Project Number: 5-C3418.00

Kaikōura Earthquake-Induced Landscape Dynamics Research

30 April 2023

CONFIDENTIAL

Theme 6 – Site Investigation Report

wsp

150 YEARS IN AOTEAROA

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Document Details:

Date:	30 April 2023
Reference:	GER 2023/13
Project no:	5-C3418.00
Status:	Final

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P. Brabhaharan

Document History and Status

Issue	Date	Author	Reviewed by	Approved by	Status
1	20/03/2023	Doug Mason	P Brabhaharan	P Brabhaharan	Draft
2	30/04/2023	Doug Mason	P Brabhaharan	P Brabhaharan	Final

Revision Details

Revision	Details
-	Draft issue
A	Final

Disclaimers and Limitations

This report ('**Report**') has been prepared by WSP exclusively for GNS Science ('**Client**') in relation to geotechnical site investigations carried out under the Kaikōura Earthquake-Induced Landslide Dynamics (EILD) research programme ('**Purpose**') and in accordance with the Short Form Agreement with the Client dated 22 August 2018. The findings in this Report are based on and are subject to the assumptions specified in the Report. WSP accepts no liability whatsoever for any reliance on or use of this Report, in whole or in part, for any use or purpose other than the Purpose or any use or reliance on the Report by any third party.

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1 Introduction

The 14 November 2016 M_w 7.8 Kaikōura earthquake triggered thousands of large landslides, hundreds of significant landslide dams and damaged hillslopes that are now susceptible to failure during rainstorms and aftershocks (Massey *et al.*, 2018). The damage caused by the earthquake included landslides, debris flows, rock falls, failure of retaining walls and bridges, fault rupture and slumping of embankments over 200 km. This resulted in severe disruption to transportation infrastructure in the North Canterbury and Marlborough regions, with the Main North Line railway closed for 9 months and State Highway 1 closed for over a year (Mason & Brabhaharan, 2019).

MBIE has funded a programme of research into the earthquake-induced landscape dynamics (EILD) following the Kaikōura earthquake under its Endeavour research programme. This is being led by GNS Science, with 7 research themes addressing different aspects of the landslides and sediment cascades triggered by that earthquake.

Under this research programme, WSP has been commissioned by GNS to investigate and analyse the performance of engineered or modified slopes in the earthquake, and to develop recommendations for resilient slope design and asset management. The objectives of this research theme are to:

1 Map the locations and extents of failures of cut slopes, natural slopes, fill embankments, and retaining systems along the transport corridors affected by the 2016 Kaikōura earthquake;

2 Carry out site investigations at selected key slope failures triggered by the Kaikōura earthquake;

3 Analyse selected landslides from the Kaikōura event to characterise the slope failure mechanisms and relate these to the observed impacts;

4 Identify critical factors that contributed to the slope failures and develop recommendations or guidelines for measures to enhance resilience for the design of new slopes and in management of landslide hazards along existing corridors;

5 Disseminate the recommendations amongst the engineering profession.

This report presents a compilation of the site investigations carried out as part of step 2 above.

2 Kaikōura earthquake-induced slope failures

The locations of slope failures along transportation corridors in the 2016 Kaikōura earthquake-affected area have been mapped based on field mapping, immediate post-event reconnaissance photos, aerial orthophotos and LiDAR terrain data (Mason & Brabhaharan, 2023). To date, 2383 failures of earthworks slopes have been mapped along the state highway, railway, and local road networks between Waipara and Picton (Figure 1).

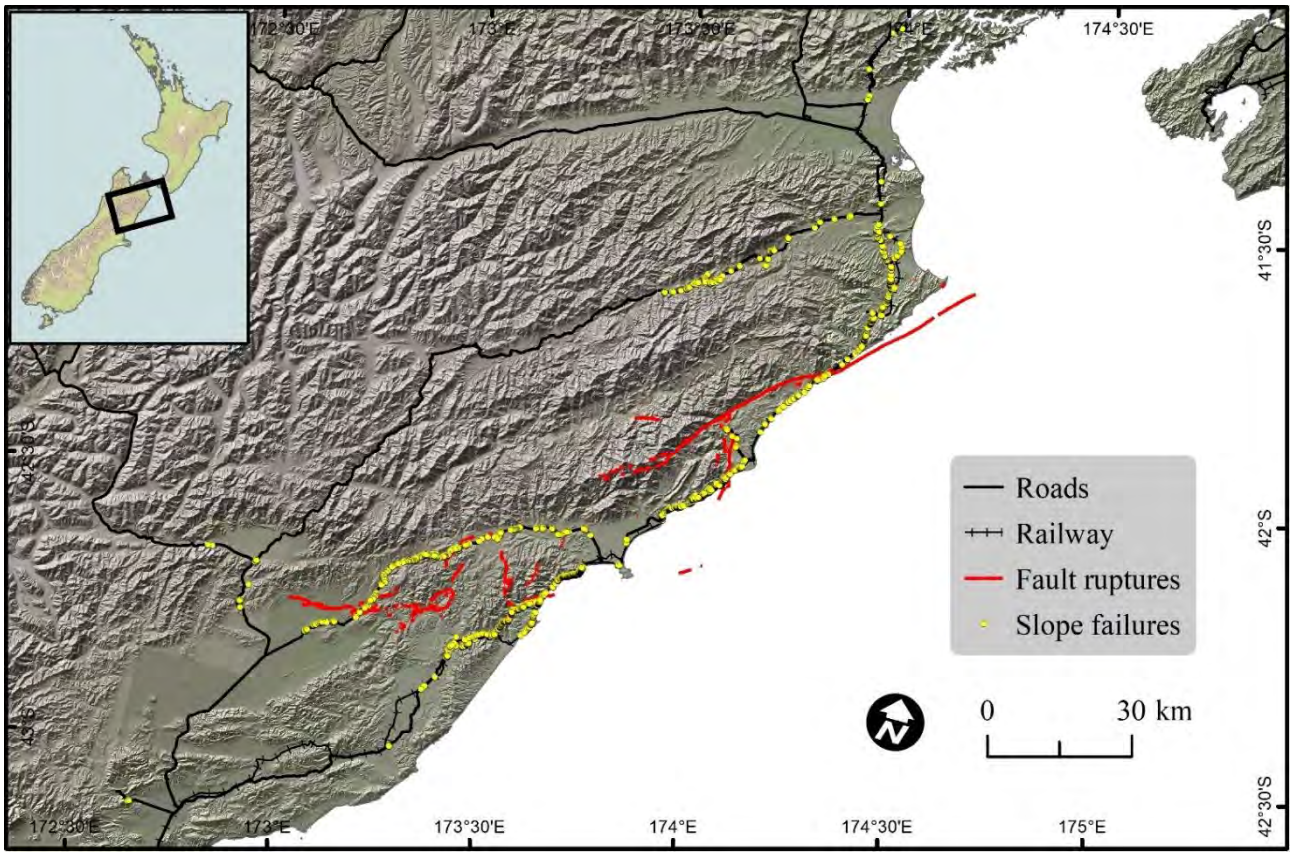


Figure 1. Locations of slope failures mapped along transport corridors in the upper South Island

A long list of failure sites was selected from the inventory of slope failures mapped through the Kaikōura earthquake-affected region. These consist of illustrative examples of the various failure modes observed in the earthquake as well as sites where significant damage occurred to the road and rail corridors. From this long list, key sites were selected for further investigation, to identify the geological and geotechnical properties of the slope failures in more detail. The chosen study sites were selected to capture particular failure mechanisms and damage impacts of engineering significance, for these to be assessed in detail. The sites are summarised in Table 1, and the locations of the sites are shown in Figure 2.

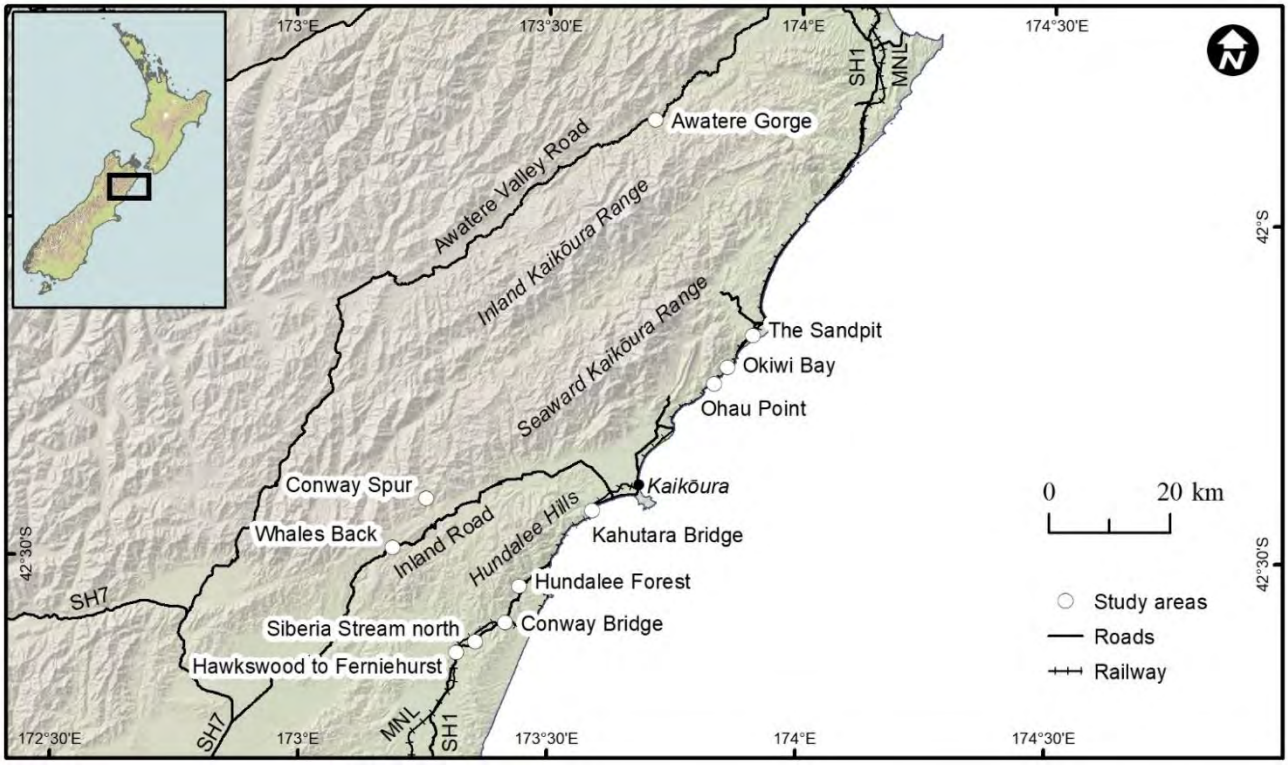


Figure 2. Locations of study sites

Table 1: Study area summary

Site		Geology	Failure type	Location[1]	Coordinates[2]
Rock slopes	Awatere Gorge	Mesozoic greywacke	Wedge and joint step-path slide	Awatere Valley Road RP-AVR3/7520	1658890 E 5365870 N
	Kahutara Bridge	Mesozoic greywacke	Planar slide	SH1S-RP-163/4300	1648356 W 5301718 N
	Ohau Point	Mesozoic greywacke	Rock/debris avalanche	SH1S-RP-118/12920	1668484 E 5322490 N
	Okiwi Bay	Mesozoic greywacke	Compound/ wedge slide	SH1S-RP-118/9200 MNL 216.6 km	1670621 E 5325173 N
	Conway Bridge	Mesozoic greywacke	Planar slide	SH1S-RP-195/400	1634105 E 5283295 N
	Siberia Stream north	Mesozoic greywacke	Step-path slide	SH1S-RP-195/6400	1629125 E 5280113 N
	Whales Back	Paleogene volcaniclastic sandstone	Planar slide	Inland Rd-RP-25300	1615557 E 5295643 N
	Conway Spur	Mesozoic greywacke	Planar slide	Conway Valley, Seaward Kaikōura Range	1621130 E 5303700 N
Fill/soil slopes	Hawkswood to Ferniehurst	Fill overlying Quaternary fan gravel	Translational/semi-rotational slide	SH1S-RP-195/10450	1626057 E 5278327 N
	Hundalee Forest	Fill overlying Neogene siltstone	Translation / spread	SH1S-RP-185/2590	1636433 E 5289208 N
	The Sandpit	Late Quaternary aeolian sand	Translational slide	SH1S-RP-118/1800 MNL 223.95 km	1674806 E 5330458 N

[1] SH1S = State Highway 1; RP = Route Position; MNL = Main North Line railway

[2] Coordinates of the approximate centre of the study site, in NZTM projection

3 Site investigations

3.1 Programme of site investigations

A programme of geotechnical site investigations has been developed to provide information on the geological and geotechnical properties at the selected failure sites, for the development of geological models and subsequent analysis of the failures. The programme of investigations consists of:

- Engineering geological and geomorphological mapping;
- Survey of rock slopes by Unmanned Aerial Vehicle (UAV), Terrestrial Laser Scanner (TLS), and LiDAR to develop 3D ground surface models;
- Drilling of rotary cored boreholes to provide information on the ground and groundwater conditions and to obtain samples for laboratory testing;
- Survey of the boreholes with downhole acoustic televiewer and full waveform sonic surveys;
- Laboratory classification and strength testing.

3.2 Engineering geological mapping

Engineering geological and geomorphological mapping of each study site was also carried out in conjunction with the drilling investigations. Soil and rock materials were observed and described using the NZ Geomechanics Society guidelines (NZGS, 2005). Desktop mapping of geomorphic features in GIS using pre- and post-earthquake aerial photography and LiDAR terrain data was used to supplement the field mapping. The engineering geology maps are given in Appendix A.

3.3 Surveys

Rock slopes where defect-controlled landslides occurred and the soil slope failure at The Sandpit have been surveyed by NCTIR, WSP and University of Canterbury survey technicians using a combination of UAV, TLS and terrestrial LiDAR. A further site is scheduled for survey by helicopter-mounted LiDAR. The locations of the surveyed slopes are listed in Table 2 and are shown in Figure 3 below.

Table 2: Summary of slope surveys

Site	Location	Coordinates[1]	Method
Awatere Gorge	BH103 site, Awatere Valley Road	1658880 E, 5365880 N	UAV
The Sandpit[2]	SH1S RS118/1800	1674805 E, 5330458 N	UAV
Conway Bridge south	SH1S RS195/400	1634120 E, 5283300 N	UAV, TLS, LiDAR
Siberia Stream north	SH1S RS195/6500	1629170 E, 5280300 N	UAV, TLS, LiDAR
Okiwi Bay[2]	BH101 site, SH1S RS118/9250	1670630 E, 5325180 N	UAV
Ohau Point[2]	SH1S RS118/12850	1668480 E, 5322490 N	UAV
Whales Back[2]	Inland Road RP25300	1615550 E, 5295630N	UAV
Conway Spur[3]	Seaward Kaikōura Range	1621180 E, 5303800 N	LiDAR

[1] Coordinates of the approximate centre of the survey area, in NZTM projection

[2] Surveys completed by WSP/NCTIR during the emergency response and recovery phases

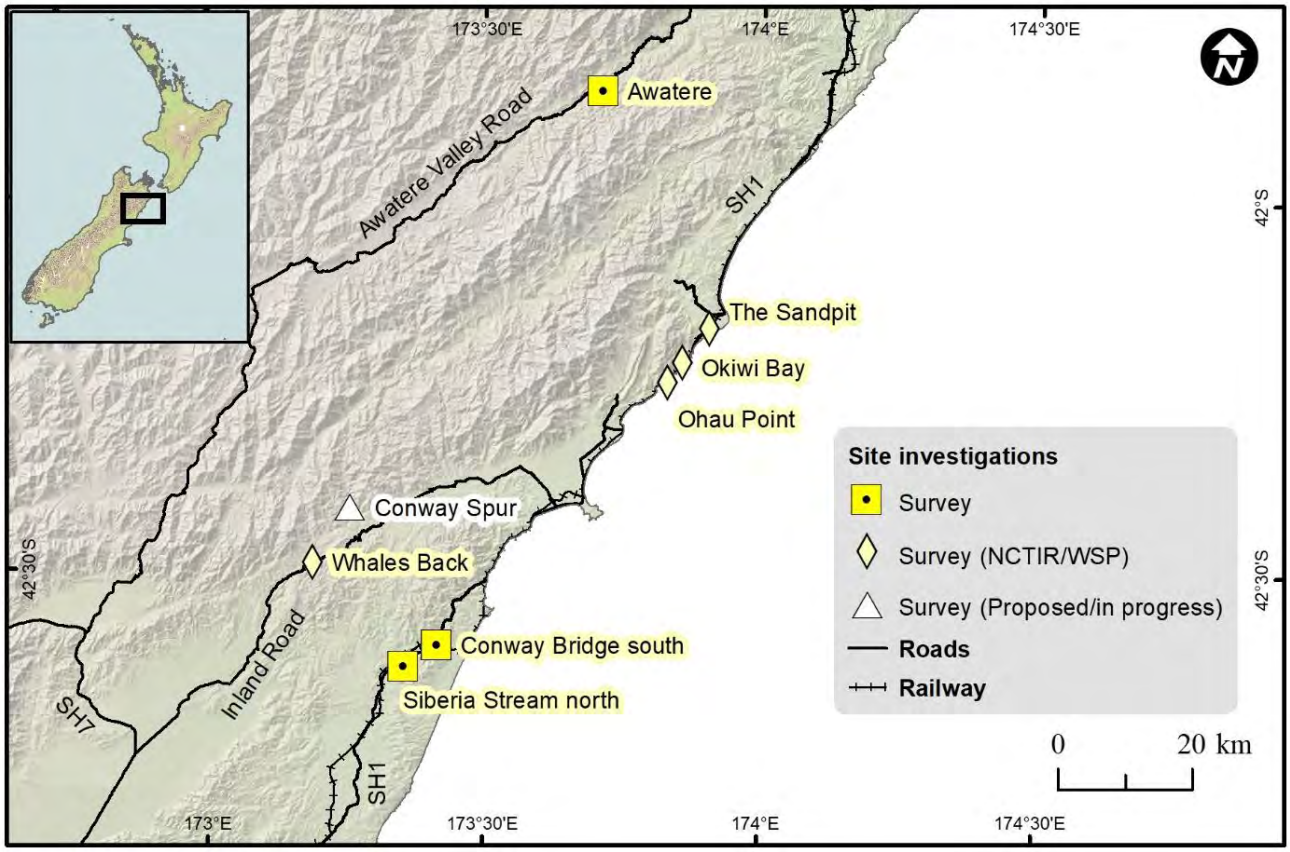


Figure 3. Locations of survey sites

3.4 Boreholes

Four boreholes were drilled in the earthquake-affected area under the direction and supervision of WSP. These were drilled by CW Drilling between August and October 2020. The boreholes were drilled using triple tube wireline rotary coring and recovered 82 mm diameter (PQ) core. The core samples were logged on site by WSP engineering geologists. All samples were logged in accordance with the New Zealand Geotechnical Society guidelines (NZGS, 2005).

Two of the boreholes (BH101 and BH103) were drilled at rock slope sites; BH104 and BH105 were drilled at fill embankment sites. A further borehole (BH102) was planned but not completed due to land access issues. All boreholes were drilled at a 90° inclination (vertical). Standard Penetration Tests (SPTs) were undertaken at 1.5 m depth intervals in boreholes BH104 and BH105.

A summary of the boreholes is given in Table 3, and their locations are shown in Figure 4. Individual borehole locations are shown in Figure 5 and on the engineering geology maps in Appendix A. The borehole logs and core photographs are presented in Appendix B.

Table 3: Summary of borehole investigations

Borehole ID	Location	Coordinates (NZTM)		Elevation (m)	Depth (m)
		Easting	Northing		
BH101	Okiwi Bay	1670538	5325187	104	90
BH102[1]	'The Punchbowl', SH1S RS163/6410	n/a	n/a	n/a	n/a
BH103	Gladstone Downs Station, Awatere Valley Road, near Isis Stream	1658900	5365810	515	49.9
BH104	Hundalee Forest, SH1S RS185/2630	1636424	5289209	190	15.4
BH105	Homestead Creek, SH1S RS195/10500	1626055	5278370	119	25.9

[1] BH102 not drilled due to land access issues

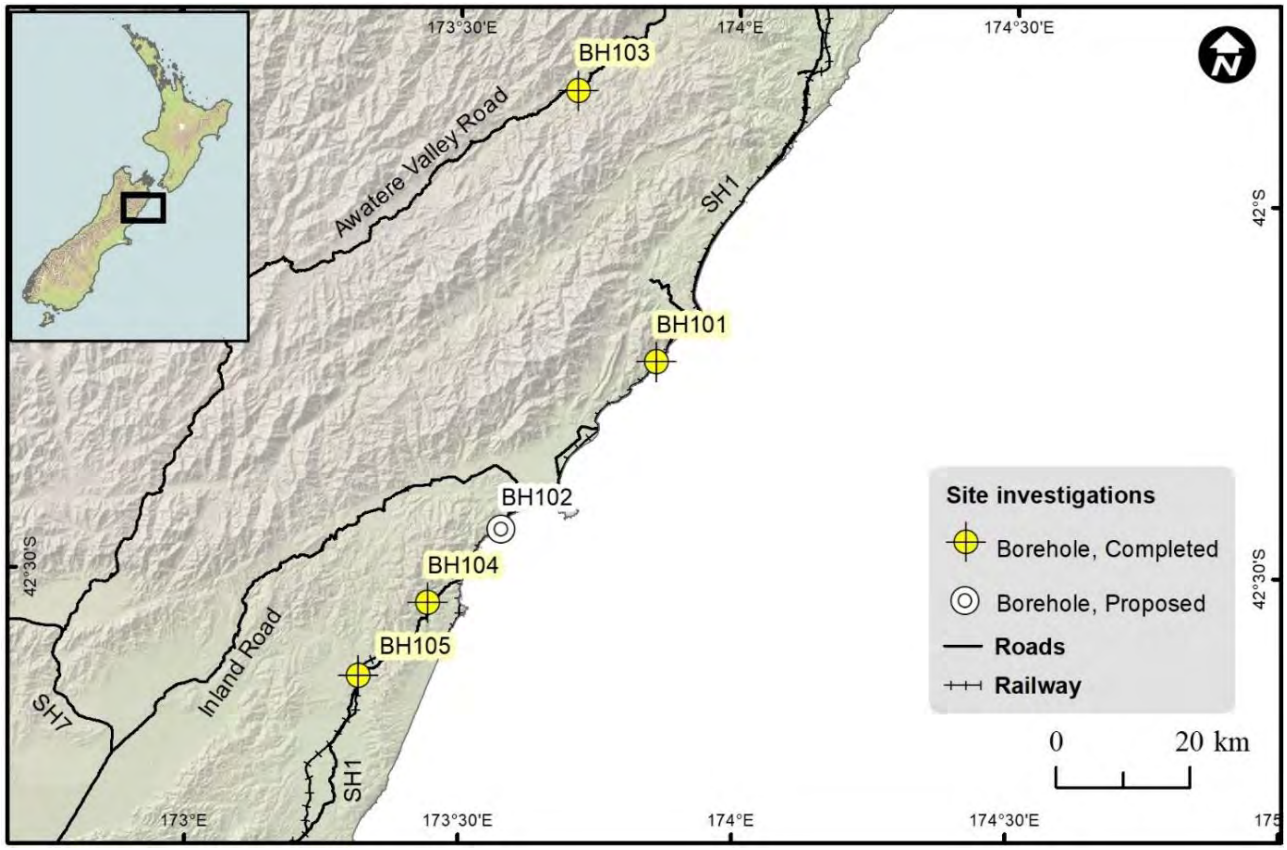


Figure 4. Borehole location overview plan

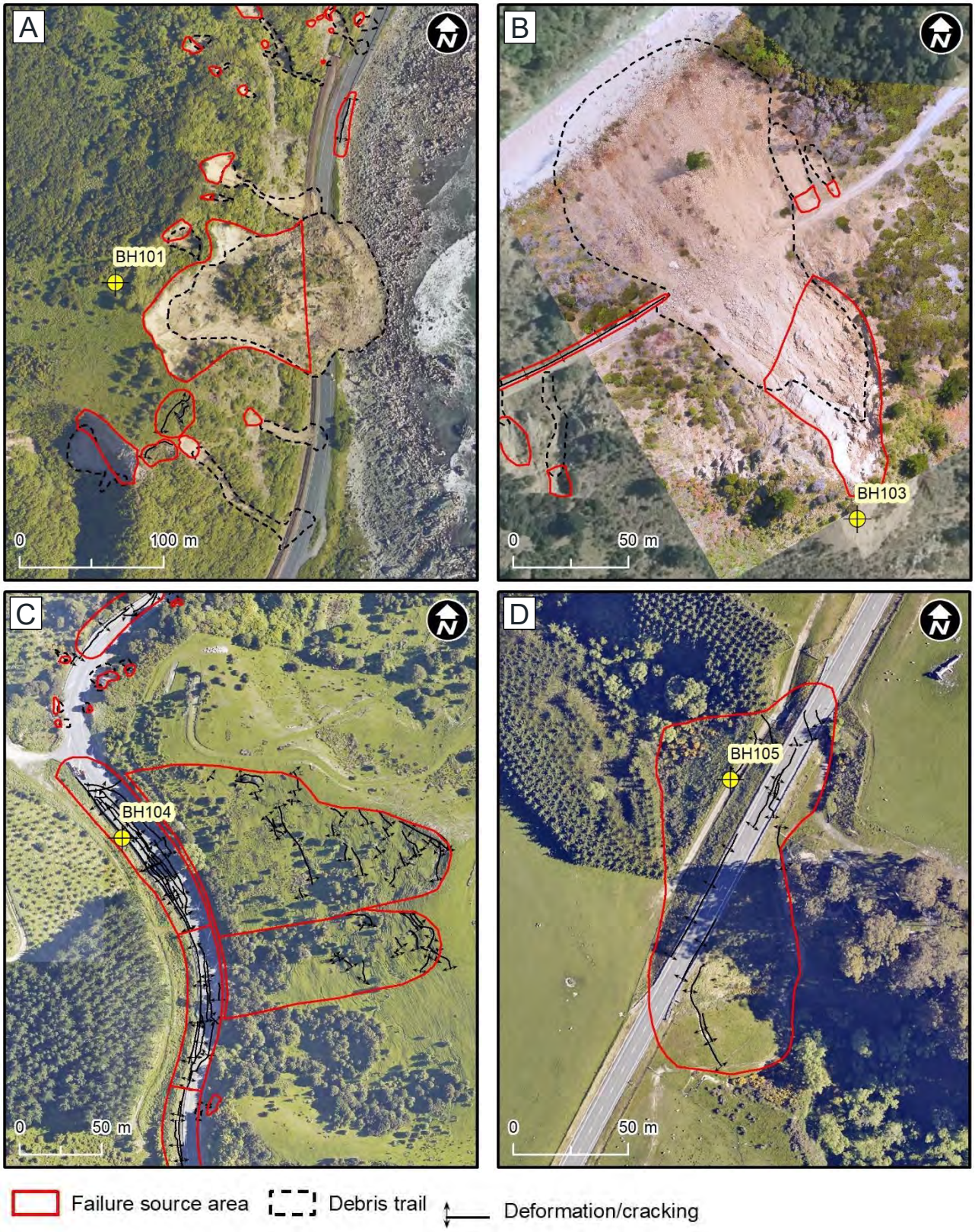


Figure 5. Borehole sites: (A) Okiwi Bay; (B) Awatere Gorge; (C) Hundalee Forest; (D) Homestead Creek.

3.5 Downhole geophysical surveys

Downhole geophysical surveys consisting of acoustic and optical televiewer (ATV/OTV), full waveform sonic and density surveys were undertaken by RDCL (subcontracted by CW Drilling) in boreholes BH101 and BH103. The purpose of the surveys was to identify the orientation of defects and characterise the rock mass properties in the fractured greywacke rock. For each hole surveyed, the data was processed and interpreted to identify rock defects and their orientation.

The geophysical survey logs are provided in Appendix C.

3.6 Laboratory testing

A series of laboratory tests were scheduled for rock and soil samples collected from the boreholes to characterise the materials and provide information for use in the slope analyses. The testing was carried out by geomechanics laboratories at WSP Research, GNS Science and the University of Canterbury School of Earth and Environment. The following tests were specified:

- Triaxial tests [In house methodology];
- Atterberg limits [NZS4402: 1986 – Methods of testing soils for civil engineering purposes – Soil classification tests - Tests 2.1 to 2.6];
- Unconfined Compressive Strength (UCS) [ISRM 1979, Suggested Methods for Determining the Uniaxial Compressive Strength and Deformability of Rock Materials].

The results of the testing received to date are provided in Appendix D.

4 References

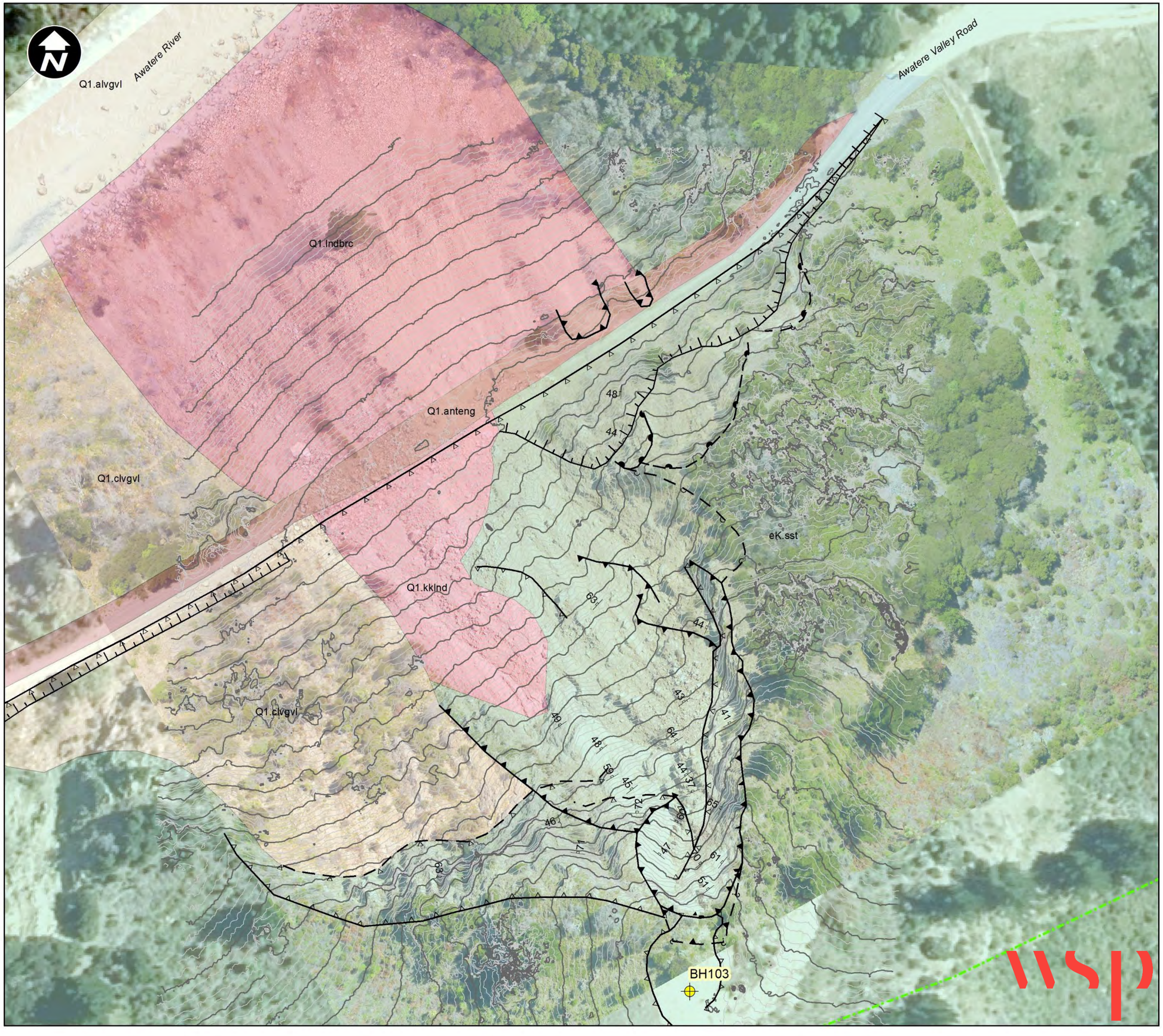
Mason, D., & Brabhaharan, P. (2019). Resilience of transport corridors in the 2016 Kaikōura earthquake, to inform recovery and future slope design and landslide hazard management. Paper presented at the 2nd International Conference on Natural Hazards and Infrastructure, Chania, Greece. 12 p.

Mason, D., & Brabhaharan, P. (2023). Kaikōura Earthquake-Induced Landscape Dynamics Research – Theme 6 – Landslide inventory report. *WSP report no. GER 2023/12*. Wellington, NZ: WSP, 18 p.

Massey, C., Townsend, D., Rathje, E., Allstadt, K. E., Lukovic, B., Kaneko, Y., . . . Villeneuve, M. (2018). Landslides triggered by the 14 November 2016 Mw 7.8 Kaikōura Earthquake, New Zealand. *Bulletin of the Seismological Society of America, 108*(3B), 1630-1648. doi:10.1785/0120170305

NZGS (2005). Field Description of Soil and Rock; Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes. New Zealand Geotechnical Society Inc, 38 p.

Appendix A
Engineering geology maps



Legend

Ground investigations

- Borehole

Structural geology

- Bedding
- Joint
- Sheared zone

Scarp

- Sharp, Accurate
- Sharp, Inferred
- Rounded, Accurate
- Rounded, Approximate
- Rounded, Inferred

Slope break

- Convex, Sharp, Accurate
- Convex, Rounded, Approximate
- Concave, Sharp, Accurate
- Concave, Sharp, Approximate

Cut slope

- Accurate

Other

- Lineament

Contours (2021 UAV survey)

- 5 m
- 1 m

Geology

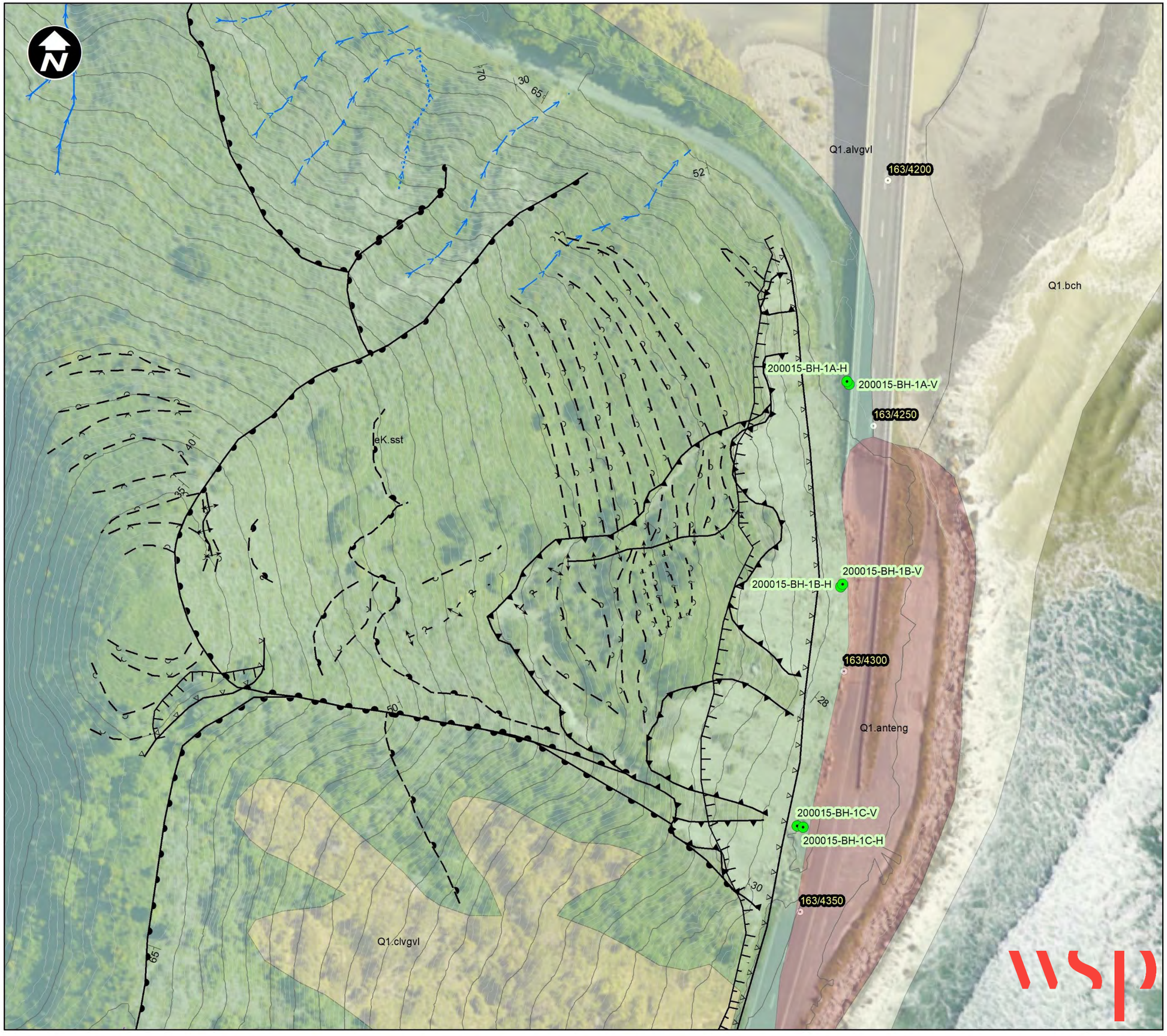
Q1.kklnd	Kaikoura earthquake landslide debris
Q1.anteng	Anthropogenic fill
Q1.alvgvl	Holocene river deposits
Q1.clvgvl	Holocene colluvium
eK.sst	Pahau Terrane greywacke

Kaikoura EILD Research
Site investigations
Engineering geology map
Awatere Gorge

Scale 1:750

0 — 50 m

Status	Proj No	Date
Final	5-C3418.00	19/03/2023



Legend

Ground investigations

- Borehole (NCTIR)

Structural geology

- Bedding
- Joint

Scarp

- Sharp, Accurate
- Rounded, Accurate
- Rounded, Approximate
- Rounded, Inferred

Slope break

- Convex, Rounded, Approximate
- Convex, Rounded, Inferred
- Concave, Sharp, Accurate
- Concave, Rounded, Approximate
- Concave, Rounded, Inferred

Tension crack

- Accurate
- Inferred

Cut slope

- Accurate

Channel

- Accurate
- Approximate
- Inferred

Contours (2016 LiDAR)

- 5 m
- 1 m

Geology

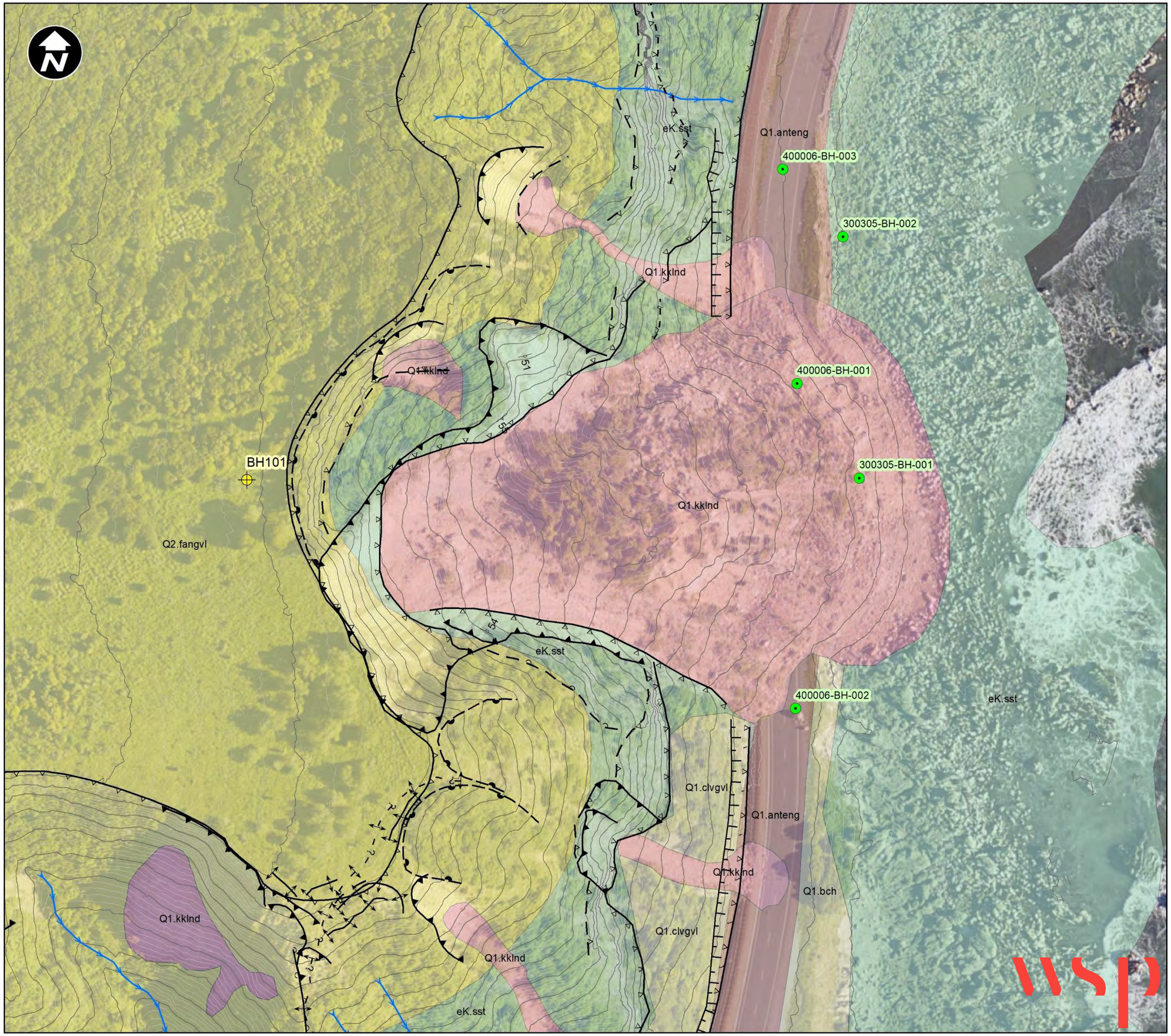
Q1.anteng	Anthropogenic fill
Q1.alvgvl	Holocene river deposits
Q1.bch	Beach deposits
Q1.clvgvl	Holocene colluvium
eK.sst	Pahau Terrane greywacke

Kaikoura EILD Research
Site investigations
Engineering geology map
Kahutara Bridge

Scale 1:750

0 — 50 m

Status	*Proj No*	*Date*
Final	5-C3418.00	19/03/2023



Legend

Ground investigations

- Borehole
- Borehole (NCTIR)

Structural geology

- Joint
- Sheared zone

Scarp

- Sharp, Accurate
- Rounded, Approximate

Slope break

- Convex, Sharp, Accurate
- Convex, Sharp, Approximate
- Convex, Rounded, Approximate
- Ridge, Rounded, Accurate
- Concave, Sharp, Accurate
- Concave, Sharp, Approximate
- Concave, Sharp, Inferred
- Concave, Rounded, Accurate
- Concave, Rounded, Approximate
- Concave, Rounded, Inferred

Tension crack

- Accurate
- Approximate
- Inferred

Cut slope

- Accurate

Channel

- Accurate

Contours (2016 LiDAR)

- 5 m
- 1 m

Geology

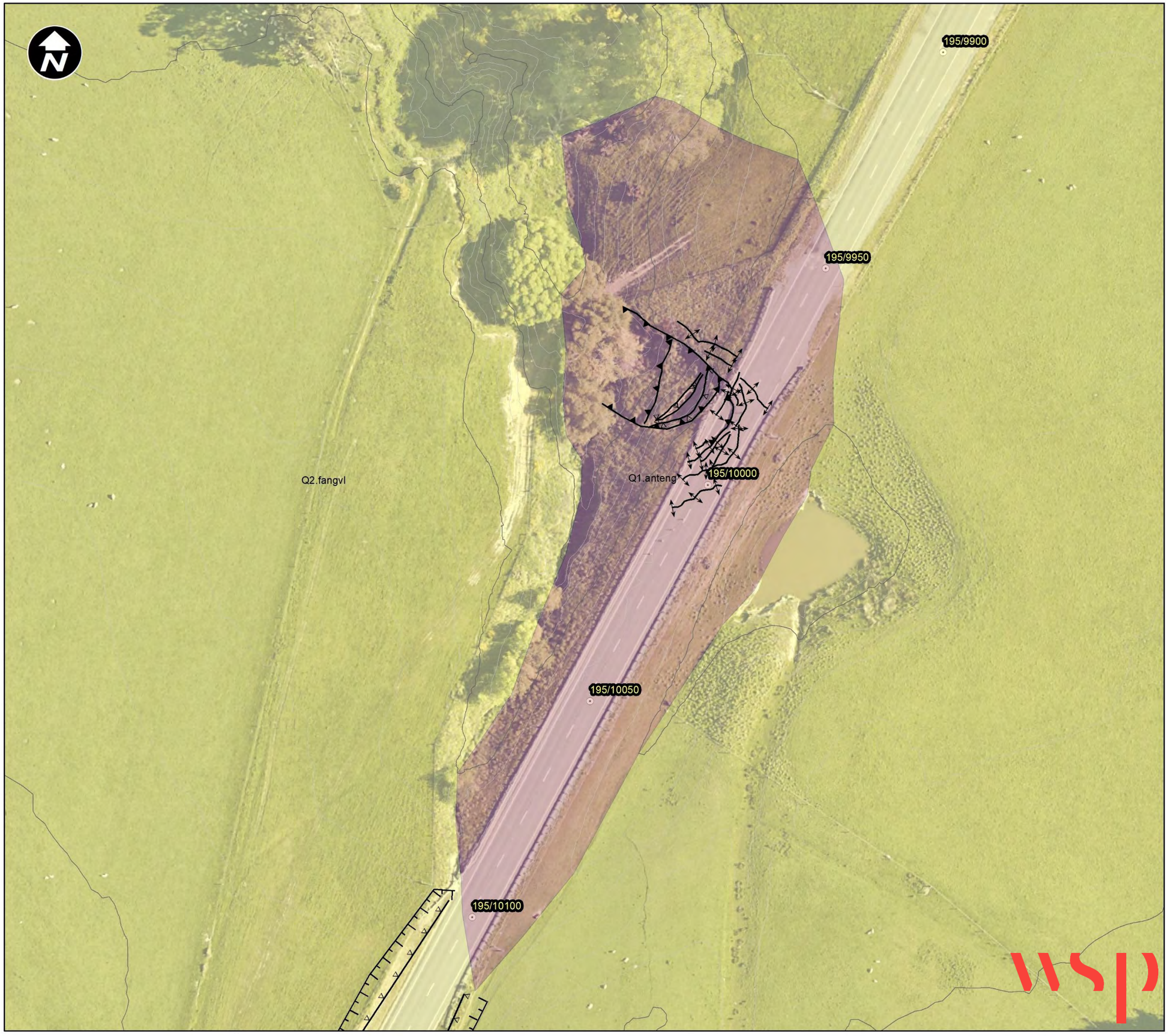
Q1.kklnd	Kaikoura earthquake landslide debris
Q1.anteng	Anthropogenic fill
Q1.bch	Beach deposits
Q1.clvgvl	Holocene colluvium
Q2.fangvl	Late Pleistocene fan deposits
eK.sst	Pahau Terrane greywacke

Kaikoura EILD Research
Site investigations
Engineering geology map
Okiwi Bay

Scale 1:1,000

0 — 50 m

Status	*Proj No*	*Date*
Final	5-C3418.00	19/03/2023



Legend

Scarp

Sharp, Accurate

Slope break

Convex, Sharp, Accurate

Concave, Sharp, Accurate

Tension crack

Accurate

Cut slope

Accurate

Contours (2016 LiDAR)

5 m

1 m

Geology

Q1.anteng Anthropogenic fill

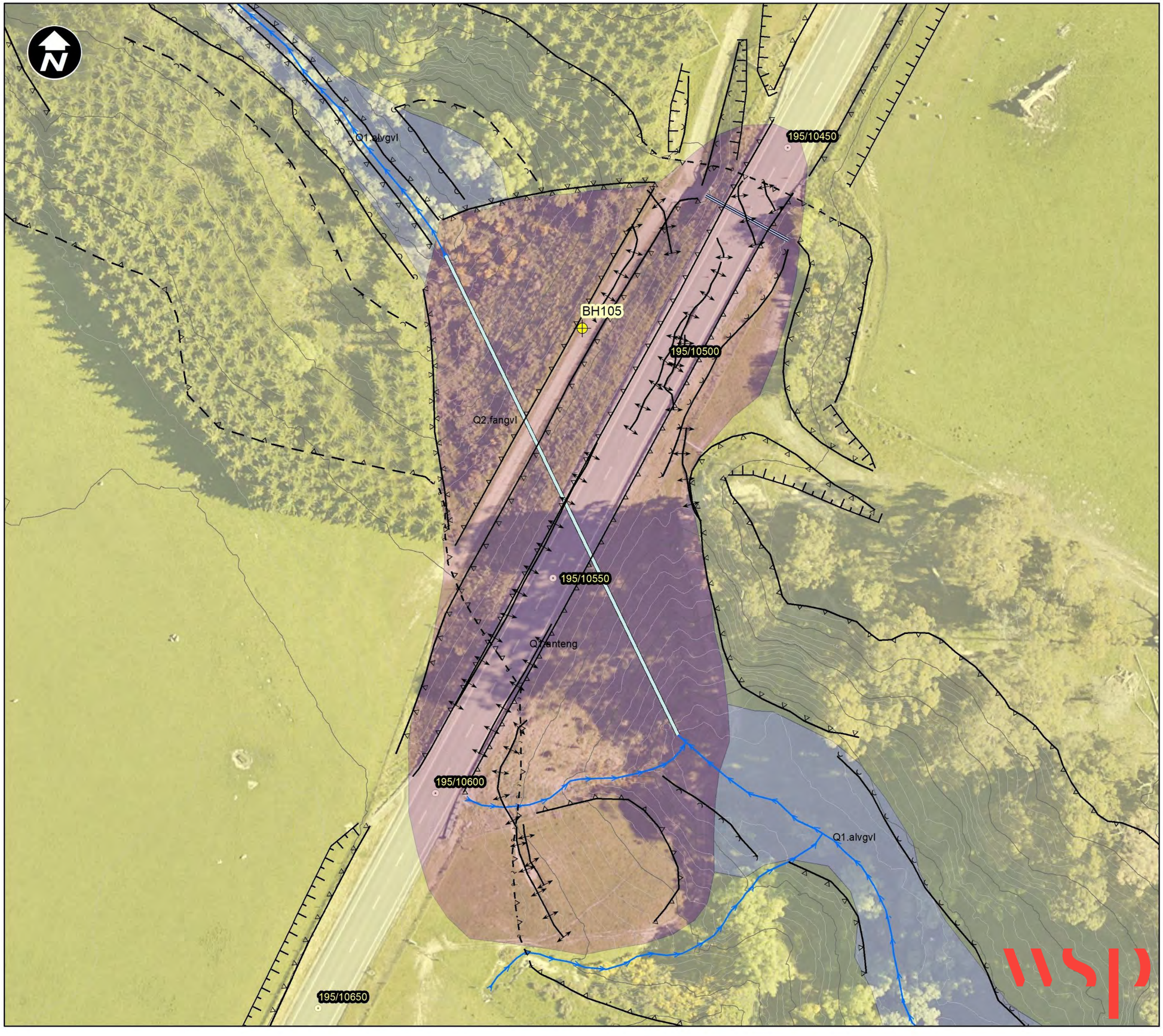
Q2.fangvl Late Pleistocene fan deposits

Kaikoura EILD Research
Site investigations
Engineering geology map
Culvert 55

Scale 1:750

0 50 m

Status	Proj No	Date
Final	5-C3418.00	19/03/2023



Legend

Ground investigations

- Borehole

Slope break

- Convex, Sharp, Accurate
- Convex, Sharp, Approximate
- Convex, Sharp, Inferred
- Convex, Rounded, Accurate
- Concave, Sharp, Accurate
- Concave, Rounded, Accurate
- Concave, Rounded, Approximate

Tension crack

- Accurate

Cut slope

- Accurate

Channel

- Accurate

Other

- Culvert
- Stock underpass

Contours (2016 LiDAR)

- 5 m
- 1 m

Geology

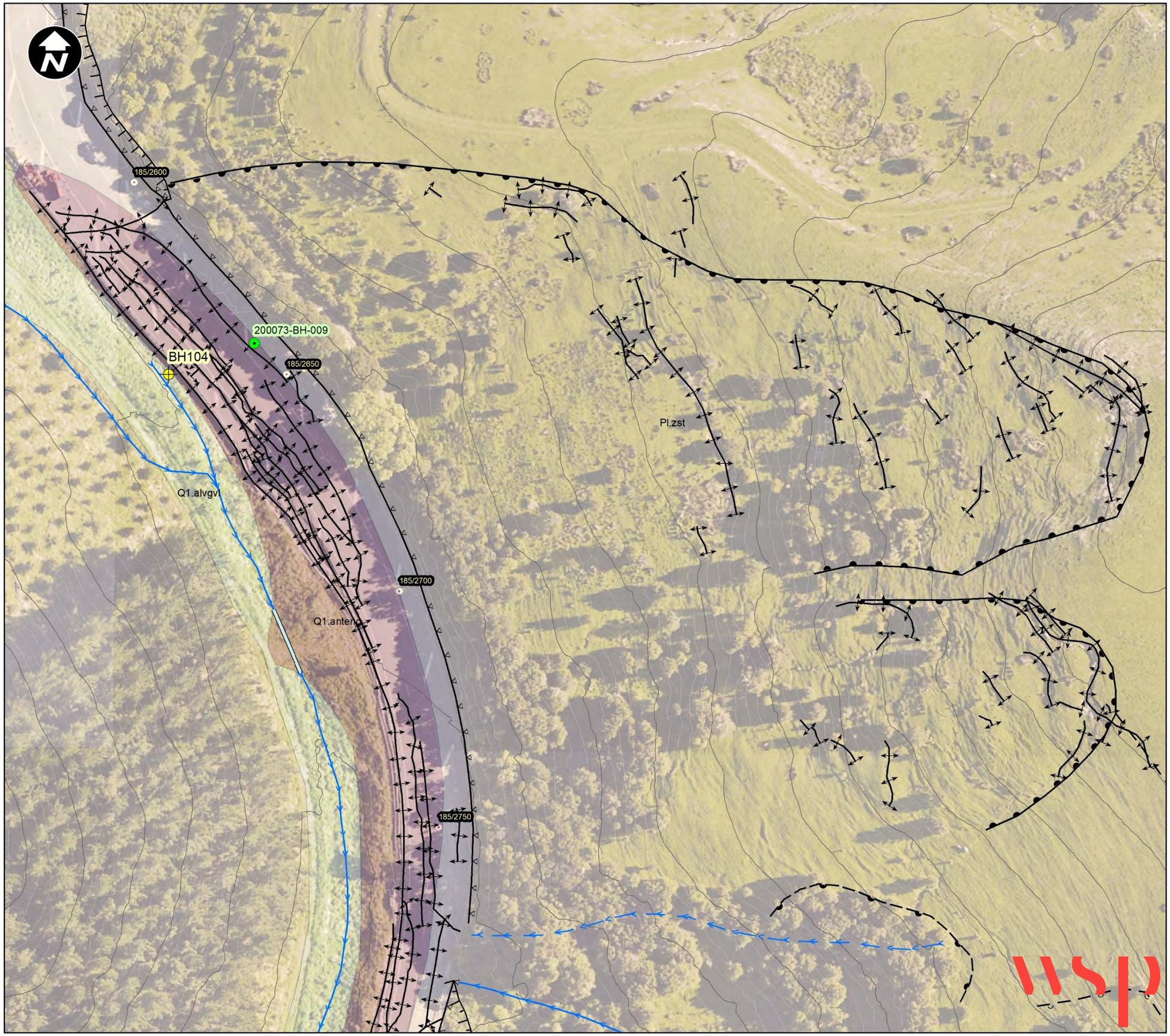
- Q1.anteng Anthropogenic fill
- Q1.alvgvl Holocene river deposits
- Q2.fangvl Late Pleistocene fan deposits

Kaikoura EILD Research
Site investigations
Engineering geology map
Homestead Creek

Scale 1:750

0 50 m

Status	Proj No	Date
Final	5-C3418.00	19/03/2023



Legend

Ground investigations

- Borehole
- Borehole (NCTIR)

Scarp

- Rounded, Accurate
- Rounded, Approximate

Slope break

- Convex, Rounded, Approximate
- Concave, Sharp, Accurate

Tension crack

- Accurate

Cut slope

- Accurate

Channel

- Accurate
- Approximate

Other

- Culvert

Contours (2016 LiDAR)

- 5 m
- 1 m

Geology

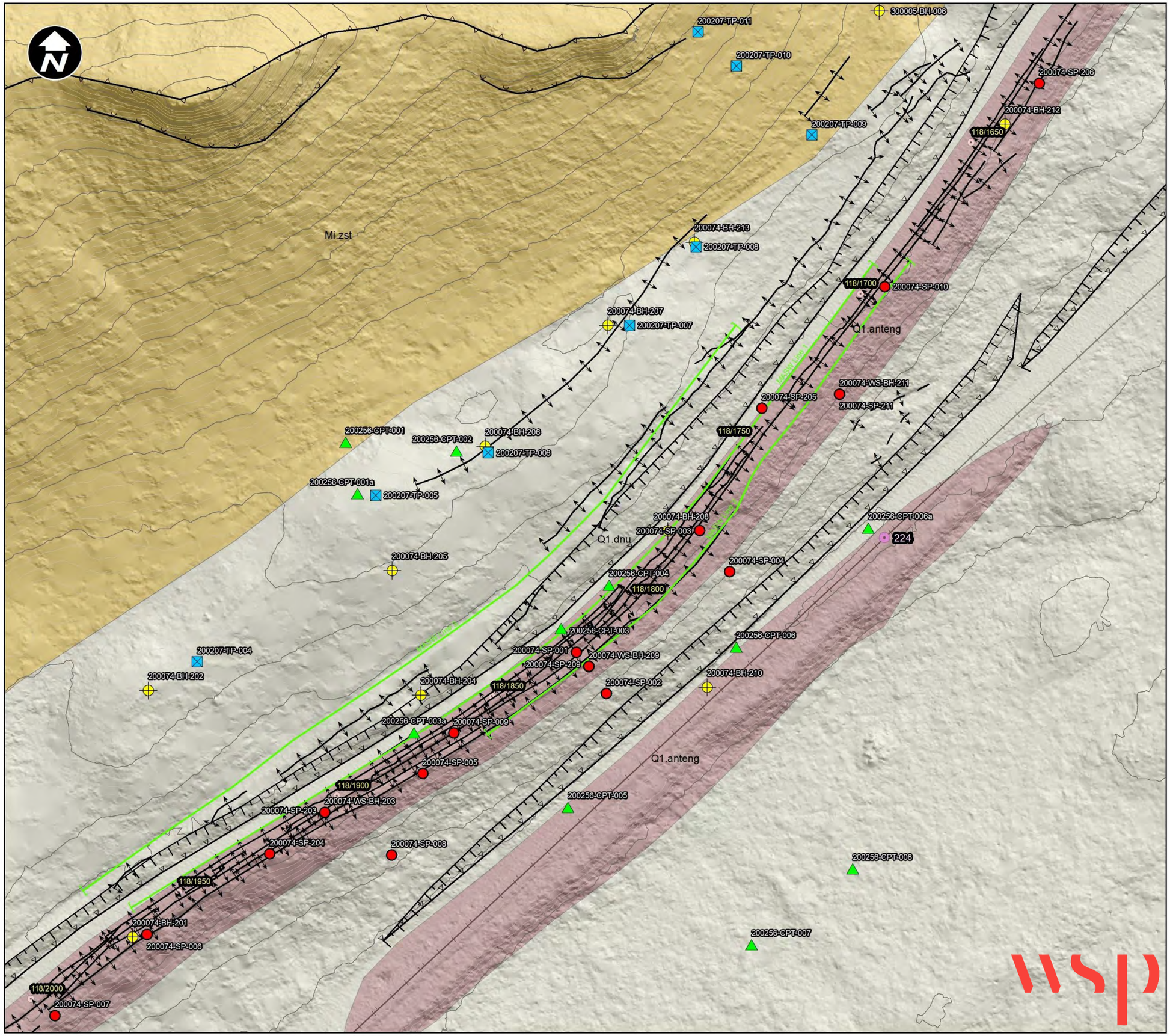
Q1.anteng	Anthropogenic fill
Q1.alvgvl	Holocene river deposits
Pl.zst	Pliocene siltstone

Kaikoura EILD Research
Site investigations
Engineering geology map
Hundalee Forest

Scale 1:750

0 — 50 m

Status	*Proj No*	*Date*
Final	5-C3418.00	19/03/2023



Legend

Sandpit Ground Investigations

The Sandpit

- Borehole
- Window sample
- Cone penetration test
- Scala penetrometer
- Test pit
- MASW lines

Slope break

- Ridge, Sharp, Accurate
- Concave, Sharp, Accurate
- Concave, Rounded, Accurate

Tension crack

- Accurate
- Approximate

Cut slope

- Accurate

Contours (2016 LiDAR)

- 5 m
- 1 m

Geology

- Q1.anteng Anthropogenic fill
- Q1.dnu Dune deposits
- Mi.zst Miocene siltstone
- Railway

Kaikoura EILD Research
Site investigations
Engineering geology map
The Sandpit

Scale 1:1,000

0 50 m

Status	Proj No	Date
Final	5-C3418.00	19/03/2023

Appendix B
Borehole logs

Borehole No. BH101

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1670538 E 5325187 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	90 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 104 m	*Inclination:*	-90°
Location:	Slip P8, Okiwi Bay North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
Quaternary Alluvium	Gravelly COBBLES with some sand and minor boulders; brownish grey, homogeneous. Tightly packed; moist; well graded. Gravel, cobbles and boulders unweathered, strong, subrounded to subangular sandstone; boulders maximum 220mm size; sand fine to coarse.		1									PQ	100		PQ Size, Triple Tube, Wireline Rotary Coring		SWL n/am 1/10	Bentonite seal
												PQ	100					
												PQ	100					
												PQ	100					
	Sandy fine to coarse GRAVEL with some cobbles and minor silt; greenish grey, homogeneous. Tightly packed; moist; well graded. Gravel subangular to subrounded, unweathered sandstone; sand fine to coarse; silt low plasticity.	102	2									PQ	94					
	2.8m - 3.65m: Fines mostly washed out, sample recovered as fine to coarse gravel and cobbles.		3									PQ	64					
												PQ	100					
		100	4									PQ	92					
	4.5m: With trace boulders, maximum 240mm size.											PQ	100					
			5									PQ	92					
												PQ	100					
		98	6									PQ	100					
												PQ	100				SWL 2.24m 2/10	
			7									PQ	92					
	7.77m - 8m: Orange-brown limonite staining on some gravels.											PQ	100					
		96	8									PQ	100					Gravel back fill
												PQ	100					
			9									PQ	90					
		94										PQ	95					

Notes:

Started:	1/10/2020	*Finished:*	16/10/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH101

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1670538 E 5325187 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	90 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 104 m	*Inclination:*	-90°
Location:	Slip P8, Okiwi Bay North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
Quaternary Alluvium	Sandy fine to coarse GRAVEL with some cobbles and minor silt; greenish grey, homogeneous. Tightly packed; moist; well graded. Gravel subangular to subrounded, unweathered sandstone; sand fine to coarse; silt low plasticity.*(continued)* 10.3m: 340mm diameter boulder - unweathered, strong, coarse sandstone.											PQ	95		PQ Size, Triple Tube, Wireline Rotary Coring			Gravel back fill
	11.4m: Cobble of coarse sandstone with siltstone clasts.	92	12									PQ	100					
												PQ	100					
			13									PQ	94					
	13.2m: Gravels and cobbles predominantly sandstone, with some siltstone; moderately strong to strong.											PQ	100					
		90	14									PQ	100					
												PQ	88					
	14.6m - 15m: Sample recovered as subangular fine to coarse gravel, fines washed out.											PQ	80					
			15									PQ	83					
												PQ	100					
	15.65m: Gravel becomes unweathered to slightly weathered.	88	16									PQ	56					
												PQ	100					
			17									PQ	100					
	Clayey SILT with some gravel and minor sand; greenish brown, homogeneous. Hard; moist; low plasticity. Gravel fine to medium, very weak, subrounded sandstone; sand fine.	86	18									PQ	100					
	18.5m: Gravel becomes fine to coarse.																	
			19									PQ	100					
	Gravelly SILT with minor sand and clay; greenish brown, homogeneous. Stiff to hard; moist; low plasticity. Gravel fine to coarse, weak to very weak, subangular to subrounded sandstone; sand fine.	84																

BOREHOLE SOIL/ROCK LOG A4 - WSP EILD.GPJ WSP-OPUS2018_TEM.GDT 20/3/23

Notes:

Started:	1/10/2020	*Finished:*	16/10/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH101

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1670538 E 5325187 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	90 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 104 m	*Inclination:*	-90°
Location:	Slip P8, Okiwi Bay North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
Quaternary Alluvium	Gravelly SILT with minor sand and clay; greenish brown, homogeneous. Stiff to hard; moist; low plasticity. Gravel fine to coarse, weak to very weak, subangular to subrounded sandstone; sand fine. *(continued)*											PQ	100		PQ Size, Triple Tube, Wireline Rotary Coring			Gravel back fill
	Silty fine to coarse GRAVEL with some clay and trace sand; greenish light brown, homogeneous. Tightly packed; moist; well graded. Gravel subangular to subrounded, unweathered to slightly weathered, moderately strong to weak sandstone; sand fine to coarse; silt/clay plastic. 21.85m: With minor cobbles, maximum 140mm size. 22m: Fe staining throughout core; gravels slightly to moderately weathered.	82	22									PQ	100					
	Sandy GRAVEL and COBBLES with some silt and minor boulders; yellowish brown, homogeneous. Tightly packed; wet; gap graded. Gravel, cobbles and boulders moderately weathered, strong, rounded to subrounded sandstone.	80	24									PQ	66					
	Sandy GRAVEL; dark bluish grey. Tightly packed; wet; gap graded. Fine gravel, subrounded, weakly cemented.																SWL 5.78m 3/10	
	Zone of core loss; limited recovery of drill cuttings from flush return	78	26									PQ	0					
												PQ	0					
												PQ	0					
			27															
Pahau Terrane	Unweathered, dark grey SILTSTONE, moderately strong								C			PQ	100	0				
										J20	27.68m - J, 20°, SM, UN	PQ	100	92				
		76	28				MS	UW	MW	J50	28.30m - J, 50°, SM, UN, T						SWL 12.23m 4/10	
										J20	28.42m - J, 20°, SM, UN	PQ	100	77				
	Very steeply dipping incipient joints exposed at the end of the core run; smooth, undulating surfaces, possibly slickensided/polished		29							J10	28.93m - J, 10°, SM, UN							
										J50	29.40m - J, 50°, RO, PL, VN	PQ	100	47				
										J30	29.70m - J, 30°, RO, ST, N							
	Shattered/sheared zone: recovered as silty	74					VW	MW	EC	SZ50	29.85m - SZ, 50°							
										J70								

Notes:

Started:	1/10/2020	*Finished:*	16/10/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH101

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1670538 E 5325187 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	90 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 104 m	*Inclination:*	-90°
Location:	Slip P8, Okiwi Bay North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
Pahau Terrane	GRAVEL, dark grey, loose, moist. Fine angular gravel of unweathered SILTSTONE, average clast size 5mm Sheared zone: moderately weathered, dark grey SILTSTONE, very weak, thin discontinuous white quartz/calcite veins						MS VW	SW MW	VC EC	J25 SZ50 J70 J90	30.00m - J, 70°, SM, UN, N 30.10m - J, 25°, RO, UN 30.13m - SZ, 50°	PQ	100	47	PQ Size, Triple Tube, Wireline Rotary Coring		SWL 10.90m 5/10	Gravel back fill
										J70	30.40m - J, 70°, RO, UN							
									MW	J30	30.80m - J, 30°, RO, UN							
	Closely spaced incipient joints dipping 50° to 90°; rough, undulating/stepped, closed	31							C	J50 J90 J25	31.10m - J, 50° 31.15m - J, 90°	PQ	100	77				
	Fissile, brittle material									J5 J20	31.20m - J, 25°, RO, ST 31.37m - J, 5°, RO, ST, VN 31.40m - J, 20°, RO, UN, N							
										J25	31.70m - J, 25°, RO, UN							
		72	32							J75 J75	31.85m - J, 75°, SM, UN, T 32.00m - J, 75°, SM, UN, T							
									MW	J40 J35	32.20m - J, 40°, SM, UN 32.30m - J, 35°, RO, UN, VN							
							MS	UW		J50	32.70m - J, 50°, RO, UN	PQ	100	93				
		33								J20 J35	33.06m - J, 20°, SM, UN 33.10m - J, 35°, RO, ST							
										J35	33.40m - J, 35°, SM, ST							
									C	J20 J40 J20 J50	33.70m - J, 20°, SM, ST 33.75m - J, 40°, SM, ST 33.80m - J, 20°, RO, PL							
		70	34							J87	33.90m - J, 50°, SM, PL, clay veneer 34.00m - J, 87°, SM, UN, T							
	Sheared zone 3 to 5 mm thick								MW	J60 J80 J40 SZ	34.20m - J, 60°, SM, UN, T 34.21m - SZ, 80° 34.32m - J, 40°, RO, ST, VN	PQ	100	73				
	Sheared zone, possibly bedding-parallel? 2 mm wide, clay infill									SZ70 SZ40	34.70m - SZ, 70°, SL, UN, T, clay gouge 34.83m - SZ, 40°							
	Sheared zone: cross cutting bedding; Moderately weathered, dark grey SILTSTONE, very weak. Layers of 2 to 5 mm thick grey SILT with sand and fine angular gravel Unweathered, dark grey SILTSTONE, moderately strong Thin undulating laminations, very steeply dipping - possibly bedding-parallel. Incipient joints opening parallel and conjugate to these laminations	35					VW	MW	EC			PQ	100	100				
										J50	35.45m - J, 50°, SM, UN							
									MW	J45	35.80m - J, 45°, SM, ST, VN							
		68	36							J35	36.02m - J, 35°, RO, UN, VN	PQ	100	70				
										J80 J	36.23m - J, 30°, RO, UN 36.24m - J, 25°, SM, ST							
										J75								
										J25	36.60m - J, 75°, T 36.68m - J, 25°, SM, ST							
										J20	36.90m - J, 20°, SM, UN, VN							
		37					MS	UW	C	J10	37.05m - J, 10°, RO, ST, T							
										J40	37.13m - J, 40°, SM, UN, VN							
										J45 J15 J30	37.30m - J, 45°, SM, UN, T 37.37m - J, 15°, RO, ST 37.40m - J, 30°, RO, ST, T	PQ	100	89				
	Incipient joints cutting across laminated bedding								MW									
		66	38						C									
												PQ	100	100				
										J30	38.44m - J, 30°, SM, ST							
									MW	J45	38.74m - J, 45°, RO, UN, clay veneer							
										J15 SZ40	38.94m - J, 15°, RO, ST 39.03m - SZ, 40°, RO, PL, T	PQ	100	92				
	Sheared zone: slightly weathered, dark grey SILTSTONE, very weak	39					VW	SW	EC									
										J50	39.30m - J, 50°, RO, ST, VN							
	Incipient joints cutting across laminated bedding						MS	MW	MW			PQ	100	95				
		64																

Notes:

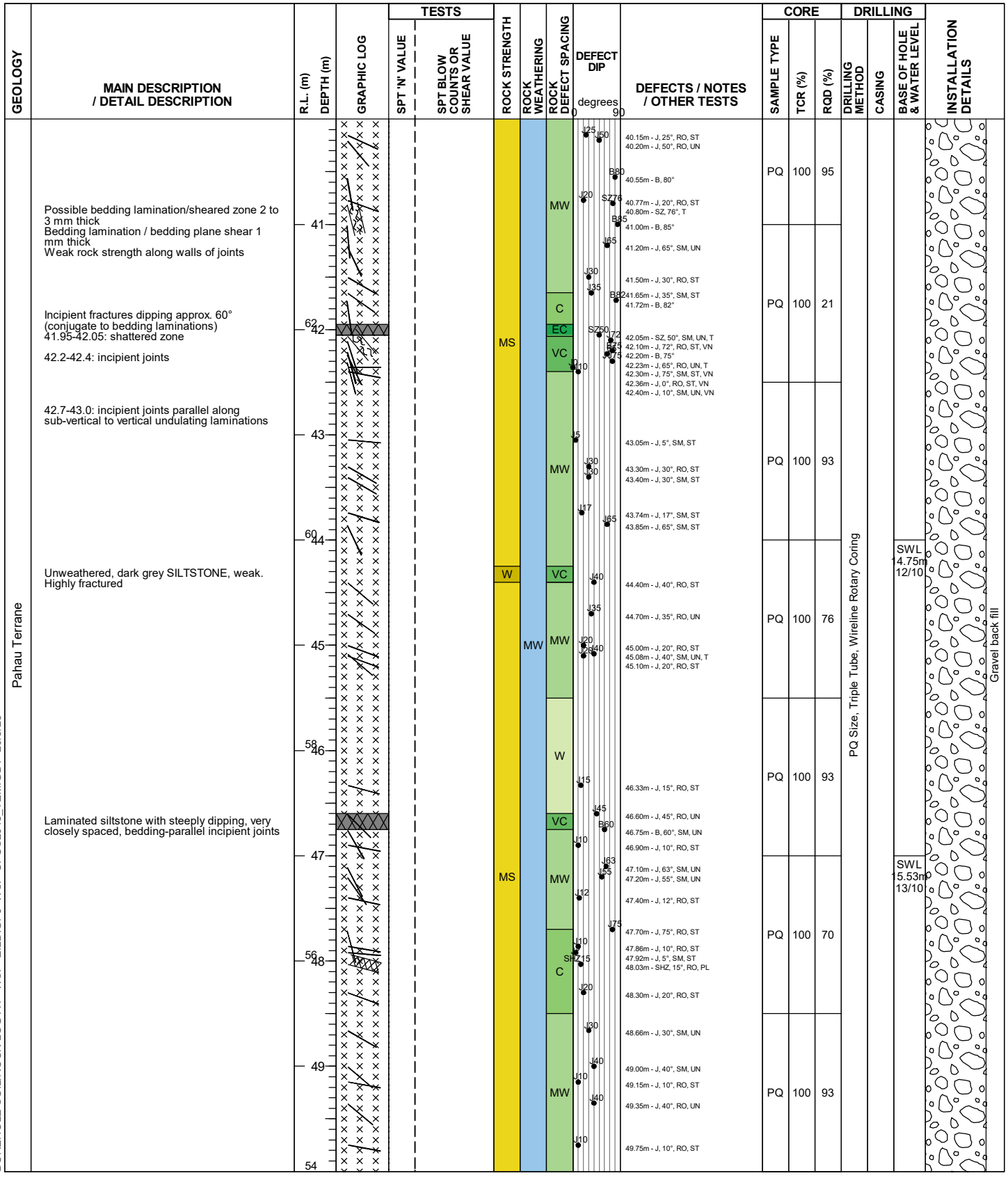
Started:	1/10/2020	*Finished:*	16/10/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH101

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1670538 E 5325187 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	90 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 104 m	*Inclination:*	-90°
Location:	Slip P8, Okiwi Bay North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°



Notes:

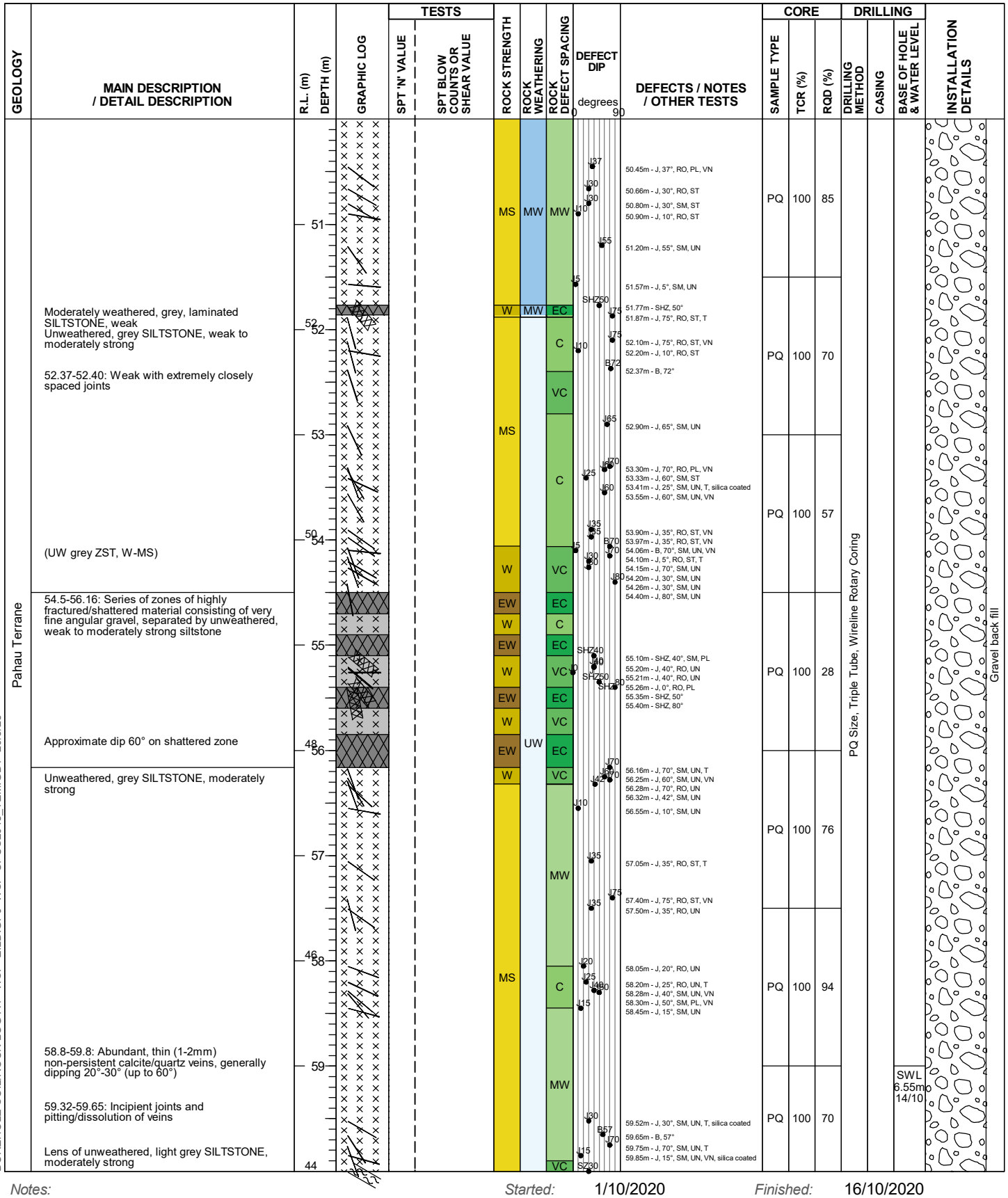
Started:	1/10/2020	*Finished:*	16/10/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH101

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1670538 E 5325187 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	90 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 104 m	*Inclination:*	-90°
Location:	Slip P8, Okiwi Bay North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°



BOREHOLE SOIL/ROCK LOG A4 - WSP EILD.GPJ WSP-OPUS2018_TEM.GDT 20/3/23

Notes:

Started:	1/10/2020	*Finished:*	16/10/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH101

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1670538 E 5325187 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	90 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 104 m	*Inclination:*	-90°
Location:	Slip P8, Okiwi Bay North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m) / DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
Pahau Terrane	59.9-60.5: Brittle/fissile, weak siltstone, with very closely spaced incipient joints Unweathered, grey SILTSTONE, moderately strong	61 (42)				MS	UW	VC	SZ30	60.00m - SZ, 30°, SM, UN	PQ	100	70	PQ Size, Triple Tube, Wireline Rotary Coring			Gravel back fill
		62 (40)						MW	J40	60.77m - J, 40°, SM, UN, T, silica coated							
		63						C	J38	61.20m - J, 38°, SM, UN	PQ	100	72				
		64						W	J10 J20 J62 J20 J20 J60	61.48m - J, 10°, RO, ST 61.53m - J, 20°, RO, ST 61.58m - J, 62°, RO, PL 61.70m - J, 20°, SM, UN, T, silica coated 61.77m - J, 60°, SM, UN 61.78m - J, 20°, RO, ST							
		65 (38)						VC	J30	62.14m - J, 30°, SM, UN	PQ	100	100				
		66						MW	J10	63.24m - J, 10°, RO, ST							
		67							J20 J60	63.75m - J, 60°, SM, UN 63.80m - J, 20°, SM, UN	PQ	100	76				
		68 (36)							J62 J18 J20 J40 J20 J40	64.45m - J, 62°, SM, UN 64.56m - J, 18°, RO, PL, silica coated 64.58m - J, 22°, RO, PL 64.62m - J, 20°, SM, UN 64.65m - J, 40°, RO, PL 64.75m - J, 20°, RO, ST 64.80m - J, 40°, RO, UN							
		69							J59 J J50	65.66m - J, 54°, SM, UN, VN 65.68m - J, 59°, SM, UN, T 65.90m - J, 50°, RO, UN, VN	PQ	100	92				
	69.15-69.4: Bed of very weak, laminated siltstone	34				VW MS			J15 J20 J22 J65 J10 J12 J30 J60 B65 J5	66.15m - J, 15°, RO, ST 66.46m - J, 20°, RO, UN 66.79m - J, 22°, RO, ST, VN 66.95m - J, 65°, SM, UN, VN 68.35m - J, 10°, RO, ST 68.57m - J, 12°, RO, UN 68.86m - J, 30°, SM, UN, T 68.90m - J, 60°, RO, ST 69.20m - B, 65°	PQ PQ PQ PQ	100 100 100 100	89 67 100 85			SWL 10.55m 15/10	

BOREHOLE SOIL/ROCK LOG A4 - WSP EILD.GPJ WSP-OPUS2018_TEM.GDT 20/3/23

Notes:

Started:	1/10/2020	*Finished:*	16/10/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH101

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1670538 E 5325187 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	90 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 104 m	*Inclination:*	-90°
Location:	Slip P8, Okiwi Bay North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m) / DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
Pahau Terrane	Incipient joints, tight to very narrow Brittle/fissile siltstone with incipient joints 79.8-81.2: Undulating/convolute laminations in	71 72 73 74 75 76 77 78 79 24				MS	UW	MW C W MW W		69.96m - J, 5°, RO, UN 70.30m - B, 63° 70.47m - J, 45°, RO, PL 70.52m - J, 40°, SM, UN 70.55m - J, 5°, SM, UN 71.06m - J, 60°, SM, UN 71.62m - J, 10°, RO, ST 71.83m - J, 35°, RO, UN 71.98m - J, 5°, RO, ST 72.10m - J, 15°, RO, UN 72.60m - B, 75°, RO, ST 72.80m - J, 70°, RO, PL 72.90m - J, 30°, RO, PL 73.10m - J, 40°, SM, UN 73.15m - J, 45°, SM, UN 73.26m - J, 20°, SM, UN 73.32m - J, 50°, RO, UN 73.40m - J, 65°, RO, UN, T 73.70m - J, 30°, SM, UN 74.10m - J, 56°, SM, UN, T 74.20m - J, 40°, SM, UN, T 74.50m - IZ, 58° 74.75m - J, 30°, SM, UN 74.80m - J, 80°, SM, UN 74.90m - J, 65°, SM, UN 75.77m - J, 40°, RO, ST 76.73m - J, 10°, RO, ST 77.94m - J, 30° 78.08m - J, 40°, SM, UN 78.15m - J, 60°, SM, UN 78.50m - J, 45°, SM, UN 78.60m - J, 15°, RO, UN 79.24m - J, 10°, RO, ST 79.35m - J, 50°, SM, UN	PQ PQ PQ PQ PQ PQ PQ	100 100 100 100 100 100 100	85 91 63 89 100 90 90	PQ Size, Triple Tube, Wireline Rotary Coring			Gravel back fill

Notes:

Started:	1/10/2020	*Finished:*	16/10/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH101

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1670538 E 5325187 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	90 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 104 m	*Inclination:*	-90°
Location:	Slip P8, Okiwi Bay North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m) / DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
Pahau Terrane	bedding. Steeply dipping (~70°)	81				MS	UW	W			PQ	100	97	PQ Size, Triple Tube, Wireline Rotary Coring		SWL 7.00m 16/10	Gravel back fill
		22 82							J40	81.72m - J, 40°, SM, UN							
									J20	81.88m - J, 20°, RO, UN							
									J30	82.20m - J, 30°, RO, PL	PQ	100	77				
									J25 J30	82.40m - J, 25°, SM, UN 82.45m - J, 30°, SM, UN							
		83							J30 J50	82.85m - J, 30°, SM, ST 82.92m - J, 30°, SM, UN							
								MW	J40 J50	83.37m - J, 40°, RO, UN 83.44m - J, 50°, RO, UN							
		20 84							J20 J10	83.72m - J, 20°, RO, UN, T 83.83m - J, 10°, RO, ST	PQ	100	80				
									J25	84.05m - J, 25°, SM, UN, VN							
									J12	84.35m - J, 12°, RO, ST							
									J45 J30	84.61m - J, 45°, SM, UN, VN 84.70m - J, 33°, SM, UN							
		85							J45 J30 J45	84.94m - J, 45°, SM, UN 85.10m - J, 30° 85.10m - J, 45°	PQ	100	83				
									J20	85.55m - J, 20°, RO, UN							
									J25	85.72m - J, 25°, SM, UN							
		18 86							J20	85.85m - J, 20°, SM, UN							
									J34 J40 J2	86.23m - J, 34°, RO, PL 86.30m - J, 40°, RO, UN 86.37m - J, 42°, SM, UN							
								C	SZ60 J80	86.55m - SZ, 60°, SM, UN 86.60m - J, 80°, SM, ST	PQ	100	50				
									J65 J12	86.82m - J, 65°, SM, UN, T 86.90m - J, 12°, RO, ST							
		87							SHZ55	87.06m - SHZ, 55°							
									J60 J55	87.40m - J, 60°, SM, UN, T 87.53m - J, 55°, RO, ST, VN							
									J25 J40 J80	87.70m - J, 25°, SM, ST 87.78m - J, 80°, RO, UN 87.80m - J, 40°, RO, PL							
		16 88							J28 J30 J35 J40 J28	88.03m - J, 20°, SM, UN 88.06m - J, 30°, SM, UN 88.09m - J, 40°, SM, PL 88.17m - J, 35°, SM, UN 88.27m - J, 40°, RO, UN 88.32m - J, 28°, RO, PL	PQ	100	65				
								VC									
								C									
								EC									
		89							J35 J55	89.00m - J, 35°, RO, ST 89.14m - J, 55°, RO, PL, T							
								C	J57 J20	89.32m - J, 57°, SM, UN 89.40m - J, 20°, SM, UN	PQ	100	71				
									J25 J20	89.68m - J, 25°, RO, ST 89.80m - J, 20°, RO, ST							
	END OF BOREHOLE AT 90m - Target Criteria Achieved	14															

