Appendix 4: Kamay Ferry Wharves, Archaeological Test Excavation Report (PACHCI Stage 3), Artefact Heritage, 2020

Kamay Ferry Wharves Project

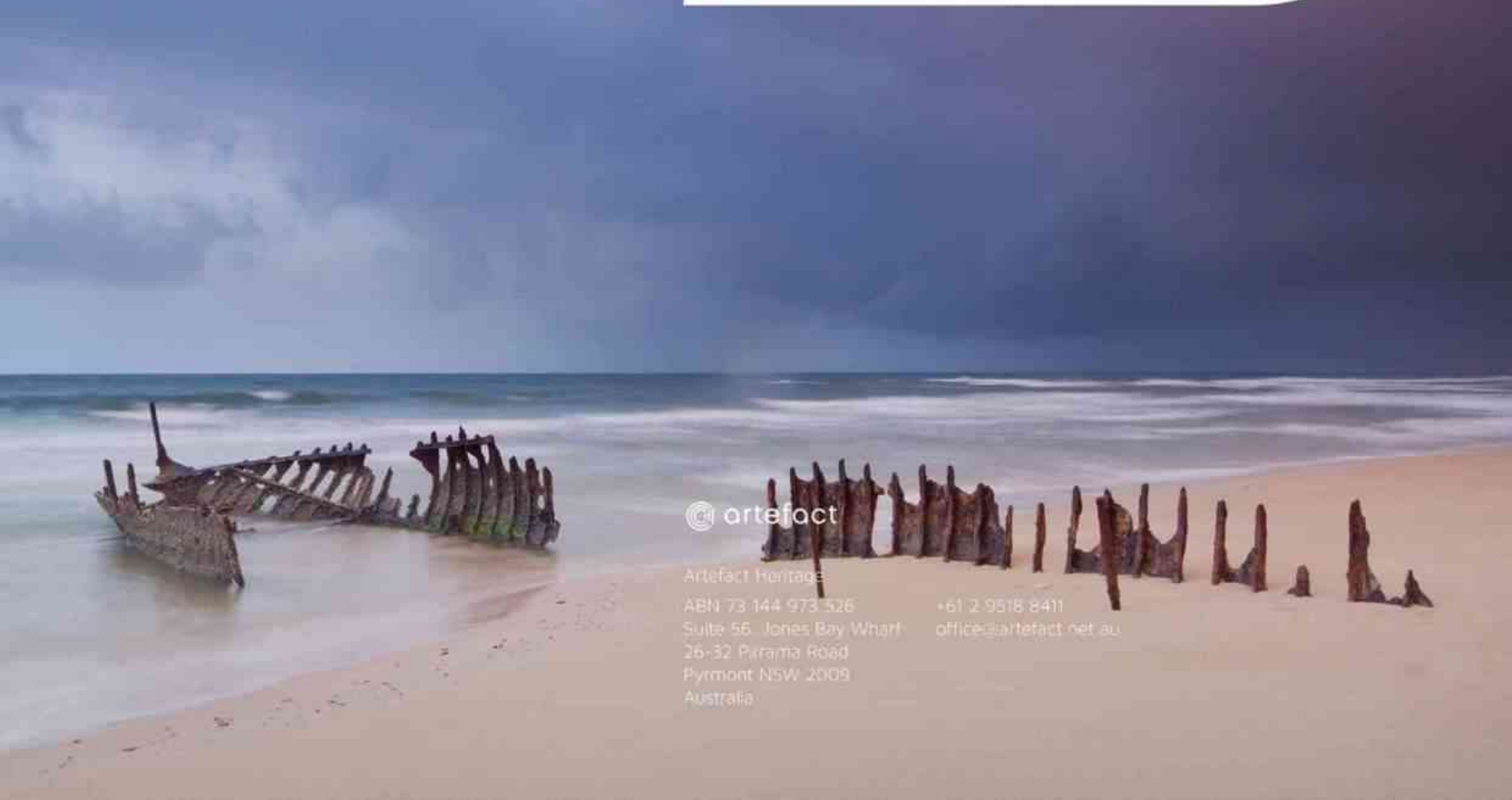
PACHCI Stage 3

Aboriginal and non-Aboriginal Archaeological Test Excavation Report

Report to Arup on behalf of Transport for NSW

Local Government Area: Sutherland Shire and City of Randwick

January 2021



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EXECUTIVE SUMMARY

Transport for NSW (TfNSW) proposes to re-establish public wharves at La Perouse and the Kurnell Peninsula for a commercial and recreational ferry service. The proposal would provide a service for commuters and tourists to the area. The associated wharf infrastructure would also provide for supplementary uses potentially including commercial vessels and recreational boating. Arup has subsequently been commissioned by TfNSW to prepare the Environmental Impact Statement (EIS) for the Kamay Ferry Wharves Project.

In April 2020, Artefact Heritage Services Pty Ltd (Artefact Heritage) completed a non-Aboriginal archaeological Preliminary Environmental Investigation (PEI) as part of the preparation of the environmental topic input for the Kamay Ferry Wharves Project. This assessment identified a number of heritage listed archaeological sites, previously identified areas of archaeological potential, and additional areas of archaeological potential within the project area. It was recommended that further investigations could be undertaken within the areas of archaeological potential to inform and support the archaeological assessment to be completed as part of the EIS.

In May 2020, Artefact Heritage completed an Aboriginal archaeological survey and heritage assessment for the Kamay Ferry Wharves Project in accordance with Stage 2 of the Procedure for Aboriginal Cultural Heritage Consultation and Investigation guidelines (PACHCI) (Roads and Maritime 2011) and the Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW (Code of Practice) (Department of Environment Climate Change and Water [DECCW] 2010a). The PACHCI Stage 2 assessment identified 11 recorded Aboriginal sites within the mapped extent of the Kamay Ferry Wharves project area.

The PACHCI Stage 2 assessment recommended that a test excavation methodology (TEM) be developed for further investigations at La Perouse Midden 19-01 (AHIMS ID Pending), Kurnell Potential Archaeological Deposit 1 (K PAD 1) (AHIMS ID 52-3-1366) and Foreshore Midden - Captain Cook's Landing Place (AHIMS ID 52-3-0219) and for test excavations to be completed under the approval of an Aboriginal Heritage Impact Permit (AHIP) or under the *Environmental Planning and Assessment Act 1979* (EPA Act) for State Significant Infrastructure (SSI).

In accordance with the recommendations of the PACHCI Stage 2 assessment and non-Aboriginal PEI, a TEM was prepared by Artefact Heritage in October 2020. A program of Aboriginal and non-Aboriginal archaeological test excavation was then undertaken at Kurnell and La Perouse between 2 November and 24 November 2020.

This Archaeological Test Excavation Report (ATER) outlines the results of the combined Aboriginal and non-Aboriginal archaeological test excavation program in accordance with Stage 3 of the PACHCI (Roads and Maritime 2011), the Code of Practice (DECCW 2010a) and the methodology outlined in the TEM.

Main findings

Aboriginal archaeological findings:

- The Kurnell testing program has satisfied the aims which were to determine if intact sub-surface Aboriginal sites would be impacted by the proposed works
- The Kurnell testing program found that the stratigraphy in the alignment of the proposed works consist of fill overlying natural strata. No shell midden material was identified during the test excavation program

- Two subsurface isolated artefacts were identified during the test excavation program at Kurnell (KMT ISO 01 [AHIMS ID 52-3-2080] and KMT ISO 02 [AHIMS ID 52-3-2081]
- KMT ISO 01 (AHIMS ID 52-3-2080) and KMT ISO 02 [AHIMS ID 52-3-2081] are assessed as having low scientific significance
- The test pit location of KU-BH01 at Kurnell, within Foreshore Midden - Captain Cook's Landing Place (AHIMS ID 52-3-0219), did not identify any significant archaeological remains
- K-PAD-1 and the Foreshore Midden PAD identified in the PACHCI Stage 2 assessment have been revised following the test excavation results
- The La Perouse test excavation program identified fill deposits comprised of contamination of demolition and introduced fill and historical construction (road) overlying natural sterile deposits. No archaeological material was identified in the completed test excavation units
- The extent of the Low Potential PAD, identified in the PACHCI Stage 2 assessment has been revised following the test excavation results
- The La Perouse testing program identified the presence of asbestos and significant non-Aboriginal archaeological remains (Wharf approach road) near the proposed wharf landing area at La Perouse, the planned test excavations in the eastern portion of the Low Potential PAD could not be completed (KU-TP05, KU-TP06, KU-TP07, KU-TP10, KU-BH01). As a result, further archaeological management would be required in the revised extent of the Low Potential PAD
- Specific management will be further detailed in the Aboriginal heritage Technical Paper for the EIS (ACHAR)

Non-Aboriginal archaeological findings:

- The Kurnell testing program has satisfied the aims which were to determine if intact sub-surface non-Aboriginal archaeological remains would be impacted by the proposed works
- Four items of local heritage significance were identified including the coursed stone sea wall (Kurnell), stone sea wall (Kurnell), Trust Wharf/ Landing place wharf abutment (Kurnell), Wharf approach road (La Perouse).

Recommendations

Recommendations for Aboriginal heritage management:

- A detailed discussion of the archaeological and heritage impacts should be included in the Aboriginal Heritage Technical Papers to be prepared as part of the EIS
- No further archaeological investigations are required in the Kurnell construction boundary except for in the Foreshore Midden - Captain Cook's Landing Place (AHIMS ID 52-3-0219) site extent
- Borehole investigations may proceed within the location of KU-BH01 at Kurnell on the condition that the borehole is confined to the location of the excavated test pit (KU-BH01). If the borehole is proposed to be relocated further archaeological management would be required
- Ongoing archaeological management in the Foreshore Midden - Captain Cook's Landing Place (AHIMS ID 52-3-0219) will be discussed in the ACHAR
- Test excavations near the proposed jetty tie-in area within the Low Potential PAD at La Perouse could not be completed due to constraints, further archaeological investigations would be required in the revised extent of the Low Potential PAD
- Borehole investigations cannot proceed within the location of KU-BH01 at La Perouse until further Aboriginal archaeological investigation has been undertaken
- Further archaeological assessment may be required where design plans are changed to impact areas beyond the extent of the current construction boundaries
- Long term arrangements for the management of excavated artefacts, should be further discussed within the ACHAR
- To keep consultation current, the registered Aboriginal parties should be sent an update on the project every six months
- The findings of this ATER are to be included into the EIS Technical Papers to facilitate compliance with the SEARs

Recommendations for non-Aboriginal heritage management:

- A detailed discussion of the archaeological and heritage impacts should be included in the Non-Aboriginal Heritage Technical Papers to be prepared as part of the EIS
- Test excavations near the proposed jetty tie-in area at La Perouse could not complete the aims of the test excavation program due to constraints, further archaeological investigations would be required in that area
- Further archaeological management and investigation will be required for the significant non-Aboriginal archaeological remains of the stone sea wall at Kurnell and the wharf approach road at La Perouse. A detailed non-Aboriginal archaeological assessment and requirements for further archaeological management and investigations, such as the preparation of a guiding Archaeological Research Design or Archaeological Work Method Statement, are to be outlined in the EIS Non-Aboriginal Heritage Technical Paper

- The detailed design for the project should take the findings of the test excavation program into consideration and redesign to avoid impacts to significant built heritage and archaeological remains where feasible. This includes:
  - Locating the utility trench at Kurnell to avoid impacting the back of the coursed stone sea wall
  - Locating the utility trench at Kurnell further to the south of the extant remains of the Trust Wharf/ Landing place wharf abutment to avoid impacting the significant structure
  - Investigate options to locate the utilities underneath the coursed stone sea wall and stone sea wall at Kurnell to avoid impacting them (depending on depth of bedrock underneath the walls). If impacts cannot be avoided then investigate options to reinstate the coursed stone sea wall and stone sea wall following the completion of the works
  - Limit the excavation depth of landscaping at La Perouse to minimise impacts to archaeological remains of the wharf approach road
- The findings of this ATER are to be included into the EIS Technical Papers to facilitate compliance with the SEARs
- No further archaeological management and investigation is required for the archaeological remains of the former Foreshore track
- The findings of this ATER are to be included into the EIS Technical Papers to facilitate compliance with the SEARs

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GLOSSARY OF TERMS

ACHAR	Aboriginal Cultural Heritage Assessment Report
AHIP	Aboriginal Heritage Impact Permit
AHIMS	Aboriginal Heritage Information Management Systems
ALR Act	*Aboriginal Land Rights Act 1983*
Artefact Heritage	Artefact Heritage Services Pty Ltd
ASR	Archaeological Survey Report
ATER	Archaeological Test Excavation Report
Code of Practice	Code of Practice for Archaeological investigation of Aboriginal Objects in New South Wales
Consultation Requirements	Aboriginal cultural heritage consultation requirements for proponents 2010
DECCW	Former NSW Department of Environment, Climate Change and Water (now DPIE – Heritage)
DPIE – Heritage	Department of Planning, Industry and Environment – Heritage
EP&A Act	*Environmental Planning and Assessment Act 1979*
gm	grams
Guide	Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW
km	kilometre
LALC	Local Aboriginal Land Council
LEP	Local Environmental Plan
LGA	Local Government Area
m	metre
mm	millimetres
NPW Act	*National Parks and Wildlife Act 1974*
OEH	Office of Environment and Heritage (now DPIE – Heritage)
PAD	Potential Archaeological Deposit
RAP	Registered Aboriginal Party

1.0 INTRODUCTION

1.1 Project background

Transport for NSW (TfNSW) proposes to re-establish public wharves at La Perouse and the Kurnell Peninsula for commercial and recreational ferry service. The proposal would provide a service for commuters and tourists to the area. The associated wharf infrastructure would also provide for supplementary uses potentially including commercial vessels and recreational boating. Arup has subsequently been commissioned by TfNSW to prepare the Environmental Impact Statement (EIS) for the Kamay Ferry Wharves Project.

In April 2020, Artefact Heritage Services Pty Ltd (Artefact Heritage) completed a non-Aboriginal archaeological Preliminary Environmental Investigation (PEI) as part of the preparation of the environmental topic input for the Kamay Ferry Wharves Project. This assessment identified a number of heritage listed archaeological sites, previously identified areas of archaeological potential, and additional areas of archaeological potential within the project area. It was recommended that further investigations could be undertaken within the areas of archaeological potential to inform and support the archaeological assessment to be completed as part of the EIS.

In May 2020, Artefact Heritage completed an Aboriginal archaeological survey and heritage assessment for the Kamay Ferry Wharves Project in accordance with Stage 2 of the Procedure for Aboriginal Cultural Heritage Consultation and Investigation guidelines (PACHCI) (Roads and Maritime 2011) and the Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW (Code of Practice) (Department of Environment Climate Change and Water [DECCW] 2010a). The PACHCI Stage 2 assessment identified 11 recorded Aboriginal sites within the mapped extent of the Kamay Ferry Wharves project area:

- Site 1, La Perouse (Aboriginal Heritage Information Management Systems [AHIMS] ID 45-6-0648)
- Site 2, La Perouse (AHIMS ID 45-6-0649)
- Site 3, La Perouse (AHIMS ID 45-6-0650)
- Site 4, La Perouse (AHIMS ID 45-6-0651)
- Site 5, La Perouse (AHIMS ID 45-6-0652)
- Site 6, La Perouse (AHIMS ID 45-6-0653)
- La Perouse (AHIMS ID 45-6-1144)
- La Perouse (AHIMS ID 45-6-1403)
- La Perouse Midden 19-01 (AHIMS ID Pending)
- Foreshore Midden - Captain Cook's Landing Place (AHIMS ID 52-3-0219)
- Kurnell Potential Archaeological Deposit 1 (K PAD 1) (AHIMS ID 52-3-1366).

The PACHCI Stage 2 assessment recommended that a test excavation methodology (TEM) be developed for further investigations at La Perouse Midden 19-01 (AHIMS ID Pending), Kurnell Potential Archaeological Deposit 1 (K PAD 1) (AHIMS ID 52-3-1366) and Foreshore Midden - Captain Cook's Landing Place (AHIMS ID 52-3-0219) and for test excavations to be completed under the approval of an Aboriginal Heritage Impact Permit (AHIP) or under the *Environmental Planning and Assessment Act 1979* (EPA Act) for State Significant Infrastructure (SSI).

In accordance with the recommendations of the PACHCI Stage 2 assessment and non-Aboriginal PEI, a TEM was prepared by Artefact Heritage in October 2020. A program of Aboriginal and non-

Aboriginal archaeological test excavation was then undertaken at Kurnell and La Perouse between 2 November and 24 November 2020.

On 1 July 2020 the Kamay Ferry Wharves Project was declared SSI and will be assessed under the EP&A Act. Under Section 5.23 of the EPA Act, approvals for the test excavation program under the *National Parks and Wildlife Act 1974* (NPW Act) and the *Heritage Act 1977* were not required. The Planning Secretary's Environmental Assessment Requirements (SEARs) application no. SSI-10049 have been issued for the project. The Aboriginal and non-Aboriginal test excavations were conducted under the project SEARs and Section 5.23 of the EPA Act.

This Archaeological Test Excavation Report (ATER) outlines the results of the combined Aboriginal and non-Aboriginal archaeological test excavation program in accordance with Stage 3 of the PACHCI (Roads and Maritime 2011), the Code of Practice (DECCW 2010a) and the methodology outlined in the TEM.

1.2 Project area

The project area is located in Kamay Botany Bay at either side of the South Pacific Ocean entrance to the Bay and is comprised of two locations: the La Perouse construction boundary and the Kurnell construction boundary (Figure 1). The La Perouse construction boundary is located approximately 14 km south of the Sydney CBD and the Kurnell construction boundary is located approximately 16 km south of the Sydney CBD. Test excavations were undertaken at both La Perouse and Kurnell portions construction boundaries.

The La Perouse construction boundary is located on the La Perouse headland, which is located next to a residential area and commercial area of Port Botany. Within the headland, La Perouse includes a museum and access to La Perouse park and beaches. The New South Wales Golf Club is located approximately 900 m east. The La Perouse headland is located within the City of Randwick Local Government Area (LGA).

The Kurnell construction boundary is located along the north-west side of the Kamay Botany Bay National Park and to the east of Silver Beach. It includes the area along the north side of Captain Cook Drive next to a residential area and follows Monument Track along the foreshore to the extant wharf about 60 m north-east of Captain Cook's Landing Place. The Kurnell construction boundary is located within the Sutherland Shire LGA.

The project area falls within the boundaries of the La Perouse Local Aboriginal Land Council (La Perouse LALC).

1.3 Proposal overview

Key features of the project include:

- Two new wharves, one at La Perouse and one at Kurnell that would include:
  - Berth for ferries (to accommodate vessels up to 40m long)
  - Berth for recreational and commercial vessels (to accommodate vessels up to 20m long).
  - Sheltered waiting areas and associated furniture
  - Additional space within waiting areas to accommodate other users such as fishing and those using recreational vessels
  - Signage and lighting
- Landside paving, access ramps, seating and landscaping at the entrance to the wharves

- Reconfiguration of existing car parking areas at La Perouse and Kurnell to increase the number of spaces (including provision of accessible parking and kiss-and-ride bays)
- Reconfiguration of footpaths around the new car parking areas
- Provision for bike racks at La Perouse
- Installation of utilities to service the wharves.
- The total construction period is anticipated to take up to 13 months, starting in early 2022. The construction of the two wharves will occur at the same time with landside and waterside works occurring simultaneously.

1.4 Project framework

The SEARs relevant to Aboriginal cultural heritage and non-Aboriginal archaeology for the project where they are addressed in this report are summarised in Table 1 and Table 2. The information contained in this TER will be used to inform the EIS Aboriginal and non-Aboriginal Heritage Technical Papers.

Table 1: Relevant Aboriginal SEARs

Requirements	Where discussed in this report
1. Aboriginal Heritage	
1. Direct and/or indirect impacts (including cumulative impacts) to the significance of: (a) Aboriginal places, objects and cultural heritage values, as defined under the National Parks and Wildlife Act 1974 and in accordance with the principles and methods of assessment identified in the current guidelines; (b) Aboriginal places of heritage significance, as defined in the Standard Instrument – Principal Local Environmental Plan; and (c) potential for unknown Aboriginal cultural heritage in the form of submerged terrestrial sites.	1 (a) & 1 (b): Section 0 outlines the results of background research to identify any previously identified areas of archaeological potential and Aboriginal sites within the project area. Section 8.0 provides an analysis of the archaeological results Section 9.0 provides a significance assessment of the archaeological remains identified during the testing program Section 10.0 provides a revision of previously identified Aboriginal sites and an impact assessment of new sites identified during the testing program Section 12.0 states that an assessment of direct and indirect impacts will be completed in an ACHAR. 1 (c): The potential for submerged terrestrial sites is not discussed as part of the scope of this report
2. Where archaeological investigations of Aboriginal objects are proposed these must be conducted by a suitably qualified archaeologist, in accordance with section 1.6 of the Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW (DECCW 2010).	Section 6.2 provides the details of the team that undertook the archaeological investigations
3. Where impacts to Aboriginal objects and/or places are proposed, consultation must be undertaken with Aboriginal people in accordance with the current guidelines and an Aboriginal Cultural Heritage Assessment Report (ACHAR).	Section 3.0 outlines the consultation with RAPs undertaken during the preparation of the TEM. Section 3.0 states that further details of the consultation of results of the test excavation program will be included in an ACHAR.

Table 2: Non-Aboriginal SEARs relevant to this assessment

Requirements	Where addressed in this report
7. Non-Aboriginal Heritage	
1. Direct and/or indirect impacts to the significance of: (a) environmental heritage, as defined under the *Heritage Act 1977*; (b) items listed on the State, National and World Heritage lists; and (c) heritage items and conservation areas identified in environmental planning instruments applicable to the project area.	1 (a): This ATER does not provide an assessment of impacts to environmental heritage. 1 (b): Section 2.1.1 identifies the heritage items listed on the National Heritage List (NHL) that would be impacted by the project. 1 (c): Section 10.2 identifies impacts to identified archaeological remains and LEP listed archaeological sites that will be detailed in the EIS Technical Paper. Section 12.0 states that an assessment of archaeological impacts will be detailed in the EIS Technical Paper.
.2. Where impacts to National, State or locally significant heritage is identified, the assessment must: (a) include a significance assessment, a statement of heritage impact, and an historical archaeological assessment; (b) assess the consistency of the project against conservation policies of any relevant conservation management plan; (c) consider impacts caused by, but not limited to, vibration, demolition, archaeological disturbance, altered historical arrangements and access, visual amenity, landscape and vistas, curtilage, subsidence and architectural noise treatment, drainage infrastructure, contamination remediation and site compounds (as relevant); and (d) be undertaken by a suitably qualified heritage consultant(s) and/or historical archaeologist (note: where archaeological excavations are proposed the relevant consultant must meet the NSW Heritage Council's Excavation Director criteria).	2 (a): Section 0 outlines the previously identified archaeological sites/elements identified in the La Perouse CMP and the associated level of significance Section 7.0 outlines the archaeological results of the test excavation program Section 9.0 outlines the significance of the identified archaeological remains 2 (b): Section 9.2.1 references relevant conservation policies in discussion of the significance of archaeological remains identified during the archaeological testing program 2 (c): Section 10.1 and 10.2 identify the proposed works which could result in impacts to archaeological remains 2 (d): Section 6.2 provides the details of the team that undertook the archaeological investigations

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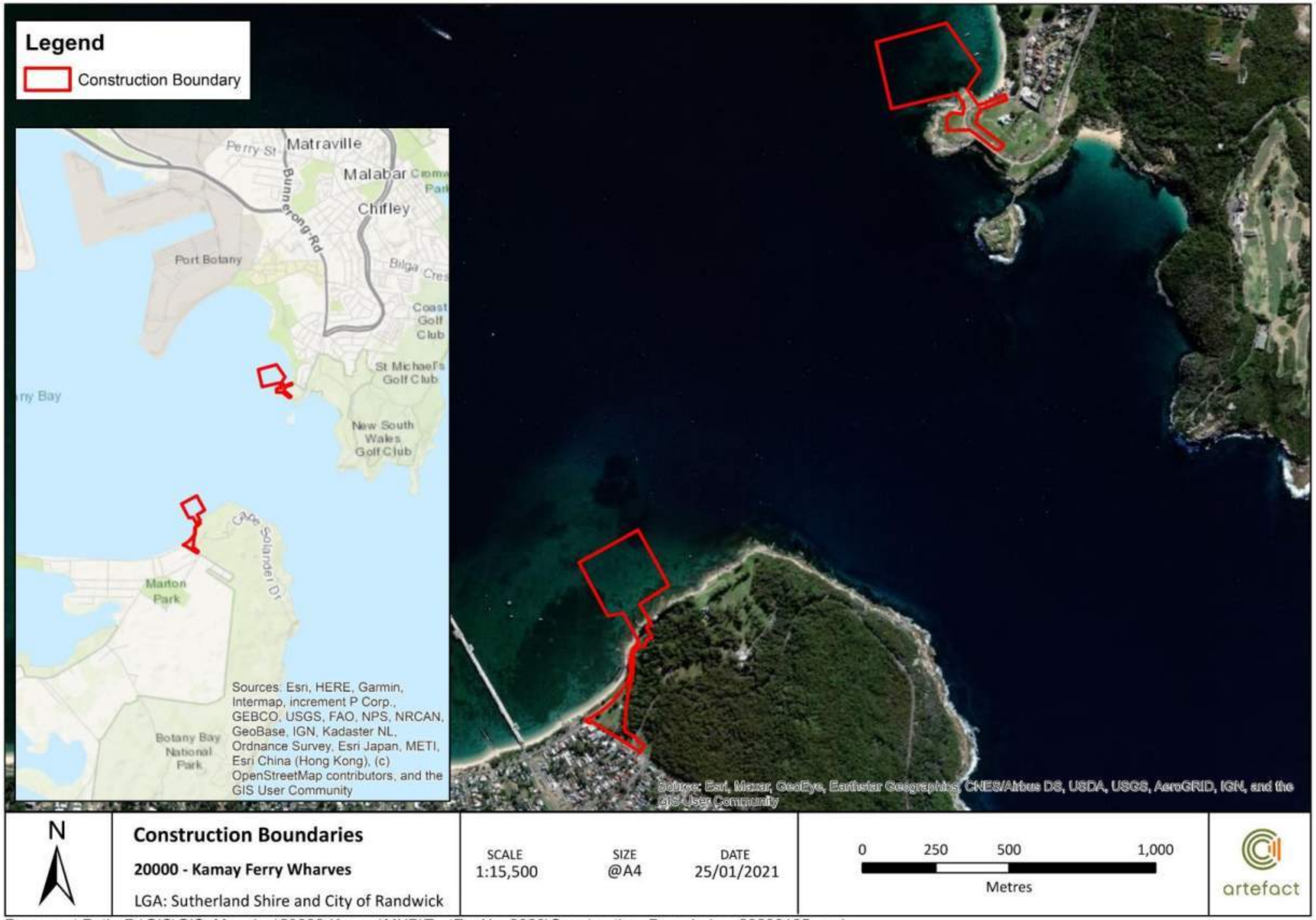

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Figure 1: Construction Boundaries

1.5 Study objectives

The scope of this project was to undertake an Aboriginal archaeological test excavation in conjunction with non-Aboriginal archaeological investigations to locate and identify subsurface Aboriginal and non-Aboriginal archaeological remains and provide recommendations for further reporting, consultation, approvals and mitigation measures that may be required. This ATER provides the combined results of the Aboriginal and non-Aboriginal archaeological investigations and has been prepared in accordance with the Code of Practice.

The objectives of this ATER are to:

- To satisfy Transport for NSW requirements for community consultation and Aboriginal heritage assessment in accordance with PACHCI Stage 3
- Assess the Aboriginal cultural heritage values of the project area in accordance with the Code of Practice
- Provide the Aboriginal and non-Aboriginal results of the testing program
- Identify Aboriginal archaeological and cultural heritage values that may be impacted by the proposed works
- Identify non-Aboriginal archaeological remains that may be impacted by the proposed works
- Identify any further investigations, mitigation and management measures that may be required, should the project proceed.

This report includes:

- A description of the project and the extent of the project area
- A historical cultural heritage assessment of the project area
- An archaeological significance assessment of the project area
- A description of the statutory requirements for the protection of Aboriginal heritage
- An impact assessment for recorded Aboriginal sites and areas of archaeological potential
- Provision of measures to avoid, minimise, and if necessary, offset the predicted impacts on Aboriginal heritage values and non-Aboriginal archaeological remains.

1.6 Report authorship and acknowledgements

This report was prepared by Brye Marshall (Heritage Consultant, Artefact Heritage), Isabel Wheeler (Heritage Consultant), Julia McLachlan (Senior Heritage Consultant, Artefact Heritage) and Jayden van Beek (Senior Heritage Consultant, Artefact Heritage). Management input and review was provided by Josh Symons (Principal, Artefact Heritage) and Jenny Winnett (Principal, Artefact Heritage).

Artefact analysis was conducted by Julia McLachlan (Senior Heritage Consultant, Artefact Heritage) and shell midden analysis was conducted by Michael Lever (Senior Heritage Consultant, Artefact Heritage). Ground penetrating radar surveys (GPR) were undertaken by Dr Sam Player (Geomorphologist, Geoprospection) and advice on skeletal remains was provided by Dr Denise Donlon (Forensic Anthropologist, Shellshear Museum, University of Sydney).

1.7 Consultation

Consultation was conducted in accordance with the Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010 (Consultation Requirements) (DECCW 2010b). Consultation for this project was conducted by TfNSW and resulted in 14 registrations of interest from Aboriginal persons or organisations. Section 3.0 provides a list of those Registered Aboriginal Parties (RAPs) that have been involved in the project and provides additional information detailing the consultation undertaken.

Artefact Heritage would like to acknowledge the support, advice and assistance of Aboriginal representative bodies and individuals before and during excavations undertaken.

2.0 LEGISLATIVE AND POLICY CONTEXT

2.1 Commonwealth heritage legislation

2.1.1 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) includes 'national heritage' as a matter of National Environmental Significance and protects listed places to the fullest extent under the Constitution. It also establishes the National Heritage List (NHL) and the Commonwealth Heritage List (CHL).

The PEI identified that the Kamay Ferry Wharves Project area is located within the NHL curtilages of:

- Kamay Botany Bay –botanical collection sites (NHL 106162)
- Kurnell Peninsula Headland (NHL 105812).

A preliminary heritage impact assessment was prepared by Artefact Heritage in May 2020 to provide input into a referral under the EPBC Act. The preliminary heritage impact assessment found that the Kamay Ferry Wharves Project may result in significant impacts to the National heritage values, setting, or fabric of the Kurnell Peninsula Headland NHL items, primarily through potential impacts to archaeological resources.

In accordance with this input into the EPBC referral was prepared by Artefact Heritage prior to the preparation of this report, with the referral being placed on public exhibition 10 December 2020 (EPBC no. 2020/8825). This input by Artefact Heritage was comprised of a preliminary heritage impact assessment to identify whether the proposed action was likely to result in a significant impact on the National Heritage values of the two items listed on the NHL.

The conclusion of that assessment was that:

- The proposed action is expected to result in a significant impact to the National heritage values, setting, and/or fabric of the Kurnell Peninsula Headland NHL items. The proposed action may result in impacts to archaeological resources
- Due to potential impacts to physical evidence of Aboriginal occupation and biodiversity, the proposed action may be considered to be a 'controlled action' under the EPBC Act with respect to potential heritage impacts
- Further detailed assessment of Aboriginal and non-Aboriginal heritage values will take place throughout preparation of the EIS.

The report also contained a list of potential mitigation recommendations for the work. This report represents further assessment into impacts on non-Aboriginal heritage values and the ways that impacts to these values can be managed and mitigated.

2.2 State legislation

2.2.1 National Parks and Wildlife Act (1974) (NPW Act)

The *National Parks and Wildlife Act 1974* (NPW Act) provides statutory protection to all Aboriginal places and objects. An Aboriginal object is defined under Section 5 of the NPW Act as:

> *any deposit, object or material evidence (not being a handicraft made for sale) relating to the Aboriginal habitation of the area that comprises New South Wales, being habitation before or concurrent with (or both) the occupation of that area by persons of non-Aboriginal extraction and includes Aboriginal remains.*

The protection provided to Aboriginal objects applies irrespective of the level of their significance or issues of land tenure. However, areas are only gazetted as Aboriginal places if the Minister is satisfied that sufficient evidence exists to demonstrate that the location was and/or is of special significance to Aboriginal culture.

A section 90 permit is the only AHIP available under the NPW Act and is granted by Heritage NSW, Department of Premier and Cabinet (Heritage NSW). Various factors are considered by Heritage NSW in the AHIP application process, such as site significance, Aboriginal consultation requirements, Ecological Sustainable Development (ESD) principles, project justification and consideration of alternatives. The penalties and fines for damaging or defacing an Aboriginal object were increased in 2010.

As this project is being assessed under Part 5 Division 5.2 of the EP&A Act 1979, section 5.23 identifies that permits issued under the NPW Act are not required for impacts approved by Heritage NSW (see Section 2.2.3).

2.2.2 Heritage Act 1977

The NSW Heritage Act provides protection for items of 'environmental heritage' in NSW. 'Environmental heritage' includes places, buildings, works, relics, movable objects or precincts considered significant based on historical, scientific, cultural, social, archaeological, architectural, natural or aesthetic values. Items considered to be significant to the State are listed on the State Heritage Register (SHR) and cannot be demolished, altered, moved or damaged, or their significance altered without approval from the Heritage Council of NSW.

The Heritage Act also provides protection for 'relics', which includes archaeological material or deposits. Excavation permits are issued by the Heritage Council of NSW, or its Delegate, under section 140 of the Heritage Act for relics not within SHR curtilages, or under section 60 for significant archaeology within SHR curtilage. An application for an excavation permit must be supported by an Archaeological Research Design (ARD) and Archaeological Assessment prepared in accordance with the NSW Heritage, DPC archaeological guidelines. Minor works that will have a minimal impact on archaeological relics may be granted an exception under section 139 (4) or an exemption under section 57 (2) of the Heritage Act.

2.2.3 Environmental Planning & Assessment Act (1979)

Division 5.2 of the EP&A Act specifies that any State environmental policy may declare any development to be SSI as can the Minister, by a Ministerial planning order.

Under Section 5.23 the following authorizations are not required for SSI that is authorized by a development consent granted after the commencement of this Division (and accordingly the provisions of any Act that prohibit an activity without such an authority do not apply):

> *1c) an approval under Part 4, or an excavation permit under section 139, of the Heritage Act 1977*
>
> *1d) an Aboriginal heritage impact permit under section 90 of the National Parks and Wildlife Act 1974*
>
> *2) Division 8 of Part 6 of the Heritage Act 1977 does not apply to prevent or interfere with the carrying out of State significant development that is authorized by a development consent granted after the commencement of this Division.*

Under Part 5, Division 5.1 (environmental impact assessment) the determining authority cannot carry out an activity or grant approval for an activity that is likely to significantly affect the environment unless an EIS is prepared.

TfNSW has advised that Section 5.23 of the EPA Act applies to archaeological test excavation under the SEARs phase of the SSI assessment process, meaning that approvals under the NPW Act 1974 and Heritage Act 1977 are not required.

3.0 CONSULTATION

Representatives of the La Perouse Local Aboriginal Land Council (LALC) participated in the archaeological survey conducted on 30 and 31 January 2020 and were given the opportunity to provide input on cultural significance of the project area in accordance with PACHCI Stage 2.

As the survey identified there was a potential for impacts on Aboriginal heritage, TfNSW commenced consultation requirements in accordance with PACHCI Stage 3 and the 'Aboriginal cultural heritage consultation requirements for proponents 2010' (the Consultation Requirements) [Department of Environment, Climate Change and Water – now Heritage NSW].

Records of the consultation process supplied by TfNSW will be included in the EIS Aboriginal Heritage Technical Paper.

PACHCI Stage 3 – Action 1 – TfNSW contacted relevant organisations on 27 May 2020 requesting the details of Aboriginal people who may hold cultural knowledge relevant to determining the Aboriginal significance of Aboriginal objects and/or places within the project site. The following organisations were contacted:

- La Perouse LALC
- NSW Aboriginal Land Council
- Heritage NSW
- Native Title Services Corporation
- National Native Title Tribunal
- Greater Sydney Local Land Services
- Office of the Registrar Aboriginal Lands Right Act 1983
- Sutherland Shire Council
- Randwick City Council.

PACHCI Stage 3 – Action 2 – letters were sent by TfNSW on 9 August 2020 to all parties identified during PACHCI Stage 3 Action 1.

PACHCI Stage 3 – Action 3 – newspaper advertisements were placed by TfNSW inviting participation of Aboriginal people who may hold cultural knowledge relevant to determining the Aboriginal significance of Aboriginal objects and places within the local area. The newspapers and dates in which the advertisements were placed are as follows:

- Koori Mail (3 June 2020)
- St George and Sutherland Shire Leader (3 June 2020)
- National Indigenous Times (3 June 2020).

PACHCI Stage 3 – Action 5 – following consultation and newspaper advertisements, five individuals and nine groups registered their interest. TfNSW then prepared a register of Aboriginal parties (Table 3) and responded to their registration.

Table 3: RAPs for the project site

Contact name	Group represented
	Individual
s	Gweagal – Bidjigal Sovereign Tribal Elders Council
	Individual
	Individual
	Wailwan Aboriginal group
	Wurrumay
	Kamilaroi Yankuntjatjara Working Group
	Individual
	Didge Ngunawal Clan
	Sutherland Shire Council Aboriginal Advisory Sub-Committee
	Gujaga Foundation
	Yurrandaali Pty Ltd
	Barraby Cultural Services
	Individual

PACHCI Stage 3 – Action 6 – An invitation to attend an Aboriginal Focus Group (AFG) meeting on the 31 August 2020 was sent on 20 August 2020. On 26 August 2020 a copy of the TEM was send to all RAPs requesting comment to be submitted by 23 September 2020. At the end of the review period, ɔrovided comment on the draft TEM. See Table 4, below for summary of comments and responses.

Table 4: Summary of comments and responses

Comment	Response
There is no commercial area on La Perouse side, apart from some cafes	The cafes are what the methodology is referring to.
There is no La Perouse Park at La Perouse	The grassed area encompassed by Anzac Parade is known as the La Perouse Park (https://www.nationalparks.nsw.gov.au/visit-a-park/parks/la-perouse-area/visitor-info).
I'm not sure this is entirely correct – would it be the "Southern side of the bay"	This is referring to the location within the Kamay Botany Bay National Park, specifically, which is on the southern side of the Bay.

Comment	Response
Local Aboriginal people should be given the opportunity to be consulted with before going to the wider Sydney/ NSW groups that don't live or are affiliated with the areas	As per the Consultation Requirements, TfNSW will consult with all RAPs.
Who will monitor the recreational boats utilising the wharves, La Perouse has many boats that beach on Frenchmans for people visiting and purchasing food from the outlets – this will cause congestion for any ferry usage. Does this mean the residents will hear the boat horn all the time.	This comment is not relevant to the methodology. TfNSW will respond.
This should be more specific – stating there is 1 wharf at La Perouse consisting of xxxxx and 1 at Kurnell consisting of xxxx – I read this thinking there are now going to be 2 wharves at each location	Updated to 'A wharf at La Perouse and a wharf at Kurnell'.
Will this cause noise banging wharves together – the residents already have enough noise to contend with and don't need more added to it	This comment is not relevant to the methodology. TfNSW will respond.
How big will this structure be – will it take away from the beauty and open space by closing it off and putting a shelter	This comment is not relevant to the methodology. TfNSW will respond.
Does this mean more buildings obstructing views from the surrounding area. Museum, museum grounds.	This comment is not relevant to the methodology. TfNSW will respond.
What times will wharves be locked up and by whom.	This comment is not relevant to the methodology. TfNSW will respond.
Does this include the reestablishment or beautification of Timbery Reserve	This comment is not relevant to the methodology. TfNSW will respond.
Is this the only plan for additional car spaces is there another phase where additional green space is taken up as per other plans for the Ferry Wharves	This comment is not relevant to the methodology. TfNSW will respond. .
Will there be RAPS on site for all Boreholes? Aboriginal and non-Aboriginal	Site officers will be present for test excavations at all borehole locations proposed. Requirements for non-Aboriginal investigations will be determined based on the results of the Aboriginal excavation program. It is anticipated that the RAPs will be on-site during the recording of any non-Aboriginal material identified during the test excavation program.
Do you have an unexpected finds protocol in place and stop works	TfNSW have the Unexpected Heritage Items Procedure which orders 'stop works' when Aboriginal cultural heritage items and/or human remains are identified during construction or investigation activities. If human remains are identified, Artefact Heritage will stop work and follow implement the appropriate steps. Further detail has been provided in section 6.6.

Comment	Response
On the La Perouse side there is a local historian who knows all non-Aboriginal heritage as well as some Aboriginal heritage who can help you with any of the impact area history – Charles Abela.	Noted, and to be determined during the completion of the non-Aboriginal heritage assessment.
Do you have a minimum number of RAP's on site?	The number of site officers will be confirmed when the methodology is finalised. The test excavation program may be shortened due to shallower test pits in some areas. Artefact has provided a recommendation for the size of the excavation team, but it is recommended that the team size is not specified in the document to limit logistical constraints.
Is this outlined and any further steps in an unexpected finds protocol? I see below you have information on human remains, the process should also be inserted here.	The Unexpected Heritage Items procedure can be provided to RAPs if requested. Artefact to comment on placement of more information here. Maybe the 3 dot points included in the Human Remains section can be added.
La Perouse has loads of heavy clay deposits	No response needed
Is this the La Perouse side of Kamay or the Kurnell, La Perouse has restrictions on heavy and long vehicles	Text has been updated to be Kurnell.
Who keeps the excavations records?	Artefact Heritage keeps the records and is available to all RAPs. Records will be collated into the final report.
Would you be putting a metal plate over any open test pits in high pedestrian traffic areas, I see this has the potential to be a safety risk due to the number of people and animals in the area	Plywood sheets may be used where required, to be determined during preparation of management plan.
Is there a time frame on this report	The report will be developed by Artefact, then reviewed by TfNSW before being finalised. The report and the ACHAR is valid until another ACHAR supersedes it with further investigations. The ACHAR would adhere to the project timeframes required by TfNSW.
Would recovered non-Aboriginal artefacts items be returned or given to the La Perouse Museum for protection	Any non-Aboriginal artefacts recovered would be of low historic and archaeological significance and unlikely to meet the requirements for accession to the La Perouse museum. TfNSW would be responsible for the long-term management of any artefacts recovered.

Comment	Response
Is there a time frame to the non-Aboriginal findings Report? If there are any findings on the La Perouse side would there be scope to provide a report to the La Perouse Museum and Historic Society	The timeframe for the non-Aboriginal report would be subject to the timing of the EIS and the nature of the results. The non-Aboriginal report would be included in the EIS submission package and enter public domain.
Will RAPs and LALC be informed of any changes to the excavation program	Yes, RAPs and LALC will be consulted.

PACHCI Stage 3 – Action 7 – An AFG was held on 31 August 2020 to present the proposal and to discuss the details of the archaeological assessment (PACHCI Stage 2 report) and the TEM. attended the AFG and indicated that they had no comment on the proposed approach.

PACHCI Stage 3 – Action 8 – A copy of the AFG PowerPoint presentation and minutes were issued to all RAPs.

PACHCI Stage 3 – Action 9 – 5 RAP groups (Including La Perouse LALC) expressed interest in participating in the test excavation program and submitted site officer applications. **Error! Not a valid bookmark self-reference.** lists the RAPs who participated in the test excavation.

Table 5: RAP groups involved in Kamay test excavation

Name	Organisation
	La Perouse LALC
	La Perouse LALC
	La Perouse LALC
	Wailwan Aboriginal group
	Yurrandaali Pty Ltd
	Barraby Cultural Services

4.0 ENVIRONMENTAL BACKGROUND

4.1 Soils and geology

The project area is located at the opening of Kamay Botany Bay to the Tasman Sea. The geology of this area consists of Triassic Hawkesbury Sandstone partially overlaid with Quaternary marine sand and sand dune formations (Herbert 1983, Stroud 1985).

During the late Pleistocene, the Kamay Botany Bay area was a swampy sand plain surrounded by higher sandstone hills. With the rise in sea levels at the end of the Pleistocene, marine sands were deposited onto the advancing shore line. These beach sands were then wind-blown onto the surrounding sandstone outcrops, forming into coastal barrier sand dunes. When the sea level stabilised during the early Holocene approximately 7,000 years ago, these barrier dunes had altered the flow of local rivers to the present courses of the Cooks and Georges Rivers (Attenbrow 2010, 39).

The Georges River rises in the Illawarra Plateau and travels 96 km before it flows into Kamay Botany Bay from the southwest. The Cooks River flows into Kamay Botany Bay from the northwest. It is partially canalled and operates as the primary stormwater runoff for residential suburbs in south Sydney. Kamay Botany Bay is a relatively shallow sand-floored inlet, with most of the bay floor being ten m or less in depth. The tidal accumulation of sand and riverine deposition of silt on the bay floor requires frequent dredging to ensure safe navigation for shipping.

The natural soil landscapes on both the Kurnell and La Perouse peninsulas are mostly associated with the marine-and wind-deposited sand at lower elevations, with sand dune formations stabilised against erosion with natural and re-planted vegetation. Marine-deposited siliceous and calcareous sands fringe the foreshore of Kamay Botany Bay . Hawkesbury Sandstone predominates on the higher elevations in the project area, with thin layers of coarse sand and loam in areas resistant to erosional effects from vegetation cover. In the south-western part of the project area, estuarine soil landscapes have accumulated from the low energy silt discharge of the George’s River on the tidal sandbanks of the southern floor of Kamay Botany Bay (AMBS 2013, 21-22 and Sheppard 2009,11-14).

These soil landscapes have been disturbed by European agricultural and industrial activities. Vegetation clearance in some parts of the project area, has exacerbated sand dune erosion. Dredging of the entrance to Kamay Botany Bay and foreshore stabilisation for navigation has altered the original shape of the headlands. Industrial facilities in the project area, have also significantly disturbed the soil profile with deep ground excavation and the introduction of modern fill.

4.2 Vegetation

The vegetation surrounding Botany Bay prior to European arrival was significantly forested. Sclerophyll vegetation such as eucalypts, angophoras and banksias were fundamental in limiting dune expansion and erosion throughout the Kurnell and Brighten-Le-Sands area. An increase in Aboriginal permanent occupation and fire-stick farming practices, facilitated the increase in salt-tolerant vegetation such as *Leptospermum laevigatum* and *Monotoca elliptica* (Benson & Eldershaw 2007).

4.3 Hydrology

The Georges River rises in the Illawarra Plateau and travels 96 km before flowing into Botany Bay from the southwest. The Cooks River flows into Botany Bay from the northwest. It is partially canalled and operates as the primary stormwater runoff for residential suburbs in south Sydney. Botany Bay is a relatively shallow drowned river valley, with most of the bay floor being ten metres or less in depth. The tidal accumulation of sand and riverine deposition of silt on the bay floor requires frequent dredging to ensure safe navigation for shipping.

Local hydrology at Kurnell includes an unnamed first order creek that originates in the slightly higher elevation sand dune terrain 600 metres to the southeast and flows into Botany Bay approximately 180 metres northeast of the extant jetty. This creek is shown on a number of maps of the area, including a 1770 map prepared by James Cook (Figure 2). This creek was mentioned in Captain Cook's Journal as a source of fresh water (Journal of HMS Endeavour 1768-1771: April 29 1770):

> *'I sent a party of men a shore in the morning to the place where we first landed to dig holes in the sand by which means and a small stream they found fresh water sufficient to water the ship'*

The current topographic maps for Kurnell do not show any watercourses within or in close proximity to the project area. Local topography indicates that an ephemeral watercourse to the east of Anzac Parade and south of Henry Head Lane drains run-off into Botany Bay. Although no watercourses are shown on the current topographic maps, James Cook map of Botany Bay from 1770 indicates the presence of two watercourses, one marked as 'fresh water', at Frenchman's Beach, north of the project area (see Figure 2).

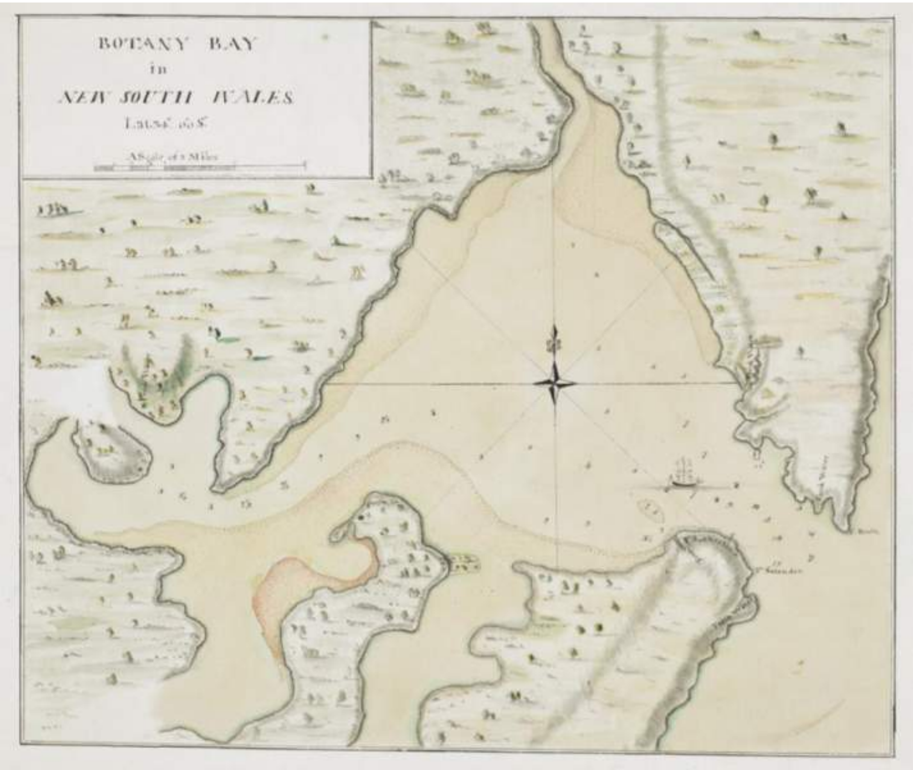

Figure 2: 1760-1780 James Cook's chartered map of Botany Bay Historical land-use

4.3.1 Early European exploration

Kamay Botany Bay was first explored by Europeans in 1770 when Lieutenant James Cook landed at Kurnell on the south side of Kamay Botany Bay with his crew in the *Endeavour* on 29 April. On the first day he made contact with the Gweagal Aboriginal community of the Dhawaral nation at a place now commemorated in Kurnell as 'Captain Cook's Landing Place' in the Kamay Botany Bay National Park. During explorations on land, Cook's crew travelled to the north side of Kamay Botany Bay and engaged in a fishing expedition at Frenchmans Bay (Cook 1770). During this expedition his crew collected wood and fresh water, gathered plant specimens, while documenting the activities of the Aboriginal people that they saw. The La Perouse headland was not explored again by Europeans for another 18 years, when Captain Arthur Phillip arrived in Kamay Botany Bay with the First Fleet, anchoring around Bare Island (Tuck 2008, 58). After the First Fleet relocated to Port Jackson and Sydney Cove, a French crew led by Jean-François de Galaup, comte de Lapérouse entered Kamay Botany Bay and anchored in Frenchmans Bay. The French, sailing on the ships *La Boussole* and *Astrolabe,* were undertaking a scientific voyage. The British, who had some ships remaining, interacted with the French and recorded that the French were 'well established' with an observatory, garden, and a stockade with two small guns for defence (Selkirk 1918, 339).

Père Receveur was a priest involved in La Perouse's expedition. He died of unknown causes at La Perouse and was subsequently buried on the headland. The burial of Père Receveur was originally informal; however, it was formalised with a memorial in 1825 by Baron de Bougainville, the leader of a later French expedition which stopped at Kamay Botany Bay (Tuck 2008, 73). In this period the headland was a significant symbolic location for French naval crews, who frequently visited La Perouse to pay their respects to La Perouse and his crew, for whom La Perouse headland was their last known location.

The grave of Receveur and the French garden and stockade were recorded by Watkin Tench to have been partially demolished, with the area reclaimed temporarily, by the local Aboriginal people (Tuck 2008, 73). The guards of the Macquarie Watchtower (see below) acted as informal guides for French visitors. While no available plans show the definitive location of the gardens, stockade, and any associated French dwellings, these features may have been located at the northwest quadrant of the headland, overlooking Frenchmans Beach and with clear views to the north and south. As much of the headland further south likely featured shallow and infertile soils, this area of the point may have been suitable for a garden.

After the British colony at Sydney Cove was established in 1788, the headlands around Kamay Botany Bay were slow to be settled by Europeans. The local environment was deemed unsuitable for settlement and in 1812 Governor Macquarie closed the northern headland for settlement and established a government reserve at Kurnell. In 1815 a grant was made to James Birnie, a ship owner and merchant, of 700 acres of land along with 160 acres of saltwater marsh, on the western side of the Kurnell peninsular. In 1821 this estate was acquired by John Connell, another early pioneer, who added it to his large land holdings in the area (Figure 3).

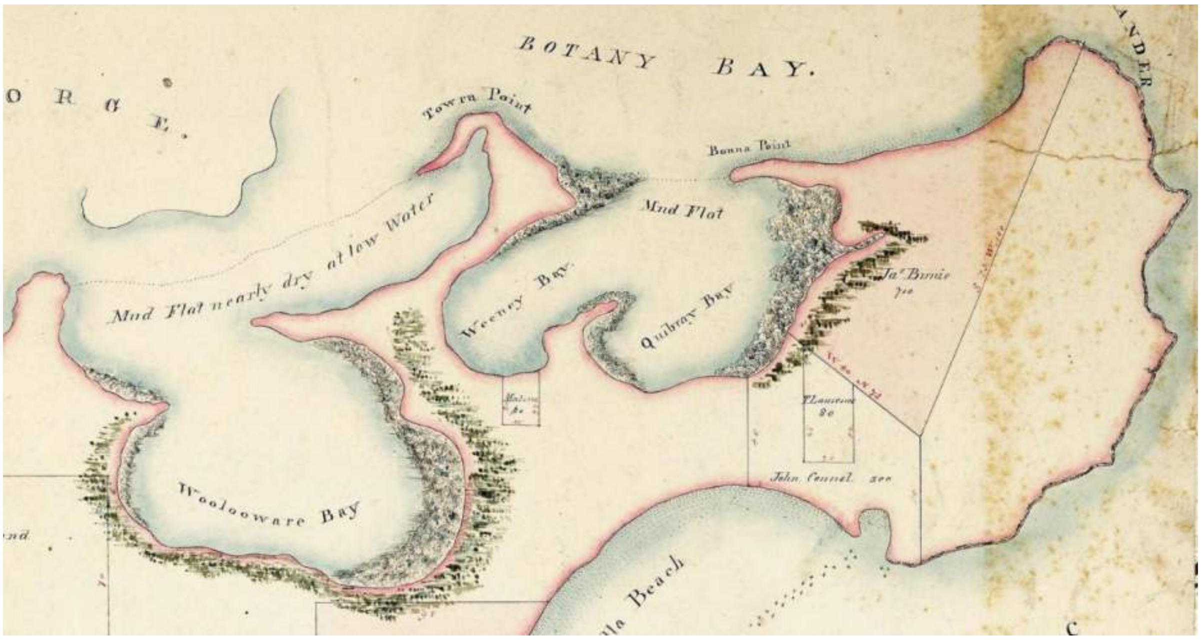

Figure 3: Sutherland parish map, 1830s, showing James Birnie's land grand. Area to the east of the Birnie land grant is a later government reserve. Source: LPI

4.3.2 Aboriginal ethnohistories

While their population had been drastically reduced from introduced diseases and violent encounters with the new settlers, numerous accounts of Aboriginal camps and communities were recorded by Europeans around Kamay Botany Bay during the nineteenth century (Nugent 2005, 55-56). Ethnographic accounts written by European explorers and settlers in the late 18th century emphasise the maritime way of life of the Aboriginal people around Kamay Botany Bay. Small groups of Aboriginal people were recorded to camp near freshwater sources, often residing in rock shelters or utilising bark huts. Bark canoes were regularly used for line fishing and spear fishing in Kamay Botany Bay. Collecting shellfish on the tidal banks of the bay was also recorded by Europeans (AMBS 2013, 25).

Aboriginal people were also recorded as burying their dead in coastal sandy environments, in middens and in rock shelters. Archaeological evidence in the project area further substantiates this practice, with a number of Aboriginal burials along the Kamay Botany Bay foreshore having been identified. One rock shelter near [redacted] on the Kurnell Peninsula has revealed up to 18 complete or partial sets of human remains, all of which have been reburied at the site at the request of the local Aboriginal community. Grave goods of stone artefacts and bone points were present in many of these burials, as well as midden deposits of discarded fish and animal bones (Irish 2007, 19).

4.3.3 The Government Reserve and military activity

During the 1820s 4175 acres of land was dedicated as a Government Reserve, including the La Perouse headland and the eastern Kurnell sandstone headland (Nugent 2005, 55-56). Shortly after, government troops were garrisoned at La Perouse to monitor activity within the Bay and the Pacific Ocean, visible between the north and south headlands. By 1822 the need for permanent troops at La Perouse was important enough to require the construction of the Macquarie Tower, which remains extant and provided a lookout, housing, and a fort for troops. A Parish Map of Botany, dated to c.1867, shows the La Perouse Monument, Père Receveur's Grave, and the Macquarie Tower and several other structures, including a fence at the end of Frenchman's Road, and potential barricades and stockyard for animals. An 1869 survey plan shows a boat house situated at the eastern end of Frenchmans Beach.

By the mid-1880s several structures were located on the headland and in the project area, including buildings associated with the Cable Station. The Cable Station was constructed in 1882 as part of the Australia to New Zealand Telegraph Cable (JSHC 2009, 17). In 1881 the Bare Island Fort was constructed, adding to the military use of the site. These structures are primarily setback from the edge of the headland, located roughly between Congwong and Frenchmen's Beaches. The existing structures are clearly labelled on an 1889 plan (Figure 4) of the area to include the La Perouse Monument, storage tanks, and several unmarked buildings, likely cottages and sheds, located on the west side of the headland. These cottages are also illustrated in watercolour paintings from the 1870s (Figure 5). Photographs from the 1880s show the northern edge of the headland adjacent to Frenchmans Beach as developed with dwellings, however the southern extent of the headland is relatively undeveloped with the exception of the La Perouse Monument (Figure 6).

By 1905 a roadway was constructed along the northwest boundary of the La Perouse headland, leading to the rocky point adjacent to Frenchmans Beach. This approach road provided access to the La Perouse wharf that was constructed in 1905. Boathouses were also located at the southern end of Frenchmans Beach and slipways were constructed off the headland into Frenchmans Bay in the late 1800s and early 1900s to enable safe launching of boats (Figure 7).

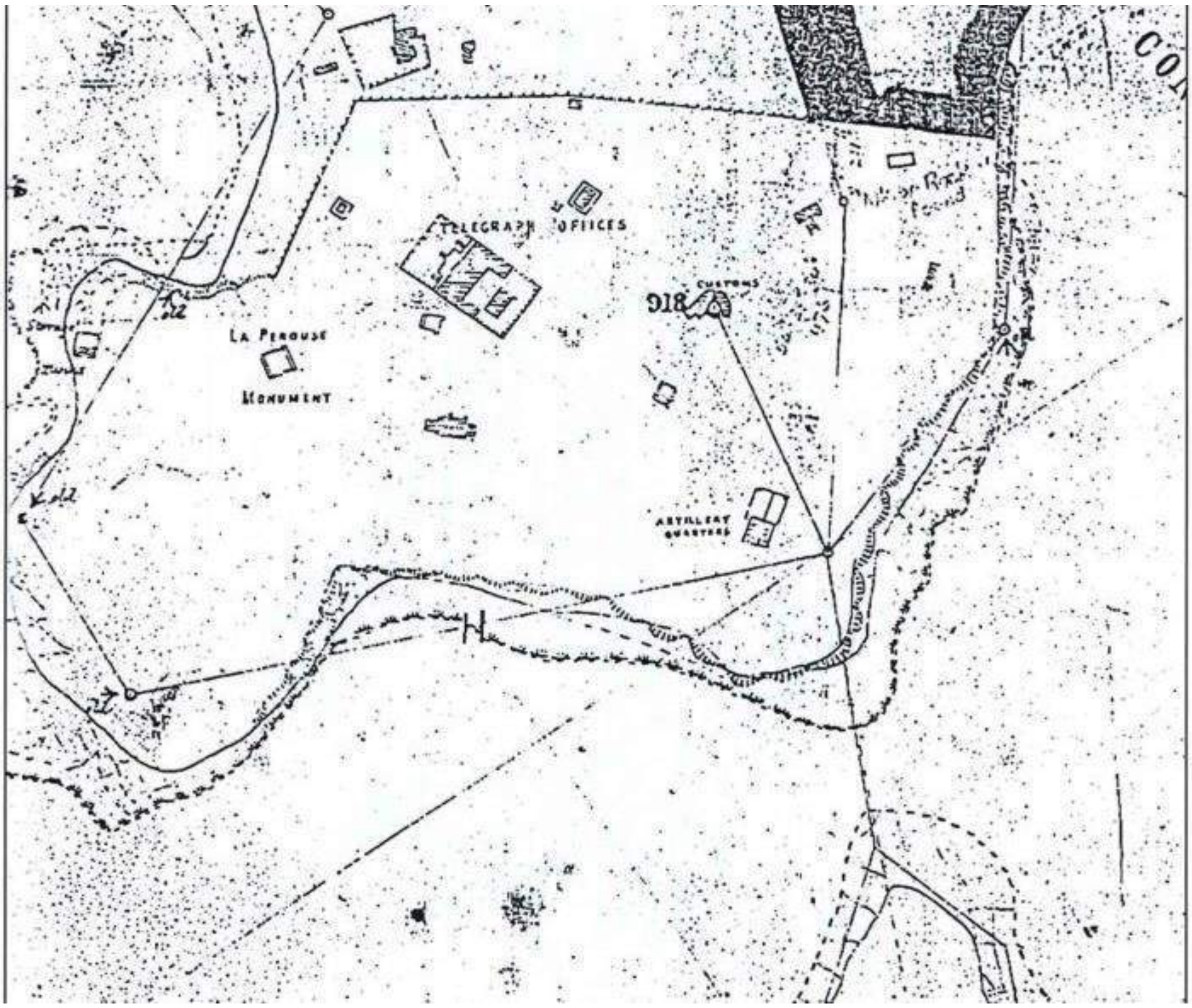

Figure 4: Deering's Plan of La Perouse headland, dated 1889. State Library of NSW, ML ML M4 811.1869/1889/1, cited in Tuck 2008

Figure 5: Thomas George Glover's La Perouse, Kamay Botany Bay, dated October 1878. Source: National Library of Australia, cited in Tuck 2008

Figure 6: Photograph of La Perouse headland from northern end of Frenchmans Beach, dated c. 1885-194. Source: State Library of NSW ML SPF, presented in Kass 1989 and cited in Tuck 2008

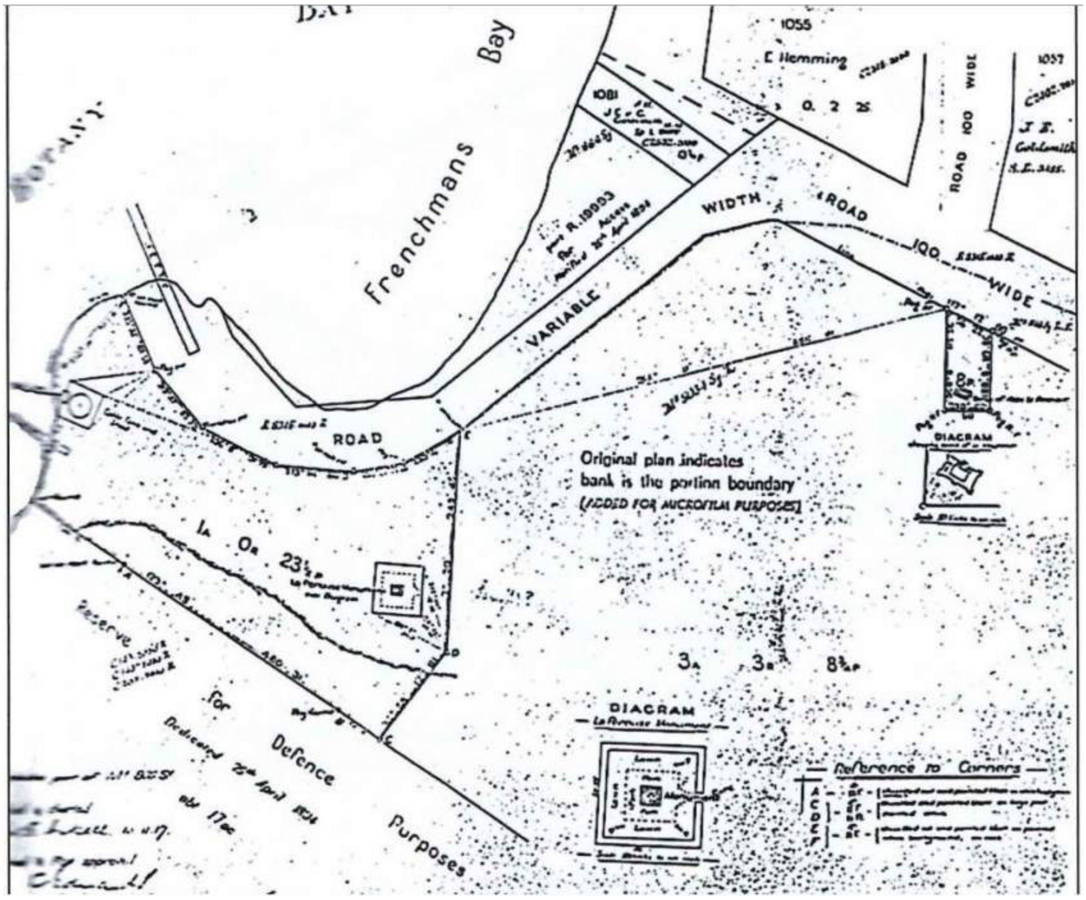

Figure 7: Structures on the west side of La Perouse headland, dated 1917. Source: NSW Department of Lands Plan Room Ms. 5034 Sy, presented in Kass 1989 and cited in Tuck 2008

4.3.4 Archaeological implications of historical activities on the Kurnell foreshore and La Perouse headland

A description of changes to the foreshore morphology at Kurnell resulting from historical activities is discussed below.

4.3.4.1 Kurnell foreshore morphology

The foreshore morphology at Kurnell has changed since the 19th century, partly as a result of the following:

- Vegetation clearance
- Construction of jetties and associated modification of the foreshore, affecting sediment movement along the foreshore
- Construction of sea walls and repairs to the sea wall over time
- Natural cycles of change to foreshore areas over time

Vegetation changes at Kurnell are directly related to vegetation clearance and pastoral activities. The vegetation within the Kurnell construction boundary at the time of Cook's landing in April 1770 would most likely have consisted of scrub along the immediate foreshore area, with coastal scrub and swamp forest across the gently undulating terrain to the south. Benson and Eldershaw (2007) have produced a map showing the likely distribution of vegetation types in 1770 overlaid onto an aerial photograph from the 21st century (Figure 8).

Figure 8: Benson and Eldershaw (2007: Figure 8b) map showing the likely extent of plant communities in 1770. The foreshore area is marked as 'foreshore scrub on sand'

The presence of grasses in the foreshore area or in swampy areas beyond the foreshore is supported by Joseph Bank's description of 'grass cutters' and 'hay cutters' being dispatched from the HMS Endeavour (Banks, April 29 1770: p. 251-252), as well as further descriptions of extensive grass areas associated with swamps in Banks' journal entry from May 4 1770 (p.252-253).

Changes to foreshore vegetation are shown in Figure 9 through Figure 14. The oldest representation of Cook's monument in this series of figures is Figure 9, which provides a representation of the foreshore area in 1875. The foreshore area is depicted with various vegetation types, including Banksia scrub, *Xanthorrhoea*, and possibly depictions of Casuarina (also described by Jospeh Banks in his journal entries) in the background.

Unless replaced by another vegetation community, removal of foreshore scrub would likely have resulted in changes to the foreshore dune and beach area due to exposure of underlying sands to wave and wind actions. Vegetation acts to help stabilise exposed marine sands.

Figure 9: Cook's monument in 1875, as drawn by William Henry Raworth. Benson and Eldershaw (2007: Figure 3) describe this as showing 'the dominance of *Banksia integrifolia* in the vegetation surrounding the moment, through when he redraws the scene in 1896, presumably after revisiting the site, the understorey is more open and grassy and the *Xanthorrhoea* has gone'

With increased visitation to Kurnell in the late 19th century and early 20th century, as well as use of the area for livestock grazing, the foreshore area was largely cleared of vegetation except for planted pines and other trees on the gently undulating terrain to the south. This reduction in vegetation is demonstrated in a sequence of photos from the late 19th to early 20th centuries, shown in Figure 10through Figure 14.

Figure 10 is a panoramic photo taken from the Trust wharf looking south towards the Kurnell construction boundary. the immediate foreshore area is exposed sandstone and marine sands, with the gently undulating terrain to the south consisting of dense grass cover with dispersed trees. Figure 10, taken in 1910, shows the cleared ground in the immediate vicinity of Cook's monument.

Figure 10: Part of a panoramic photo from the Trust period jetty (ca. 1905) showing the Kurnell construction boundary between 1890-1910. Note the sparse vegetation and grass covering a

lot of the landscape, and exposed sandstone and sand foreshore zone in front of Cook's monument (Benson and Eldershaw 2007: Figure 4a)

Figure 11: Photo of Cook's monument, taken around 1912. View west. Grass covered ground surface, small vegetation around Cook's monument, sandstone outcropping at front of Cook's monument (https://localhistory.sutherlandshire.nsw.gov.au/nodes/view/4868?keywords=kurnell&type=all&highlights=WyJrdXJuZWxsIl0=)

A sea wall was constructed by the early twentieth century, presumably to help stabilise the foreshore from erosion due both to natural processes and potentially also due to destabilisation of the foreshore area from vegetation clearance. Construction of the sea wall would have involved introduction of fill, possibly from the local area, to in-fill the area behind the sea wall. A series of photos showing the foreshore area in front of Cook's monument are included as Figure 12 through Figure 14 below.

Figure 12: Photo of Cook's monument, taken between 1900 and 1910. Photo shows sandstone in front of Cook's monument in the approximate location of the current shared path on Monument Track (https://localhistory.sutherlandshire.nsw.gov.au/nodes/view/1852?keywords=cook%20monument&highlights=WyJjb29rIiwibW9udW1lbnQiXQ==)

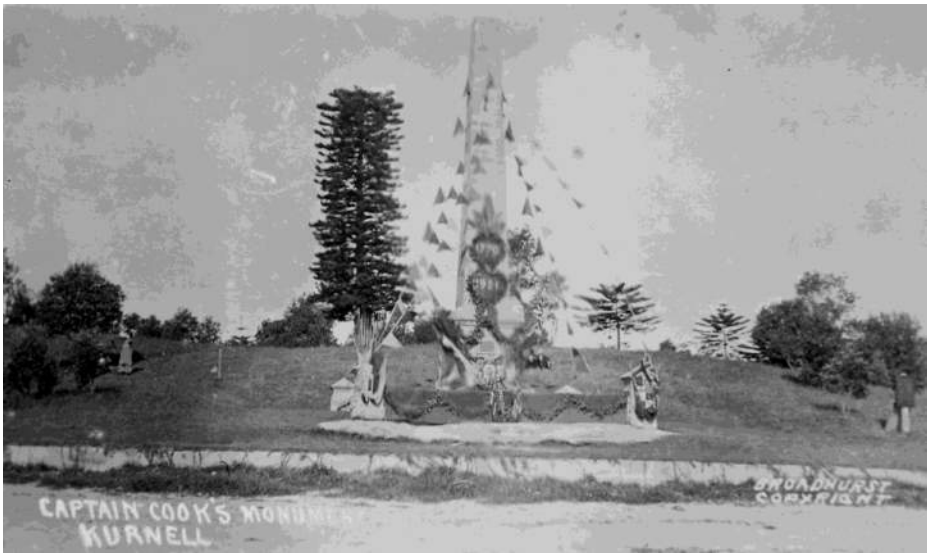

Figure 13: Photo of Cook's monument, taken in 1921. Sea wall visible, sandstone outcrop in front of Cook's monument visible (https://localhistory.sutherlandshire.nsw.gov.au/nodes/view/420?keywords=cook%20monument&highlights=WyJjb29rIiwibW9udW1lbnQiXQ==)

Figure 14: Photo of Cook's monument, taken in 1927. The sea wall is not visible in this photo (see Figure 13), likely to be covered by marine sands (https://localhistory.sutherlandshire.nsw.gov.au/nodes/view/1622?keywords=cook%20monument&highlights=WyJjb29rIiwibW9udW1lbnQiXQ==)

Construction of the coursed sea wall sea wall was associated with construction of the Trust Wharf in 1912. The Trust Wharf included construction of a large, tipped stone wall extending out into Kamay Botany Bay, from which the timber jetty extended into deeper water. Construction of the jetty and associated stone wall, as well as subsequent stabilisation works to that area, have resulted in changes to coastal morphology in this area.

A series of aerial photographs (Figure 16 through Figure 21) show the changes to the morphology of this location over the late 20th century.

An 1899 plan of the area, prepared before the Trust Jetty was constructed, shows the foreshore as broadly similar to the extant foreshore, with one exception being the area around the extant jetty landing (delineated by red arrow in Figure 15).

Figure 15: detailed plan of Kurnell foreshore produced in 1899 overlaid on current aerial photograph (1899 plan sourced from State Library of NSW: http://digital.sl.nsw.gov.au/delivery/DeliveryManagerServlet?embedded=true&toolbar=false&dps_pid=IE10406950&_ga=2.34788961.1393472140.1609196310-21586183.1581933350)

The series of aerial photographs shown in Figure 16 through Figure 21shows a build-up of sand on the northern side of the jetty landing (shown by blue arrow in Figure 16 through Figure 18), and exposed bedrock and marine sand on the southern side of the jetty landing (shown by yellow arrow in Figure 16 through Figure 21). In 1970 (Figure 19), it appears that the build-up of marine sand on the northern side of the jetty landing has been removed (shown by green arrow in Figure 19).

Marine sand has since built-up on the southern side of the jetty landing and has stabilised under grass cover (shown by orange arrow in Figure 21).

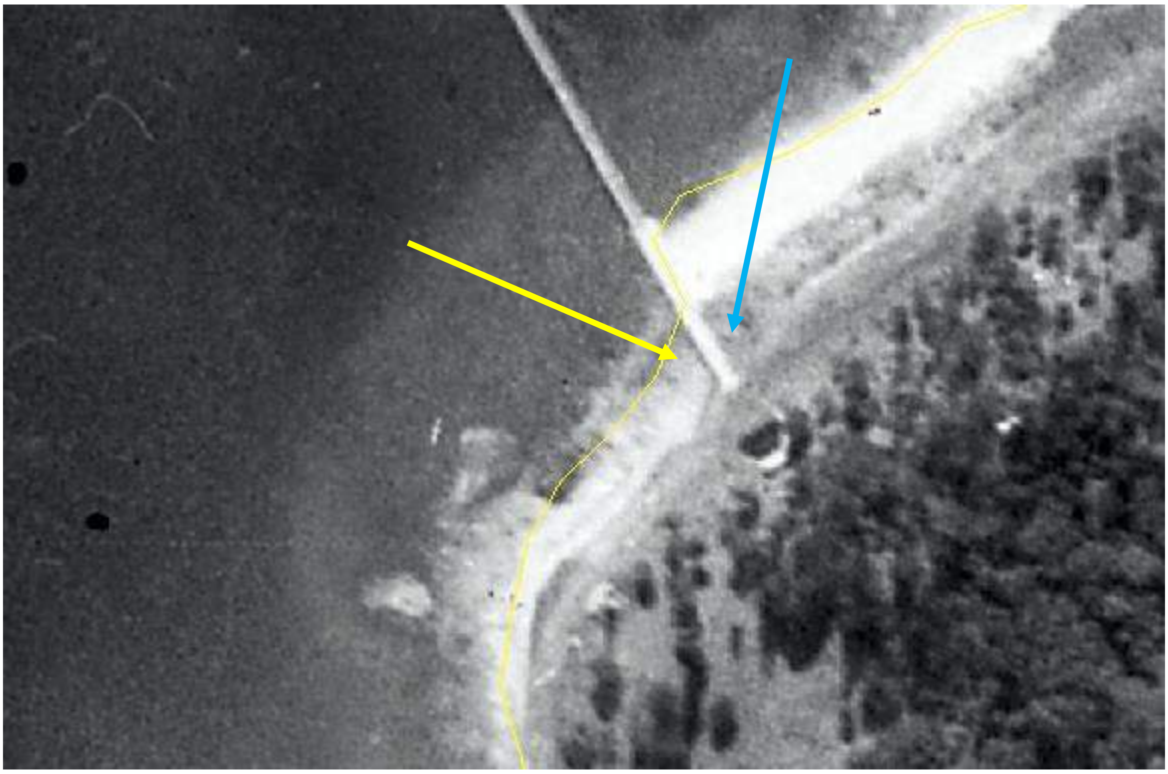

Figure 16: 1943 aerial photograph of Trust Jetty landing (Sutherland Shire Council https://maps.ssc.nsw.gov.au/ShireMaps/)

Figure 17: 1955 aerial photograph of Trust Jetty landing (Sutherland Shire Council https://maps.ssc.nsw.gov.au/ShireMaps/)

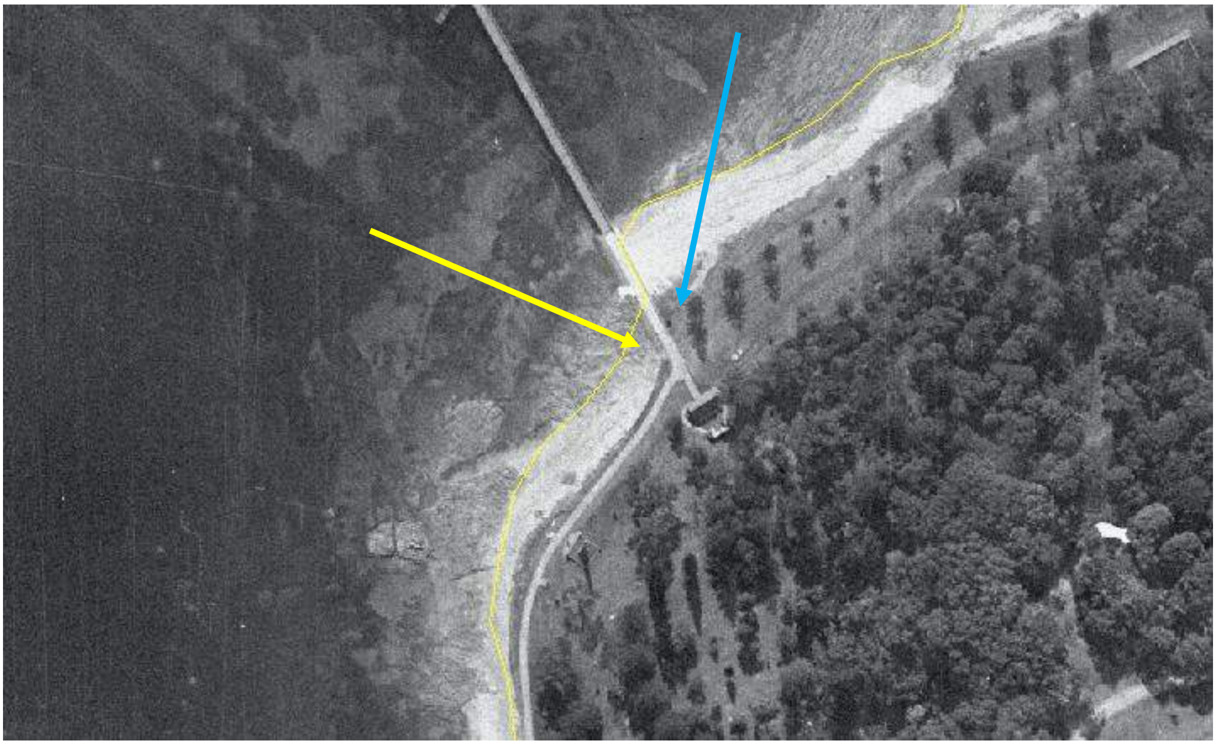

Figure 18: 1961 aerial photograph of Trust Jetty landing (Sutherland Shire Council https://maps.ssc.nsw.gov.au/ShireMaps/)

Figure 19: 1970 aerial photograph of Trust Jetty landing (Sutherland Shire Council https://maps.ssc.nsw.gov.au/ShireMaps/)

Figure 20: 1978 aerial photograph of Trust Jetty landing (Sutherland Shire Council https://maps.ssc.nsw.gov.au/ShireMaps/)

Figure 21: 2016 aerial photograph of Trust Jetty landing (Sutherland Shire Council https://maps.ssc.nsw.gov.au/ShireMaps/)

Figure 19through Figure 21 demonstrate that a section of the extant grass-covered sand on the southern side of the Trust Jetty landing is likely to post-date 1970. Sand on the northern side of the Trust Jetty landing is possibly an accumulation of marine sands during the early 20th century following construction of the Trust Jetty in. It appears that a section of grass covered sand on the northern side of the Trust Jetty landing was removed in c.1970 either through storm damage or for works in that area.

Summary

In summary, vegetation clearance in the 19th and early 20th centuries is likely to have resulted in some destabilisation of the immediate foreshore area at Kurnell, potentially resulting in the movement or removal of former foreshore dune contexts.

Construction of a sea wall in the late 19th/early 20th centuries included introduction of fill, potentially sourced from the local area, to raise and create a level ground surface behind the sea wall. It is likely that former marine sand foreshore dune contexts would be buried beneath the introduced fill.

Construction of the Trust Jetty appears to have altered the deposition of marine sediments in that area, principally a build-up of marine sediment on the northern side of the jetty landing in the early 20th century, followed by a build-up of sand across a portion of the southern side of the jetty landing post-1970. An event in c.1978 appears to have removed/impacted the marine sands on the northern side of the jetty landing.

4.3.4.2 La Perouse Headland

The construction boundary at La Perouse is located on the headland and not immediately adjacent to the foreshore area as at Kurnell (see Section 4.3.4.1).

Late 18th century European activities at La Perouse included collection of plant specimens in 1770. No known structures or land clearance apart from sample collection and potentially grass collection for livestock feeding on the ships are associated with this phase. This was followed by British and French arrival in Kamay Botany Bay in January 1788. The French established a garden and stockade on La Perouse headland, and also buried Père Receveur, one of La Perouse's crew. It is assumed that some vegetation clearance and minor landscape modification would have taken place for the establishment of the garden and stockade, although the French were only on site for 5-6 weeks so it is unlikely that these were extensive works.

The 19th – early 20th century period includes a series of military developments throughout the vicinity, and the establishment of the headland as a memorial site for French visitors. Later in the 19th century development across the western portion of La Perouse Headland included sheds or cottages, a permanent Cable Station, including additional outbuildings and the cable tanks in the headland.

By 1894 a roadway was constructed along the northwest boundary of the La Perouse headland, leading to the rocky point adjacent to Frenchmans Beach. This may have provided suitable vehicle access to the customs department buildings. The boathouse was located at the southern end of Frenchmans Beach and slipways were constructed off the road into Frenchmans Bay in the late 1800s and early 1900s to enable safe launching of boats.

In 1905 the formal La Perouse wharf was erected at the west end of the headland. The wharf was a timber construction built off the headland, with timber piles projecting into the bay. Some portions of this timber are still evident in the rockface today. The approach to the wharf extended well onto the headland, ending in close proximity to a temporary shed and cable tanks on the headland.

The 1917 survey plan shows that Anzac Parade was extended to the southwest to meet the ferry wharf established in 1905 and an approach road was constructed from the wharf to meet the road surface. The 1917 plan also shows a tennis court established in the northeast quadrant of the headland, however the surface of this court and how formalised it was is uncertain as there is no photographic evidence of the court. The court would have potentially been grass surface with an enclosed fence.

Throughout the mid-twentieth century, several of the ancillary structures associated with the cable station, Macquarie Watchtower and wharf infrastructure were demolished as they become redundant. With the removal of the tram line, wharf, and ancillary structures in the mid- and late-twentieth century, the La Perouse headland largely became a tourist destination which retained its primary historic structures.

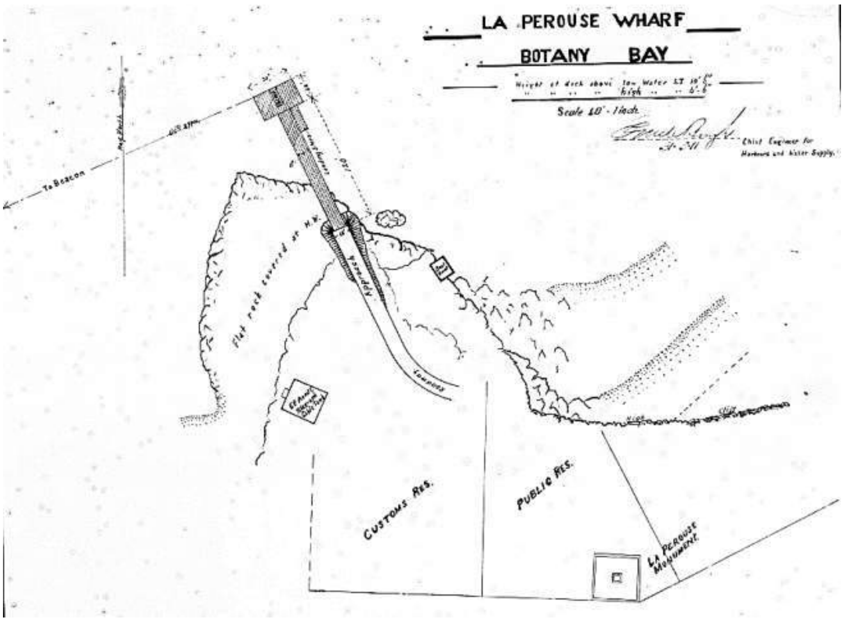

Figure 22. 1925 arrangements of the wharf at La Perouse, showing cable tanks and boat shed. Source: State Archives & Records NSW

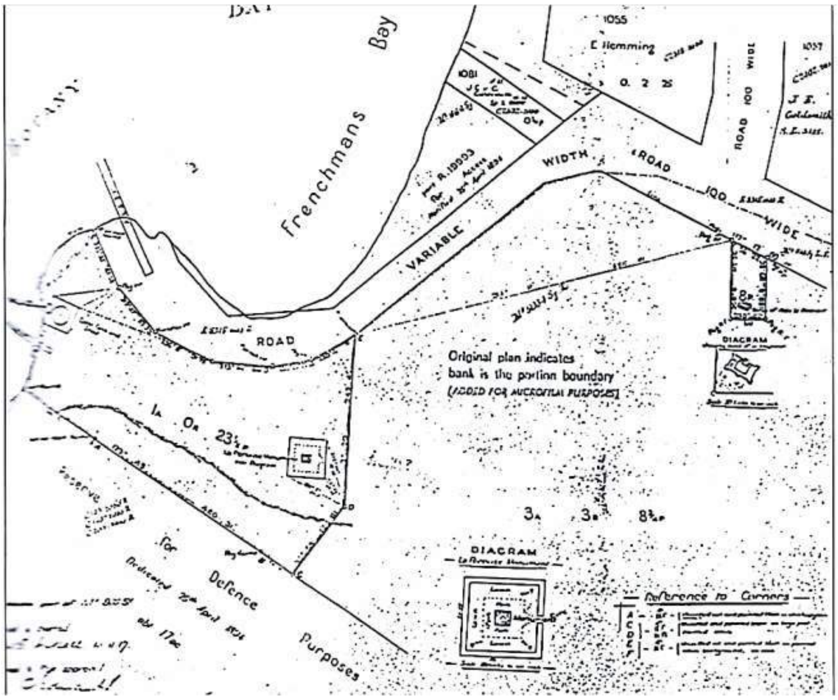

Figure 23. Structures on the west side of the La Perouse headland, 1917. Source: NSW Department of Lands

Aerial photography from the 1960s to the 21st century shows development of infrastructure at La Perouse headland to accommodate access facilities as a tourist destination (see Figure 24 to Figure 28).

An aerial photograph from 1961 (Figure 24) shows road layout similar to the layout from 1925 (Figure 22), with the wharf road alignment and car parking. A number of significant changes are made to the headland between the 1961 photograph and 1965 (see Figure 25). This includes completion of the 'loop' section of Anzac Parade that is still extant, as well as visible earthworks around the road alignment to flatten out some of the undulating terrain visible in the 1961 photograph.

The landscape modifications between 1961 and 1965 included widening Anzac Parade adjacent to Frenchman's Beach. This widening includes further changes in the subsequent decades to include a fenced footpath, now a shared path, and rock across the underlying embankment face for stabilisation. The road widening extent can be seen in Figure 26, with the 1961 aerial photograph overlaid on a more recent aerial photograph.

Figure 24: 1961 aerial photograph of La Perouse headland

Figure 25: 1965 aerial photograph of La Perouse headland

Figure 26: 1961 aerial photograph overlaid on a more recent aerial photograph, showing the extent of road widening in the late 20th century

The former road access to La Perouse wharf off Anzac Parade was covered over/ removed between 2007 and 2012 when further refinements to the layout and facilities on La Perouse Headland to the extant layout within the footprint occurred. This included construction of a shared path around the outside permitter of the Anzac Parade ‘loop’ road and covering over/ removing a portion of the access road to La Perouse wharf (see Figure 27).

Figure 27: 2007 aerial photograph of La Perouse Headland (Google Earth)

Figure 28: 2012 aerial photograph of La Perouse Headland (Google Earth)

Summary

In summary, the La Perouse headland has undergone some modification mostly relating to the military developments of the 19th – early 20th century and for the tourism industry and the 21st century. These developments have likely resulted in movement of soils and introduction of fills across the site.

Subsequent landscaping and the construction of the 'loop' road resulted in changes to the headland landscape namely through the introduction of fills and burying of existing sandstone outcrops. It is likely that some of the recorded AHIMS sites that have not been located in recent years (e.g. Site 6, La Perouse [AHIMS ID 45-6-0653]) .

5.0 ARCHAEOLOGICAL CONTEXT

A full description of previous studies within the vicinity of the project area was provided in the PACHCI Stage 2 report (Artefact Heritage 2020a).

Aboriginal Cultural Heritage Assessment for Master Plan – Paul Irish, La Perouse Aboriginal Land Council, and NPWS Towra Team 2007

In 2007, test excavations were conducted to inform the proposed master plan works to upgrade visitor facilities within the ''Meeting Place Precinct". It was determined that proposed works should avoid impact to any *in situ* archaeological remains, due to their high degree of significance. Test excavations were conducted with the La Perouse LALC and 'Towra Team' of NPWS Aboriginal workers to provide more information about the location and depth of Aboriginal archaeological remains within the Meeting Place Precinct. A total of 115 small test pits were excavated to the depth of proposed works only, in order to minimise risk of impact on archaeological material (Dimensions of shovel pits have been summarised in Table 6). The majority of the test pits were excavated to a depth of 400mm and did not encounter *in situ* deposits. However, some test pits encountered *in situ* deposits at 100 – 200mm in depth.

Table 6: Summary of shovel pit dimensions of numbers

Test pit size	Number of test pits
1m x 1m	1
500mm x 500mm	1
500mm x 200mm	46
200mm x 200mm	67
Total	**115**

A total of 216 artefacts were retrieved from 29 of 115 test pits, with the highest density of artefacts being located to the northeast of the Kurnell construction boundary (Figure 29). A total of 20 of the artefact bearing test pits also included midden material. An attempt was also made to uncover rock engravings recorded in 1968 (AHIMS ID 52-3-0221), but they were not found. It is likely the sandstone outcrop where they were originally recorded has since been covered by vegetation.

Overall, the majority of the test pits located within the Kurnell construction boundary did not yield stone artefacts or midden material. However, these excavations were generally completed to a depth of 400mm, with only two completed in a depth of 500mm. It is likely that *in situ*, artefact bearing deposits are located at greater depths.

A range of historical archaeological artefacts were also encountered during the test excavations. It was found that the artefactual material dated from the mid-nineteenth century to the present day, with the majority of the artefacts dating to the twentieth century. Most of the artefacts were from disturbed and mixed contexts and were generally small and non-diagnostic. Around the ferry wharf there was evidence that numerous crab burrows had further disturbed the area. Structural remains were primarily limited to a single pit (P6/180) to the north of Cooks Stream, in which sandstone blocks were identified that were interpreted as possibly being post-hole packing for one of a series of flag poles.

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Figure 29: Location of test and salvage excavation (2004-2008) and archaeological monitoring (2008-2010)

La Perouse Headland Botany Bay National Park Conservation Management Plan – Jill Sheppard Heritage Consultants (JSHC) 2009

The La Perouse Headland Conservation Management Plan (CMP) covers much of the La Perouse headland, including Bare Island but excluding the Frenchman's Bay area. The purpose of the CMP is to guide future use and management of the area through the provision of conservation strategies and guidelines. The CMP also provides an extensive discussion of potential archaeological resources within the headland, which was primarily informed by the 1989 report *La Perouse and Bare Island Historic Sites, La Perouse – Conservation Plan – Historical Archaeology*, which was prepared by Edward Higginbotham for the Department of Public Works, NSW. The archaeological excavation methodology in this report is based on the archaeological assessment detailed in the CMP.

A total of 85 archaeological sites/elements were identified and mapped by Higginbotham (Figure 31). This included a mix of potential subsurface features and archaeological sites and items that are partially visible on the surface. Of these archaeological sites/elements, 35 sites were identified as being visible and a corresponding assessment of archaeological potential and significance was included in the CMP (Table 7). The majority of the archaeological sites were identified as being of no or low archaeological potential and local significance. This included the archaeological sites of the former slipways, 'wharf and approach road', 'remains of wharf buildings', and 'footings of 2 cable tanks' situated on the west side of the headland.

The CMP identified the north-west side of the headland as being the possible location of the Former French Stockade and Garden (Figure 30). The CMP identified the area as having high archaeological potential. It was assessed that although archaeological remains associated with the stockade and garden would potentially be of national and international significance (JSHC 2009, 96). It was noted however that the exact location of the stockade and garden is not known, and that until excavations have definitively demonstrated the location of the stockade and garden then all excavations in undisturbed ground has the risk of encountering the significant archaeological sites (JSHC 2009, 38). However, it was assessed that archaeological remains associated with these would likely be ephemeral in nature and would primarily consist of the remains of timbers, possibly garden edging and refuse pits or deposits.

The location of the archaeological sites/elements identified by Higginbotham and included in the La Perouse Headland CMP are identified in Figure 30 and Figure 31 , and the details and associated significance assessments of the sites are listed in Table 7 and Table 8.

Table 7: Archaeological sites/elements key for Figure 8. Source: sites identified by Higginbotham 1989 and included in the JSHC 2009 CMP

No.	Name	No.	Name
1	Tram Terminus	44	Boatman's cottages, wood
2	Monument & drinking trough	45	Boatman's cottage, wood
3	Tram shed shelter	46	Garden
4	Cutting	47	Military road
5	Tram terminus	48	Enclosure (Customs?)
6	Snake Pit	49	Boat davits
7	Public conveniences	50	Fisherman's boathouse
8	Stormwater drain outflow	51	Telegraph testing house, wood

No.	Name	No.	Name
9	Stormwater drain outflow	52	Stables, wood
10	Terraced area	53	Dwelling house & offices, wood
11	Rock-cut steps	54	Kitchens, wood
12	Road to Bare Island	55	Garden, out-building
13	Circuit road	56	Boatman's cottage, wood, garden
14	Levelled area	57	Garden, out-building
15	Remains of slipway	58	Out-building
16	Cable tank footings	59	Out-building
17	Slipway	60	Pond
18	Stormwater drain outflow	61	Out-building
19	Wharf & approach road	62	Out-building
20	Remains of wharf buildings	63	Garden
21	Rock cut drainage trench	64	Enclosure
22	Rock-cut steps, other features	65	Edward hemming
23	Circular sandstone feature	66	Aboriginal Quarters
24	Circular sandstone feature	67	Cottage
25	Circuit road, embankment	68	Artillery quarters
26	Two storey building	69	Old weatherboard residence, 1917
27	La Perouse Monument	70	Building
28	Tomb of Père Le Receveur	71	Public school site
29	Embankment, boundary	72	Enclosure?
30	Cable Station	73	Enclosure?
31	Cable Station: Battery Room	74	Enclosure?
32	Cable Station: reservoir	75	Stables, E Hemming
33	Sandstone blocks	76	Tennis court
34	Tower	77	Jetty
35	Cistern & well	78	Buildings
36	Bare Island Fort	79	Road reserve to jetty
37	Garden	80	Top House
38	Stockade	81	Stable
39	Flagstaff	82	Lavatory

No.	Name	No.	Name
40	Footpath	83	Store room
41	Building	84	Cow shed
42	Stables	85	Out-buildings
43	Boatman's cottage		

Table 8: List of visible archaeological sites in the vicinity of the proposed works. Source: sites identified by Higginbotham 1989 and included in the JSHC 2009 CMP

No.	Item recorded by Higginbotham	Archaeological potential	Assessed significance
13	Circuit road raised embankment	None	Detracting
14	Large partially levelled area	Low	Local
15	Remains of slipway	Low	Local
16	Footings of 2 cable tanks	Low	Local
17	Slipway	Low	Local
18	Stormwater drain outflow	None	None
19	Wharf & approach road	Low	Local
20	Remains of wharf buildings	Low	Local
21	Rock cut trench	Low	None
22	Rock cut steps & other features	Low	Local
23	Circular sandstone feature	Low	Local
24	Circular sandstone feature	Low	Local
25	Circuit roadway raised embankment	None	None
26	Two storey building	None	Local
27	La Perouse Monument	Low	State
28	Tomb of Père Le Receveur	Low	State
29	Raised earthen embankment	Low	Local

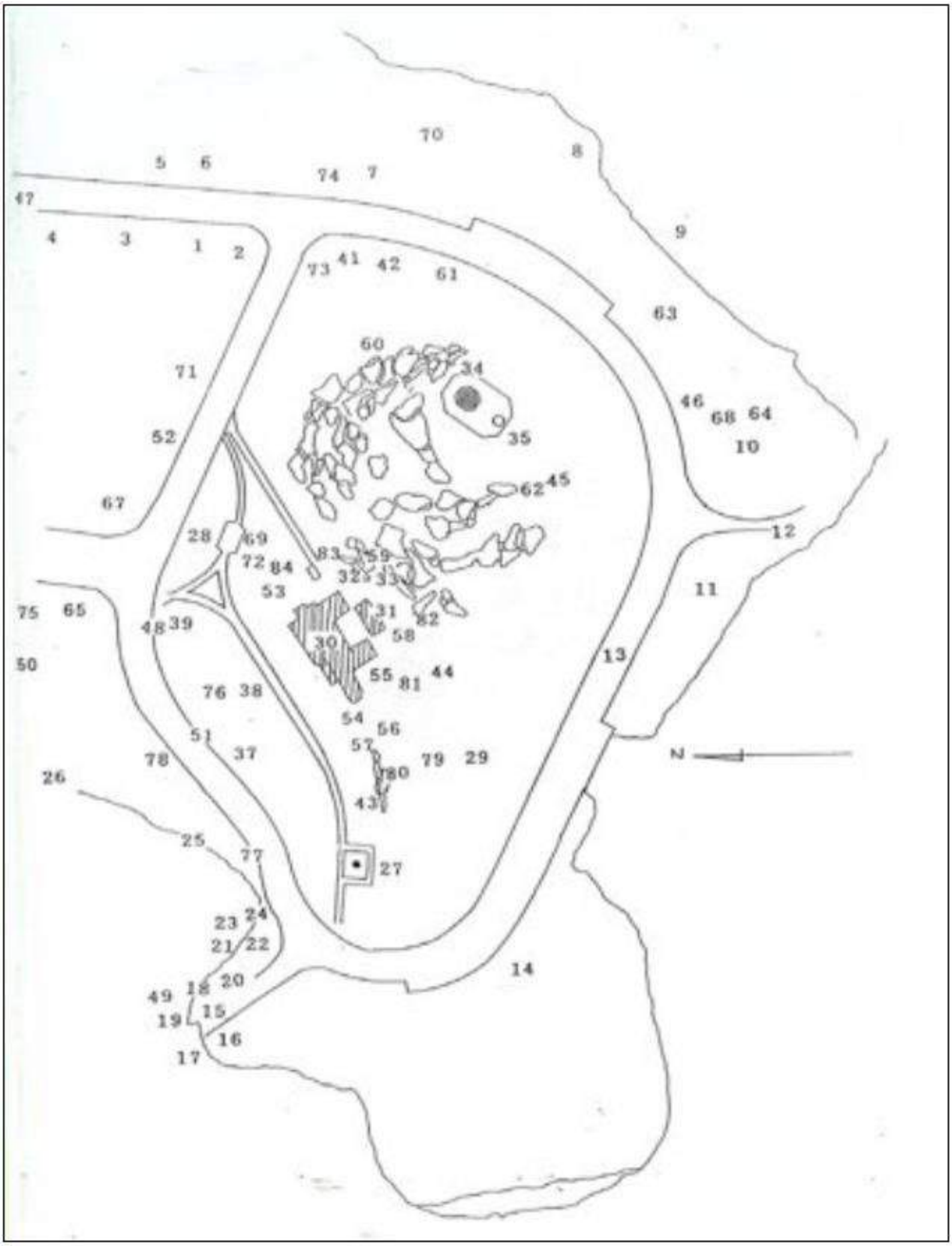

Figure 30: Archaeological sites/elements on the La Perouse headland, identified during the 1989 Higginbotham Conservation Plan for Historical Archaeology Appendix 3., prepared for The Department of Public Works. Source: Higginbotham 1989 and included in the JSHC 2009 CMP

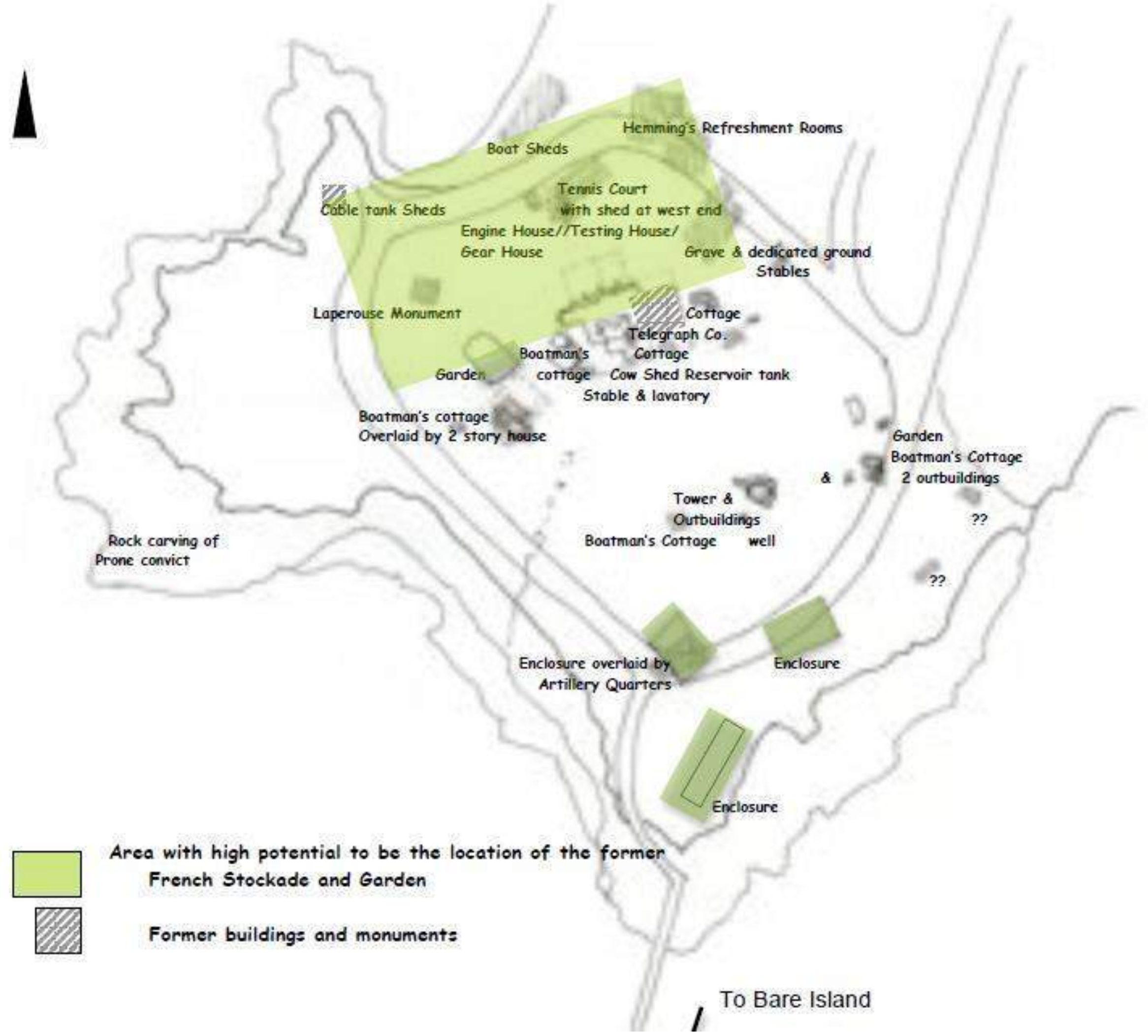

Figure 31: Areas of non-Aboriginal archaeological potential on the La Perouse headland. Source: JSHC 2009

5.1 Aboriginal material culture

The AHIMS register has registered 72 varying sites within approximately 200m of the project area. Shell artefact and pigment or engraved artwork cover approximately 62% of recorded Aboriginal cultural material across both construction boundaries. Artefacts such as shell hooks or bone points (Figure 32 and Figure 33) are indicative of what could be expected during excavation. Some sandstone outcrops along the La Perouse headland have historically been used for engravings. W.D. Campbell (1897) and R.H. Matthews (1898) describe the intricate rock engraving of a whale and its calf, approximately two meters above sea level. This particular engraving was officially registered in 2006 by Navin Officer (Figure 34), while eroded, is indicated of the type of material engraved onto sandstone. It is possible that subsurface sandstone outcrops may present more engravings. At Kurnell, there are registered engraving sites (AHIMS ID 52-3-0221) and a potential midden (AHIMS ID 52-3-0219) in proximity to Captain Cook's landing place.

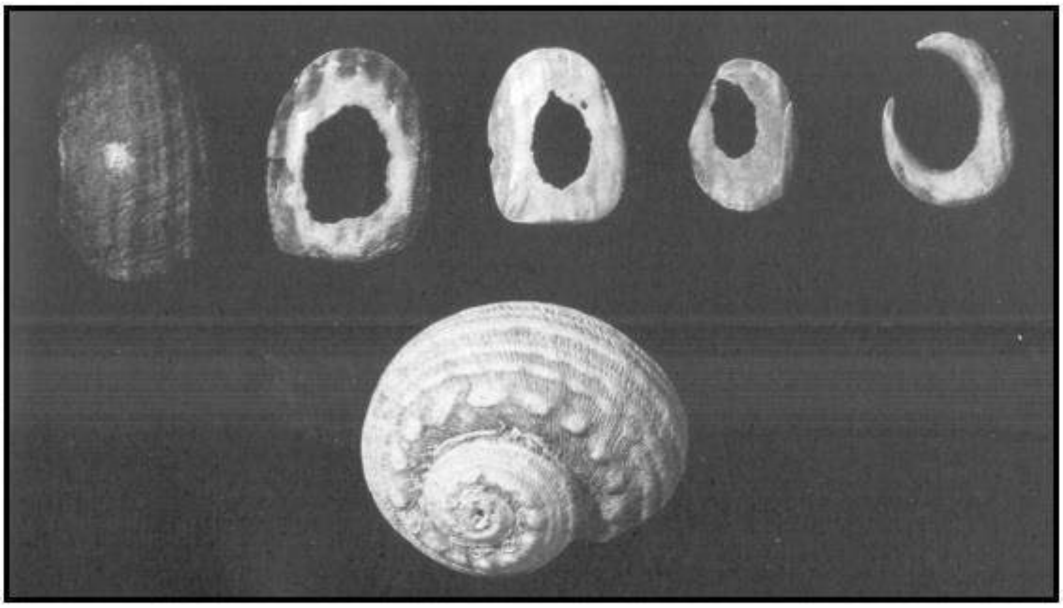

Figure 32: Shell fish hooks recovered from Captain Cook's Landing Place Midden site, image reproduced from Irish 2007, p 16

Figure 33: Bone points recovered from Captain Cook's Landing Place Midden site, image reproduced from Irish 2007, p 17

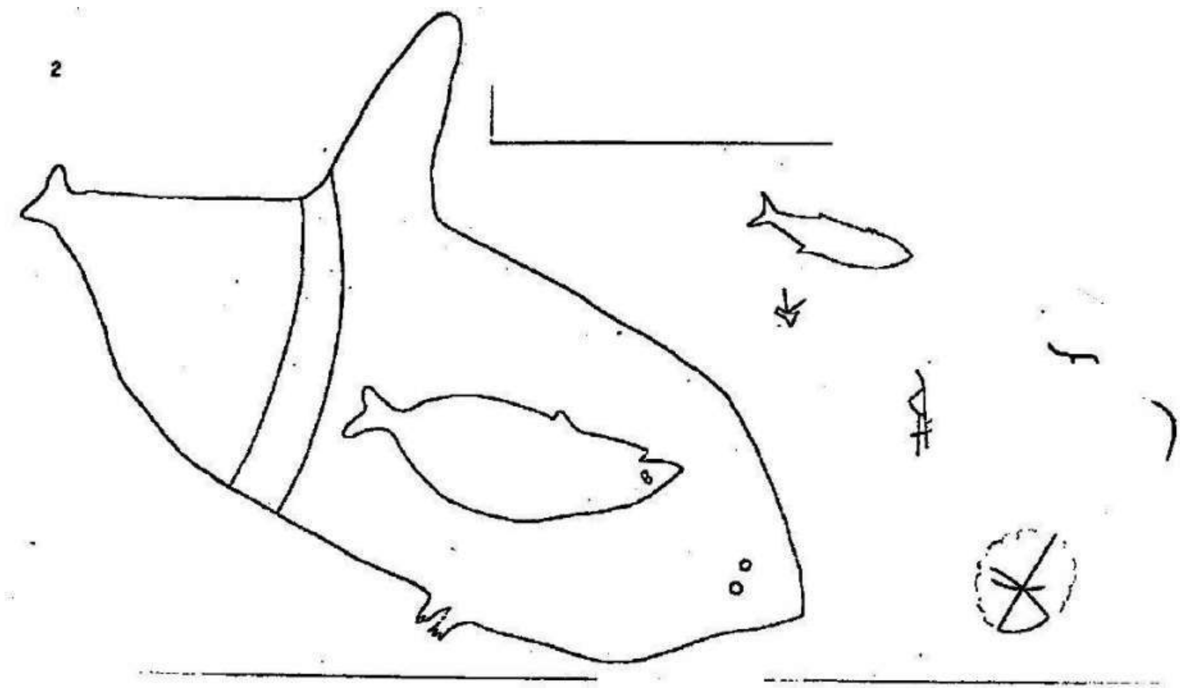

Figure 34: Whale and calf engraving. Source: AHIMS site card

5.2 Aboriginal histories of the locality

5.2.1 Regional context

Aboriginal people have been living in the Sydney Basin and surrounding areas for a minimum of 36,000 years, based upon evidence from archaeological sites located on the Parramatta and Nepean Rivers (JMCHM 2005 and AHMS 2013). Before the sea reached its present level around 7,000 years ago, the Kamay Botany Bay area would have consisted of freshwater valleys and swamplands (Attenbrow,2012, 1-2), with Aboriginal people subsisting on a diet of land animals and plants, supplemented with freshwater fish resources (Attenbrow 2010,70-79). Following the inundation of the coastline, Aboriginal people in the project area primarily utilised marine foods of sea fish and shellfish for their subsistence needs (Attenbrow 2010, 70-79).

The majority of archaeological evidence in the Sydney Basin has been dated as occurring within the last 3,000 to 5,000 years, possibly reflecting the increased use of the foreshore areas by Aboriginal people who occupied areas around the modern coastline. Older occupation sites are likely to exist along the now submerged coastline and flooded river valleys prior to the last sea level rise, consistent with a pattern of higher intensity utilisation of marine resources in supporting Aboriginal populations (AMBS 2013, 25).

The shell midden site at Captain Cook's Landing Place in Kurnell, on the south-eastern foreshore of Kamay Botany Bay, was excavated between 1968 and 1971. Deposits at this site have been dated and show that they have been accumulating for at least 1,200 years. Based upon the large extent of materials recovered, it is likely that this shell midden site, and other nearby rock art and burial sites, extends for much of the Kurnell foreshore [redacted] (Attenbrow 2010, 172 and Irish 2007, 11-18).

Large quantities of Aboriginal artefacts, including shellfish hooks (Figure 7), retouched stone artefact flakes, ground stone hatchets and bone points (Figure 8) were recovered. Fish bones and shell comprise the majority of food resource remains, including snapper, bream, mud oyster and Sydney cockle. Lesser quantities of land and sea animal bones, including dingo, seal, whale, dolphin, wallabies and mutton birds are also present in the midden site (Attenbrow 2010, 172-173).

Aboriginal people were also recorded burying their dead in coastal sandy environments, in middens and in rock shelters. Archaeological evidence in the project area further substantiates this practice, with a number of Aboriginal burials along the Kamay Botany Bay foreshore having been identified. One rock shelter near [redacted] on the Kurnell Peninsula has revealed up to 18 complete or partial sets of human remains, all of which have been reburied at the site at the request of the local Aboriginal community. Grave goods of stone artefacts and bone points were present in many of these burials, as well as midden deposits of discarded fish and animal bones (Irish 2007, 19).

Aboriginal people often utilised the exposed Hawkesbury Sandstone rock faces around Sydney Harbour and Kamay Botany Bay to engrave and draw art. These sites are well-recorded and comprise 40% of all Aboriginal sites in the Sydney Basin (Attenbrow 2010, 146-147). Several rock art sites have been recorded on the exposed sandstone faces and caves at La Perouse near Bare Island, as well as on the Kurnell foreshore. Motifs on rock art in the area show frequent engravings of footprints and fish (Irish 2007, 20). The landscape at Kamay Botany Bay prior to the arrival of Europeans in the 18th century was significantly more forested than it is today. Sclerophyll woodland vegetation, consisting of eucalypts, angophoras and banksias, were pivotal in securing the barrier dunes of the Kurnell and Brighton-Le-Sands area from erosion. It is possible that the increase in the proportion of salt-tolerant shrubs such as *Leptospermum* laevigatum and *Monotoca* elliptica was the result of more intense Aboriginal settlement and human initiated fire-regimes around the shores of Kamay Botany Bay from around 2,000 years ago (Benson & Eldershaw 2007, 114).

5.3 Aboriginal heritage information management system search

The location of Aboriginal sites is considered culturally sensitive information. It is advised that this information, including the AHIMS data appearing on the heritage map for the proposal be removed from this report if it is to enter the public domain.

An extensive search of the Aboriginal Heritage Information Management System (AHIMS) database was undertaken on 9 January 2020 (Client ID: 475474).

An area of approximately 8 km (east-west) by 7.6 km (north-south) was searched to gain information on the archaeological context of the project area, and to ascertain whether any previously recorded Aboriginal sites are located within the project area. The details of the AHIMS search parameters are as follows:

GDA 1994 MGA 56	[redacted]
Buffer	0 m
Number of sites	72
AHIMS Search ID	475474

A total of 72 sites were identified within the extensive AHIMS search area. AHIMS lists 20 standard site features that can be used to describe a site registered with AHIMS, and more than one feature can be used for each site. The frequency of recorded site types is summarised in Table 9: Frequency of site types from AHIMS data. For the 72 sites within the search area, 12 site features were recorded. The majority of recorded sites are Shell, Artefacts (n=29, 42.03%) followed by Art (Pigment or Engraved) (n=15, 21.74%). The distribution of recorded sites within the AHIMS search area is shown in Table 9.

Three restricted sites are also listed in the AHIMS search results. The location and details of restricted sites are not publicly available. Restricted sites are generally of high cultural significance. AHIMS was contacted on 2 March 2020 to confirm if the three restricted sites are located within the project area or are within close enough proximity that they may be impacted by the proposal. On 5 March 2020, AHIMS confirmed that the three restricted sites would not be impacted by works within the project area.

The nature and location of the registered sites reflects the past Aboriginal occupation from which they derive, but is also influenced by historical land-use, and the nature and extent of previous archaeological investigations. Although Aboriginal occupation covered the whole of the landscape, the availability of fresh water, and associated resources, was a significant factor in repeated and long-term occupation of specific areas within the landscape. Certain site types, such as culturally modified trees, are particularly vulnerable to destruction through historical occupation, while others, such as stone artefacts, are more resilient.

Table 9: Frequency of site types from AHIMS data

Site Feature	Frequency	Percentage (%)
Restricted	*3*	4.17
Shell, Artefact	29	40.28
Artefact	6	8.33
[redacted]	2	2.78
Art (Pigment or Engraved)	15	20.83
Artefact, Potential Archaeological Deposit (PAD), Shell	2	2.78
Potential Archaeological Deposit (PAD)	7	9.72
Ochre Quarry	1	1.39
[redacted]	3	4.17
Artefact, Shell, Aboriginal Ceremony and Dreaming	1	1.39
Grinding Groove	1	1.39
[redacted]	1	1.39
Aboriginal Resource and Gathering, Shell	1	1.39
Total	**69**	**100.00**

Seven AHIMS registered sites are located within the project area and an additional 10 are located within 250 m of the project area (Table 10).

Table 10: AHIMS registered sites within the study area or within close proximity

AHIMS ID	Site name	Site type	Distance from project area *
52-3-1366	Kurnell Potential Archaeological Deposit 1 (K PAD 1)	Potential Archaeological Deposit (PAD)	
45-6-0653	Site 6, La Perouse	Art (Pigment or Engraved)	
45-6-0650	Site 3, La Perouse	Art (Pigment or Engraved)	
45-6-1403	La Perouse	Art (Pigment or Engraved)	
45-6-1144	La Perouse	Shell, Artefact	

AHIMS ID	Site name	Site type	Distance from project area *
45-6-0649	Site 2, La Perouse	Art (Pigment or Engraved)	
45-6-0651	Site 4, La Perouse	Art (Pigment or Engraved)	
52-3-0219	Foreshore Midden - Captain Cook's Landing Place	[redacted]	
52-3-0221	Kurnell Engraving - Captain Cook's Landing Place	Art (Pigment or Engraved)	
52-3-1381	Cundlemongs Grave	[redacted]	
45-5-2587	Frenchmans Bay Foredune	Shell, Artefact	
45-6-0652	Site 5, La Perouse	Art (Pigment or Engraved)	
45-6-1145	La Perouse	Shell, Artefact	
45-6-0648	Site 1, La Perouse	Art (Pigment or Engraved)	
45-6-1146	Congwong Cave, La Perouse	Art (Pigment or Engraved)	
45-6-0561	Congwong Beach	Shell, Artefact	
45-6-1762	Congwong Beach	Shell, Artefact	

*based on geographical information for each site on the AHIMS site register

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Figure 35: PACHCI Stage 2 assessment - revised location of Aboriginal sites within the Kurnell construction boundary

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Figure 36: PACHCI Stage 2 assessment - revised location of Aboriginal sites within the La Perouse construction boundary

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5.4 Predictive model

Based on previous archaeological excavations completed within the Kurnell construction boundary, it was anticipated that additional stone artefacts and midden material would be identified within the defined extent of the Foreshore Midden - Captain Cook's Landing Place (AHIMS ID 52-3-0219). Coast (2019) predicted that *in situ* midden material would not extend further than 70 m from the shoreline. However, individual, pre-contact burials may be located elsewhere within the Kurnell construction boundary. It is also likely that low quantities of stone artefacts will be located across the Kurnell construction boundary.

It was predicted that the La Perouse headland is likely to contain Aboriginal rock engravings and shell middens.

The most common Aboriginal site types anticipated in the project area include:

- Midden and stone artefacts – These are the most frequently recorded site type in the locality. Middens and stone artefacts are mostly likely to be identified in areas of increased ground surface visibility such as rock outcrops or within rock shelters.
- Art sites – These are likely to be present in areas where suitable stone surfaces are present, including in rock shelters, outcroppings and cliff walls. Painted art sites may have faded beyond ready identification, however inscribed art may be more identifiable.
- Rock shelter – These will be found in suitable sandstone outcrops in the project area and may contain occupation deposit (potentially hearths, midden, stone artefacts and animal/fish bone). They may also contain art (pigment or engraved), grinding grooves and burials.
- Burials – These may occur at any point in the landscape where deep soils are present. They are most likely to occur in areas of sandy or soft soils. Burials are unlikely to be detected through surface survey.

5.5 Non-Aboriginal archaeological potential

5.5.1 Kurnell

The PEI identified that within the Kurnell construction boundary there are seven archaeological sites listed on the Sutherland Shire LEP 2015 (Figure 37). These include:

- Captain Cook’s landing site (Sutherland Shire LEP A2511)
- Banks memorial (Sutherland Shire LEP A2512)
- Captain Cook monument (Sutherland Shire LEP A2514)
- Landing place wharf abutment (Sutherland Shire LEP A2516)
- Captain Cook’s watering hole (Sutherland Shire LEP A2518)
- Captain Cook watering well (Sutherland Shire LEP A2519)

The PEI also identified additional potential archaeological remains identified in previous assessments and historical overlays, including evidence of a seawall which is partially exposed in places. The previous test excavations undertaken by Irish 2007, which included excavations within the curtilages of Captain Cook monument (Sutherland Shire LEP A2514) and Captain Cook watering well (Sutherland Shire LEP A2519), did not identify any significant archaeological remains associated with the archaeological sites. As a result, the TEM determined that a separate targeted non-Aboriginal archaeological test excavation program would not be appropriate, and therefore the potential non-Aboriginal archaeological remains would be managed in conjunction with the Aboriginal archaeological test excavations.

5.5.2 La Perouse

The La Perouse Headland CMP and historical overlays indicated that the proposed test excavations would be located in the vicinity of a number of archaeological sites/features (Figure 38 and Figure 39). Most of the potential archaeological sites have been assessed in the CMP as only being of low archaeological potential. However, at least one proposed borehole was to be located within the area identified in the CMP as having high potential to contain evidence of the former French Stockade and Garden. The CMP also noted that due to the uncertainty of the location of the stockade and garden, any excavations in previously undisturbed grounds on the headland have the potential to encounter and impact evidence of the stockade and garden (JSHC 2009, 38). As a result, the TEM determined that a separate targeted non-Aboriginal archaeological test excavation program was not appropriate, and therefore the potential non-Aboriginal archaeological remains would be managed in conjunction with the Aboriginal archaeological test excavations. The Aboriginal heritage test excavation program was recommended to be monitored for the presence of significant remains associated with the French Stockade and Gardens.

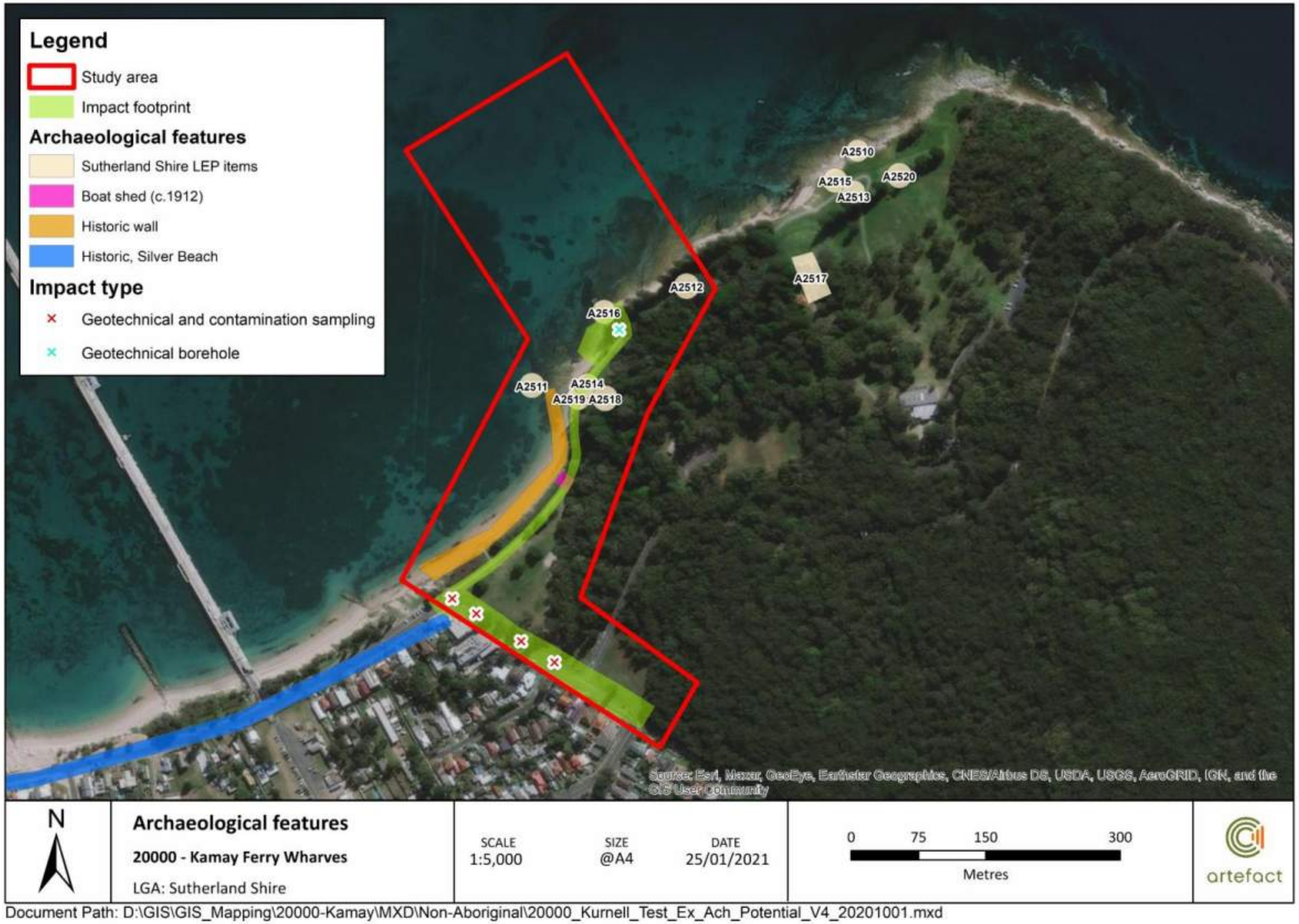

Figure 37: PACHCI Stage 2 assessment - proposed impacts (Kurnell) identified in the TEM in relation to LEP listed archaeological sites and potential non-Aboriginal archaeological features

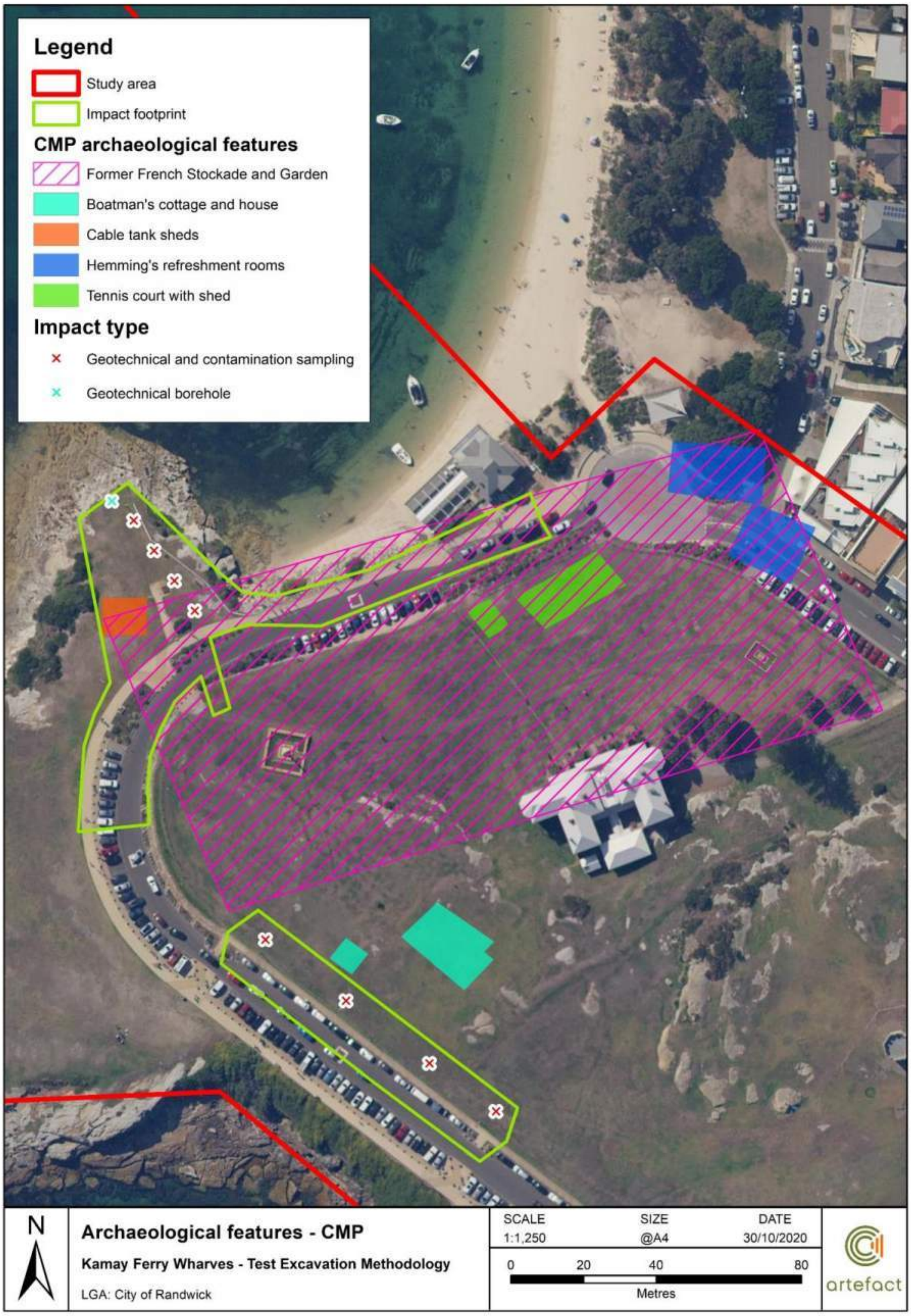

Figure 38: PACHCI Stage 2 assessment - Proposed impacts (La Perouse) identified in the TEM in relation to the non-Aboriginal archaeological sites/elements identified in the La Perouse CMP

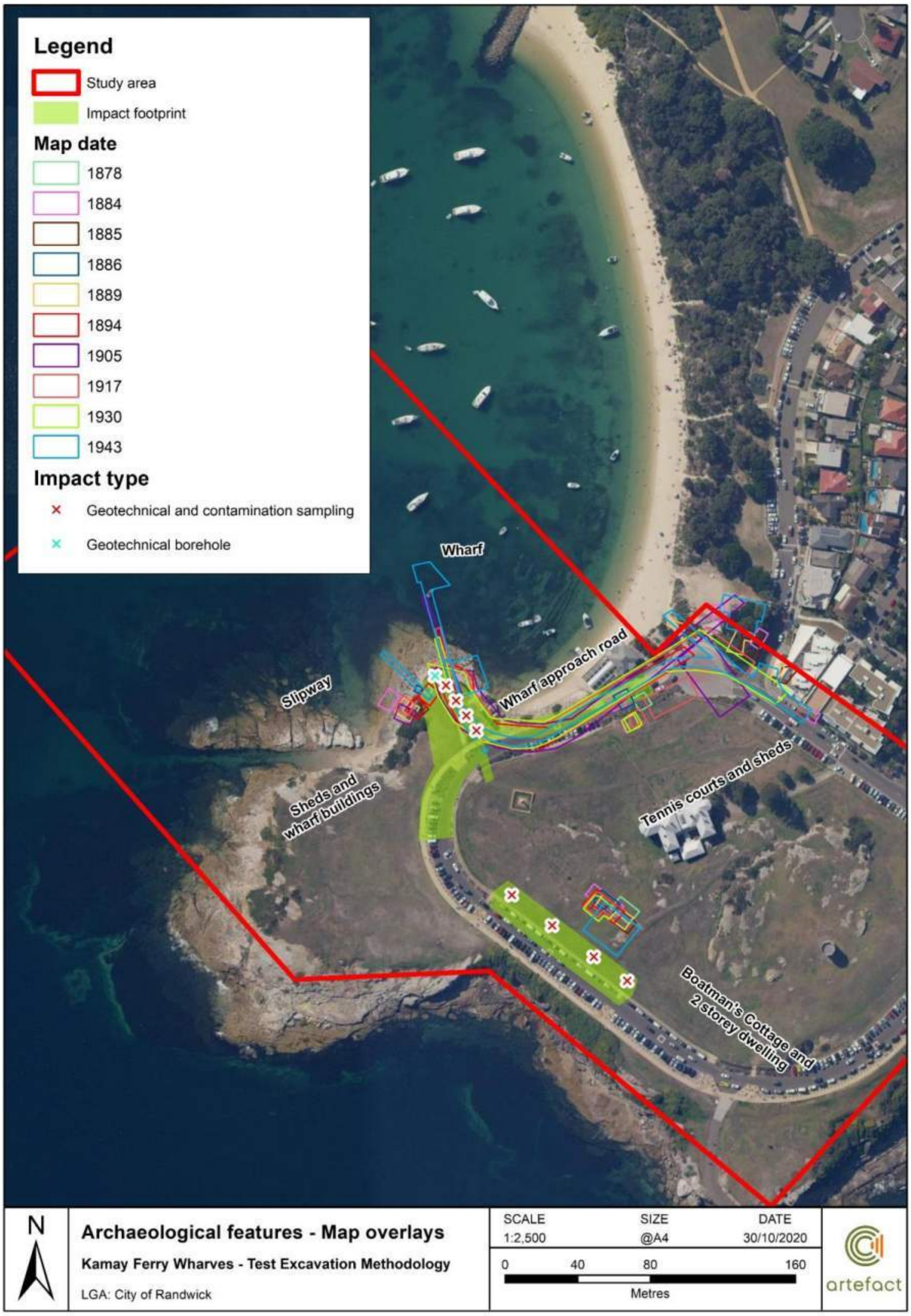

Figure 39: PACHCI Stage 2 assessment - proposed impacts (La Perouse) identified in the TEM in relation to the non-Aboriginal archaeological features identified in overlays of historical plans and maps

6.0 ARCHAEOLOGICAL TEST EXCAVATION METHODOLOGY

The archaeological test excavation program was undertaken in accordance with the TEM (Artefact Heritage 2019). Consultation with RAPs has been an integral part of the test excavation program in accordance with subclause 80C (6) of the NPW Regulation.

6.1 Aims of test excavation

- Due to the potential for significant archaeological remains within the project area, the aim was to limit archaeological test excavation to the proposed impact footprint only. Test excavation would cease at the proposed impact depth in each location, and a surveyor would ensure that test excavation is kept within the proposed impact footprint
- The primary objective of the archaeological test excavation program was to determine if intact sub-surface Aboriginal sites and non-Aboriginal archaeological remains are likely be impacted by the proposal, and to assist in the determination of the nature and significance of any encountered archaeological remains:
    - Previous archaeological test excavation locations at Kurnell that overlap with the current project footprint identified a disturbed context to a depth of around 400mm. Proposed impacts for the installation of utilities and for geotechnical boreholes will exceed 400mm depth.
    - No previous archaeological investigations that overlap with the La Perouse footprint have been identified through background research and review of background information
    - The TEM outlined that because the majority of the potential and known archaeological sites at the La Perouse headland had been assessed as being of low archaeological potential and local significance, and because the exact location of the nationally significant French Stockade and Garden is unknown, separate targeted non-Aboriginal test excavations were not appropriate as part of the archaeological test excavation program. Therefore, the TEM considered it appropriate to undertake a combined non-Aboriginal archaeological test excavation as part of the Aboriginal archaeological test excavation.
- To determine if significant non-Aboriginal archaeological remains are present to inform significance and impact assessments in the EIS non-Aboriginal Heritage Technical Paper.

6.2 Timing and personnel

The excavation team comprised archaeologists experienced in both Aboriginal and non-Aboriginal archaeology. The excavation team also included representatives from the RAP groups.

As per section 1.6 of the Code of Practice, archaeological investigations in NSW must use the services of people who are skilled and experienced in archaeology. The Code of Practice states that an appropriately skilled person has:

> *a minimum of a bachelor's degree with honours in archaeology or relevant experience in the field of Aboriginal cultural heritage management, and*
>
> *the equivalent of two years' full-time experience in Aboriginal archaeological investigation, including involvement in a project of similar scope, and*
>
> *a demonstrated ability to conduct a project of the scope required through inclusion as an attributed author on a report of similar scope.*

The test excavation was managed and supervised by suitably qualified heritage professionals whose qualifications met or exceeded the requirements of the Code of Practice. In accordance with the TEM, the non-Aboriginal archaeological remains identified during the test excavation program were managed through advice provided by the nominated Excavation Director (Jenny Winnett) and Site Director (Jayden van Beek).

The test excavation program commenced on 2 November 2020 and was completed on 24 November 2020. Table 11 identifies the participants of the test excavation program.

Table 11: List of participants in test excavations

Name	Organisation	Role	Dates of participation
Jayden van Beek	Artefact Heritage	Excavation supervisor / Site Director	2, 12, 24 November 2020
Julia McLachlan	Artefact Heritage	Excavation supervisor	2-4, 6, 9-11 November 2020
Brye Marshall	Artefact Heritage	Field archaeologist	2, 4, 6, 9-12, 24 November 2020
Isabel Wheeler	Artefact Heritage	Field archaeologist	2, 3, 6, 24 November 2020
Riley Finnerty	Artefact Heritage	Field archaeologist	2-4, 6, 9-12, 24 November 2020
John Sokalik	Artefact Heritage	Field archaeologist	2-4, 6, 9-12, November 2020
Alexis Schlegel	Artefact Heritage	Field archaeologist	3, 4, 6, 9-12, 24 November 2020
Samantha Eardly	Artefact Heritage	Field archaeologist	4, 6, 9-12, 24 November 2020

Name	Organisation	Role	Dates of participation
Owen Barrett	Artefact Heritage	Field archaeologist	6 November 2020
	Wailwan Aboriginal Group	Site Officer	2-4, 6, 9-12, 24 November 2020
	Yurrandali Pty Ltd	Site Officer	2-4, 6,9-12, 24 November 2020
	Barraby Cultural Services	Site Officer	2-4, 6, 9-12, 24 November 2020
	La Perouse LALC	Site Officer	3-4, 6, 9-12, 24 November 2020
	La Perouse LALC	Site Officer	2-4, 6, 9-12, 24 November 2020
	La Perouse LALC	Site Officer	2-4, 6, 9-12, 24 November 2020

6.3 Sample strategy

The overall guiding principle for cultural heritage management is that where possible archaeological sites should be conserved. Test excavations only occurred within the proposed impact footprint, to the maximum depth of impacts or until the location was determined to be archaeologically sterile.

Excavations targeted the locations of the proposed boreholes, geotechnical and contamination sampling, carpark upgrades and the proposed utility lines (Figure 40 and Figure 41). One test pit was located at each borehole, geotechnical and contamination sampling location, whilst along the proposed utility alignments test pits were spaced approximately 20 m apart. Test pits were spaced up to 30 m apart in certain areas due to the presence of obstructing features such as service pits. It was anticipated that test excavations would involve the testing of at least every second test pit along the proposed utility alignments to minimise impacts to archaeological resources. Changes to this approach were required due to the discovery of a shallow concrete slab which obstructed access to a number of test pits along Monument Track in the vicinity of Captain Cook monument at Kurnell. Where a test pit could not be completed due to the constraints, efforts were made to excavate the adjacent test pit instead. Additionally, the discovery of asbestos at both the Kurnell and La Perouse test areas forced abandonment of further excavations for a number of test pits. Further details of the constraints encountered are provided in Section 6.6.

The proposed location of the utility trench at Kurnell is partially located underneath Monument Track and partially adjacent to Monument Track. Removing portions of Monument Track were not permissible as part of the test excavation program therefore test pits were located only in the adjacent portions of Monument Track. This resulted in a minimum of 50% of each test pit being within the impact footprint.

In total, 22 test pits were excavated within the Kurnell construction boundary and a total of 9 test pits were excavated within the La Perouse construction boundary (Figure 40 and Figure 41).

Table 12 summarises the number of pits completed and abandoned due to constraints during the test excavation program.

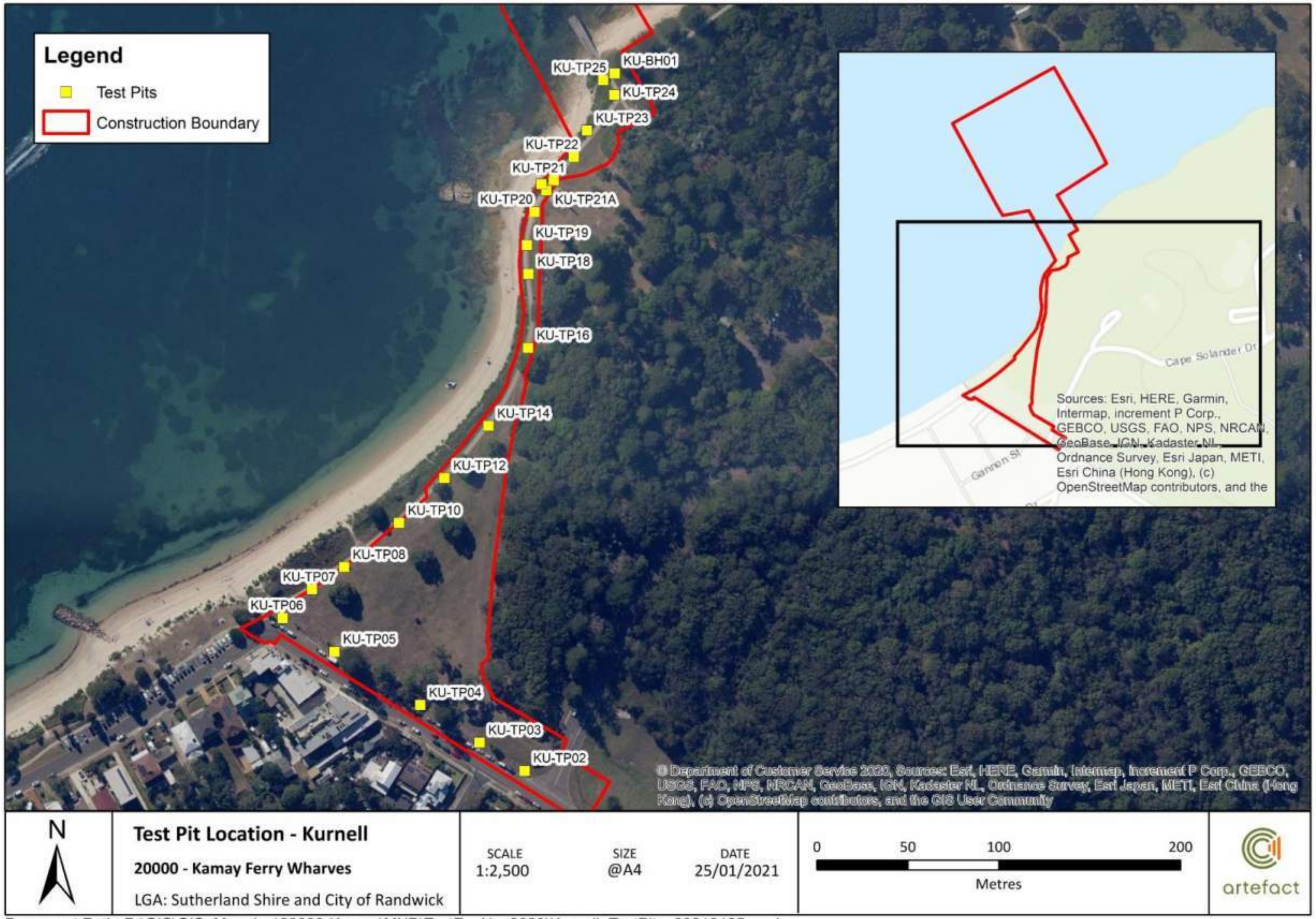

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Figure 40: Location of test pits (Kurnell)

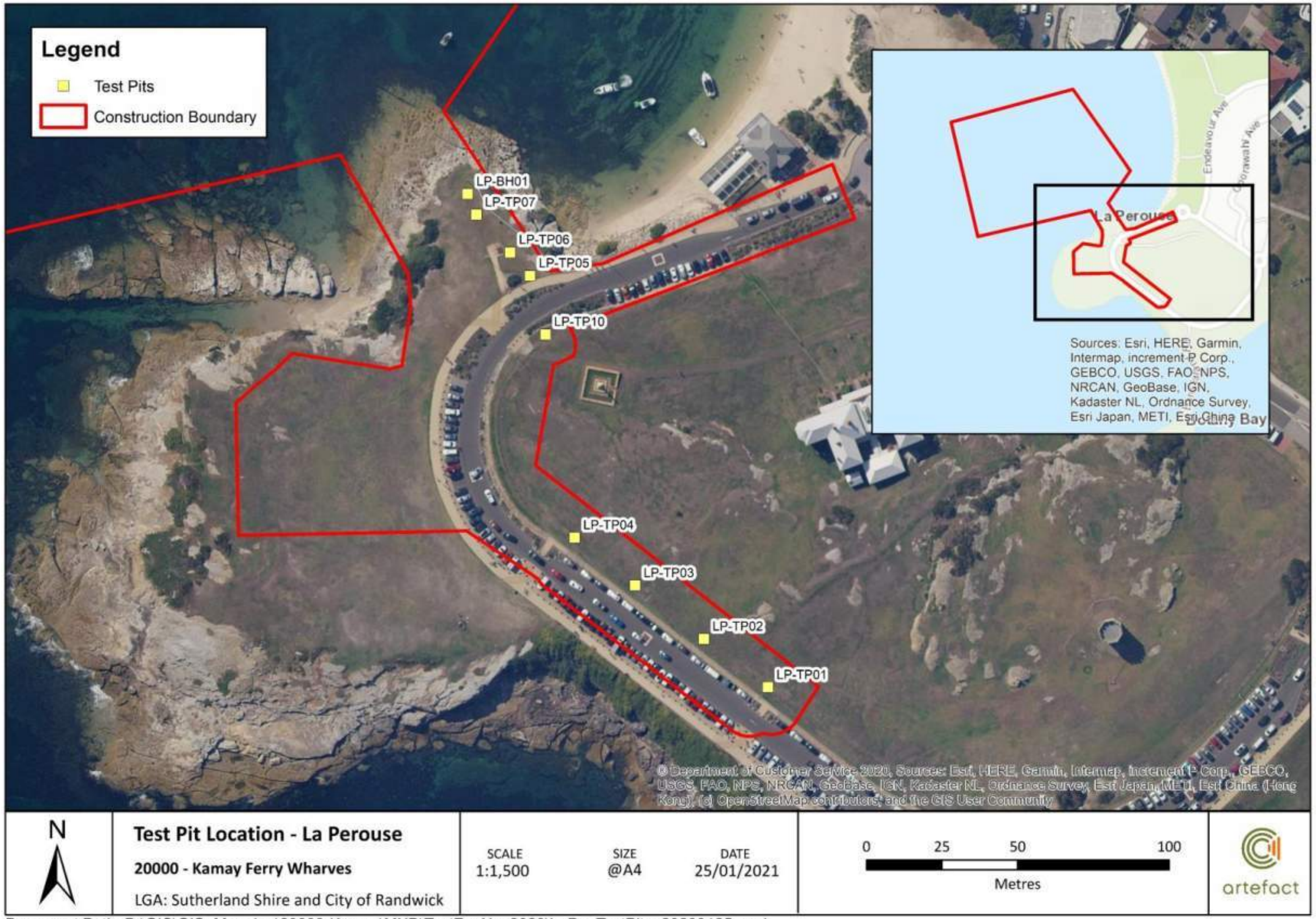

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Figure 41: Location of test pits (La Perouse)

Table 12: Excavation area

Location	Total abandoned due to constraints (incomplete)	Total excavated (completed)
Kurnell	6	16
La Perouse	6	3
Total	12	19

6.4 Ground penetrating radar survey

GPR survey was conducted at the test pit locations prior to the excavation at both Kurnell and La Perouse. GPR survey was conducted by Dr Sam Player on 21-22 October and 28 October 2020. The purpose of the GPR survey was to provide a non-invasive method of identifying potential burials associated with AHIMS ID 52-3-0219 – a recorded shell midden with burials, or within the remainder of the testing area. The GPR survey did not conclusively identify any results that would indicate a burial at the surveyed test pit locations.

6.5 Excavation procedure

The test excavations were undertaken as a combined Aboriginal and non-Aboriginal archaeological test excavation. The test excavation methodology utilised hand excavated test pits measuring 1 m x 1 m. All excavated test pits were recorded in detail including photographs, level readings and context sheets (where non-Aboriginal features were identified). Stratigraphic sections detailing the stratigraphy and features within the excavated deposit were also drawn.

All test pits were excavated by arbitrary 100mm spits. Excavation depth was guided by:

- Depth of impacts:
    - The majority of the proposed utilities footprint did not exceed approximately 900mm depth, with some portions of the design (stormwater pits, for example) planned to a depth of approximately 1.2 m. Archaeologist test excavation did not exceed proposed impact depths in those portions of the construction boundaries
    - Borehole locations – archaeological test excavation needed to reach archaeological sterile layer or the limit of safe excavation depth (1.5 m) before cessation of excavation. KU-BH01 did reach 1.5 m in depth, however, the borehole has yet to investigated
- Archaeological test excavation did not exceed a safe depth. No test excavations exceeded the safe depth at either Kurnell or La Perouse
- Water table – hand excavation beneath the water table poses a limitation for both safety and integrity of the excavation program. In sandy contexts section walls are likely to start collapsing once the water table is reached, potentially leading to a larger area of impact and loss of excavation integrity. Test excavations at KU-TP18 and LP-TP 01 did reach the water table and consequently work on these pits ceased
- Encountering human remains – *excavation will cease at any location where human remains are encountered and the NSW police be notified.* Where bone fragments were recovered from KU-TP14 and KU-BH01 during the test excavations, works ceased at those locations and specialist

advice was sought from Dr Denise Donlon to identify if the fragments were potentially human skeletal remains. Dr Donlon confirmed that none of the bone fragments retrieved during the test excavations represented human skeletal remains

- Non-Aboriginal archaeological remains – test excavation undertaken at KU-TP19 (concrete slab), KU-TP20 (concrete slab), KU-TP21 (concrete slab), KU-TP21a (concrete slab), KU-TP22 (concrete slab), KU-TP23 (sea wall), KU-TP24 (sea wall and concrete slab), LP-TP05 (old wharf road) and LP-TP06 (old wharf road) identified non-Aboriginal archaeological remains. Where non-Aboriginal archaeological remains were determined to be significant (the sea wall and old wharf road) these were retained *in situ*. After the remains of the concrete slab had been assessed as not reaching the threshold of local significance, the concrete was removed and excavations resumed in KU-TP20, KU-TP21 and KU-TP21a.

All material retrieved from the test pits was dry sieved, by hand, through 3mm mesh. All sieving occurred over tarps and sieved material was used for backfilling and compacted at the end of the excavation. Wet sieving was not utilised for this project.

Recovered stone and historical artefacts were bagged and labelled with contextual information (test pits ID and spit/context number). These items were taken off site for analysis.

6.6 Constraints

Constraints encountered during the test excavation program resulted in the abandonment of some of the planned test pits. Asbestos was identified in three of the test pits at Kurnell (KU-TP04, KU-TP05 and KU-TP06) and four test pits at La Perouse (LP-TP04, LP-TP07, LP-BH01, LP-TP10). These test pits were abandoned in accordance with Arup's contaminated material procedure.

Water seepage occurred in KU-TP18 and LP-TP01 at depths of 600mm and 1250mm respectively. Every attempt was made to continue excavation in KU-TP18 by removing the water, however the rate of inundation exceeded the rate of excavation and as a result the test pit could not be completed. Despite the water seepage excavation in LP-TP01 was able to be completed.

The identification of non-Aboriginal historical features which could not be impacted at the time of excavation limited the completion of some of the test pits to the required depth. Test pits which could not be completed due to the presence of non-Aboriginal archaeological remains included LP-TP05 LP-TP06 (old wharf road), and KU-TP19 (concrete slab). The concrete slab only partially covered KU-TP18, KU-TP22 and KU-TP24 and therefore the test pits were still partially completed to depth. The concrete in KU-TP20, KU-TP21 and KU-TP21a was carefully saw cut and lifted. This process was chosen as it would not affect the underlying stratigraphy and as such, the excavation of these test pits could be completed.

7.0 EXCAVATION RESULTS

7.1 Soils, disturbance, constraints and features

7.1.1 Kurnell testing program

A total of 22 units were excavated as part of the testing program at Kurnell, 16 of which were carried through to completion (refer to Section 6.6 on constraints). In general, soils were comprised of a shallow topsoil overlying redeposited material with extensive grass roots, rubble and other inorganic litter which was indicative of multiple fill events. The fill directly overlayed natural sands which comprised of a coarse medium grained yellow sand with well sorted shell in varying degrees of intactness.

Three test pits (KU-TP04, KU-TP-TP05 and KU-TP06) were abandoned due to identification of contaminated material. KU-TP18 was inundated with water at approximately 600mm depth and therefore excavation could not reach the required depth.

Fragments of bone were identified in several of the test pits (KU-BH01, KU-TP20, KU-TP16, KU-TP14) which were found in both fill and intact deposits. All bone fragments were analysed by Dr. Denise Donlon (Forensic Anthropologist) and none were determined to be human.

A concrete feature, identified as a former footpath, was exposed in KU-TP19, KU-TP20, KU-TP21, KU-TP21a and KU-TP22. The concrete was saw cut and hand excavation continued in KU-TP20, KU-TP20 and KU-TP21a. Additional non-Aboriginal features were identified in KU-TP23, KU-TP24 and KU-TP25. These non-Aboriginal features were left *in situ*. The non-Aboriginal archaeological features identified are discussed in Section 7.2.

KU-TP25 contained a significant amount of shell material between 600-900mm below ground surface however was determined not to be midden material. This is further discussed in Section 8.3.1.

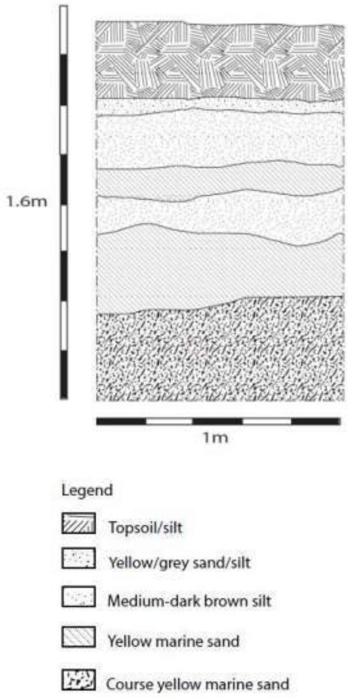
A sample summary of the soils encountered in the testing area is provided below (Table 13 to Table 21).

7.1.1.1 KU-BH01

Table 13: Summary of stratigraphy KU-BH01

Soil Horizon	Description
Fill	0-850mm Lenses of fill material including medium to dark-brown sand/silt mixture and coarse yellow sand. Inclusions: shell, shell fragments, bone fragments, ceramic fragments, glass fragments.
Sand	850-1500mm Coarse yellow marine sand Inclusions: shell, shell fragments, bone fragments, glass fragments.

KU-BH01 North Section **Drawing Scale 1:10**

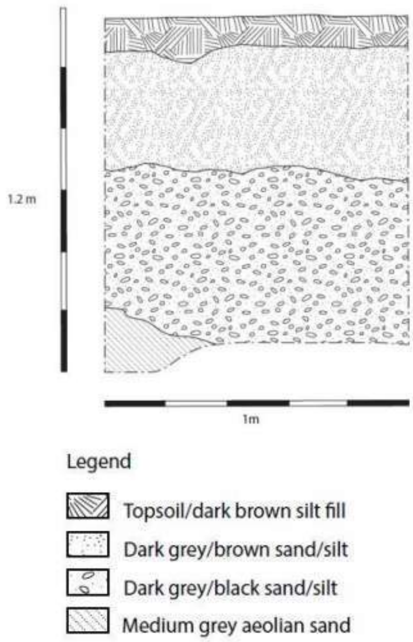


KU-TP02

Table 14: Summary of stratigraphy KU-TP02

Soil Horizon	Description
A Horizon	0-100mm Grass and associated root system. Dark brown/black sand/silt mixture. Sand/silt is of medium grain. Inclusions: few gravels
Fill	100-950mm Dark grey and black sandy silt. Inclusions: fragments of concrete, asphalt, gravels, pebbles
Sand	950-1200mm Medium grained grey aeolian(?) sand Inclusions: nil

KU-TP02 North Section	Drawing Scale 1:10

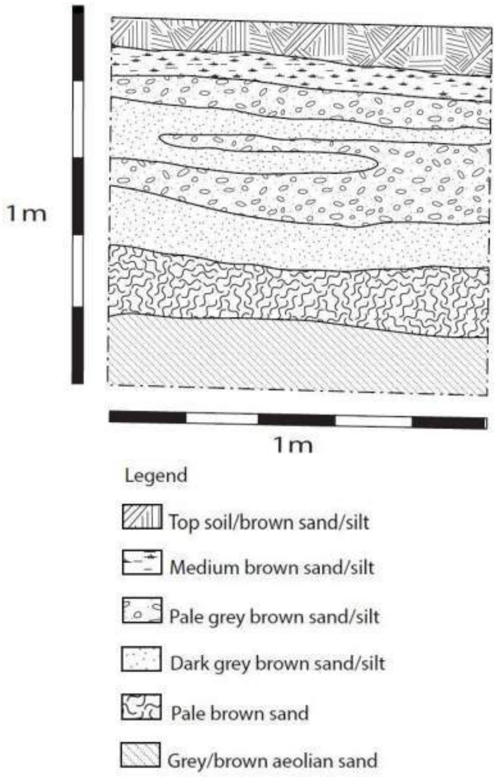


KU-TP07

Table 15: Summary of stratigraphy KU-TP07

Soil Horizon	Description
A Horizon	0-80mm
Fill	80-350mm Layers of fill deposit including medium brown sand/silt mixture of a medium grain, loosely compact fine grain grey brown and yellow brown sand/silt mixture. Inclusions: Blue stone and shell fragments, charcoal fragments
Sand	350-900mm Loosely compact fine-medium grain grey, brown aeolian (?) sand Inclusions: shell fragments

KU-TP07 North Section **Drawing Scale 1:10**

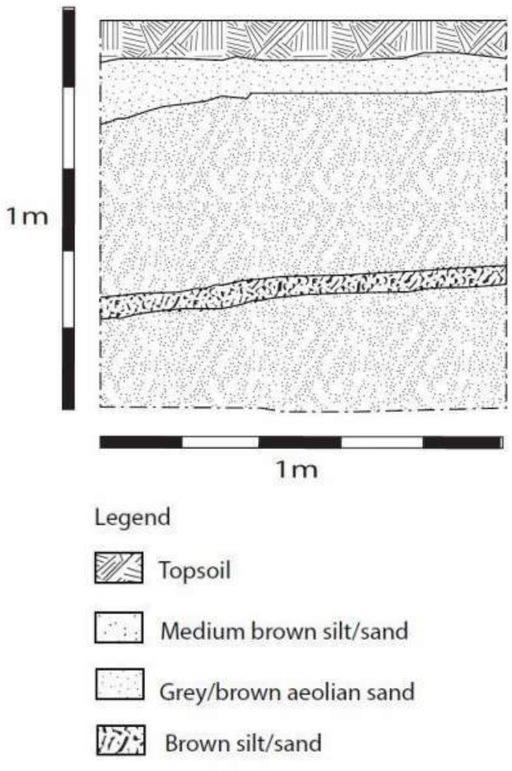


7.1.1.2 KU-TP12

Table 16: Summary of stratigraphy KU-TP12

Soil Horizon	Description
A Horizon	0-60mm Medium brown topsoil with grass rootlets
Fill	60-650mm Medium brown sand/silt mixture of a medium grain. Inclusions: Blue stone and shell fragments, charcoal fragments
Sand	650-900mm Loosely compact fine-medium grain grey, brown aeolian (?) sand Inclusions: shell fragments

KU-TP12 North Section **Drawing Scale 1:10**

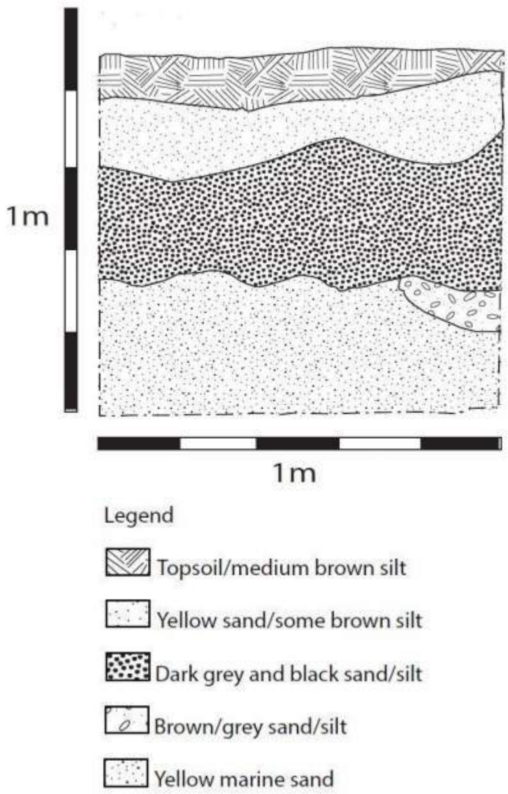


KU-TP14

Table 17: Summary of stratigraphy KU-TP14

Soil Horizon	Description
A Horizon	0-60mm Medium brown topsoil with grass rootlets
Fill	60-550mm Fill material comprising of Dark grey and black silt/sand. Inclusions: pebbles, blue-stone, road aggregate
Sand	550-900mm Coarse yellow marine sand Inclusions: shell, shell fragments, bone fragments.

KU-TP14 North Section **Drawing Scale 1:10**

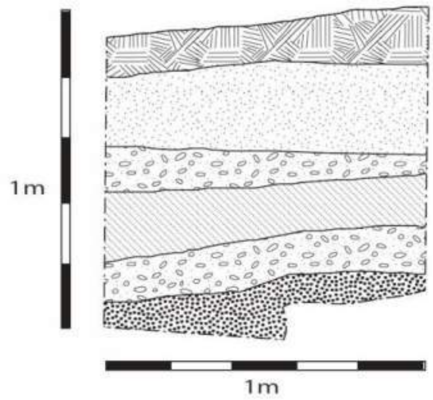


KU-TP16

Table 18: Summary of stratigraphy KU-TP16

Soil Horizon	Description
A Horizon	0-100mm Medium brown topsoil with grass rootlets
Fill	100-350mm Dark grey/brown silt/sand mixture. Grass and tree roots throughout section. Inclusions: Shell, inorganic litter and bone fragments.
Sand	350-600mm Coarse yellow marine sand Inclusions: shell
A Horizon (buried)	600-800mm Brown silty sand, with orange discolouration from sandstone Inclusions: shell, one stone artefact
R Horizon	800mm Sandstone bedrock

KU-TP16 North Section **Drawing Scale 1:10**

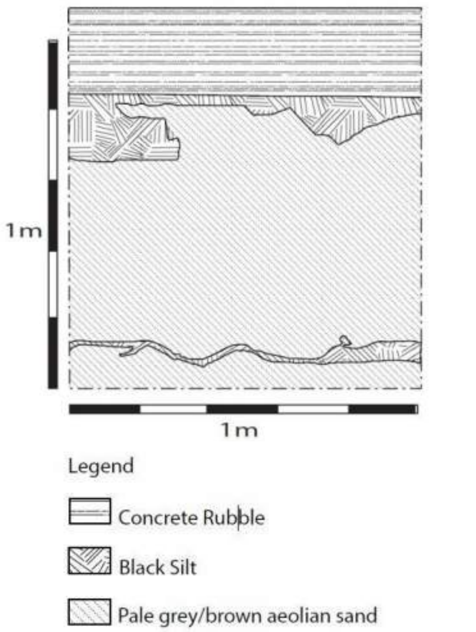


7.1.1.3 KU-TP21a

Table 19: Summary of stratigraphy KU-TP21A

Soil Horizon	Description
Fill	0-400mm Fill overlying concrete pathway and dark brown silt fill underlay.
Sand	400-700mm Fine grain pale grey-brown aeolian (?) sand to pale white sand. Inclusions: shell, shell fragments, broken glass and charcoals fragments.
A Horizon (Buried)	700-800mm Dark brown silty sand. Inclusions: shell fragments, rubble and degraded sandstone
R Horizon	800mm Sandstone bedrock

KU-TP21a North Section	Drawing Scale 1:10

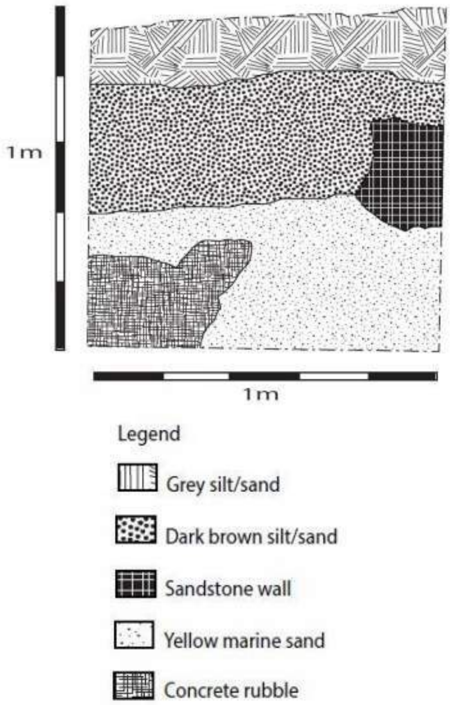


KU-TP23

Table 20: Summary of stratigraphy KU-TP23

Soil Horizon	Description
Fill	0-500mm Dark brown silty sand Inclusions shell, glass, gravel, fragments of asphalt
Sand	500-900mm Coarse yellow marine sand Inclusions: shell, sandstone rubble wall cut into the deposit, one stone artefact

KU-TP23 North Section **Drawing Scale 1:10**

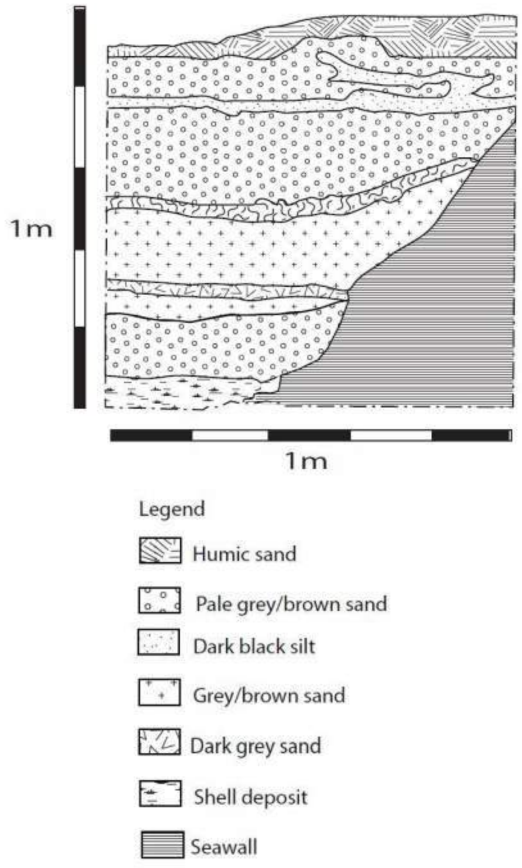


7.1.1.4 KU-TP25

Table 21: Summary of stratigraphy KU-TP25

Soil Horizon	Description
A horizon	0-20mm Humic sand with vegetation and rootlets
Fill/ natural deposition of sand	20-900mm Horizons of very loose grey-brown sand. N.B buried landing place wharf abutment protruding from northeast wall Inclusions: very high proportion of modern refuse material increasing with depth, high concentration of shell material Spits 7-9

KU-TP25 West Section **Drawing Scale 1:10**



7.1.2 La Perouse testing program

A total of 9 units were excavated as part of the testing program at La Perouse, 3 of which were carried thought to completion. Both contaminated material and the identification of non-Aboriginal archaeological features limited the extent to which the test program could be completed at the remainder of the test pits. This is further discussed in Section 6.6.

The three excavated test pits identified that the stratigraphy generally comprised of fill, evidenced by the concentration of non-organic debris, overlying natural deposits.

Non-Aboriginal archaeological remains of the old wharf road were identified in LP-TP05 and LP-TP06. The archaeological remains were left *in situ*. The non-Aboriginal features identified are discussed in Section 7.2.

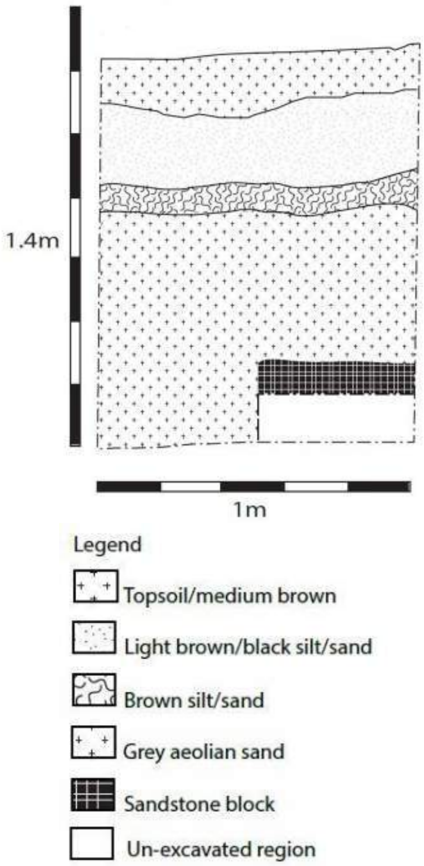
A summary of the soils encountered in the completed test pits in the testing area, and one test pit containing the non-Aboriginal archaeological remains of the old wharf road, is provided below (Table 22 and Table 24).

7.1.2.1 LP-TP01

Table 22: Summary of stratigraphy LP-TP01

Soil Horizon	Description
A Horizon	0-100mm Medium brown topsoil with grass rootlets
Fill	100-500mm Dark grey/black sand/silt mixture of a medium grain. Inclusions: sandstone fragments, gravel, concrete fragments and non-organic matter
Sand	500-1200mm Fine grain loosely compact grey aeolian (?) sand. Inclusions: nil
R horizon	1000-1200mm Undulating sandstone bedrock

LP-TP01 North Section **Drawing Scale 1:10**

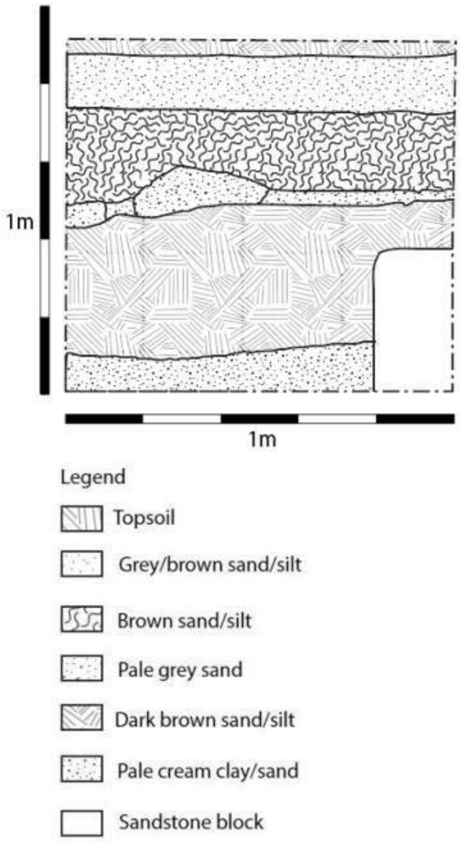


7.1.2.2 LP-TP03

Table 23: Summary of stratigraphy LP-TP 03

Soil Horizon	Description
A Horizon	0-50mm Dark brown topsoil with grass rootlets
Fill	50-750 Sediment transitions from fine grain dark brown silt/sand to brown/green gravel/sand/silt mixture. Sediment is loosely compacted. Clay nodules exposed through section Inclusions: Gravel and mixed sandstone rubble
C Horizon	750-800 White clay, degraded sandstone bedrock Inclusions: nil
R Horizon	800mm Sandstone bedrock

LP-TP03 West Section **Drawing Scale 1:10**



7.1.2.3 LP-TP05

Table 24: Summary of stratigraphy LP-TP05

Soil Horizon	Description
Fill	0-600mm Dark brown/black silty sand and gravel fill, sediment is loosely compacted within shale like aggregate deposit dominating section Inclusions: gravel, blue stone
Structure	600mm Old Wharf Road surface

LP-TP05 West Section **Drawing Scale 1:10**

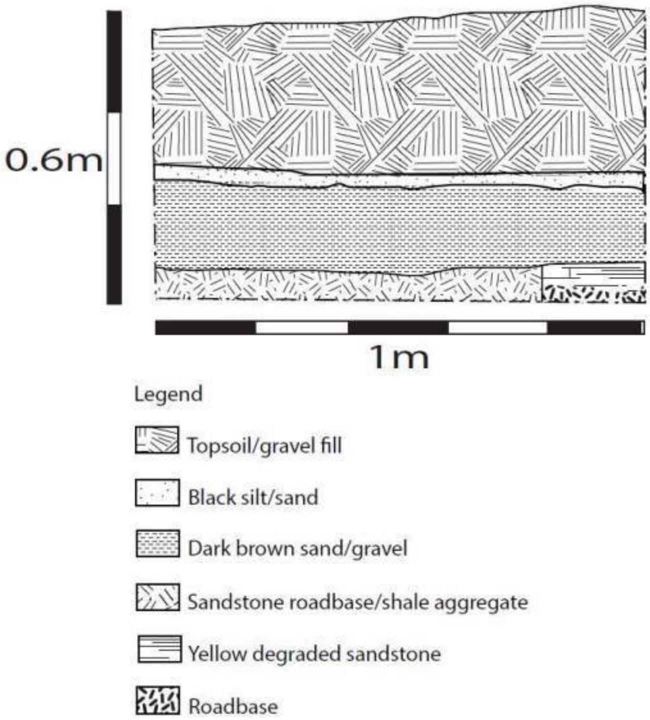


Table 25: Summary of excavation depths across the project area

Test area	Test pit	Depth excavated (mm)	Completed/obstructed
Kurnell	KU-BH01	1500	Completed
	KU-TP02	1200	Completed
	KU-TP03	900	Completed
	KU-TP04	200	Obstructed
	KU-TP05	100	Obstructed
	KU-TP06	400	Obstructed
	KU-TP07	980	Completed
	KU-TP08	900	Completed
	KU-TP10	900	Completed
	KU-TP12	900	Completed
	KU-TP14	900	Completed
	KU-TP16	800	Obstructed
	KU-TP18	600	Obstructed
La Perouse	KU-TP19	140	Obstructed
	KU-TP20	900	Completed
	KU-TP21	900	Completed
	KU-TP21A	1000	Completed
	KU-TP21B	900	Completed
	KU-TP22	930	Completed
	KU-TP23	900	Completed
	KU-TP24	900	Completed
	KU-TP25	900	Completed
	LP-TP01	1200	Completed
	LP-TP02	700	Completed
	LP-TP03	830	Completed
	LP-TP04	300	Obstructed
	LP-TP05	560	Obstructed
	LP-TP06	400	Obstructed
	LP-TP07	200	Obstructed

Test area	Test pit	Depth excavated (mm)	Completed/obstructed
	LP-TP10	300	Obstructed
	LP-BH01	200	Obstructed

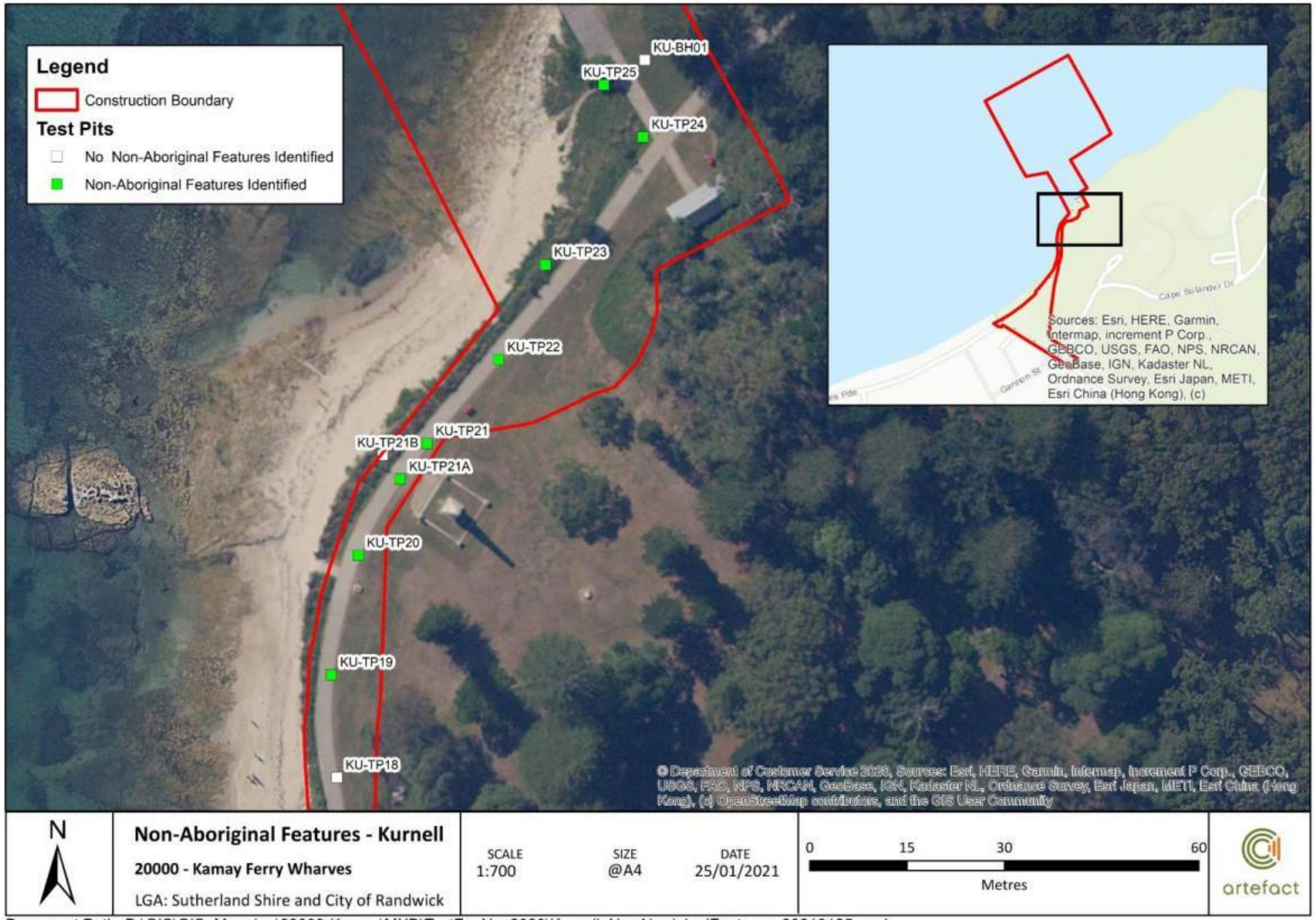


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Figure 42: Location of the test pits (Kurnell) containing non-Aboriginal features

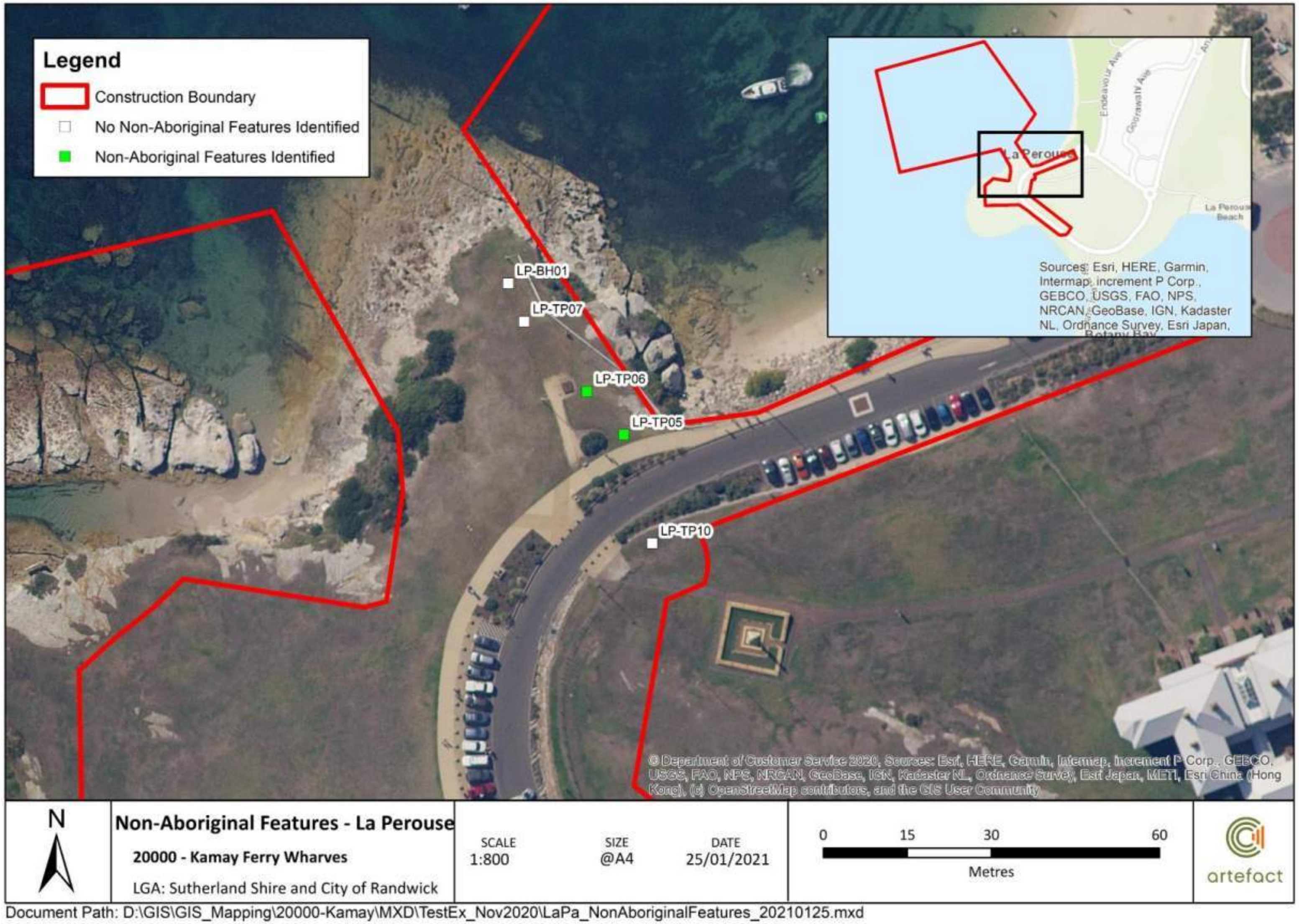

Figure 43: Location of the test pits (La Perouse) containing non-Aboriginal features

7.2 Non-Aboriginal archaeological features

A summary of the non-Aboriginal archaeological features that were identified during the test excavation program is provided below.

7.2.1 KU-TP19, KU-TP20, KU-TP21, KU-TP21a, KU-TP22 and KU-TP24

Evidence of a concrete slab alongside Monument Track in the Kurnell construction boundary was encountered in six of the test pits. In KU-TP18, KU-TP22 and KU-TP24 the concrete slab partially covered the test pit (in KU-TP24 only a small portion was present in the corner of the test pit). In KU-TP19, KU-TP20, KU-TP21 and KU-TP21a the concrete slab covered the entire 1 x 1m test pit (Figure 44).

The concrete slab was initially left *in situ* during the test excavation program at Kurnell. Following the completion of the main portion of the test excavation program a separate heritage assessment was prepared for the concrete slab (Artefact 2020b), which assessed that it did not reach the threshold of local significance. Following this, the slab was saw cut and carefully removed in KU-TP20, KU-TP21 and KU-TP21a on 24 November 2020 to allow excavations to continue in those test pits.

The concrete slab was located at a depth of 150mm below the ground surface. Where excavations could continue beside the slab, it was demonstrated to be about 60-70mm thick with an uneven base (Figure 45), indicating that it had likely been poured over the undulating fill deposit. . Where the slab was removed in KU-TP20, KU-TP21 and KU-TP21a it was found that the concrete did not continue underneath Monument Track. The concrete contained blue metal aggregate, but no metal reinforcement bars. There was no visible evidence that the concrete slab encountered was made up of multiple separate slabs.

Figure 44: Overview of the concrete slab encountered in KU-TP20

Figure 45: Profile view of the concrete slab in KU-TP22 where the concrete did not cover the entire test pit and therefore excavations were able to continue beside it

7.2.2 KU-TP23

Excavations in KU-TP23 encountered a north-east by south-west oriented linear feature constructed of irregular sandstone blocks at a depth of 500mm, which appeared to form a wall (Figure 46). The wall was located along the north-east side of the test pit. Individual blocks ranged in size from 400 x 170 x 200mm to 180 x 130 x 120mm and were not bonded. The wall extended to a depth of 400mm (two courses).

As the archaeological remains of the wall were identified as being of significance they were left *in situ* and reburied in accordance with the TEM.

Figure 46: Sandstone wall feature identified in KU-TP23

7.2.3 KU-TP24

Excavations in KU-TP24 encountered a north-west by south-east oriented sandstone wall at a depth of 600mm (Figure 47). The wall consisted of irregularly shaped sandstone blocks on its south-western face measuring 250 x 250 x 100mm. The interior of the wall was constructed of packed irregular sandstone blocks and rubble material. The overall exposed portion of the wall measured 1000 x 950mm in plan. The base of the wall was not exposed during the test excavation program.

The wall was more substantial than the feature identified in KU-TP23 and in alignment with the adjacent sandstone landing that is visible beneath the extant jetty. However, unlike the extant sandstone landing the wall found in KU-TP24 the exterior face of the wall was roughly vertical (i.e. the wall was not 'tipped').

As the archaeological remains of the wall were identified as being of significance they were left *in situ* and reburied in accordance with the TEM.

Figure 47: Sandstone wall feature identified in KU-TP24

7.2.4 KU-TP25

Excavations in KU-TP25 identified the continuation of the sandstone landing that is visible beneath the extant jetty (Figure 48). The landing was comprised of irregular sandstone blocks running parallel to the extant jetty. The sandstone blocks typically measured about 450 x 200mm, with the exposed section of the wall measuring 1000 x 1000 x 900mm. The landing was not vertical, which can be seen from the extant section that is visible on the surface, and widened outwards at the base. Six courses of sandstone were exposed. The base of the landing and its widest extent were not exposed during the test excavation program.

As the structural remains of the landing were identified as being of significance they were left *in situ* and reburied in accordance with the TEM.

Figure 48: Sandstone wall feature identified in KU-TP24

7.2.5 LP-TP05 and LP-TP05

Excavations in LP-TP05 and LP-TP06 exposed a 100mm thick compacted layer of dark grey-black aggregate, gravel and bitumen interpreted as being a former road surface (Figure 49). The layer was located 200-500mm below the ground surface and sealed a layer of compacted sandstone rubble fill (Figure 50).

Because the bitumen surface on its own may not have represented significant archaeological remains of the former approach road, excavations continued into the bitumen surface. Excavations ceased within these test pits at the top of the sandstone rubble fill once it had been confirmed that archaeological remains of the former approach road had been uncovered, and that the archaeological feature was intact and would therefore be of significance in accordance with the La Perouse Headland CMP. The archaeological remains were then reburied in accordance with the TEM.

Figure 49: Gravel surface layer of the road construction identified in LP-TP05

Figure 50: Sandstone body of the road construction identified in LP-TP06

8.0 ANALYSIS AND DISCUSSION

8.1 Site integrity and extent

8.1.1 Kurnell

The results of the test excavation program at Kurnell indicate that the area has been subject to multiple fill events that have stabilised the underlying natural sands. The fill material comprised largely of multiple stratigraphic units containing modern refuse, shell and isolated fragments of bone. The underlying marine sand contained shell material in varying degrees of intactness as well as some refuse material such as worn glass or plastic.

8.1.2 La Perouse

The results of the test excavation program at La Perouse indicate that the area has been filled and levelled to create the existing topography on the headland. Upper fill deposits comprised of general refuse, gravel and sandstone rubble. The sandstone rubble is likely to have derived, and been redeposited, from the local landscape. Three of the test pits encountered a natural sandstone bedrock. Sandstone outcrops are evident in the surrounding landscape.

8.2 Identified site formation processes

8.2.1 Kurnell

Completed test pits adjacent to Monument Track (KU-TP07 through KU-TP23) show fill over natural marine sand. The presence of an upper layer of fill in the vicinity of Monument Track has been documented by previous archaeological test excavation in the area (Irish 2007) and through historical research (see Section 4.3.4.1). Historical research indicates that fill was introduced to support the sea wall and foreshore stabilisation works in the late 19th/ early 20th centuries.

Test excavation has documented marine sand beneath approximately 400-500mm of fill. The encountered marine sand is likely to be remnant foreshore aeolian and water deposited sands. As described in Section 4.3.4.1, the foreshore area at Kamay in the early 19th century was likely to have been stabilised by coastal shrub vegetation and grasses, which were partially cleared and kept clear throughout the remainder of the 19th century/ early 20th century. As shown by historical photographs in Section 4.3.4.1, this process is likely to have resulted in some destabilisation and possible movement of exposed foreshore marine sands. The exposed marine sands were then sealed over with fill behind the sea wall and are likely to only have been exposed again where the sea wall was damaged during large storms.

With the exception of occasional animal bone and two stone artefacts, the lack of inclusions and podsols in the buried marine sand in KU-TP07 through KU-TP25 and KU-BH01 indicates the encountered marine sands are remains of a dynamic foreshore dune that was likely to have been at least partially exposed and re-worked during the 19th century.

Test excavation on the southern side of the jetty landing (KU-TP24 and KU-TP25) demonstrated fill over recent marine sediments, particularly in KU-TP25. The identification of modern rubbish in the marine sand supports the aerial photography analysis in Section 4.3.4.1 that the location of KU-TP25 was an exposed intertidal area until the 1970s. On the northern side of the jetty landing, KU-BH01 demonstrated marine sands with 20th century rubbish beneath the overlying fill. These results support the suggestion from analysis of aerial photographs in Section 4.3.4.1 that this location was disturbed in the 1970s from either storm damage or works in that area which exposed the underlying sand.

8.2.2 La Perouse

Completed test pits at La Perouse on the northern side of Anzac Parade (LP-TP01 – LP-TP03) demonstrate deep fill (approximately 500-700mm) overlying natural sands onto sandstone bedrock. The presence of fill has been documented through historical research (see Section 4.3.4.1).

One of the three completed test pits comprised of fill overlying a sterile fine-grained sand, with little to no inclusions, directly overlying sandstone bedrock. It is likely the sand is a natural aeolian deposit, accumulated by wind on the south-west portion of the headland. The accumulation of the sand directly on the sandstone indicates, in this particular location, the sandstone was exposed at the time of the sand deposition.

Two of the remaining three completed test pits identified fill directly on sandstone bedrock. This would indicate that at the time of the fill deposition, the sandstone was exposed. Exposed sandstone outcrops are still extant on the La Perouse headland however earlier imagery (see Section 4.3.4.1) show that these sandstone outcrops were more frequent in the early 20th century.

The remaining five test pits that weren't completed only identified a fill deposit before the pits were terminated. As such, the test excavation results indicate that the La Perouse headland has undergone some modification largely evident in the importation of fill to level the headland. As discussed in see Section 4.3.4.1, the landscape modifications associated with the military developments, landscaping, amenities and road/car park construction have resulted in the introductions of fills across the headland through the 19th-20th centuries.

8.3 Aboriginal Archaeology

8.3.1 Shell material

KU-TP25 identified a significant deposit of shell material between 600-900mm below the ground surface. Analysis of species representation and morphology was carried out on shell derived from Spit 7 (600-700mm below surface). This material weighed a total of 1792 grams and represents an estimated 10% by weight of the total shell material retrieved during this phase of excavation. A sample of 10% was determined an adequate statistically representative sample. As shown in Table 26 below, the vast majority of shell (95%) is blue mussel (*Mytilus galloprovincialis)*, with no other species contributing more than 2% of total. Abundant refuse material was incorporated with the shell material. This includes plastic, metal and glass inclusions which indicate that these shells date to no earlier than the second half of the 20th century.

Mytilus galloprovincialis is an invasive species originating in the Mediterranean and which is thought to have originally invaded Australian waters from the Atlantic during the Pleistocene (2.5 million to 11,500 years ago), with subsequent major invasion resulting in modern times as a result of ship-borne introduction.[1] *Mytilus galloprovincialis* grows faster and larger on exposed shores that are not subject to extreme wave action. In such locations, greater water flow results in increased rates of waterborne nutrients. These conditions lead to *Mytilus galloprovincialis* becoming highly competitive in terms of growth and condition, when compared to other shell species. [2]

Analysis has determined that the shell material identified in KU-TP25 (600-700mm below surface) does not represent Aboriginal shell midden material. The assemblage is predominated by *Mytilus*

[1] Svane, I. 2011. An Overview of the Blue Mussel in Southern Australia – A Serial Invader, a Blind Passenger, or Just a welcome Addition to the Menu? *Transactions of the Royal Society of South Australia, Incorporating Records of the South Australian Museum 135(2)*

[2] Steffani, C., Branch, G. 2003. Growth rate, condition, and shell shape of Mytilus galloprovincialis: Responses to wave exposure *Marine Ecology Progress Series* 246:197-209

galloprovincialis that it would indicate a homogenous environment or mussel colony that had outperformed competing species (see Section 8.2).

Table 26: KU-TP25 shell analysis spit 7

Location	Test Pit	Spit	Depth mm	Element	Common name	Weight (g)	% of total weight
Kurnell	KU-TP25	7	600-700	Shell	Mussell	1700	94.87%
Kurnell	KU-TP25	7	600-700	Shell	Bivalve	25	1.40%
Kurnell	KU-TP25	7	600-700	Shell	Limpet / cockle	28	1.56%
Kurnell	KU-TP25	7	600-700	Bone	Fish cranial element	0.5	0.03%
Kurnell	KU-TP25	7	600-700	Operculii	Gastropod	3	0.17%
Kurnell	KU-TP25	7	600-700	Shell	Gastropod	4	0.22%
Kurnell	KU-TP25	7	600-700	Shell	Oyster	20	1.12%
Kurnell	KU-TP25	7	600-700	Shell	Crustacean	9	0.50%

8.3.2 Stone artefact assemblage

Two subsurface artefacts were identified during the excavation program at Kurnell. No artefacts were identified at La Perouse. The artefact assemblage was comprised of two isolated flakes identified within a natural deposit.

Table 27: Summary of stone artefact assemblage characteristics

Features	KMT ISO 01	KMT ISO 02
Artefact Type	Proximal flake fragment	Complete flake
Raw material type	Silcrete	Chert
Length (mm)	9.22	14.49
Width (mm)	9.56	13.77
Thickness (mm)	2.50	3.88
Weight (g)	0.44	1.28

8.3.3 AHIMS database updates

8.3.3.1 Kurnell Monument Track Isolated Find 01 (KMT ISO 01) (AHIMS ID 52-3-2080)

Site type: Isolated find

Centroid:

Site Extent:

Status:

KMT ISO 01 (AHIMS ID 52-3-2080) is comprised of one silcrete proximal flake fragment (Figure 51). The site is

The artefact was identified within natural marine sands approximately 500-600mm below the current ground surface.

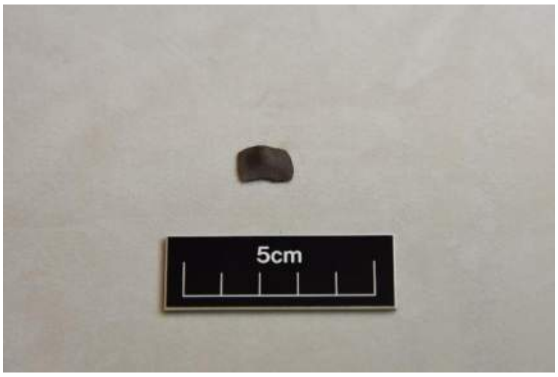

Figure 51: KMT ISO 01 recovered from KU-TP23

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Figure 52: Location shot of KU-TP23

8.3.3.2 Kurnell Monument Track Isolated Find 02 (KMT ISO 02) (AHIMS ID 52-3-2081)

KMT ISO 02 (AHIMS ID 52-3-2081) is comprised of one complete chert flake (Figure 53). The site is located along the north-west side of the Kamay Botany Bay National Park and to the east of Silver Beach The artefact was identified within natural marine sands approximately 700-800mm below the current ground surface.

Site type: Isolated find

Centroid:

Site Extent:

Status:

Figure 53: KMT ISO 02 recovered from KU-TP16

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Figure 54: Location shot of KU-TP16

8.4 Non-Aboriginal archaeology

8.4.1 Foreshore track

During the test excavation program, a separate heritage assessment was prepared for the concrete slab feature that was identified in KU-TP19, KU-TP20, KU-TP21, KU-TP21a, KU-TP22 and KU-TP24 in order to determine if the archaeological feature was significant and could be impacted during the testing program (Artefact Heritage 2020b).

The assessment determined that the concrete slab feature represents the former Foreshore track that was established in c.1923-32 (Figure 55). This pathway can be identified on historical aerial photographs from the mid-twentieth century (Figure 56) which indicate that the former pathway mostly followed the alignment of the existing Monument Track constructed in 2009.

Concrete was widely used during this period and therefore given the construction material, design and location of the concrete slab it is interpreted that it represents the remains of the former pathway.

8.4.2 Stone sea walls

Two of the test pits excavated at Kurnell identified portions of sandstone wall that likely represent sea or retaining walls. Although the exact relationship between the walls identified in KU-TP23 and KU-TP24 could not be confirmed during the test excavation program, it is interpreted that two separate walls were encountered.

The sandstone wall encountered in KU-TP23 was located along the north side of the test pit. The Meeting Place Precinct CMP identifies that to the south of the extant jetty a 'coursed stone sea wall' is present alongside Monument Track and the foreshore (Figure 55). This sea wall is still extant and can be seen from the foreshore further to the south of the jetty. However, adjacent to the jetty the sea wall has been covered over by vegetation and sand. The location of the wall can be seen in the 1955 aerial imagery of the site (Figure 56). Based on the location and construction of the wall, it is interpreted that the sandstone feature identified in KU-TP23 represents the back (land side) continuation of the coursed stone sea wall that is identified in the CMP.

The sandstone wall encountered in KU-TP24 appears to be a separate feature however, as it is located further to the south of the expected location of the coursed stone sea wall as seen in aerial photographs. Based on historical data it is likely that the coursed stone sea wall was constructed around the same time that the former Trust Wharf was built in 1912. However, newspaper articles from 1912 refer to a sea wall that had been established by the Landing Place Trust 'some years ago' which had been damaged by storms (The Daily Telegraph 1912). If the coursed stone sea wall was built around 1912, likely after the storm had caused damage along the foreshore, this indicates that an earlier sea wall had been present from c.1899-1912. Therefore, as the wall encountered in KU-TP24 is located to the south of the coursed stone sea wall, it is interpreted that the wall encountered in KU-TP24 represents an earlier sea wall.

8.4.3 Trust Wharf / Landing place wharf abutment

The Meeting Place Precinct CMP identifies the extant jetty as being situated on the location of the former 1912-1974 Trust Wharf (Figure 55). This site is also within the curtilage of the 'Landing place wharf abutment', which is listed as an item of local significance on the Sutherland Shire LEP (no. A2516). Remains of the former sandstone landing place can still be seen beneath the extant jetty today. The sandstone feature exposed in KU-TP25 is the buried continuation of the former landing place.

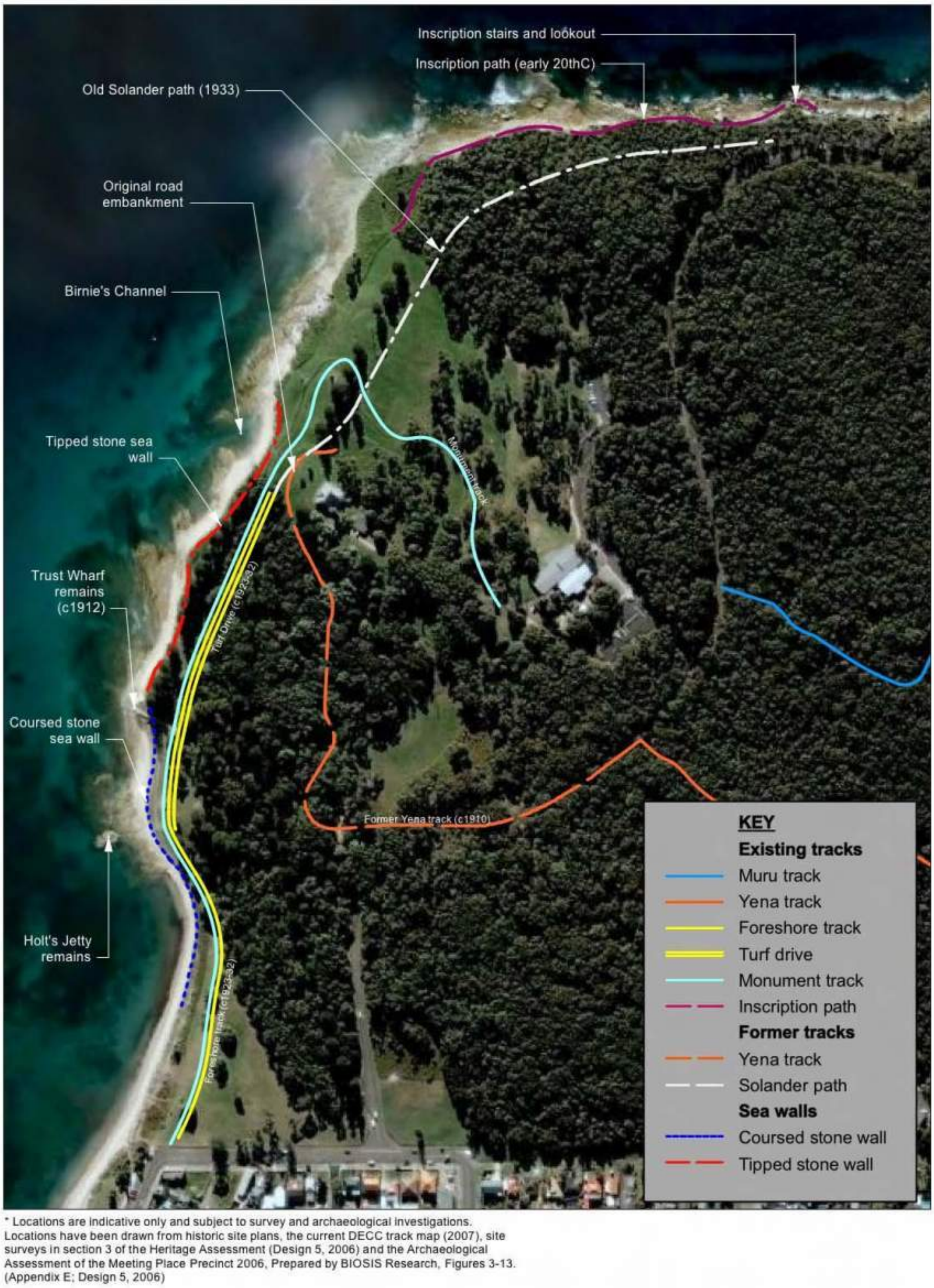

Figure 55: Circulation patterns throughout the Meeting Place Precinct (existing tracks, former tracks) and sea walls, as identified in the Meeting Place Precinct CMP (Context 2008, 28)

Figure 56: Aerial photograph of Kurnell dated to 1955, showing the former pathway of which only the northern half between Captain Cook Drive and the wharf appears to have been formalised (Sutherland Shire Council 2020)

8.4.4 Wharf approach road

The La Perouse Headland CMP archaeological sites/elements mapping and historical overlays of the La Perouse headland all indicate the presence of the former approach road that was established in c.1905 to provide access to the wharf (Figure 30 and Figure 39).

The aggregate and sandstone material identified in LP-TP05 and LP-TP06 likely represents the former surface and body of the wharf approach road. The construction method used, consisting of placing an aggregate and bitumen surface over a body of sandstone material, is consistent with historical road construction designs of the late nineteenth century.

Evidence of the former road was not identified in the adjacent test pits LP-TP07 and LP-TP08. These pits contained a loose sandstone fill that was markedly different from the compacted sandstone body of the former road. These pits did not contain aggregate or bitumen material. It is noted that these test pits were abandoned at a shallow depth due to the presence of asbestos. Evidence of the former road may also be more heavily degraded towards the foreshore and the start of the former wharf.

9.0 SIGNIFICANCE ASSESSMENT

9.1 Aboriginal archaeological significance

9.1.1 Assessment criteria

Archaeological significance refers to the archaeological or scientific importance of a landscape or area. This is characterised by using archaeological criteria such as archaeological research potential, representativeness and rarity of the archaeological resource and potential for educational values. These are outlined below:

- Research potential: does the evidence suggest any potential to contribute to an understanding of the area and/or region and/or state's natural and cultural history?
- Representativeness: how much variability (outside and/or inside the subject area) exists, what is already conserved, how much connectivity is there?
- Rarity: is the subject area important in demonstrating a distinctive way of life, custom, process, land-use, function or design no longer practised? Is it in danger of being lost or of exceptional interest?
- Education potential: does the subject area contain teaching sites or sites that might have teaching potential?

Cultural values and significance of the construction boundary are discussed in the ACHAR.

9.1.2 Scientific significance assessment

Table 28: Assessment of archaeological significance

Site (AHIMS ID)	Research potential	Representativeness	Rarity	Education potential	Overall significance assessment
KMT ISO 01 (AHIMS ID 52-3-2080)	Low	Low	Low	Low	Low
KMT ISO 02 (AHIMS ID 52-3-2081)	Low	Low	Low	Low	Low

9.1.2.1 KMT ISO 01 (AHIMS ID 52-3-2080)

Sites KMT ISO 01 (AHIMS ID 52-3-2080) is comprised of an isolated artefact, a silcrete proximal flake fragment. KMT ISO 01 has limited research potential. As an isolated flake fragment, the artefact is considered to be a common example of the artefact type in the region and therefore exhibits low rarity values. The site KMT ISO 01 (AHIMS ID 52-3-2080) is therefore considered to have low representative values and education potential.

9.1.2.2 KMT ISO 02 (AHIMS ID 52-3-2081)

Sites KMT ISO 02 (AHIMS ID 52-3-2081) is comprised of an isolated artefact, a complete chert flake. KMT ISO 02 has limited research potential. As an isolated flake, the artefact is considered to be a common example of the artefact type in the region and therefore exhibit low rarity values. The site

KMT ISO 02 (AHIMS ID 52-3-2081) are therefore considered to have low representative values and education potential.

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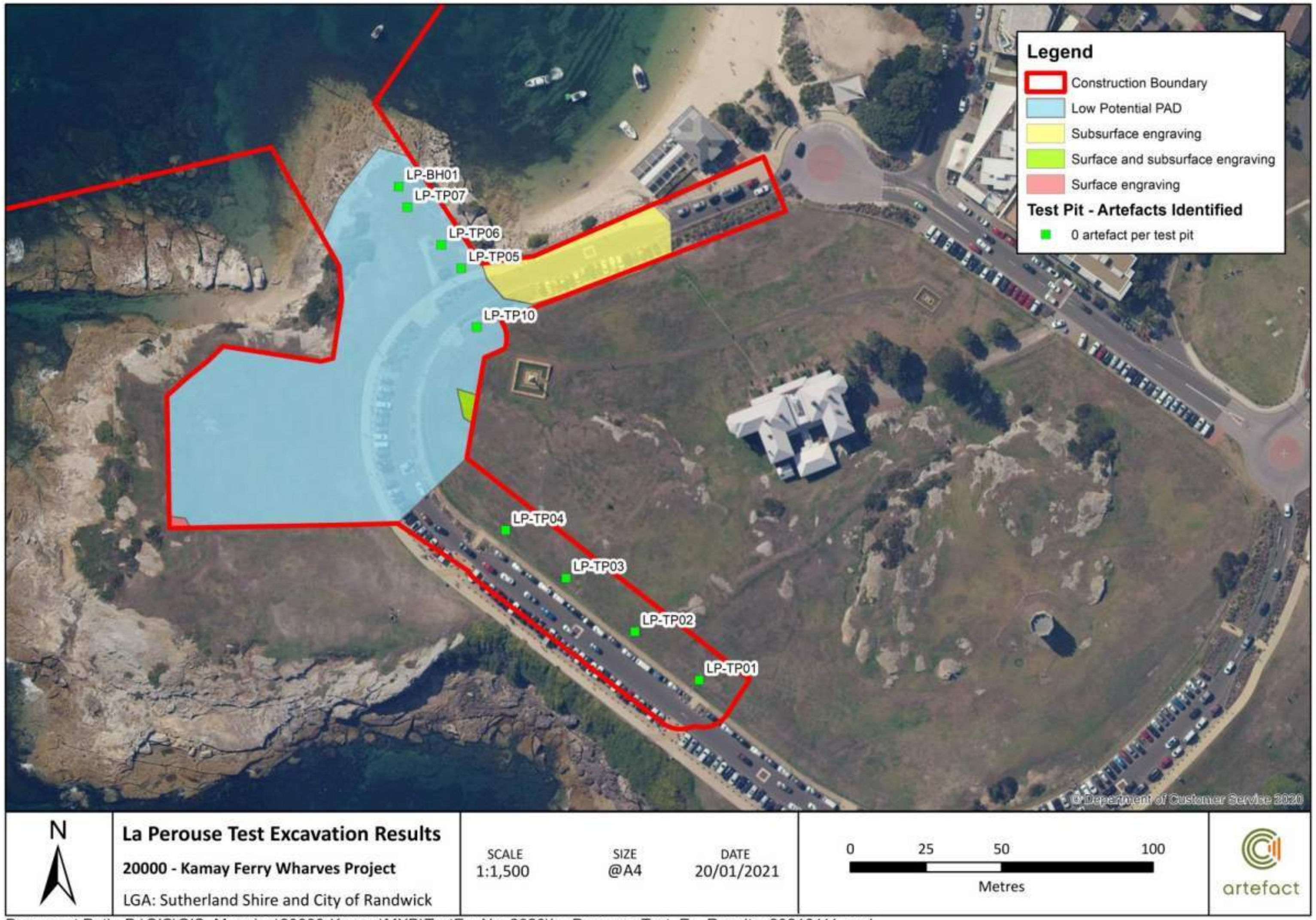
Figure 57: Location of identified Aboriginal sites - Kurnell



Document Path: D:\GIS\GIS_Mapping\20000-Kamay\MXD\TestEx_Nov2020\La Perouse_Test_Ex_Results_20210111.mxd

Figure 58: Location of identified Aboriginal sites – La Perouse

9.2 Non-Aboriginal archaeological significance

A discussion of the significance of the non-Aboriginal archaeological remains identified during the test excavation program is provided below.

9.2.1 Foreshore track

The Meeting Place Precinct CMP includes assessments of the integrated significance concepts and the assessments of contributory and relative significance of individual elements within the National heritage listed Kamay Botany Bay: Botanical Collection Sites (NHL place ID 106162). The CMP identifies tangible elements such as Yena Track, Muru Track, Former Solander Track and Monument Track as elements of local significance within the heritage item and as being associated with the concept of 'A place for leisure'. In contrast to these elements though, it was noted in the separate heritage assessment prepared for the former footpath (Artefact Heritage 2020b) that the CMP does not identify the former Foreshore track as either a tangible element of significance or as an element of archaeological potential within the heritage item.

The CMP does include policies relating to the management of the path, as outlined in Policy 5.5.12 (Context 2008, 106):

> *Historic circulation patterns should be conserved, maintained and interpreted. This includes:*
>
> - *The path following the foreshore from the Kurnell edge through the Captain Cook Drive Parkland to the Cook Obelisk, and the continuation of this route from the Cook Obelisk to the Dam (where it formerly intersected with the Yena Track, below Alpha House)*

However, it was noted that the unlike the other pathways, the Foreshore track was not included in Policy 5.5.5 as a significant element within the cultural landscape of the Meeting Place Precinct. Based on this information, it was interpreted that Policy 5.5.12 is referring more to the overall pattern of the pathways through the park rather than suggesting that the potential physical fabric of Foreshore track itself has significance.

As a result, to clarify whether the archaeological remains of the former footpath were significant, a full significance assessment was undertaken for the archaeological remains of the Foreshore track against the NSW heritage significance criteria (Artefact Heritage 2020b). This significance assessment is presented in Table 29.

Table 29: Significance assessment for the archaeological remains of the former Foreshore track

Criteria	Description
A – Historical Significance	The archaeological remains of the Foreshore track are associated with the development of Botany Bay National Park and the establishment of circulation patterns and pathways within the park to provide greater public access to the park, Captain Cook monument, and the wharf. However, the historic circulation pattern along this part of the foreshore is already represented through the extant Monument Track, and the archaeological remains contribute little to the historical significance of the park. Archaeological remains of the Foreshore track would not reach the threshold of local significance under this criterion
B – Associative Significance	The archaeological remains of the Foreshore track are not associated with the life or works of a person, or group of persons, of importance in the cultural or natural history of Botany Bay National Park. Archaeological remains of the Foreshore track would not reach the threshold of local significance under this criterion
C – Aesthetic Significance	The archaeological remains of the Foreshore track are limited to a buried concrete slab. The archaeological remains do not demonstrate particular aesthetic or technical qualities. Archaeological remains of the Foreshore track would not reach the threshold of local significance under this criterion
D – Social Significance	The former Foreshore track is associated with the concept of ‘a place for leisure’ as the track provided members of the public with access to the park, Captain Cook monument and the ferry wharf. However, the historic circulation pattern used by members of the public is retained by the extant Monument Track, and as the archaeological remains are limited to a concrete slab it is unlikely that they would be of particular significance to the local community. Archaeological remains of the Foreshore track would not reach the threshold of local significance under this criterion
E – Research Potential	The archaeological remains of the Foreshore track are limited to a concrete slab. The remains provide information regarding the change to the track alignment over time, however, this information is already available through other sources such as historical aerial photographs. As a result, the archaeological remains would not provide new information that is not available from readily accessible sources. Archaeological remains of the Foreshore track would not reach the threshold of local significance under this criterion
F – Rarity	Archaeological remains of concrete pathways are not considered to be rare and there are numerous other such pathways within Botany Bay National Park. Archaeological remains of the Foreshore track would not reach the threshold of local significance under this criterion
G – Representativeness	The archaeological remains of the Foreshore track are representative of the former track along the foreshore and through Botany Bay National Park, and the track is representative of the theme of ‘a place for leisure’. However, the historic circulation pattern is better represented by the extant Monument Track which follows the same alignment. Archaeological remains of the Foreshore track would not reach the threshold of local significance under this criterion

9.2.2 Stone sea walls

The Meeting Place Precinct CMP identifies the Coursed stone sea wall as an element of local significance which demonstrates exceptional contribution to the significance of the place as a whole (Context 2008, 48). The CMP identifies the Coursed stone sea wall as being associated with the integrated significance concept of ‘A place for leisure’.

The Meeting Place Precinct CMP identifies significant archaeological remains of other stone sea walls, such as the one encountered in KP-TP24, as being associated with the integrated significance concepts of ‘A place for leisure’ and also ‘A European settled landscape’ (Context 2008, 57).

9.2.3 Trust Wharf / Landing place wharf abutment

The Meeting Place Precinct CMP identifies the Trust Wharf remains as an element of local significance which demonstrates exceptional contribution to the significance of the place as a whole (Context 2008, 48). The CMP identifies the Trust Wharf remains as being associated with the integrated significance concept of ‘A place for leisure’.

The archaeological remains identified in KU-TP25 are also part of the listed archaeological site ‘Landing place wharf abutment’ which is an item of local significance on the Sutherland Shire LEP (no. A2516). As a result, the archaeological remains are assessed as being of local significance.

9.2.4 Wharf approach road

The La Perouse Headland CMP identifies the archaeological remains of the former wharf approach road as being of local significance within the overall heritage item (Table 7) (JSHC 2009). The test excavation program indicated that the archaeological remains of the former approach road appear to have survived relatively intact in the vicinity of the test pits. As a result, in accordance with the La Perouse Headland CMP it is assessed that the archaeological remains of the former wharf approach road identified in LP-TP05 and LP-TP06 would reach the threshold of local significance.

10.0 IMPACT ASSESSMENT

10.1 Proposed works

10.1.1 Kurnell

Within the Kurnell construction boundary, additional car parking spaces are proposed along Captain Cook Drive (immediately northwest of Solander Drive). Excavations for the proposed car parking spaces would be to a depth of 600mm. One geotechnical borehole is proposed adjacent to the new Ferry Wharf location, to a depth of 6 m into medium strength rock or 20 m depth, whichever is encountered first. This geotechnical borehole was planned to be undertaken following the completion of the test excavation program, however, at the time of the preparation of this ATER the geotechnical borehole has yet to be undertaken.

Water and electrical utilities are proposed to run from the new wharf location to the corner of Prince Charles Parade and Captain Cook Drive. Excavations associated with the Kurnell utilities line will extend to a maximum depth of 900mm. The utilities along Monument Track are planned to be primarily located underneath Monument Track and to the land side of the track, with the utilities then crossing to the foreshore side of the track as the utilities connect to the new wharf location. A series of stormwater pits are proposed along Captain Cook Drive, associated with additional parking spaces. The stormwater pits are proposed to extend to a minimum depth of 900mm and no more than 1.2m. Any additional ground breaking works associated with landscaping activities are expected to be limited to a depth of no greater than 300mm.

10.1.2 La Perouse

Design plans indicate additional parking spaces are proposed along the southwest part of Anzac Parade within the La Perouse construction boundary. Excavations for the proposed car parking spaces would be to a depth of 600mm below the surface of the existing car parking spaces. However, as the proposed car parking would extend into the adjacent raised landscape, the depth of impact beneath the grassed landscape would be up to 1.4m deep.

One geotechnical borehole is proposed at the northern most point of the proposed location of the new wharf on the La Perouse side. As the test pit in the location of the proposed borehole (LP-BH01) was abandoned due to the presence of asbestos, the geotechnical borehole could not be undertaken following the completion of the test excavation program. Current design plans indicate that water and electrical utilities are proposed to run from the new wharf, along the footpath north of Anzac Parade to the roundabout at Endeavour Avenue (test excavations for the utilities within the footpath were removed from the scope of the TEM). A new structure will be established immediately west of the new La Perouse Wharf. The proposed utilities will extend to a depth of 750mm and will not run along an existing service route.

10.2 Impacts of the proposed works.

10.2.1 Non-Aboriginal impacts

The proposed works will at Kurnell will impact the foreshore track. The foreshore track as been determined not reach a level of local significance.

The proposed works will impact the following built and archaeological items which have been determined to have significance:

- Coursed stone sea wall (Kurnell) – built element listed in the Meeting Place Precinct CMP
- Stone sea wall (Kurnell) – archaeological element listed in the Meeting Place Precinct CMP
- Trust Wharf / Landing place wharf abutment (Kurnell) – built and archaeological element listed in the Meeting Place Precinct CMP and on the Sutherland Shire LEP (no. A2516)
- Wharf approach road (La Perouse) – archaeological element listed in the La Perouse Headland CMP

10.2.2 Aboriginal archaeological impacts

The identified artefacts are considered isolated finds given the low density and sparse nature of the finds. KMT ISO 01 (AHIMS ID 52-3-2080) and KMT ISO 02 (AHIMS ID 52-3-2081) will be impacted by the proposed works.

Table 30: Impact assessment

Site name (AHIMS ID)	Type of harm	Degree of harm	Consequence of harm
KMT ISO 01 (AHIMS ID 52-3-2080)	Direct	Total	Total loss of value
KMT ISO 02 (AHIMS ID 52-3-2081)	Direct	Total	Total loss of value

10.3 Review of Aboriginal sites/ PADs

10.3.1 Kurnell

10.3.1.1 Foreshore Midden - Captain Cook's Landing Place (AHIMS ID 42-3-0219)

The Foreshore Midden - Captain Cook's Landing Place (AHIMS ID 52-3-0219) is a burial, shell, artefact site.
. Previous excavations have resulted in the determination of the site extent and the identification of Aboriginal burials, midden material and stone artefacts. One test pit was conducted within the southern portion of the site extent however did not identify any archaeological material. Based on the results of the test pit (Artefact Heritage 2020), it is unlikely significant deposits would be impacted within the southern portion of the Foreshore Midden - Captain Cook's Landing Place (AHIMS ID 52-3-0219).

10.3.1.2 Foreshore midden PAD

The PACHCHI Stage 2 investigations for this project (Artefact Heritage 2020) identified an area of PAD directly south of the Foreshore Midden - Captain Cook's Landing Place (AHIMS ID 52-3-0219). The location of the PAD had been subject to previous archaeological testing (Irish 2007) however this was only to the depth of the proposed impact (400mm). As such, it was determined that it would be likely that Aboriginal objects may be present below the ground surface associated with the Foreshore Midden - Captain Cook's Landing Place (AHIMS ID 52-3-0219).

The results of the test excavation program conducted by Artefact Heritage in late 2020 identified two isolated finds (KMT ISO 01 [AHIMS ID 52-3-2080] and KMT ISO 02 [AHIMS ID 52-3-2081]). However, no substantial evidence of Aboriginal occupation was identified within the Foreshore Midden PAD.

In general, the results of the test excavation found that the area is comprised of fill overlying natural material of marine sediment and aeolian sands. No artefacts were found in the remainder of the excavation units. As such, the Foreshore Midden PAD has been modified and is no longer within the Kurnell construction boundary (Figure 57).

10.3.1.3 K-PAD-1 (AHIMS 52-3-1366)

The area known as K PAD 1 (AHIMS ID 52-3-1366) was identified by Navin Officer in 2006. The location of the PAD was listed as an area west of Captain Cook Drive, bordered to the north by Prince Charles Parade. Subsequent test excavations to the west of Captain Cook Drive (Irish 2007) did not identify any Aboriginal objects, however these investigations were only completed to the depth of proposed impacts (400mm). As a result, the PACHCHI Stage 2 investigations for this project (Artefact Heritage 2020) extended the location of the PAD to the east as far as the identified extent of the Foreshore Midden PAD to facilitate additional subsurface investigations that would be impacted by the proposed works.

The results of the test excavation program conducted by Artefact Heritage in late 2020 did not identify any subsurface archaeological deposits within the revised extent of the K PAD 1 (AHIMS ID 52-3-1366) footprint. As such, the area of PAD is not considered to be within the Kurnell construction footprint (Figure 59).

10.3.2 La Perouse

10.3.2.1 Low Potential PAD (identified in PACHCI Stage 2)

An area of low potential PAD was identified during PACHCI Stage 2. It was predicted the low potential PAD may contain buried engravings and midden material. The testing program (Artefact Heritage 2020) tested portions of the PAD and identified fill overlying natural sterile material onto sandstone. The PAD of low potential has been refined following the test excavation program. The extent of the PAD has been excluded in those locations where archaeological testing was completed and no significant archaeological material was identified. The Low Potential PAD extent encompasses those portions within the La Perouse construction boundary where testing could not be completed (Figure 60).

REDACTED FOR PUBLIC VIEW

Figure 59: Kurnell revised location of PADs

REDACTED FOR PUBLIC VIEW

Figure 60: La Perouse revised location of PADs

11.0 ONGOING AND FUTURE MANAGEMENT

11.1 Guiding principles

The overall guiding principle for cultural heritage management is that where possible Aboriginal sites should be conserved. If conservation is not practicable, measures should be taken to mitigate against impacts to Aboriginal sites.

The nature of the mitigation measures recommended is based on the assessed significance of the sites. The final recommendations would also be informed by cultural significance, which will be discussed by the Aboriginal community in their responses during the next stage of consultation, outlined in the ACHAR.

11.2 Ongoing consultation with Registered Aboriginal Parties

Consultation with the RAPs would continue throughout the life of the project, as necessary. Ongoing consultation with RAPs will take place throughout all facets of the project, including reburial of retrieved artefacts and in the event of any unexpected Aboriginal objects being identified during works.

11.3 Further archaeological management

The aim of the test excavation program was to determine if intact sub-surface Aboriginal sites and non-Aboriginal archaeological remains are likely be impacted by the proposal so as to inform the EIS Technical Papers. The test excavation program undertaken was largely able to achieve the intended aims, however, due to constraints encountered during the testing program the aims could not be achieved across all areas.

The Kurnell and La Perouse test excavation programs both identified significant non-Aboriginal built heritage and archaeological remains that would be impacted by the proposed works. As a result, further management of the Coursed stone sea wall (Kurnell), Stone sea wall (Kurnell), Trust Wharf / Landing place wharf abutment (Kurnell), and Wharf approach road (La Perouse) will be required.

In addition, testing in the location o
was not conducted during the test excavation program. It was determined that archaeological supervision was the best archaeological management to identify the Site 6, La Perouse and this would be managed prior or during the construction phase of the program.

11.3.1 Kurnell

Within the Kurnell construction boundary, the test excavation program was able to achieve the investigation aims. The test excavations were able to demonstrate that natural stratigraphy is present within the area, but that midden deposits and substantial intact sub-surface Aboriginal sites) are unlikely to be present within the proposed impact area. This has allowed for the boundaries of Foreshore Midden PAD and K-PAD-1 to be revised. No archaeological material was identified in the test pit (KU-BH01) within registered site known as the Foreshore Midden - Captain Cook's Landing Place (AHIMS ID 52-3-0219). The boundary of the Foreshore Midden - Captain Cook's Landing Place (AHIMS ID 52-3-0219) is likely to be further north than the southern extent of the registered site. However, given the significant nature of the site to contain burials, the site extent has not been refined and only the location of KU-BH01 can be cleared for further work. Additional excavation within the Foreshore Midden - Captain Cook's Landing Place (AHIMS ID 52-3-0219), outside the excavated parameters of KU-BH01, would require further archaeological investigations. Management and recommendations would be further discussed in the ACHAR.

