CONSTRUCTION ENVIRONMENT MANAGEMENT PLAN

APPENDIX 5

GPR SURVEYS

(Towers 106, 111, 112 & 113)

Geodata
Chartered Land Surveyors

Technical Report

Ground-Penetrating Radar (GPR) & Utility Detection Survey

Client: OCB Geotechnical Ltd

Project: 21719 –Monaghan, Site 106.

28th of February 2022

GeoData Surveying Ltd
Registered Office: 47 Oliver Plunkett Street, Bandon, Co Cork. P72 A443.
Tel: 023 8852798 | www.geodatasurveying.ie

Summary

Technical Report - Ground-Penetrating Radar (GPR) & Utility Survey

Client: OBC Geotechnical Ltd

Project: Project: 21719–Monaghan, Site 106

Document Evolution					
Job no	**Issue**	**Date**	**Prepared by**	**Checked by**	**Description**
21719	01	28-02-22	S. Forys	K O'Brien	First Edition

1. Introduction

Geodata were requested to carry out a Ground-Penetrating Radar (GPR)Surveyfor OCB Geotechnical.



Extent of Survey

2. Scope of the Investigation

The scope of the investigation is to Ground Penetrating Radar (GPR) on a 50m x 50m area at a 5m grid spacing using a 200 MHz shielded antennae with A Real Time Kinematic (RTK) differential GPS to accurately log the position of each GPR trace.

3. Limitation of Survey

It must be noted the geophysical data by itself does not allow identification of the anomalies detected. No GPR survey can be considered a 100% accurate depiction of the sub-surface environment and the use of these drawings does not remove the requirement for the use of safe digging techniques at all times.

4. Method of Investigation

The Survey was carried out using the following methods:

- Desk Top Studies;
- Site reconnaissance
- Establish Survey grids
- Ground Penetrating Radar (GPR);
- Record and Process markings
- Post Processing GPR Data;
- Quality Check
- Final Report

5. Detection Methodology

The Survey was carried using IDS Opera Duo multi frequency Ground Penetrating Radar with a frequency of 200MHz to allow greater penetration on a 50m x 50m area at a 5m grid spacing. position of each GPR trace.

5.1. Geo-radar

Ground Penetrating Radar is a non invasive technology that uses radar waves from a surface transmitter that can penetrate through ground materials and are reflected back to the instrument by a change of ground material or other buried objects.

The transmission frequency is an importance factor in GPR. Low frequency radars will provide high penetration into the target but these results can lead to unfavourable resolutions. High frequency radar provides greater resolution in regards to radar images but the penetration is less than the low frequency.

In this instance the Opera Duo achieved a penetration of typically 1.2-2.0m below the surface. The position of the array was continually monitored and recorded using a total station.



Figure 5.0 C-Stream IDS -High Density Array (GPR)

5.2. Post Process of Ground Penetrating Radar (GPR) data

Ground Penetrating Radar (GPR) data was post processed to improve the interpretation of raw data using GRED HD GPR Post processing software.

Post processing aids in the identification of responses to gain a better understanding of areas of complex or more obscure utility networks..

6. Quality Check

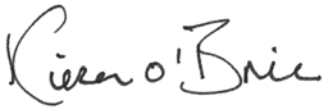
GeoData has inbuilt quality check system involving cross checking and discussion between teams to identify any possible inaccuracies and to improve the interpretation of the Post processing of GPR data and onsite observations. All Equipment used was calibrated and tested in line with manufacturer guidelines and survey carried out in accordance with TSA guidelines.

7. Conclusions and Recommendations.

Ground Penetration Radar resolution was generally good on site with penetration of typically 1.2-2.0m below the surface in area of optimal ground conditions. Areas unable to be surveyed due to surface obstructions, vegetation, slope or lack of access were marked in the survey drawings (Appendix A)

The Radiograms show a uniform substrate of soil, I would not be in a position to comment on the physical characteristic of the substrate due to the absent of site investigation to reference the Ground Penetrating Radar data.

Yours sincerely,

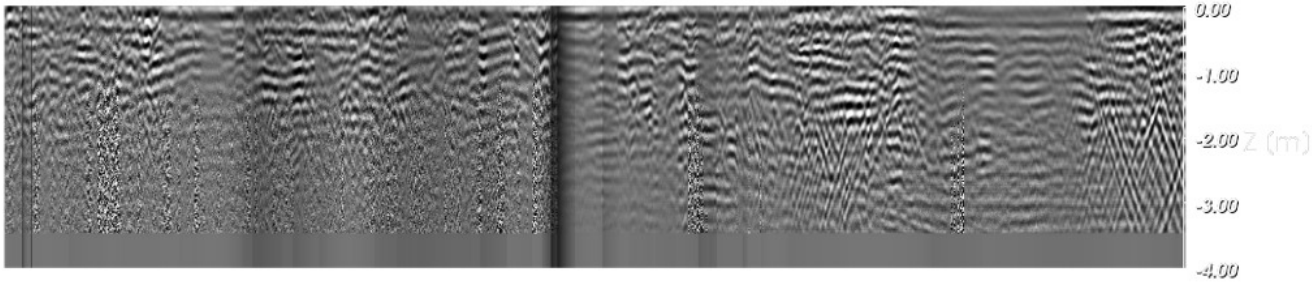


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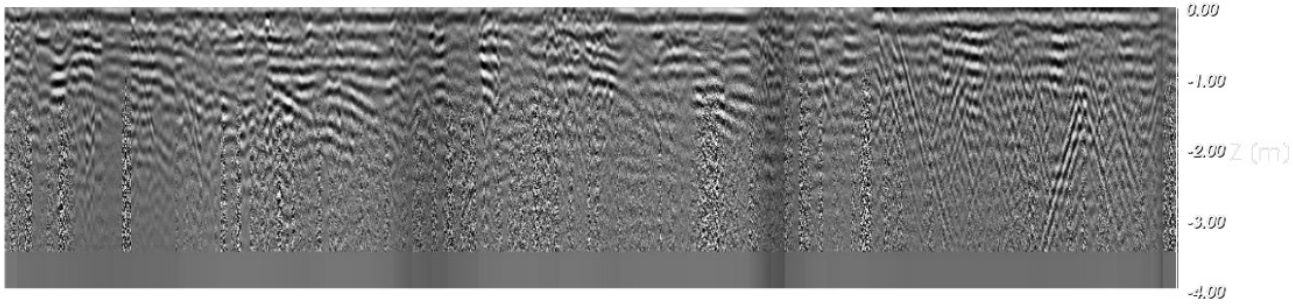
Kieran O'Brien
Chartered Engineer & Chartered Geomatics Surveyor
BEng(Hons) CEng MIEI MSCSI/MRIC

Appendix A

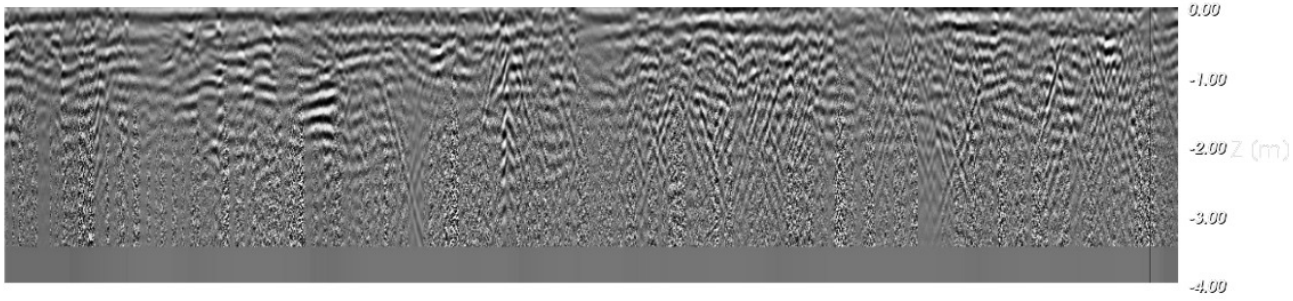
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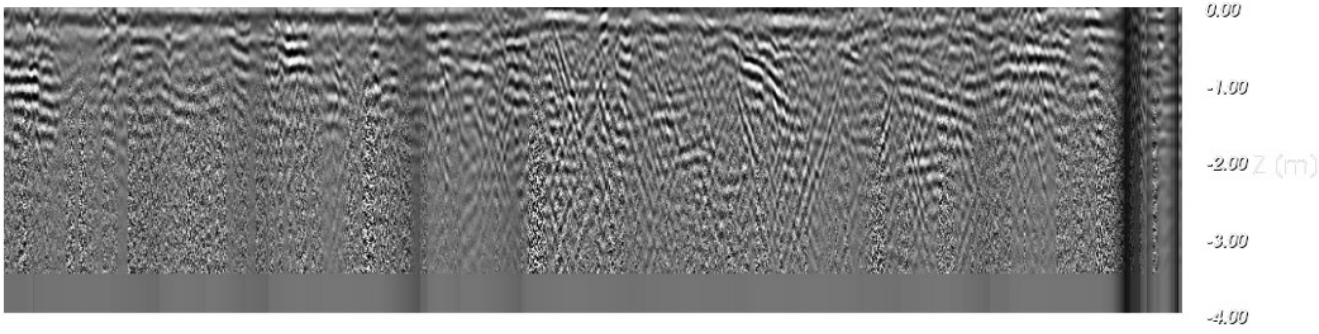
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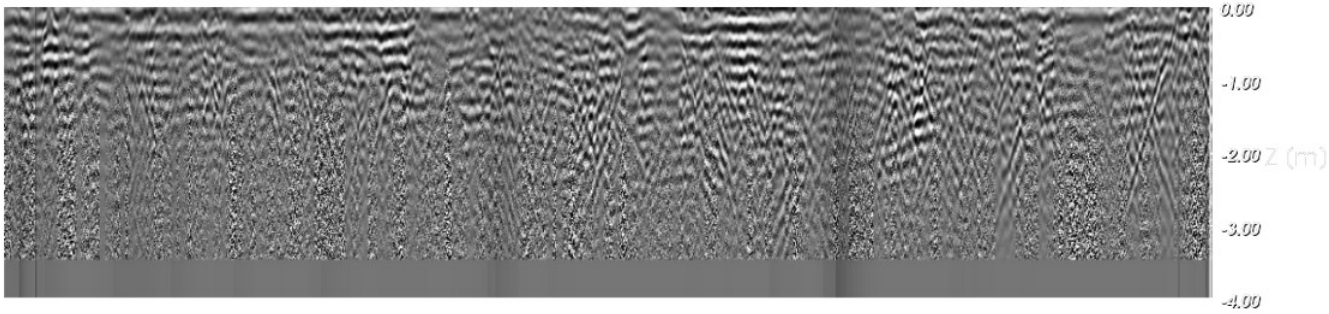
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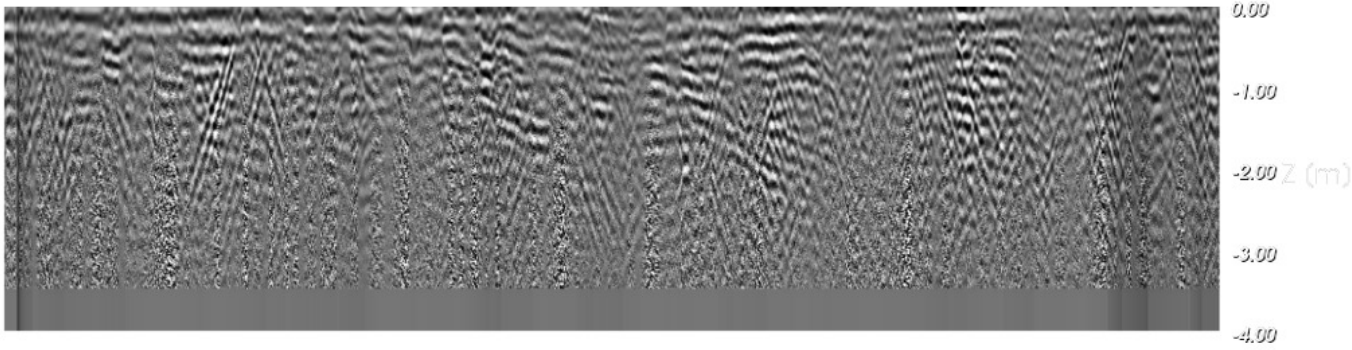
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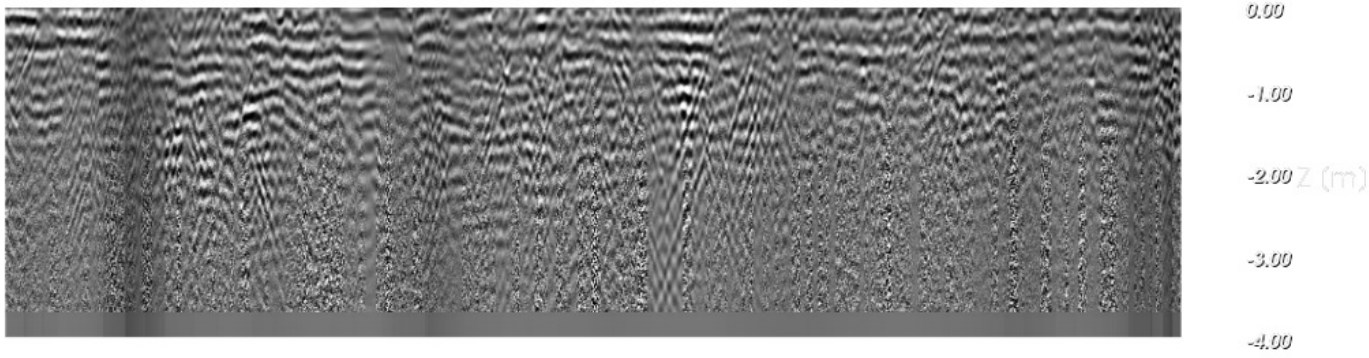
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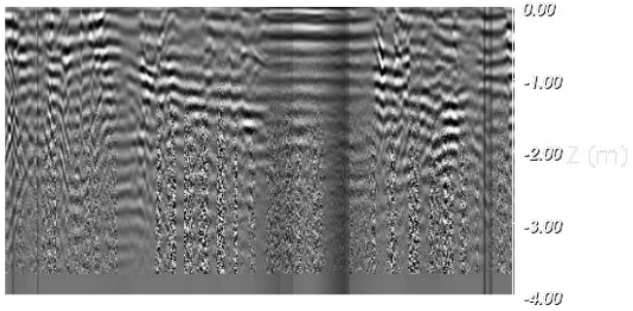
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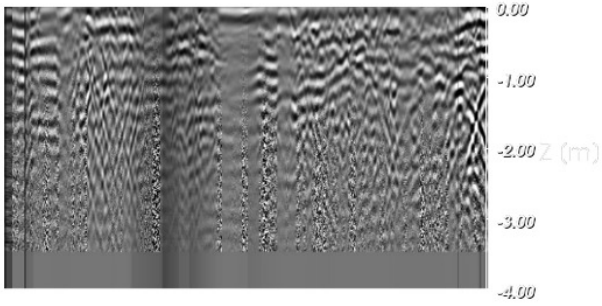
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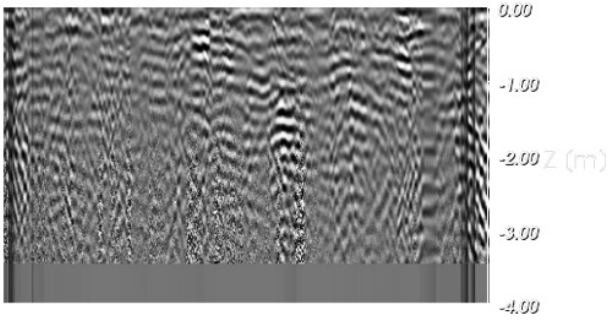
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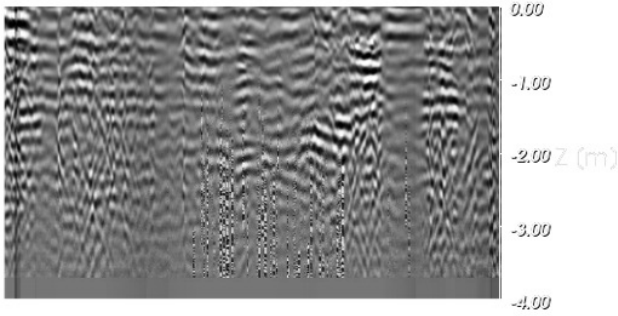
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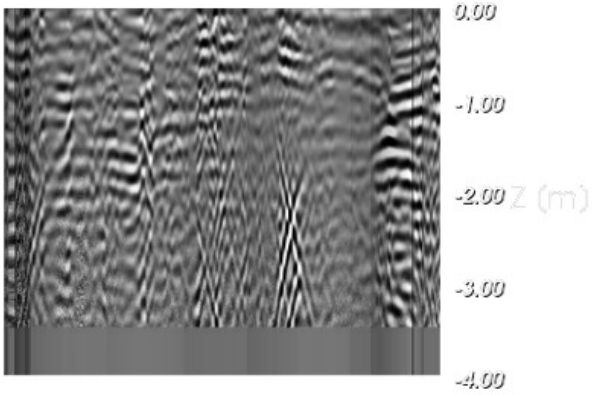
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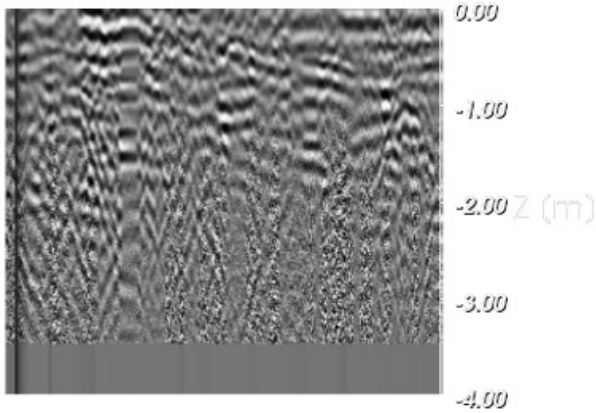
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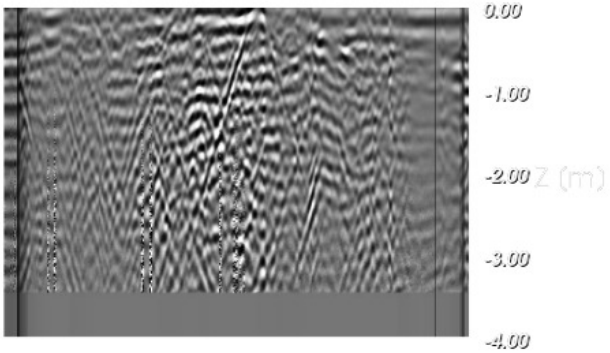
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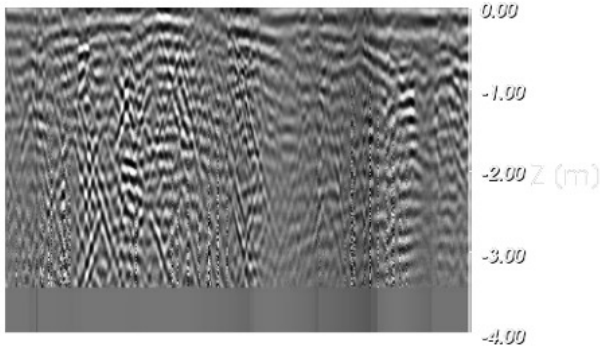
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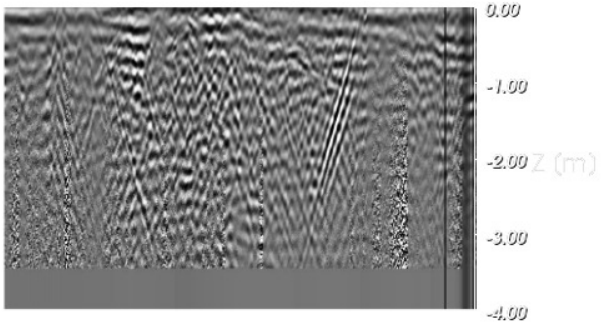
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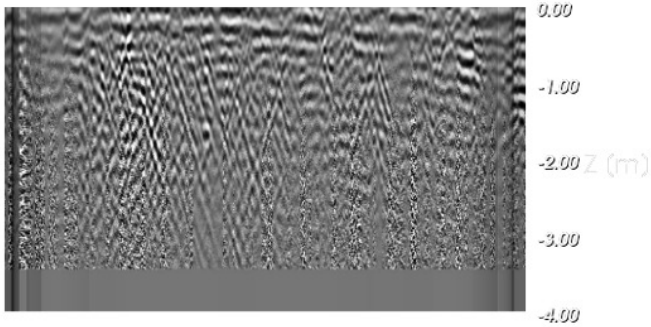
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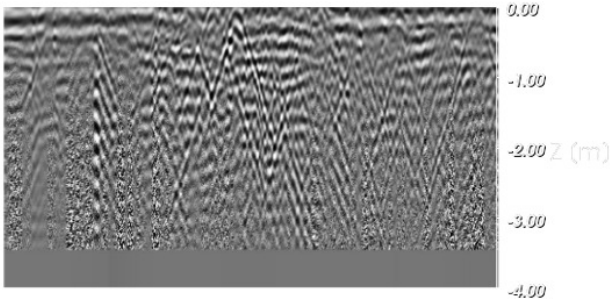
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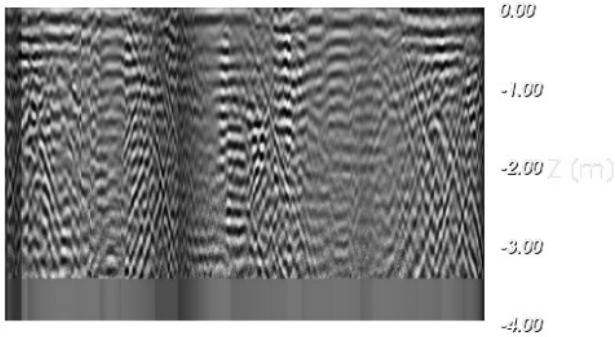
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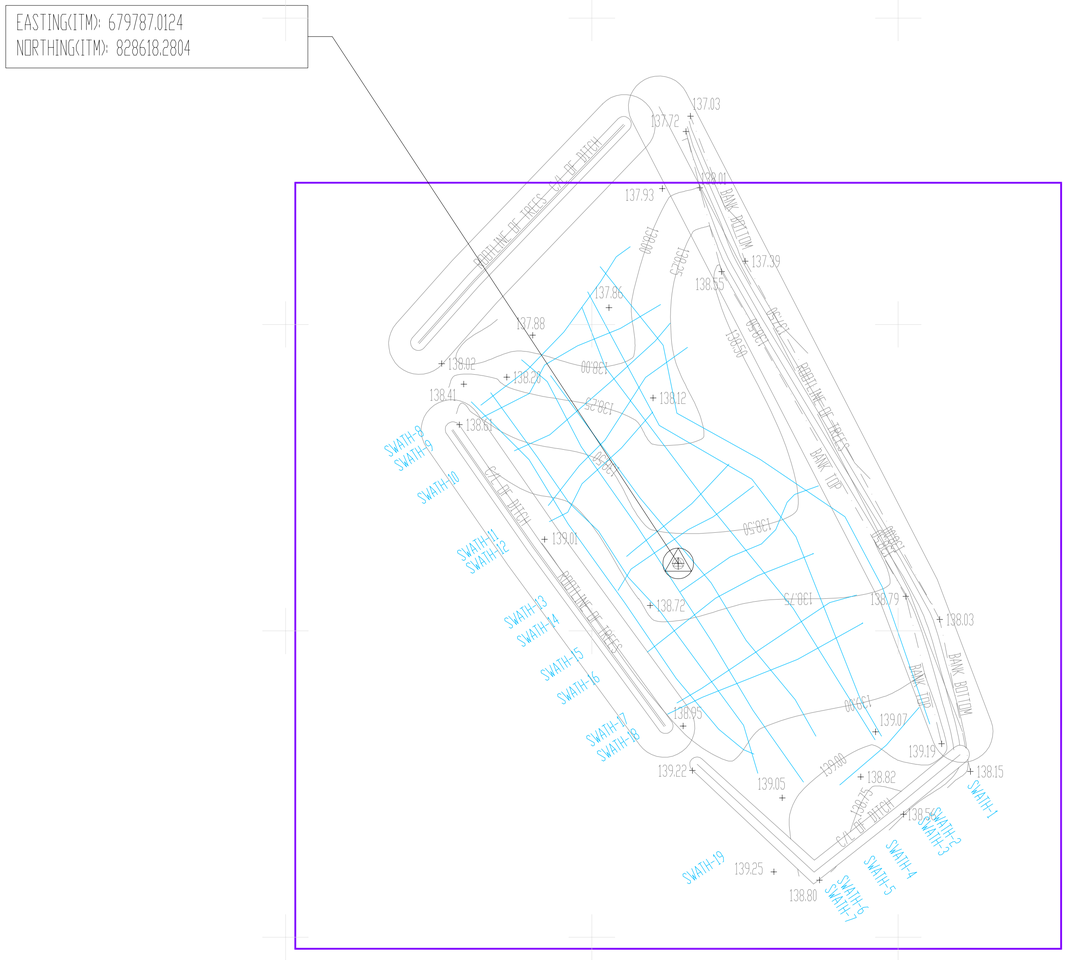


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Swath: 19
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GPR SURVEY
Scale 1:200

NOTES

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The data presented in this drawing have been collected using a combination of the following: consultation of utility asset information, visual survey & inspection of manholes and inspection chambers; electromagnetic location techniques; ground penetrating radar, and, where applicable, trial hole excavations. These techniques have been deployed in accordance with the BSI PAS128 Specification for Underground Utility Detection, Verification and Location using the search methodologies indicated below and described in the accompanying report. This drawing should be used in conjunction with the accompanying report which details the limitations of these techniques and any hindering factors encountered during this survey.

Unless otherwise stated, all utilities shown on this plan have been surveyed using approved detectors and the connections between inspection chambers, if unable to be detected, are generally assumed to be direct unless there are indications to the contrary. The detection confidence for each utility segment is depicted in line with the PAS128 scheme outlined below. Information depicted as QL–C or QL–D cannot be guaranteed as it is based on historic utility records which can be inaccurate and incomplete.

The utility routes depicted may reflect the routes of multiple cables or pipes. It is not always possible to differentiate between buried construction features, utilities and other subsurface linear features therefore it is possible that some features shown are not utility related, and due to the limitations of electromagnetic techniques all utility identifications should be treated with caution and verified prior to use during design/building works.

If the location or depth of utilities and features is of particular importance to a project then it is recommended that discussions are held with GeoData Surveying Ltd regarding any possible limitations or anomalies.

Please note that not all buried pipes, cables and ducts can be detected and mapped in consideration of their depth, location, material type, geology and proximity to other utilities. Even an appropriate and professionally executed survey may not be able to achieve a 100% detection rate. Where an area of utilities is likely to affect client project requirements, it is strongly recommended that a PAS128 Quality Level A verification survey is carried out

No utility mapping survey can be considered a 100% accurate depiction of the sub-surface environment, and the use of these drawings does not remove the requirement for the use of safe digging techniques at all times, in line with the requirements of current regulations.

ABBREVIATIONS

AJ	ARMSTRONG JUNCTION	FH	FIRE HYDRANT	UTS	UNABLE TO SURVEY
AR	ASSUMED ROUTE	FFL	FLOOR LEVEL	UTT	UNABLE TO TRACE
AV	AIR VALVE	FS	FLAG STAFF/ POLE	VP	VENT PIPE
BD	BACKDROP	G	GULLY	VE	VALVE
BL	BED LEVEL	G=	GRTH	SWL	WATER LEVEL
BH	BOREHOLE	GP	GAS INLET PIPE	STN	CONTROL STATION
Bin	LITTER / GRIT SALT BIN	GP	GUIDE POST	SV	SLUICE VALVE
BO	BOLLARD	GPR	TRACED BY G.P.R.	SC	STOP COCK
BP	BOUNDARY POST	GV	GAS VALVE	STP	SOIL STACK PIPE
BS	BUS STOP	HV	HIGH VOLTAGE	TEL	TELECOM INSP
CATV	CABLE TV COVER	IC	INSP CHAMBER	TL	TRAFFIC LIGHT
CB	CONTROL BOX	IL	INVERT LEVEL	TP	TELECOM POLE
CL	COVER LEVEL	IP	INLET PIPE	WM	WATER METER
Cpst	CAMERA POST	LP	LAMP STANDARD	WO	WASH OUT VALVE
CulP	CULVERT PIPE	LV	LOW VOLTAGE		
d	DEPTH	MH	MANHOLE		
DA	DIAMETER	MP	MINI PILLAR		
DS	DIRECTION SIGN	MCP	MICRO PILLAR		
ESB	ELECTRIC INSP COVER	O/H	OVER HEAD LINE		
EOT	END OF TRACE	OS	OUTSIDE SURVEY AREA		
EP	ELECTRICITY STANDARD	UL	UTILITY INSP CHAMBER		
ER	EARTH ROD	UTF	UNABLE TO LIFT		
FB	FOOTBRIDGE	UTR	UNABLE TO ROD		

SUB-SURFACE KEY

COMBINED HEATING AND POWER	CHP–XX
DISTRICT HEATING	DH–XX
DRAINAGE COMBINED *	C2–XX ——> C3–XX
DRAINAGE FOUL*	F2–XX ——> F3–XX
DRAINAGE SURFACE*	S2–XX ——> S3–XX
DRAINAGE UNIDENTIFIED*	U2–XX ——> U3–XX
[* FLOW DIRECTION DENOTED BY ARROW (>) or (<) IF KNOWN]	
ELECTRIC	E–XX E–XX
ELECTRIC LV	LV–XX
ELECTRIC HV	HV–XX
ELECTRIC STREET LIGHTING	SL–XX
GAS	G–XX G–XX
OIL/FUEL PIPELINE	O–XX O–XX
STREET FURNITURE CABLES	SF–XX
TELECOMS	T–XX T–XX
TELECOMS – FIBRE OPTIC	FO–XX
TELECOMS – EIR	EIR–XX
TRAFFIC CONTROL	TC–XX
WATER	W–XX W–XX
UNIDENTIFIED UTILITY	U–XX U–XX
UNIDENTIFIED CABLES	C–XX C–XX
UNIDENTIFIED EMPTY DUCT	X–XX X–XX
GPR LINEAR FEATURE	GPR–XX
GPR AREA ANOMALY	
GPR AREA ANOMALY – REBAR	
CHAMBER EXTENTS	
MEASURED DEPTH BGL TO PIPE/CABLE/DUCT	0.65d
INVERT LEVEL OF PIPE/DUCT/CABLE (TO OS DATUM)	IL 12.34
SOFFIT LEVEL OF PIPE/DUCT/CABLE (TO OS DATUM)	SL 45.67
COVER LEVEL OF INSPECTION CHAMBER (TO OS DATUM)	CL 78.90
DIAMETER OF PIPE/DUCT IN MILLIMETERS	150Ø
[BGL – BELOW GROUND LEVEL]	
AREA UNABLE TO BE SURVEYED DUE TO SURFACE OBSTRUCTIONS, VEGETATION OR LACK OF ACCESS	
TRENCH SCAR / SURFACE SCAR	
EXTENT OF SURVEY – BOUNDARY	

WITH CLIENT CONFIDENCE LEVELS

UTILITY CONFIDENCE LEVELS (Listed from High to Low)

(A)	HORIZONTAL AND VERTICAL POSITION VERIFIED VISUALLY (Accuracy: Horizontal ±25mm Vertical±50mm)
(B1P)	HORIZONTAL AND VERTICAL POSITION DETECTED BY MULTIPLE METHODS W H POST PROCESSING OF GPR DATA (Estimated Accuracy: ±150mm OR ±15% of detected depth)
(B1)	HORIZONTAL AND VERTICAL POSITION DETECTED BY MULTIPLE METHODS Estimated Accuracy: ±150mm OR ±15% of detected depth)
(B2P)	HORIZONTAL AND VERTICAL POSITION DETECTED VIA POST–PROCESSED GPR (Estimated Accuracy: ±250mm OR ±40% of detected depth)
(B2)	HORIZONTAL AND VERTICAL POSITION DETECTED BY A SINGLE METHOD (Estimated Accuracy: ±250mm OR ±40% of detected depth)
(B3P)	HORIZONTAL POSITION DETECTED VIA POST–PROCESSED GPR (Estimated Accuracy: ±500mm in the Horizontal – Depth is undefined)
(B3)	HORIZONTAL POSITION DETECTED BY A SINGLE METHOD (Estimated Accuracy: ±500mm in the Horizontal – Depth is undefined)
(C)	ROUTE TRANSCRIBED FROM UTILITY ASSET PLANS AND CORRELATED VISUAL INDICATORS AND SURFACE FEATURES (Accuracy Undefined)
(D)	ROUTE TRANSCRIBED FROM UTILITY ASSET PLANS (Accuracy Undefined)

SURVEY NOTES

1. All levels are related to Malin Head Datum (OSGM15)
2. All dimensions are in meters unless otherwise stated.
3. any descripencies in the survey should be reported to Geodata Surveying Ltd immediately.
4. Do not scale, this shall only be permitted in digital form.
5. Grid is 20m x 20m

ITM GRID

0 4m 8m 12m
1:200

PAS128 SURVEY METHODOLOGY
LOCATION PLAN

PAS128 SURVEY METHODOLOGY KEY

THIS SURVEY HAS BEEN CARRIED OUT IN ACCORDANCE WITH THE PAS128 SPECIFICATION FOR UNDERGROUND UTILITY DETECTION, VERIFICATION & LOCATION. THE SPECIFICATION ALLOWS FOR A RANGE OF TECHNIQUES AND METHODS OF VARYING INTENSITY TO BE DEPLOYED. THE COLOUR CODED SCHEME INDICATES WHERE DIFFERENT SURVEY METHODOLOGIES HAVE BEEN USED ON SITE, AND THE LIST BELOW IDENTIFIES EQUIPMENT USED TO OBTAIN THE SURVEY RESULTS.
NB: PLEASE SEE ACCOMPANYING REPORT FOR FULL DETAILS.

ELECTROMAGNETIC DETECTION	GROUND PENETRATING RADAR	TOTAL STATION	GPS/GNSS
IDS Opera Dual Antenna		S9 Trimble Robotic	Trimble R10

- M4P - EML SEARCH TRANSECT AT 2m INTERVALS - TRACED AT 0.5m INTERVALS. GPR SURVEY GRID AT 0.5m INTERVALS OR HIGH DENSITY ARRAY. POST PROCESSING OF GPR DATA.
- M3P - EML SEARCH TRANSECT AT 2m INTERVALS - TRACED AT 1m INTERVALS. GPR SURVEY GRID AT 1m INTERVALS OR HIGH DENSITY ARRAY. POST PROCESSING OF GPR DATA.
- M2P - EML SEARCH TRANSECT AT 5m INTERVALS - TRACED AT 2m INTERVALS. GPR SURVEY GRID AT 2m INTERVALS OR HIGH DENSITY ARRAY. POST PROCESSING OF GPR DATA.
- M1P - EML SEARCH TRANSECT AT 10m INTERVALS - TRACED AT 5m INTERVALS. GPR SURVEY AS APPROPRIATE. POST PROCESSING OF GPR DATA.
- M4 - EML SEARCH TRANSECT AT 2m INTERVALS - TRACED AT 0.5m INTERVALS. GPR SURVEY GRID AT 0.5m INTERVALS. GPR MARK-UP ON SITE
- M3 - EML SEARCH TRANSECT AT 2m INTERVALS - TRACED AT 1m INTERVALS. GPR SURVEY GRID AT 1m INTERVALS. GPR MARK-UP ON SITE.
- M2 - EML SEARCH TRANSECT AT 5m INTERVALS - TRACED AT 2m INTERVALS. GPR SURVEY GRID AT 2m INTERVALS. GPR MARK-UP ON SITE.
- M1 - EML SEARCH TRANSECT AT 10m INTERVALS - TRACED AT 5m INTERVALS. GPR SURVEY AS APPROPRIATE. GPR MARK-UP ON SITE

DUCT FORMATION

1W:	1 WAY SINGLE DUCT
2W:	2 WAY FLAT
2W:1/2	2 WAY: 1 WIDE, 2 DEEP
4W:2/2	4 WAY: 2 WIDE, 2 DEEP
6W:3/2	6 WAY: 3 WIDE, 2 DEEP
12W:4/3	12 WAY: 4 WIDE, 3 DEEP

NB: TO BE ADAPTED TO FOR EACH CHAMBER

Rev	Date	Description	Drn By	Ckd By
01	28-02-23	GPR Survey	SF	KOB

RICS · SOCIETY OF CHARTERED SURVEYORS IRELAND

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Client:	OCB Geotechnical Ltd.
Rev.	01
Project:	Site 106 Co Monaghan
Job. No:	20695
Dwg. No:	430
Title:	GPR Detection Survey
Drawn By:	KL
Checked By:	SF
Date:	28-02-23
Sheet:	A1
Scale:	1-200
Approved By:	KOB

Geodata

Chartered Land Surveyors

SOCIETY OF CHARTERED SURVEYORS IRELAND

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RICS™

Geodata
Chartered Land Surveyors

Technical Report

Ground-Penetrating Radar (GPR) Detection Survey

Client: OCB Geotechnical Ltd

Project: 21719 –Monaghan, Site 111.

Date: 28th of February 2022

GeoData Surveying Ltd
Registered Office: 47 Oliver Plunkett Street, Bandon, Co Cork. P72 A443.
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Client: OCB Geotechnical Ltd

Project: Project: 21719-400 –Monaghan, Site 111

Document Evolution					
Job no	**Issue**	**Date**	**Prepared by**	**Checked by**	**Description**
21719	01	28-02-22	S. Forys	KO'Brien	First Edition

1. Introduction

Geodata were requested to carry out a Ground-Penetrating Radar (GPR) Survey on behalf of OCB Geotechnical and Topographical Survey on the site outlined in the figure below.



Extent of Survey

2. Scope of the Investigation

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The transmission frequency is an importance factor in GPR. Low frequency radars will provide high penetration into the target but these results can lead to unfavourable resolutions. High frequency radar provides greater resolution in regards to radar images but the penetration is less than the low frequency.

In this instance the Opera Duo achieved a penetration of typically 1.2-2.0m below the surface.The position of the array was continually monitored and recorded using a total station.



Figure 5.0 C-Stream IDS -High Density Array (GPR)

5.2. Post Process of Ground Penetrating Radar (GPR) data

Ground Penetrating Radar (GPR) data was post processed to improve the interpretation of raw datausing GRED HD GPR Post processing software.

Post processing aids in the identification of responses to gain a better understanding of areas of complex or more obscure utility networks.

6. Quality Check

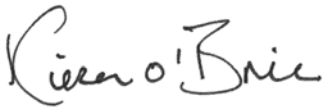
Geodata has inbuilt quality check system involving cross checking and discussion between teams to identify any possible inaccuracies and to improve the interpretation of the Post processing of GPR data and onsite observations. All Equipment used was calibrated and tested in line with manufacturer guidelines

7. Conclusions and Recommendations.

Ground Penetration Radar resolution was generally good on site with penetration of typically 1.2-2.0m below the surface in area of optimal ground conditions. Areas unable to be surveyed due to surface obstructions, vegetation, slope or lack of access were marked in the survey drawings (Appendix A)

The Radiograms show a uniform substrate of soil, I would not be in a position to comment on the physical characteristic of the substrate due to the absent of site investigation to reference the Ground Penetrating Radar data.

Yours sincerely,

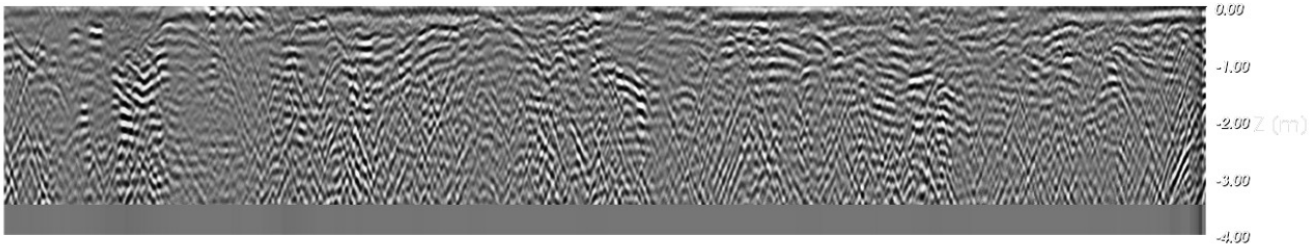


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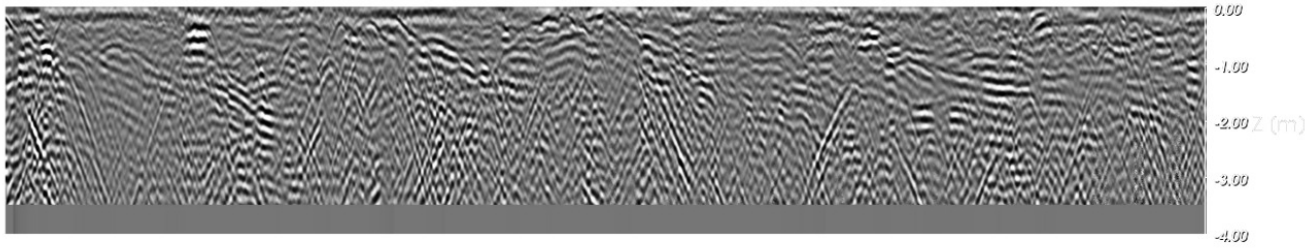
Kieran O'Brien
Chartered Engineer &CharteredGeomatics Surveyor
BEng(Hons) CEng MIEI MSCSI/MRIC