Notes:

Started: 1/10/2020 *Finished:* 16/10/2020

Drilling Co.: CW Drilling *Drilling Rig:* Marooka

Logged by: D Mason *Checked by:* P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH101

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1670538 E 5325187 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	90 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 104 m	*Inclination:*	-90°
Location:	Slip P8, Okiwi Bay North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

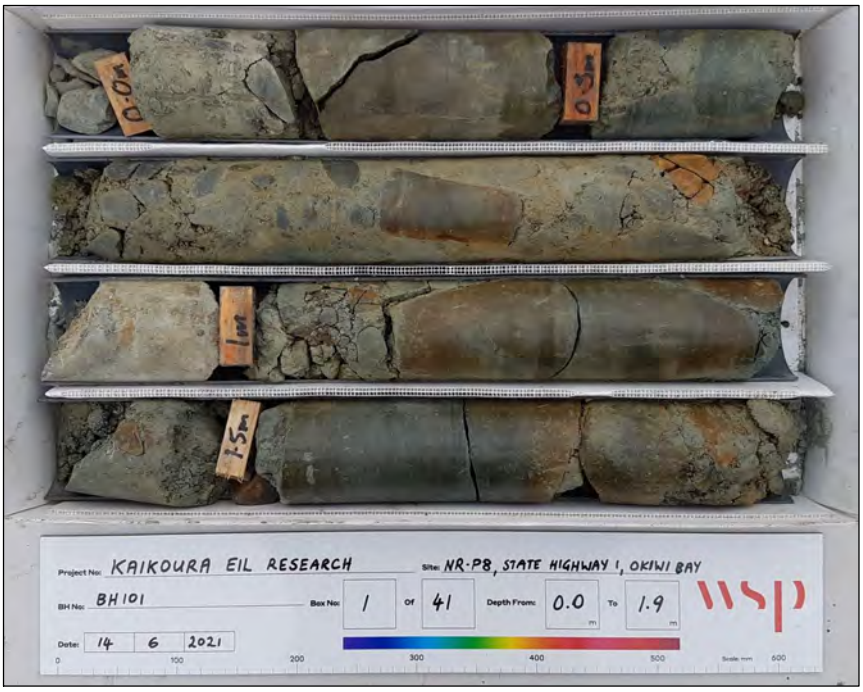


Photo BH101.1
BH101 Box 01

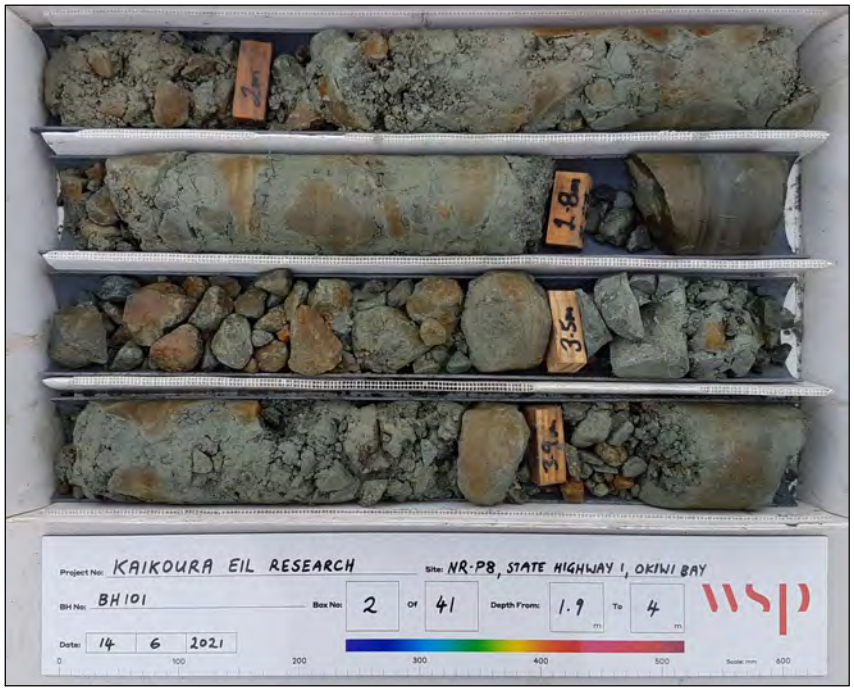


Photo BH101.2
BH101 Box 02

BOREHOLE SOIL/ROCK LOG A4 - WSP EILD.GPJ WSP-OPUS2018_TEM.GDT 20/3/23

Notes:

Started:	1/10/2020	*Finished:*	16/10/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH101

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1670538 E 5325187 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	90 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 104 m	*Inclination:*	-90°
Location:	Slip P8, Okiwi Bay North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

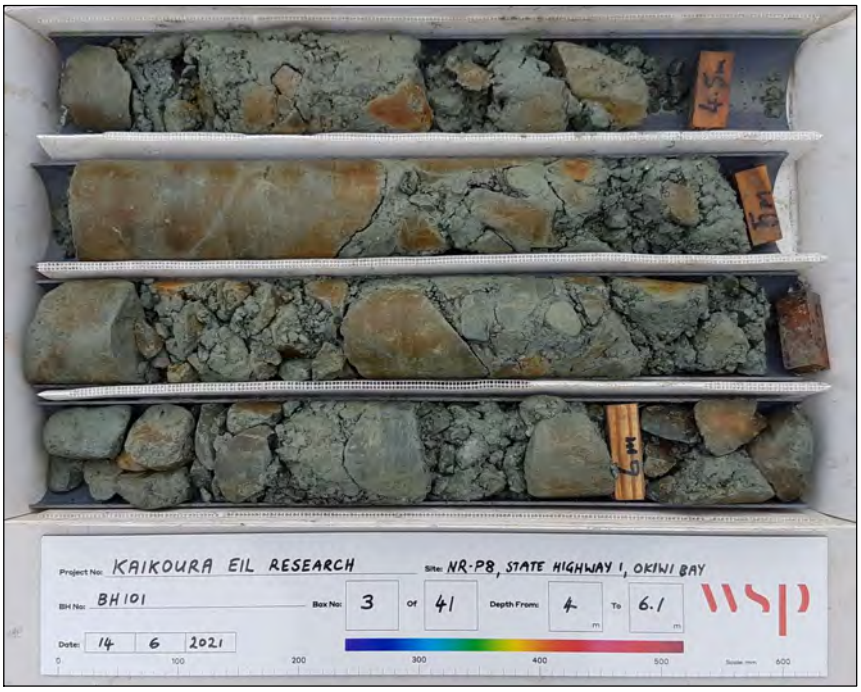


Photo BH101.3
BH101 Box 03

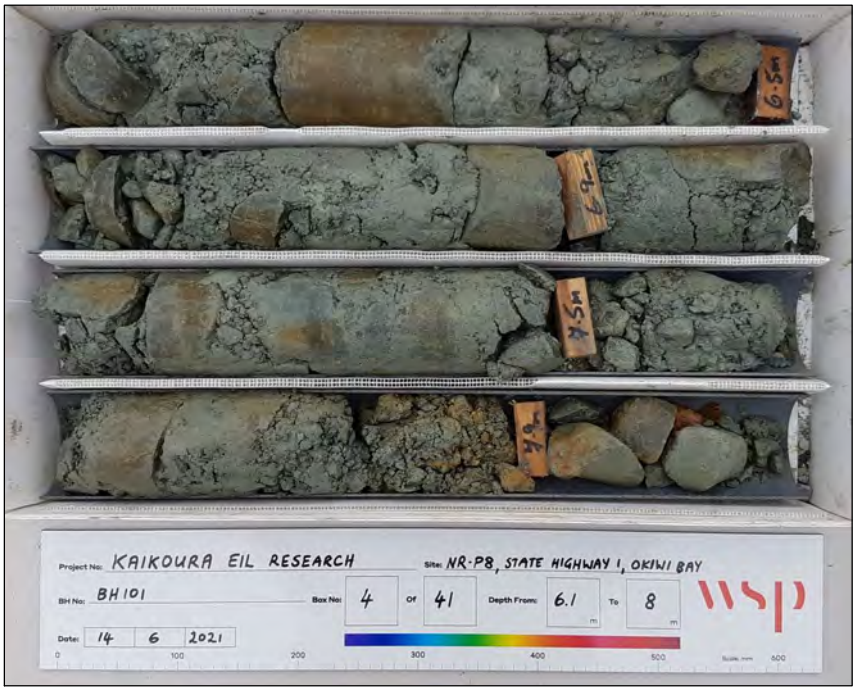


Photo BH101.4
BH101 Box 04

BOREHOLE SOIL/ROCK LOG A4 - WSP EILD.GPJ WSP-OPUS2018_TEM.GDT 20/3/23

Notes:

Started:	1/10/2020	*Finished:*	16/10/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH101

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1670538 E 5325187 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	90 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 104 m	*Inclination:*	-90°
Location:	Slip P8, Okiwi Bay North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

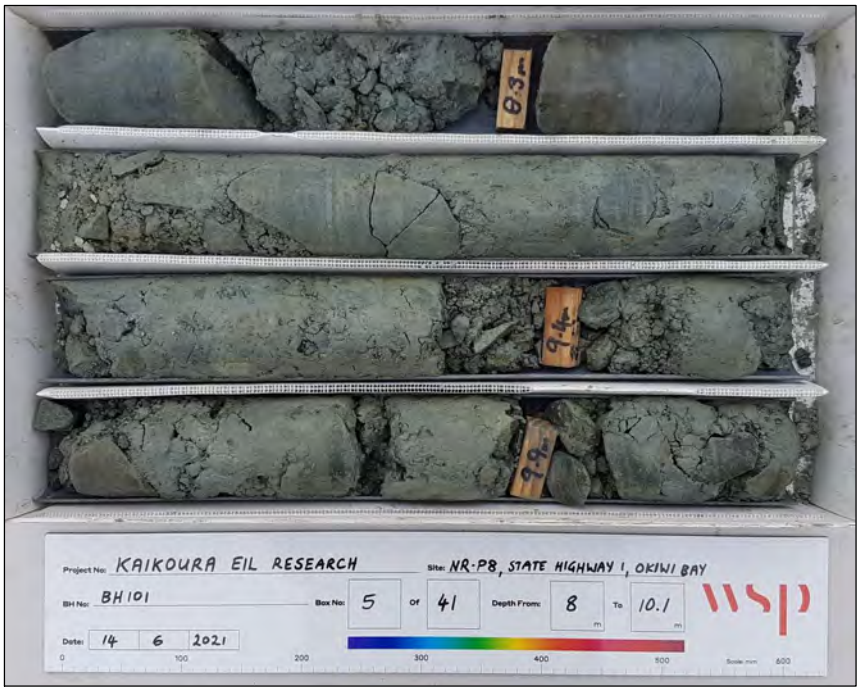


Photo BH101.5
BH101 Box 05

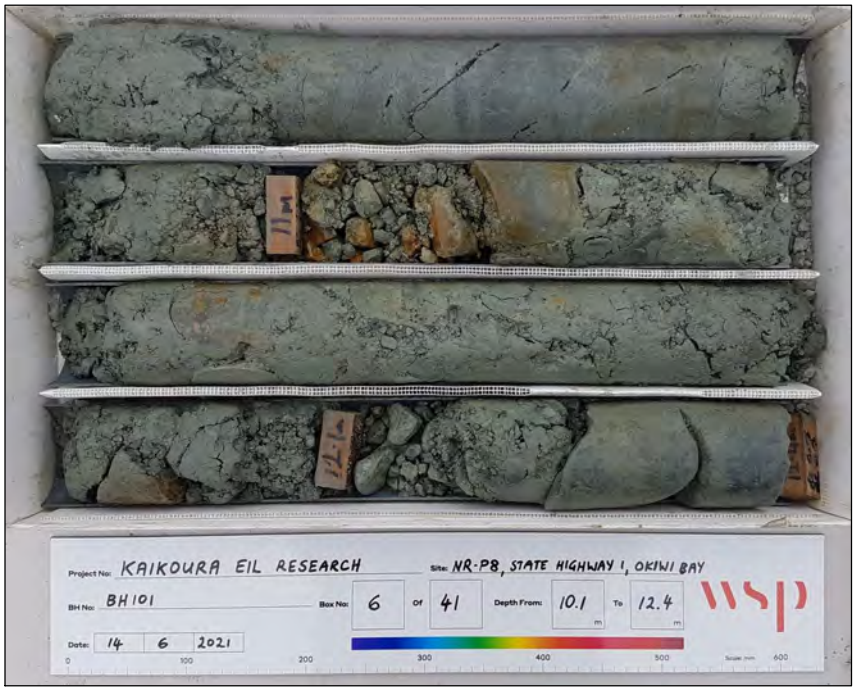


Photo BH101.6
BH101 Box 06

Notes:

Started:	1/10/2020	*Finished:*	16/10/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH101

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1670538 E 5325187 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	90 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 104 m	*Inclination:*	-90°
Location:	Slip P8, Okiwi Bay North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

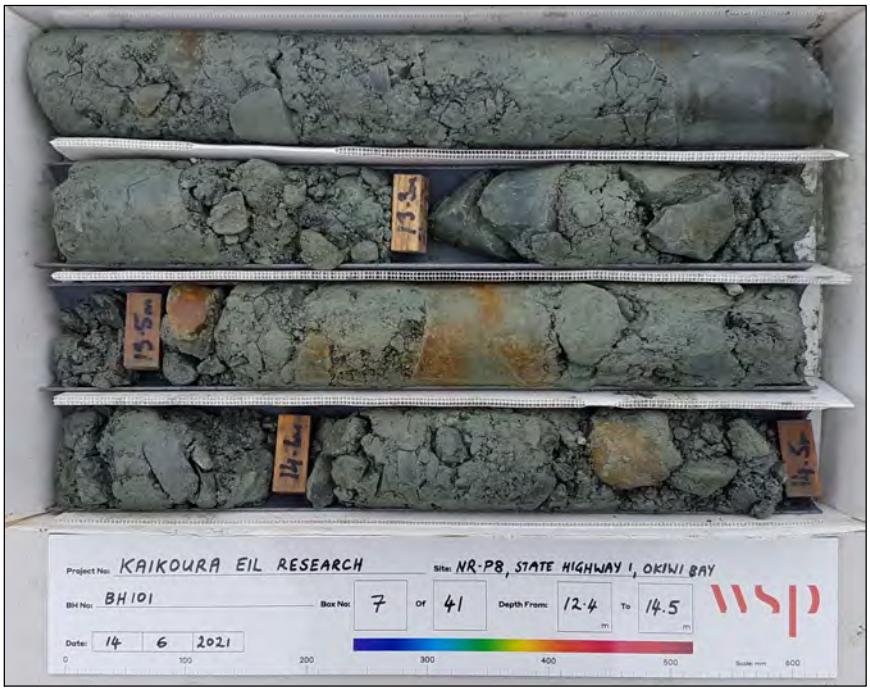


Photo BH101.7
BH101 Box 07

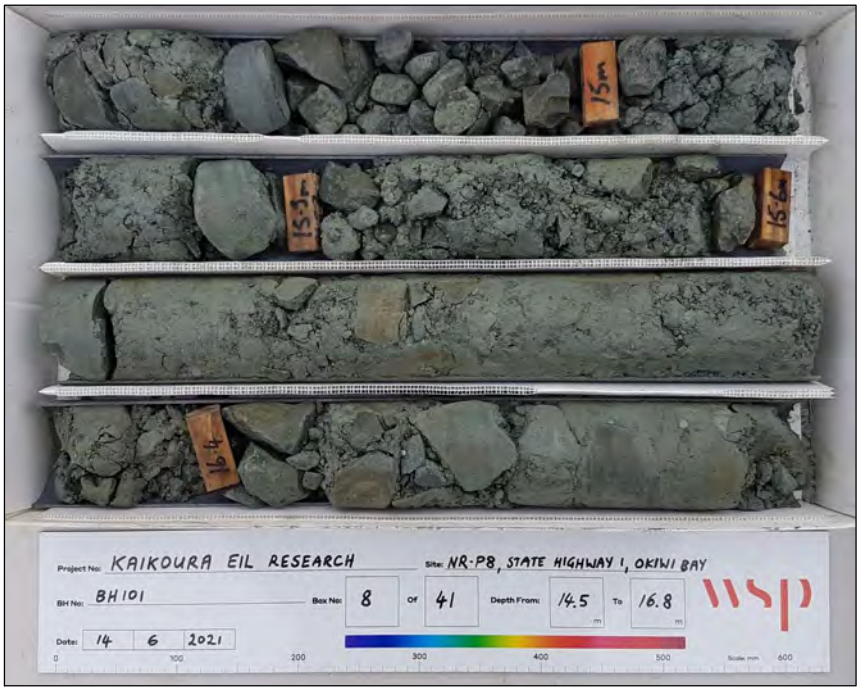


Photo BH101.8
BH101 Box 08

BOREHOLE SOIL/ROCK LOG A4 - WSP EILD.GPJ WSP-OPUS2018_TEM.GDT 20/3/23

Notes:

Started:	1/10/2020	*Finished:*	16/10/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH101

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1670538 E 5325187 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	90 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 104 m	*Inclination:*	-90°
Location:	Slip P8, Okiwi Bay North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

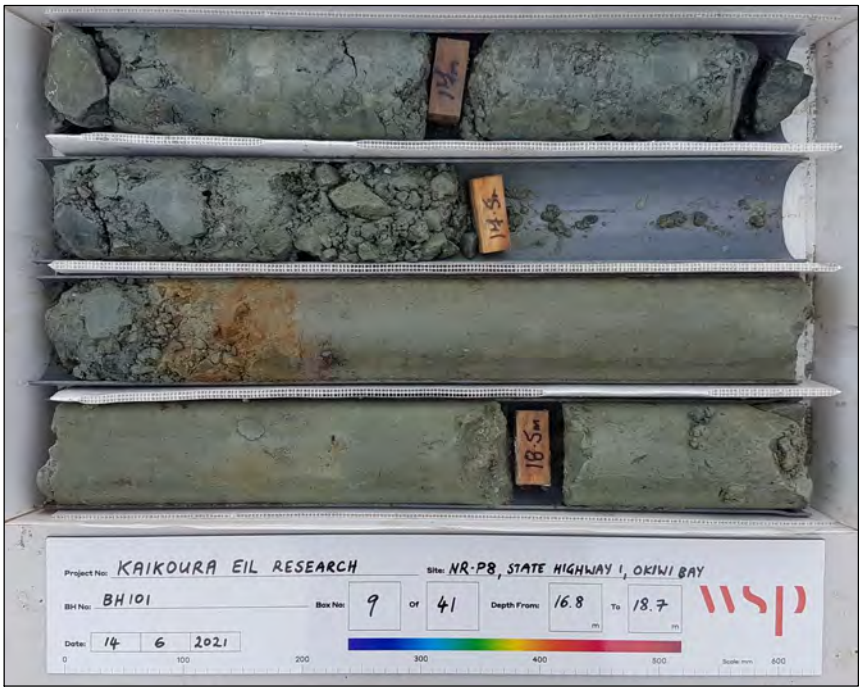


Photo BH101.9
BH101 Box 09

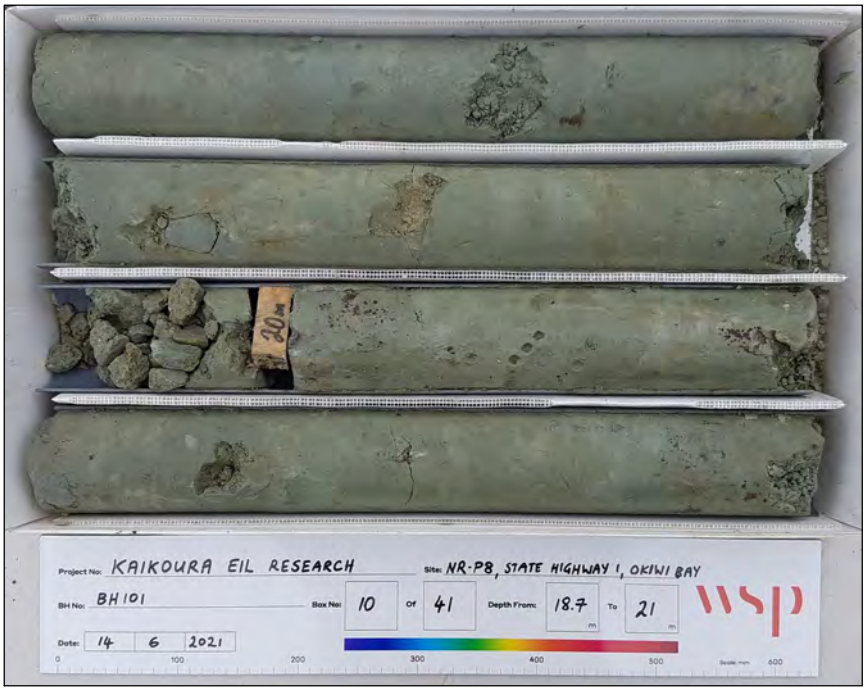


Photo BH101.10
BH101 Box 10

BOREHOLE SOIL/ROCK LOG A4 - WSP EILD.GPJ WSP-OPUS2018_TEM.GDT 20/3/23

Notes:

Started:	1/10/2020	*Finished:*	16/10/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH101

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1670538 E 5325187 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	90 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 104 m	*Inclination:*	-90°
Location:	Slip P8, Okiwi Bay North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

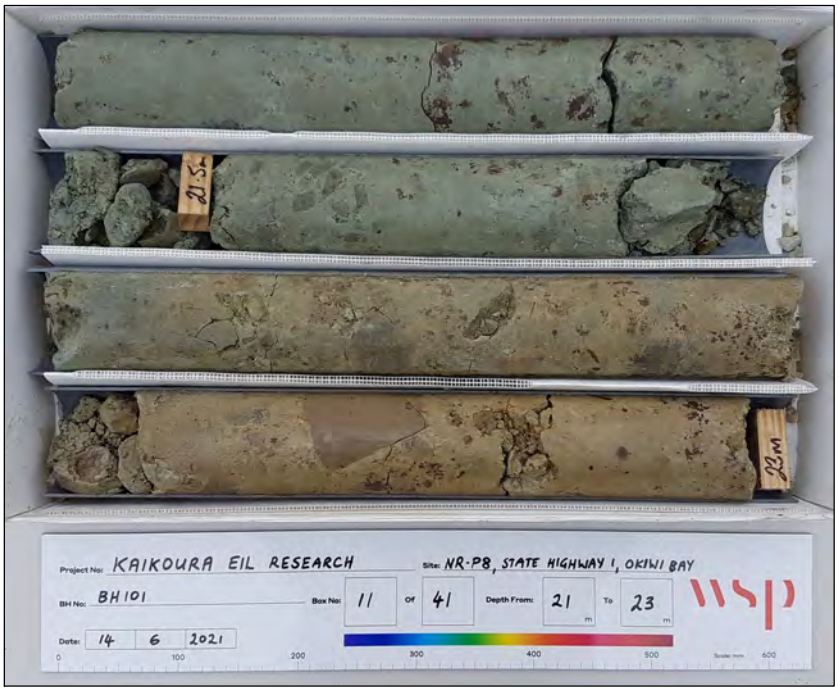


Photo BH101.11
BH101 Box 11

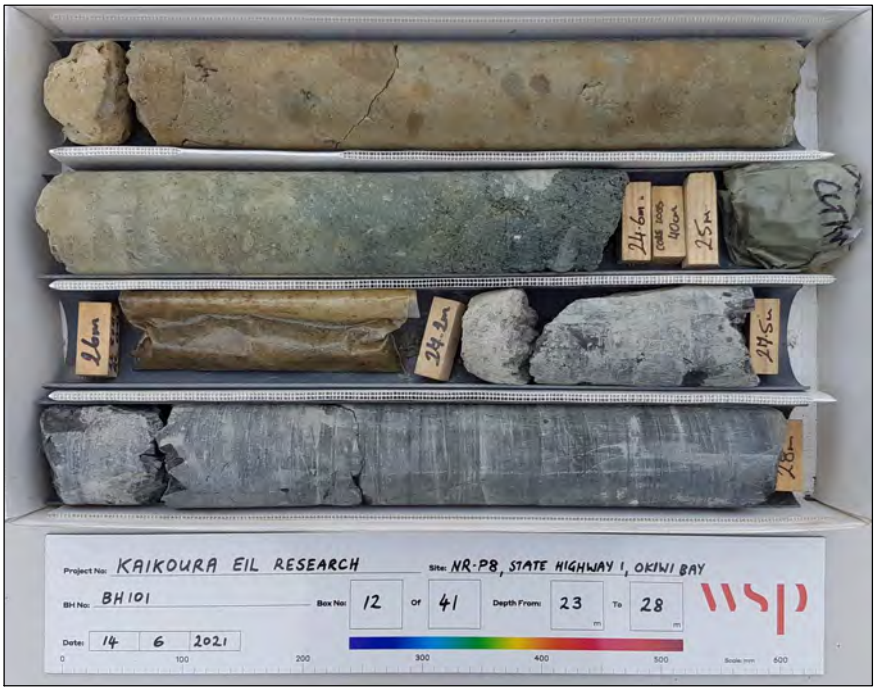


Photo BH101.12
BH101 Box 12

Notes:		*Started:*	1/10/2020	*Finished:*	16/10/2020
		Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
		Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH101

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1670538 E 5325187 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	90 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 104 m	*Inclination:*	-90°
Location:	Slip P8, Okiwi Bay North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

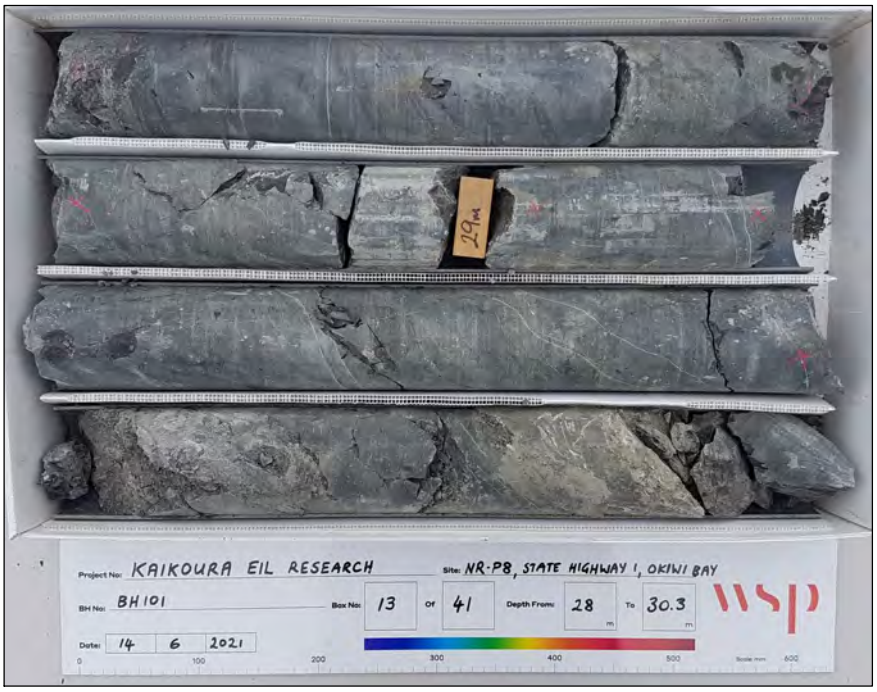


Photo BH101.13
BH101 Box 13

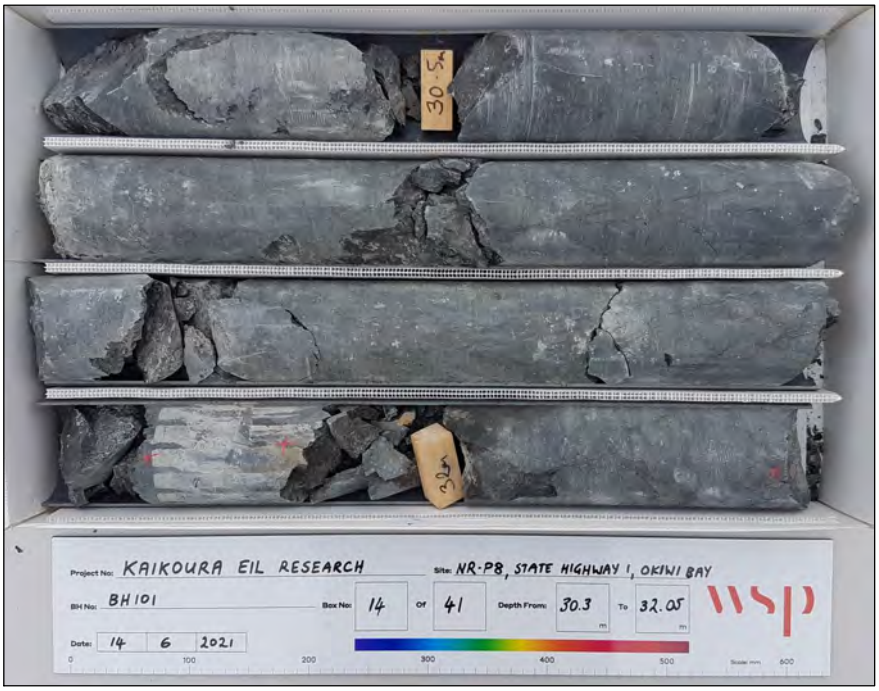


Photo BH101.14
BH101 Box 14

Notes:

Started:	1/10/2020	*Finished:*	16/10/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH101

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1670538 E 5325187 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	90 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 104 m	*Inclination:*	-90°
Location:	Slip P8, Okiwi Bay North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

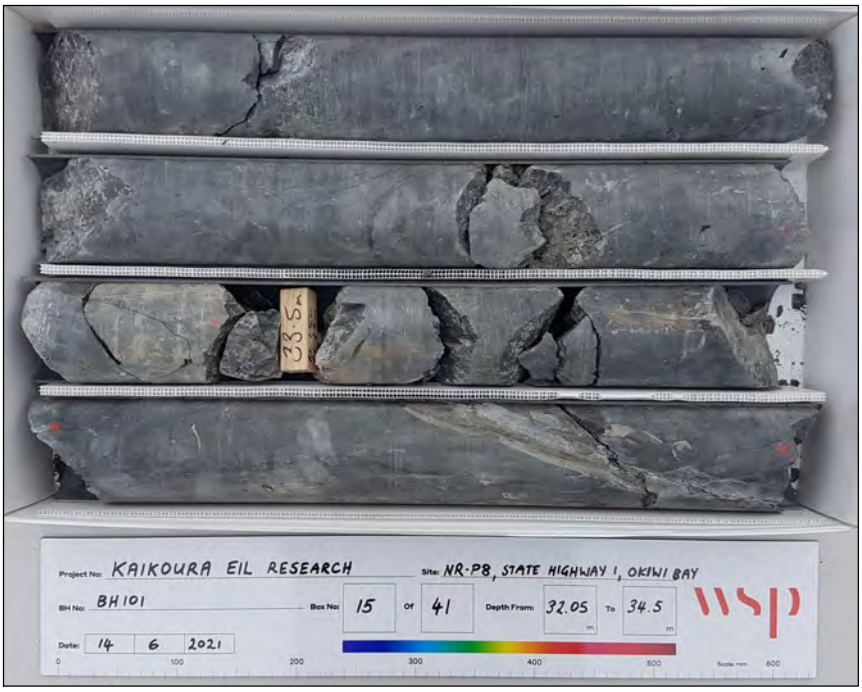


Photo BH101.15
BH101 Box 15

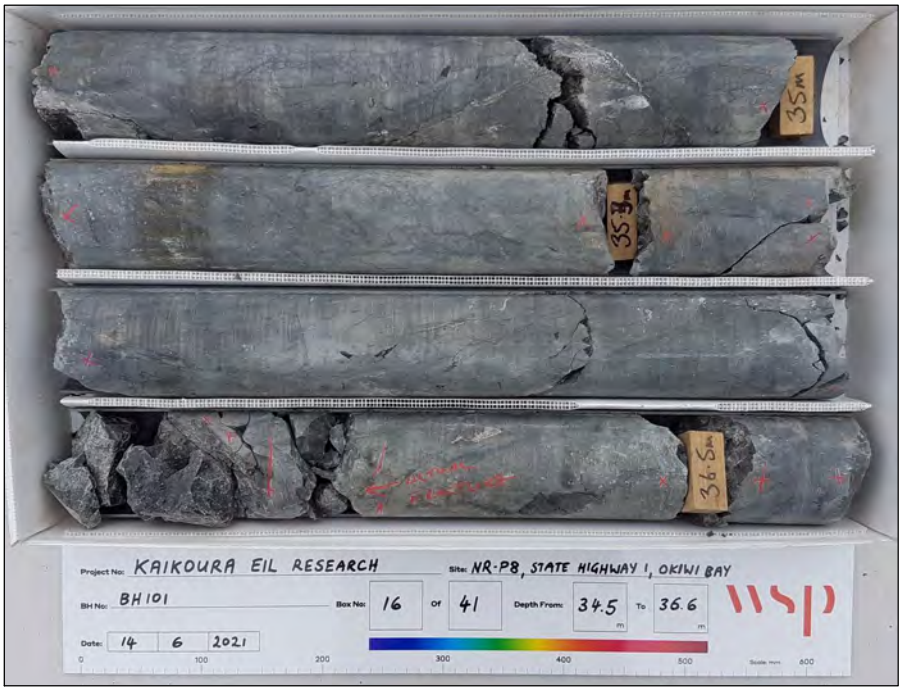


Photo BH101.16
BH101 Box 16

BOREHOLE SOIL/ROCK LOG A4 - WSP EILD.GPJ WSP-OPUS2018_TEM.GDT 20/3/23

Notes:

Started:	1/10/2020	*Finished:*	16/10/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH101

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1670538 E 5325187 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	90 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 104 m	*Inclination:*	-90°
Location:	Slip P8, Okiwi Bay North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

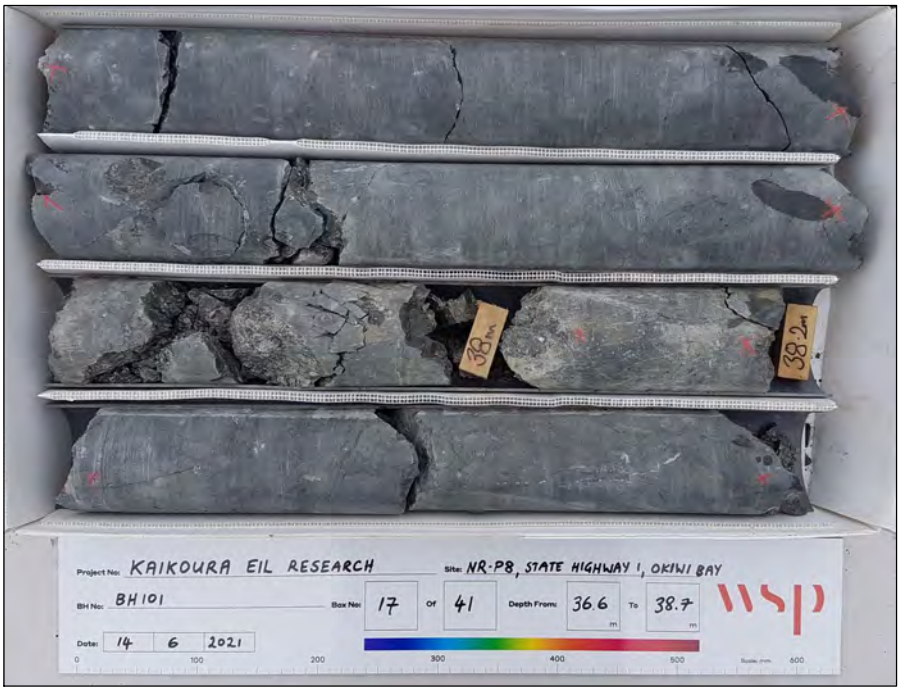


Photo BH101.17
BH101 Box 17

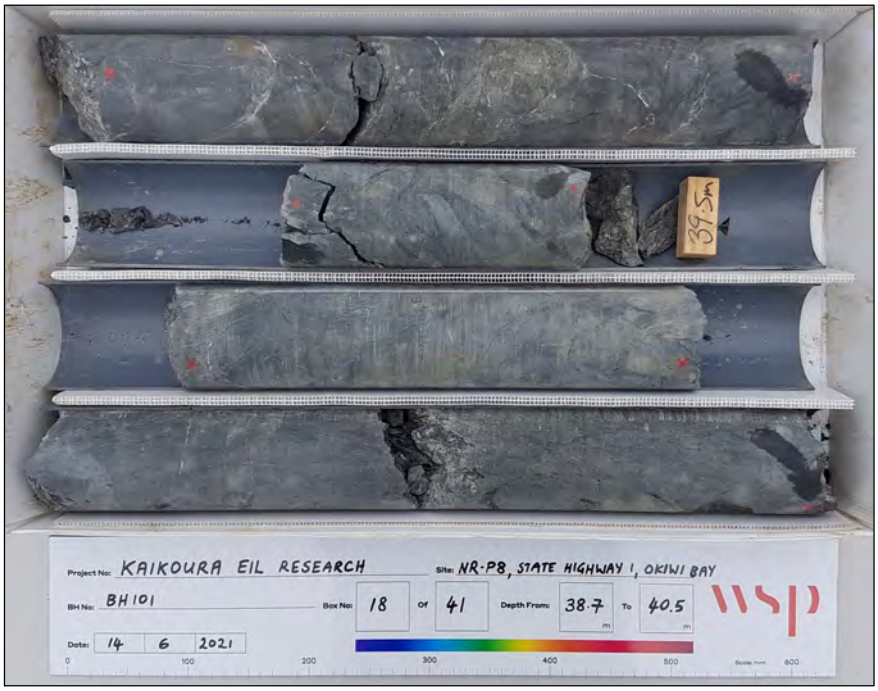


Photo BH101.18
BH101 Box 18

BOREHOLE SOIL/ROCK LOG A4 - WSP EILD.GPJ WSP-OPUS2018_TEM.GDT 20/3/23

Notes:

Started:	1/10/2020	*Finished:*	16/10/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH101

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1670538 E 5325187 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	90 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 104 m	*Inclination:*	-90°
Location:	Slip P8, Okiwi Bay North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

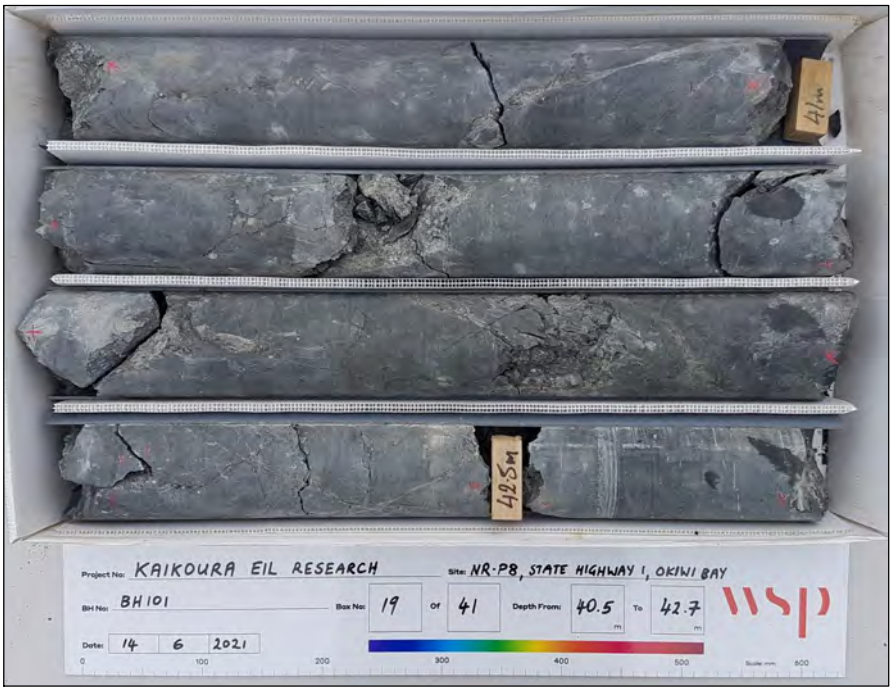


Photo BH101.19
BH101 Box 19

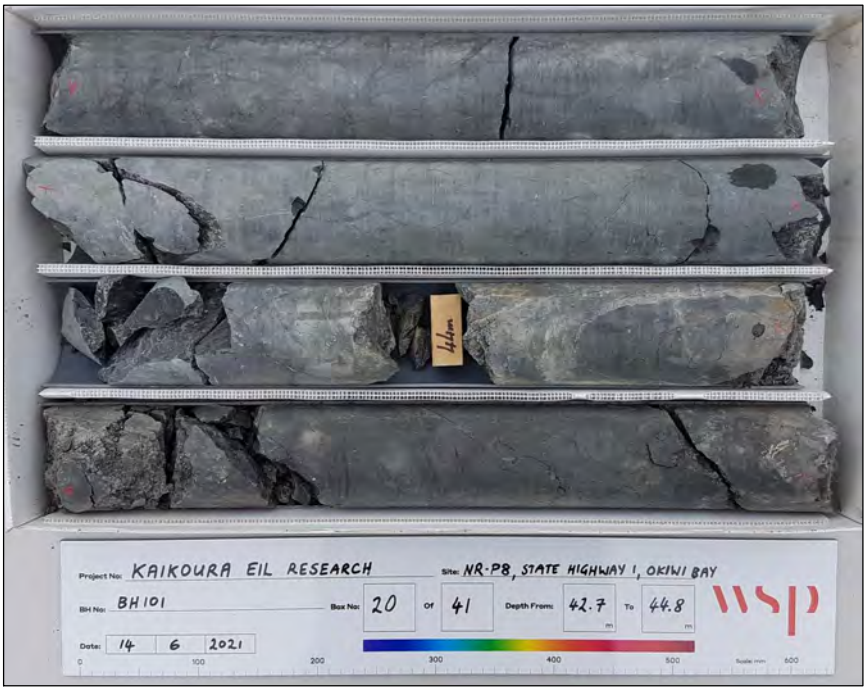


Photo BH101.20
BH101 Box 20

BOREHOLE SOIL/ROCK LOG A4 - WSP EILD.GPJ WSP-OPUS2018_TEM.GDT 20/3/23

Notes:

Started:	1/10/2020	*Finished:*	16/10/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH101

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1670538 E 5325187 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	90 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 104 m	*Inclination:*	-90°
Location:	Slip P8, Okiwi Bay North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

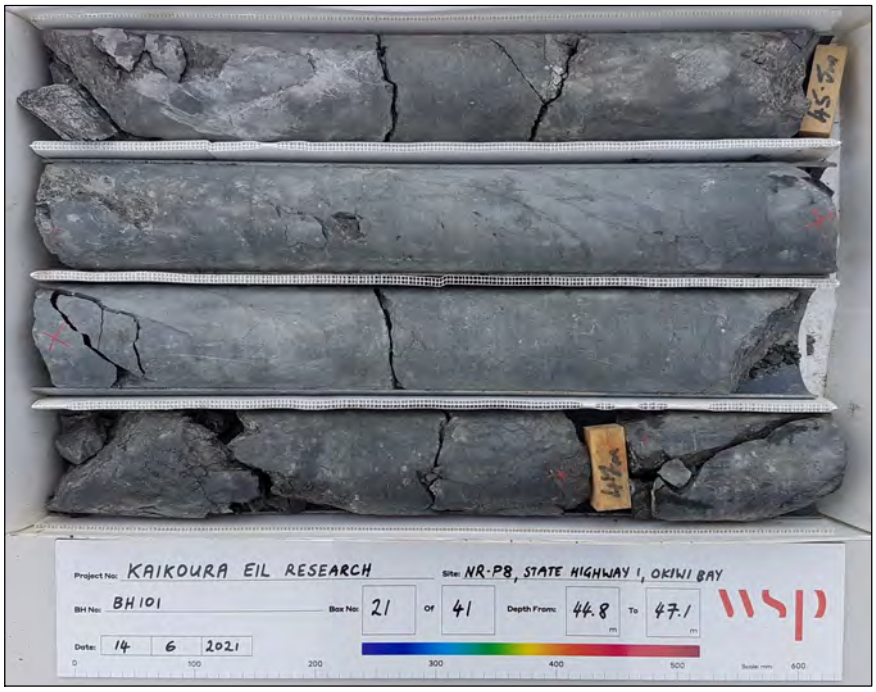


Photo BH101.21
BH101 Box 21

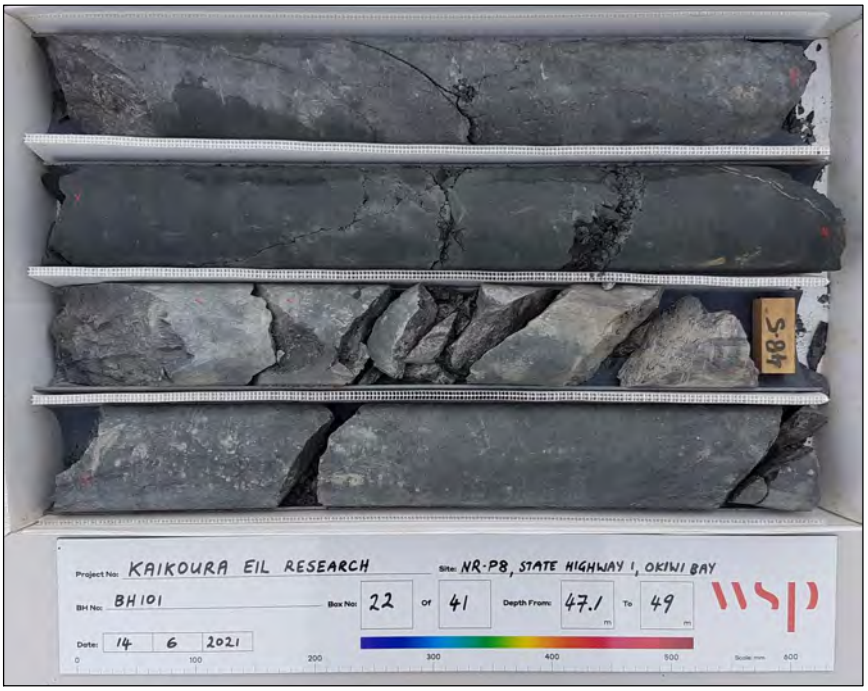


Photo BH101.22
BH101 Box 22

Notes:

Started:	1/10/2020	*Finished:*	16/10/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH101

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1670538 E 5325187 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	90 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 104 m	*Inclination:*	-90°
Location:	Slip P8, Okiwi Bay North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

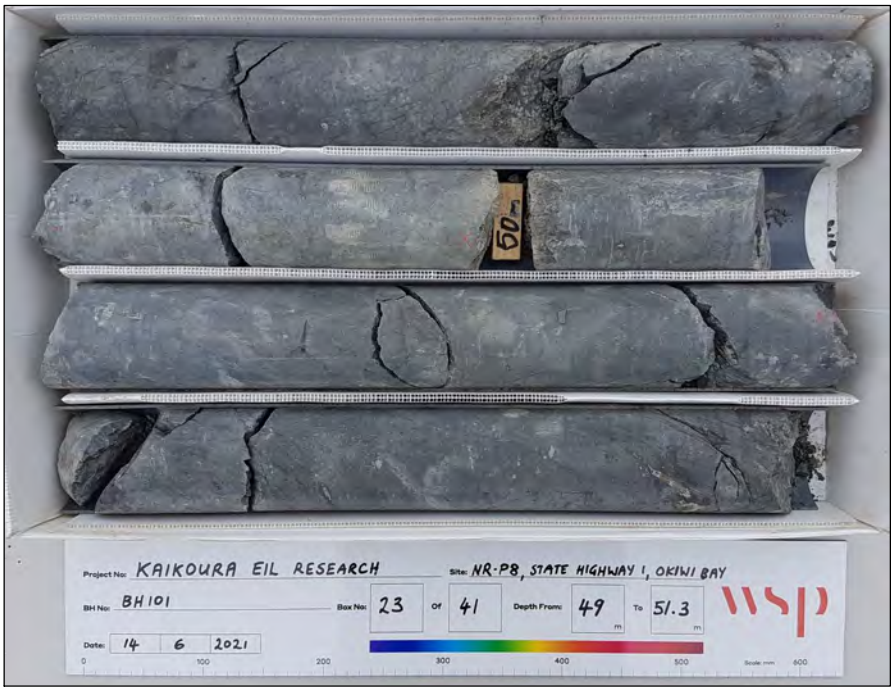


Photo BH101.23
BH101 Box 23

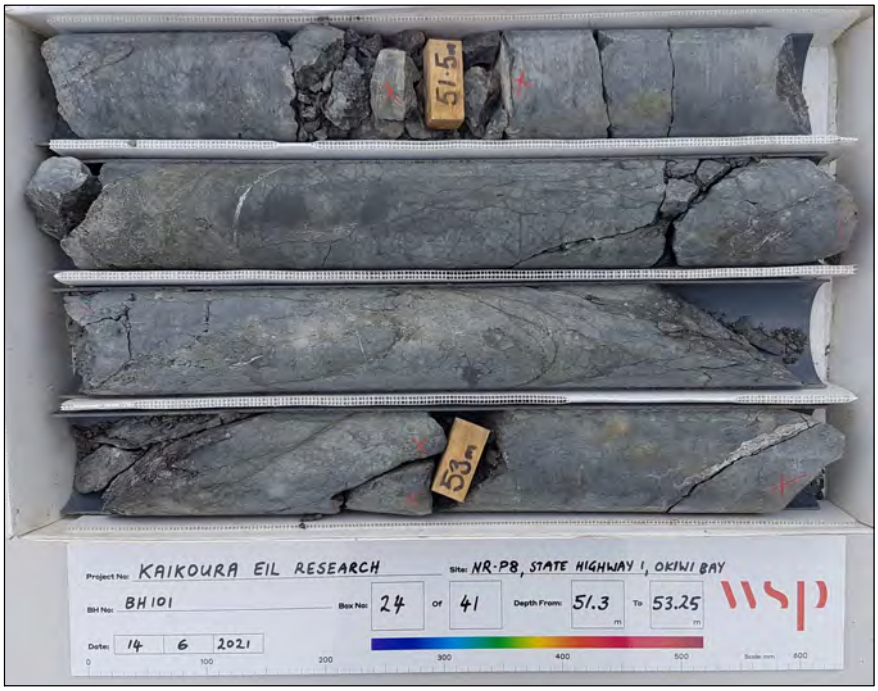


Photo BH101.24
BH101 Box 24

BOREHOLE SOIL/ROCK LOG A4 - WSP EILD.GPJ WSP-OPUS2018_TEM.GDT 20/3/23

Notes:

Started:	1/10/2020	*Finished:*	16/10/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH101

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1670538 E 5325187 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	90 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 104 m	*Inclination:*	-90°
Location:	Slip P8, Okiwi Bay North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

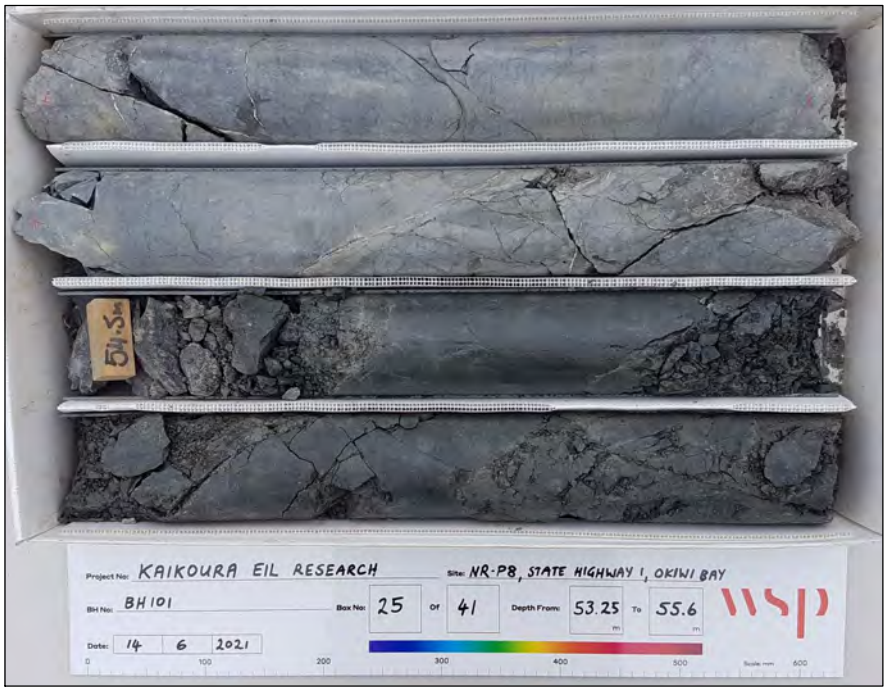


Photo BH101.25
BH101 Box 25

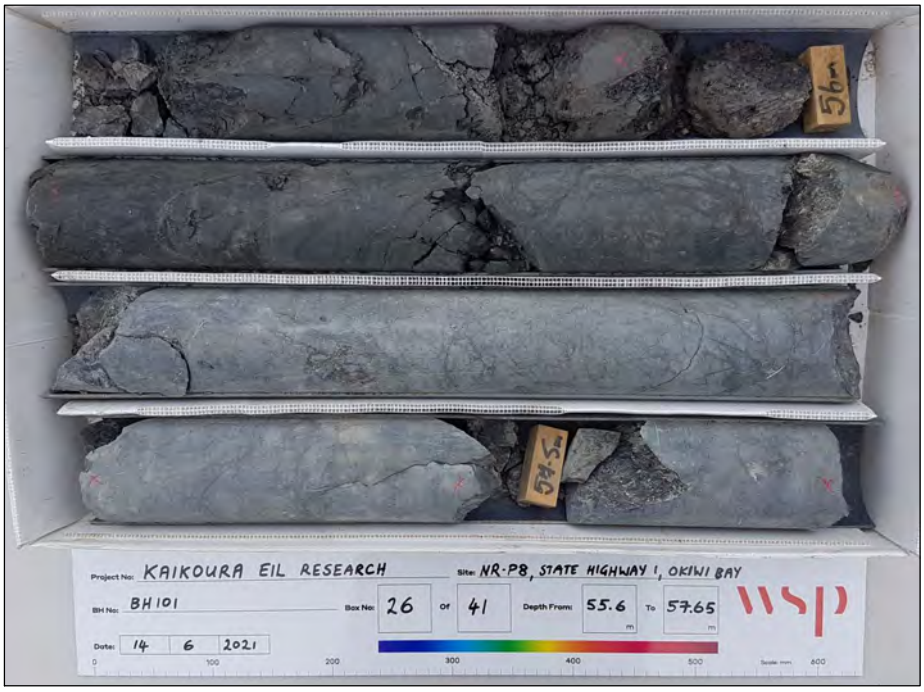


Photo BH101.26
BH101 Box 26

Notes:

Started:	1/10/2020	*Finished:*	16/10/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH101

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1670538 E 5325187 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	90 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 104 m	*Inclination:*	-90°
Location:	Slip P8, Okiwi Bay North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

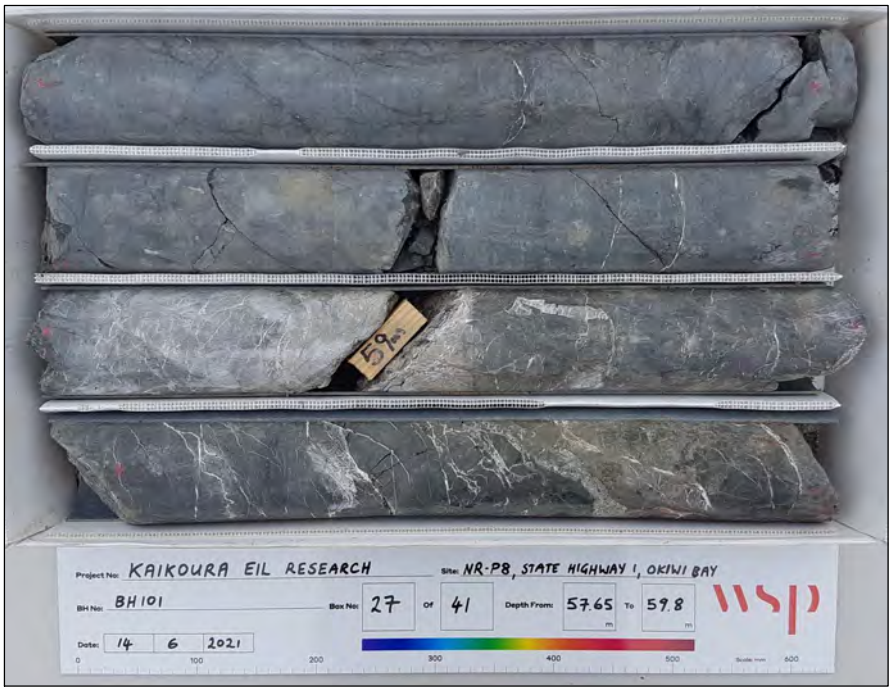


Photo BH101.27
BH101 Box 27

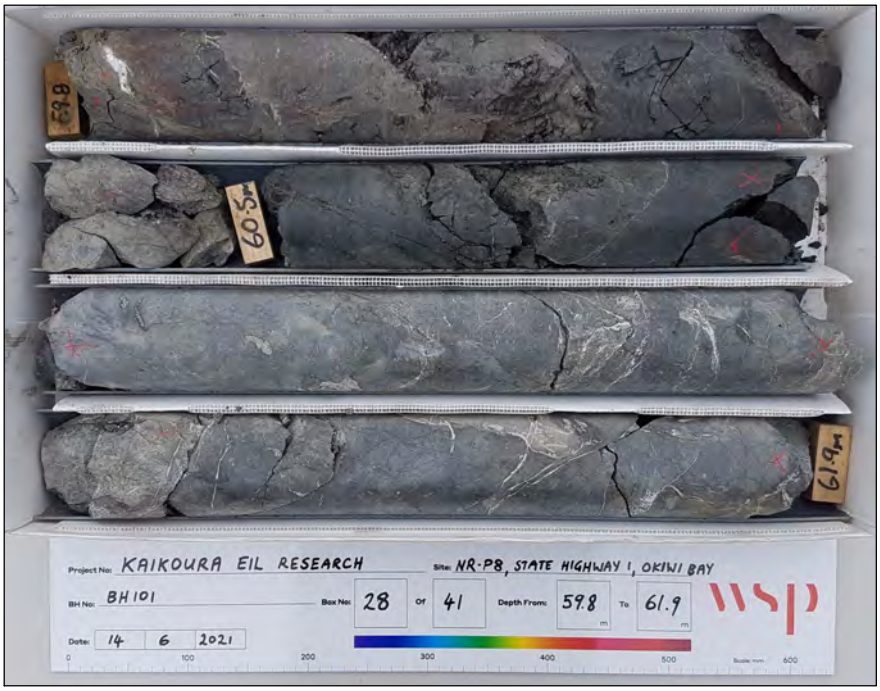


Photo BH101.28
BH101 Box 28

Notes:

Started:	1/10/2020	*Finished:*	16/10/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH101

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1670538 E 5325187 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	90 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 104 m	*Inclination:*	-90°
Location:	Slip P8, Okiwi Bay North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

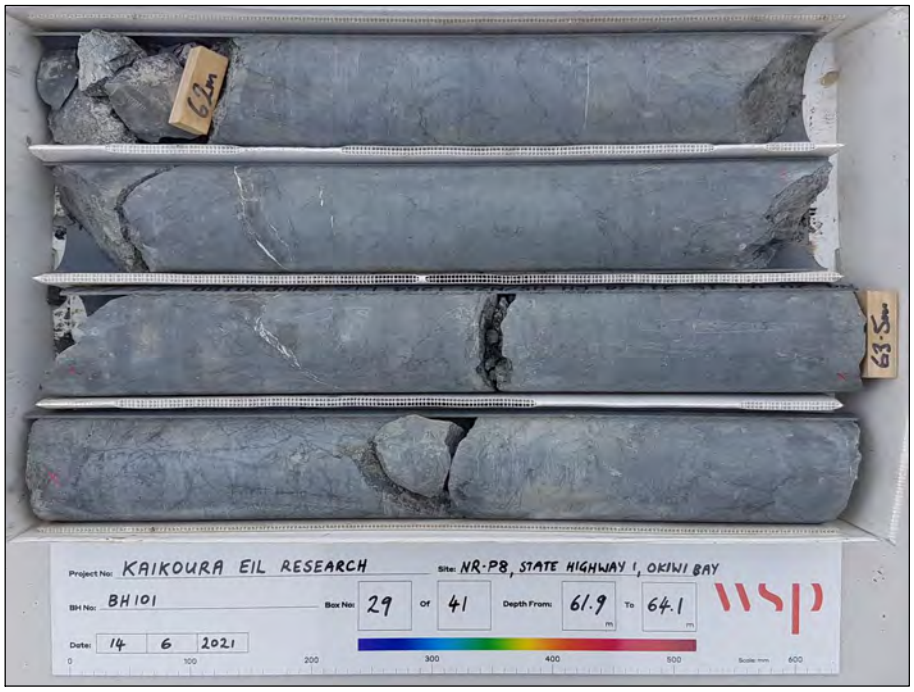


Photo BH101.29
BH101 Box 29

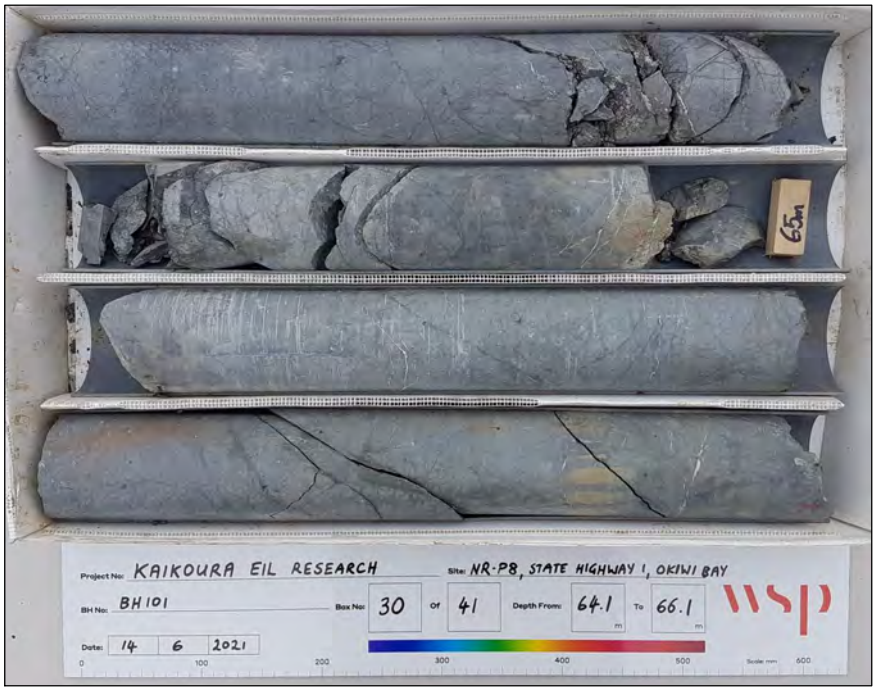


Photo BH101.30
BH101 Box 30

BOREHOLE SOIL/ROCK LOG A4 - WSP EILD.GPJ WSP-OPUS2018_TEM.GDT 20/3/23

Notes:

Started:	1/10/2020	*Finished:*	16/10/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH101

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1670538 E 5325187 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	90 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 104 m	*Inclination:*	-90°
Location:	Slip P8, Okiwi Bay North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

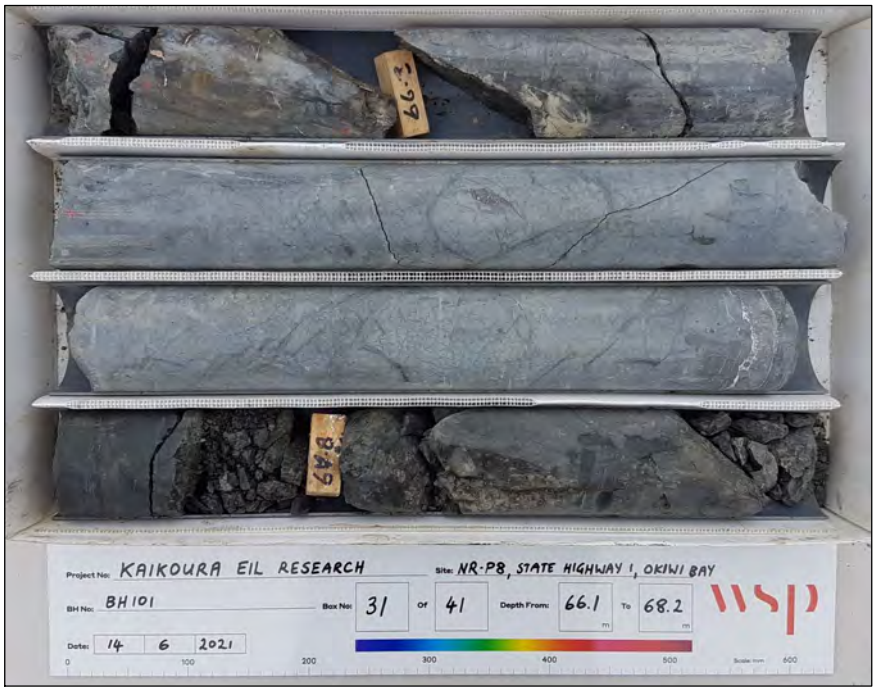


Photo BH101.31
BH101 Box 31

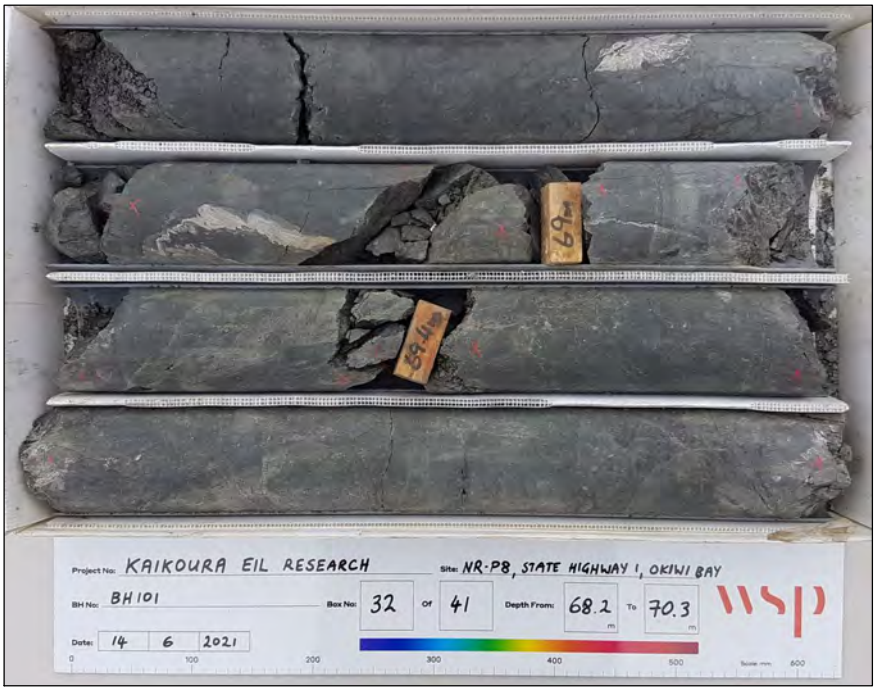


Photo BH101.32
BH101 Box 32

BOREHOLE SOIL/ROCK LOG A4 - WSP EILD.GPJ WSP-OPUS2018_TEM.GDT 20/3/23

Notes:

Started:	1/10/2020	*Finished:*	16/10/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH101

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1670538 E 5325187 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	90 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 104 m	*Inclination:*	-90°
Location:	Slip P8, Okiwi Bay North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

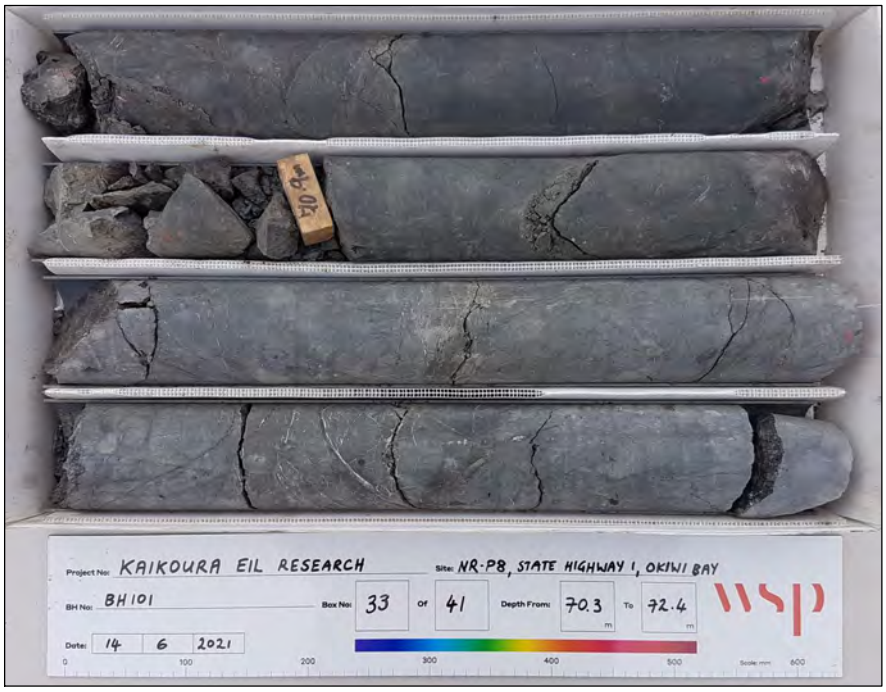


Photo BH101.33
BH101 Box 33

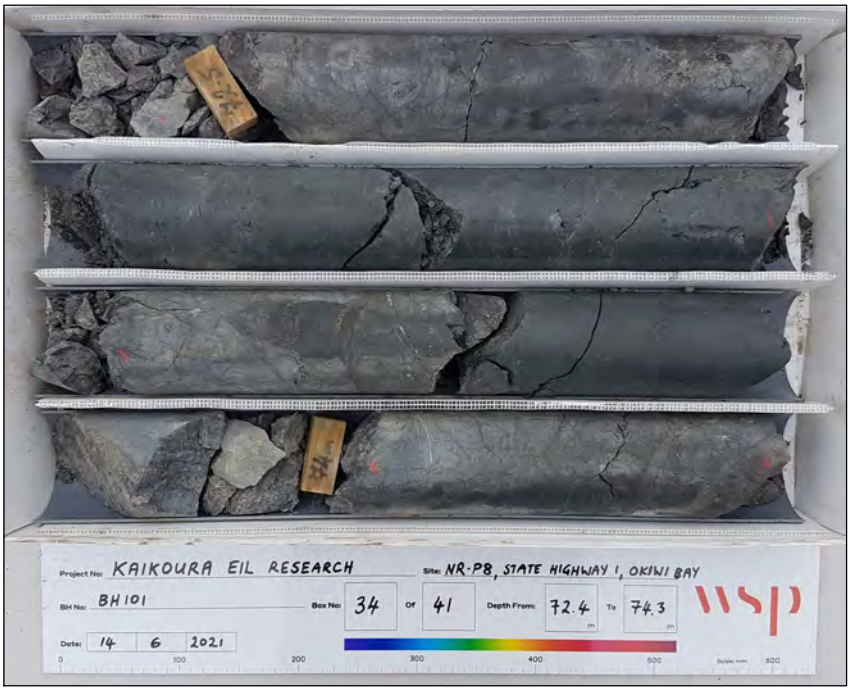


Photo BH101.34
BH101 Box 34

BOREHOLE SOIL/ROCK LOG A4 - WSP EILD.GPJ WSP-OPUS2018_TEM.GDT 20/3/23

Notes:

Started:	1/10/2020	*Finished:*	16/10/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH101

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1670538 E 5325187 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	90 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 104 m	*Inclination:*	-90°
Location:	Slip P8, Okiwi Bay North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

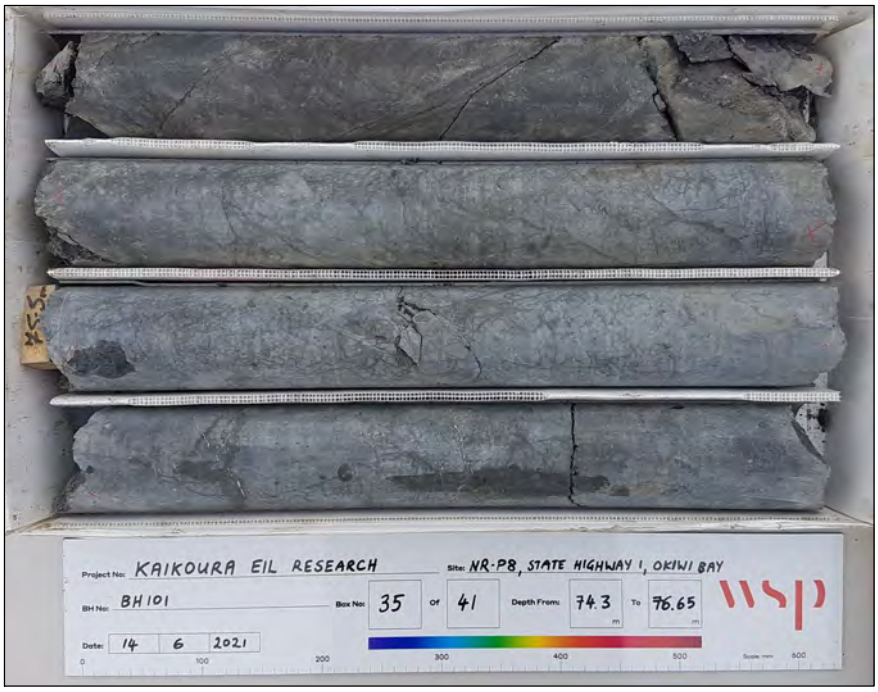


Photo BH101.35
BH101 Box 35

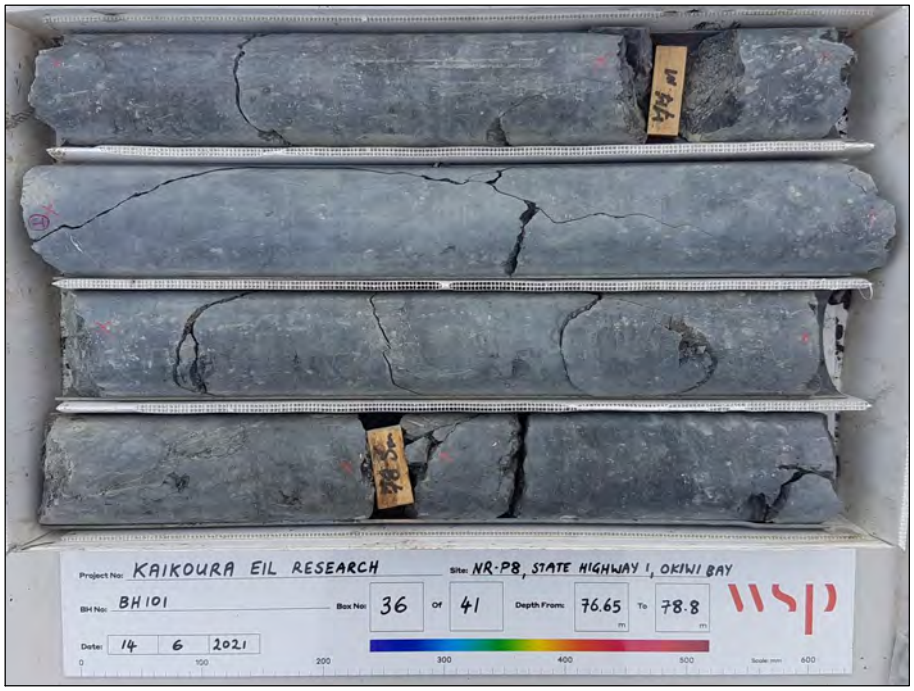


Photo BH101.36
BH101 Box 36

BOREHOLE SOIL/ROCK LOG A4 - WSP EILD.GPJ WSP-OPUS2018_TEM.GDT 20/3/23

Notes:

Started:	1/10/2020	*Finished:*	16/10/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH101

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1670538 E 5325187 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	90 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 104 m	*Inclination:*	-90°
Location:	Slip P8, Okiwi Bay North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

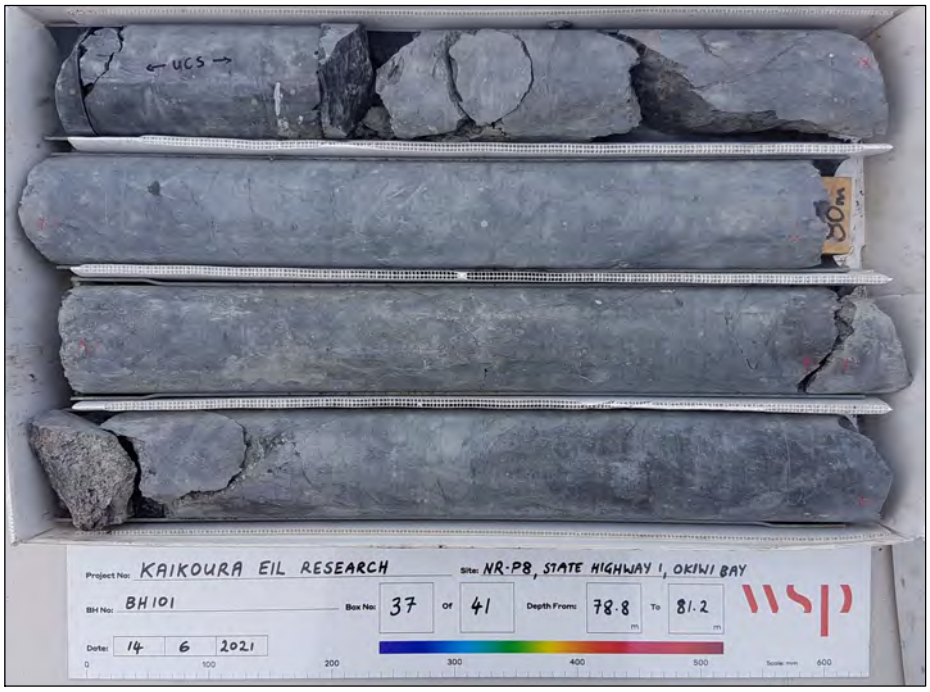


Photo BH101.37
BH101 Box 37

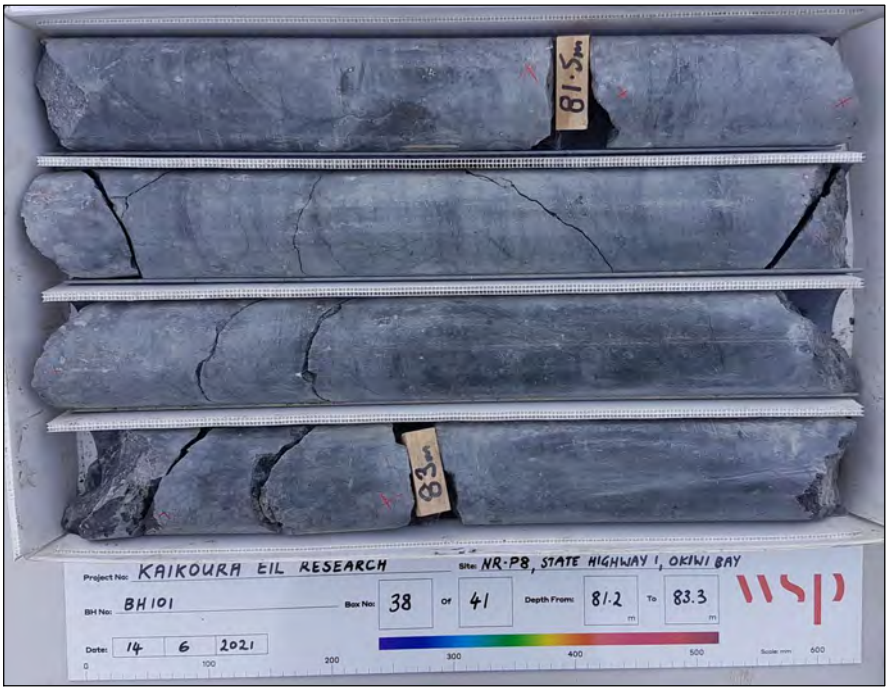


Photo BH101.38
BH101 Box 38

BOREHOLE SOIL/ROCK LOG A4 - WSP EILD.GPJ WSP-OPUS2018_TEM.GDT 20/3/23

Notes:

Started:	1/10/2020	*Finished:*	16/10/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH101

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1670538 E 5325187 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	90 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 104 m	*Inclination:*	-90°
Location:	Slip P8, Okiwi Bay North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

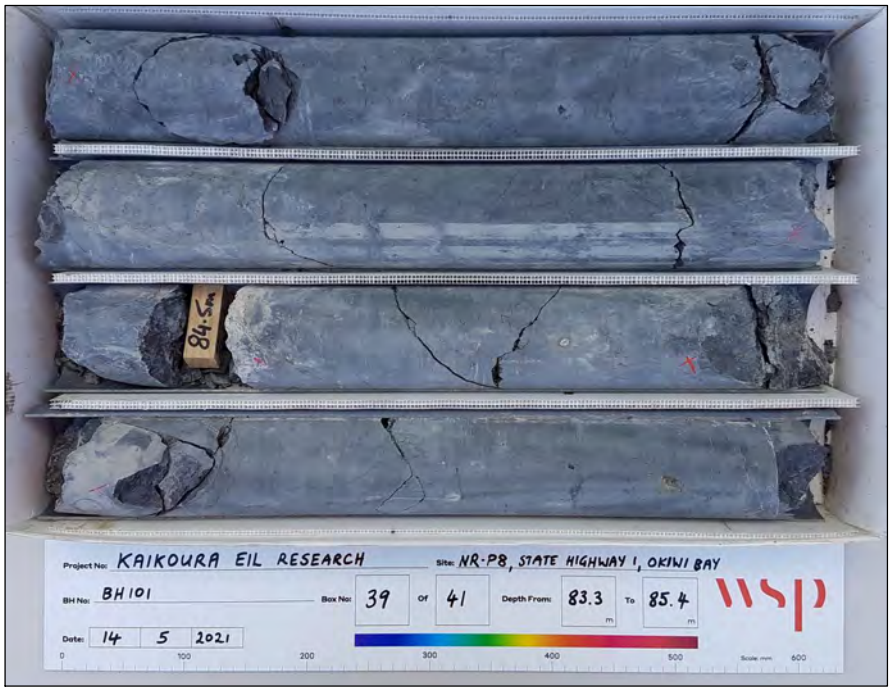


Photo BH101.39
BH101 Box 39

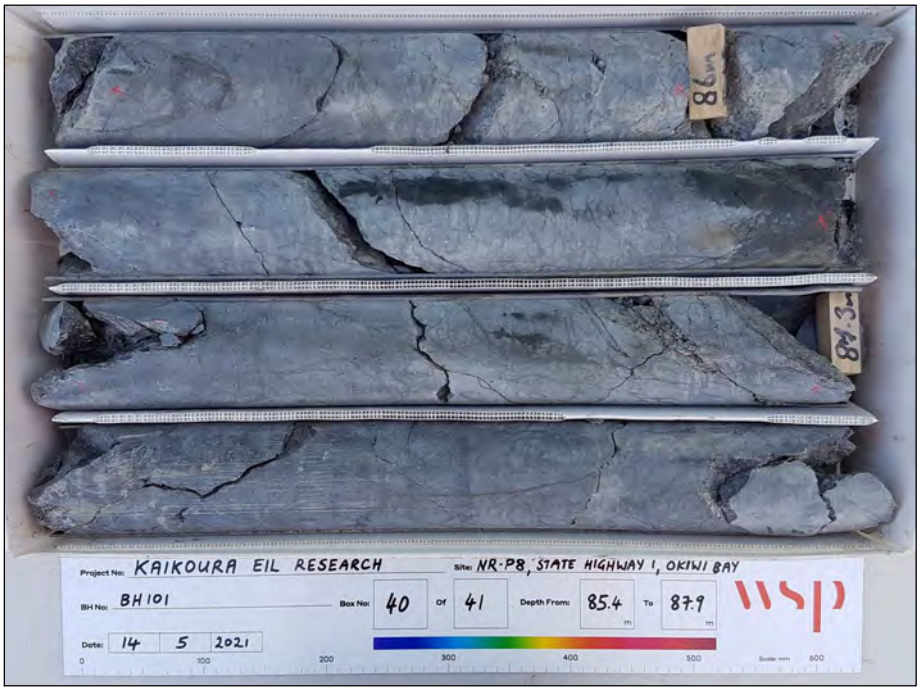


Photo BH101.40
BH101 Box 40

BOREHOLE SOIL/ROCK LOG A4 - WSP EILD.GPJ WSP-OPUS2018_TEM.GDT 20/3/23

Notes:

Started:	1/10/2020	*Finished:*	16/10/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH101

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1670538 E 5325187 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	90 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 104 m	*Inclination:*	-90°
Location:	Slip P8, Okiwi Bay North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

