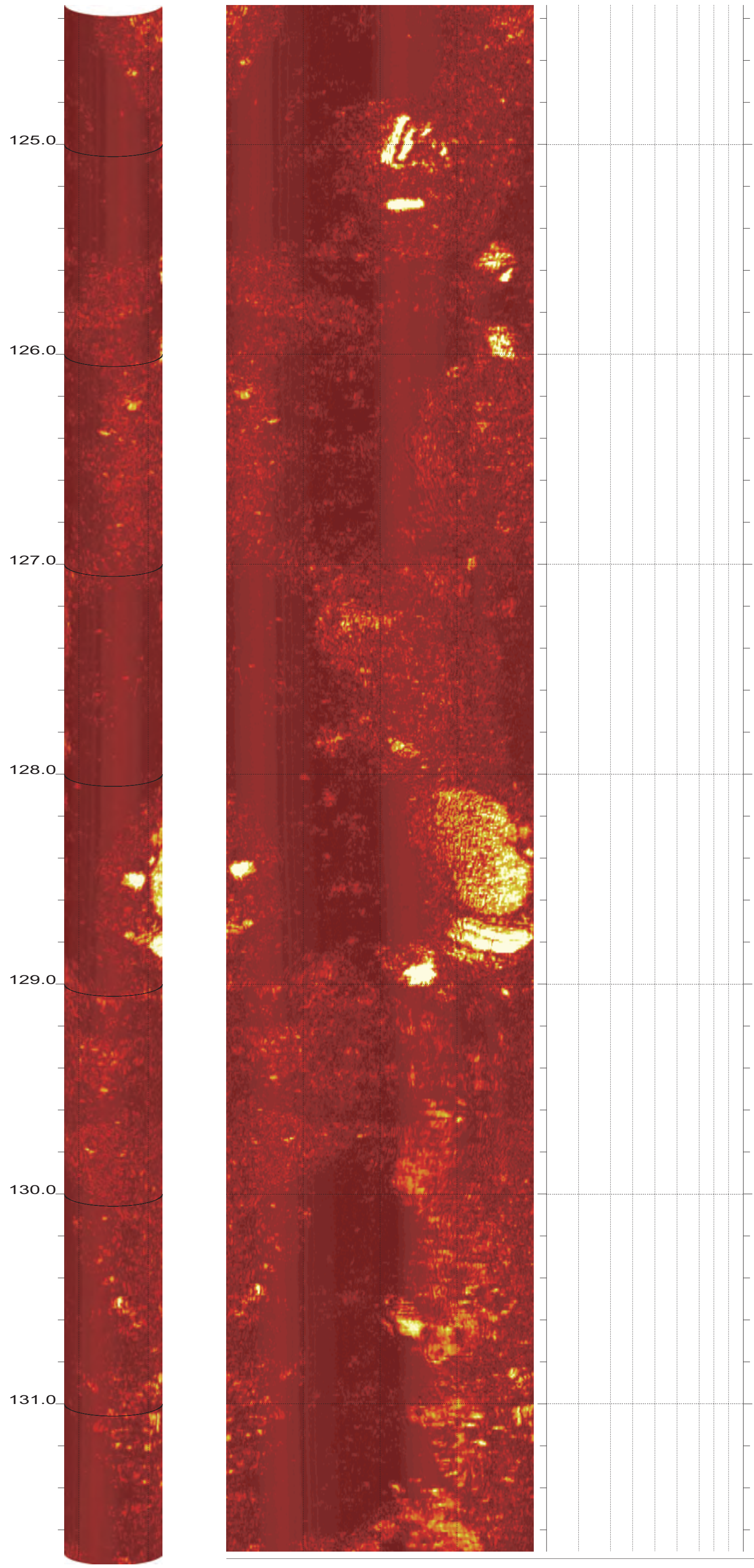


SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 16 of 38



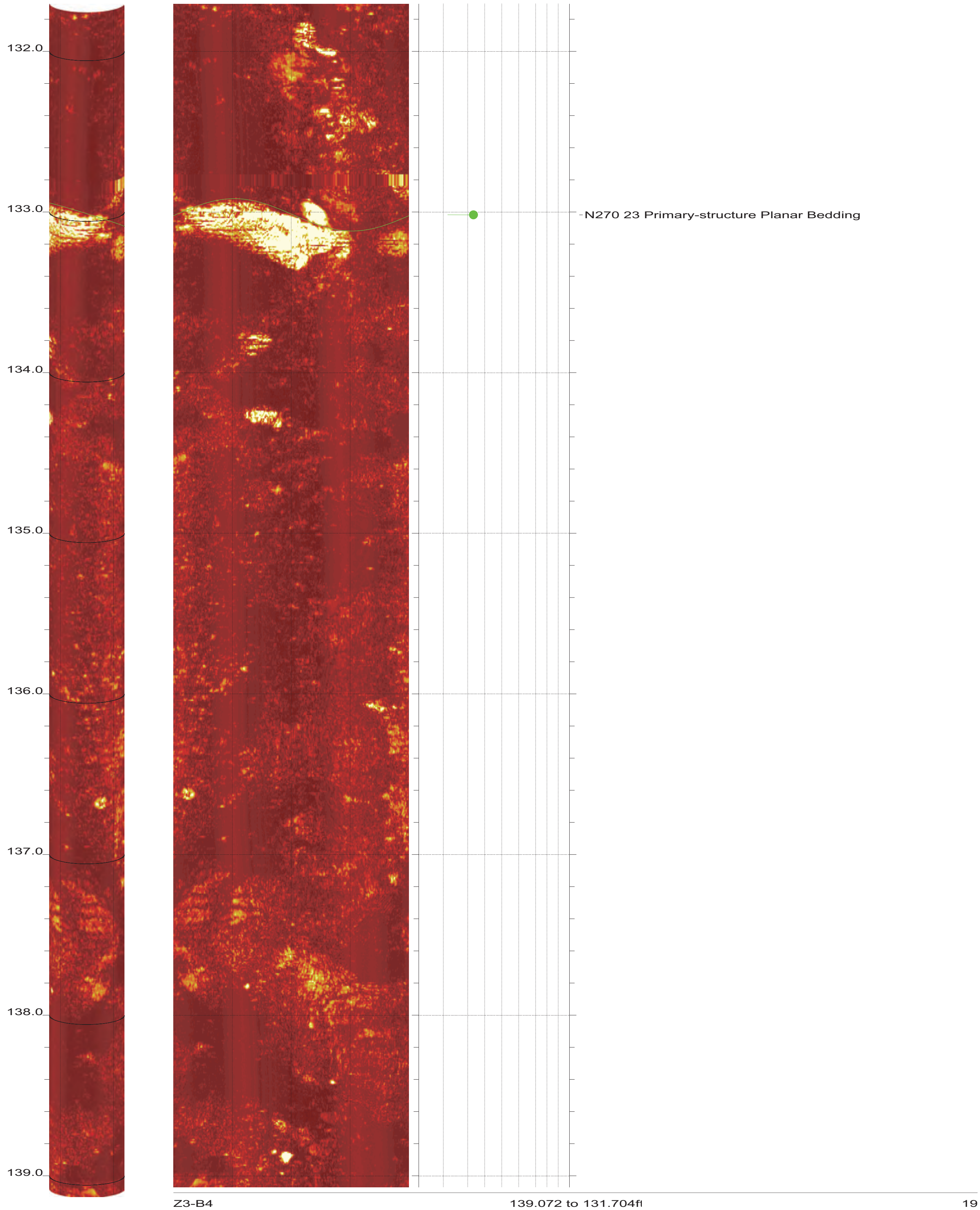
Z3-B4 124.336 to 116.968ft 17

SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 17 of 38

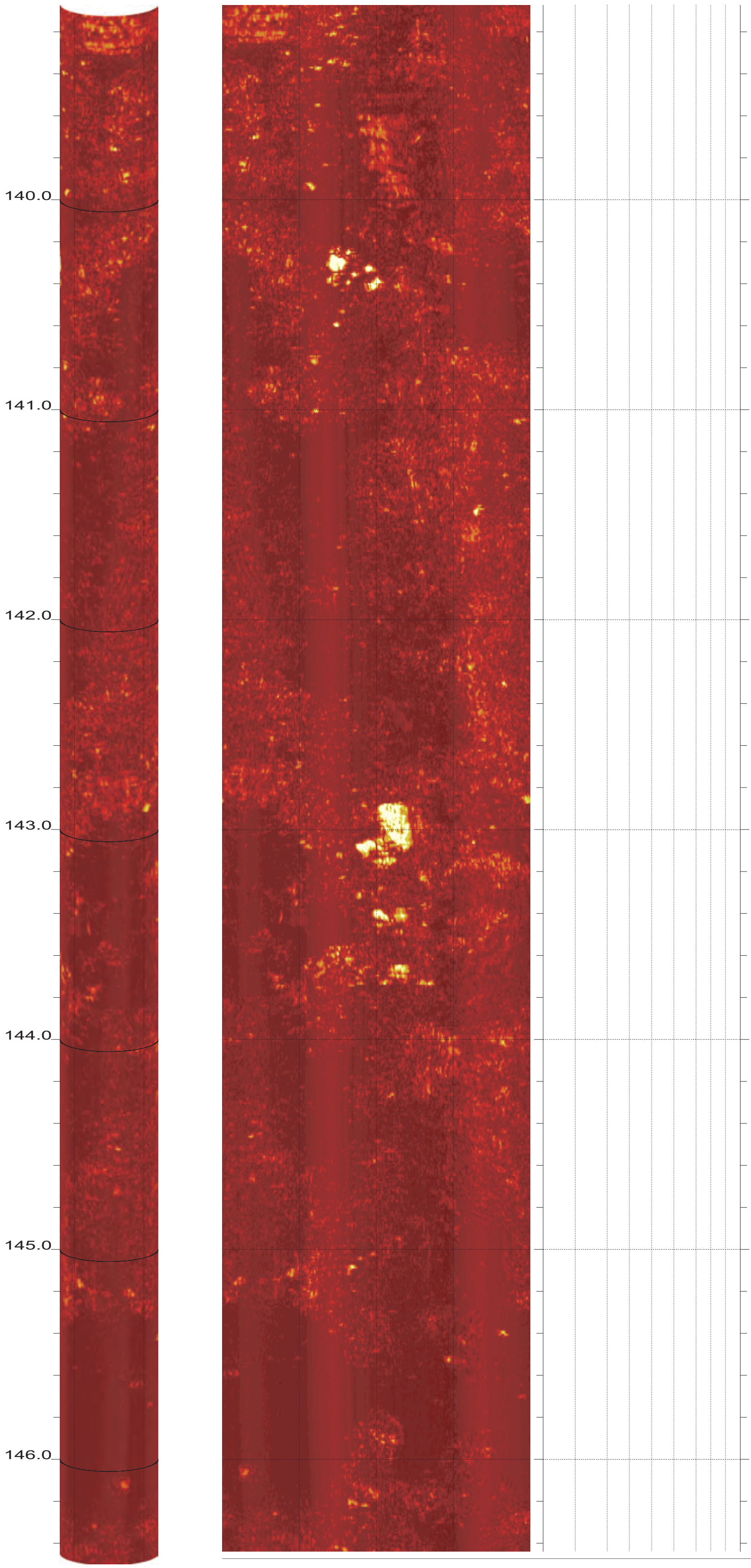


Z3-B4 131.704 to 124.336ft 18

SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 18 of 38

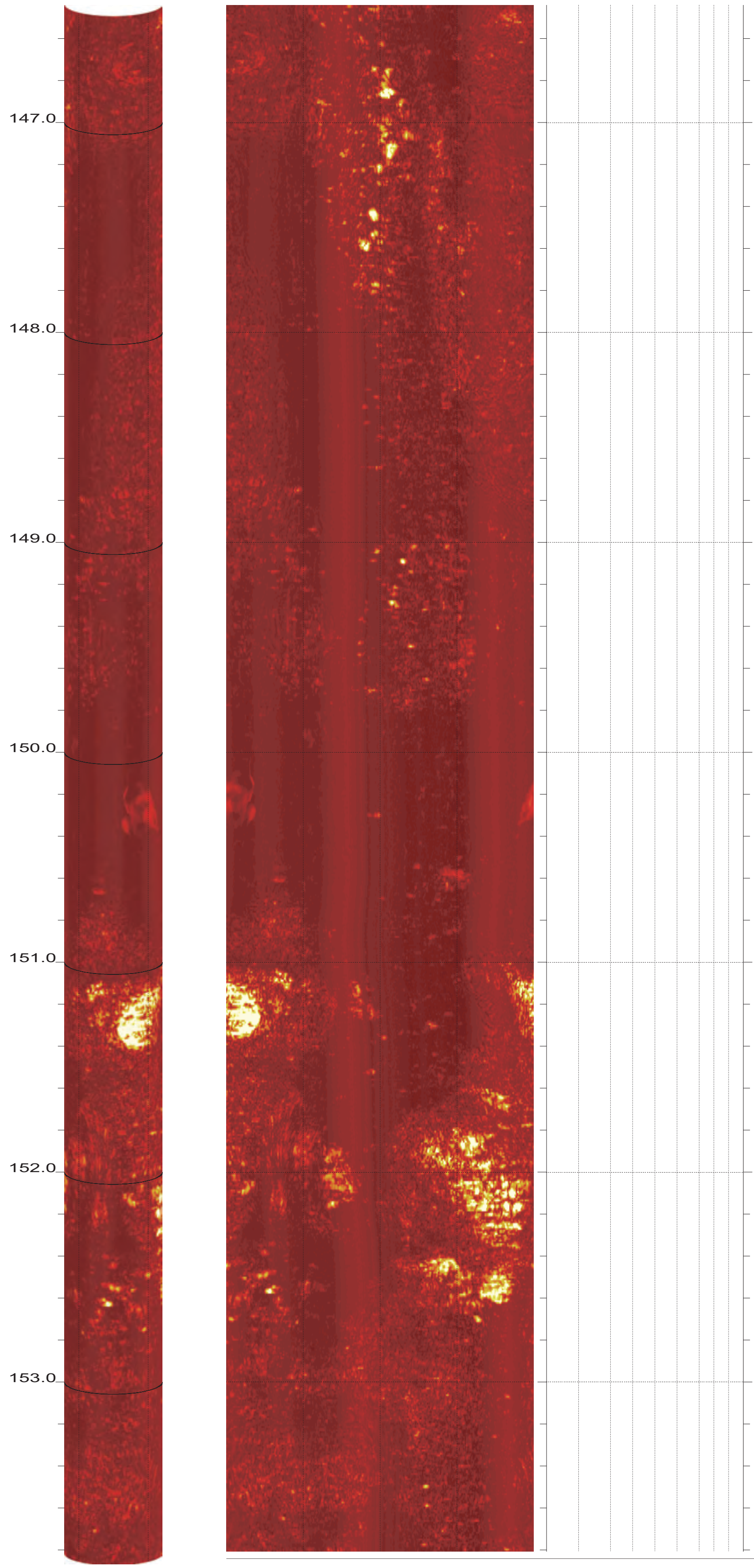


SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 19 of 38



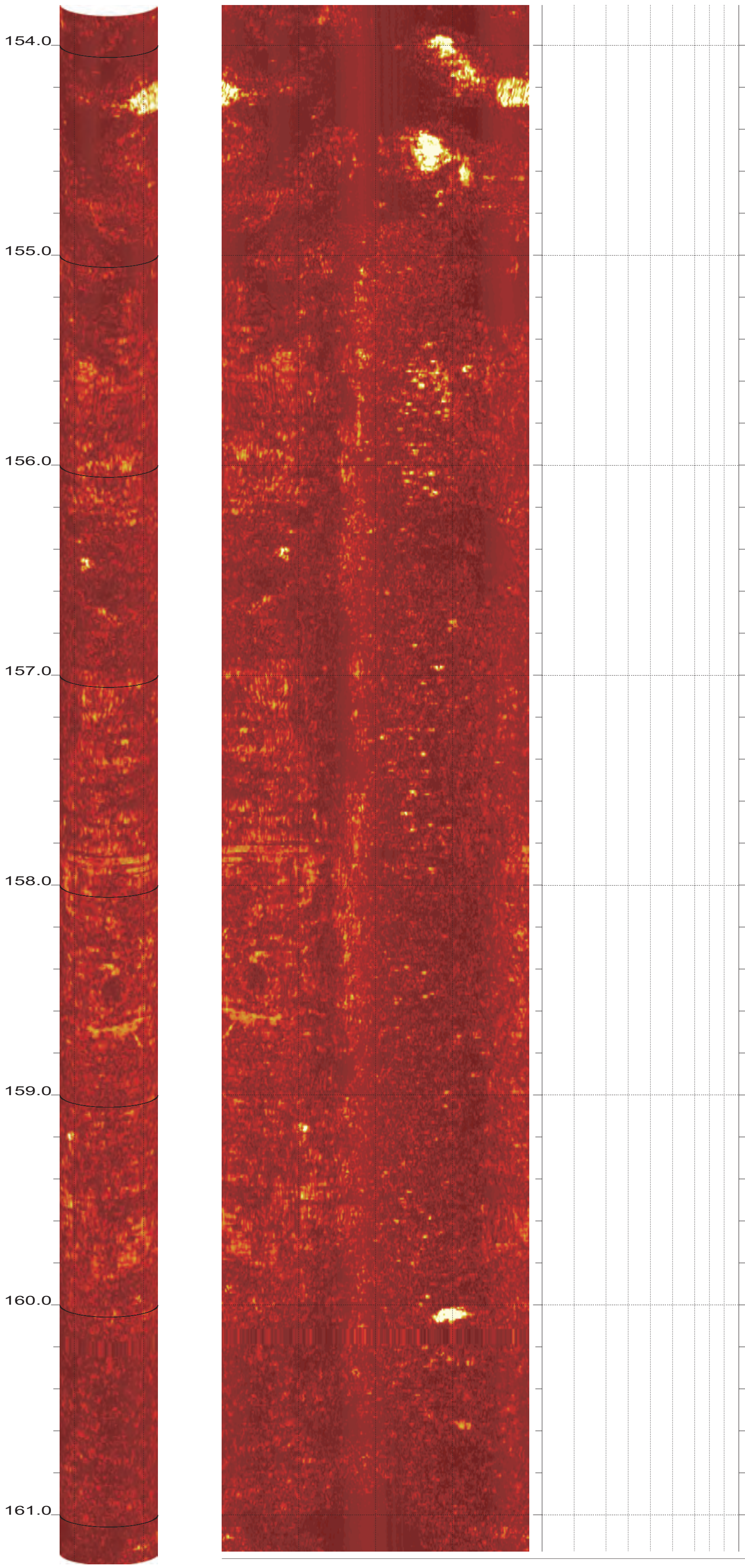
Z3-B4 146.440 to 139.072ft 20

SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 20 of 38



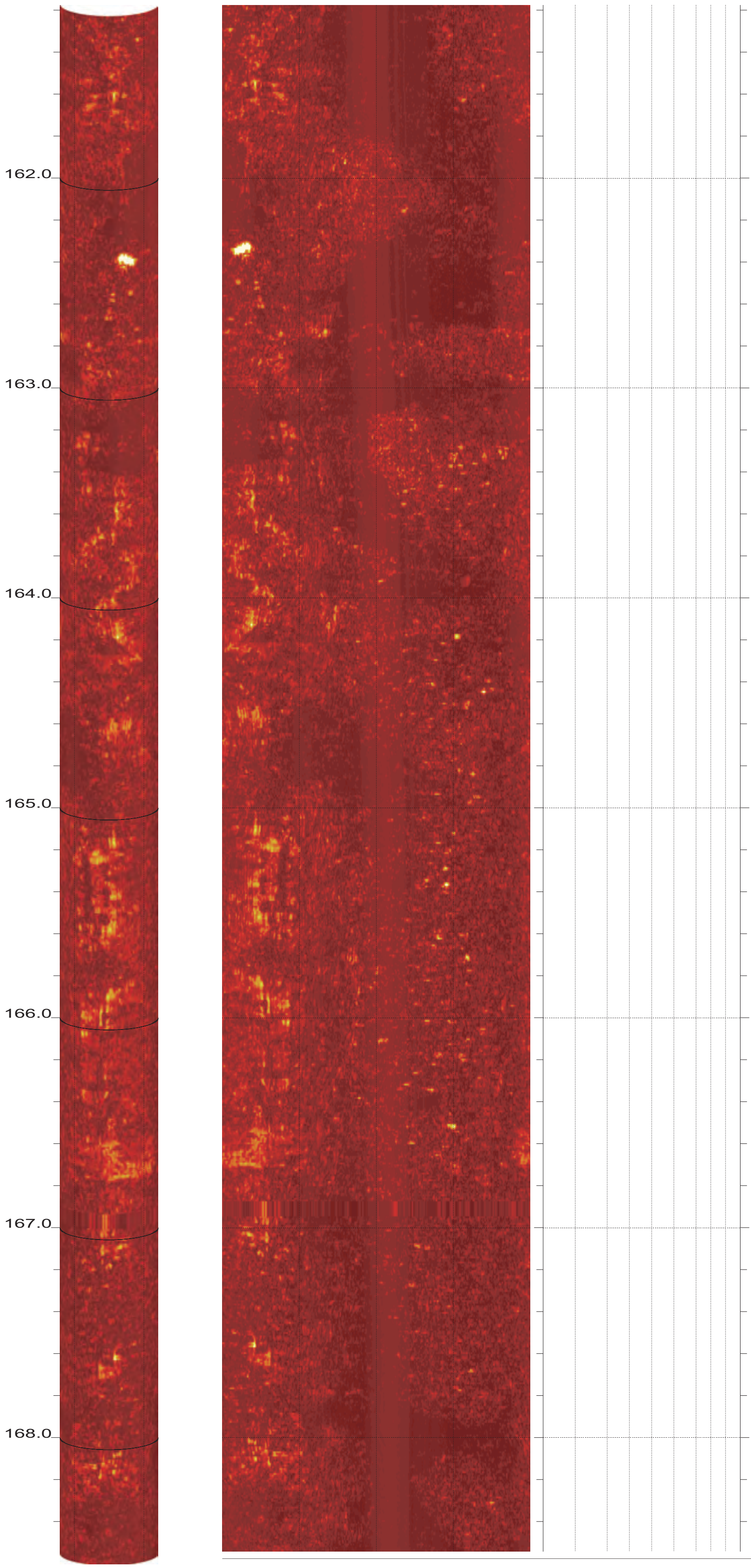
Z3-B4 153.808 to 146.440ft 21

SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 21 of 38



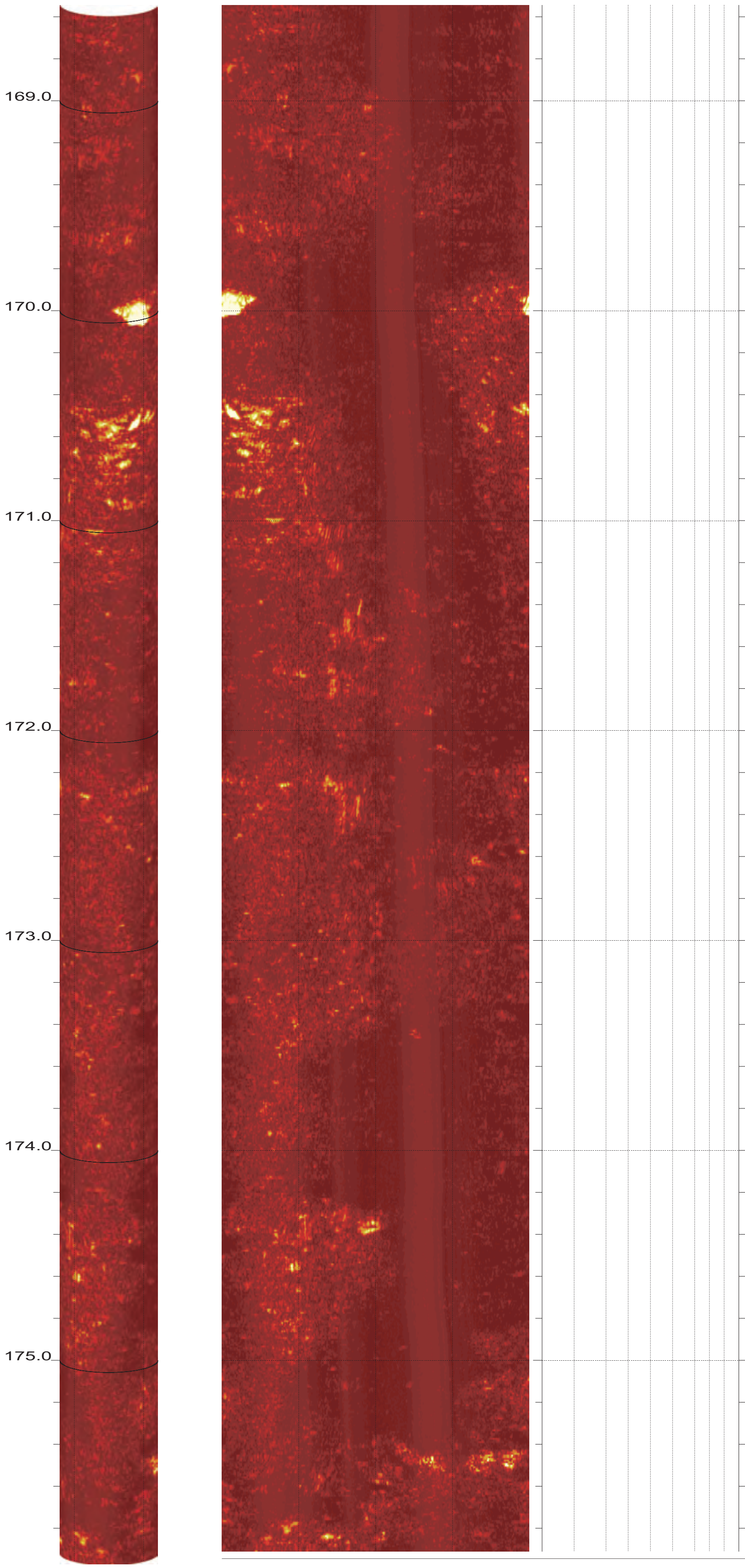
Z3-B4 161.176 to 153.808ft 22

SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 22 of 38



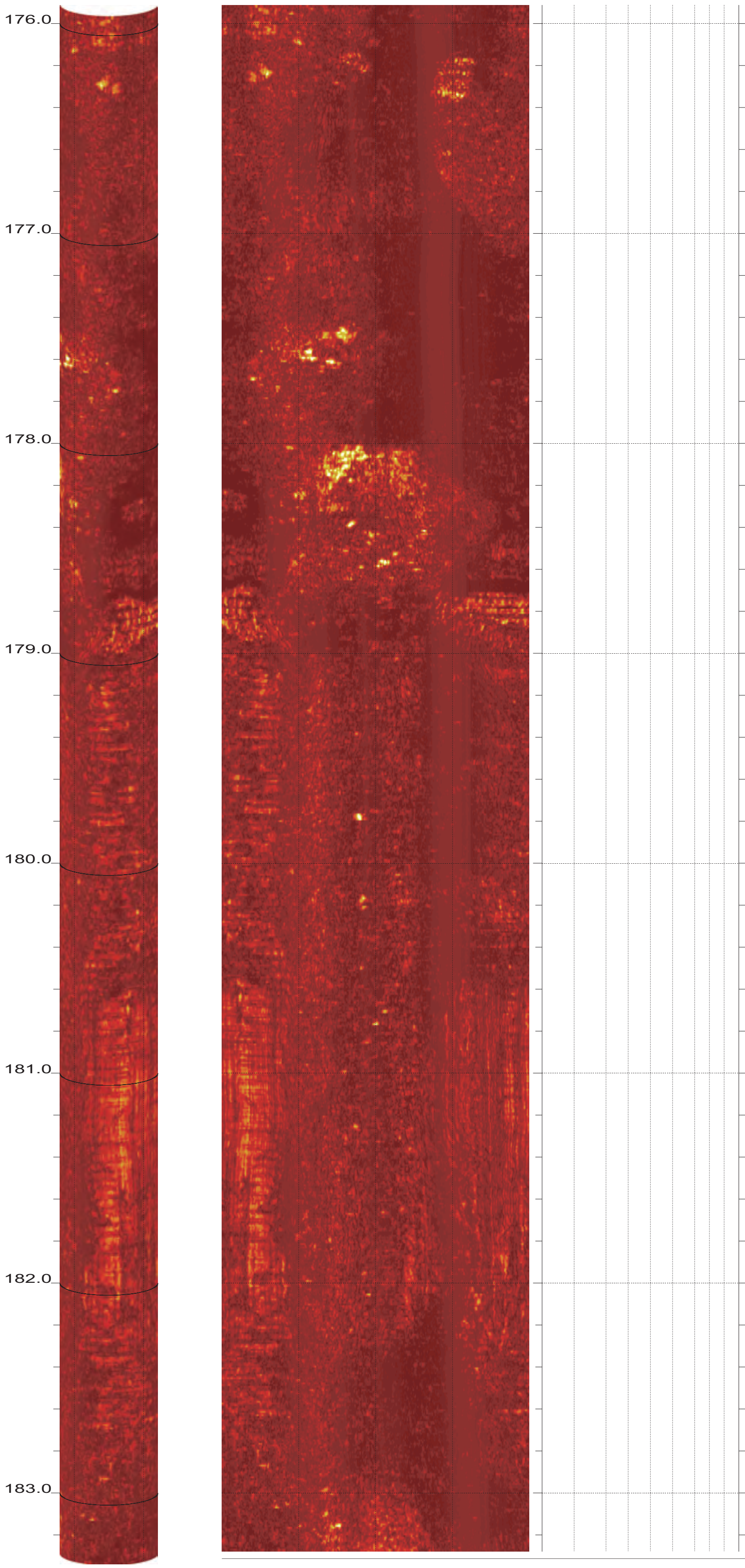
Z3-B4 168.544 to 161.176ft 23

SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 23 of 38



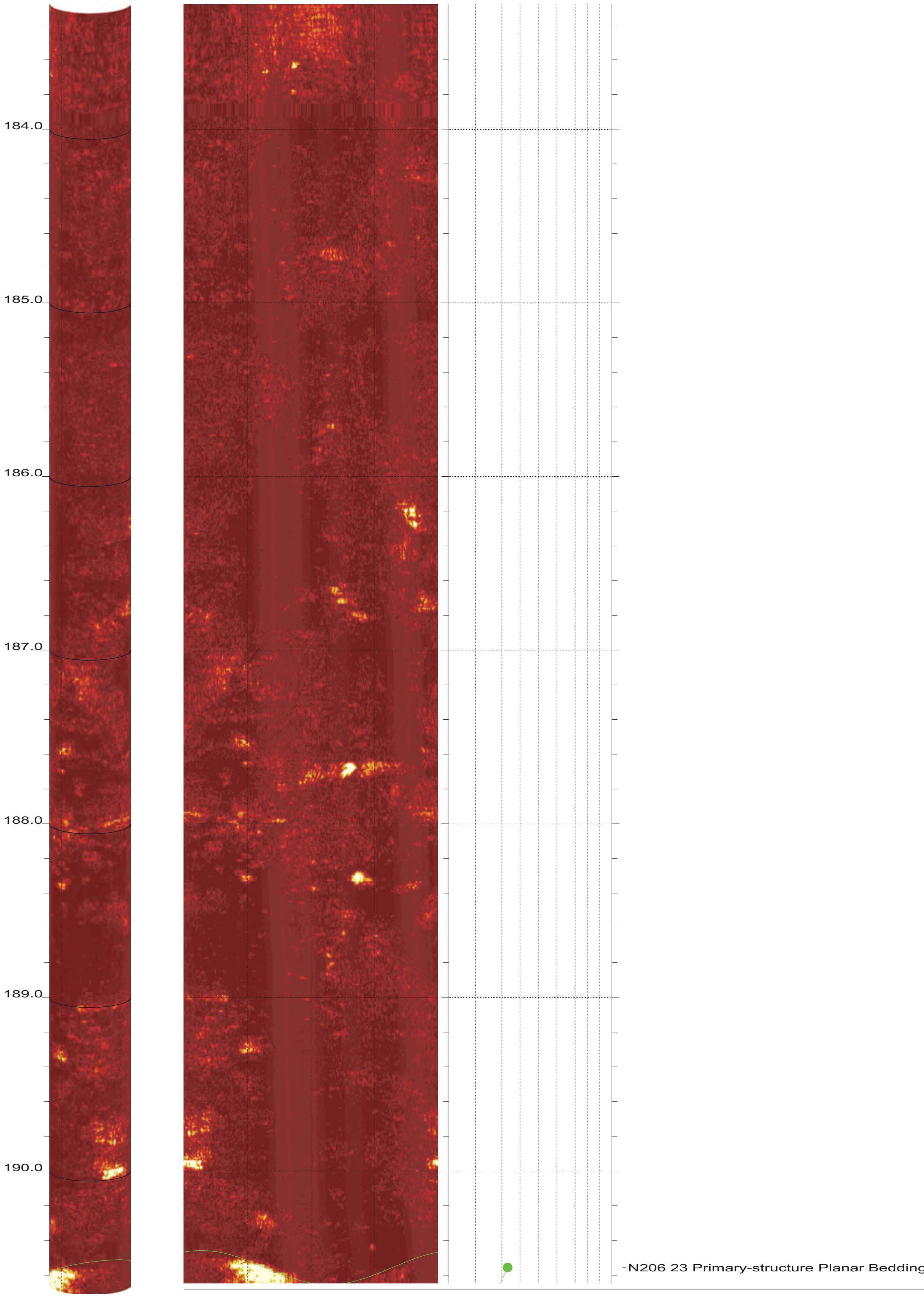
Z3-B4 175.912 to 168.544ft 24

SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 24 of 38



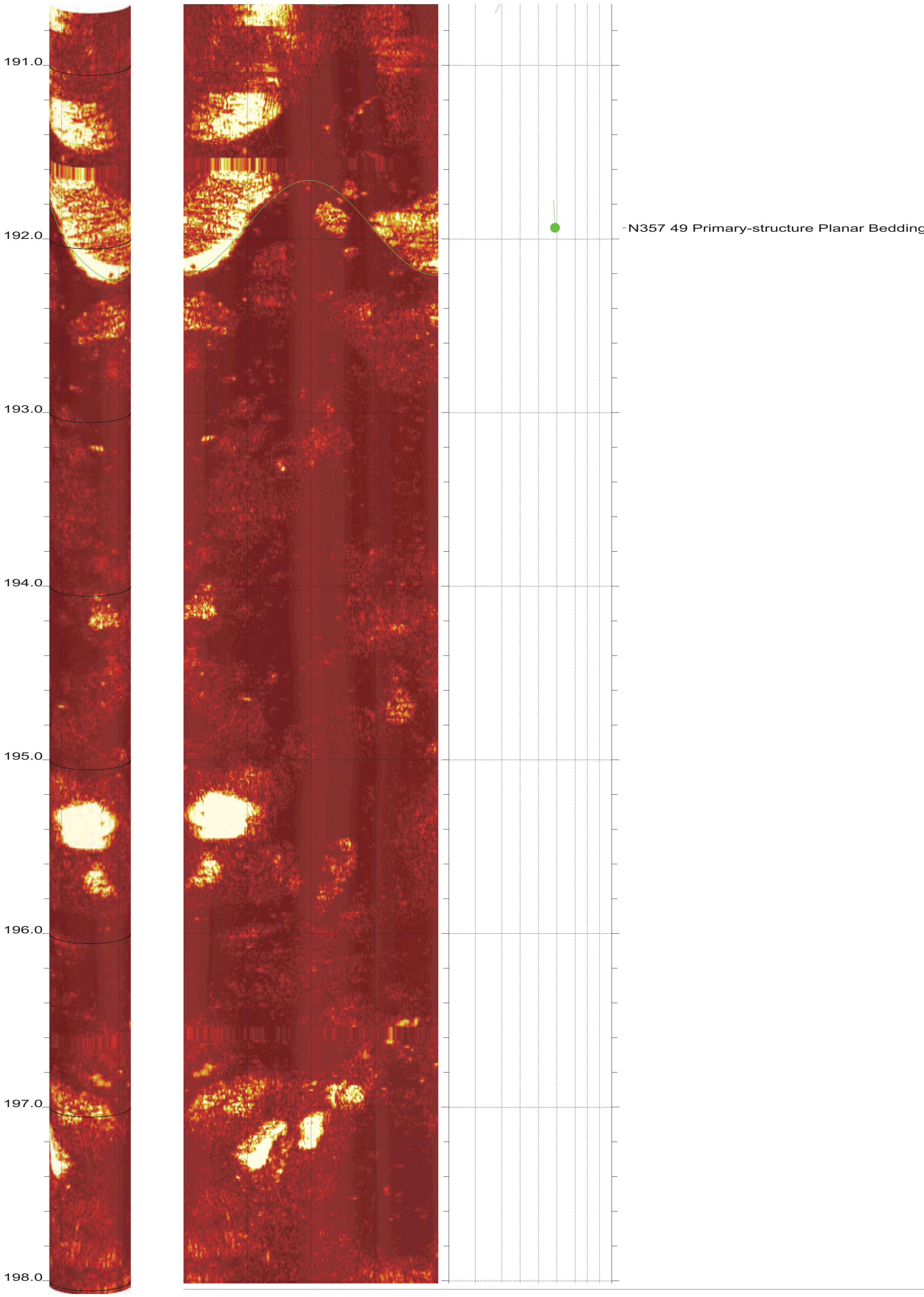
Z3-B4 183.280 to 175.912ft 25

SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 25 of 38



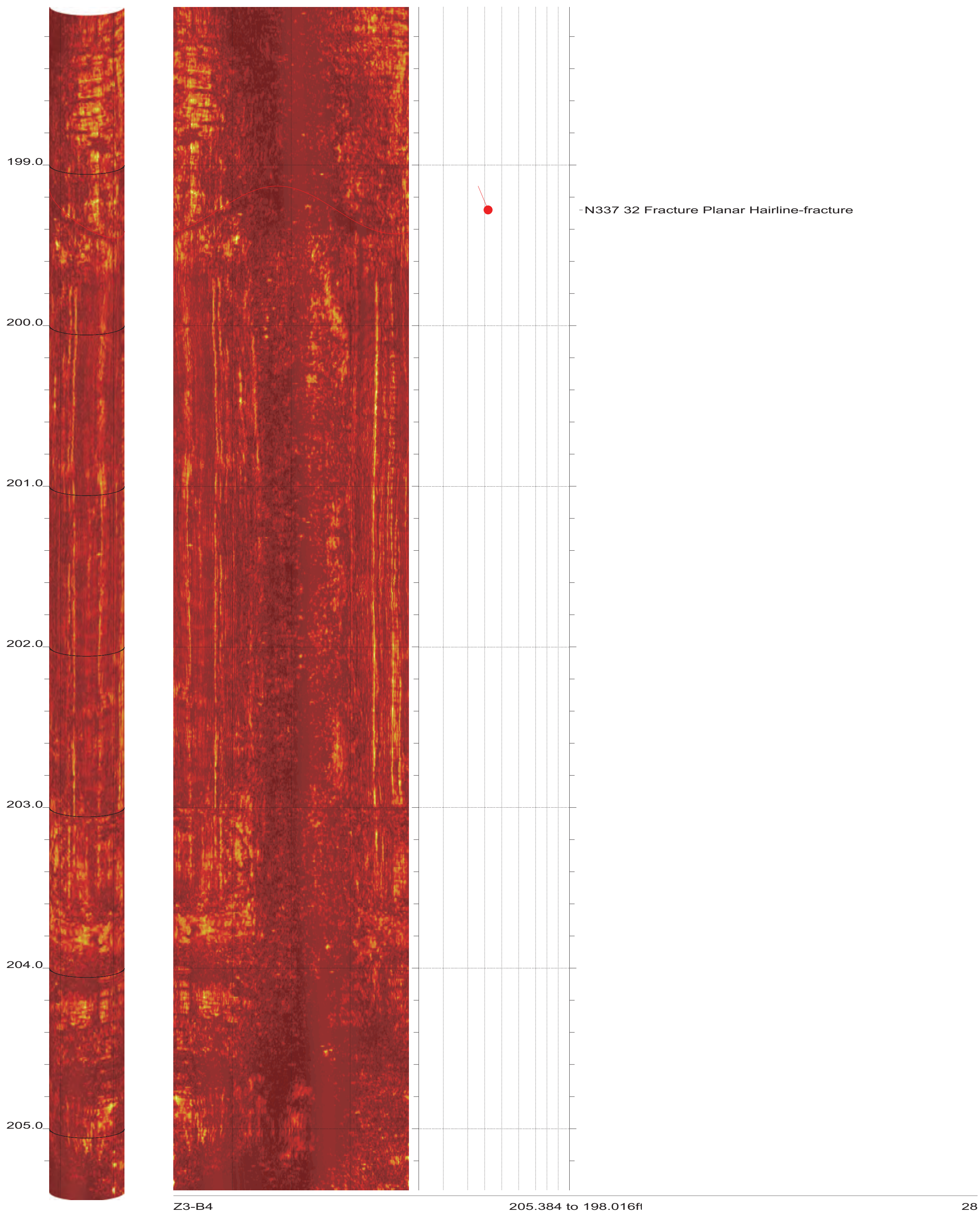
Z3-B4 190.648 to 183.280ft 26

SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 26 of 38

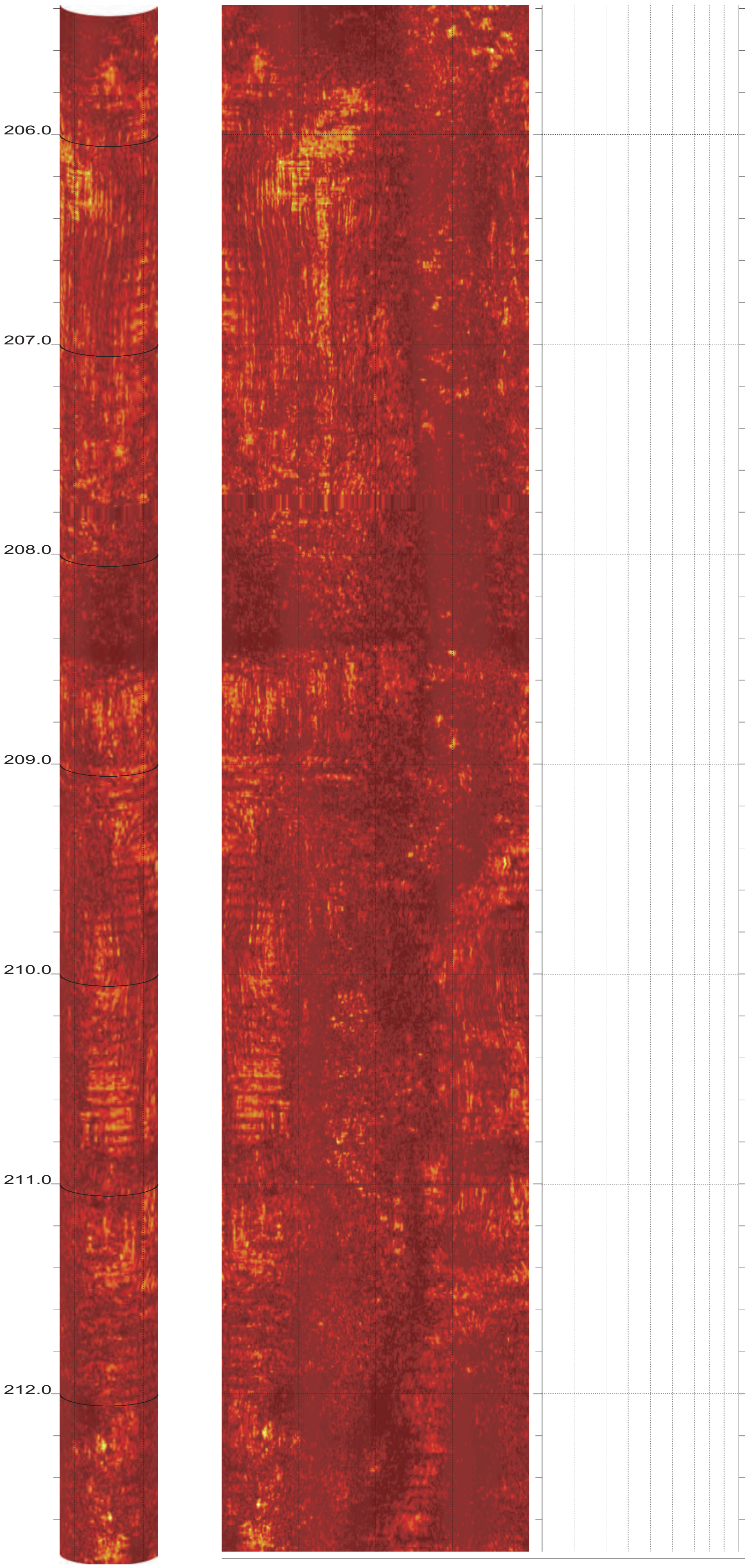


Z3-B4 198.016 to 190.648ft 27

SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 27 of 38

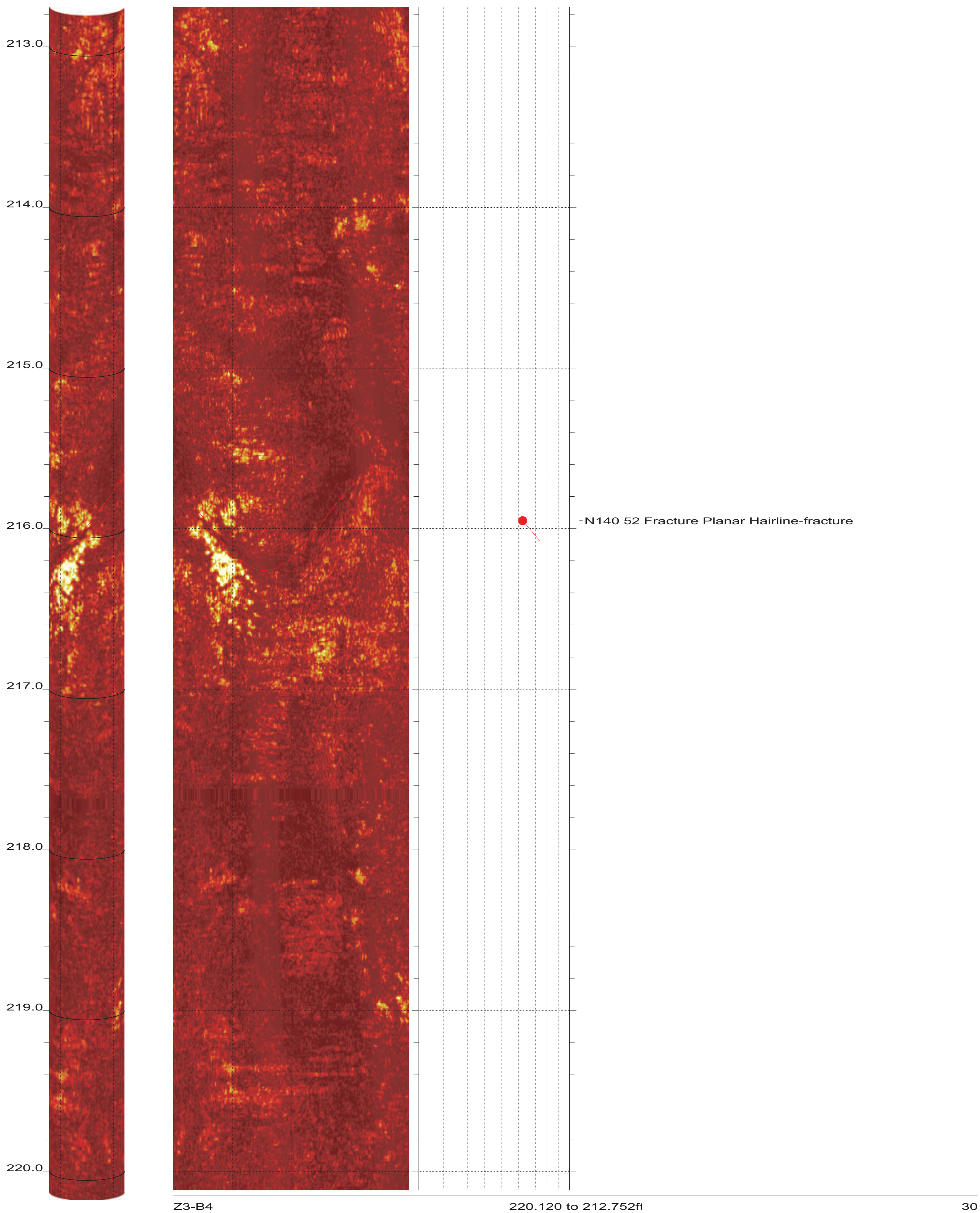


SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 28 of 38

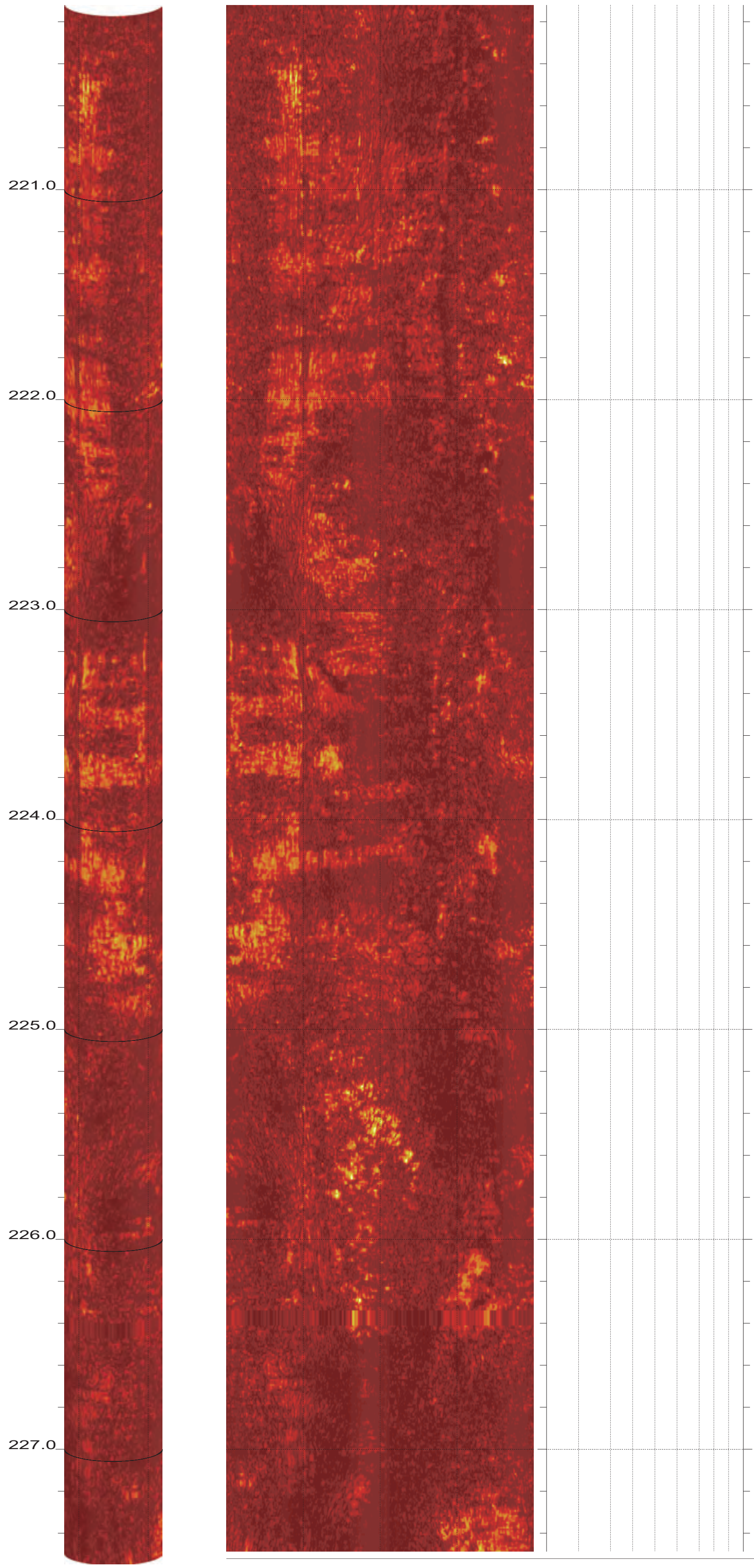


Z3-B4 212.752 to 205.384ft 29

SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 29 of 38

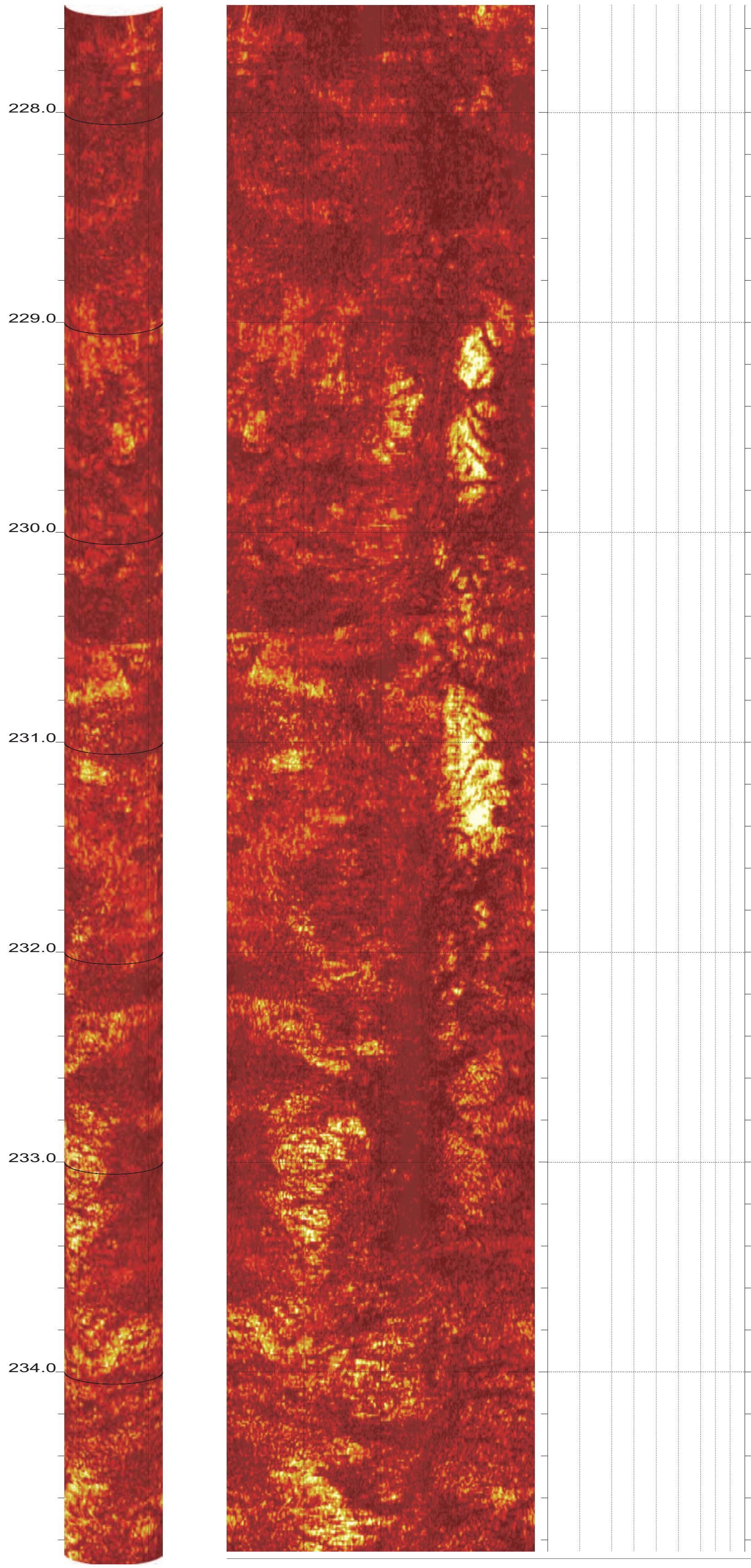


SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 30 of 38



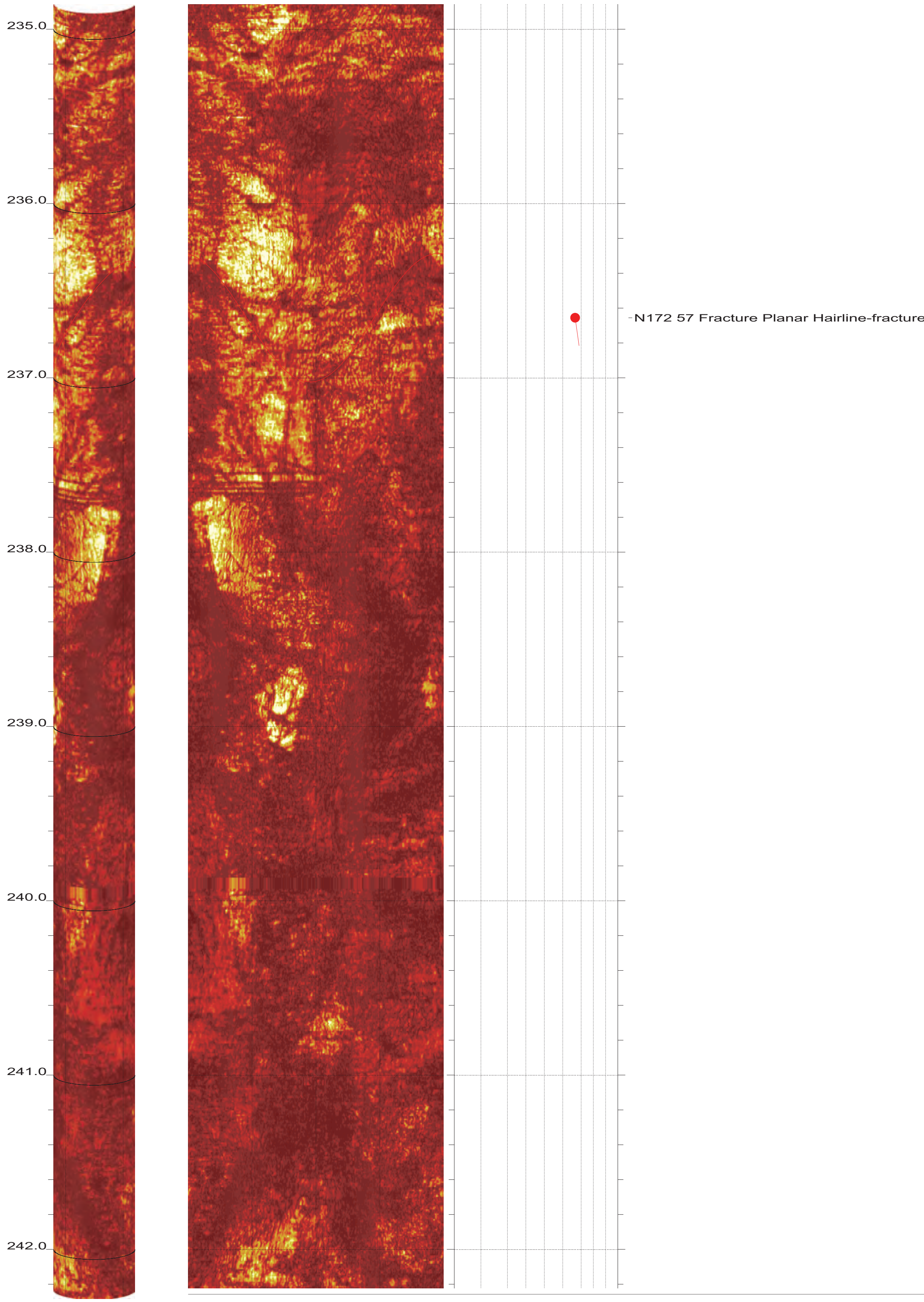
Z3-B4 227.488 to 220.120ft 31

SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 31 of 38



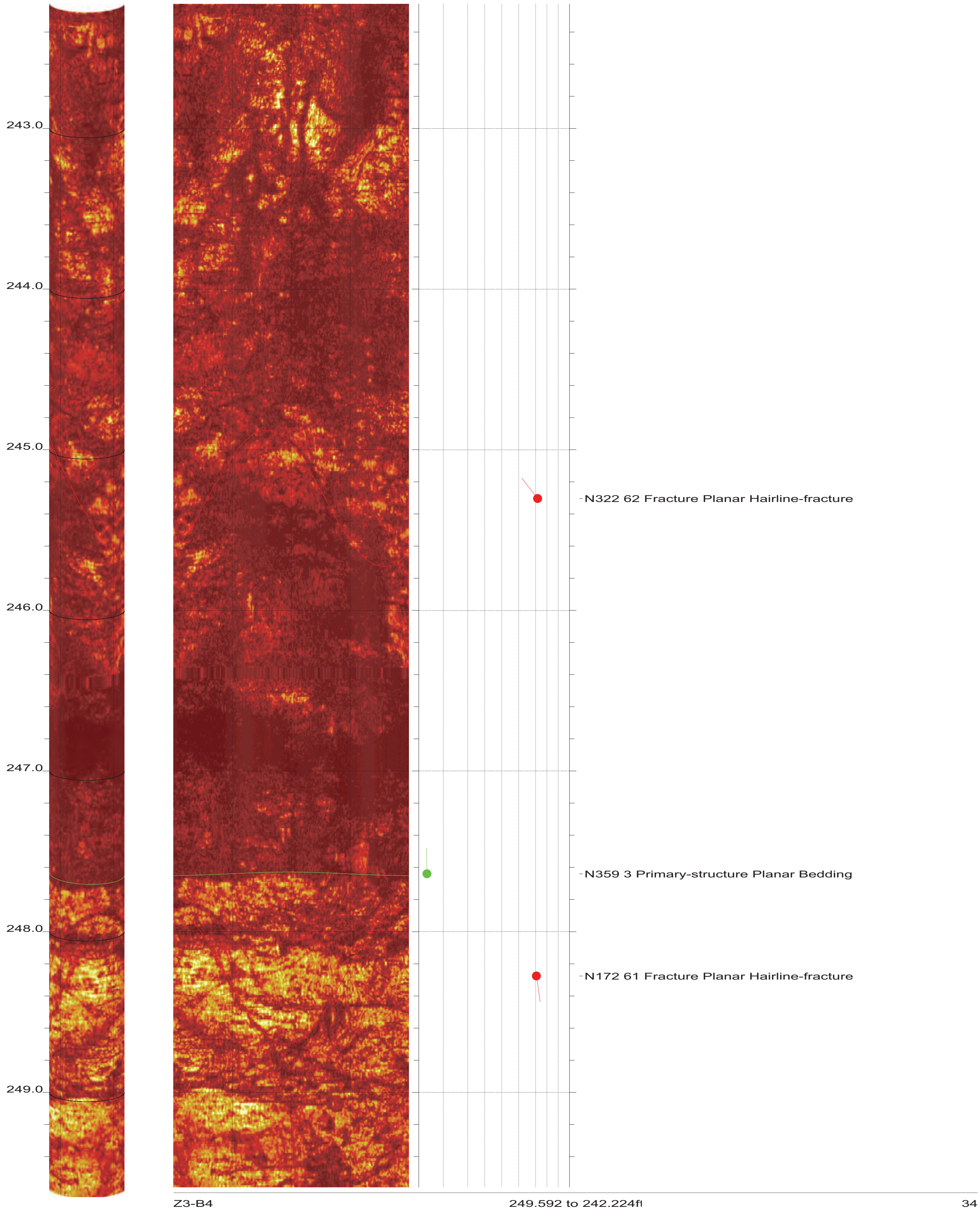
Z3-B4 234.856 to 227.488ft 32

SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 32 of 38

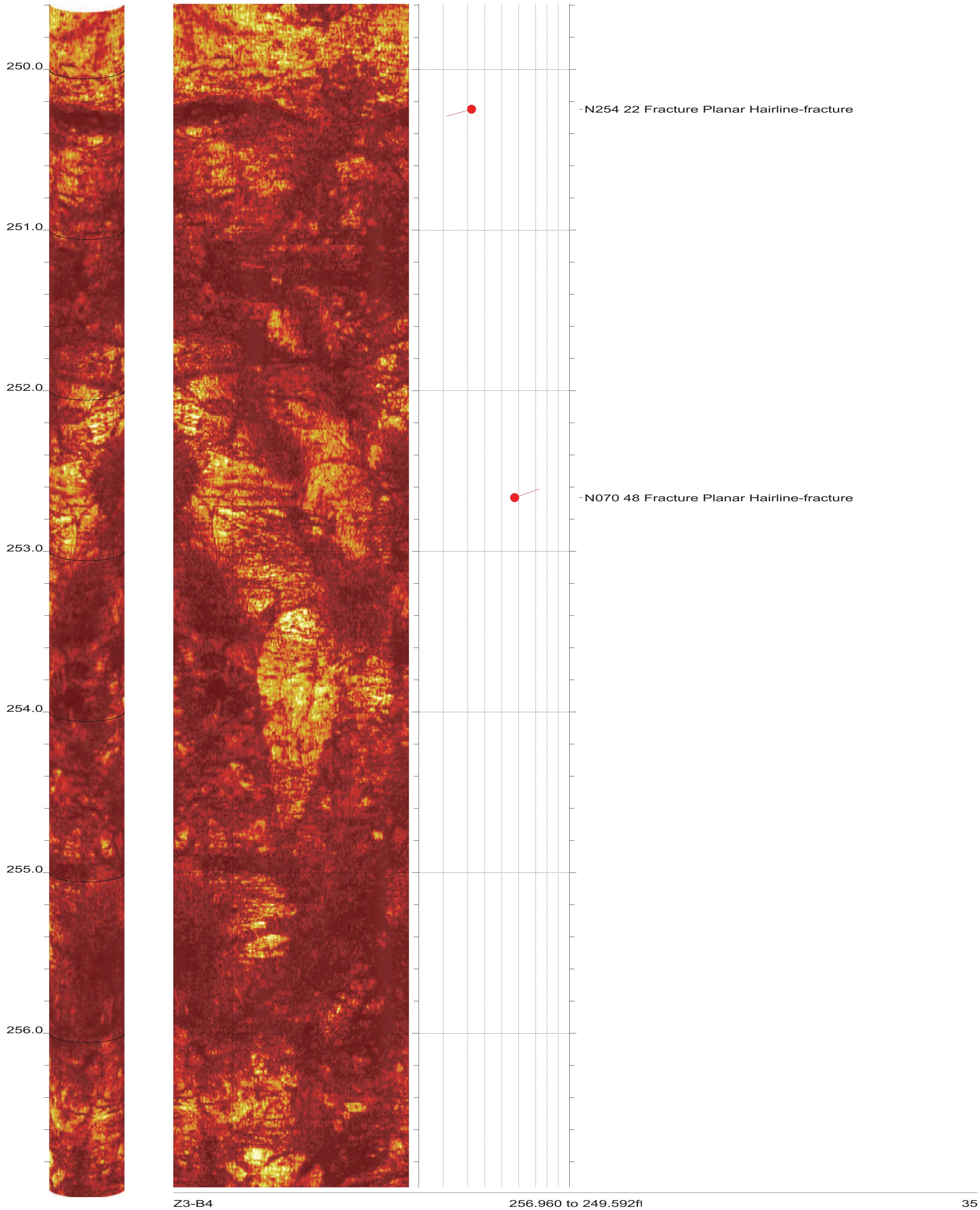


Z3-B4 242.224 to 234.856ft 33

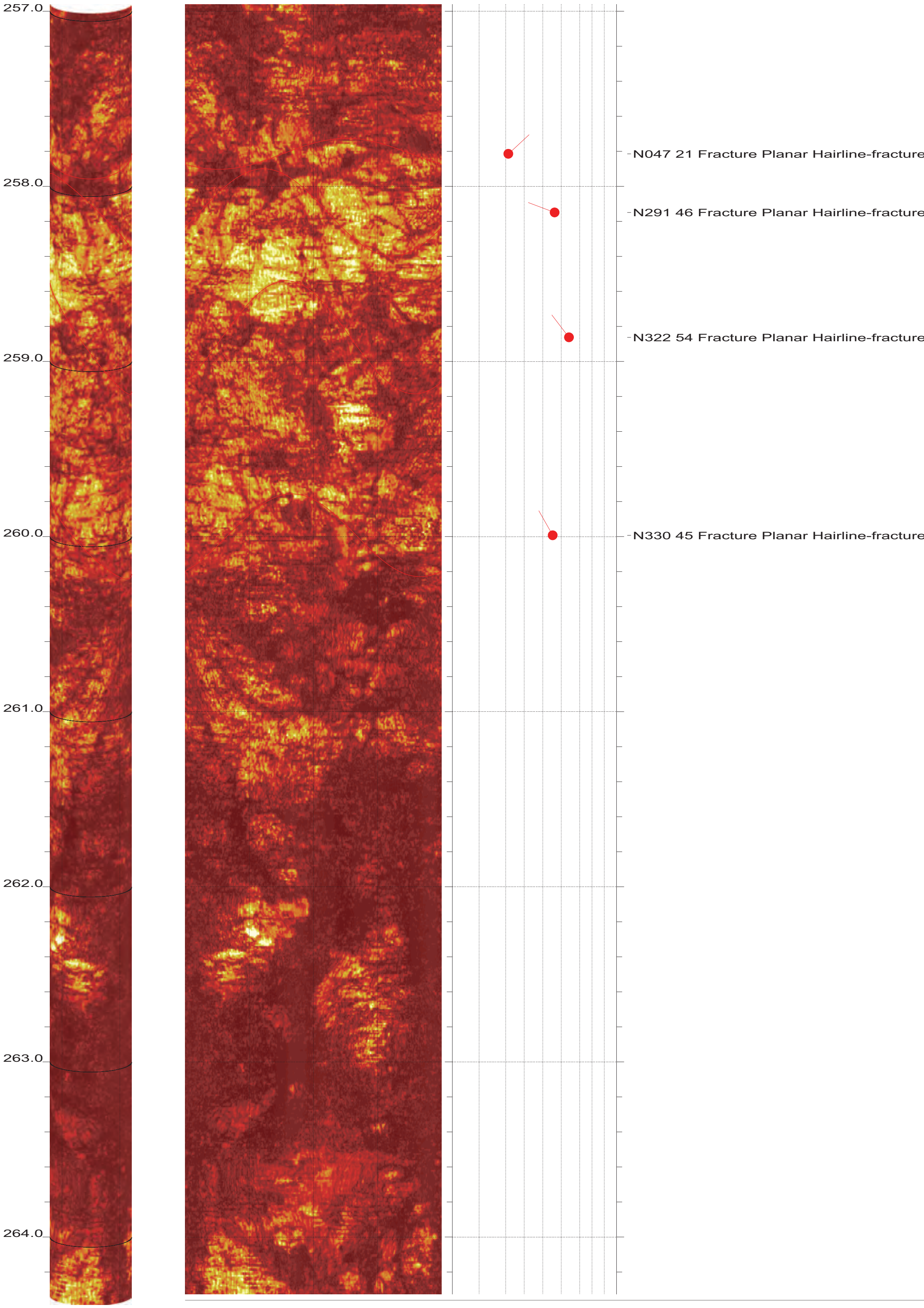
SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 33 of 38



SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 34 of 38

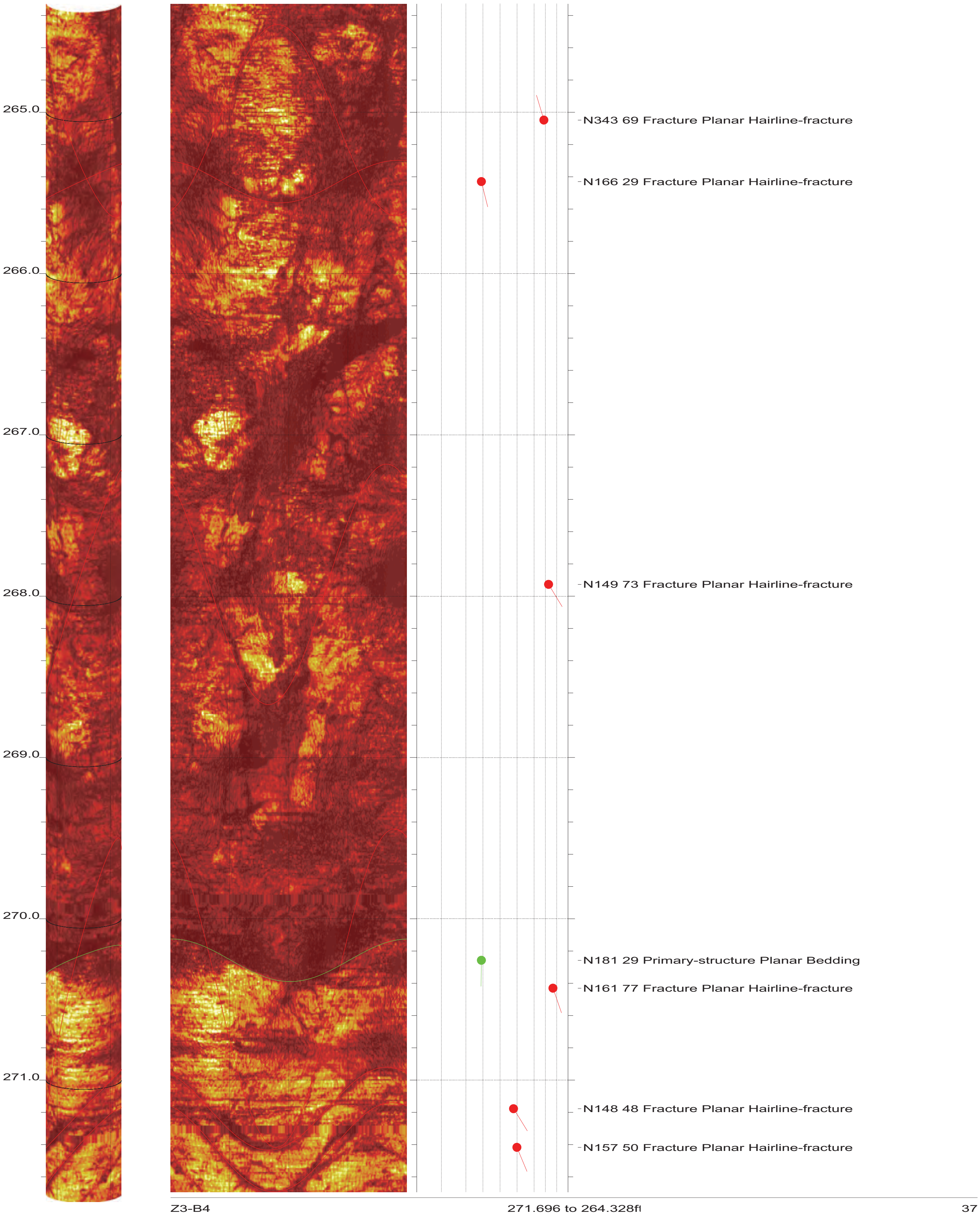


SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 35 of 38

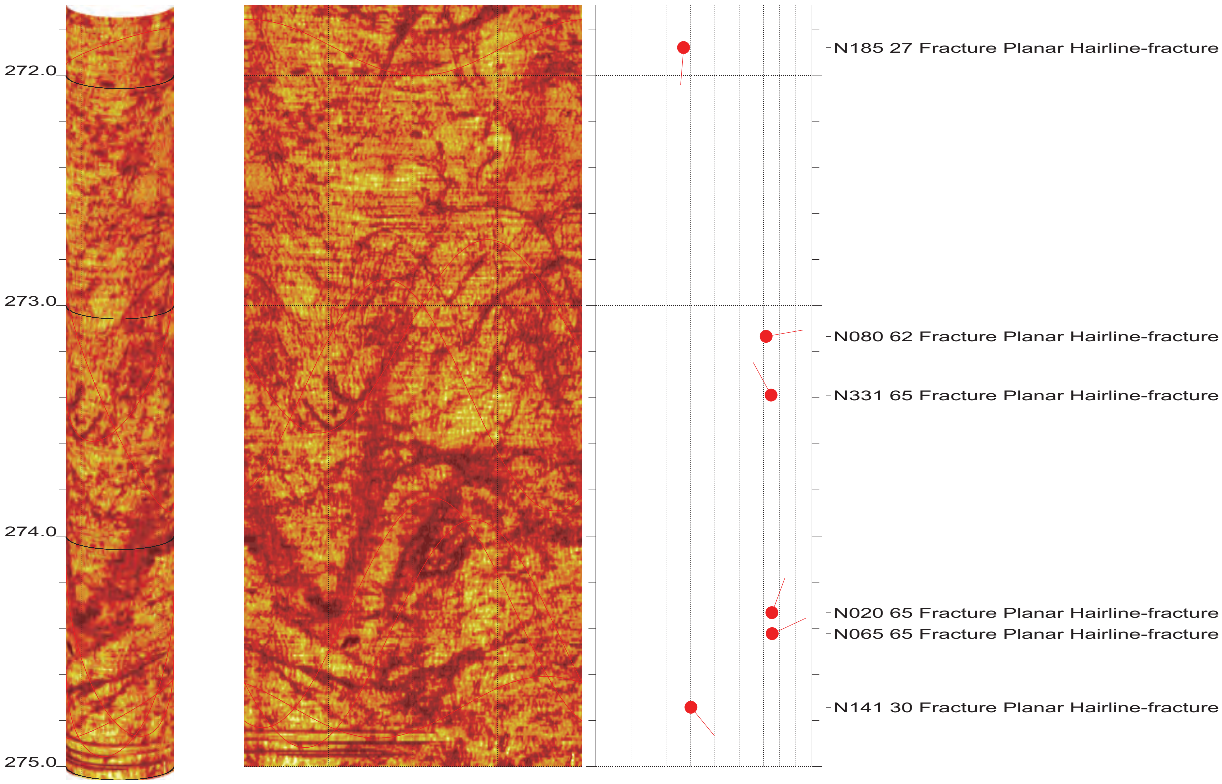


Z3-B4 264.328 to 256.960ft 36

SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 36 of 38



SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 37 of 38



SR-710 Boring Z3-B4 Acoustic Televiewer Dips rev 1 Sheet 38 of 38

BHTV DATA PROCESSING
RGLDIP vsn 6.2
INTERPRETED BHTV DIPS LOG

CASCADE DRILLING

Borehole: Z3-B6

SR-710 TUNNEL INVESTIGATION

top of borehole.....	North ref. is true
East: _	Depth units are feet
North: _	Vertical scale: 1/10
Elev: _	Horiz scale = 1.00x Vert scale

Zone from 318.600 to 28.400ft	Borehole diam: 5.600inch
Format: BHTV-NESWN	Vertical = borehole-axis
	Image: Amplitude

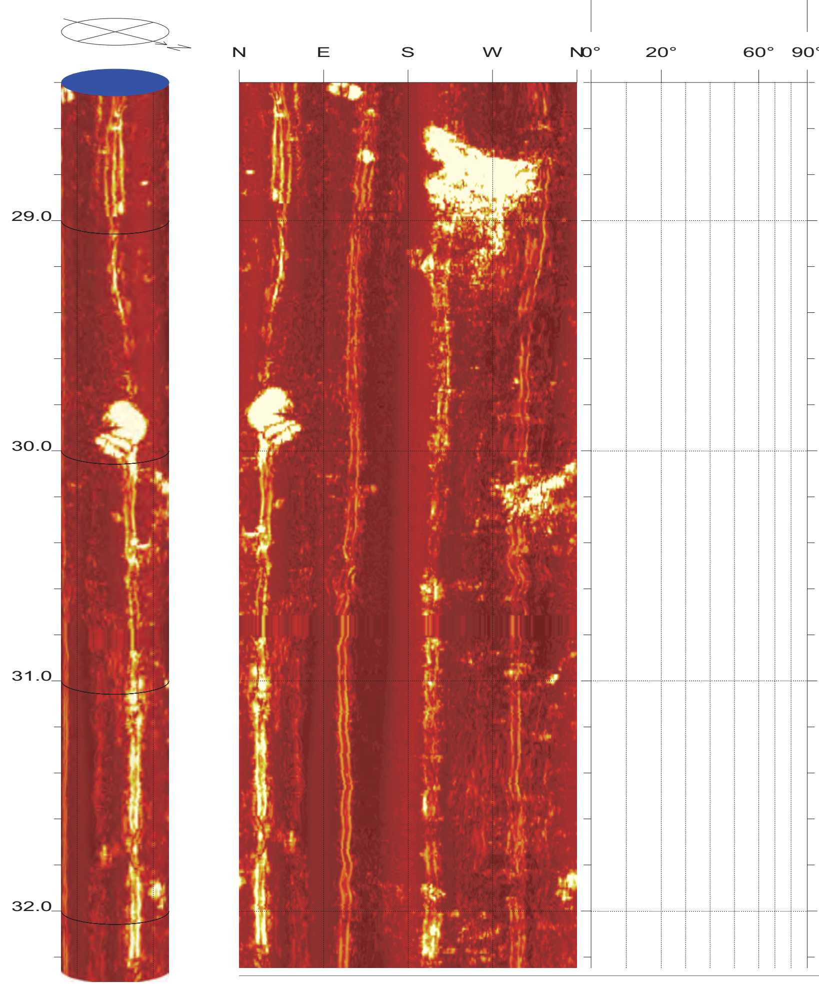
Stratigraphic dips

Non-stratigraphic dips

Identified units

ARROW PLOT

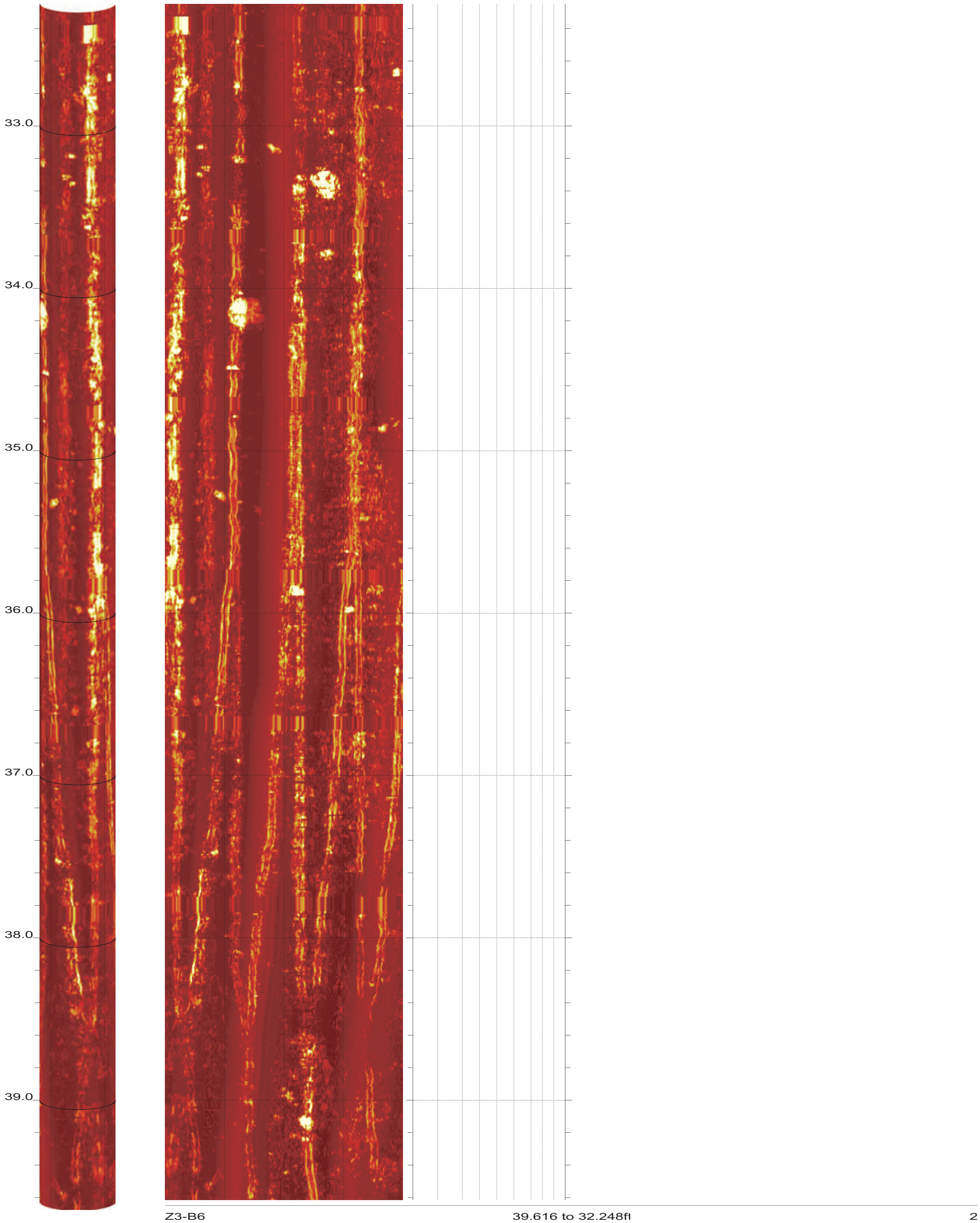
COMMENTS



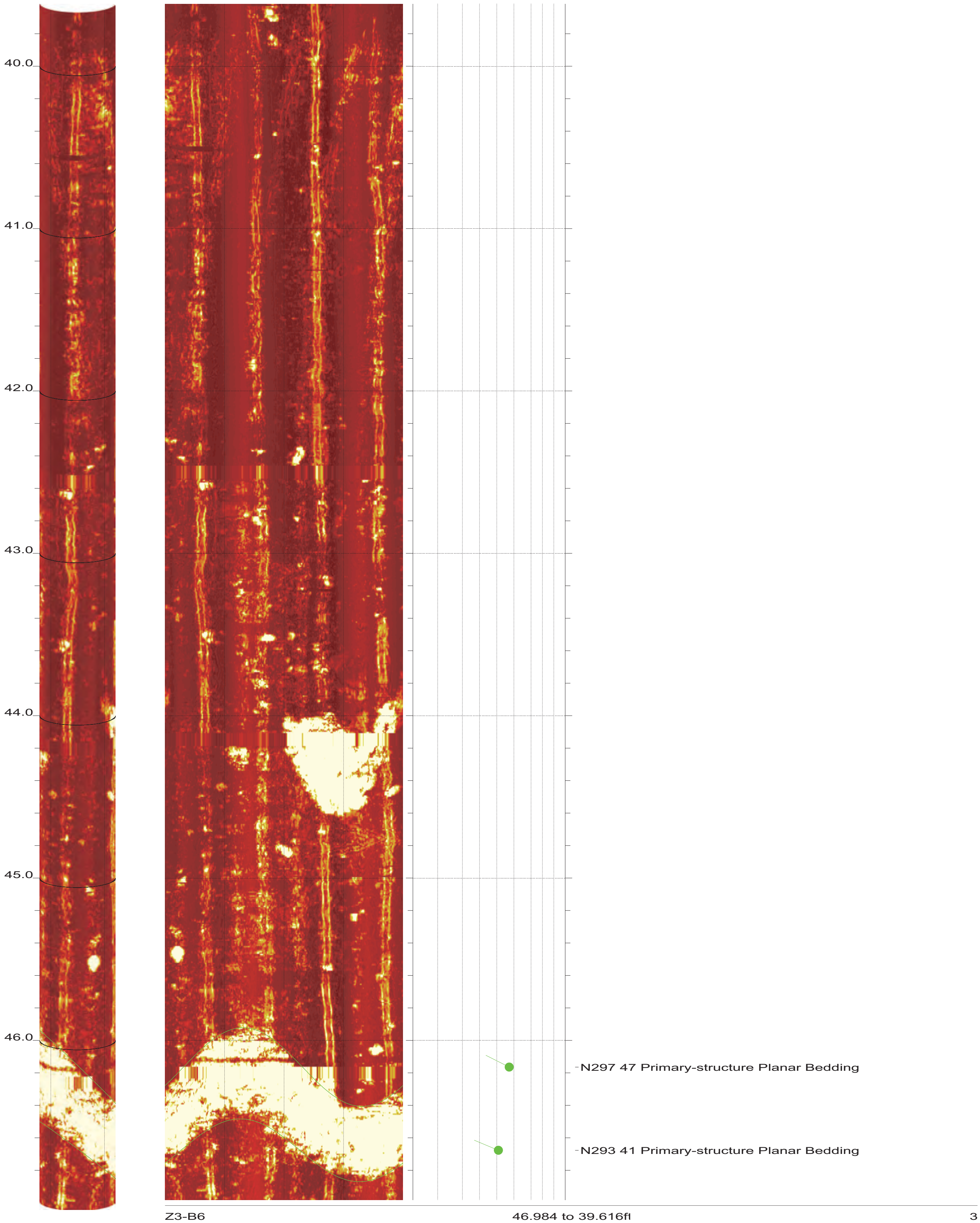
-Vertical lines are from centralizers
-in soft wall cake

Z3-B6 32.248 to 28.400ft 1

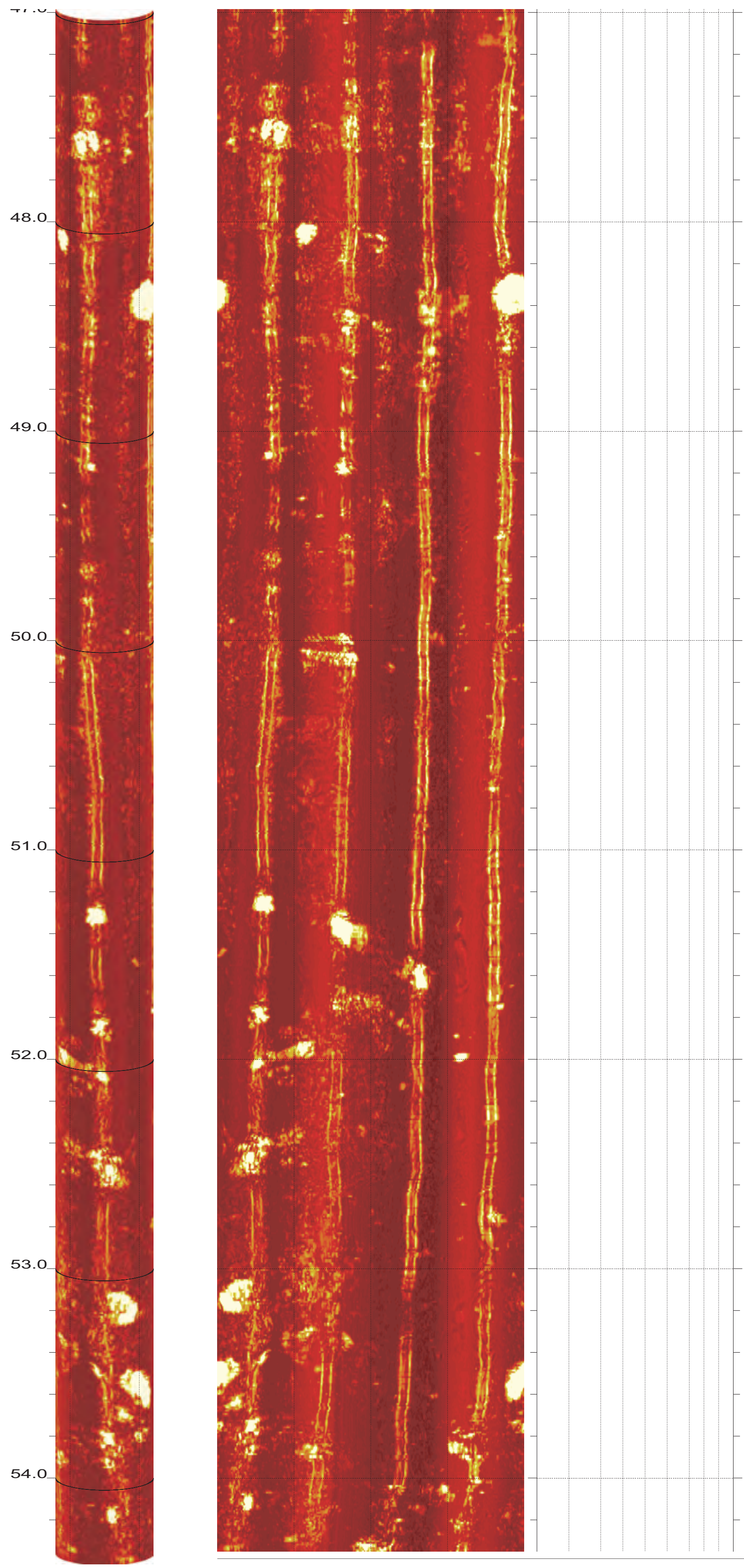
SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 1 of 40



SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 2 of 40

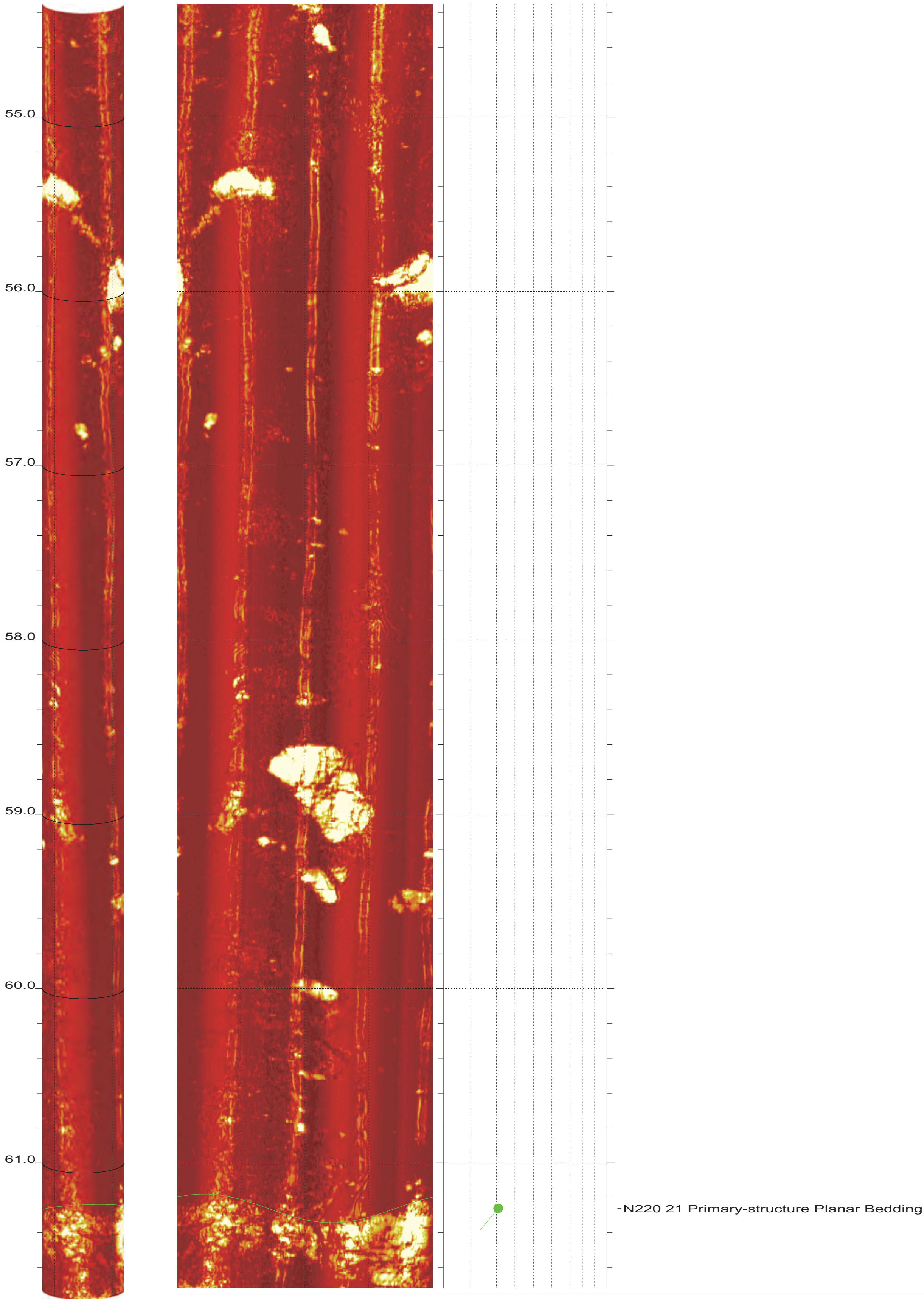


SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 3 of 40



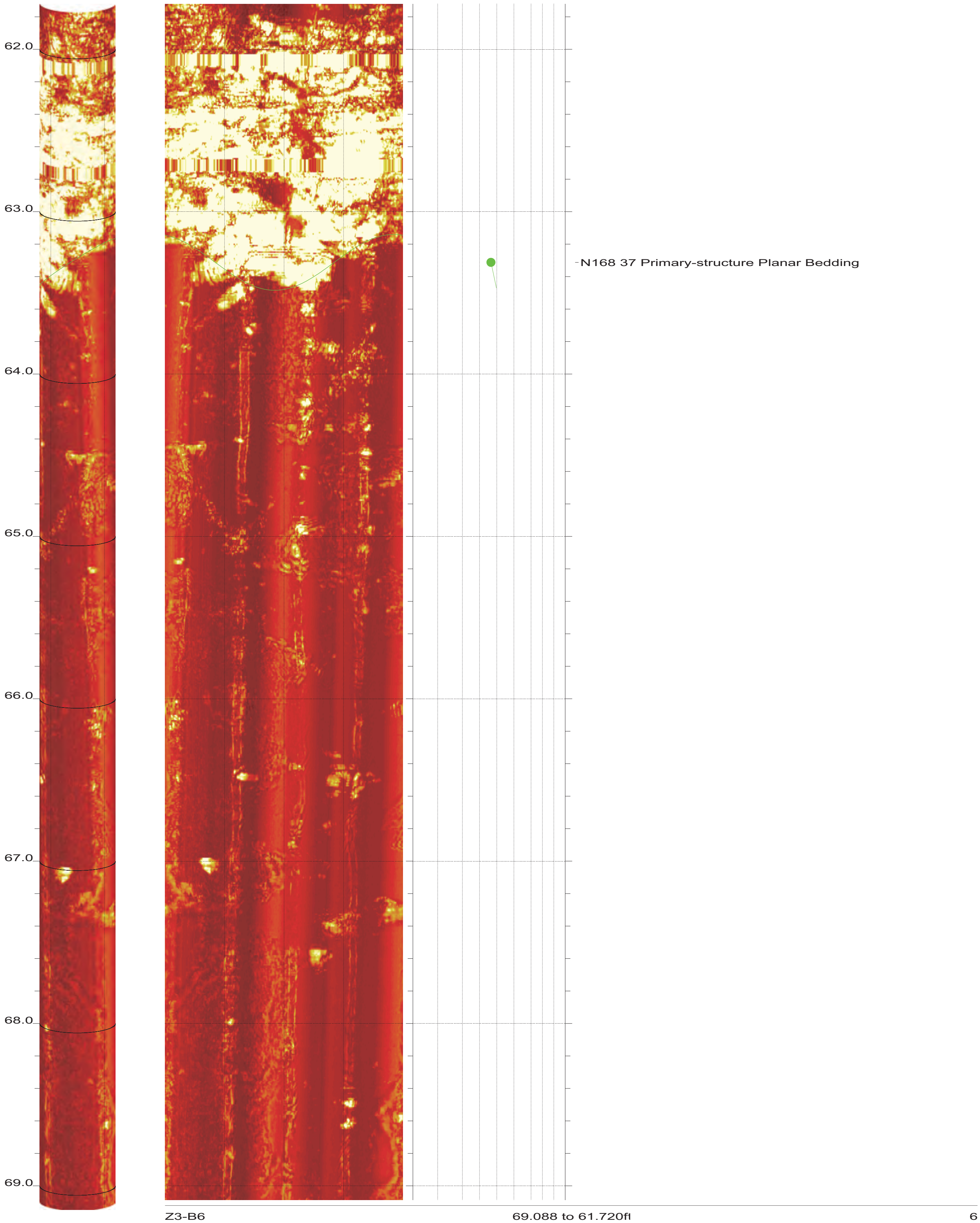
Z3-B6 54.352 to 46.984ft 4

SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 4 of 40

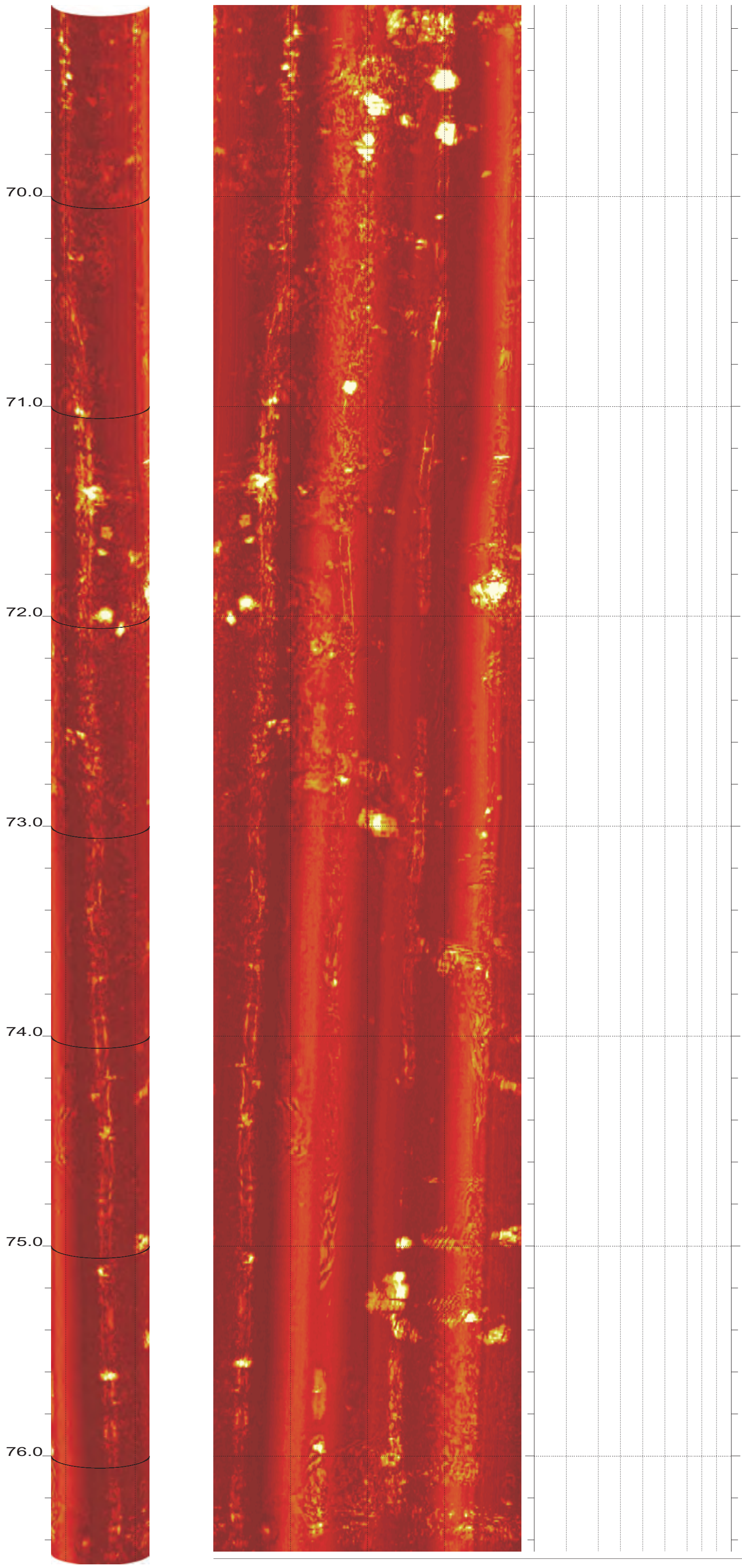


Z3-B6 61.720 to 54.352ft 5

SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 5 of 40

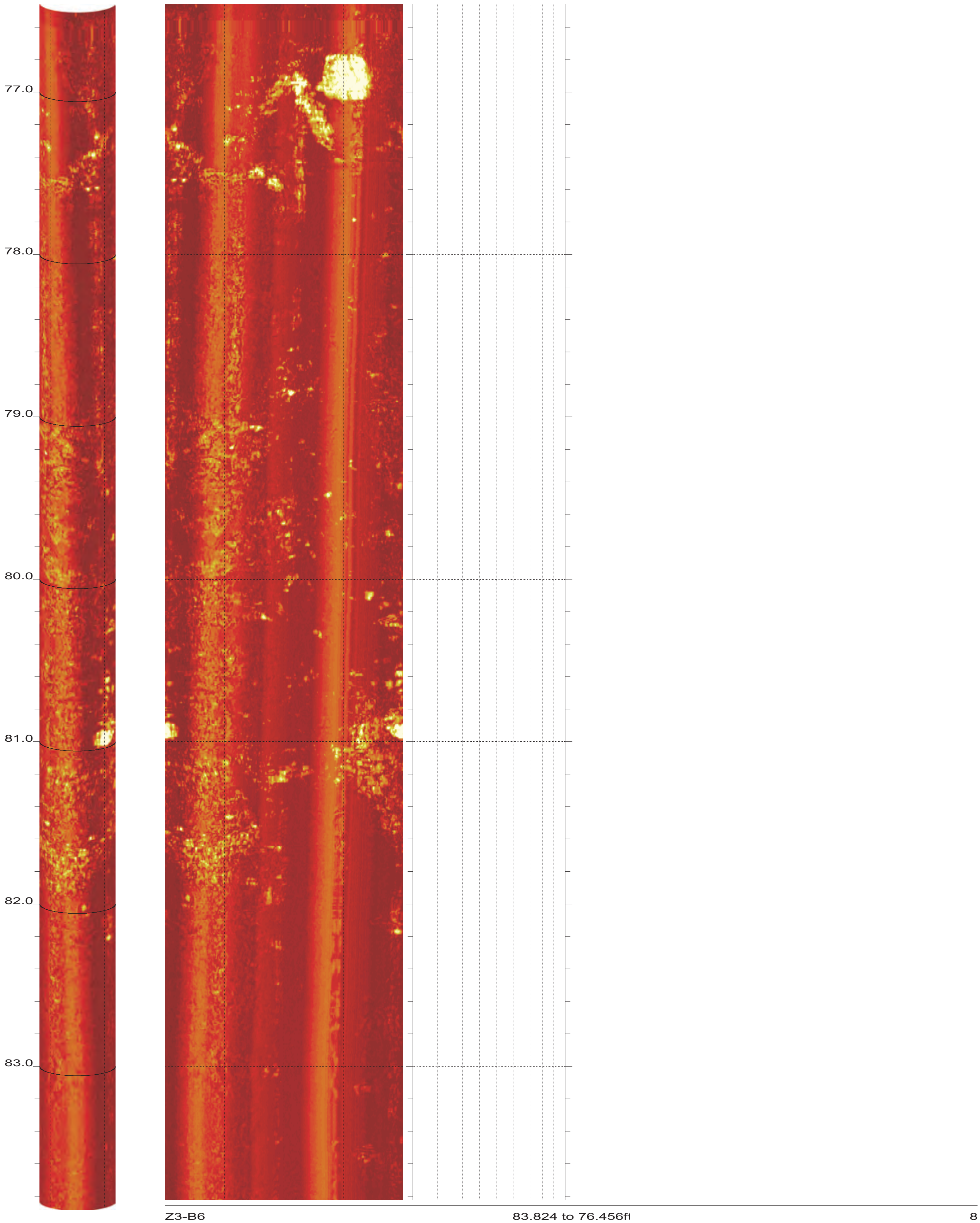


SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 6 of 40

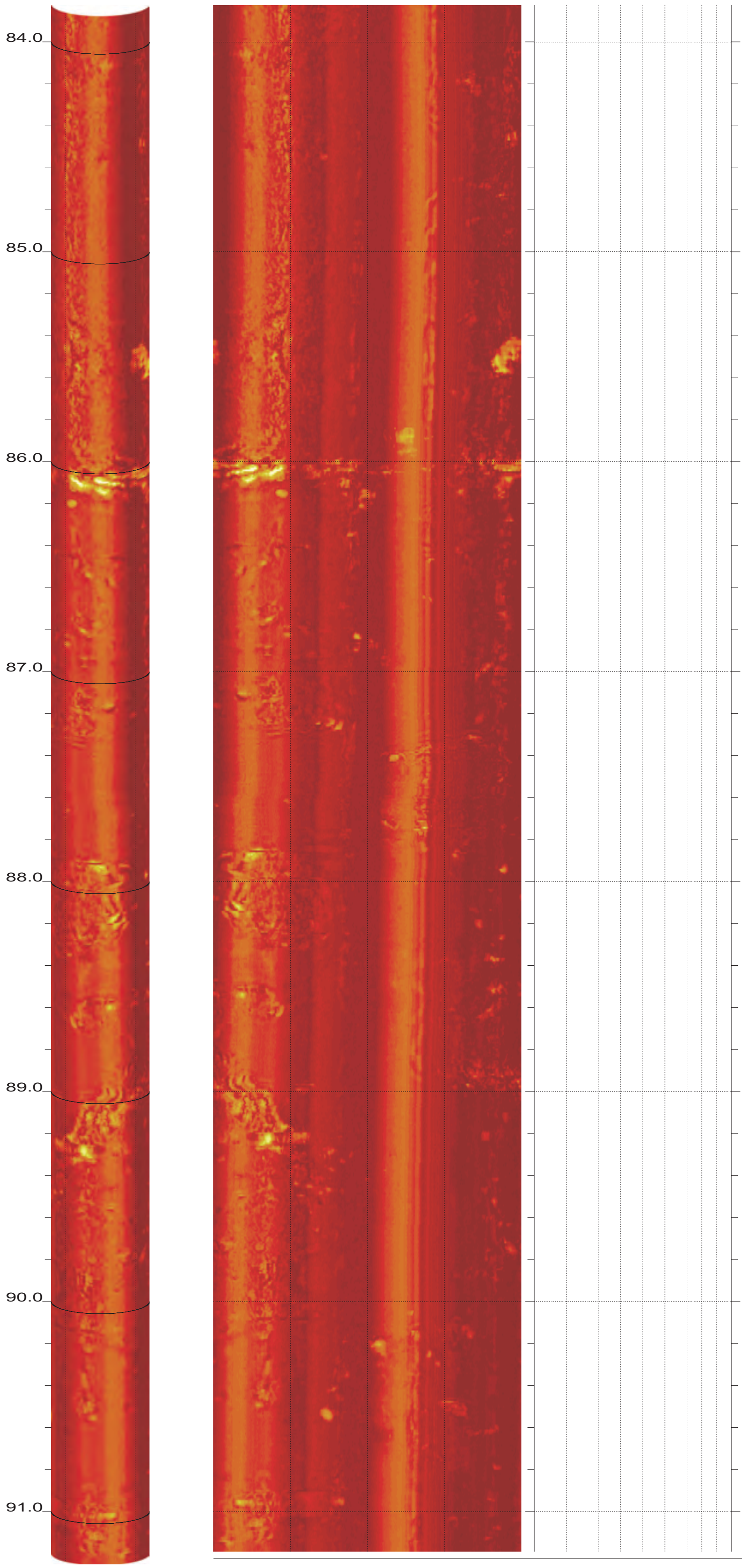


Z3-B6 76.456 to 69.088ft 7

SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 7 of 40

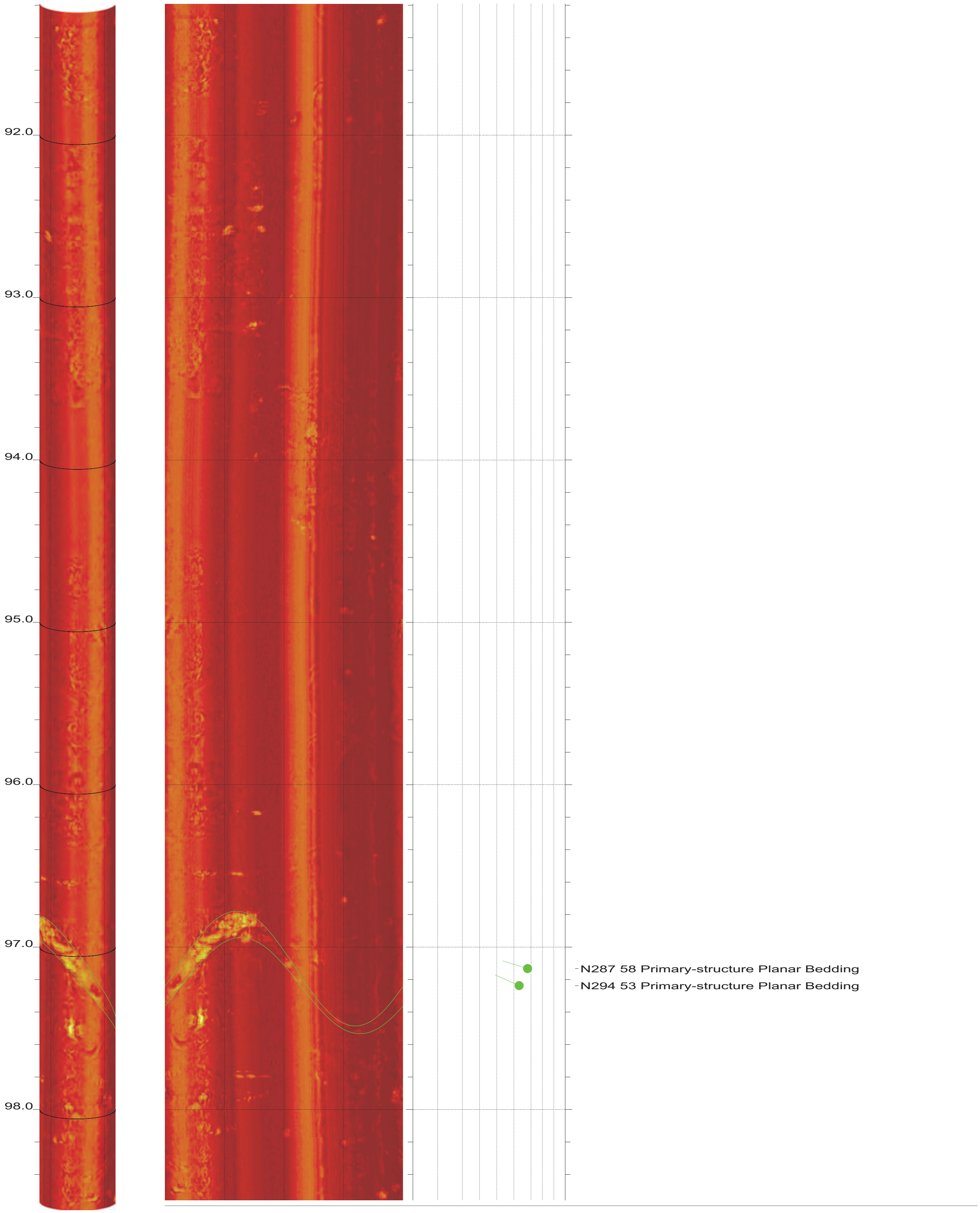


SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 8 of 40

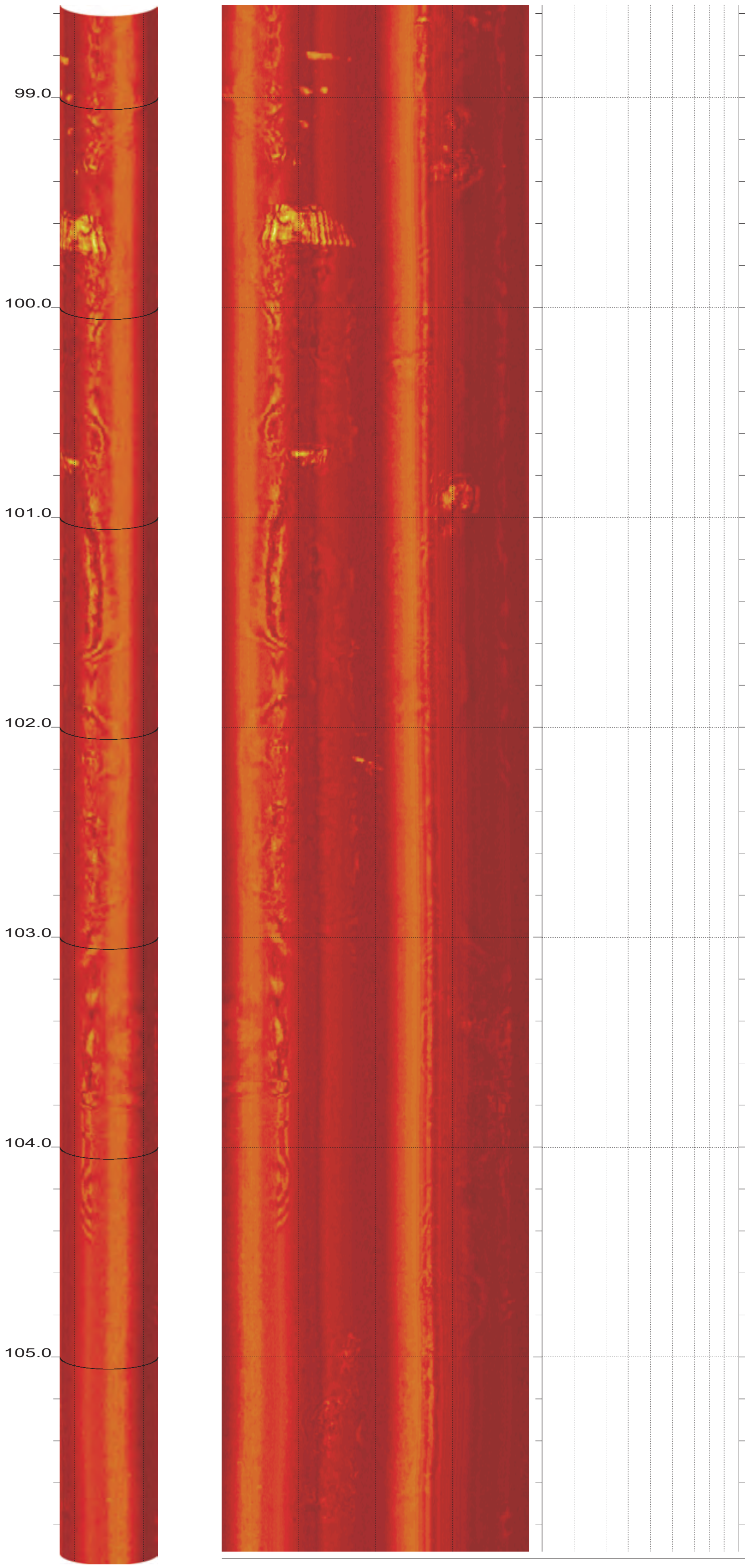


Z3-B6 91.192 to 83.824ft 9

SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 9 of 40



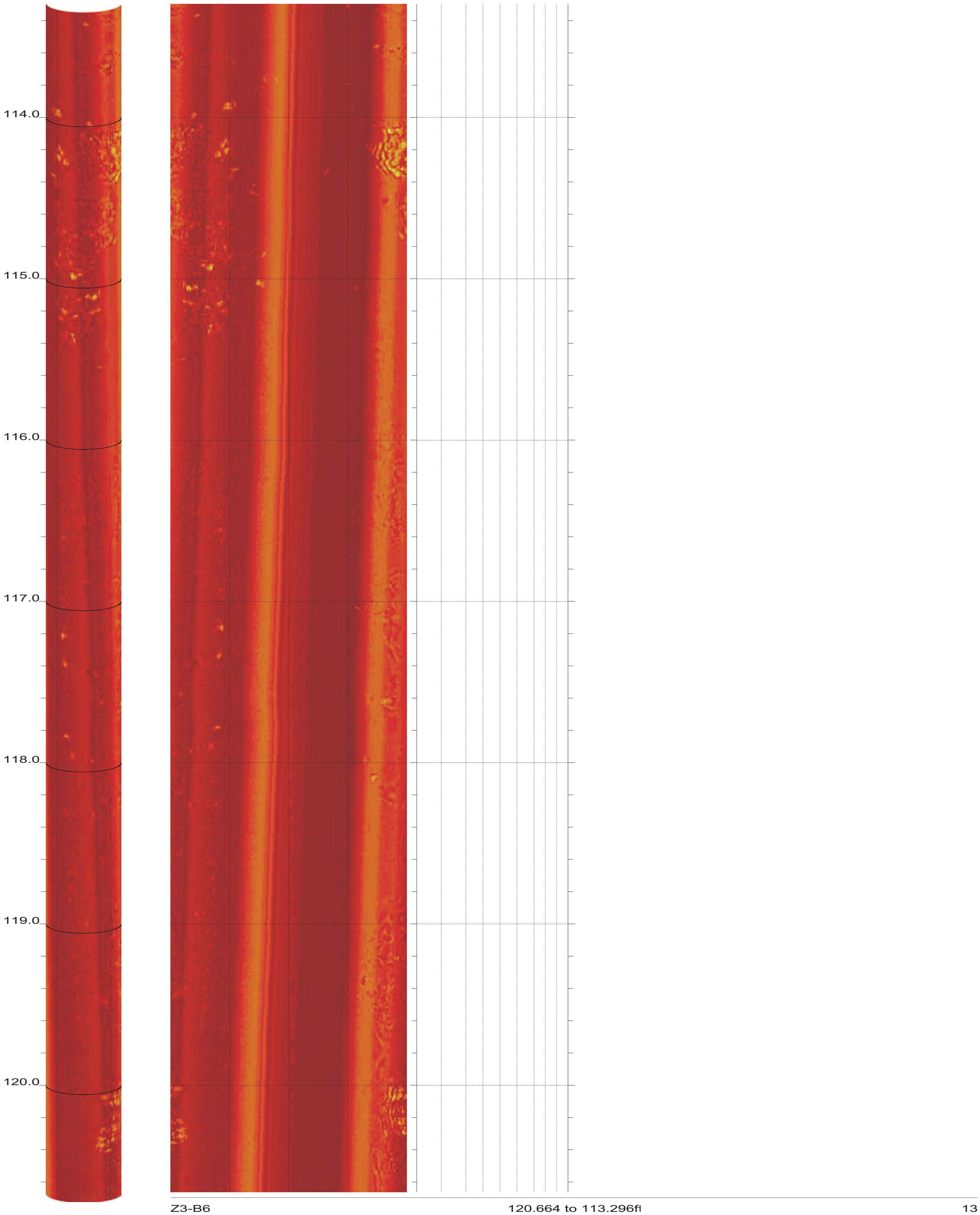
SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 10 of 40