Appendix A

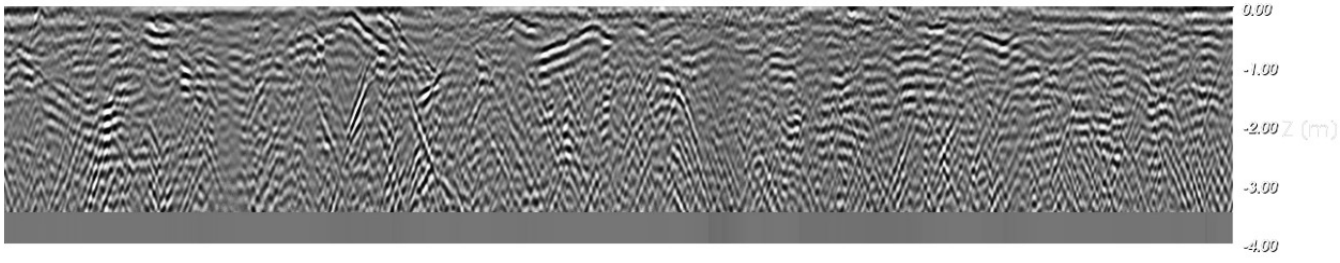
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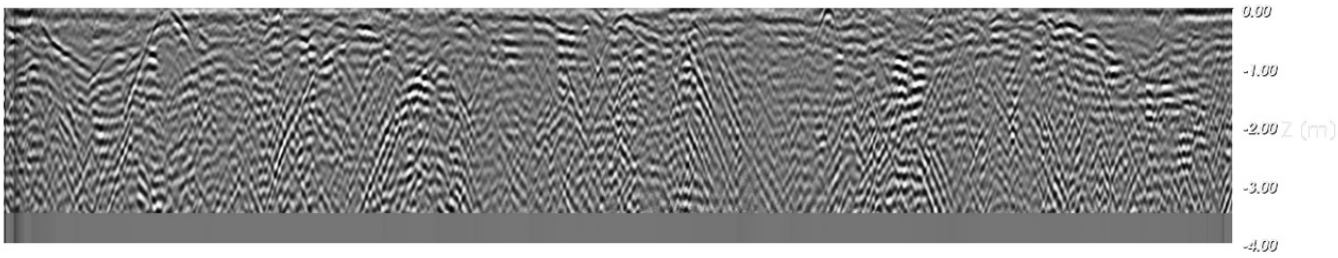
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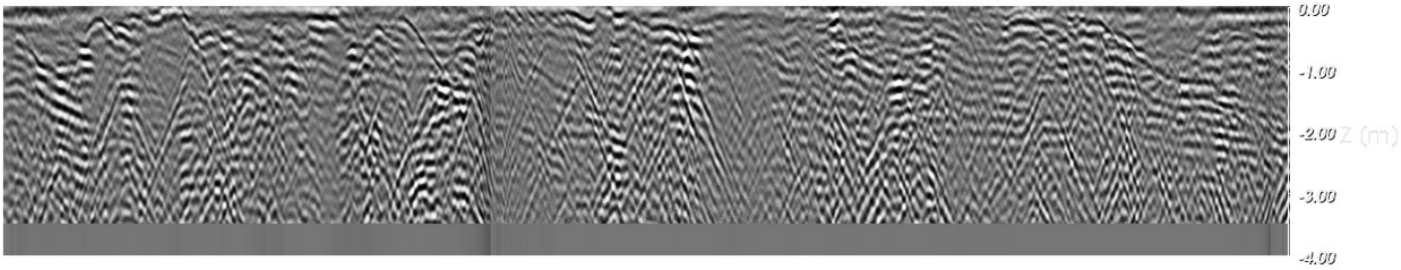
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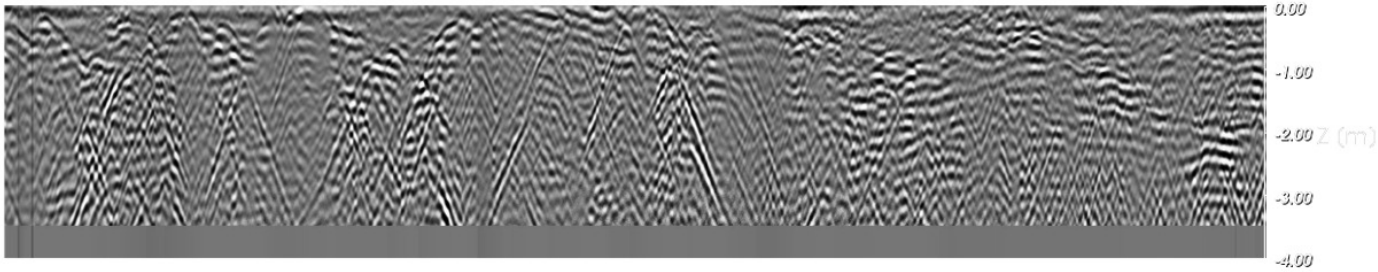
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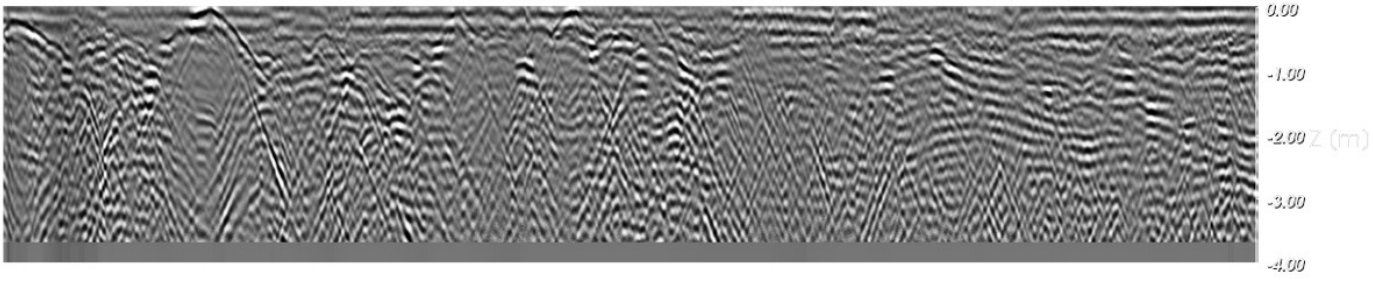
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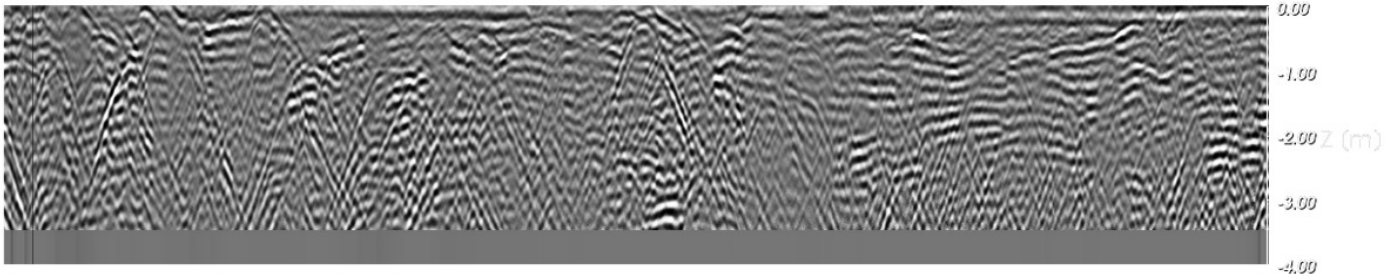
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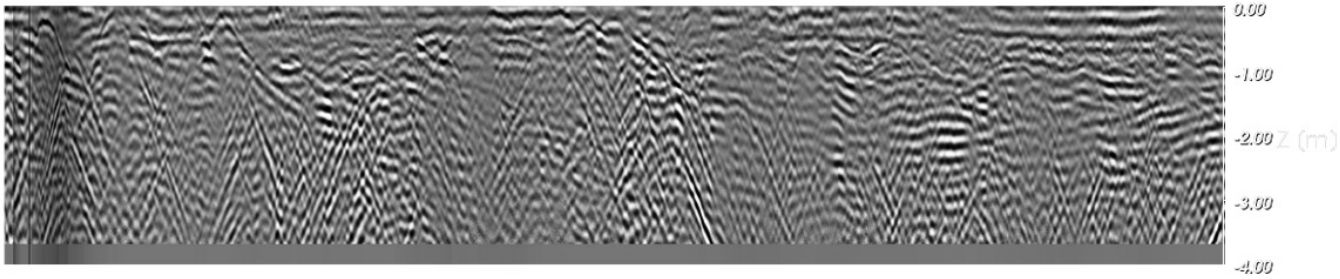
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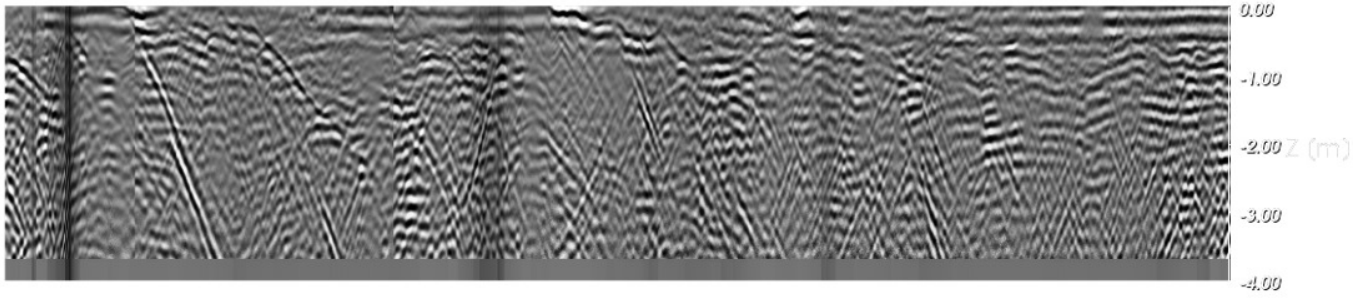
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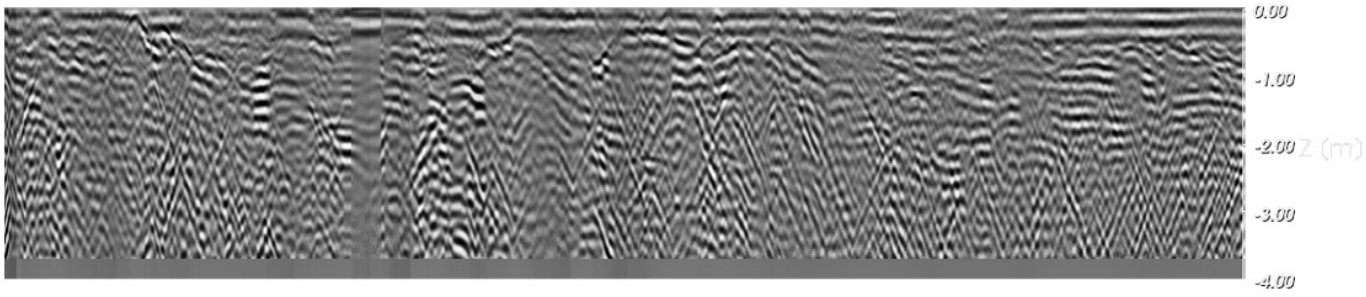
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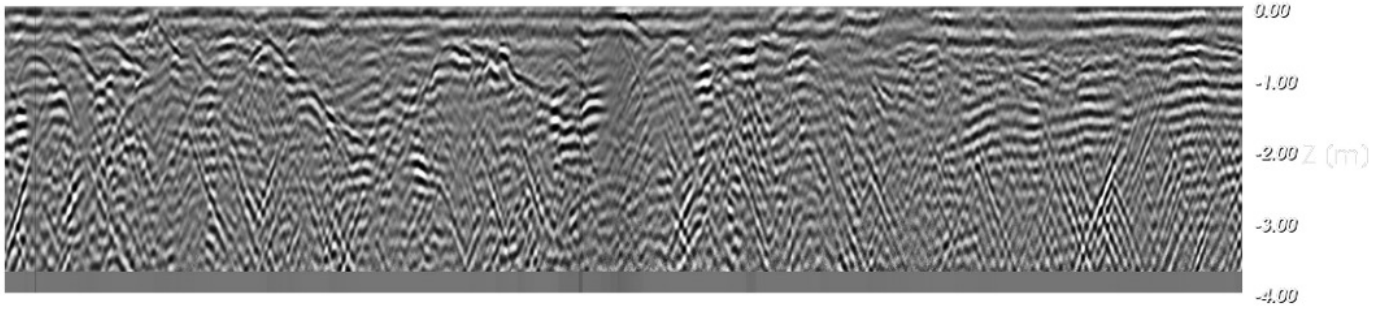
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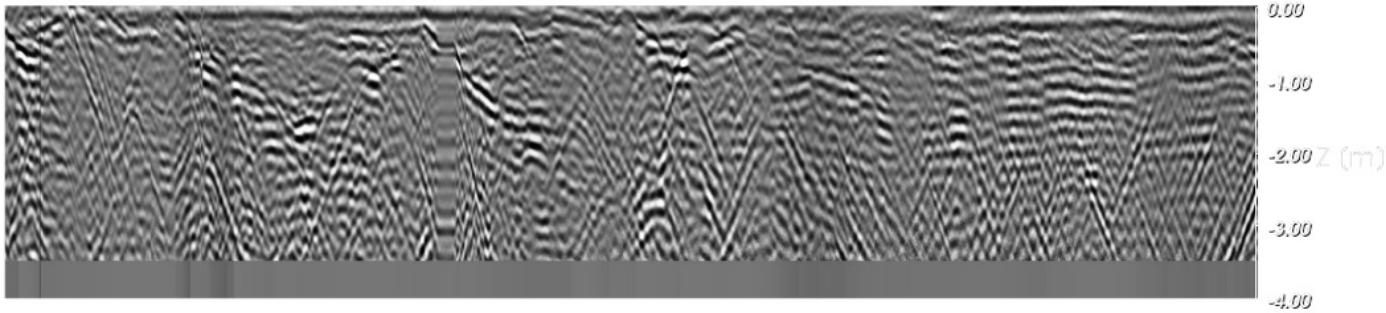
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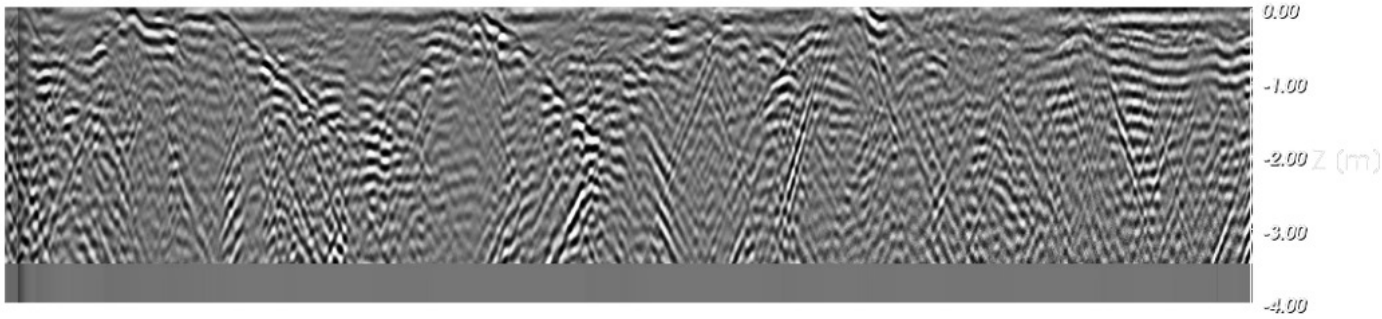
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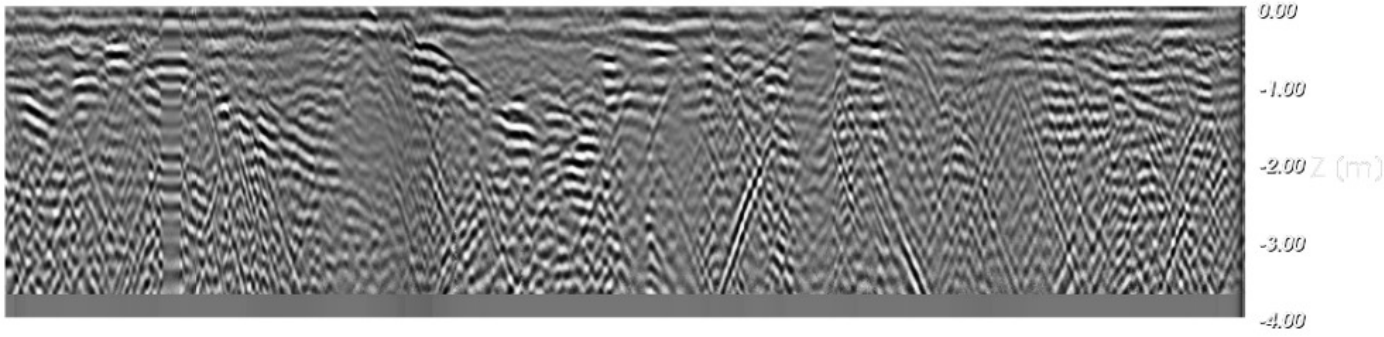
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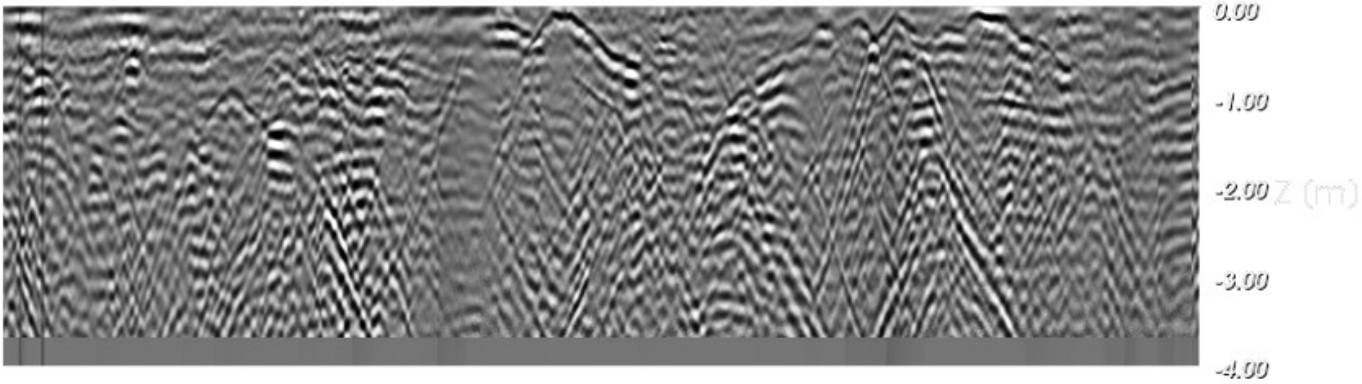
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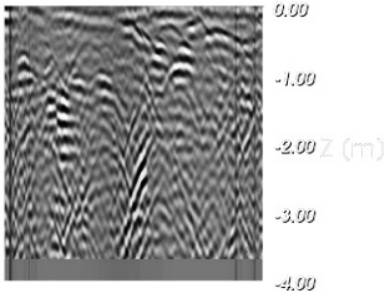
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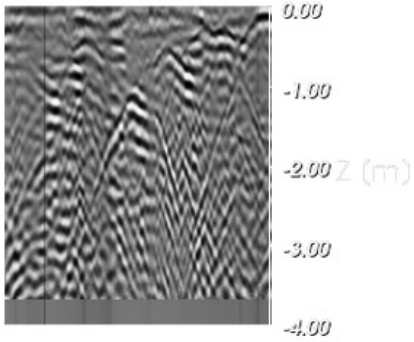
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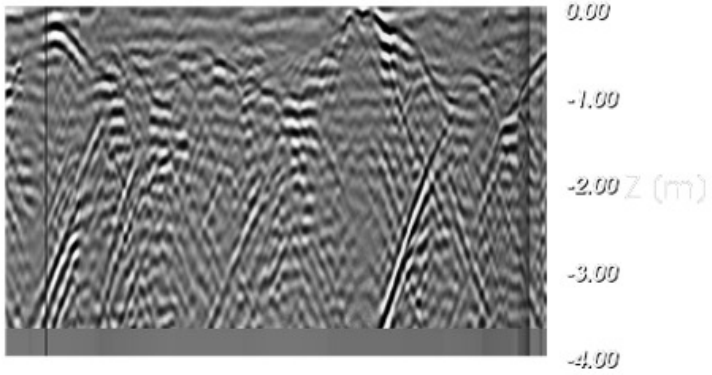
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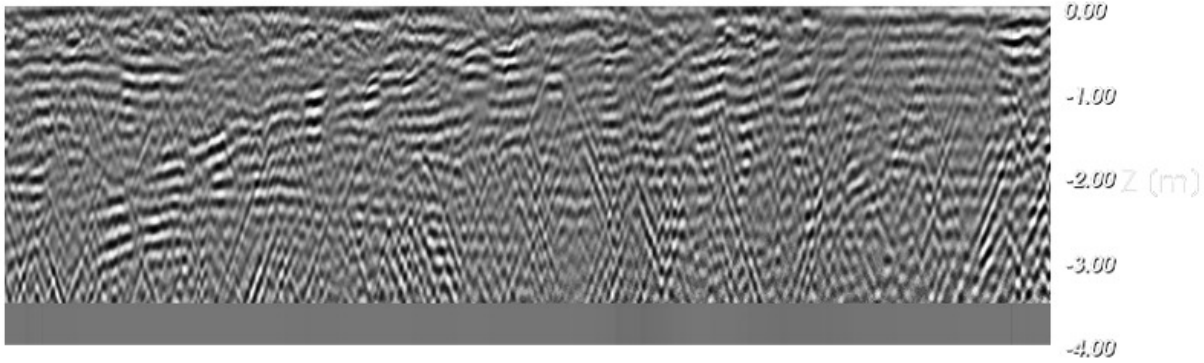


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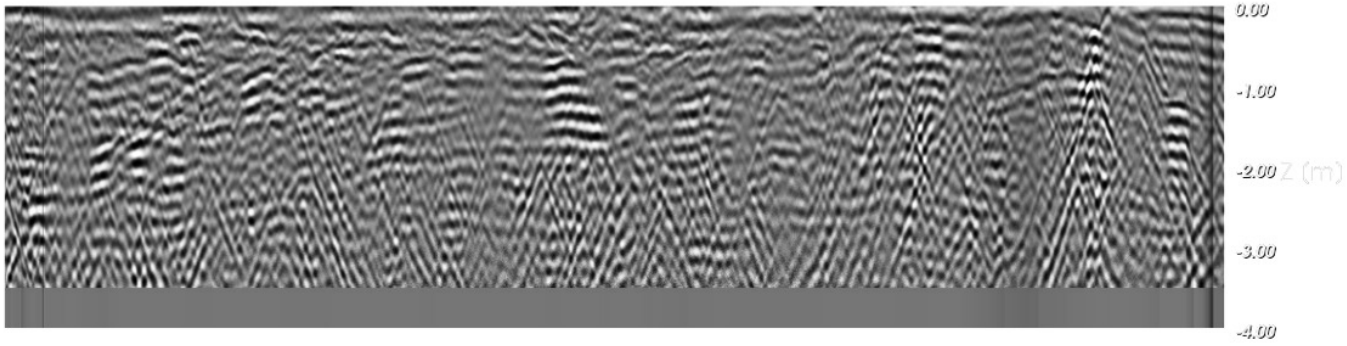


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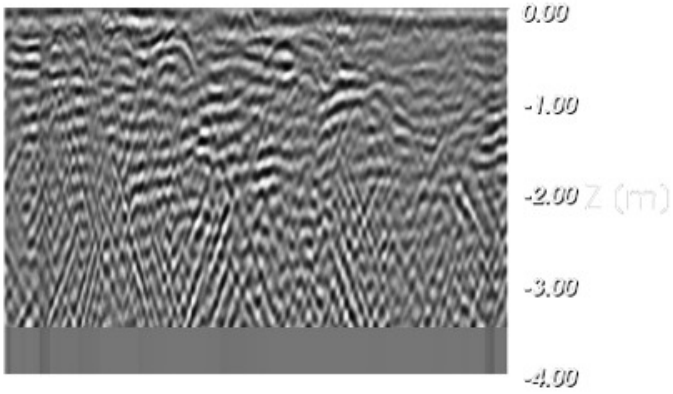
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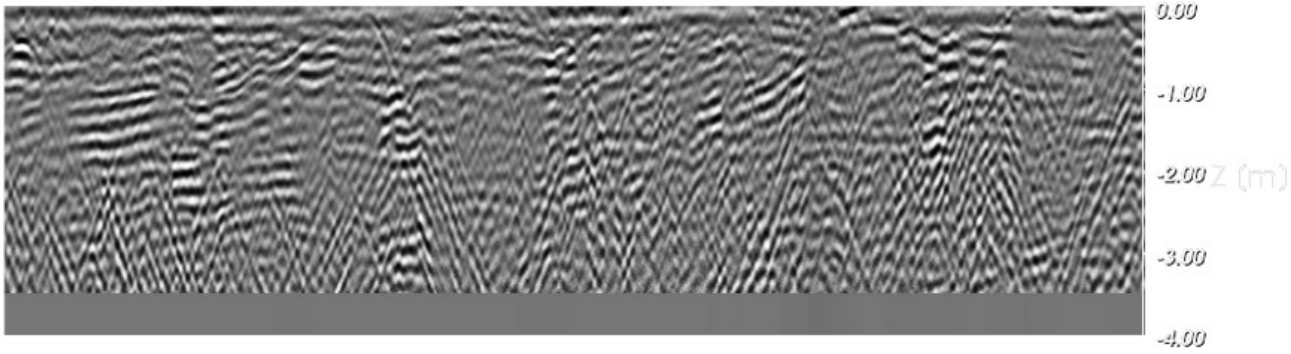
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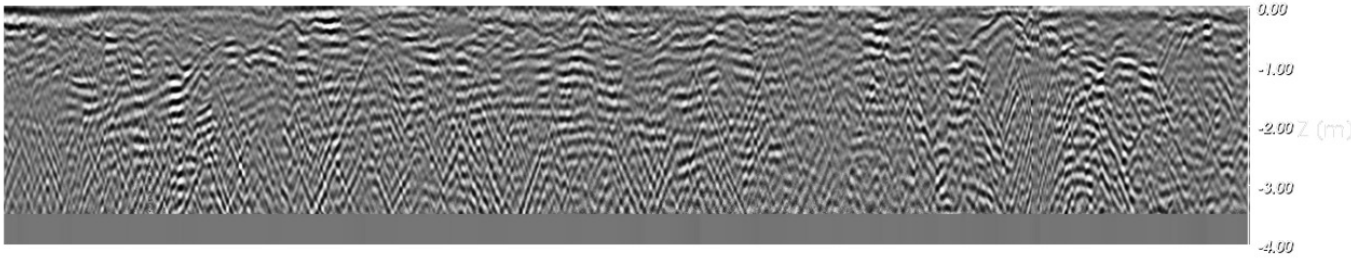
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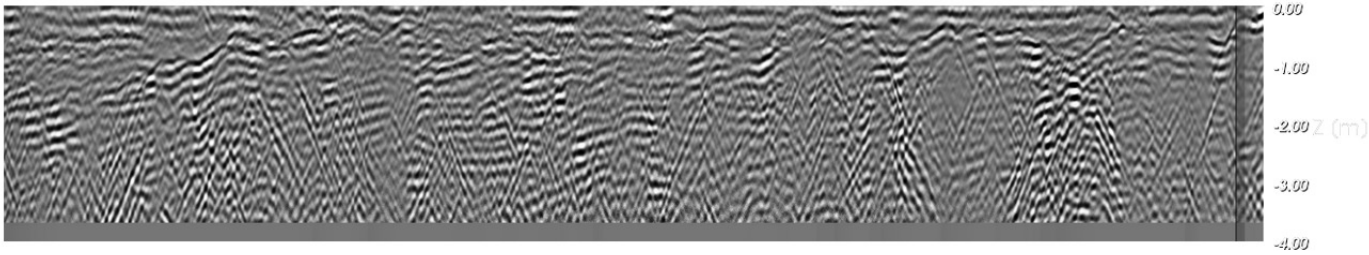
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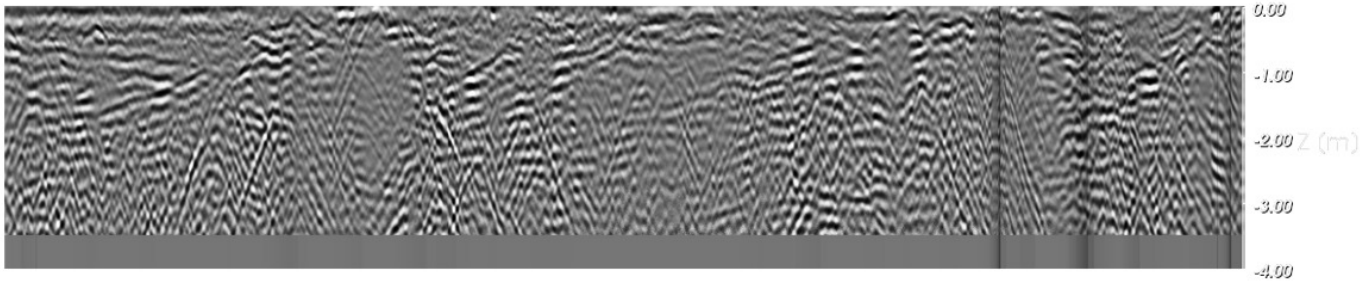
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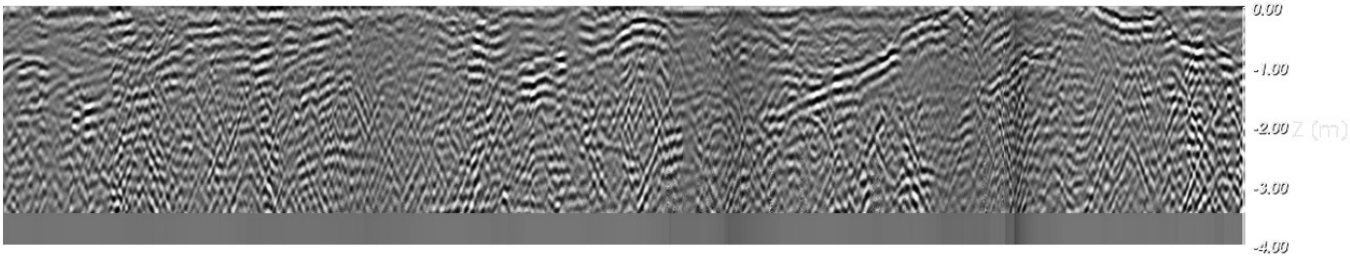
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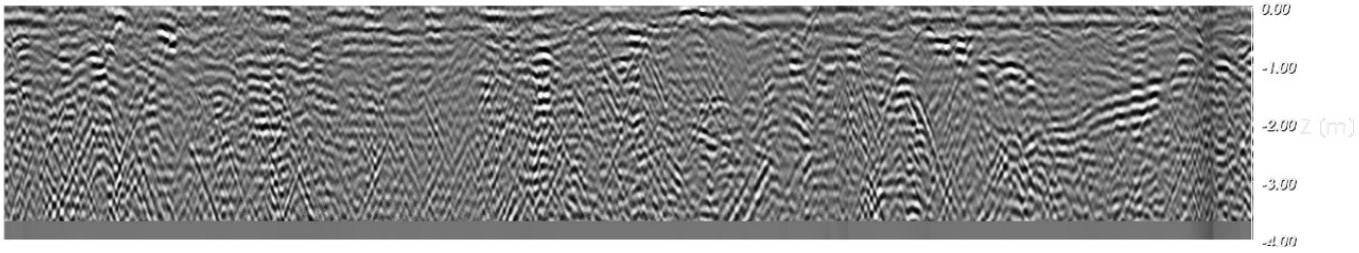
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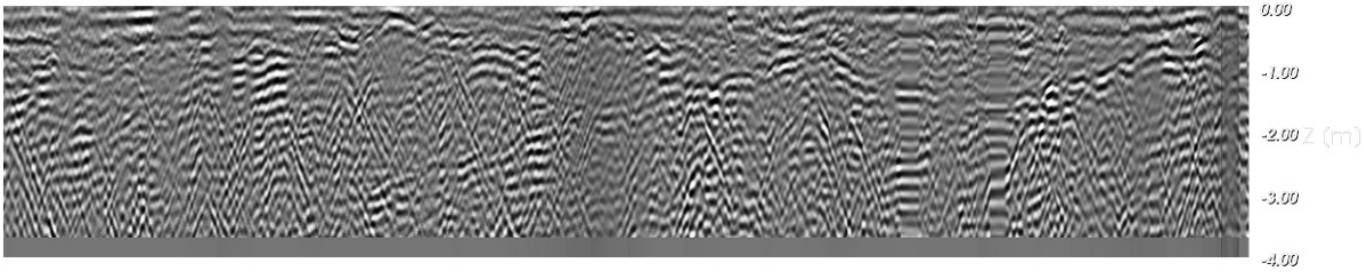
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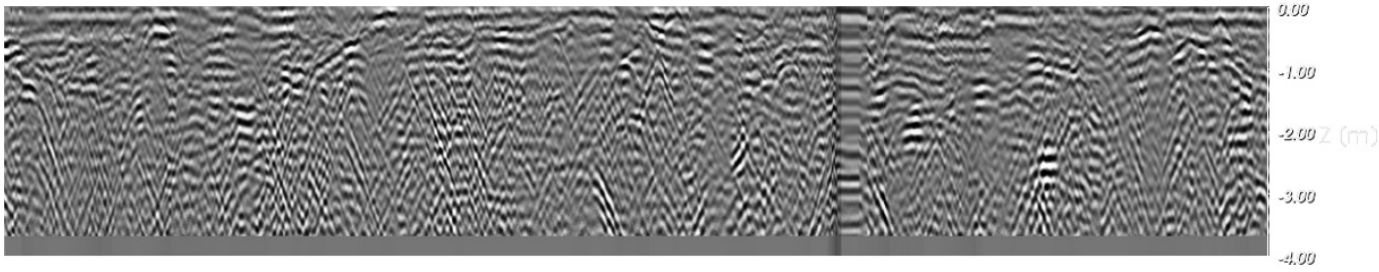
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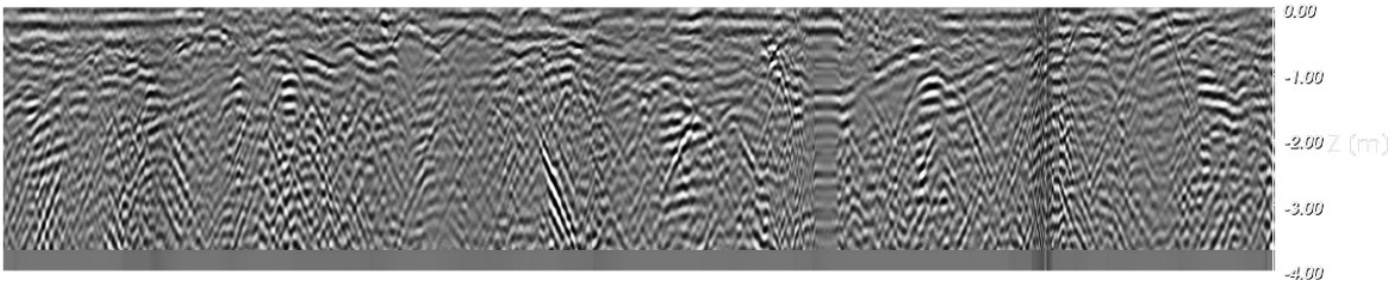
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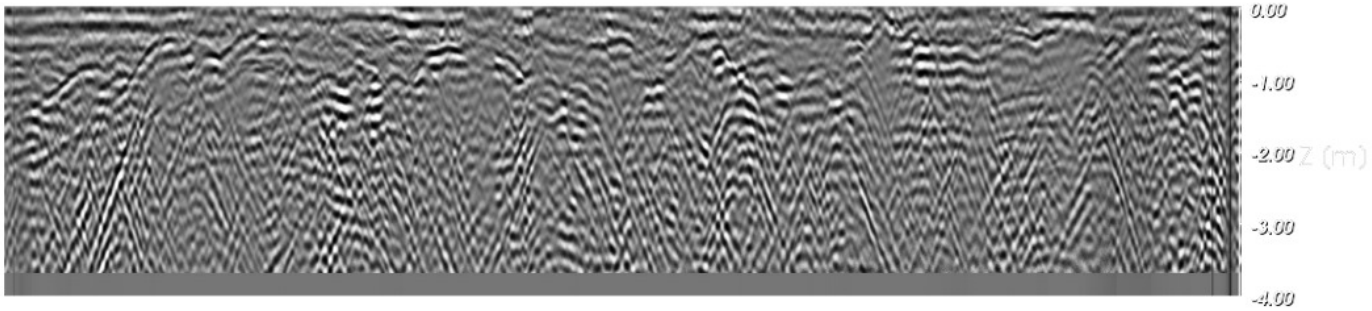


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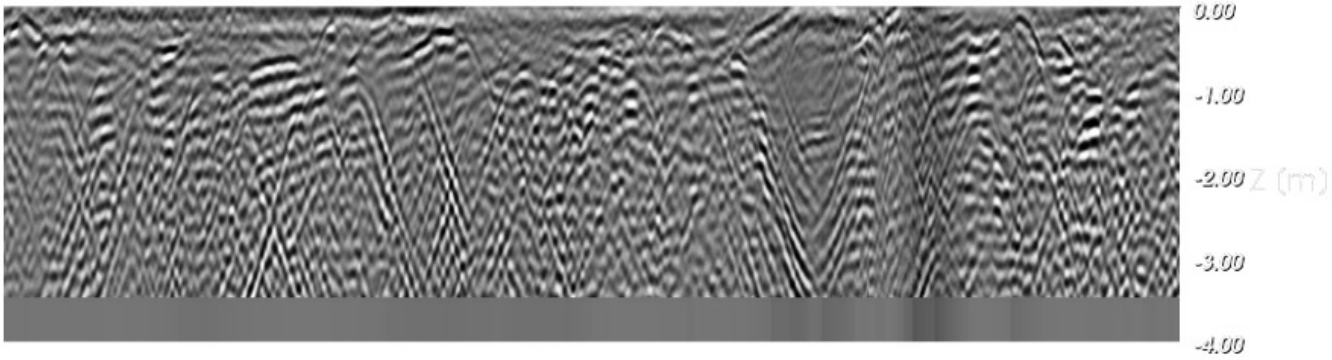


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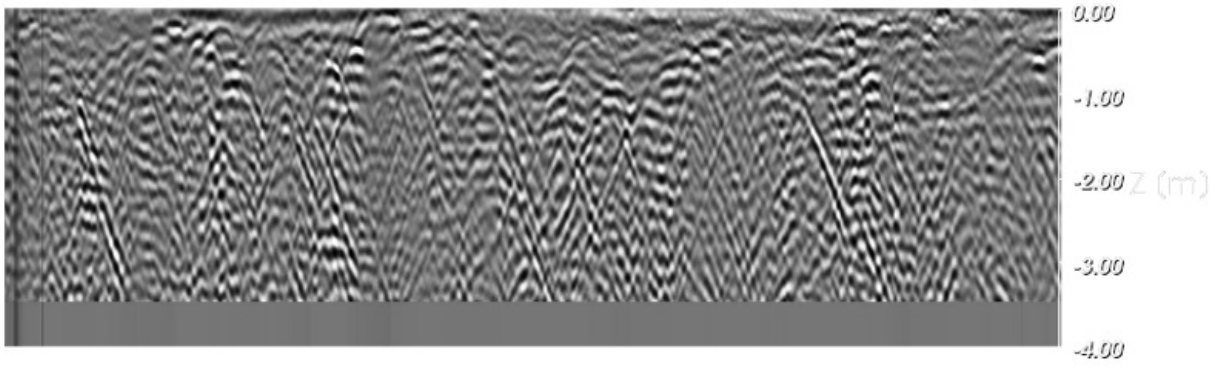
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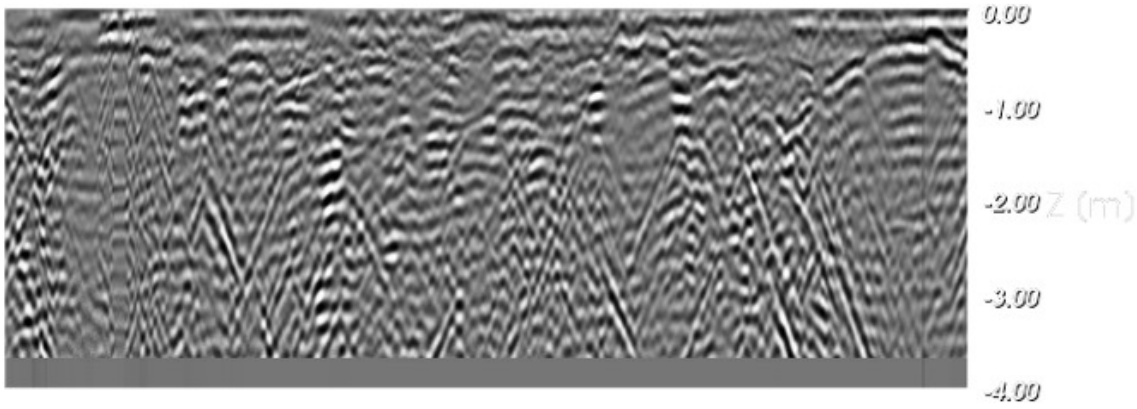
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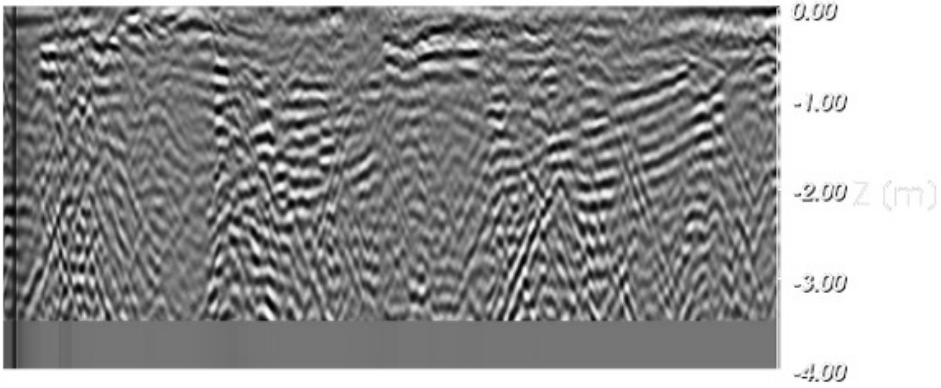


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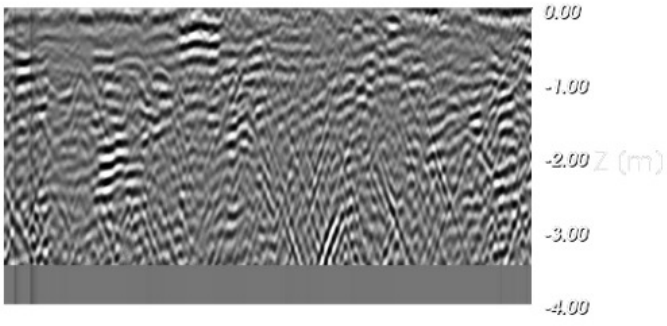
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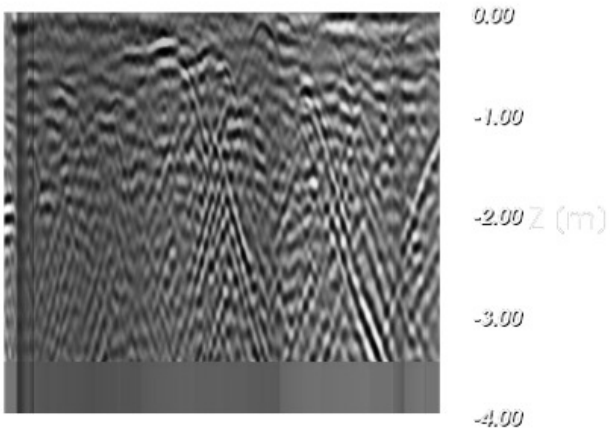
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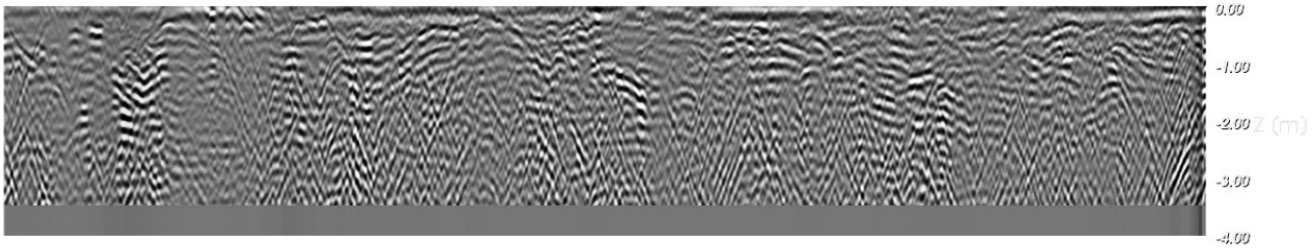


Appendix A

Cartographic maps & Radargram data

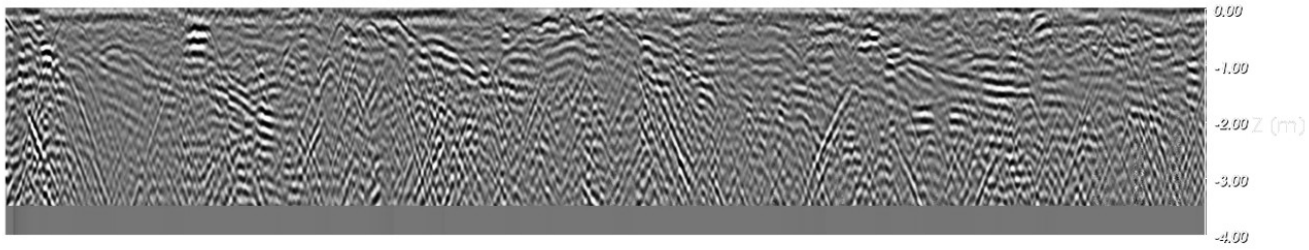
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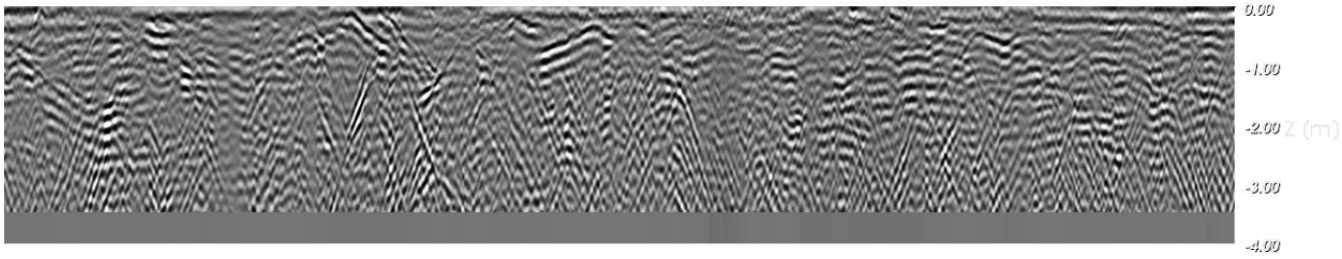
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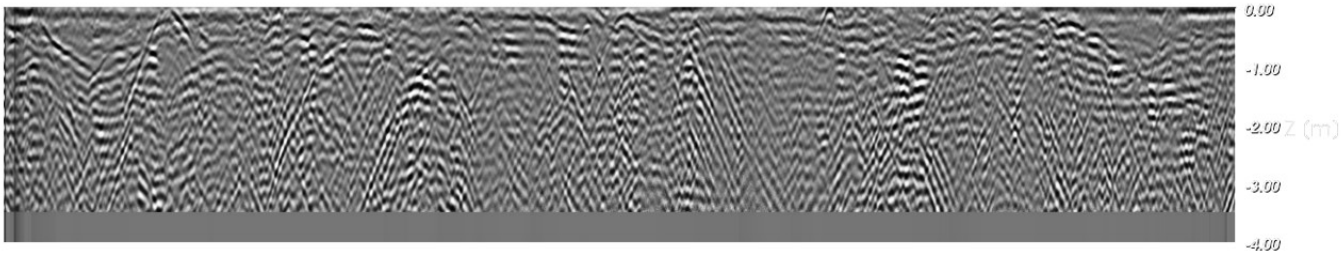
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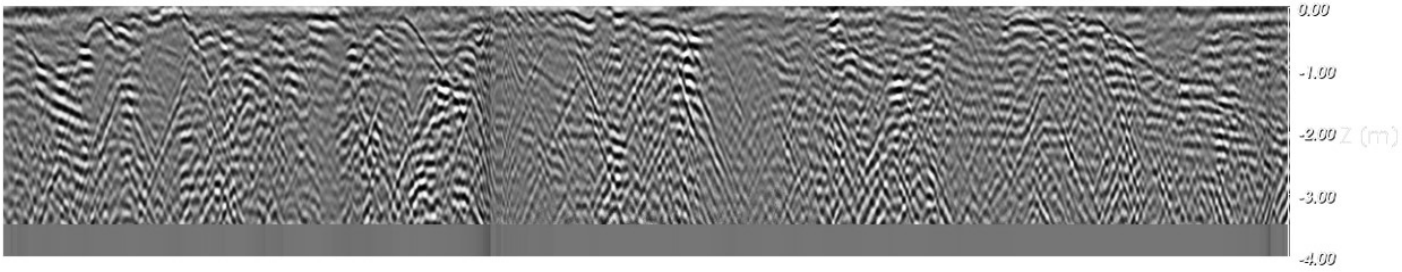