The test excavation in the proposed car park at Kurnell could not be completed due to the identification of contaminated material during the program. However, the excavation results of the adjacent test pits and previous investigations by Irish (2007) identified fill overlying natural sterile material. Based on the combined results, it is unlikely that archaeological material will be buried beneath the ground surface and therefore no further archaeological investigations would be required in this location.

11.3.2 La Perouse

The La Perouse test excavation program was only completed in a portion of the construction boundary. Completed testing was in the location of the proposed La Perouse car park area along Anzac Parade. The test excavations were able to demonstrate that natural stratigraphy is present within the proposed car park location and midden deposits and intact sub-surface Aboriginal sites are unlikely to be present within its proposed impact area. As a result, no further Aboriginal archaeological investigations are required within the proposed La Perouse car parking area.

Due to the presence of asbestos and significant non-Aboriginal archaeological remains (Wharf approach road) near the proposed wharf landing area at La Perouse, the planned test excavations in that area could not be completed (LP-TP05, LP-TP06, LP-TP07, LP-TP10, LP-BH01). As such, the test excavation program was not able to determine if intact sub-surface Aboriginal sites were present in the eastern portion of the Low Potential PAD. In addition, due to constraints involved with excavating within the footpath test excavations along the planned utility line were not included within the scope of this test excavation program. Further archaeological investigations would be required in these locations. Management and recommendations would be further discussed in the ACHAR.

12.0 FINDINGS AND RECOMMENDATIONS

The following recommendations are based on consideration of:

- Statutory requirements under the *National Parks and Wildlife Act 1974* as amended
- The results of this ATER
- The interests of the RAPs
- The likely impacts of the proposed development.

Aboriginal archaeological findings:

- The Kurnell testing program has satisfied the aims which were to determine if intact sub-surface Aboriginal sites would be impacted by the proposed works
- The Kurnell testing program found that the stratigraphy in the alignment of the proposed works consist of fill overlying natural strata. No shell midden material was identified during the test excavation program
- Two subsurface isolated artefacts were identified during the test excavation program at Kurnell (KMT ISO 01 [AHIMS ID 52-3-2080] and KMT ISO 02 [AHIMS ID 52-3-2081]
- KMT ISO 01 (AHIMS ID 52-3-2080) and KMT ISO 02 [AHIMS ID 52-3-2081] are assessed as having low scientific significance
- The test pit location of KU-BH01 at Kurnell, within Foreshore Midden - Captain Cook's Landing Place (AHIMS ID 52-3-0219), did not identify any significant archaeological remains
- K-PAD-1 and the Foreshore Midden PAD identified in the PACHCI Stage 2 assessment have been revised following the test excavation results
- The La Perouse test excavation program identified fill deposits comprised of contamination of demolition and introduced fill and historical construction (road) overlying natural sterile deposits. No archaeological material was identified in the completed test excavation units
- The extent of the Low Potential PAD, identified in the PACHCI Stage 2 assessment has been revised following the test excavation results
- The La Perouse testing program identified the presence of asbestos and significant non-Aboriginal archaeological remains (Wharf approach road) near the proposed wharf landing area at La Perouse, the planned test excavations in the eastern portion of the Low Potential PAD could not be completed (KU-TP05, KU-TP06, KU-TP07, KU-TP10, KU-BH01). As a result, further archaeological management would be required in the revised extent of the Low Potential PAD
- Specific management will be further detailed in the Aboriginal heritage Technical Paper for the EIS (ACHAR)

Non-Aboriginal archaeological findings:

- The Kurnell testing program has satisfied the aims which were to determine if intact sub-surface non-Aboriginal archaeological remains would be impacted by the proposed works

- Four items of local heritage significance were identified including the coursed stone sea wall (Kurnell), stone sea wall (Kurnell), Trust Wharf/ Landing place wharf abutment (Kurnell), Wharf approach road (La Perouse).

Recommendations for Aboriginal heritage management:

- A detailed discussion of the archaeological and heritage impacts should be included in the Aboriginal Heritage Technical Papers to be prepared as part of the EIS
- No further archaeological investigations are required in the Kurnell construction boundary except for in the Foreshore Midden - Captain Cook's Landing Place (AHIMS ID 52-3-0219) site extent
- Borehole investigations may proceed within the location of KU-BH01 at Kurnell on the condition that the borehole is confined to the location of the excavated test pit (KU-BH01). If the borehole is proposed to be relocated further archaeological management would be required
- Ongoing archaeological management in the Foreshore Midden - Captain Cook's Landing Place (AHIMS ID 52-3-0219) will be discussed in the ACHAR
- Test excavations near the proposed jetty tie-in area within the Low Potential PAD at La Perouse could not be completed due to constraints, further archaeological investigations would be required in the revised extent of the Low Potential PAD
- Borehole investigations cannot proceed within the location of KU-BH01 at La Perouse until further Aboriginal archaeological investigation has been undertaken
- Further archaeological assessment may be required where design plans are changed to impact areas beyond the extent of the current construction boundaries
- Long term arrangements for the management of excavated artefacts, should be further discussed within the ACHAR
- To keep consultation current, the registered Aboriginal parties should be sent an update on the project every six months
- The findings of this ATER are to be included into the EIS Technical Papers to facilitate compliance with the SEARs

Recommendations for non-Aboriginal heritage management:

- A detailed discussion of the archaeological and heritage impacts should be included in the Non-Aboriginal Heritage Technical Papers to be prepared as part of the EIS
- Test excavations near the proposed jetty tie-in area at La Perouse could not complete the aims of the test excavation program due to constraints, further archaeological investigations would be required in that area
- Further archaeological management and investigation will be required for the significant non-Aboriginal archaeological remains of the stone sea wall at Kurnell and the wharf approach road at La Perouse. A detailed non-Aboriginal archaeological assessment and requirements for further

archaeological management and investigations, such as the preparation of a guiding Archaeological Research Design or Archaeological Work Method Statement, are to be outlined in the EIS Non-Aboriginal Heritage Technical Paper

- The detailed design for the project should take the findings of the test excavation program into consideration and redesign to avoid impacts to significant built heritage and archaeological remains where feasible. This includes:
  - Locating the utility trench at Kurnell to avoid impacting the back of the coursed stone sea wall
  - Locating the utility trench at Kurnell further to the south of the extant remains of the Trust Wharf/ Landing place wharf abutment to avoid impacting the significant structure
  - Investigate options to locate the utilities underneath the coursed stone sea wall and stone sea wall at Kurnell to avoid impacting them (depending on depth of bedrock underneath the walls). If impacts cannot be avoided then investigate options to reinstate the coursed stone sea wall and stone sea wall following the completion of the works
  - Limit the excavation depth of landscaping at La Perouse to minimise impacts to archaeological remains of the wharf approach road
- The findings of this ATER are to be included into the EIS Technical Papers to facilitate compliance with the SEARs
- No further archaeological management and investigation is required for the archaeological remains of the former Foreshore trackThe findings of this ATER are to be included into the EIS Technical Papers to facilitate compliance with the SEARs

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14.0 APPENDICES

APPENDIX 1: GLOSSARY

Aboriginal cultural heritage: The material (objects) and intangible (mythological places, dreaming stories etc) traditions and practices associated with past and present-day Aboriginal communities.

Aboriginal object: Any deposit, object or material evidence (not being a handicraft made for sale), including Aboriginal remains, relating to the Aboriginal habitation of NSW.

Aboriginal place: Any place declared to be an Aboriginal place under s.94 of the *National Parks and Wildlife Act 1974*.

AHIMS: Acronym for 'Aboriginal heritage information management system'. AHIMS is a register that contains information about NSW Aboriginal heritage, and it is maintained by DECCW.

Alluvium: A deposit left by the flow of water. It can include sediments of gravel, mud or sand.

Angular fragment: A flaked piece of stone that does not have characteristic features which allow for it to be positively identified as a flake, core or tool.

Archaeological site: A location that has evidence of past Aboriginal activity (both material and mythological/ritual).

Archaeology: The scientific study of human history, with focus on material remains and ethnographic evidence.

Area of archaeological sensitivity: A part of the landscape that contains demonstrated occurrences of cultural material. The precise level of sensitivity will depend on the density and significance of the material.

Artefact: An item of cultural material created by humans.

Artefact scatter: Where two or more stone artefacts are found within an area of potential archaeological deposit or a site.

Backed blade/ artefact: Bladelets that have one edge blunted by steep retouch to form a back.

Basalt: A common volcanic rock. It is fine grained (approximately 45-50 per cent silica) and rich in iron and magnesium.

Bedrock: A consolidated rock that is unbroken and un-weathered, located beneath soil or rock fragments.

Bifacial flaking: The removal of flakes from two faces of a single platform.

Bipolar: A method of flaking stone, especially quartz, where cores are rested upon an anvil during flaking.

Bipolar core: A core used to create bipolar flakes.

Blade: A stone flake that is at least twice as long as it is wide.

Bioturbation: Disturbance in soil profiles caused by living organisms, such as ants and roots.

Bora ground: These are usually identified as flat, mounded earth rings that were used for Aboriginal ceremonial activities.

Bulb of percussion: A partial cone of force produced when a flake is struck off a core. The cone occurs on the ventral (inside surface) of the flake.

Burials: Burial sites may be composed of a single burial, isolated individuals in a general area, or cemeteries containing many individuals.

Carved/ modified trees: Carved trees exhibit evidence of purposeful removal of bark but differ from scarred trees in that geometric patterns and figures are cut into the tree. The motifs of the mid-north coast region are mostly linear geometric patterns (Craib and Bonhomme 1995: 27).

Chalcedony: A mineral with high silica content that has a microcrystalline structure. It is often described as 'waxy' and can be translucent. It is found in a variety of colours such as white, grey, greyish-blue or brown.

Chert: A fine grained rock composed of cryptocrystalline silica. It exhibits a range of textures and colours including red, green or black. Chert is easy to work and retains a sharp edge for an extensive period of time before resharpening is required. It has a low to medium fracture toughness.

Clast: A broken fragment of rock or crystal particle that was created either through erosion or weathering.

Clay: A type of sediment with particles less than 4 microns in size and that is composed of clay minerals (Keary 2001: 49).

Conglomerate: Is a geological term used to describe clasts that are cemented in a fine-grained matrix. It is a sedimentary rock.

Core: A stone piece from which a flake has been removed by percussion (striking it) or by pressure. It is identified by the presence of flake scars showing the negative attributes of flakes, from where flakes have been removed.

Cortical platform: This term is used to describe a platform that has cortex present and may indicate that the core's surface (where the flake was struck) was previously un-worked.

Cortex: The outer weathered surface of stone; if smooth, it can indicate the source of stone was a pebble.

Crushed platform: This term is used to describe a flake that has a damaged platform and where the platform's attributes cannot be recorded as a result.

Cultural heritage assessment report: A report combining an Aboriginal archaeological assessment and Aboriginal cultural assessment, required to be submitted to DECCW for any Part 6 *National Parks and Wildlife Act 1974* approval or prepared for projects under Section 5.1 of the *Environmental Planning and Assessment Act 1979* where Aboriginal cultural heritage is identified as a key issue.

Debitage: Small, unmodified flakes produced as part of the flaking process, but discarded unused.

Distal: Term of view used to describe the lower portion of a flake in respect to where the striking force terminates.

Distal flake: A broken flake with the presence of a termination and the absence of a platform or impact point.

Dorsal: The side of a flake that was originally part of the core's outer surface (often referred to as the 'dorsal surface').

Easting: This is a measurement used to determine location. The easting is the x-coordinate and relates to the vertical lines on a map, which divide east to west. It increases in size when moving further east.

Edge damage: Where the edge of a tool has been used, resulting in microscopic fractures along the surface.

Exposure: The level of ground exposure is based on the whether the landform is eroding, aggrading or stable.

Faceted platform: A faceted platform has three or more flake scars present on its surface.

Feather termination: A feather termination has a 'minimal thickness at the distal end and an acute angle between the dorsal and ventral surfaces' (Holdaway and Stern 2008: 129). In appearance, a feather termination becomes gradually thinner towards the end of the flake.

Fine grained siliceous material: A rock that has a high content of silica and that is fine grained in appearance without any further identifying characteristics.

Flake: A stone piece removed from a core by percussion (striking it) or by pressure. It is identified by the presence of a striking platform and bulb of percussion, not usually found on a naturally shattered stone.

Flake scar: Often called a 'negative flake scar', it is the remnant of a previous flake that was struck from the core. This appears on the dorsal surface of a flake.

Flaked fragment: This is a chipped stone artefact which cannot be classed as a flake, core or retouched flake, the reason being that the defining attributes are missing. This often happens when a core contains a number of incipient fracture planes. Artefacts that are heavily weathered or which have been shattered in a fire are also difficult to categorise.

Flaked platform: This term is used to describe a platform that has been worked previously; one or more flakes were removed prior.

Floodplain: The area covered by water during a major flood and/or the area of alluvium deposits laid down during past floods.

Fluvial: Pertaining to or produced from a river.

Focalised platform: A small platform that is intentionally prepared for percussion by overhang removal.

Footprint: The scale, extent or mark that a development makes on the land in relation to its surroundings.

Geometric microliths: Backed at one end, the other end or both, these tools are made on geometric shaped flakes, <80mm maximum dimension.

Geomorphic: Relating to the structure, shape and development of landforms.

Hammerstone: A piece of stone used to knock flakes from a core. Evidence of pitting or bashing can usually be seen along some part of the margins of this artefact.

Hinge termination: A hinge termination occurs 'when the fracture meets the surface of the core at approximately right angles to the longitudinal axis of the flake' (Holdaway and Stern 2008: 130). This can present as a rounded surface that curves downwards at the distal end of a flake.

Holocene: The Holocene epoch forms part of the late Quaternary period and extends from about 11,000 years ago to the present day.

Humic: Soil that contains organic matter (from 'humus').

Igneous: After magma or lava cools and solidifies, it forms igneous rock. This can happen in volcanic and plutonic (under the surface of the earth) scenarios. An example of this is basalt.

In situ: A description of any cultural material that lies undisturbed in its original point of deposition.

Ironstone: A type of sedimentary rock that contains iron.

Knapping: The removal of flakes and flaked pieces from a stone core by the use of percussion.

Layer: In stratigraphy, it is used to describe a horizon (soil, rock, charcoal) that is distinct from its surrounds.

Landform: Description for an area of land based on an assessment of a series of environmental characteristics including geology, geomorphology, soils and vegetation.

Loam: Soil that contains roughly equal concentrations of silt, sand and clay.

Longitudinally split flake: This is a flake that is broken (split) from the point of percussion (the strike) through to the termination.

Manuport: An unmodified piece of stone transported to a site by humans.

Medial: Term of view referring to the intermediate section or middle section of a broken flake.

Medial flake: Absence of proximal and distal margins, but with an identifiable ventral surface.

Metamorphism: The process where an existing rock (which can be sedimentary or igneous) is transformed into another mineral through the application of temperature and pressure. An example of this is hornfels.

Mudstone: A sedimentary rock formed from mud/clay.

Muller: A large stone artefact which differs in construction depending on the environment. These were used as an aide for processing seeds and other low return plant material or ochre.

Multiple platform core: Is a core with more than one identifiable platform.

Munsell colour: This is a colour code chart used to standardise colour specifications.

Non-diagnostic: An amorphous piece of stone that is neither a flake, flaked fragment, core or retouched flake.

Northing: This is a measurement used to determine location. The northing is the y-coordinate and relates to the horizontal lines on a map, which divide north to south. It increases in size when moving further north.

Notched tool: Flakes that exhibit a small area of retouch, forming a concave edge on lateral or distal margin.

Oriented length: This is a measurement taken from the point of impact through to the termination.

Oriented thickness: This is a measurement taken from where the oriented width and oriented length intersect.

Oriented width: This is a measurement taken across the middle of a flake (halfway between the point of impact and the termination).

Overhang removal: This occurs when a platform is prepared for striking; small flakes are struck before a flake is detached, leaving visible scars behind.

Potential Archaeological Deposit (PAD): A PAD is a location that is considered to have a potential for sub-surface cultural material. This is determined from a visual inspection of the site, background research of the area and the landform's cultural importance.

pH: A measure of the acidity or alkalinity of the soil. Neutral is indicated by a pH of 7, with strongly acidic being 0 and strongly basic (alkaline) being 14. The 'pH' is said to stand for 'potential of hydrogen'.

Platform: On a flake, this is a core remnant from where the flake was struck off the core.

Platform width: This is a measurement taken across the width of a platform between the two lateral margins of a flake.

Platform thickness: This is a measurement taken from the ventral to dorsal surfaces of a flake (beginning at the point of impact/percussion).

Plunge termination: This occurs when the ventral surface 'curves markedly away from the face of a core.and continues directly into the core, removing the base of the core' (Holdaway and Stern 2008: 132). This can present as a 'J' shape when holding the flake in profile.

Proximal: Term of view used to describe the upper portion of a flake in respect from where it was initially struck off a core.

Proximal flake: A broken flake with the presence of a platform, but the absence of a termination.

Pot-lidded: The damage caused by exposure to extreme heat, resulting in a circular depression on the surface of a stone artefact.

Pressure flaking: A process to remove a flake from a core by applying pressure (from a piece of wood or bone) along the core's edge.

Quarry: In this report, 'quarry' can refer to a native source of stone that was mined by Aboriginal people in the past. Rock from these sites could be used to make artefacts.

Quartz: A mineral composed of silica with an irregular fracture pattern. The quartz used in artefact manufacture is generally semi-translucent, although it varies from milky white to glassy. Glassy quartz can be used for conchoidal flaking, but poorer quality material is more commonly used for block fracturing techniques. Quartz can be derived from water worn pebbles, crystalline or vein (terrestrial) sources.

Quartzite: A form of metamorphosed sandstone. It is often white or grey in colour but can occur in other shades due to mineral impurities.

Refit: Knapping is a reductive technology. As such, it is possible to 'refit' tools back together after breakage or knapping (i.e. refitting a proximal and distal flake back together or refitting a flake back to the core it was knapped from).

Resource area: An area of the landscape or part of the environment that provides a resource (be it food or material items such as a source of stone for making artefacts) for Aboriginal people. Swamps are good examples of rich resource zones.

Retouch: A flake, flaked piece or core with intentional secondary flaking along one or more edges.

Sand: A material composed of small grains (0.625-2.0mm) (Keary 2001: 233). Sand is formed from a variety of minerals and rocks, but commonly contains silica, such as quartz.

Sandstone: Is a sedimentary rock formed from sand-sized grains.

Scarred trees: Trees that feature Aboriginal derived scars are distinct due to the scar's oval or symmetrical shape and the occasional use of steel, or more rarely, stone axe marks on the scar's surface. Scarred trees are identified by the purposeful removal of bark for use in the manufacture of artefacts such as containers, shields and canoes. The bark was also used for the construction of shelters. Other types of scarring include toeholds cut in the trunks or branches of trees for climbing purposes and the removal of bark to indicate the presence of burials in the area.

Sediment: Is a mineral that has undergone erosion or weathering and that is then deposited via aeolian, glacial or fluvial means.

Sedimentary: Sedimentary rock is formed through the accumulation of sediment deposits that are then consolidated. An example of this is mudstone.

Shale: A sedimentary rock of well-defined layers comprised of small particles (less than 4 microns in size) (Keary 2001: 16) sourced from weathered or eroded materials.

Significant ground disturbance: Means disturbance of (a) the topsoil or surface rock layer of the ground; or (b) a waterway, by machinery in the course of grading, excavating, digging, dredging or deep ripping, but does not include ploughing other than deep ripping.

Silt: A sediment with grains ranging from 4.0-62.5 microns in size (Keary 2001: 245). It can be found as a soil or in water.

Single platform core: Is a core with one identifiable platform.

Scraper: A stone tool, usually with steep retouch along its edges that was ethnographically used to make wooden implements or process foods and other resources.

Silcrete: Soil, clay or sand sediments that have silicified under basalt through groundwater percolation. It ranges in texture from very fine grained to coarse grained. At one extreme it is cryptocrystalline with very few clasts. It generally has characteristic yellow streaks of titanium oxide that occur within a grey and less commonly reddish background. Used for flaked stone artefacts.

Spit: Refers to an arbitrarily defined strata of soil removed during excavation (often 50mm to 100mm in depth).

Step termination: This occurs when a 'flake terminates abruptly in a right-angle break' (Holdaway and Stern 2008: 130).

Stratification: The way in which soil forms in layers.

Stratigraphy: The study of soil stratification (layers) and deposition.

Sub-surface testing: An archaeological method used to determine the cultural sensitivity of an area by excavating small (0.5m x 0.5m) pits and recording the stratigraphy, material remains (such as stone tools) and disturbance.

Survey: In archaeological terms, this refers to walking over a surface while studying the location of artefacts and landmarks. These are then recorded and photographed.

Termination: Refers to the shape of the distal end of a flake.

Tool: A stone flake that has undergone secondary flaking or retouch.

Usewear: A pattern of wear that is left on a stone artefact due to utilisation.

Ventral: The side of a flake that was originally attached to the core (often called the 'ventral surface'). Features such as the bulb of percussion are found on this surface of a flake.

Visibility: Refers to the degree to which the surface of the ground can be observed. This may be influenced by natural processes such as wind erosion or the character of the native vegetation, and by land use practices, such as ploughing or grading. It is generally expressed in terms of the percentage of the ground surface visible for an observer on foot.

APPENDIX 2: SITE CARDS

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APPENDIX 3: SITE RECORDING FORMS

REDACTED FOR PUBLIC DISPLAY

artefact

Artefact Heritage
ABN 73 144 973 526
Suite 56, Jones Bay Wharf
26-32 Pirrama Road
Pyrmont NSW 2009 Australia
+61 2 9518 8411
office@artefact.net.au
www.artefact.net.au

Appendix 5: Extensive AHIMS search

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Appendix 6: Site Cards

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Appendix 7: Specialist Report: Ground Penetrating Radar Report

Ground-penetrating Radar Survey at the Kamay Ferry Wharves Project, NSW.

Report to Artefact Heritage

1st April 2021

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Volume One: Report

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1 Introduction

Geoprospection was commissioned by Artefact Heritage to undertake ground-penetrating radar (GPR) survey as part of the Kamay Ferry Wharves Project. Test pits targeting Aboriginal heritage were to be excavated at pre-determined locations at both La Perouse (Figure 1.1) and Kurnell (Figure 1.2). Because of the potential for the presence of Aboriginal burials, ground-penetrating radar (GPR) survey was conducted at the location of test pits prior to excavation so that any potential burials might be avoided. The following report details the results of that survey.

Figure 1.1: Location of test pits at La Perouse.

2 Ground-penetrating Radar (GPR)

GPR is an active geophysical method that utilises the reflective and refractive properties of electromagnetic radiation passing through mediums of differing physical properties. The degree to which a medium reflects or transmits electromagnetic radiation is referred to as its dielectric permittivity. Objects or layers of materials under the ground surface can be identified by emitting electromagnetic radiation at a location and measuring the return times of the signal. A returned signal of relatively large amplitude indicates that the signal has passed between two mediums of differing

Figure 1.2: Location of test pits at Kurnell.

dielectric permittivity. The time over which the signal returned is proportional to its distance from the transmitting antenna. In that manner, objects and layers beneath the subsurface can be imaged for analysis and interpretation. Further details of the method can be found in Davis and Annan (1989) and Conyers (2004).

3 Method

Survey grids of approximately 10 x 10 m were established around each test pit using long tapes and an arbitrary Cartesian coordinate system assigned to each. A MALA X3M control unit was coupled with a 500MHz antennae to measure a series of equally spaced parallel lines across each survey grid. Because the primary target was potential Aboriginal graves, line spacing was set at 0.25 m to maximise resolution. Signal travel velocity was estimated at 0.08 nm/s and sufficient time window was recorded to allow imaging up to approximately 2 m depth.

Data was processed in ReflexW 9.5 (Sandmeier, 2021) and included signal start time adjustment, average subtraction, an energy decay gain, and a mean filter. The processed lines were meshed into a 3-dimensional array using custom python scripts employing the numpy (Oliphant, 2006) package. The matplotlib (Hunter, 2007) package was utilised to output 2-dimensional radargram and timeslice images from the array; radargrams are vertically oriented 2-dimensional images showing the amplitudes of a GPR measurement line plotted against distance and time/depth; timeslices are planview 2-dimensional images showing amplitude over space at a defined depth range (e.g. 0-5cm).

4 Results

Because of the numerous test pits and small line spacing a substantial quantity of data was generated. Each radargram and depth-averaged timeslices are presented in the appendices for examination, however, only a small subset are presented here to illustrate the range of features observed.

4.1 La Perouse

The La Perouse study area was divided into 'upslope' and 'downslope' categories for convenience of reporting. The survey areas relative to the given GPS points are shown in Figures 4.1 and 4.2.

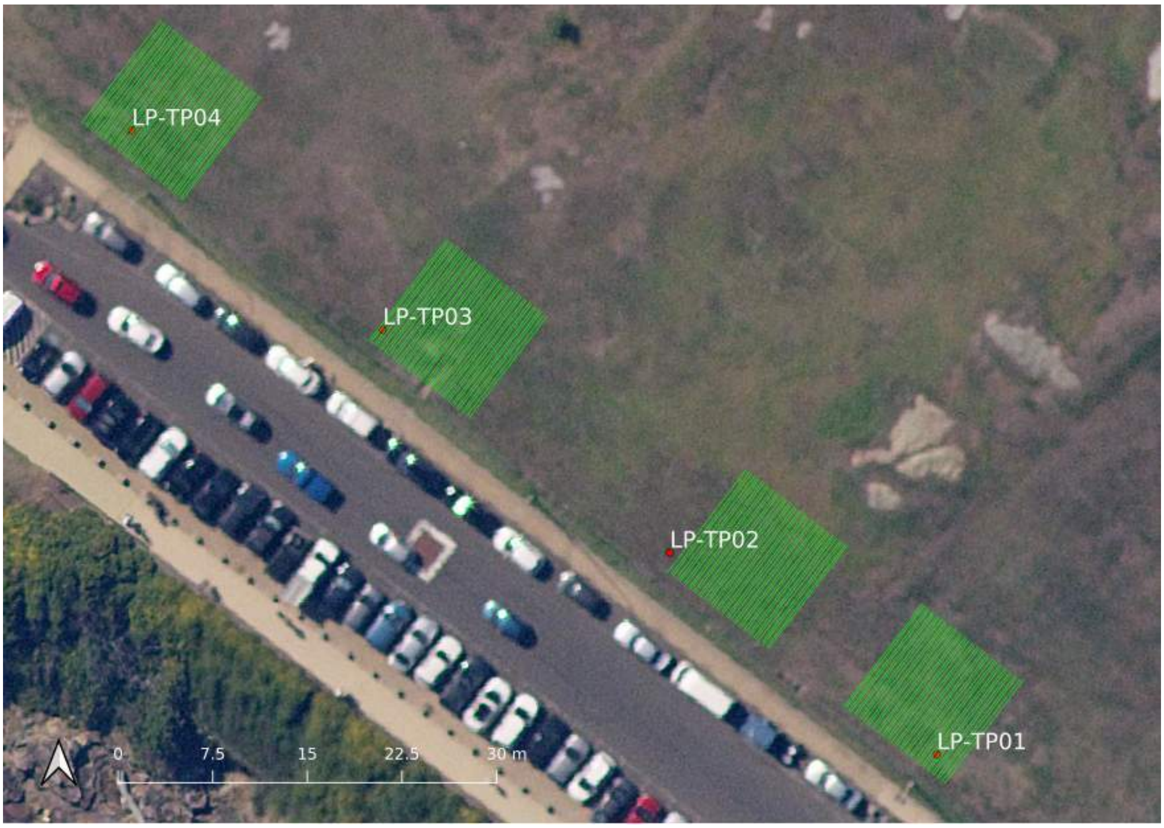


Figure 4.1: La Perouse study area, upslope. GPR survey lines are shown in green.

4.1.1 Upslope

Test pits excavated at the upslope of the La Perouse study area, and surveyed by GPR, included LP-TP01, LP-TP02, LP-TP03, and LP-TP04. Radargrams were generally comparable and showed a strong and continuous subsurface boundary at approximately 0.4 m depth, deepening downslope (Figure 4.5). The boundary is most likely the sandstone substrate, but alternatively it may be

Figure 4.2: La Perouse study area, downslope. GPR survey lines are shown in green.

a subsoil boundary. Various other discontinuous boundaries occur above, suggesting mechanical disturbance of that material. Timeslices demonstrate the presence of multiple linear services, one of which is parallel to the southwestern boundary of the survey area (along the fence line) (Figure 4.6).

4.1.2 Downslope

Test pits excavated at the downslope of the La Perouse study area, and surveyed by GPR, included LP-TP05, LP-TP06, LP-TP07, and LP-BH01. Radargrams were generally comparable and showed a strong and broadly continuous reflection surface between above approximately 0.2 m (Figure 4.7). Based on observations of sandstone outcropping in places at the surface, it is likely the sandstone basement rock is very shallow across the area. Timeslices show at least 2 services, but considerably deeper than the interpreted sandstone surface (Figure 4.8).

4.2 Kurnell

The Kurnell study area was divided into 'Polo' Street and 'Footpath' categories for convenience of reporting. The survey areas relative to the given GPS points are shown in Figures **??** and 4.4.

Figure 4.3: Kurnell study area, Polo Street. GPR survey lines are shown in green.

4.2.1 Polo Street

Test pits surveyed along Polo Street at the Kurnell study area, and surveyed by GPR, included KU-TP02, KU-TP03, KU-TP04, KU-TP05, and KU-TP06. Radargrams were generally comparable

Figure 4.4: Kurnell study area, footpath. GPR survey lines are shown in green.

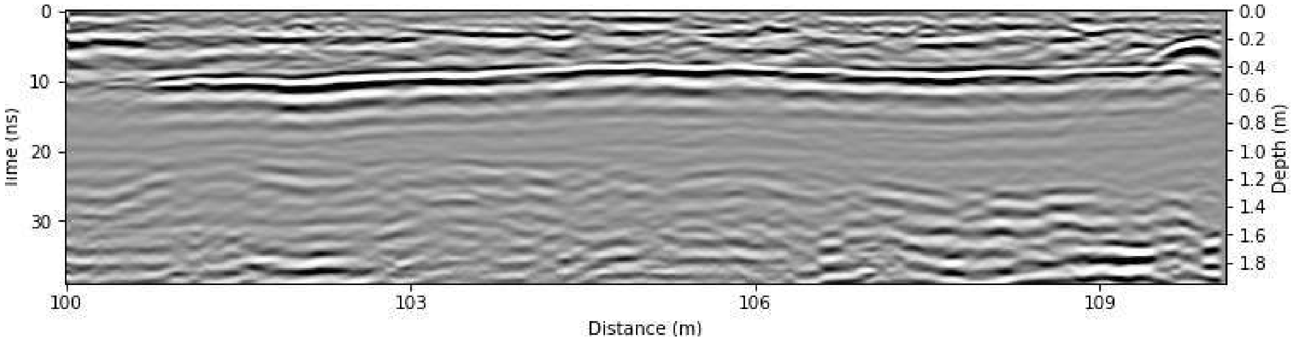
and showed a subsurface boundary below approximately 1.2 m, likely corresponding to a sediment boundary (e.g Figure 4.9). Strong and continuous subsurface boundaries also occur at the very near surface and may indicate dressing of the surface during landscaping works. Timeslices show at least 1, and sometimes 2 service trenches parallel to the kerb (Figure 4.10).

4.2.2 The Footpath

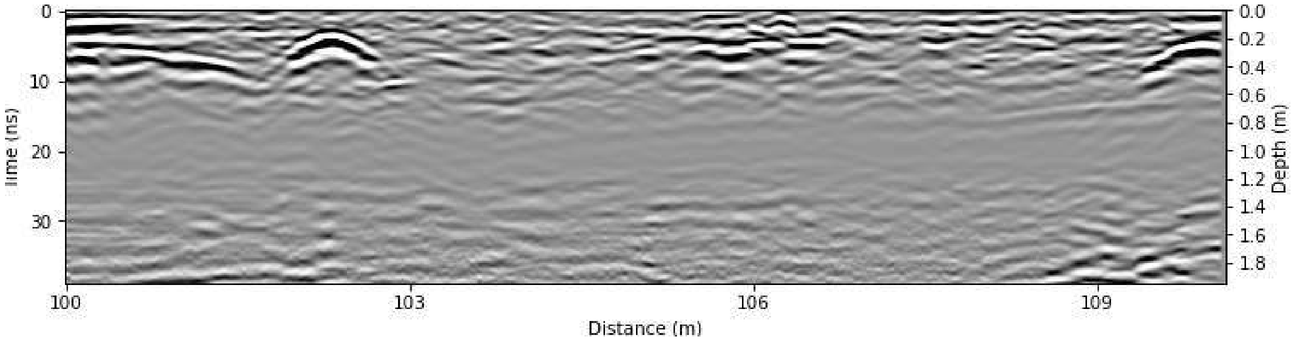
Test pits excavated along the footpath of the Kurnell study area, and surveyed by GPR, included KU-TP07, KU-TP08, KU-TP10, KU-TP12, KU-TP14, KU-TP18, KU-TP19, KU-TP22, KU-TP23, KU-TP24, and KU-BH01. Radargrams were generally comparable and showed the footpath as a distinctive pattern at the ground surface likely caused by a row of reinforcement bar. A predominantly continuous subsurface boundary was also observable below at least 1 m and likely corresponded to a sediment or pedological boundary (Figure 4.11). Timeslices predominantly showed the boundary of the footpath and a service access (Figure 4.12).

4.3 Discussion and Conclusion

The large GPR dataset predominantly found the presence of subsurface boundaries and modern infrastructure. No features were identified that could be confidently attributed to an Aboriginal burial.

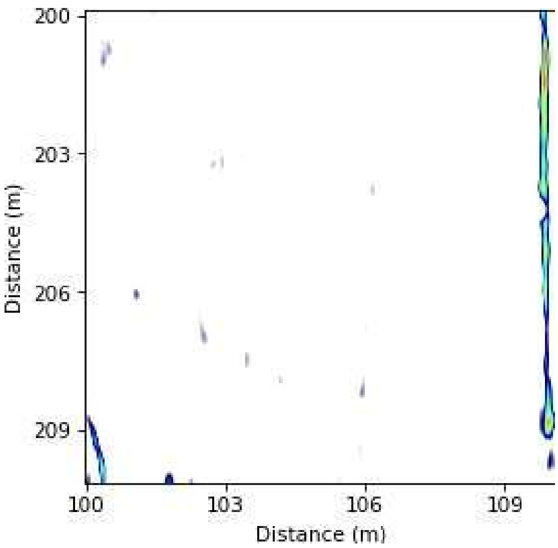


(a) LP-TP01, parallel to y = 200.50 m.

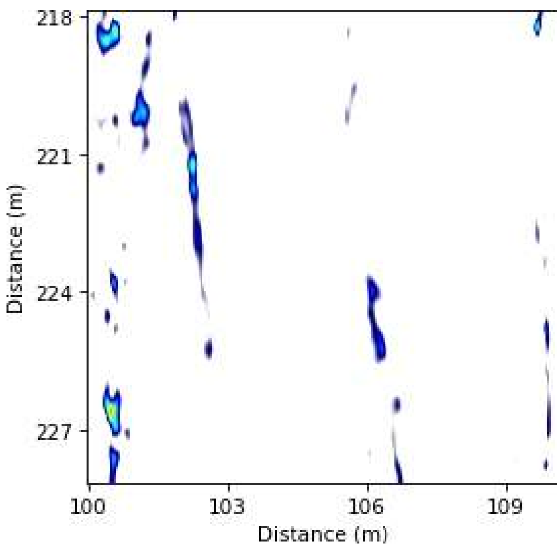


(b) LP-TP02, parallel to y = 221.75 m.

Figure 4.5: Example radargrams from the upslope area of the La Perouse study area, which bear southwest to northeast from left to right respectively. Features include a strong subsurface boundary below approximately 0.4 m. Linear underground services are expressed as hyperbolas.



(a) LP-TP01, at 0.25 m.



(b) LP-TP02, at 0.4 m.

Figure 4.6: Example timeslices from the upslope area of the La Perouse study area with y-axis increasing approximately towards the southeast. Features include linear underground services.

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Conyers, L. B. (2004). *Ground-penetrating radar for archaeology*. AltaMira Press.

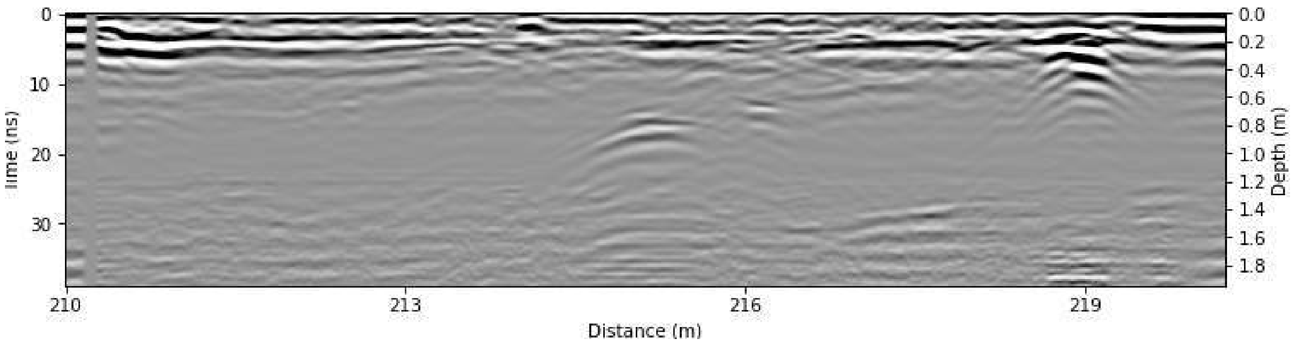

Figure 4.7: Example radargram from downslope at the La Perouse study area, parallel to y = 276.00 m and bearing southwest to northeast from left to right respectively. A strong reflection boundary can be observed at the very near surface.

Davis, J. L. and A. P. Annan (1989). "Ground-penetrating radar for high-resolution mapping of soil and rock stratigraphy". In: *Geophysical Prospecting* 37, pp. 531–551.

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Oliphant, T. (Jan. 2006). *Guide to NumPy*.

Sandmeier, K. J. (2021). *ReflexW: Version 9.5*.

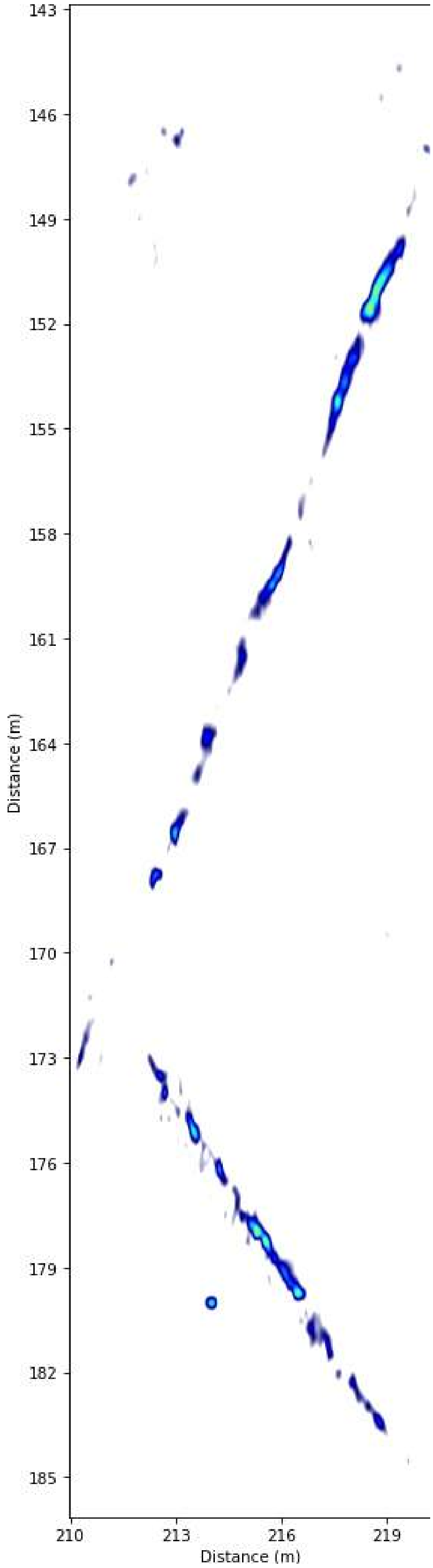
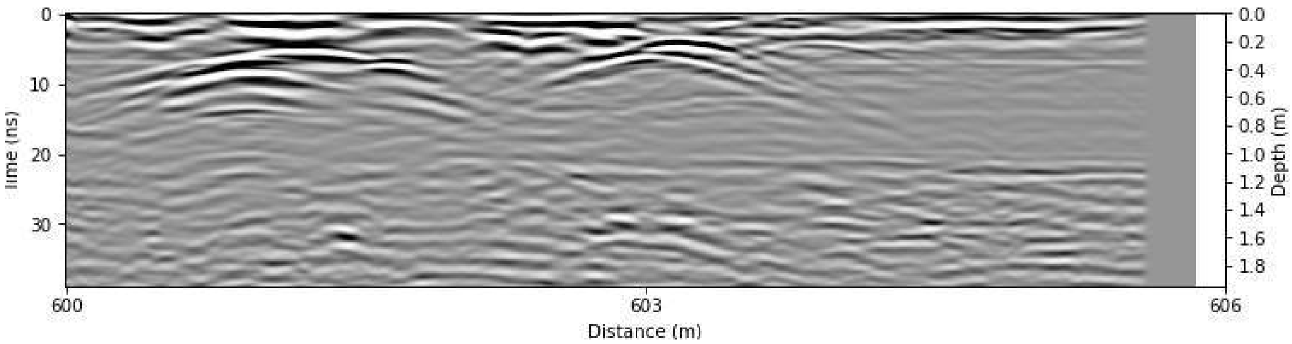
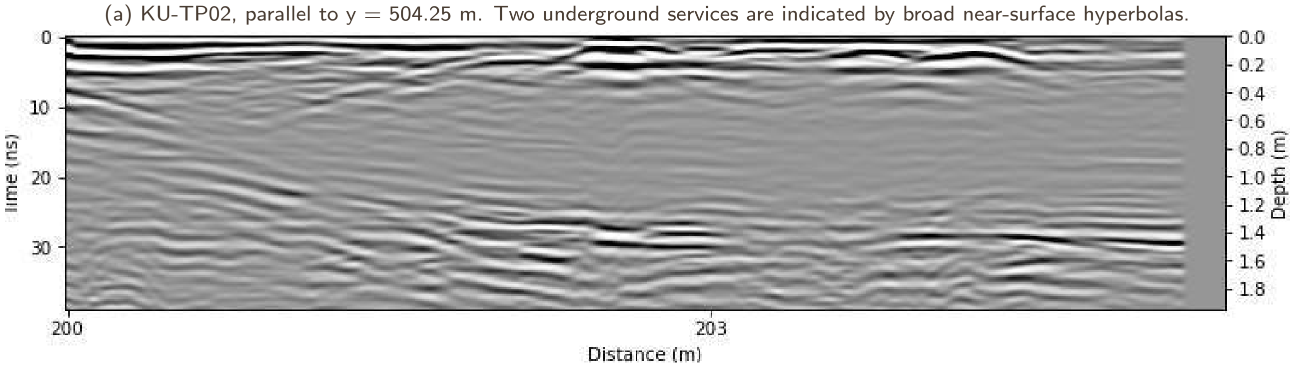


Figure 4.8: Example timeslice from downslope at the La Perouse study area, at 0.95 m depth and the y-axis increasing approximately southeast. At least 2 linear underground services are observable.



(a) KU-TP02, parallel to y = 504.25 m. Two underground services are indicated by broad near-surface hyperbolas.



(b) KU-TP06, parallel to y = 109.25 m.

Figure 4.9: Example radargrams from Polo Street at the Kurnell study area, which bear southwest to northeast from left to right respectively. Features include underground services indicated by broad near-surface hyperbolas and a subsurface boundary below approximately 1.2 m.

Ground-penetrating Radar Survey at the Kamay Ferry Wharves Project, NSW.

Report to Artefact Heritage

1st April 2021

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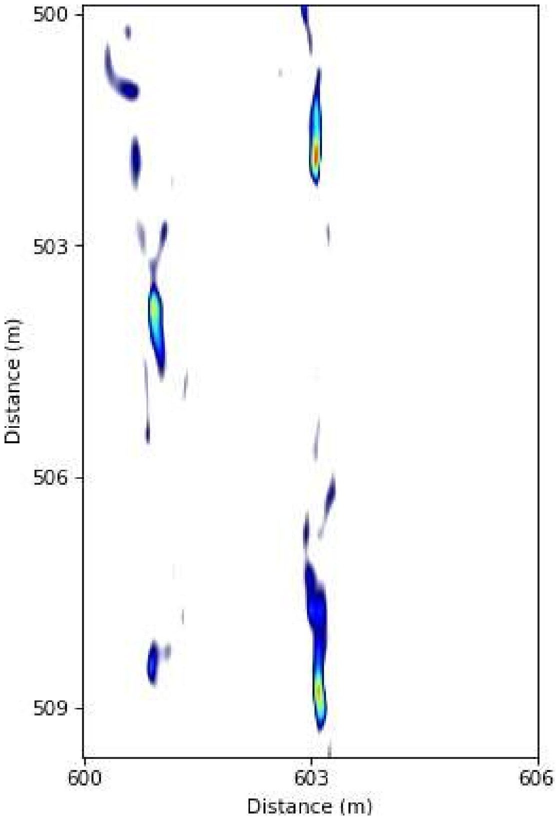
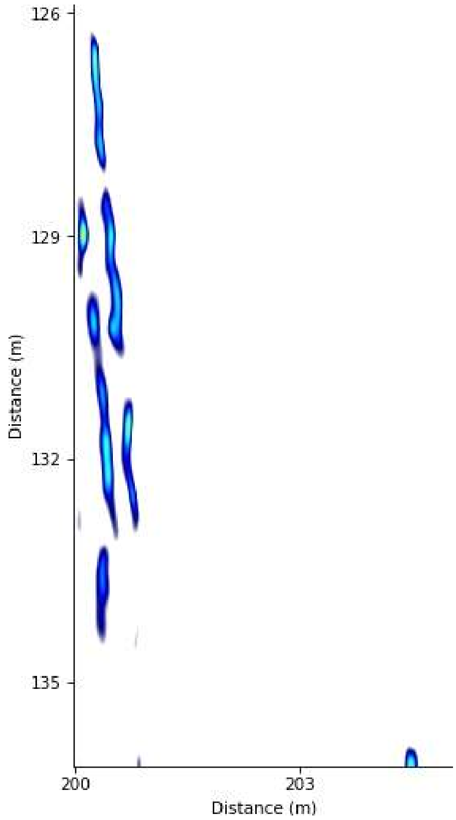


(a) KU-TP02, at 0.45 m depth.



(b) KU-TP05, at 0.40 m depth.

Figure 4.10: Example timeslices from Polo Street at the Kurnell study area, with y-axis increasing approximately towards the southeast. Features include linear service trenches parallel to Polo Street.

Volume Two: Appendices

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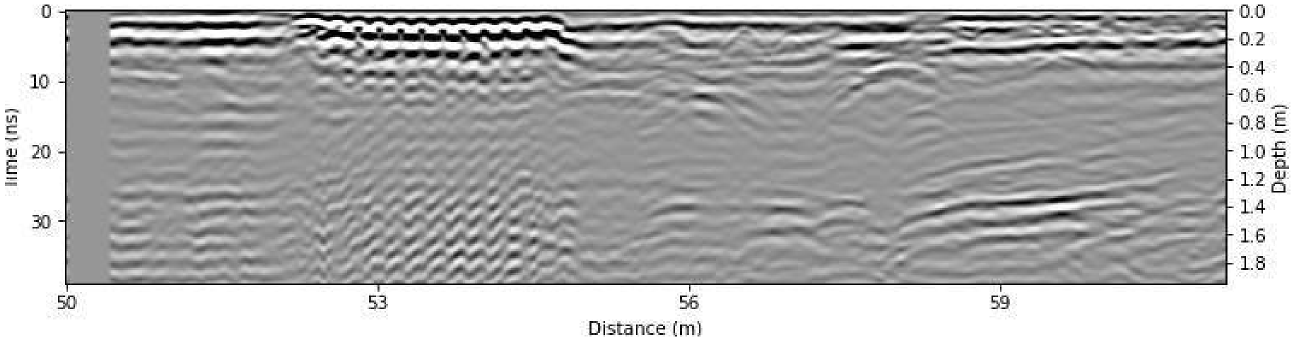
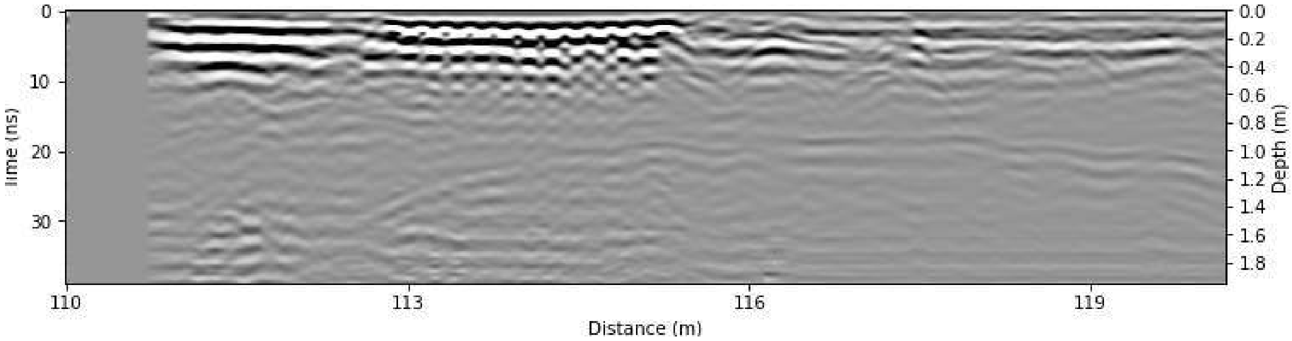
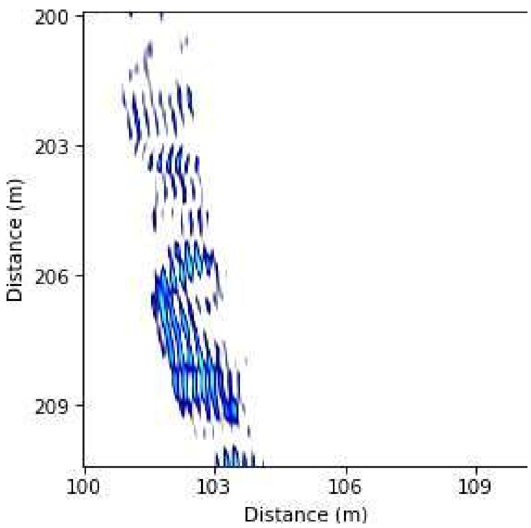


(a) KU-TP10, parallel to y = 257.5 m.

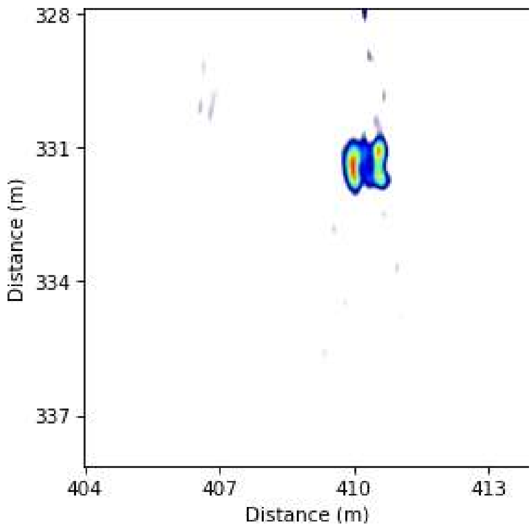


(b) KU-TP14, parallel to y = 243.00 m.

Figure 4.11: Example radargrams from the footpath at the Kurnell study area, which bear generally west to east from left to right respectively. Features include the footpath characterised by a distinctive pattern likely caused by reinforcement bar, and a strong subsurface boundary below approximately 1 m.



(a) KU-TP19, at 0.3 m depth.



(b) KU-TP23, at 0.6 m depth.

Figure 4.12: Example timeslices from the footpath at the Kurnell study area, with y-axis increasing approximately towards the southeast. Features include the footpath and a service access.

A Kamay

A.1 LP-TP01

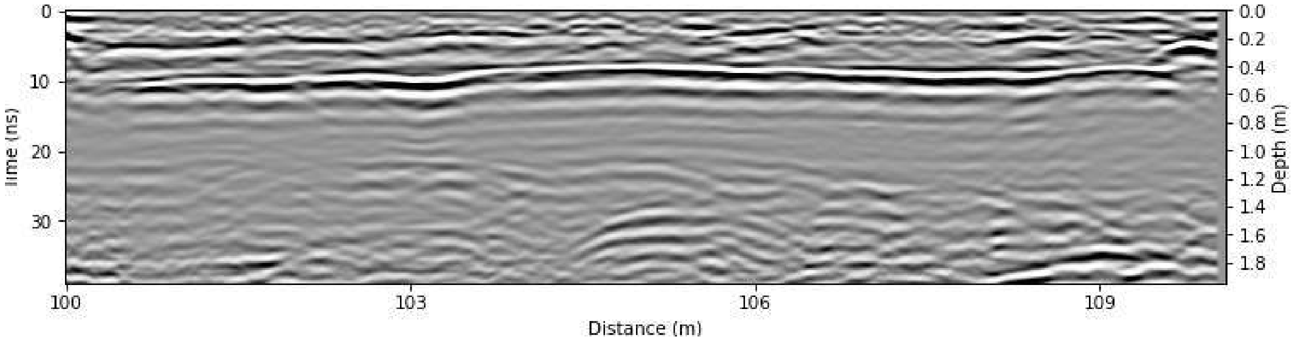


Figure A.1: Radargram at x = 200.0 m.

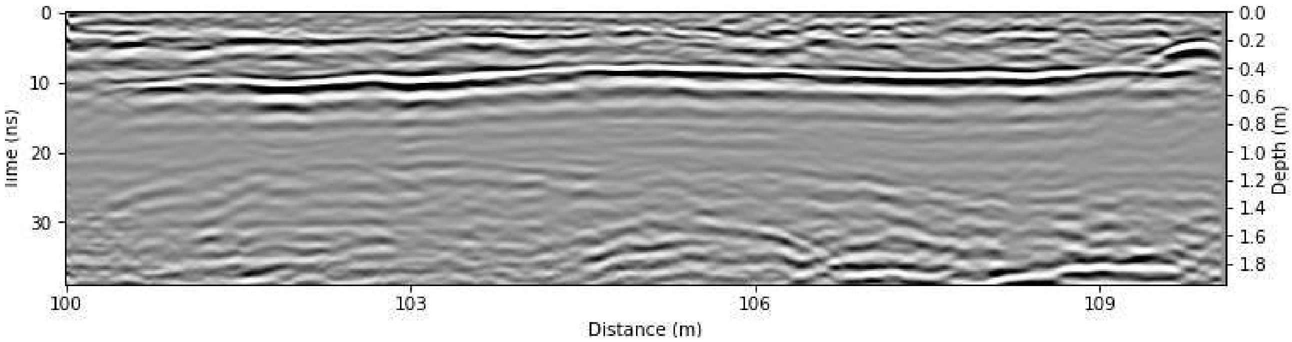


Figure A.2: Radargram at x = 200.25 m.

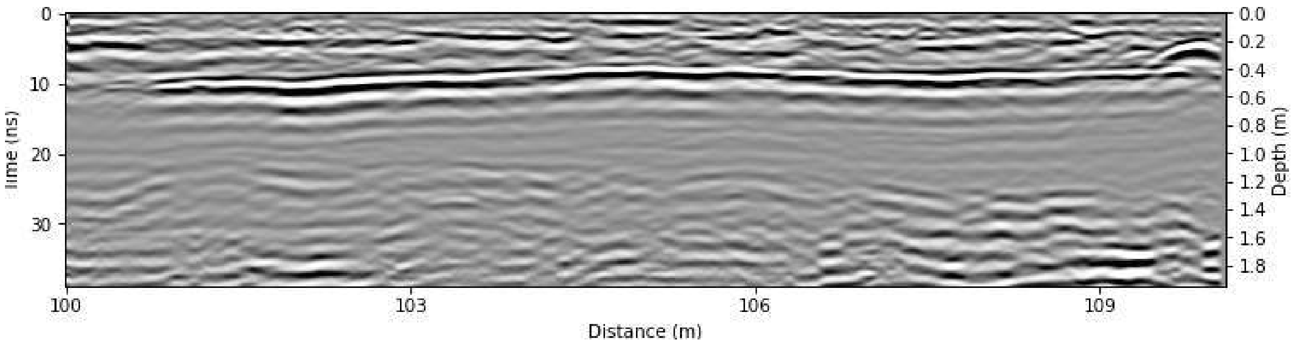


Figure A.3: Radargram at x = 200.5 m.

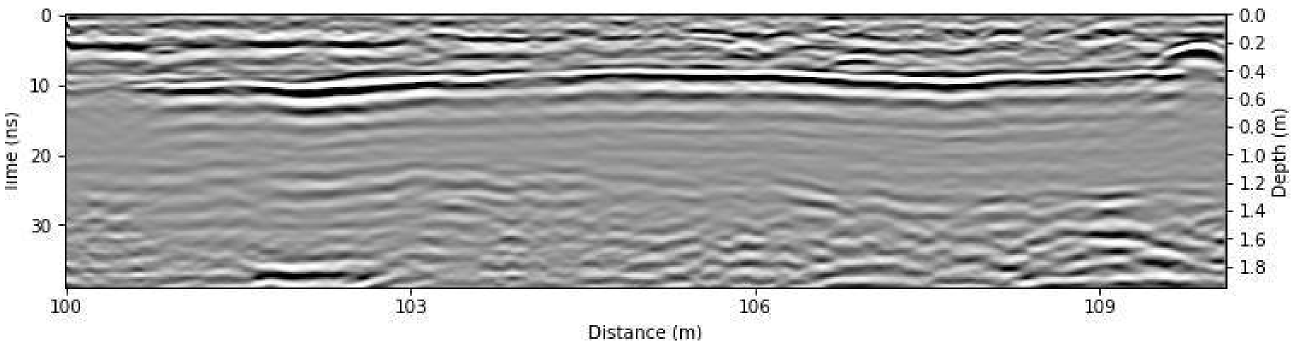


Figure A.4: Radargram at x = 200.75 m.

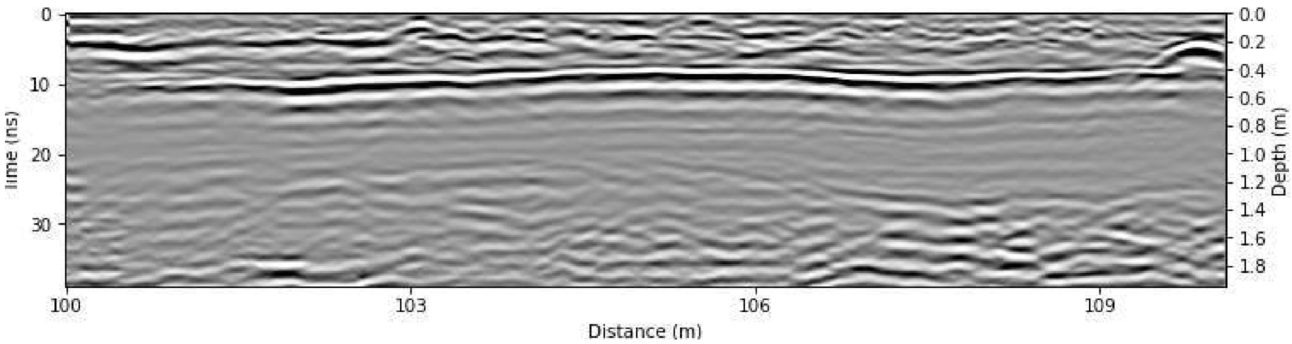


Figure A.5: Radargram at x = 201.0 m.

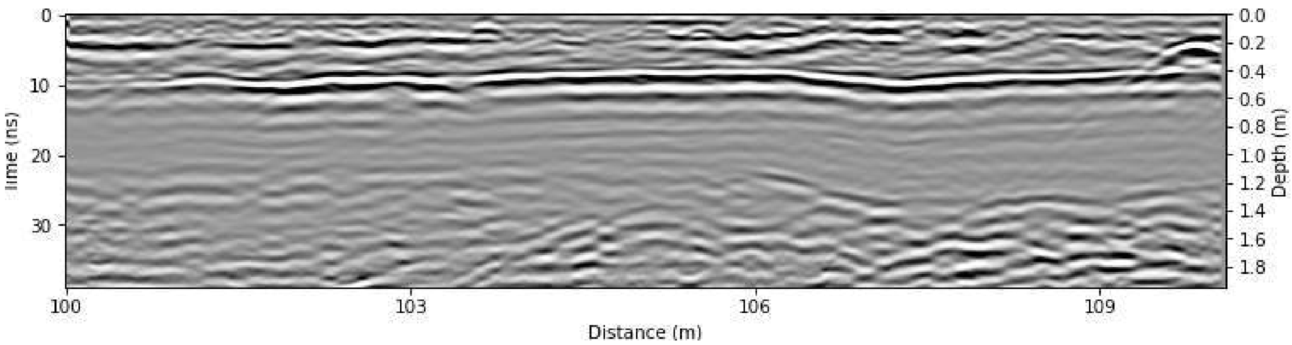
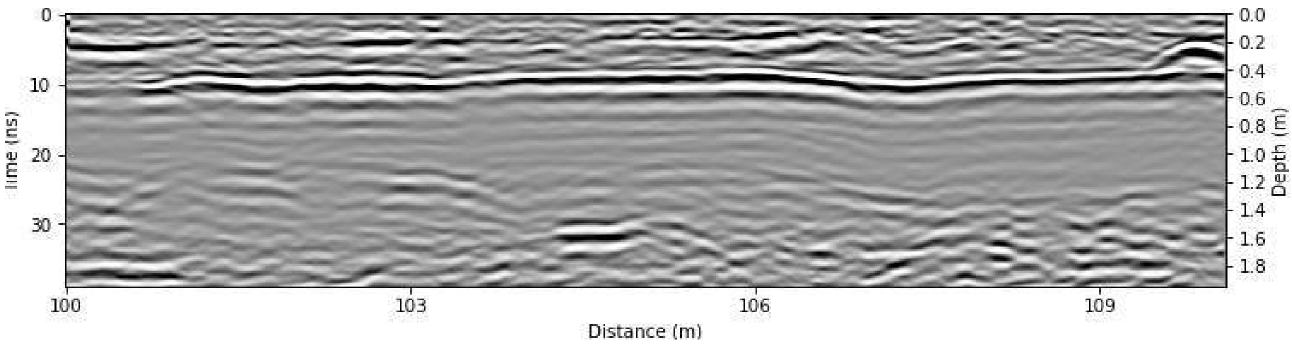


Figure A.6: Radargram at x = 201.25 m.



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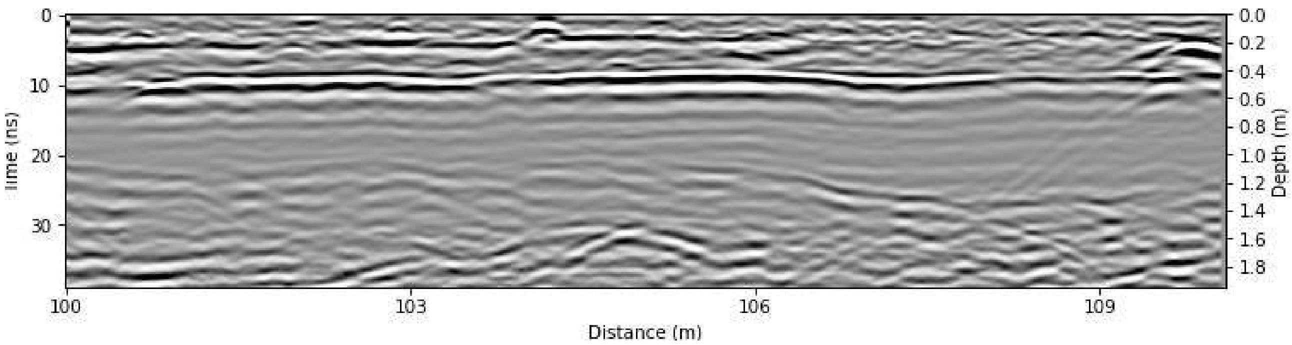


Figure A.8: Radargram at x = 201.75 m.

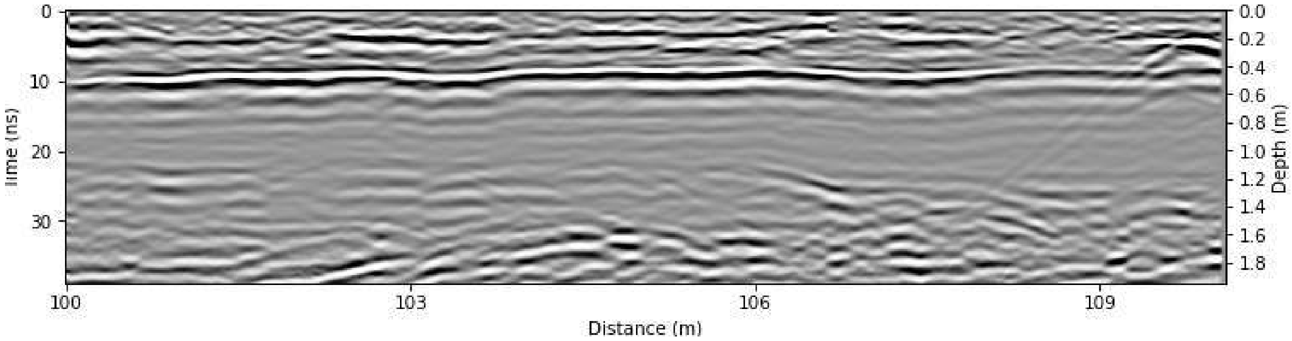


Figure A.9: Radargram at x = 202.0 m.

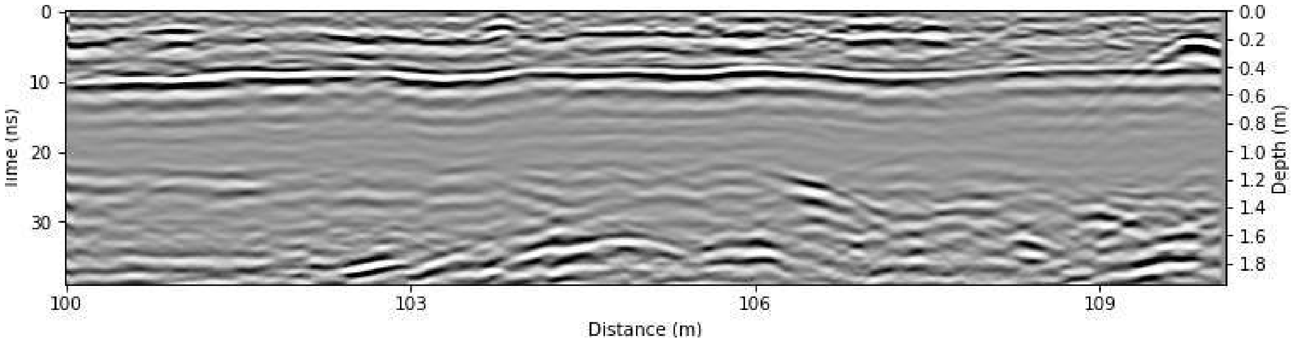
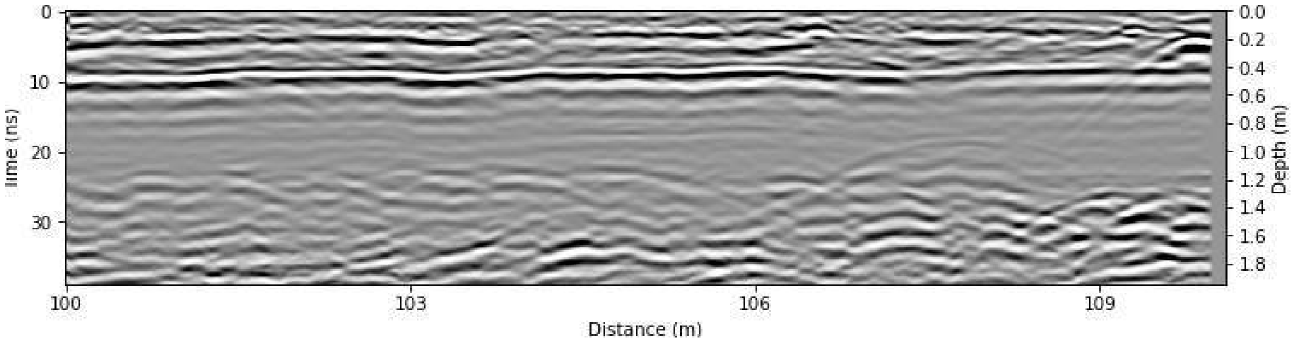


Figure A.10: Radargram at x = 202.25 m.



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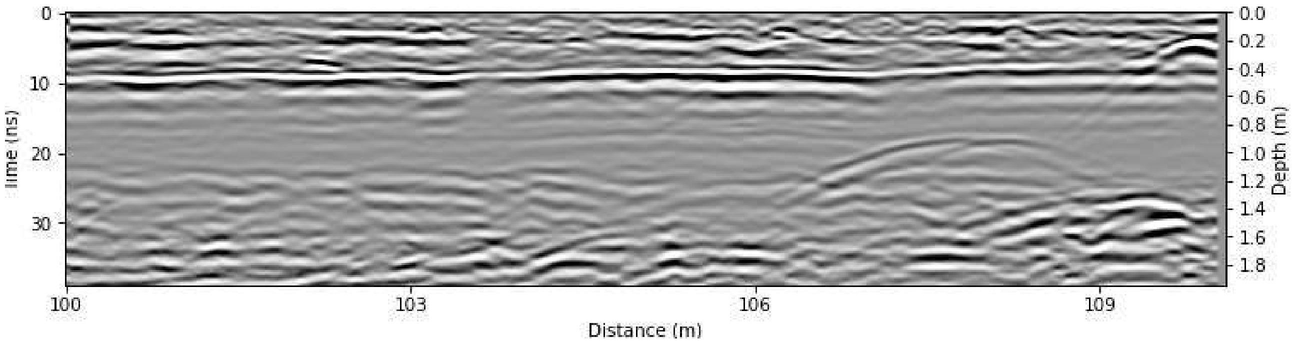


Figure A.12: Radargram at x = 202.75 m.

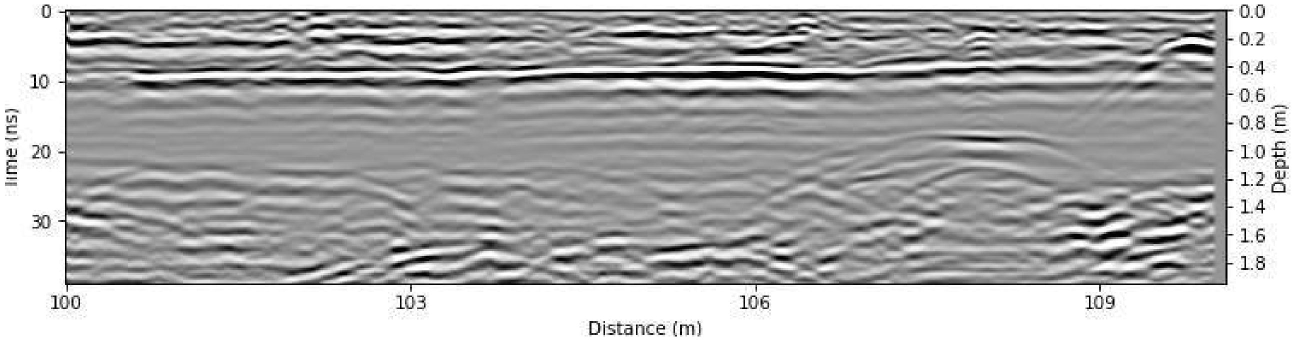


Figure A.13: Radargram at x = 203.0 m.

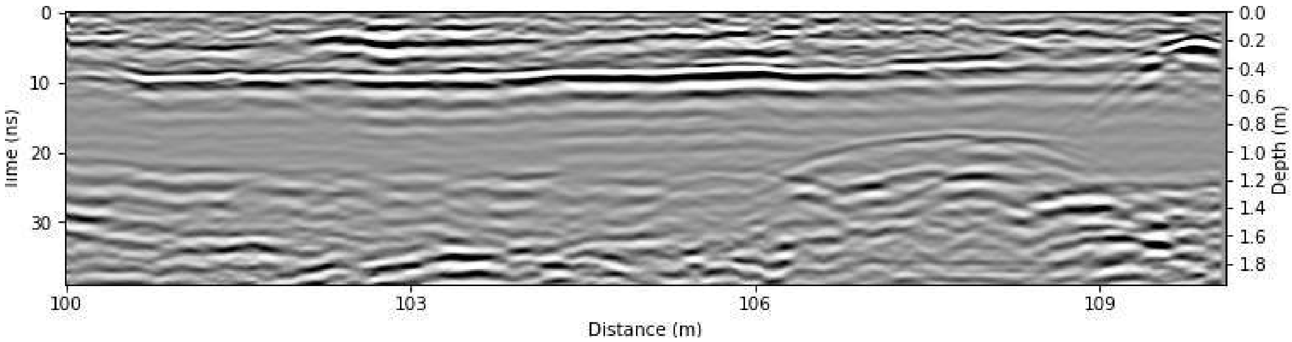


Figure A.14: Radargram at x = 203.25 m.

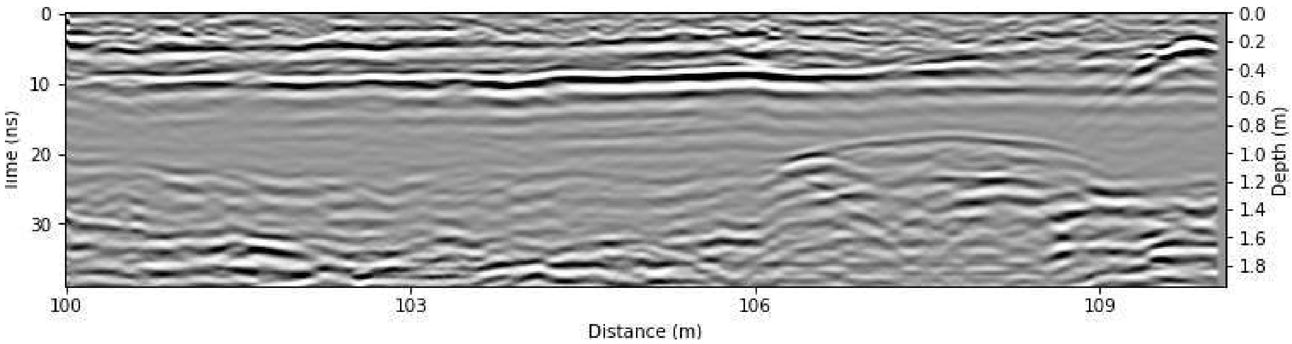


Figure A.15: Radargram at x = 203.5 m.

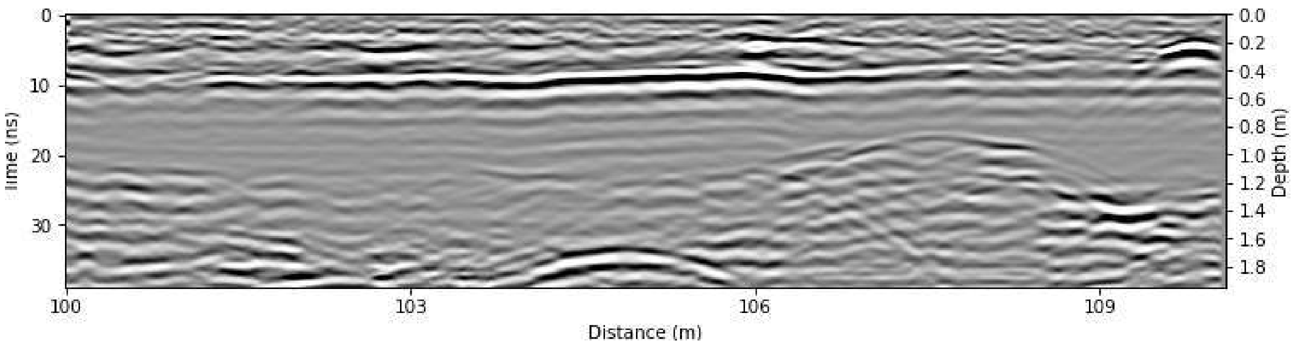


Figure A.16: Radargram at x = 203.75 m.

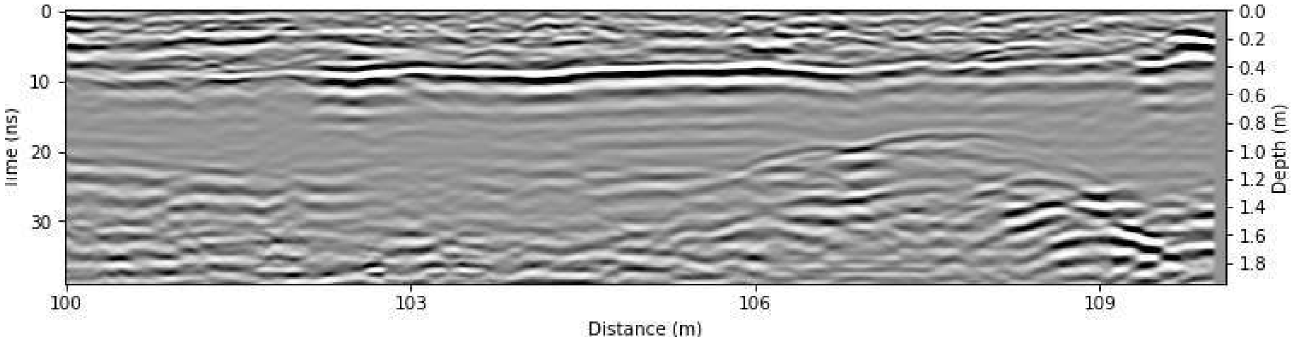


Figure A.17: Radargram at x = 204.0 m.

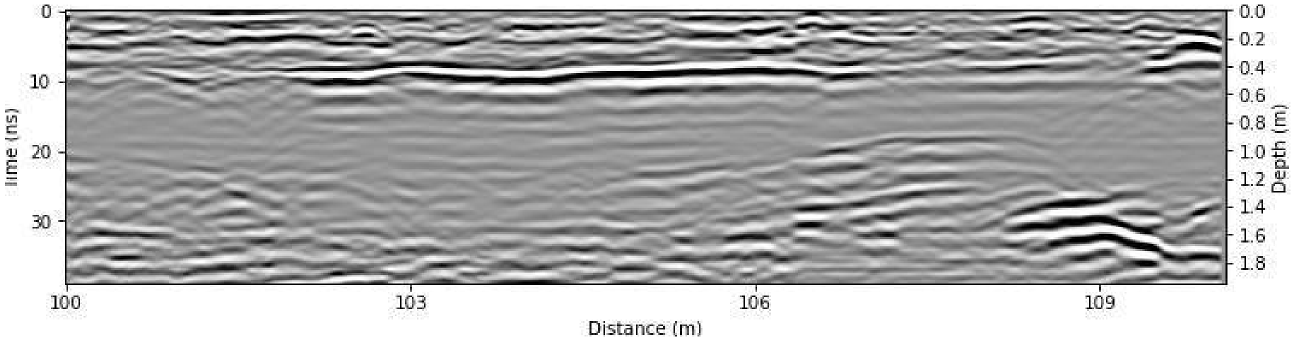


Figure A.18: Radargram at x = 204.25 m.

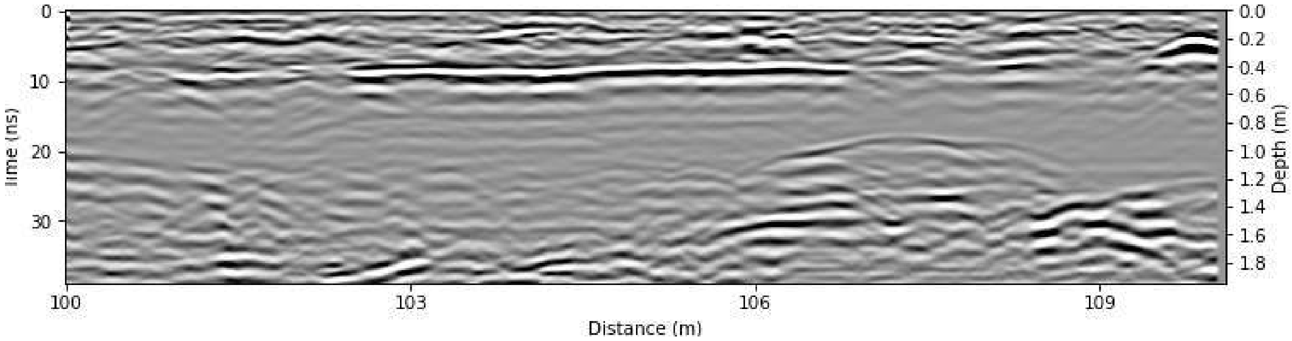
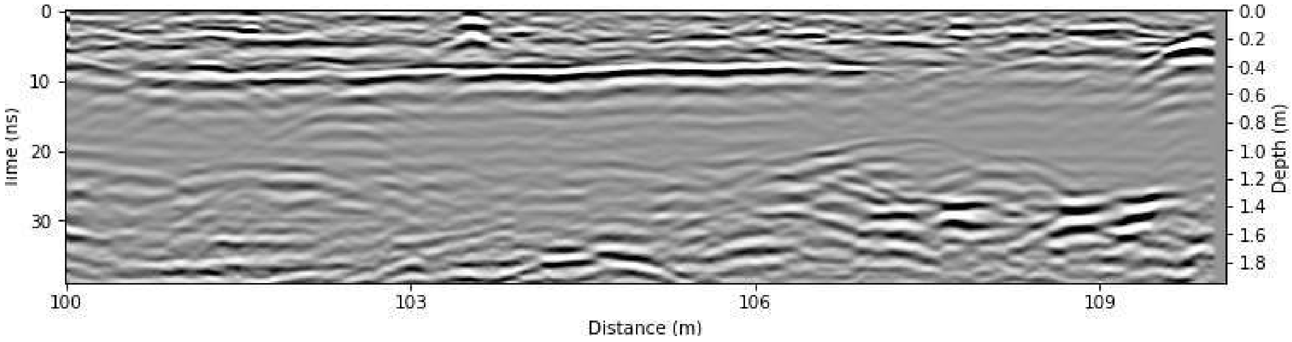


Figure A.19: Radargram at x = 204.5 m.



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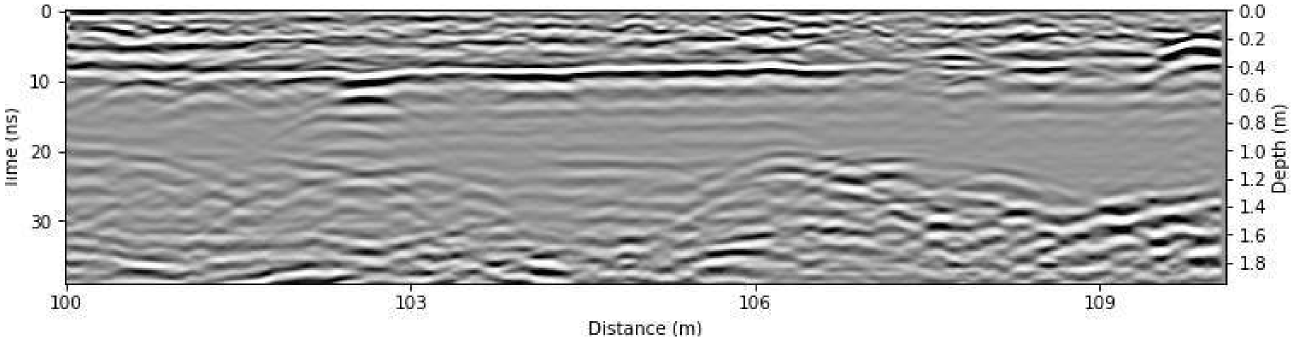


Figure A.21: Radargram at x = 205.0 m.

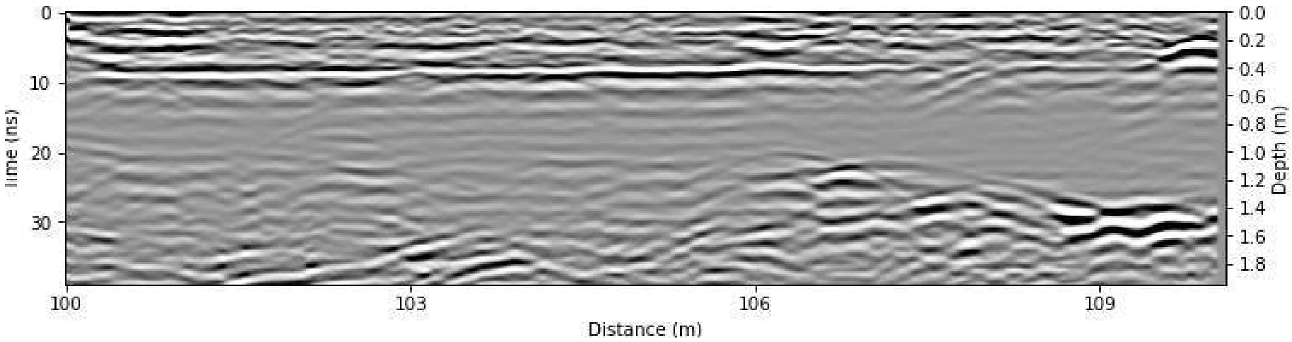


Figure A.22: Radargram at x = 205.25 m.

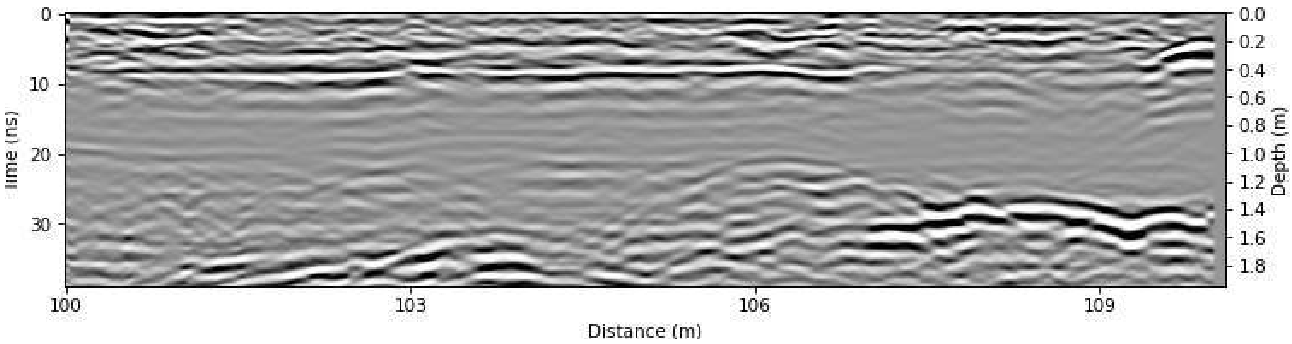


Figure A.23: Radargram at x = 205.5 m.

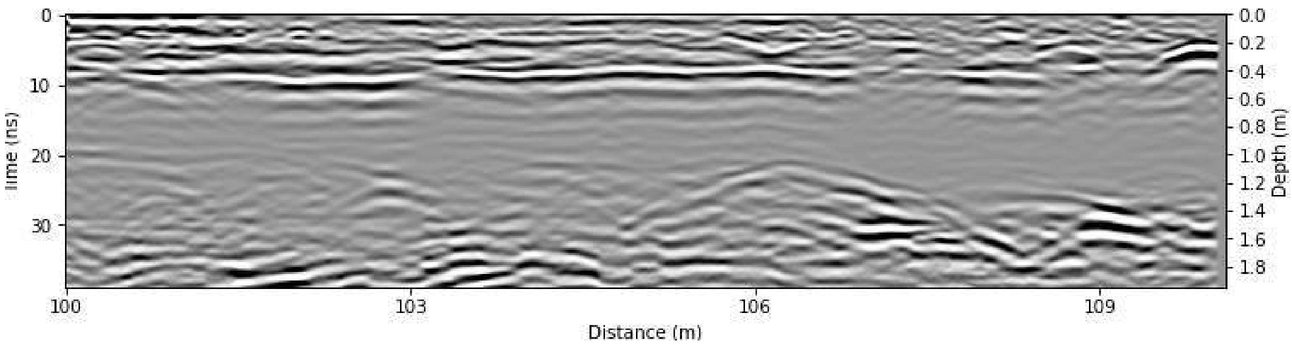


Figure A.24: Radargram at x = 205.75 m.

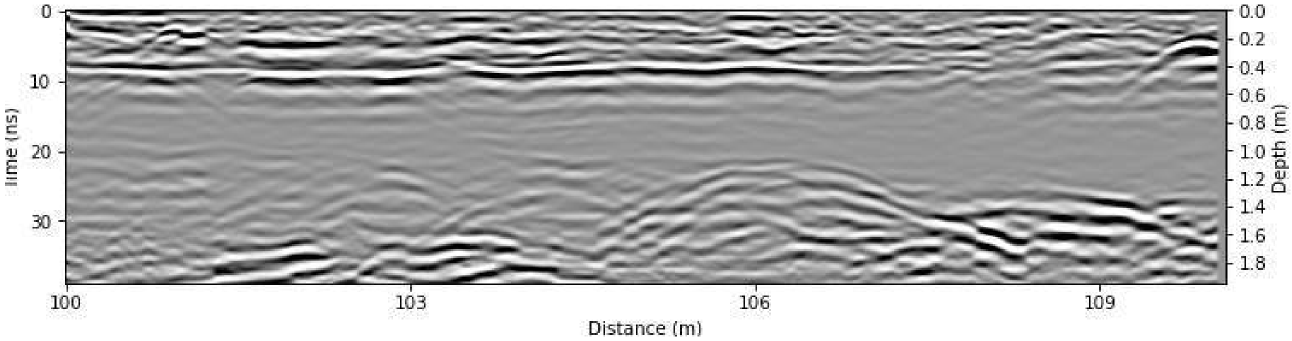


Figure A.25: Radargram at x = 206.0 m.

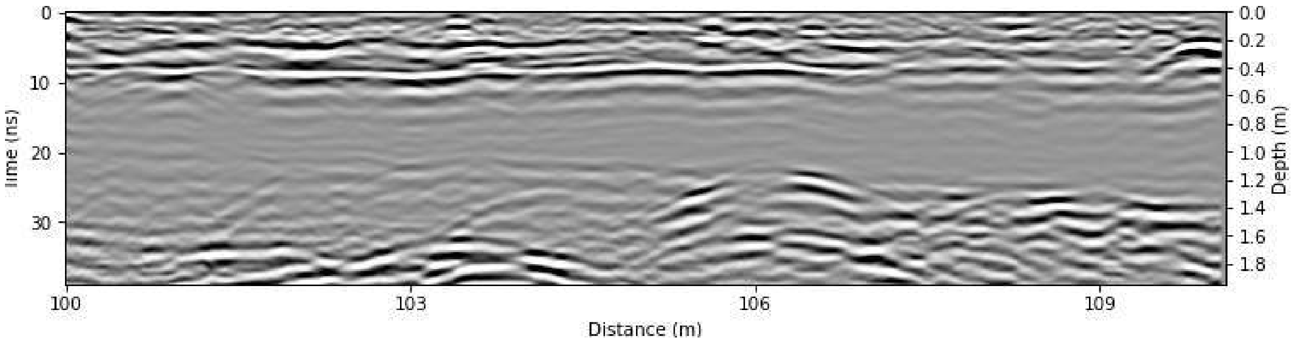


Figure A.26: Radargram at x = 206.25 m.

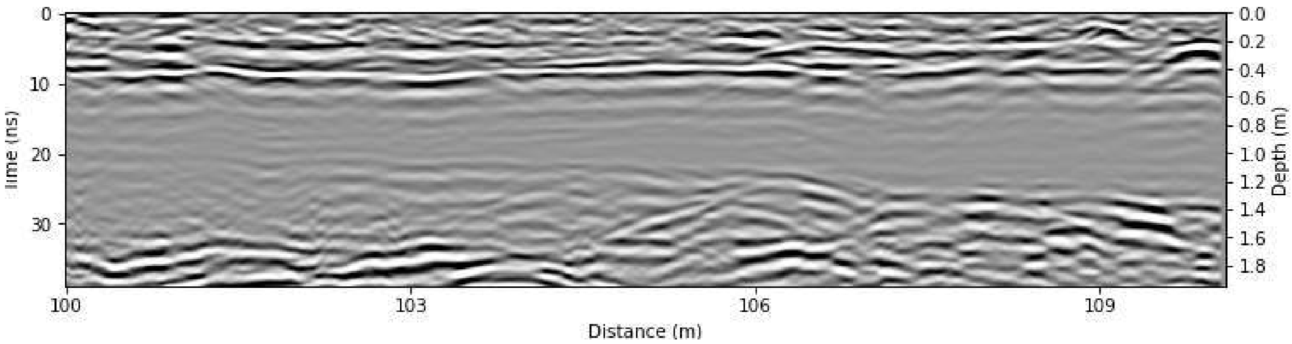


Figure A.27: Radargram at x = 206.5 m.

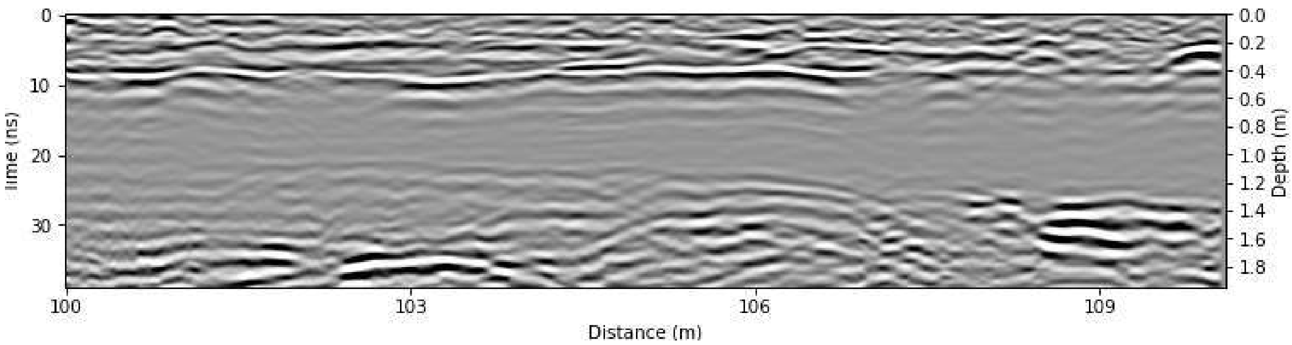


Figure A.28: Radargram at x = 206.75 m.

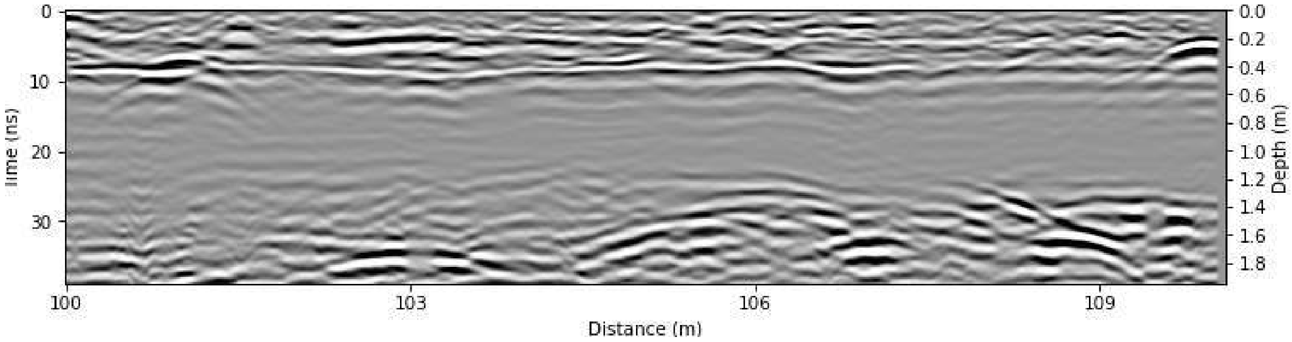


Figure A.29: Radargram at x = 207.0 m.

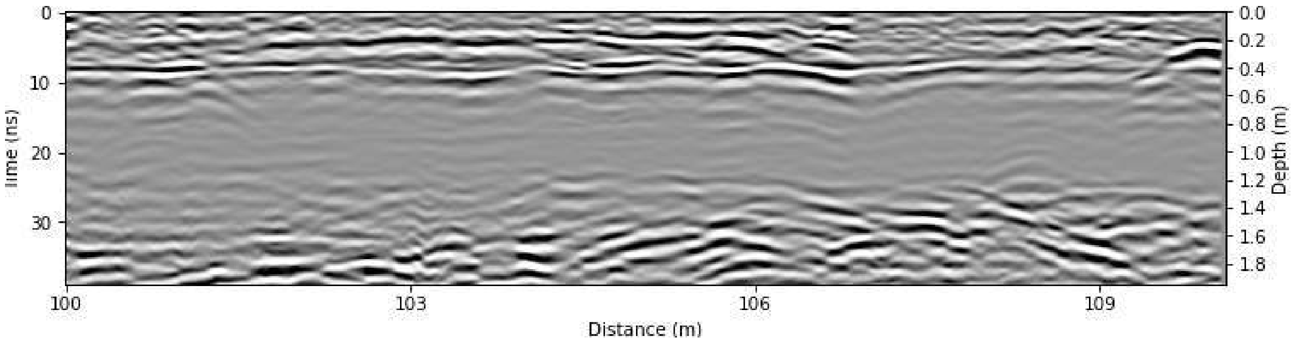


Figure A.30: Radargram at x = 207.25 m.

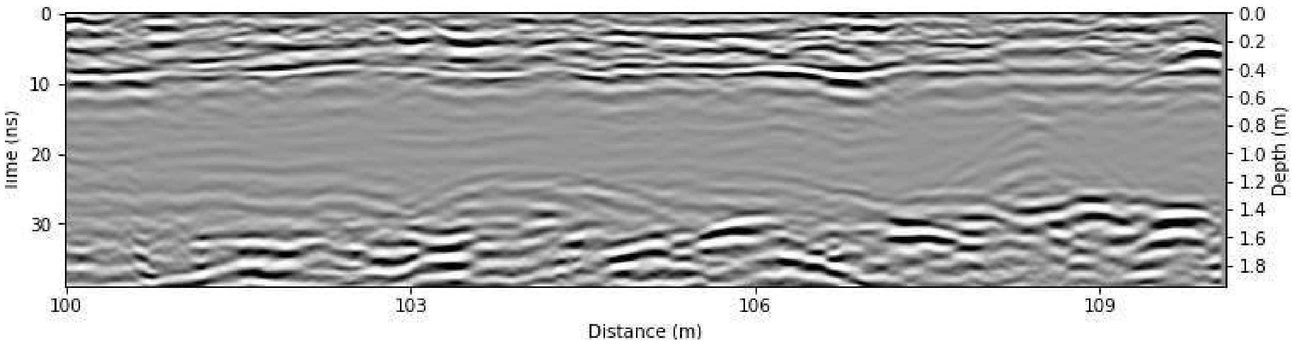


Figure A.31: Radargram at x = 207.5 m.

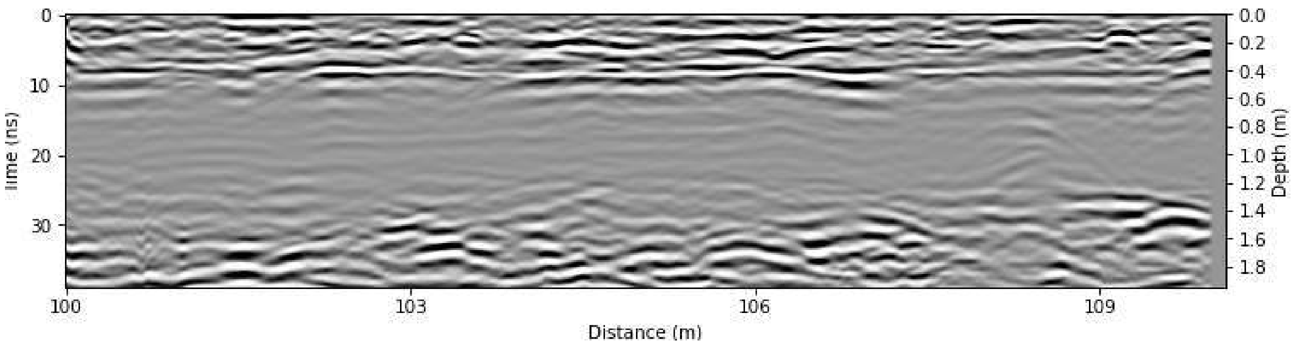


Figure A.32: Radargram at x = 207.75 m.

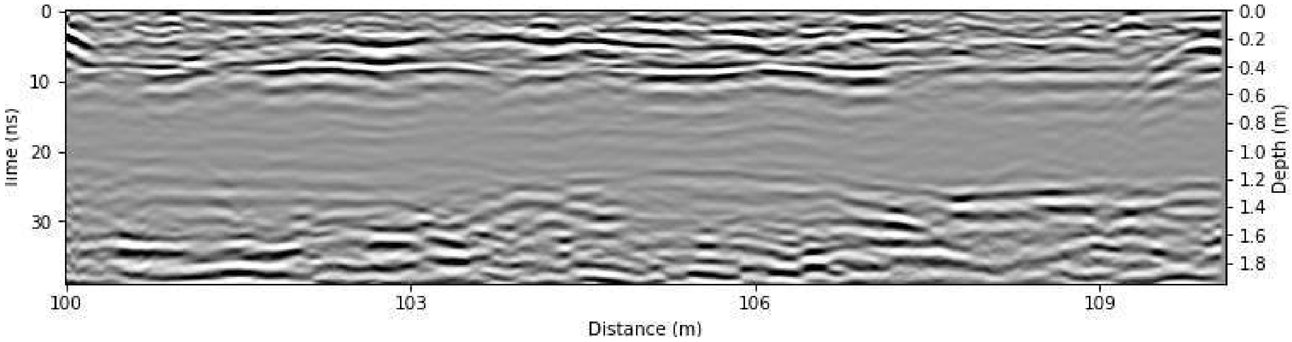


Figure A.33: Radargram at x = 208.0 m.

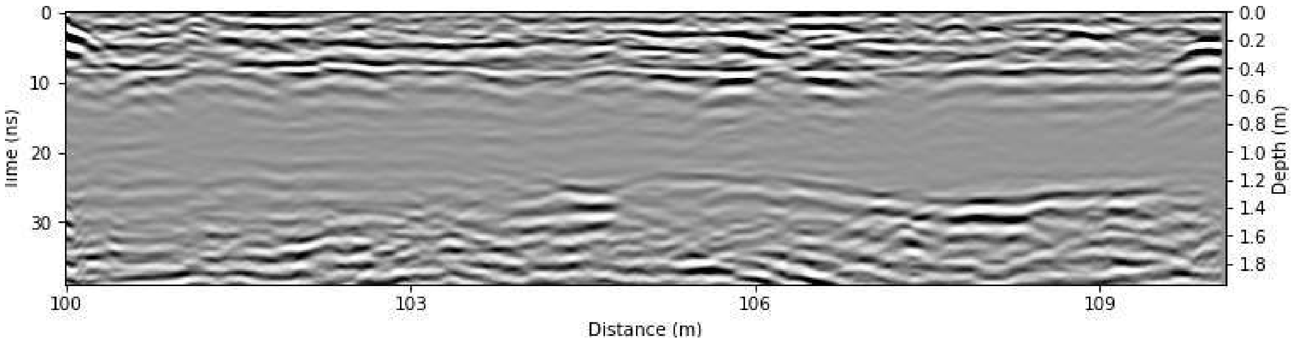


Figure A.34: Radargram at x = 208.25 m.

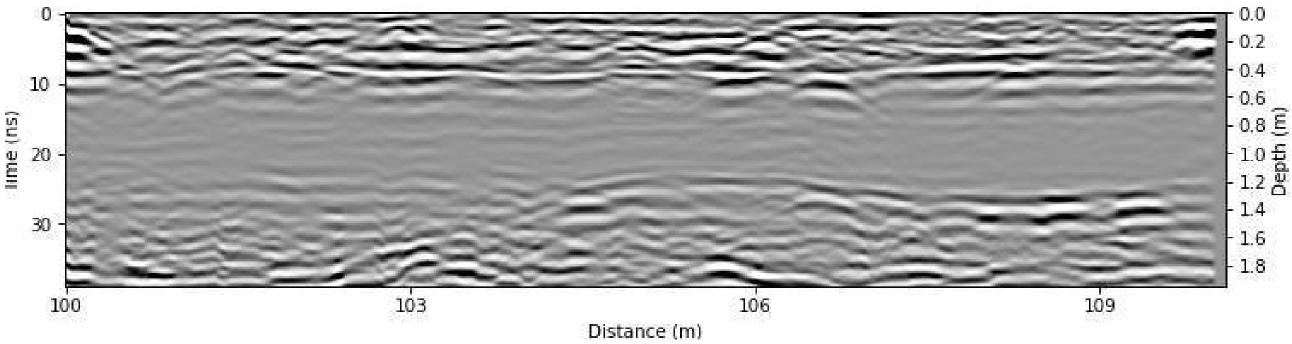


Figure A.35: Radargram at x = 208.5 m.

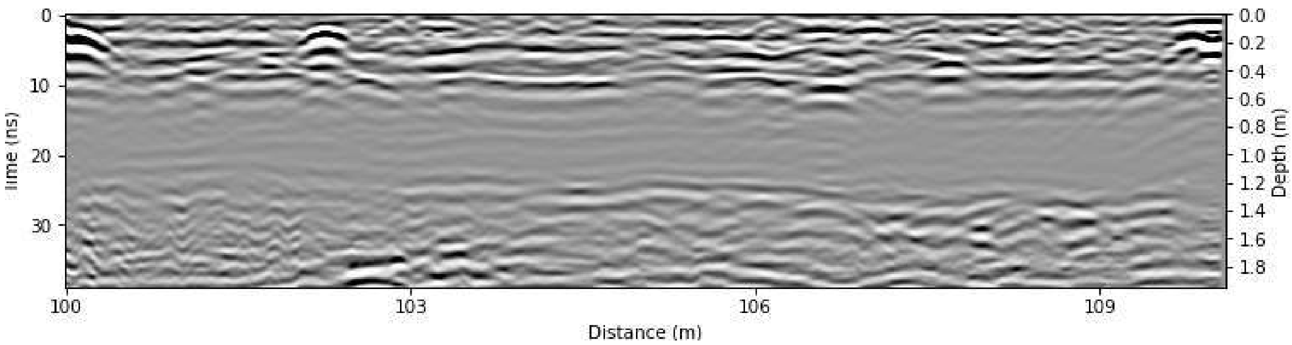


Figure A.36: Radargram at x = 208.75 m.

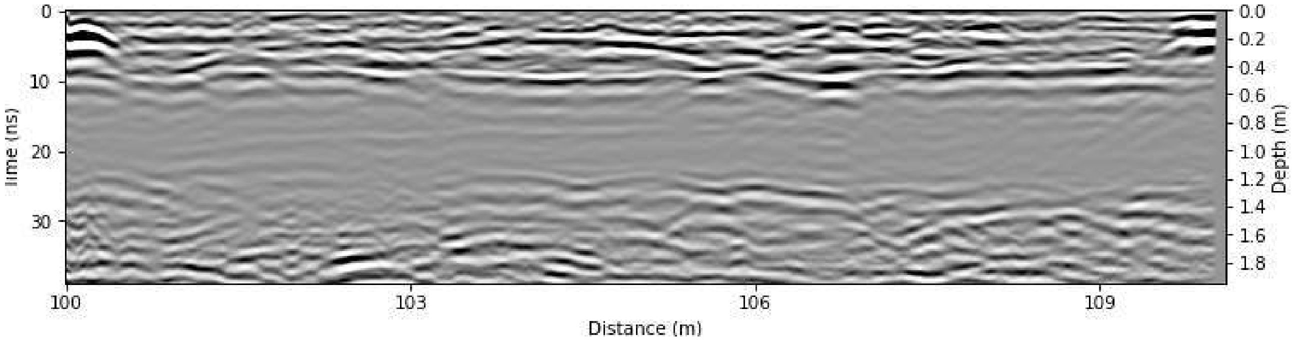


Figure A.37: Radargram at x = 209.0 m.

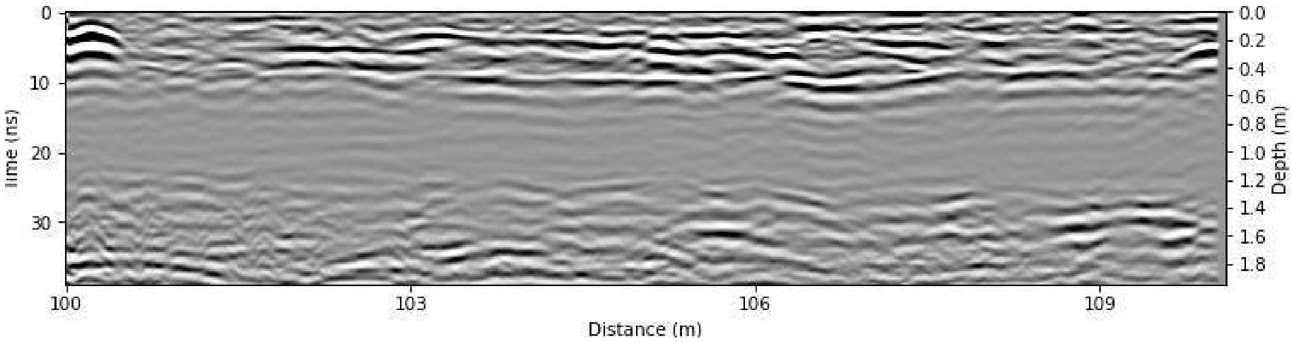


Figure A.38: Radargram at x = 209.25 m.

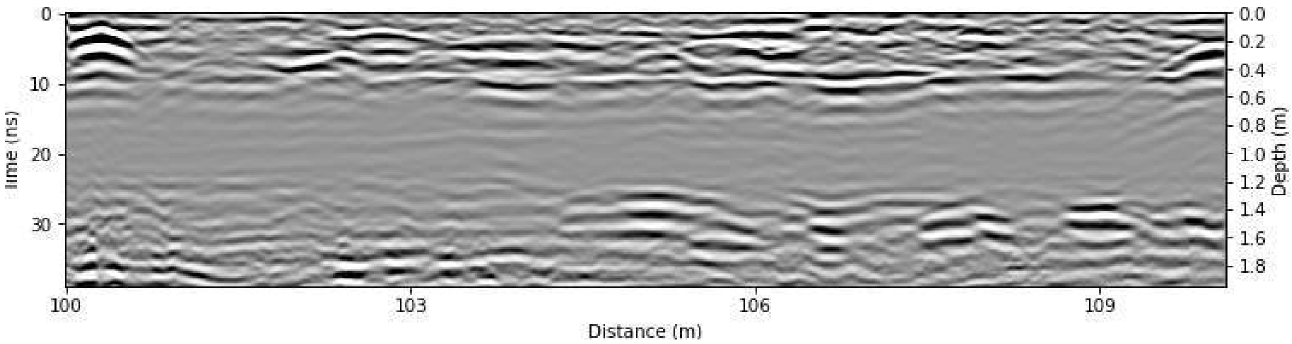


Figure A.39: Radargram at x = 209.5 m.

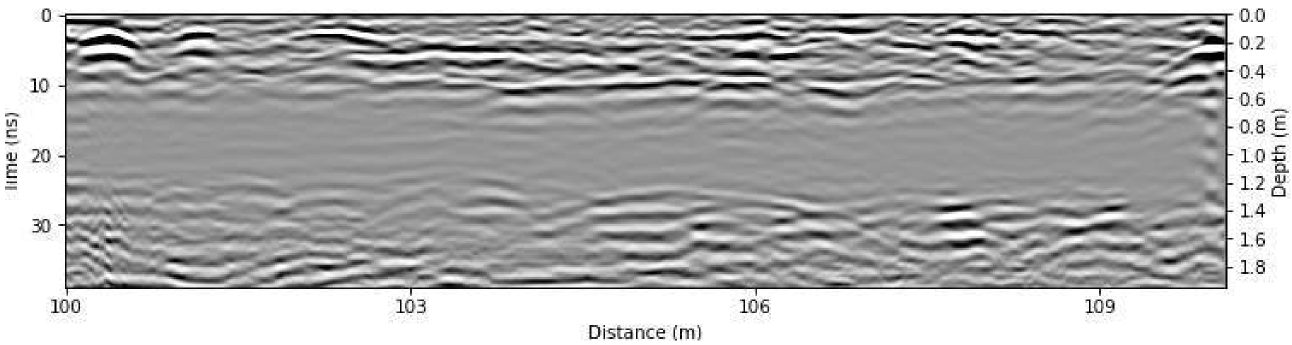


Figure A.40: Radargram at x = 209.75 m.

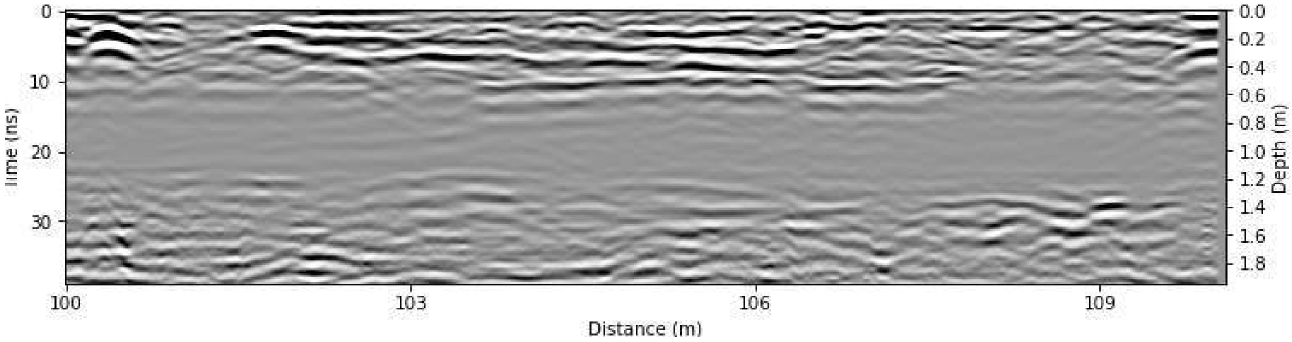
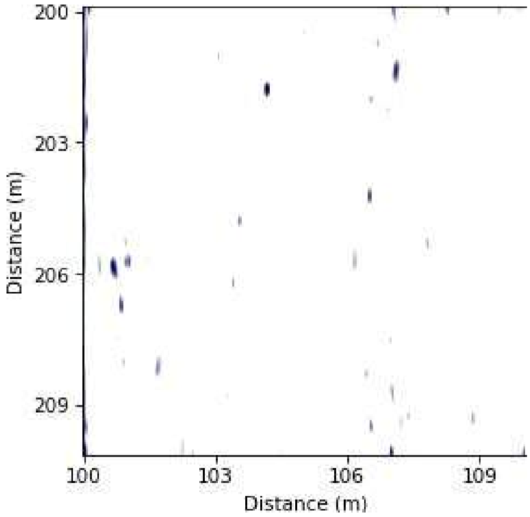
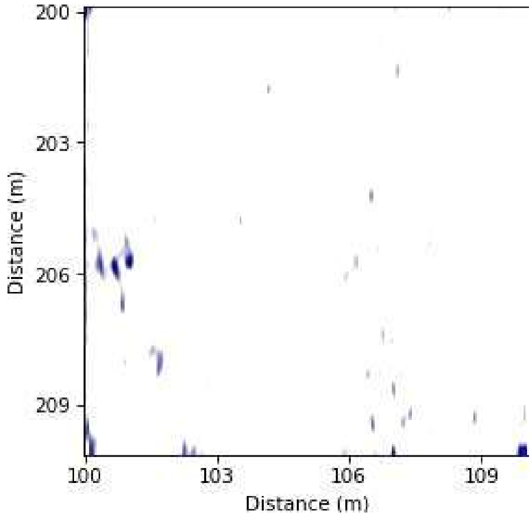


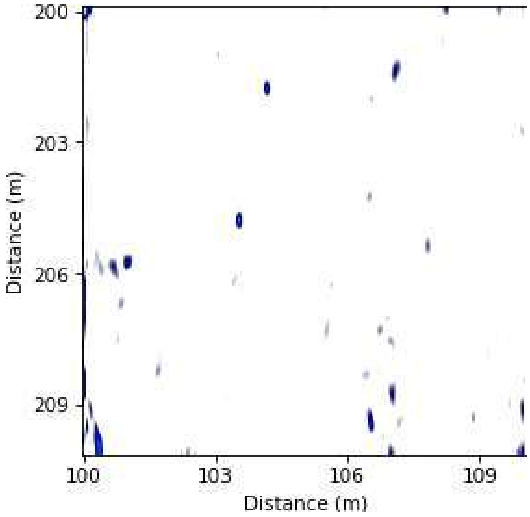
Figure A.41: Radargram at x = 210.0 m.



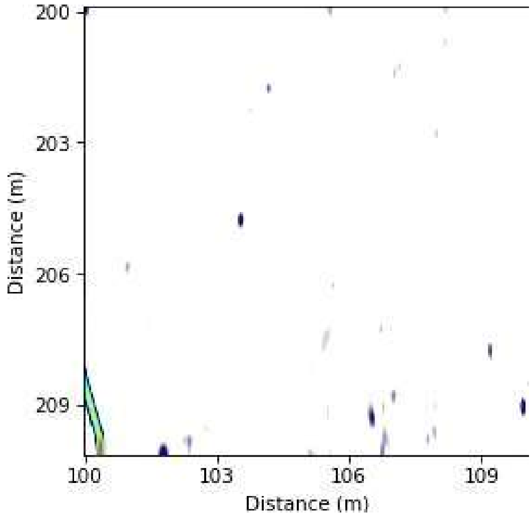
(a) Timeslice at z = 0.0 m.



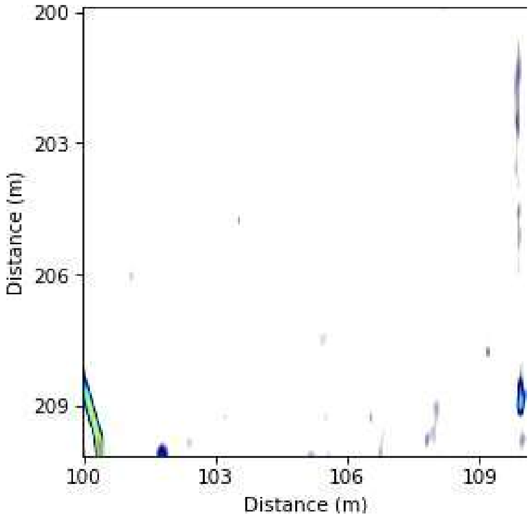
(b) Timeslice at z = 0.05 m.



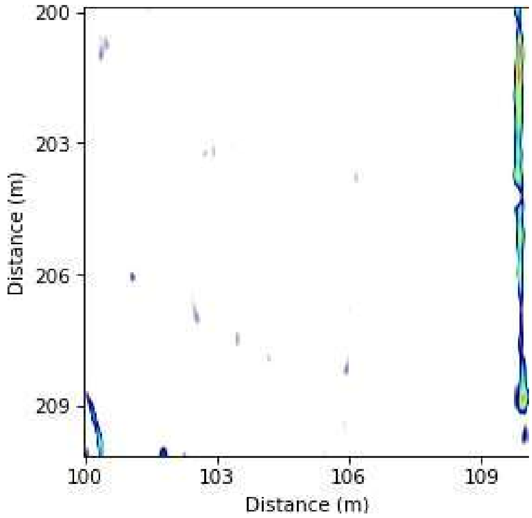
(c) Timeslice at z = 0.1 m.



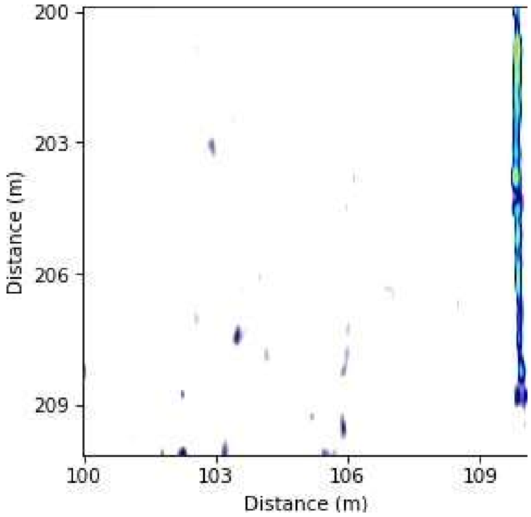
(d) Timeslice at z = 0.15 m.



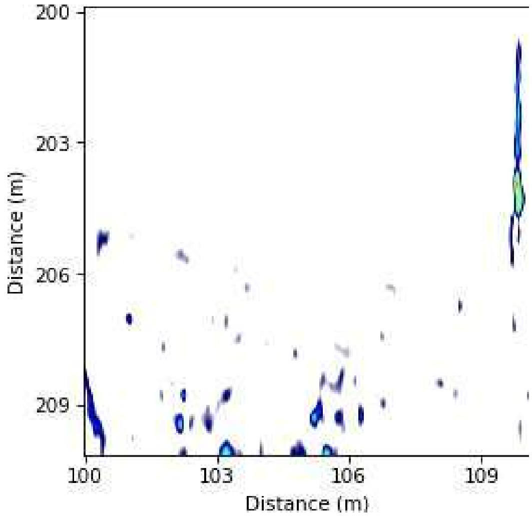
(e) Timeslice at z = 0.2 m.



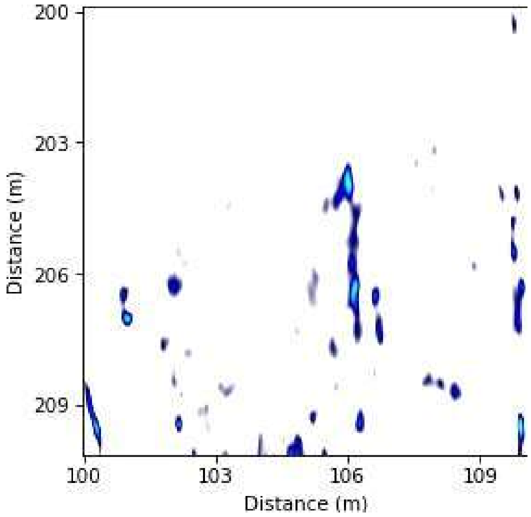
(f) Timeslice at z = 0.25 m.



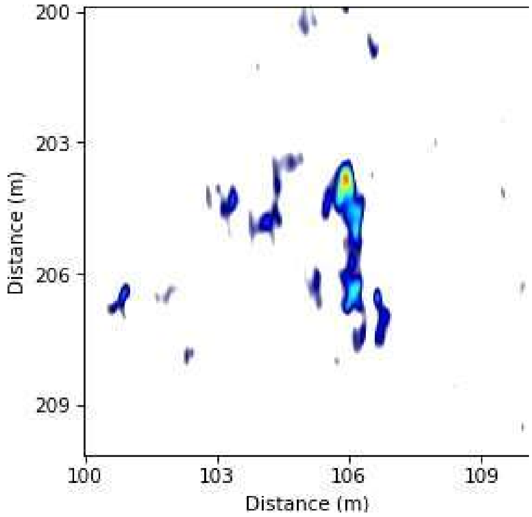
(a) Timeslice at z = 0.3 m.



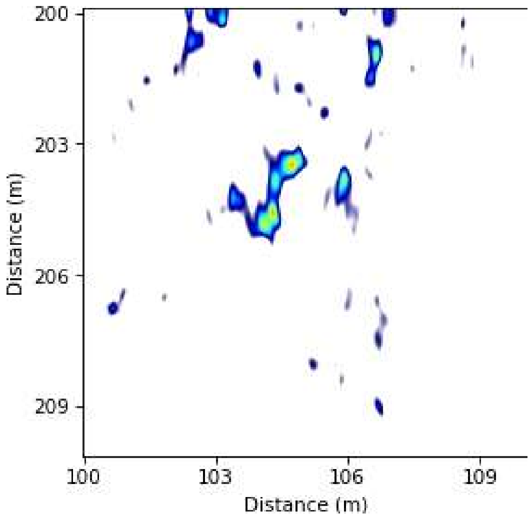
(b) Timeslice at z = 0.35 m.



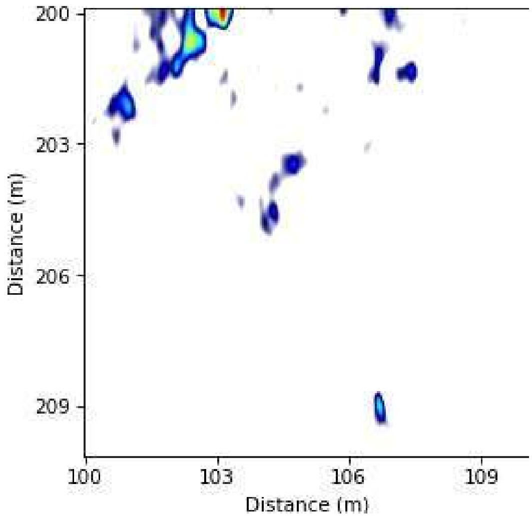
(c) Timeslice at z = 0.4 m.



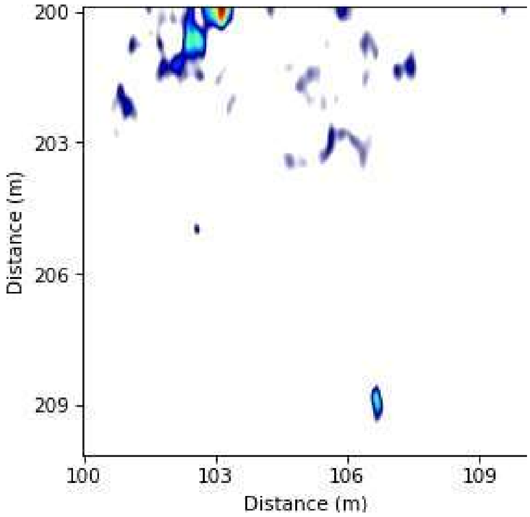
(d) Timeslice at z = 0.45 m.



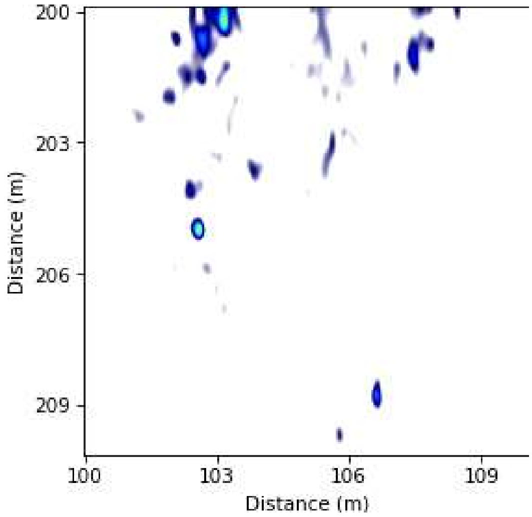
(e) Timeslice at z = 0.5 m.



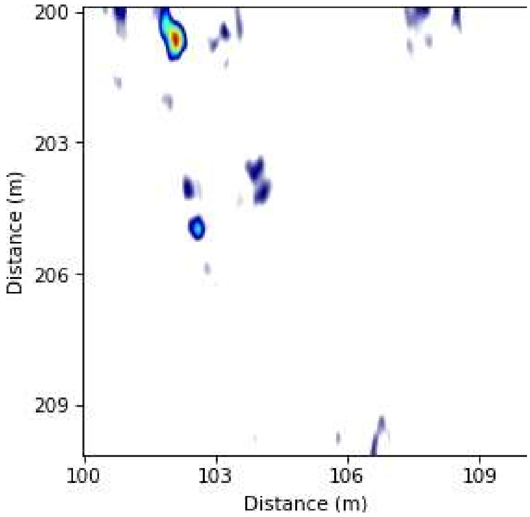
(f) Timeslice at z = 0.55 m.



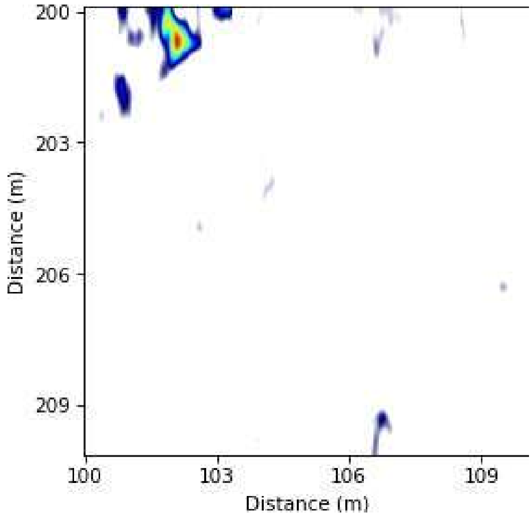
(a) Timeslice at z = 0.6 m.



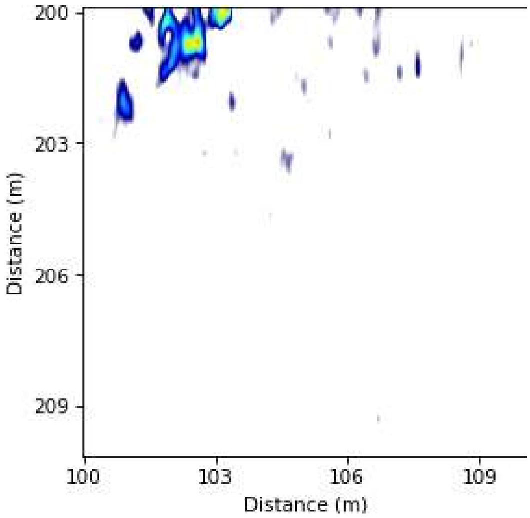
(b) Timeslice at z = 0.65 m.



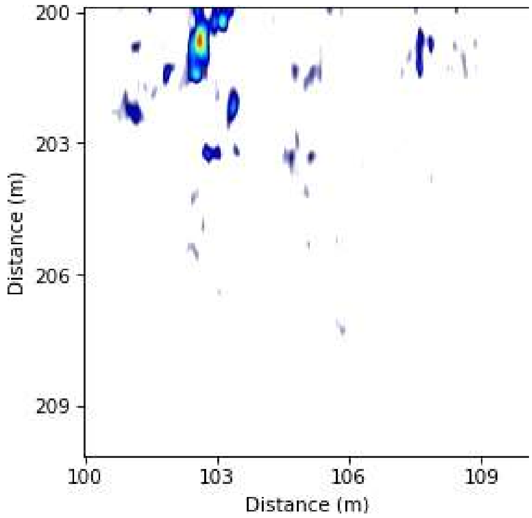
(c) Timeslice at z = 0.7 m.



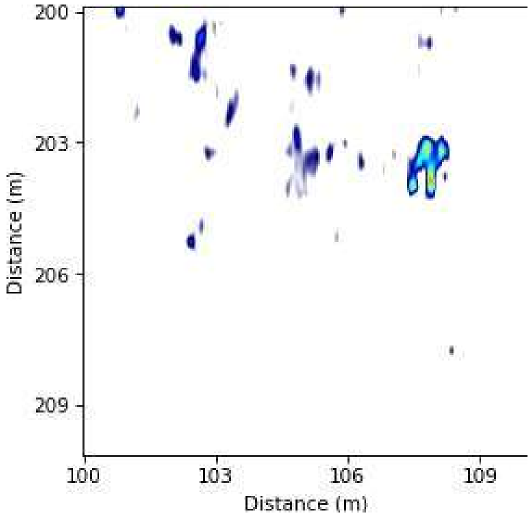
(d) Timeslice at z = 0.75 m.



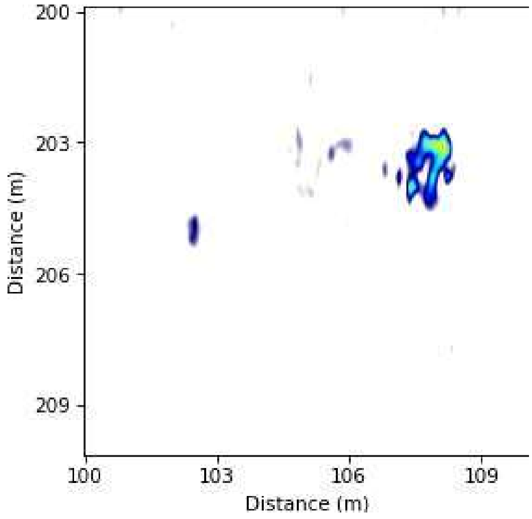
(e) Timeslice at z = 0.8 m.



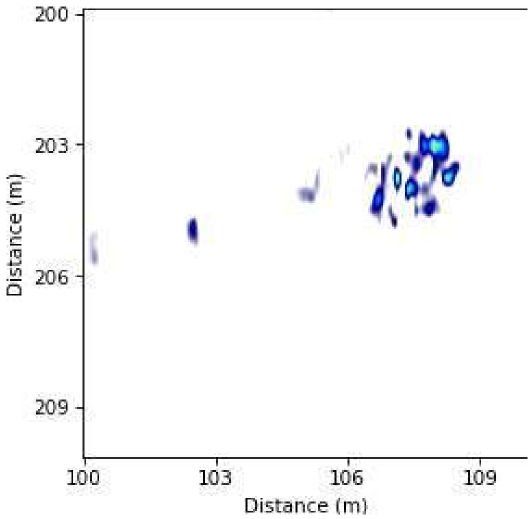
(f) Timeslice at z = 0.85 m.



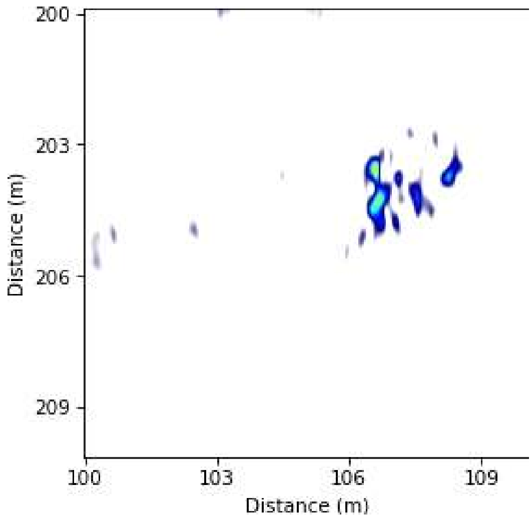
(a) Timeslice at z = 0.9 m.



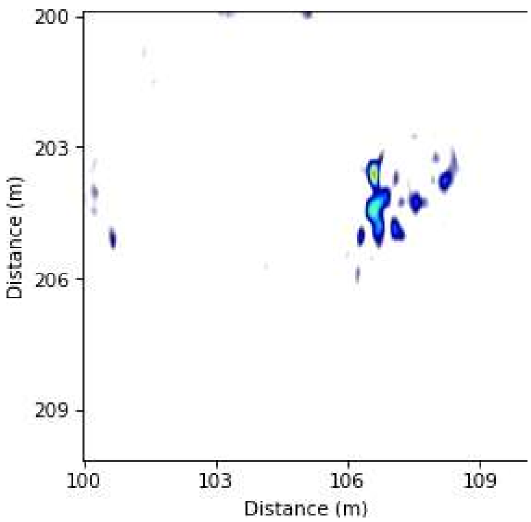
(b) Timeslice at z = 0.95 m.



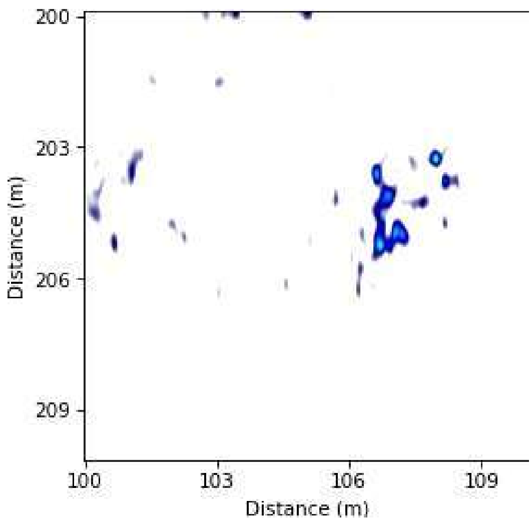
(c) Timeslice at z = 1.0 m.



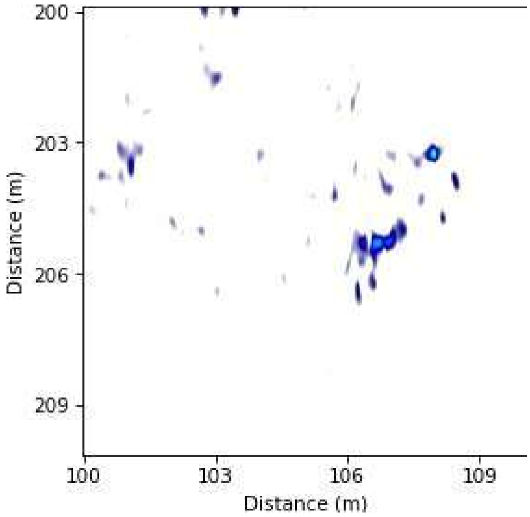
(d) Timeslice at z = 1.05 m.



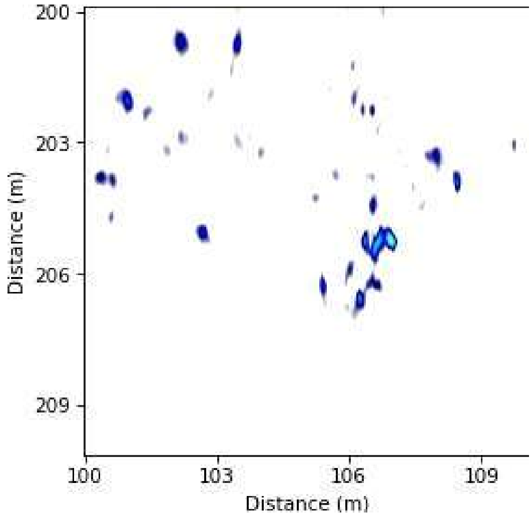
(e) Timeslice at z = 1.1 m.



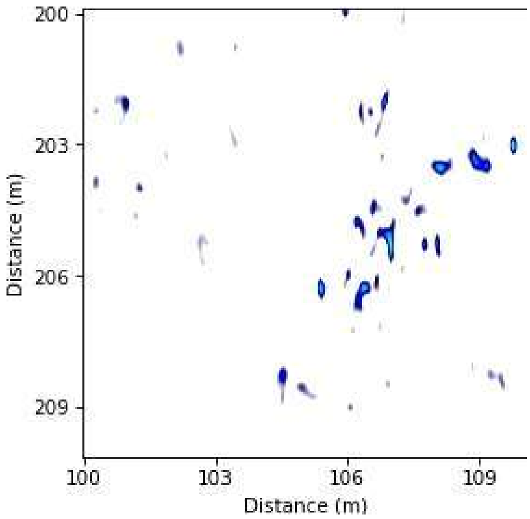
(f) Timeslice at z = 1.15 m.



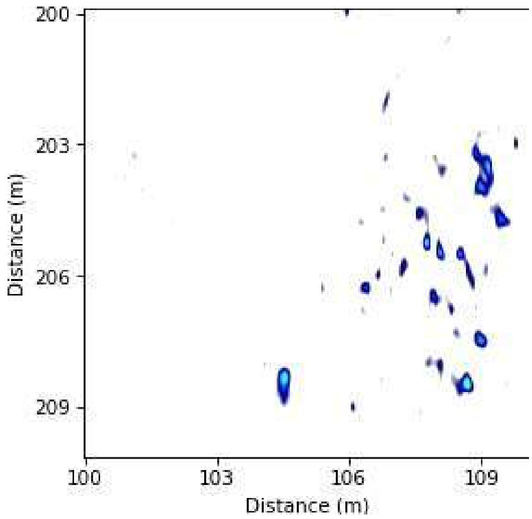
(a) Timeslice at z = 1.2 m.



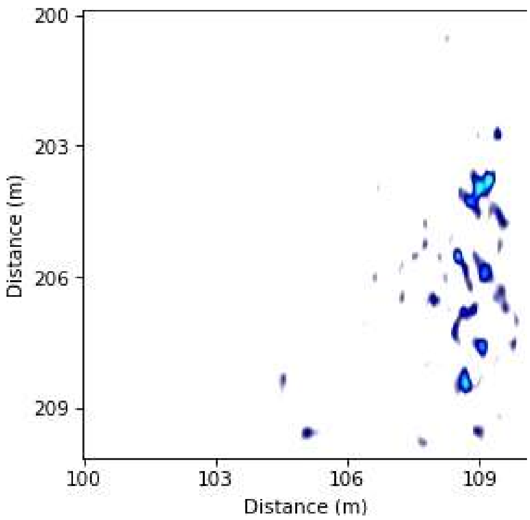
(b) Timeslice at z = 1.25 m.



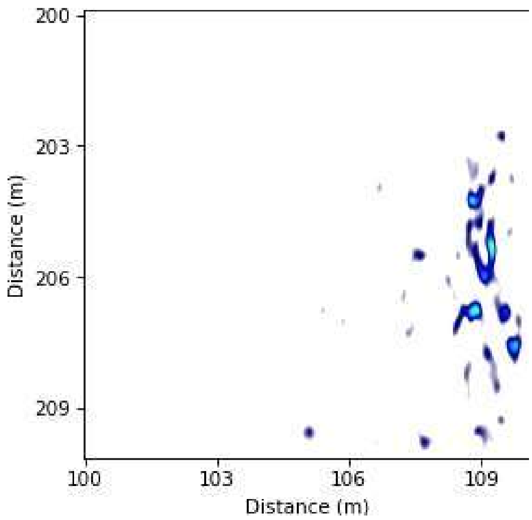
(c) Timeslice at z = 1.3 m.



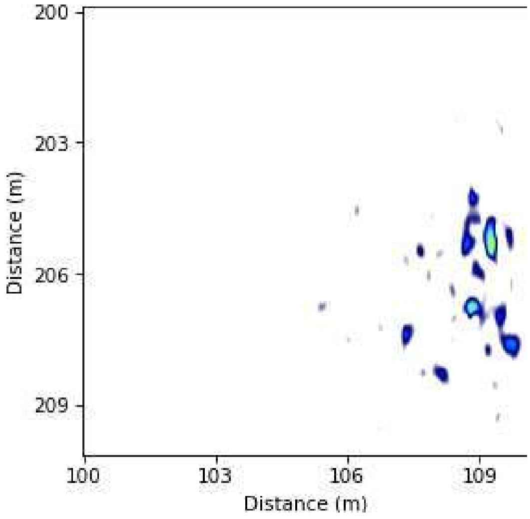
(d) Timeslice at z = 1.35 m.



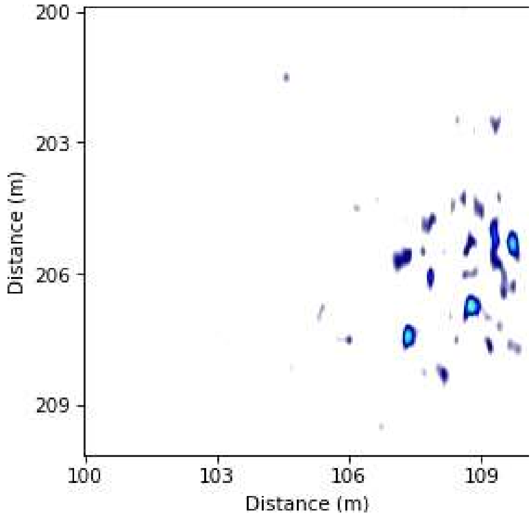
(e) Timeslice at z = 1.4 m.



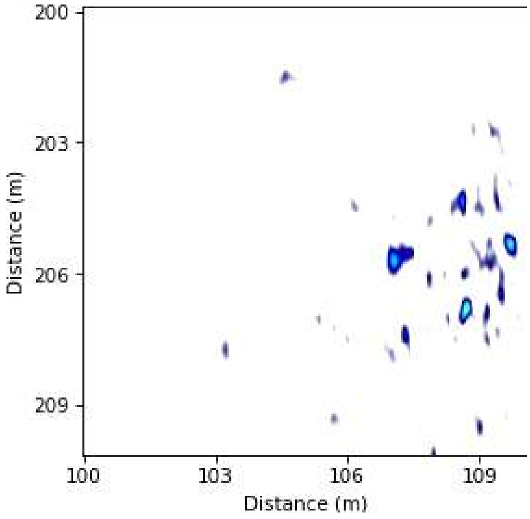
(f) Timeslice at z = 1.45 m.



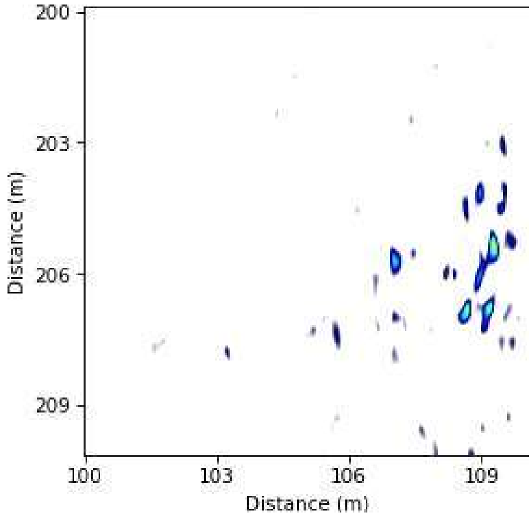
(a) Timeslice at z = 1.5 m.



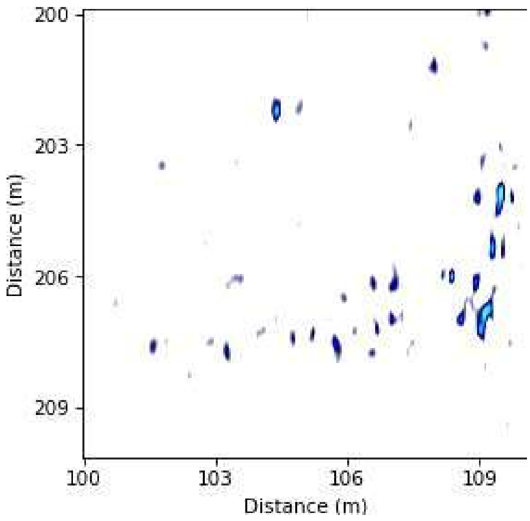
(b) Timeslice at z = 1.55 m.



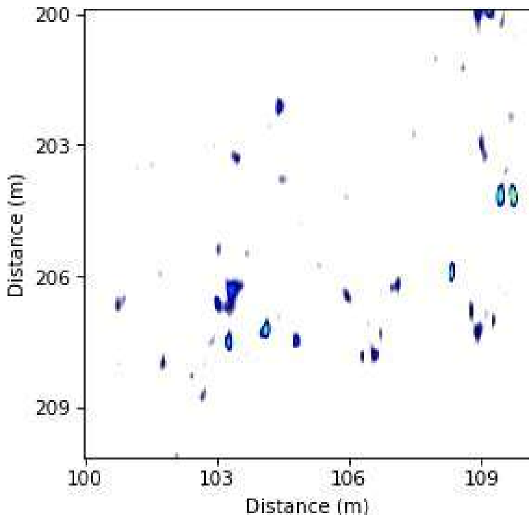
(c) Timeslice at z = 1.6 m.



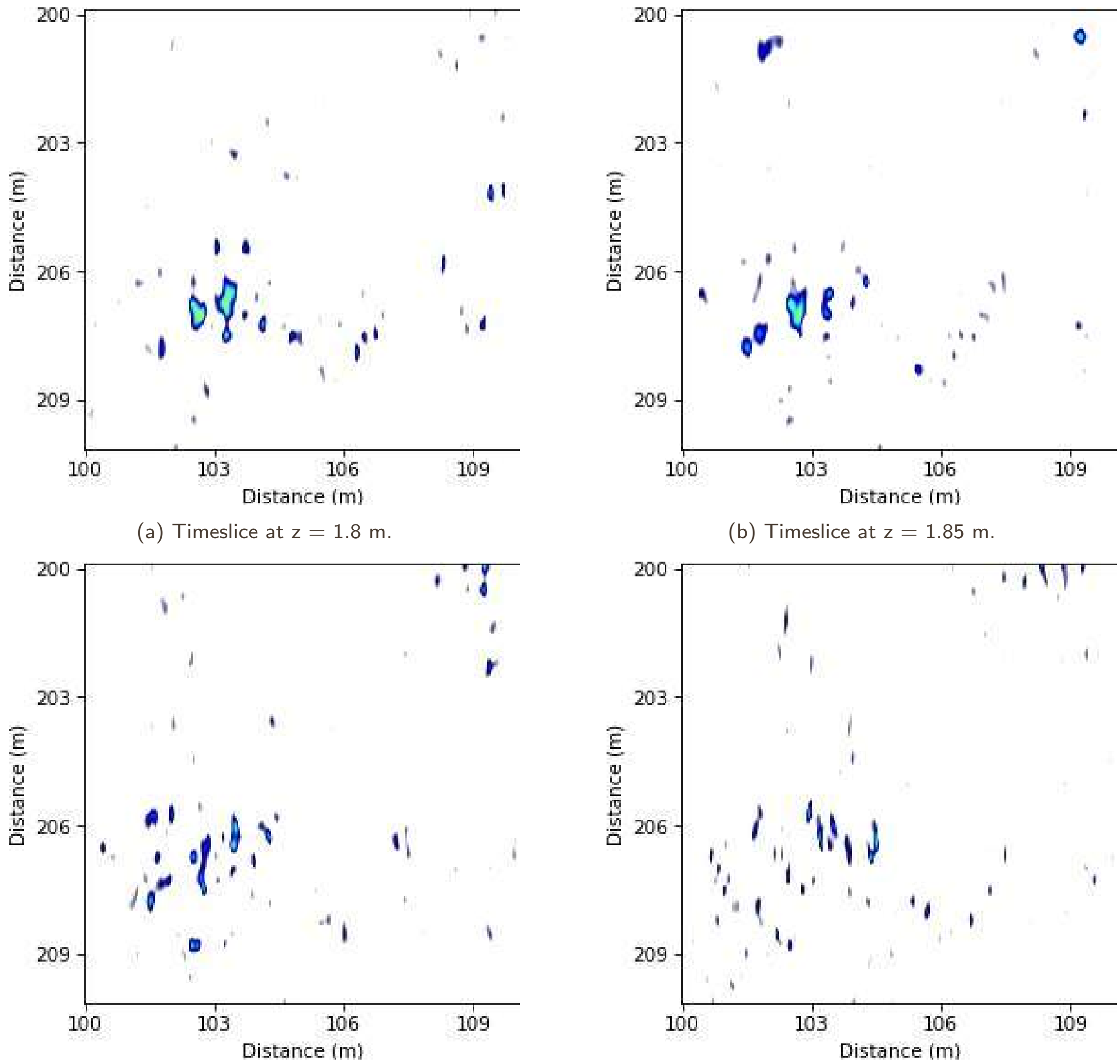
(d) Timeslice at z = 1.65 m.



(e) Timeslice at z = 1.7 m.



(f) Timeslice at z = 1.75 m.



(a) Timeslice at z = 1.8 m.

(b) Timeslice at z = 1.85 m.

(c) Timeslice at z = 1.9 m.

(d) Timeslice at z = 1.95 m.

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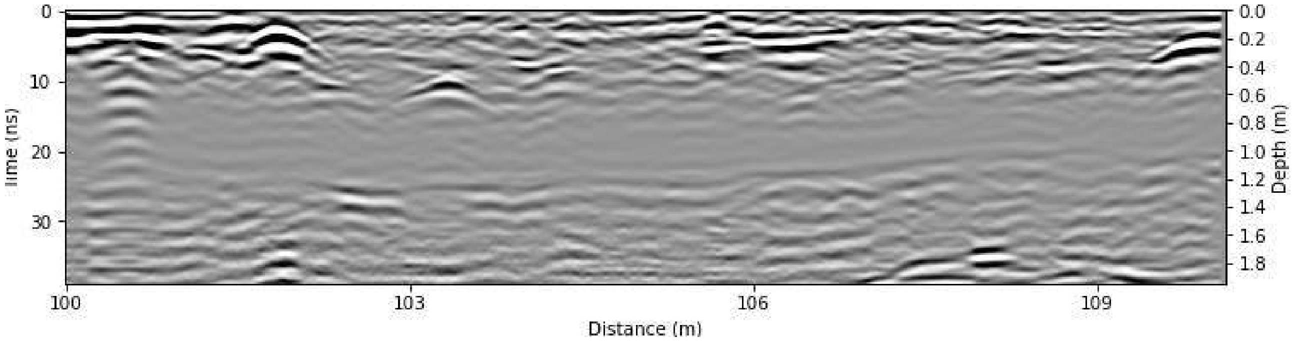


Figure A.49: Radargram at x = 217.5 m.

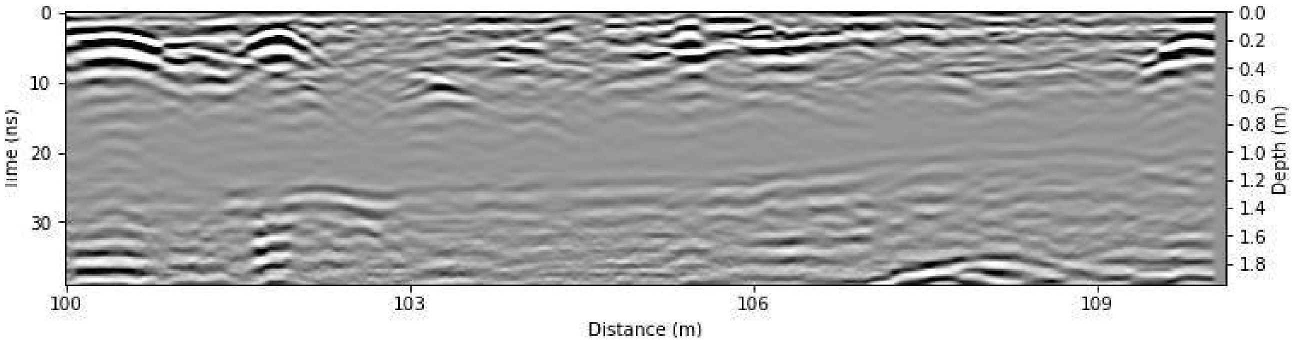


Figure A.50: Radargram at x = 217.75 m.

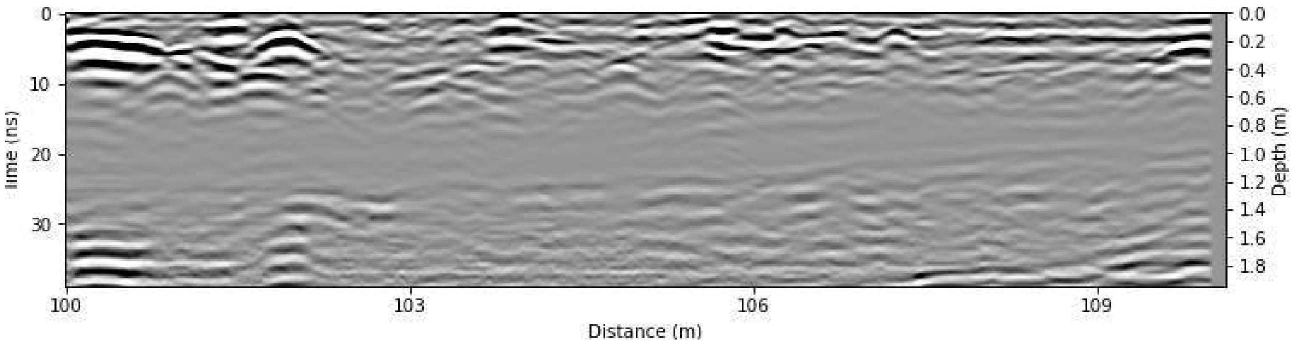


Figure A.51: Radargram at x = 218.0 m.

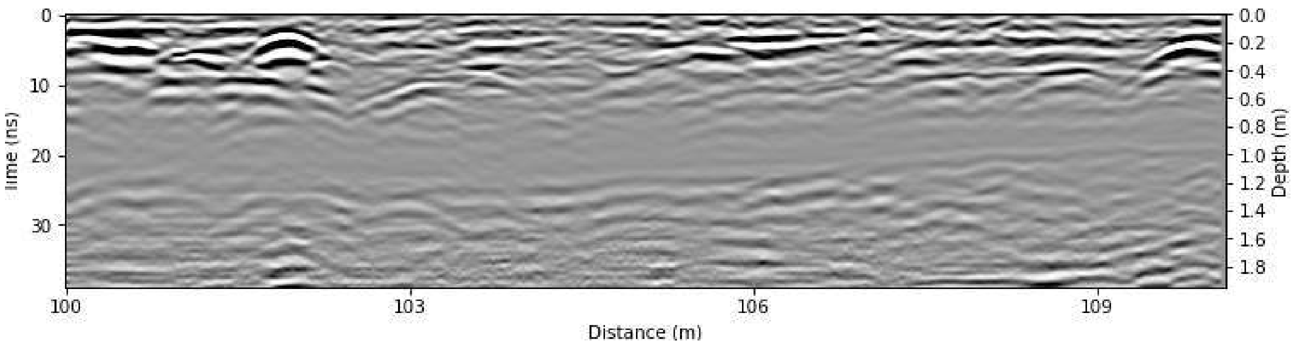


Figure A.52: Radargram at x = 218.25 m.

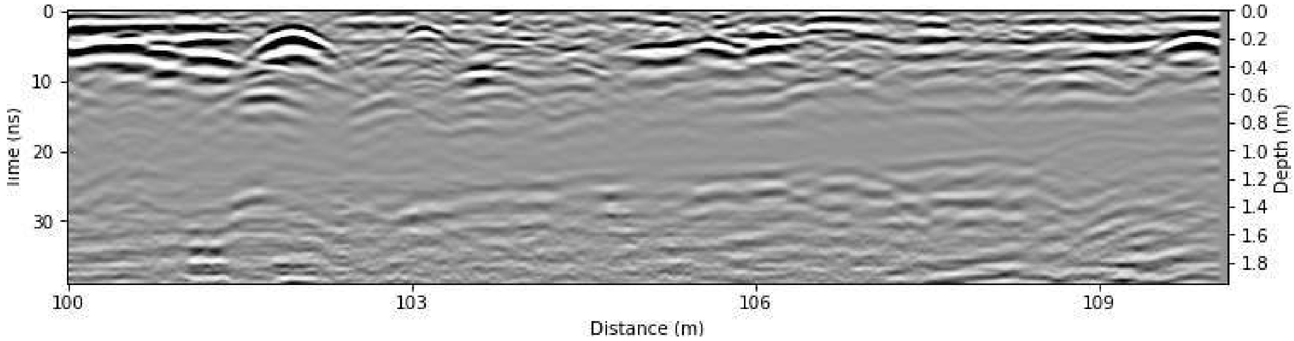


Figure A.53: Radargram at x = 218.5 m.

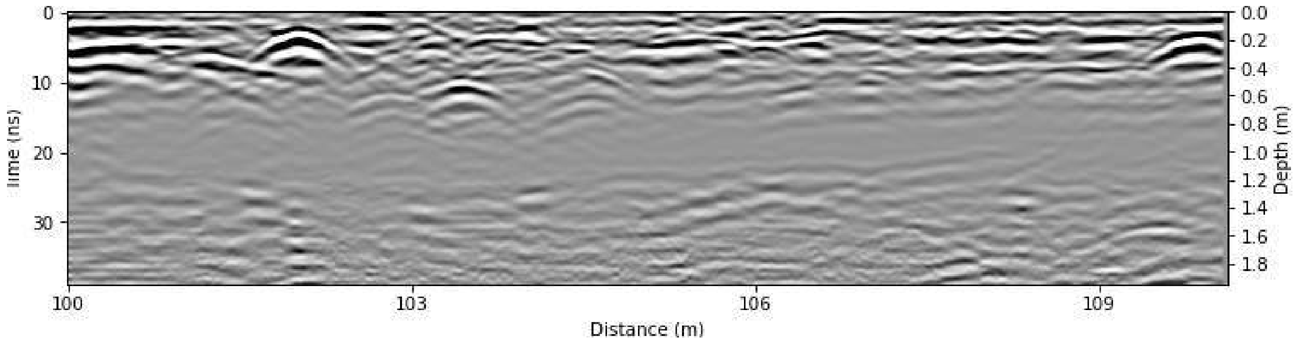


Figure A.54: Radargram at x = 218.75 m.

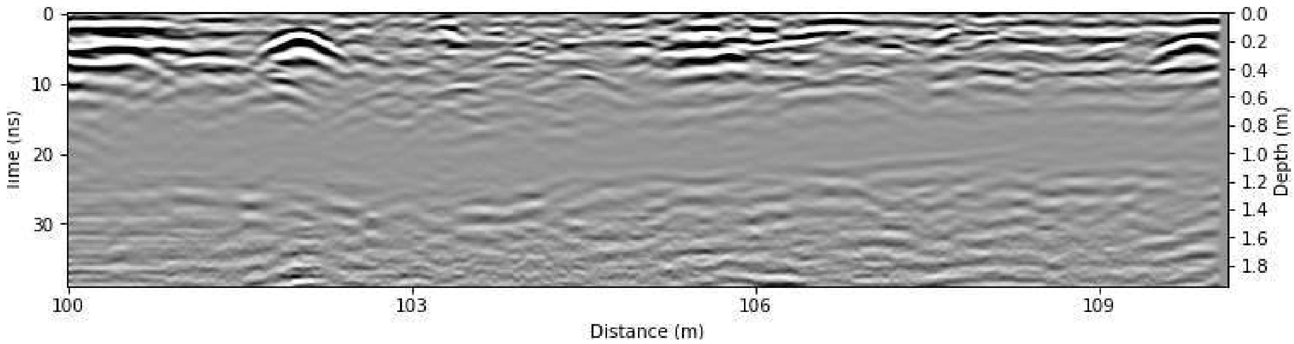


Figure A.55: Radargram at x = 219.0 m.

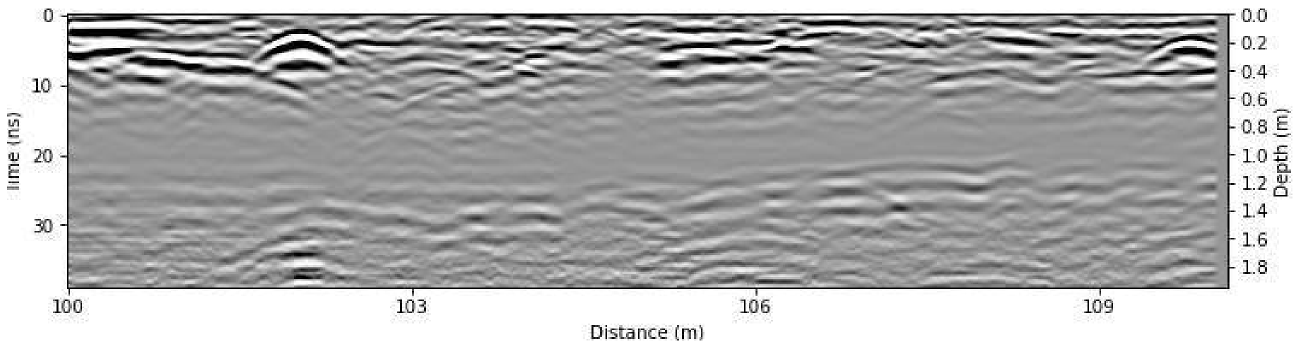


Figure A.56: Radargram at x = 219.25 m.

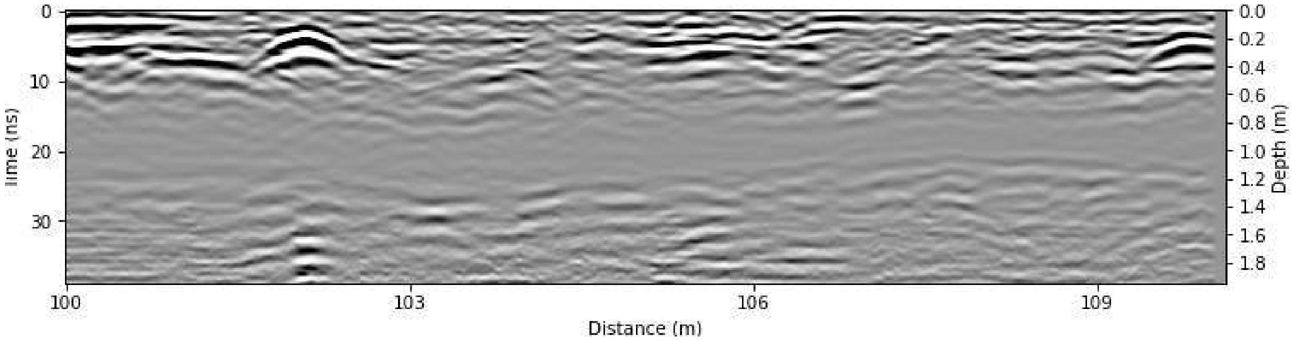


Figure A.57: Radargram at x = 219.5 m.

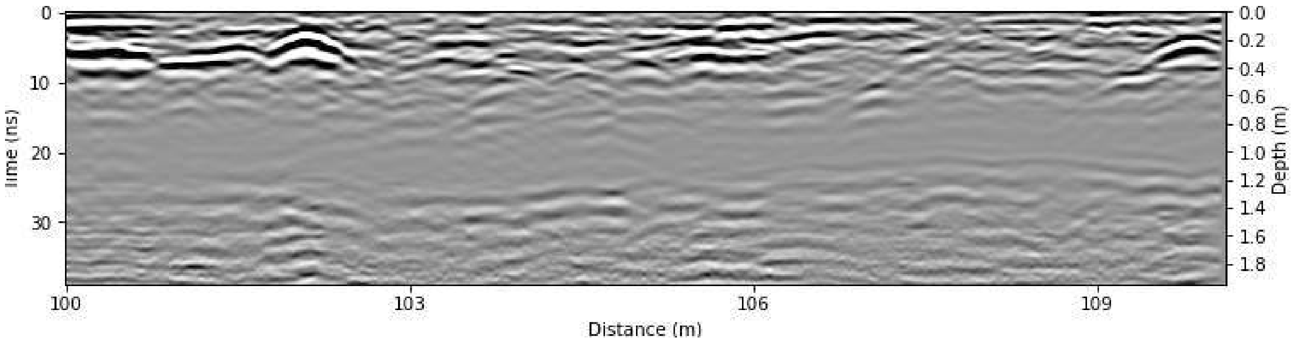


Figure A.58: Radargram at x = 219.75 m.

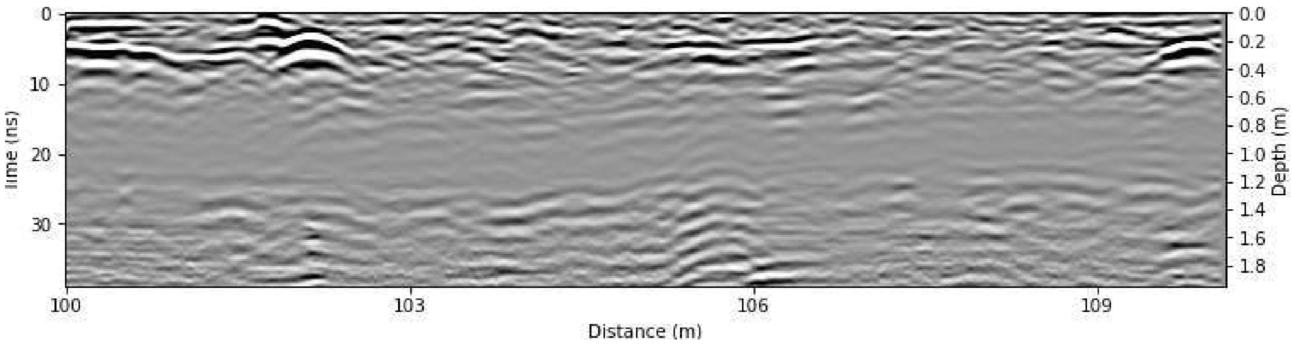


Figure A.59: Radargram at x = 220.0 m.

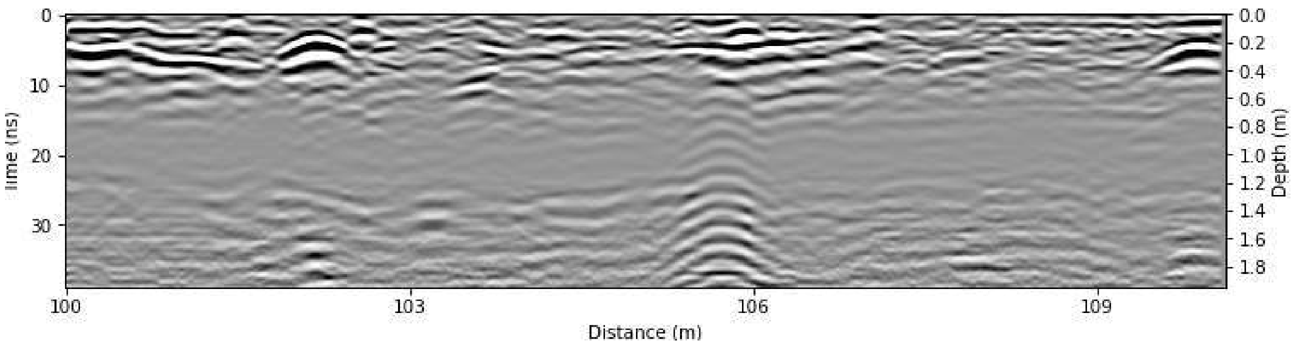


Figure A.60: Radargram at x = 220.25 m.

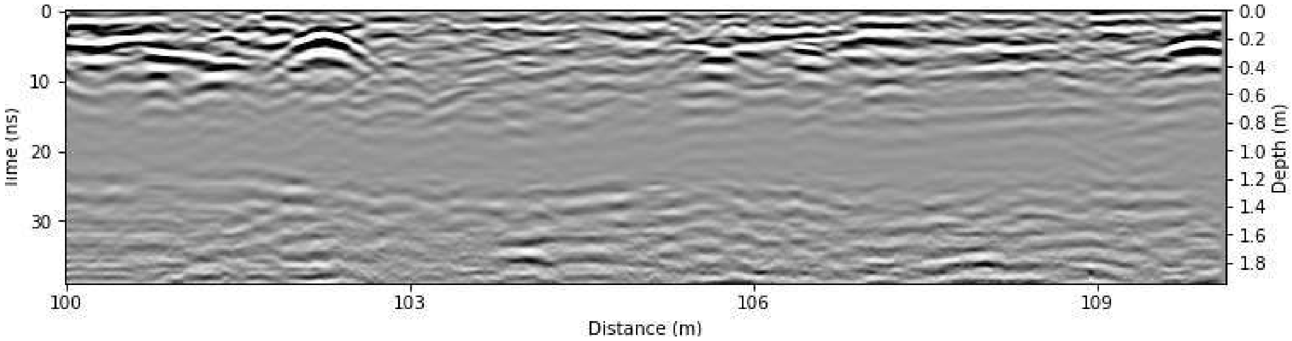


Figure A.61: Radargram at x = 220.5 m.

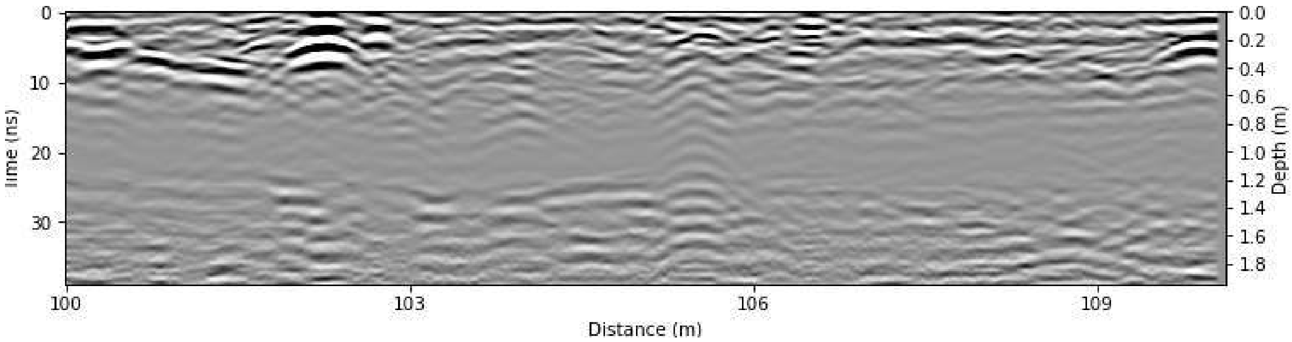


Figure A.62: Radargram at x = 220.75 m.

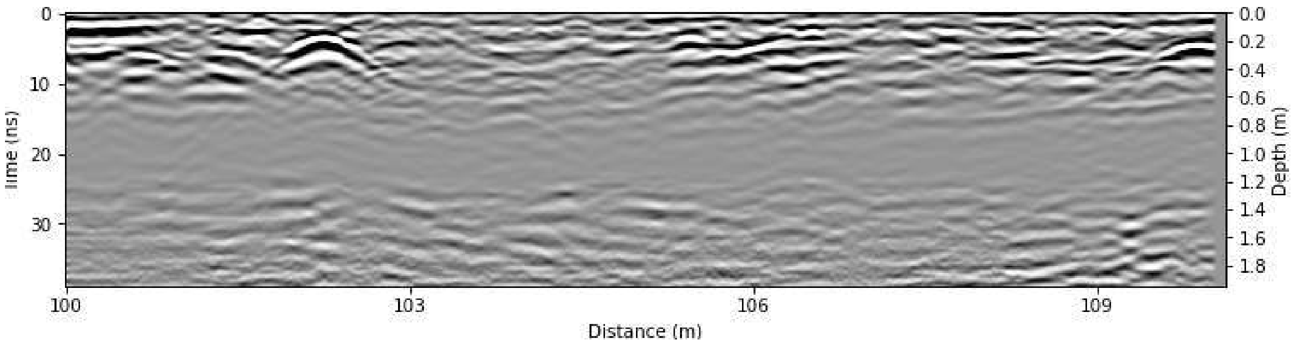


Figure A.63: Radargram at x = 221.0 m.

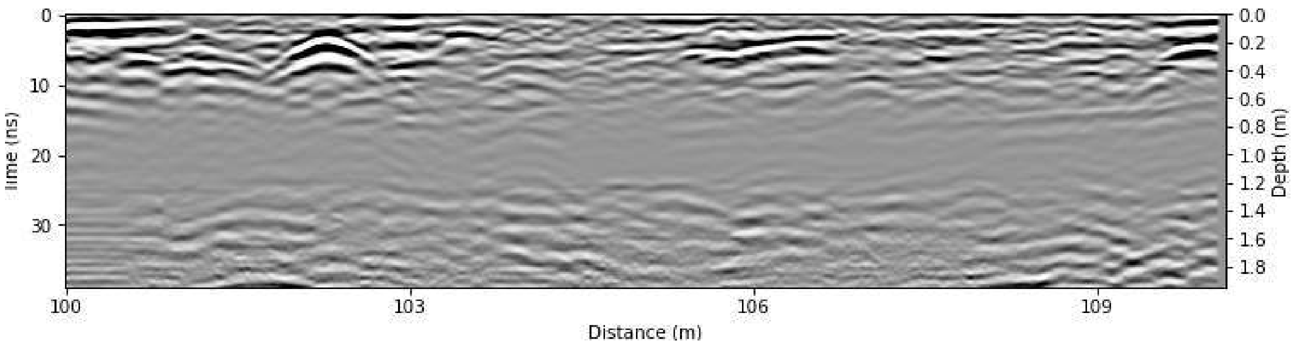


Figure A.64: Radargram at x = 221.25 m.

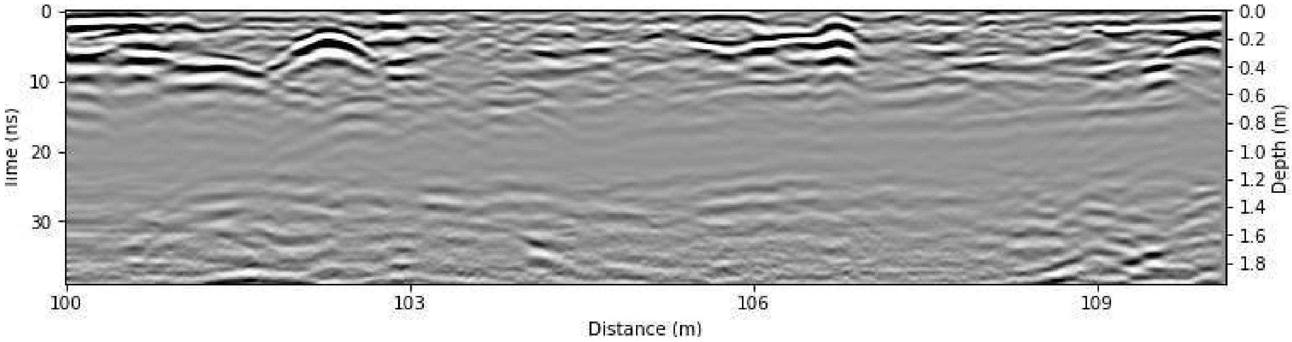


Figure A.65: Radargram at x = 221.5 m.

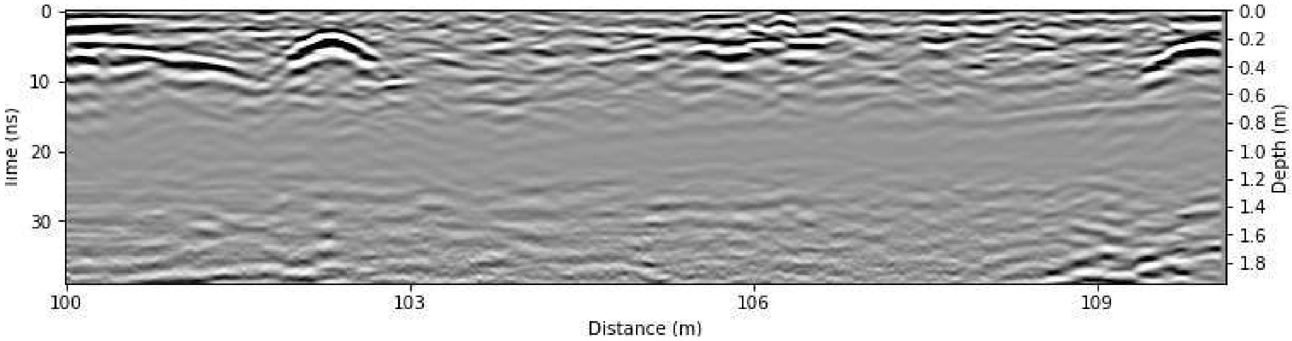


Figure A.66: Radargram at x = 221.75 m.

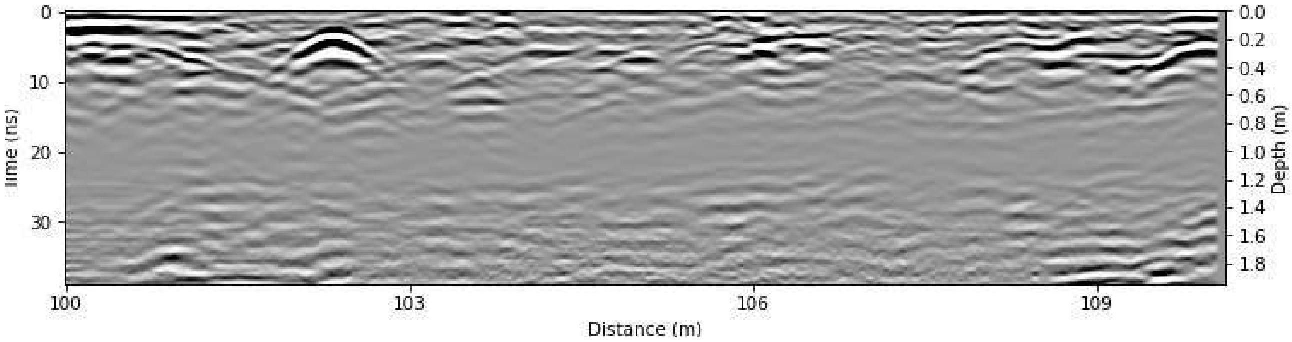


Figure A.67: Radargram at x = 222.0 m.

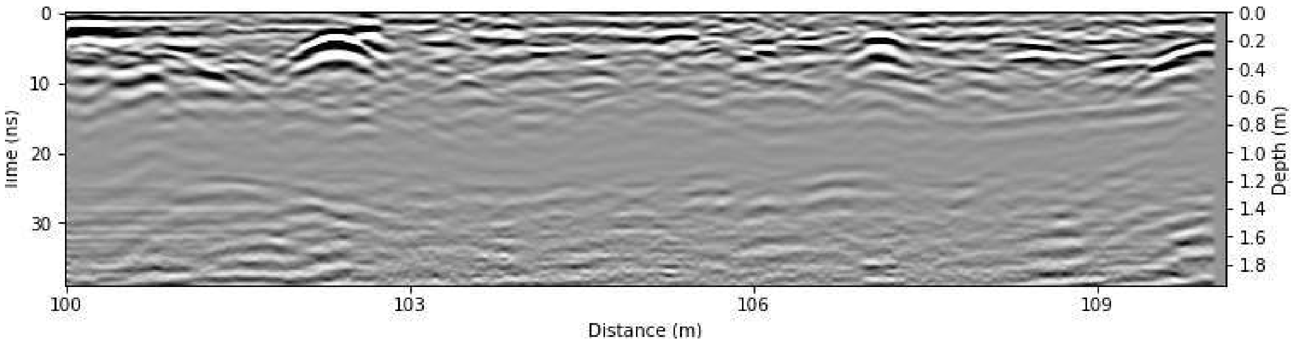


Figure A.68: Radargram at x = 222.25 m.

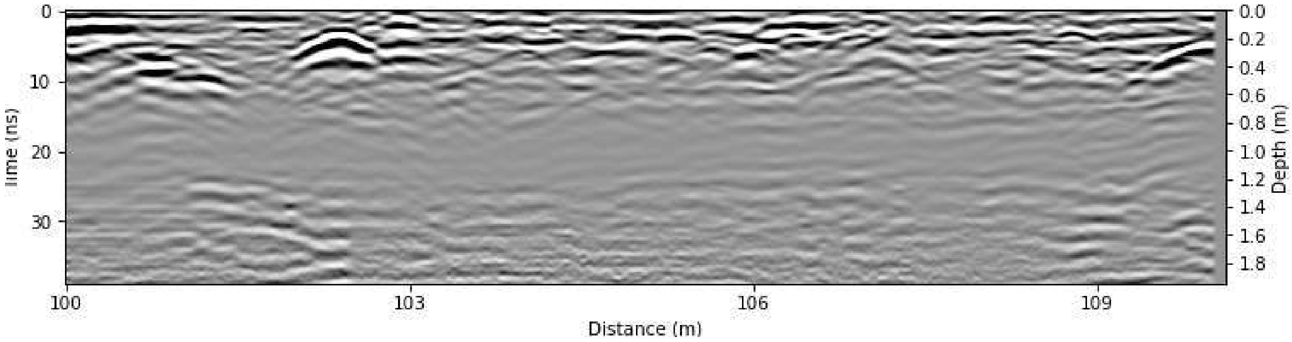


Figure A.69: Radargram at x = 222.5 m.

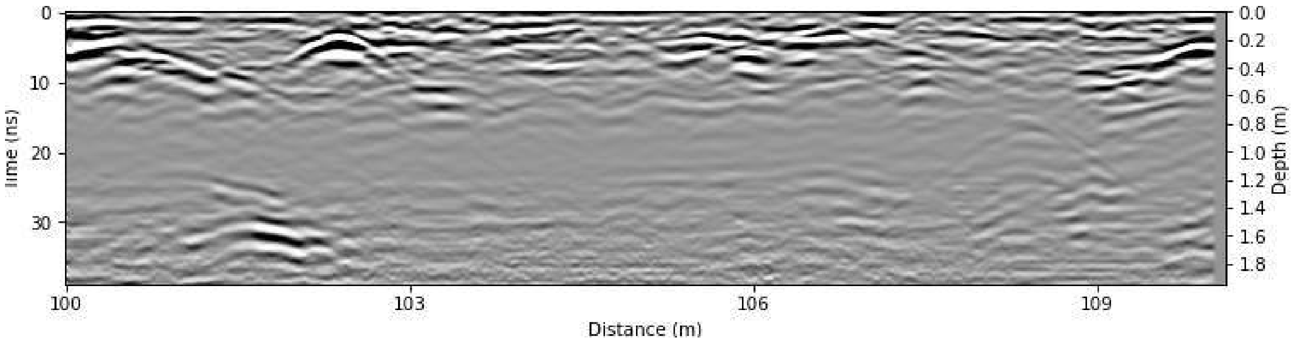


Figure A.70: Radargram at x = 222.75 m.

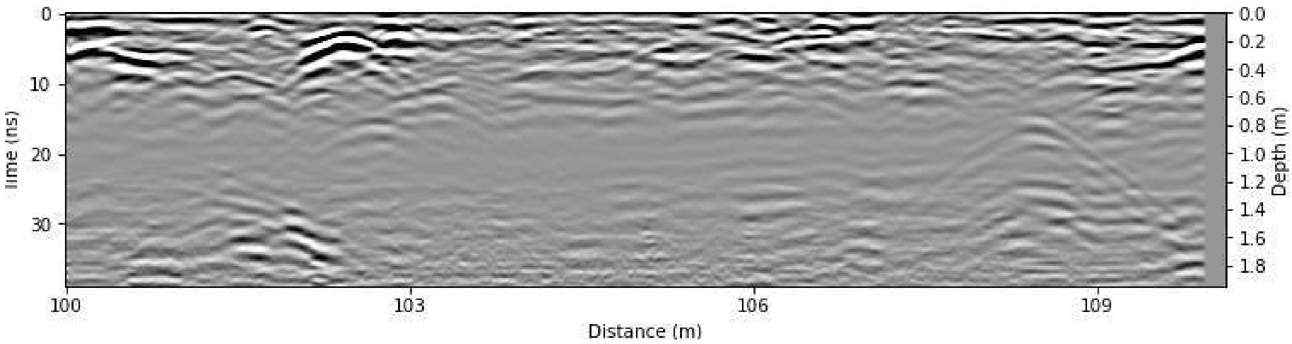


Figure A.71: Radargram at x = 223.0 m.

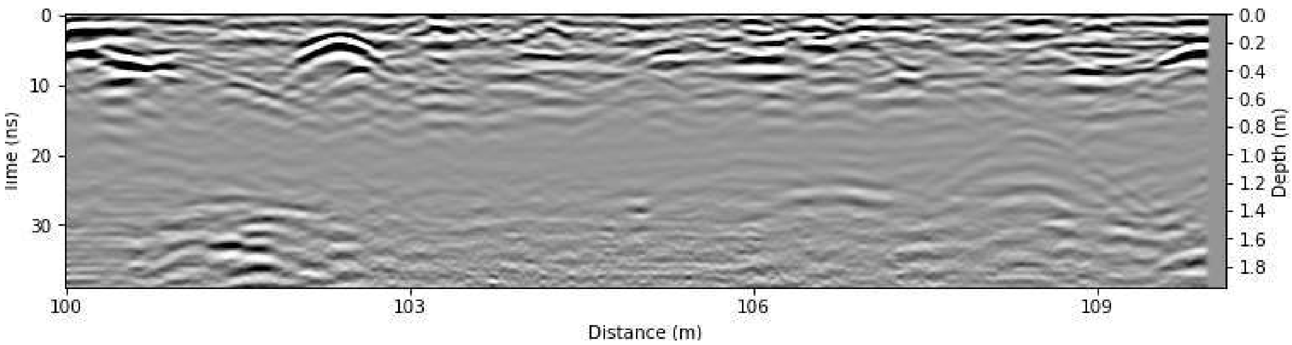


Figure A.72: Radargram at x = 223.25 m.

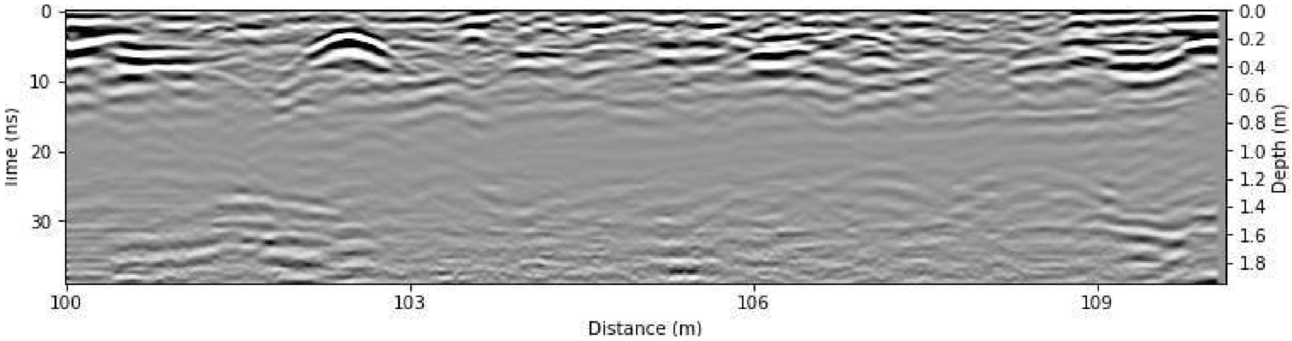


Figure A.73: Radargram at x = 223.5 m.

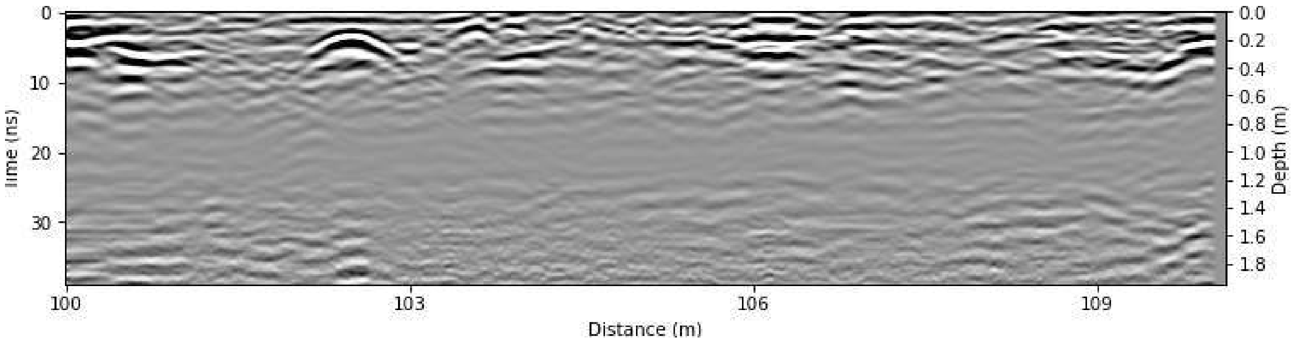


Figure A.74: Radargram at x = 223.75 m.

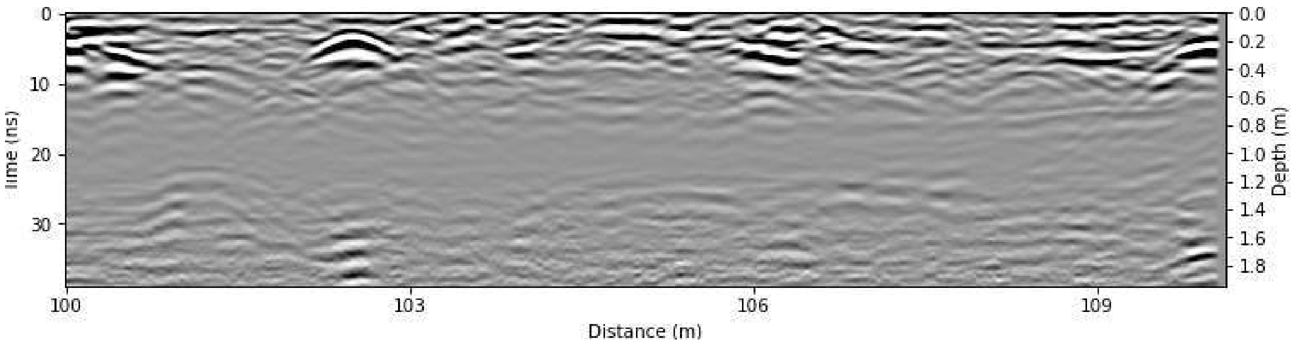


Figure A.75: Radargram at x = 224.0 m.

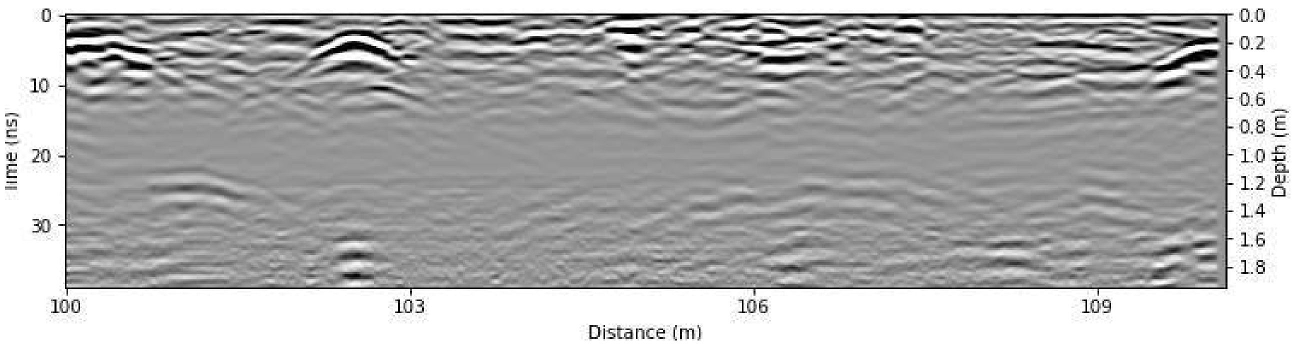


Figure A.76: Radargram at x = 224.25 m.

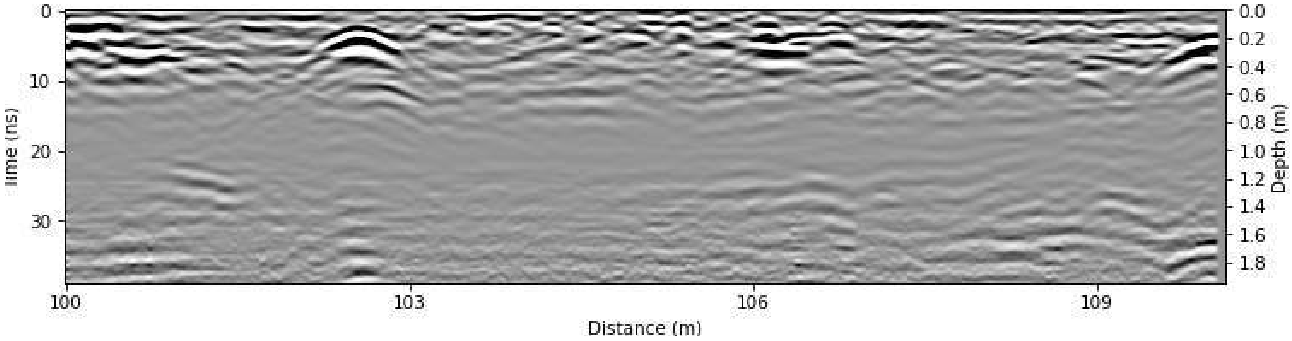


Figure A.77: Radargram at x = 224.5 m.

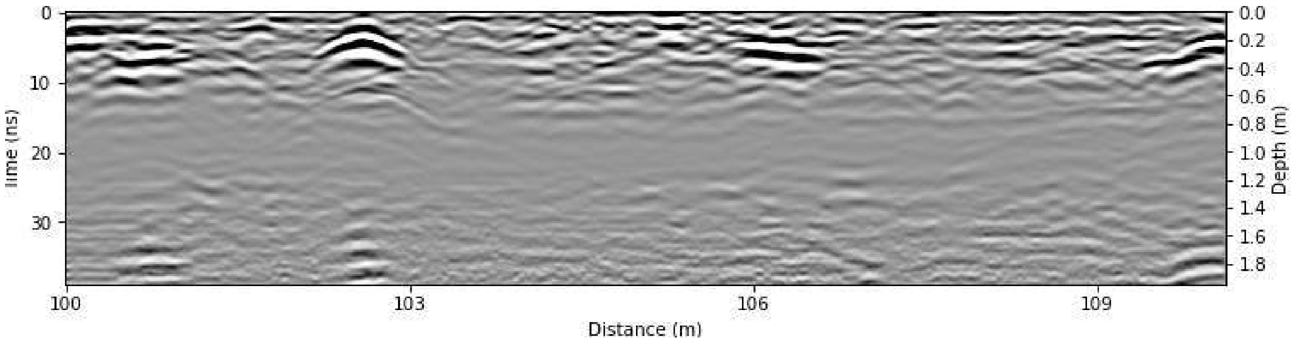


Figure A.78: Radargram at x = 224.75 m.

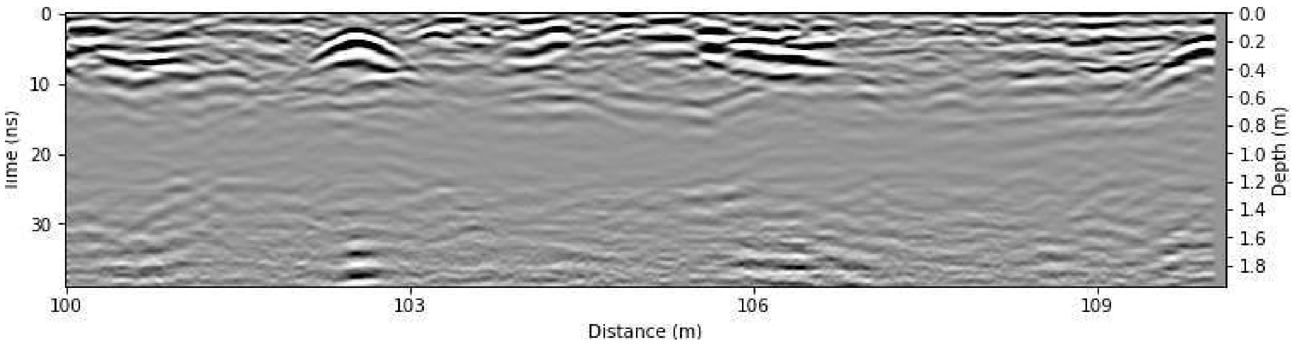


Figure A.79: Radargram at x = 225.0 m.

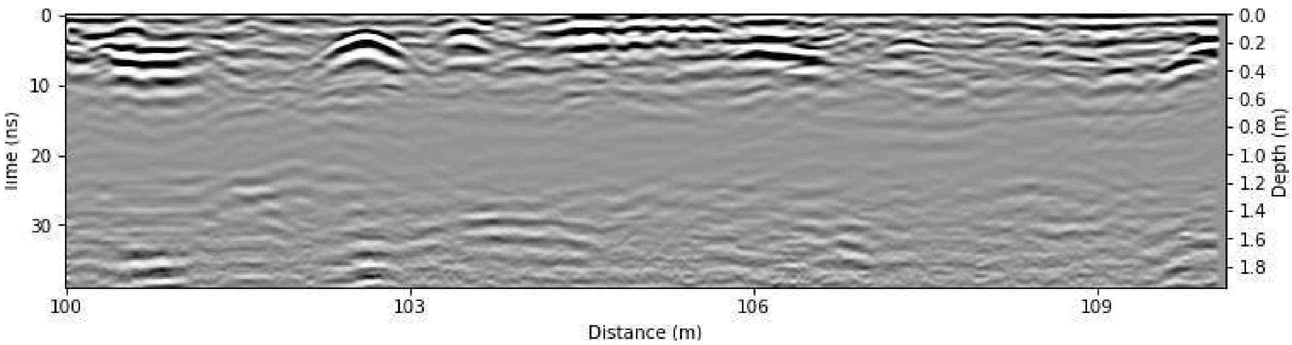


Figure A.80: Radargram at x = 225.25 m.

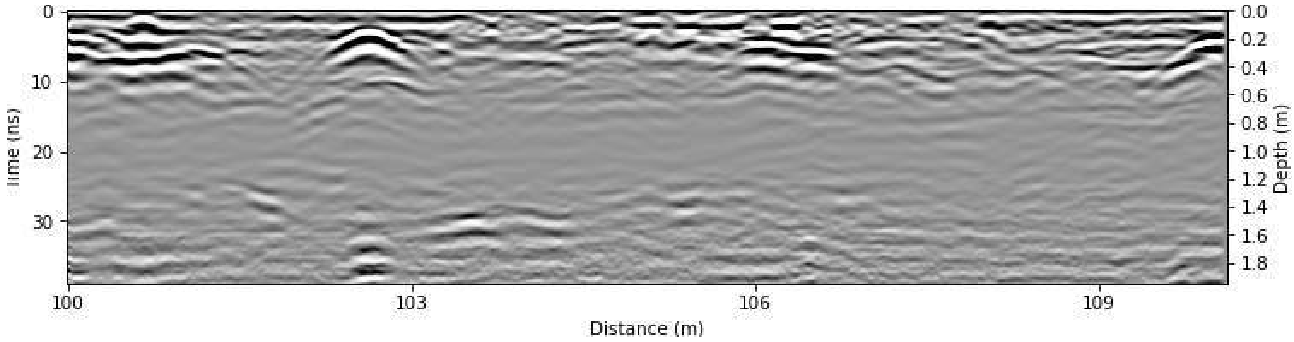


Figure A.81: Radargram at x = 225.5 m.

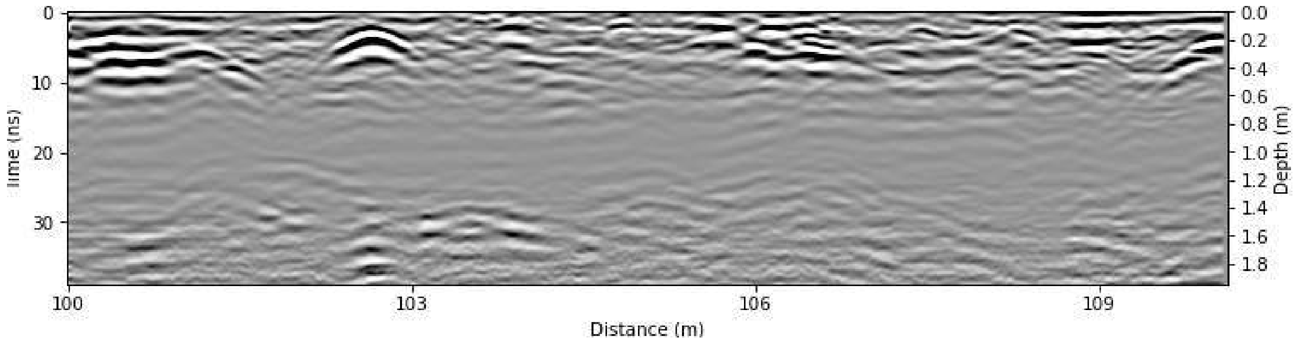


Figure A.82: Radargram at x = 225.75 m.

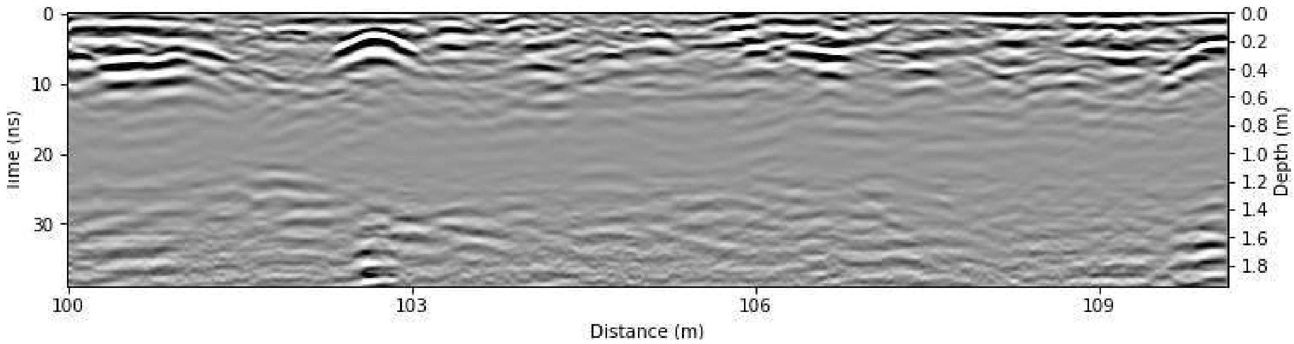


Figure A.83: Radargram at x = 226.0 m.

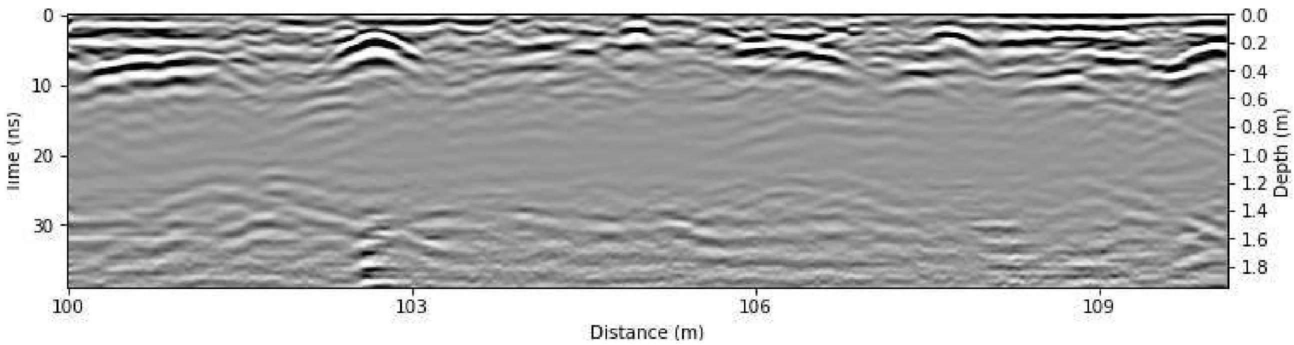


Figure A.84: Radargram at x = 226.25 m.

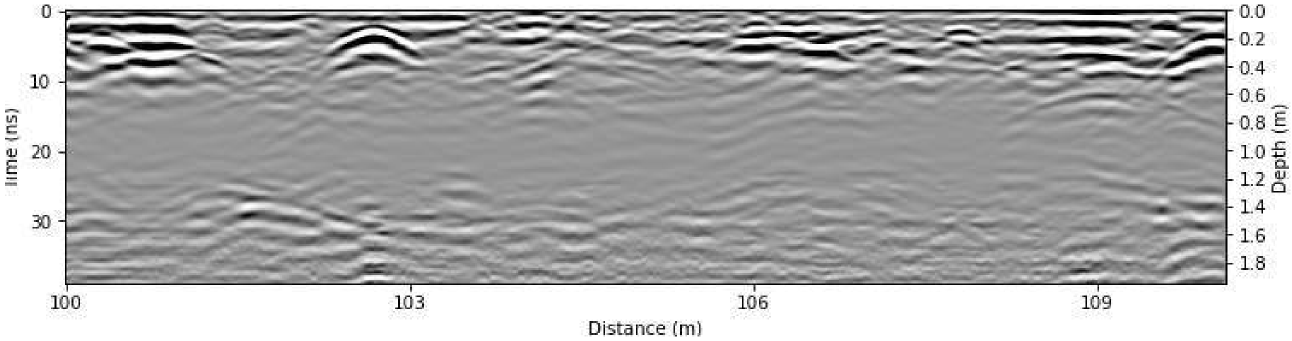


Figure A.85: Radargram at x = 226.5 m.

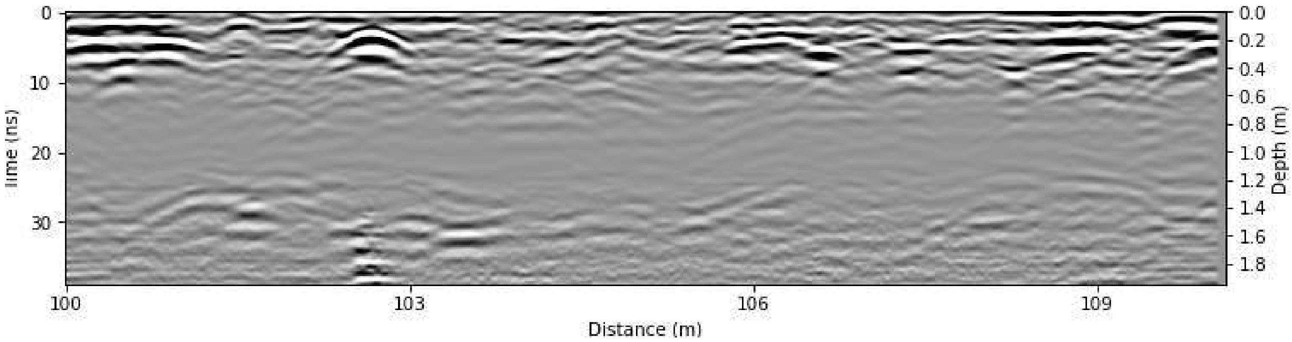


Figure A.86: Radargram at x = 226.75 m.

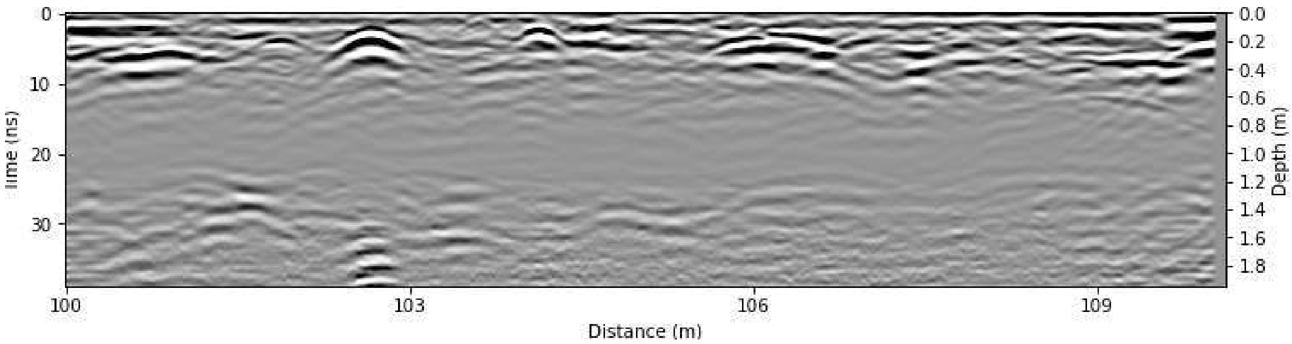


Figure A.87: Radargram at x = 227.0 m.

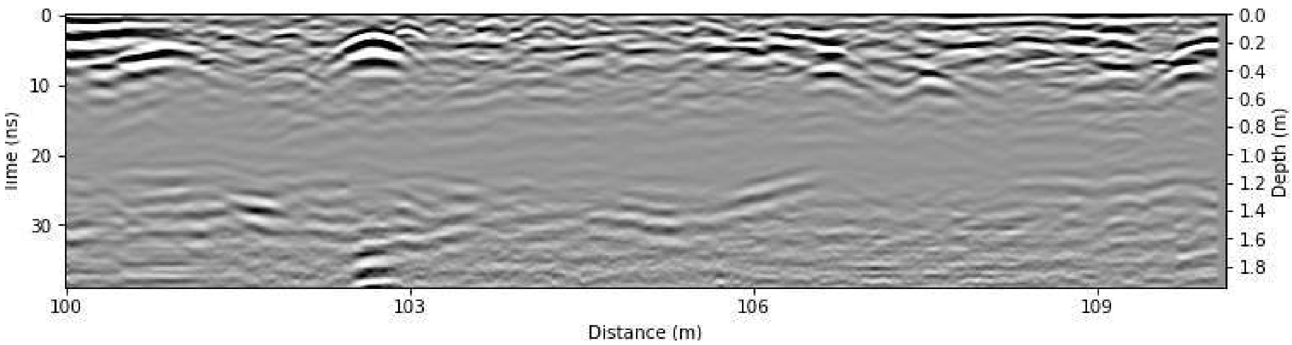


Figure A.88: Radargram at x = 227.25 m.

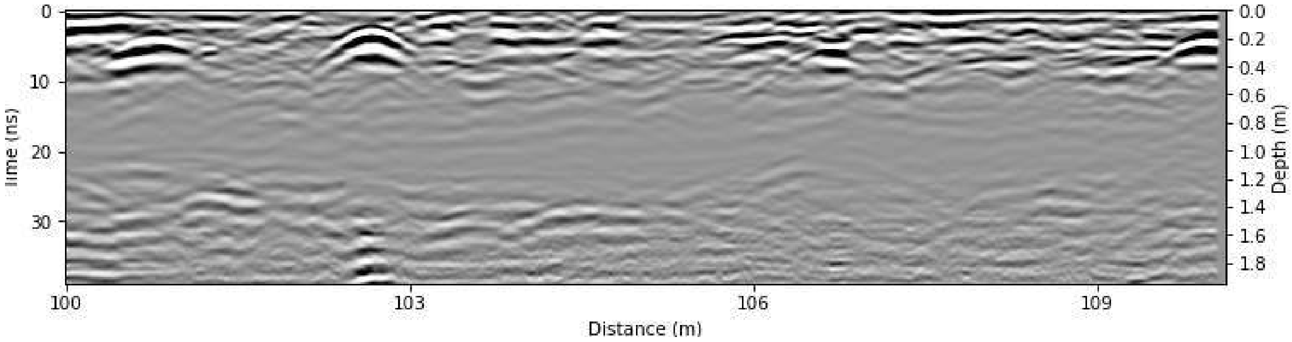
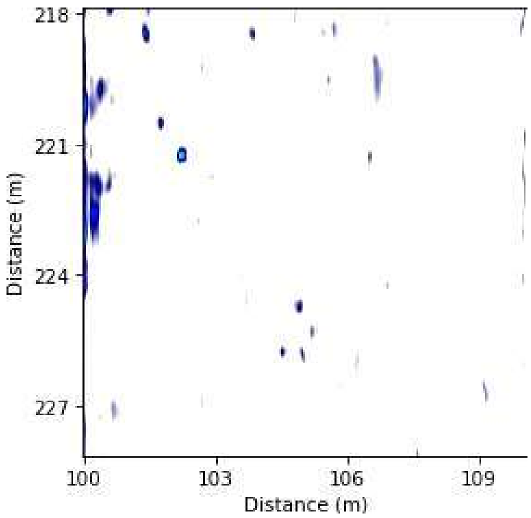
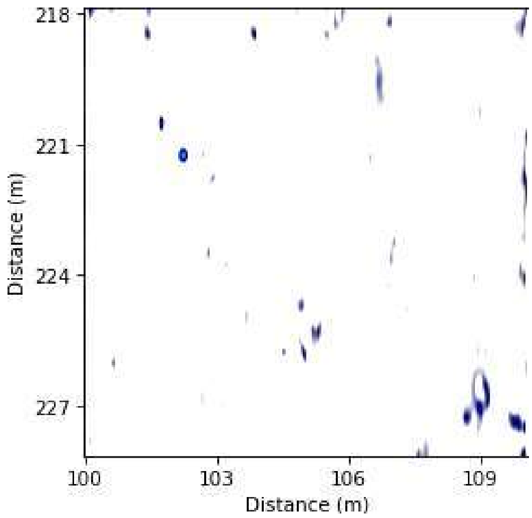


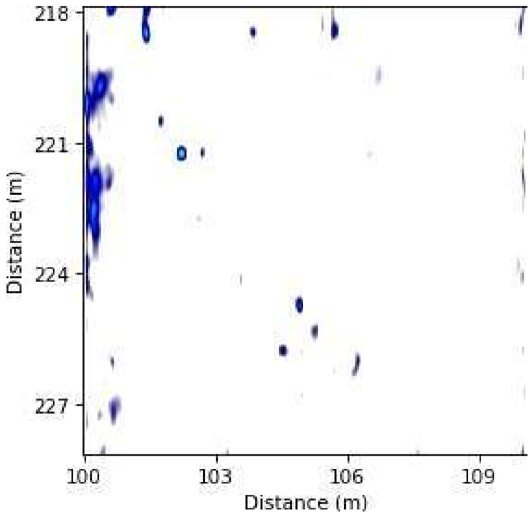
Figure A.89: Radargram at x = 227.5 m.



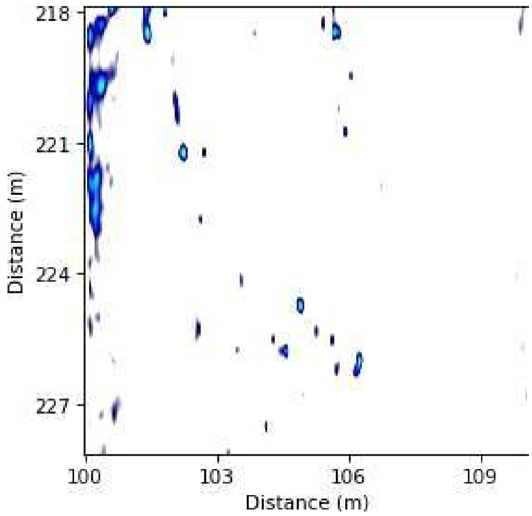
(a) Timeslice at z = 0.0 m.



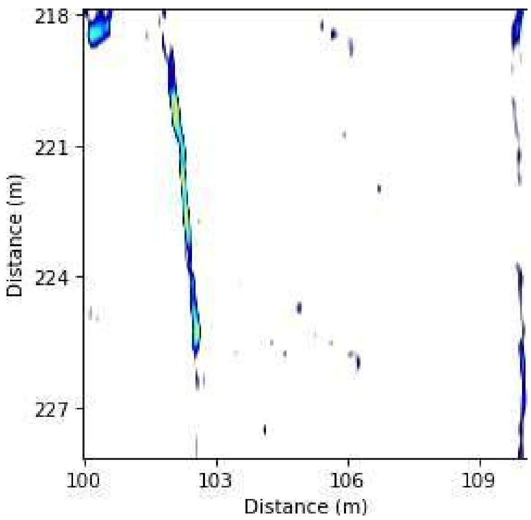
(b) Timeslice at z = 0.05 m.



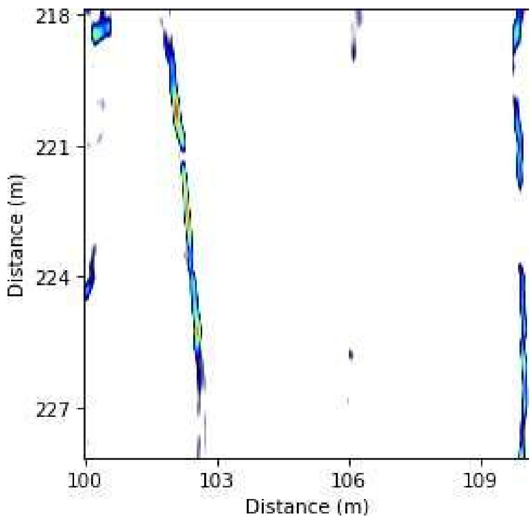
(c) Timeslice at z = 0.1 m.



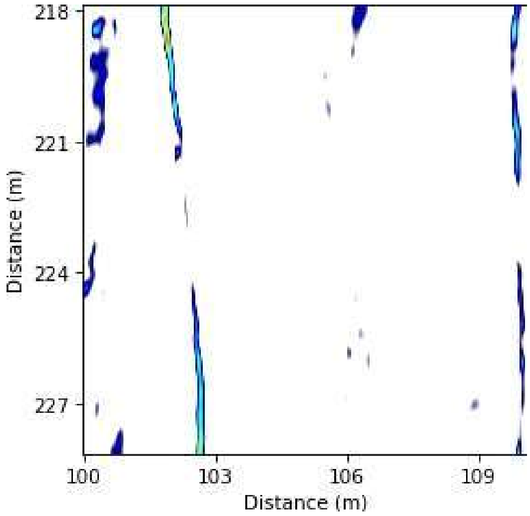
(d) Timeslice at z = 0.15 m.



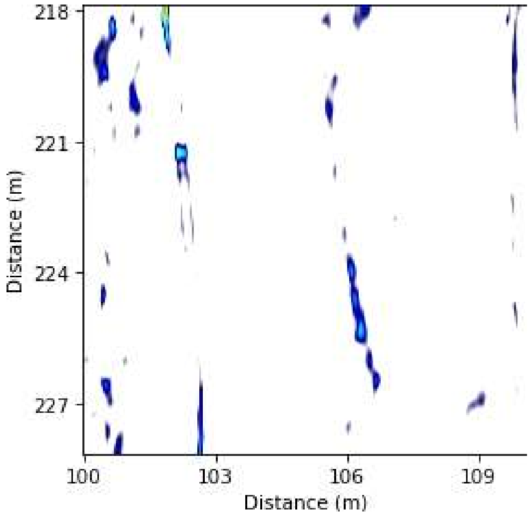
(e) Timeslice at z = 0.2 m.



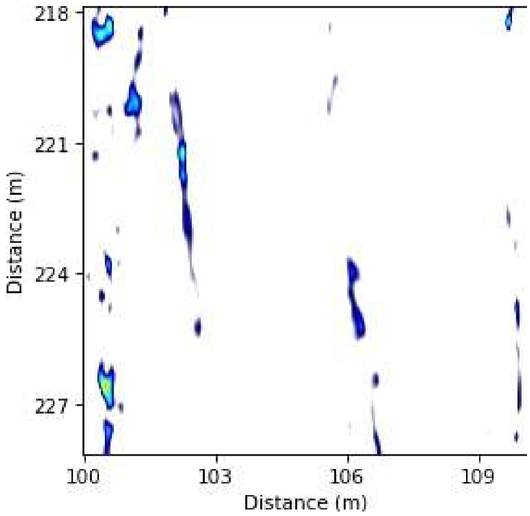
(f) Timeslice at z = 0.25 m.



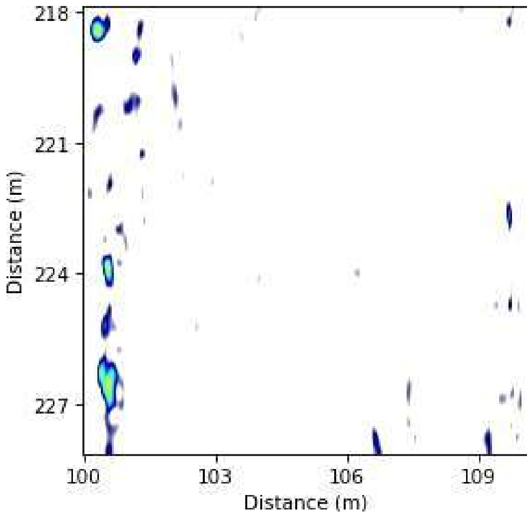
(a) Timeslice at z = 0.3 m.



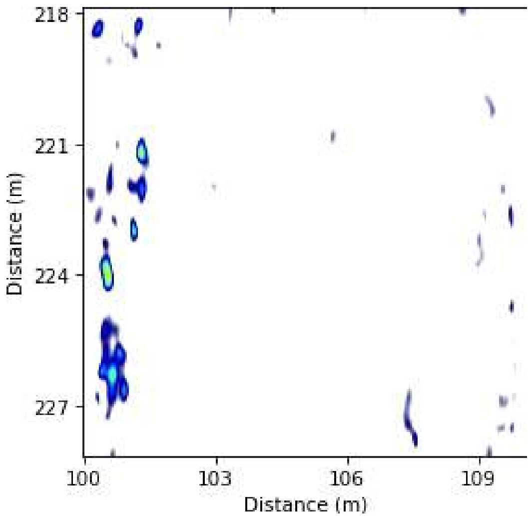
(b) Timeslice at z = 0.35 m.



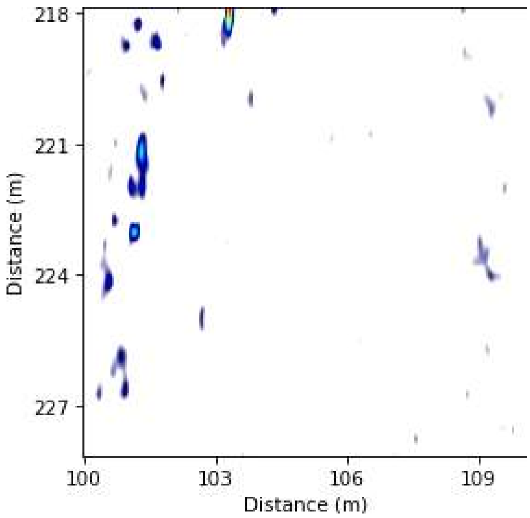
(c) Timeslice at z = 0.4 m.



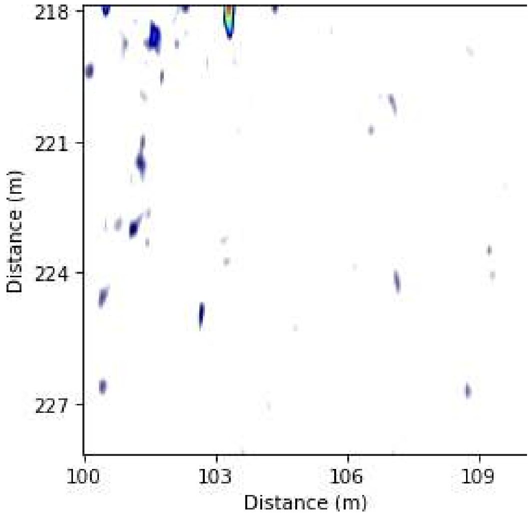
(d) Timeslice at z = 0.45 m.



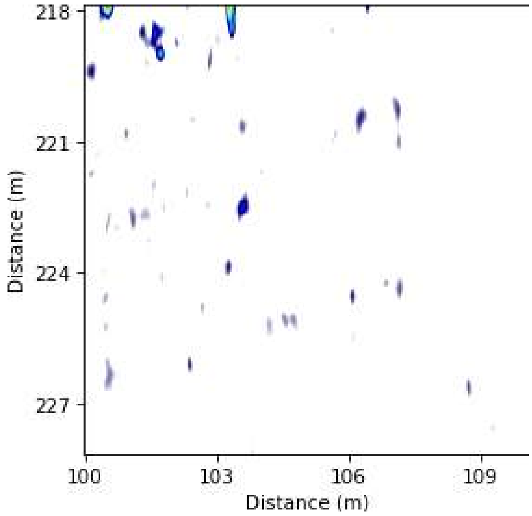
(e) Timeslice at z = 0.5 m.