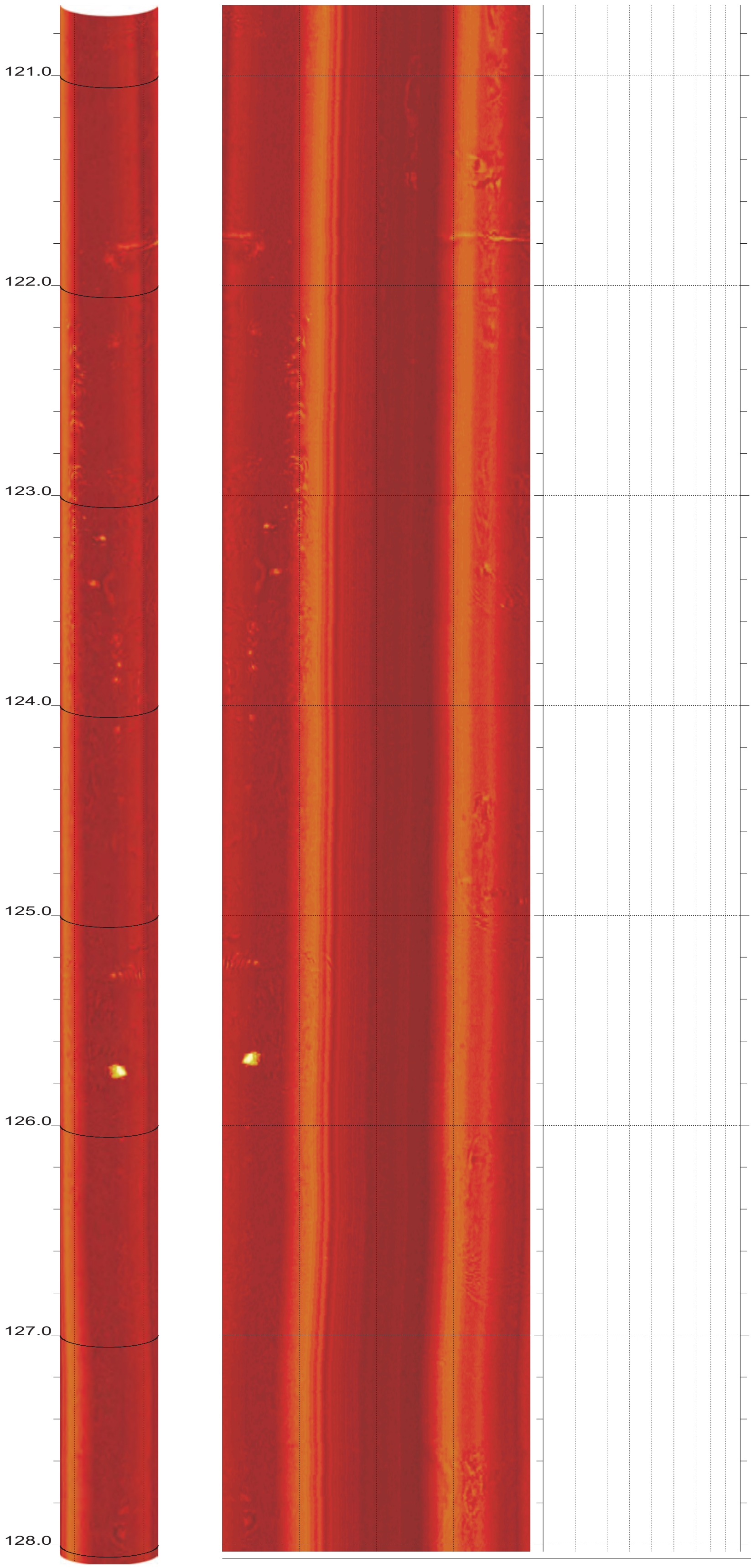
Z3-B6 105.928 to 98.560ft 11

SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 11 of 40

SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 12 of 40

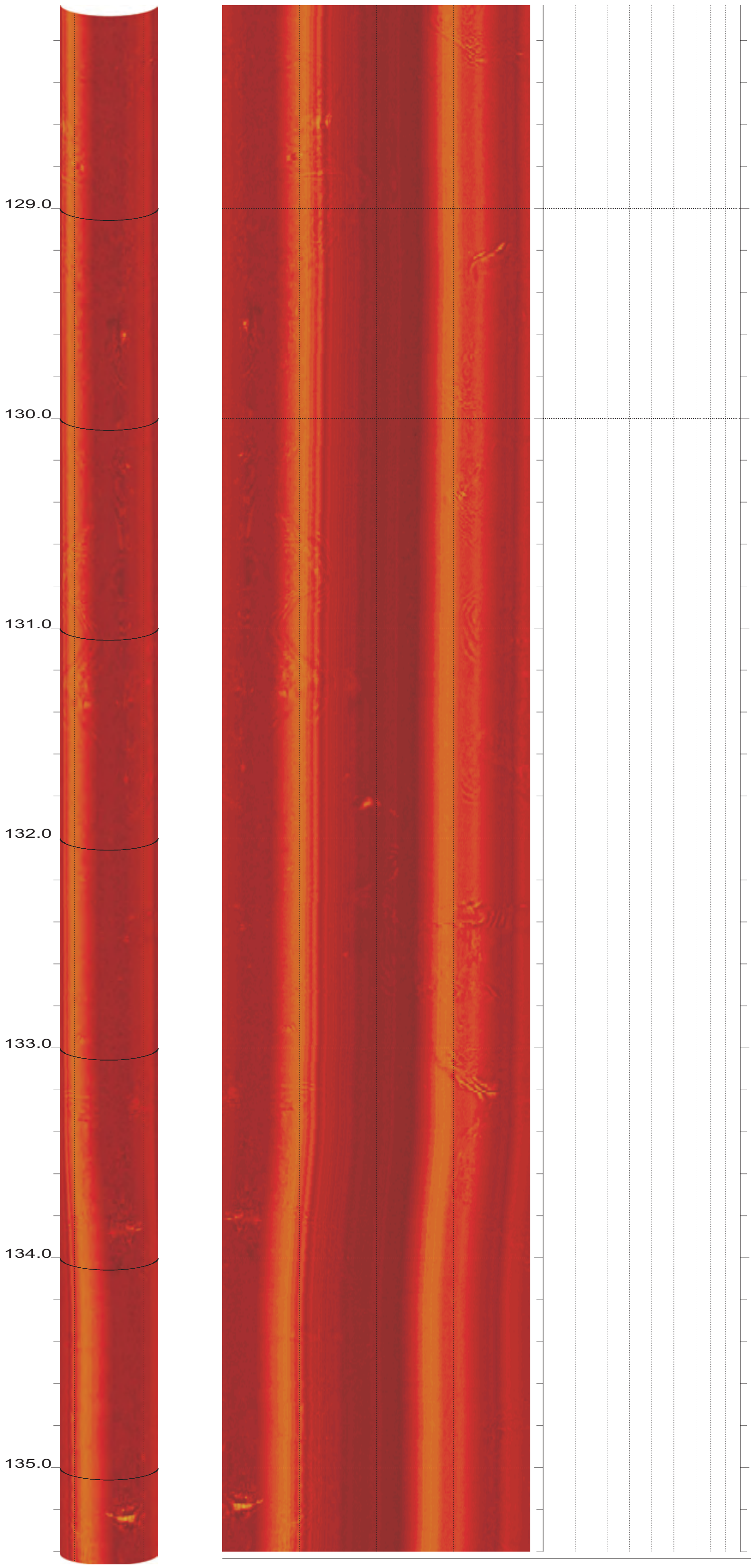


SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 13 of 40



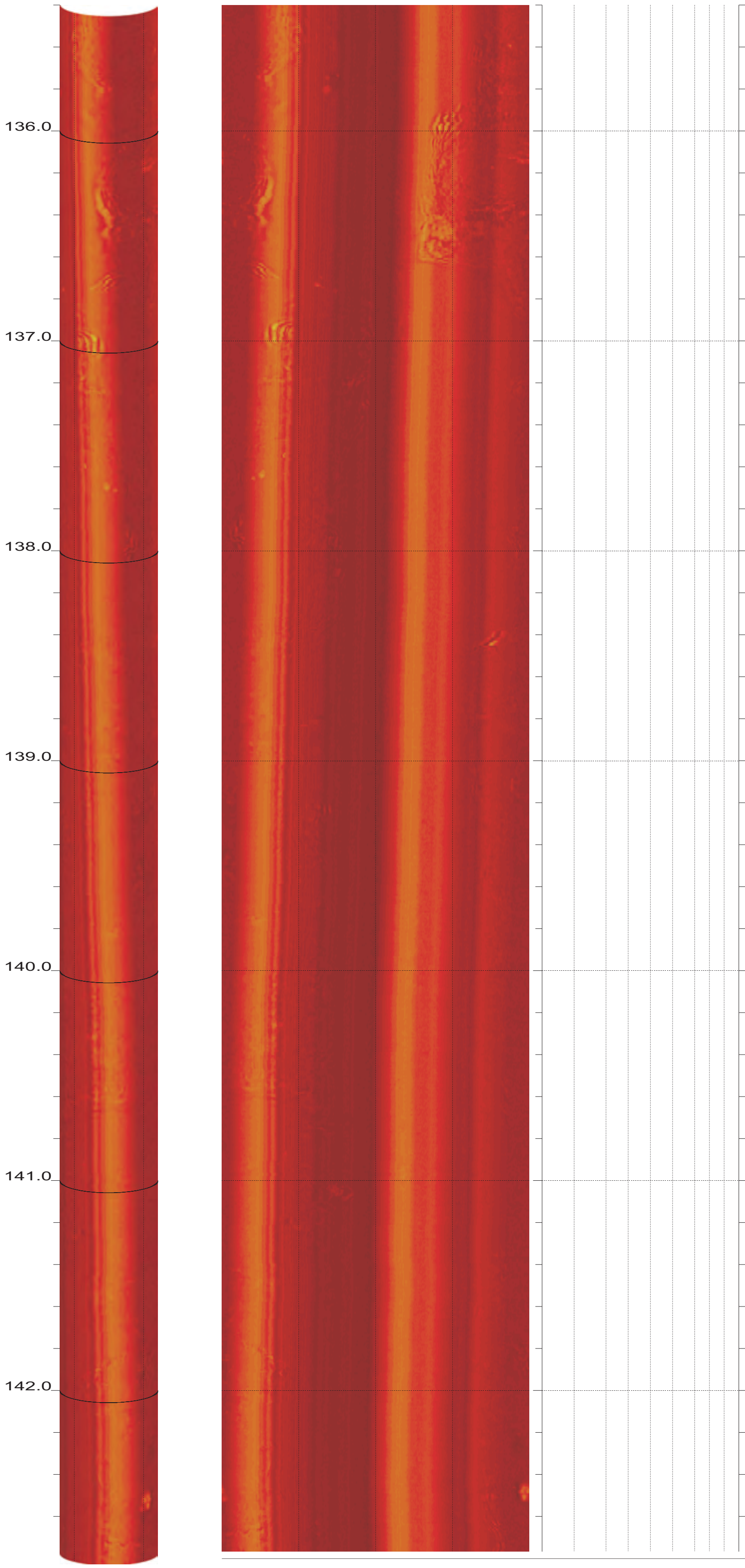
Z3-B6 128.032 to 120.664ft 14

SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 14 of 40



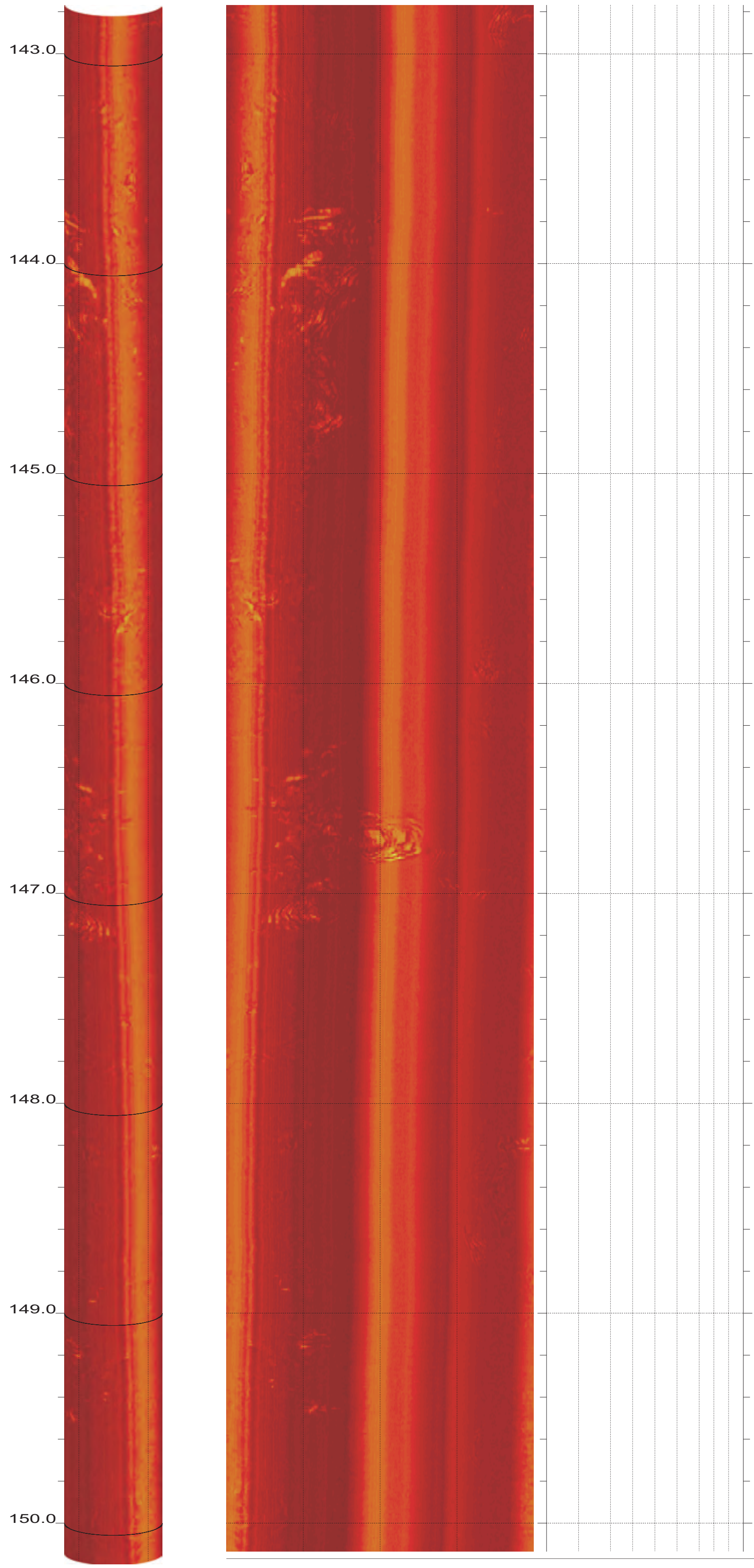
Z3-B6 135.400 to 128.032ft 15

SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 15 of 40



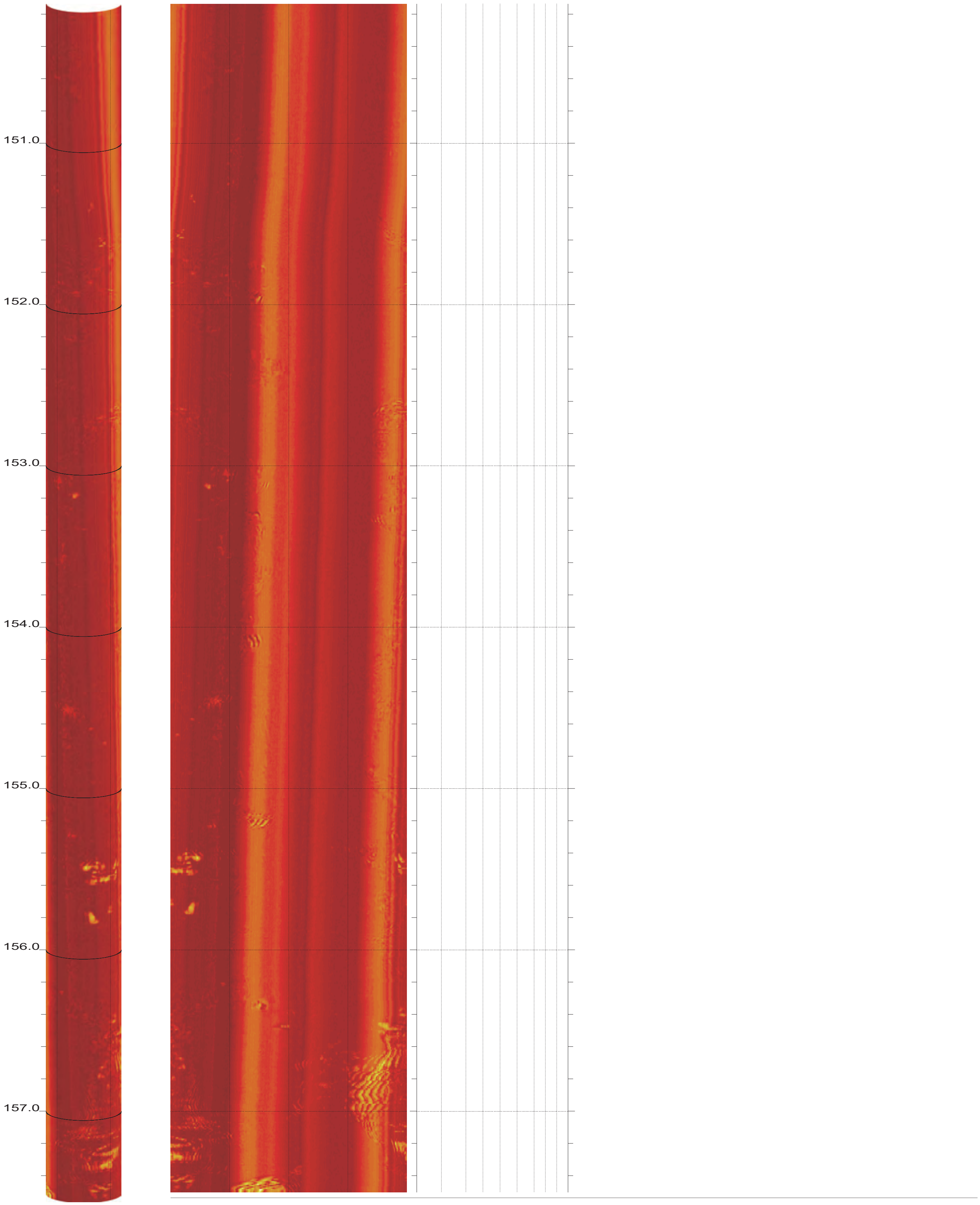
Z3-B6 142.768 to 135.400ft 16

SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 16 of 40

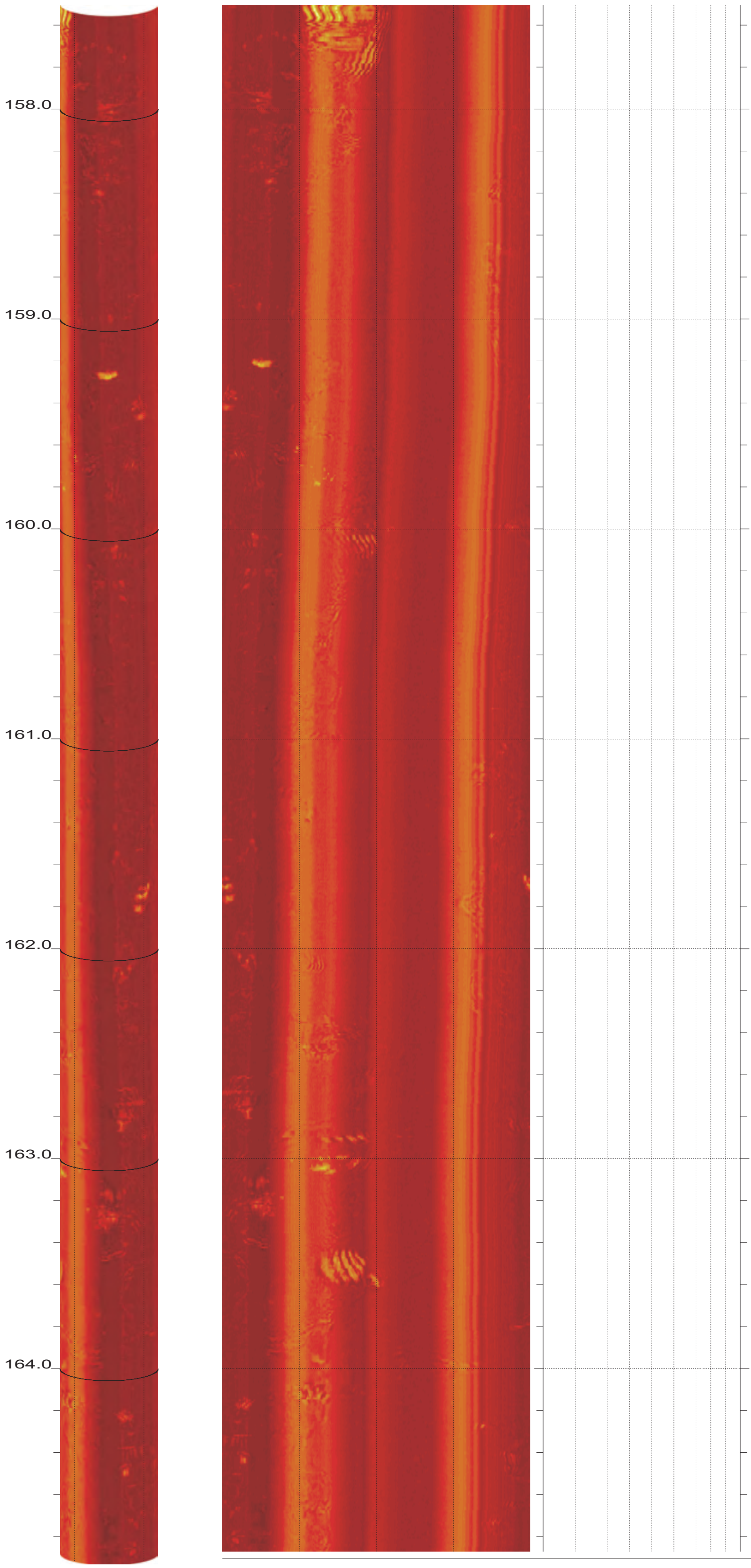


Z3-B6 150.136 to 142.768ft 17

SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 17 of 40

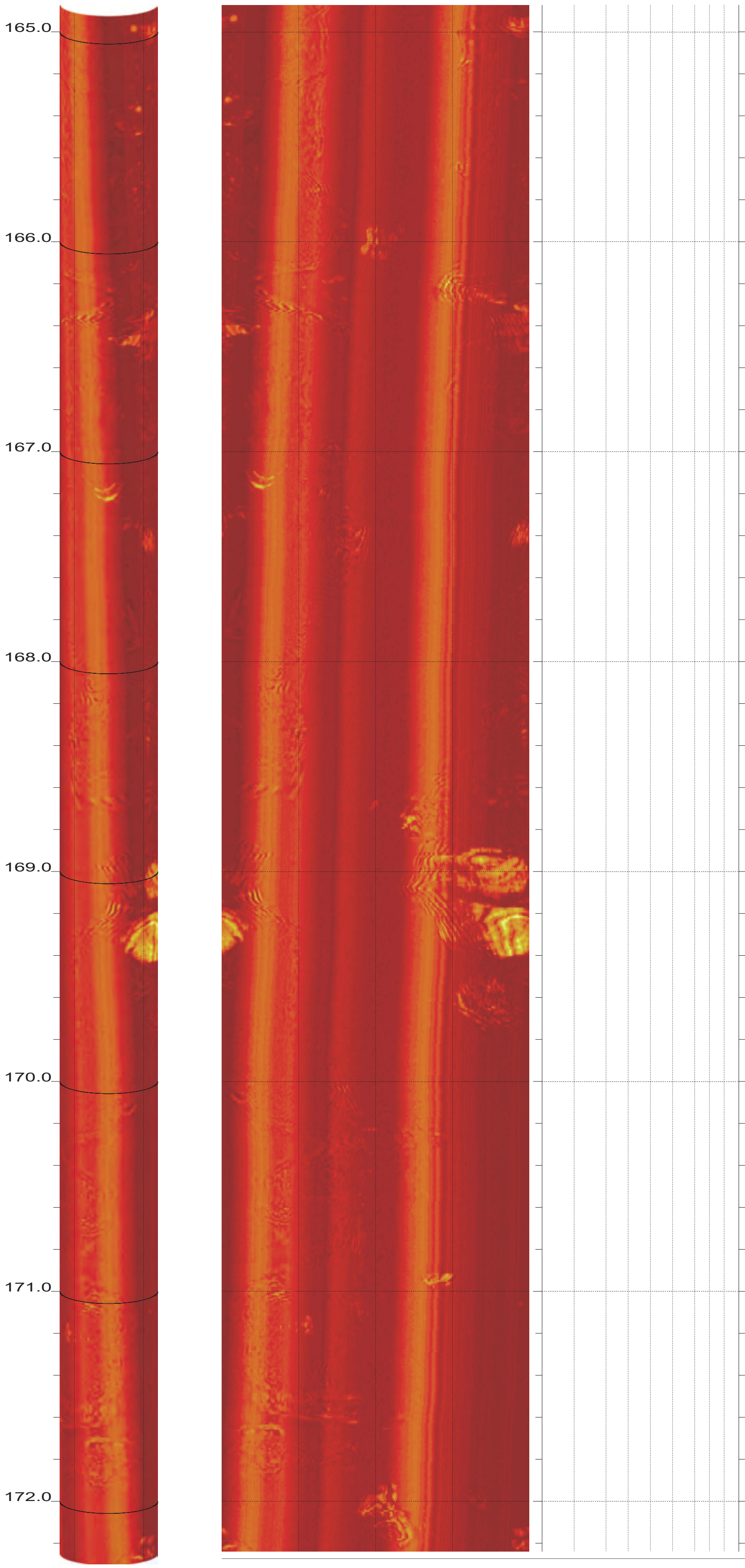


SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 18 of 40



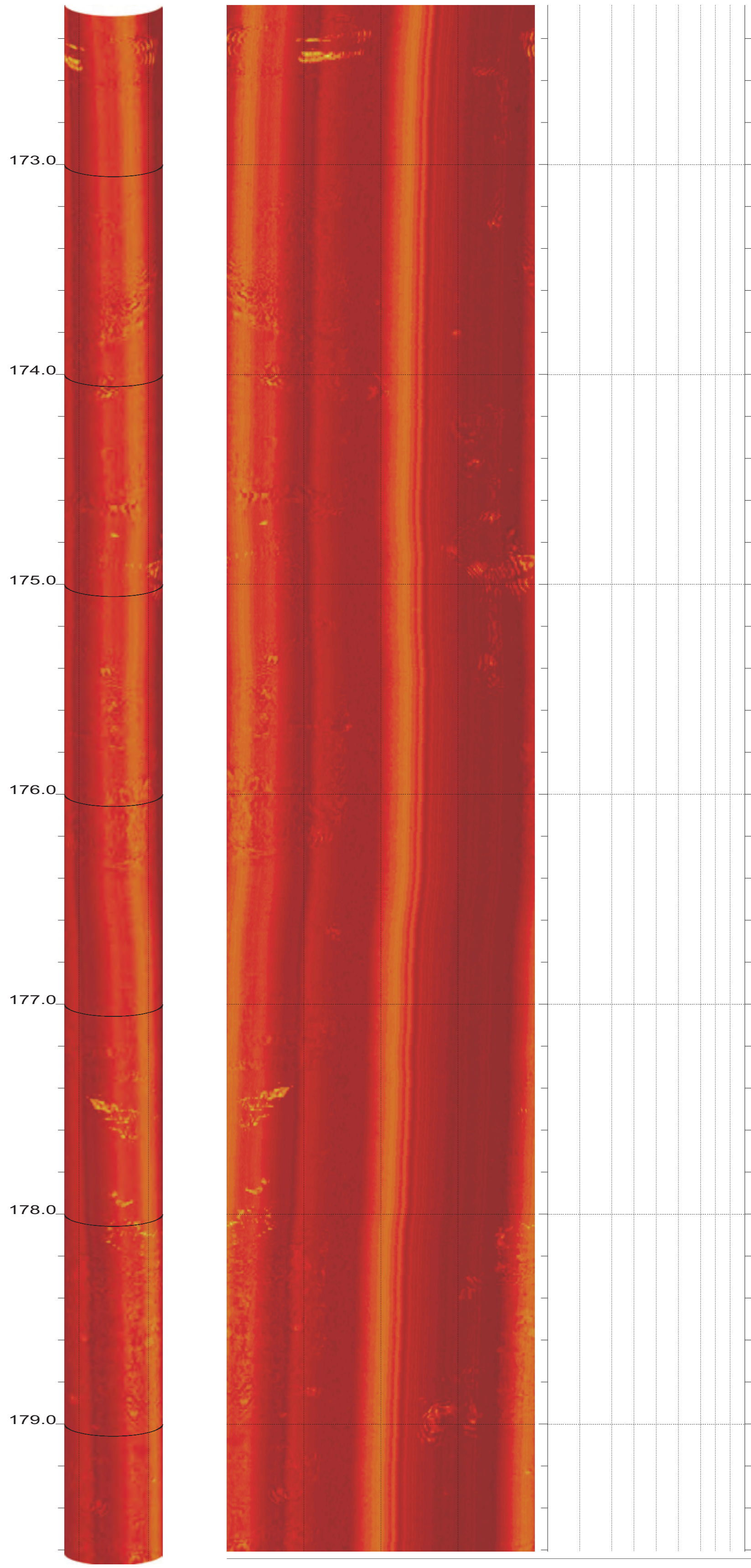
Z3-B6 164.872 to 157.504ft 19

SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 19 of 40



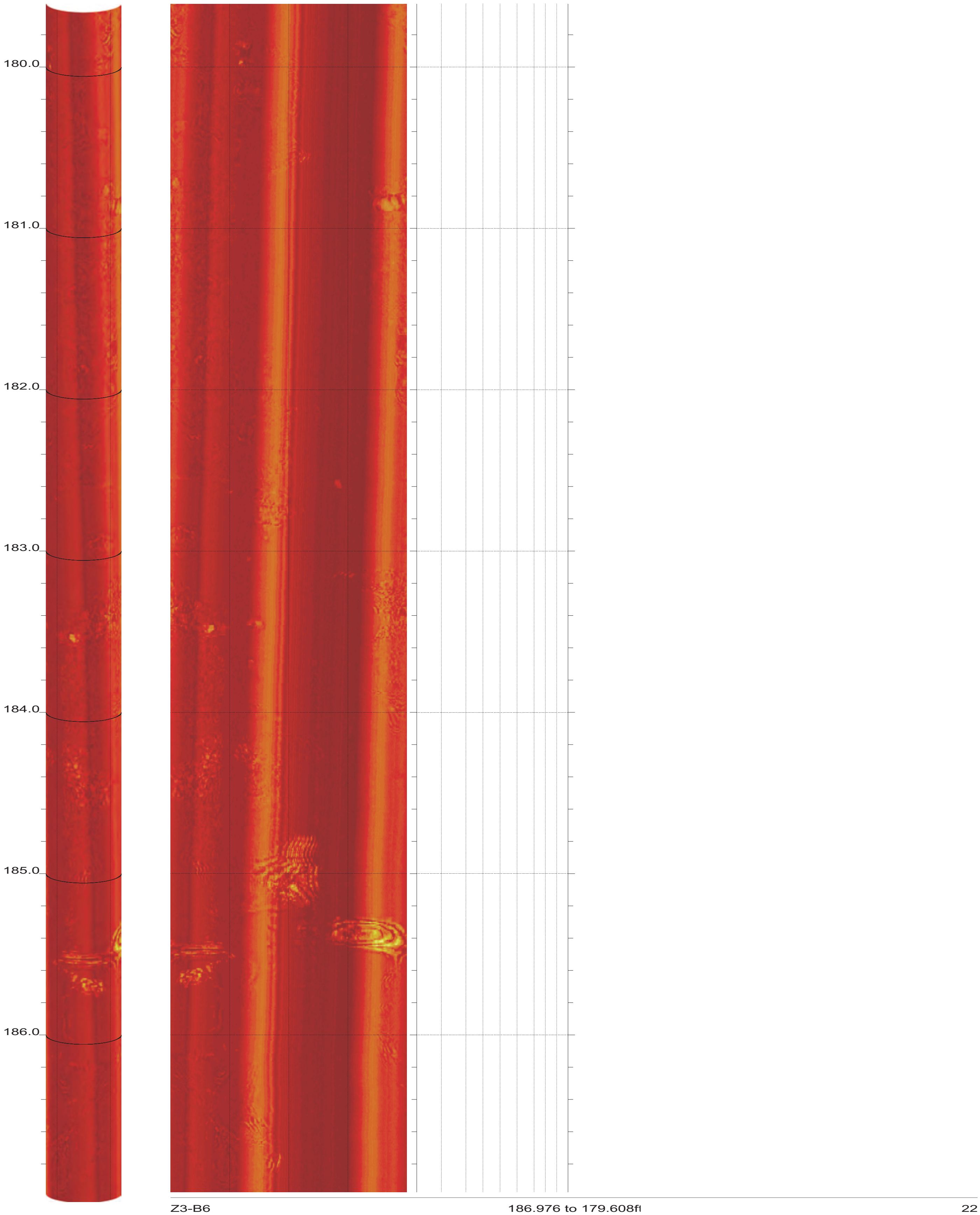
Z3-B6 172.240 to 164.872ft 20

SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 20 of 40

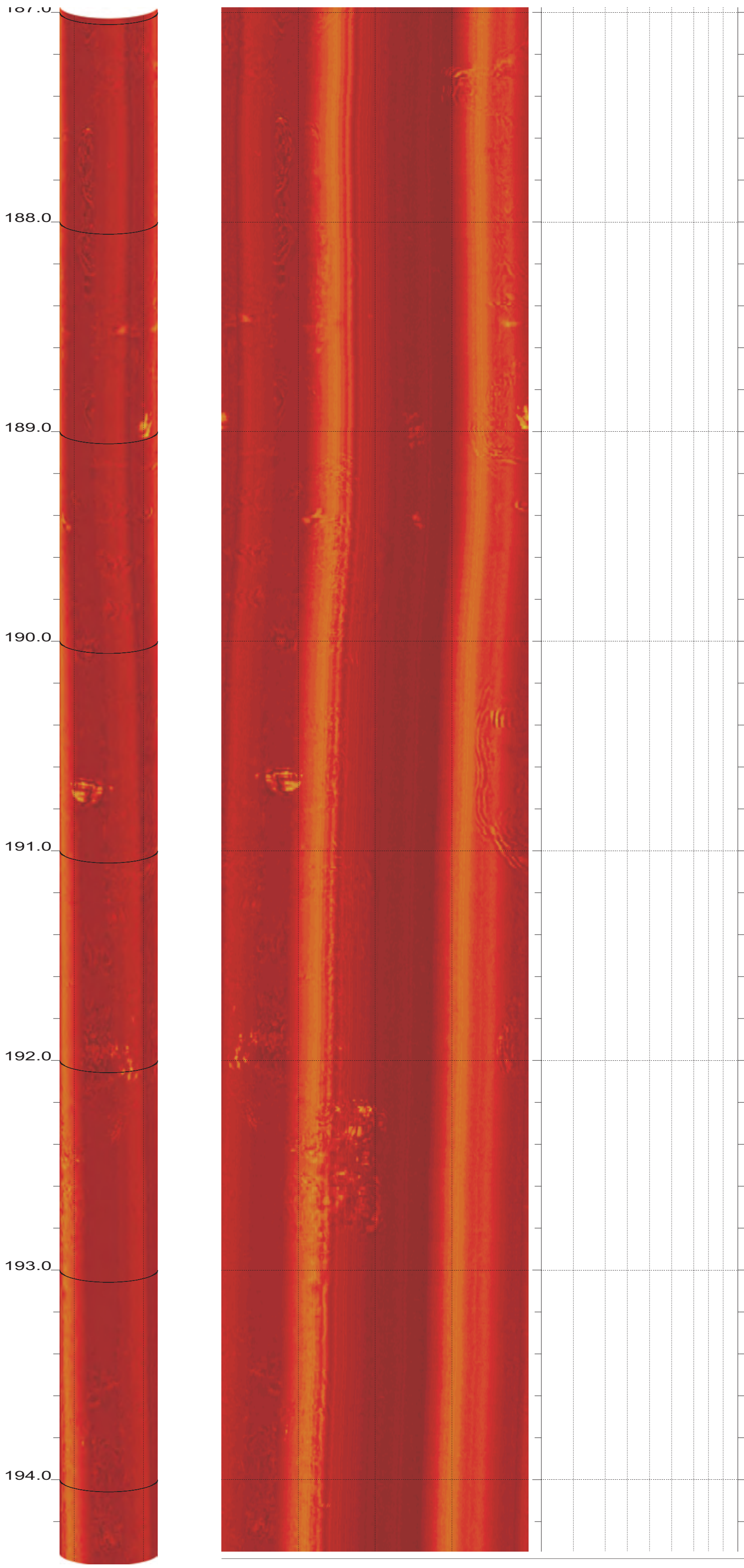


Z3-B6 179.608 to 172.240ft 21

SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 21 of 40

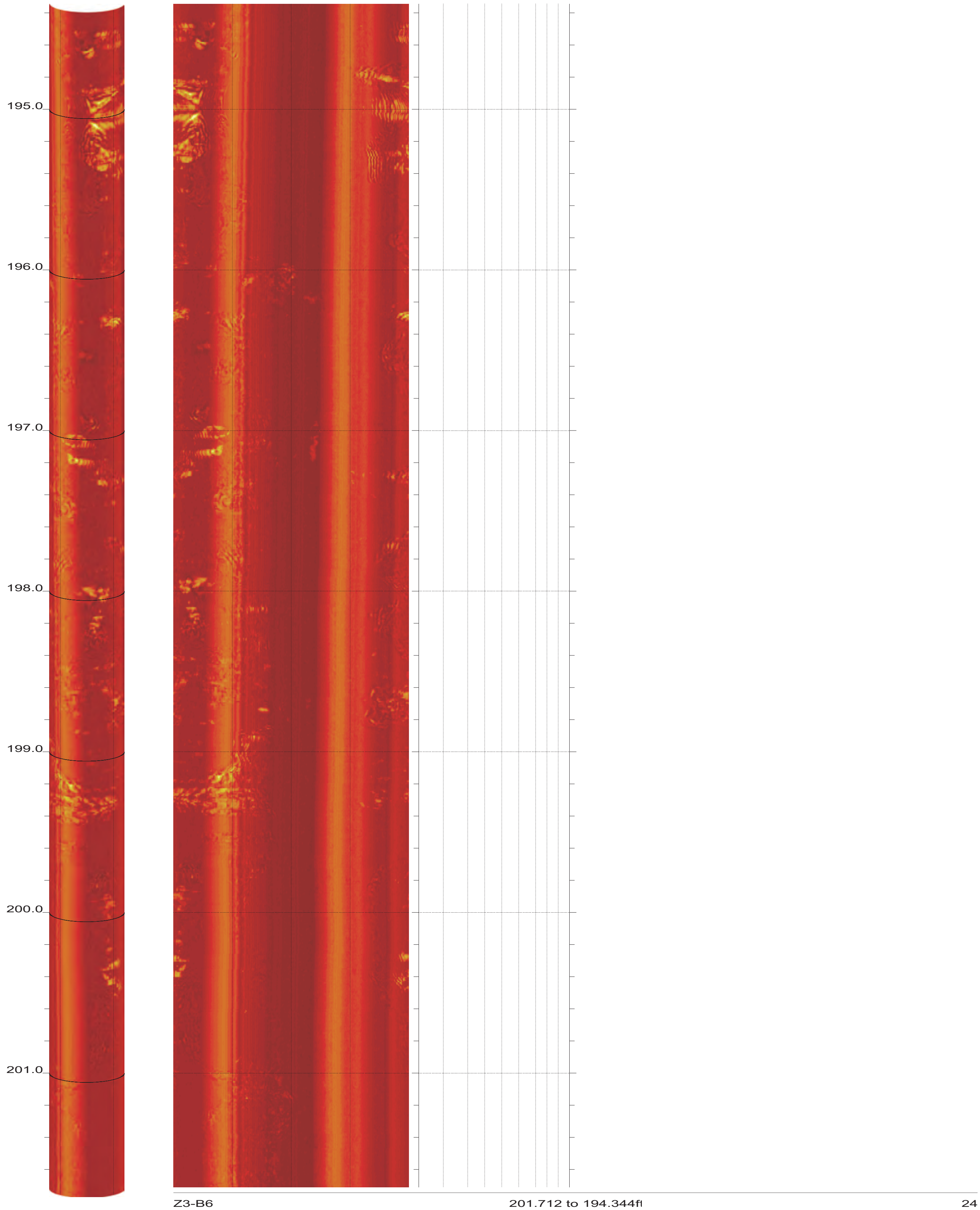


SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 22 of 40

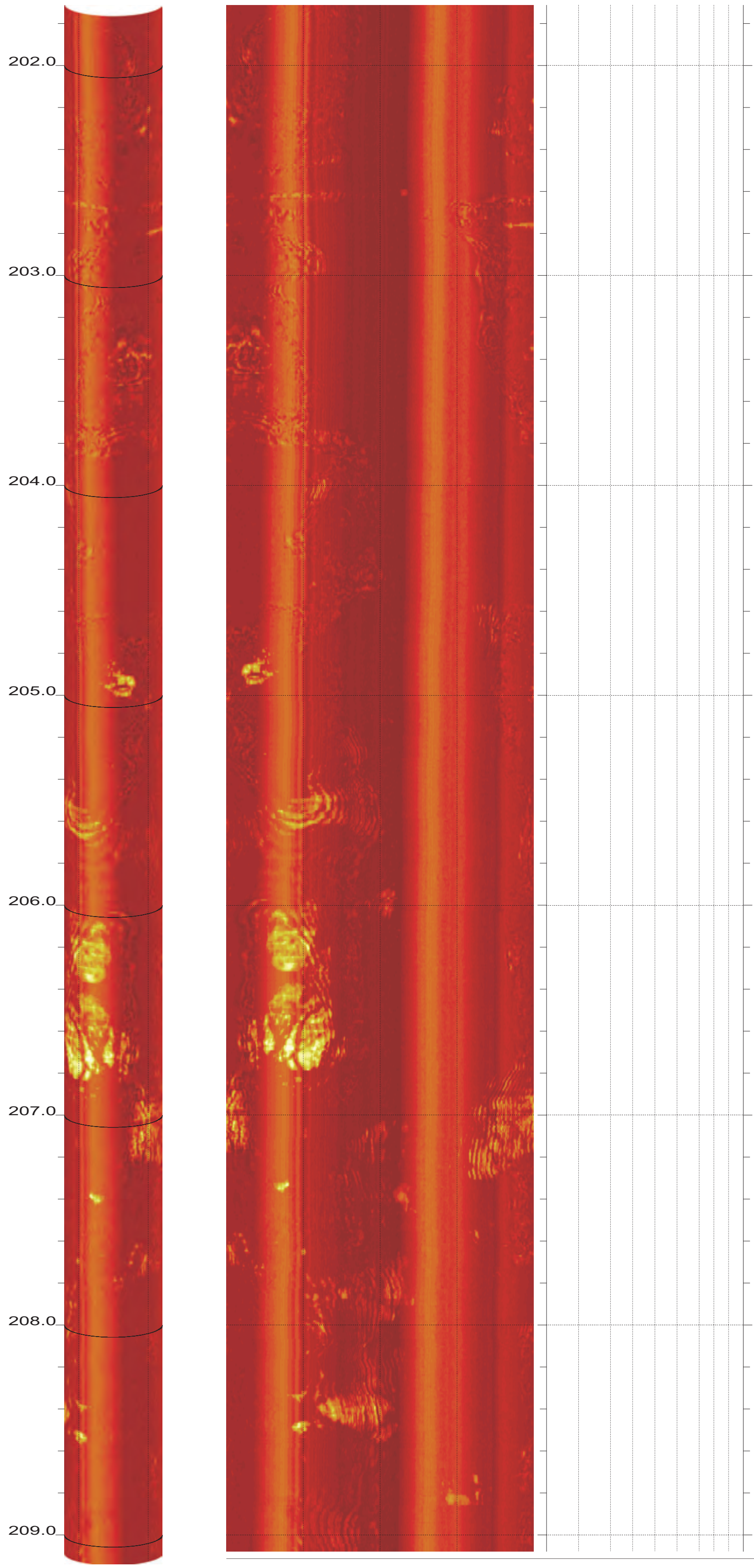


Z3-B6 194.344 to 186.976ft 23

SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 23 of 40

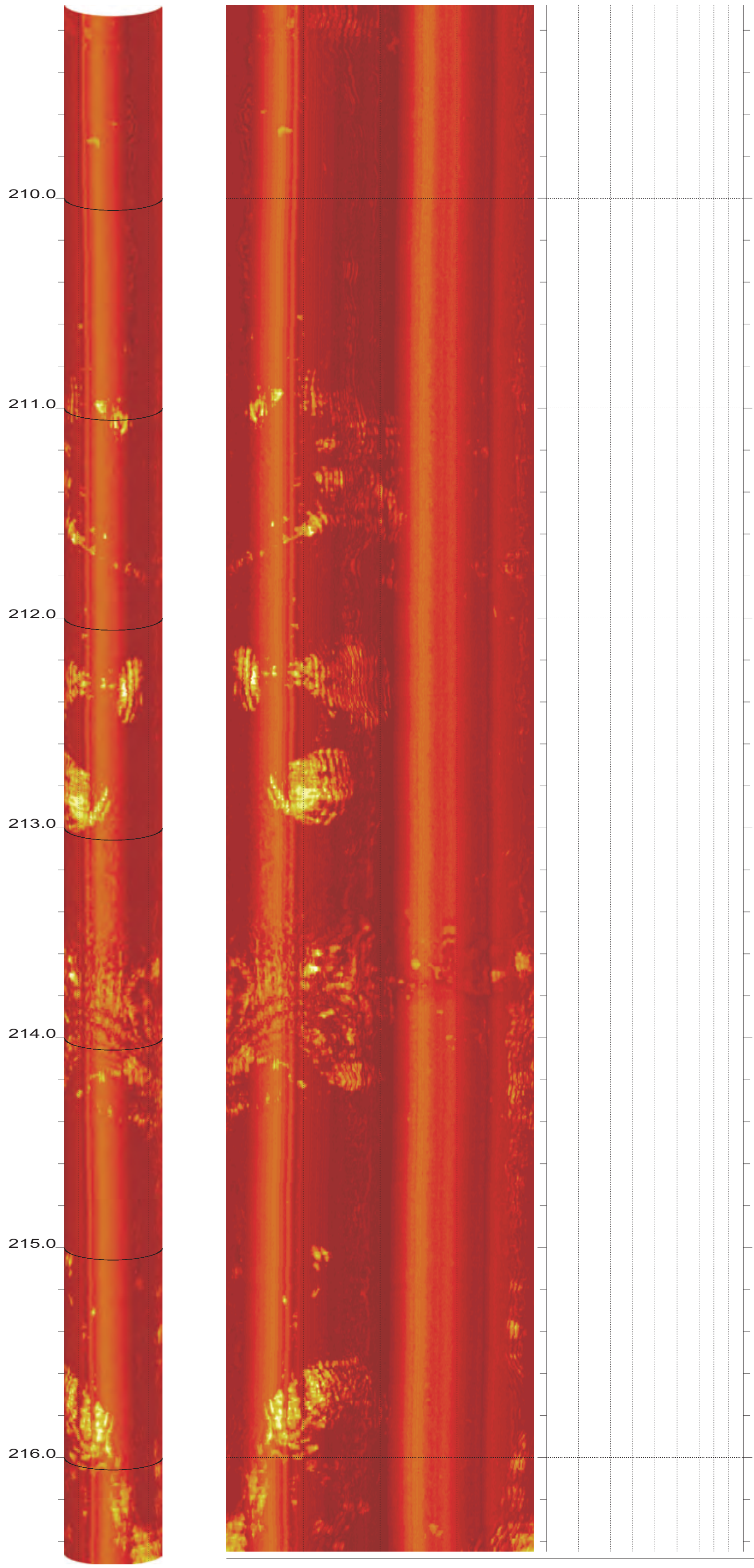


SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 24 of 40



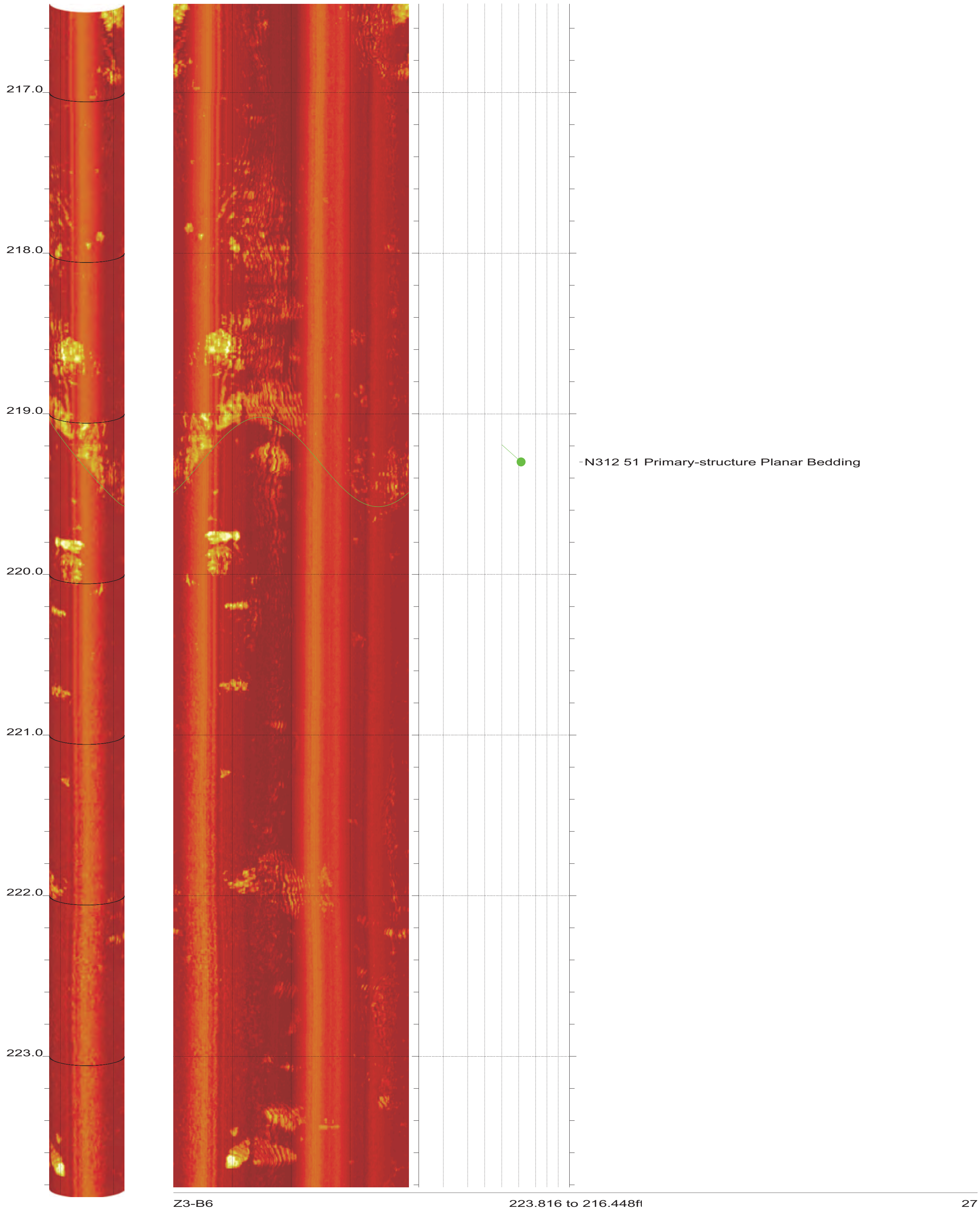
Z3-B6 209.080 to 201.712ft 25

SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 25 of 40

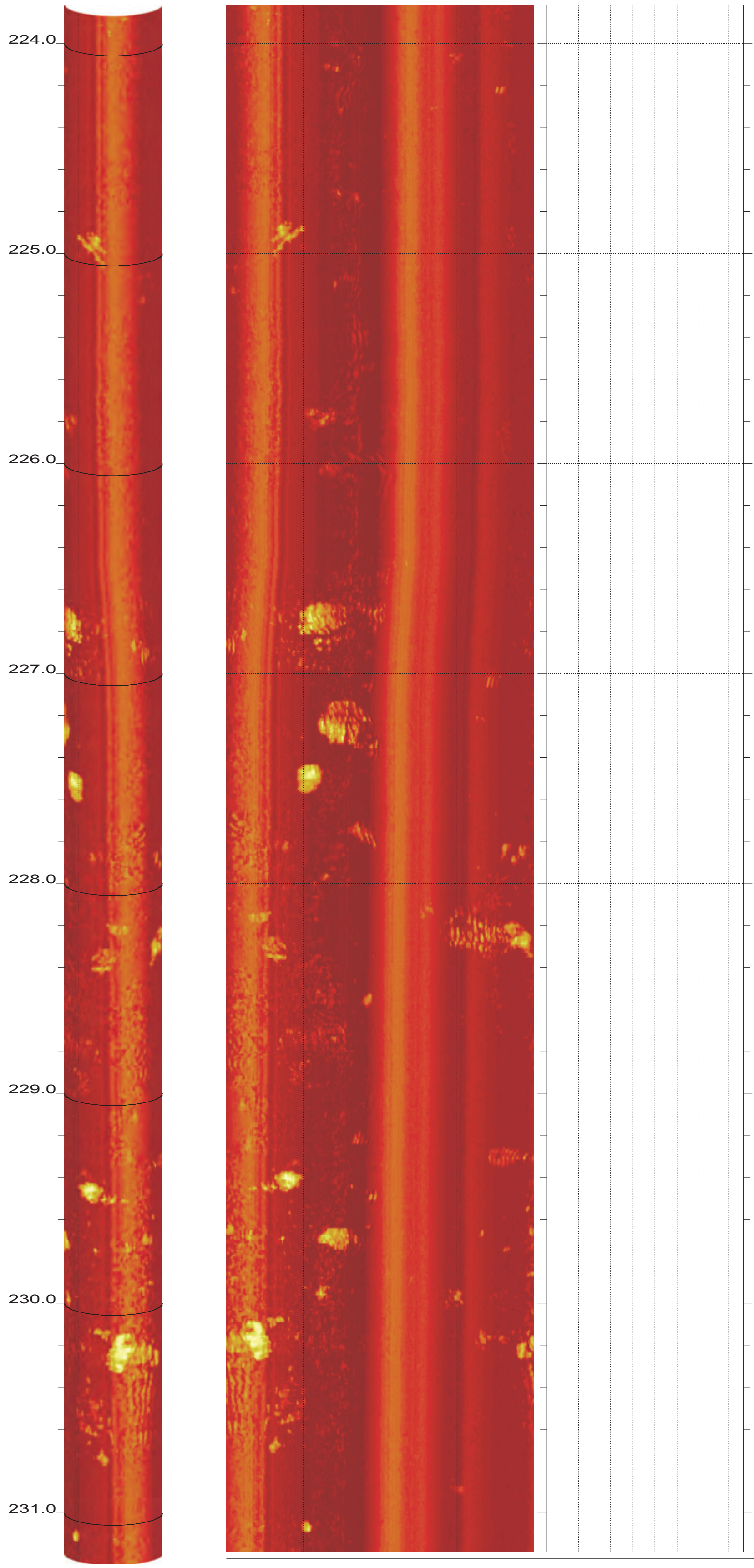


Z3-B6 216.448 to 209.080ft 26

SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 26 of 40

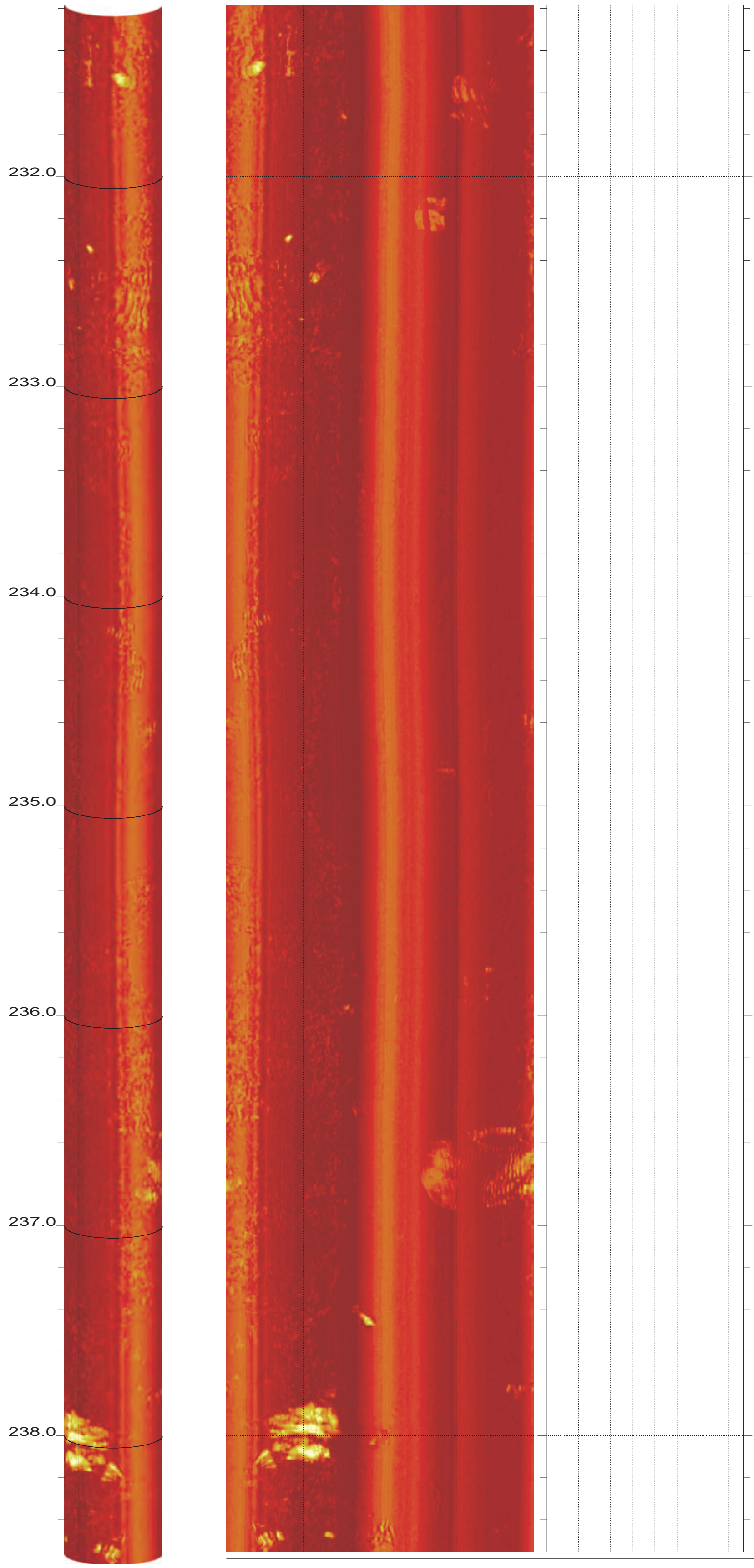


SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 27 of 40



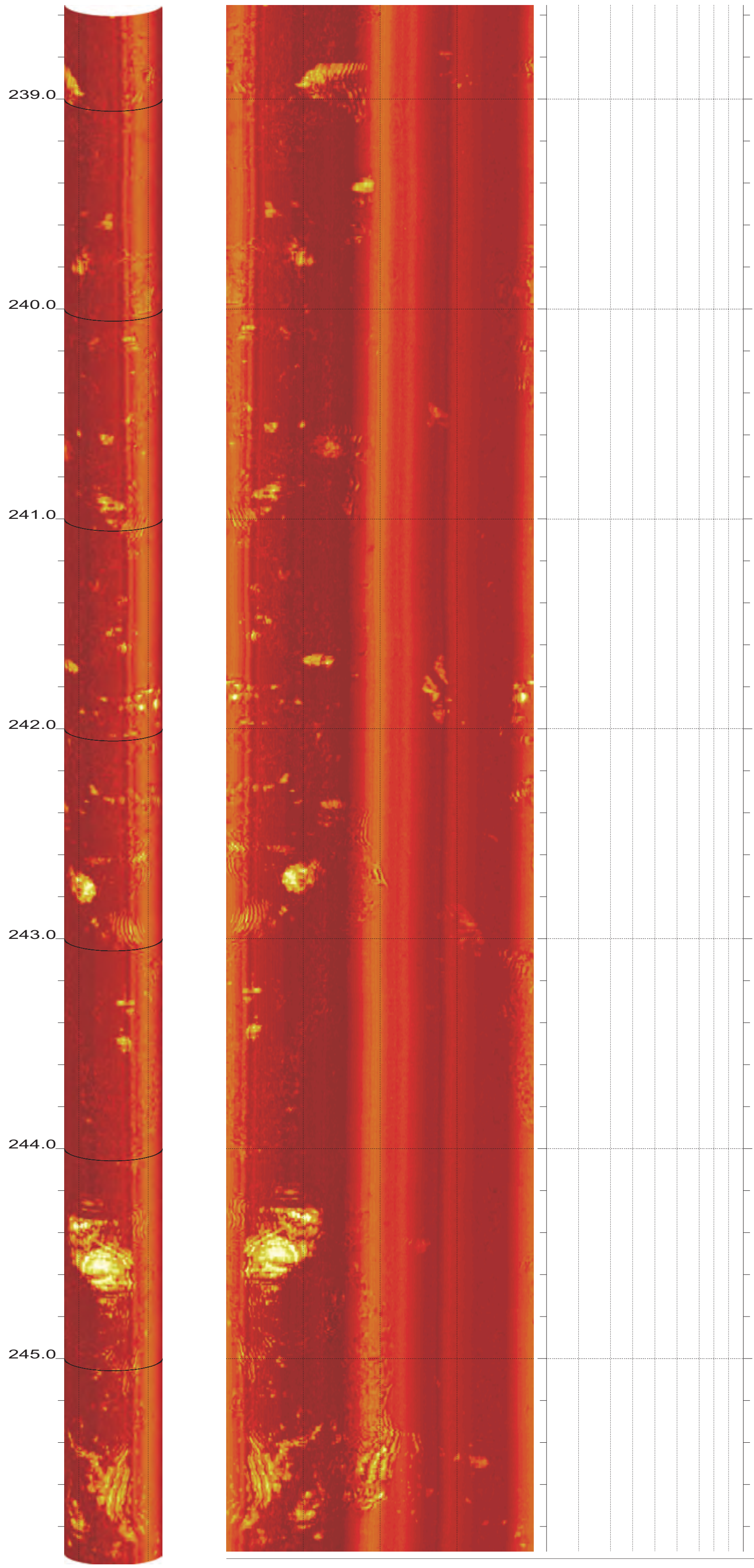
Z3-B6 231.184 to 223.816ft 28

SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 28 of 40



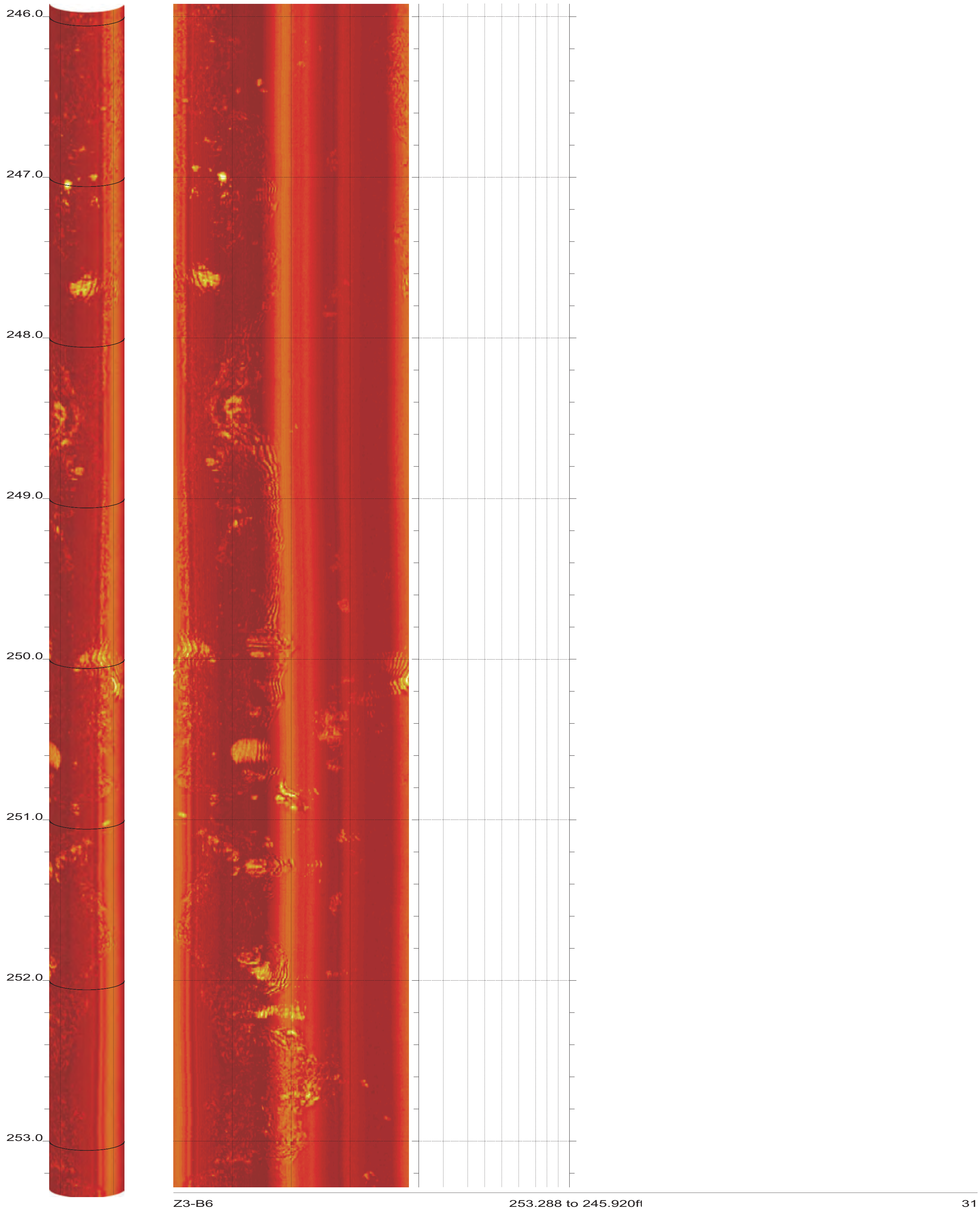
Z3-B6 238.552 to 231.184ft 29

SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 29 of 40

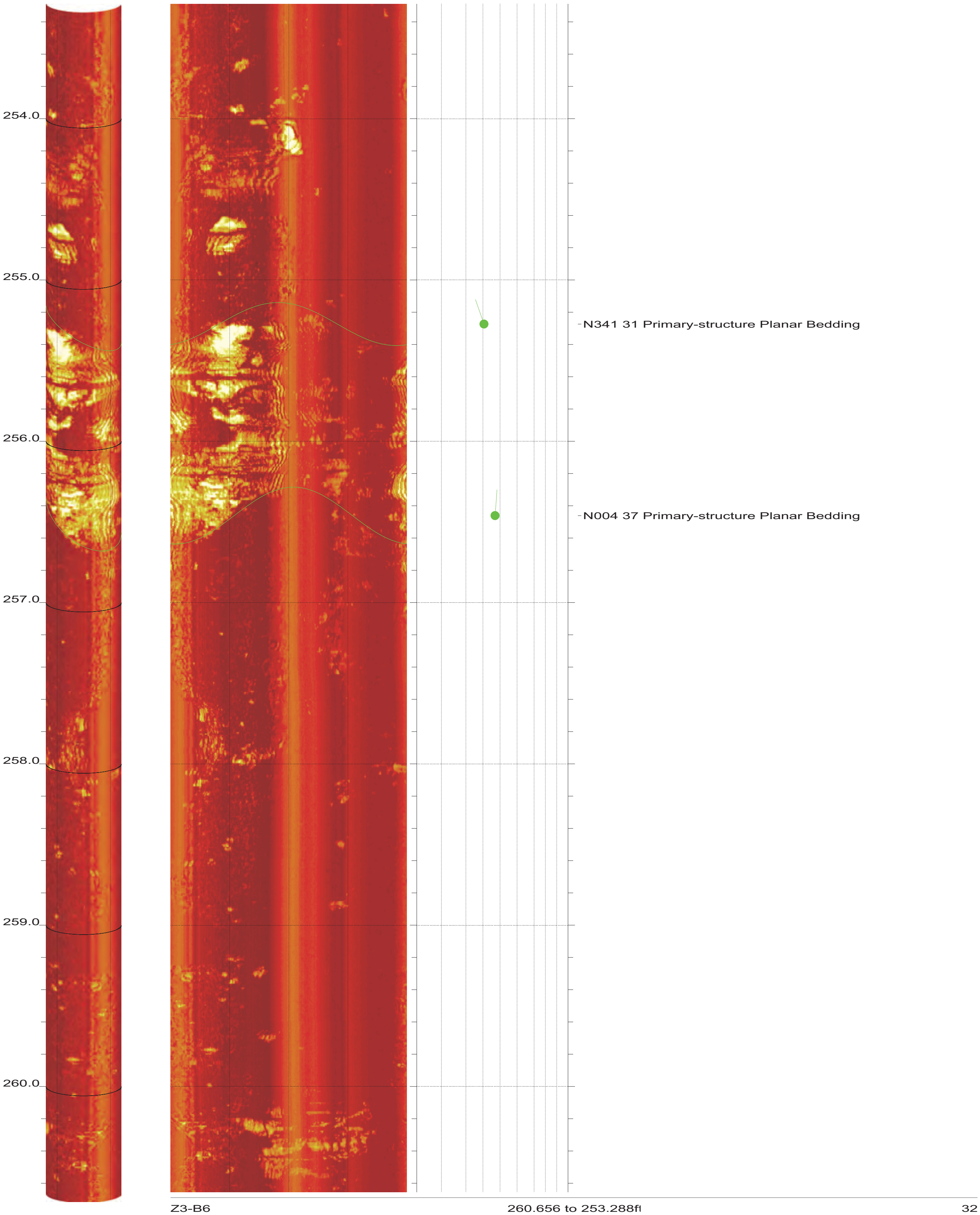


Z3-B6 245.920 to 238.552ft 30

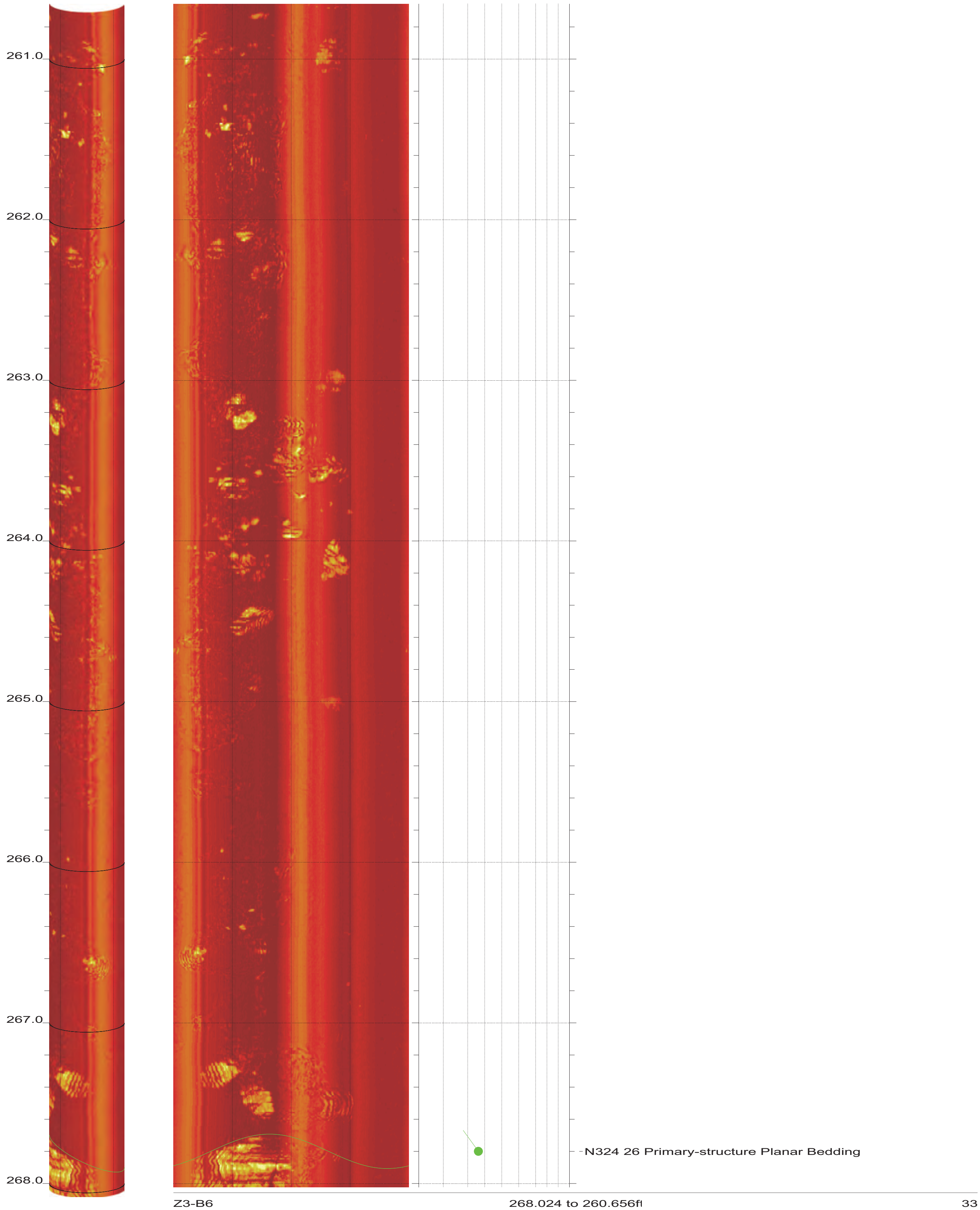
SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 30 of 40