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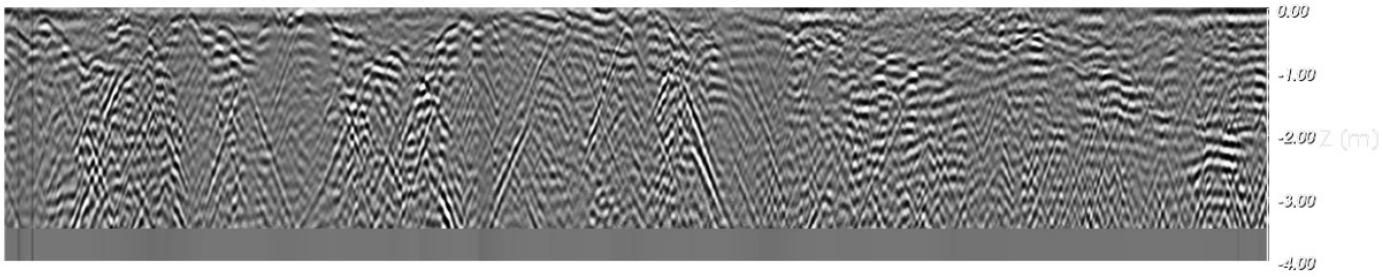
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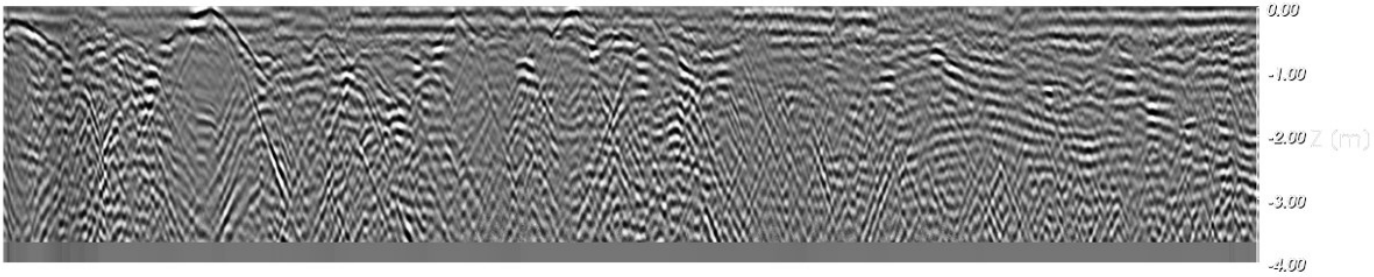
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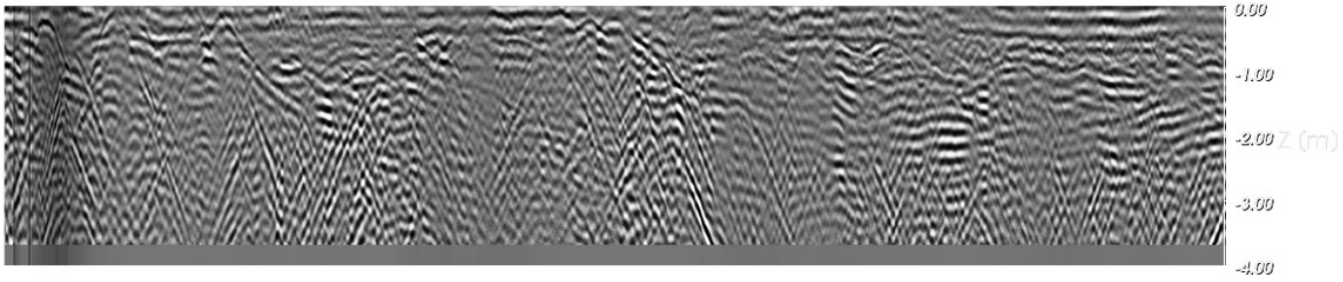
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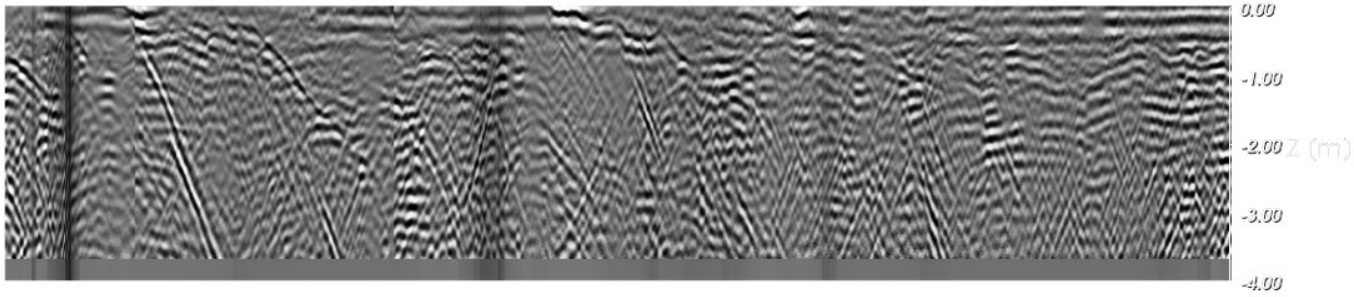
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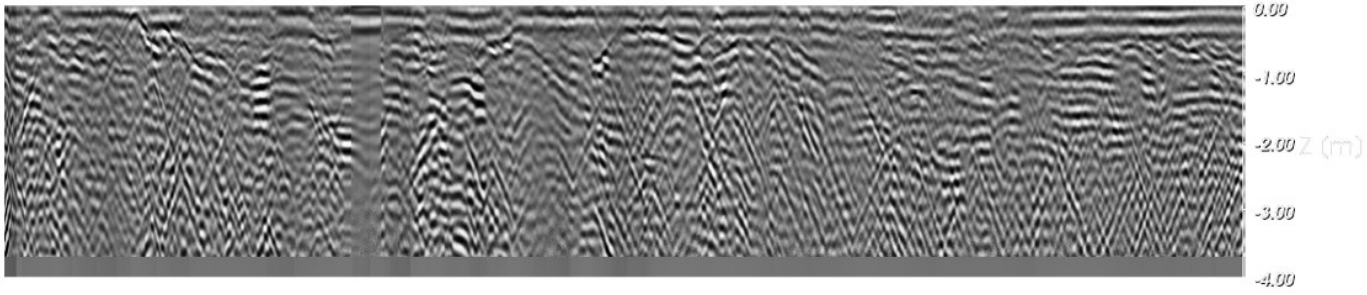
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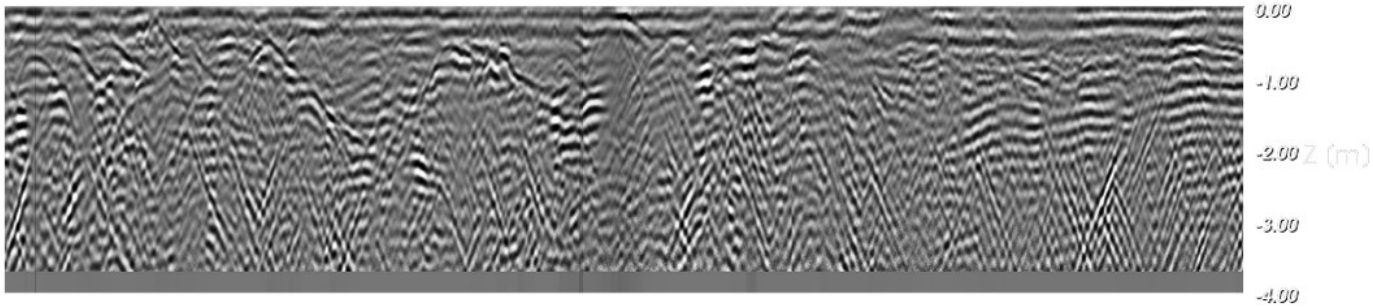
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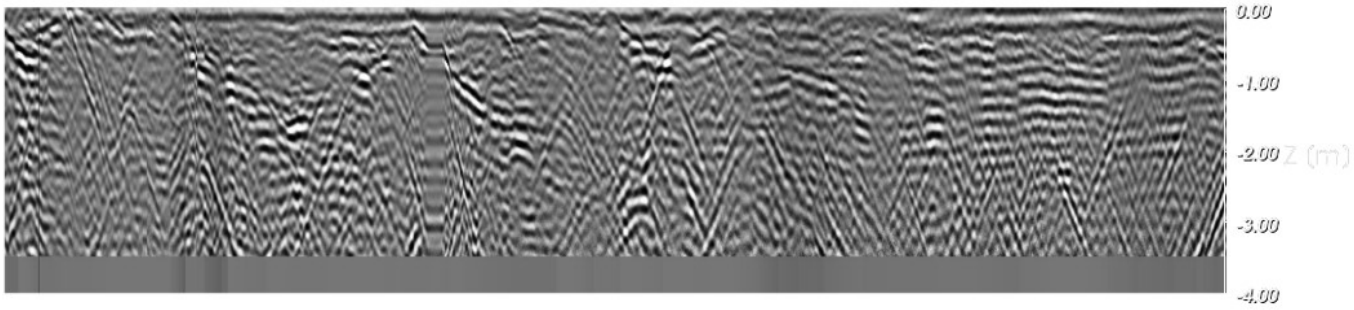
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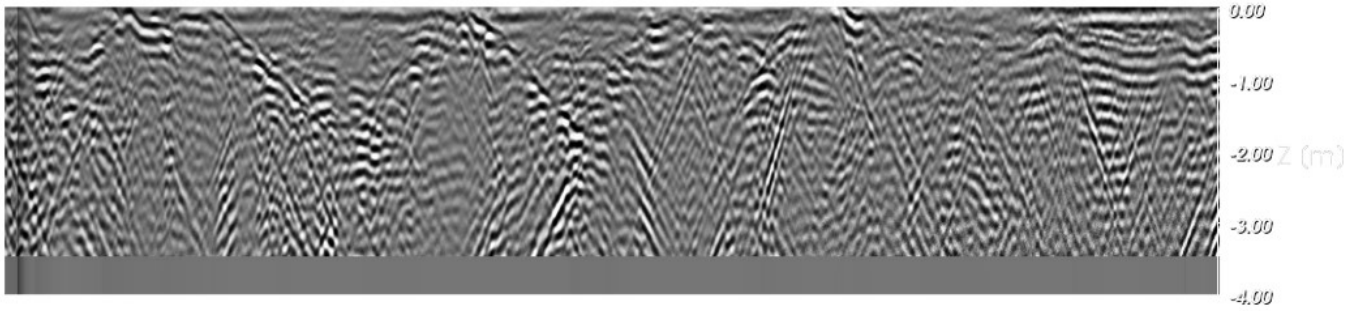
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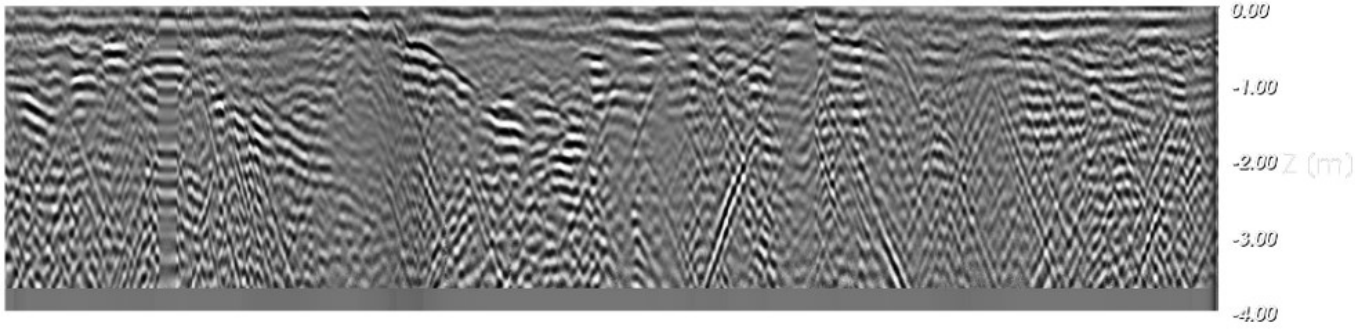
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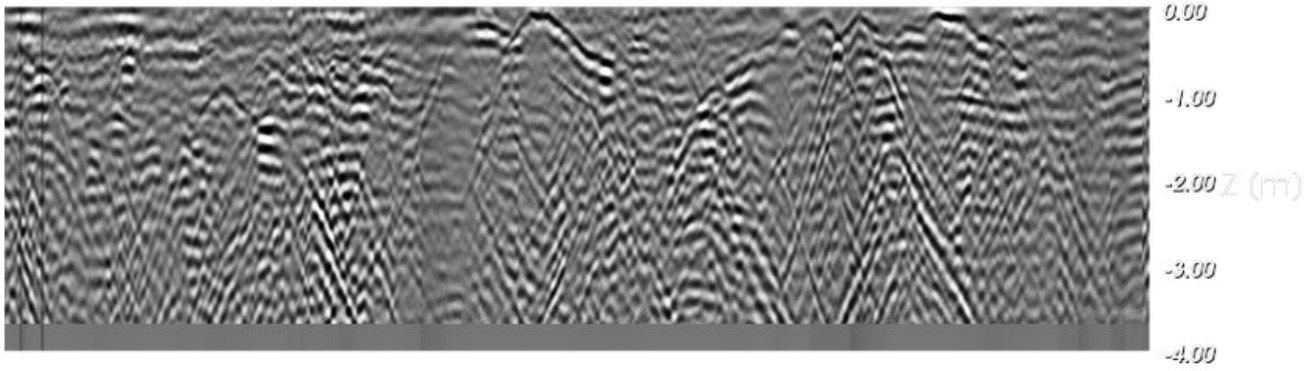
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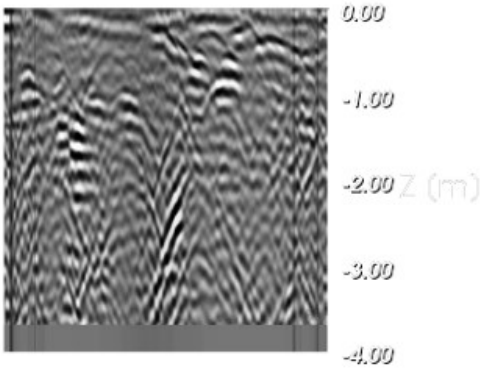
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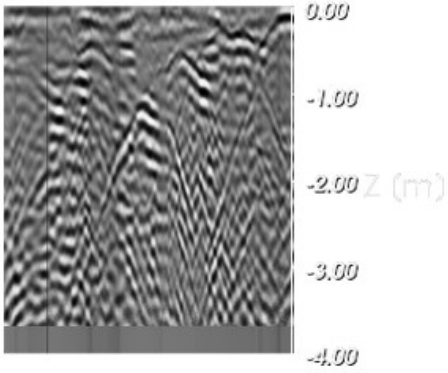
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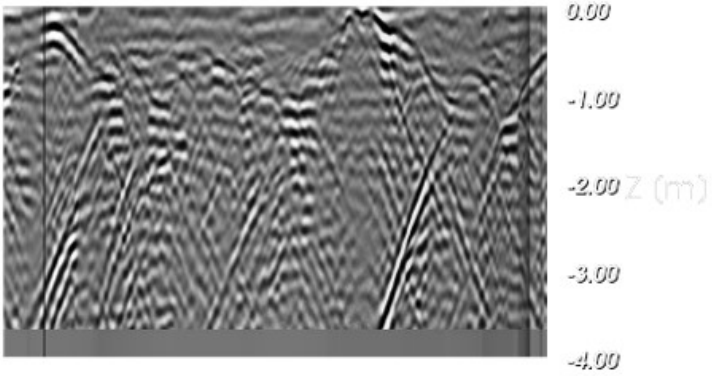
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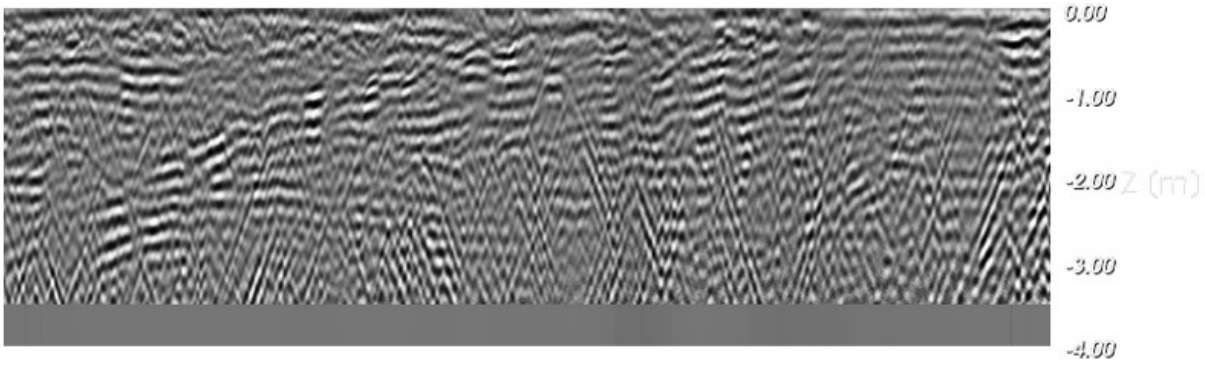
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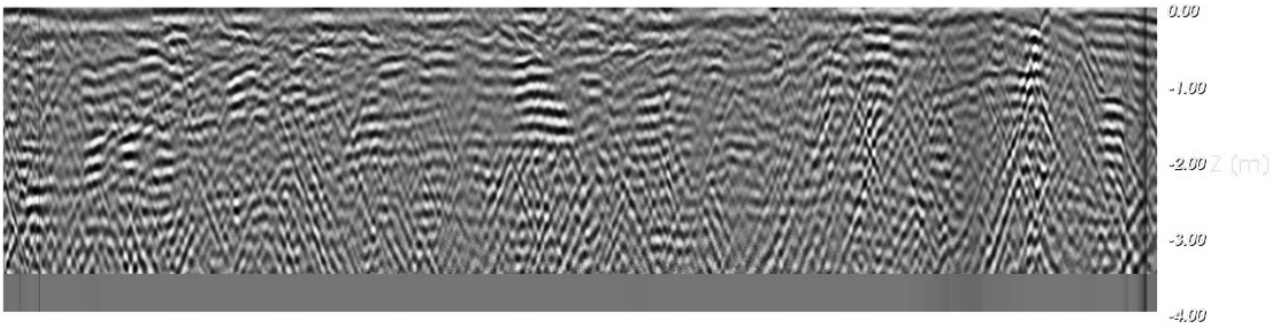
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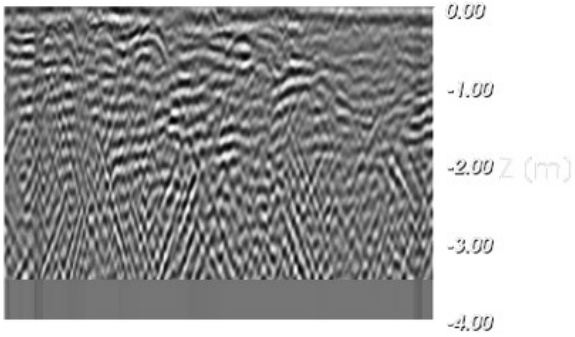
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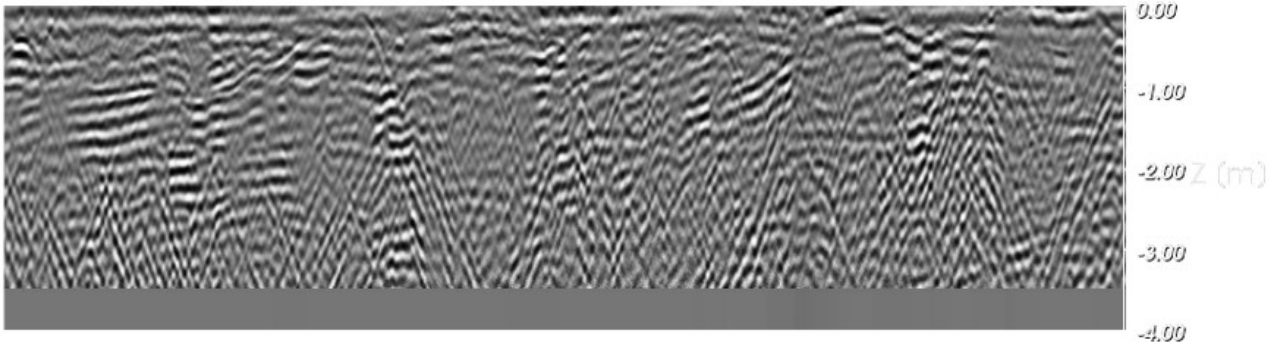
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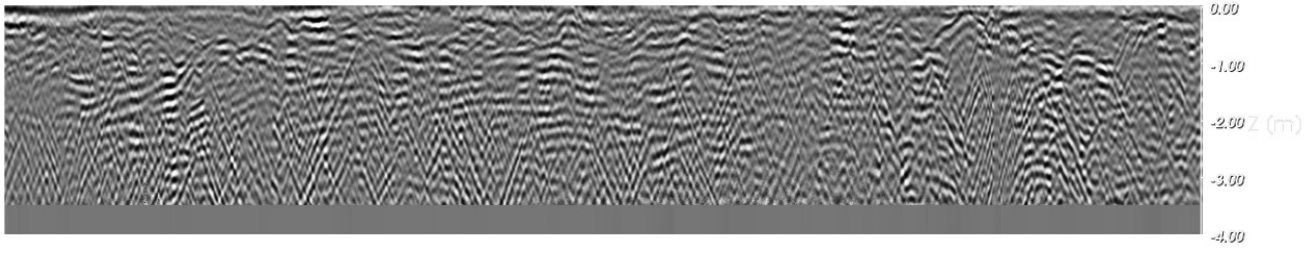
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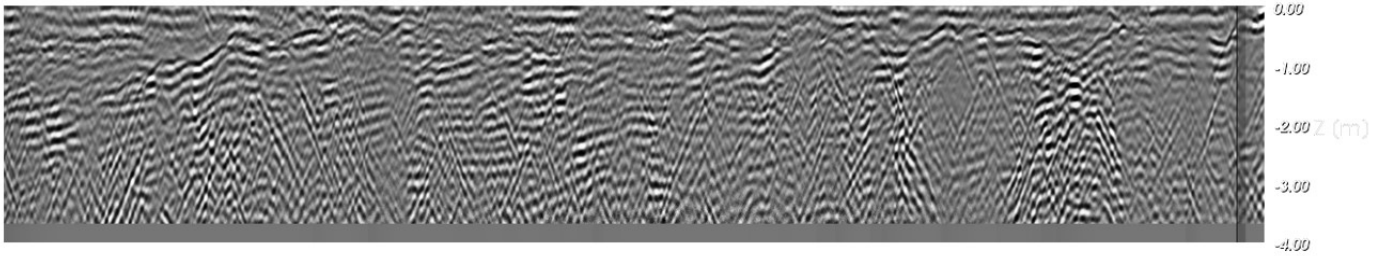
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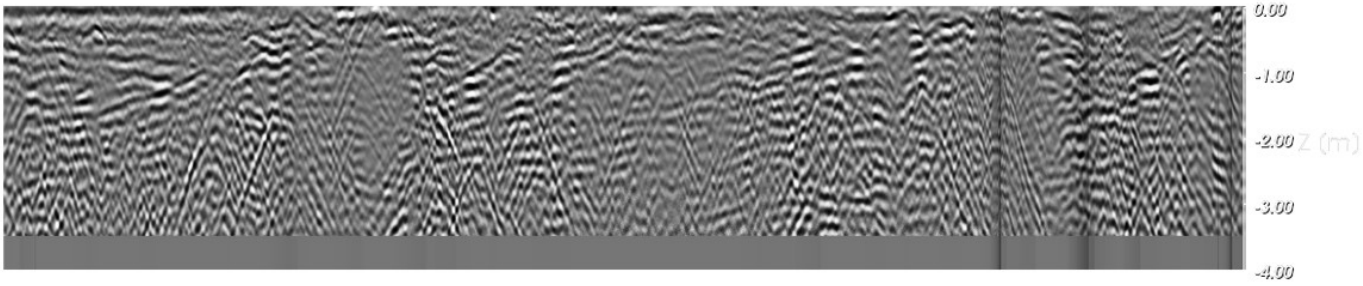
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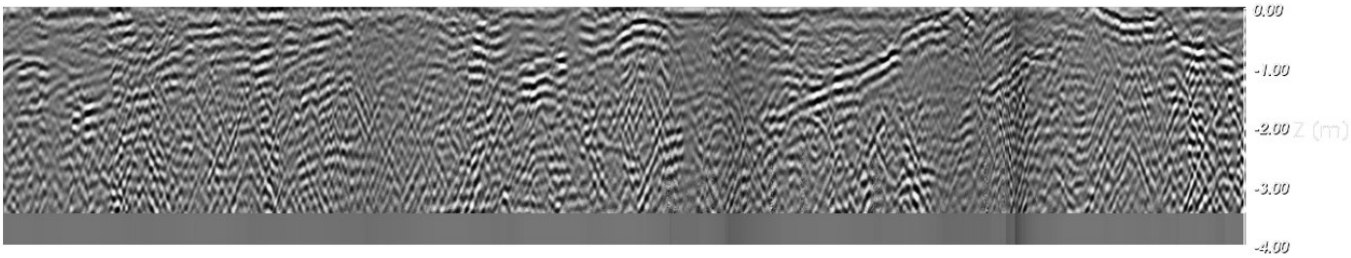
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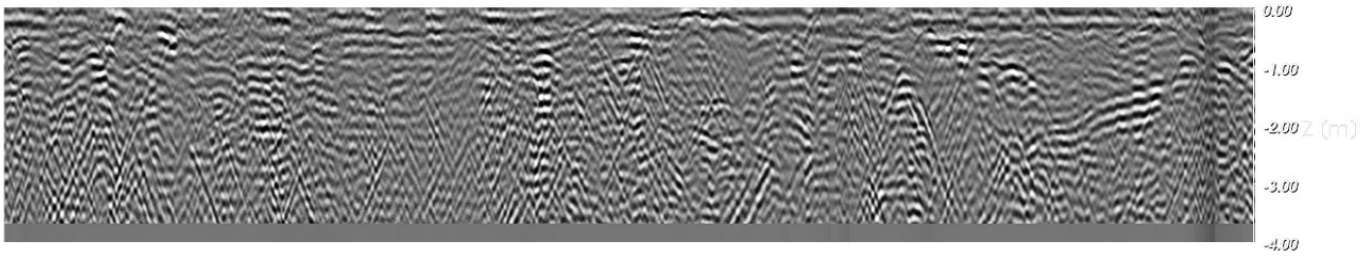
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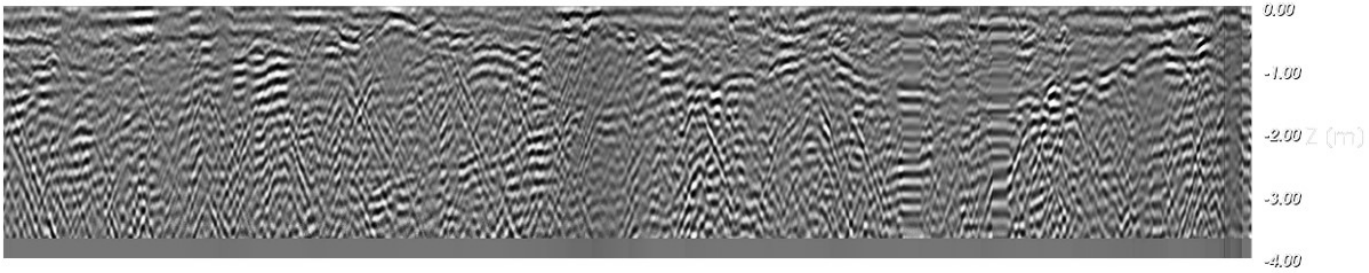
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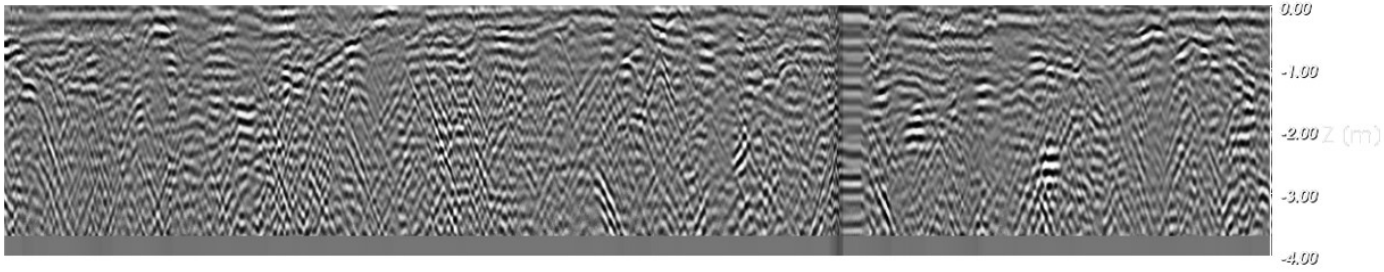
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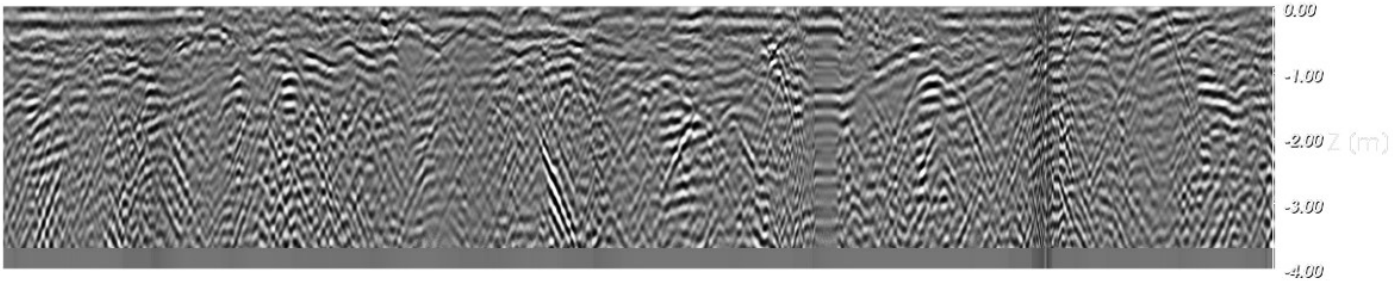
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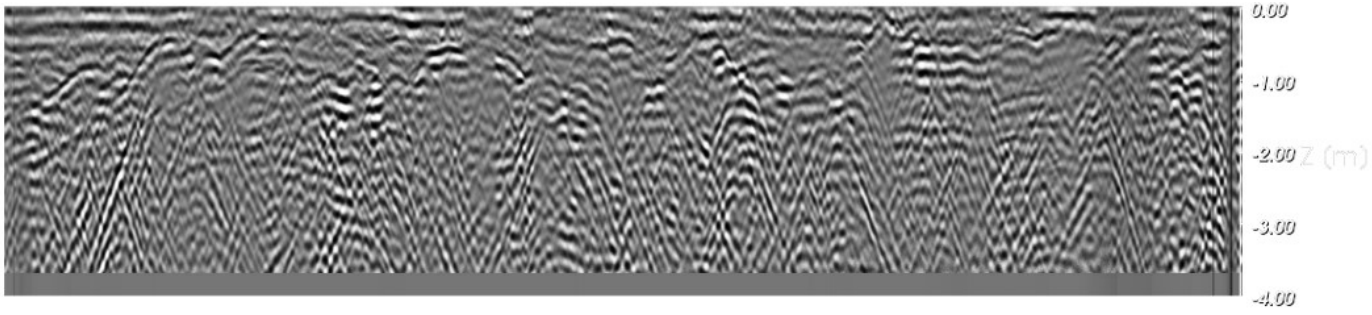
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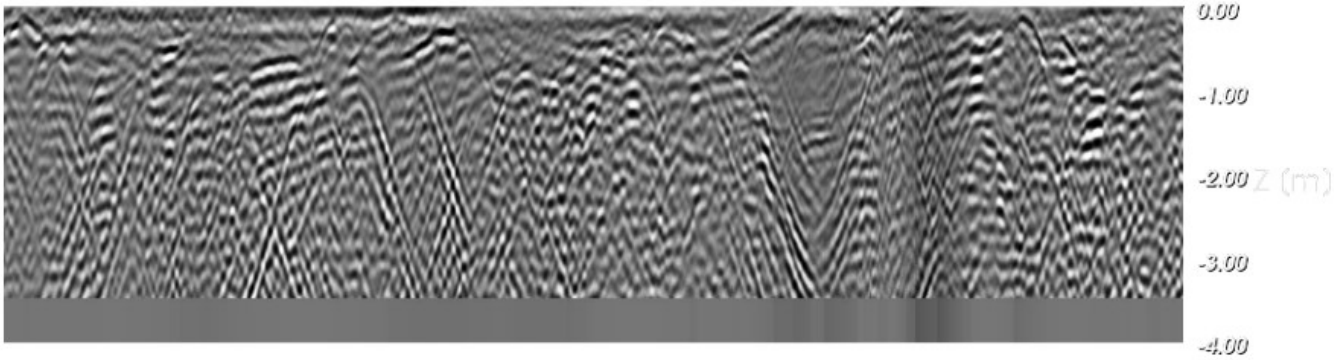


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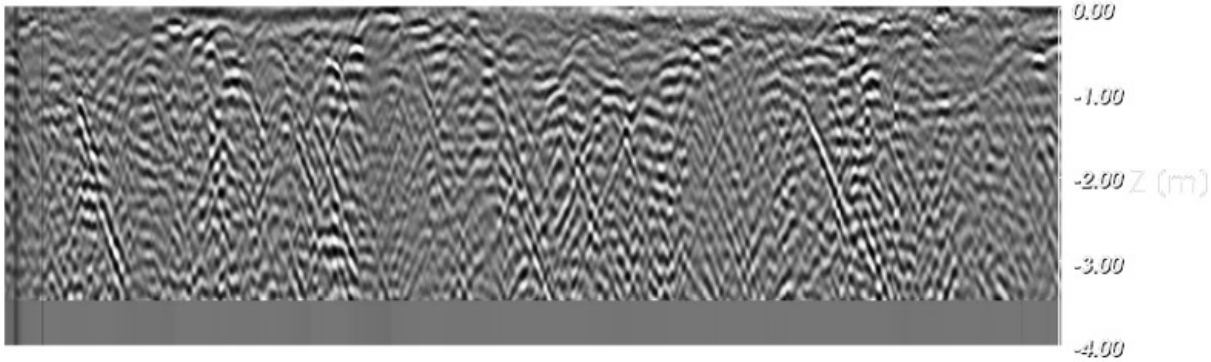
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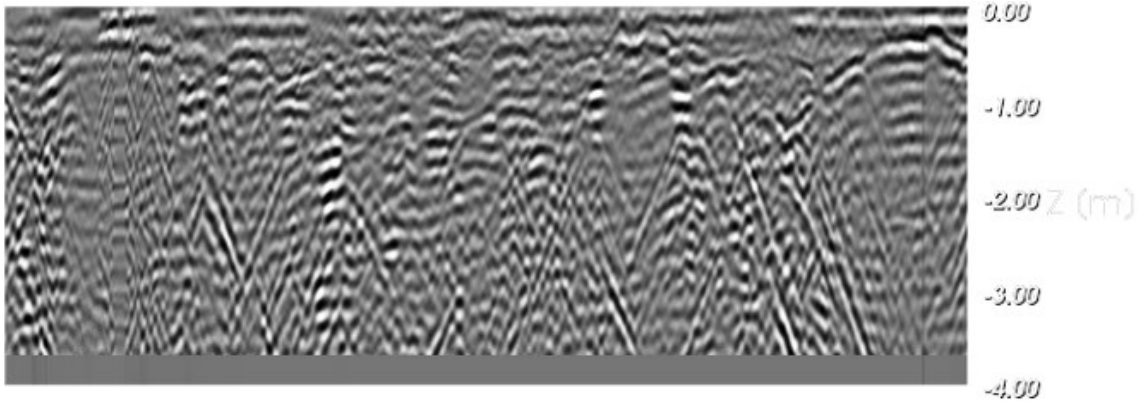
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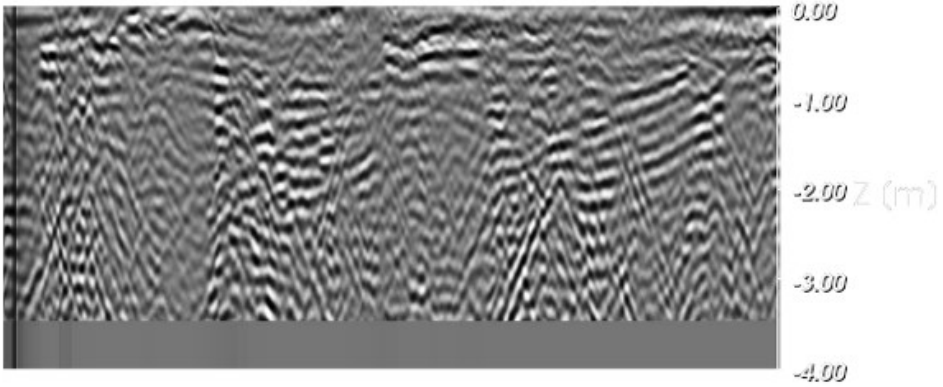
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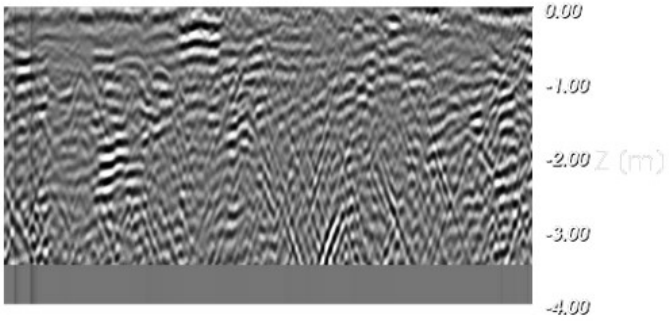


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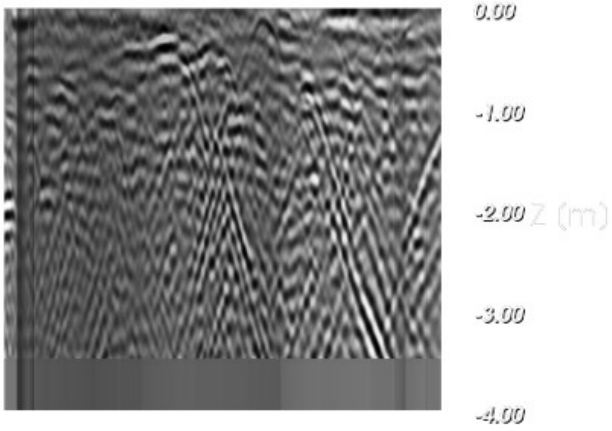
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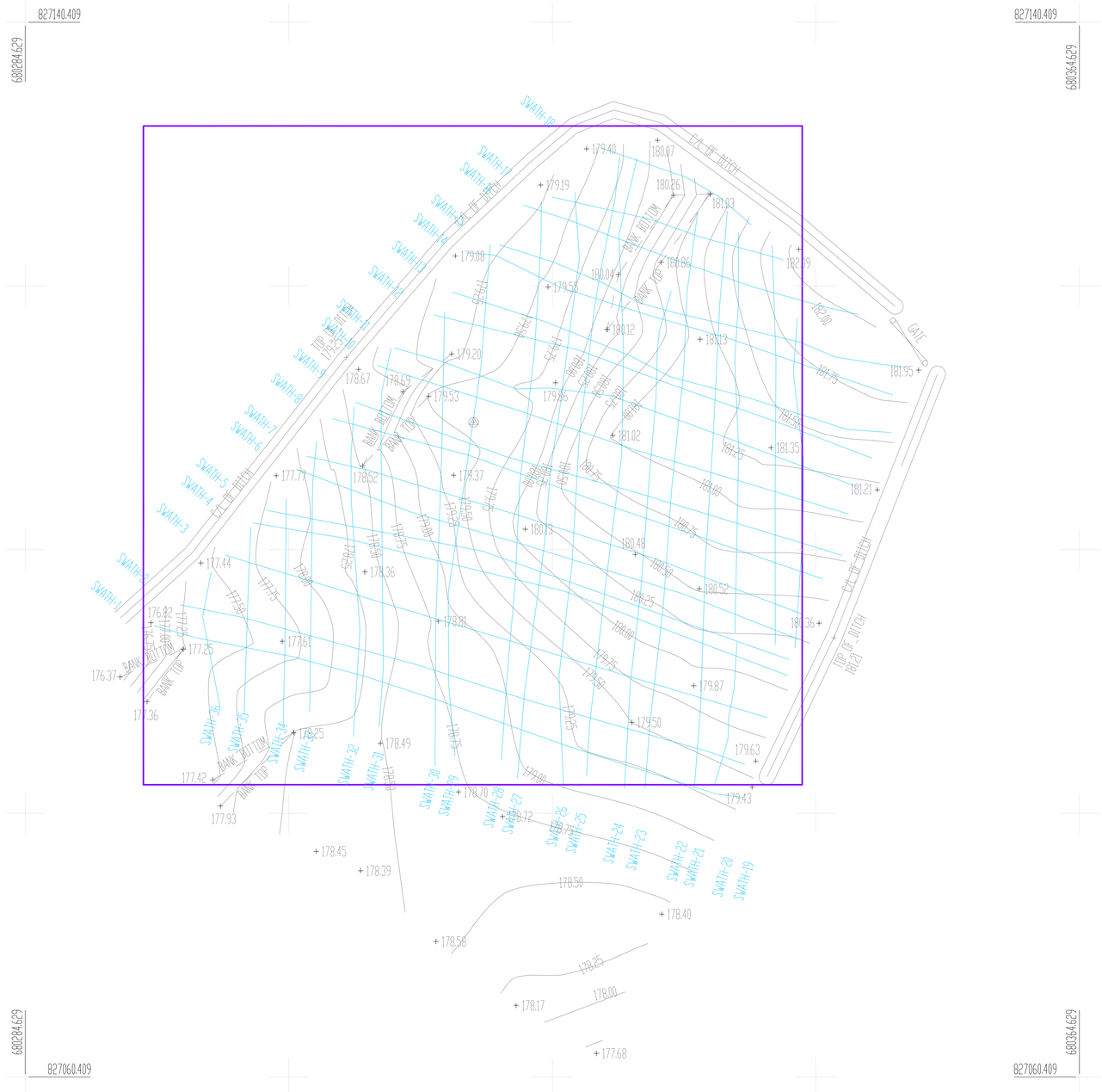


Swath: 35
Array: HH_200MHz_L



Swath: 36
Array: HH_200MHz_L





GPR DETECTION SURVEY
Scale 1:200

NOTES

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The data presented in this drawing have been collected using a combination of the following: consultation of utility asset information, visual survey & inspection of manholes and inspection chambers; electromagnetic location techniques; ground penetrating radar, and, where applicable, trial hole excavations. These techniques have been deployed in accordance with the BSI PAS128 Specification for Underground Utility Detection, Verification and Location using the search methodologies indicated below and described in the accompanying report. This drawing should be used in conjunction with the accompanying report which details the limitations of these techniques and any hindering factors encountered during this survey.

Unless otherwise stated, all utilities shown on this plan have been surveyed using approved detectors and the connections between inspection chambers, if unable to be detected, are generally assumed to be direct unless there are indications to the contrary. The detection confidence for each utility segment is depicted in line with the PAS128 scheme outlined below. Information depicted as QL–C or QL–D cannot be guaranteed as it is based on historic utility records which can be inaccurate and incomplete.

The utility routes depicted may reflect the routes of multiple cables or pipes. It is not always possible to differentiate between buried construction features, utilities and other subsurface linear features therefore it is possible that some features shown are not utility related, and due to the limitations of electromagnetic techniques all utility identifications should be treated with caution and verified prior to use during design/building works.

If the location or depth of utilities and features is of particular importance to a project then it is recommended that discussions are held with GeoData Surveying Ltd regarding any possible limitations or anomalies.

Please note that not all buried pipes, cables and ducts can be detected and mapped in consideration of their depth, location, material type, geology and proximity to other utilities. Even an appropriate and professionally executed survey may not be able to achieve a 100% detection rate. Where an area of utilities is likely to affect client project requirements, it is strongly recommended that a PAS128 Quality Level A verification survey is carried out

No utility mapping survey can be considered a 100% accurate depiction of the sub-surface environment, and the use of these drawings does not remove the requirement for the use of safe digging techniques at all times, in line with the requirements of current regulations.

ABBREVIATIONS

AJ	ARMSTRONG JUNCTION	FH	FIRE HYDRANT	UTS	UNABLE TO SURVEY
AR	ASSUMED ROUTE	FFL	FLOOR LEVEL	UTT	UNABLE TO TRACE
AV	AIR VALVE	FS	FLAG STAFF/ POLE	VP	VENT PIPE
BD	BACKDROP	G	GULLY	VE	VALVE
BL	BED LEVEL	G=	GRTH	SWL	WATER LEVEL
BH	BOREHOLE	GP	GAS INLET PIPE	STN	CONTROL STATION
Bin	LITTER / GRIT SALT BIN	GP	GUIDE POST	SV	SLUICE VALVE
BO	BOLLARD	GPR	TRACED BY G.P.R.	SC	STOP COCK
BP	BOUNDARY POST	GV	GAS VALVE	STP	SOIL STACK PIPE
BS	BUS STOP	HV	HIGH VOLTAGE	TEL	TELECOM INSP
CATV	CABLE TV COVER	IC	INSP CHAMBER	TL	TRAFFIC LIGHT
CB	CONTROL BOX	IL	INVERT LEVEL	TP	TELECOM POLE
CL	COVER LEVEL	IP	INLET PIPE	WM	WATER METER
Cpst	CAMERA POST	LP	LAMP STANDARD	WO	WASH OUT VALVE
CulP	CULVERT PIPE	LV	LOW VOLTAGE		
d	DEPTH	MH	MANHOLE		
DIA	DIAMETER	MP	MINI PILLAR		
DS	DIRECTION SIGN	MCP	MICRO PILLAR		
ESB	ELECTRIC INSP COVER	O/H	OVER HEAD LINE		
EOT	END OF TRACE	OS	OUTSIDE SURVEY AREA		
EP	ELECTRICITY STANDARD	UL	UTILITY INSP CHAMBER		
ER	EARTH ROD	UTF	UNABLE TO LIFT		
FB	FOOTBRIDGE	UTR	UNABLE TO ROD		

SUB-SURFACE KEY

COMBINED HEATING AND POWER — CHP-XX
DISTRICT HEATING — DH-XX
DRAINAGE COMBINED * — C2-XX / C3-XX
DRAINAGE FOUL* — F2-XX / F3-XX
DRAINAGE SURFACE* — S2-XX / S3-XX
DRAINAGE UNIDENTIFIED* — U2-XX / U3-XX
[* FLOW DIRECTION DENOTED BY ARROW (>) or (<) IF KNOWN]
ELECTRIC — E-XX / E-XX
ELECTRIC LV — LV-XX
ELECTRIC HV — HV-XX
ELECTRIC STREET LIGHTING — SL-XX
GAS — G-XX / G-XX
OIL/FUEL PIPELINE — OP-XX / OP-XX
STREET FURNITURE CABLES — SF-XX
TELECOMS — T-XX / T-XX
TELECOMS – FIBRE OPTIC — FO-XX
TELECOMS – EIR — EIR-XX
TRAFFIC CONTROL — TC-XX
WATER — W-XX / W-XX
UNIDENTIFIED UTILITY — U-XX / U-XX
UNIDENTIFIED CABLES — C-XX / C-XX
UNIDENTIFIED EMPTY DUCT — X-XX / X-XX
GPR LINEAR FEATURE — GPR-XX
GPR AREA ANOMALY
GPR AREA ANOMALY – REBAR
CHAMBER EXTENTS

WITH EXAMPLE CONFIDENCE LEVELS

MEASURED DEPTH BGL TO PIPE/CABLE/DUCT — 0.65d
INVERT LEVEL OF PIPE/DUCT/CABLE (TO OS DATUM) — IL 12.34
SOFFIT LEVEL OF PIPE/DUCT/CABLE (TO OS DATUM) — SL 45.67
COVER LEVEL OF INSPECTION CHAMBER (TO OS DATUM) — CL 78.90
DIAMETER OF PIPE/DUCT IN MILLIMETERS — 150#
[BGL – BELOW GROUND LEVEL]

AREA UNABLE TO BE SURVEYED DUE TO SURFACE OBSTRUCTIONS, VEGETATION OR LACK OF ACCESS
TRENCH SCAR / SURFACE SCAR
EXTENT OF SURVEY – BOUNDARY

UTILITY CONFIDENCE LEVELS (Listed from High to Low)

(A)	HORIZONTAL AND VERTICAL POSITION VERIFIED VISUALLY (Accuracy: Horizontal (±25mm) Vertical(±50mm)
(B1P)	HORIZONTAL AND VERTICAL POSITION DETECTED BY MULTIPLE METHODS W H POST PROCESSING OF GPR DATA (Estimated Accuracy: ±150mm OR ±15% of detected depth)
(B1)	HORIZONTAL AND VERTICAL POSITION DETECTED BY MULTIPLE METHODS Estimated Accuracy: ±150mm OR ±15% of detected depth)
(B2P)	HORIZONTAL AND VERTICAL POSITION DETECTED VIA POST-PROCESSED GPR (Estimated Accuracy: ±250mm OR ±40% of detected depth)
(B2)	HORIZONTAL AND VERTICAL POSITION DETECTED BY A SINGLE METHOD (Estimated Accuracy: ±250mm OR ±40% of detected depth)
(B3P)	HORIZONTAL POSITION DETECTED VIA POST-PROCESSED GPR (Estimated Accuracy: ±500mm in the Horizontal – Depth is undefined)
(B3)	HORIZONTAL POSITION DETECTED BY A SINGLE METHOD (Estimated Accuracy: ±500mm in the Horizontal – Depth is undefined)
(C)	ROUTE TRANSCRIBED FROM UTILITY ASSET PLANS AND CORRELATED VISUAL INDICATORS AND SURFACE FEATURES (Accuracy Undefined)
(D)	ROUTE TRANSCRIBED FROM UTILITY ASSET PLANS (Accuracy Undefined)

SURVEY NOTES

1. All levels are related to Malin Head Datum (OSGM15)
2. All dimensions are in meters unless otherwise stated.
3. any descripencies in the survey should be reported to Geodata Surveying Ltd immediately.
4. Do not scale, this shall only be permitted in digital form.
5. Grid is 20m x 20m

ITM GRID

0 4m 8m 12m
1:200

PAS128 SURVEY METHODOLOGY LOCATION PLAN

PAS128 SURVEY METHODOLOGY KEY

THIS SURVEY HAS BEEN CARRIED OUT IN ACCORDANCE WITH THE PAS128 SPECIFICATION FOR UNDERGROUND UTILITY DETECTION, VERIFICATION & LOCATION. THE SPECIFICATION ALLOWS FOR A RANGE OF TECHNIQUES AND METHODS OF VARYING INTENSITY TO BE DEPLOYED. THE COLOUR CODED SCHEME INDICATES WHERE DIFFERENT SURVEY METHODOLOGIES HAVE BEEN USED ON SITE, AND THE LIST BELOW IDENTIFIES EQUIPMENT USED TO OBTAIN THE SURVEY RESULTS.
NB: PLEASE SEE ACCOMPANYING REPORT FOR FULL DETAILS.