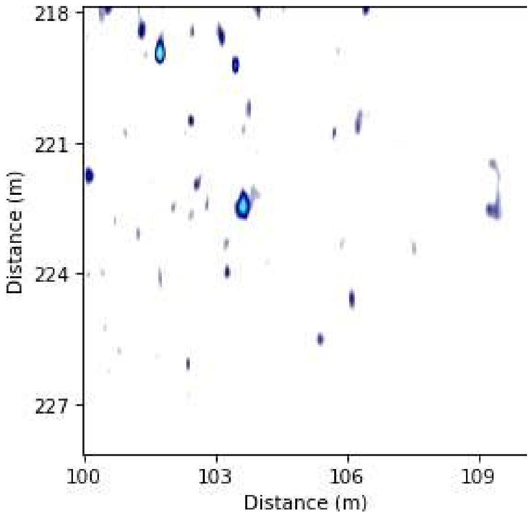
(f) Timeslice at z = 0.55 m.



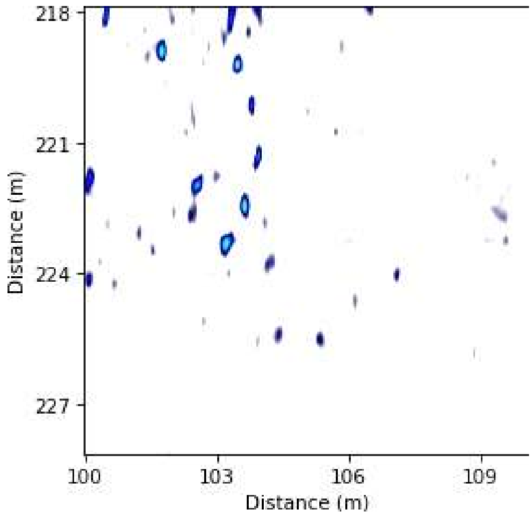
(a) Timeslice at z = 0.6 m.



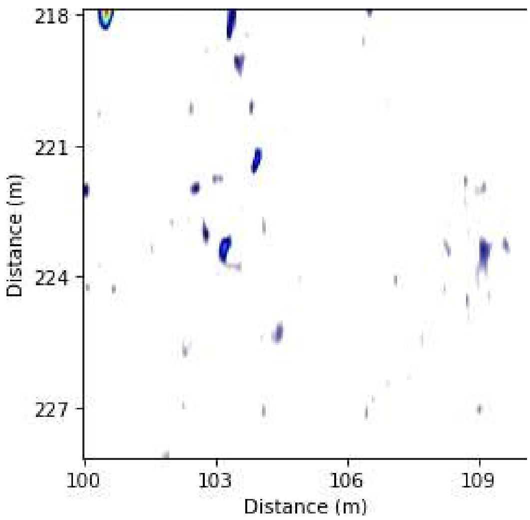
(b) Timeslice at z = 0.65 m.



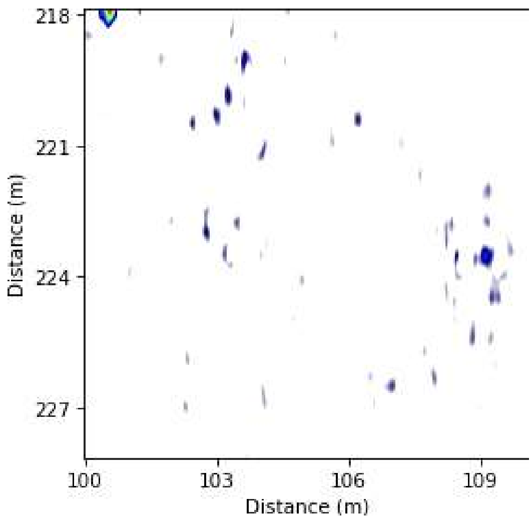
(c) Timeslice at z = 0.7 m.



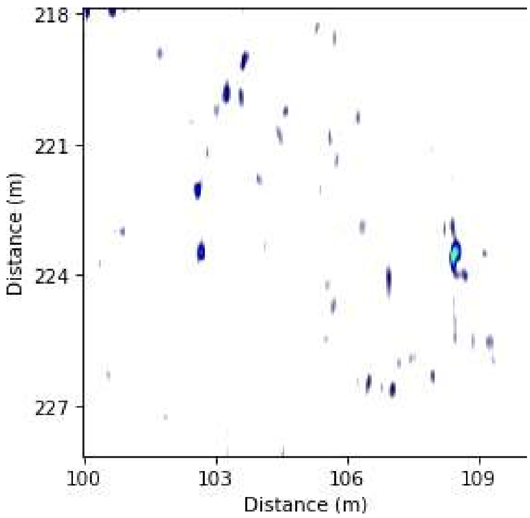
(d) Timeslice at z = 0.75 m.



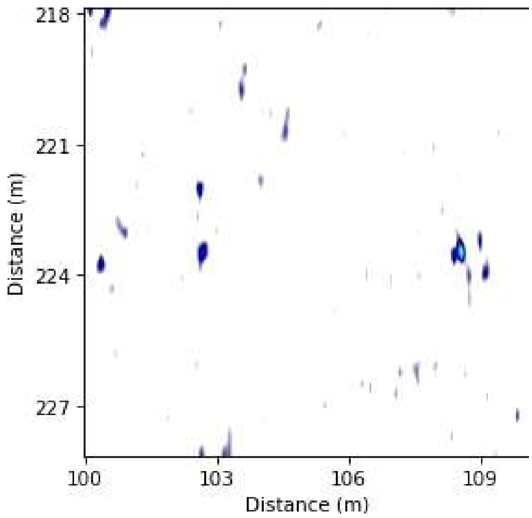
(e) Timeslice at z = 0.8 m.



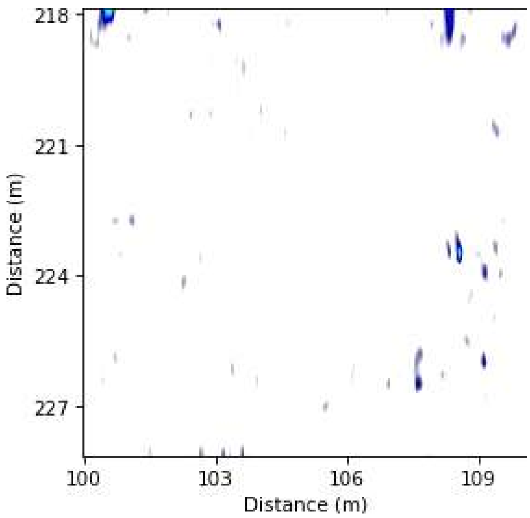
(f) Timeslice at z = 0.85 m.



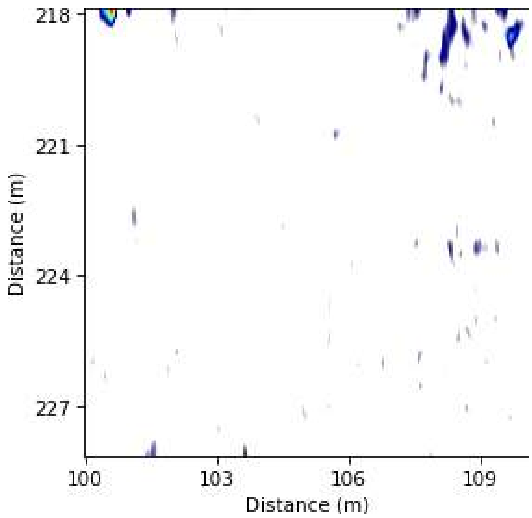
(a) Timeslice at z = 0.9 m.



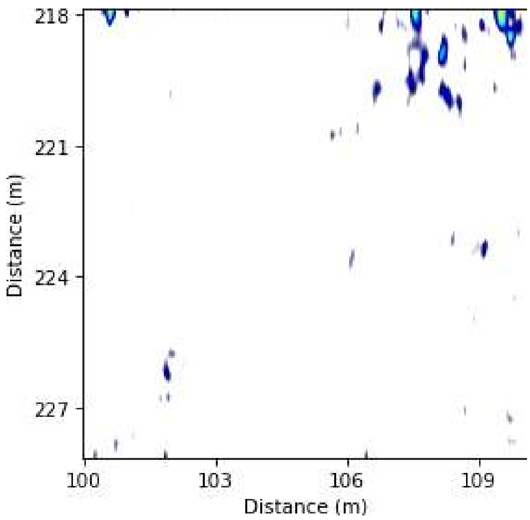
(b) Timeslice at z = 0.95 m.



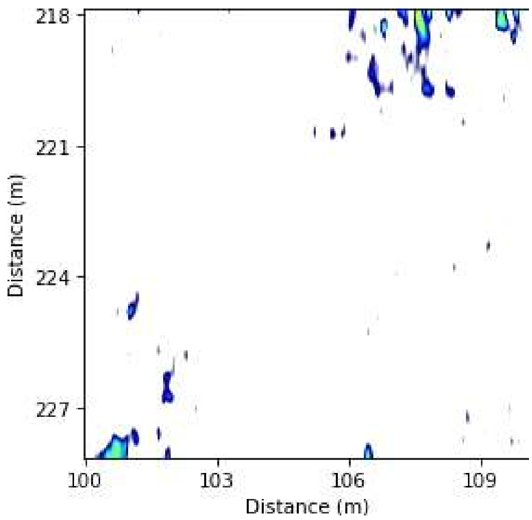
(c) Timeslice at z = 1.0 m.



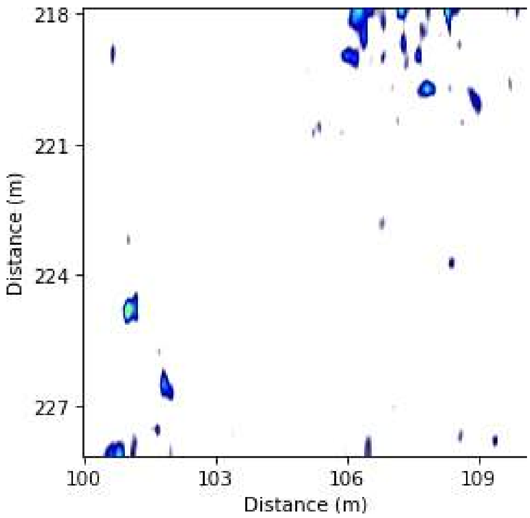
(d) Timeslice at z = 1.05 m.



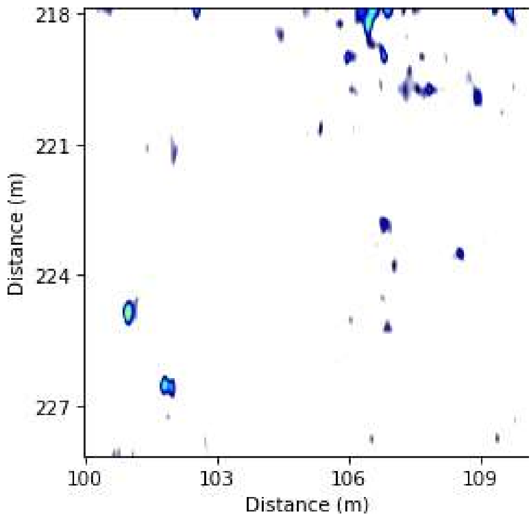
(e) Timeslice at z = 1.1 m.



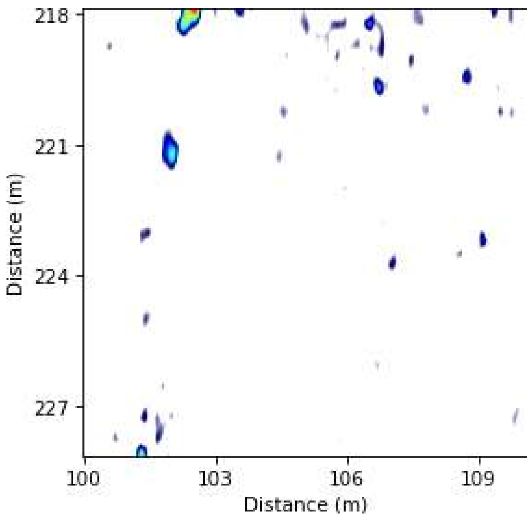
(f) Timeslice at z = 1.15 m.



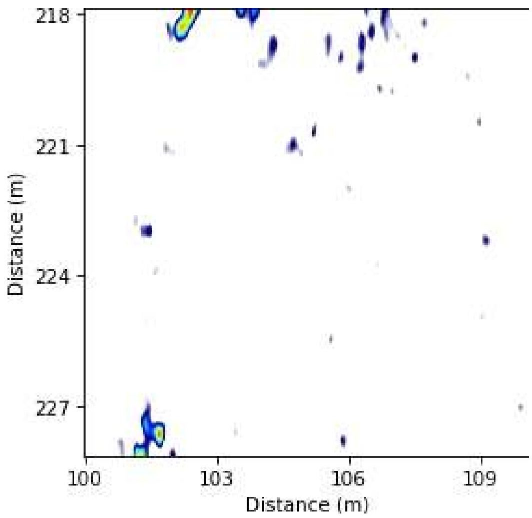
(a) Timeslice at z = 1.2 m.



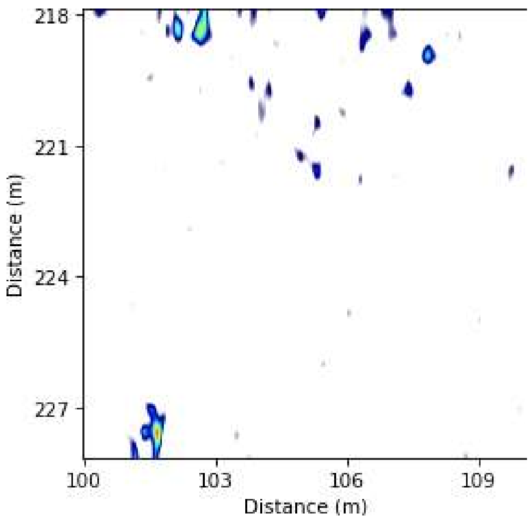
(b) Timeslice at z = 1.25 m.



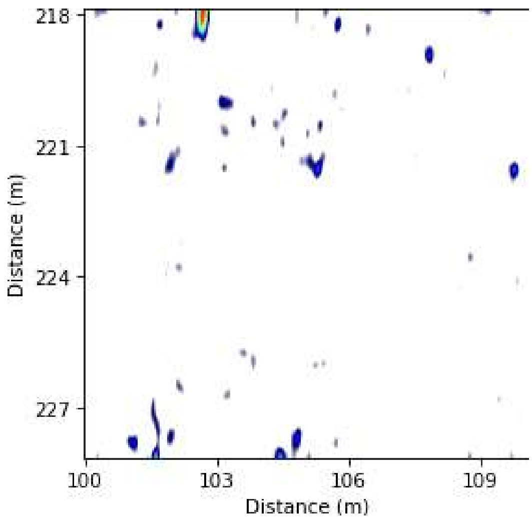
(c) Timeslice at z = 1.3 m.



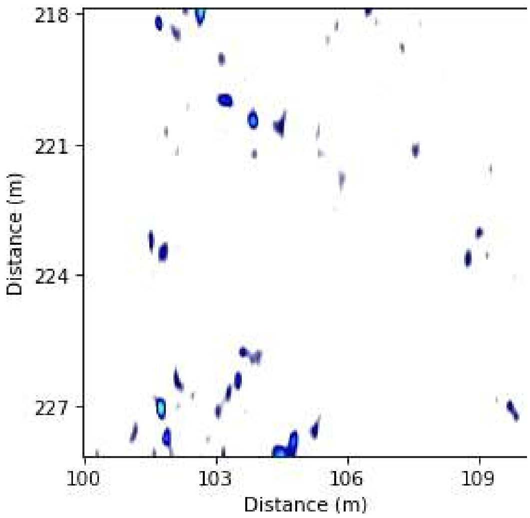
(d) Timeslice at z = 1.35 m.



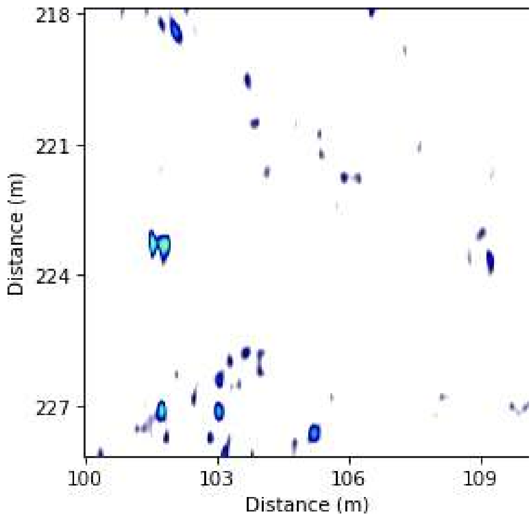
(e) Timeslice at z = 1.4 m.



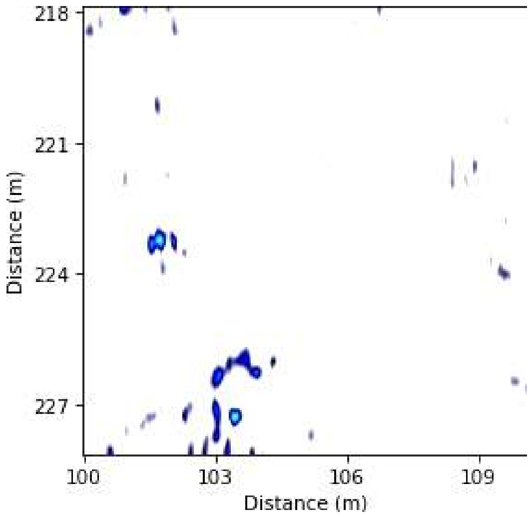
(f) Timeslice at z = 1.45 m.



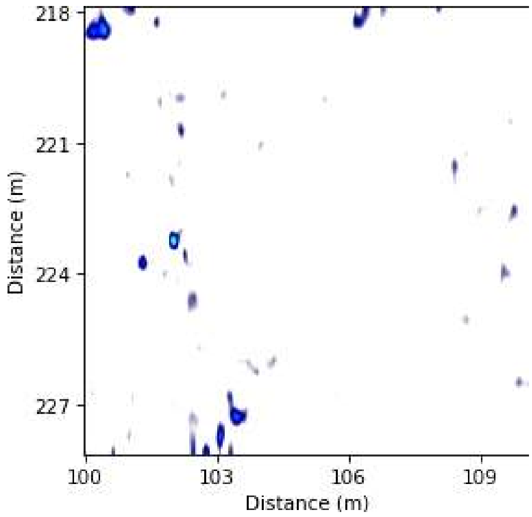
(a) Timeslice at z = 1.5 m.



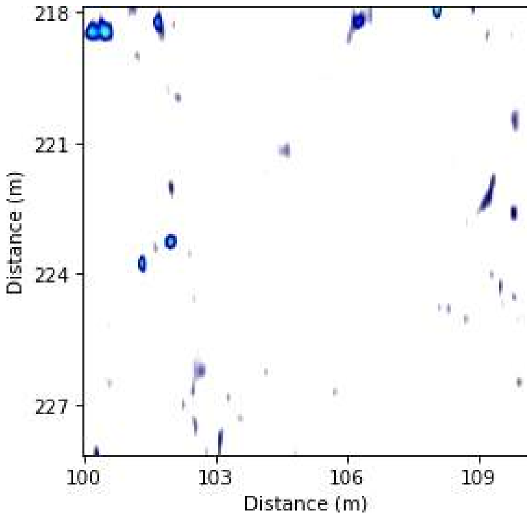
(b) Timeslice at z = 1.55 m.



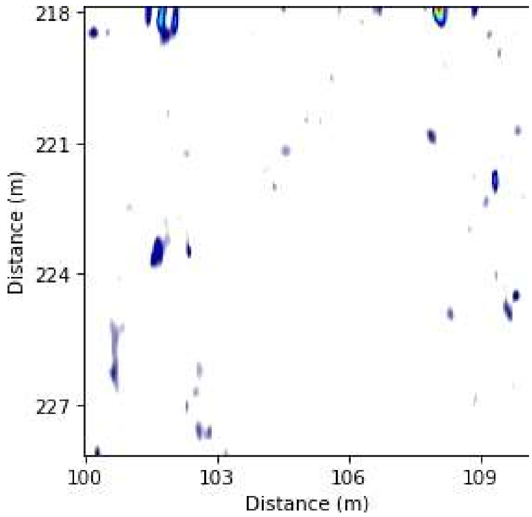
(c) Timeslice at z = 1.6 m.



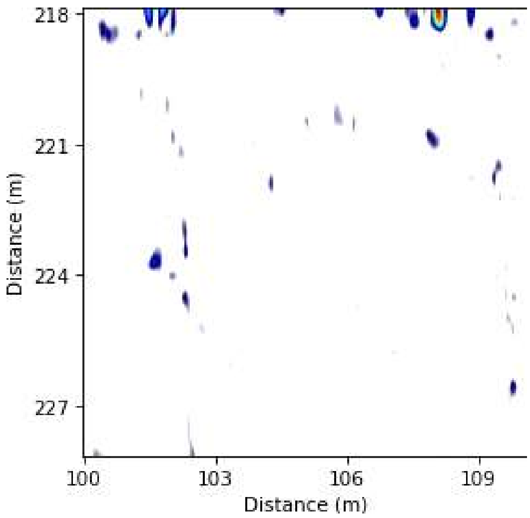
(d) Timeslice at z = 1.65 m.



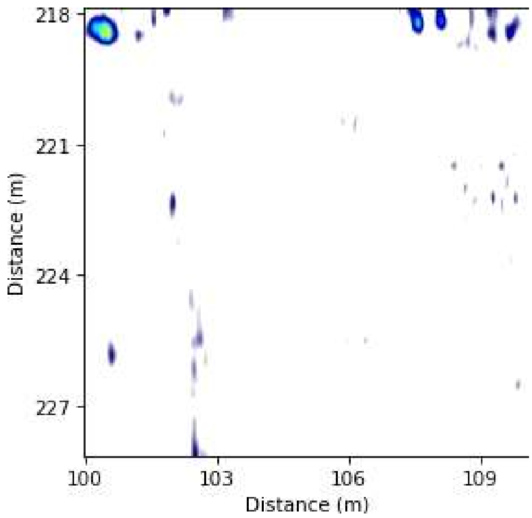
(e) Timeslice at z = 1.7 m.



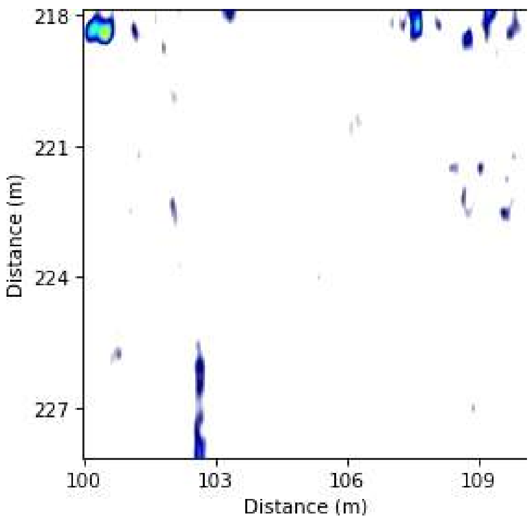
(f) Timeslice at z = 1.75 m.



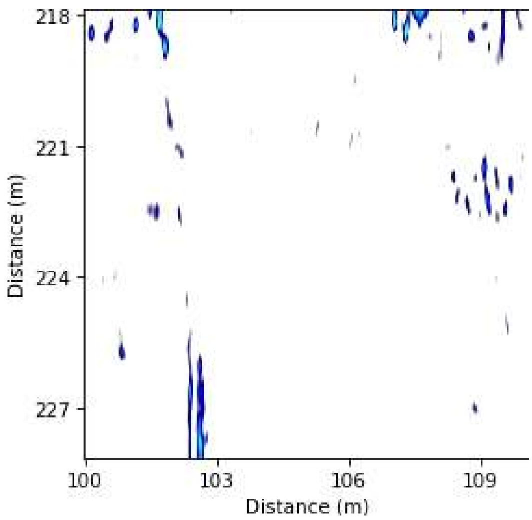
(a) Timeslice at z = 1.8 m.



(b) Timeslice at z = 1.85 m.



(c) Timeslice at z = 1.9 m.



(d) Timeslice at z = 1.95 m.

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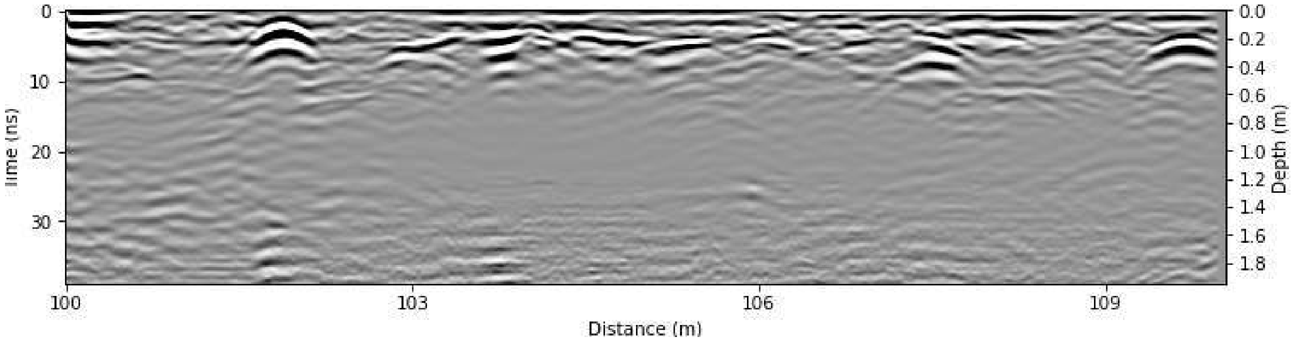


Figure A.97: Radargram at x = 247.5 m.

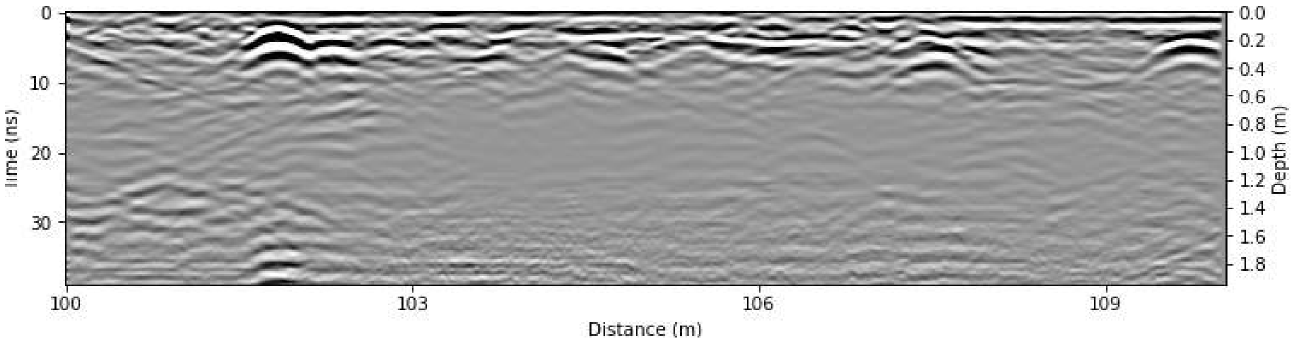


Figure A.98: Radargram at x = 247.75 m.

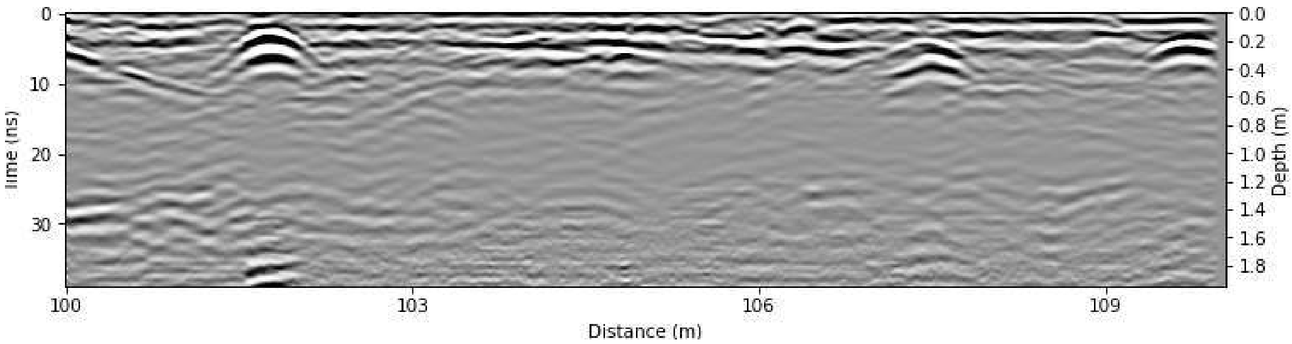


Figure A.99: Radargram at x = 248.0 m.

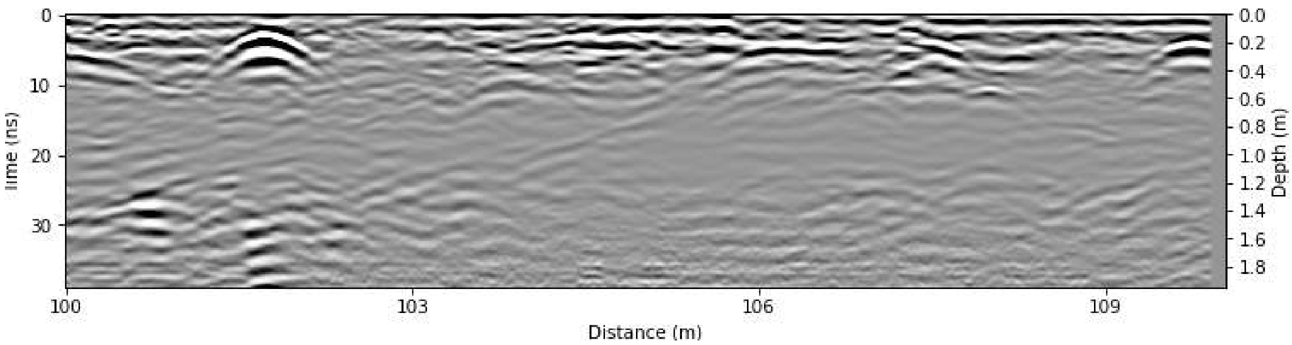


Figure A.100: Radargram at x = 248.25 m.

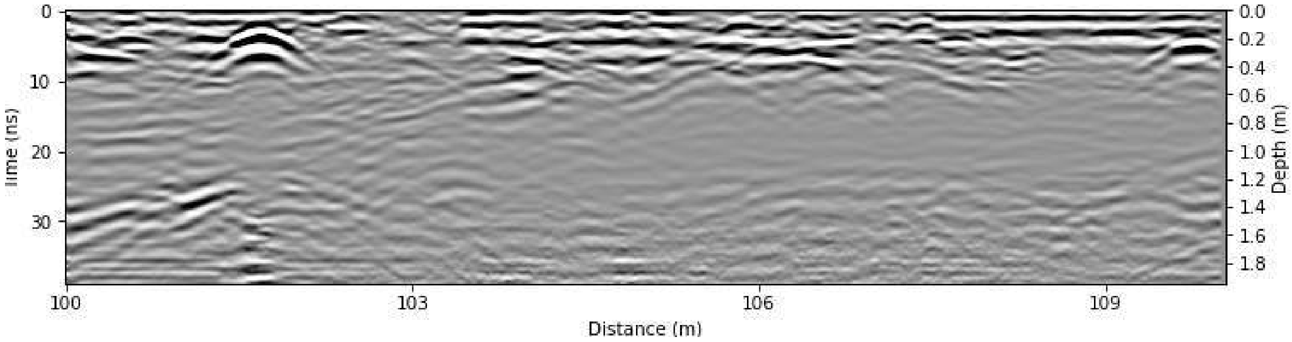


Figure A.101: Radargram at x = 248.5 m.

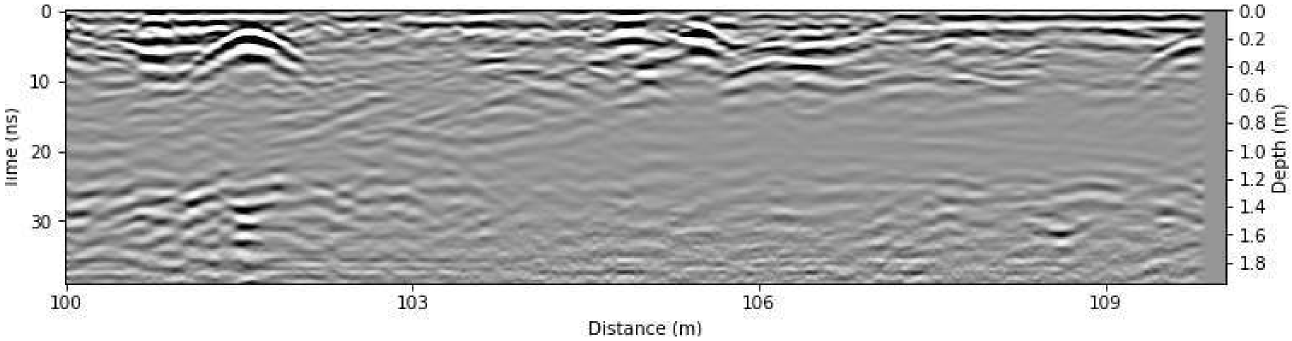


Figure A.102: Radargram at x = 248.75 m.

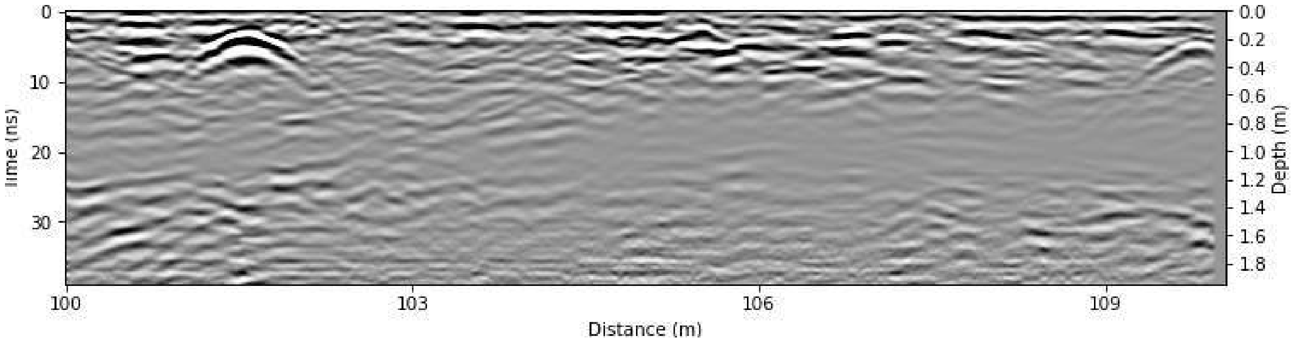


Figure A.103: Radargram at x = 249.0 m.

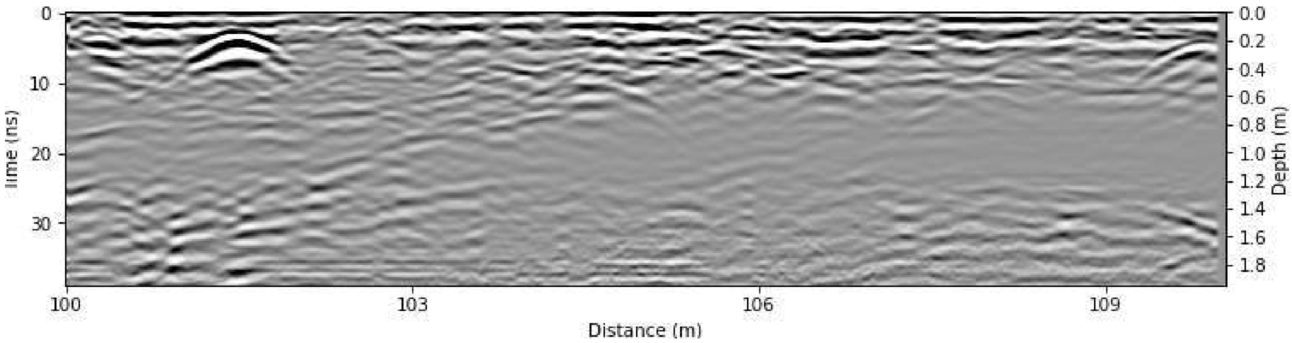


Figure A.104: Radargram at x = 249.25 m.

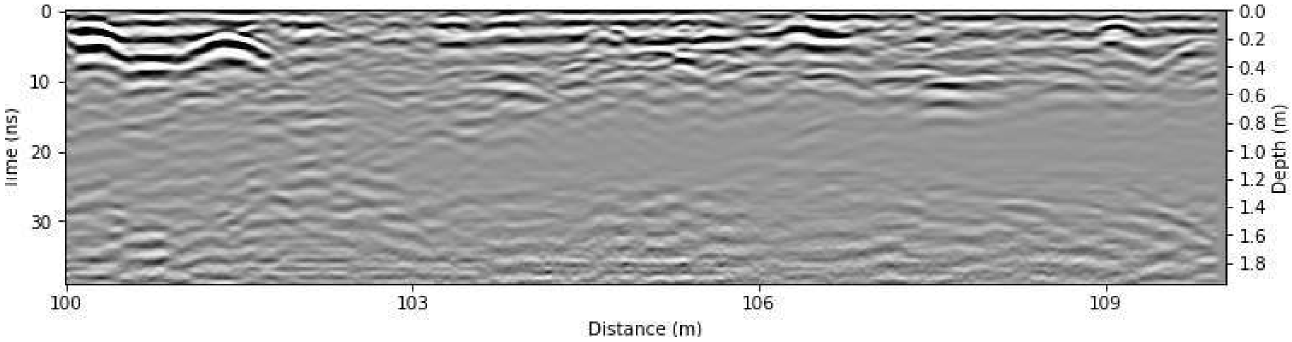


Figure A.105: Radargram at x = 249.5 m.

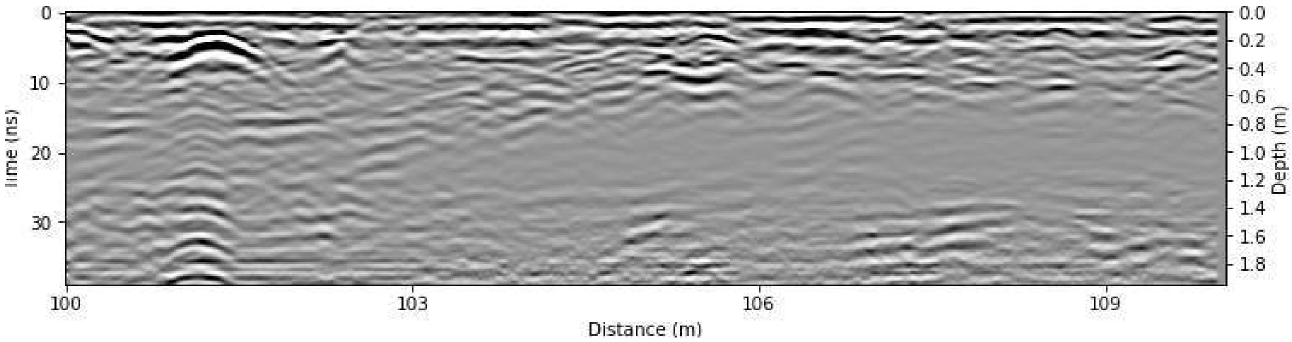


Figure A.106: Radargram at x = 249.75 m.

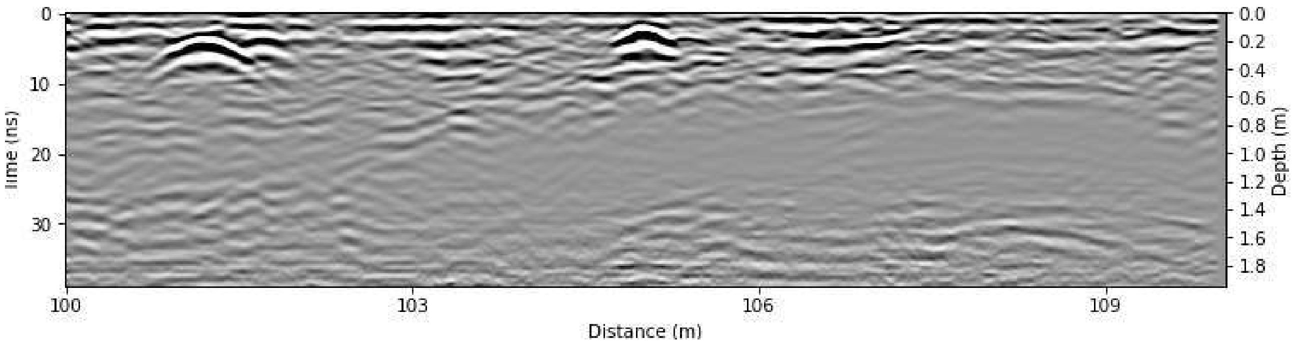


Figure A.107: Radargram at x = 250.0 m.

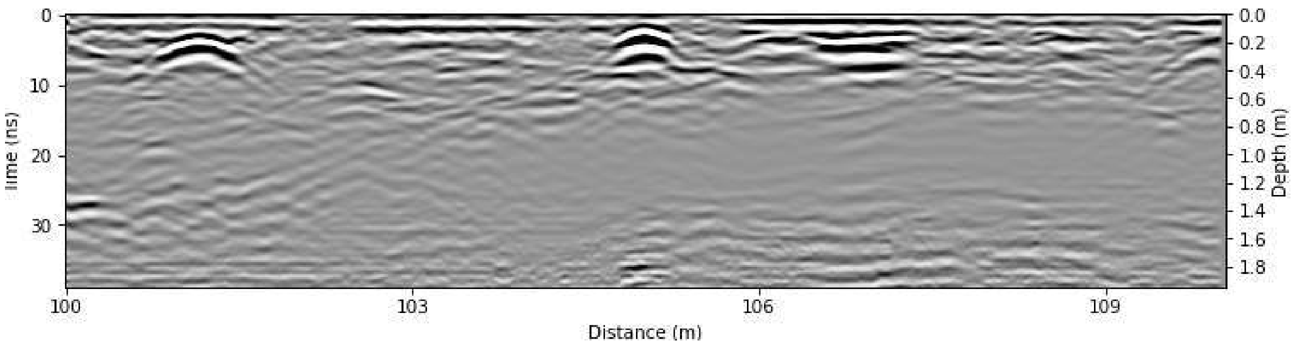


Figure A.108: Radargram at x = 250.25 m.

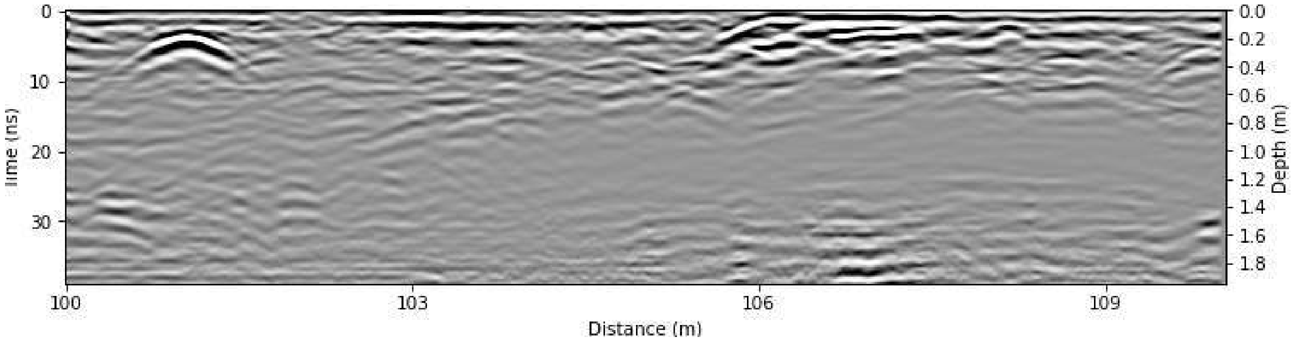


Figure A.109: Radargram at x = 250.5 m.

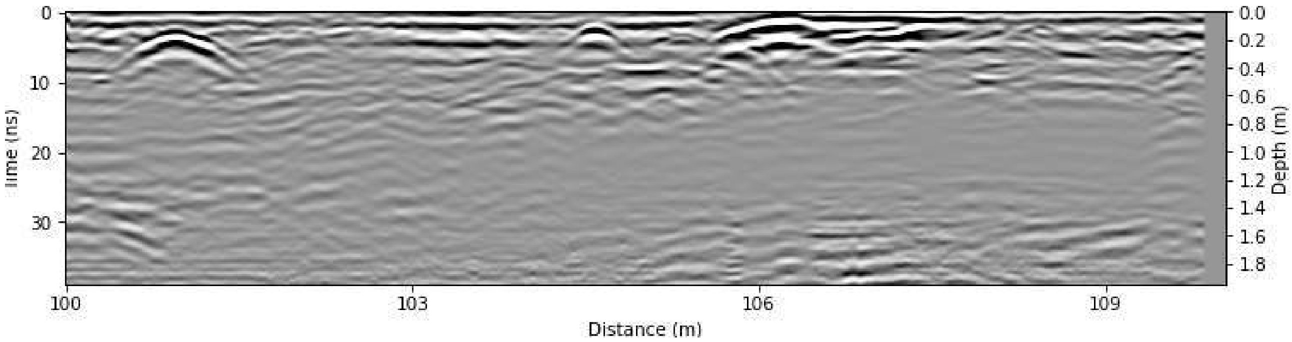


Figure A.110: Radargram at x = 250.75 m.

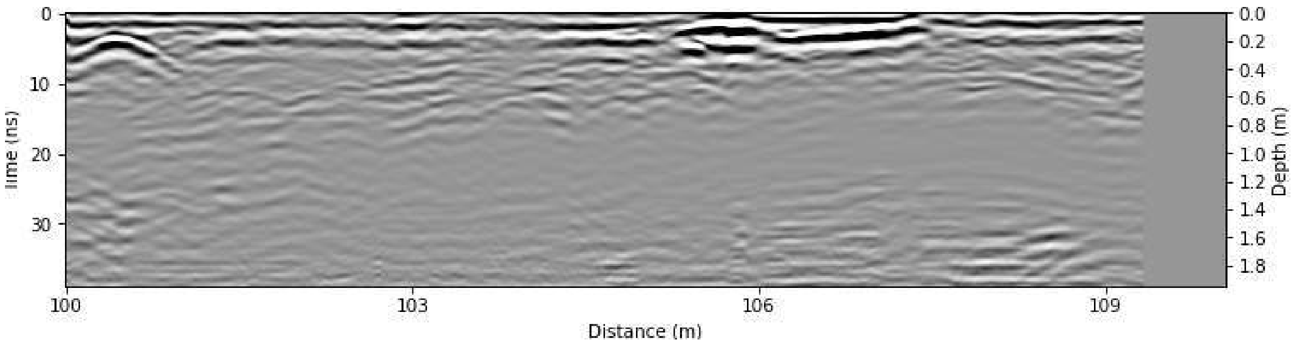


Figure A.111: Radargram at x = 251.0 m.

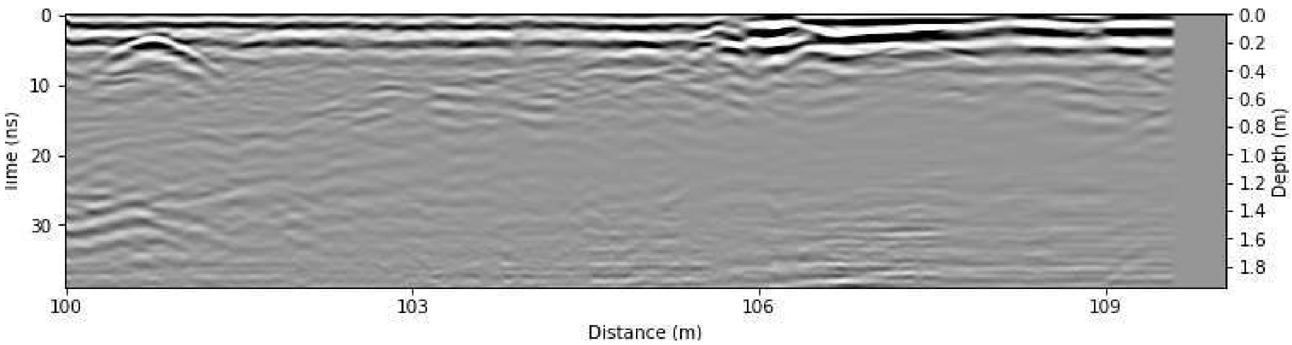


Figure A.112: Radargram at x = 251.25 m.

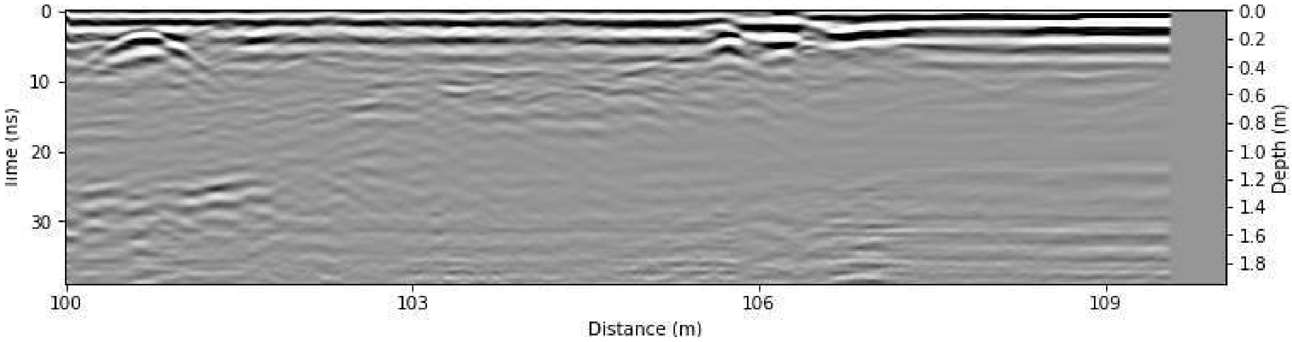


Figure A.113: Radargram at x = 251.5 m.

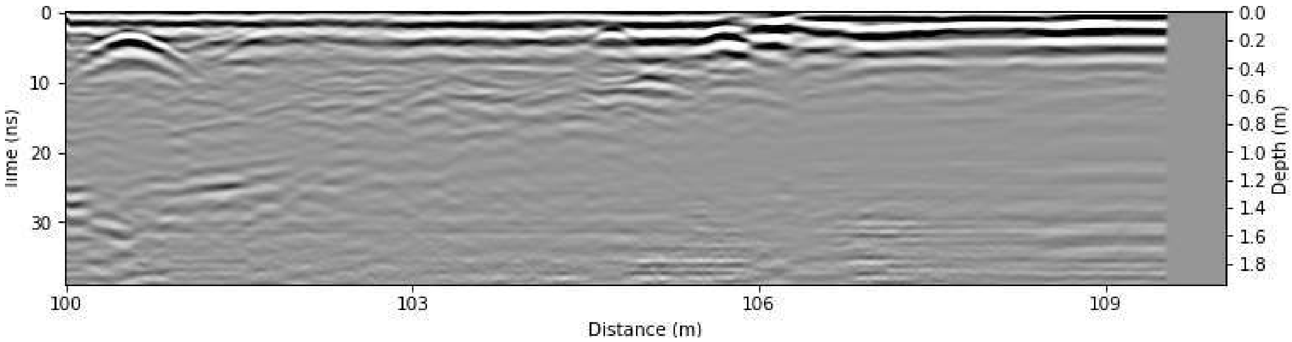


Figure A.114: Radargram at x = 251.75 m.

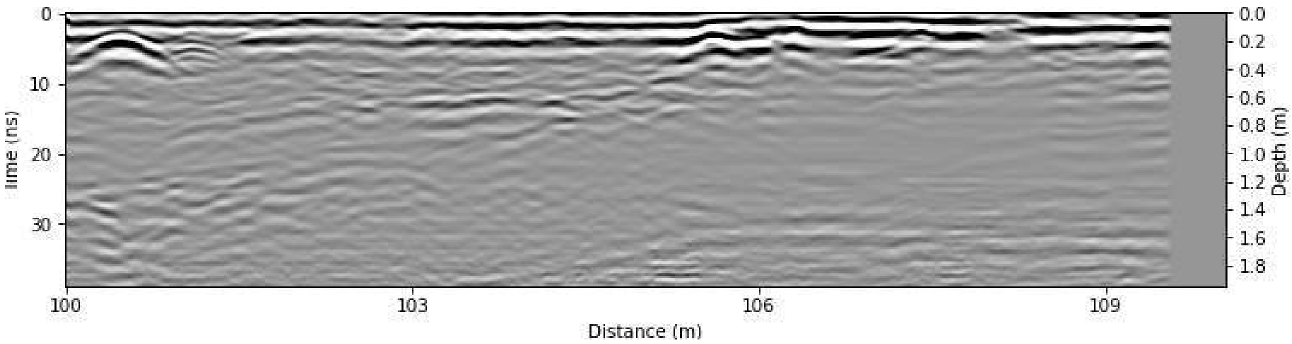


Figure A.115: Radargram at x = 252.0 m.

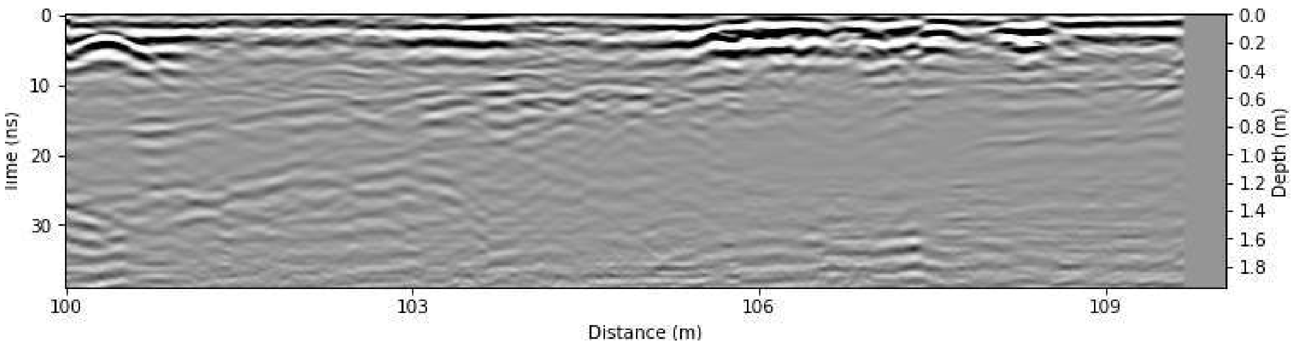


Figure A.116: Radargram at x = 252.25 m.

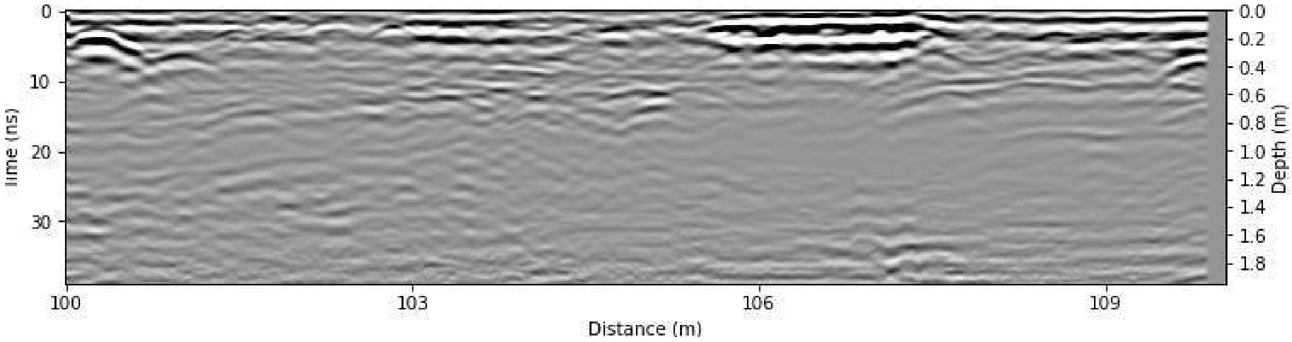


Figure A.117: Radargram at x = 252.5 m.

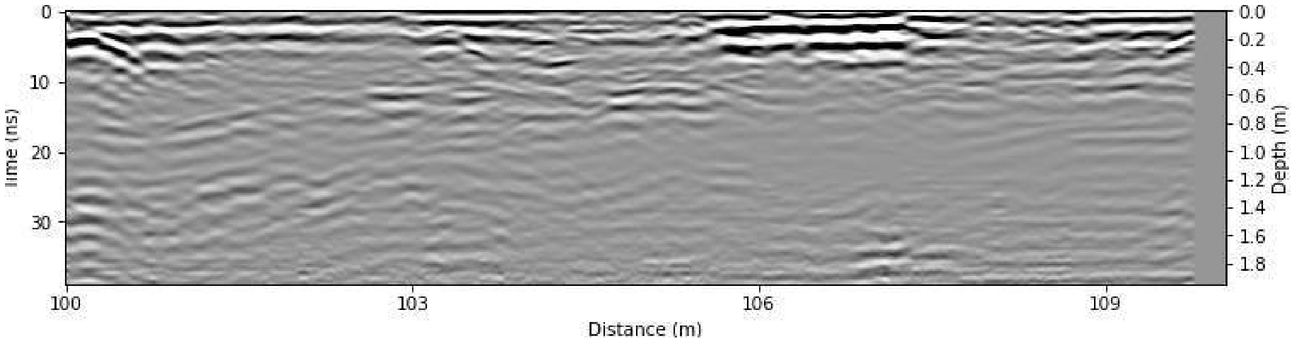


Figure A.118: Radargram at x = 252.75 m.

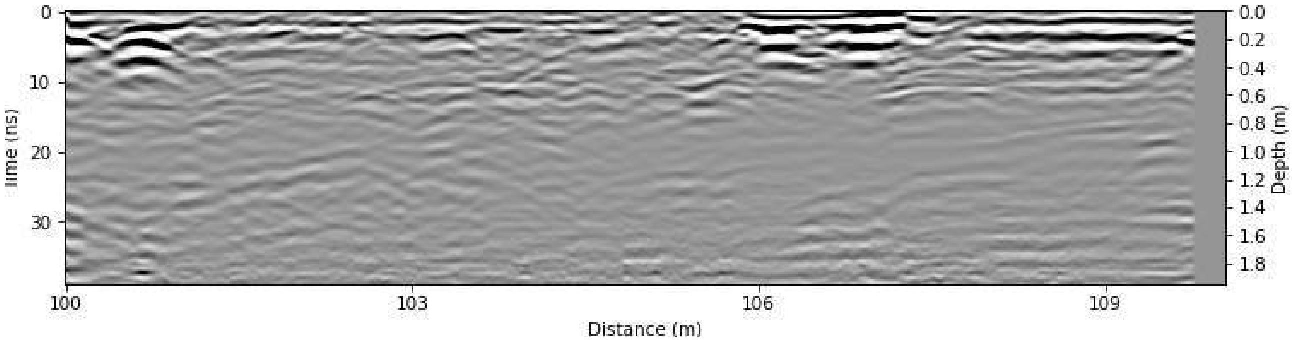


Figure A.119: Radargram at x = 253.0 m.

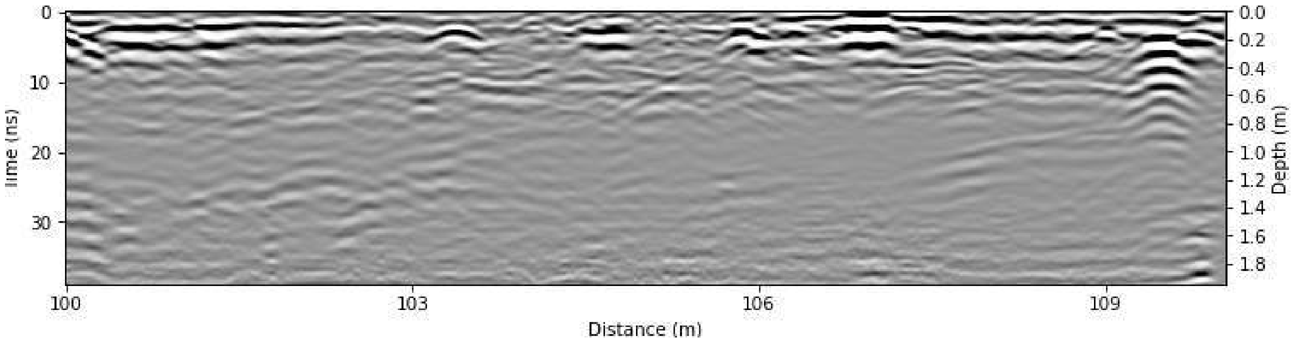


Figure A.120: Radargram at x = 253.25 m.

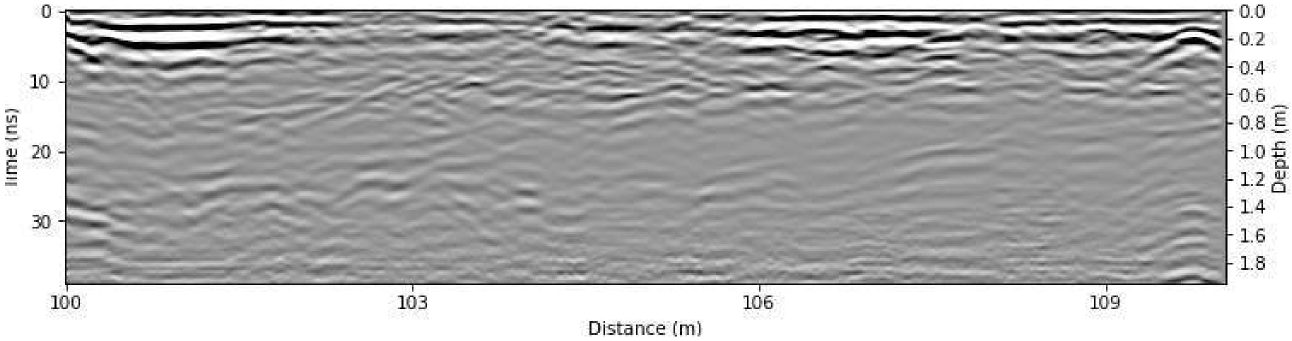


Figure A.121: Radargram at x = 253.5 m.

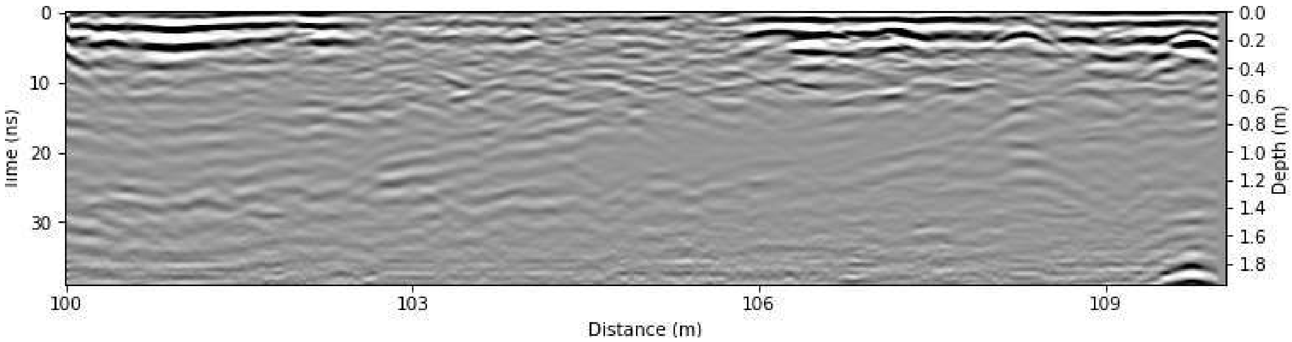


Figure A.122: Radargram at x = 253.75 m.

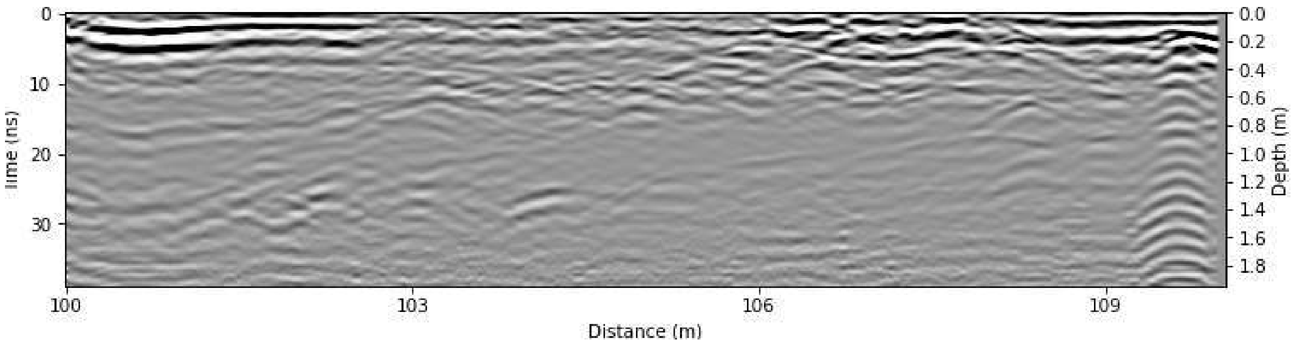


Figure A.123: Radargram at x = 254.0 m.

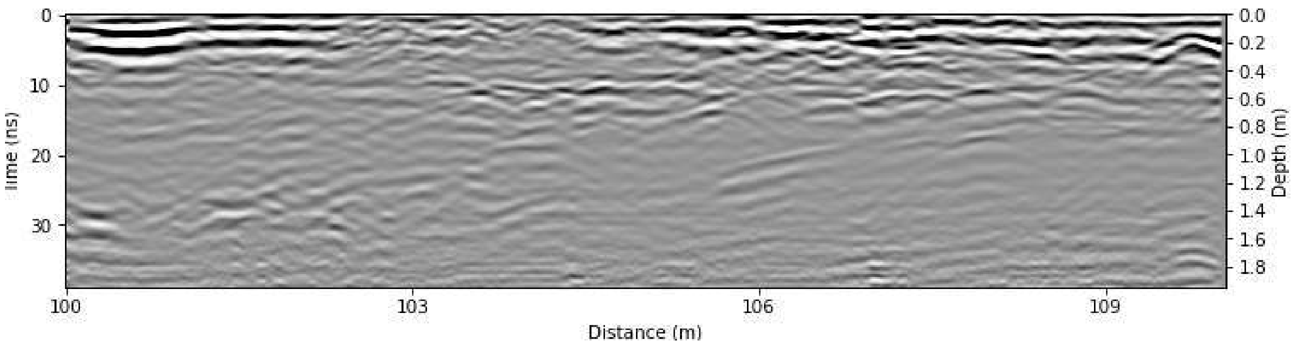


Figure A.124: Radargram at x = 254.25 m.

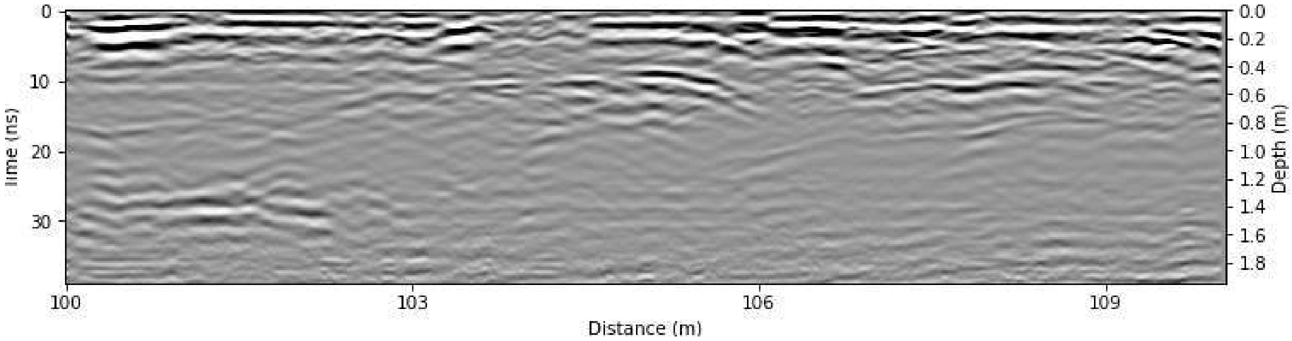


Figure A.125: Radargram at x = 254.5 m.

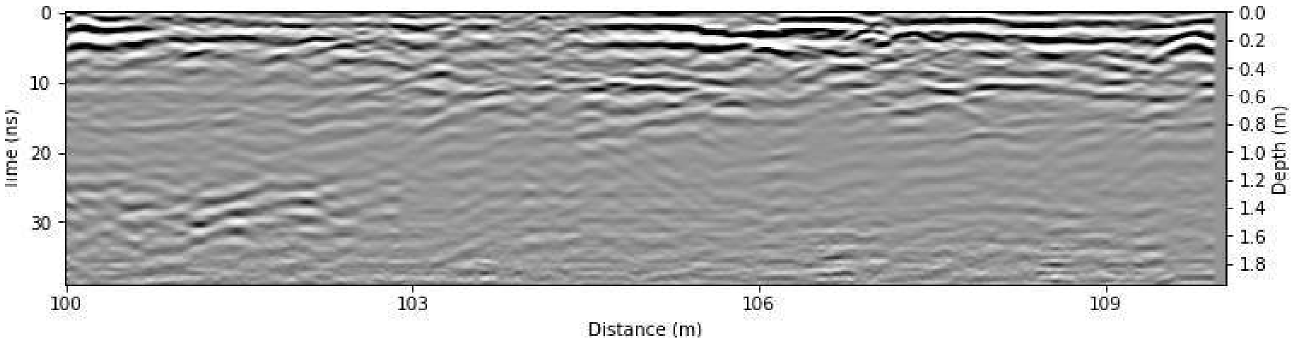


Figure A.126: Radargram at x = 254.75 m.

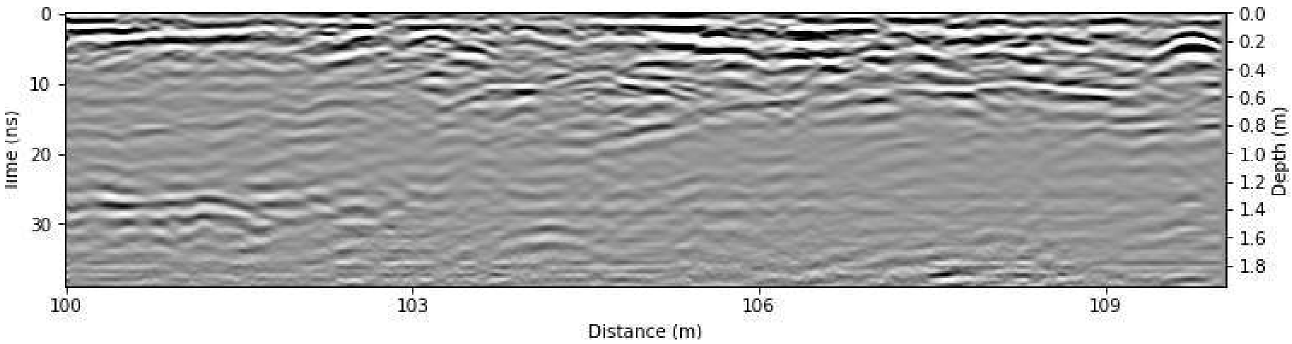


Figure A.127: Radargram at x = 255.0 m.

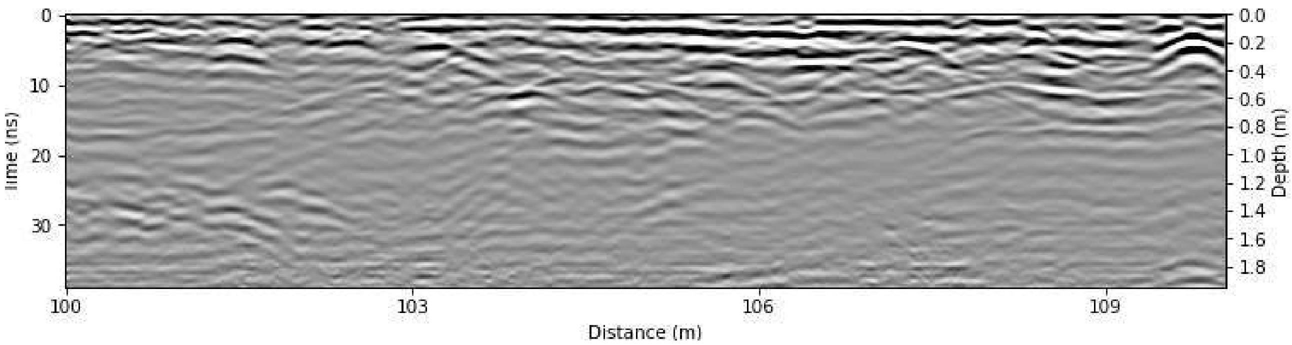


Figure A.128: Radargram at x = 255.25 m.

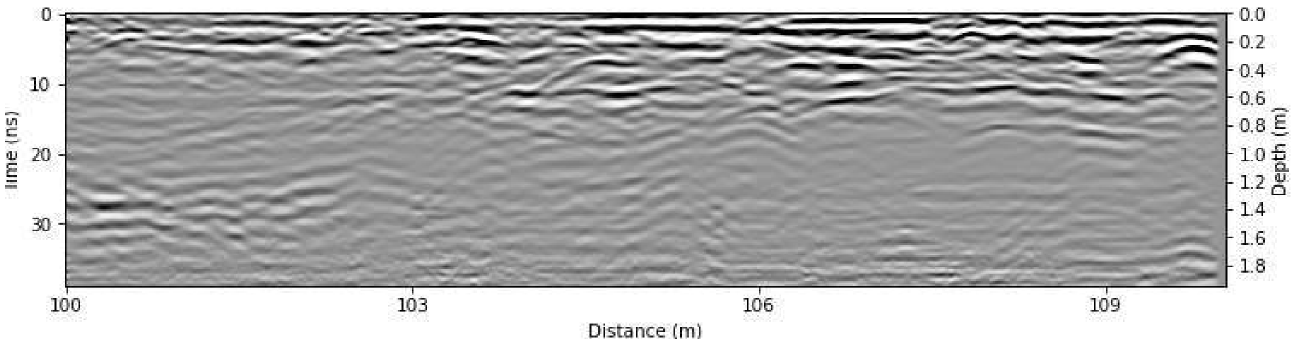


Figure A.129: Radargram at x = 255.5 m.

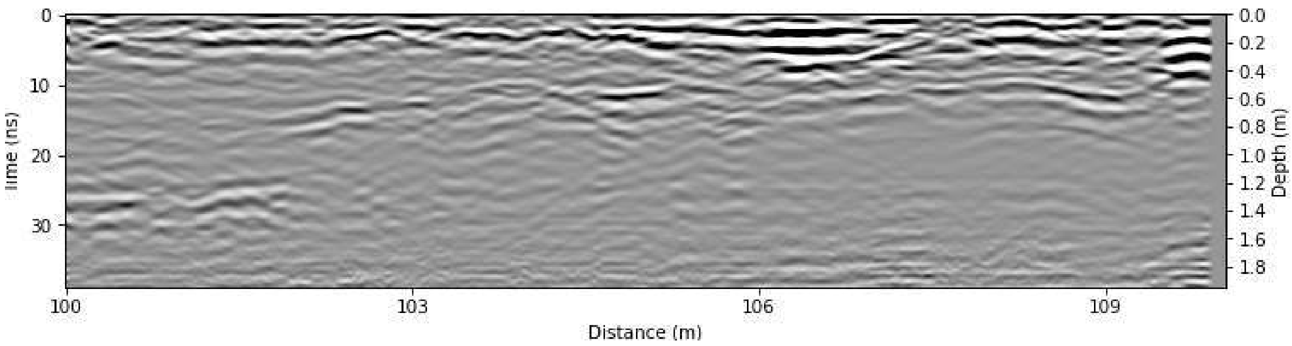


Figure A.130: Radargram at x = 255.75 m.

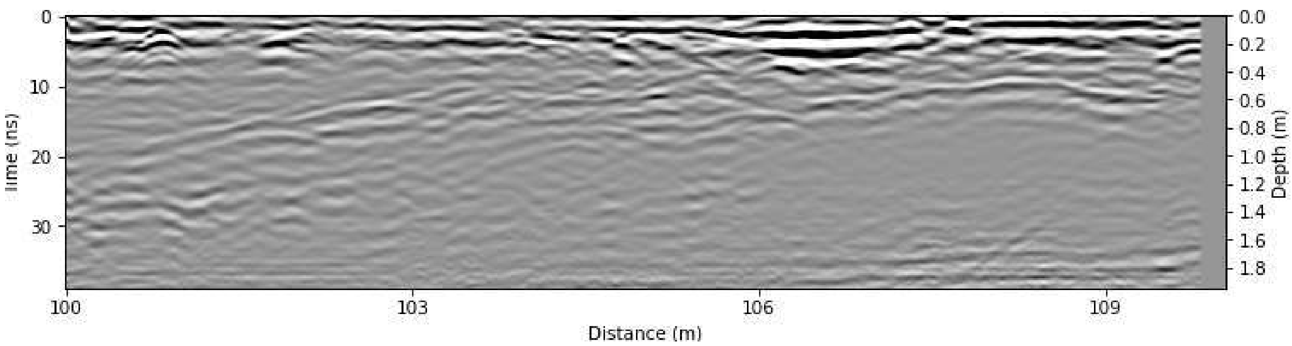


Figure A.131: Radargram at x = 256.0 m.

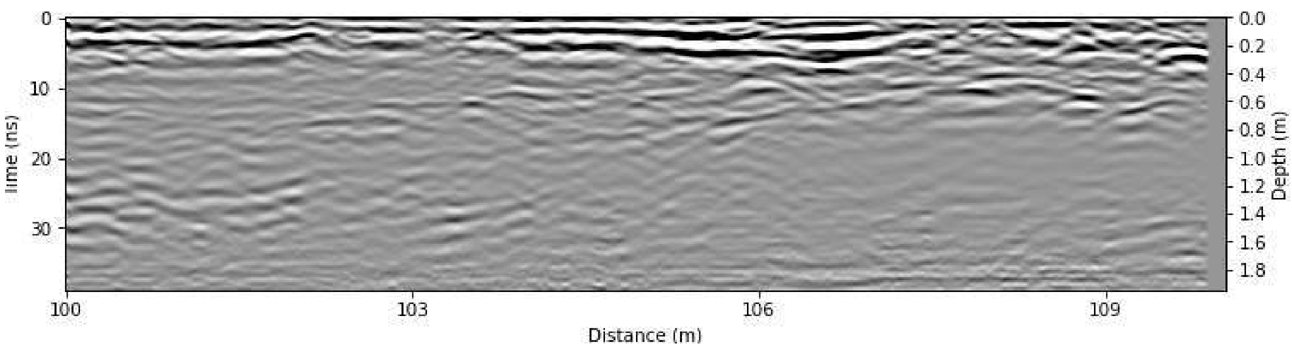


Figure A.132: Radargram at x = 256.25 m.

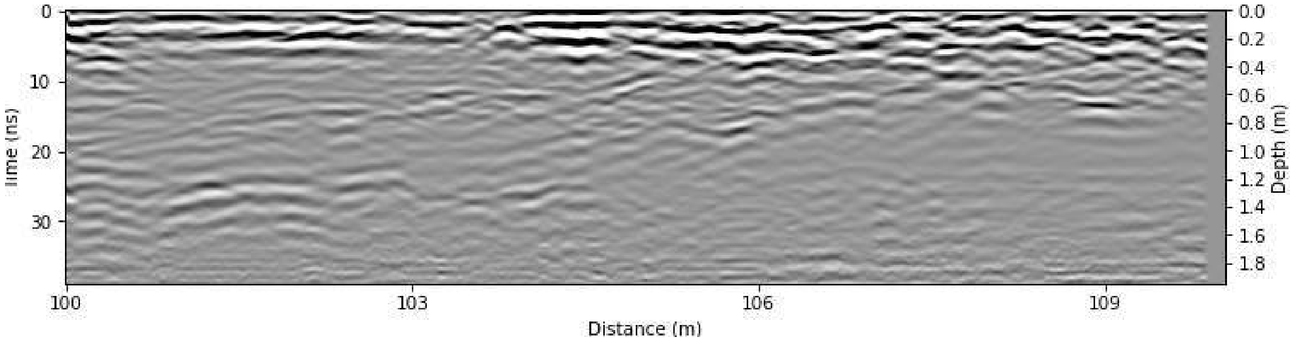


Figure A.133: Radargram at x = 256.5 m.

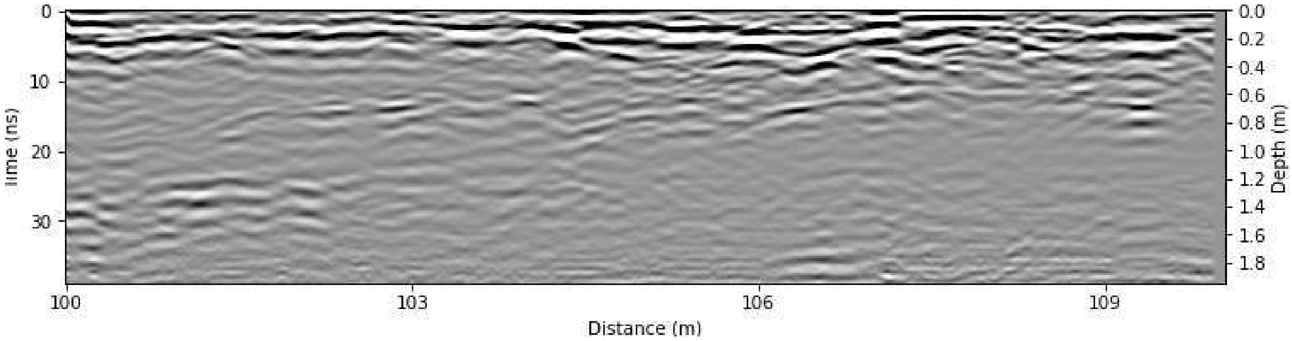


Figure A.134: Radargram at x = 256.75 m.

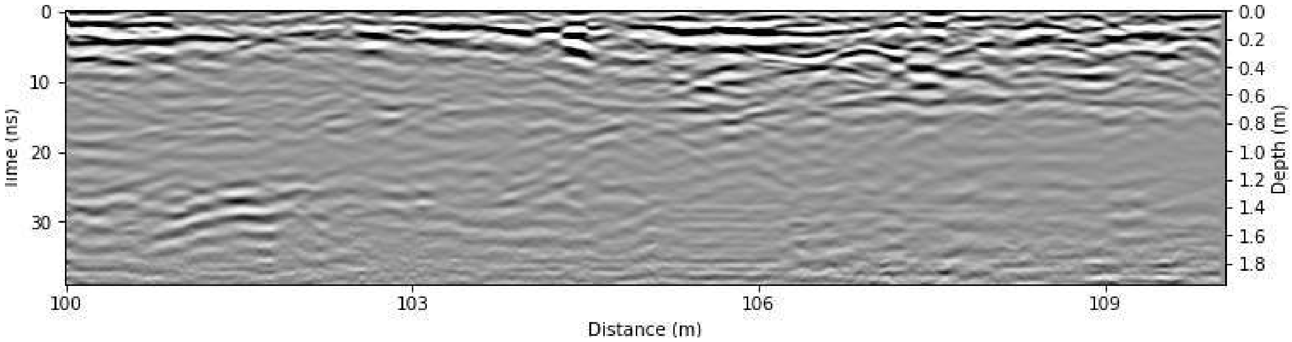


Figure A.135: Radargram at x = 257.0 m.

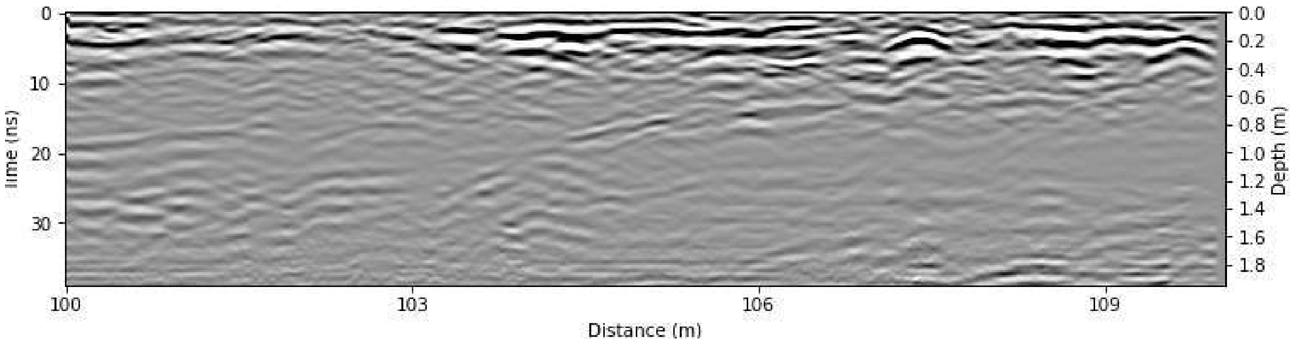


Figure A.136: Radargram at x = 257.25 m.

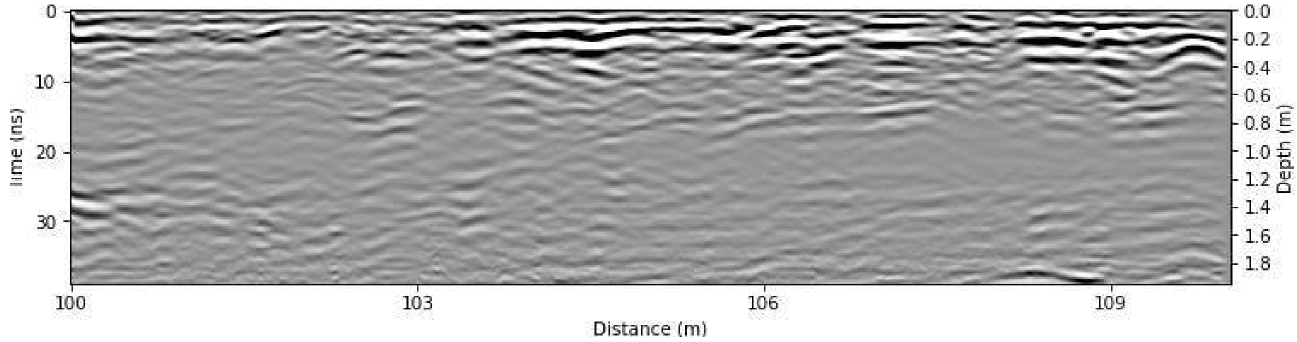
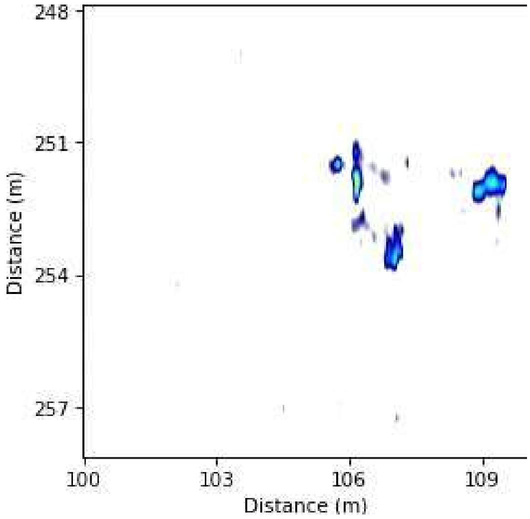
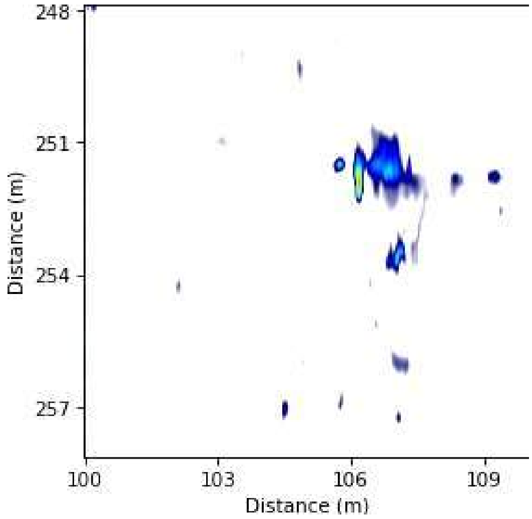


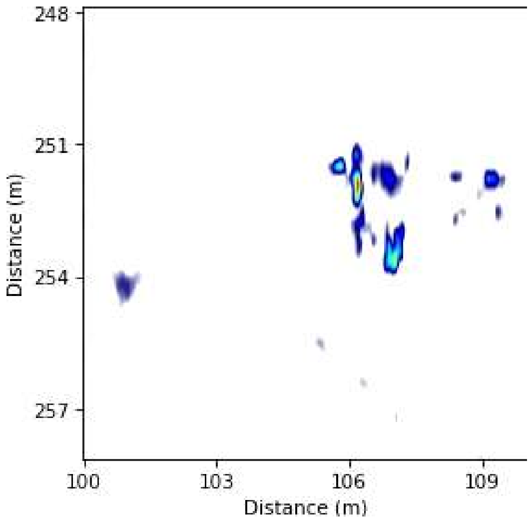
Figure A.137: Radargram at x = 257.5 m.



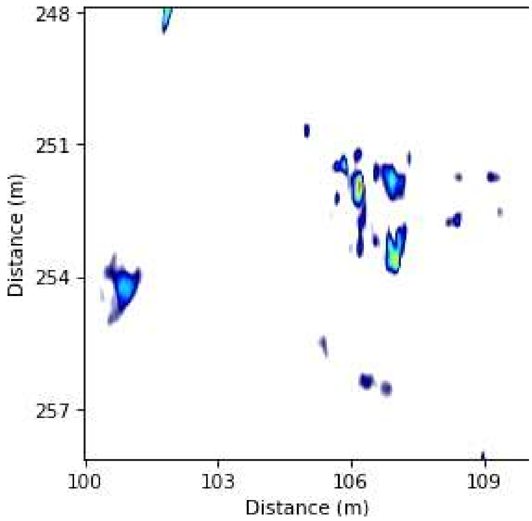
(a) Timeslice at z = 0.0 m.



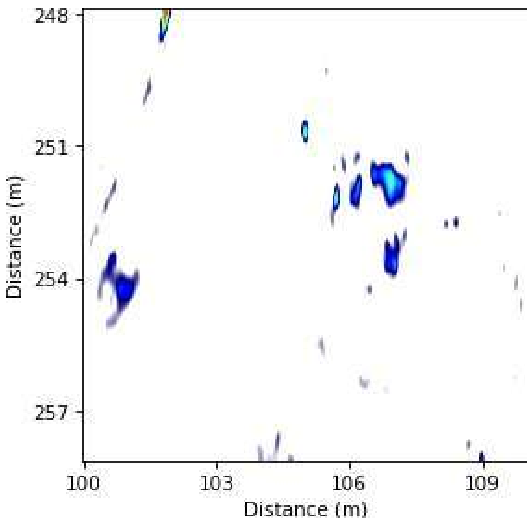
(b) Timeslice at z = 0.05 m.



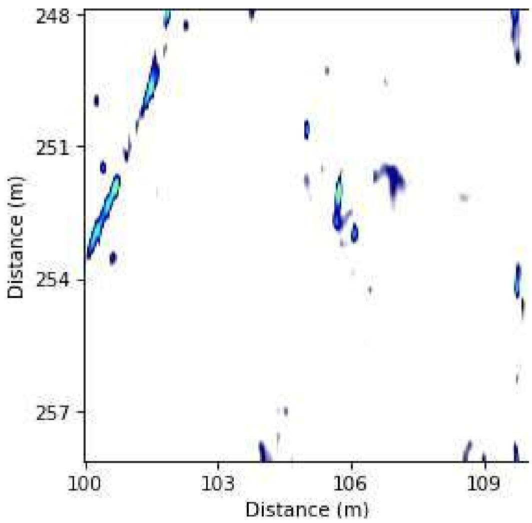
(c) Timeslice at z = 0.1 m.



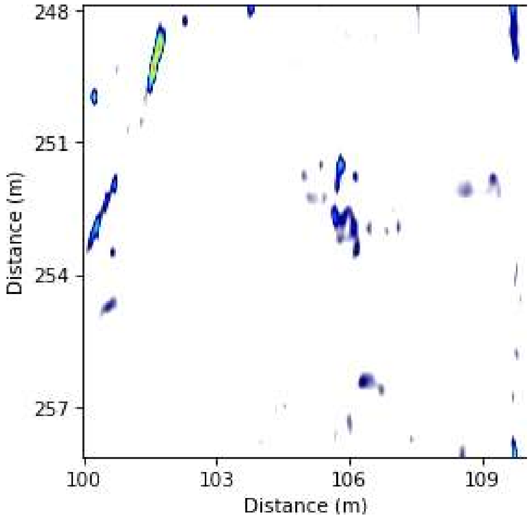
(d) Timeslice at z = 0.15 m.



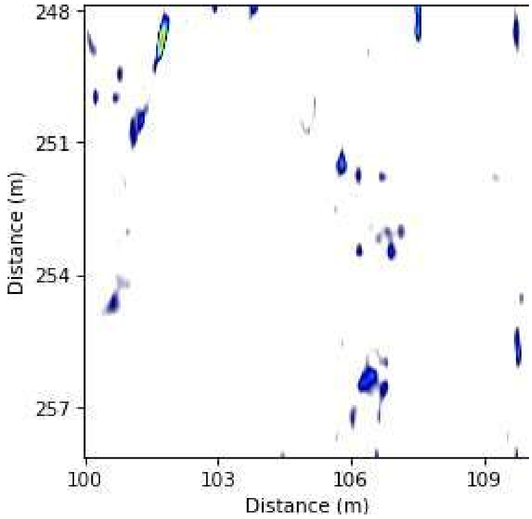
(e) Timeslice at z = 0.2 m.



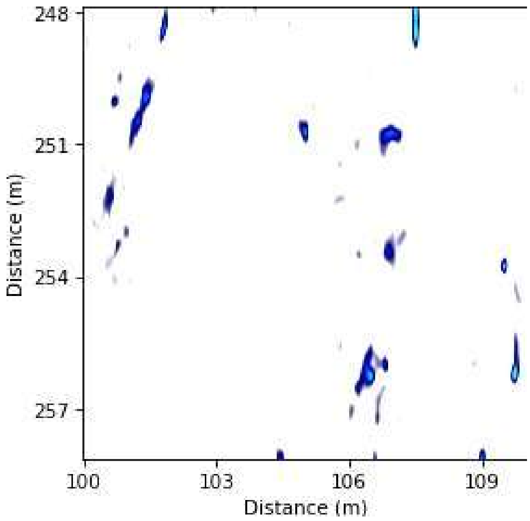
(f) Timeslice at z = 0.25 m.



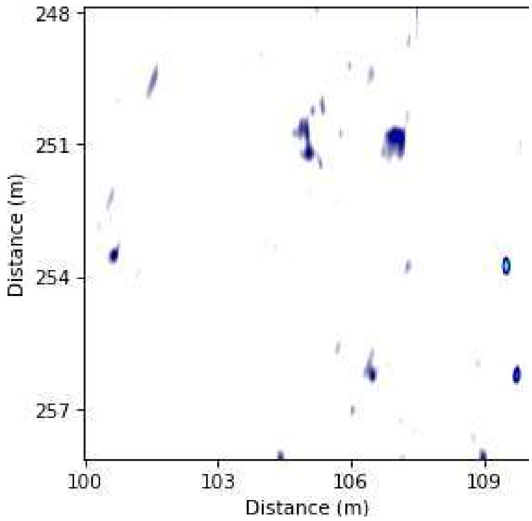
(a) Timeslice at z = 0.3 m.



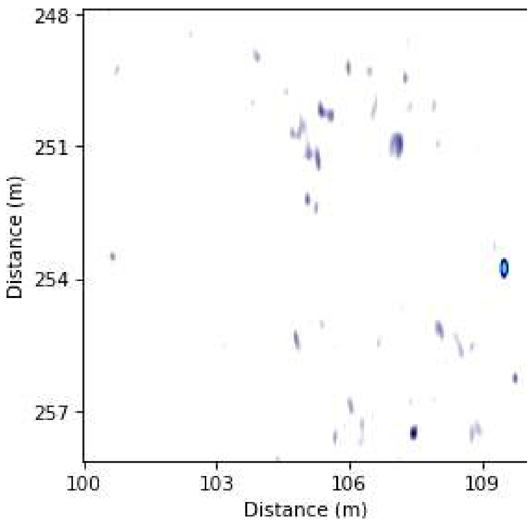
(b) Timeslice at z = 0.35 m.



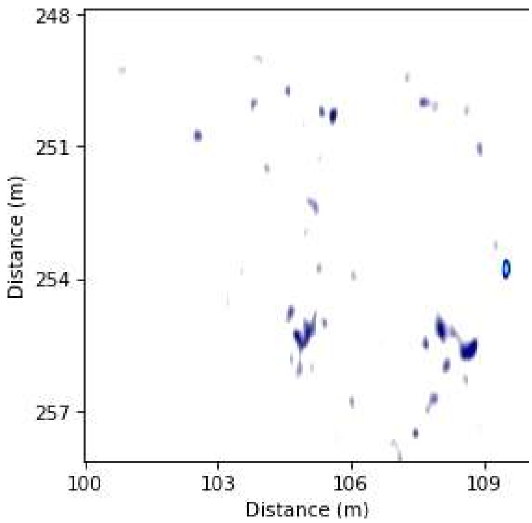
(c) Timeslice at z = 0.4 m.



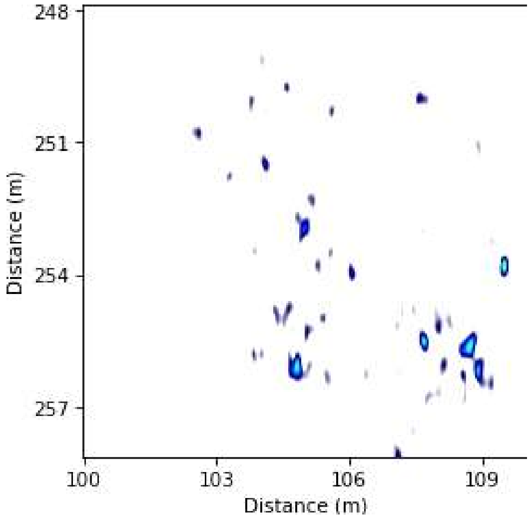
(d) Timeslice at z = 0.45 m.



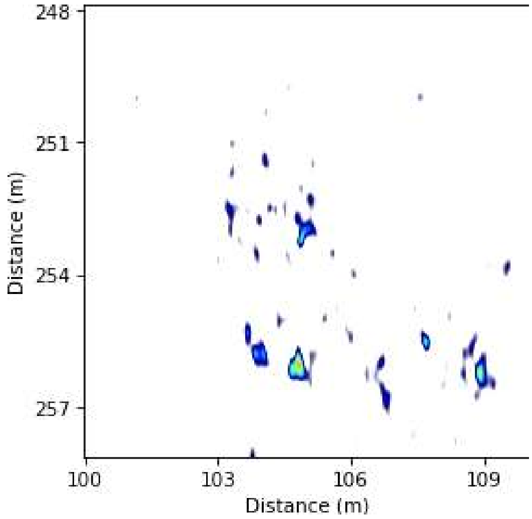
(e) Timeslice at z = 0.5 m.



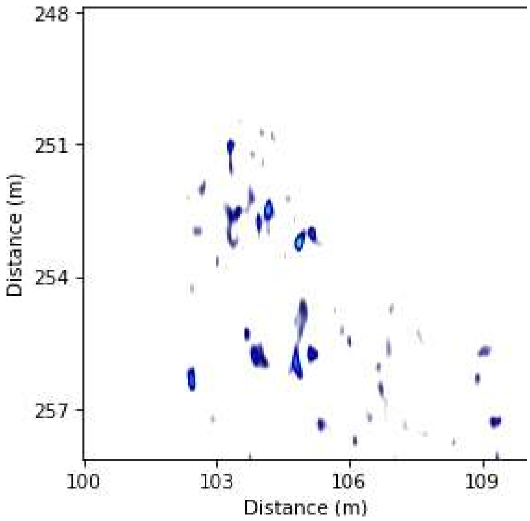
(f) Timeslice at z = 0.55 m.



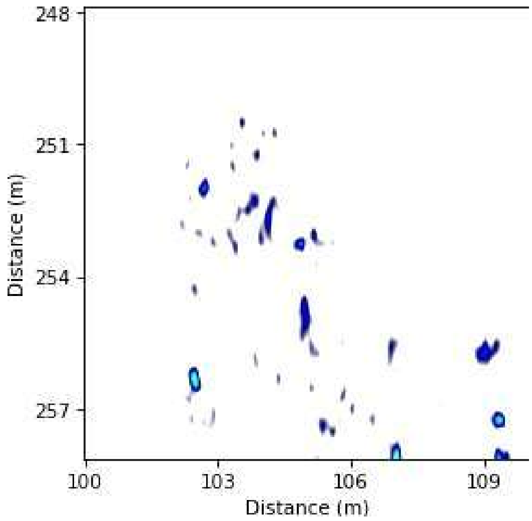
(a) Timeslice at z = 0.6 m.



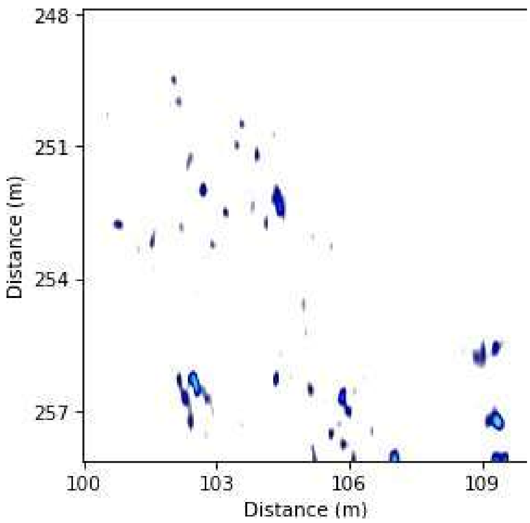
(b) Timeslice at z = 0.65 m.



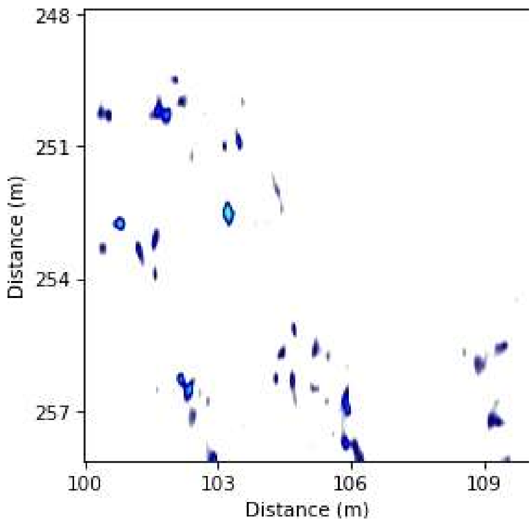
(c) Timeslice at z = 0.7 m.



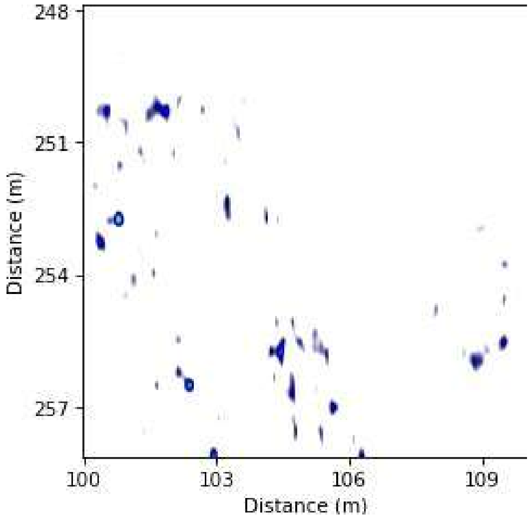
(d) Timeslice at z = 0.75 m.



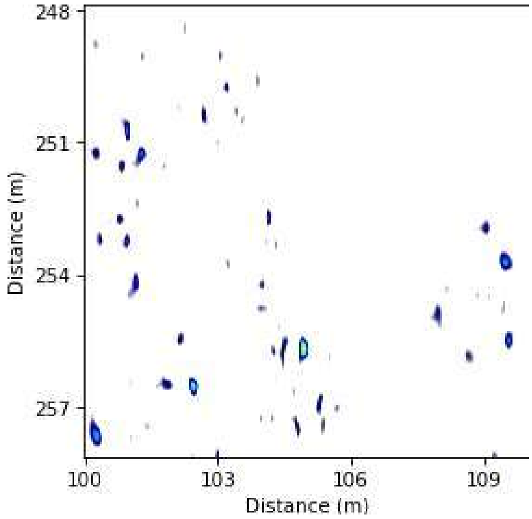
(e) Timeslice at z = 0.8 m.



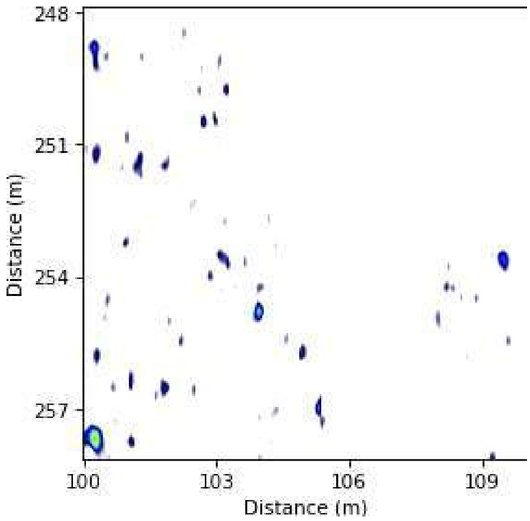
(f) Timeslice at z = 0.85 m.



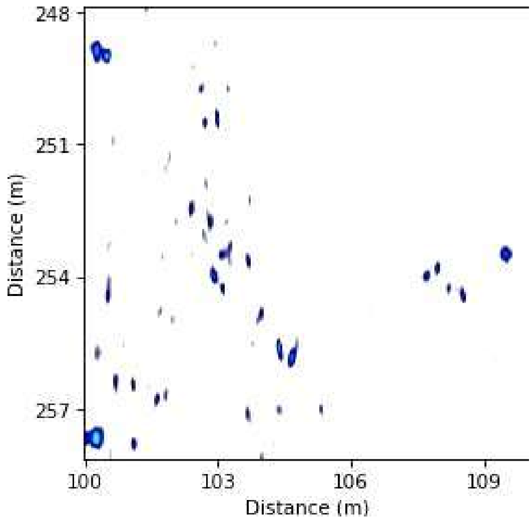
(a) Timeslice at z = 0.9 m.



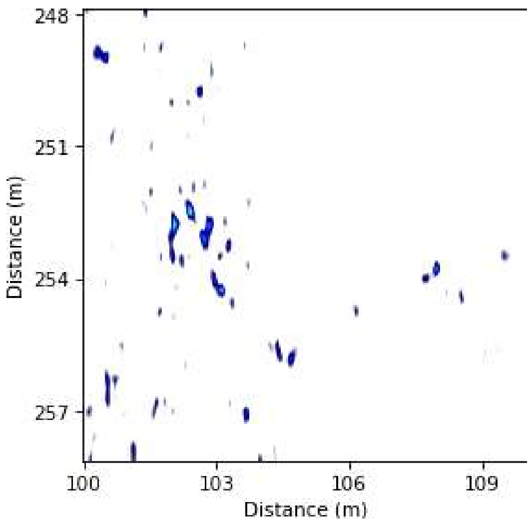
(b) Timeslice at z = 0.95 m.



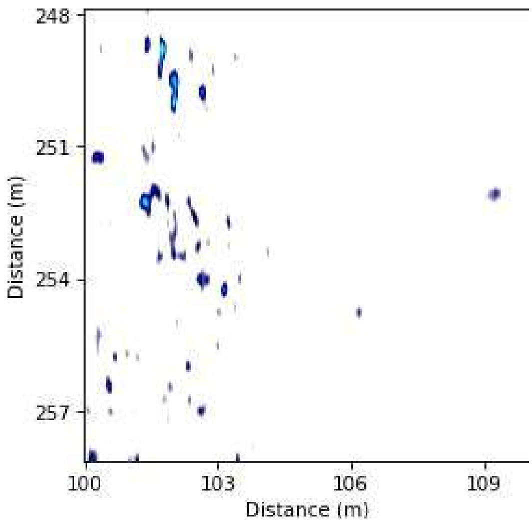
(c) Timeslice at z = 1.0 m.



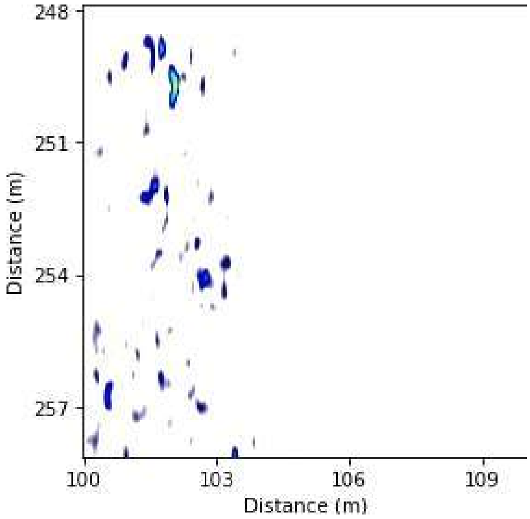
(d) Timeslice at z = 1.05 m.



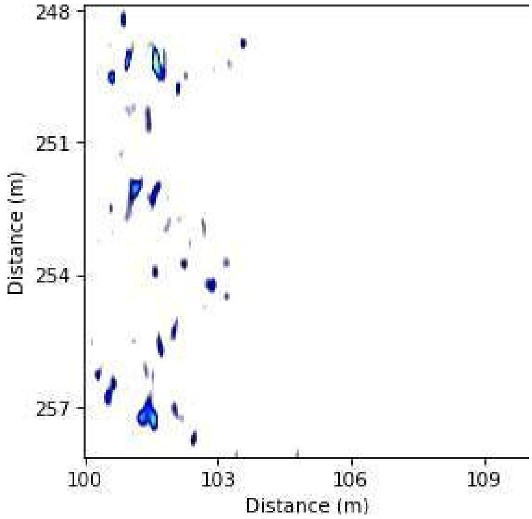
(e) Timeslice at z = 1.1 m.



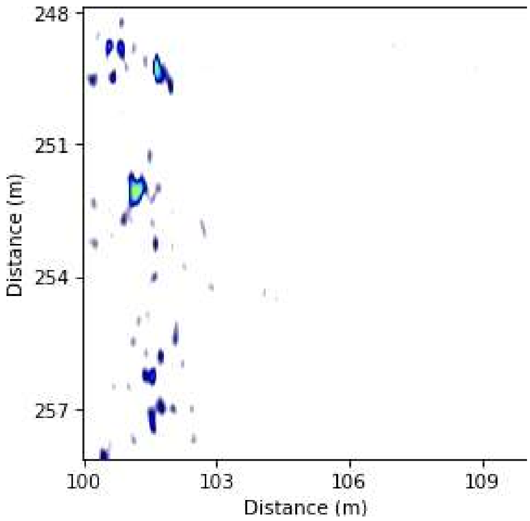
(f) Timeslice at z = 1.15 m.



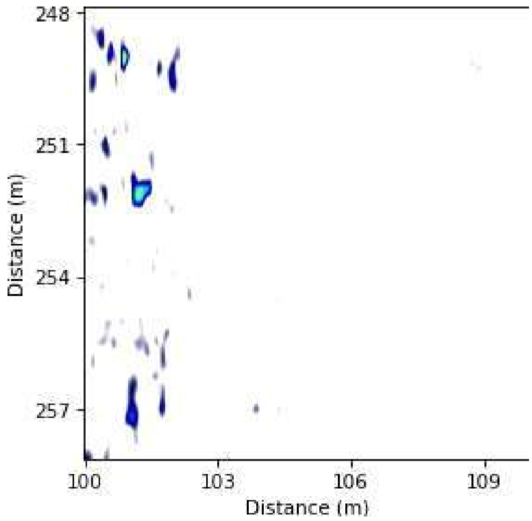
(a) Timeslice at z = 1.2 m.



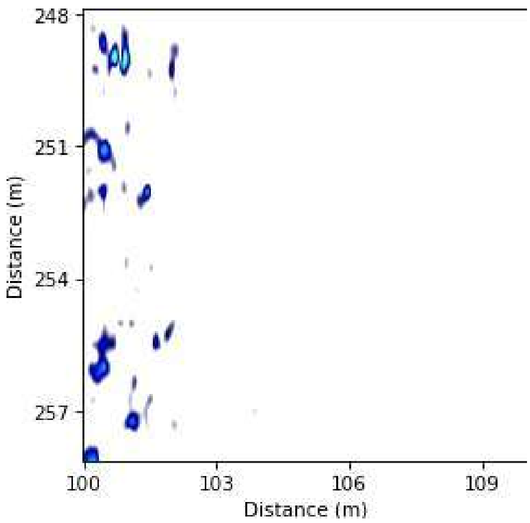
(b) Timeslice at z = 1.25 m.



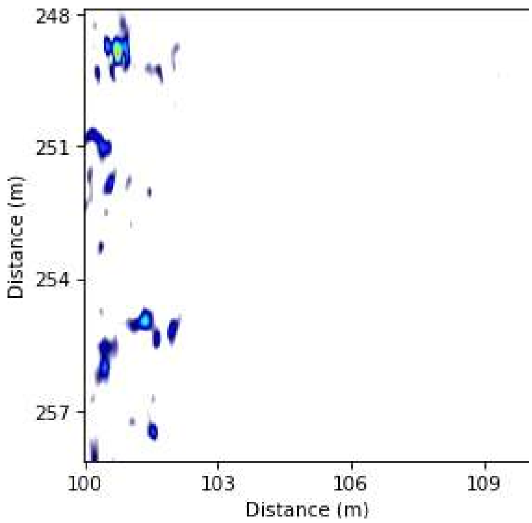
(c) Timeslice at z = 1.3 m.



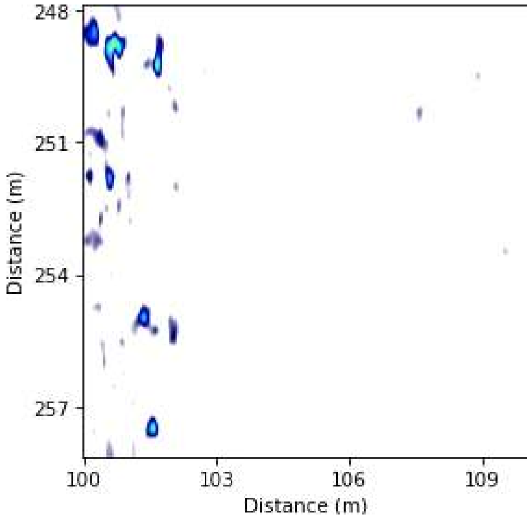
(d) Timeslice at z = 1.35 m.



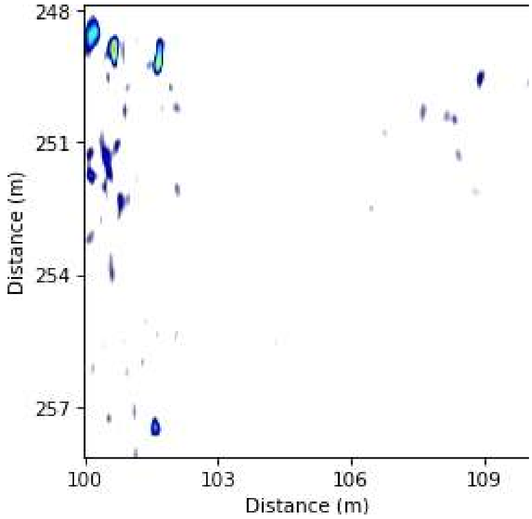
(e) Timeslice at z = 1.4 m.



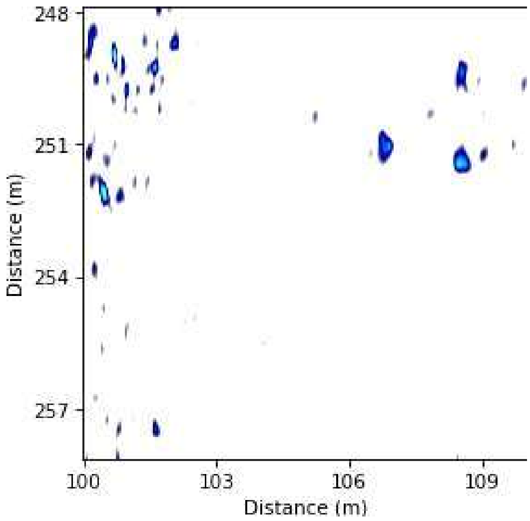
(f) Timeslice at z = 1.45 m.



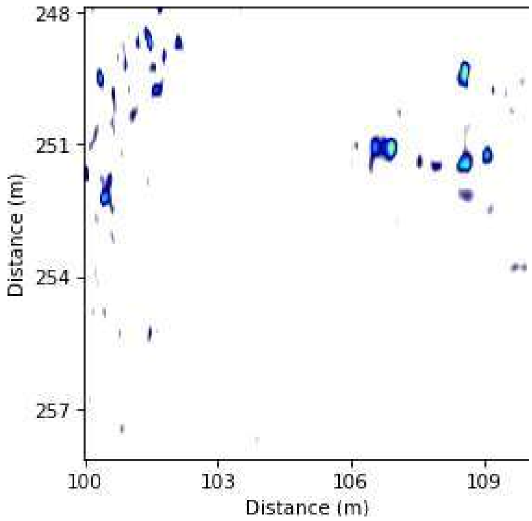
(a) Timeslice at z = 1.5 m.



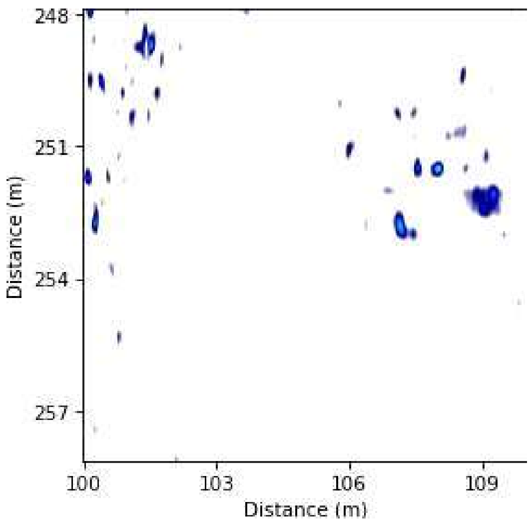
(b) Timeslice at z = 1.55 m.



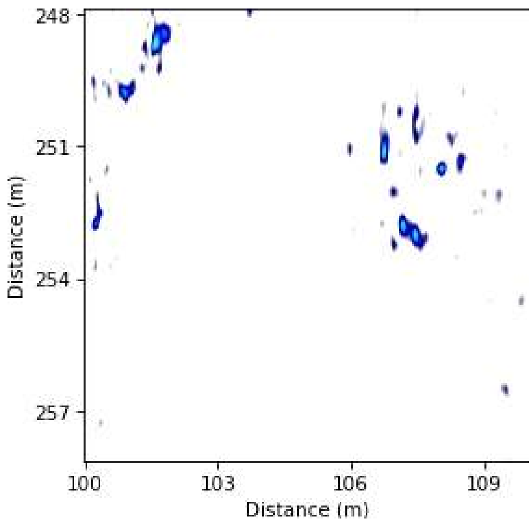
(c) Timeslice at z = 1.6 m.



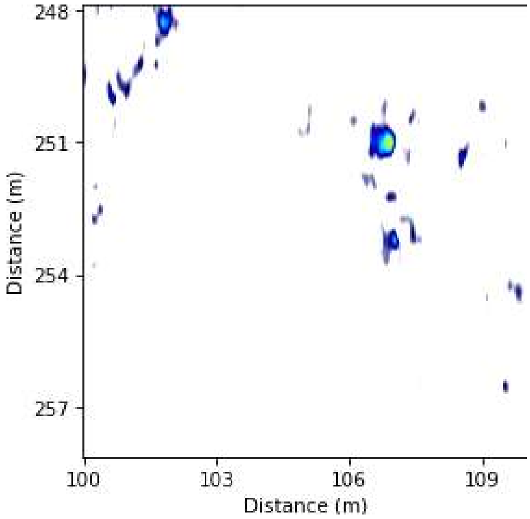
(d) Timeslice at z = 1.65 m.



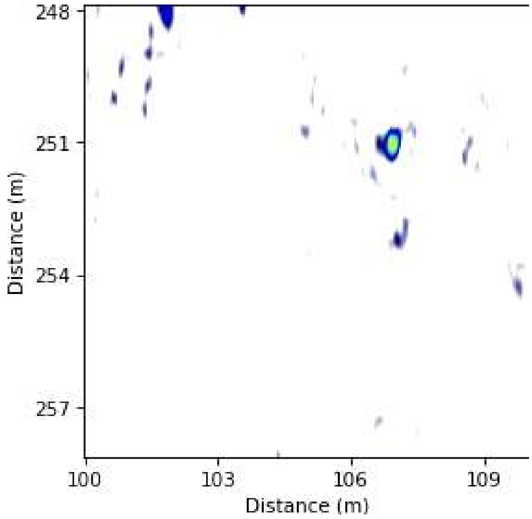
(e) Timeslice at z = 1.7 m.



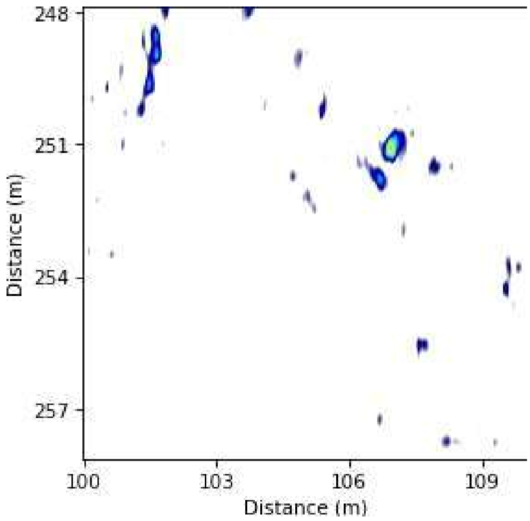
(f) Timeslice at z = 1.75 m.



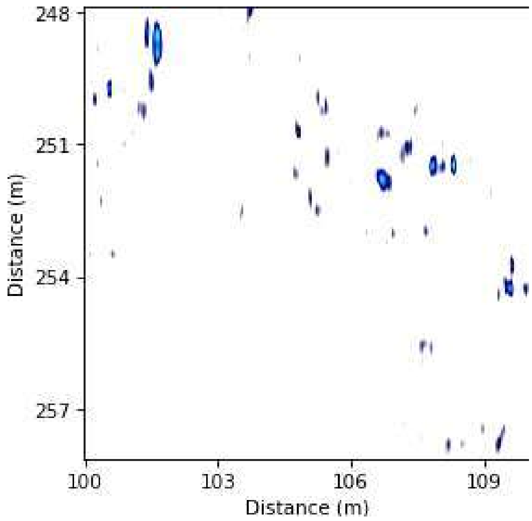
(a) Timeslice at z = 1.8 m.



(b) Timeslice at z = 1.85 m.



(c) Timeslice at z = 1.9 m.



(d) Timeslice at z = 1.95 m.

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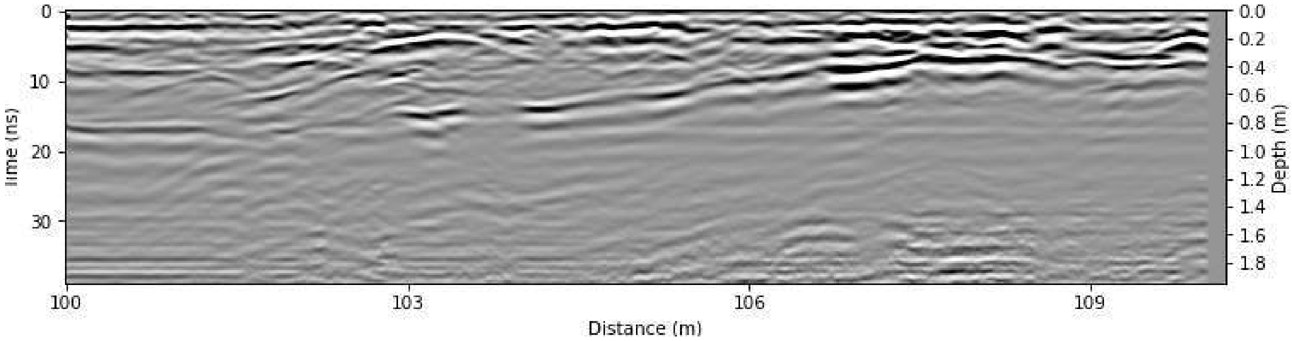


Figure A.145: Radargram at x = 276.0 m.

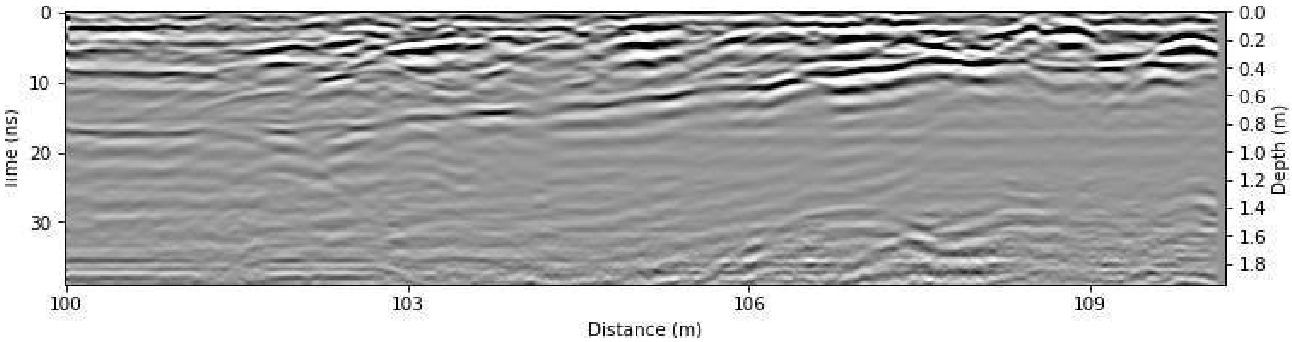


Figure A.146: Radargram at x = 276.25 m.

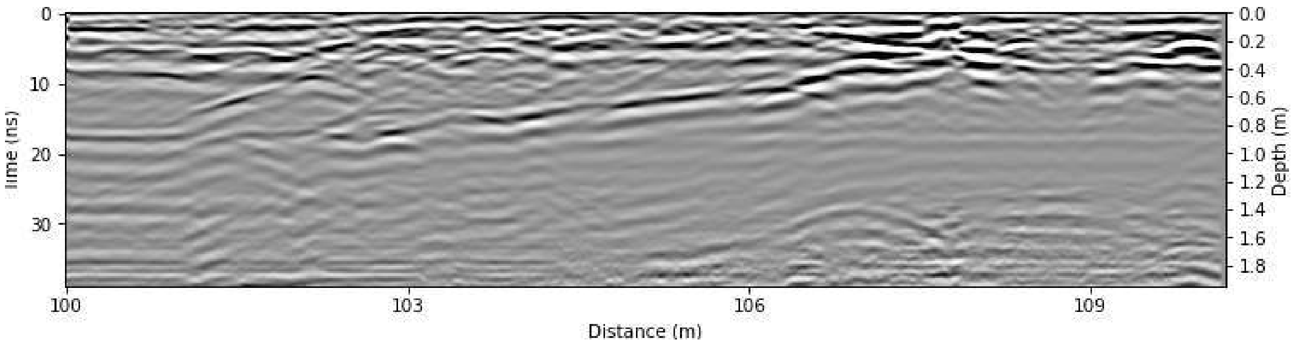


Figure A.147: Radargram at x = 276.5 m.

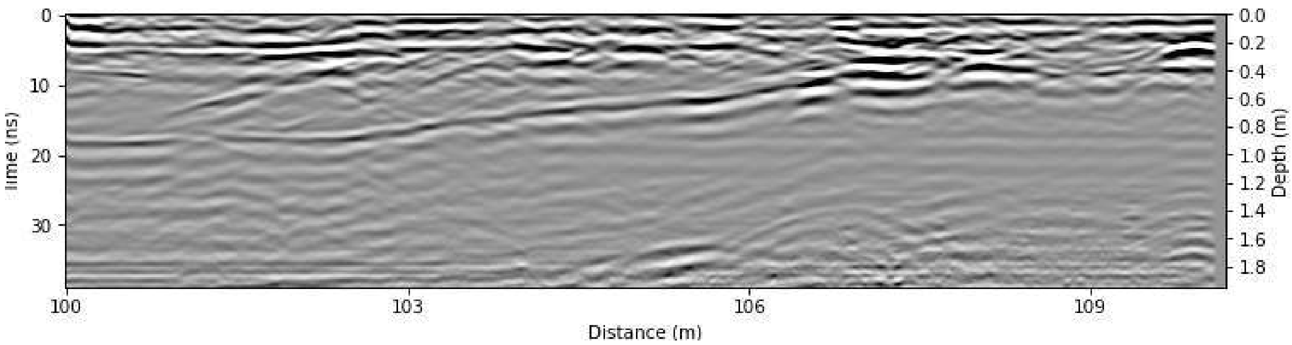


Figure A.148: Radargram at x = 276.75 m.

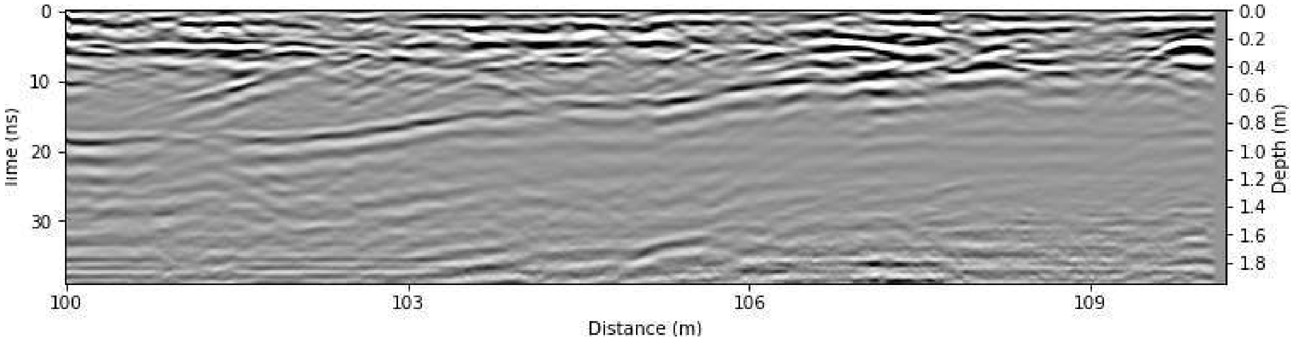


Figure A.149: Radargram at x = 277.0 m.

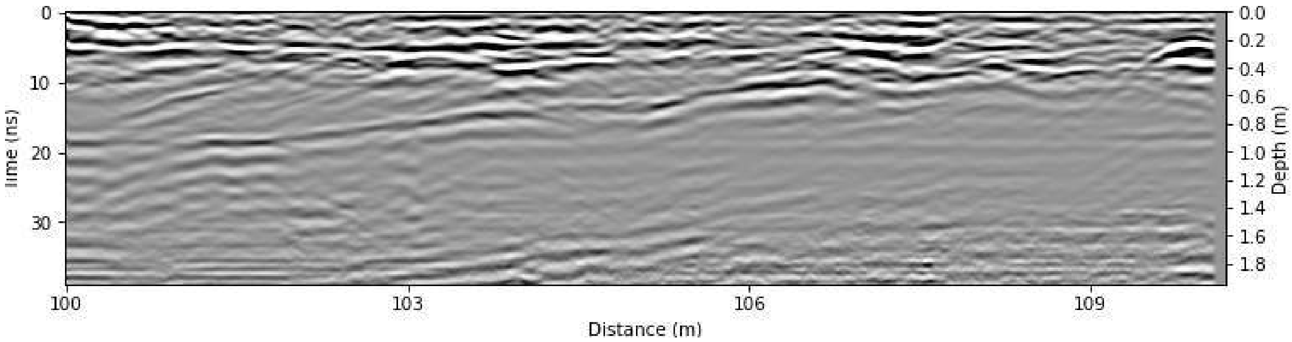


Figure A.150: Radargram at x = 277.25 m.

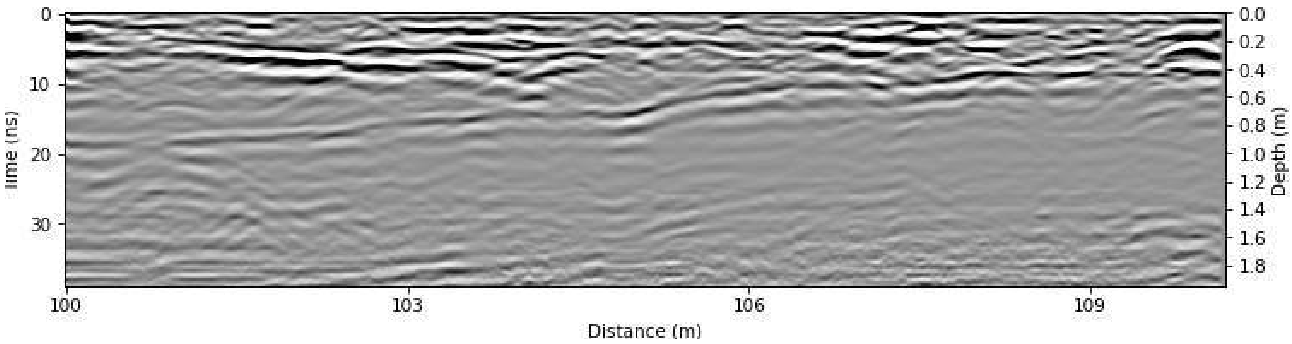


Figure A.151: Radargram at x = 277.5 m.

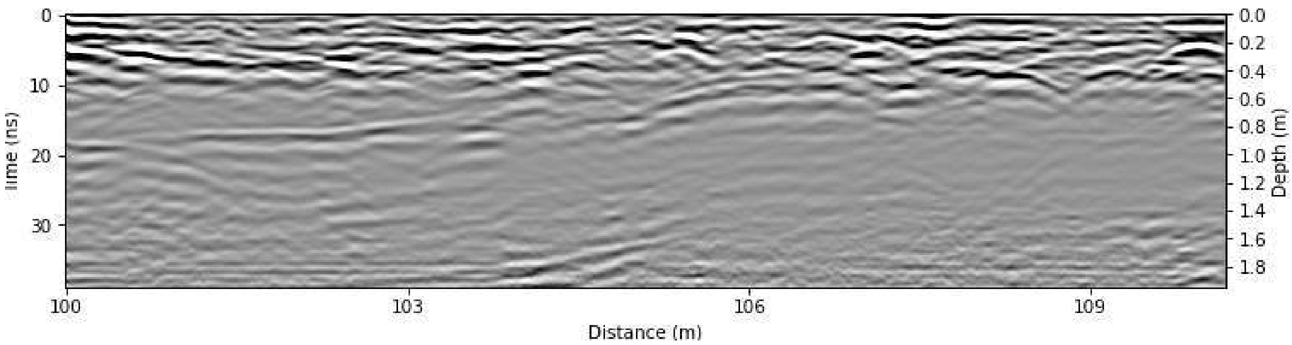


Figure A.152: Radargram at x = 277.75 m.

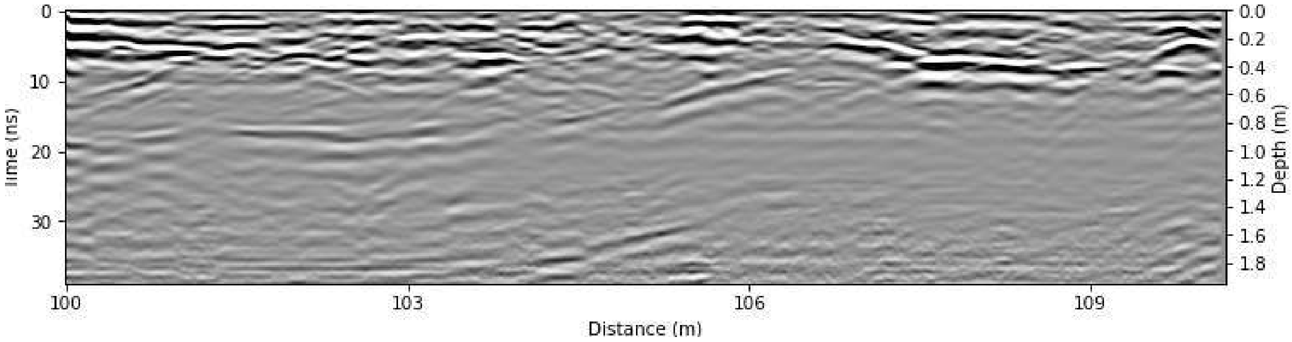


Figure A.153: Radargram at x = 278.0 m.

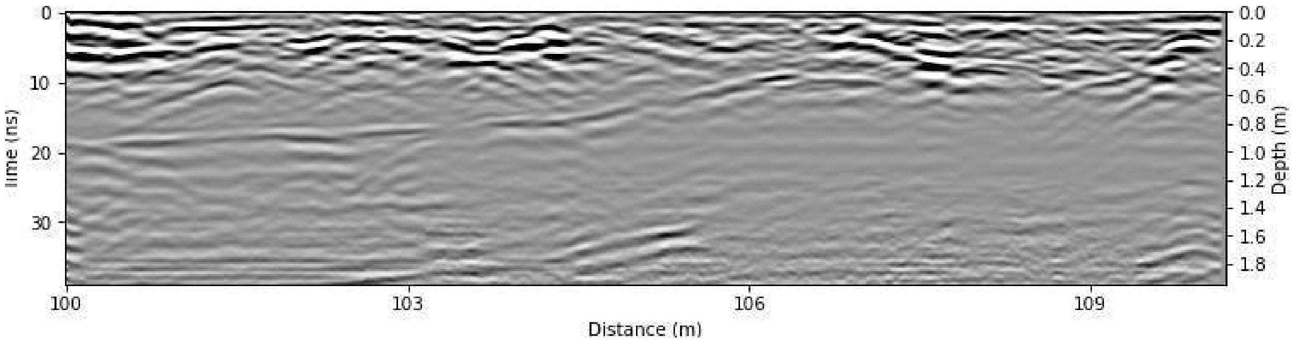


Figure A.154: Radargram at x = 278.25 m.

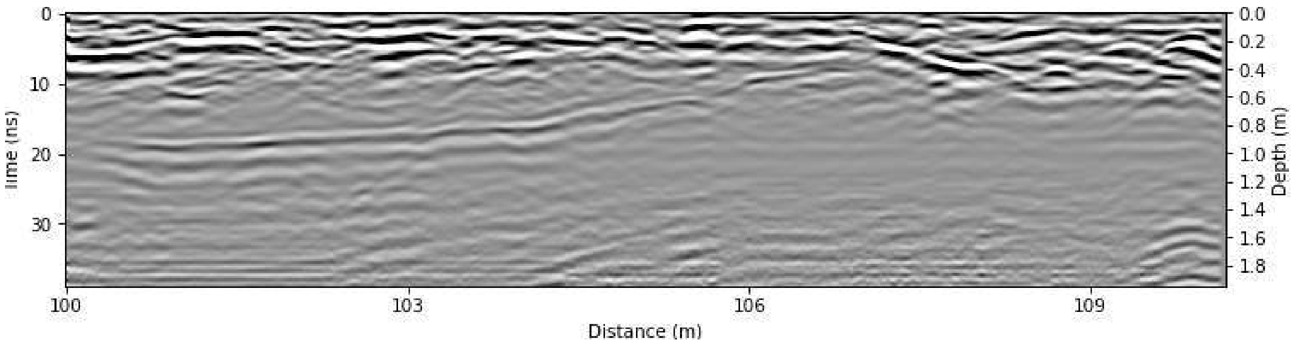


Figure A.155: Radargram at x = 278.5 m.

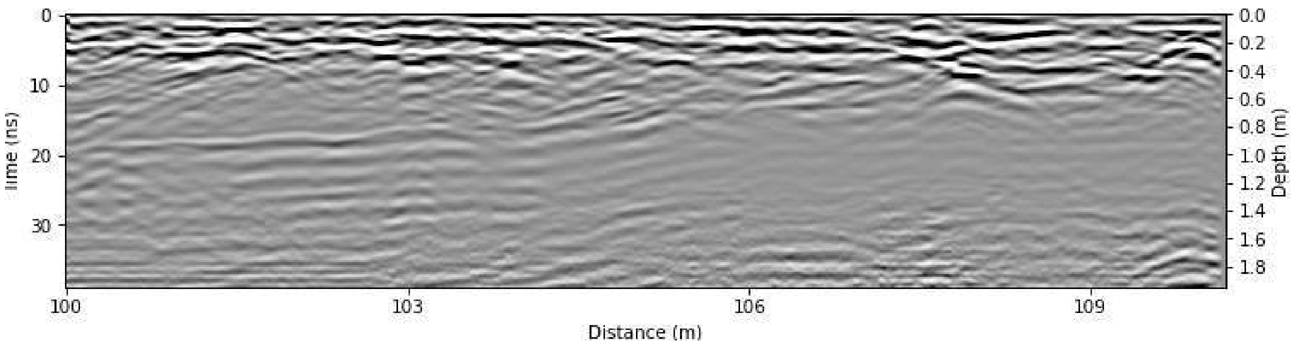


Figure A.156: Radargram at x = 278.75 m.

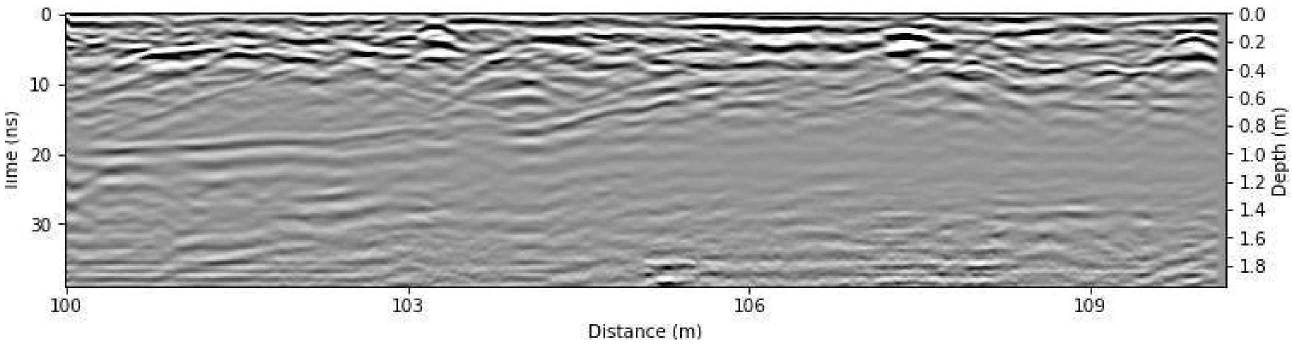


Figure A.157: Radargram at x = 279.0 m.

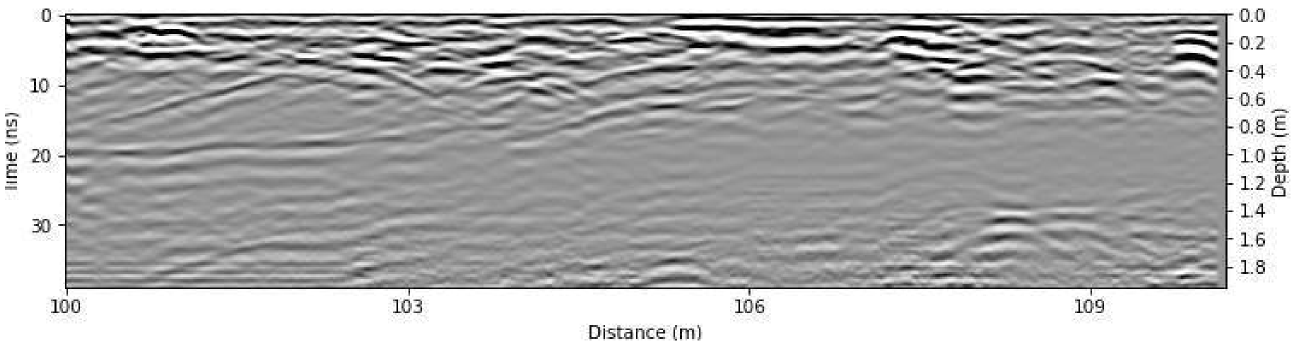


Figure A.158: Radargram at x = 279.25 m.

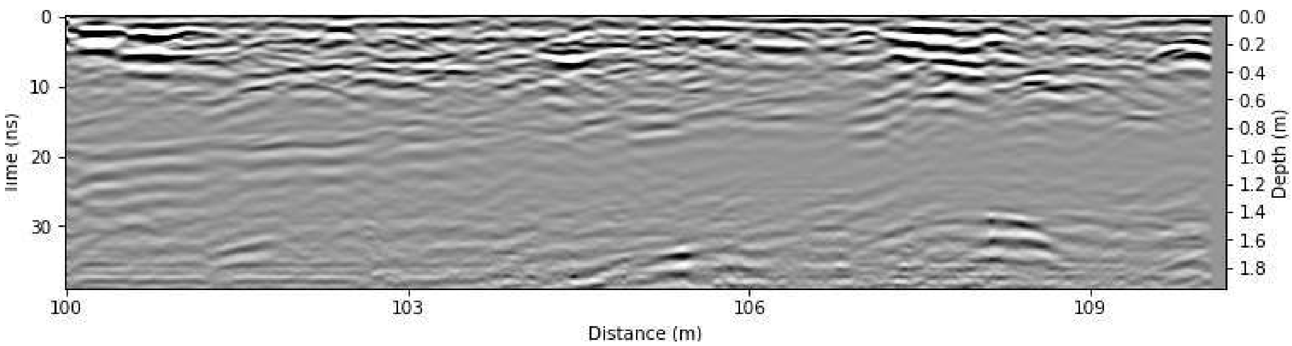


Figure A.159: Radargram at x = 279.5 m.

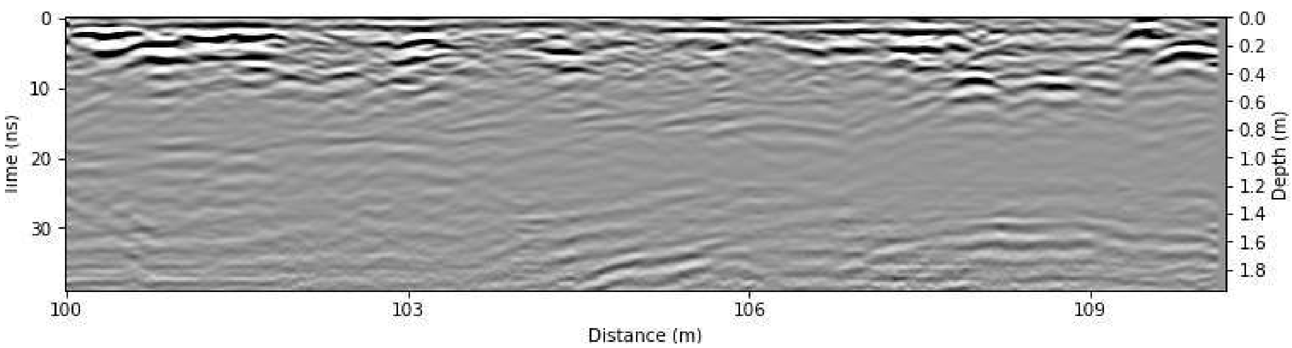


Figure A.160: Radargram at x = 279.75 m.

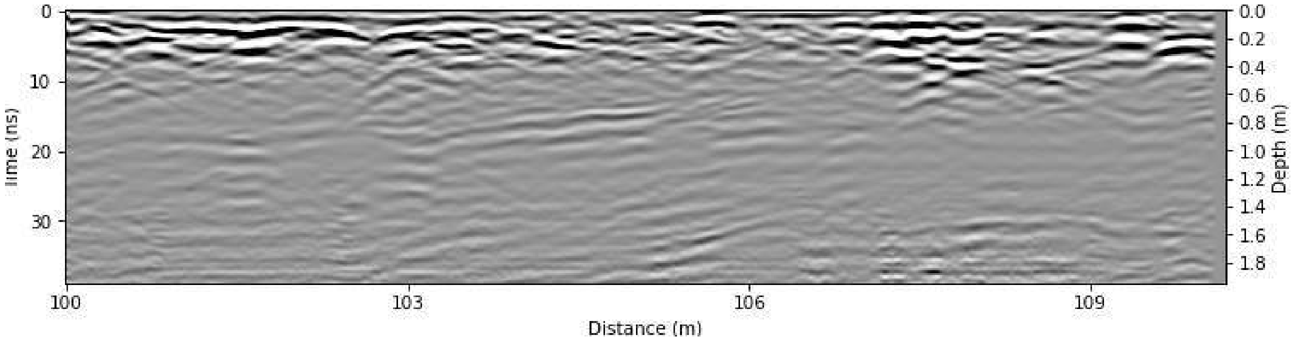


Figure A.161: Radargram at x = 280.0 m.

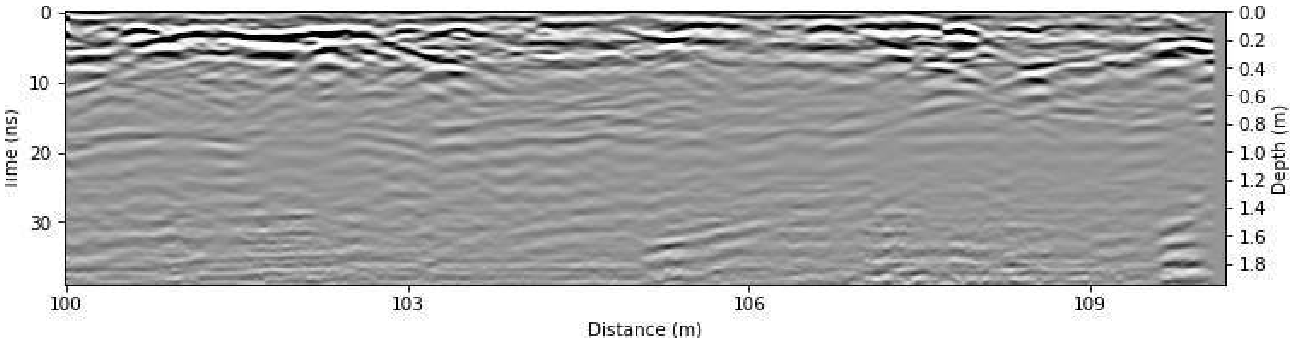


Figure A.162: Radargram at x = 280.25 m.

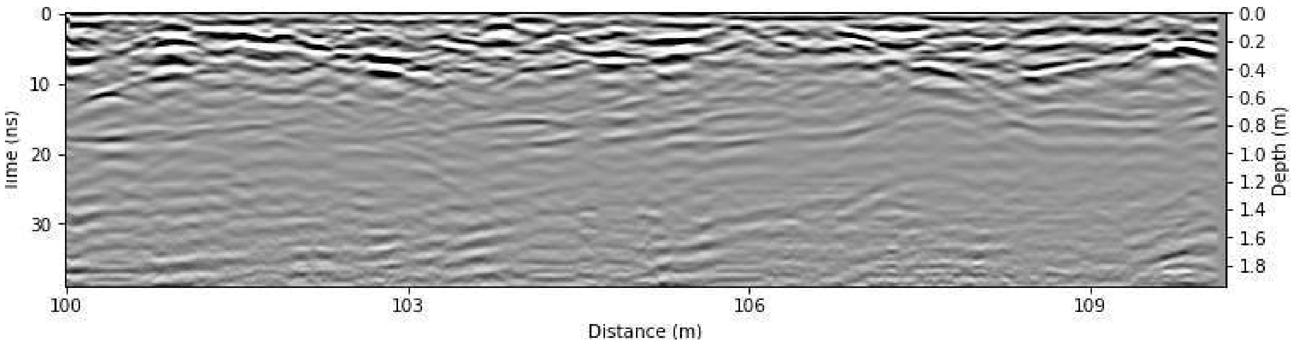


Figure A.163: Radargram at x = 280.5 m.

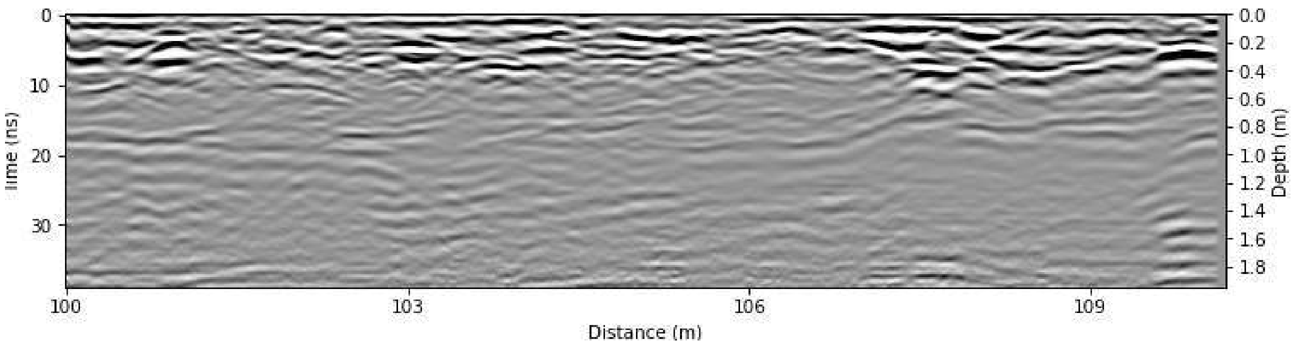


Figure A.164: Radargram at x = 280.75 m.

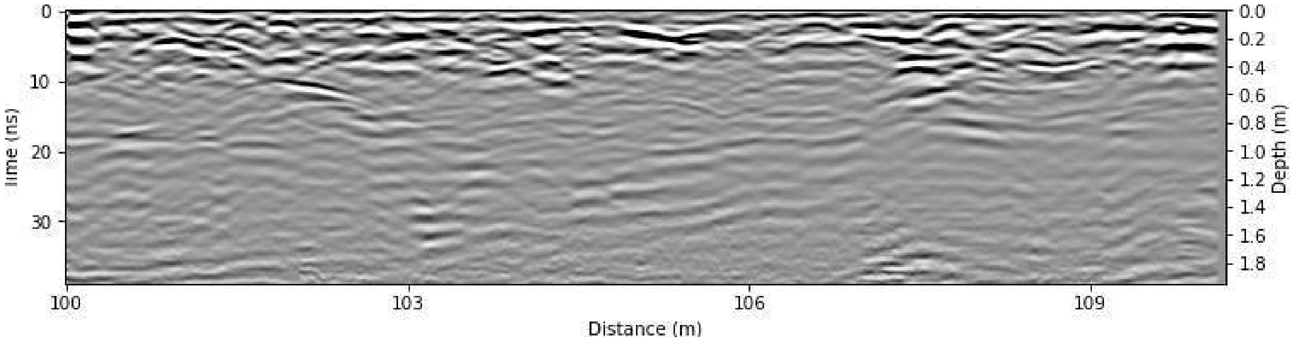


Figure A.165: Radargram at x = 281.0 m.

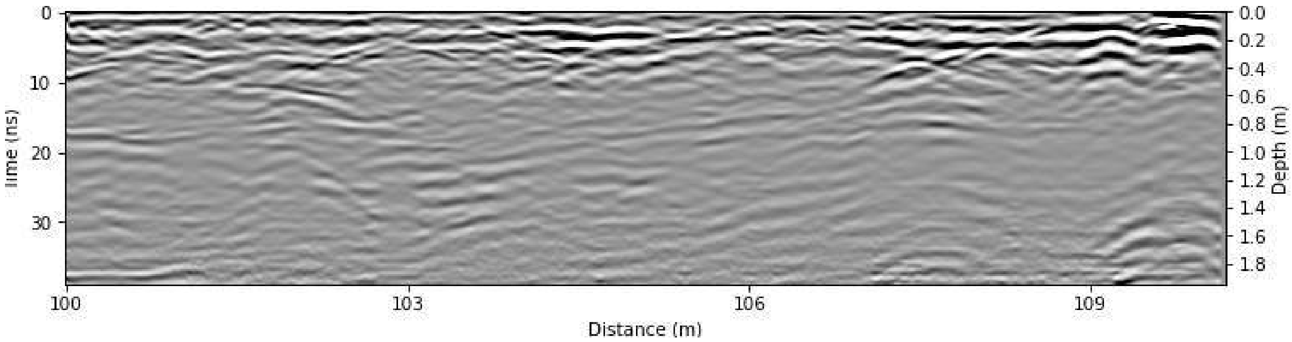


Figure A.166: Radargram at x = 281.25 m.

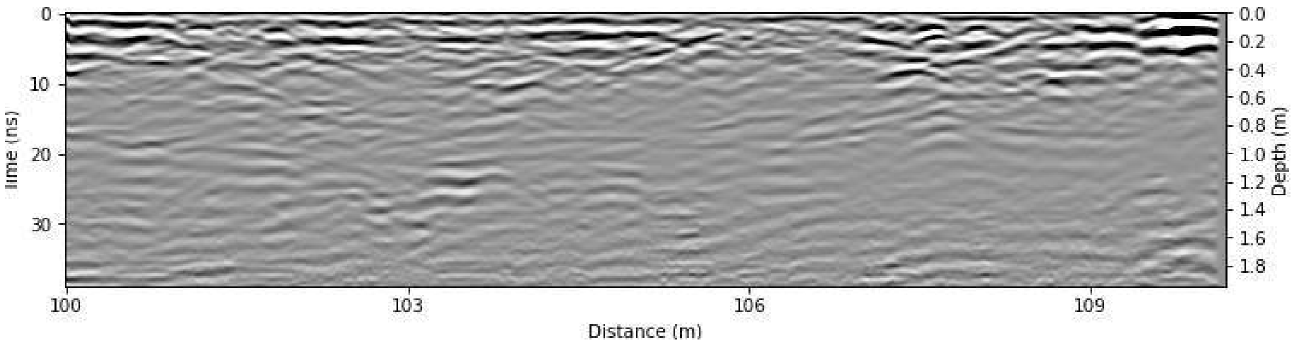


Figure A.167: Radargram at x = 281.5 m.

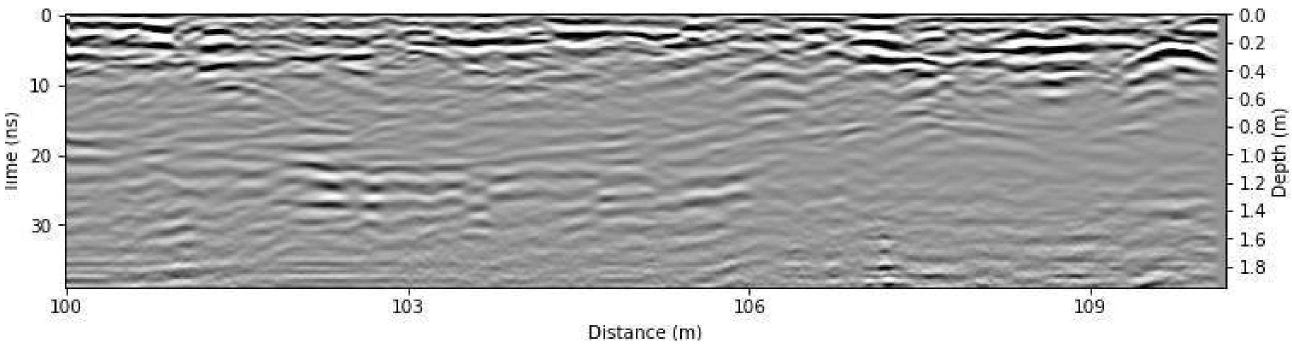


Figure A.168: Radargram at x = 281.75 m.

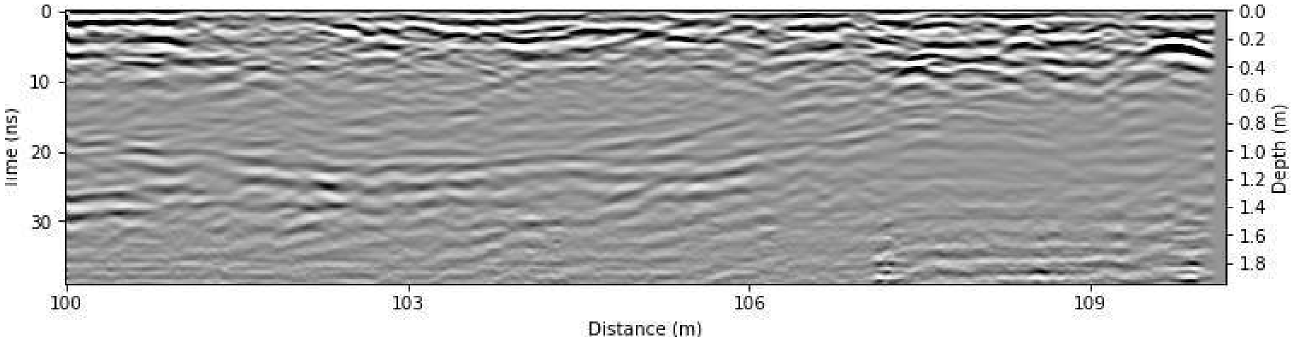


Figure A.169: Radargram at x = 282.0 m.

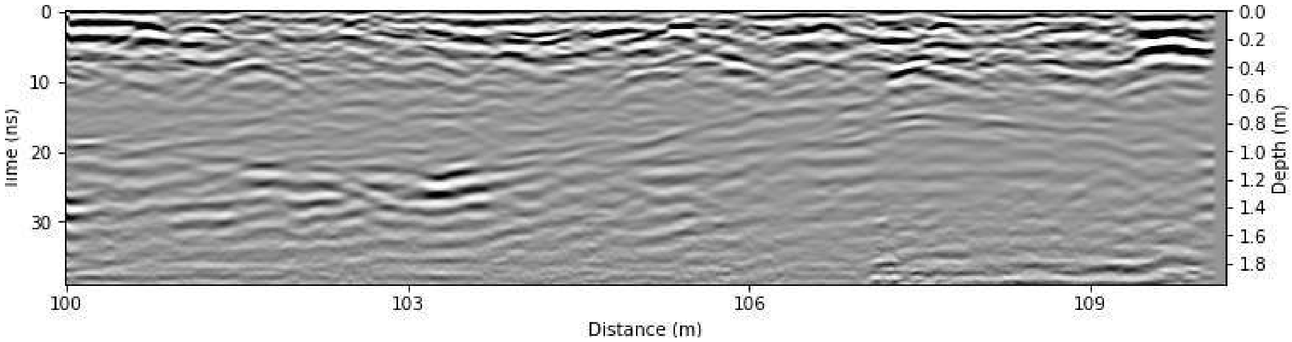


Figure A.170: Radargram at x = 282.25 m.

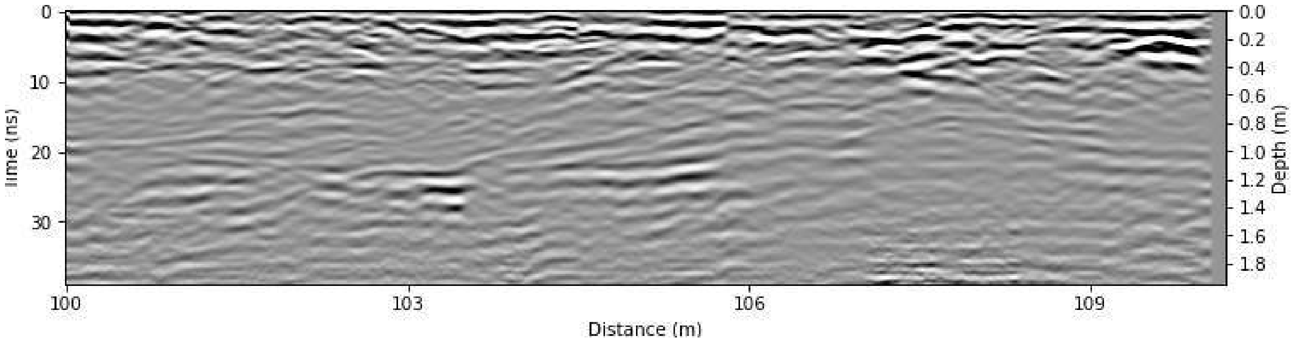


Figure A.171: Radargram at x = 282.5 m.

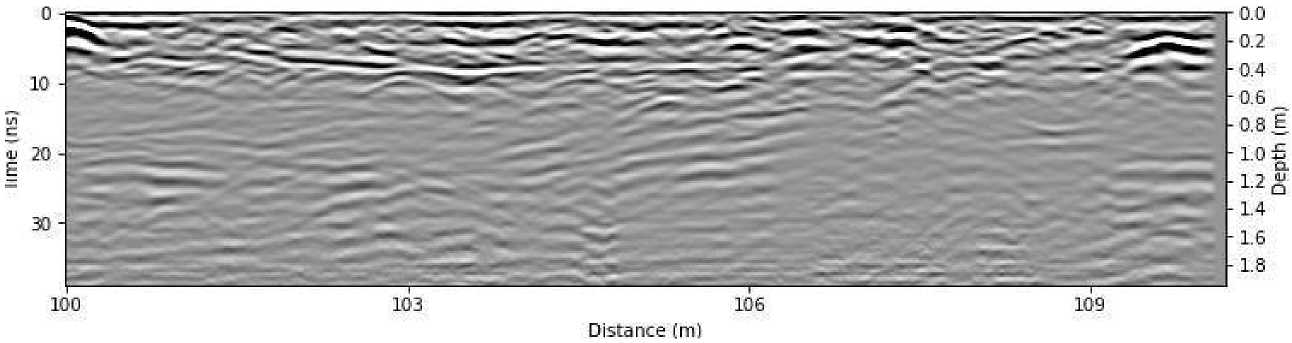


Figure A.172: Radargram at x = 282.75 m.

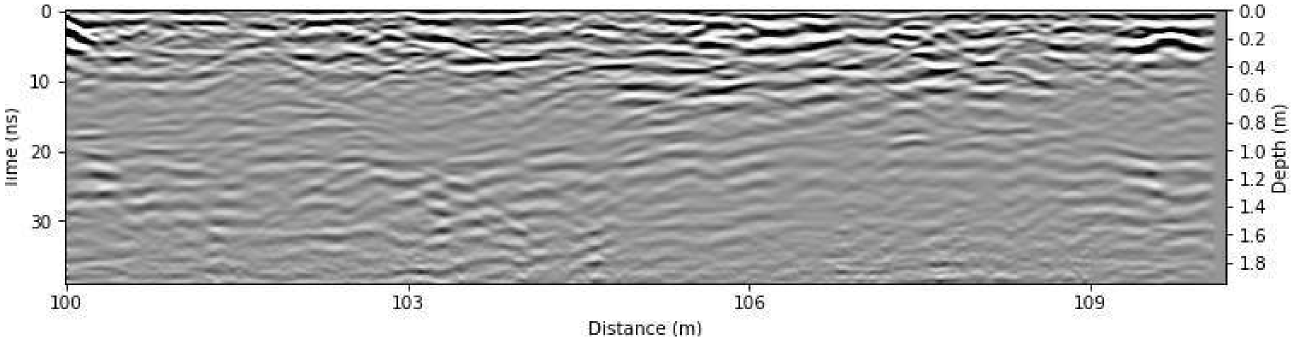


Figure A.173: Radargram at x = 283.0 m.

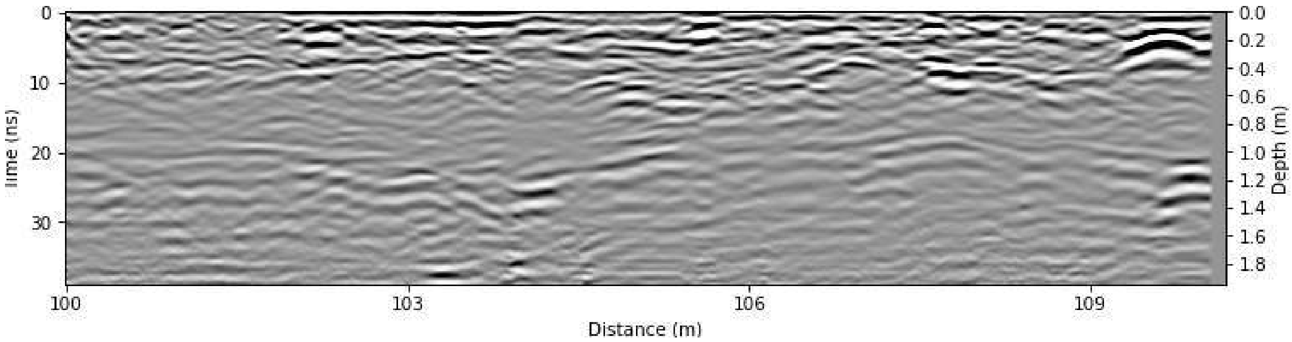


Figure A.174: Radargram at x = 283.25 m.

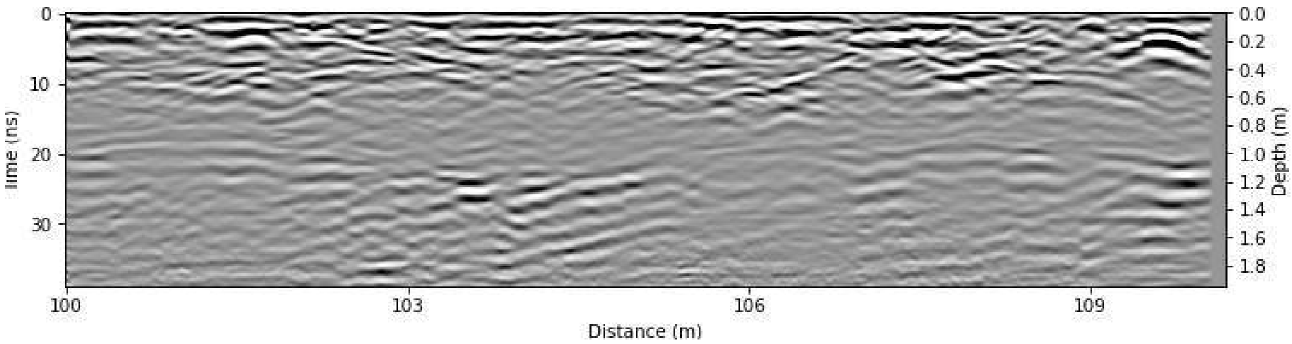


Figure A.175: Radargram at x = 283.5 m.

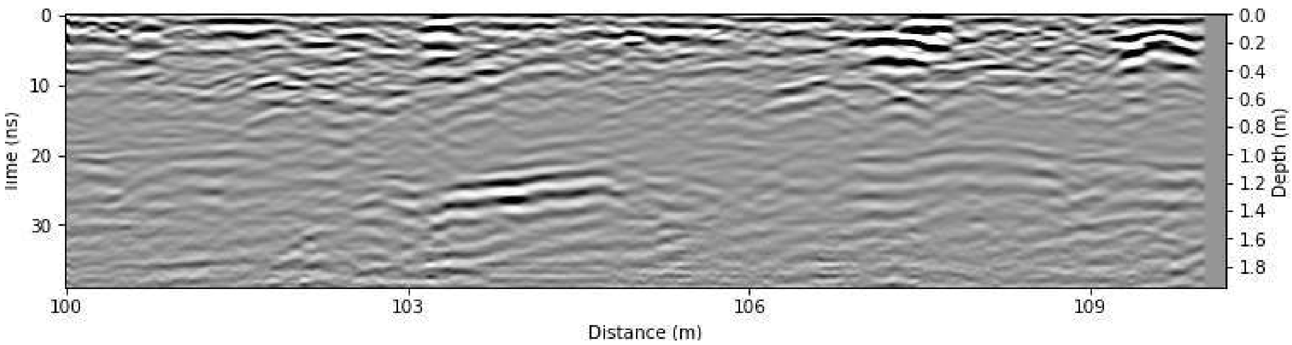


Figure A.176: Radargram at x = 283.75 m.

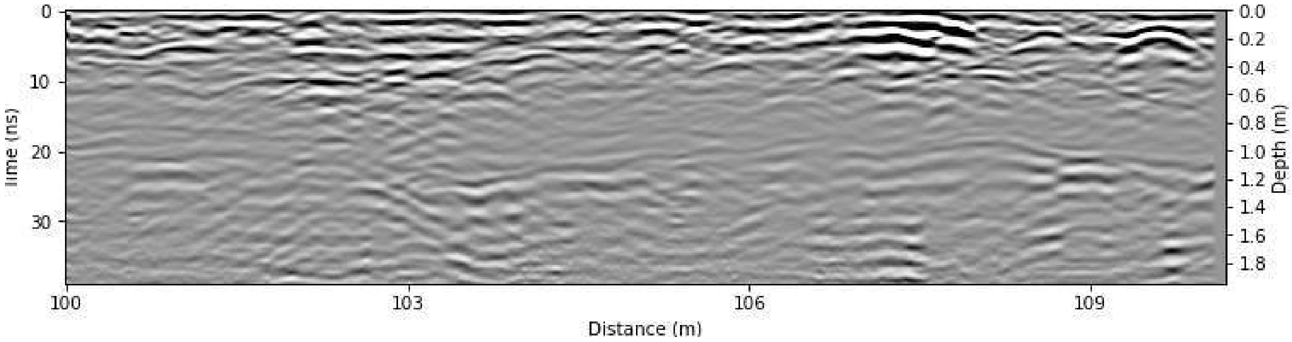


Figure A.177: Radargram at x = 284.0 m.

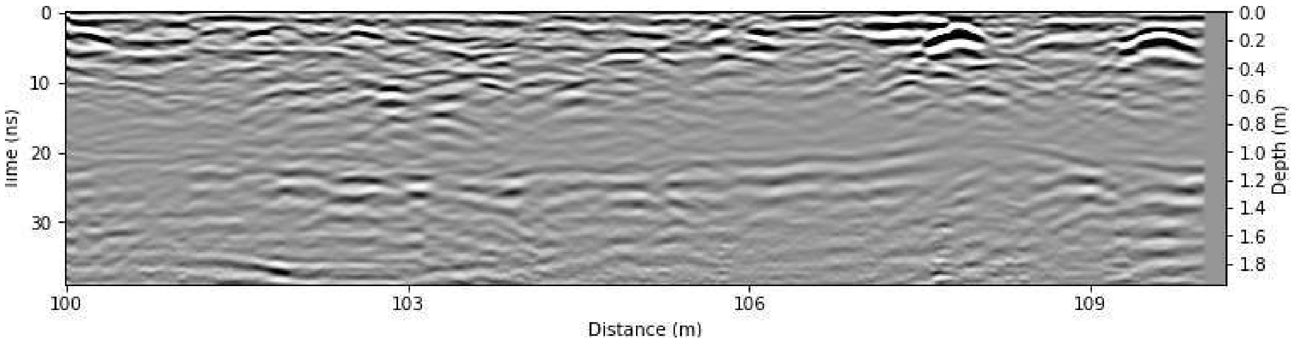


Figure A.178: Radargram at x = 284.25 m.

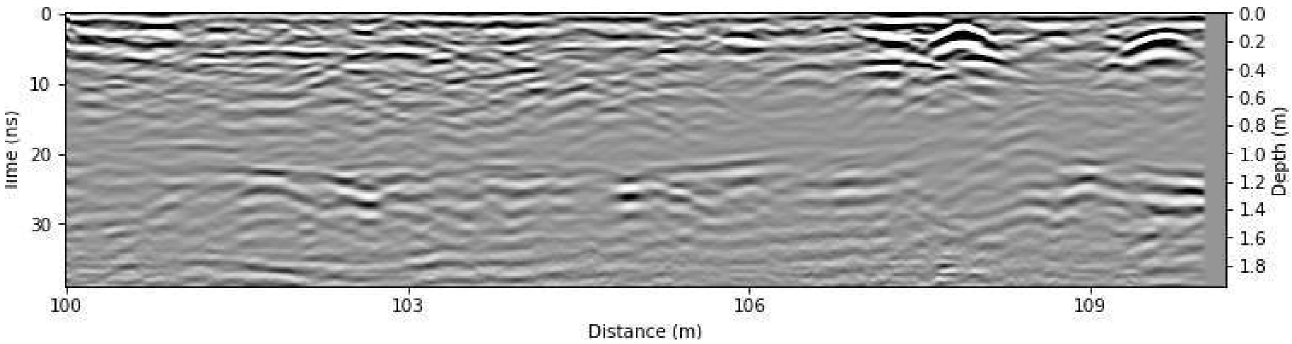


Figure A.179: Radargram at x = 284.5 m.

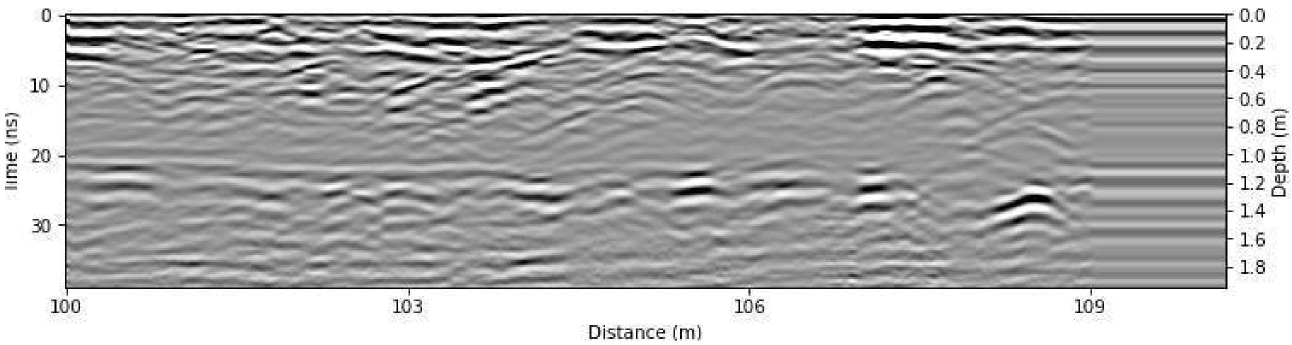


Figure A.180: Radargram at x = 284.75 m.

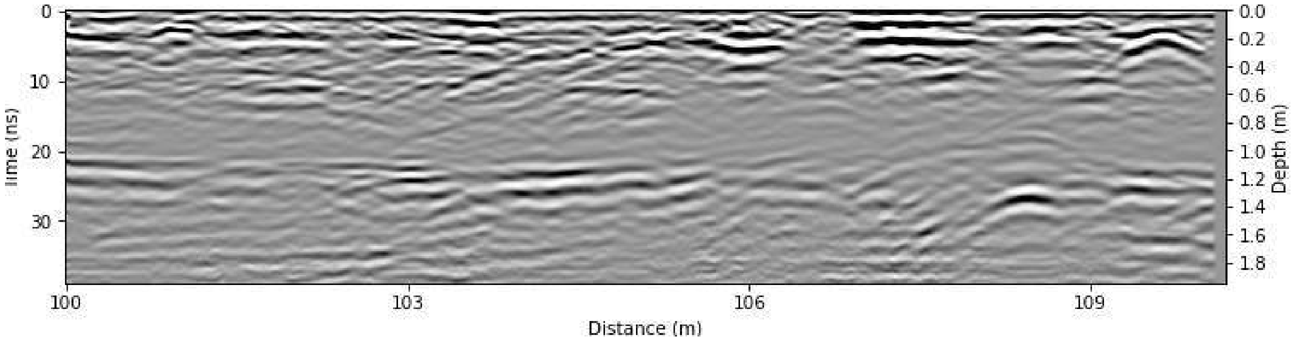


Figure A.181: Radargram at x = 285.0 m.

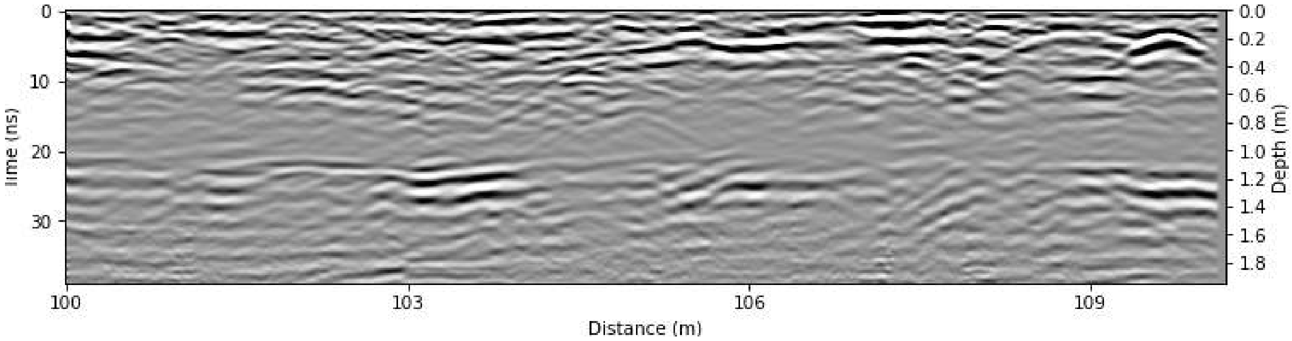


Figure A.182: Radargram at x = 285.25 m.

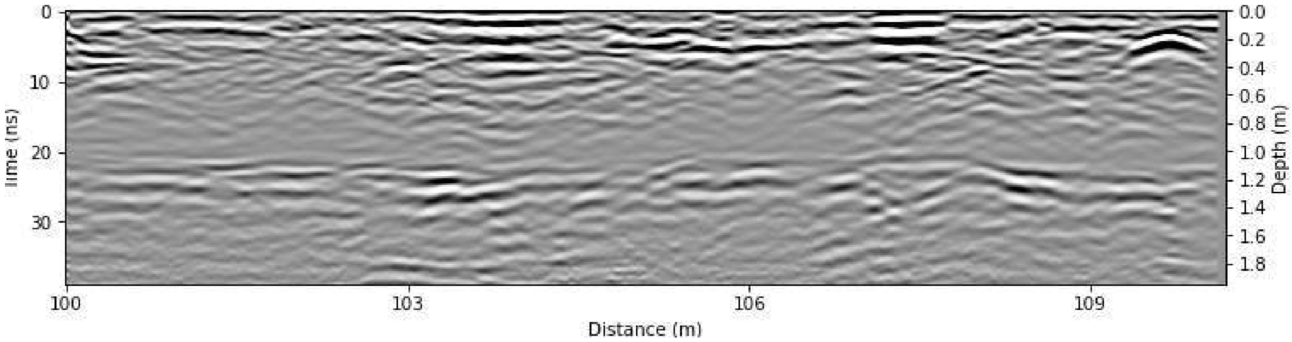


Figure A.183: Radargram at x = 285.5 m.

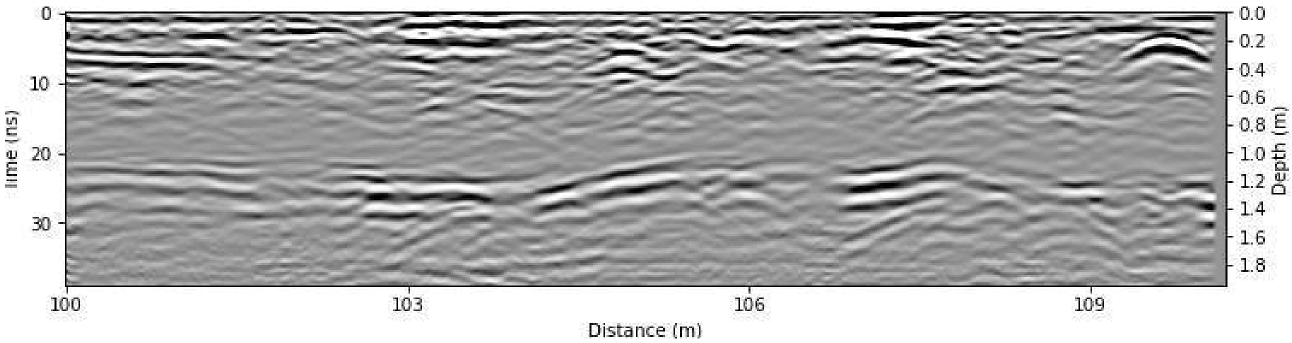


Figure A.184: Radargram at x = 285.75 m.

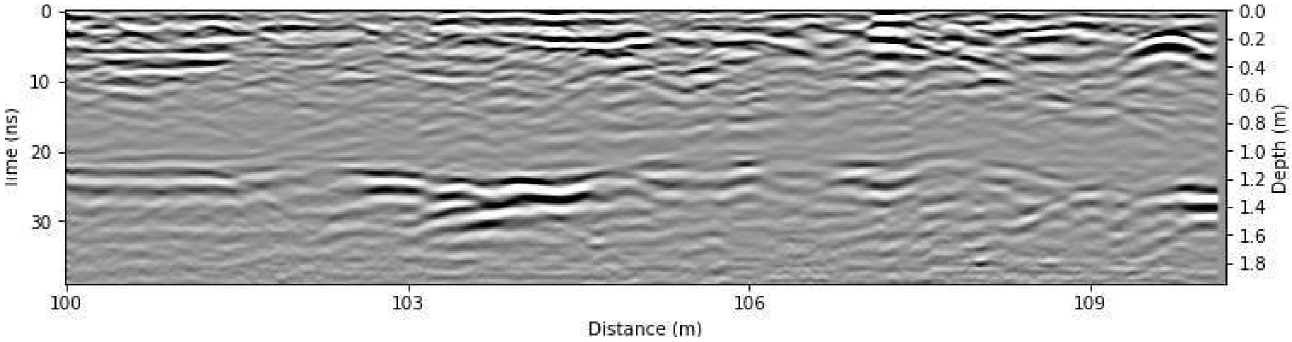
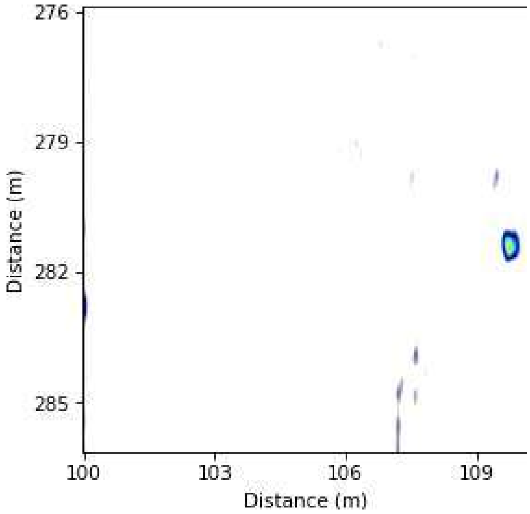
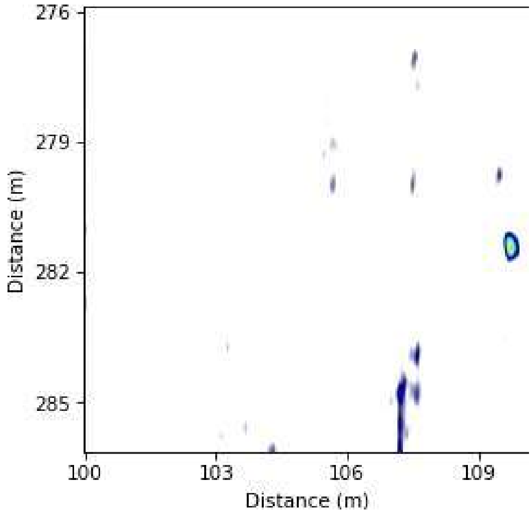


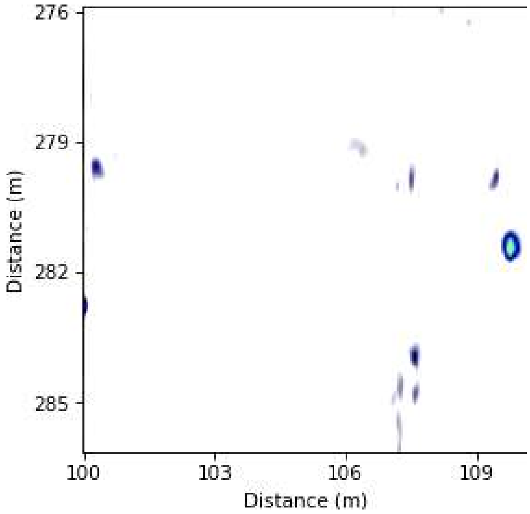
Figure A.185: Radargram at x = 286.0 m.



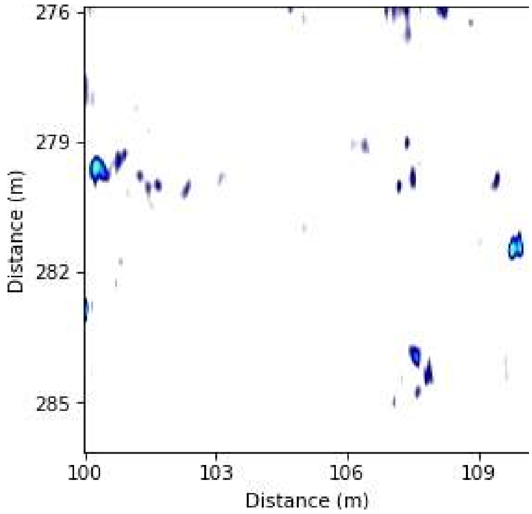
(a) Timeslice at z = 0.0 m.



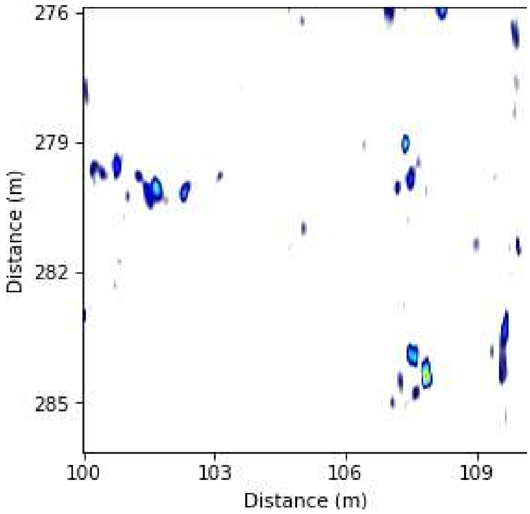
(b) Timeslice at z = 0.05 m.



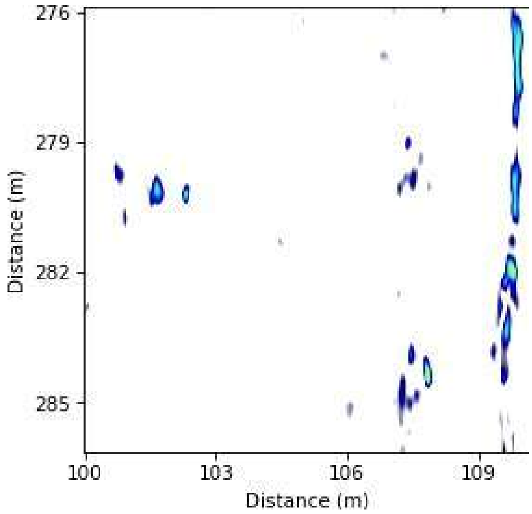
(c) Timeslice at z = 0.1 m.



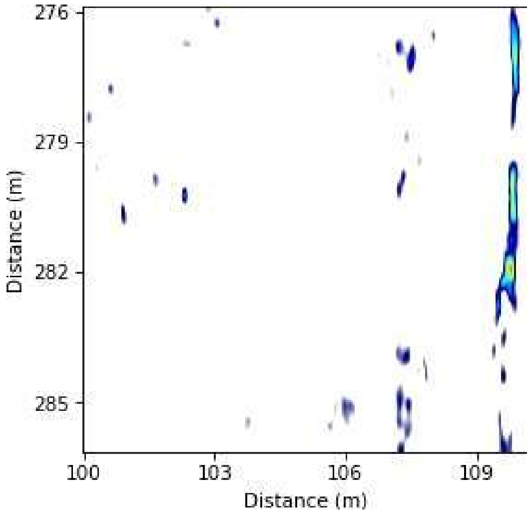
(d) Timeslice at z = 0.15 m.



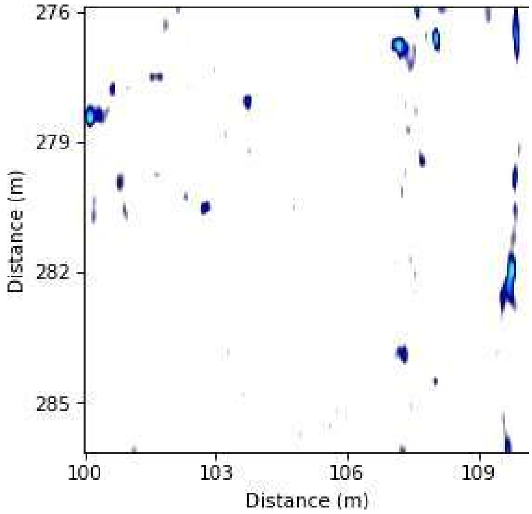
(e) Timeslice at z = 0.2 m.



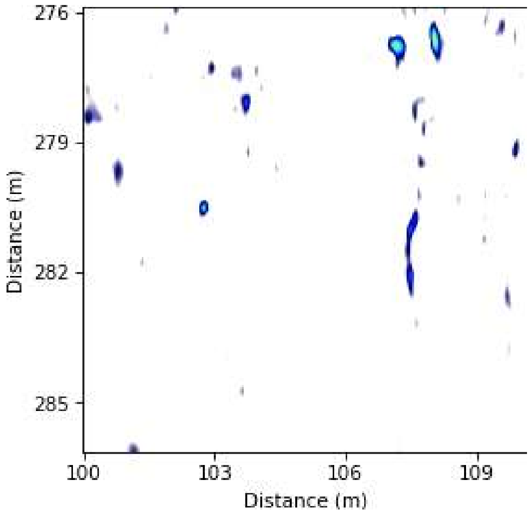
(f) Timeslice at z = 0.25 m.



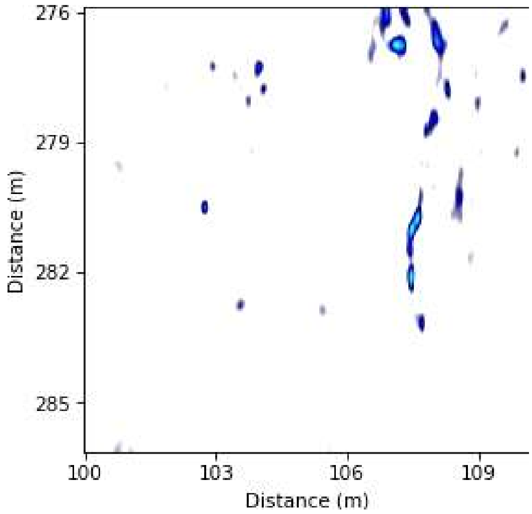
(a) Timeslice at z = 0.3 m.



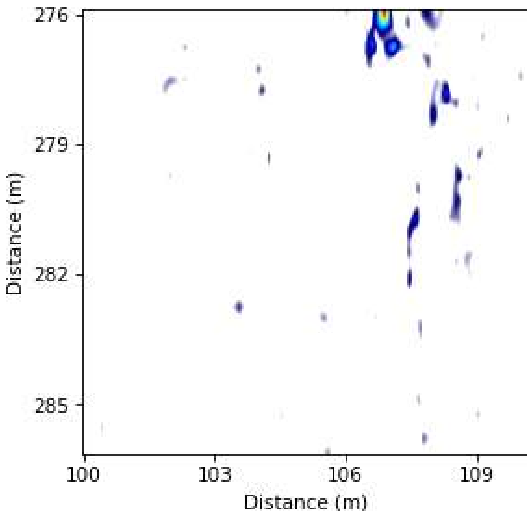
(b) Timeslice at z = 0.35 m.



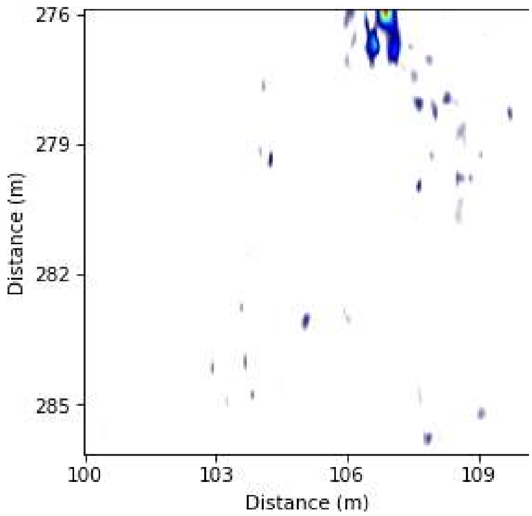
(c) Timeslice at z = 0.4 m.



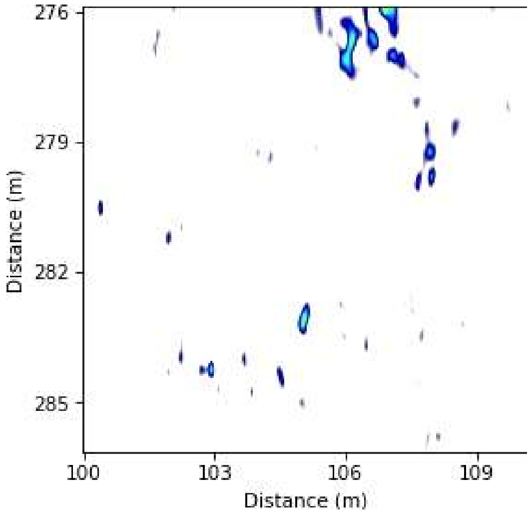
(d) Timeslice at z = 0.45 m.



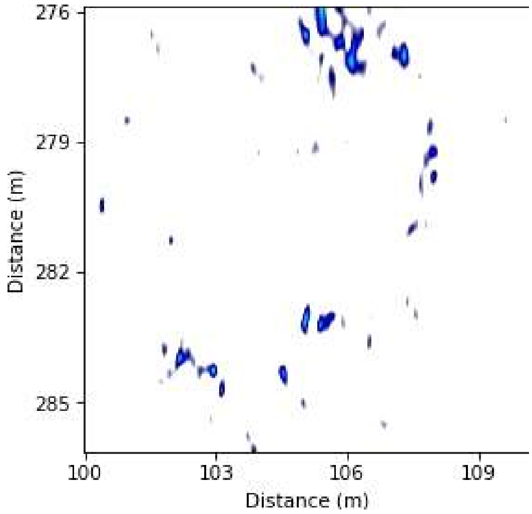
(e) Timeslice at z = 0.5 m.



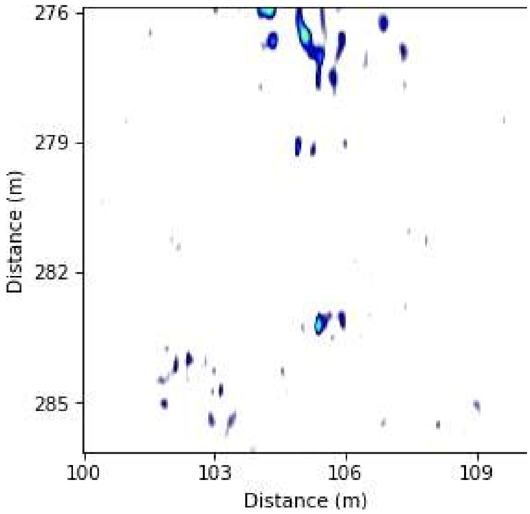
(f) Timeslice at z = 0.55 m.



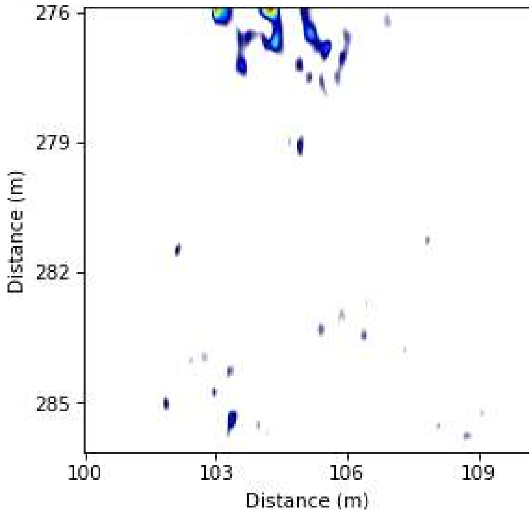
(a) Timeslice at z = 0.6 m.



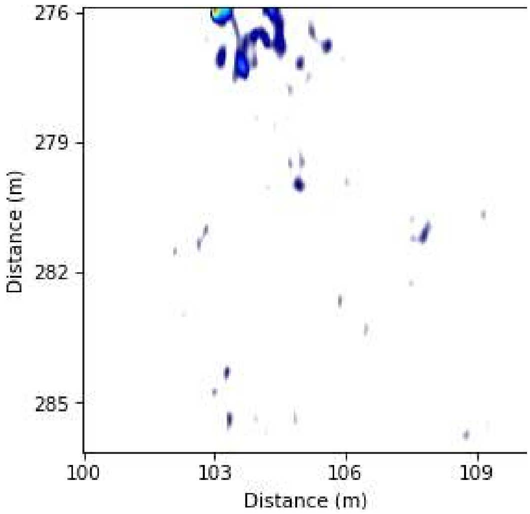
(b) Timeslice at z = 0.65 m.



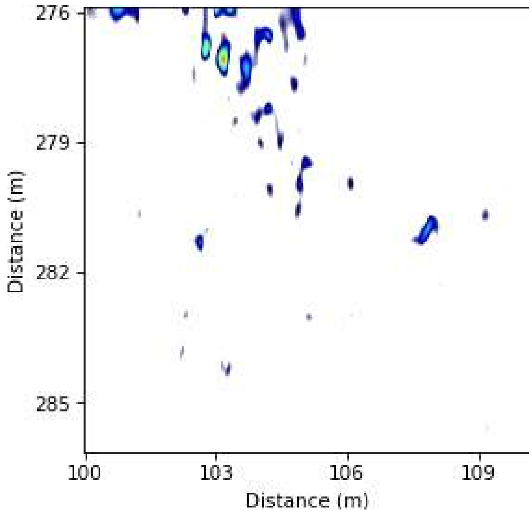
(c) Timeslice at z = 0.7 m.



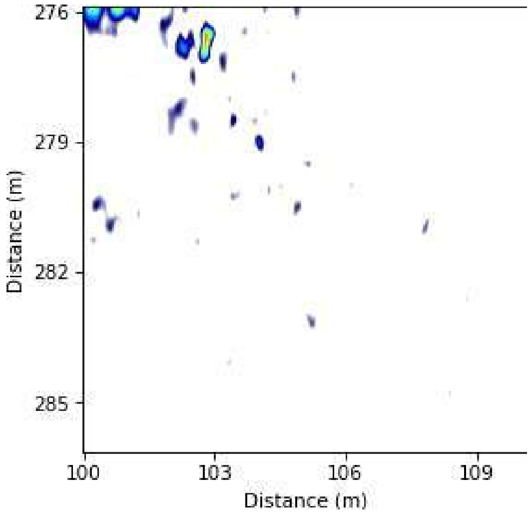
(d) Timeslice at z = 0.75 m.



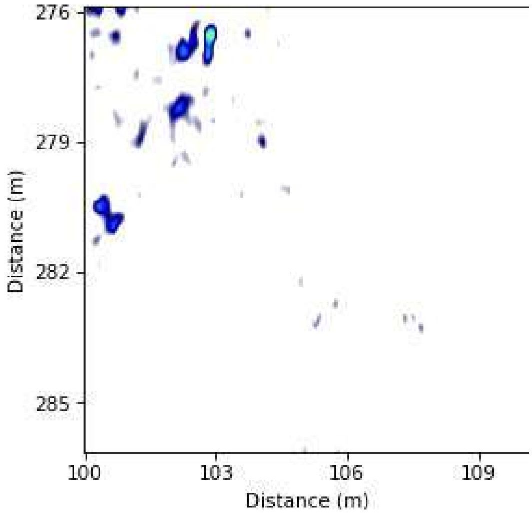
(e) Timeslice at z = 0.8 m.



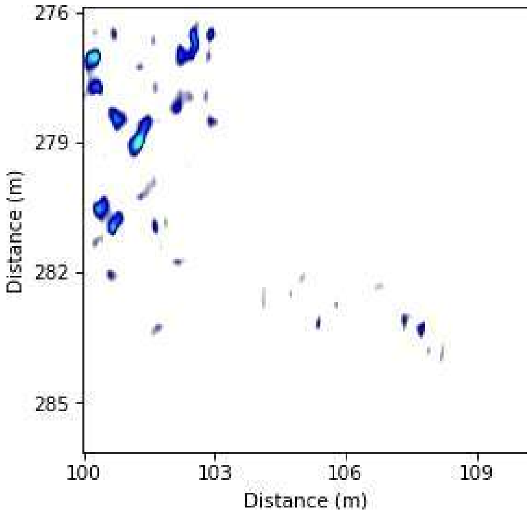
(f) Timeslice at z = 0.85 m.



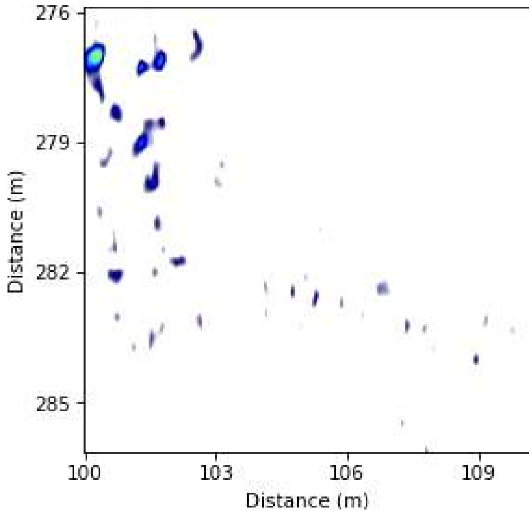
(a) Timeslice at z = 0.9 m.



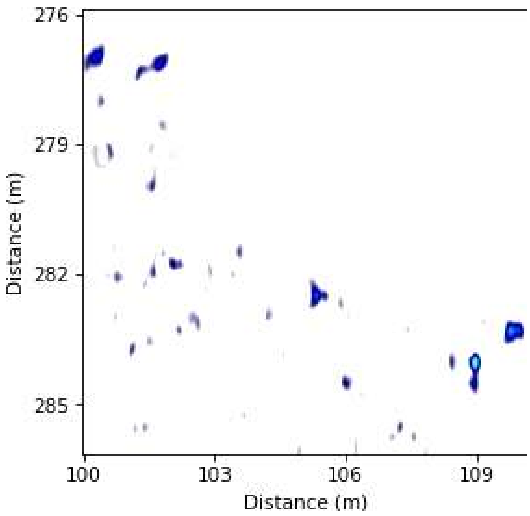
(b) Timeslice at z = 0.95 m.



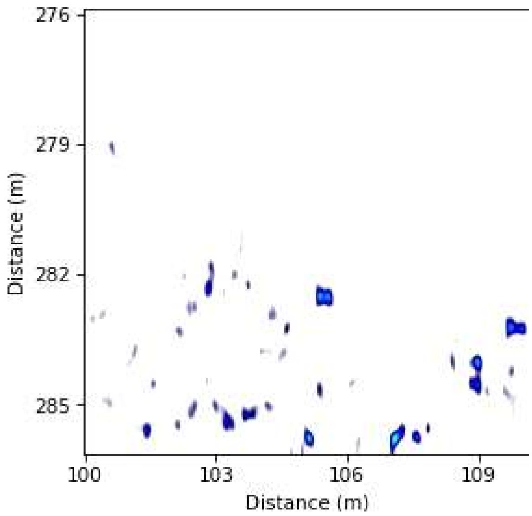
(c) Timeslice at z = 1.0 m.



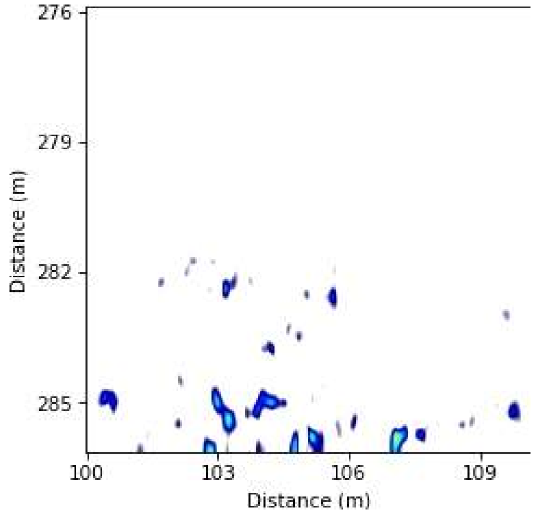
(d) Timeslice at z = 1.05 m.



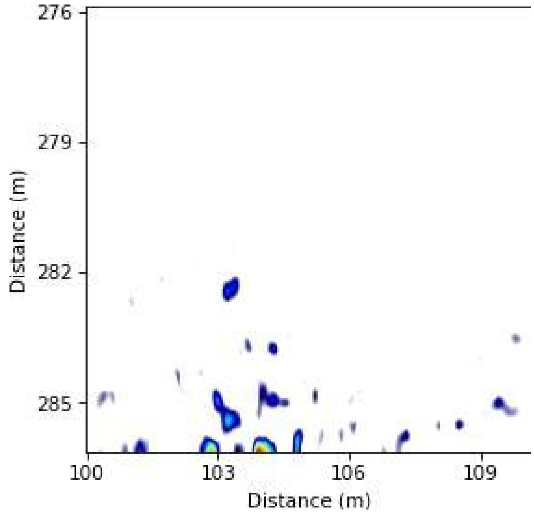
(e) Timeslice at z = 1.1 m.



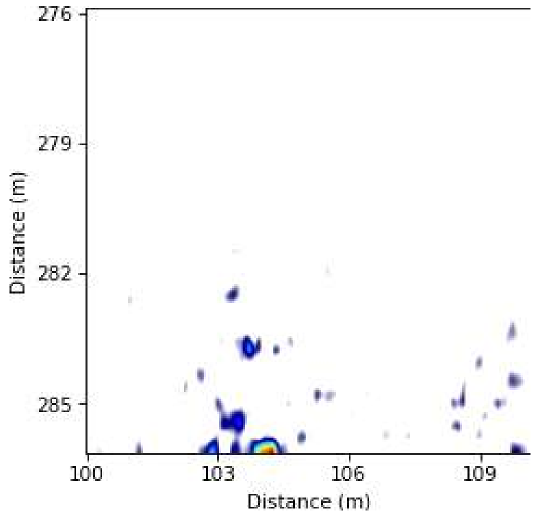
(f) Timeslice at z = 1.15 m.



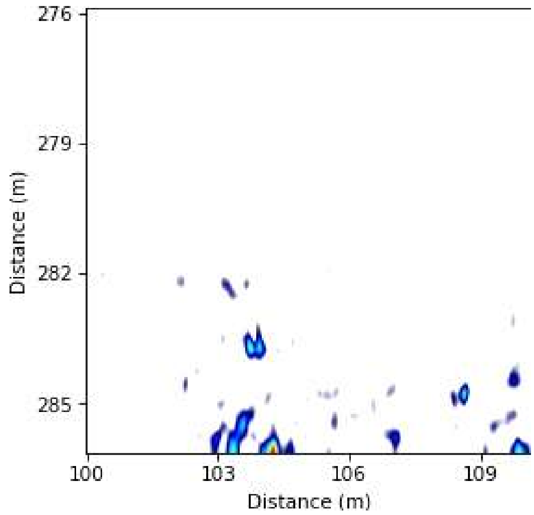
(a) Timeslice at z = 1.2 m.



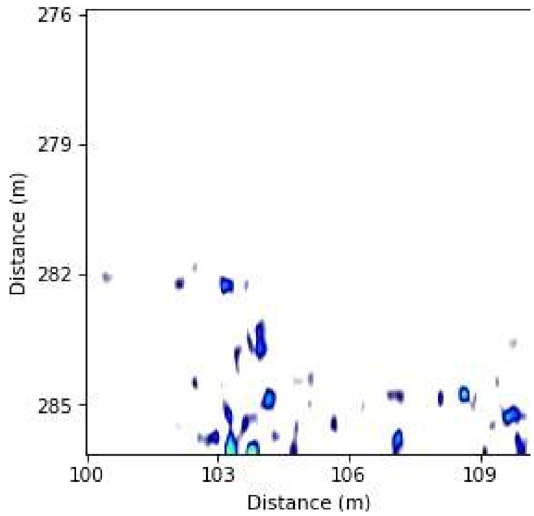
(b) Timeslice at z = 1.25 m.



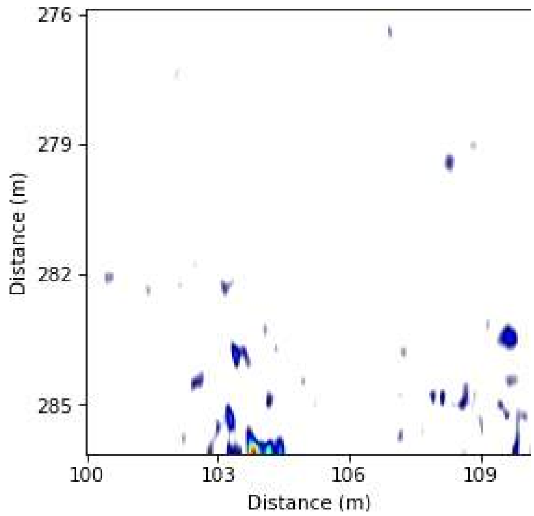
(c) Timeslice at z = 1.3 m.



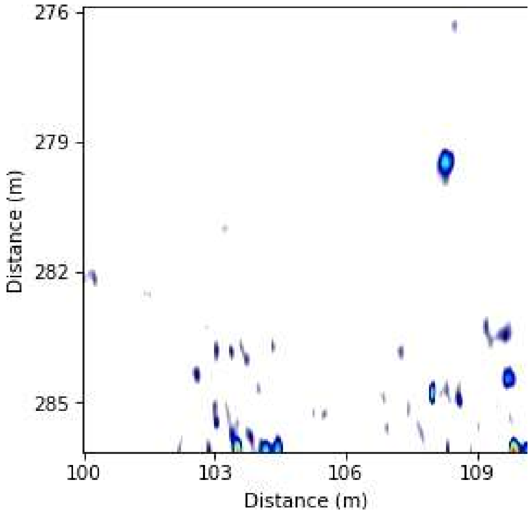
(d) Timeslice at z = 1.35 m.



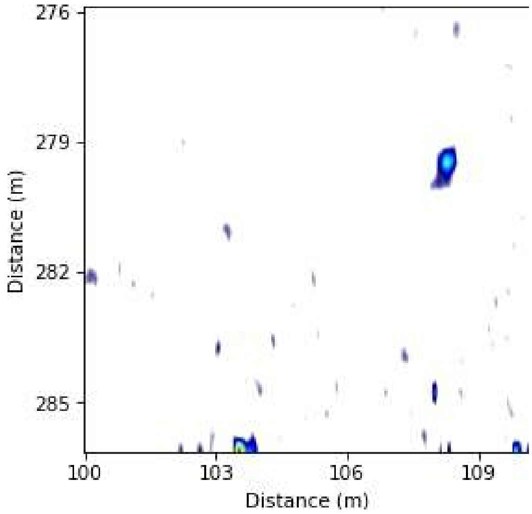
(e) Timeslice at z = 1.4 m.



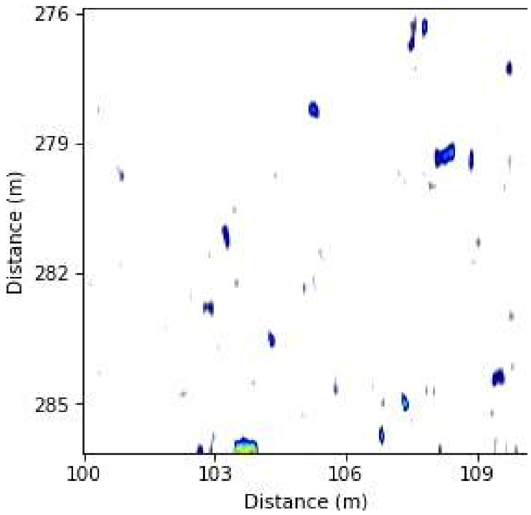
(f) Timeslice at z = 1.45 m.



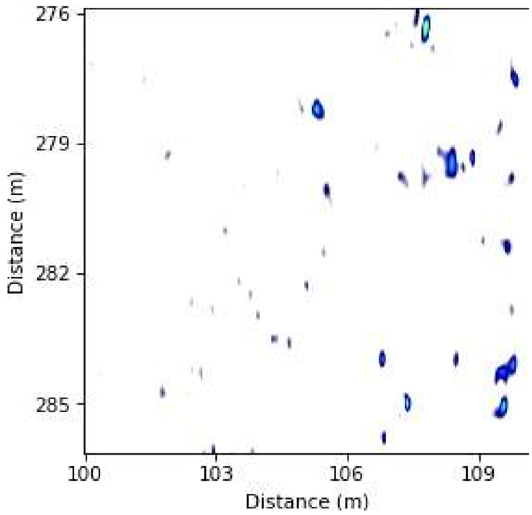
(a) Timeslice at z = 1.5 m.



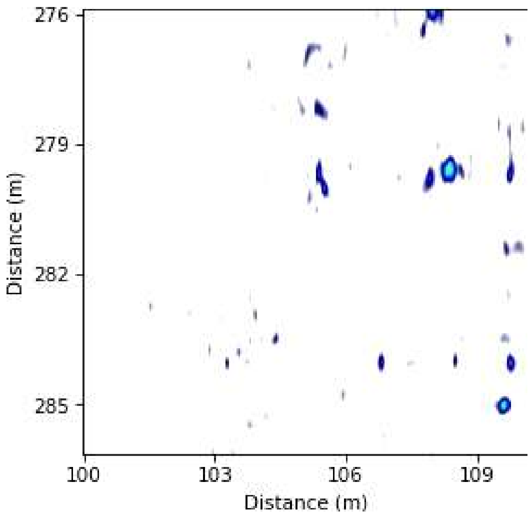
(b) Timeslice at z = 1.55 m.



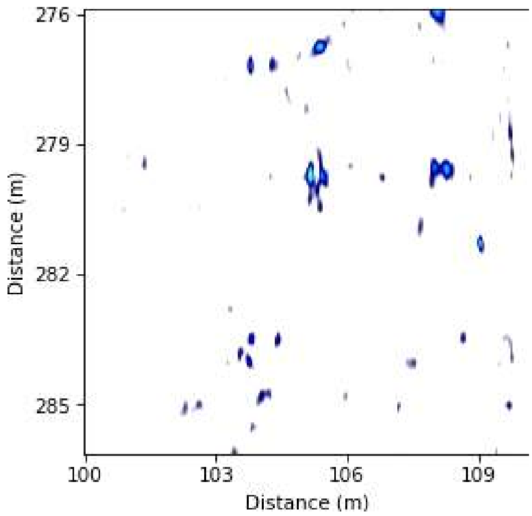
(c) Timeslice at z = 1.6 m.



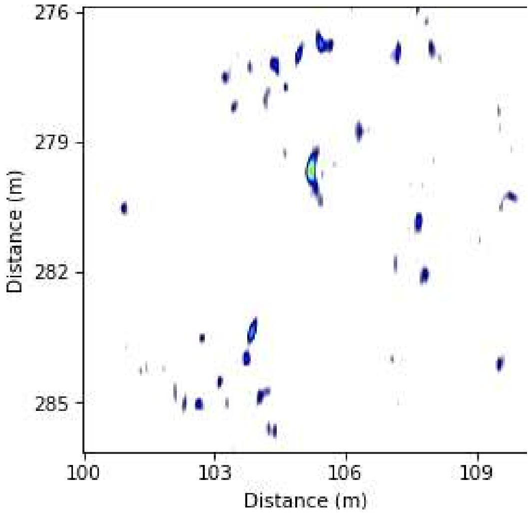
(d) Timeslice at z = 1.65 m.



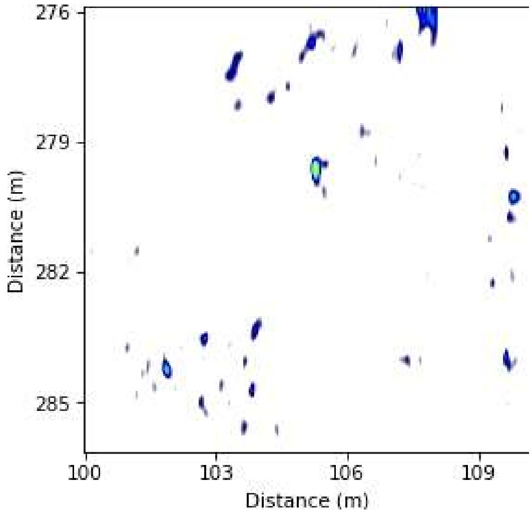
(e) Timeslice at z = 1.7 m.



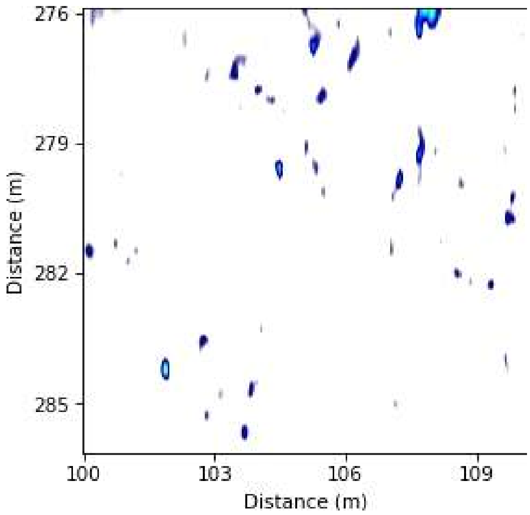
(f) Timeslice at z = 1.75 m.



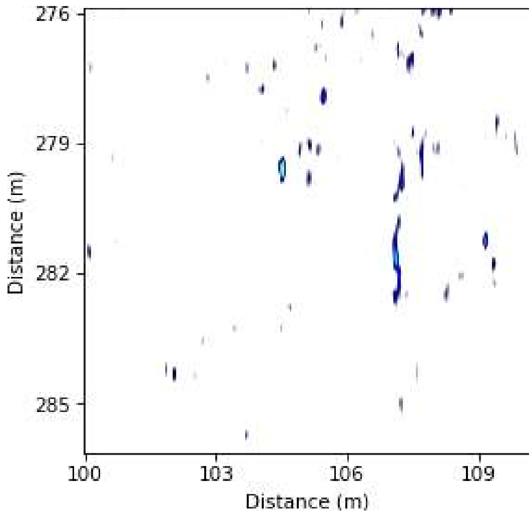
(a) Timeslice at z = 1.8 m.



(b) Timeslice at z = 1.85 m.



(c) Timeslice at z = 1.9 m.



(d) Timeslice at z = 1.95 m.

A.5 LP-TP05, LP-TP06, LP-TP07, and LP-BH01

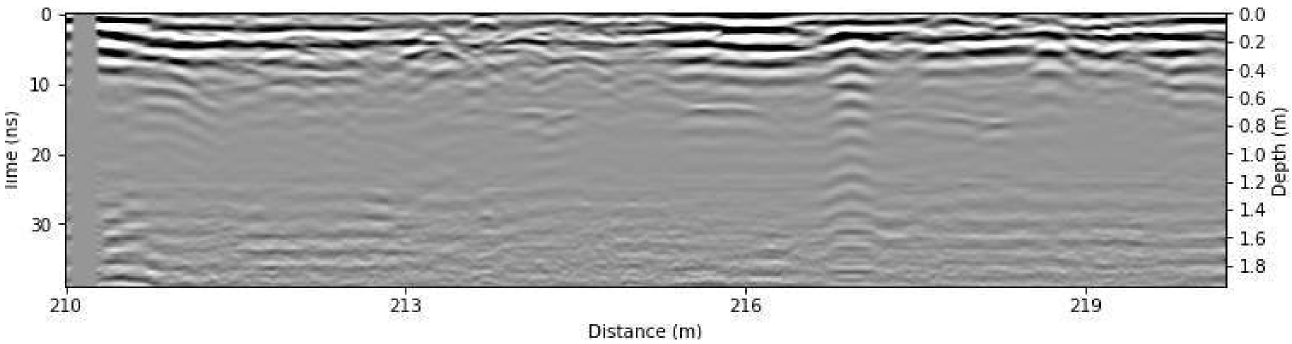


Figure A.193: Radargram at x = 143.0 m.

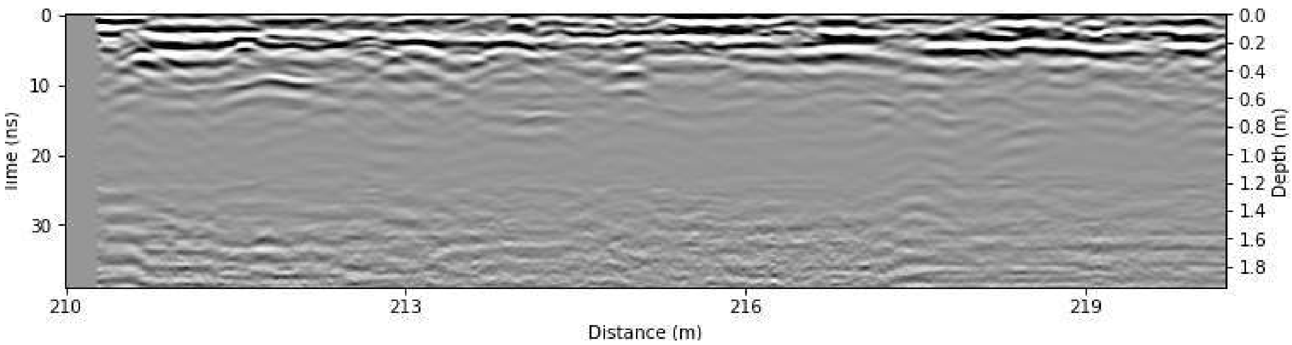


Figure A.194: Radargram at x = 143.25 m.

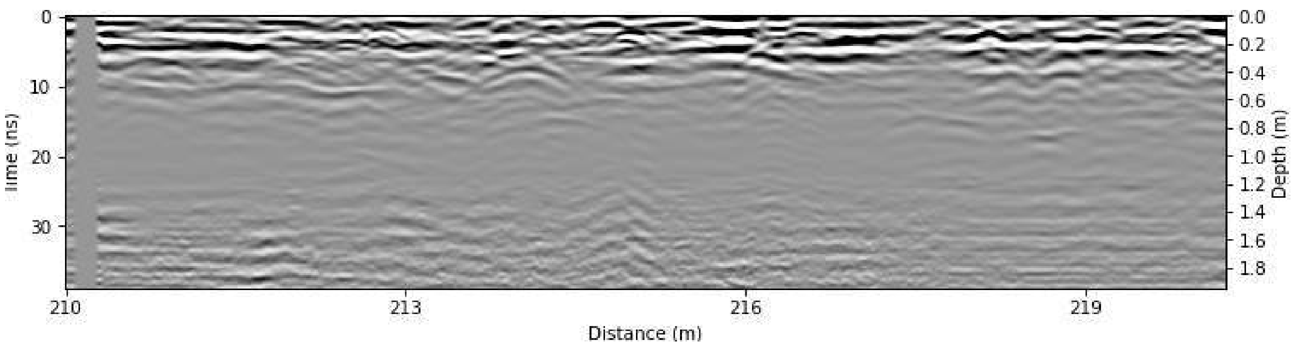


Figure A.195: Radargram at x = 143.5 m.