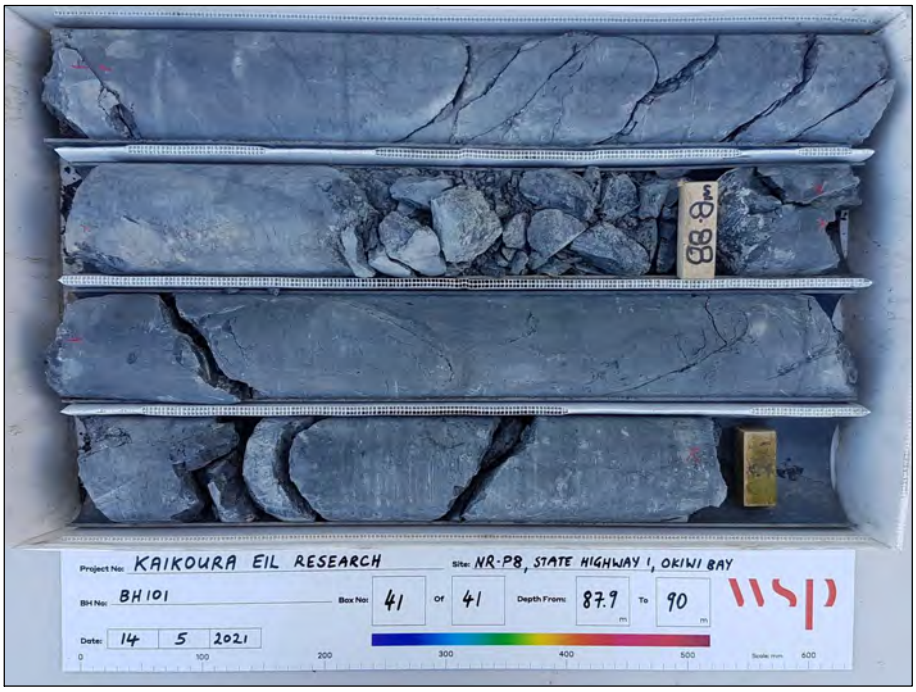


Photo BH101.41
BH101 Box 41

Notes:

Started:	1/10/2020	*Finished:*	16/10/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

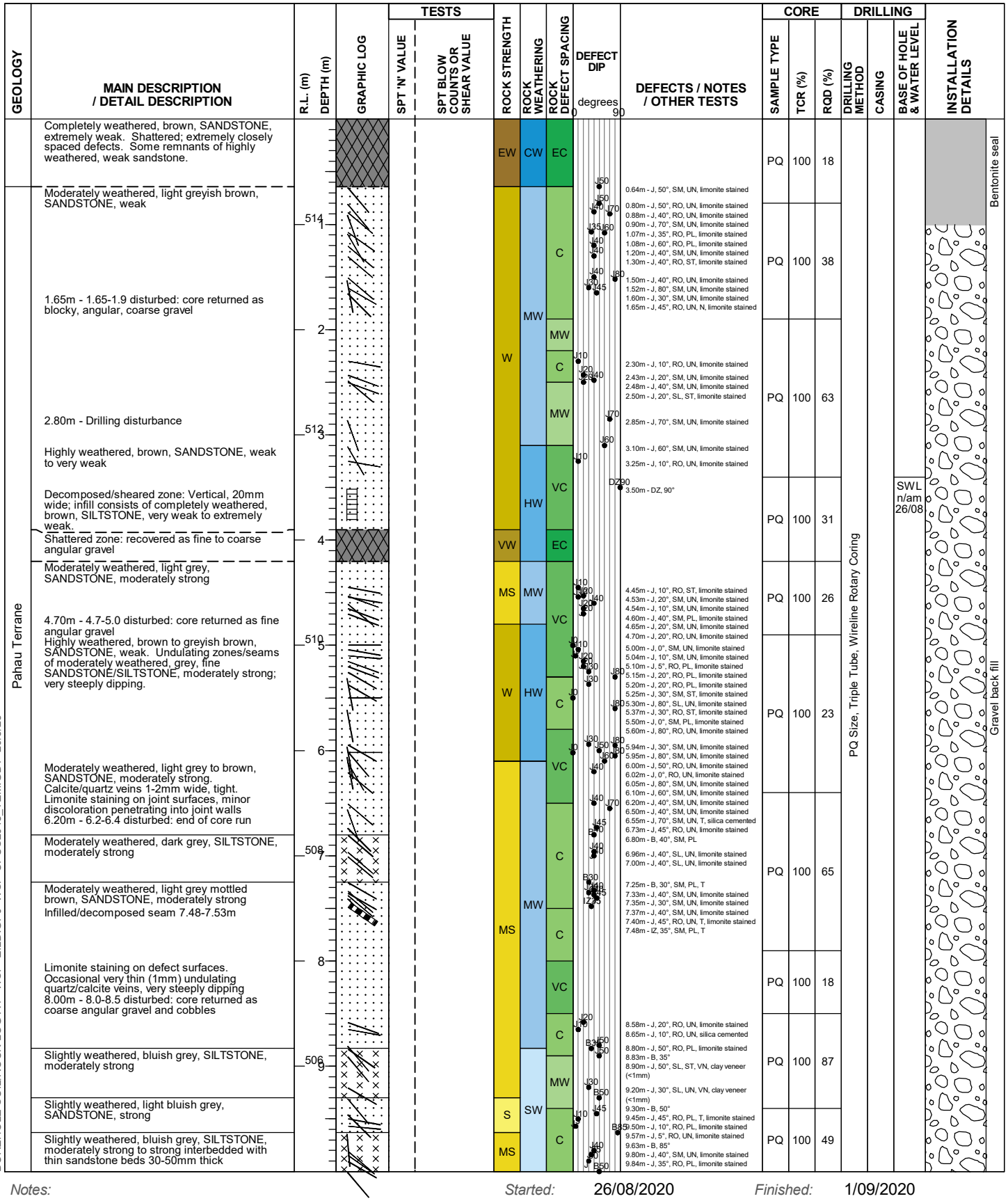
Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH103

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1658900 E 5365810 N
Client:	GNS Science	*Ref. Grid:*	NZTM
Project No.:	5-C3418.00	*R.L.:*	Approx. 515 m
Location:	Awatere Valley Road North Canterbury	*Datum:*	Mean Sea Level

Depth: 49.9 m
Inclination: -90°
Azimuth: 0°



Notes:

Started:	26/08/2020	*Finished:*	1/09/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH103

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1658900 E 5365810 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	49.9 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 515 m	*Inclination:*	-90°
Location:	Awatere Valley Road North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
Pahau Terrane	Slightly weathered, light bluish grey, SANDSTONE, strong to very strong						S		C / VC	0 B50 90	9.90m - J, 30°, RO, PL, limonite stained 10.00m - B, 50° 10.10m - J, 40°, SM, UN, limonite stained 10.20m - J, 40°, SM, PL 10.30m - J, 40°, RO, UN 10.32m - J, 60°, SL, UN 10.35m - J, 40°, RO, UN 10.50m - J, 20°, RO, UN 10.53m - J, 40°, RO, UN 10.55m - J, 85°, SM, UN	PQ	100	49	PQ Size, Triple Tube, Wireline Rotary Coring			Gravel back fill
	Slightly weathered, bluish grey, SILTSTONE, weak						W		EC		10.60m - J, 60°, SM, UN, clay veneer (<1mm)							
	10.75m - 10.75-10.9 disturbed: highly fractured/shattered at end of core run	504	11				S	SW	C		10.70m - J, 35°, RO, UN 10.92m - J, 25°, SM, UN 10.95m - B, 40° 11.03m - J, 0°, SM, UN 11.36m - J, 85°, SM, UN 11.42m - J, 5°, RO, PL 11.47m - J, 20°, RO, PL 11.48m - J, 30°, SM, PL 11.50m - B, 30°	PQ	100	69				
	Slightly weathered, light bluish grey, SANDSTONE, strong																	
	Slightly weathered, bluish grey, SILTSTONE, moderately strong		12				MS		MW / VC		11.66m - J, 40°, RO, PL, clay veneer (<1mm) 11.77m - J, 30°, SL, UN 12.10m - J, 50°, RO, PL, clay veneer (<1mm) 12.20m - J, 75°, SM, UN 12.24m - J, 40°, SM, UN							
	Unweathered, light bluish grey, SANDSTONE, strong						S	UW	C / MW		12.50m - B, 40° 12.68m - J, 20°, SL, UN, silica cemented 12.72m - J, 30°, SM, UN	PQ	100	52				
		502	13								13.13m - J, 15°, SM, UN 13.24m - J, 20°, SM, UN 13.30m - J, 50°, RO, UN 13.40m - J, 20°, RO, UN 13.53m - J, 30°, SM, UN 13.62m - J, 20°, RO, UN 13.65m - J, 40°, RO, UN 13.74m - J, 10°, SM, UN 13.81m - J, 20°, SM, ST							
			14						C / MW		14.00m - J, 20°, SM, UN 14.06m - J, 10°, SM, UN 14.32m - J, 10°, SM, UN	PQ	100	33				
	Slightly weathered, dark bluish grey, SILTSTONE, weak. Highly fractured, fissile.	500	15				W	SW	VC		14.67m - J, 30°, SM, ST 14.80m - B, 50° 14.93m - J, 60°, RO, PL 15.00m - J, 65°, RO, PL							
	Unweathered, light grey, SANDSTONE, strong 15.20m - 15.2-15.4 disturbed						S	UW	C		15.20m - J, 50°, SM, UN, T 15.64m - J, 10°, RO, ST							
	Shattered zone: brittle, fissile, weak SANDSTONE						W		EC		15.75m - SHZ, 50°							
	Slightly weathered, light grey, SANDSTONE, moderately strong		16				MS	SW	C		15.95m - J, 50°, SM, UN 16.04m - J, 50°, SM, UN	PQ	100	39				
	Shattered zone: brittle, fissile, weak SANDSTONE. Rough to smooth, stepped to undulating defects						W		EC		16.46m - J, 30°, SM, UN 16.56m - J, 50°, RO, UN							
	Unweathered, light bluish grey, fine SANDSTONE, strong to very strong	498	17				S	UW	C		17.00m - J, 55°, SL, UN, silica cemented 17.22m - J, 30°, RO, PL 17.27m - J, 20°, RO, UN 17.42m - J, 55°, SM, ST 17.54m - J, 5°, SM, UN 17.60m - J, 60°, SM, UN 17.75m - J, 50°, SM, UN	PQ	100	56				
			18						VC / C		17.94m - J, 40°, RO, PL 17.95m - J, 70°, RO, PL 18.00m - J, 15°, SM, UN 18.10m - J, 20°, SM, UN 18.13m - J, 60°, RO, PL 18.20m - J, 55°, SM, ST 18.33m - J, 55°, SM, UN							
	18.40m - 18.4-18.5 disturbed: start of core run	496	19						VC		18.73m - J, 70°, RO, PL 18.80m - J, 15°, SM, UN 18.85m - J, 75°, SM, UN 18.94m - J, 70°, RO, UN 18.97m - J, 70°, RO, UN	PQ	100	31				
	Unweathered, dark grey, SILTSTONE, laminated, weak						W	UW	MW / C		19.20m - B, 70° 19.50m - J, 60°, RO, UN 19.63m - J, 40°, RO, UN 19.68m - J, 75°, RO, UN 19.90m - J, 85°, SM, UN	PQ	100	0				

Notes:

Started:	26/08/2020	*Finished:*	1/09/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

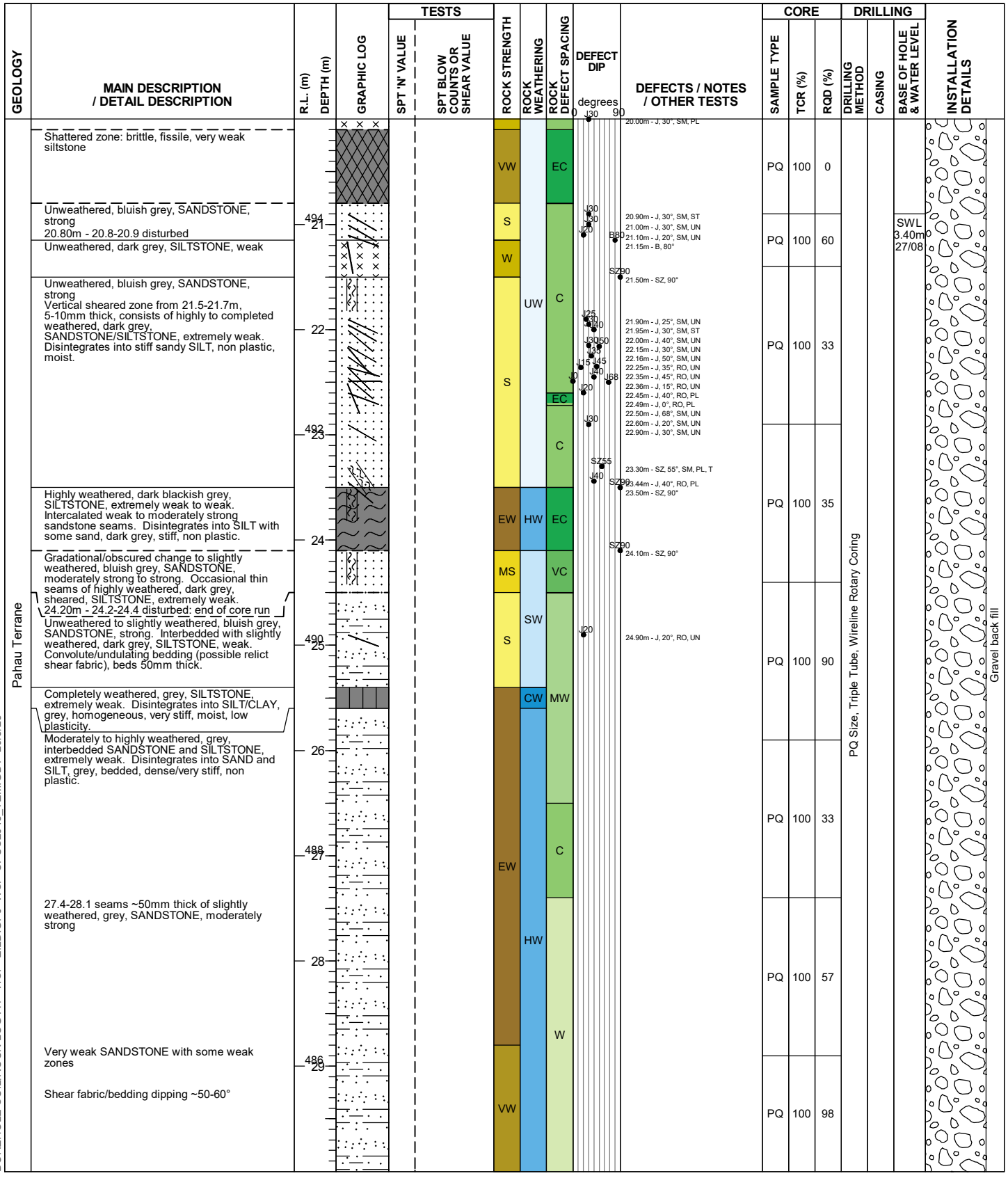
Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH103

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1658900 E 5365810 N
Client:	GNS Science	*Ref. Grid:*	NZTM
Project No.:	5-C3418.00	*R.L.:*	Approx. 515 m
Location:	Awatere Valley Road North Canterbury	*Datum:*	Mean Sea Level

Depth: 49.9 m
Inclination: -90°
Azimuth: 0°



BOREHOLE SOIL/ROCK LOG A4 - WSP EILD.GPJ WSP-OPUS2018_TEM.GDT 20/3/23

Notes:

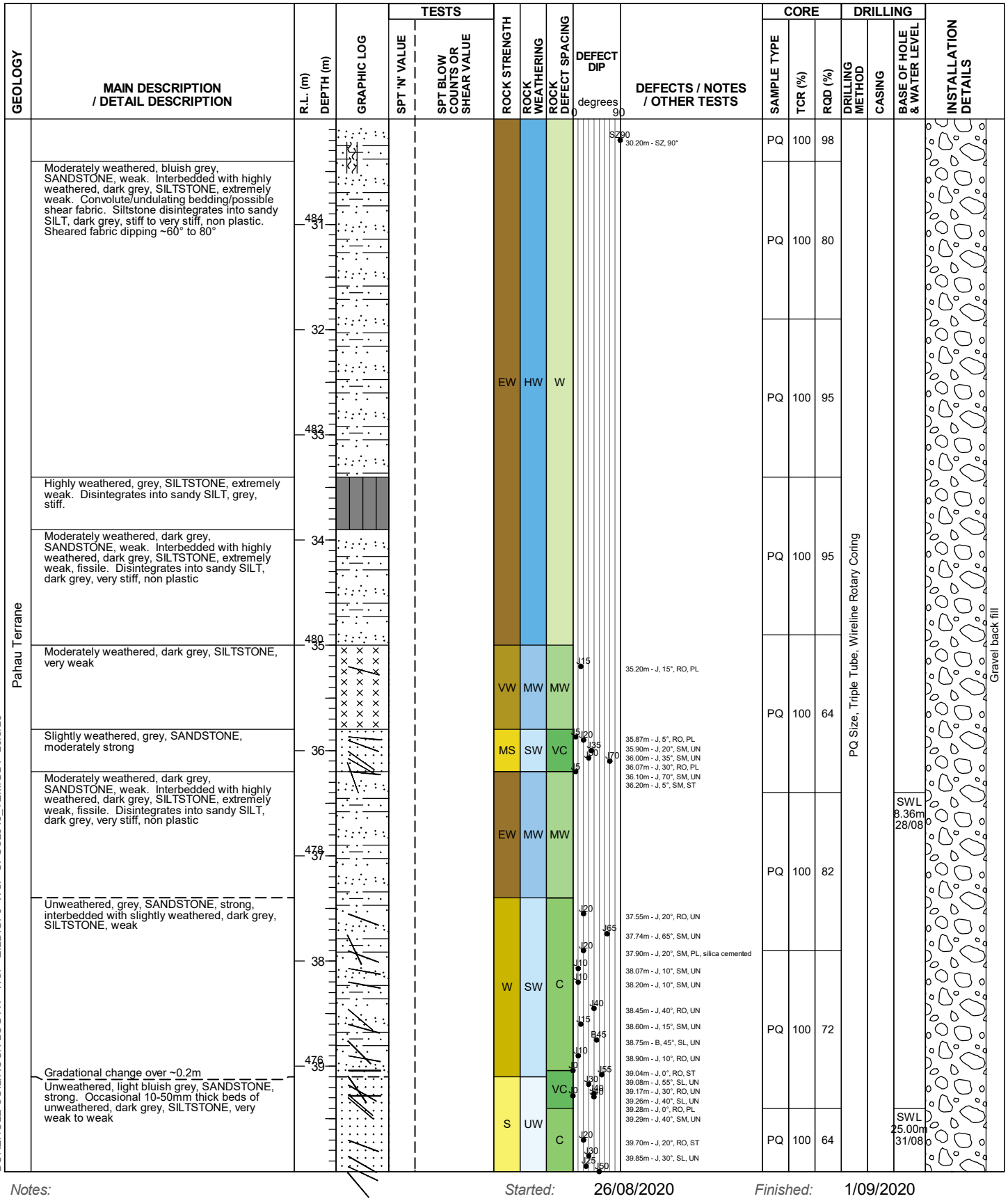
Started:	26/08/2020	*Finished:*	1/09/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH103

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1658900 E 5365810 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	49.9 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 515 m	*Inclination:*	-90°
Location:	Awatere Valley Road North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°



BOREHOLE SOIL/ROCK LOG A4 - WSP EILD.GPJ WSP-OPUS2018_TEM.GDT 20/3/23

Notes:

Started:	26/08/2020	*Finished:*	1/09/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH103

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1658900 E 5365810 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	49.9 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 515 m	*Inclination:*	-90°
Location:	Awatere Valley Road North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
Pahau Terrane	Unweathered, light bluish grey, SANDSTONE, strong. Occasional 10-50mm thick beds of unweathered, dark grey, SILTSTONE, very weak to weak *(continued)*						S		C	J10 J50 J50 J15 J60 J60 B50 J20	39.95m - J, 25°, SM, UN 40.00m - J, 50°, SM, UN 40.10m - J, 50°, RO, UN 40.12m - J, 10°, SM, UN 40.14m - J, 60°, SM, UN 40.35m - J, 15°, RO, PL 40.40m - J, 60°, SL, UN, T 40.62m - J, 60°, SM, UN 40.78m - B, 50°, SM, UN 40.96m - J, 20°, SM, UN	PQ	100	64	PQ Size, Triple Tube, Wireline Rotary Coring			Gravel back fill
	Unweathered, grey, SILTSTONE, moderately strong 40.80m - 40.8-40.9 drilling disturbance	474	41				MS		VC	J35 J50 J30 J30 J40 SZ85	41.35m - J, 35°, SM, UN 41.40m - J, 50°, RO, UN 41.50m - J, 30°, SM, UN 41.60m - J, 30°, RO, PL 41.65m - SZ, 85°, SL, UN, clay gouge (>1mm) 41.70m - J, 40°, RO, PL	PQ	100	72				
			42						MW									
									VC	J30 J70	42.10m - J, 30°, SM, UN 42.15m - J, 70°, SM, UN, clay veneer (<1mm)							
		472	43						MW	J30 J85 J60 J70 SZ80	42.56m - J, 30°, SM, UN, clay veneer (<1mm) 42.80m - J, 85°, SM, UN, clay veneer (<1mm) 43.00m - J, 60°, SM, UN 43.10m - J, 70°, SM, UN 43.30m - SZ, 80°	PQ	100	53				
	Sheared zone: consists of 10mm wide zone of highly weathered, grey, foliated, SILTSTONE, extremely weak. Disintegrates into SILT with some sand, grey, very stiff																	
	Unweathered, bluish grey, SANDSTONE, strong. Interbedded with unweathered, dark grey, SILTSTONE, moderately strong. ~100mm thick convolute/undulating beds		44							J50 J55 J40 J55 J25	44.40m - J, 50°, RO, UN 44.45m - J, 40°, SM, UN 44.50m - J, 55°, RO, PL, silica cemented 44.66m - J, 40°, SM, UN 44.80m - J, 55°, SM, UN 44.90m - J, 45°, SM, UN	PQ	100	72				
		470	45					UW	C	J5	45.05m - J, 5°, SM, ST							
	Unweathered, bluish grey, SANDSTONE, strong								MW									
			46						C	J10 J50 J10 J20 J30 J20 J50	46.05m - J, 50°, SM, UN 46.06m - J, 10°, SM, UN 46.08m - J, 10°, SM, UN 46.20m - J, 10°, SM, UN 46.35m - J, 20°, RO, PL 46.40m - J, 30°, RO, ST 46.50m - J, 20°, RO, PL 46.54m - J, 15°, RO, UN 46.55m - J, 50°, RO, UN	PQ	100	67				
		468	47						MW									
									C	J50 J40 J40 J70 J50 J50	46.92m - J, 50°, RO, PL 47.10m - J, 40°, SM, UN 47.20m - J, 30°, SM, UN 47.22m - J, 40°, SM, UN 47.40m - J, 70°, RO, PL, T 47.50m - J, 60°, SL, UN 47.53m - J, 70°, SL, UN 47.60m - J, 60°, SL, UN	PQ	100	61				
			48				S		MW	J30 J15 J30	47.82m - J, 30°, SM, UN 47.90m - J, 15°, RO, ST 47.95m - J, 10°, RO, ST 48.00m - J, 10°, SM, UN							
									C	J20 J20 J35 J30 SHZ40 J40 J30 J50	48.35m - J, 20°, SL, UN 48.40m - J, 20°, SM, UN 48.50m - J, 35°, RO, UN 48.70m - J, 30°, SM, UN 48.80m - SHZ, 40° 48.90m - J, 40°, SL, UN 49.00m - J, 30°, SM, UN 49.02m - J, 50°, SM, UN	PQ	100	52				
	Unweathered, dark grey, SILTSTONE, weak and fissile	466	49						MW									
	Unweathered, bluish grey, SANDSTONE, strong								VC	J20 J30 J20	49.60m - J, 20°, SM, UN 49.68m - J, 5°, SM, UN 49.72m - J, 5°, SM, UN 49.75m - J, 20°, SM, UN 49.78m - J, 20°, SM, UN							
	END OF BOREHOLE AT 49.9m - Target Criteria Achieved																	

Notes:

Started:	26/08/2020	*Finished:*	1/09/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH103

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1658900 E 5365810 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	49.9 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 515 m	*Inclination:*	-90°
Location:	Awatere Valley Road North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
		464	51														SWL 20.70m 1/09	
			52															
		462	53															
			54															
		460	55															
			56															
		458	57															
			58															
		456	59															

BOREHOLE SOIL/ROCK LOG A4 - WSP EILD.GPJ WSP-OPUS2018_TEM.GDT 20/3/23

Notes:

Started:	26/08/2020	*Finished:*	1/09/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH103

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1658900 E 5365810 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	49.9 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 515 m	*Inclination:*	-90°
Location:	Awatere Valley Road North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

Photo BH103.1
BH103 Box 01

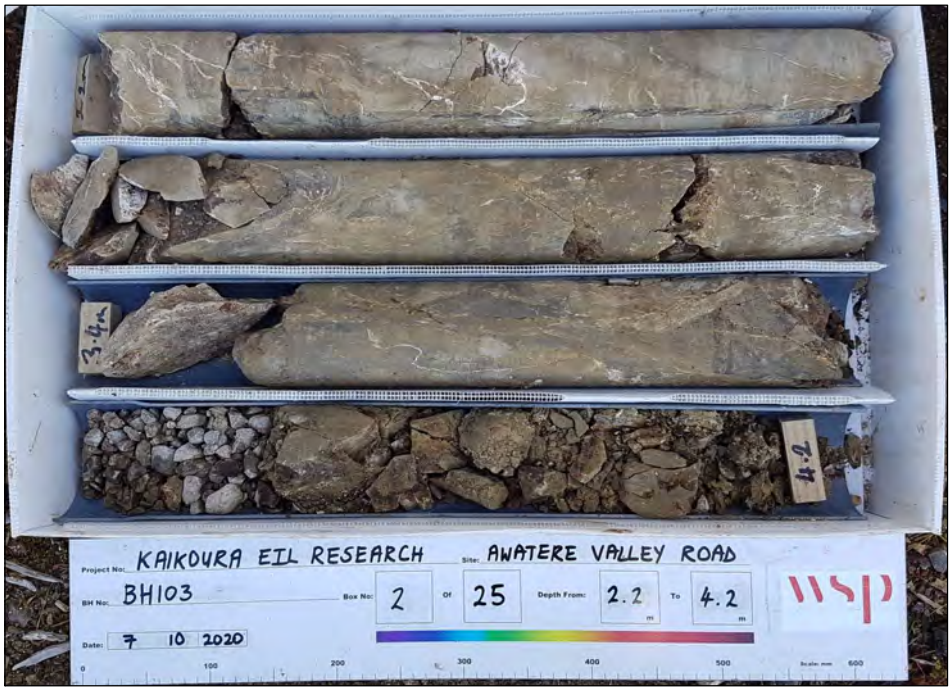


Photo BH103.2
BH103 Box 02

Notes:		*Started:*	26/08/2020	*Finished:*	1/09/2020
		Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
		Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH103

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1658900 E 5365810 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	49.9 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 515 m	*Inclination:*	-90°
Location:	Awatere Valley Road North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

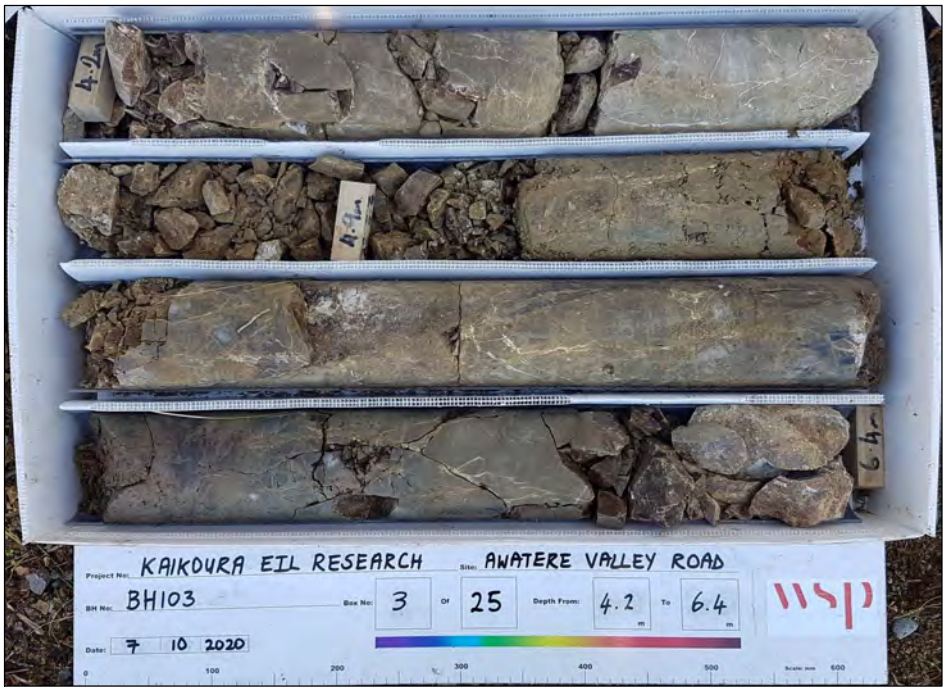


Photo BH103.3
BH103 Box 03

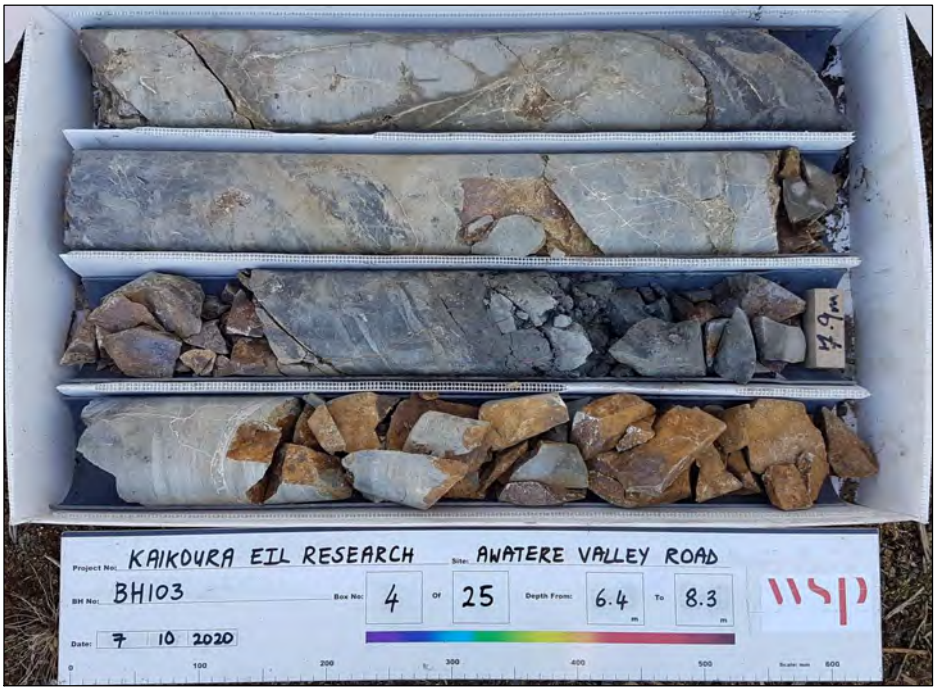


Photo BH103.4
BH103 Box 04

Notes:

Started:	26/08/2020	*Finished:*	1/09/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH103

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1658900 E 5365810 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	49.9 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 515 m	*Inclination:*	-90°
Location:	Awatere Valley Road North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

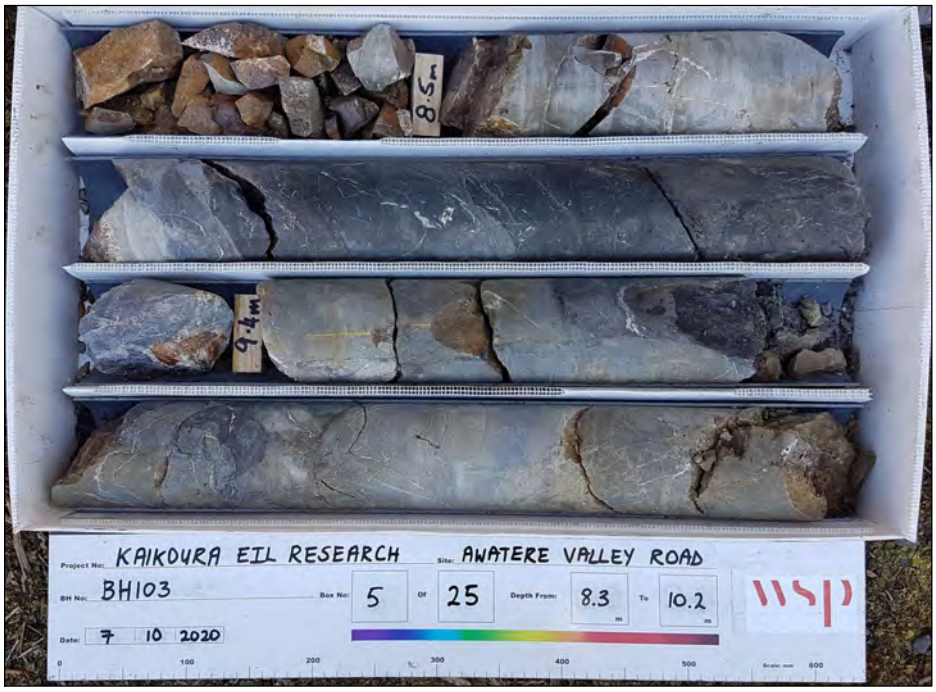


Photo BH103.5
BH103 Box 05

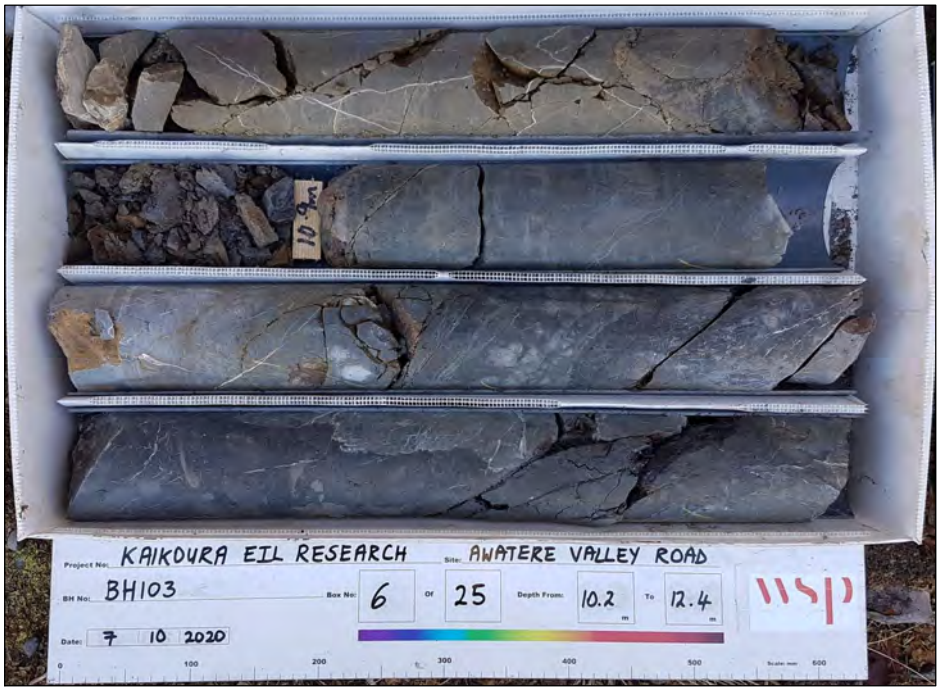


Photo BH103.6
BH103 Box 06

BOREHOLE SOIL/ROCK LOG A4 - WSP EILD.GPJ WSP-OPUS2018_TEM.GDT 20/3/23

Notes:

Started:	26/08/2020	*Finished:*	1/09/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH103

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1658900 E 5365810 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	49.9 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 515 m	*Inclination:*	-90°
Location:	Awatere Valley Road North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

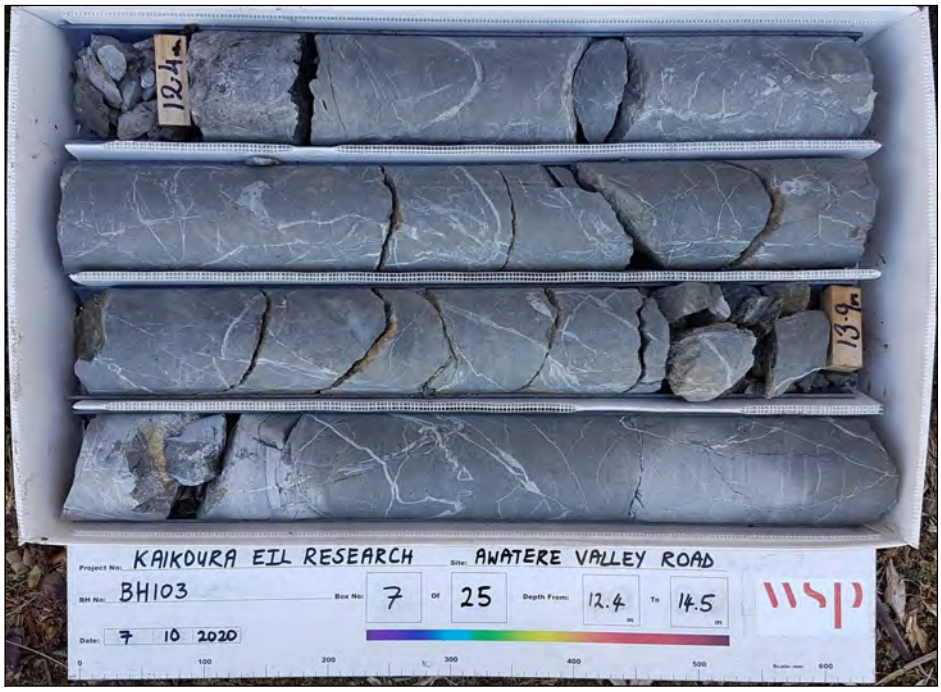


Photo BH103.7
BH103 Box 07

Photo BH103.8
BH103 Box 08

BOREHOLE SOIL/ROCK LOG A4 - WSP EILD.GPJ WSP-OPUS2018_TEM.GDT 20/3/23

Notes:

Started:	26/08/2020	*Finished:*	1/09/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH103

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1658900 E 5365810 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	49.9 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 515 m	*Inclination:*	-90°
Location:	Awatere Valley Road North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

Photo BH103.9
BH103 Box 09

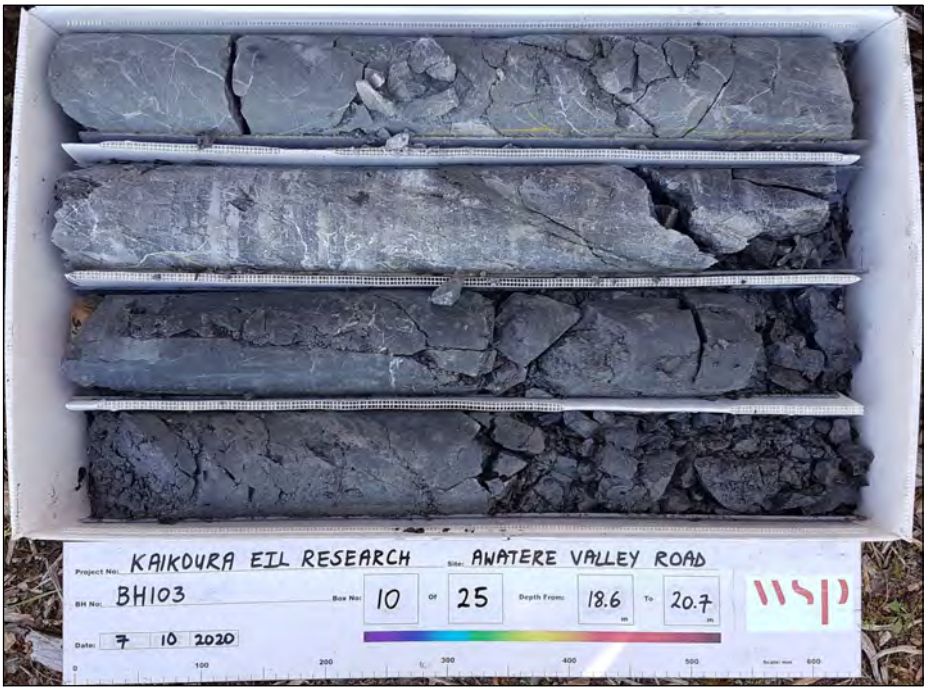


Photo BH103.10
BH103 Box 10

BOREHOLE SOIL/ROCK LOG A4 - WSP EILD.GPJ WSP-OPUS2018_TEM.GDT 20/3/23

Notes:

Started:	26/08/2020	*Finished:*	1/09/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH103

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1658900 E 5365810 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	49.9 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 515 m	*Inclination:*	-90°
Location:	Awatere Valley Road North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

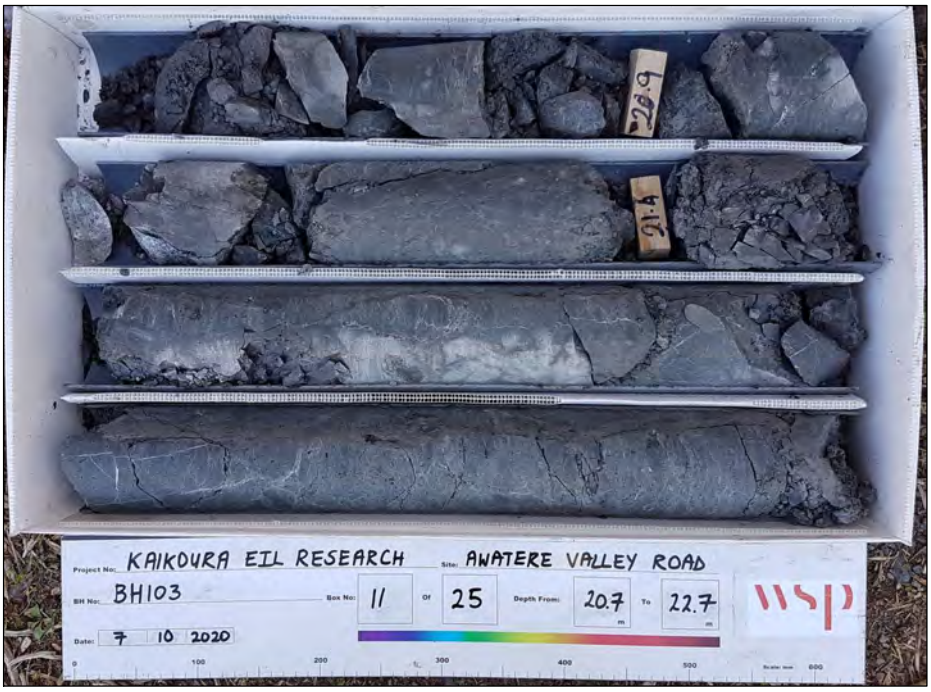


Photo BH103.11
BH103 Box 11

Photo BH103.12
BH103 Box 12

BOREHOLE SOIL/ROCK LOG A4 - WSP EILD.GPJ WSP-OPUS2018_TEM.GDT 20/3/23

Notes:

Started:	26/08/2020	*Finished:*	1/09/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH103

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1658900 E 5365810 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	49.9 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 515 m	*Inclination:*	-90°
Location:	Awatere Valley Road North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

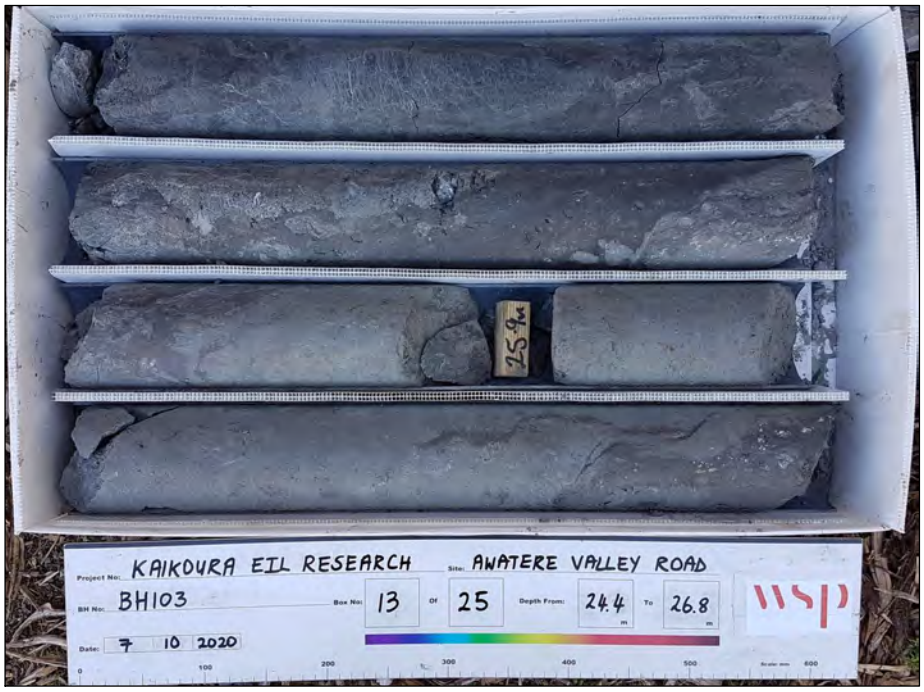


Photo BH103.13
BH103 Box 13

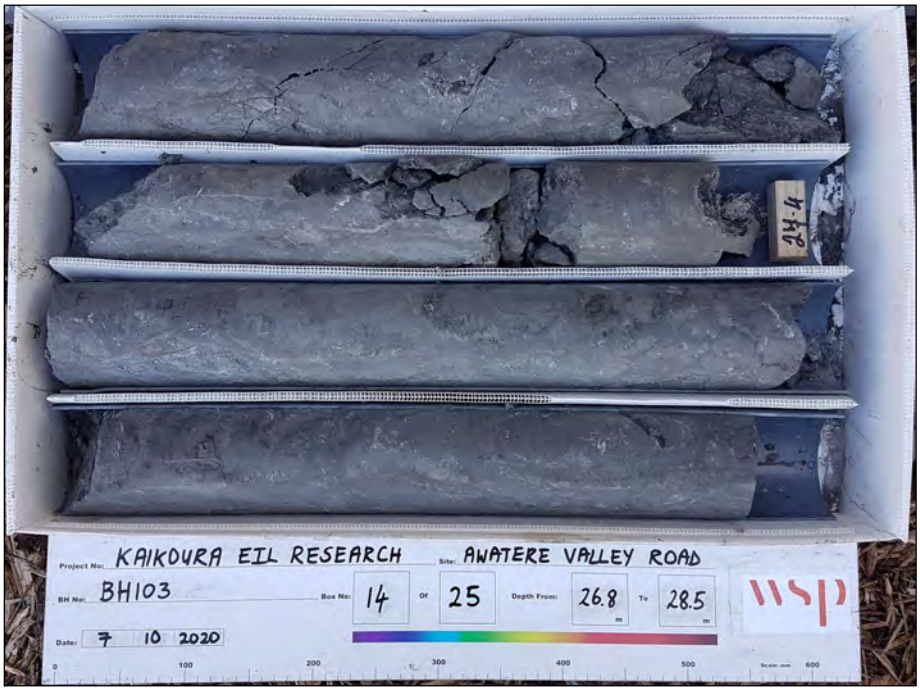


Photo BH103.14
BH103 Box 14

Notes:

Started:	26/08/2020	*Finished:*	1/09/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH103

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1658900 E 5365810 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	49.9 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 515 m	*Inclination:*	-90°
Location:	Awatere Valley Road North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

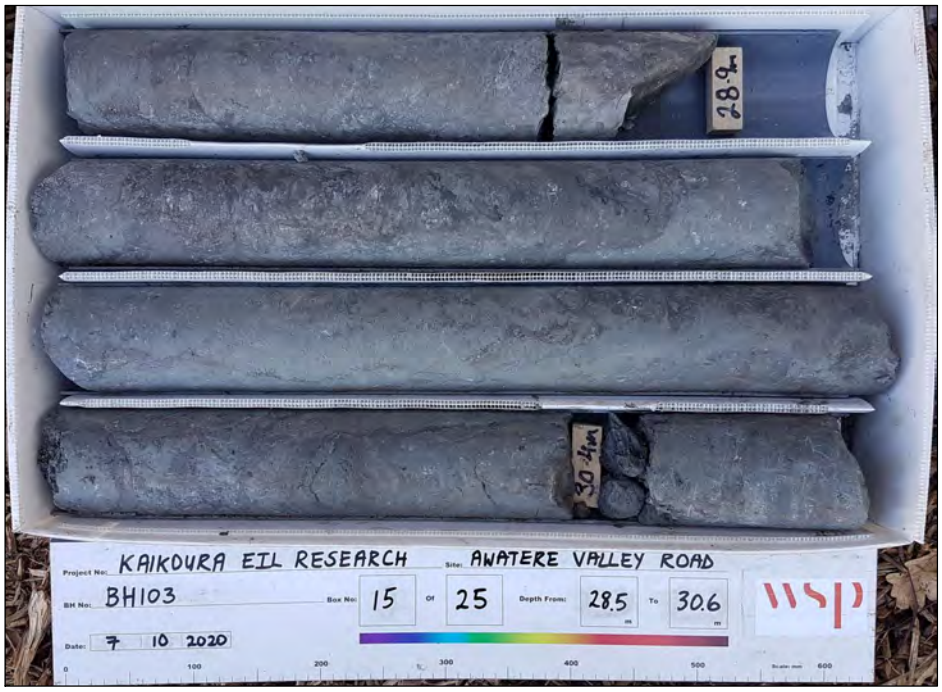


Photo BH103.15
BH103 Box 15

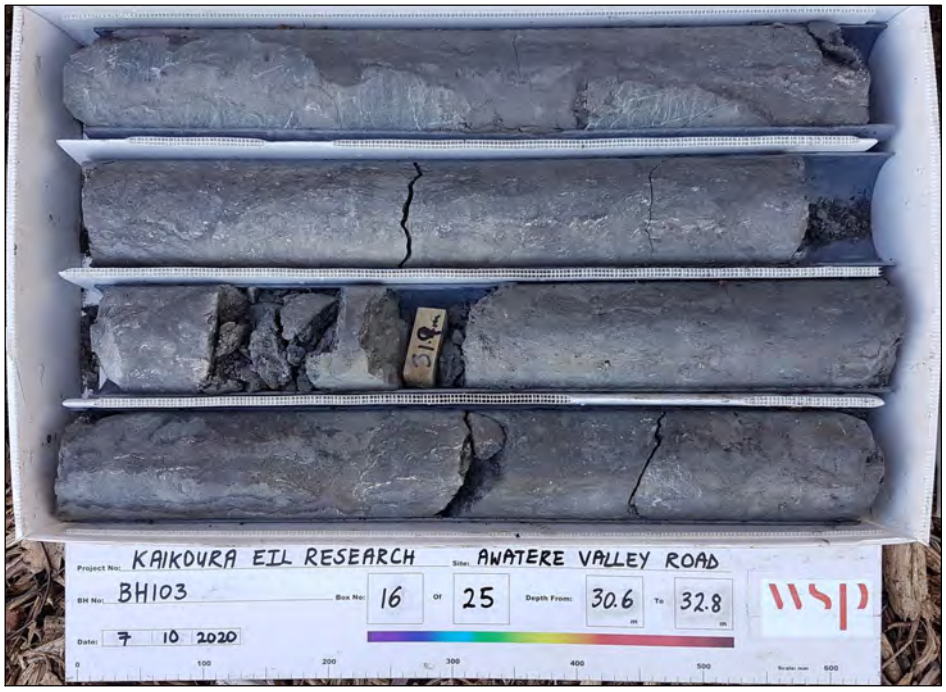


Photo BH103.16
BH103 Box 16

BOREHOLE SOIL/ROCK LOG A4 - WSP EILD.GPJ WSP-OPUS2018_TEM.GDT 20/3/23

Notes:

Started:	26/08/2020	*Finished:*	1/09/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH103

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1658900 E 5365810 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	49.9 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 515 m	*Inclination:*	-90°
Location:	Awatere Valley Road North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

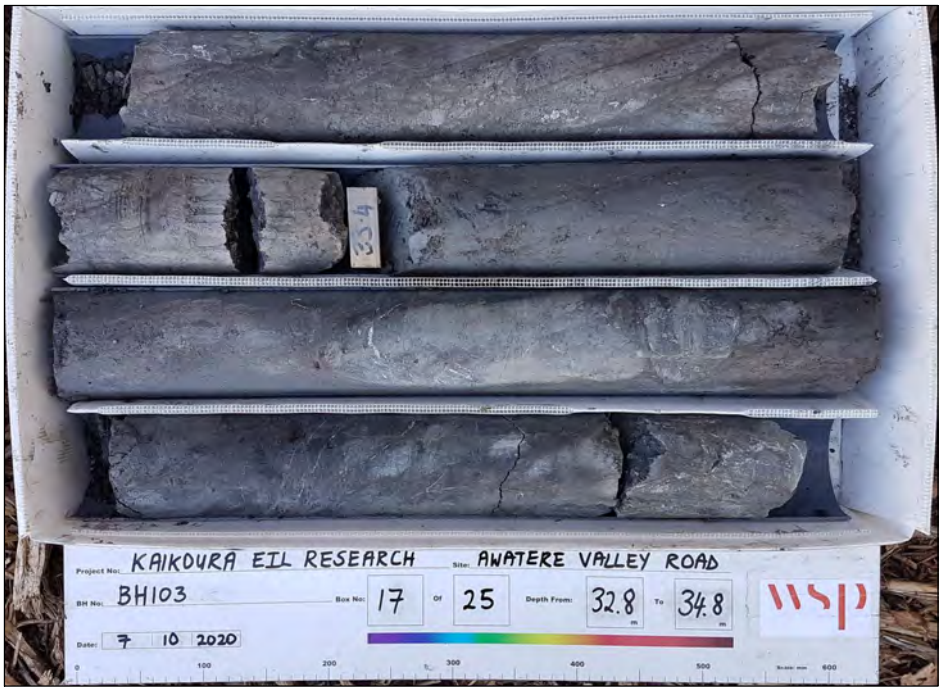


Photo BH103.17
BH103 Box 17

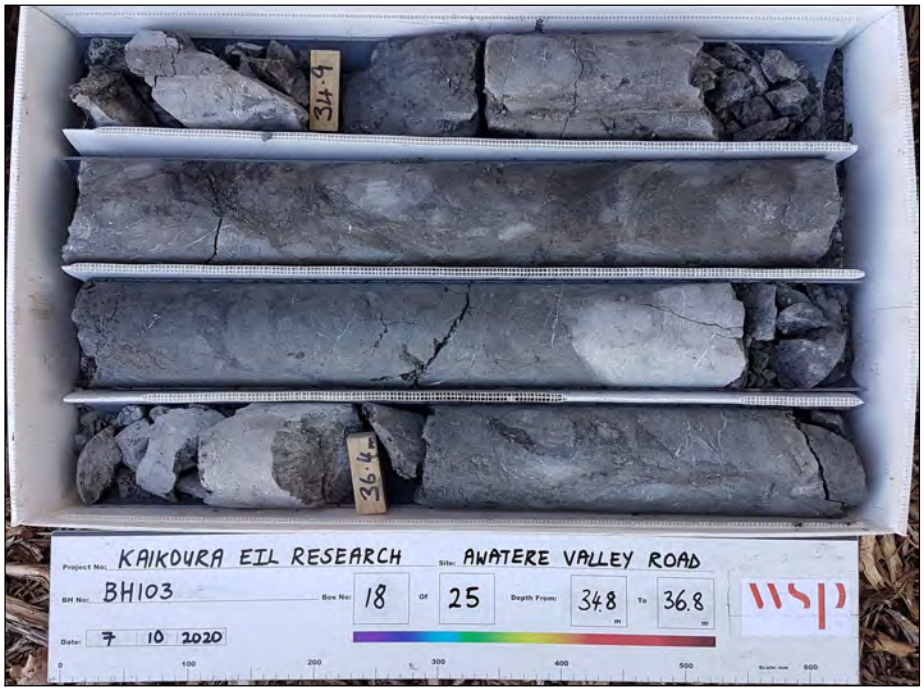


Photo BH103.18
BH103 Box 18

BOREHOLE SOIL/ROCK LOG A4 - WSP EILD.GPJ WSP-OPUS2018_TEM.GDT 20/3/23

Notes:

Started:	26/08/2020	*Finished:*	1/09/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH103

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1658900 E 5365810 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	49.9 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 515 m	*Inclination:*	-90°
Location:	Awatere Valley Road North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

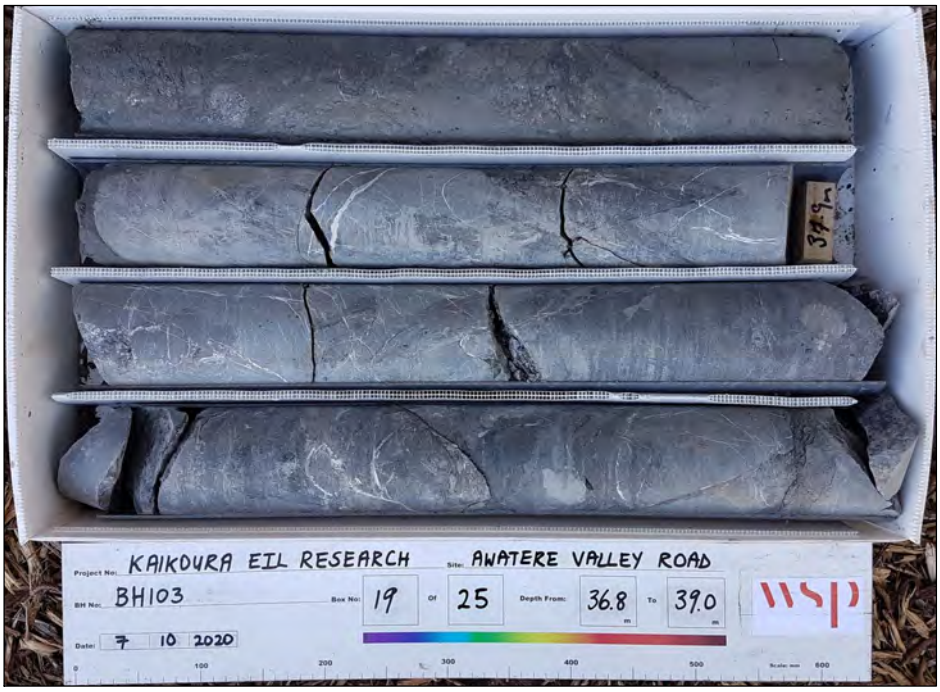


Photo BH103.19
BH103 Box 19

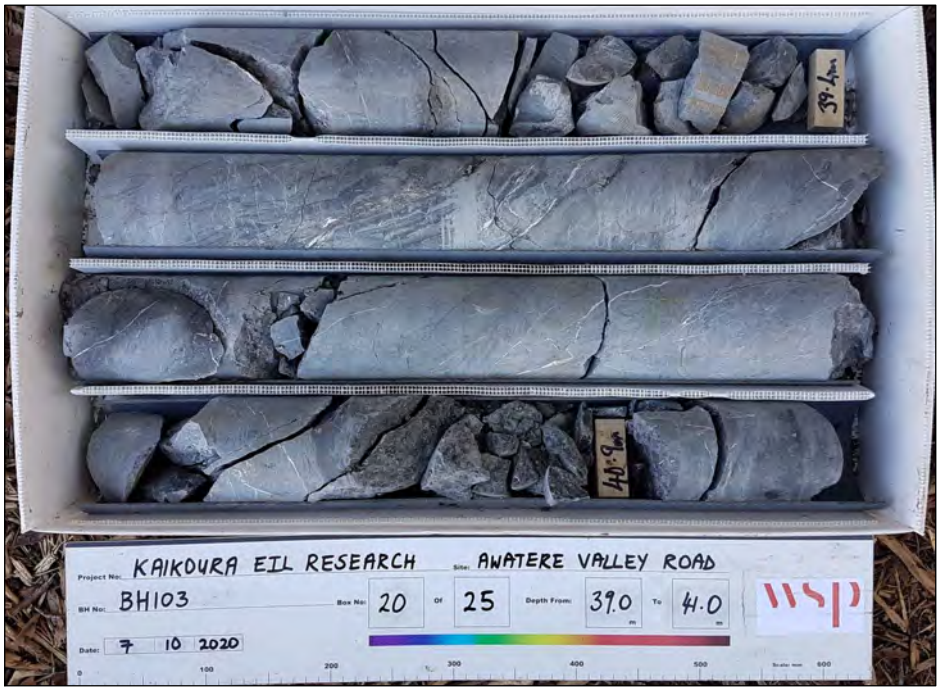


Photo BH103.20
BH103 Box 20

BOREHOLE SOIL/ROCK LOG A4 - WSP EILD.GPJ WSP-OPUS2018_TEM.GDT 20/3/23

Notes:

Started:	26/08/2020	*Finished:*	1/09/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH103

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1658900 E 5365810 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	49.9 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 515 m	*Inclination:*	-90°
Location:	Awatere Valley Road North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

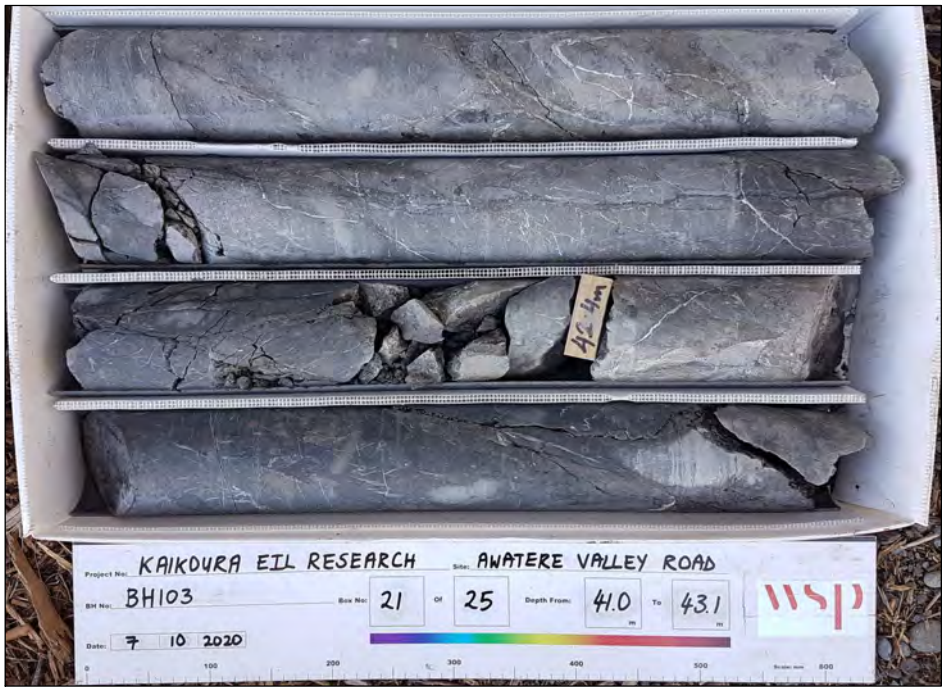


Photo BH103.21
BH103 Box 21

Photo BH103.22
BH103 Box 22

BOREHOLE SOIL/ROCK LOG A4 - WSP EILD.GPJ WSP-OPUS2018_TEM.GDT 20/3/23

Notes:

Started:	26/08/2020	*Finished:*	1/09/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH103

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1658900 E 5365810 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	49.9 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 515 m	*Inclination:*	-90°
Location:	Awatere Valley Road North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

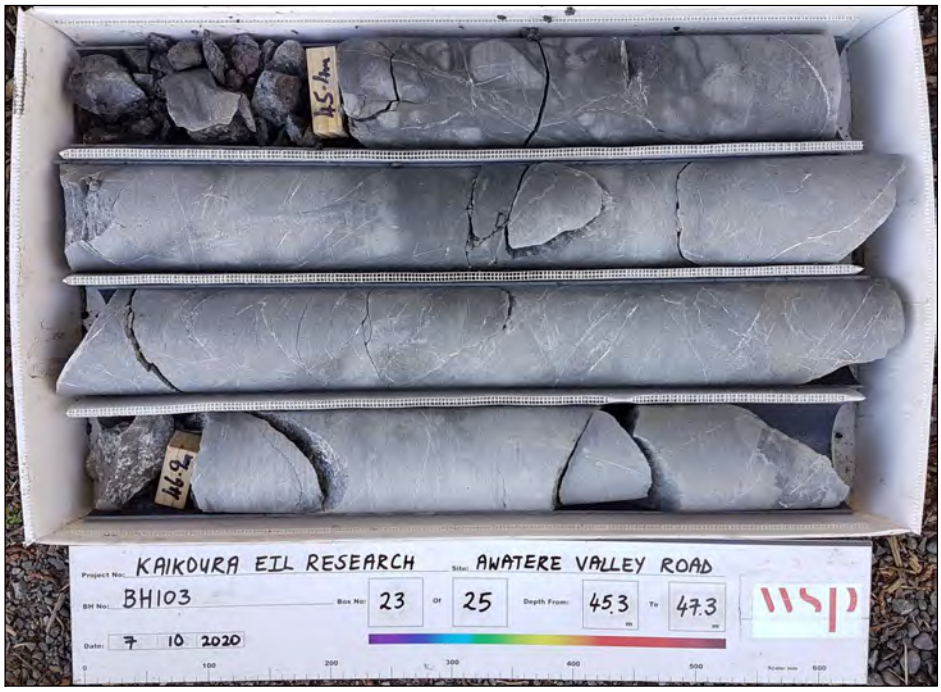


Photo BH103.23
BH103 Box 23

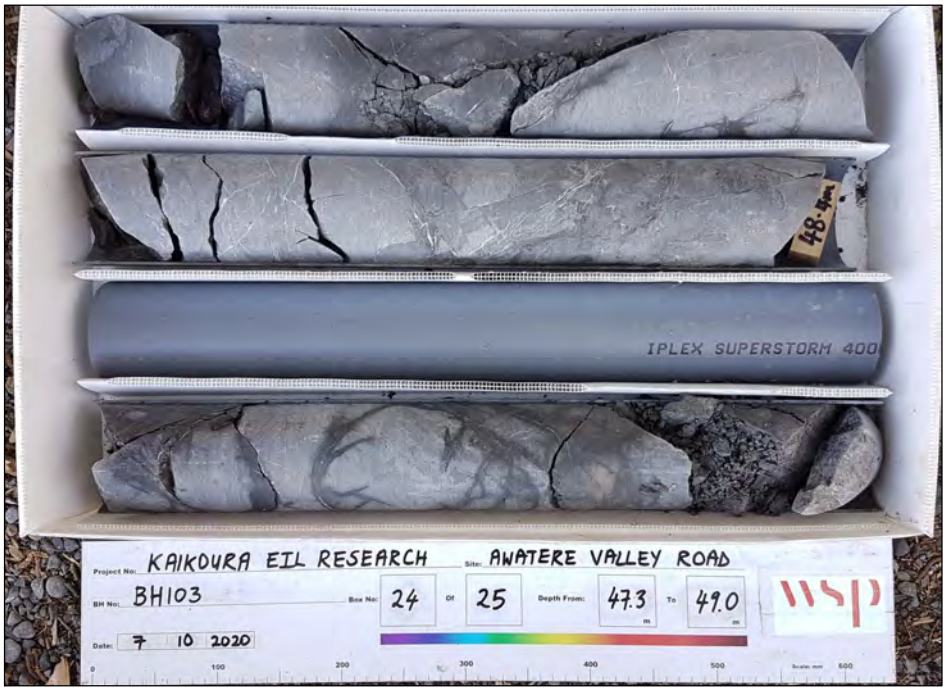


Photo BH103.24
BH103 Box 24

BOREHOLE SOIL/ROCK LOG A4 - WSP EILD.GPJ WSP-OPUS2018_TEM.GDT 20/3/23

Notes:

Started:	26/08/2020	*Finished:*	1/09/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH103

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1658900 E 5365810 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	49.9 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 515 m	*Inclination:*	-90°
Location:	Awatere Valley Road North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

Photo BH103.25
BH103 Box 25

BOREHOLE SOIL/ROCK LOG A4 - WSP EILD.GPJ WSP-OPUS2018_TEM.GDT 20/3/23

Notes:

Started:	26/08/2020	*Finished:*	1/09/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	D Mason	*Checked by:*	P Brabhaharan

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH104

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1636424 E 5289209 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	15.4 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 190 m	*Inclination:*	-90°
Location:	Hundalee Hills, south of Okarahia Stream North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
	Hand dug to clear underground services - no sample recovered. Driller comments: "Cobble fill to 800mm. 800 to 200mm clay bound sand."											HC	0					Bentonite seal
Fill	Gravelly SILT with trace sand; dark greyish brown. Firm; moist; non plastic. Gravel fine to maximum 30mm size, subrounded siltstone; sand fine grained.		1		5	2// 1/2/1/1						SPT						
	Silty fine to coarse GRAVEL with some cobbles and trace sand; greyish brown, homogeneous. Very loose; moist; well graded. Gravel subrounded siltstone; cobbles maximum 70mm size; sand fine to medium grained.											PQ	88					
	1.9m: With minor sand and trace clay; low plasticity. Sand fine to coarse; gravel subangular to subrounded; strong.	188	2		2	2// 0/1/0/1						PQ	100					
												SPT						
	Becomes greenish grey, with trace organics.											PQ	0					
	3.1m: Gravel subangular, very weak.		3									WS	100					
												PQ	0					
Alluvial Deposits	Silty CLAY with some gravel; brownish grey. Very soft; moist; plastic. Organics present. Gravel subangular to subrounded, unweathered, strong siltstone, fine to medium grained.				0	0// 0/0/0/0						SPT						
		186	4									PQ	40					
	4.6m: With trace gravel. Swelling clay.					SV: 87						PT	100					
												PQ	100					
			5		1	0// 0/0/0/1						SPT						
		184	6									PQ	47		PQ Size, Triple Tube, Wireline Rotary Coring			
	6.35m: Becoming firm; bluish grey mottled dark brown; no gravel.																	
	Sandy SILT with minor gravel; greyish brown, homogeneous. Firm; moist; non plastic. Sand fine to coarse; gravel very weak, angular, fine to medium grained. Organics present. 6.9m: Becomes stiff.		7		18	6// 5/5/4/4						SPT						
	Silty fine to coarse GRAVEL with some sand; dark brown, homogeneous. Dense; moist; well graded. Gravel unweathered siltstone, subangular; sand fine to coarse.											PQ	92					
												PQ	48					
		182	8															
	8.15m: Trace cobbles, maximum 80mm size.				31	10// 5/6/10/10						SPT						
	Clayey SILT; greyish brown. Stiff; moist; low plasticity. Organics present.											PQ	90					
Greta Formation	Unweathered, brownish grey, homogeneous SILTSTONE; very weak.		9				VW	UW	W			PQ	100	81				Gravel back fill
		180			35	11// 7/8/9/11						SPT						

Notes:
Pilcon shear vane, serial # DR2009, 19mm blade, calibrated 4/10/19

Started:	5/09/2020	*Finished:*	6/09/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	J Hodgkinson	*Checked by:*	D Mason

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH104

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1636424 E 5289209 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	15.4 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 190 m	*Inclination:*	-90°
Location:	Hundalee Hills, south of Okarahia Stream North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
Greta Formation	Unweathered, brownish grey, homogeneous SILTSTONE; very weak.*(continued)*	178	12				VW	UW	W			PQ	100	80	PQ Size, Triple Tube, Wireline Rotary Coring			Gravel back fill
												PQ	100	80				
			11									PQ	100	94				
			13									PQ	100	88				
		176	14															
	14.4m: Joint, 45 deg., rough, undulating.								C	J45	14.40m - J, 45°, RO, UN, clean	PQ	100	78				
	15.1m: Joints x2, 30 deg., possibly drilling induced.		15							J30	15.10m - J, 30°, RO, UN, clean							
	END OF BOREHOLE AT 15.4m - Target Criteria Achieved	174	16														SWL 0.54m 6/09	
			17															
		172	18															
			19															
		170																

Notes:
Pilcon shear vane, serial # DR2009, 19mm blade, calibrated 4/10/19

Started:	5/09/2020	*Finished:*	6/09/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	J Hodgkinson	*Checked by:*	D Mason

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH104

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1636424 E 5289209 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	15.4 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 190 m	*Inclination:*	-90°
Location:	Hundalee Hills, south of Okarahia Stream North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

Photo BH104.1
BH104 Box 1: 1m - 4.6m

Photo BH104.2
BH104 Box 2: 4.6m - 6.5m

BOREHOLE SOIL/ROCK LOG A4 - WSP EILD.GPJ WSP-OPUS2018_TEM.GDT 20/3/23

Notes:
Pilcon shear vane, serial # DR2009, 19mm blade, calibrated 4/10/19

Started:	5/09/2020	*Finished:*	6/09/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	J Hodgkinson	*Checked by:*	D Mason

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH104

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1636424 E 5289209 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	15.4 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 190 m	*Inclination:*	-90°
Location:	Hundalee Hills, south of Okarahia Stream North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

Photo BH104.3
BH104 Box 3: 6.5m - 9.1m

Photo BH104.4
BH104 Box 4: 9.1m - 11m

Notes:
Pilcon shear vane, serial # DR2009, 19mm blade, calibrated 4/10/19

Started:	5/09/2020	*Finished:*	6/09/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	J Hodgkinson	*Checked by:*	D Mason

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH104

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1636424 E 5289209 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	15.4 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 190 m	*Inclination:*	-90°
Location:	Hundalee Hills, south of Okarahia Stream North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

Photo BH104.5
BH104 Box 5: 11m - 13.2m

Photo BH104.6
BH104 Box 6: 13.2m - 15.4m

Notes:
Pilcon shear vane, serial # DR2009, 19mm blade, calibrated 4/10/19

Started:	5/09/2020	*Finished:*	6/09/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	J Hodgkinson	*Checked by:*	D Mason

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH105

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1626055 E 5278370 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	25.9 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 119 m	*Inclination:*	-90°
Location:	Homestead Creek North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
Fill	Sandy fine to coarse GRAVEL with minor silt; brown. Loosely packed; moist; well graded. Gravel maximum 50mm size, subangular to subrounded siltstone; sand fine to coarse.											PQ	38		PQ Size, Triple Tube, Wireline Rotary Coring			Cement
	Silty fine to medium GRAVEL with minor sand and clay; orange brown, homogeneous. Medium dense; moist; well graded. Gravel subangular to subrounded, maximum 20mm size, sandstone and quartz. 0.6m: With trace cobbles, maximum 80mm size.	118	1									PQ	67					
												PQ	50					Bentonite
												WS	100					
			2															
	Gravelly CLAY with minor silt and sand; greyish brown, homogeneous. Soft; moist; plastic.				20	5// 1/7/7/5					2.10m - Gravel fine to medium grained, subangular. 2.25m - Gravel subangular to subrounded, maximum 20mm size, sandstone and quartz. 2.55m - Gravel fine to medium grained, highly to completely weathered sandstone.	SPT						
	Silty fine to medium GRAVEL with minor sand and clay; orange brown, homogeneous. Medium dense; moist; well graded.											PQ	88					
	Clayey SILT with trace gravel; light brown, homogeneous. Stiff; moist; low plasticity.																	
	Silty CLAY; dark bluish grey, homogeneous. Firm; moist; plastic.	116	3								2.95m - Gravel subrounded, unweathered to moderately weathered siltstone. 3.10m - Gravel subrounded, fine to coarse, maximum 50mm size.	PQ	89					
	Silty fine to medium GRAVEL with minor clay and trace sand; light brown, homogeneous. Tightly packed; moist; well graded.																	
	Clayey SILT with trace gravel; light brown, homogeneous. Stiff; moist; low plasticity.				10	3// 2/2/3/3					3.60m - Gravel fine to coarse, subangular, very weak siltstone.	SPT						
	Silty CLAY; dark bluish grey, homogeneous. Firm; moist; plastic.																	
	Clayey SILT with minor gravel; light brown, homogeneous. Stiff; moist; low plasticity.		4									PQ	89					
	Silty CLAY; dark bluish grey, homogeneous. Stiff; moist; plastic.											PQ	87					
Fill	Silty fine to coarse GRAVEL with some clay; light brown mottled bluish grey, homogeneous. Loosely packed; moist; gap graded.	114	5		6	4// 1/2/1/2					4.90m - Gravel subangular, moderately to highly weathered sandstone.	SPT						
												PQ	46					
	Clayey SILT with minor gravel; light brown, homogeneous. Stiff; moist; low plasticity.										5.65m - Gravel fine to coarse, subangular, very weak siltstone.	PQ	75					
			6		7	1// 2/1/2/2						SPT						
		112	7									PQ	50					Screen with sand
	Clayey SILT; light brown, homogeneous. Stiff; moist; low plasticity.		8								7.75m - Gravel fine to coarse, subangular, very weak siltstone. Minor organic flecks throughout.	PT	100					
	Silty CLAY; light greyish brown, homogeneous. Soft; wet; plastic. 8.45m: With minor fine to medium gravel, subangular.					SV: 180						PQ	100					
					8	3// 1/1/2/4						SPT						
	Silty fine to coarse GRAVEL with minor sand; dark greenish brown, homogeneous. Dense; moist; well graded. Organics present. Gravel subrounded, slightly to moderately sandstone; sand fine to coarse.	110	9									PQ	57					
												PQ	100					
	9.47m - 9.57m: Sample recovered as gravel, fines washed out. 9.57m: Becomes light brown.				34	14// 6/8/10/10						SPT						
												PQ	50					

Notes:
Pilcon shear vane, serial # DR2009, 19mm blade, calibrated 4/10/19

Started:	6/09/2020	*Finished:*	8/09/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	J Hodgkinson	*Checked by:*	D Mason

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH105

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1626055 E 5278370 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	25.9 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 119 m	*Inclination:*	-90°
Location:	Homestead Creek North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
Fill	10.6m: Trace cobbles, maximum 70mm size.	108	11		35	11// 7/9/9/10						PQ PQ PQ SPT PQ PQ PQ PQ PQ SPT PQ PQ PQ SPT PQ PQ SPT PQ PQ PQ PQ SPT PQ PQ PQ PQ SPT PQ PQ PQ	85 100 83 66 100 100 100 57 100 0 83 50 53 0 55 42 0 40 0 88 80 70 100 73		PQ Size, Triple Tube, Wireline Rotary Coring		SWL 3.70m 9/09 SWL 4.20m 7/09	Screen with sand Bentonite Gravel back fill
	13.9m: With some sand.	106	13		34	11// 8/9/8/9												
		104	15		50+	26// 14/15/11 for 65mm												
	16.9m: Becomes very dense.	102	17		50+	18// 14/13/13 for 60mm												
	Sandy fine to coarse GRAVEL with minor silt and cobbles; light brown, homogeneous. Very dense; moist; well graded. Gravel subangular to subrounded, slightly to moderately weathered sandstone; sand fine to coarse; cobbles maximum 100mm size.	100	19		50+	12// 11/10/14/15 for 20mm												
					50+	18// 25 for 5mm												

Notes:
Pilcon shear vane, serial # DR2009, 19mm blade, calibrated 4/10/19

Started:	6/09/2020	*Finished:*	8/09/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	J Hodgkinson	*Checked by:*	D Mason

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH105

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1626055 E 5278370 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	25.9 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 119 m	*Inclination:*	-90°
Location:	Homestead Creek North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
Fill	Sandy fine to coarse GRAVEL with minor silt and cobbles; light brown, homogeneous. Very dense; moist; well graded. Gravel subangular to subrounded, slightly to moderately weathered sandstone; sand fine to coarse; cobbles maximum 100mm size. *(continued)*											PQ	73		PQ Size, Triple Tube, Wireline Rotary Coring			Gravel back fill
Greta Formation	Moderately weathered, bluish grey, homogeneous SILTSTONE; extremely weak.	98	21				EW	MW	W			PQ	83					
	21.1m: Becomes light brown.											PQ	100	50				
	21.4m: Slightly weathered, no jointing.				50+	18// 12/14/18 for 75mm						SPT						
		96	22					SW				PQ	100	100				
			23															
	23.5m: Becomes unweathered, bluish grey.											PQ	100	40				
	23.86m: Crushed zone, 0 deg., 5mm wide, sandy infill.		24							CZ 0	23.86m - CZ, 0°, RO, N, limonite stained							
	24.1m - 24.4m: Drilling induced fractures.							UW										
		94	25									PQ	100	90				
	END OF BOREHOLE AT 25.9m - Target Criteria Achieved		26														SWL 3.55m 8/09	
		92	27															
			28															
		90	29															

Notes:
Pilcon shear vane, serial # DR2009, 19mm blade, calibrated 4/10/19

Started:	6/09/2020	*Finished:*	8/09/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	J Hodgkinson	*Checked by:*	D Mason

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH105

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1626055 E 5278370 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	25.9 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 119 m	*Inclination:*	-90°
Location:	Homestead Creek North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

Photo BH105.1
BH105 Box 1: 0m - 2.6m

Photo BH105.2
BH105 Box 2: 2.6m - 4.9m

Notes:
Pilcon shear vane, serial # DR2009, 19mm blade, calibrated 4/10/19

Started:	6/09/2020	*Finished:*	8/09/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	J Hodgkinson	*Checked by:*	D Mason

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH105

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1626055 E 5278370 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	25.9 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 119 m	*Inclination:*	-90°
Location:	Homestead Creek North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

Photo BH105.3
BH105 Box 3: 4.9m - 8.5m

Photo BH105.4
BH105 Box 4: 8.5m - 10.9m

Notes:
Pilcon shear vane, serial # DR2009, 19mm blade, calibrated 4/10/19

Started:	6/09/2020	*Finished:*	8/09/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	J Hodgkinson	*Checked by:*	D Mason

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH105

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1626055 E 5278370 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	25.9 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 119 m	*Inclination:*	-90°
Location:	Homestead Creek North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

Photo BH105.5
BH105 Box 5: 10.9m - 12.6m

Photo BH105.6
BH105 Box 6: 12.6m - 15.8m

Notes:
Pilcon shear vane, serial # DR2009, 19mm blade, calibrated 4/10/19

Started:	6/09/2020	*Finished:*	8/09/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	J Hodgkinson	*Checked by:*	D Mason

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH105

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1626055 E 5278370 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	25.9 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 119 m	*Inclination:*	-90°
Location:	Homestead Creek North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

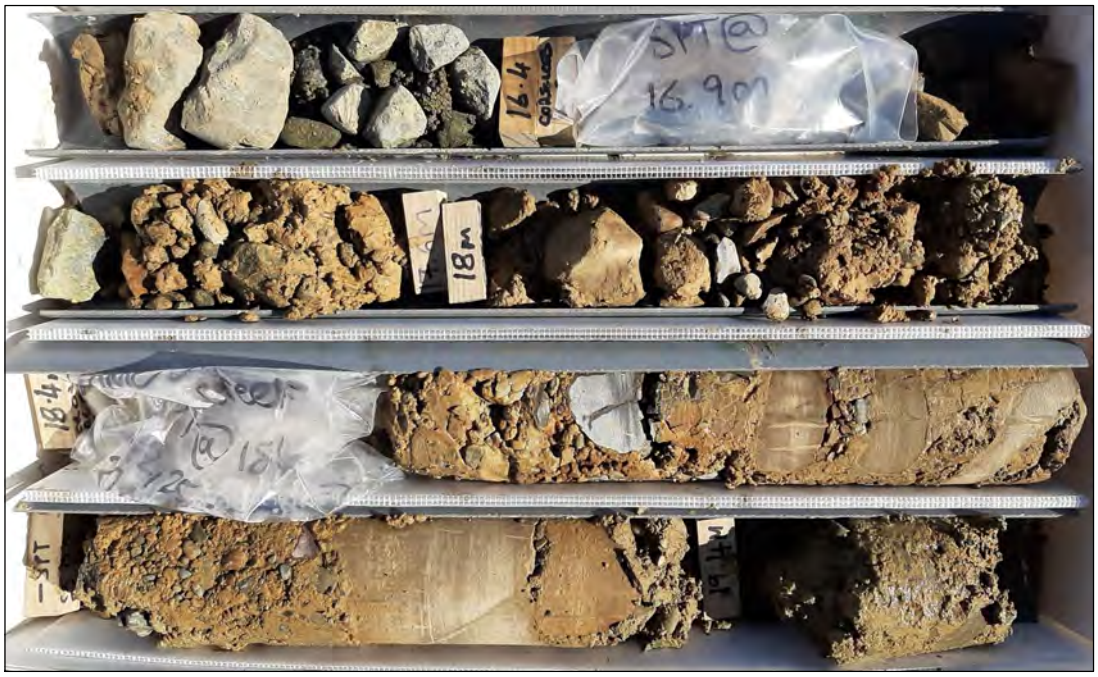


Photo BH105.7
BH105 Box 7: 15.8m - 19.5m

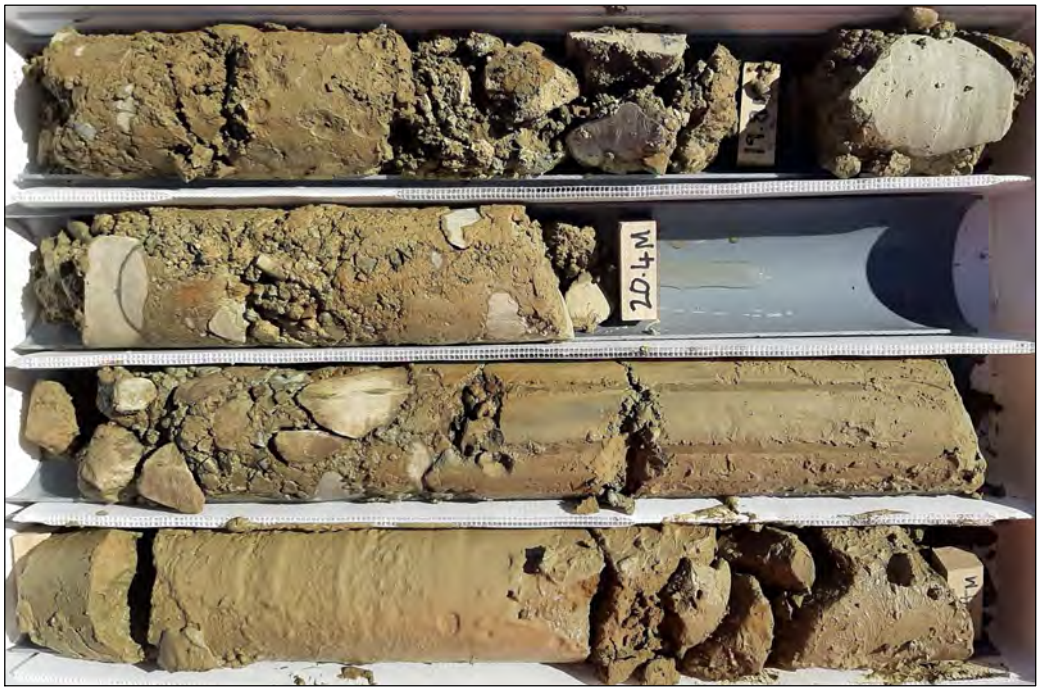


Photo BH105.8
BH105 Box 8: 19.5m - 21.4m

Notes:
Pilcon shear vane, serial # DR2009, 19mm blade, calibrated 4/10/19

Started:	6/09/2020	*Finished:*	8/09/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	J Hodgkinson	*Checked by:*	D Mason

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH105

Project:	Kaikoura Earthquake-Induced Landslide Research	*Coordinates:*	1626055 E 5278370 N		
Client:	GNS Science	*Ref. Grid:*	NZTM	*Depth:*	25.9 m
Project No.:	5-C3418.00	*R.L.:*	Approx. 119 m	*Inclination:*	-90°
Location:	Homestead Creek North Canterbury	*Datum:*	Mean Sea Level	*Azimuth:*	0°

PHOTOGRAPHS

Photo BH105.9
BH105 Box 9: 21.4m - 23.7m

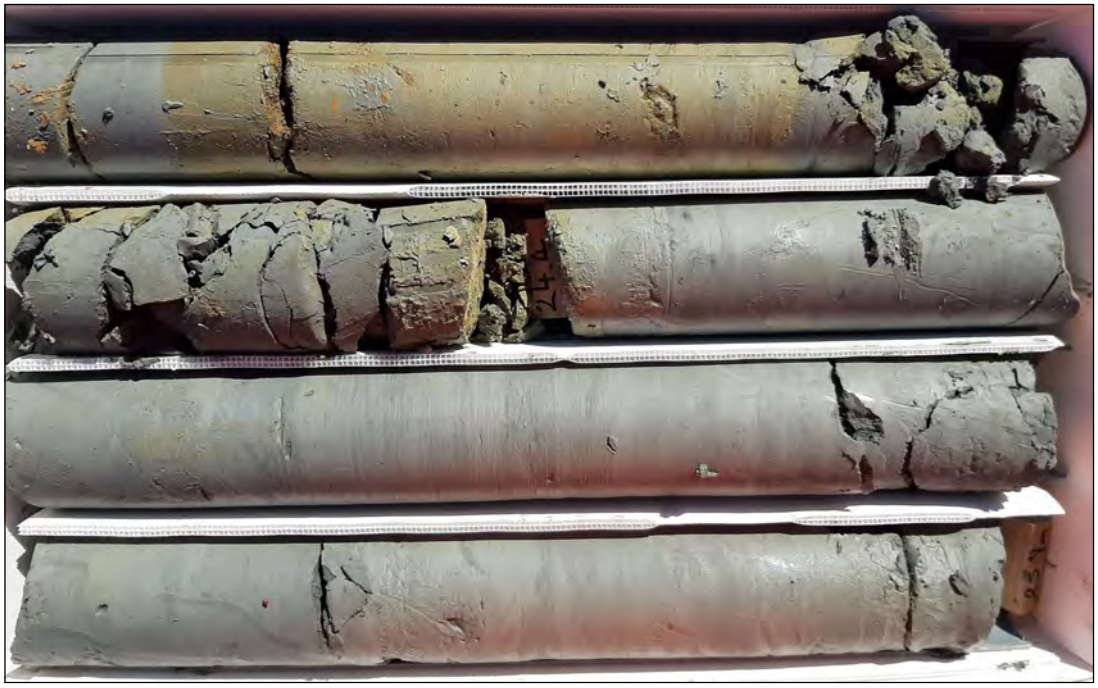


Photo BH105.10
BH105 Box 10: 23.7m - 25.9m

Notes:
Pilcon shear vane, serial # DR2009, 19mm blade, calibrated 4/10/19

Started:	6/09/2020	*Finished:*	8/09/2020
Drilling Co.:	CW Drilling	*Drilling Rig:*	Marooka
Logged by:	J Hodgkinson	*Checked by:*	D Mason

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Appendix C
Downhole geophysical survey logs

The logs displayed on the televiewer plots are as follows:

- **Depth** – Distance along borehole axis, measured in metres and referenced to ground level.
- **ATV Caliper/Combined Caliper** – A synthetic caliper log calculated from ATV travel time data, combined with mechanical caliper data above water level where applicable.
- **App. Hardness** – Apparent hardness, the median value of the ATV amplitude or reflectivity. This is a proxy for rock hardness.
- **3D Acoustic** – Three dimensional “wrapped” view of ATV amplitude log. Azimuthal angle of view given in log title.
- **Centralized TravelTime-NM** – This is an “unwrapped" ATV Image, inside-looking-out view, aligned with magnetic north (0°) at the extreme left and extreme right of the image. The imagery is coloured to show the measured travel time of the ATV signal, which is a function of the distance from the tool to the borehole wall. Centralization has been applied.
- **Amplitude-NM** – This is an “unwrapped" ATV Image, inside-looking-out view, aligned with magnetic north (0°) at the extreme left and extreme right of the image. The image is coloured to show the amplitude of the reflected ATV signal, which is related to the reflectivity or hardness of the borehole wall.
- **Apparent Structure Log** – Sine curves (colour coded) representing the planar features manually interpreted from televiewer imagery.
- **OTV Image-NM** - (where available) an “unwrapped" optical televiewer (OTV) Image, inside-looking-out view, aligned with magnetic north (0°) at the extreme left and extreme right of the image.
- **3D Optical**– (where available) a three dimensional “wrapped” view of OTV image log. Azimuthal angle of view given in log title.
- **Structures** – Orientation "tadpole" symbols indicate the dip angle and dip direction (true north azimuth) of manually interpreted planar features identified on the ATV image. Dip angle is indicated by the position of the tadpole within the track and dip direction is indicated by the tail of the tadpole relative to true north which is toward the top of the page. Note that the dip and dip direction have been corrected for borehole deviation using borehole tilt and azimuth.