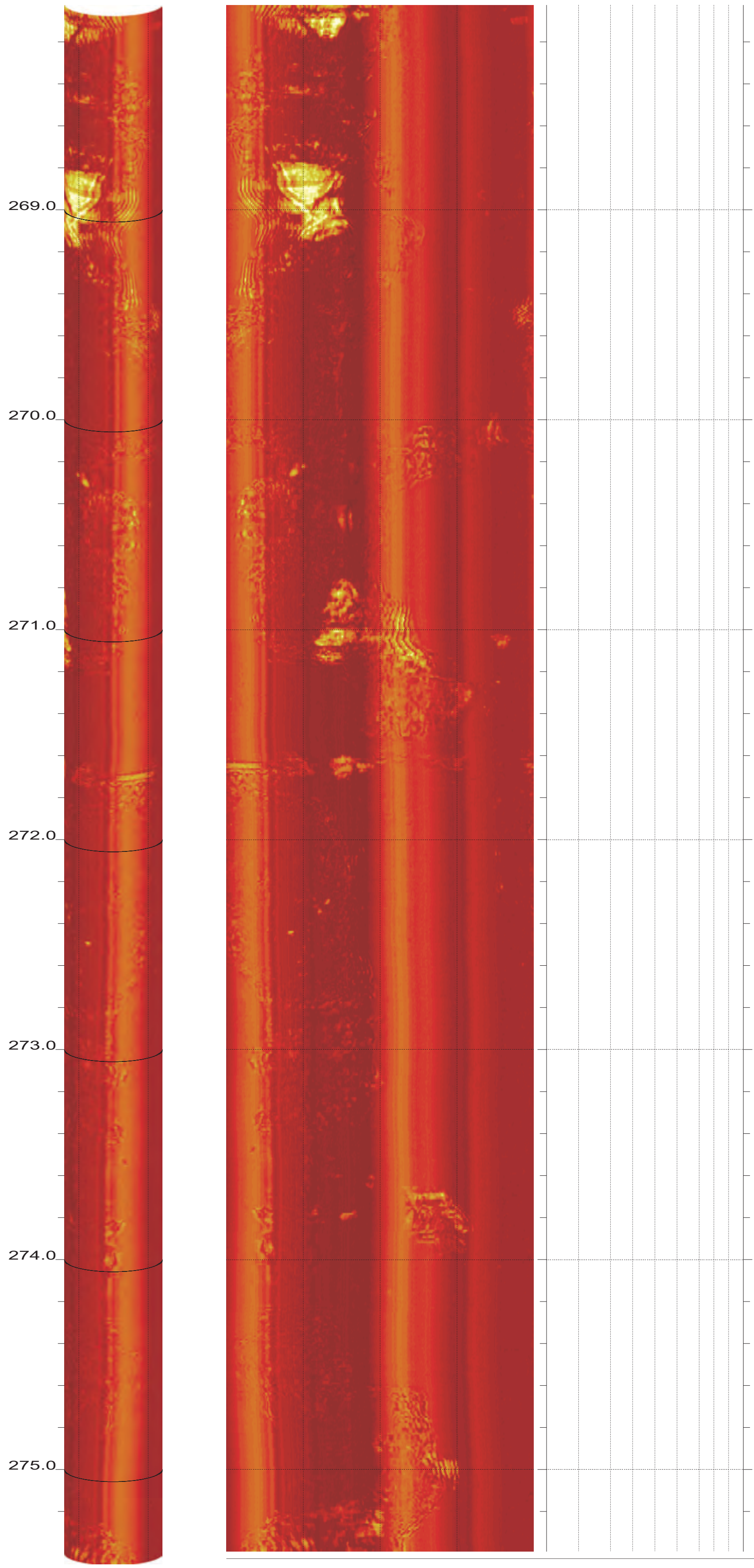
SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 31 of 40



SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 32 of 40

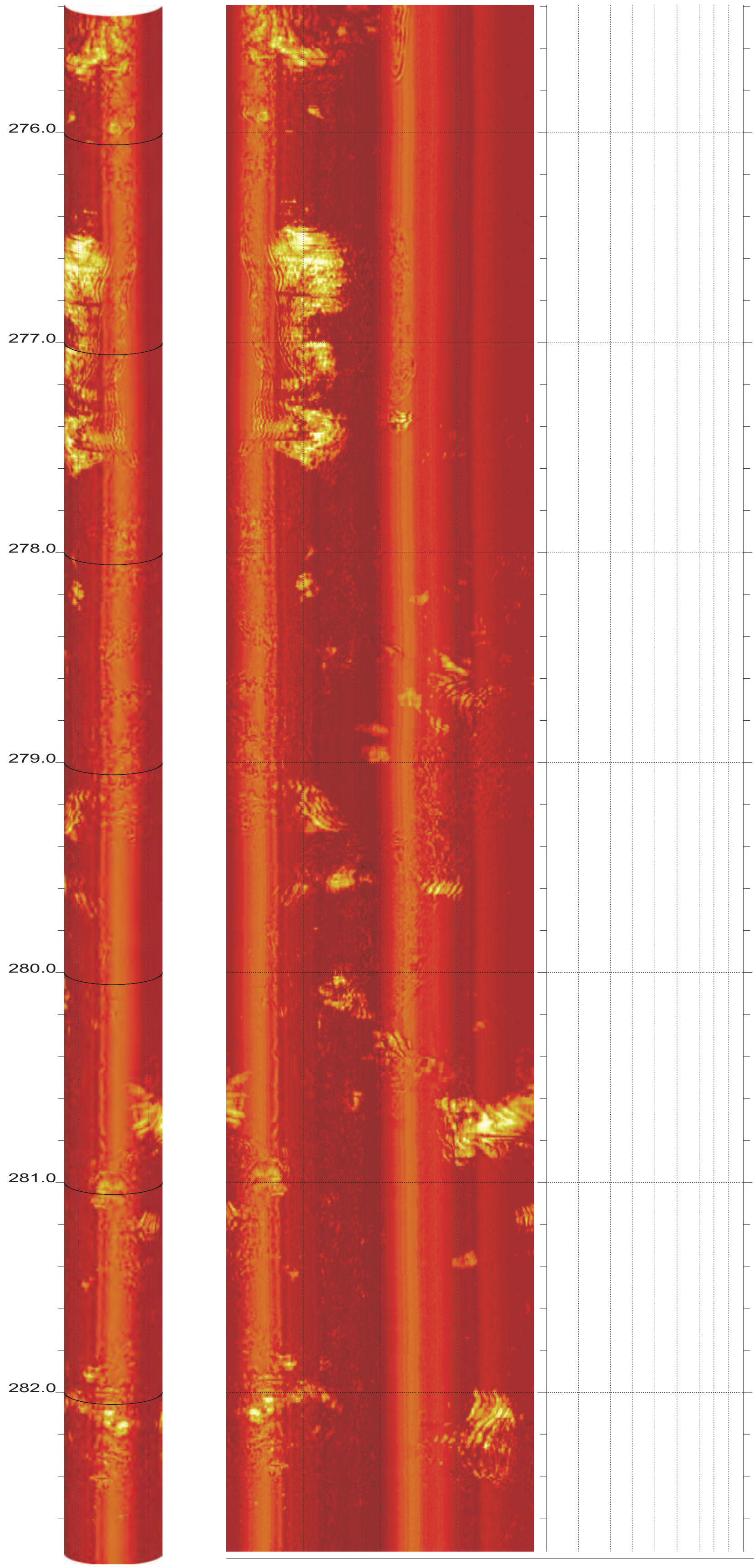


SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 33 of 40



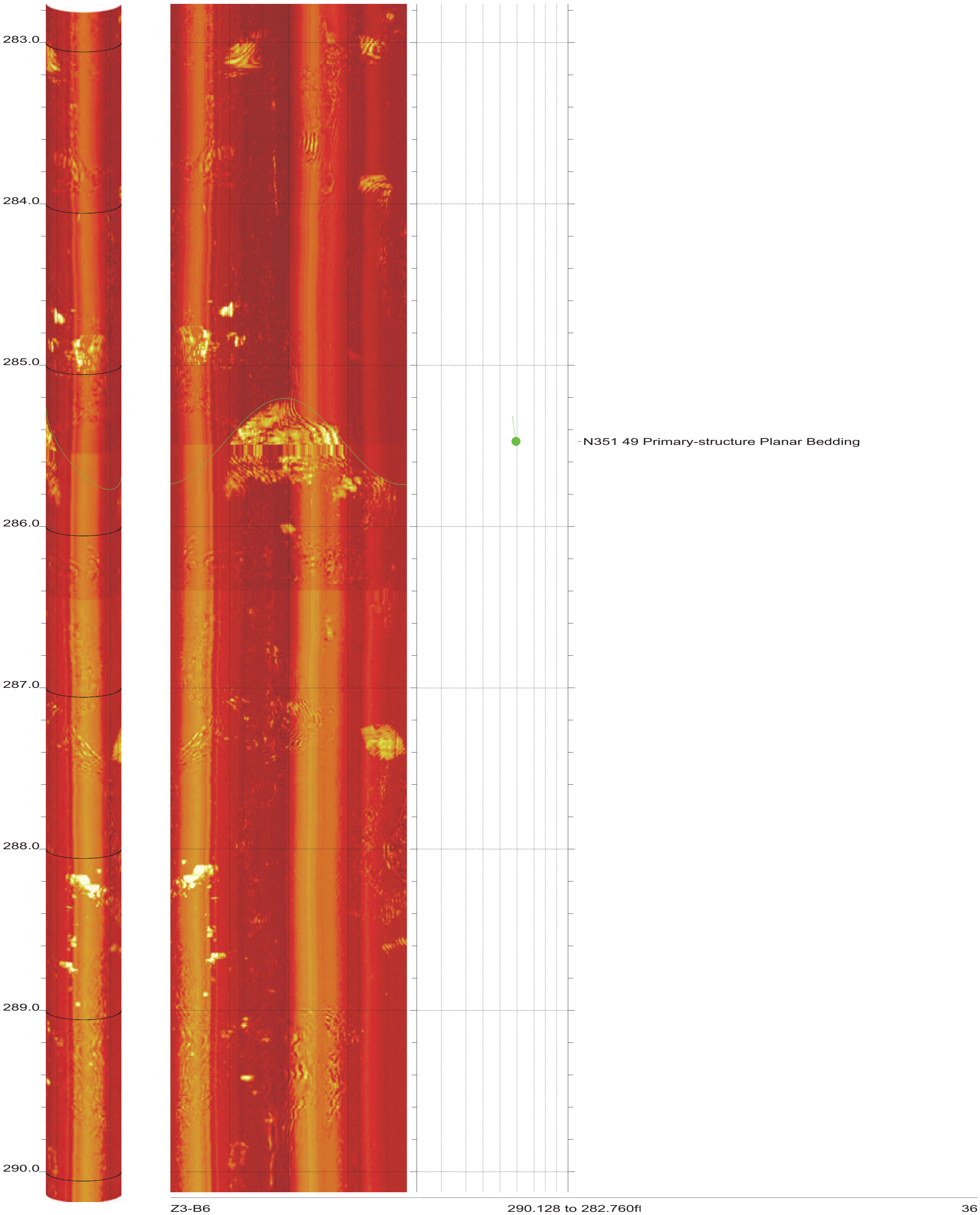
Z3-B6 275.392 to 268.024ft 34

SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 34 of 40

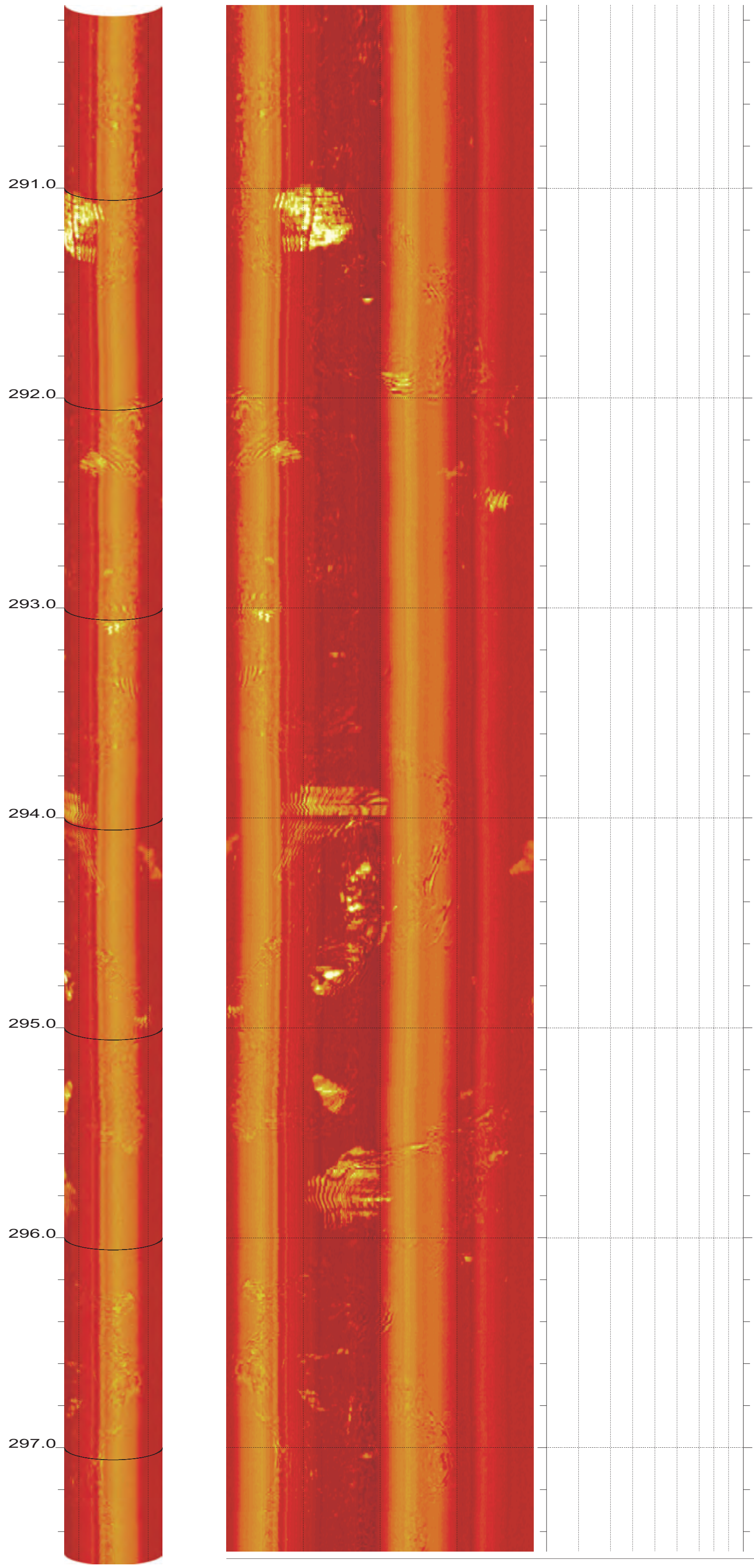


Z3-B6 282.760 to 275.392ft 35

SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 35 of 40

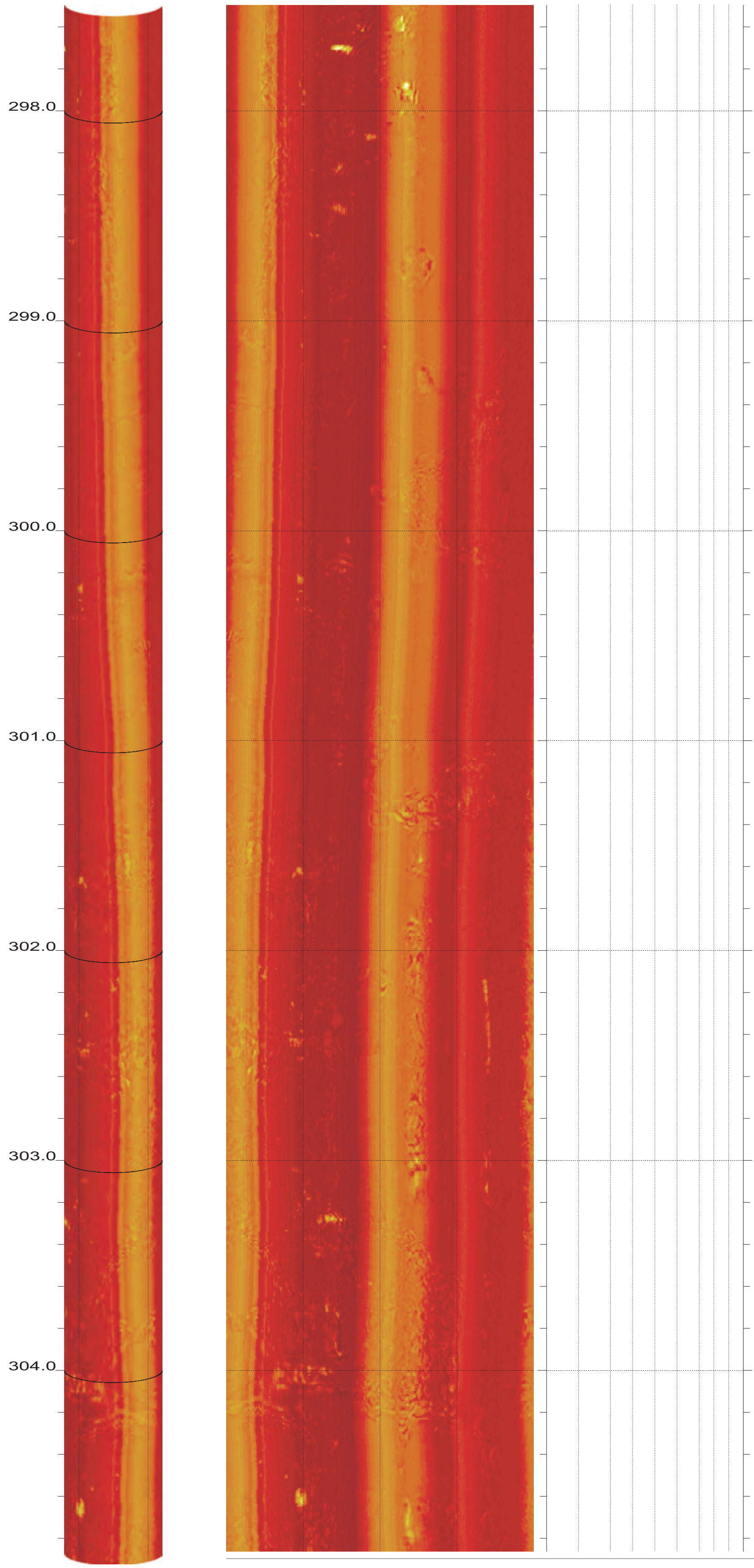


SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 36 of 40



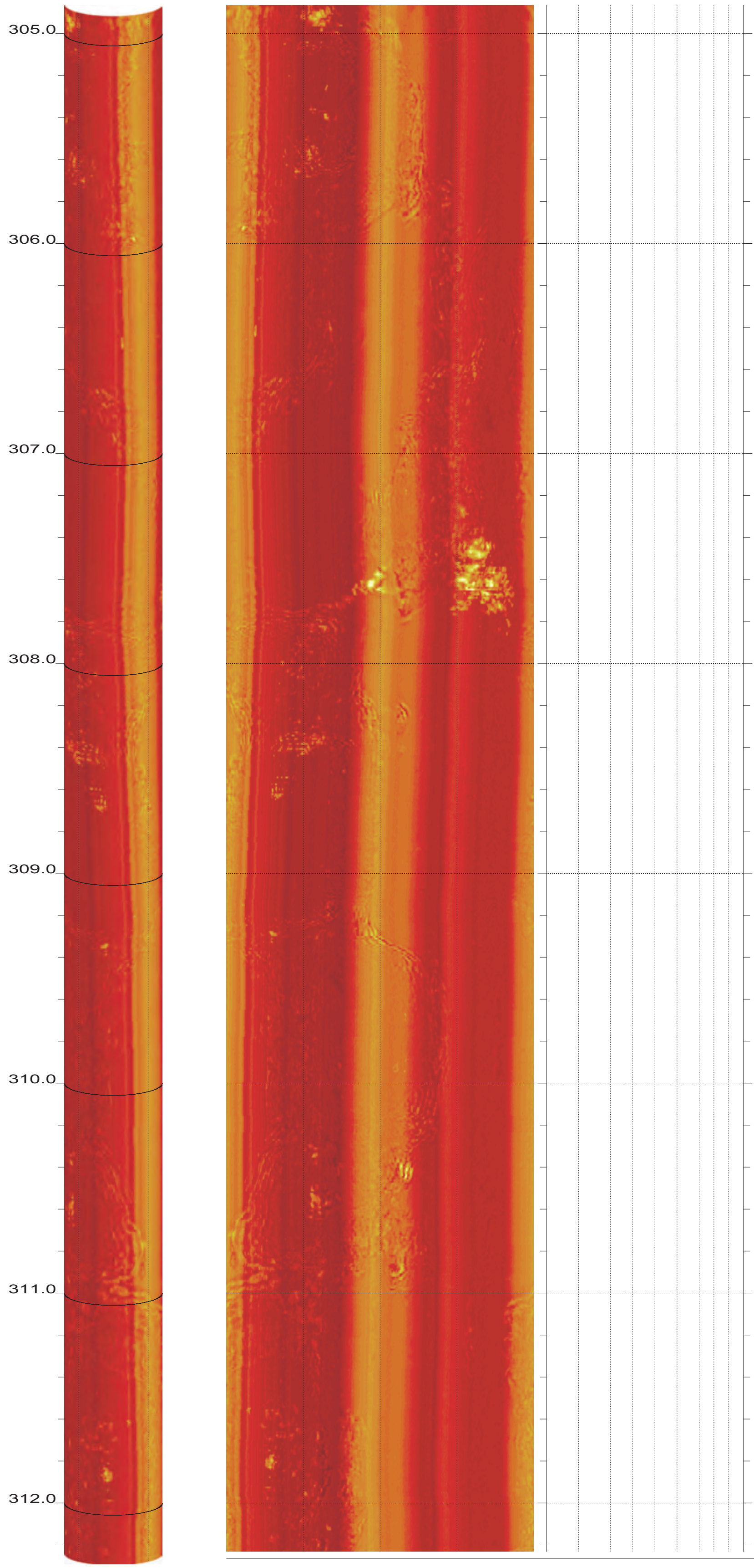
Z3-B6 297.496 to 290.128ft 37

SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 37 of 40



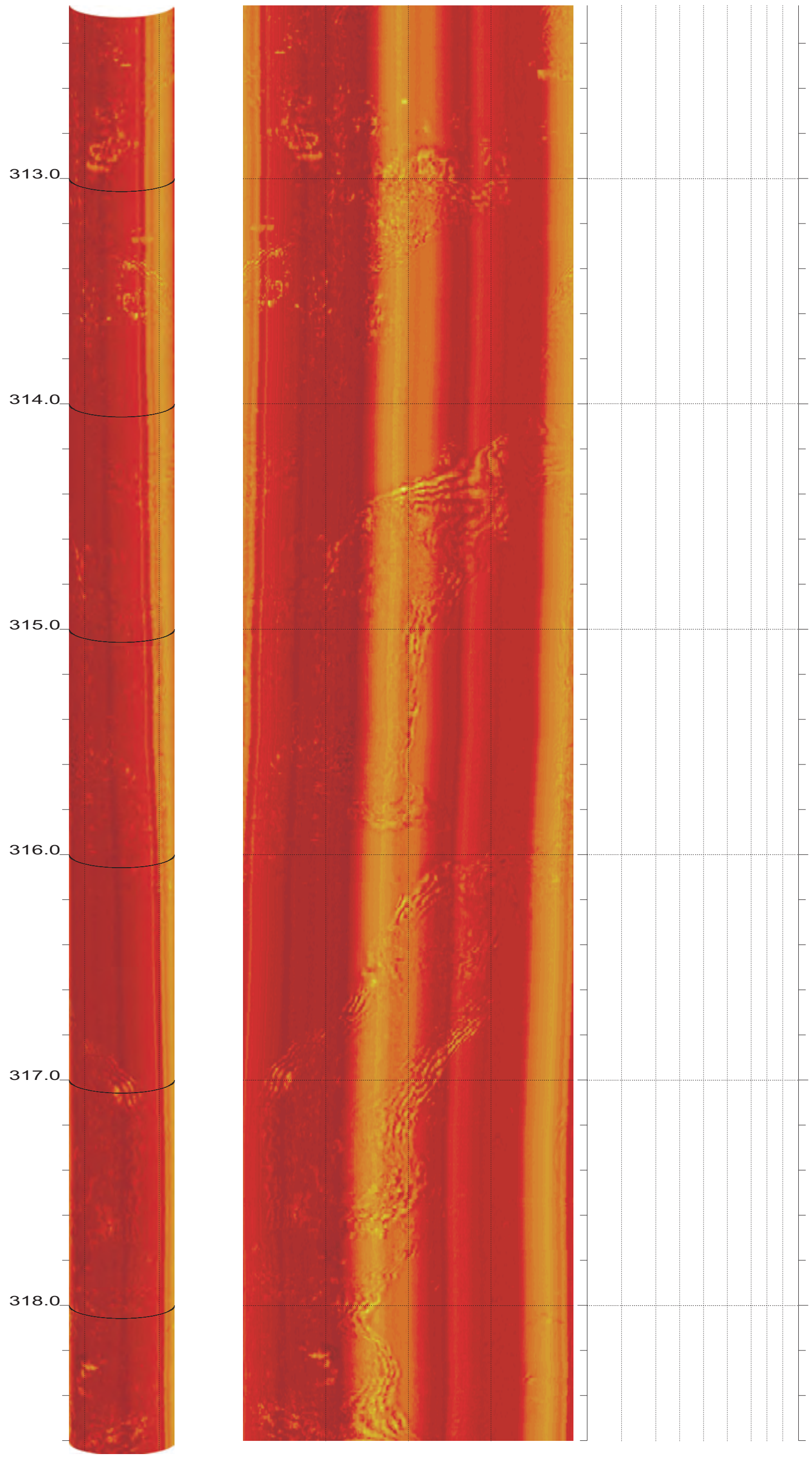
Z3-B6 304.864 to 297.496ft 38

SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 38 of 40



Z3-B6 312.232 to 304.864ft 39

SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 39 of 40



Z3-B6 318.600 to 312.232ft 40

SR-710 Boring Z3-B6 Acoustic Televiewer Dips rev 1 Sheet 40 of 40

BHTV DATA PROCESSING
RGLDIP vsn 6.2
INTERPRETED BHTV DIPS LOG

CASCADE DRILLING

Borehole: Z3-B12

SR-710 TUNNEL INVESTIGATION

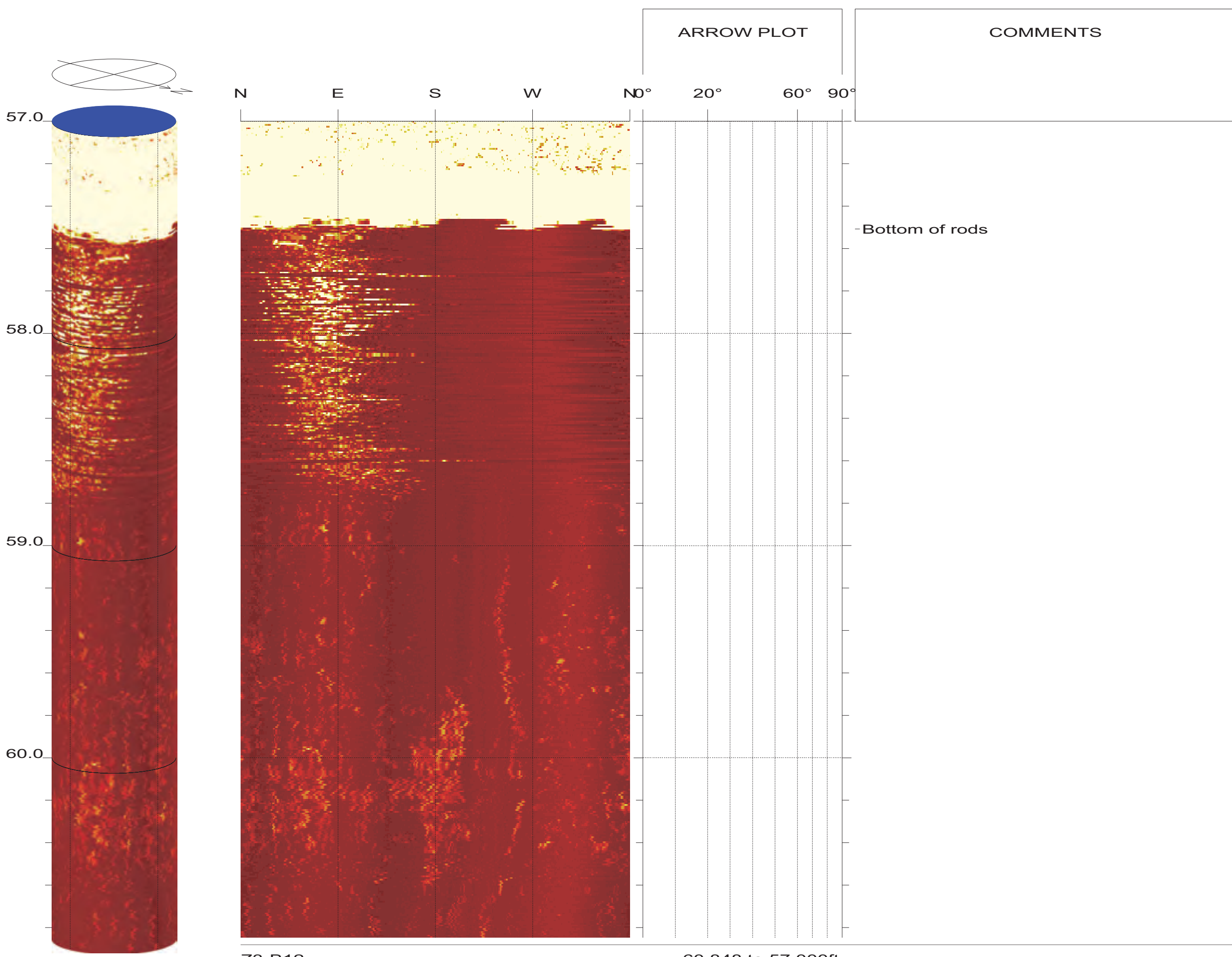
top of borehole.....
East: _
North: _
Elev: _

North ref. is true
Depth units are feet
Vertical scale: 1/10
Horiz scale = 1.00x Vert scale

Zone from 182.400 to 57.000ft
Format: BHTV-NESWN

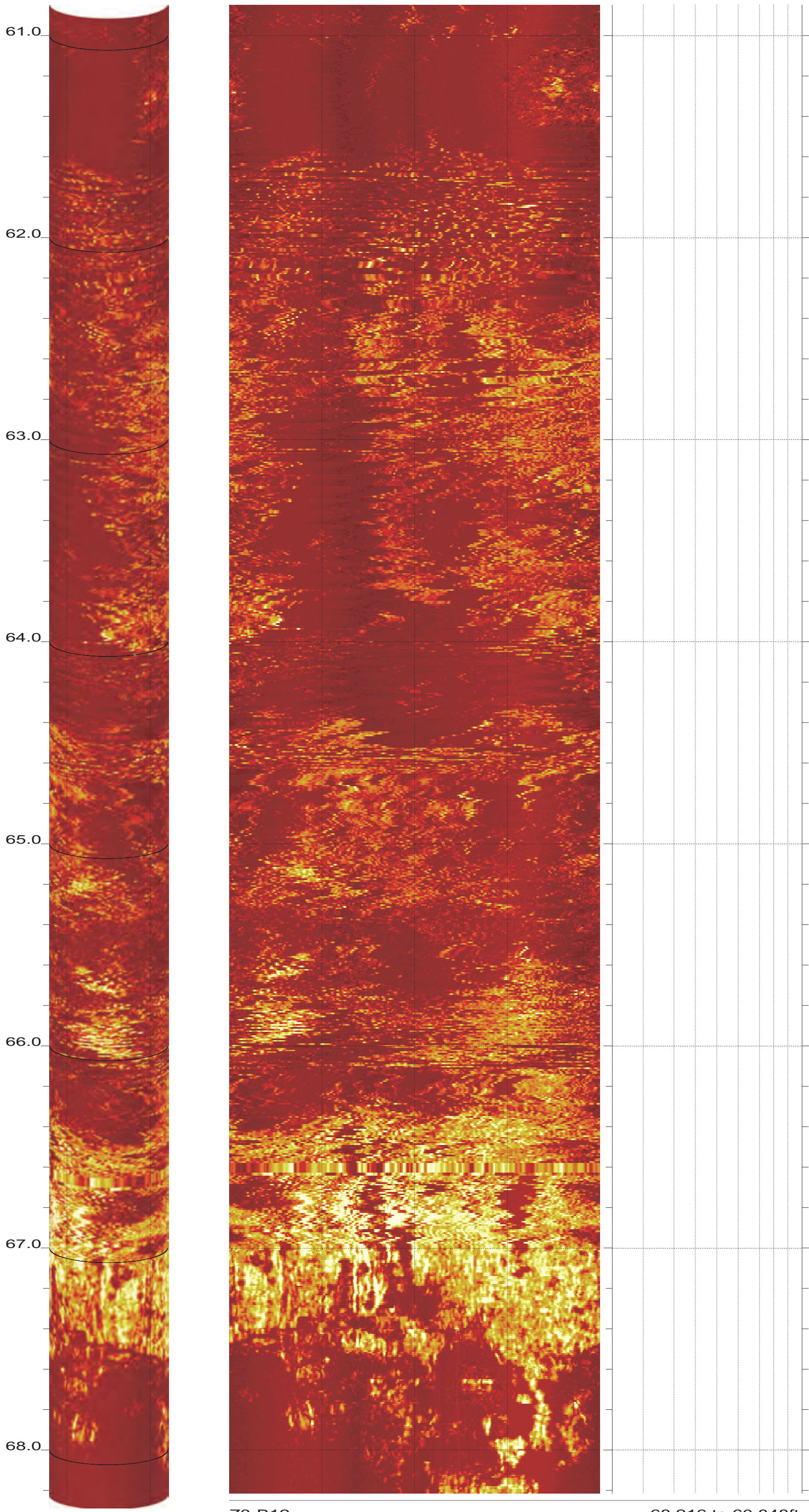
Borehole diam: 7.000inch
Vertical = borehole-axis
Image: Amplitude