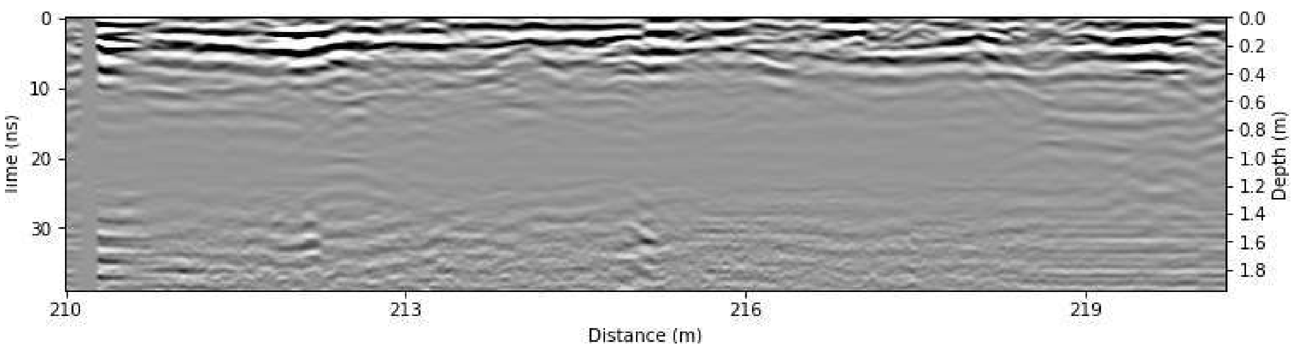


Figure A.196: Radargram at x = 143.75 m.

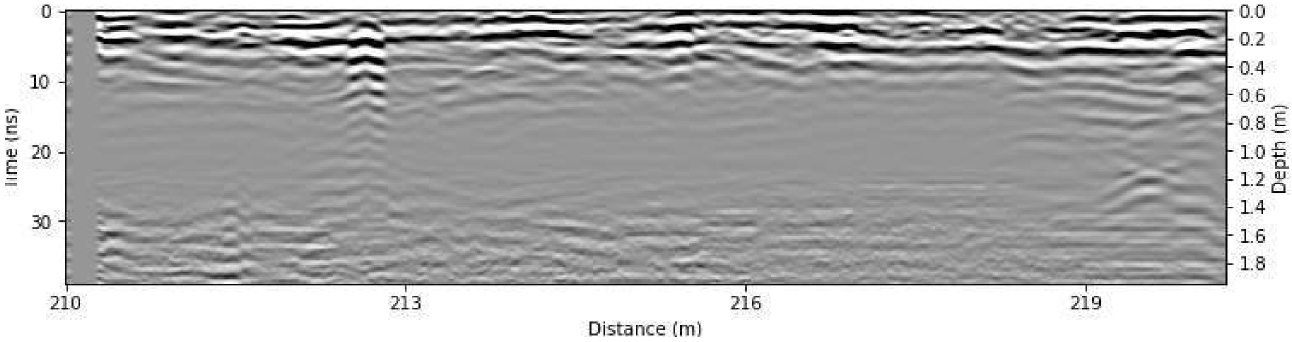


Figure A.197: Radargram at x = 144.0 m.

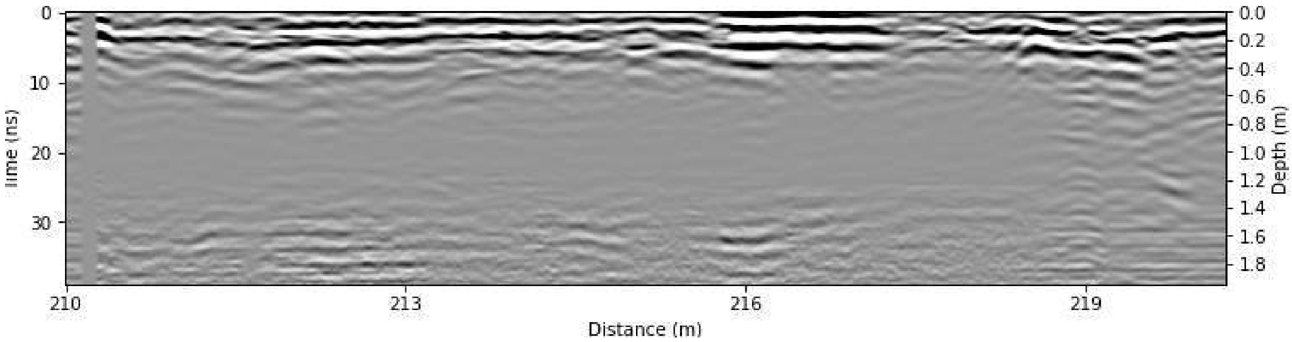


Figure A.198: Radargram at x = 144.25 m.

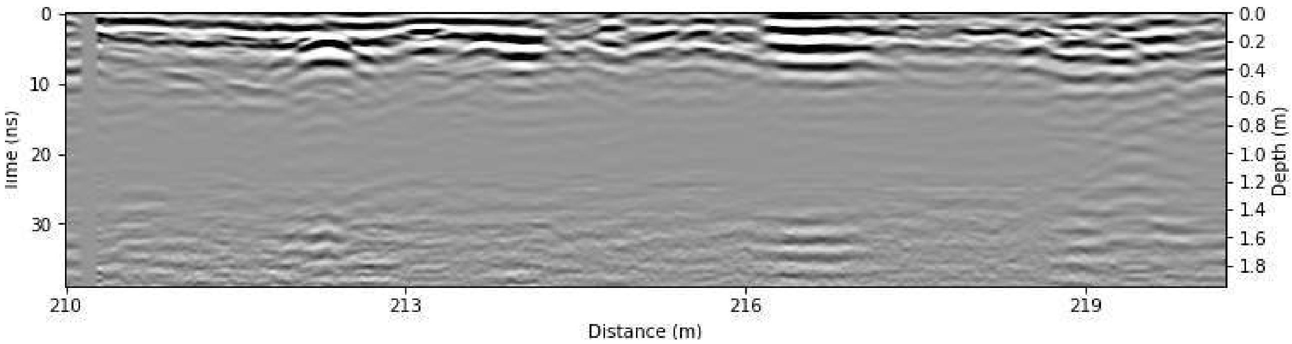


Figure A.199: Radargram at x = 144.5 m.

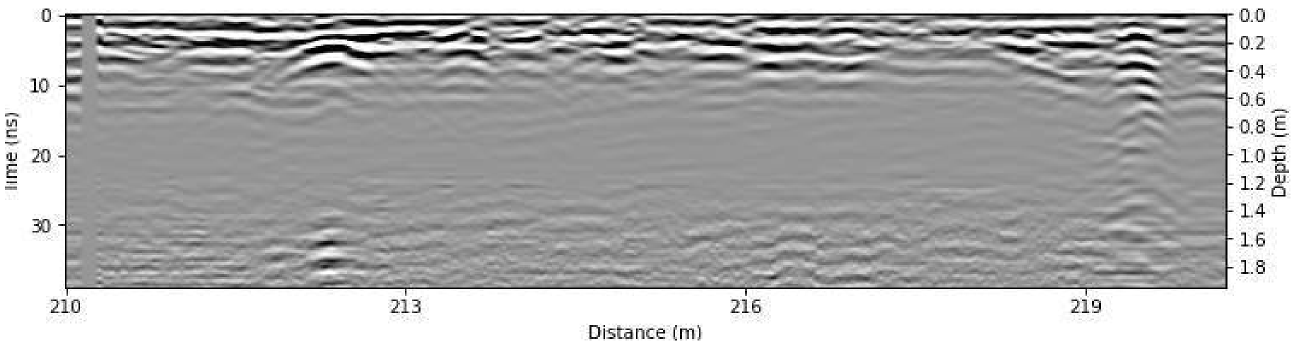


Figure A.200: Radargram at x = 144.75 m.

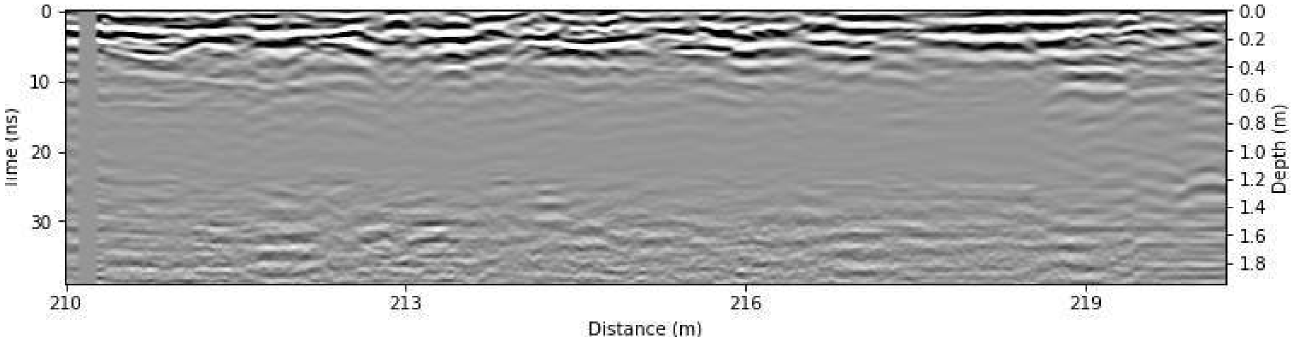


Figure A.201: Radargram at x = 145.0 m.

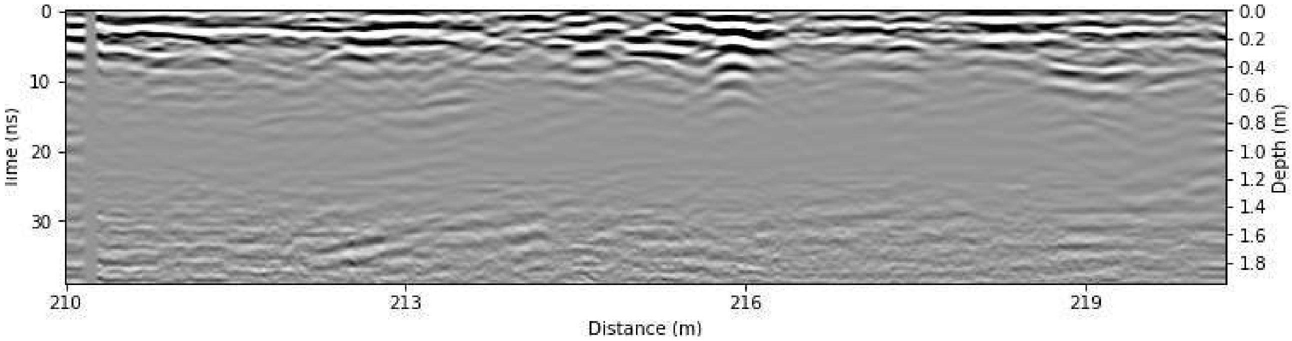


Figure A.202: Radargram at x = 145.25 m.

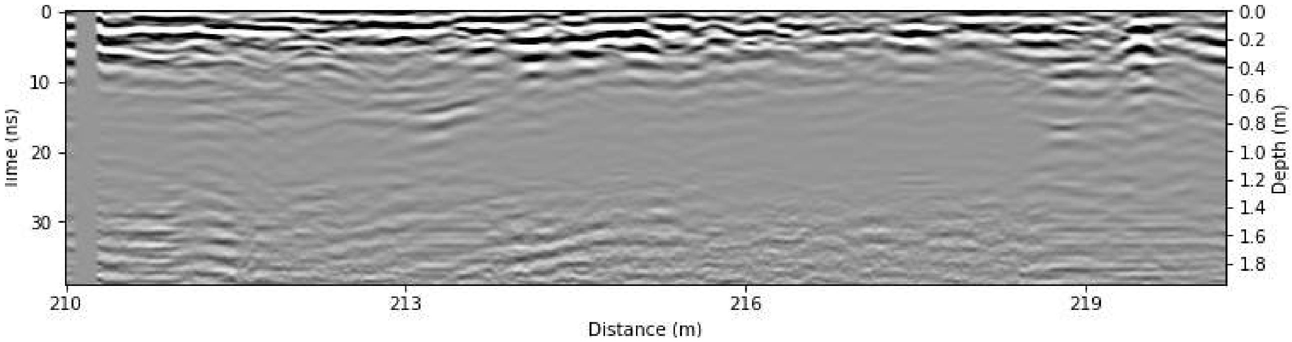


Figure A.203: Radargram at x = 145.5 m.

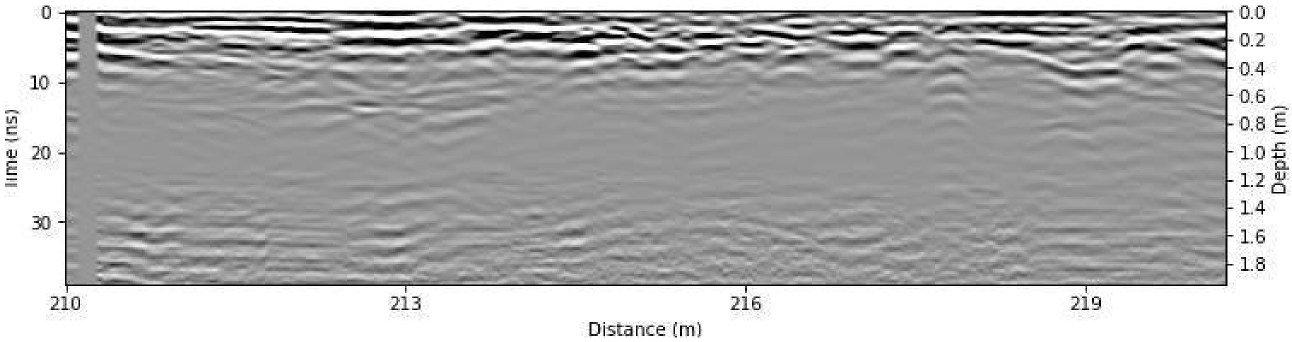


Figure A.204: Radargram at x = 145.75 m.

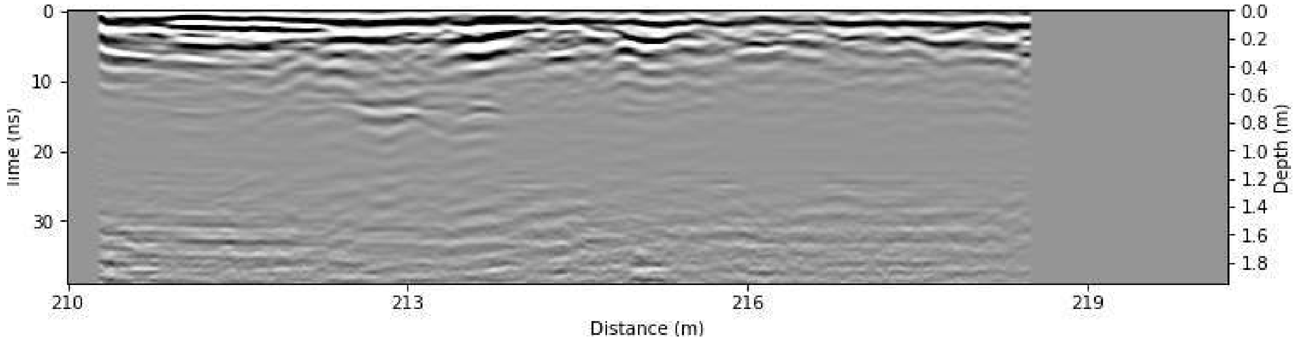


Figure A.205: Radargram at x = 146.0 m.

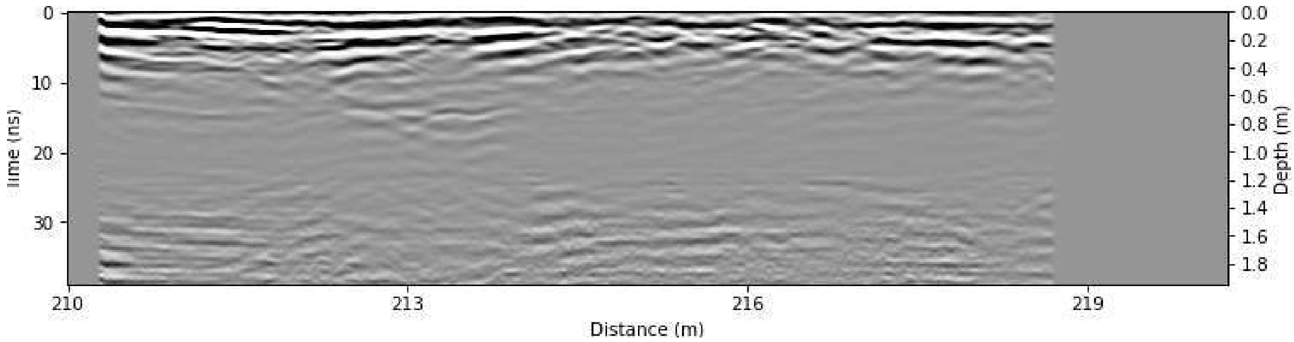


Figure A.206: Radargram at x = 146.25 m.

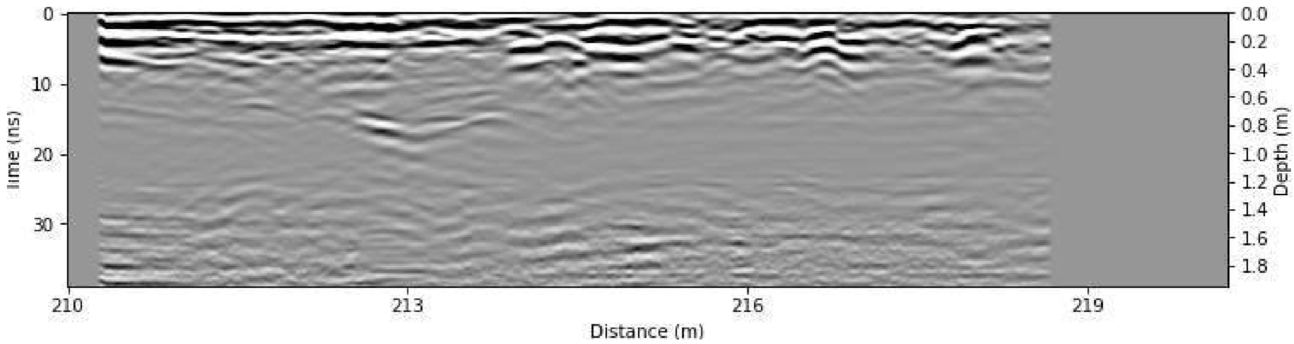


Figure A.207: Radargram at x = 146.5 m.

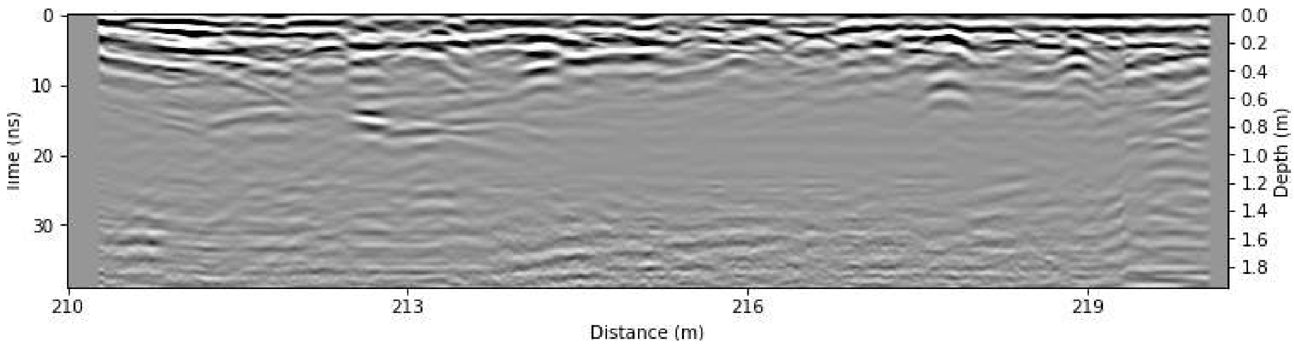


Figure A.208: Radargram at x = 146.75 m.

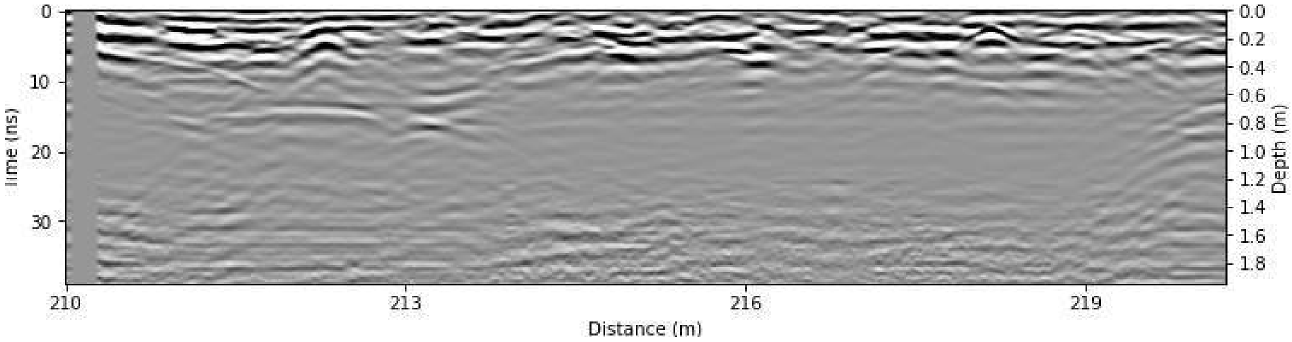


Figure A.209: Radargram at x = 147.0 m.

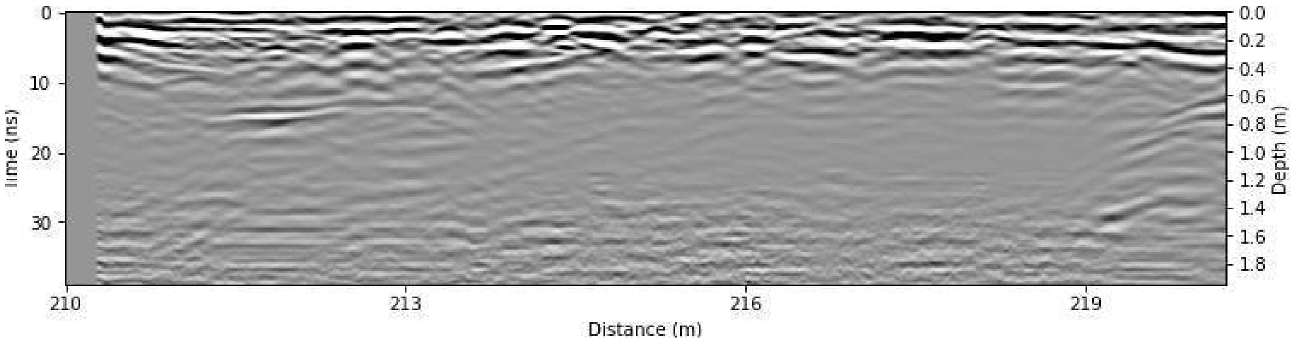


Figure A.210: Radargram at x = 147.25 m.

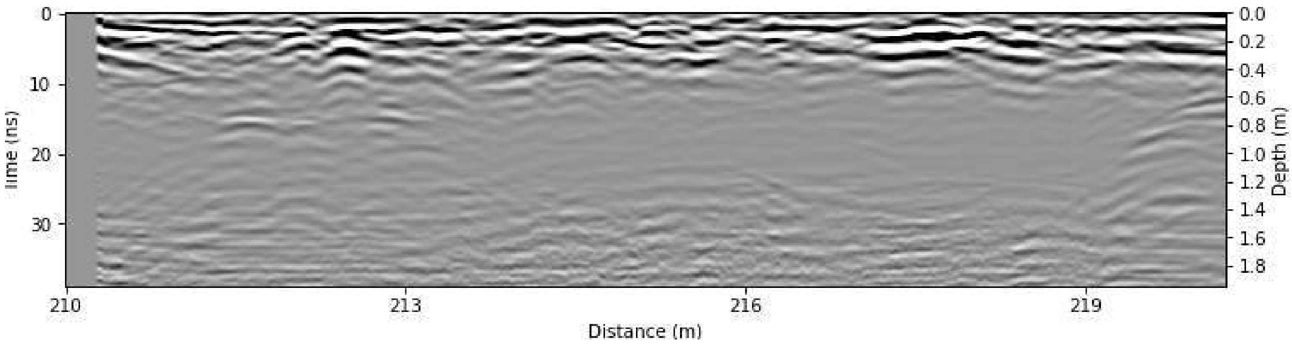


Figure A.211: Radargram at x = 147.5 m.

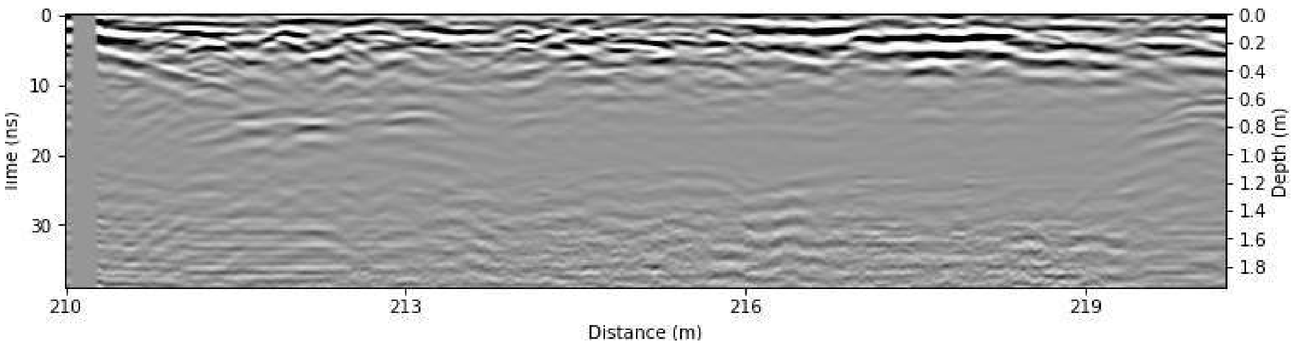


Figure A.212: Radargram at x = 147.75 m.

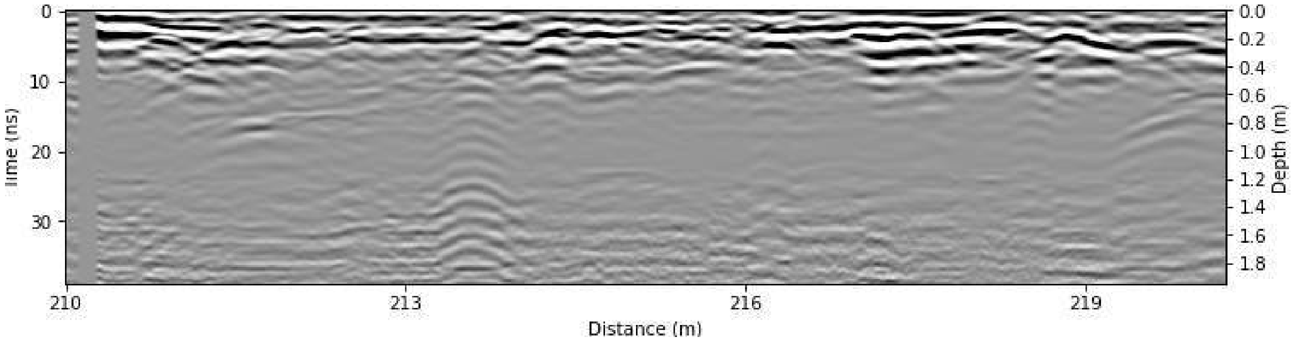


Figure A.213: Radargram at x = 148.0 m.

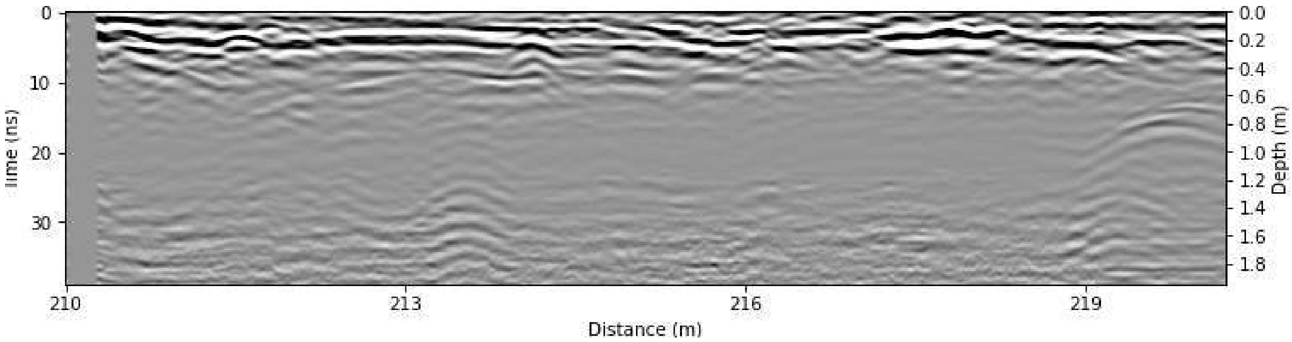


Figure A.214: Radargram at x = 148.25 m.

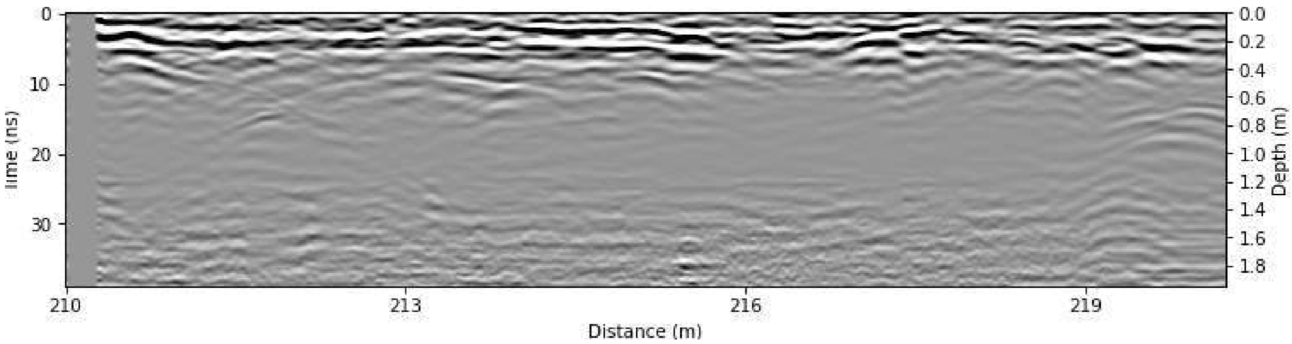


Figure A.215: Radargram at x = 148.5 m.

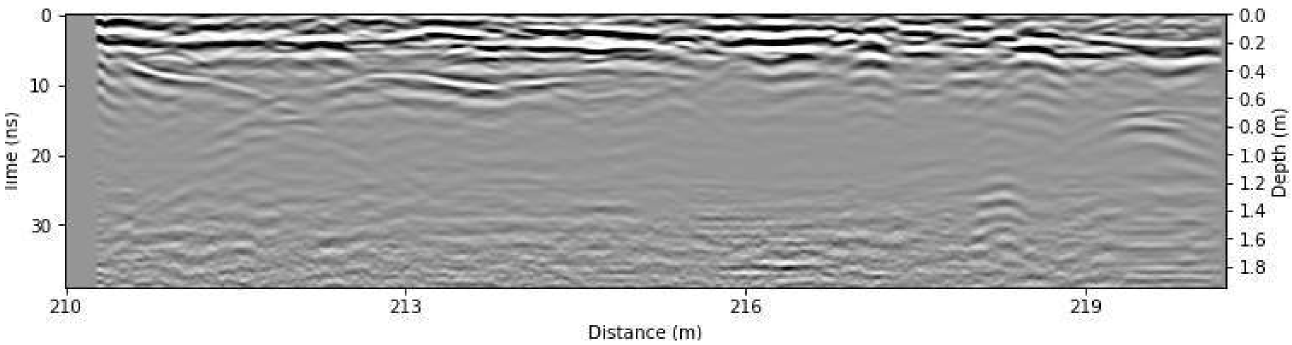


Figure A.216: Radargram at x = 148.75 m.

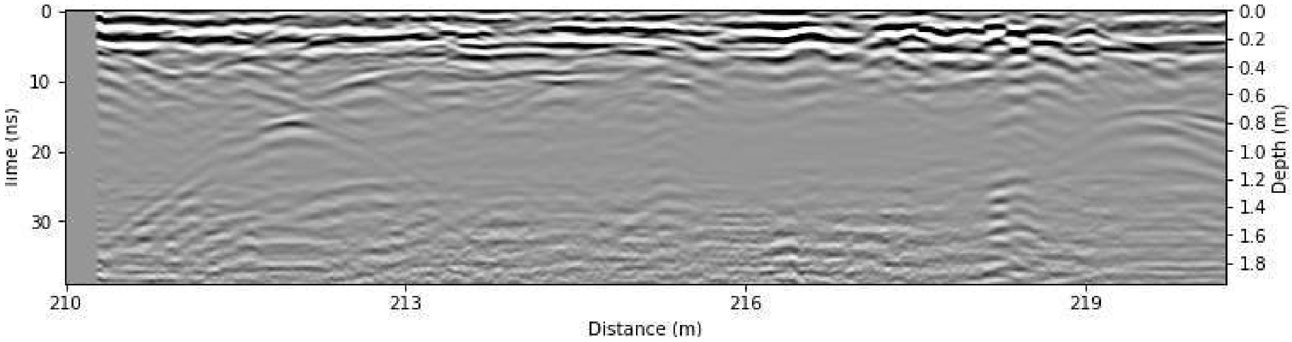


Figure A.217: Radargram at x = 149.0 m.

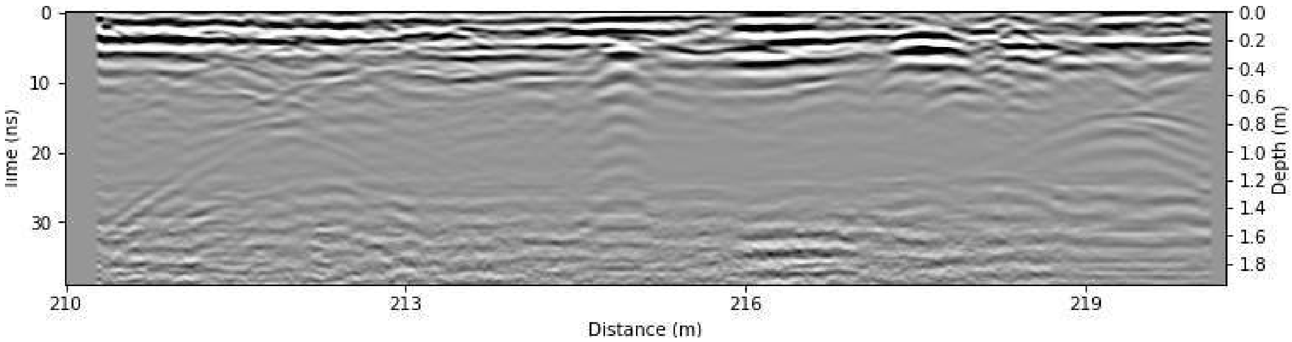


Figure A.218: Radargram at x = 149.25 m.

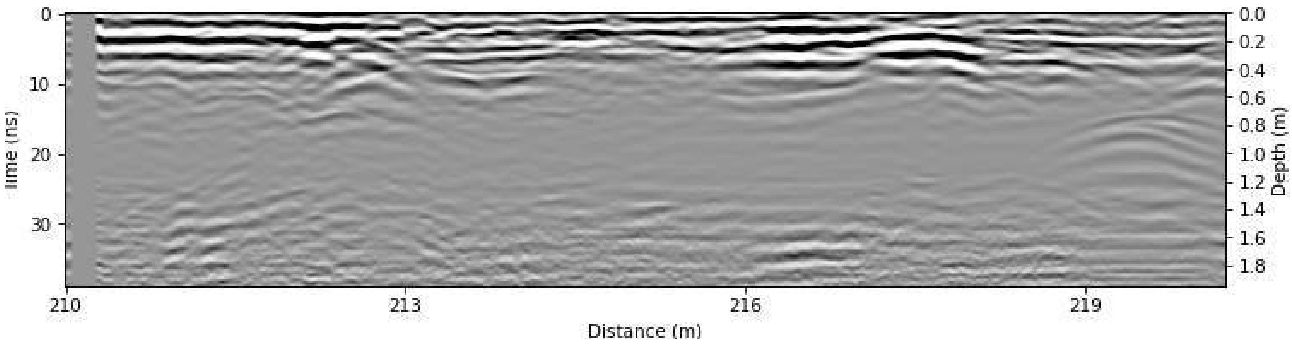


Figure A.219: Radargram at x = 149.5 m.

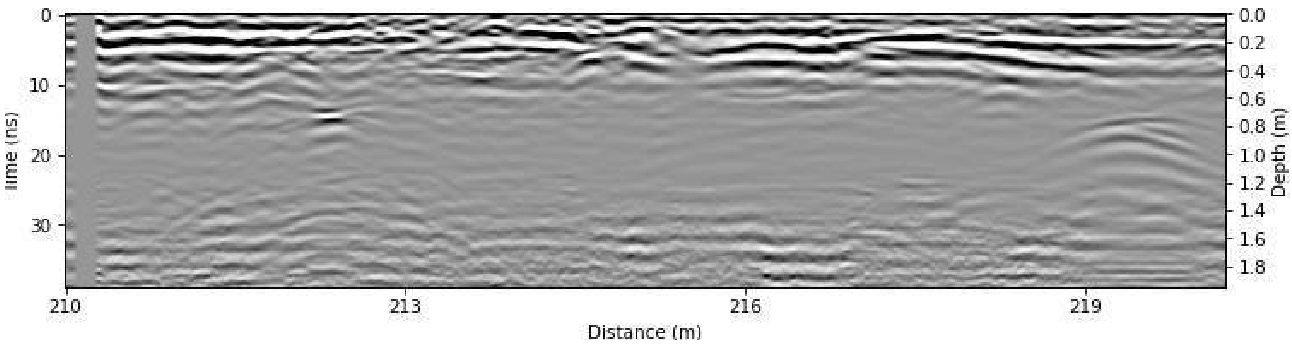


Figure A.220: Radargram at x = 149.75 m.

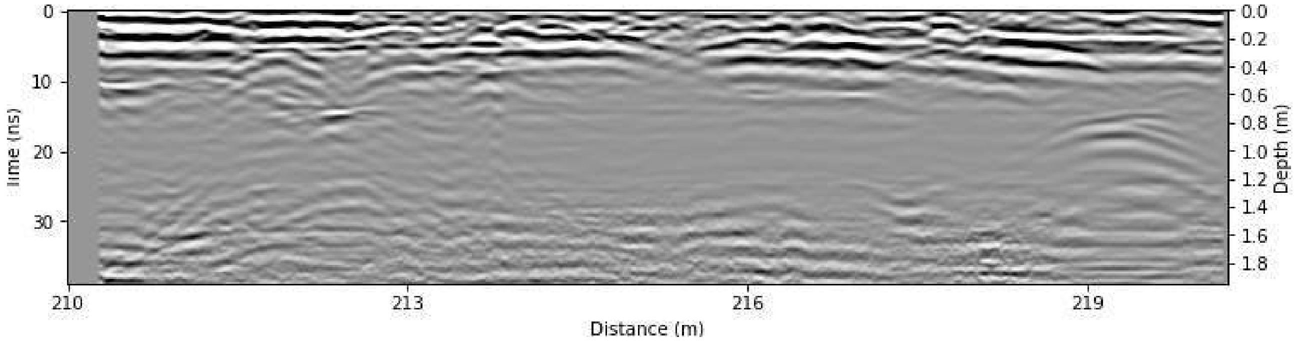


Figure A.221: Radargram at x = 150.0 m.

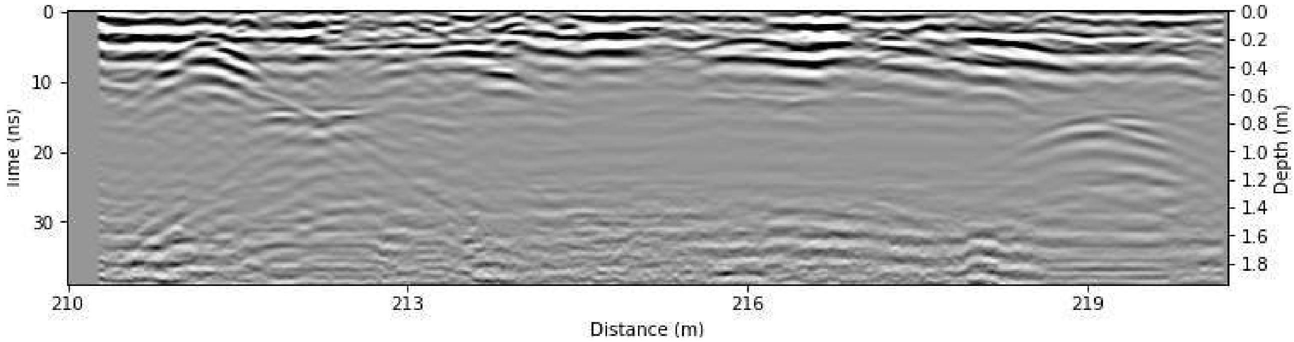


Figure A.222: Radargram at x = 150.25 m.

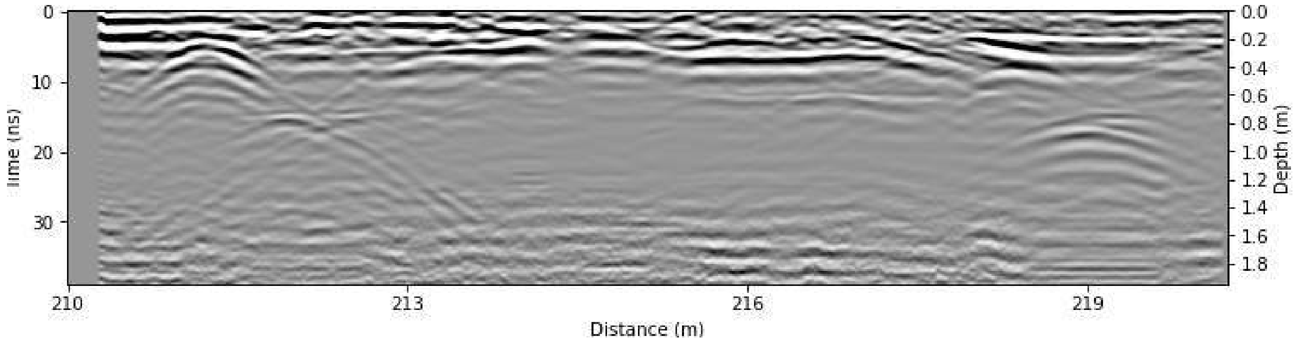


Figure A.223: Radargram at x = 150.5 m.

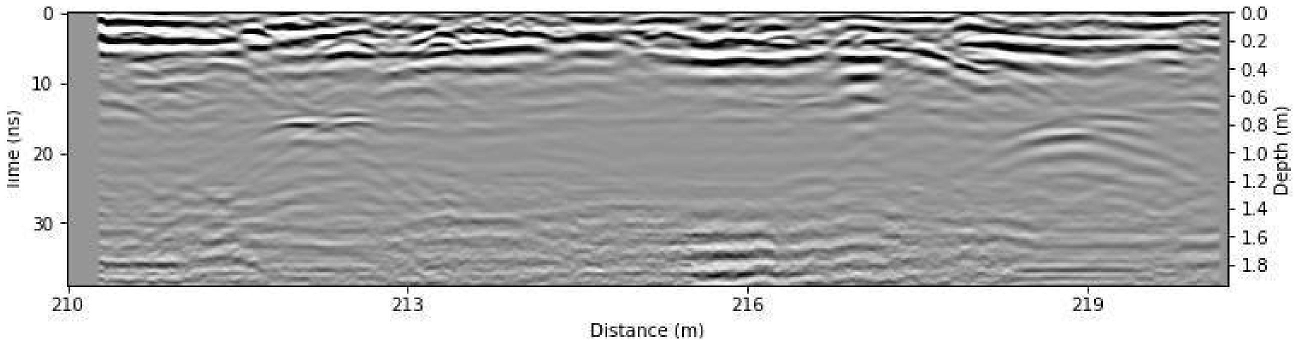


Figure A.224: Radargram at x = 150.75 m.

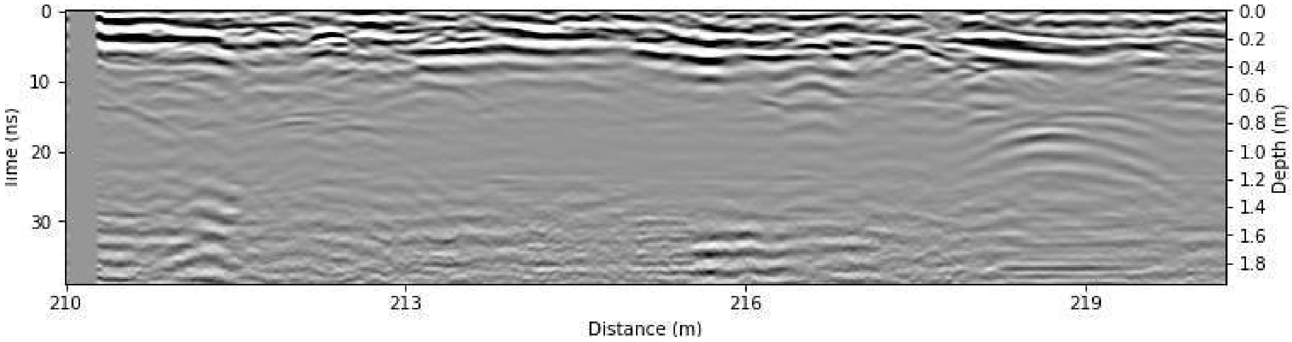


Figure A.225: Radargram at x = 151.0 m.

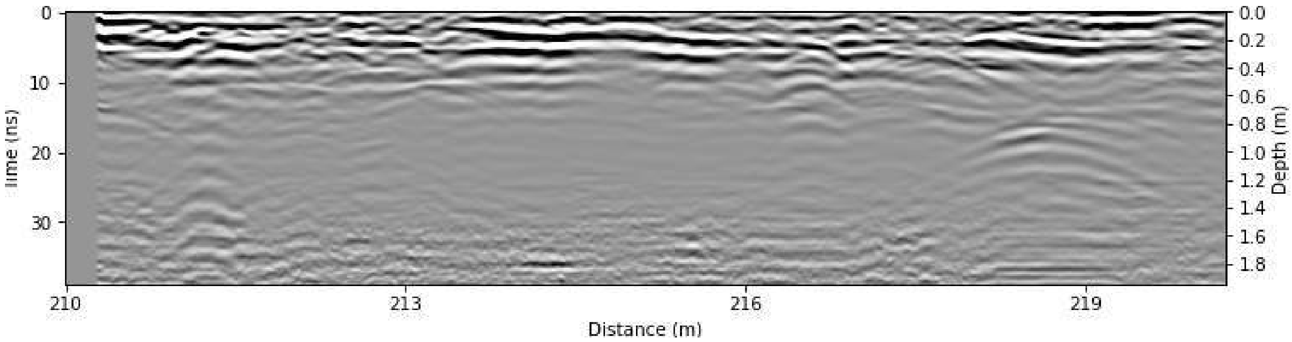


Figure A.226: Radargram at x = 151.25 m.

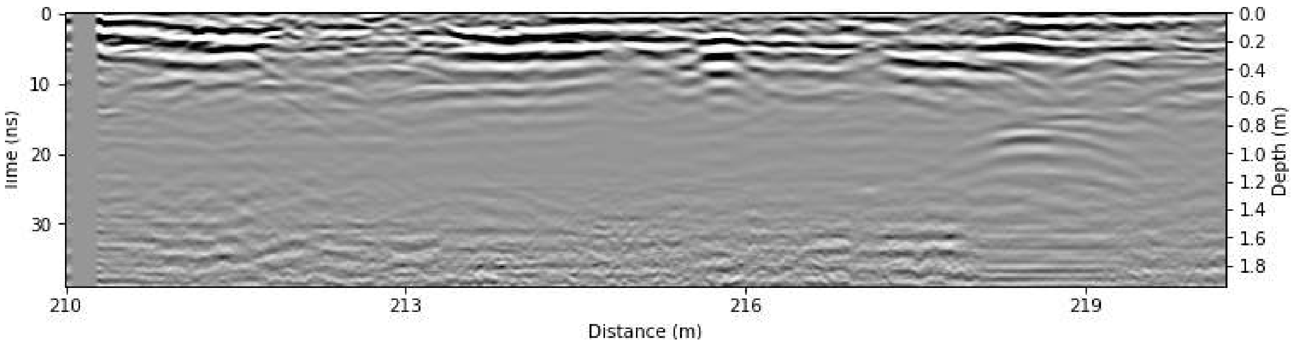


Figure A.227: Radargram at x = 151.5 m.

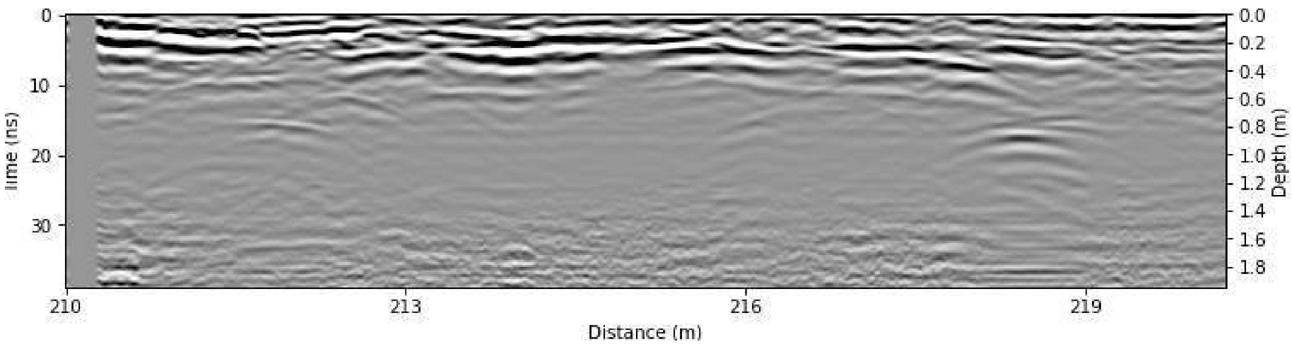


Figure A.228: Radargram at x = 151.75 m.

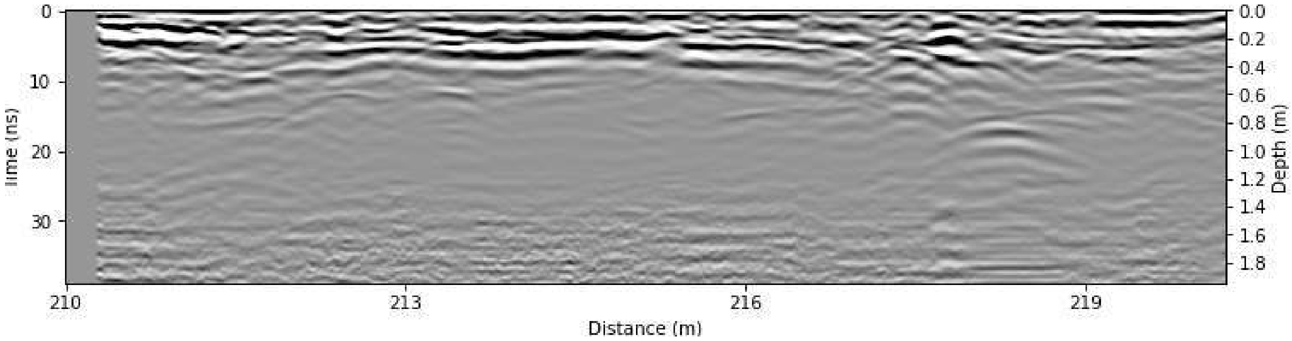


Figure A.229: Radargram at x = 152.0 m.

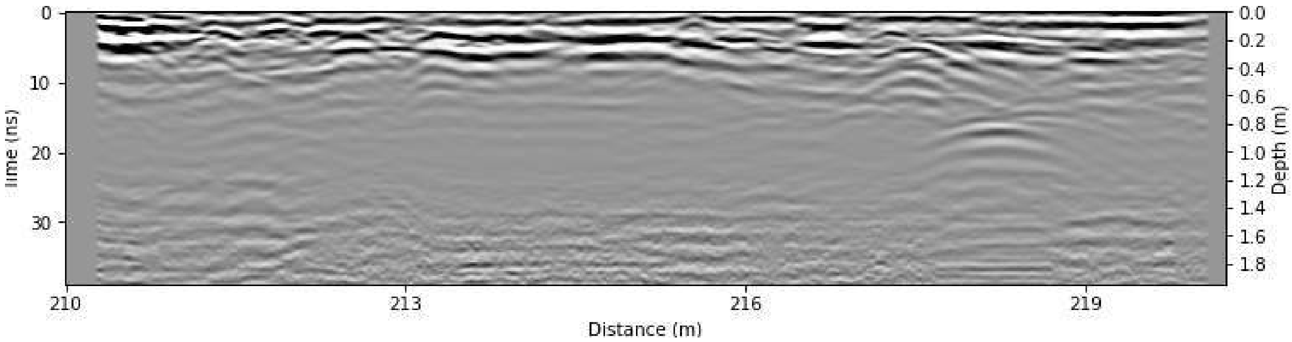


Figure A.230: Radargram at x = 152.25 m.

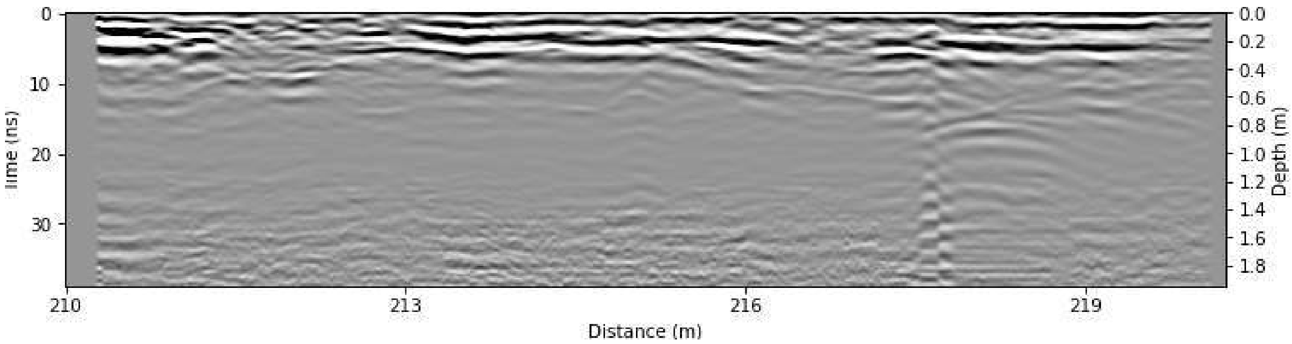


Figure A.231: Radargram at x = 152.5 m.

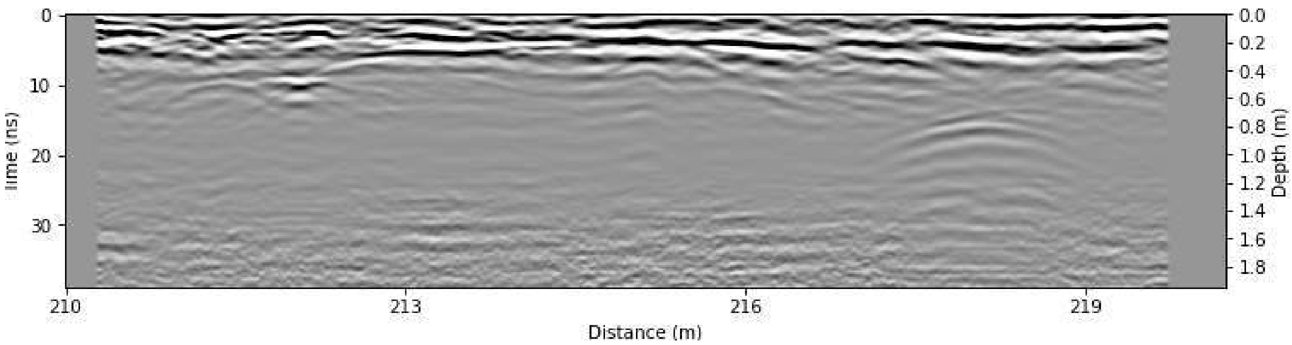


Figure A.232: Radargram at x = 152.75 m.

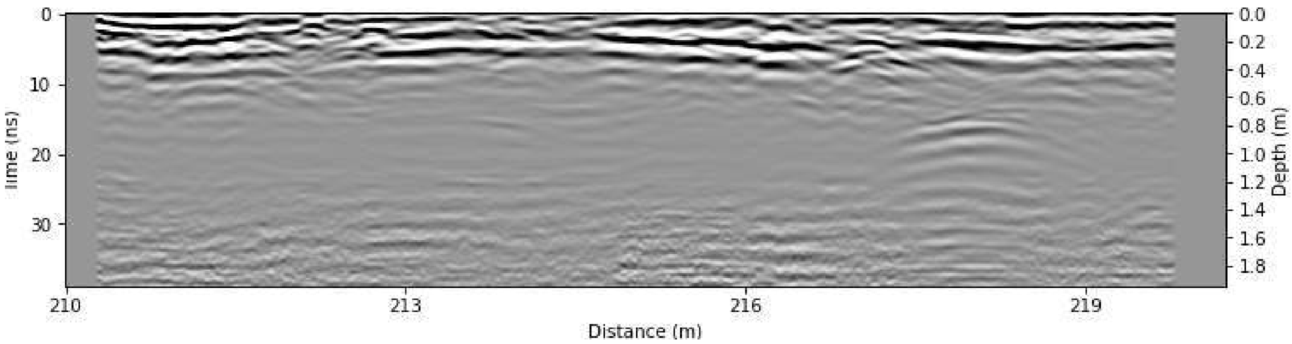


Figure A.233: Radargram at x = 153.0 m.

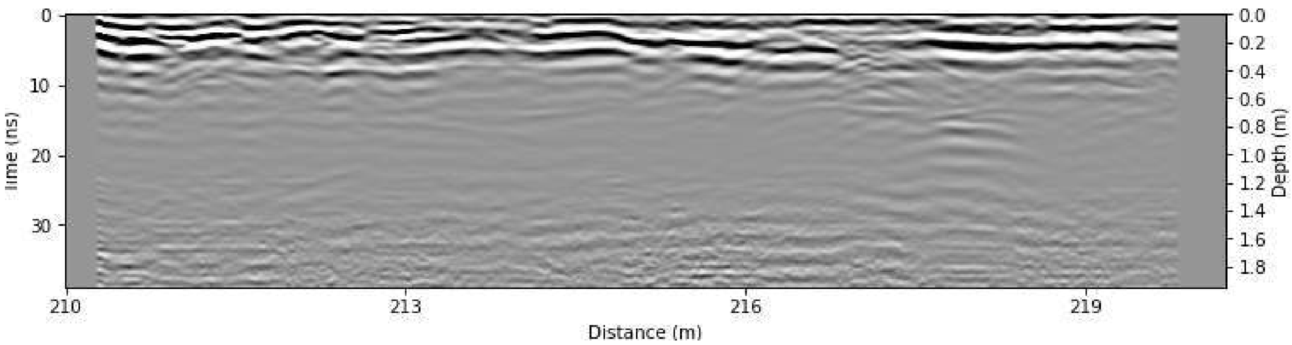


Figure A.234: Radargram at x = 153.25 m.

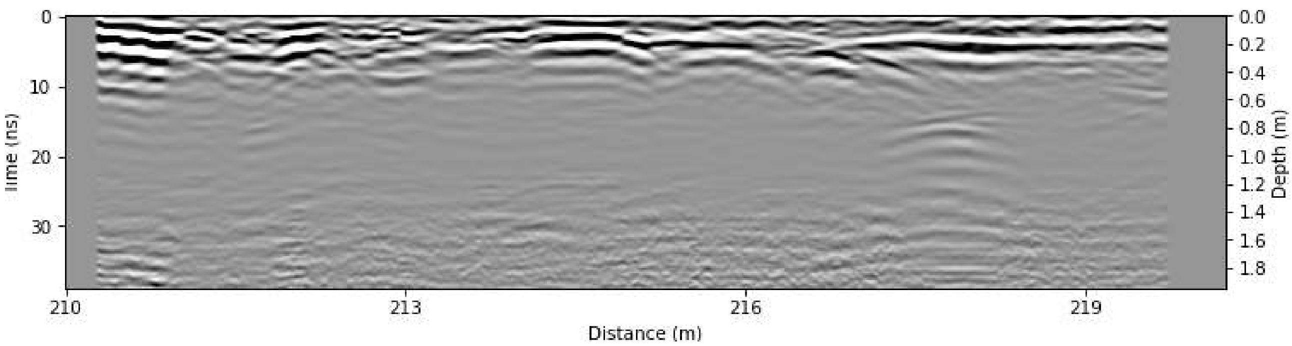


Figure A.235: Radargram at x = 153.5 m.

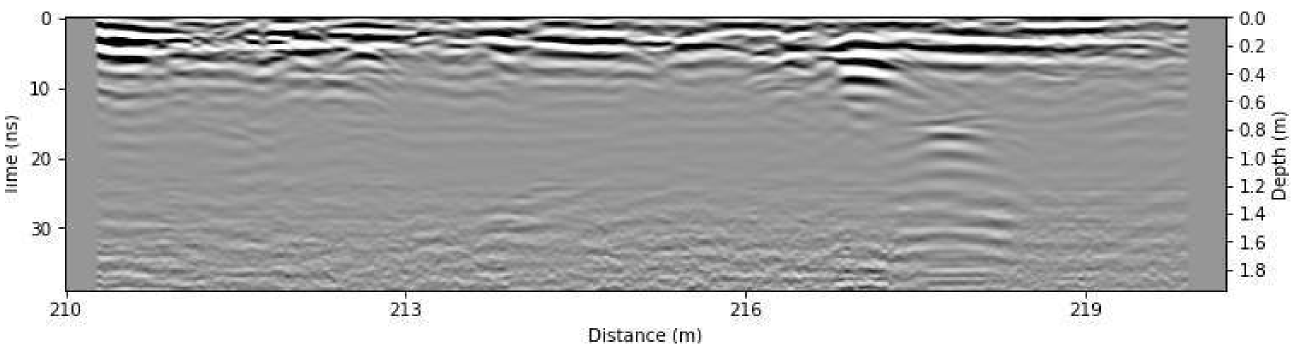


Figure A.236: Radargram at x = 153.75 m.

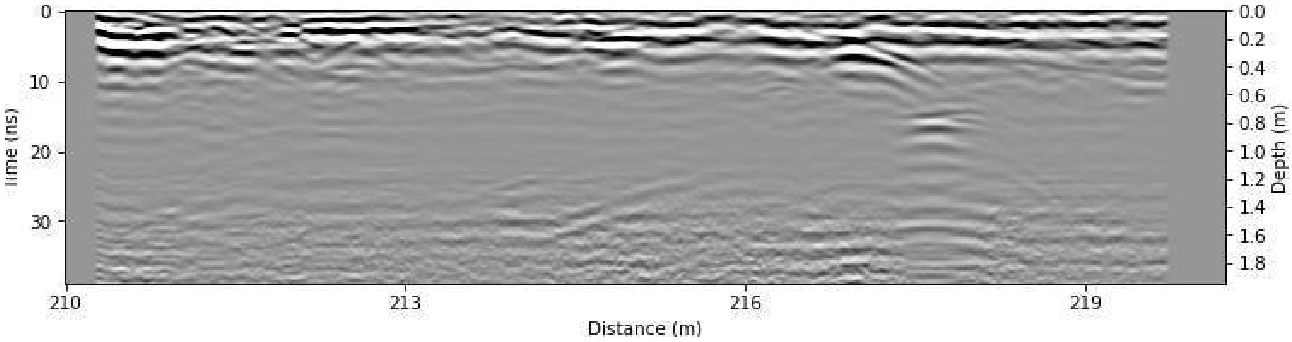


Figure A.237: Radargram at x = 154.0 m.

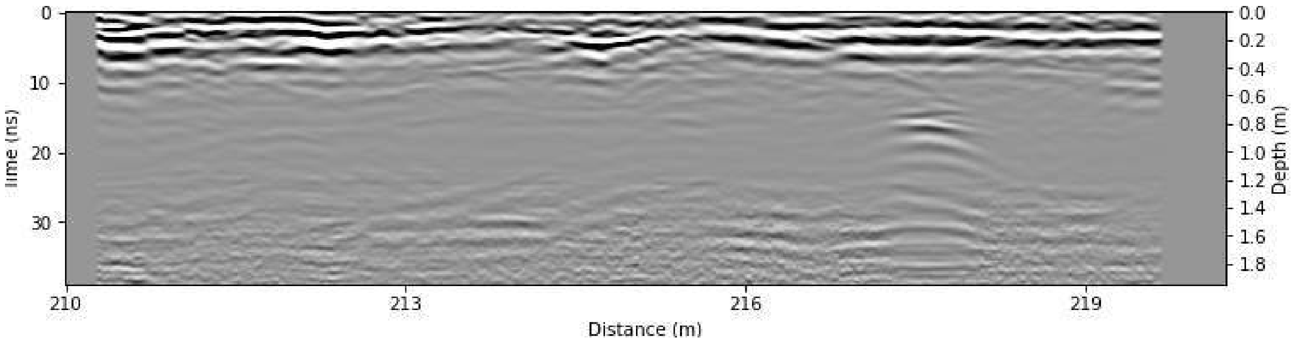


Figure A.238: Radargram at x = 154.25 m.

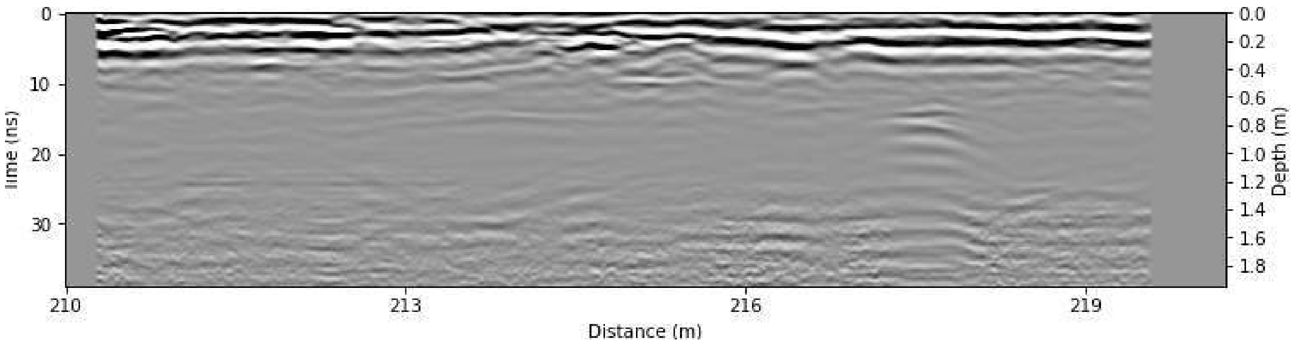


Figure A.239: Radargram at x = 154.5 m.

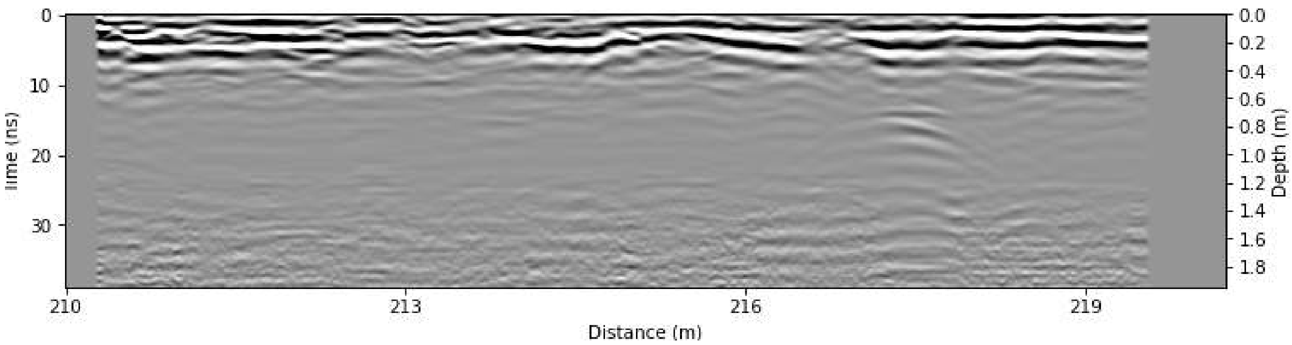


Figure A.240: Radargram at x = 154.75 m.

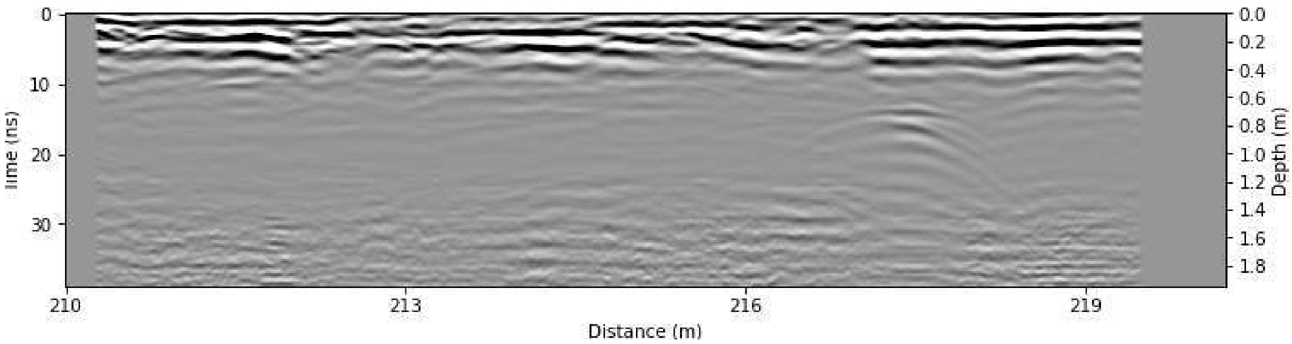


Figure A.241: Radargram at x = 155.0 m.

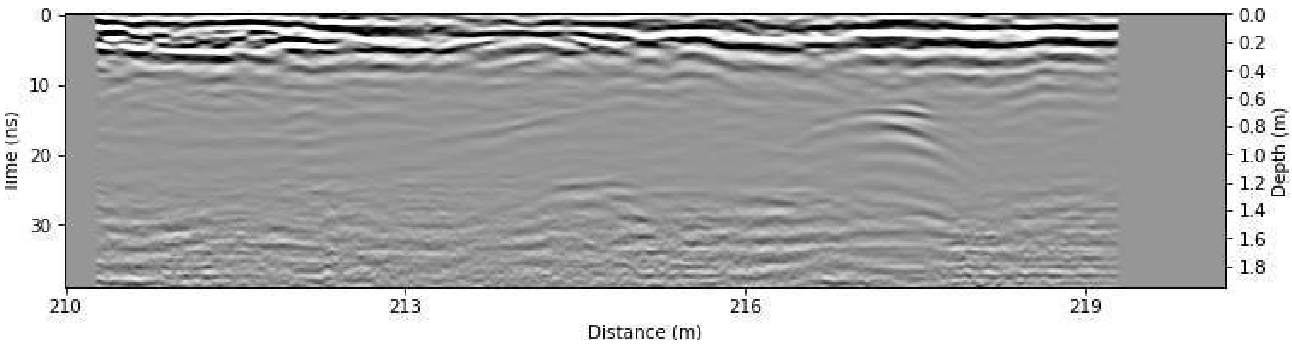


Figure A.242: Radargram at x = 155.25 m.

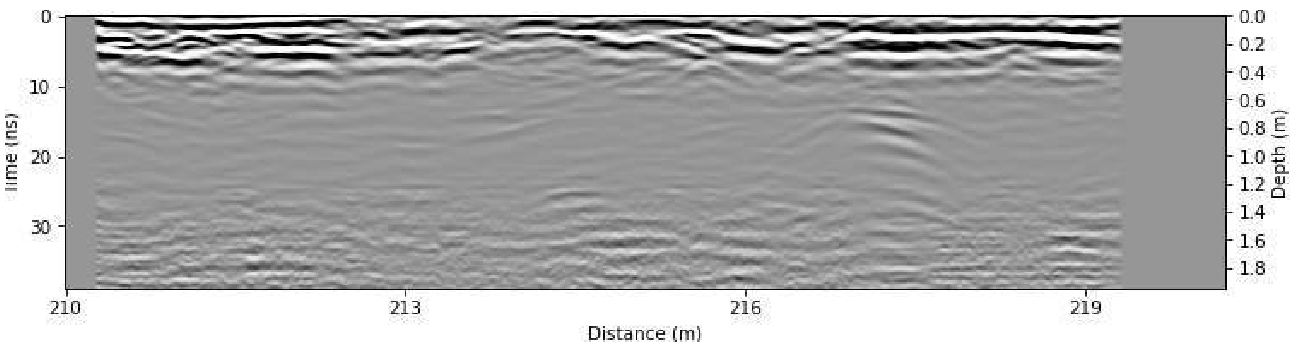


Figure A.243: Radargram at x = 155.5 m.

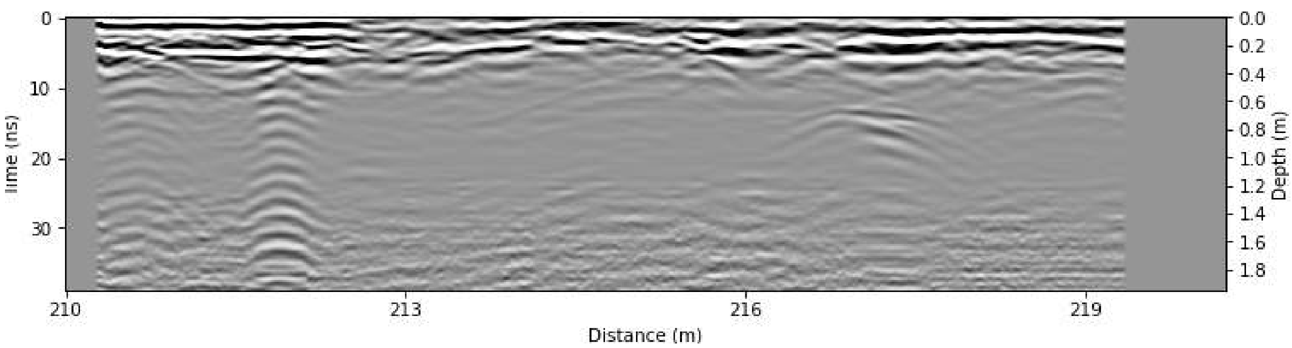


Figure A.244: Radargram at x = 155.75 m.

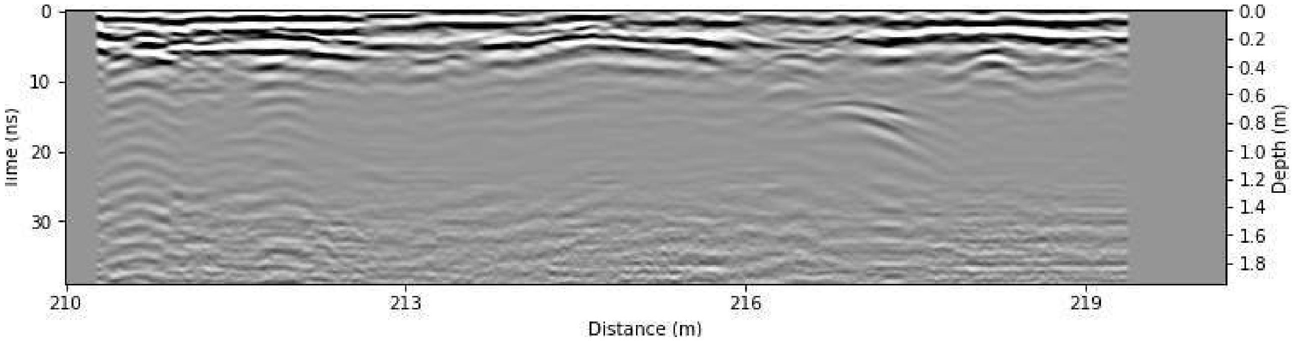


Figure A.245: Radargram at x = 156.0 m.

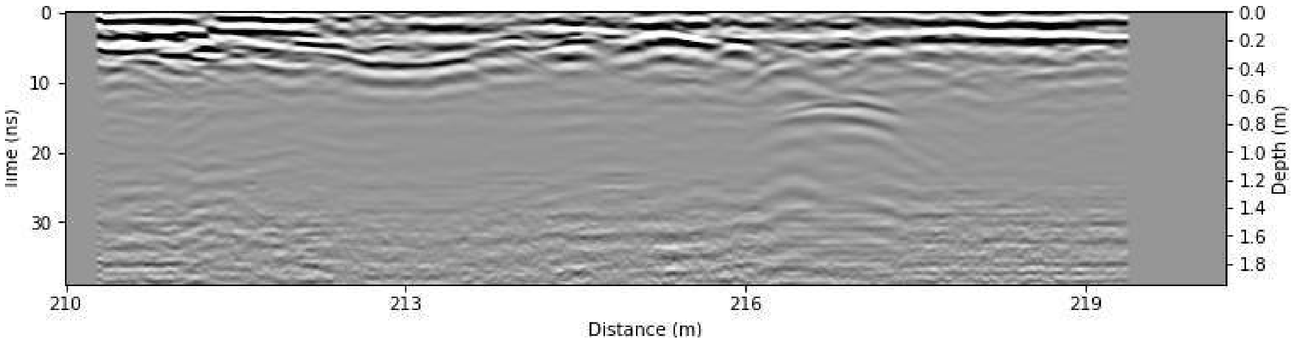


Figure A.246: Radargram at x = 156.25 m.

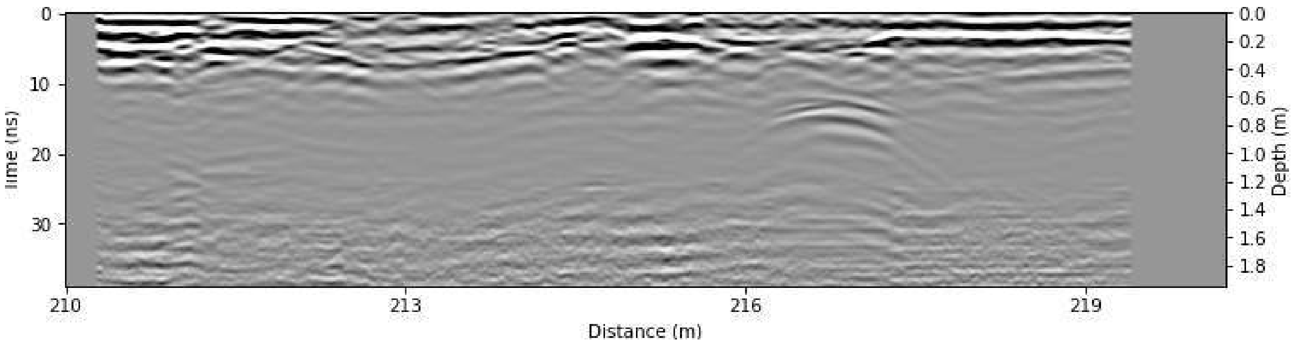


Figure A.247: Radargram at x = 156.5 m.

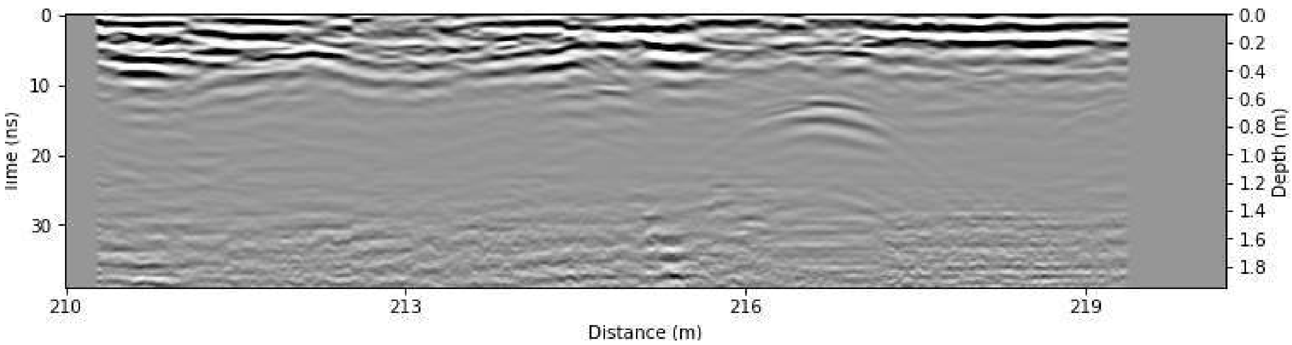


Figure A.248: Radargram at x = 156.75 m.

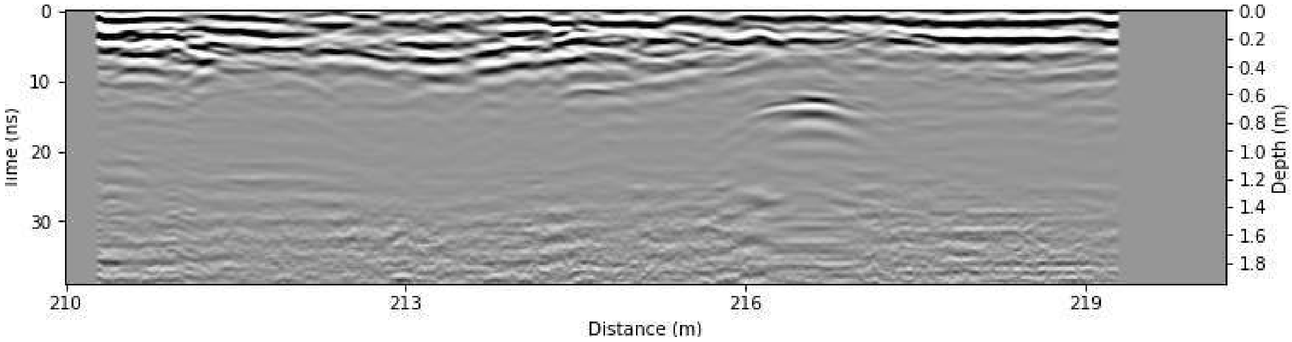


Figure A.249: Radargram at x = 157.0 m.

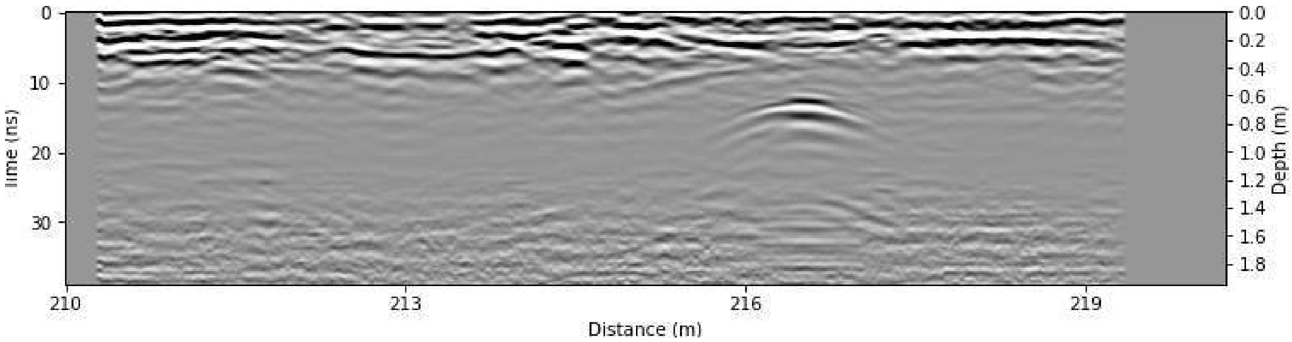


Figure A.250: Radargram at x = 157.25 m.

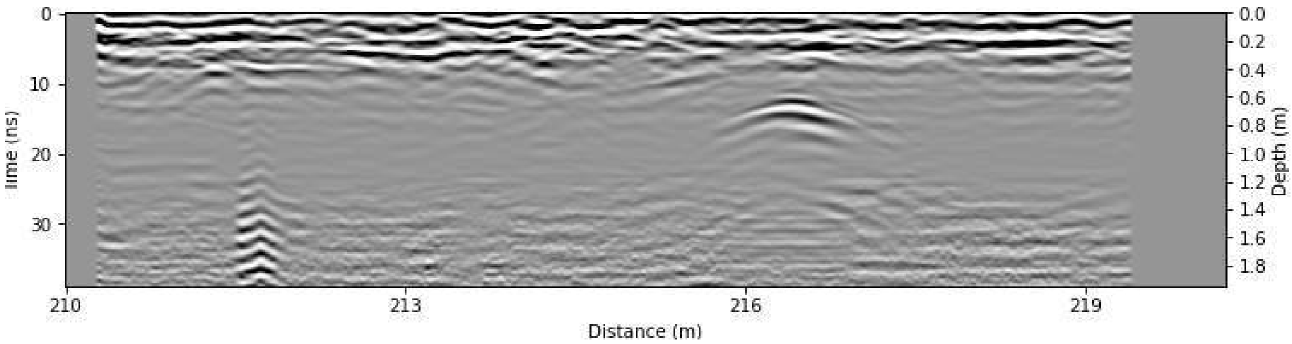


Figure A.251: Radargram at x = 157.5 m.

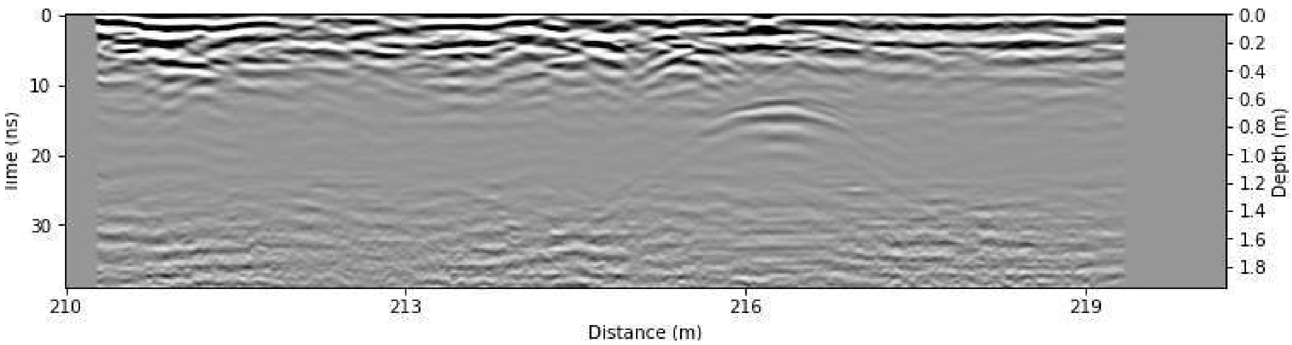


Figure A.252: Radargram at x = 157.75 m.

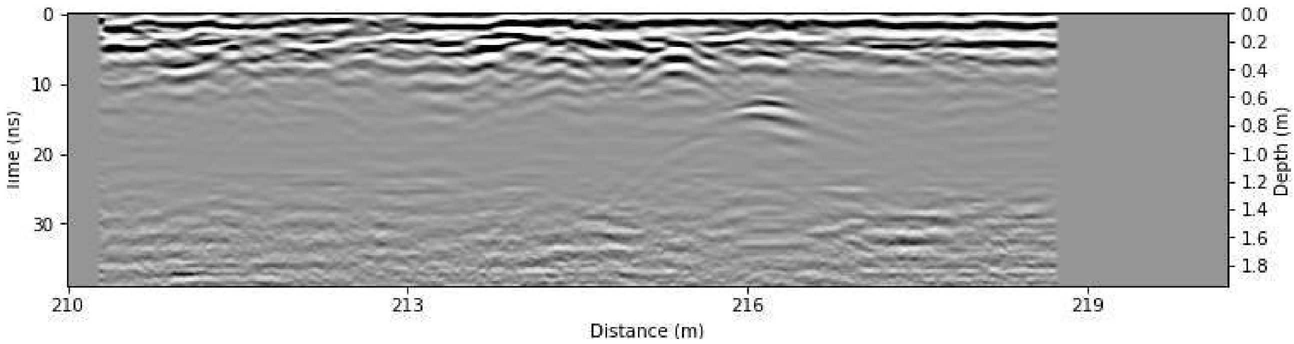


Figure A.253: Radargram at x = 158.0 m.

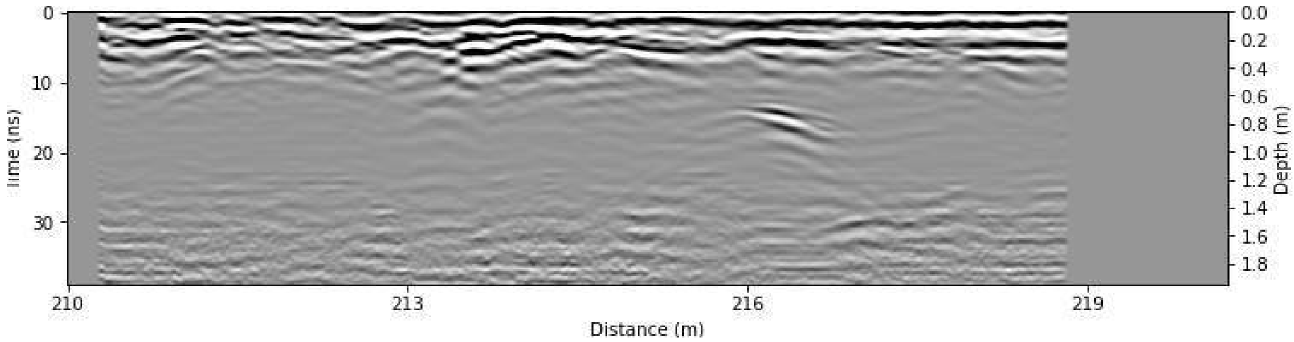


Figure A.254: Radargram at x = 158.25 m.

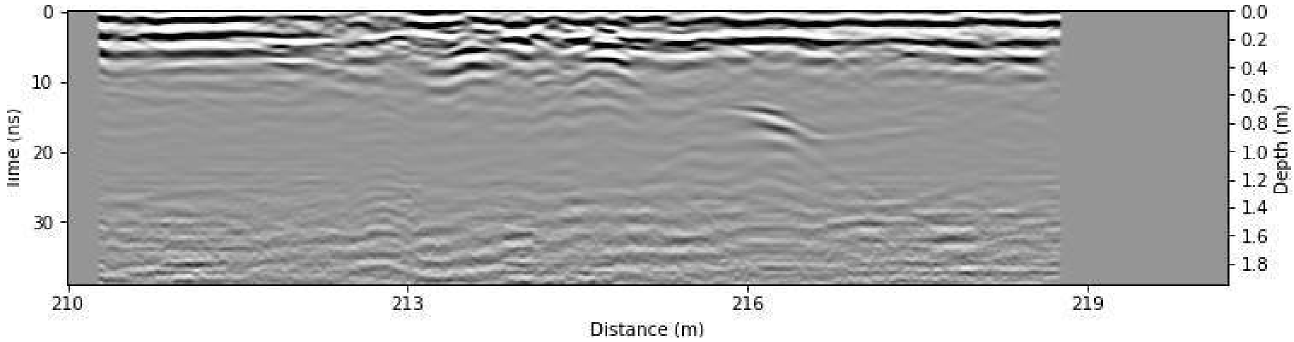


Figure A.255: Radargram at x = 158.5 m.

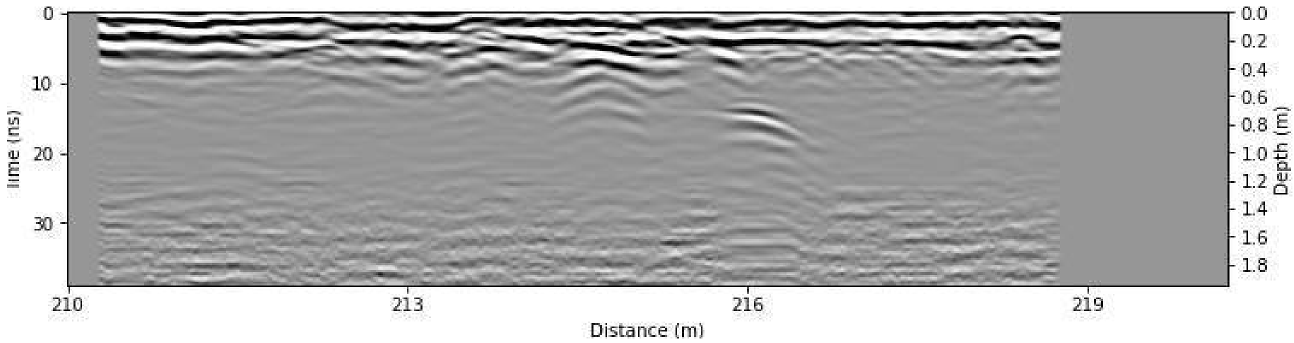


Figure A.256: Radargram at x = 158.75 m.

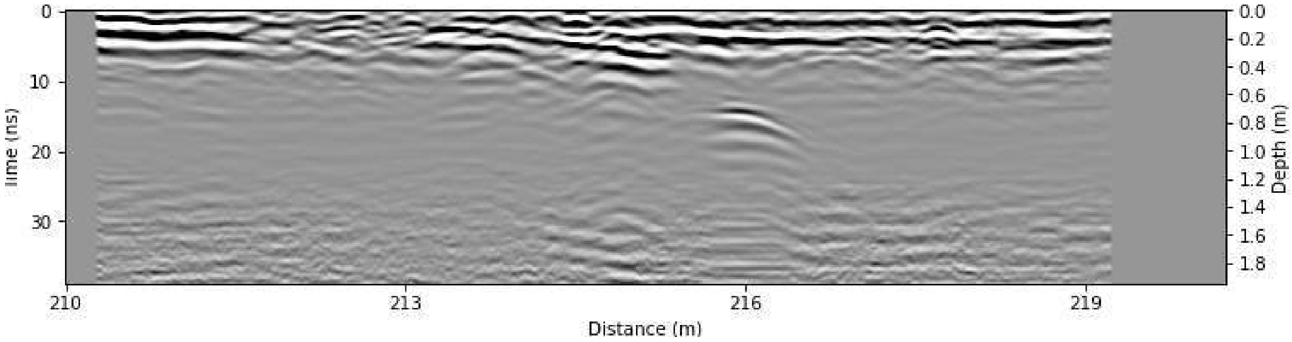


Figure A.257: Radargram at x = 159.0 m.

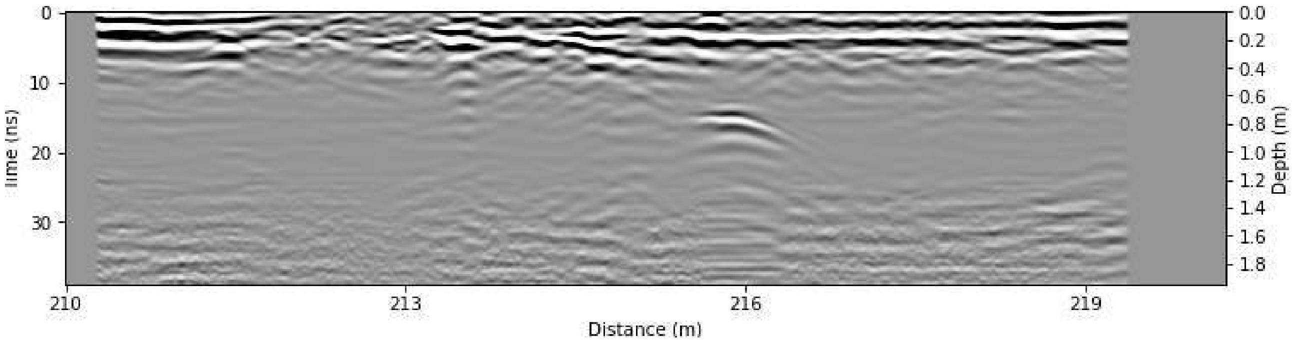


Figure A.258: Radargram at x = 159.25 m.

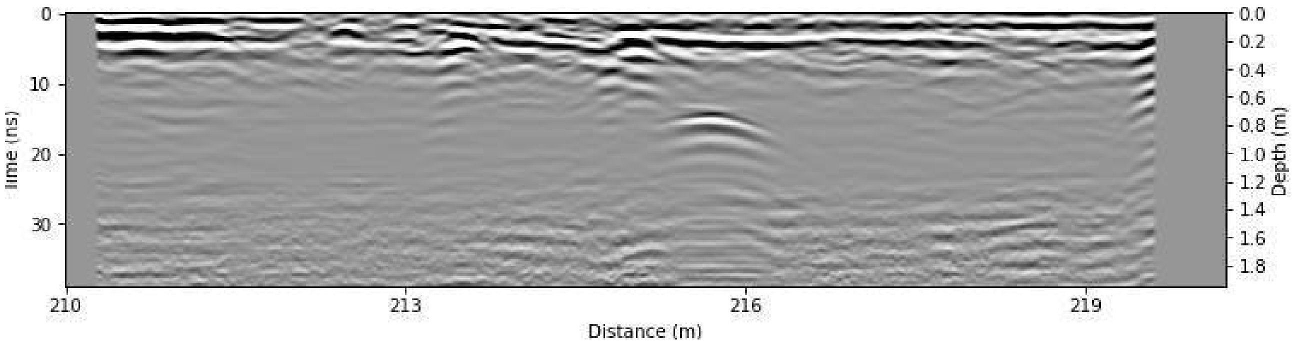


Figure A.259: Radargram at x = 159.5 m.

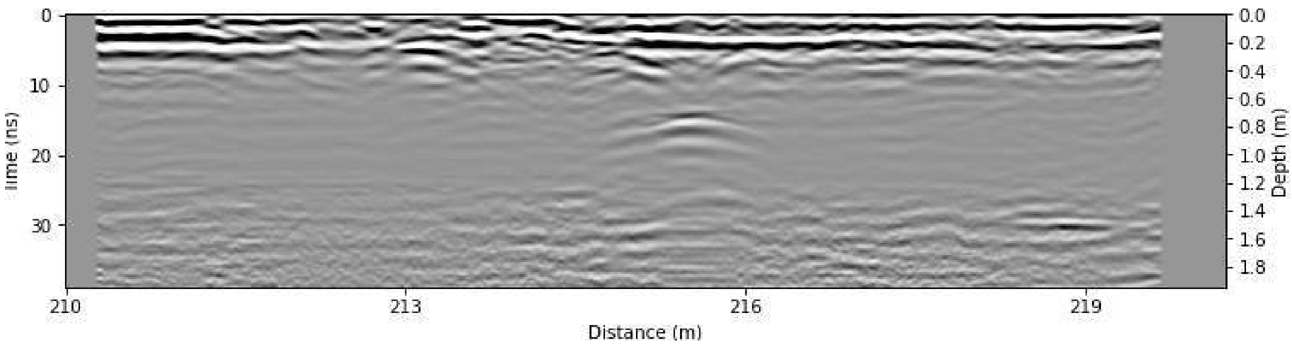


Figure A.260: Radargram at x = 159.75 m.

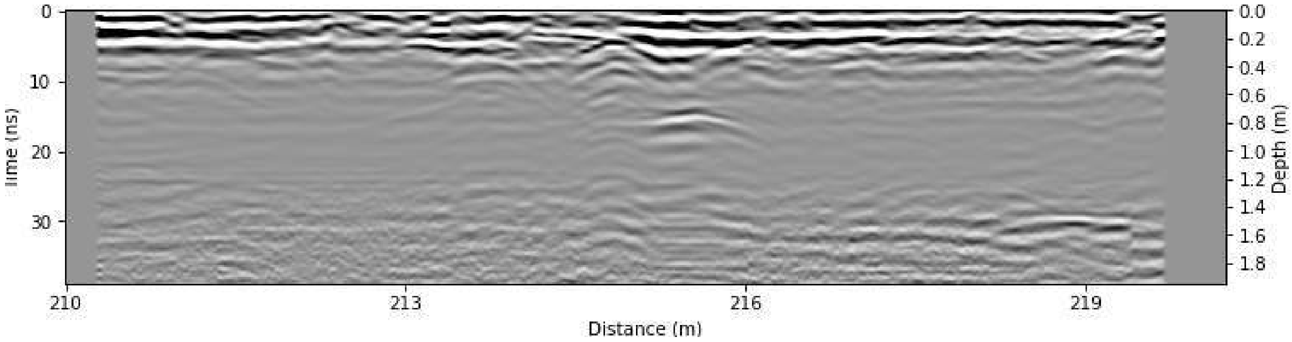


Figure A.261: Radargram at x = 160.0 m.

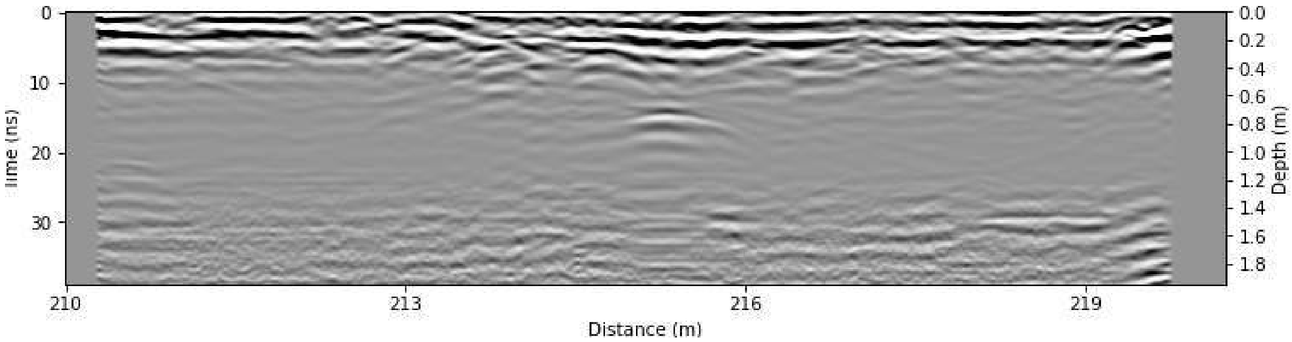


Figure A.262: Radargram at x = 160.25 m.

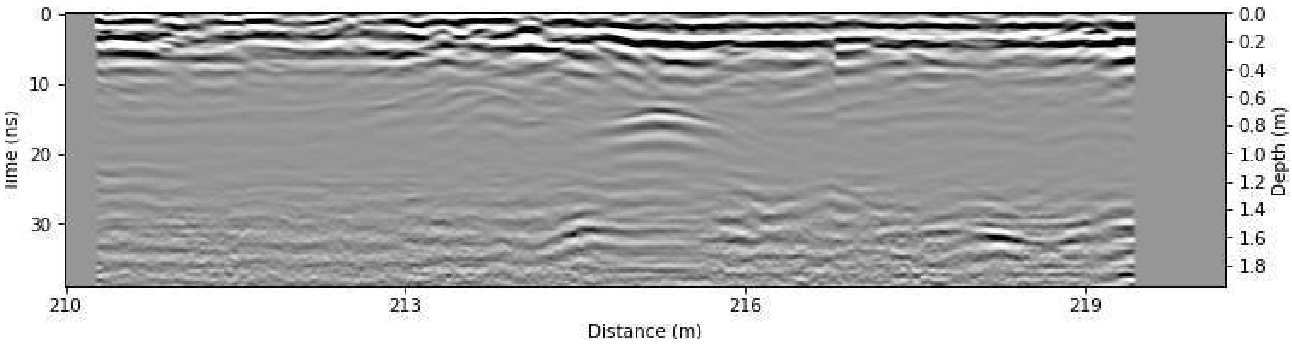


Figure A.263: Radargram at x = 160.5 m.

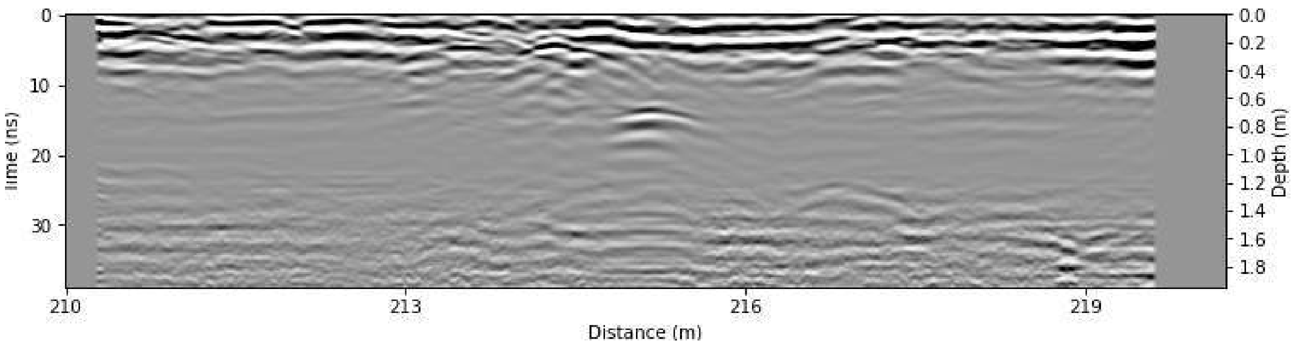


Figure A.264: Radargram at x = 160.75 m.

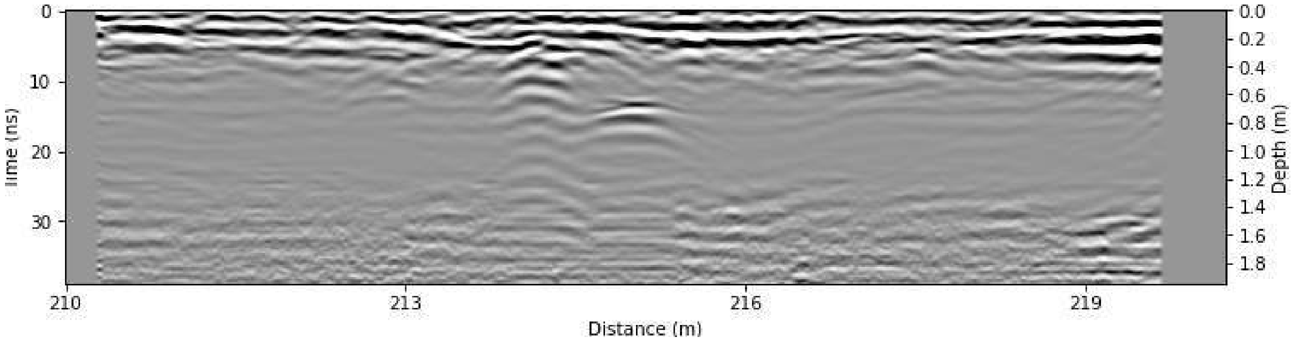


Figure A.265: Radargram at x = 161.0 m.

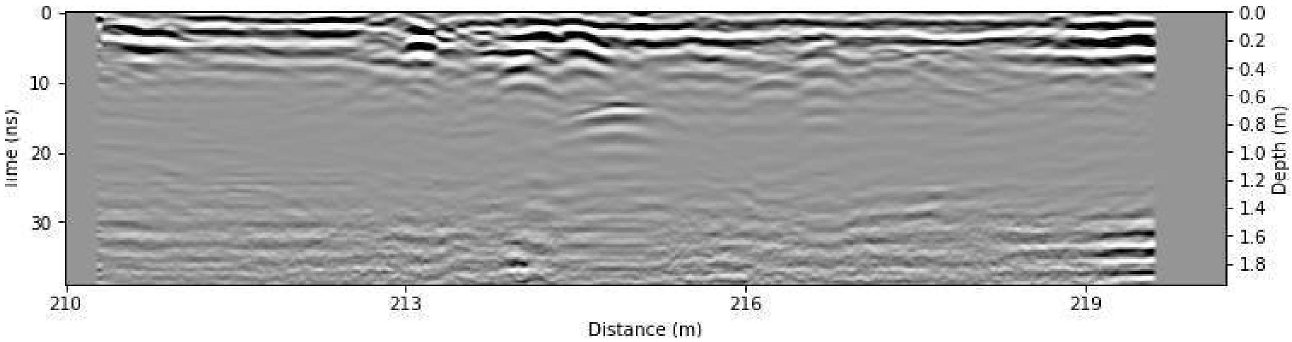


Figure A.266: Radargram at x = 161.25 m.

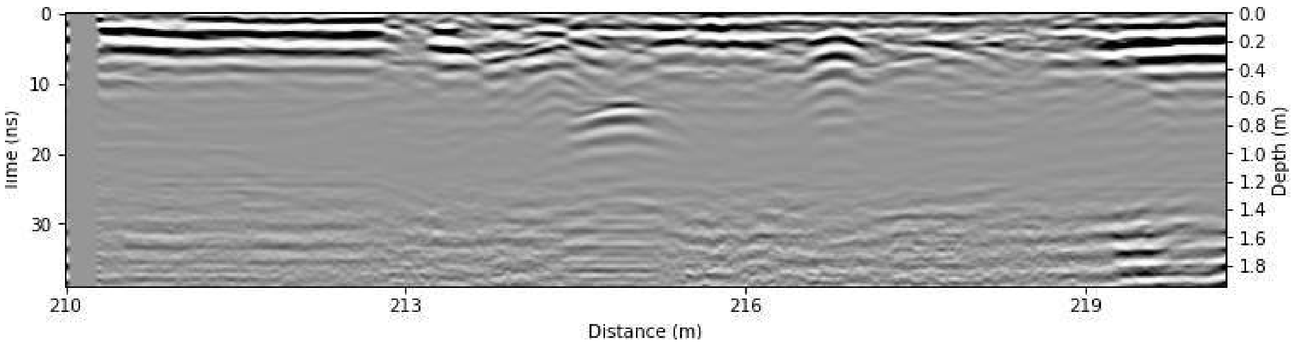


Figure A.267: Radargram at x = 161.5 m.

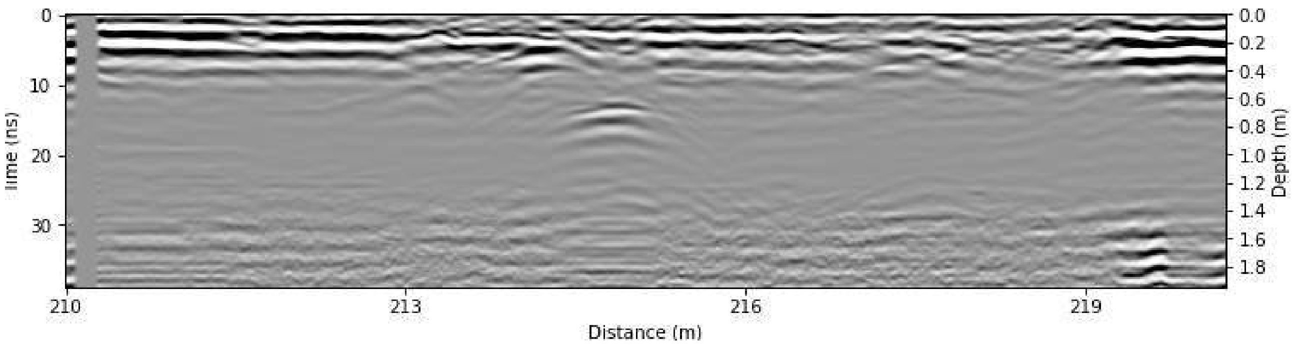


Figure A.268: Radargram at x = 161.75 m.

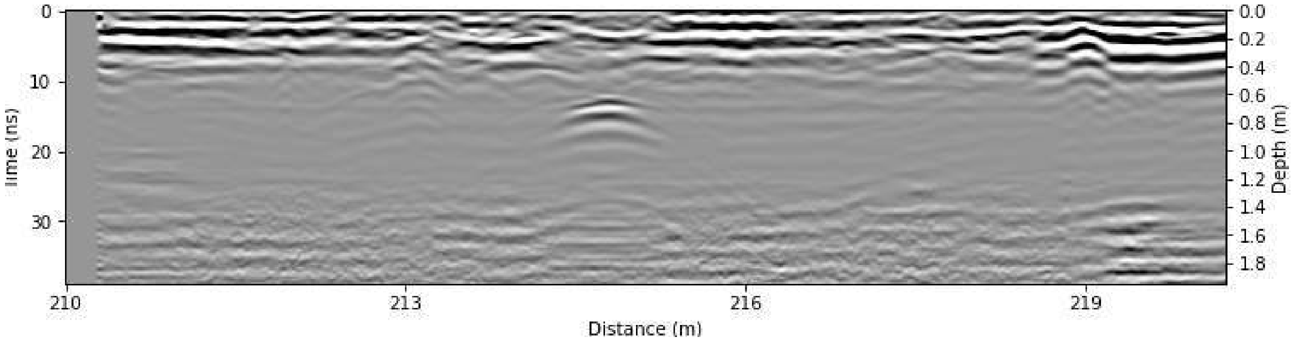


Figure A.269: Radargram at x = 162.0 m.

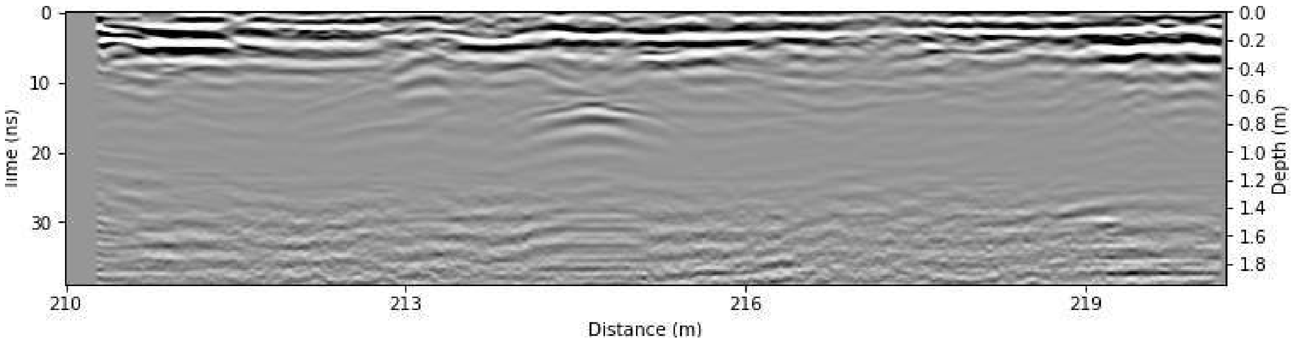


Figure A.270: Radargram at x = 162.25 m.

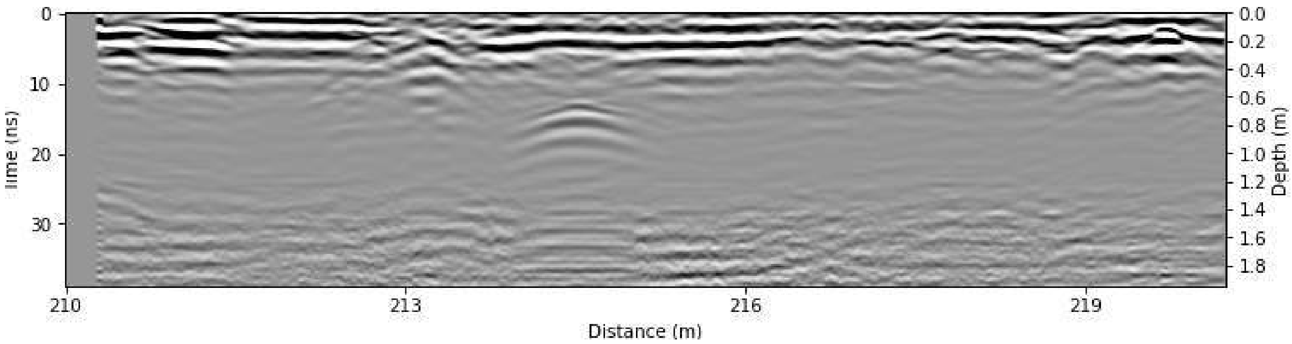


Figure A.271: Radargram at x = 162.5 m.

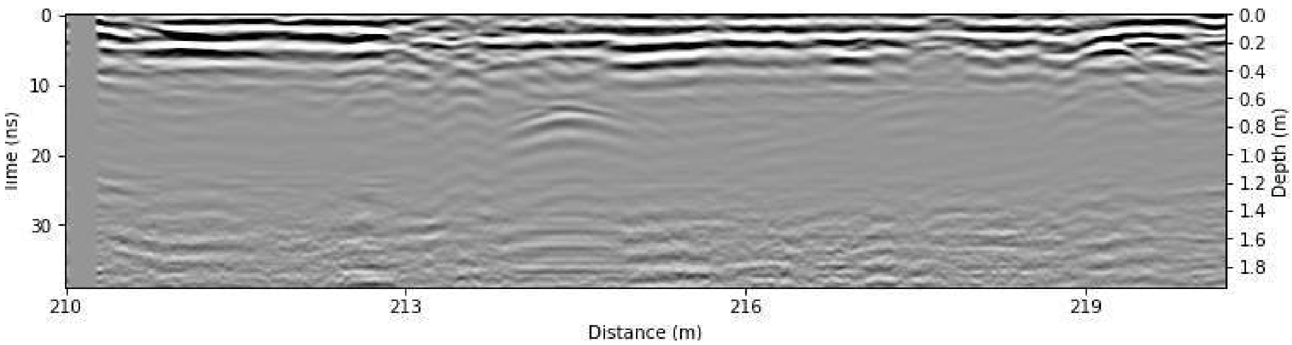


Figure A.272: Radargram at x = 162.75 m.

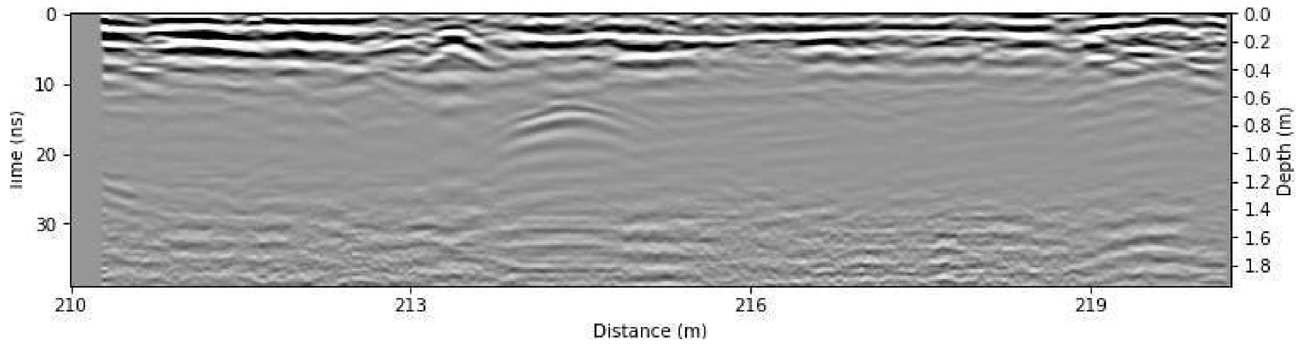


Figure A.273: Radargram at x = 163.0 m.

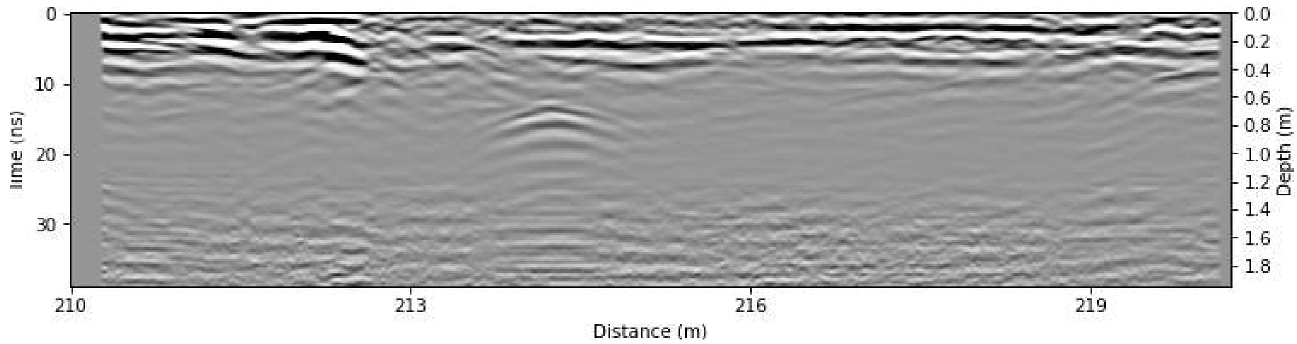


Figure A.274: Radargram at x = 163.25 m.

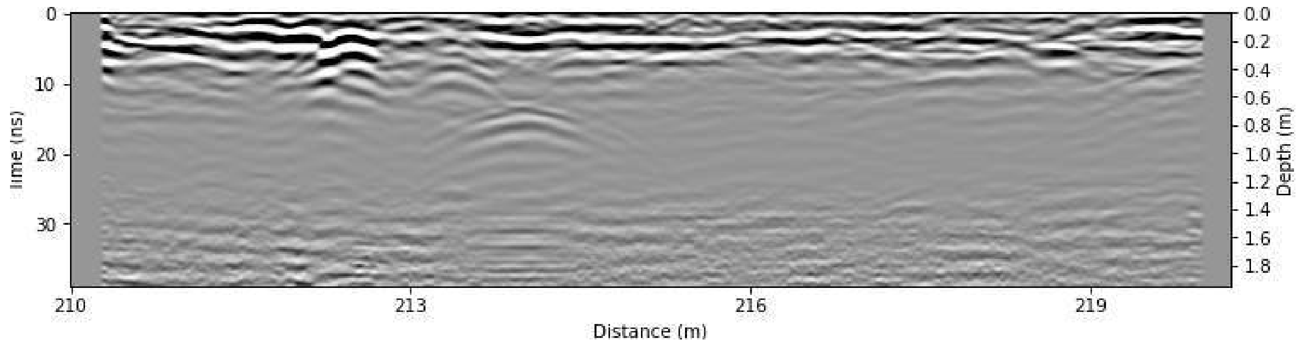


Figure A.275: Radargram at x = 163.5 m.

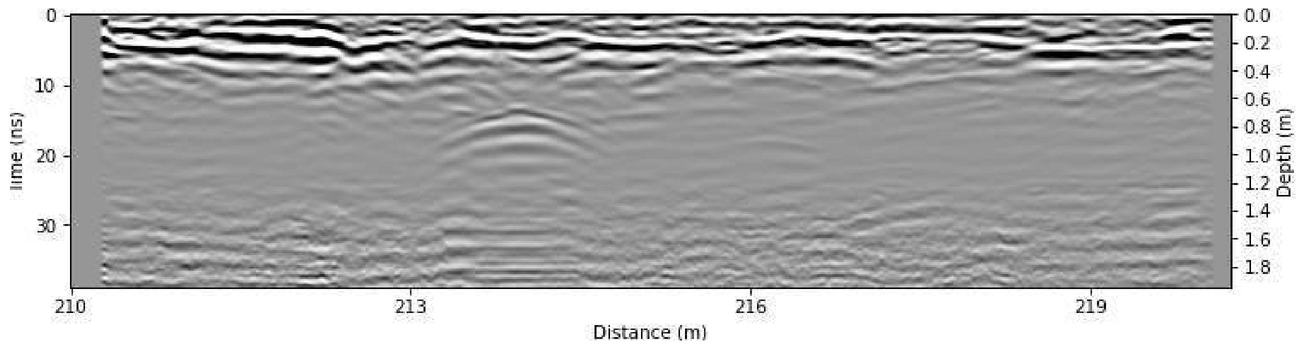


Figure A.276: Radargram at x = 163.75 m.

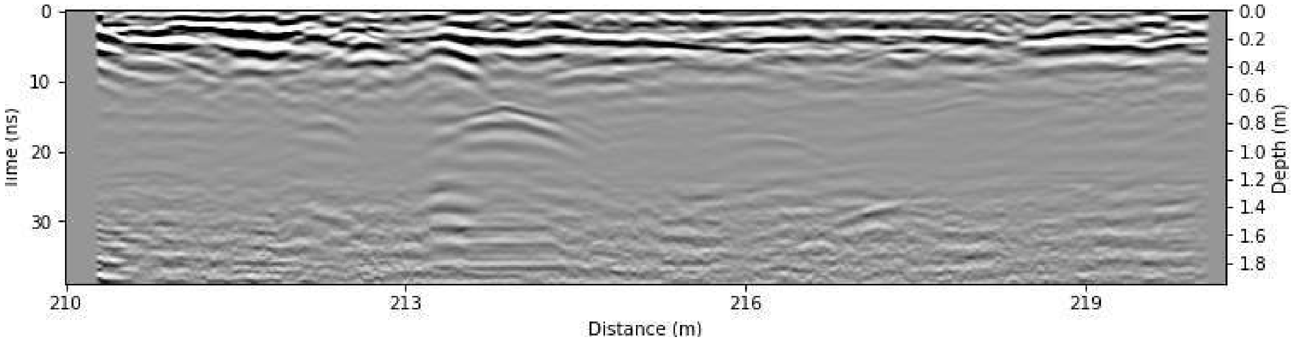


Figure A.277: Radargram at x = 164.0 m.

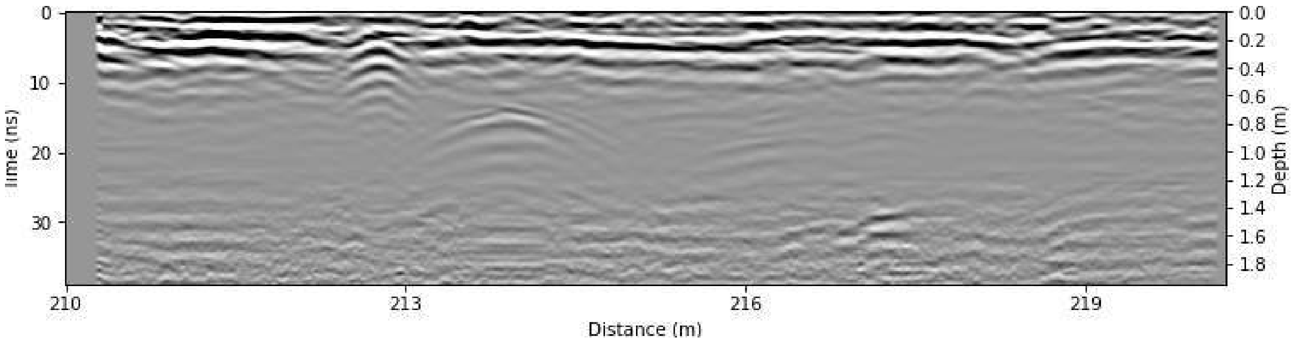


Figure A.278: Radargram at x = 164.25 m.

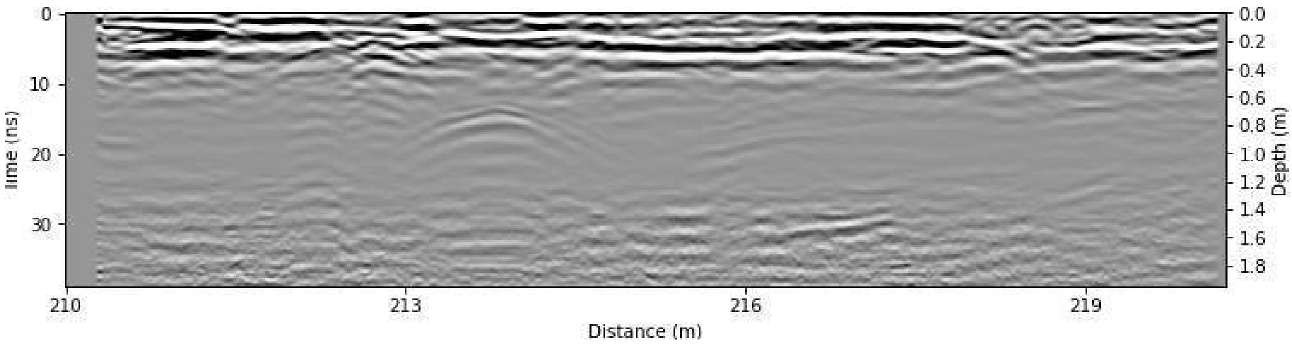


Figure A.279: Radargram at x = 164.5 m.

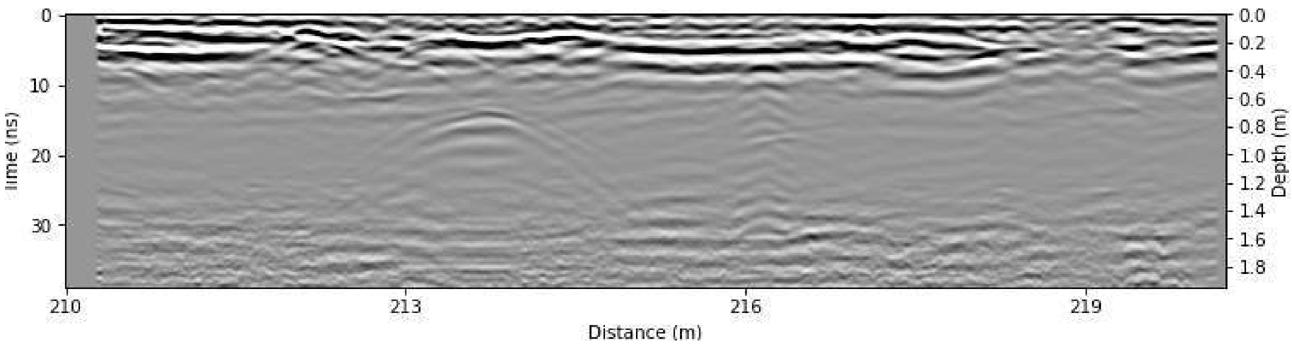


Figure A.280: Radargram at x = 164.75 m.

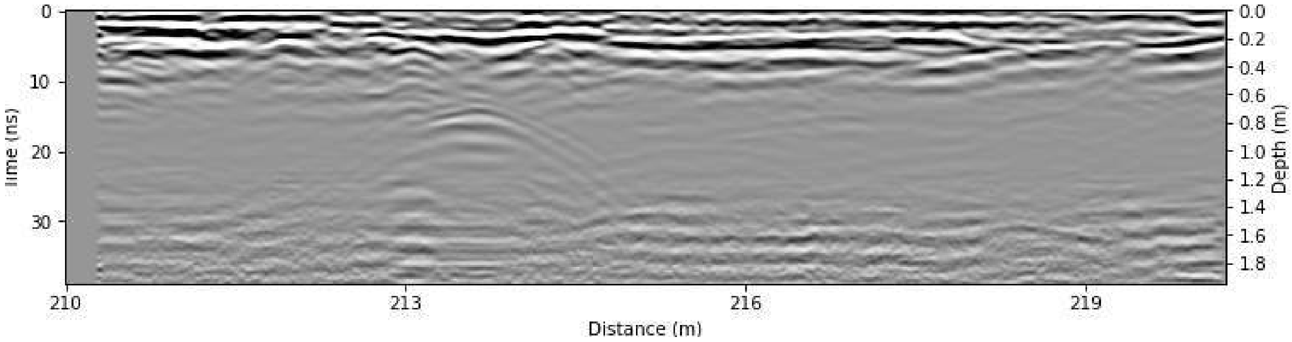


Figure A.281: Radargram at x = 165.0 m.

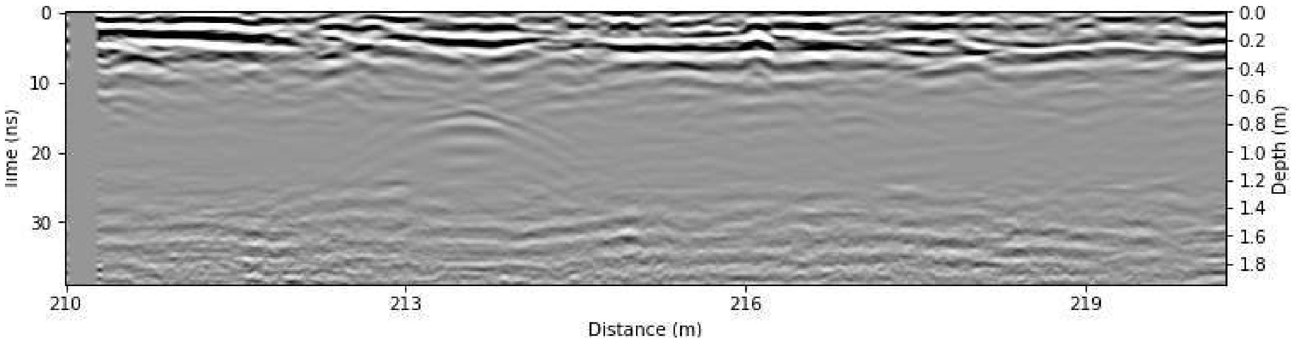


Figure A.282: Radargram at x = 165.25 m.

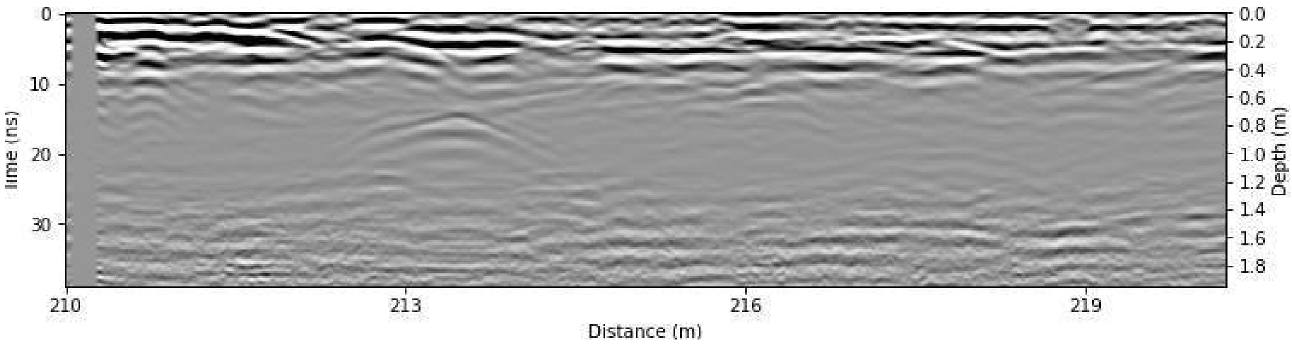


Figure A.283: Radargram at x = 165.5 m.

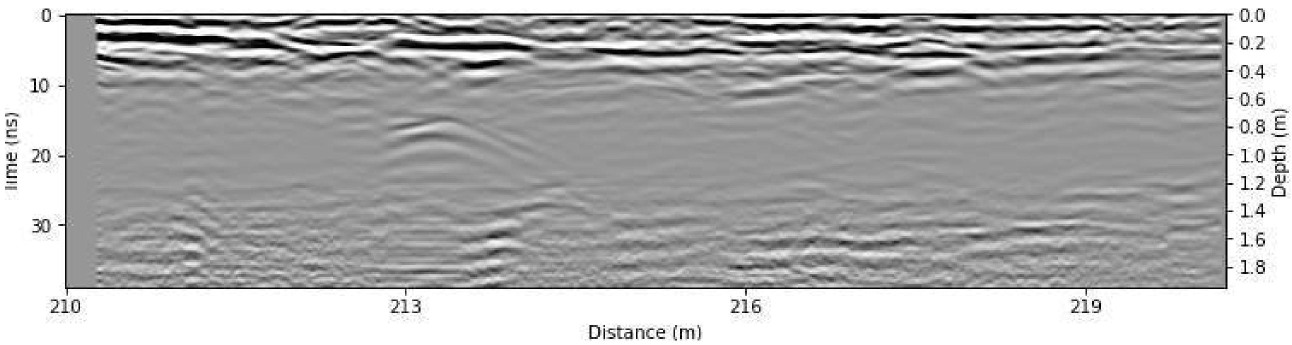


Figure A.284: Radargram at x = 165.75 m.

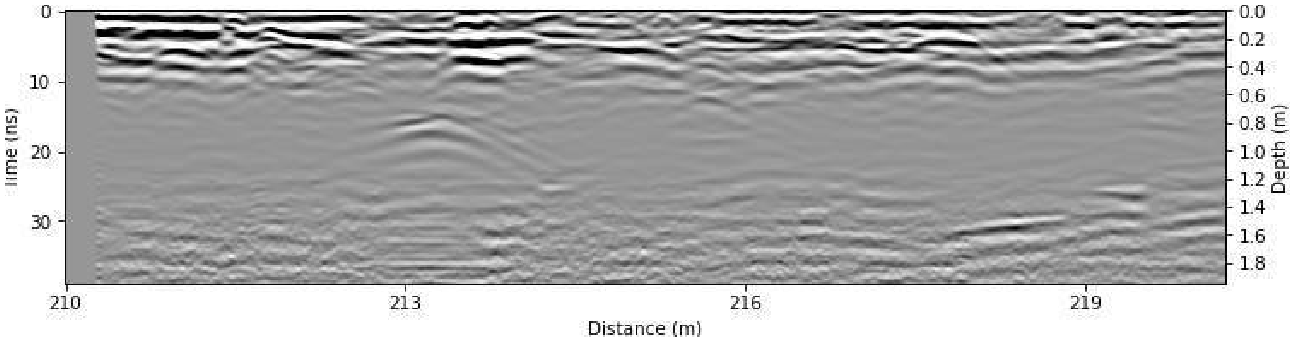


Figure A.285: Radargram at x = 166.0 m.

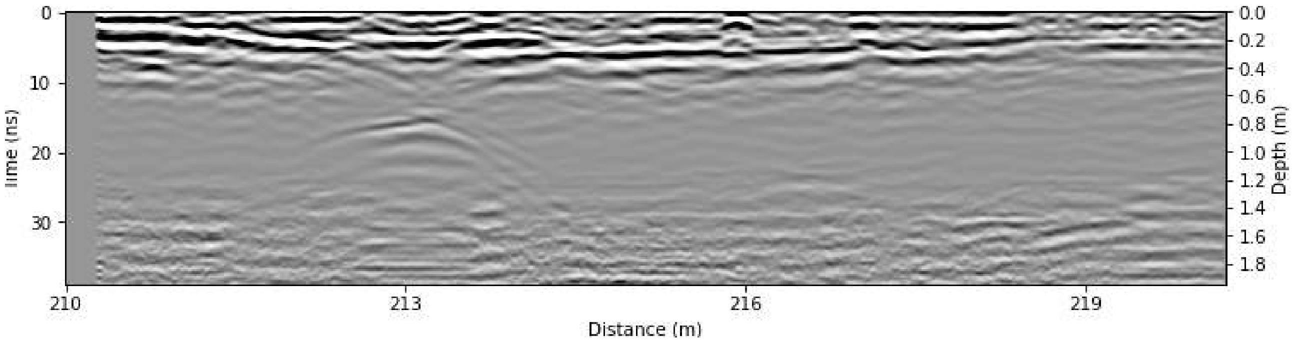


Figure A.286: Radargram at x = 166.25 m.

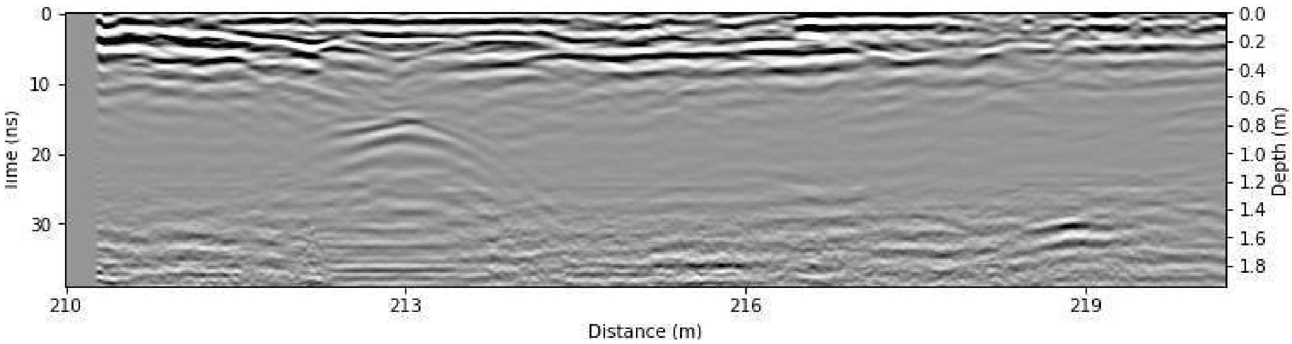


Figure A.287: Radargram at x = 166.5 m.

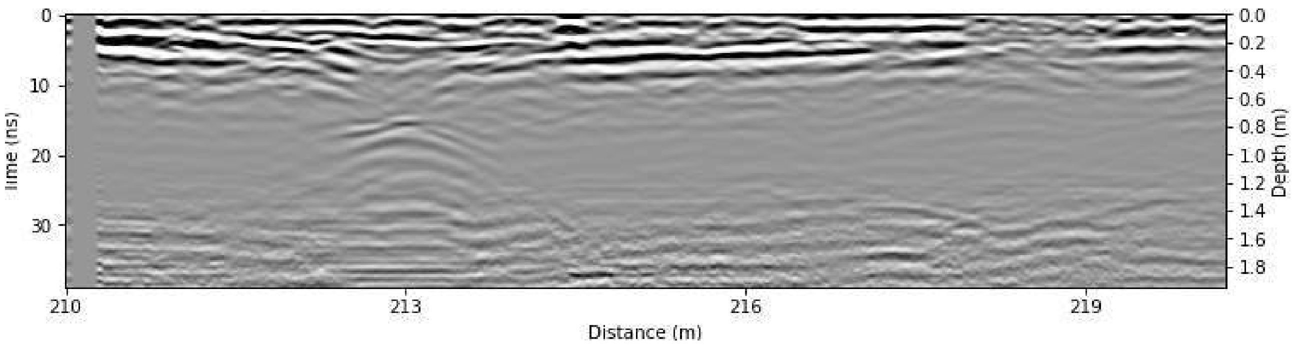


Figure A.288: Radargram at x = 166.75 m.

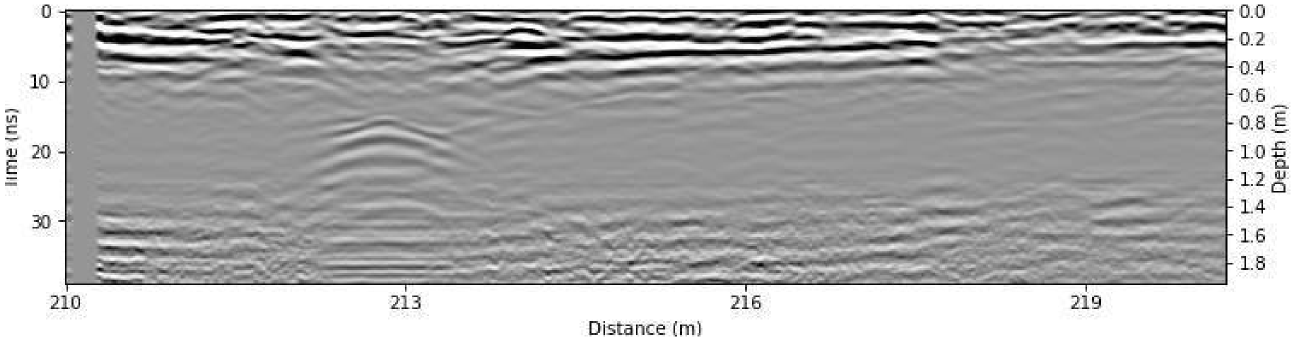


Figure A.289: Radargram at x = 167.0 m.

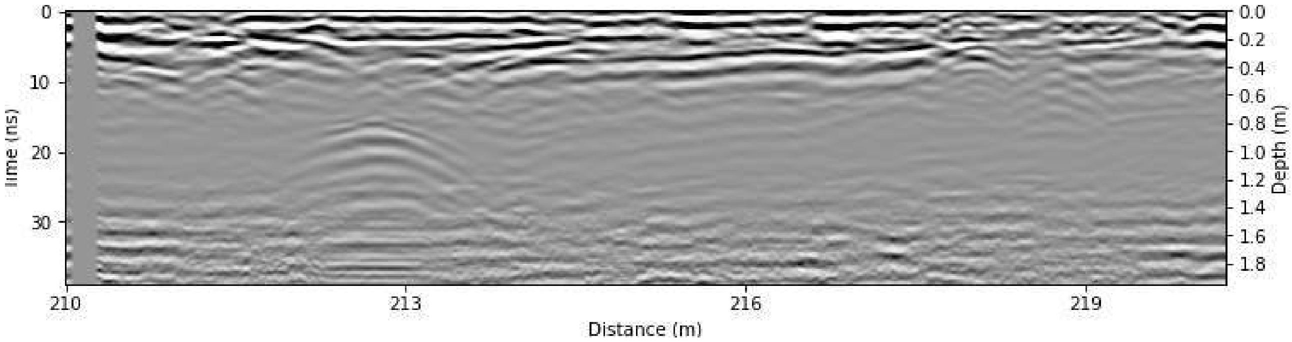


Figure A.290: Radargram at x = 167.25 m.

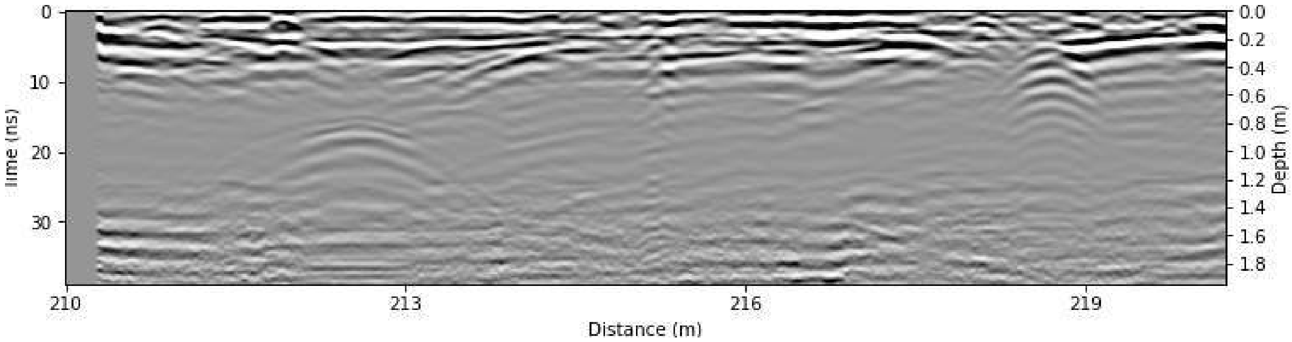


Figure A.291: Radargram at x = 167.5 m.

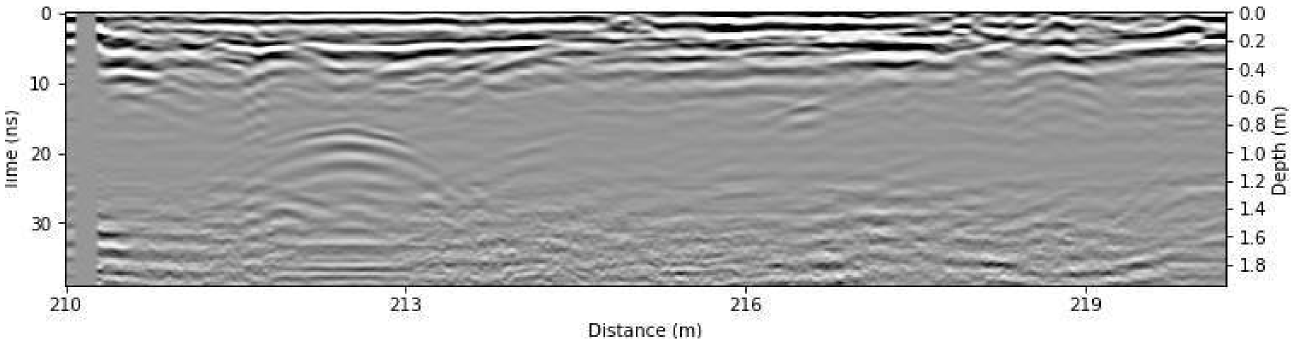


Figure A.292: Radargram at x = 167.75 m.

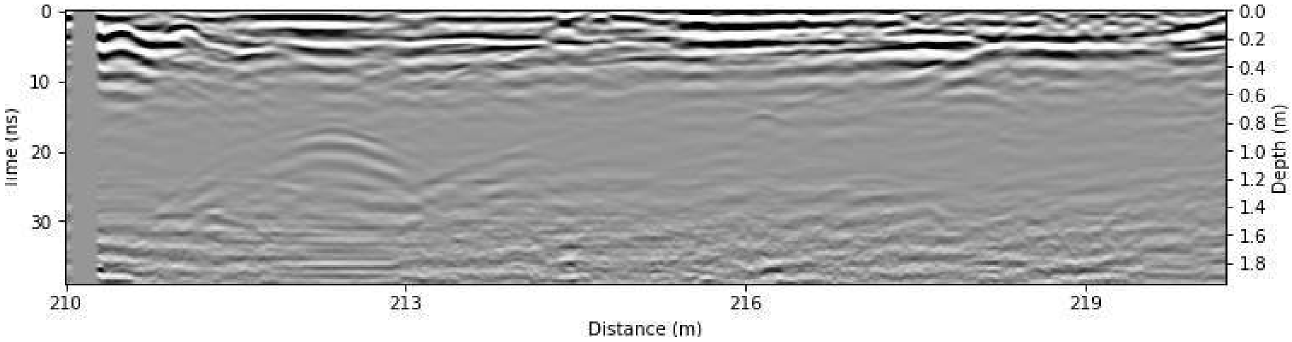


Figure A.293: Radargram at x = 168.0 m.

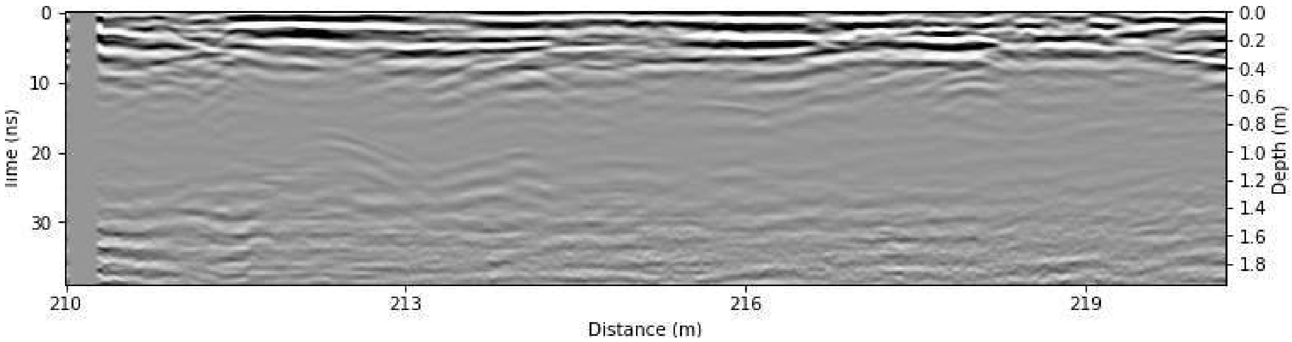


Figure A.294: Radargram at x = 168.25 m.

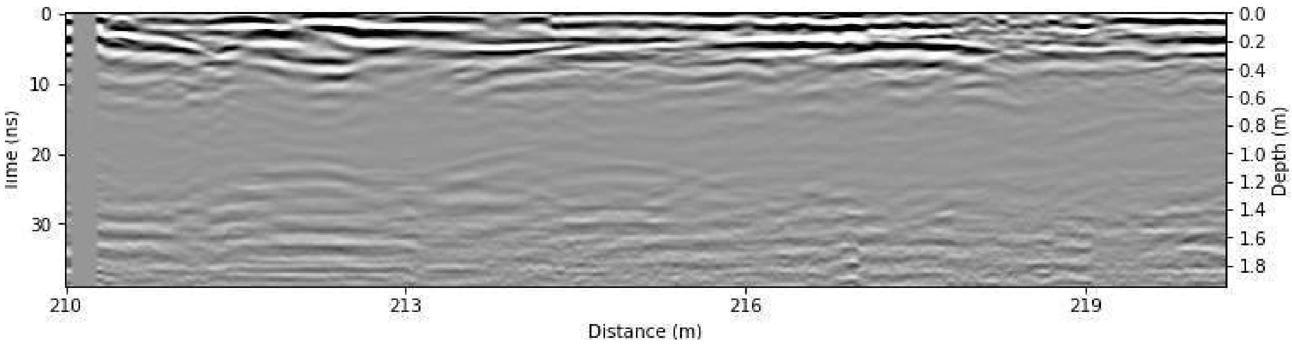


Figure A.295: Radargram at x = 168.5 m.

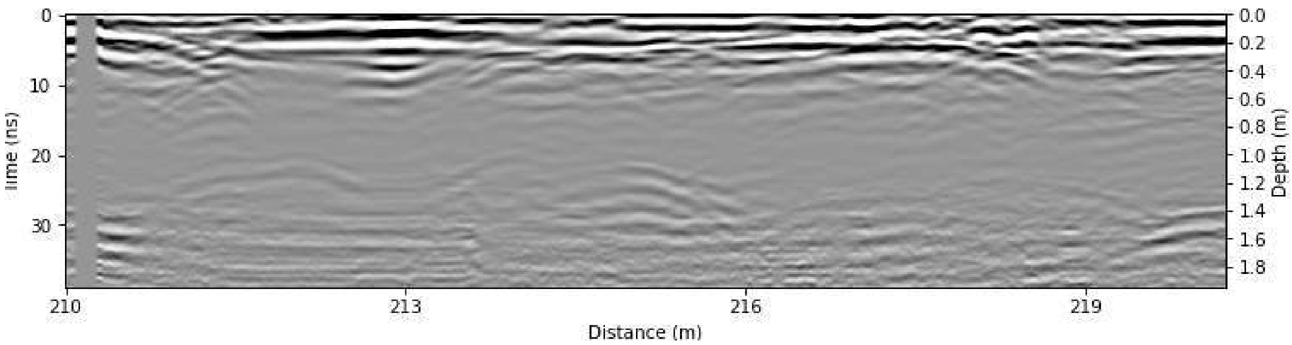


Figure A.296: Radargram at x = 168.75 m.

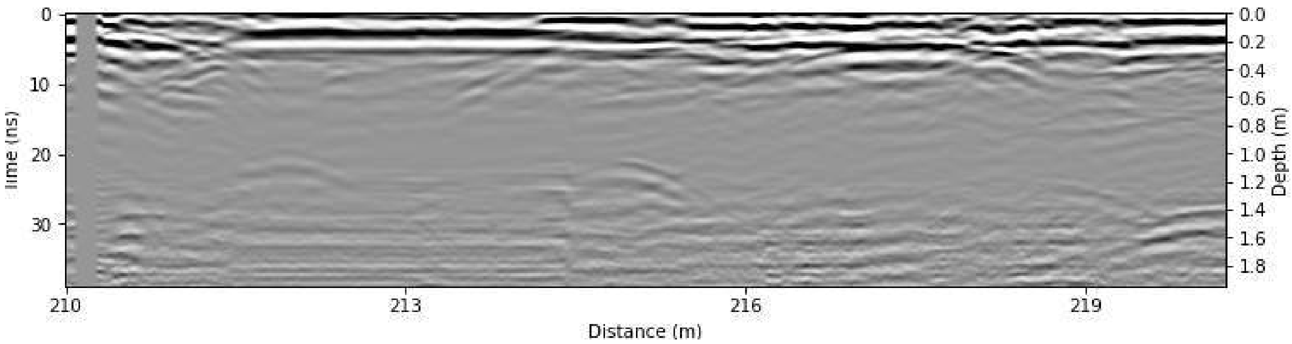


Figure A.297: Radargram at x = 169.0 m.

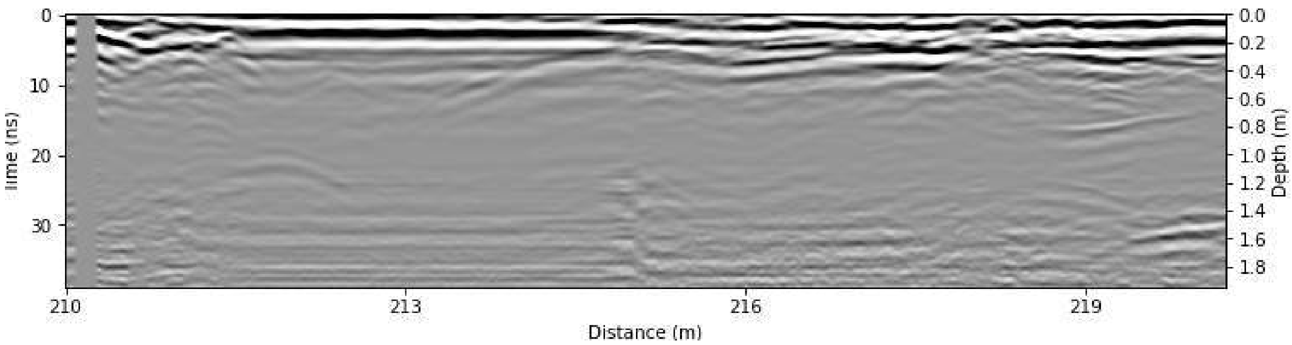


Figure A.298: Radargram at x = 169.25 m.

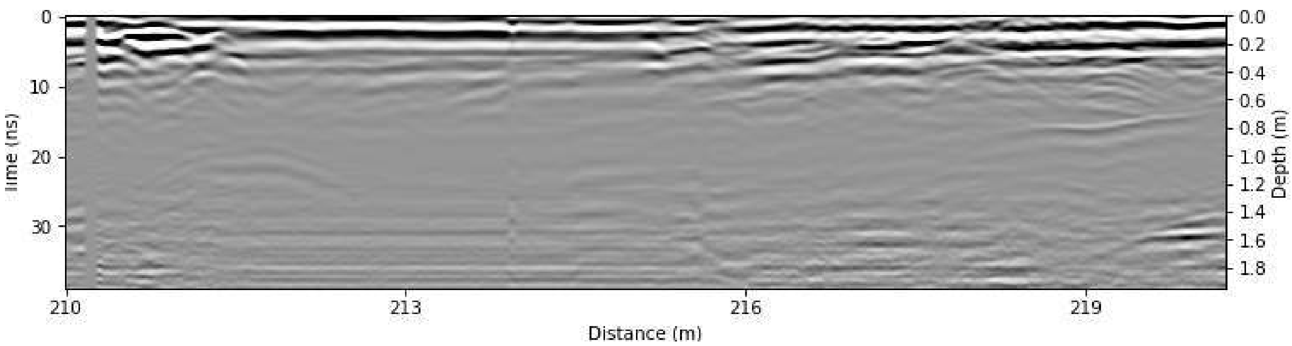


Figure A.299: Radargram at x = 169.5 m.

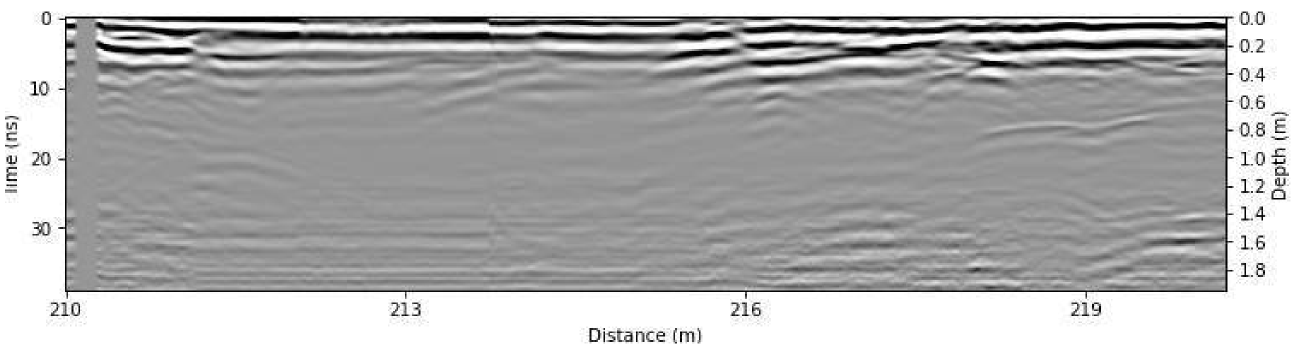


Figure A.300: Radargram at x = 169.75 m.

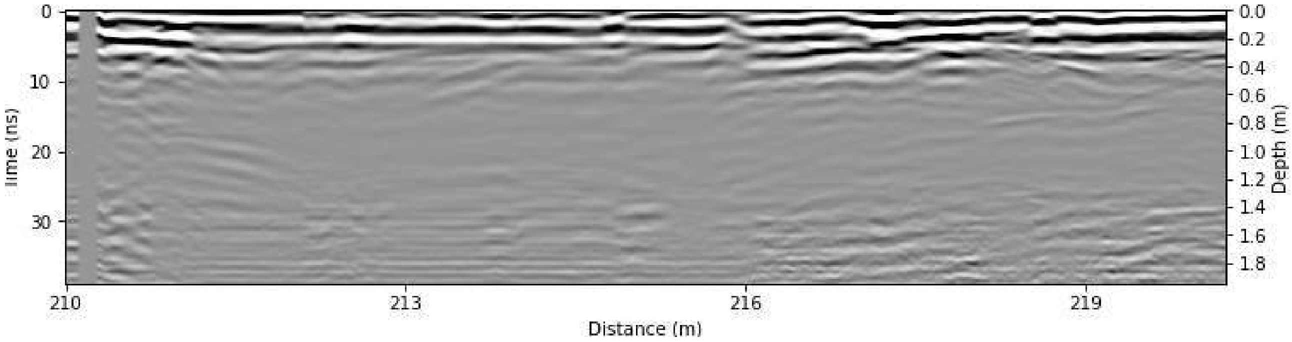


Figure A.301: Radargram at x = 170.0 m.

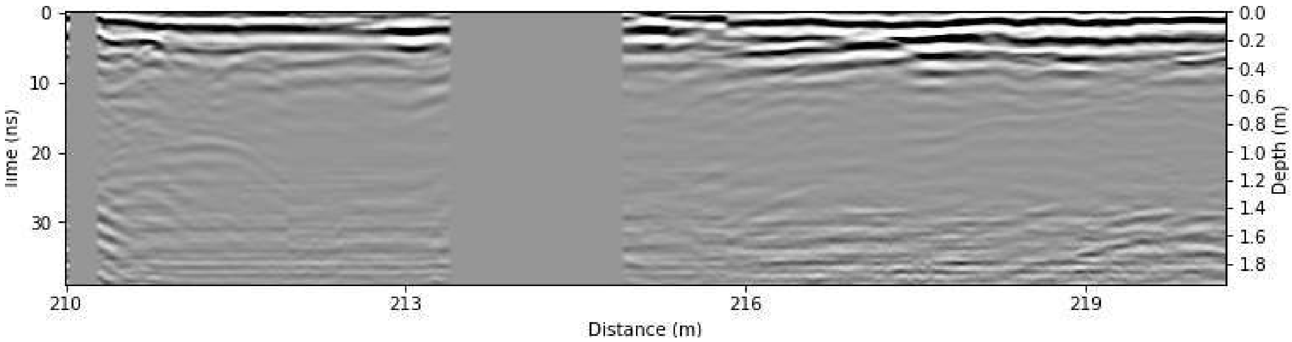


Figure A.302: Radargram at x = 170.25 m.

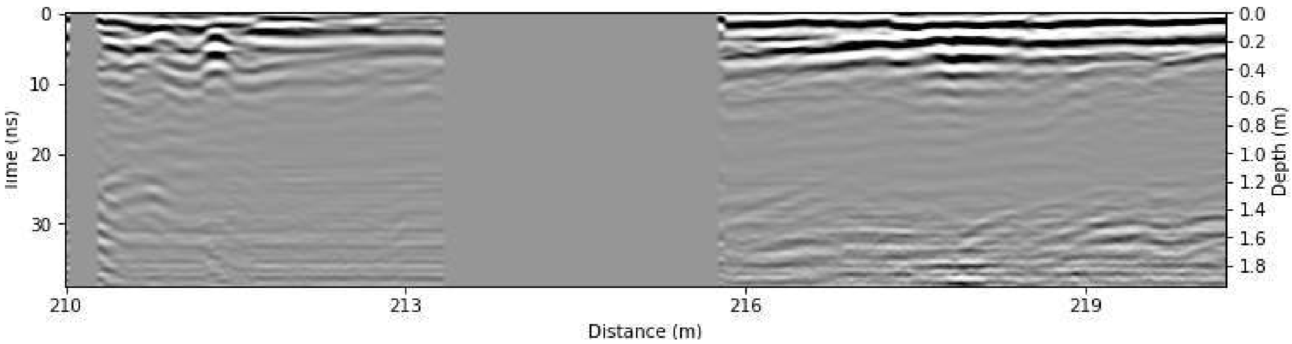


Figure A.303: Radargram at x = 170.5 m.

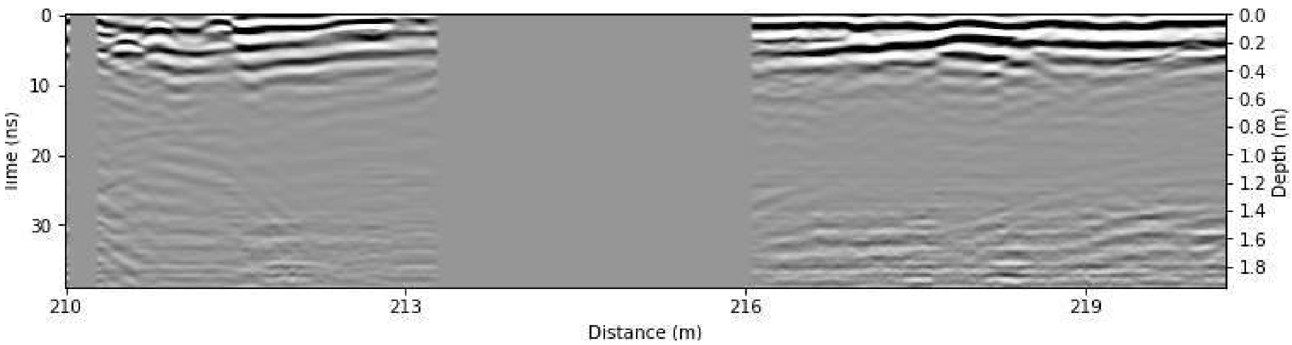


Figure A.304: Radargram at x = 170.75 m.

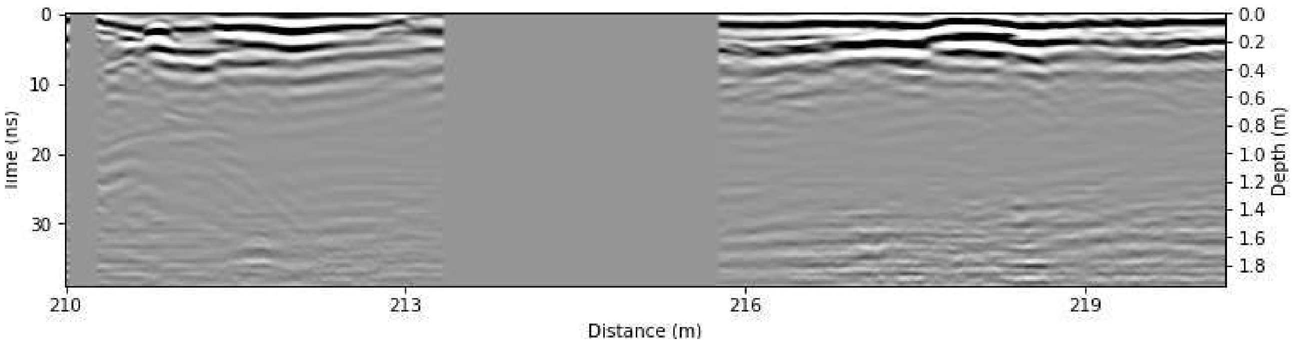


Figure A.305: Radargram at x = 171.0 m.

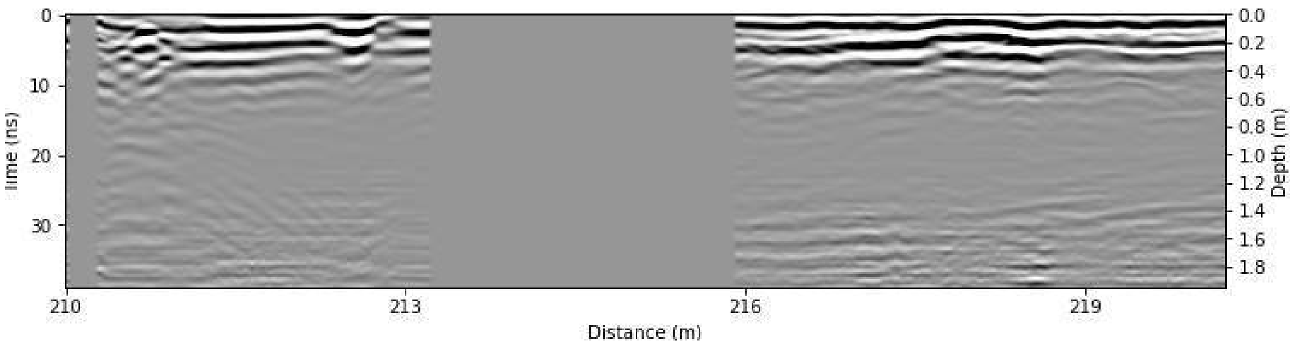


Figure A.306: Radargram at x = 171.25 m.

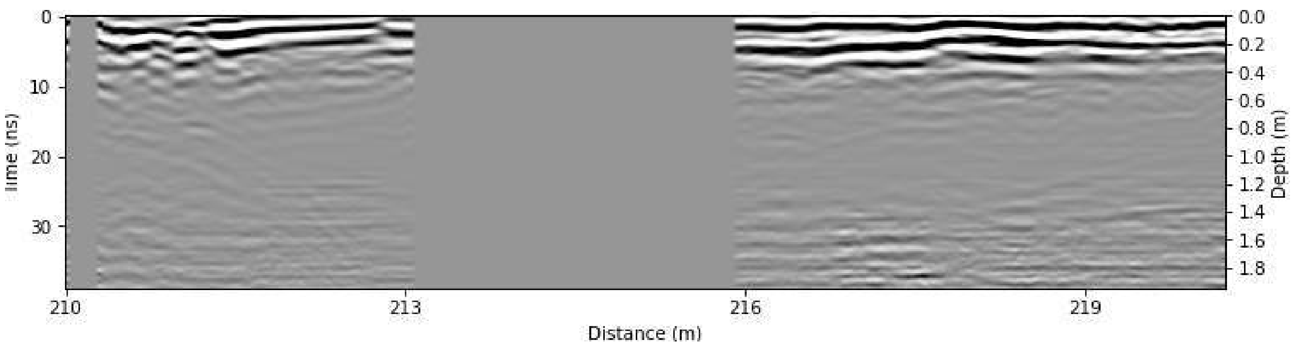


Figure A.307: Radargram at x = 171.5 m.

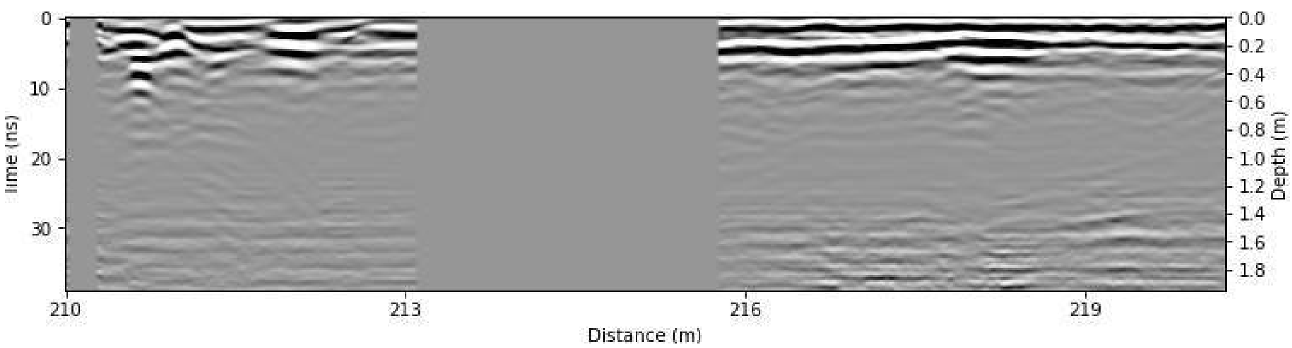


Figure A.308: Radargram at x = 171.75 m.

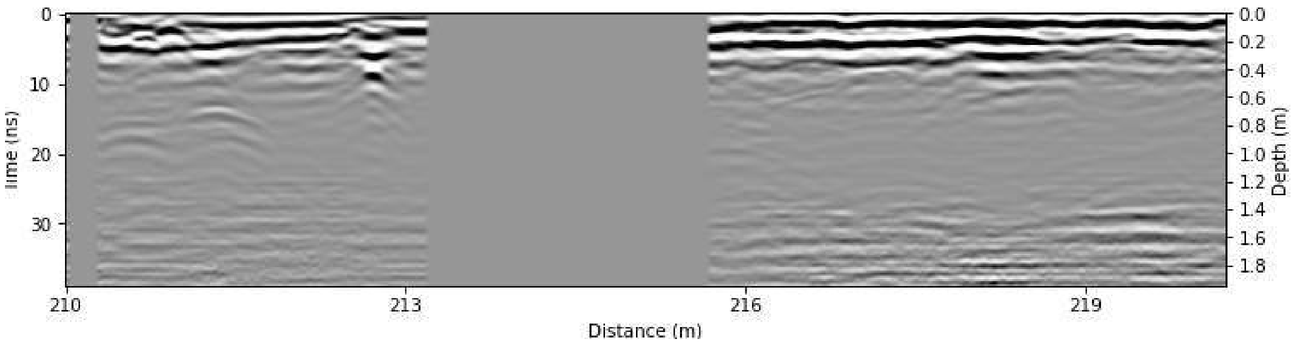


Figure A.309: Radargram at x = 172.0 m.

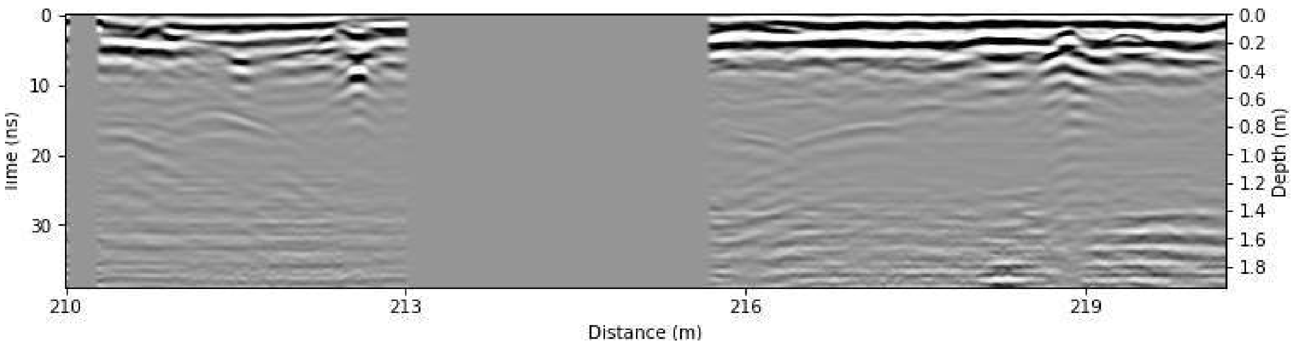


Figure A.310: Radargram at x = 172.25 m.

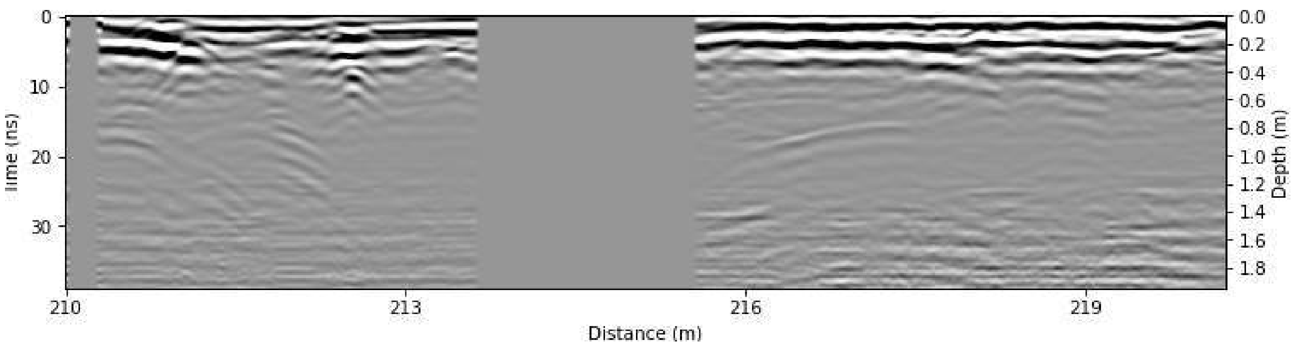


Figure A.311: Radargram at x = 172.5 m.

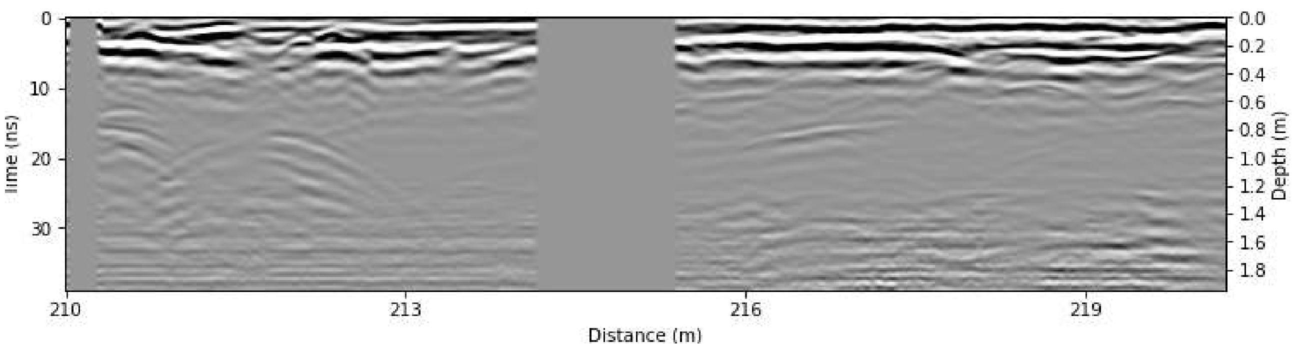


Figure A.312: Radargram at x = 172.75 m.

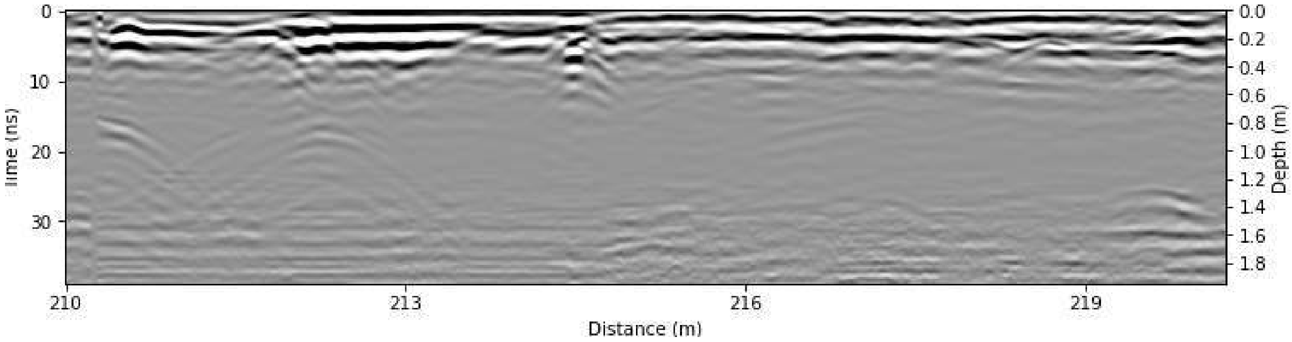


Figure A.313: Radargram at x = 173.0 m.

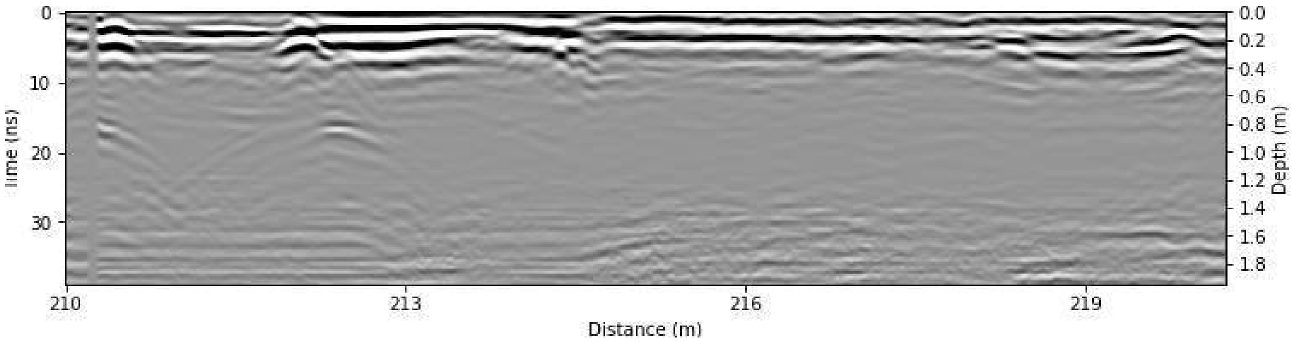


Figure A.314: Radargram at x = 173.25 m.

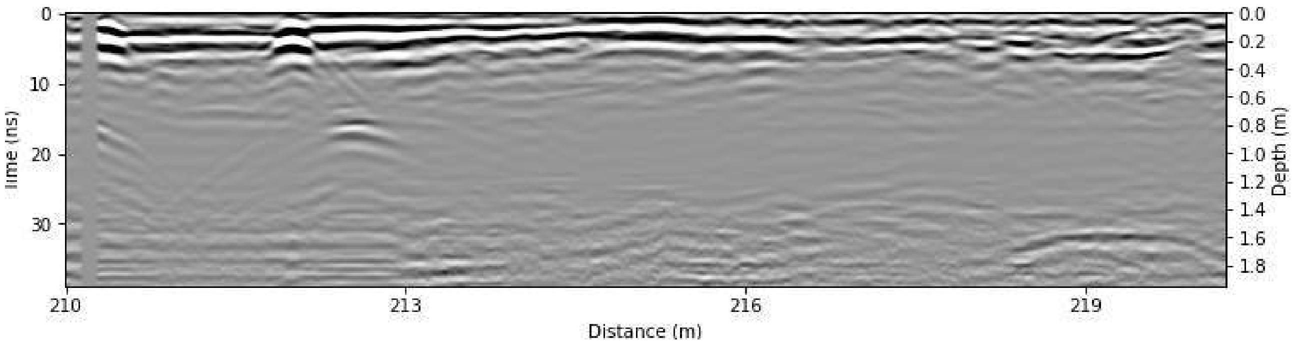


Figure A.315: Radargram at x = 173.5 m.

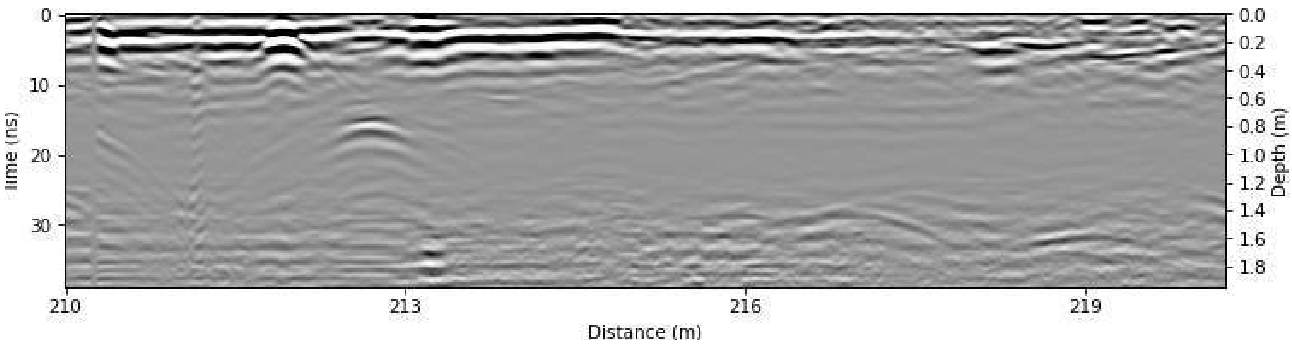


Figure A.316: Radargram at x = 173.75 m.

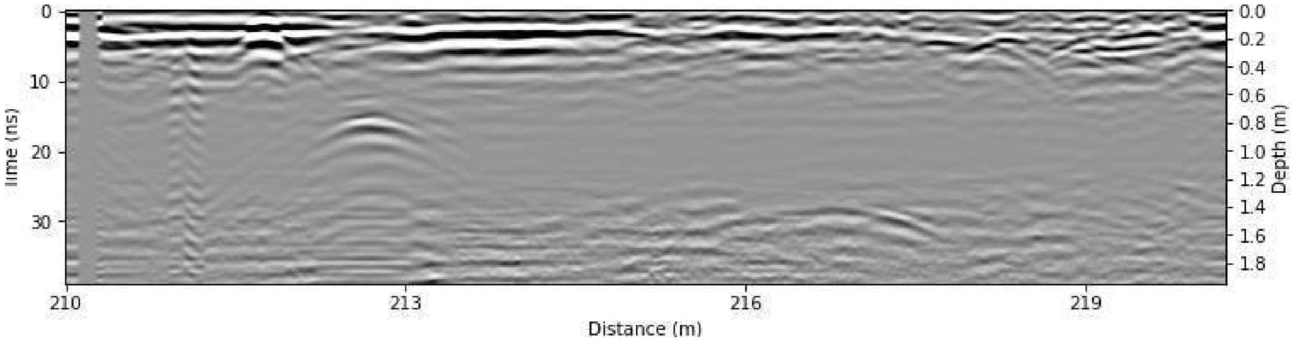


Figure A.317: Radargram at x = 174.0 m.

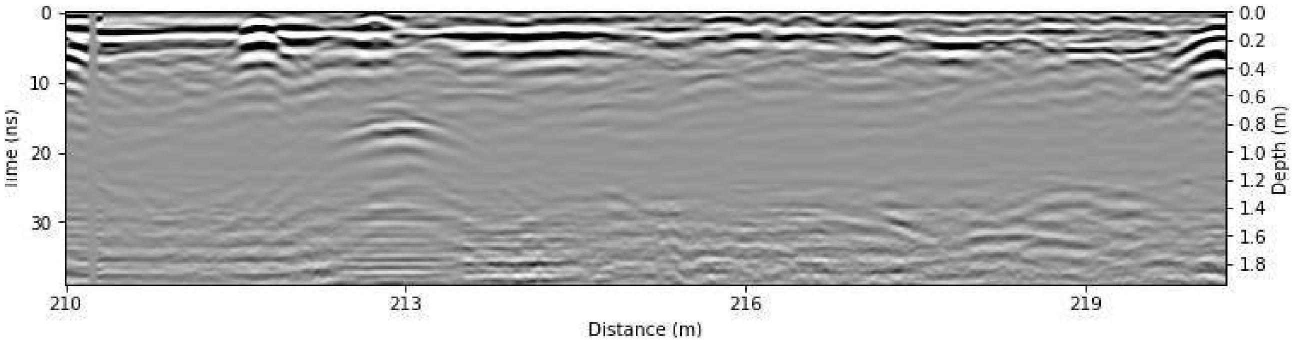


Figure A.318: Radargram at x = 174.25 m.

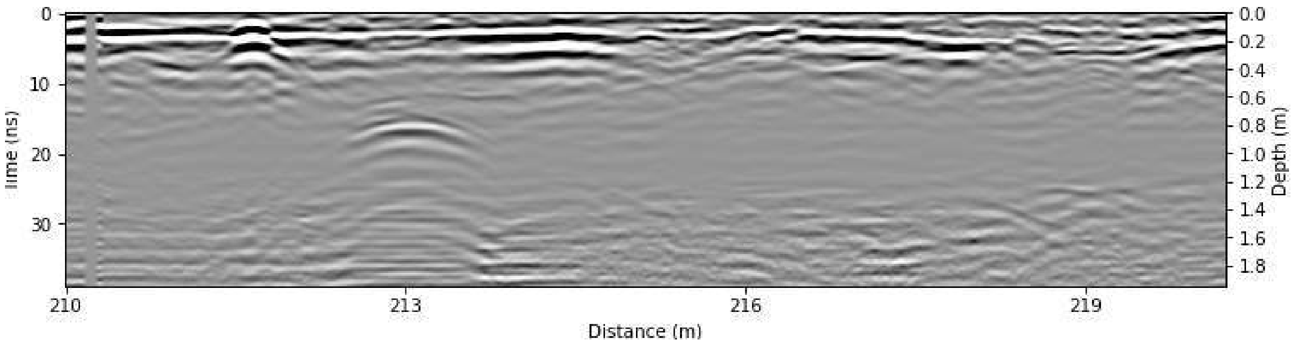


Figure A.319: Radargram at x = 174.5 m.

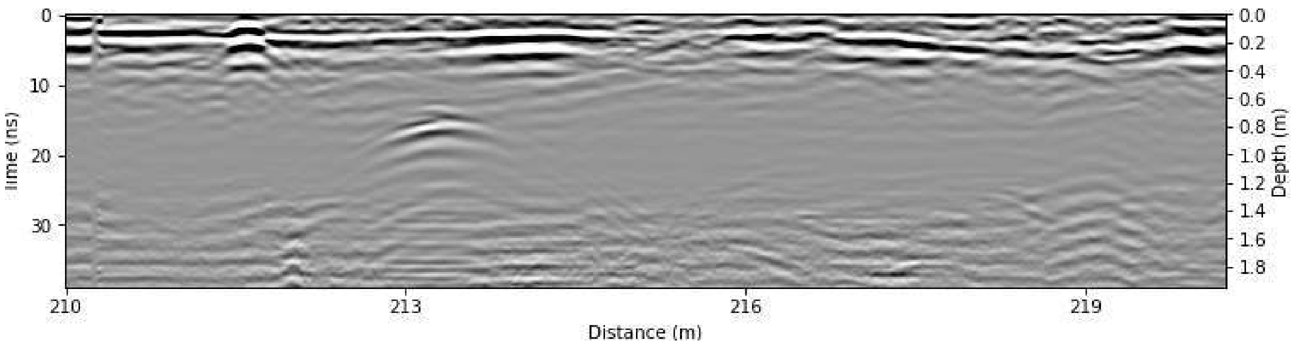


Figure A.320: Radargram at x = 174.75 m.

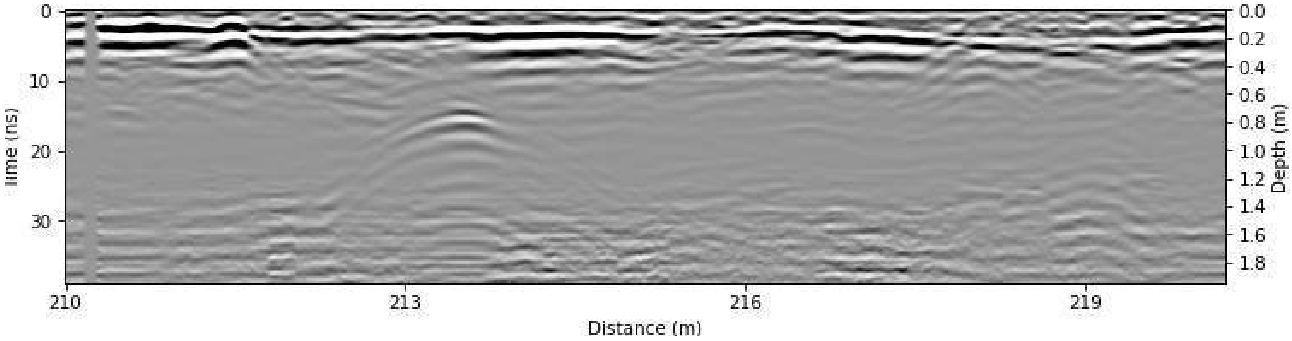


Figure A.321: Radargram at x = 175.0 m.

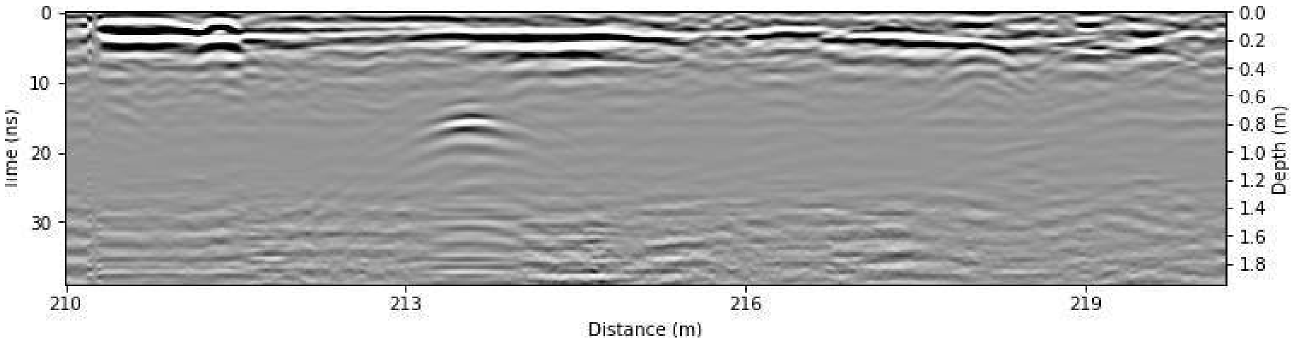


Figure A.322: Radargram at x = 175.25 m.

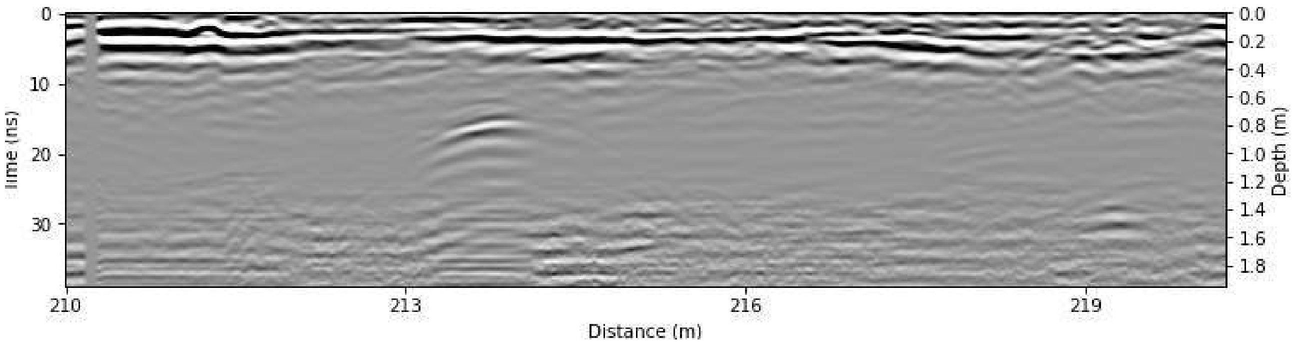


Figure A.323: Radargram at x = 175.5 m.

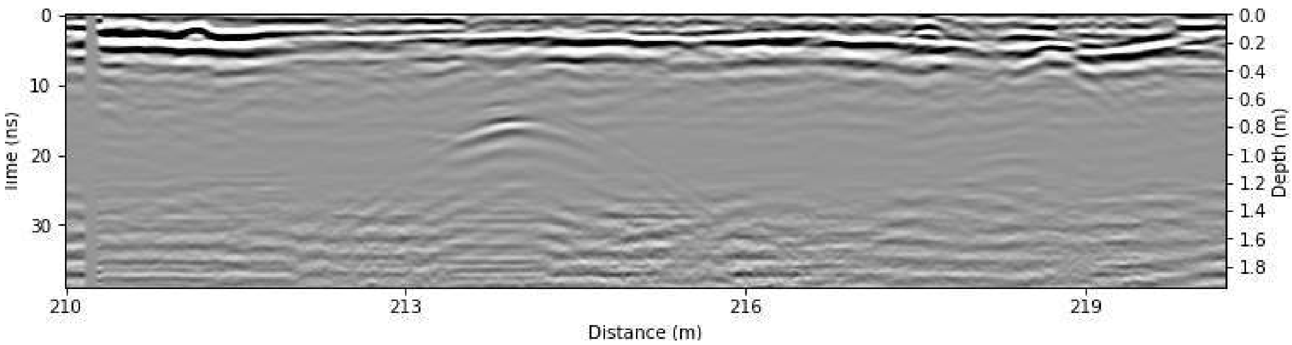


Figure A.324: Radargram at x = 175.75 m.

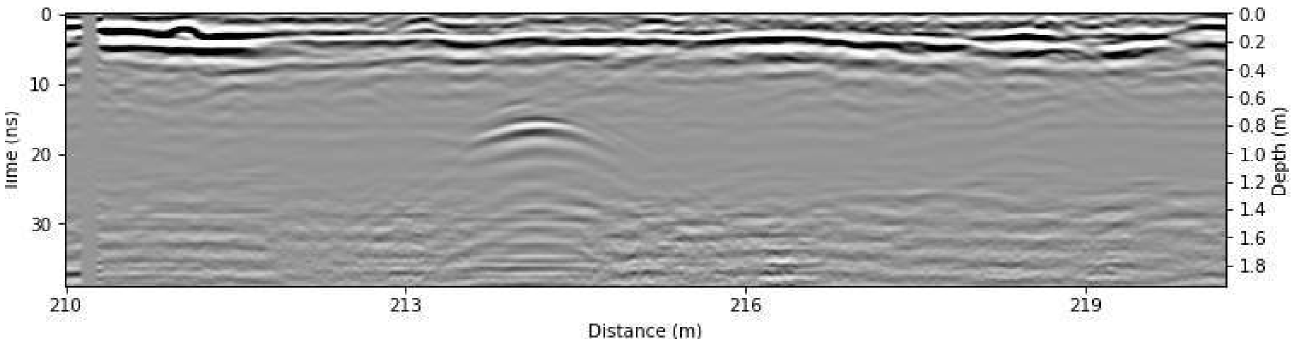


Figure A.325: Radargram at x = 176.0 m.

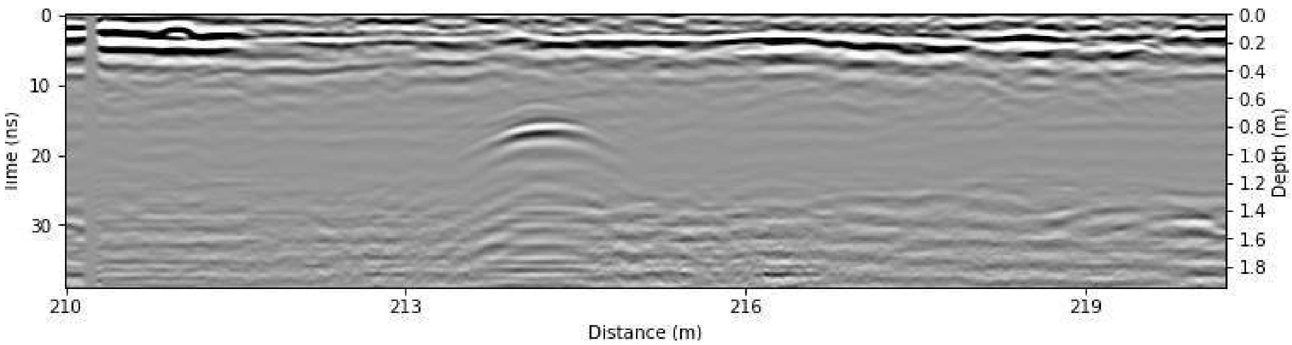


Figure A.326: Radargram at x = 176.25 m.

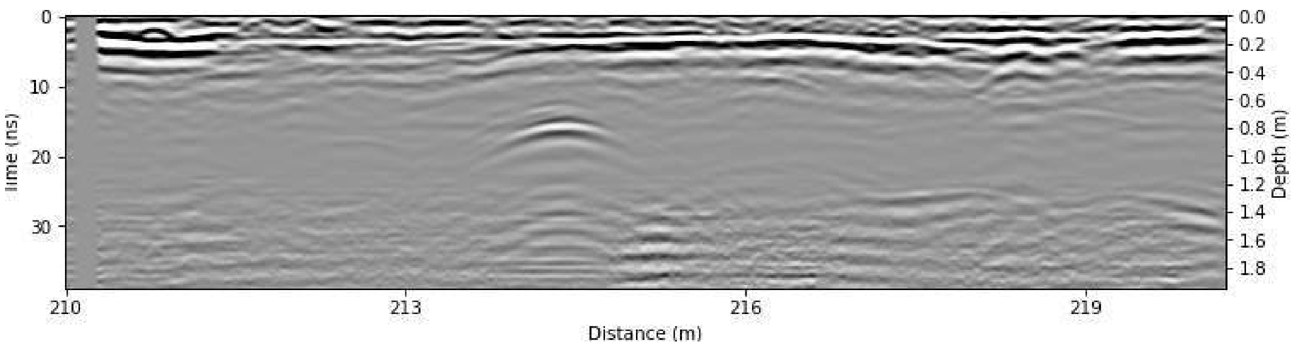


Figure A.327: Radargram at x = 176.5 m.

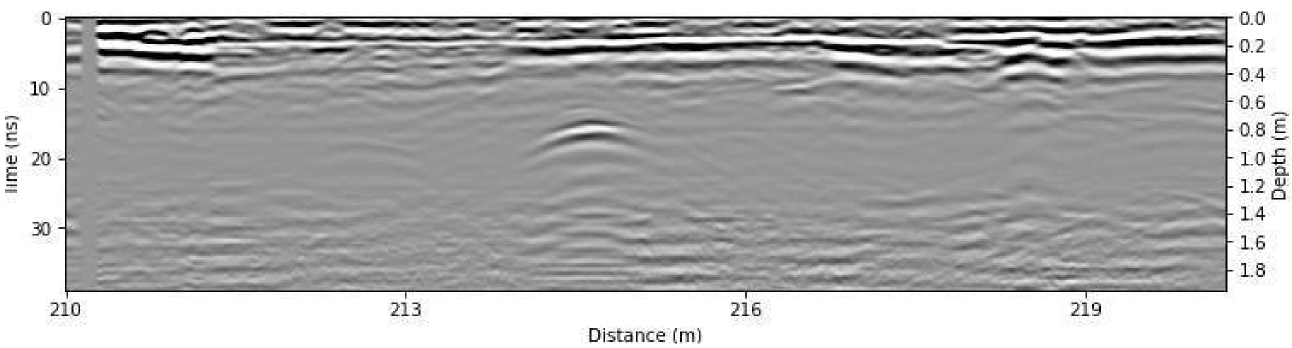


Figure A.328: Radargram at x = 176.75 m.

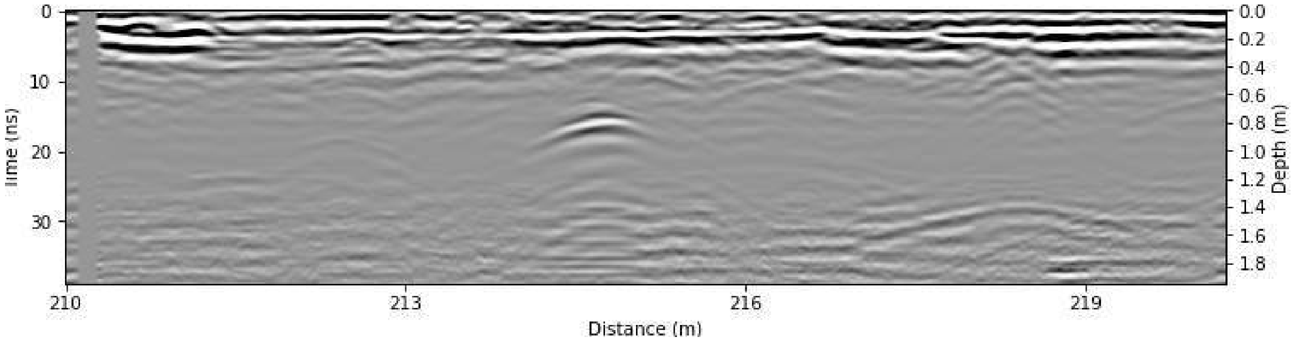


Figure A.329: Radargram at x = 177.0 m.

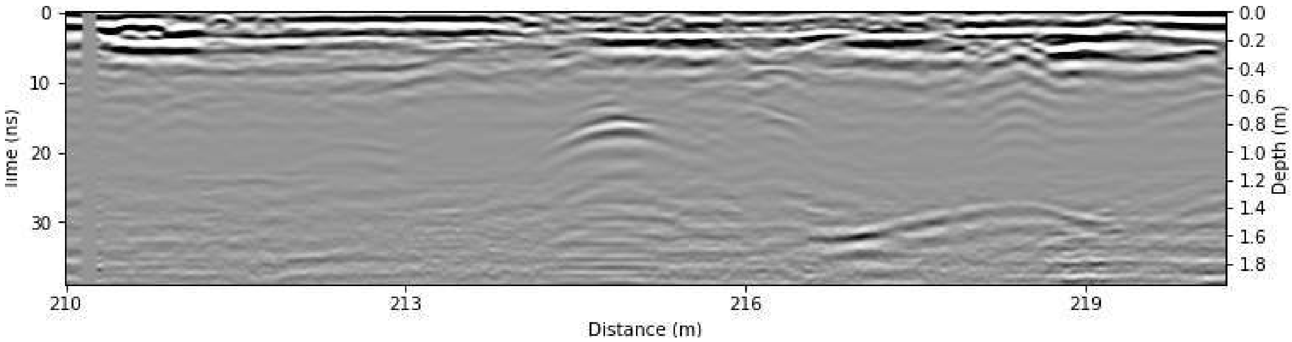


Figure A.330: Radargram at x = 177.25 m.

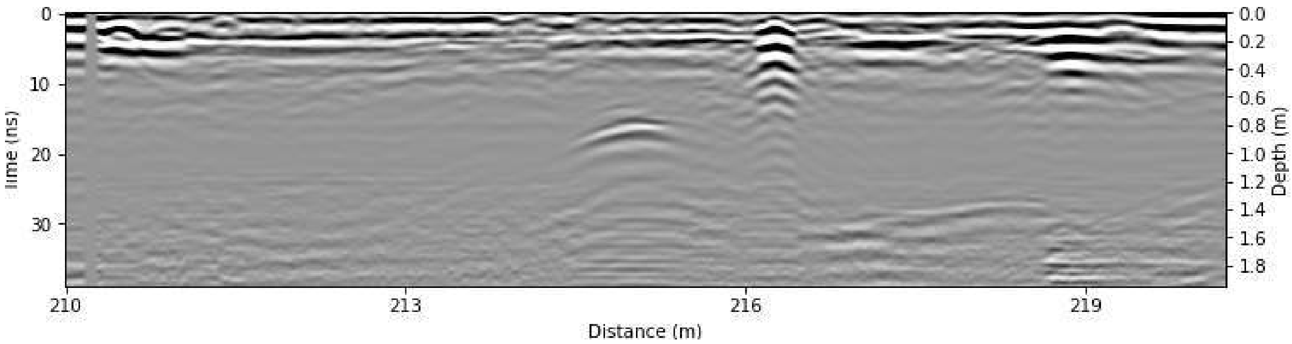


Figure A.331: Radargram at x = 177.5 m.

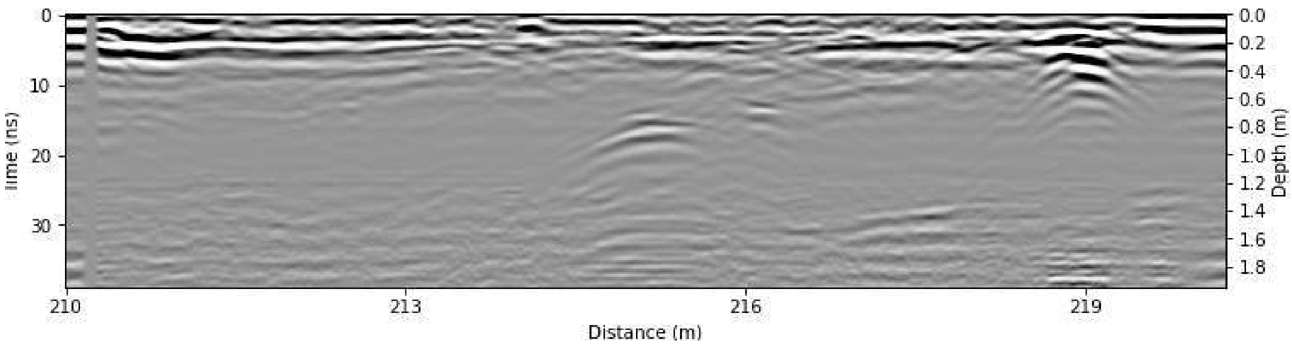


Figure A.332: Radargram at x = 177.75 m.

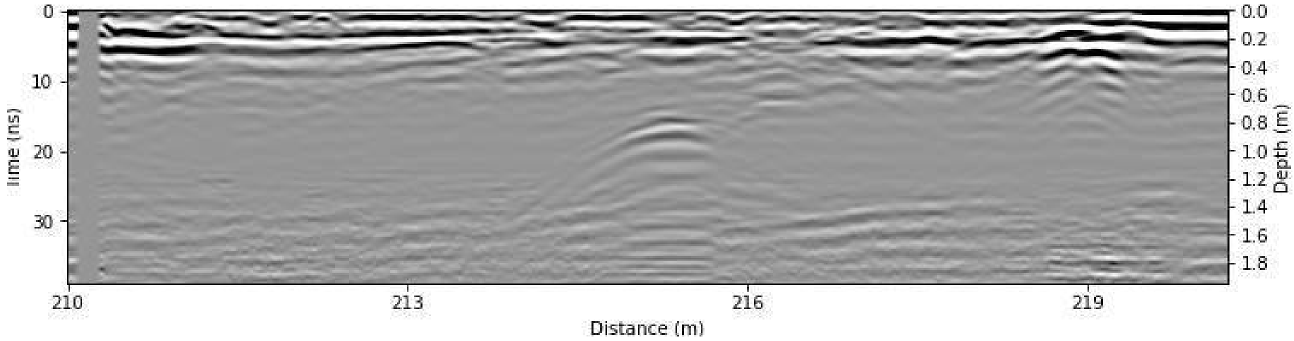


Figure A.333: Radargram at x = 178.0 m.

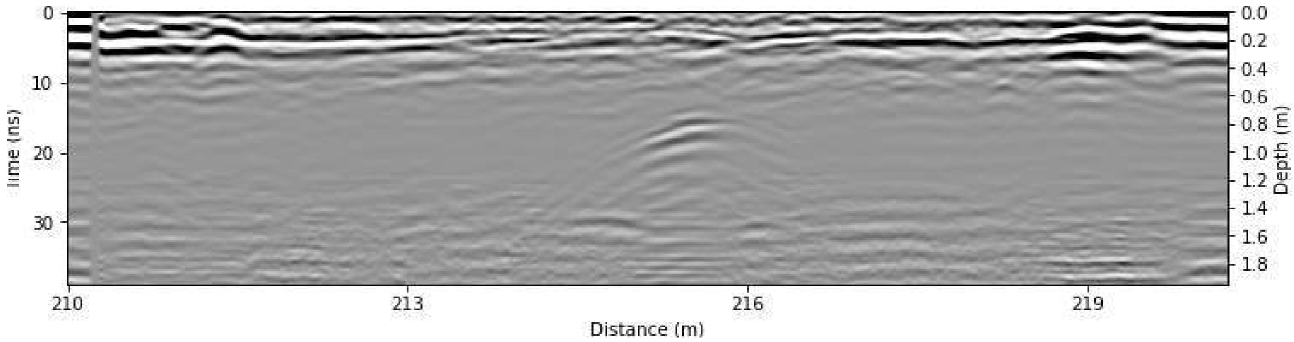


Figure A.334: Radargram at x = 178.25 m.

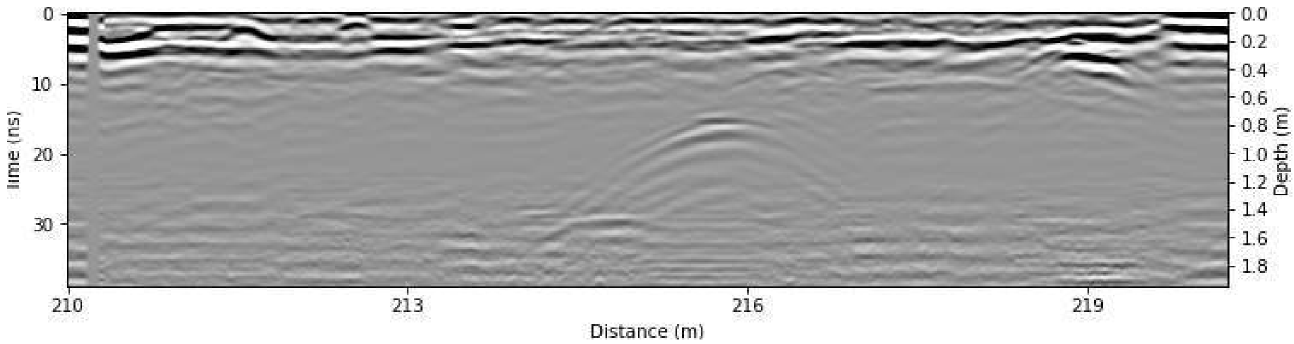


Figure A.335: Radargram at x = 178.5 m.

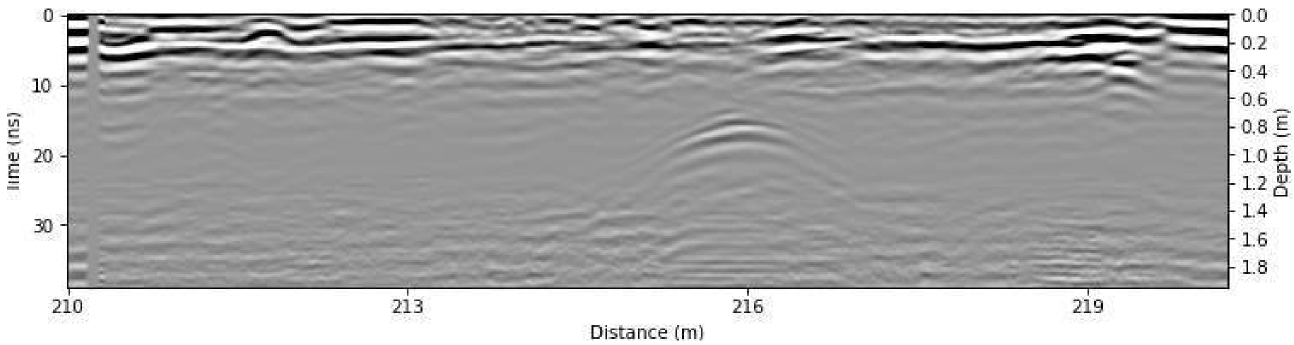


Figure A.336: Radargram at x = 178.75 m.

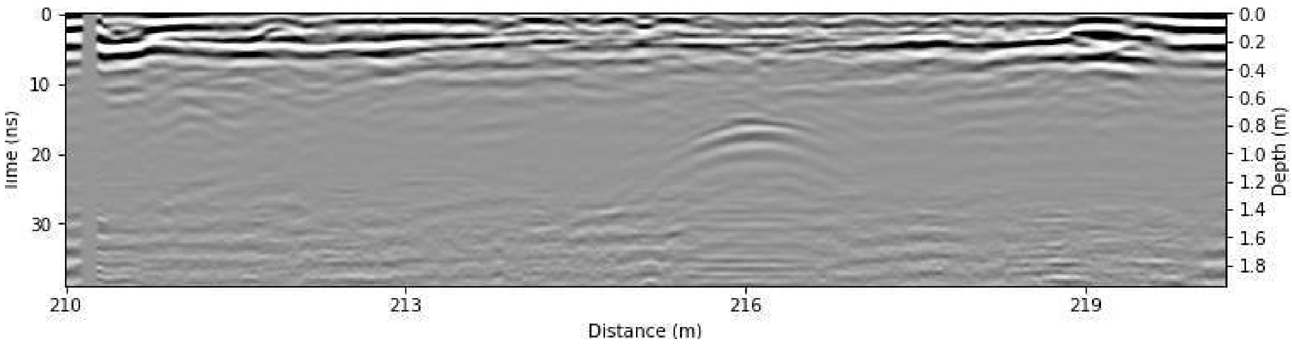


Figure A.337: Radargram at x = 179.0 m.

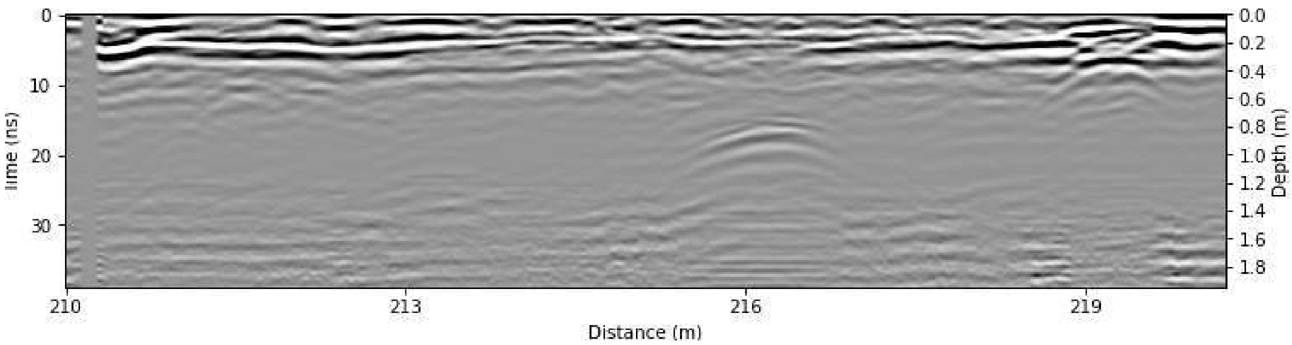


Figure A.338: Radargram at x = 179.25 m.

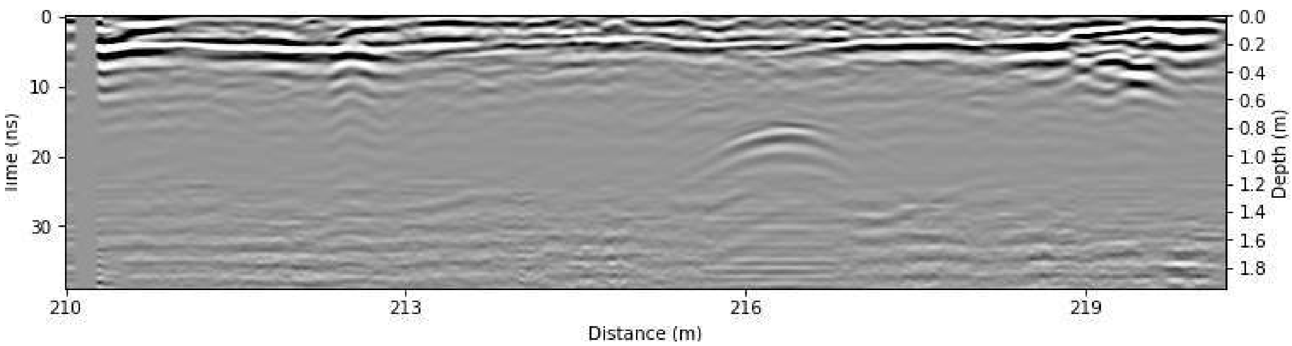


Figure A.339: Radargram at x = 179.5 m.

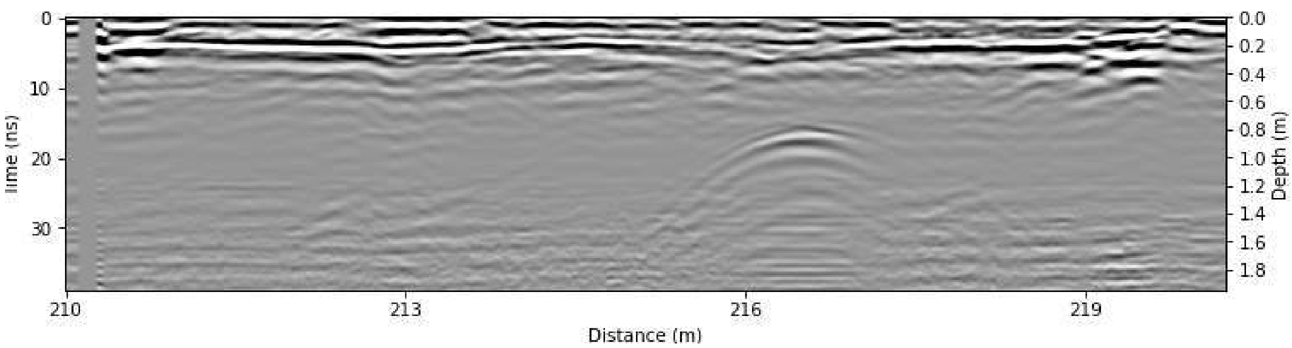


Figure A.340: Radargram at x = 179.75 m.

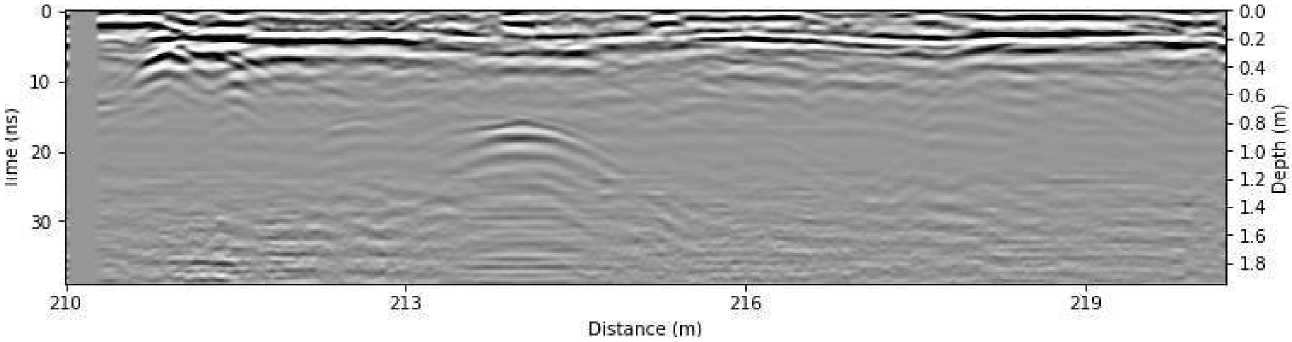


Figure A.341: Radargram at x = 180.0 m.

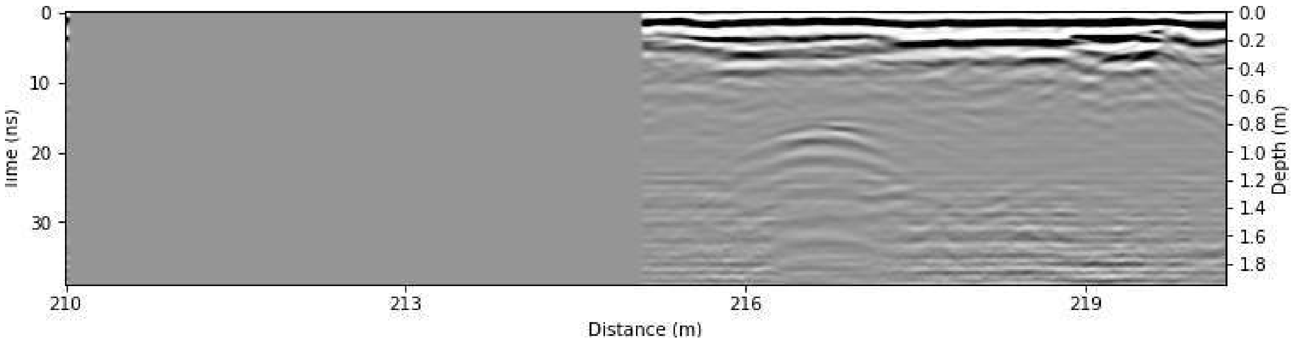


Figure A.342: Radargram at x = 180.25 m.

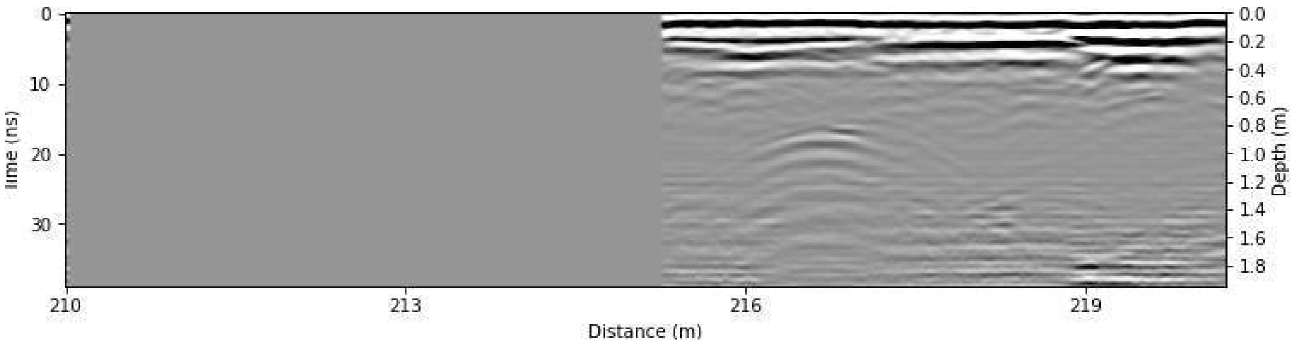


Figure A.343: Radargram at x = 180.5 m.