  The assigned defect type is indicated by the shape and colour of the tadpole symbol. The defect type has been classified using the core log and core photos. Defect classifications are provided in the header of the log under “Interpreted Structures”.
- **Defect freq/metre** – Defect frequency log showing the number of interpreted defects in each 1 m depth interval of the ATV log.

BF		Bedding Fabric
BP		Bedding Parting
XWS		Extremely Weathered / Infilled Seam
CSS		Crushed / Sheared Seam
SZ		Sheared Zone
J		Joint
HJ		Healed Joint
V		Vein
F		Fault
X		Foliation

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Basic Information:

Drill hole ID:	BH101
Client:	CW Drill
Run Number(s):	2 (Mob1) & 3 (Mob2)
Tool Type(s):	ABI40-2G-VLB Acoustic Televiewer (Mob1) ABI40-2G Acoustic Televiewer (Mob2)
Service Company:	RDCL
Operator:	O Gibson
Date Logged:	19/10/2020 (Mob1) & 31/10/2020 (Mob2)
Field:	Okiwi Bay
State / Province:	Kaikōura
Country:	New Zealand

Location Description:

Okiwi Bay, 25 km North West of Kaikōura.

Drillhole Information:

Log interval from (m):	22.50	Log interval to (m):	89.70
Depth Driller (m):	90.00	Depth Logger (m):	89.70
Fluid Type:	Water	Fluid Level (m):	23.04 (ATV Mob2)
Easting:	1670535	Northing:	5325184
Elevation:	N/A	Coord Ref System:	NZTM
Hole Azimuth:	182-343° (Magnetic)	Hole Inclination:	>-87.7°
Magnetic Declination:	+22° 59' East	Magnetic Inclination:	66° 58'
Drill Company:	CW Drill		

Printing Information:

Depth Unit: Metres Log Scale: 1:10 Log Version: Final

Processed: O Gibson Log Reviewer: P Greville

Bit Size Record:

Size (mm):	From (m):	To (m):
PQ (122.6)	0.00	90.00
##.#	##.#	##.#
##.#	##.#	##.#
##.#	##.#	##.#

Casing Record:

Type:	Size:	From (m):	To (m):
PQ	122.6	0.00	28.13
XX	##.#	##.#	##.#
XX	##.#	##.#	##.#
XX	##.#	##.#	##.#

Comments:

1. Acoustic Tool became stuck at 71.91 m during logging (Mobilisation1).
2. Hole relogged from 69.88 m during second mobilisation hence data gap.
3. Optical televiewer data not presented due to turbid hole conditions.
4. Amplitude difference between mobilisations due to different probe types being used and different fluid conditions.

Log Nomenclature:

Azimuth = Tool azimuth from magnetic north

Tilt = Inclination from vertical

Acoustic Calliper = 360° average from travel time

Calliper from Cent = Calliper derived from travel time

Image-NM = Optical image oriented to magnetic north

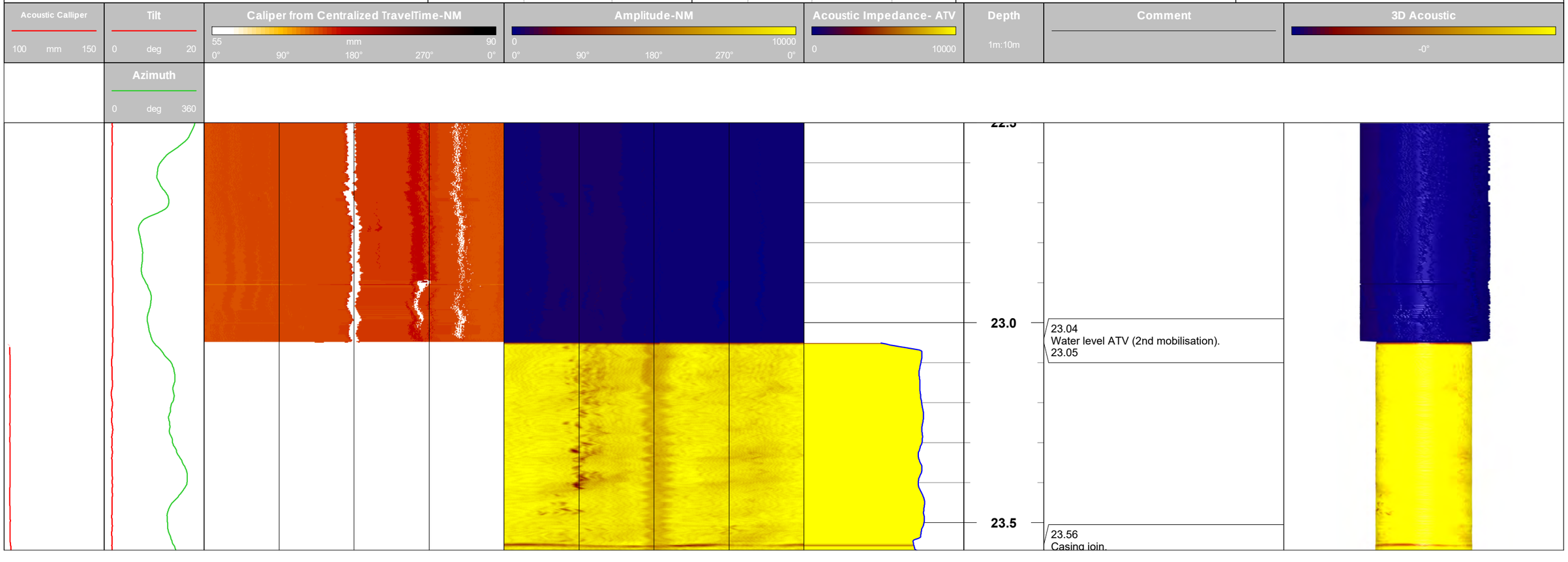
Amplitude-NM = Acoustic amplitude (magnetic north)

Structures = Apparent Structures oriented to hole

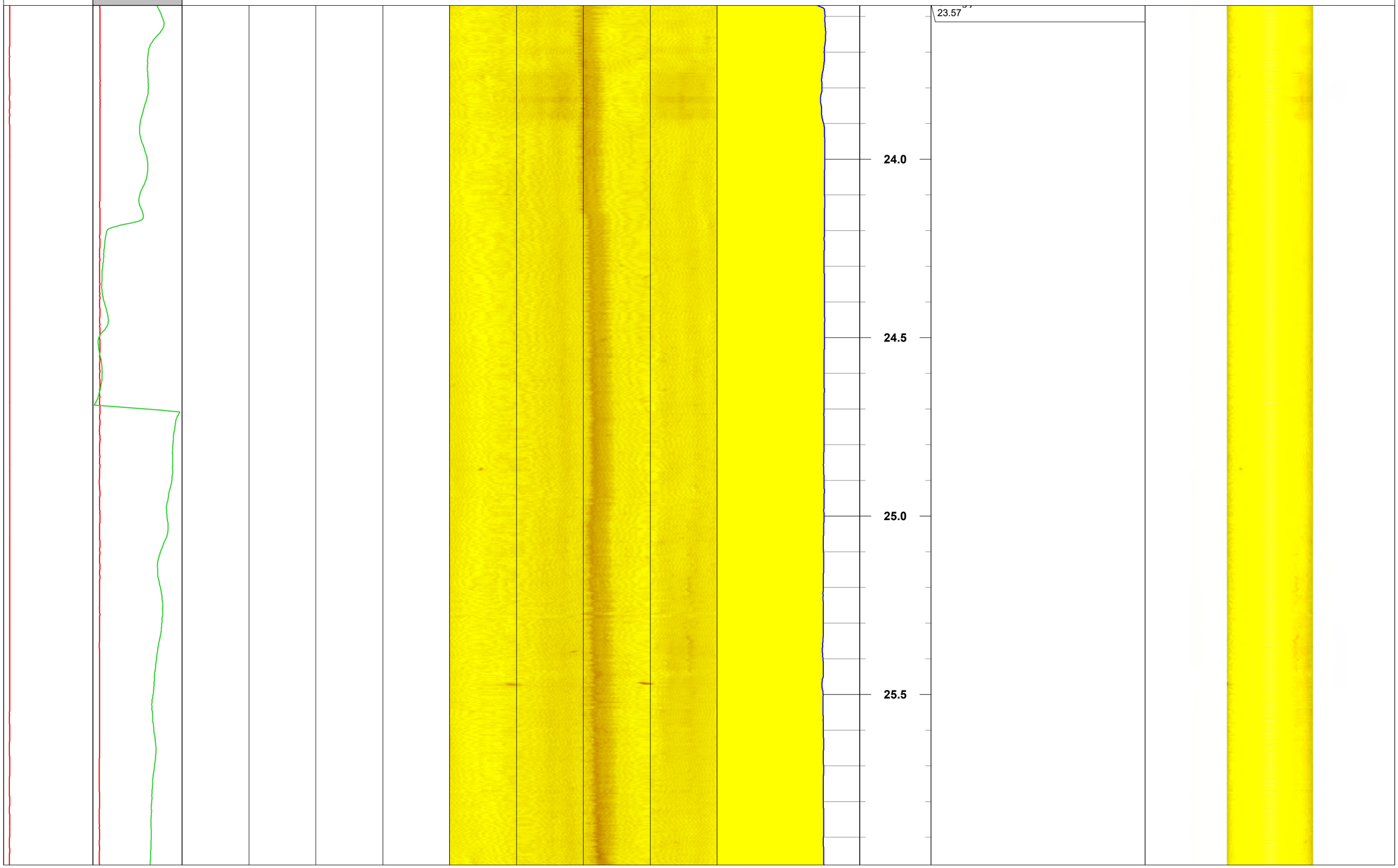
Structures - True =Structures Oriented to true north

3D Optical = 3D representation of optical log

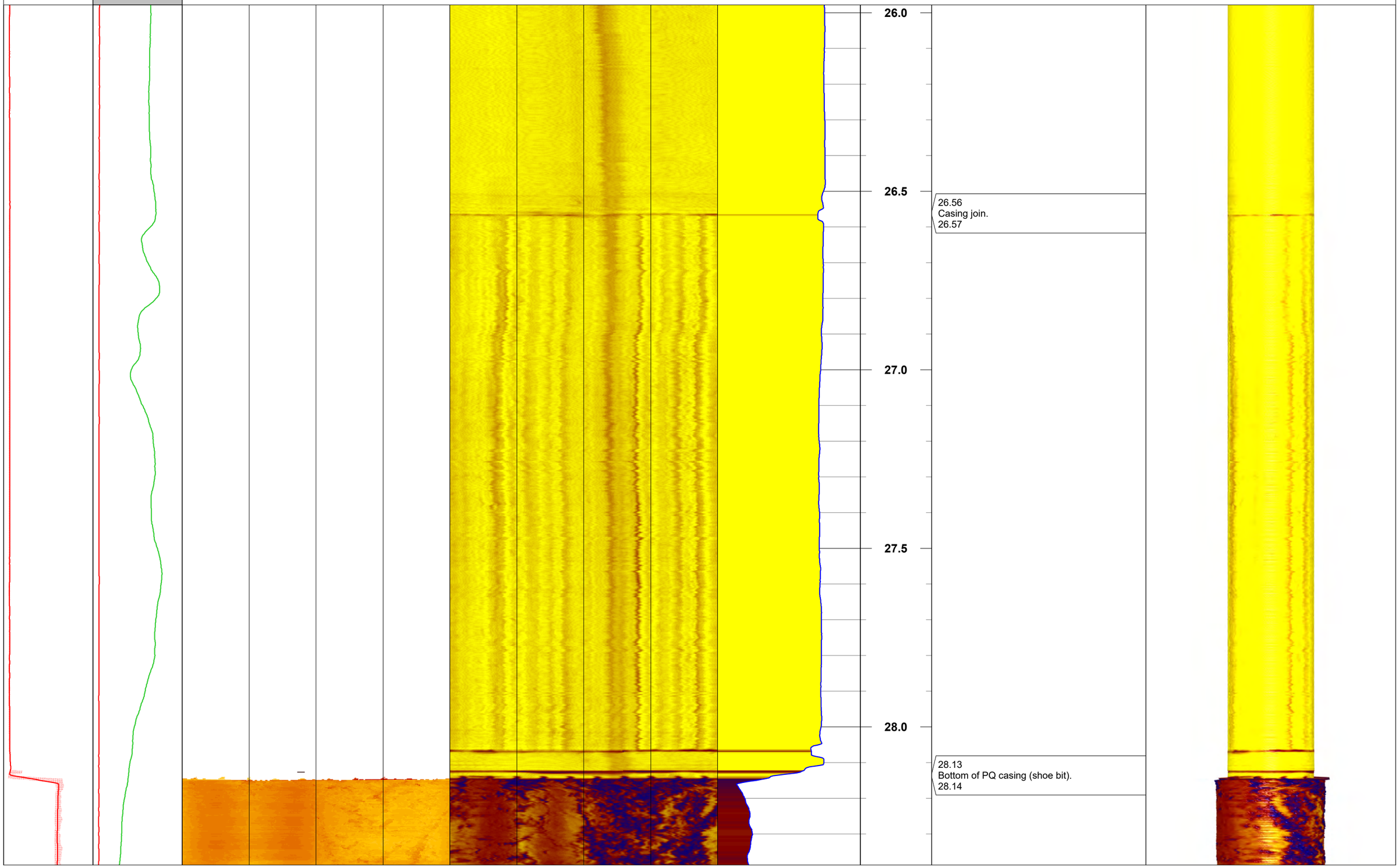
3D Acoustic = 3D representation of acoustic log



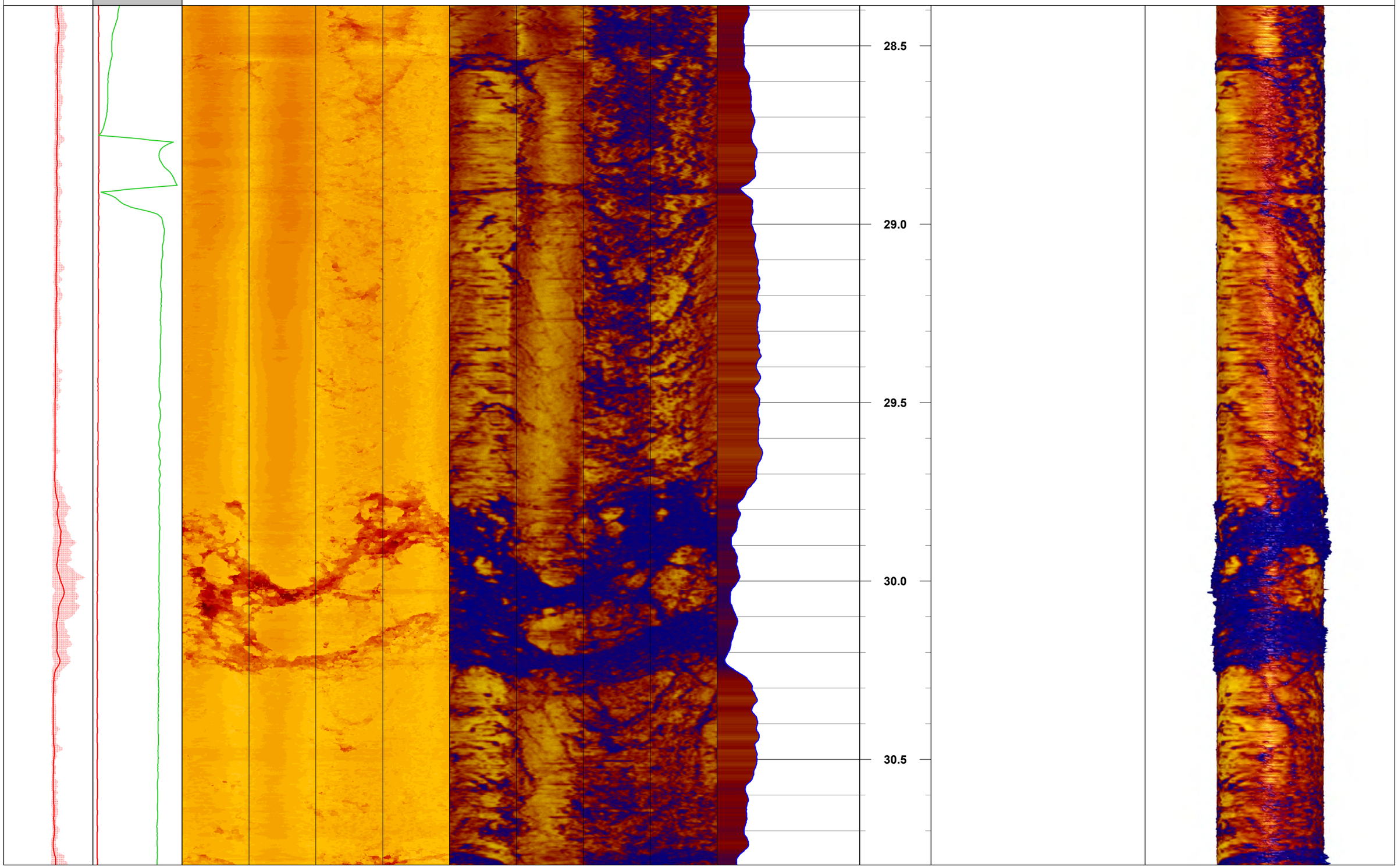
Acoustic Calliper	Tilt	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	Comment	3D Acoustic
100 mm 150	0 deg 20	55 mm 90 0° 90° 180° 270° 0°	0 10000 0° 90° 180° 270° 0°	0 10000	1m:10m		-0°
	Azimuth						
	0 deg 360						



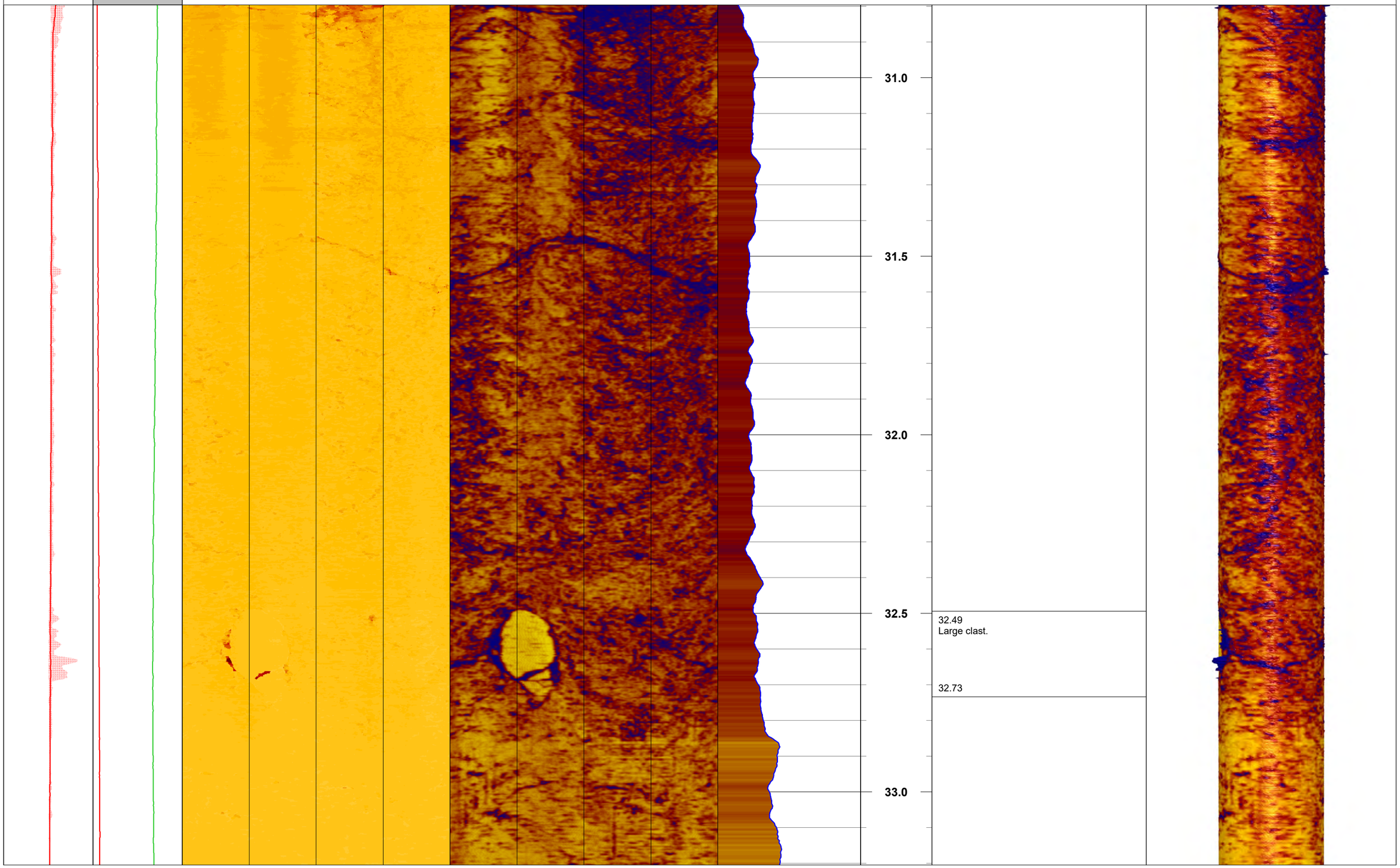
Acoustic Calliper	Tilt	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	Comment	3D Acoustic
100 mm 150	0 deg 20	55 mm 90 0° 90° 180° 270° 0°	0 10000 0° 90° 180° 270° 0°	0 10000	1m:10m		-0°
	Azimuth 0 deg 360						



Acoustic Caliper	Tilt	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	Comment	3D Acoustic
100 mm 150	0 deg 20	55 mm 90 0° 90° 180° 270° 0°	0 10000 0° 90° 180° 270° 0°	0 10000	1m:10m		-0°
	Azimuth 0 deg 360						



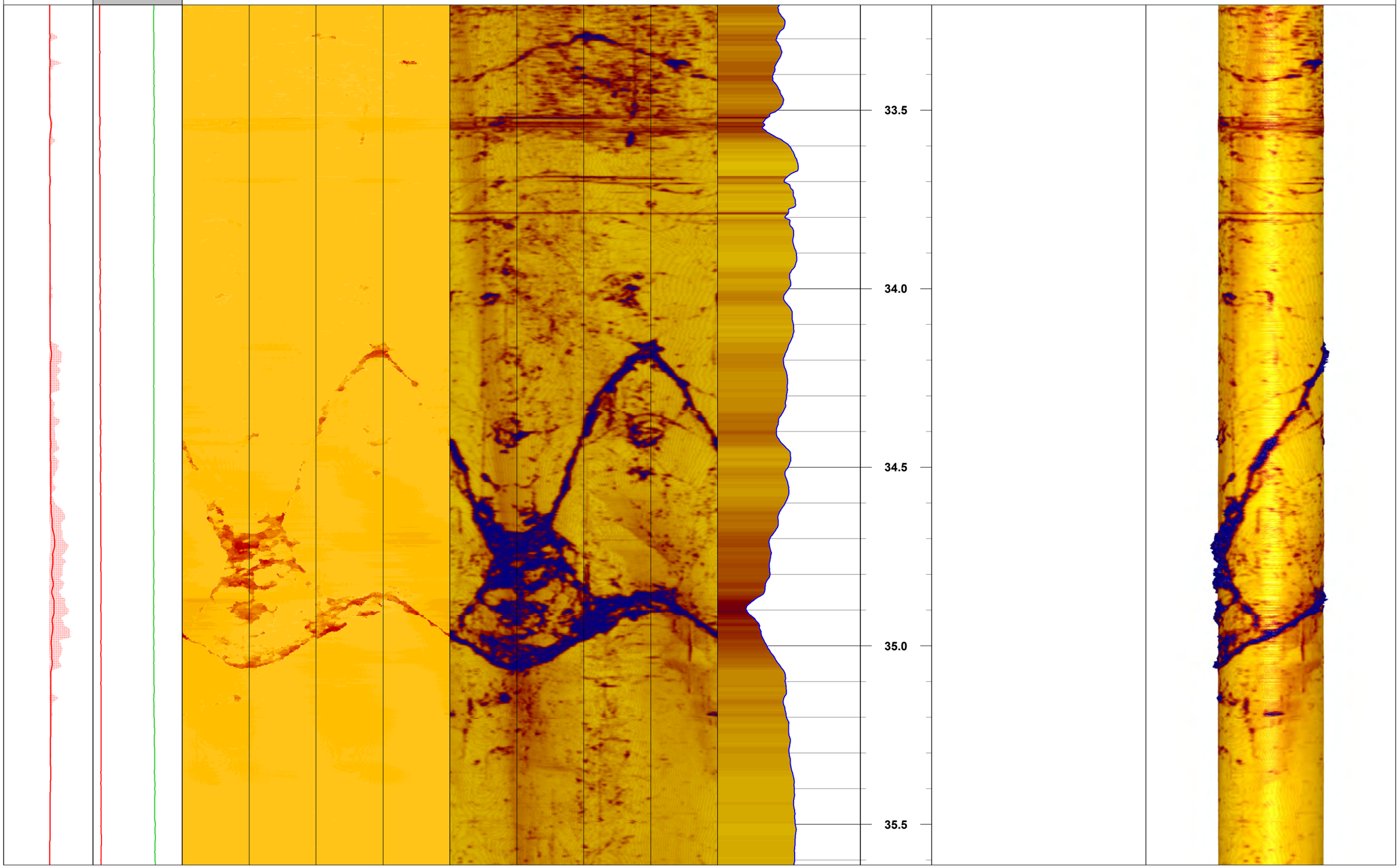
Acoustic Calliper	Tilt	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	Comment	3D Acoustic
100 mm 150	0 deg 20	55 mm 90 0° 90° 180° 270° 0°	0 10000 0° 90° 180° 270° 0°	0 10000	1m:10m		-0°
	Azimuth 0 deg 360						



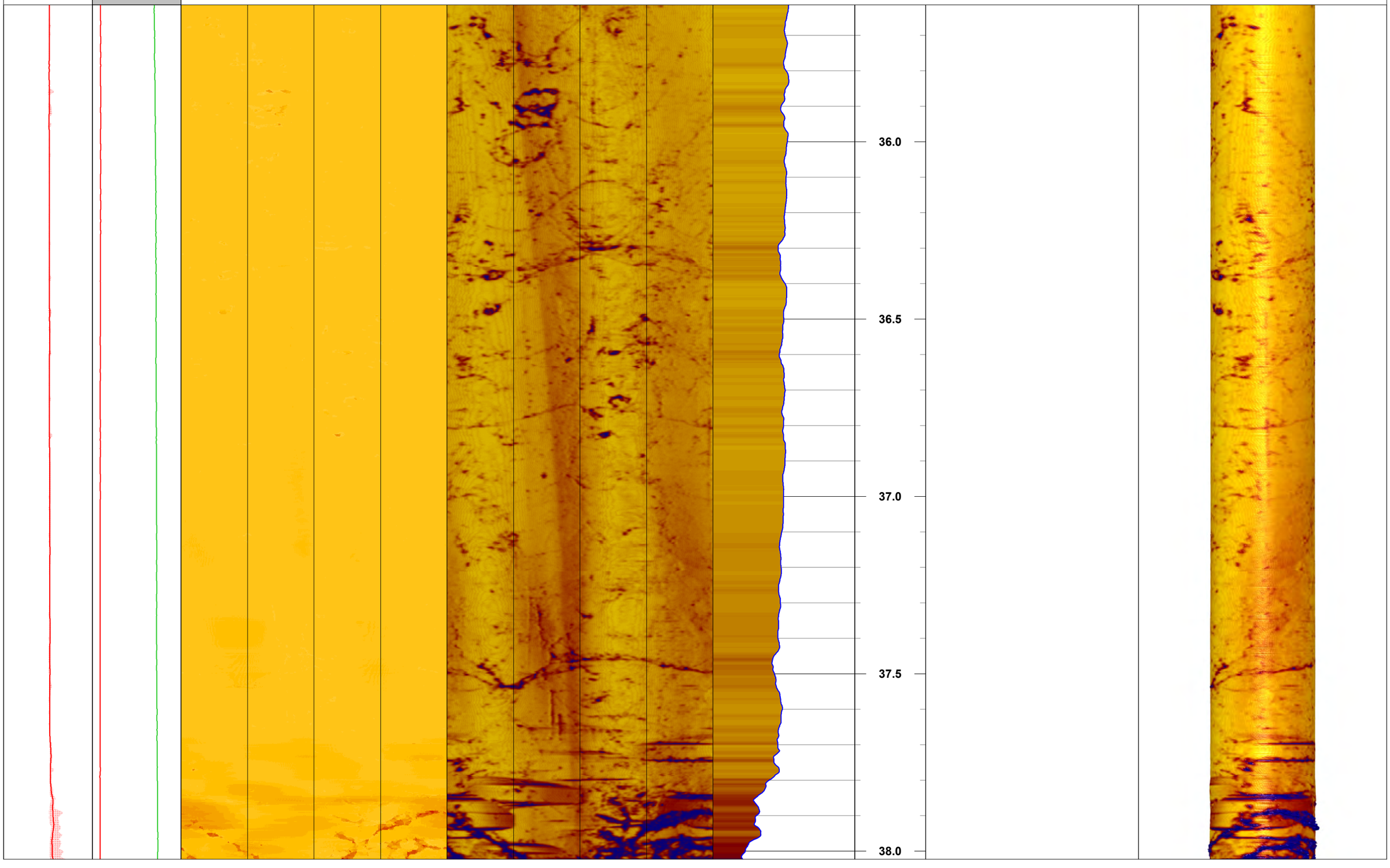
32.49
Large clast.

32.73

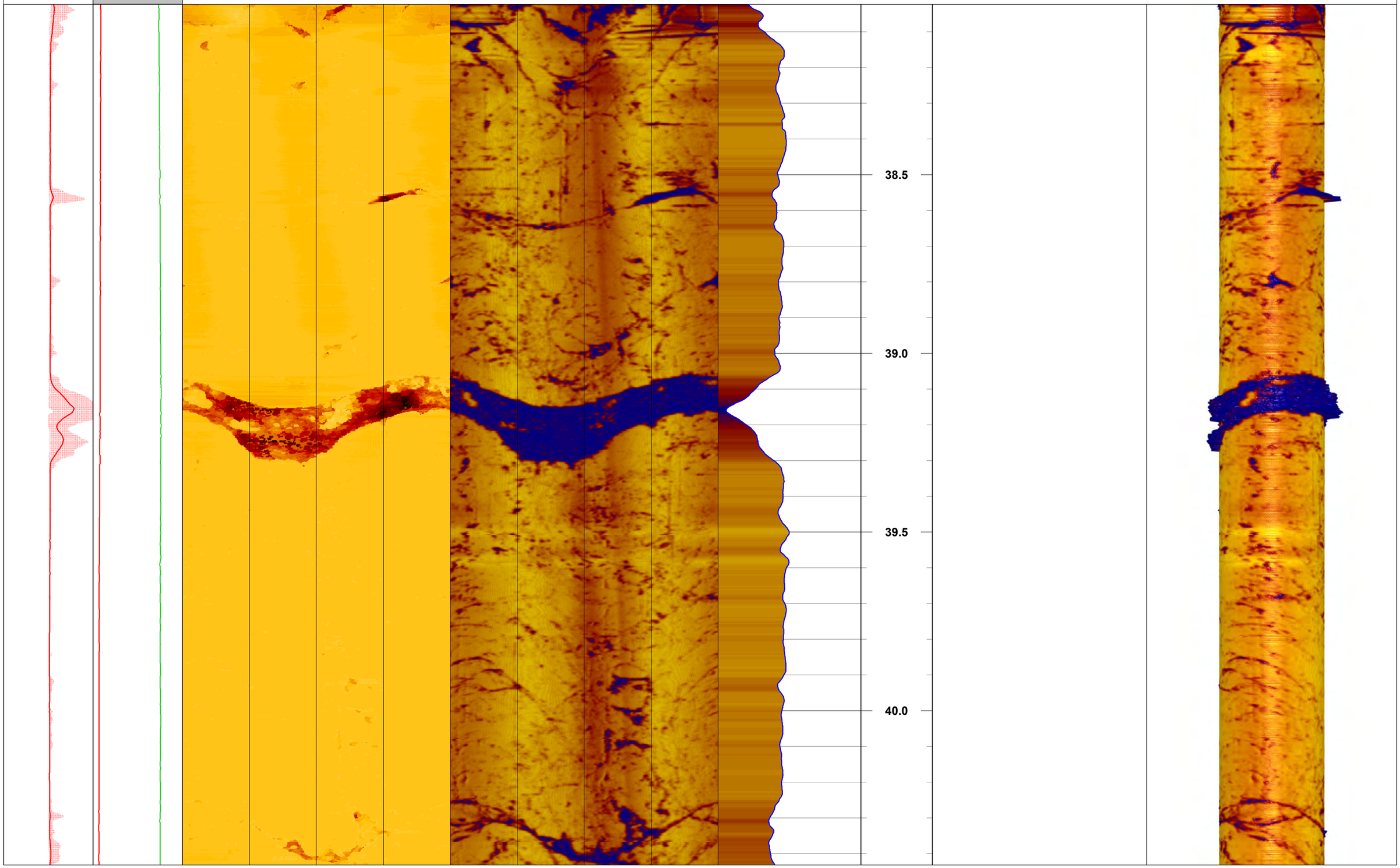
Acoustic Calliper	Tilt	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	Comment	3D Acoustic
100 mm 150	0 deg 20	55 mm 90 0° 90° 180° 270° 0°	0 10000 0° 90° 180° 270° 0°	0 10000	1m:10m		-0°
	Azimuth 0 deg 360						



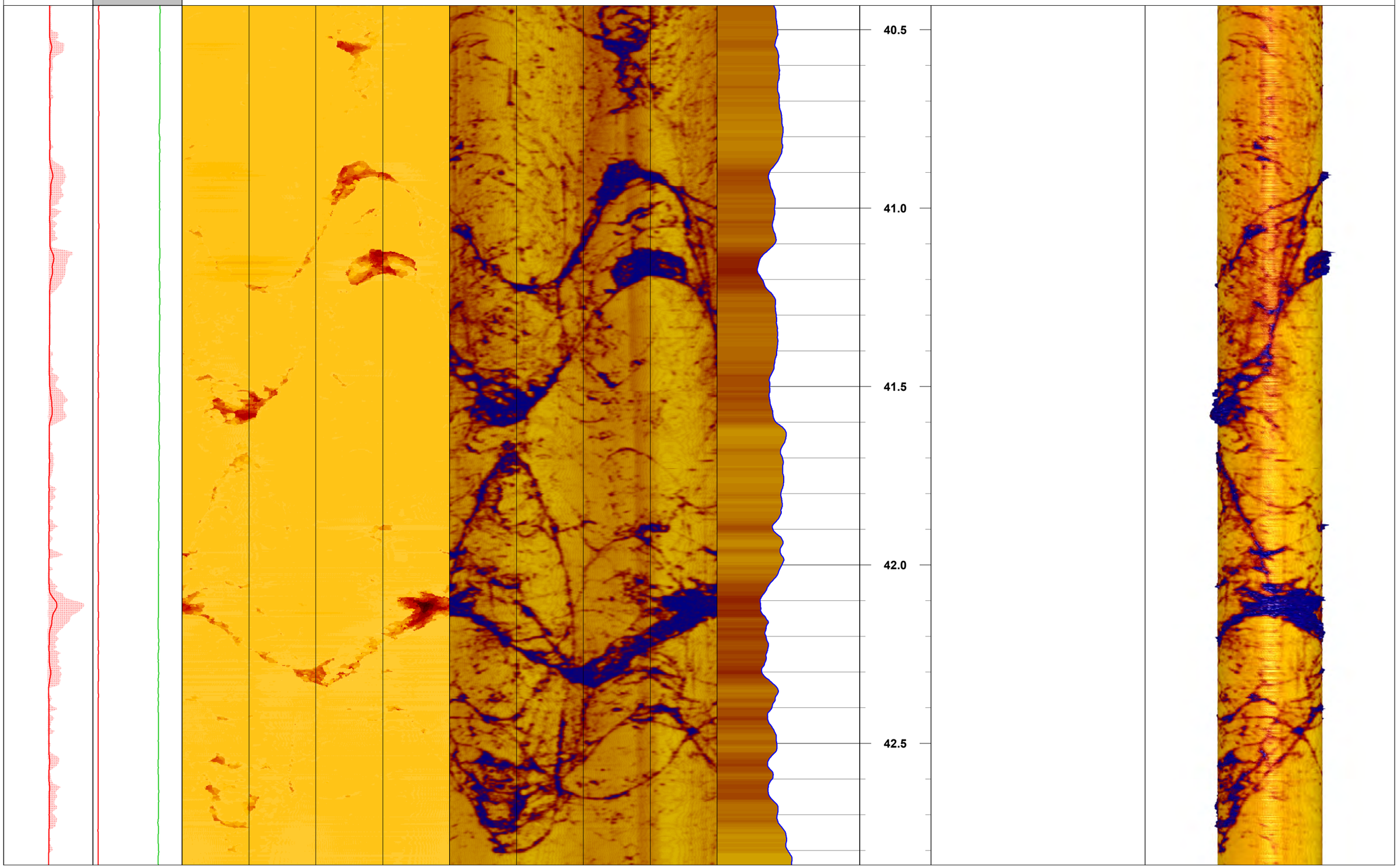
Acoustic Calliper	Tilt	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	Comment	3D Acoustic
100 mm 150	0 deg 20	55 mm 90 0° 90° 180° 270° 0°	0 10000 0° 90° 180° 270° 0°	0 10000	1m:10m		-0°
	Azimuth 0 deg 360						



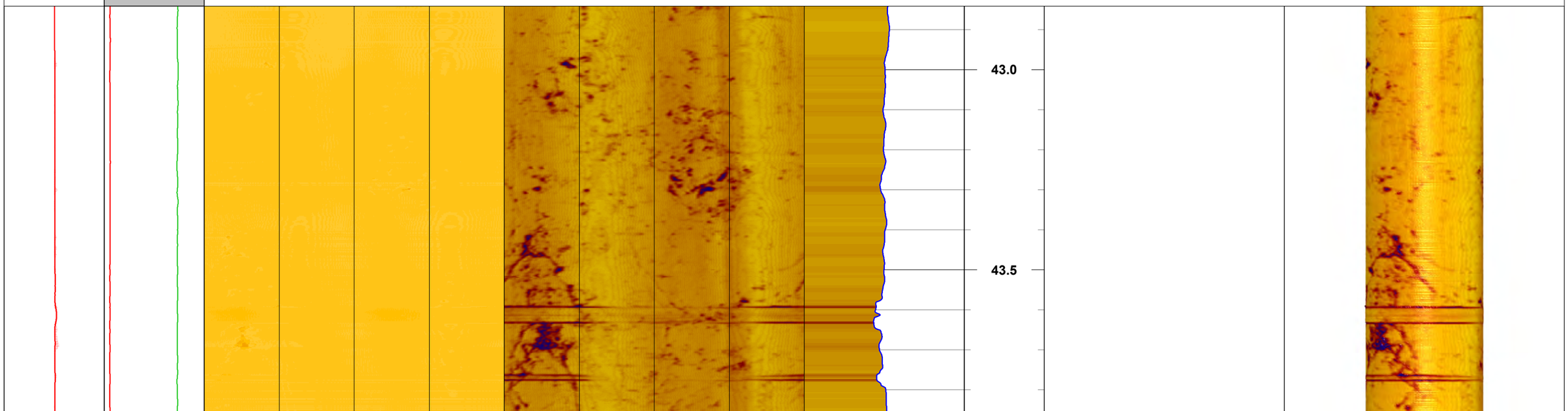
Acoustic Calliper	Tilt	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	Comment	3D Acoustic
100 mm 150	0 deg 20	55 mm 90 0° 90° 180° 270° 0°	0 10000 0° 90° 180° 270° 0°	0 10000	1m:10m		-0°
	Azimuth 0 deg 360						



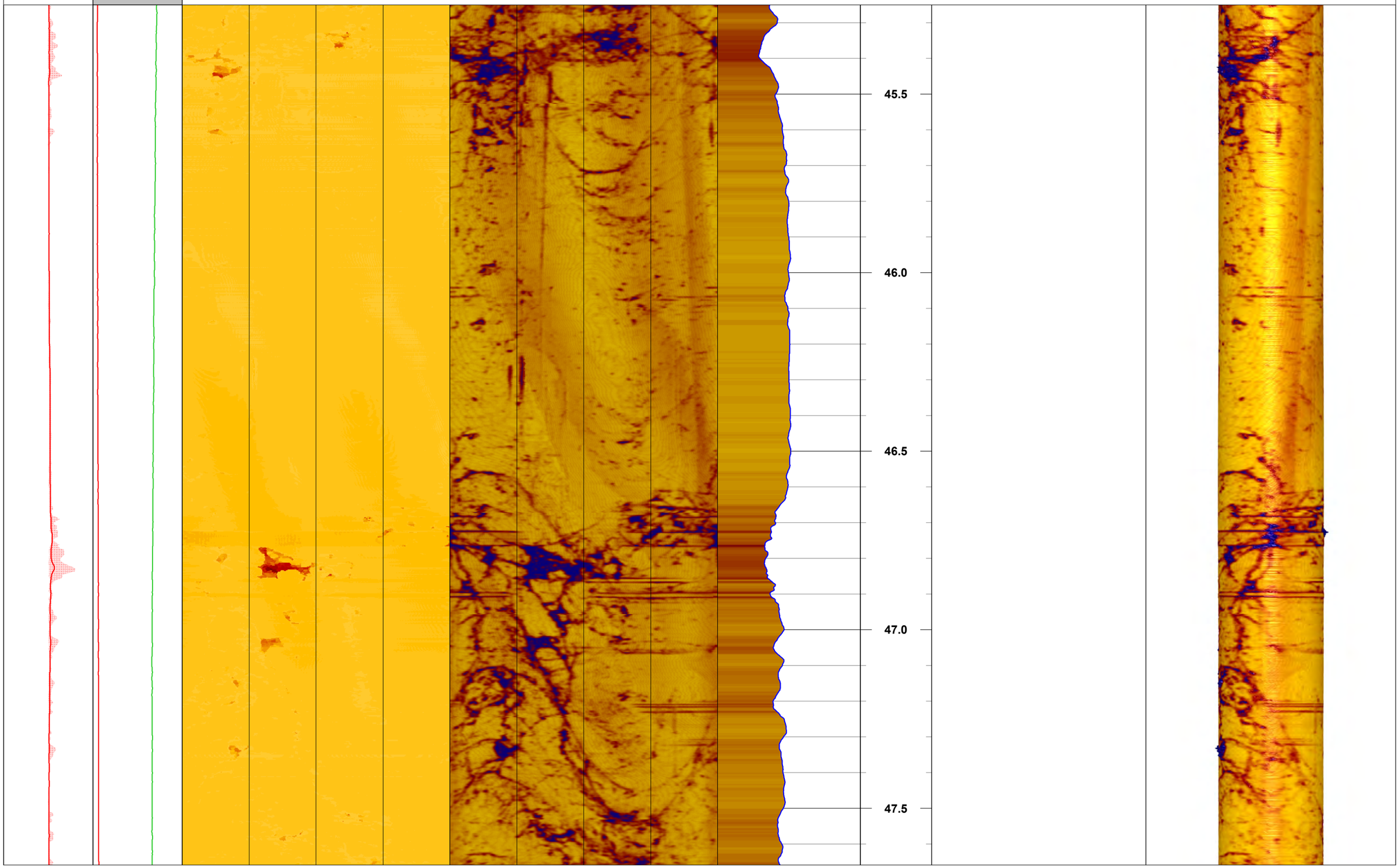
Acoustic Calliper	Tilt	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	Comment	3D Acoustic
100 mm 150	0 deg 20	55 mm 90 0° 90° 180° 270° 0°	0 10000 0° 90° 180° 270° 0°	0 10000	1m:10m		-0°
	Azimuth 0 deg 360						



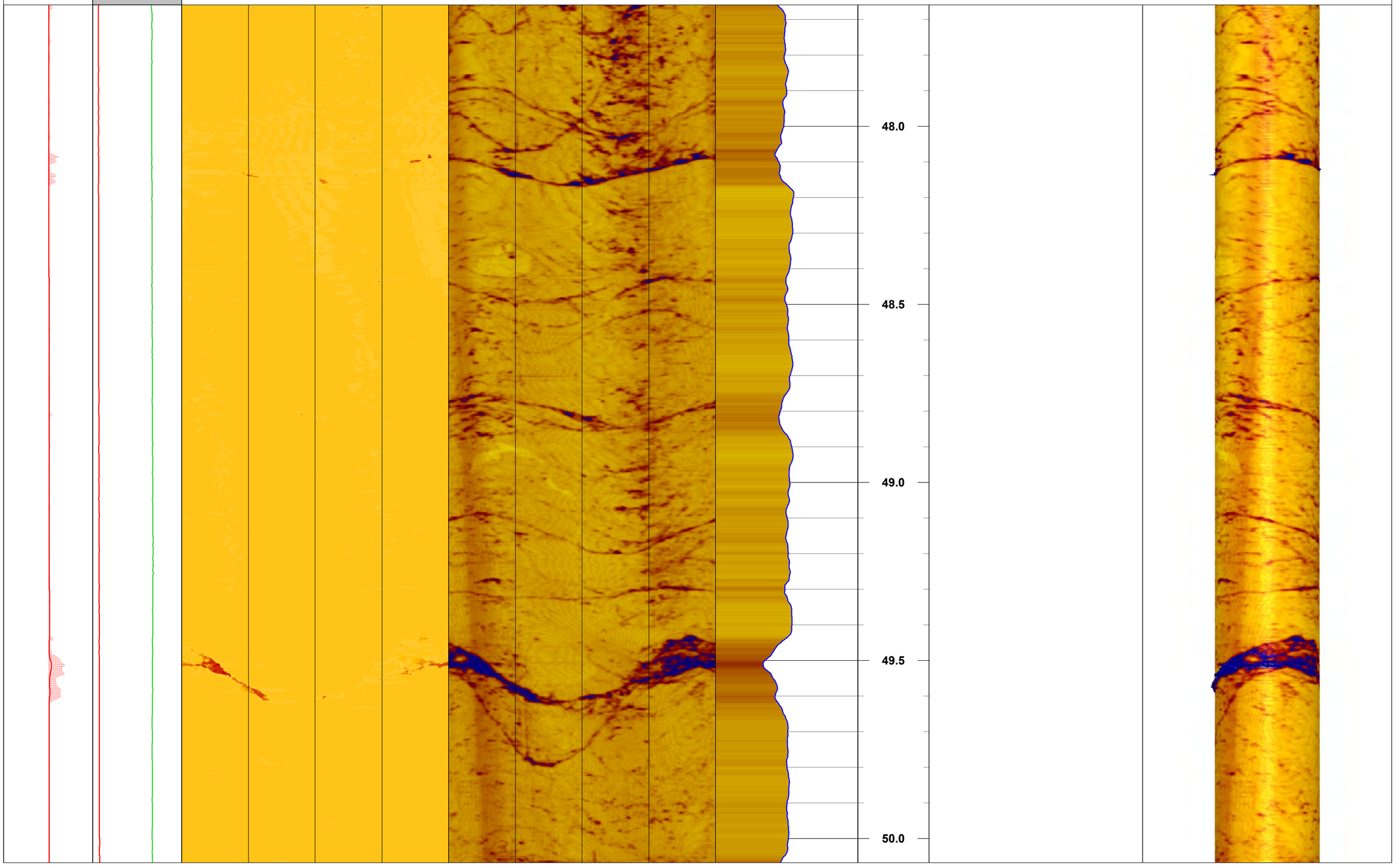
Acoustic Calliper	Tilt	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	Comment	3D Acoustic
100 mm 150	0 deg 20	55 mm 90 0° 90° 180° 270° 0°	0 10000 0° 90° 180° 270° 0°	0 10000	1m:10m		-0°
	Azimuth 0 deg 360						



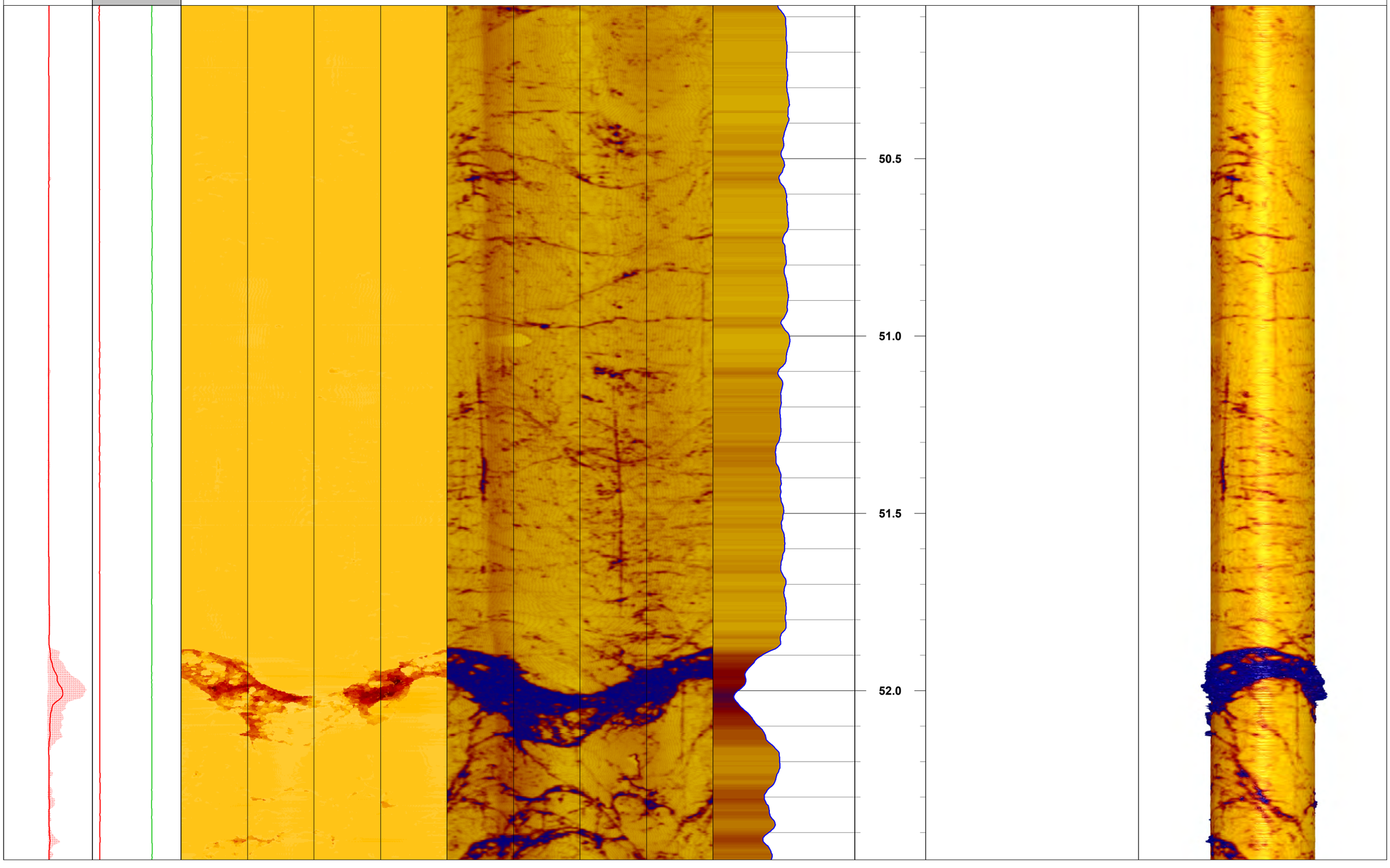
Acoustic Calliper	Tilt	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	Comment	3D Acoustic
100 mm 150	0 deg 20	55 mm 90 0° 90° 180° 270° 0°	0 10000 0° 90° 180° 270° 0°	0 10000	1m:10m		-0°
	Azimuth 0 deg 360						



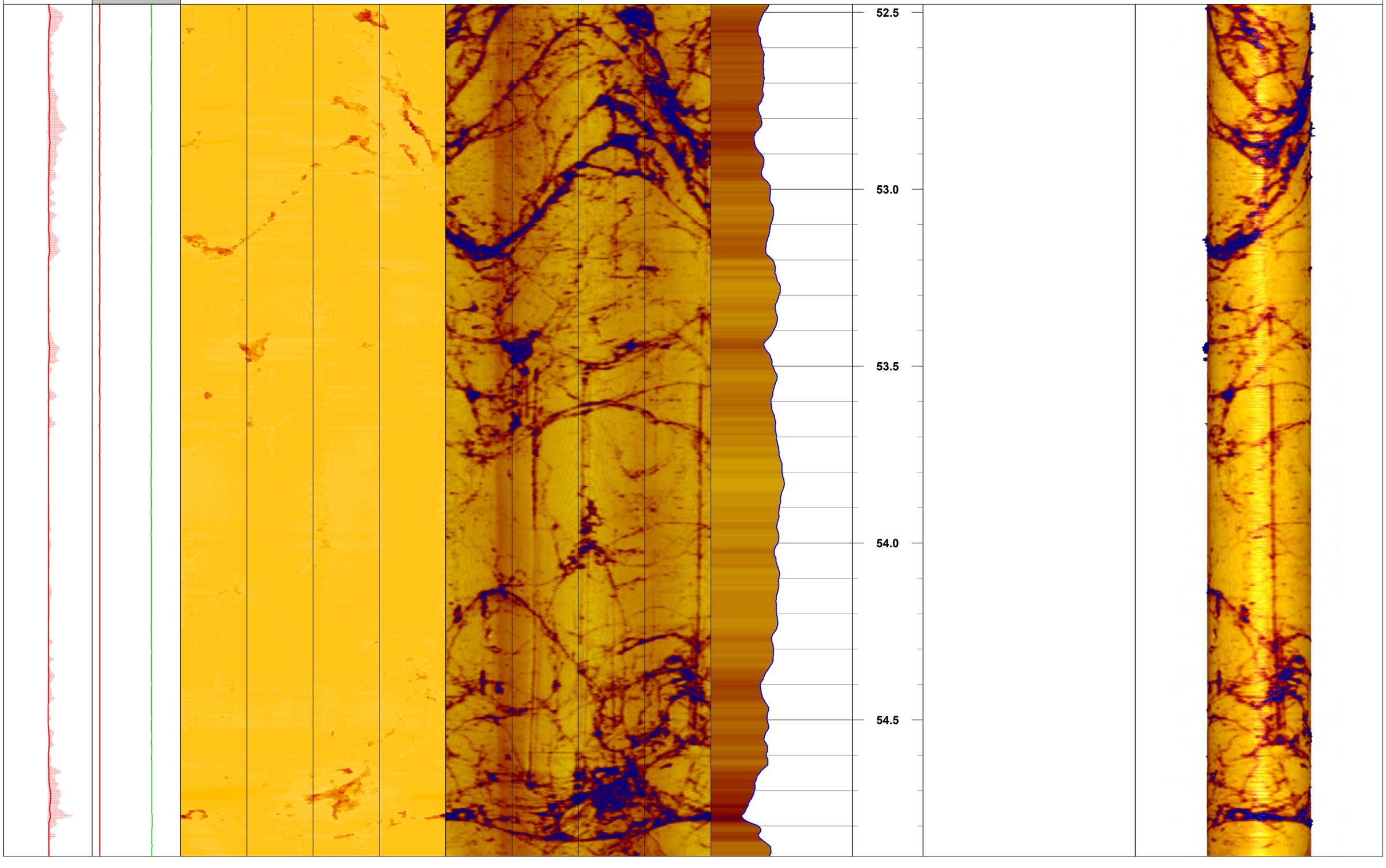
Acoustic Calliper	Tilt	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	Comment	3D Acoustic
100 mm 150	0 deg 20	55 mm 90 0° 90° 180° 270° 0°	0 10000 0° 90° 180° 270° 0°	0 10000	1m:10m		-0°
	Azimuth 0 deg 360						



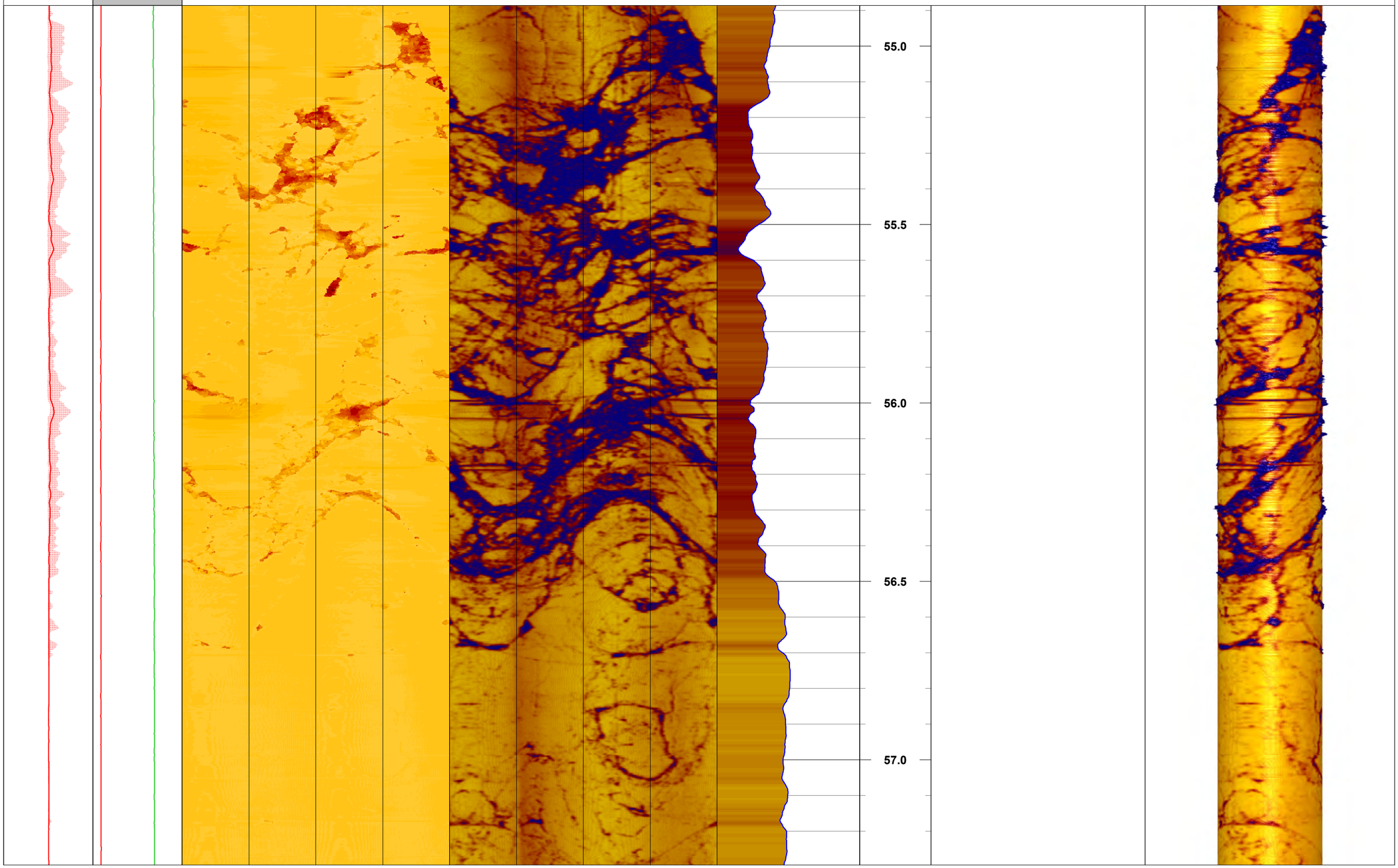
Acoustic Calliper	Tilt	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	Comment	3D Acoustic
100 mm 150	0 deg 20	55 mm 90 0° 90° 180° 270° 0°	0 10000 0° 90° 180° 270° 0°	0 10000	1m:10m		-0°
	Azimuth 0 deg 360						



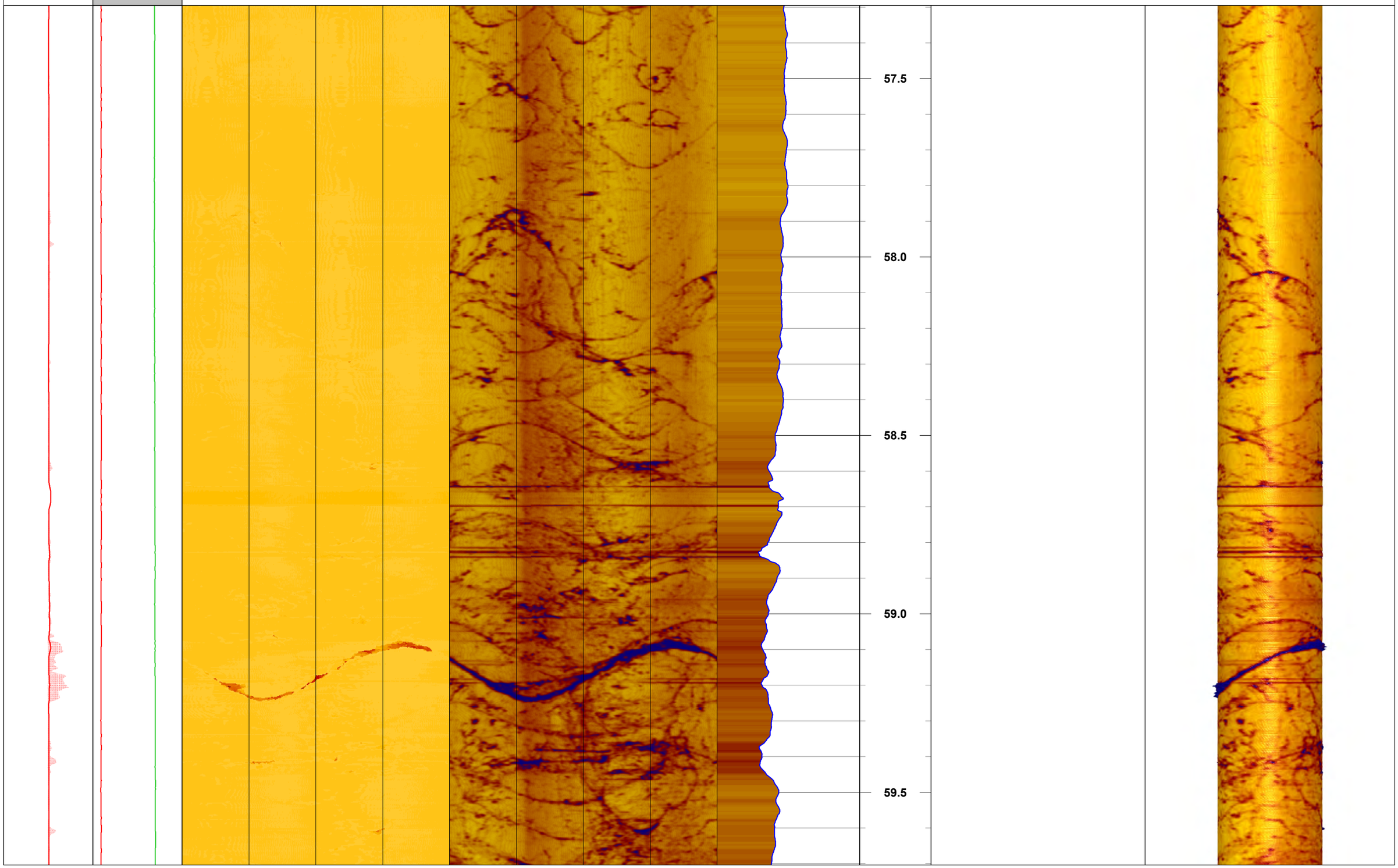
Acoustic Caliper	Tilt	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	Comment	3D Acoustic
100 mm 150	0 deg 20	55 mm 90 0° 90° 180° 270° 0°	0 10000 0° 90° 180° 270° 0°	0 10000	1m:10m		-0°
	Azimuth 0 deg 360						



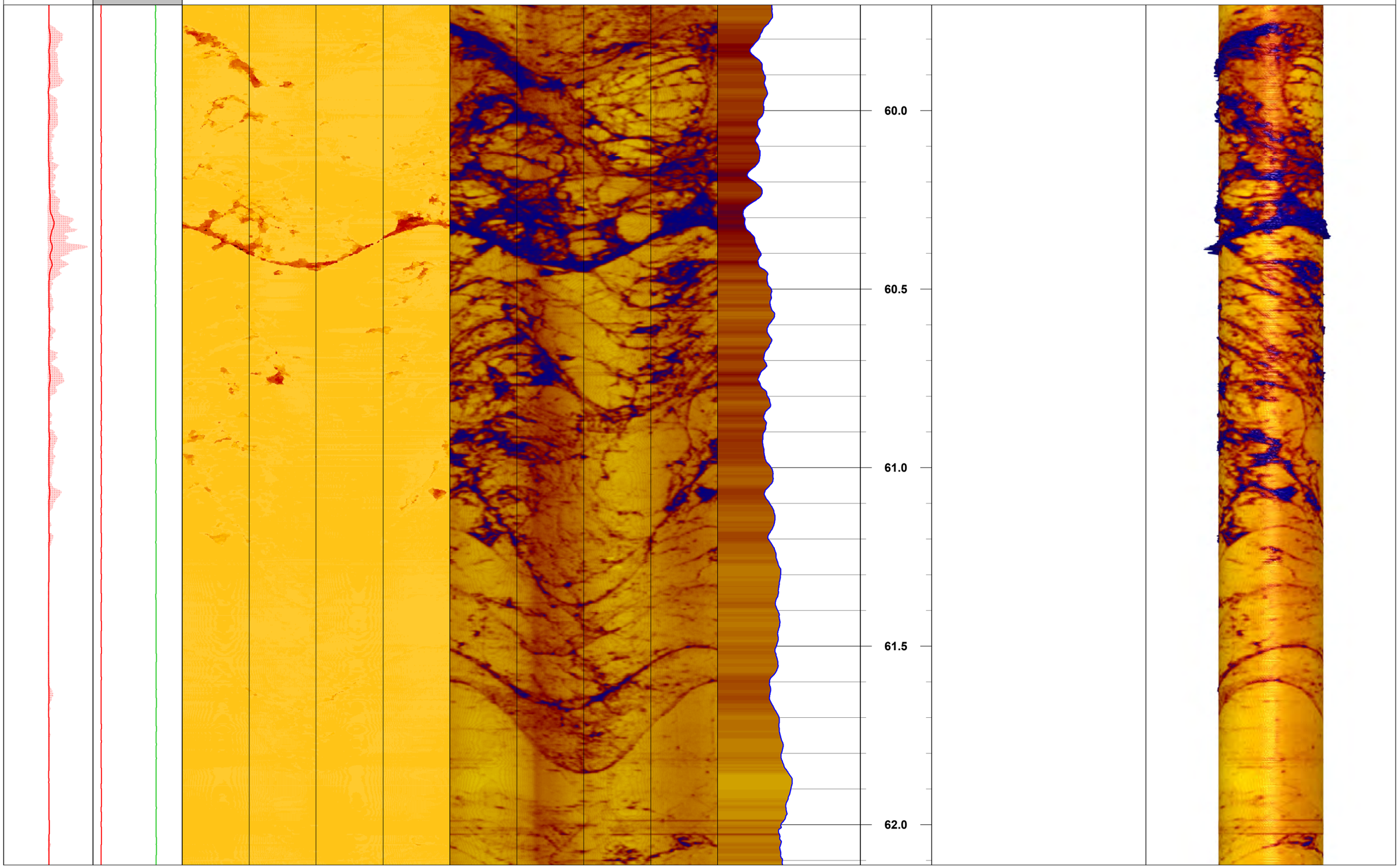
Acoustic Caliper	Tilt	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	Comment	3D Acoustic
100 mm 150	0 deg 20	55 mm 90 0° 90° 180° 270° 0°	0 10000 0° 90° 180° 270° 0°	0 10000	1m:10m		-0°
	Azimuth 0 deg 360						



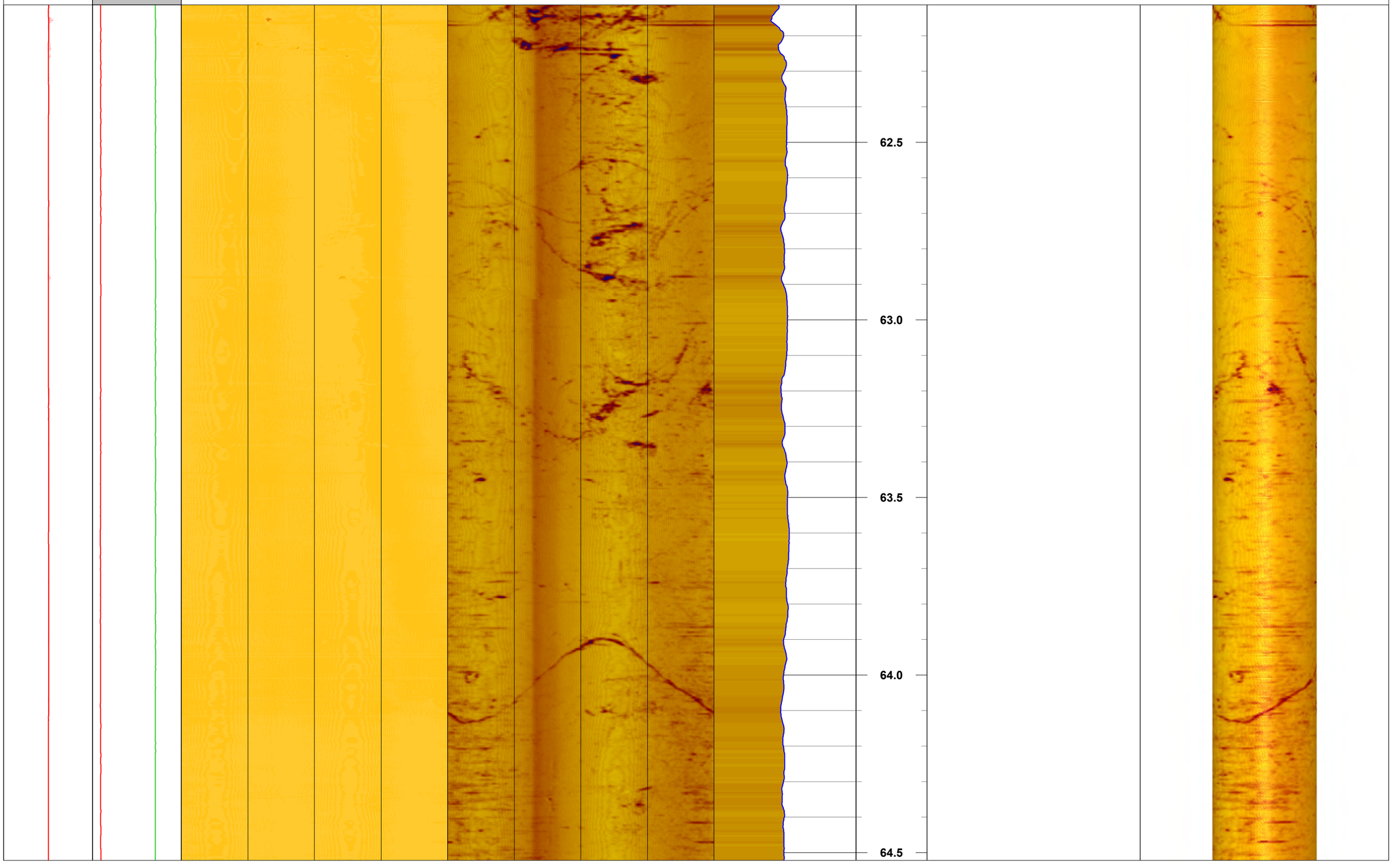
Acoustic Calliper	Tilt	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	Comment	3D Acoustic
100 mm 150	0 deg 20	55 mm 90 0° 90° 180° 270° 0°	0 10000 0° 90° 180° 270° 0°	0 10000	1m:10m		-0°
	Azimuth 0 deg 360						



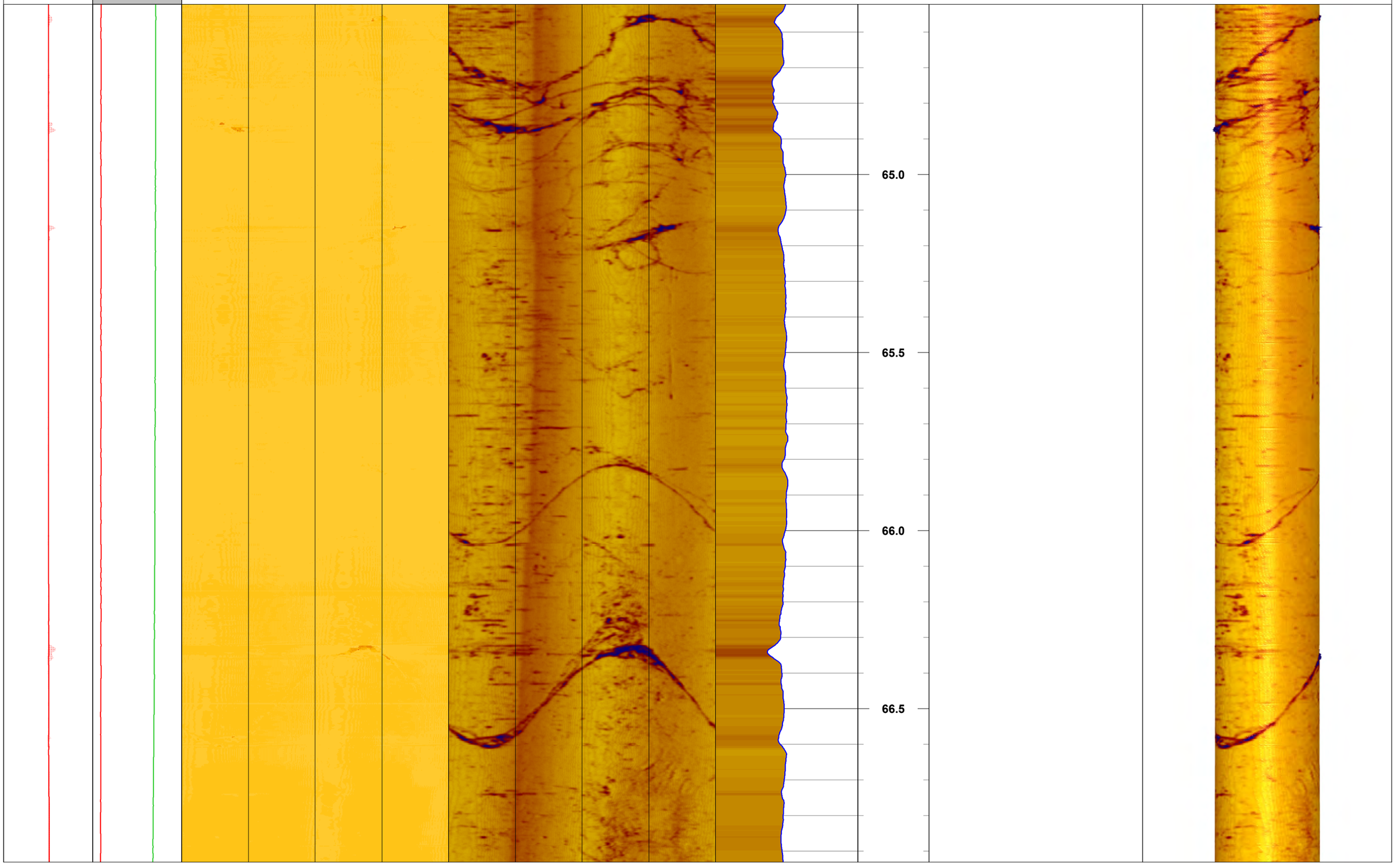
Acoustic Caliper	Tilt	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	Comment	3D Acoustic
100 mm 150	0 deg 20	55 mm 90 0° 90° 180° 270° 0°	0 10000 0° 90° 180° 270° 0°	0 10000	1m:10m		-0°
	Azimuth 0 deg 360						



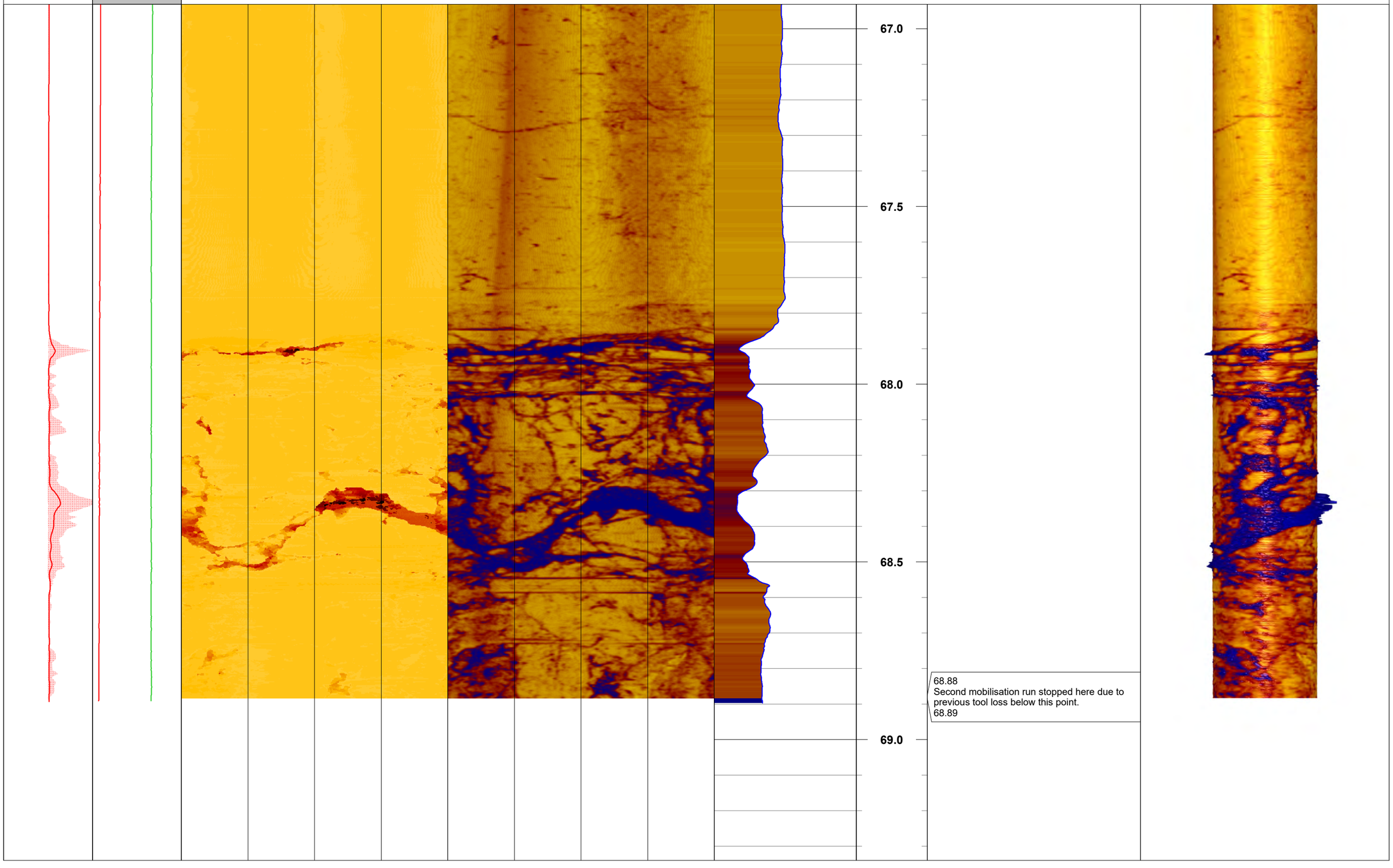
Acoustic Calliper	Tilt	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	Comment	3D Acoustic
100 mm 150	0 deg 20	55 mm 90 0° 90° 180° 270° 0°	0 10000 0° 90° 180° 270° 0°	0 10000	1m:10m		-0°
	Azimuth 0 deg 360						



Acoustic Calliper	Tilt	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	Comment	3D Acoustic
100 mm 150	0 deg 20	55 mm 90 0° 90° 180° 270° 0°	0 10000 0° 90° 180° 270° 0°	0 10000	1m:10m		-0°
	Azimuth 0 deg 360						

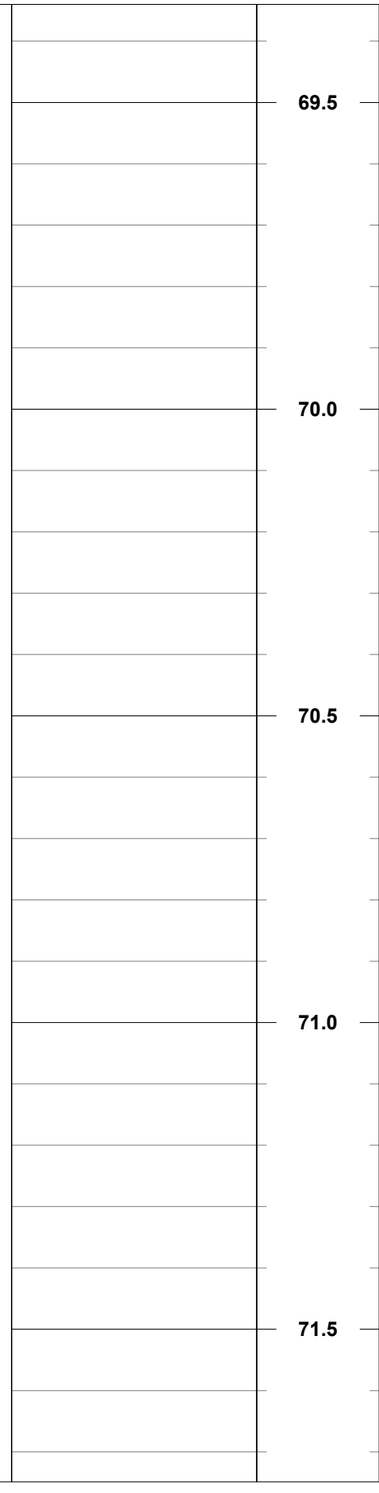


Acoustic Calliper	Tilt	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	Comment	3D Acoustic
100 mm 150	0 deg 20	55 mm 90 0° 90° 180° 270° 0°	0 10000 0° 90° 180° 270° 0°	0 10000	1m:10m		-0°
	Azimuth 0 deg 360						