Stratigraphic dips
Non-stratigraphic dips
Identified units



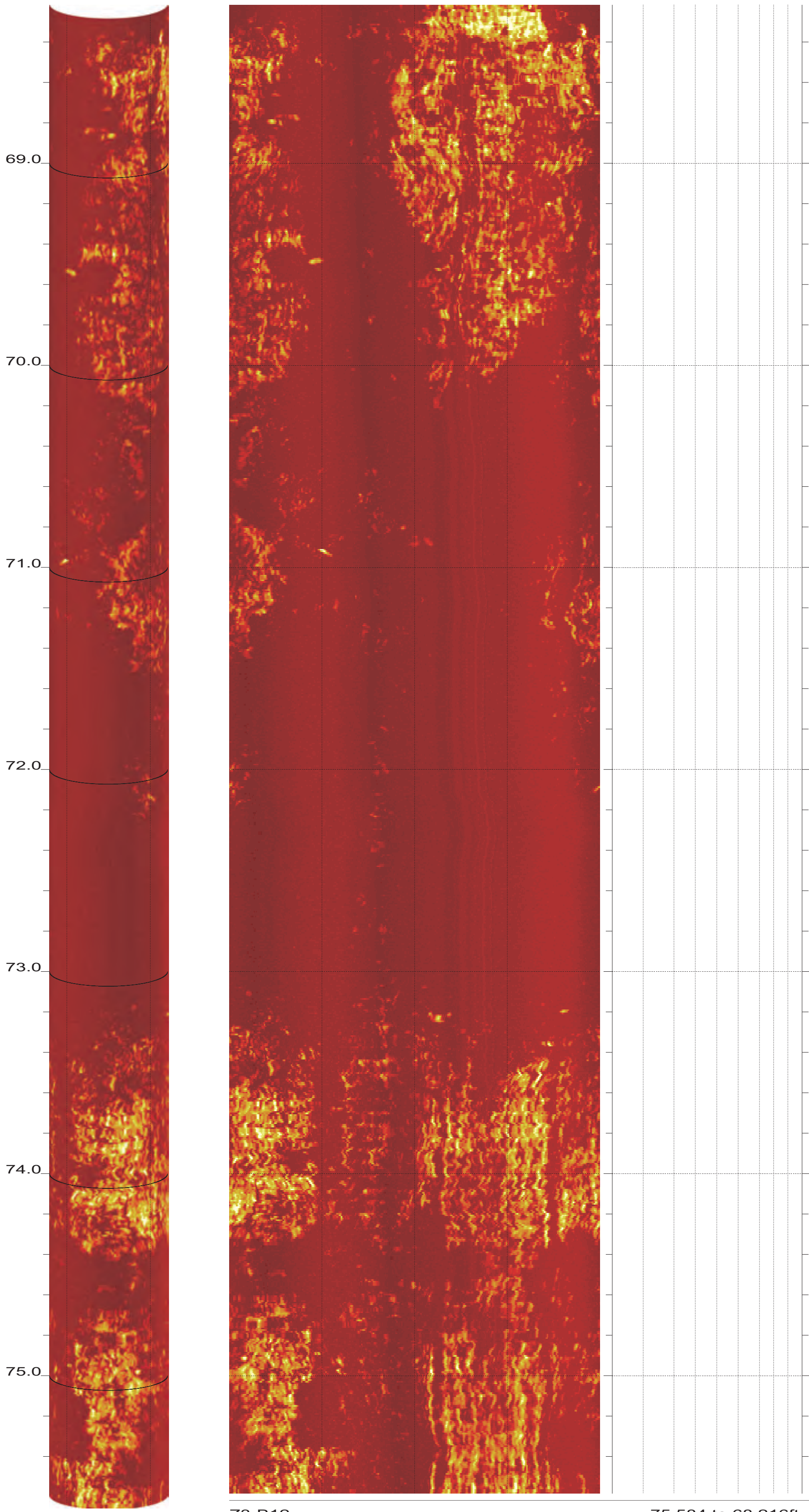
Z3-B12 60.848 to 57.000ft 1

SR-710 Boring Z3-B12 Acoustic Televiewer Dips rev 1 Sheet 1 of 18



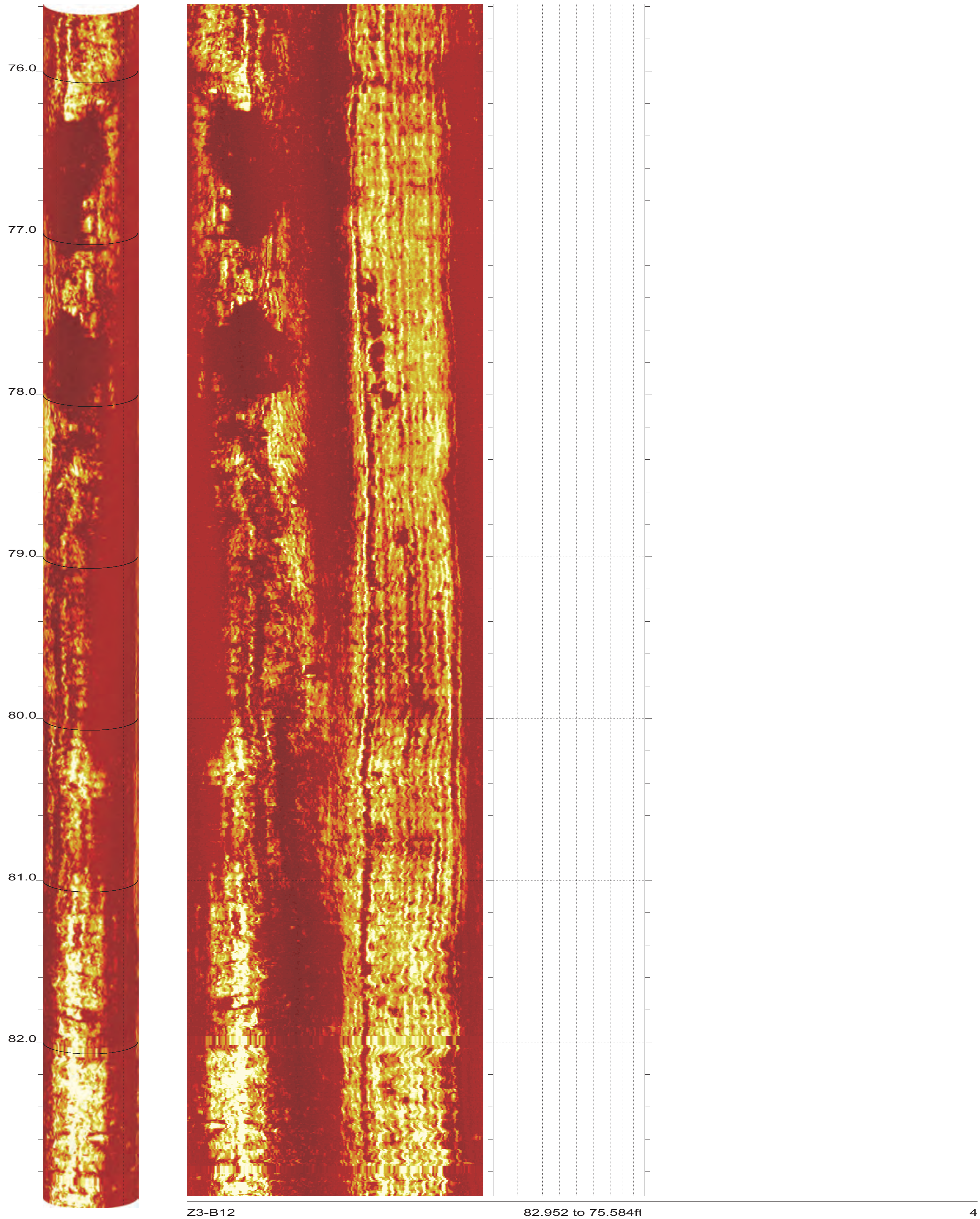
Z3-B12 68.216 to 60.848ft 2

SR-710 Boring Z3-B12 Acoustic Televiewer Dips rev 1 Sheet 2 of 18

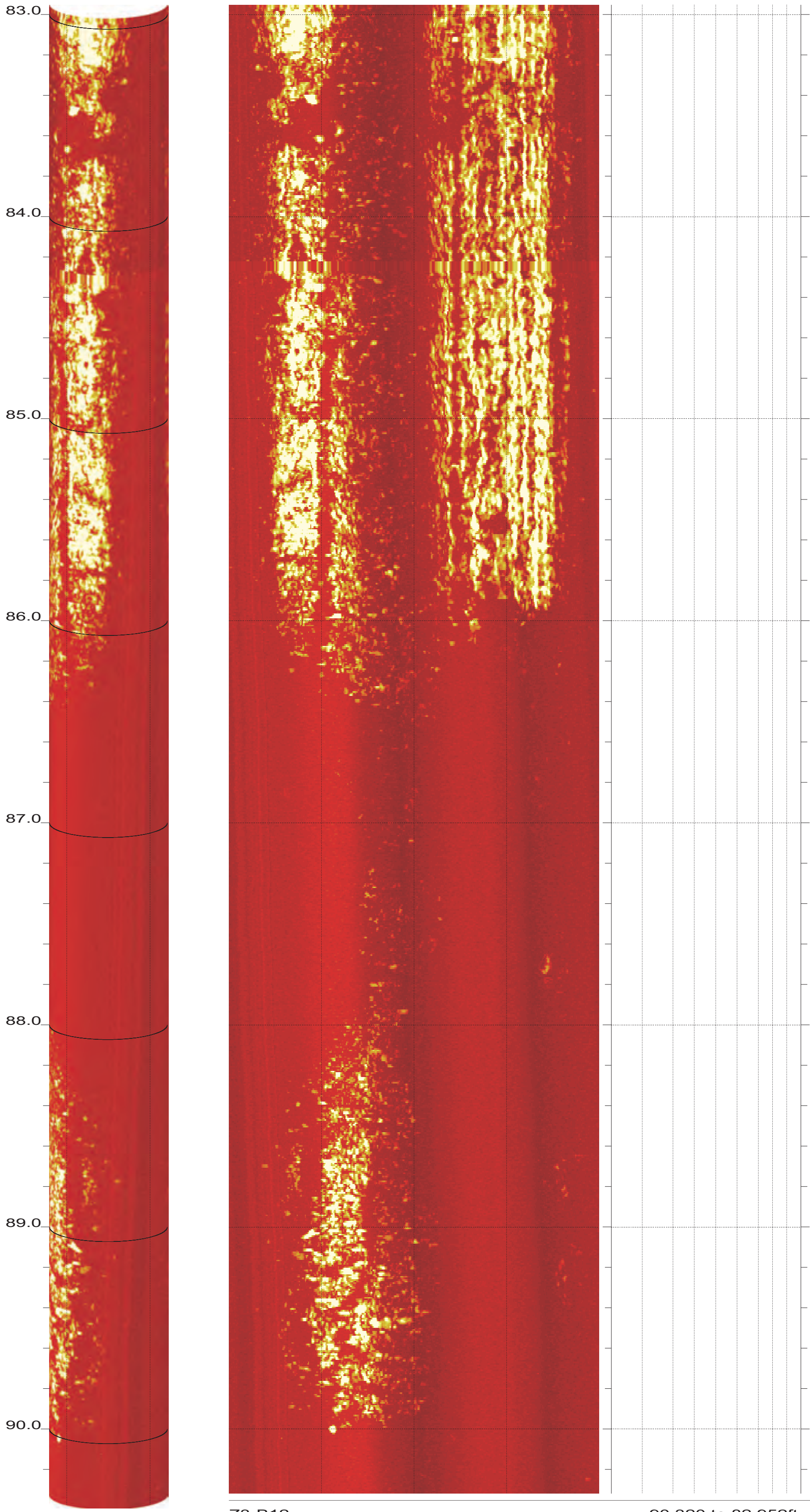


Z3-B12 75.584 to 68.216ft 3

SR-710 Boring Z3-B12 Acoustic Televiewer Dips rev 1 Sheet 3 of 18

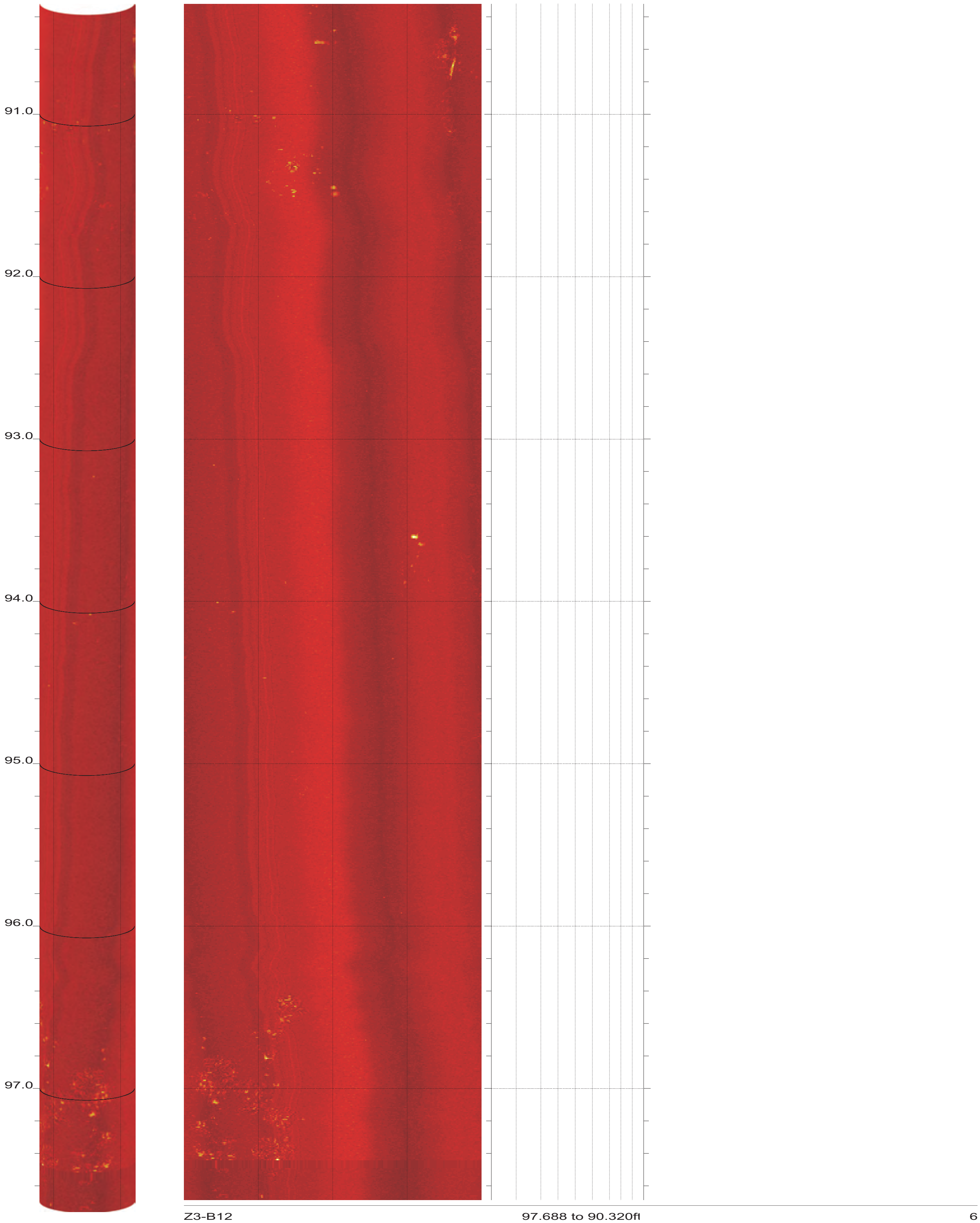


SR-710 Boring Z3-B12 Acoustic Televiewer Dips rev 1 Sheet 4 of 18

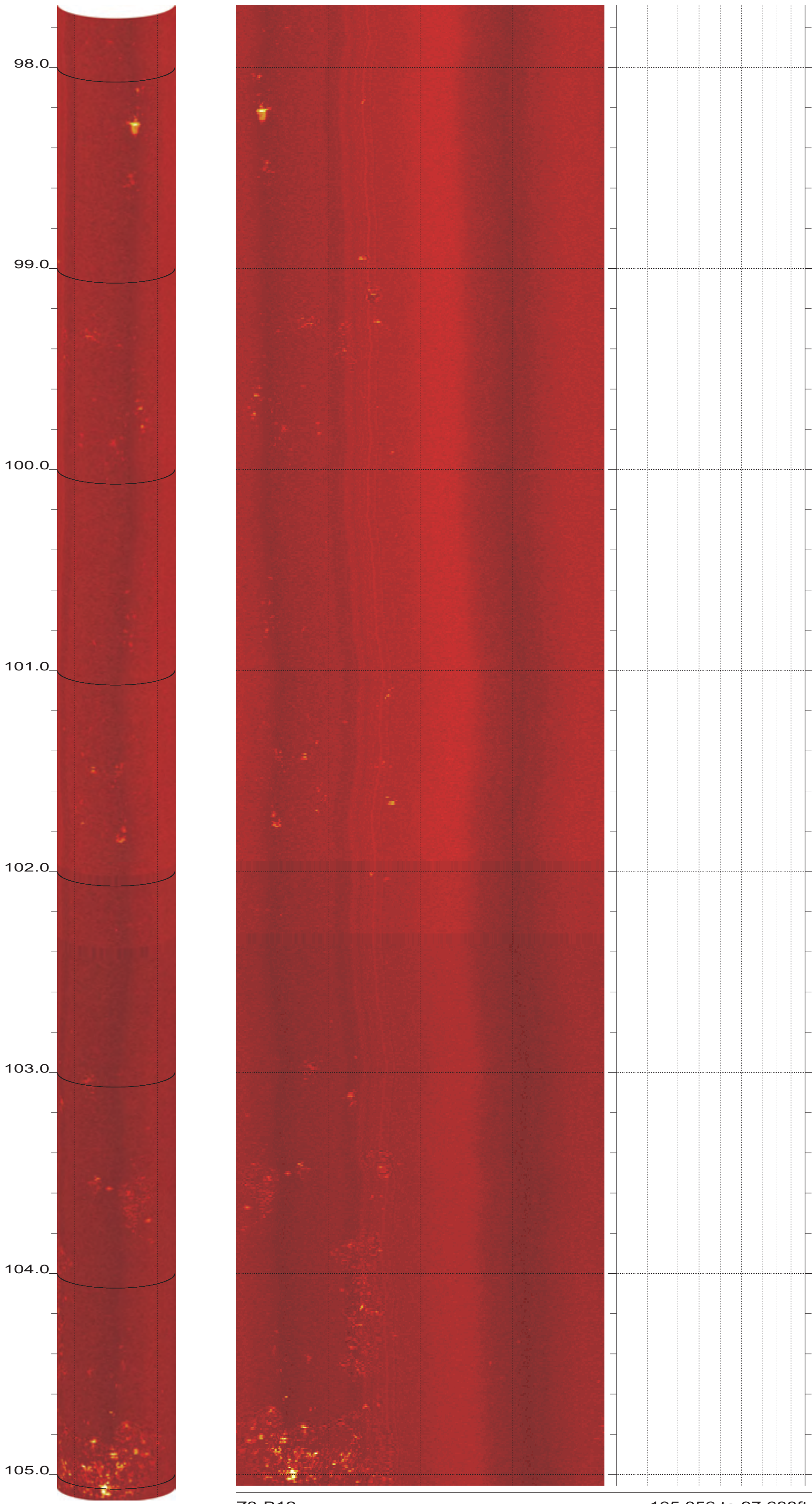


Z3-B12 90.320 to 82.952ft 5

SR-710 Boring Z3-B12 Acoustic Televiewer Dips rev 1 Sheet 5 of 18

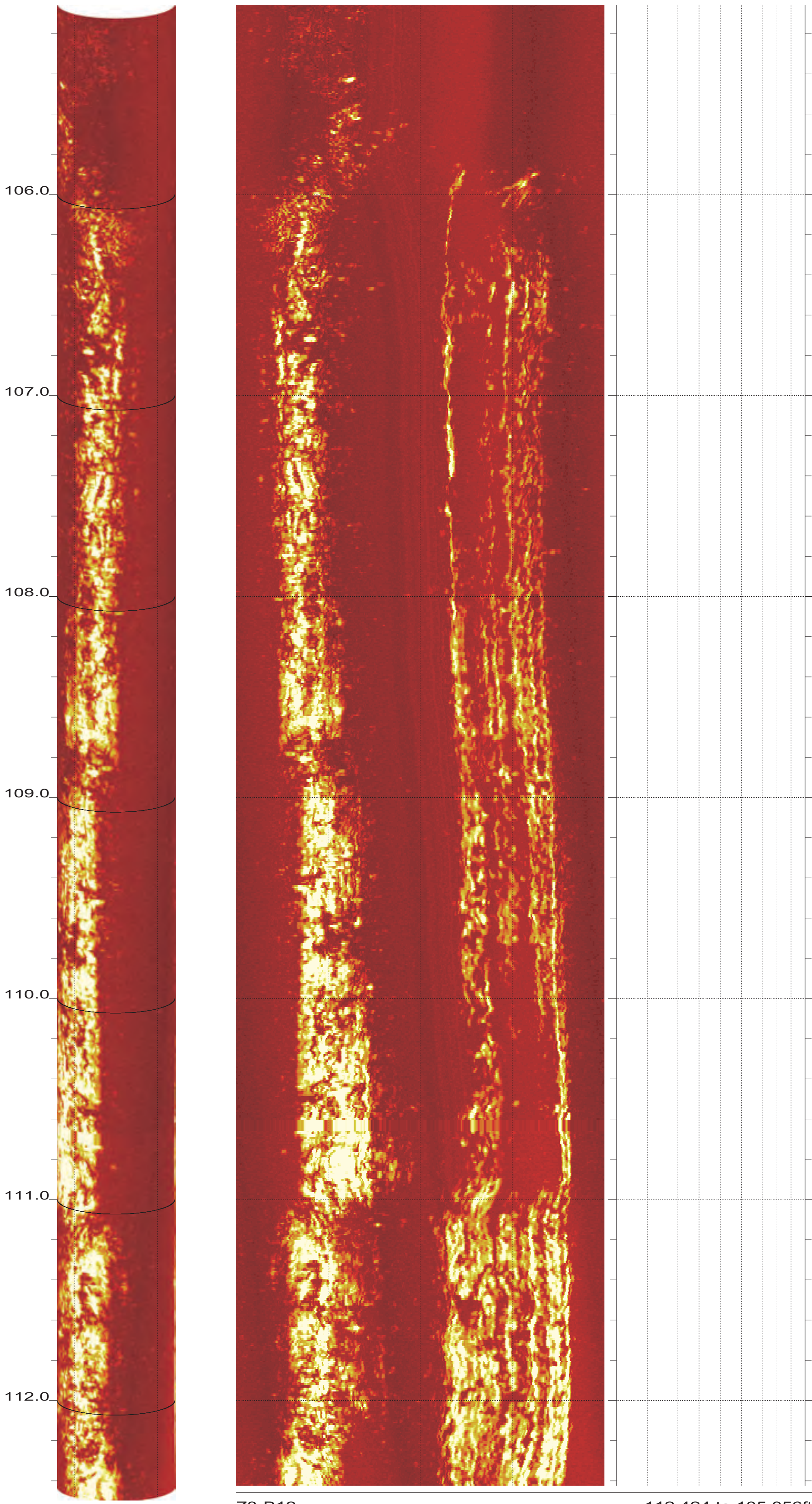


SR-710 Boring Z3-B12 Acoustic Televiewer Dips rev 1 Sheet 6 of 18



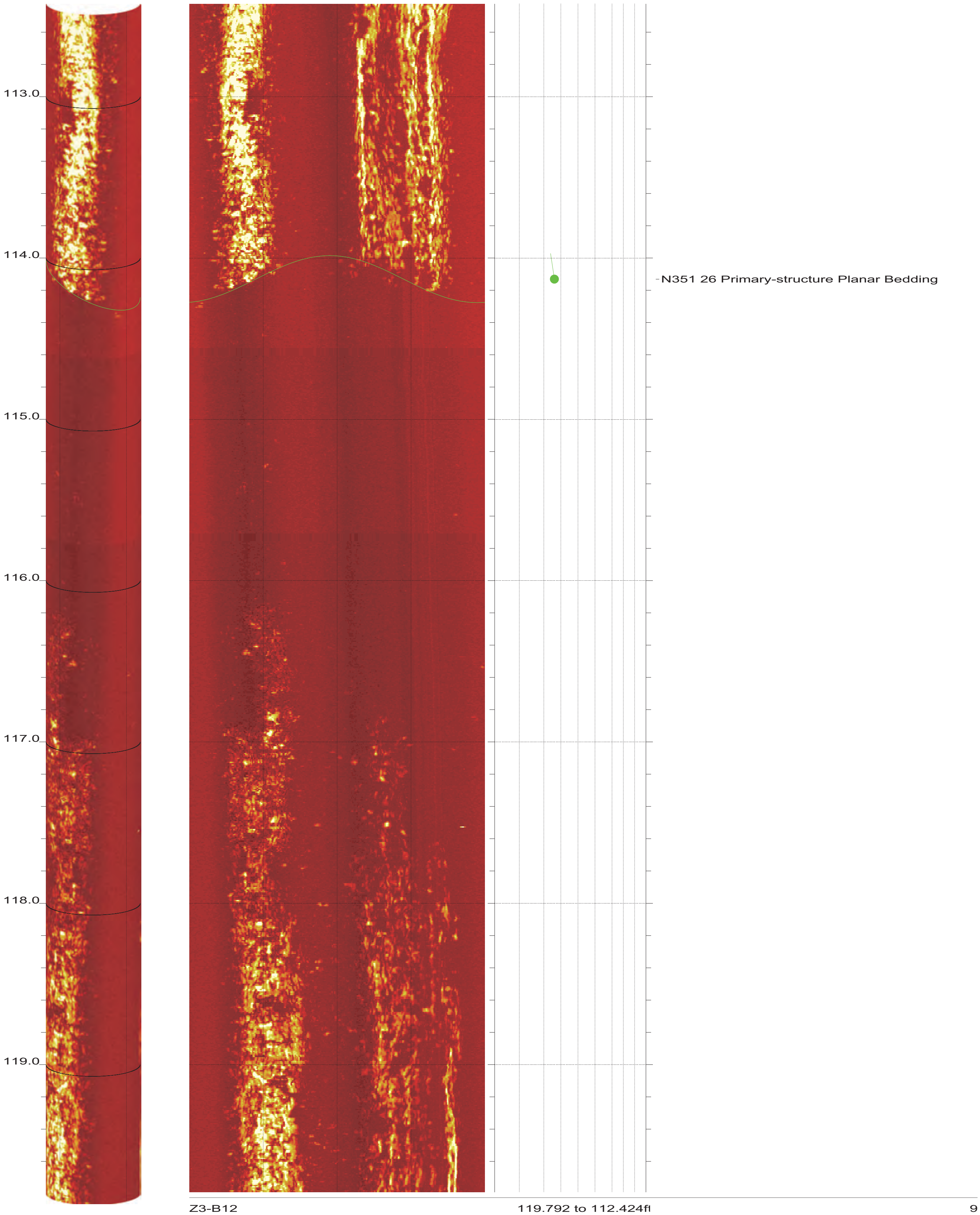
Z3-B12 105.056 to 97.688ft 7

SR-710 Boring Z3-B12 Acoustic Televiewer Dips rev 1 Sheet 7 of 18

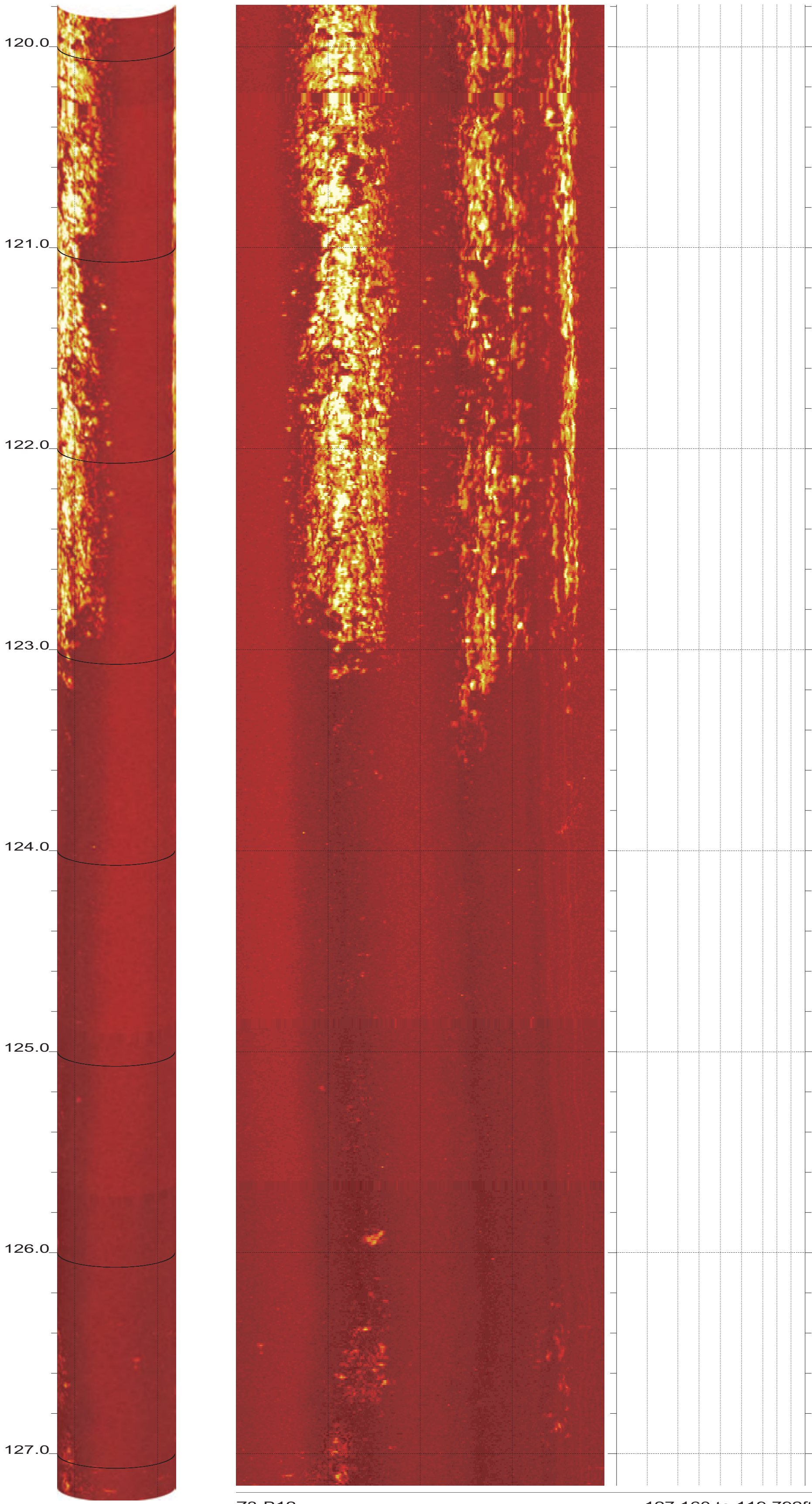


Z3-B12 112.424 to 105.056ft 8

SR-710 Boring Z3-B12 Acoustic Televiewer Dips rev 1 Sheet 8 of 18

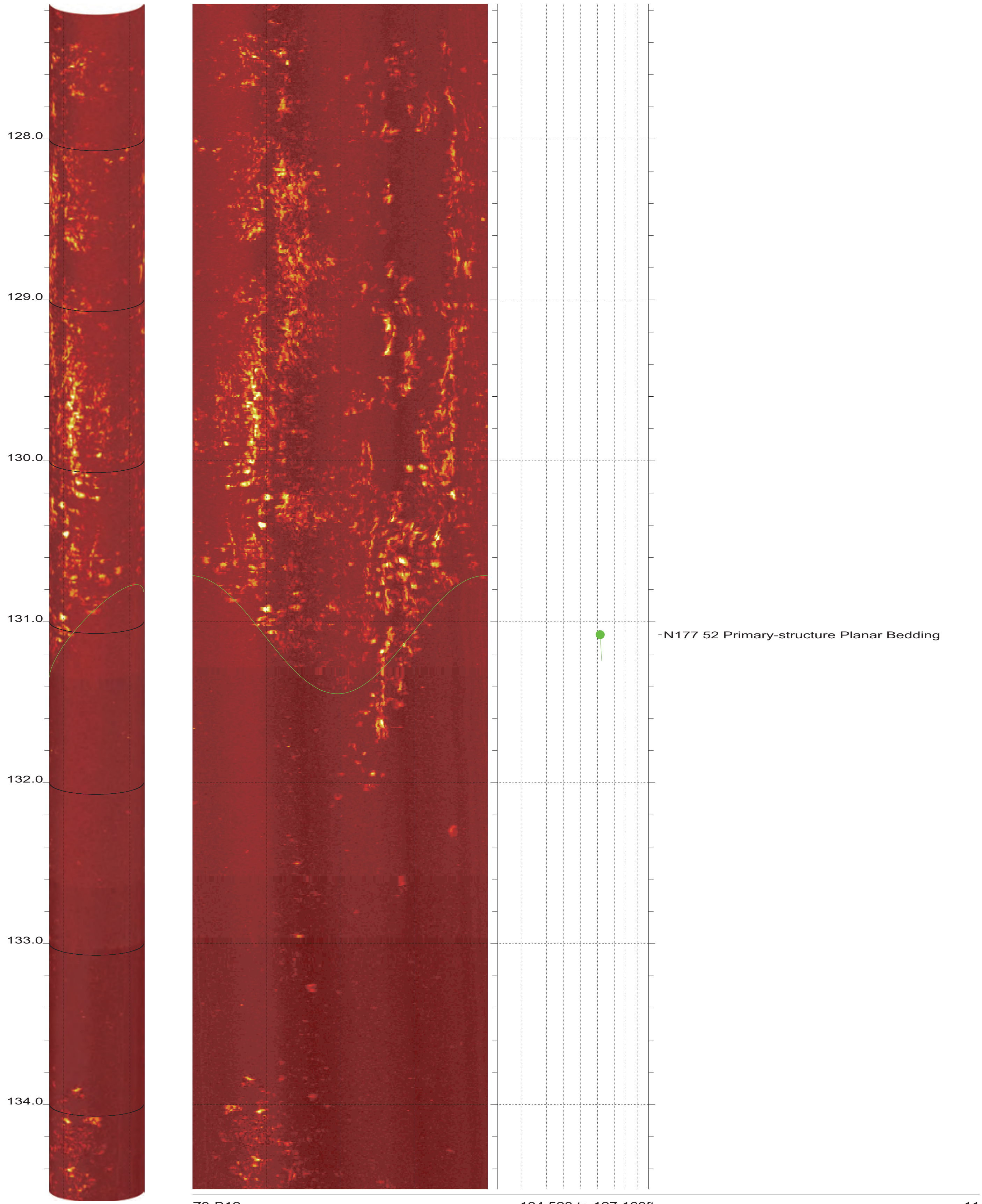


SR-710 Boring Z3-B12 Acoustic Televiewer Dips rev 1 Sheet 9 of 18



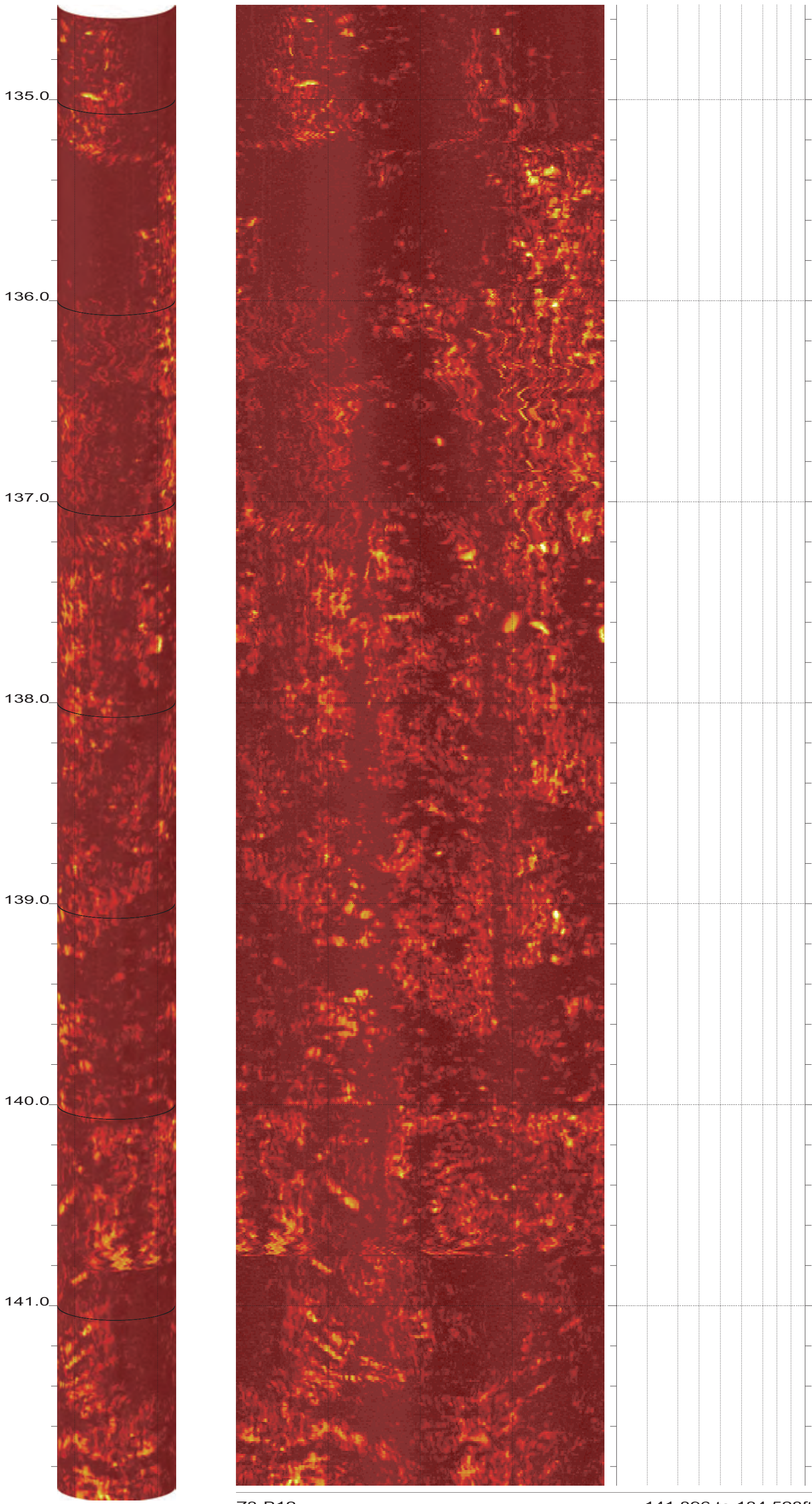
Z3-B12 127.160 to 119.792ft 10

SR-710 Boring Z3-B12 Acoustic Televiewer Dips rev 1 Sheet 10 of 18



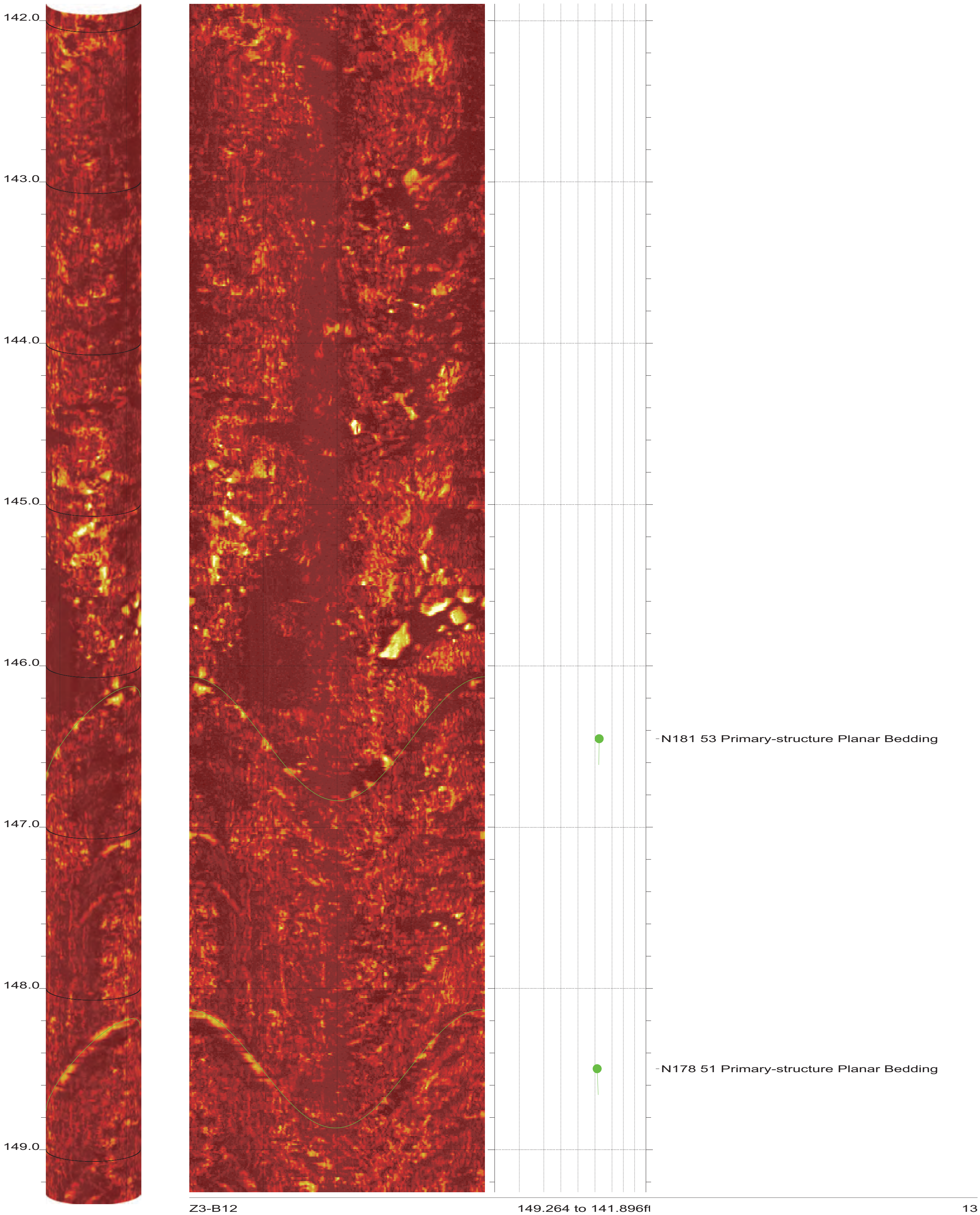
Z3-B12 134.528 to 127.160ft 11

SR-710 Boring Z3-B12 Acoustic Televiewer Dips rev 1 Sheet 11 of 18

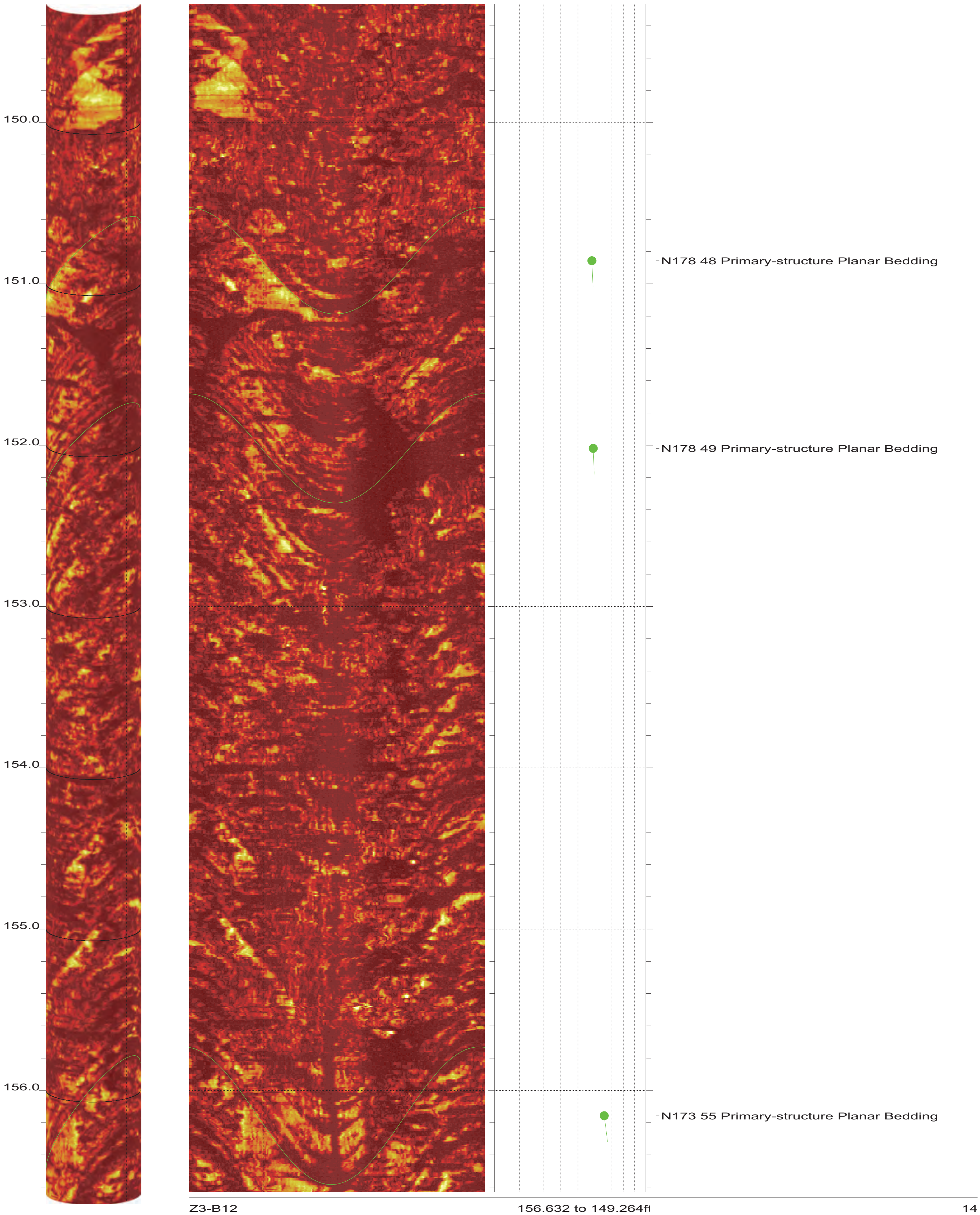


Z3-B12 141.896 to 134.528ft 12

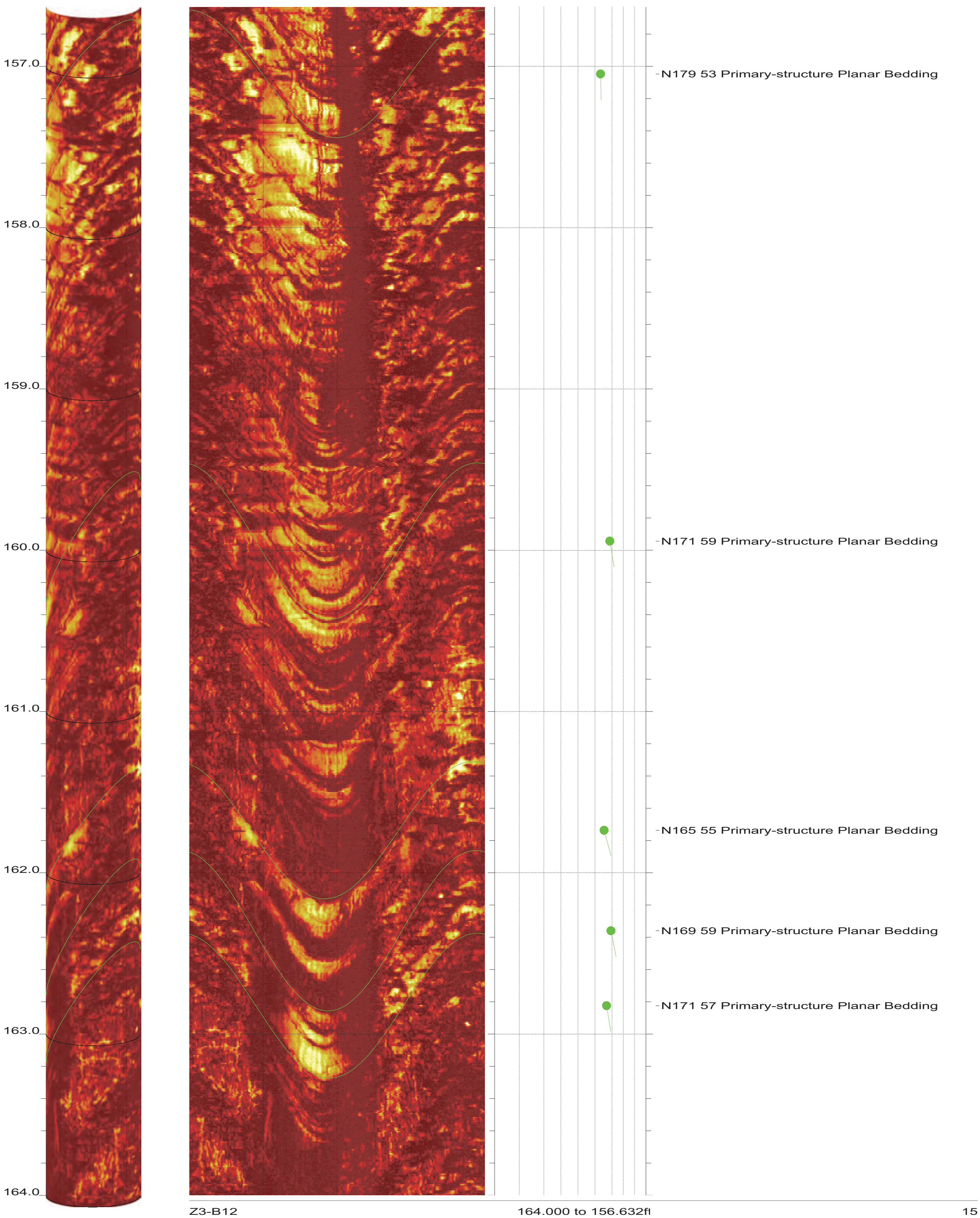
SR-710 Boring Z3-B12 Acoustic Televiewer Dips rev 1 Sheet 12 of 18



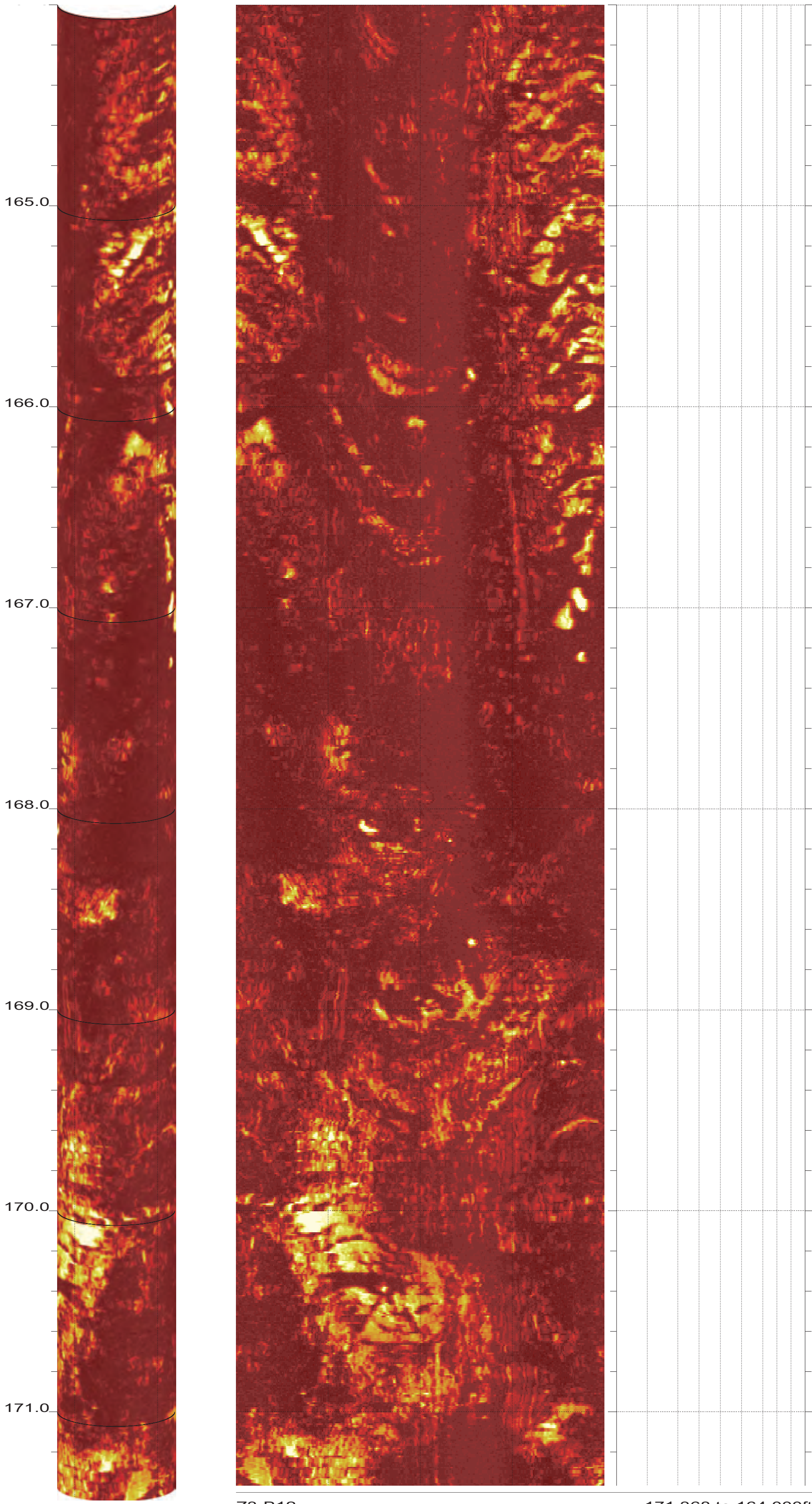
SR-710 Boring Z3-B12 Acoustic Televiewer Dips rev 1 Sheet 13 of 18



SR-710 Boring Z3-B12 Acoustic Televiewer Dips rev 1 Sheet 14 of 18

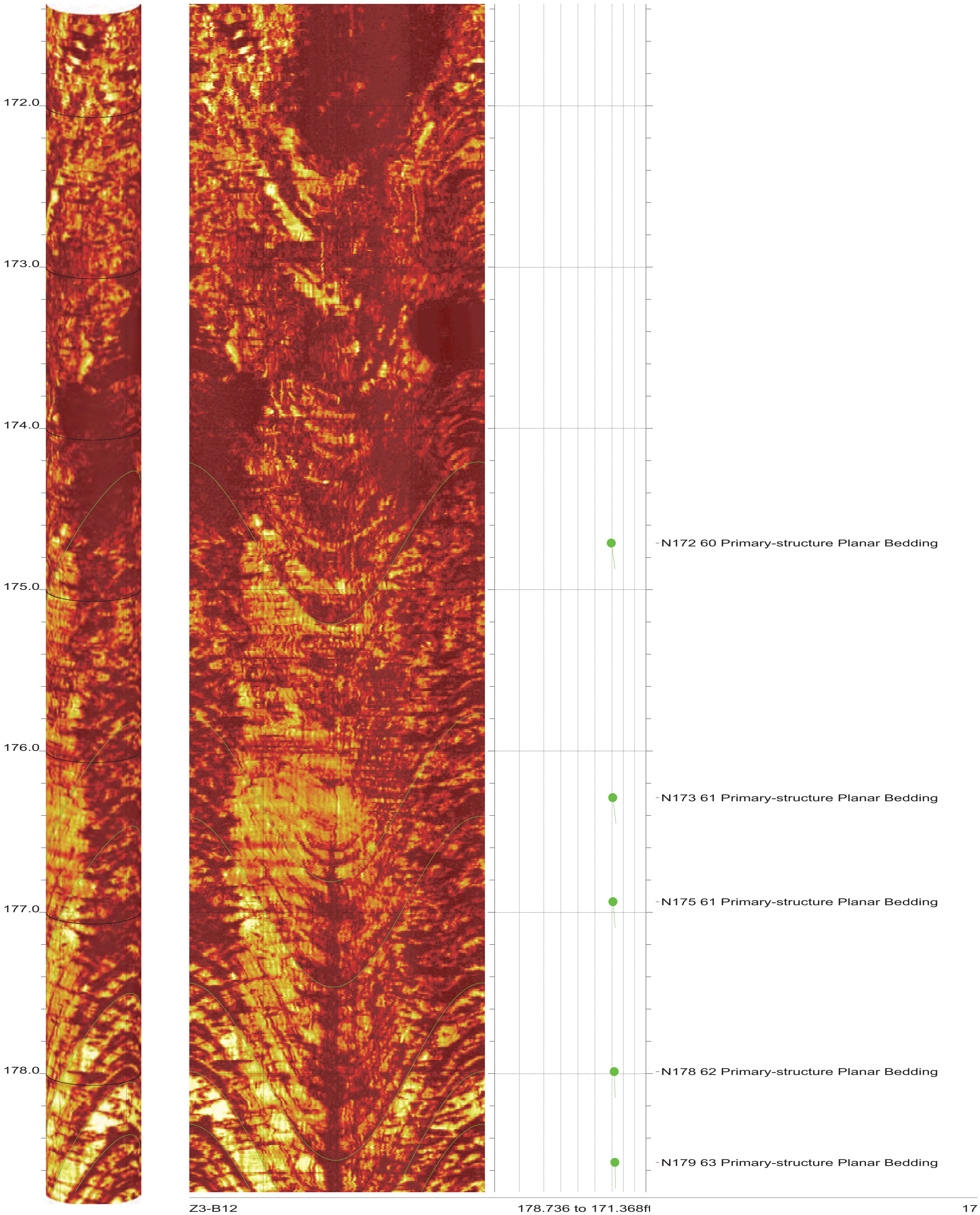


SR-710 Boring Z3-B12 Acoustic Televiewer Dips rev 1 Sheet 15 of 18

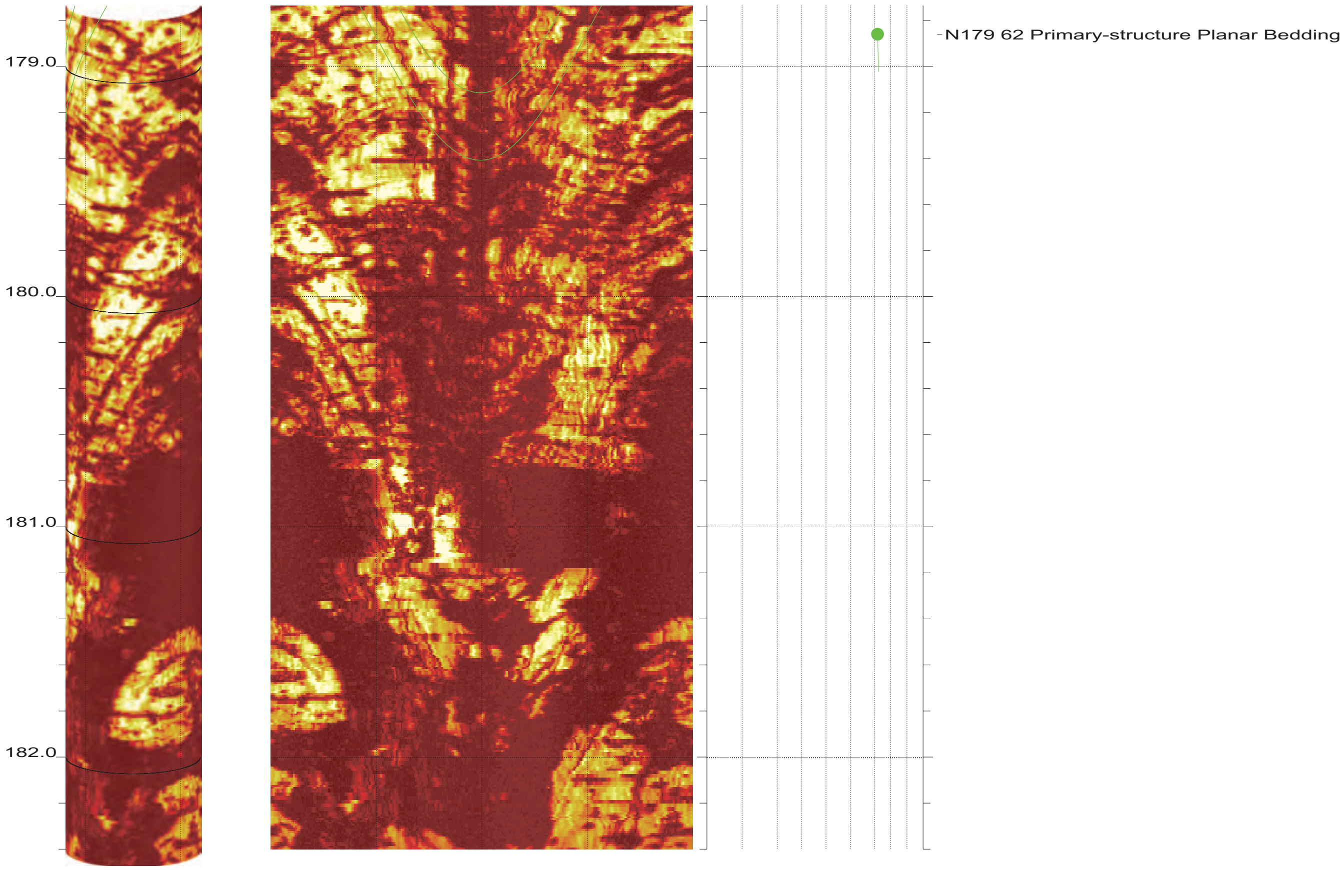


Z3-B12 171.368 to 164.000ft 16

SR-710 Boring Z3-B12 Acoustic Televiewer Dips rev 1 Sheet 16 of 18



SR-710 Boring Z3-B12 Acoustic Televiewer Dips rev 1 Sheet 17 of 18


179.0
180.0
181.0
182.0
N179 62 Primary-structure Planar Bedding

BHTV DATA PROCESSING
RGLDIP vsn 6.2
INTERPRETED BHTV DIPS LOG

CASCADE DRILLING

Borehole: Z4-B4

SR-710 TUNNEL INVESTIGATION

top of borehole.....	North ref. is true
East: _	Depth units are feet
North: _	Vertical scale: 1/10
Elev: _	Horiz scale = 1.00x Vert scale

Zone from 275.000 to 6.800ft	Borehole diam: 5.700inch
Format: BHTV-NESWN	Vertical = borehole-axis
	Image: Amplitude

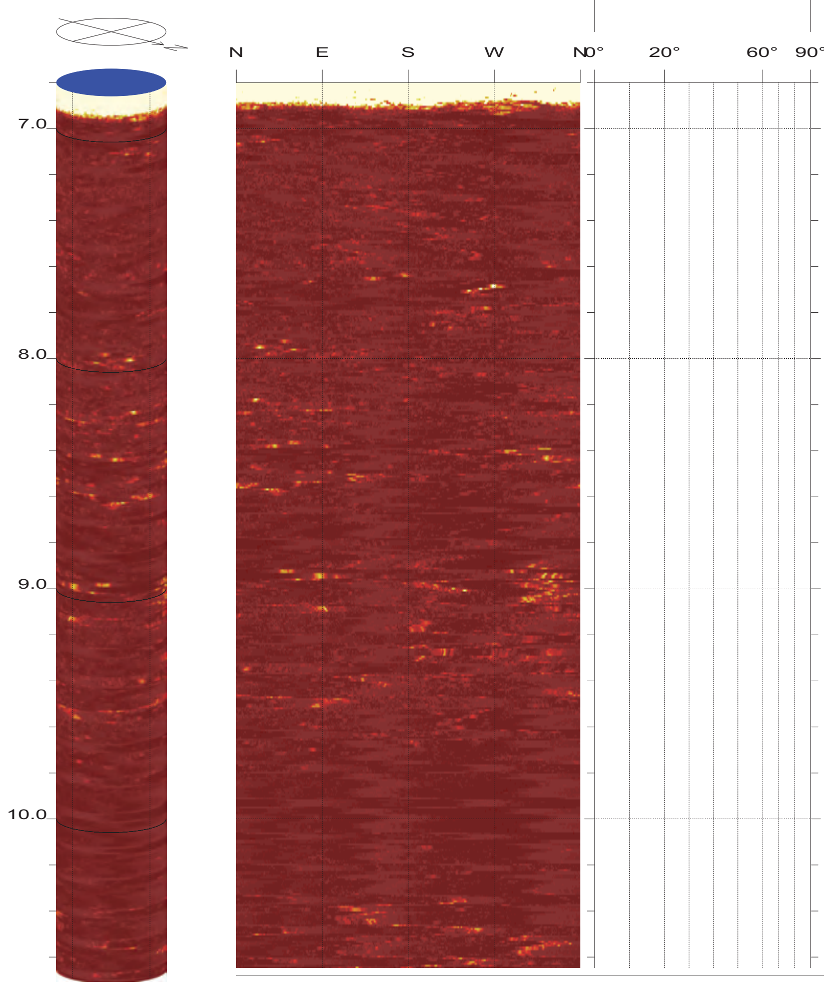
Stratigraphic dips

Non-stratigraphic dips

Identified units

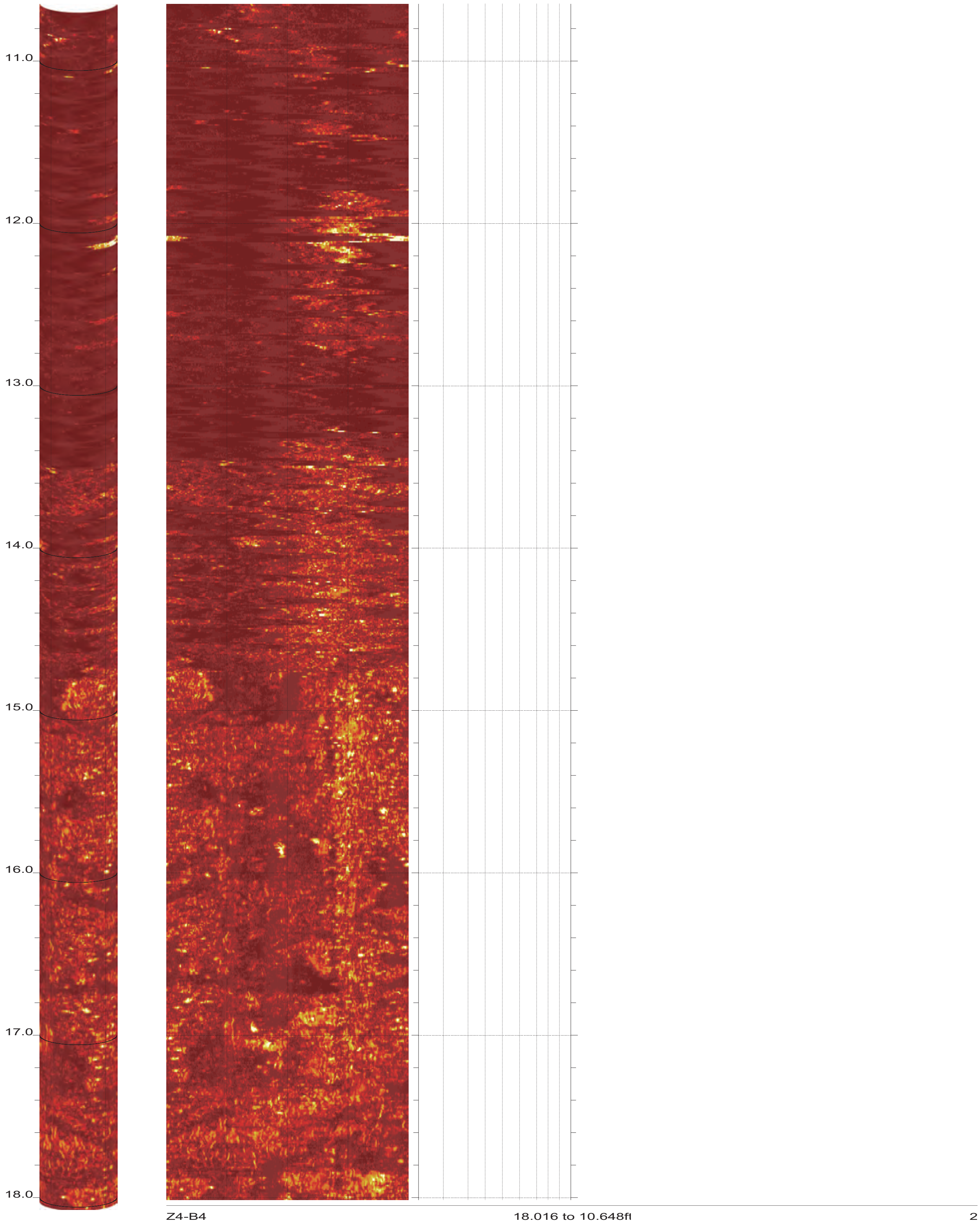
ARROW PLOT

COMMENTS

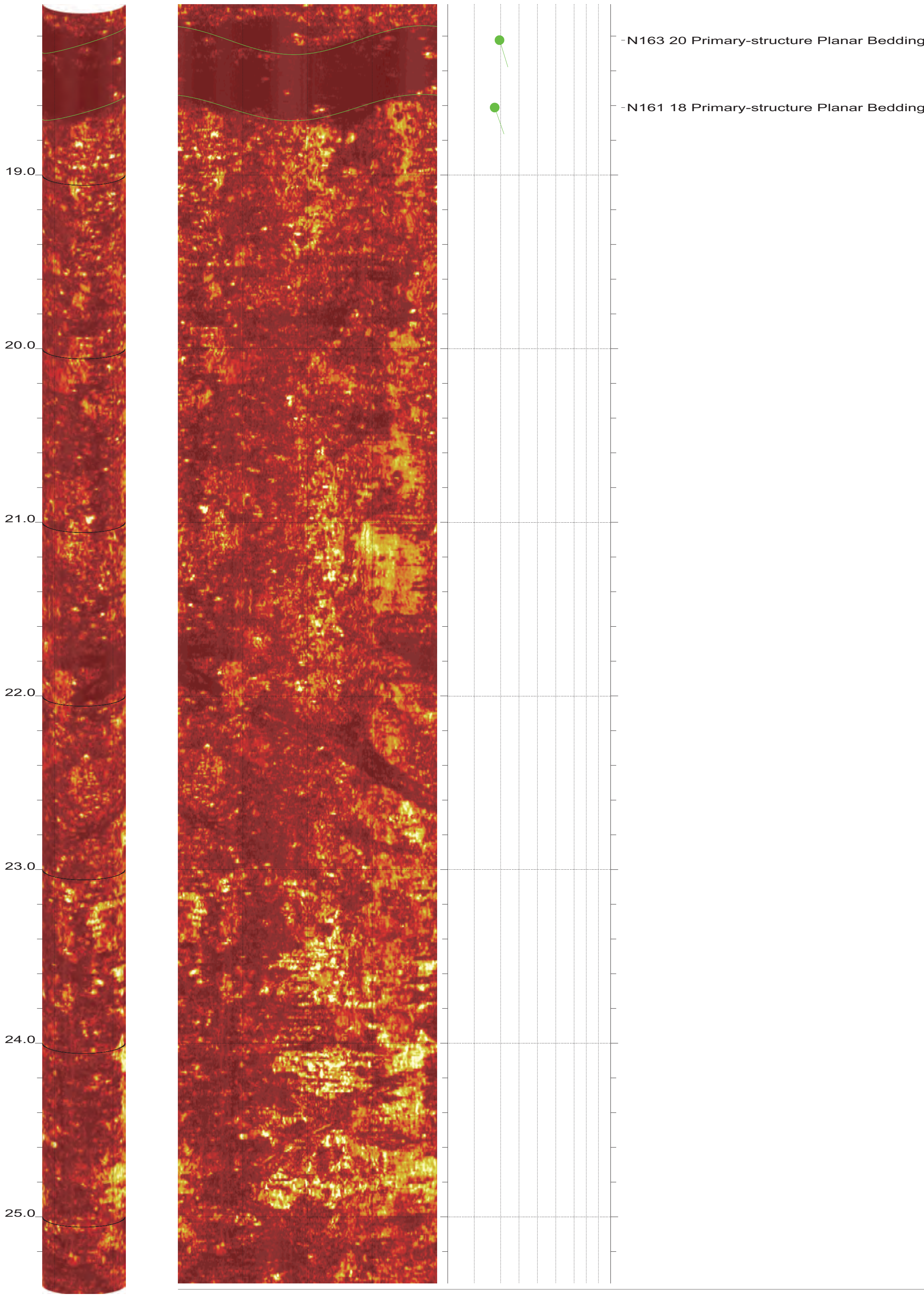


Z4-B4 10.648 to 6.800ft 1

SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 1 of 37

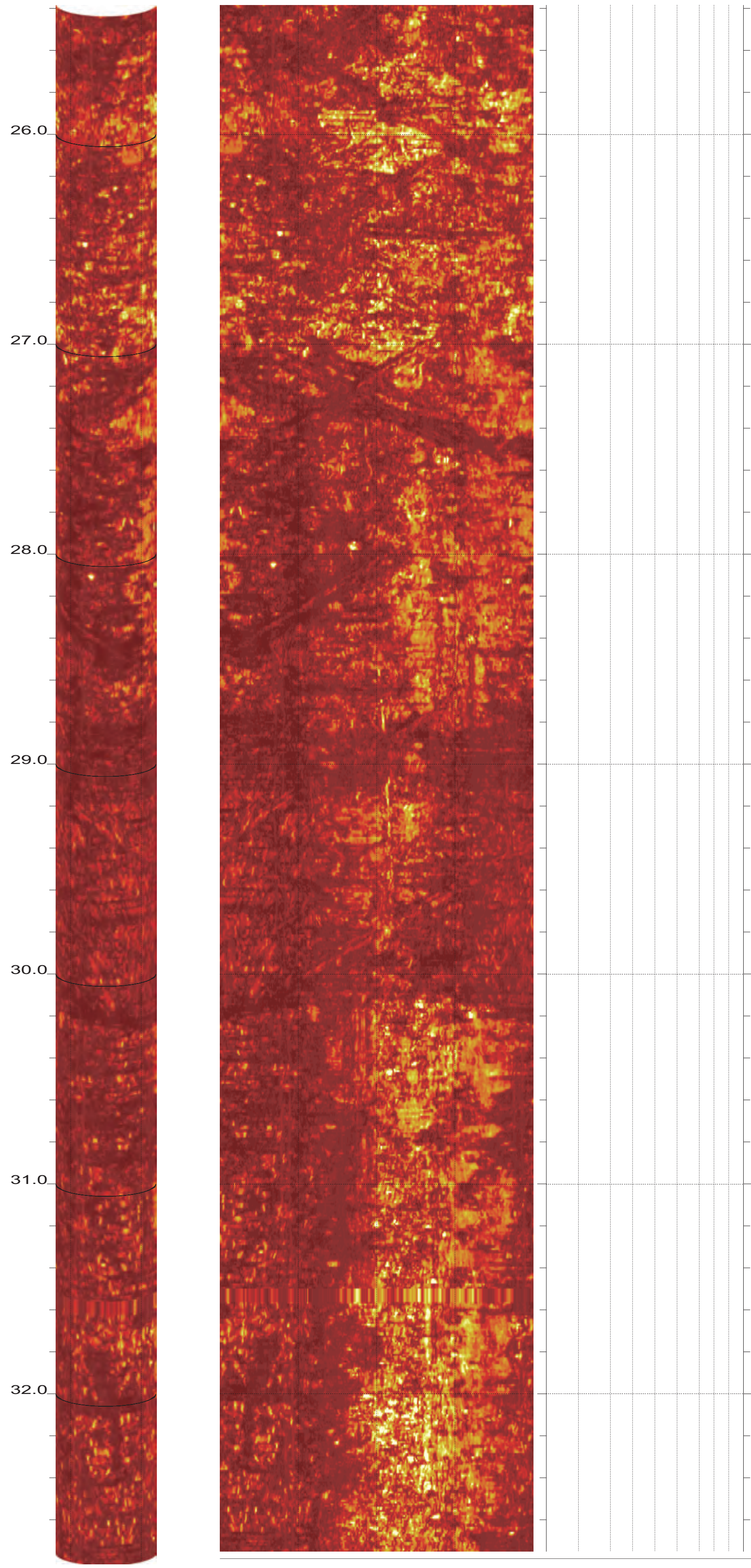


SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 2 of 37



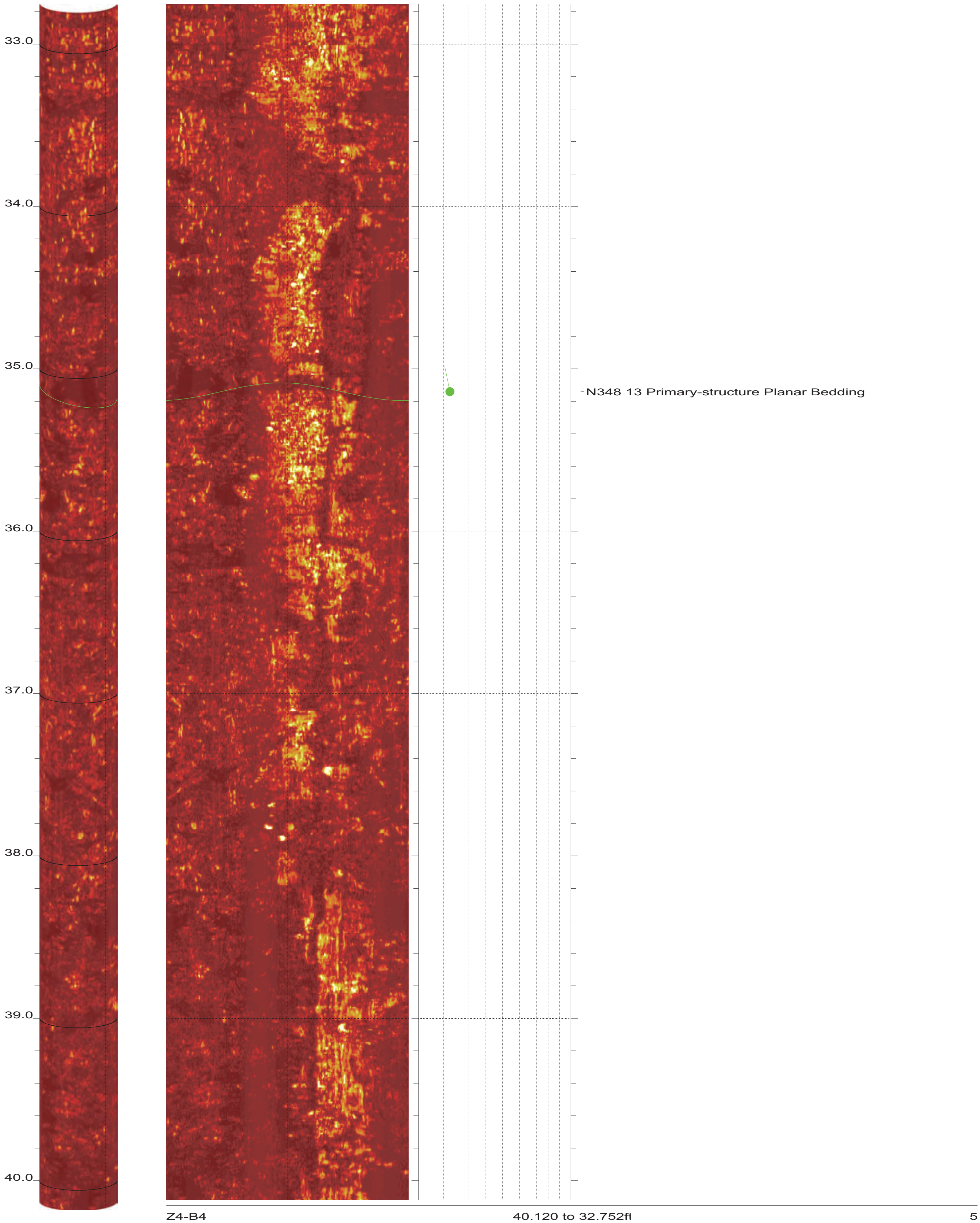
Z4-B4 25.384 to 18.016ft 3

SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 3 of 37

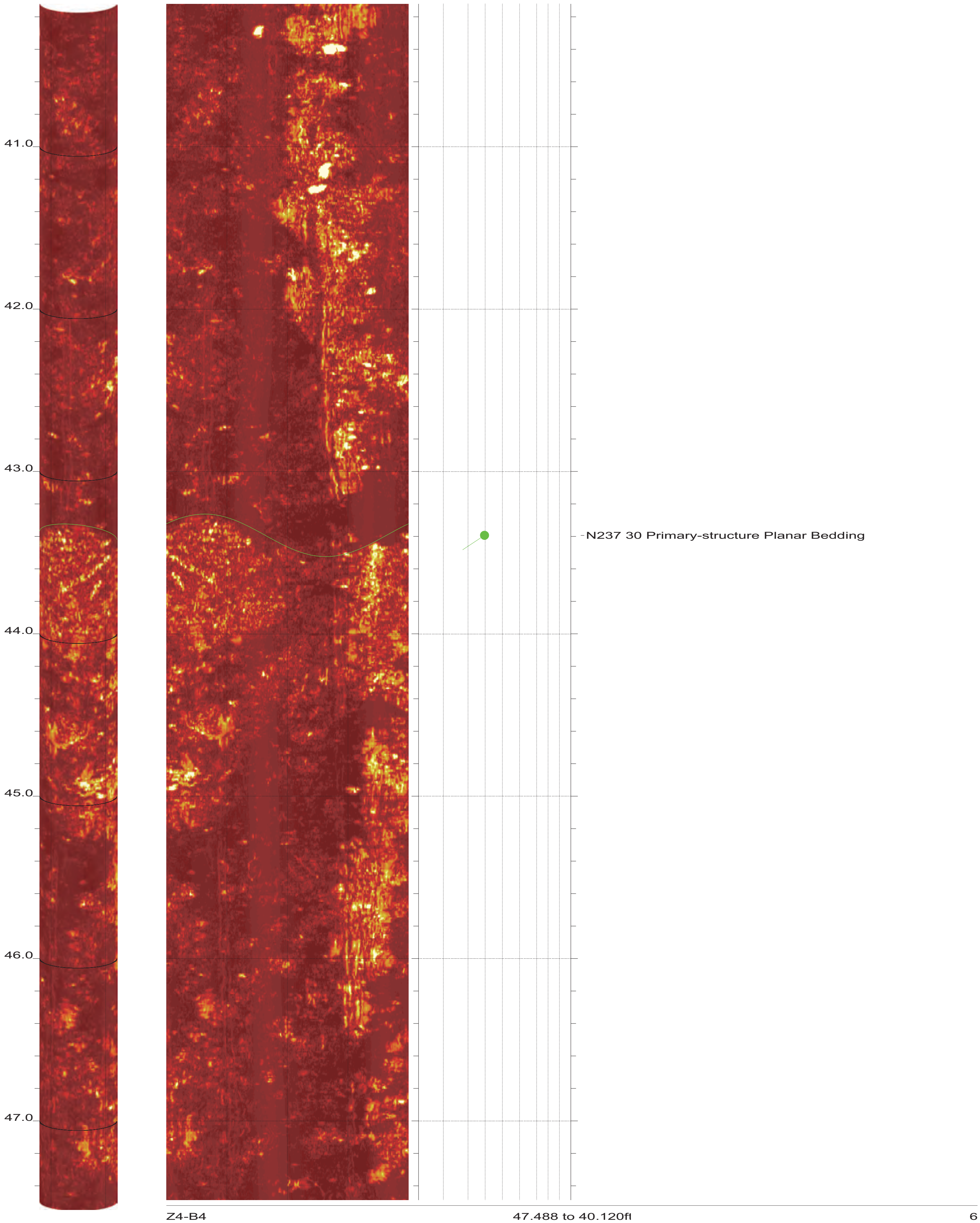


Z4-B4 32.752 to 25.384ft 4

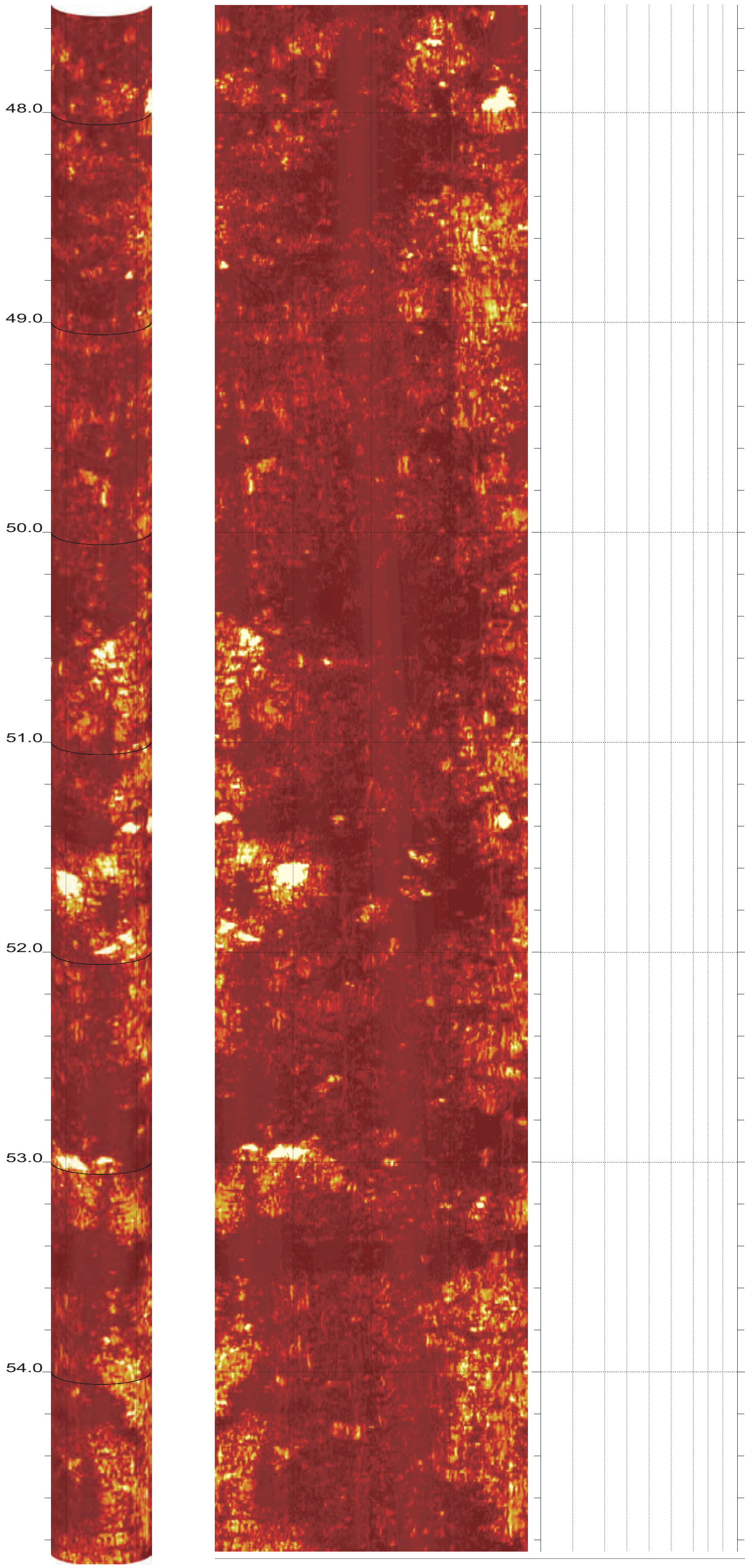
SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 4 of 37



SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 5 of 37

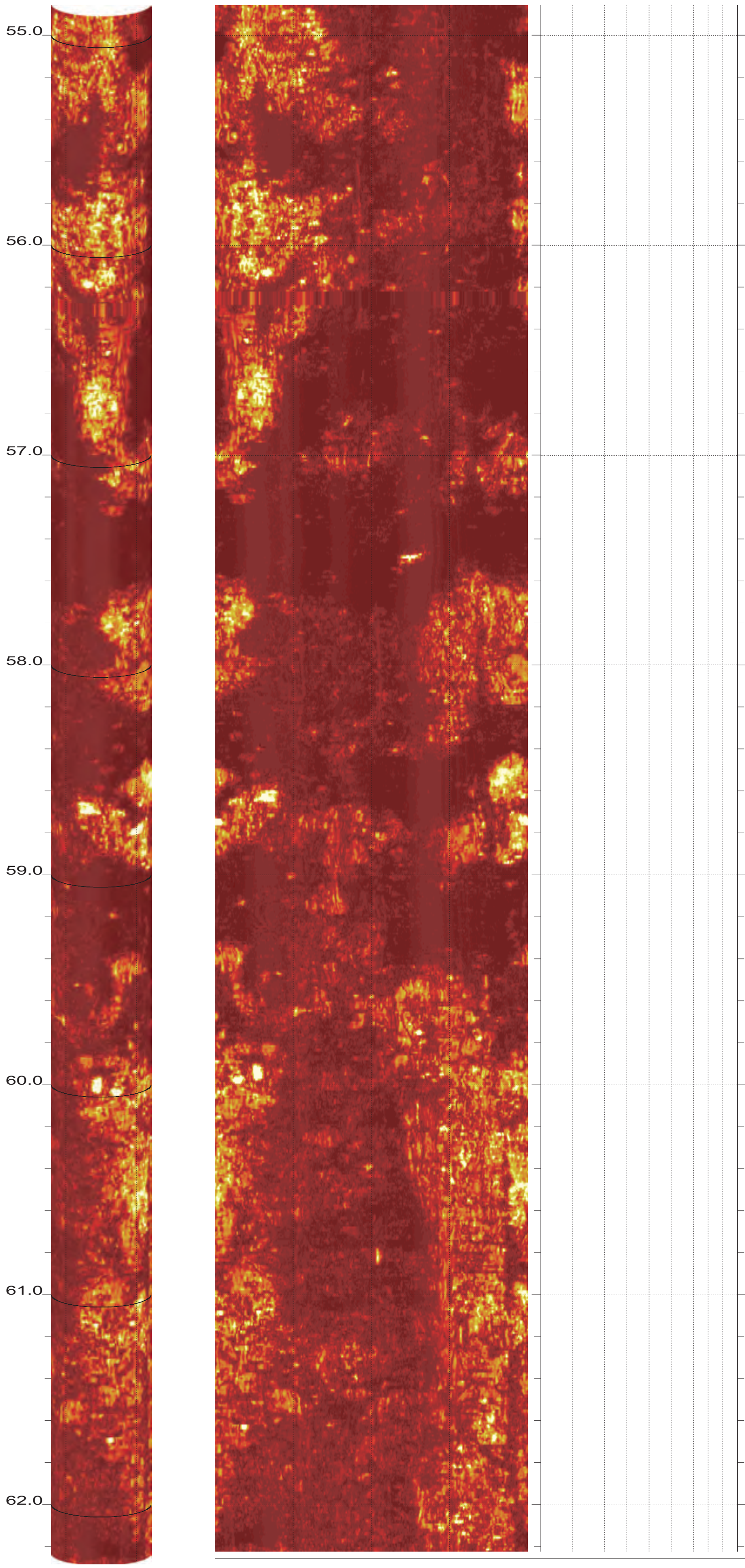


SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 6 of 37



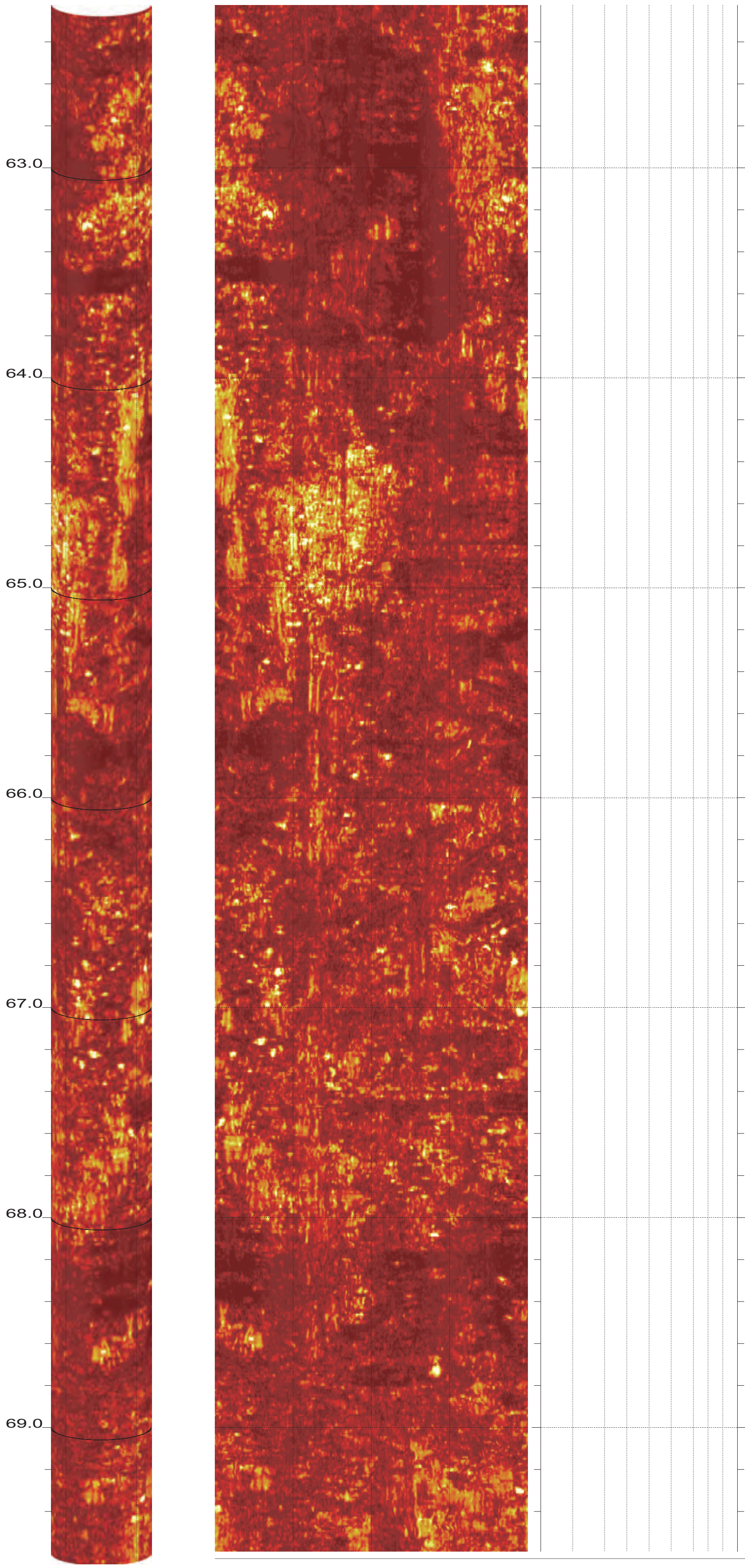
Z4-B4 54.856 to 47.488ft 7

SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 7 of 37



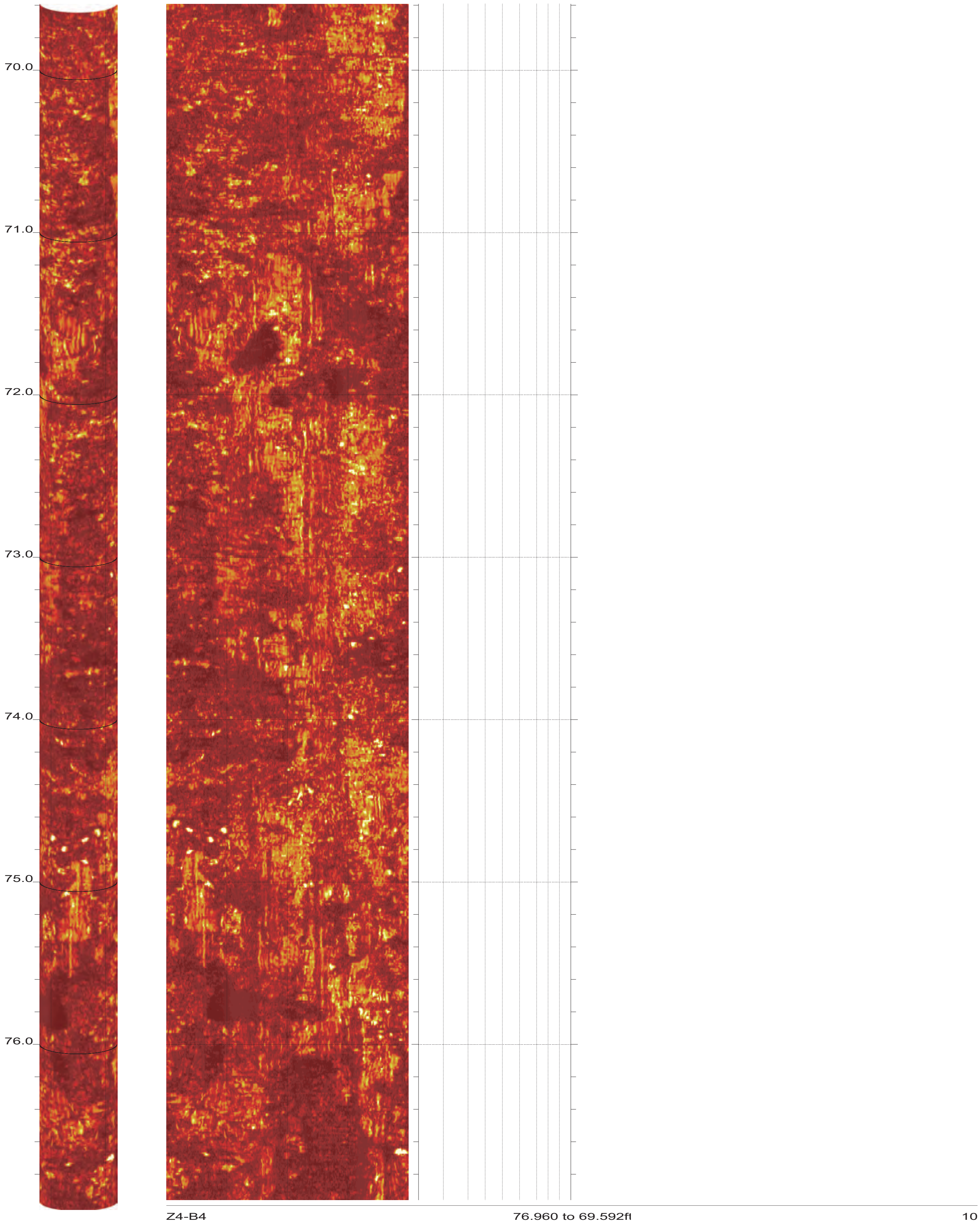
Z4-B4 62.224 to 54.856ft 8

SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 8 of 37

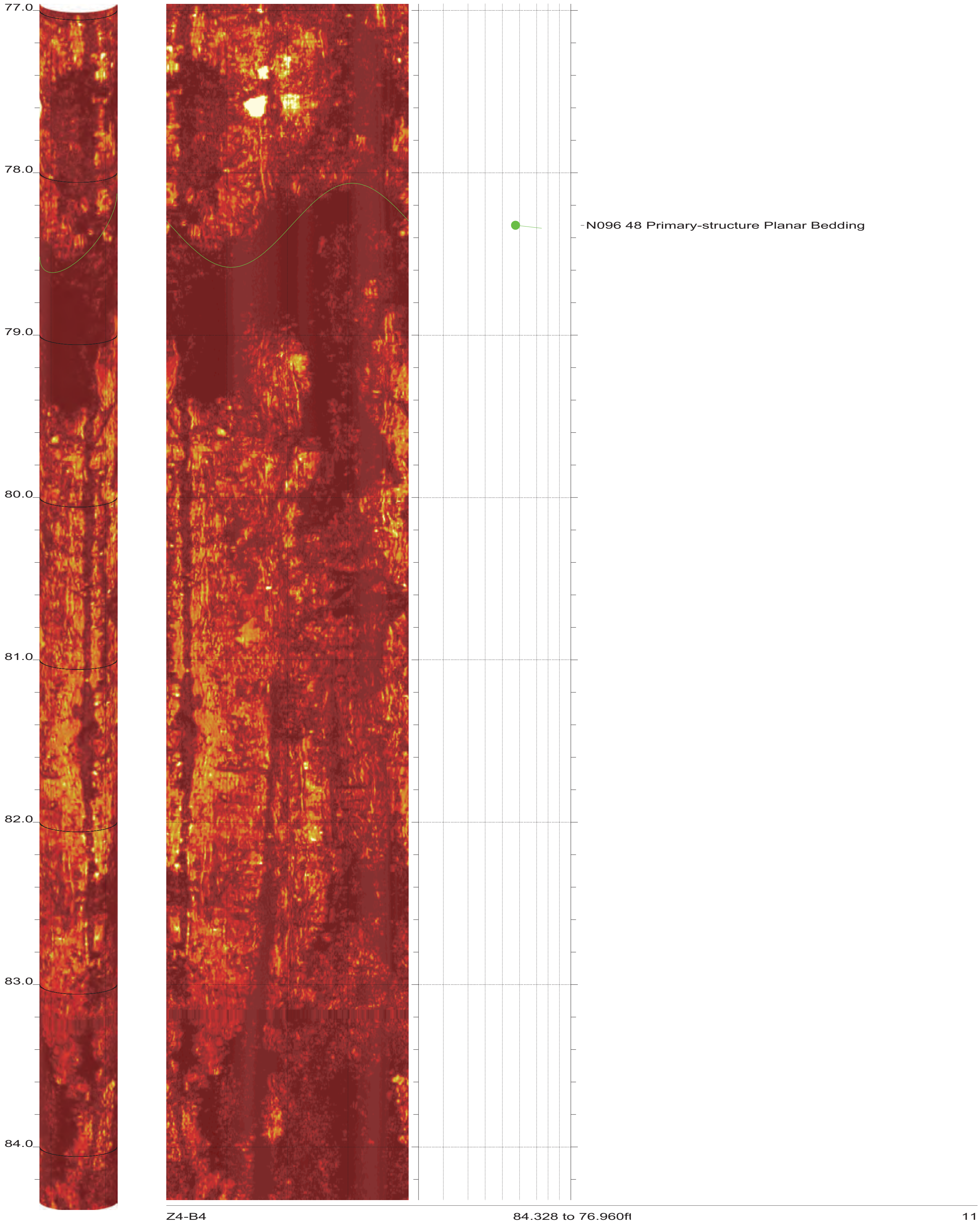


Z4-B4 69.592 to 62.224ft 9

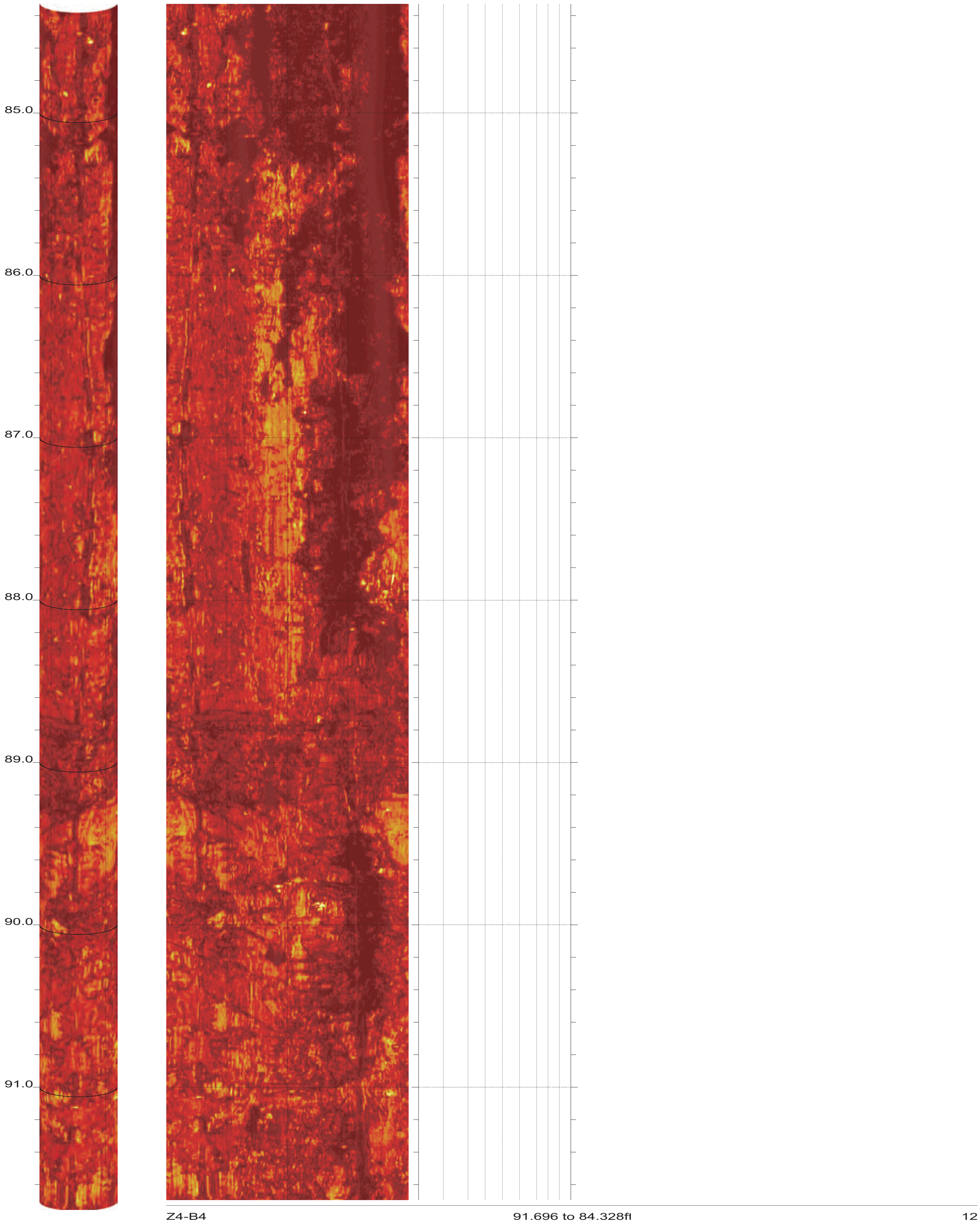
SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 9 of 37



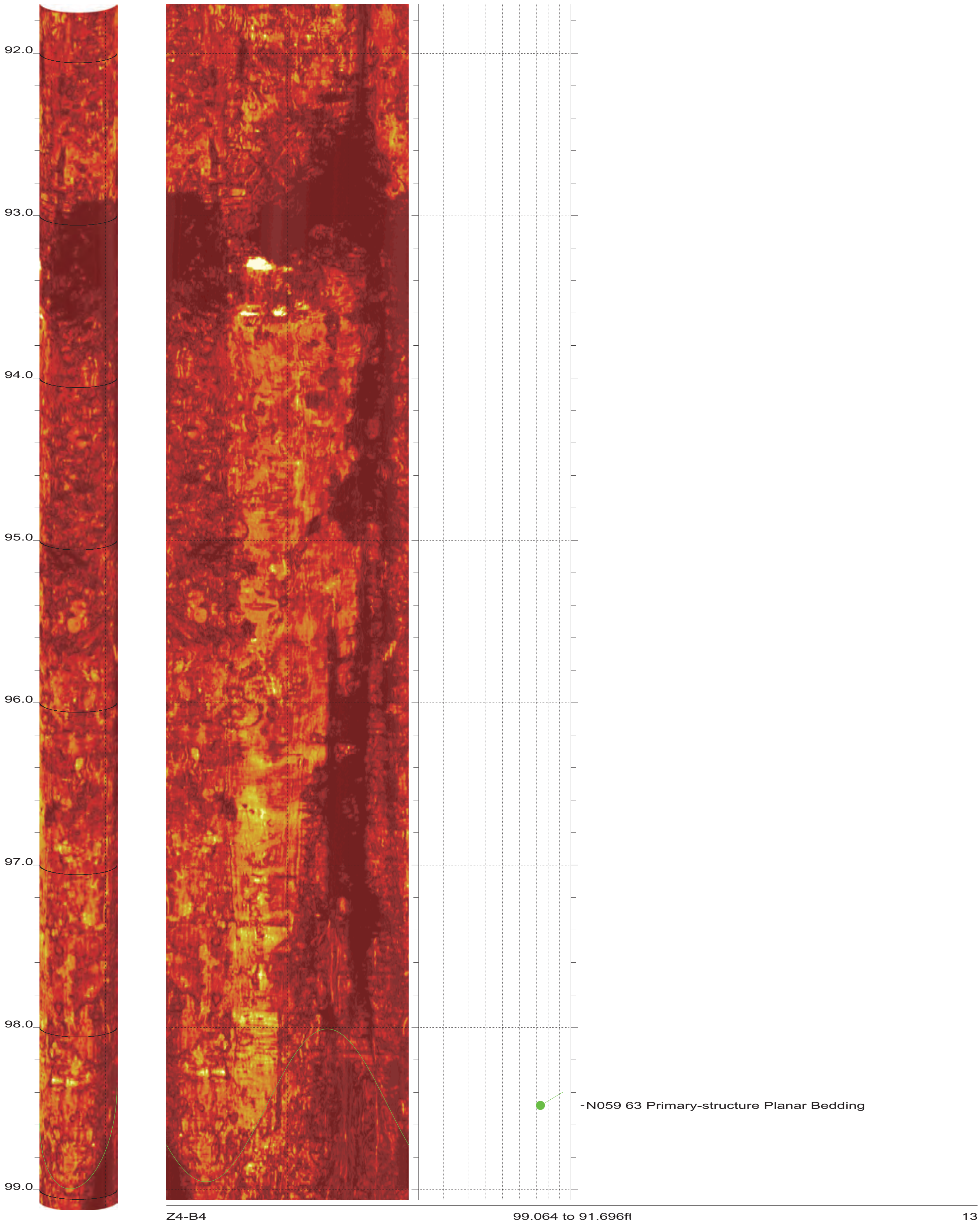
SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 10 of 37



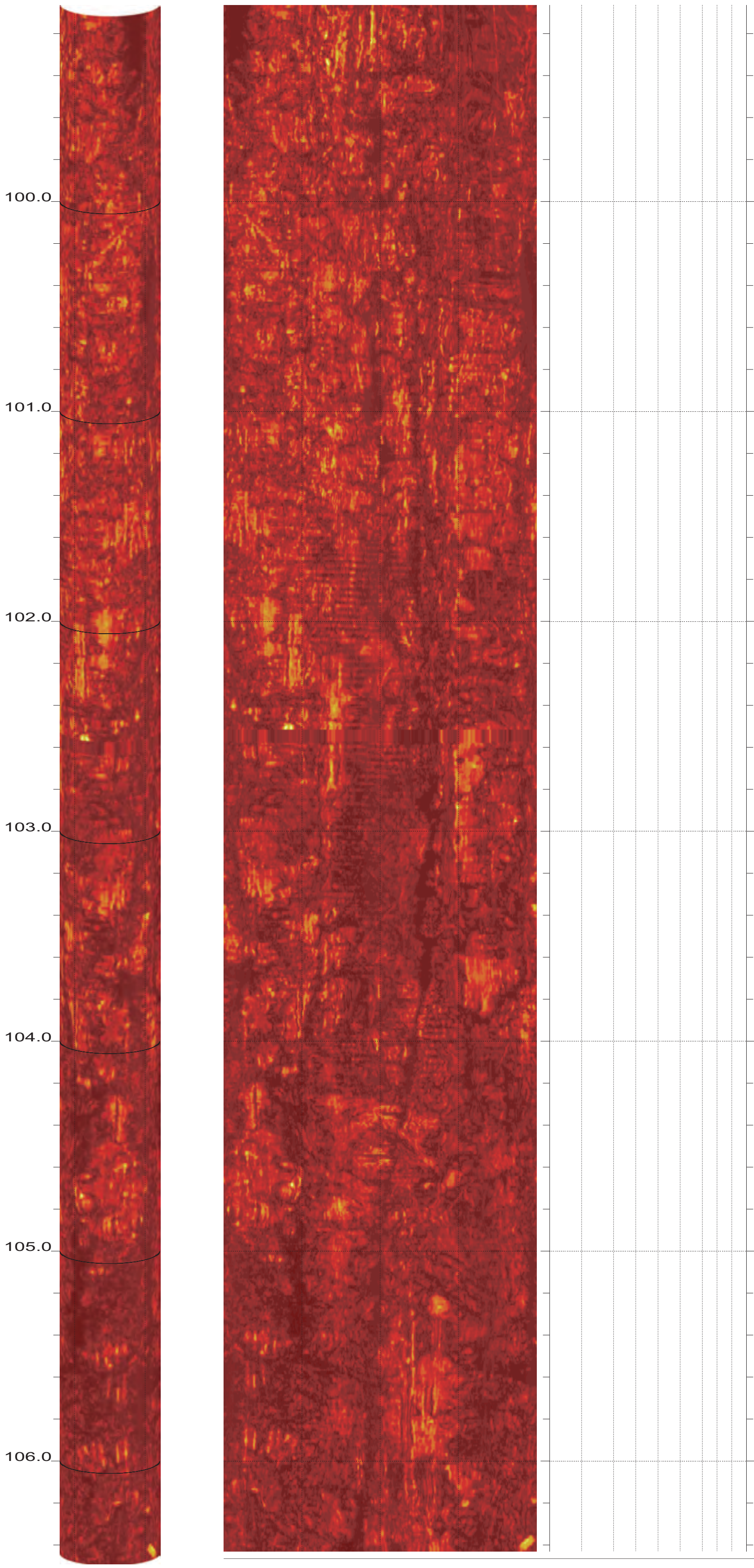
SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 11 of 37



SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 12 of 37

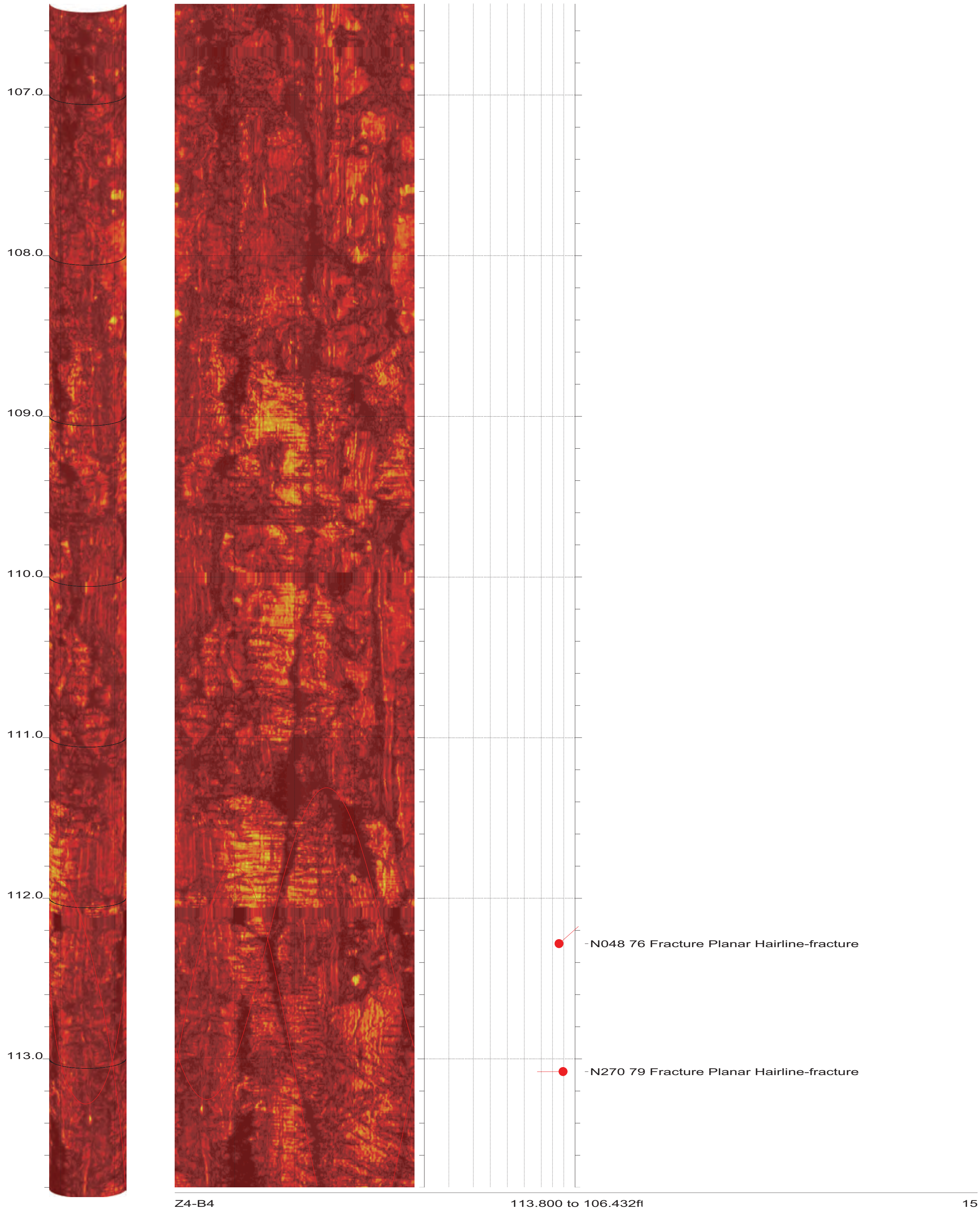


SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 13 of 37

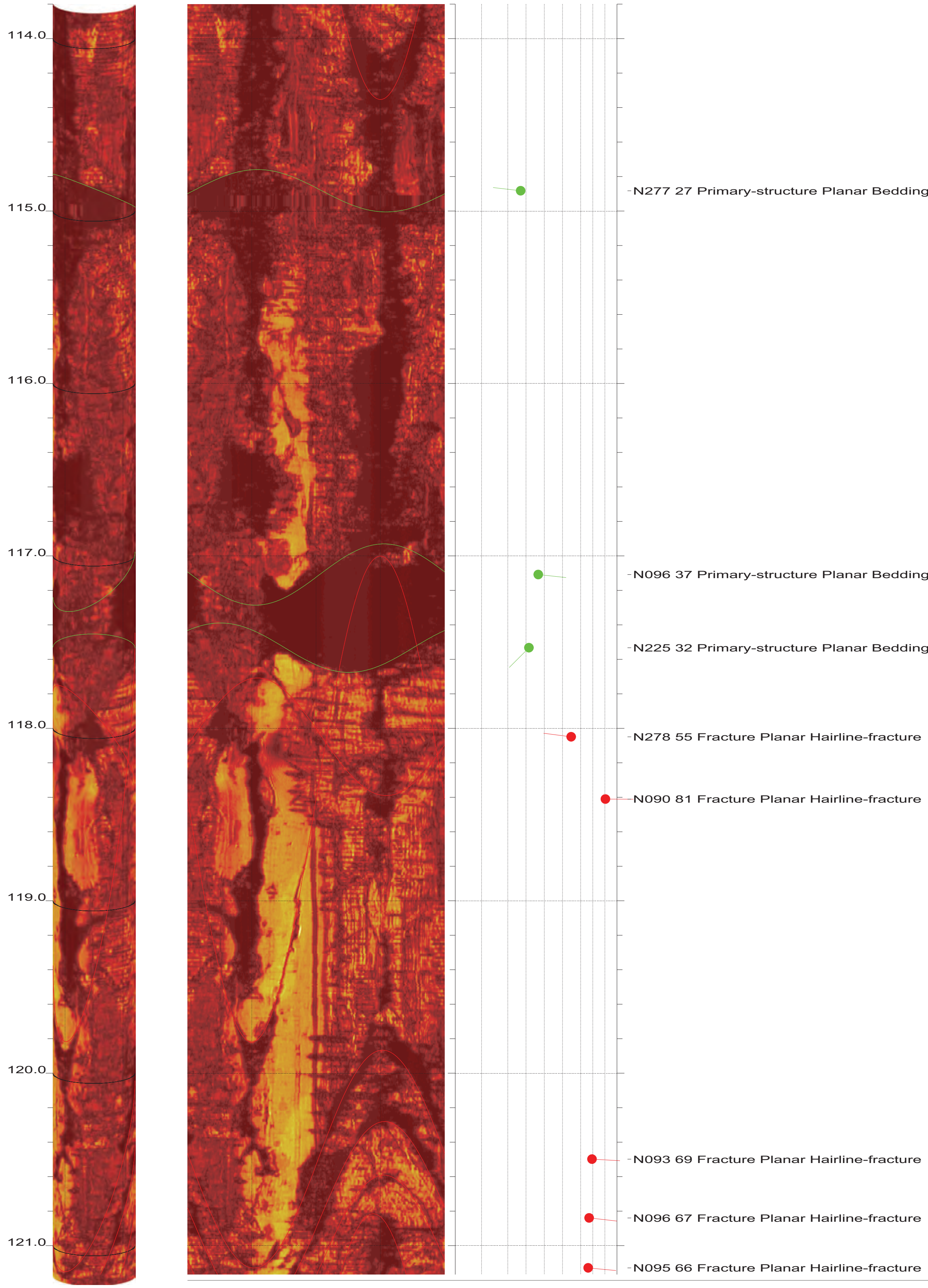


Z4-B4 106.432 to 99.064ft 14

SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 14 of 37

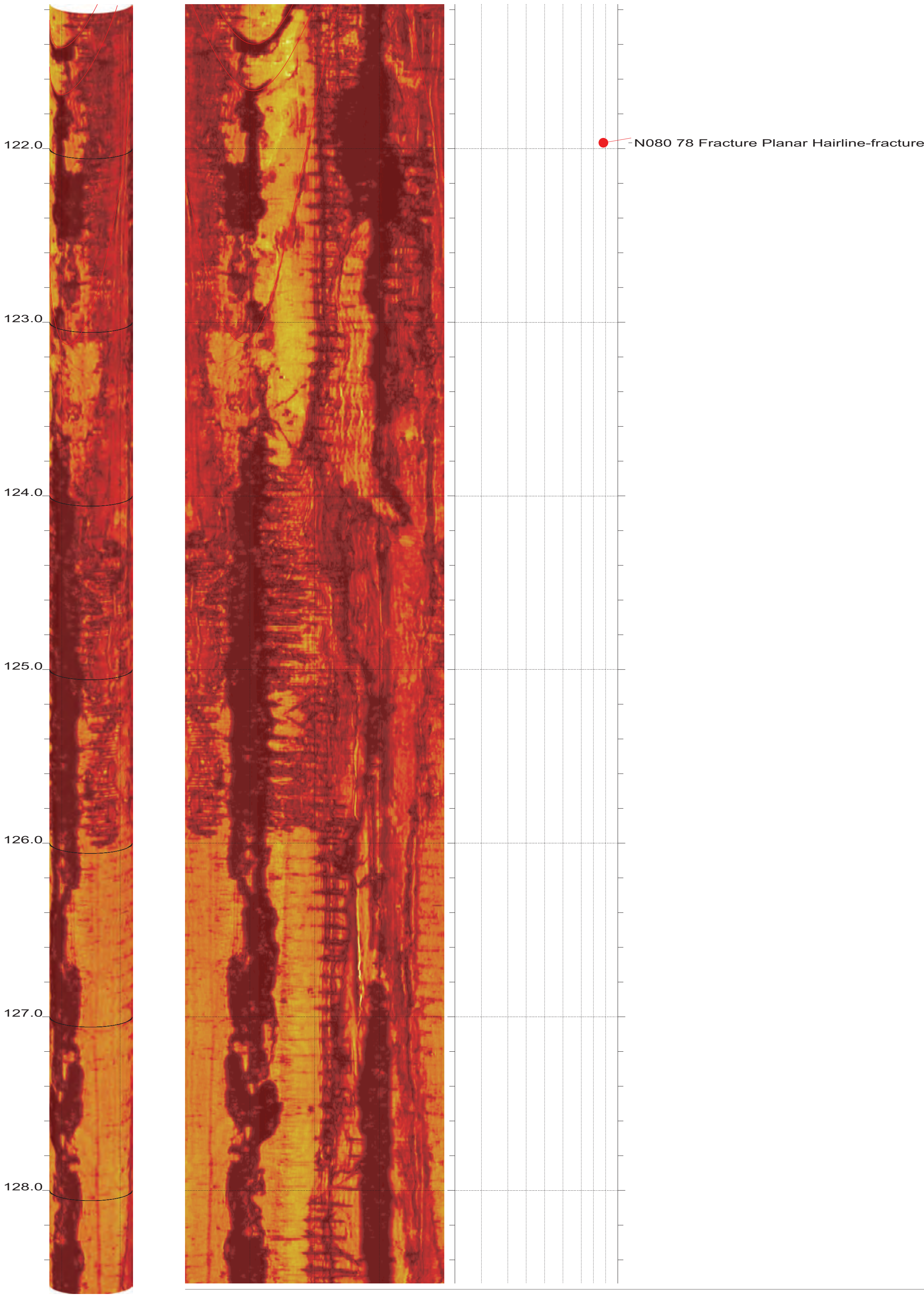


SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 15 of 37



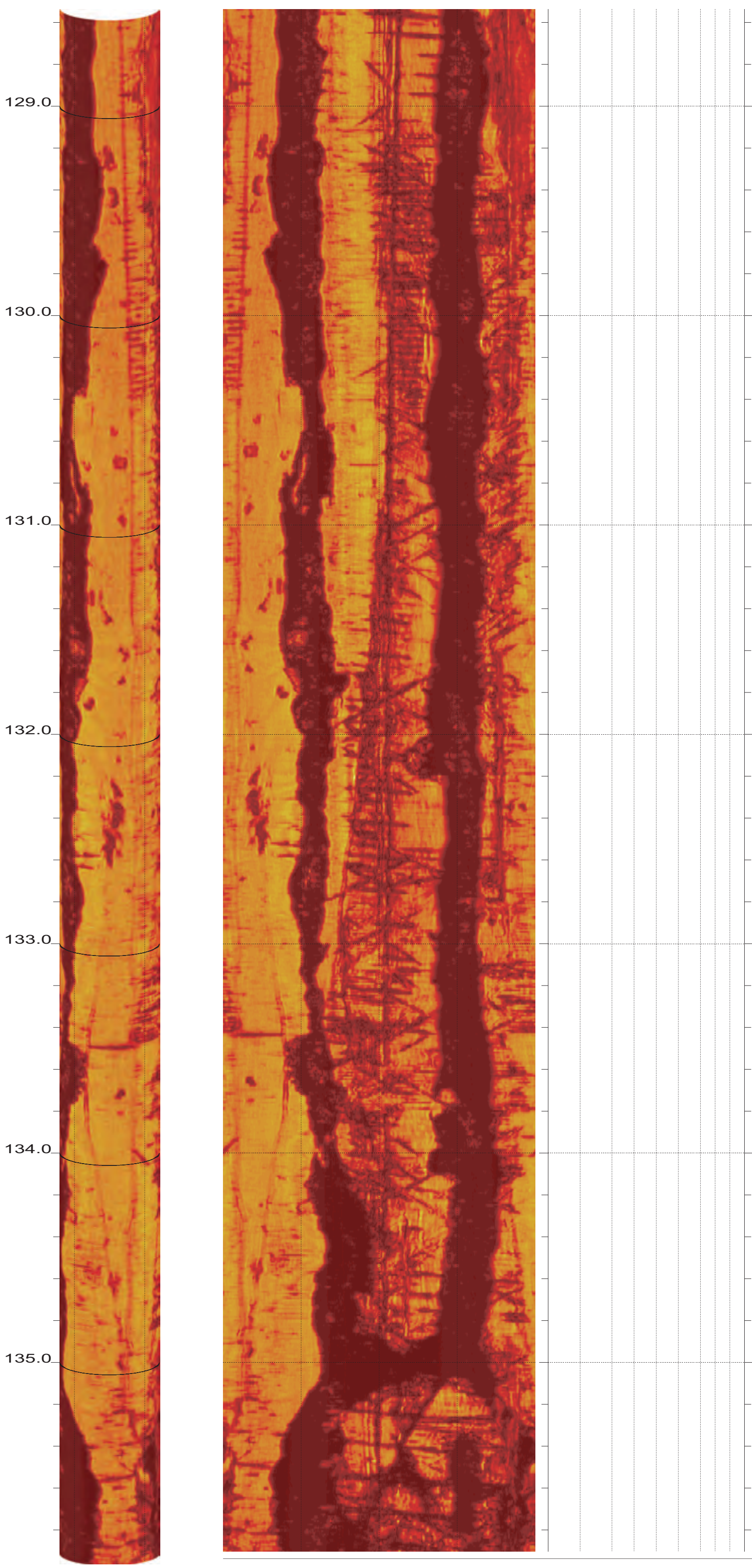
Z4-B4 121.168 to 113.800ft 16

SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 16 of 37



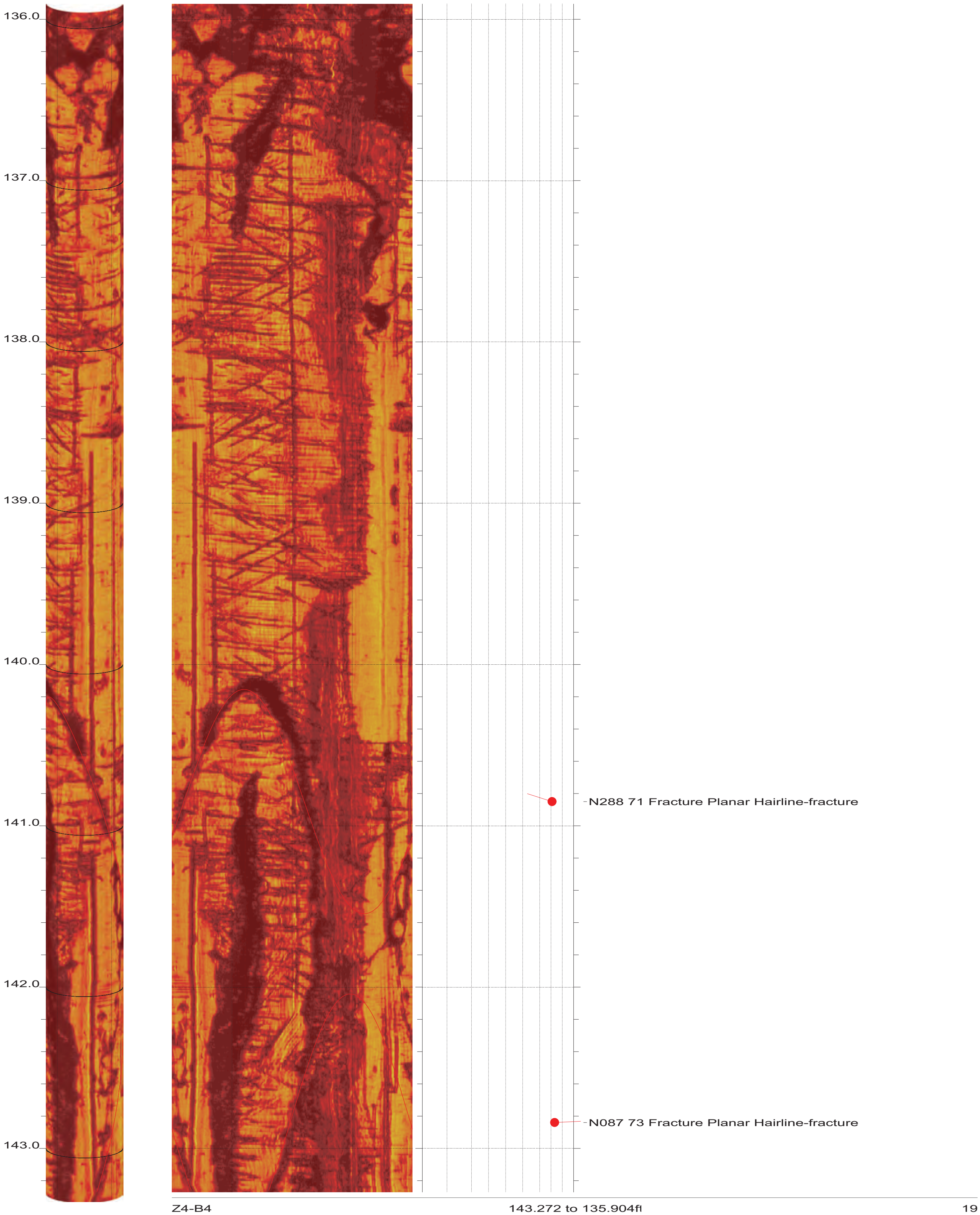
Z4-B4 128.536 to 121.168ft 17

SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 17 of 37

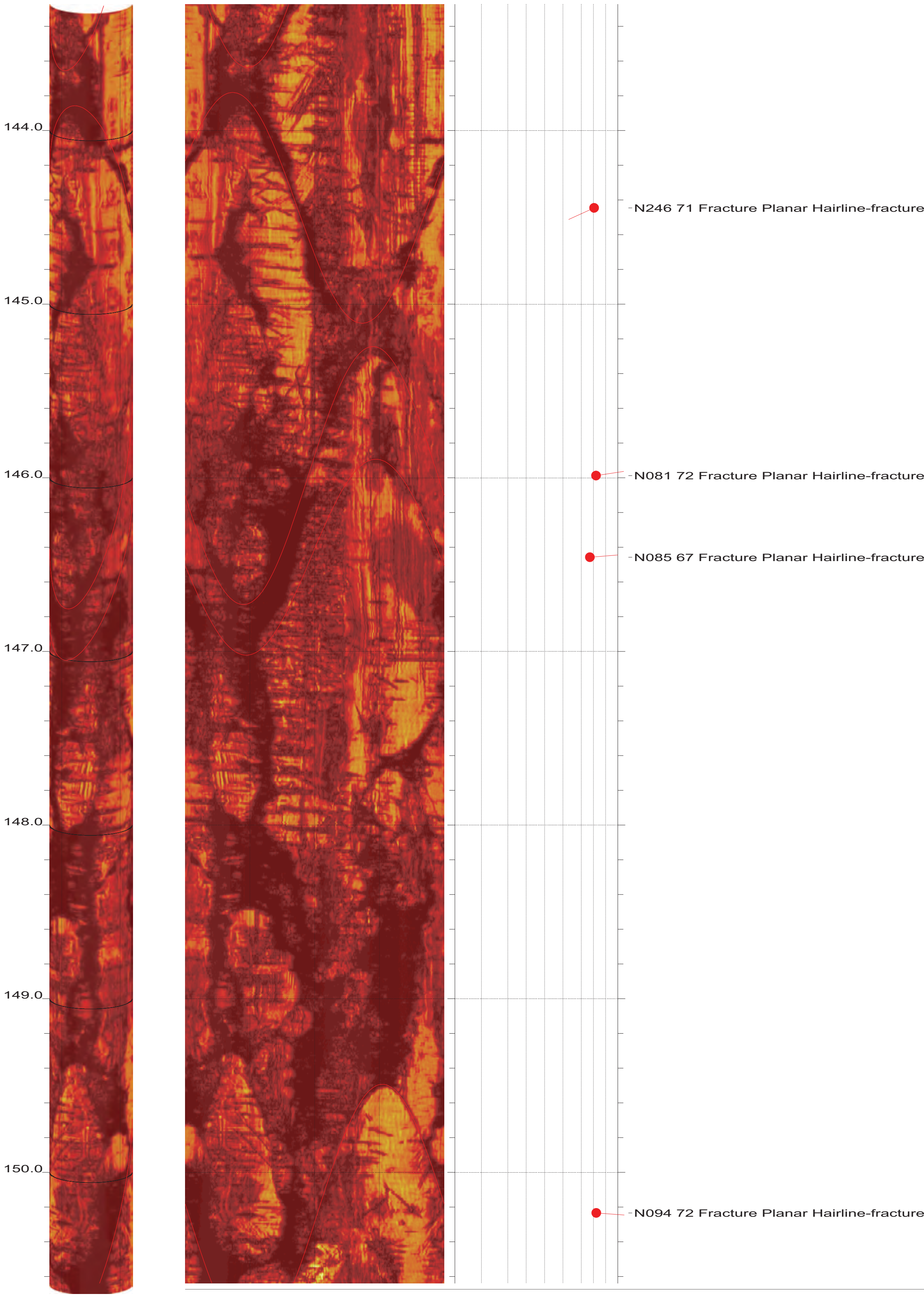


Z4-B4 135.904 to 128.536ft 18

SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 18 of 37

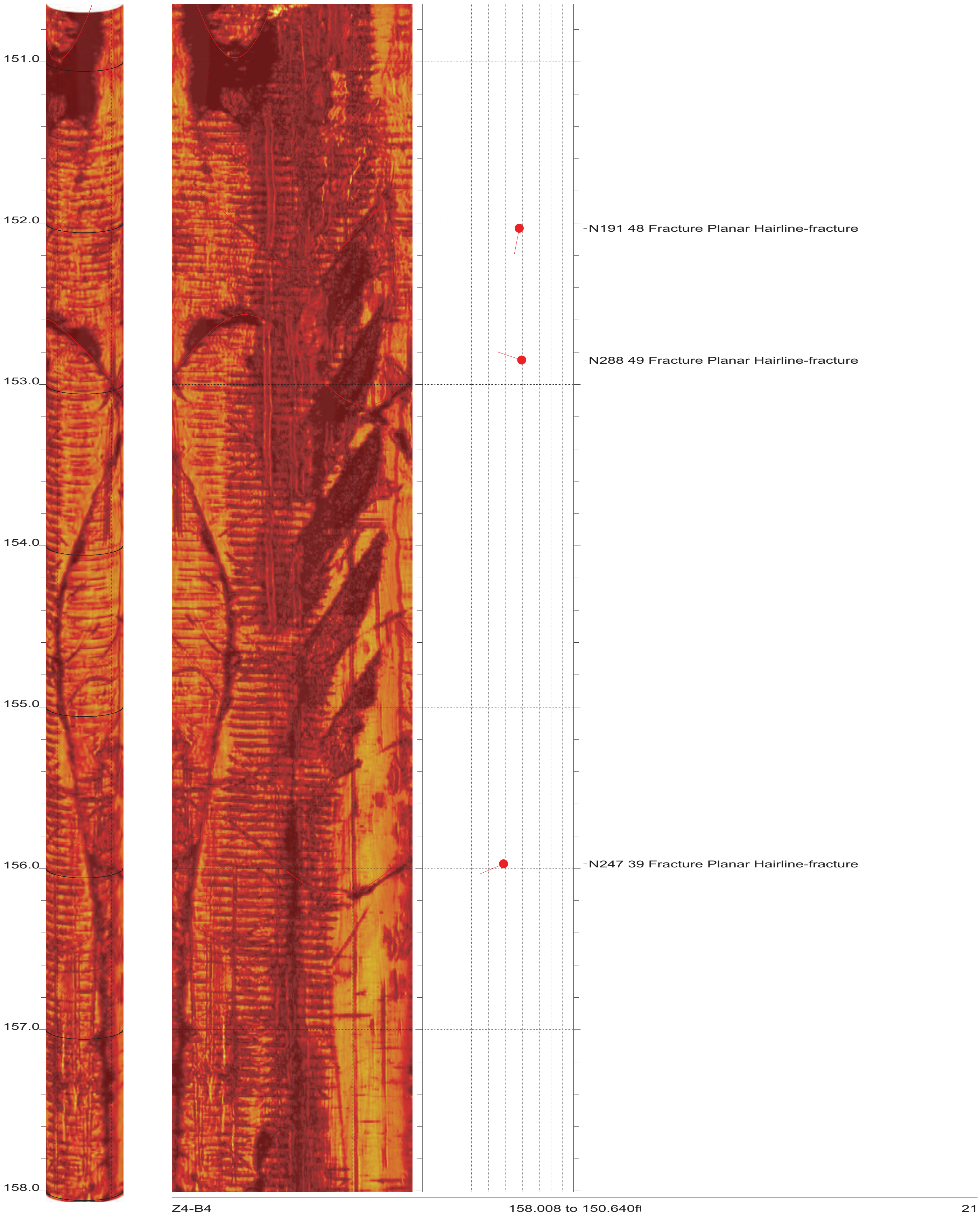


SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 19 of 37



Z4-B4 150.640 to 143.272ft 20

SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 20 of 37



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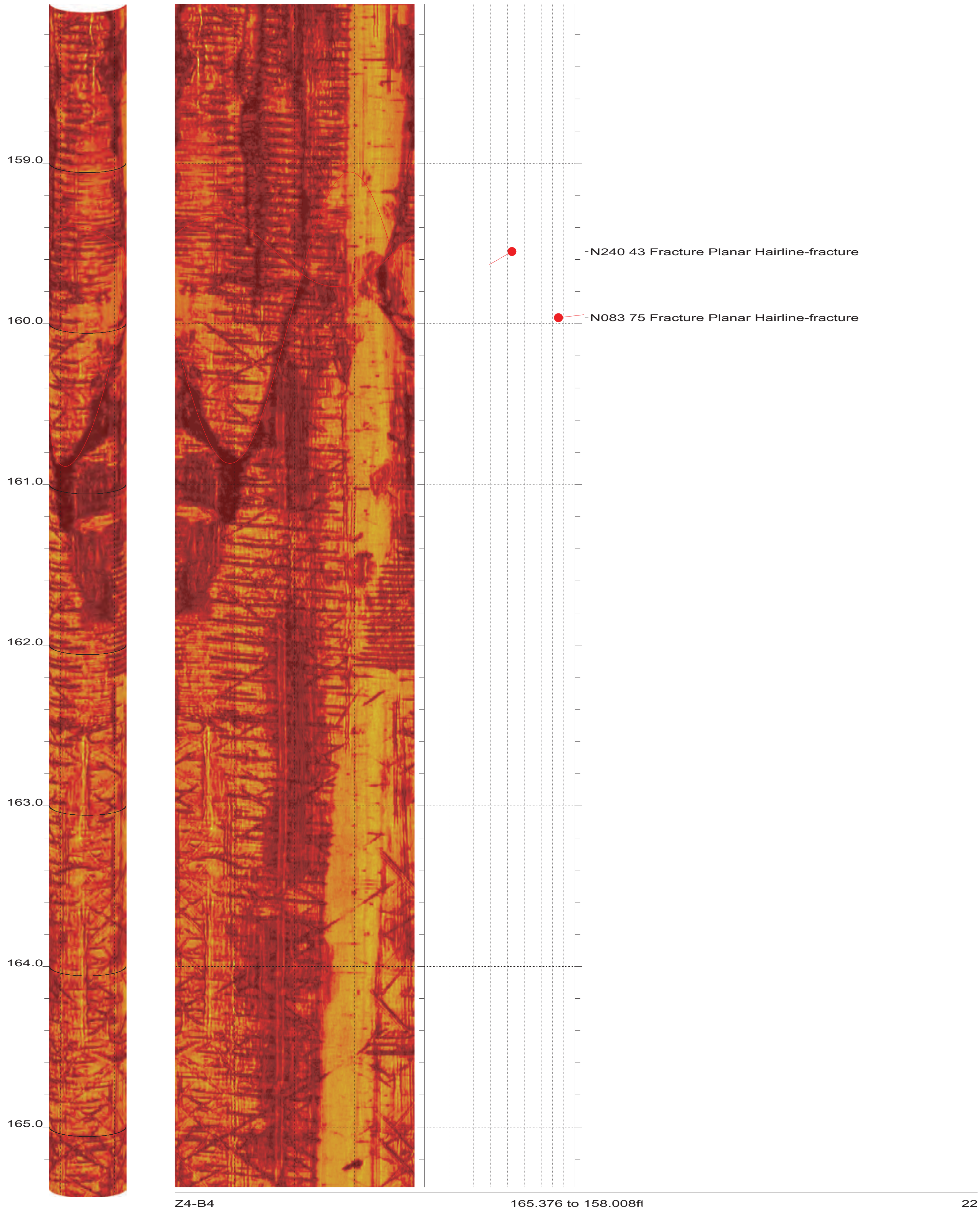
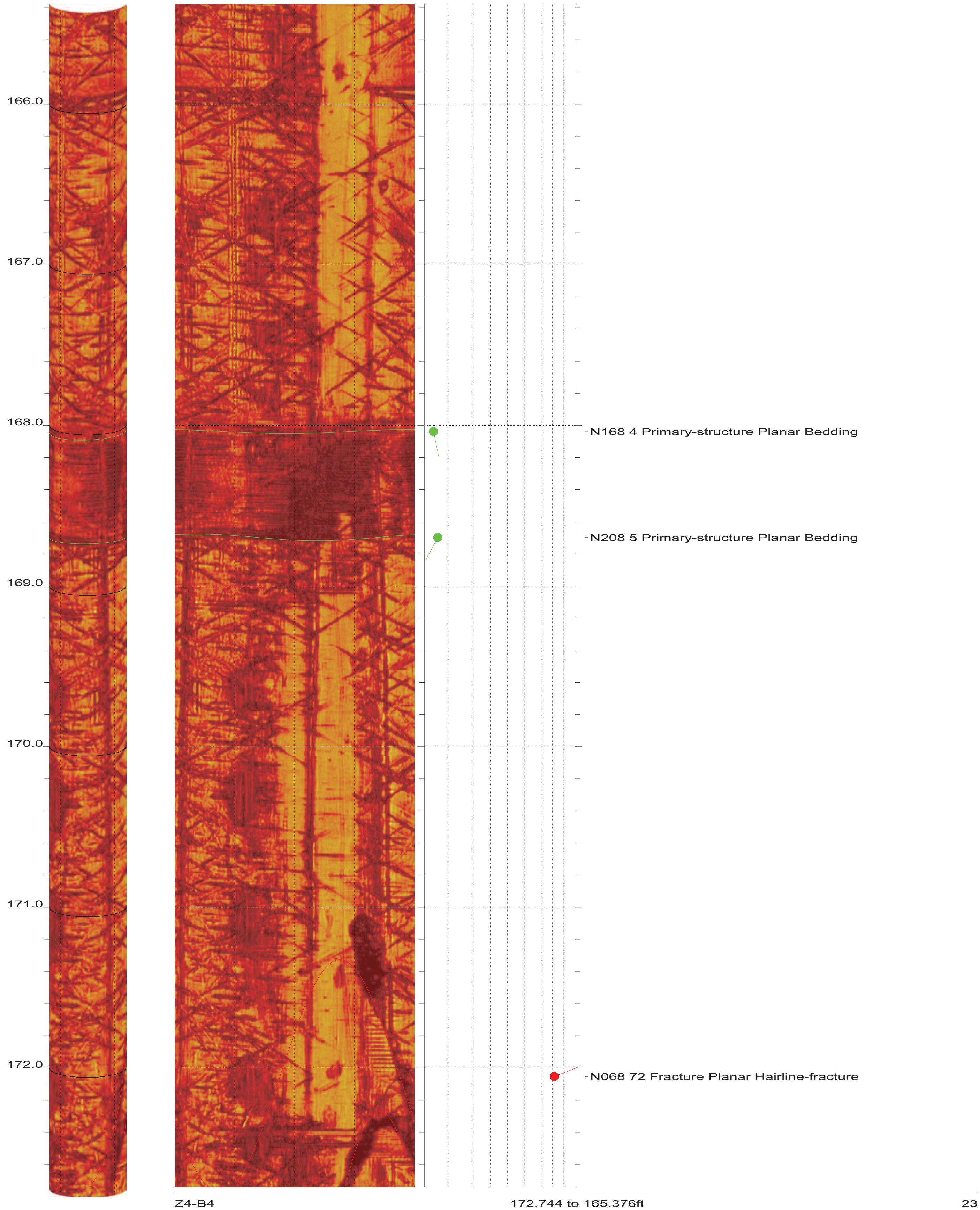
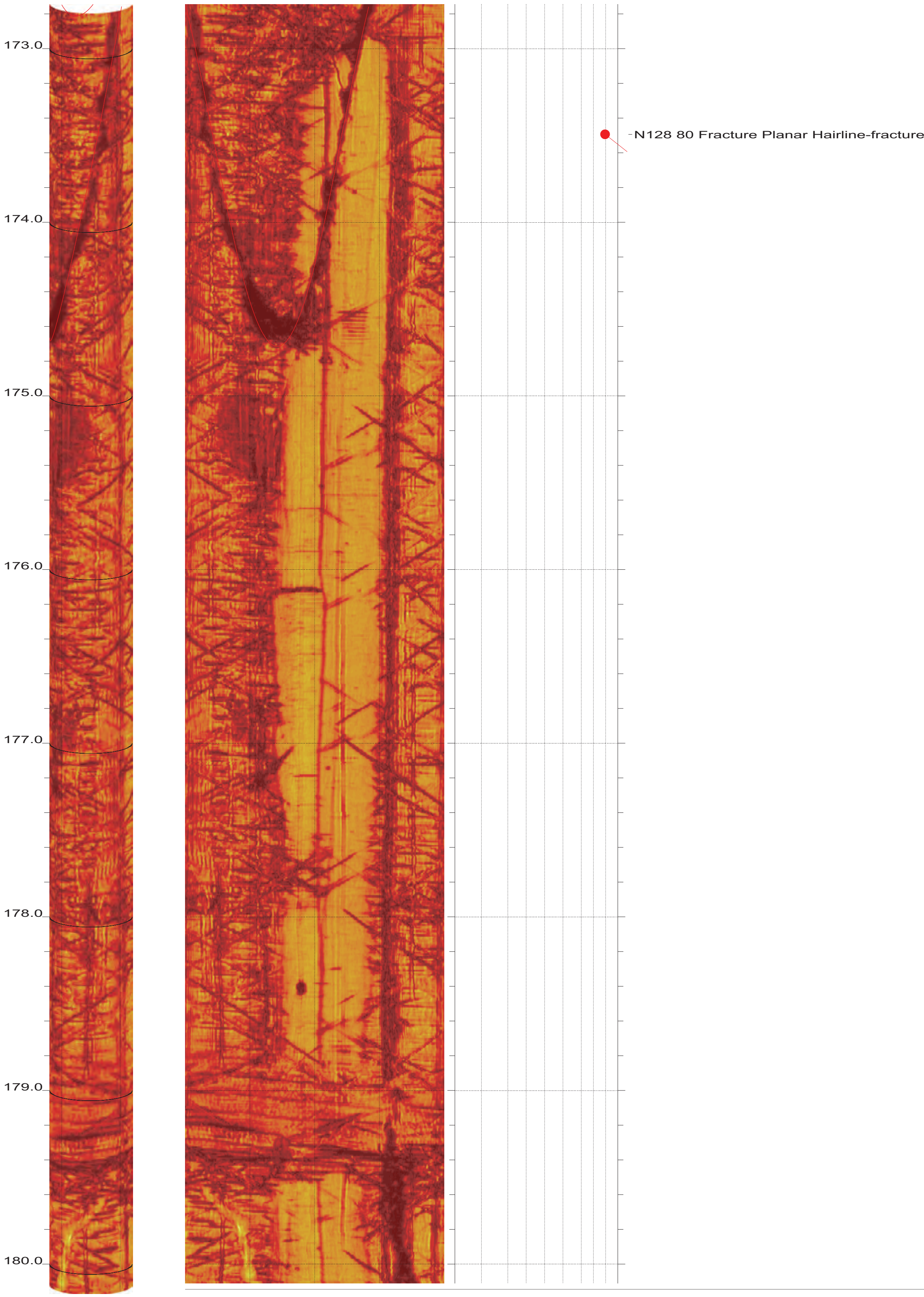


SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 22 of 37

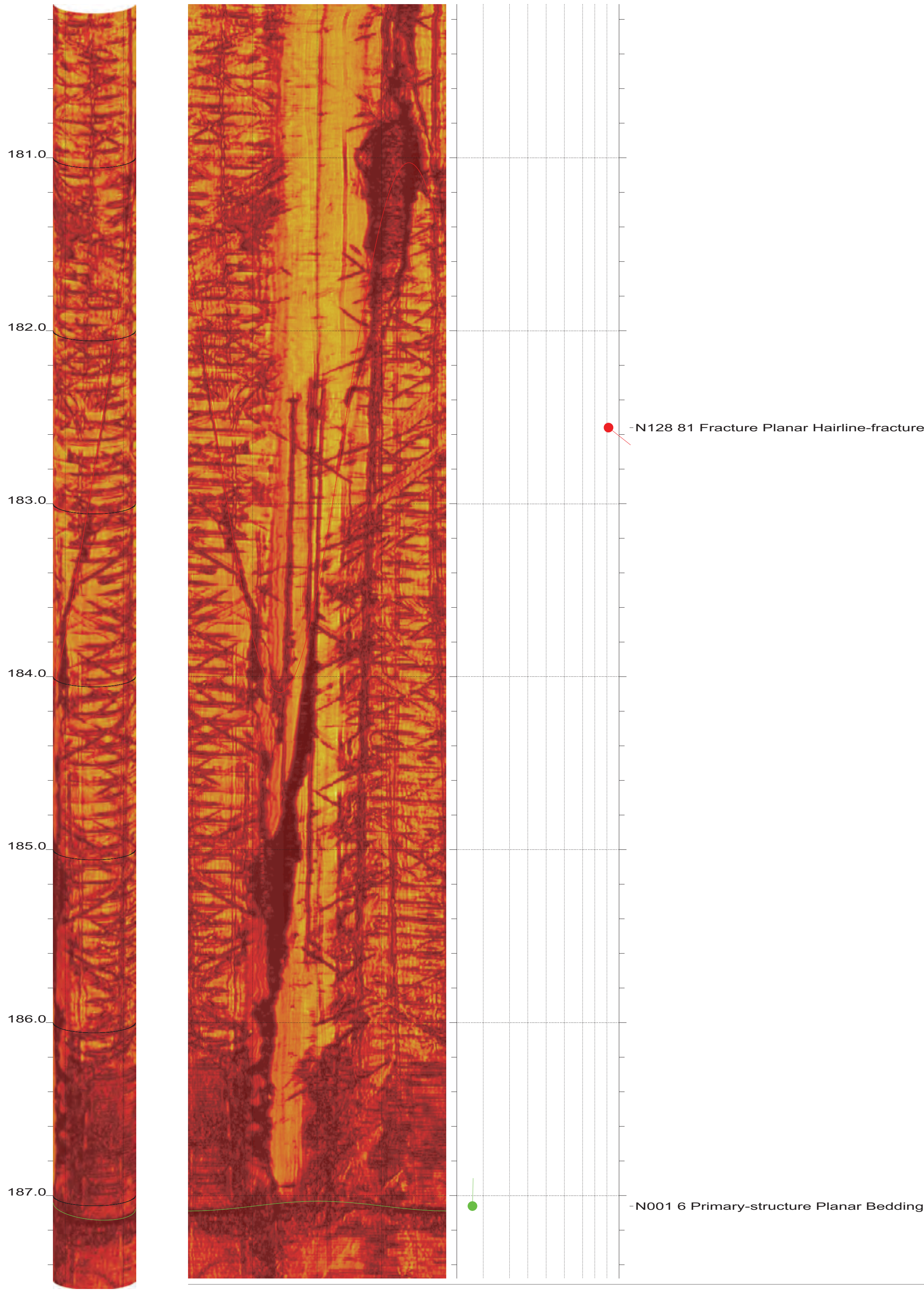


SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 23 of 37



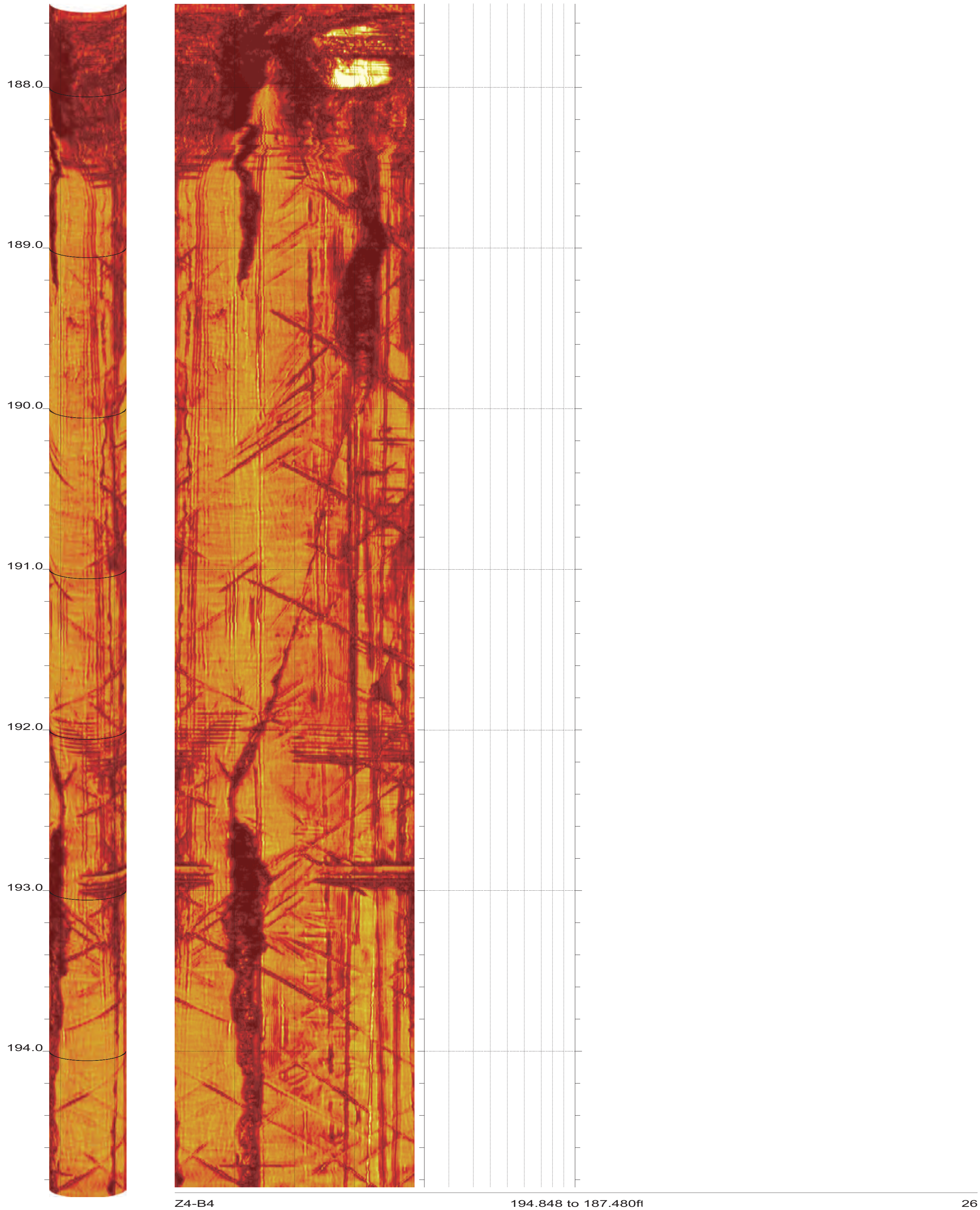
Z4-B4 180.112 to 172.744ft 24

SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 24 of 37

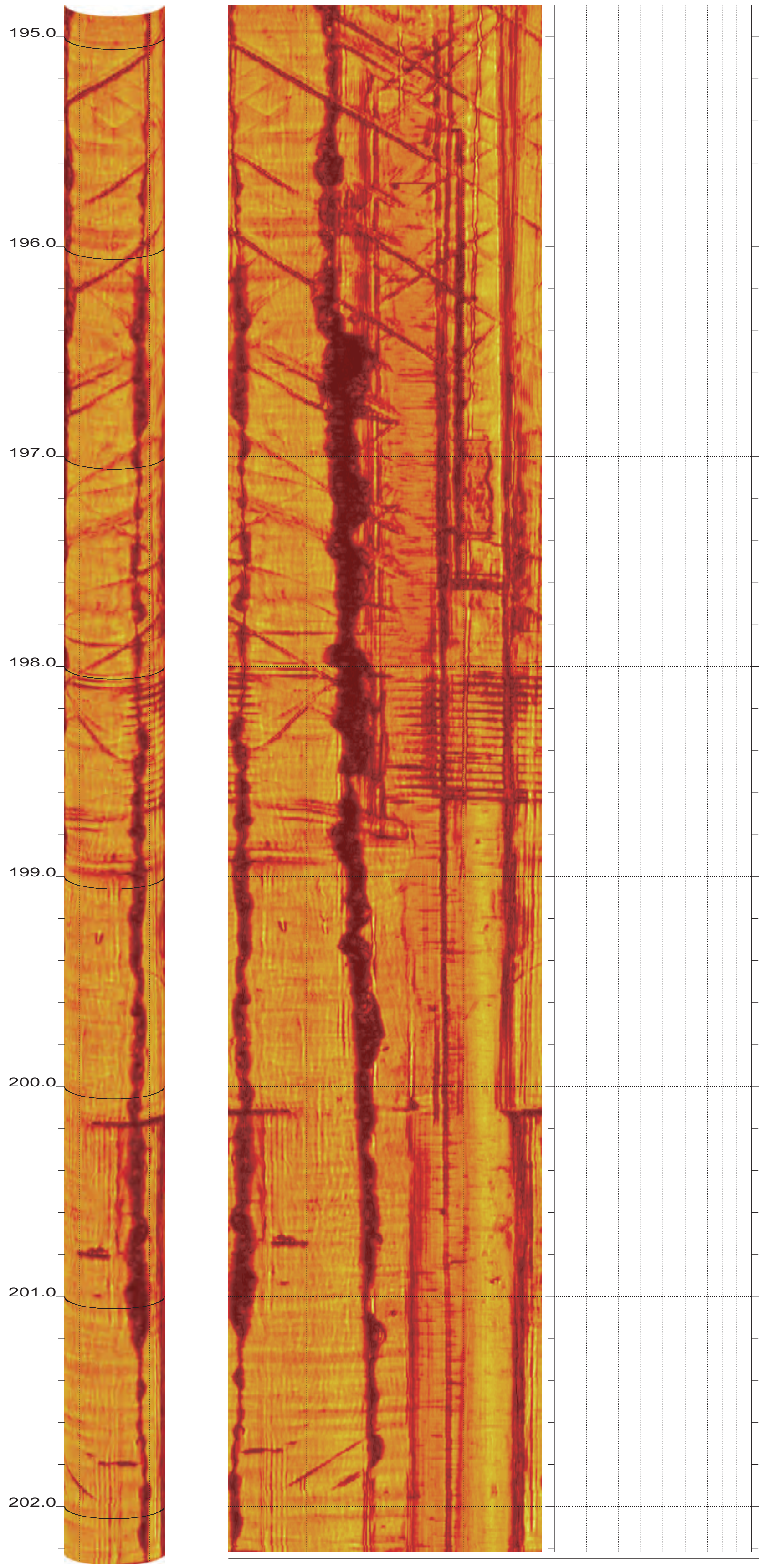


Z4-B4 187.480 to 180.112ft 25

SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 25 of 37

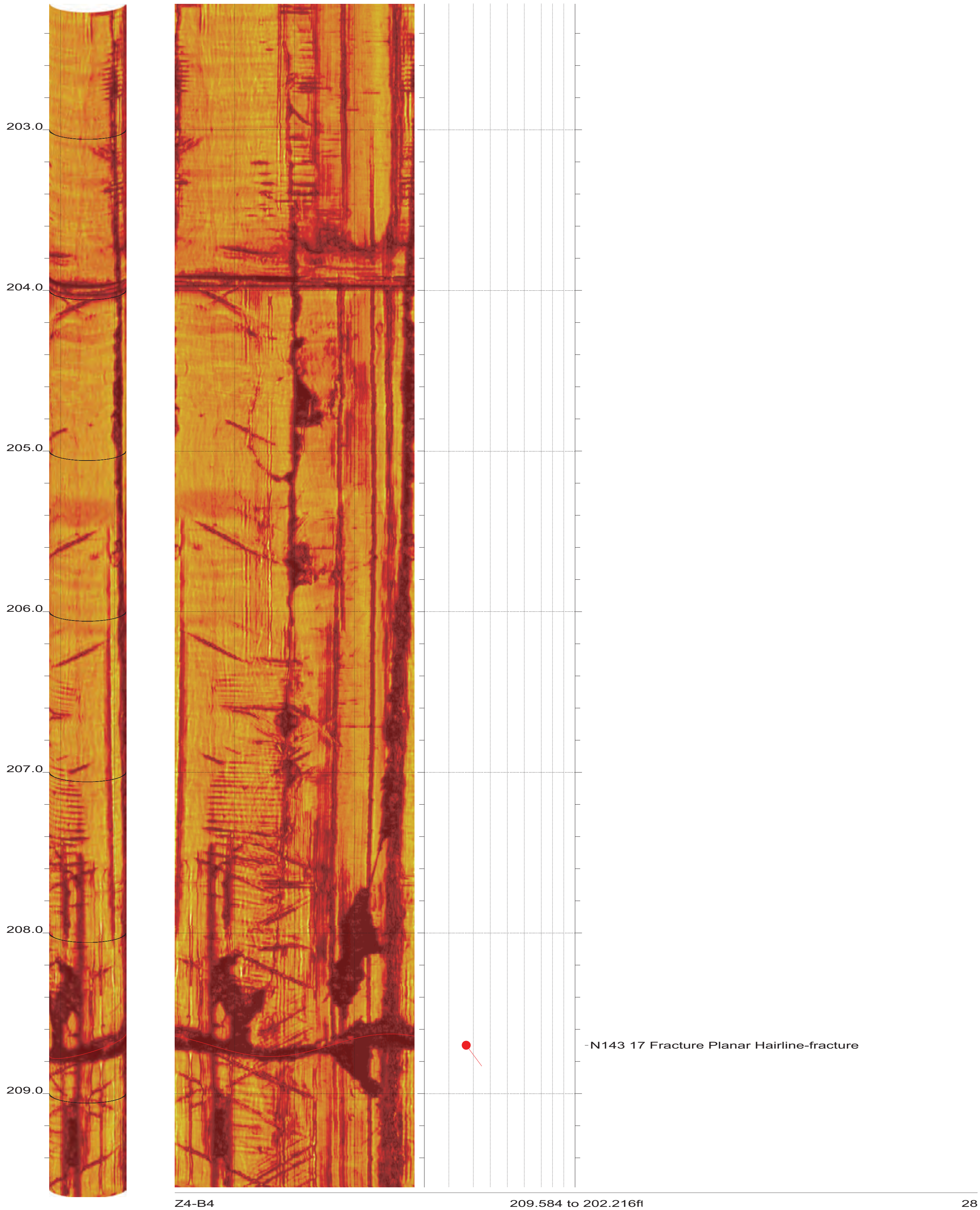


SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 26 of 37

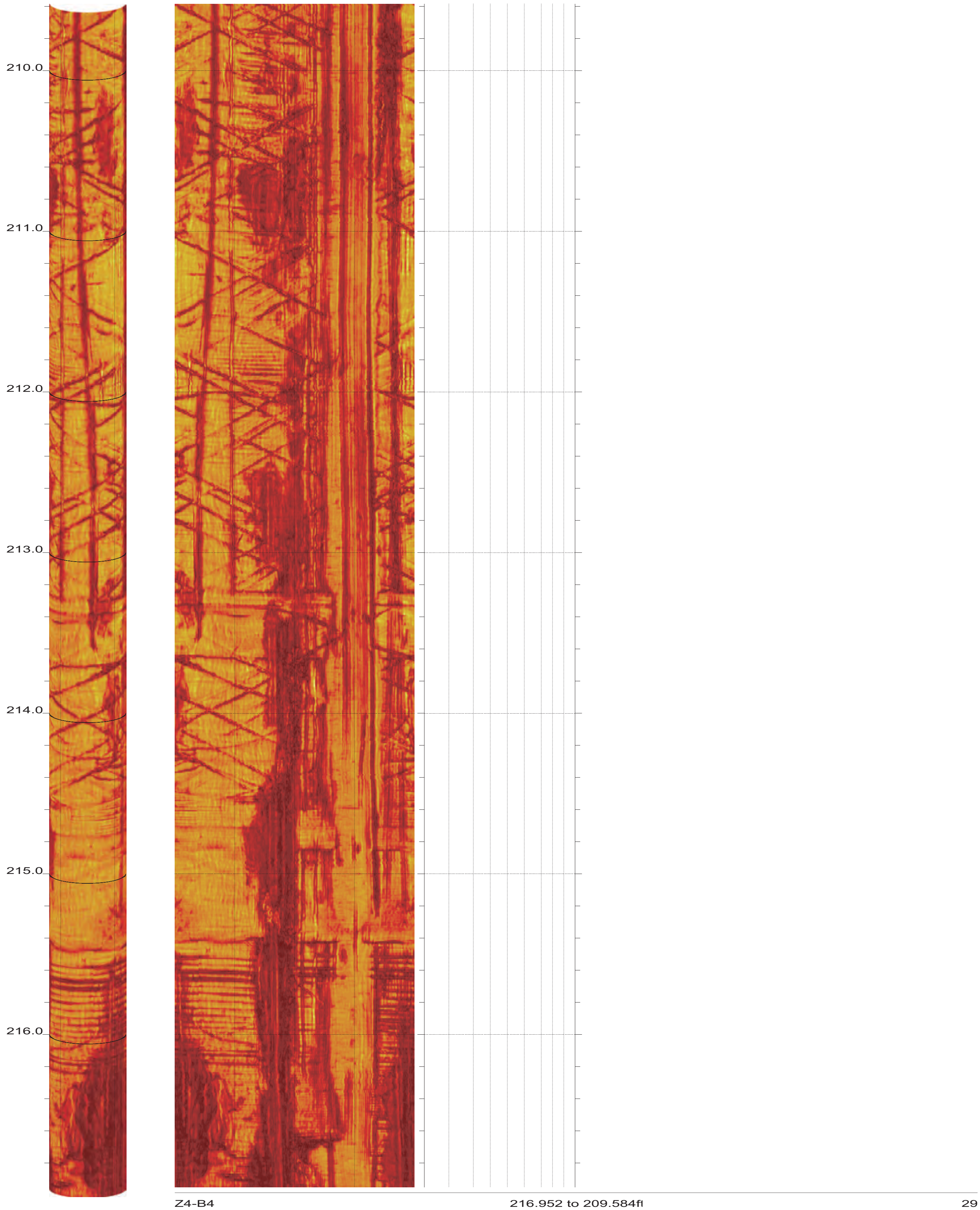


Z4-B4 202.216 to 194.848ft 27

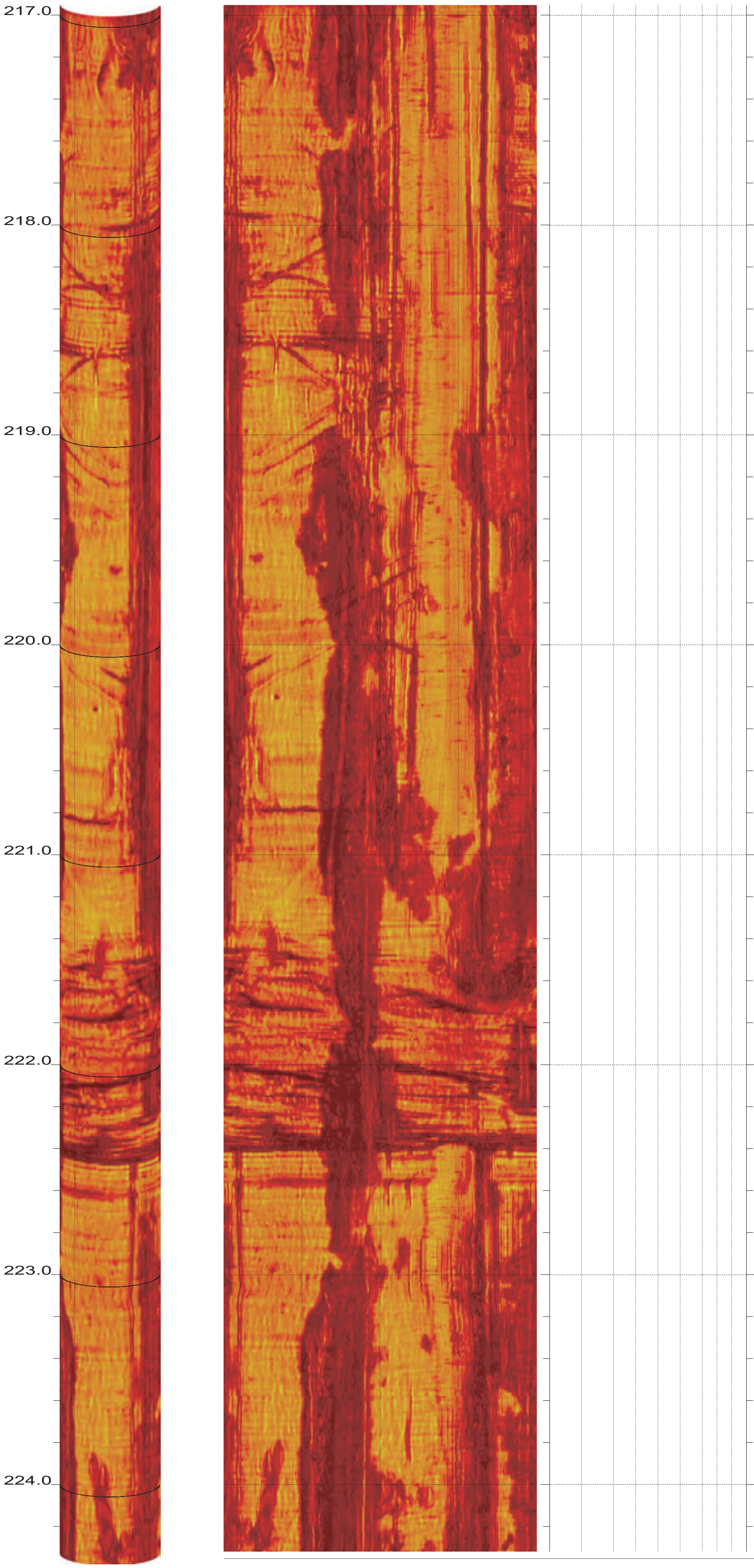
SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 27 of 37



SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 28 of 37

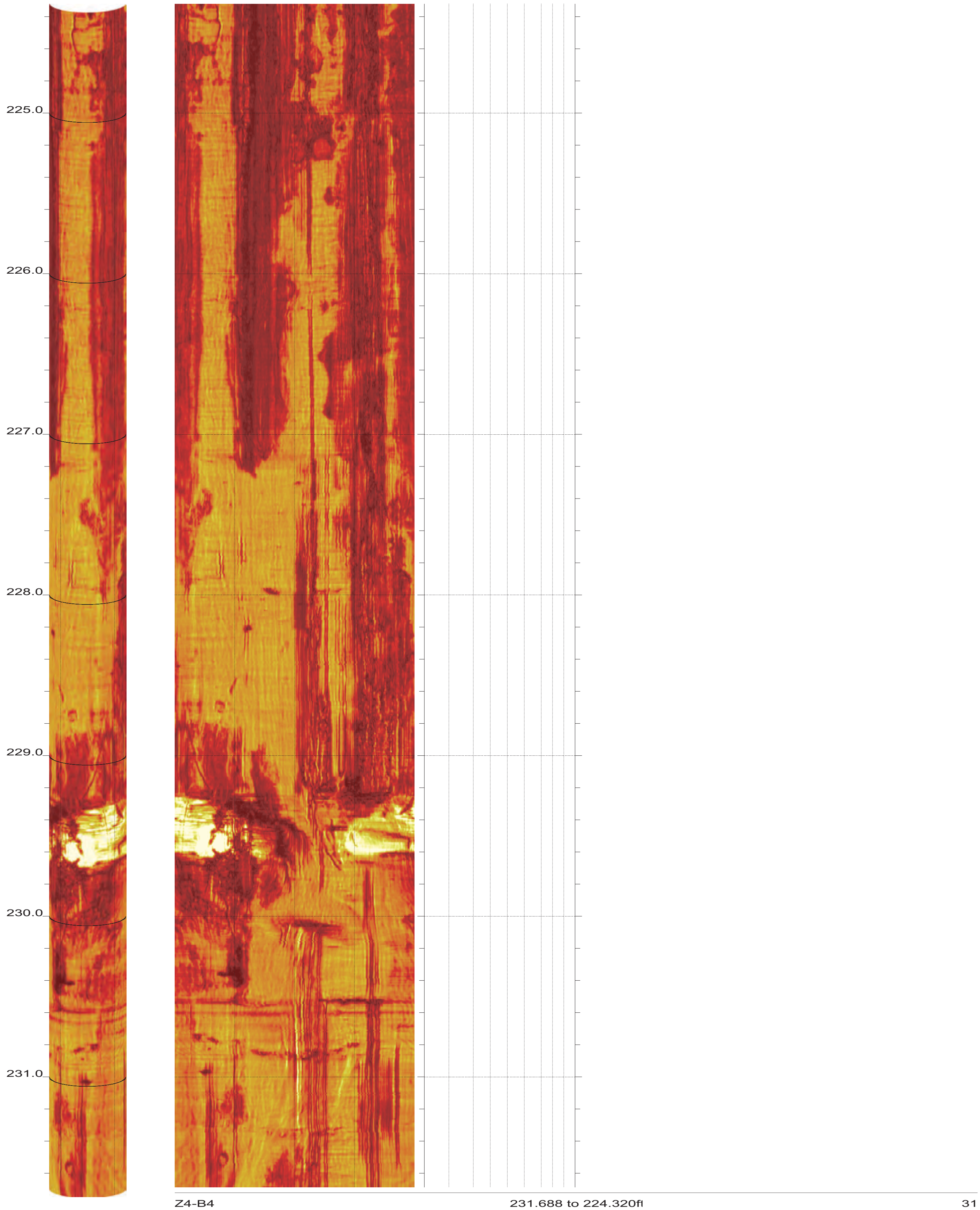


SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 29 of 37

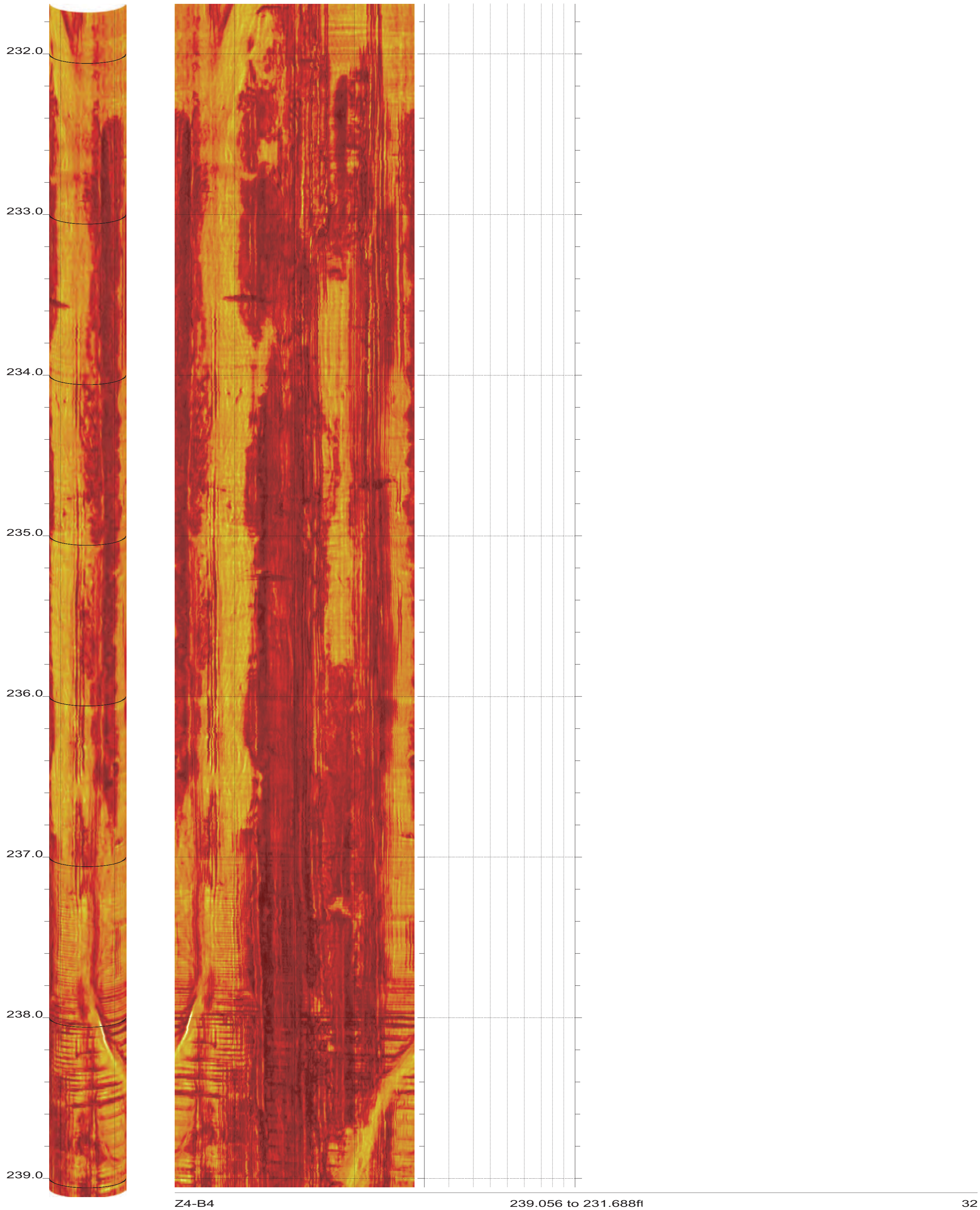


Z4-B4 224.320 to 216.952ft 30

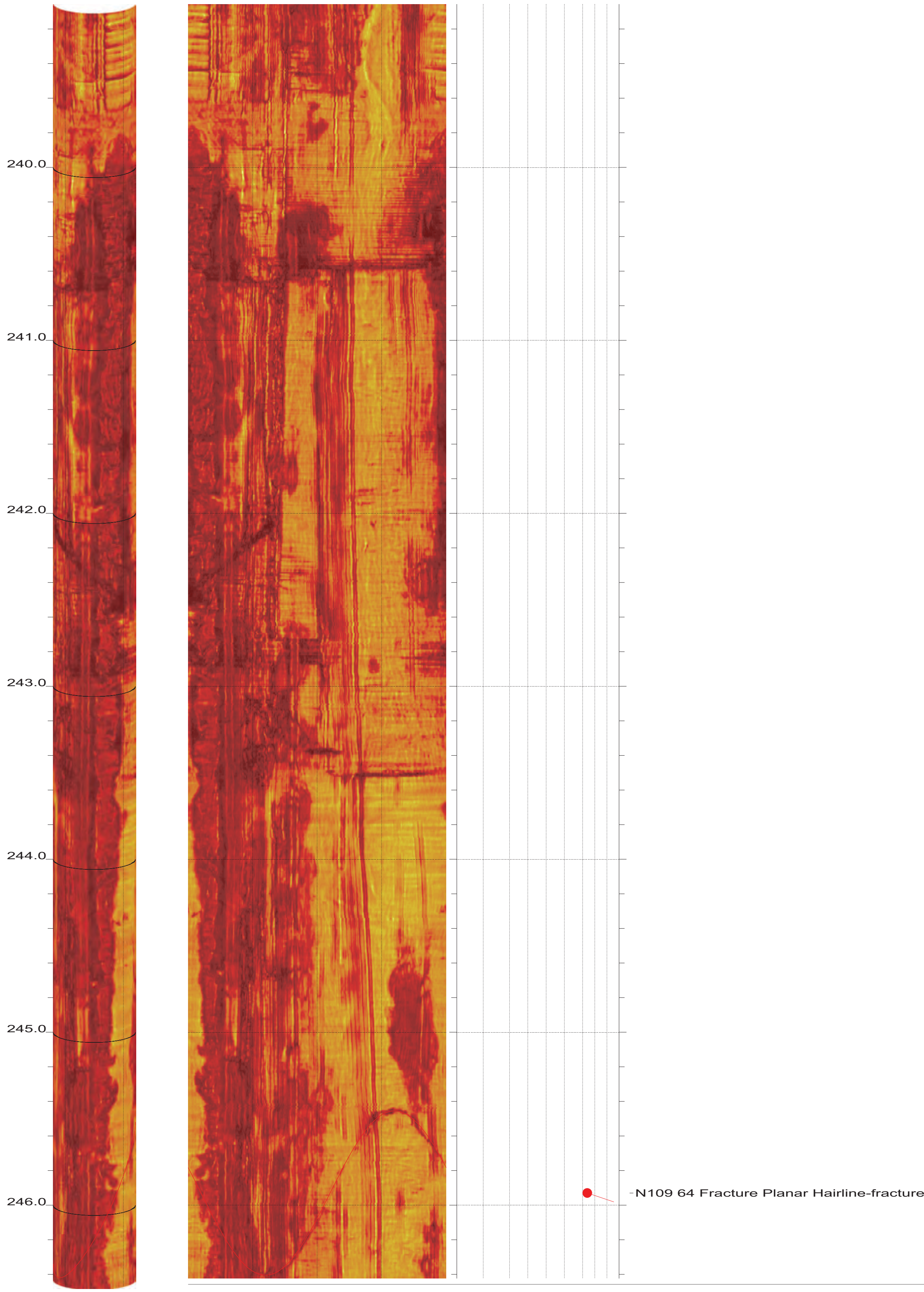
SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 30 of 37



SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 31 of 37

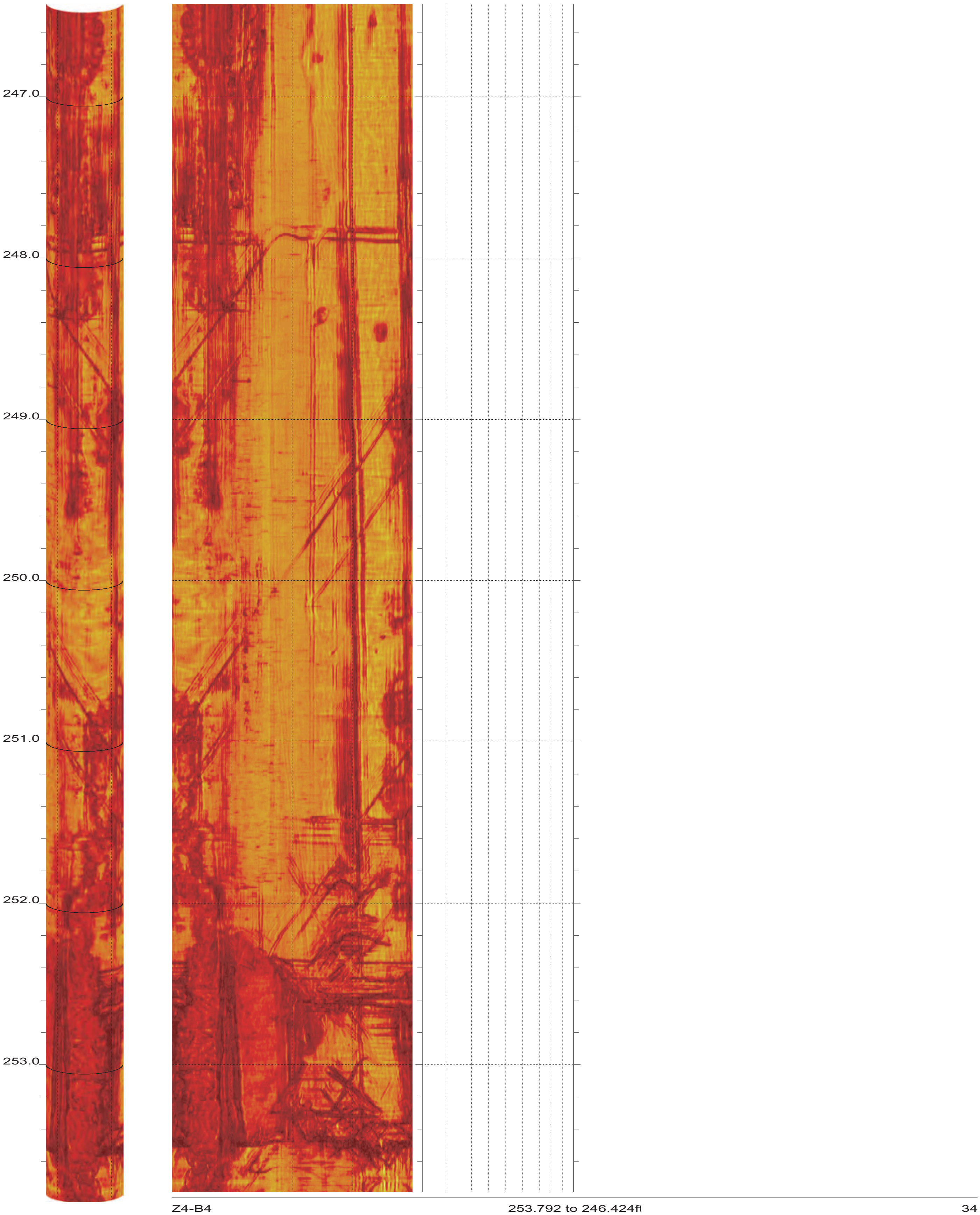


SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 32 of 37

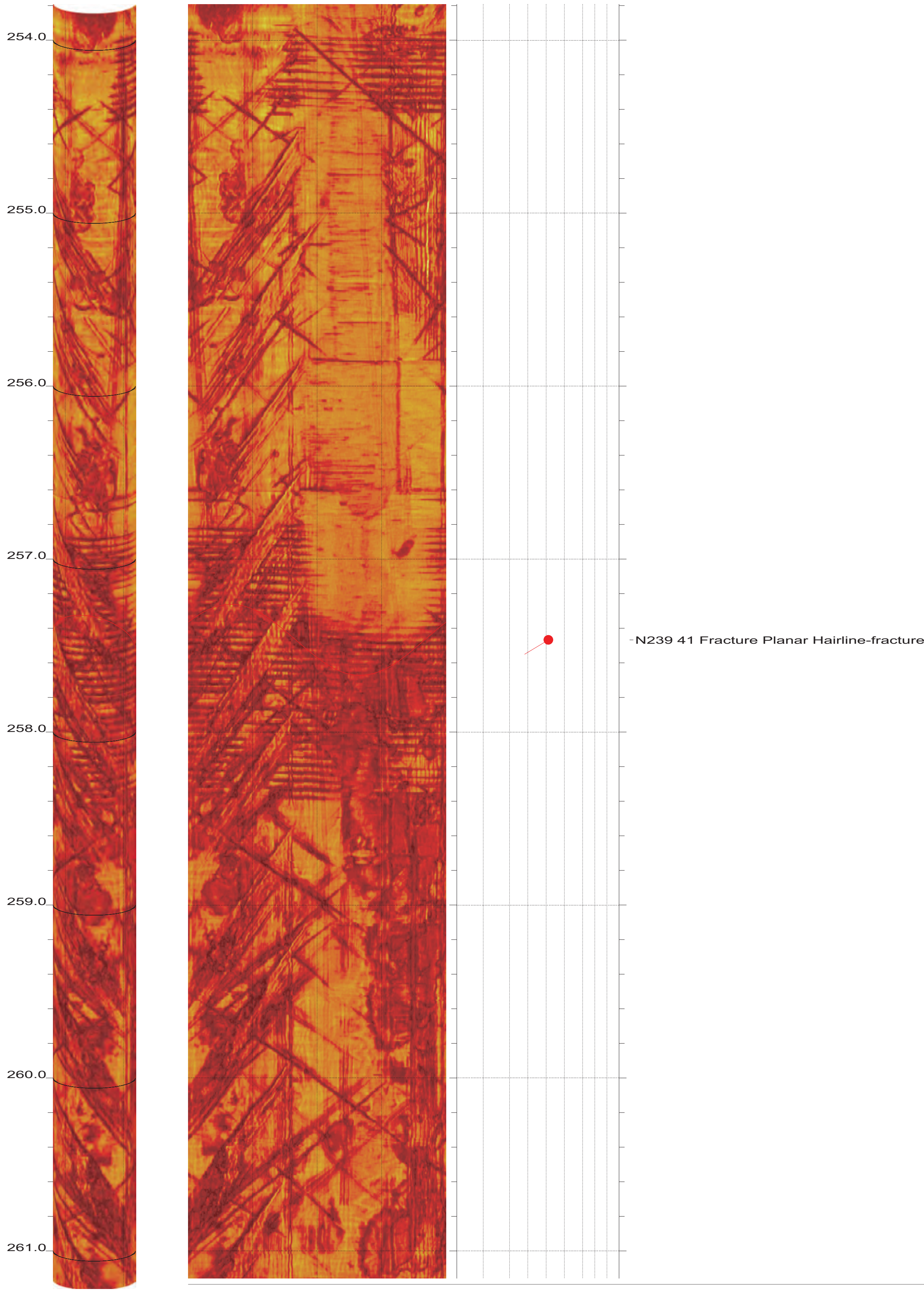


Z4-B4 246.424 to 239.056ft 33

SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 33 of 37

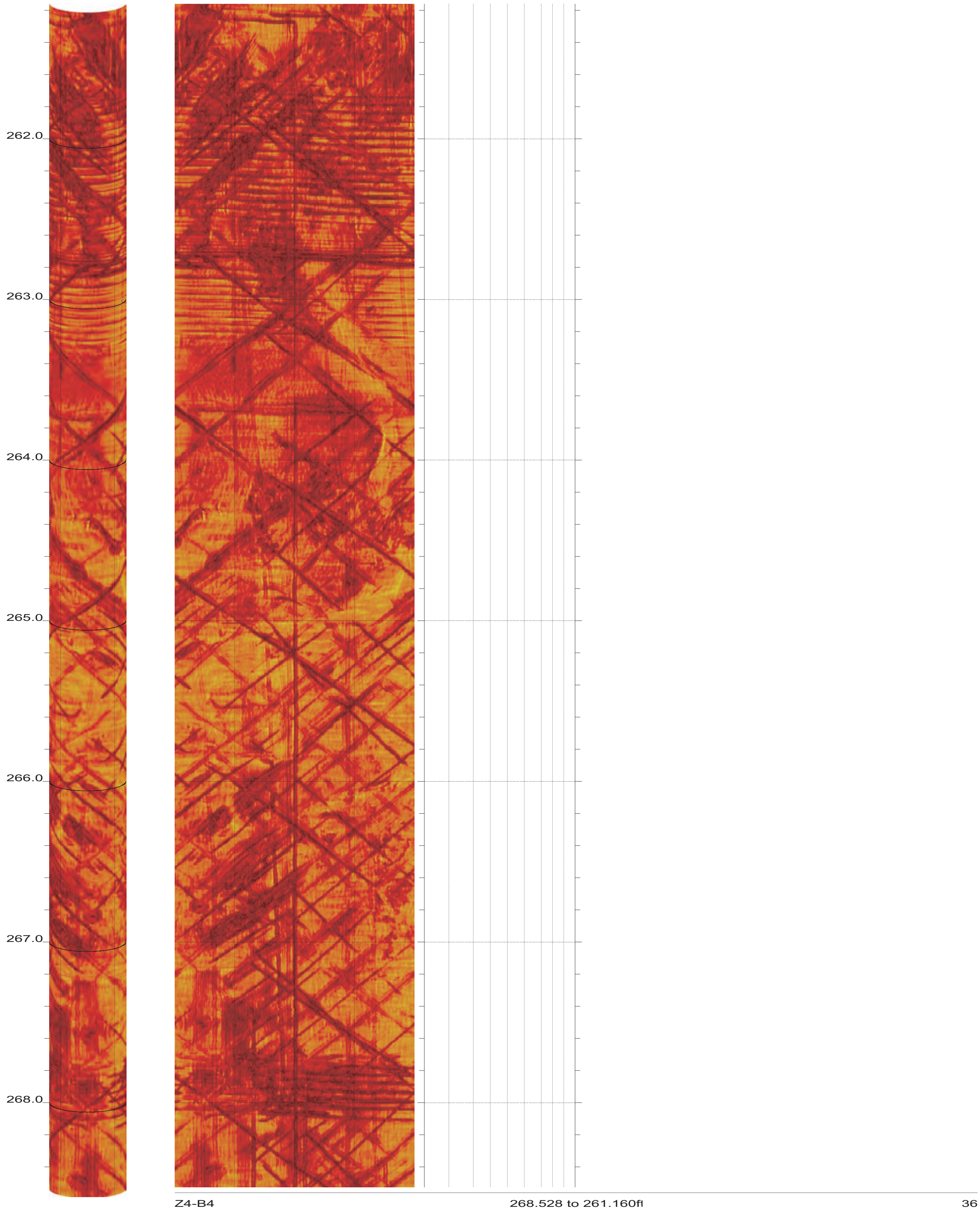


SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 34 of 37

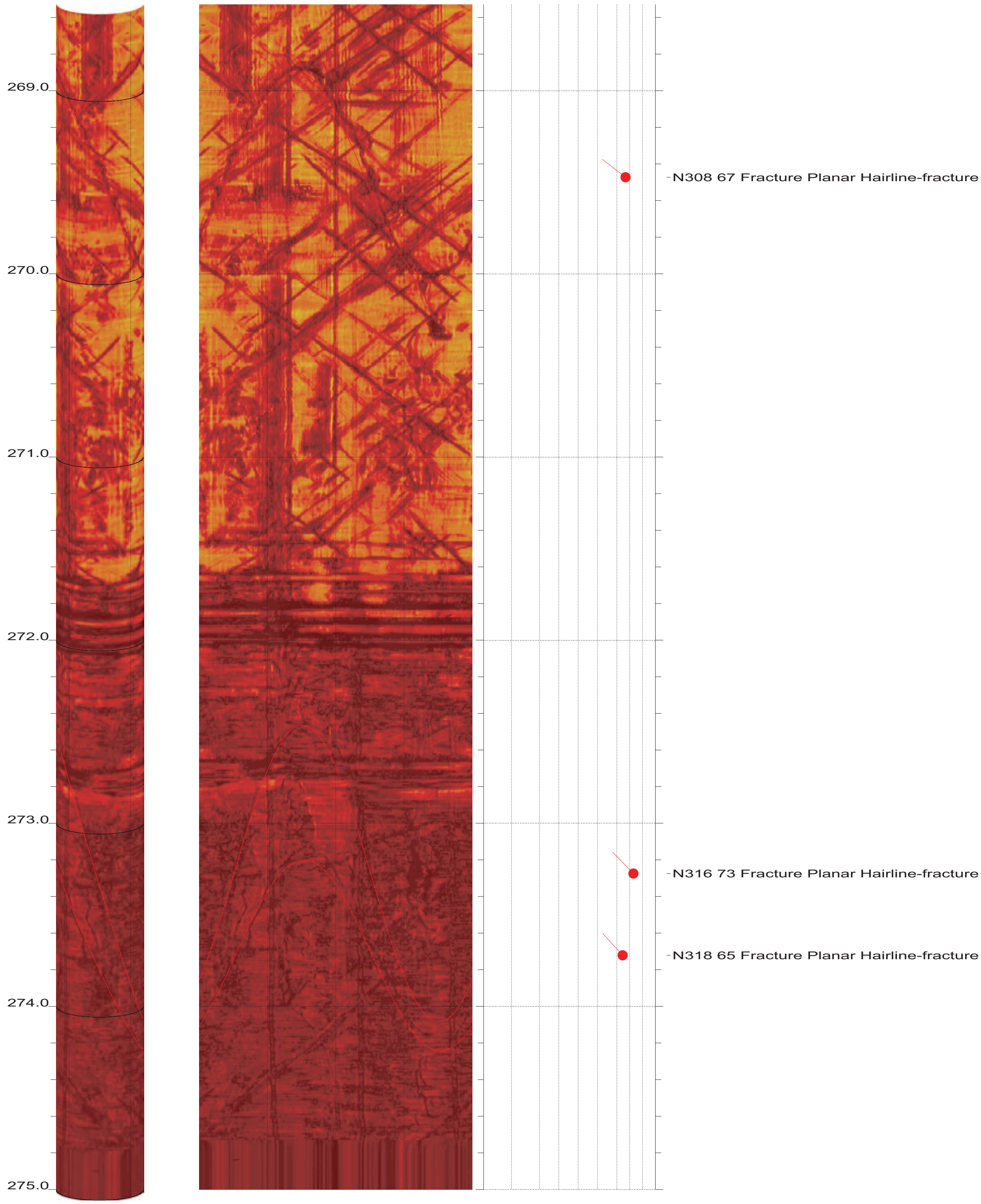


Z4-B4 261.160 to 253.792ft 35

SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 35 of 37



SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 36 of 37



Z4-B4 275.000 to 268.528ft 37

SR-710 Boring Z4-B4 Acoustic Televiewer Dips rev 1 Sheet 37 of 37

APPENDIX D

GEOPHYSICAL LOGGING SYSTEMS – NIST TRACEABLE CALIBRATION PROCEDURES AND CALIBRATION RECORDS

CALIBRATION PROCEDURE FOR

GEOVision SEISMIC RECORDER/LOGGER

Reviewed 4/6/06

Objective

The timing/sampling accuracy of seismic recorders or data loggers is required for several GEOVision field procedures including Seismic Refraction, Downhole Seismic Velocity Logging, and P-S Suspension Logging. This procedure describes the method for measuring the timing accuracy of a seismic data logger, such as the OYO Model 170, OYO/Robertson Model 3403, Geometrics Strataview or Geometrics Geode. The objective of this procedure is to verify that the timing accuracy of the recorder is accurate to within 1%.

Frequency of Calibration

The calibration of each GEOVision seismic data logger is twelve (12) months. In the case of rented seismic data loggers, calibration must be performed prior to use.

Test Equipment Required

The following equipment is required. Item #2 must have current NIST traceable calibration.

1. Function generator, Krohn Hite 5400B or equivalent
2. Frequency counter, HP 5315A or equivalent
3. Test cables, from item 1 to item 2, and from item 1 to subject data logger.

Procedure

This procedure is designed to be performed using the accompanying Seismograph Calibration Data Sheet with the same revision number. All data must be entered and the procedure signed by the technician performing the test.

1. Record all identification data on the form provided.
2. Connect function generator to data logger (such as OYO Model 170) using test cable
3. Connect the function generator to the frequency counter using test cable.

4. Set up generator to produce a 100.0 Hz, 0.25 volt (amplitude is approximate, modify as necessary to yield less than full scale waveforms on logger display) peak square wave or sine wave. Verify frequency using the counter and initial space on the data sheet.

5. Initialize data logger and record a data record of at least 0.1 second using a 100 microsecond or less sample period.

6. Measure the recorded square wave frequency by measuring the duration of 9 cycles of data. This measurement can be made using the data logger display device, or by printing out a paper tape. If a paper tape can be printed, the resulting printout must be attached to this procedure. Record the data in the space provided.

7. Repeat steps 5 and 6 three more times using separate files.

Criteria

The duration for 9 cycles in any file must be 90.0 milliseconds plus or minus 0.9 milliseconds, corresponding to an average frequency for the nine cycles of 100.0 Hz plus or minus 1 Hz (obtained by dividing 9 cycles by the duration in milliseconds).

If the results are outside this range, the data logger must be marked with a GEOVision REJECT tag until it can be repaired and retested.

If results are acceptable affix label indicating the initials of the person performing the calibration, the date of calibration, and the due date for the next calibration (12 months).

Procedure Approval

Approved by:

John G. Diehl	President
Name	Title
	April 6, 2006
Signature	Date

Client Approval (if required):

Name	Title
Signature	Date

GEOVision SUSPENSION PS SEISMIC LOGGER/RECORDER

CALIBRATION PROCEDURE

Reviewed 7/21/08

Objective

The timing/sampling accuracy of seismic recorders or data loggers is required for several GEOVision field procedures including Seismic Refraction, Downhole P-S Seismic Velocity Logging, and Suspension P-S Seismic Velocity Logging. This procedure describes the method for measuring the timing accuracy of a seismic data logger, such as the OYO Model 170 or OYO/Robertson Model 3403. The objective of this procedure is to verify that the timing accuracy of the recorder is accurate to within 1%.

Frequency of Calibration

The calibration of each GEOVision seismic data logger is twelve (12) months. In the case of rented seismic logger/recorders, calibration must be performed prior to use.

Test Equipment Required

The following equipment is required. Item #2 must have current NIST traceable calibration.

1. Function generator, Krohn Hite 5400B or equivalent
2. Frequency counter, HP 5315A or equivalent
3. Test cables, from item 1 to item 2, and from item 1 to subject data logger.

Procedure

This procedure is designed to be performed using the accompanying Suspension P-S Seismic Logger/Recorder Calibration Data Form with the same revision number. All data must be entered and the procedure signed by the technician performing the test.

1. Record all identification data on the form provided.
2. Connect function generator to data logger (such as OYO Model 170) using test cable
3. Connect the function generator to the frequency counter using test cable.
4. Set signal generator to target frequency specified on data form, 0.25 volt (amplitude is approximate, modify as necessary to yield less than full scale waveforms on

logger display) peak sine wave. Verify frequency using the counter and note actual frequency on the data form.

5. Set data logger to file length specified on data form and record a data file to disk. Note file name on data form.

6. Measure the duration of 9 complete sine wave cycles on the data file. This measurement must be made using the analysis program PSLOG.EXE version 1.00, and saved as a .sps pick file. Note the duration in milliseconds in the spaces provided on the data form. Calculate average recorded sine wave frequency for each channel pair (Hn, Hr, V) by dividing the duration by 9. Note the average frequency of each channel pair on the data form.

7. Repeat steps 4 through 6 until all target frequencies have been recorded, producing 6 separate data and pick files.

Criteria

The average frequency for the nine cycles (obtained by dividing 9 cycles by the duration in seconds) must be within plus or minus 1% of the actual frequency for each of the 6 records.

If the results are outside this range, the data logger must be marked with a GEOVision REJECT tag until it can be repaired and retested.

If results are acceptable affix label indicating the initials of the person performing the calibration, the date of calibration, and the due date for the next calibration (12 months).

Procedure Approval

Approved by:

John G. Diehl	President
Name	Title
	July 21, 2008
Signature	Date

Calibration Laboratory Approval (if required):

Name	Title
Signature	Date

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Metrology
7300 Fenwick Lane
Westminster, CA 92683
Phone: 866-723-2257

Calibration Report

NVLAP Accredited
Calibration

GEOVision Geophysical Services
1124 Olympic Drive
Corona, CA 92881-3390

TEST NUMBER
558549

NVLAP
Lab Code:105014-0

Manufacturer: Oyo
Model Number: 3403
Description: Unit, Suspension Telemetry,
Asset Number: 160024
Serial Number: 160024
PO Number: 8200-080122-01

Condition As Found: In Tolerance
Condition As Left: In Tolerance
Calibration Date: 08/01/2008
Calibration Due Date: 08/01/2009
Calibration Interval: 12 Months

Remarks:

This unit was calibrated with the customer's old procedure and specifications which have been reviewed by Metrology Engineering and documented in SCE Document M013684. The data can be found on page 2 of this report with the original observation data on page 3. The unit was then calibrated with the customer's new procedure and specification's which have been reviewed by Metrology Engineering and documented in SCE Document M013987. The data can be found on pages 4 and 5 of this report with the original observation data on page 6 of this report. Corrected Copy: This record created to add missing maximum error calculations on page 6 of 6. CAB 8-5-08

Standards Utilized

I.D. No.	Mfg.	Model No.	Description	Cal. Date	Due Date
S1-01252	Hewlett Packard	5335A OPT 010,203040	Counter, Universal,	07/17/2008	01/17/2009
S1-01347	Hewlett Packard	3325A	Generator, Function, Synthesizer	04/24/2008	10/24/2008
S1-03686	Fluke	910	Standard, Frequency, Controlled, Gps	01/22/2008	01/22/2009

Procedure: Customer
Temperature: 23° C
Humidity: 52% RH
Test No.: 558549

Calibration Performed By:			Quality Reviewer:	
Branson, Craig A CAB	Metrologist	714-895-0714		8-5-08
Name	Title	Phone	Name	Date

Test No. 558549
Asset No. 160024

Custom Specification Report

Oyo 3403 Unit, Suspension Telemetry,

STEP NUM	FUNCTION TESTED	NOMINAL VALUE	AS FOUND	AS LEFT	Out of Tol	CALIBRATION TOLERANCE
	CH HN Frequency Square Wave	100.0 Hz	100.0	Same		99.0 to 101.0 Hz [EMU 0.000500 Hz]
	|	100.0 Hz	100.0	Same		99.0 to 101.0 Hz [EMU 0.000500 Hz]
	Sine Wave	100.0 Hz	100.0	Same		99.0 to 101.0 Hz [EMU 0.000500 Hz]
	|	100.0 Hz	100.0	Same		99.0 to 101.0 Hz [EMU 0.000500 Hz]
	CH HR Frequency Square Wave	100.0 Hz	100.0	Same		99.0 to 101.0 Hz [EMU 0.000500 Hz]
	|	100.0 Hz	100.0	Same		99.0 to 101.0 Hz [EMU 0.000500 Hz]
	Sine Wave	100.0 Hz	100.0	Same		99.0 to 101.0 Hz [EMU 0.000500 Hz]
	|	100.0 Hz	100.0	Same		99.0 to 101.0 Hz [EMU 0.000500 Hz]
	CH V Frequency Square Wave	100.0 Hz	100.0	Same		99.0 to 101.0 Hz [EMU 0.000500 Hz]
	|	100.0 Hz	100.0	Same		99.0 to 101.0 Hz [EMU 0.000500 Hz]
	Sine Wave	100.0 Hz	100.0	Same		99.0 to 101.0 Hz [EMU 0.000500 Hz]
	|	100.0 Hz	100.0	Same		99.0 to 101.0 Hz [EMU 0.000500 Hz]

Remarks:

GEOVision geophysical services PAGE 3 OF 6

SEISMOGRAPH CALIBRATION DATA SHEET REV 4/6/06

INSTRUMENT DATA

SYSTEM MFR:	OYO	MODEL NO.:	3403
SERIAL NO.:	160024	CALIBRATION DATE:	8/1/2008
BY:	CRAIG BRANSON	DUE DATE:	8/1/2009
COUNTER MFR:	HEWLETT PACKARD	MODEL NO.:	5335A
SERIAL NO.:	2626A09881	CALIBRATION DATE:	7/17/2008
BY:	SCE #S1-01252	DUE DATE:	1/17/2009
FCTN GEN MFR:	HEWLETT PACKARD	MODEL NO.:	3325A
SERIAL NO.:	2652A25647	CALIBRATION DATE:	4/24/2008
BY:	SCE #S1-01347	DUE DATE:	10/24/2008

SYSTEM SETTINGS:

GAIN:	2
FILTER:	10 KHZ
RANGE:	100 MILLISEC
DELAY:	0
STACK: 1 (STD)	1
PULSE:	1.6
DISPLAY:	NA
SYSTEM: DATE = CORRECT DATE & TIME	8/1/2008 715

PROCEDURE:
SET FREQUENCY TO 100.0HZ SQUAREWAVE WITH AMPLITUDE APPROXIMATELY 0.25 VOLT PEAK. RECORD BOTH ON DISK AND PAPER TAPE, IF AVAILABLE. ANALYZE AND PRINT WAVEFORMS FROM ANALYSIS UTILITY. ATTACH PAPER COPIES OF PRINTOUT AND PAPER TAPES, IF AVAILABLE, TO THIS FORM. AVERAGE FREQUENCY MUST BE BETWEEN 99.0 AND 101.0 HZ.

AS FOUND 100.0 HZ AS LEFT 100.0 HZ

WAVEFORM	FILE NO	FREQUENCY	TIME FOR 9 CYCLES Hn	TIME FOR 9 CYCLES Hr	TIME FOR 9 CYCLES V	AVERAGE FREQ.
SQUARE	501	100.0	90.00 ms	90.00 ms	90.00 ms	100.0 HZ
SQUARE	502	100.0	90.00 ms	90.00 ms	90.00 ms	100.0 HZ
SINE	503	100.0	90.00 ms	90.00 ms	90.00 ms	100.0 HZ
SINE	504	100.0	90.00 ms	90.00 ms	90.00 ms	100.0 HZ

CALIBRATED BY: CRAIG BRANSON (NAME) 8/1/2008 (DATE) Craig Branson (SIGNATURE)

Seismic recorder/Logger Calibration Data Sheet Rev 1.30 4-6-06

Custom Specification Report

Oyo 3403 Logger/Recorder, Seismic, PS Suspension

STEP NUM	FUNCTION TESTED	NOMINAL VALUE	AS FOUND	AS LEFT	Out of Tol	CALIBRATION TOLERANCE
	CH HN Frequency Sine Wave	50.00 Hz	50.00	Same		49.50 to 50.50 Hz [EMU 0.000250]
	|	100.0 Hz	100.0	Same		99.0 to 101.0 Hz [EMU 0.000500]
	|	200.0 Hz	200.0	Same		198.0 to 202.0 Hz [EMU 0.001000]
	|	500.0 Hz	500.0	Same		495.0 to 505.0 Hz [EMU 0.002500]
	|	1000 Hz	1000	Same		990 to 1010 Hz [EMU 0.005000]
	|	2000 Hz	2000	Same		1980 to 2020 Hz [EMU 0.010000]
	CH HR Frequency Sine Wave	50.00 Hz	49.95	Same		49.50 to 50.50 Hz [EMU 0.000250]
	|	100.0 Hz	100.0	Same		99.0 to 101.0 Hz [EMU 0.000500]
	|	200.0 Hz	200.2	Same		198.0 to 202.0 Hz [EMU 0.001000]
	|	500.0 Hz	500.0	Same		495.0 to 505.0 Hz [EMU 0.002500]
	|	1000 Hz	1001	Same		990 to 1010 Hz [EMU 0.005000]
	|	2000 Hz	2000	Same		1980 to 2020 Hz [EMU 0.010000]
	CH V Frequency Sine Wave	50.00 Hz	50.00	Same		49.50 to 50.50 Hz [EMU 0.000250]
	|	100.0 Hz	100.0	Same		99.0 to 101.0 Hz [EMU 0.000500]
	|	200.0 Hz	199.8	Same		198.0 to 202.0 Hz [EMU 0.001000]
	|	500.0 Hz	500.0	Same		495.0 to 505.0 Hz [EMU 0.002500]

Remarks:

Custom Specification Report

Oyo 3403 Logger/Recorder, Seismic, PS Suspension

STEP NUM	FUNCTION TESTED	NOMINAL VALUE	AS FOUND	AS LEFT	Out of Tol	CALIBRATION TOLERANCE
	CH V Frequency Sine Wave	1000 Hz	1000	Same		990 to 1010 Hz [EMU 0.005000]
	|	2000 Hz	1998	Same		1980 to 2020 Hz [EMU 0.010000]

Remarks:

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PAGE 6 OF 6

SUSPENSION PS SEISMIC LOGGER/RECORDER CALIBRATION DATA FORM

INSTRUMENT DATA

System mfg.:	Oyo	Model no.:	3403
Serial no.:	160024	Calibration date:	8/1/2008
By:	Craig Branson	Due date:	8/1/2009
Counter mfg.:	Hewlett-Packard	Model no.:	5335A
Serial no.:	2626A09881	Calibration date:	7/17/2008
By:	SCE #S1-01252	Due date:	1/17/2009
Signal generator mfg.:	Hewlett-Packard	Model no.:	3325A
Serial no.:	2652A25647	Calibration date:	4/24/2008
By:	SCE #S1-01347	Due date:	10/24/2008

SYSTEM SETTINGS:

Gain:	2
Filter	10KHz
Range:	See sample period in table below
Delay:	0
Stack (1 std)	1
System date = correct date and time	8/1/2008 728

PROCEDURE:

Set sine wave frequency to target frequency with amplitude of approximately 0.25 volt peak
Note actual frequency on data form.
Set sample period and record data file to disk. Note file name on data form.
Pick duration of 9 cycles using PSLOG.EXE program, note duration on data form, and save as .sps file. Calculate average frequency for each channel pair and note on data form.

Average frequency must be within +/- 1% of actual frequency at all data points.