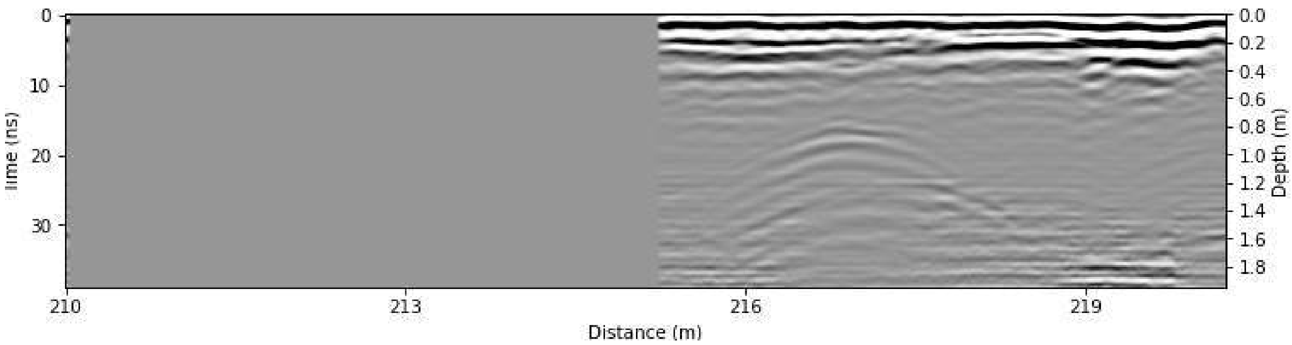


Figure A.344: Radargram at x = 180.75 m.

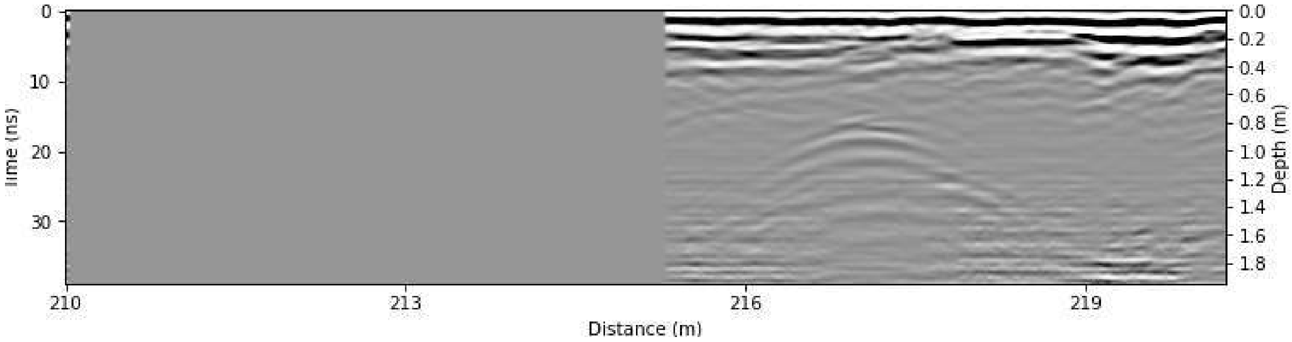


Figure A.345: Radargram at x = 181.0 m.

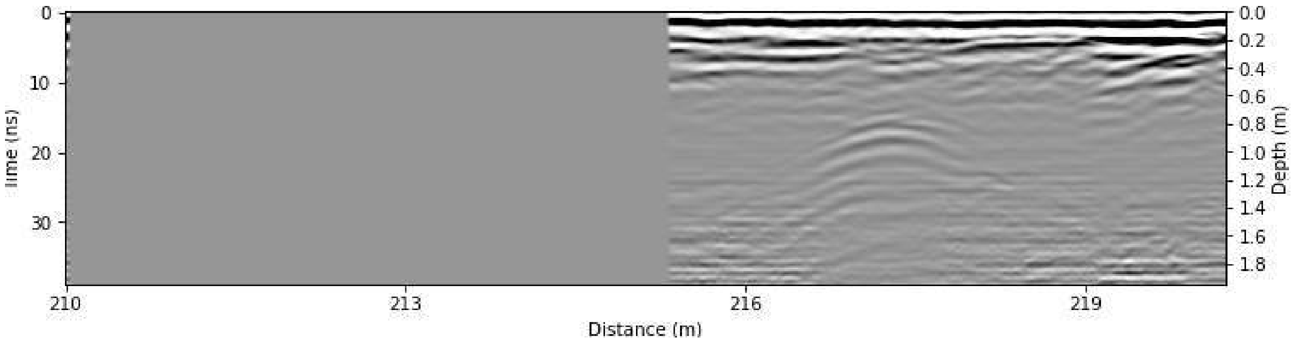


Figure A.346: Radargram at x = 181.25 m.

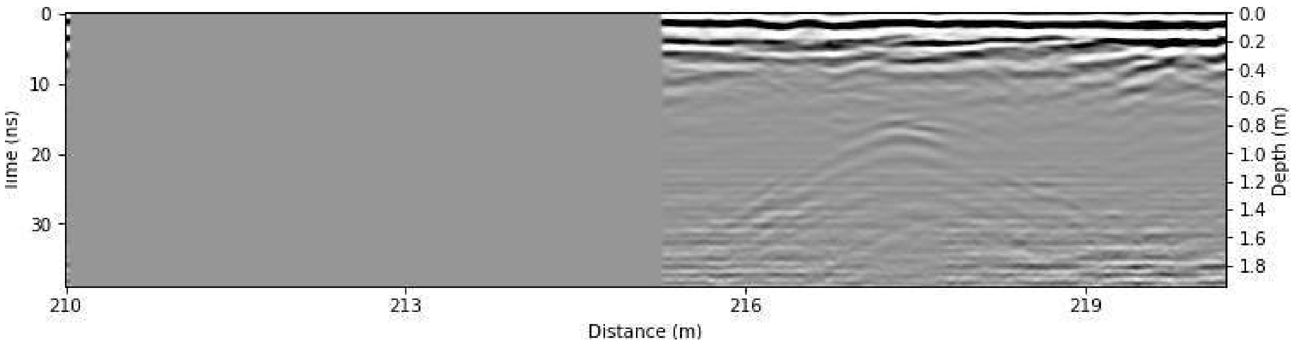


Figure A.347: Radargram at x = 181.5 m.

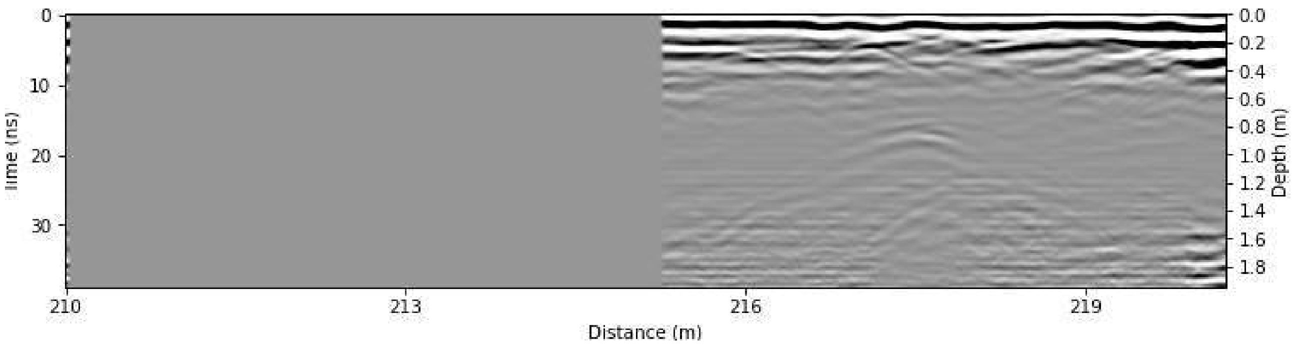


Figure A.348: Radargram at x = 181.75 m.

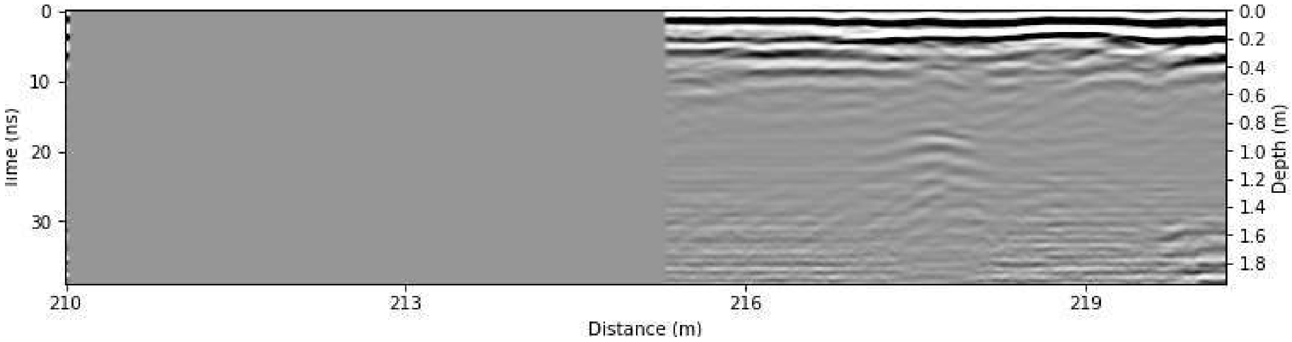


Figure A.349: Radargram at x = 182.0 m.

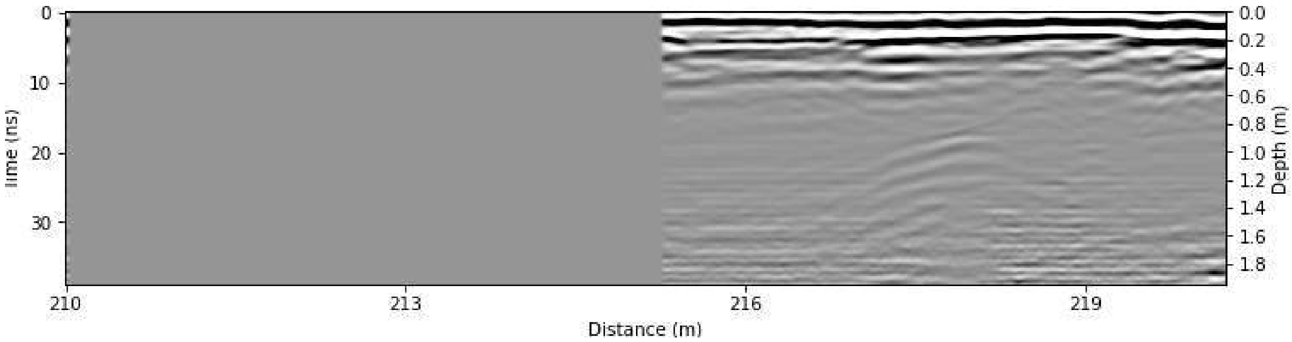


Figure A.350: Radargram at x = 182.25 m.

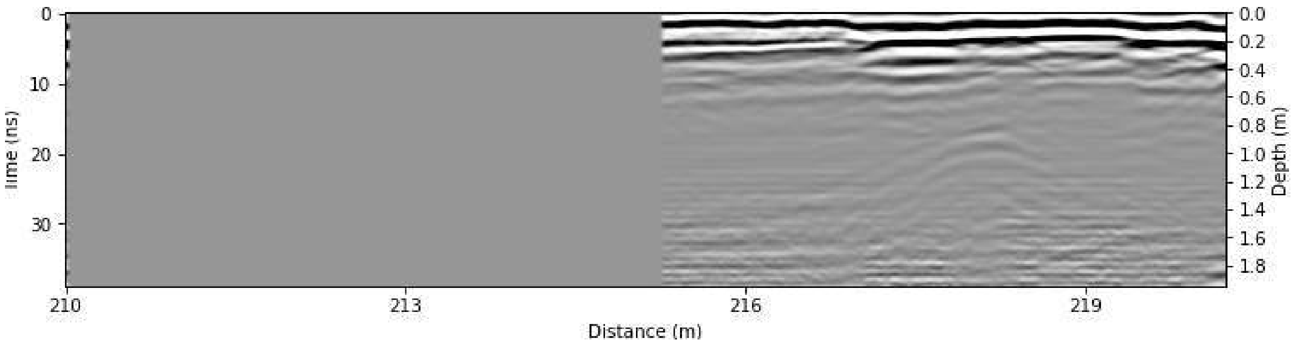


Figure A.351: Radargram at x = 182.5 m.

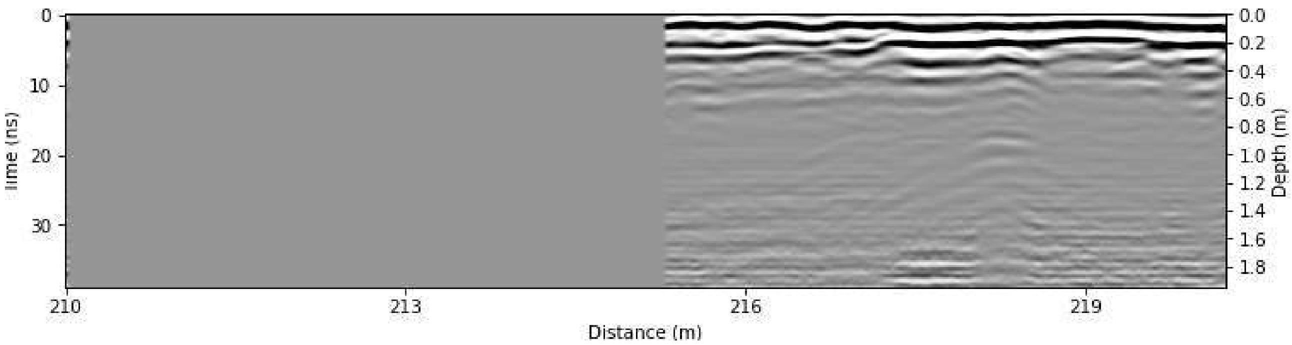


Figure A.352: Radargram at x = 182.75 m.

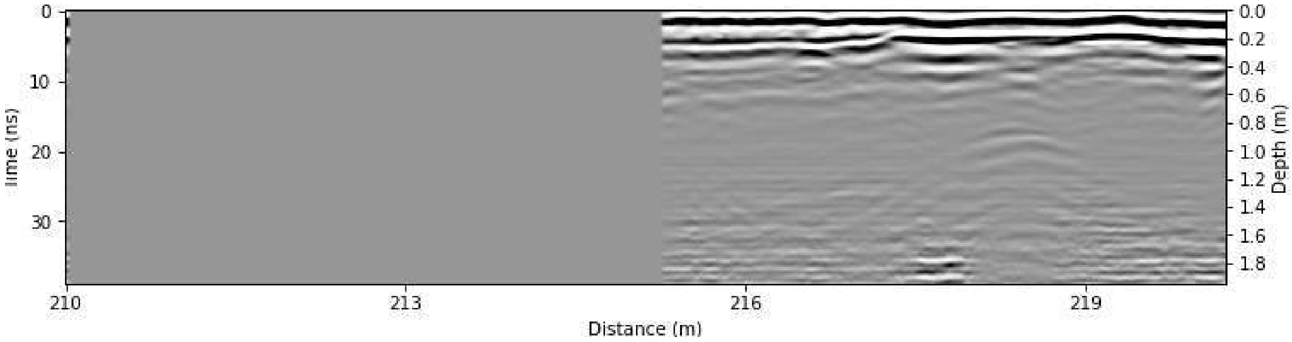


Figure A.353: Radargram at x = 183.0 m.

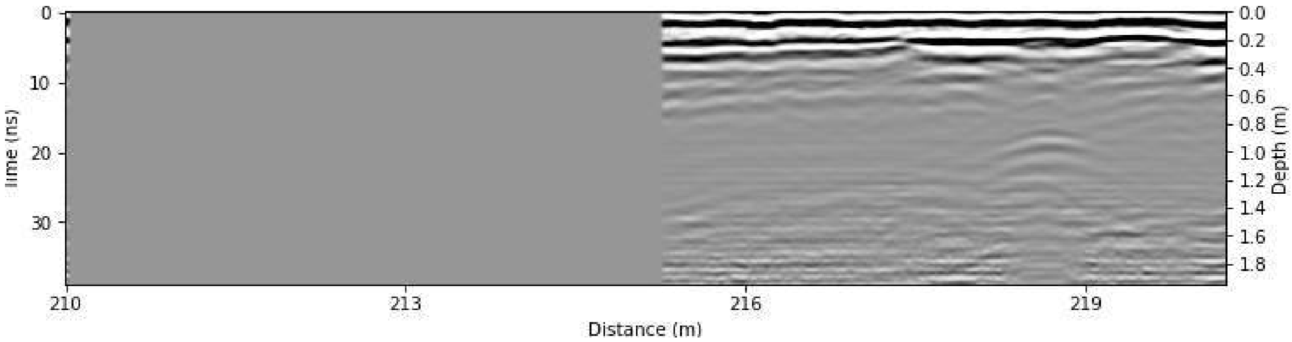


Figure A.354: Radargram at x = 183.25 m.

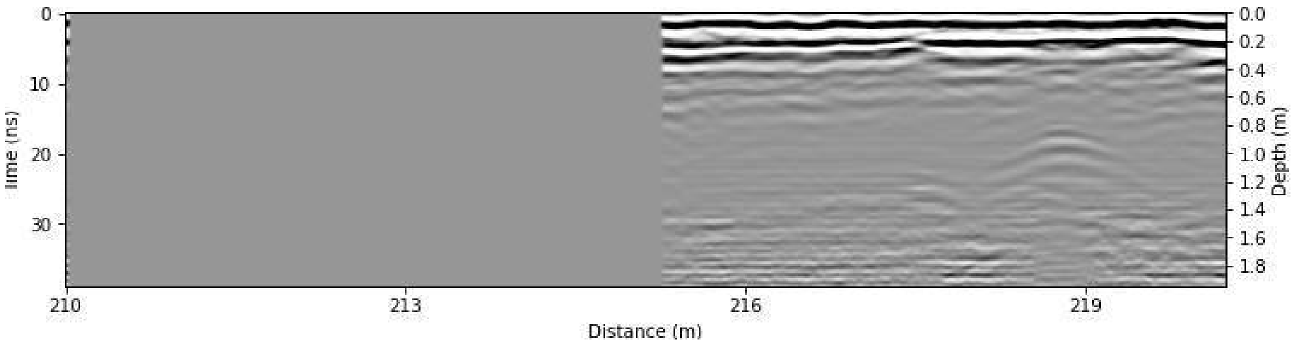


Figure A.355: Radargram at x = 183.5 m.

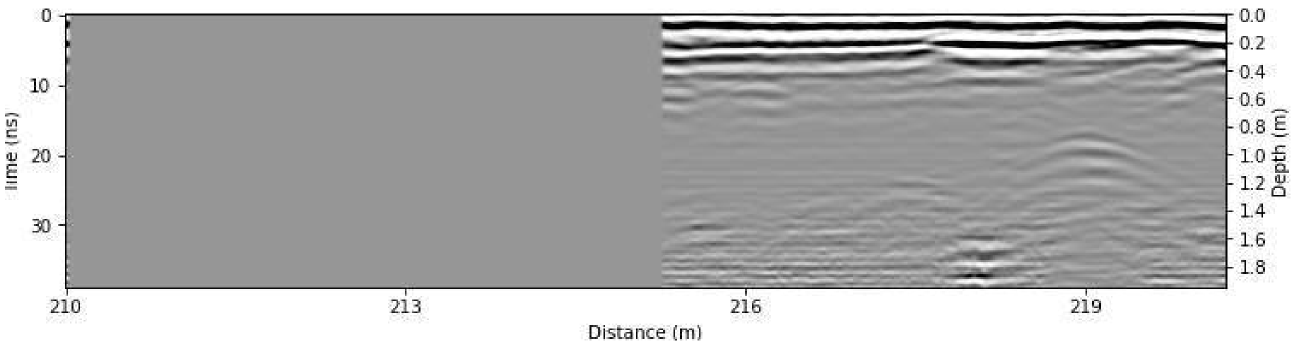


Figure A.356: Radargram at x = 183.75 m.

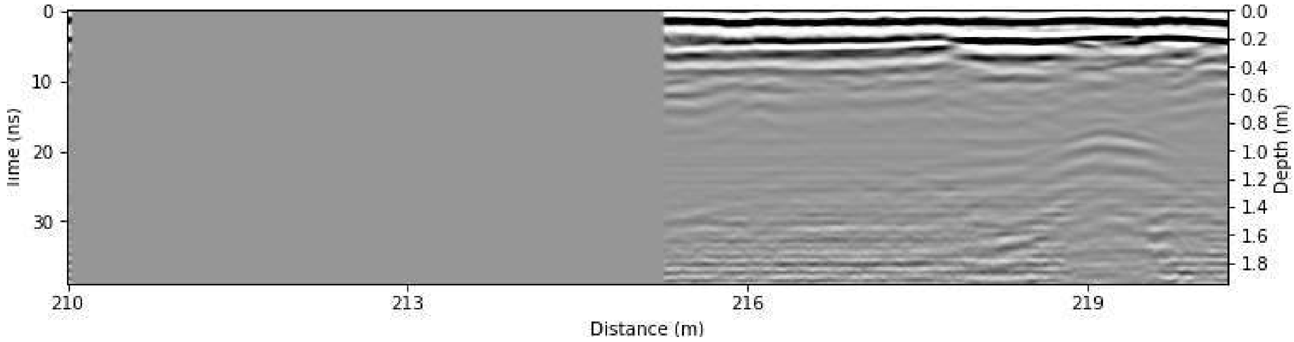


Figure A.357: Radargram at x = 184.0 m.

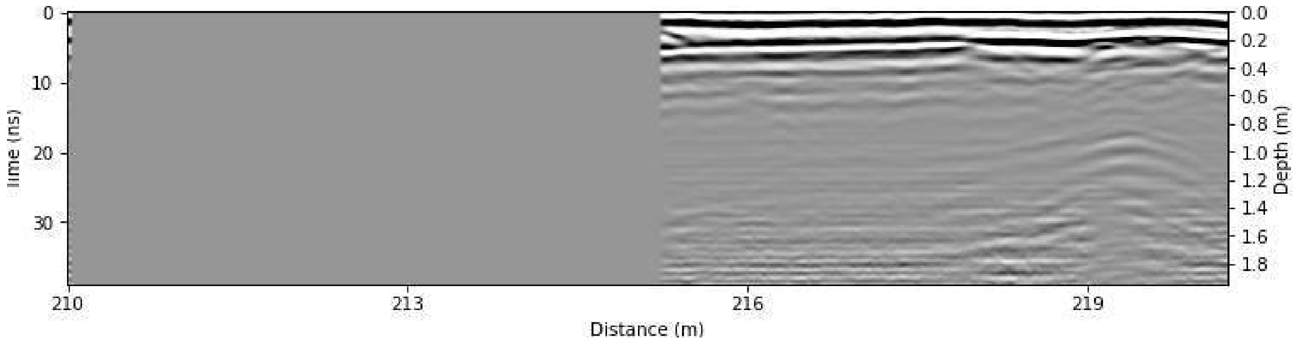


Figure A.358: Radargram at x = 184.25 m.

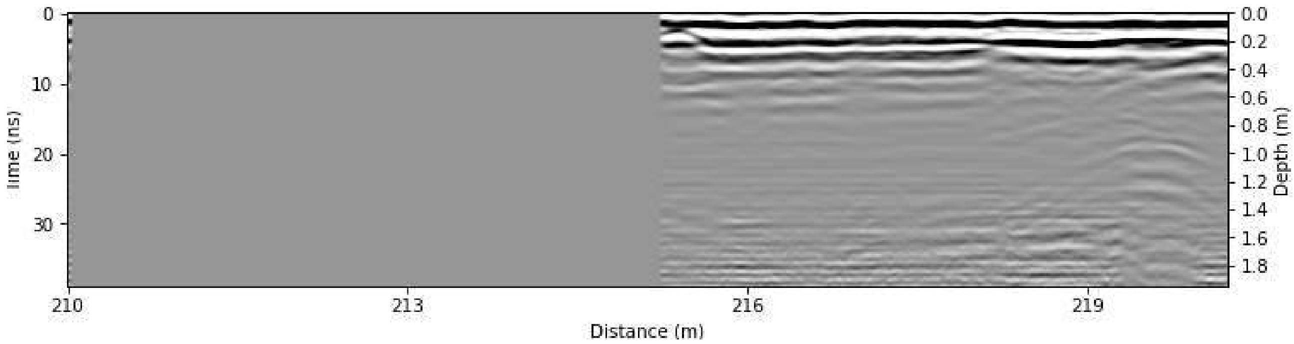


Figure A.359: Radargram at x = 184.5 m.

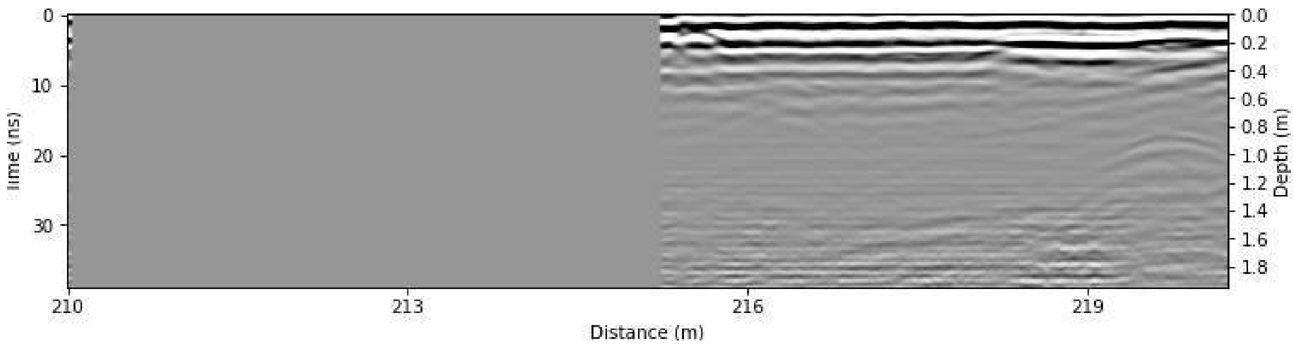


Figure A.360: Radargram at x = 184.75 m.

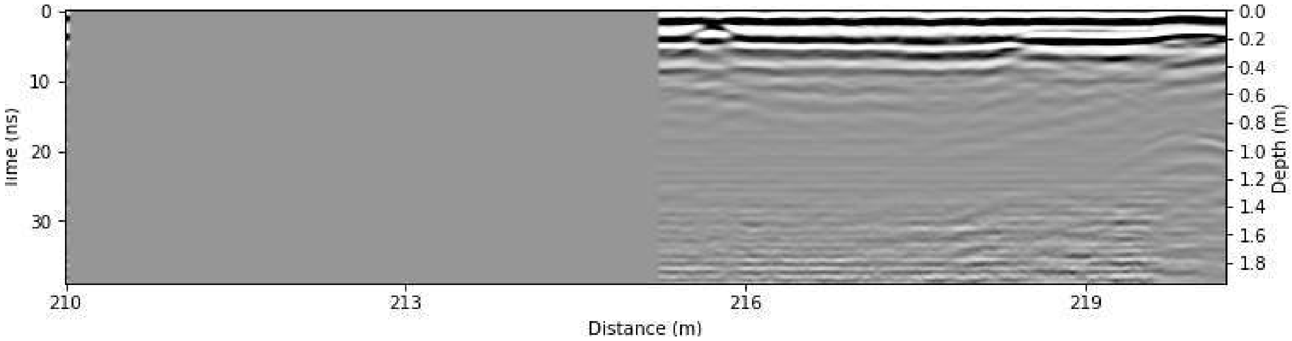


Figure A.361: Radargram at x = 185.0 m.

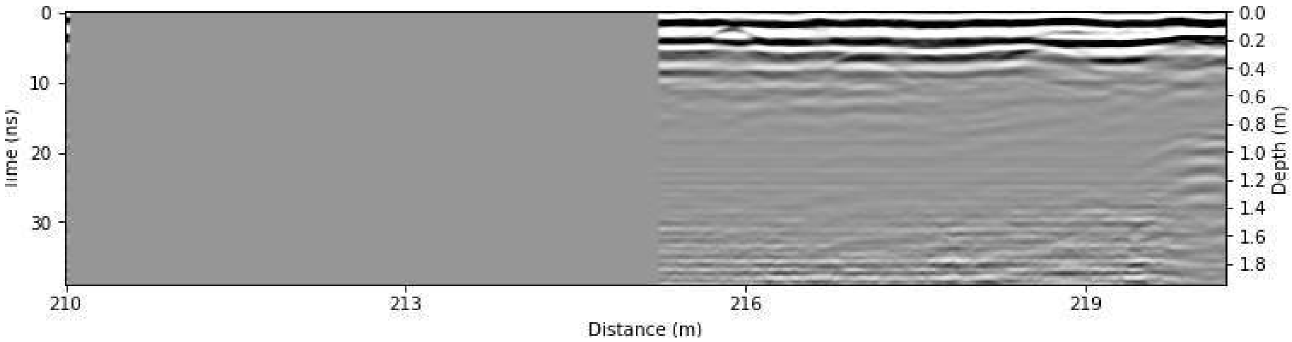


Figure A.362: Radargram at x = 185.25 m.

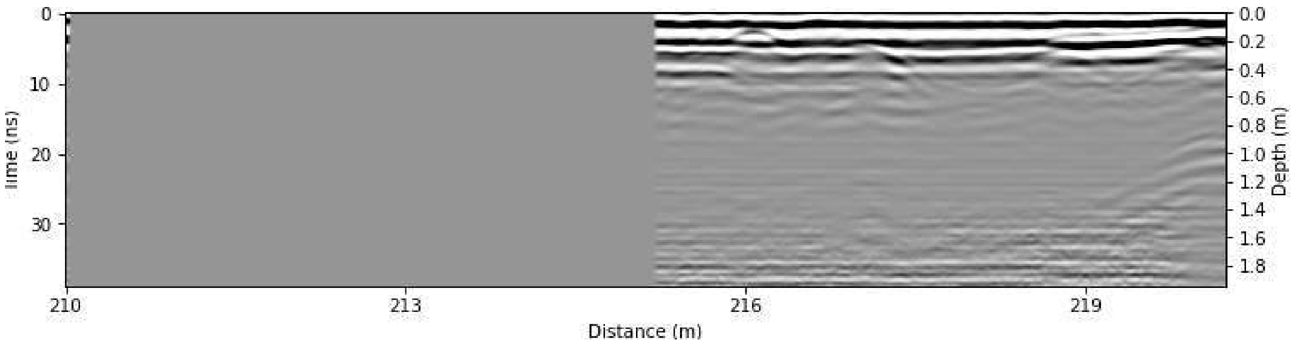


Figure A.363: Radargram at x = 185.5 m.

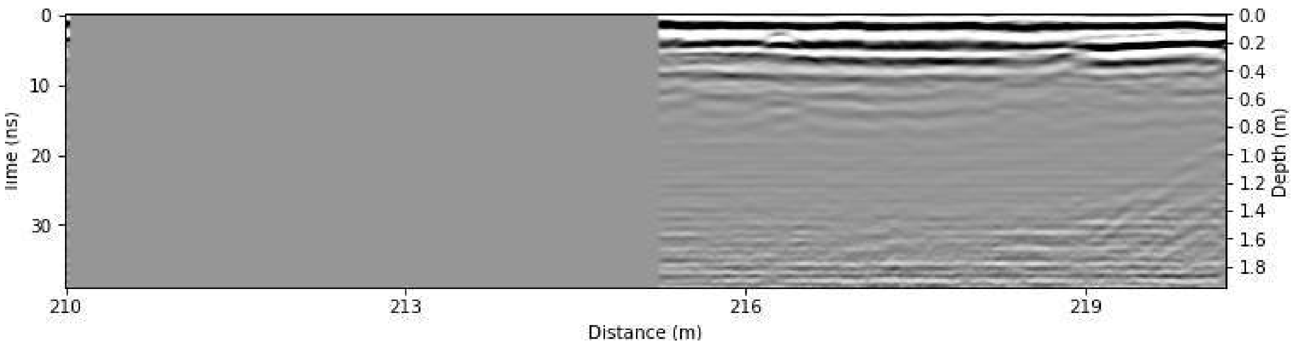


Figure A.364: Radargram at x = 185.75 m.

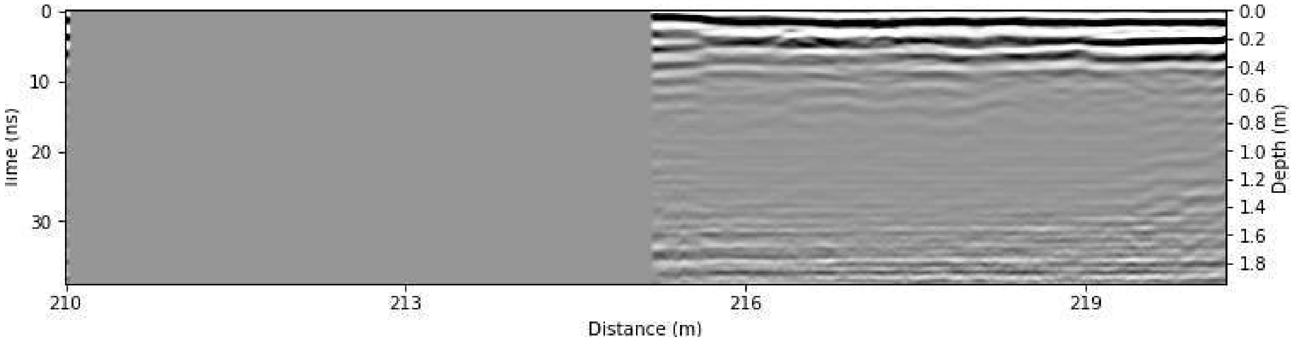
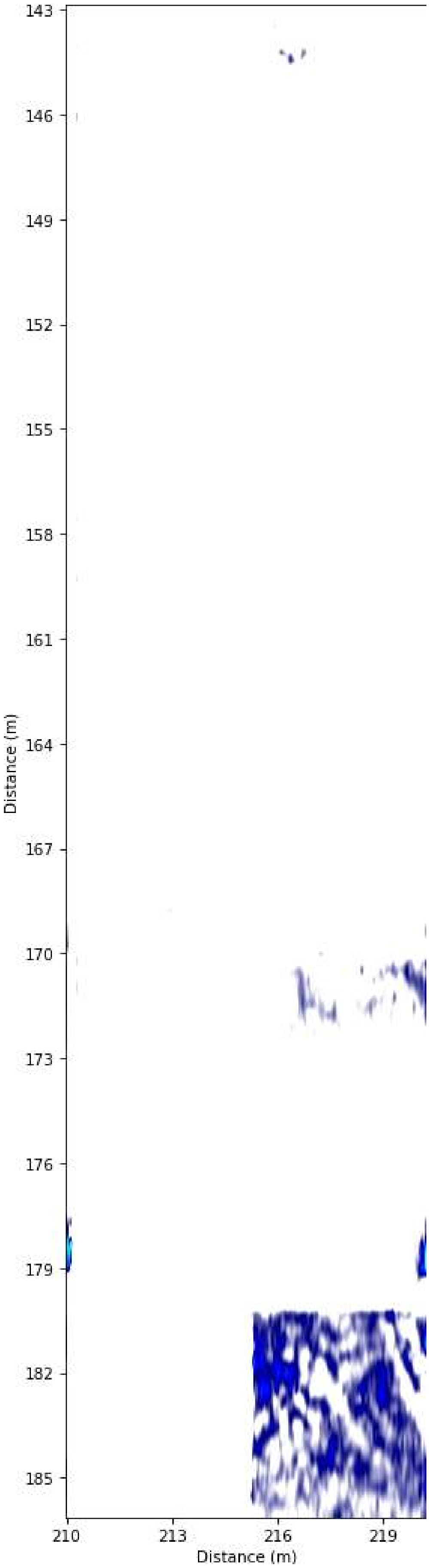
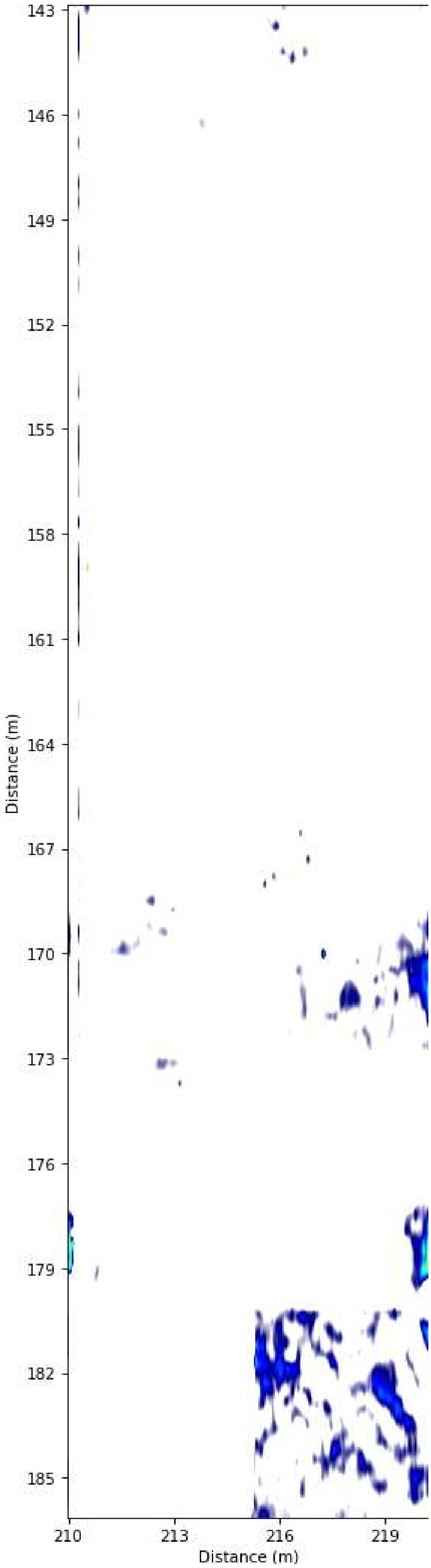


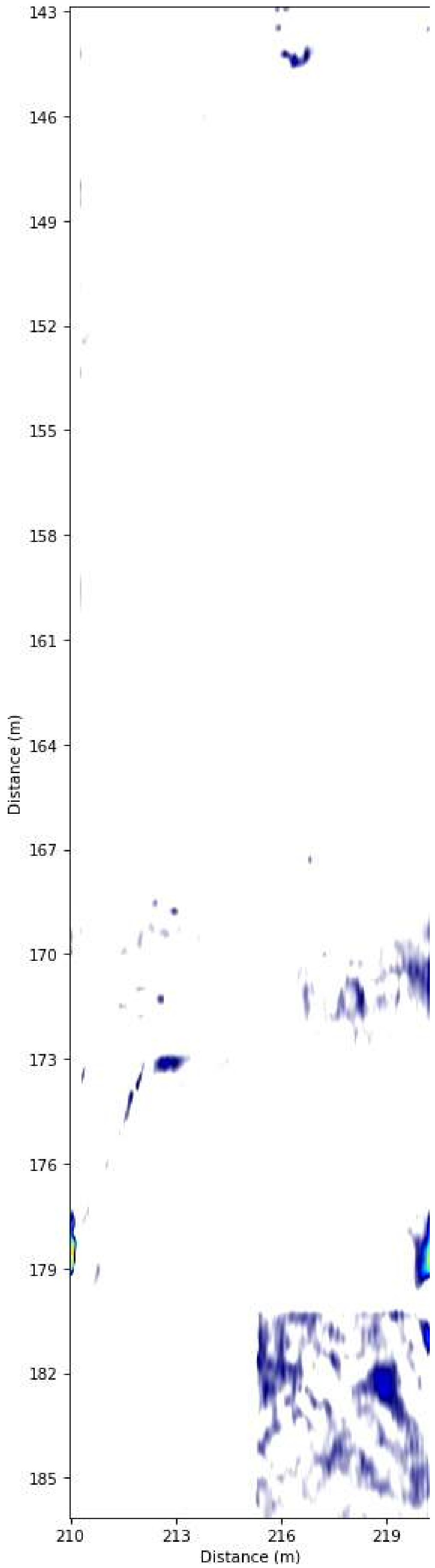
Figure A.365: Radargram at x = 186.0 m.



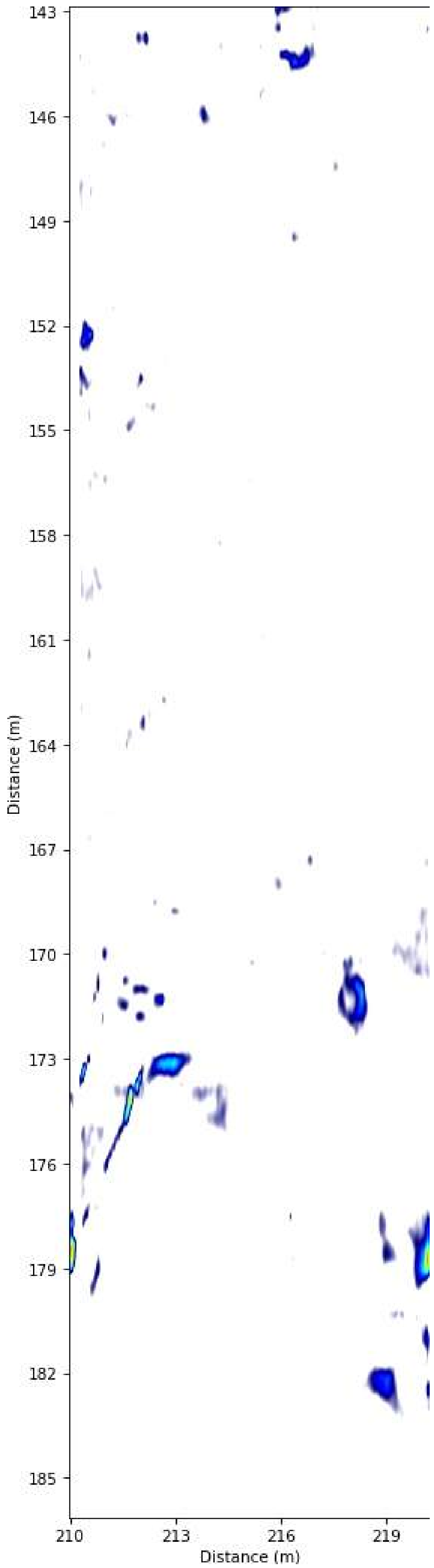
(a) Timeslice at z = 0.0 m.



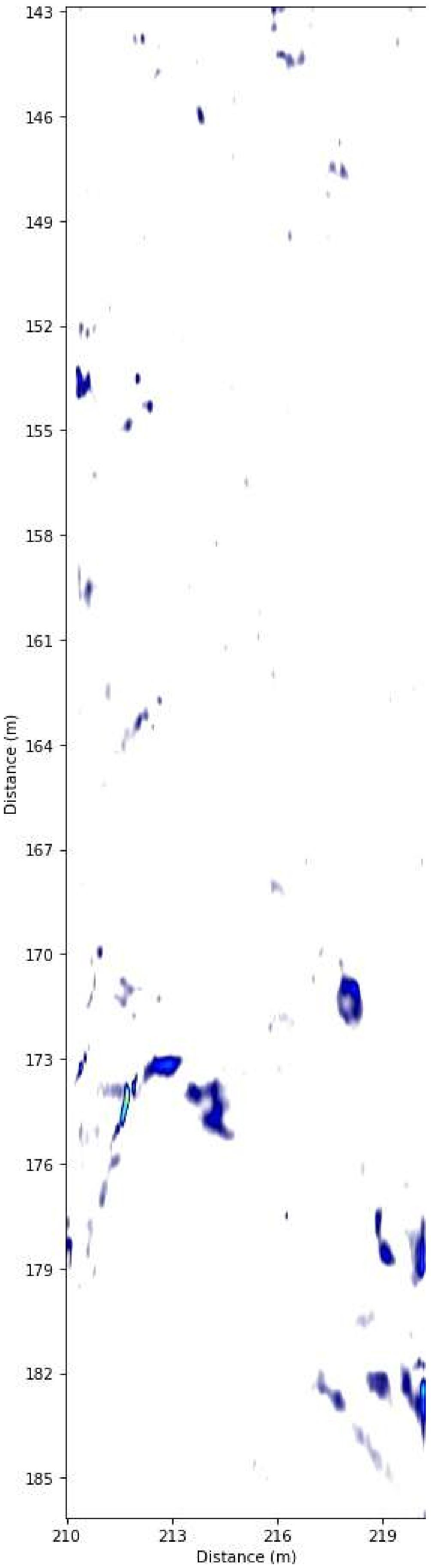
(b) Timeslice at z = 0.05 m.



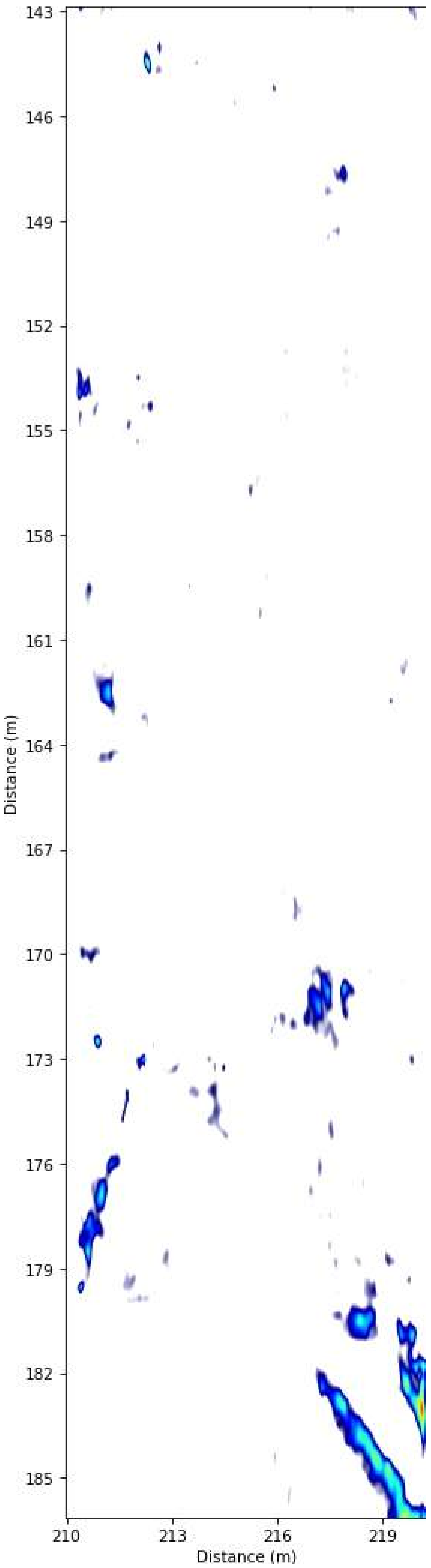
(a) Timeslice at z = 0.1 m.



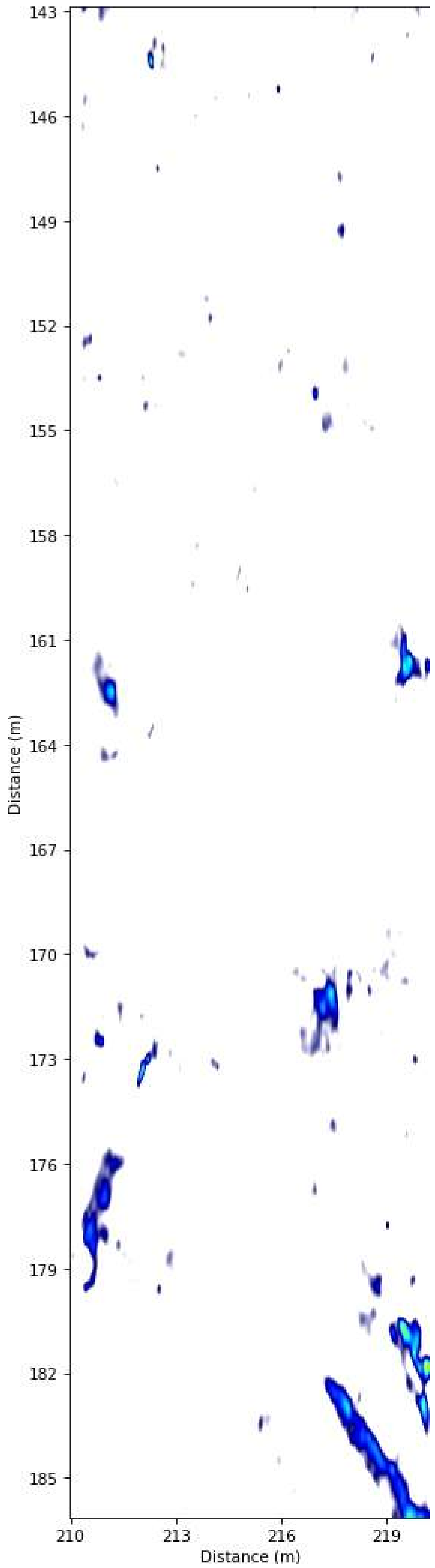
(b) Timeslice at z = 0.15 m.



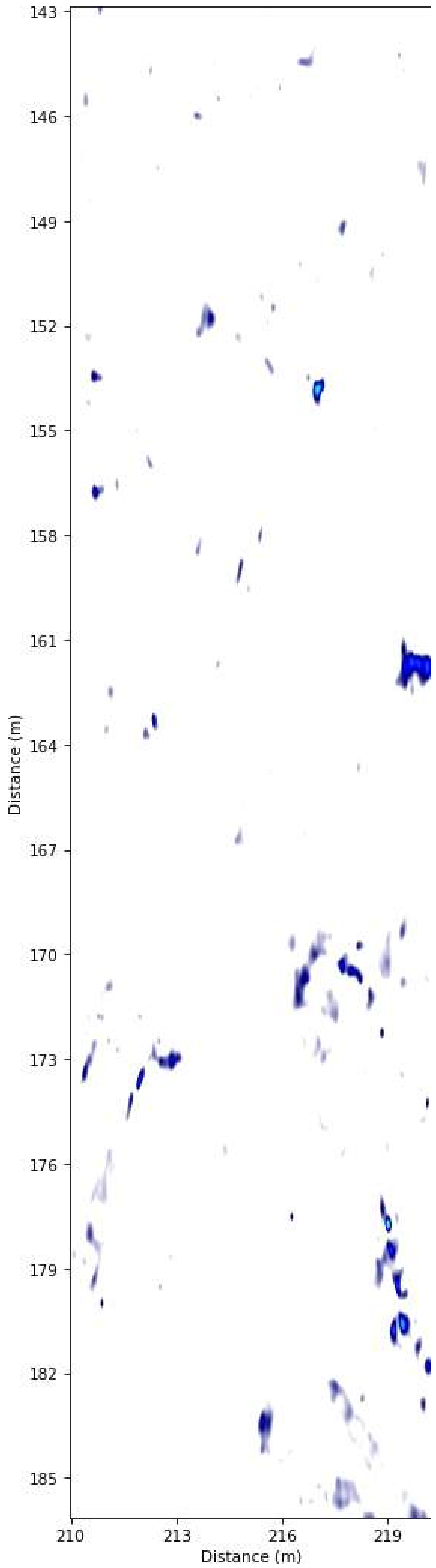
(a) Timeslice at z = 0.2 m.



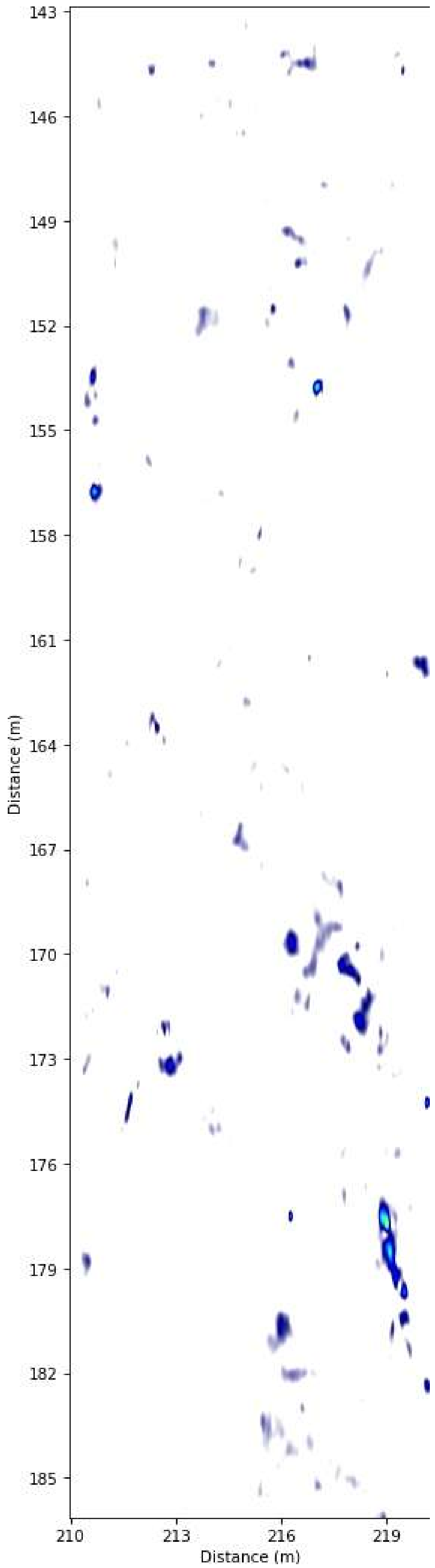
(b) Timeslice at z = 0.25 m.



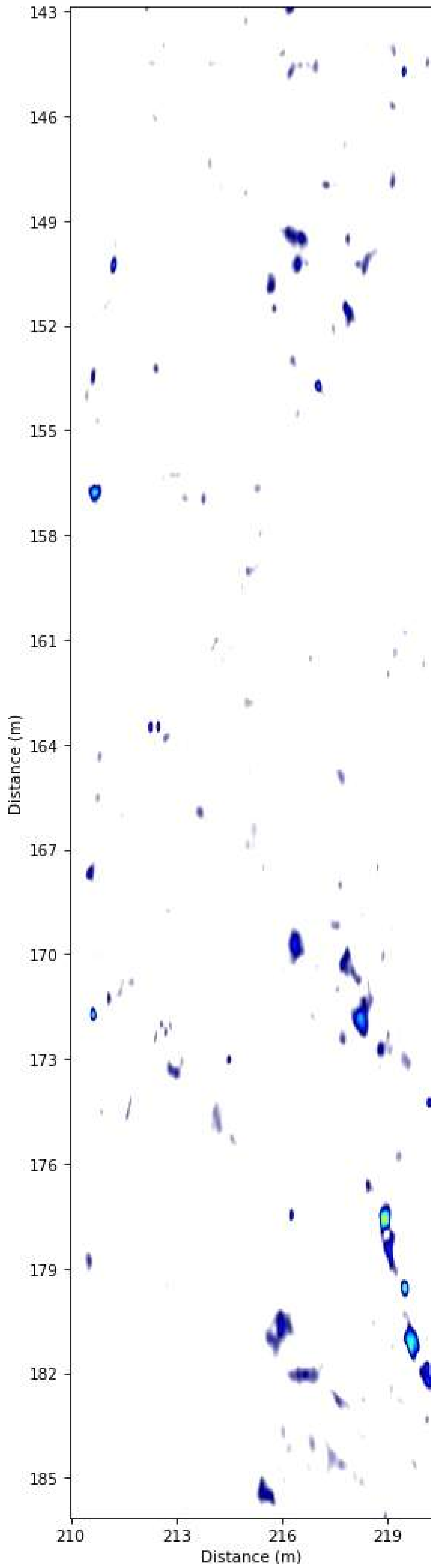
(a) Timeslice at z = 0.3 m.



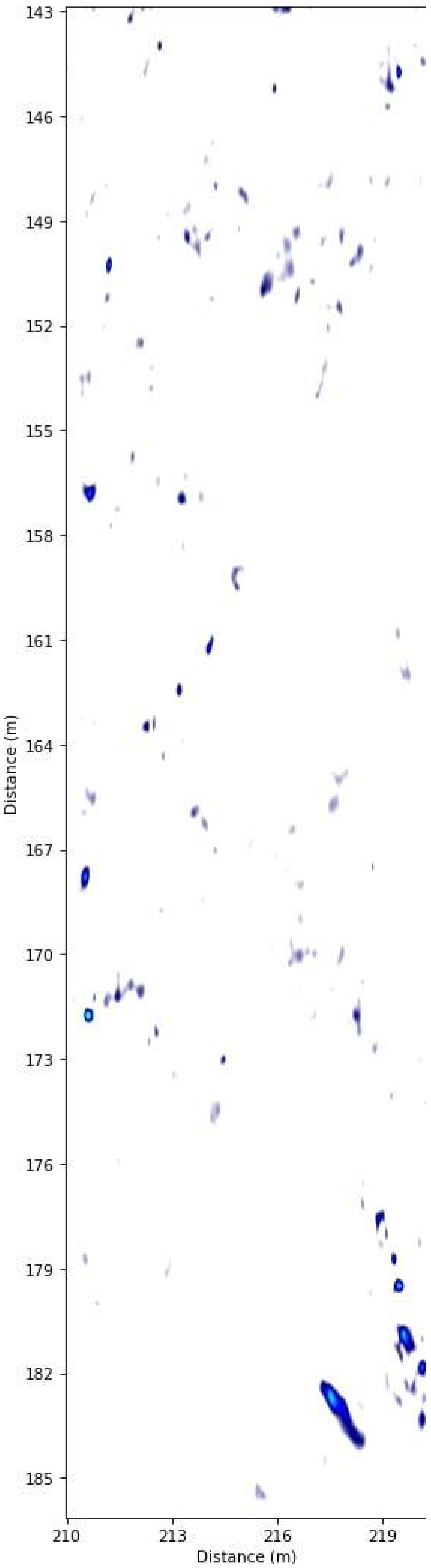
(b) Timeslice at z = 0.35 m.



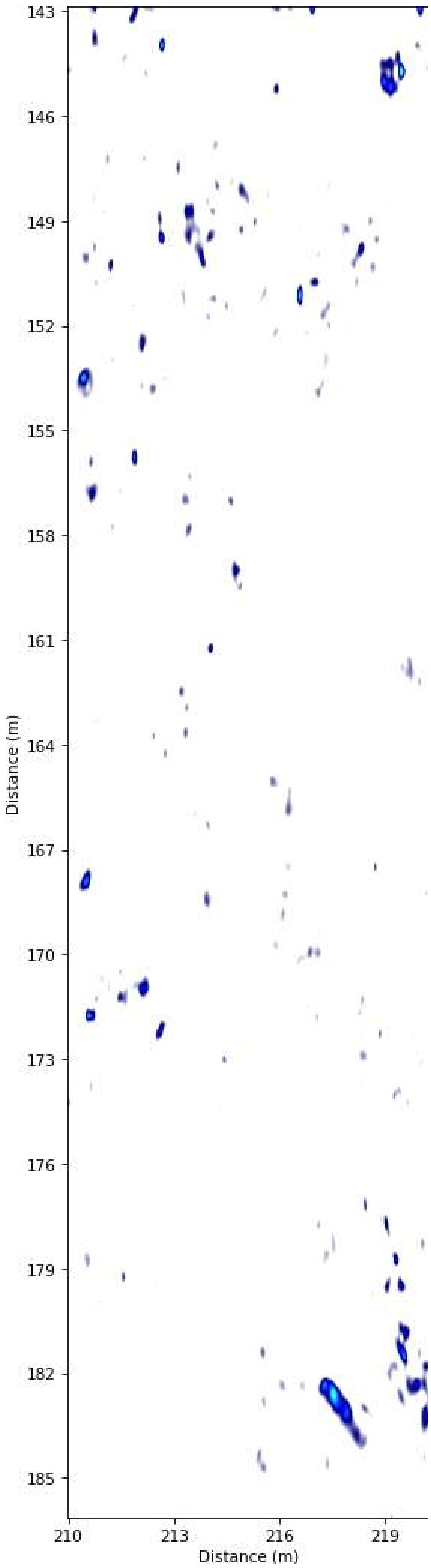
(a) Timeslice at z = 0.4 m.



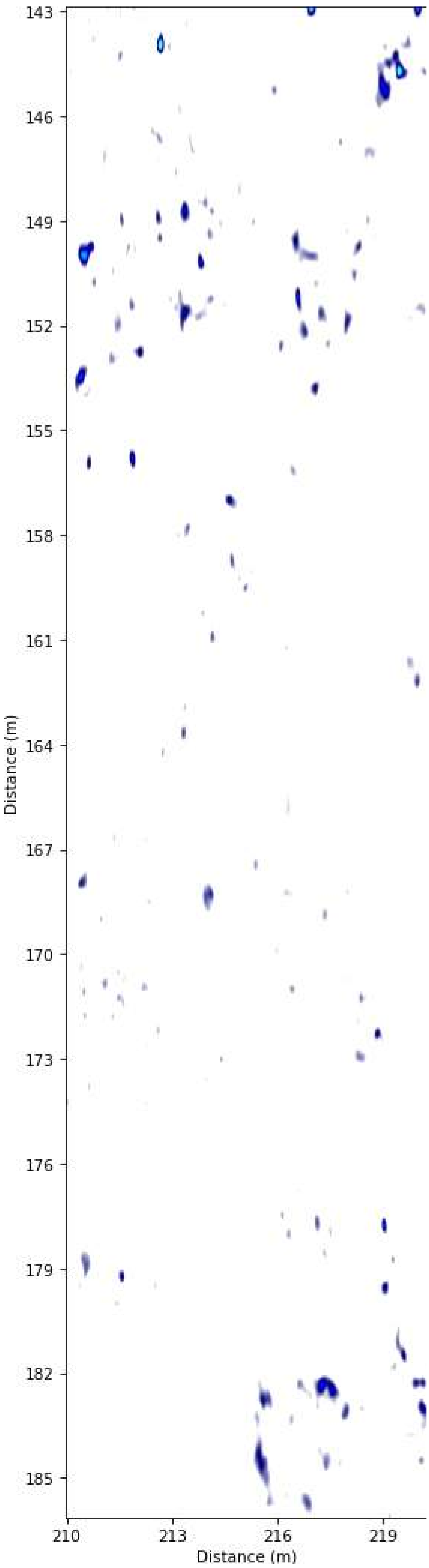
(b) Timeslice at z = 0.45 m.



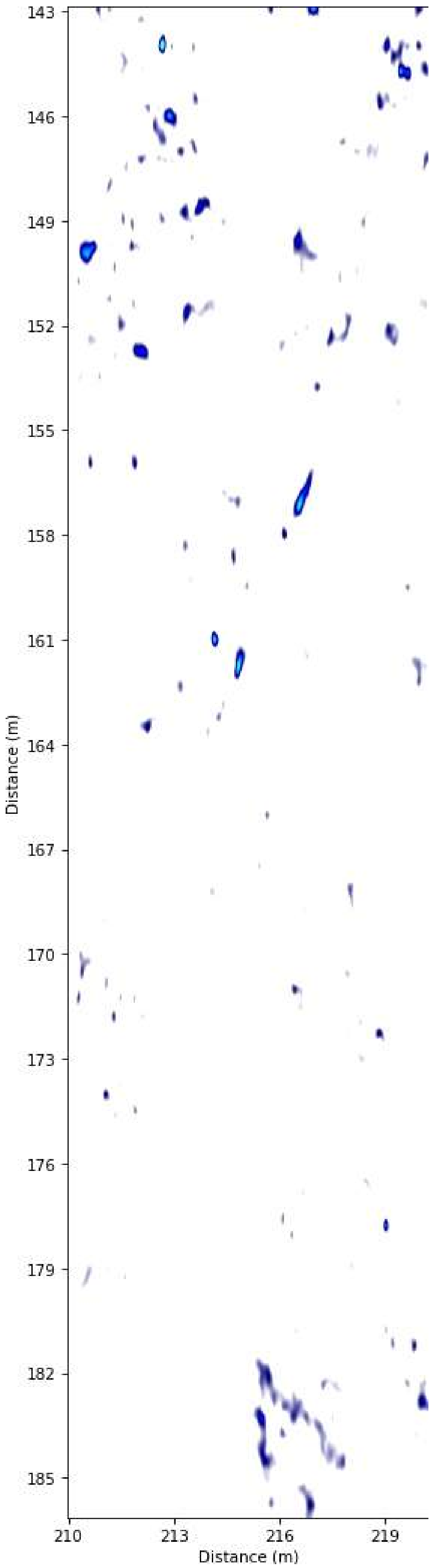
(a) Timeslice at z = 0.5 m.



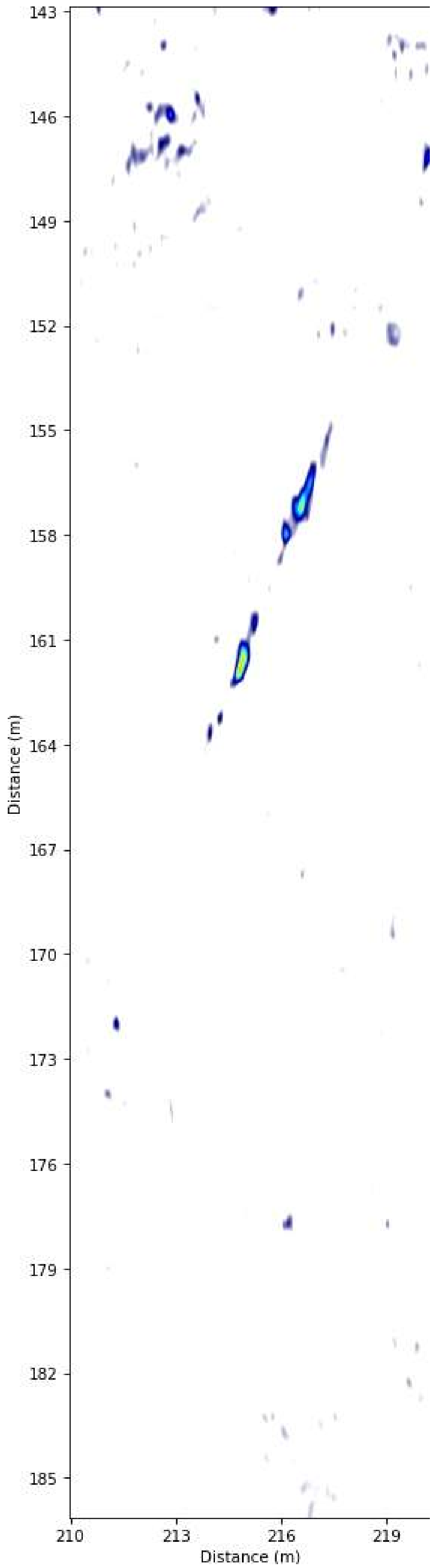
(b) Timeslice at z = 0.55 m.



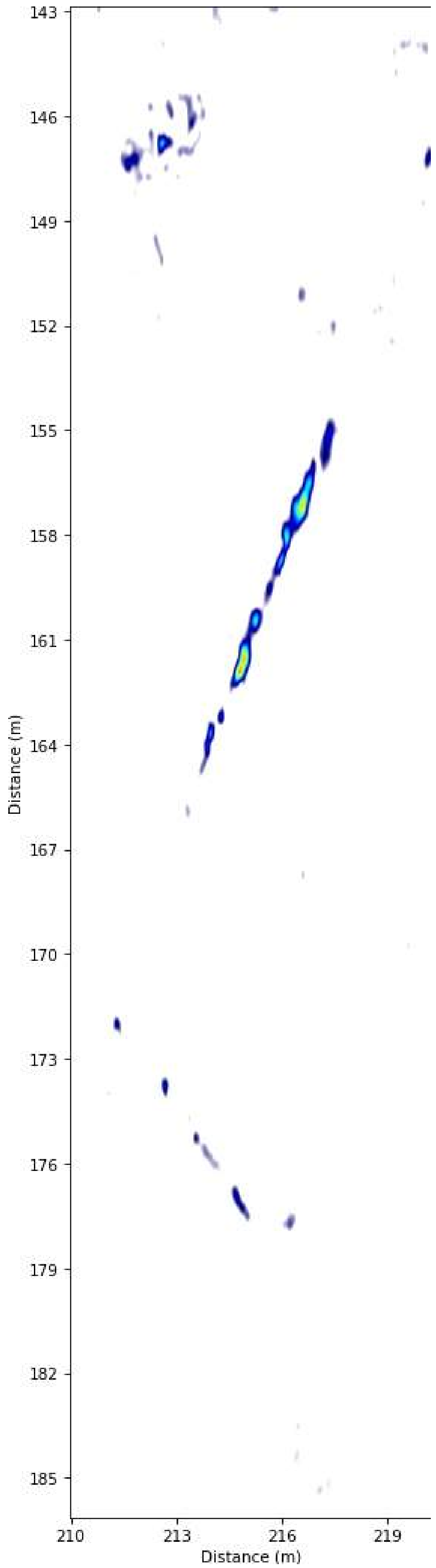
(a) Timeslice at z = 0.6 m.



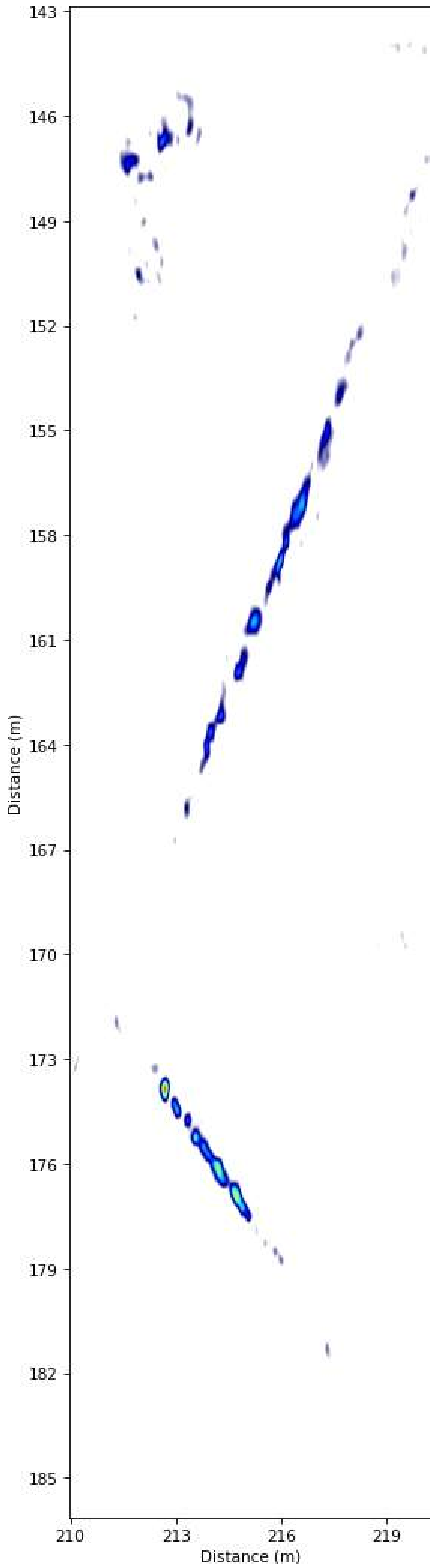
(b) Timeslice at z = 0.65 m.



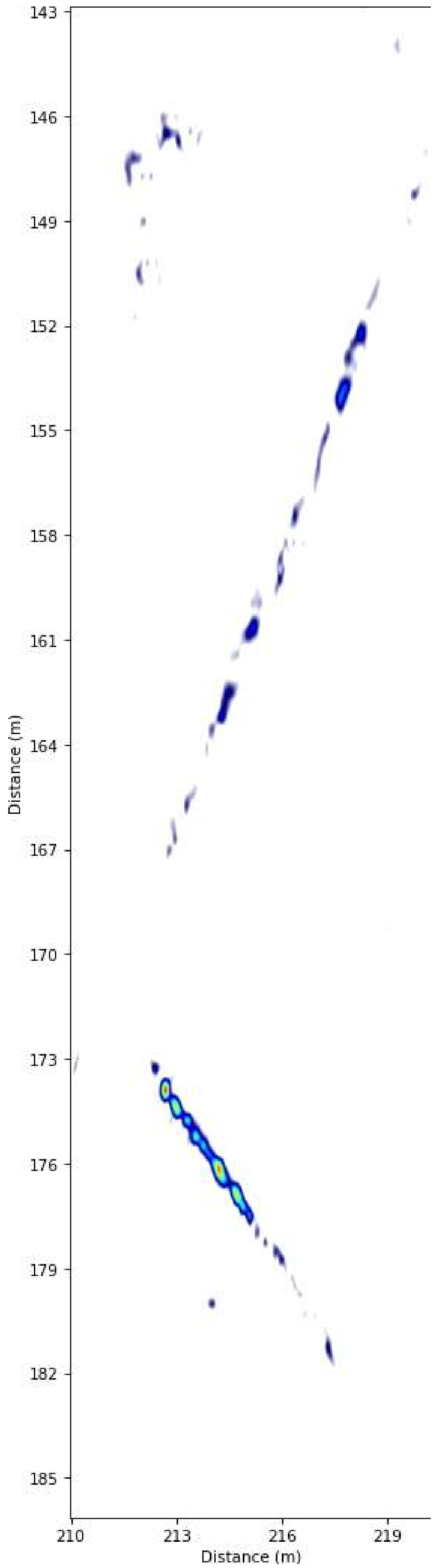
(a) Timeslice at z = 0.7 m.



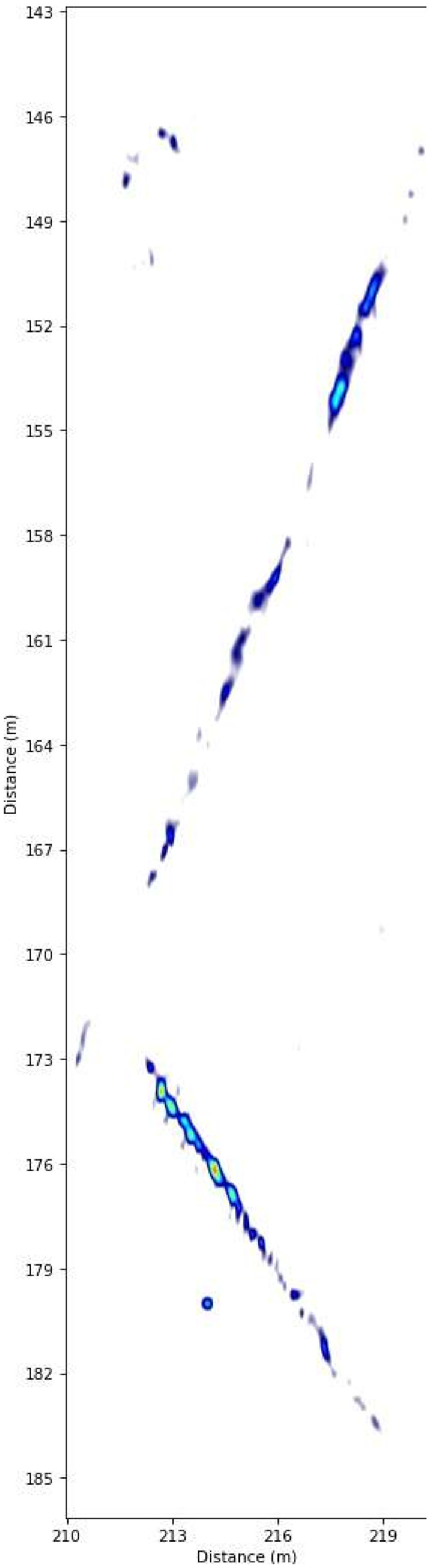
(b) Timeslice at z = 0.75 m.



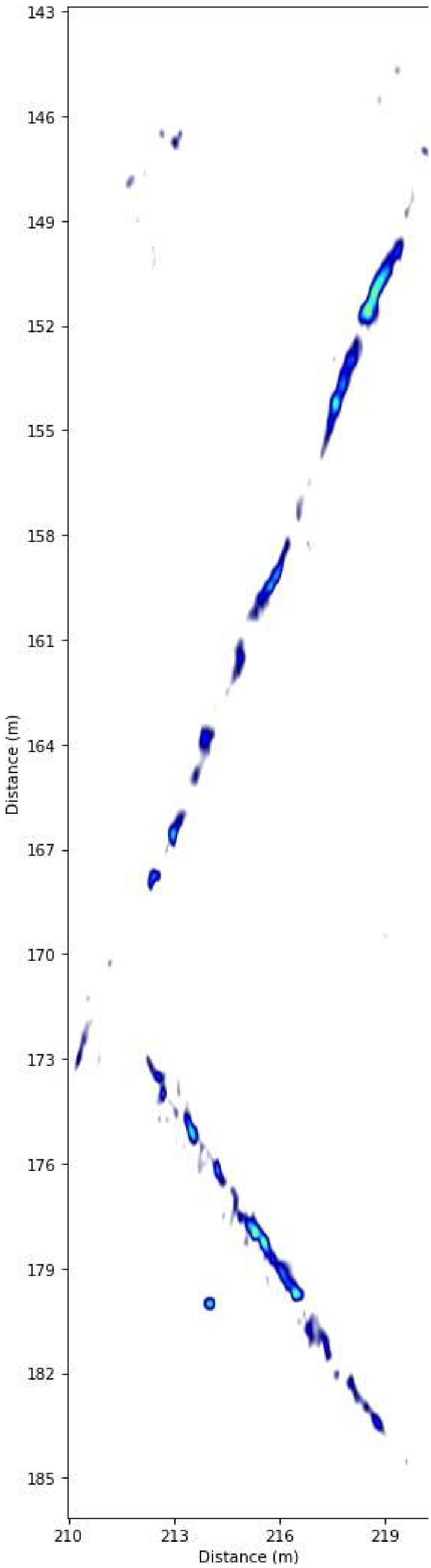
(a) Timeslice at z = 0.8 m.



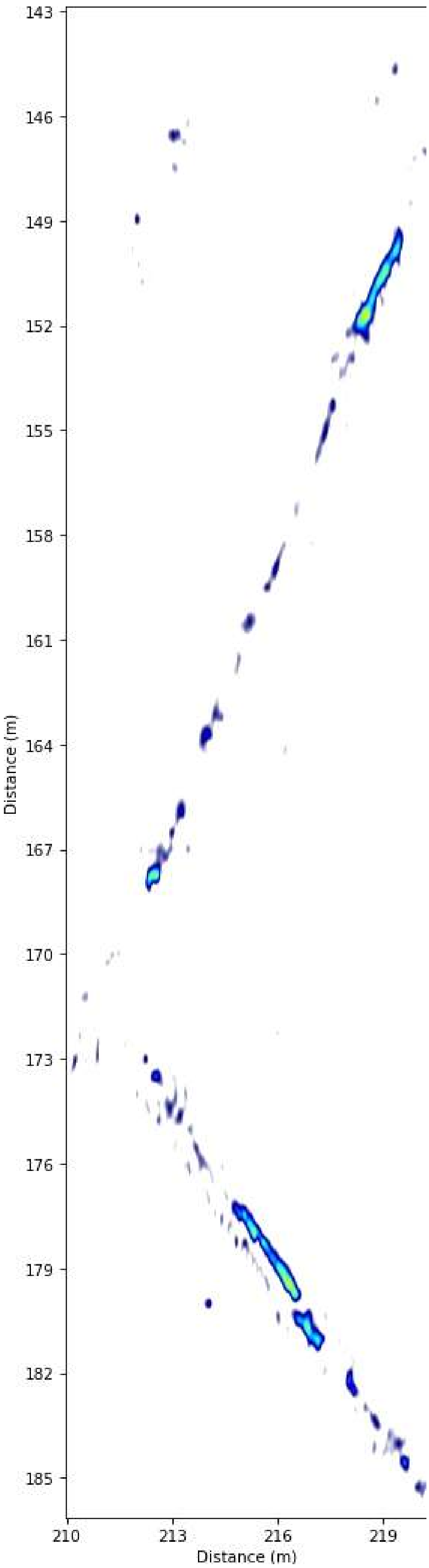
(b) Timeslice at z = 0.85 m.



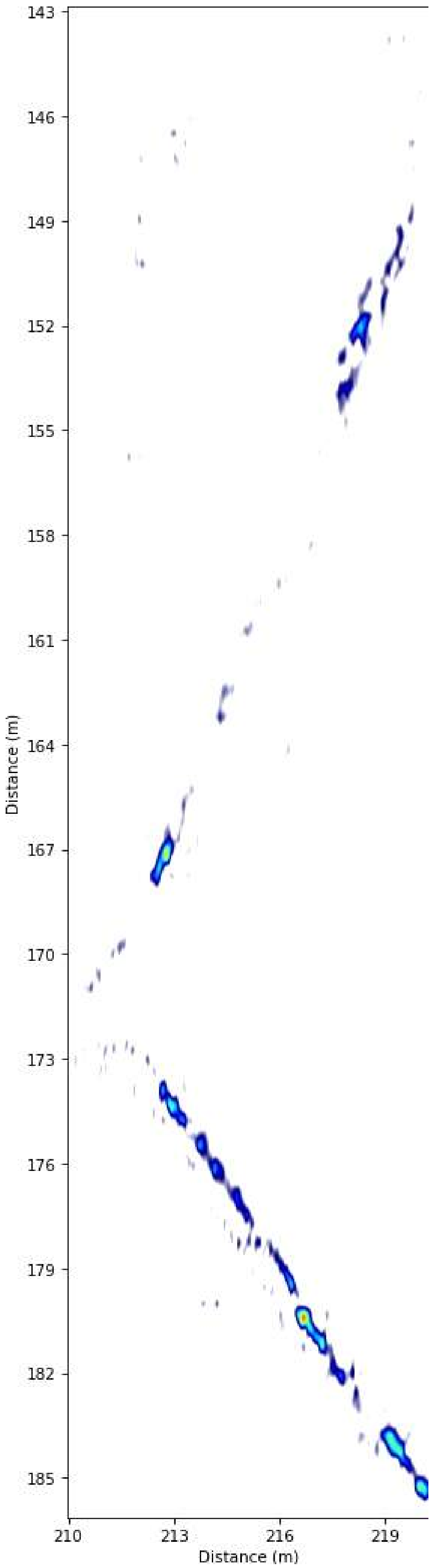
(a) Timeslice at z = 0.85 m.



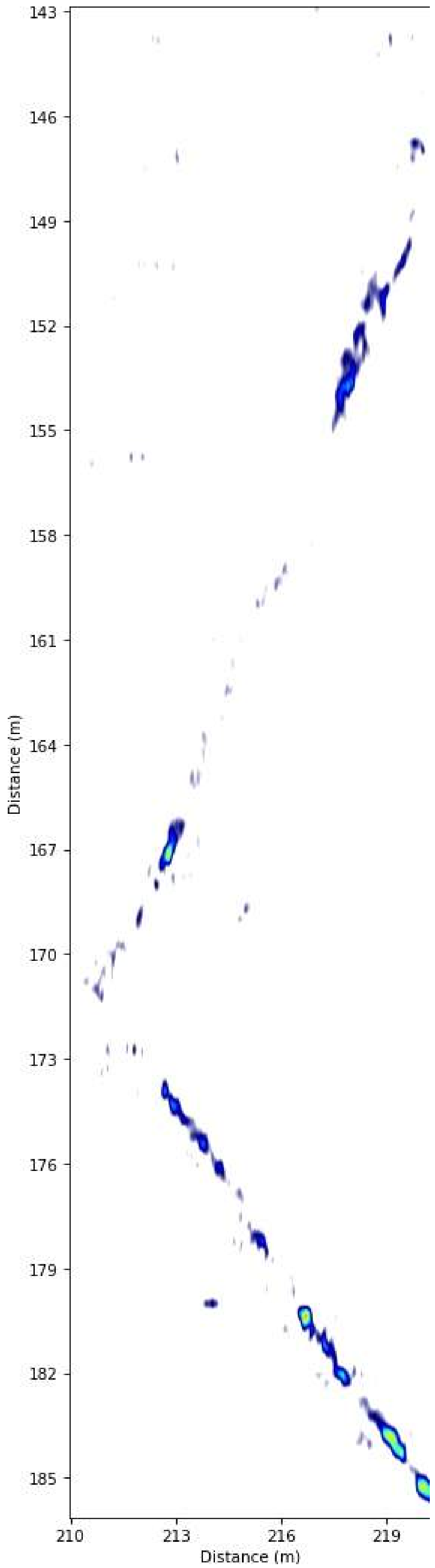
(b) Timeslice at z = 0.855 m.



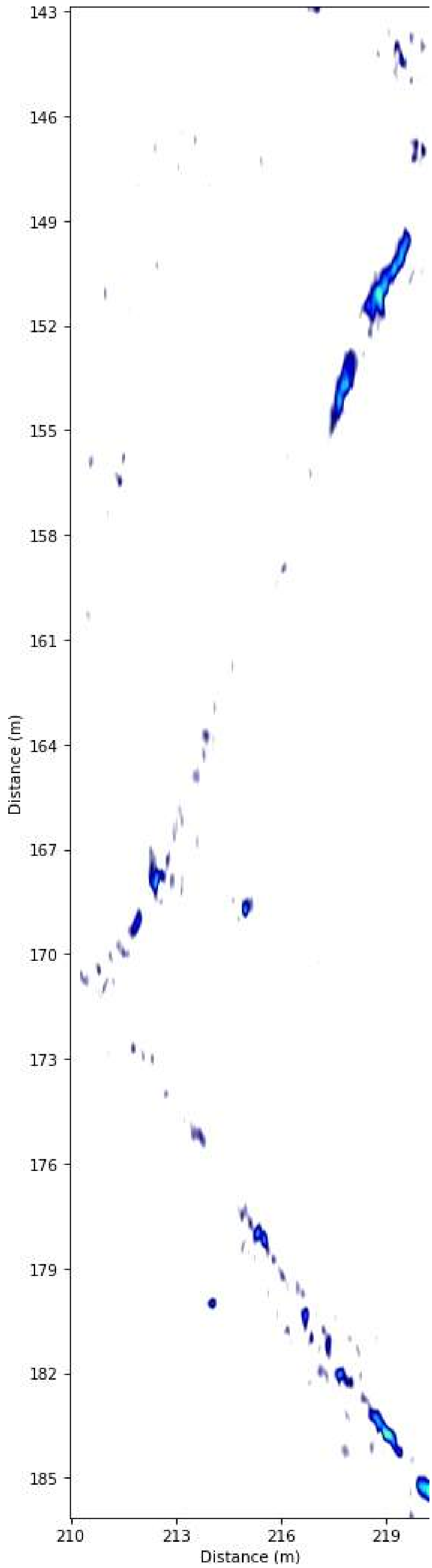
(a) Timeslice at z = 1.0 m.



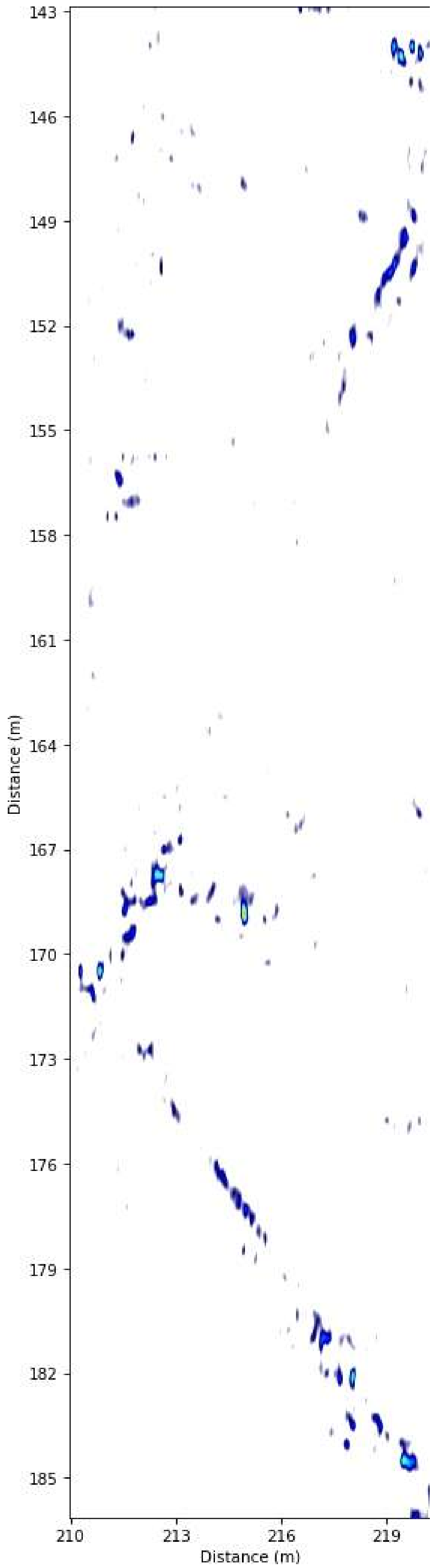
(b) Timeslice at z = 1.05 m.



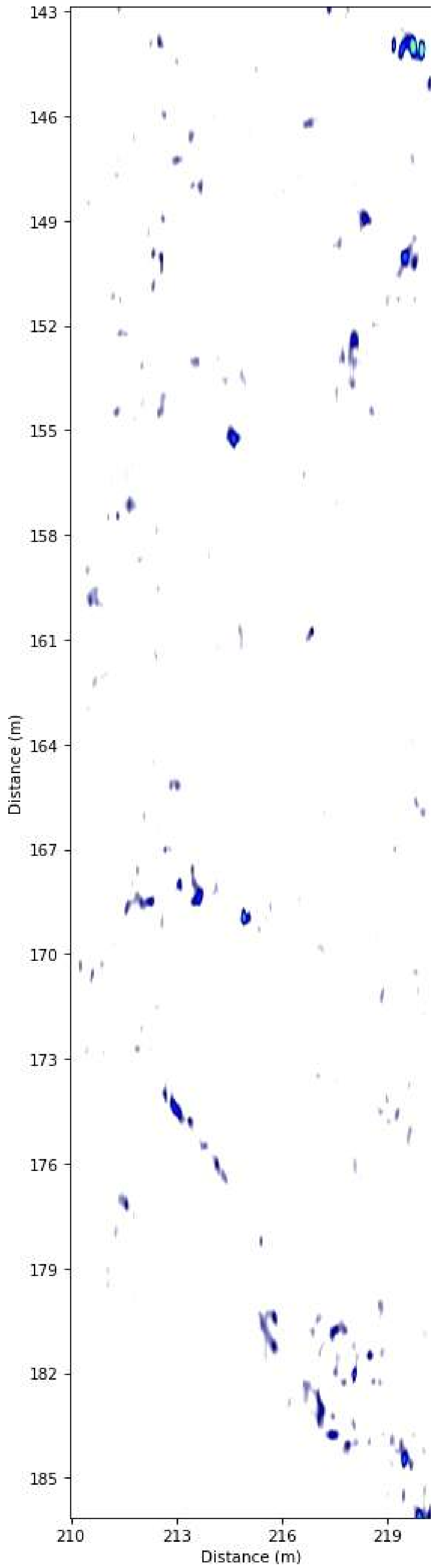
(a) Timeslice at z = 1.1 m.



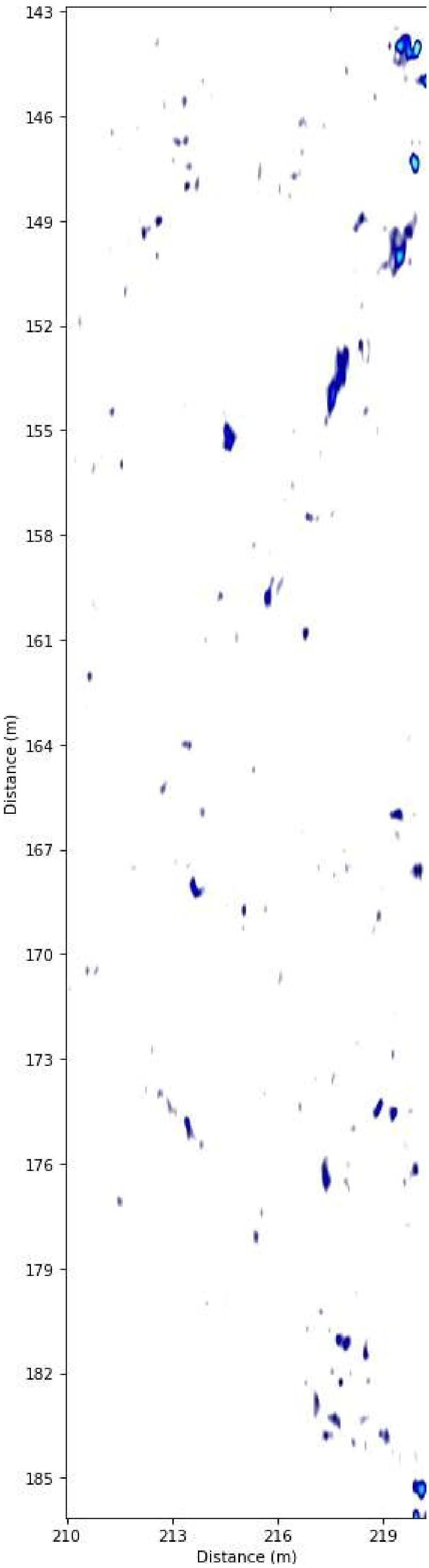
(b) Timeslice at z = 1.15 m.



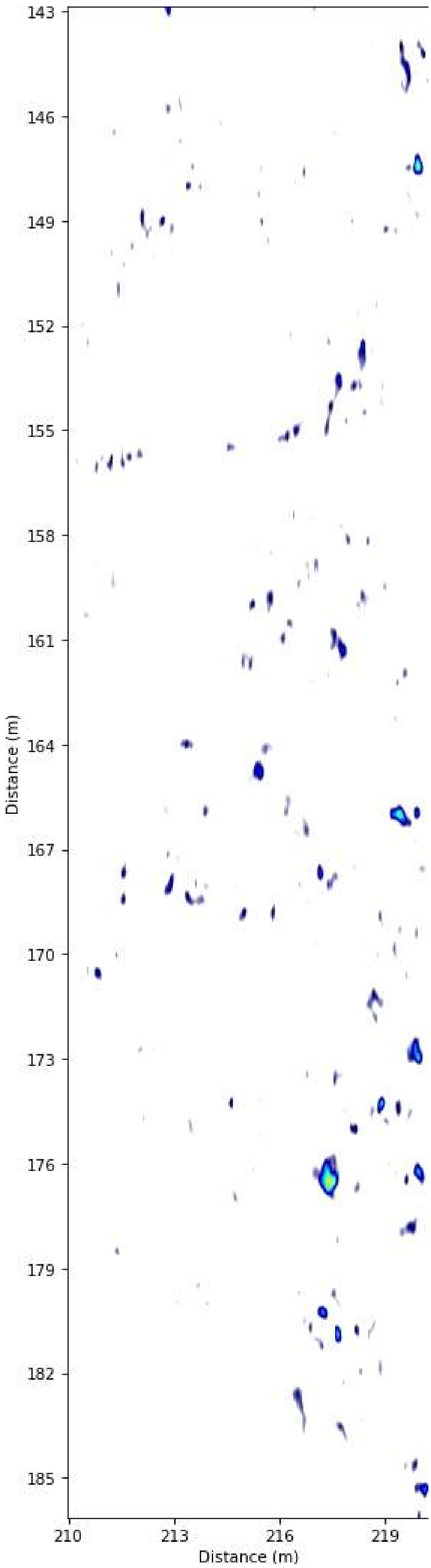
(a) Timeslice at z = 1.2 m.



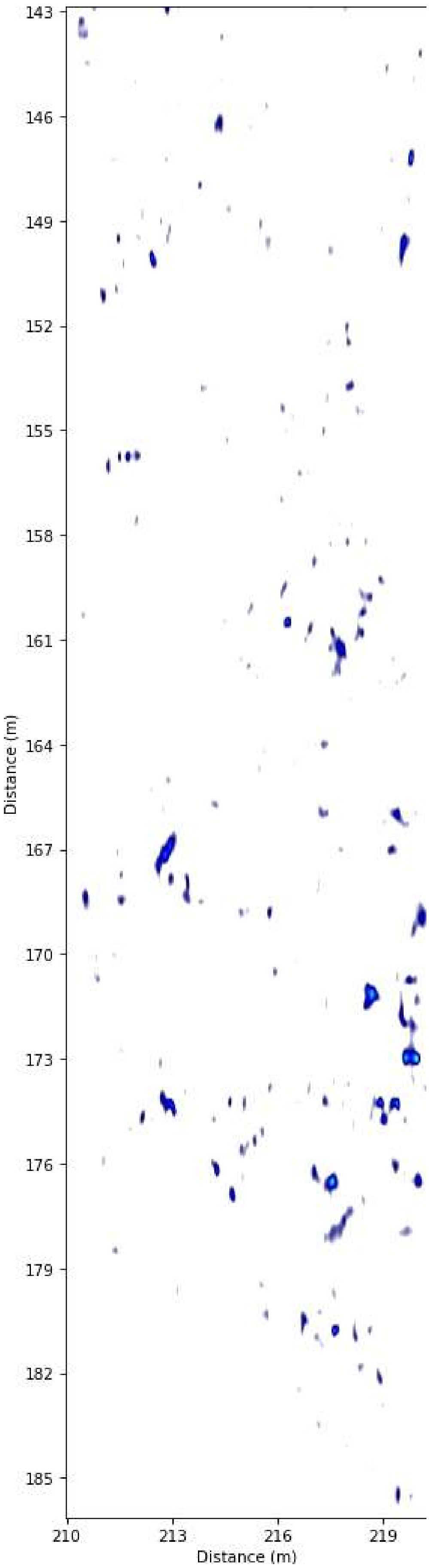
(b) Timeslice at z = 1.25 m.



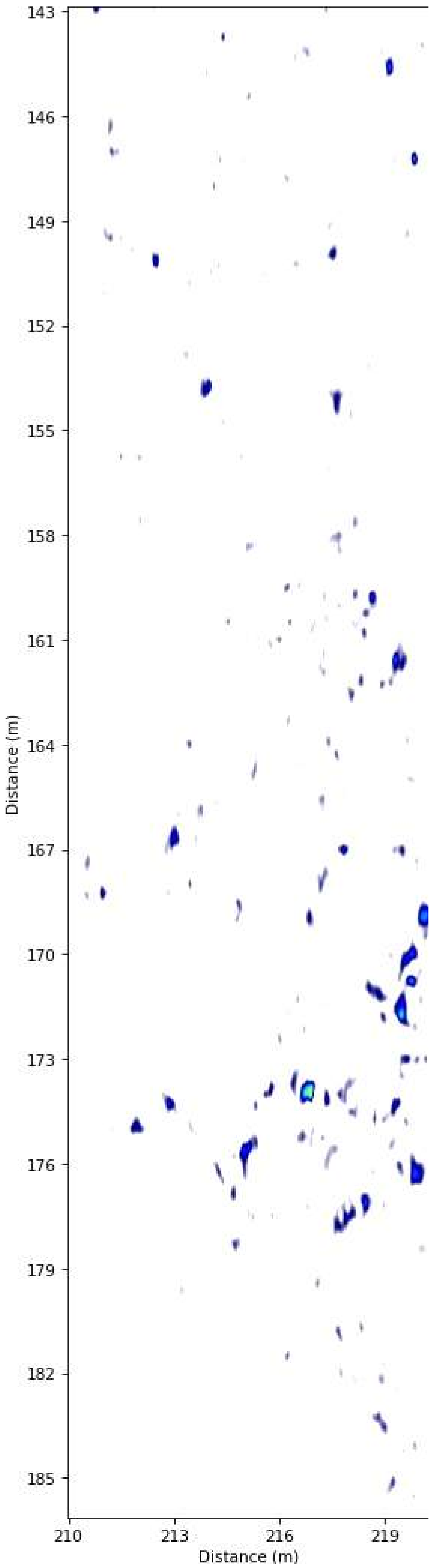
(a) Timeslice at z = 1.3 m.



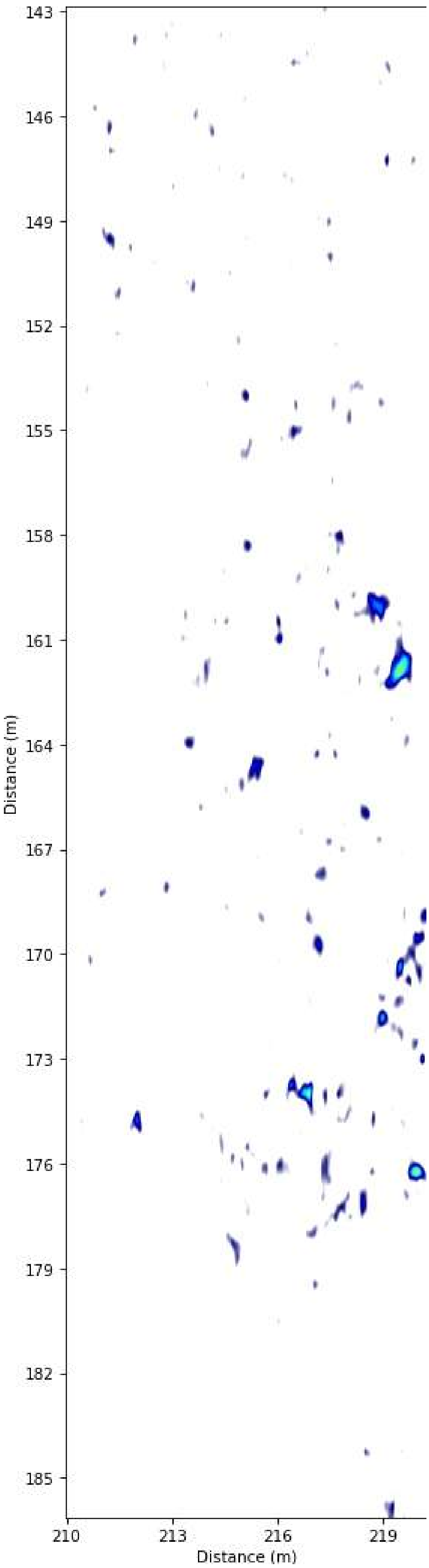
(b) Timeslice at z = 1.35 m.



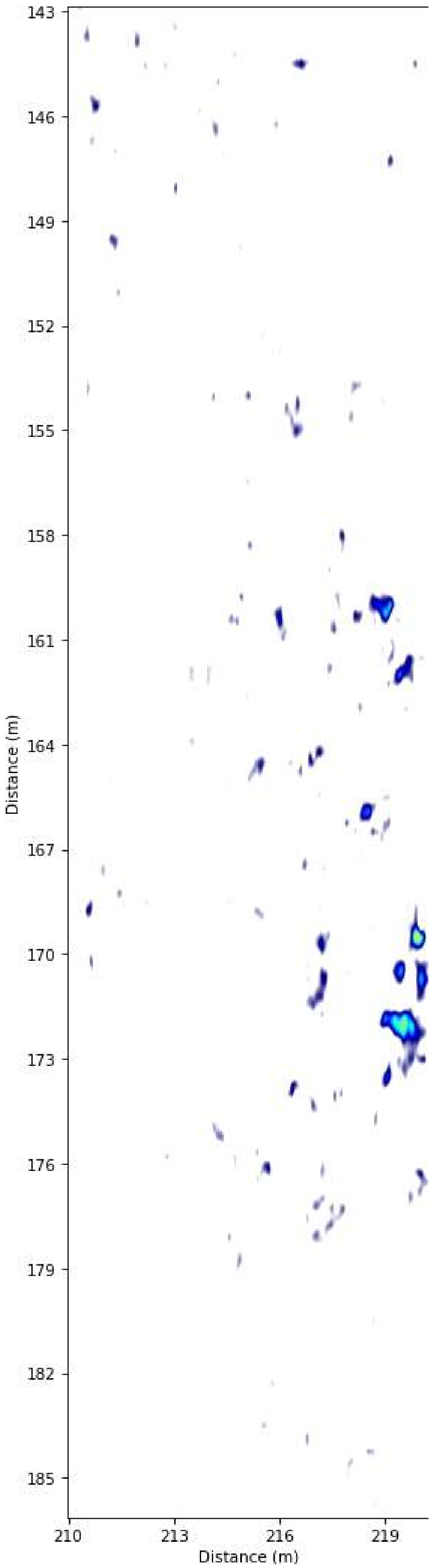
(a) Timeslice at z = 1.4 m.



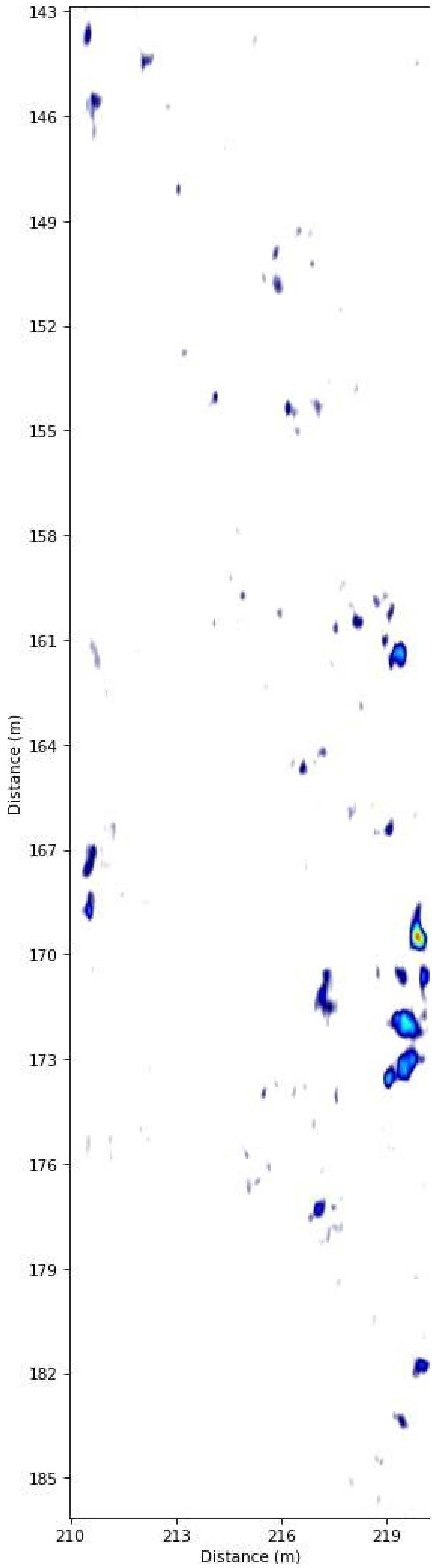
(b) Timeslice at z = 1.45 m.



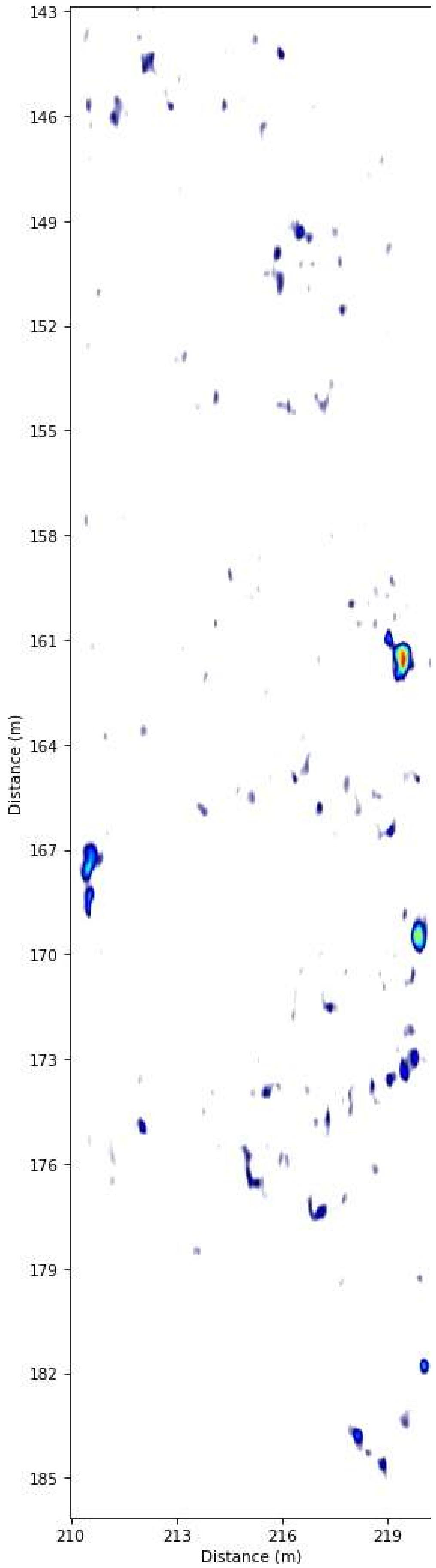
(a) Timeslice at z = 1.5 m.



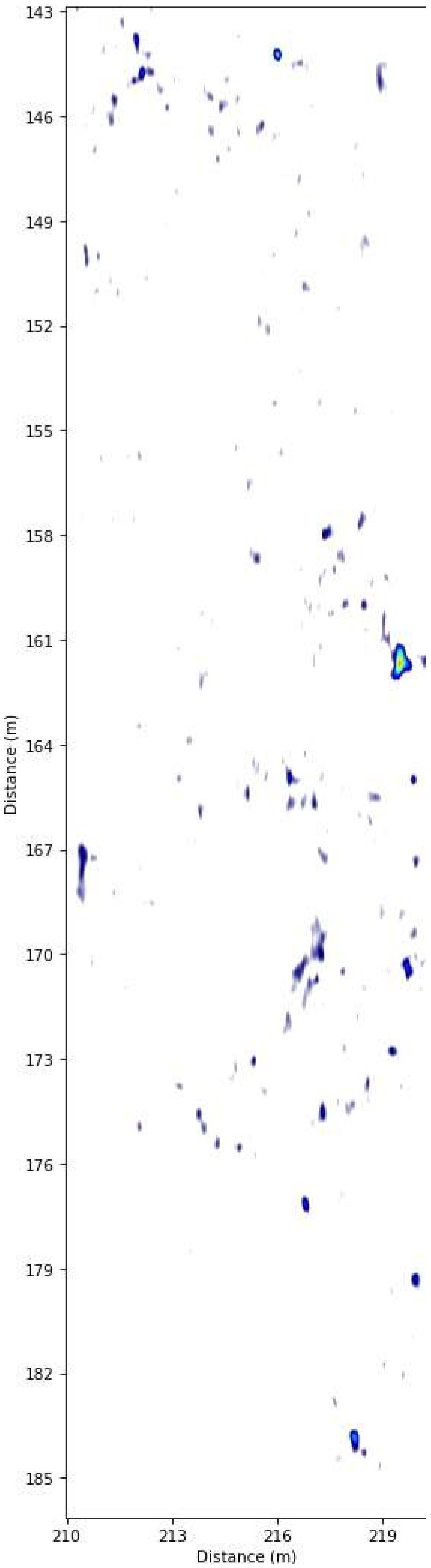
(b) Timeslice at z = 1.55 m.



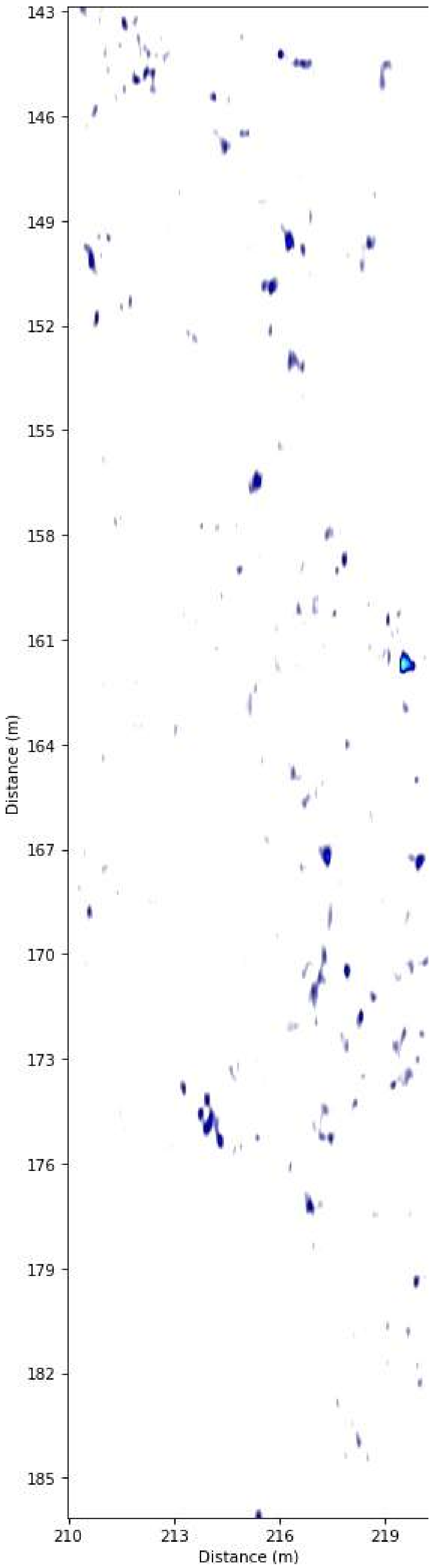
(a) Timeslice at z = 1.6 m.



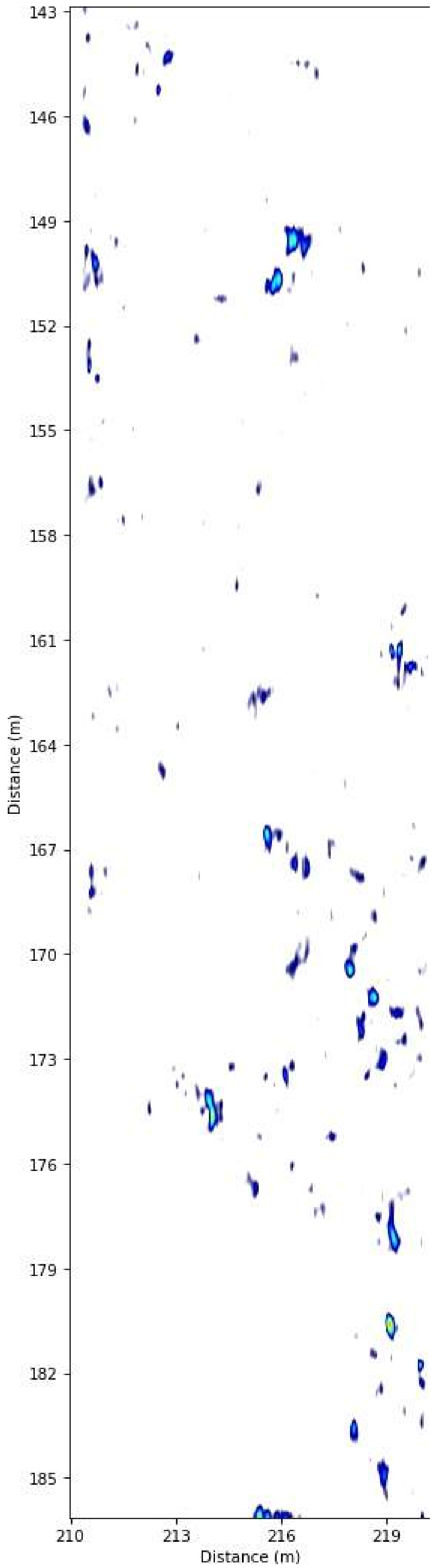
(b) Timeslice at z = 1.65 m.



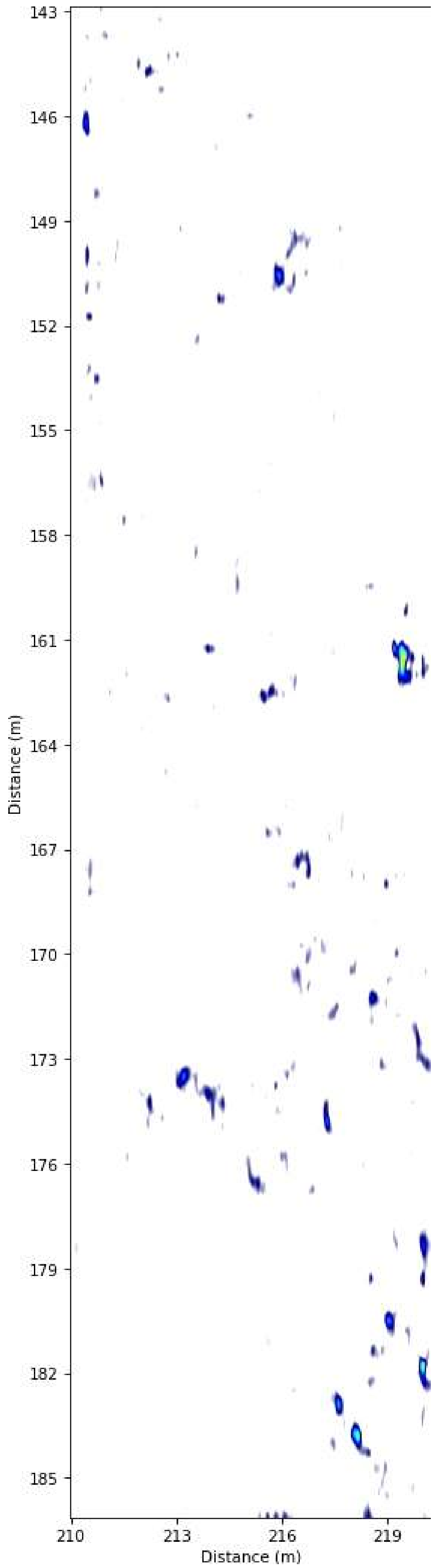
(a) Timeslice at z = 1.7 m.



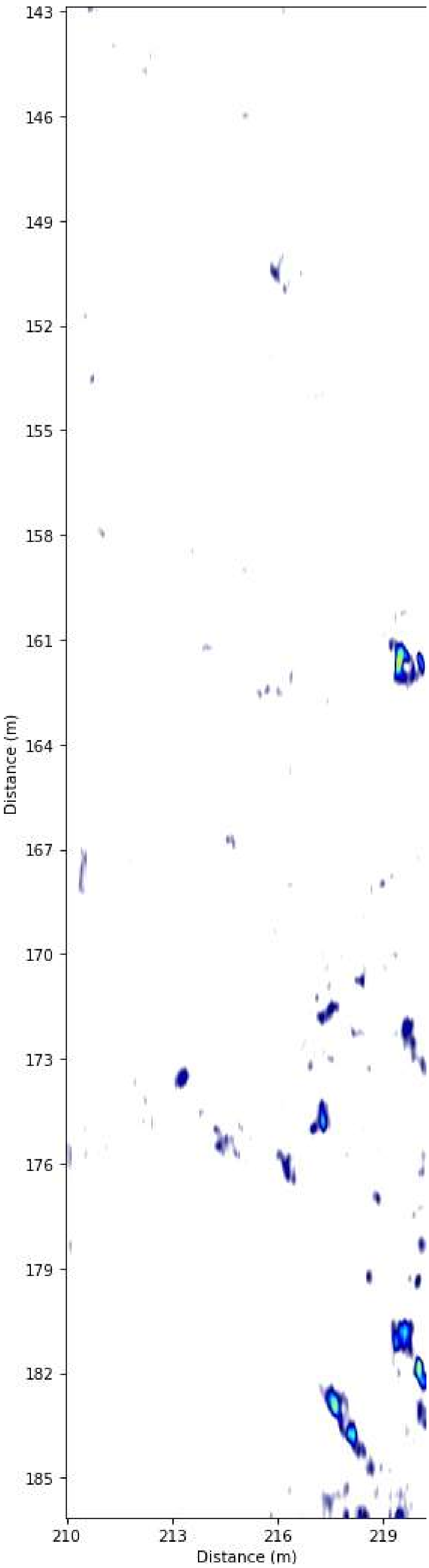
(b) Timeslice at z = 1.75 m.



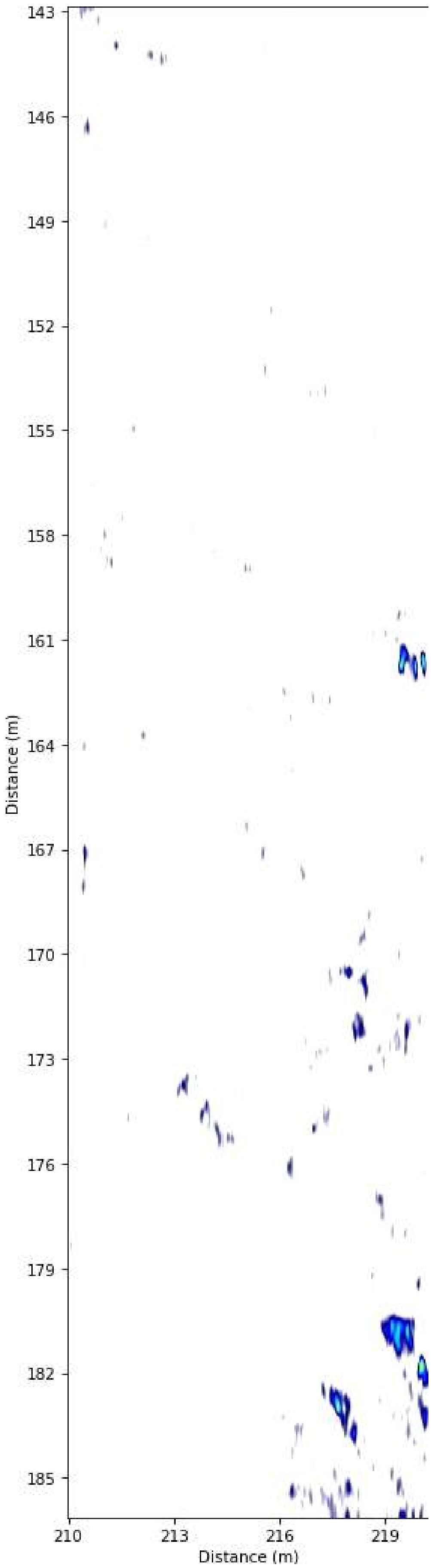
(a) Timeslice at z = 1.8 m.



(b) Timeslice at z = 1.85 m.



(a) Timeslice at z = 1.9 m.



(b) Timeslice at z = 1.95 m.

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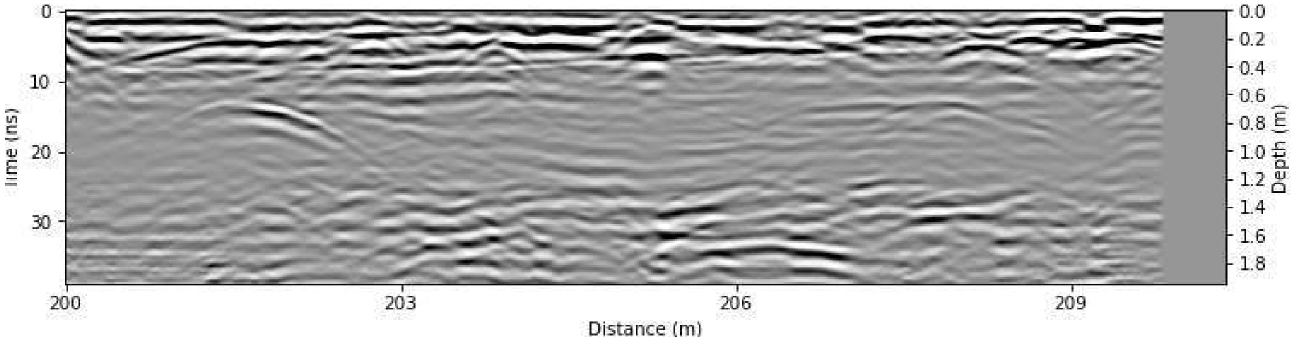


Figure B.1: Radargram at x = 100.0 m.

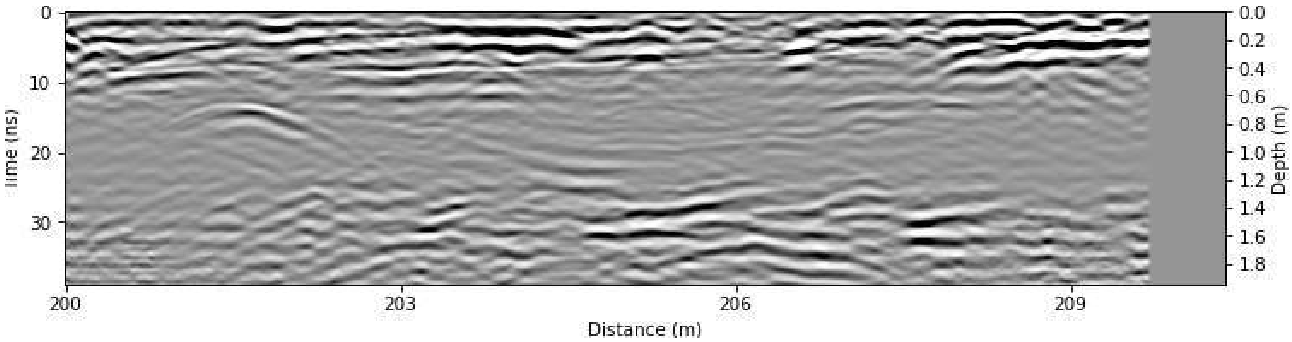


Figure B.2: Radargram at x = 100.25 m.

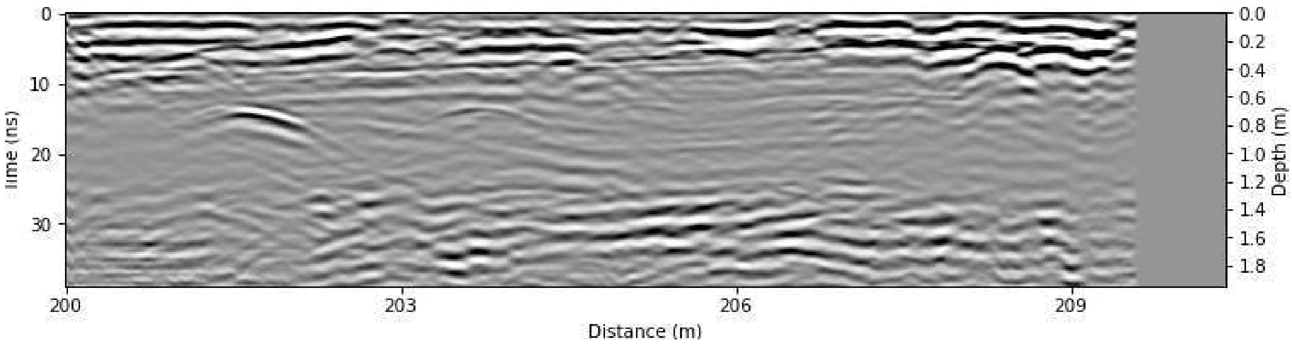


Figure B.3: Radargram at x = 100.5 m.

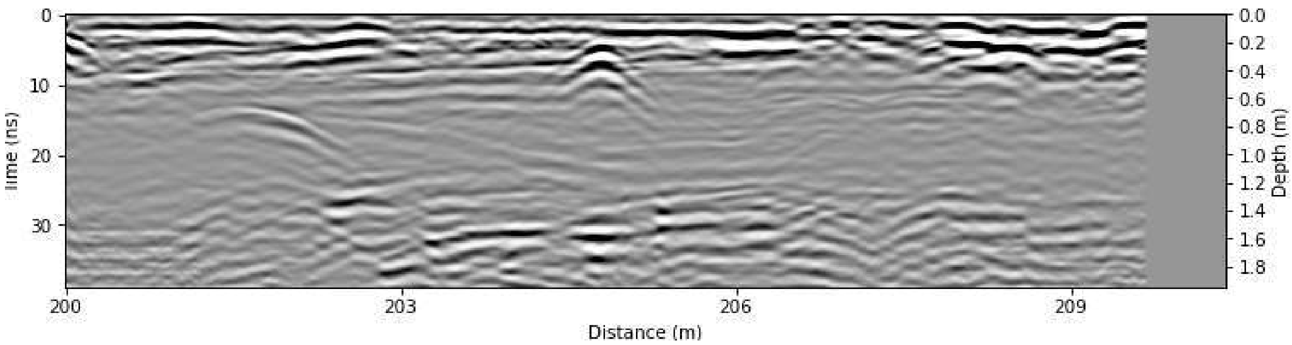


Figure B.4: Radargram at x = 100.75 m.

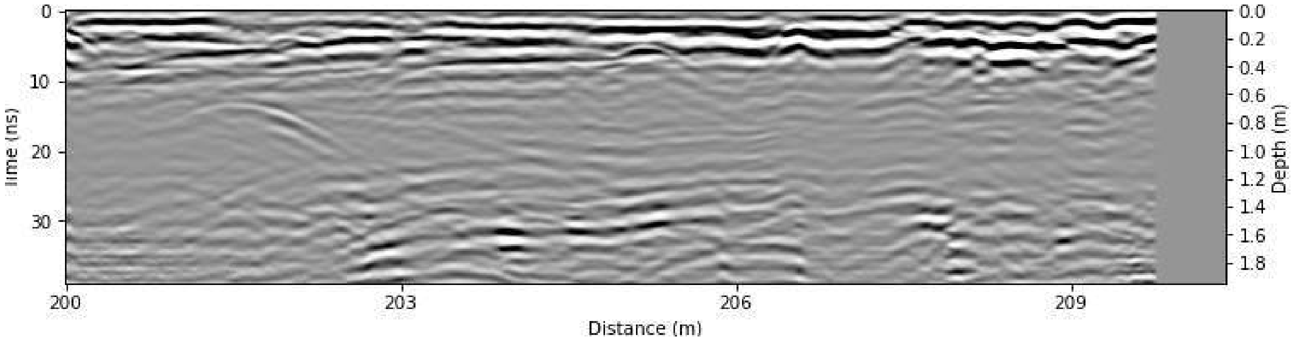


Figure B.5: Radargram at x = 101.0 m.

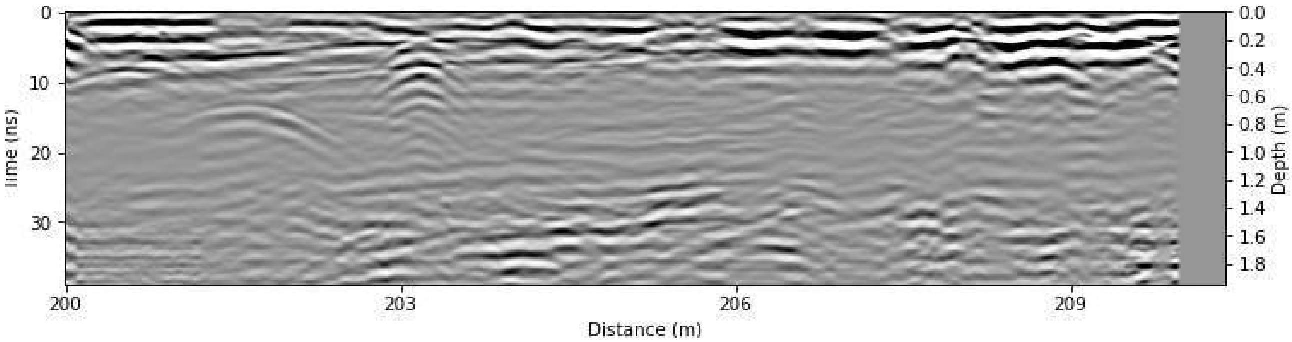


Figure B.6: Radargram at x = 101.25 m.

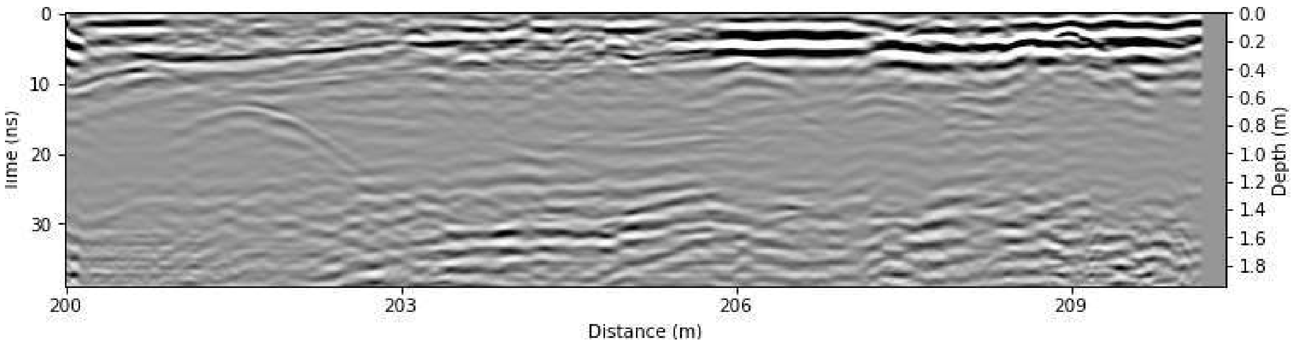


Figure B.7: Radargram at x = 101.5 m.

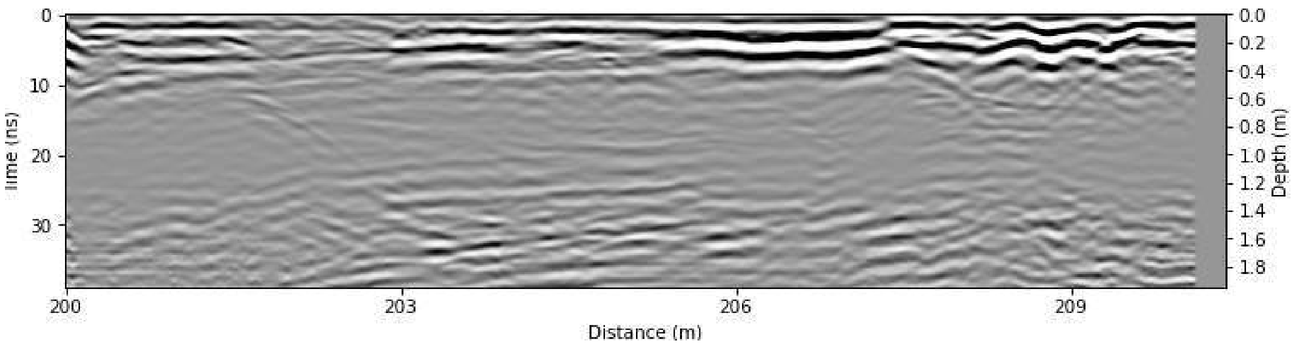


Figure B.8: Radargram at x = 101.75 m.

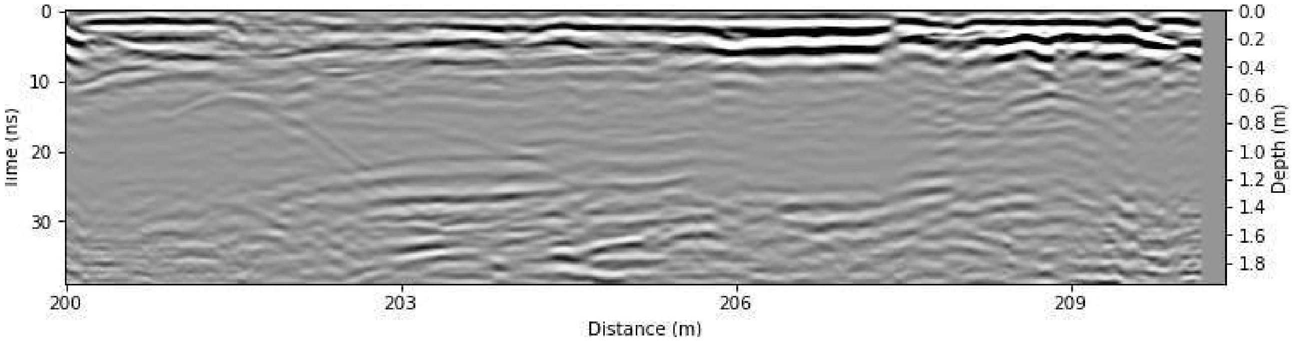


Figure B.9: Radargram at x = 102.0 m.

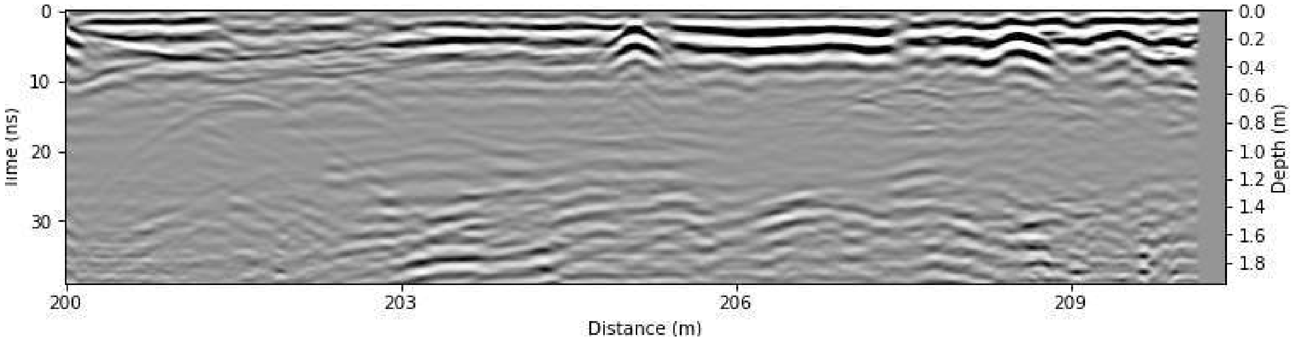


Figure B.10: Radargram at x = 102.25 m.

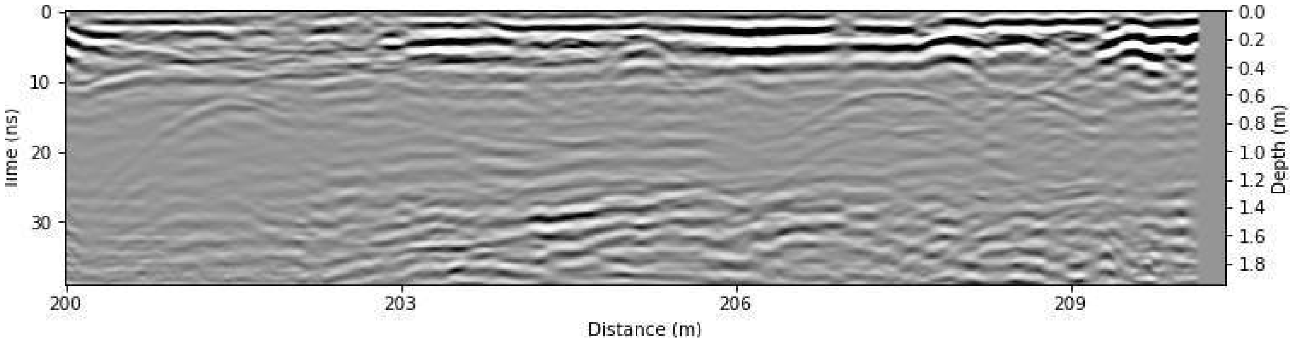


Figure B.11: Radargram at x = 102.5 m.

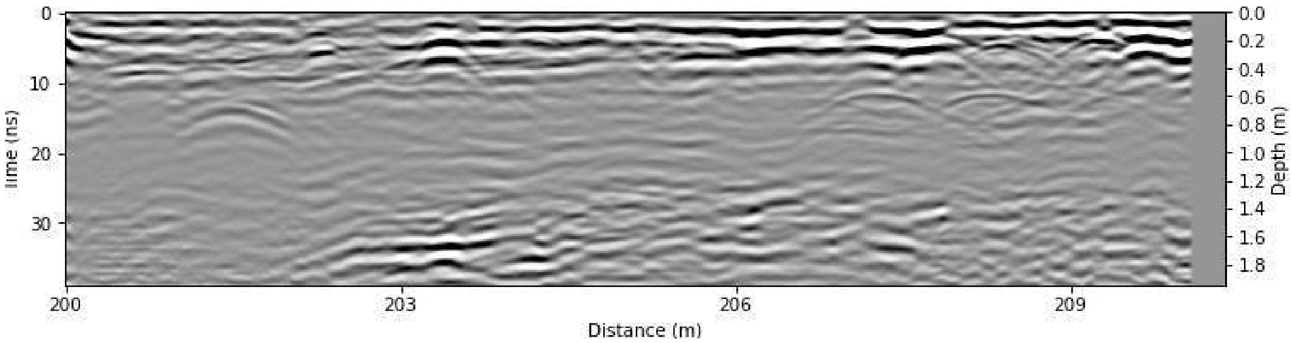


Figure B.12: Radargram at x = 102.75 m.

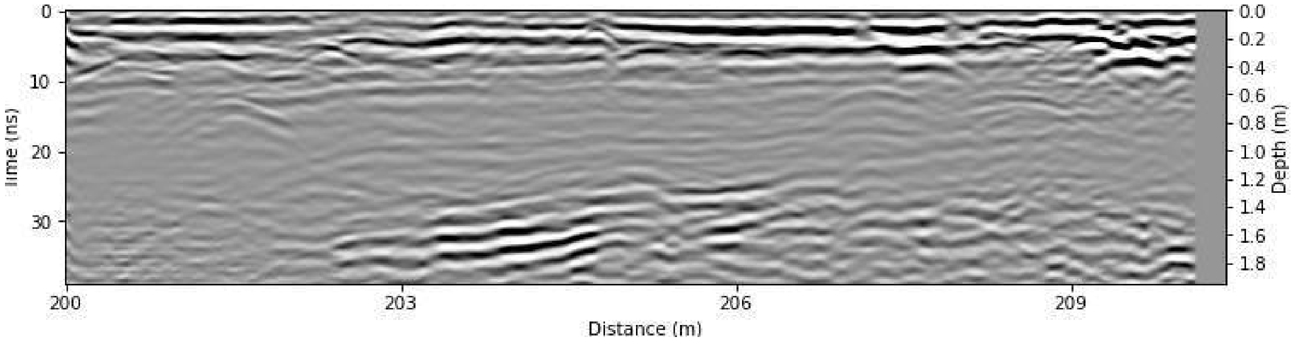


Figure B.13: Radargram at x = 103.0 m.

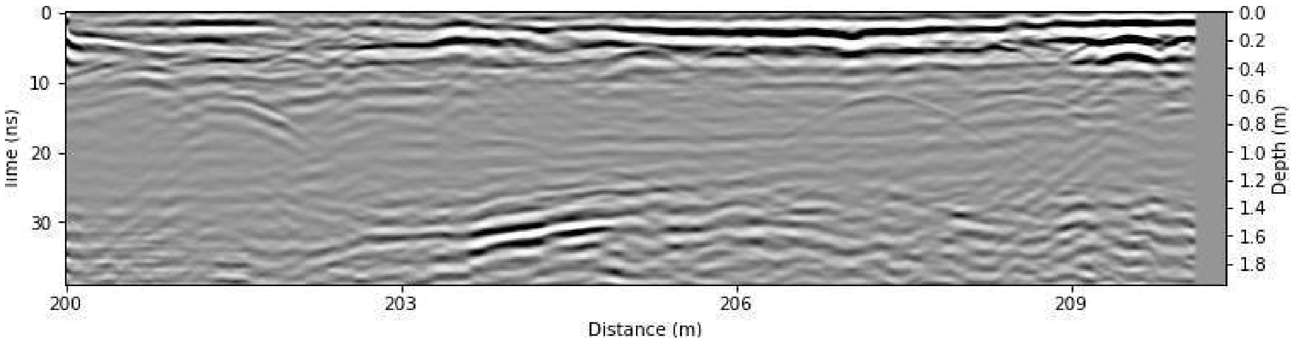


Figure B.14: Radargram at x = 103.25 m.

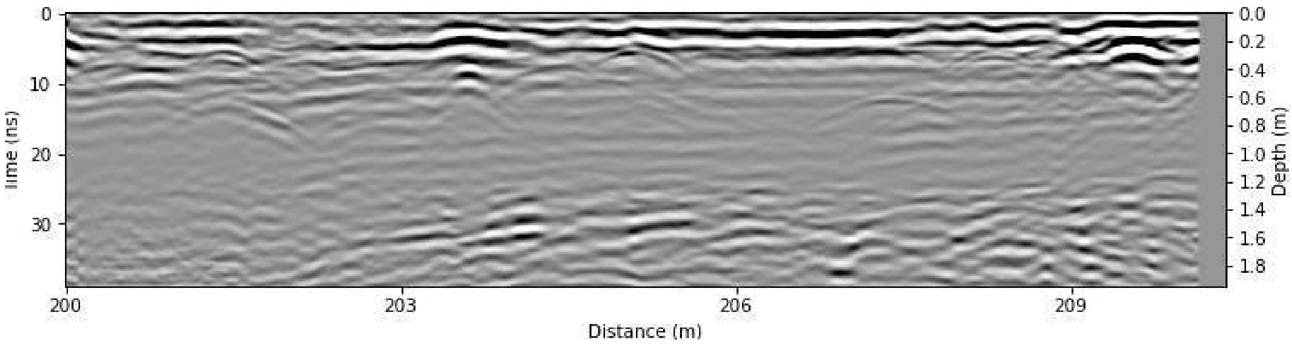


Figure B.15: Radargram at x = 103.5 m.

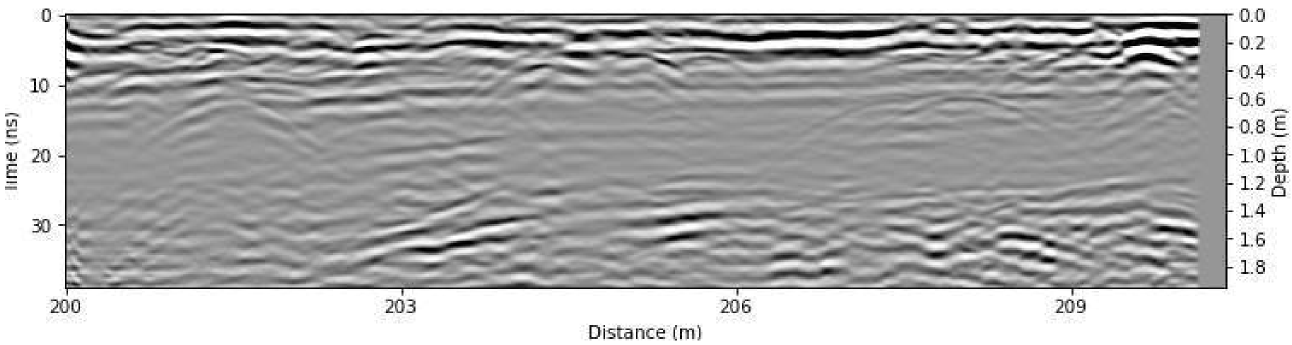


Figure B.16: Radargram at x = 103.75 m.

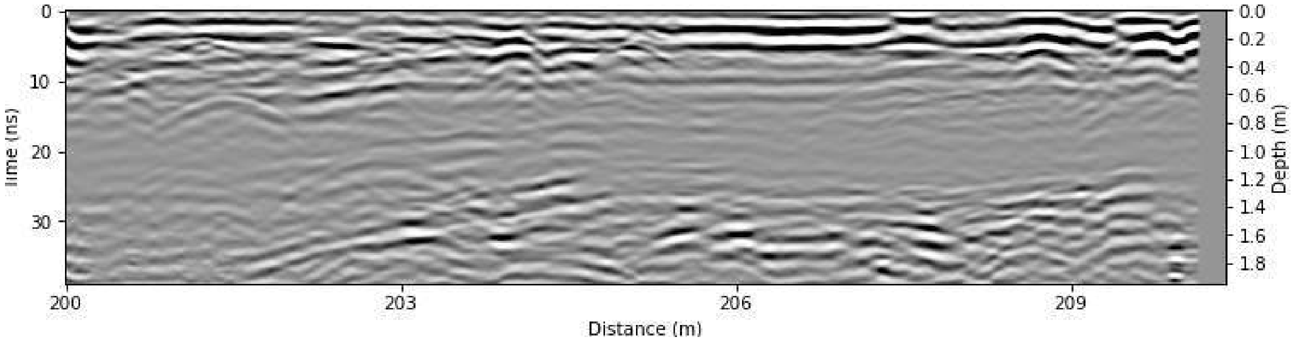


Figure B.17: Radargram at x = 104.0 m.

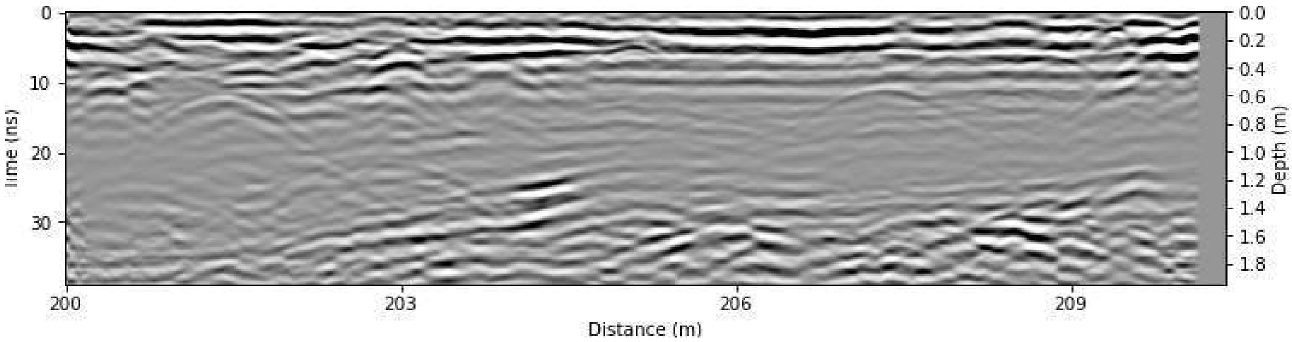


Figure B.18: Radargram at x = 104.25 m.

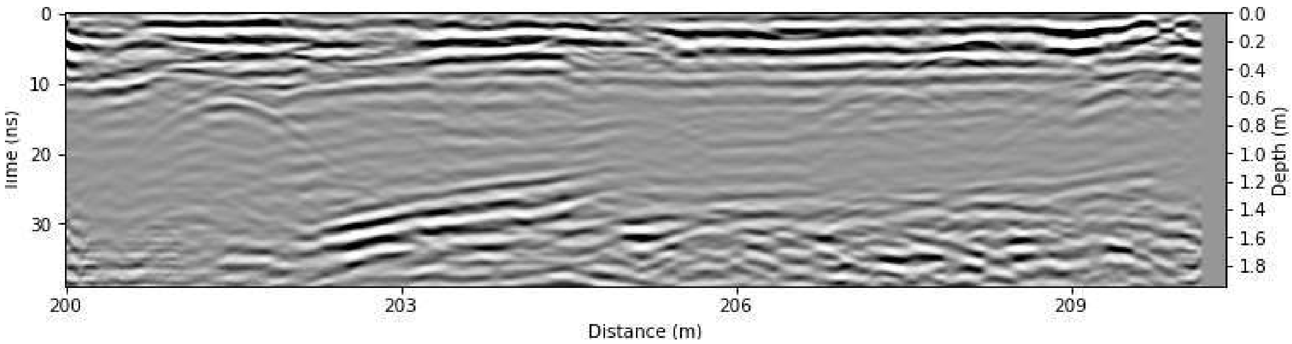


Figure B.19: Radargram at x = 104.5 m.

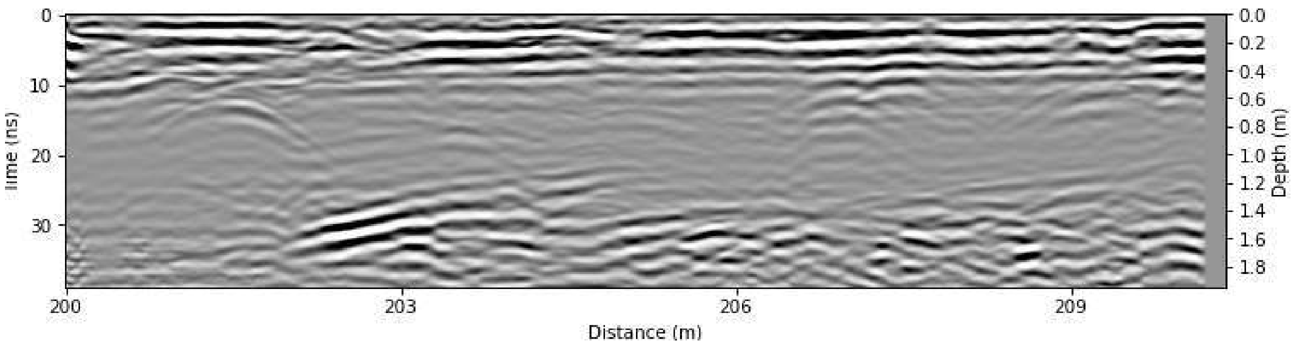


Figure B.20: Radargram at x = 104.75 m.

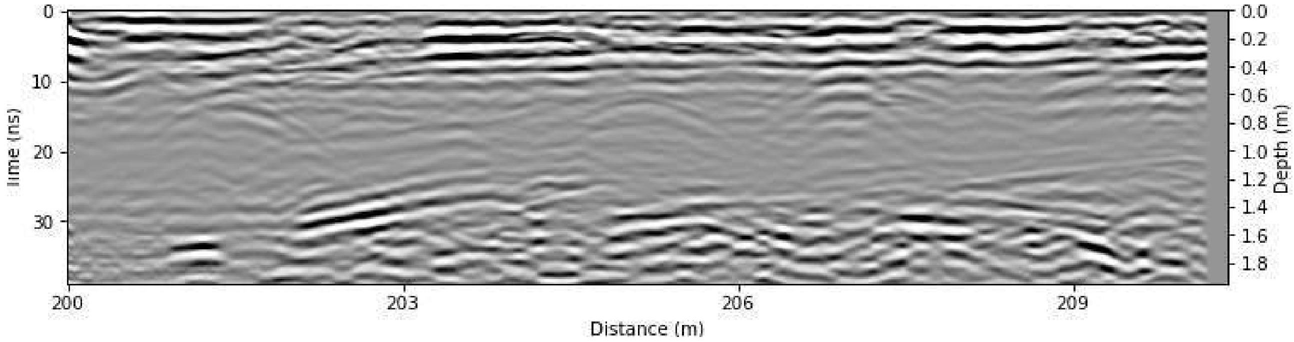


Figure B.21: Radargram at x = 105.0 m.

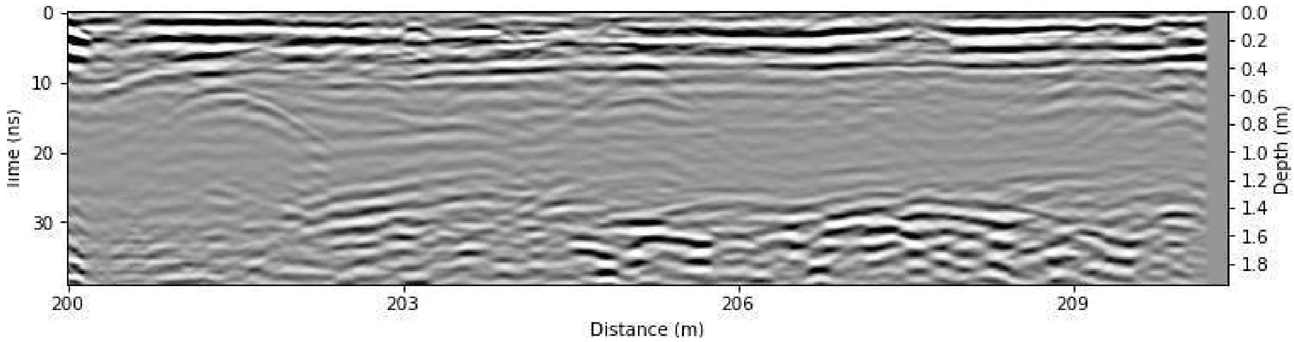


Figure B.22: Radargram at x = 105.25 m.

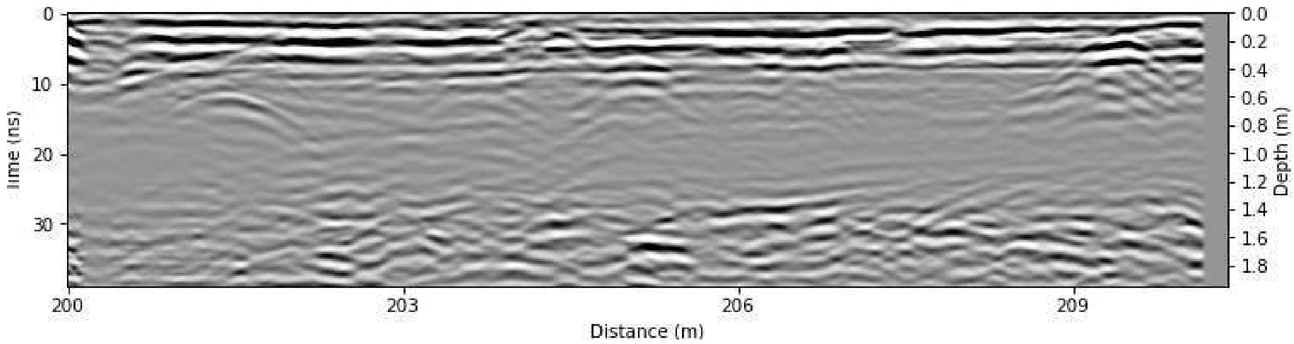


Figure B.23: Radargram at x = 105.5 m.

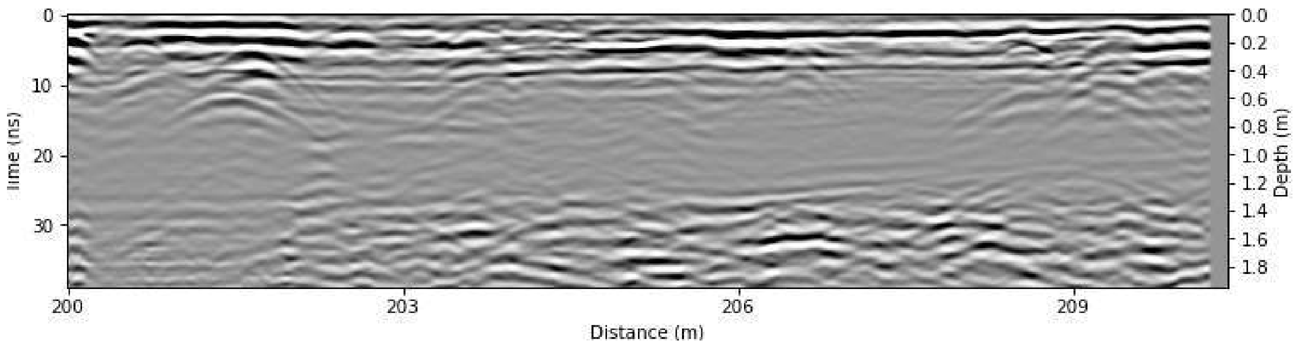


Figure B.24: Radargram at x = 105.75 m.

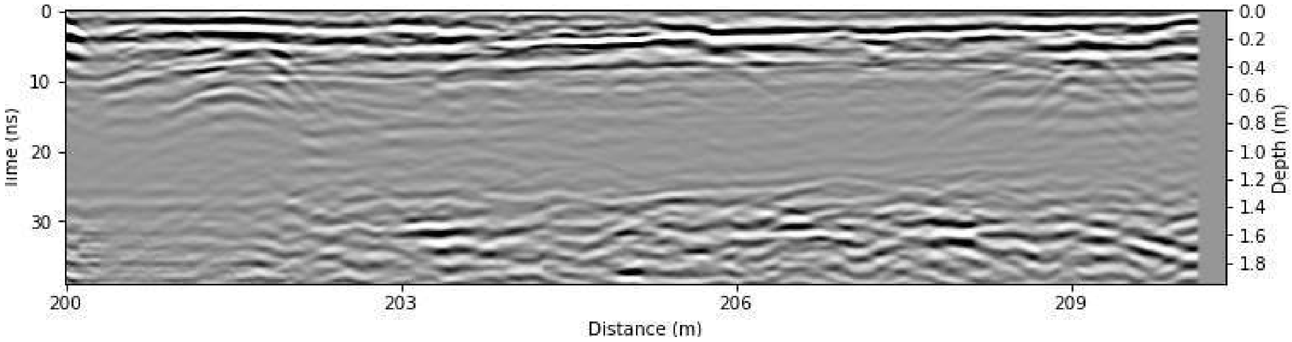


Figure B.25: Radargram at x = 106.0 m.

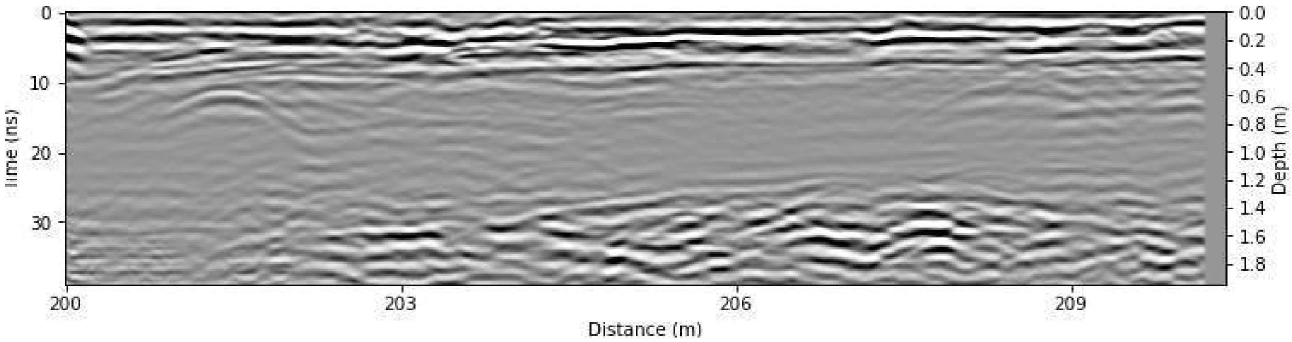


Figure B.26: Radargram at x = 106.25 m.

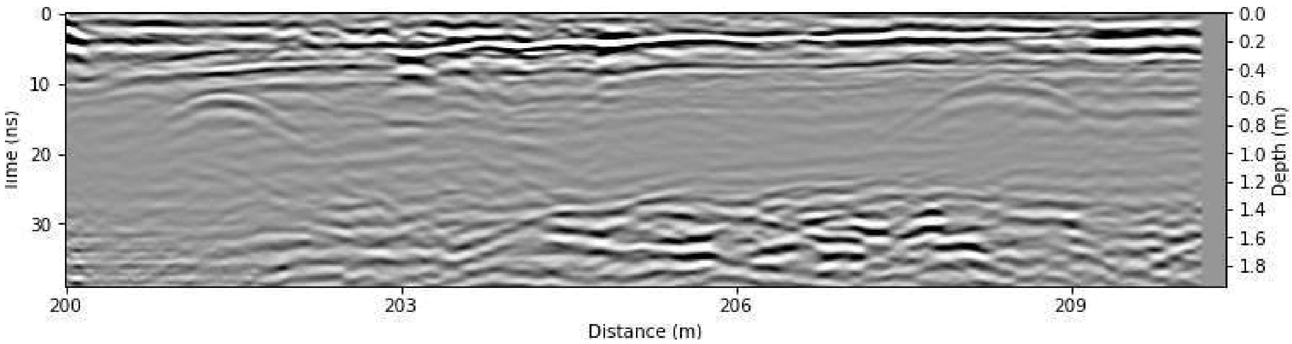


Figure B.27: Radargram at x = 106.5 m.

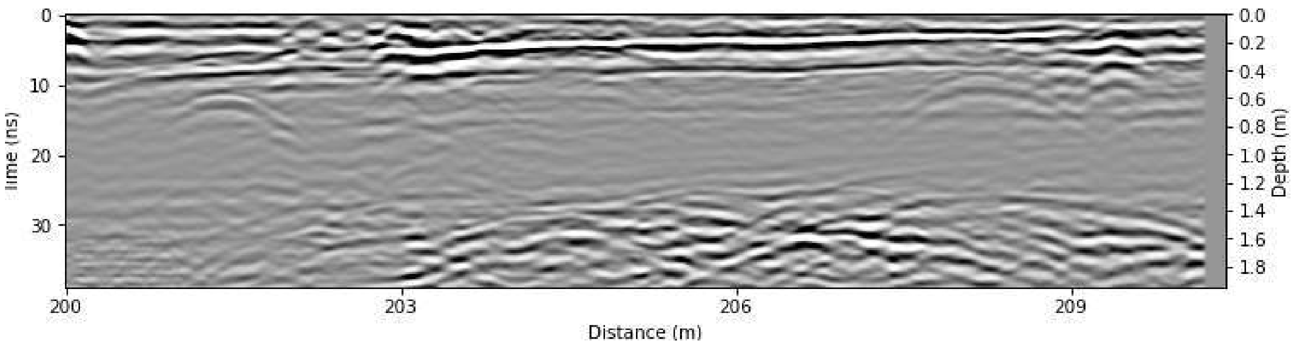


Figure B.28: Radargram at x = 106.75 m.

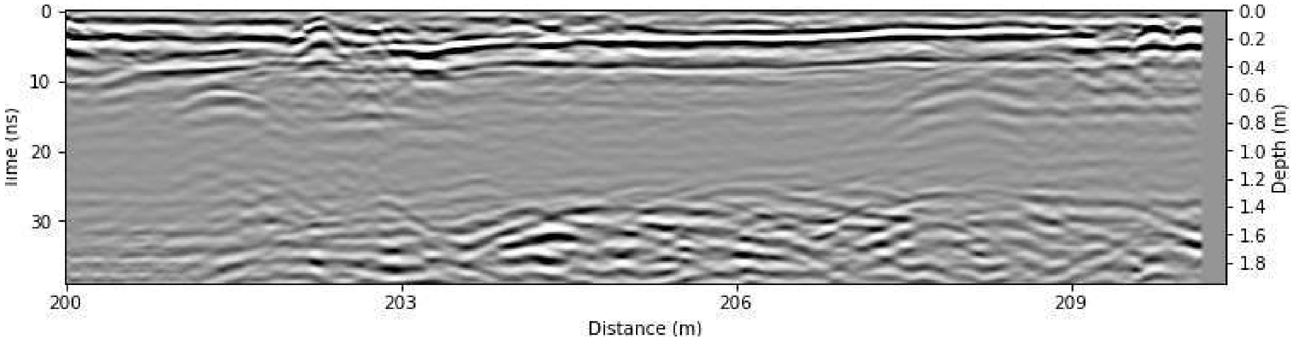


Figure B.29: Radargram at x = 107.0 m.

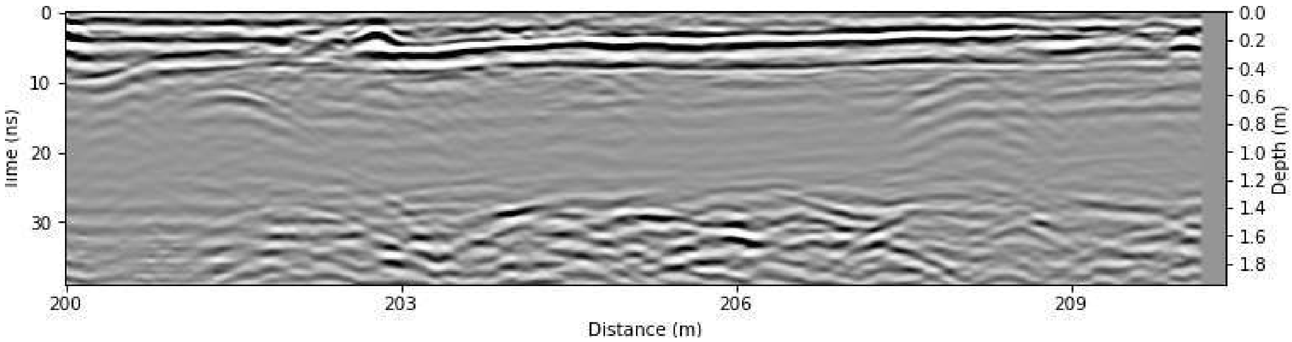


Figure B.30: Radargram at x = 107.25 m.

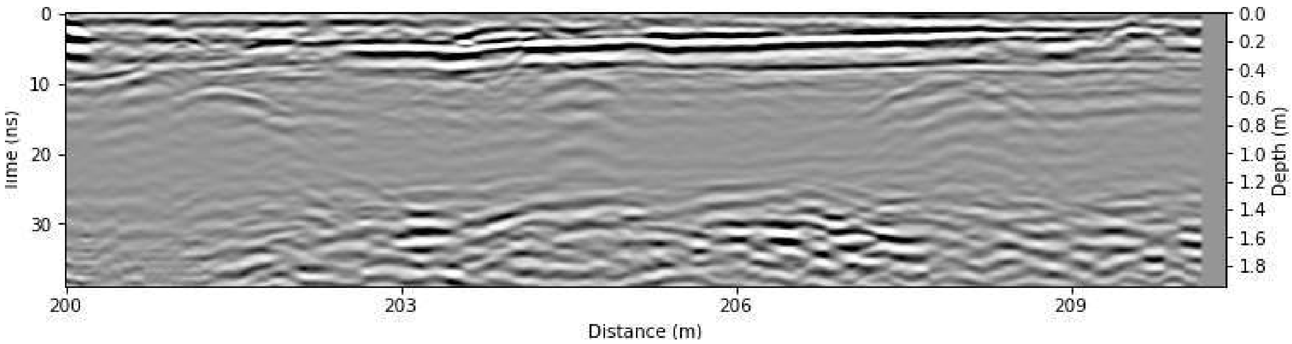


Figure B.31: Radargram at x = 107.5 m.

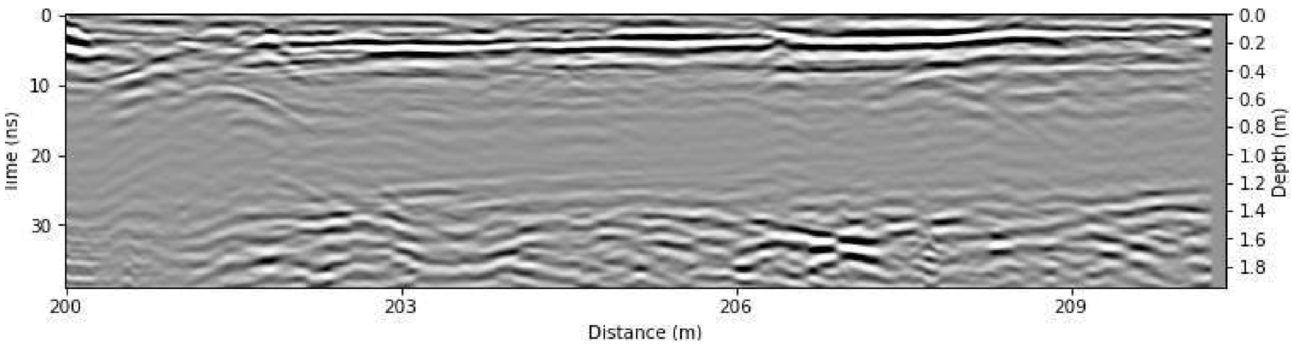


Figure B.32: Radargram at x = 107.75 m.

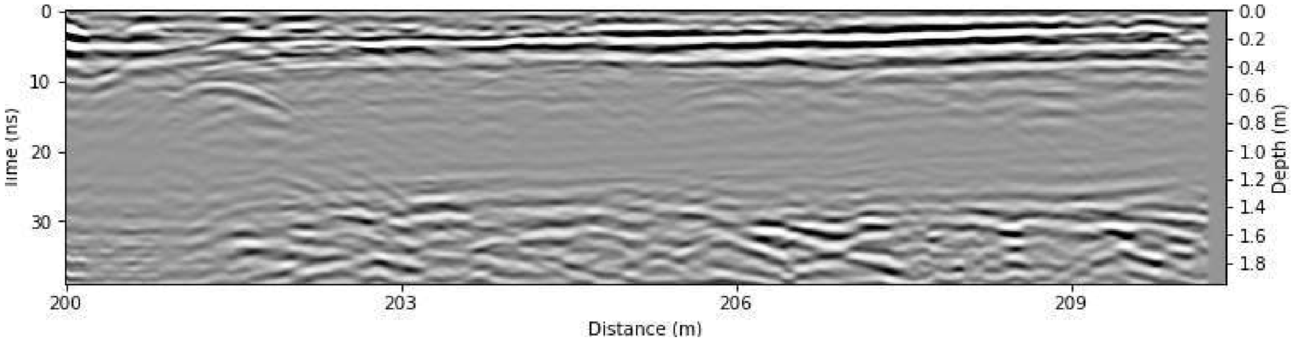


Figure B.33: Radargram at x = 108.0 m.

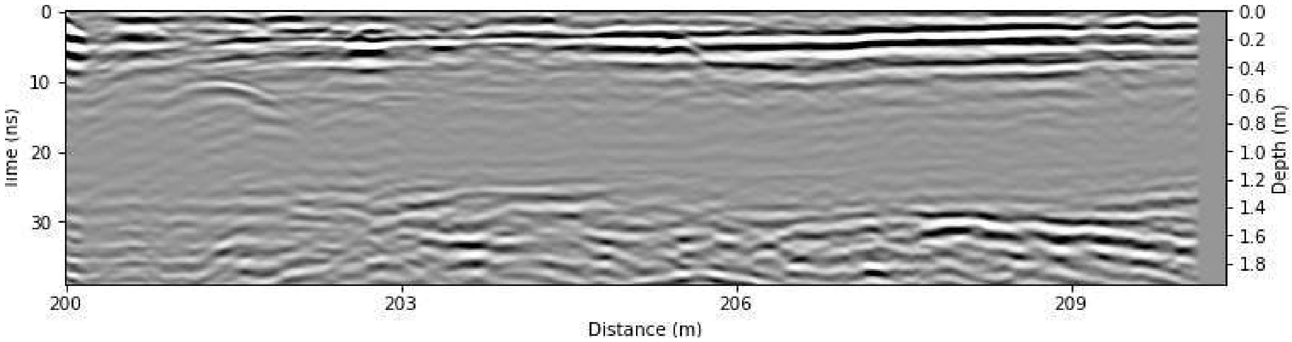


Figure B.34: Radargram at x = 108.25 m.

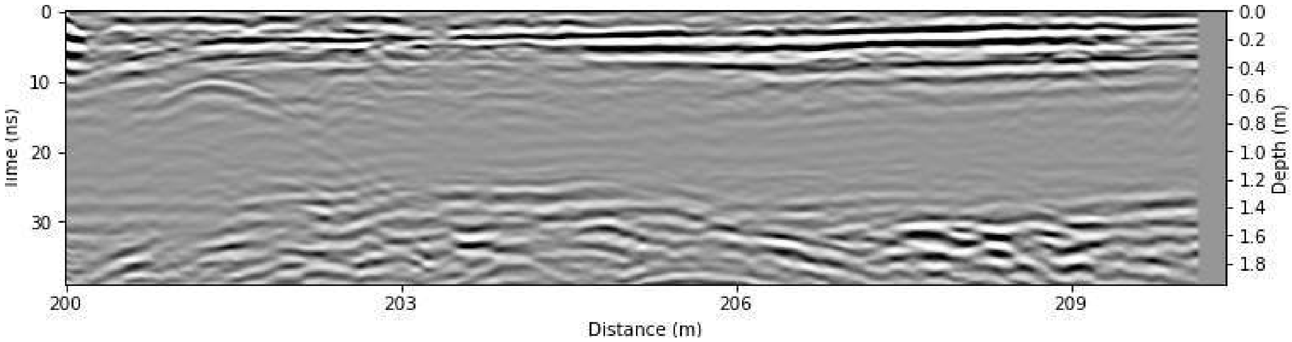


Figure B.35: Radargram at x = 108.5 m.

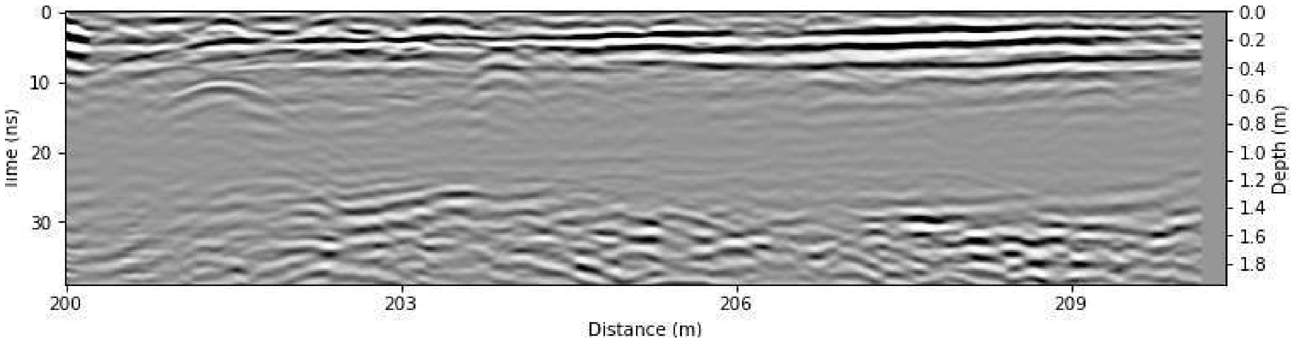


Figure B.36: Radargram at x = 108.75 m.

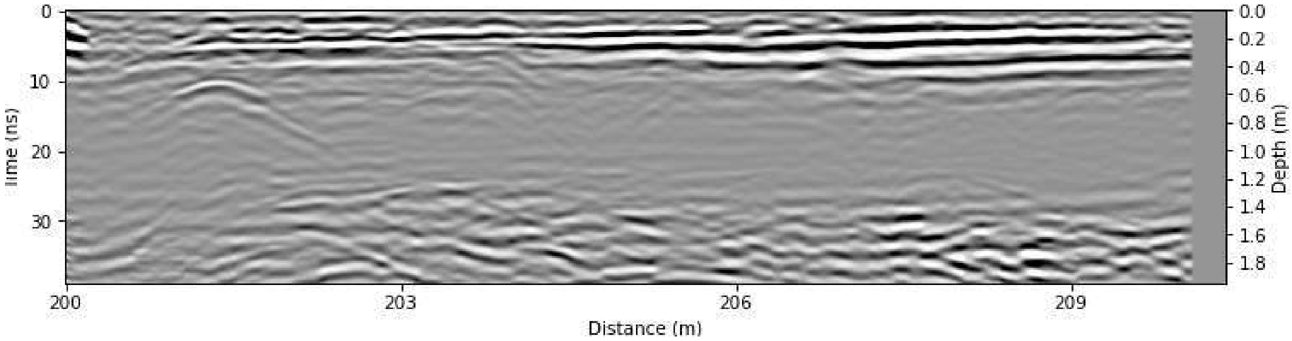


Figure B.37: Radargram at x = 109.0 m.

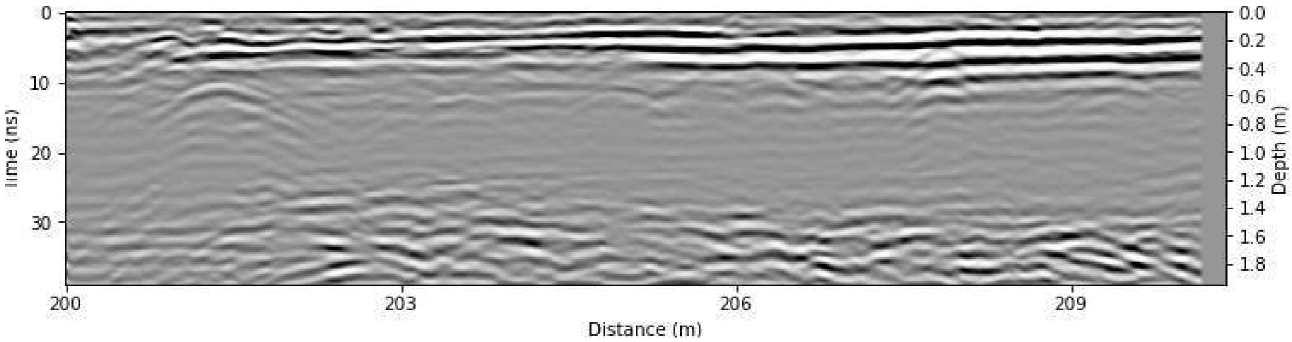


Figure B.38: Radargram at x = 109.25 m.

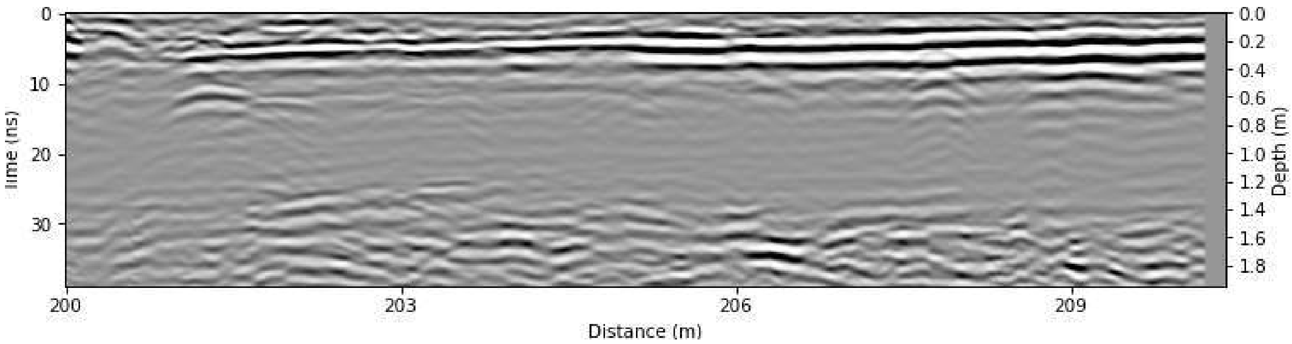


Figure B.39: Radargram at x = 109.5 m.

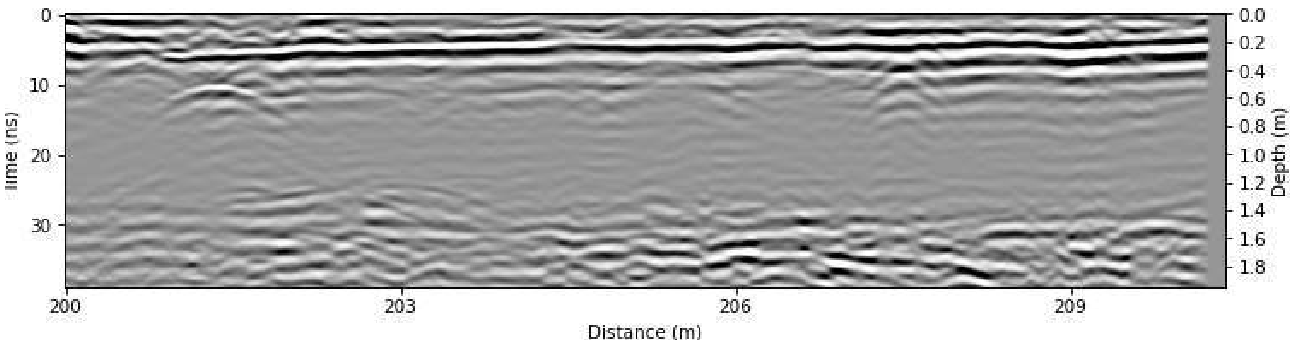


Figure B.40: Radargram at x = 109.75 m.

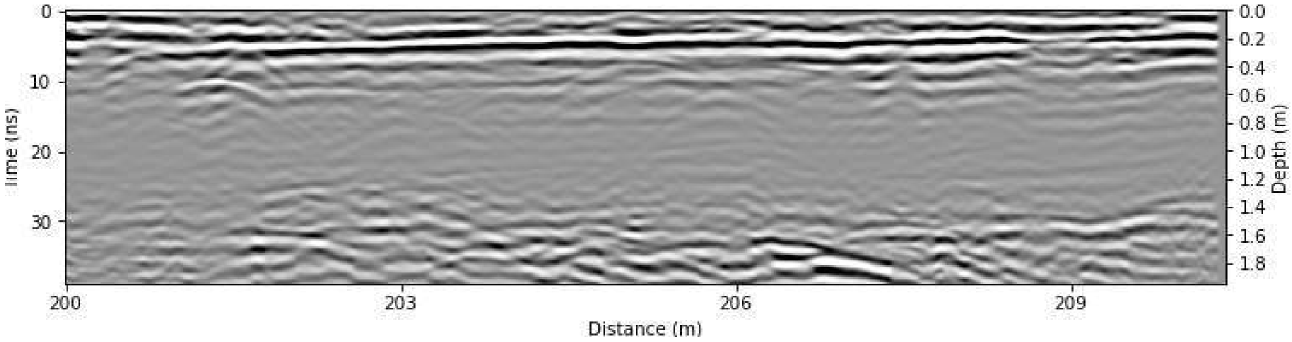
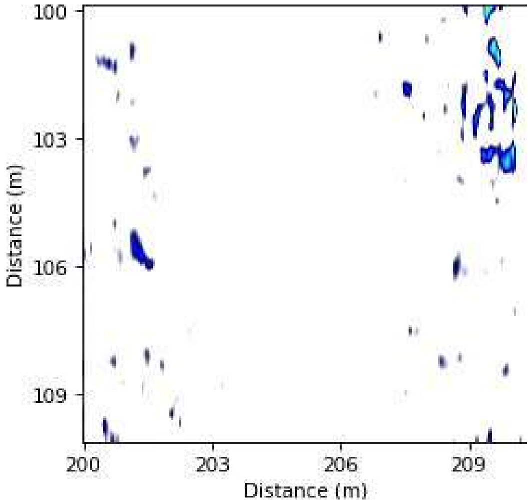
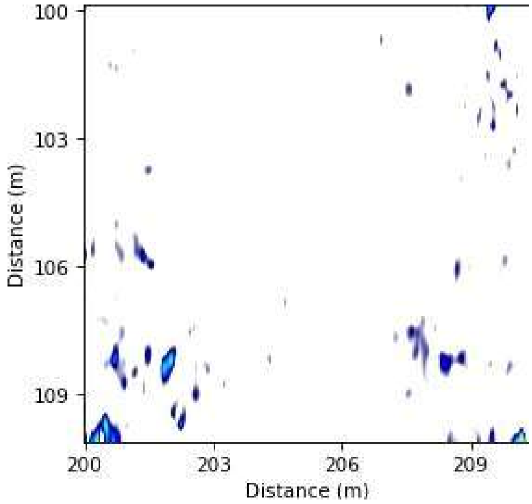


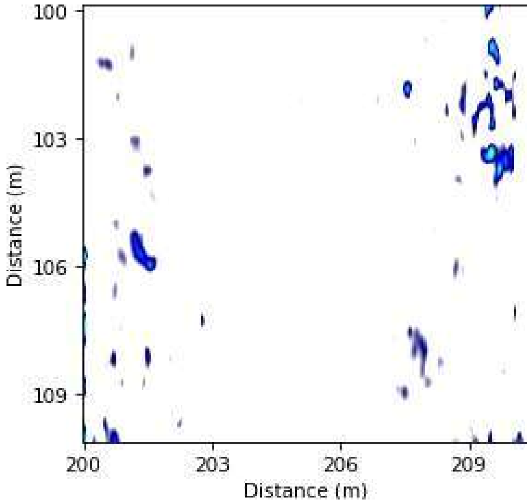
Figure B.41: Radargram at x = 110.0 m.



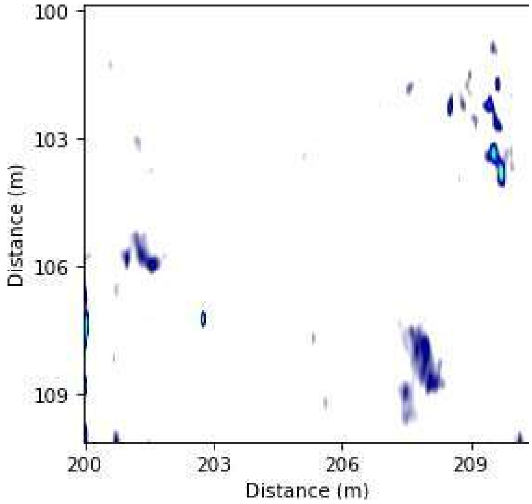
(a) Timeslice at z = 0.0 m.



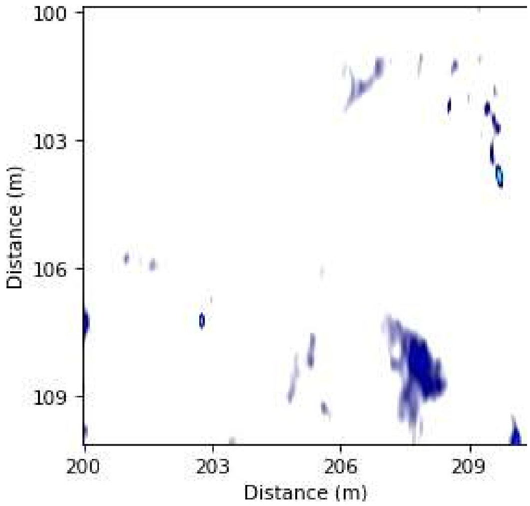
(b) Timeslice at z = 0.05 m.



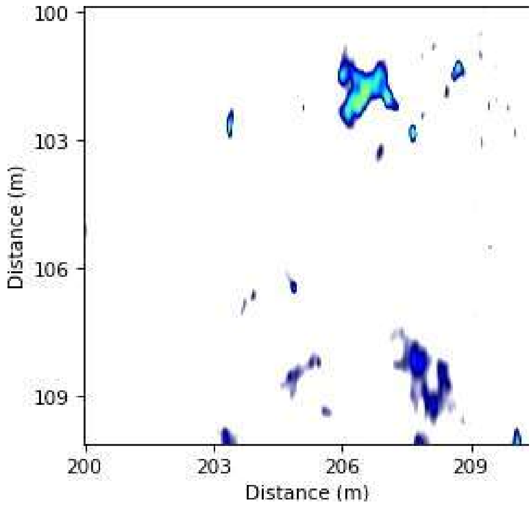
(c) Timeslice at z = 0.1 m.



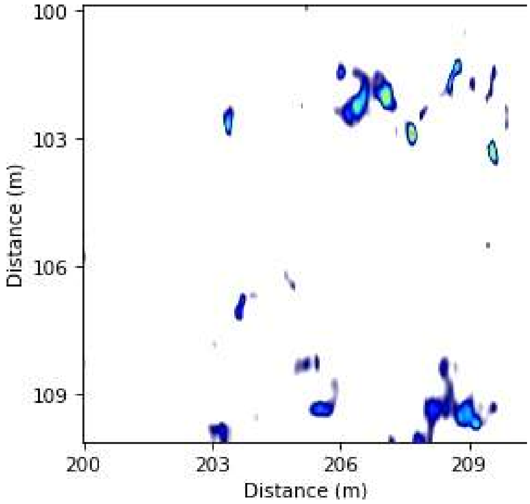
(d) Timeslice at z = 0.15 m.



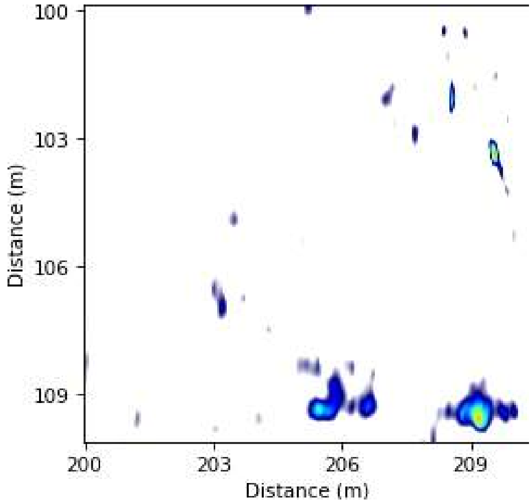
(e) Timeslice at z = 0.2 m.



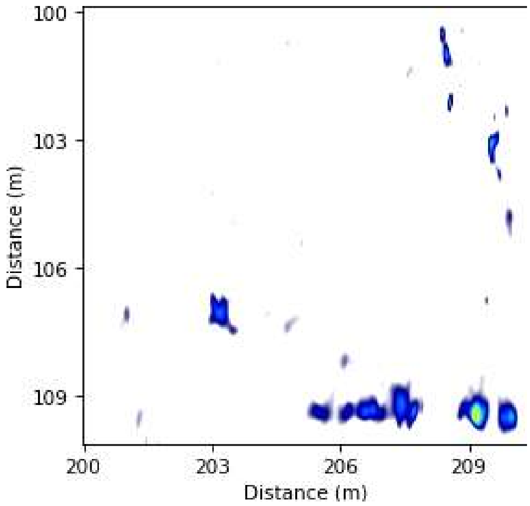
(f) Timeslice at z = 0.25 m.



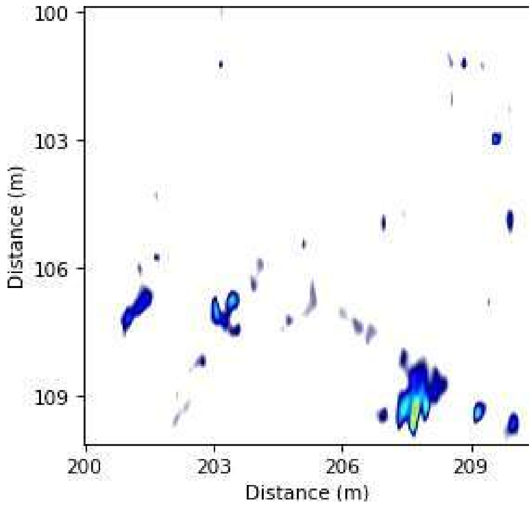
(a) Timeslice at z = 0.3 m.



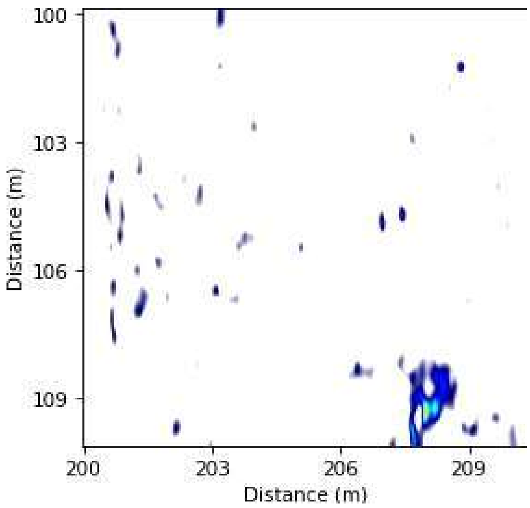
(b) Timeslice at z = 0.35 m.



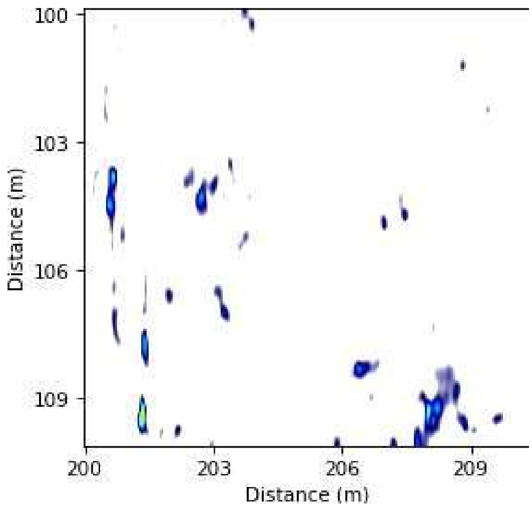
(c) Timeslice at z = 0.4 m.



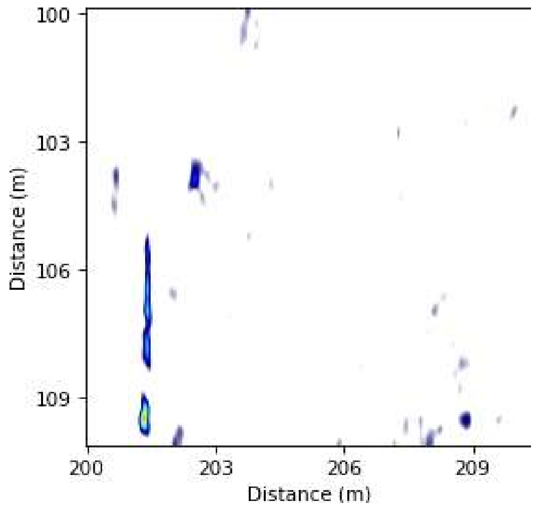
(d) Timeslice at z = 0.45 m.



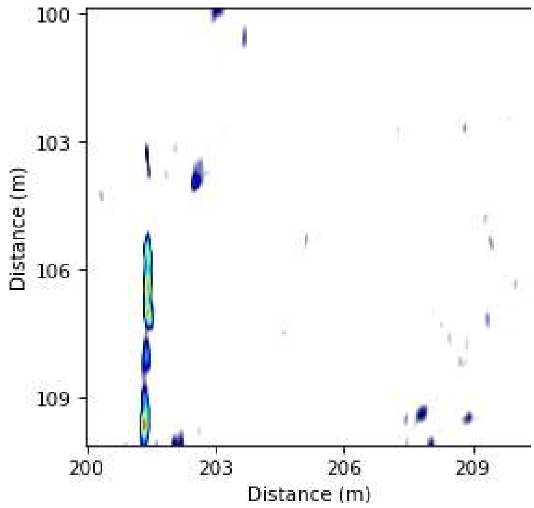
(e) Timeslice at z = 0.5 m.



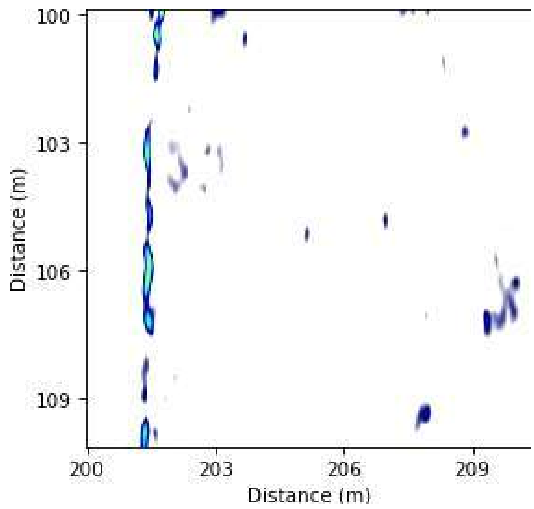
(f) Timeslice at z = 0.55 m.



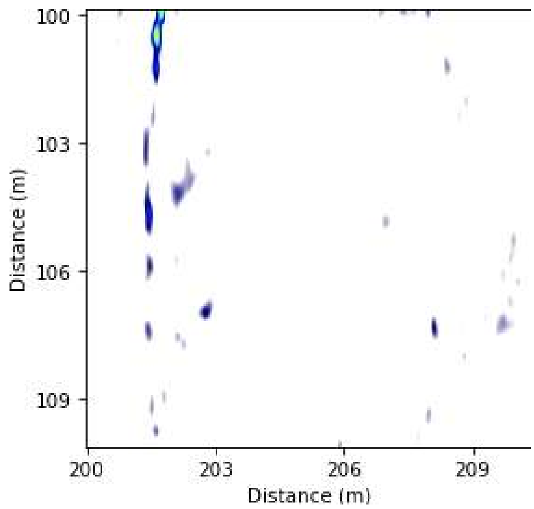
(a) Timeslice at z = 0.6 m.



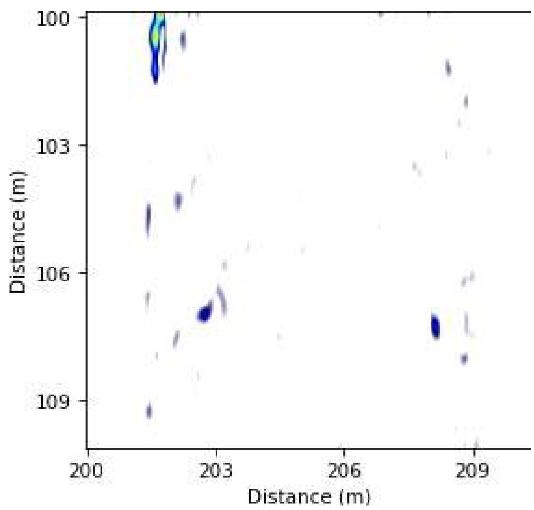
(b) Timeslice at z = 0.65 m.



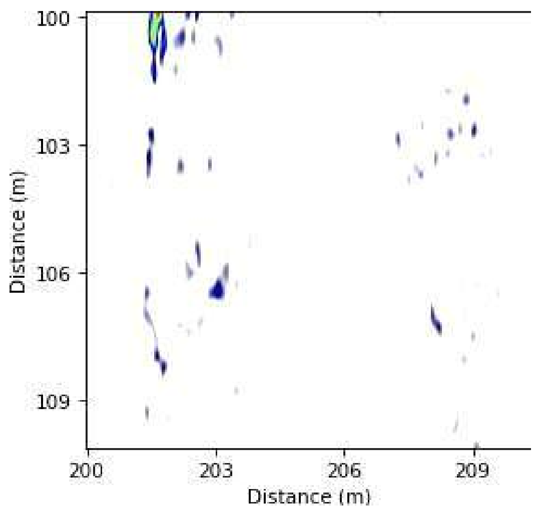
(c) Timeslice at z = 0.7 m.



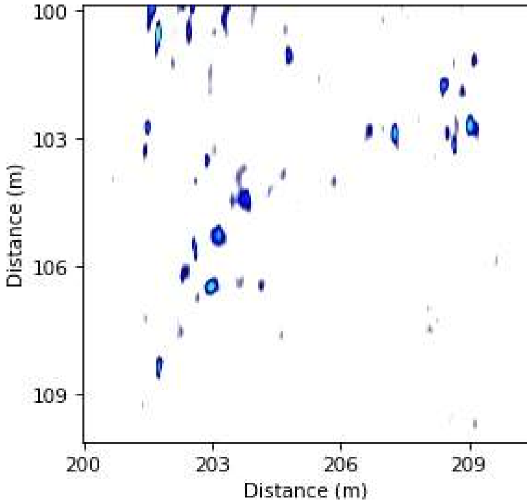
(d) Timeslice at z = 0.75 m.



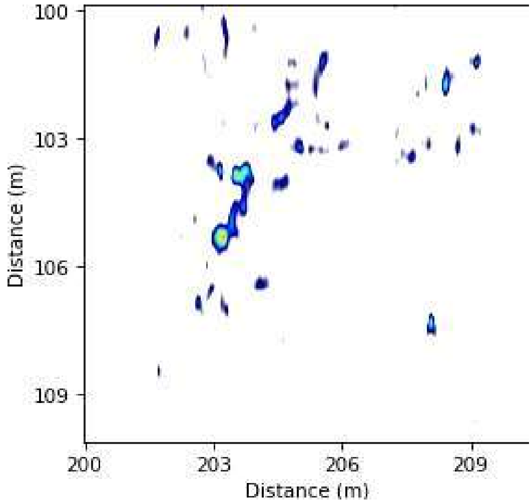
(e) Timeslice at z = 0.8 m.



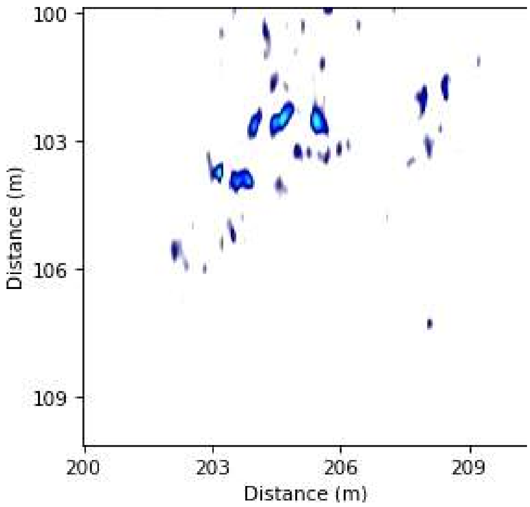
(f) Timeslice at z = 0.85 m.



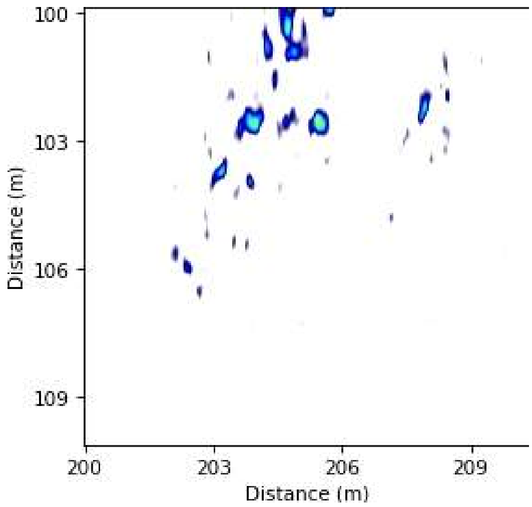
(a) Timeslice at z = 0.9 m.



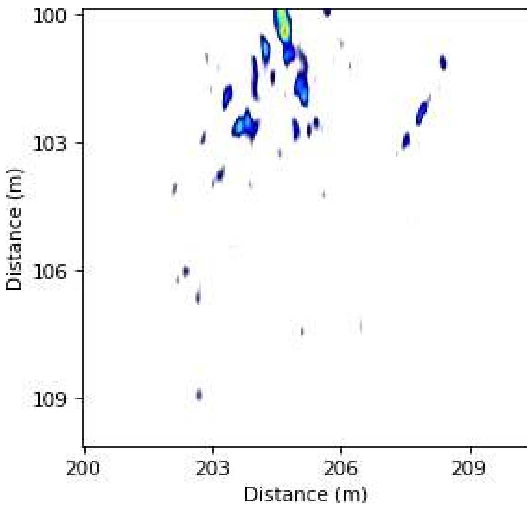
(b) Timeslice at z = 0.95 m.



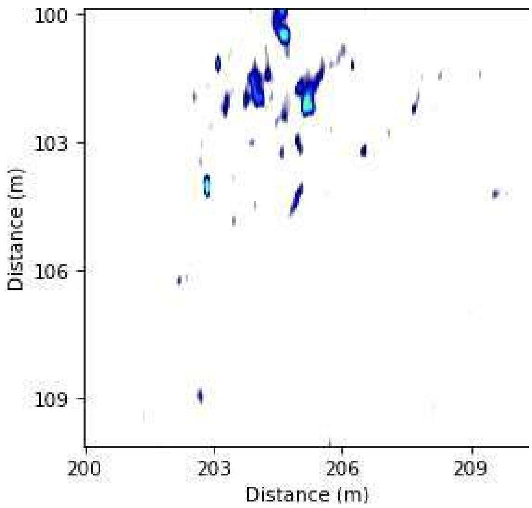
(c) Timeslice at z = 1.0 m.



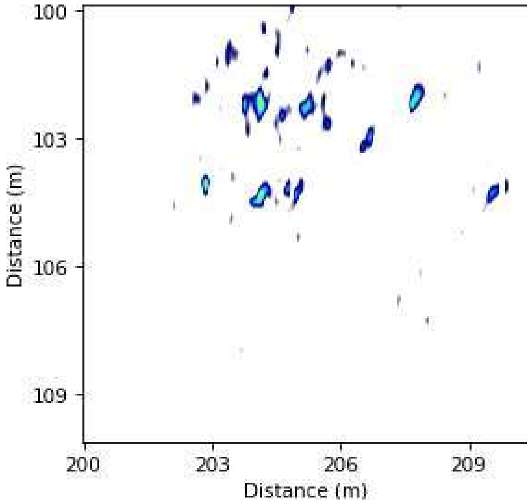
(d) Timeslice at z = 1.05 m.



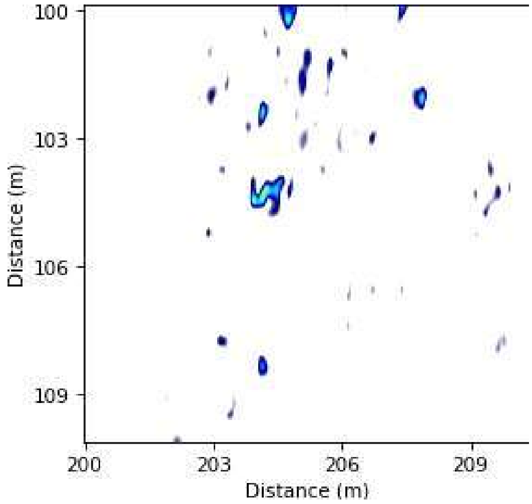
(e) Timeslice at z = 1.1 m.



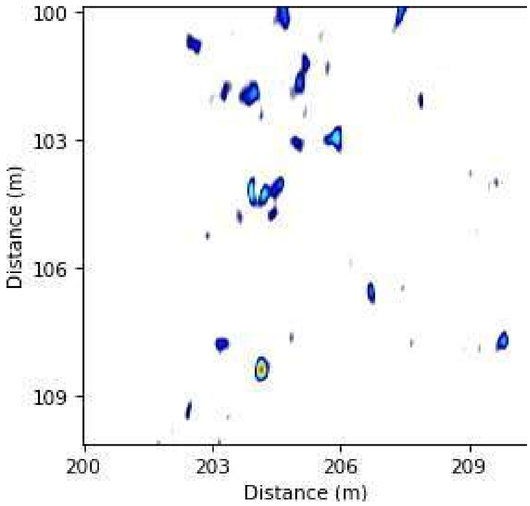
(f) Timeslice at z = 1.15 m.



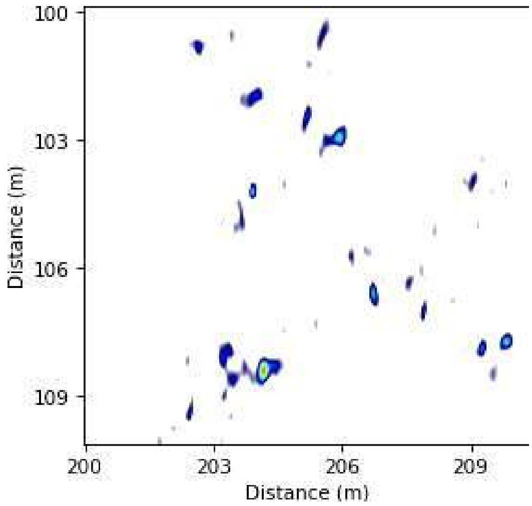
(a) Timeslice at z = 1.2 m.



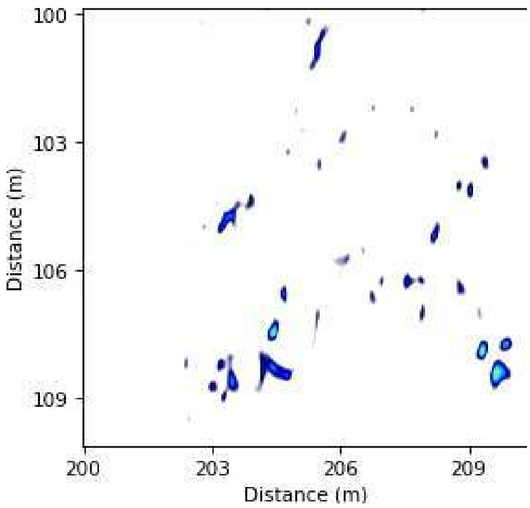
(b) Timeslice at z = 1.25 m.



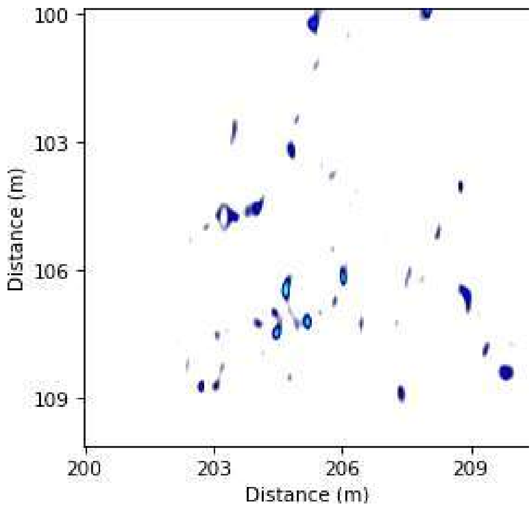
(c) Timeslice at z = 1.3 m.



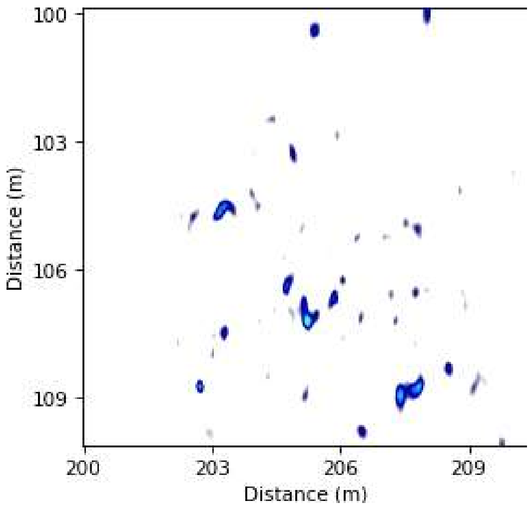
(d) Timeslice at z = 1.35 m.



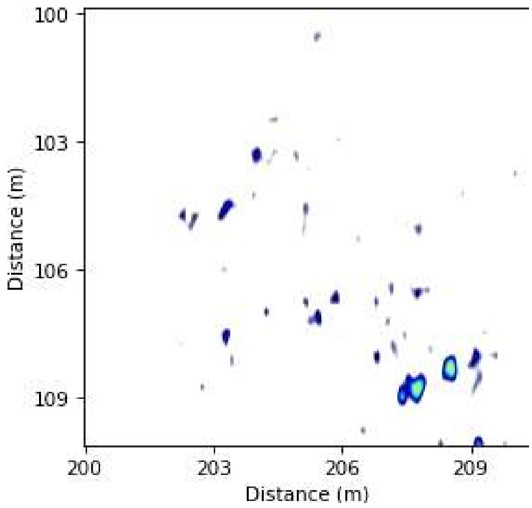
(e) Timeslice at z = 1.4 m.



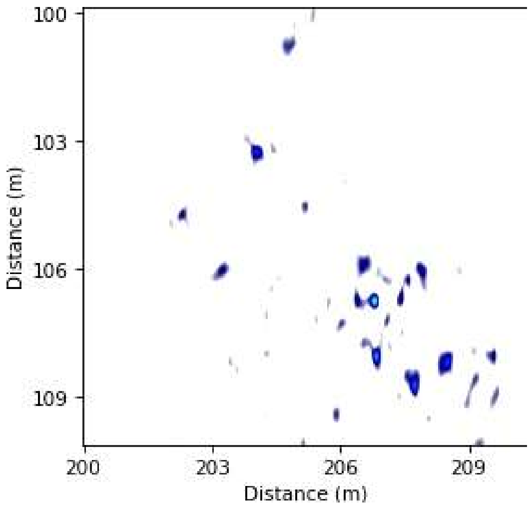
(f) Timeslice at z = 1.45 m.



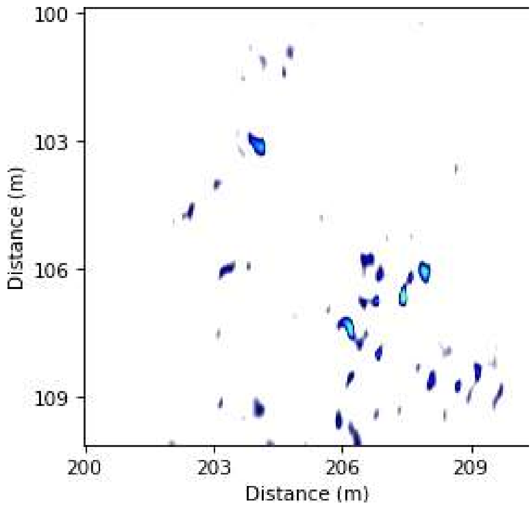
(a) Timeslice at z = 1.5 m.



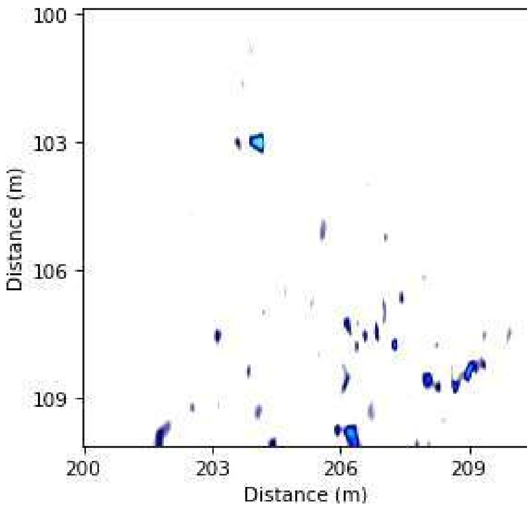
(b) Timeslice at z = 1.55 m.



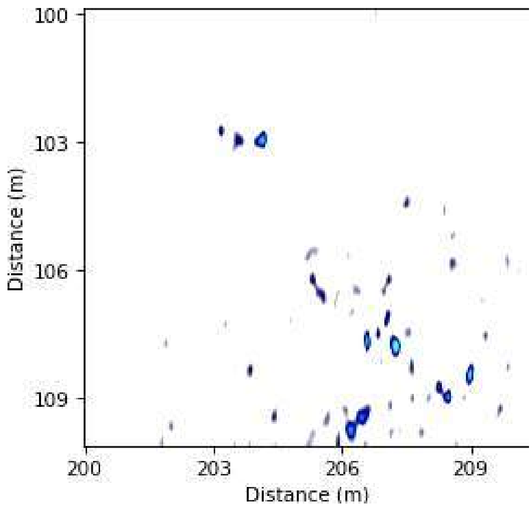
(c) Timeslice at z = 1.6 m.



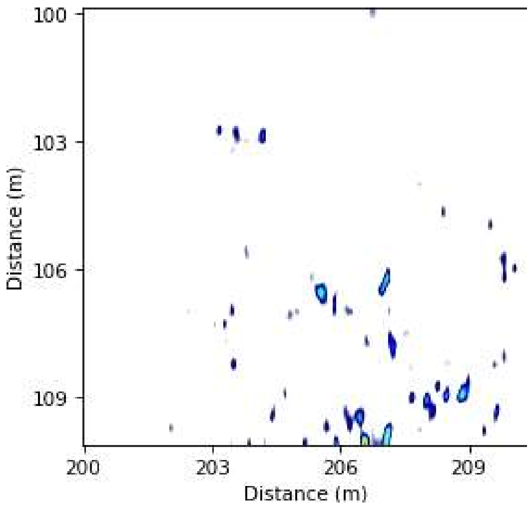
(d) Timeslice at z = 1.65 m.



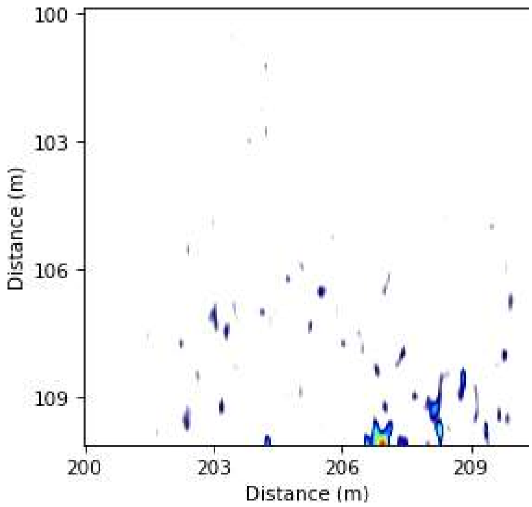
(e) Timeslice at z = 1.7 m.



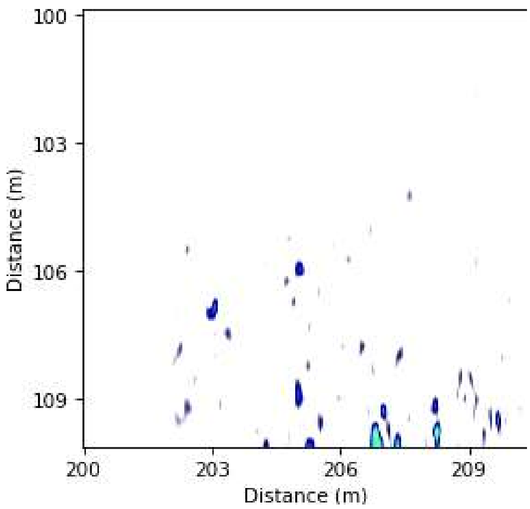
(f) Timeslice at z = 1.75 m.



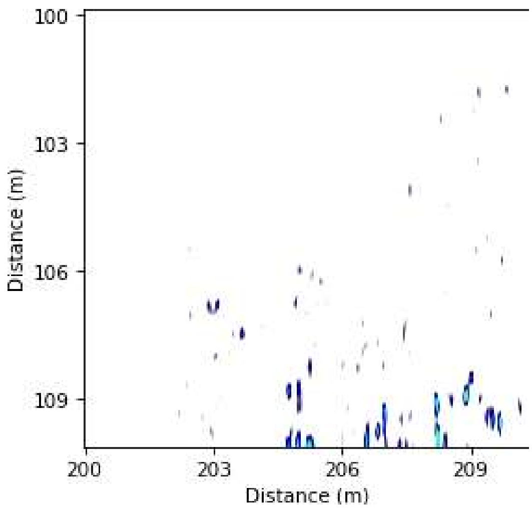
(a) Timeslice at z = 1.8 m.



(b) Timeslice at z = 1.85 m.



(c) Timeslice at z = 1.9 m.



(d) Timeslice at z = 1.95 m.

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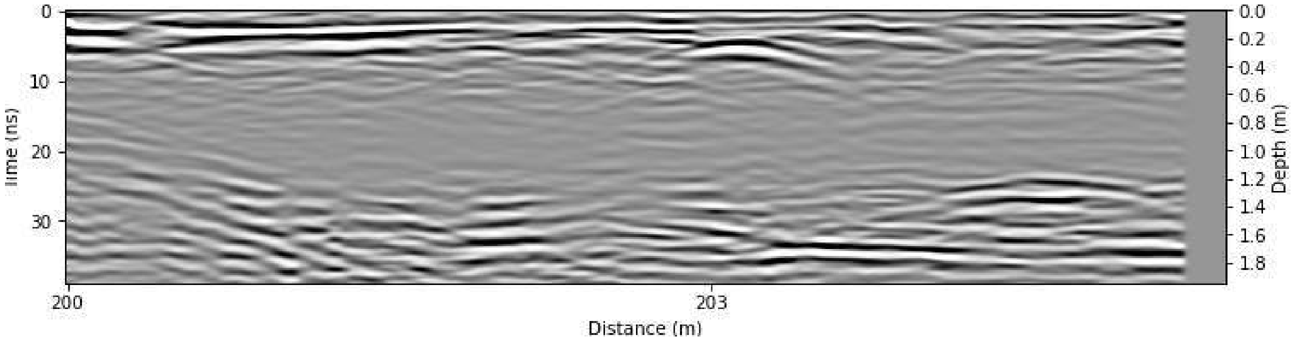


Figure B.49: Radargram at x = 100.5 m.

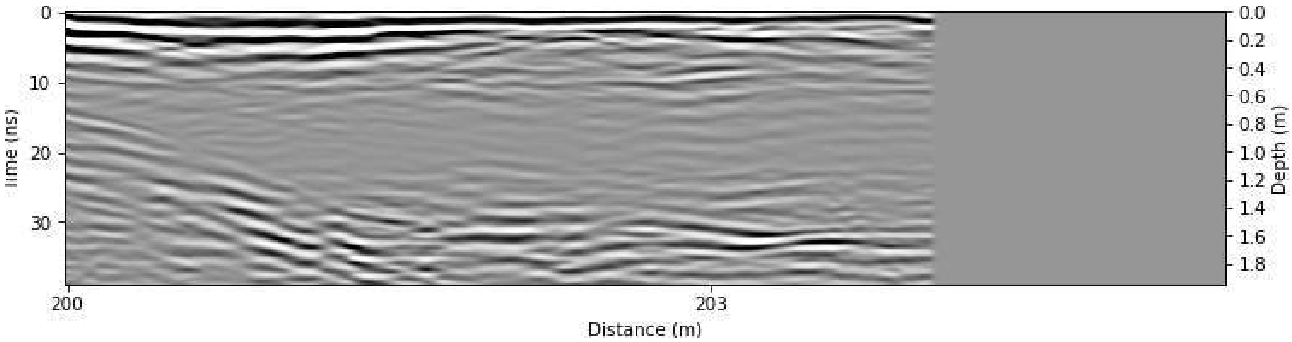


Figure B.50: Radargram at x = 100.75 m.

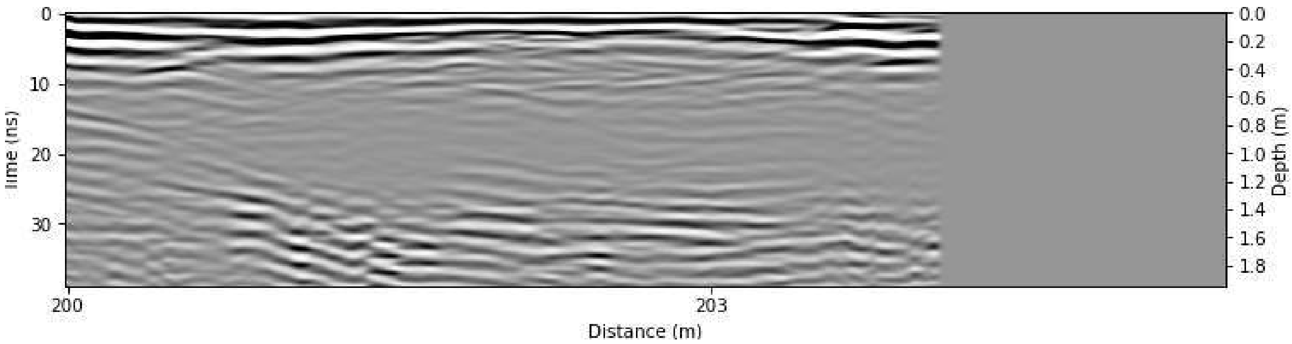


Figure B.51: Radargram at x = 101.0 m.

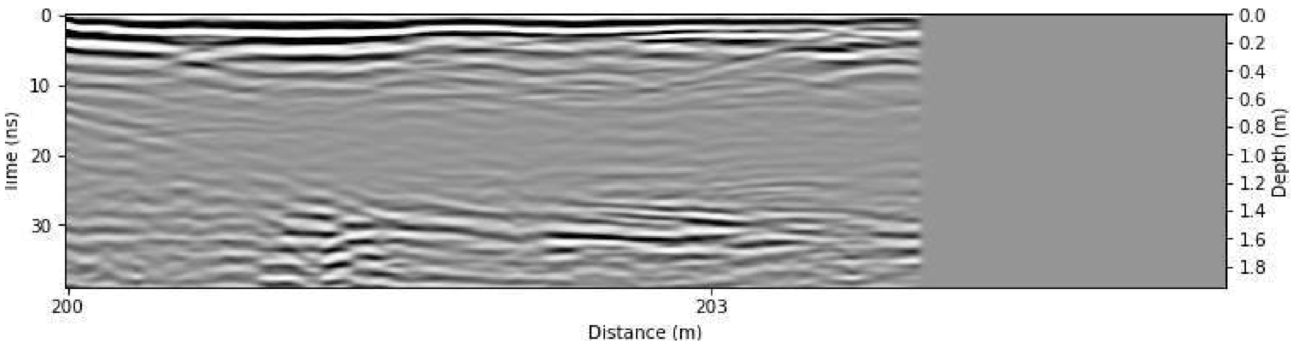


Figure B.52: Radargram at x = 101.25 m.