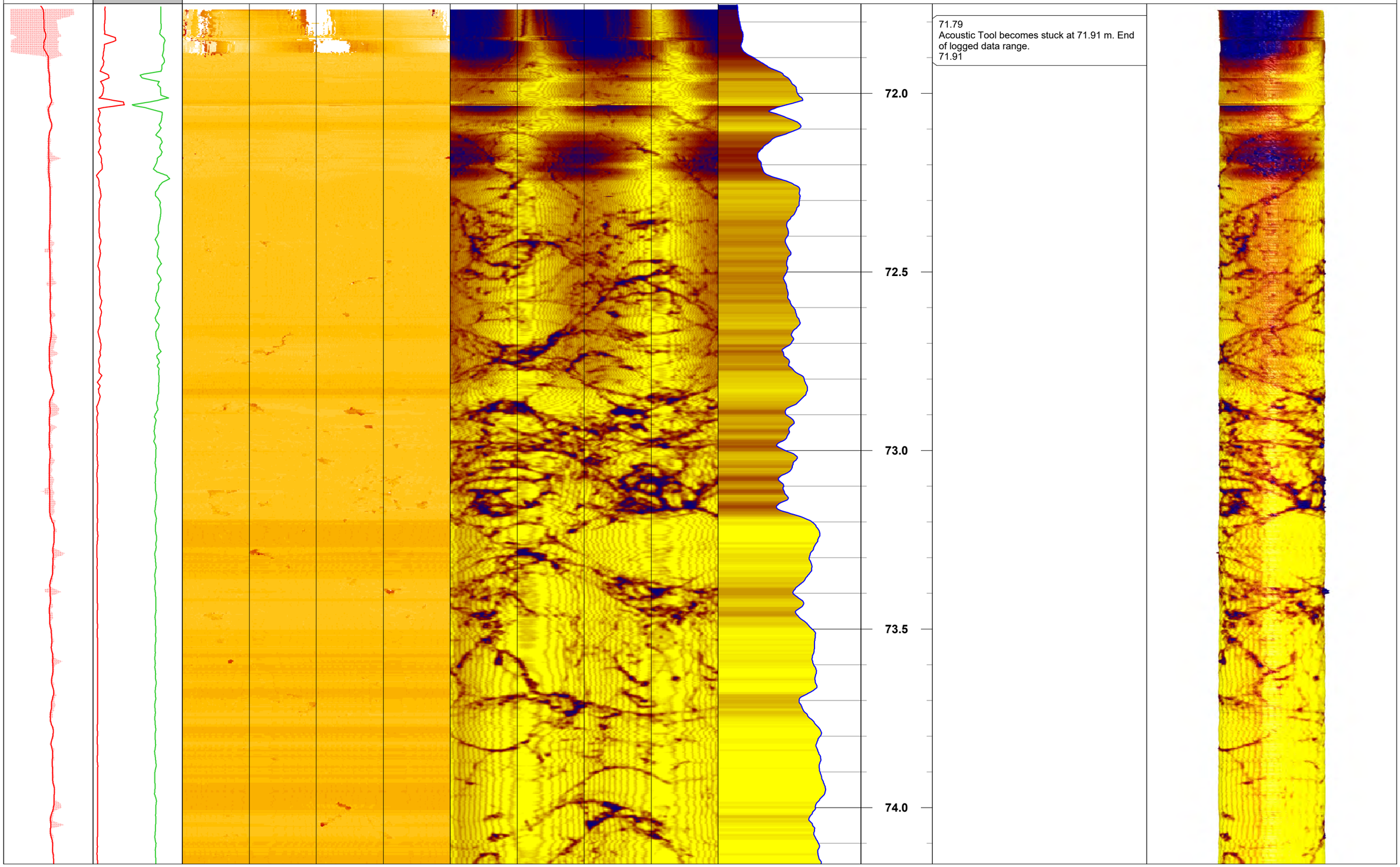


68.88
Second mobilisation run stopped here due to previous tool loss below this point.
68.89

Acoustic Calliper	Tilt	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	Comment	3D Acoustic
100 mm 150	0 deg 20	55 mm 90 0° 90° 180° 270° 0°	0 10000 0° 90° 180° 270° 0°	0 10000	1m:10m		-0°
	Azimuth 0 deg 360						

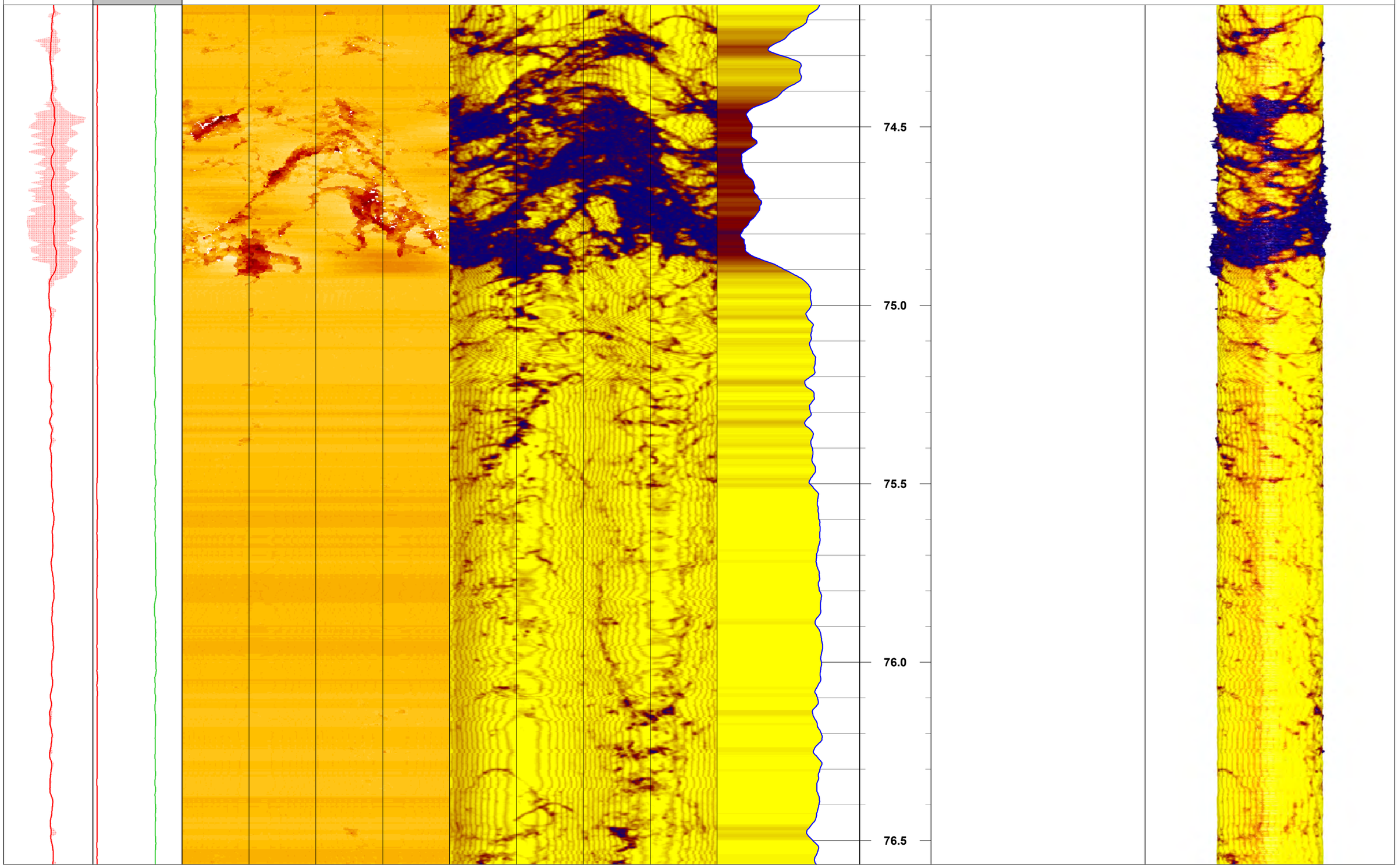


Acoustic Caliper	Tilt	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	Comment	3D Acoustic
100 mm 150	0 deg 20	55 mm 90 0° 90° 180° 270° 0°	0 10000 0° 90° 180° 270° 0°	0 10000	1m:10m		-0°
	Azimuth 0 deg 360						

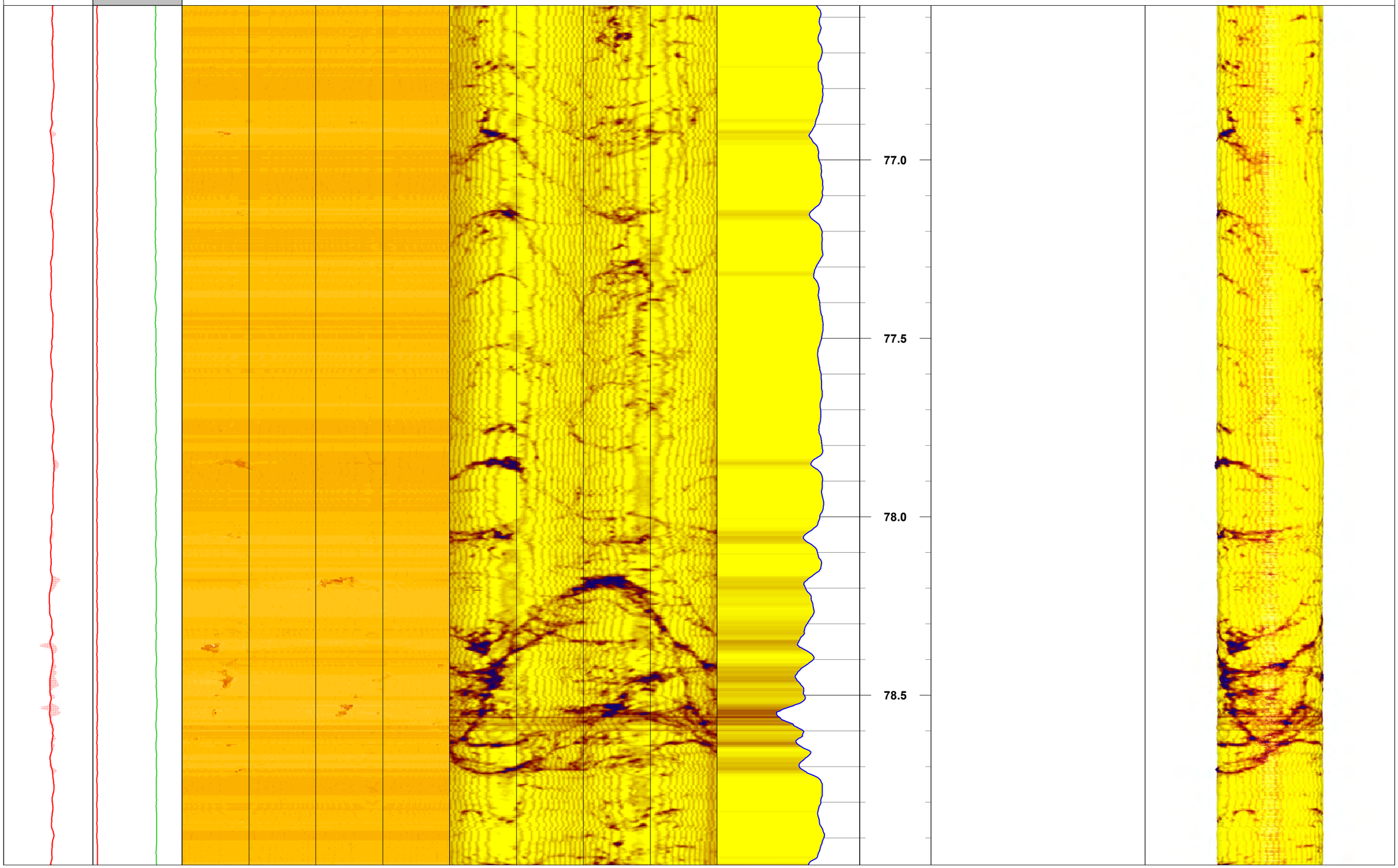


71.79
Acoustic Tool becomes stuck at 71.91 m. End of logged data range.
71.91

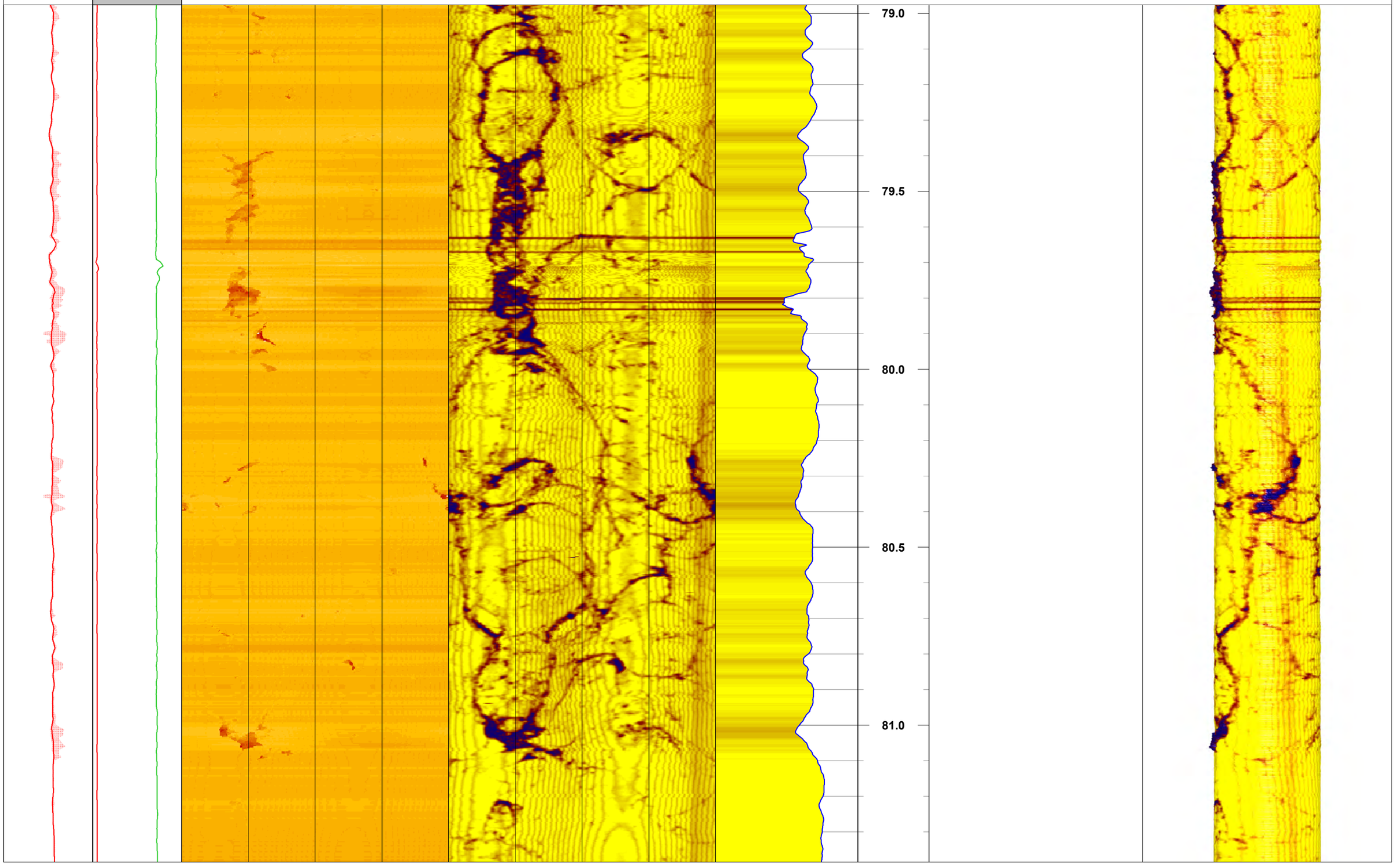
Acoustic Caliper	Tilt	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	Comment	3D Acoustic
100 mm 150	0 deg 20	55 mm 90 0° 90° 180° 270° 0°	0 10000 0° 90° 180° 270° 0°	0 10000	1m:10m		-0°
	Azimuth 0 deg 360						



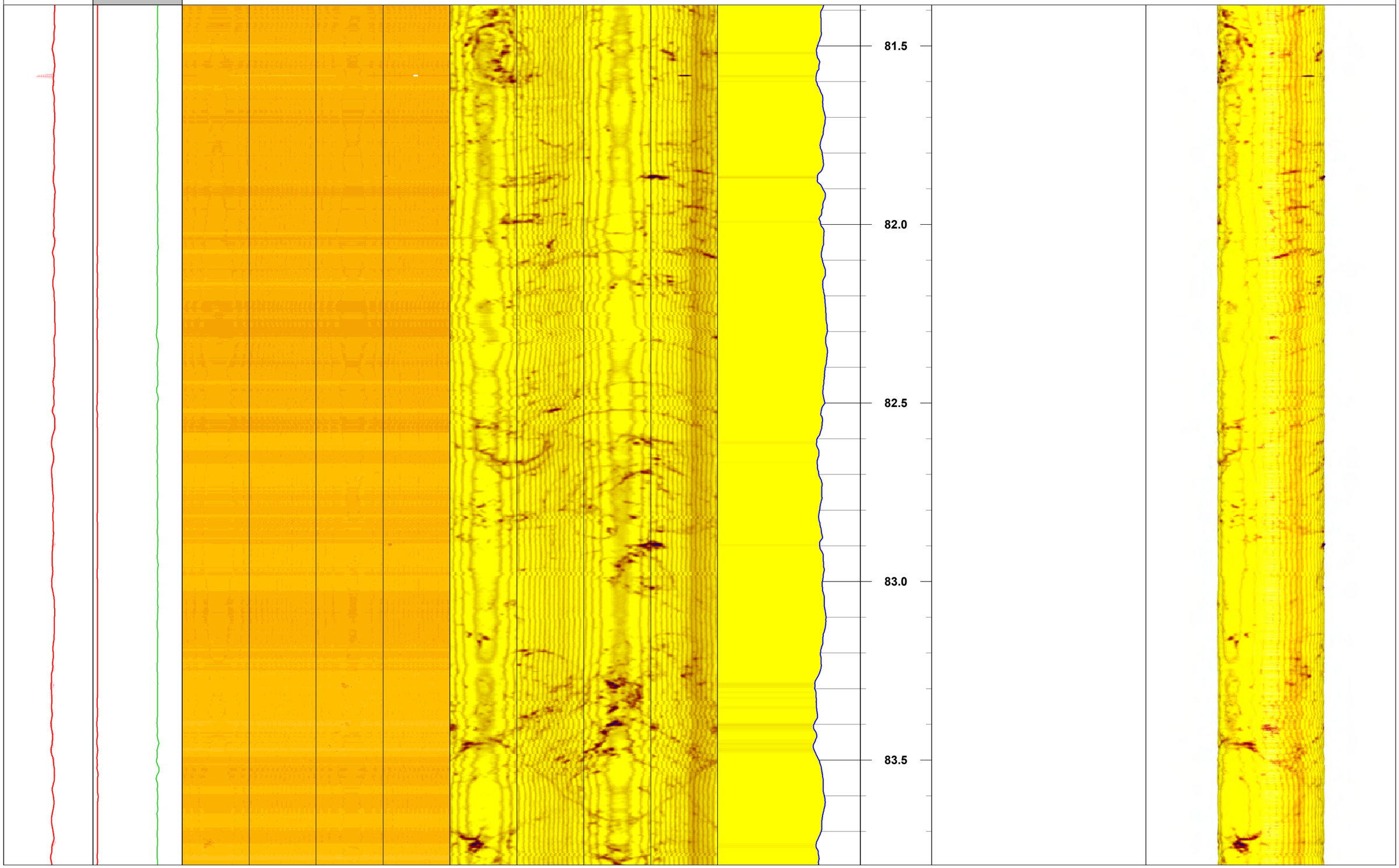
Acoustic Calliper	Tilt	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	Comment	3D Acoustic
100 mm 150	0 deg 20	55 mm 90 0° 90° 180° 270° 0°	0 10000 0° 90° 180° 270° 0°	0 10000	1m:10m		-0°
	Azimuth 0 deg 360						



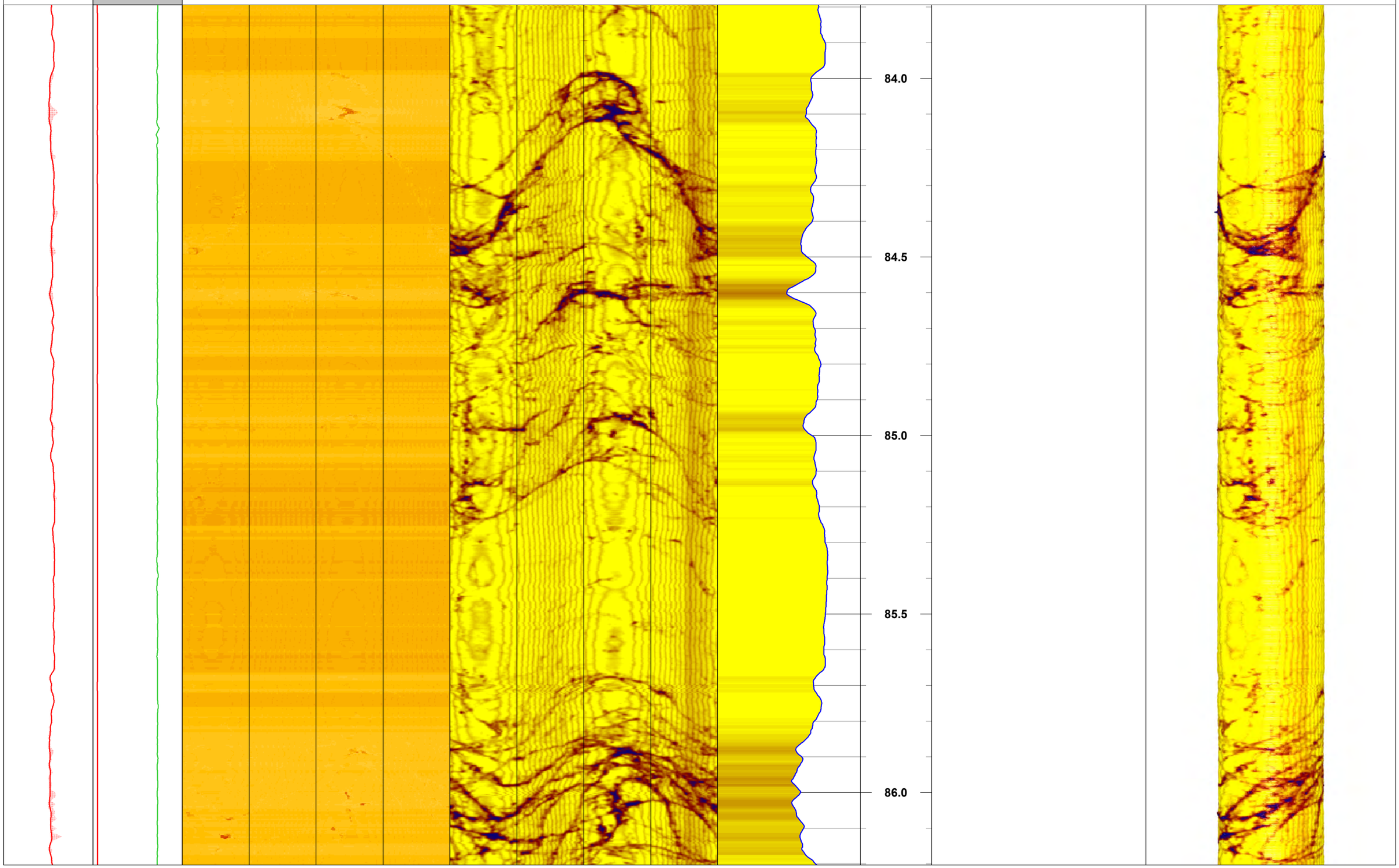
Acoustic Caliper	Tilt	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	Comment	3D Acoustic
100 mm 150	0 deg 20	55 mm 90	0 10000	0 10000	1m:10m		-0°
	Azimuth	0° 90° 180° 270° 0°	0° 90° 180° 270° 0°				
	0 deg 360						



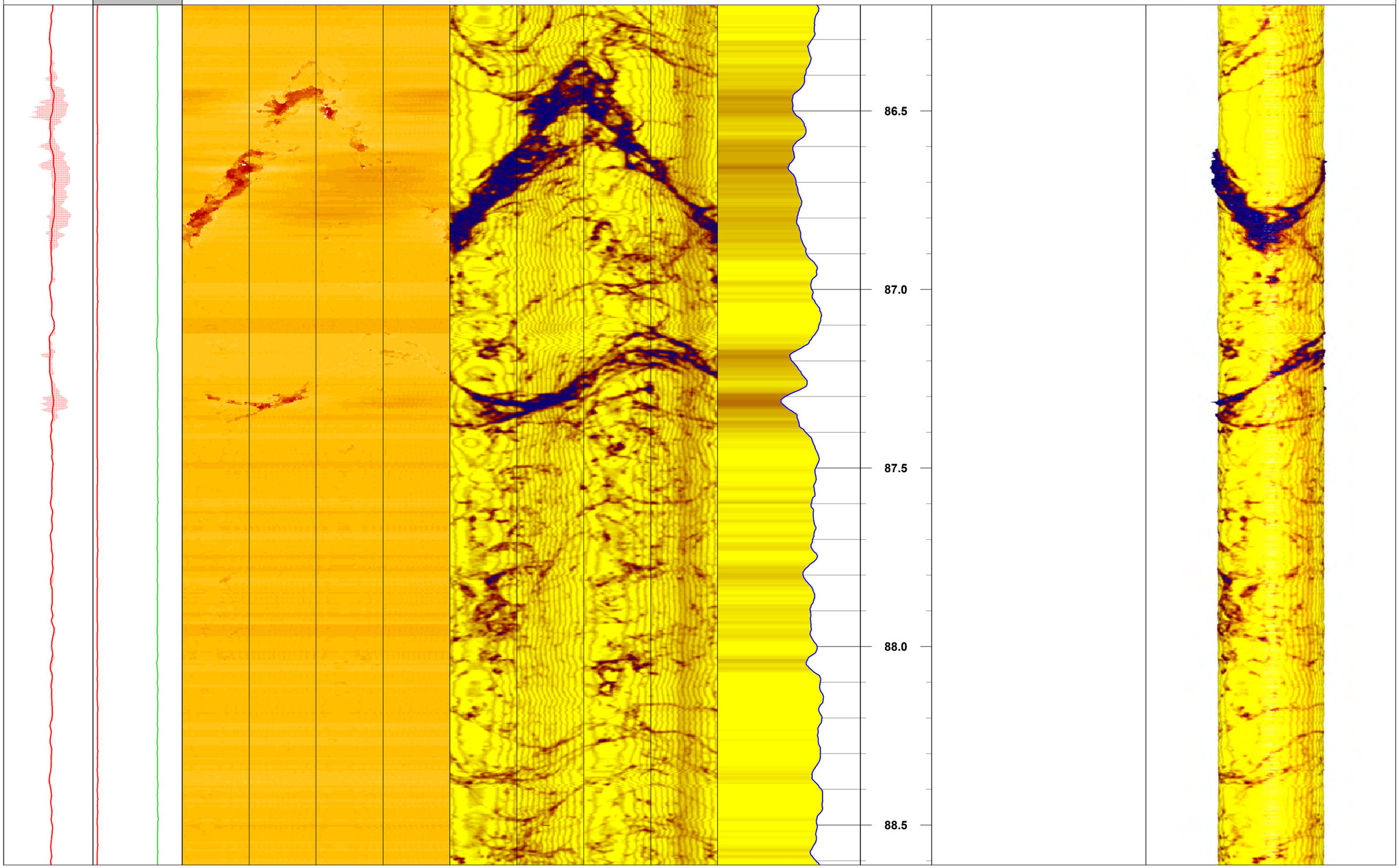
Acoustic Calliper	Tilt	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	Comment	3D Acoustic
100 mm 150	0 deg 20	55 mm 90 0° 90° 180° 270° 0°	0 10000 0° 90° 180° 270° 0°	0 10000	1m:10m		-0°
	Azimuth 0 deg 360						



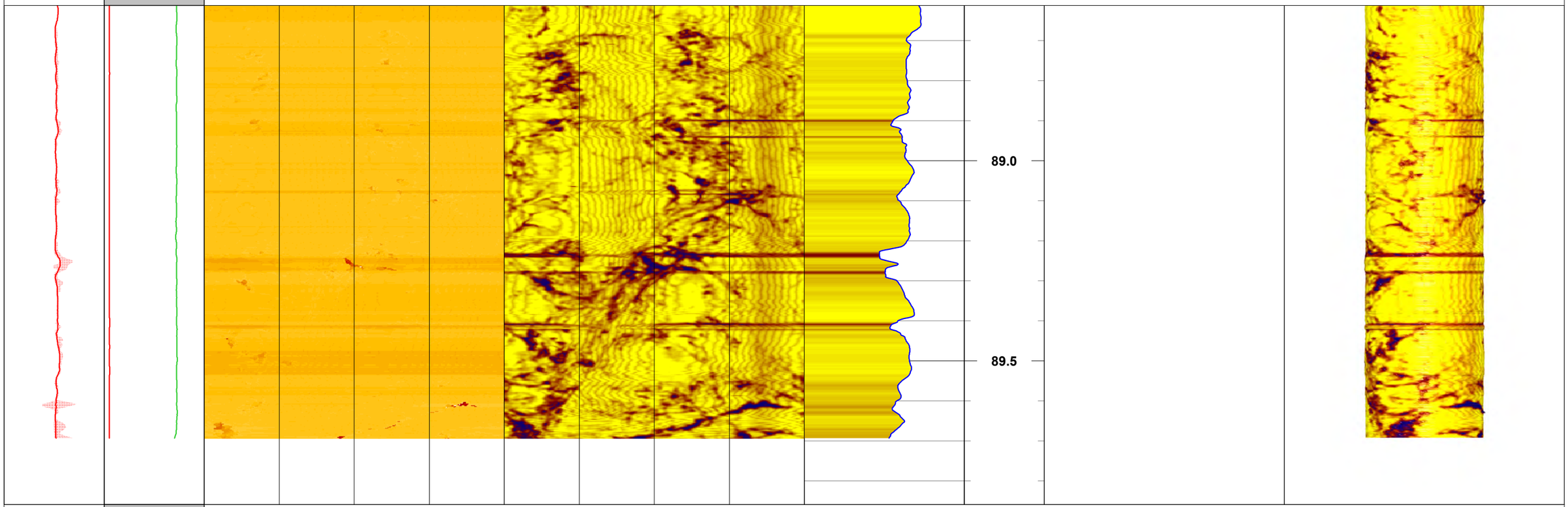
Acoustic Calliper	Tilt	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	Comment	3D Acoustic
100 mm 150	0 deg 20	55 mm 90 0° 90° 180° 270° 0°	0 10000 0° 90° 180° 270° 0°	0 10000	1m:10m		-0°
	Azimuth 0 deg 360						



Acoustic Calliper	Tilt	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	Comment	3D Acoustic
100 mm 150	0 deg 20	55 mm 90 0° 90° 180° 270° 0°	0 10000 0° 90° 180° 270° 0°	0 10000	1m:10m		-0°
	Azimuth 0 deg 360						



Acoustic Calliper	Tilt	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	Comment	3D Acoustic
100 mm 150	0 deg 20	55 mm 90 0° 90° 180° 270° 0°	0 10000 0° 90° 180° 270° 0°	0 10000	1m:10m		-0°
	Azimuth 0 deg 360						



	Azimuth 0 deg 360						
100 mm 150	0 deg 20	0° 90° 180° 270° 0° 55 mm 90	0° 90° 180° 270° 0° 0 10000	0 10000	1m:10m		-0°
Acoustic Calliper	Tilt	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	Comment	3D Acoustic

GOLDER
MEMBER OF WSP

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Level 2, Nielsen Centre
129 Hurstmere Road
Takapuna, Auckland 0622
New Zealand
www.golder.com

GEOPHYSICAL RECORD OF BOREHOLE BH101

PROJECT	**Kaikoura Earthquake-Induced Landslide Research**	PROJECT #	**5-C3418.00**
CLIENT	**GNS Science**	DATE	**05 December 2021**

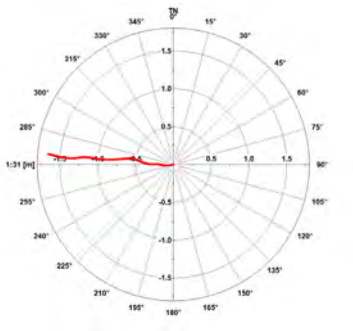
LOCATION	**Slip P8, Okiwi Bay, North Canterbury**	LOGGED BY	**RDCL (O Gibson)**
EASTING	**1670538 m**	LOGGED DATE	**19 October 2020**
NORTHING	**5325187 m**	LOGGING DATUM	**GL**
ELEVATION	**Approx. 104 m**	LOGGED DEPTH	**22.3 - 89.7 m**
DRILLED DEPTH	**90.0 m**	DRAWN BY	**MH**
INCLINATION	**-87.7°** AZIMUTH **276° (TN)**	REVIEWED BY	**TR**
DIAMETER	**PQ**	FILE NAME	**BH101_ATV_Rev0.wcl**

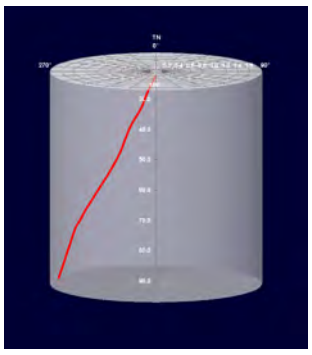
Imagery is presented relative to magnetic north.

Acoustic caliper log used for structure tilt correction.

Summary structural data are presented relative to true north (declination correction of 23.2° applied).

DEVIATION DATA





INTERPRETED STRUCTURES

Extremely Weathered / Infilled Seam
Crushed / Sheared Seam
Sheared Zone
Joint
Healed Joint
Vein

BH101

Depth | **Caliper** | **ATV Data** | **Structural Summary**

Depth 1m:20m

ATV Caliper 100 160

App Hardness

3D Acoustic -0°

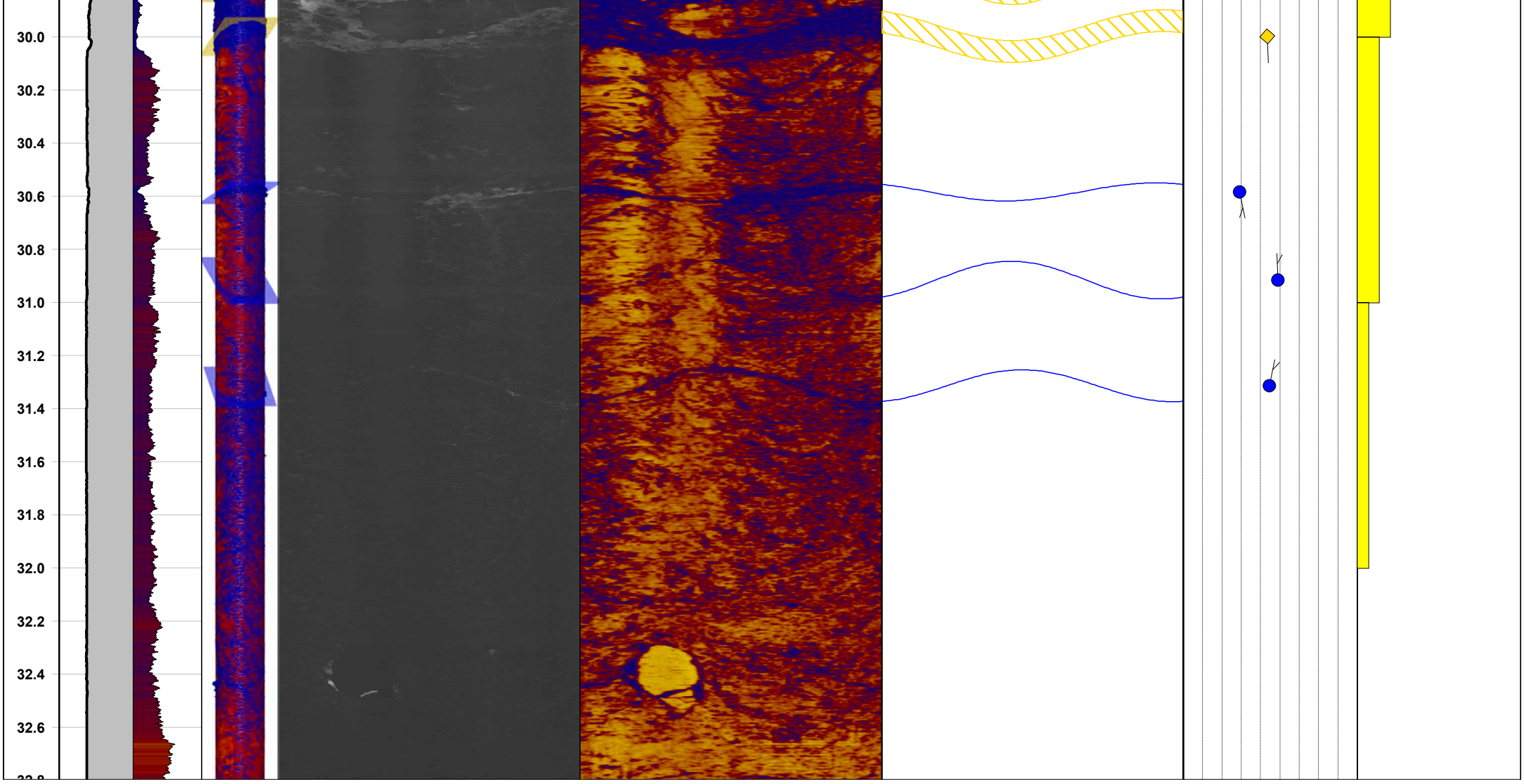
Centralized TravelTime-NM 50 us 95 (0° 90° 180° 270° 0°)

Amplitude-NM 0 10000 (0° 90° 180° 270° 0°)

Apparent Structure Log 0° 90° 180° 270° 0°

Structures 0 90

Defect freq/meter 0 counts/m 15



BH101

Depth | **Caliper** | **ATV Data** | **Structural Summary**

Depth
1m:20m

ATV Caliper
100 160

App Hardness

3D Acoustic
-0°

Centralized TravelTime-NM
50 us 95
0° 90° 180° 270° 0°

Amplitude-NM
0 10000
0° 90° 180° 270° 0°

Apparent Structure Log
0° 90° 180° 270° 0°

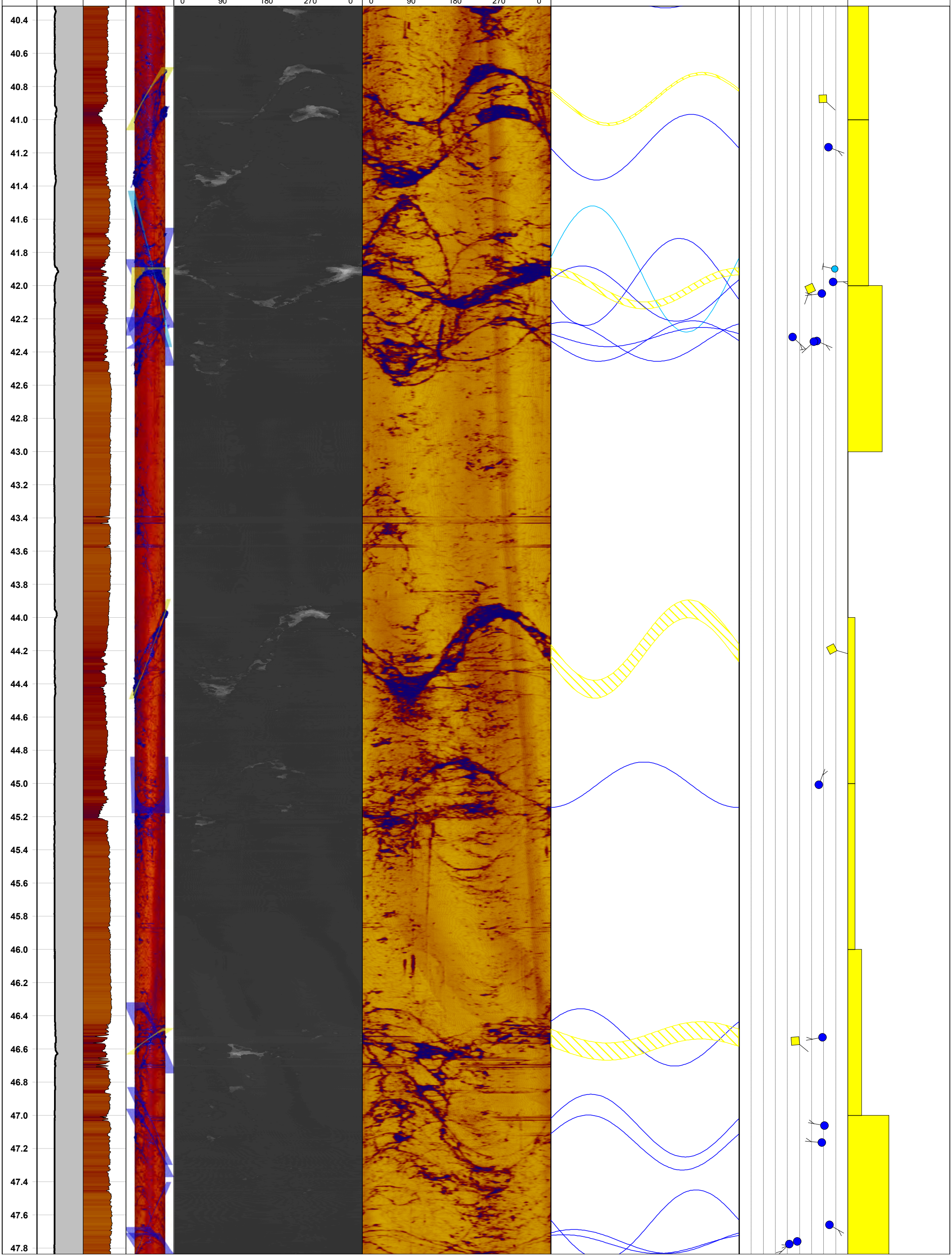
Structures
0 90

Defect freq/meter
0 counts/m 15

32.8
33.0
33.2
33.4
33.6
33.8
34.0
34.2
34.4
34.6
34.8
35.0
35.2
35.4
35.6
35.8
36.0
36.2
36.4
36.6
36.8
37.0
37.2
37.4
37.6
37.8
38.0
38.2
38.4
38.6
38.8
39.0
39.2
39.4
39.6
39.8
40.0
40.2

BH101

Depth	Caliper	ATV Data					Structural Summary	
Depth	ATV Caliper	App Hardness	3D Acoustic	Centralized TravelTime-NM	Amplitude-NM	Apparent Structure Log	Structures	Defect freq/meter
1m:20m	100 160		-0°	50 us 95 0° 90° 180° 270° 0°	0 10000 0° 90° 180° 270° 0°	0° 90° 180° 270° 0°	0 90	0 counts/m 15



BH101

Depth | **Caliper** | **ATV Data** | **Structural Summary**

Depth
1m:20m

ATV Caliper
100 160

App Hardness

3D Acoustic
-0°

Centralized TravelTime-NM
50 us 95
0° 90° 180° 270° 0°

Amplitude-NM
0 10000
0° 90° 180° 270° 0°

Apparent Structure Log
0° 90° 180° 270° 0°

Structures
0 90

Defect freq/meter
0 counts/m 15

48.0
48.2
48.4
48.6
48.8
49.0
49.2
49.4
49.6
49.8
50.0
50.2
50.4
50.6
50.8
51.0
51.2
51.4
51.6
51.8
52.0
52.2
52.4
52.6
52.8
53.0
53.2
53.4
53.6
53.8
54.0
54.2
54.4
54.6
54.8
55.0
55.2

BH101

Depth | **Caliper** | **ATV Data** | **Structural Summary**

Depth
1m:20m

ATV Caliper
100 160

App Hardness

3D Acoustic
-0°

Centralized TravelTime-NM
50 us 95
0° 90° 180° 270° 0°

Amplitude-NM
0 10000
0° 90° 180° 270° 0°

Apparent Structure Log
0° 90° 180° 270° 0°

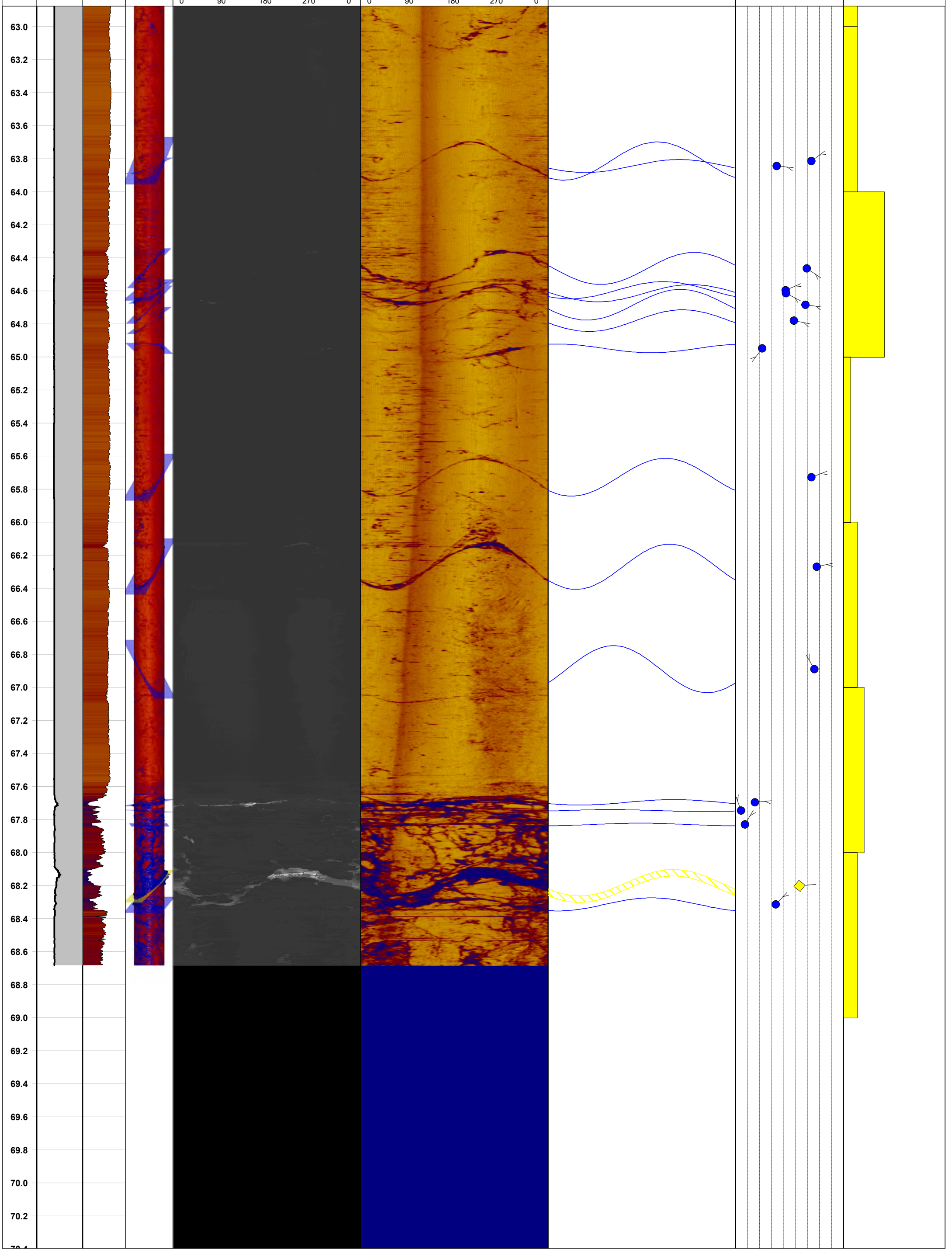
Structures
0 90

Defect freq/meter
0 counts/m 15

55.4
55.6
55.8
56.0
56.2
56.4
56.6
56.8
57.0
57.2
57.4
57.6
57.8
58.0
58.2
58.4
58.6
58.8
59.0
59.2
59.4
59.6
59.8
60.0
60.2
60.4
60.6
60.8
61.0
61.2
61.4
61.6
61.8
62.0
62.2
62.4
62.6
62.8

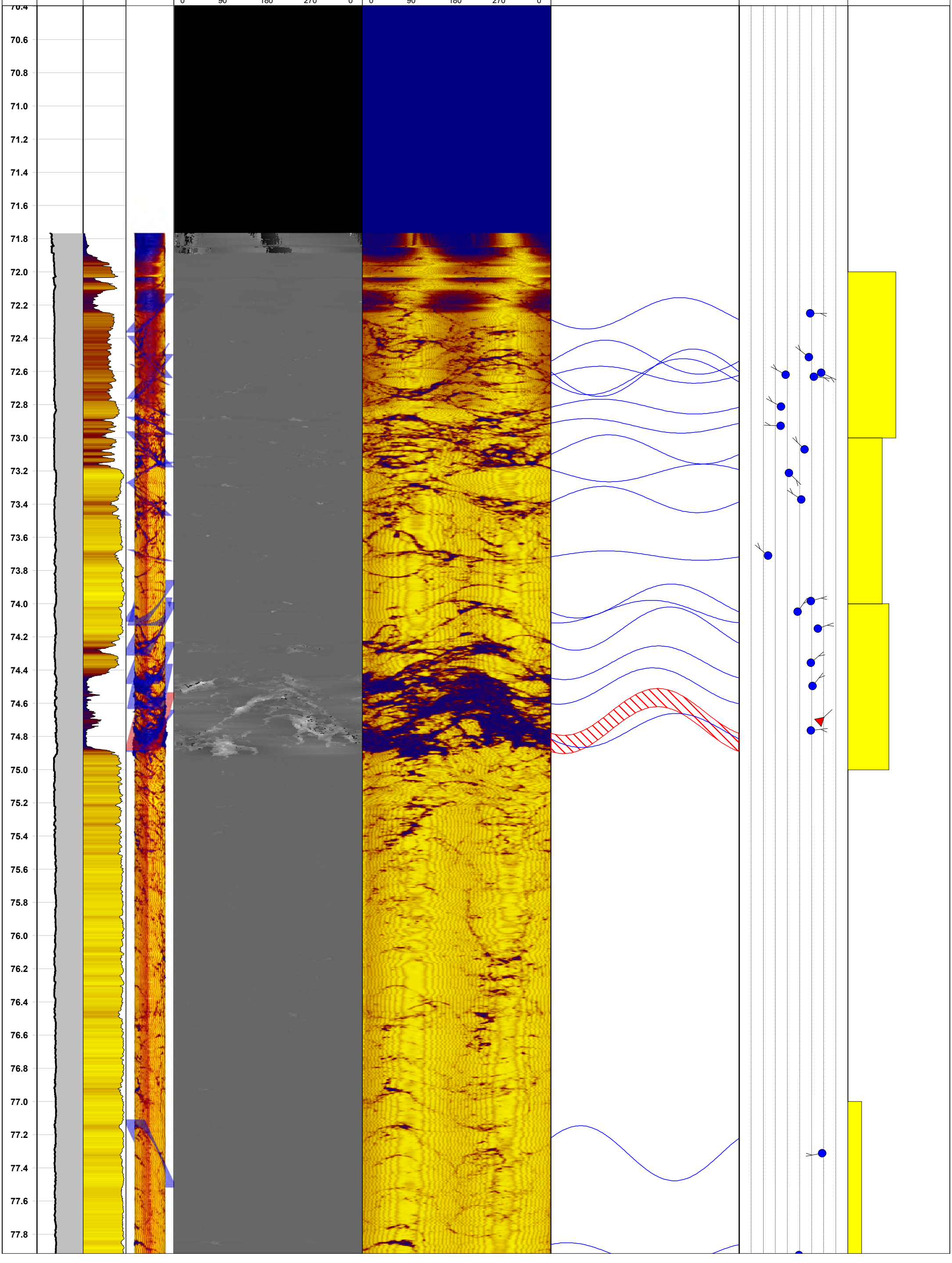
BH101

Depth	Caliper	ATV Data					Structural Summary	
Depth	ATV Caliper	App Hardness	3D Acoustic	Centralized TravelTime-NM	Amplitude-NM	Apparent Structure Log	Structures	Defect freq/meter
1m:20m	100 160		-0°	50 us 95 0° 90° 180° 270° 0°	0 10000 0° 90° 180° 270° 0°	0° 90° 180° 270° 0°	0 90	0 counts/m 15



BH101

Depth	Caliper	ATV Data					Structural Summary	
Depth	ATV Caliper	App Hardness	3D Acoustic	Centralized TravelTime-NM	Amplitude-NM	Apparent Structure Log	Structures	Defect freq/meter
1m:20m	100 160		-0°	50 us 95 0° 90° 180° 270° 0°	0 10000 0° 90° 180° 270° 0°	0° 90° 180° 270° 0°	0 90	0 counts/m 15



BH101

Depth | **Caliper** | **ATV Data** | **Structural Summary**

Depth
1m:20m

ATV Caliper
100 160

App Hardness

3D Acoustic
-0°

Centralized TravelTime-NM
50 us 95
0° 90° 180° 270° 0°

Amplitude-NM
0 10000
0° 90° 180° 270° 0°

Apparent Structure Log
0° 90° 180° 270° 0°

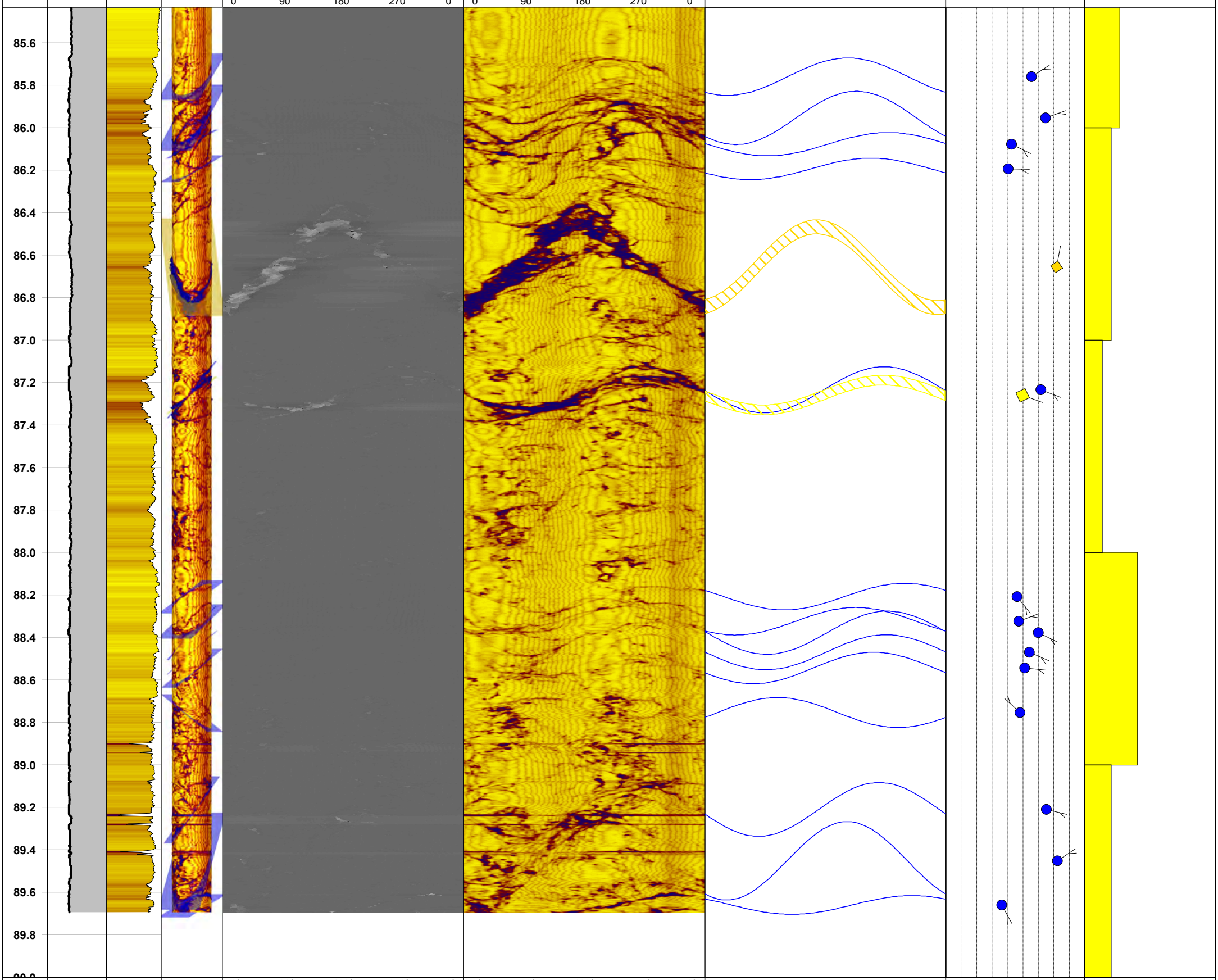
Structures
0 90

Defect freq/meter
0 counts/m 15

78.0
78.2
78.4
78.6
78.8
79.0
79.2
79.4
79.6
79.8
80.0
80.2
80.4
80.6
80.8
81.0
81.2
81.4
81.6
81.8
82.0
82.2
82.4
82.6
82.8
83.0
83.2
83.4
83.6
83.8
84.0
84.2
84.4
84.6
84.8
85.0
85.2
85.4

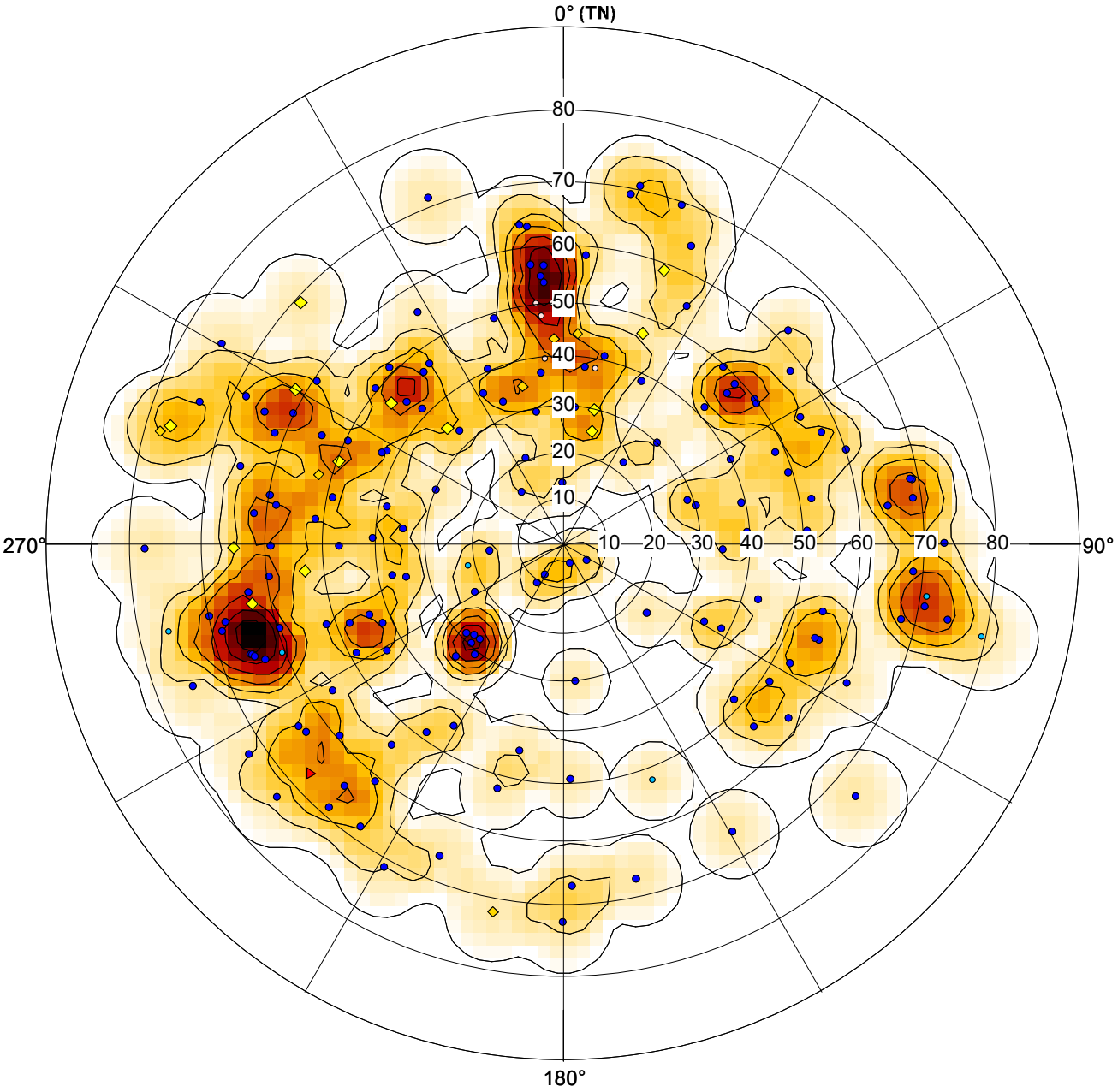
BH101

Depth	Caliper	ATV Data					Structural Summary	
Depth	ATV Caliper	App Hardness	3D Acoustic	Centralized TravelTime-NM	Amplitude-NM	Apparent Structure Log	Structures	Defect freq/meter
1m:20m	100 160		-0°	50 us 95 0° 90° 180° 270° 0°	0 10000 0° 90° 180° 270° 0°	0° 90° 180° 270° 0°	0 90	0 counts/m 15



1m:20m	100 160		-0°	0° 90° 180° 270° 0° 50 us 95	0° 90° 180° 270° 0° 0 10000	0° 90° 180° 270° 0°	0 90	0 counts/m 15
Depth	ATV Caliper	App Hardness	3D Acoustic	Centralized TravelTime-NM	Amplitude-NM	Apparent Structure Log	Structures	Defect freq/meter
Depth	Caliper	ATV Data					Structural Summary	

BH101



Notes:
1. Poles of interpreted structures are displayed.
2. Structures are orientated relative to true north.
3. Projection is angle-equal (Wulff), southern hemisphere.
4. Coloured contours indicate the density of clustered structures, and were calculated using the Schmidt method.

CLIENT
GNS SCIENCE

PROJECT
KAIKOURA EARTHQUAKE-INDUCED LANDSLIDE RESEARCH

CONSULTANT
GOLDER

YYYY-MM-DD	2021-12-05
DESIGNED	MH
PREPARED	MH
REVIEWED	TR
APPROVED	TR

TITLE
BH101
SUMMARY POLAR PLOT OF INTERPRETED STRUCTURES

PROJECT NO. 5-C3418.00 | REV. 0 | FIGURE 01

PO Box 28057
308 Queen's Street East
Hastings 4122
New Zealand

Ph: +64 6 8771652
Fax: +64 6 8775015
Email: info@rdcl.co.nz

Basic Information:

Well Name:	BH101R
Company:	C W Drill
Run No:	06
Tool Type(s):	QL40-FWSS Full Wave Form Sonic
Service Company:	RDCL
Operator:	O Gibson
Witness:	Todd
Date Logged:	31/10/2020
Field:	Kaikōura
State / Province:	Canterbury
Country:	New Zealand

Location Description:

Okiwi Bay, 25 km North West of Kaikōura.

Drillhole Information:

Bit Size:	PQ		
Log interval from:	25.8	Log interval to:	69.0
Depth Driller:	90	Depth Logger:	89.7
Fluid Type:	Water	Fluid Level:	23.04 (ATV Mob2)
Northing:	1670535	Easting:	5325184
Elevation:	N/A	Projection:	NZTM
Hole Azimuth:	182-343° (Magnetic)	Hole Inclination:	>-87.7°
Magnetic Declination:	+22° 59' East	Magnetic Inclination:	66° 58'
Casing Size:	PQ (Shoe bit)	Casing Depth:	28.13

Printing Information:

Print Type:	Paginated	Log Version:	Final
Depth Unit:	Metres	Scale Ratio:	1:10

Comments:

1. Acoustic Tool became stuck at 71.91 m during logging (Mobilisation1).
2. Hole relogged from 69.88 m during second mobilisation hence no data at depth.

Log Notes:

The elastic moduli and engineering parameters were calculated from Full Wave Form Sonic Tool Vp and Vs measurements and CCS tool density measurements. As such the logs should be considered in-situ, small strain and bulk measurements. These measurements may differ from laboratory testing for these reasons.

Log Calculations:

SI unit calculations:
Shear Modulus (G) = dVs^2
Bulk Modulus (K) = 1/3*(E/(1-2*PR))
Young's Modulus (E) = 2G(1+PR)
Poisson's Ratio (PR) = $2-(Vp/Vs)^2/2-2(Vp/Vs)^2$

Where:
Vp = P-wave seismic velocity
Vs = S-wave seismic velocity
d = Density

Log Nomenclature:

Velocity Analysis = Output of semblance processing

S_Slowness = Shear wave slowness from semblane

Vp = P-wave velocity

Vs = Shear wave velocity from S-Slowness

DEN(CDL) = Compensated Density

Shear Modulus = Shear Modulus (G0)

Bulk Modulus = Bulk Modulus (K)

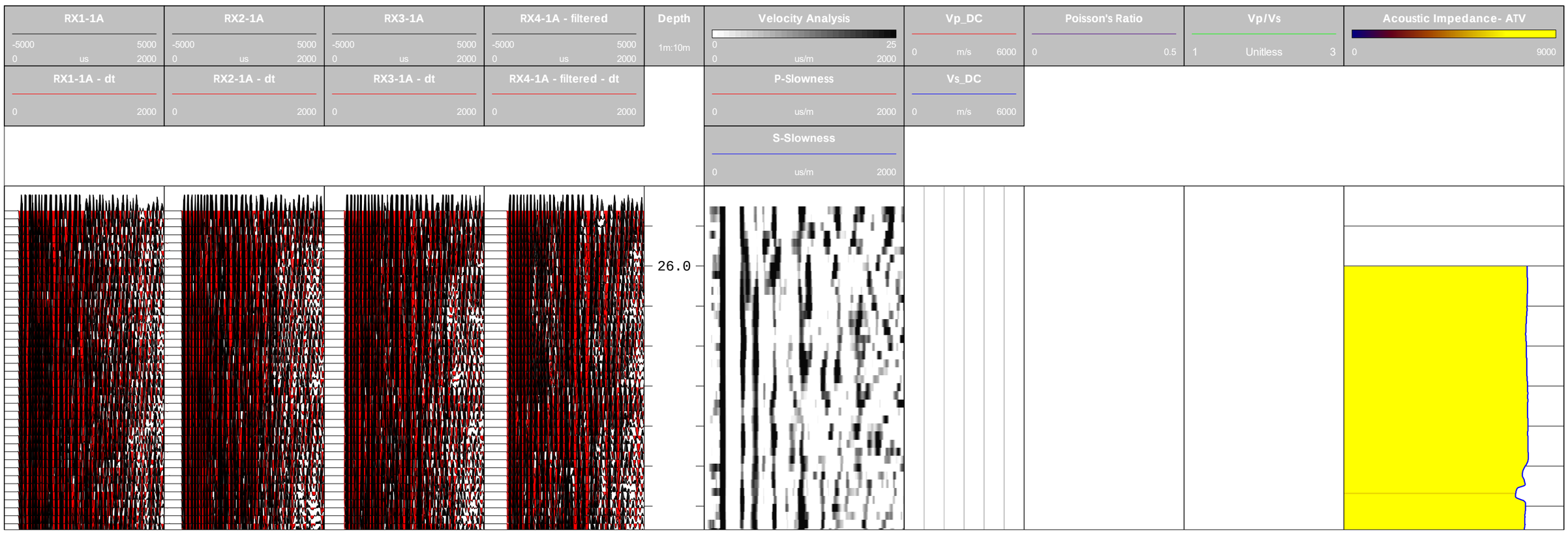
Young's Modulus = Young's Modulus (E)

Poisson's Ratio = Poisson's Ratio (PR)

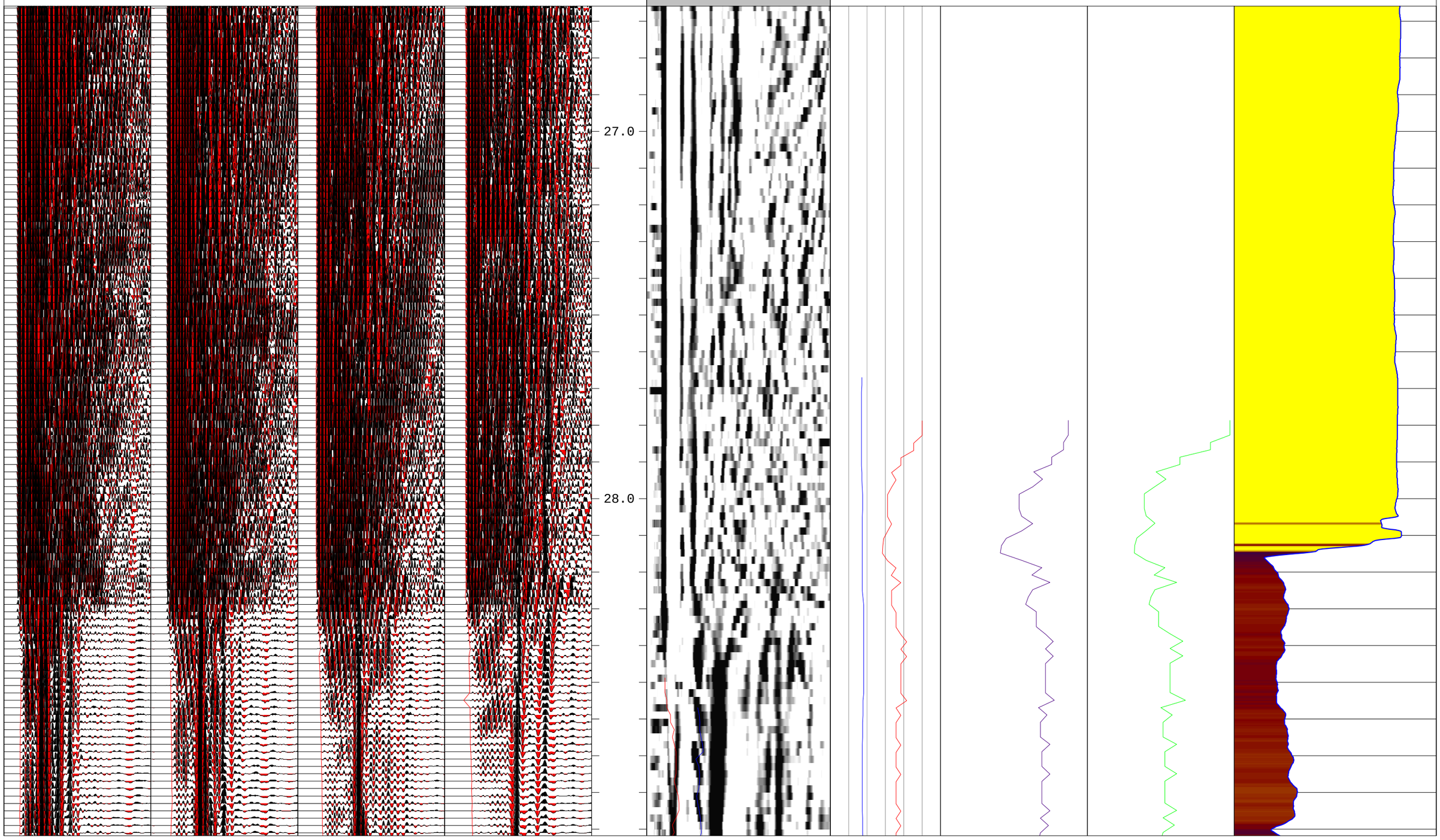
Vp/Vs = P-wave S-wave ratio

RX#-1A = Wiggle window of sensor #

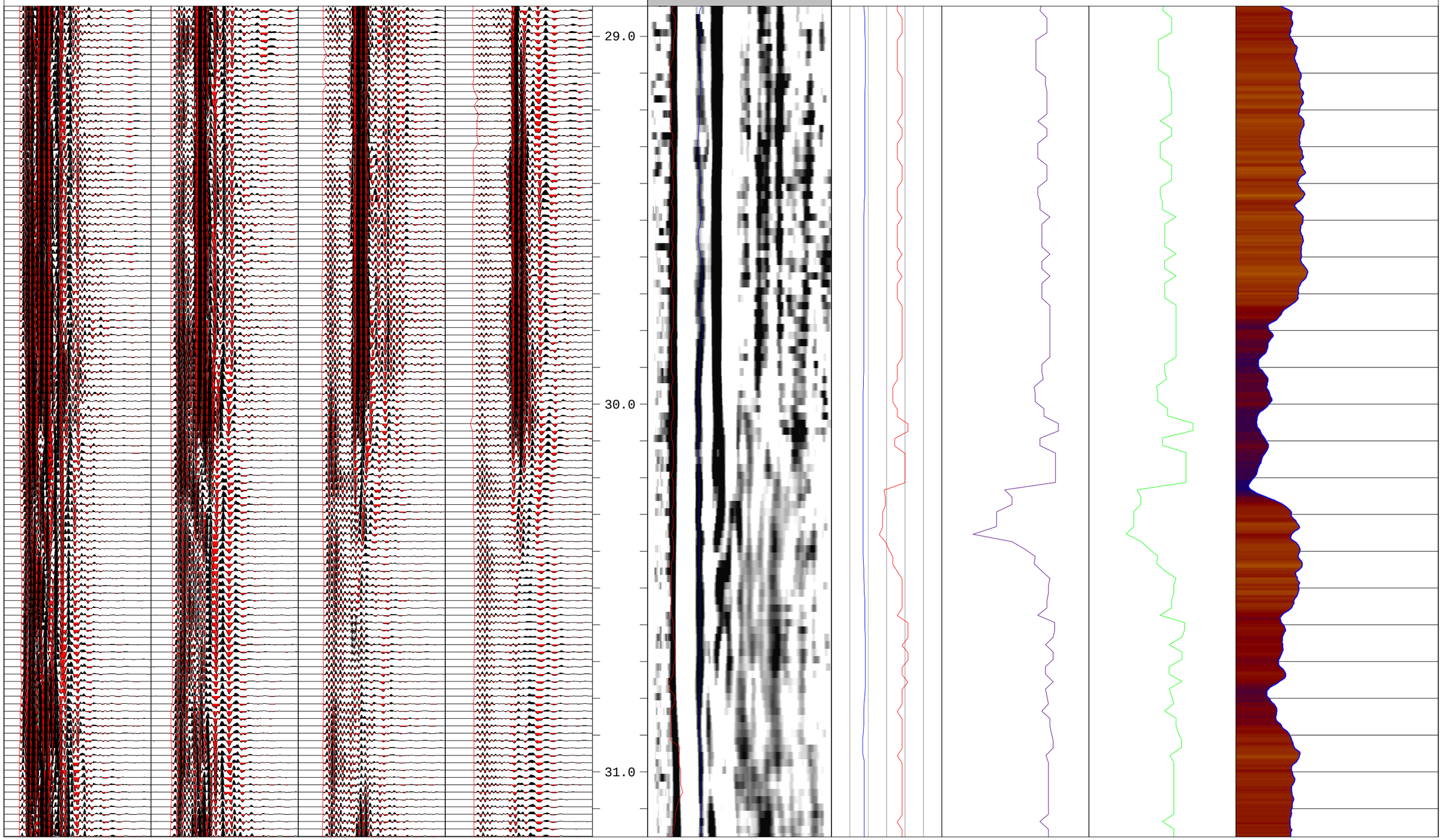
RX#-1A - dt = Picked first arrival time for sensor #



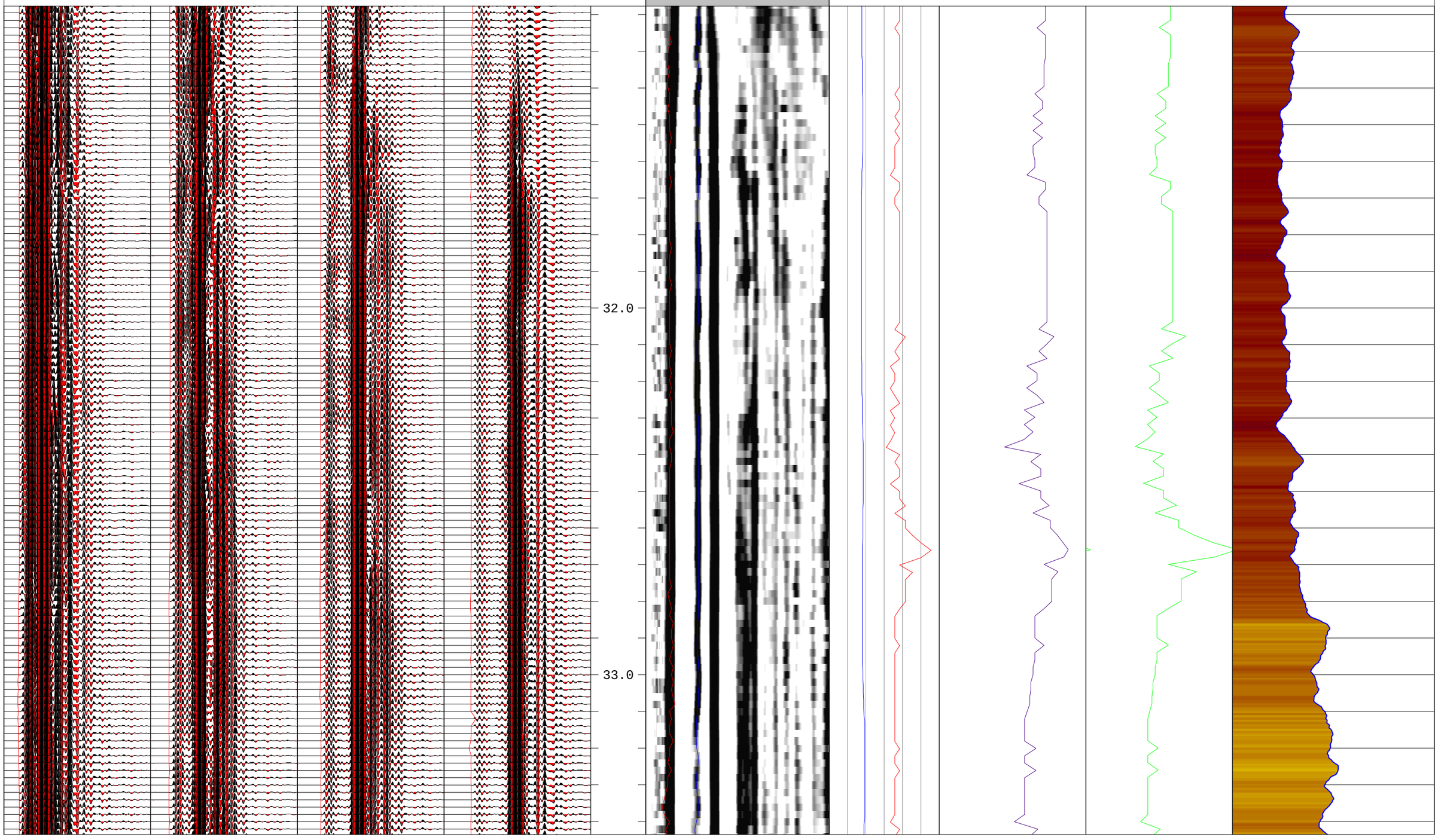
RX1-1A	RX2-1A	RX3-1A	RX4-1A - filtered	Depth	Velocity Analysis	Vp_DC	Poisson's Ratio	Vp/Vs	Acoustic Impedance- ATV
-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	1m:10m	0 25 0 us/m 2000	0 m/s 6000	0 0.5	1 Unitless 3	0 9000
RX1-1A - dt	RX2-1A - dt	RX3-1A - dt	RX4-1A - filtered - dt		P-Slowness	Vs_DC			
0 2000	0 2000	0 2000	0 2000		0 us/m 2000	0 m/s 6000			
					S-Slowness				
					0 us/m 2000				



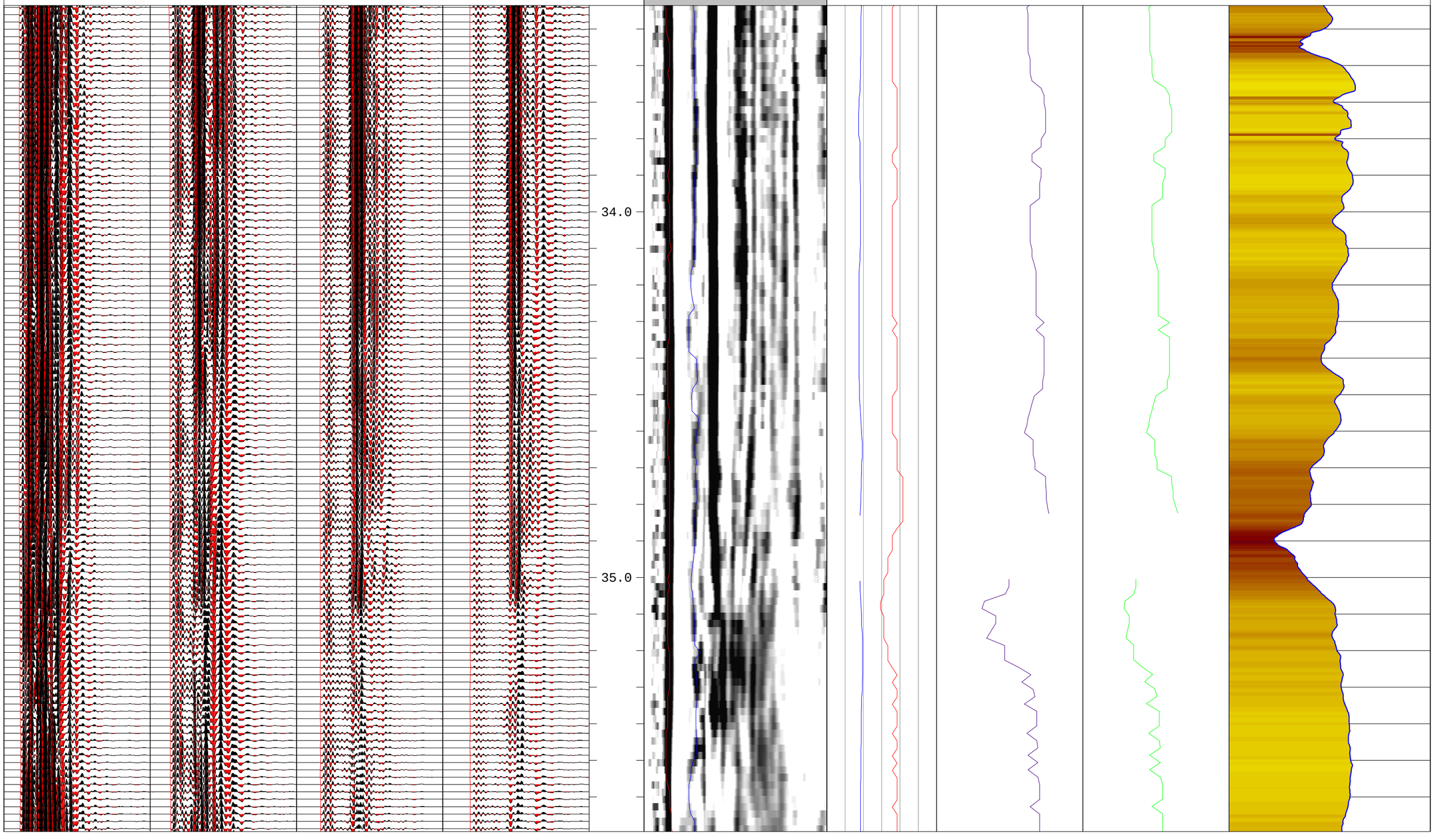
RX1-1A	RX2-1A	RX3-1A	RX4-1A - filtered	Depth	Velocity Analysis	Vp_DC	Poisson's Ratio	Vp/Vs	Acoustic Impedance- ATV
-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	1m:10m	0 25 0 us/m 2000	0 m/s 6000	0 0.5	1 Unitless 3	0 9000
RX1-1A - dt	RX2-1A - dt	RX3-1A - dt	RX4-1A - filtered - dt		P-Slowness	Vs_DC			
0 2000	0 2000	0 2000	0 2000		0 us/m 2000	0 m/s 6000			
					S-Slowness				
					0 us/m 2000				