ELECTROMAGNETIC DETECTION	GROUND PENETRATING RADAR	TOTAL STATION	GPS/GNSS
RD 8000 Precision Locating	IDS C-Stream - High Density Array	59 Trimble Robotic	Trimble R10
	IDS Opera Dual Antenna	36 Trimble Robotic	

M4P - EML SEARCH TRANSECT AT 2m INTERVALS - TRACED AT 0.5m INTERVALS. GPR SURVEY GRID AT 0.5m INTERVALS OR HIGH DENSITY ARRAY. POST PROCESSING OF GPR DATA.
M3P - EML SEARCH TRANSECT AT 2m INTERVALS - TRACED AT 1m INTERVALS. GPR SURVEY GRID AT 1m INTERVALS OR HIGH DENSITY ARRAY. POST PROCESSING OF GPR DATA.
M2P - EML SEARCH TRANSECT AT 5m INTERVALS - TRACED AT 2m INTERVALS. GPR SURVEY GRID AT 2m INTERVALS OR HIGH DENSITY ARRAY. POST PROCESSING OF GPR DATA.
M1P - EML SEARCH TRANSECT AT 10m INTERVALS - TRACED AT 5m INTERVALS. GPR SURVEY AS APPROPRIATE. POST PROCESSING OF GPR DATA.
M4 - EML SEARCH TRANSECT AT 2m INTERVALS - TRACED AT 0.5m INTERVALS. GPR SURVEY GRID AT 0.5m INTERVALS. GPR MARK-UP ON SITE
M3 - EML SEARCH TRANSECT AT 2m INTERVALS - TRACED AT 1m INTERVALS. GPR SURVEY GRID AT 1m INTERVALS. GPR MARK-UP ON SITE.
M2 - EML SEARCH TRANSECT AT 5m INTERVALS - TRACED AT 2m INTERVALS. GPR SURVEY GRID AT 2m INTERVALS. GPR MARK-UP ON SITE.
M1 - EML SEARCH TRANSECT AT 10m INTERVALS - TRACED AT 5m INTERVALS. GPR SURVEY AS APPROPRIATE. GPR MARK-UP ON SITE

DUCT FORMATION

1W:	1 WAY SINGLE DUCT
2W:	2 WAY FLAT
2W:1/2	2 WAY: 1 WIDE, 2 DEEP
4W:2/2	4 WAY: 2 WIDE, 2 DEEP
6W:3/2	6 WAY: 3 WIDE, 2 DEEP
12W:4/3	12 WAY: 4 WIDE, 3 DEEP

NB: TO BE ADAPTED TO FOR EACH CHAMBER

Rev	Date	Description	Drn By	Ckd By
01	28-02-23	GPR SURVEY	SF	KOB

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Client: OCB Geotechnical Ltd. — Rev. 01
Project: Site 111 Co Monaghan — Job. No: 21719 — Dwg. No: 400
Title: GPR Detection Survey — Drawn By: KL — Checked By: SF
Date: 28-02-23 — Sheet: A1 — Scale: 1-200 — Approved By: KOB

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Geodata
Chartered Land Surveyors

Technical Report

Ground-Penetrating Radar (GPR) Detection Survey

Client: OCB Geotechnical Ltd

Project: 21719 –Monaghan, Site 112.

28th of February 2022

GeoData Surveying Ltd
Registered Office: 47 Oliver Plunkett Street, Bandon, Co Cork. P72 A443.
Tel: 023 8852798 | www.geodatasurveying.ie

Summary

Technical Report - Ground-Penetrating Radar (GPR) & Utility Survey

Client: OBC Geotechnical

Project: 21719–Monaghan, Site 112

Document Evolution					
Job no	**Issue**	**Date**	**Prepared by**	**Checked by**	**Description**
21719	01	07-01-22	S. Forys	KO'Brien	First Edition

1. Introduction

GeoData were requested to carry out a Ground-Penetrating Radar (GPR) Survey for OCB Geotechnical.



Extent of Survey

2. Scope of the Investigation

The scope of the investigation is to Ground Penetrating Radar (GPR) on a 50m x 50m area at a 5m grid spacing using a 200 MHz shielded antennae with A Real Time Kinematic (RTK) differential GPS to accurately log the position of each GPR trace.

3. Limitation of Survey

It must be noted the geophysical data by itself does not allow identification of the anomalies detected. No GPR survey can be considered a 100% accurate depiction of the sub-surface environment and the use of these drawings does not remove the requirement for the use of safe digging techniques at all times.

4. Method of Investigation

The Survey was carried out using the following methods:

- Desk Top Studies;
- Site reconnaissance
- Establish Survey grids
- Ground Penetrating Radar (GPR);
- Record and Process markings
- Post Processing GPR Data;
- Quality Check
- Final Report

5. Detection Methodology

The Survey was carried using IDS Opera Duo multi frequency Ground Penetrating Radar with a frequency of 200MHz to allow greater penetration on a 50m x 50m area at a 5m grid spacing. position of each GPR trace.

5.1. Geo-radar

Ground Penetrating Radar is a non invasive technology that uses radar waves from a surface transmitter that can penetrate through ground materials and are reflected back to the instrument by a change of ground material or other buried objects.

The transmission frequency is an importance factor in GPR. Low frequency radars will provide high penetration into the target but these results can lead to unfavourable resolutions. High frequency radar provides greater resolution in regards to radar images but the penetration is less than the low frequency.

In this instance the Opera Duo achieved a penetration of typically 1.2-2.0m below the surface. The position of the array was continually monitored and recorded using a total station.



Figure 5.0 C-Stream IDS -High Density Array (GPR)

5.2. Post Process of Ground Penetrating Radar (GPR) data

Ground Penetrating Radar (GPR) data was post processed to improve the interpretation of raw data using GRED HD GPR Post processing software.

Post processing aids in the identification of responses to gain a better understanding of areas of complex or more obscure utility networks..

6. Quality Check

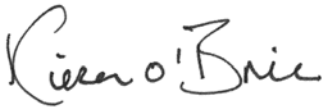
GeoData has inbuilt quality check system involving cross checking and discussion between teams to identify any possible inaccuracies and to improve the interpretation of the Post processing of GPR data and onsite observations. All Equipment used was calibrated and tested in line with manufacturer guidelines and survey carried out in accordance with TSA guidelines.

7. Conclusions and Recommendations.

Ground Penetration Radar resolution was generally good on site with penetration of typically 1.2-2.0m below the surface in area of optimal ground conditions. Areas unable to be surveyed due to surface obstructions, vegetation, slope or lack of access were marked in the survey drawings (Appendix A)

The Radiograms show a uniform substrate of soil, I would not be in a position to comment on the physical characteristic of the substrate due to the absent of site investigation to reference the Ground Penetrating Radar data.

Yours sincerely,

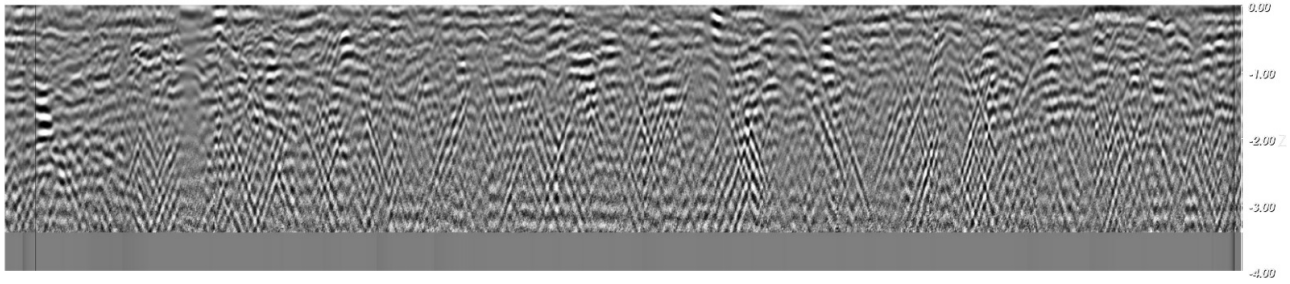


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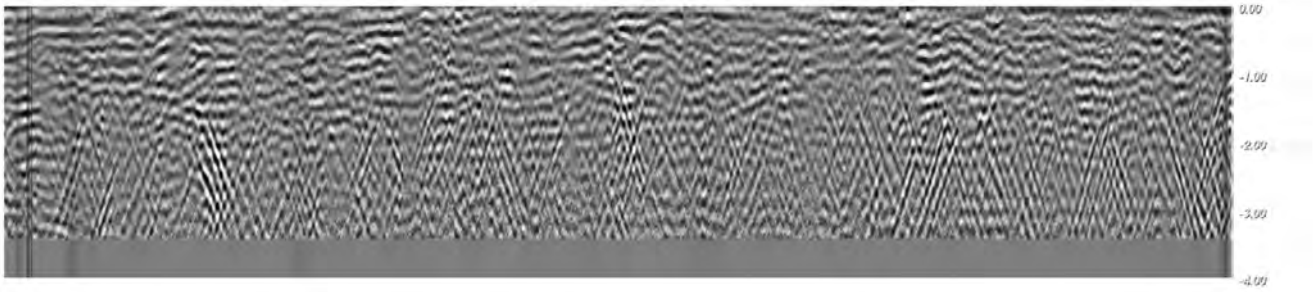
Kieran O'Brien
Chartered Engineer & Chartered Geomatics Surveyor
BEng(Hons) CEng MIEI MSCSI/MRIC

Appendix A

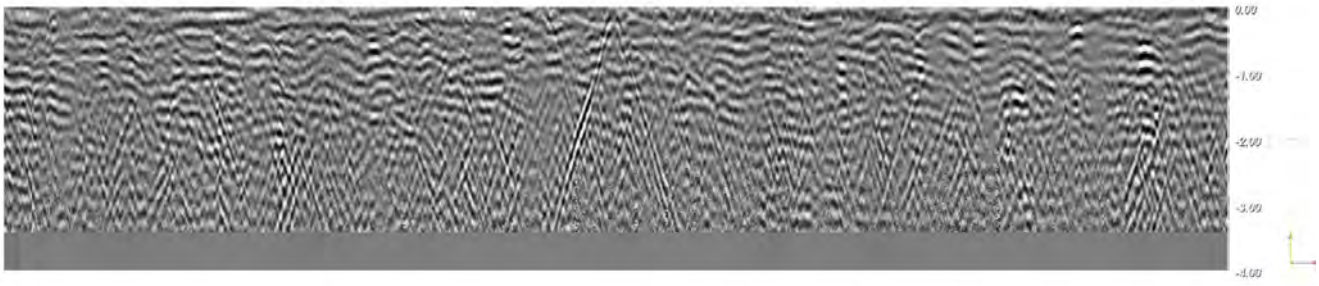
Swath:1
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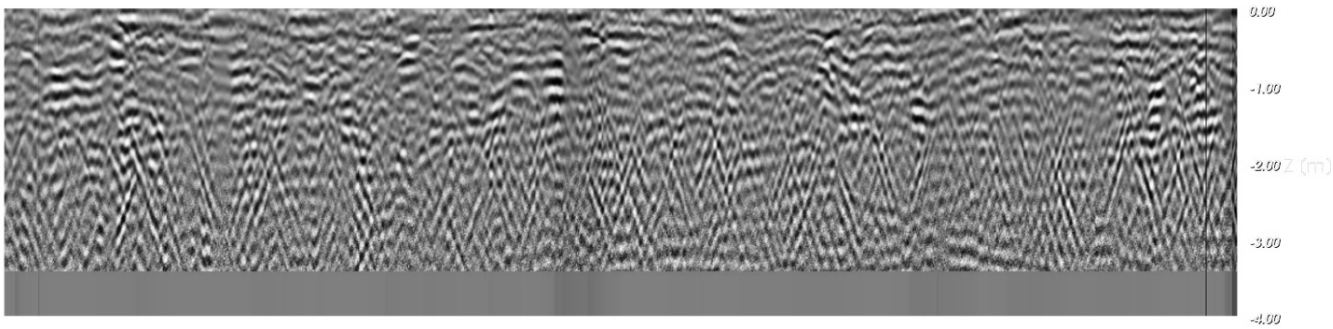
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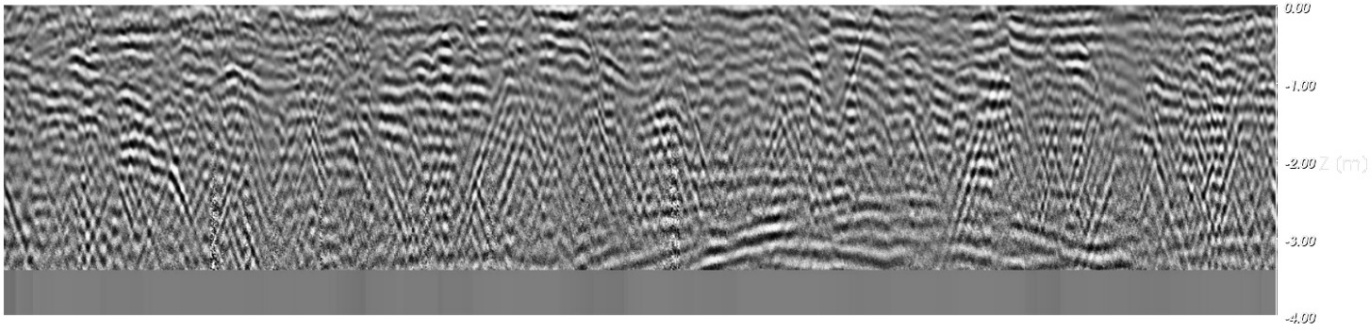
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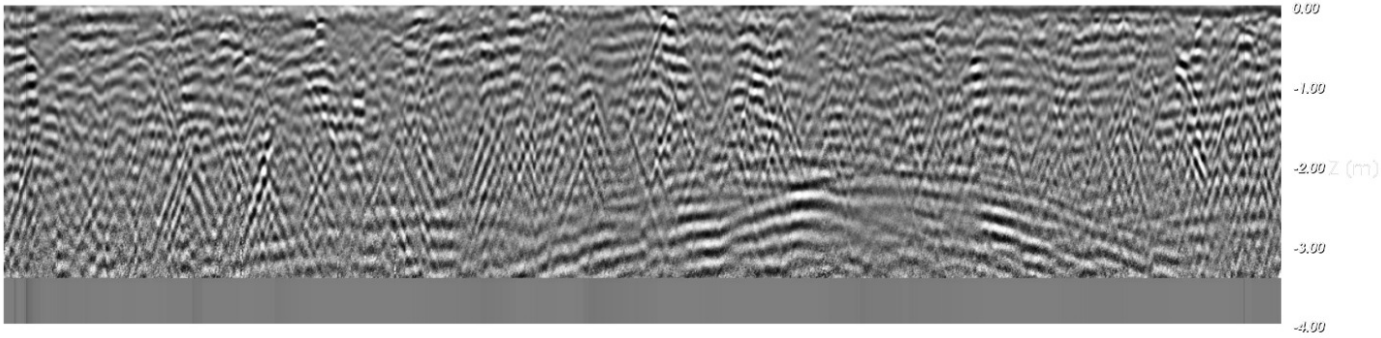
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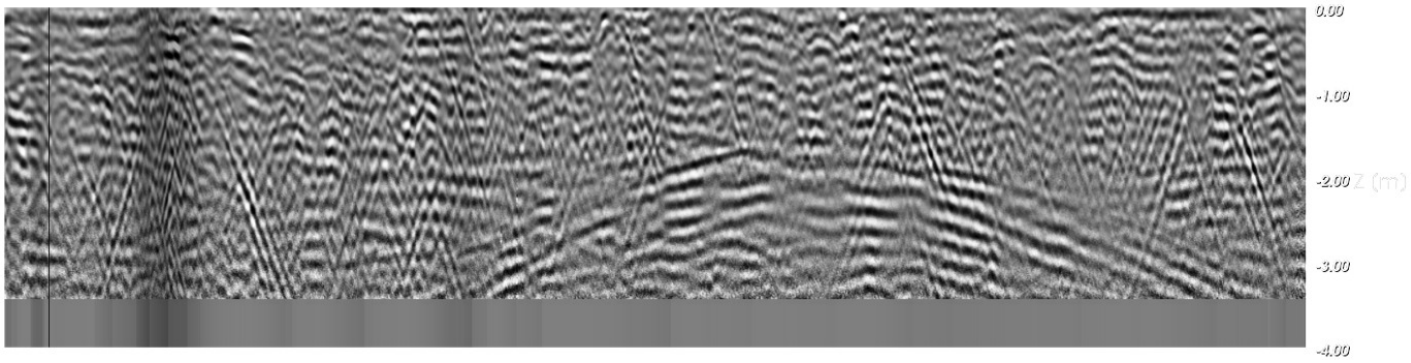
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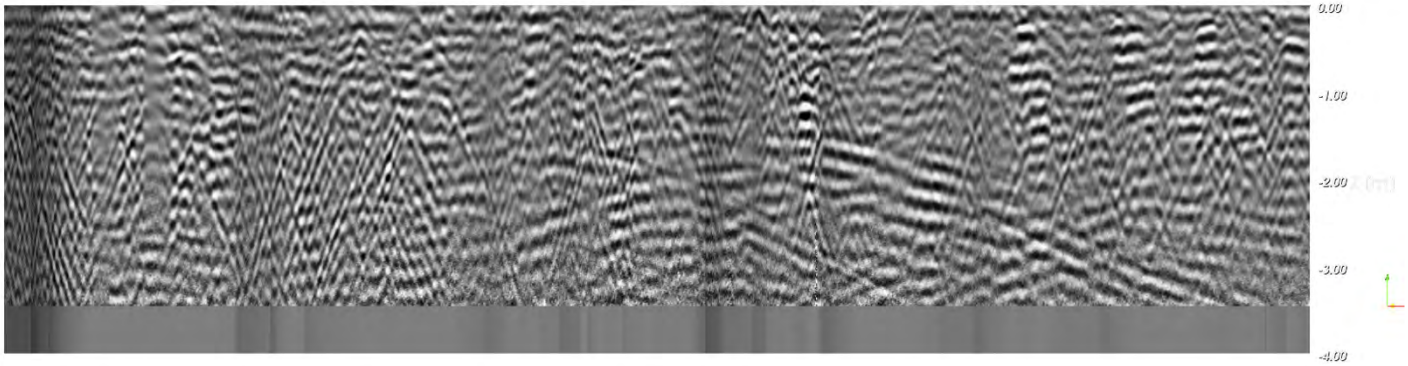
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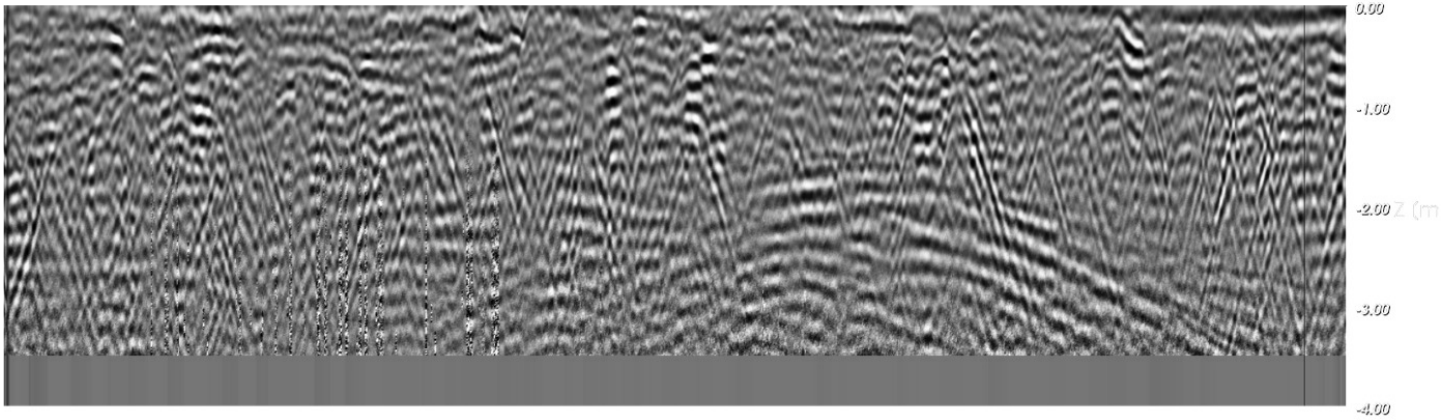
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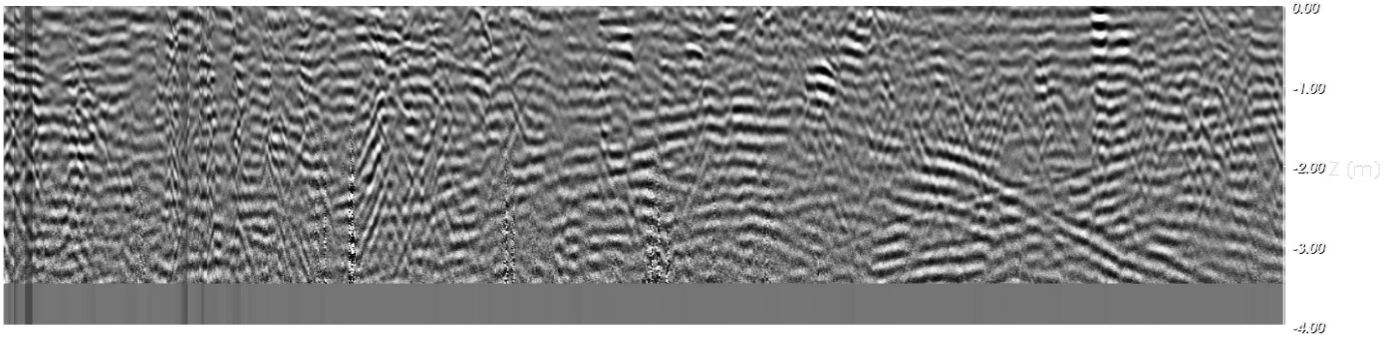
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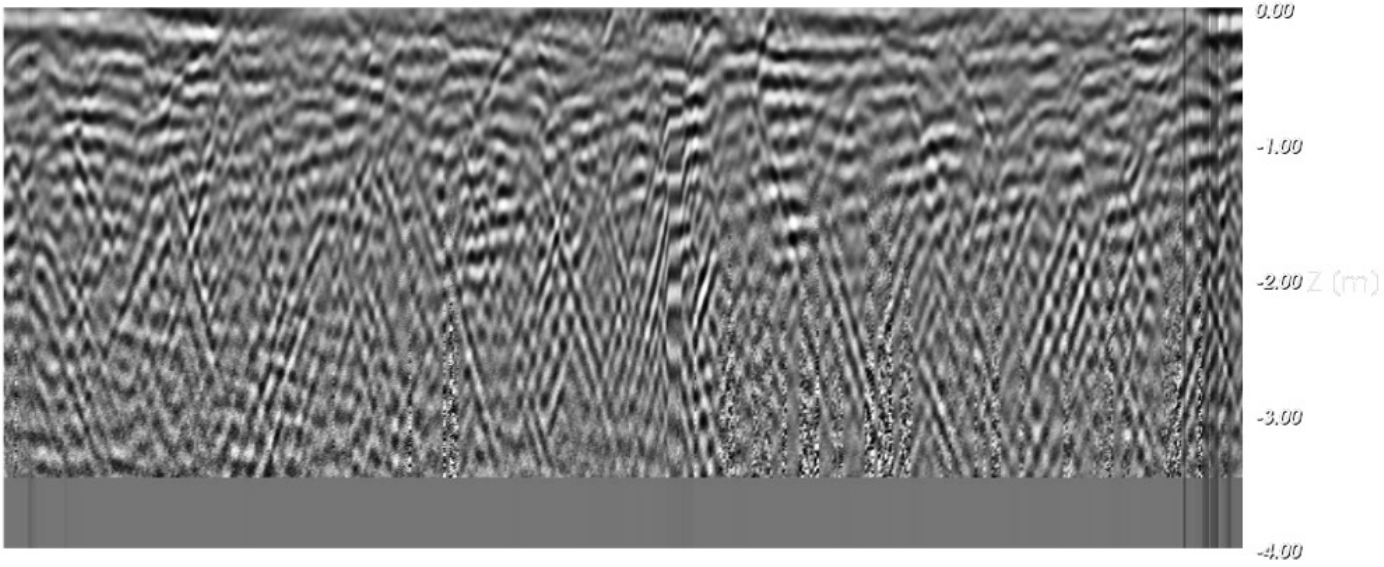
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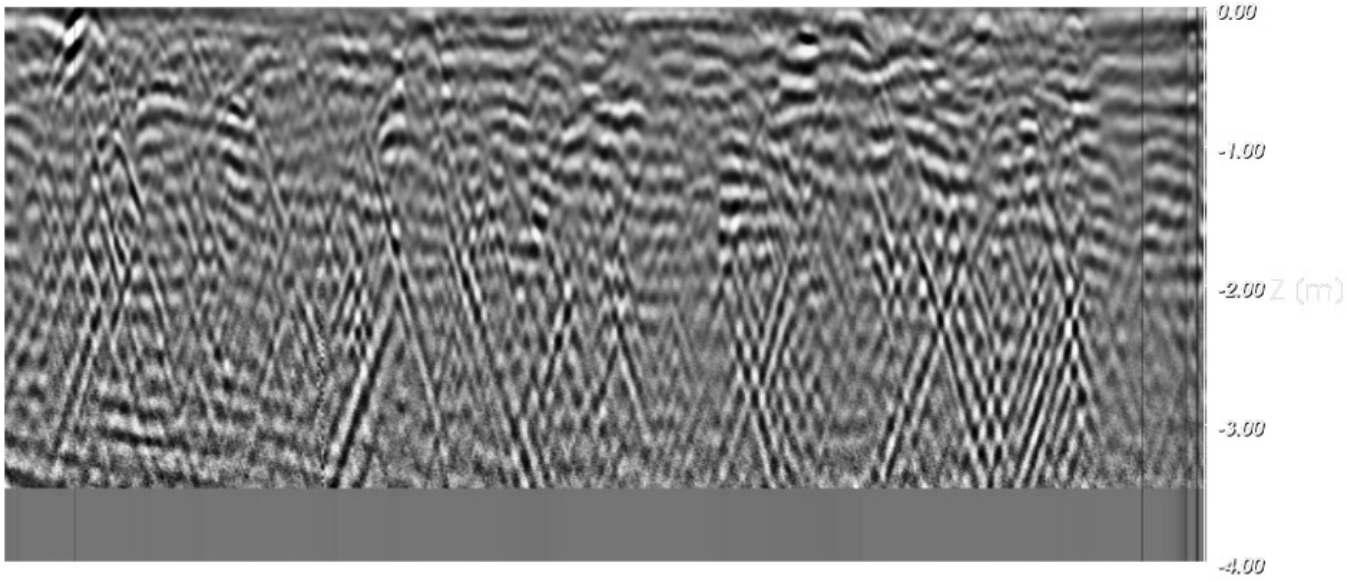
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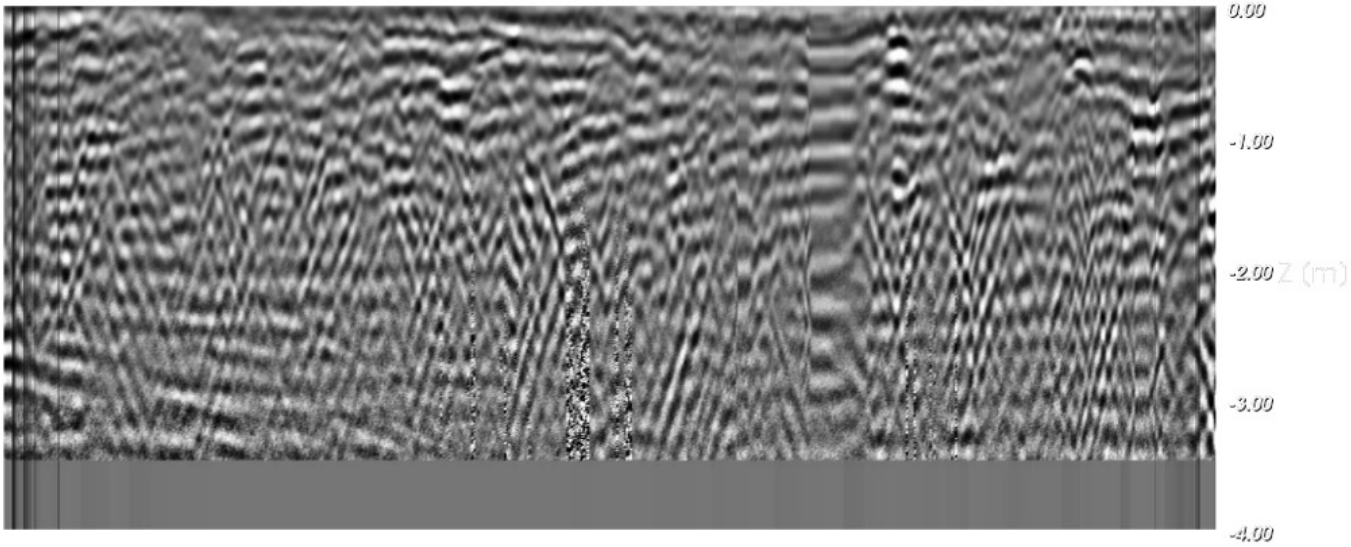
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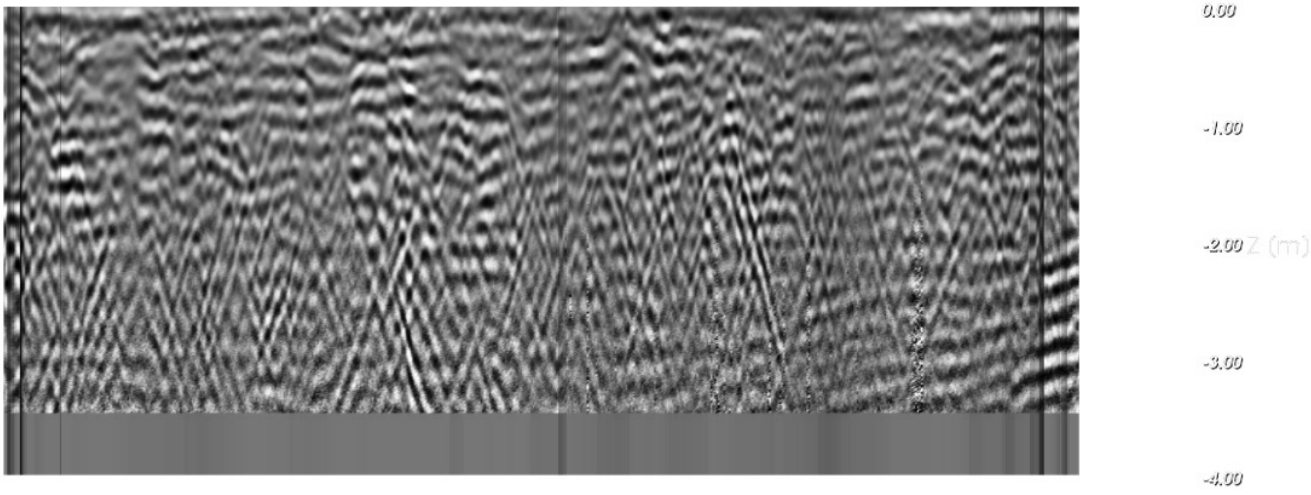
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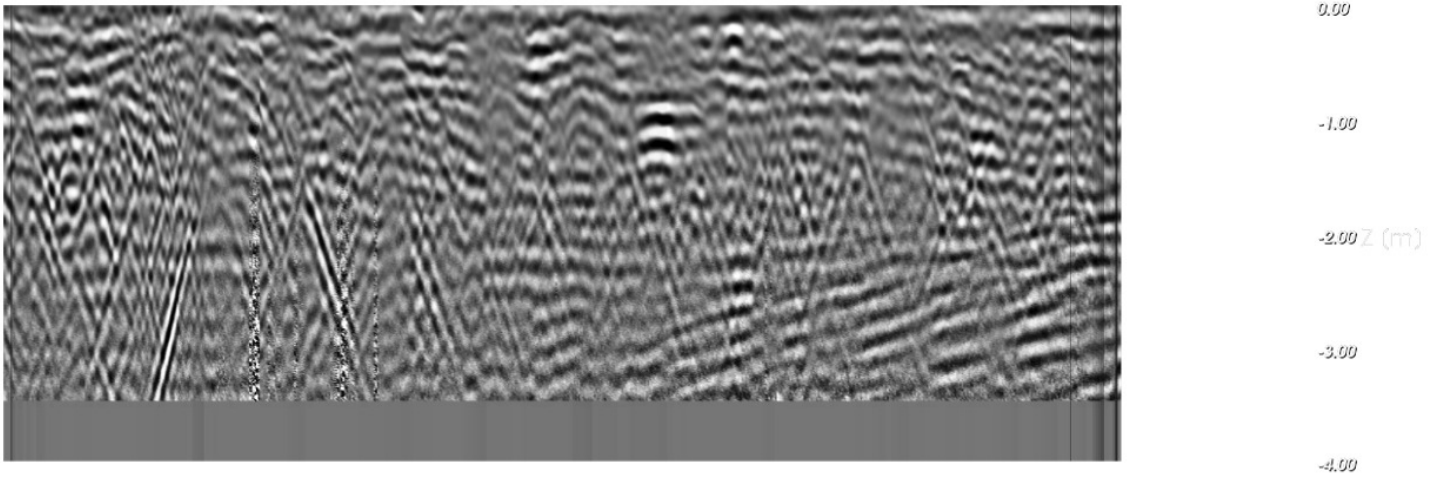
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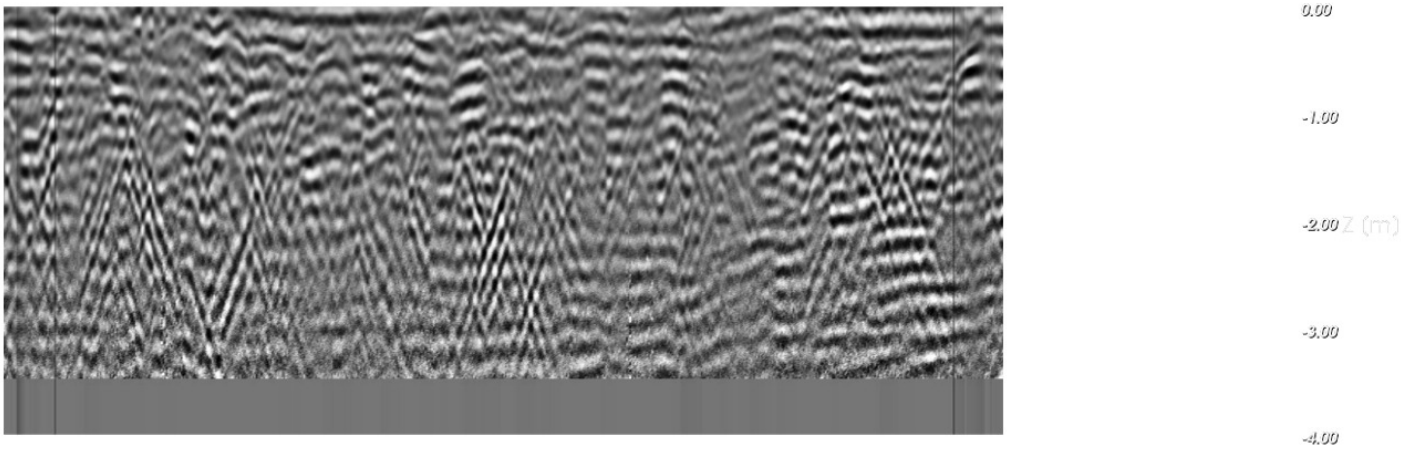
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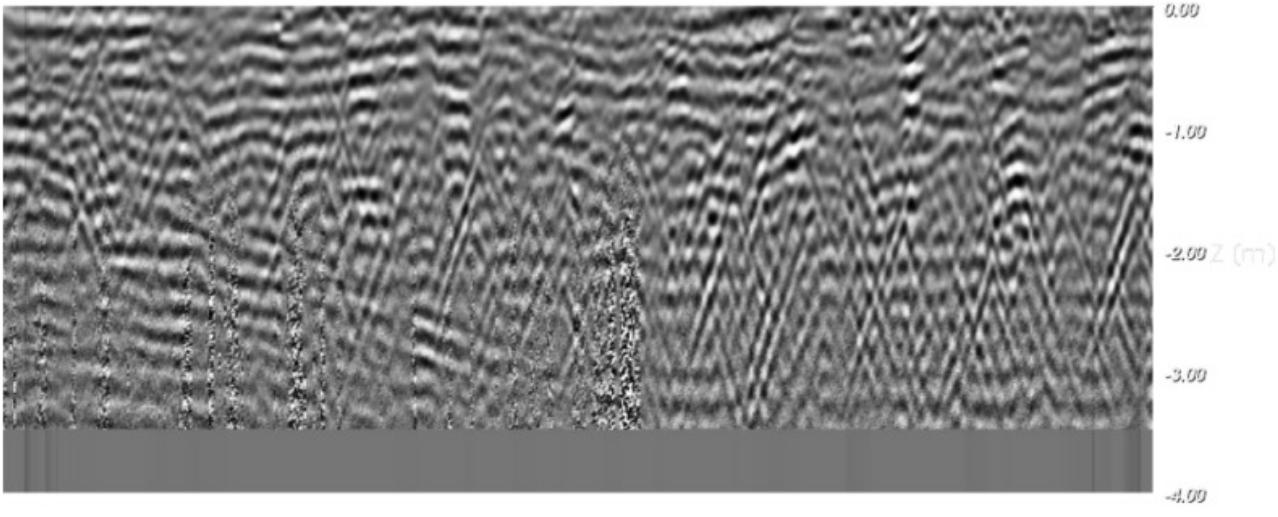
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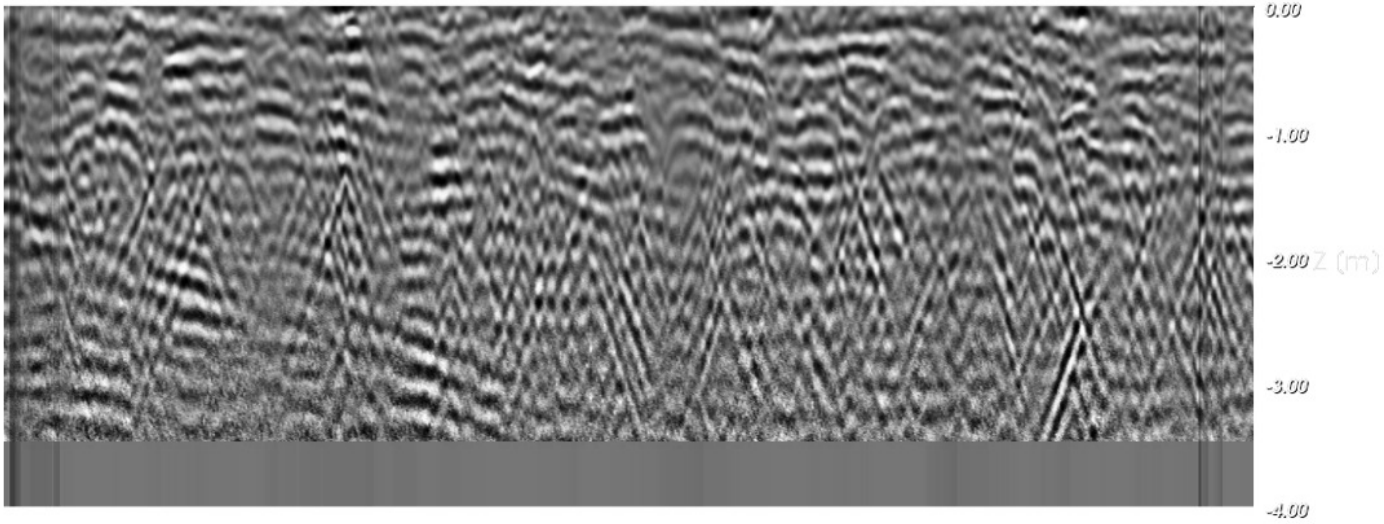
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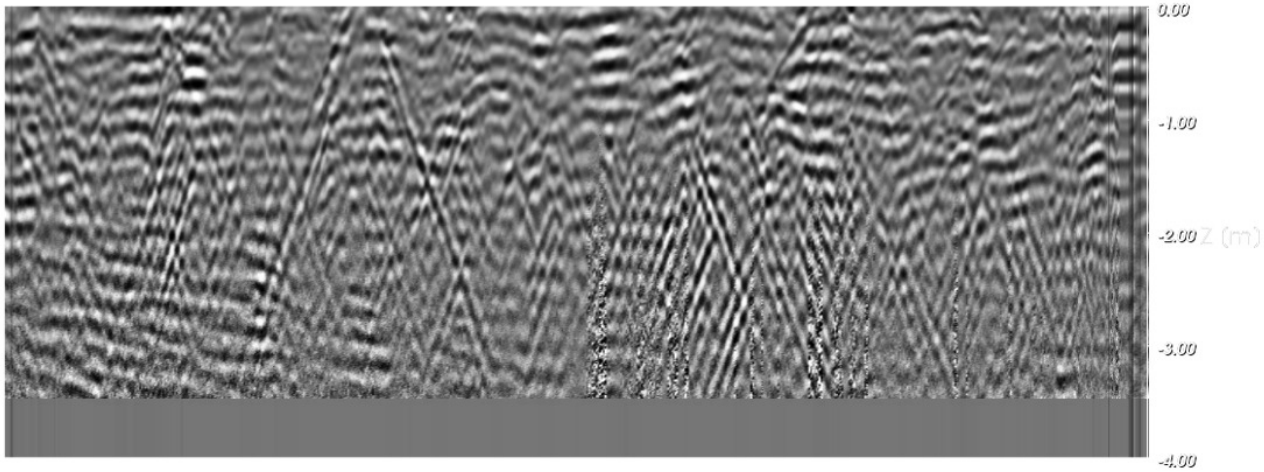
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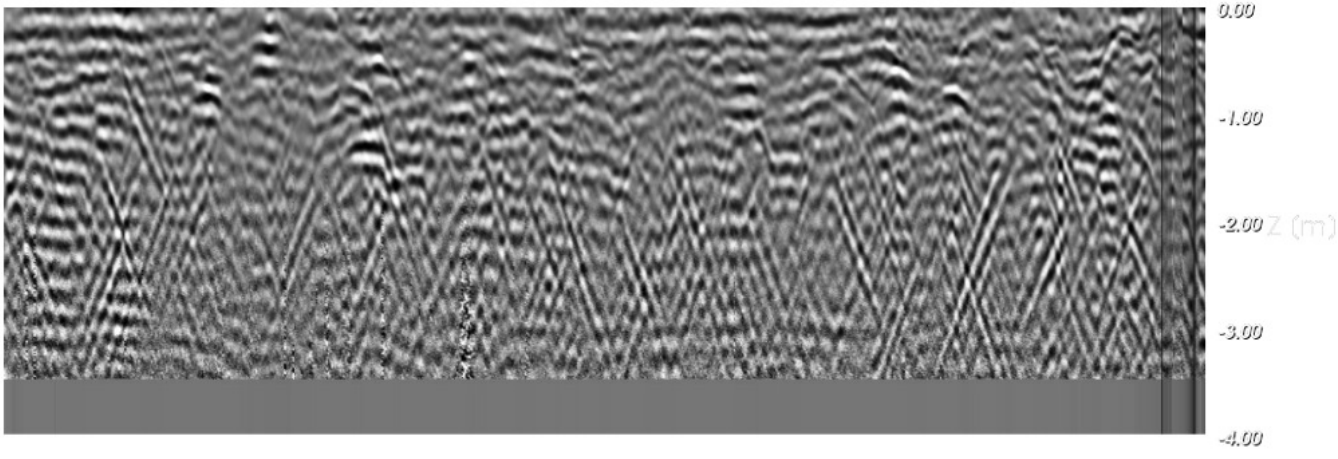
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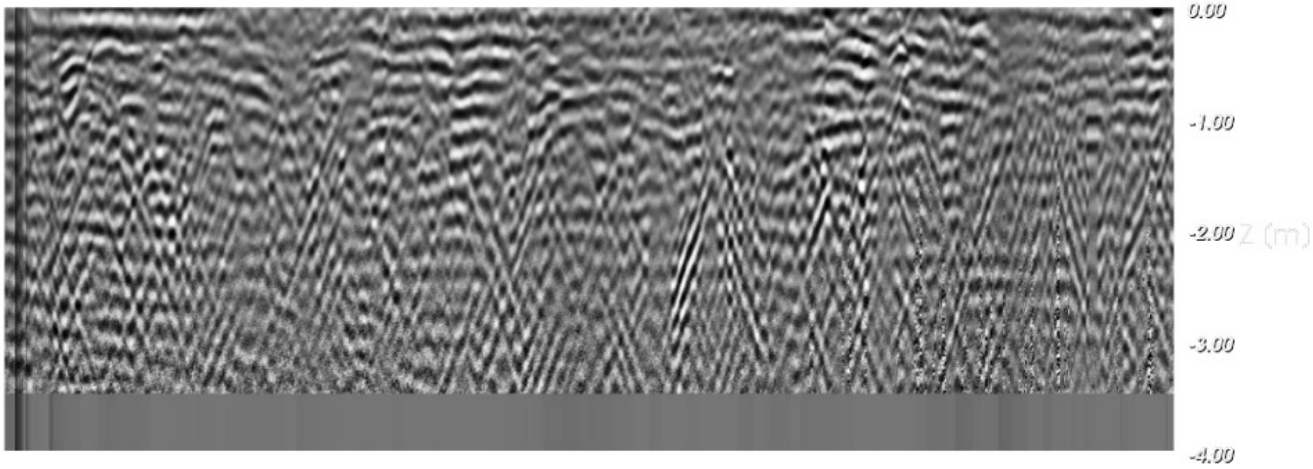
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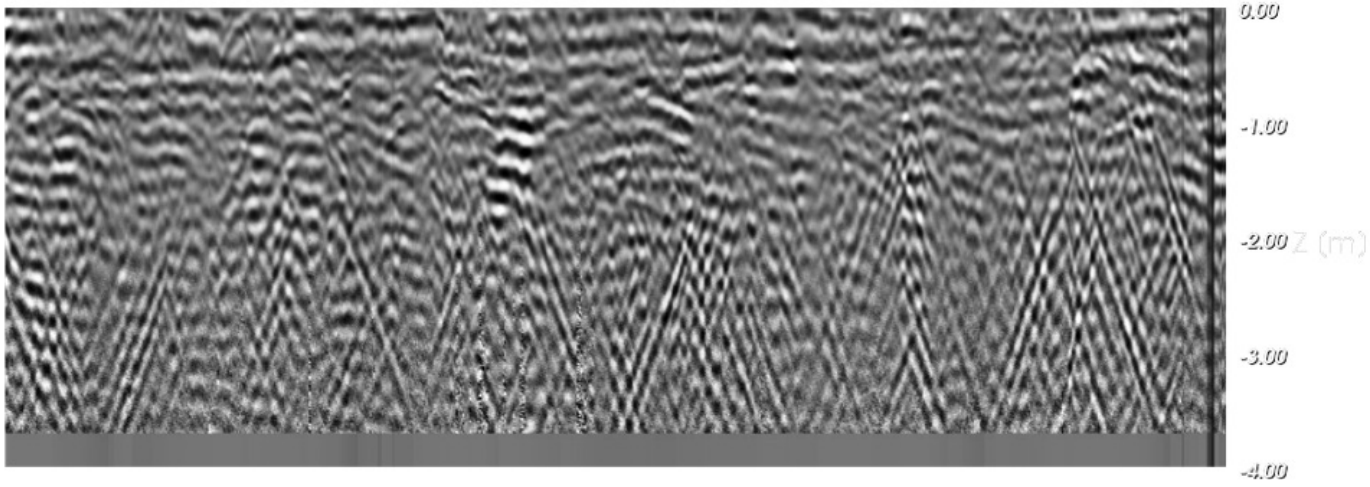
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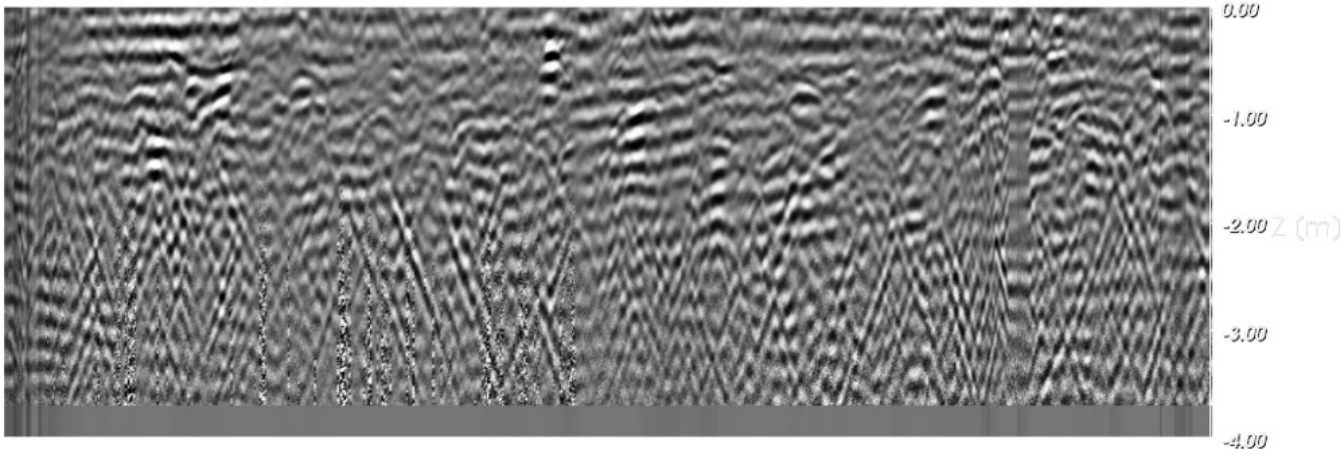
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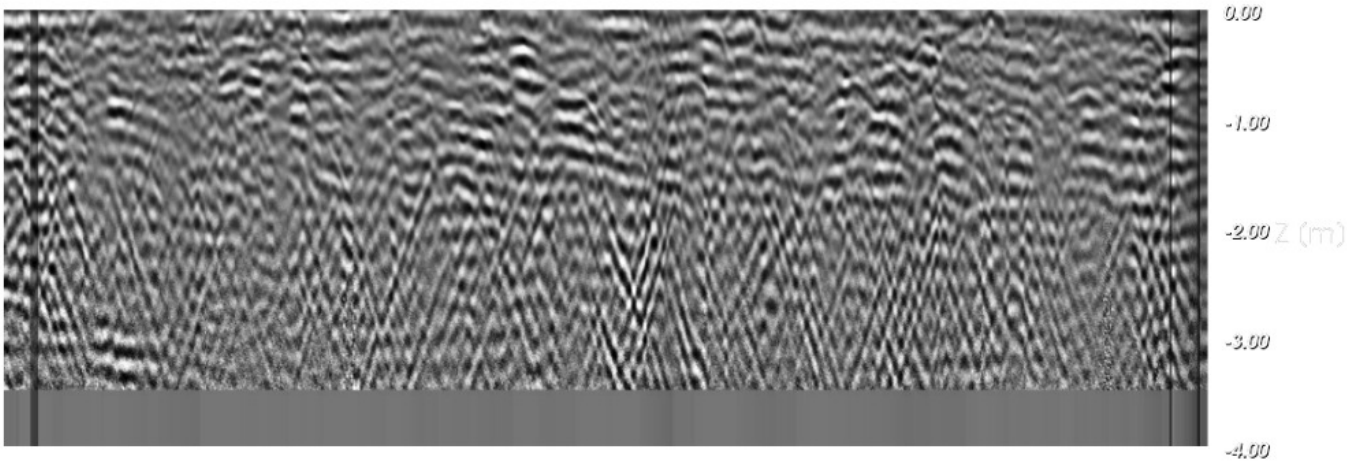
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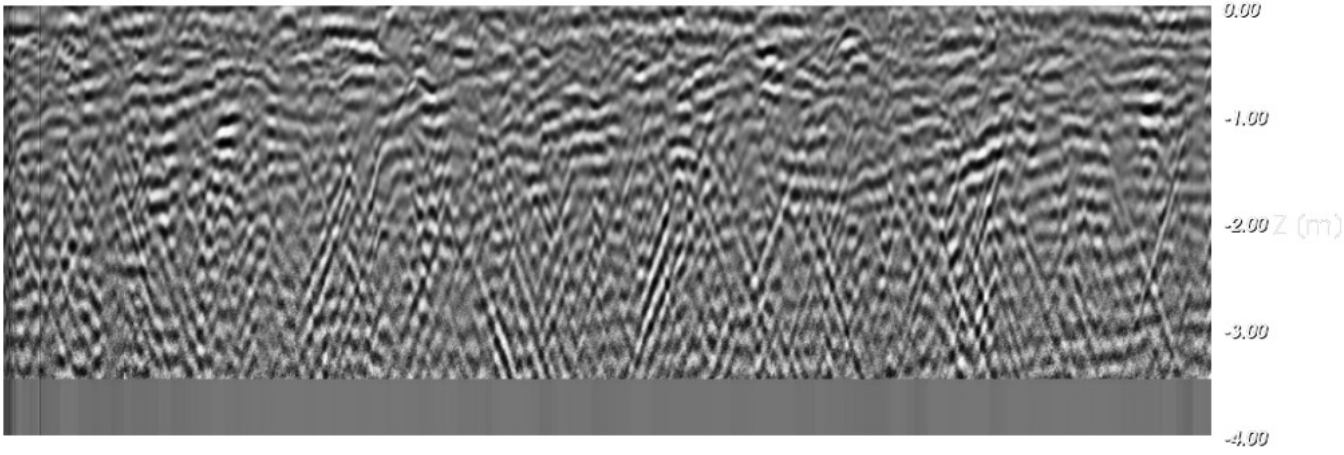
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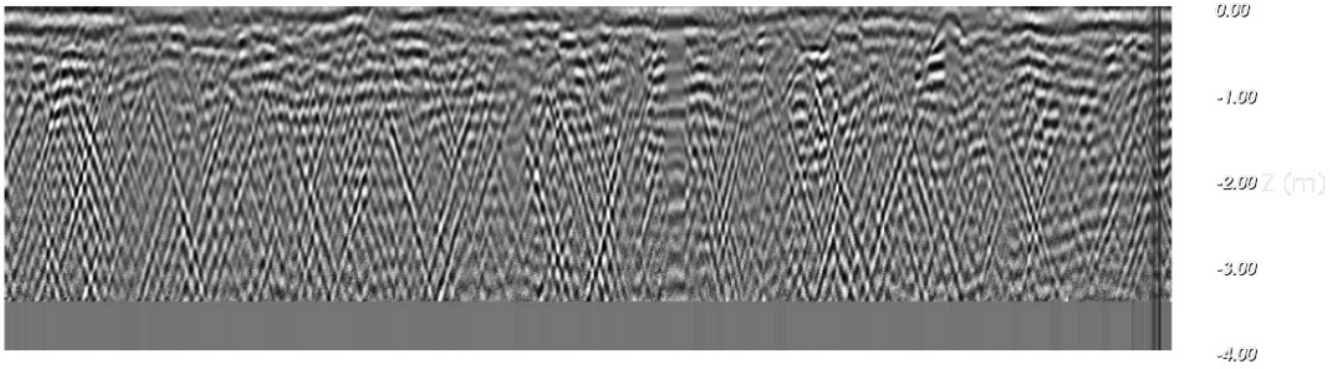
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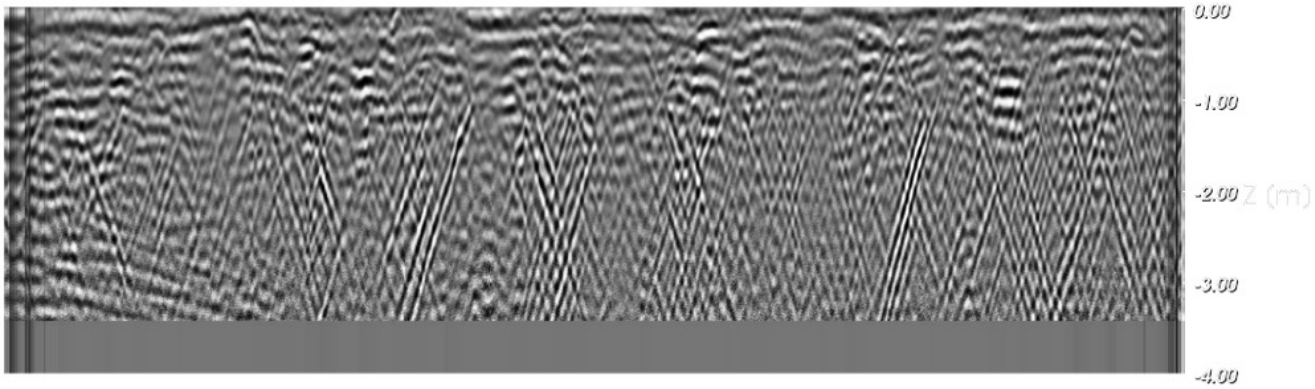
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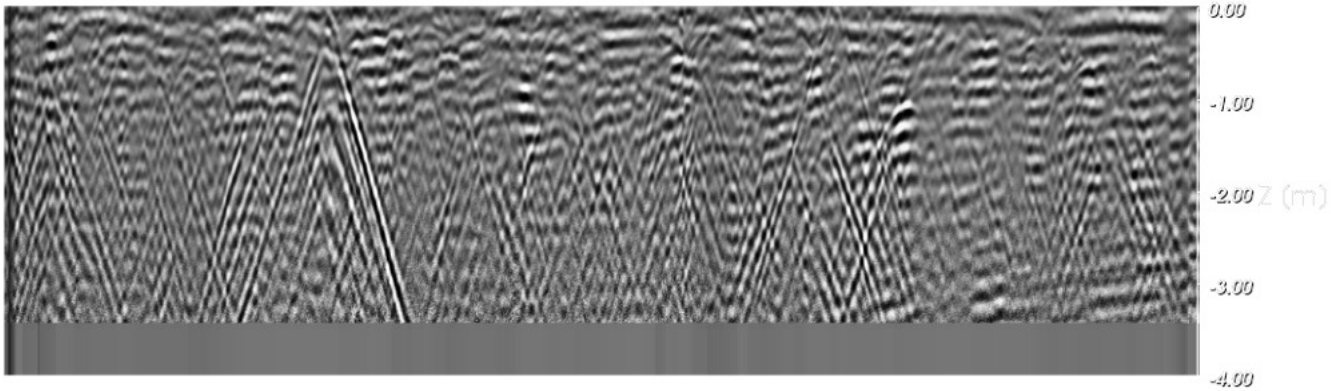
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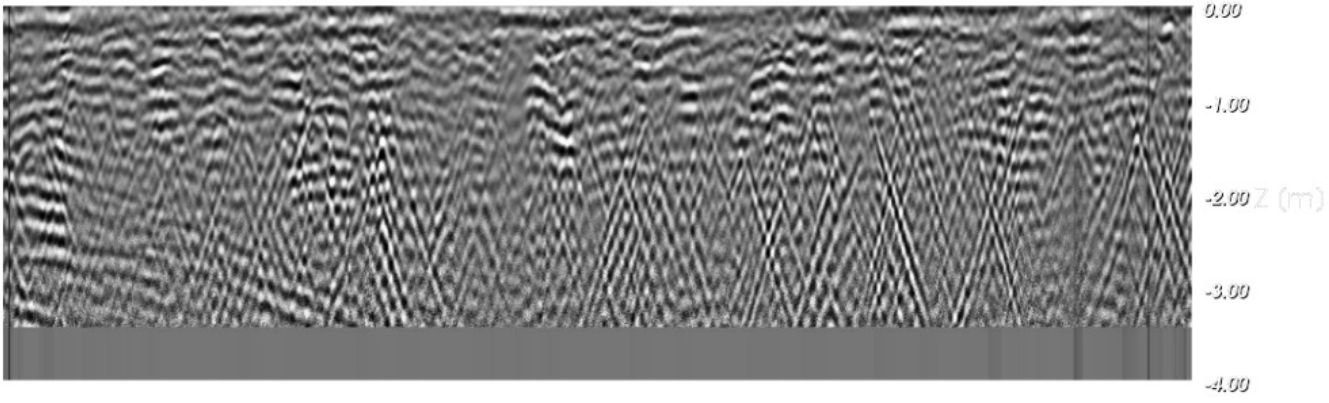
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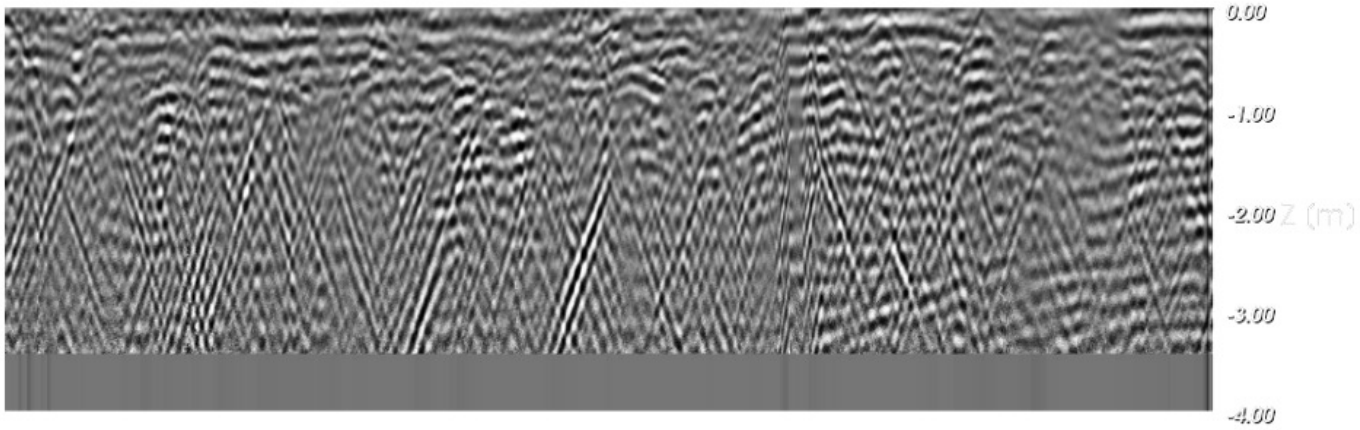
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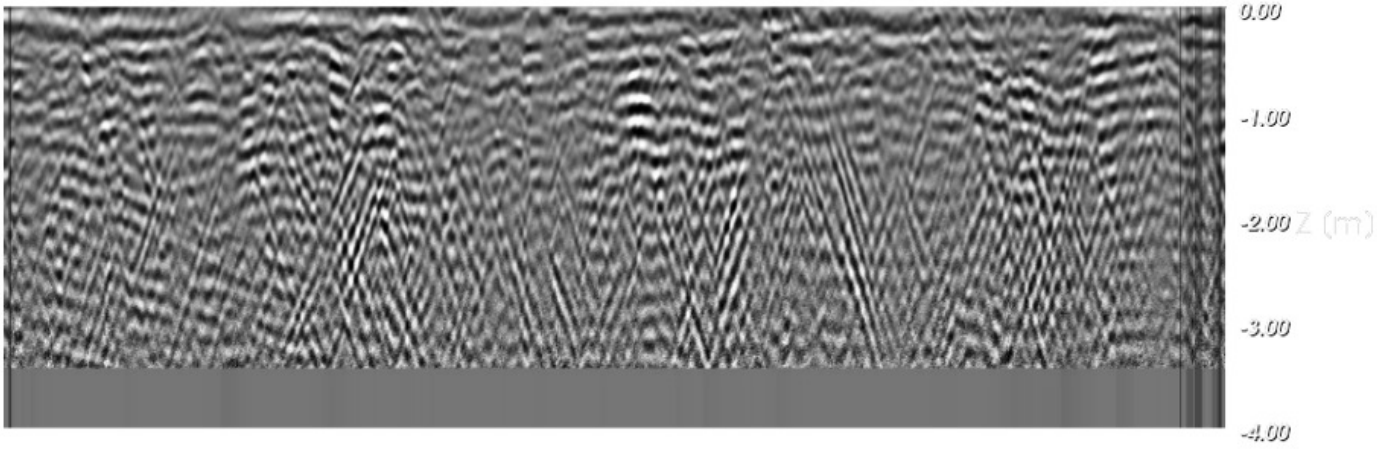
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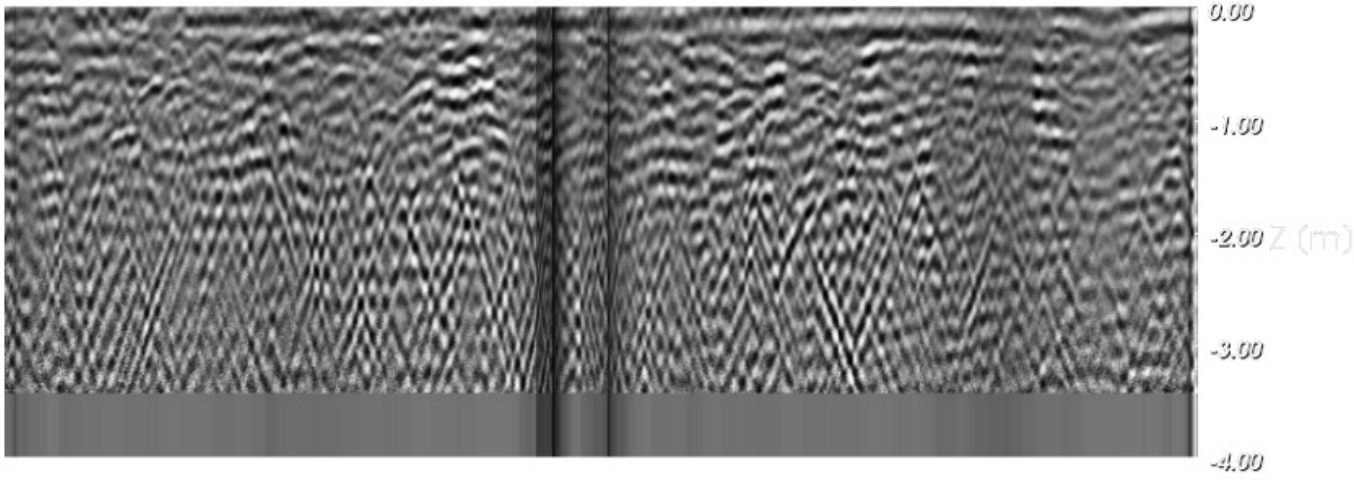
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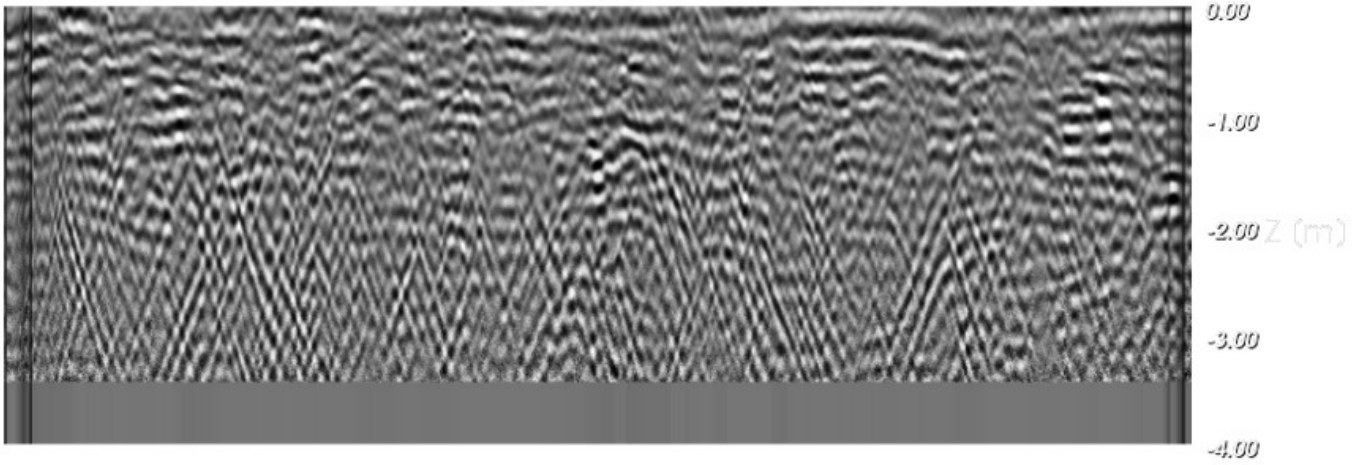
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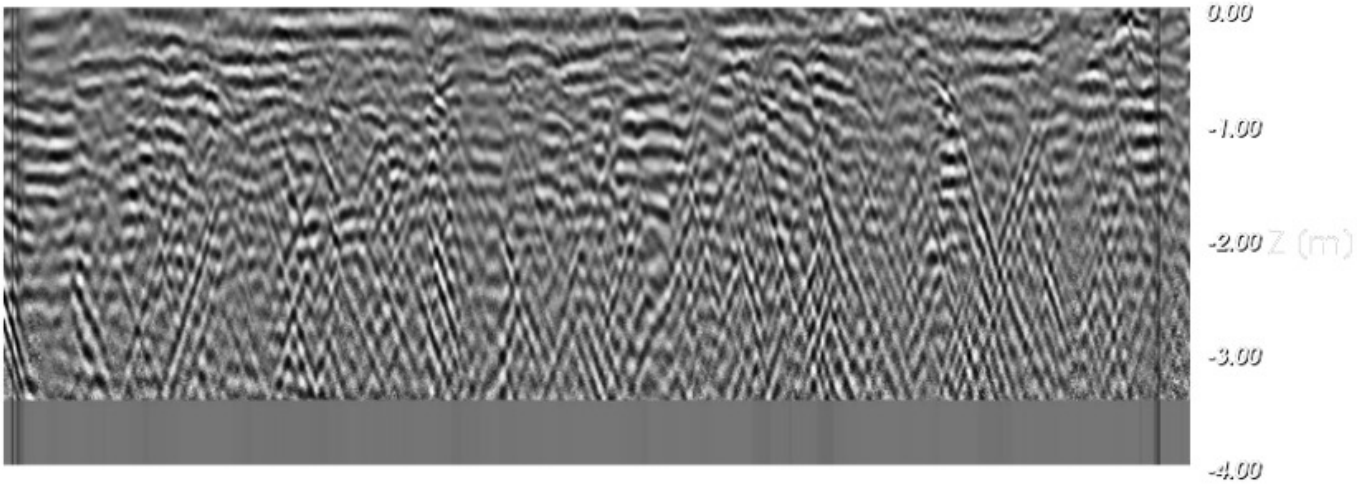
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Array: HH_200MHz_L