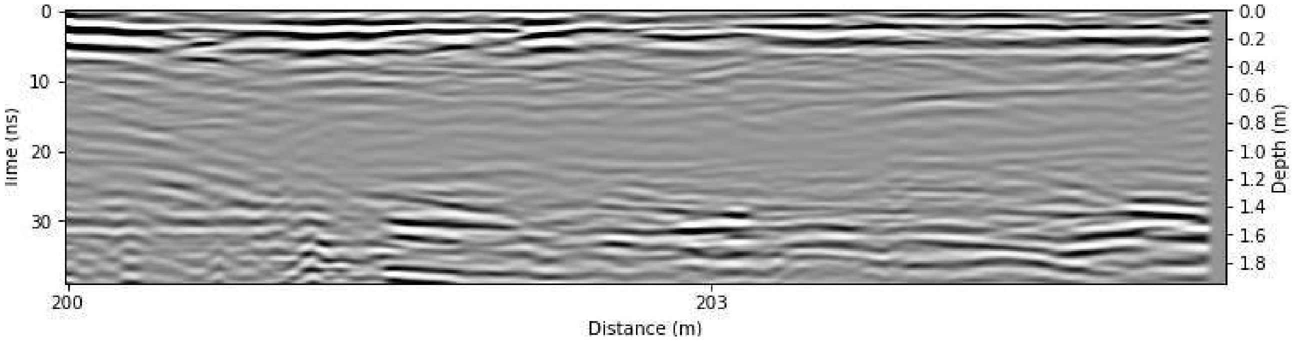


Figure B.53: Radargram at x = 101.5 m.

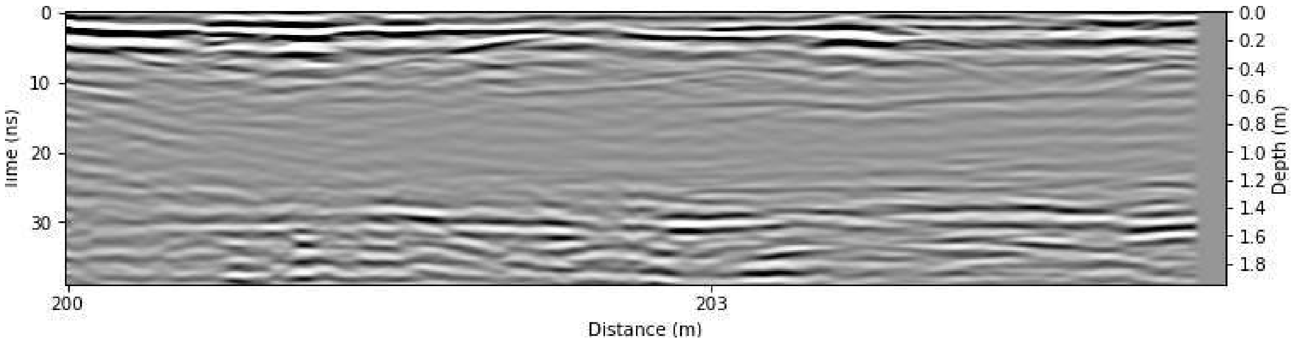


Figure B.54: Radargram at x = 101.75 m.

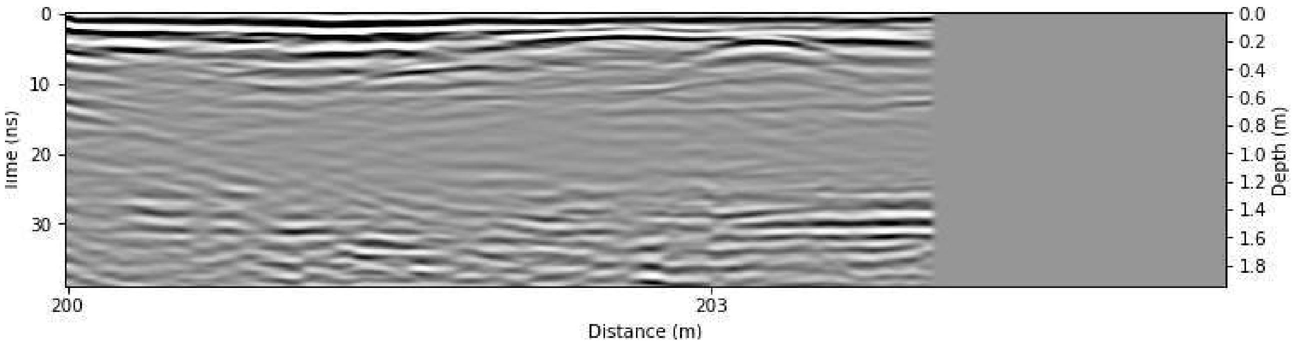


Figure B.55: Radargram at x = 102.0 m.

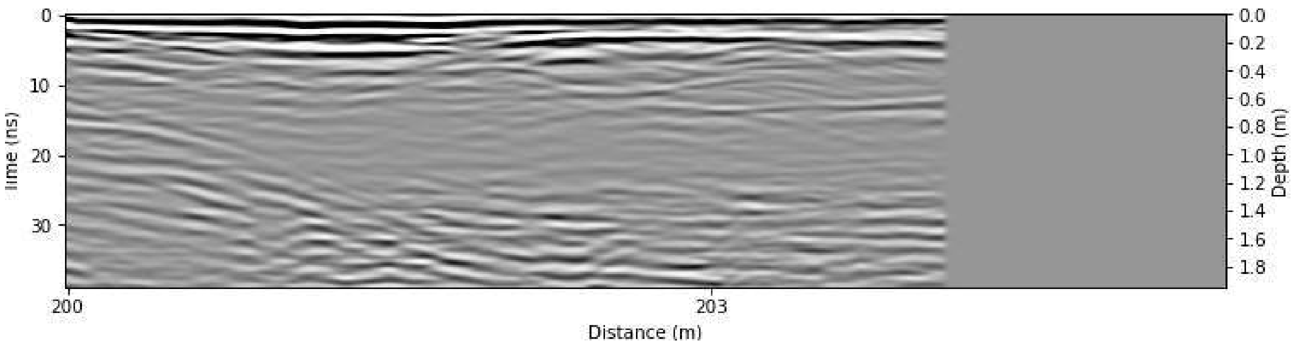


Figure B.56: Radargram at x = 102.25 m.

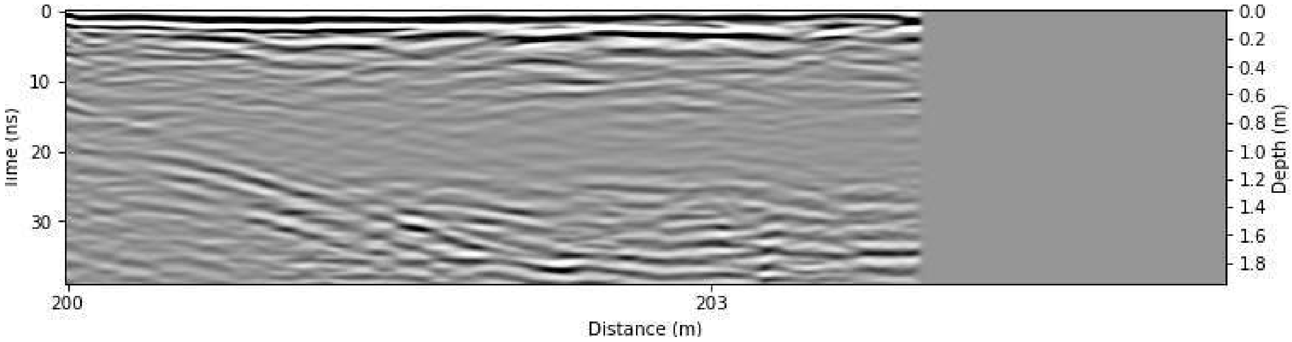


Figure B.57: Radargram at x = 102.5 m.

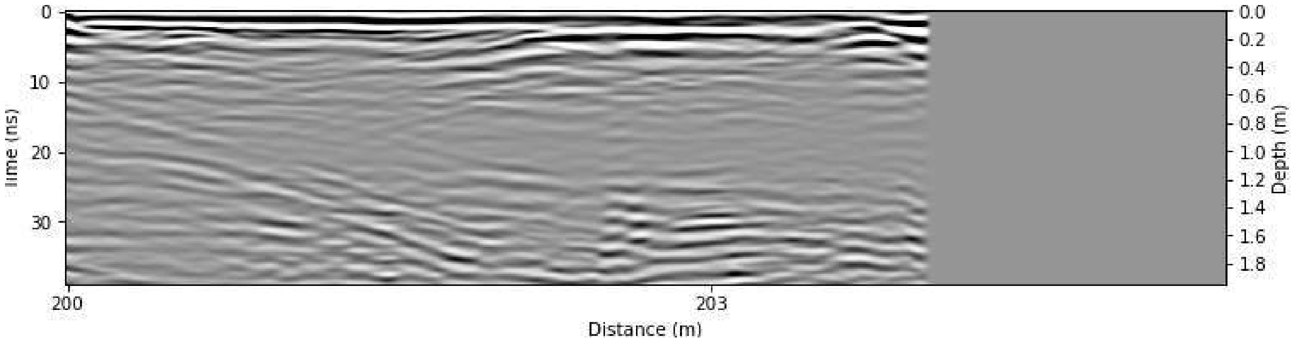


Figure B.58: Radargram at x = 102.75 m.

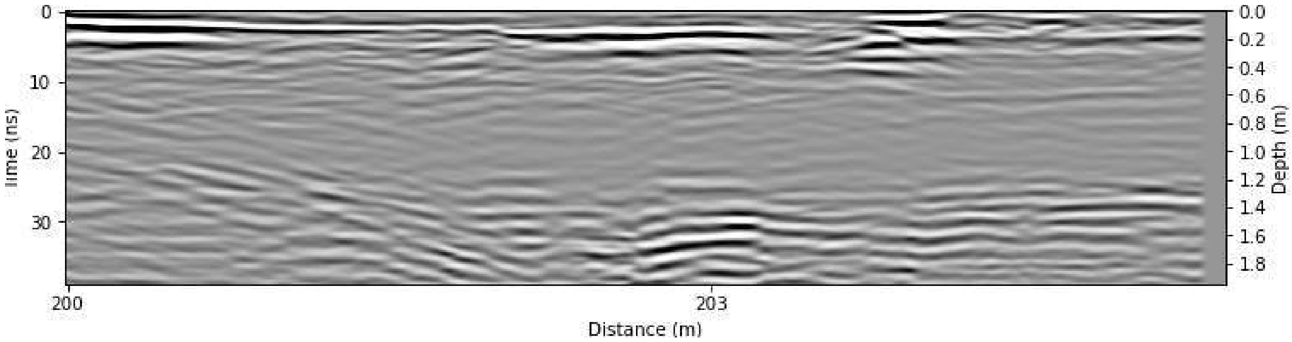


Figure B.59: Radargram at x = 103.0 m.

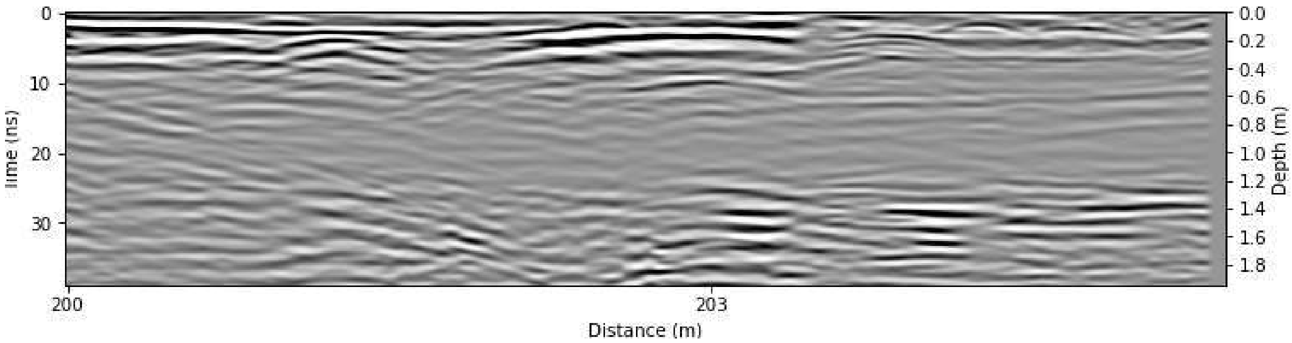


Figure B.60: Radargram at x = 103.25 m.

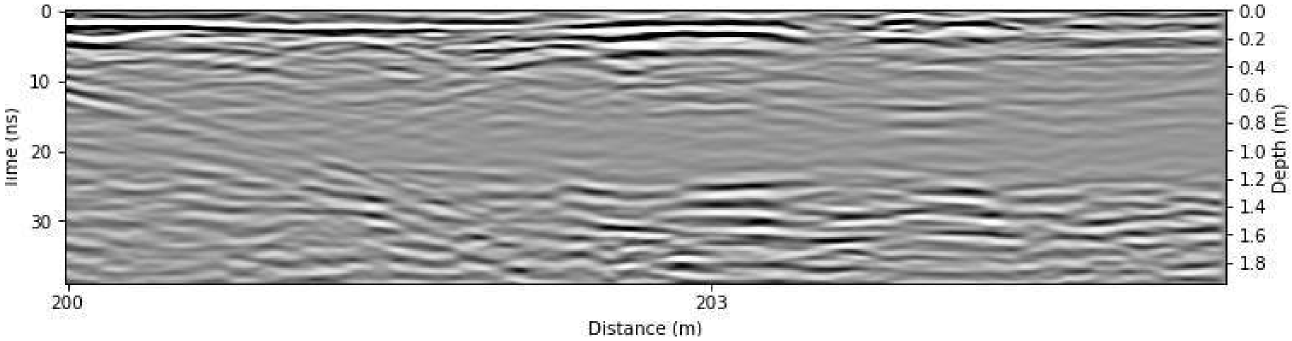


Figure B.61: Radargram at x = 103.5 m.

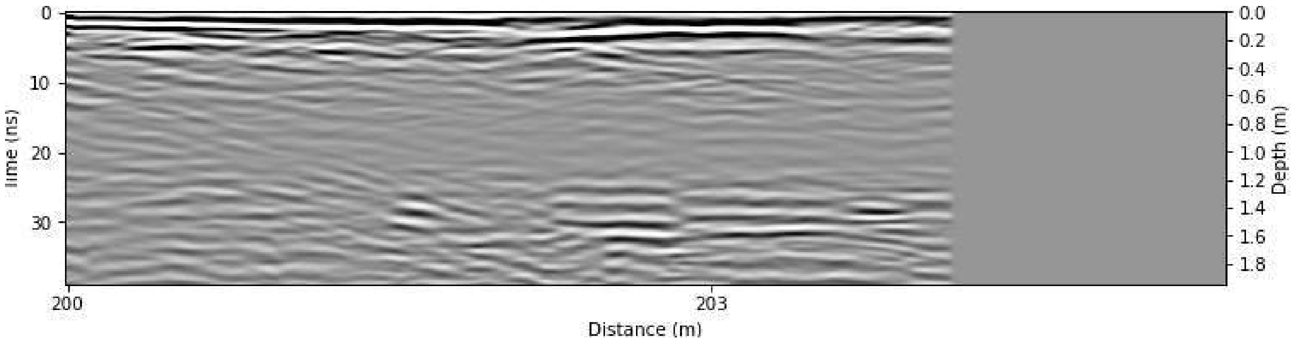


Figure B.62: Radargram at x = 103.75 m.

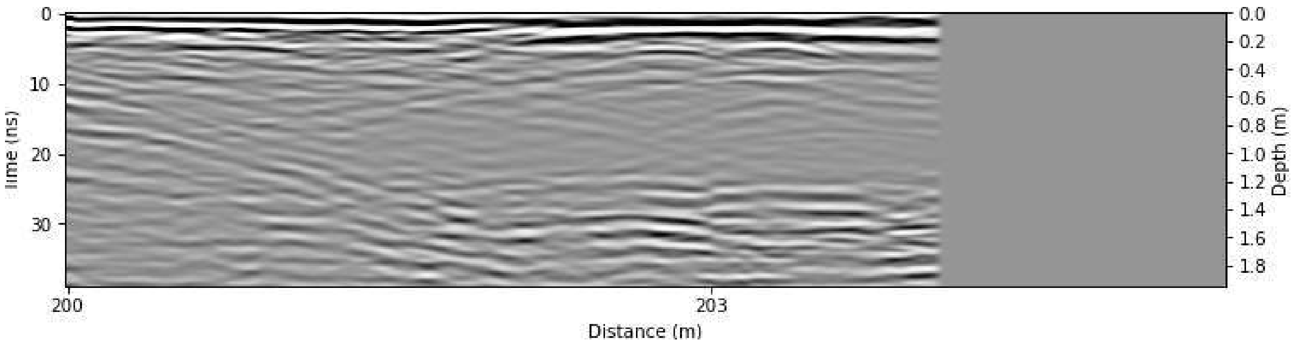


Figure B.63: Radargram at x = 104.0 m.

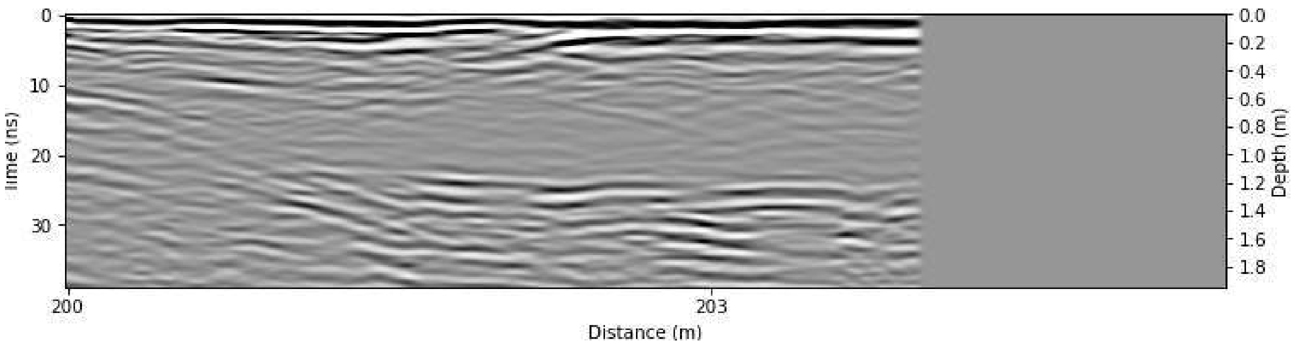


Figure B.64: Radargram at x = 104.25 m.

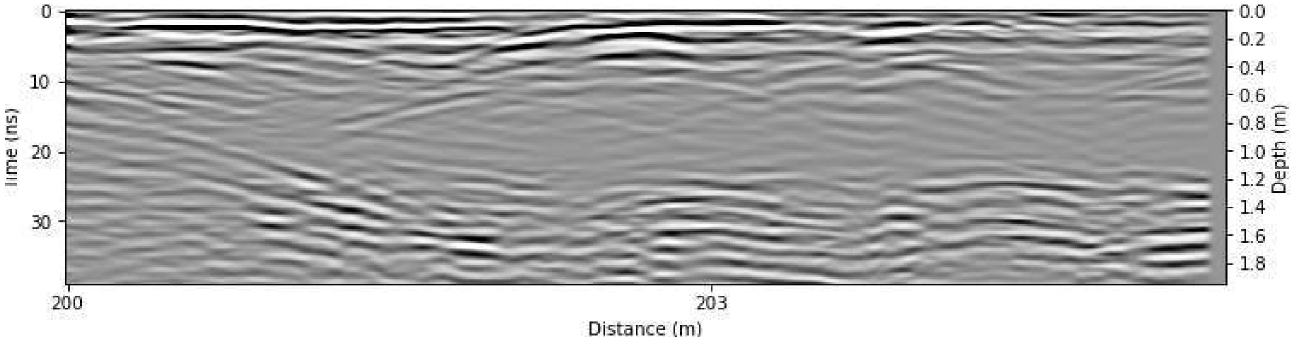


Figure B.65: Radargram at x = 104.5 m.

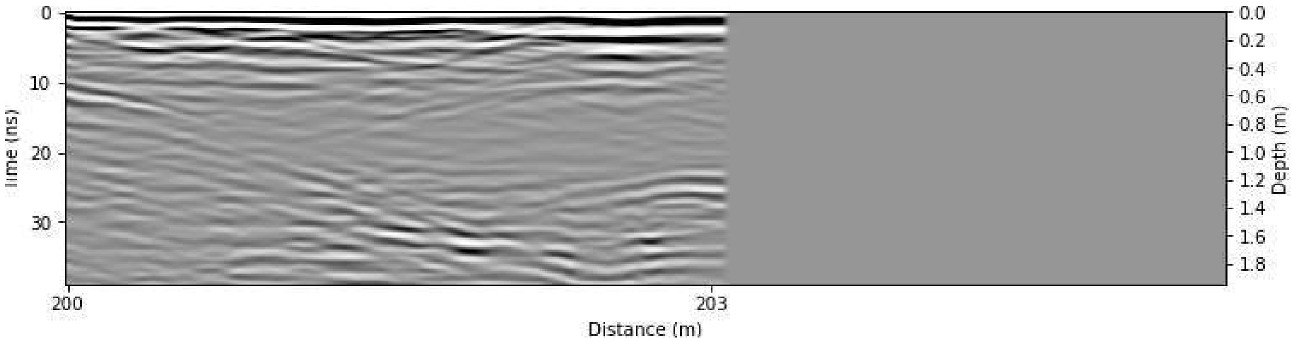


Figure B.66: Radargram at x = 104.75 m.

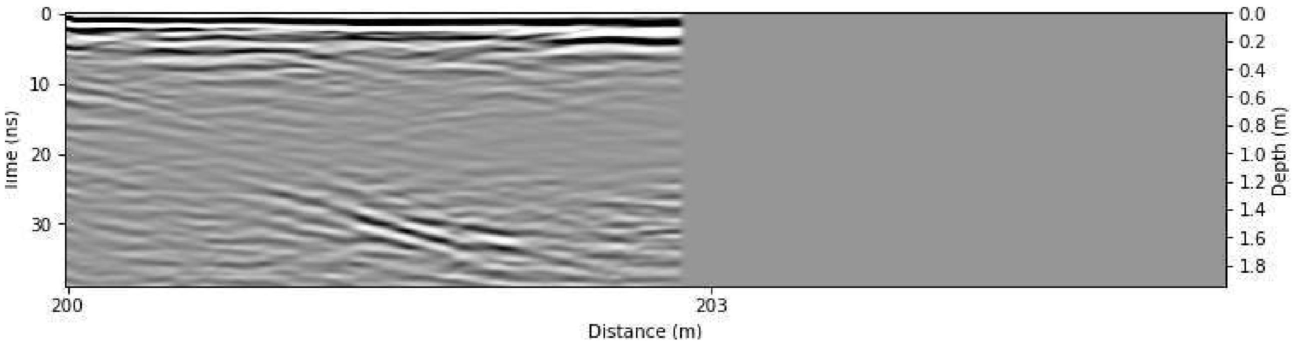


Figure B.67: Radargram at x = 105.0 m.

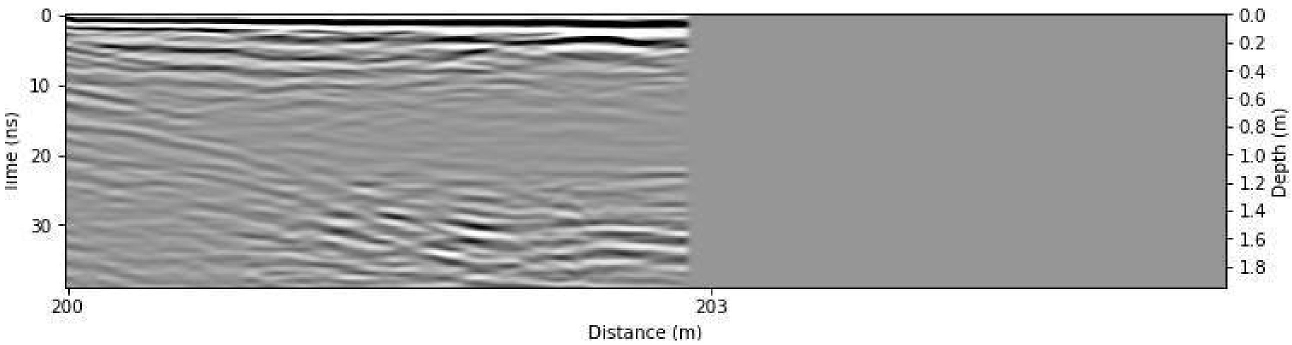


Figure B.68: Radargram at x = 105.25 m.

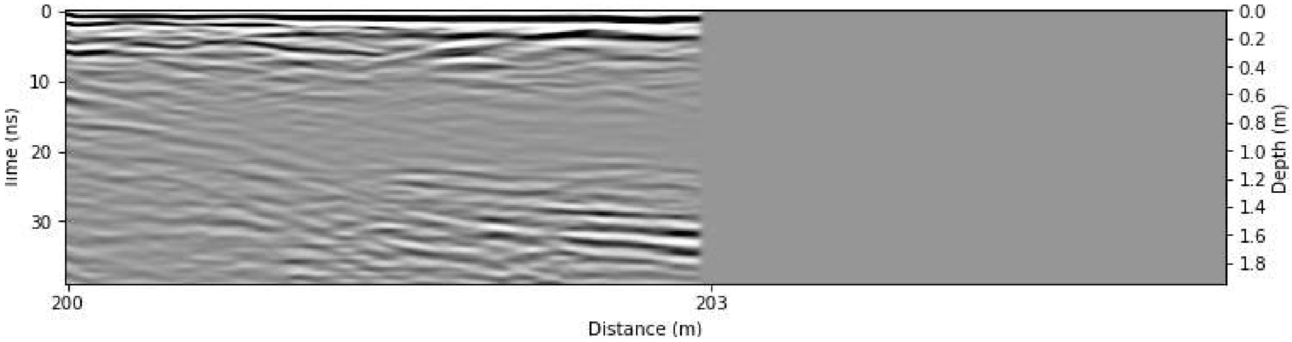


Figure B.69: Radargram at x = 105.5 m.

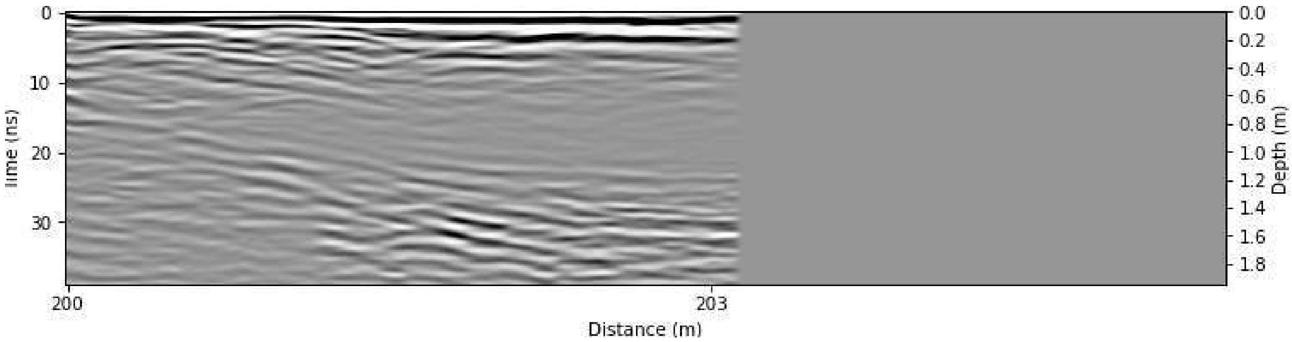


Figure B.70: Radargram at x = 105.75 m.

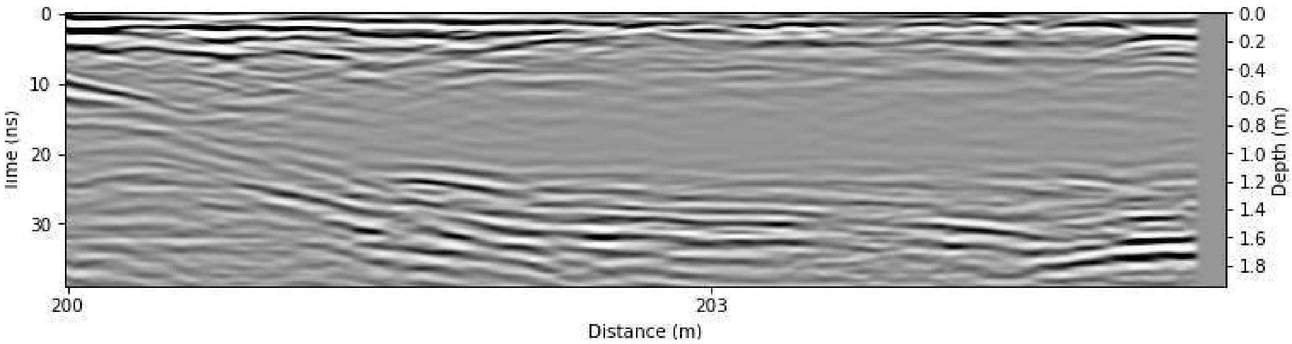


Figure B.71: Radargram at x = 106.0 m.

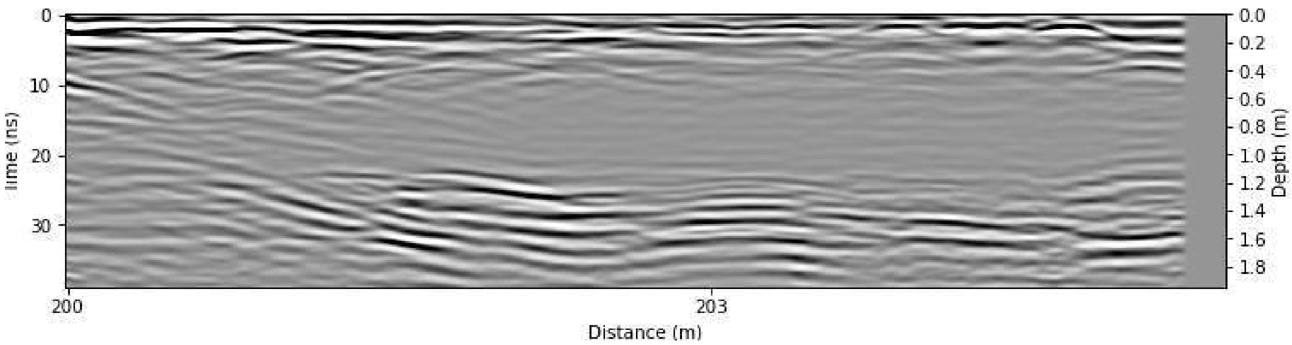


Figure B.72: Radargram at x = 106.25 m.

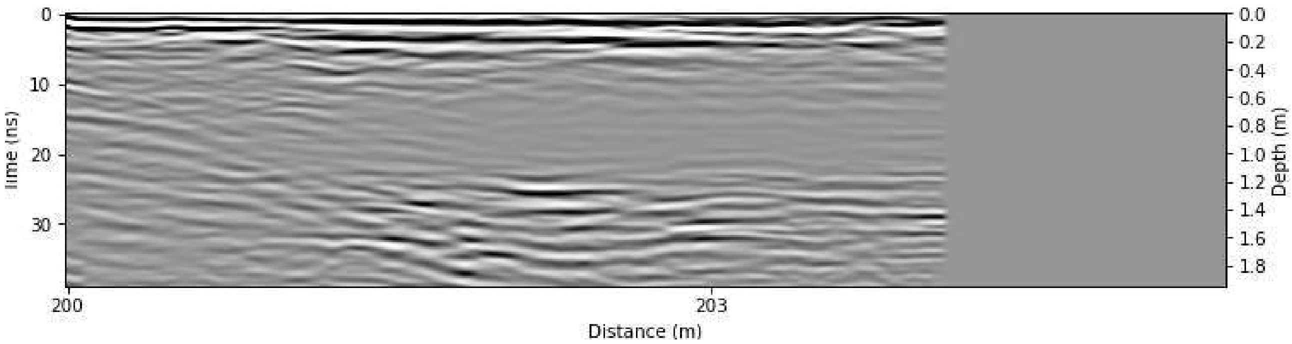


Figure B.73: Radargram at x = 106.5 m.

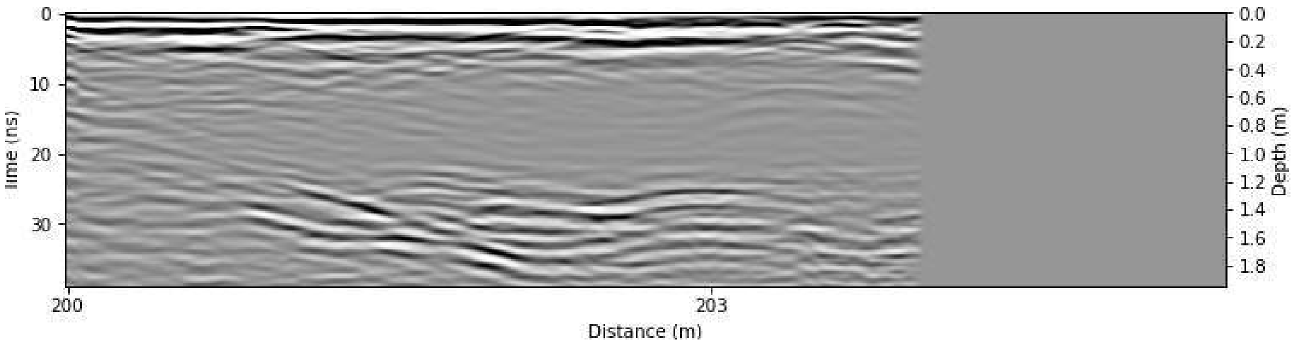


Figure B.74: Radargram at x = 106.75 m.

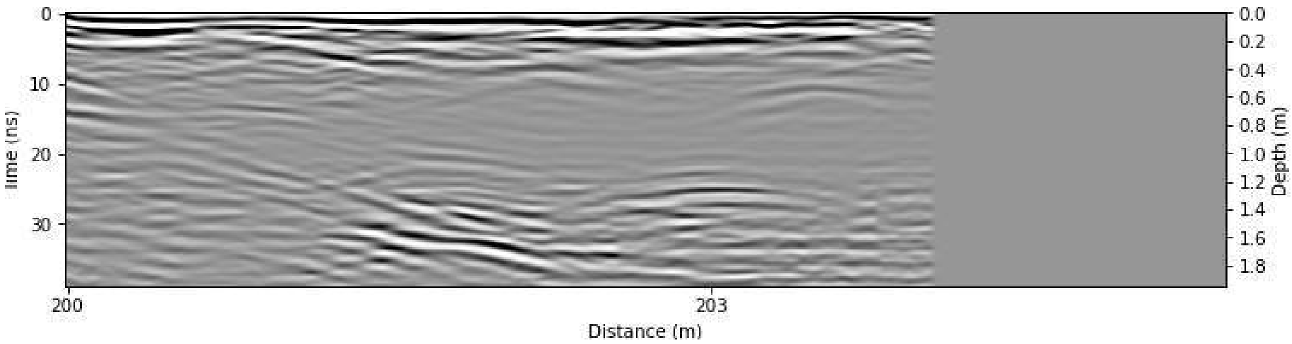


Figure B.75: Radargram at x = 107.0 m.

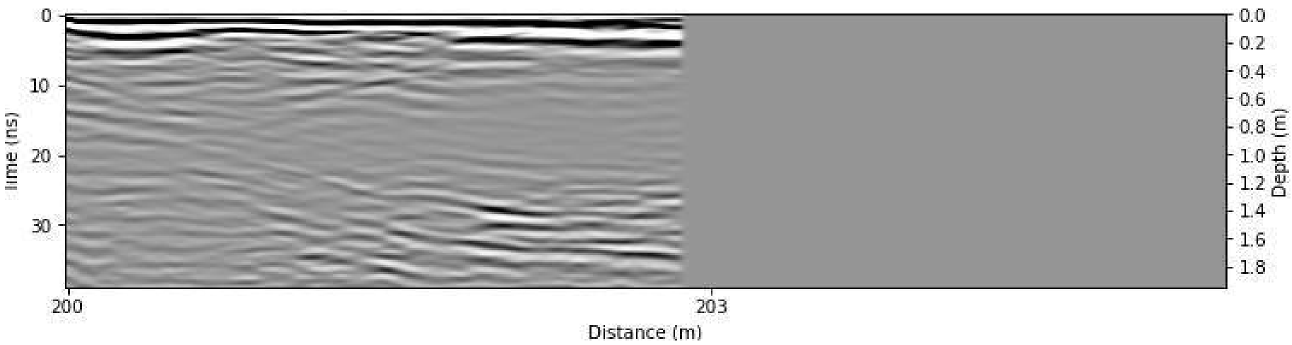


Figure B.76: Radargram at x = 107.25 m.

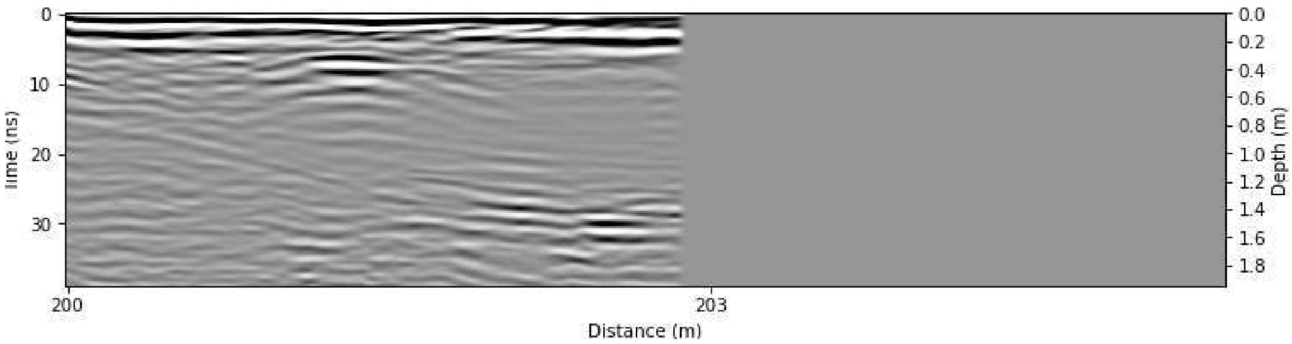


Figure B.77: Radargram at x = 107.5 m.

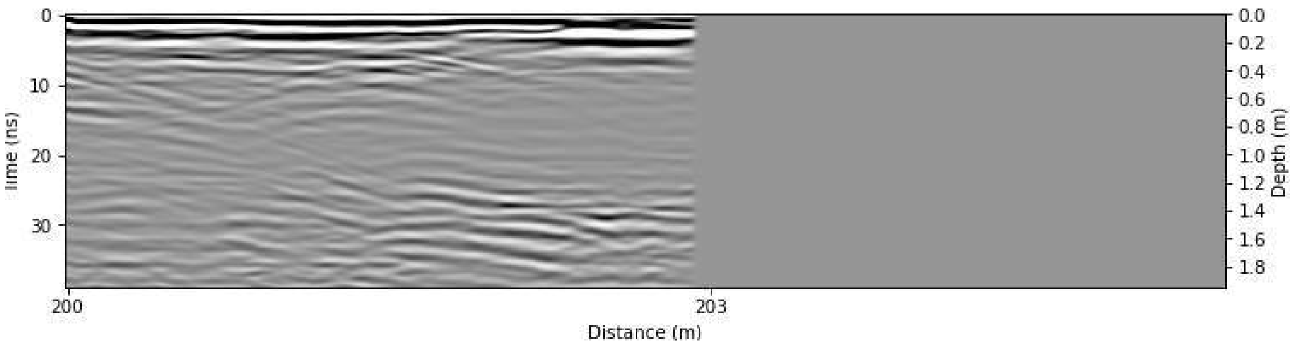


Figure B.78: Radargram at x = 107.75 m.

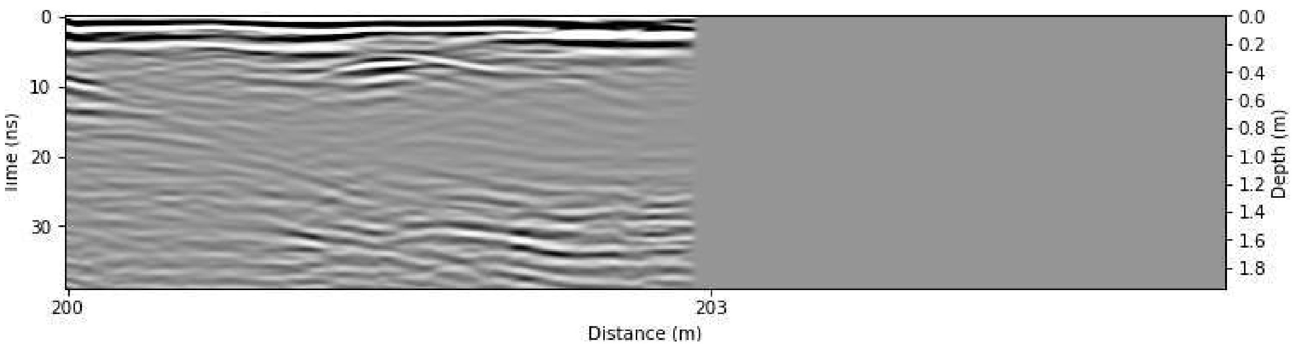


Figure B.79: Radargram at x = 108.0 m.

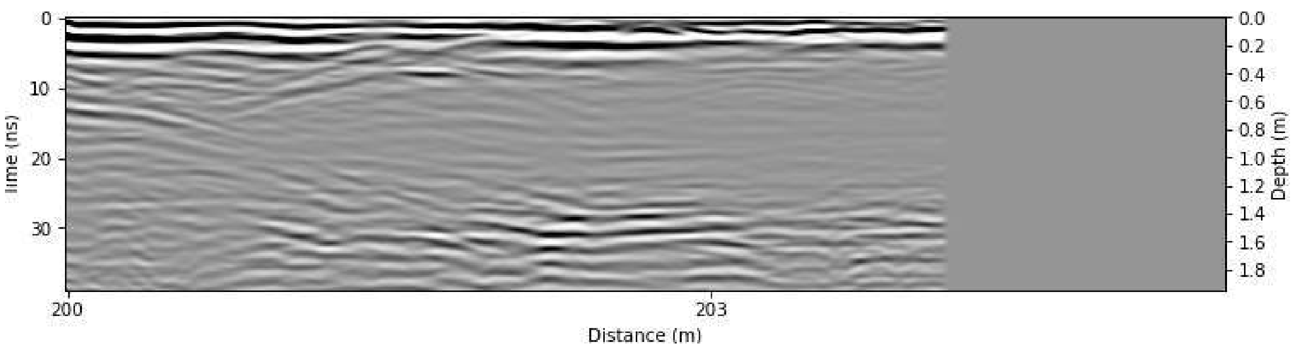


Figure B.80: Radargram at x = 108.25 m.

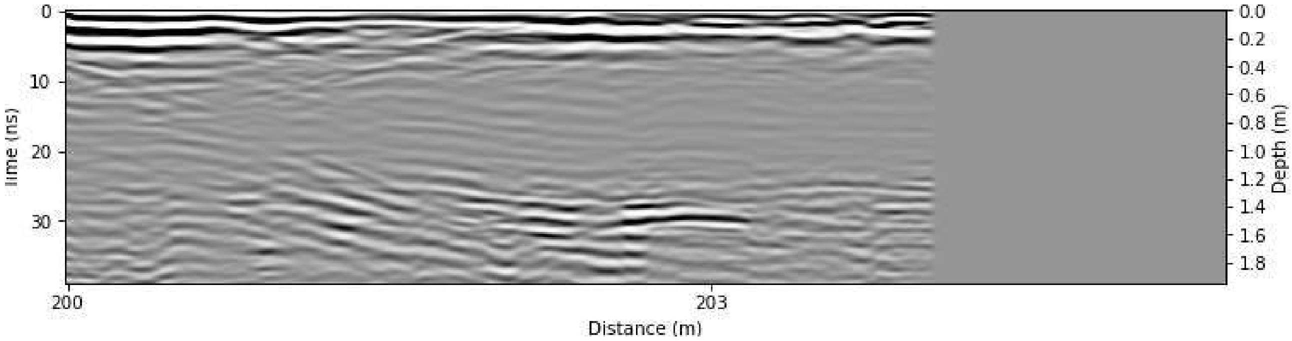


Figure B.81: Radargram at x = 108.5 m.

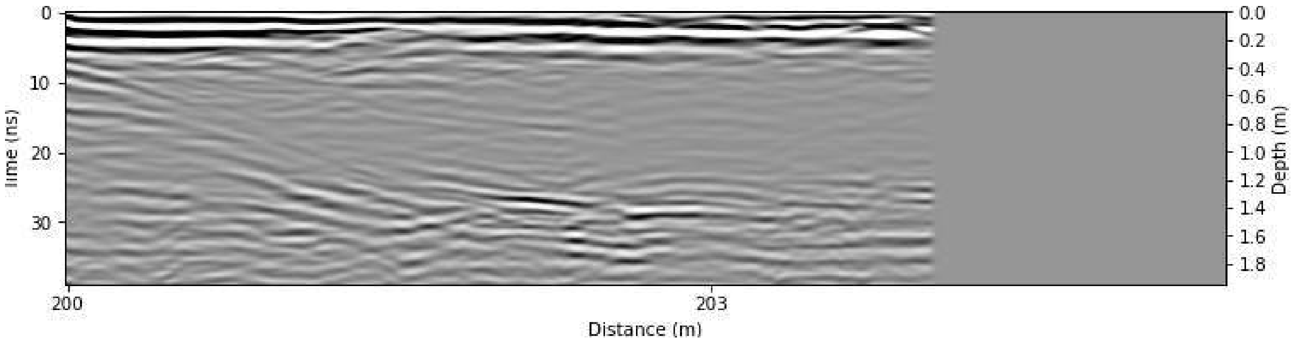


Figure B.82: Radargram at x = 108.75 m.

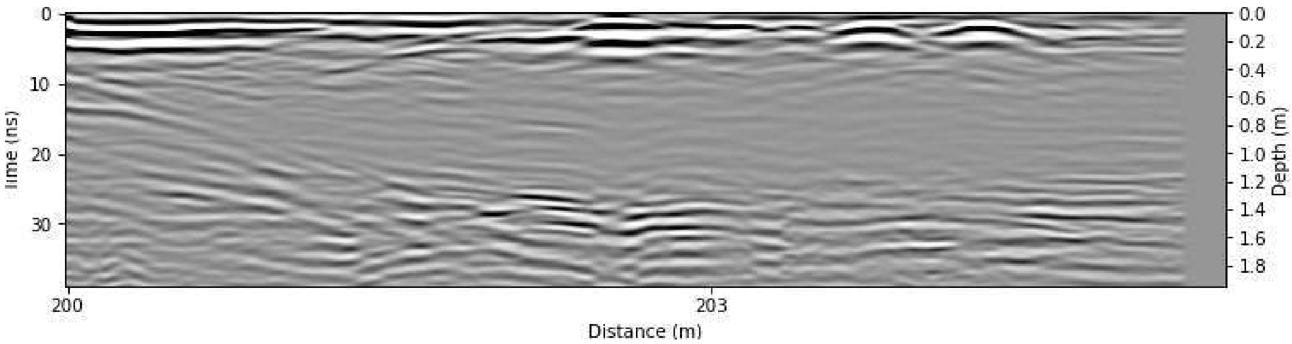


Figure B.83: Radargram at x = 109.0 m.

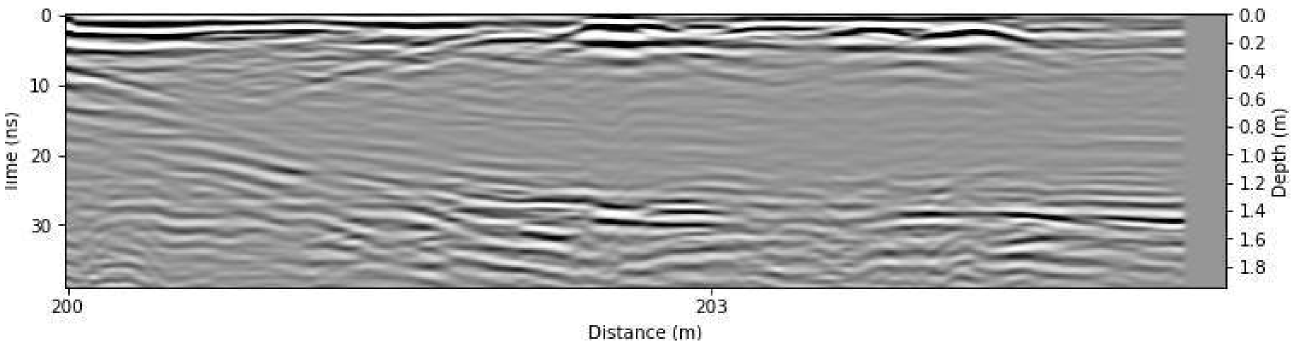


Figure B.84: Radargram at x = 109.25 m.

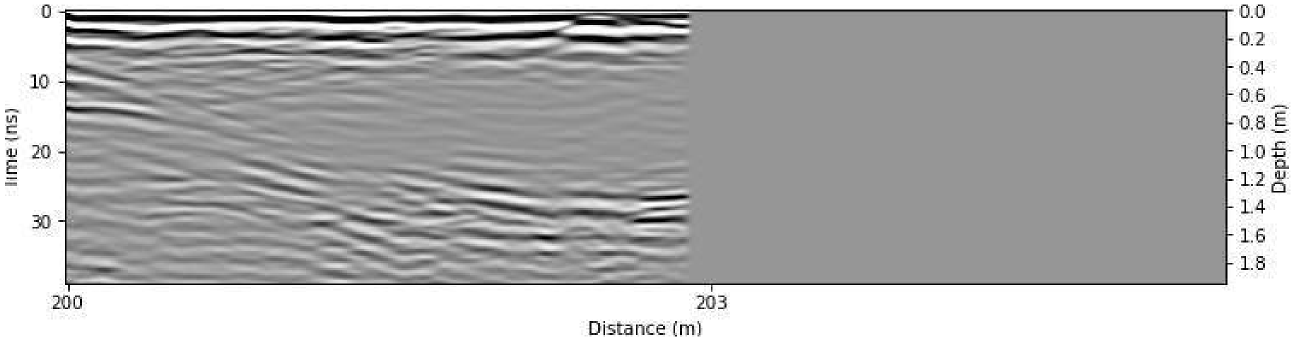


Figure B.85: Radargram at x = 109.5 m.

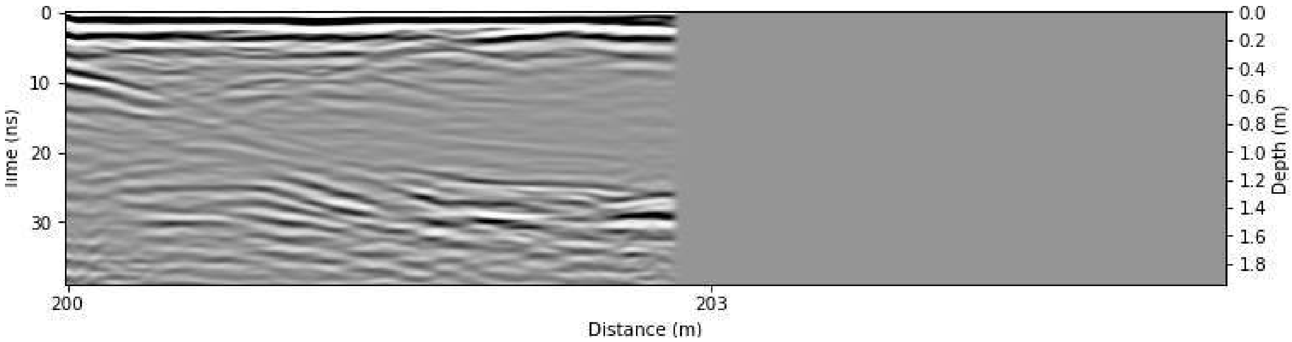


Figure B.86: Radargram at x = 109.75 m.

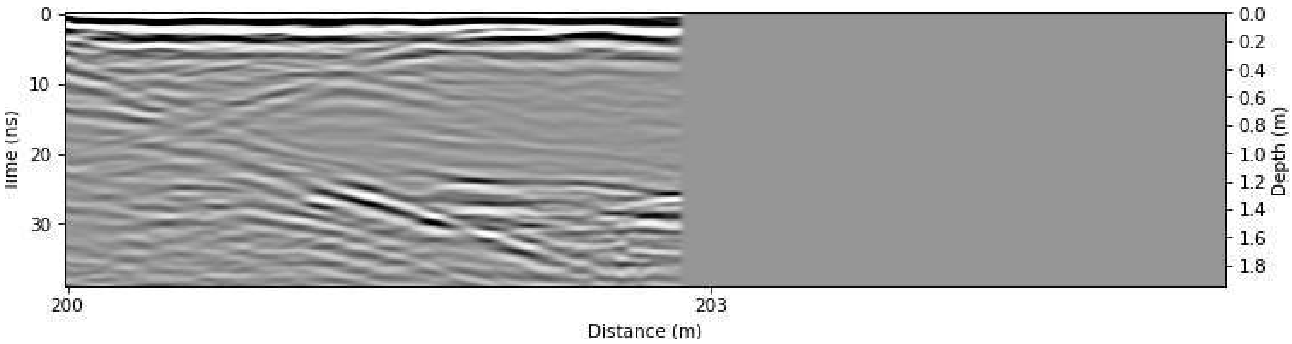
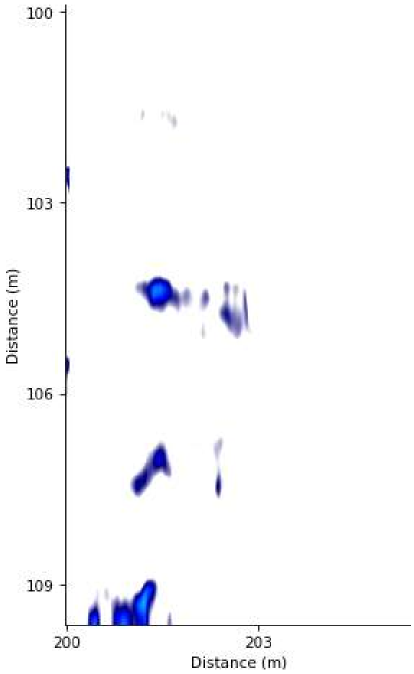
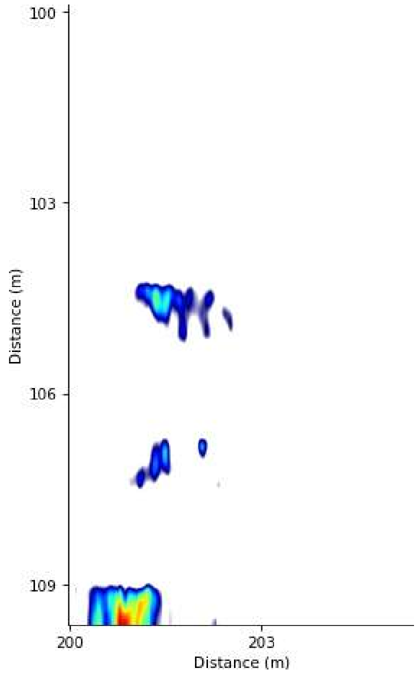


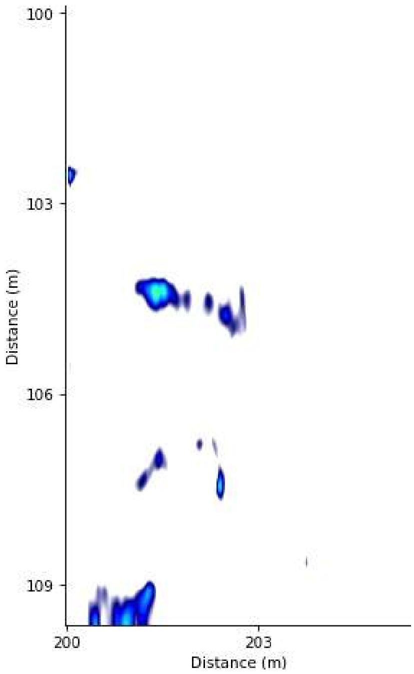
Figure B.87: Radargram at x = 110.0 m.



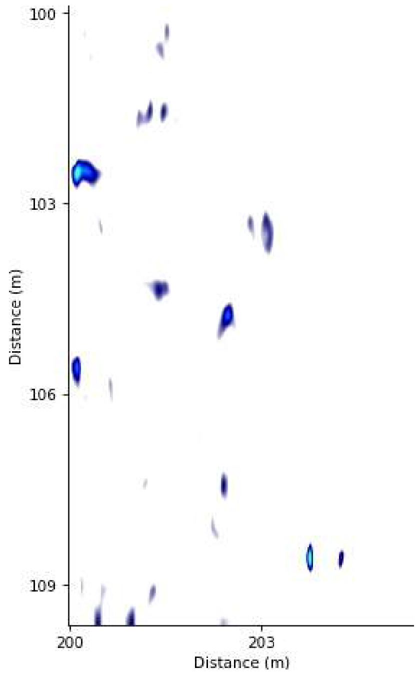
(a) Timeslice at z = 0.0 m.



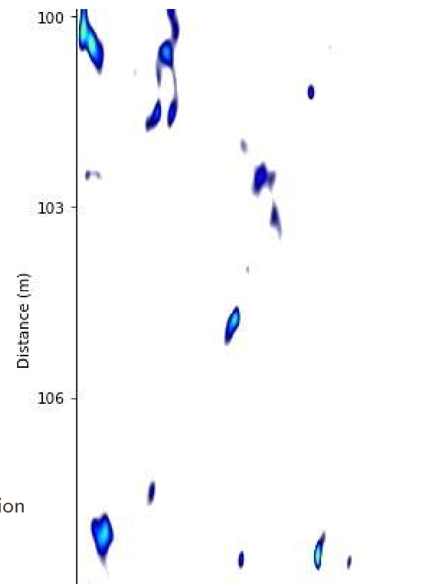
(b) Timeslice at z = 0.05 m.

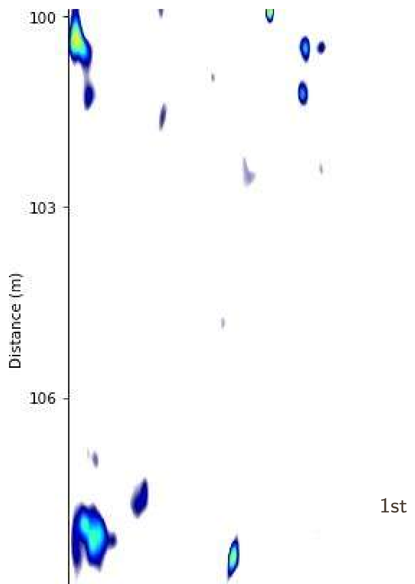


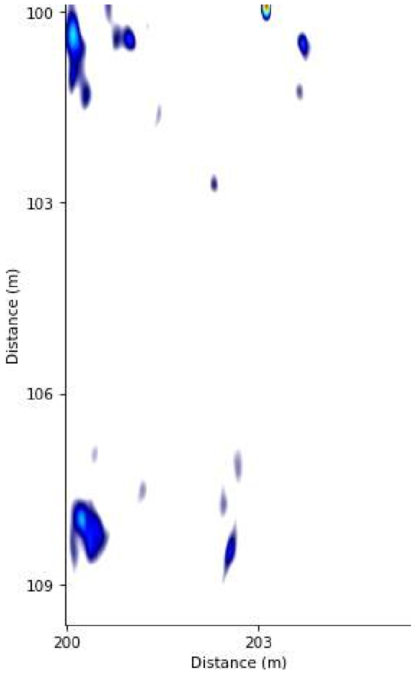
(c) Timeslice at z = 0.1 m.



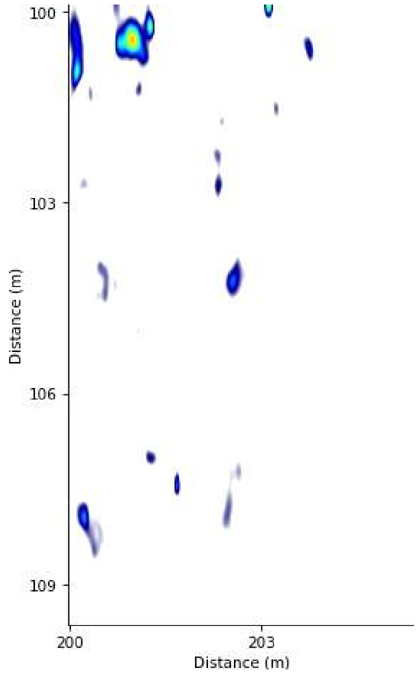
(d) Timeslice at z = 0.15 m.



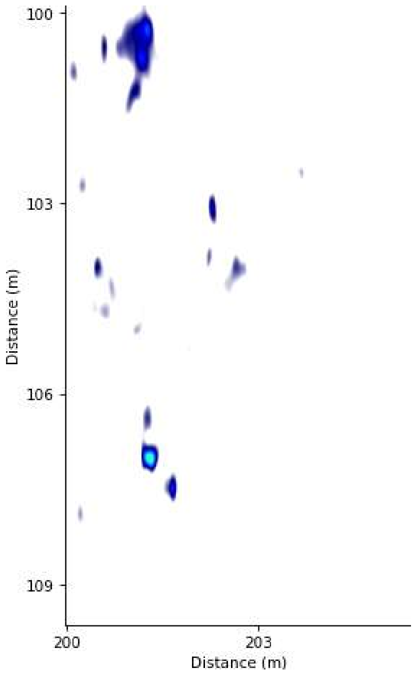




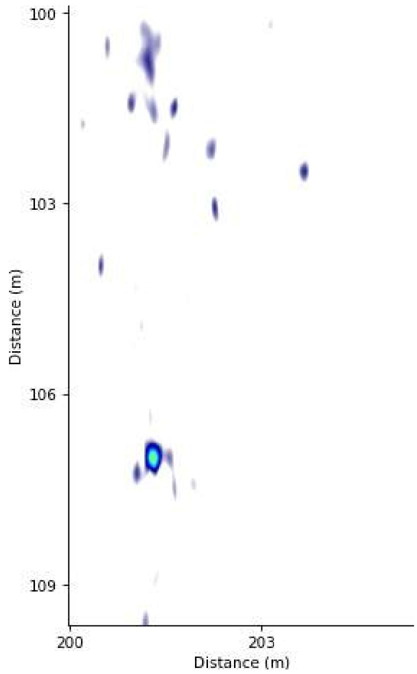
(a) Timeslice at z = 0.3 m.



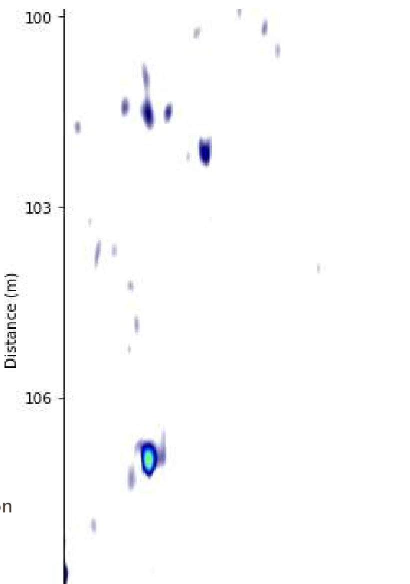
(b) Timeslice at z = 0.35 m.

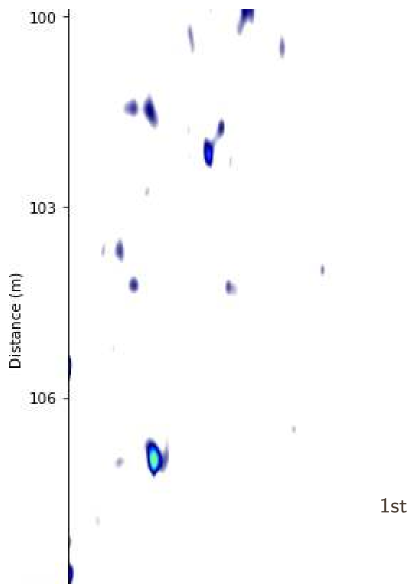


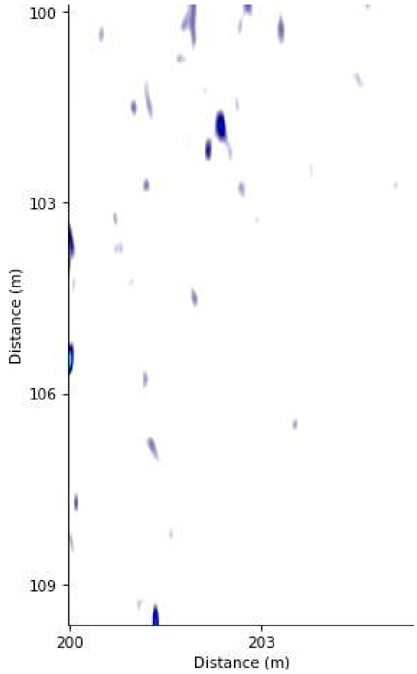
(c) Timeslice at z = 0.4 m.



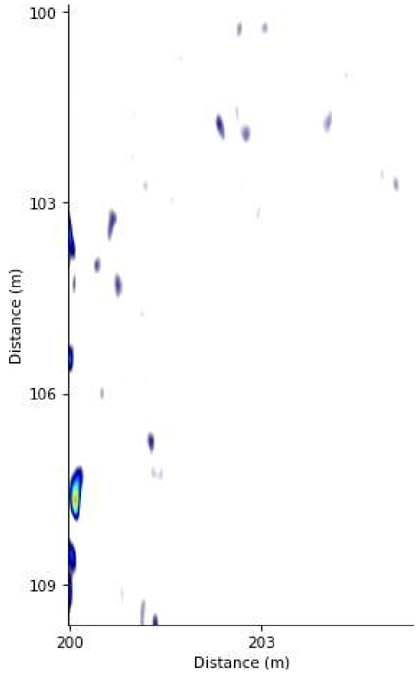
(d) Timeslice at z = 0.45 m.



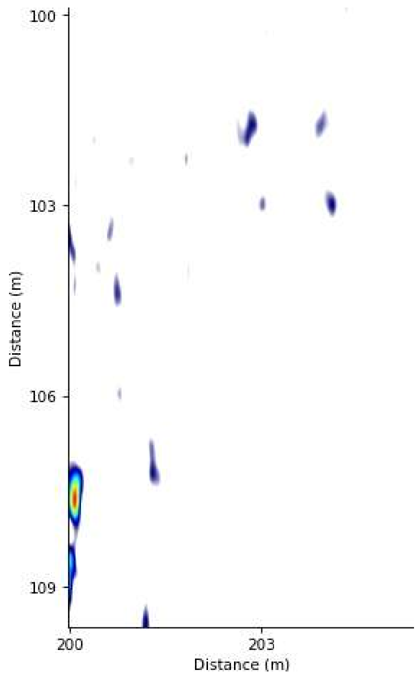




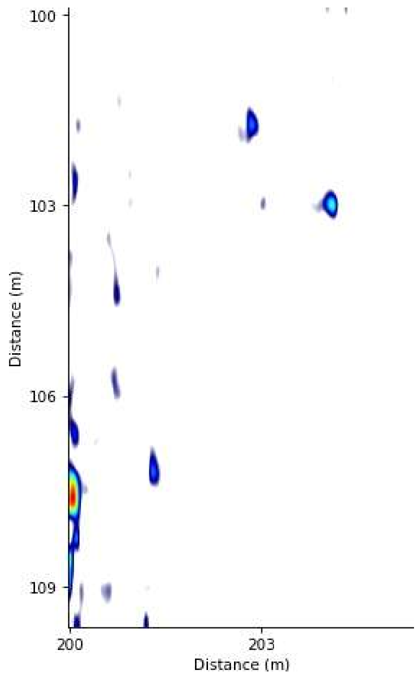
(a) Timeslice at z = 0.6 m.



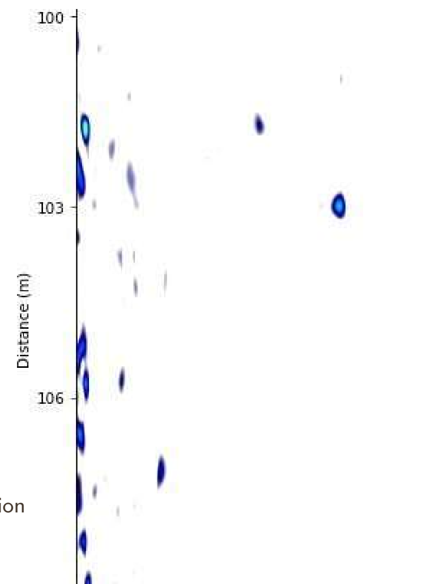
(b) Timeslice at z = 0.65 m.

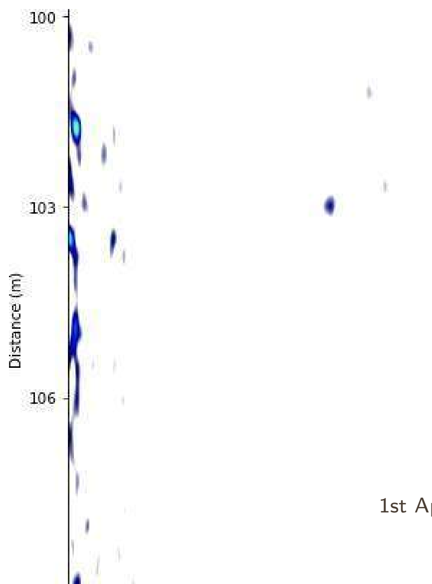


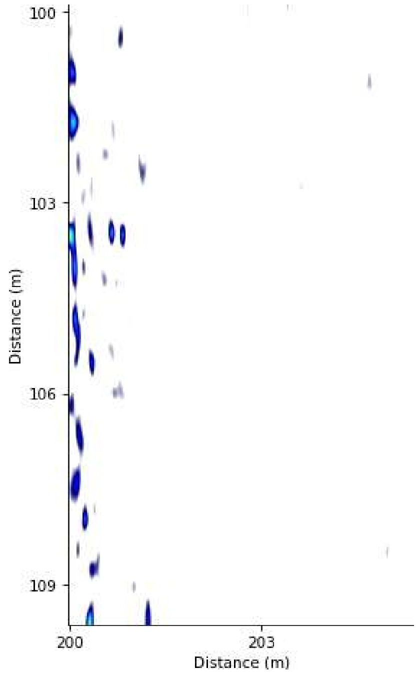
(c) Timeslice at z = 0.7 m.



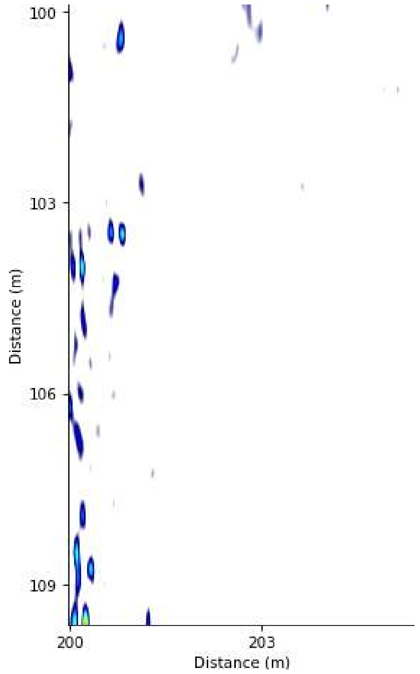
(d) Timeslice at z = 0.75 m.



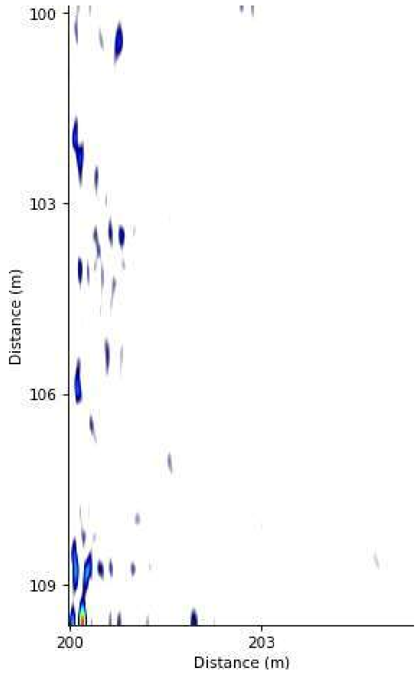




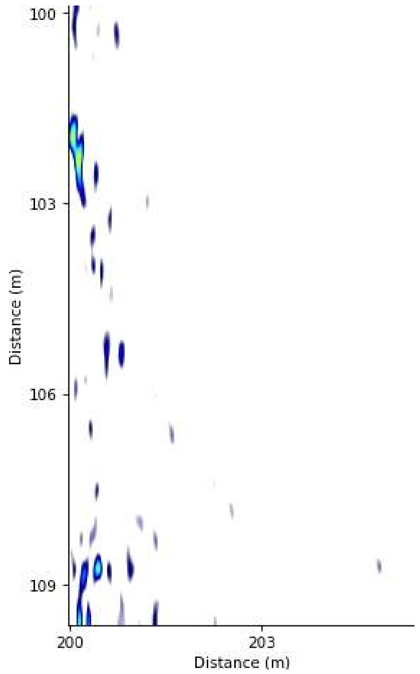
(a) Timeslice at z = 0.7 m.



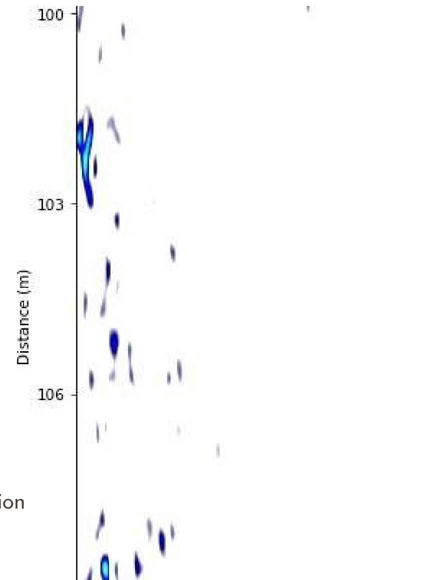
(b) Timeslice at z = 0.75 m.

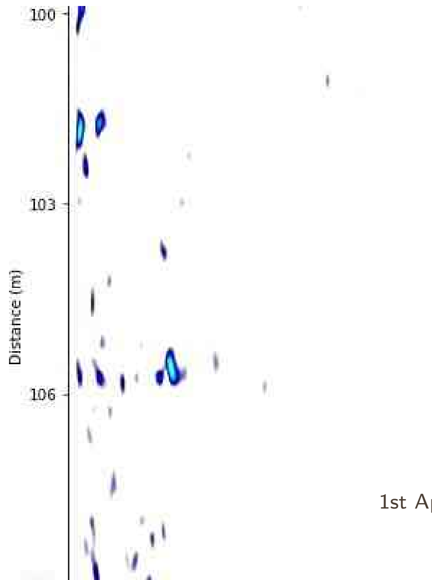


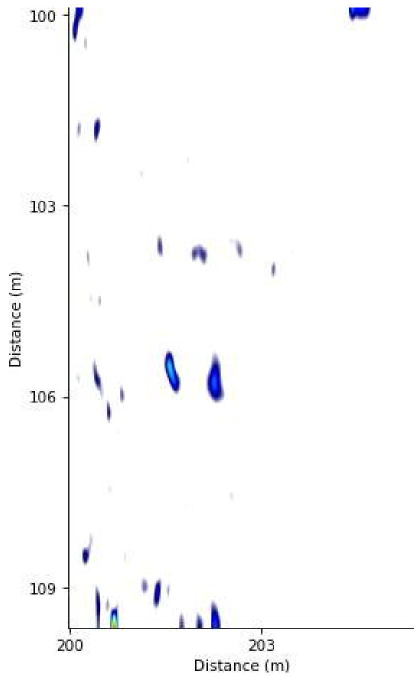
(c) Timeslice at z = 1.0 m.



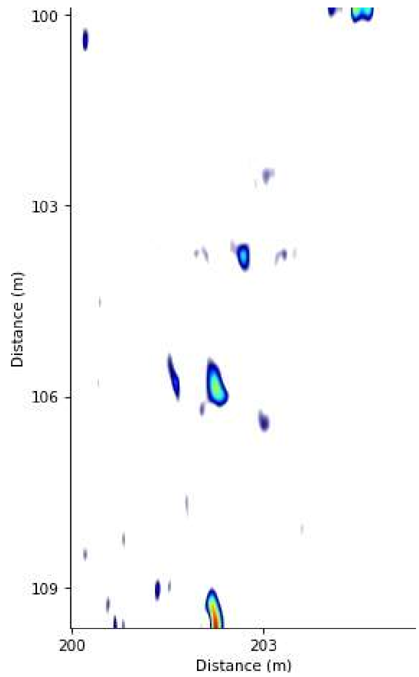
(d) Timeslice at z = 1.05 m.



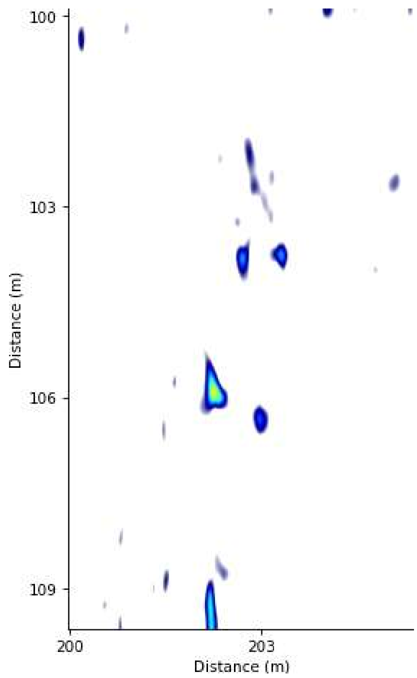




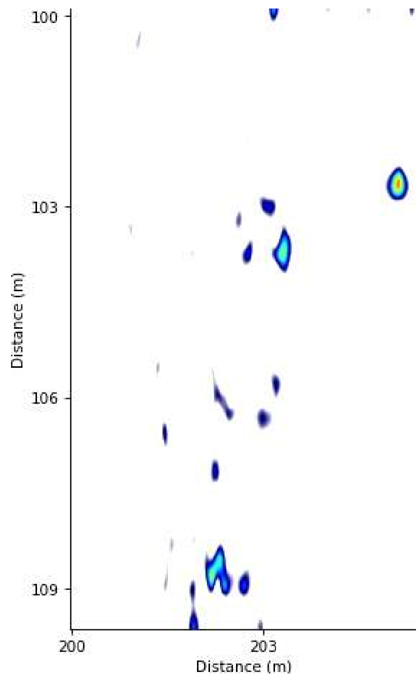
(a) Timeslice at z = 1.2 m.



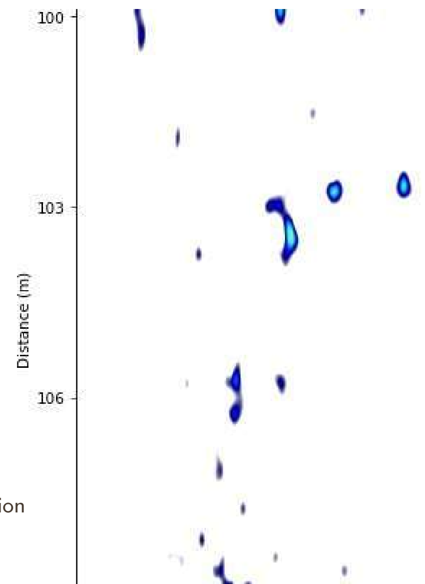
(b) Timeslice at z = 1.25 m.

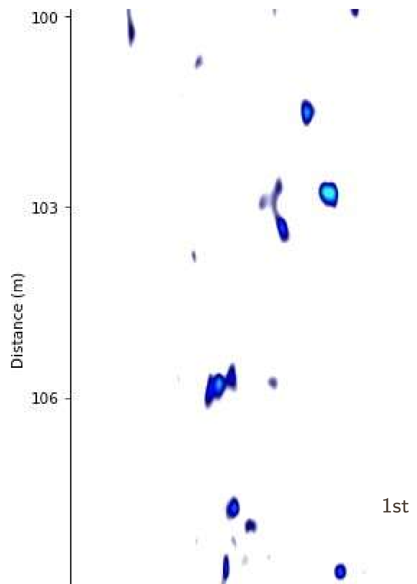


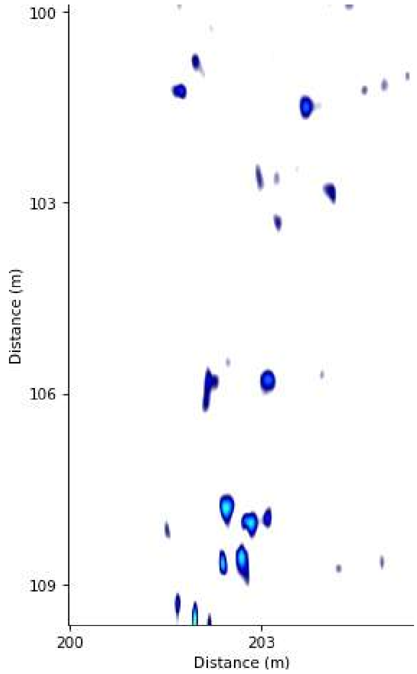
(c) Timeslice at z = 1.3 m.



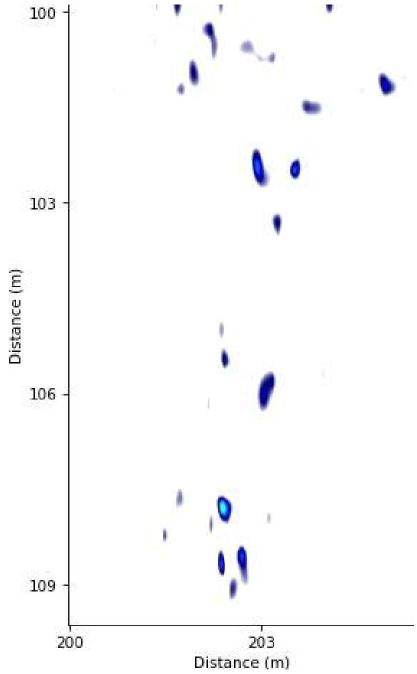
(d) Timeslice at z = 1.35 m.



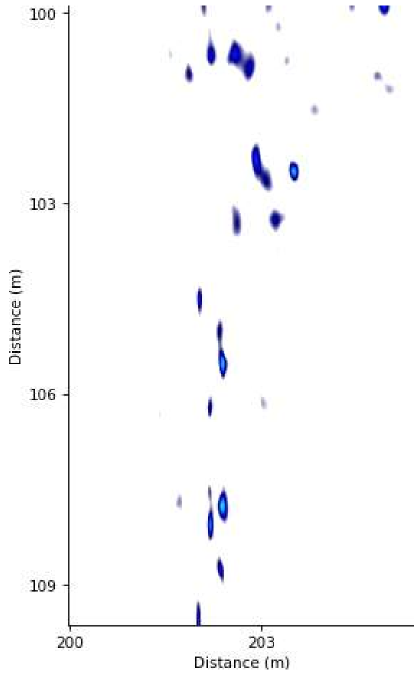




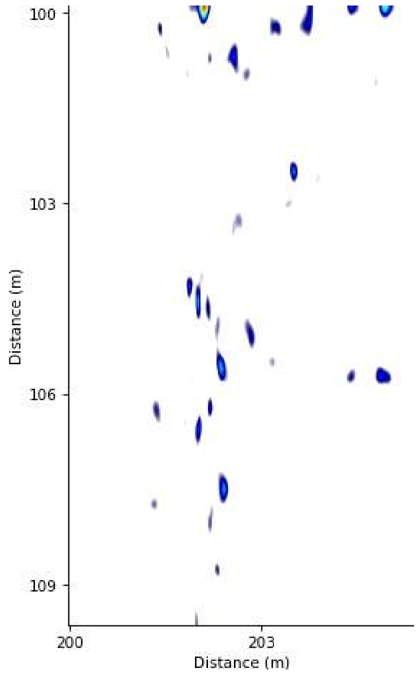
(a) Timeslice at z = 1.5 m.



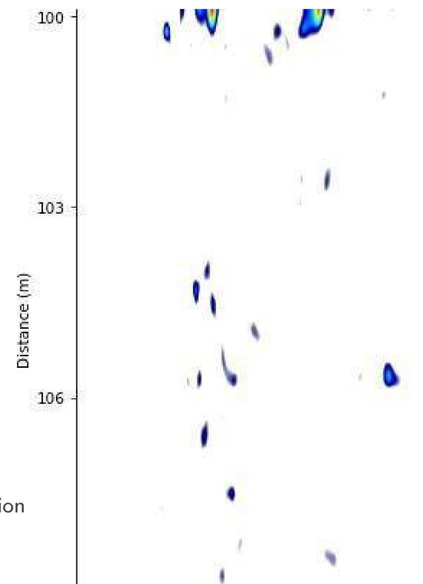
(b) Timeslice at z = 1.55 m.

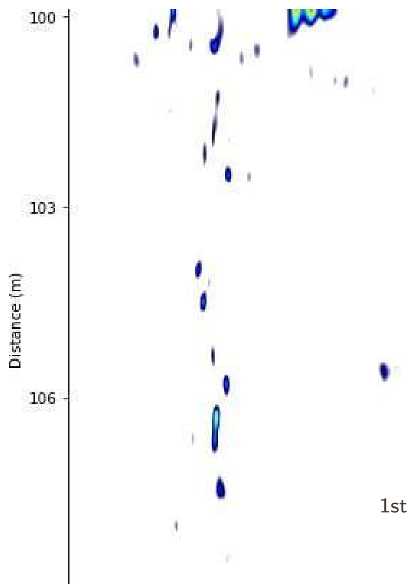


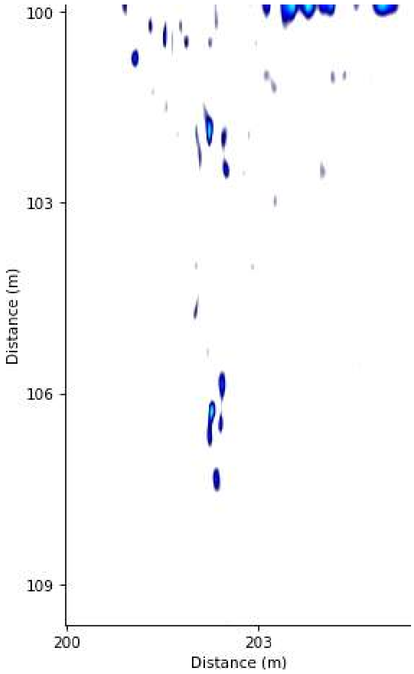
(c) Timeslice at z = 1.6 m.



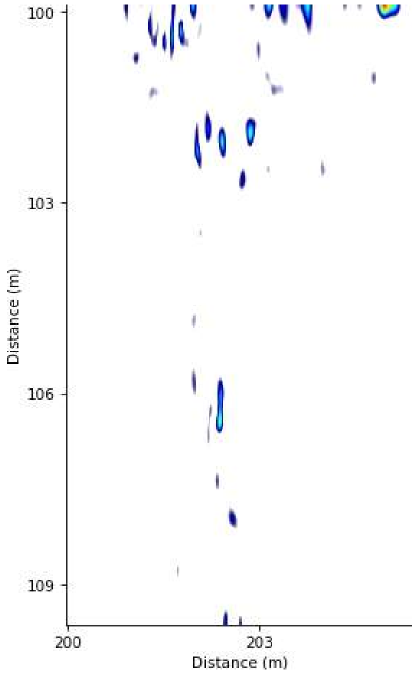
(d) Timeslice at z = 1.65 m.



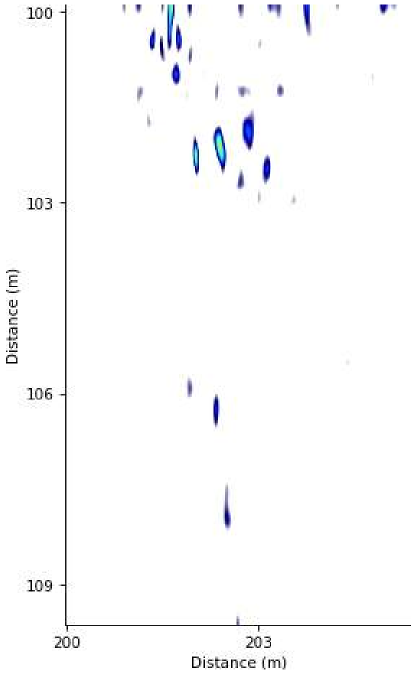




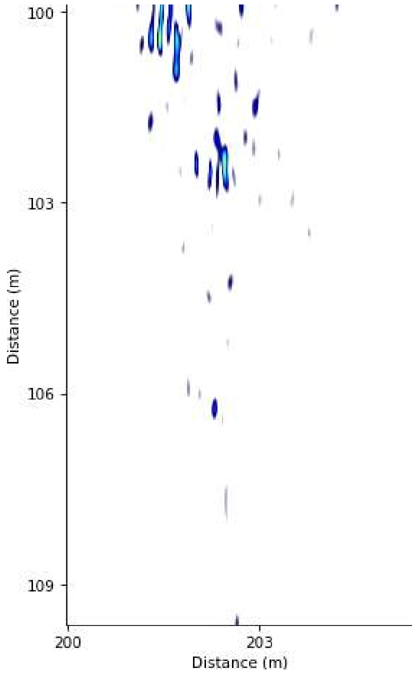
(a) Timeslice at z = 1.8 m.



(b) Timeslice at z = 1.85 m.



(c) Timeslice at z = 1.9 m.



(d) Timeslice at z = 1.95 m.

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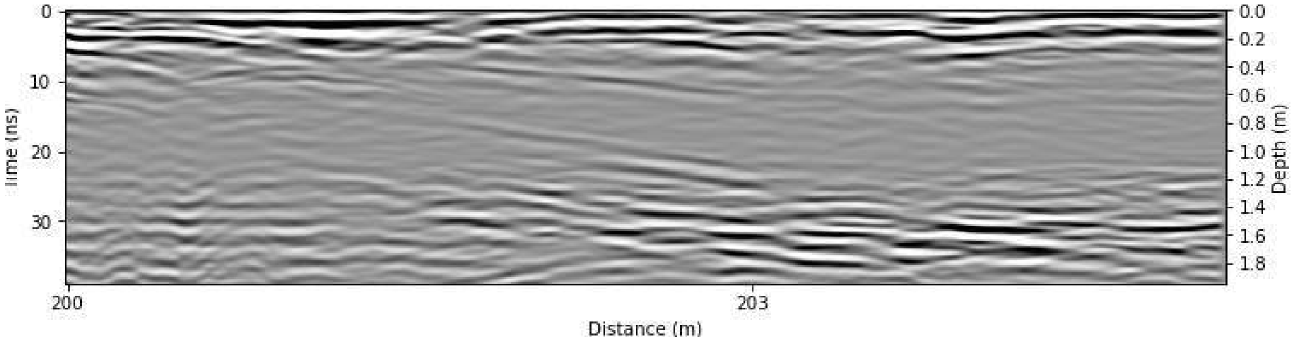


Figure B.95: Radargram at x = 126.0 m.

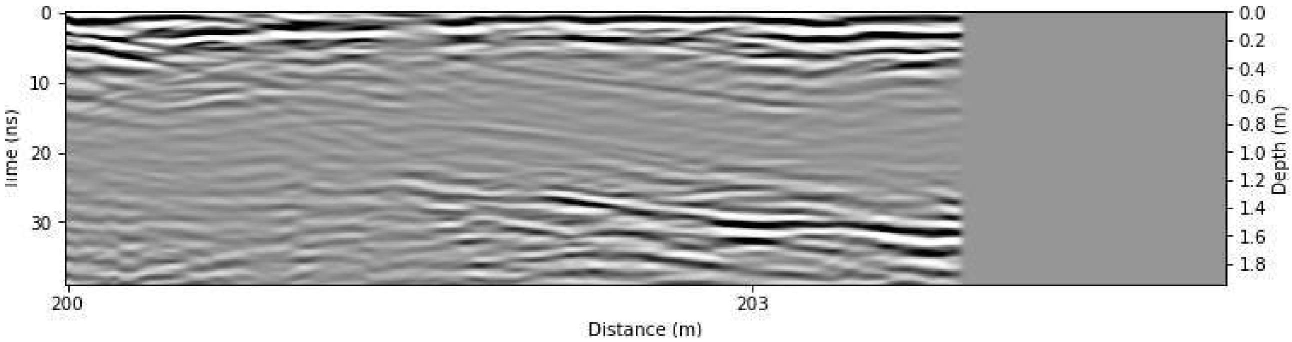


Figure B.96: Radargram at x = 126.25 m.

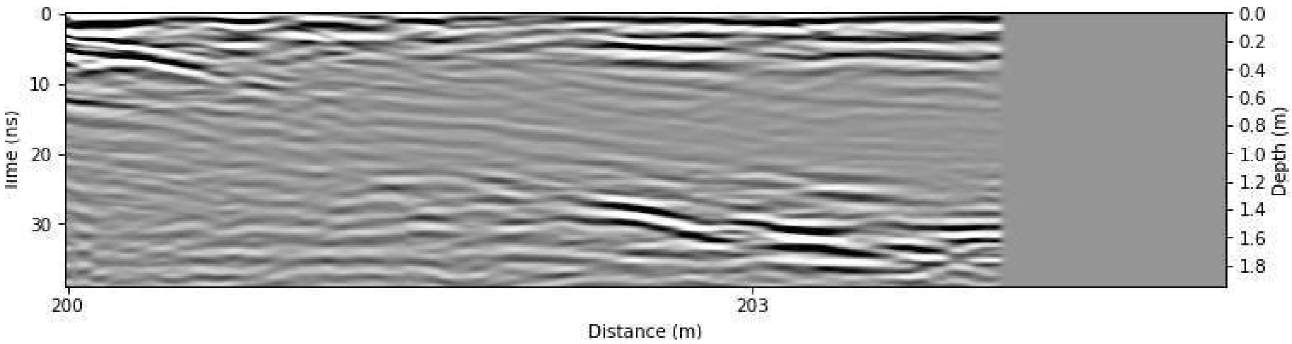


Figure B.97: Radargram at x = 126.5 m.

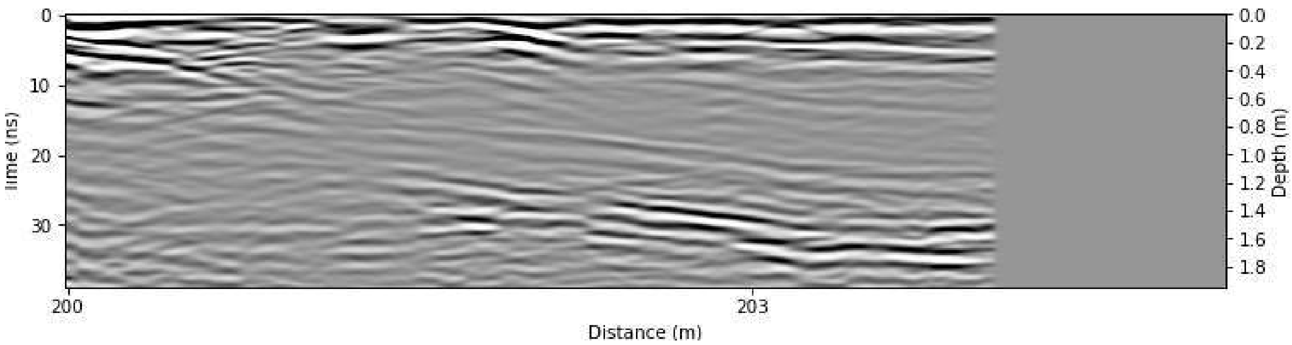


Figure B.98: Radargram at x = 126.75 m.

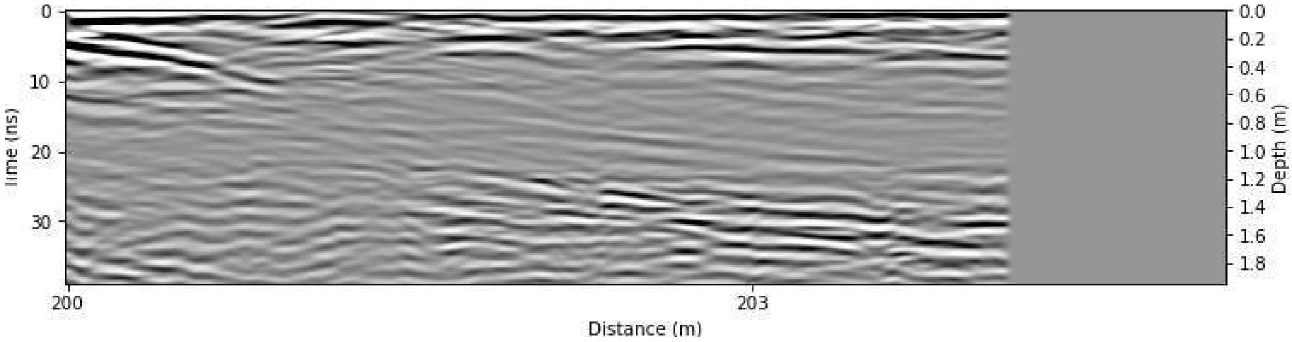


Figure B.99: Radargram at x = 127.0 m.

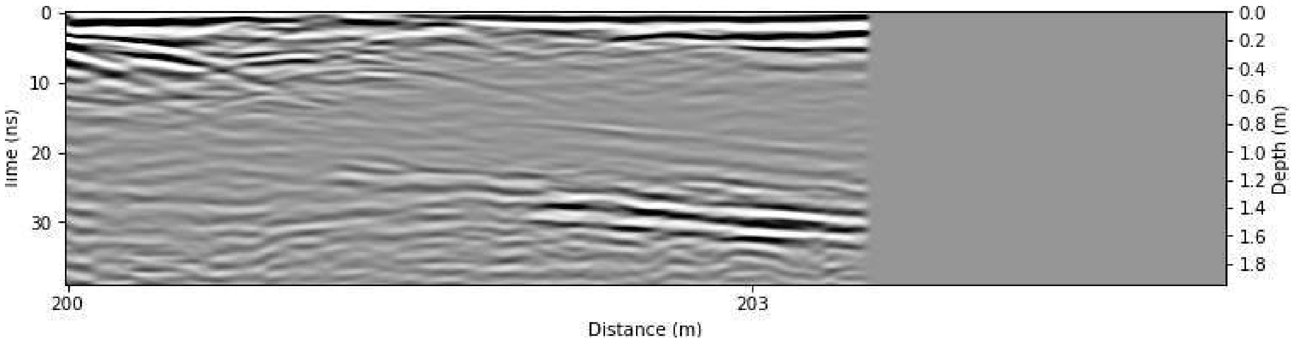


Figure B.100: Radargram at x = 127.25 m.

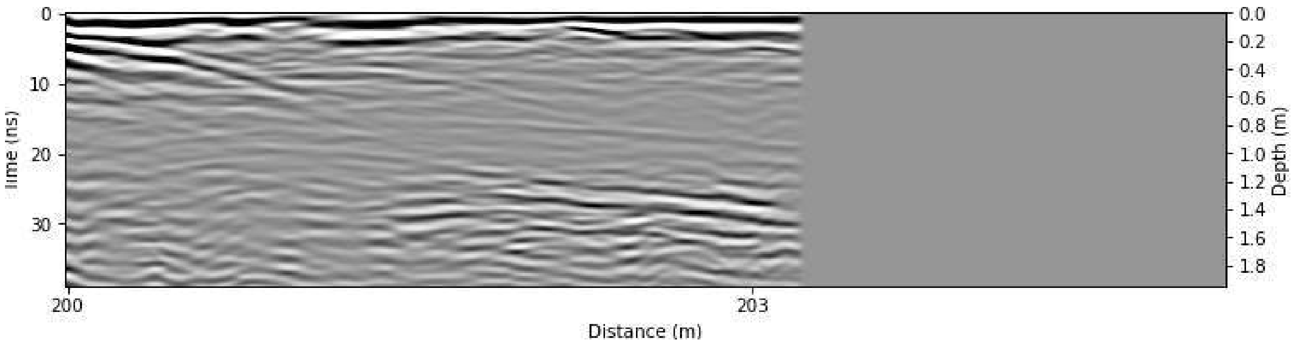


Figure B.101: Radargram at x = 127.5 m.

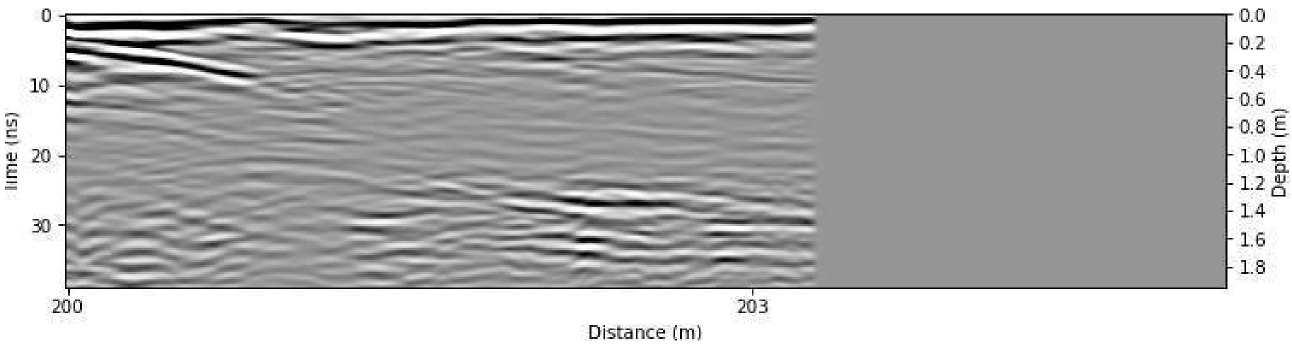


Figure B.102: Radargram at x = 127.75 m.

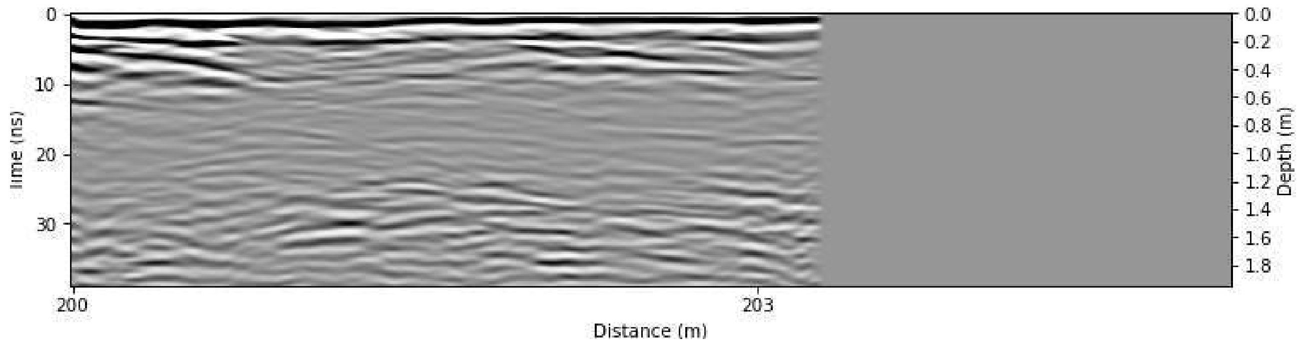


Figure B.103: Radargram at x = 128.0 m.

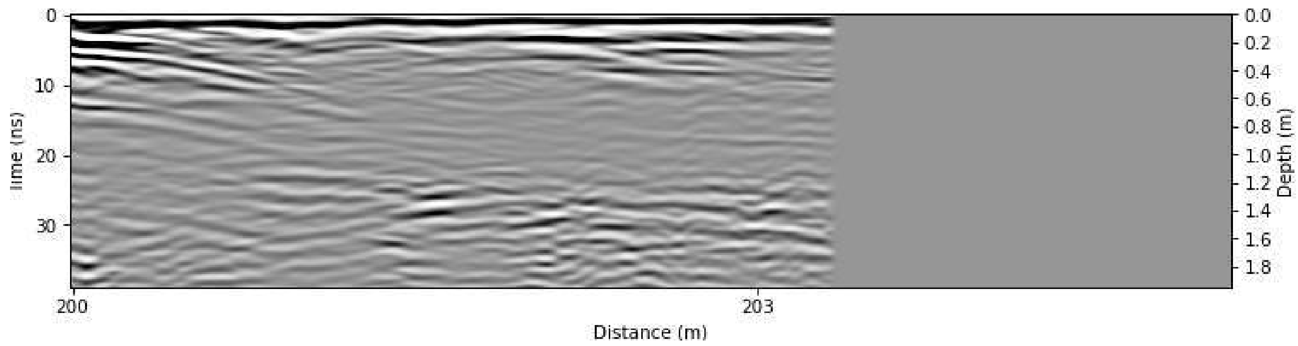


Figure B.104: Radargram at x = 128.25 m.

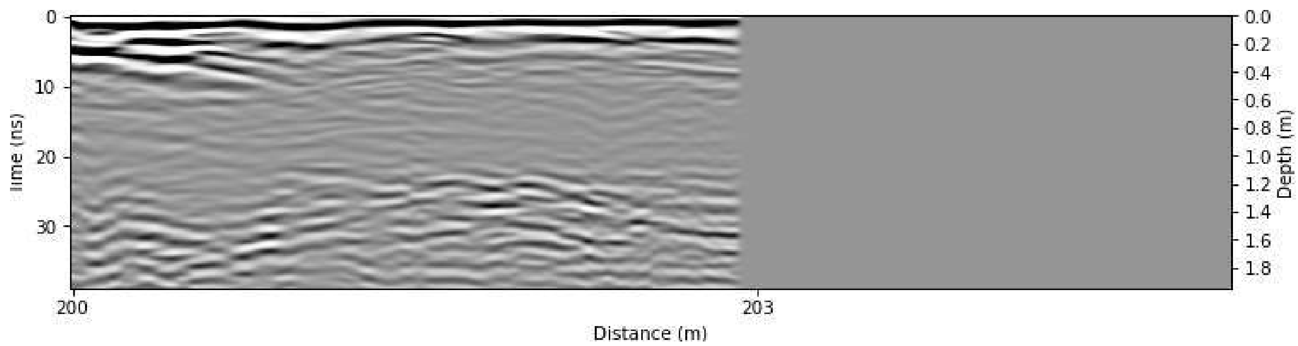


Figure B.105: Radargram at x = 128.5 m.

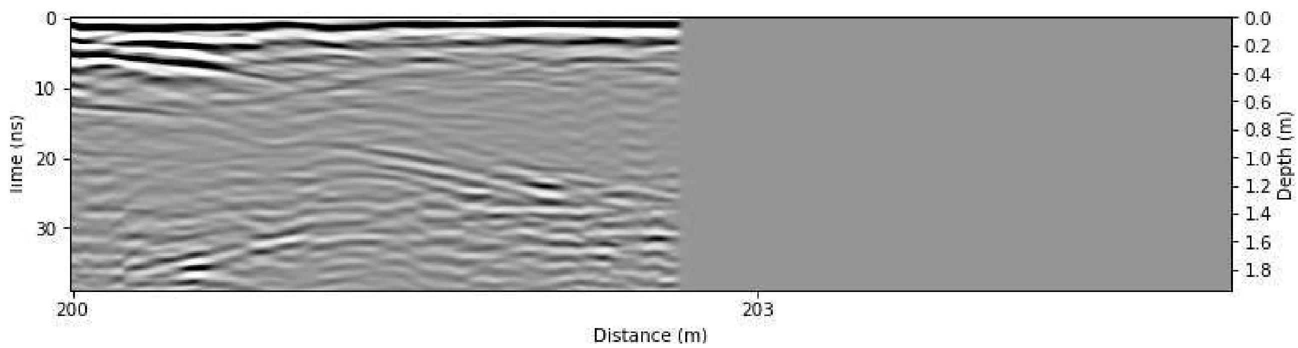


Figure B.106: Radargram at x = 128.75 m.

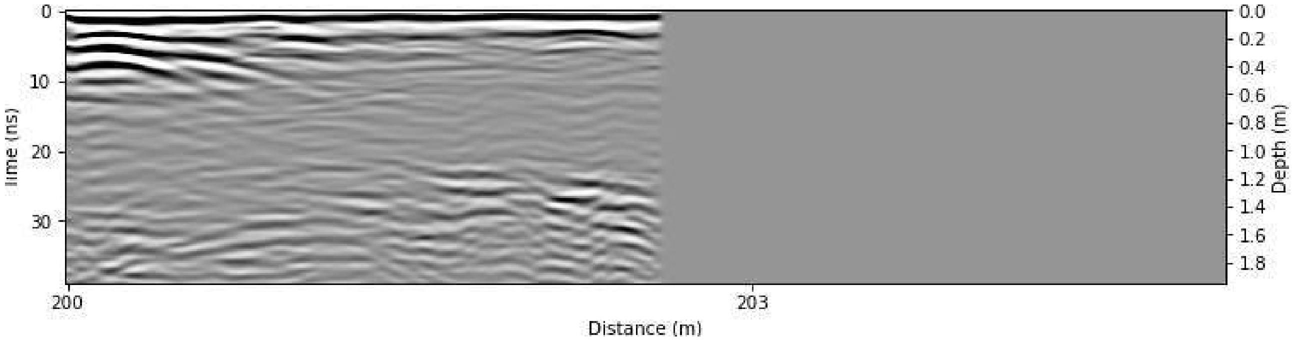


Figure B.107: Radargram at x = 129.0 m.

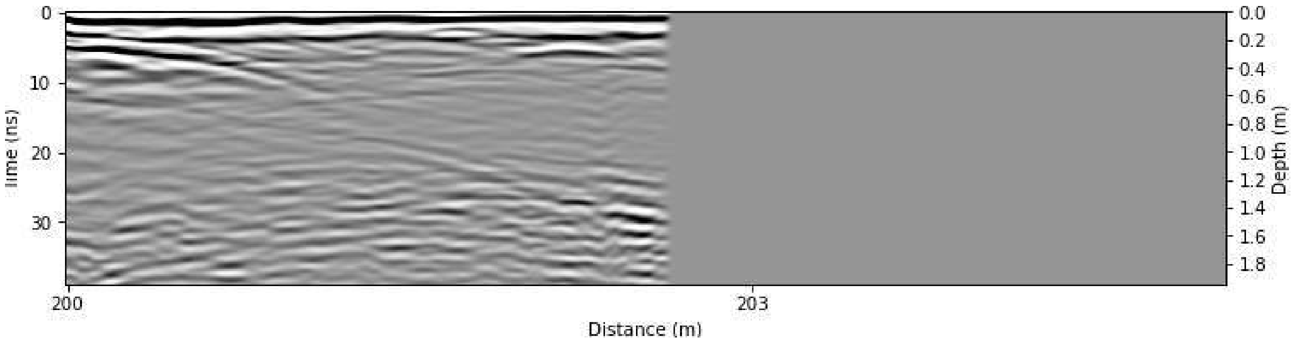


Figure B.108: Radargram at x = 129.25 m.

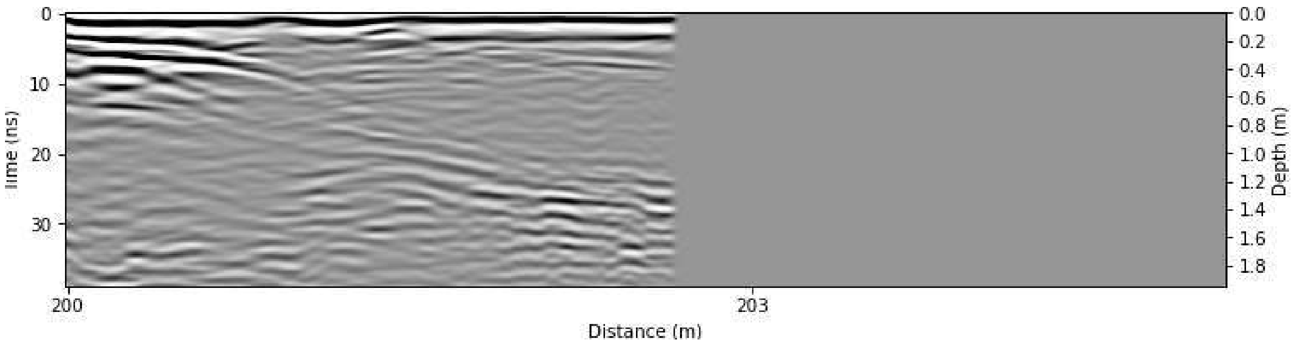


Figure B.109: Radargram at x = 129.5 m.

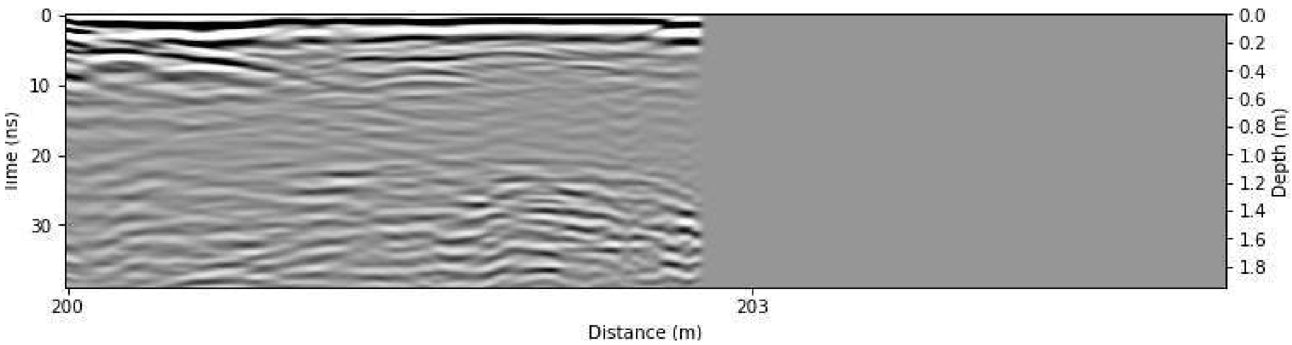


Figure B.110: Radargram at x = 129.75 m.

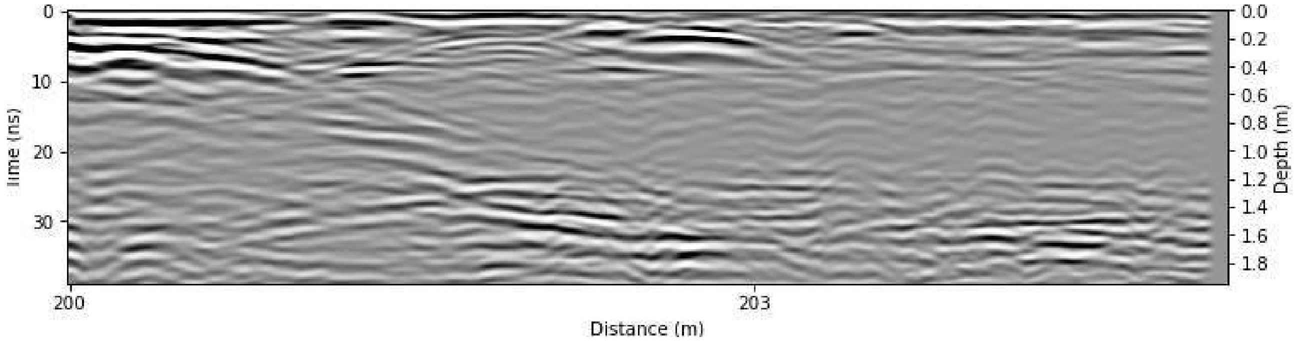


Figure B.111: Radargram at x = 130.0 m.

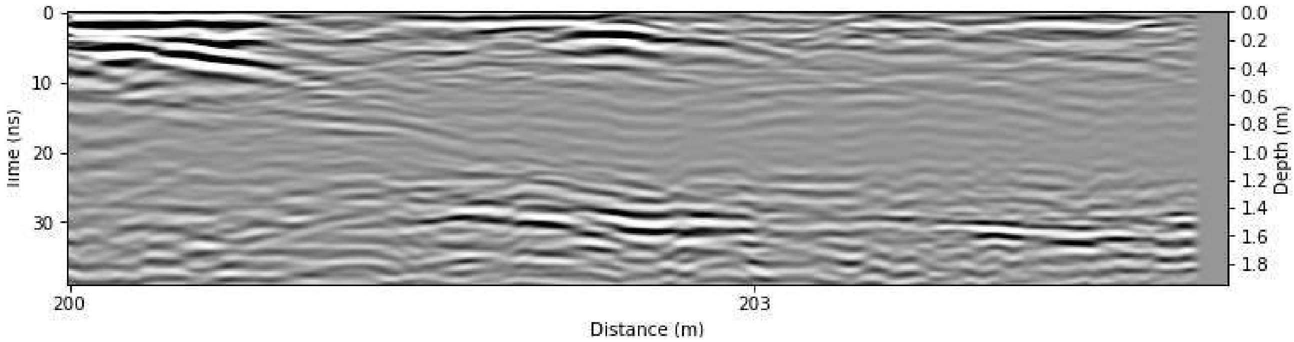


Figure B.112: Radargram at x = 130.25 m.

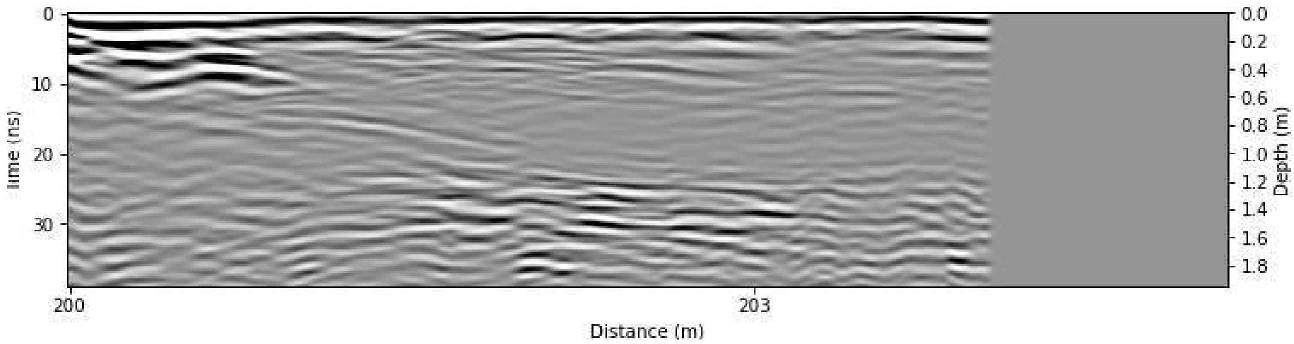


Figure B.113: Radargram at x = 130.5 m.

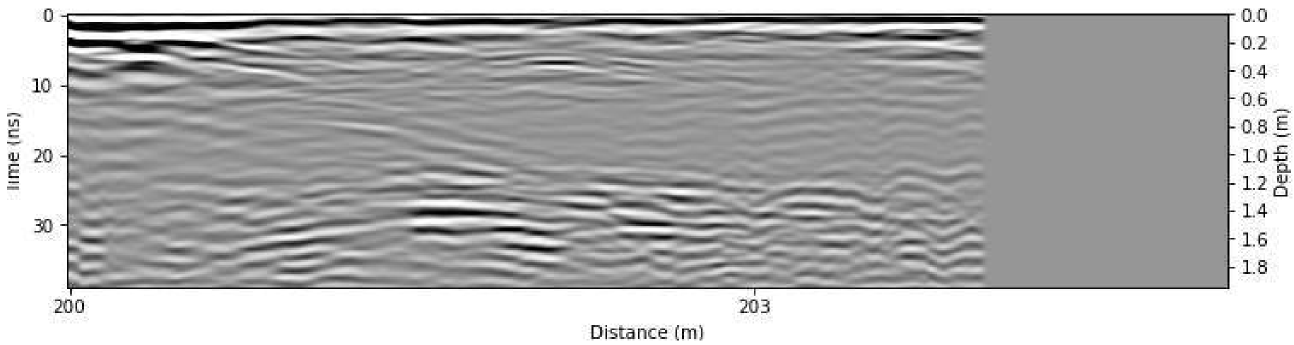


Figure B.114: Radargram at x = 130.75 m.

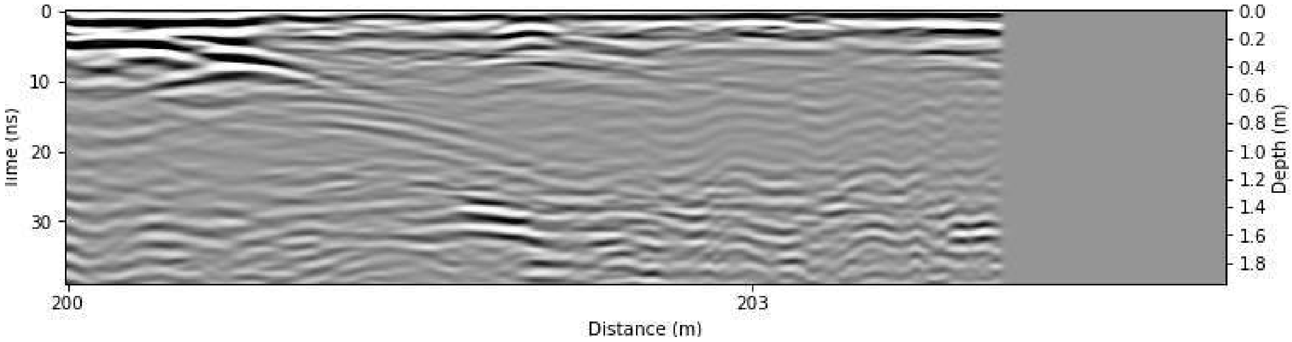


Figure B.115: Radargram at x = 131.0 m.

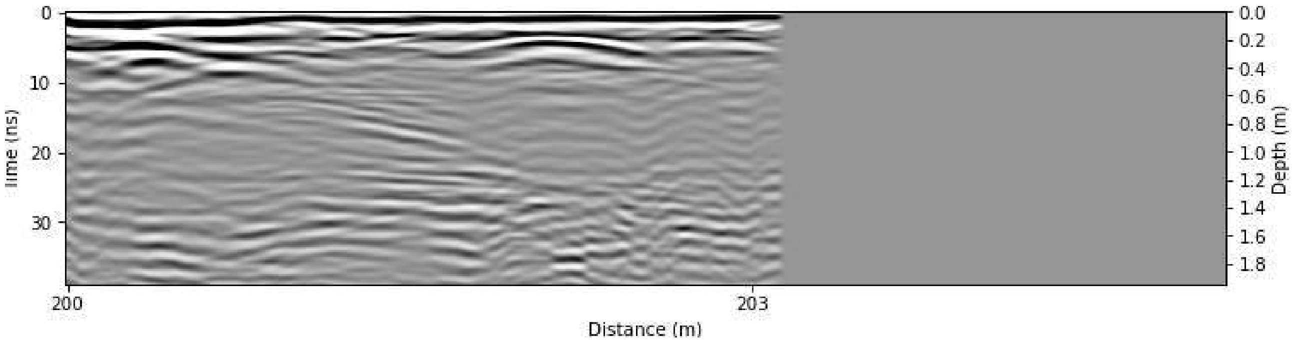


Figure B.116: Radargram at x = 131.25 m.

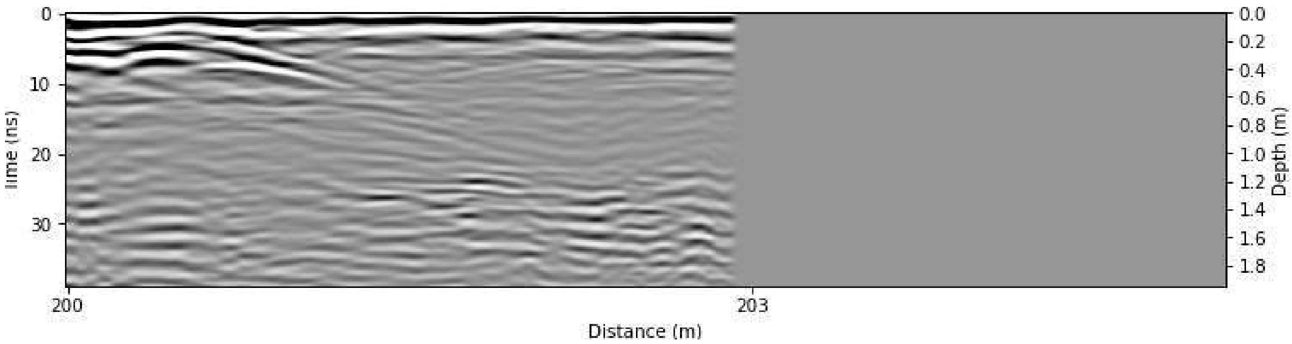


Figure B.117: Radargram at x = 131.5 m.

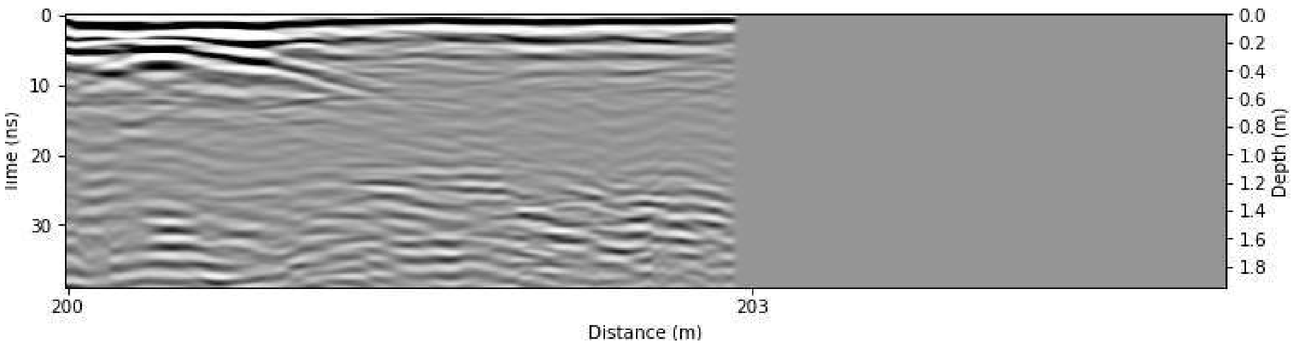


Figure B.118: Radargram at x = 131.75 m.

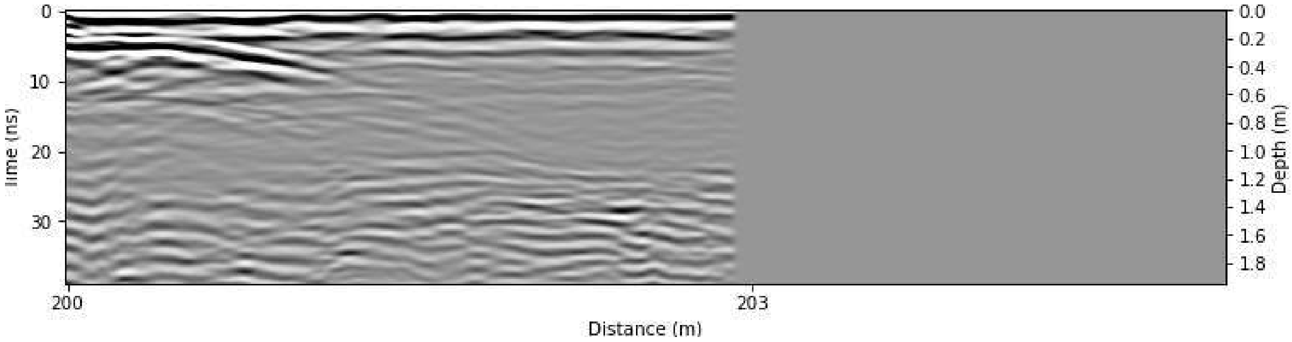


Figure B.119: Radargram at x = 132.0 m.

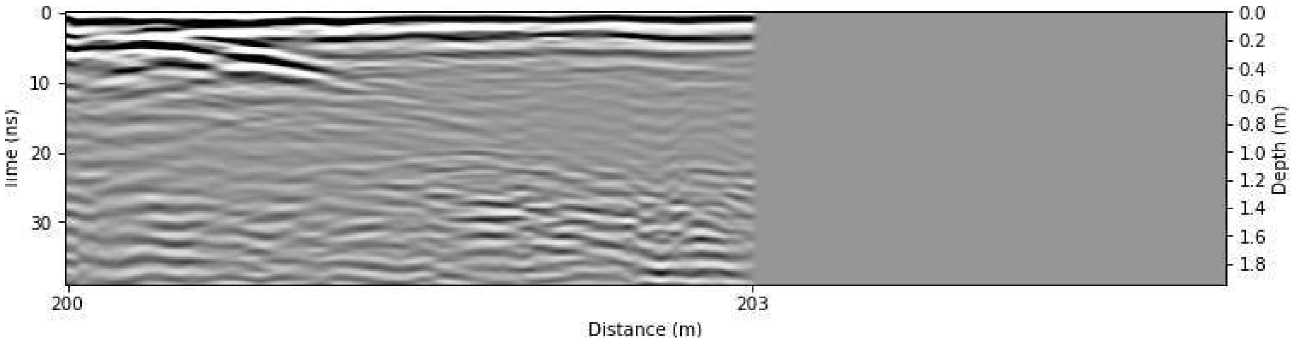


Figure B.120: Radargram at x = 132.25 m.

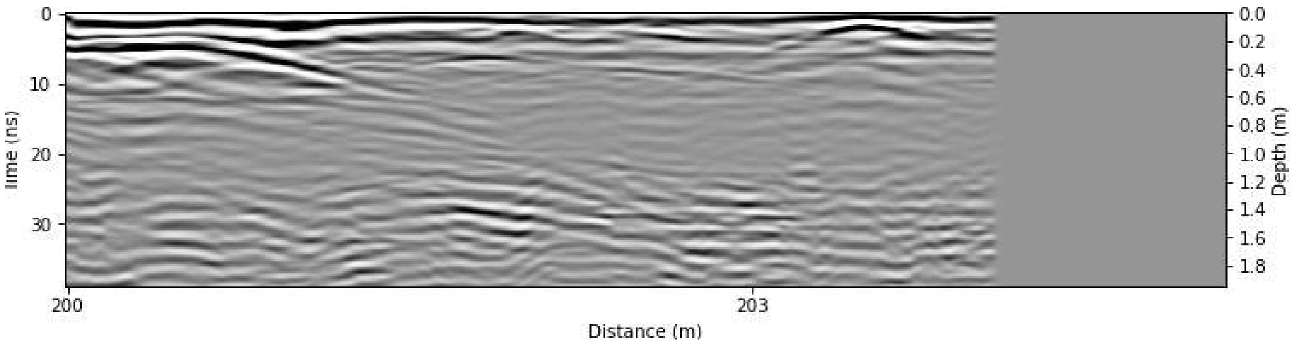


Figure B.121: Radargram at x = 132.5 m.

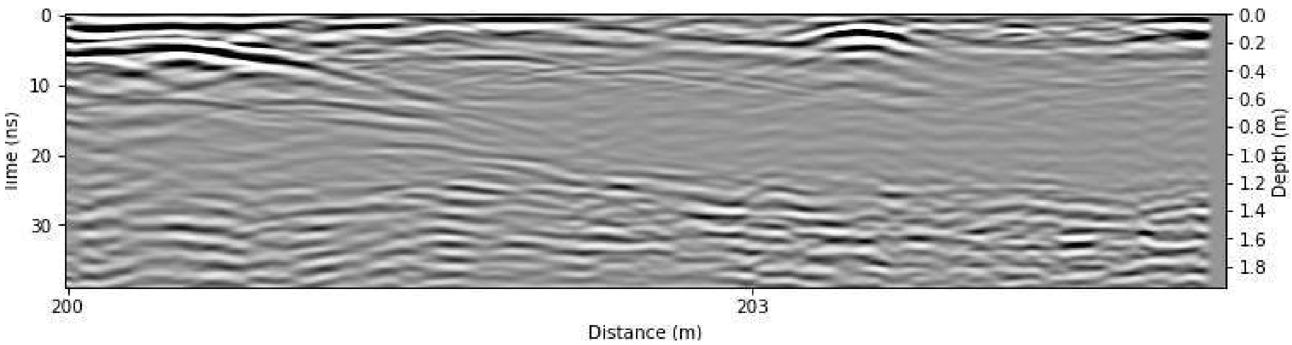


Figure B.122: Radargram at x = 132.75 m.

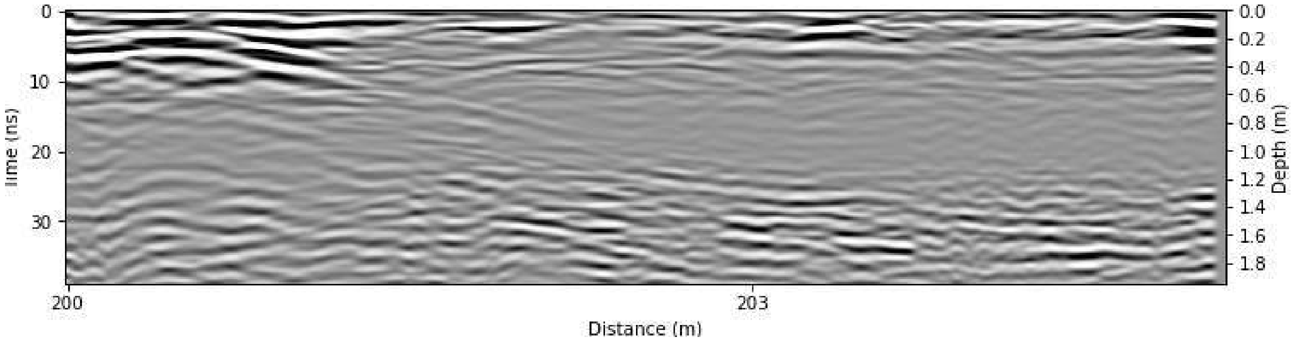


Figure B.123: Radargram at x = 133.0 m.

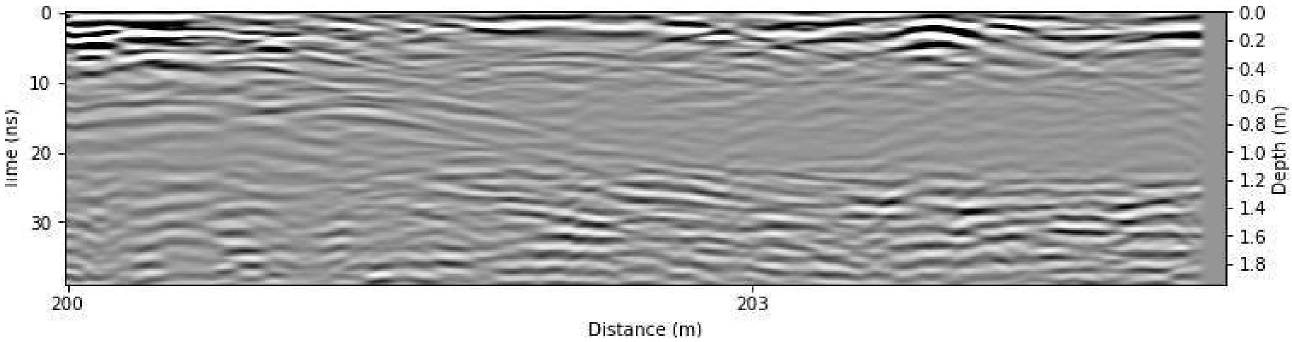


Figure B.124: Radargram at x = 133.25 m.

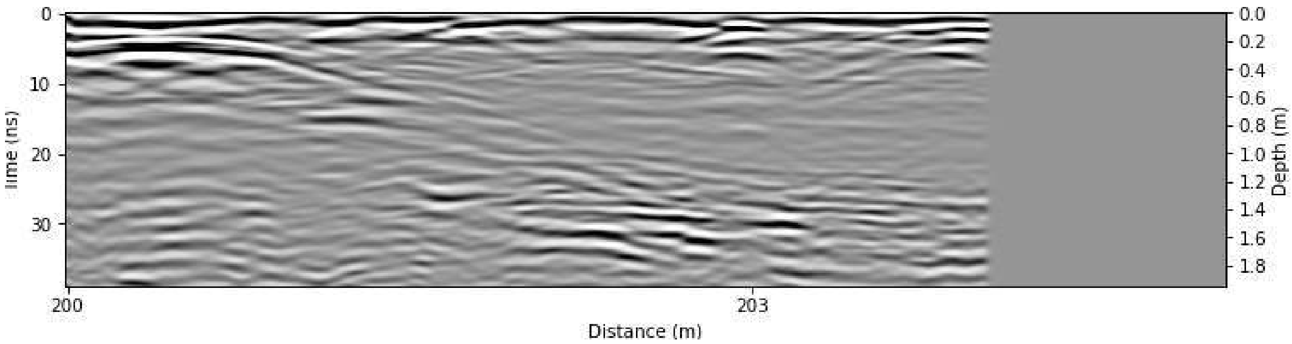


Figure B.125: Radargram at x = 133.5 m.

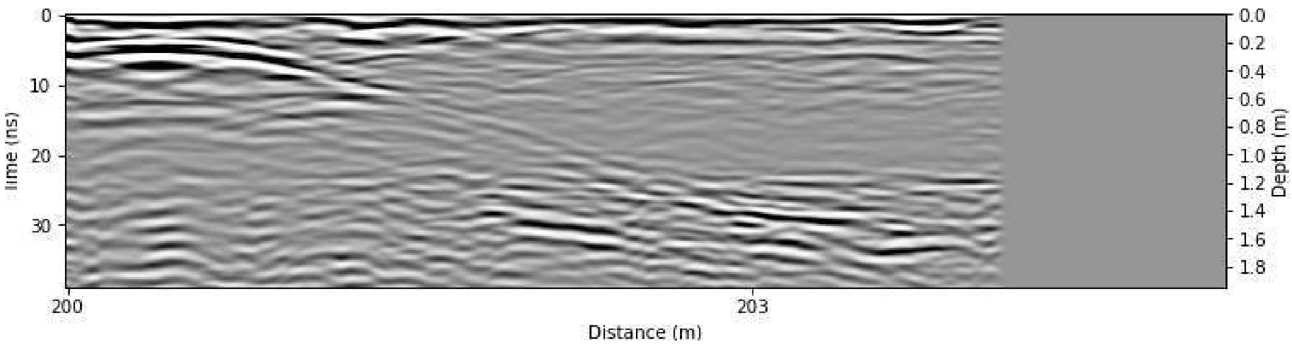


Figure B.126: Radargram at x = 133.75 m.

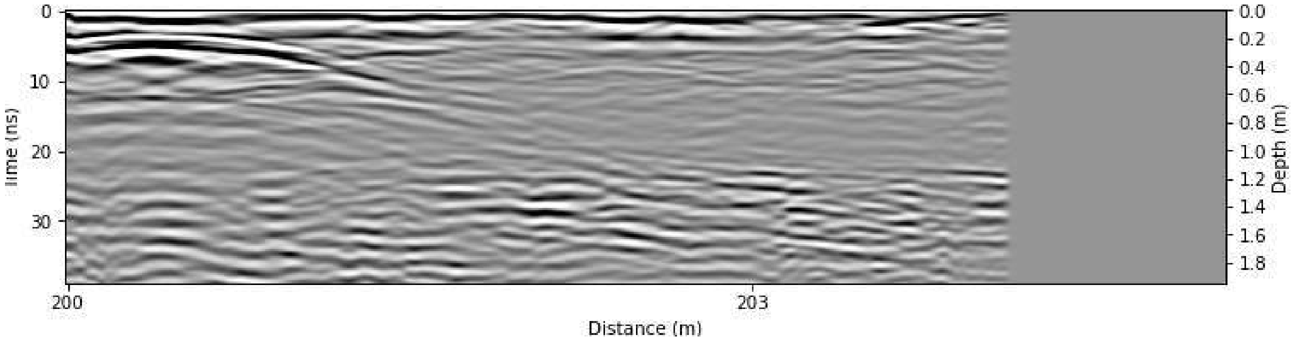


Figure B.127: Radargram at x = 134.0 m.

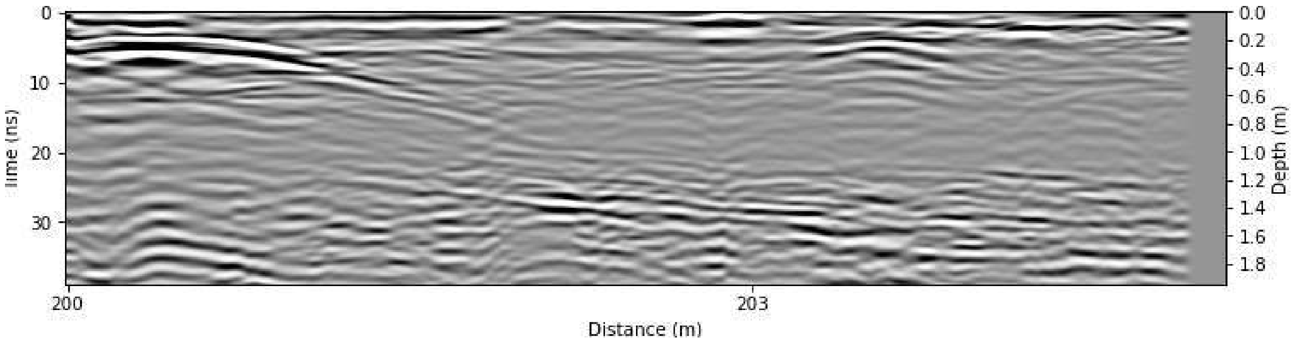


Figure B.128: Radargram at x = 134.25 m.

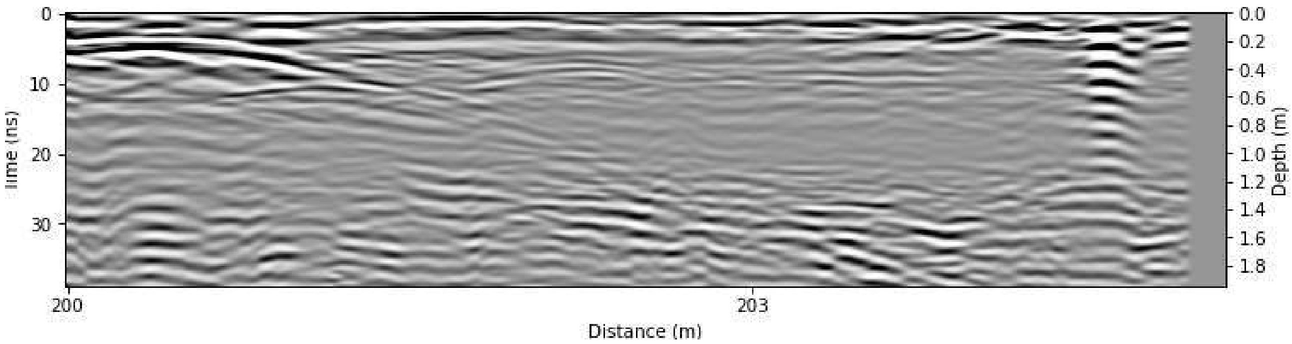


Figure B.129: Radargram at x = 134.5 m.

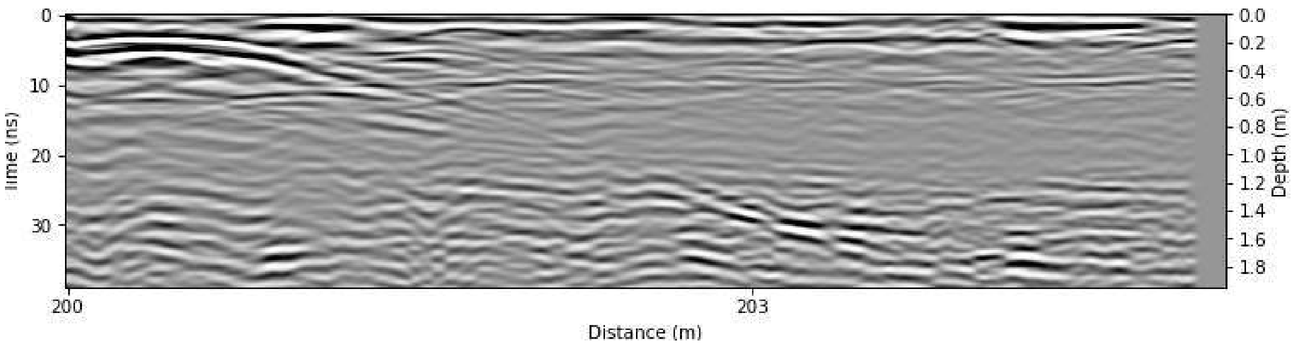


Figure B.130: Radargram at x = 134.75 m.

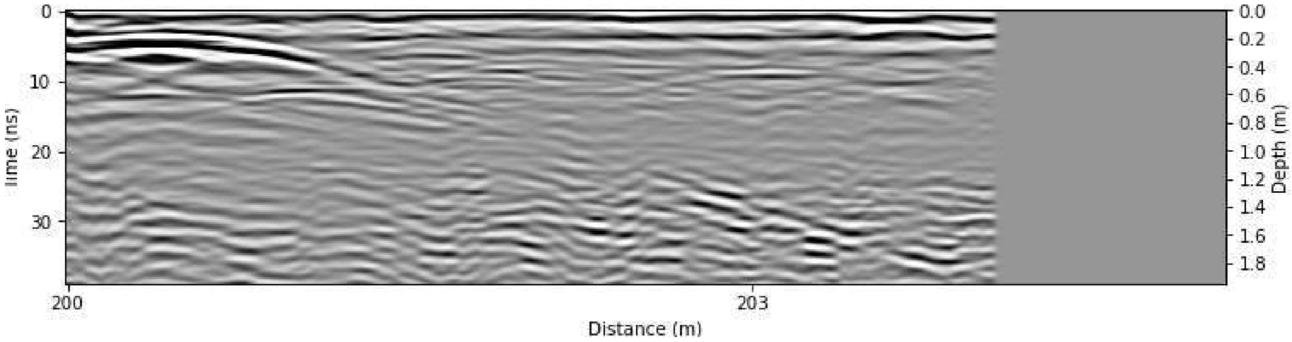


Figure B.131: Radargram at x = 135.0 m.

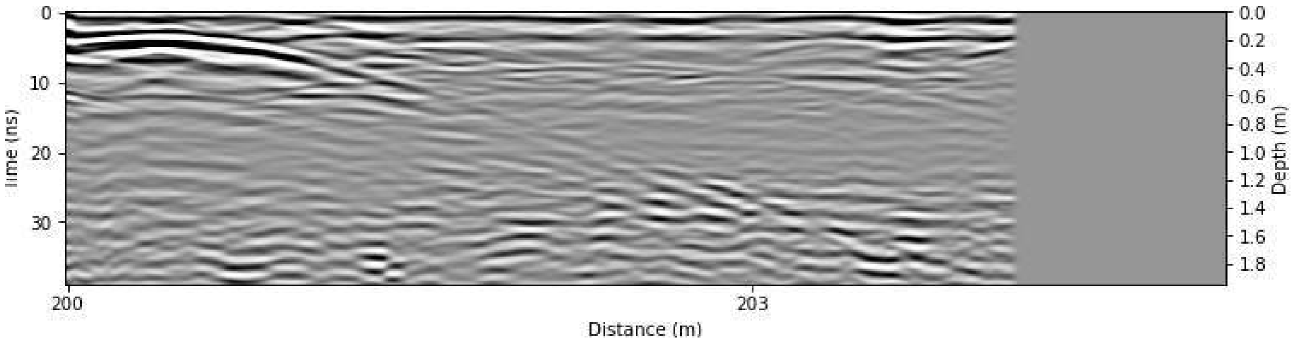


Figure B.132: Radargram at x = 135.25 m.

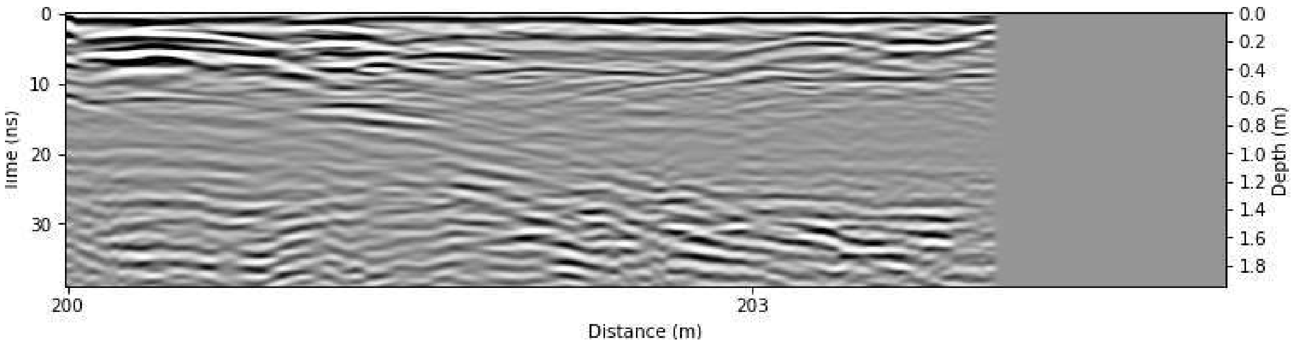


Figure B.133: Radargram at x = 135.5 m.

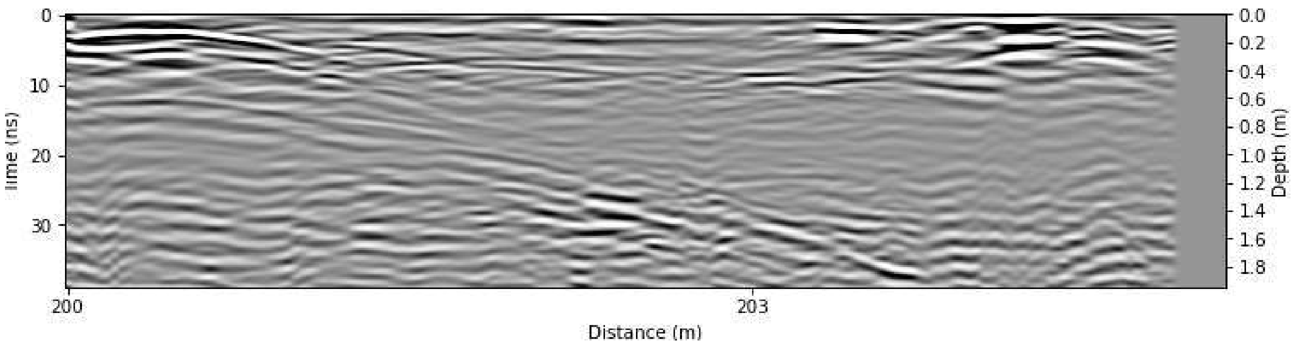


Figure B.134: Radargram at x = 135.75 m.

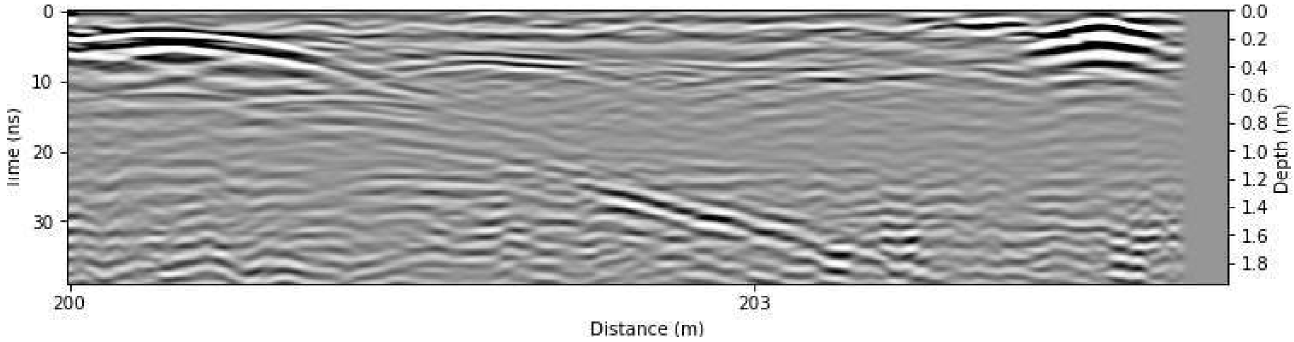
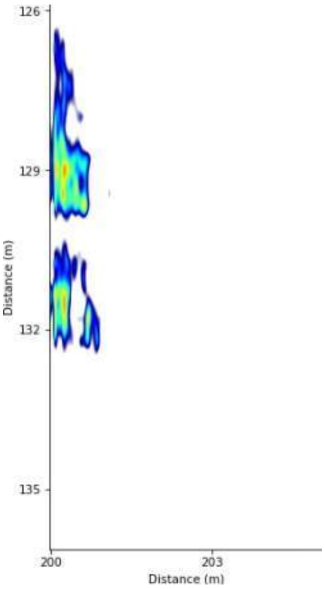
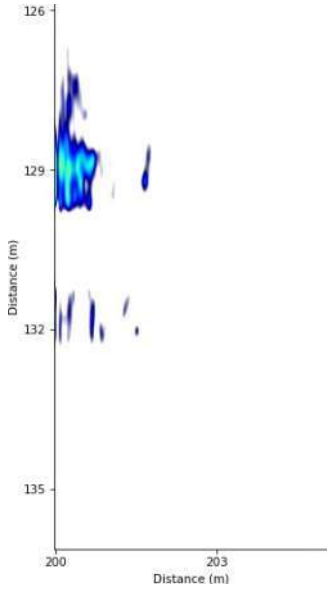


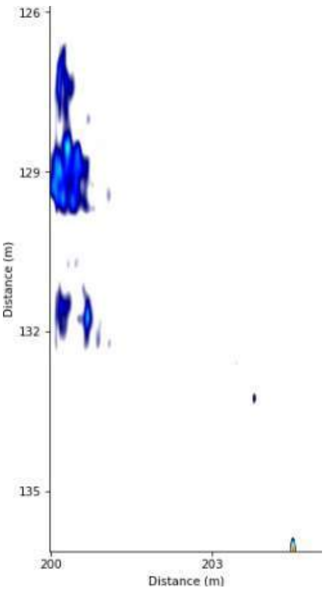
Figure B.135: Radargram at x = 136.0 m.



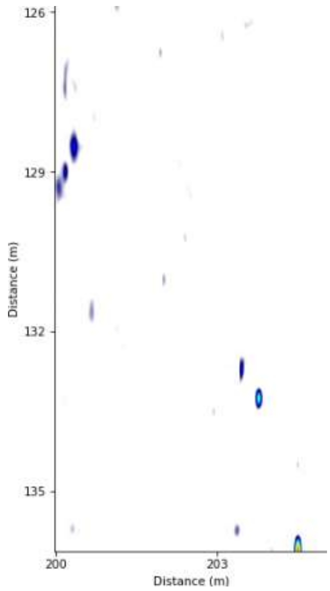
(a) Timeslice at z = 0.0 m.



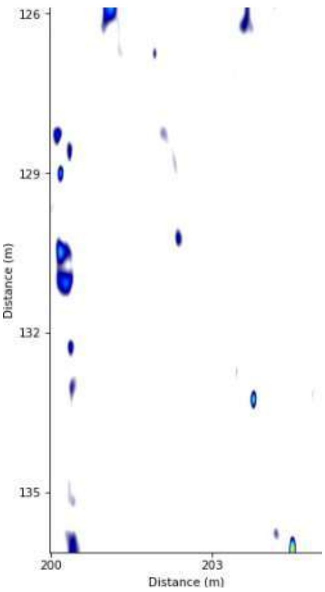
(b) Timeslice at z = 0.05 m.



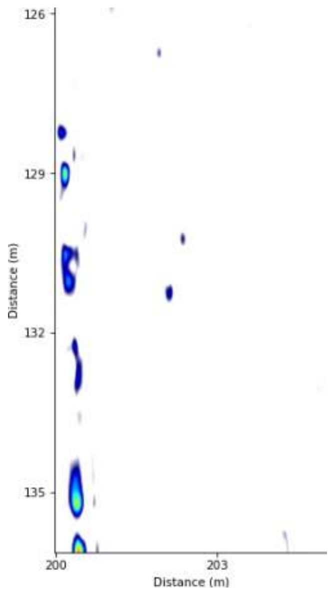
(c) Timeslice at z = 0.1 m.



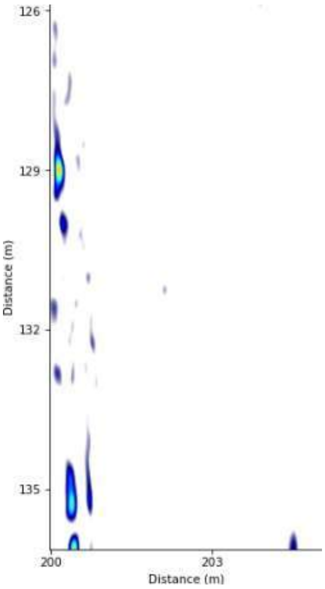
(d) Timeslice at z = 0.15 m.



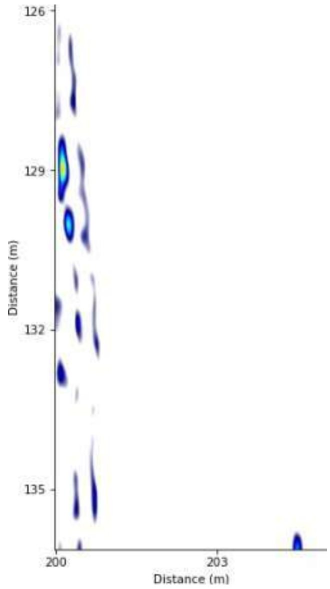
(e) Timeslice at z = 0.2 m.



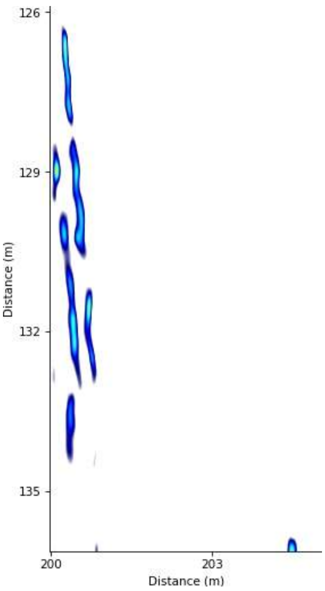
(f) Timeslice at z = 0.25 m.



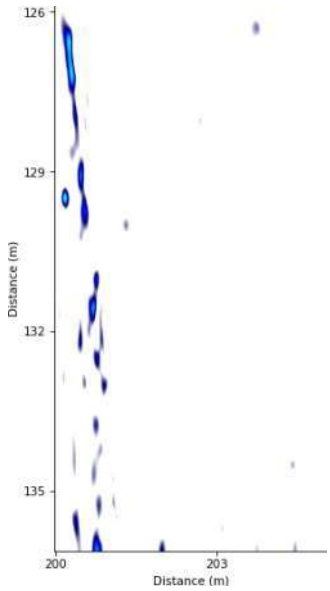
(a) Timeslice at z = 0.3 m.



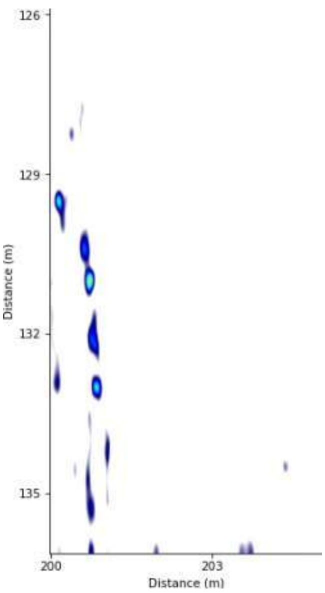
(b) Timeslice at z = 0.35 m.



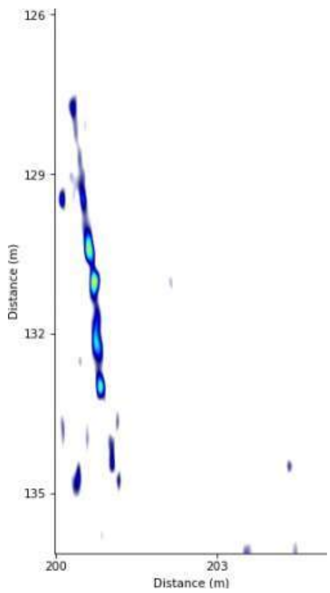
(c) Timeslice at z = 0.4 m.



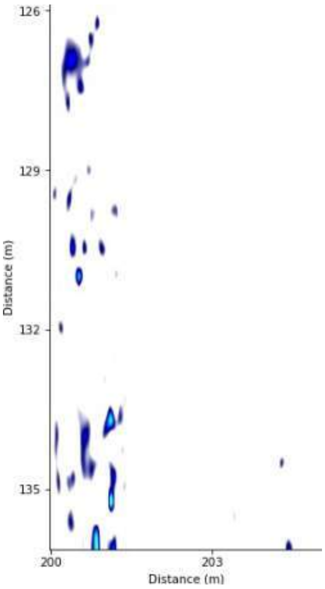
(d) Timeslice at z = 0.45 m.



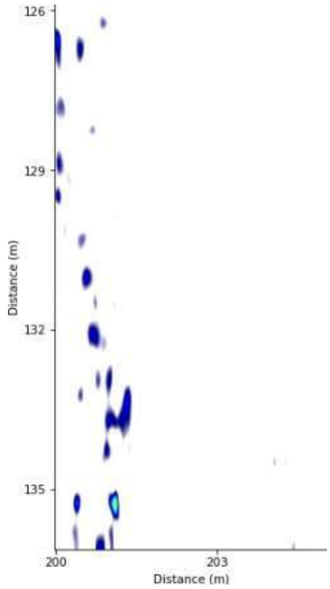
(e) Timeslice at z = 0.5 m.



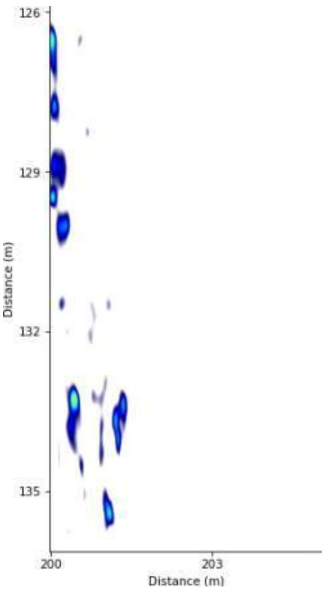
(f) Timeslice at z = 0.55 m.



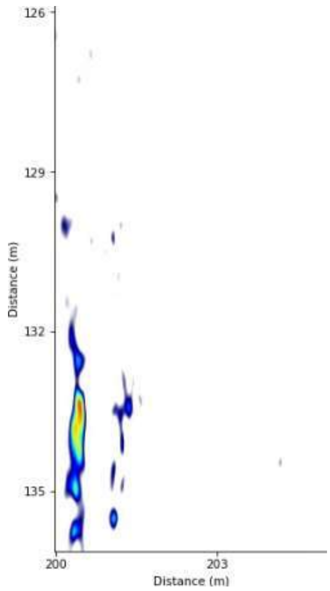
(a) Timeslice at z = 0.6 m.



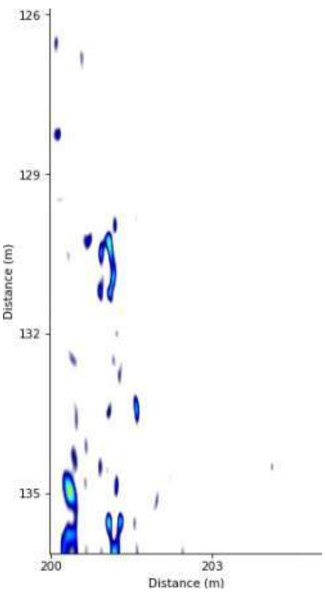
(b) Timeslice at z = 0.65 m.



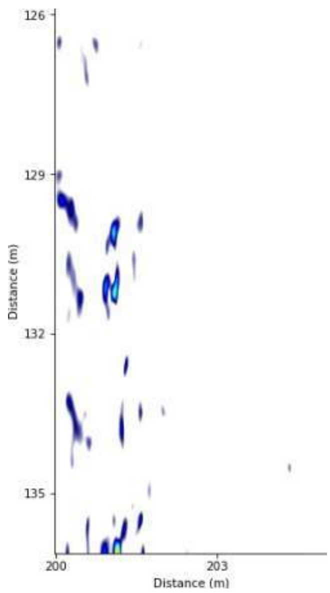
(c) Timeslice at z = 0.7 m.



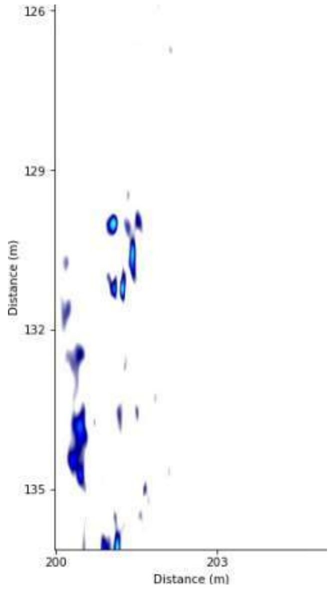
(d) Timeslice at z = 0.75 m.



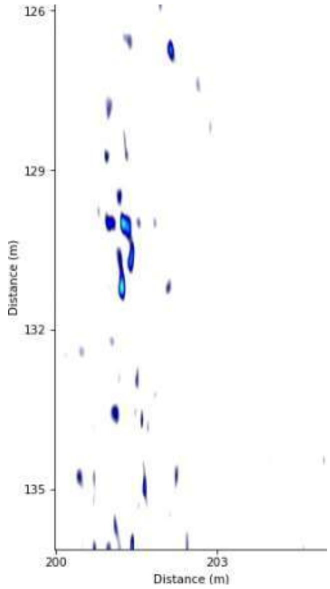
(e) Timeslice at z = 0.8 m.



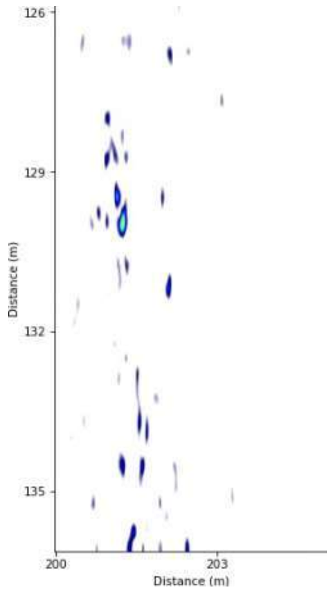
(f) Timeslice at z = 0.85 m.



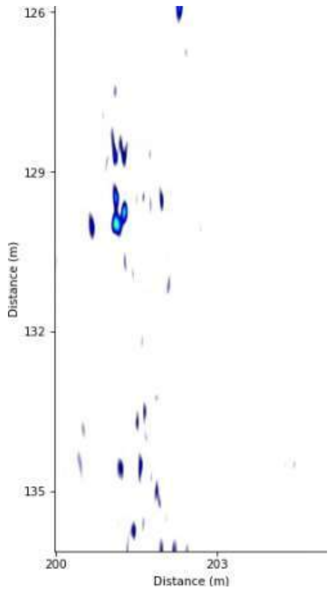
(a) Timeslice at z = 0.55 m.



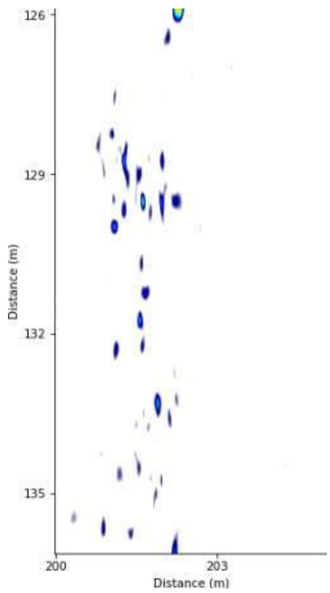
(b) Timeslice at z = 0.555 m.



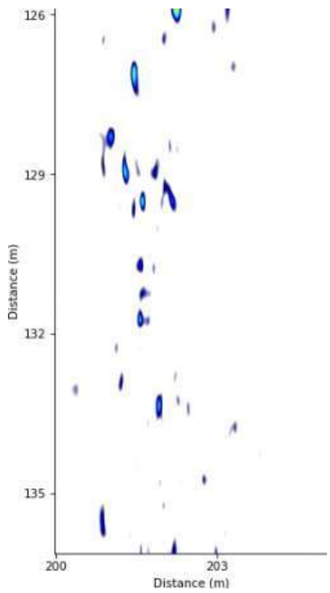
(c) Timeslice at z = 1.0 m.



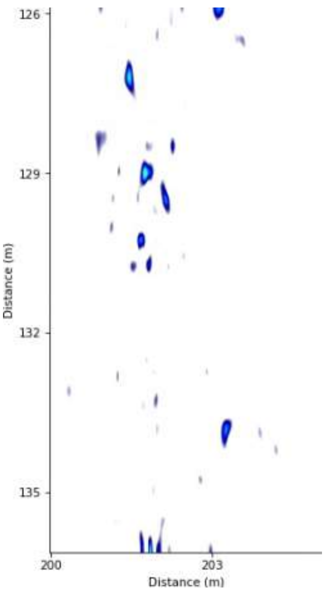
(d) Timeslice at z = 1.05 m.



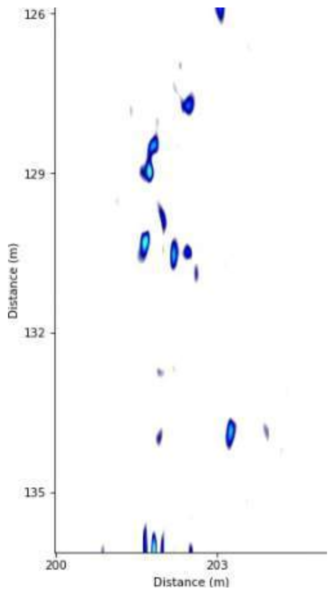
(e) Timeslice at z = 1.1 m.



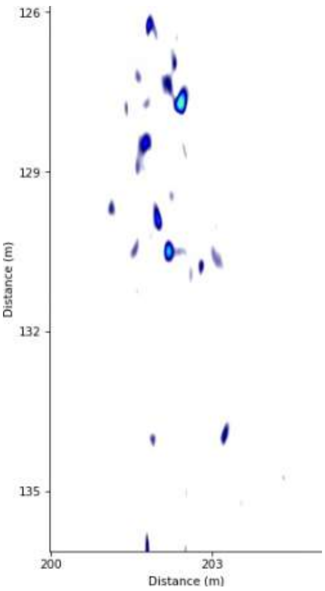
(f) Timeslice at z = 1.15 m.



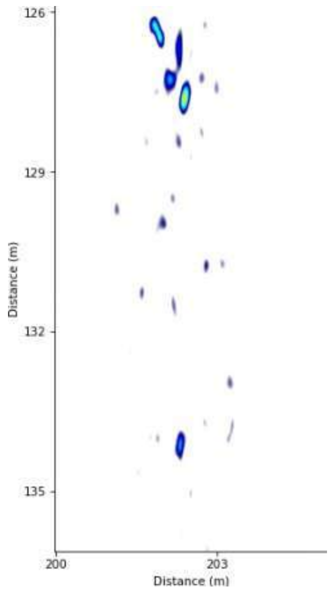
(a) Timeslice at z = 1.2 m.



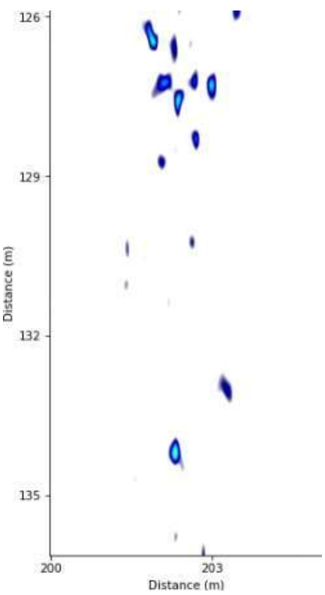
(b) Timeslice at z = 1.25 m.



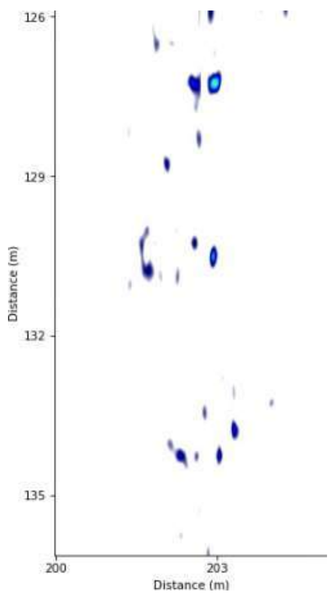
(c) Timeslice at z = 1.3 m.



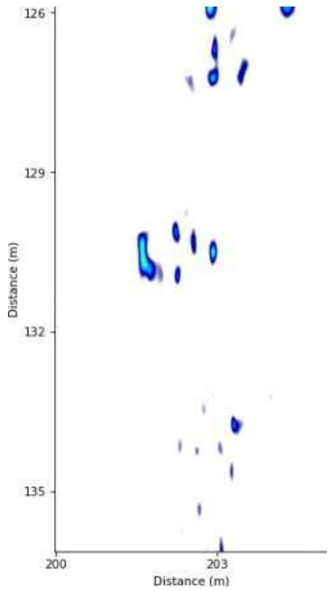
(d) Timeslice at z = 1.35 m.



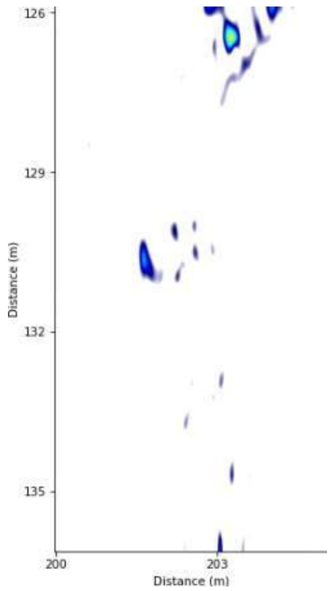
(e) Timeslice at z = 1.4 m.



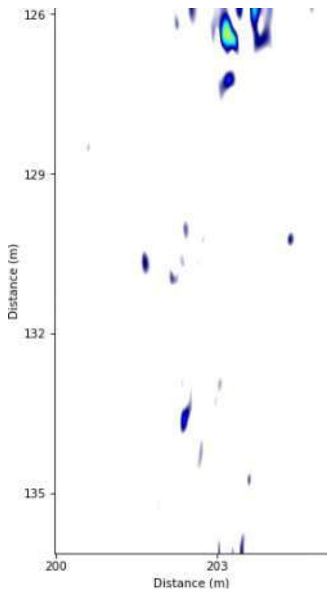
(f) Timeslice at z = 1.45 m.



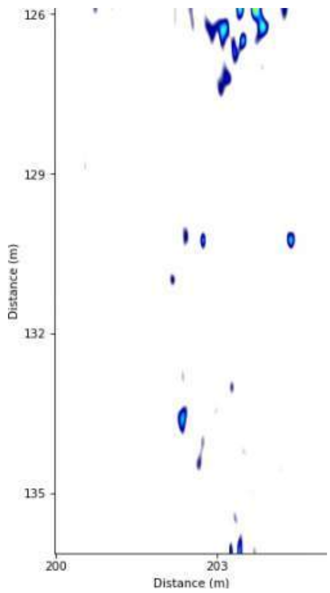
(a) Timeslice at z = 1.5 m.



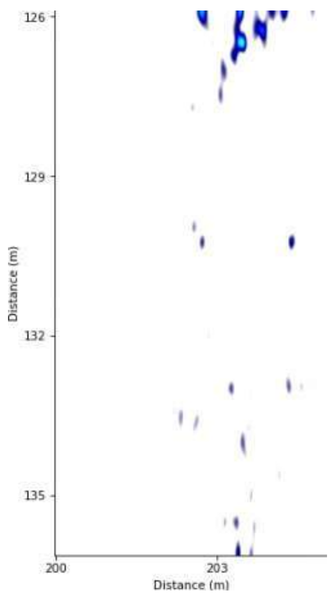
(b) Timeslice at z = 1.55 m.



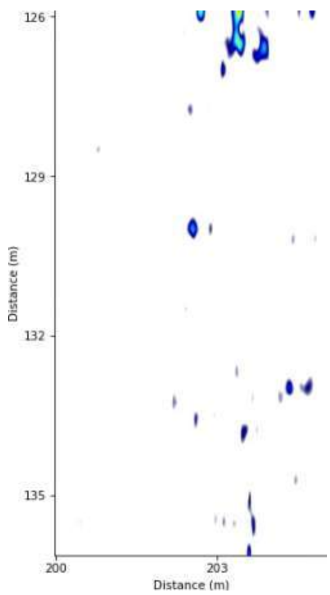
(c) Timeslice at z = 1.6 m.



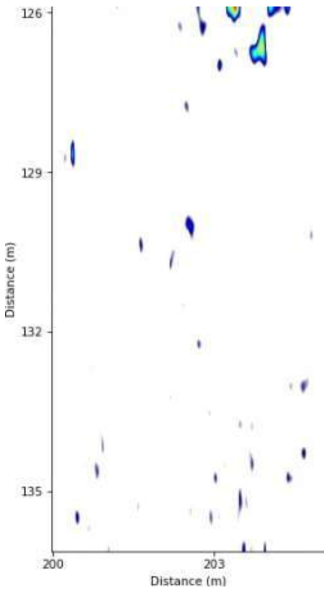
(d) Timeslice at z = 1.65 m.



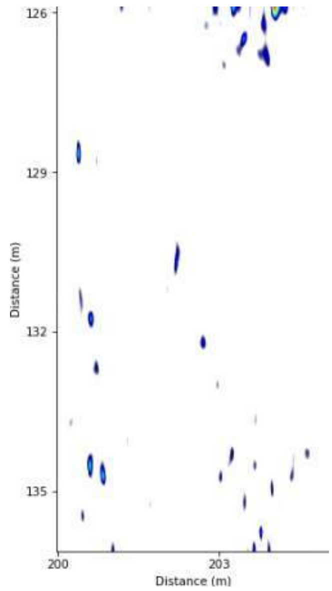
(e) Timeslice at z = 1.7 m.



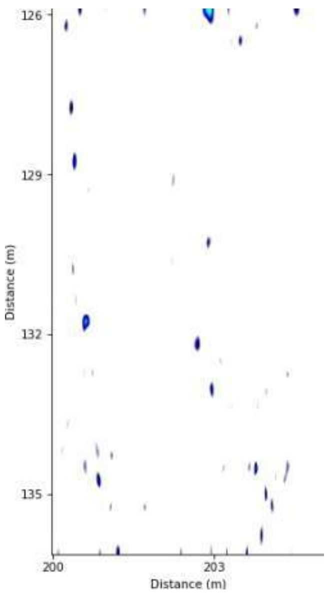
(f) Timeslice at z = 1.75 m.



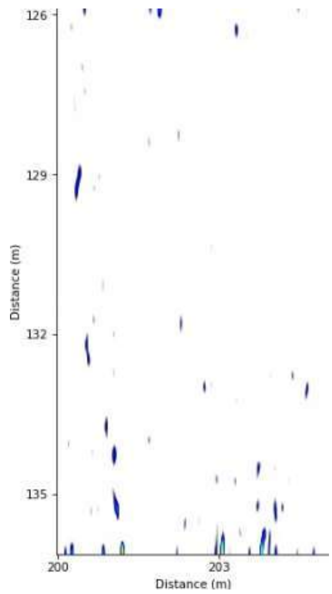
(a) Timeslice at z = 1.8 m.



(b) Timeslice at z = 1.85 m.



(c) Timeslice at z = 1.9 m.



(d) Timeslice at z = 1.95 m.

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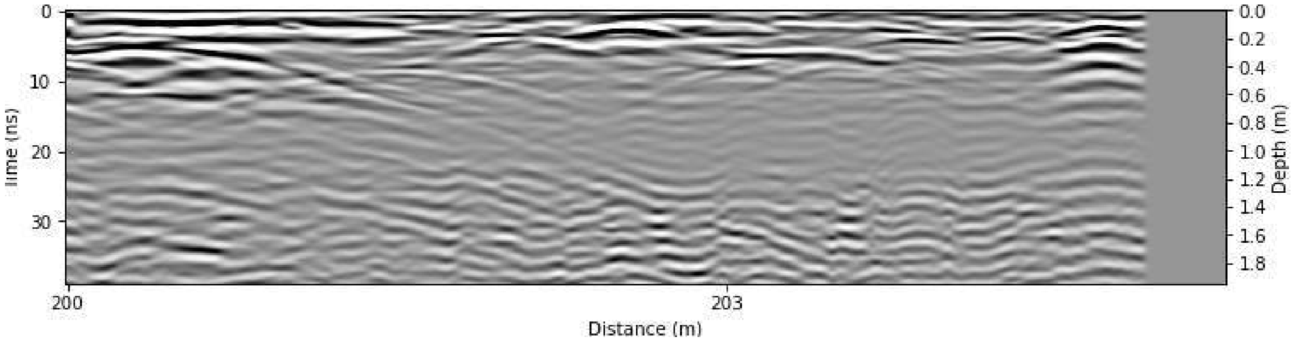


Figure B.143: Radargram at x = 185.0 m.

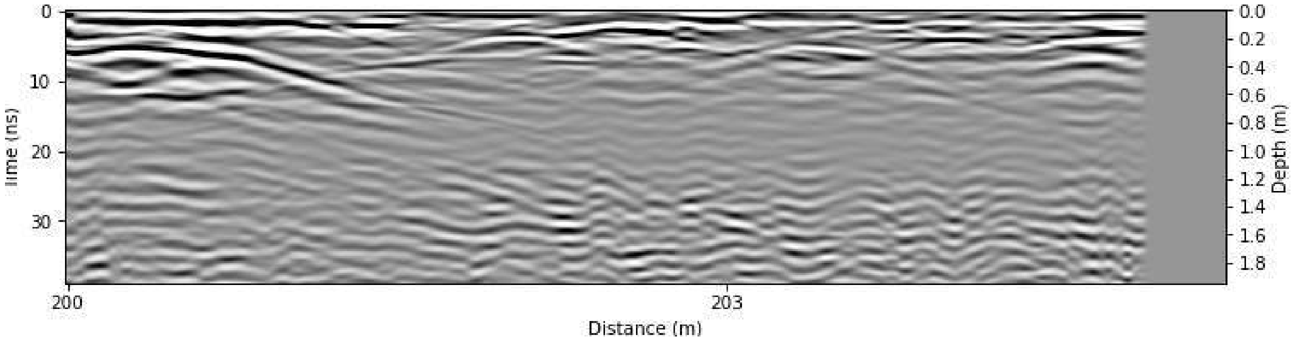


Figure B.144: Radargram at x = 185.25 m.

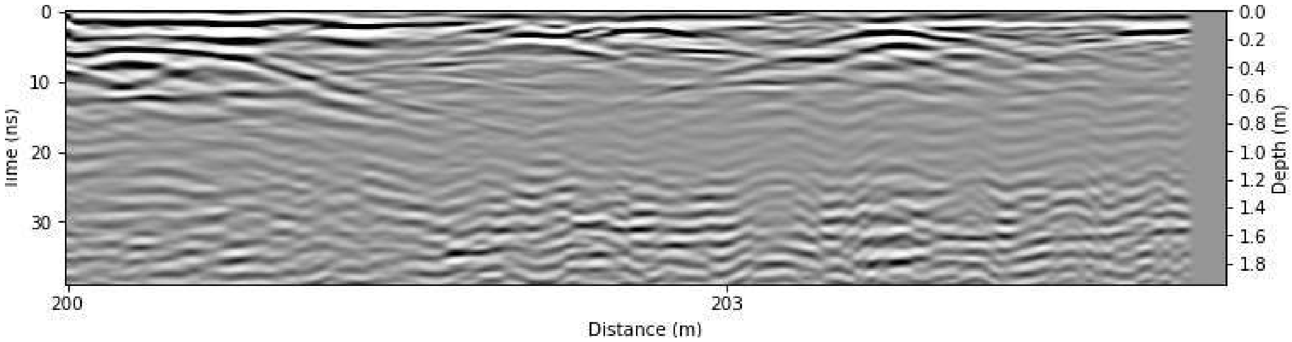


Figure B.145: Radargram at x = 185.5 m.

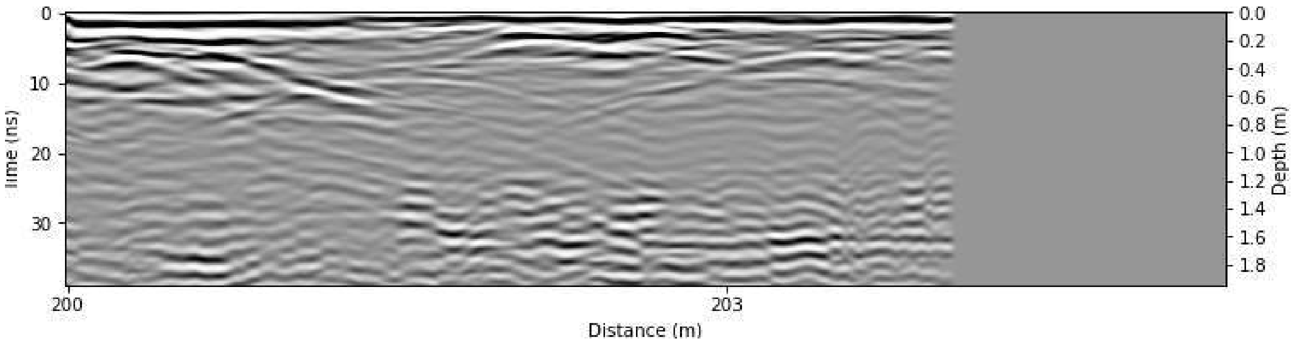


Figure B.146: Radargram at x = 185.75 m.

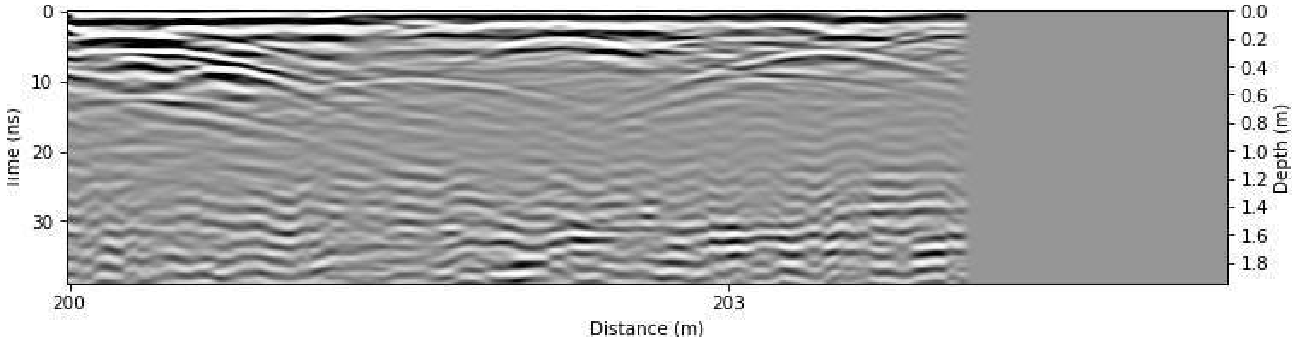


Figure B.147: Radargram at x = 186.0 m.

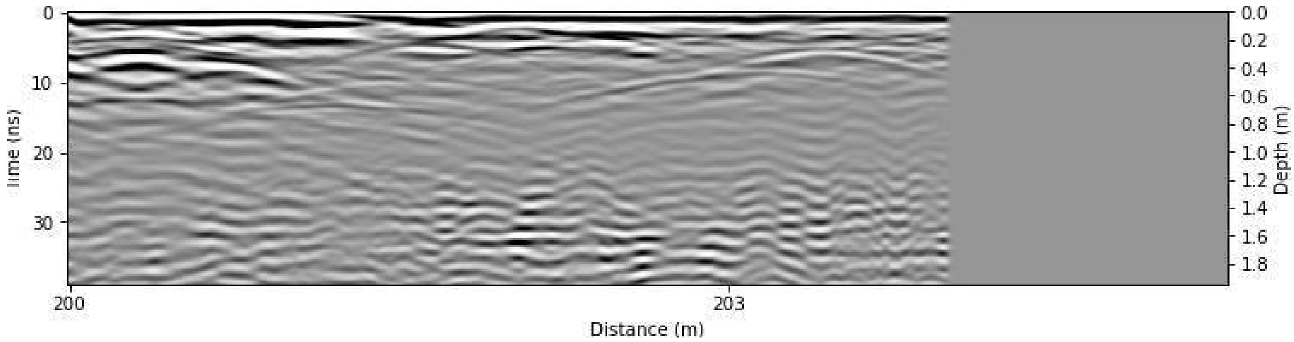


Figure B.148: Radargram at x = 186.25 m.

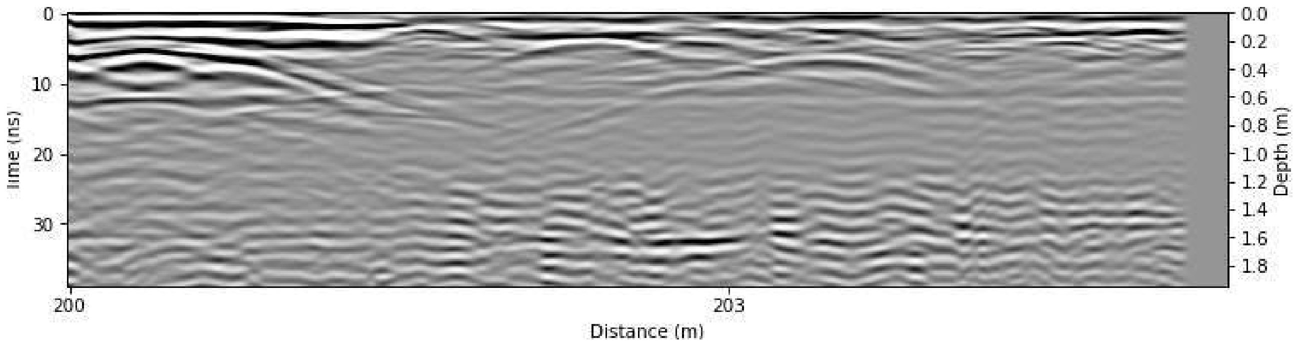


Figure B.149: Radargram at x = 186.5 m.

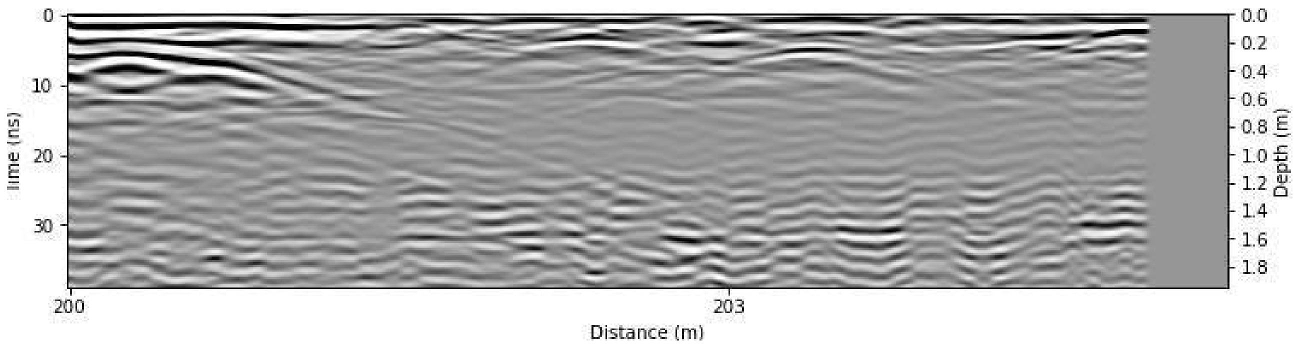


Figure B.150: Radargram at x = 186.75 m.

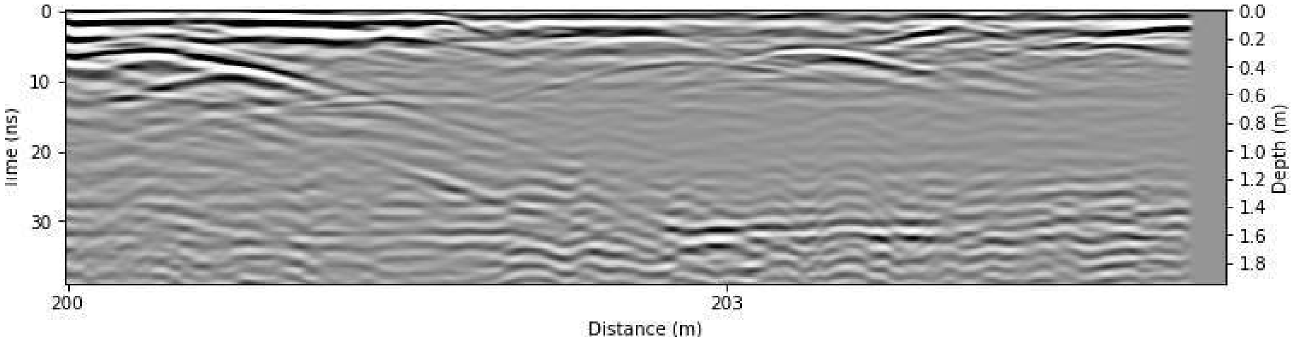


Figure B.151: Radargram at x = 187.0 m.

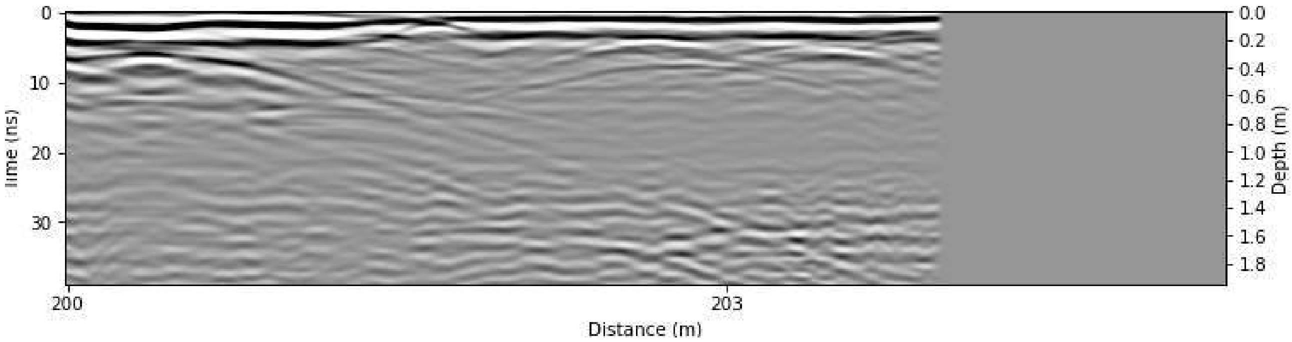


Figure B.152: Radargram at x = 187.25 m.

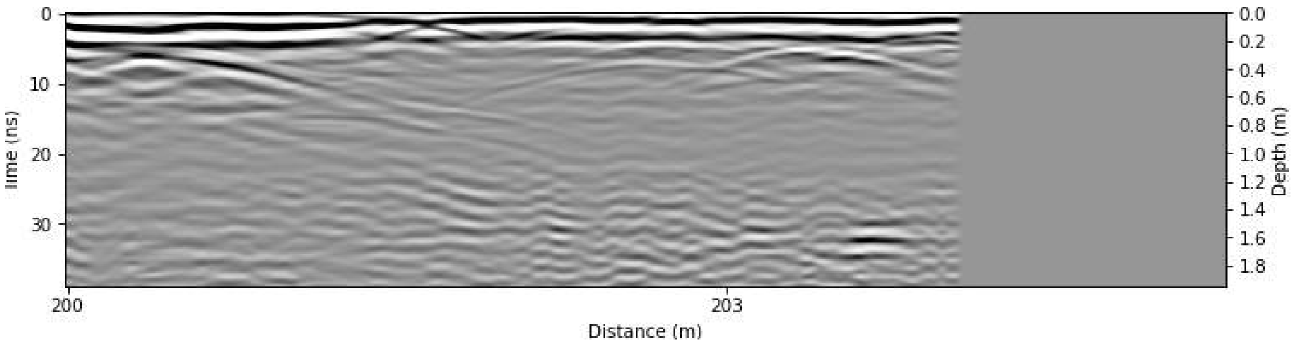


Figure B.153: Radargram at x = 187.5 m.

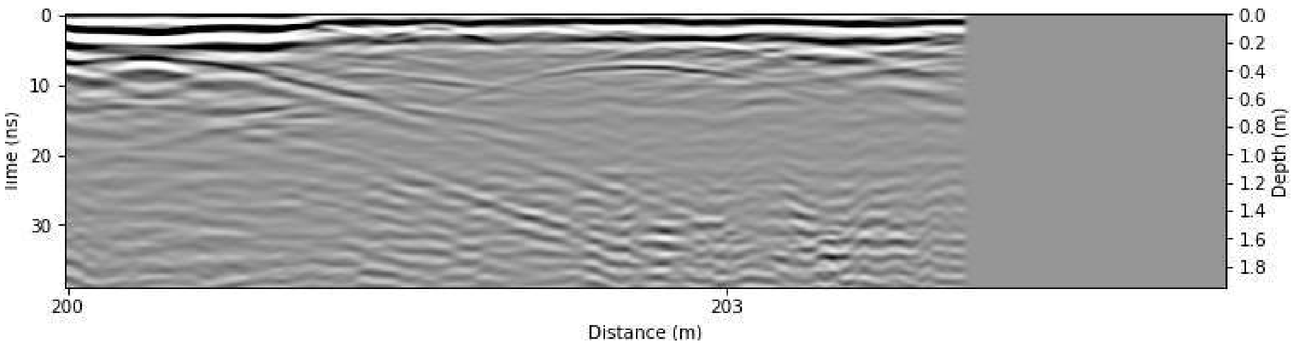


Figure B.154: Radargram at x = 187.75 m.

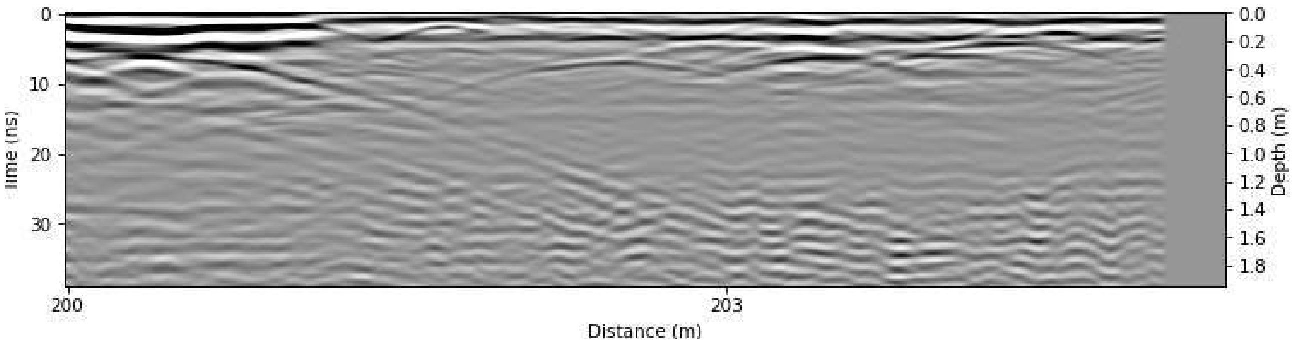


Figure B.155: Radargram at x = 188.0 m.

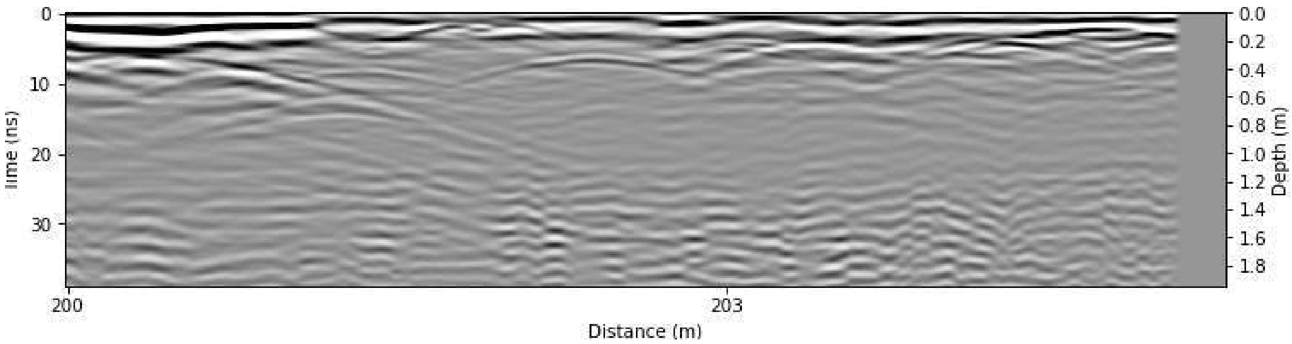


Figure B.156: Radargram at x = 188.25 m.

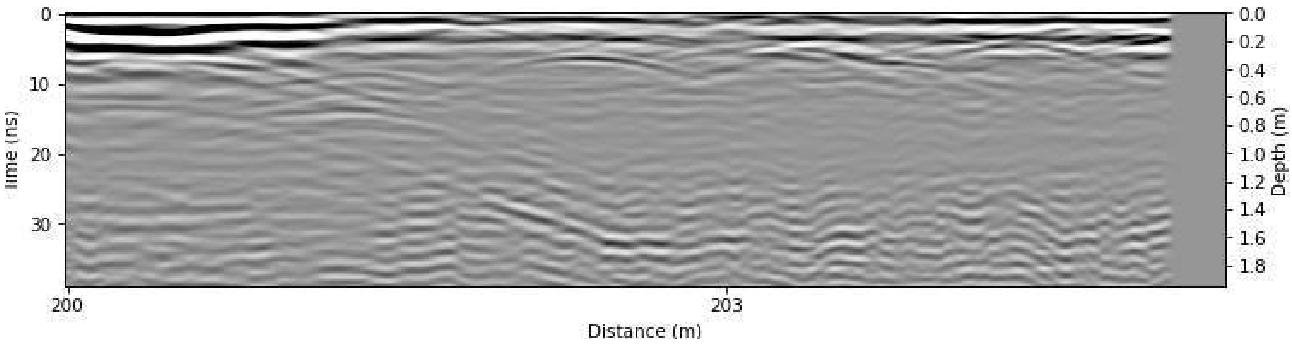


Figure B.157: Radargram at x = 188.5 m.

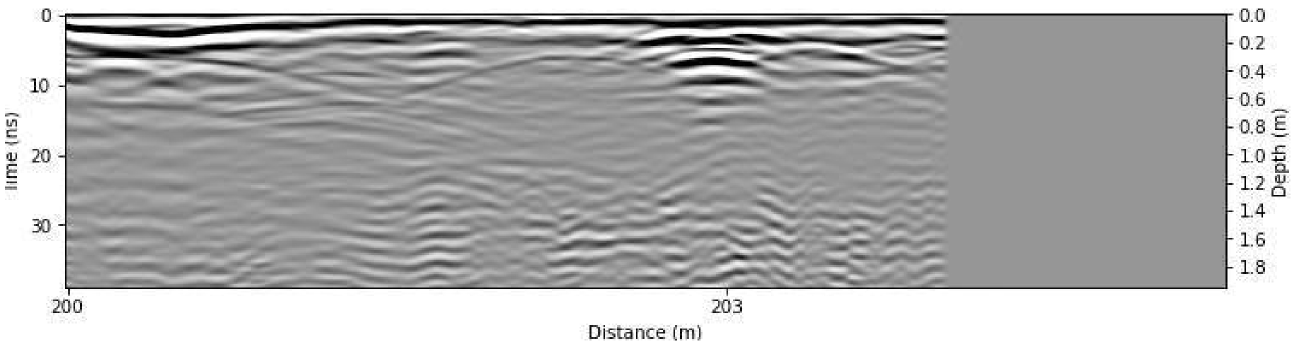


Figure B.158: Radargram at x = 188.75 m.

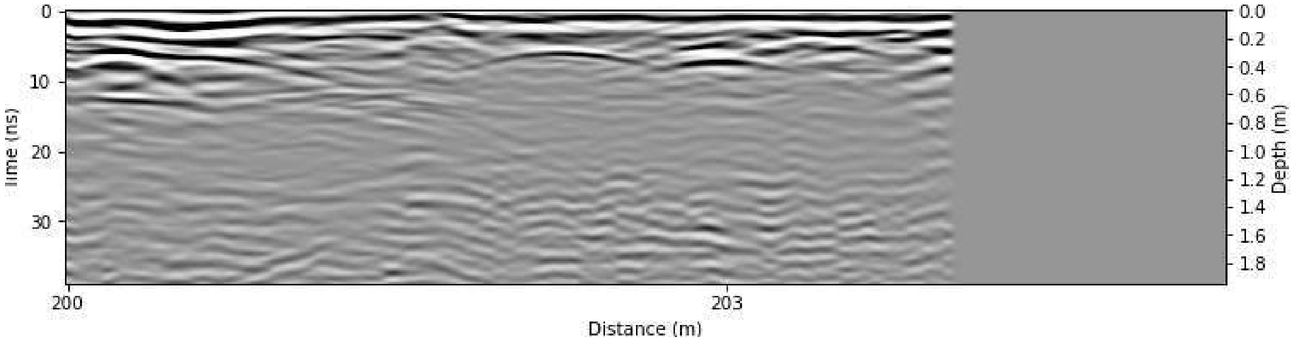


Figure B.159: Radargram at x = 189.0 m.

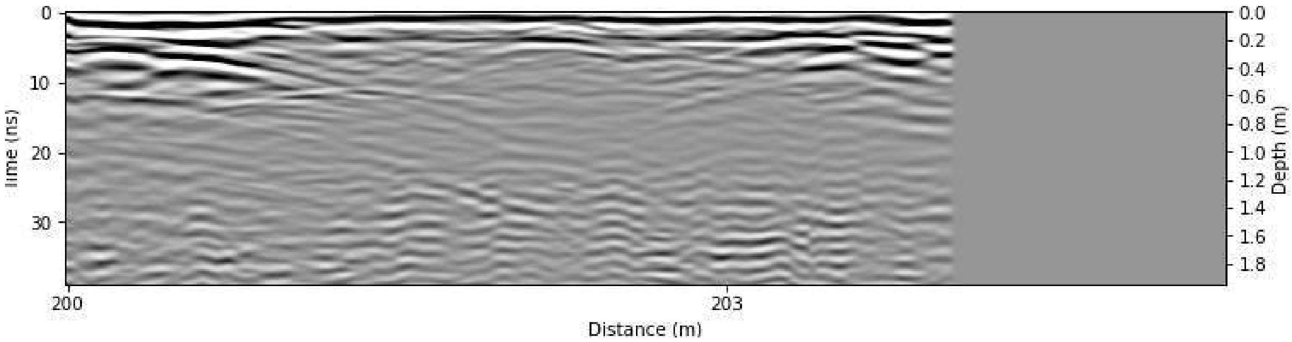


Figure B.160: Radargram at x = 189.25 m.

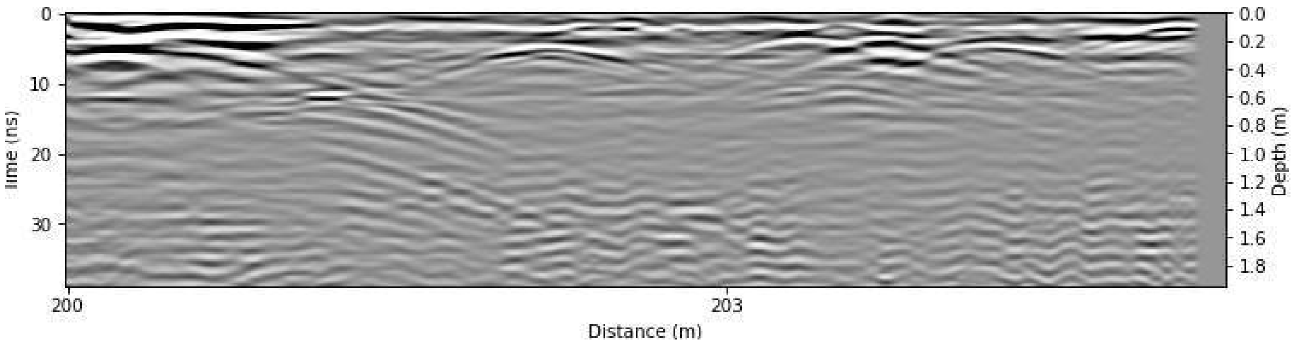


Figure B.161: Radargram at x = 189.5 m.

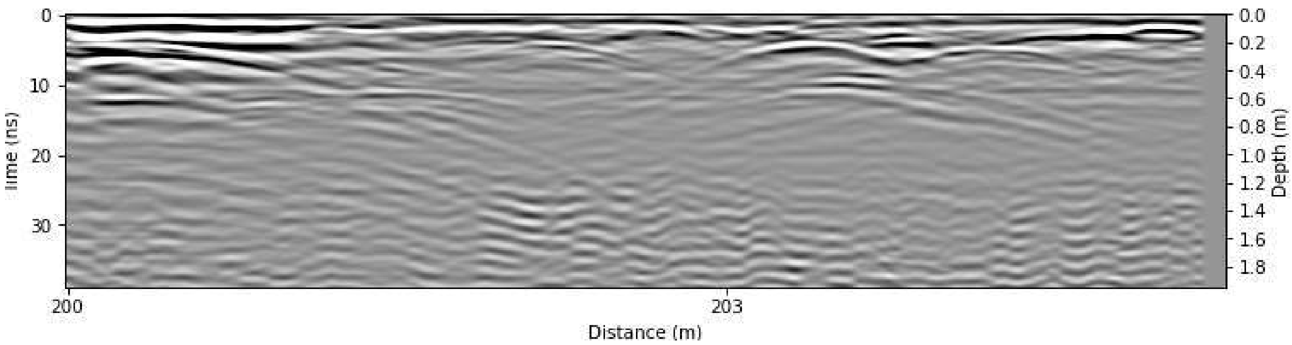


Figure B.162: Radargram at x = 189.75 m.

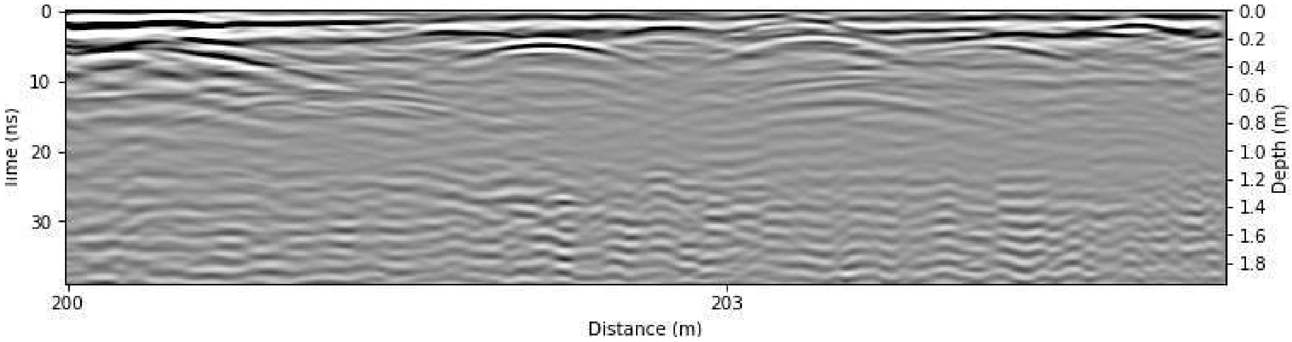


Figure B.163: Radargram at x = 190.0 m.

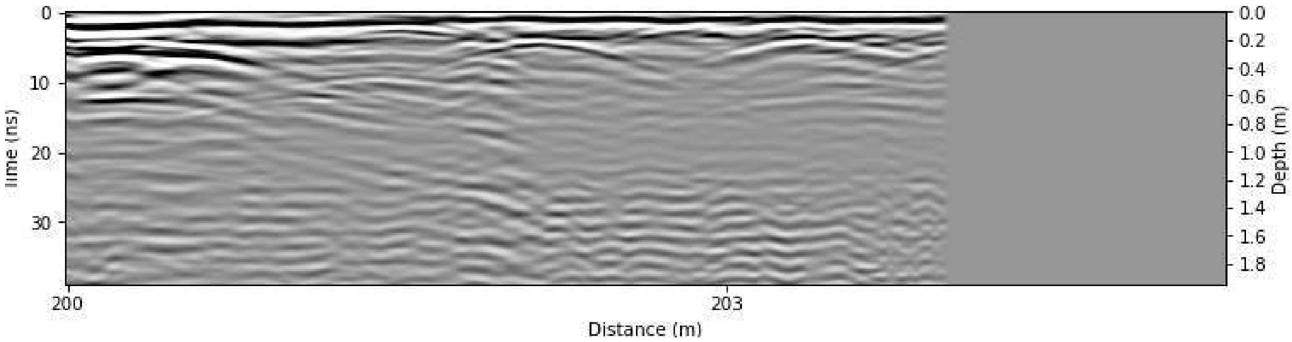


Figure B.164: Radargram at x = 190.25 m.

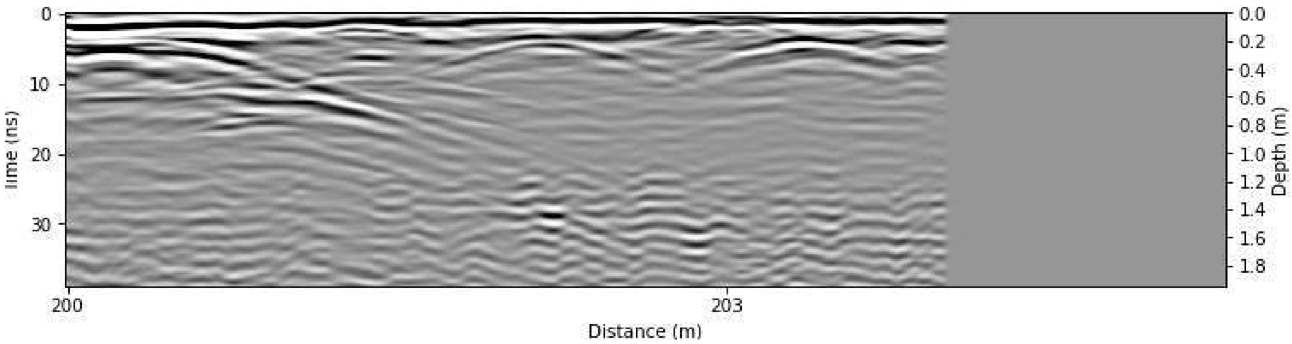


Figure B.165: Radargram at x = 190.5 m.

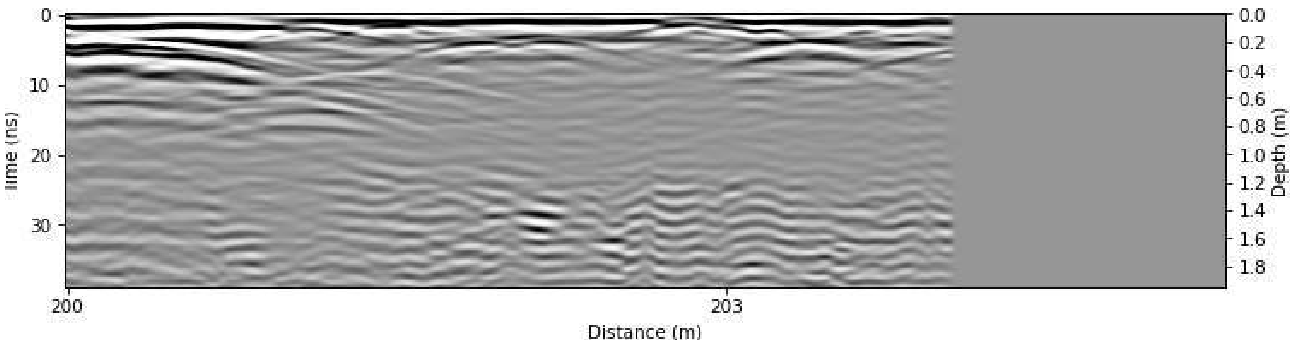


Figure B.166: Radargram at x = 190.75 m.

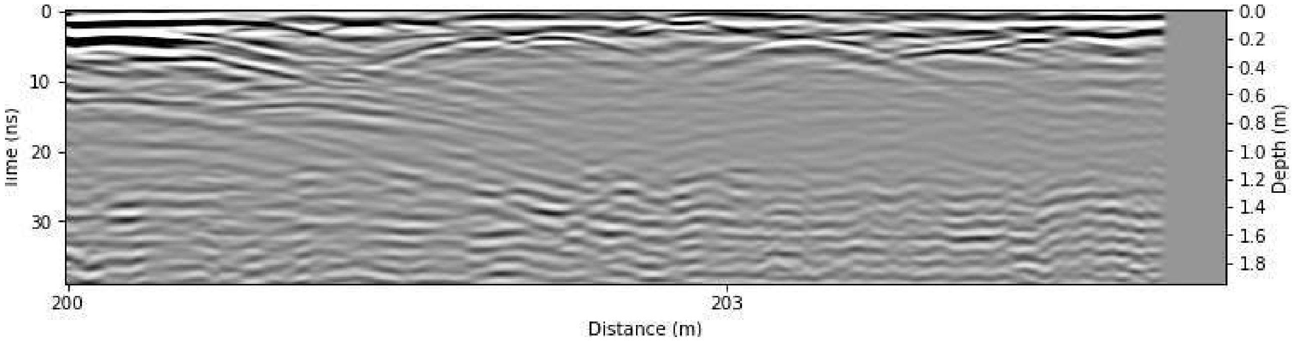


Figure B.167: Radargram at x = 191.0 m.

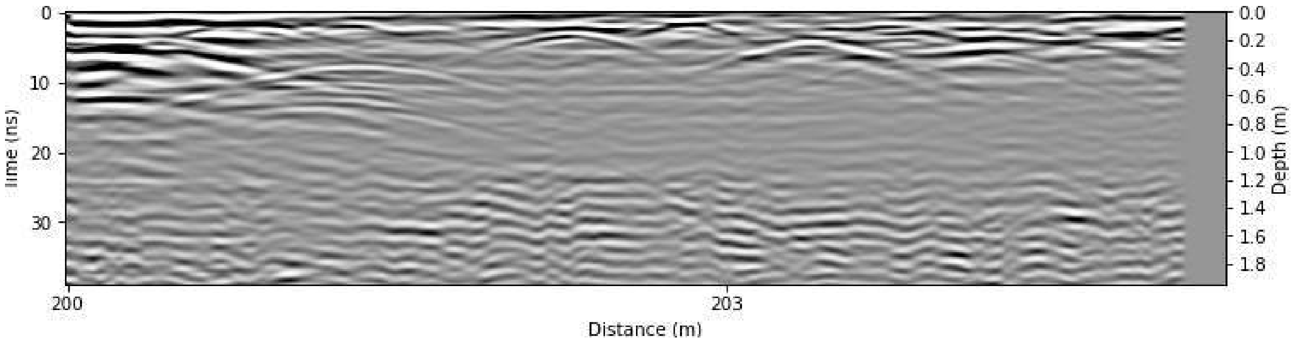


Figure B.168: Radargram at x = 191.25 m.

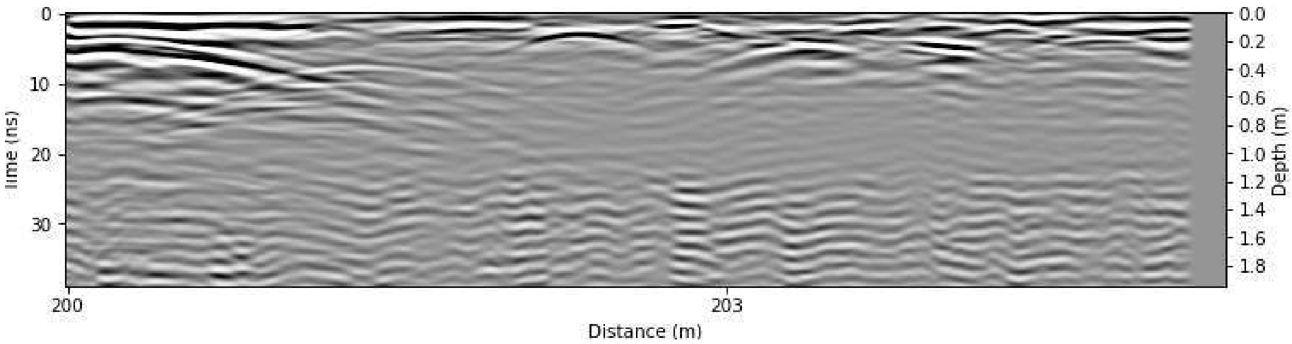


Figure B.169: Radargram at x = 191.5 m.

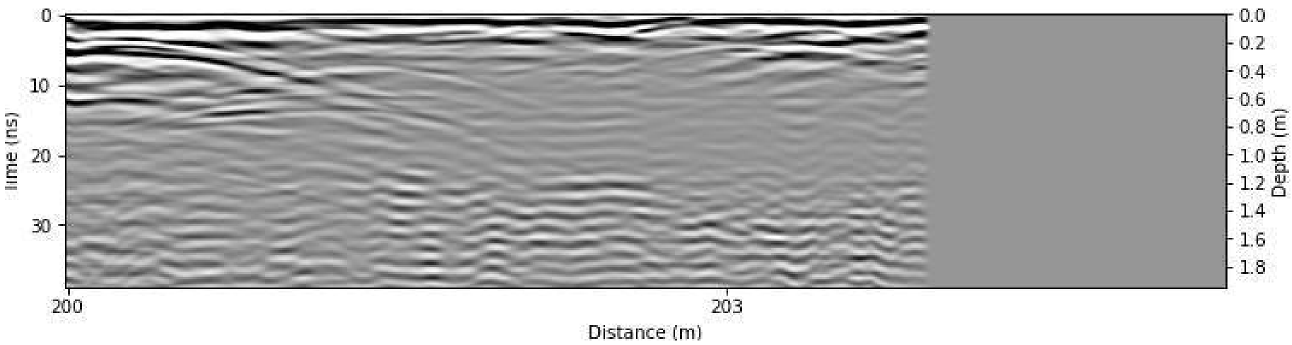


Figure B.170: Radargram at x = 191.75 m.

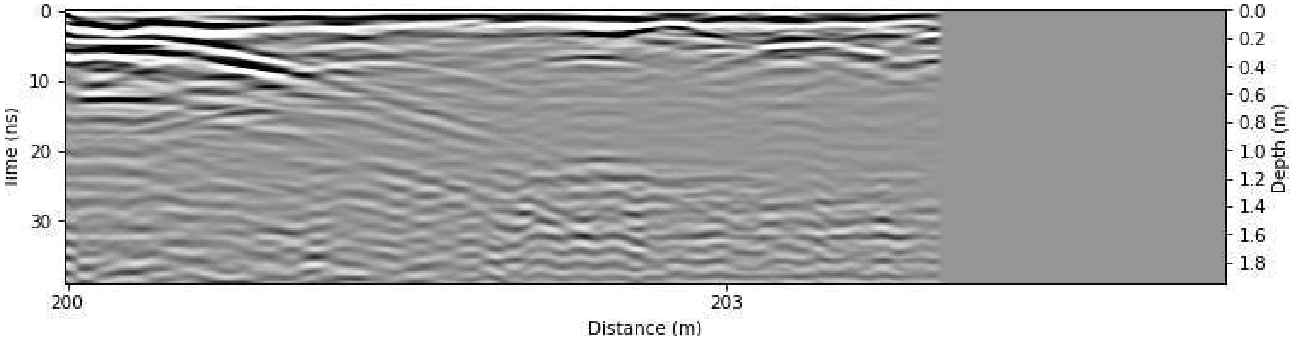


Figure B.171: Radargram at x = 192.0 m.

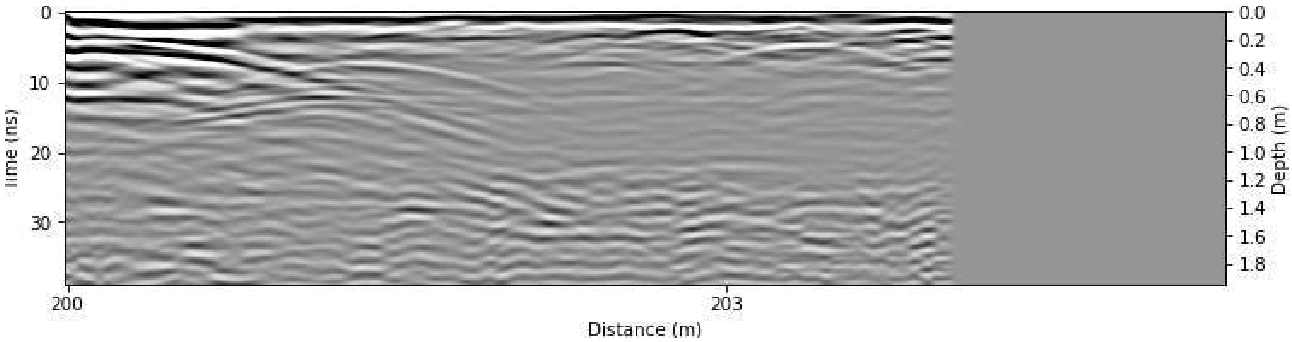


Figure B.172: Radargram at x = 192.25 m.

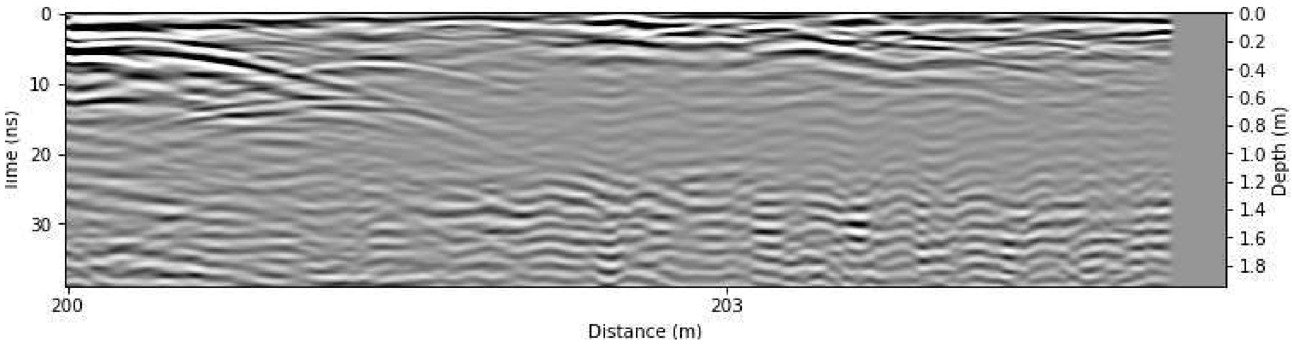


Figure B.173: Radargram at x = 192.5 m.