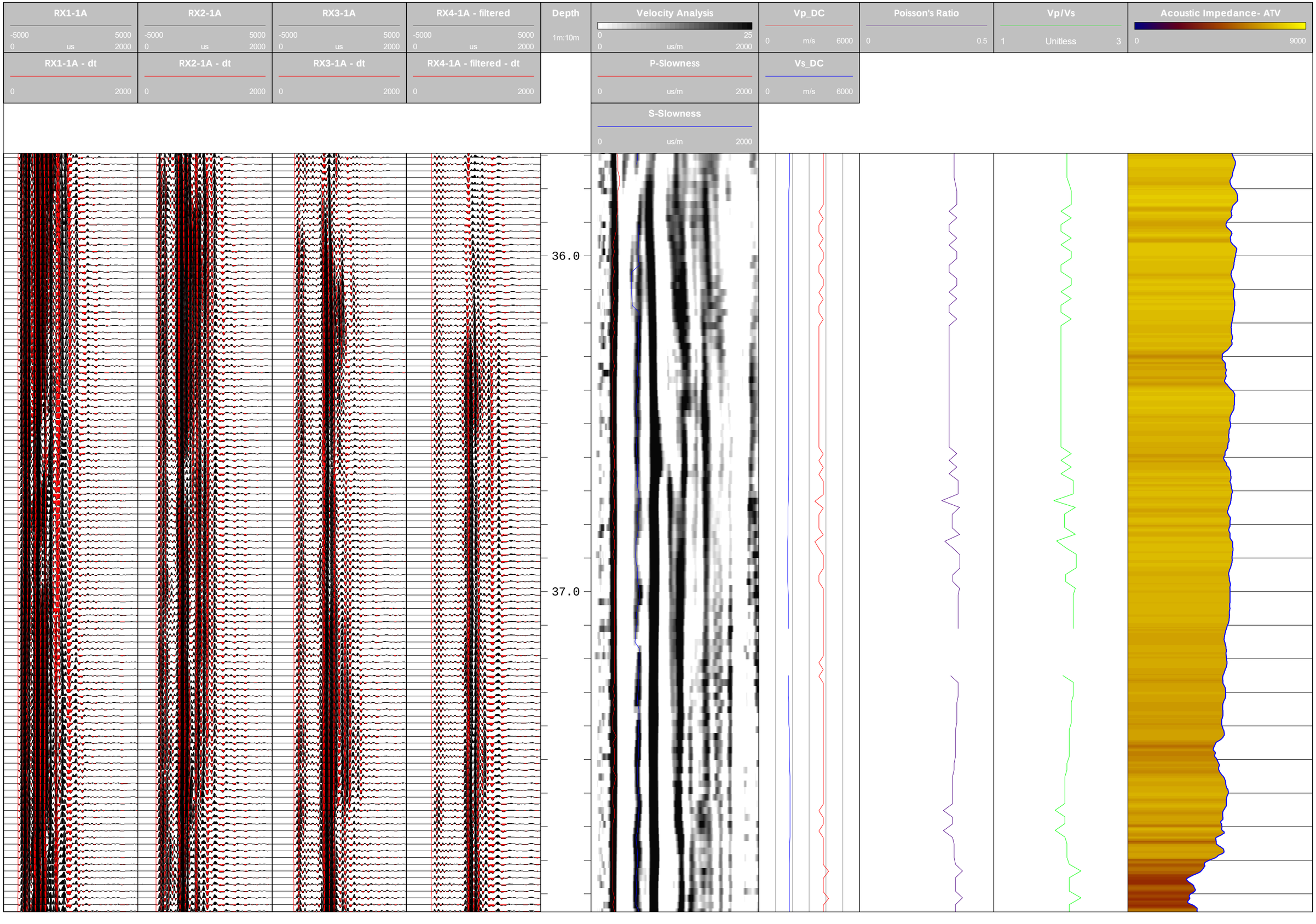


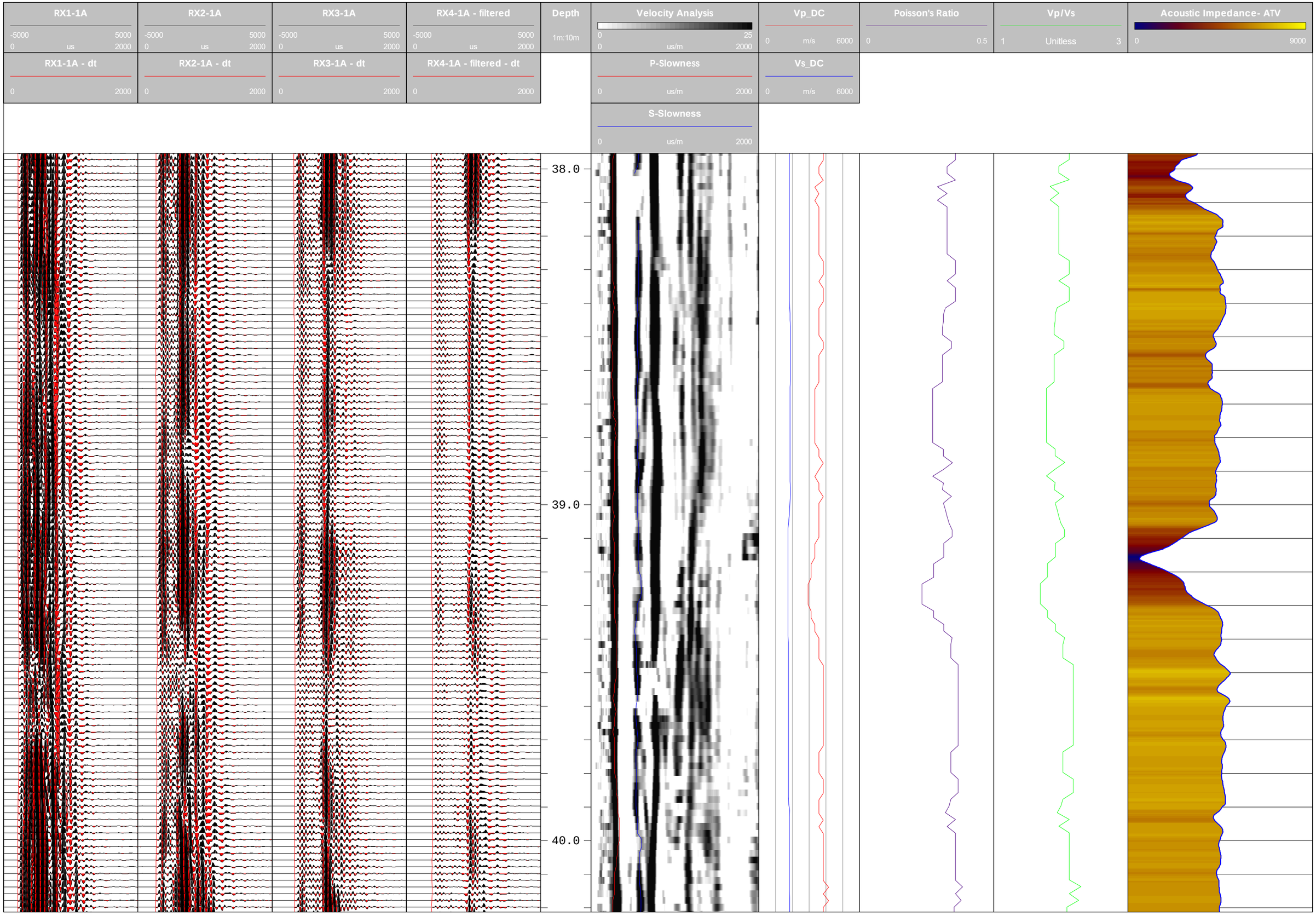
RX1-1A	RX2-1A	RX3-1A	RX4-1A - filtered	Depth	Velocity Analysis	Vp_DC	Poisson's Ratio	Vp/Vs	Acoustic Impedance- ATV
-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	1m:10m	0 25 0 us/m 2000	0 m/s 6000	0 0.5	1 Unitless 3	0 9000
RX1-1A - dt	RX2-1A - dt	RX3-1A - dt	RX4-1A - filtered - dt		P-Slowness	Vs_DC			
0 2000	0 2000	0 2000	0 2000		0 us/m 2000	0 m/s 6000			
					S-Slowness				
					0 us/m 2000				



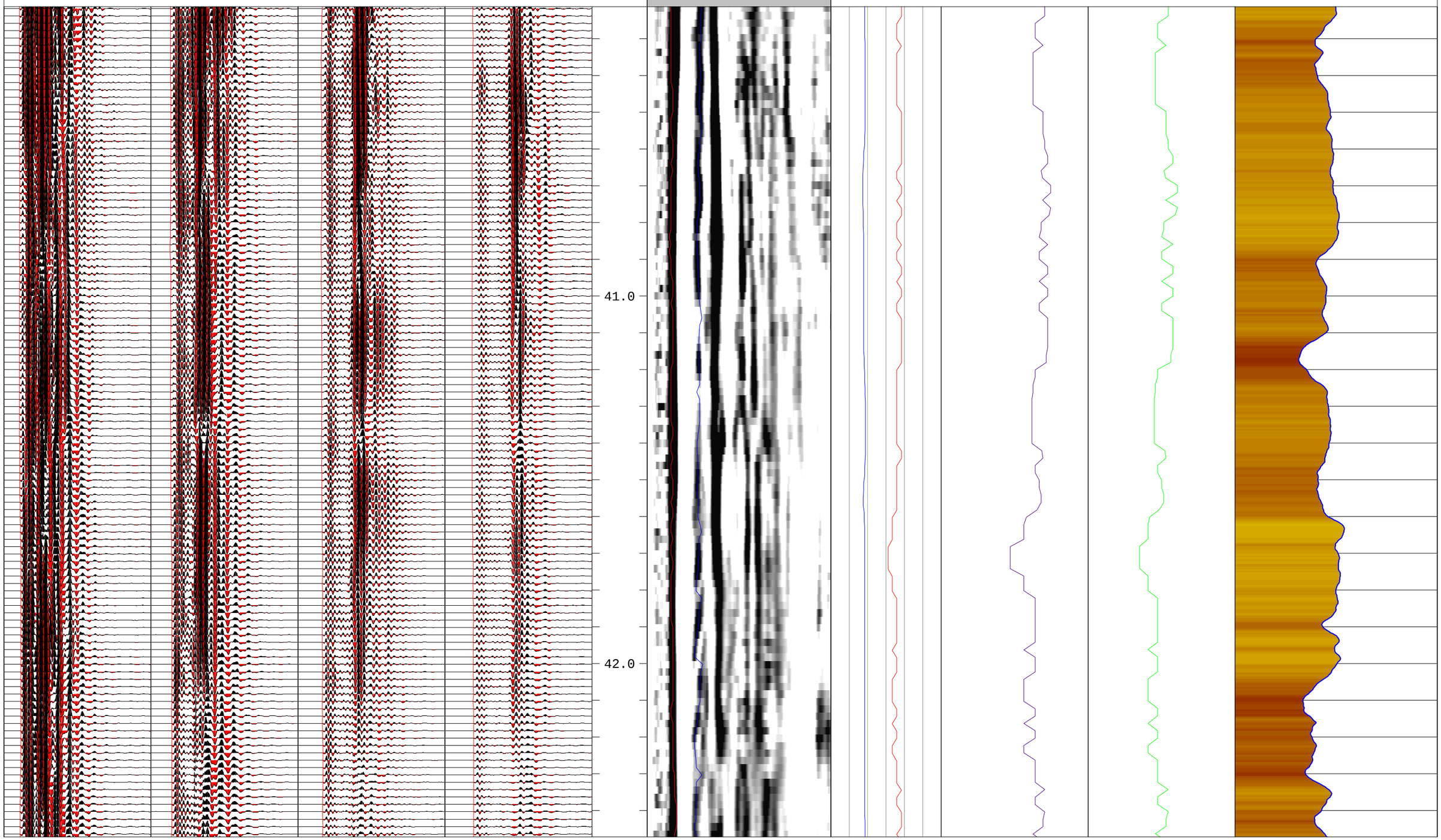
RX1-1A	RX2-1A	RX3-1A	RX4-1A - filtered	Depth	Velocity Analysis	Vp_DC	Poisson's Ratio	Vp/Vs	Acoustic Impedance- ATV
-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	1m:10m	0 25 0 us/m 2000	0 m/s 6000	0 0.5	1 Unitless 3	0 9000
RX1-1A - dt	RX2-1A - dt	RX3-1A - dt	RX4-1A - filtered - dt		P-Slowness	Vs_DC			
0 2000	0 2000	0 2000	0 2000		0 us/m 2000	0 m/s 6000			
					S-Slowness				
					0 us/m 2000				



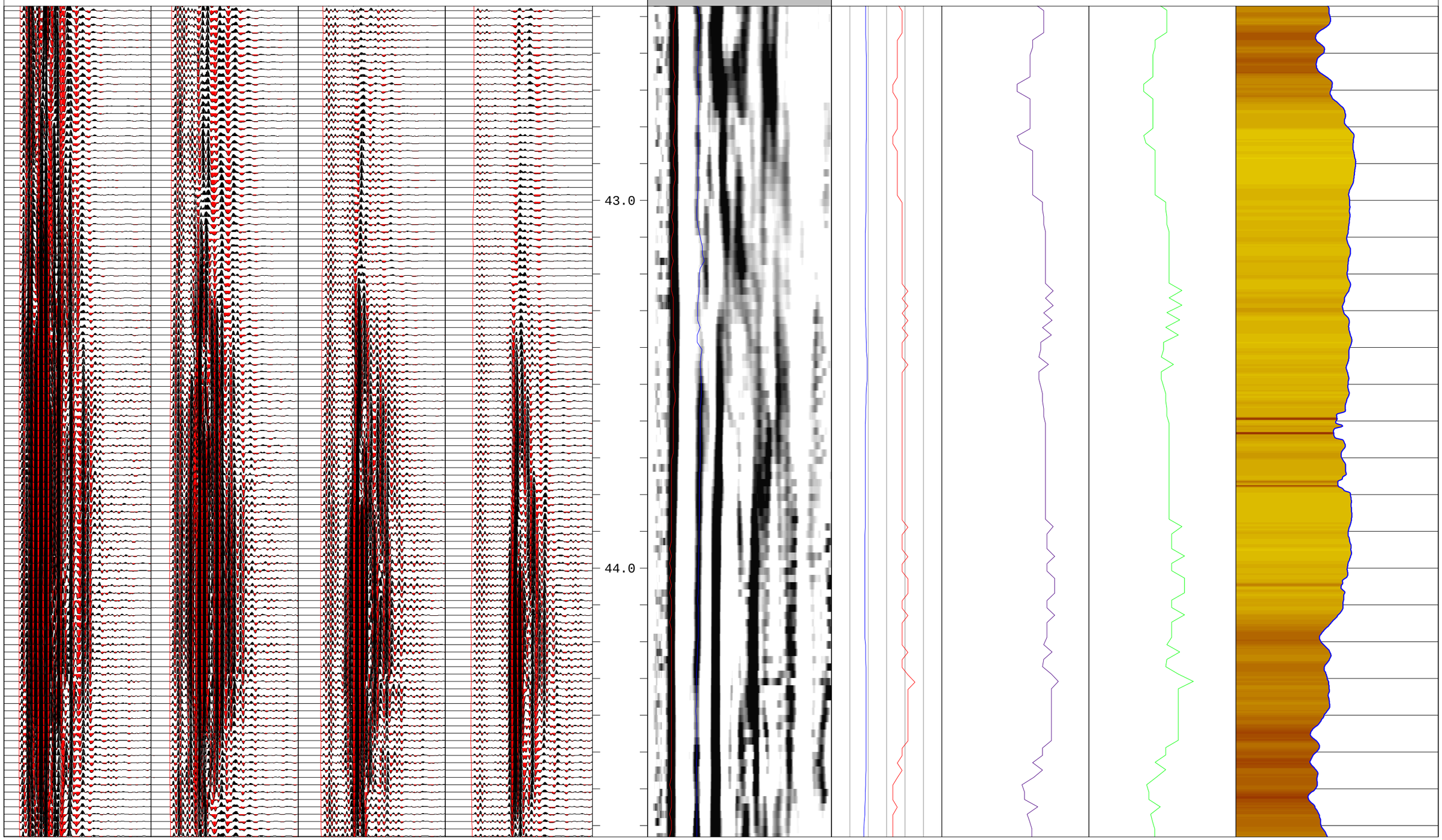

RX1-1A
-5000
5000
0
us
2000
RX2-1A
-5000
5000
0
us
2000
RX3-1A
-5000
5000
0
us
2000
RX4-1A - filtered
-5000
5000
0
us
2000
Depth
1m:10m
Velocity Analysis
0
25
0
us/m
2000
Vp_DC
0
m/s
6000
Poisson's Ratio
0
0.5
Vp/Vs
1
Unitless
3
Acoustic Impedance- ATV
0
9000
RX1-1A - dt
0
2000
RX2-1A - dt
0
2000
RX3-1A - dt
0
2000
RX4-1A - filtered - dt
0
2000
P-Slowness
0
us/m
2000
Vs_DC
0
m/s
6000
S-Slowness
0
us/m
2000
36.0
37.0


RX1-1A
-5000
5000
0
us
2000
RX2-1A
-5000
5000
0
us
2000
RX3-1A
-5000
5000
0
us
2000
RX4-1A - filtered
-5000
5000
0
us
2000
Depth
1m:10m
Velocity Analysis
0
25
0
us/m
2000
Vp_DC
0
m/s
6000
Poisson's Ratio
0
0.5
Vp/Vs
1
Unitless
3
Acoustic Impedance- ATV
0
9000
RX1-1A - dt
0
2000
RX2-1A - dt
0
2000
RX3-1A - dt
0
2000
RX4-1A - filtered - dt
0
2000
P-Slowness
0
us/m
2000
Vs_DC
0
m/s
6000
S-Slowness
0
us/m
2000
38.0
39.0
40.0

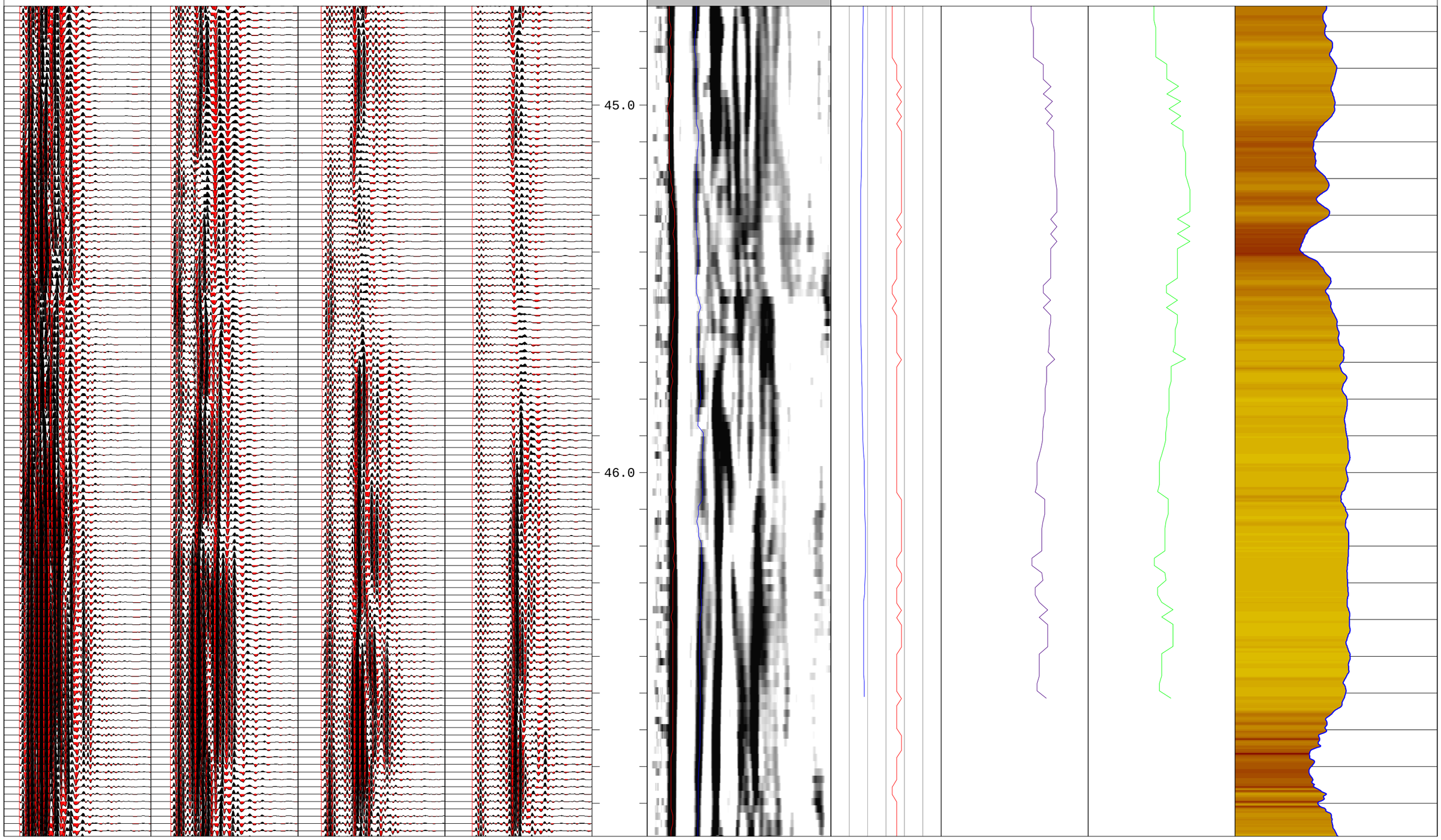
RX1-1A	RX2-1A	RX3-1A	RX4-1A - filtered	Depth	Velocity Analysis	Vp_DC	Poisson's Ratio	Vp/Vs	Acoustic Impedance- ATV
-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	1m:10m	0 25 0 us/m 2000	0 m/s 6000	0 0.5	1 Unitless 3	0 9000
RX1-1A - dt	RX2-1A - dt	RX3-1A - dt	RX4-1A - filtered - dt		P-Slowness	Vs_DC			
0 2000	0 2000	0 2000	0 2000		0 us/m 2000	0 m/s 6000			
					S-Slowness				
					0 us/m 2000				



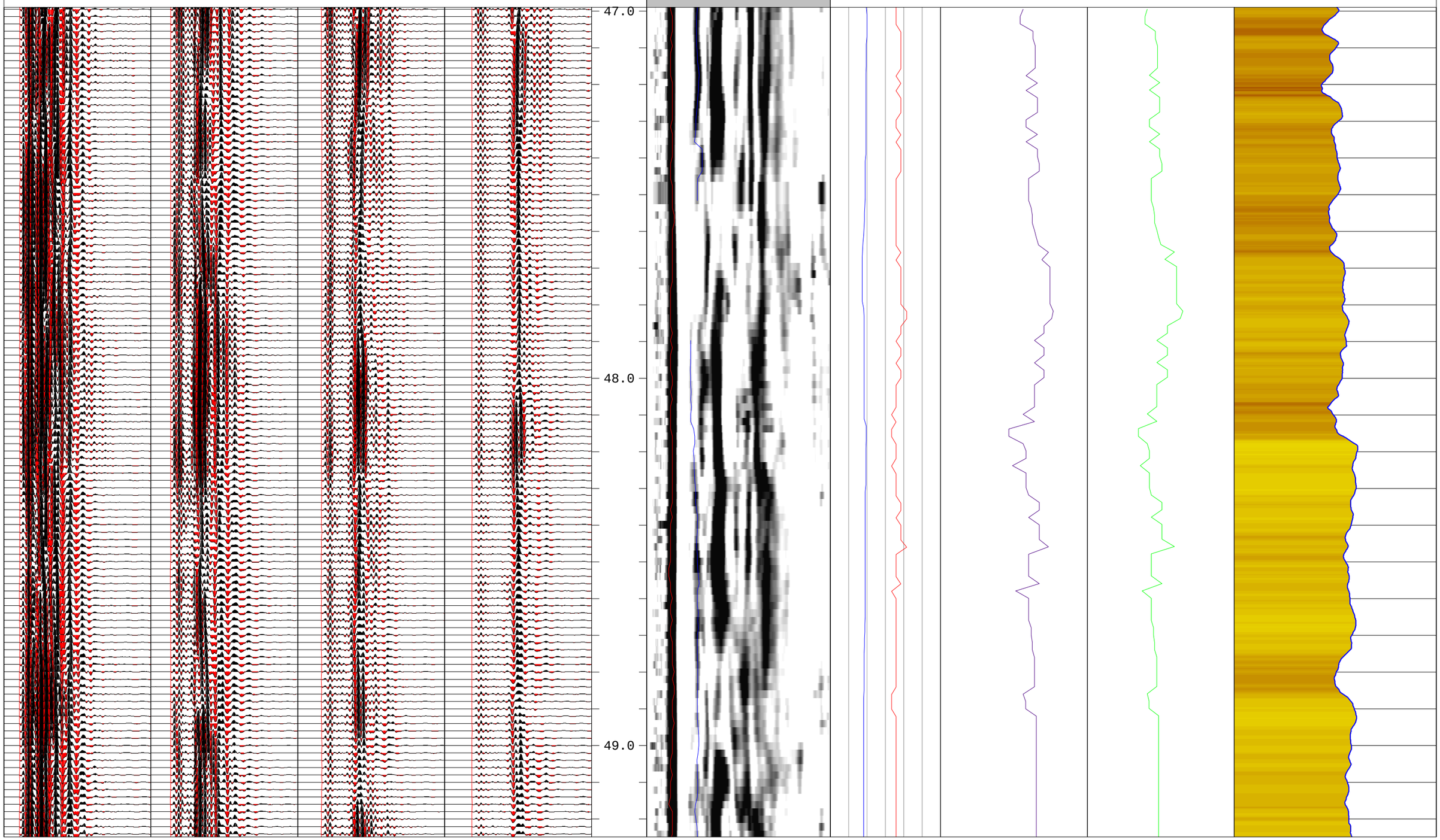
RX1-1A	RX2-1A	RX3-1A	RX4-1A - filtered	Depth	Velocity Analysis	Vp_DC	Poisson's Ratio	Vp/Vs	Acoustic Impedance- ATV
-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	1m:10m	0 25 0 us/m 2000	0 m/s 6000	0 0.5	1 Unitless 3	0 9000
RX1-1A - dt	RX2-1A - dt	RX3-1A - dt	RX4-1A - filtered - dt		P-Slowness	Vs_DC			
0 2000	0 2000	0 2000	0 2000		0 us/m 2000	0 m/s 6000			
					S-Slowness				
					0 us/m 2000				



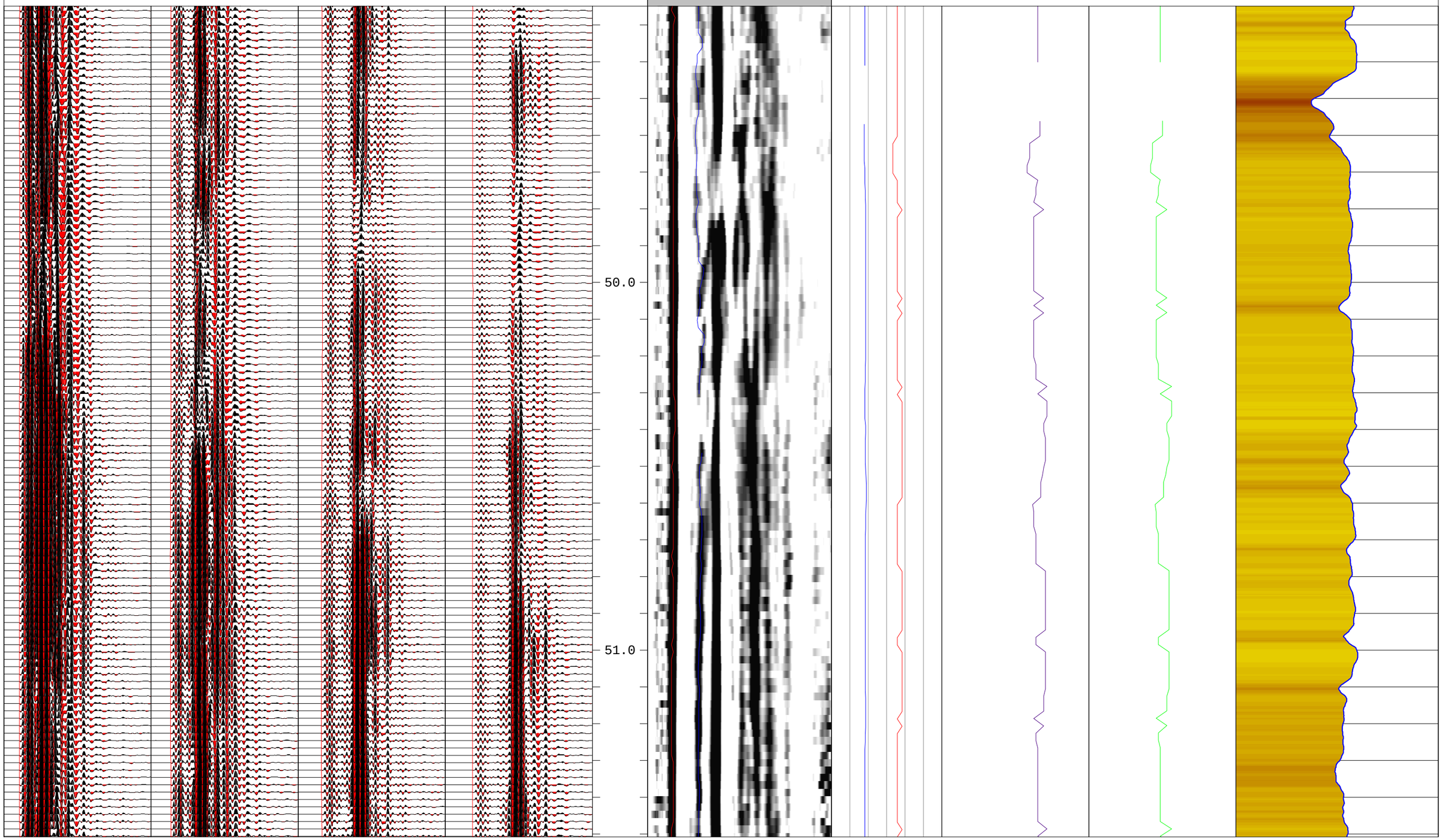
RX1-1A	RX2-1A	RX3-1A	RX4-1A - filtered	Depth	Velocity Analysis	Vp_DC	Poisson's Ratio	Vp/Vs	Acoustic Impedance- ATV
-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	1m:10m	0 25 0 us/m 2000	0 m/s 6000	0 0.5	1 Unitless 3	0 9000
RX1-1A - dt	RX2-1A - dt	RX3-1A - dt	RX4-1A - filtered - dt		P-Slowness	Vs_DC			
0 2000	0 2000	0 2000	0 2000		0 us/m 2000	0 m/s 6000			
					S-Slowness				
					0 us/m 2000				



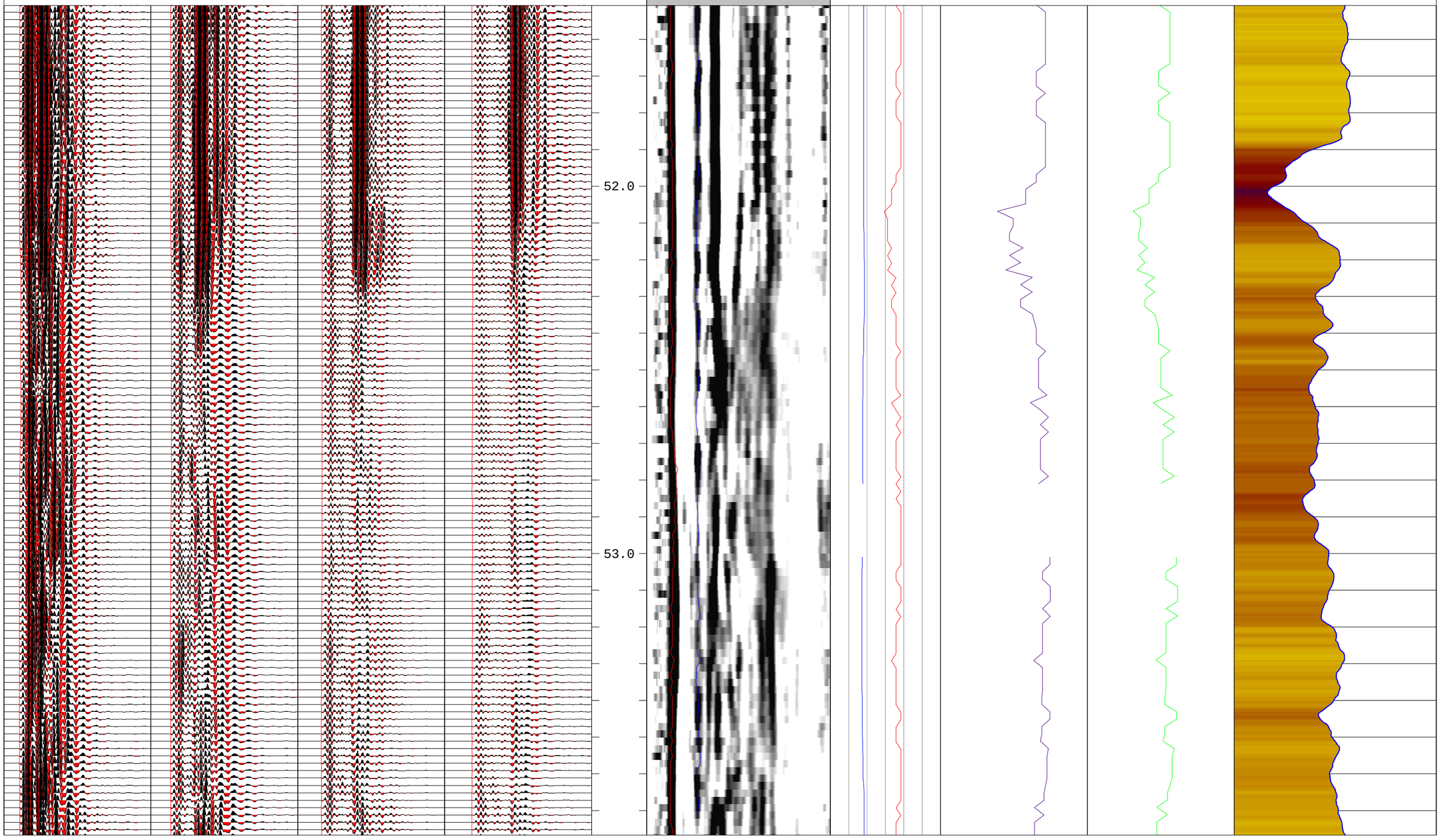
RX1-1A	RX2-1A	RX3-1A	RX4-1A - filtered	Depth	Velocity Analysis	Vp_DC	Poisson's Ratio	Vp/Vs	Acoustic Impedance- ATV
-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	1m:10m	0 25 0 us/m 2000	0 m/s 6000	0 0.5	1 Unitless 3	0 9000
RX1-1A - dt	RX2-1A - dt	RX3-1A - dt	RX4-1A - filtered - dt		P-Slowness	Vs_DC			
0 2000	0 2000	0 2000	0 2000		0 us/m 2000	0 m/s 6000			
					S-Slowness				
					0 us/m 2000				



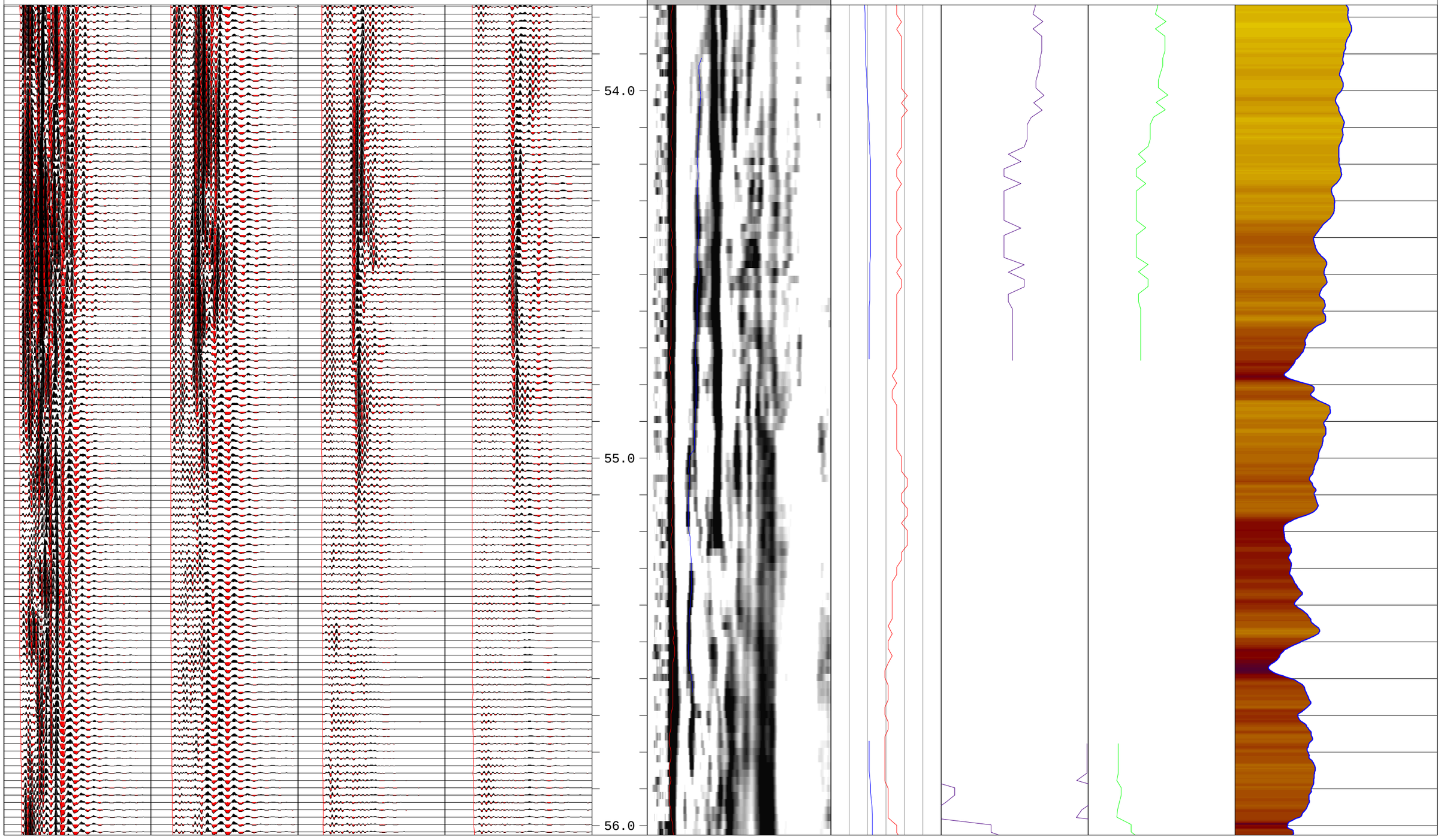
RX1-1A	RX2-1A	RX3-1A	RX4-1A - filtered	Depth	Velocity Analysis	Vp_DC	Poisson's Ratio	Vp/Vs	Acoustic Impedance- ATV
-5000 5000	-5000 5000	-5000 5000	-5000 5000	1m:10m	0 25	0 6000	0 0.5	1 3	0 9000
0 us 2000	0 us 2000	0 us 2000	0 us 2000		0 us/m 2000	m/s		Unitless	
RX1-1A - dt	RX2-1A - dt	RX3-1A - dt	RX4-1A - filtered - dt		P-Slowness	Vs_DC			
0 2000	0 2000	0 2000	0 2000		0 us/m 2000	0 6000			
					S-Slowness				
					0 us/m 2000				



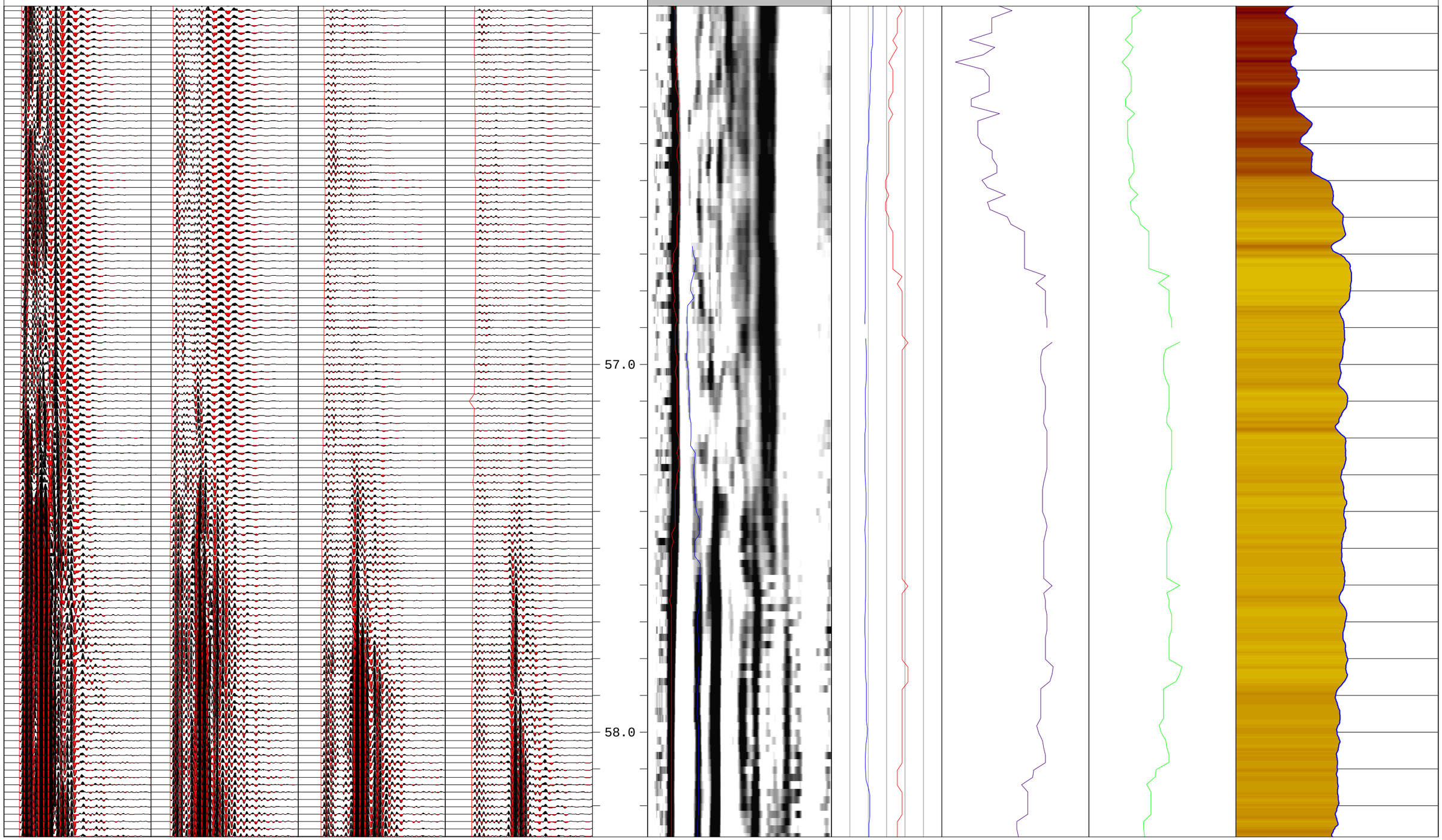
RX1-1A	RX2-1A	RX3-1A	RX4-1A - filtered	Depth	Velocity Analysis	Vp_DC	Poisson's Ratio	Vp/Vs	Acoustic Impedance- ATV
-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	1m:10m	0 25 0 us/m 2000	0 m/s 6000	0 0.5	1 Unitless 3	0 9000
RX1-1A - dt	RX2-1A - dt	RX3-1A - dt	RX4-1A - filtered - dt		P-Slowness	Vs_DC			
0 2000	0 2000	0 2000	0 2000		0 us/m 2000	0 m/s 6000			
					S-Slowness				
					0 us/m 2000				



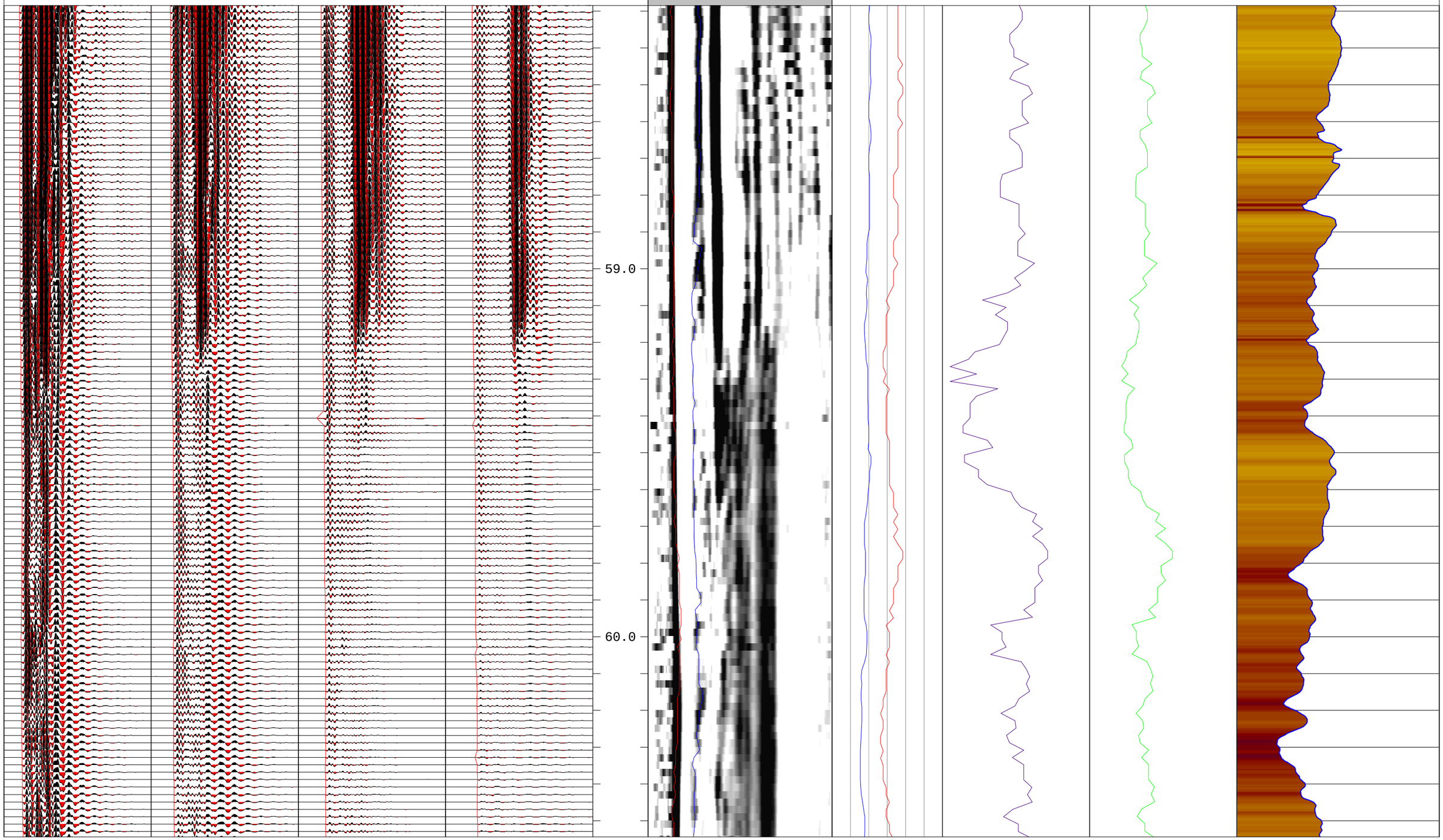
RX1-1A	RX2-1A	RX3-1A	RX4-1A - filtered	Depth	Velocity Analysis	Vp_DC	Poisson's Ratio	Vp/Vs	Acoustic Impedance- ATV
-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	1m:10m	0 25 0 us/m 2000	0 m/s 6000	0 0.5	1 Unitless 3	0 9000
RX1-1A - dt	RX2-1A - dt	RX3-1A - dt	RX4-1A - filtered - dt		P-Slowness	Vs_DC			
0 2000	0 2000	0 2000	0 2000		0 us/m 2000	0 m/s 6000			
					S-Slowness				
					0 us/m 2000				



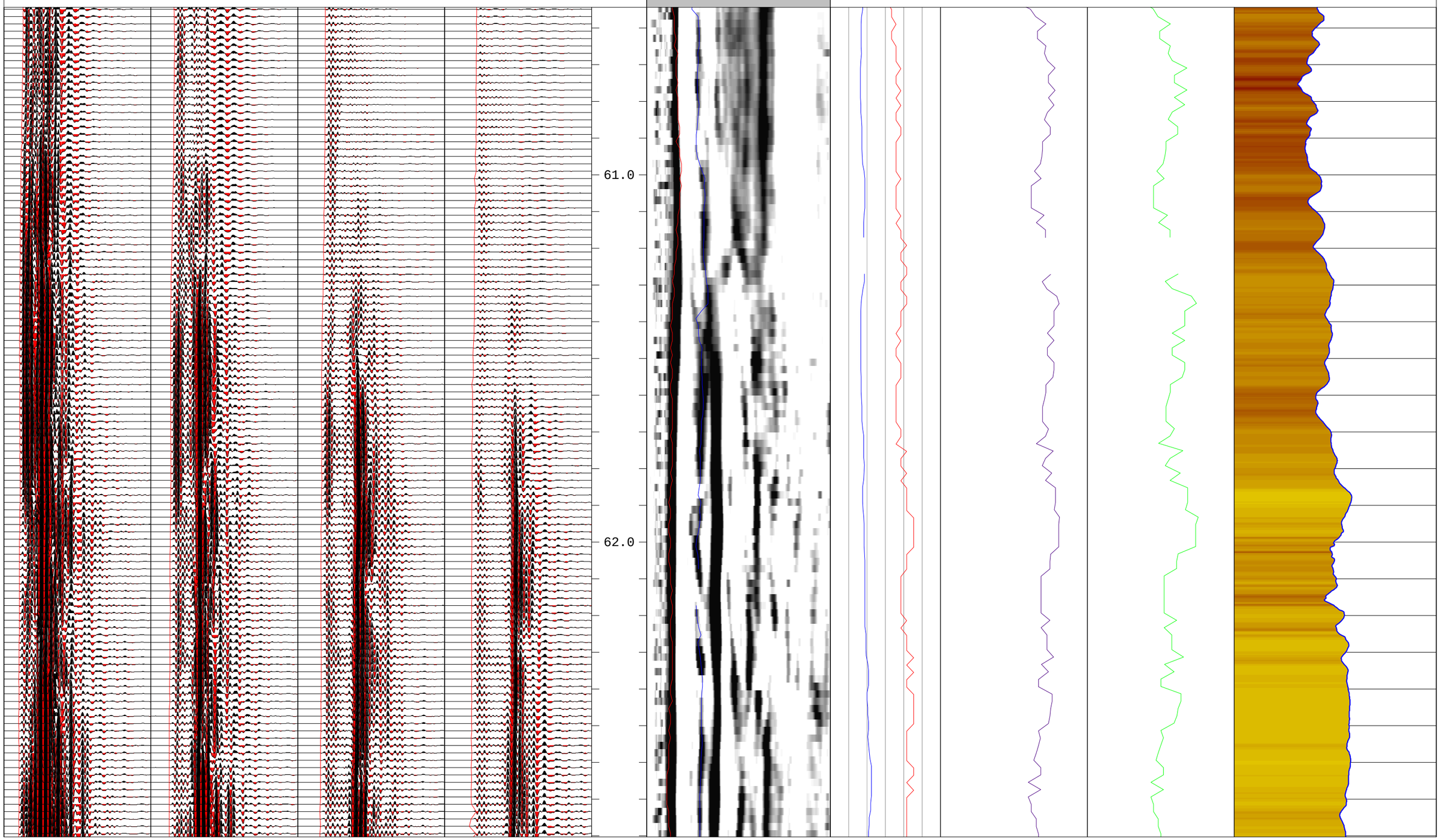
RX1-1A	RX2-1A	RX3-1A	RX4-1A - filtered	Depth	Velocity Analysis	Vp_DC	Poisson's Ratio	Vp/Vs	Acoustic Impedance- ATV
-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	1m:10m	0 25 0 us/m 2000	0 m/s 6000	0 0.5	1 Unitless 3	0 9000
RX1-1A - dt	RX2-1A - dt	RX3-1A - dt	RX4-1A - filtered - dt		P-Slowness	Vs_DC			
0 2000	0 2000	0 2000	0 2000		0 us/m 2000	0 m/s 6000			
					S-Slowness				
					0 us/m 2000				



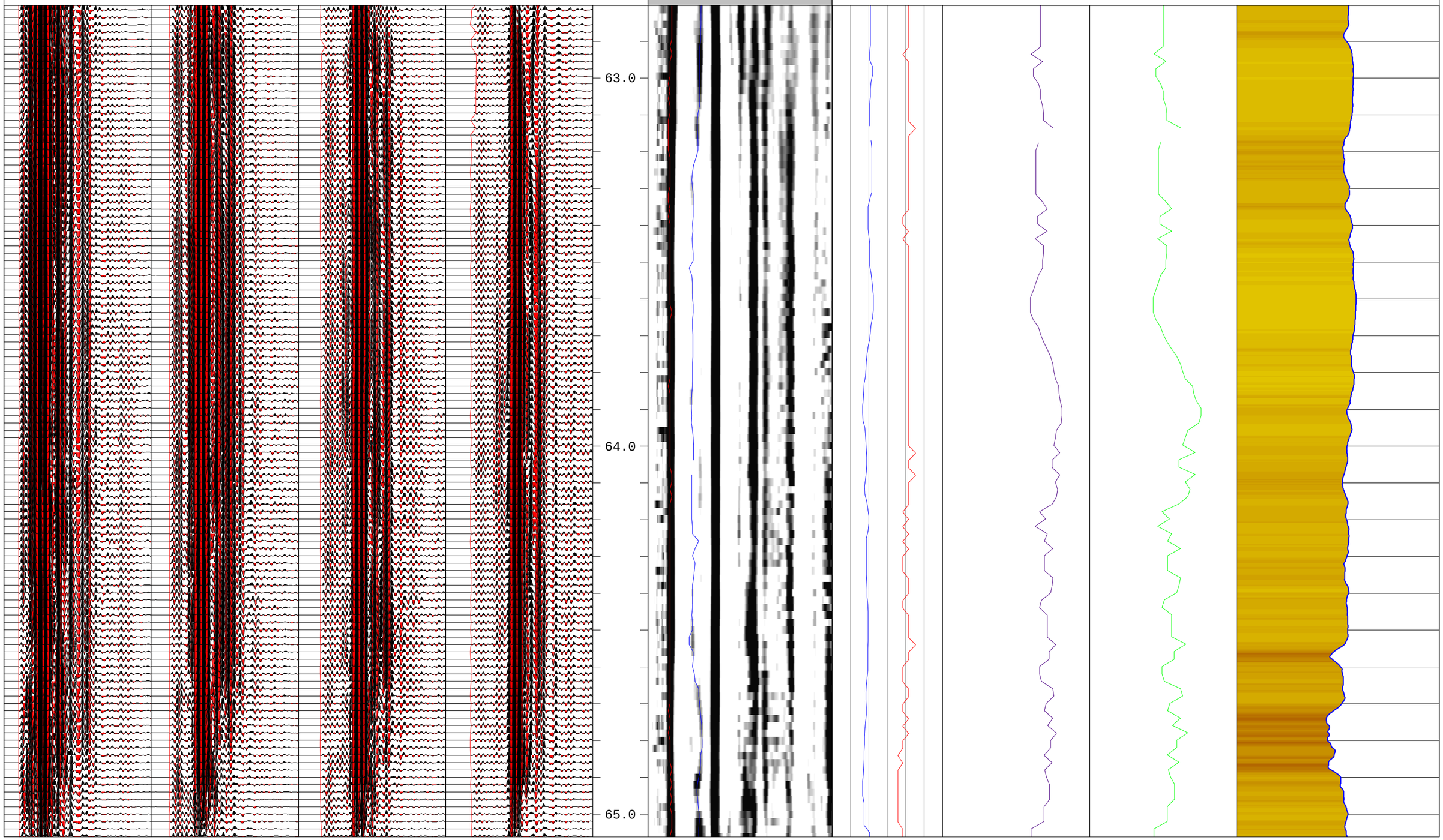
RX1-1A	RX2-1A	RX3-1A	RX4-1A - filtered	Depth	Velocity Analysis	Vp_DC	Poisson's Ratio	Vp/Vs	Acoustic Impedance- ATV
-5000 5000	-5000 5000	-5000 5000	-5000 5000	1m:10m	0 25	0 6000	0 0.5	1 3	0 9000
0 us 2000	0 us 2000	0 us 2000	0 us 2000		0 us/m 2000	m/s		Unitless	
RX1-1A - dt	RX2-1A - dt	RX3-1A - dt	RX4-1A - filtered - dt		P-Slowness	Vs_DC			
0 2000	0 2000	0 2000	0 2000		0 us/m 2000	0 m/s 6000			
					S-Slowness				
					0 us/m 2000				



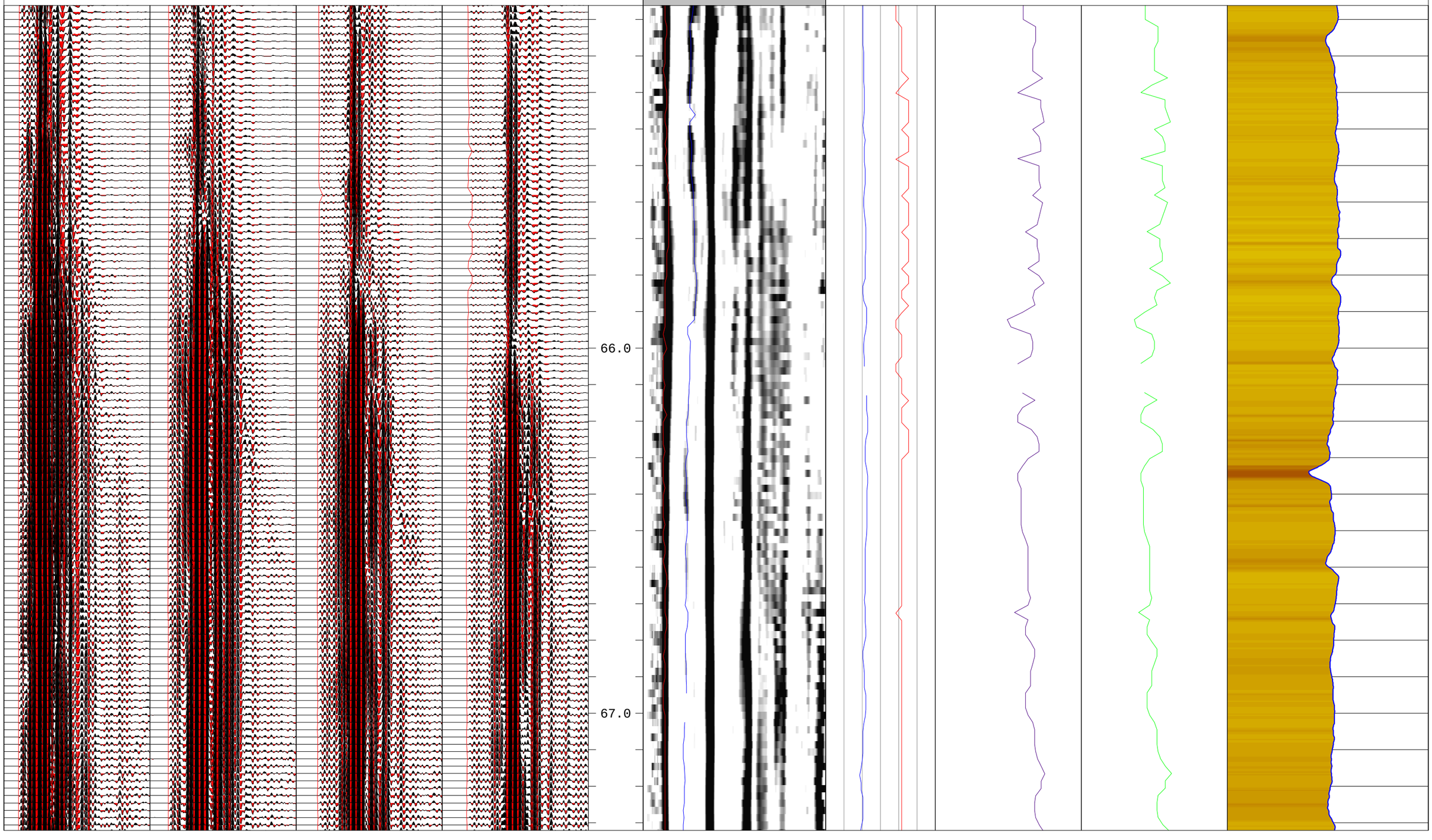
RX1-1A	RX2-1A	RX3-1A	RX4-1A - filtered	Depth	Velocity Analysis	Vp_DC	Poisson's Ratio	Vp/Vs	Acoustic Impedance- ATV
-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	1m:10m	0 25 0 us/m 2000	0 m/s 6000	0 0.5	1 Unitless 3	0 9000
RX1-1A - dt	RX2-1A - dt	RX3-1A - dt	RX4-1A - filtered - dt		P-Slowness	Vs_DC			
0 2000	0 2000	0 2000	0 2000		0 us/m 2000	0 m/s 6000			
					S-Slowness				
					0 us/m 2000				

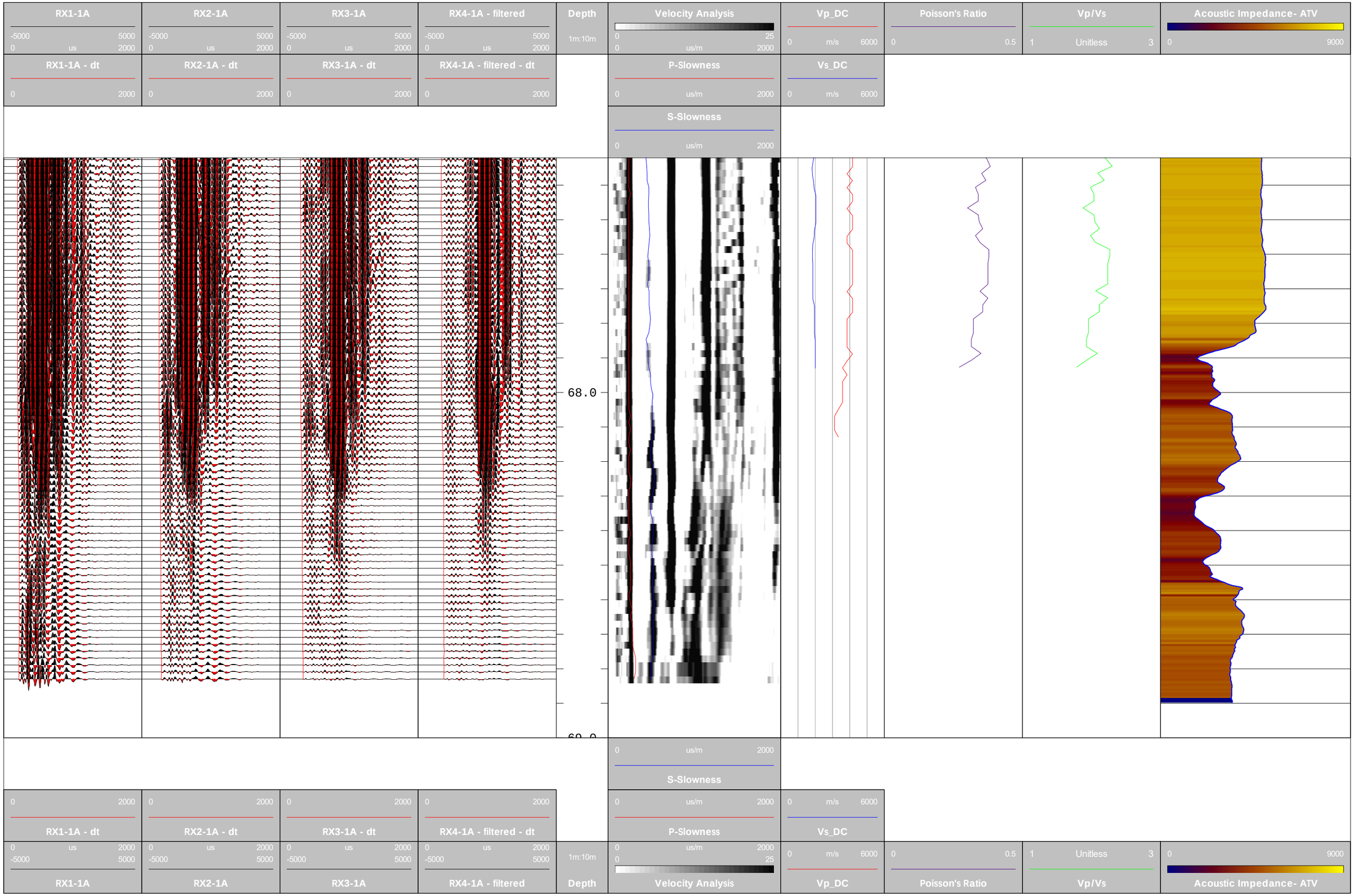


RX1-1A	RX2-1A	RX3-1A	RX4-1A - filtered	Depth	Velocity Analysis	Vp_DC	Poisson's Ratio	Vp/Vs	Acoustic Impedance- ATV
-5000 5000	-5000 5000	-5000 5000	-5000 5000	1m:10m	0 25	0 6000	0 0.5	1 3	0 9000
0 us 2000	0 us 2000	0 us 2000	0 us 2000		0 us/m 2000	m/s		Unitless	
RX1-1A - dt	RX2-1A - dt	RX3-1A - dt	RX4-1A - filtered - dt		P-Slowness	Vs_DC			
0 2000	0 2000	0 2000	0 2000		0 us/m 2000	0 6000			
					S-Slowness				
					0 us/m 2000				



RX1-1A	RX2-1A	RX3-1A	RX4-1A - filtered	Depth	Velocity Analysis	Vp_DC	Poisson's Ratio	Vp/Vs	Acoustic Impedance- ATV
-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	1m:10m	0 25 0 us/m 2000	0 m/s 6000	0 0.5	1 Unitless 3	0 9000
RX1-1A - dt	RX2-1A - dt	RX3-1A - dt	RX4-1A - filtered - dt		P-Slowness	Vs_DC			
0 2000	0 2000	0 2000	0 2000		0 us/m 2000	0 m/s 6000			
					S-Slowness				
					0 us/m 2000				




RX1-1A
-5000 5000
0 us 2000
RX2-1A
-5000 5000
0 us 2000
RX3-1A
-5000 5000
0 us 2000
RX4-1A - filtered
-5000 5000
0 us 2000
Depth
1m:10m
Velocity Analysis
0 25
0 us/m 2000
Vp_DC
0 m/s 6000
Poisson's Ratio
0 0.5
Vp/Vs
1 Unitless 3
Acoustic Impedance- ATV
0 9000
RX1-1A - dt
0 2000
RX2-1A - dt
0 2000
RX3-1A - dt
0 2000
RX4-1A - filtered - dt
0 2000
P-Slowness
0 us/m 2000
Vs_DC
0 m/s 6000
S-Slowness
0 us/m 2000
68.0
60.0
0 us/m 2000
S-Slowness
0 2000
RX1-1A - dt
0 2000
RX2-1A - dt
0 2000
RX3-1A - dt
0 2000
RX4-1A - filtered - dt
0 us/m 2000
P-Slowness
0 m/s 6000
Vs_DC
0 us 2000
-5000 5000
RX1-1A
0 us 2000
-5000 5000
RX2-1A
0 us 2000
-5000 5000
RX3-1A
0 us 2000
-5000 5000
RX4-1A - filtered
1m:10m
Depth
0 us/m 2000
0 25
Velocity Analysis
0 m/s 6000
Vp_DC
0 0.5
Poisson's Ratio
1 Unitless 3
Vp/Vs
0 9000
Acoustic Impedance- ATV

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New Zealand

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Fax: +64 6 8775015
Email: info@rdcl.co.nz
www.rdcl.co.nz

Basic Information:

Drill hole ID:	BH103
Client:	CW Drill
Run Number(s):	2, 4, 5 & 7
Tool Type(s):	ABI40-2G-VLB Acoustic Televiewer OBI40-2G Optical Televiewer QL40-CAL Mechanical Calliper
Service Company:	RDCL
Operator:	O Gibson
Date Logged:	01/09/2020
Field:	Awatere Valley
State / Province:	Marlborough
Country:	New Zealand

Location Description:

3.34 km south west of Awapiri, above the Awatere Valley Road, Malborough.

Drillhole Information:

Log interval from (m):	1.05	Log interval to (m):	49.41
Depth Driller (m):	50.00	Depth Logger (m):	49.41 (Acoustic)
Fluid Type:	Water	Fluid Level (m):	13.30 (Acoustic)
Easting:	173.709719	Northing:	-41.857479
Elevation:	Unknown	Coord Ref System:	WGS84
Hole Azimuth:	288-359° (Magnetic)	Hole Inclination:	-87.9°
Magnetic Declination:	+22° 59' East	Magnetic Inclination:	66° 58'
Drill Company:	CW Drill		

Printing Information:

Depth Unit:	Metres	Log Scale:	1:10	Log Version:	Final
Processed:	K Koria			Log Reviewer:	O Gibson

Bit Size Record:

Size (mm):	From (m):	To (m):
PQ (122.6)	0.00	50.00
##.#	##.#	##.#
##.#	##.#	##.#
##.#	##.#	##.#

Casing Record:

Type:	Size:	From (m):	To (m):
XX	##.#	##.#	##.#
XX	##.#	##.#	##.#
XX	##.#	##.#	##.#
XX	##.#	##.#	##.#

Comments:

1. Water becomes turbid at 27.16m, obscuring optical data.
2. Optical run stopped at 39.58m due to thick mud in sump of hole.
3. All data presented has been depth corrected.
4. Coordinates approximated from google earth.

Log Nomenclature:

Azimuth = Tool azimuth from magnetic north

Tilt = Inclination from vertical

Acoustic Calliper = 360° average from travel time

Calliper from Cent = Calliper derived from travel time

Image-NM = Optical image oriented to magnetic north

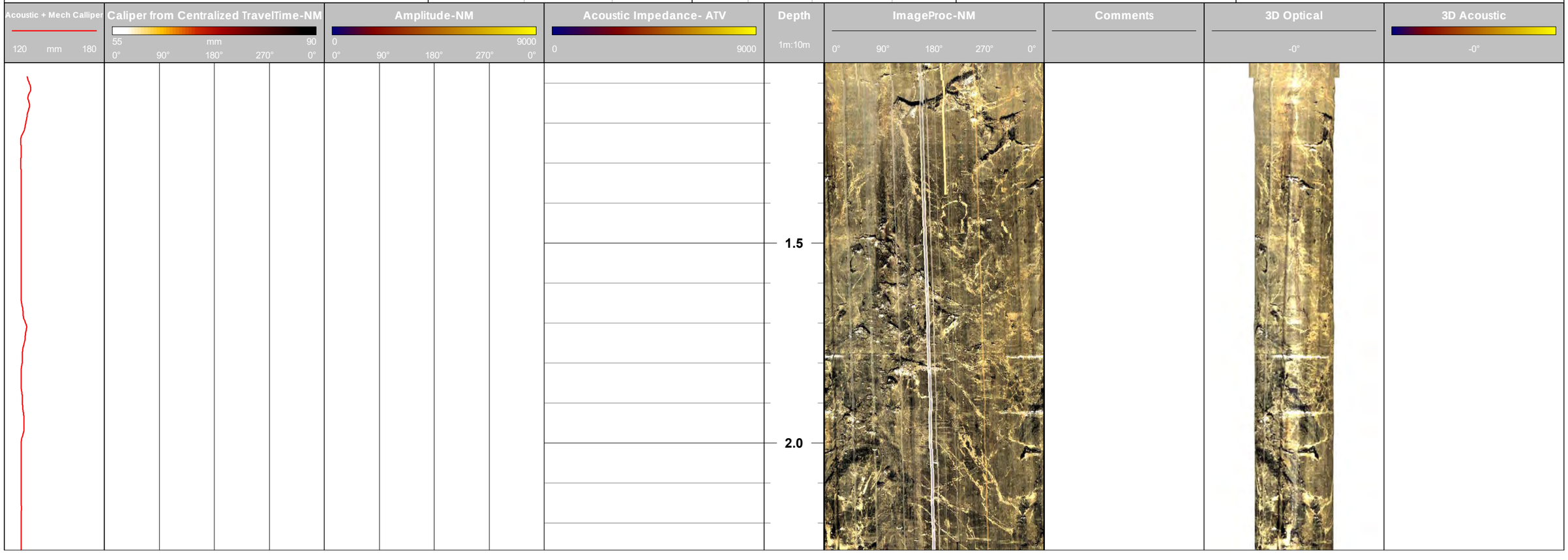
Amplitude-NM = Acoustic amplitude (magnetic north)

Structures = Apparent Structures oriented to hole

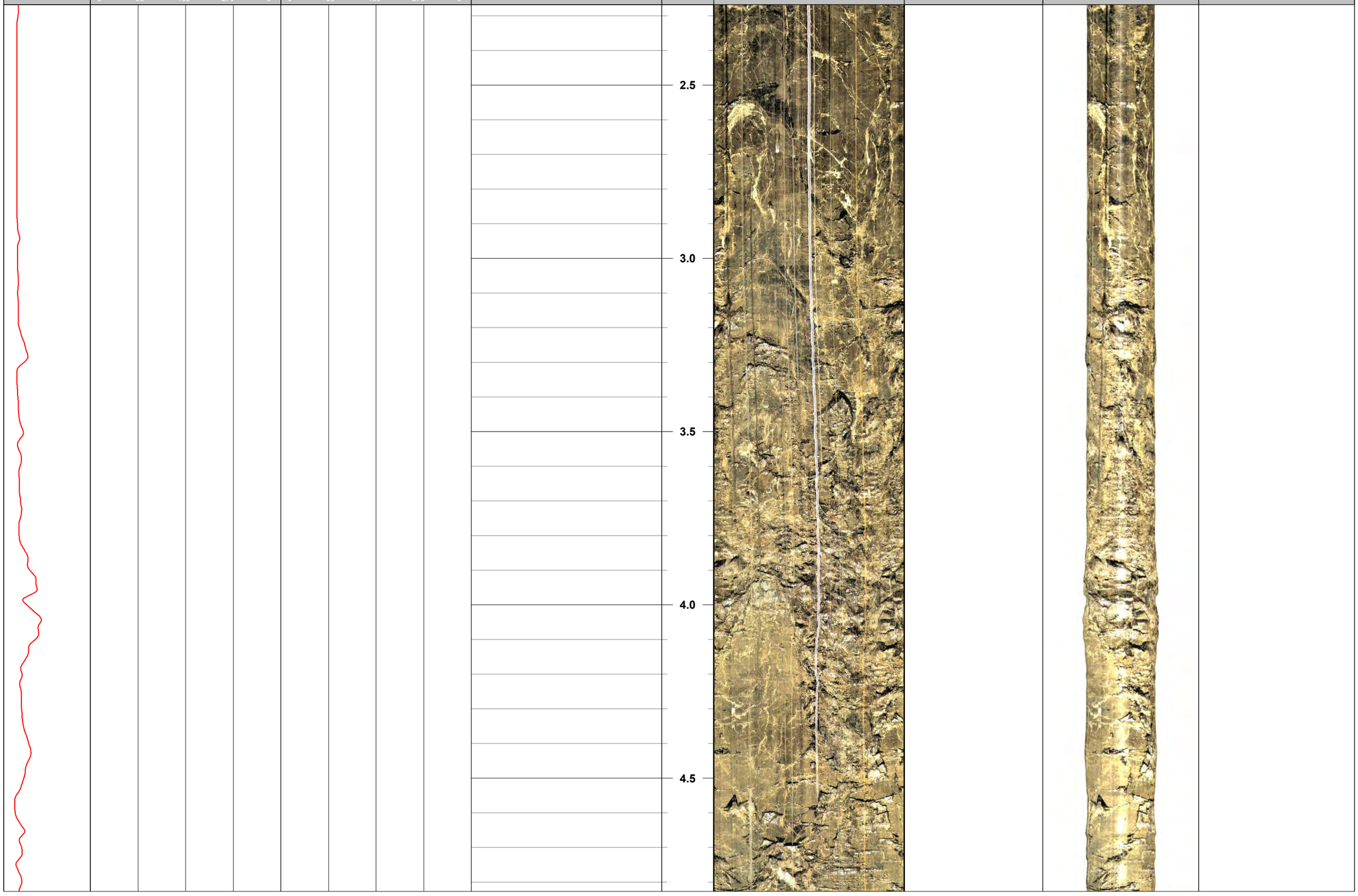
Structures - True =Structures Oriented to true north

3D Optical = 3D representation of optical log

3D Acoustic = 3D representation of acoustic log



Acoustic + Mech Calliper	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	ImageProc-NM	Comments	3D Optical	3D Acoustic
120 mm 180	55 mm 90 0° 90° 180° 270° 0°	0 9000 0° 90° 180° 270° 0°	0 9000	1m:10m	0° 90° 180° 270° 0°		-0°	-0°



Acoustic + Mech Calliper	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	ImageProc-NM	Comments	3D Optical	3D Acoustic
120 mm 180	55 mm 90 0° 90° 180° 270° 0°	0 9000 0° 90° 180° 270° 0°	0 9000	1m:10m	0° 90° 180° 270° 0°		-0°	-0°

5.0

5.5

6.0

6.5

7.0

Acoustic + Mech Calliper	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	ImageProc-NM	Comments	3D Optical	3D Acoustic
120 mm 180	55 mm 90 0° 90° 180° 270° 0°	0 9000 0° 90° 180° 270° 0°	0 9000	1m:10m	0° 90° 180° 270° 0°		-0°	-0°

7.5

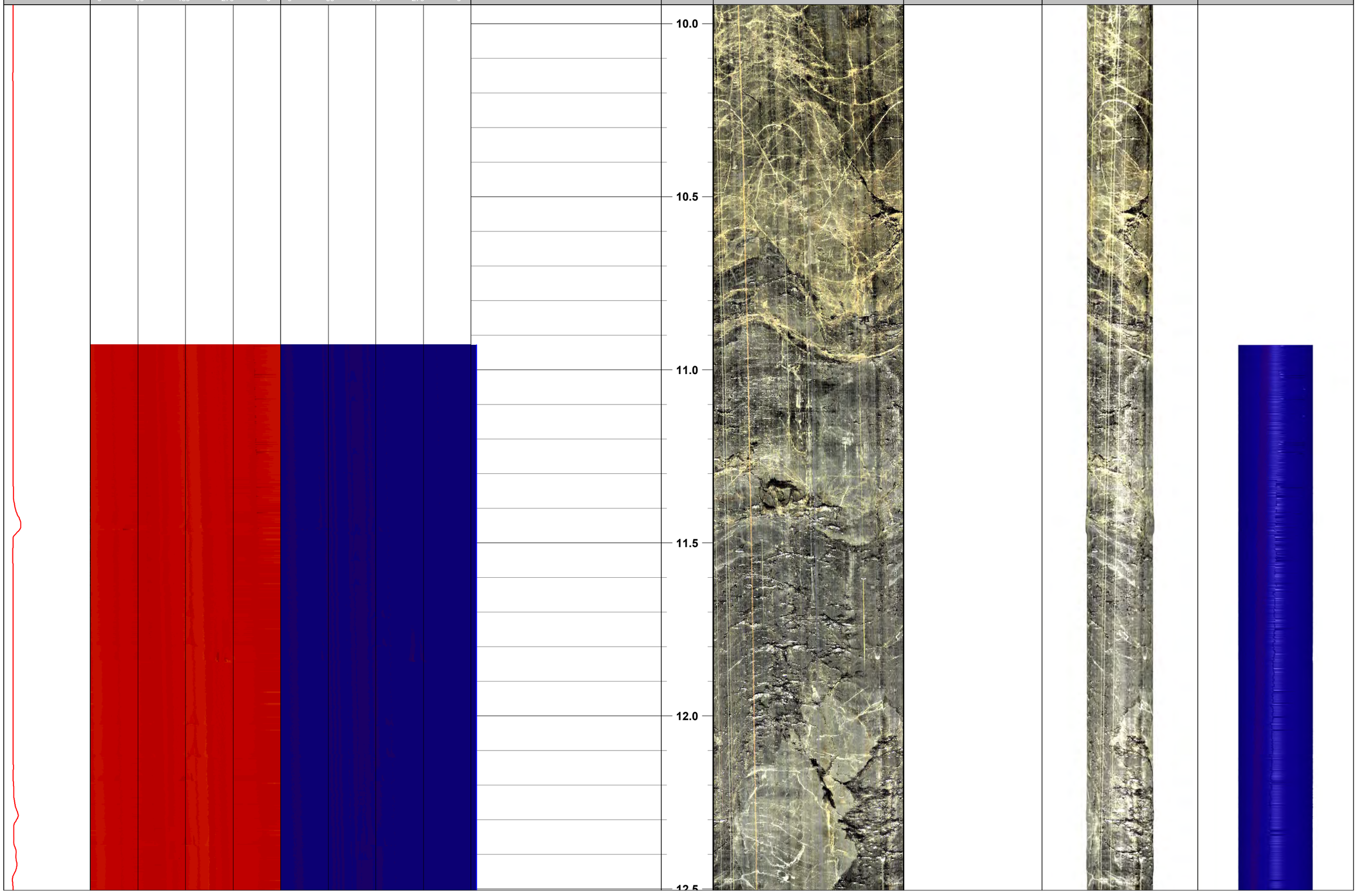
8.0

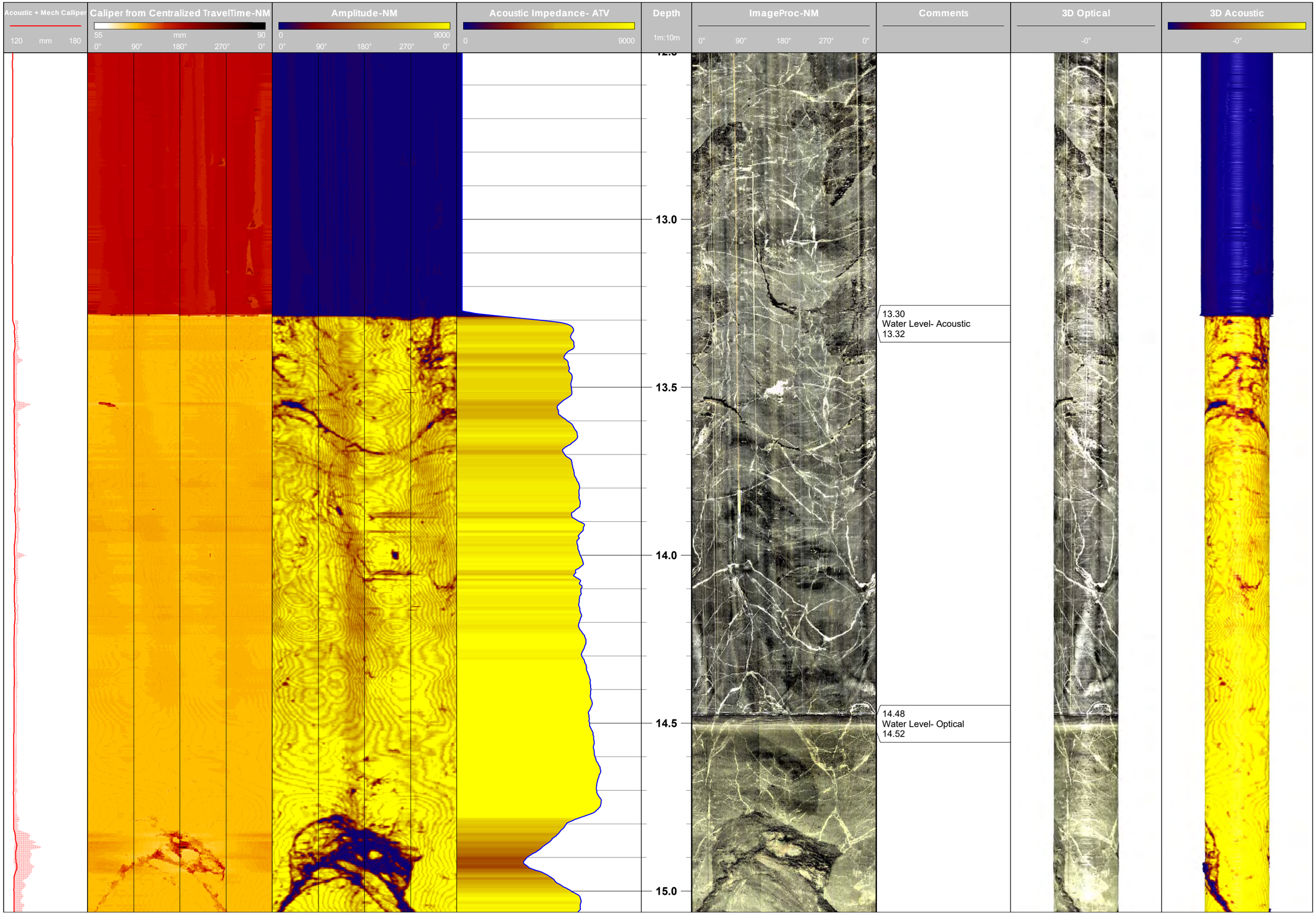
8.5

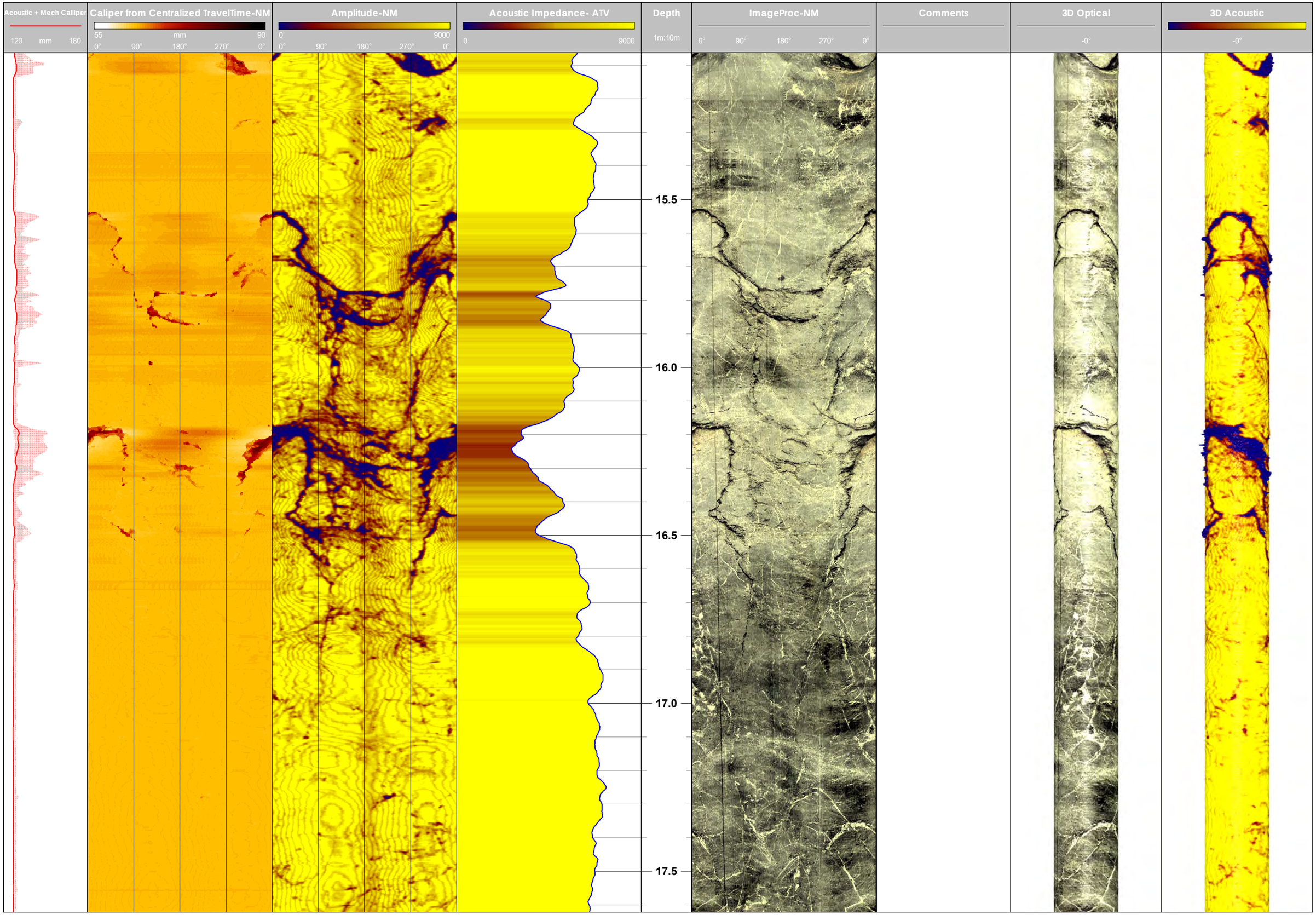
9.0

9.5

Acoustic + Mech Calliper	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	ImageProc-NM	Comments	3D Optical	3D Acoustic
120 mm 180	55 mm 90 0° 90° 180° 270° 0°	0 9000 0° 90° 180° 270° 0°	0 9000	1m:10m	0° 90° 180° 270° 0°		-0°	-0°