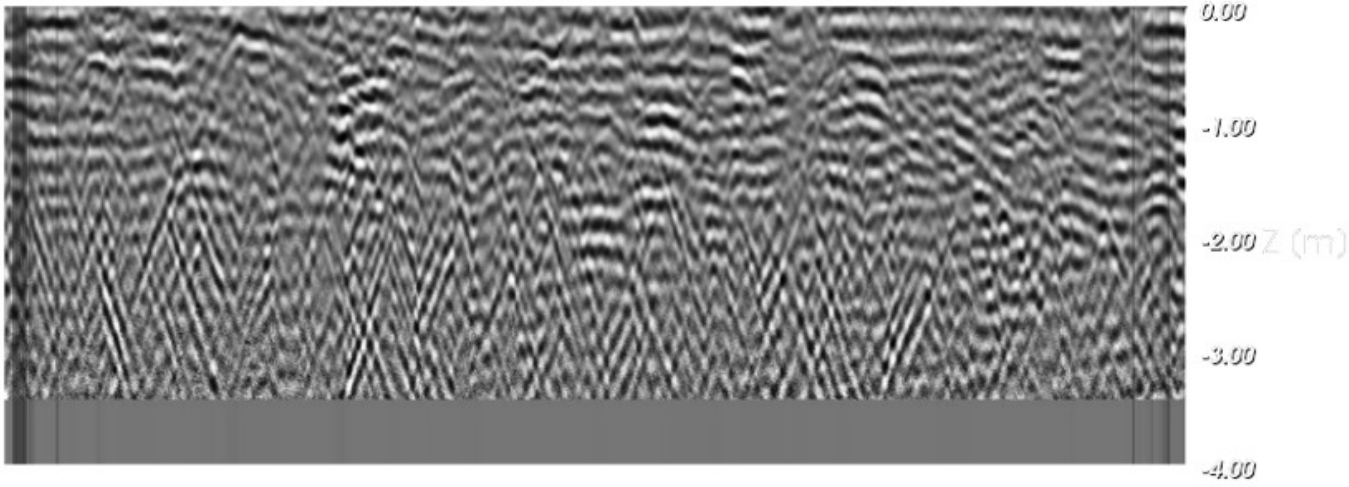
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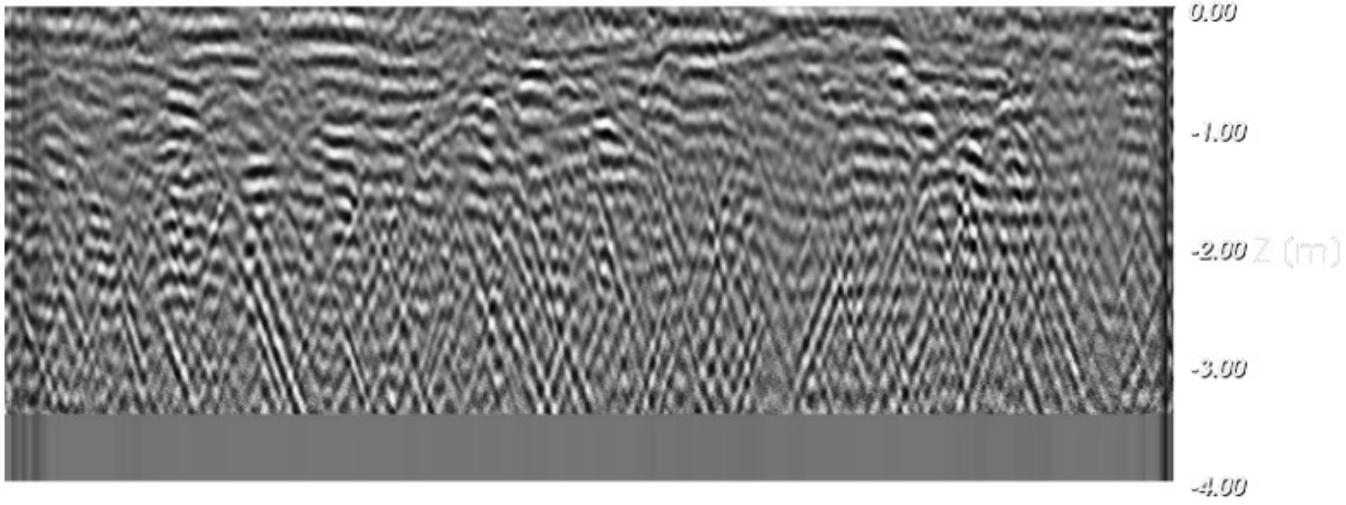
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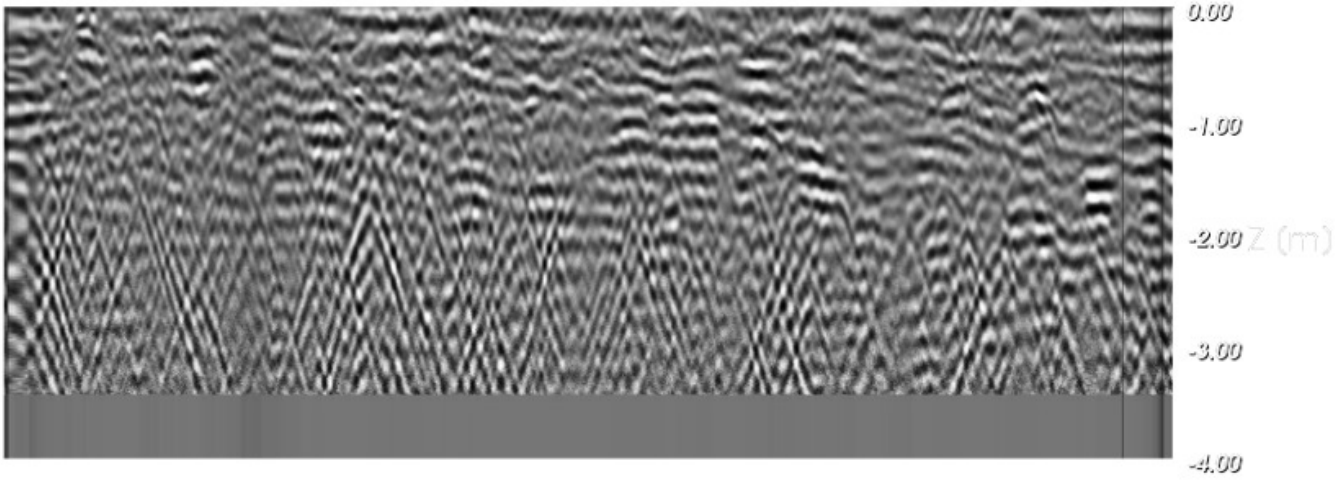
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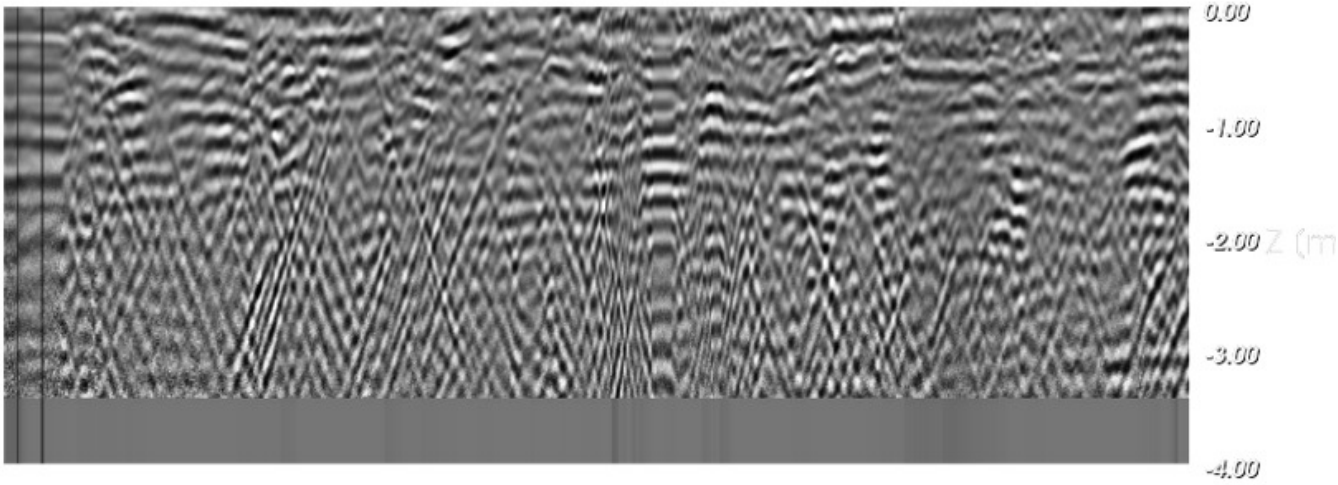
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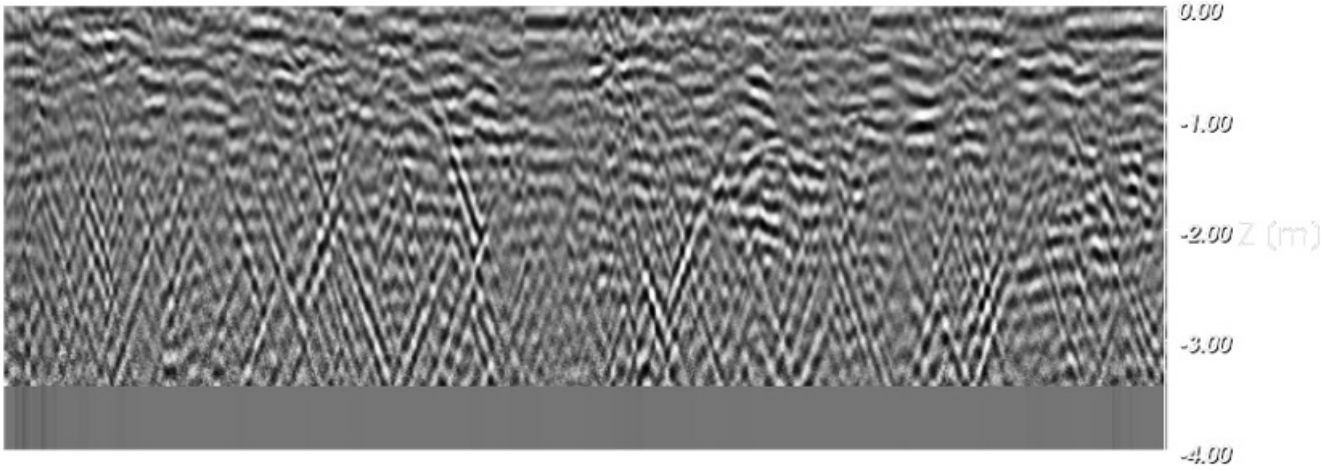
Swath: 37
Array: HH_200MHz_L



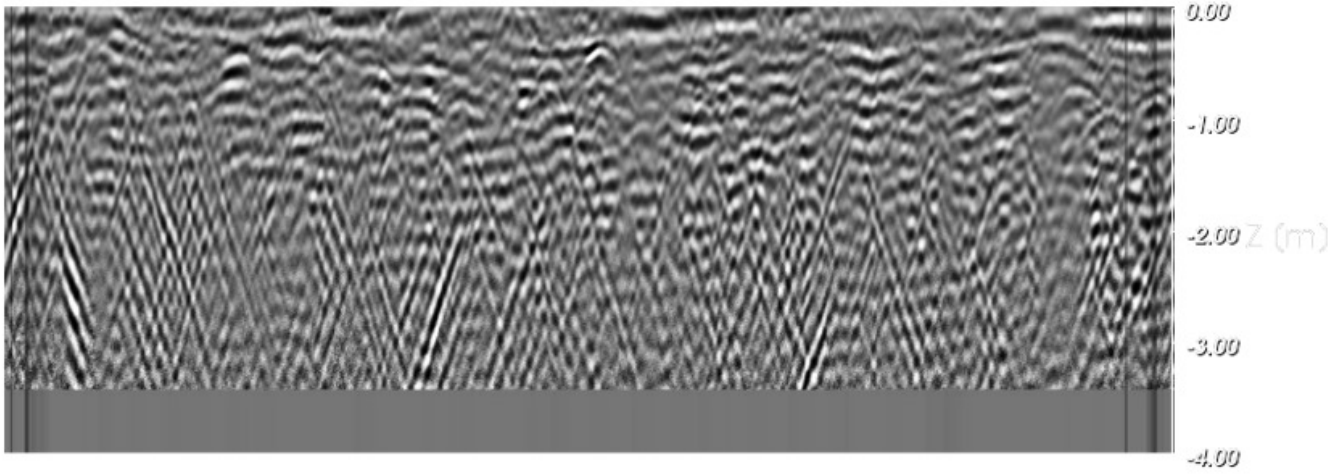
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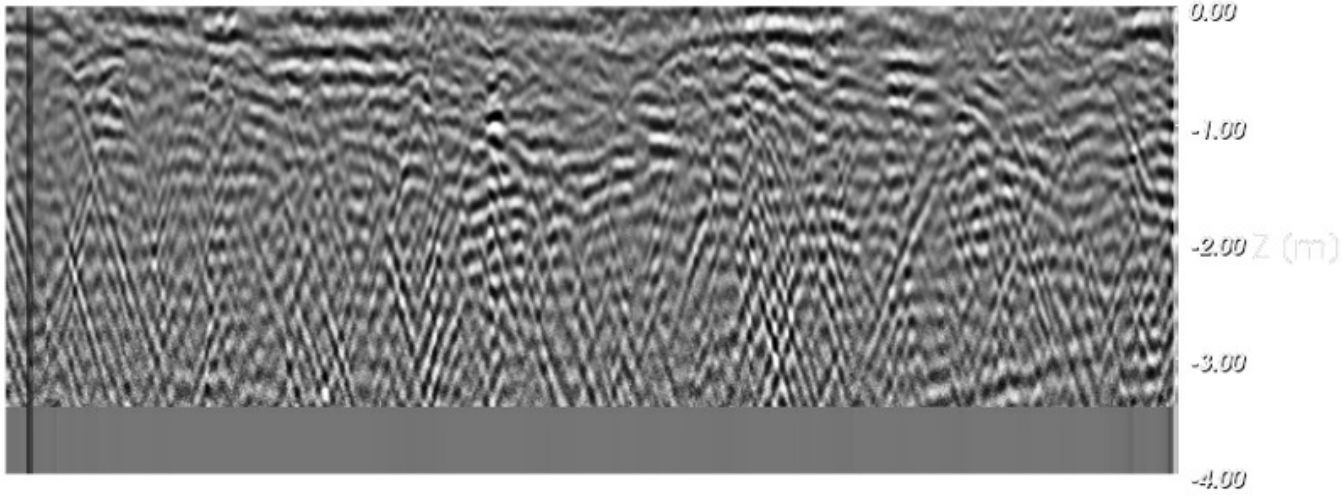
Swath: 39
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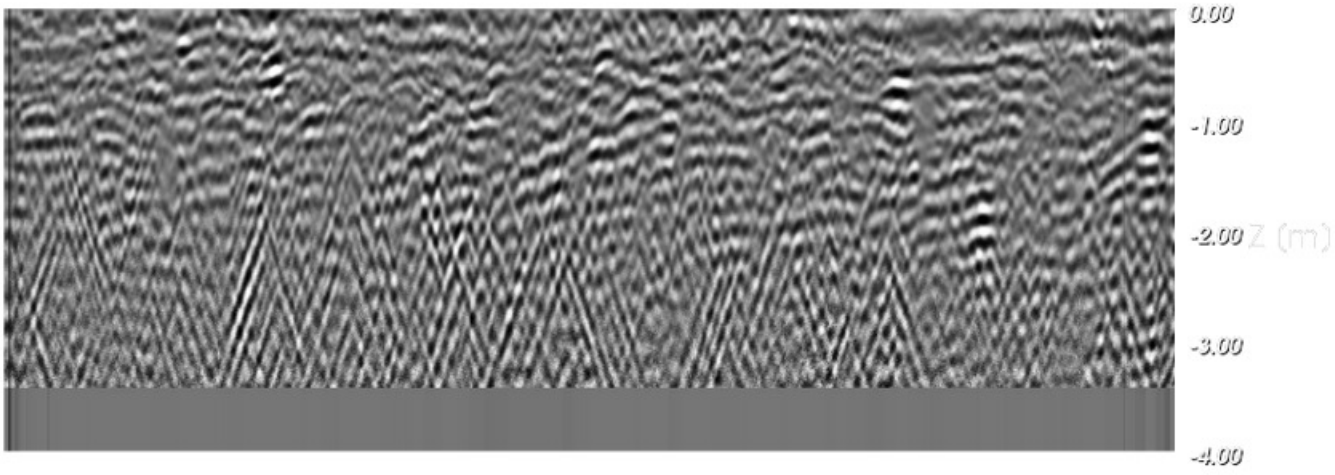
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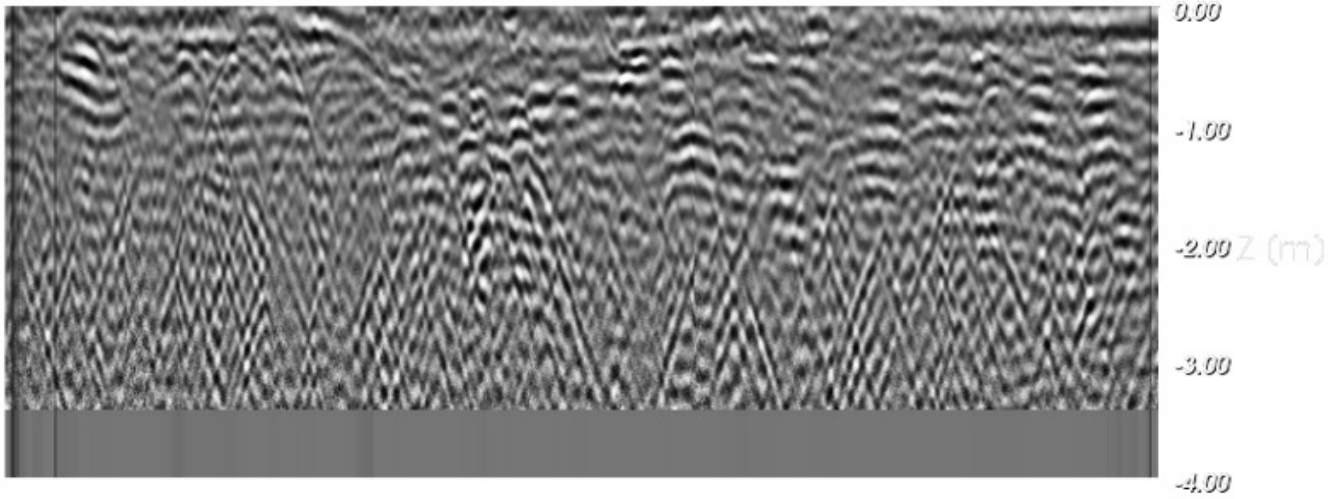
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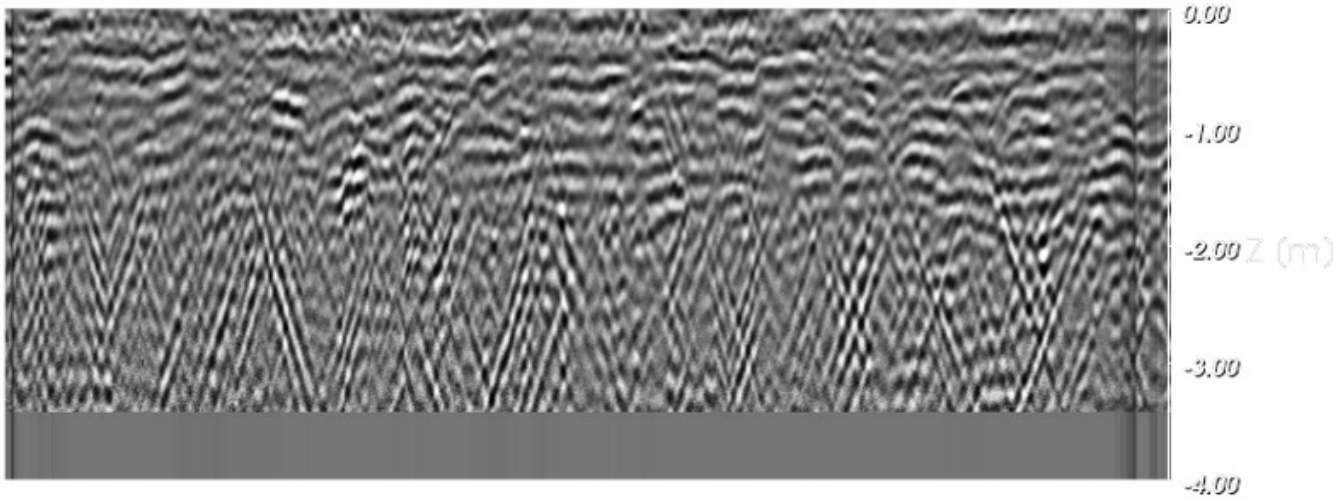
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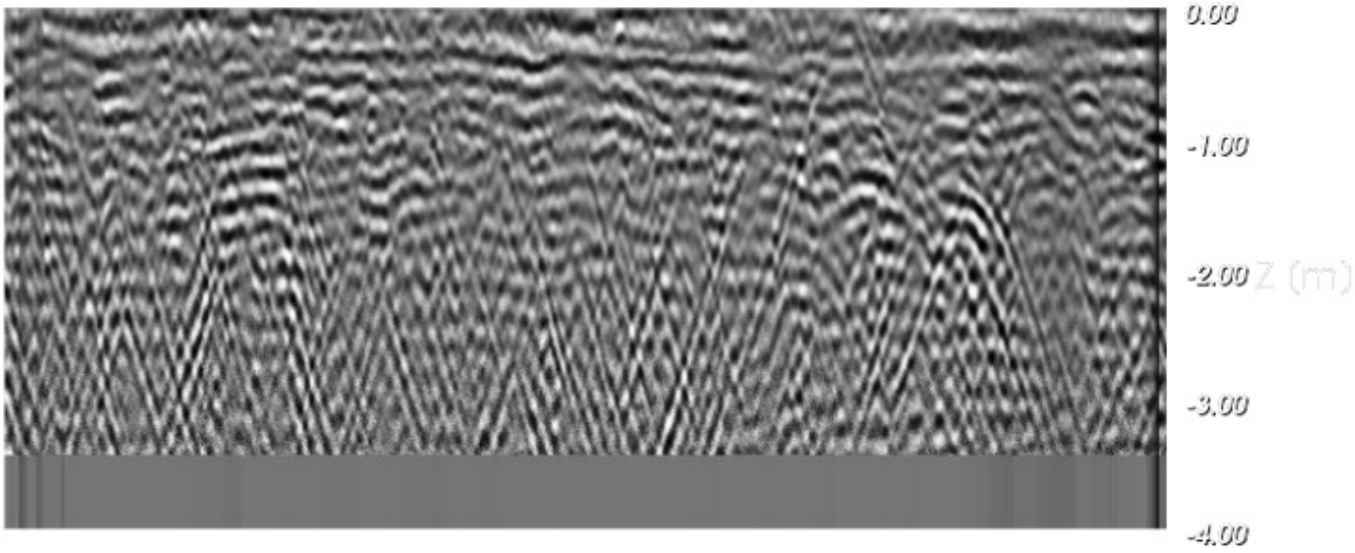
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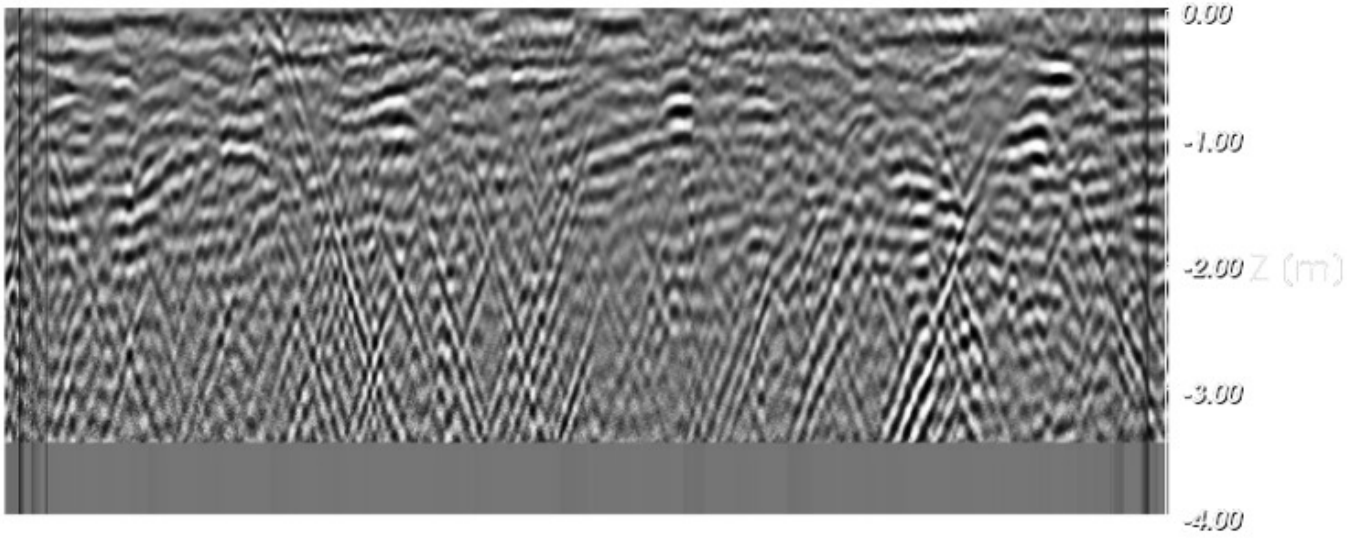
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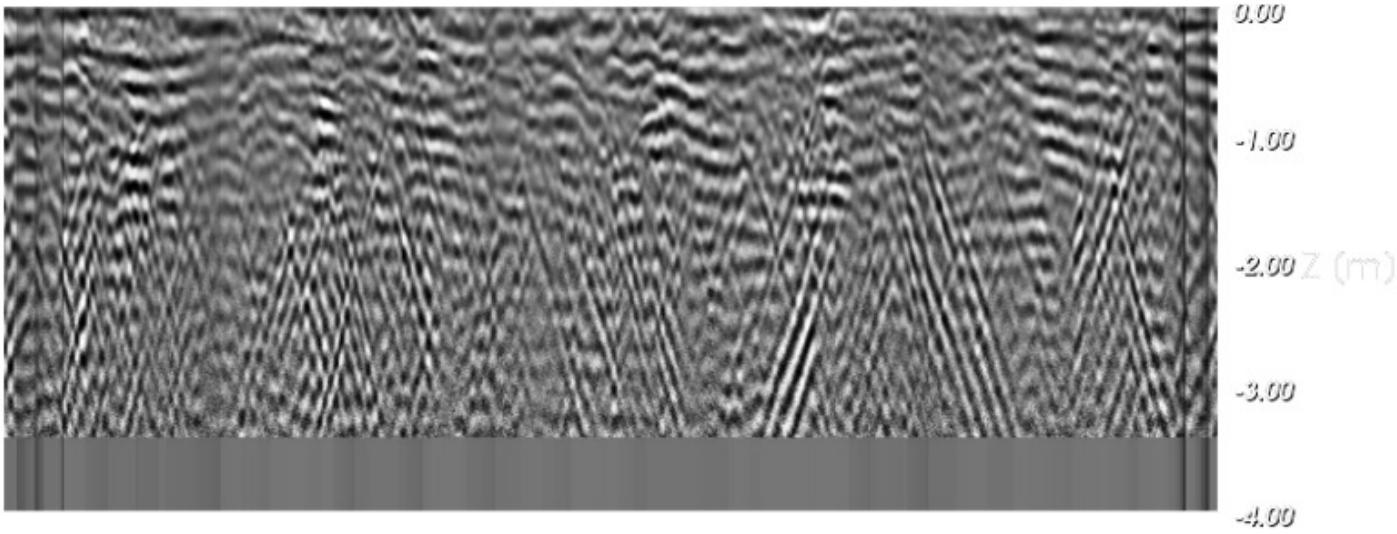
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Array: HH_200MHz_L