Maximum error ((AVG-ACT)/ACT*100)% As found 0.10% As left 0.10%

Target Frequency (Hz)	Actual Frequency (Hz)	Sample Period (microS)	File Name	Time for 9 cycles Hn (msec)	Average Frequency Hn (Hz)	Time for 9 cycles Hr (msec)	Average Frequency Hr (Hz)	Time for 9 cycles V (msec)	Average Frequency V (Hz)
50.00	50.00	200	505	180.0	50.00	180.2	49.95	180.0	50.00
100.0	100.0	100	506	90.00	100.0	90.00	100.0	90.00	100.0
200.0	200.0	50	507	45.00	200.0	44.95	200.2	45.05	199.8
500.0	500.0	20	508	18.00	500.0	18.00	500.0	18.00	500.0
1000	1000	10	509	9.000	1000	8.990	1001	9.000	1000
2000	2000	5	510	4.500	2000	4.500	2000	4.505	1998

	Name	Date	Signature
Calibrated by:	Craig Branson	8/1/2008	Craig Branson
Witnessed by:	Robert Steller	8/1/2008	[signature]

Suspension PS Seismic Recorder/Logger Calibration Data Form Rev 2.0 July 21, 2008

GEOVision Borehole Geophysics depth wheel verification

Performed by Robert Steller

	Depth reading in #1	Depth reading out	Depth reading in #2
Depth wheel S/N 101 500 pulse/revolution (gear 1:5, encoder 100 ppr) Circumference = 983mm (3225.07 millifeet)	100.1 feet (30.51 m) September 23, 2006	99.95 feet (30.46 m) September 23, 2006	100.05 feet (30.50 m) September 23, 2006
Depth wheel S/N 103 500 pulse/revolution (gear 1:5, encoder 100 ppr) Circumference = 994mm (3261.15 millifeet)	100.00 feet (30.48) m September 23, 2006	100.00 feet (30.48 m) September 23, 2006	100.00 feet (30.48) m September 23, 2006
Aries winch 200 pulse/revolution (gear 1:1, encoder 200 ppr) Circumference = 305.9mm (1003.51 millifeet)	100.05 feet (30.50 m) September 23, 2006	100.05 feet (30.50 m) September 23, 2006	100.00 feet (30.48 m) September 23, 2006
Robertson Depth wheel For MiniWinch 1000 pulse/revolution (gear 1:1, encoder 1000 ppr) Circumference = 400mm (1312 millifeet)	99.92 feet (30.46 m) Re-verified June 7, 2007	100.10 feet (30.51 m) Re-verified June 7, 2007	99.90 feet (30.45 m) Re-verified June 7, 2007
Robertson Smartwinch 200 S/N 5802 5000 pulse/revolution (gear 1:4, encoder 1250 ppr) Circumference = 404mm (1326 millifeet)	99.99 feet (30.48 m) June 6, 2007	99.97 feet (30.47 m) June 6, 2007	100.00 feet (30.48 m) June 6, 2007
Comprobe winch 500 pulse/revolution (gear 1:1, encoder 500 ppr) Circumference = 1000mm (3.281 feet)	100.1 feet (30.5 m) Re-verified June 7, 2007	100.1 feet (30.5 m) Re-verified June 7, 2007	100.1 feet (30.5 m) Re-verified June 7, 2007

All measurements taken with a Stanley 100-foot flexible stainless steel tape model number 34-130, and a Keeson 300-foot fiberglass tape, both marked in feet, inches and 1/8ths of inches. Enough cable was spooled off of the winch to allow the cable and tape measures to be laid flat on the parking lot surface side-by-side. A permanent marker was used to mark a 100.0-foot interval on the cable, and the marks were also tagged with electrical tape for visibility. The cable was then spooled back onto the winch. When the first mark was at the top of the measuring wheel, a matching permanent mark was placed, and the recording system (Robertson Micrologger) was set to 0.0 feet depth. The cable was spooled in to the second mark, and the distance was recorded. The recording system was set to 0.0 feet again, and the cable spooled out to the first mark again, and the distance was recorded. The process was repeated one more time to spool the cable back onto the winch, and the distance was recorded.

Estimated accuracy is of these measurements is +/- 0.1 foot or +/- 0.03m.

GEOVision Suspension PS probe Receiver 1–Receiver 2 (R1-R2) spacing verification

Performed by Robert Steller on September 23, 2006

	R2 center to R1 center hanging dry	R2 center to R1 center hanging submerged	R1 bottom to source center hanging submerged with 1m isolation tube S/N 280068	R1 center to source center hanging submerged with 1m isolation tube S/N 280068
Receiver S/N 30086	40.2in 1.02m	40.0in 1.02m	76.0in 1.93m	83.5in 2.12m
Receiver S/N 20042	39.8in 1.01m	39.6in 1.01m	75.7in 1.92m	83.2in 2.11m
Receiver S/N 12008	40.2in 1.02m	40.0in 1.02m	76.0in 1.93m	83.5in 2.12m

All measurements taken with a Lufkin 3.7m flexible steel tape model number HV1034DM, marked in mm and 100th of feet. Probe suspended in 3-inch diameter clear PVC pipe, using chain clamp placed between bottom and center of Receiver 2 hard section (See Figure). Probe “bounced” to establish unrestricted hanging length before measurement. Probe allowed to relax for 5 minutes prior to each measurement. Water level set to submerge bottom of Receiver 2 hard section.. Estimated accuracy due to hysterisis in rubber section approximately +/- 0.01’ or +/- 0.003m.

APPENDIX E

BORING GEOPHYSICAL LOGGING FIELD MEASUREMENT PROCEDURES

PROCEDURE FOR

OYO P-S SUSPENSION SEISMIC VELOCITY LOGGING

Background

This procedure describes a method for measuring shear and compressional wave velocities in soil and rock. The OYO P-S Suspension Method is applied by generating shear and compressional waves in a borehole using the OYO P-S Suspension Logger borehole tool and measuring the travel time between two receiver geophones or hydrophones located in the same tool.

Objective

The outcome of this procedure is a plot and table of P and S_H wave velocity versus depth for each borehole. Standard analysis is performed on receiver to receiver data. Data is presented in report format, with digital data files transmitted in Excel, Word or ASCII format.

Instrumentation

1. OYO Model 170 Digital Logging Recorder or equivalent
2. OYO P-S Suspension Logger probe or equivalent, including two sets horizontal and vertical geophones, seismic source, and power supply for the source and receivers
3. Winch and winch controller, with logging cable
4. Batteries to operate P-S Logger and winch

The Suspension P-S Logger system, manufactured by OYO Corporation, or the Robertson Digital P-S Suspension Probe with the Robertson Micrologger2 are currently the only commercially available suspension logging systems. As shown in Figure 1, these systems consists of a borehole probe suspended by a cable and a recording/control electronics package on the surface.

The suspension system probe consists of a combined reversible polarity solenoid horizontal shear-wave generator (S_H) and compressional-wave generator (P), joined to two biaxial geophones by a flexible isolation cylinder. The separation of the two geophones is one meter, allowing average wave velocity in the region between the geophones to be determined by inversion of the wave travel time between the two geophones. The total length of the probe is approximately 7 meters; the center point of the geophones is approximately 4 meters above the bottom end of the probe.

The probe receives control signals from, and sends the amplified geophone signals to, the instrumentation package on the surface via an armored 4 or 7 conductor cable. The cable is wound onto the drum of a winch and is used to support the probe. Cable travel is measured by a rotary encoder to provide probe depth data.

The entire probe is suspended by the cable and may be centered in the borehole by nylon “whiskers.” Therefore, source motion is not coupled directly to the borehole walls; rather, the source motion creates a horizontally propagating pressure wave in the fluid filling the borehole and surrounding the source. This pressure wave produces a horizontal displacement of the soil forming the wall of the borehole. This displacement propagates up and down the borehole wall, in turn causing a pressure wave to be generated in the fluid surrounding the geophones as the soil displacement wave passes their location.

Environmental Conditions

The OYO P-S Suspension Logging Method can be used in either cased or uncased boreholes. For best results, the uncased borehole must be between 10 and 20 cm in diameter, or 4 to 8 inches. A cased borehole may be as small as 3 inches, if properly grouted (see below) and the grout annulus does not exceed 1 inch.

Uncased boreholes are preferred because the effects of the casing and grouting are removed. It is recommended that the borehole be drilled using the rotary mud method. This method does little damage to the borehole wall, and the drilling fluid coats and seals the borehole wall reducing fluid loss and wall collapse. The borehole fluid is required for the logging, and must be well circulated prior to logging.

If the borehole must be cased, the casing must be PVC and properly installed and grouted. Any voids in the grout will cause problems with the data. Likewise, large grout bulbs used to fill cavities will also cause problems. The grout must be set before testing. This means the grouting must take place at least 48 hours before testing.

For borehole casing, applicable preparation procedures are presented in ASTM Standard D4428/D4428M-91 Section 4.1 (see ASTM website for copy).

Calibration

Calibration of the digital recorder is required. Calibration is limited to the timing accuracy of the recorder. GEOVision’s Seismograph Calibration Procedure or equivalent should be used. Calibration must be performed on an annual basis.

Measurement Procedure

The entire probe is lowered into the borehole to a specific measurement depth by the winch. A measurement sequence is then initiated by the operator from the instrumentation package control panel. No further operator intervention is then needed to complete the measurement sequence described below.

The system electronics activates the SH-wave source in one direction and records the output of the two horizontally oriented geophone axes which are situated parallel to the axis of motion of the source. The source is then activated in the opposite direction, and the horizontal output signals are again recorded, producing a SH-wave record of polarity opposite to the previous record. The source is finally actuated in the first direction again, and the responses of the vertical geophone axes to the resultant P-wave are recorded during this sampling.

The data from each geophone during each source activation is recorded as a different channel on the recording system. The seismograph has at least six channels (two simultaneous recording channels), each with at least a 12 bit 1024 sample record. Newer seismographs may have longer record lengths. The recorded data is displayed on a CRT or LCD display and possibly on paper tape output as six channels with a common time scale. Data is stored on digital media for further processing. Up to 8 sampling sequences can be stacked (averaged) to improve the signal to noise ratio of the signals.

Review of the data on the display or paper tape allows the operator to set the gains, filters, delay time, pulse length (energy), sample rate, and stacking number in order to optimize the quality of the data before recording. In the case of the Model 170, printed data is verified by the operator prior to moving the probe. In the case of the Robertson Micrologger2, storage on the hard disk should be verified from time-to-time, certainly before exiting the borehole.

Typical depth spacing for measurements is 1.0 meters, or 3.3 feet. Alternative spacing is 0.5 meter, or 1.6 feet.

Required Field Records

1) Field log for each borehole showing
   a) Borehole identification
   b) Date of test
   c) Tester or data recorder

d) Description of measurement

e) Any deviations from test plan and action taken as a result

f) QA Review

2) Paper output records are no longer required, since the Micrologger2 cannot generate them. However, data must be stored in at least 2 places prior to leaving the site

3) List of record ID numbers (for data on digital media) and corresponding depth

4) Diskettes, CDRom, or USB flash drives with backup copies of data on hard disk, labeled with borehole designation, record ID numbers, date, and tester name.

An example Field Log is attached to this procedure.

Analysis

Following completion of field work, the recorded digital records are processed by computer using the OYO Corporation software program PSLOG and interactively analyzed by an experienced geophysicist to produce plots and tables of P and S_H wave velocity versus depth.

The digital time series records from each depth are transferred to a personal computer for analysis. Figure 2 shows a sample of the data from a single depth. These digital records are analyzed to locate the first minima on the vertical axis records, indicating the arrival of P-wave energy. The difference in travel time between these arrivals is used to calculate the P-wave velocity for that 1-meter interval. When observable, P-wave arrivals on the horizontal axis records are used to verify the velocities determined from the vertical axis data. In addition, the soil velocity calculated from the travel time from source to first receiver is compared to the velocity derived from the travel time between receivers.

The digital records are studied to establish the presence of clear SH-wave pulses, as indicated by the presence of opposite polarity pulses on each pair of horizontal records. Ideally, the SH-wave signals from the ‘normal’ and ‘reverse’ source pulses are very nearly inverted images of each other. Digital FFT – IFFT lowpass filtering are used to remove the higher frequency P-wave signal from the SH-wave signal.

The first maxima are picked for the ‘normal’ signals and the first minima are picked for the 'reverse' signals. The absolute arrival time of the ‘normal’ and ‘reverse’ signals may vary by +/- 0.2 milliseconds, due to differences in actuation time of the solenoid source caused by constant mechanical bias in the source or by borehole inclination. This variation does not affect the velocity determinations, as the differential time is measured between arrivals of waves created by the same source actuation. The final velocity value is the average of the values obtained from the 'normal' and 'reverse' source actuations.

In Figure 2, the time difference over the 1-meter interval of 1.70 millisecond is equivalent to a SH-wave velocity of 588 m/sec. Whenever possible, time differences are determined from several phase points on the S_H -wave pulse trains to verify the data obtained from the first arrival of the S_H -wave pulse. In addition, the soil velocity calculated from the travel time from source to first receiver is compared to the velocity derived from the travel time between receivers.

Figure 3 is a sample composite plot of the far normal horizontal geophone records for a range of depths. This plot shows the waveforms at each depth, clearly showing the S-wave arrivals. This display format is used during analysis to observe trends in velocity with changing depth.

Once the proper picks are entered in PSLOG, the picks are transferred to an Excel spreadsheet where Vs and Vp are calculated. The spreadsheet allows output for presentation in charts and tables.

Standard analysis is performed on receiver 1 to receiver 2 data, with separate analysis performed on source to receiver data as a quality assurance procedure.

Registered Geophysicist Antony J Martin Date 9/11/06

QA Review ______________ Date 9/11/06

References:

1. "In Situ P and S Wave Velocity Measurement", Ohya, S. 1986. Proceedings of In-Situ '86, *Use of In-Situ Tests In Geotechnical Engineering*, an ASCE Specialty Conference sponsored by the Geotechnical Engineering Division of ASCE and co-sponsored by the Civil Engineering Dept of Virginia Tech.

2. Guidelines for Determining Design Basis Ground Motions, Report TR-102293, Electric Power Research Institute, Palo Alto, California, November 1993, Sections 7 and 8.

3. "Standard test Methods for Crosshole Seismic Testing", ASTM Standard D4428/D4428M-91, July 1991, Philadelphia, PA

OYO SUSPENSION P-S VELOCITY LOGGING SETUP

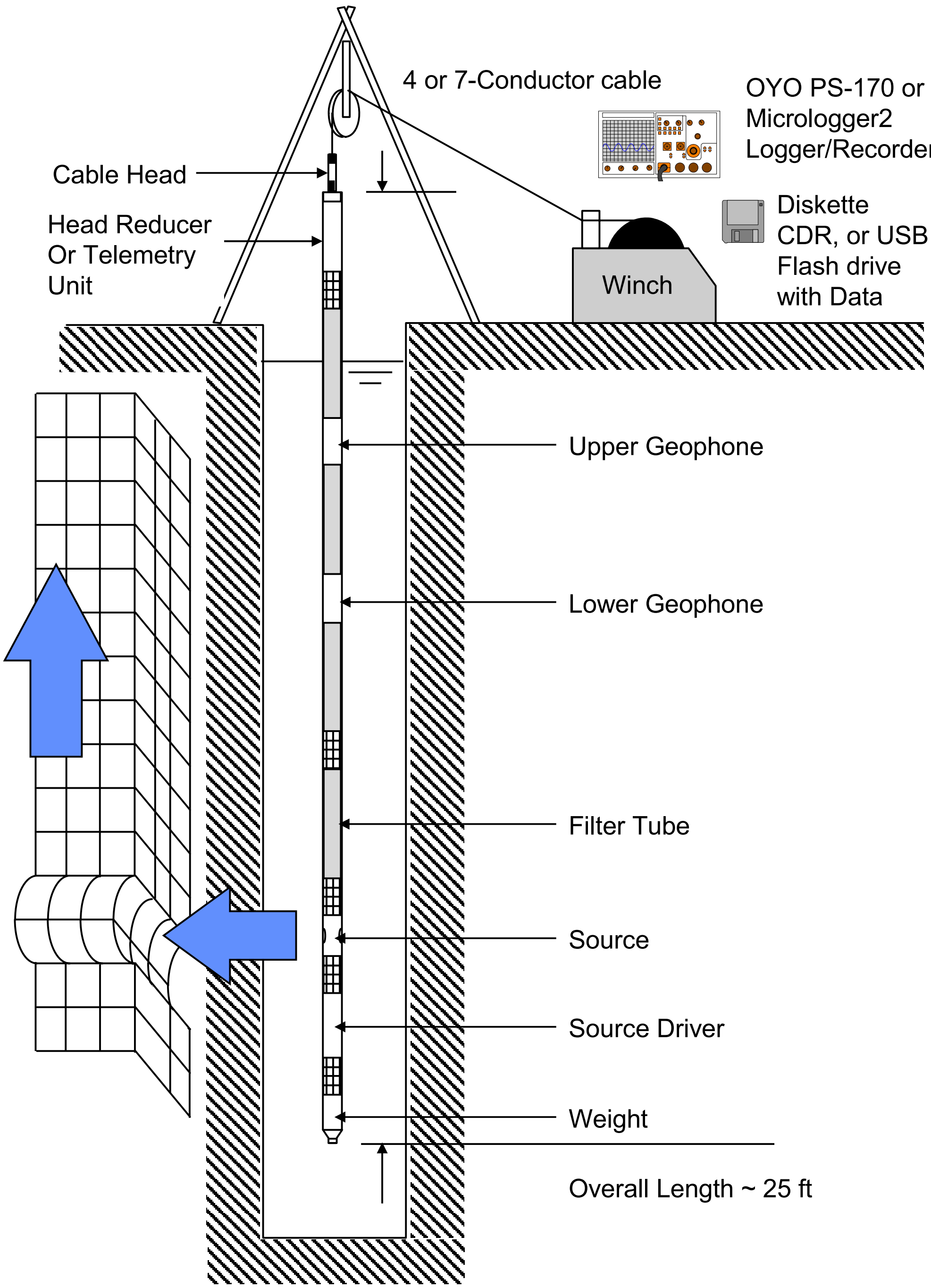


Figure 1. Suspension PS logging method setup

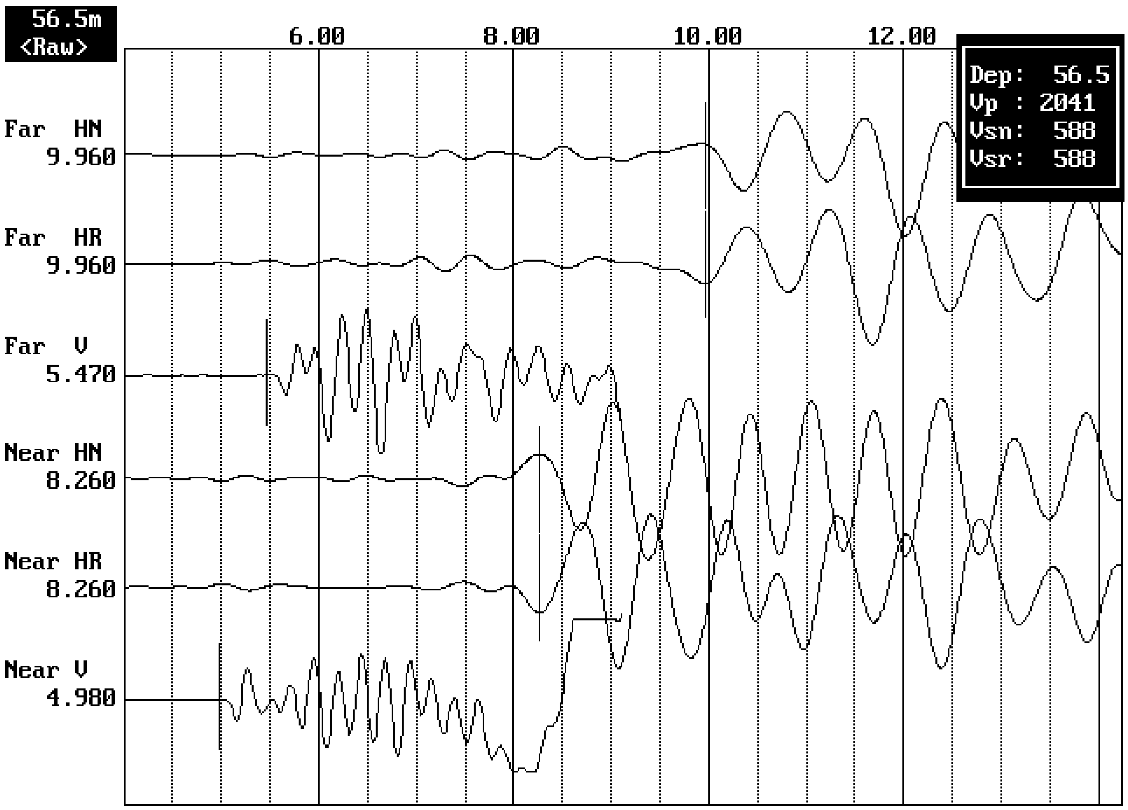


Figure 2. Sample suspension method waveform data showing horizontal normal and reversed (HR and HN), and vertical (V) waveforms received at the near (bottom 3 channels) and far (top 3 channels) geophones. The arrivals in milliseconds for each pick are shown on the left. The box in the upper right corner shows the depth in the borehole and the velocities calculated based on the picks.

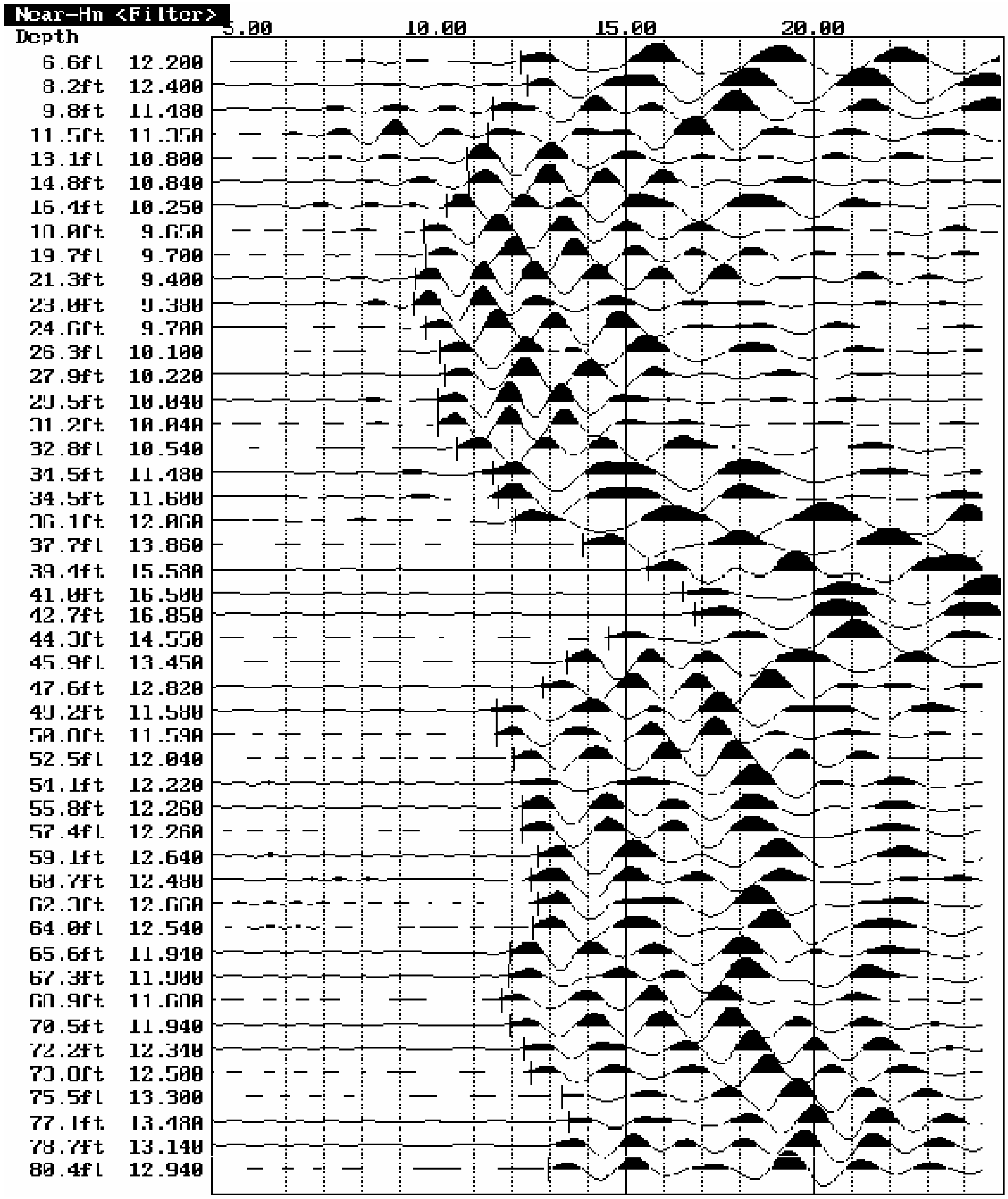


Figure 3. Sample composite waveform plot for normal shear waves received at the near geophone in a single borehole

P-S SUSPENSION VELOCITY FIELD LOG

SITE:______________________________________ DATE:__________________________
CLIENT:____________________________________ JOB:__________________________
AUTHOR:____________________________________ PAGE 1 OF _____

CONTACT:__________________________ _OFFICE__ PHONE:_______________________
__________ PHONE:_______________________
CONTACT:__________________________ _OFFICE__ PHONE:_______________________
__________ PHONE:_______________________
CONTACT:__________________________ __________ PHONE:_______________________
__________ PHONE:_______________________
CONTACT:__________________________ __________ PHONE:_______________________
__________ PHONE:_______________________
DRILLER:__________________________ __________ PHONE:_______________________
COMPANY:__________________________ __________ PHONE:_______________________

DIRECTIONS TO SITE:____

GENERAL SITE CONDITIONS/LOCATION:____

EA#:___________________________________
BOREHOLE DESIGNATION:___________________LOCATION:______________________

COUNTY:_______________RANGE:_________TOWNSHIP:____________SECTION:______
BOREHOLE CONSTRUCTION: CASED_____ UNCASED______
DIAMETERS AND DEPTH RANGES: _______ 0 TO _________ ; ______, _______ TO ________
BOREHOLE TOTAL DEPTH AS DRILLED:________________
CONDUCTOR CASING?: YES____ DEPTH TO BOTTOM OF CASING_______; NO____
DEPTH TO BEDROCK:________ DEPTH TO WATER TABLE:_________
BOREHOLE FLUID: WATER_____; FRESH WATER MUD_____; SALT WATER MUD _____;
OTHER:____
DEPTH TO BOREHOLE FLUID:__________ TIME SINCE LAST CIRCULATION:__________

GEOVision Geophysical Services 1151 Pomona Road, Suite P, Corona, CA 92882 Ph (951) 549-1234 Fx (951) 549-1236

SITE:____ DATE:__________________________
CLIENT:____ JOB:__________________________
AUTHOR:____ PAGE 2 OF _____

LOGGING CREW:____
VEHICLE(S) USED AND MILEAGE: ____
MOBILIZED FROM:______________________ DEPARTURE TIME:_______________________
ARRIVED ON SITE:_______________________
STANDBY TIME:_________________________ CAUSE:_________________________________
LOGGING STARTED:____________________ LOGGING COMPLETED:__________________
STANDBY TIME:_________________________ CAUSE:_________________________________
LOGGING STARTED:____________________ LOGGING COMPLETED:__________________
DEMOBILIZED TO:______________________ ARRIVAL TIME:___________________________
ADDITIONAL DEMOB TIME:_______________ REASON:________________________________

BATTERIES CHANGED BEFORE LOGGING: YES_____; NO_____; STORED WITH NEW_____

WINCH		COMPROBE ☐	GREY ☐	OYO ☐	RG ☐	OTH ☐
INSTRUMENT	OYO	12004 ☐	15014 ☐	19029 ☐	RG 160023 ☐	160024 ☐
RECEIVER S/N		12008 ☐	20042 ☐	26066 ☐	11001 ☐	23053 ☐

MAINTENANCE PERFORMED ON SITE:____
____
____
____
EQUIPMENT PROBLEMS OR FAILURES:____
____
____

SUGGESTIONS, ADDITIONS, CHANGES:____
____
____

COMMENTS:____
____
____
____
____
____

GEOVision Geophysical Services 1151 Pomona Road, Suite P, Corona, CA 92882 Ph (951) 549-1234 Fx (951) 549-1236

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: ____________________ DATE: __________

CLIENT: ____________________ JOB: __________

AUTHOR: ____________________ PAGE ______ OF ______

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
0.5	1.64			
1.0	3.28			
1.5	4.92			
2.0	6.56			
2.5	8.20			
3.0	9.84			
3.5	11.48			
4.0	13.12			
4.5	14.76			
5.0	16.40			
5.5	18.04			
6.0	19.69			
6.5	21.33			
7.0	22.97			
7.5	24.61			
8.0	26.25			
8.5	27.89			
9.0	29.53			
9.5	31.17			
10.0	32.81			
10.5	34.45			
11.0	36.09			
11.5	37.73			
12.0	39.37			
12.5	41.01			
13.0	42.65			
13.5	44.29			
14.0	45.93			
14.5	47.57			
15.0	49.21			
15.5	50.85			
16.0	52.49			
16.5	54.13			
17.0	55.77			
17.5	57.41			
18.0	59.06			

GEOVISION SUSPENSION LOGGING FIELD NOTES

SITE: ______ DATE: ______
CLIENT: ______ JOB: ______
AUTHOR: ______ PAGE ______ OF ______

DEPTH METERS	DEPTH FEET	UNFILTERED FILE NO.	FILTERED FILE NO.	COMMENTS CASING, WATER, ROCK, ETC
18.5	60.70			
19.0	62.34			
19.5	63.98			
20.0	65.62			
20.5	67.26			
21.0	68.90			
21.5	70.54			
22.0	72.18			
22.5	73.82			
23.0	75.46			
23.5	77.10			
24.0	78.74			
24.5	80.38			
25.0	82.02			
25.5	83.66			
26.0	85.30			
26.5	86.94			
27.0	88.58			
27.5	90.22			
28.0	91.86			
28.5	93.50			
29.0	95.14			
29.5	96.78			
30.0	98.43			
30.5	100.07			
31.0	101.71			
31.5	103.35			
32.0	104.99			
32.5	106.63			
33.0	108.27			
33.5	109.91			
34.0	111.55			
34.5	113.19			
35.0	114.83			
35.5	116.47			
36.0	118.11			

PROCEDURE FOR USING THE ROBERTSON GEOLOGGING HI-RESOLUTION ACOUSTIC TELEVIEWER (HiRAT)

Reviewed 2/13/06

Background

The acoustic televiewer is a device for producing a qualitative image of the wall of a borehole. Because it uses ultrasound rather than visible light it is able to work in dirty or opaque borehole fluids, although heavy drilling mud will cause excessive dispersion of the acoustic beam. The picture below shows the sonde's lower nylon section, and one of the bowspring attachments which are used to centralize the sonde in the borehole.

Pulses of ultrasound (0.5 - 1.5MHz) are generated by a piezo-electric resonator. The pulses are transmitted through the oil in which the resonator is immersed, through the wall of the acoustic housing, then propagate through the borehole fluid and are reflected from the wall of the borehole. The reflected energy is picked up by the same transducer, from which is recorded both the ***amplitude*** of the returned pulse and the ***travel-time*** which have elapsed. Blanking must be applied to prevent the transducer from registering reflections from the inside surface of the acoustic housing. The material of the housing is chosen so that its acoustic properties are similar to the oil which fills it. The housing is not designed to withstand borehole fluid pressures, but has a piston device to allow equalization between inside and outside pressure.

The ***amplitude*** of the returned pulse is a function of the acoustic reflectivity of the borehole wall. If the beam strikes a hard borehole wall normally to the surface the energy will be returned to the transducer and a strong return will be recorded. If the formation is softer, then less energy will be reflected. Also, if the surface of the borehole is rough, or effectively missing because of the presence of a fracture or other structure, then energy will be dispersed and a poor return will be recorded.

The ***travel-time*** is a simple function of the diameter of the borehole and the velocity of sound in the borehole fluid (typically 1.5Km/sec). An A/D converter monitors the output from the transducer once the blanking period has expired and a comparator is used to detect the peak amplitude during the sampling window.

The coaxially-mounted transducer has a planar radiating surface, but the vibration characteristics are such that the acoustic pulse is emitted as a 'pencil' beam. The emitted beam is deflected by a planar mirror so that it leaves the acoustic housing at right angles to the sonde axis. The mirror is rotated to scan the borehole wall. The ultrasound pulses are synchronized with rotation of the mirror so that up to 360 pulses are emitted in every revolution. Because of the time which must elapse for the two-way transit of the borehole fluid, there is an upper limit upon the number of radial samples that may be acquired from a borehole of a particular radius. In larger boreholes, therefore, it may be necessary to reduce the number of radial samples. The sonde is able to operate at 90, 180 or 360 samples per revolution.

An image of the borehole wall is produced by moving the sonde along the borehole axis while it is scanning radially. By the same logic as shown above, it can be seen that any horizontal point will be imaged by more than one sweep of the acoustic beam so long as the axial movement of the sonde during one complete sweep is no greater than the beam diameter. An upper limit is therefore imposed upon the logging speed which will be a function of the rotational speed of the transducer, the radial sampling interval and borehole diameter.

Objective

The objective of this procedure is to provide a pseudo "core" of the borehole, and map the orientation and angles of cracks and voids in rock boreholes.

Instrumentation

This procedure is written specifically for the Robertson Geologging High-Resolution Acoustic Televiewer (HiRAT). The required equipment includes:

1. The Robertson High-Resolution Acoustic Televiewer (HiRAT) sonde with centralizers
2. A 4-conductor wire-line winch with cable at least 30m (100ft) longer than the depth of the borehole (RG Smart Winch or equivalent. GEOVision has adapted all our 4-conductor winches)
3. A sheave with depth encoder with minimum 500 pulse/revolution
4. A Robertson Geologging Micrologger II
5. A laptop with Winlogger installed and the following minimum system requirements:
    - Windows 98SE or above
    - 64M System memory
    - 800x600x24 SVGA Display with DirectX 8.0
    - 500Mhz CPU
    - USB 2.0 connection
6. Battery power supply with cables

Environmental Conditions

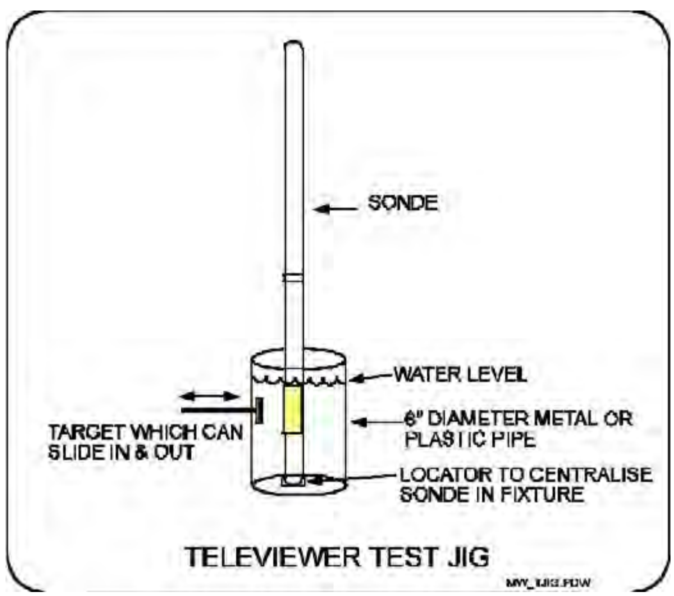
This tool is designed for fluid-filled boreholes between 67 and 150mm (3-6in) in rock. Since fine cracks are usually not visible in the walls of soil borings, the televiewers add very little information from a soil boring than a simple video. Now if the boring has soil AND rock, televiewer visuals in the soil may still be useful.

Calibration

The acoustic televiewer uses the variability in reflectance and the travel time to make an image of the borehole wall, mostly resulting from relative differences of materials and the physical characteristics of the wall. Since these are relative measurements, no field calibration of the sonde is required. However, it is important that the same location in the borehole be checked at the start and finish of the logging to make sure that the response or functionality haven't changed during the measurement.

A test fixture may be used to check function of the acoustic televiewer prior to use. This test fixture should comprise a plastic pipe, with a known internal diameter between 3 and 6 inches. This should be filled with water and the sonde stood upright in the fixture. A target made of metal or metal foil is glued on the inside of the container, or optionally on a seal and shaft so that it can be moved in and out on a line radial to the center-line of the pipe. A representation of this is shown in the figure below.

The purpose of this test fixture is to check the ability of the sonde to differentiate between materials of different acoustic reflectances, and different travel times, and to check the calibration of the caliper function of the sensor using the measured diameter of the pipe. However, if calibrated caliper measurements are required, it is recommended that a mechanical 3-arm caliper tool be used for this purpose because it can be calibrated in the field prior to use. The HiRAT will give very accurate results but this procedure does not cover calibration.

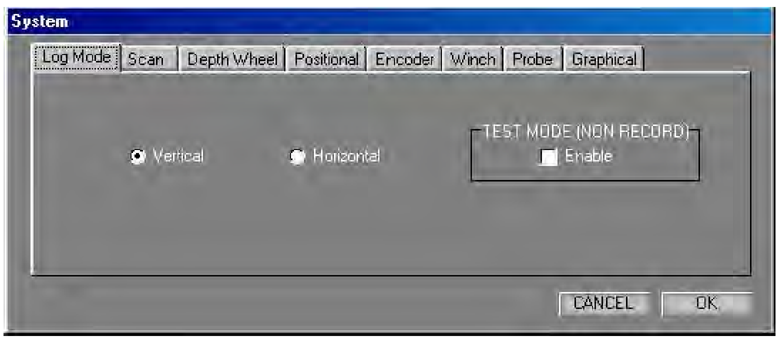


Hi-RAT Field Procedure

Because the logging software is a standalone module, there are a number of settings which must be initialized independently of the WinLogger software. These include the depth measurement subsystem and sonde operating modes. Click on 'System' on the menu bar to show the following dialog boxes:

1.0 Log Mode

The sonde can operate in three distinct modes:



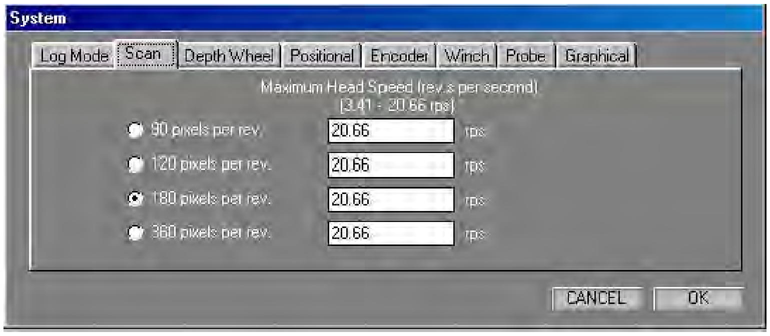
- Vertical mode is used for boreholes which are drilled from the surface and are deviated at less than 70 degrees from the vertical. Most exploration boreholes will fall into this class. In this mode the image is orientated according to compass directions (magnetic co-ordinates).

- Horizontal mode is used for boreholes which are sub-horizontal so their inclination will probably exceed 70 degrees from the vertical. Boreholes in this class would normally be drilled as part of ground investigations for tunneling and mining, drilling ahead of a drive to determine the nature and extent of fracturing. In this mode the image is orientated according to gravitational coordinates (up/down) since there is no unique point of the image circle which can be orientated to North with any precision.

- Test mode is used to exercise all sonde functions without creating a log. The image will scroll on the screen in the normal fashion, and orientation readouts will be refreshed continuously.

2.0 Scan Parameters

The scan parameters control the radial sampling of the borehole. The values will be retained between logging sessions, so the sonde will be initialized correctly at power-on. There are three parameters in the dialog:



- The radial sampling rate can be set to one of 90, 120, 180, 360 samples per revolution. There is a relationship between the logging speed and the radial sampling rate, since the time taken to send the dataset to the surface depends upon its length. The size of the log file is also determined by the radial sampling rate. The probe will always try to use the maximum head speed entered. If limited by a low Baud rate or a large 'window' setting then the probe will reduce its head speed automatically to compensate - see sonde operation section.

3.0 Depth Wheel Configuration

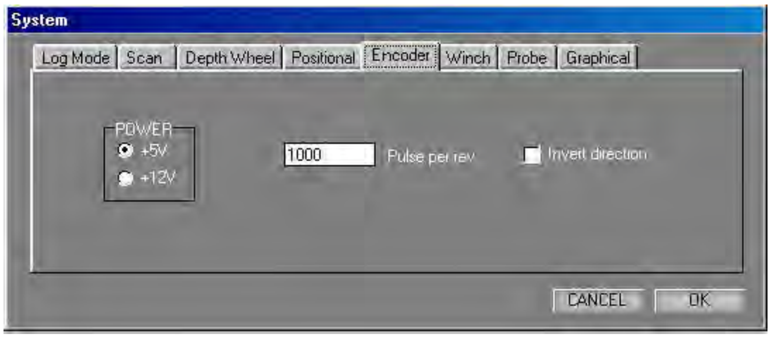
The depth measurement system is dependent upon the combination of depth measurement wheel with its calibrated groove, and the shaft encoder which translates rotation into pulses which are counted by the logging system controller. Two parameters are therefore required: depth wheel circumference and encoder pulse rate. The encoder parameters are covered in a subsequent topic.

- Select Metric or Imperial depth measurement units from the left-hand pane.

- Type the circumference of the depth measurement wheel into the 'wheel size' box. The standard sizes of GEOVision wheels are 1000mm. If you are measuring in Imperial units (or changing back to metric units), the standard wheel size can be converted automatically by clicking the left mouse button and choosing the appropriate conversion. The size is always specified in units of 1/1000 of the depth unit i.e. millimetres (mm) or millifeet (mft).

4.0 Encoder Configuration

The depth measurement system is dependent upon the combination of depth measurement wheel with its calibrated groove, and the shaft encoder which translates rotation into pulses which are counted by the logging system controller. The depth wheel circumference is covered in a previous topic. In order to accommodate a variety of encoders, their operational characteristics can be configured in the software.



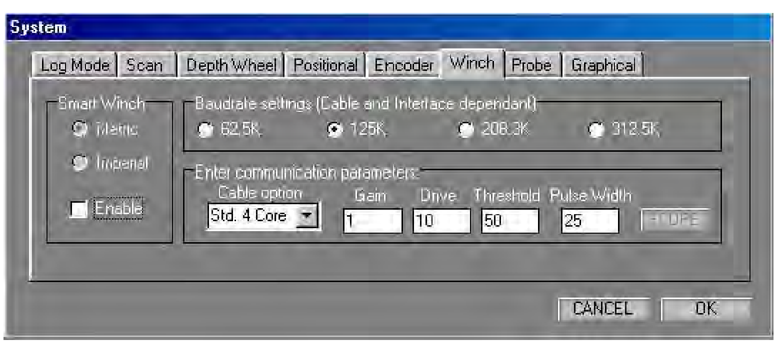
- Select supply voltage from the radio buttons in the left-hand pane. The options are 5 Volt and 12 Volt. GEOVision encoders are always specified for 5 Volt operation.

- Type the number of pulses emitted per revolution into the central box. The standard values for all GEOVision winches are 500 pulses/rev.

- The logical direction of movement can be reversed if required to accommodate the directional characteristics (phase lead or lag) of the different encoder types.

5.0 Winch and Cable Configuration

Support for remote control of the RG Smart Winch is provided, and can be enabled by checking the ***Enable*** control in the left-hand Smart Winch pane. If the Smart Winch control is enabled, it is also necessary to select the measure units in force - select ***Metric*** or ***Imperial*** from the radio buttons on offer.



The Baud settings can be chosen to match the *quality* of the communication channel. The channel will be effected by cable type and length. Typically a Baudrate of 312.5K is used. The remaining controls in the dialog relate to the communications parameters. The operation is entirely compatible with the WinLogger software operation and the values would be expected to be the same as those in force for logging six-channel type sondes with that software. (Certain probe types may be fitted with a digital interface that does not require set-up and in this case the parameter edit boxes will not appear.)

- ***Cable Option*** is used to select the logging cable type which is available on the winch. The options are *Not Connected*, *Std. 4 Core*, *Differential* and *Monocable*. The only cable types used in GEOVision systems is Std. 4 Core. Select the appropriate type from the drop-down menu box. Note this value can only be changed when the probe power is turned off.

- ***Gain*** is related to cable length and uphole signal attenuation. Gain values range from 0-3 and control the amplification applied to the incoming signal. Use the *Scope* dialog to visualize the incoming signals. Gain should be set so that the signal reaches between 70% and 100% of the height of the display, generally obtained with a setting of 0 for GEOVision winches. If the peak height exceeds this level, clipping will result in artifacts which will be detected erroneously. Click *Apply* to set the parameters before proceeding to the *Scope* dialog.

- ***Threshold*** is the level at which the incoming signals are detected. Gain and Threshold are related, and can be visualized using the *Scope* dialog. Set the gain so that the signal reaches between 70% and 100% of the height of the display. Then adjust the threshold so that it is between 50% and 70% of the height of the pulses displayed and clear of any region of 'overshoot' of the positive and negative pulses. This will ensure that peaks are detected and noise is ignored. Generally a setting of 25 is used for GEOVision winches. When the scope dialog is displayed, the position of the mouse is reported as a threshold value to make it simpler to infer the correct setting. The scope option is greyed out when the probe power is turned off.

- ***Drive*** sets the strength of the downhole signal. It is not possible to visualize the downhole signal, but the effect of insufficient drive is to disable downhole communication, which will result in the commands being ignored by the sonde. Values range from 0 -127, and for GEOVision winches will be around 10. Increase the drive for longer cables.

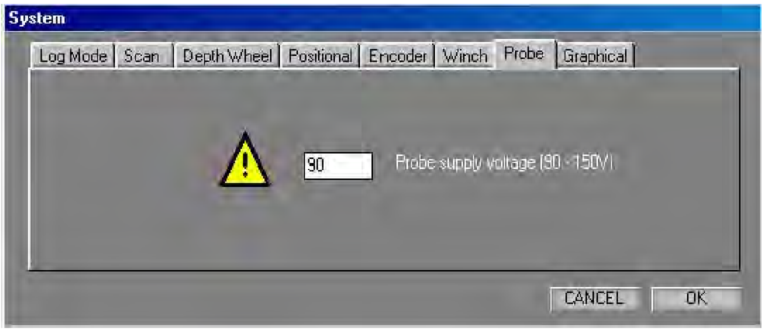
- ***Pulse Width*** This is the width of the transmitted communication pulses in 100nS steps. The default is 25 equivalent to 2.5uS. The range is from 8 to 64. The pulse width can be reduced to prevent signal overshoot on short cables. The default value is used in most cases. Note any changes only come into effect during a log. (Note setting too large a pulse width when using the highest Baud rates will automatically be prevented within the probe and the pulse width reduced.)

IMPORTANT Please note the effects of changing 'Baud' will not appear until the first new log is made. The setting for 'threshold' may be effected by an increase in the 'Baud' rate please recheck 'threshold' if 'Baud' is altered using the 'Scope' function after making a short test log.

The parameters which are entered will be applied automatically if you close the dialog with ***OK***. The above parameters once set correctly will be remembered by the system and should never need to be altered.

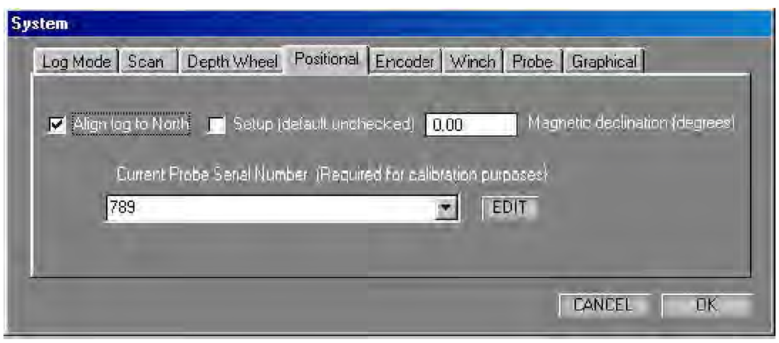
6.0 Probe Configuration

The probe is normally energized at 90 Volts from the surface. However, it may be necessary to compensate for voltage drop on longer cables due to the higher power draw of this sonde. The voltage at the surface may be increased in order to deliver 90 Volts at the sonde. Simply type the value into the text box provided. The voltage should be set at 90V for all GEOVision winches. Values outside the indicated range will be rejected.



7.0 Positional Configuration

The probe includes a 3-axis orientation package, and is capable of producing a borehole image aligned to geographic North. This is achieved by determining and applying two image rotation parameters:



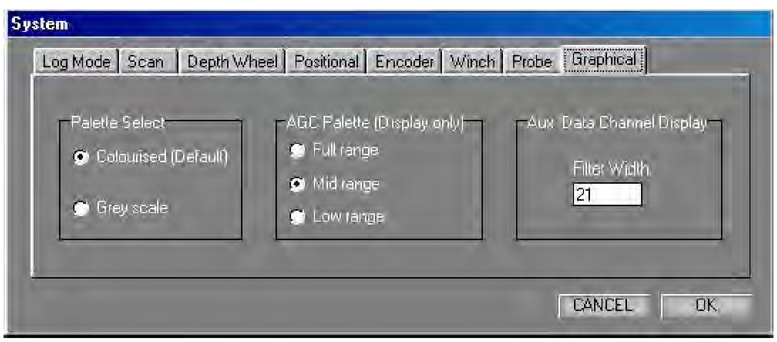
- ***Magnetic Declination*** is used to correct for the difference between Magnetic North and True North. The value varies from place to place, so the local value must be inserted here if you wish to perform this correction during data collection. This correction may also be made during processing. If the value is zero, the log will be referred to Magnetic North.
- ***Align to North*** is a check-box used to select image rotation to start at Magnetic North. If in addition a value is set for Magnetic Declination (see above) the image will be rotated to start at True North. If the box is not checked, the image will not be oriented to geographic co-ordinates, but will use the local co-ordinate frame of the sonde (X, Y, Z axis of the orientation module). This mode may be used to inspect the inside of magnetic casing, where an orientated image would be subjected to random effects caused by the metalwork.
- Set-up mode is selected by checking the ***Setup*** box, and is used to determine the required image rotation offset to correct for the angle between the axis of the orientation package and the index mark of the rotating transducer section. In set-up mode the normal sonde azimuth display is modified, and will instead show the 'relative bearing' which is measured between the high side of the borehole and the orientation sensor index. Check ***Setup***, then OK to close the dialog. The icon adjacent to the sonde azimuth readout at the top of the screen is modified with the legend CAL when the system is in set-up mode. The sonde must now be placed in a stand or jig so that it

is inclined at about 20 degrees to the vertical, and adjacent to a target fixed to the jig so that it is directly above the transducer in the vertical plane. Lower the sonde with its attachment into a large bucket of water so that the transducer and target are fully immersed. Start the radial amplitude display, when it will be possible to see the strong signal returning from the target. Rotate the sonde so that the image of the target moves to the top of the display. When the two are coincident, the 'relative bearing' reads out the image rotation offset. This value is fixed for the sonde unless it is disassembled and rebuilt, at which point the procedure MUST be repeated. Please see the additional topic on the Radial Amplitude Display for further details.

- The ***Serial Number*** list box is used to select the sonde which is in use. When the appropriate sonde is selected, the image rotation offset determined by the above procedure is selected. To edit the image offset click the '***Edit***' and enter the new offset. Several serial numbers and associated offsets can be stored and selected as required.

8.0 Graphical

The palette can be changed between a colored and grey scale setting. The changes affect the log screen palette display and are also applied when replaying a log. Selecting Full range in the 'AGC Palette' will cause the software to spread the palette over the full 16bit signal. 'Mid range' will spread the palette over the first quarter of the 16bit range and 'Low range' will spread the palette over the first eighth of the 16 bit range. In most cases the 'Low range' selection is used. Note these settings do not affect the stored log data in any way. The 'Filter Width' is applied to the Natural Gamma trace data and is a simply running average filter. The range of the filter width is from 1 to 50 (x 10 millidepth units ie. mm or mft).



9.0 Sonde Operation

When the operations specified above have been reviewed and the correct settings have been selected, the system is ready for use. The main screen area is divided into 3 horizontal elements. At the top is the depth and orientation readout, together with the scale headings for the scrolling display of unwrapped borehole image.

On the left side of the depth track is the travel time display, with text boxes for sonde inclination, azimuth and head temperature.

On the right side is the display of amplitude and indication of current operating mode. Located in the center above the depth track are the text boxes for depth and cable speed (computed at the surface). The ranges for the ‘Natural Gamma’ channel overlay (optional) are shown above the Amplitude.

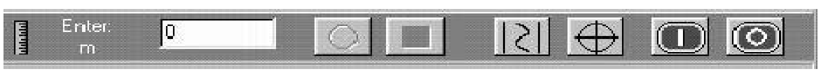
The central area is utilized for the scrolling display of unwrapped borehole data. The display is orientated with the left edge corresponding to North point of the aligned image data (if orientation is selected) according to the outputs of the sonde’s orientation package.

The lower area has controls for the winch (applicable to RG Smart Winch only), depth initialization and sonde control.

The winch control area is only displayed when RG SmartWinch operation is enabled - see section 5 - and has four controls. Set Target Speed by typing the required speed into the window and pressing Enter.

Cable movement is initiated by clicking on either the UP or DOWN arrow control.

Cable movement is halted by clicking on the square STOP control.



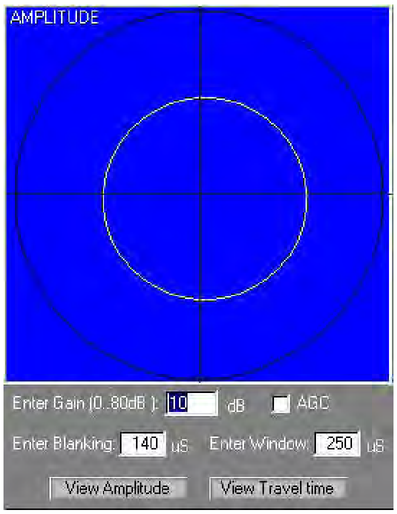
Depth is initialized by typing the required value into the entry box and pressing Enter. The entry box is not available at times when the system is in logging mode and the depth should not be changed by user entry.

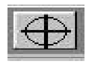
Sonde power is applied by clicking on the green-colored 1 button. Power is turned off by clicking on the red-colored 0 button. There is no indicator for the state of the power supply on the desktop, so the external indicators should be observed for this purpose.

To make a log ensure that the Test Mode is disabled - see section 1, Log Mode setting. Click File|New Log and select a filename. Old logs may be overwritten if necessary -TAKE CARE. The header editor will be started automatically. A previous set of header data may be loaded by clicking LOAD and choosing a template.

To start logging, click on the red Record (circle) control. The log data will start to scroll down the screen after a brief pause for synchronization. The messages “DSP2: Detecting data stream” and “Updating probe settings” will be observed at the bottom of the screen during this process. Note that the screen scrolling direction is not affected by the actual direction of movement of the sonde. To cease logging, click on the black STOP control (square). The data should be immediately backed up to a USB drive, CD, or other data storage prior to beginning another log.

If the data display from a probe which is properly connected appears to occupy only half of the track area, with the remainder filled with random colors such as green which are not part of the regular palette, then it is most likely that the downhole data communication is not functioning properly. This symptom is due to the fact that the probe settings cannot be communicated properly, and it is operating in its default power-up mode. If this is the case, the Drive setting of the System|Winch dialog should be increased or decreased accordingly. See section 5 for full details.





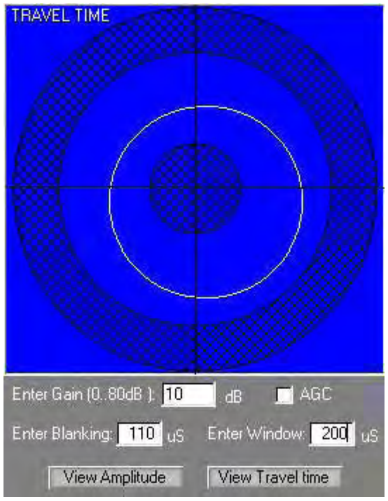
To adjust the sonde gain it is necessary to use the Radial Amplitude plot, which is enabled by clicking on the circle with cross-hairs symbol. When the dialog is active a new window will open on top of the unwrapped data display. In this display, the data is presented as a ‘polar’ plot. Press the ‘View Amplitude’ button to display the amplitude plot. This plot shows amplitude increasing towards the outside of the circle and the compass direction following the sweep of the transducer. The line indicating the data is drawn in the regular palette, so that high amplitudes are drawn in white and low amplitudes in black/brown. The picture here shows the image of the inside of a cylinder.

If the data is concentrated in a small circle at the center, the gain is too low and should be increased. If the data is obviously clipped at the outside of the circle, then the gain should be reduced. Type the new gain value into the entry box and press Enter. The ideal would be to set a gain value which allows the peak values to be displayed without clipping, with the majority of the data around the half-way level. It may also be necessary to adjust the blanking to ensure that internal reflections from the acoustic housing are not detected at the new gain value. This will be apparent in the unwrapped data display as pronounced patterning unrelated to the true target. The AGC option causes the probe to set gain automatically thus preventing signal saturation in most cases. (The gain is varied in 6dB steps

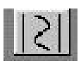
Blanking Period and window length can be set independently. Blanking is set to avoid reflections from the housing of the acoustic transducer or random reflections from a rugose borehole, and window length is set to accommodate the range of borehole radius that might be expected. An error will be indicated if the sum of the blanking period and window length would be greater than 409 microseconds, which is the maximum range of the timer. The default value for the blanking period is 145 microseconds, which is the minimum required for the two-way transit from the transceiver to the outer surface of the acoustic housing. It is not advisable to reduce this value beyond the default setting, although it may be increased for larger boreholes at the rate of 1.5mm of one-way travel per microsecond.

Window Length (sample time) defines the period during which the arrival gate remains open to detect the returned acoustic pulse. The acoustic pulse will travel in water at a speed of approximately 1.5mm per microsecond. The default window length is 150 microseconds, which is equivalent to 225 mm of (two-way) travel in the borehole fluid, or approximately 110mm of borehole diameter. If this is added to the default blanking period, which is equivalent to the outside diameter of the acoustic housing, it can be seen that the default set-up will be correct for boreholes up to 150mm. An error will be indicated if the sum of the blanking period and window length would be greater than 409 microseconds, which is the maximum range of the timer. Choose your window setting to best match the borehole diameter.

Pressing the ‘View Travel time’ button changes the display to that shown below:



The unhatched ring between the two cross hatched zones represents the sample window. The width of this ring will vary with window length value. The profile of a cylinder is represented here appearing as a circle in the sample window.



Pressing this button displays the following dialog box:

This box allows you to enable the Natural Gamma option by checking the ‘Enable Overlay’ check box. The Overlay appears as a trace upon the Amplitude plot. The trace range and color can also be set by this dialog. The level of filtering can also be altered (see section 8) (note that any displayed trace data is automatically aligned with the acoustic scan data but only when logging up. The Natural Gamma sensor occupies a higher position in the probe so sufficient data has to be prebuffered so that the acoustic data can depth aligned with gamma. The prebuffering results in a delay at the start of a log before correct gamma data appears this is normal.)

Data Analysis and Interpretation

RG-DIP, the manufacturer’s image interpretation package, offers manual and automatic feature recognition options. Feature orientations (dip/strike and azimuth) are automatically calculated. Display options include stereographic projections of zone axes, orientation frequency plots and 'synthetic cores' for comparison with real core data. The last option is invaluable for orientating core samples, particularly in the case of incomplete recovery.

Reporting

The final report will include the objective and scope of the survey, location of the boreholes, discussion of instrumentation and procedures in the field and lab. For each borehole there will be a plot showing the dip/strike and azimuth of features. The next page shows an example.

Assumptions and limitations of the results will be discussed. Supporting references will be listed as necessary

Required Field Records

Field log for each borehole showing

a) Location and description of the borehole

b) Date of test

c) Field personnel

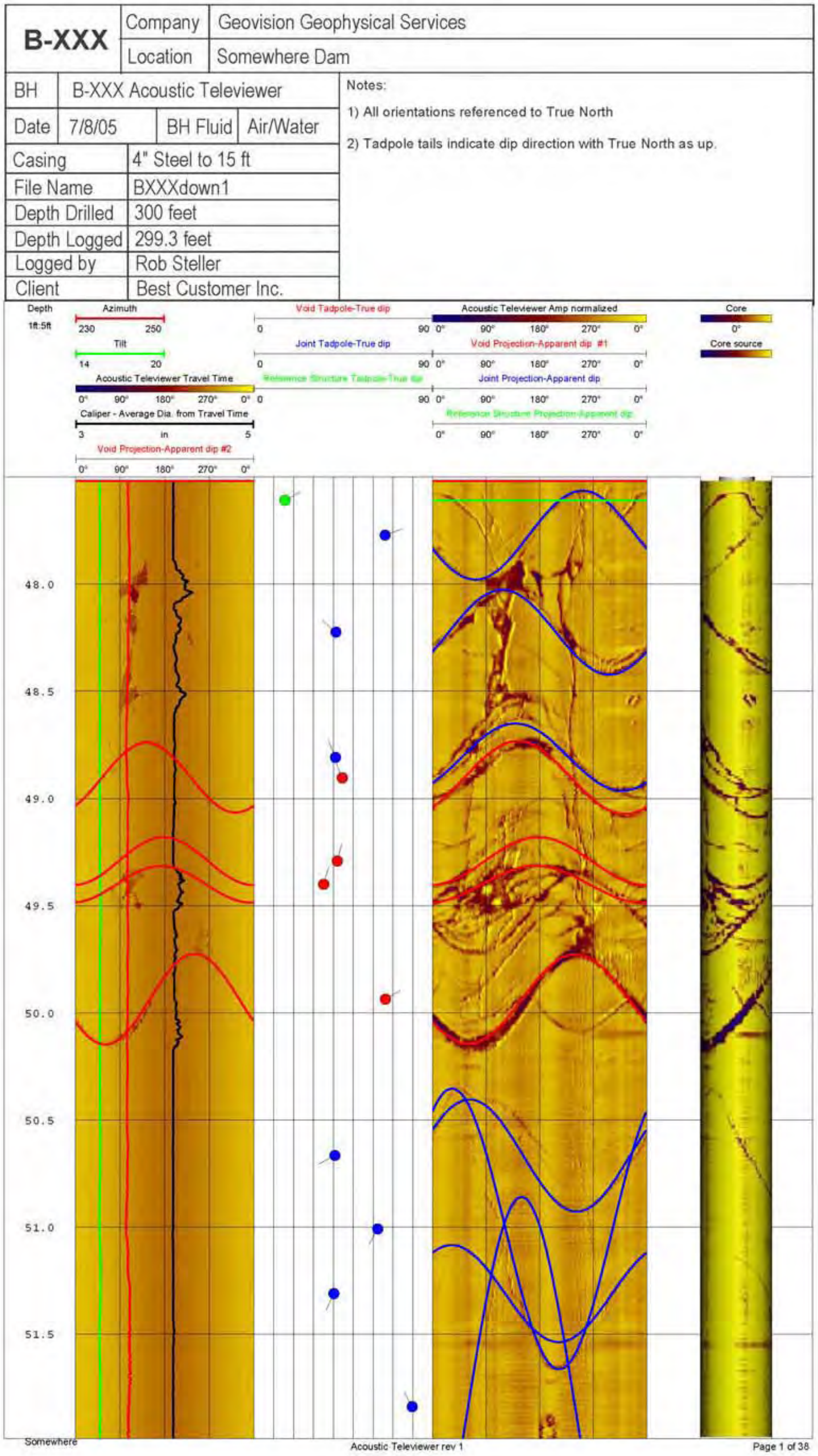
d) Instrumentation

e) Any deviations from test plan and action taken as a result

This procedure has been reviewed and approved by the undersigned:

Professional Geophysicist____________________Date___Feb 13. 2006___

QA Review ____________________Date___Feb 13. 2006___


B-XXX
Company
Geovision Geophysical Services
Location
Somewhere Dam
BH
B-XXX Acoustic Televiewer
Date
7/8/05
BH Fluid
Air/Water
Casing
4" Steel to 15 ft
File Name
BXXXdown1
Depth Drilled
300 feet
Depth Logged
299.3 feet
Logged by
Rob Steller
Client
Best Customer Inc.
Notes:
1) All orientations referenced to True North
2) Tadpole tails indicate dip direction with True North as up.
Depth
1ft:5ft
Azimuth
230
250
Tilt
14
20
Acoustic Televiewer Travel Time
Caliper - Average Dia. from Travel Time
3
in
5
Void Projection-Apparent dip #2
Void Tadpole-True dip
Joint Tadpole-True dip
Reference Structure Tadpole-True dip
Acoustic Televiewer Amp normalized
Void Projection-Apparent dip #1
Joint Projection-Apparent dip
Reference Structure Projection-Apparent dip
Core
Core source
48.0
48.5
49.0
49.5
50.0
50.5
51.0
51.5
Somewhere
Acoustic Televiewer rev 1
Page 1 of 38