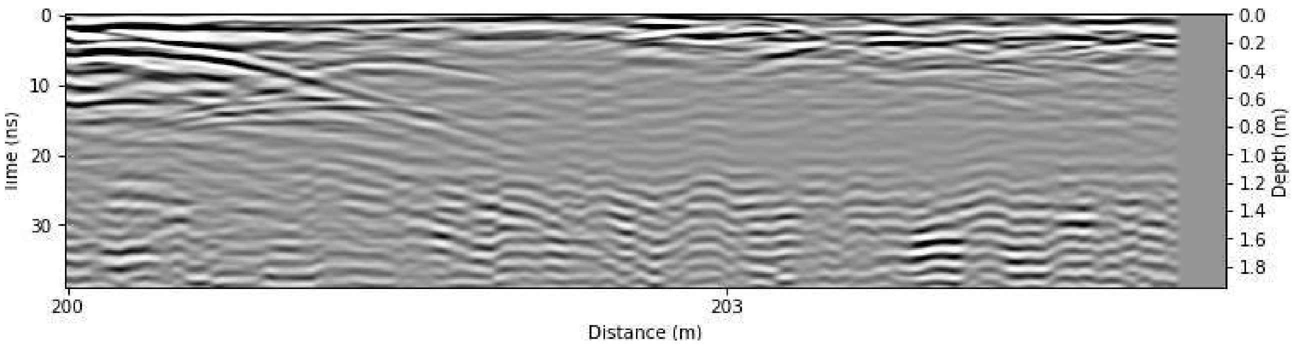


Figure B.174: Radargram at x = 192.75 m.

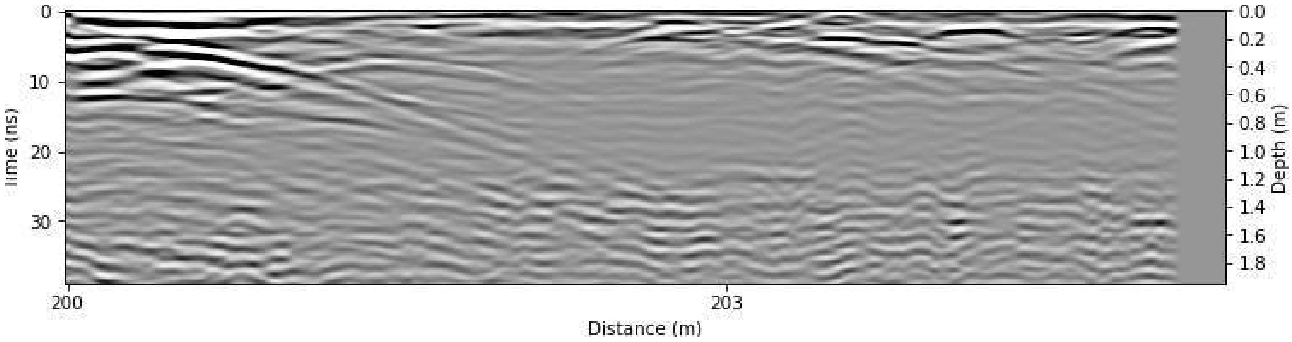


Figure B.175: Radargram at x = 193.0 m.

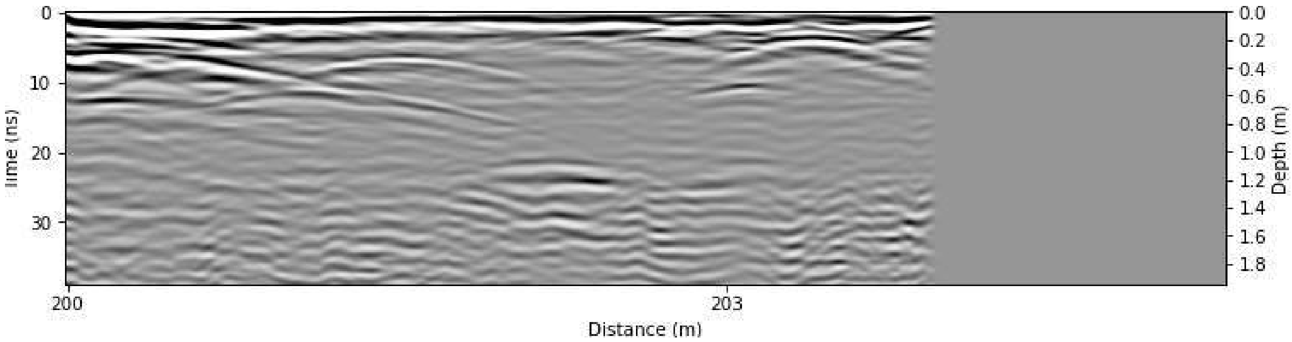


Figure B.176: Radargram at x = 193.25 m.

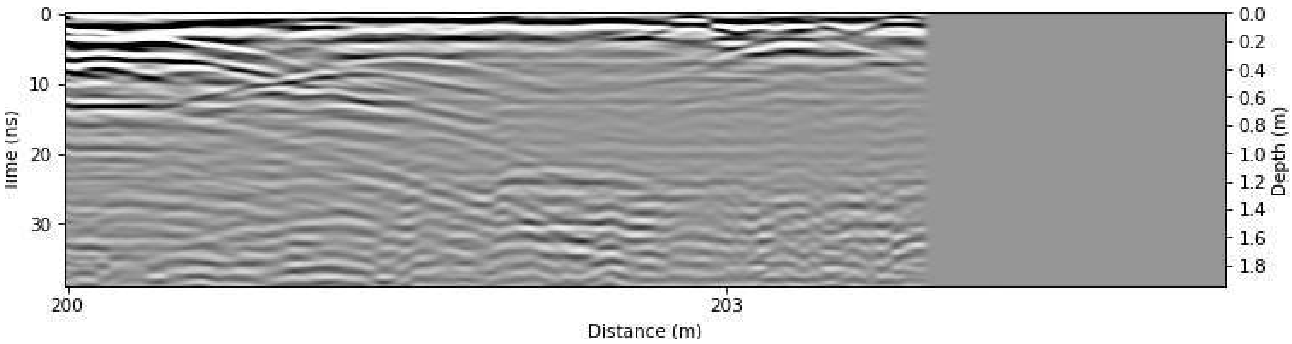


Figure B.177: Radargram at x = 193.5 m.

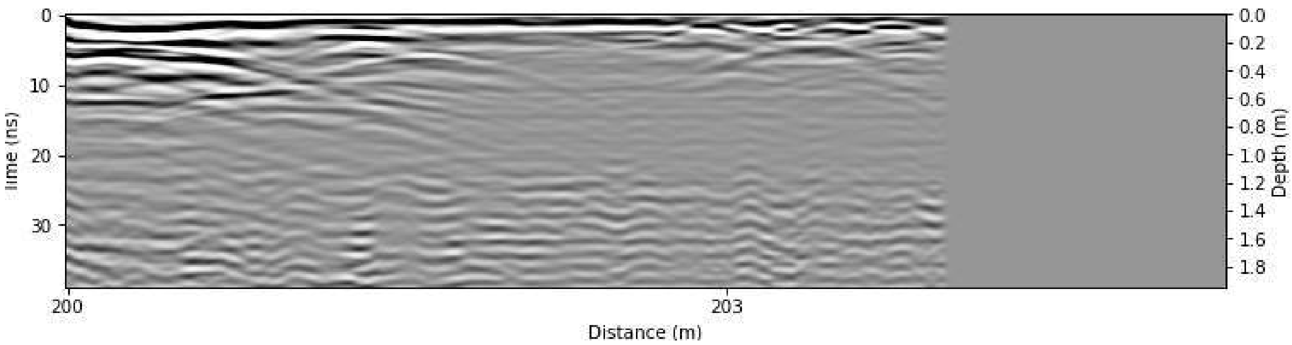


Figure B.178: Radargram at x = 193.75 m.

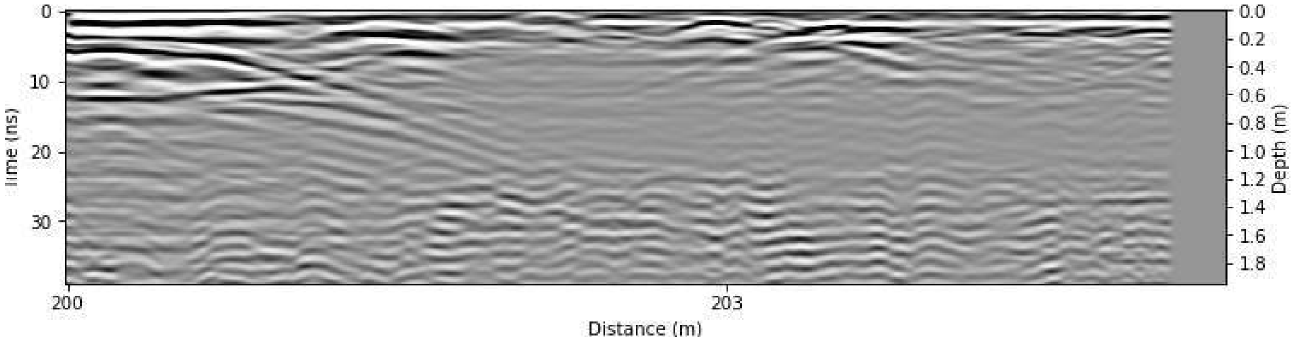


Figure B.179: Radargram at x = 194.0 m.

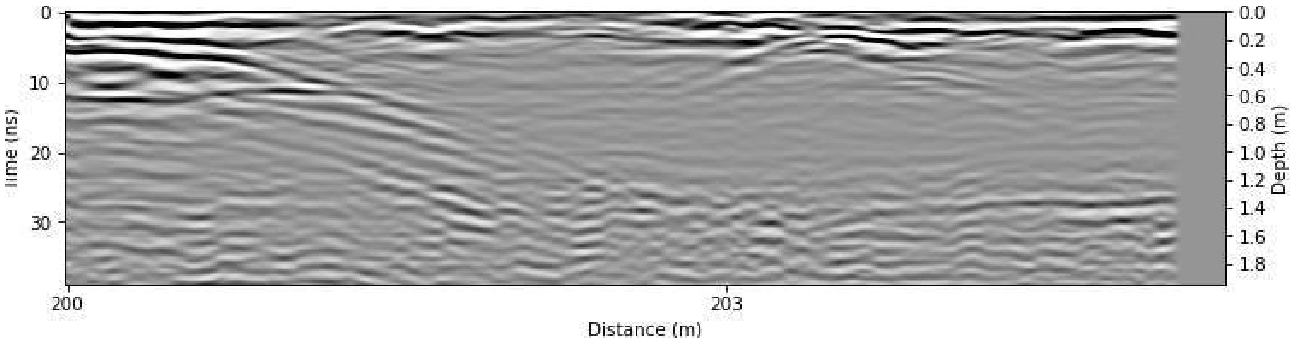


Figure B.180: Radargram at x = 194.25 m.

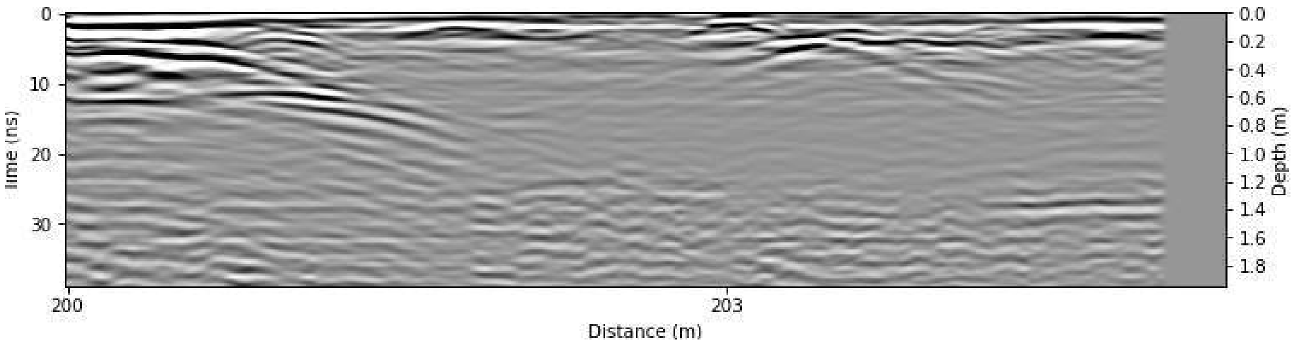


Figure B.181: Radargram at x = 194.5 m.

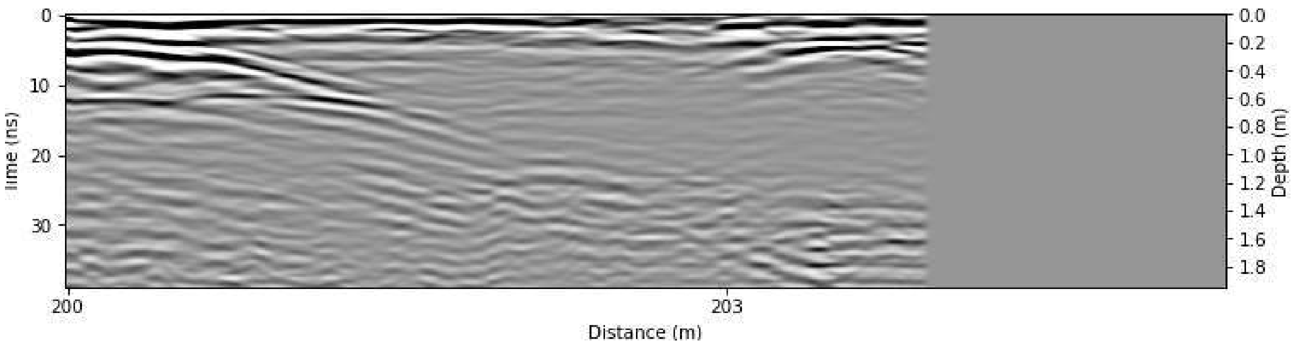


Figure B.182: Radargram at x = 194.75 m.

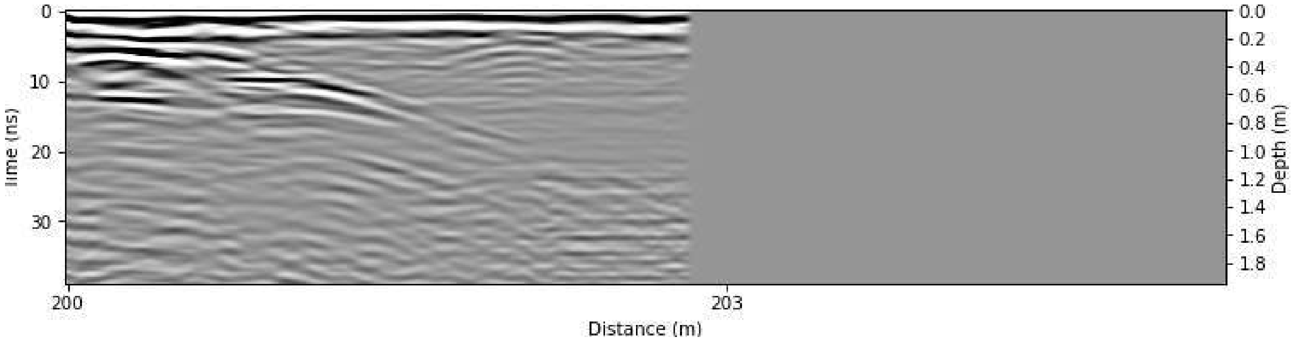
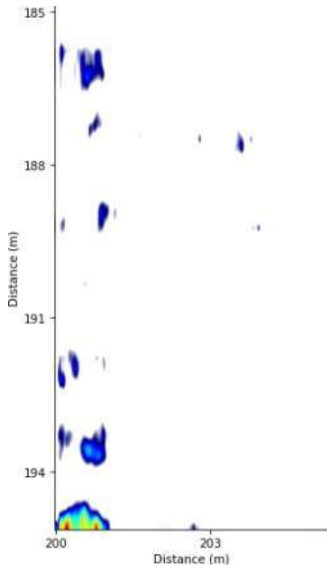
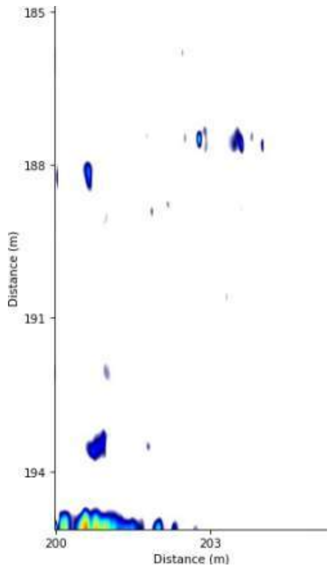


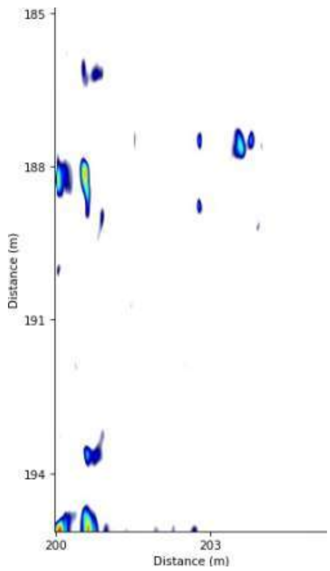
Figure B.183: Radargram at x = 195.0 m.



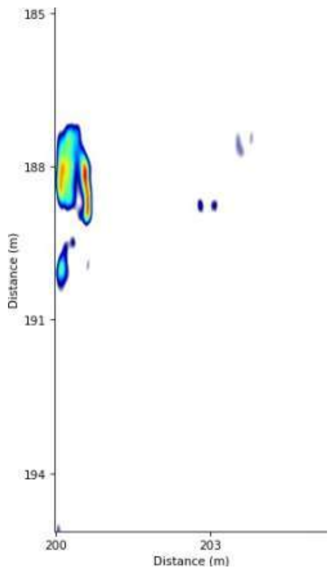
(a) Timeslice at z = 0.0 m.



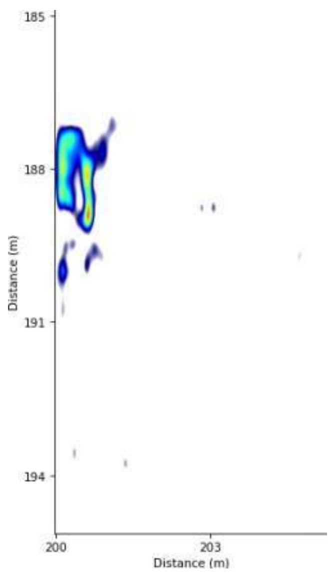
(b) Timeslice at z = 0.05 m.



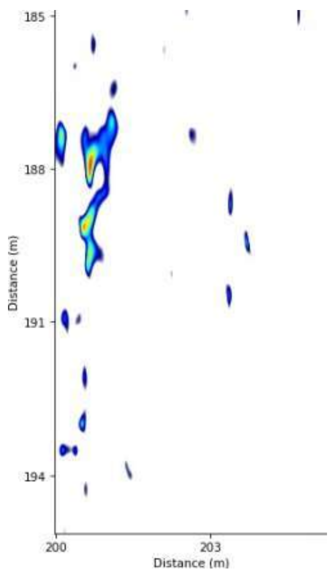
(c) Timeslice at z = 0.1 m.



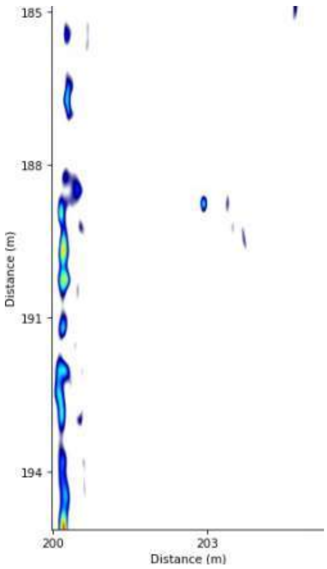
(d) Timeslice at z = 0.15 m.



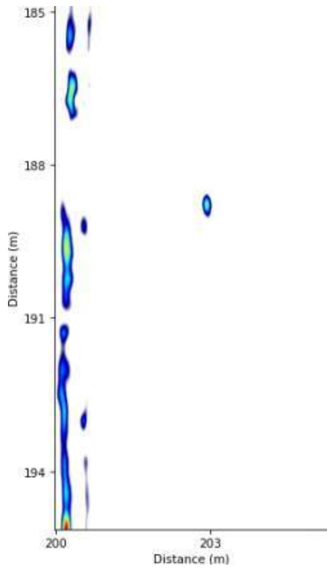
(e) Timeslice at z = 0.2 m.



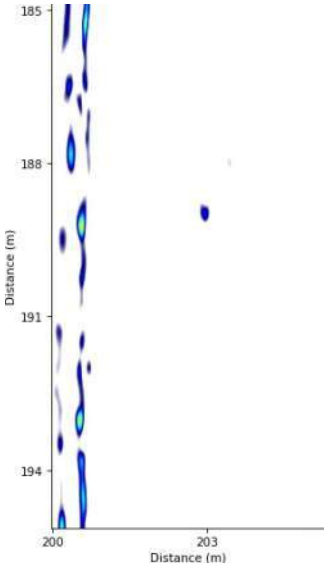
(f) Timeslice at z = 0.25 m.



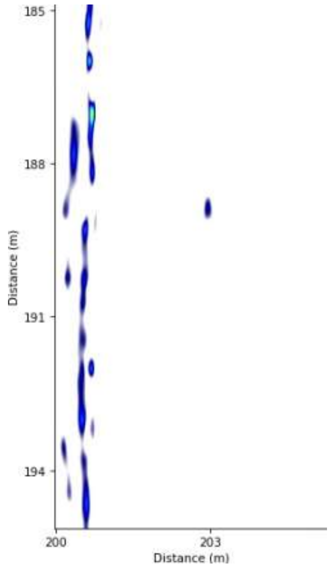
(a) Timeslice at z = 0.3 m.



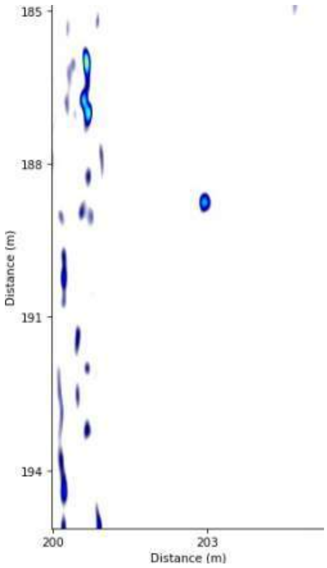
(b) Timeslice at z = 0.35 m.



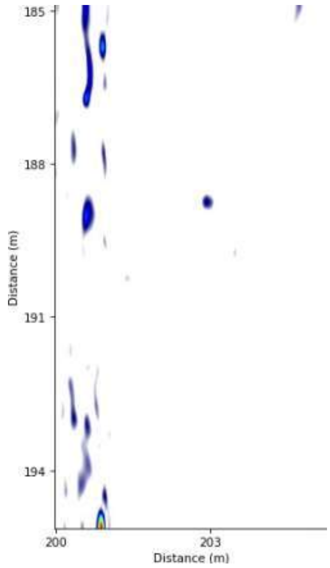
(c) Timeslice at z = 0.4 m.



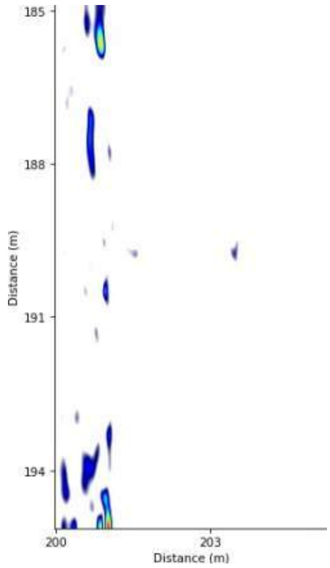
(d) Timeslice at z = 0.45 m.



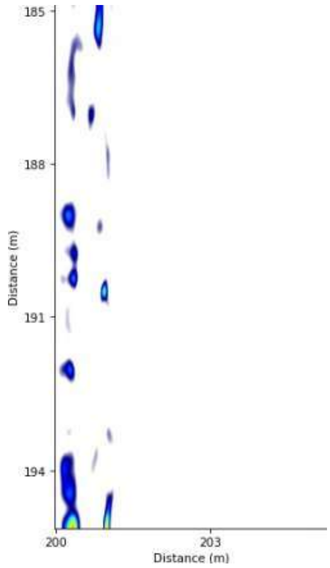
(e) Timeslice at z = 0.5 m.



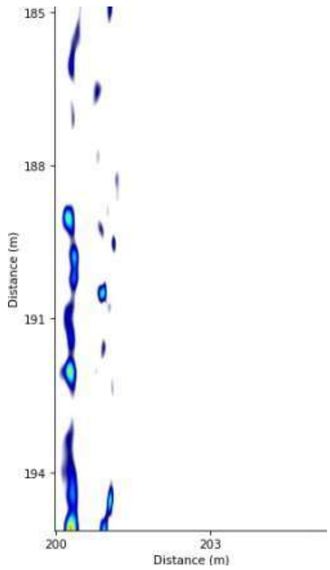
(f) Timeslice at z = 0.55 m.



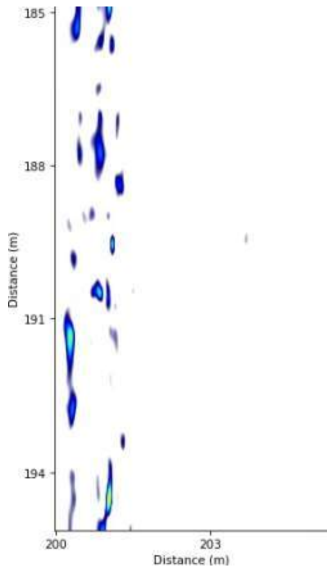
(a) Timeslice at z = 0.6 m.



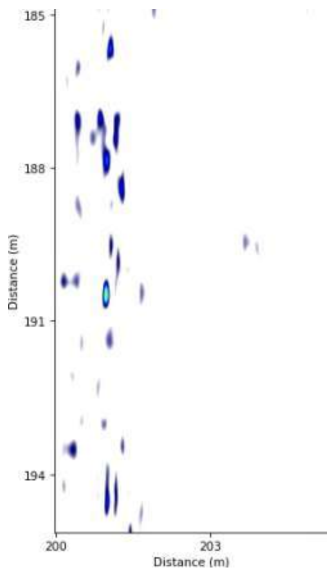
(b) Timeslice at z = 0.65 m.



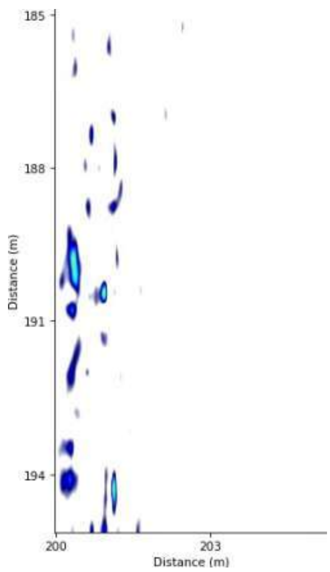
(c) Timeslice at z = 0.7 m.



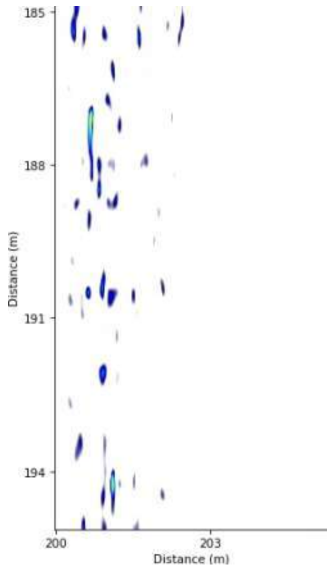
(d) Timeslice at z = 0.75 m.



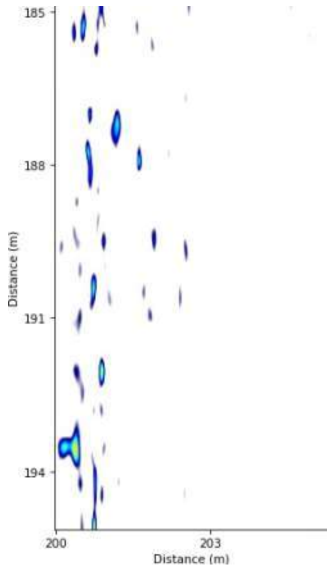
(e) Timeslice at z = 0.8 m.



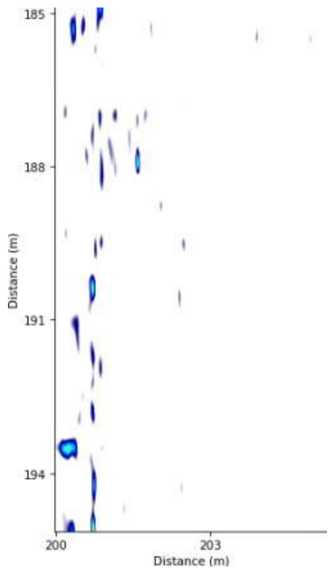
(f) Timeslice at z = 0.85 m.



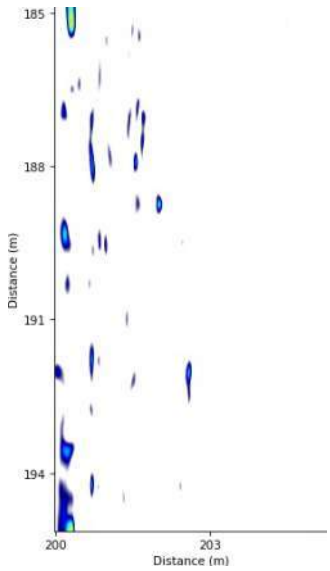
(a) Timeslice at z = 0.55 m.



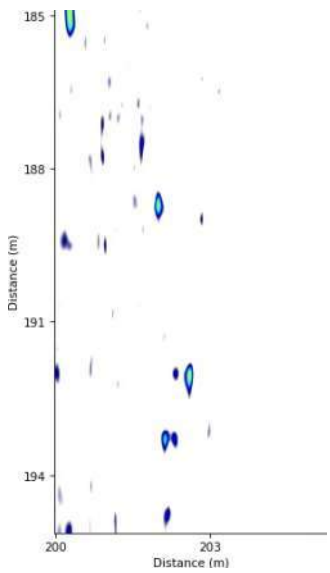
(b) Timeslice at z = 0.555 m.



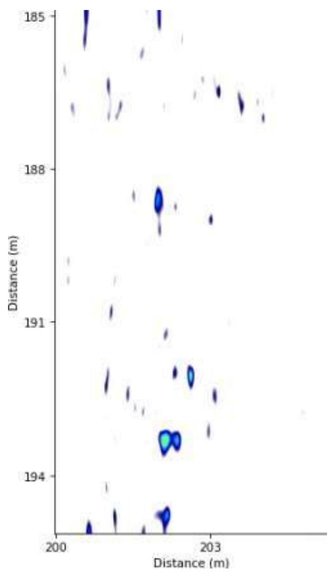
(c) Timeslice at z = 1.0 m.



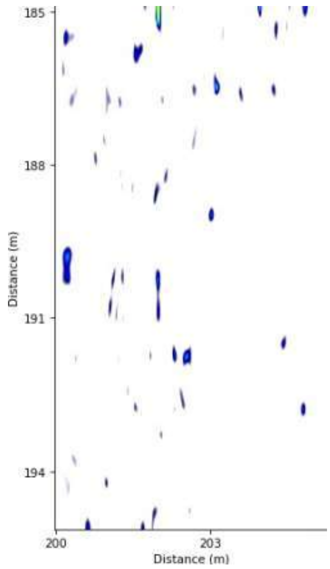
(d) Timeslice at z = 1.05 m.



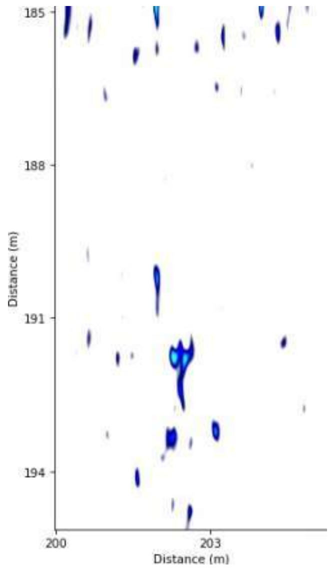
(e) Timeslice at z = 1.1 m.



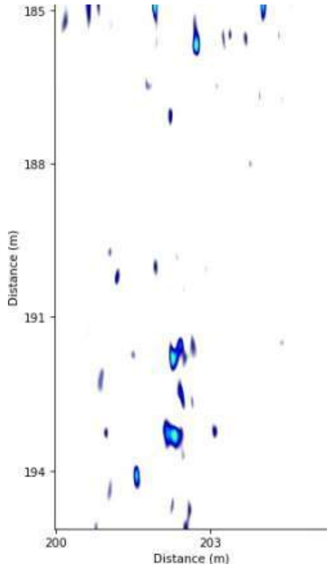
(f) Timeslice at z = 1.15 m.



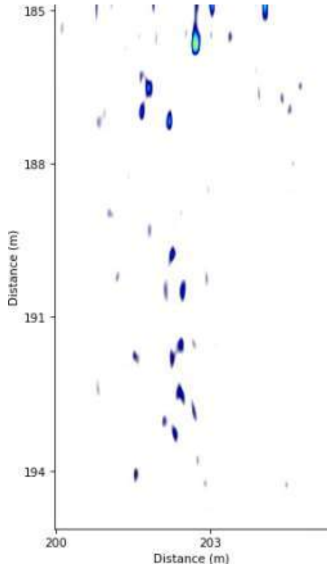
(a) Timeslice at z = 1.2 m.



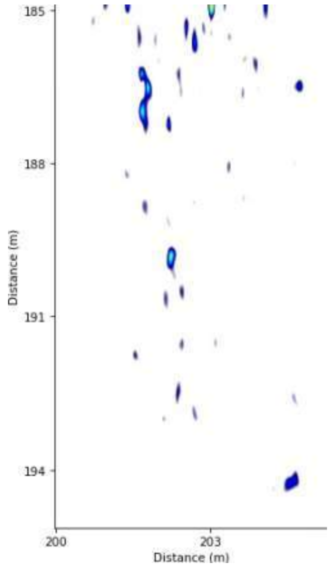
(b) Timeslice at z = 1.25 m.



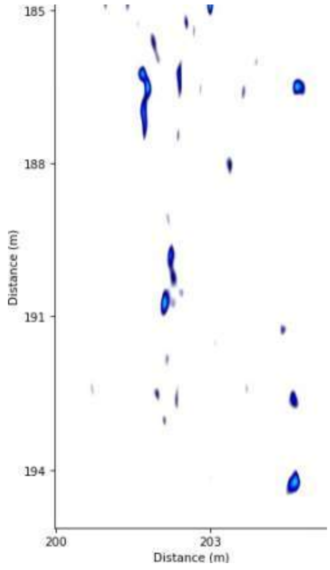
(c) Timeslice at z = 1.3 m.



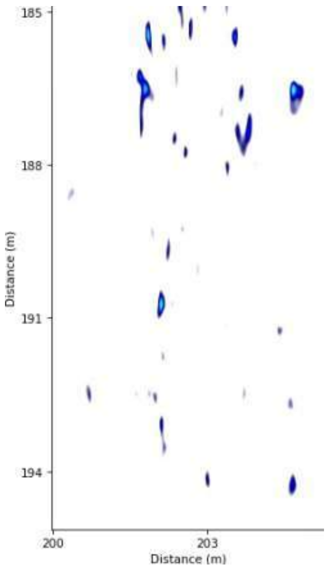
(d) Timeslice at z = 1.35 m.



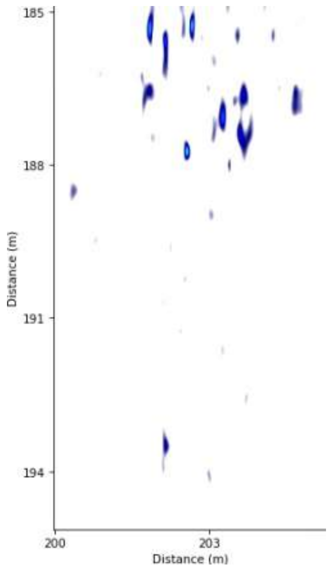
(e) Timeslice at z = 1.4 m.



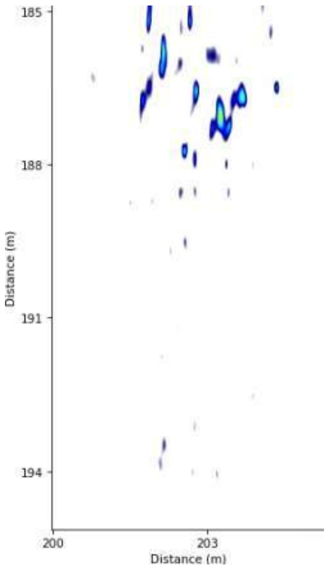
(f) Timeslice at z = 1.45 m.



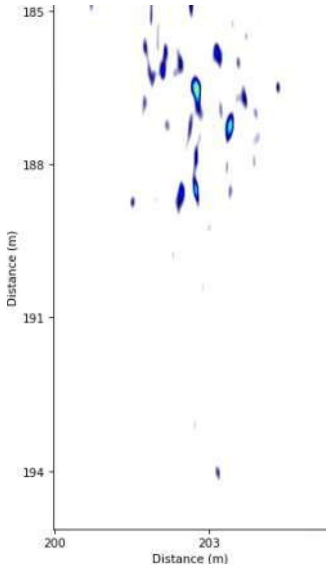
(a) Timeslice at z = 1.5 m.



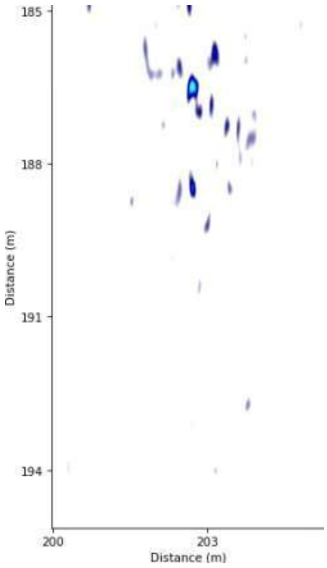
(b) Timeslice at z = 1.55 m.



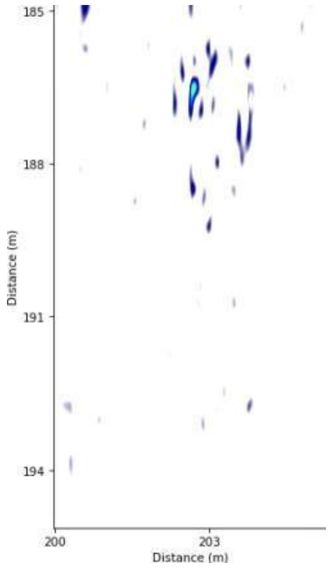
(c) Timeslice at z = 1.6 m.



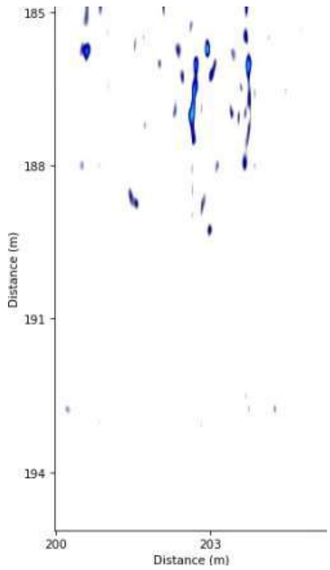
(d) Timeslice at z = 1.65 m.



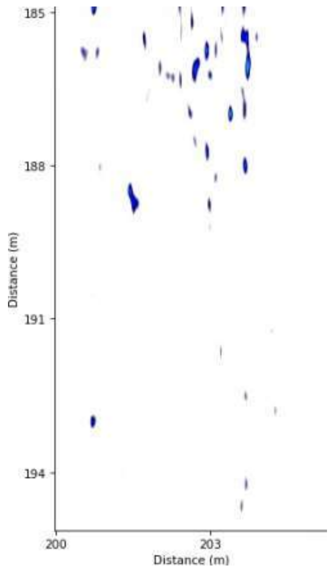
(e) Timeslice at z = 1.7 m.



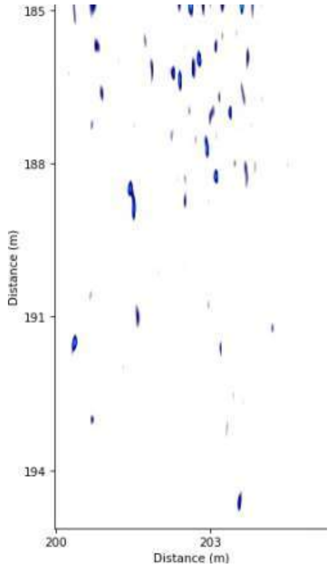
(f) Timeslice at z = 1.75 m.



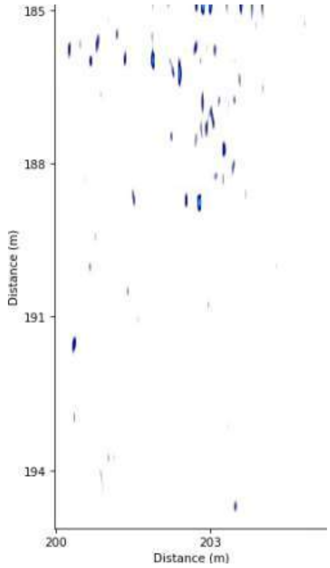
(a) Timeslice at z = 1.8 m.



(b) Timeslice at z = 1.85 m.



(c) Timeslice at z = 1.9 m.



(d) Timeslice at z = 1.95 m.

B.5 KU-TP03

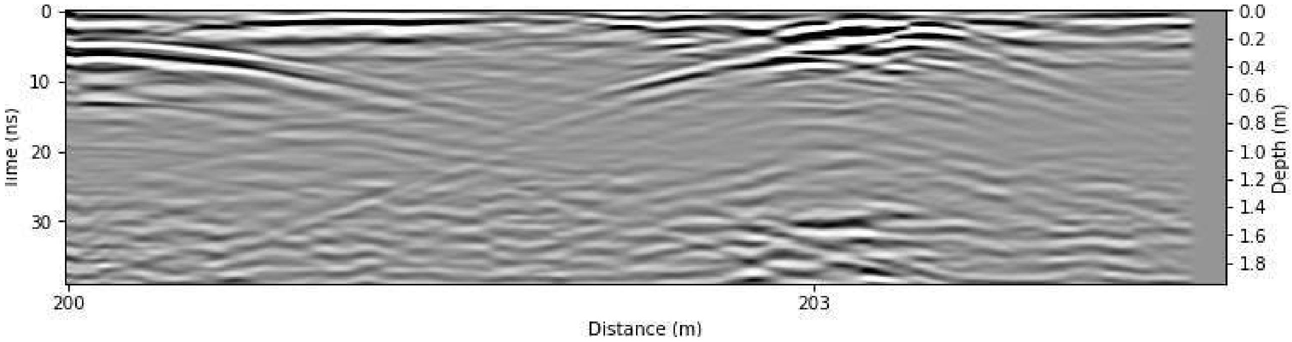


Figure B.191: Radargram at x = 226.0 m.

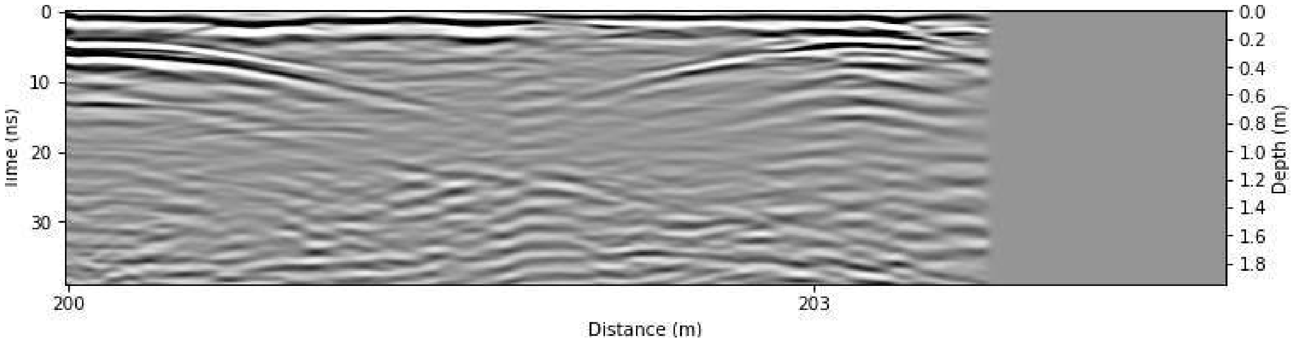


Figure B.192: Radargram at x = 226.25 m.

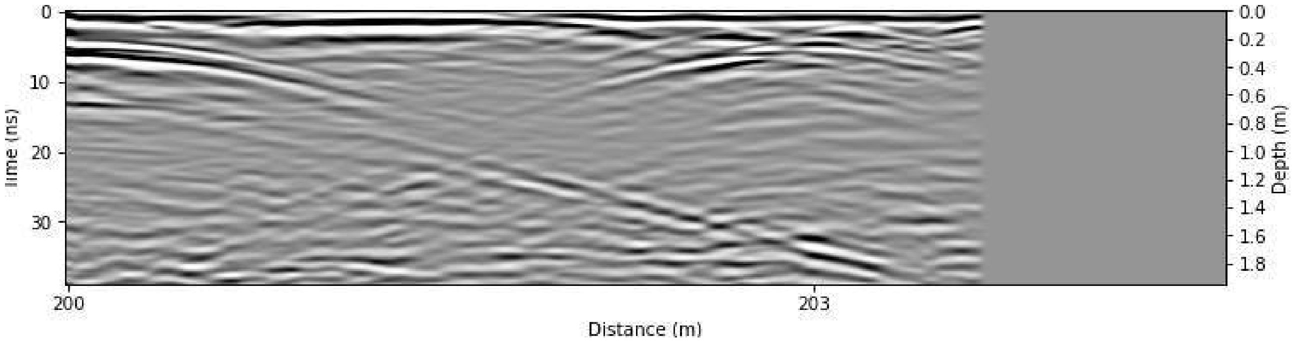


Figure B.193: Radargram at x = 226.5 m.

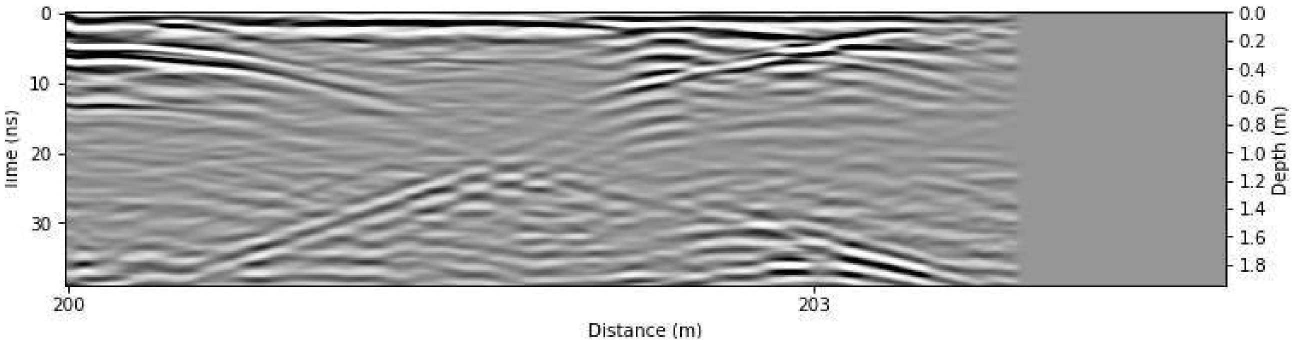


Figure B.194: Radargram at x = 226.75 m.

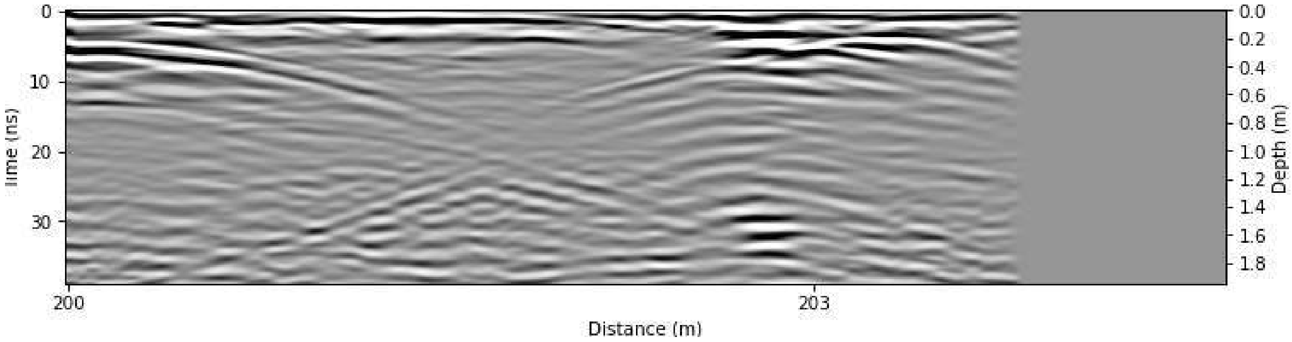


Figure B.195: Radargram at x = 227.0 m.

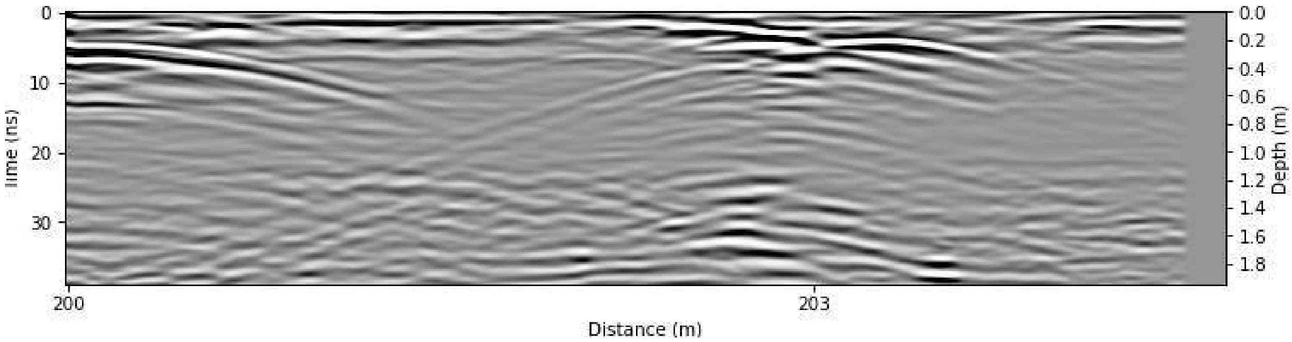


Figure B.196: Radargram at x = 227.25 m.

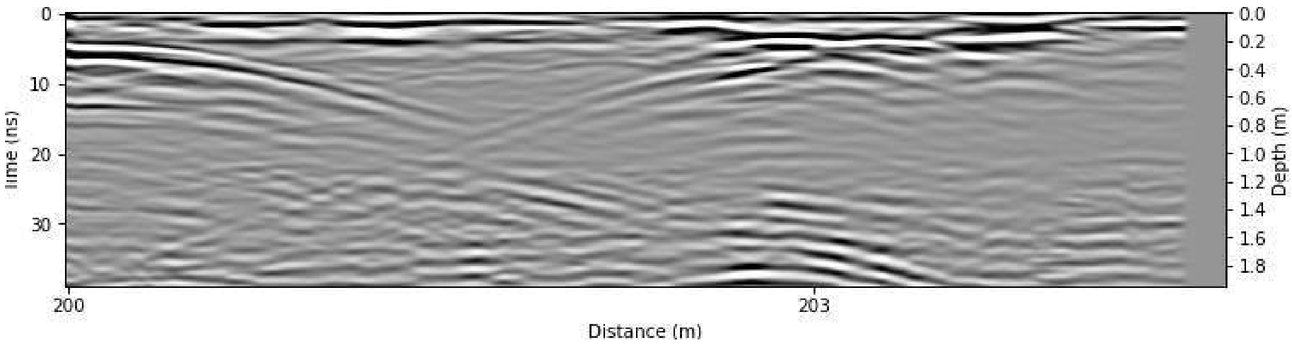


Figure B.197: Radargram at x = 227.5 m.

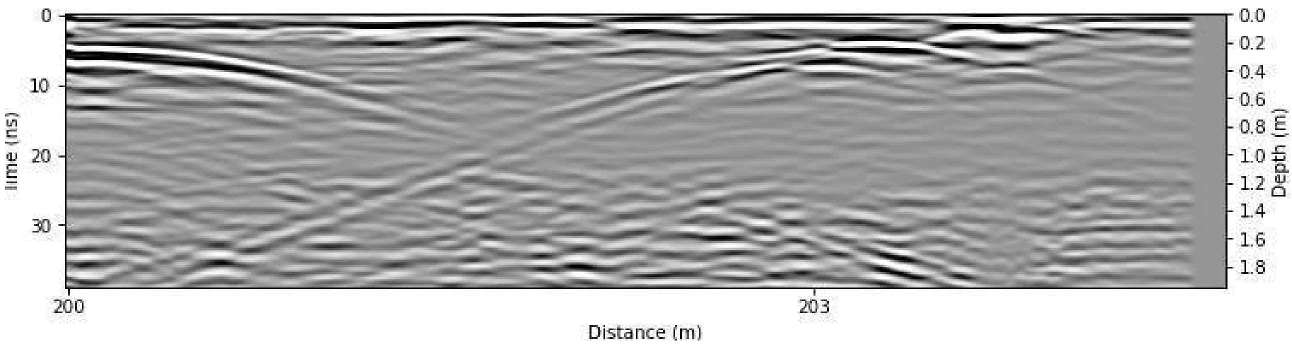


Figure B.198: Radargram at x = 227.75 m.

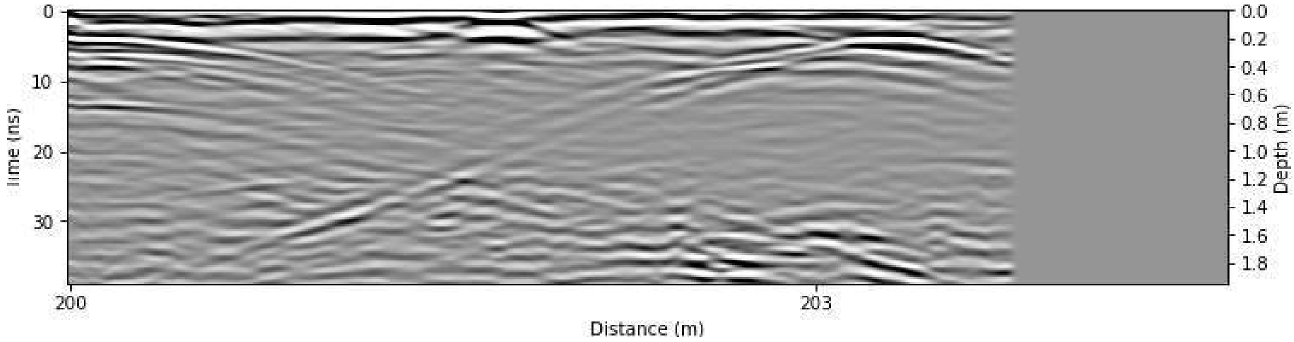


Figure B.199: Radargram at x = 228.0 m.

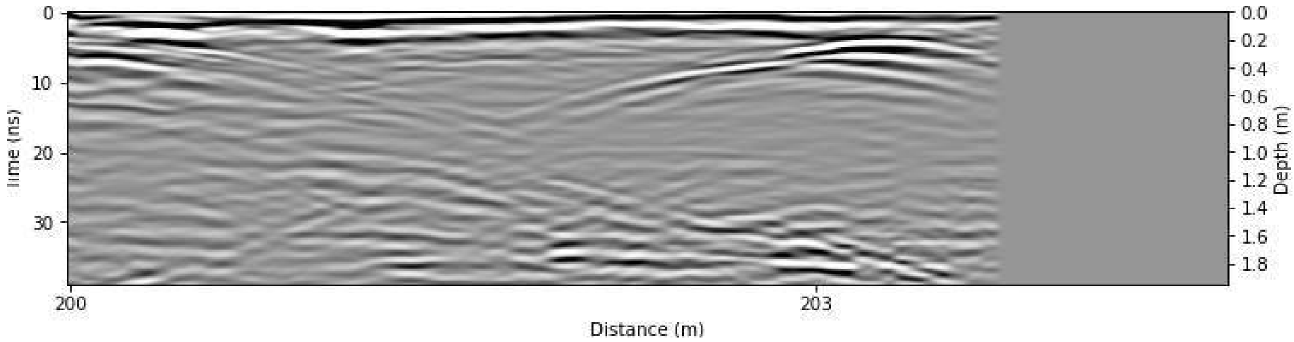


Figure B.200: Radargram at x = 228.25 m.

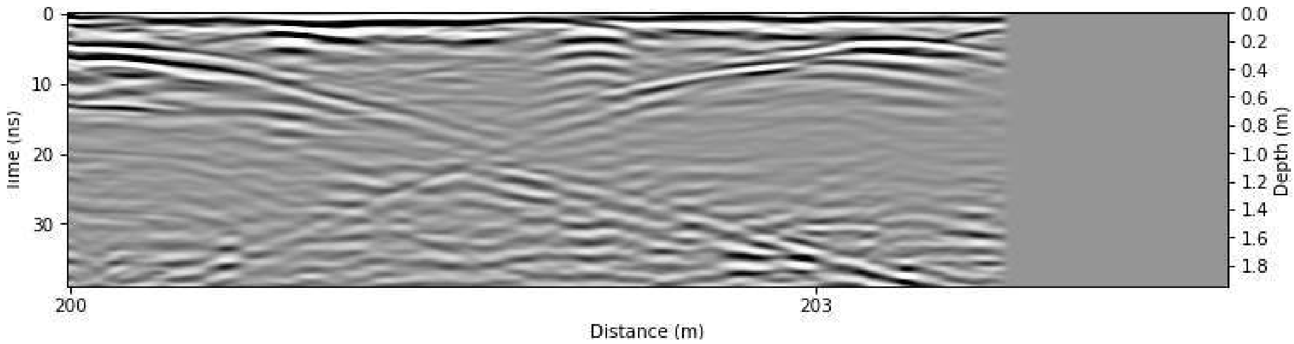


Figure B.201: Radargram at x = 228.5 m.

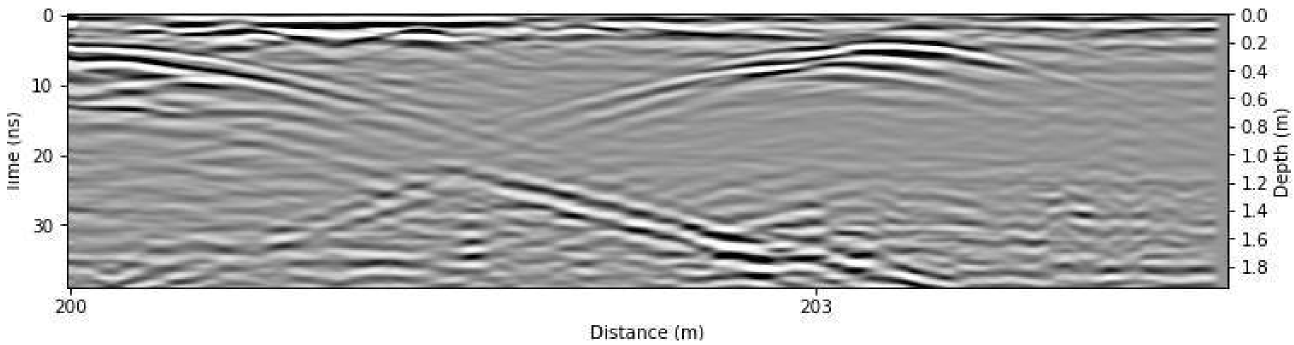


Figure B.202: Radargram at x = 228.75 m.

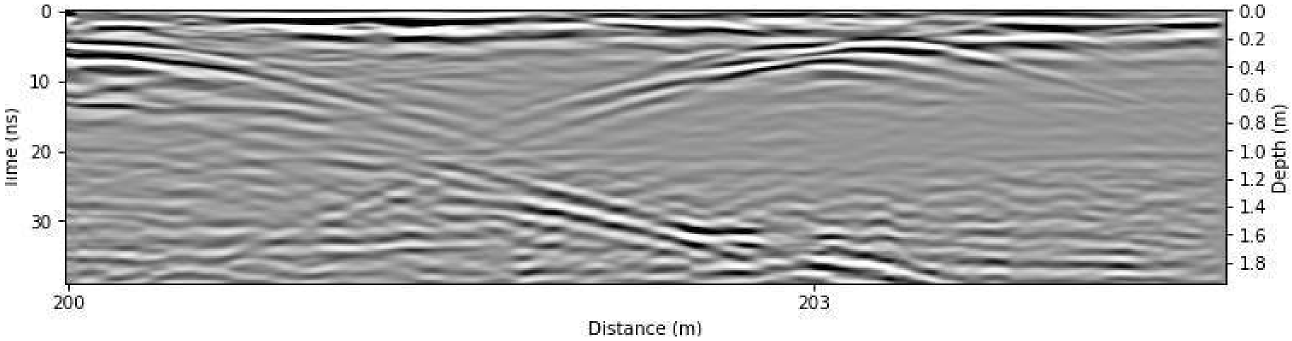


Figure B.203: Radargram at x = 229.0 m.

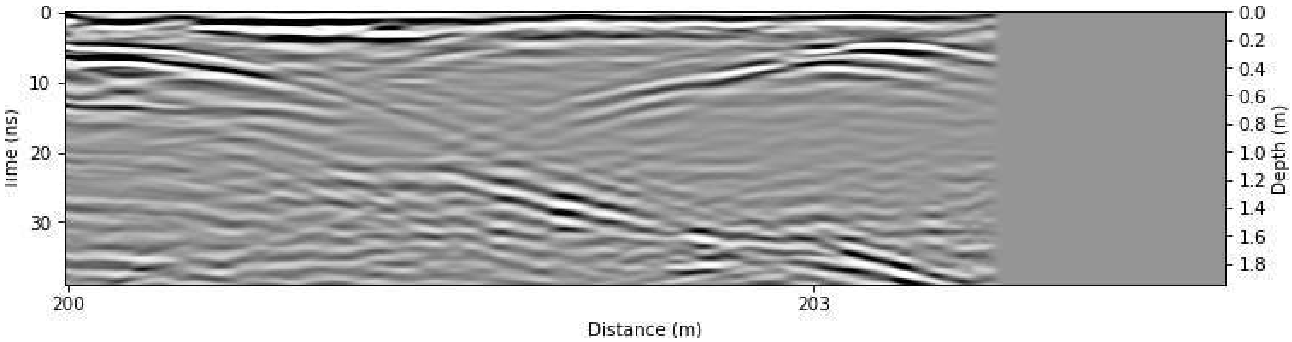


Figure B.204: Radargram at x = 229.25 m.

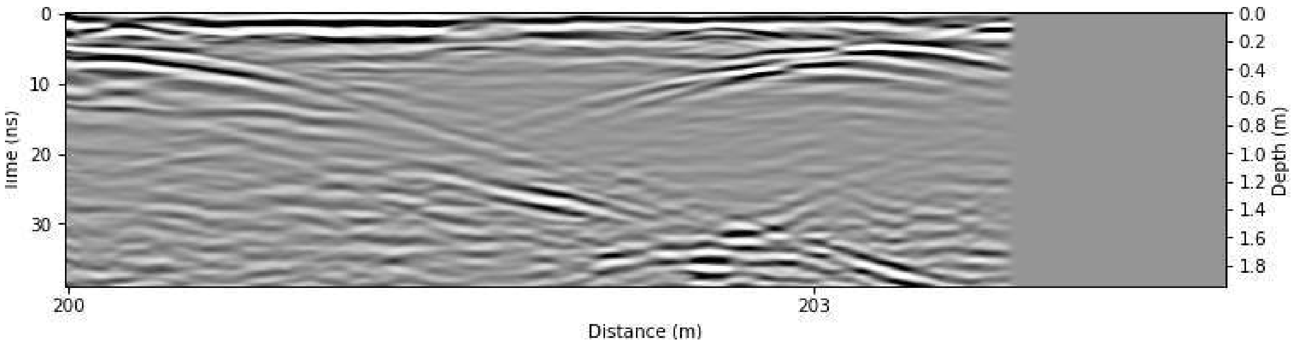


Figure B.205: Radargram at x = 229.5 m.

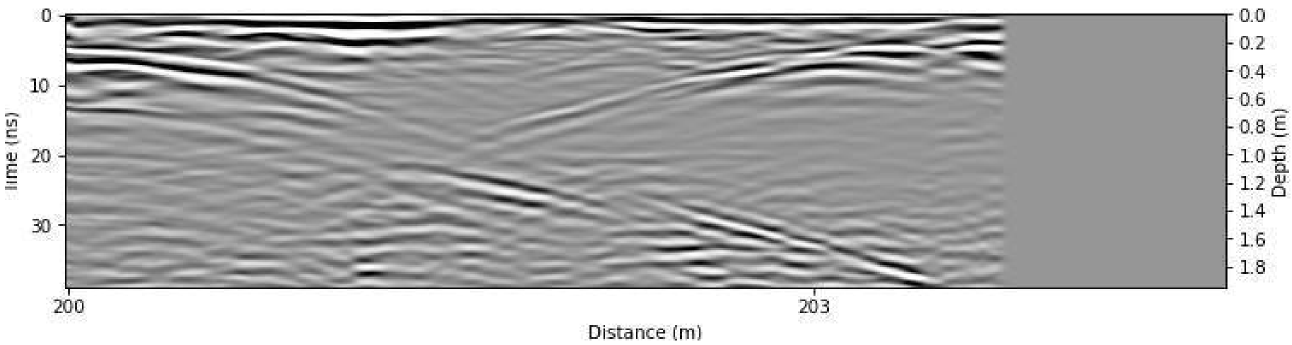


Figure B.206: Radargram at x = 229.75 m.

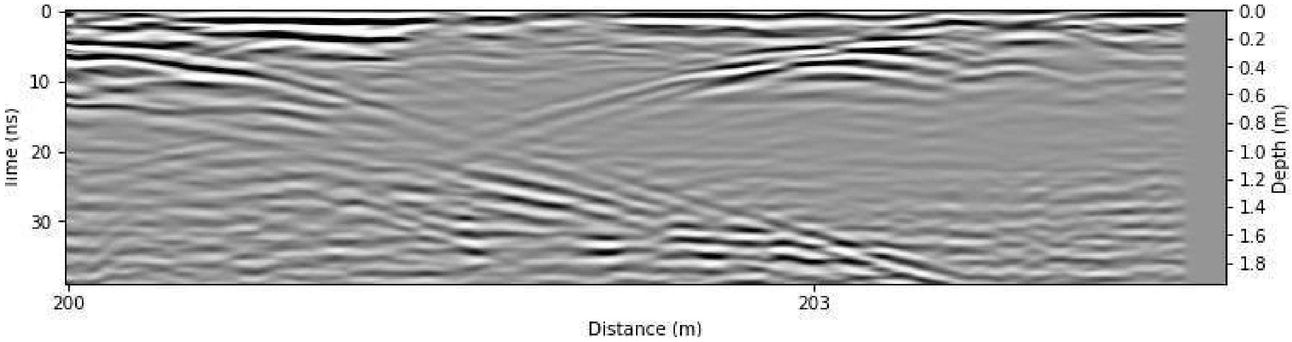


Figure B.207: Radargram at x = 230.0 m.

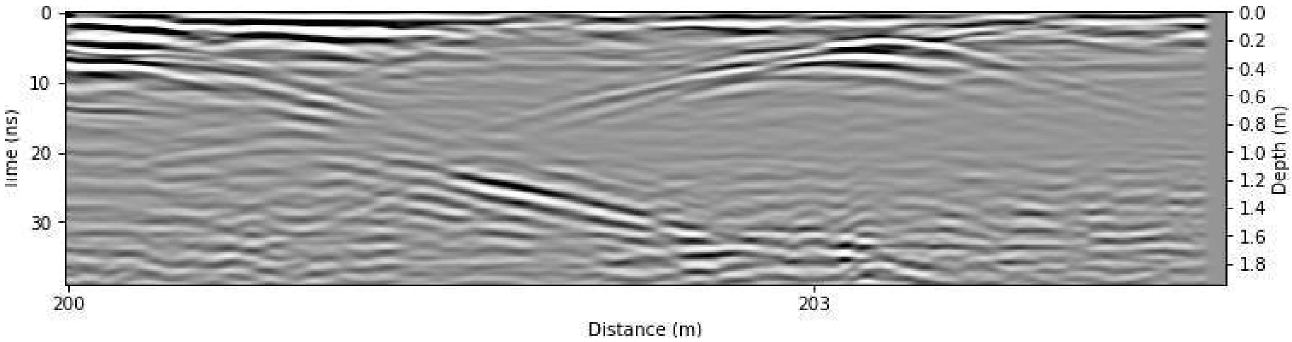


Figure B.208: Radargram at x = 230.25 m.

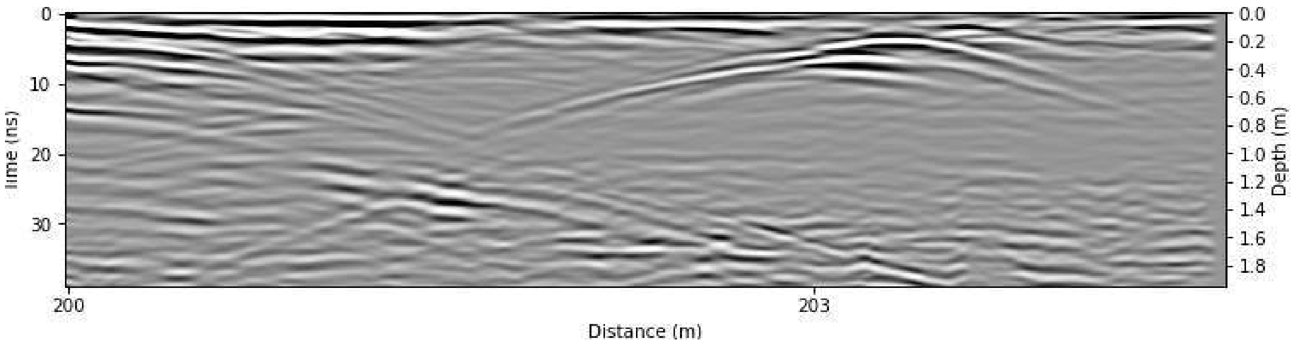


Figure B.209: Radargram at x = 230.5 m.

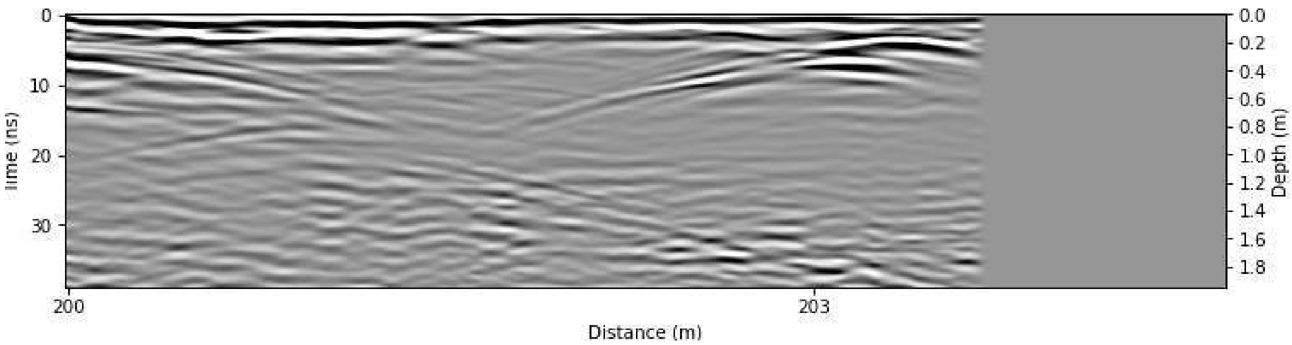


Figure B.210: Radargram at x = 230.75 m.

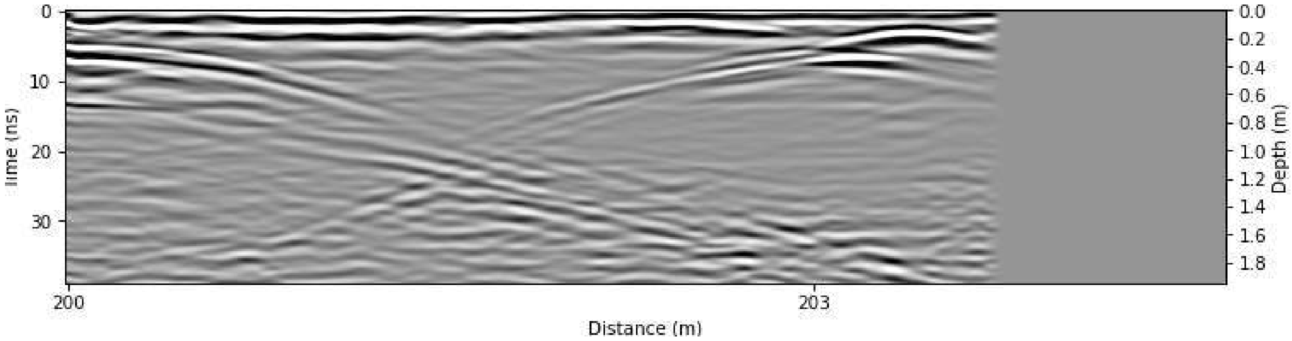


Figure B.211: Radargram at x = 231.0 m.

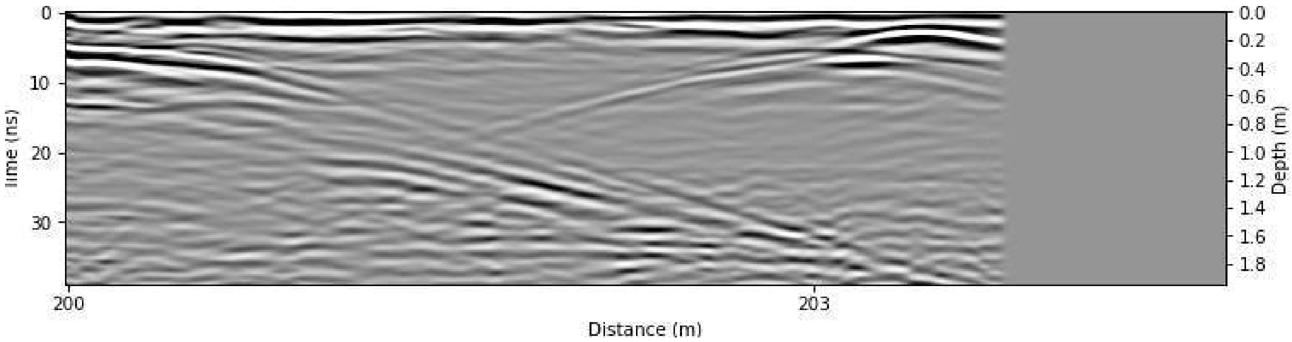


Figure B.212: Radargram at x = 231.25 m.

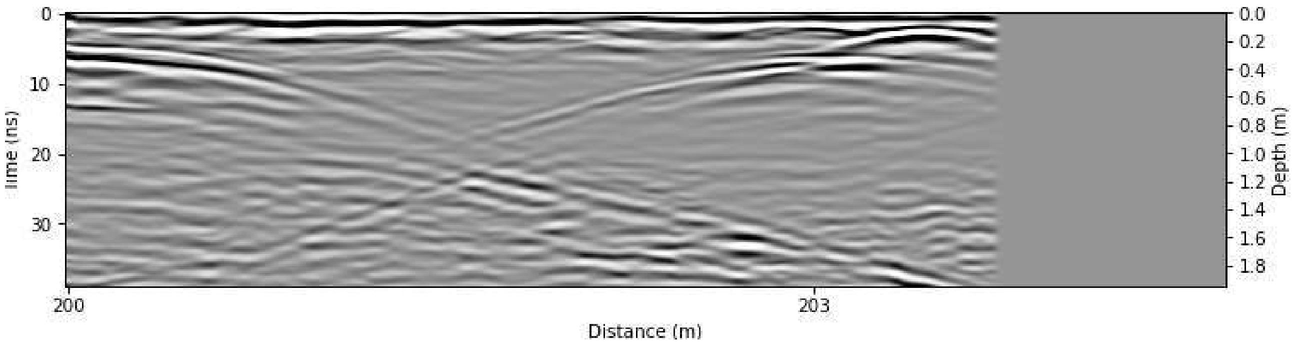


Figure B.213: Radargram at x = 231.5 m.

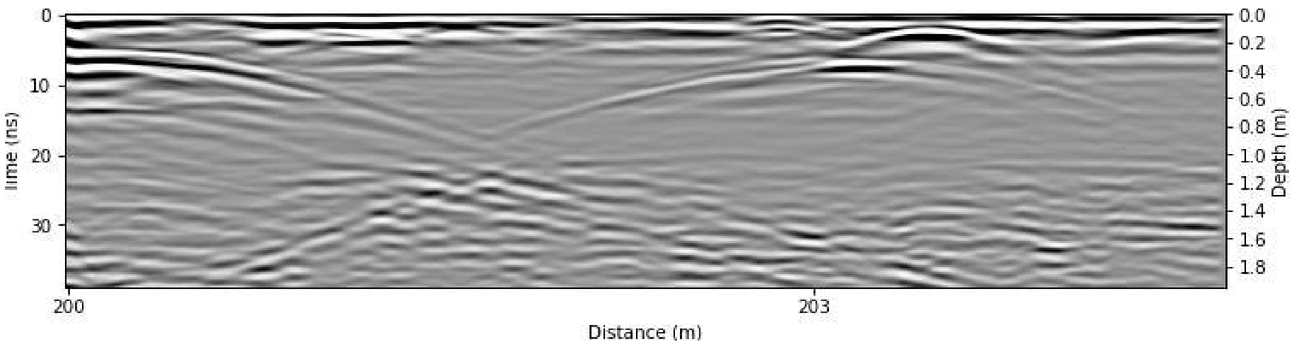


Figure B.214: Radargram at x = 231.75 m.

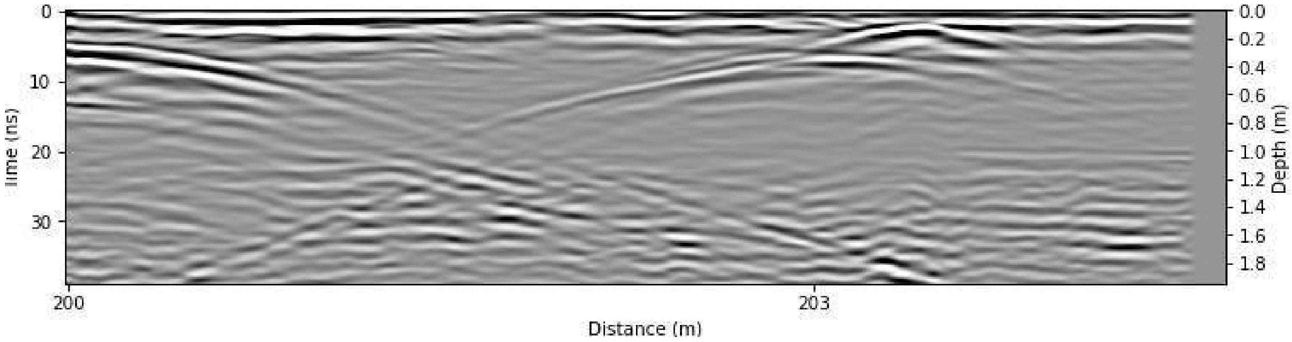


Figure B.215: Radargram at x = 232.0 m.

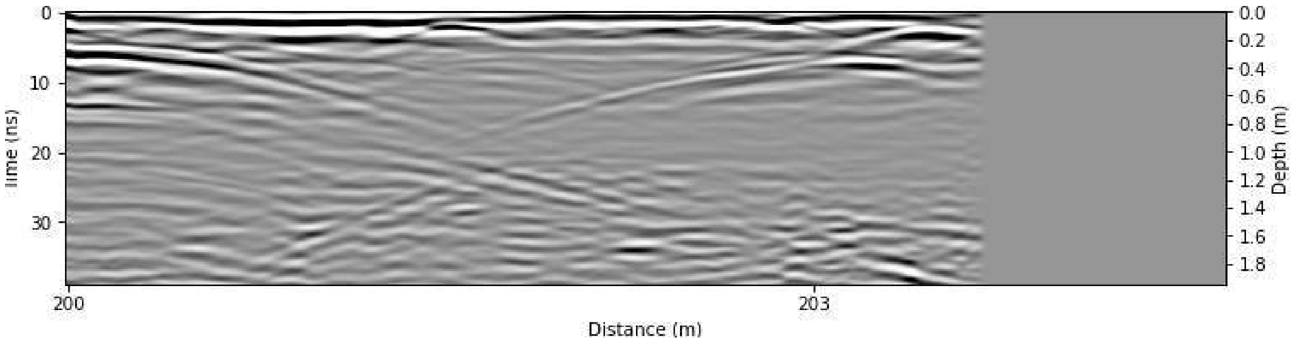


Figure B.216: Radargram at x = 232.25 m.

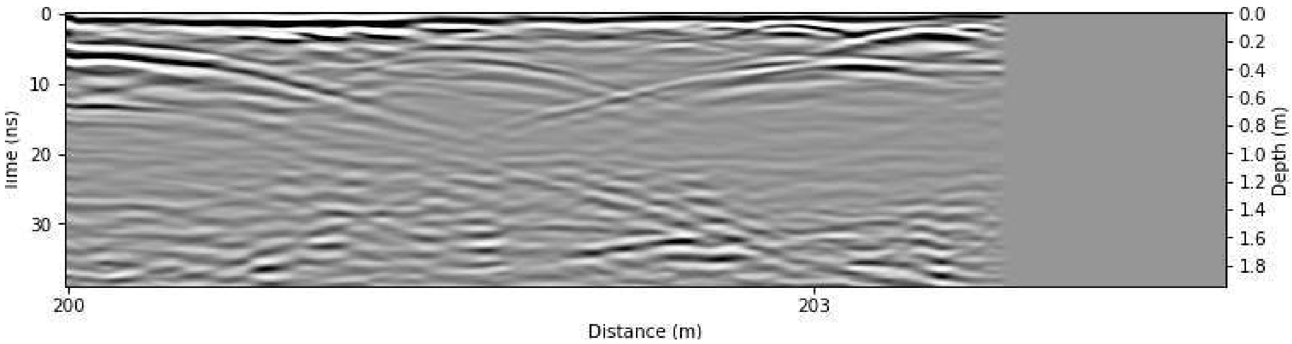


Figure B.217: Radargram at x = 232.5 m.

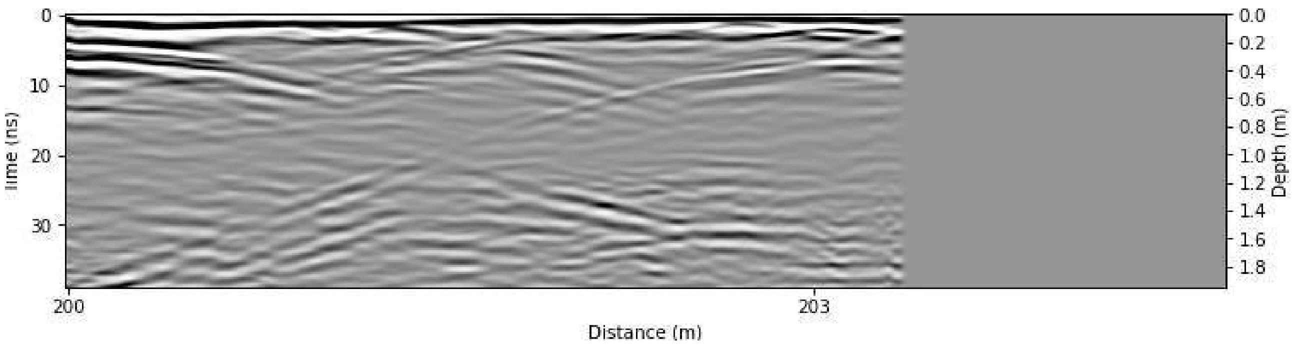


Figure B.218: Radargram at x = 232.75 m.

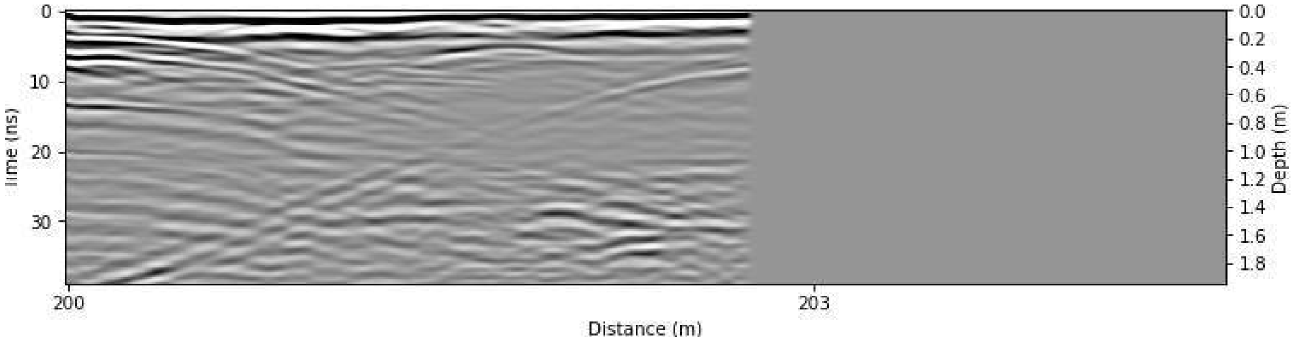


Figure B.219: Radargram at x = 233.0 m.

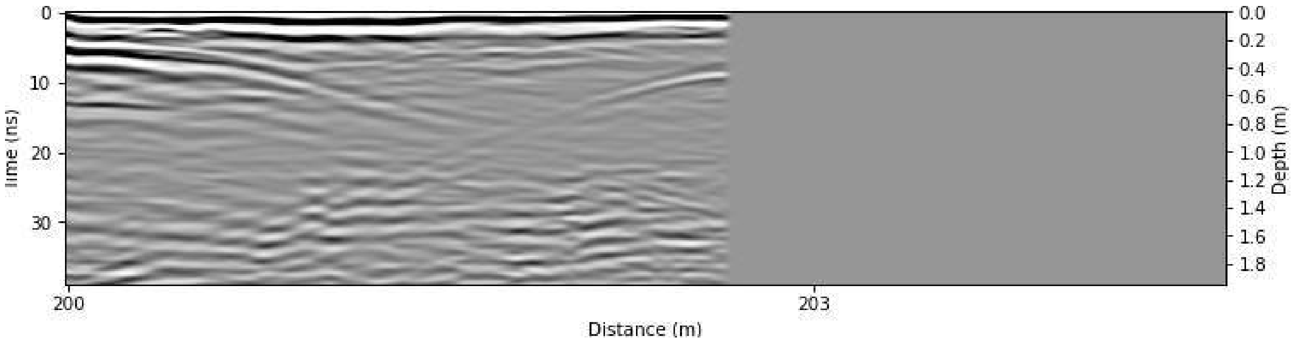


Figure B.220: Radargram at x = 233.25 m.

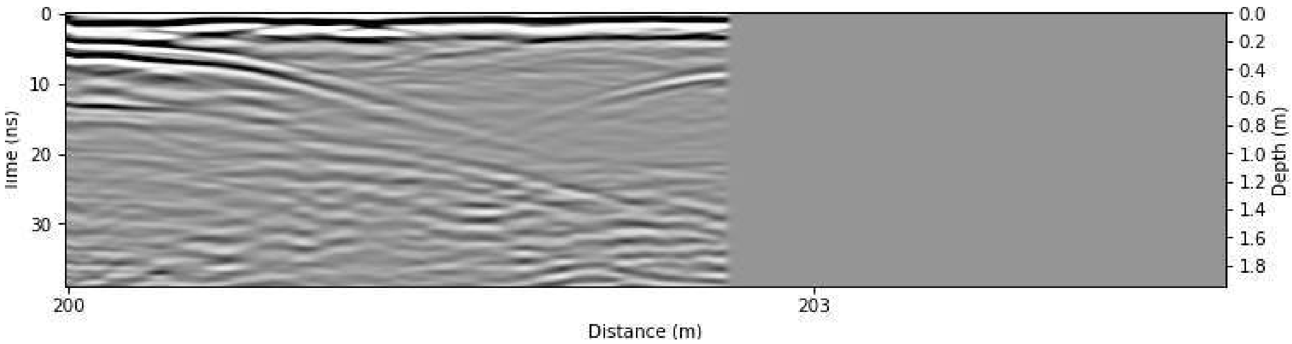


Figure B.221: Radargram at x = 233.5 m.

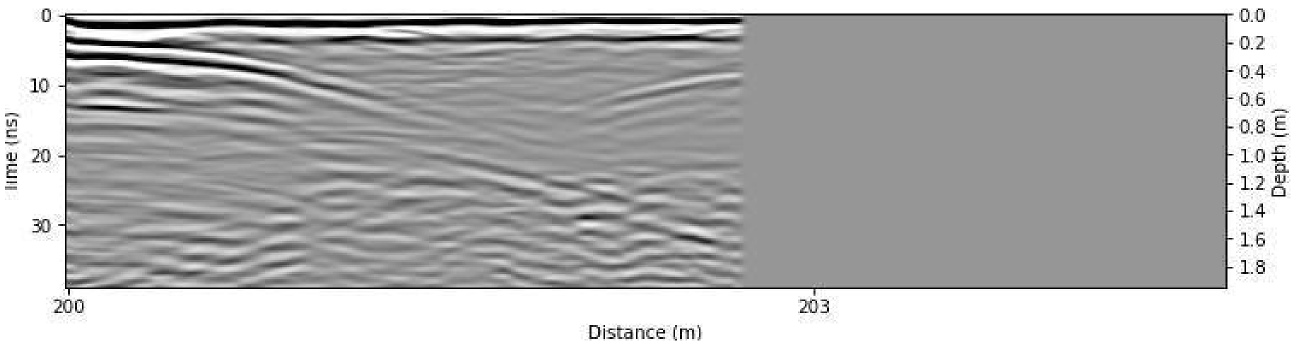


Figure B.222: Radargram at x = 233.75 m.

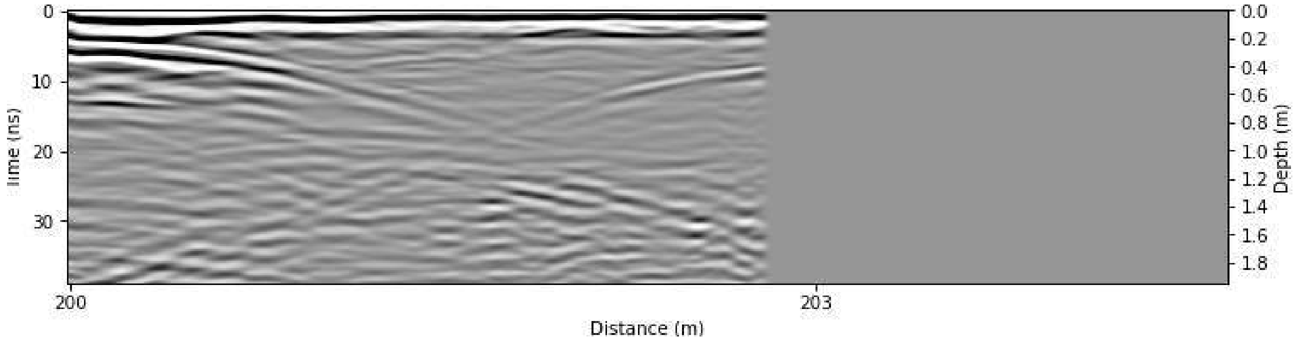


Figure B.223: Radargram at x = 234.0 m.

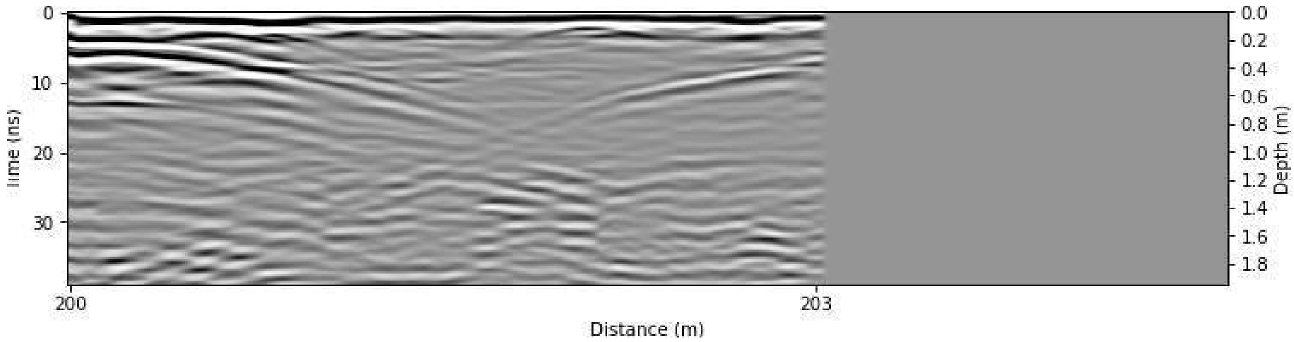


Figure B.224: Radargram at x = 234.25 m.

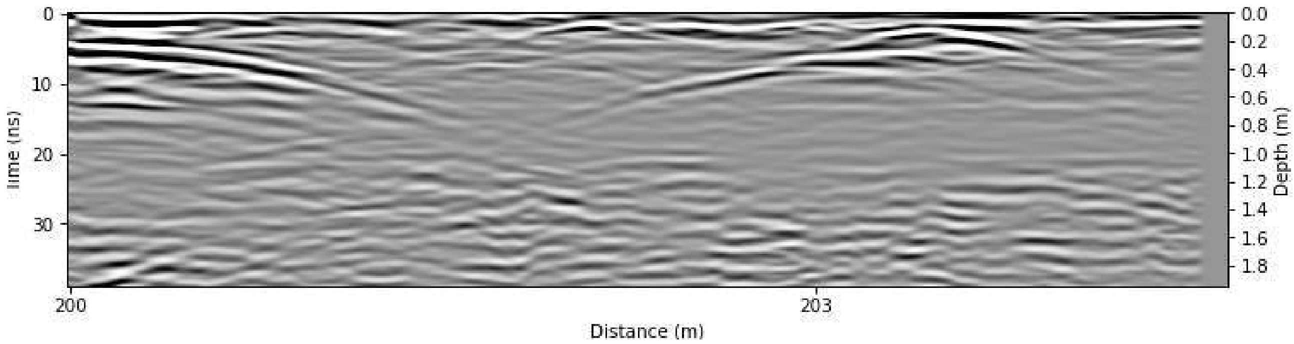


Figure B.225: Radargram at x = 234.5 m.

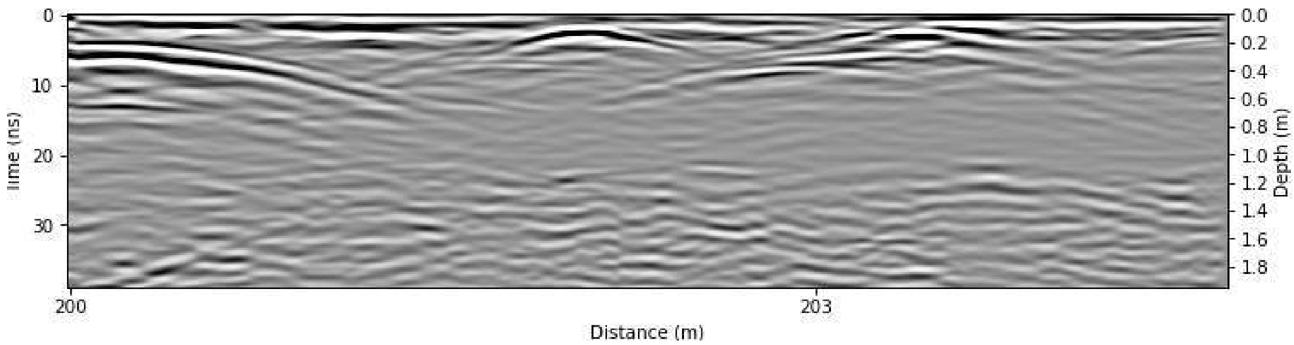


Figure B.226: Radargram at x = 234.75 m.

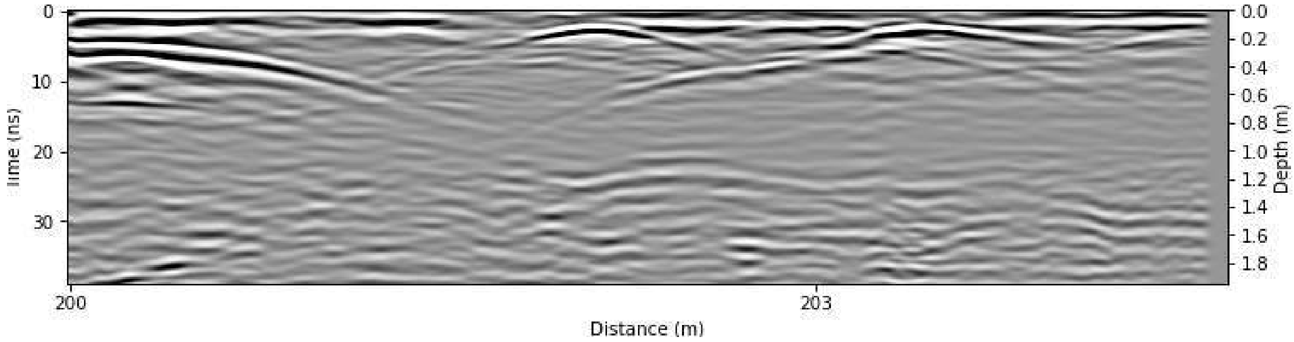


Figure B.227: Radargram at x = 235.0 m.

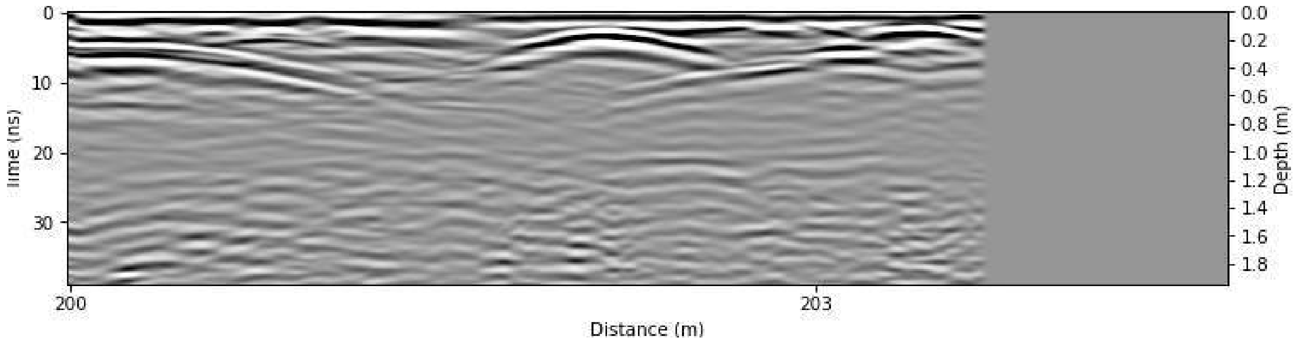


Figure B.228: Radargram at x = 235.25 m.

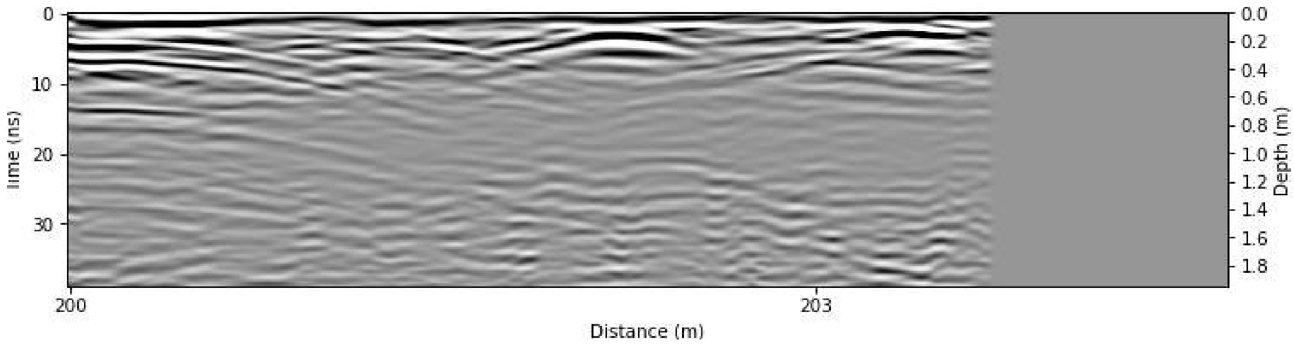


Figure B.229: Radargram at x = 235.5 m.

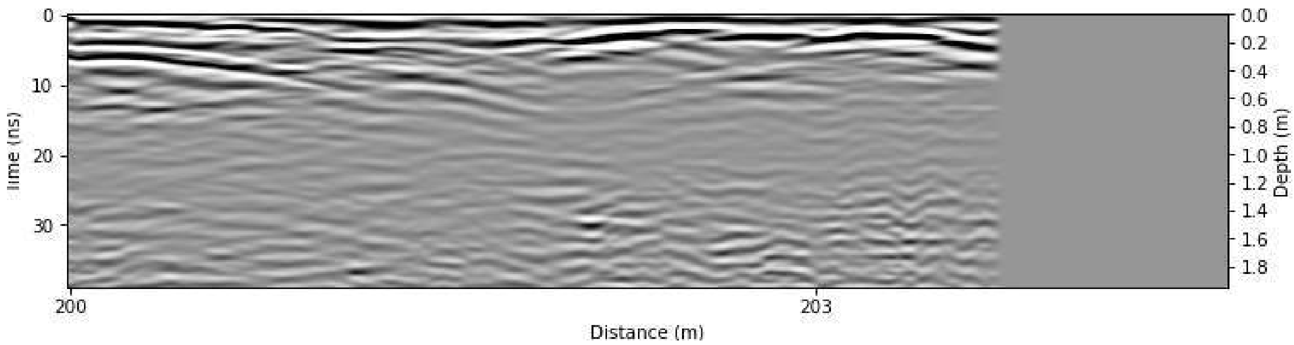


Figure B.230: Radargram at x = 235.75 m.

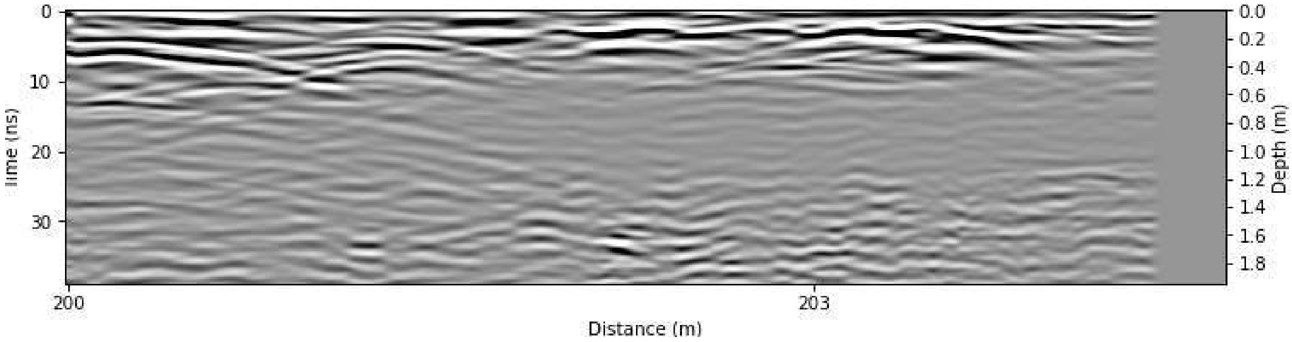
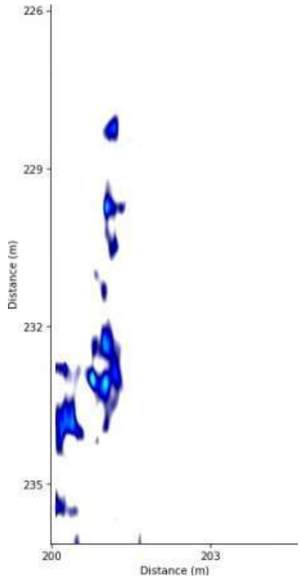
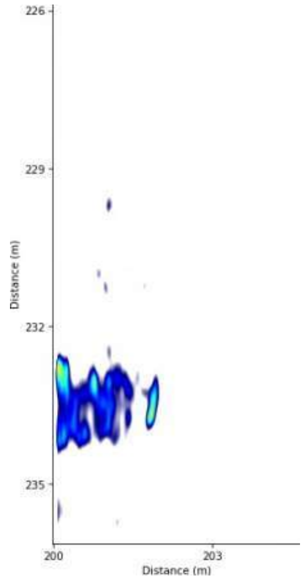


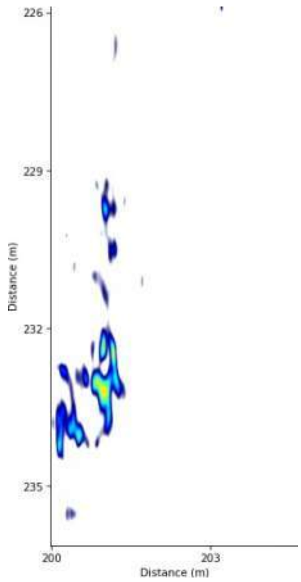
Figure B.231: Radargram at x = 236.0 m.



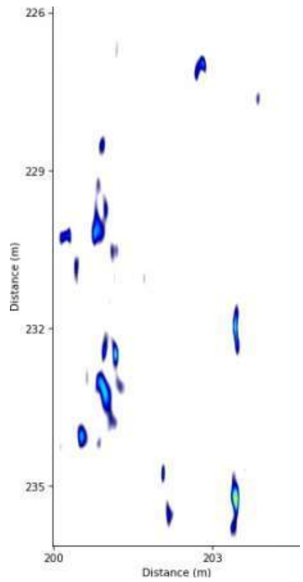
(a) Timeslice at z = 0.0 m.



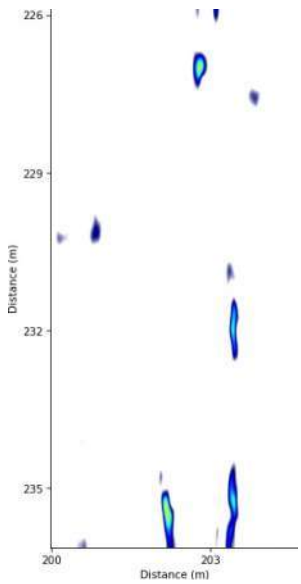
(b) Timeslice at z = 0.05 m.



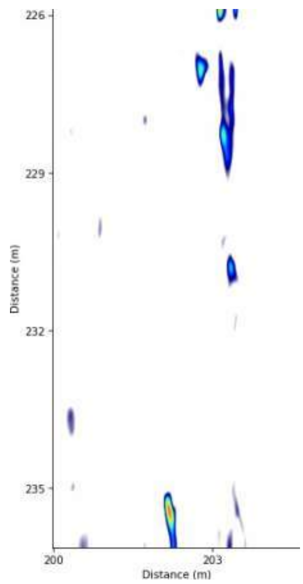
(c) Timeslice at z = 0.1 m.



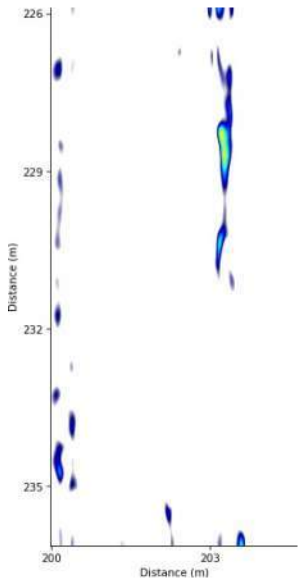
(d) Timeslice at z = 0.15 m.



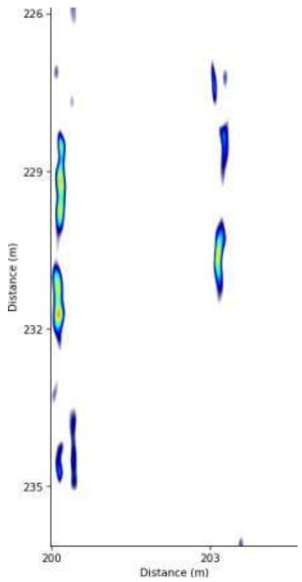
(e) Timeslice at z = 0.2 m.



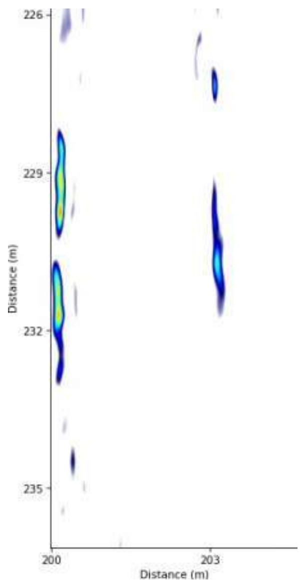
(f) Timeslice at z = 0.25 m.



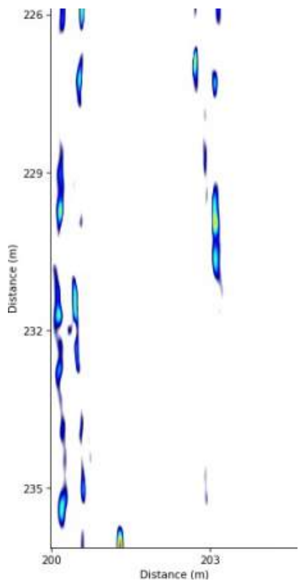
(a) Timeslice at z = 0.3 m.



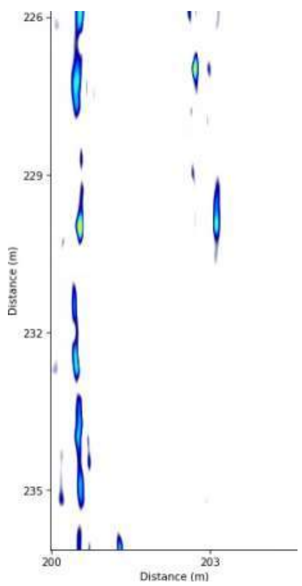
(b) Timeslice at z = 0.35 m.



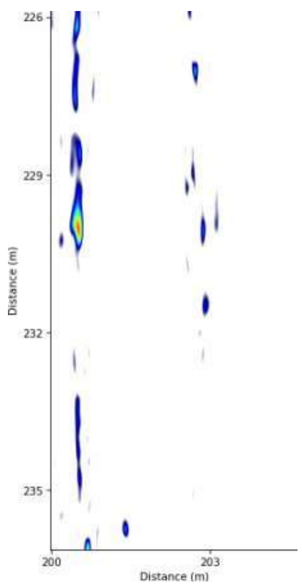
(c) Timeslice at z = 0.4 m.



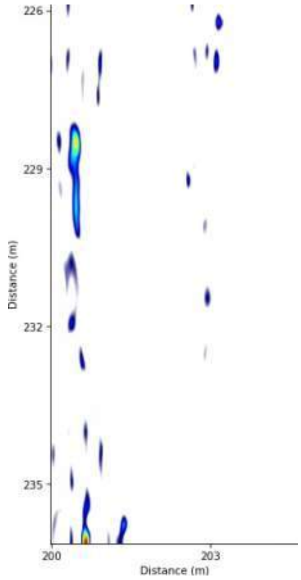
(d) Timeslice at z = 0.45 m.



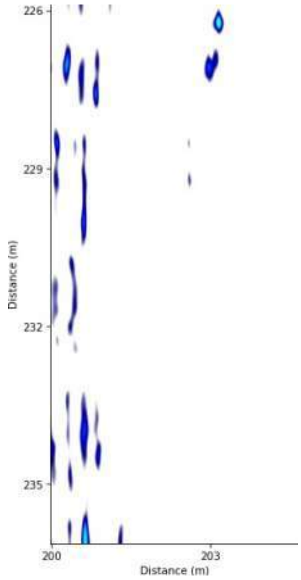
(e) Timeslice at z = 0.5 m.



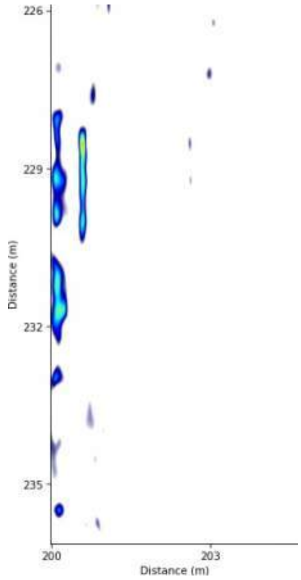
(f) Timeslice at z = 0.55 m.



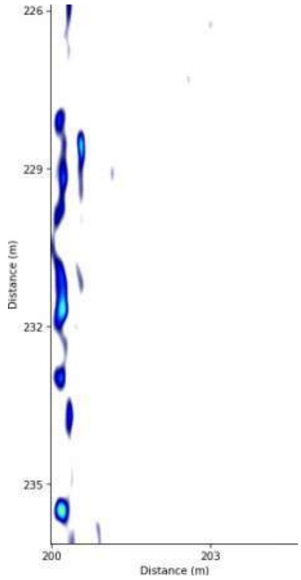
(a) Timeslice at z = 0.6 m.



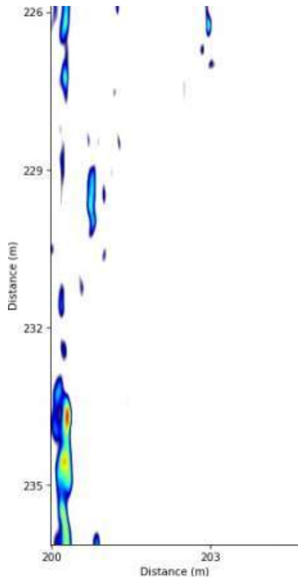
(b) Timeslice at z = 0.65 m.



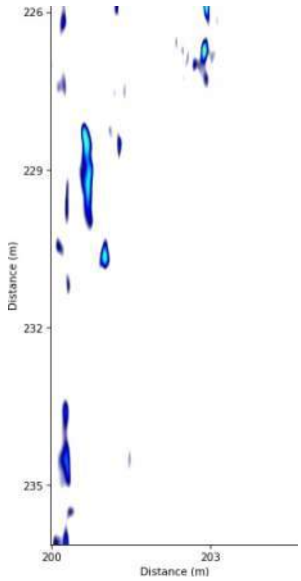
(c) Timeslice at z = 0.7 m.



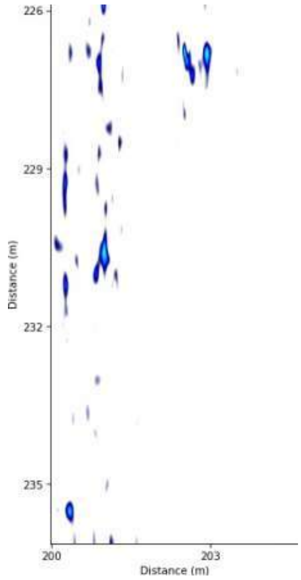
(d) Timeslice at z = 0.75 m.



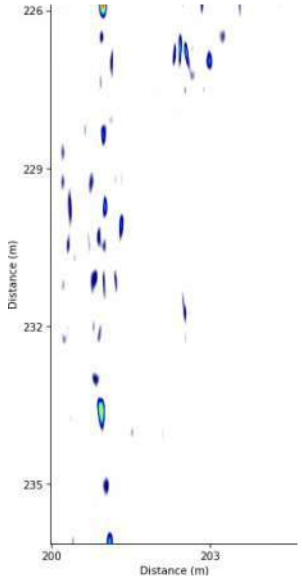
(e) Timeslice at z = 0.8 m.



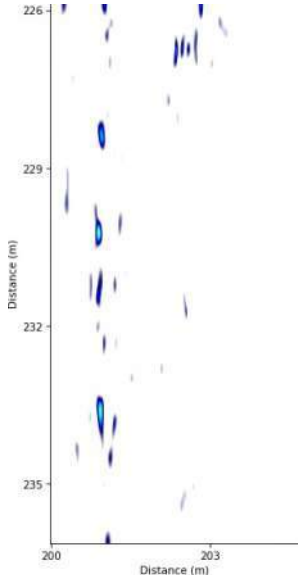
(f) Timeslice at z = 0.85 m.



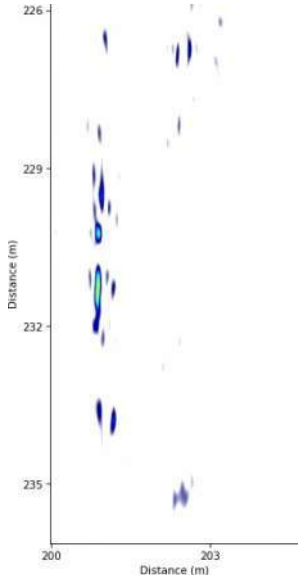
(a) Timeslice at z = 0.5 m.



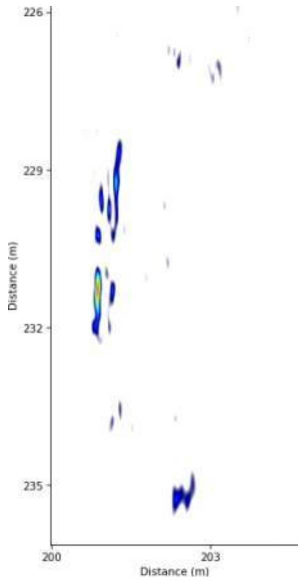
(b) Timeslice at z = 0.55 m.



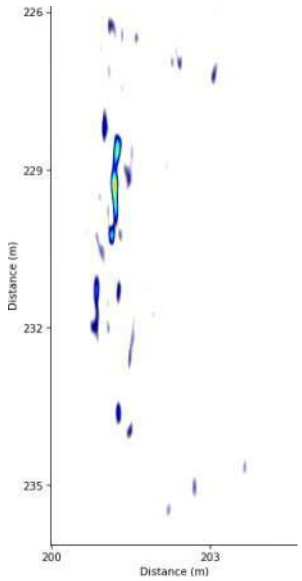
(c) Timeslice at z = 1.0 m.



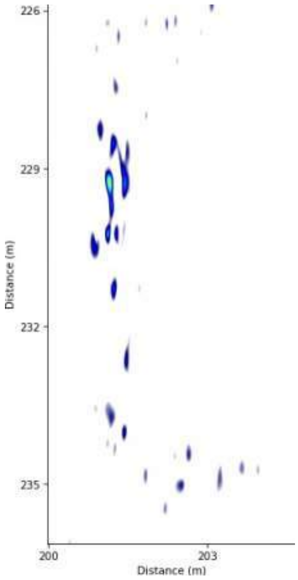
(d) Timeslice at z = 1.05 m.



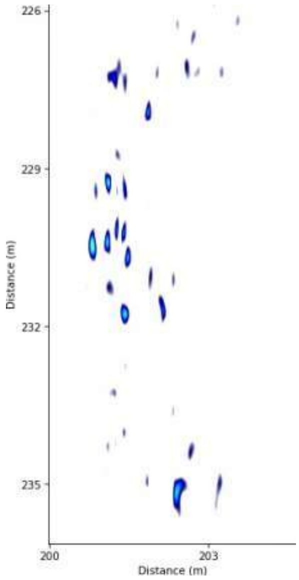
(e) Timeslice at z = 1.1 m.



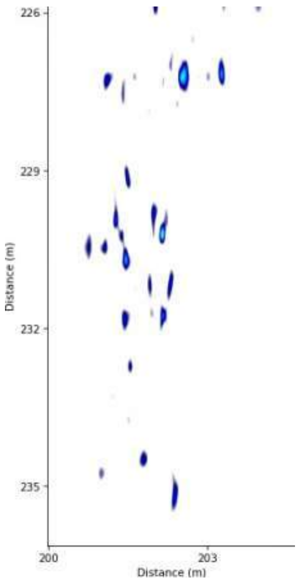
(f) Timeslice at z = 1.15 m.



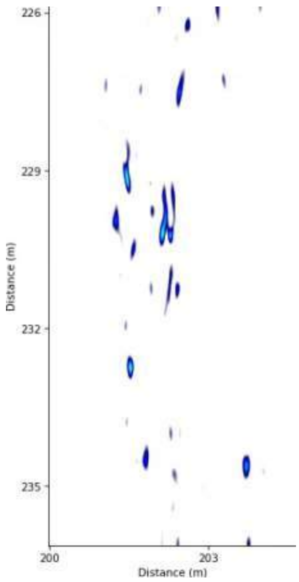
(a) Timeslice at z = 1.2 m.



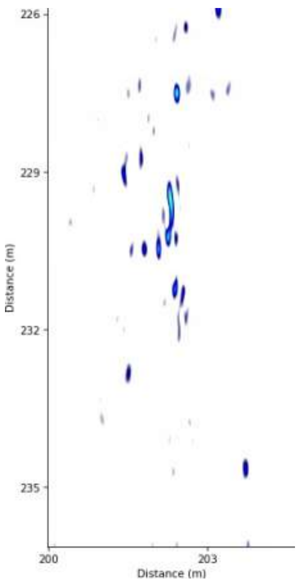
(b) Timeslice at z = 1.25 m.



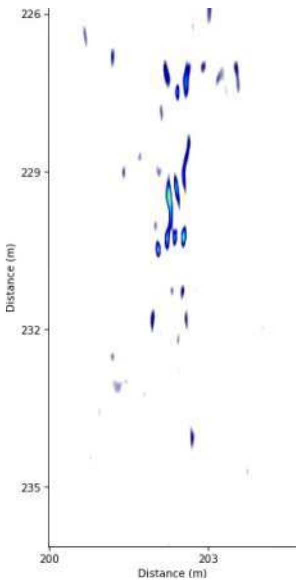
(c) Timeslice at z = 1.3 m.



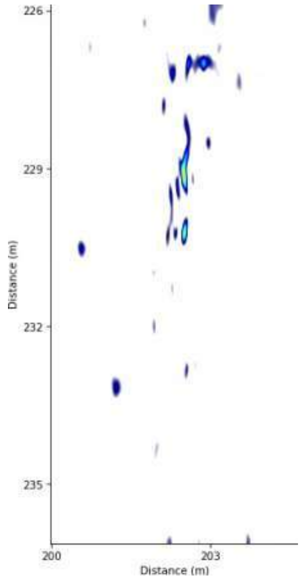
(d) Timeslice at z = 1.35 m.



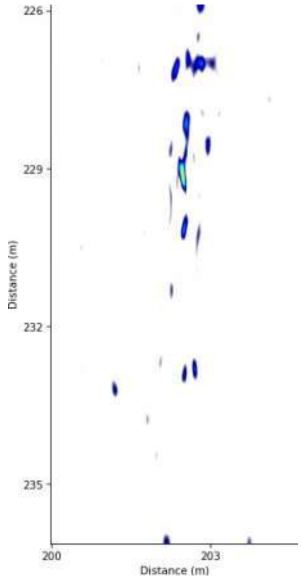
(e) Timeslice at z = 1.4 m.



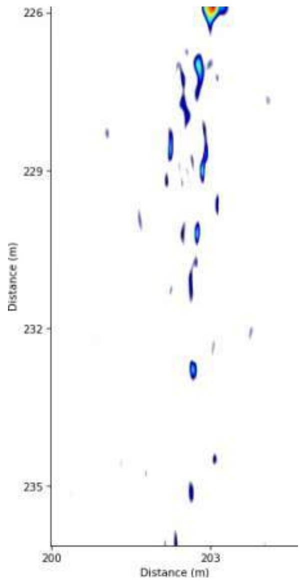
(f) Timeslice at z = 1.45 m.



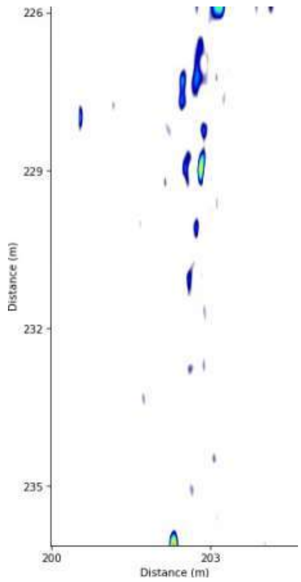
(a) Timeslice at z = 1.5 m.



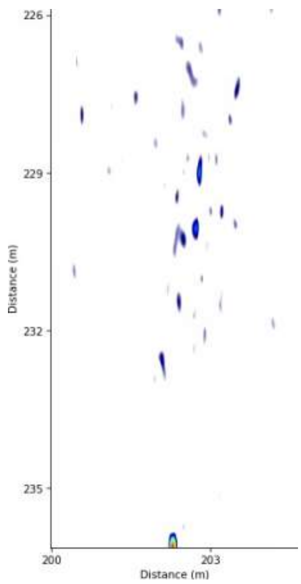
(b) Timeslice at z = 1.55 m.



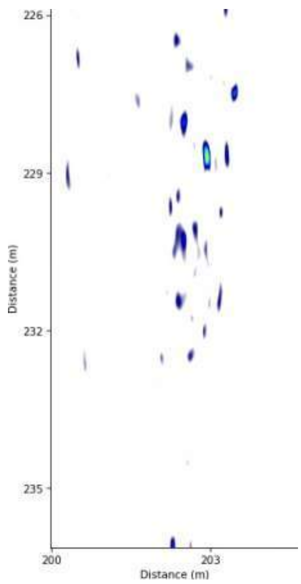
(c) Timeslice at z = 1.6 m.



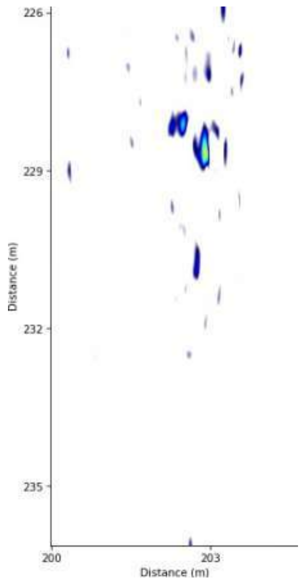
(d) Timeslice at z = 1.65 m.



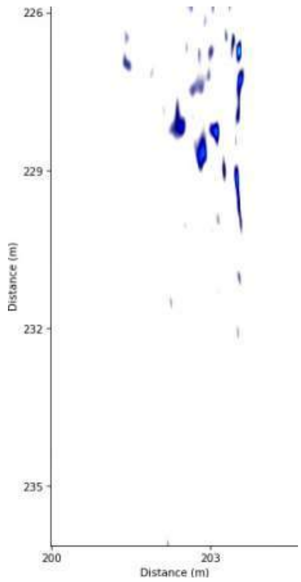
(e) Timeslice at z = 1.7 m.



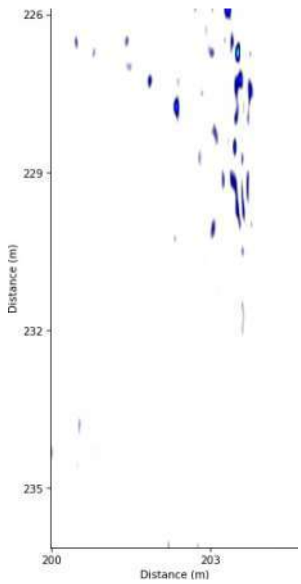
(f) Timeslice at z = 1.75 m.



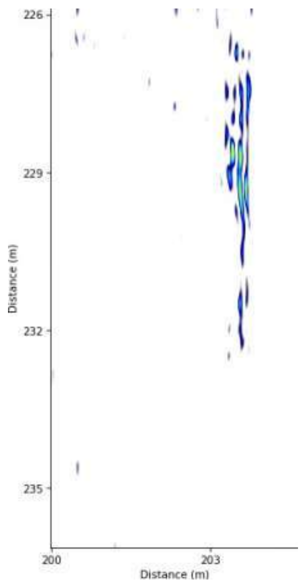
(a) Timeslice at z = 1.8 m.



(b) Timeslice at z = 1.85 m.



(c) Timeslice at z = 1.9 m.



(d) Timeslice at z = 1.95 m.

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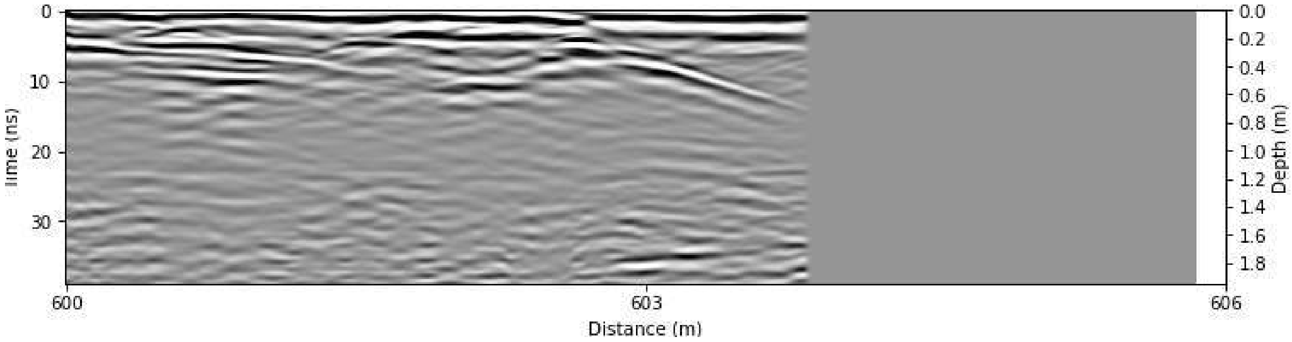


Figure B.239: Radargram at x = 500.5 m.

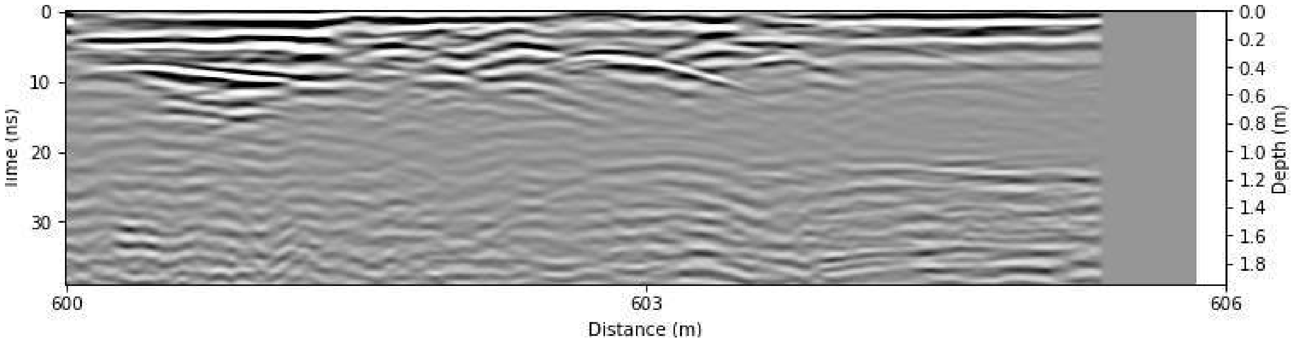


Figure B.240: Radargram at x = 500.75 m.

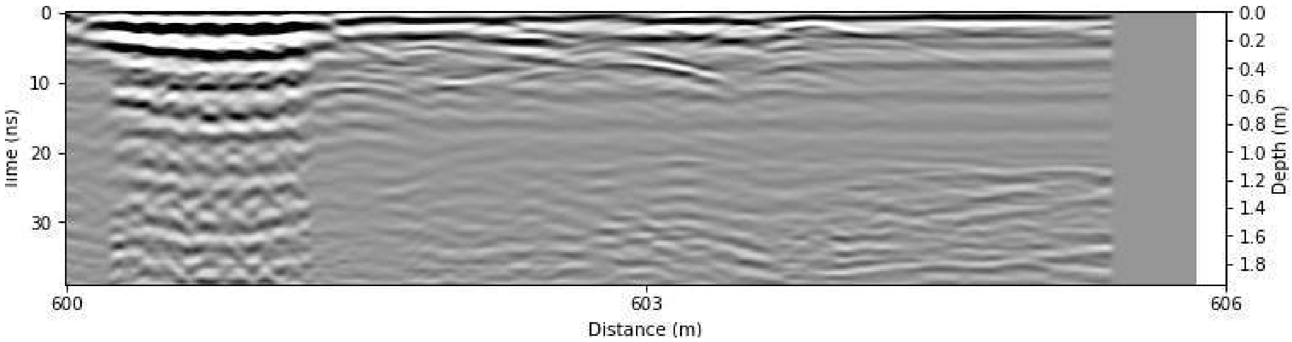


Figure B.241: Radargram at x = 501.0 m.

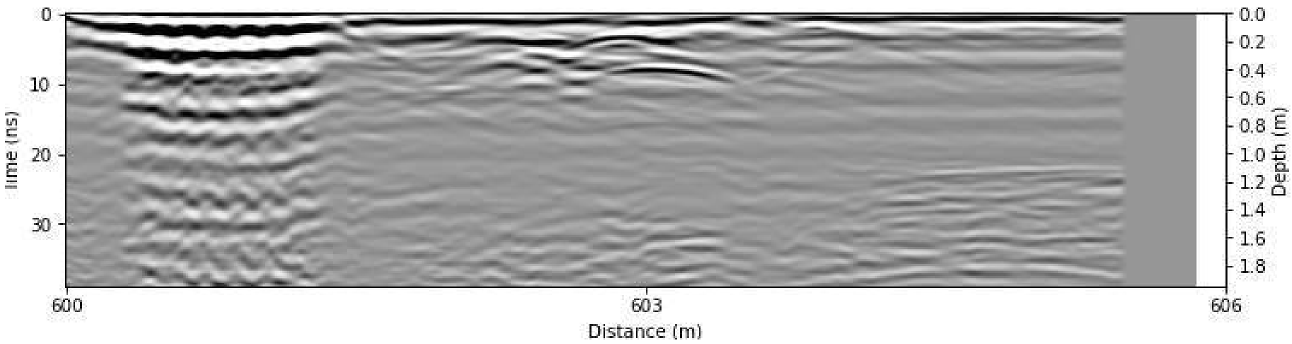


Figure B.242: Radargram at x = 501.25 m.

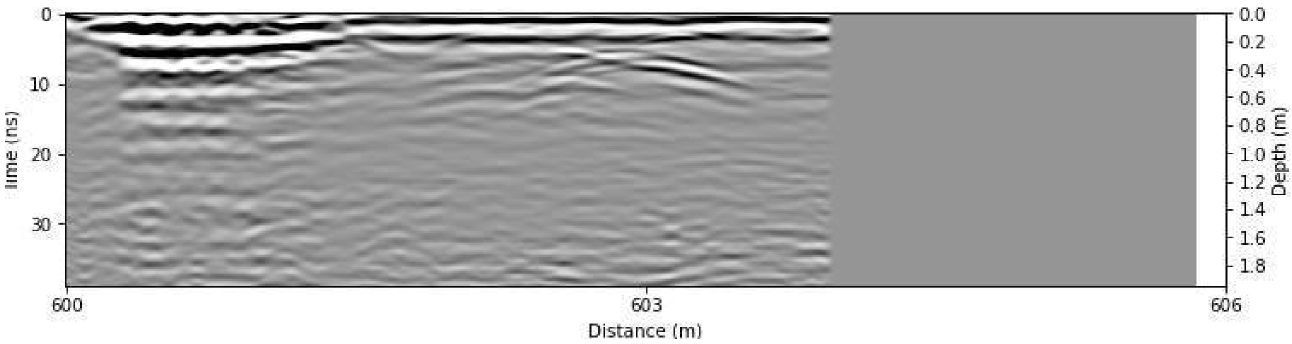


Figure B.243: Radargram at x = 501.5 m.

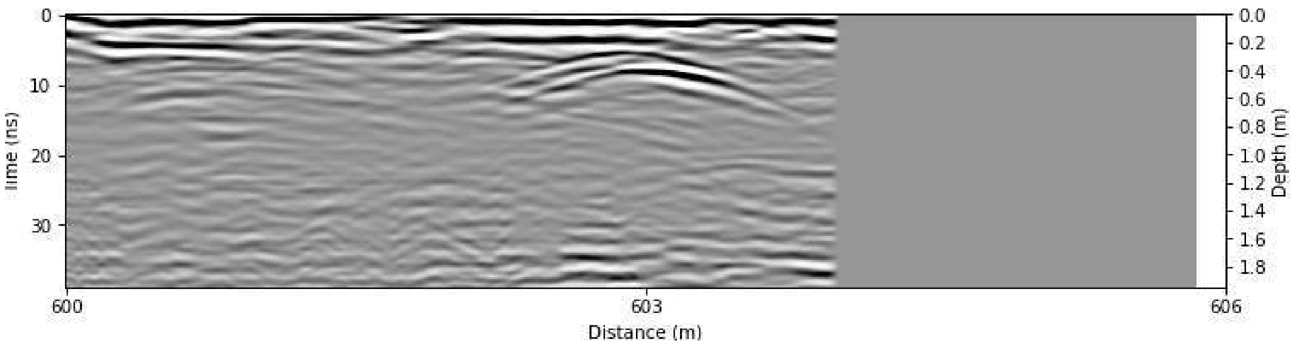


Figure B.244: Radargram at x = 501.75 m.

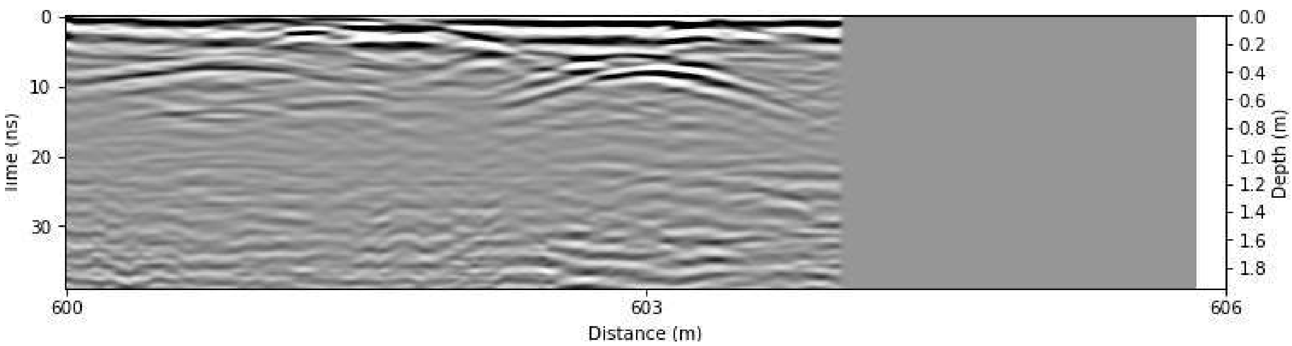


Figure B.245: Radargram at x = 502.0 m.

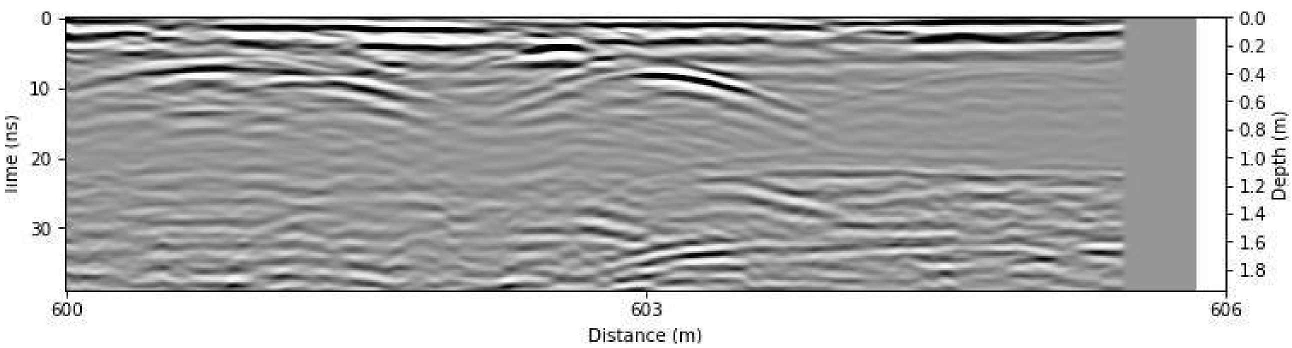


Figure B.246: Radargram at x = 502.25 m.

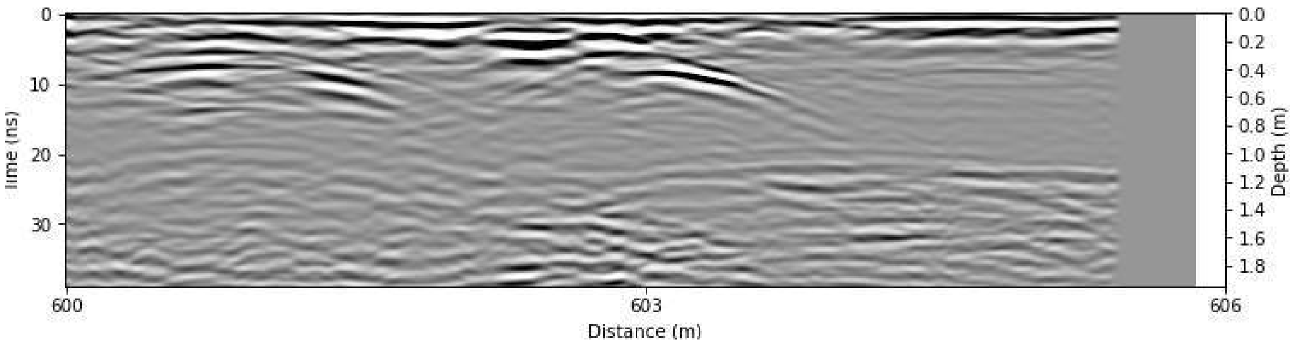


Figure B.247: Radargram at x = 502.5 m.

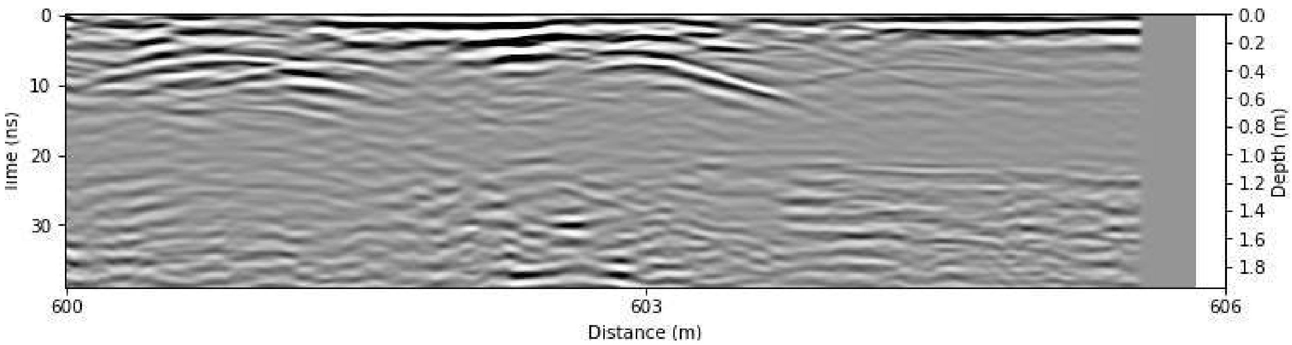


Figure B.248: Radargram at x = 502.75 m.

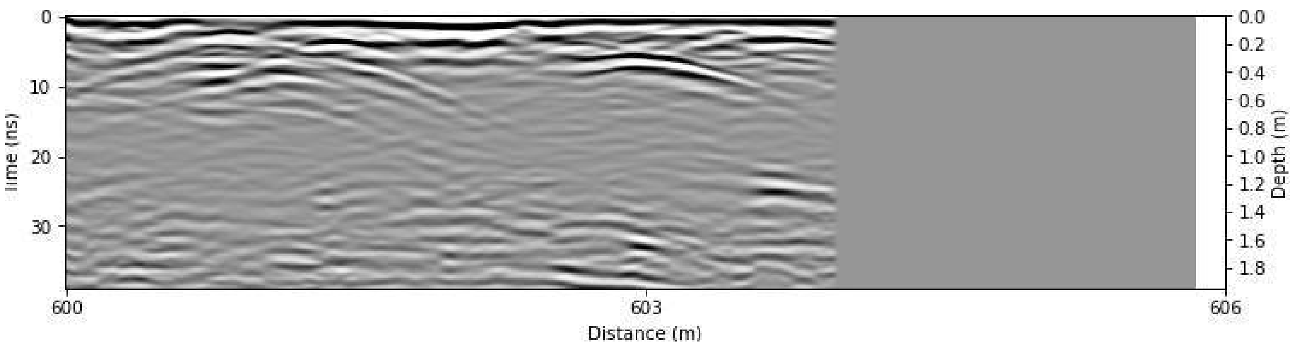


Figure B.249: Radargram at x = 503.0 m.

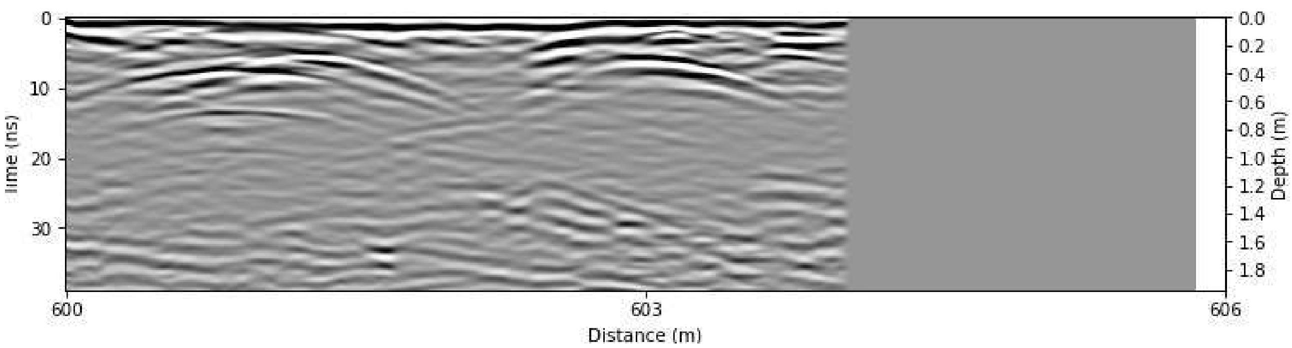


Figure B.250: Radargram at x = 503.25 m.

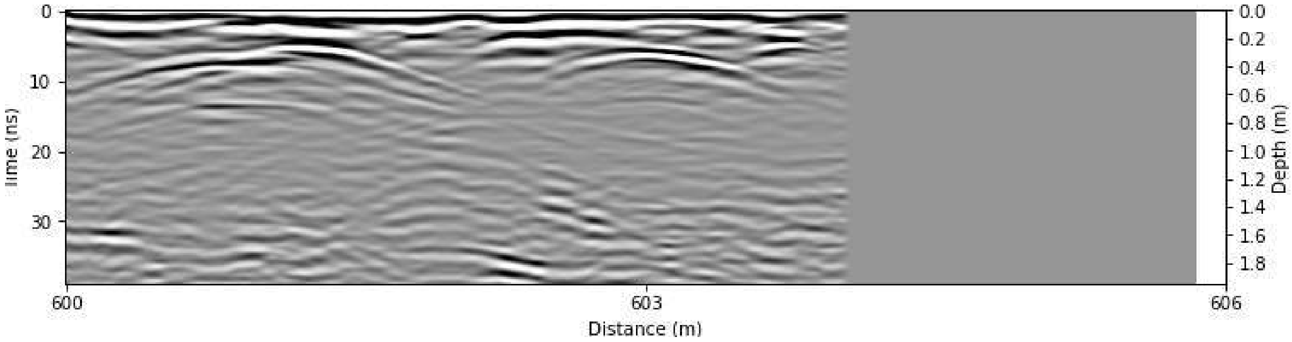


Figure B.251: Radargram at x = 503.5 m.

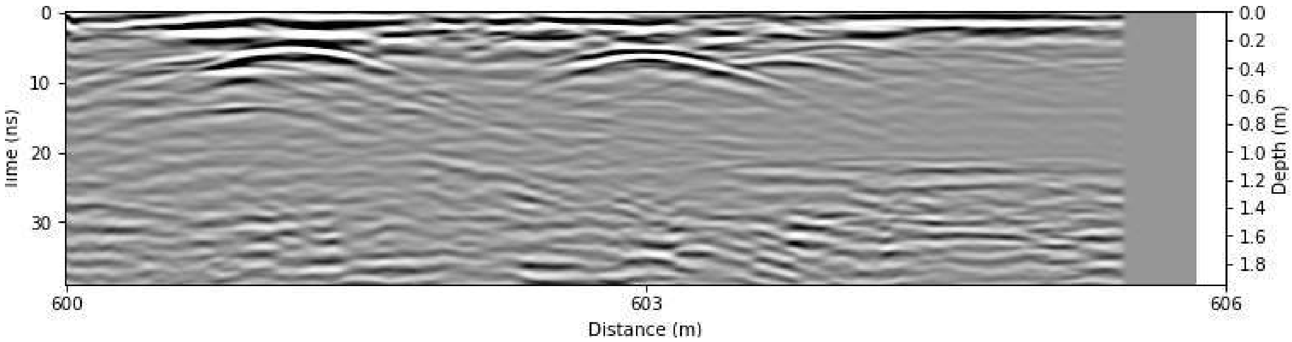


Figure B.252: Radargram at x = 503.75 m.

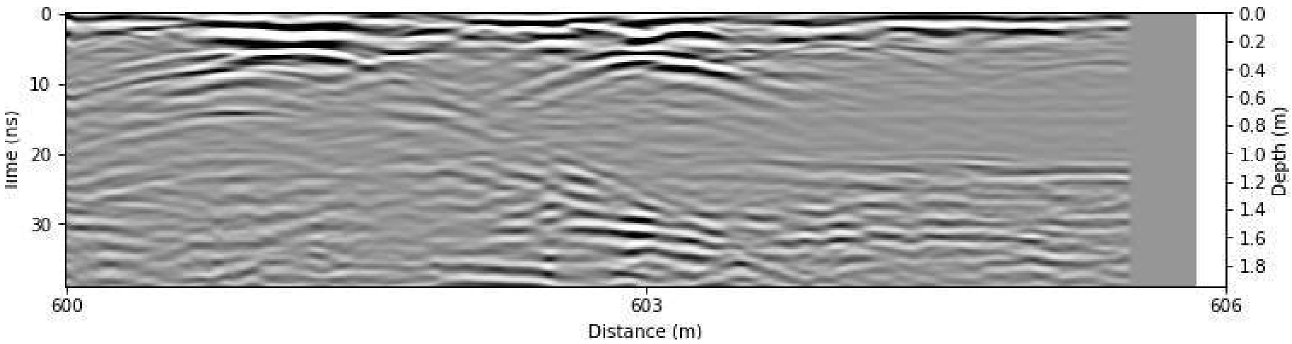


Figure B.253: Radargram at x = 504.0 m.

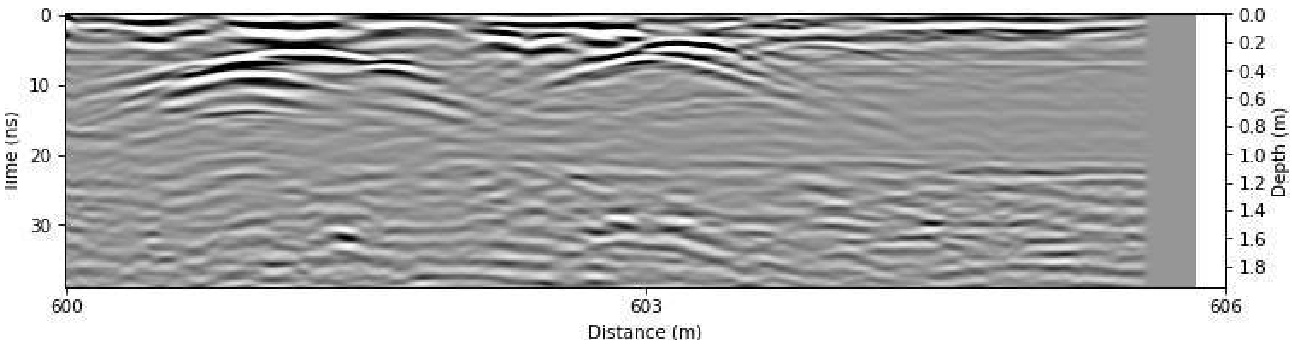


Figure B.254: Radargram at x = 504.25 m.

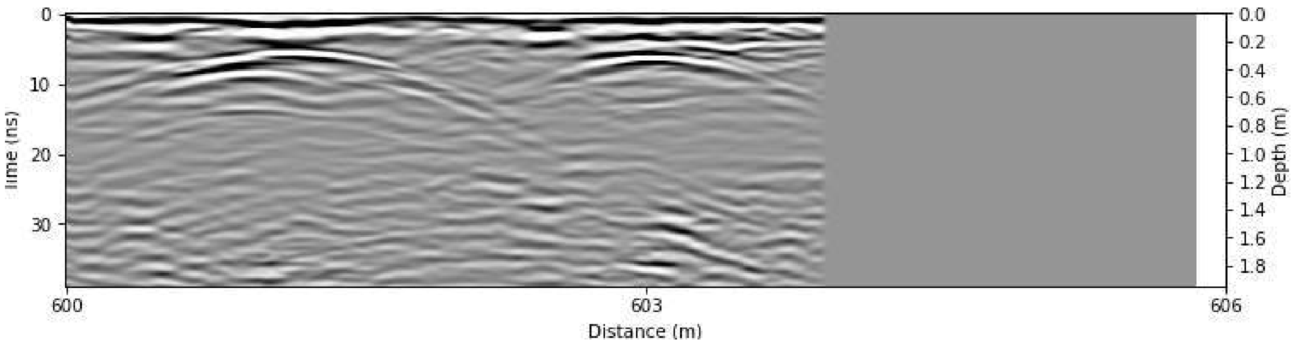


Figure B.255: Radargram at x = 504.5 m.

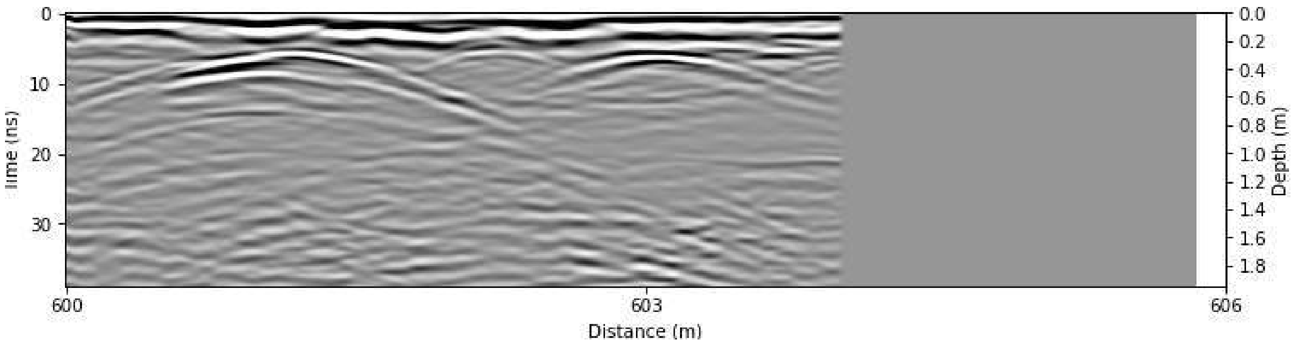


Figure B.256: Radargram at x = 504.75 m.

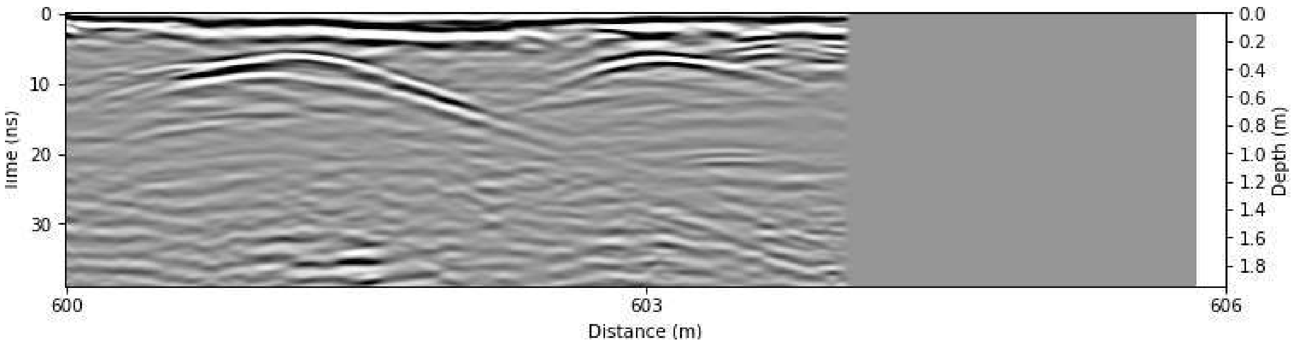


Figure B.257: Radargram at x = 505.0 m.

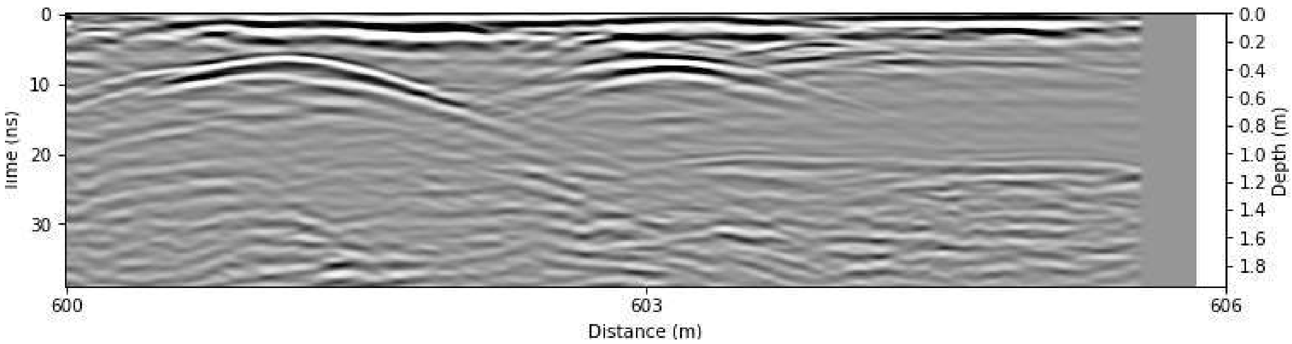


Figure B.258: Radargram at x = 505.25 m.

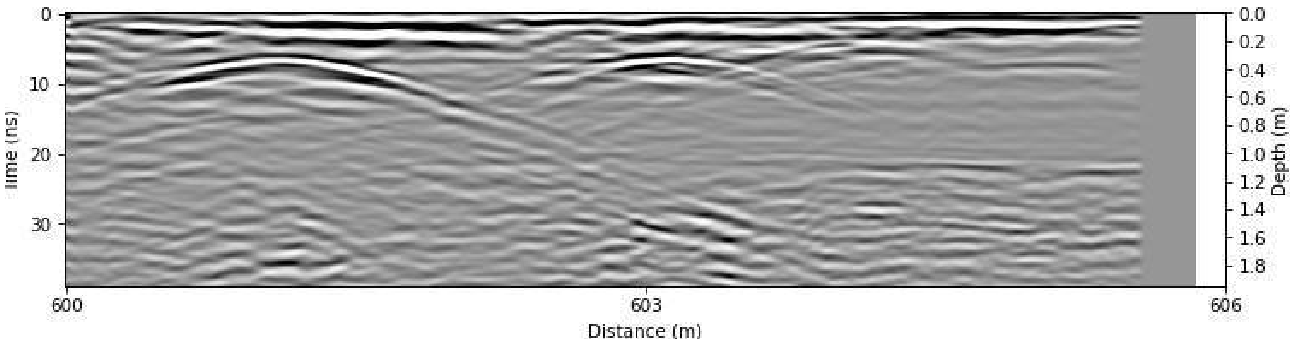


Figure B.259: Radargram at x = 505.5 m.

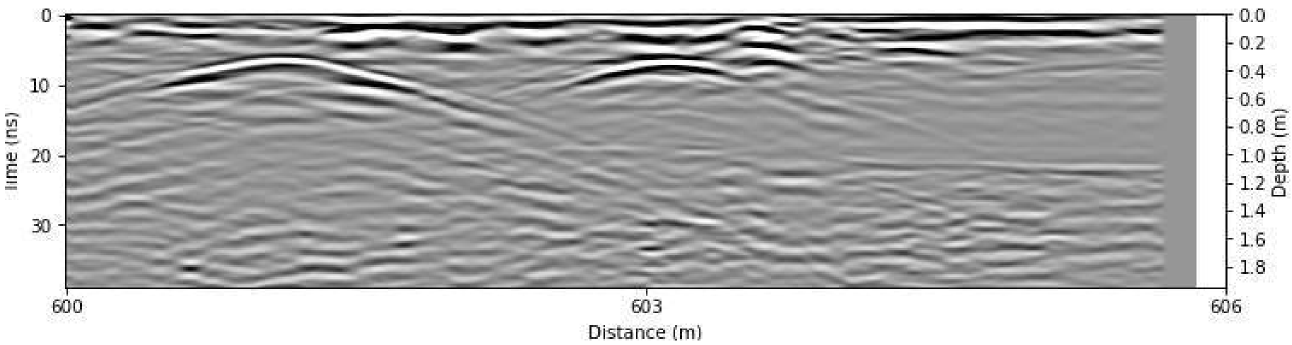


Figure B.260: Radargram at x = 505.75 m.

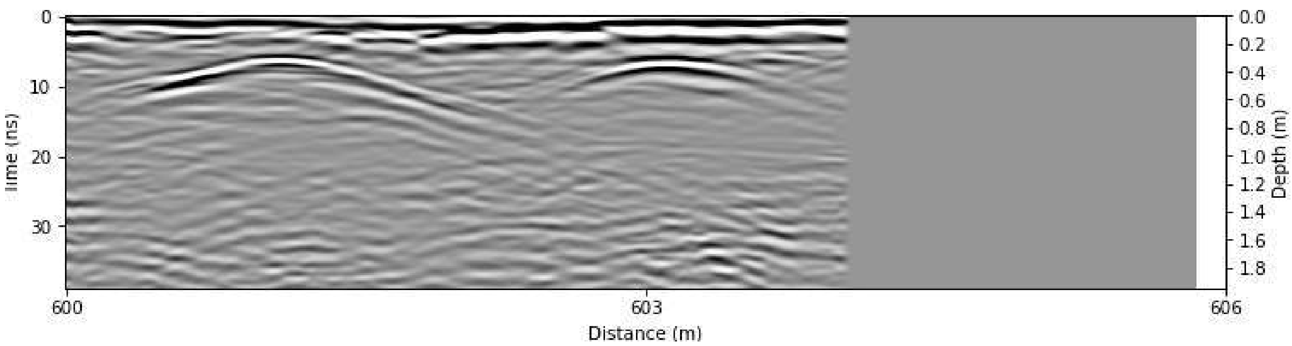


Figure B.261: Radargram at x = 506.0 m.

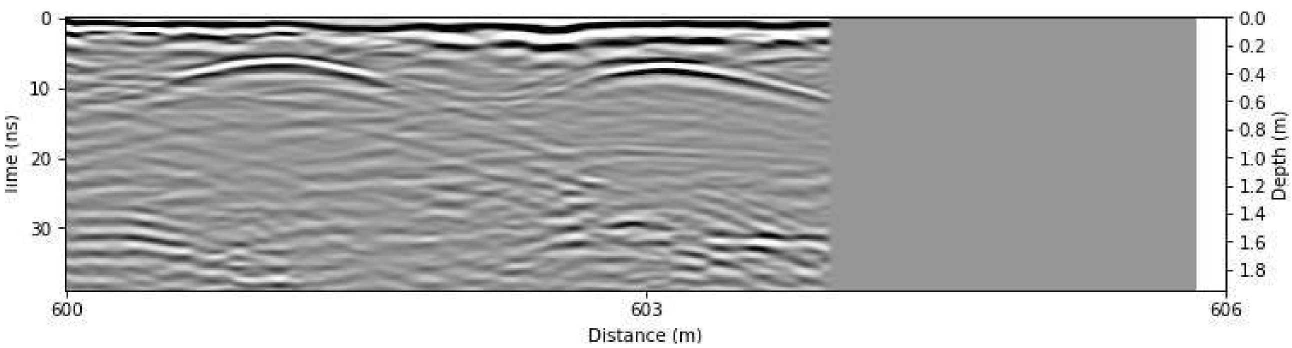


Figure B.262: Radargram at x = 506.25 m.

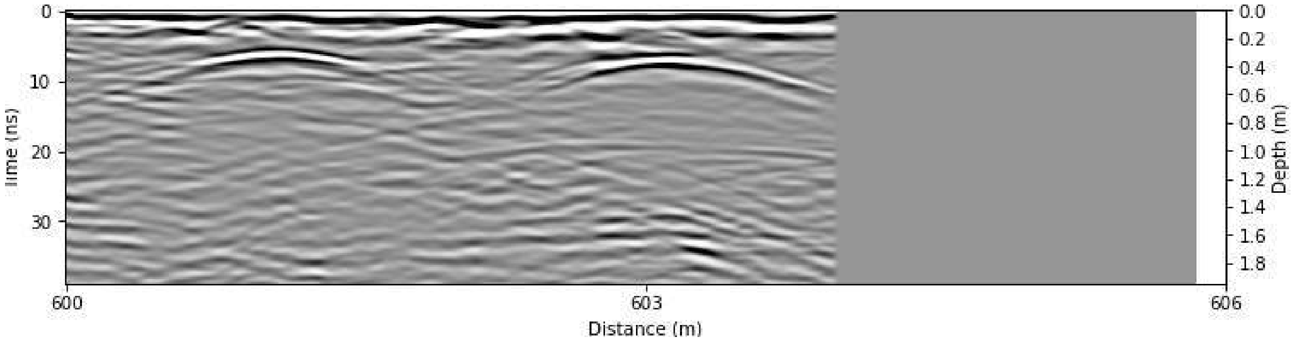


Figure B.263: Radargram at x = 506.5 m.

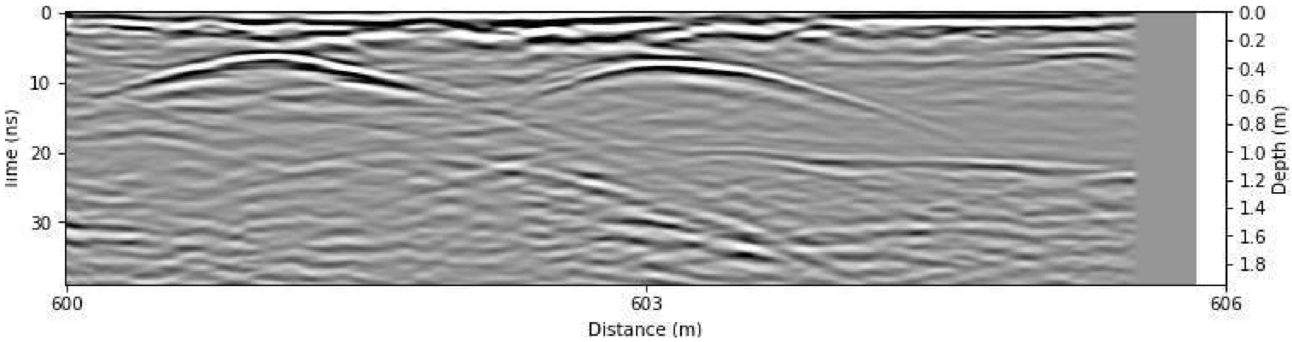


Figure B.264: Radargram at x = 506.75 m.

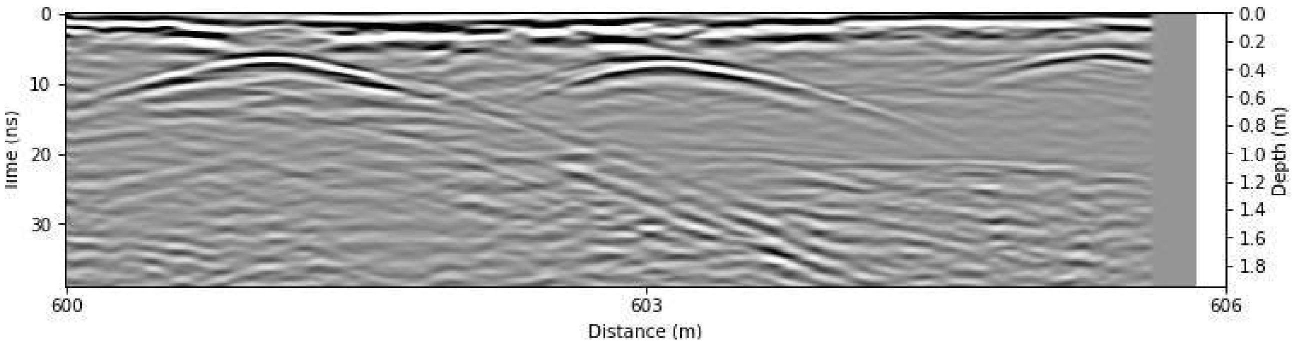


Figure B.265: Radargram at x = 507.0 m.

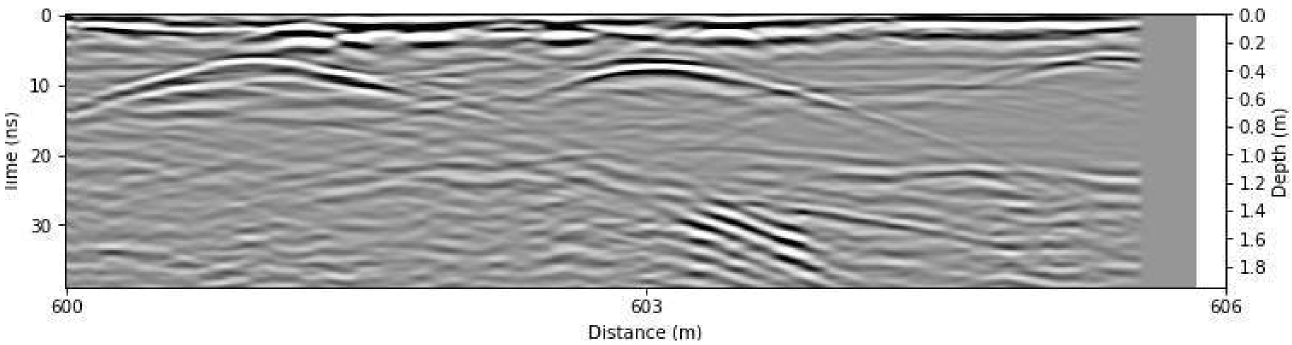


Figure B.266: Radargram at x = 507.25 m.

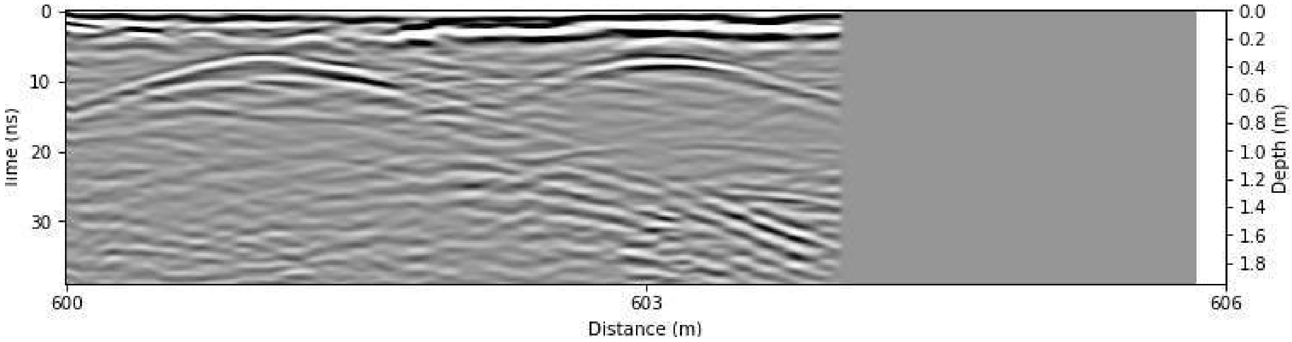


Figure B.267: Radargram at x = 507.5 m.

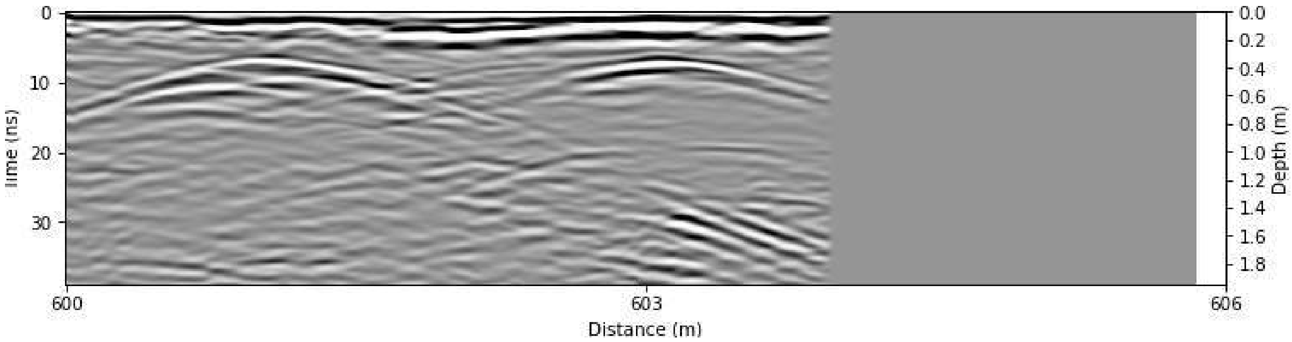


Figure B.268: Radargram at x = 507.75 m.

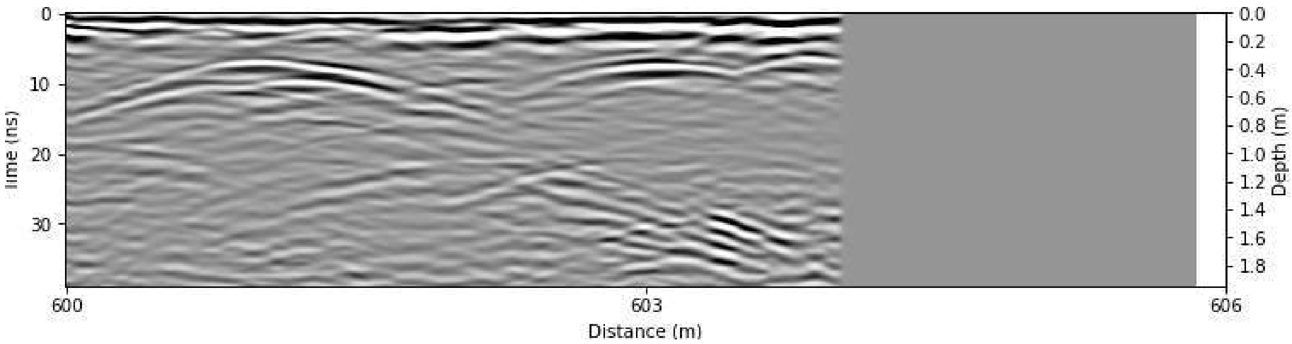


Figure B.269: Radargram at x = 508.0 m.

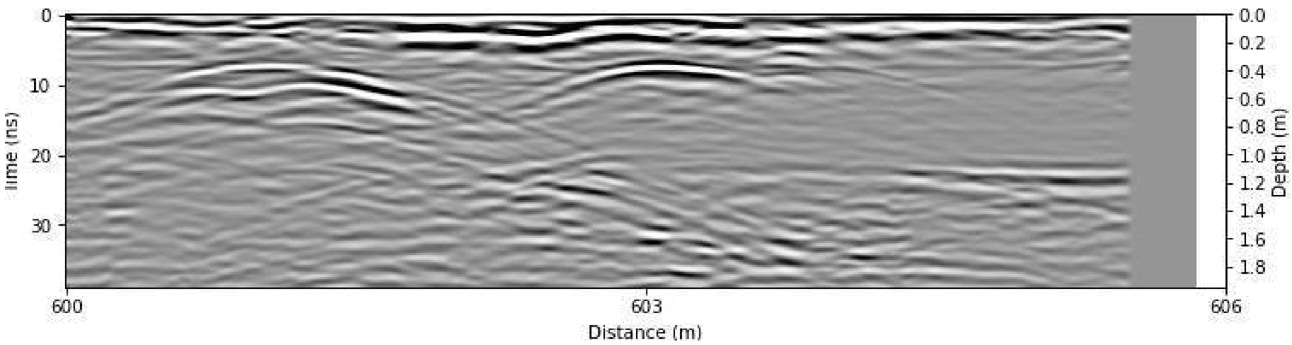


Figure B.270: Radargram at x = 508.25 m.

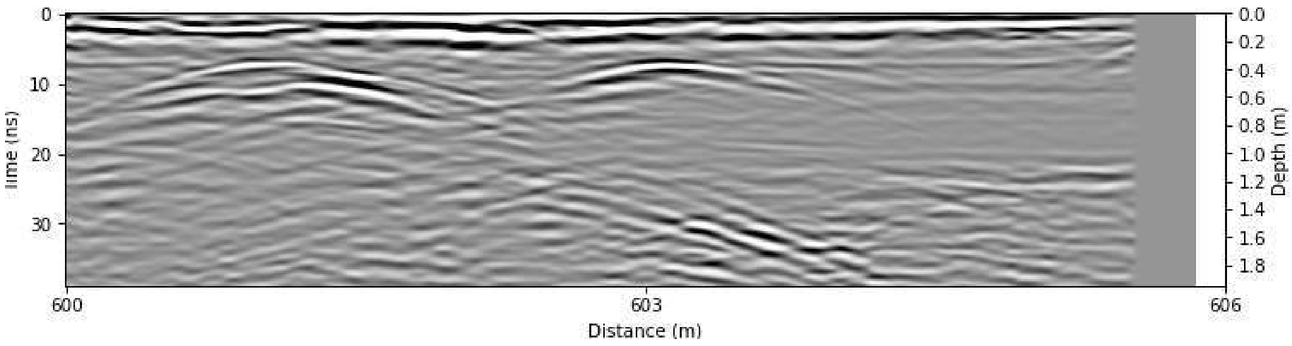


Figure B.271: Radargram at x = 508.5 m.

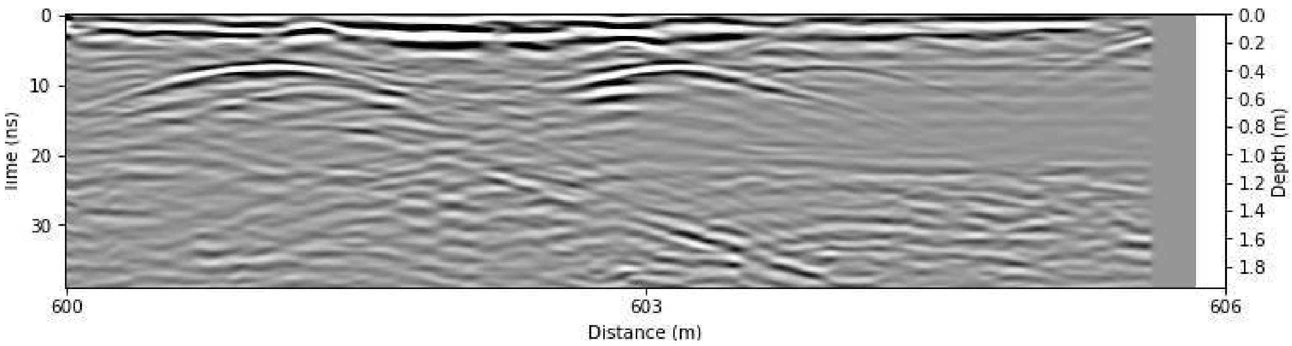


Figure B.272: Radargram at x = 508.75 m.

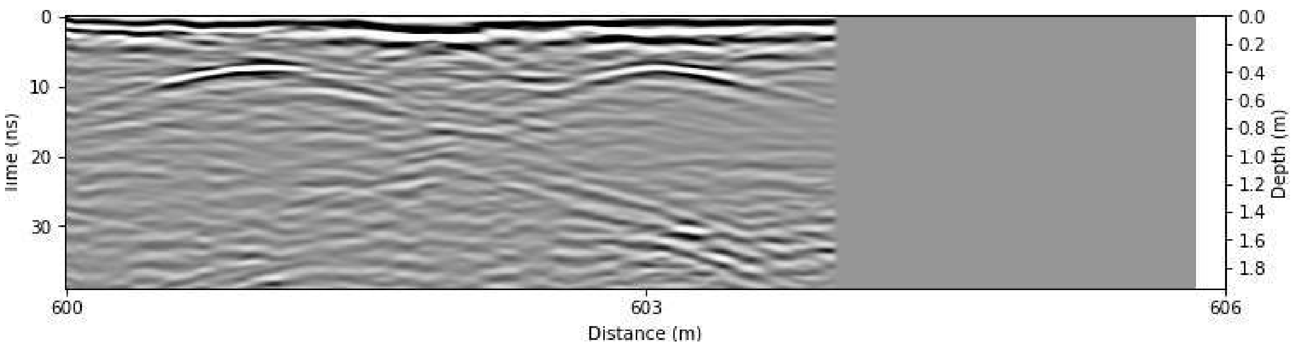


Figure B.273: Radargram at x = 509.0 m.

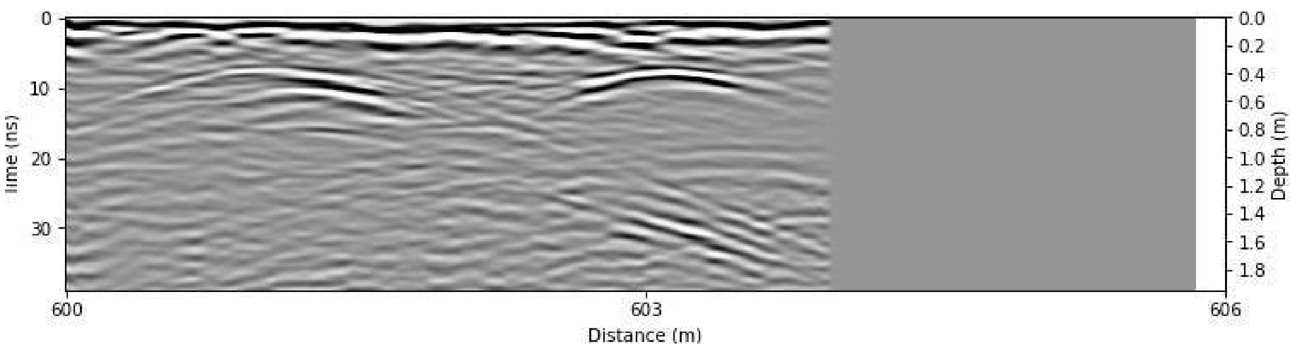


Figure B.274: Radargram at x = 509.25 m.

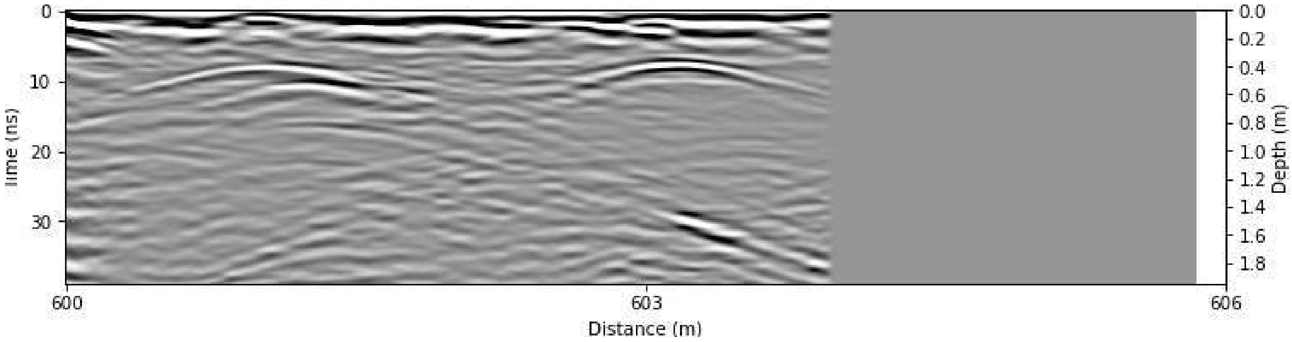


Figure B.275: Radargram at x = 509.5 m.

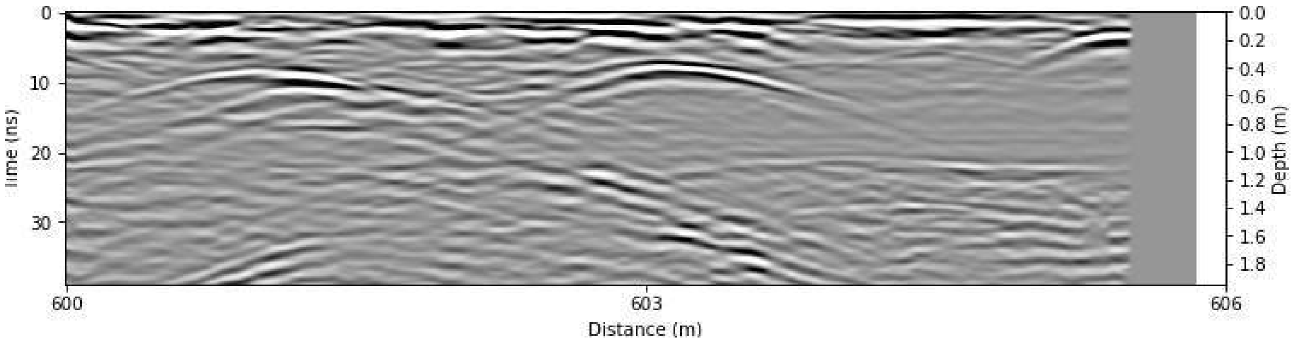


Figure B.276: Radargram at x = 509.75 m.

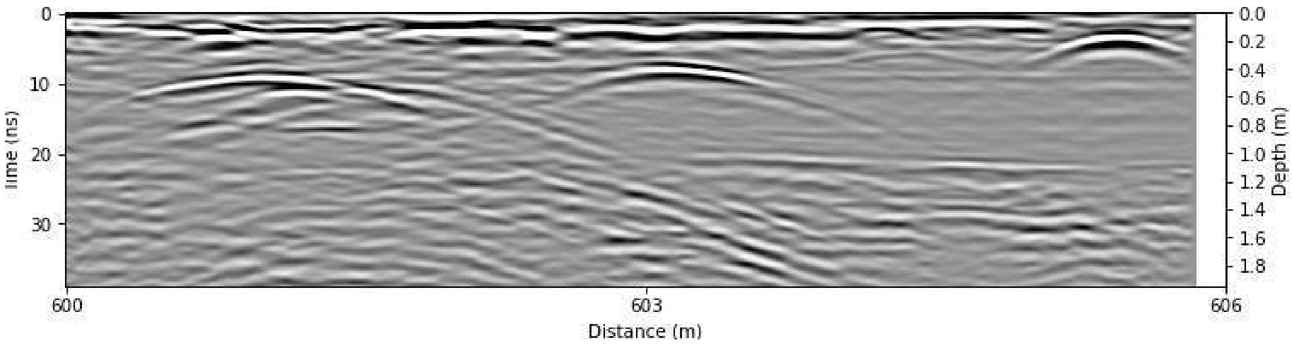
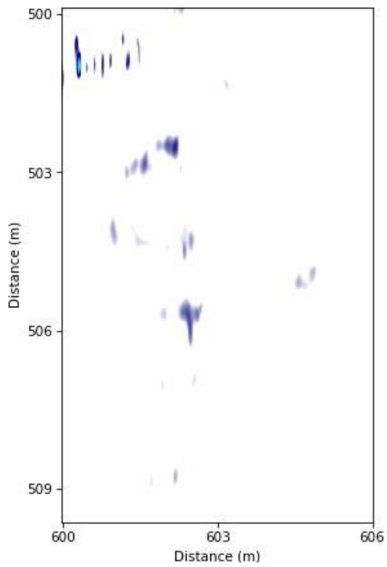
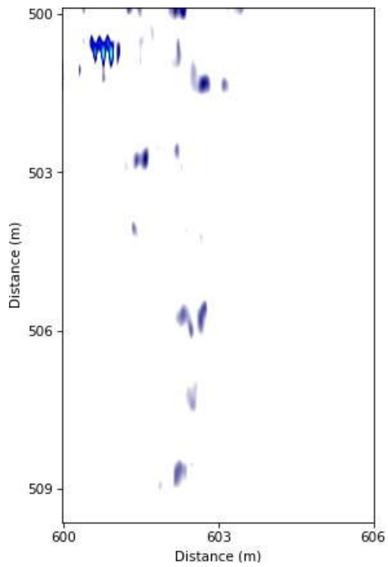


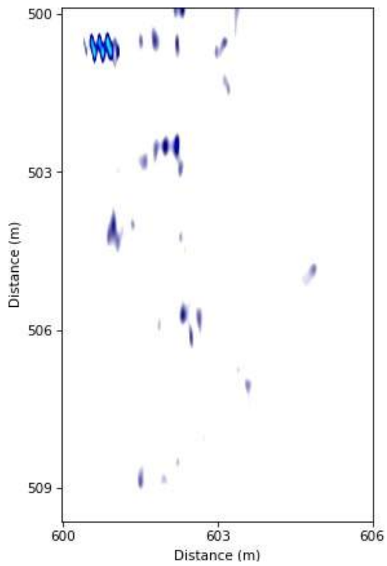
Figure B.277: Radargram at x = 510.0 m.



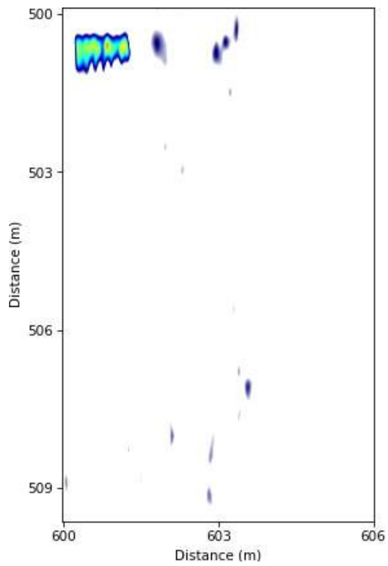
(a) Timeslice at z = 0.0 m.



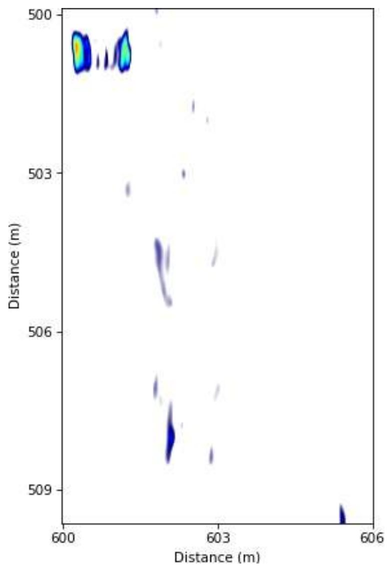
(b) Timeslice at z = 0.05 m.



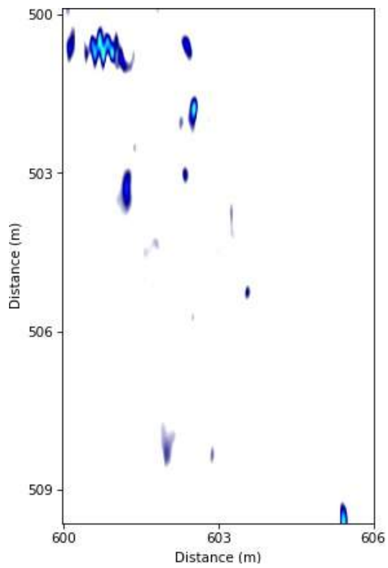
(c) Timeslice at z = 0.1 m.



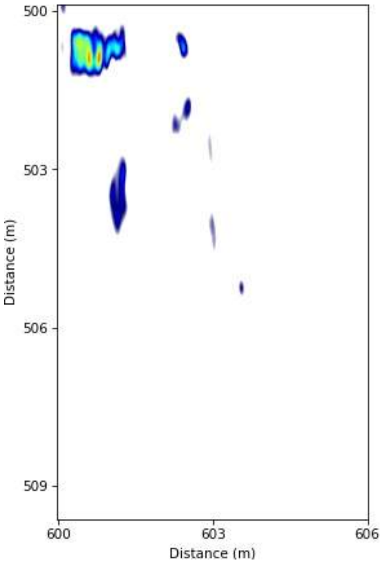
(d) Timeslice at z = 0.15 m.



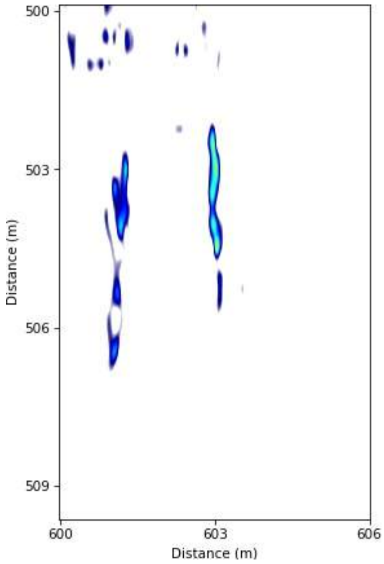
(e) Timeslice at z = 0.2 m.



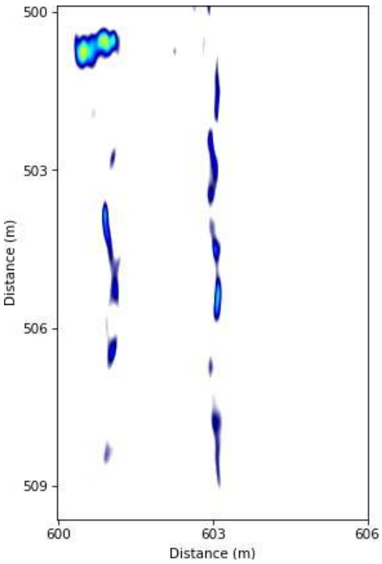
(f) Timeslice at z = 0.25 m.



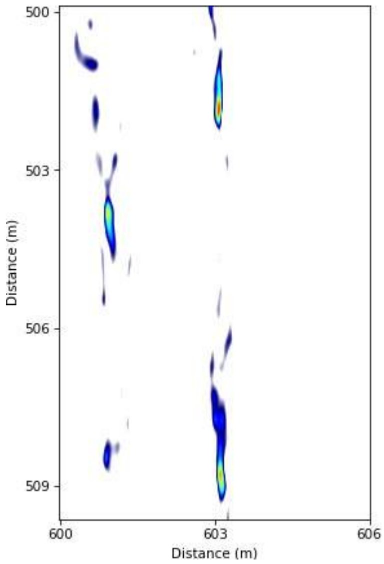
(a) Timeslice at z = 0.3 m.



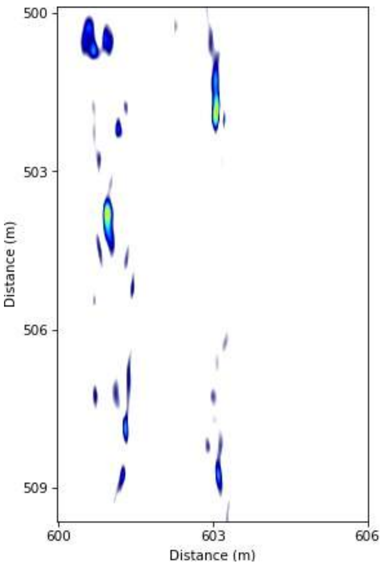
(b) Timeslice at z = 0.35 m.



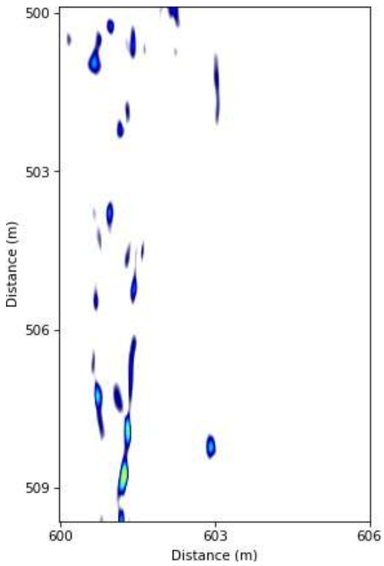
(c) Timeslice at z = 0.4 m.



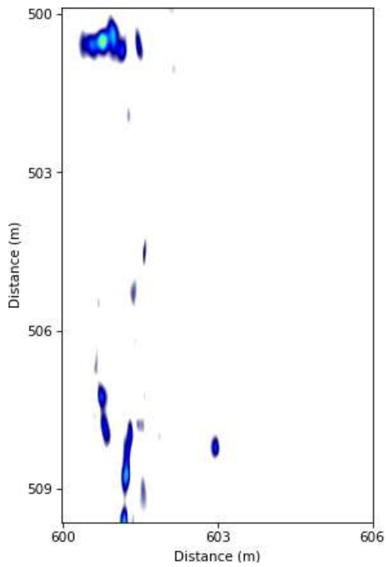
(d) Timeslice at z = 0.45 m.



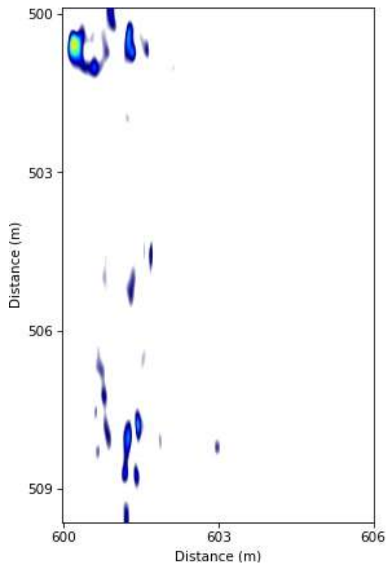
(e) Timeslice at z = 0.5 m.



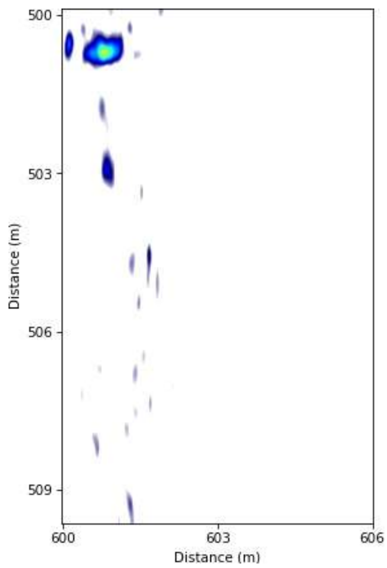
(f) Timeslice at z = 0.55 m.



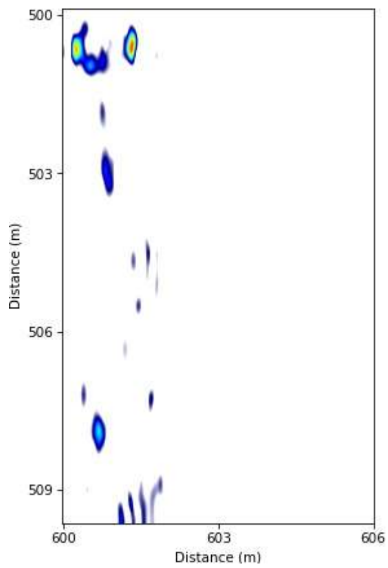
(a) Timeslice at z = 0.6 m.



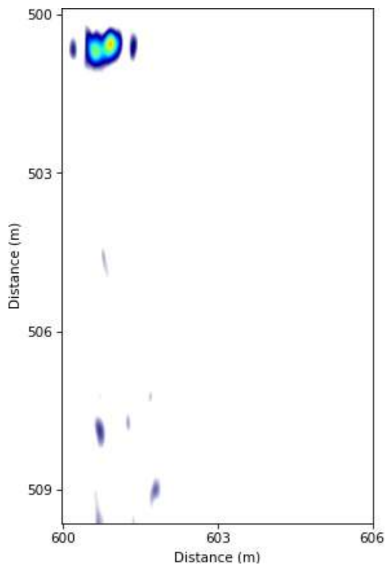
(b) Timeslice at z = 0.65 m.



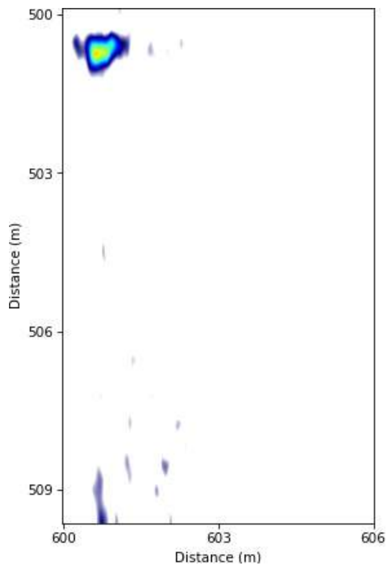
(c) Timeslice at z = 0.7 m.



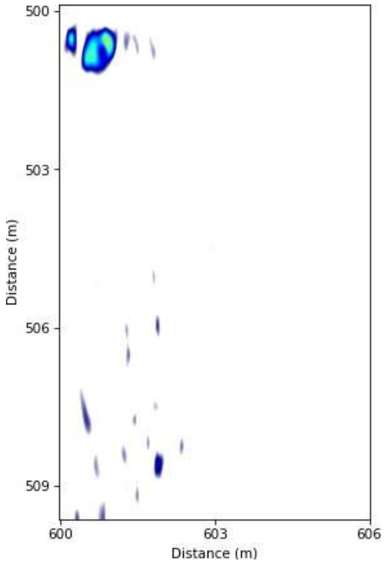
(d) Timeslice at z = 0.75 m.



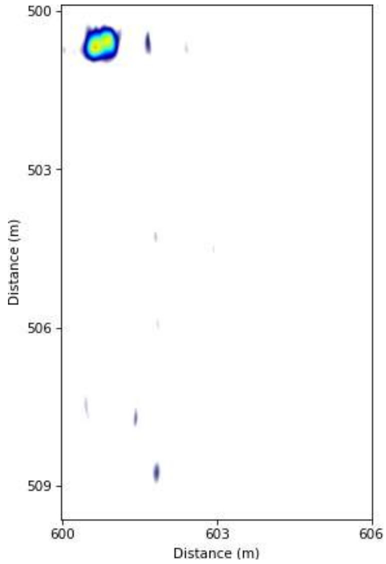
(e) Timeslice at z = 0.8 m.



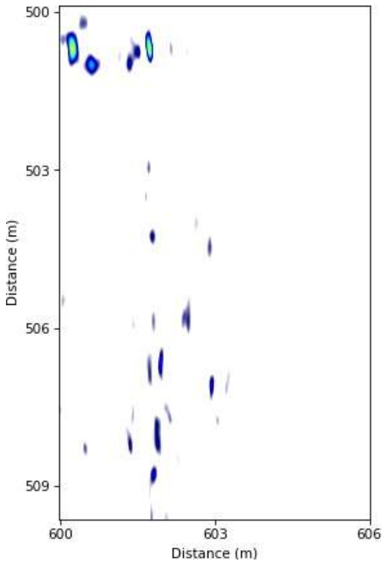
(f) Timeslice at z = 0.85 m.



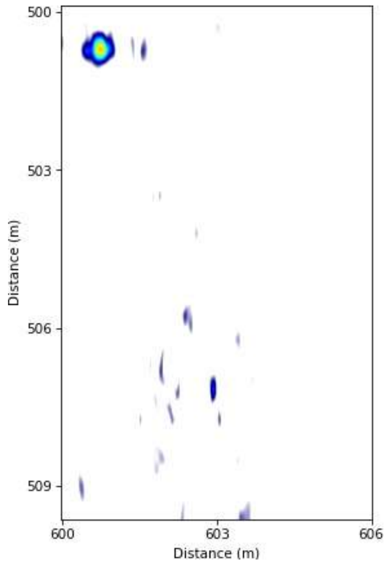
(a) Timeslice at z = 0.65 m.



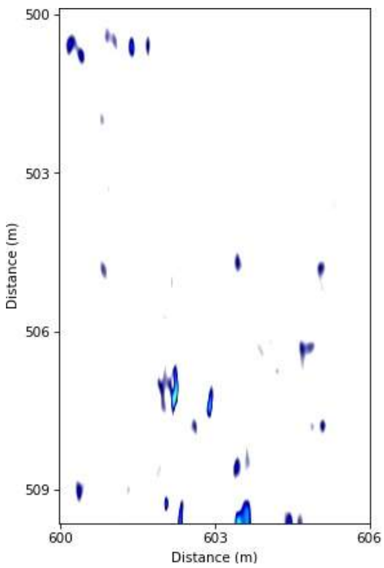
(b) Timeslice at z = 0.655 m.



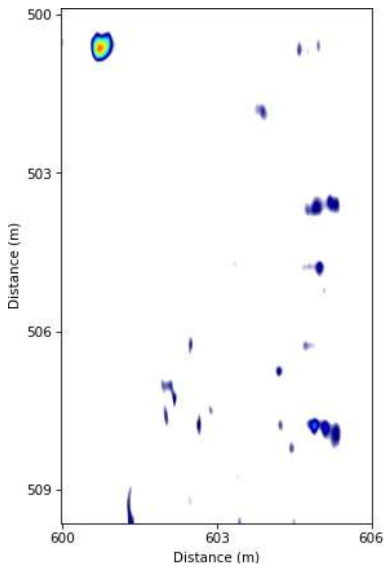
(c) Timeslice at z = 1.0 m.



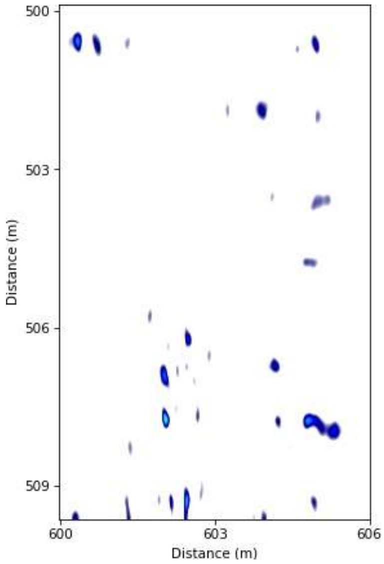
(d) Timeslice at z = 1.05 m.



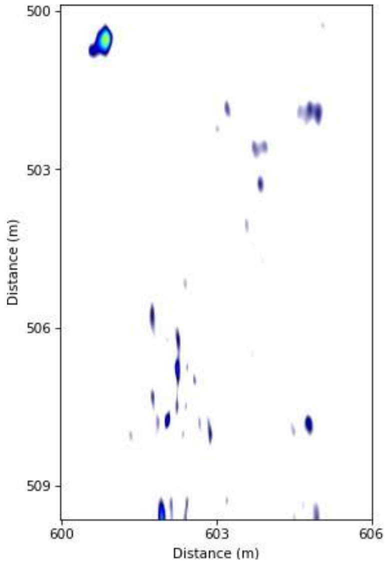
(e) Timeslice at z = 1.1 m.



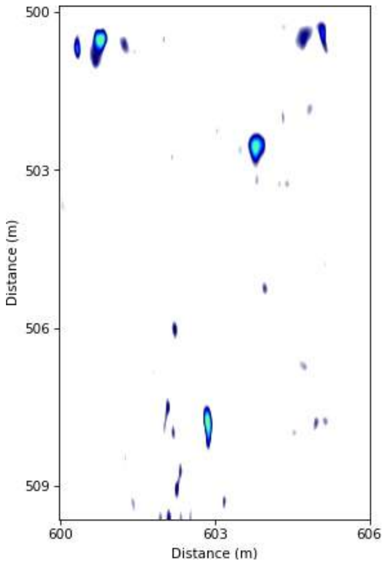
(f) Timeslice at z = 1.15 m.



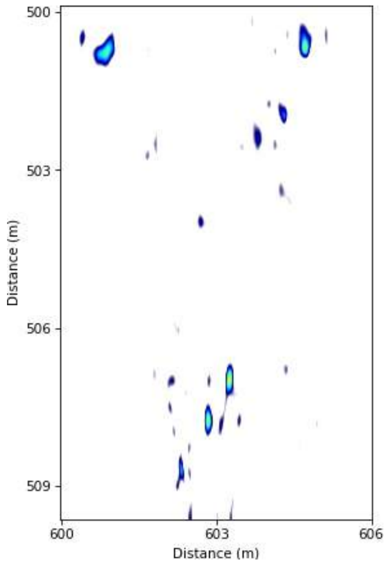
(a) Timeslice at z = 1.2 m.



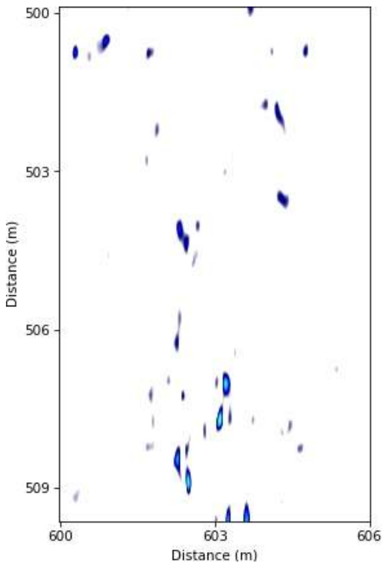
(b) Timeslice at z = 1.25 m.



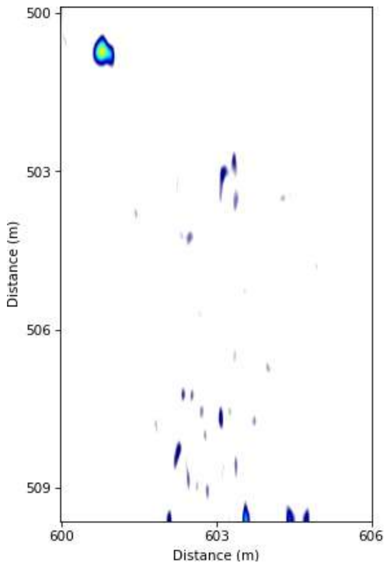
(c) Timeslice at z = 1.3 m.



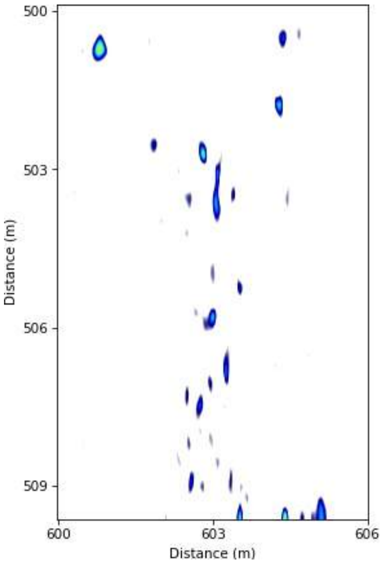
(d) Timeslice at z = 1.35 m.



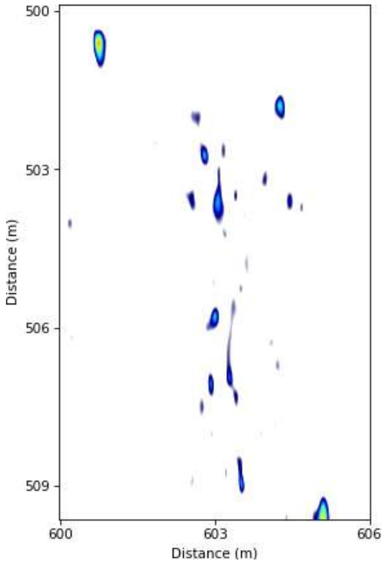
(e) Timeslice at z = 1.4 m.



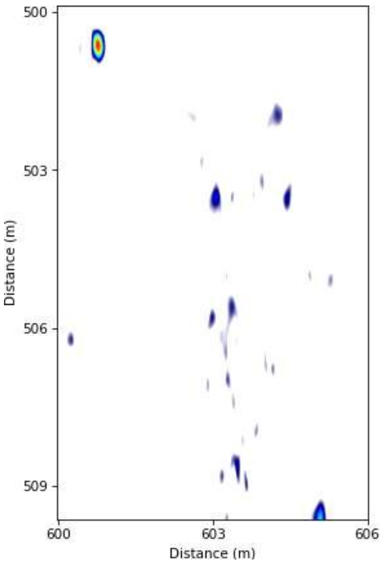
(f) Timeslice at z = 1.45 m.



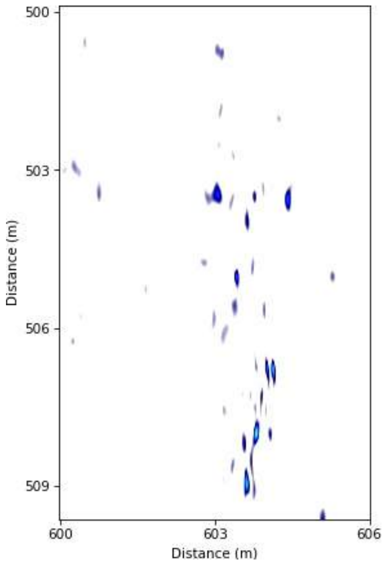
(a) Timeslice at z = 1.5 m.



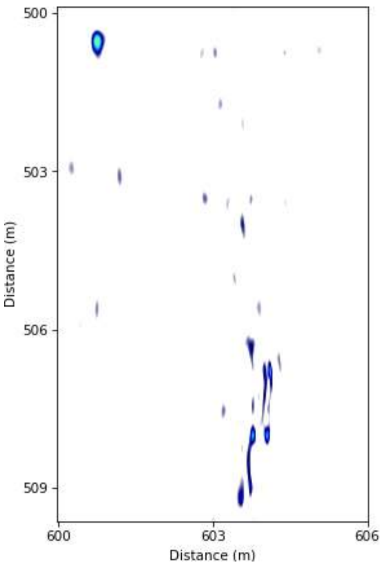
(b) Timeslice at z = 1.55 m.



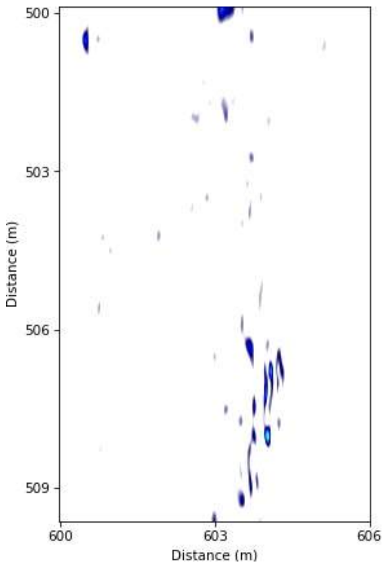
(c) Timeslice at z = 1.6 m.



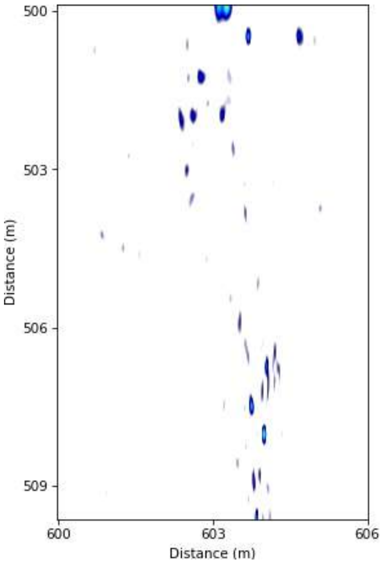
(d) Timeslice at z = 1.65 m.



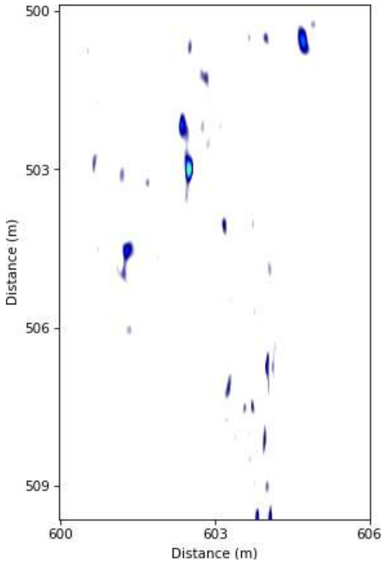
(e) Timeslice at z = 1.7 m.



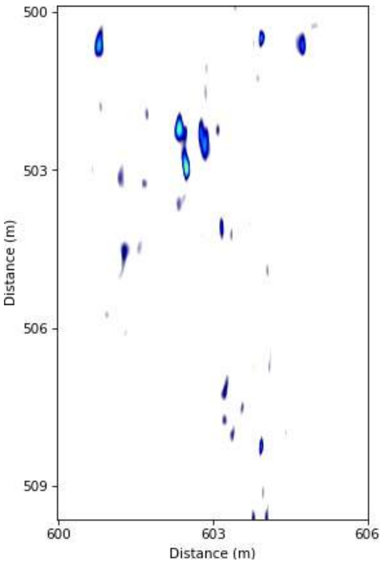
(f) Timeslice at z = 1.75 m.



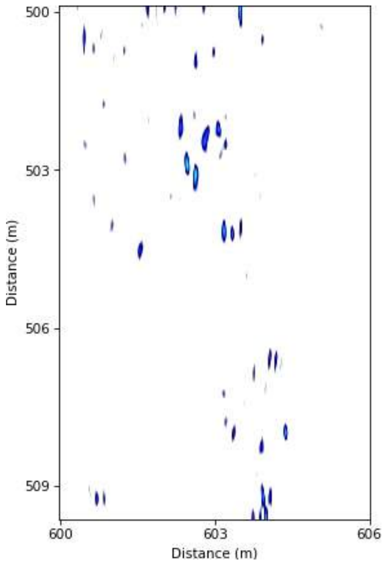
(a) Timeslice at z = 1.8 m.



(b) Timeslice at z = 1.85 m.



(c) Timeslice at z = 1.9 m.



(d) Timeslice at z = 1.95 m.

B.7 KU-TP18

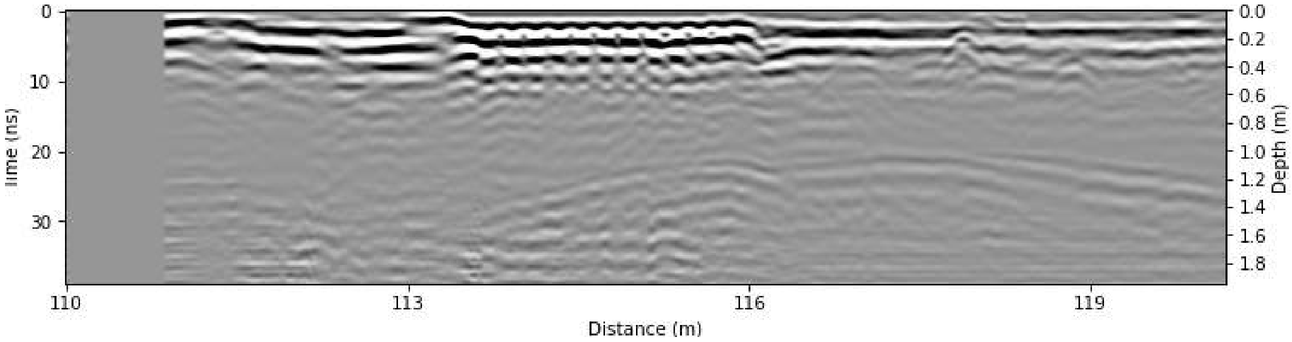


Figure B.285: Radargram at x = 240.0 m.

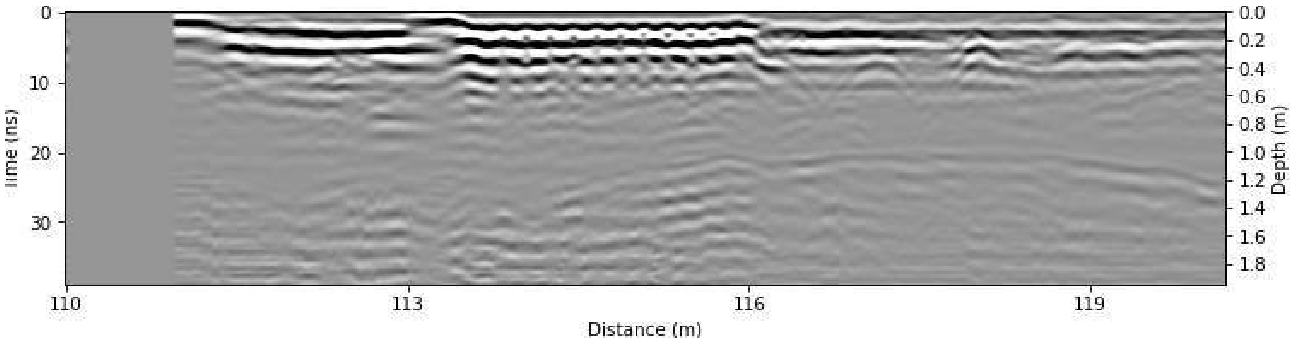


Figure B.286: Radargram at x = 240.25 m.

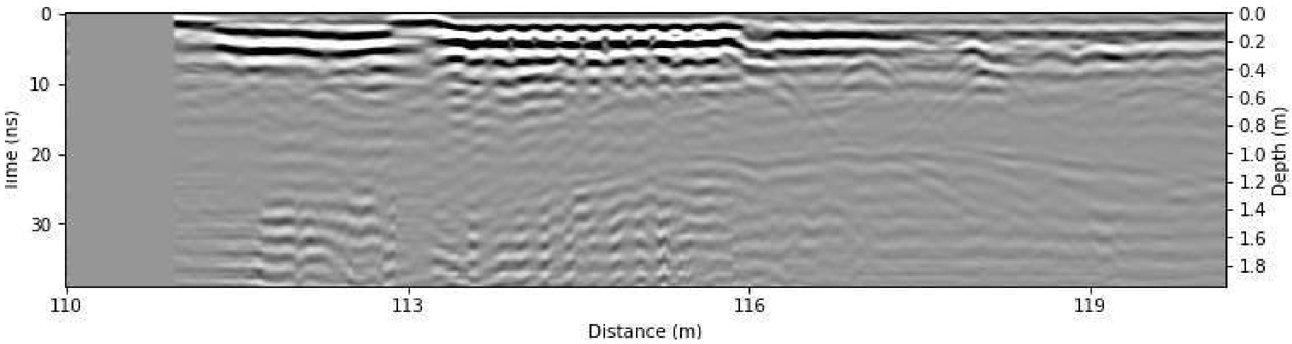


Figure B.287: Radargram at x = 240.5 m.

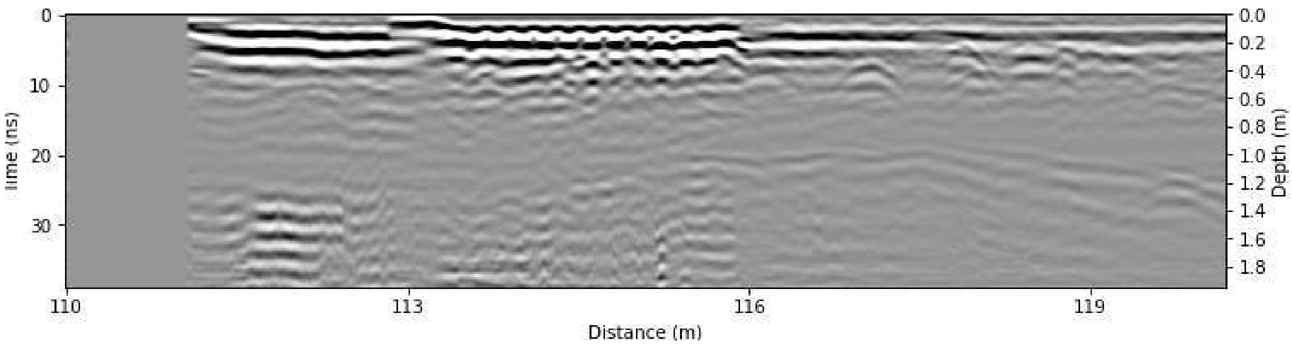


Figure B.288: Radargram at x = 240.75 m.

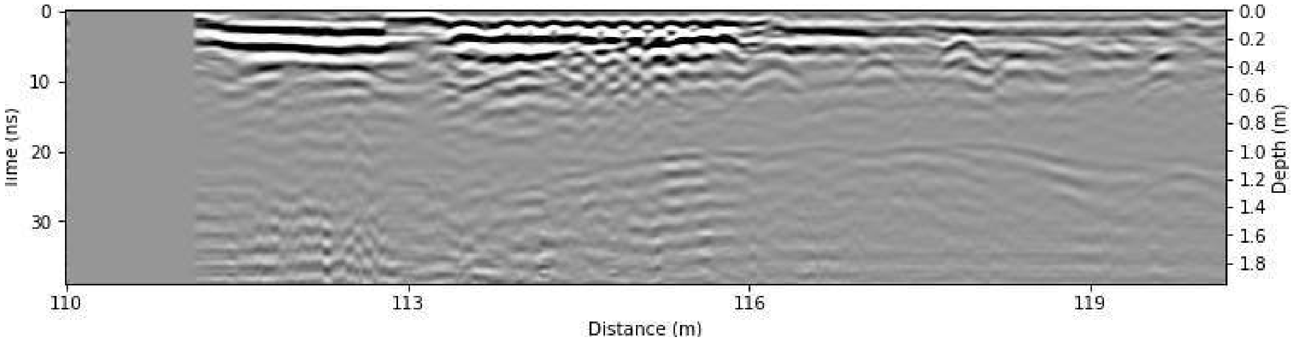


Figure B.289: Radargram at x = 241.0 m.

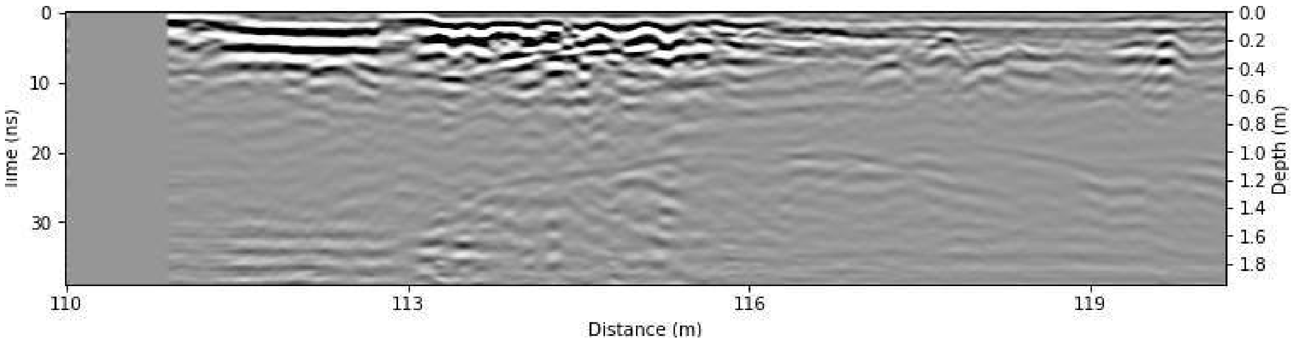


Figure B.290: Radargram at x = 241.25 m.