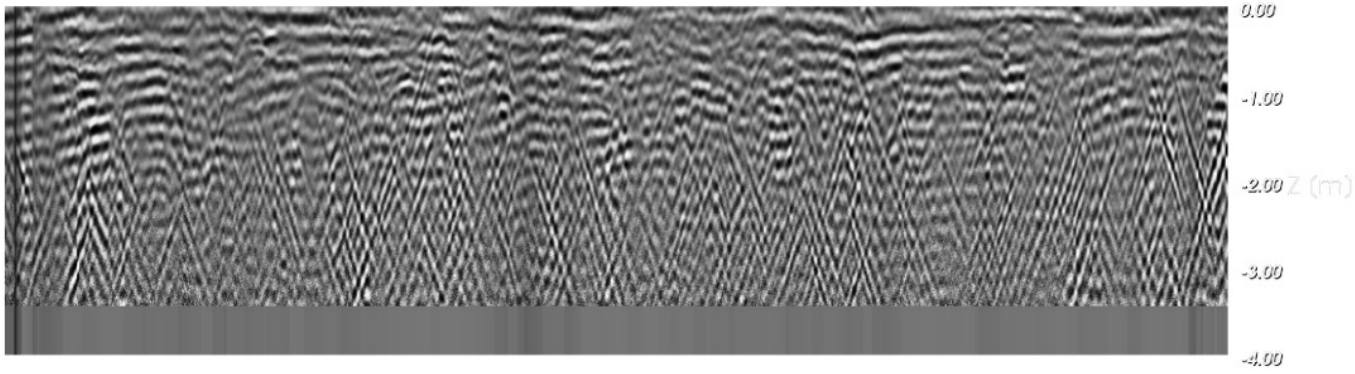
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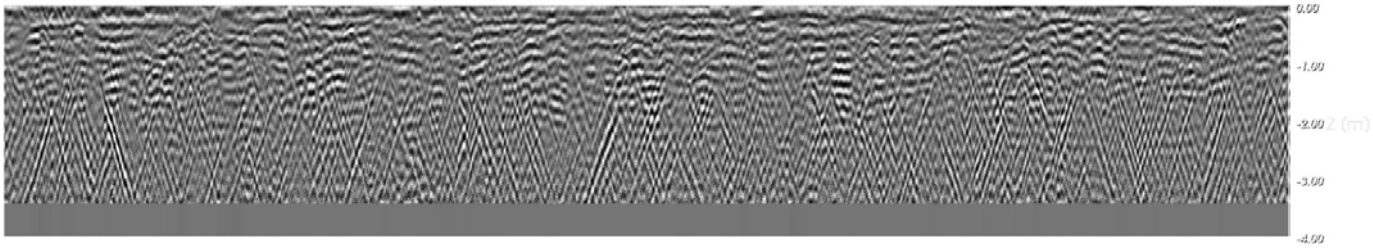
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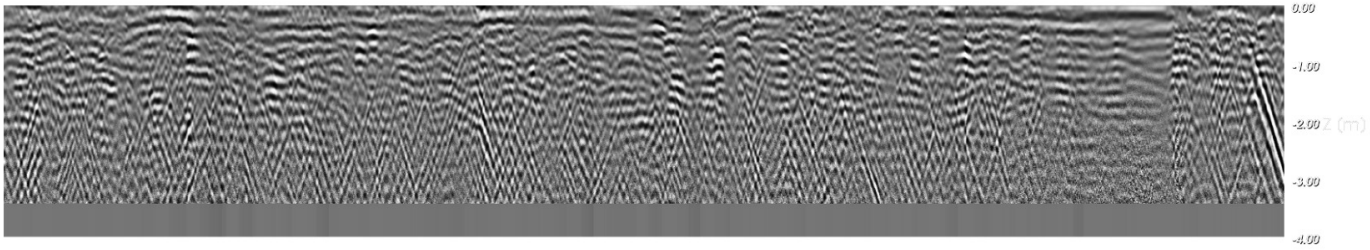
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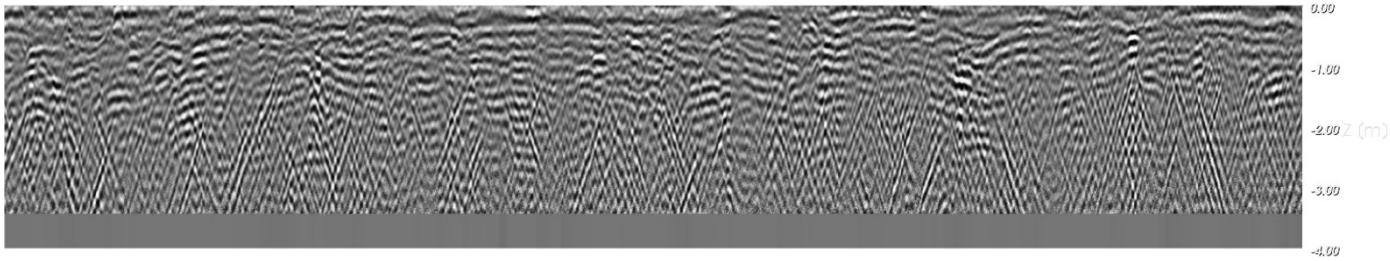
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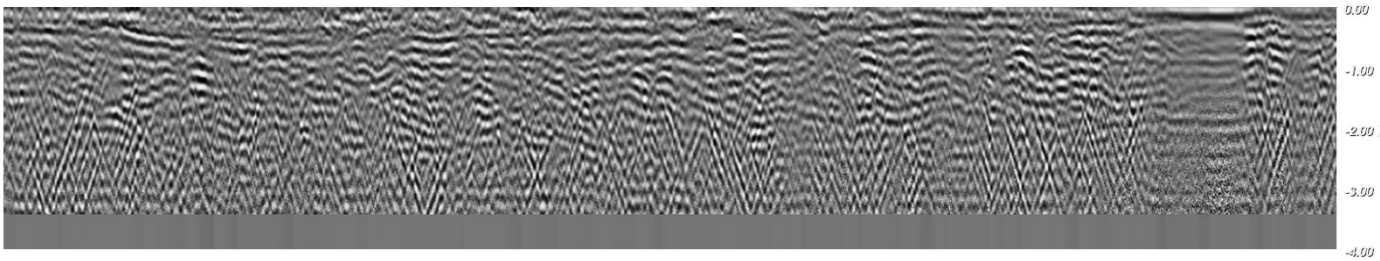
Swath: 50
Array: HH_200MHz_L



Swath: 51
Array: HH_200MHz_L



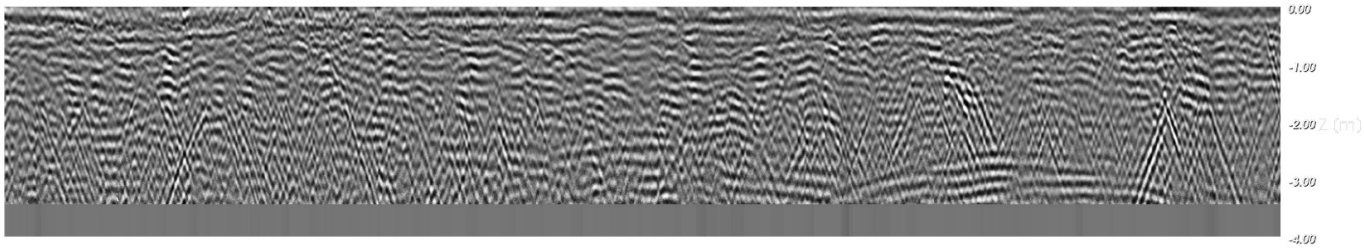
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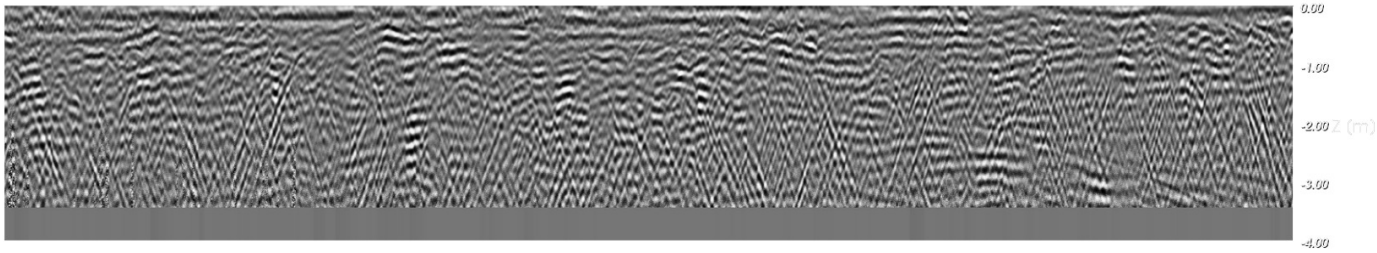
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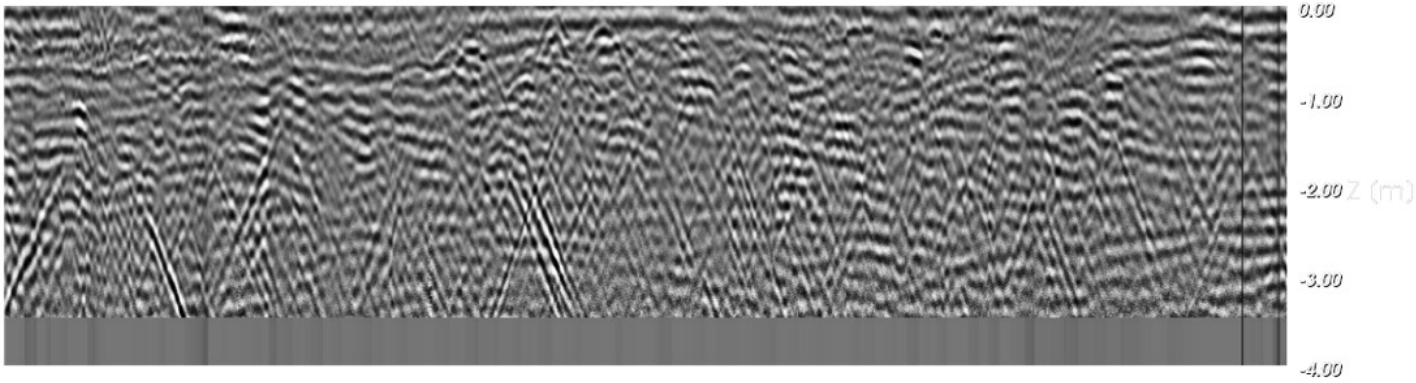
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Array: HH_200MHz_L



Swath: 55
Array: HH_200MHz_L



Swath: 56
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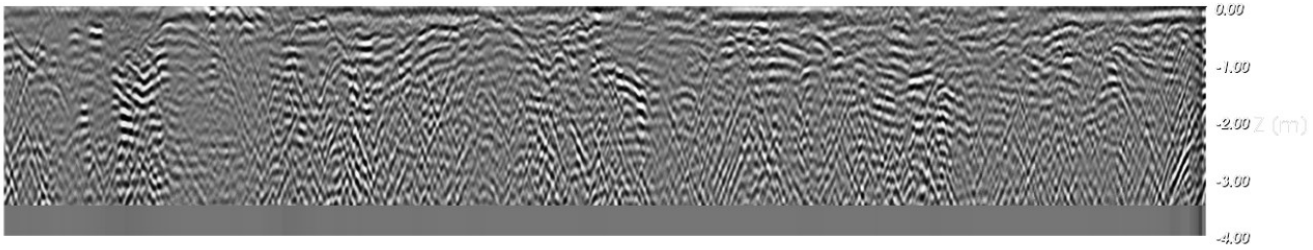


Appendix A

Cartographic maps & Radargram data

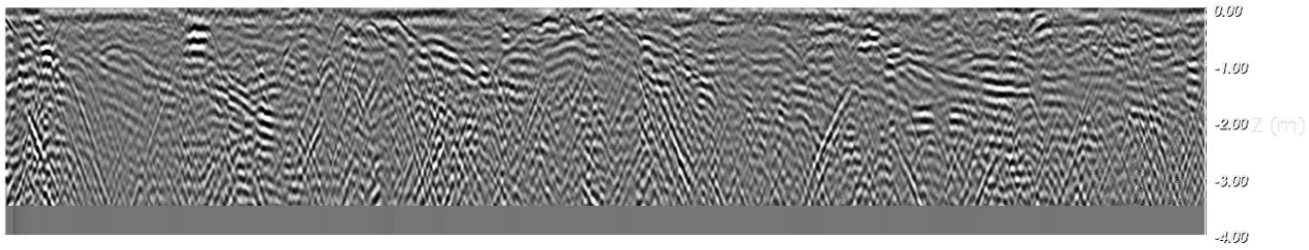
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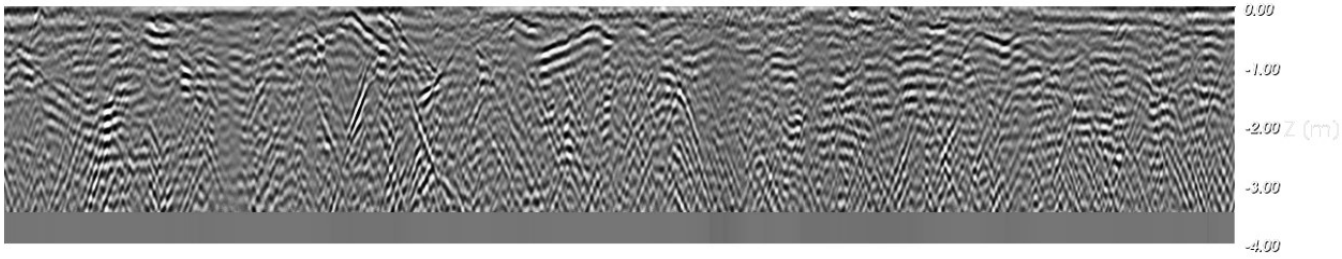
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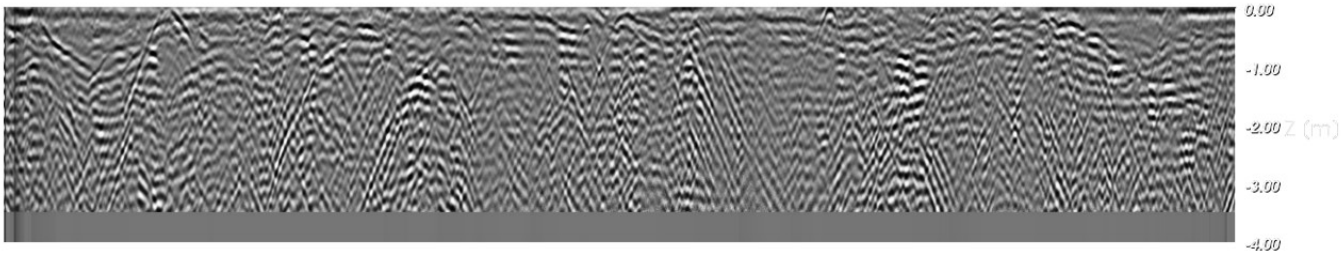
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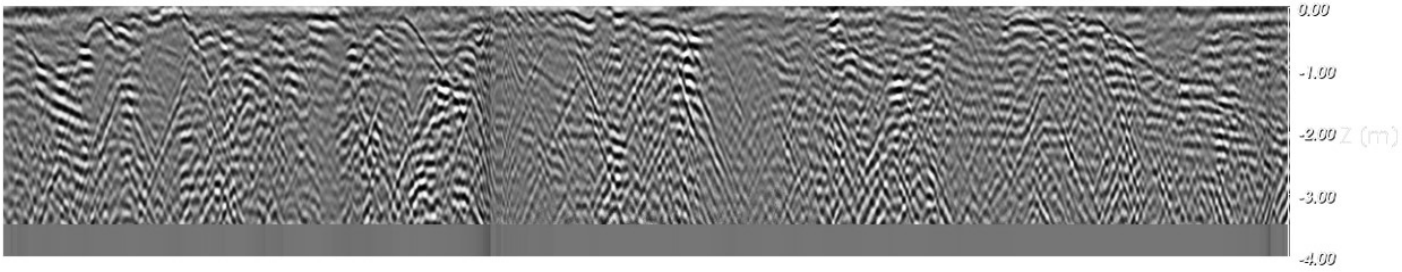


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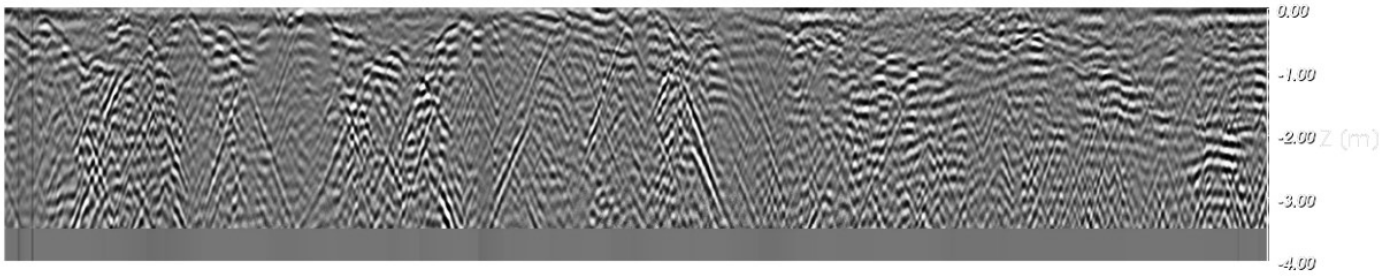
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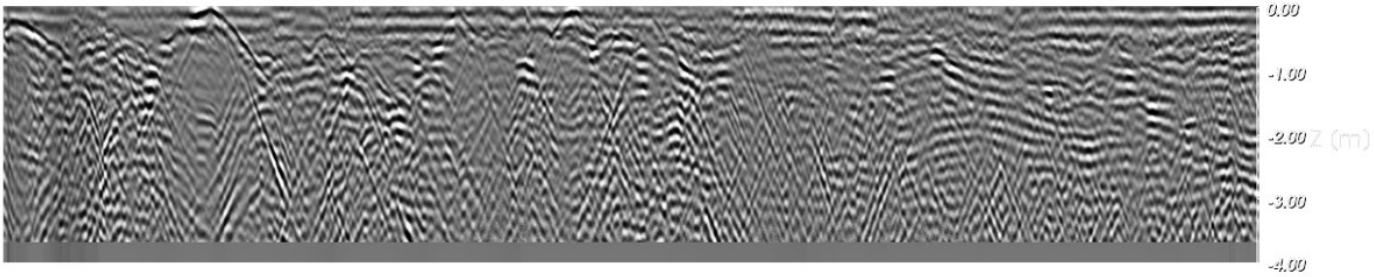
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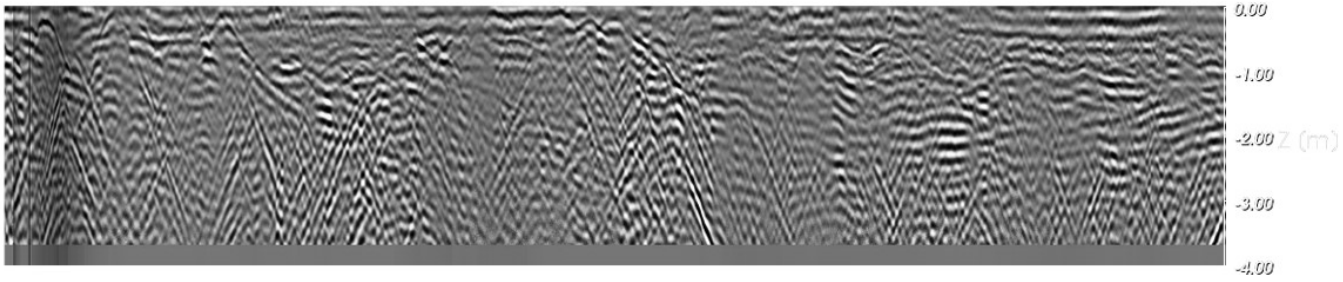
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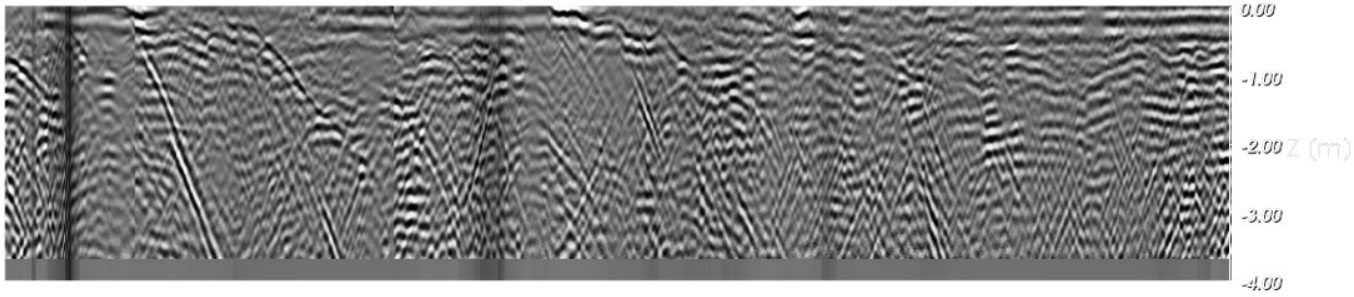
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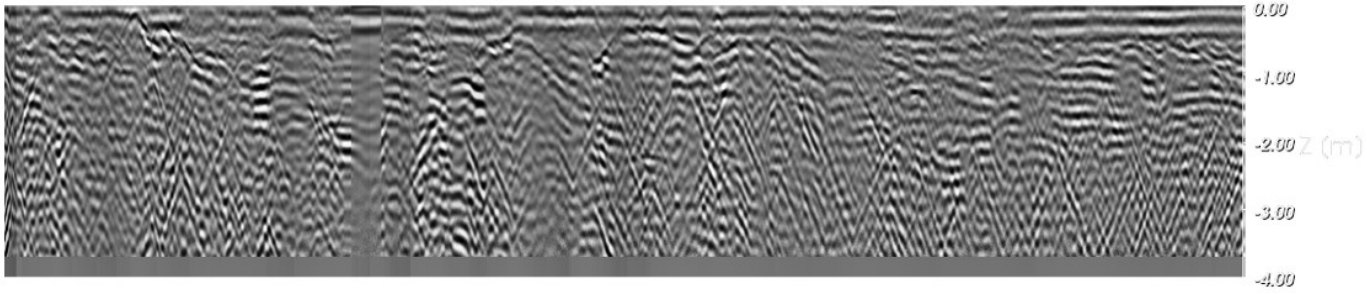
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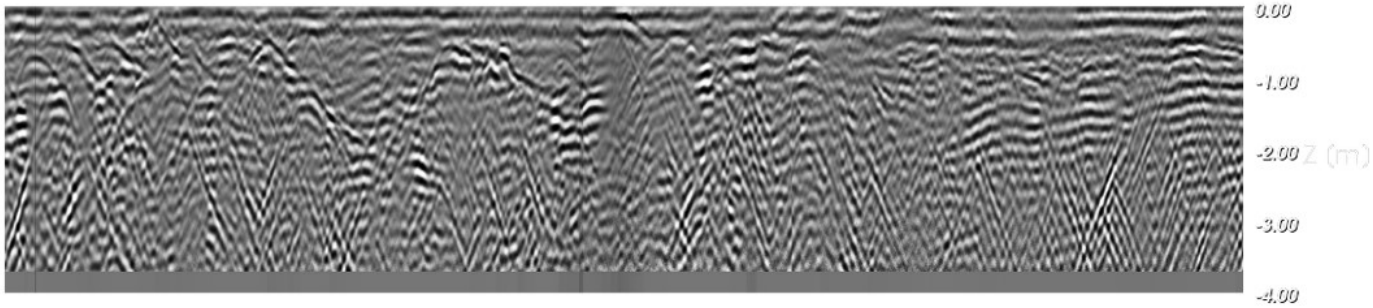
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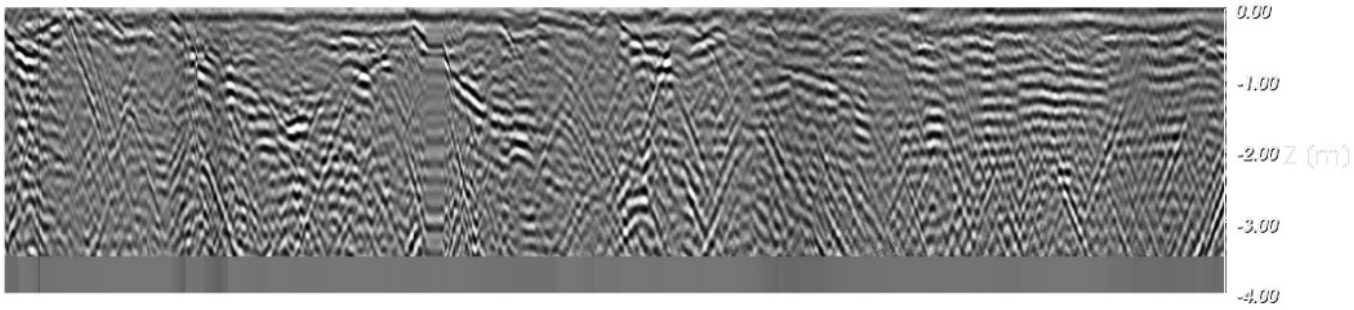
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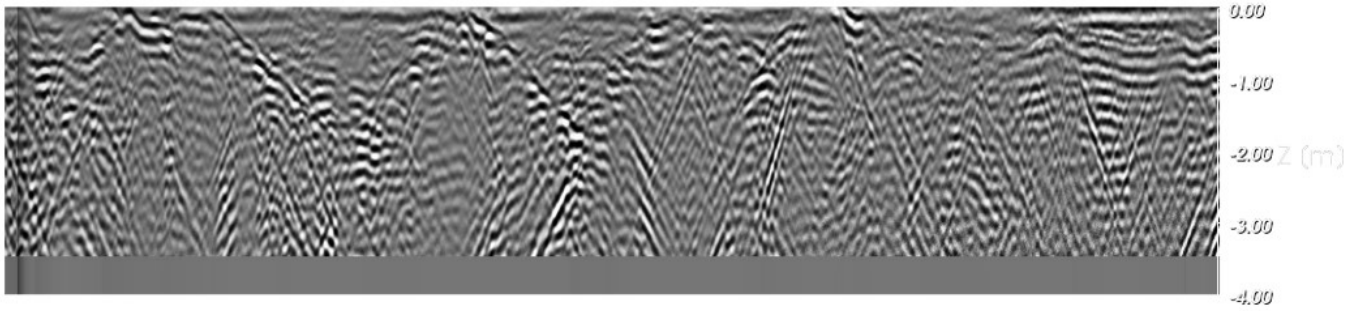
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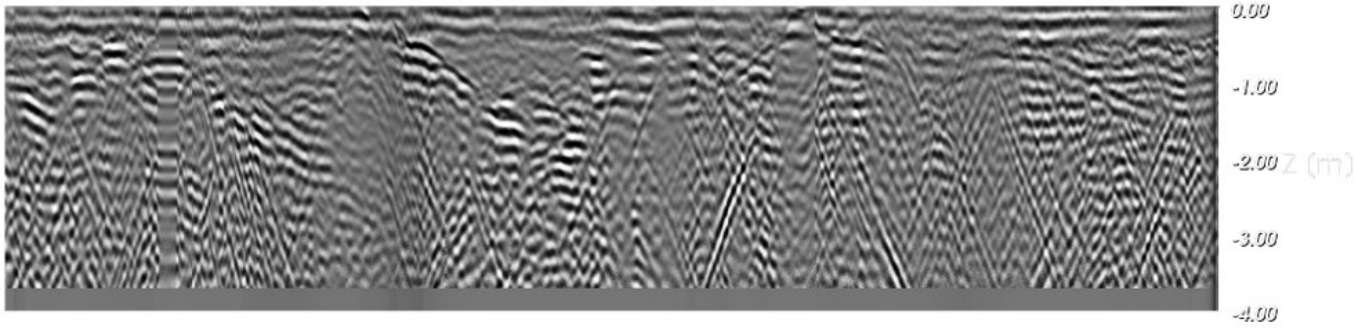
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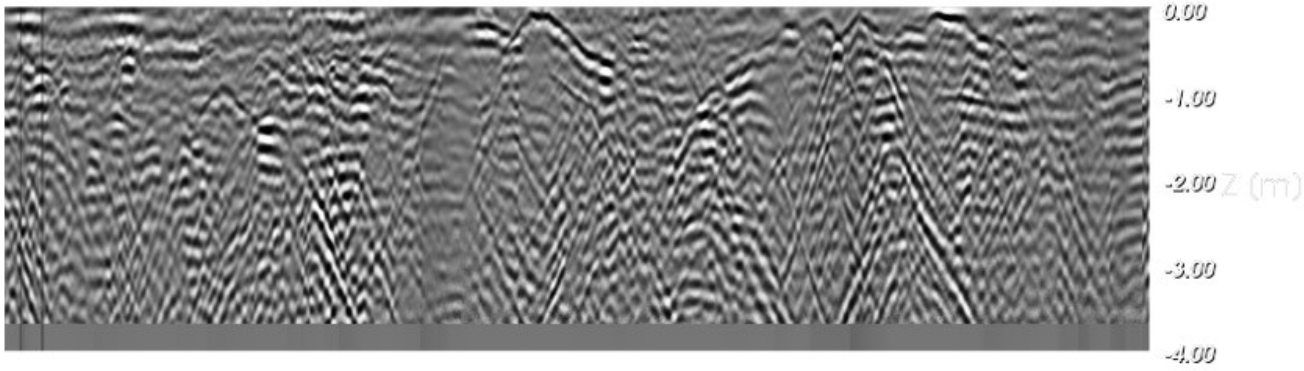
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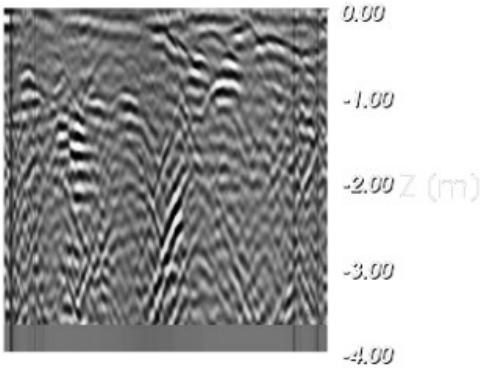
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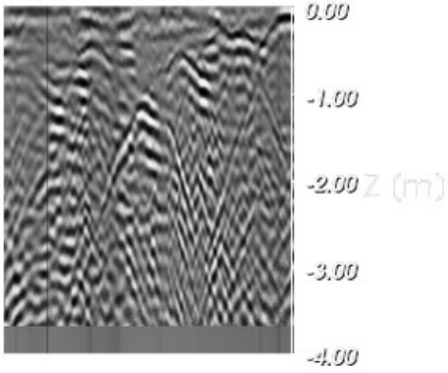
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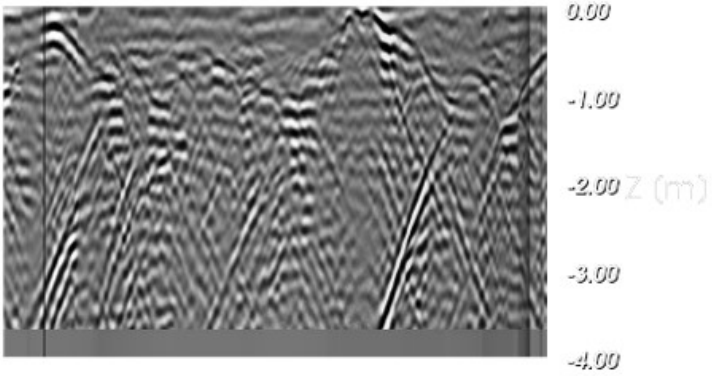
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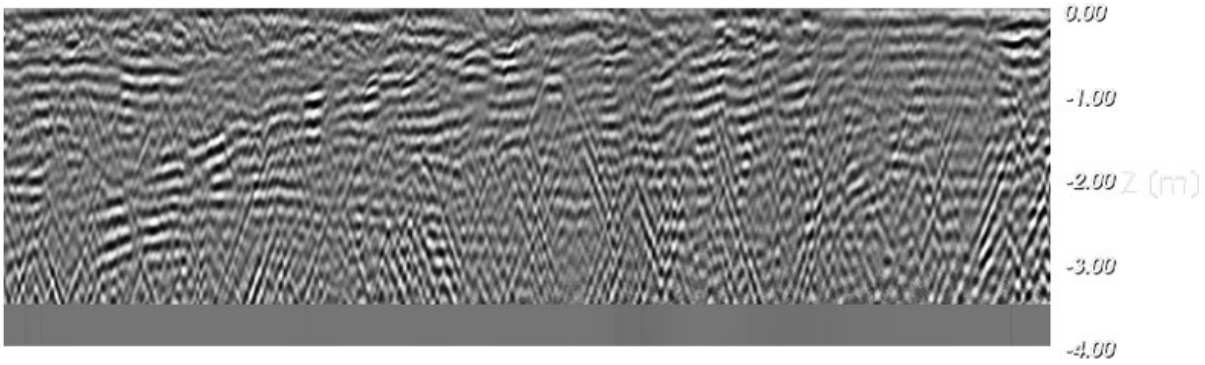
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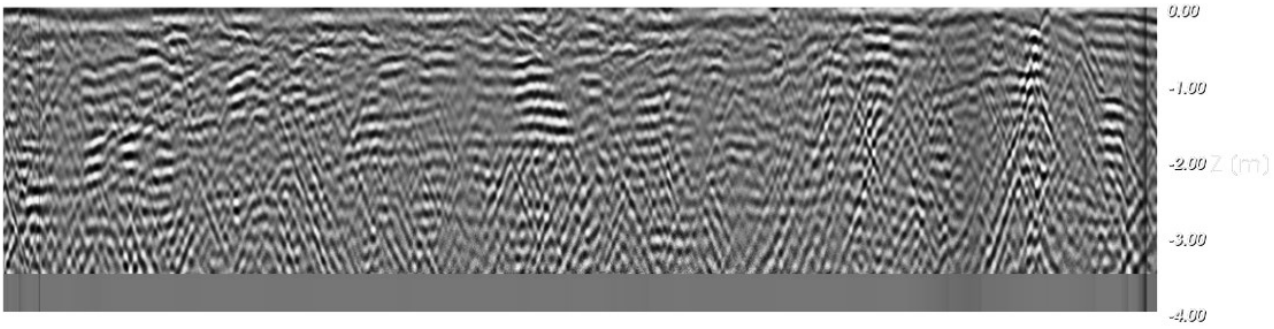
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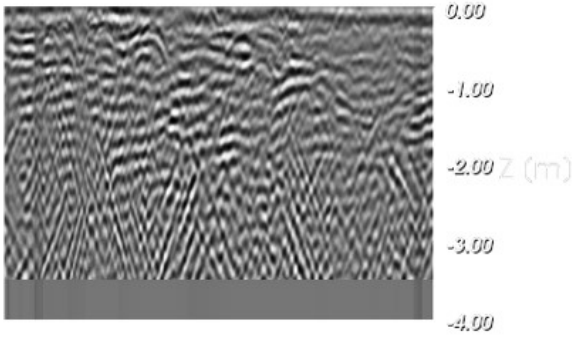
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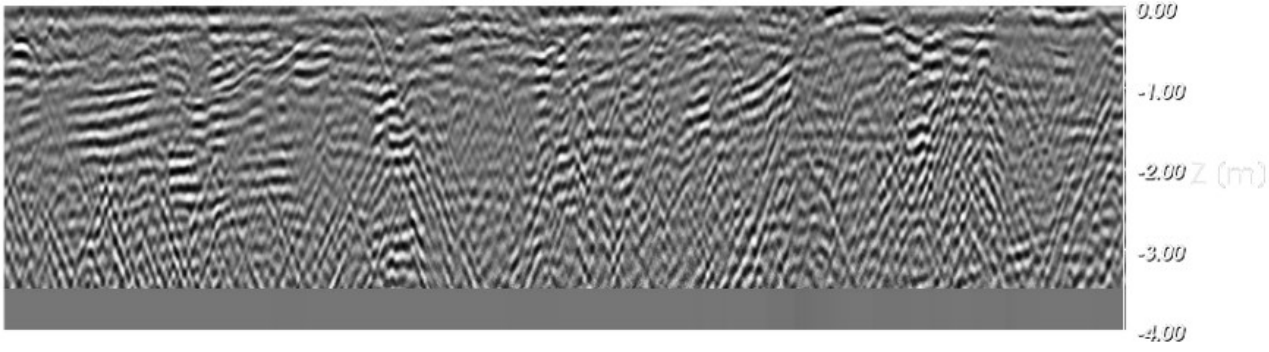
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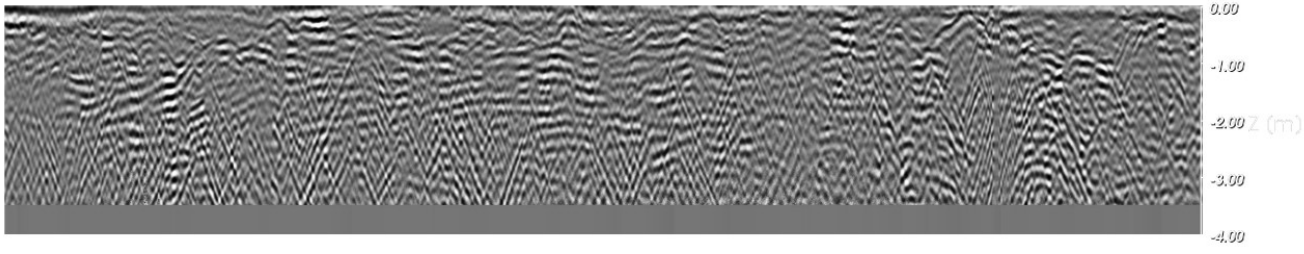
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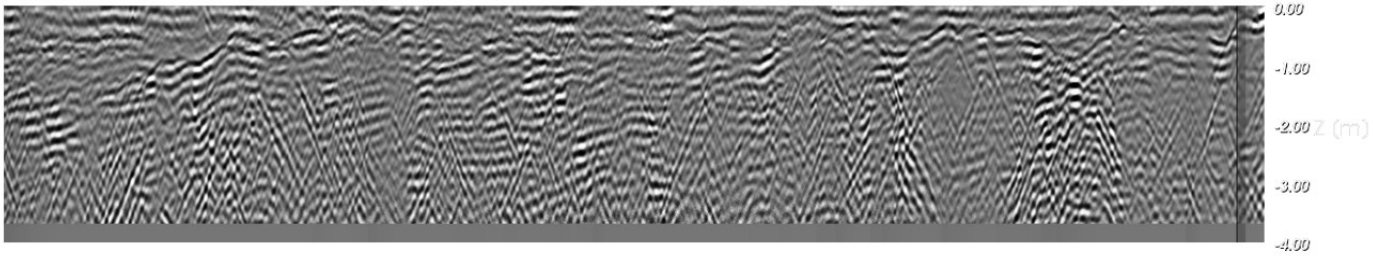
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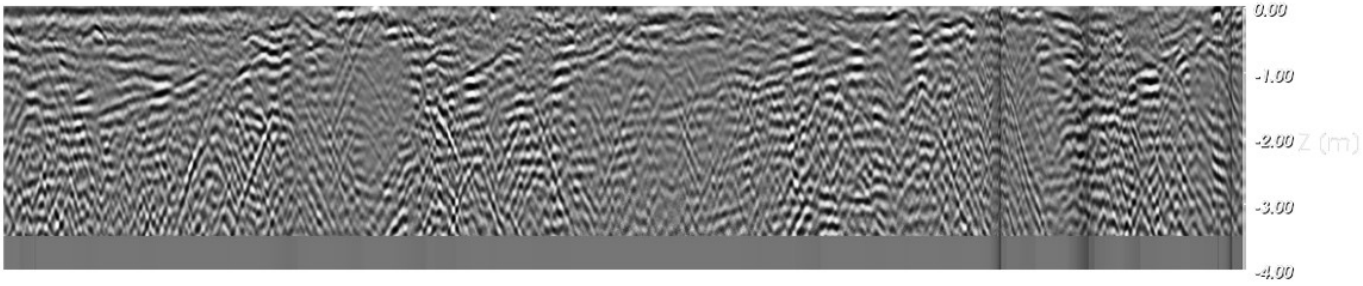
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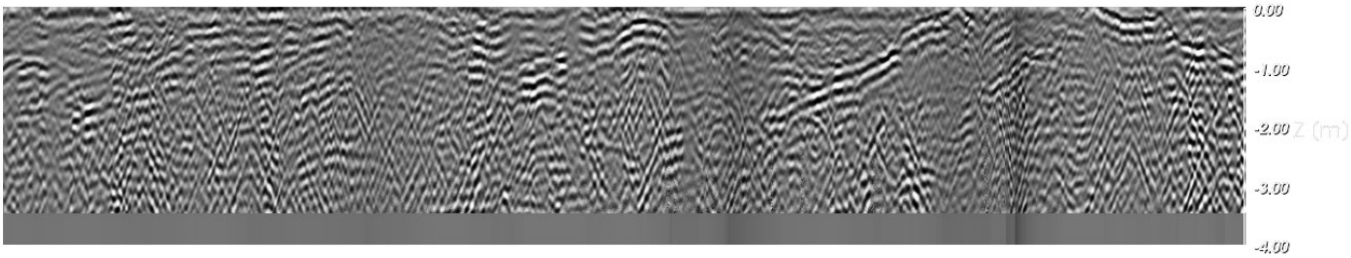
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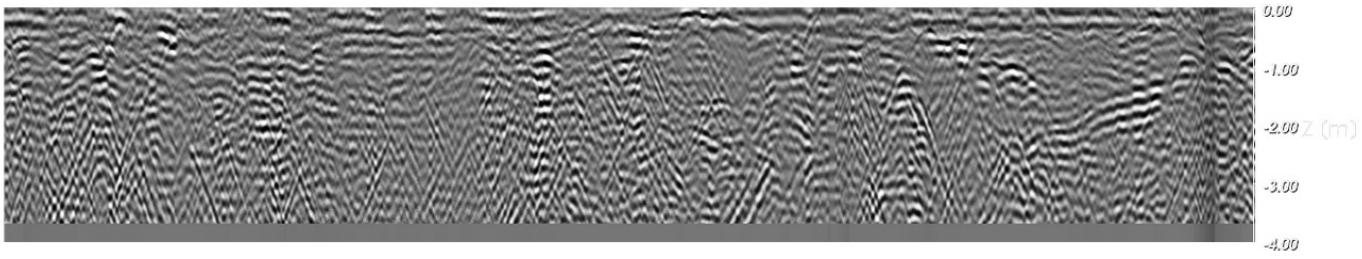
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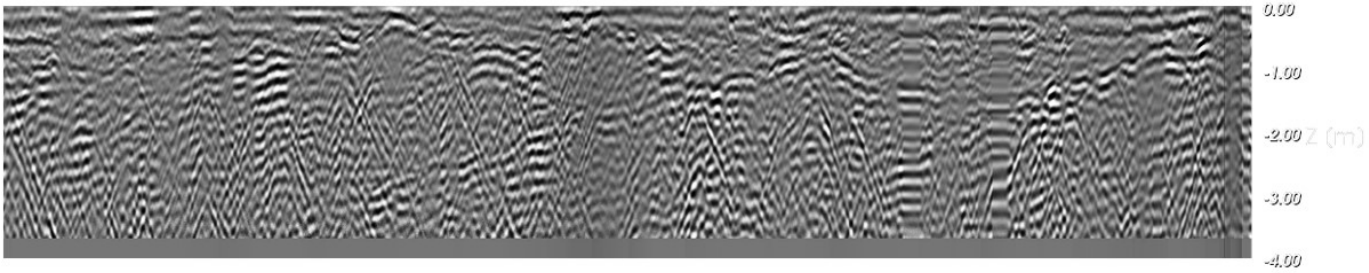
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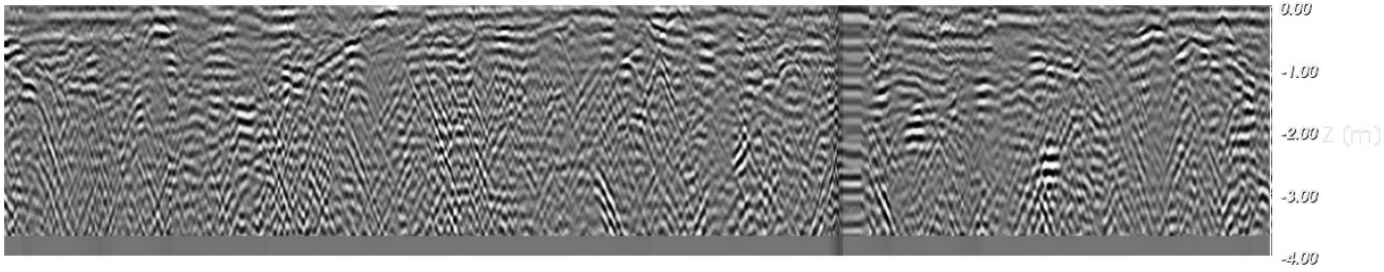
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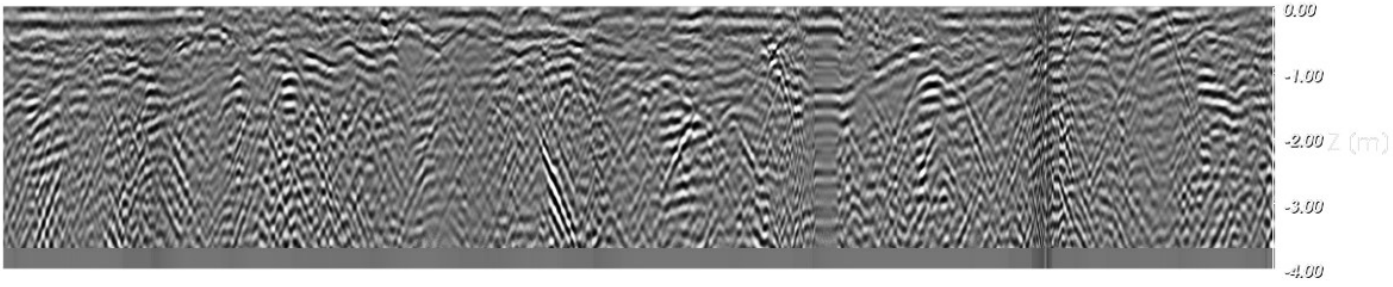
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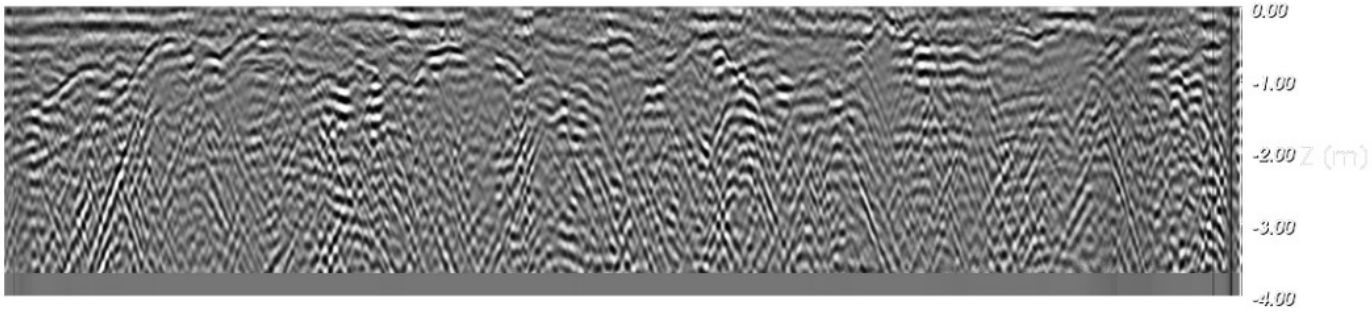
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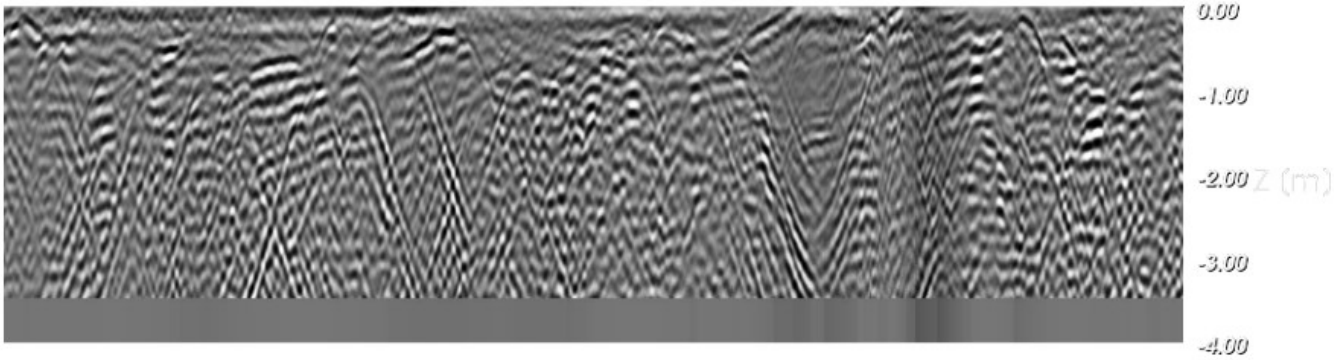