Acoustic + Mech Calliper
120 mm 180
Caliper from Centralized TravelTime-NM
55 mm 90
0° 90° 180° 270° 0°
Amplitude-NM
0 9000
0° 90° 180° 270° 0°
Acoustic Impedance- ATV
0 9000
Depth
1m:10m
13.0
13.5
14.0
14.5
15.0
ImageProc-NM
0° 90° 180° 270° 0°
Comments
13.30
Water Level- Acoustic
13.32
14.48
Water Level- Optical
14.52
3D Optical
-0°
3D Acoustic
-0°


Acoustic + Mech Calliper
120 mm 180
Caliper from Centralized TravelTime-NM
55 mm 90
0° 90° 180° 270° 0°
Amplitude-NM
0 9000
0° 90° 180° 270° 0°
Acoustic Impedance- ATV
0 9000
Depth
1m:10m
15.5
16.0
16.5
17.0
17.5
ImageProc-NM
0° 90° 180° 270° 0°
Comments
3D Optical
-0°
3D Acoustic
-0°

Acoustic + Mech Calliper

120 mm 180

Caliper from Centralized TravelTime-NM

55 mm 90

0° 90° 180° 270° 0°

Amplitude-NM

0 9000

0° 90° 180° 270° 0°

Acoustic Impedance- ATV

0 9000

Depth

1m:10m

18.0

18.5

19.0

19.5

20.0

ImageProc-NM

0° 90° 180° 270° 0°

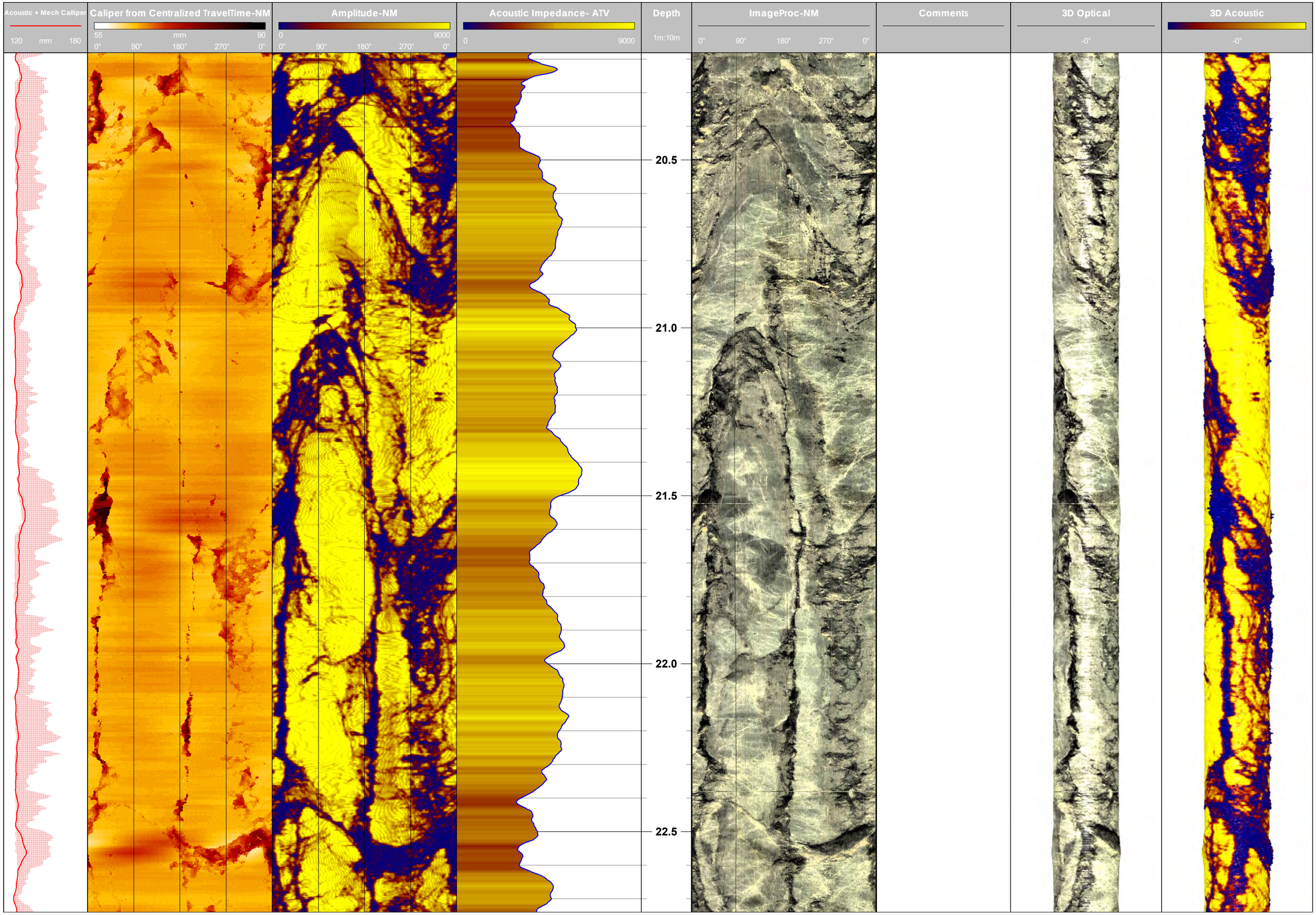
Comments

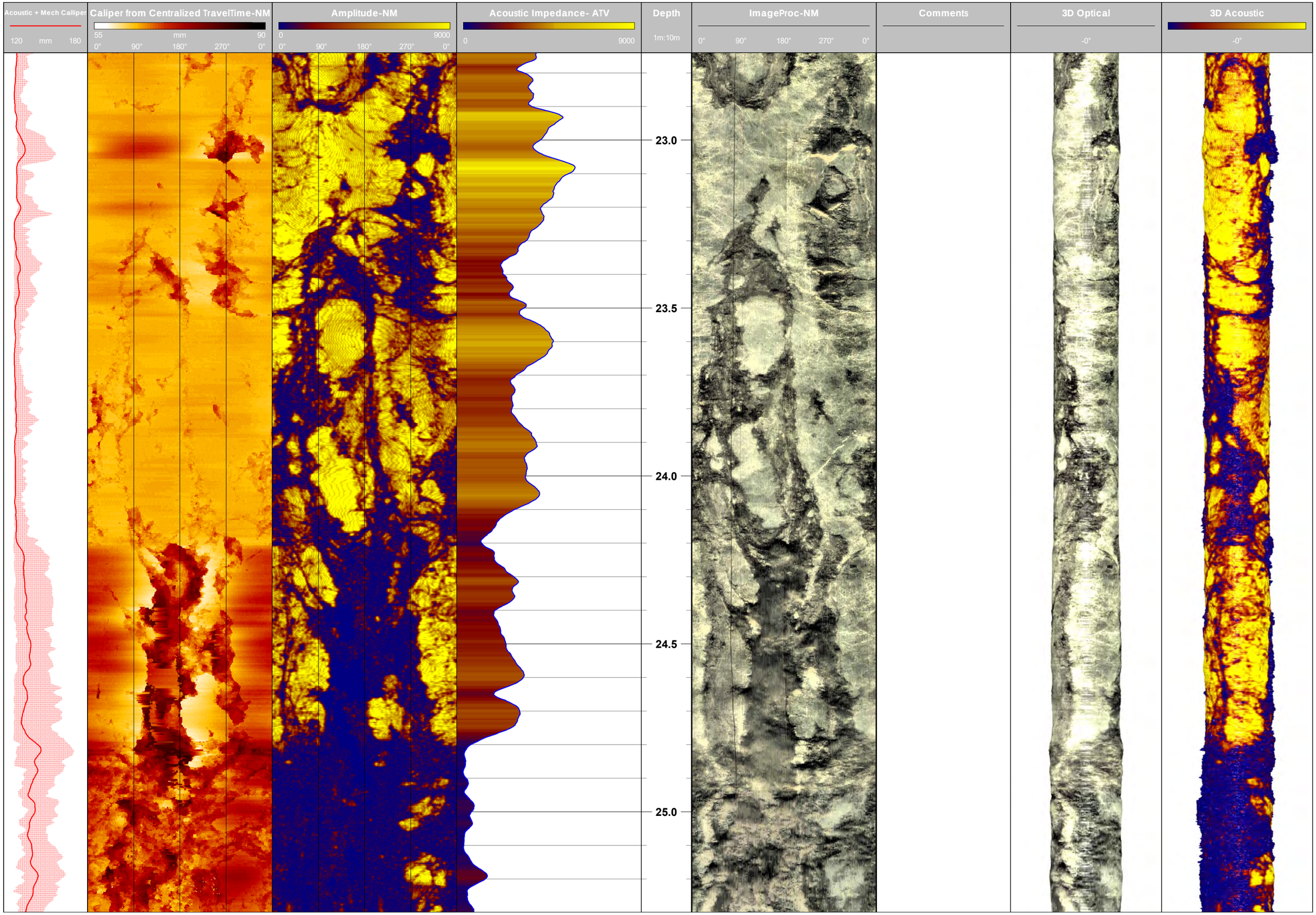
3D Optical

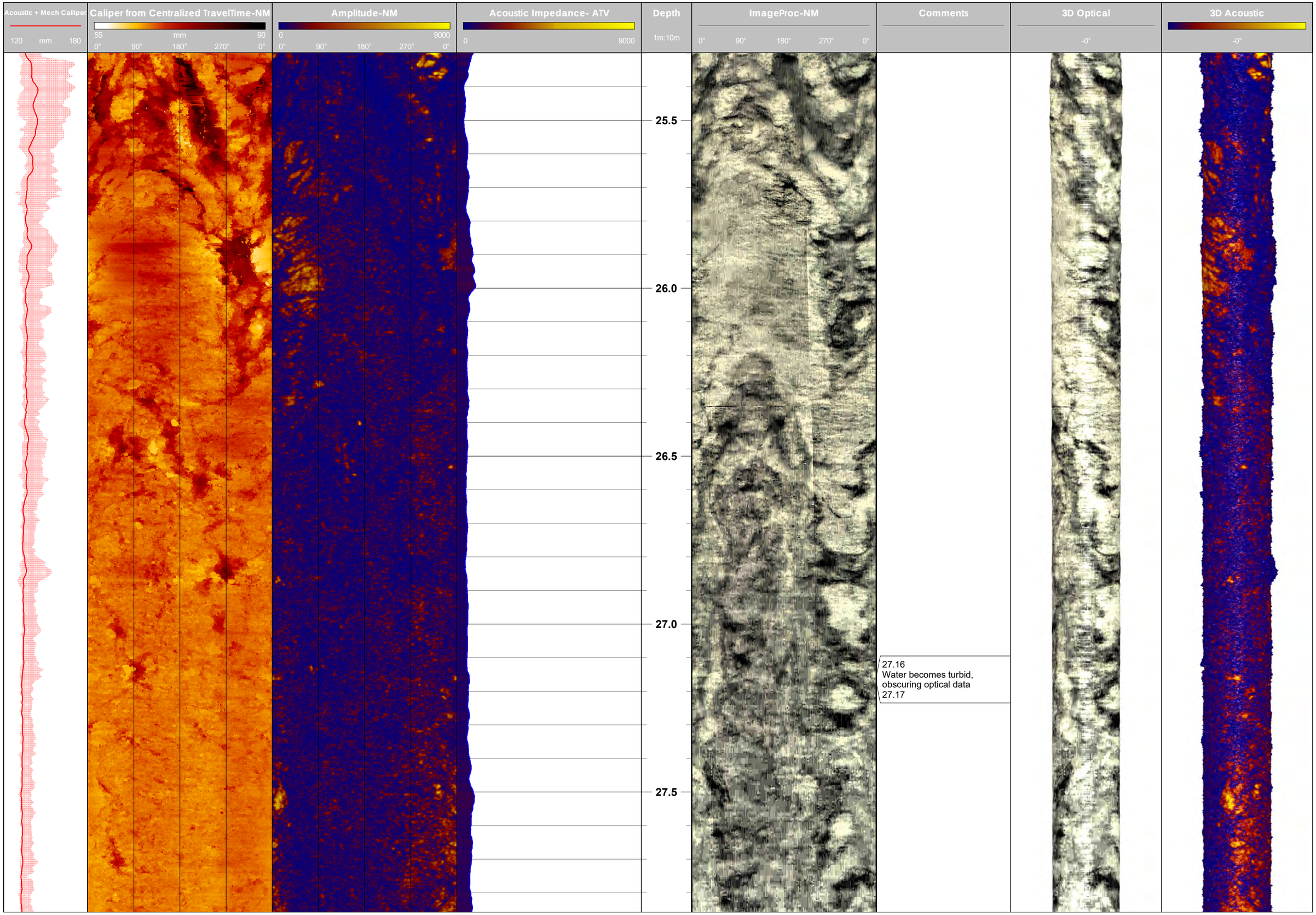
-0°

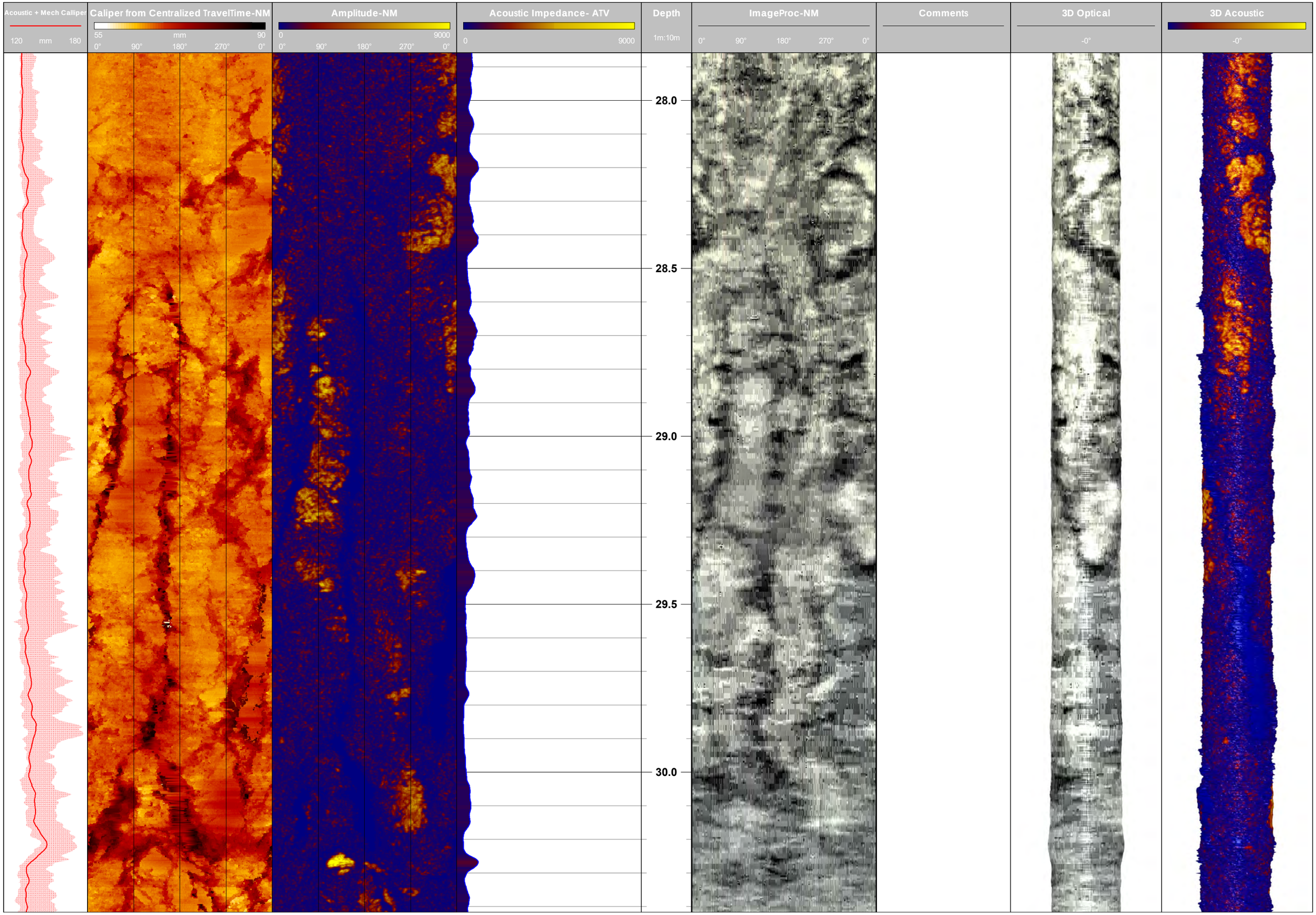
3D Acoustic

-0°


Acoustic + Mech Calliper
120 mm 180
Caliper from Centralized TravelTime-NM
55 mm 90
0° 90° 180° 270° 0°
Amplitude-NM
0 9000
0° 90° 180° 270° 0°
Acoustic Impedance- ATV
0 9000
Depth
1m:10m
20.5
21.0
21.5
22.0
22.5
ImageProc-NM
0° 90° 180° 270° 0°
Comments
3D Optical
-0°
3D Acoustic
-0°


Acoustic + Mech Calliper
120 mm 180
Caliper from Centralized TravelTime-NM
55 mm 90
0° 90° 180° 270° 0°
Amplitude-NM
0 9000
0° 90° 180° 270° 0°
Acoustic Impedance- ATV
0 9000
Depth
1m:10m
23.0
23.5
24.0
24.5
25.0
ImageProc-NM
0° 90° 180° 270° 0°
Comments
3D Optical
-0°
3D Acoustic
-0°


Acoustic + Mech Calliper
120 mm 180
Caliper from Centralized TravelTime-NM
55 mm 90
0° 90° 180° 270° 0°
Amplitude-NM
0 9000
0° 90° 180° 270° 0°
Acoustic Impedance- ATV
0 9000
Depth
1m:10m
25.5
26.0
26.5
27.0
27.5
ImageProc-NM
0° 90° 180° 270° 0°
Comments
27.16
Water becomes turbid,
obscuring optical data
27.17
3D Optical
-0°
3D Acoustic
-0°


Acoustic + Mech Calliper
120 mm 180
Caliper from Centralized TravelTime-NM
55 mm 90
0° 90° 180° 270° 0°
Amplitude-NM
0 9000
0° 90° 180° 270° 0°
Acoustic Impedance- ATV
0 9000
Depth
1m:10m
28.0
28.5
29.0
29.5
30.0
ImageProc-NM
0° 90° 180° 270° 0°
Comments
3D Optical
-0°
3D Acoustic
-0°

Acoustic + Mech Calliper

120 mm 180

Caliper from Centralized TravelTime-NM

55 mm 90

0° 90° 180° 270° 0°

Amplitude-NM

0 9000

0° 90° 180° 270° 0°

Acoustic Impedance- ATV

0 9000

Depth

1m:10m

30.5

31.0

31.5

32.0

32.5

ImageProc-NM

0° 90° 180° 270° 0°

Comments

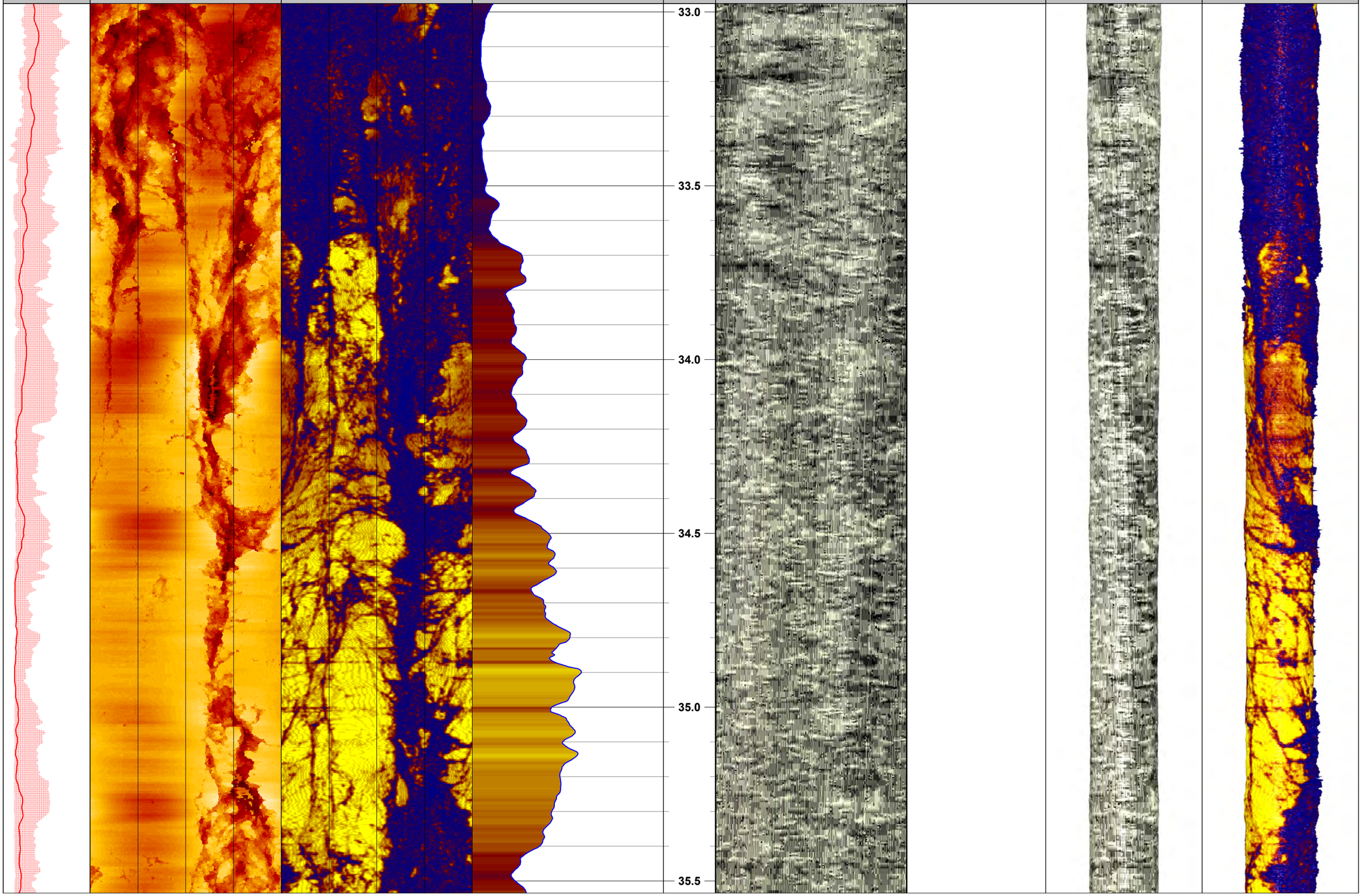
3D Optical

-0°

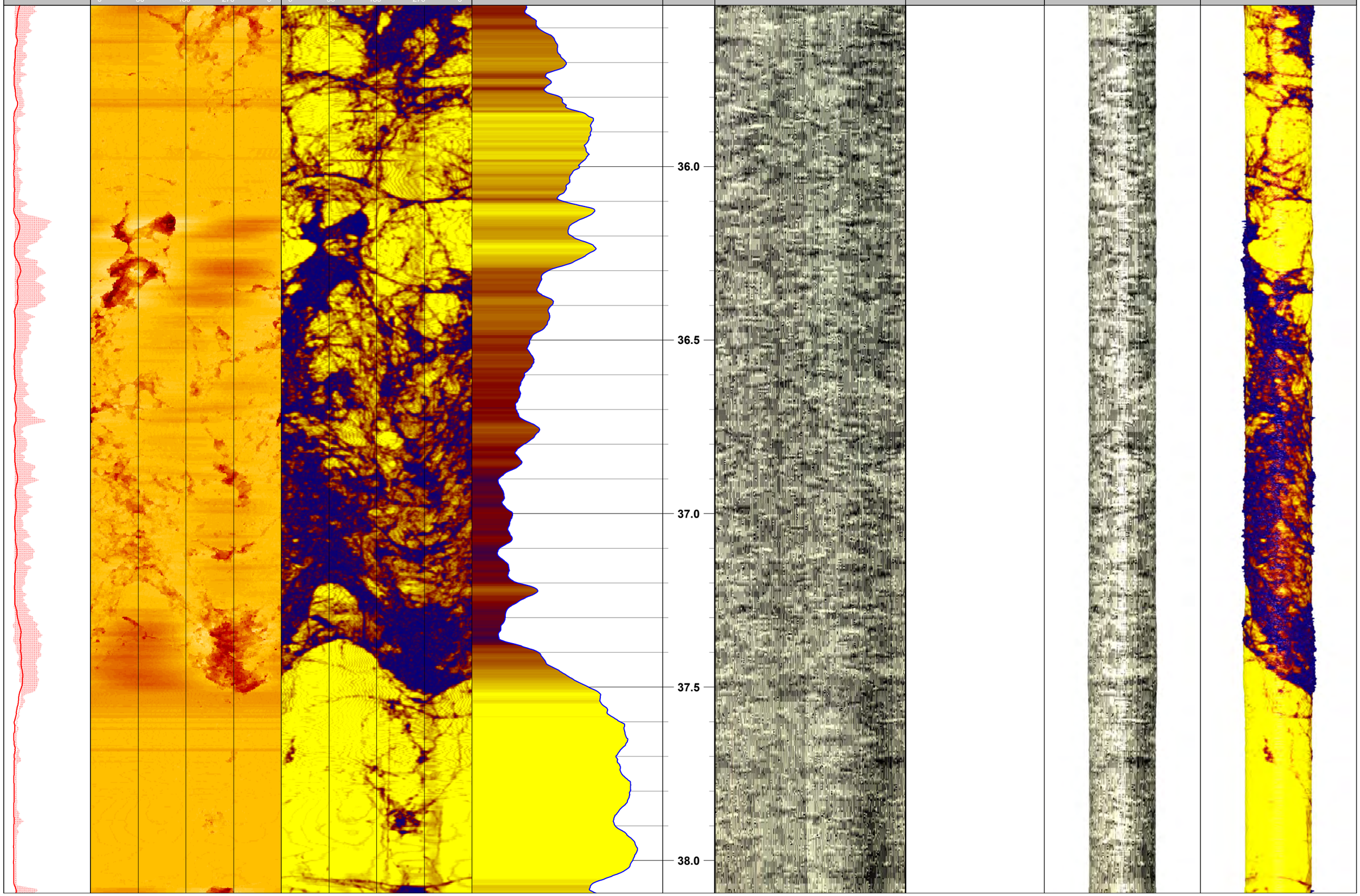
3D Acoustic

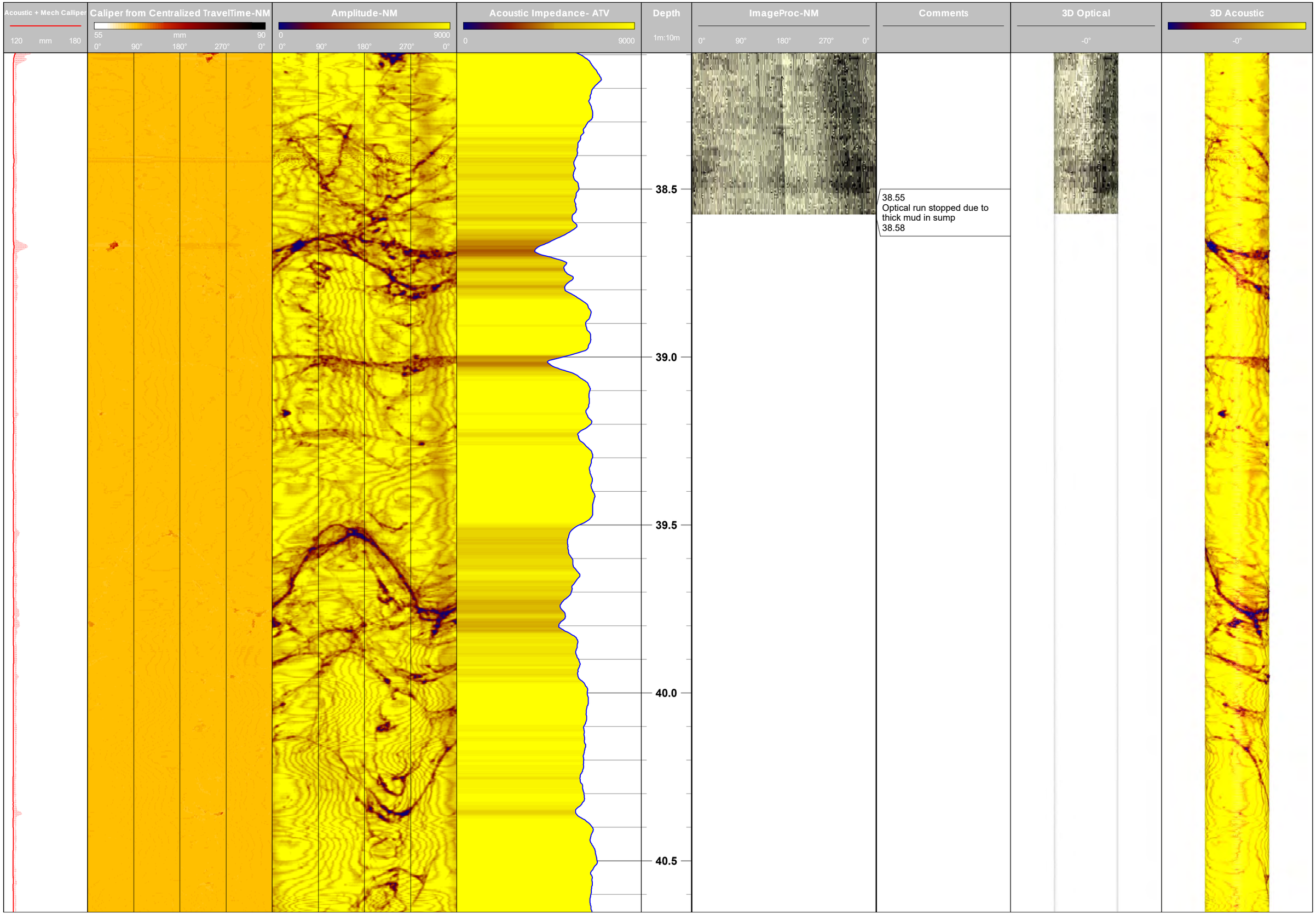
-0°

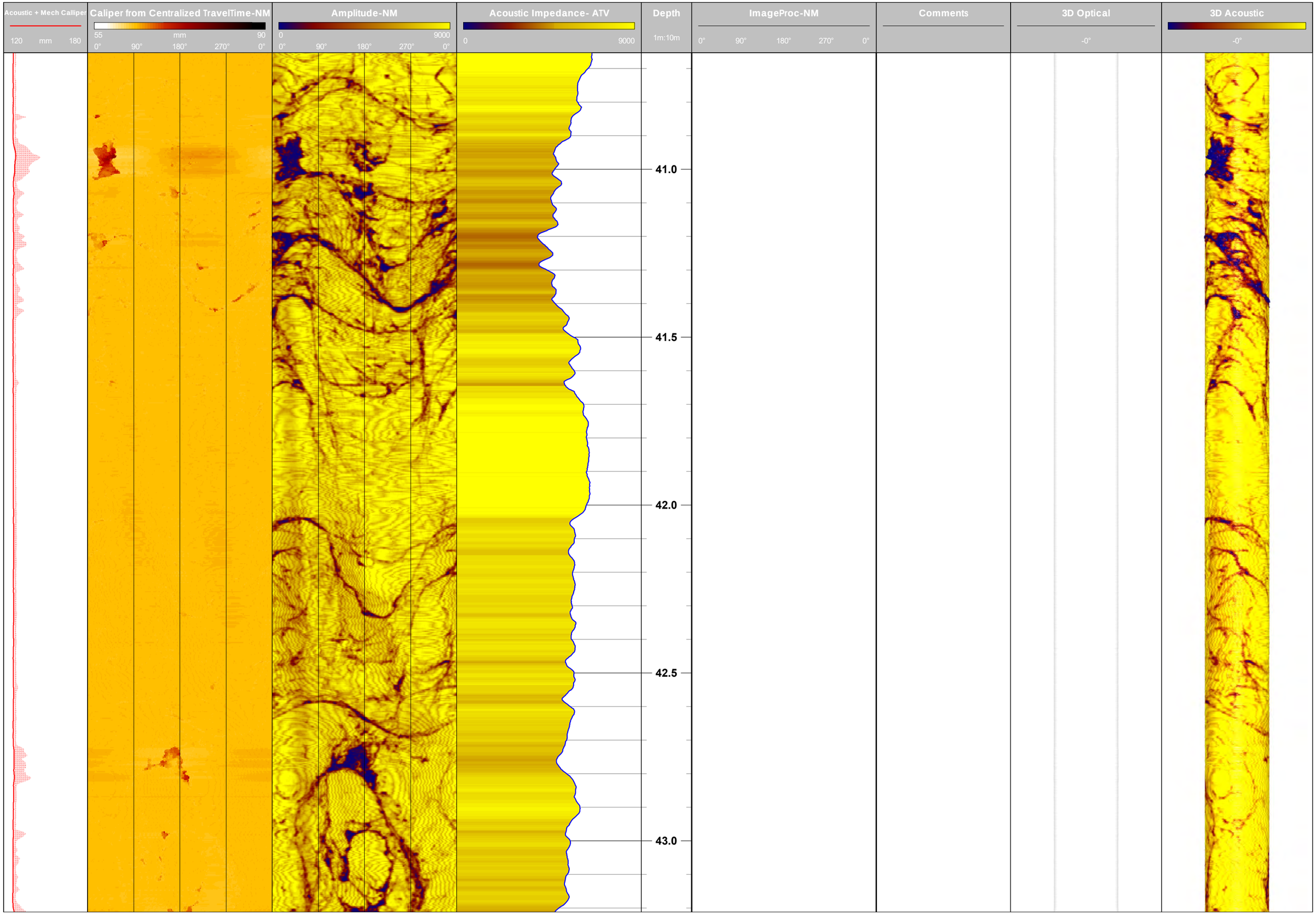
Acoustic + Mech Calliper	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	ImageProc-NM	Comments	3D Optical	3D Acoustic
120 mm 180	55 mm 90 0° 90° 180° 270° 0°	0 9000 0° 90° 180° 270° 0°	0 9000	1m:10m	0° 90° 180° 270° 0°		-0°	-0°

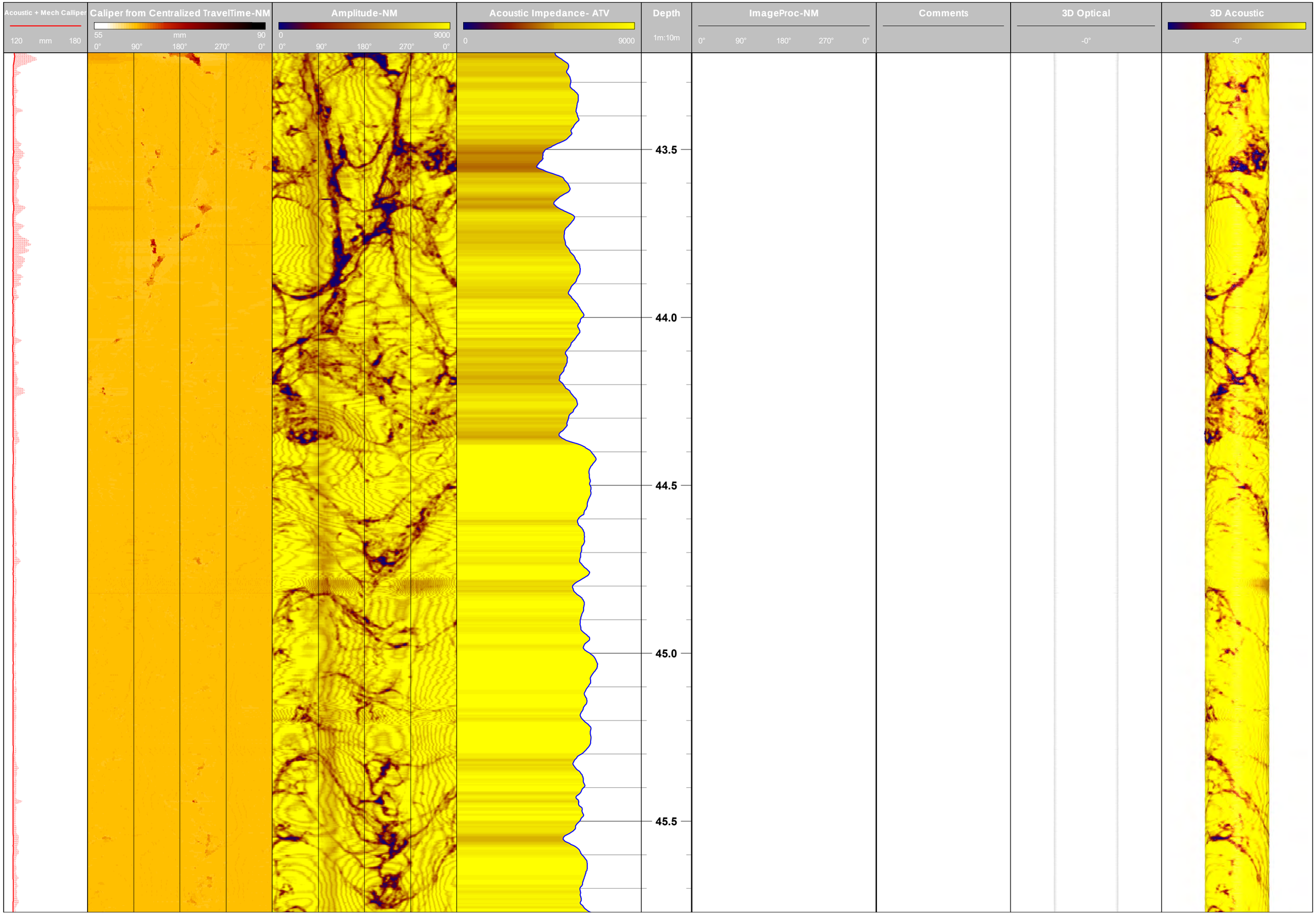


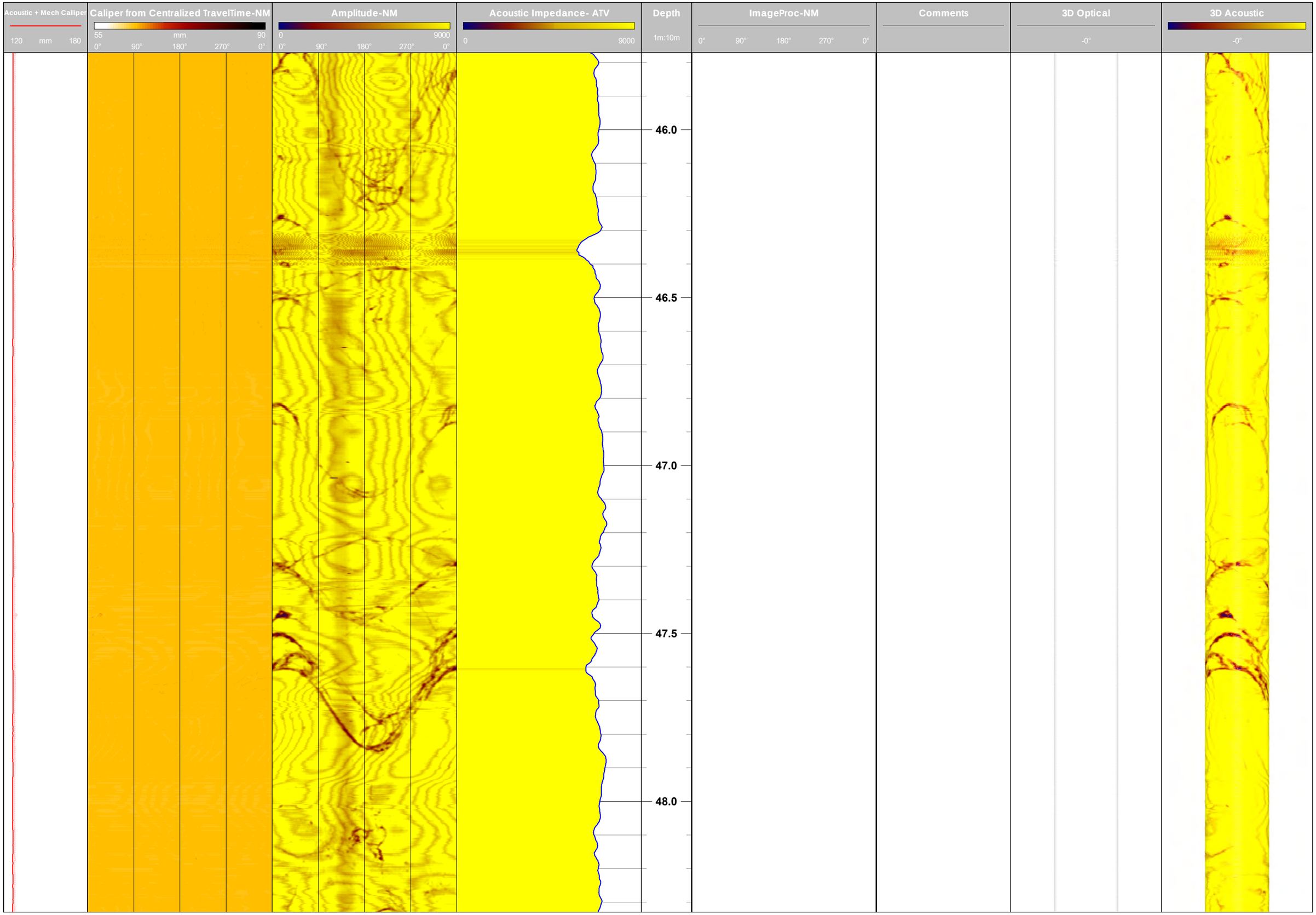
Acoustic + Mech Calliper	Caliper from Centralized TravelTime-NM	Amplitude-NM	Acoustic Impedance- ATV	Depth	ImageProc-NM	Comments	3D Optical	3D Acoustic
120 mm 180	55 mm 90 0° 90° 180° 270° 0°	0 9000 0° 90° 180° 270° 0°	0 9000	1m:10m	0° 90° 180° 270° 0°		-0°	-0°

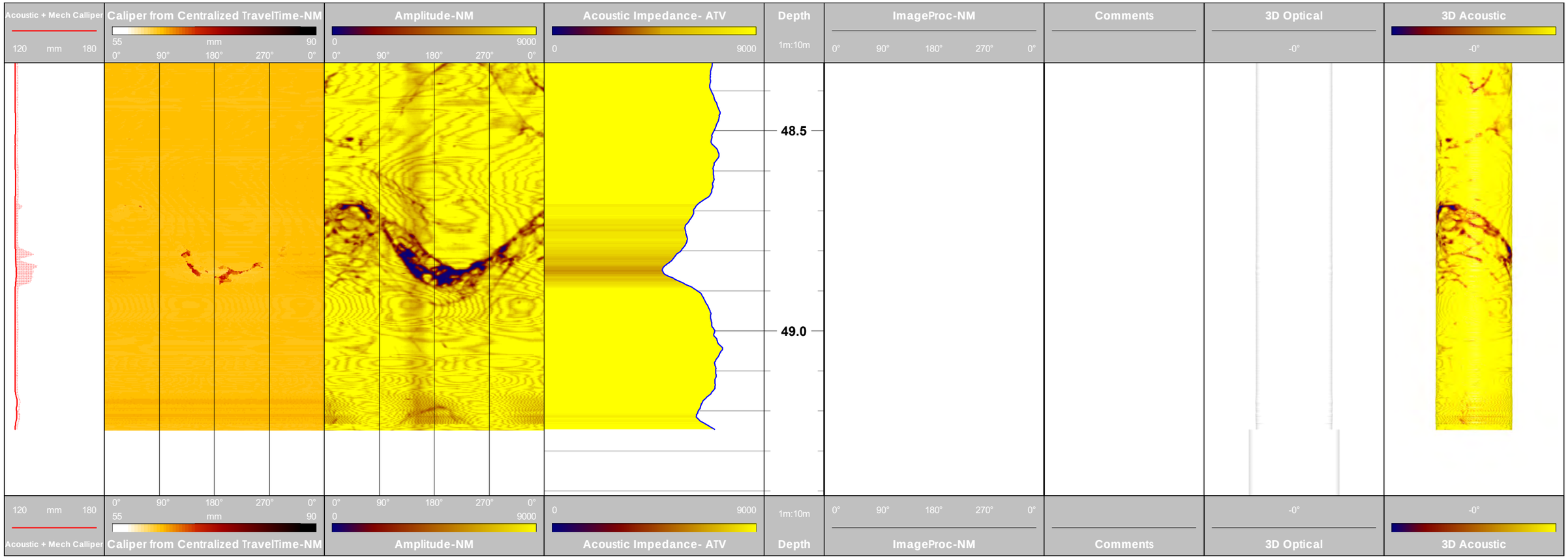



Acoustic + Mech Calliper
120 mm 180
Caliper from Centralized TravelTime-NM
55 mm 90
0° 90° 180° 270° 0°
Amplitude-NM
0 9000
0° 90° 180° 270° 0°
Acoustic Impedance- ATV
0 9000
Depth
1m:10m
38.5
39.0
39.5
40.0
40.5
ImageProc-NM
0° 90° 180° 270° 0°
Comments
38.55
Optical run stopped due to thick mud in sump
38.58
3D Optical
-0°
3D Acoustic
-0°


Acoustic + Mech Calliper
120 mm 180
Caliper from Centralized TravelTime-NM
55 mm 90
0° 90° 180° 270° 0°
Amplitude-NM
0 9000
0° 90° 180° 270° 0°
Acoustic Impedance- ATV
0 9000
Depth
1m:10m
41.0
41.5
42.0
42.5
43.0
ImageProc-NM
0° 90° 180° 270° 0°
Comments
3D Optical
-0°
3D Acoustic
-0°


Acoustic + Mech Calliper
120 mm 180
Caliper from Centralized TravelTime-NM
55 mm 90
0° 90° 180° 270° 0°
Amplitude-NM
0 9000
0° 90° 180° 270° 0°
Acoustic Impedance- ATV
0 9000
Depth
1m:10m
43.5
44.0
44.5
45.0
45.5
ImageProc-NM
0° 90° 180° 270° 0°
Comments
3D Optical
-0°
3D Acoustic
-0°


Acoustic + Mech Calliper
120 mm 180
Caliper from Centralized TravelTime-NM
55 mm 90
0° 90° 180° 270° 0°
Amplitude-NM
0 9000
0° 90° 180° 270° 0°
Acoustic Impedance- ATV
0 9000
Depth
1m:10m
46.0
46.5
47.0
47.5
48.0
ImageProc-NM
0° 90° 180° 270° 0°
Comments
3D Optical
-0°
3D Acoustic
-0°


Acoustic + Mech Caliper
120 mm 180
Caliper from Centralized TravelTime-NM
55 mm 90
0° 90° 180° 270° 0°
Amplitude-NM
0 9000
0° 90° 180° 270° 0°
Acoustic Impedance- ATV
0 9000
Depth
1m:10m
48.5
49.0
ImageProc-NM
0° 90° 180° 270° 0°
Comments
3D Optical
-0°
3D Acoustic
-0°

GOLDER
MEMBER OF WSP

Golder Associates (NZ) Limited
Level 2, Nielsen Centre
129 Hurstmere Road
Takapuna, Auckland 0622
New Zealand
www.golder.com

GEOPHYSICAL RECORD OF BOREHOLE BH103

PROJECT	**Kaikoura Earthquake-Induced Landslide Research**	PROJECT #	**5-C3418.00**
CLIENT	**GNS Science**	DATE	**05 December 2021**

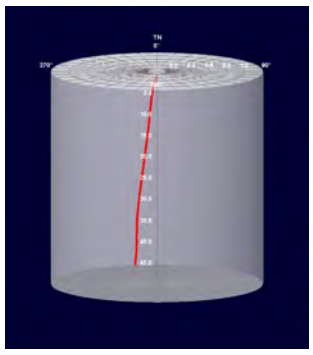
LOCATION	**Awatere Valley Road, Marlborough**	LOGGED BY	**RDCL (O Gibson)**
EASTING	**1658900 m**	LOGGED DATE	**01 September 2020**
NORTHING	**5365810 m**	LOGGING DATUM	**GL**
ELEVATION	**Approx. 515 m**	LOGGED DEPTH	**1.0 - 49.3 m**
DRILLED DEPTH	**49.9 m**	DRAWN BY	**MH**
INCLINATION	**-88.8°** AZIMUTH **346° (TN)**	REVIEWED BY	**TR**
DIAMETER	**PQ**	FILE NAME	**BH103_ATV_Rev0.wcl**

Imagery is presented relative to magnetic north.

Acoustic caliper log used for structure tilt correction.

Summary structural data are presented relative to true north (declination correction of 23.2° applied).

DEVIATION DATA

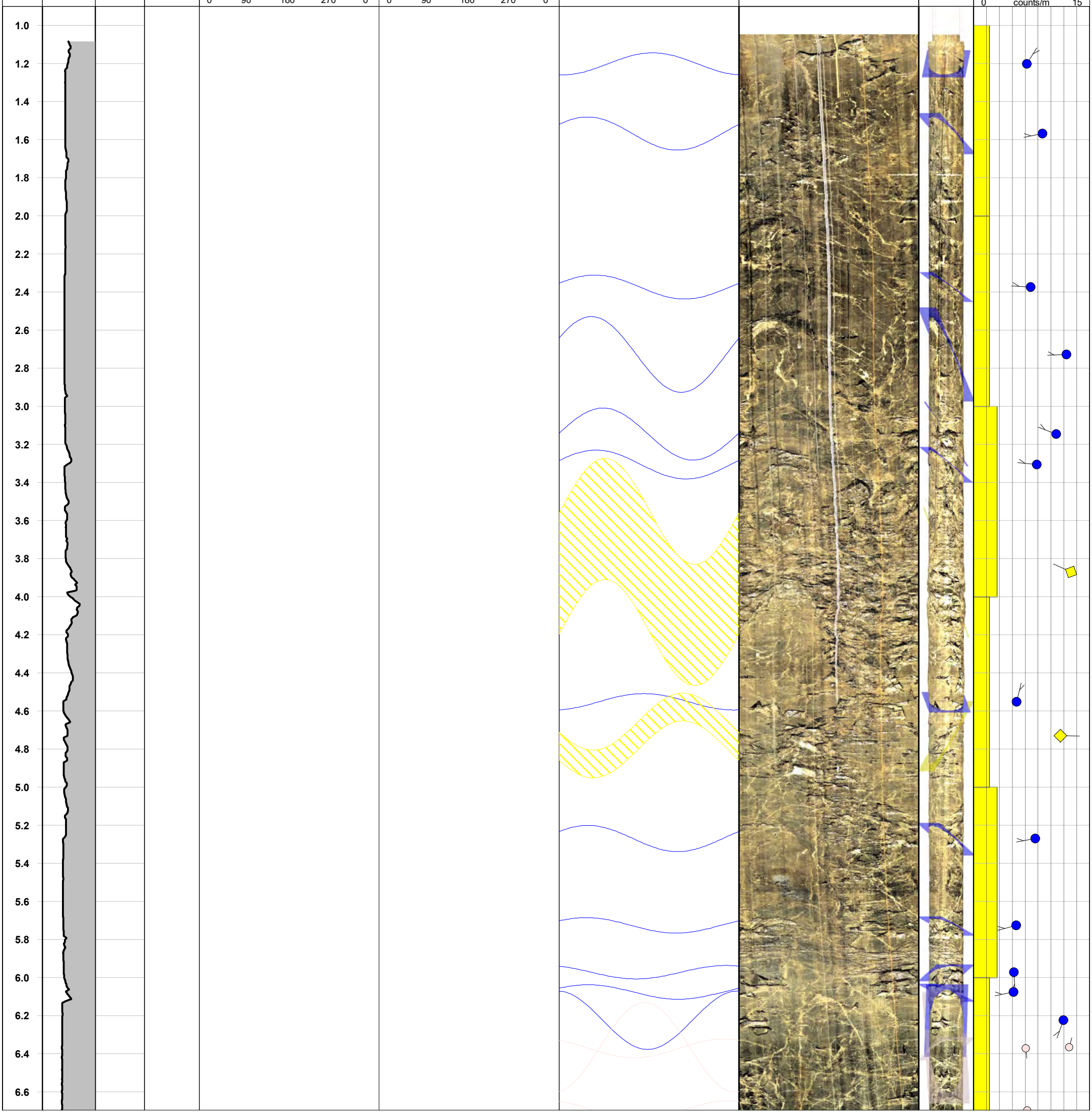


INTERPRETED STRUCTURES

Bedding Fabric | Extremely Weathered / Infilled Seam | Crushed / Sheared Seam | Joint | Healed Joint | Vein

BH103

Depth	Caliper	ATV Data				OTV Data		Structural Summary
Depth 1m:20m	Combined Caliper 100 160	App Hardness	3D Acoustic -0°	Centralized TravelTime-NM 60 us 95 0° 90° 180° 270° 0°	Amplitude-NM 0 9800 0° 90° 180° 270° 0°	Apparent Structure_merged 0° 90° 180° 270° 0°	OTV Image-NM	3D Optical -0°	Structures 0 90 Defect freq/metre 0 counts/m 15



BH103

Depth | **Caliper** | **ATV Data** | **OTV Data** | **Structural Summary**

Depth
1m:20m

Combined Caliper
100 160

App Hardness

3D Acoustic
-0°

Centralized TravelTime-NM
60 us 95
0° 90° 180° 270° 0°

Amplitude-NM
0 9800
0° 90° 180° 270° 0°

Apparent Structure_merged
0° 90° 180° 270° 0°

OTV Image-NM

3D Optical
-0°

Structures
0 90

Defect freq/metre
0 counts/m 15

6.8
7.0
7.2
7.4
7.6
7.8
8.0
8.2
8.4
8.6
8.8
9.0
9.2
9.4
9.6
9.8
10.0
10.2
10.4
10.6
10.8
11.0
11.2
11.4
11.6
11.8
12.0
12.2
12.4
12.6
12.8
13.0
13.2
13.4
13.6
13.8
14.0
14.2

BH103

Depth | **Caliper** | **ATV Data** | **OTV Data** | **Structural Summary**

Depth
1m:20m

Caliper
Combined Caliper
100 160

App Hardness

3D Acoustic
-0°

Centralized TravelTime-NM
60 us 95
0° 90° 180° 270° 0°

Amplitude-NM
0 9800
0° 90° 180° 270° 0°

Apparent Structure_merged
0° 90° 180° 270° 0°

OTV Image-NM

3D Optical
-0°

Structures
0 90

Defect freq/metre
0 counts/m 15

14.4
14.6
14.8
15.0
15.2
15.4
15.6
15.8
16.0
16.2
16.4
16.6
16.8
17.0
17.2
17.4
17.6
17.8
18.0
18.2
18.4
18.6
18.8
19.0
19.2
19.4
19.6
19.8
20.0
20.2
20.4
20.6
20.8
21.0
21.2
21.4
21.6

BH103

Depth | **Caliper** | **ATV Data** | **OTV Data** | **Structural Summary**

Depth
1m:20m

Caliper
Combined Caliper
100 160

App Hardness

3D Acoustic
-0°

Centralized TravelTime-NM
60 us 95
0° 90° 180° 270° 0°

Amplitude-NM
0 9800
0° 90° 180° 270° 0°

Apparent Structure_merged
0° 90° 180° 270° 0°

OTV Image-NM

3D Optical
-0°

Structures
0 90

Defect freq/metre
0 counts/m 15

21.8
22.0
22.2
22.4
22.6
22.8
23.0
23.2
23.4
23.6
23.8
24.0
24.2
24.4
24.6
24.8
25.0
25.2
25.4
25.6
25.8
26.0
26.2
26.4
26.6
26.8
27.0
27.2
27.4
27.6
27.8
28.0
28.2
28.4
28.6
28.8
29.0
29.2

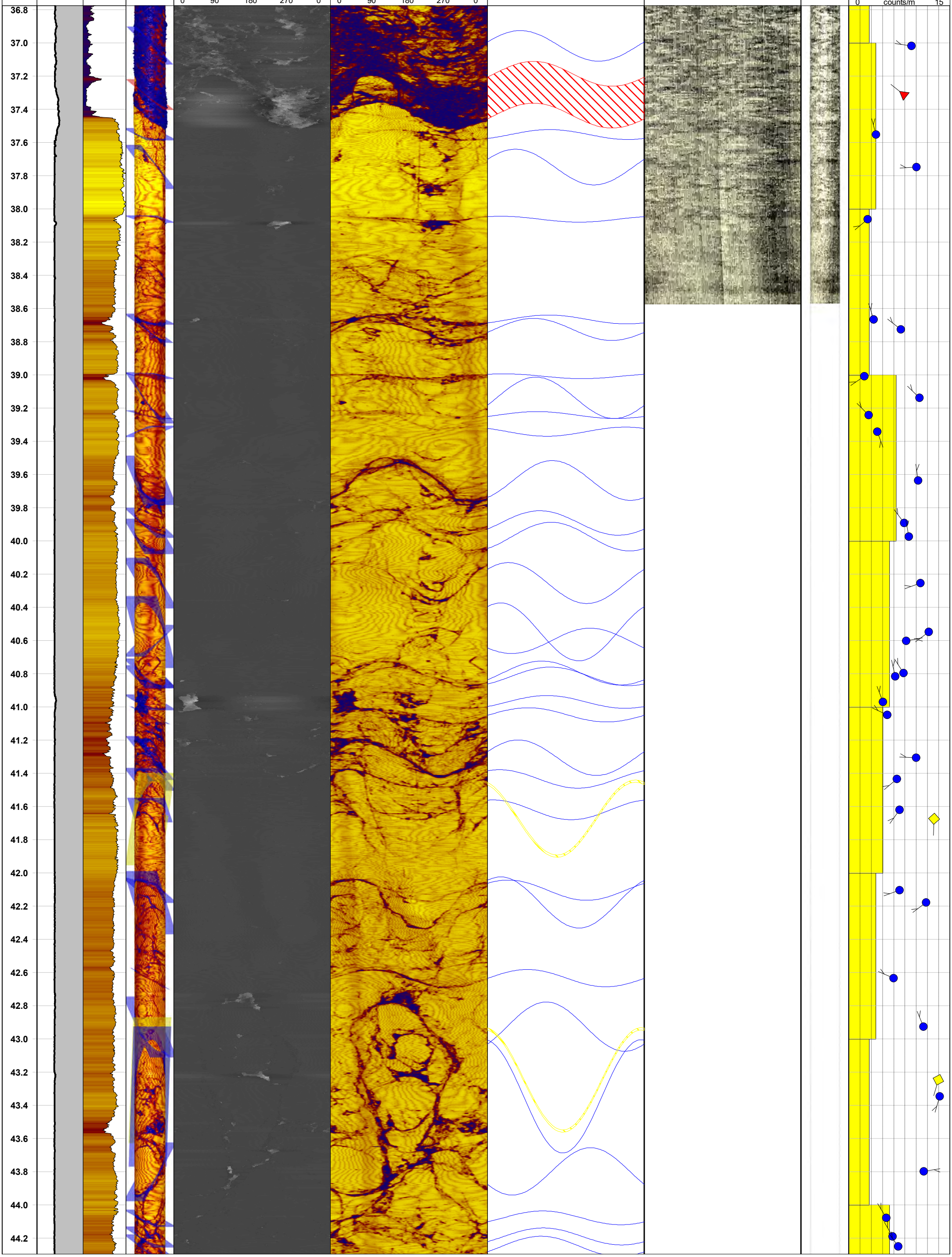
BH103

Depth	Caliper	ATV Data					OTV Data		Structural Summary
Depth	Combined Caliper	App Hardness	3D Acoustic	Centralized TravelTime-NM	Amplitude-NM	Apparent Structure_merged	OTV Image-NM	3D Optical	Structures
1m:20m	100 160		-0°	60 us 95 0° 90° 180° 270° 0°	0 9800 0° 90° 180° 270° 0°	0° 90° 180° 270° 0°		-0°	0 90 Defect freq/metre 0 counts/m 15

29.4
29.6
29.8
30.0
30.2
30.4
30.6
30.8
31.0
31.2
31.4
31.6
31.8
32.0
32.2
32.4
32.6
32.8
33.0
33.2
33.4
33.6
33.8
34.0
34.2
34.4
34.6
34.8
35.0
35.2
35.4
35.6
35.8
36.0
36.2
36.4
36.6

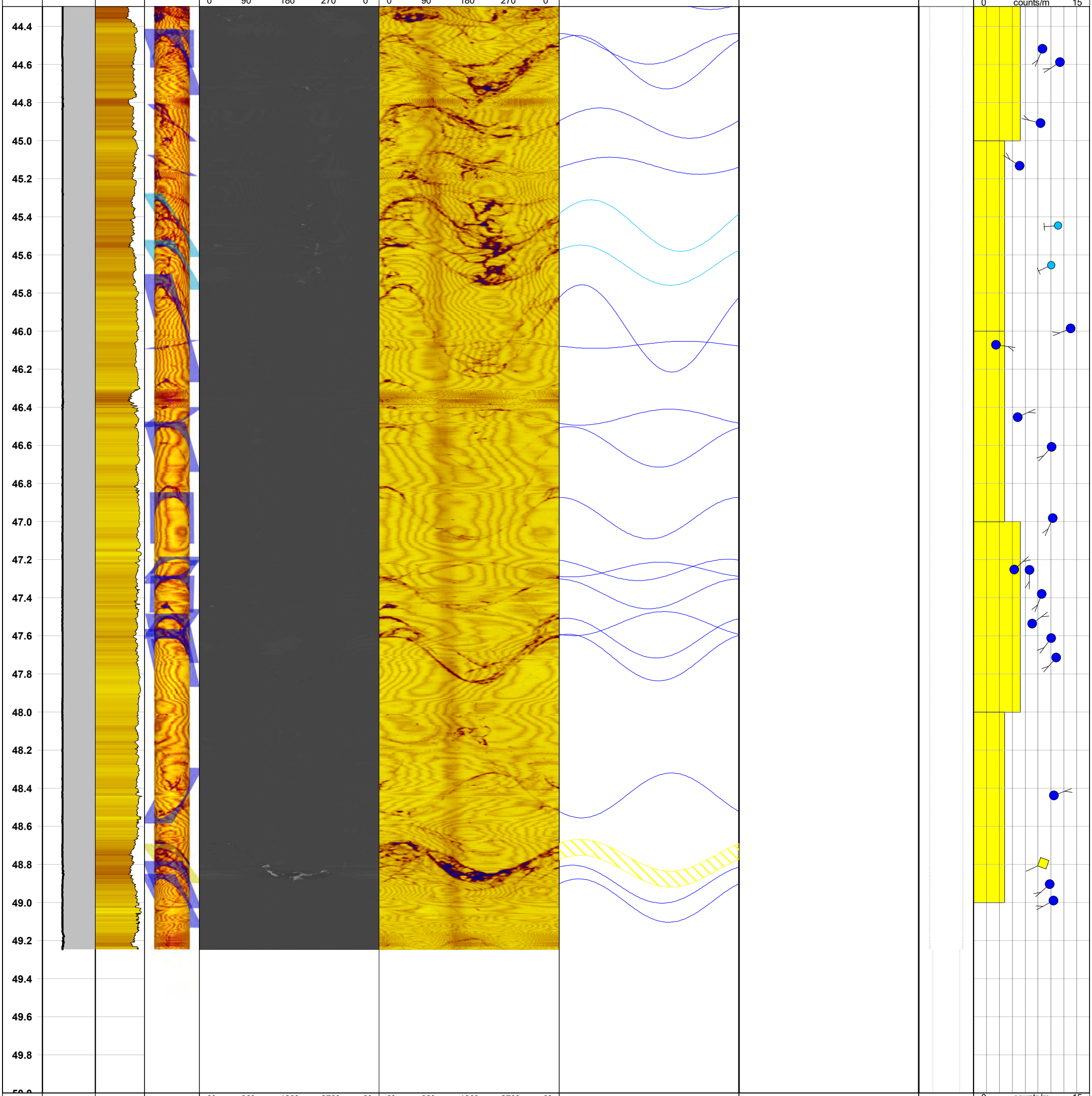
BH103

Depth	Caliper	ATV Data				OTV Data		Structural Summary
Depth	Combined Caliper	App Hardness	3D Acoustic	Centralized TravelTime-NM	Amplitude-NM	Apparent Structure_merged	OTV Image-NM	3D Optical	Structures / Defect freq/metre
1m:20m	100 160		-0°	60 us 95 0° 90° 180° 270° 0°	0 9800 0° 90° 180° 270° 0°	0° 90° 180° 270° 0°		-0°	0 90 0 counts/m 15



BH103

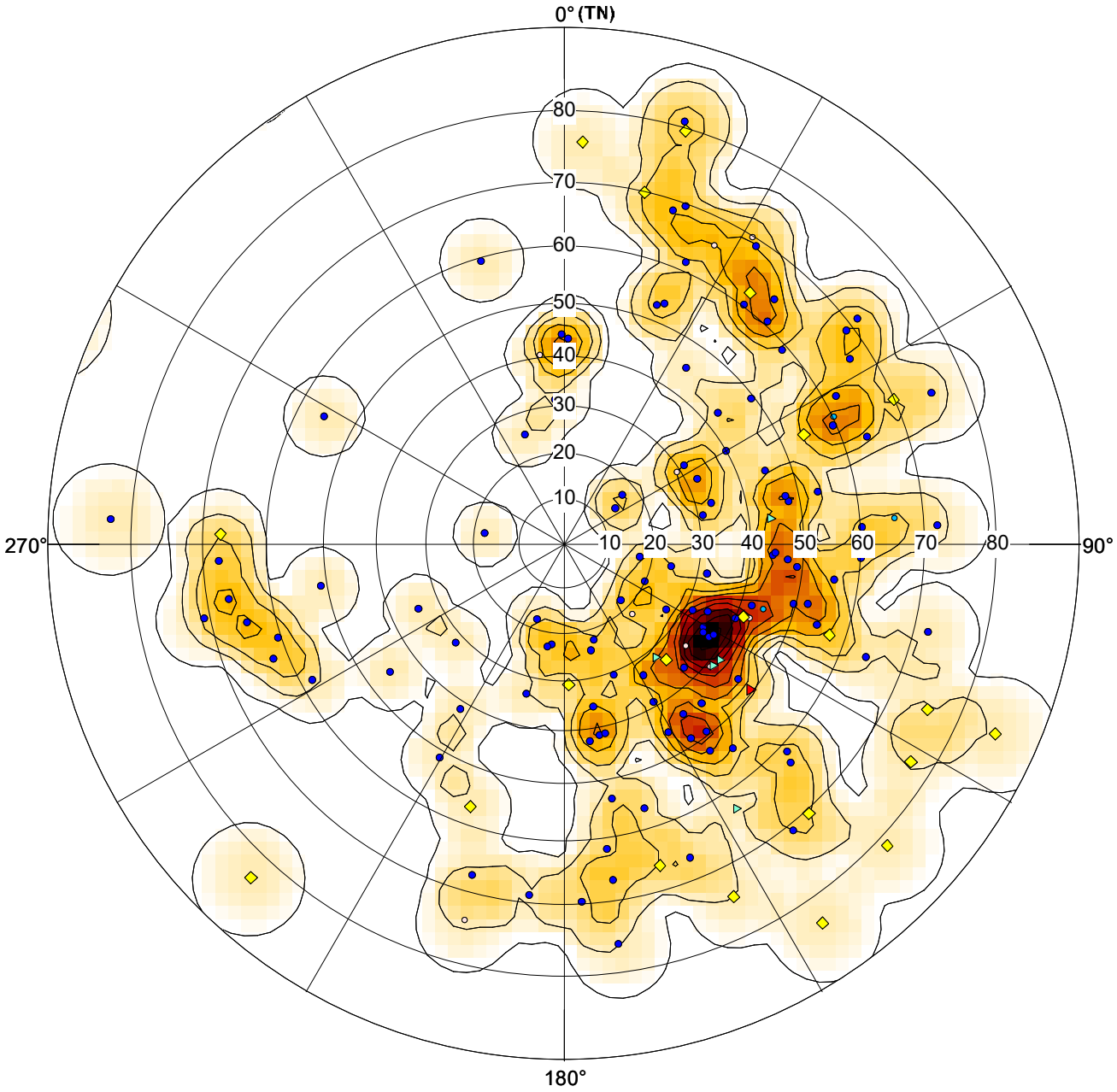
Depth	Caliper	ATV Data				OTV Data		Structural Summary
Depth	Combined Caliper	App Hardness	3D Acoustic	Centralized TravelTime-NM	Amplitude-NM	Apparent Structure_merged	OTV Image-NM	3D Optical	Structures / Defect freq/metre
1m:20m	100 160		-0°	60 us 95	0 9800	0° 90° 180° 270° 0°		-0°	0 90 / 0 counts/m 15



1m:20m	100 160		-0°	0° 90° 180° 270° 0°	0° 90° 180° 270° 0°	0° 90° 180° 270° 0°		-0°	0 counts/m 15 / 0 90
Depth	Combined Caliper	App Hardness	3D Acoustic	60 us 95 Centralized TravelTime-NM	0 9800 Amplitude-NM	Apparent Structure_merged	OTV Image-NM	3D Optical	Defect freq/metre / 0 90 Structures

Depth	Caliper	ATV Data	OTV Data	Structural Summary

BH103



Notes:
1. Poles of interpreted structures are displayed.
2. Structures are orientated relative to true north.
3. Projection is angle-equal (Wulff), southern hemisphere.
4. Coloured contours indicate the density of clustered structures, and were calculated using the Schmidt method.

CLIENT
GNS SCIENCE

PROJECT
KAIKOURA EARTHQUAKE-INDUCED LANDSLIDE RESEARCH

CONSULTANT
GOLDER

YYYY-MM-DD	2021-11-18
DESIGNED	MH
PREPARED	MH
REVIEWED	TR
APPROVED	TR

TITLE
BH103
SUMMARY POLAR PLOT OF INTERPRETED STRUCTURES

PROJECT NO. 5-C3418.00
REV. 0
FIGURE 02

PO Box 28057
308 Queen's Street East
Hastings 4122
New Zealand

Ph: +64 6 8771652
Fax: +64 6 8775015
Email: info@rdcl.co.nz

Basic Information:

Well Name:	BH1003
Company:	CW Drill
Run No:	06
Tool Type(s):	QL40-FWSS Full Wave Form Sonic
Service Company:	RDCL
Operator:	O Gibson
Witness:	D Mason
Date Logged:	01/09/2020
Field:	Awatere Valley
State / Province:	Marlborough
Country:	New Zealand

Location Description:

3.34 km south west of Awapiri, above the Awatere Valley Road, Malborough.

Drillhole Information:

Bit Size:	PQ		
Log interval from:		Log interval to:	
Depth Driller:	50 m	Depth Logger:	49.41 (Acoustic)
Fluid Type:	Water	Fluid Level:	13.30 (Acoustic)
Northing:	-41.857479	Easting:	173.709719
Elevation:	N/A	Projection:	WGS84
Hole Azimuth:	288-359° (Magnetic)	Hole Inclination:	-87.9°
Magnetic Declination:	+22° 59' East	Magnetic Inclination:	66° 58'
Casing Size:	N/A	Casing Depth:	N/A

Printing Information:

Print Type:	Paginated	Log Version:	Final
Depth Unit:	Metres	Scale Ratio:	1:10

Comments:

1. Vs has been calculated using semblance analysis.
2. Vp and Vs values have been depth corrected to the centre port of their respective array.
3. All data presented has been depth corrected.
4. Coordinates approximated from google earth.

Log Notes:

The elastic moduli and engineering parameters were calculated from Full Wave Form Sonic Tool Vp and Vs measurements and CCS tool density measurements. As such the logs should be considered in-situ, small strain and bulk measurements. These measurements may differ from laboratory testing for these reasons.

Log Calculations:

SI unit calculations:
Shear Modulus (G) = dVs^2
Bulk Modulus (K) = 1/3*(E/(1-2*PR))
Young's Modulus (E) = 2G(1+PR)
Poisson's Ratio (PR) = $2-(Vp/Vs)^2/2-2(Vp/Vs)^2$

Where:
Vp = P-wave seismic velocity
Vs = S-wave seismic velocity
d = Density

Log Nomenclature:

Velocity Analysis = Output of semblance processing

S_Slowness = Shear wave slowness from semblane

Vp = P-wave velocity

Vs = Shear wave velocity from S-Slowness

DEN(CDL) = Compensated Density

Shear Modulus = Shear Modulus (G0)

Bulk Modulus = Bulk Modulus (K)

Young's Modulus = Young's Modulus (E)

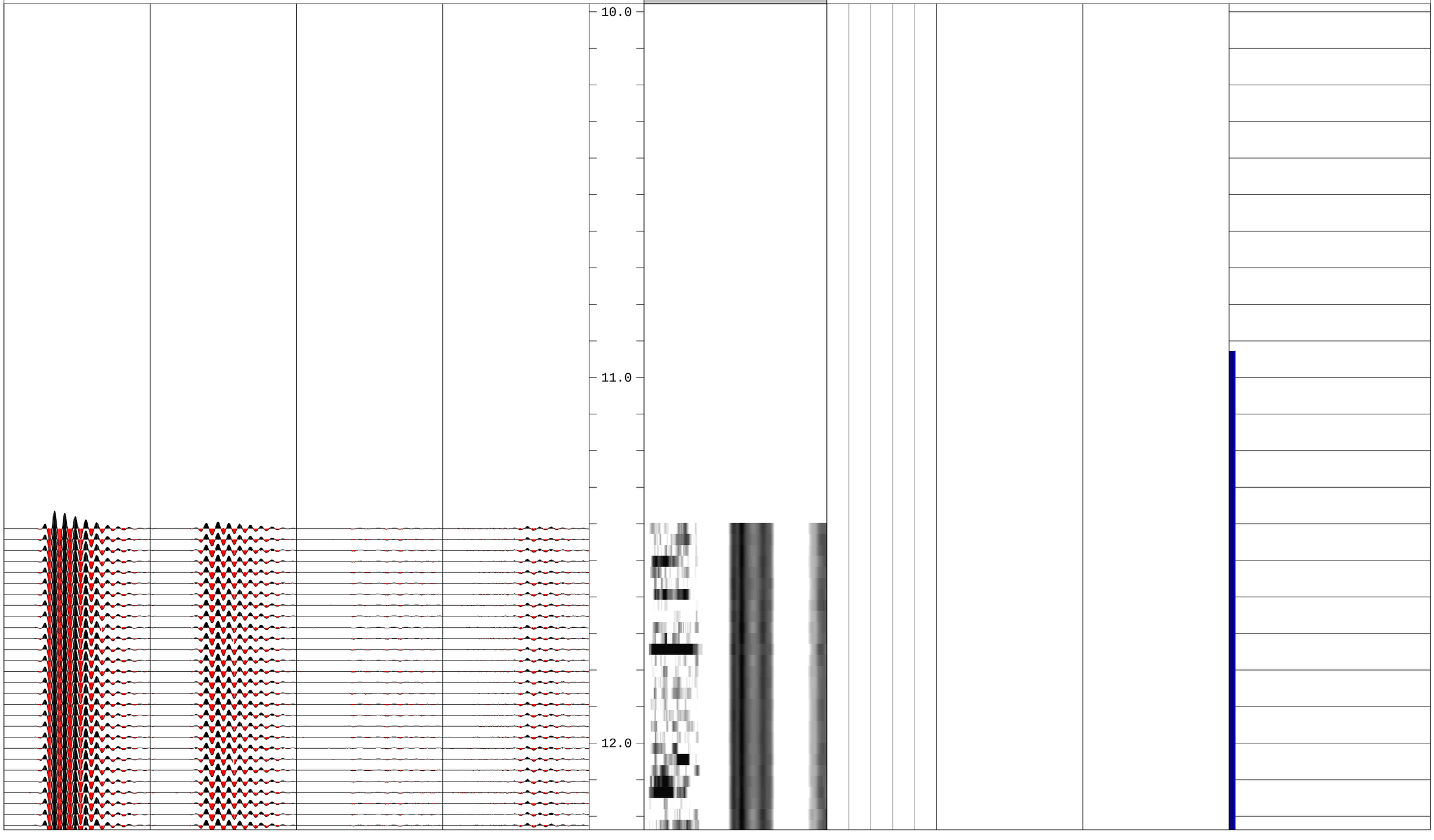
Poisson's Ratio = Poisson's Ratio (PR)

Vp/Vs = P-wave S-wave ratio

RX#-1A = Wiggle window of sensor #

RX#-1A - dt = Picked first arrival time for sensor #

RX1-1A	RX2-1A	RX3-1A	RX4-1A	Depth	P-Slowness	Vs_DC	Poisson's Ratio	Vp/Vs	Acoustic Impedance- ATV
-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	1m:10m	0 us/m 2000	0 m/s 5000	0 0.5	1 Unitless 3	0 9000
RX1-1A - dt	RX2-1A - dt	RX3-1A - dt	RX4-1A - dt		Velocity Analysis 0 25 0 us/m 2000	Vp_DC 0 m/s 5000			
0 2000	0 2000	0 2000	0 2000		S-Slowness - max 0 us/m 2000				