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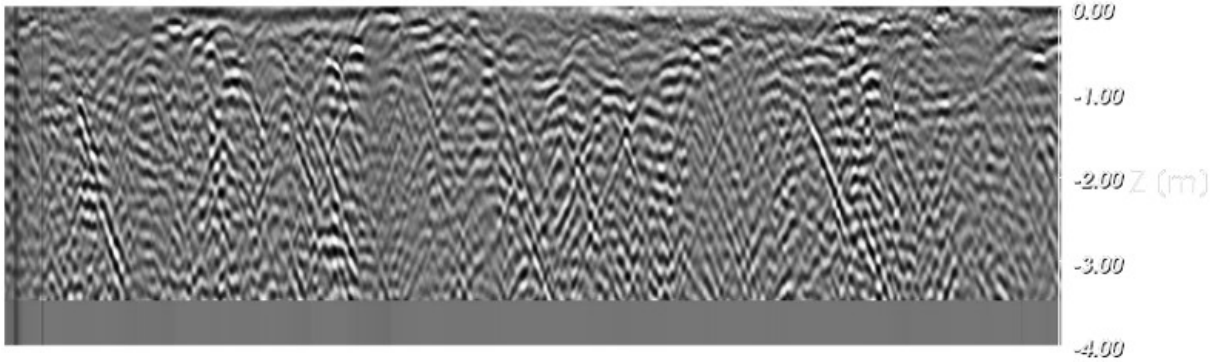
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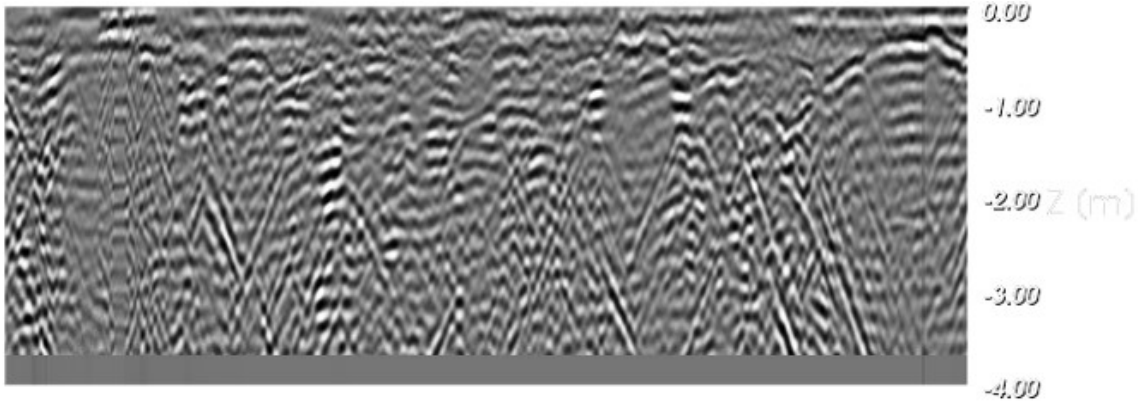
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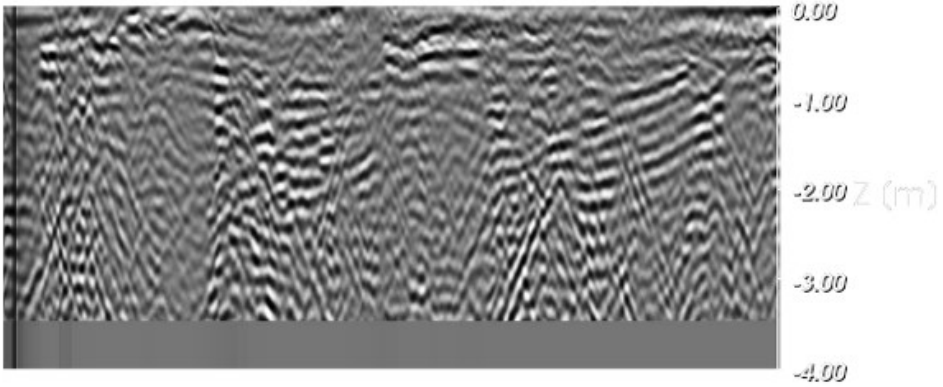
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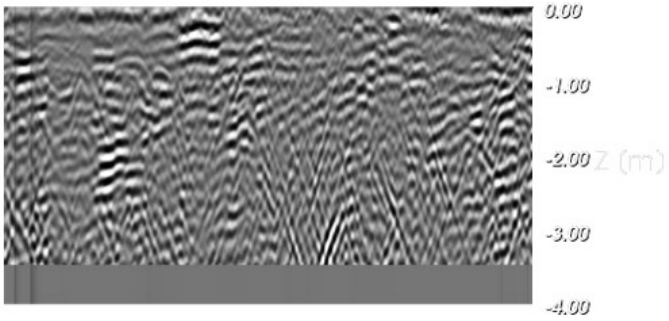


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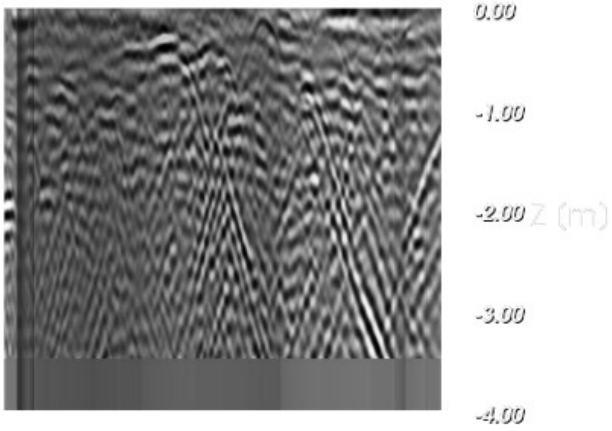
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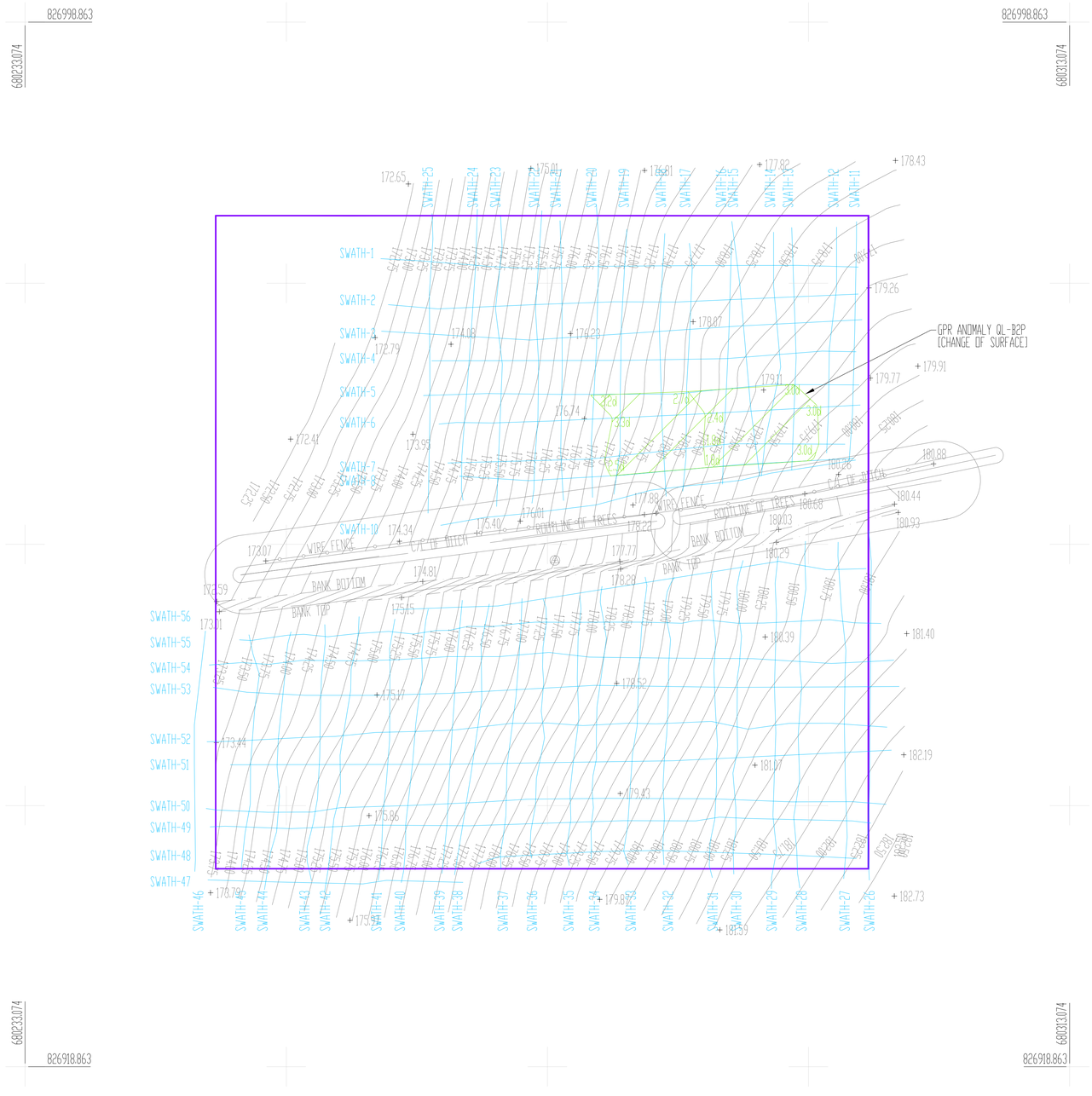


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Swath: 36
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NOTES

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The data presented in this drawing have been collected using a combination of the following: consultation of utility asset information, visual survey & inspection of manholes and inspection chambers; electromagnetic location techniques; ground penetrating radar, and, where applicable, trial hole excavations. These techniques have been deployed in accordance with the BSI PAS128 Specification for Underground Utility Detection, Verification and Location using the search methodologies indicated below and described in the accompanying report. This drawing should be used in conjunction with the accompanying report which details the limitations of these techniques and any hindering factors encountered during this survey.

Unless otherwise stated, all utilities shown on this plan have been surveyed using approved detectors and the connections between inspection chambers, if unable to be detected, are generally assumed to be direct unless there are indications to the contrary. The detection confidence for each utility segment is depicted in line with the PAS128 scheme outlined below. Information depicted as QL–C or QL–D cannot be guaranteed as it is based on historic utility records which can be inaccurate and incomplete.

The utility routes depicted may reflect the routes of multiple cables or pipes. It is not always possible to differentiate between buried construction features, utilities and other subsurface linear features therefore it is possible that some features shown are not utility related, and due to the limitations of electromagnetic techniques all utility identifications should be treated with caution and verified prior to use during design/building works.

If the location or depth of utilities and features is of particular importance to a project then it is recommended that discussions are held with GeoData Surveying Ltd regarding any possible limitations or anomalies.

Please note that not all buried pipes, cables and ducts can be detected and mapped in consideration of their depth, location, material type, geology and proximity to other utilities. Even an appropriate and professionally executed survey may not be able to achieve a 100% detection rate. Where an area of utilities is likely to affect client project requirements, it is strongly recommended that a PAS128 Quality Level A verification survey is carried out

No utility mapping survey can be considered a 100% accurate depiction of the sub-surface environment, and the use of these drawings does not remove the requirement for the use of safe digging techniques at all times, in line with the requirements of current regulations.

ABBREVIATIONS

AJ	ARMSTRONG JUNCTION	FH	FIRE HYDRANT	UTS	UNABLE TO SURVEY
AR	ASSUMED ROUTE	FFL	FLOOR LEVEL	UTT	UNABLE TO TRACE
AV	AIR VALVE	FS	FLAG STAFF/ POLE	VP	VENT PIPE
BD	BACKDROP	G	GULLY	VE	VALVE
BL	BED LEVEL	G=	GRTH	SWL	WATER LEVEL
BH	BOREHOLE	GP	GAS INLET PIPE	STN	CONTROL STATION
Bin	LITTER / GRIT SALT BIN	GP	GUIDE POST	SV	SLUICE VALVE
BO	BOLLARD	GPR	TRACED BY G.P.R.	SC	STOP COCK
BP	BOUNDARY POST	GV	GAS VALVE	STP	SOIL STACK PIPE
BS	BUS STOP	HV	HIGH VOLTAGE	TEL	TELECOM INSP
CATV	CABLE TV COVER	IC	INSP CHAMBER	TL	TRAFFIC LIGHT
CB	CONTROL BOX	IL	INVERT LEVEL	TP	TELECOM POLE
CL	COVER LEVEL	IP	INLET PIPE	WM	WATER METER
Cpst	CAMERA POST	LP	LAMP STANDARD	WO	WASH OUT VALVE
CulP	CULVERT PIPE	LV	LOW VOLTAGE		
d	DEPTH	MH	MANHOLE		
DIA	DIAMETER	MP	MINI PILLAR		
DS	DIRECTION SIGN	MCP	MICRO PILLAR		
ESB	ELECTRIC INSP COVER	O/H	OVER HEAD LINE		
EOT	END OF TRACE	OS	OUTSIDE SURVEY AREA		
EP	ELECTRICITY STANDARD	UL	UTILITY INSP CHAMBER		
ER	EARTH ROD	UTF	UNABLE TO LIFT		
FB	FOOTBRIDGE	UTR	UNABLE TO ROD		

SUB-SURFACE KEY

COMBINED HEATING AND POWER	CHP–XX
DISTRICT HEATING	DH–XX
DRAINAGE COMBINED *	C3–XX
DRAINAGE FOUL*	F3–XX
DRAINAGE SURFACE*	S3–XX
DRAINAGE UNIDENTIFIED*	U3–XX
[* FLOW DIRECTION DENOTED BY ARROW (>) or (<) IF KNOWN]	
ELECTRIC	E–XX
ELECTRIC LV	LV–XX
ELECTRIC HV	HV–XX
ELECTRIC STREET LIGHTING	SL–XX
GAS	G–XX
OIL/FUEL PIPELINE	O–XX
STREET FURNITURE CABLES	SF–XX
TELECOMS	T–XX
TELECOMS – FIBRE OPTIC	FO–XX
TELECOMS – EIR	EIR–XX
TRAFFIC CONTROL	TC–XX
WATER	W–XX
UNIDENTIFIED UTILITY	U–XX
UNIDENTIFIED CABLES	C–XX
UNIDENTIFIED EMPTY DUCT	X–XX
GPR LINEAR FEATURE	GPR–XX
GPR AREA ANOMALY	
GPR AREA ANOMALY – REBAR	
CHAMBER EXTENTS	

WITH CLIENT CONFIDENCE LEVELS

MEASURED DEPTH BGL TO PIPE/CABLE/DUCT	0.65d
INVERT LEVEL OF PIPE/DUCT/CABLE (TO OS DATUM)	IL 12.34
SOFFIT LEVEL OF PIPE/DUCT/CABLE (TO OS DATUM)	SL 45.67
COVER LEVEL OF INSPECTION CHAMBER (TO OS DATUM)	CL 78.90
DIAMETER OF PIPE/DUCT IN MILLIMETERS	150Ø
[BGL – BELOW GROUND LEVEL]	
AREA UNABLE TO BE SURVEYED DUE TO SURFACE OBSTRUCTIONS, VEGETATION OR LACK OF ACCESS	
TRENCH SCAR / SURFACE SCAR	
EXTENT OF SURVEY – BOUNDARY	

UTILITY CONFIDENCE LEVELS (Listed from High to Low)

(A)	HORIZONTAL AND VERTICAL POSITION VERIFIED VISUALLY (Accuracy: Horizontal ±25mm) Vertical±50mm)
(B1P)	HORIZONTAL AND VERTICAL POSITION DETECTED BY MULTIPLE METHODS W H POST PROCESSING OF GPR DATA (Estimated Accuracy: ±150mm OR ±15% of detected depth)
(B1)	HORIZONTAL AND VERTICAL POSITION DETECTED BY MULTIPLE METHODS Estimated Accuracy: ±150mm OR ±15% of detected depth)
(B2P)	HORIZONTAL AND VERTICAL POSITION DETECTED VIA POST–PROCESSED GPR (Estimated Accuracy: ±250mm OR ±40% of detected depth)
(B2)	HORIZONTAL AND VERTICAL POSITION DETECTED BY A SINGLE METHOD (Estimated Accuracy: ±250mm OR ±40% of detected depth)
(B3P)	HORIZONTAL POSITION DETECTED VIA POST–PROCESSED GPR (Estimated Accuracy: ±500mm in the Horizontal – Depth is undefined)
(B3)	HORIZONTAL POSITION DETECTED BY A SINGLE METHOD (Estimated Accuracy: ±500mm in the Horizontal – Depth is undefined)
(C)	ROUTE TRANSCRIBED FROM UTILITY ASSET PLANS AND CORRELATED VISUAL INDICATORS AND SURFACE FEATURES (Accuracy Undefined)
(D)	ROUTE TRANSCRIBED FROM UTILITY ASSET PLANS (Accuracy Undefined)

GPR DETECTION SURVEY

Scale 1:200

ITM GRID

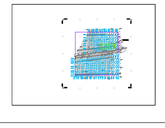
0 4m 8m 12m

1:200

SURVEY NOTES

1. All levels are related to Malin Head Datum (OSGM15)
2. All dimensions are in meters unless otherwise stated.
3. any descripencies in the survey should be reported to Geodata Surveying Ltd immediately.
4. Do not scale, this shall only be permitted in digital form.
5. Grid is 20m x 20m

PAS128 SURVEY METHODOLOGY LOCATION PLAN



PAS128 SURVEY METHODOLOGY KEY

THIS SURVEY HAS BEEN CARRIED OUT IN ACCORDANCE WITH THE PAS128 SPECIFICATION FOR UNDERGROUND UTILITY DETECTION, VERIFICATION & LOCATION. THE SPECIFICATION ALLOWS FOR A RANGE OF TECHNIQUES AND METHODS OF VARYING INTENSITY TO BE DEPLOYED. THE COLOUR CODED SCHEME INDICATES WHERE DIFFERENT SURVEY METHODOLOGIES HAVE BEEN USED ON SITE, AND THE LIST BELOW IDENTIFIES EQUIPMENT USED TO OBTAIN THE SURVEY RESULTS.
NB: PLEASE SEE ACCOMPANYING REPORT FOR FULL DETAILS.

ELECTROMAGNETIC DETECTION	GROUND PENETRATING RADAR	TOTAL STATION	GPS/GNSS
RD 8000 Precision Locating	IDS C-Stream - High Density Array	S9 Trimble Robotic	Trimble R10
	IDS Opera Dual Antenna	S6 Trimble Robotic	

M4P - EML SEARCH TRANSECT AT 2m INTERVALS - TRACED AT 0.5m INTERVALS. GPR SURVEY GRID AT 0.5m INTERVALS OR HIGH DENSITY ARRAY. POST PROCESSING OF GPR DATA.

M3P - EML SEARCH TRANSECT AT 2m INTERVALS - TRACED AT 1m INTERVALS. GPR SURVEY GRID AT 1m INTERVALS OR HIGH DENSITY ARRAY. POST PROCESSING OF GPR DATA.

M2P - EML SEARCH TRANSECT AT 5m INTERVALS - TRACED AT 2m INTERVALS. GPR SURVEY GRID AT 2m INTERVALS OR HIGH DENSITY ARRAY. POST PROCESSING OF GPR DATA.

M1P - EML SEARCH TRANSECT AT 10m INTERVALS - TRACED AT 5m INTERVALS. GPR SURVEY AS APPROPRIATE. POST PROCESSING OF GPR DATA.

M4 - EML SEARCH TRANSECT AT 2m INTERVALS - TRACED AT 0.5m INTERVALS. GPR SURVEY GRID AT 0.5m INTERVALS. GPR MARK-UP ON SITE

M3 - EML SEARCH TRANSECT AT 2m INTERVALS - TRACED AT 1m INTERVALS. GPR SURVEY GRID AT 1m INTERVALS. GPR MARK-UP ON SITE.

M2 - EML SEARCH TRANSECT AT 5m INTERVALS - TRACED AT 2m INTERVALS. GPR SURVEY GRID AT 2m INTERVALS. GPR MARK-UP ON SITE.

M1 - EML SEARCH TRANSECT AT 10m INTERVALS - TRACED AT 5m INTERVALS. GPR SURVEY AS APPROPRIATE. GPR MARK-UP ON SITE

DUCT FORMATION

1W:	1 WAY SINGLE DUCT
2W:	2 WAY FLAT
2W:1/2	2 WAY: 1 WIDE, 2 DEEP
4W:2/2	4 WAY: 2 WIDE, 2 DEEP
6W:3/2	6 WAY: 3 WIDE, 2 DEEP
12W:4/3	12 WAY: 4 WIDE, 3 DEEP

NB: TO BE ADAPTED TO FOR EACH CHAMBER

Rev	Date	Description	Drn By	Ckd By
01	28-02-23	GPR SURVEY	SF	KOB

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Client: OCB Geotechnical Ltd.

Rev. 01

Project: Site 112 Co Monaghan

Job. No: 21719

Dwg. No: 410

Title: GPR Detection Survey

Drawn By: KL

Checked By: SF

Approved By: KOB

Date: 28-02-23

Sheet: A1

Scale: 1-200

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Technical Report

Ground-Penetrating Radar (GPR) & Utility Detection Survey

Client: OCB Geotechnical Ltd

Project: 21719 –Monaghan, Site 113.

28th of February 2022

GeoData Surveying Ltd
Registered Office: 47 Oliver Plunkett Street, Bandon, Co Cork. P72 A443.
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Summary

Technical Report - Ground-Penetrating Radar (GPR) & Utility Survey

Client: OBC Geotechnical Ltd

Project: Project: 21719–Monaghan, Site 113

Document Evolution					
Job no	**Issue**	**Date**	**Prepared by**	**Checked by**	**Description**
21719	03	28-02-22	S. Forys	K O'Brien	First Edition

1. Introduction

Geodata were requested to carry out a Ground-Penetrating Radar (GPR)Surveyfor OCB Geotechnical.



Extent of Survey

2. Scope of the Investigation

The scope of the investigation is to Ground Penetrating Radar (GPR) on a 50m x 50m area at a 5m grid spacing using a 200 MHz shielded antennae with A Real Time Kinematic (RTK) differential GPS to accurately log the position of each GPR trace.

3. Limitation of Survey

It must be noted the geophysical data by itself does not allow identification of the anomalies detected. No GPR survey can be considered a 100% accurate depiction of the sub-surface environment and the use of these drawings does not remove the requirement for the use of safe digging techniques at all times.

4. Method of Investigation

The Survey was carried out using the following methods:

- Desk Top Studies;
- Site reconnaissance
- Establish Survey grids
- Ground Penetrating Radar (GPR);
- Record and Process markings
- Post Processing GPR Data;
- Quality Check
- Final Report

5. Detection Methodology

The Survey was carried using IDS Opera Duo multi frequency Ground Penetrating Radar with a frequency of 200MHz to allow greater penetration on a 50m x 50m area at a 5m grid spacing. position of each GPR trace.

5.1. Geo-radar

Ground Penetrating Radar is a non invasive technology that uses radar waves from a surface transmitter that can penetrate through ground materials and are reflected back to the instrument by a change of ground material or other buried objects.

The transmission frequency is an importance factor in GPR. Low frequency radars will provide high penetration into the target but these results can lead to unfavourable resolutions. High frequency radar provides greater resolution in regards to radar images but the penetration is less than the low frequency.

In this instance the Opera Duo achieved a penetration of typically 1.2-2.0m below the surface. The position of the array was continually monitored and recorded using a total station.



Figure 5.0 C-Stream IDS -High Density Array (GPR)

5.2. Post Process of Ground Penetrating Radar (GPR) data

Ground Penetrating Radar (GPR) data was post processed to improve the interpretation of raw data using GRED HD GPR Post processing software.

Post processing aids in the identification of responses to gain a better understanding of areas of complex or more obscure utility networks..

6. Quality Check

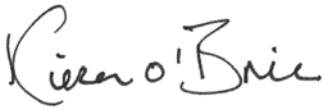
GeoData has inbuilt quality check system involving cross checking and discussion between teams to identify any possible inaccuracies and to improve the interpretation of the Post processing of GPR data and onsite observations. All Equipment used was calibrated and tested in line with manufacturer guidelines and survey carried out in accordance with TSA guidelines.

7. Conclusions and Recommendations.

Ground Penetration Radar resolution was generally good on site with penetration of typically 1.2-2.0m below the surface in area of optimal ground conditions. Areas unable to be surveyed due to surface obstructions, vegetation, slope or lack of access were marked in the survey drawings (Appendix A)

The Radiograms show a uniform substrate of soil, I would not be in a position to comment on the physical characteristic of the substrate due to the absent of site investigation to reference the Ground Penetrating Radar data.

Yours sincerely,

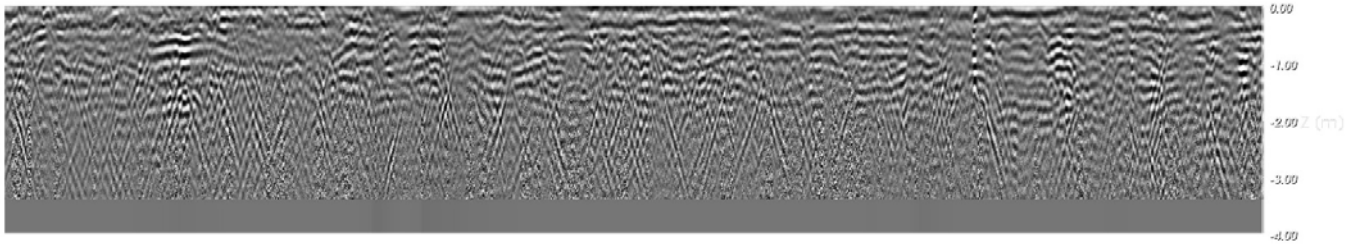


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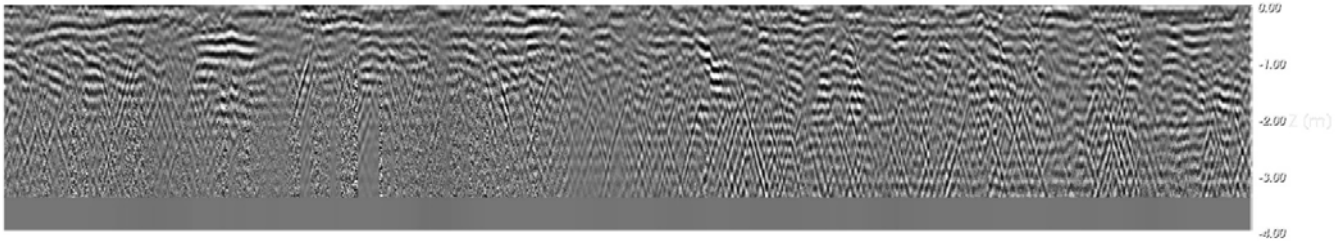
Kieran O'Brien
Chartered Engineer & Chartered Geomatics Surveyor
BEng(Hons) CEng MIEI MSCSI/MRIC

Appendix A

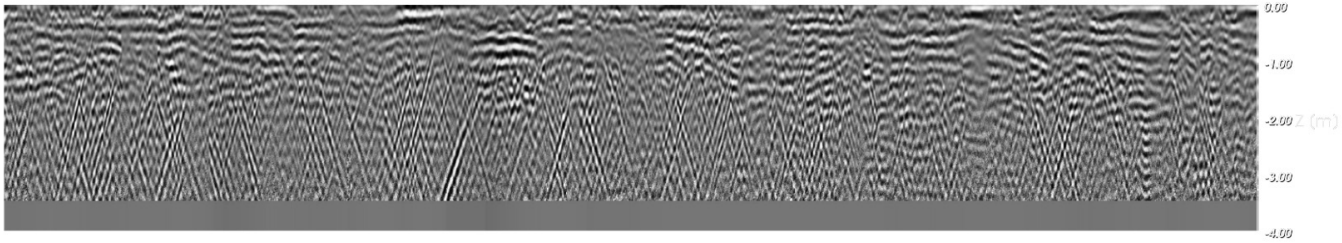
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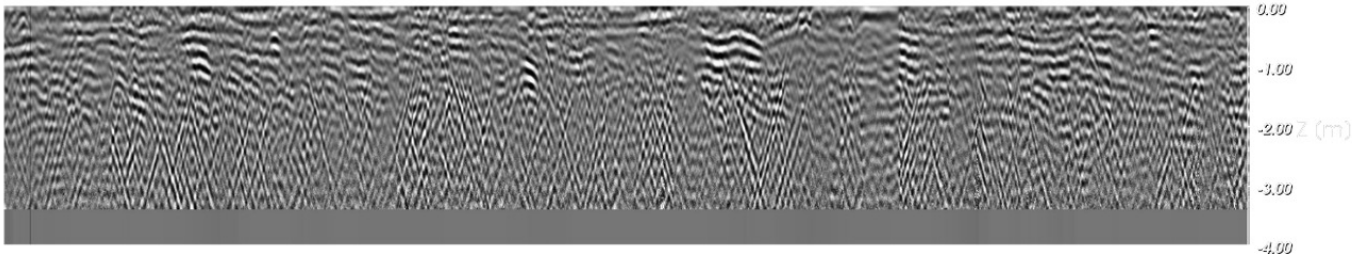
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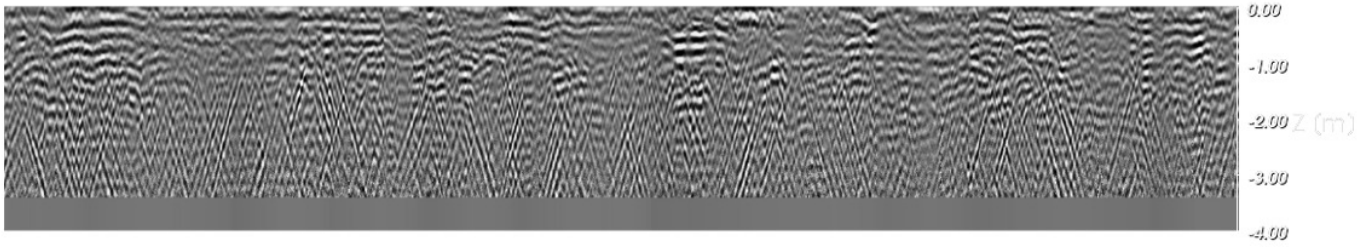
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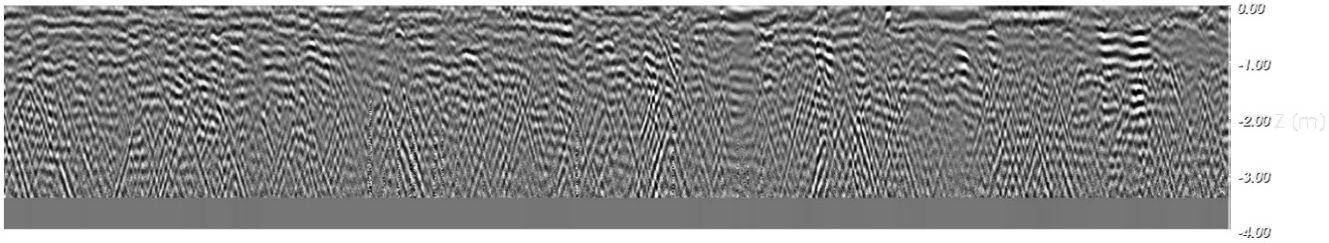
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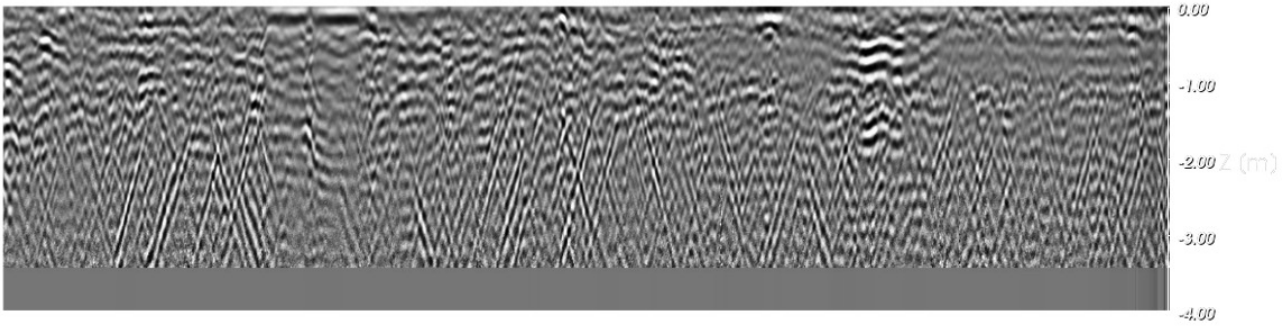
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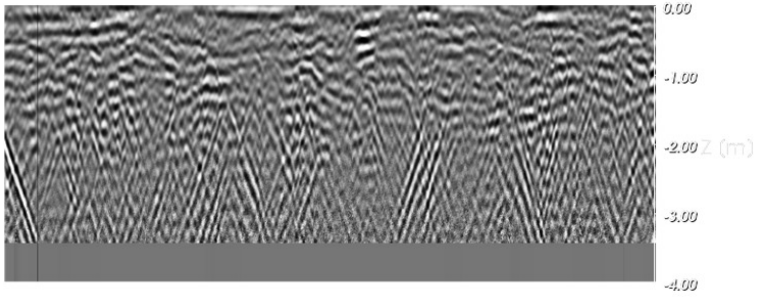
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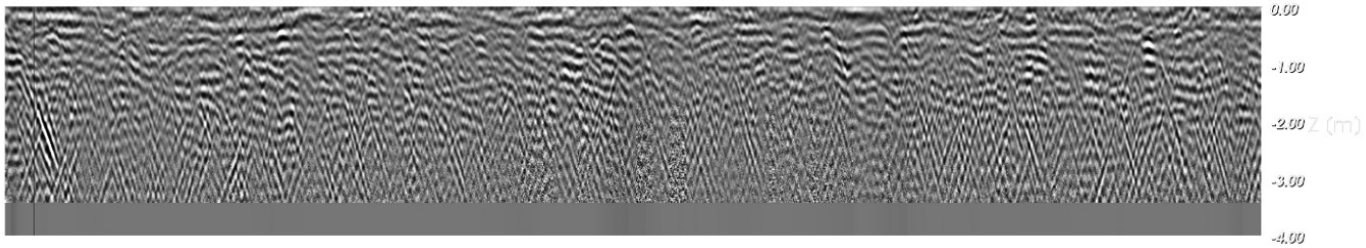
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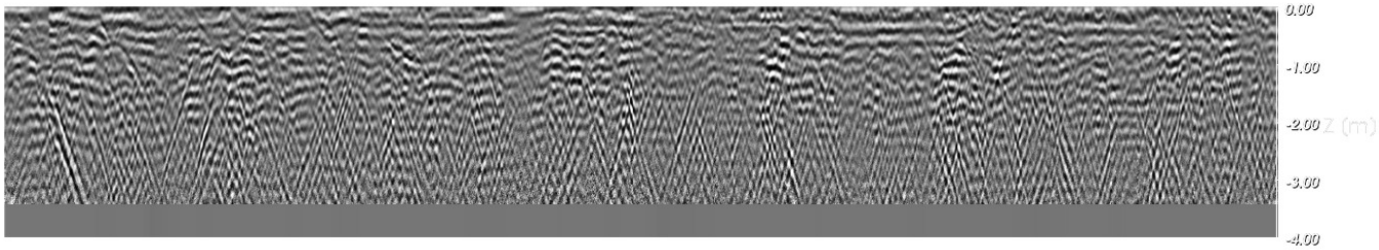
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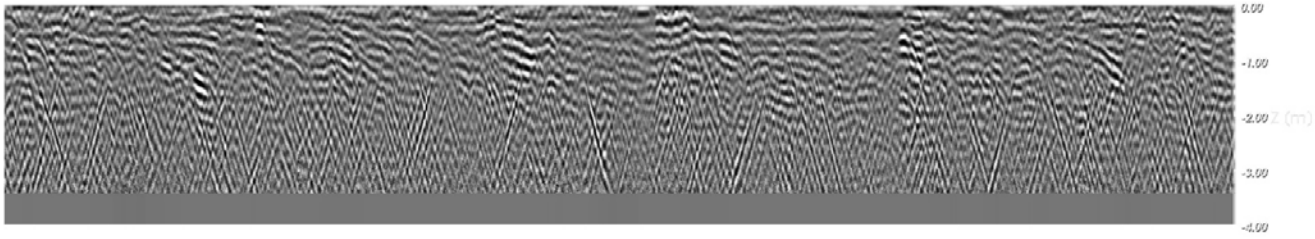
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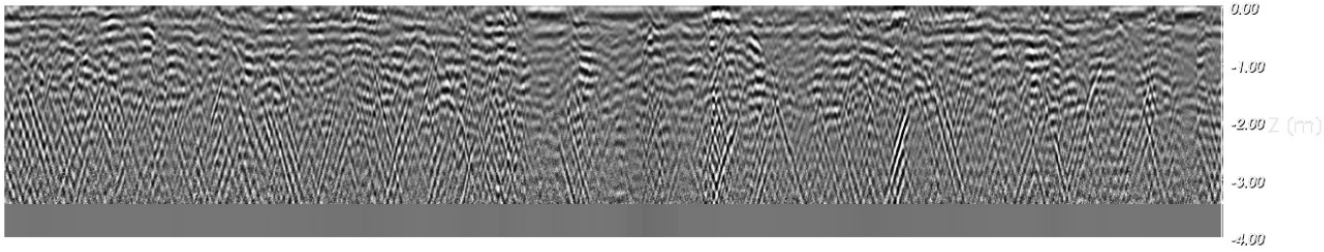
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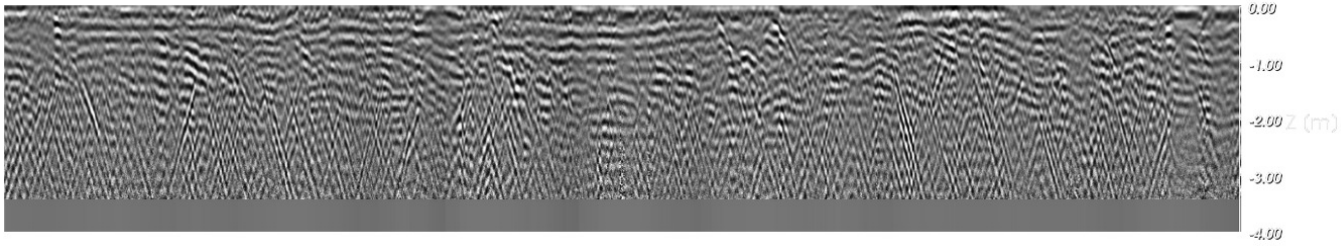
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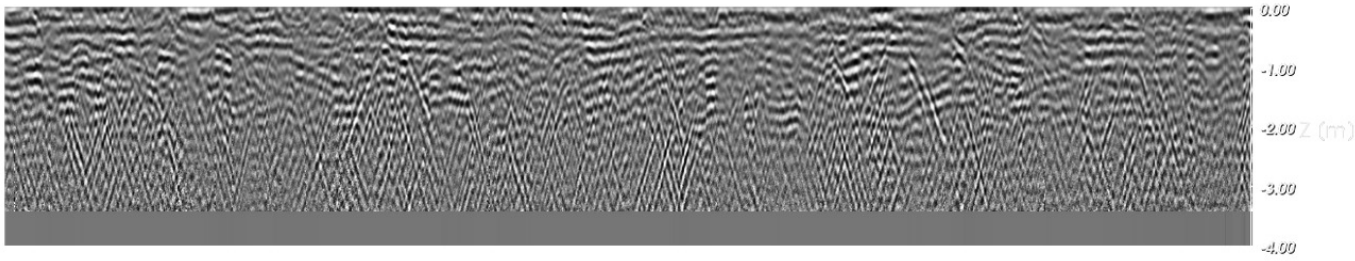
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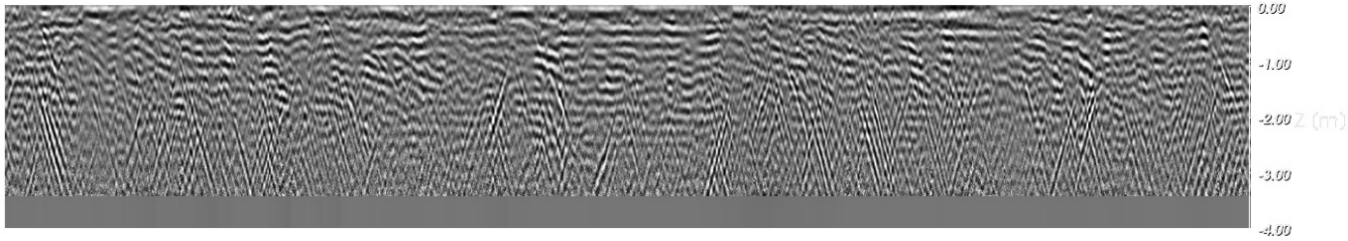
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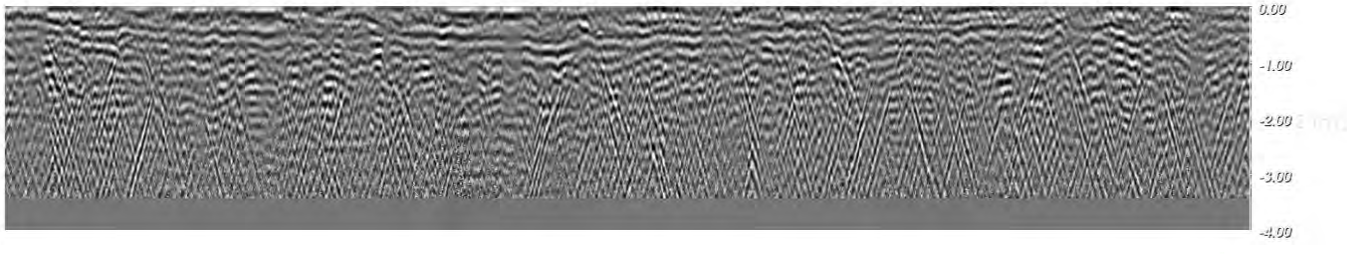
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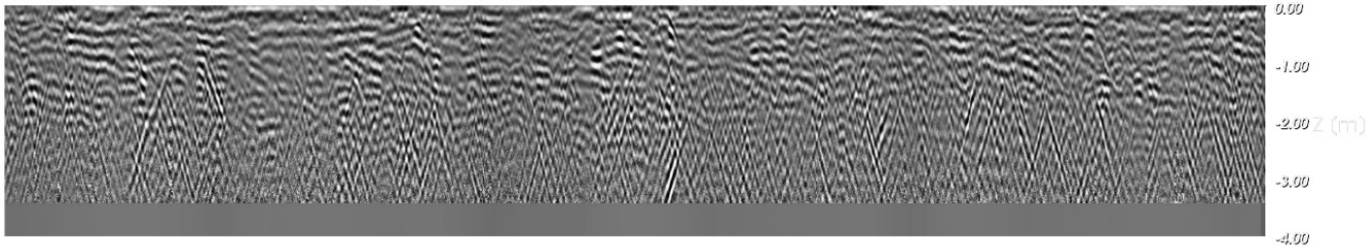
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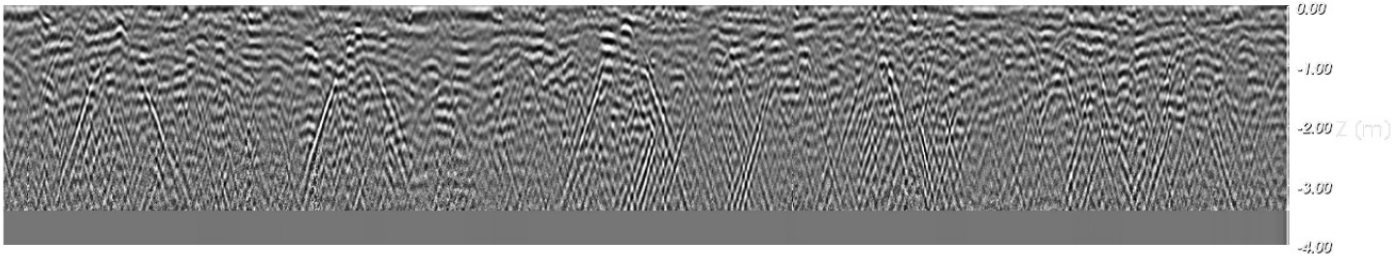
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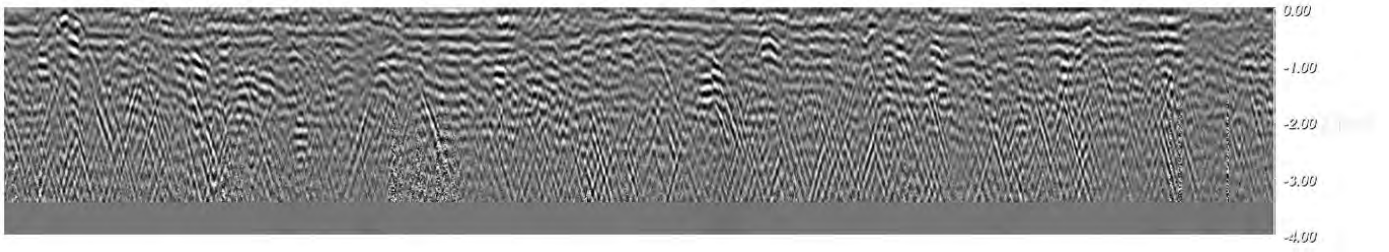
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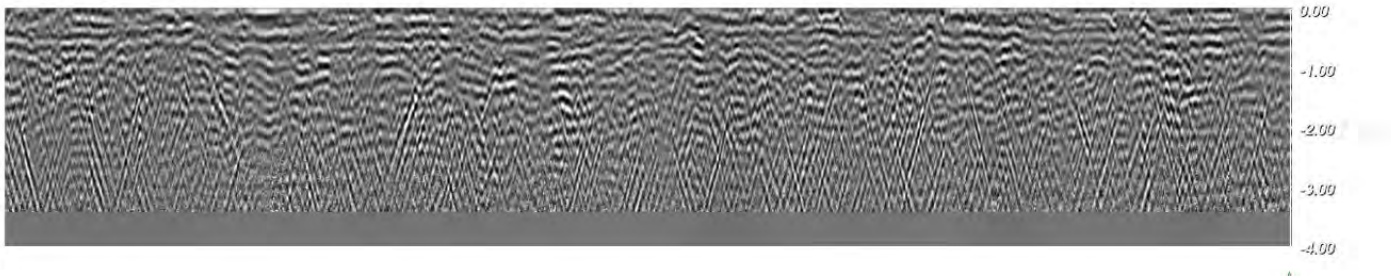
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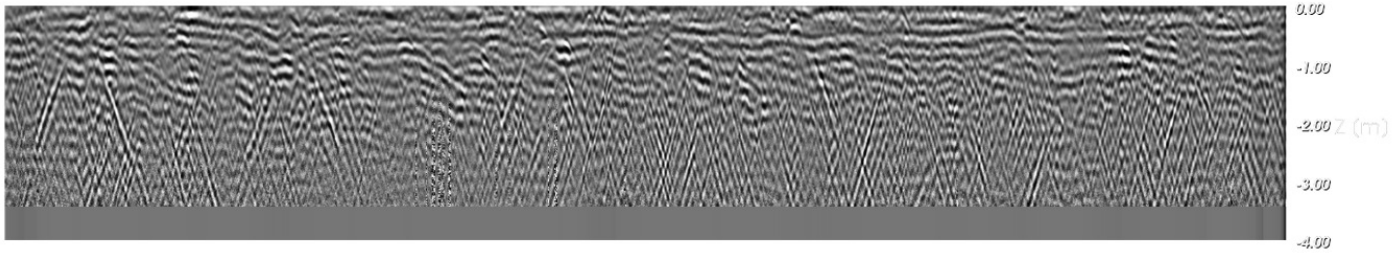
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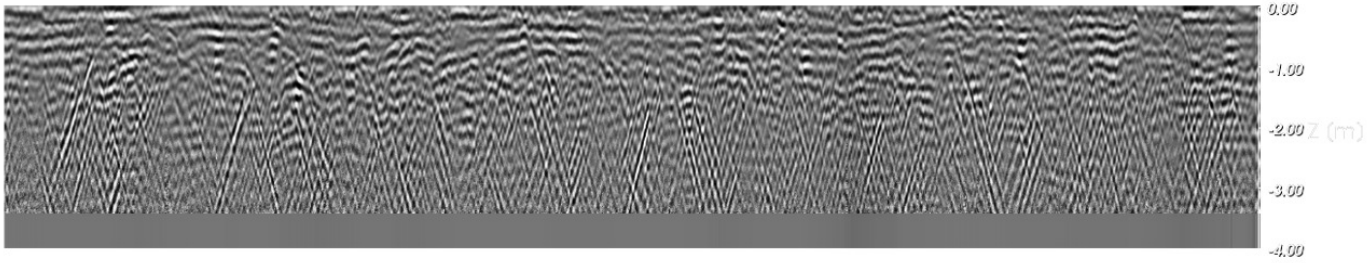
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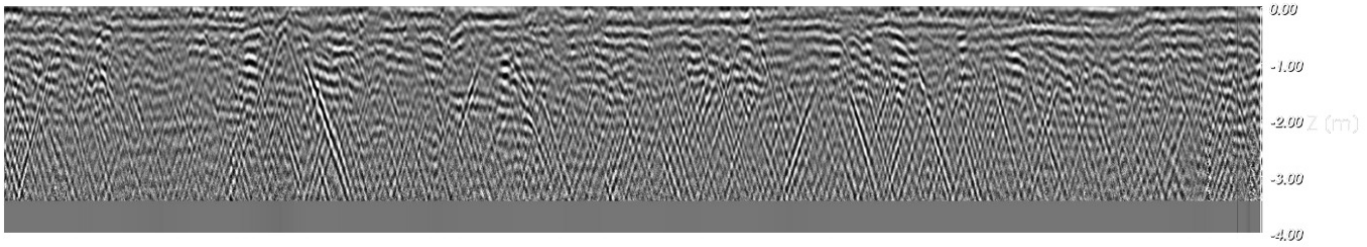
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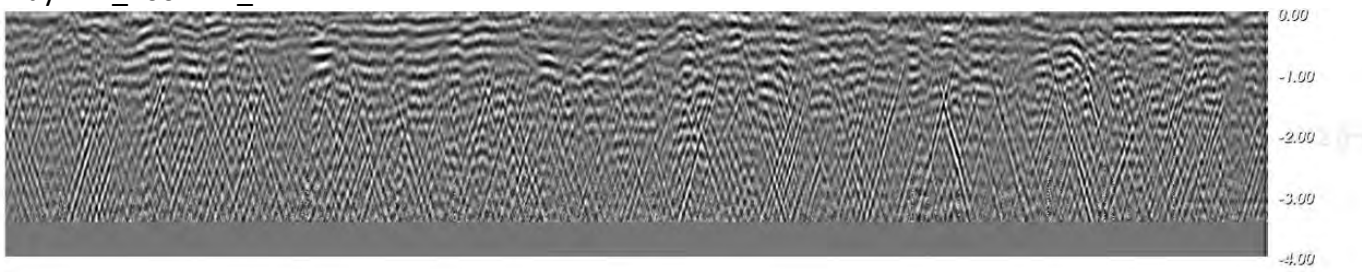
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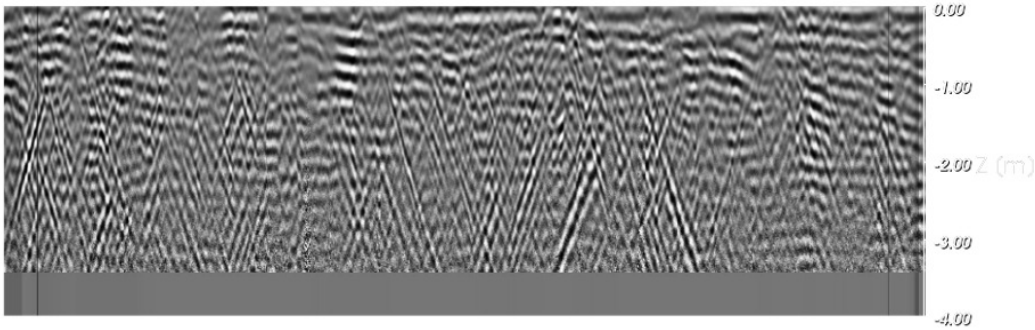
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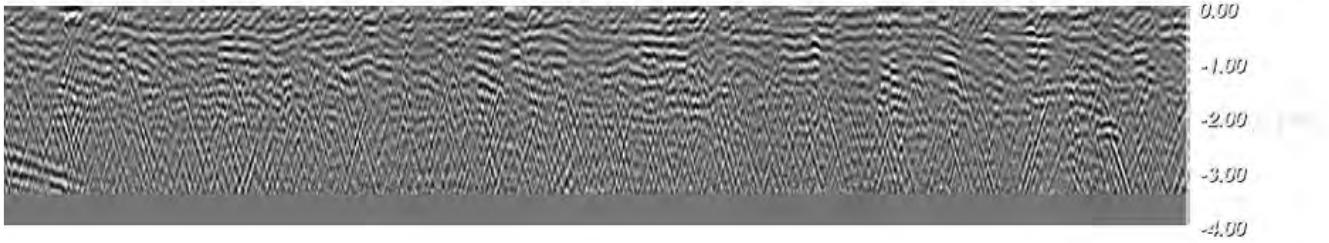
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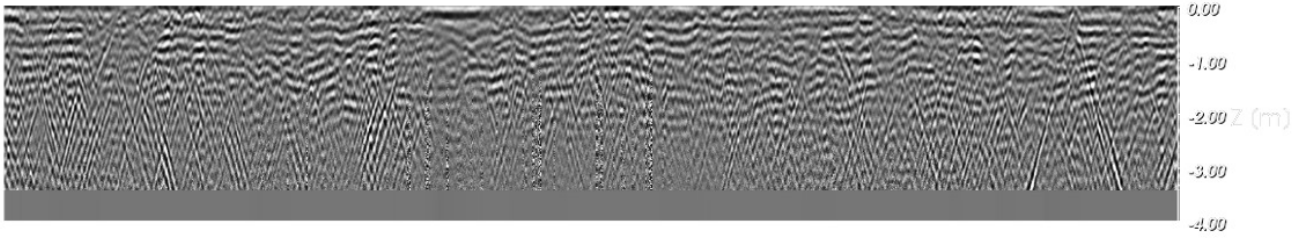
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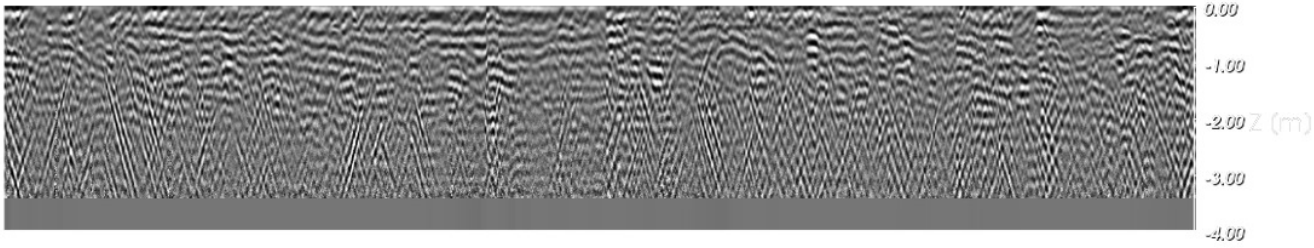
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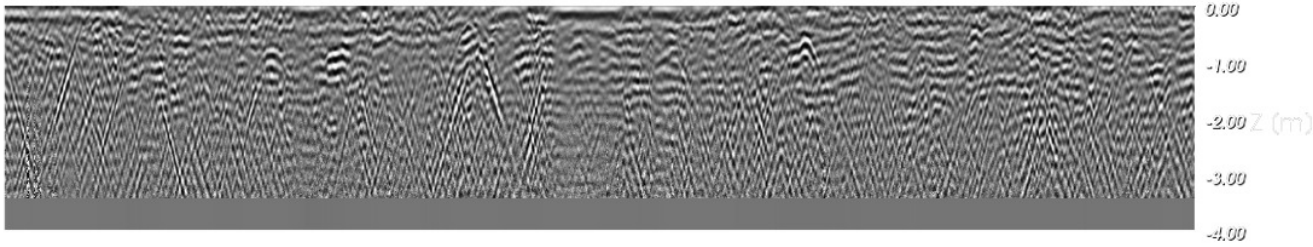
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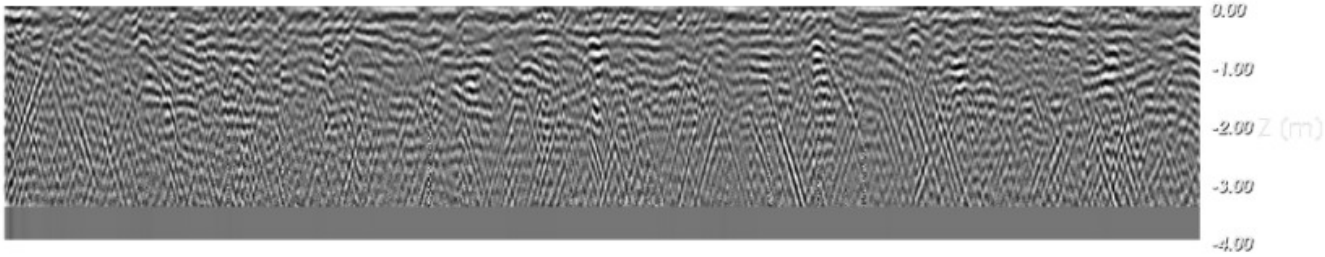
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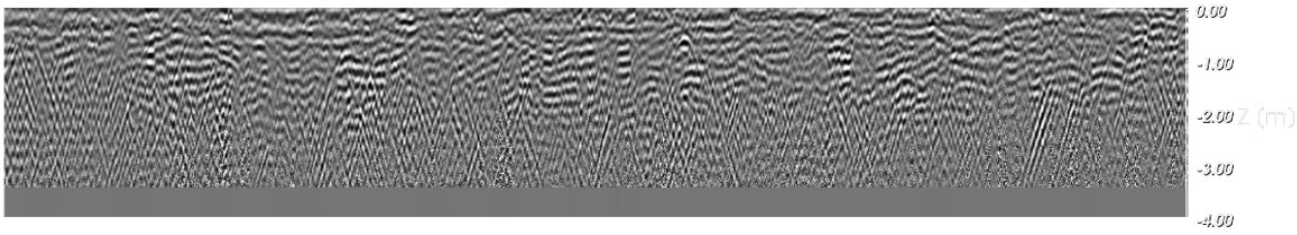
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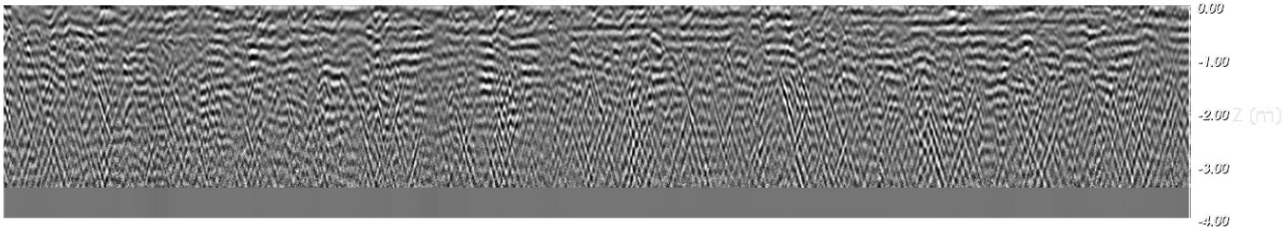
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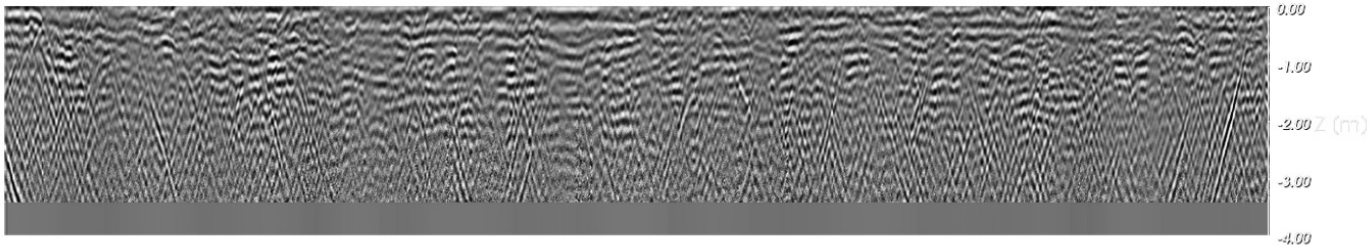
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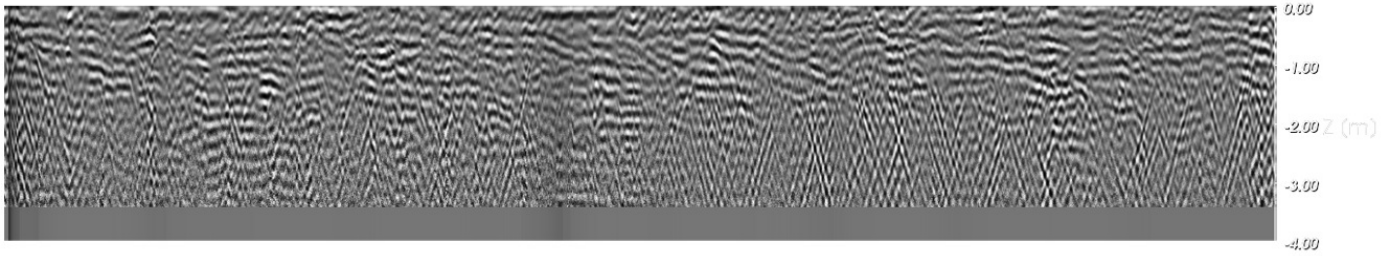
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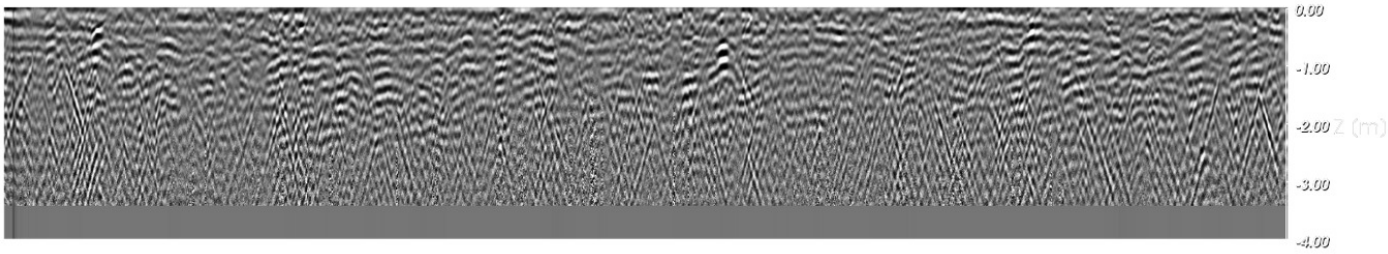
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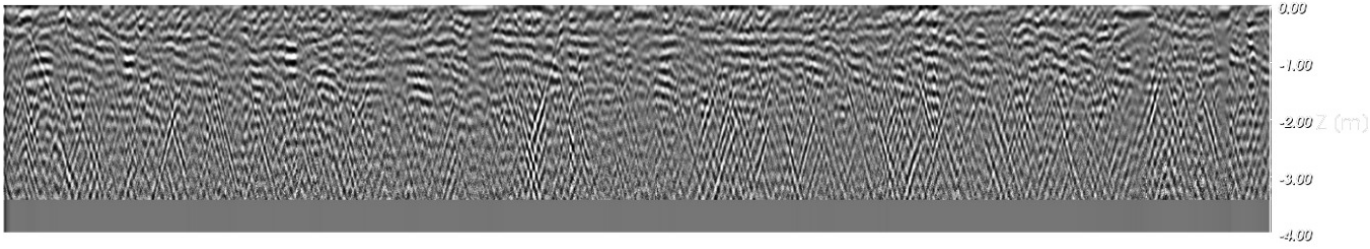
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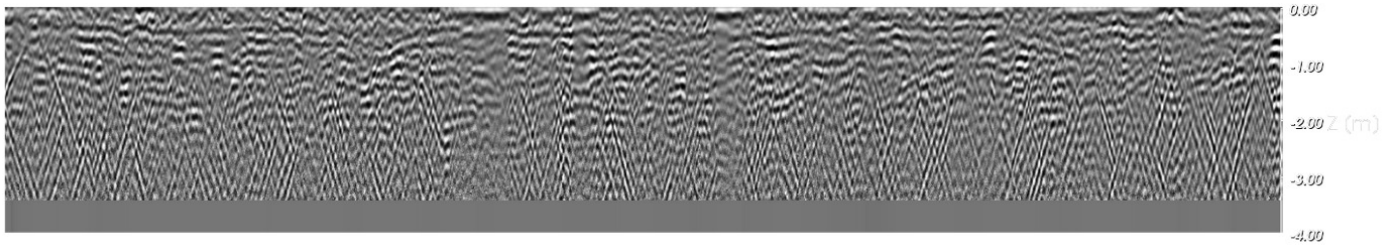
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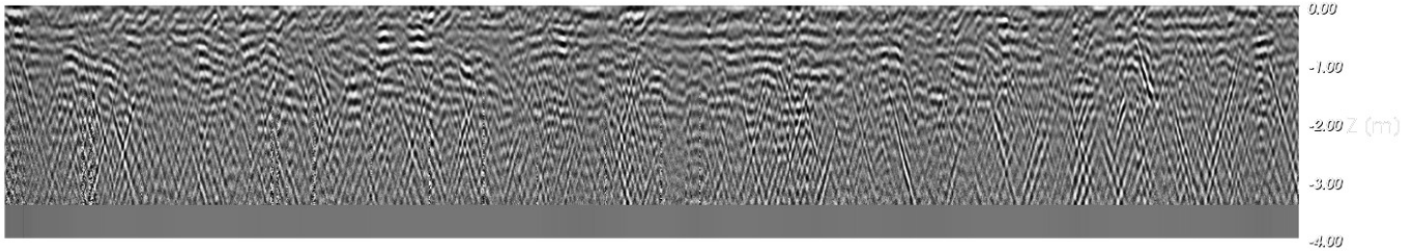
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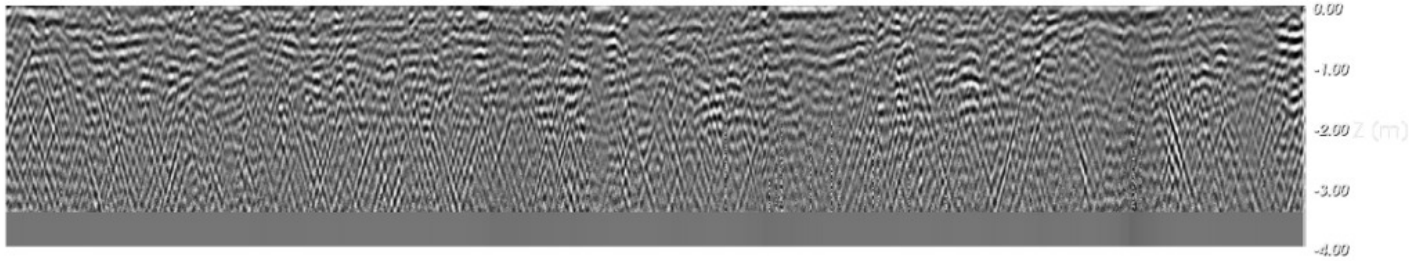
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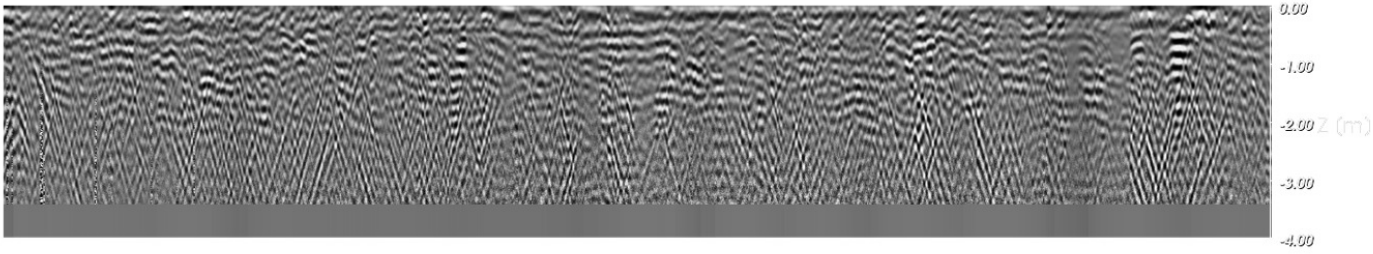
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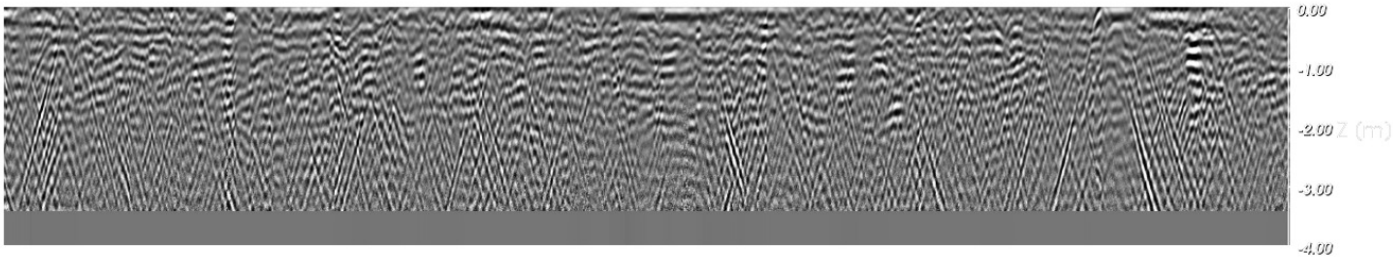
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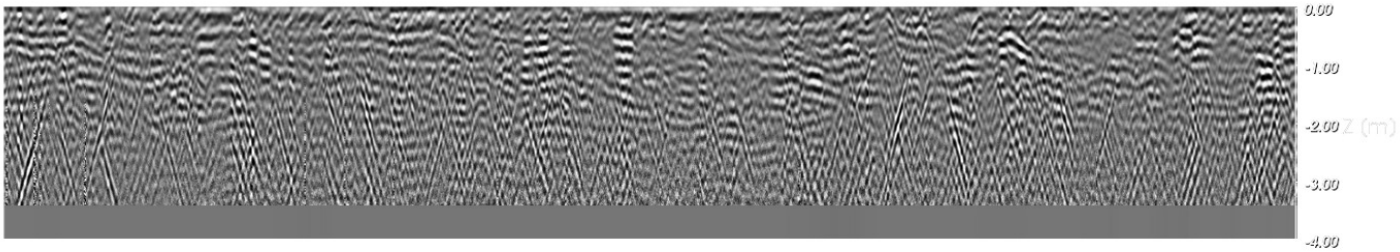
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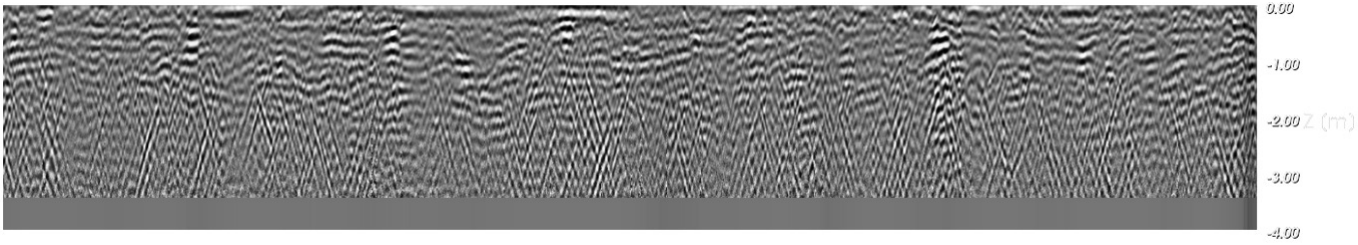
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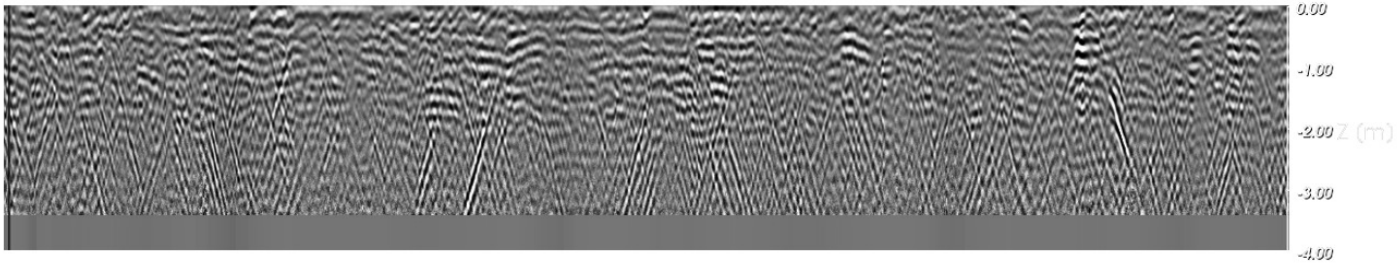
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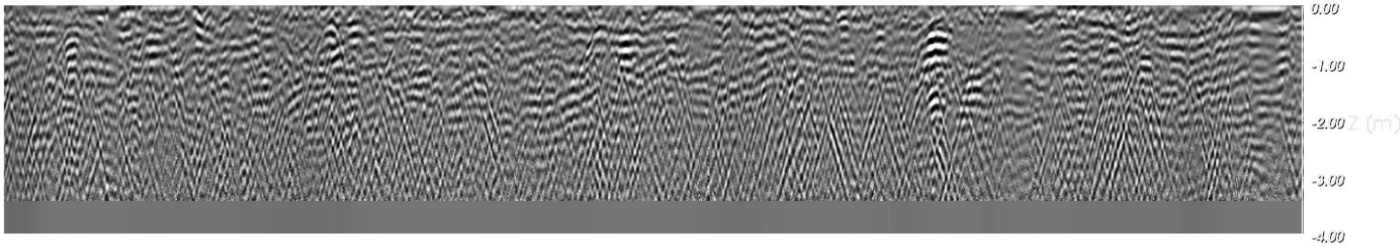
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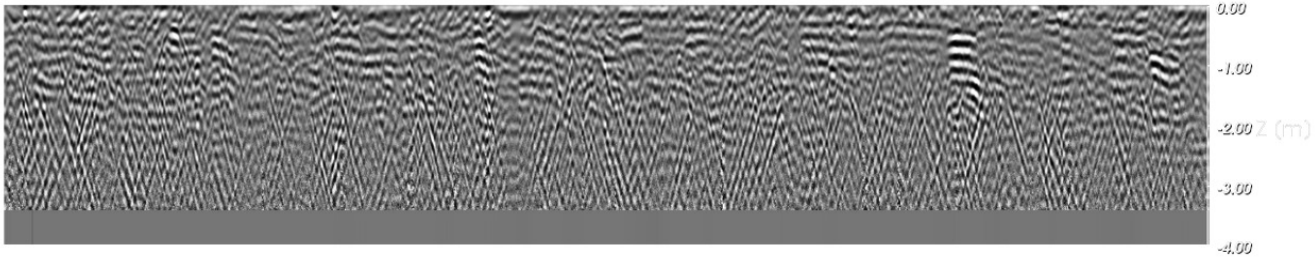
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Array: HH_200MHz_L



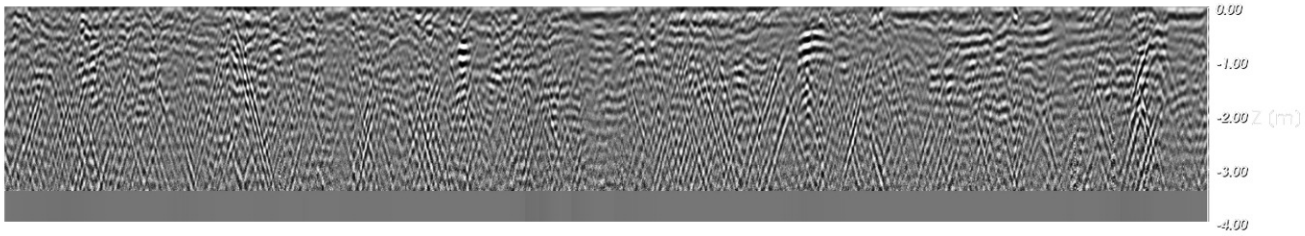
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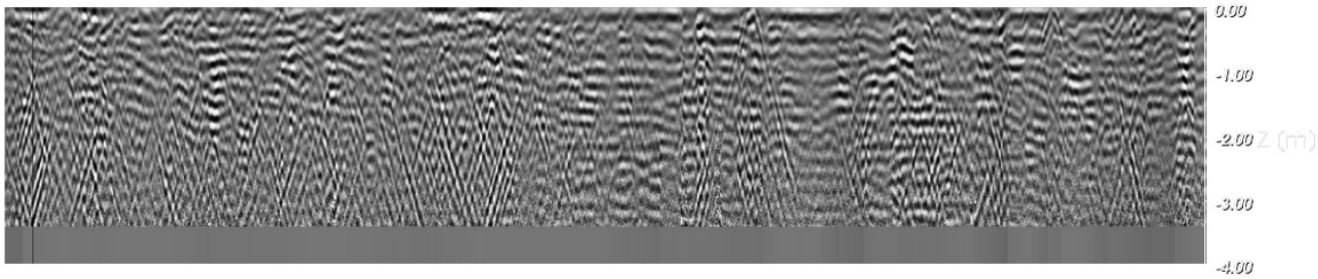
Swath: 45
Array: HH_200MHz_L



Swath: 46
Array: HH_200MHz_L



Swath: 47
Array: HH_200MHz_L





GPR UTILITY SURVEY
Scale 1:200

NOTES

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The data presented in this drawing have been collected using a combination of the following: consultation of utility asset information, visual survey & inspection of manholes and inspection chambers; electromagnetic location techniques; ground penetrating radar, and, where applicable, trial hole excavations. These techniques have been deployed in accordance with the BSI PAS128 Specification for Underground Utility Detection, Verification and Location using the search methodologies indicated below and described in the accompanying report. This drawing should be used in conjunction with the accompanying report which details the limitations of these techniques and any hindering factors encountered during this survey.

Unless otherwise stated, all utilities shown on this plan have been surveyed using approved detectors and the connections between inspection chambers, if unable to be detected, are generally assumed to be direct unless there are indications to the contrary. The detection confidence for each utility segment is depicted in line with the PAS128 scheme outlined below. Information depicted as QL–C or QL–D cannot be guaranteed as it is based on historic utility records which can be inaccurate and incomplete.

The utility routes depicted may reflect the routes of multiple cables or pipes. It is not always possible to differentiate between buried construction features, utilities and other subsurface linear features therefore it is possible that some features shown are not utility related, and due to the limitations of electromagnetic techniques all utility identifications should be treated with caution and verified prior to use during design/building works.

If the location or depth of utilities and features is of particular importance to a project then it is recommended that discussions are held with GeoData Surveying Ltd regarding any possible limitations or anomalies.

Please note that not all buried pipes, cables and ducts can be detected and mapped in consideration of their depth, location, material type, geology and proximity to other utilities. Even an appropriate and professionally executed survey may not be able to achieve a 100% detection rate. Where an area of utilities is likely to affect client project requirements, it is strongly recommended that a PAS128 Quality Level A verification survey is carried out

No utility mapping survey can be considered a 100% accurate depiction of the sub-surface environment, and the use of these drawings does not remove the requirement for the use of safe digging techniques at all times, in line with the requirements of current regulations.

ABBREVIATIONS

AJ	ARMSTRONG JUNCTION	FH	FIRE HYDRANT	UTS	UNABLE TO SURVEY
AR	ASSUMED ROUTE	FFL	FLOOR LEVEL	UTT	UNABLE TO TRACE
AV	AIR VALVE	FS	FLAG STAFF/ POLE	VP	VENT PIPE
BD	BACKDROP	G	GULLY	VE	VALVE
BL	BED LEVEL	G=	GRTH	SWL	WATER LEVEL
BH	BOREHOLE	GIP	GAS INLET PIPE	STN	CONTROL STATION
Bin	LITTER / GRIT SALT BIN	GP	GUIDE POST	SV	SLUICE VALVE
BO	BOLLARD	GPR	TRACED BY G.P.R.	SC	STOP COCK
BP	BOUNDARY POST	GV	GAS VALVE	STP	SOIL STACK PIPE
BS	BUS STOP	HV	HIGH VOLTAGE	TEL	TELECOM INSP
CATV	CABLE TV COVER	IC	INSP CHAMBER	TL	TRAFFIC LIGHT
CB	CONTROL BOX	IL	INVERT LEVEL	TP	TELECOM POLE
CL	COVER LEVEL	IP	INLET PIPE	WM	WATER METER
Cpst	CAMERA POST	LP	LAMP STANDARD	WO	WASH OUT VALVE
CulP	CULVERT PIPE	LV	LOW VOLTAGE		
d	DEPTH	MH	MANHOLE		
DIA	DIAMETER	MP	MINI PILLAR		
DS	DIRECTION SIGN	MCP	MICRO PILLAR		
ESB	ELECTRIC INSP COVER	O/H	OVER HEAD LINE		
EOT	END OF TRACE	OS	OUTSIDE SURVEY AREA		
EP	ELECTRICITY STANDARD	UL	UTILITY INSP CHAMBER		
ER	EARTH ROD	UIT	UNABLE TO LIFT		
FB	FOOTBRIDGE	UTR	UNABLE TO ROD		

SUB-SURFACE KEY

COMBINED HEATING AND POWER — CHP-XX
DISTRICT HEATING — DH-XX
DRAINAGE COMBINED * — C3-XX / C3-XX
DRAINAGE FOUL* — F3-XX / F3-XX
DRAINAGE SURFACE* — S3-XX / S3-XX
DRAINAGE UNIDENTIFIED* — U3-XX / U3-XX
[* FLOW DIRECTION DENOTED BY ARROW (>) or (<) IF KNOWN]
ELECTRIC — E-XX E-XX
ELECTRIC LV — LV-XX
ELECTRIC HV — HV-XX
ELECTRIC STREET LIGHTING — SL-XX
GAS — G-XX G-XX
OIL/FUEL PIPELINE — O-XX O-XX
STREET FURNITURE CABLES — SF-XX
TELECOMS — T-XX T-XX
TELECOMS – FIBRE OPTIC — FO-XX
TELECOMS – EIR — EIR-XX
TRAFFIC CONTROL — TC-XX
WATER — V-XX V-XX
UNIDENTIFIED UTILITY — U-XX U-XX
UNIDENTIFIED CABLES — C-XX C-XX
UNIDENTIFIED EMPTY DUCT — X-XX X-XX
GPR LINEAR FEATURE — GPR-XX
GPR AREA ANOMALY
GPR AREA ANOMALY – REBAR
CHAMBER EXTENTS

WITH EXAMPLE CONFIDENCE LEVELS

MEASURED DEPTH BGL TO PIPE/CABLE/DUCT	0.65d
INVERT LEVEL OF PIPE/DUCT/CABLE (TO OS DATUM)	IL 12.34
SOFFIT LEVEL OF PIPE/DUCT/CABLE (TO OS DATUM)	SL 45.67
COVER LEVEL OF INSPECTION CHAMBER (TO OS DATUM)	CL 78.90
DIAMETER OF PIPE/DUCT IN MILLIMETERS	150#

[BGL – BELOW GROUND LEVEL]

AREA UNABLE TO BE SURVEYED DUE TO SURFACE OBSTRUCTIONS, VEGETATION OR LACK OF ACCESS
TRENCH SCAR / SURFACE SCAR
EXTENT OF SURVEY – BOUNDARY

UTILITY CONFIDENCE LEVELS (Listed from High to Low)

(A)	HORIZONTAL AND VERTICAL POSITION VERIFIED VISUALLY (Accuracy: Horizontal ±25mm Vertical±50mm)
(B1P)	HORIZONTAL AND VERTICAL POSITION DETECTED BY MULTIPLE METHODS W H POST PROCESSING OF GPR DATA (Estimated Accuracy: ±150mm OR ±15% of detected depth)
(B1)	HORIZONTAL AND VERTICAL POSITION DETECTED BY MULTIPLE METHODS Estimated Accuracy: ±150mm OR ±15% of detected depth)
(B2P)	HORIZONTAL AND VERTICAL POSITION DETECTED VIA POST-PROCESSED GPR (Estimated Accuracy: ±250mm OR ±40% of detected depth)
(B2)	HORIZONTAL AND VERTICAL POSITION DETECTED BY A SINGLE METHOD (Estimated Accuracy: ±250mm OR ±40% of detected depth)
(B3P)	HORIZONTAL POSITION DETECTED VIA POST-PROCESSED GPR (Estimated Accuracy: ±500mm in the Horizontal – Depth is undefined)
(B3)	HORIZONTAL POSITION DETECTED BY A SINGLE METHOD (Estimated Accuracy: ±500mm in the Horizontal – Depth is undefined)
(C)	ROUTE TRANSCRIBED FROM UTILITY ASSET PLANS AND CORRELATED VISUAL INDICATORS AND SURFACE FEATURES (Accuracy Undefined)
(D)	ROUTE TRANSCRIBED FROM UTILITY ASSET PLANS (Accuracy Undefined)

SURVEY NOTES

1. All levels are related to Malin Head Datum (OSGM15)
2. All dimensions are in meters unless otherwise stated.
3. any descripencies in the survey should be reported to Geodata Surveying Ltd immediately.
4. Do not scale, this shall only be permitted in digital form.
5. Grid is 20m x 20m

ITM GRID

0 4m 8m 12m
1:200

PAS128 SURVEY METHODOLOGY LOCATION PLAN

PAS128 SURVEY METHODOLOGY KEY

THIS SURVEY HAS BEEN CARRIED OUT IN ACCORDANCE WITH THE PAS128 SPECIFICATION FOR UNDERGROUND UTILITY DETECTION, VERIFICATION & LOCATION. THE SPECIFICATION ALLOWS FOR A RANGE OF TECHNIQUES AND METHODS OF VARYING INTENSITY TO BE DEPLOYED. THE COLOUR CODED SCHEME INDICATES WHERE DIFFERENT SURVEY METHODOLOGIES HAVE BEEN USED ON SITE, AND THE LIST BELOW IDENTIFIES EQUIPMENT USED TO OBTAIN THE SURVEY RESULTS.
NB: PLEASE SEE ACCOMPANYING REPORT FOR FULL DETAILS.

ELECTROMAGNETIC DETECTION	GROUND PENETRATING RADAR	TOTAL STATION	GPS/GNSS
	IDS Opera Dual Antenna	S9 Trimble Robotic	Trimble R10

- M4P - EML SEARCH TRANSECT AT 2m INTERVALS - TRACED AT 0.5m INTERVALS. GPR SURVEY GRID AT 0.5m INTERVALS OR HIGH DENSITY ARRAY. POST PROCESSING OF GPR DATA.
- M3P - EML SEARCH TRANSECT AT 2m INTERVALS - TRACED AT 1m INTERVALS. GPR SURVEY GRID AT 1m INTERVALS OR HIGH DENSITY ARRAY. POST PROCESSING OF GPR DATA.
- M2P - EML SEARCH TRANSECT AT 5m INTERVALS - TRACED AT 2m INTERVALS. GPR SURVEY GRID AT 2m INTERVALS OR HIGH DENSITY ARRAY. POST PROCESSING OF GPR DATA.
- M1P - EML SEARCH TRANSECT AT 10m INTERVALS - TRACED AT 5m INTERVALS. GPR SURVEY AS APPROPRIATE. POST PROCESSING OF GPR DATA.
- M4 - EML SEARCH TRANSECT AT 2m INTERVALS - TRACED AT 0.5m INTERVALS. GPR SURVEY GRID AT 0.5m INTERVALS. GPR MARK-UP ON SITE
- M3 - EML SEARCH TRANSECT AT 2m INTERVALS - TRACED AT 1m INTERVALS. GPR SURVEY GRID AT 1m INTERVALS. GPR MARK-UP ON SITE.
- M2 - EML SEARCH TRANSECT AT 5m INTERVALS - TRACED AT 2m INTERVALS. GPR SURVEY GRID AT 2m INTERVALS. GPR MARK-UP ON SITE.
- M1 - EML SEARCH TRANSECT AT 10m INTERVALS - TRACED AT 5m INTERVALS. GPR SURVEY AS APPROPRIATE. GPR MARK-UP ON SITE

DUCT FORMATION

1W:	1 WAY SINGLE DUCT
2W:	2 WAY FLAT
2W:1/2	2 WAY: 1 WIDE, 2 DEEP
4W:2/2	4 WAY: 2 WIDE, 2 DEEP
6W:3/2	6 WAY: 3 WIDE, 2 DEEP
12W:4/3	12 WAY: 4 WIDE, 3 DEEP

NB: TO BE ADAPTED TO FOR EACH CHAMBER

Rev	Date	Description	Drn By	Ckd By
01	28-02-23	GPR Survey	SF	KOB

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Client: OCB Geotechnical Ltd.
Rev. 01
Project: Site 113 Co Monaghan
Job. No: 20695
Dwg. No: 420
Title: GPR Detection Survey
Drawn By: KL
Checked By: SF
Date: 28-02-23
Sheet: A1
Scale: 1-200
Approved By: KOB

Geodata

Chartered Land Surveyors

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