RX1-1A
-5000 5000
0 us 2000

RX2-1A
-5000 5000
0 us 2000

RX3-1A
-5000 5000
0 us 2000

RX4-1A
-5000 5000
0 us 2000

Depth
1m:10m

P-Slowness
0 us/m 2000

Vs_DC
0 m/s 5000

Poisson's Ratio
0 0.5

Vp/Vs
1 Unitless 3

Acoustic Impedance- ATV
0 9000

RX1-1A - dt
0 2000

RX2-1A - dt
0 2000

RX3-1A - dt
0 2000

RX4-1A - dt
0 2000

Velocity Analysis
0 25
0 us/m 2000

Vp_DC
0 m/s 5000

S-Slowness - max
0 us/m 2000

13.0

14.0

RX1-1A
-5000 5000
0 us 2000

RX2-1A
-5000 5000
0 us 2000

RX3-1A
-5000 5000
0 us 2000

RX4-1A
-5000 5000
0 us 2000

Depth
1m:10m

P-Slowness
0 us/m 2000

Vs_DC
0 m/s 5000

Poisson's Ratio
0 0.5

Vp/Vs
1 Unitless 3

Acoustic Impedance- ATV
0 9000

RX1-1A - dt
0 2000

RX2-1A - dt
0 2000

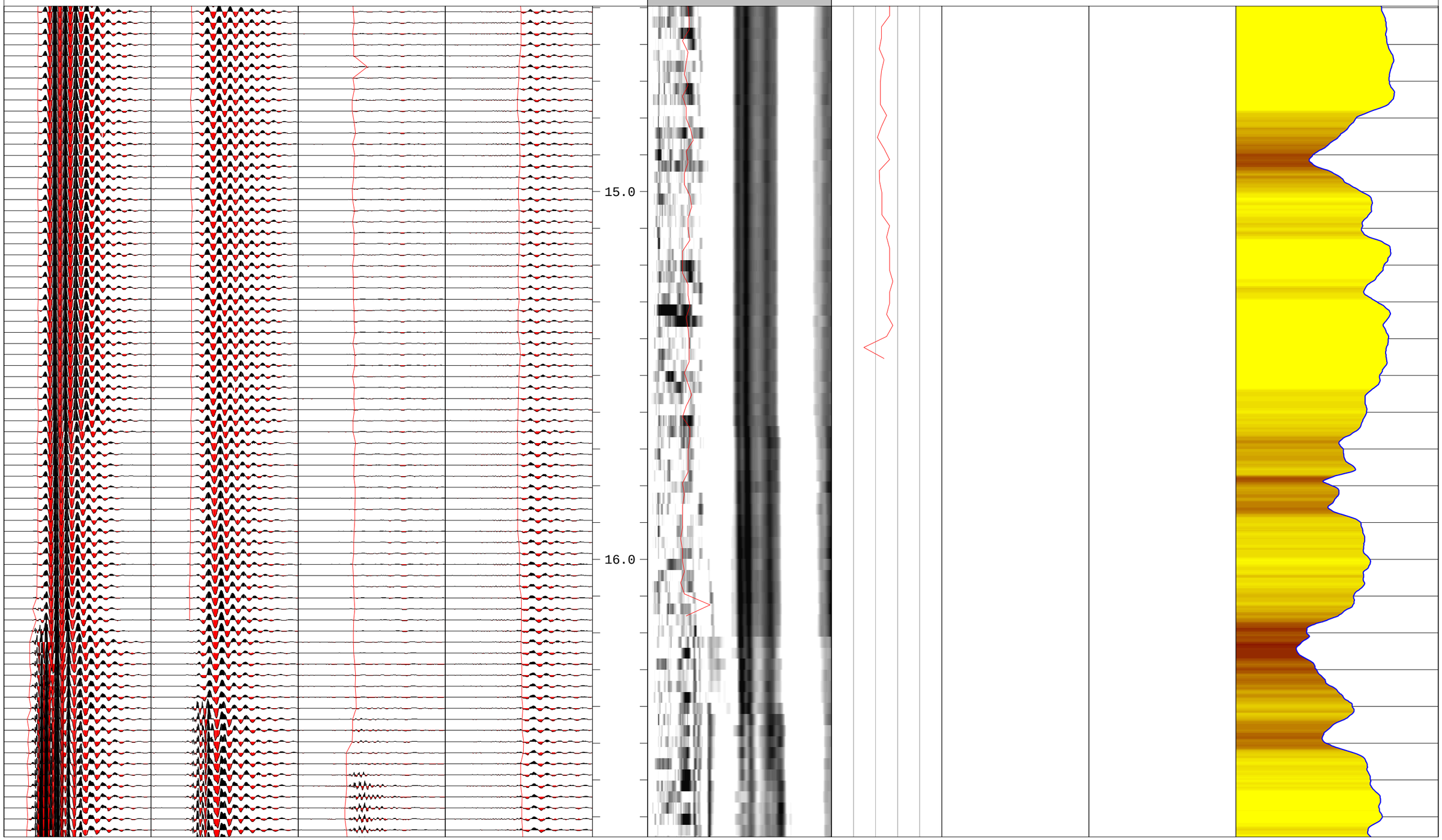
RX3-1A - dt
0 2000

RX4-1A - dt
0 2000

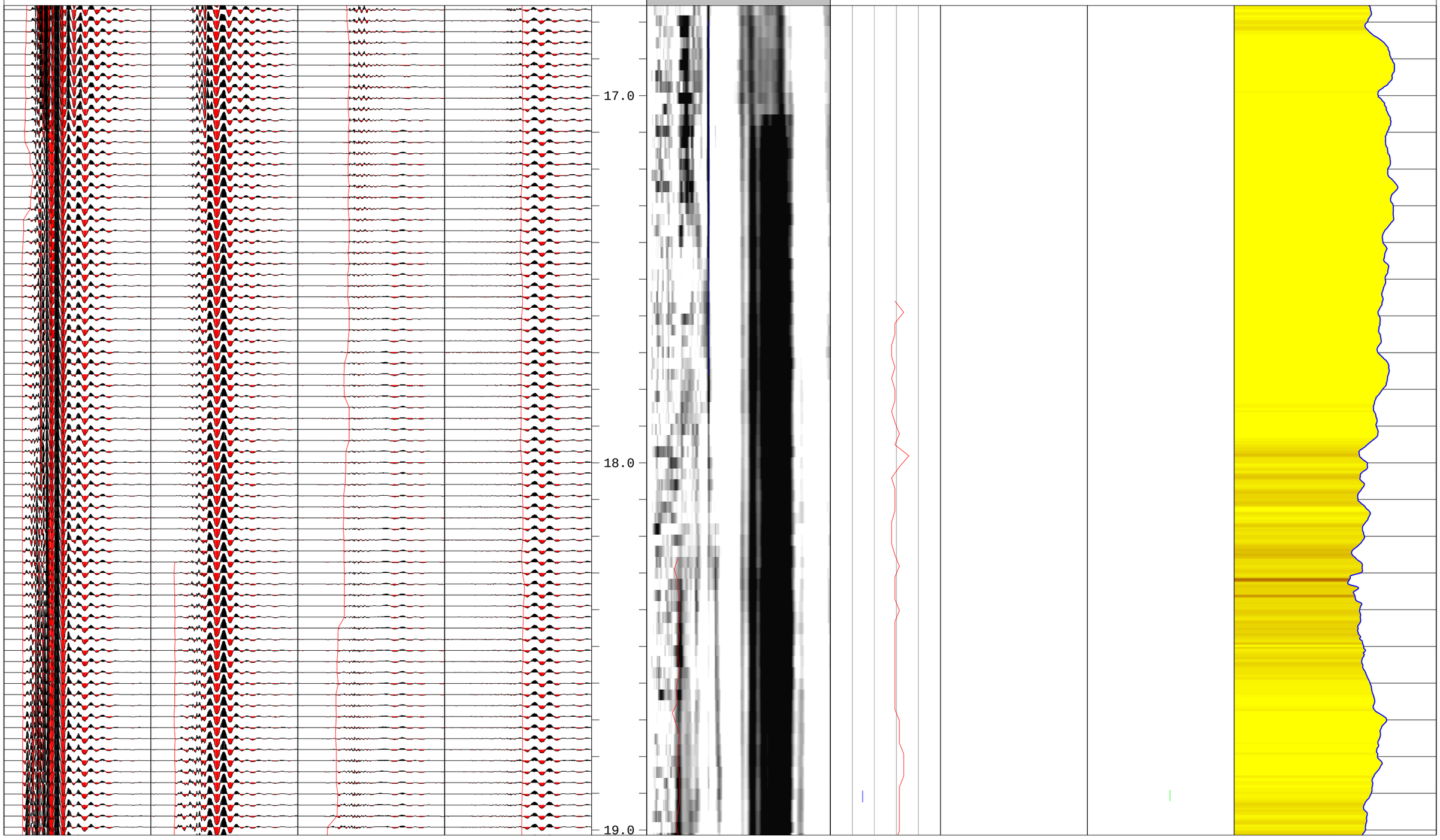
Velocity Analysis
0 25
0 us/m 2000

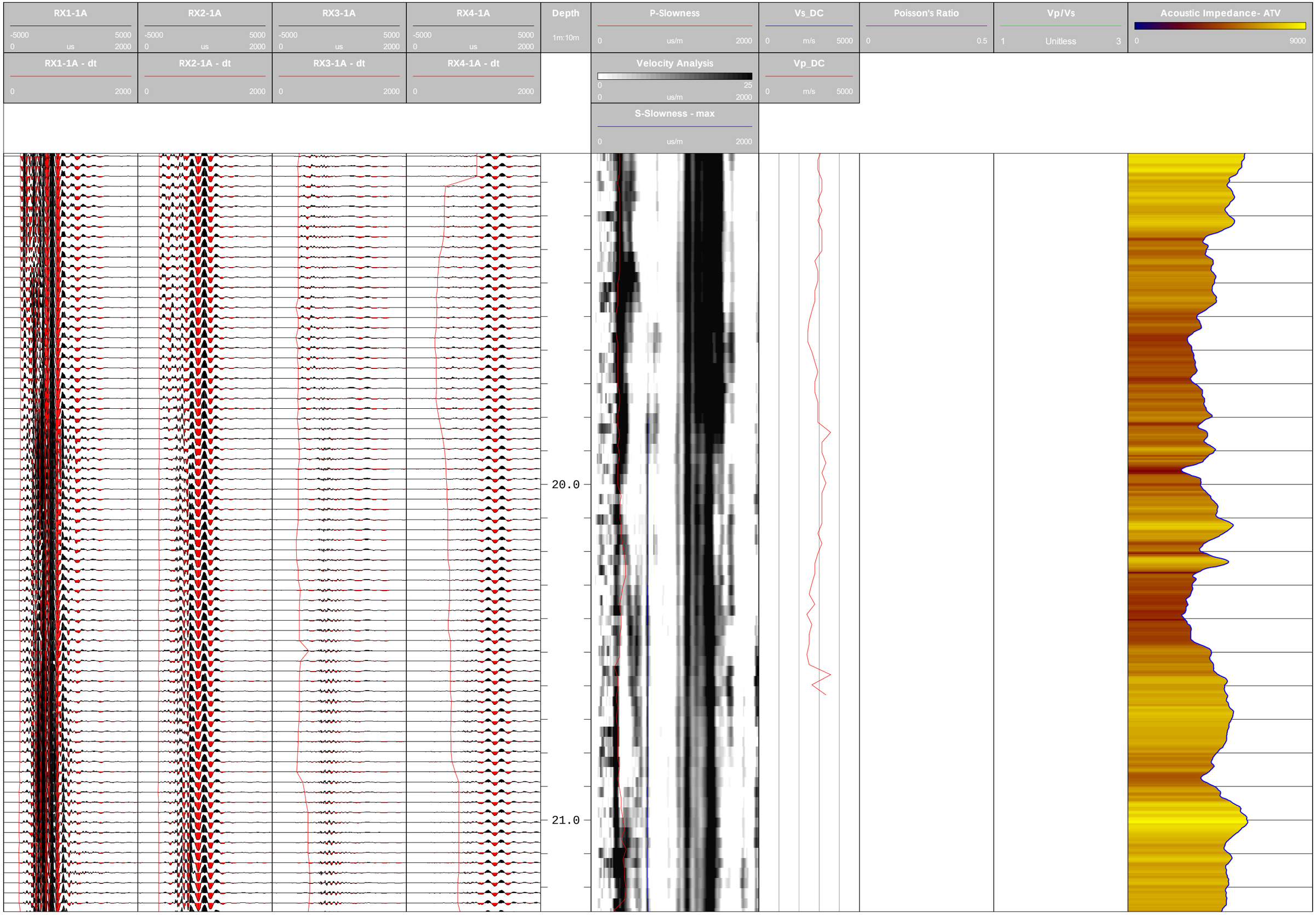
Vp_DC
0 m/s 5000

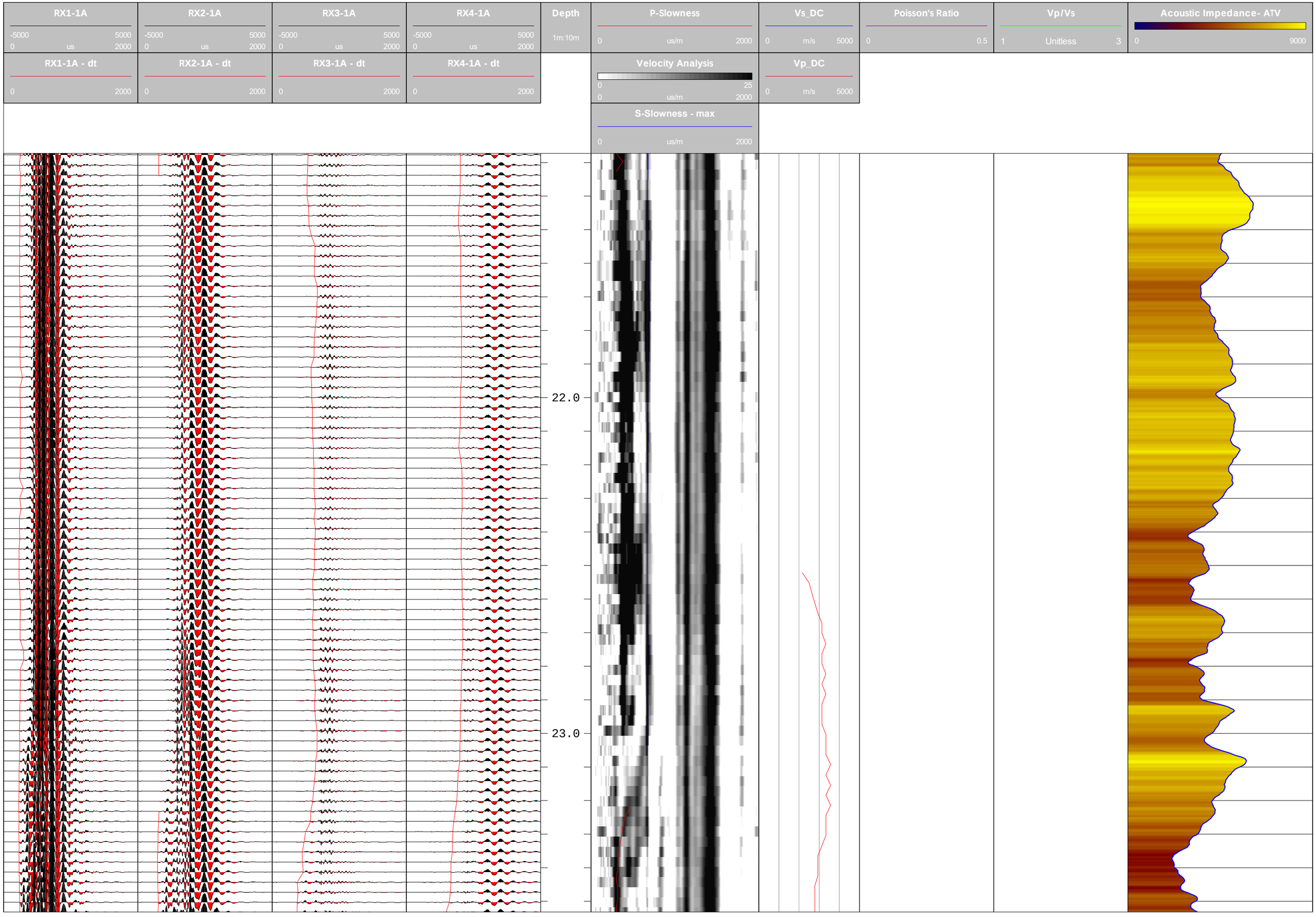
S-Slowness - max
0 us/m 2000



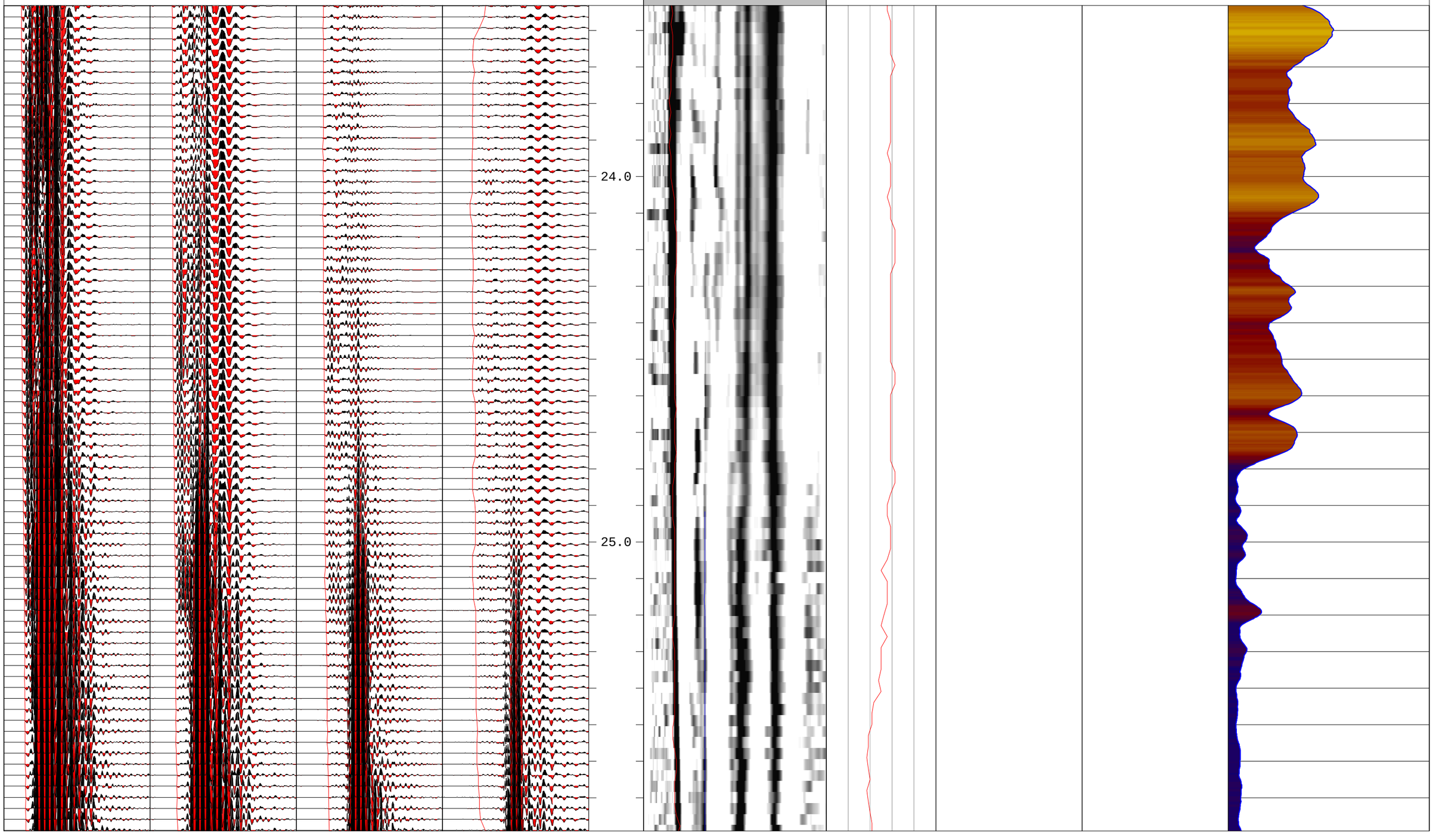
RX1-1A	RX2-1A	RX3-1A	RX4-1A	Depth	P-Slowness	Vs_DC	Poisson's Ratio	Vp/Vs	Acoustic Impedance- ATV
-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	1m:10m	0 us/m 2000	0 m/s 5000	0 0.5	1 Unitless 3	0 9000
RX1-1A - dt	RX2-1A - dt	RX3-1A - dt	RX4-1A - dt		Velocity Analysis 0 25 0 us/m 2000	Vp_DC 0 m/s 5000			
0 2000	0 2000	0 2000	0 2000		S-Slowness - max 0 us/m 2000				



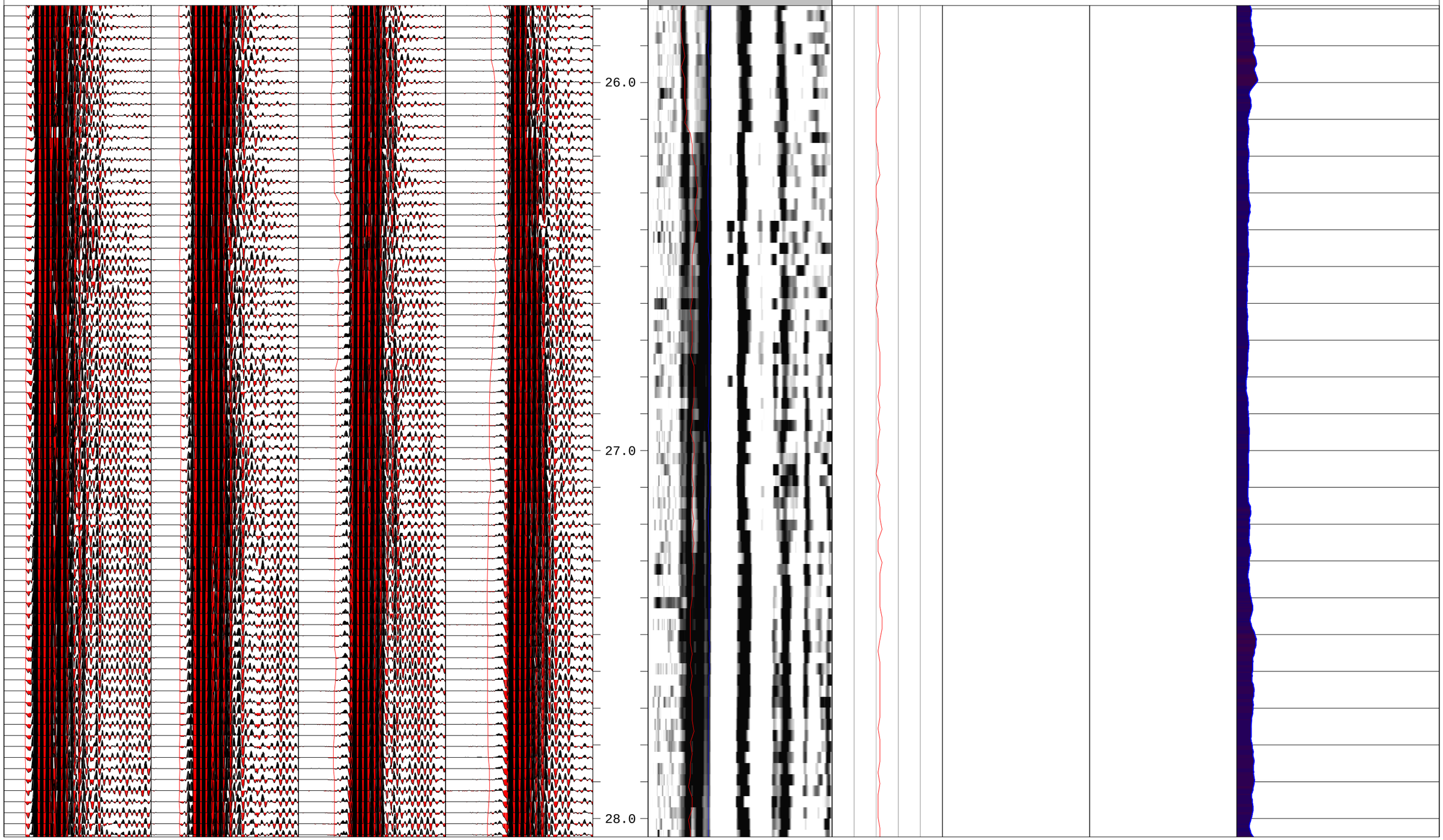

RX1-1A
-5000
5000
0
us
2000
RX2-1A
-5000
5000
0
us
2000
RX3-1A
-5000
5000
0
us
2000
RX4-1A
-5000
5000
0
us
2000
Depth
1m:10m
P-Slowness
0
us/m
2000
Vs_DC
0
m/s
5000
Poisson's Ratio
0
0.5
Vp/Vs
1
Unitless
3
Acoustic Impedance- ATV
0
9000
RX1-1A - dt
0
2000
RX2-1A - dt
0
2000
RX3-1A - dt
0
2000
RX4-1A - dt
0
2000
Velocity Analysis
0
25
0
us/m
2000
Vp_DC
0
m/s
5000
S-Slowness - max
0
us/m
2000
20.0
21.0


RX1-1A
-5000
5000
0
us
2000
RX2-1A
-5000
5000
0
us
2000
RX3-1A
-5000
5000
0
us
2000
RX4-1A
-5000
5000
0
us
2000
Depth
1m:10m
P-Slowness
0
us/m
2000
Vs_DC
0
m/s
5000
Poisson's Ratio
0
0.5
Vp/Vs
1
Unitless
3
Acoustic Impedance- ATV
0
9000
RX1-1A - dt
0
2000
RX2-1A - dt
0
2000
RX3-1A - dt
0
2000
RX4-1A - dt
0
2000
Velocity Analysis
0
25
0
us/m
2000
Vp_DC
0
m/s
5000
S-Slowness - max
0
us/m
2000
22.0
23.0

RX1-1A	RX2-1A	RX3-1A	RX4-1A	Depth	P-Slowness	Vs_DC	Poisson's Ratio	Vp/Vs	Acoustic Impedance- ATV
-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	1m:10m	0 us/m 2000	0 m/s 5000	0 0.5	1 Unitless 3	0 9000
RX1-1A - dt	RX2-1A - dt	RX3-1A - dt	RX4-1A - dt		Velocity Analysis 0 25 0 us/m 2000	Vp_DC 0 m/s 5000			
0 2000	0 2000	0 2000	0 2000		S-Slowness - max 0 us/m 2000				



RX1-1A	RX2-1A	RX3-1A	RX4-1A	Depth	P-Slowness	Vs_DC	Poisson's Ratio	Vp/Vs	Acoustic Impedance- ATV
-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	1m:10m	0 us/m 2000	0 m/s 5000	0 0.5	1 Unitless 3	0 9000
RX1-1A - dt	RX2-1A - dt	RX3-1A - dt	RX4-1A - dt		Velocity Analysis 0 25 0 us/m 2000	Vp_DC 0 m/s 5000			
0 2000	0 2000	0 2000	0 2000		S-Slowness - max 0 us/m 2000				



RX1-1A
-5000 5000
0 us 2000

RX2-1A
-5000 5000
0 us 2000

RX3-1A
-5000 5000
0 us 2000

RX4-1A
-5000 5000
0 us 2000

Depth
1m:10m

P-Slowness
0 us/m 2000

Vs_DC
0 m/s 5000

Poisson's Ratio
0 0.5

Vp/Vs
1 Unitless 3

Acoustic Impedance- ATV
0 9000

RX1-1A - dt
0 2000

RX2-1A - dt
0 2000

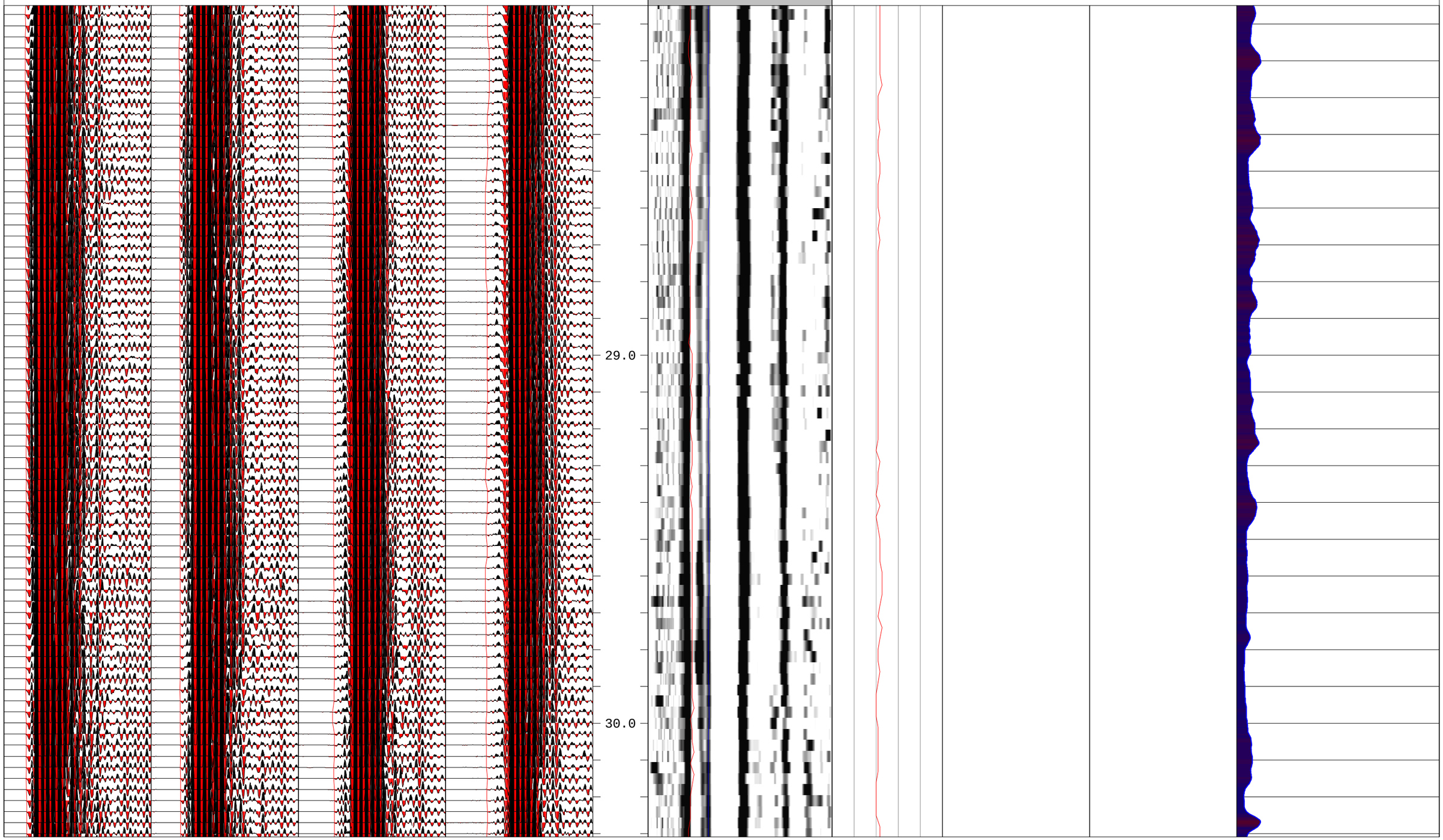
RX3-1A - dt
0 2000

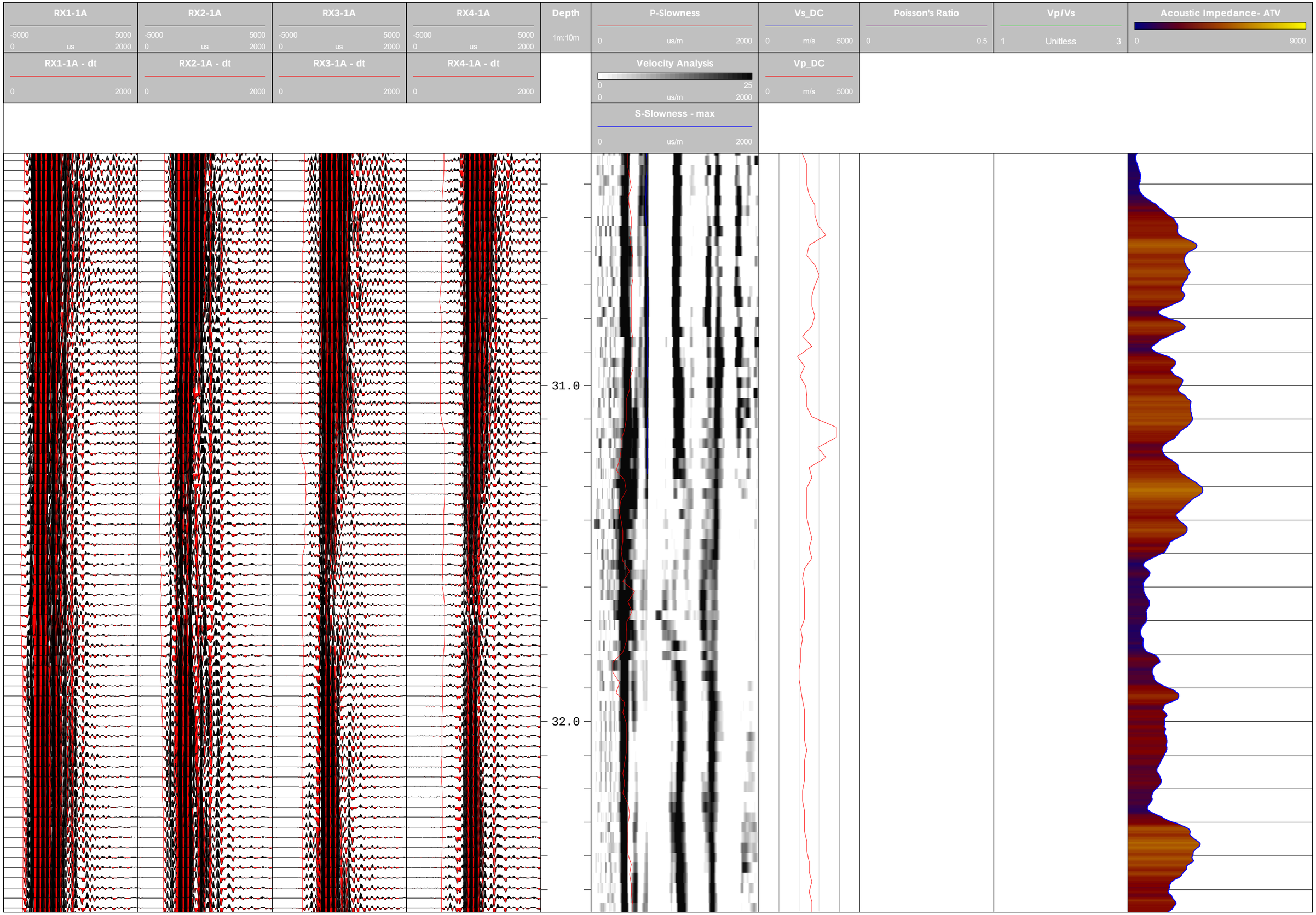
RX4-1A - dt
0 2000

Velocity Analysis
0 25
0 us/m 2000

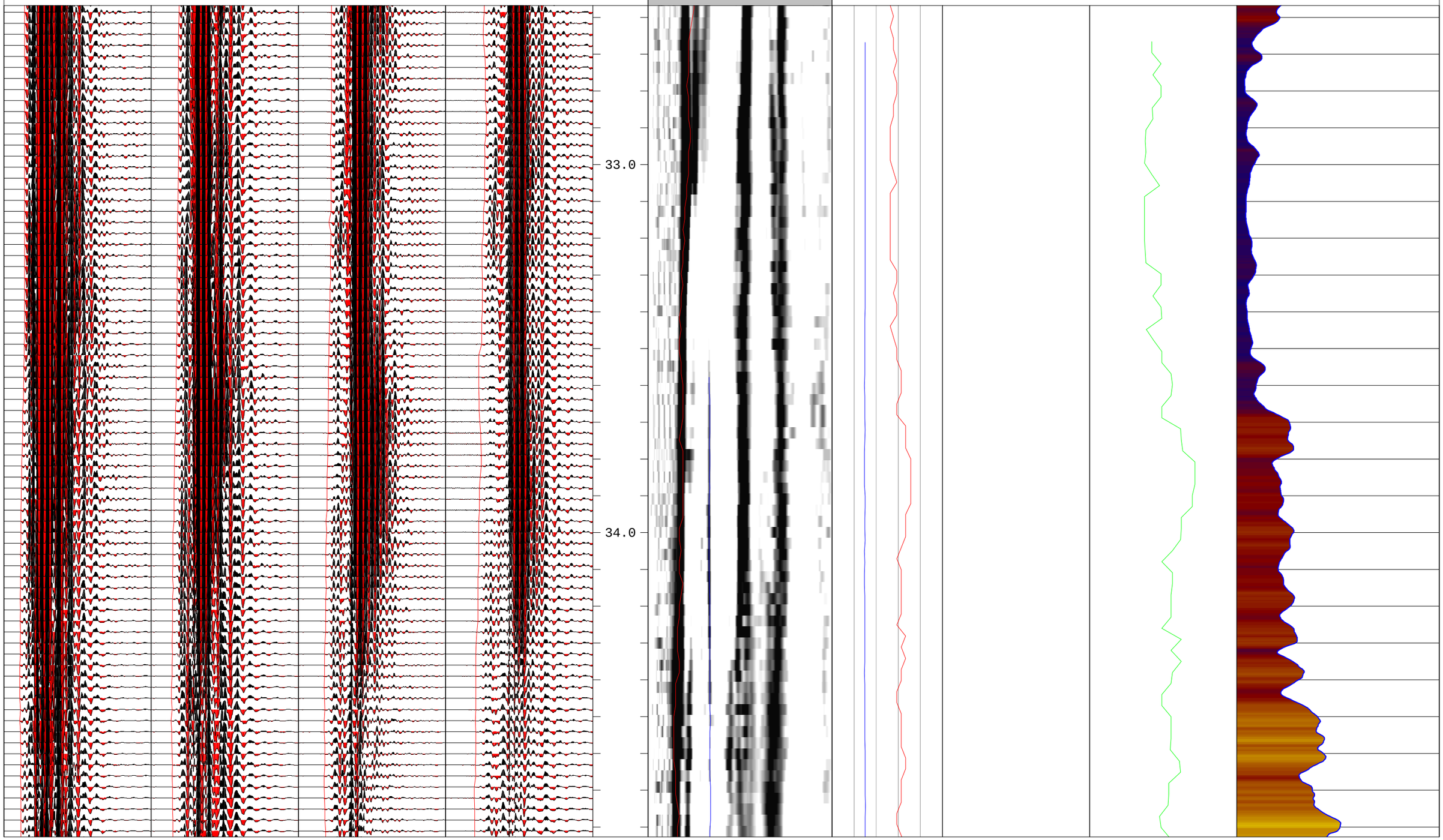
Vp_DC
0 m/s 5000

S-Slowness - max
0 us/m 2000




RX1-1A
-5000
5000
0
us
2000
RX2-1A
-5000
5000
0
us
2000
RX3-1A
-5000
5000
0
us
2000
RX4-1A
-5000
5000
0
us
2000
Depth
1m:10m
P-Slowness
0
us/m
2000
Vs_DC
0
m/s
5000
Poisson's Ratio
0
0.5
Vp/Vs
1
Unitless
3
Acoustic Impedance- ATV
0
9000
RX1-1A - dt
0
2000
RX2-1A - dt
0
2000
RX3-1A - dt
0
2000
RX4-1A - dt
0
2000
Velocity Analysis
0
25
0
us/m
2000
Vp_DC
0
m/s
5000
S-Slowness - max
0
us/m
2000
31.0
32.0

RX1-1A	RX2-1A	RX3-1A	RX4-1A	Depth	P-Slowness	Vs_DC	Poisson's Ratio	Vp/Vs	Acoustic Impedance- ATV
-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	1m:10m	0 us/m 2000	0 m/s 5000	0 0.5	1 Unitless 3	0 9000
RX1-1A - dt	RX2-1A - dt	RX3-1A - dt	RX4-1A - dt		Velocity Analysis 0 25 0 us/m 2000	Vp_DC 0 m/s 5000			
0 2000	0 2000	0 2000	0 2000		S-Slowness - max 0 us/m 2000				



RX1-1A
-5000 5000
0 us 2000

RX2-1A
-5000 5000
0 us 2000

RX3-1A
-5000 5000
0 us 2000

RX4-1A
-5000 5000
0 us 2000

Depth
1m:10m

P-Slowness
0 us/m 2000

Vs_DC
0 m/s 5000

Poisson's Ratio
0 0.5

Vp/Vs
1 Unitless 3

Acoustic Impedance- ATV
0 9000

RX1-1A - dt
0 2000

RX2-1A - dt
0 2000

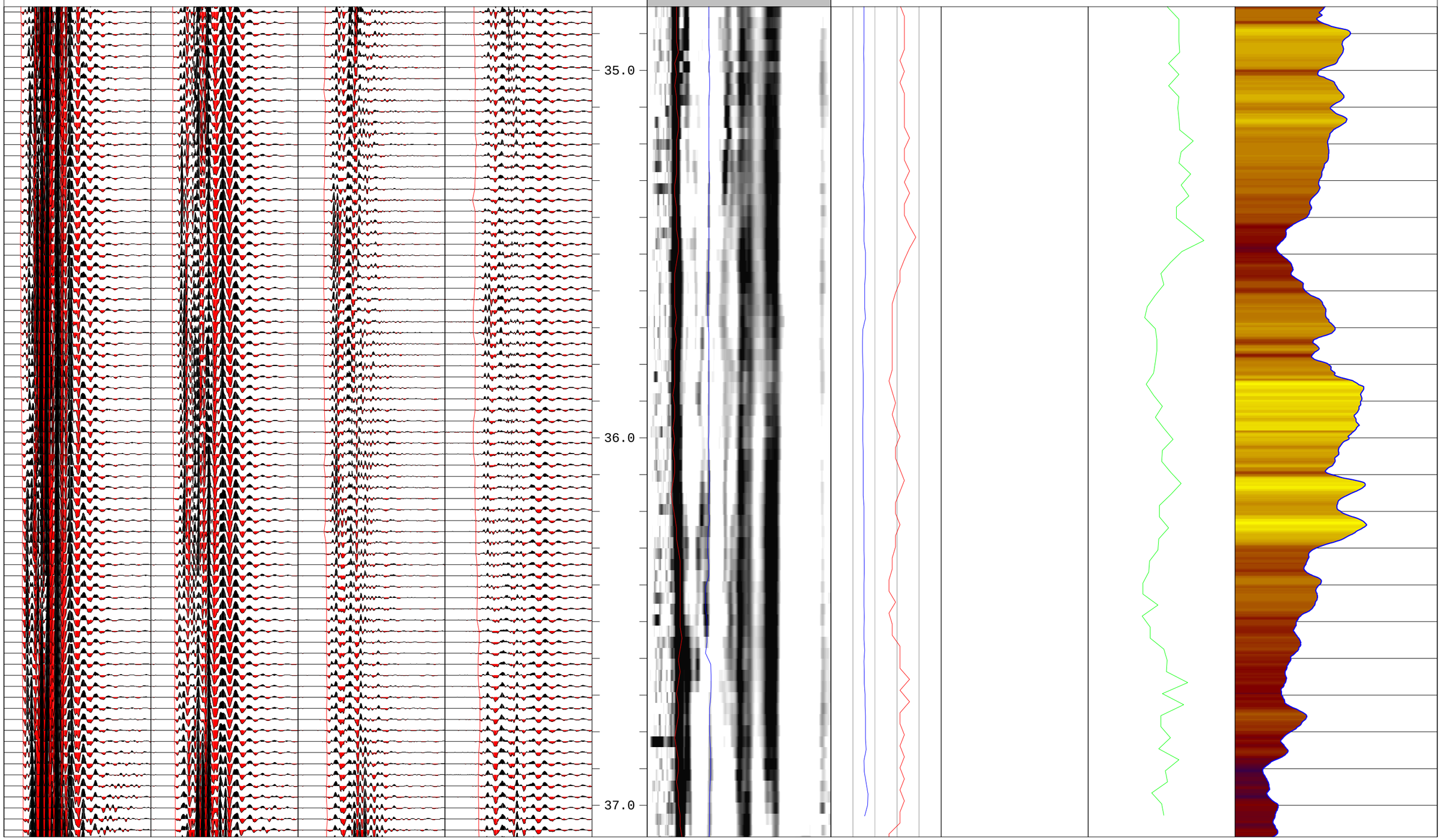
RX3-1A - dt
0 2000

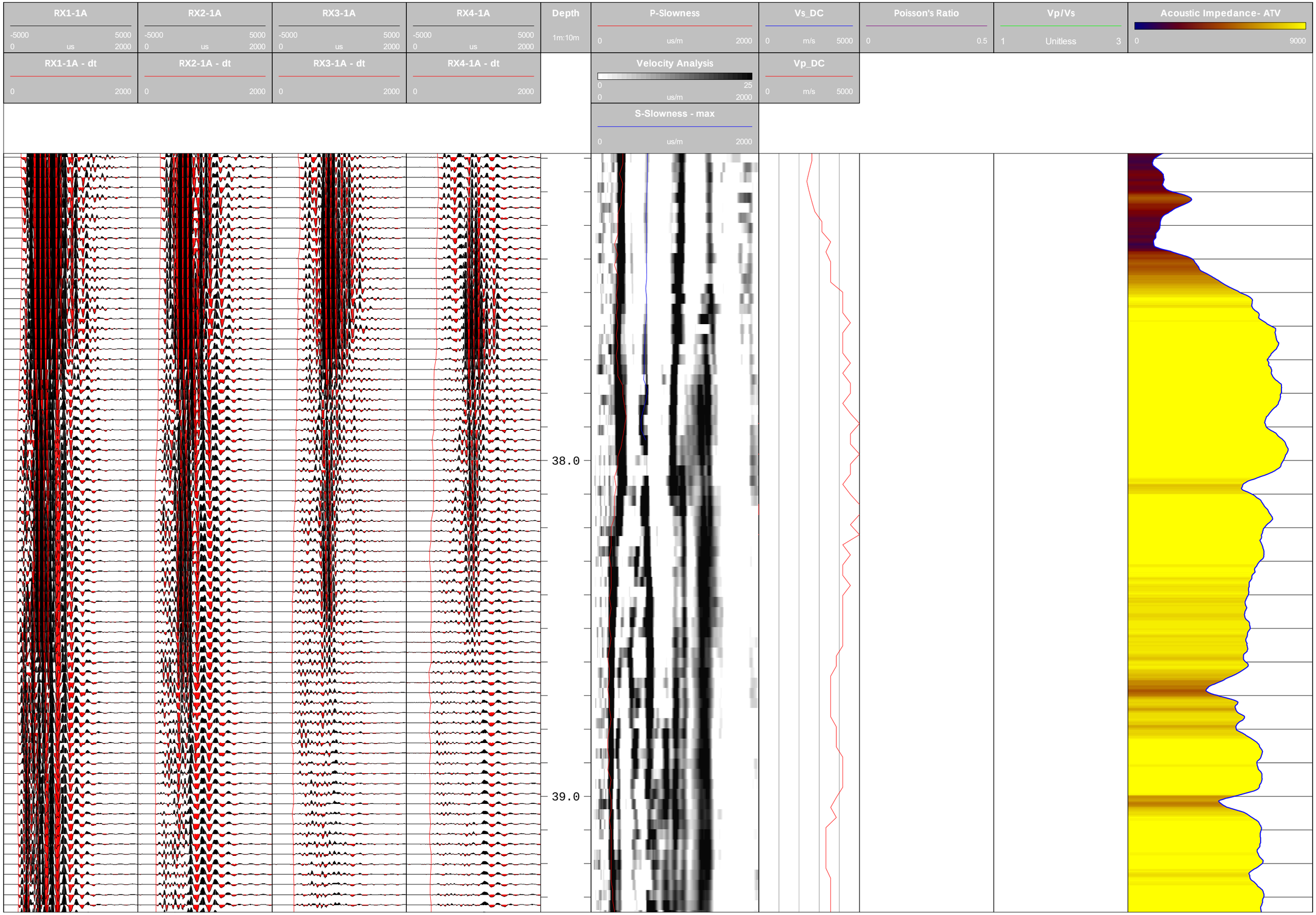
RX4-1A - dt
0 2000

Velocity Analysis
0 25
0 us/m 2000

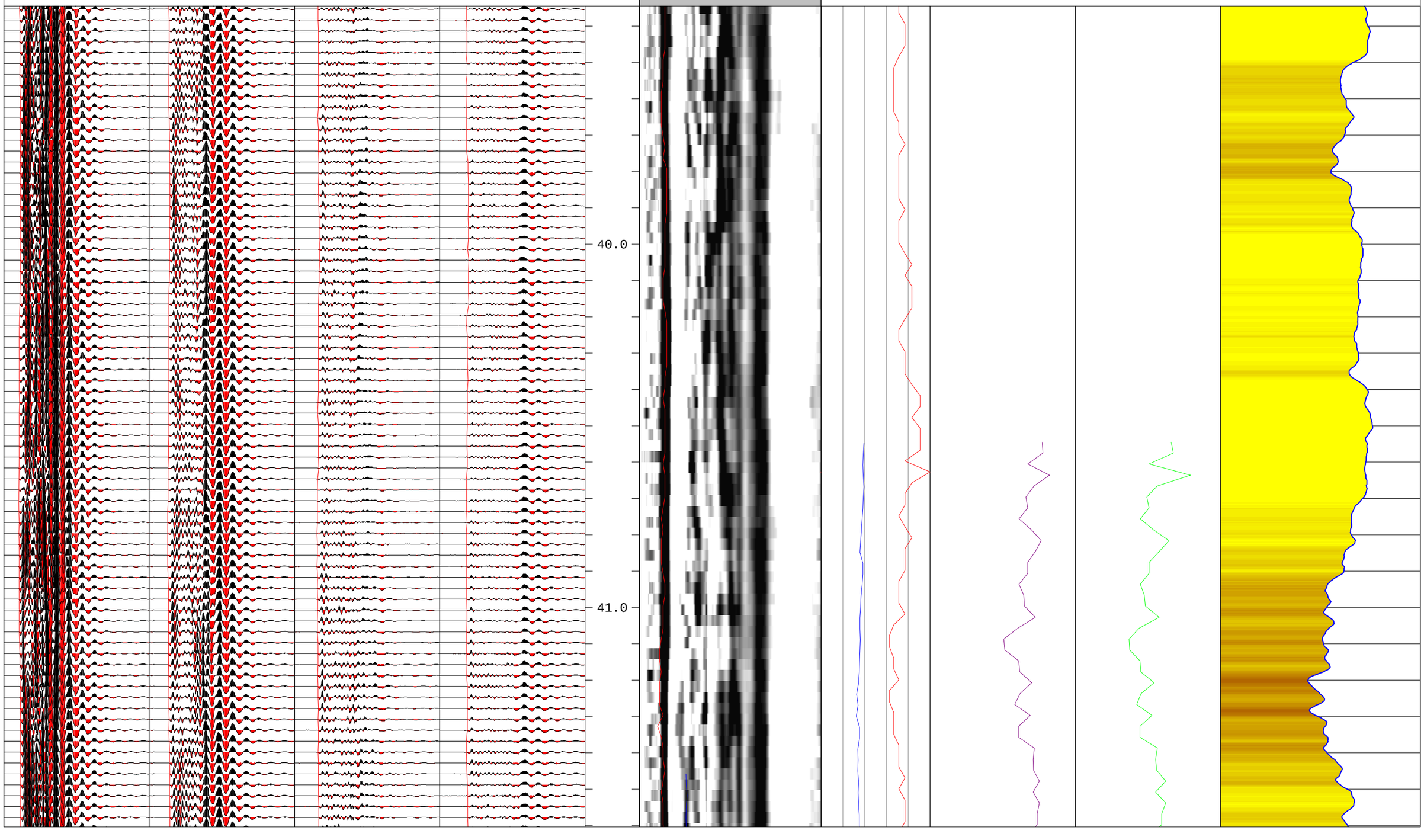
Vp_DC
0 m/s 5000

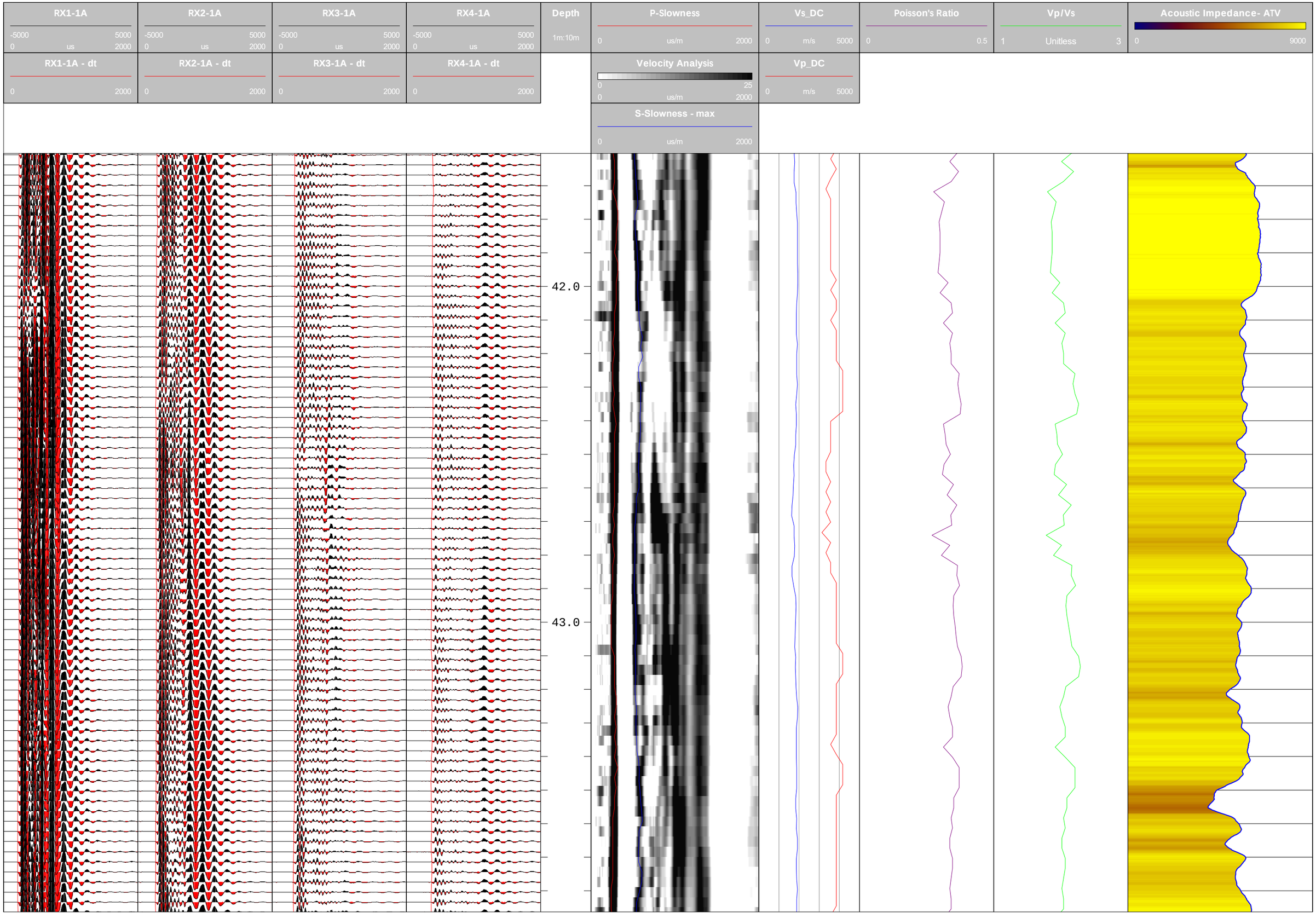
S-Slowness - max
0 us/m 2000

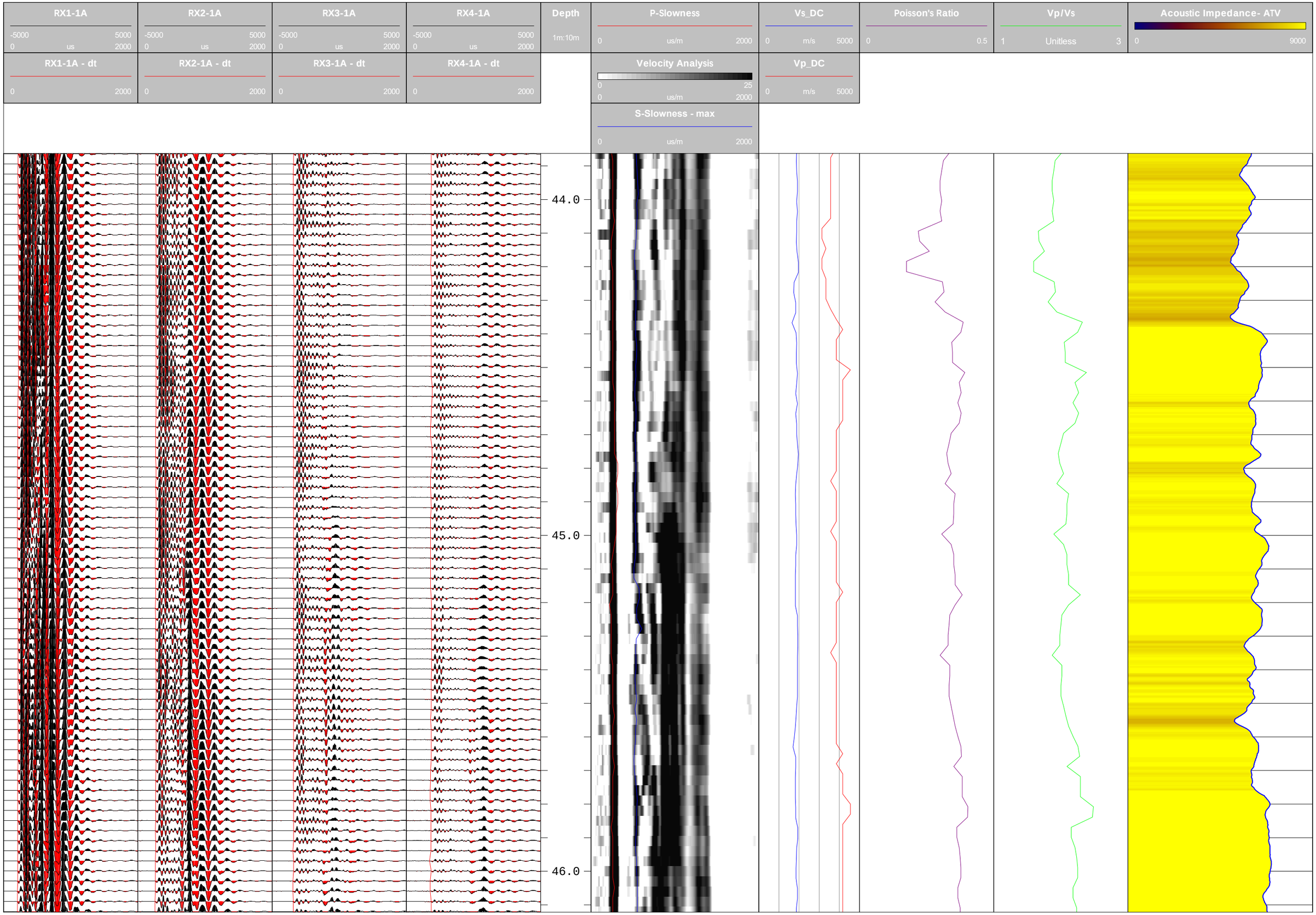


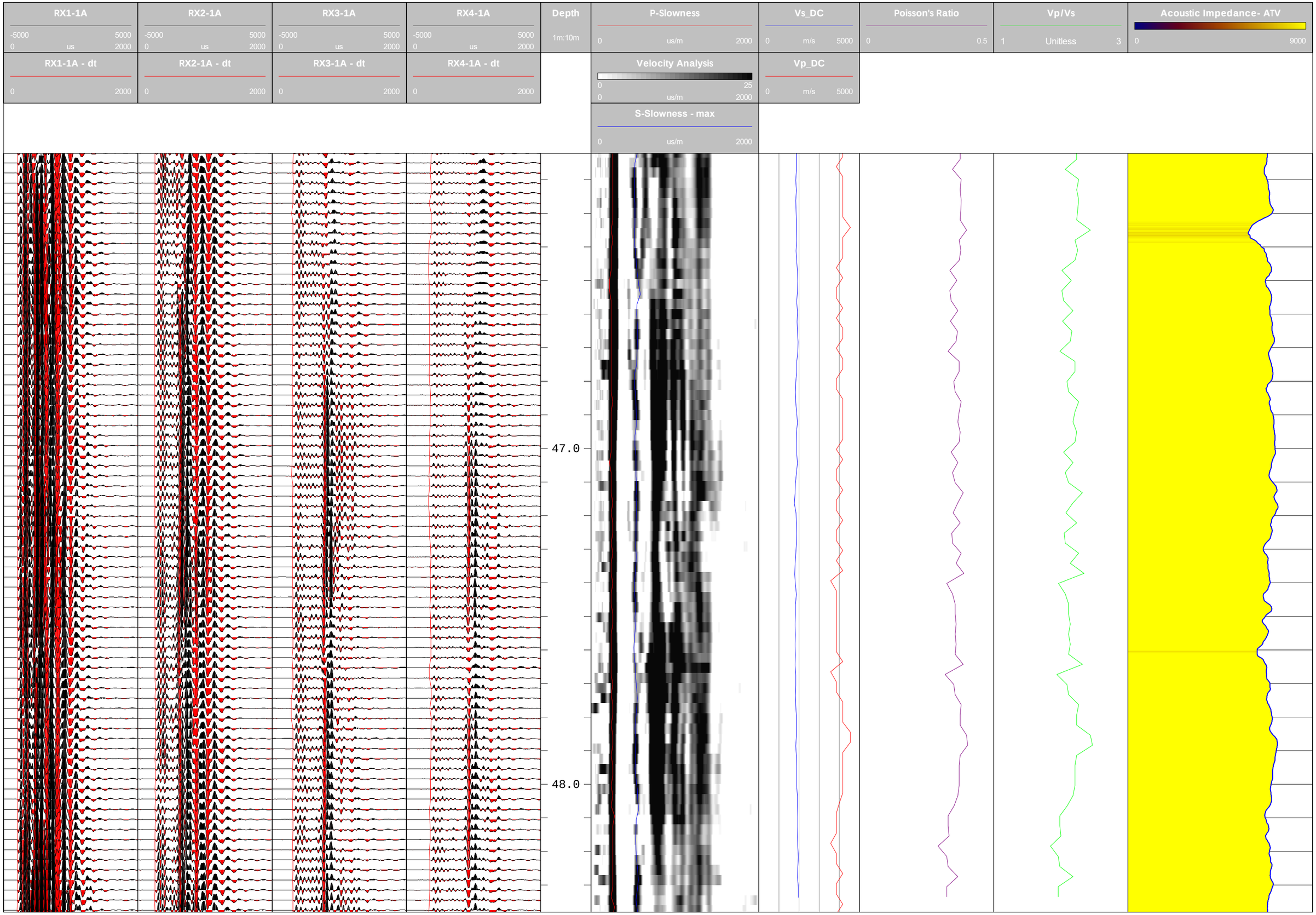

RX1-1A
-5000
5000
0
us
2000
RX2-1A
-5000
5000
0
us
2000
RX3-1A
-5000
5000
0
us
2000
RX4-1A
-5000
5000
0
us
2000
Depth
1m:10m
P-Slowness
0
us/m
2000
Vs_DC
0
m/s
5000
Poisson's Ratio
0
0.5
Vp/Vs
1
Unitless
3
Acoustic Impedance- ATV
0
9000
RX1-1A - dt
0
2000
RX2-1A - dt
0
2000
RX3-1A - dt
0
2000
RX4-1A - dt
0
2000
Velocity Analysis
0
25
0
us/m
2000
Vp_DC
0
m/s
5000
S-Slowness - max
0
us/m
2000
38.0
39.0

RX1-1A	RX2-1A	RX3-1A	RX4-1A	Depth	P-Slowness	Vs_DC	Poisson's Ratio	Vp/Vs	Acoustic Impedance- ATV
-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	-5000 5000 0 us 2000	1m:10m	0 us/m 2000	0 m/s 5000	0 0.5	1 Unitless 3	0 9000
RX1-1A - dt	RX2-1A - dt	RX3-1A - dt	RX4-1A - dt		Velocity Analysis 0 25 0 us/m 2000	Vp_DC 0 m/s 5000			
0 2000	0 2000	0 2000	0 2000		S-Slowness - max 0 us/m 2000				

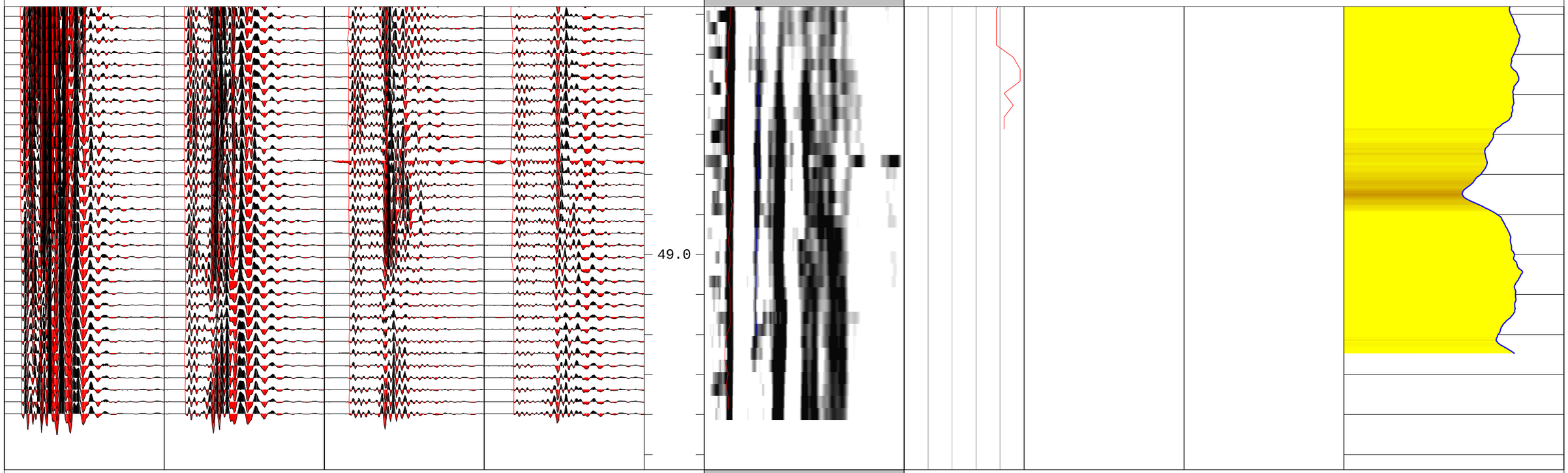



RX1-1A
-5000
5000
0
us
2000
RX2-1A
-5000
5000
0
us
2000
RX3-1A
-5000
5000
0
us
2000
RX4-1A
-5000
5000
0
us
2000
Depth
1m:10m
P-Slowness
0
us/m
2000
Vs_DC
0
m/s
5000
Poisson's Ratio
0
0.5
Vp/Vs
1
Unitless
3
Acoustic Impedance- ATV
0
9000
RX1-1A - dt
0
2000
RX2-1A - dt
0
2000
RX3-1A - dt
0
2000
RX4-1A - dt
0
2000
Velocity Analysis
0
25
0
us/m
2000
Vp_DC
0
m/s
5000
S-Slowness - max
0
us/m
2000
42.0
43.0


RX1-1A
-5000
5000
0
us
2000
RX2-1A
-5000
5000
0
us
2000
RX3-1A
-5000
5000
0
us
2000
RX4-1A
-5000
5000
0
us
2000
Depth
1m:10m
P-Slowness
0
us/m
2000
Vs_DC
0
m/s
5000
Poisson's Ratio
0
0.5
Vp/Vs
1
Unitless
3
Acoustic Impedance- ATV
0
9000
RX1-1A - dt
0
2000
RX2-1A - dt
0
2000
RX3-1A - dt
0
2000
RX4-1A - dt
0
2000
Velocity Analysis
0
25
0
us/m
2000
Vp_DC
0
m/s
5000
S-Slowness - max
0
us/m
2000
44.0
45.0
46.0


RX1-1A
-5000
5000
0
us
2000
RX2-1A
-5000
5000
0
us
2000
RX3-1A
-5000
5000
0
us
2000
RX4-1A
-5000
5000
0
us
2000
Depth
1m:10m
P-Slowness
0
us/m
2000
Vs_DC
0
m/s
5000
Poisson's Ratio
0
0.5
Vp/Vs
1
Unitless
3
Acoustic Impedance- ATV
0
9000
RX1-1A - dt
0
2000
RX2-1A - dt
0
2000
RX3-1A - dt
0
2000
RX4-1A - dt
0
2000
Velocity Analysis
0
25
0
us/m
2000
Vp_DC
0
m/s
5000
S-Slowness - max
0
us/m
2000
47.0
48.0

RX1-1A	RX2-1A	RX3-1A	RX4-1A	Depth	P-Slowness	Vs_DC	Poisson's Ratio	Vp/Vs	Acoustic Impedance- ATV
-5000 5000	-5000 5000	-5000 5000	-5000 5000	1m:10m	0 us/m 2000	0 m/s 5000	0 0.5	1 Unitless 3	0 9000
0 us 2000	0 us 2000	0 us 2000	0 us 2000						
RX1-1A - dt	RX2-1A - dt	RX3-1A - dt	RX4-1A - dt		Velocity Analysis	Vp_DC			
0 2000	0 2000	0 2000	0 2000		0 25 0 us/m 2000	0 m/s 5000			
					S-Slowness - max				
					0 us/m 2000				



RX1-1A - dt	RX2-1A - dt	RX3-1A - dt	RX4-1A - dt		Velocity Analysis	Vp_DC			
0 2000	0 2000	0 2000	0 2000		0 us/m 2000 0 25	0 m/s 5000			
					S-Slowness - max				
					0 us/m 2000				
RX1-1A	RX2-1A	RX3-1A	RX4-1A	Depth	P-Slowness	Vs_DC	Poisson's Ratio	Vp/Vs	Acoustic Impedance- ATV
0 us 2000 -5000 5000	0 us 2000 -5000 5000	0 us 2000 -5000 5000	0 us 2000 -5000 5000	1m:10m	0 us/m 2000	0 m/s 5000	0 0.5	1 Unitless 3	0 9000

Appendix D
Laboratory test results

EFFECTIVE STRESS TRIAXIAL TEST REPORT

Project*	**Kaikoura Earthquake-Induced Landslide Research**
Location*	**North Canterbury**
Client*	**WSP Wellington**
Contractor*	**GNS Science**
Sampled by*	**CW Drilling**
Date sampled*	**6-8/09/2020**
Sampling method*	**Push Tube**
Sample condition	**Moist/wet**

Report No:	**522900/1494**
Sample No:	**2-22/069**
Client Ref*	**5C3418.00**

Test Results

Specimen stage		1	2	3			
Sample source*		**Hundalee Hills 1636424 E 5289209 N BH 104 4.0 - 4.6mm**					
Sample description*		**Clayey SILT Push Tube nom. 72mm**					
Specimen type/ history		**Core**	←	←			
Specimen dimension dia. x L	mm	**72 x 142**	←	←			
As rec'd water content	%	**27.9**	←	←			
Bulk density (ρ)	t/m^3	**2.04**	←	←			
Dry density (ρ_d)	t/m^3	**1.60**	←	←			
Compaction % MDD #	%	**n/a**	←	←			
Saturation check (B)	%	**99.8**	**n/a**	**n/a**			
Initial confining stress (σ_3)	kPa	**50**	**120**	**300**			
Vol. change during consol. (Δv)	%	**0.3**	**1.1**	**2.1**			
Values at max. Stress Ratio (σ_1'/σ_3') stages 1, 2, 3							
Strain (∈)	%	**1.98**	**2.98**	**3.55**			
Deviator stress ($\sigma_1'- \sigma_3'$)	kPa	**114.9**	**203.7**	**400.5**			
Pore press change (ΔP)	kPa	**15.2**	**49.8**	**151.4**			
Shear stress Q ($\sigma_1'- \sigma_3'$)/2	kPa	**57.5**	**101.8**	**200.2**			
Mean Pr. Stress P ($\sigma_1'+ \sigma_3'$)/2	kPa	**92.3**	**172.0**	**348.8**			
Final water content (w_1)	%	**n/a**	**n/a**	**19.4**			
Failure type		**n/a**	**n/a**	**n/a**			

By linear regression analysis of the Q and P values - Stages 1,2,3

Strength Parameters for the (σ_3) range = 50 - 300 kPa

Apparent Cohesion c' = 7 kPa

Angle of Internal Friction ϕ' = 33.8 Degrees.

Test type: Back pressure saturated, consolidated, undrained with pore pressure measurement. Stage loaded.

Strain rates for all stages 1-3 = 0.0237 mm/min.

* Client supplied project / sample information

Test method: In house Opus Research Report 2-82/9

Date tested: 5 - 20.07.2022

Reported by: DWP

Approved Signatory

Designation : *Civil Engineering Technician (DW Pollard)*

Date: 03.08.2022

Testing only is covered by IANZ Accreditation

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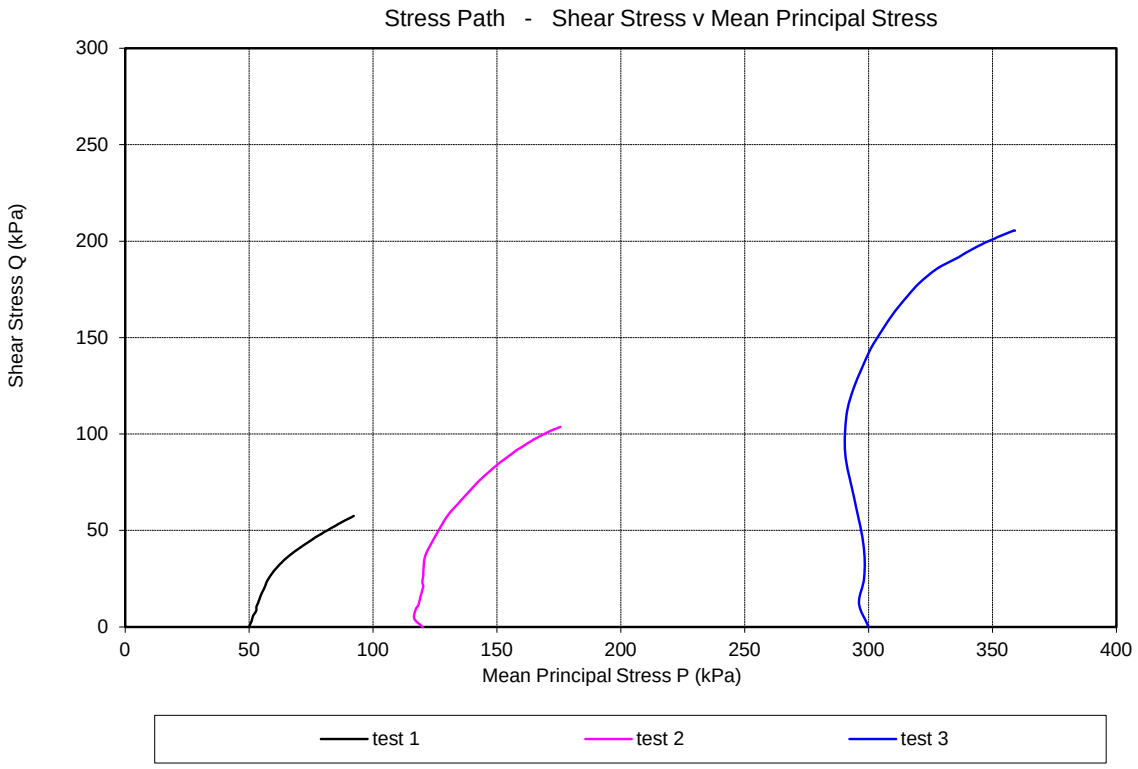
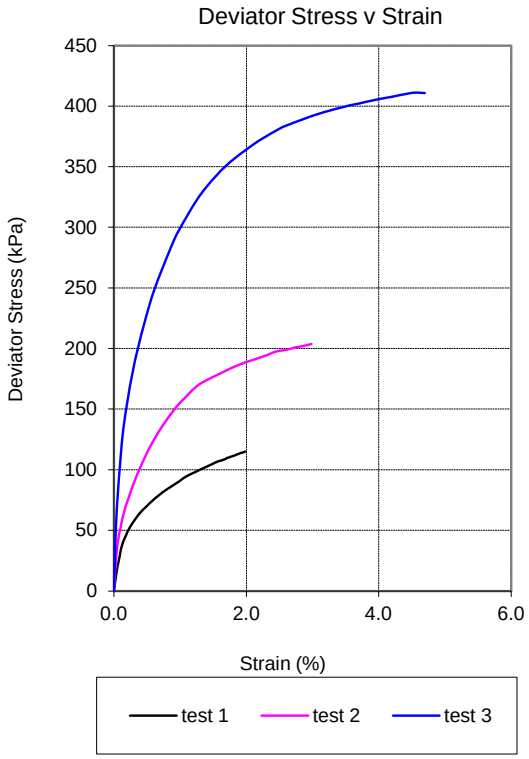
Web www.wsp.com/en-NZ

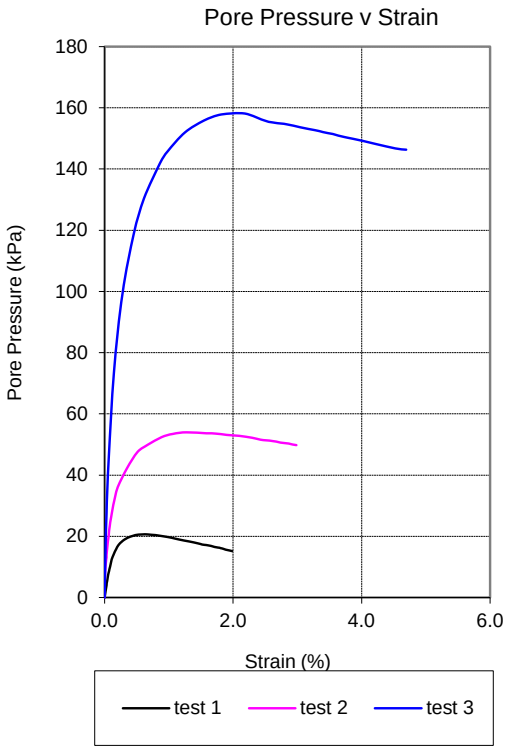
EFFECTIVE STRESS TRIAXIAL TEST REPORT

Report No.	**522900/1494**
Sample No.	**2-22/069**
Client Ref:	**5C3418.00**

Test Results







EFFECTIVE STRESS TRIAXIAL
TEST REPORT

Report No.	**522900/1494**
Sample No.	**2-22/069**
Client Ref:	**5C3418.00**

Test Results - Photos

EFFECTIVE STRESS TRIAXIAL TEST REPORT

Project*	**Kaikoura Earthquake-Induced Landslide Research**
Location*	**North Canterbury**
Client*	**WSP Wellington**
Contractor*	**GNS Science**
Sampled by*	**CW Drilling**
Date sampled*	**6-8/09/2022**
Sampling method*	**Push Tube**
Sample condition	**Moist/wet**

Report No:	**522900/1494**
Sample No:	**2-22/070**
Client Ref*	**5C3418.00**

Test Results

Lab. Sample/specimen		**2-22/070**						
Specimen stage		**1**	**2**	**3**				
Sample source*		**Homestead Creek 1626055 E 5278370 N BH 105 7.9 – 8.4m**						
Sample description*		**Clayey SILT Push Tube nom. 72mm**						
Specimen type/ history		**Core**	←	←				
Specimen dimension dia. x L	mm	**73 x 141**	←	←				
As rec'd water content	%	**20.6**	←	←				
Bulk density (ρ)	t/m^3	**2.08**	←	←				
Dry density (ρ_d)	t/m^3	**1.73**	←	←				
Compaction % MDD #	%	**n/a**	←	←				
Saturation check (B)	%	**100.0**	**n/a**	**n/a**				
Initial confining stress (σ_3)	kPa	**50**	**200**	**500**				
Vol. change during consol. (Δv)	%	**0.5**	**1.9**	**2.3**				
Values at max. Stress Ratio (σ_1'/σ_3') stages 1, 2, 3								
Strain ($\in$)	%	**1.89**	**2.99**	**3.08**				
Deviator stress ($\sigma_1'- \sigma_3'$)	kPa	**102.4**	**266.0**	**547.8**				
Pore press change (ΔP)	kPa	**27.3**	**95.5**	**264.7**				
Shear stress Q ($\sigma_1'- \sigma_3'$)/2	kPa	**51.2**	**133.0**	**273.9**				
Mean Pr. Stress P ($\sigma_1'+ \sigma_3'$)/2	kPa	**73.9**	**237.5**	**509.2**				
Final water content (w_1)	%	**n/a**	**n/a**	**17.0**				
Failure type		**n/a**	**n/a**	**n/a**				

By linear regression analysis of the Q and P values - Stages 1,2,3

Strength Parameters for the (σ_3) range = 50-500 kPa

Apparent Cohesion c' = 15 kPa

Angle of Internal Friction ϕ' = 30.8 Degrees.

Test type: Back pressure saturated, consolidated, undrained with pore pressure measurement. Stage loaded.

Strain rates for stages 1-3 = 0.0235, 0.0010 & 0.0010 mm/min.

* Client supplied project / sample information

Test method: In house Opus Research Report 2-82/9

Date tested: 4.05-10.06.2022

Reported by: DWP

Approved Signatory

Designation : *Civil Engineering Technician (DW Pollard)*

Date: 03.08.2022

Testing only is covered by IANZ Accreditation

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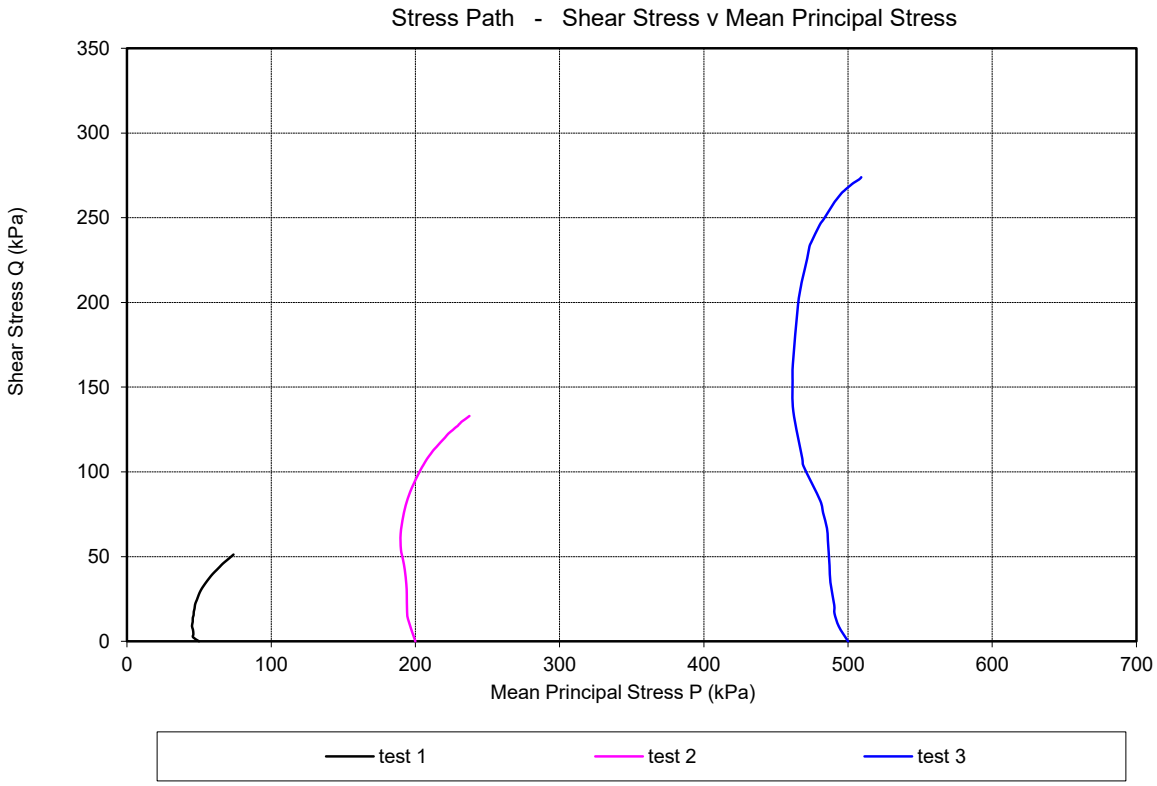
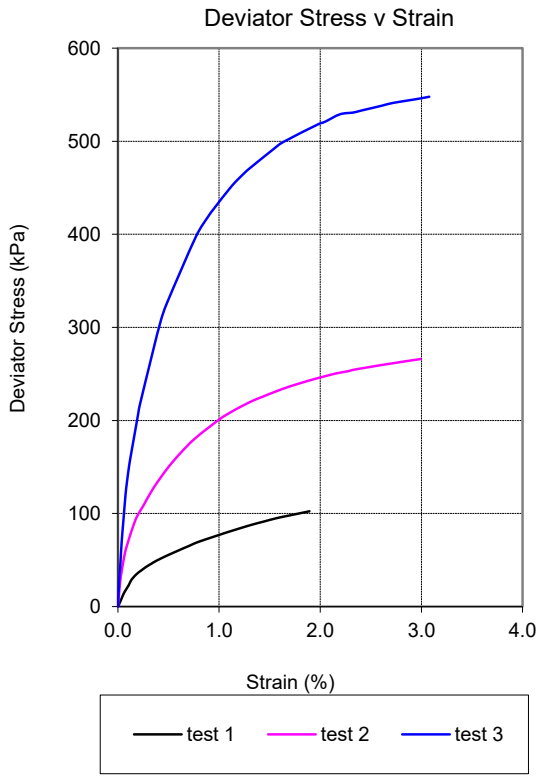
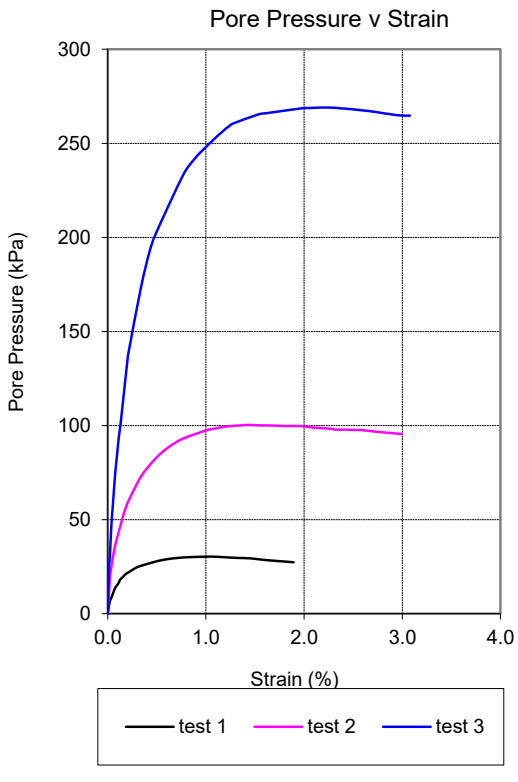
EFFECTIVE STRESS TRIAXIAL TEST REPORT

Report No.	**522900/1494**
Sample No.	**2-22/070**
Client Ref:	**5C3418.00**

Test Results







EFFECTIVE STRESS TRIAXIAL
TEST REPORT

Report No.	**522900/1494**
Sample No.	**2-22/070**
Client Ref:	**5C3418.00**

Test Results - Photos

PLASTICITY INDEX TEST REPORT

Project*	**Kaikoura Earthquake-Induced Landslide Research**
Location*	**North Canterbury**
Client*	**WSP Wellinton**
Contractor*	**GNS Science**
Sampled by*	**CW Drilling**
Date sampled*	**6-8/09/2020**
Sampling method*	**Push tube**
Sample condition:	**Natural (Ex tx sample)**

Report No:	**522900/1494**
Sample No:	**see table**
Client Ref:	**5-C3418.00**

Test Results		
WSP Sample no:	**2-22/069**	**2-22/070**
Sample source*	**Hundalee Hills** **1636424 E 5289209 N** **BH 104** **4.0 – 4.6m**	**Homestead Creek** **1626055 E 5278370 N** **BH 105** **7.9 – 8.4m**
Sample description	**Clayey SILT** **Push Tube** **nom. 72mm**	**Clayey SILT** **Push Tube** **nom. 72mm**
Liquid Limit (LL):	**34 ± 1**	**36 ± 1**
Cone Penetration Limit (CPL):	**-**	**-**
Plastic Limit (PL):	**19 ± 1**	**18 ± 1**
Plasticity Index (PI):	**15 ± 2**	**18 ± 2**
Linear Shrinkage (LS):	**9**	**10**
Water Content (%): (Whole soil)	**27.9**	**20.6**
Fraction tested:	**-0.425mm**	**-0.425mm**
Number of LL or CPL points:	**4**	**4**

Test Methods		**Notes**
Water Content	NZS 4402 : 1986, Test 2.1	Variation: Alternative 0.01g accuracy balance used. NZS 4402:1986 requires the reporting of a range of values. N.P = Non Plastic N.A = Not Achievable
Liquid Limit	NZS 4402 : 1986, Test 2.2	
Plastic Limit	NZS 4402 : 1986, Test 2.3	
Plasticity Index	NZS 4402 : 1986, Test 2.4	*Supplied data/information by WSP Wellington
Cone Penetration Limit	NZS 4402 : 1986, Test 2.5	
Linear shrinkage	NZS 4402 : 1986, Test 2.6	History: Natural - Ex Triaxial sample

Date tested : 19-27.07.2022
Date reported : 8.08.2022

Sampling is not is covered by IANZ Accreditation
Results apply only to sample tested.
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Approved Signatory
Designation : *Senior Engineering Technician (DW Pollard)*
Date : 8.08.2022

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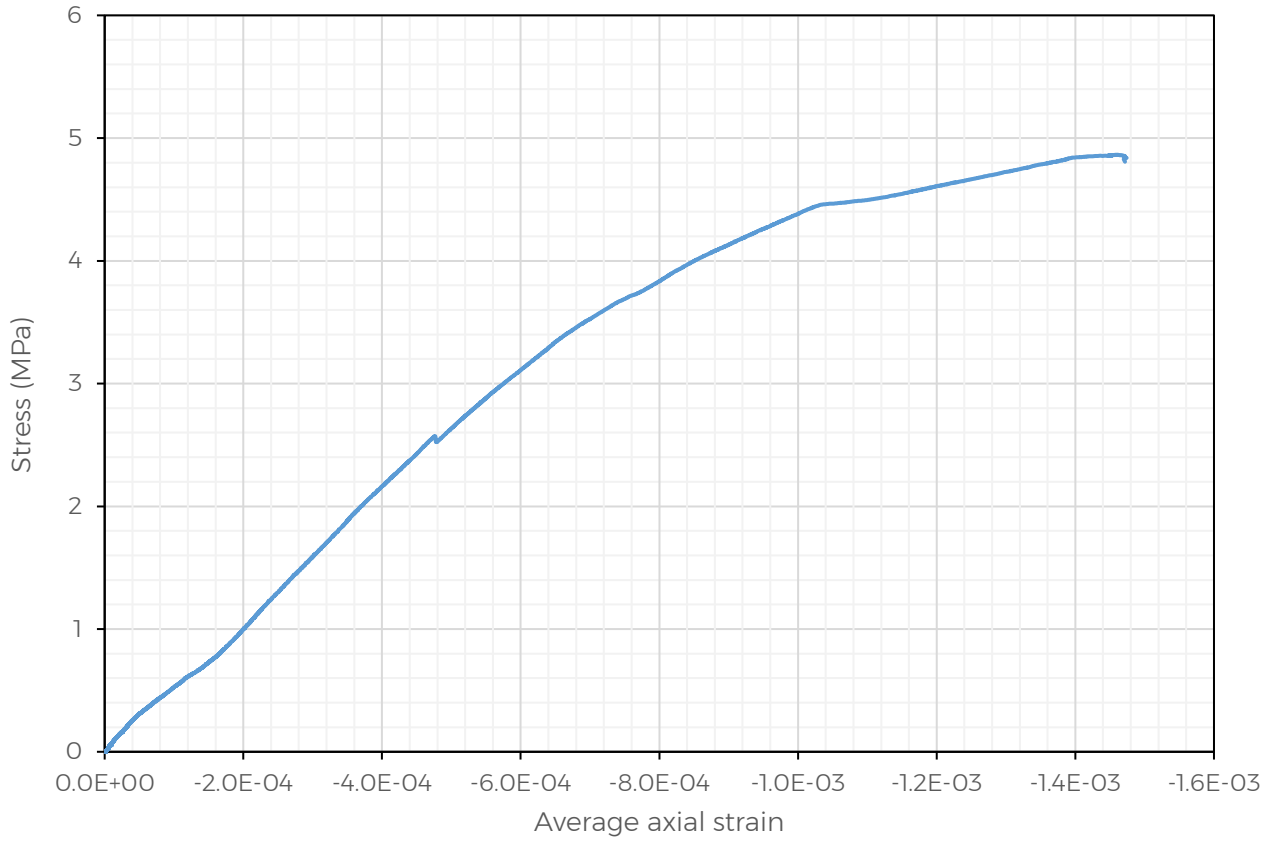
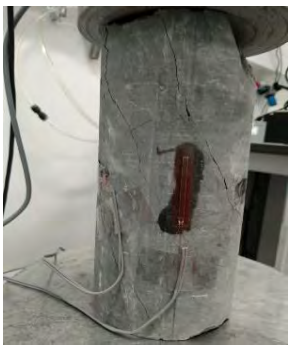
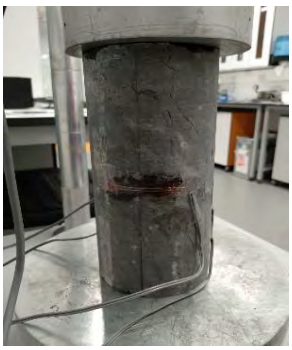
Unconfined Compression Test

Project	Kaikōura Earthquake-Induced Landslide Research
Location	Okiwi Bay
Client	GNS Science
Sampled by	CW Drilling
Date sampled	12/10/2020
Sampling method	Rotary coring
Sample diameter	85 mm (PQ)
Sample ID	BH101-46.5m
Date tested	14/07/2021
Tested by	C Higgins, University of Canterbury

Load at failure	27.607	kN
σ_{ax}	4.8651	axial stress at failure, MPa
σ_{c50}	5.4013	corrected axial compressive strength, MPa



Test set up: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