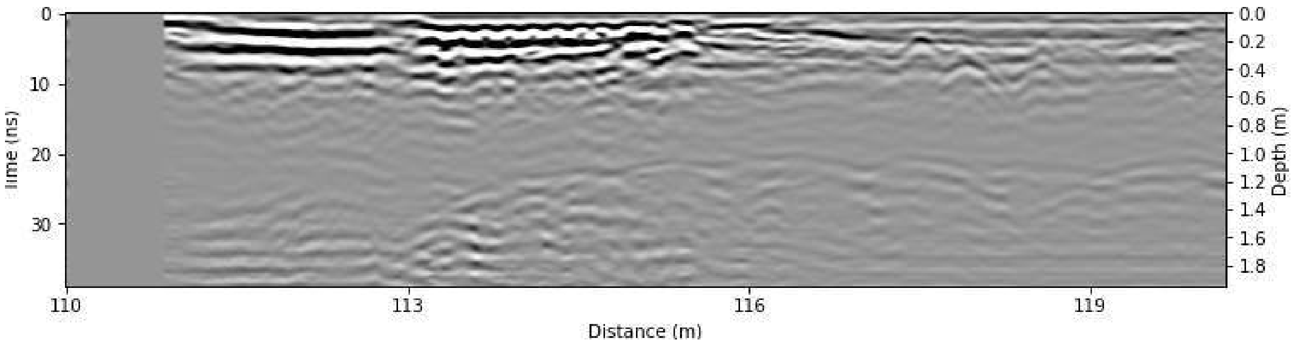


Figure B.291: Radargram at x = 241.5 m.

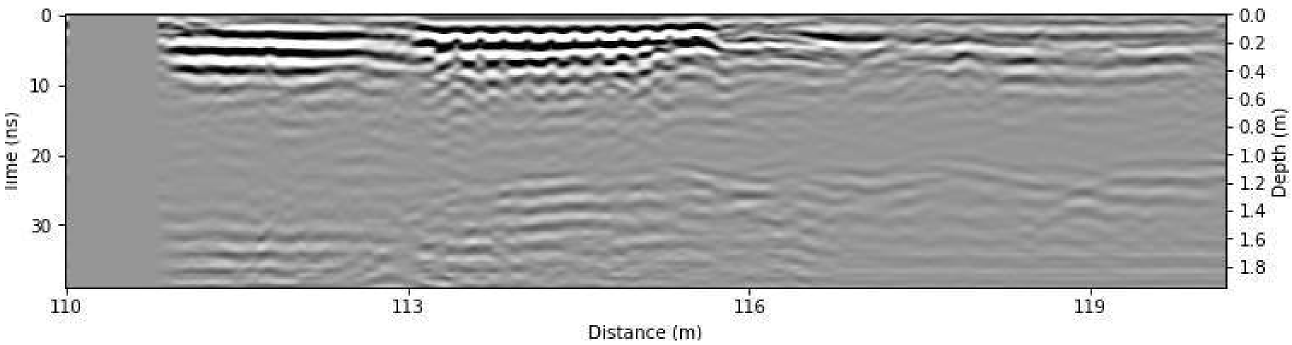


Figure B.292: Radargram at x = 241.75 m.

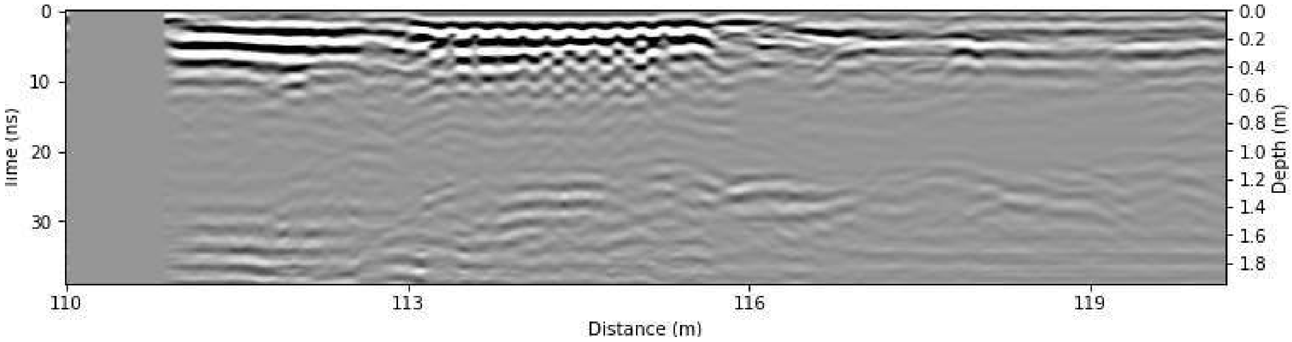


Figure B.293: Radargram at x = 242.0 m.

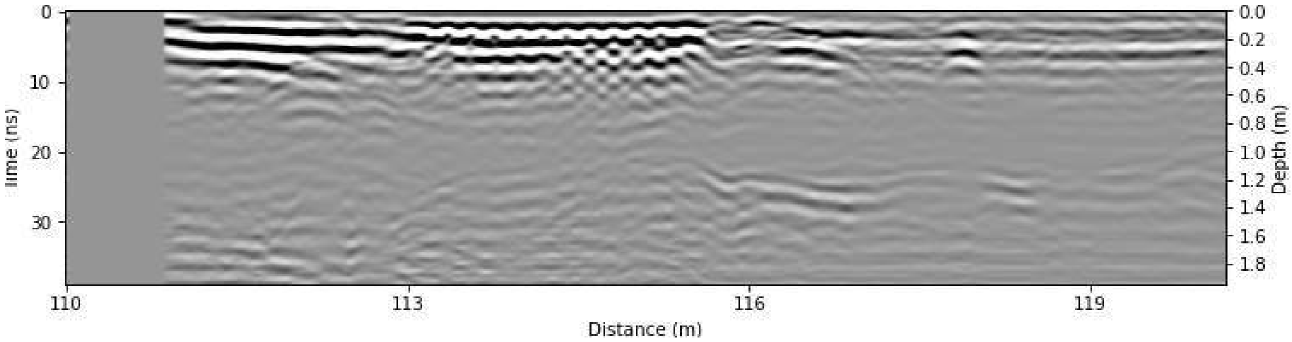


Figure B.294: Radargram at x = 242.25 m.

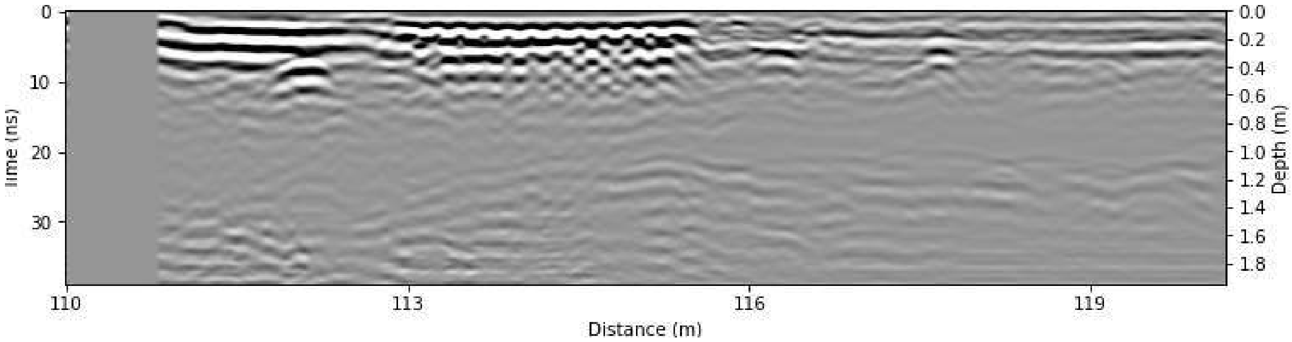


Figure B.295: Radargram at x = 242.5 m.

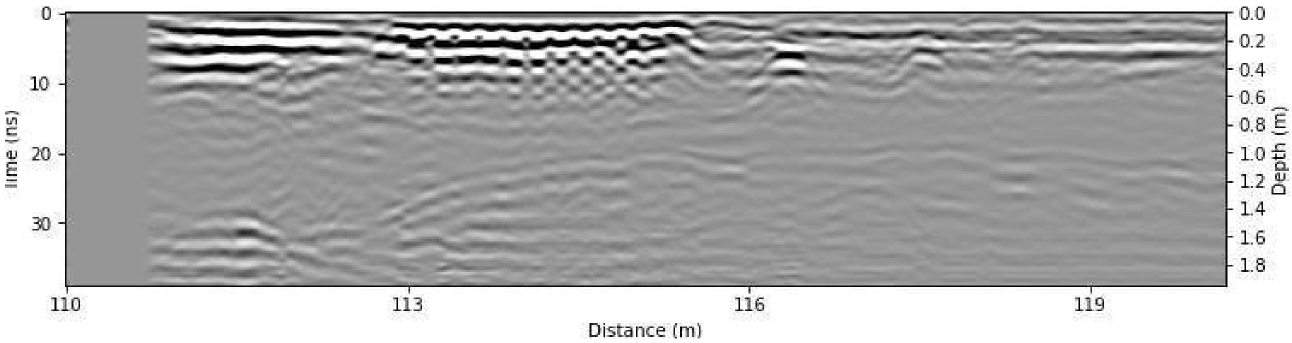


Figure B.296: Radargram at x = 242.75 m.

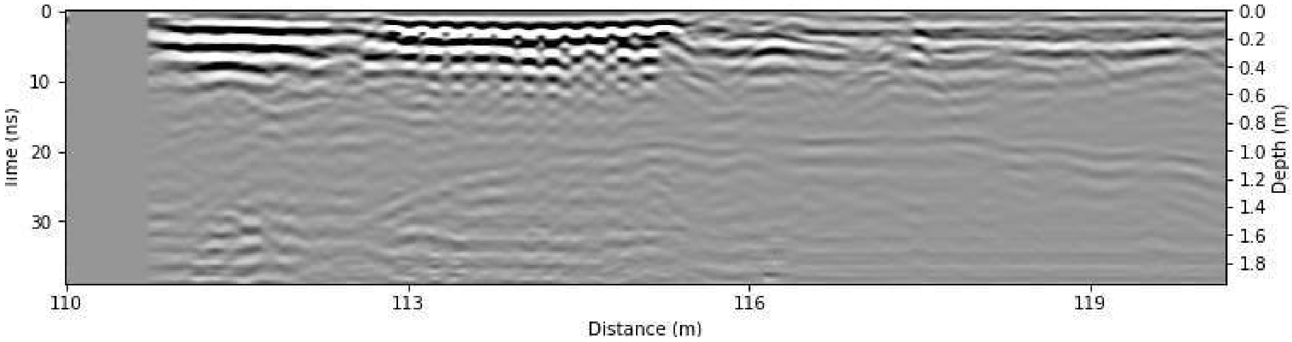


Figure B.297: Radargram at x = 243.0 m.

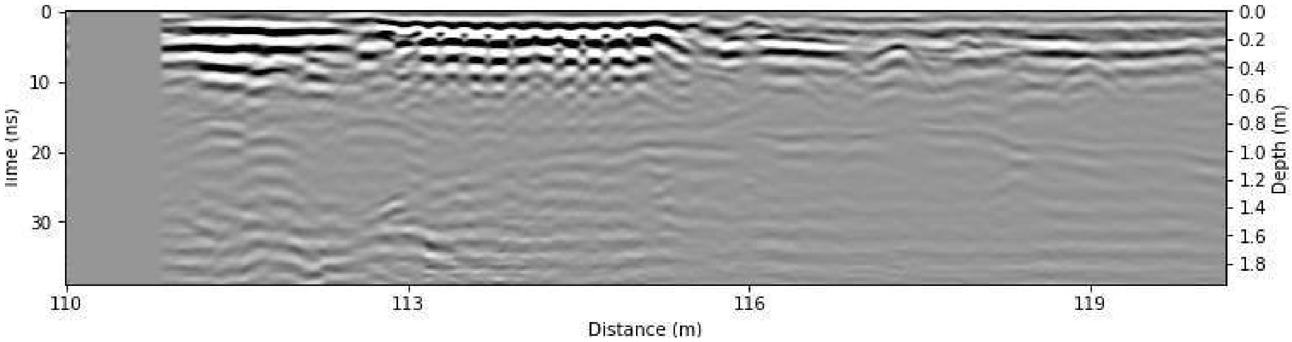


Figure B.298: Radargram at x = 243.25 m.

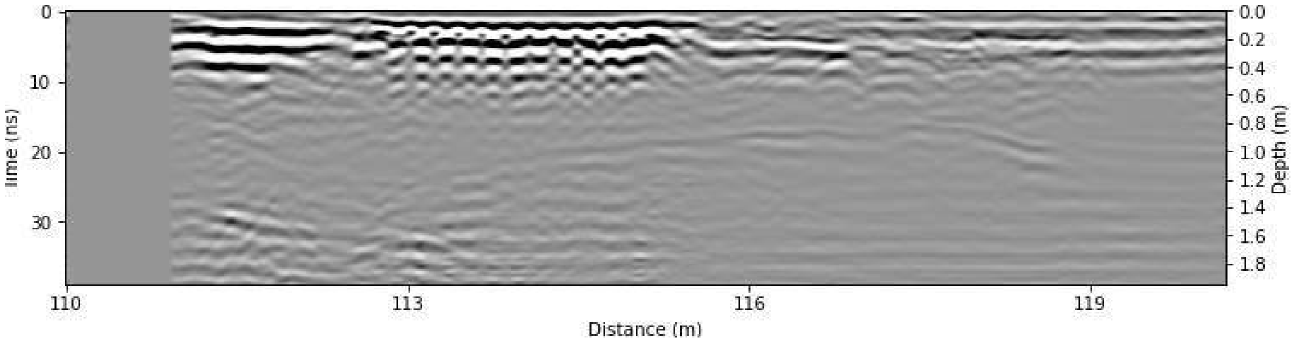


Figure B.299: Radargram at x = 243.5 m.

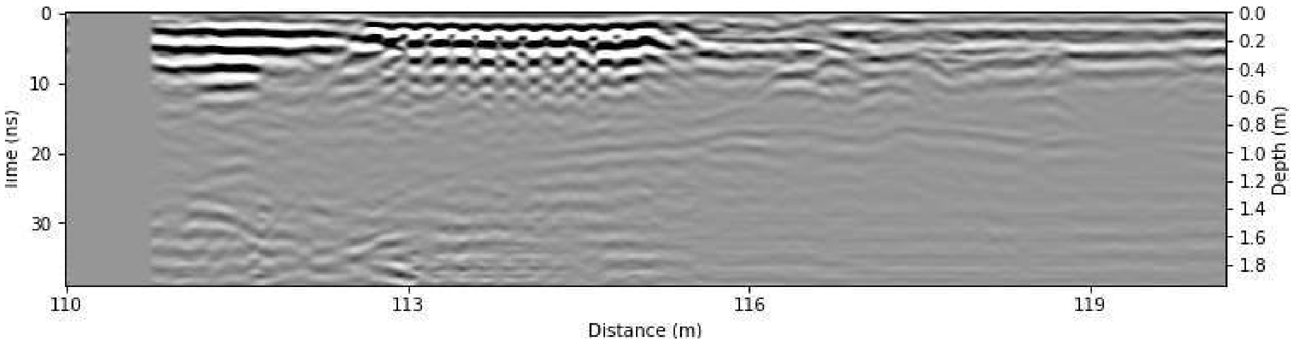


Figure B.300: Radargram at x = 243.75 m.

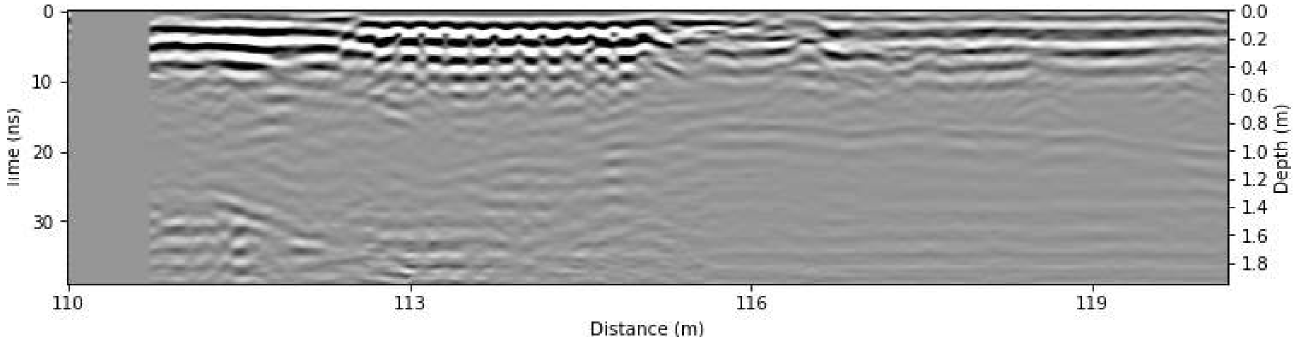


Figure B.301: Radargram at x = 244.0 m.

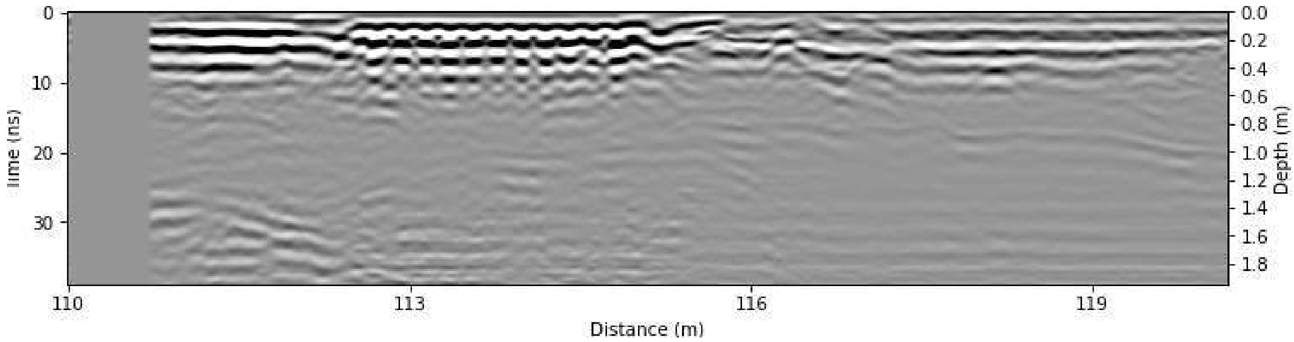


Figure B.302: Radargram at x = 244.25 m.

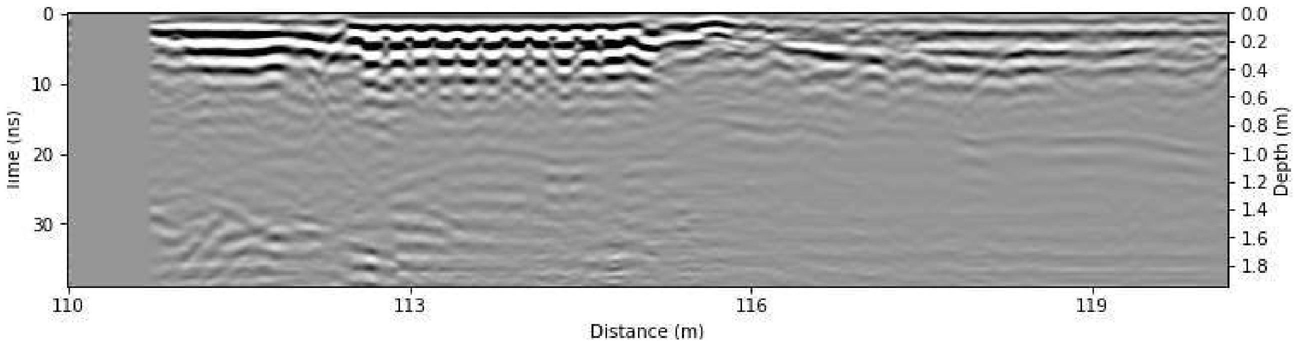


Figure B.303: Radargram at x = 244.5 m.

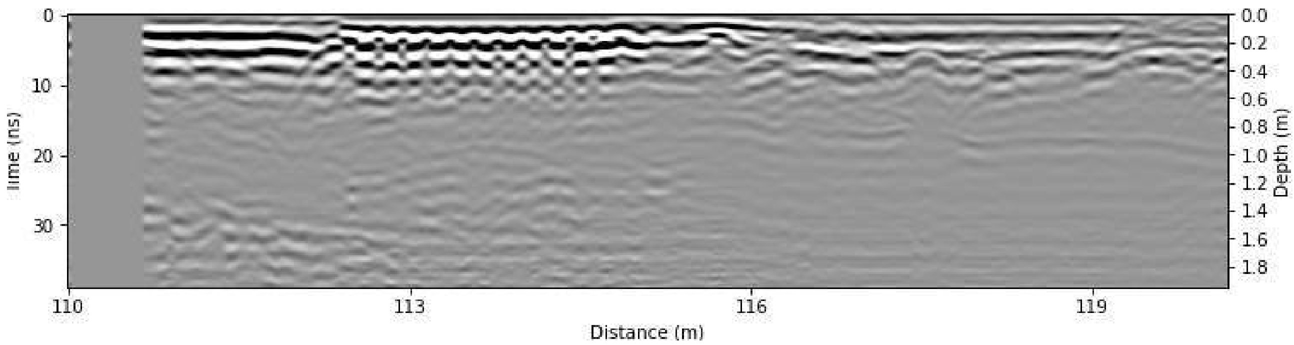


Figure B.304: Radargram at x = 244.75 m.

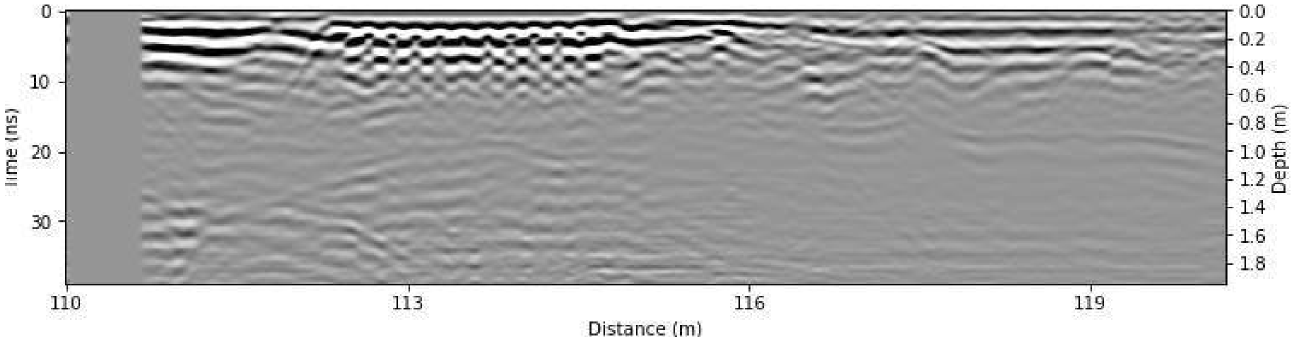


Figure B.305: Radargram at x = 245.0 m.

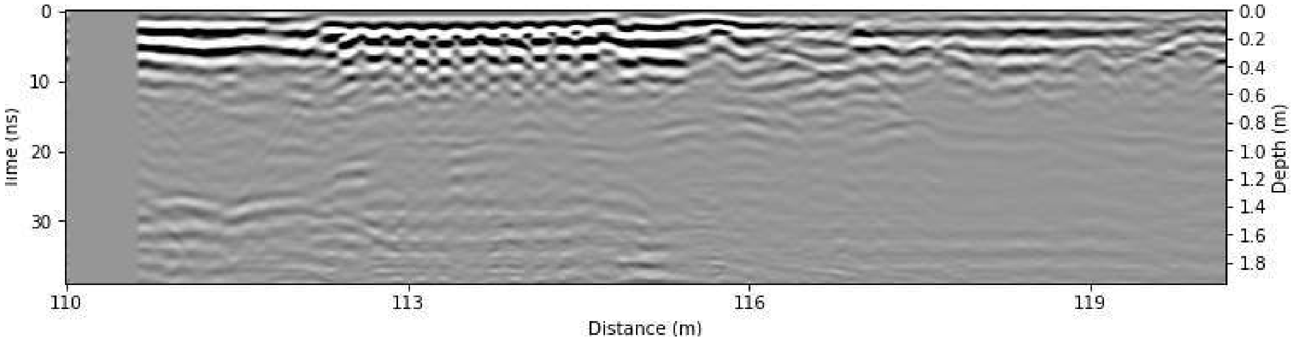


Figure B.306: Radargram at x = 245.25 m.

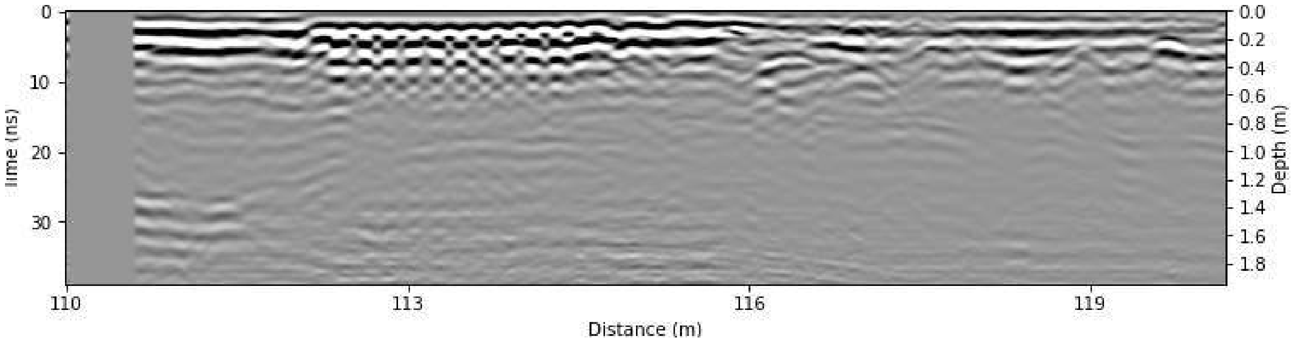


Figure B.307: Radargram at x = 245.5 m.

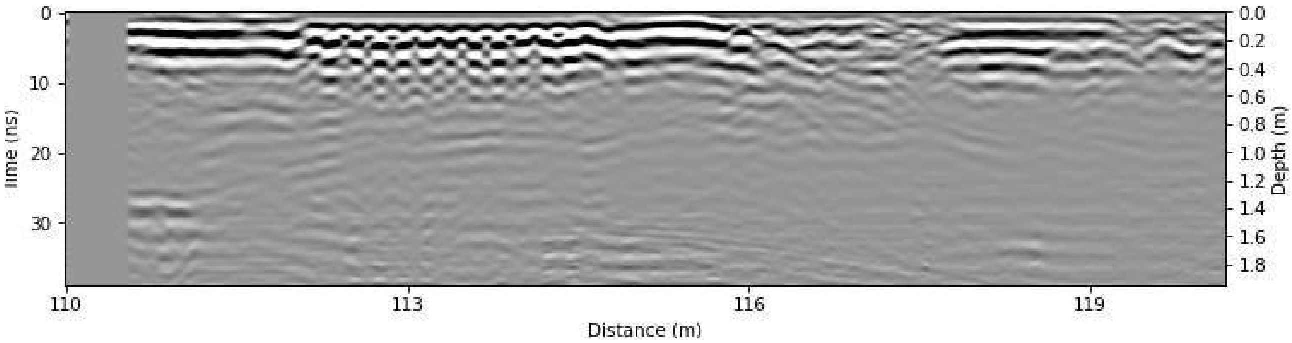


Figure B.308: Radargram at x = 245.75 m.

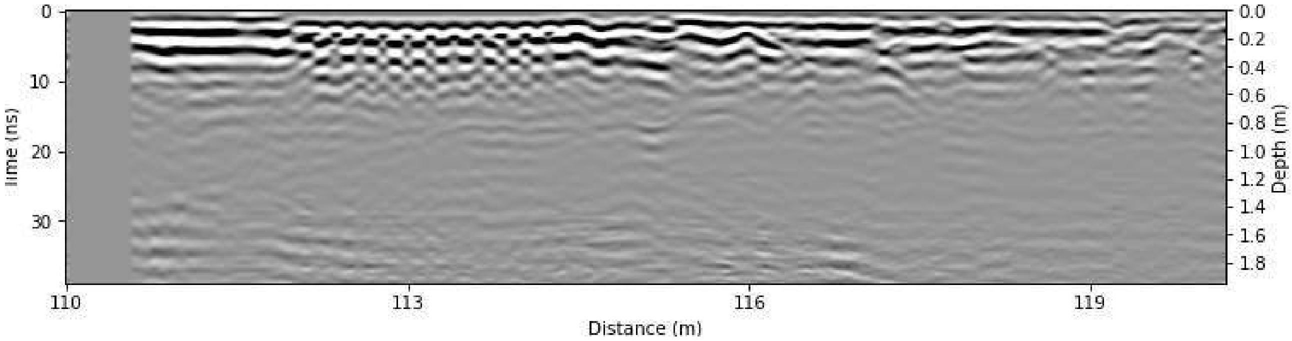


Figure B.309: Radargram at x = 246.0 m.

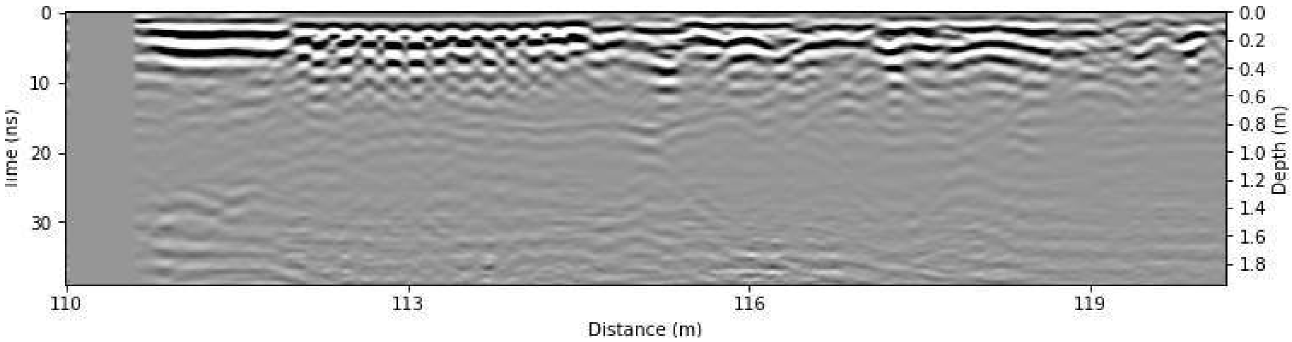


Figure B.310: Radargram at x = 246.25 m.

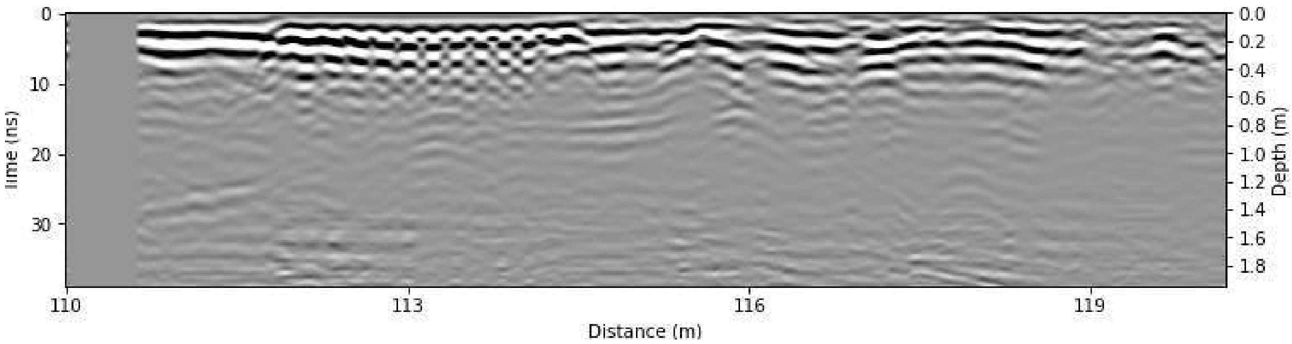


Figure B.311: Radargram at x = 246.5 m.

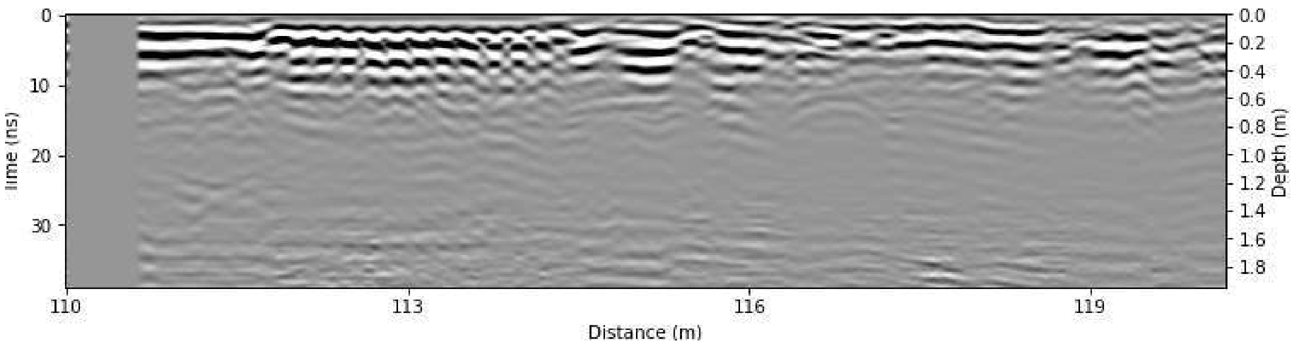


Figure B.312: Radargram at x = 246.75 m.

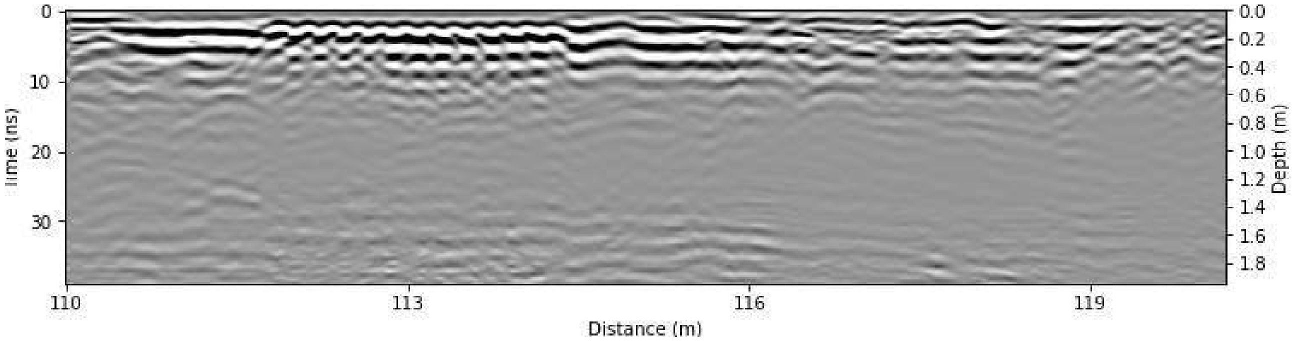


Figure B.313: Radargram at x = 247.0 m.

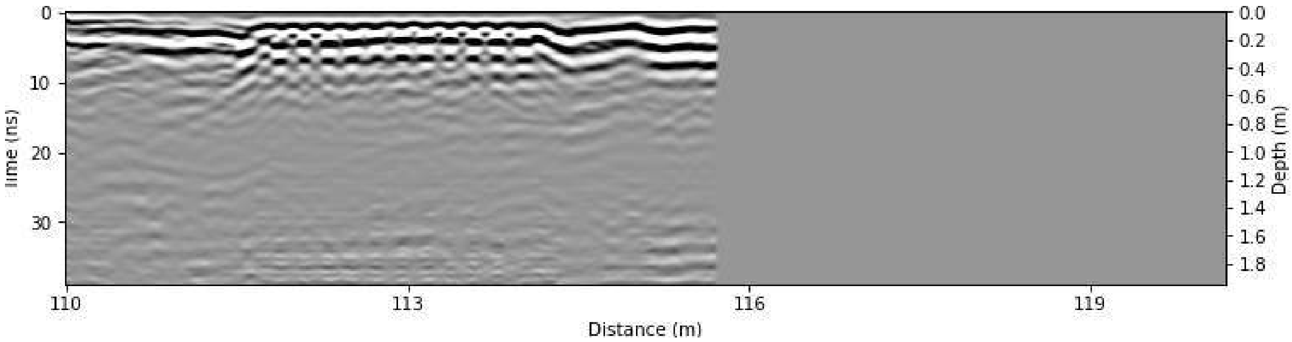


Figure B.314: Radargram at x = 247.25 m.

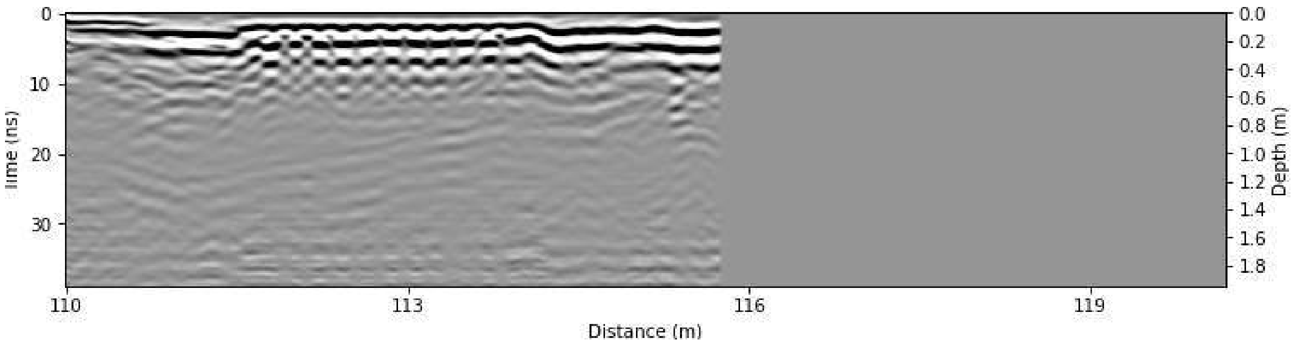


Figure B.315: Radargram at x = 247.5 m.

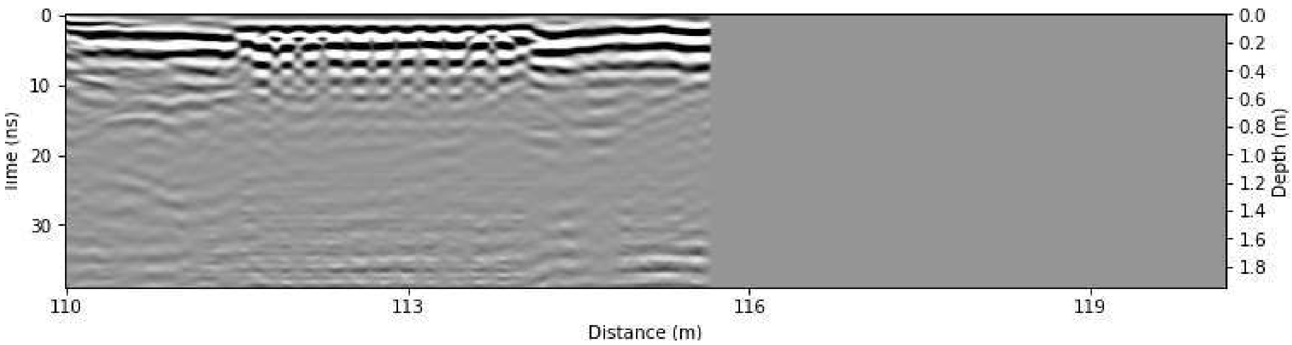


Figure B.316: Radargram at x = 247.75 m.

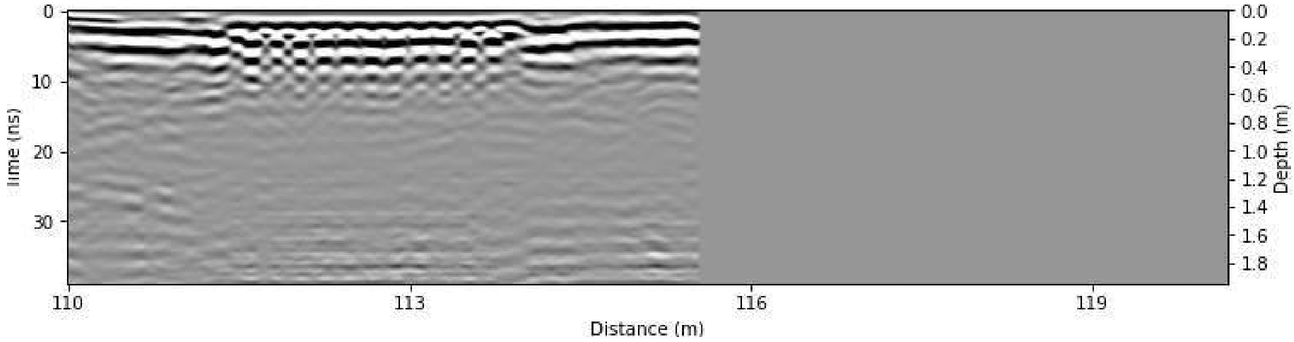


Figure B.317: Radargram at x = 248.0 m.

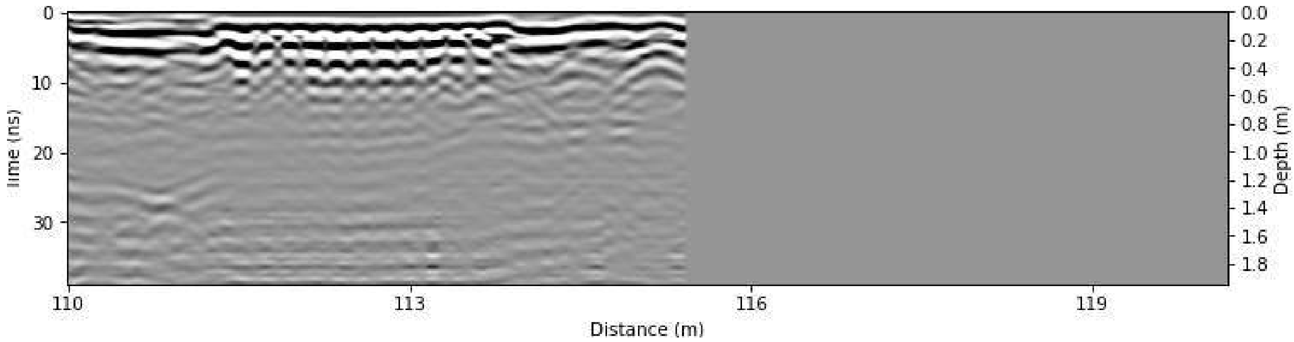


Figure B.318: Radargram at x = 248.25 m.

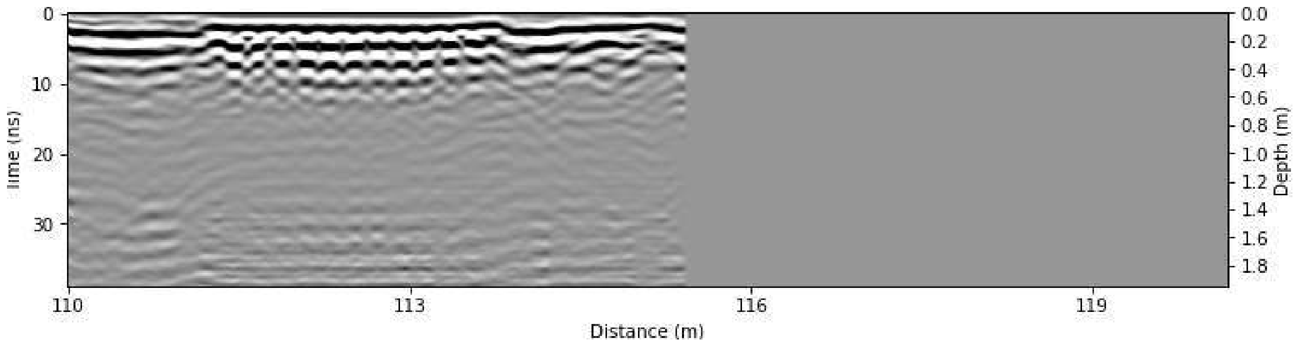


Figure B.319: Radargram at x = 248.5 m.

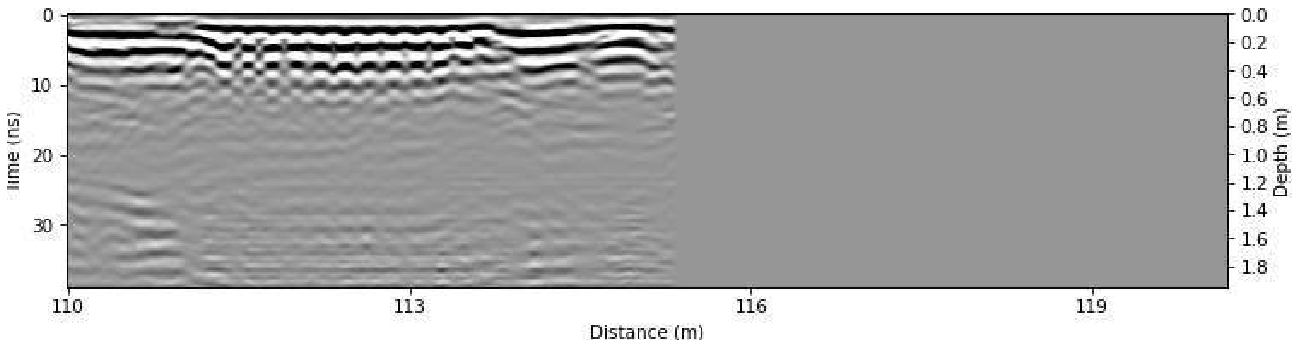


Figure B.320: Radargram at x = 248.75 m.

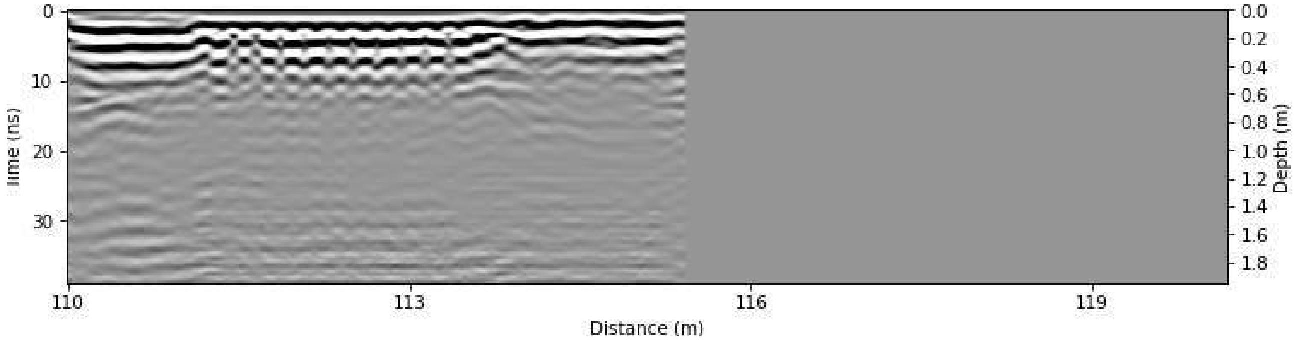


Figure B.321: Radargram at x = 249.0 m.

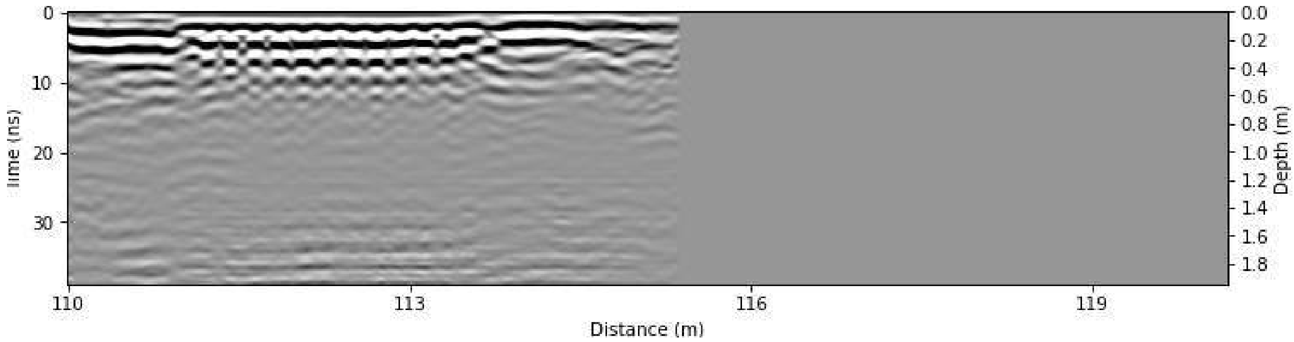


Figure B.322: Radargram at x = 249.25 m.

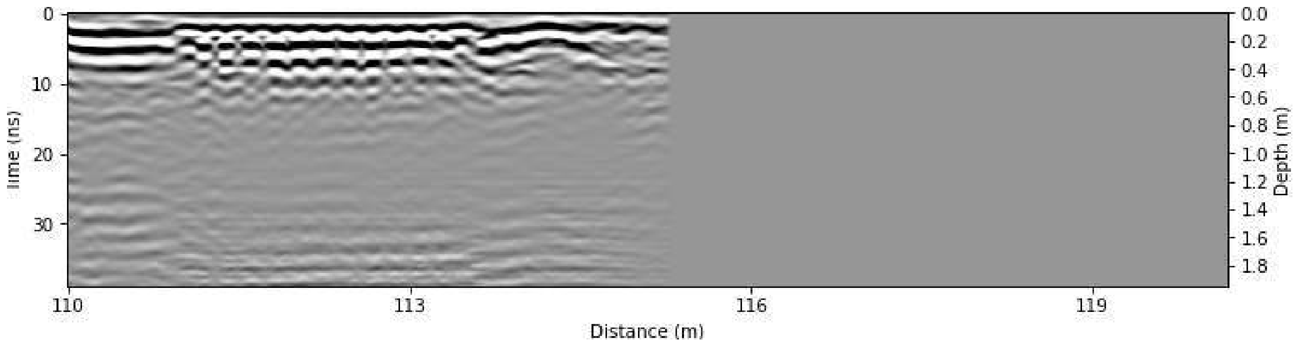


Figure B.323: Radargram at x = 249.5 m.

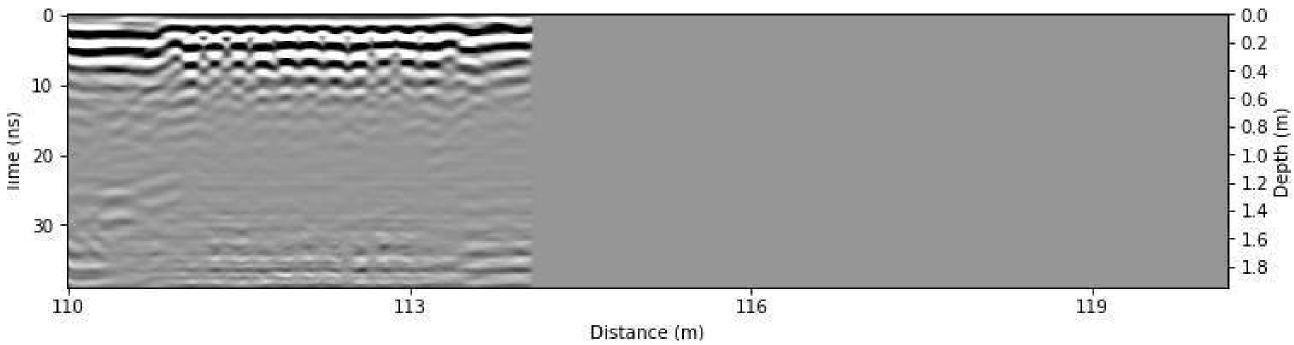


Figure B.324: Radargram at x = 249.75 m.

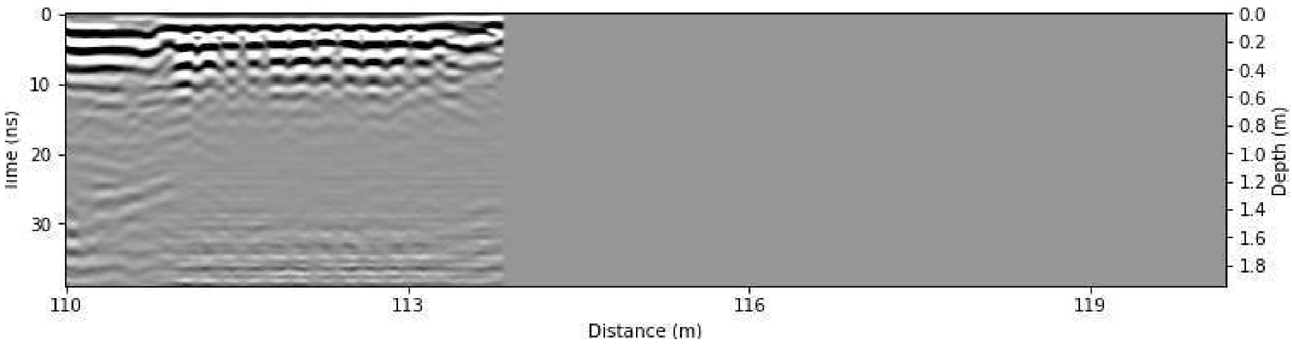
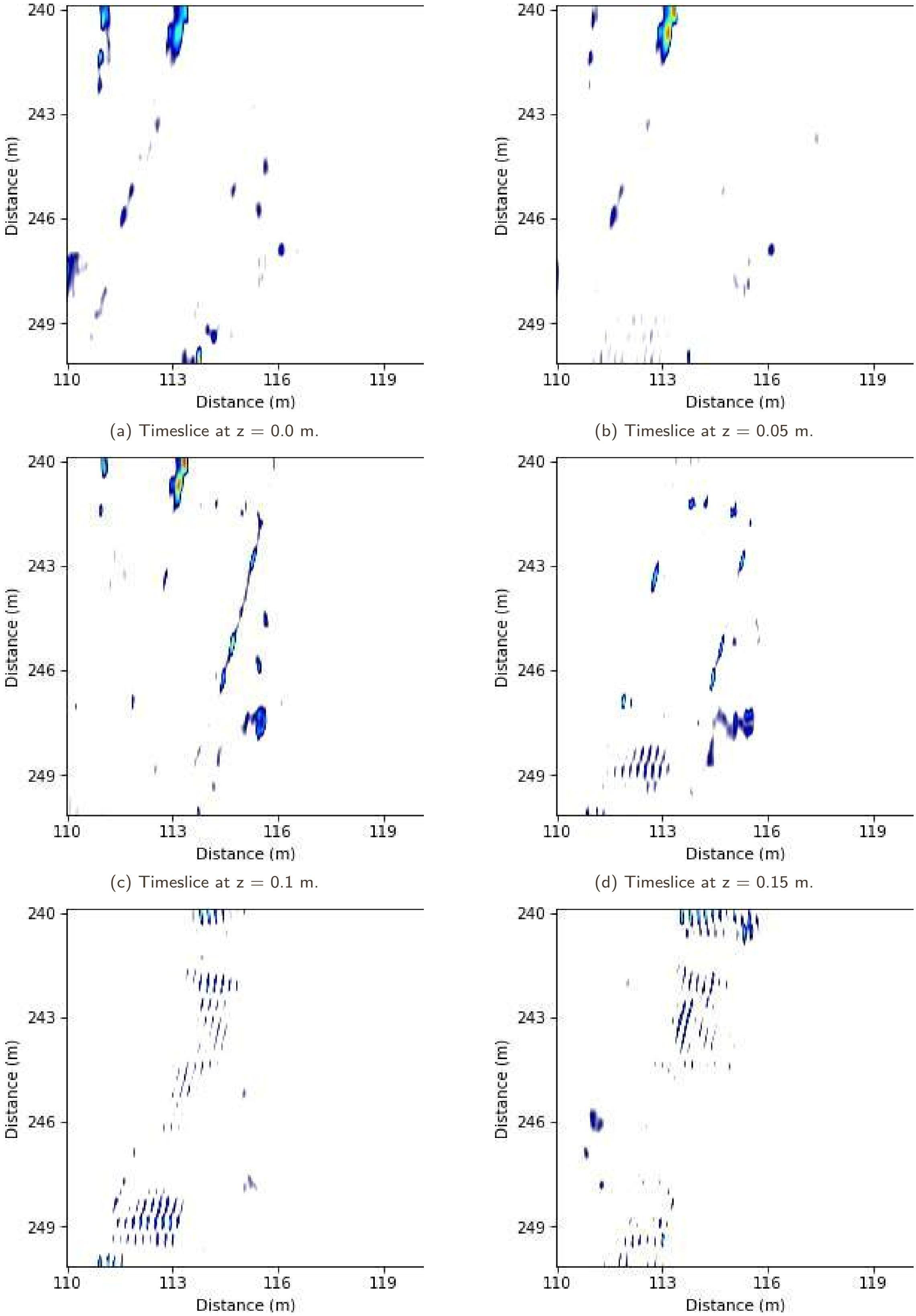


Figure B.325: Radargram at x = 250.0 m.



(a) Timeslice at z = 0.0 m.

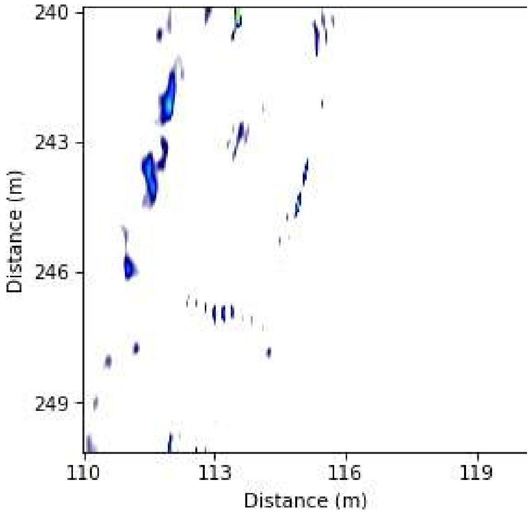
(b) Timeslice at z = 0.05 m.

(c) Timeslice at z = 0.1 m.

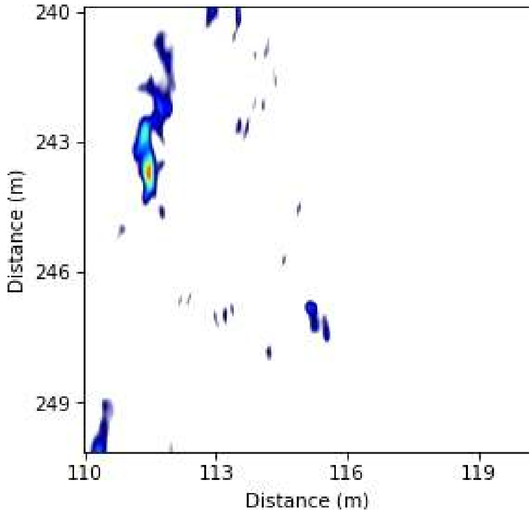
(d) Timeslice at z = 0.15 m.

(e) Timeslice at z = 0.2 m.

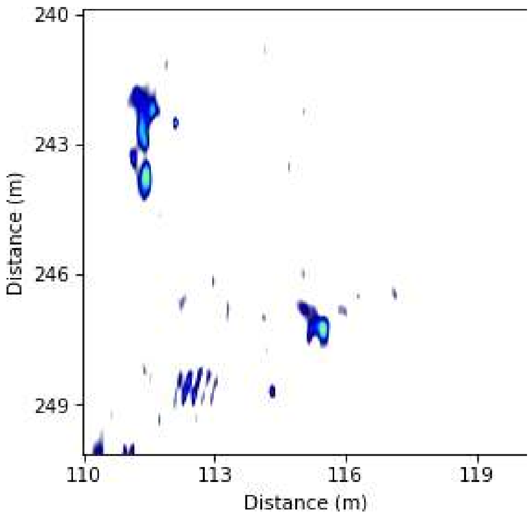
(f) Timeslice at z = 0.25 m.



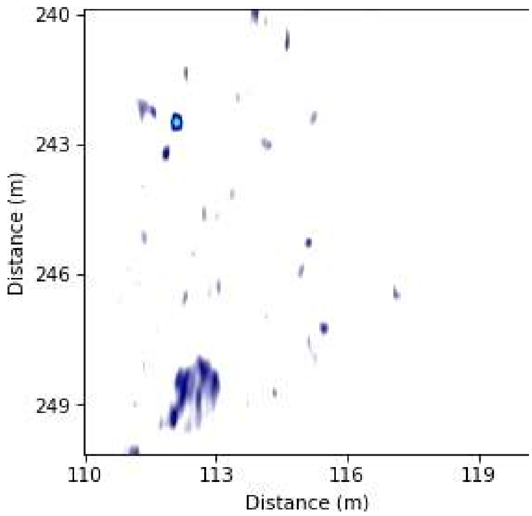
(a) Timeslice at z = 0.3 m.



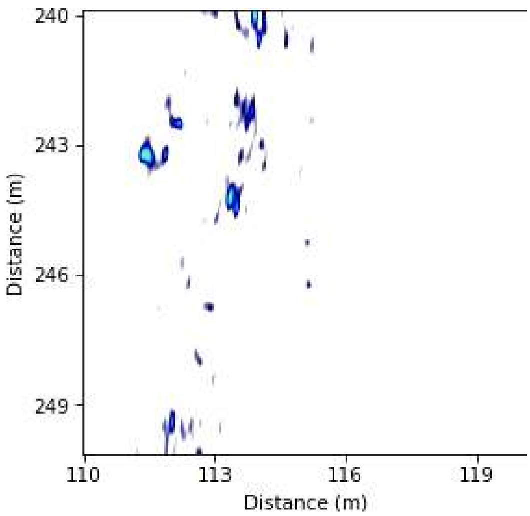
(b) Timeslice at z = 0.35 m.



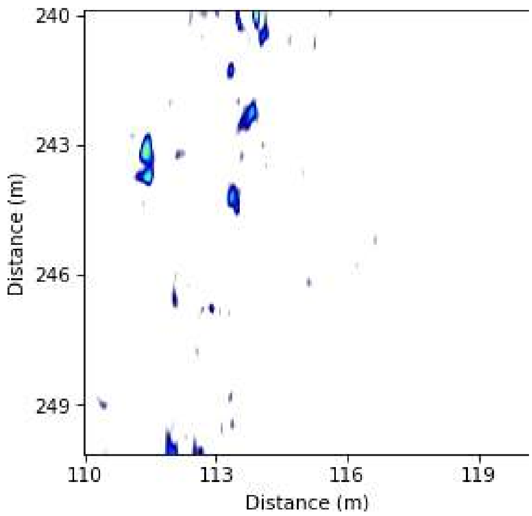
(c) Timeslice at z = 0.4 m.



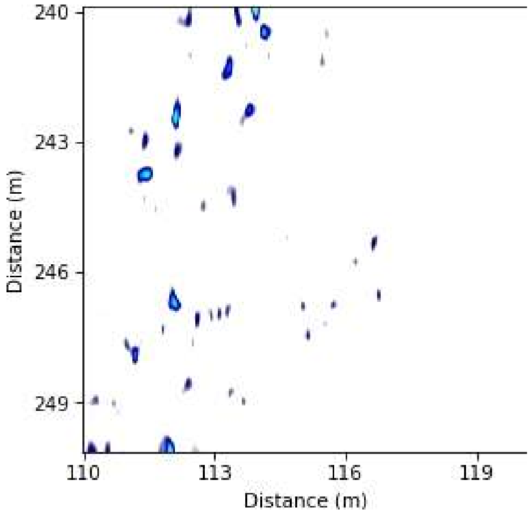
(d) Timeslice at z = 0.45 m.



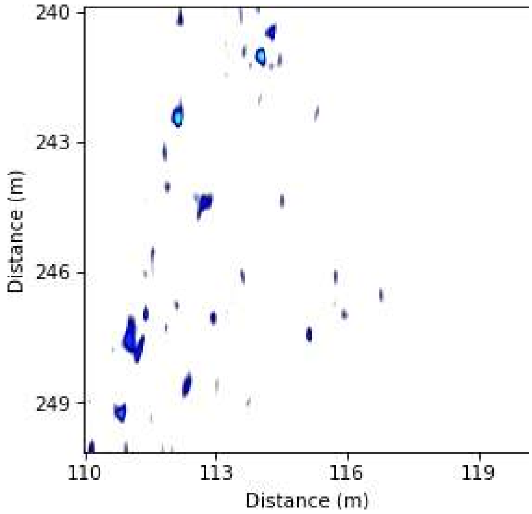
(e) Timeslice at z = 0.5 m.



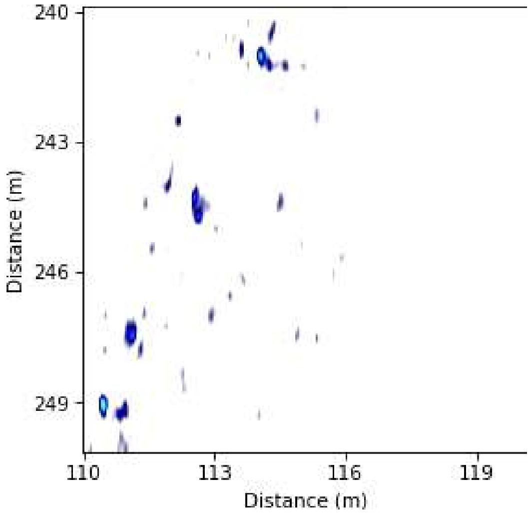
(f) Timeslice at z = 0.55 m.



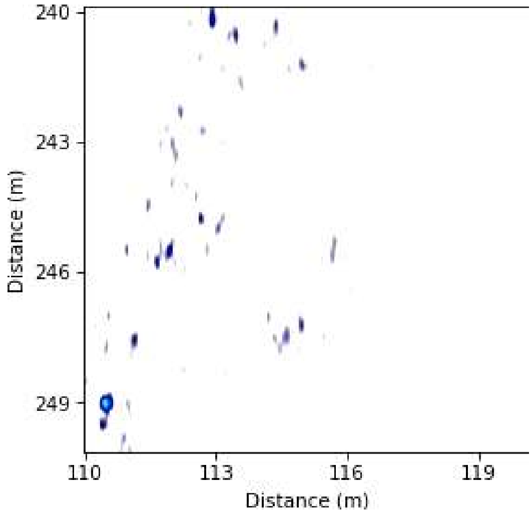
(a) Timeslice at z = 0.6 m.



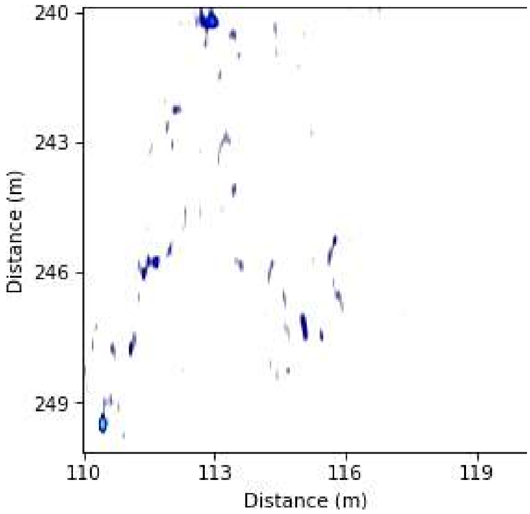
(b) Timeslice at z = 0.65 m.



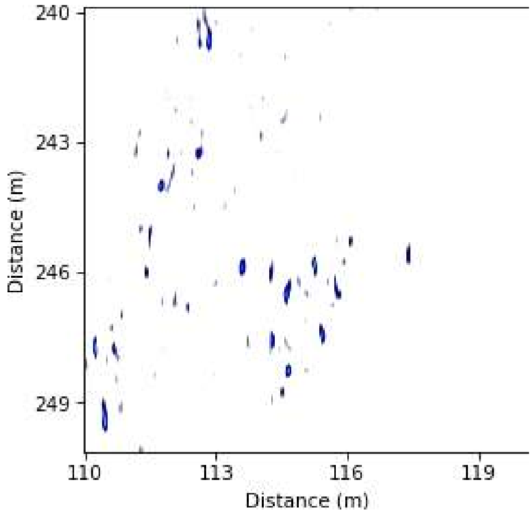
(c) Timeslice at z = 0.7 m.



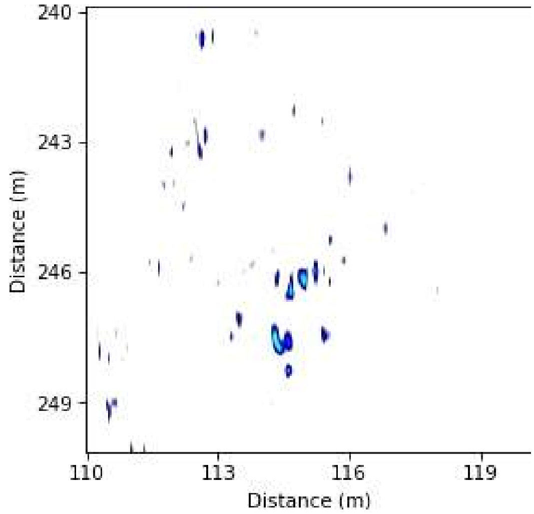
(d) Timeslice at z = 0.75 m.



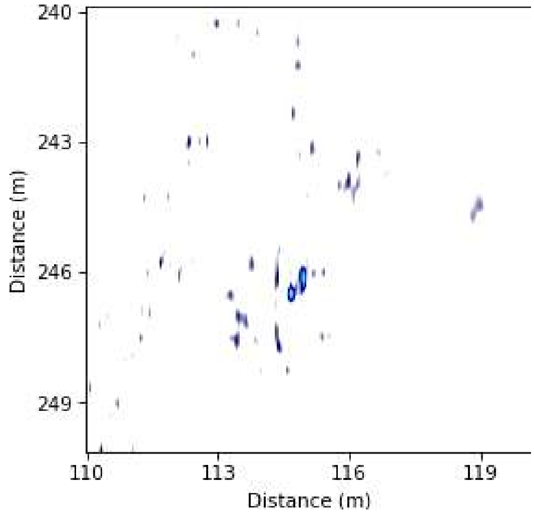
(e) Timeslice at z = 0.8 m.



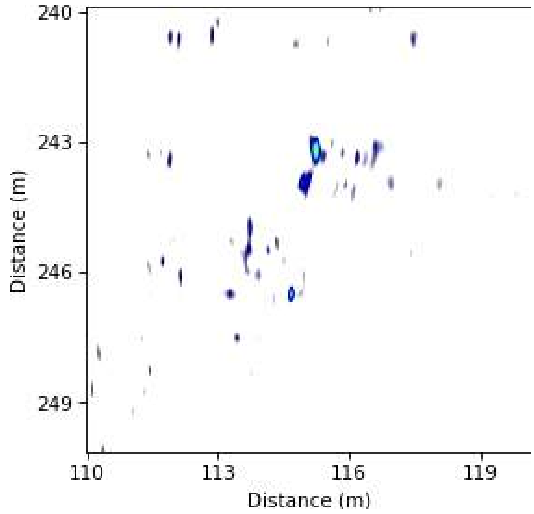
(f) Timeslice at z = 0.85 m.



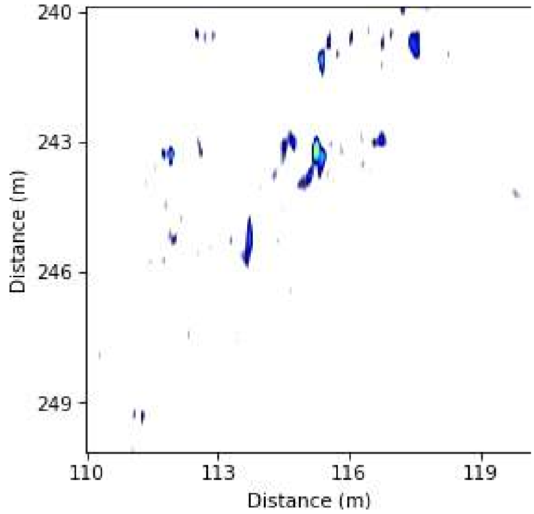
(a) Timeslice at z = 0.9 m.



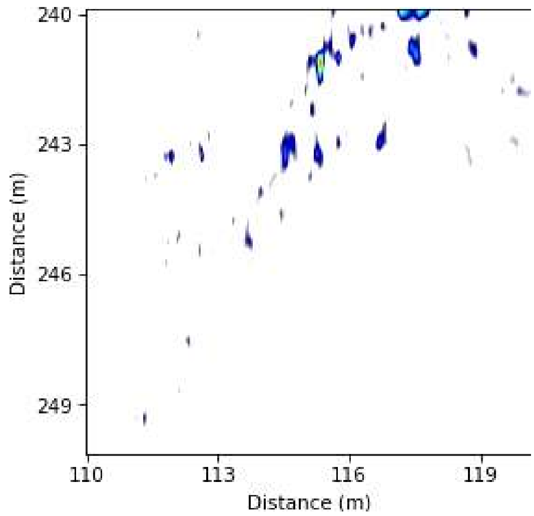
(b) Timeslice at z = 0.95 m.



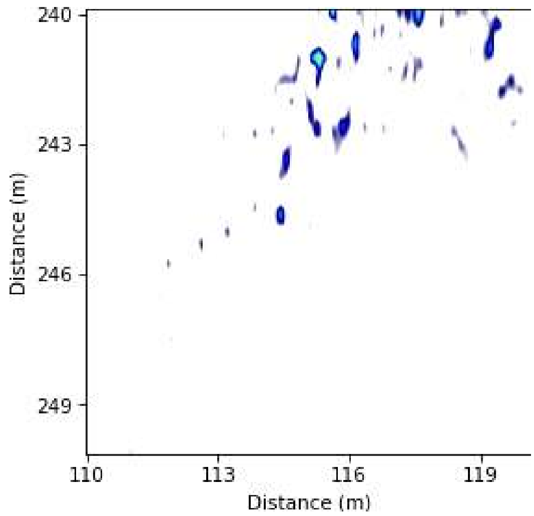
(c) Timeslice at z = 1.0 m.



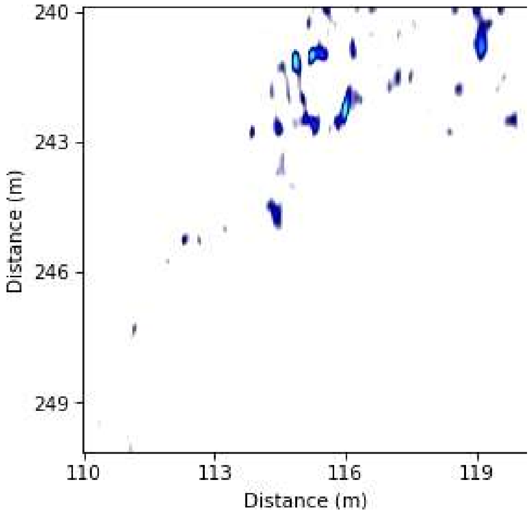
(d) Timeslice at z = 1.05 m.



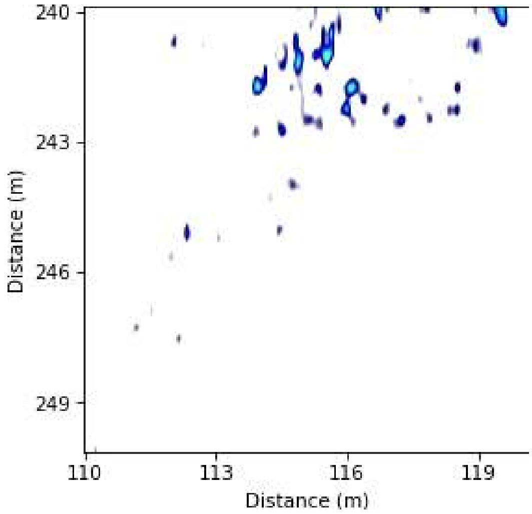
(e) Timeslice at z = 1.1 m.



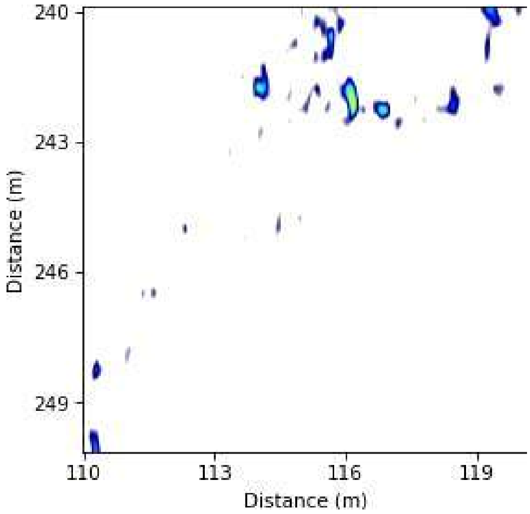
(f) Timeslice at z = 1.15 m.



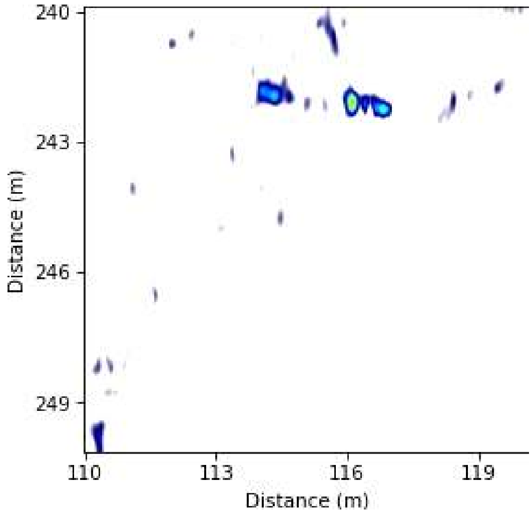
(a) Timeslice at z = 1.2 m.



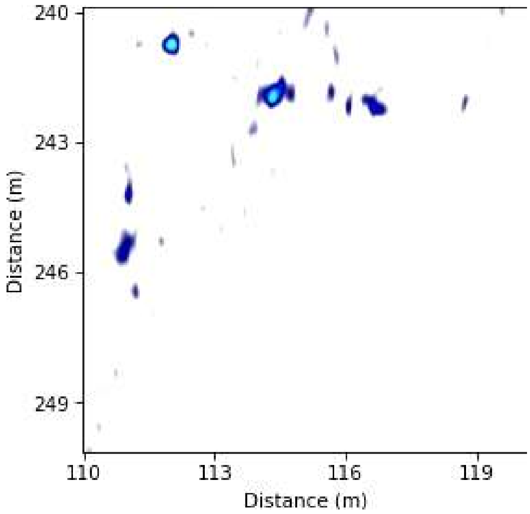
(b) Timeslice at z = 1.25 m.



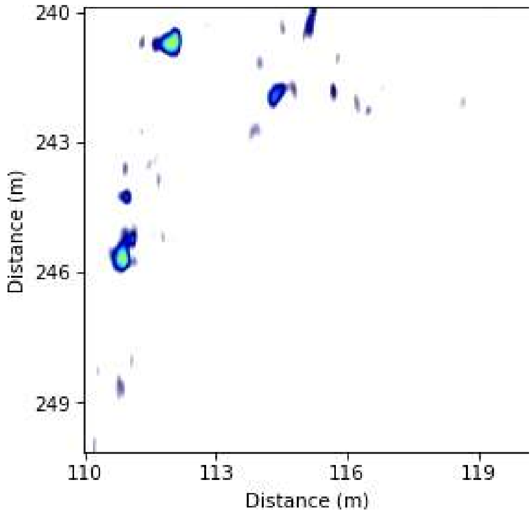
(c) Timeslice at z = 1.3 m.



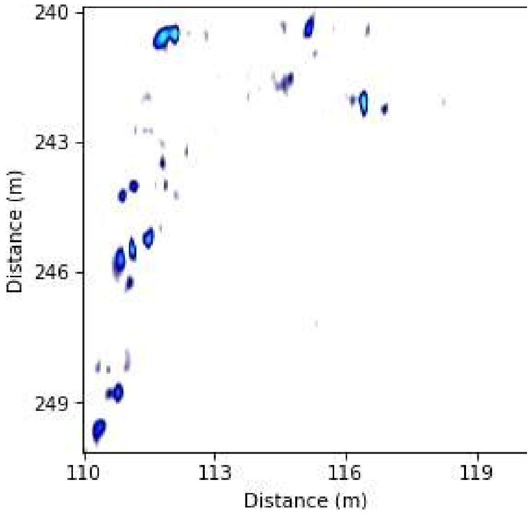
(d) Timeslice at z = 1.35 m.



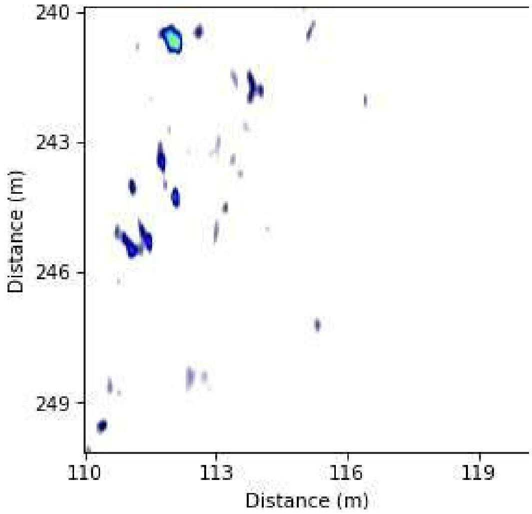
(e) Timeslice at z = 1.4 m.



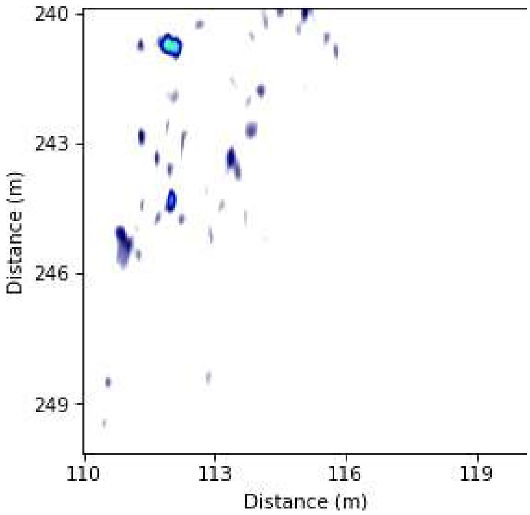
(f) Timeslice at z = 1.45 m.



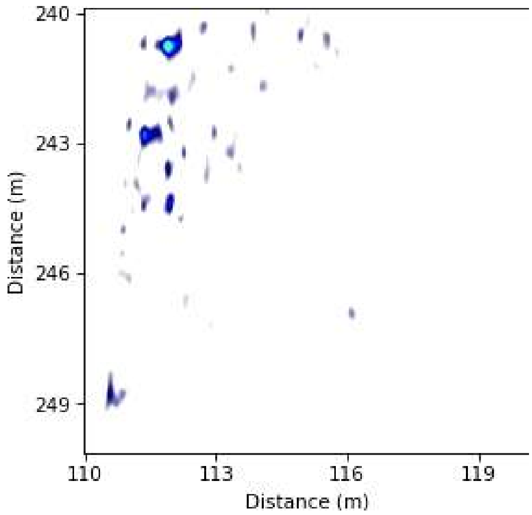
(a) Timeslice at z = 1.5 m.



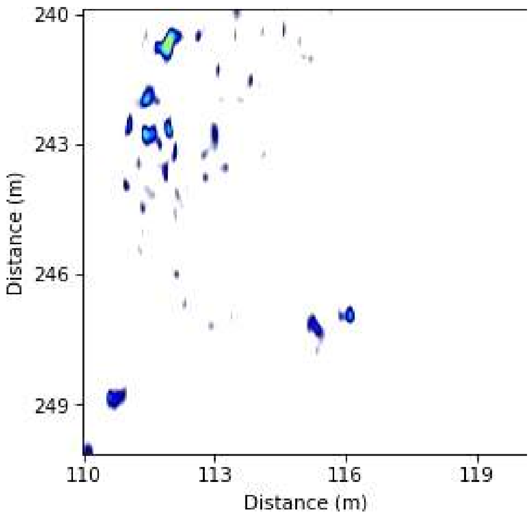
(b) Timeslice at z = 1.55 m.



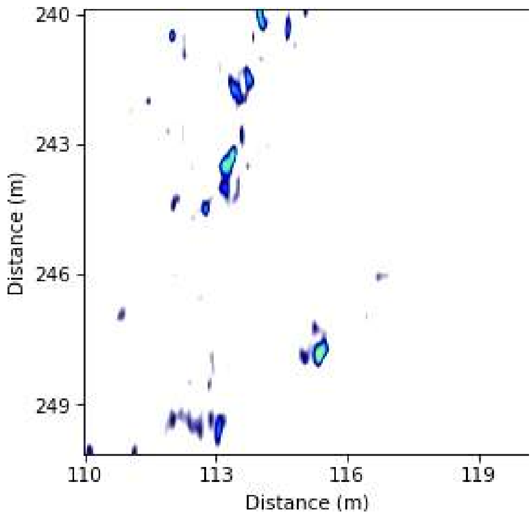
(c) Timeslice at z = 1.6 m.



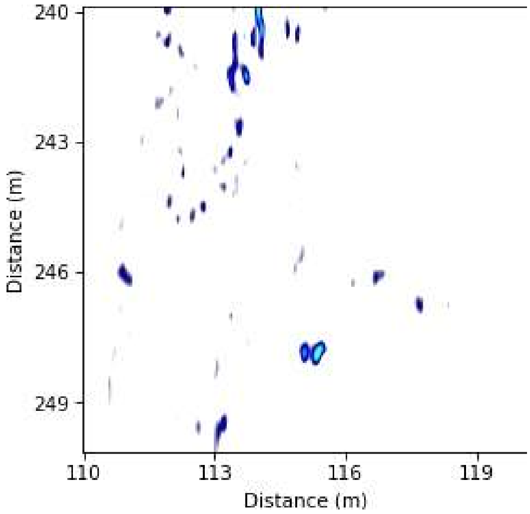
(d) Timeslice at z = 1.65 m.



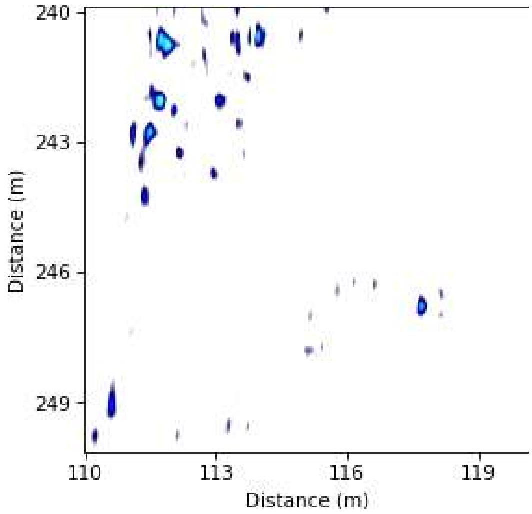
(e) Timeslice at z = 1.7 m.



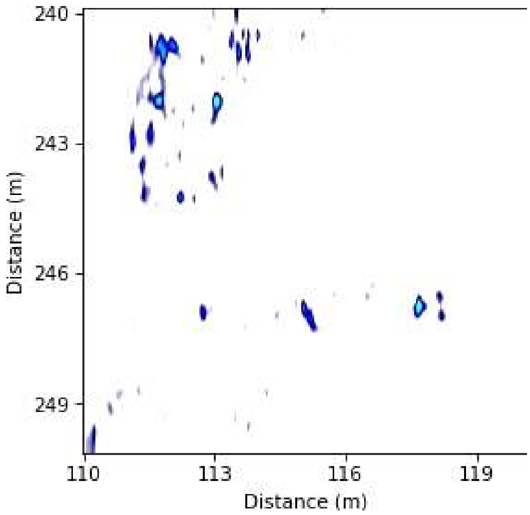
(f) Timeslice at z = 1.75 m.



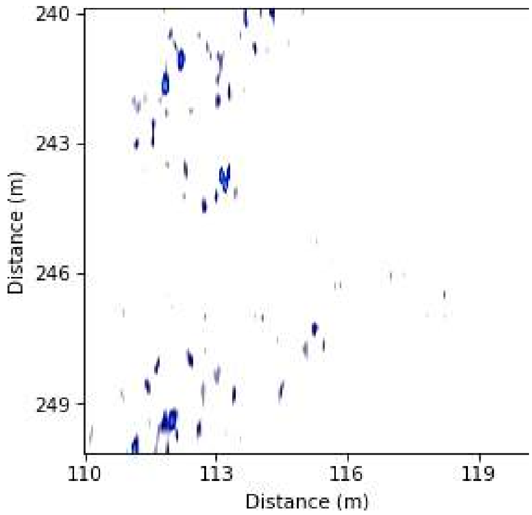
(a) Timeslice at z = 1.8 m.



(b) Timeslice at z = 1.85 m.



(c) Timeslice at z = 1.9 m.



(d) Timeslice at z = 1.95 m.

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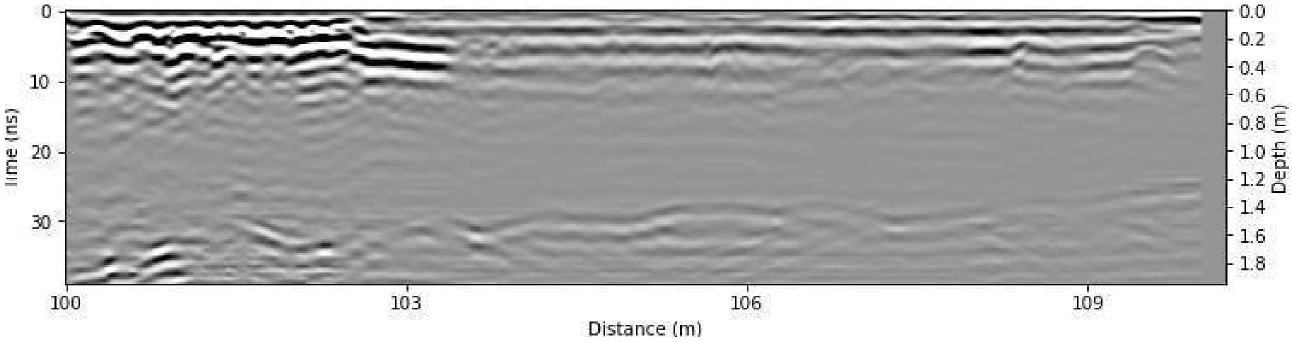


Figure B.333: Radargram at x = 200.0 m.

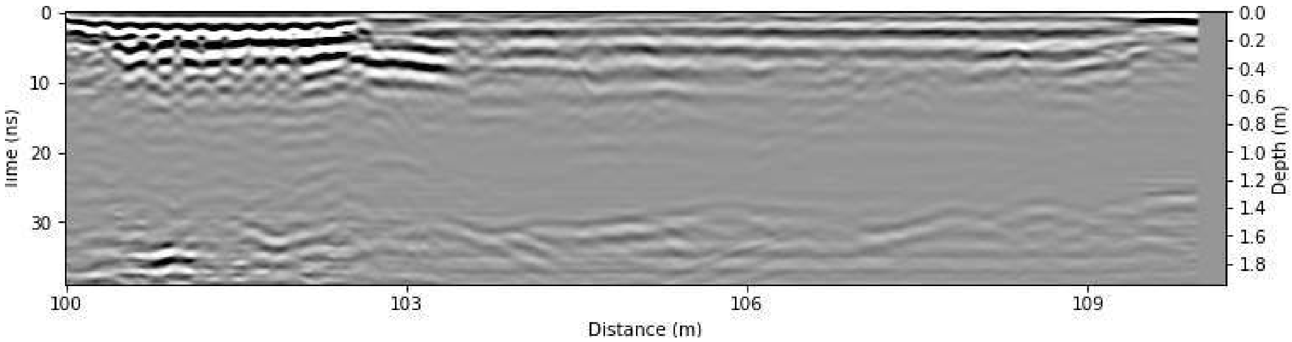


Figure B.334: Radargram at x = 200.25 m.

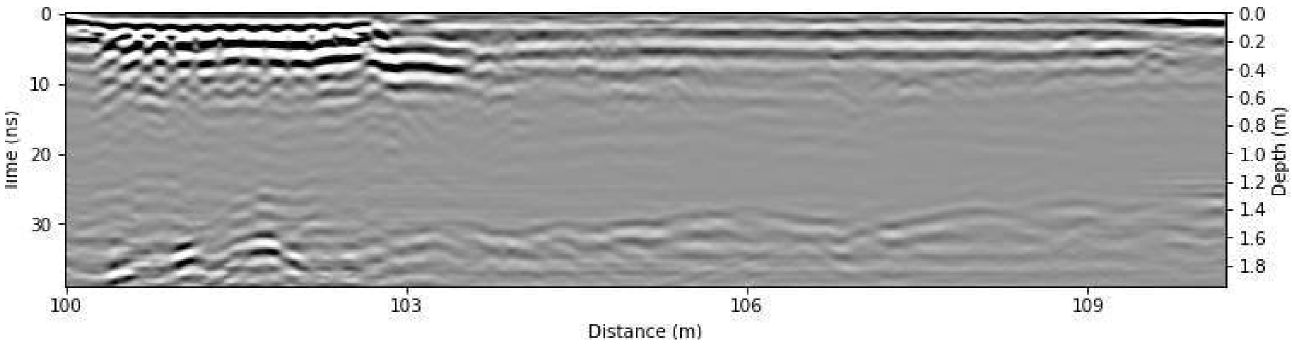


Figure B.335: Radargram at x = 200.5 m.

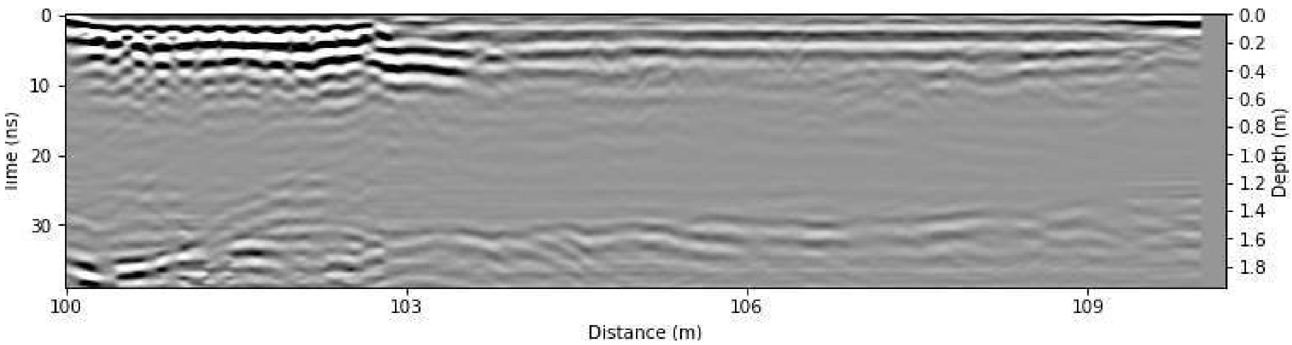


Figure B.336: Radargram at x = 200.75 m.

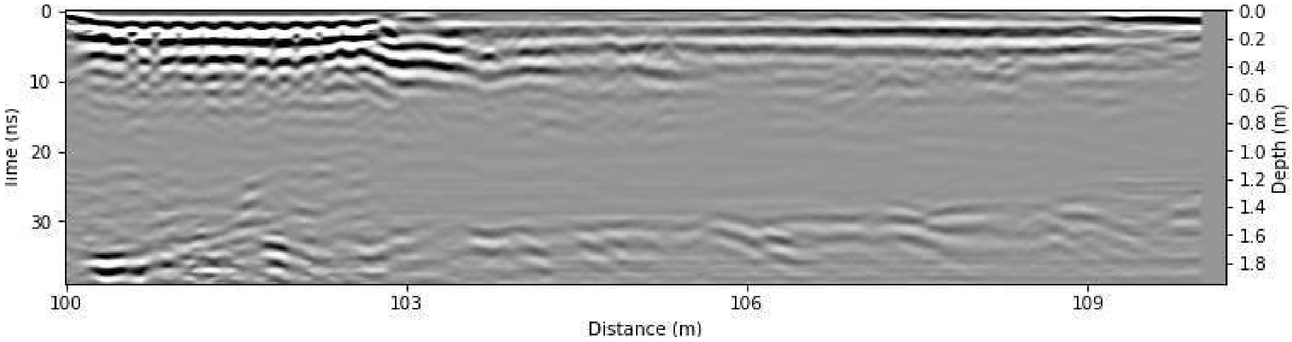


Figure B.337: Radargram at x = 201.0 m.

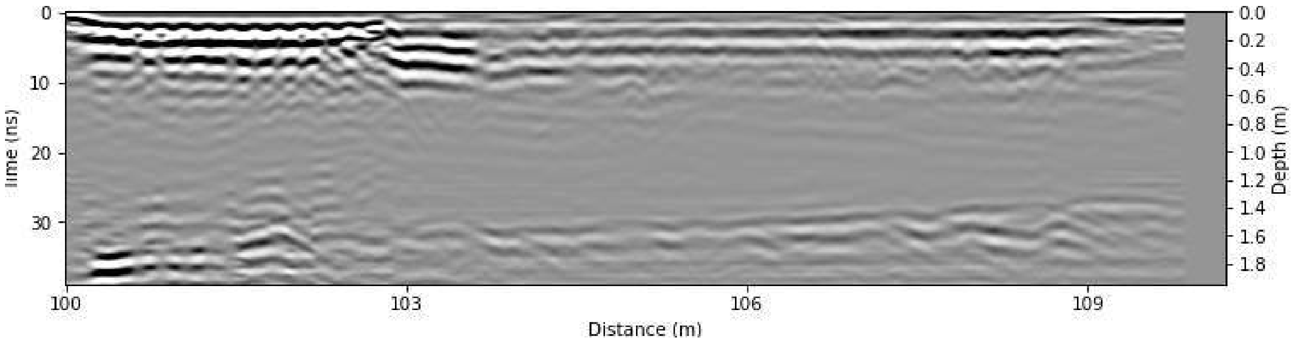


Figure B.338: Radargram at x = 201.25 m.

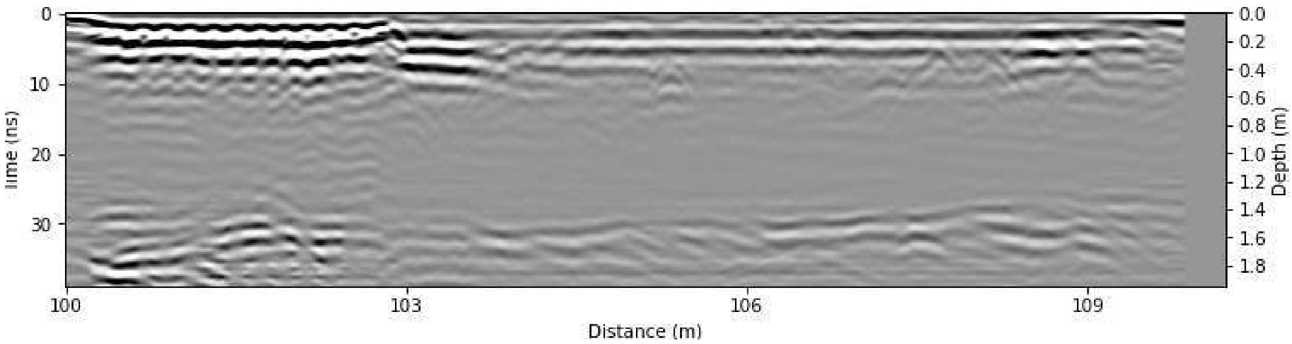


Figure B.339: Radargram at x = 201.5 m.

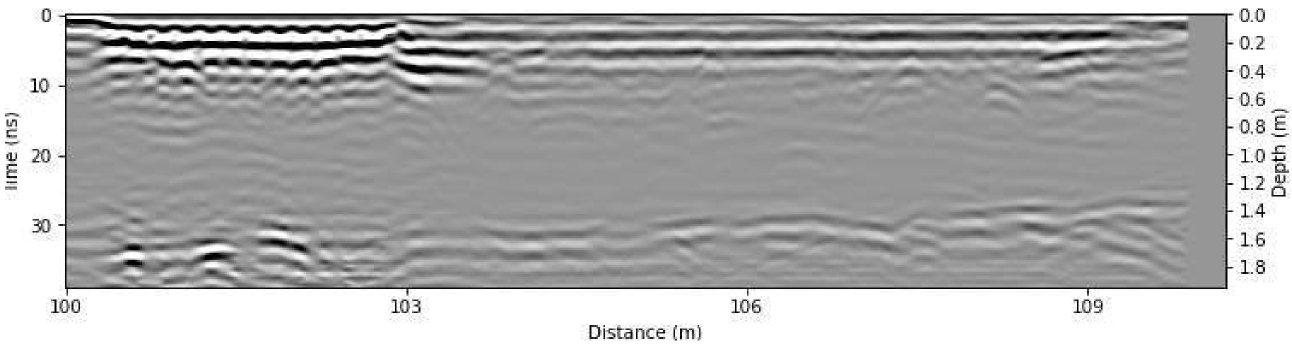


Figure B.340: Radargram at x = 201.75 m.

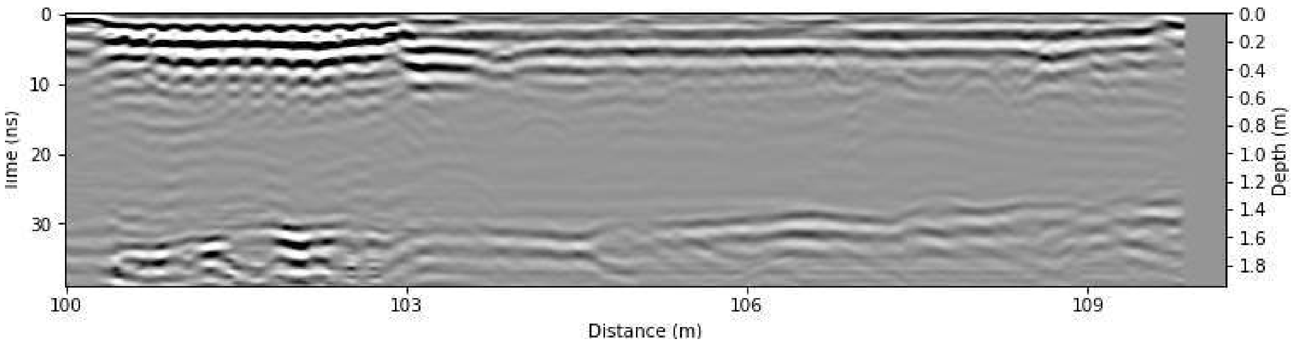


Figure B.341: Radargram at x = 202.0 m.

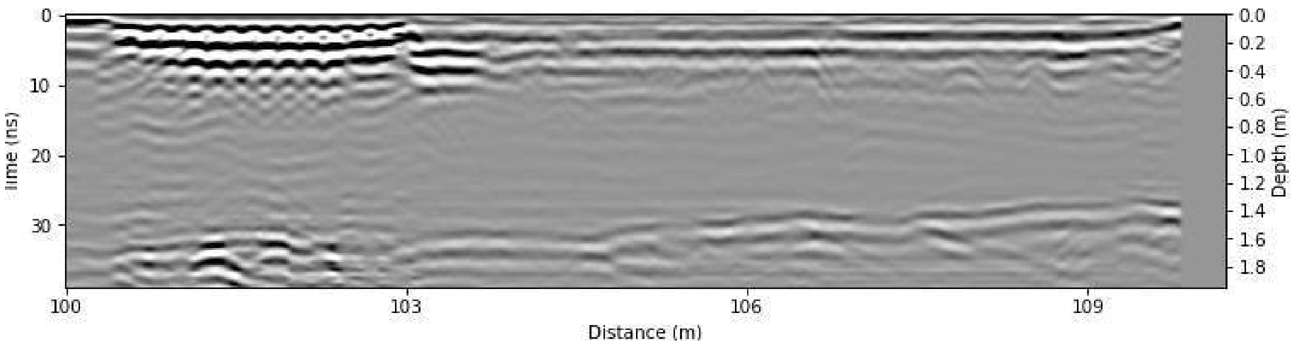


Figure B.342: Radargram at x = 202.25 m.

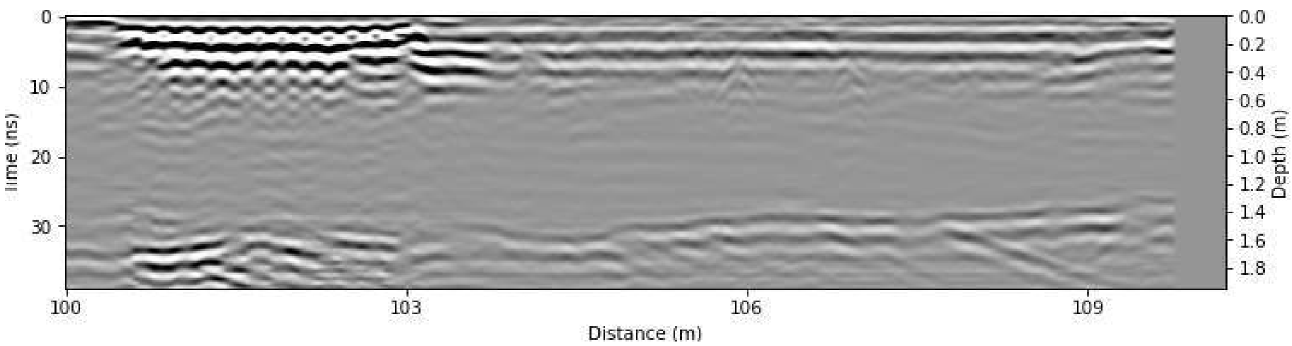


Figure B.343: Radargram at x = 202.5 m.

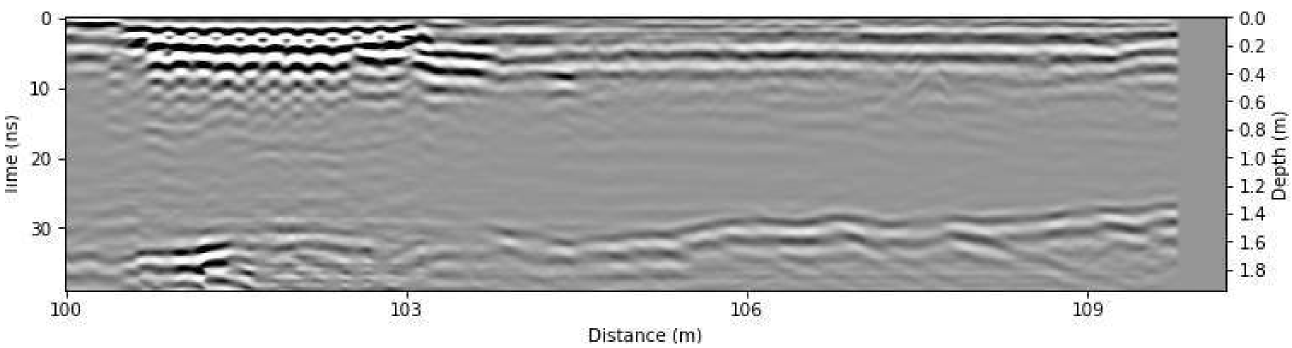


Figure B.344: Radargram at x = 202.75 m.

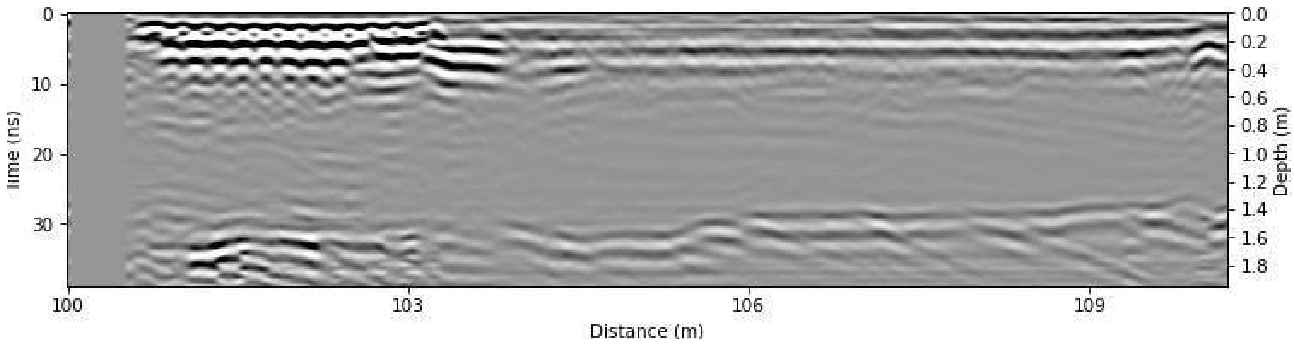


Figure B.345: Radargram at x = 203.0 m.

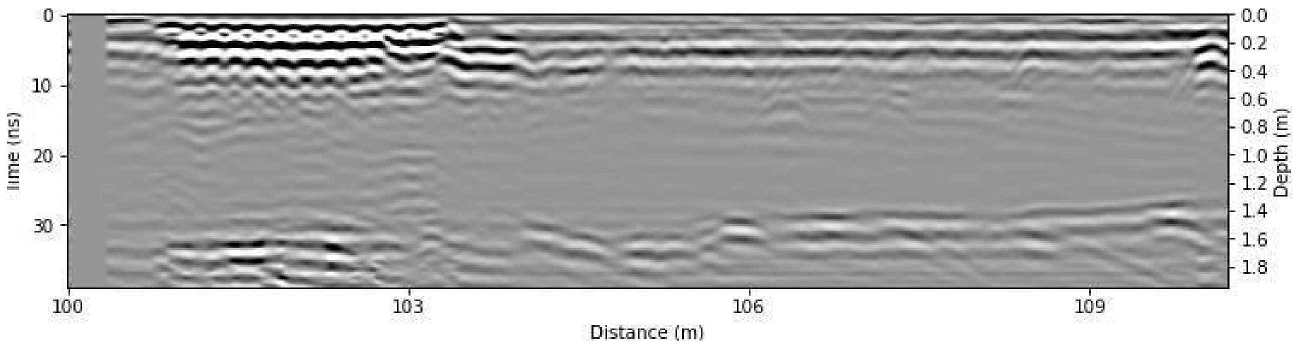


Figure B.346: Radargram at x = 203.25 m.

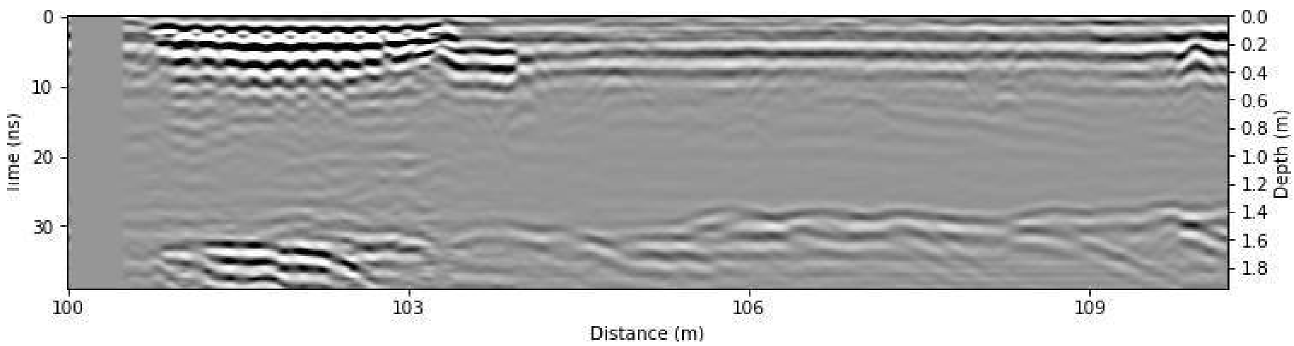


Figure B.347: Radargram at x = 203.5 m.

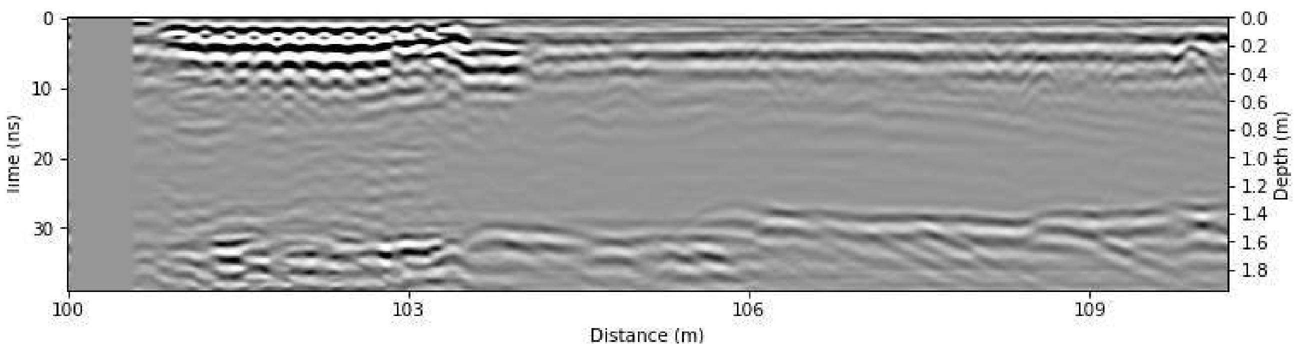


Figure B.348: Radargram at x = 203.75 m.

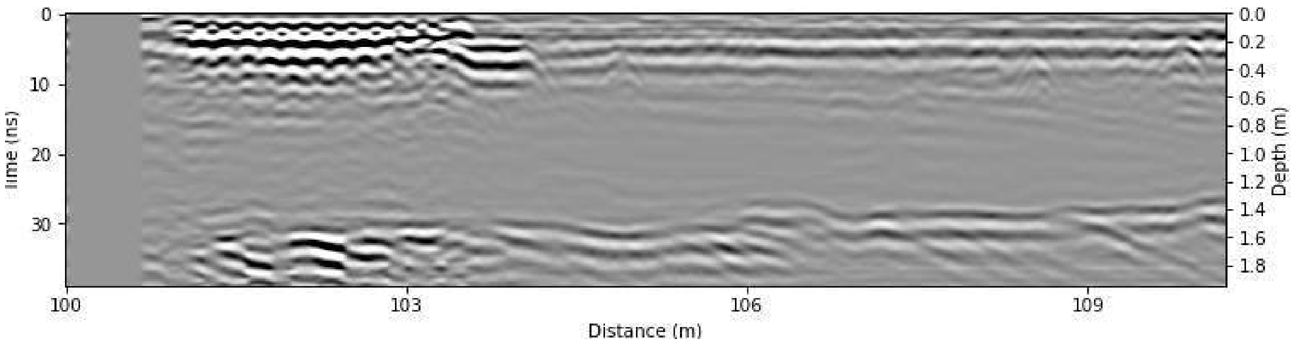


Figure B.349: Radargram at x = 204.0 m.

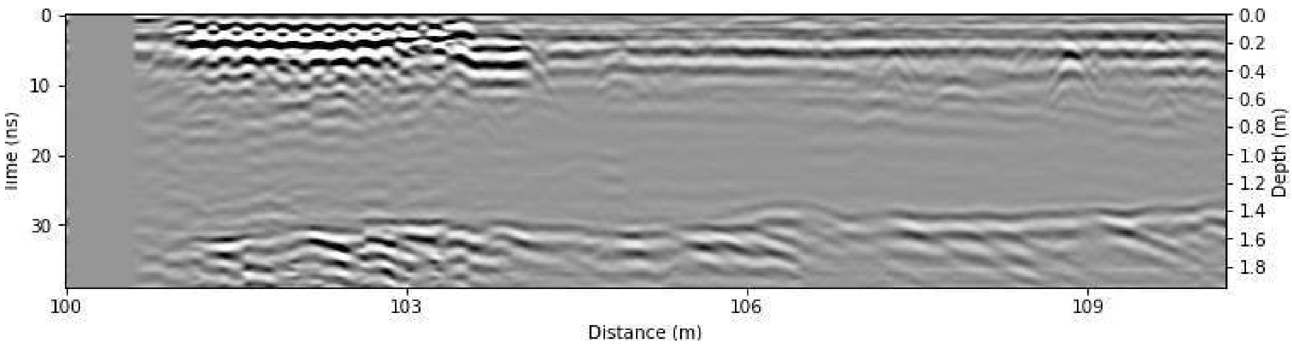


Figure B.350: Radargram at x = 204.25 m.

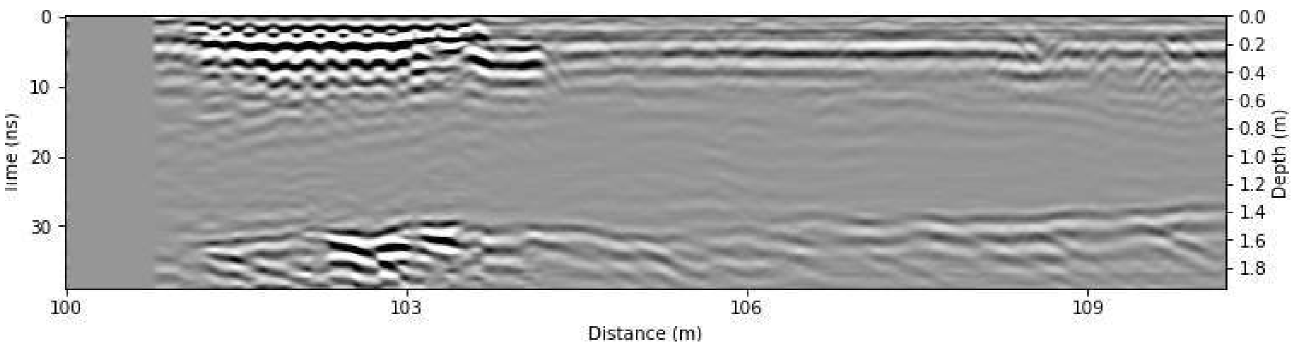


Figure B.351: Radargram at x = 204.5 m.

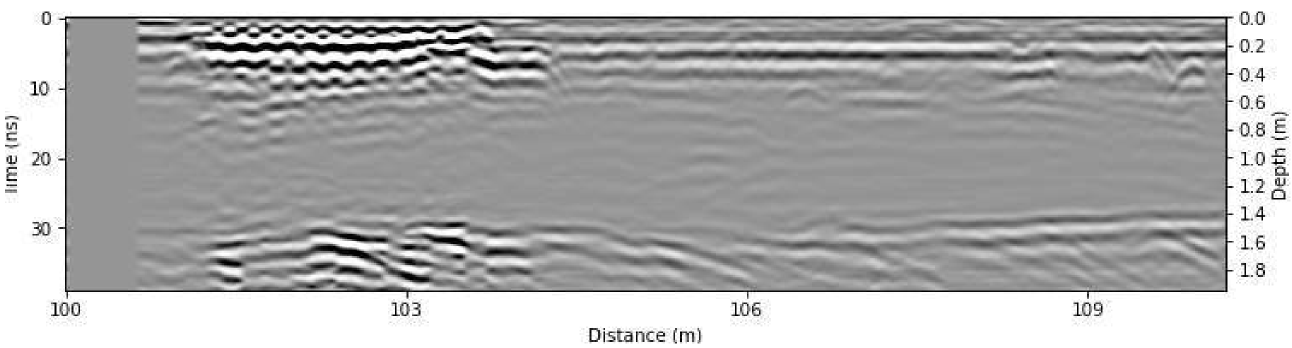


Figure B.352: Radargram at x = 204.75 m.

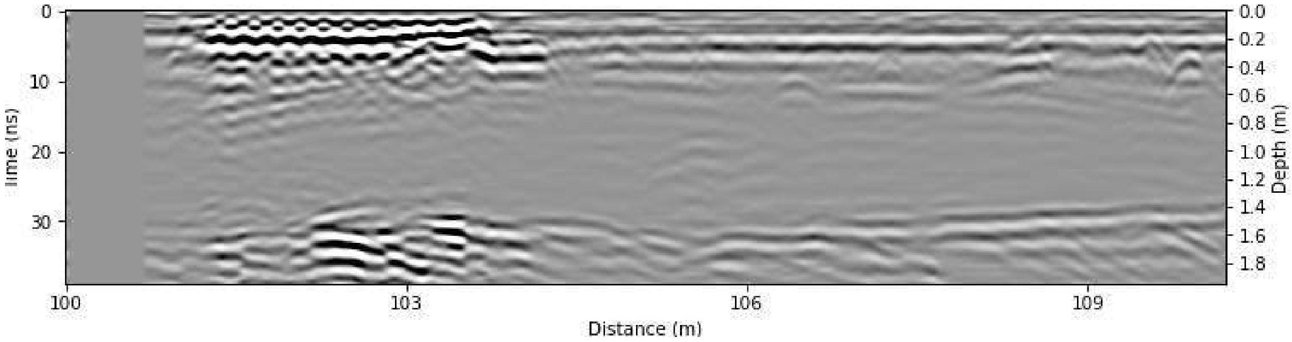


Figure B.353: Radargram at x = 205.0 m.

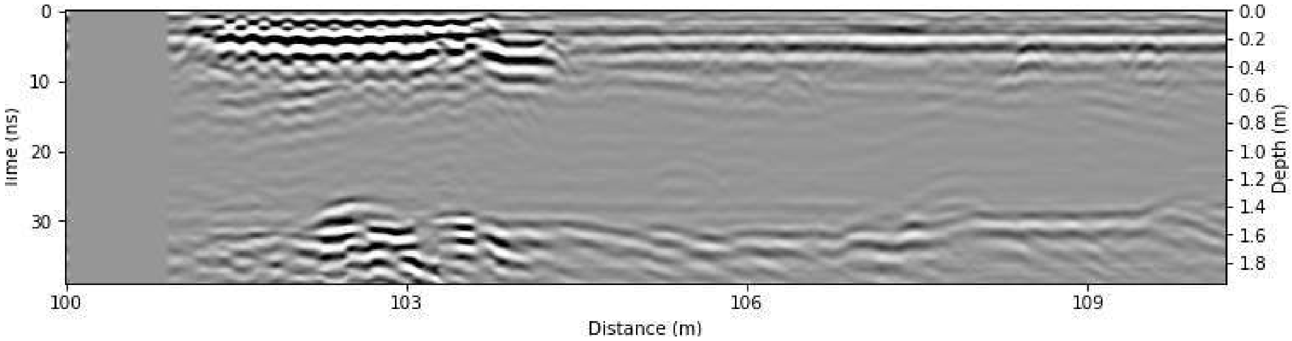


Figure B.354: Radargram at x = 205.25 m.

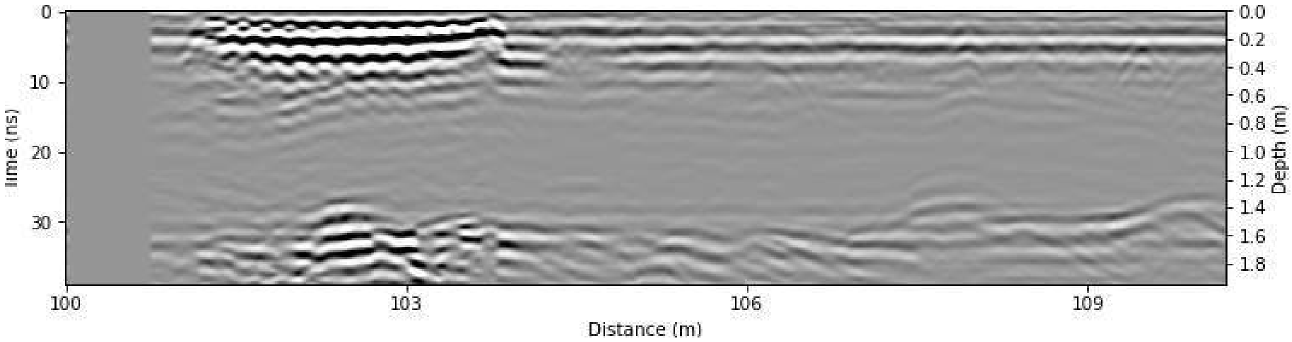


Figure B.355: Radargram at x = 205.5 m.

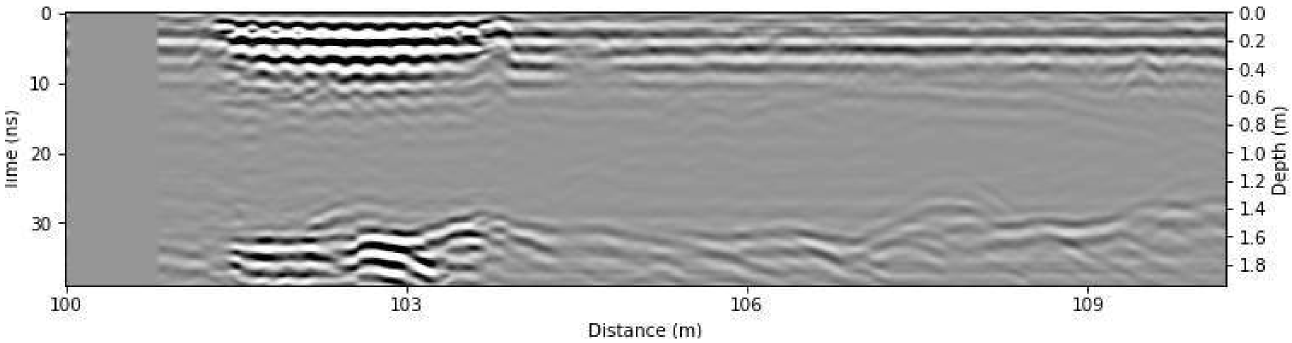


Figure B.356: Radargram at x = 205.75 m.

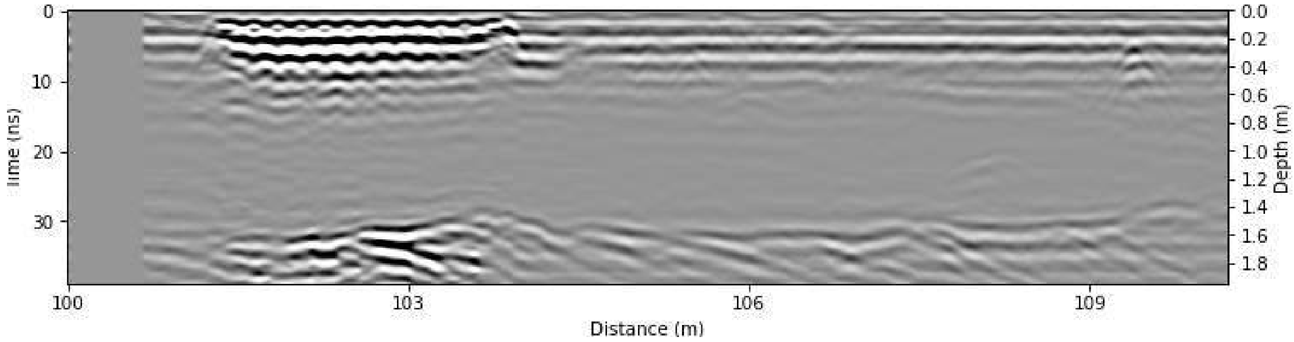


Figure B.357: Radargram at x = 206.0 m.

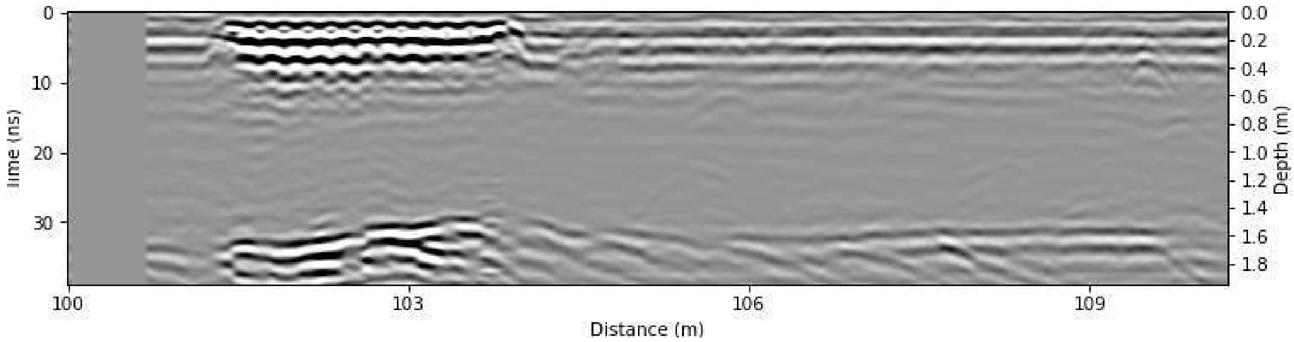


Figure B.358: Radargram at x = 206.25 m.

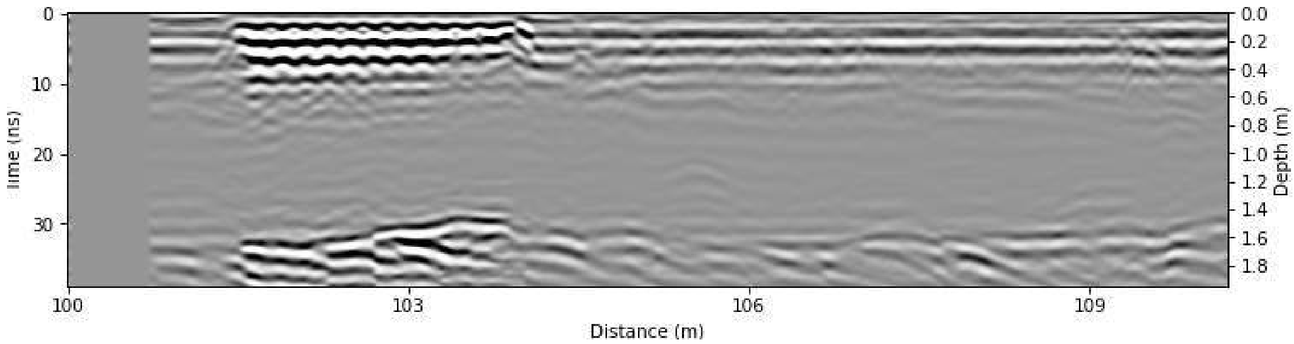


Figure B.359: Radargram at x = 206.5 m.

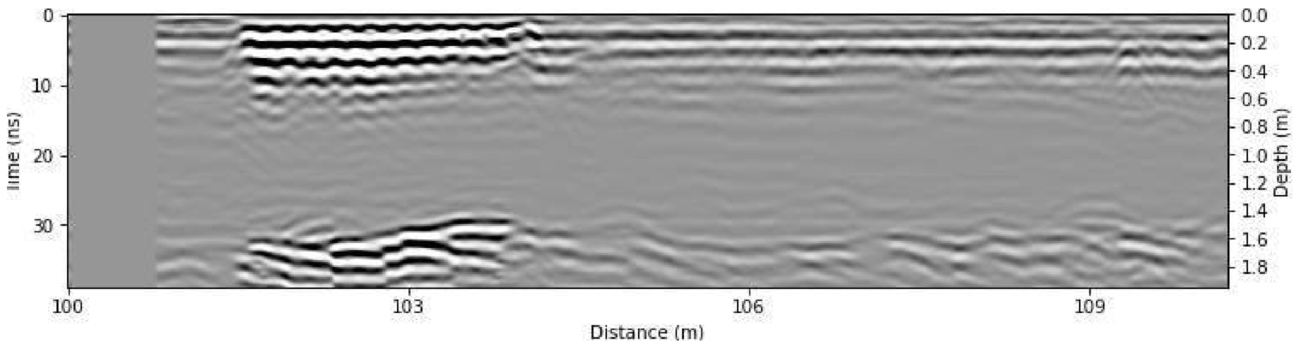


Figure B.360: Radargram at x = 206.75 m.

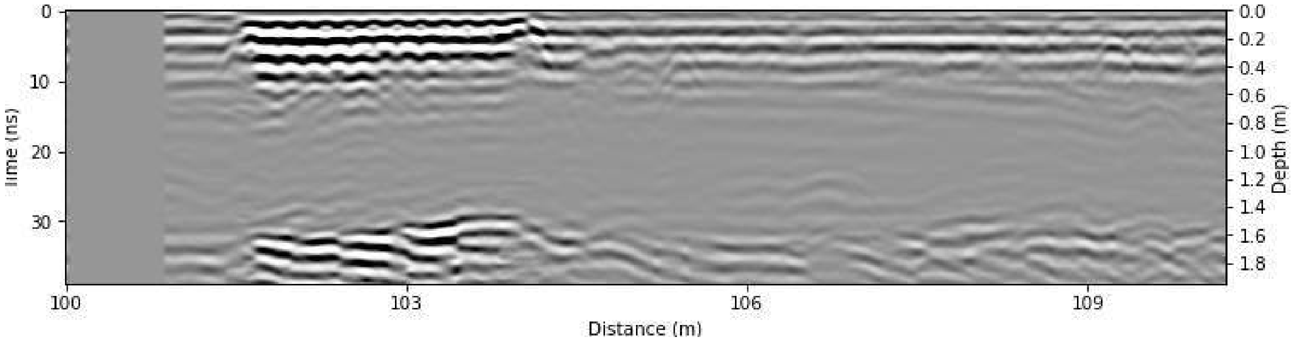


Figure B.361: Radargram at x = 207.0 m.

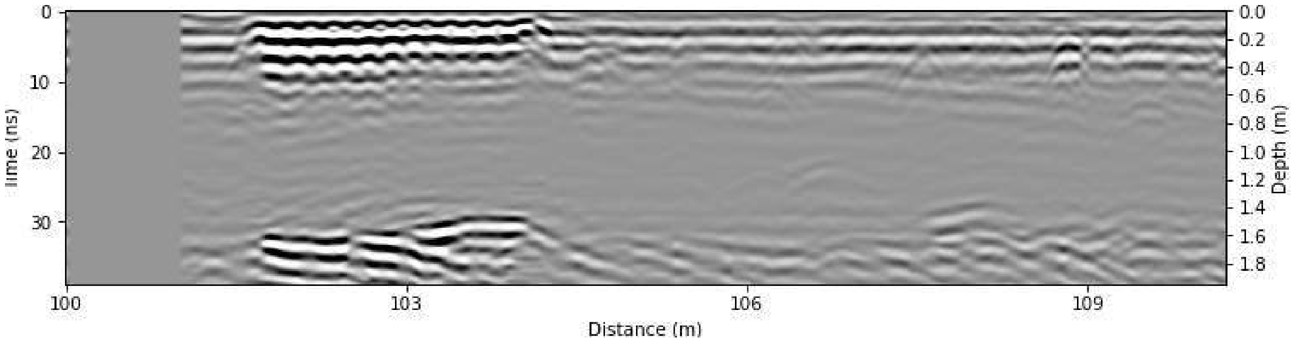


Figure B.362: Radargram at x = 207.25 m.

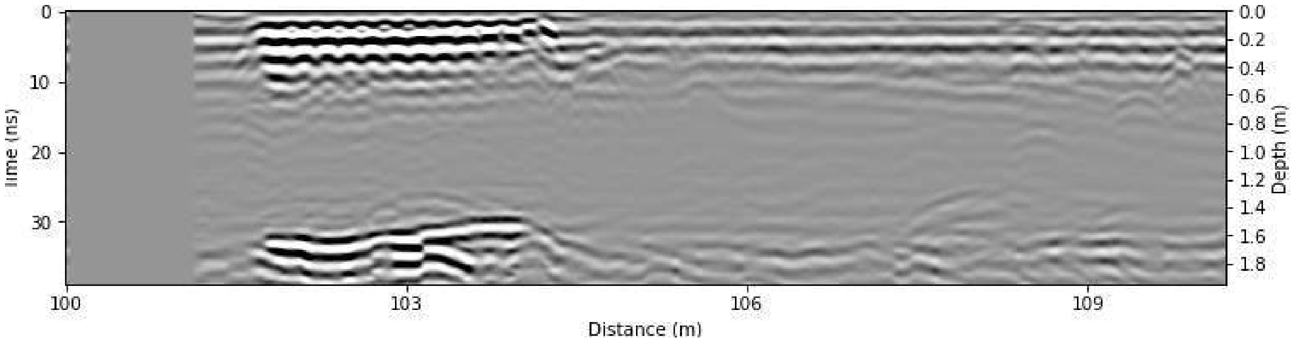


Figure B.363: Radargram at x = 207.5 m.

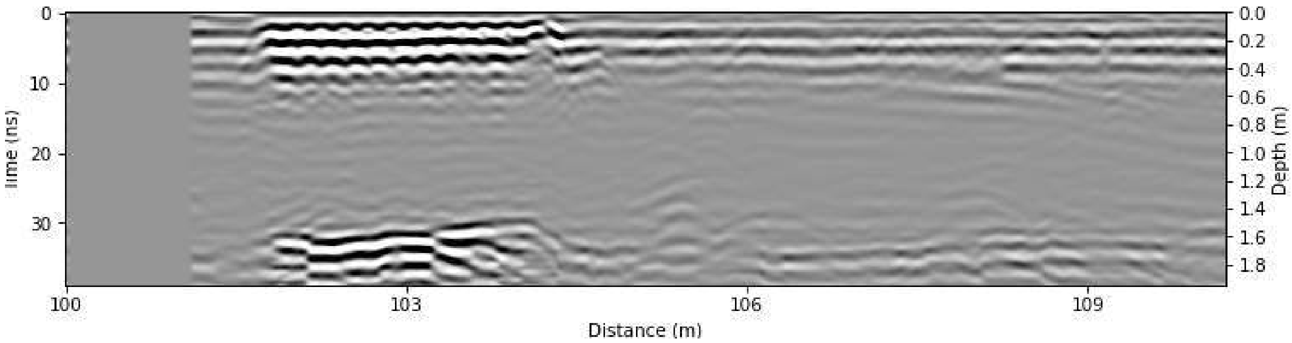


Figure B.364: Radargram at x = 207.75 m.

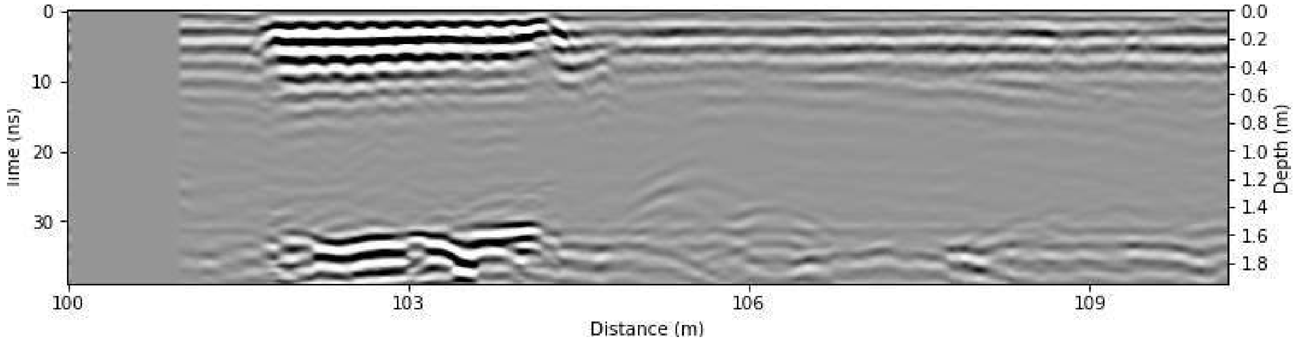


Figure B.365: Radargram at x = 208.0 m.

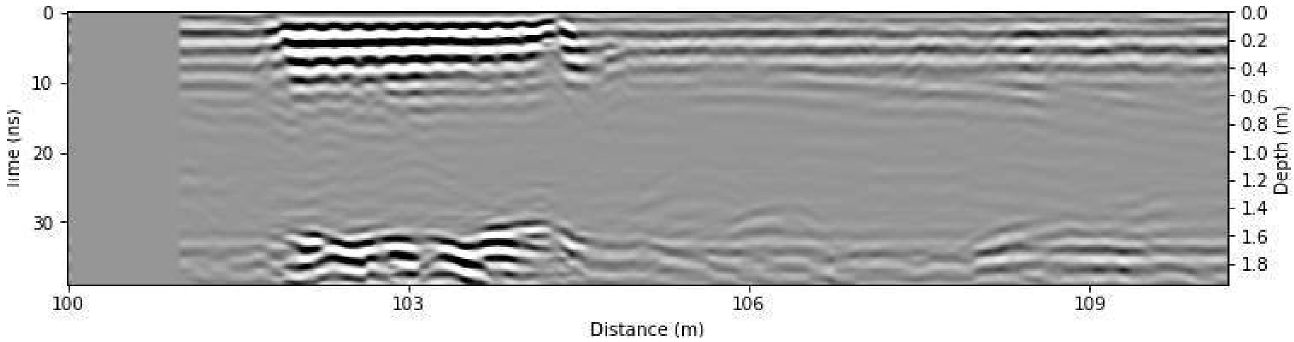


Figure B.366: Radargram at x = 208.25 m.

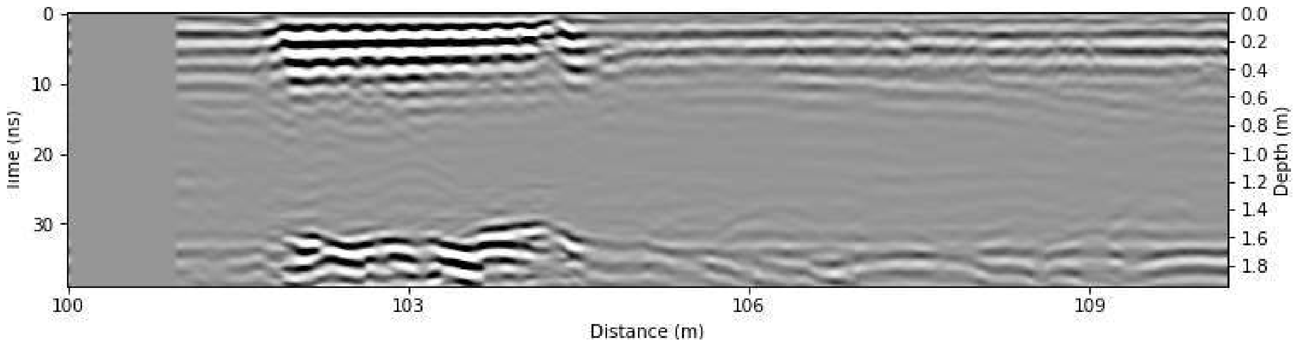


Figure B.367: Radargram at x = 208.5 m.

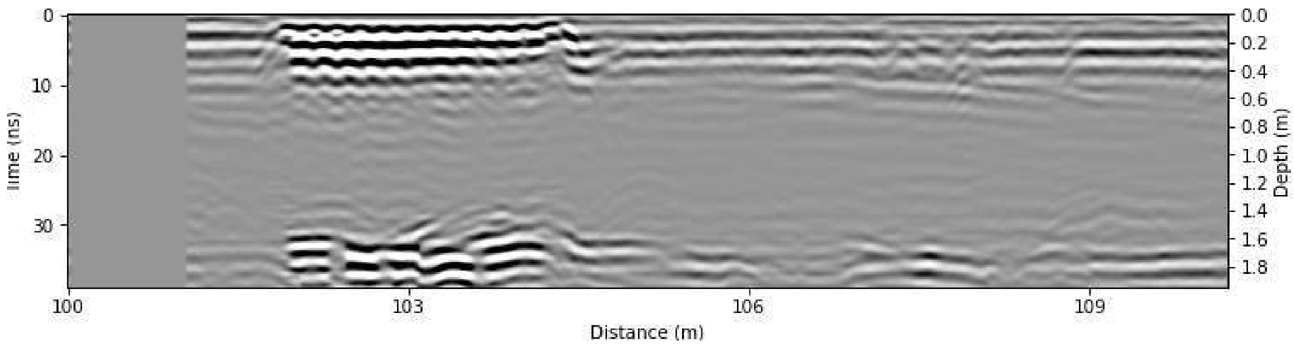


Figure B.368: Radargram at x = 208.75 m.

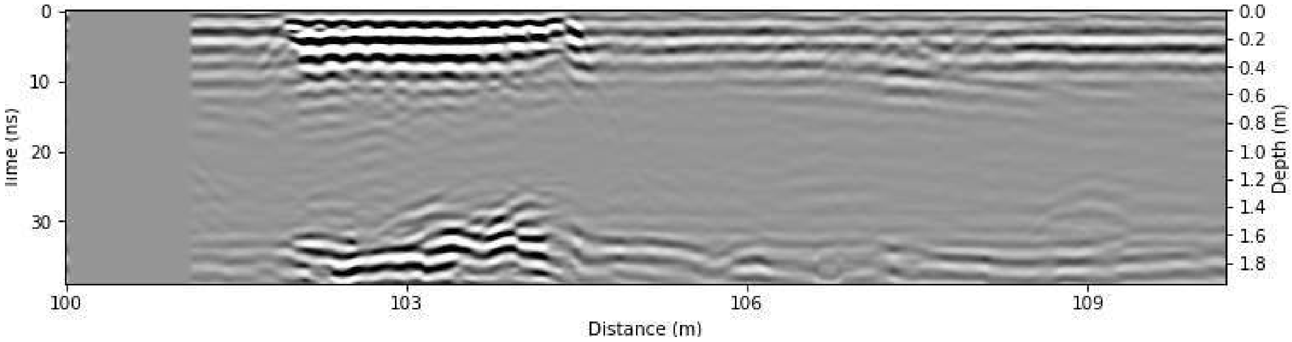


Figure B.369: Radargram at x = 209.0 m.

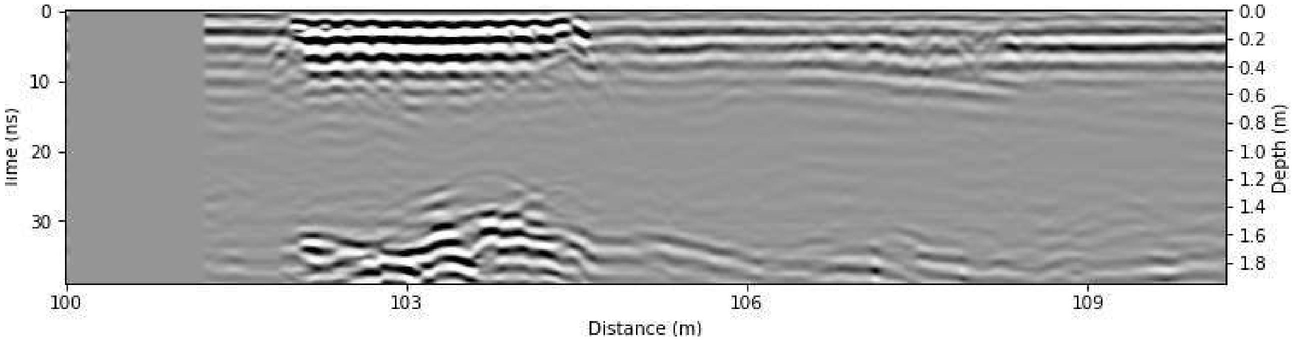


Figure B.370: Radargram at x = 209.25 m.

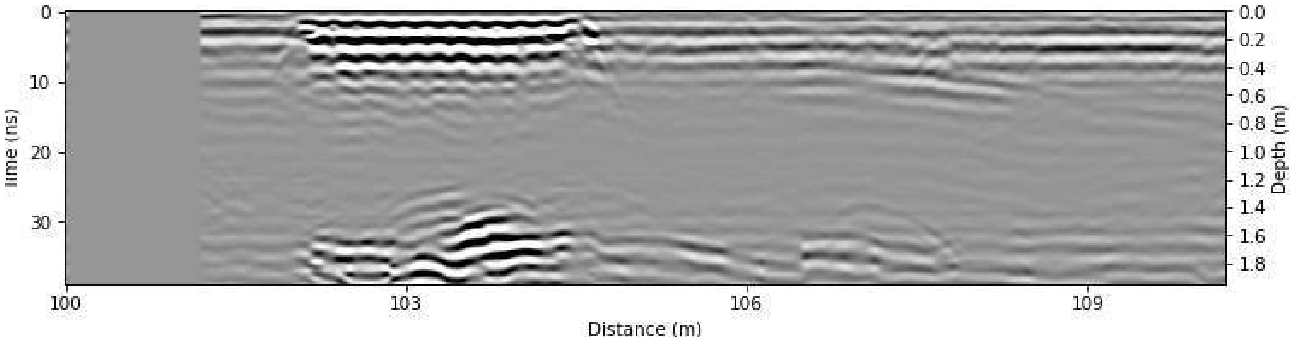


Figure B.371: Radargram at x = 209.5 m.

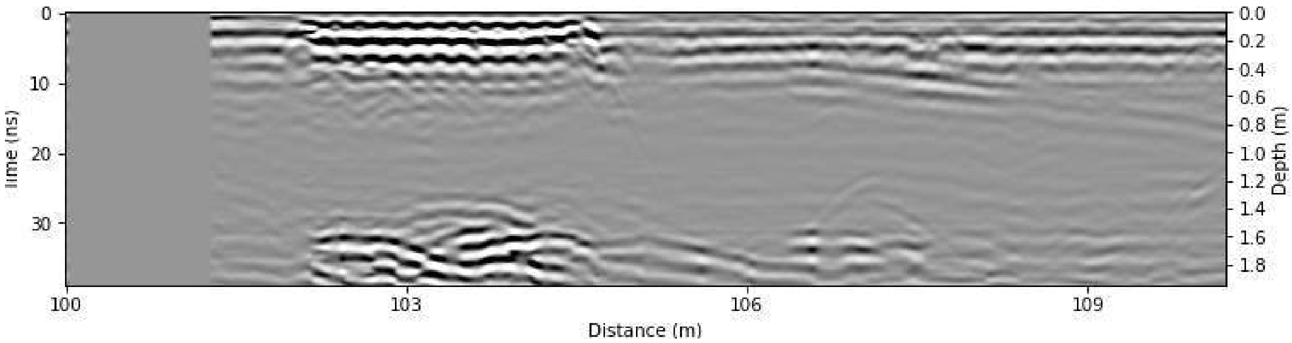


Figure B.372: Radargram at x = 209.75 m.

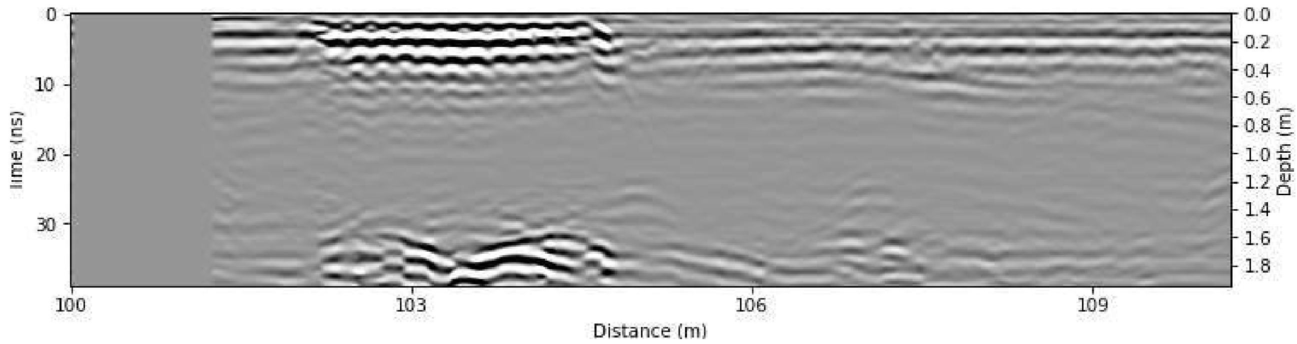


Figure B.373: Radargram at x = 210.0 m.

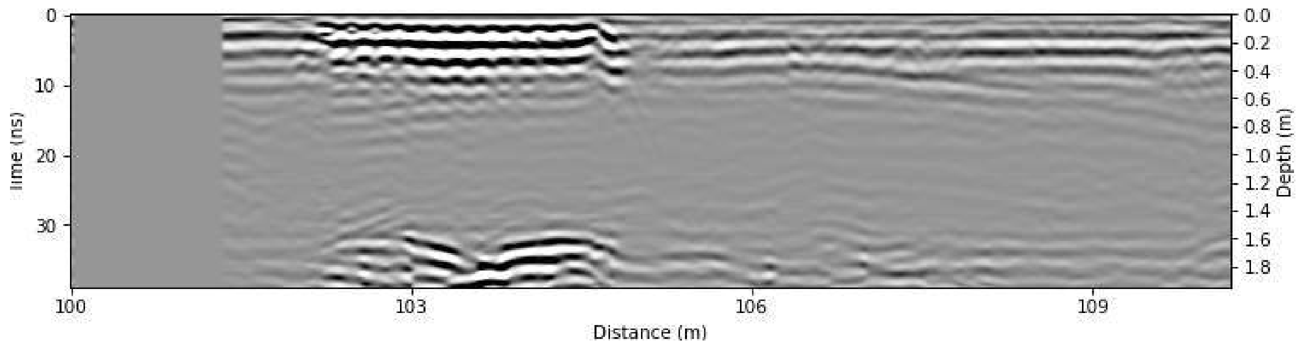
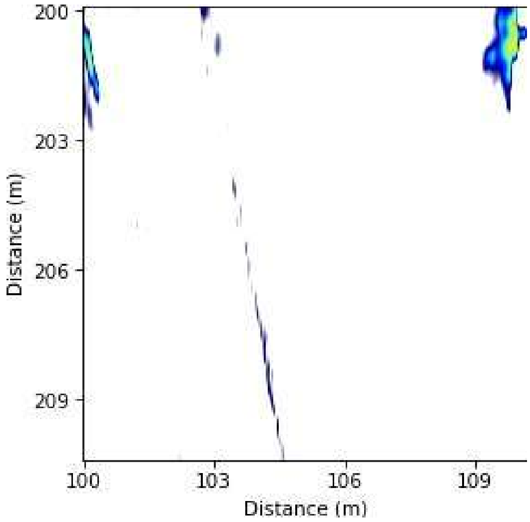
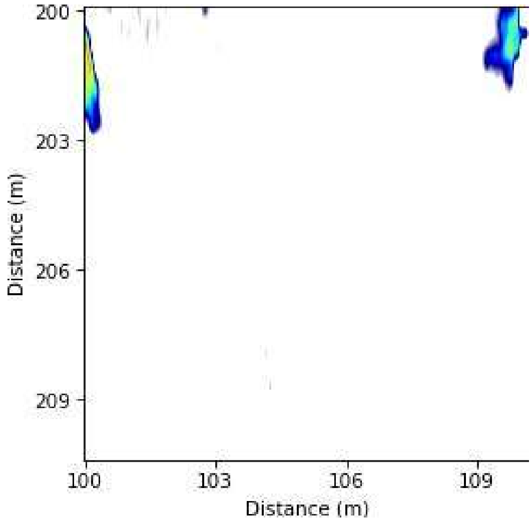


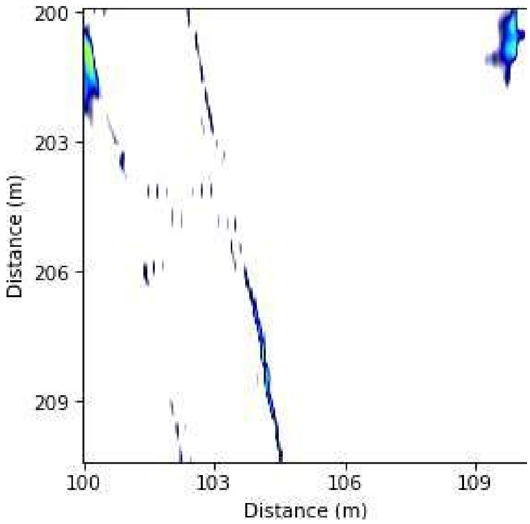
Figure B.374: Radargram at x = 210.25 m.



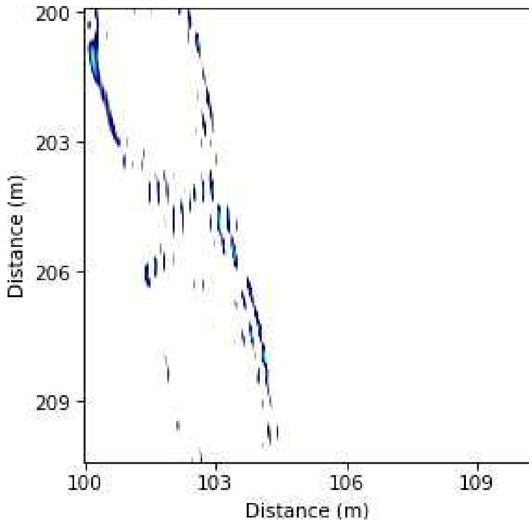
(a) Timeslice at z = 0.0 m.



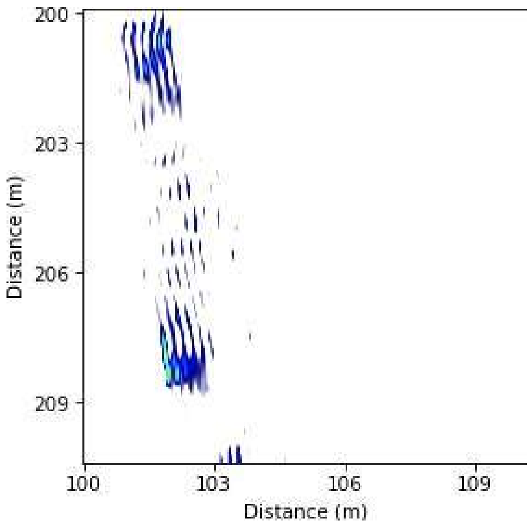
(b) Timeslice at z = 0.05 m.



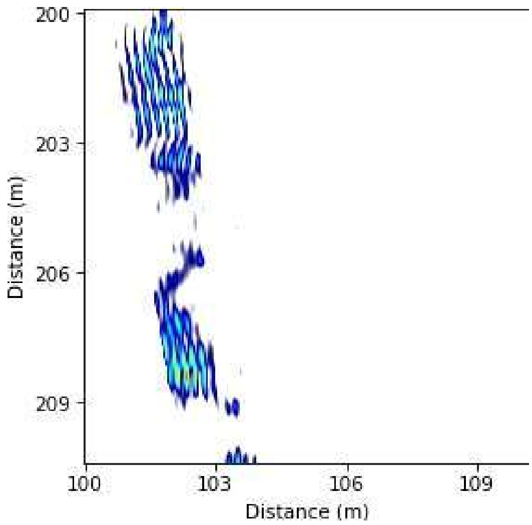
(c) Timeslice at z = 0.1 m.



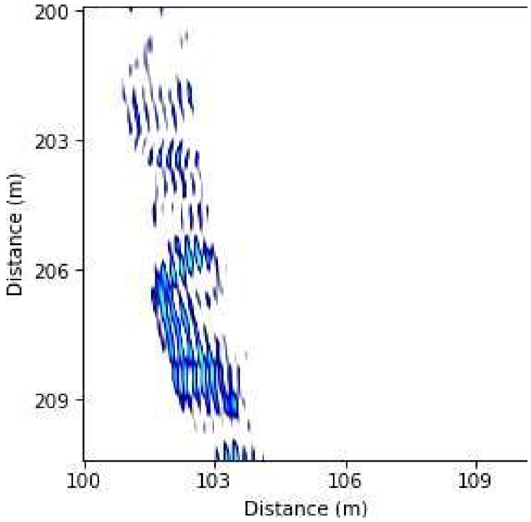
(d) Timeslice at z = 0.15 m.



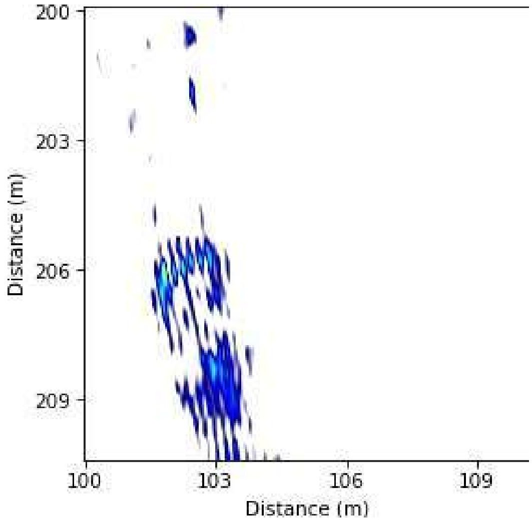
(e) Timeslice at z = 0.2 m.



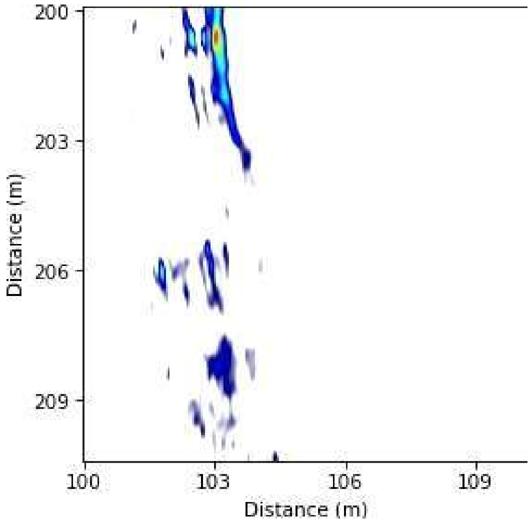
(f) Timeslice at z = 0.25 m.



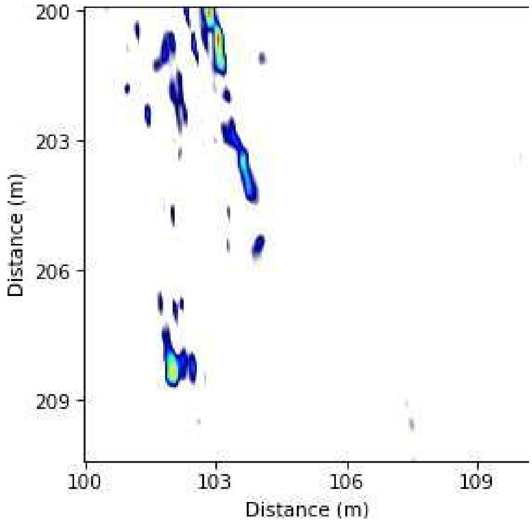
(a) Timeslice at z = 0.3 m.



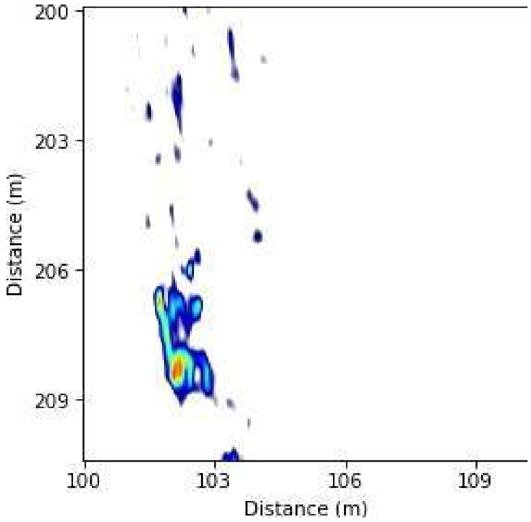
(b) Timeslice at z = 0.35 m.



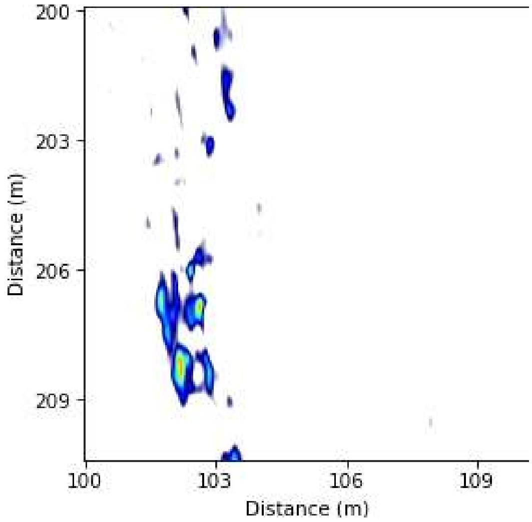
(c) Timeslice at z = 0.4 m.



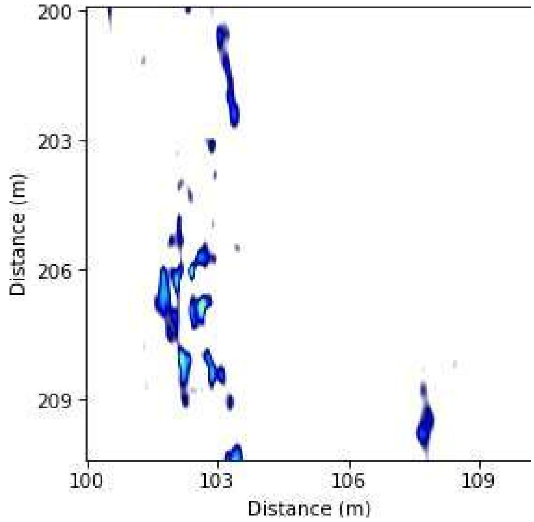
(d) Timeslice at z = 0.45 m.



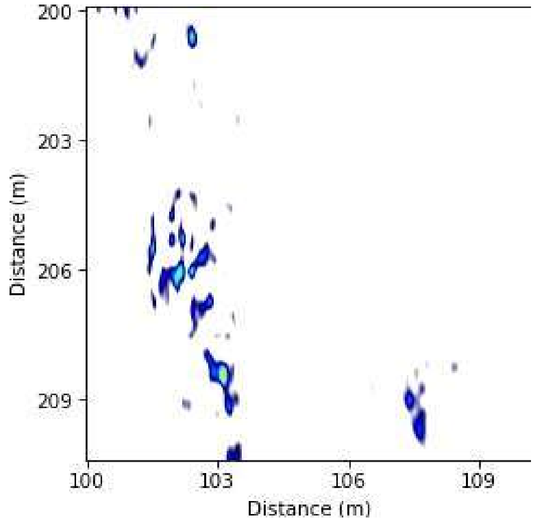
(e) Timeslice at z = 0.5 m.



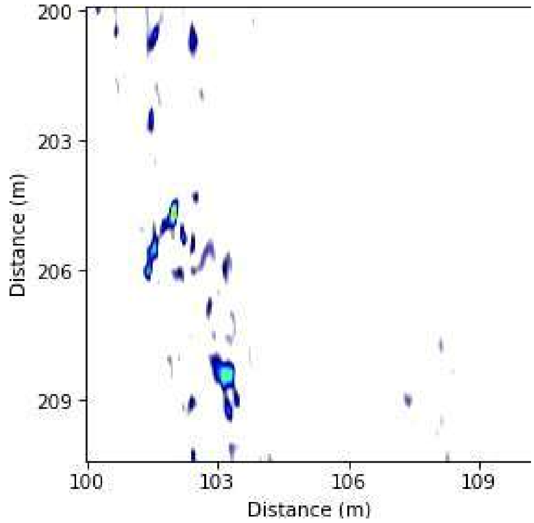
(f) Timeslice at z = 0.55 m.



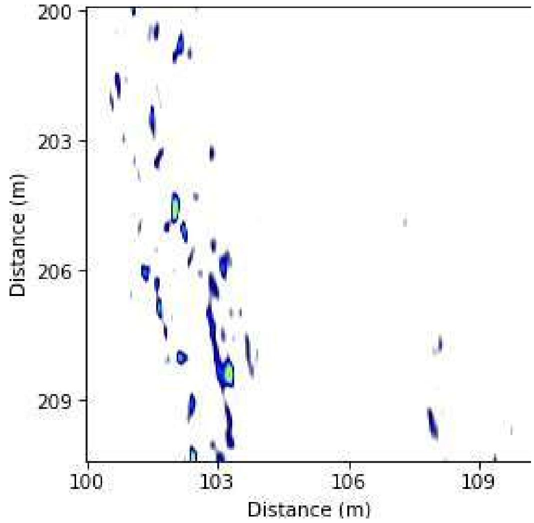
(a) Timeslice at z = 0.6 m.



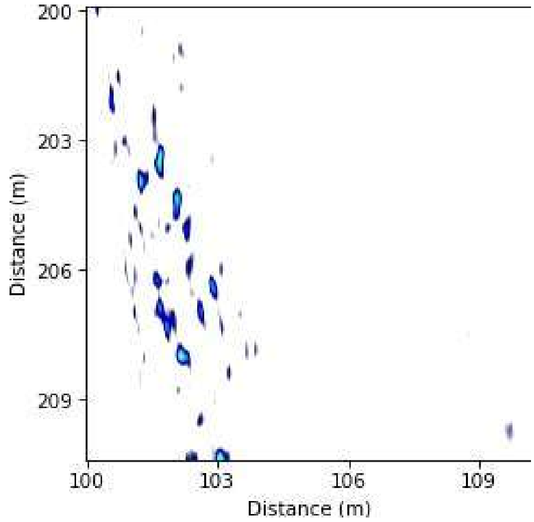
(b) Timeslice at z = 0.65 m.



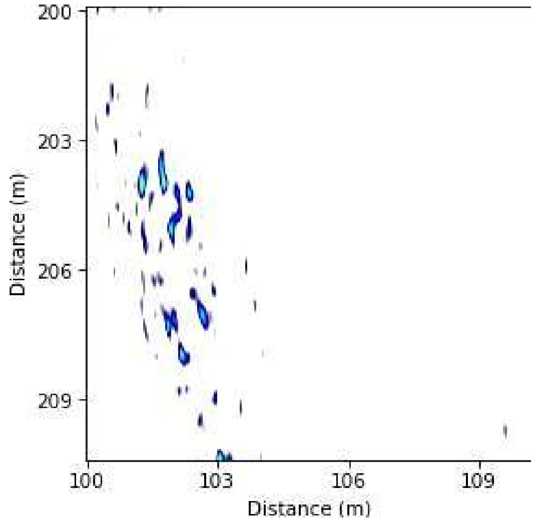
(c) Timeslice at z = 0.7 m.



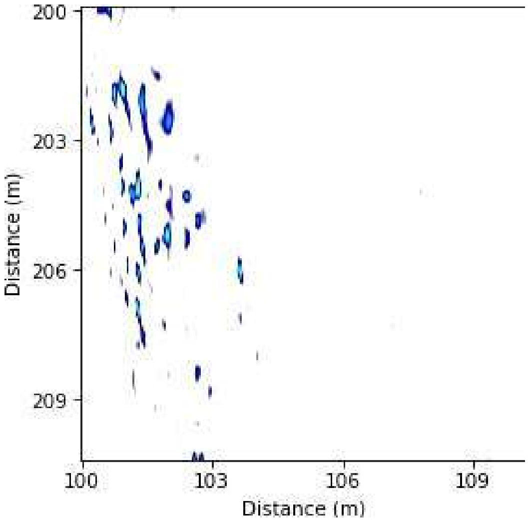
(d) Timeslice at z = 0.75 m.



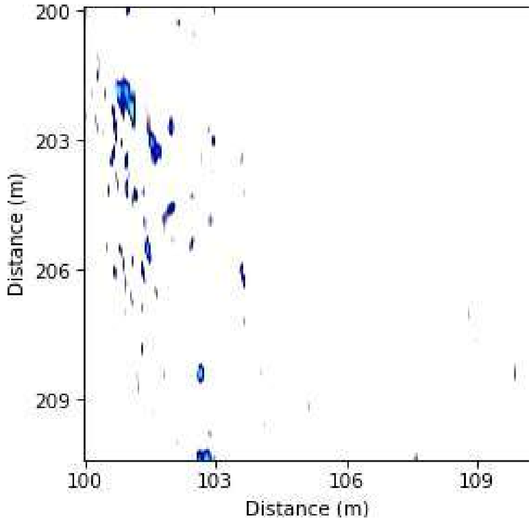
(e) Timeslice at z = 0.8 m.



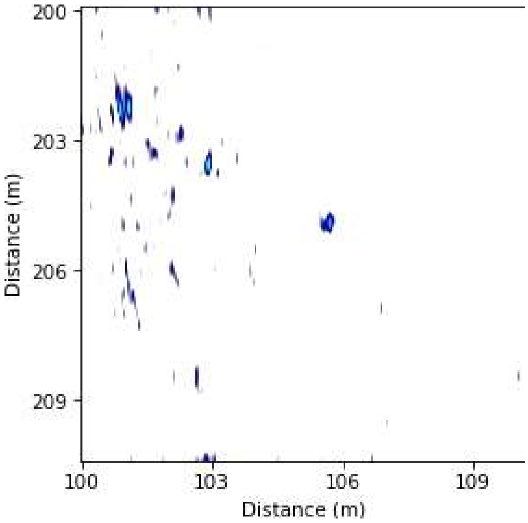
(f) Timeslice at z = 0.85 m.



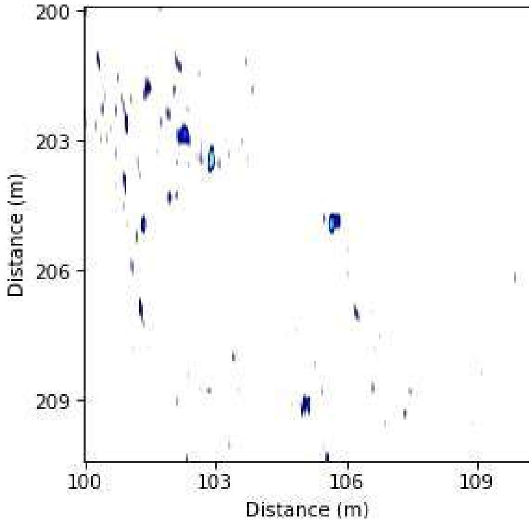
(a) Timeslice at z = 0.9 m.



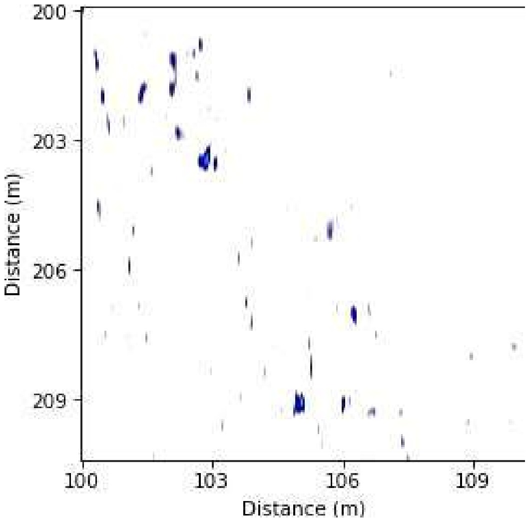
(b) Timeslice at z = 0.95 m.



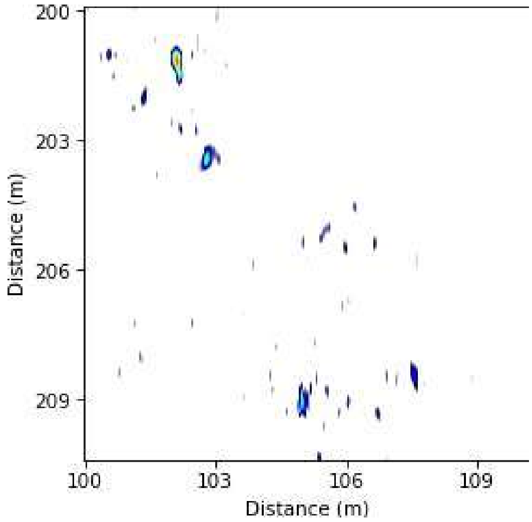
(c) Timeslice at z = 1.0 m.



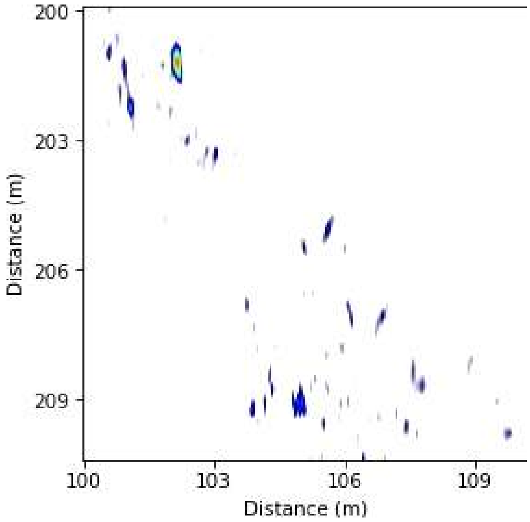
(d) Timeslice at z = 1.05 m.



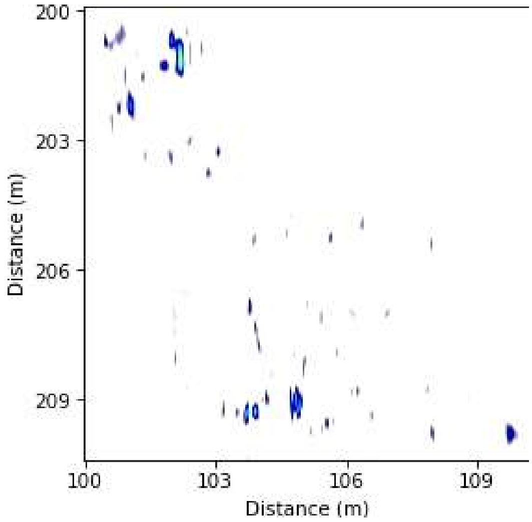
(e) Timeslice at z = 1.1 m.



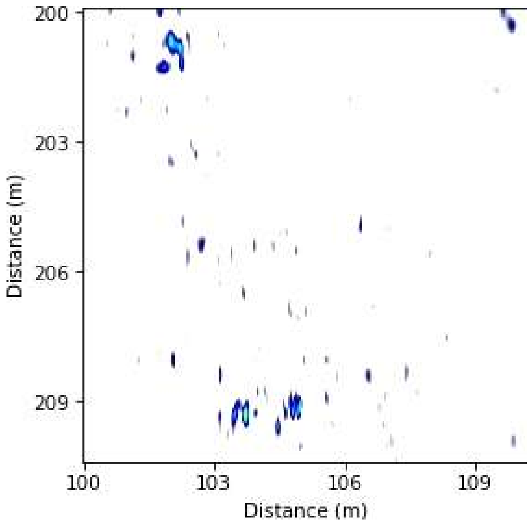
(f) Timeslice at z = 1.15 m.



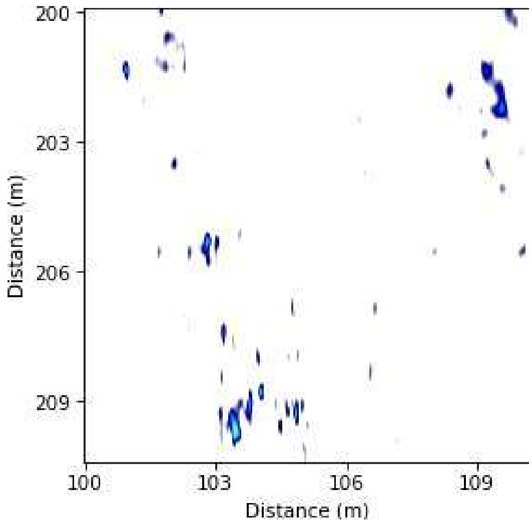
(a) Timeslice at z = 1.2 m.



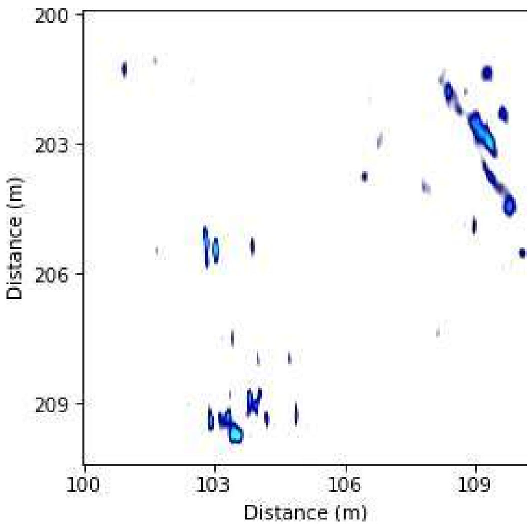
(b) Timeslice at z = 1.25 m.



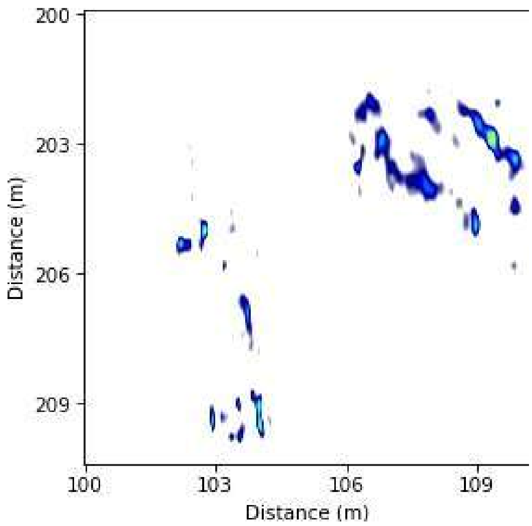
(c) Timeslice at z = 1.3 m.



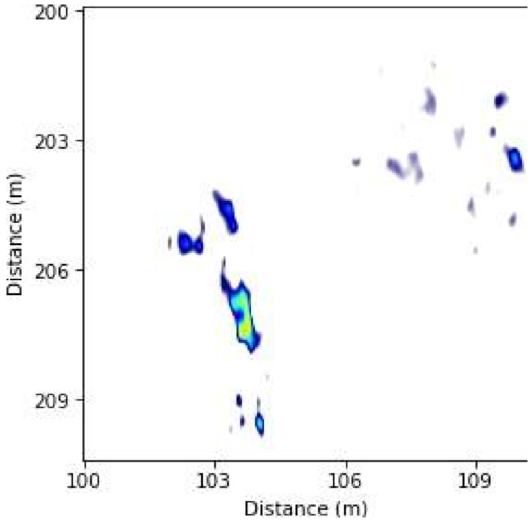
(d) Timeslice at z = 1.35 m.



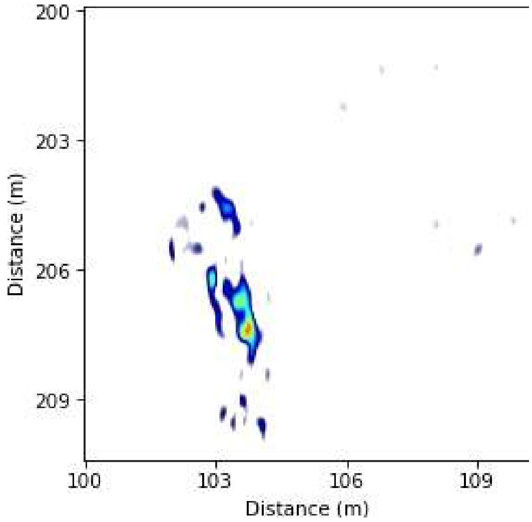
(e) Timeslice at z = 1.4 m.



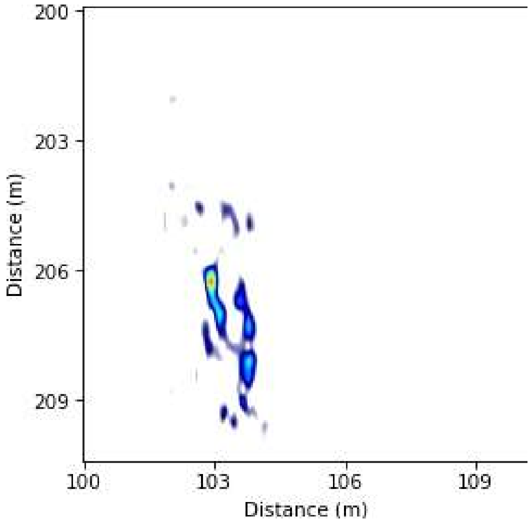
(f) Timeslice at z = 1.45 m.



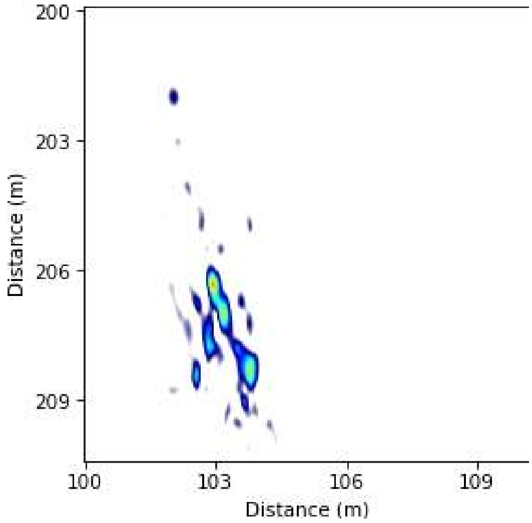
(a) Timeslice at z = 1.5 m.



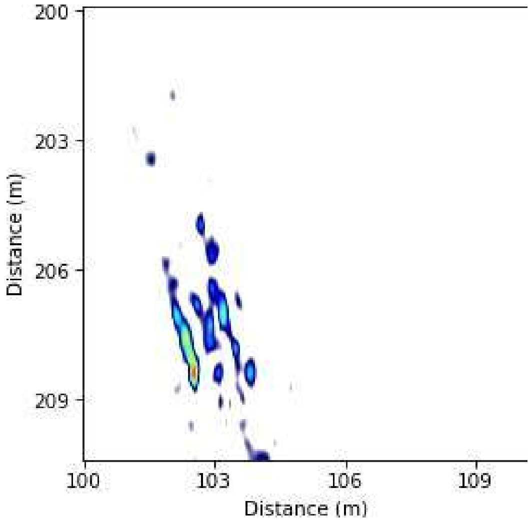
(b) Timeslice at z = 1.55 m.



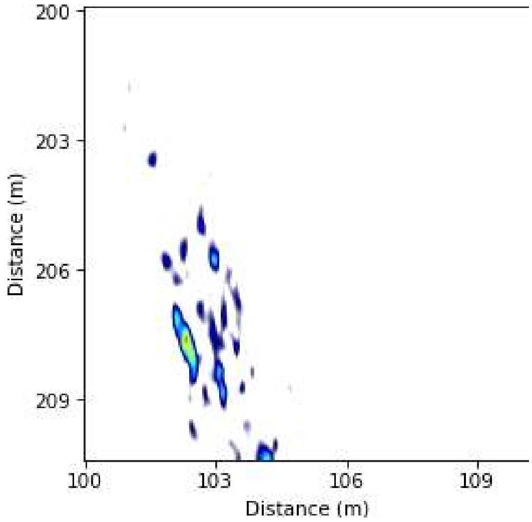
(c) Timeslice at z = 1.6 m.



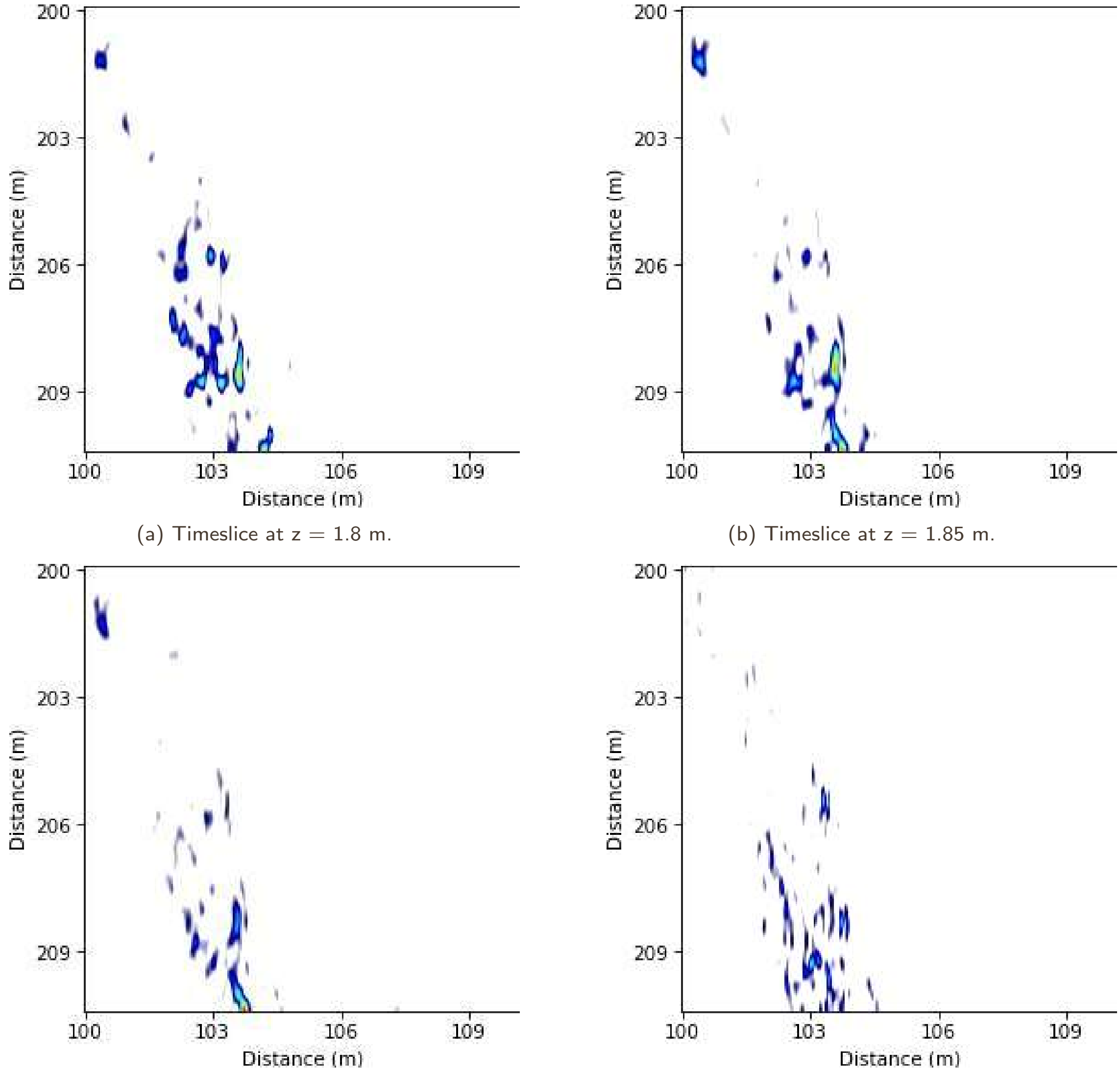
(d) Timeslice at z = 1.65 m.



(e) Timeslice at z = 1.7 m.



(f) Timeslice at z = 1.75 m.



(a) Timeslice at z = 1.8 m.

(b) Timeslice at z = 1.85 m.

(c) Timeslice at z = 1.9 m.

(d) Timeslice at z = 1.95 m.

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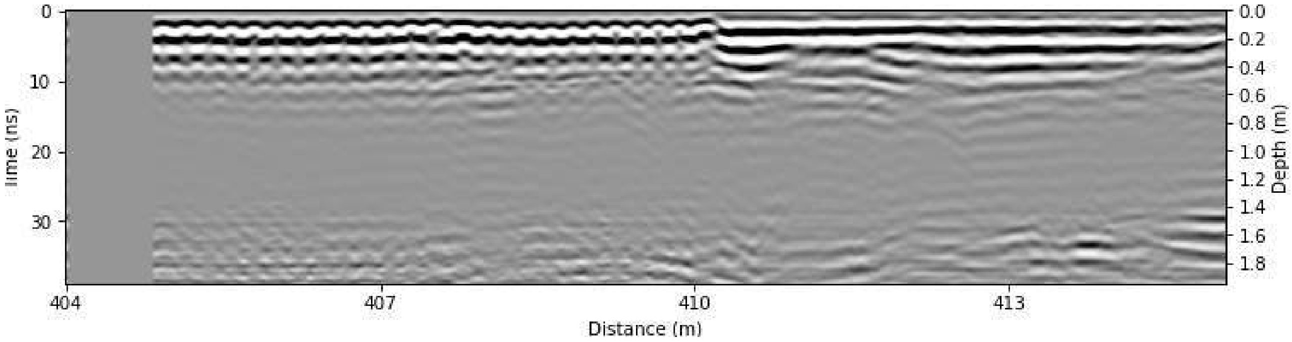


Figure B.382: Radargram at x = 305.0 m.

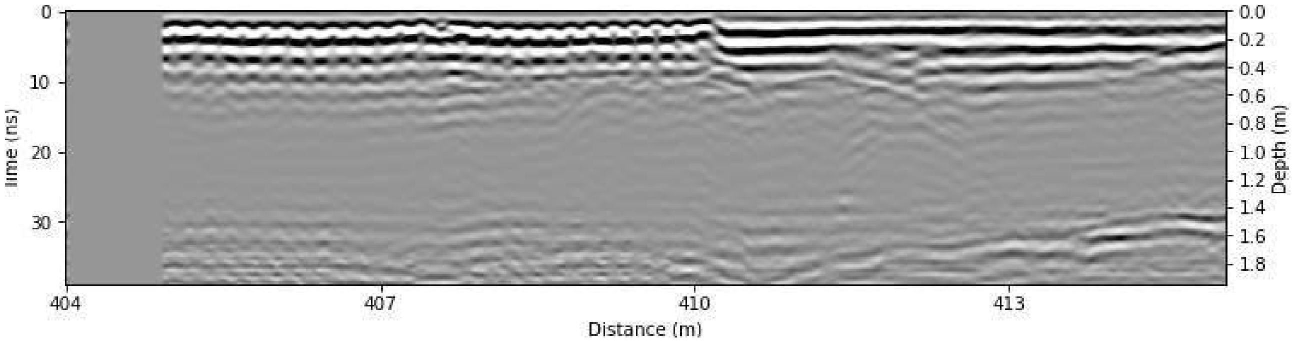


Figure B.383: Radargram at x = 305.25 m.

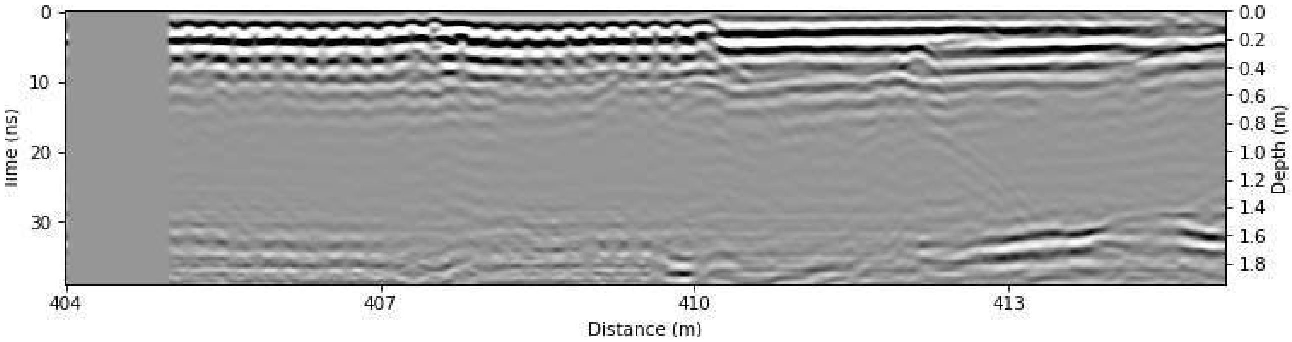


Figure B.384: Radargram at x = 305.5 m.

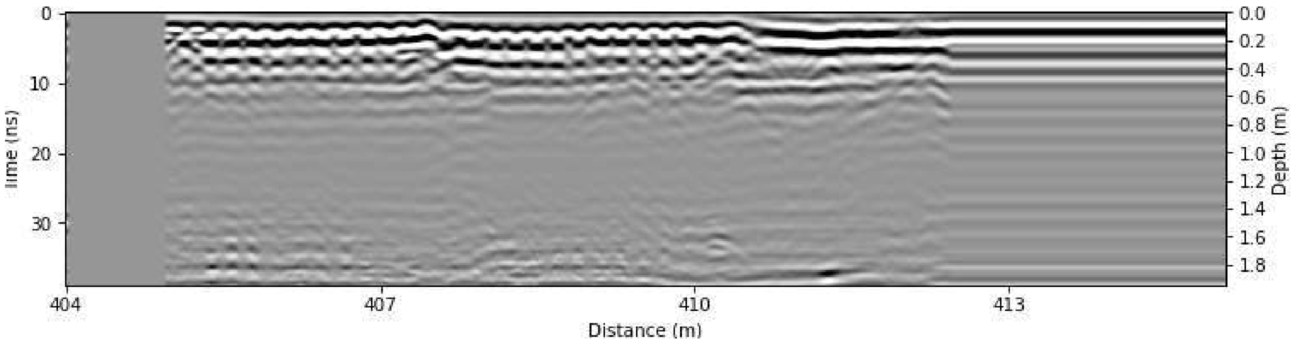


Figure B.385: Radargram at x = 305.75 m.

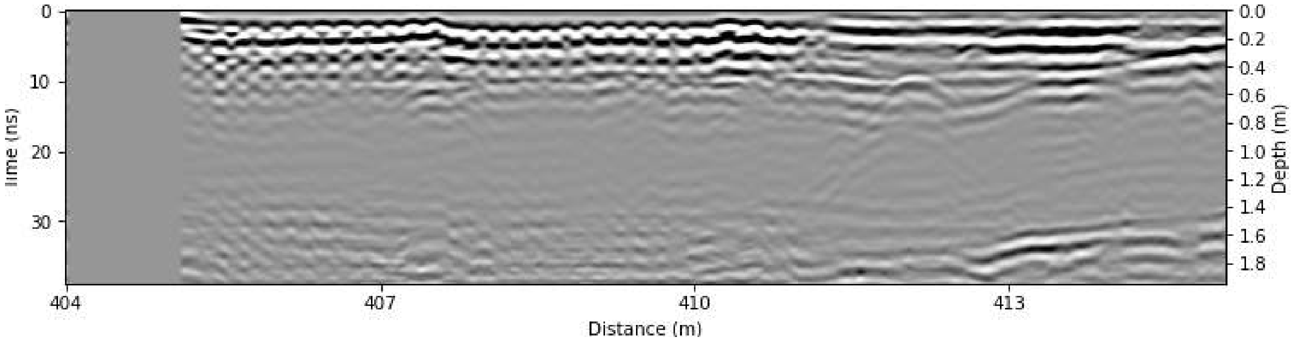


Figure B.386: Radargram at x = 306.0 m.

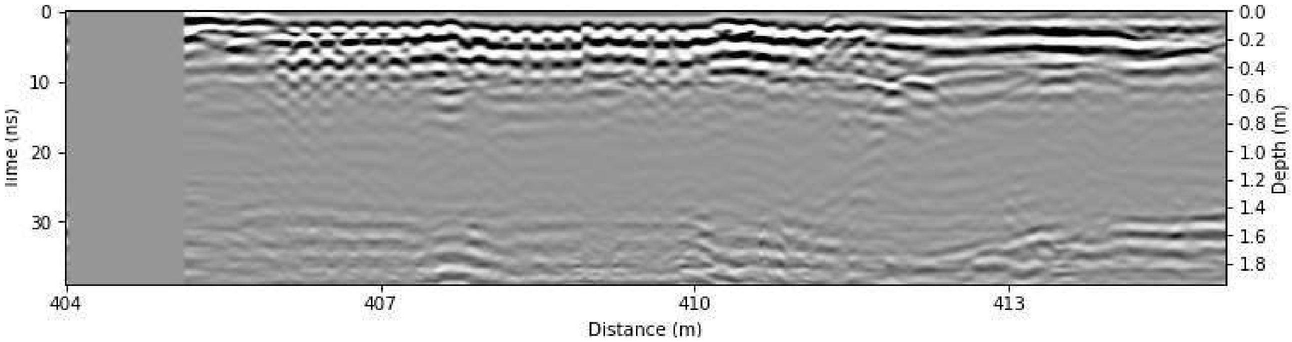


Figure B.387: Radargram at x = 306.25 m.

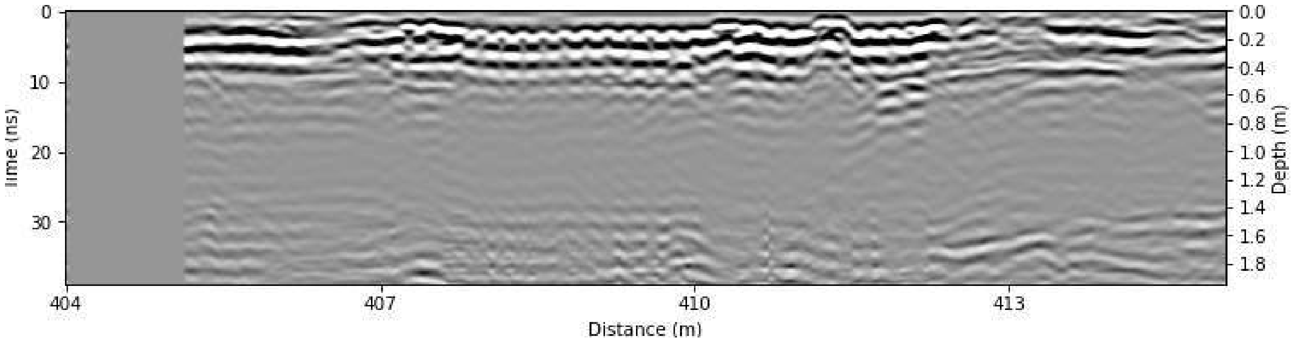


Figure B.388: Radargram at x = 306.5 m.

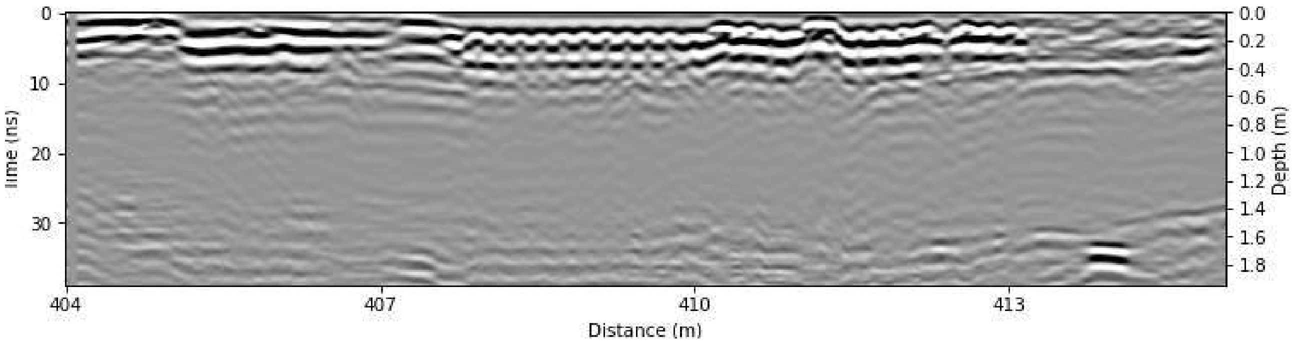


Figure B.389: Radargram at x = 306.75 m.

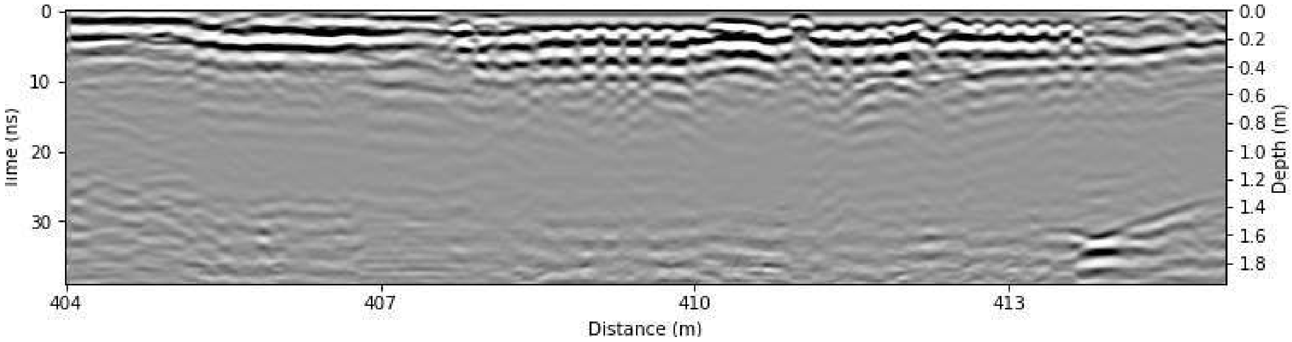


Figure B.390: Radargram at x = 307.0 m.

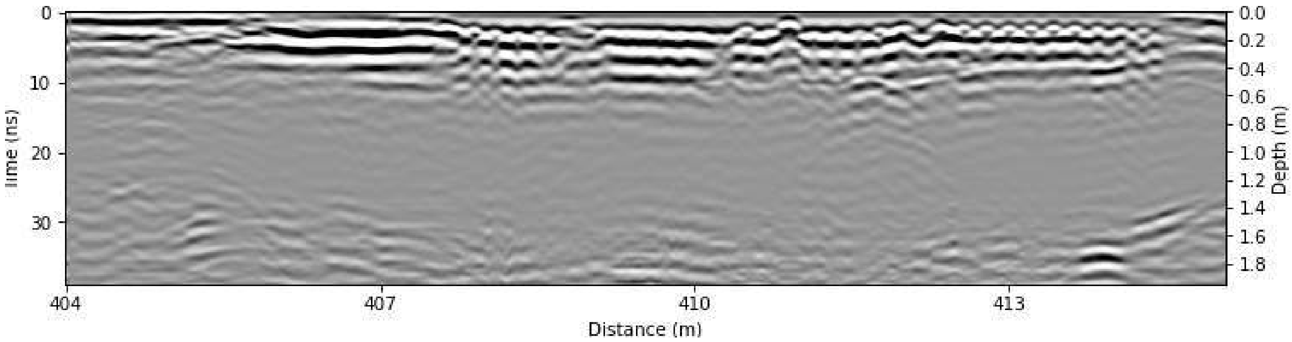


Figure B.391: Radargram at x = 307.25 m.

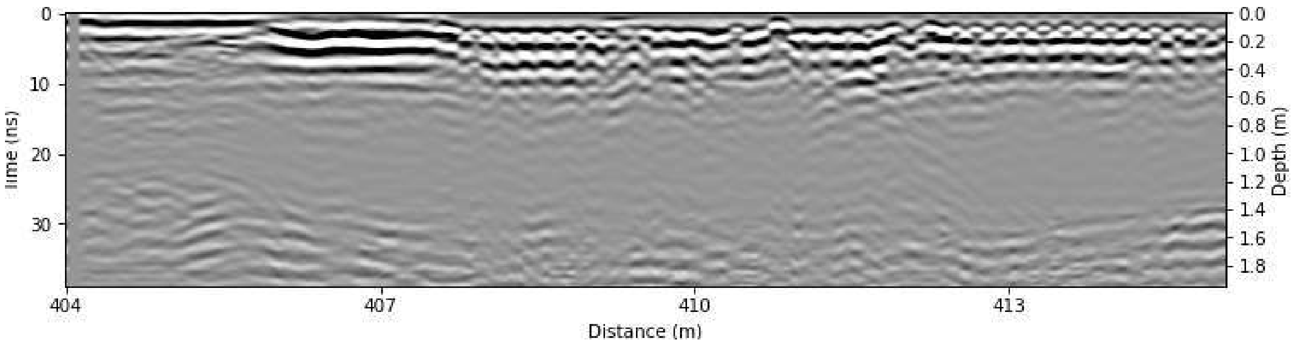


Figure B.392: Radargram at x = 307.5 m.

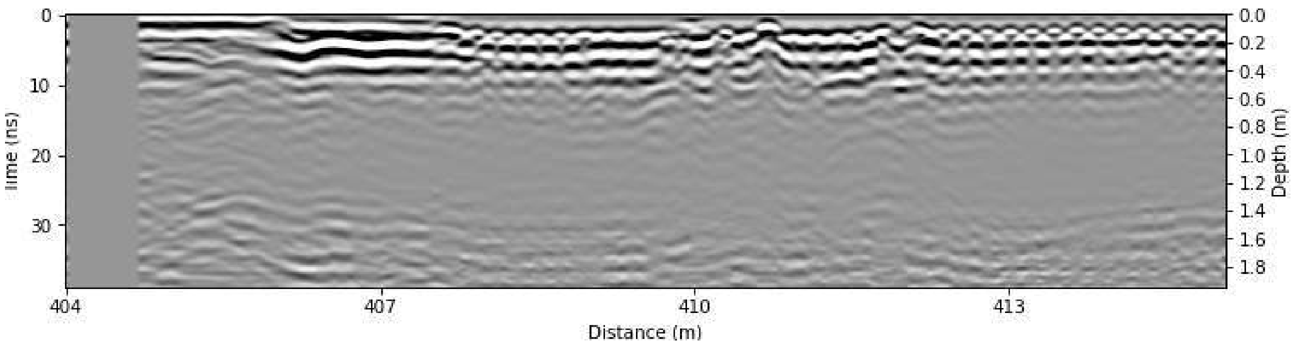


Figure B.393: Radargram at x = 307.75 m.

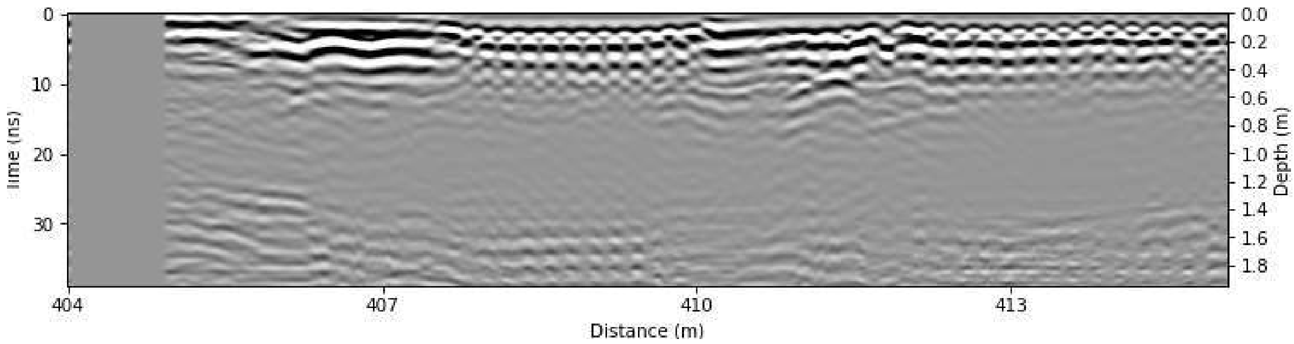


Figure B.394: Radargram at x = 308.0 m.

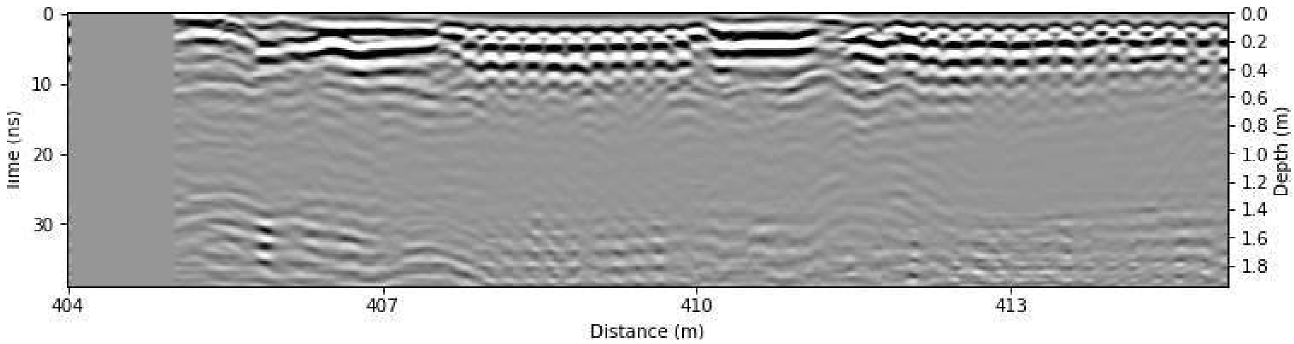


Figure B.395: Radargram at x = 308.25 m.

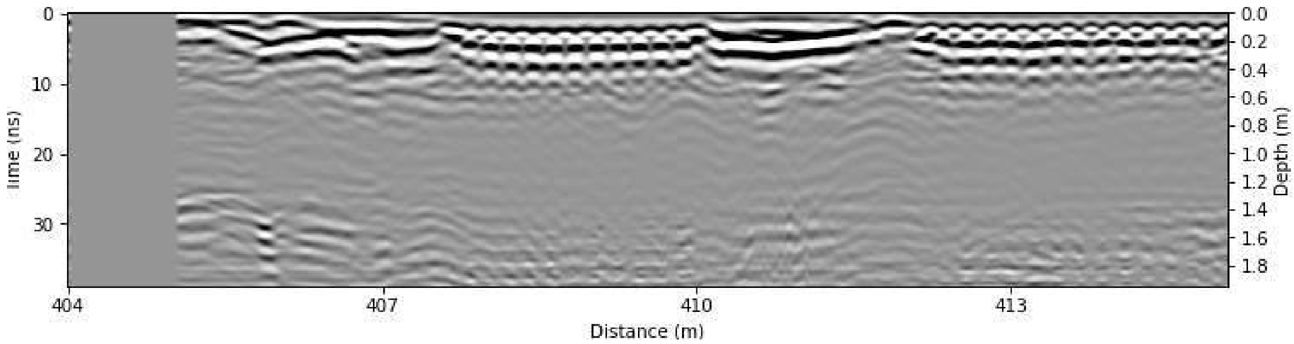


Figure B.396: Radargram at x = 308.5 m.

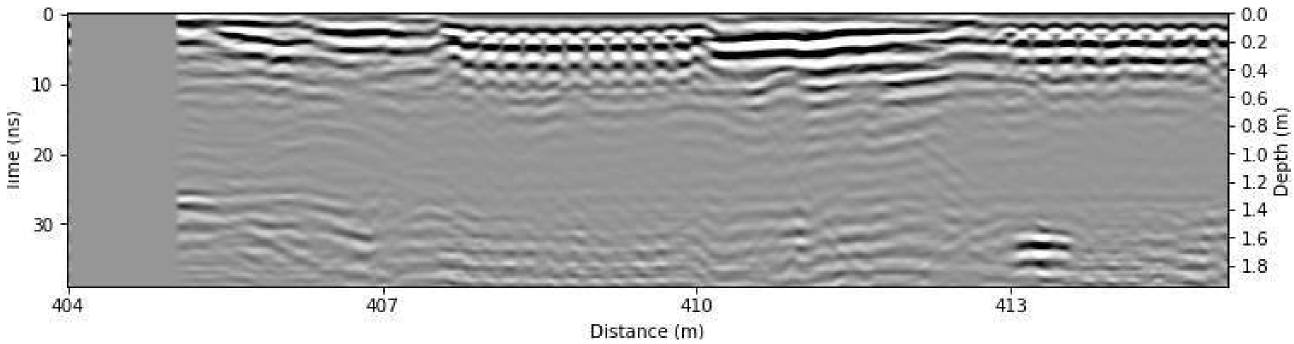


Figure B.397: Radargram at x = 308.75 m.

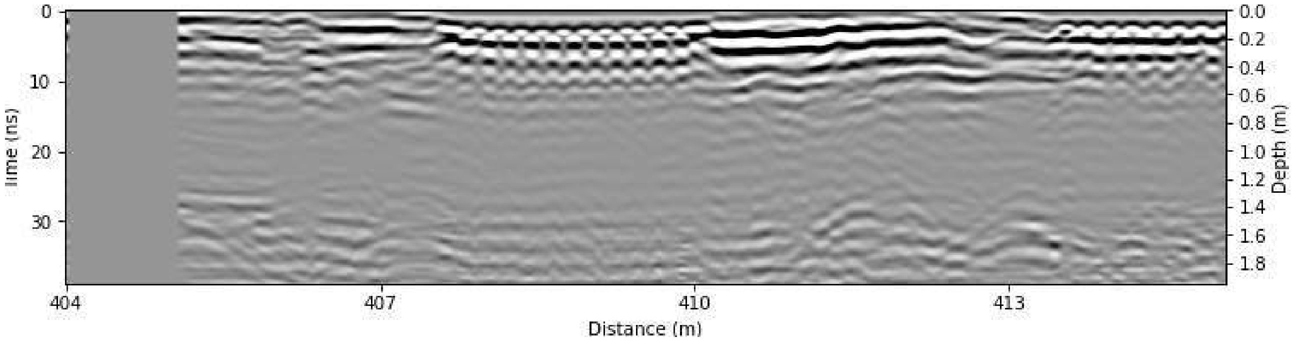


Figure B.398: Radargram at x = 309.0 m.

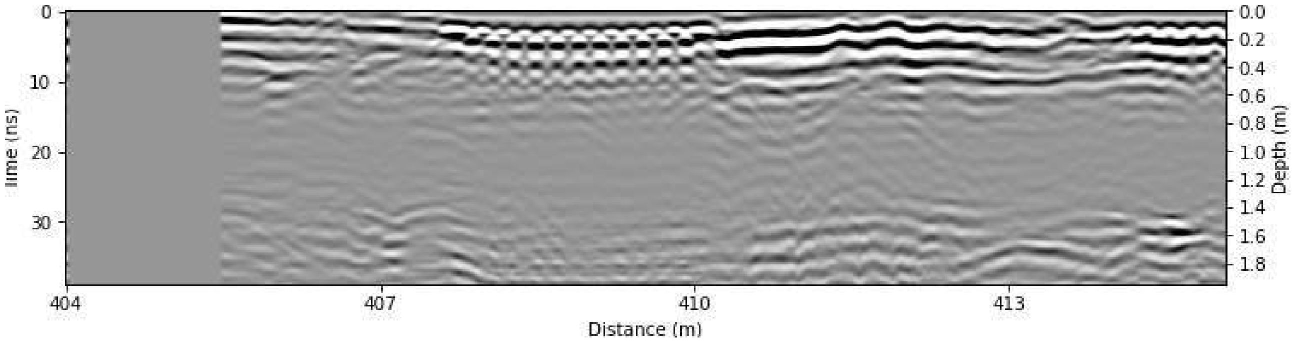


Figure B.399: Radargram at x = 309.25 m.

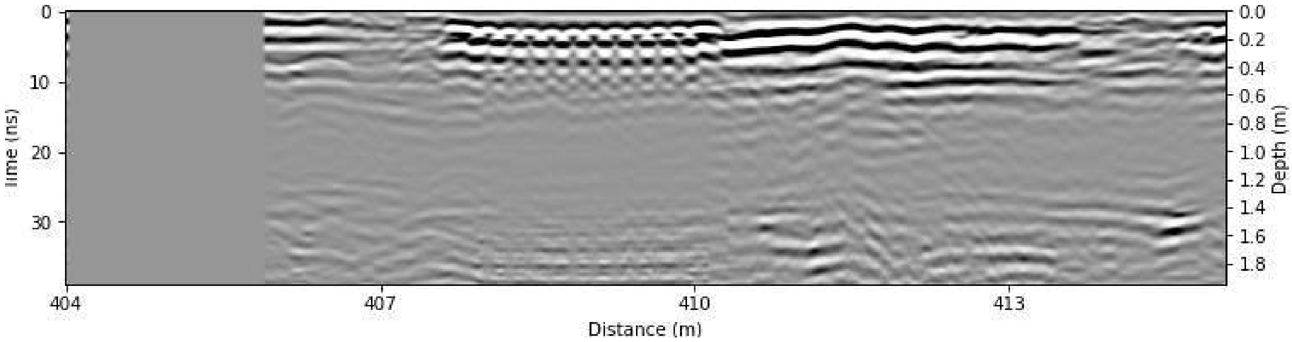


Figure B.400: Radargram at x = 309.5 m.

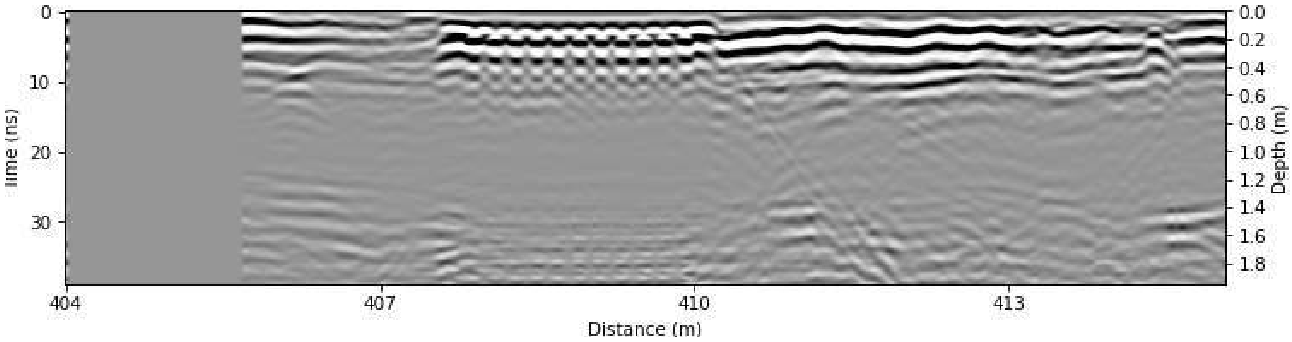


Figure B.401: Radargram at x = 309.75 m.

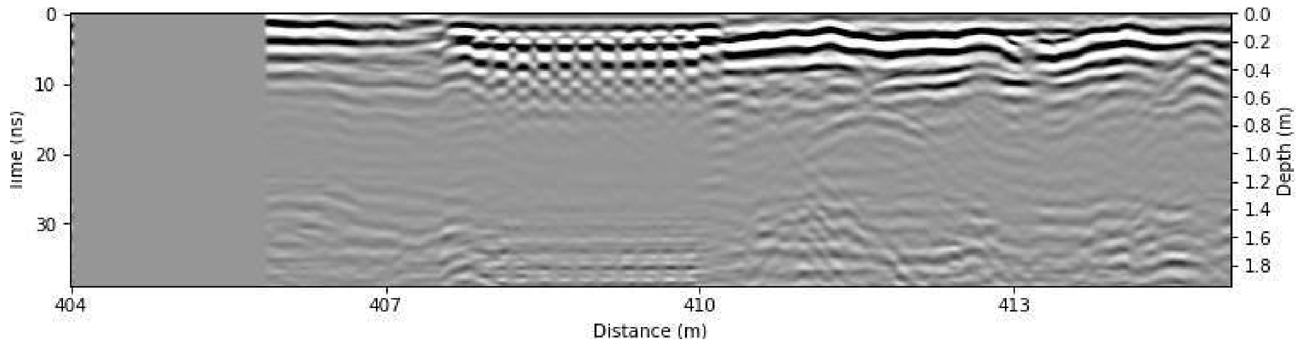


Figure B.402: Radargram at x = 310.0 m.

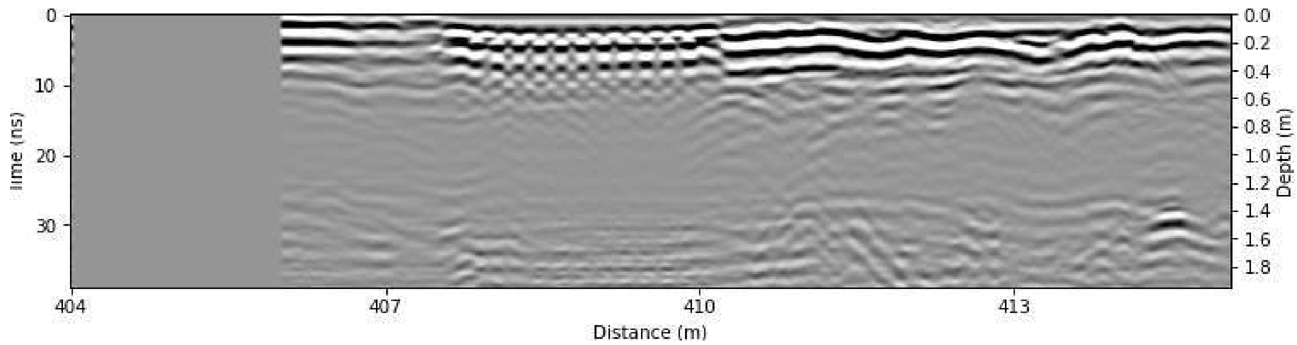


Figure B.403: Radargram at x = 310.25 m.

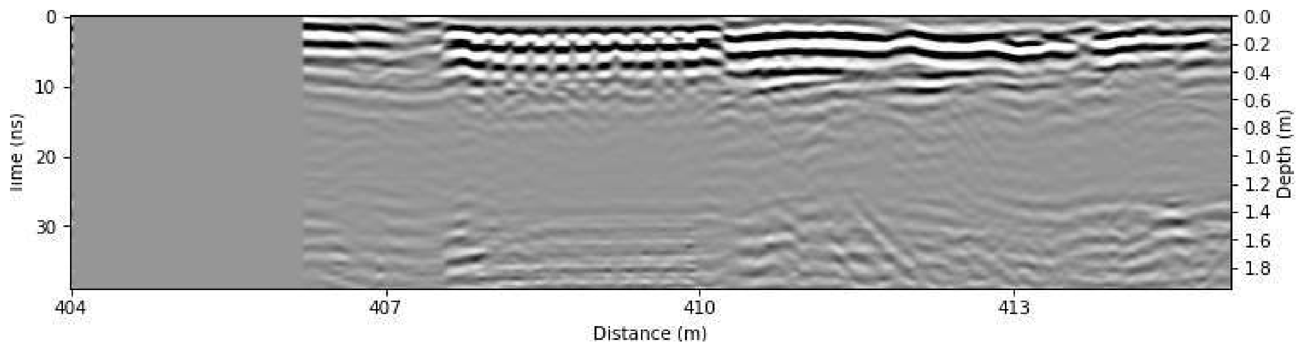


Figure B.404: Radargram at x = 310.5 m.

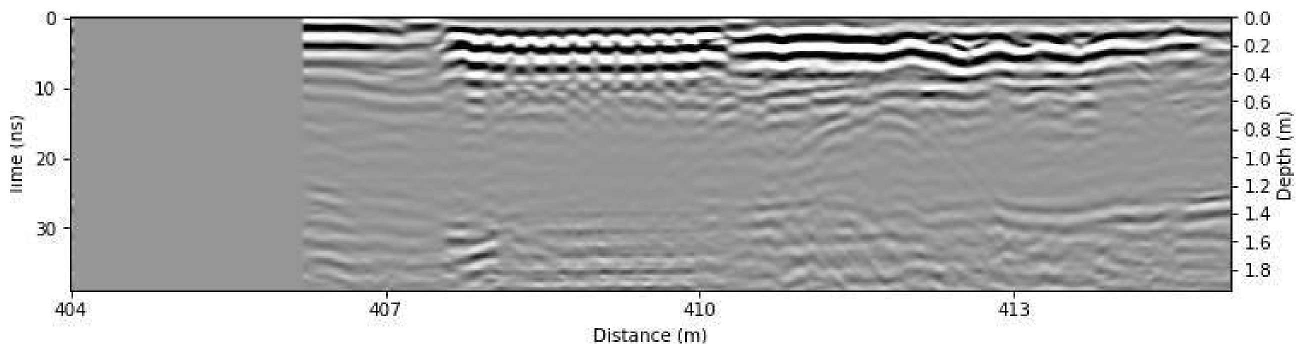


Figure B.405: Radargram at x = 310.75 m.

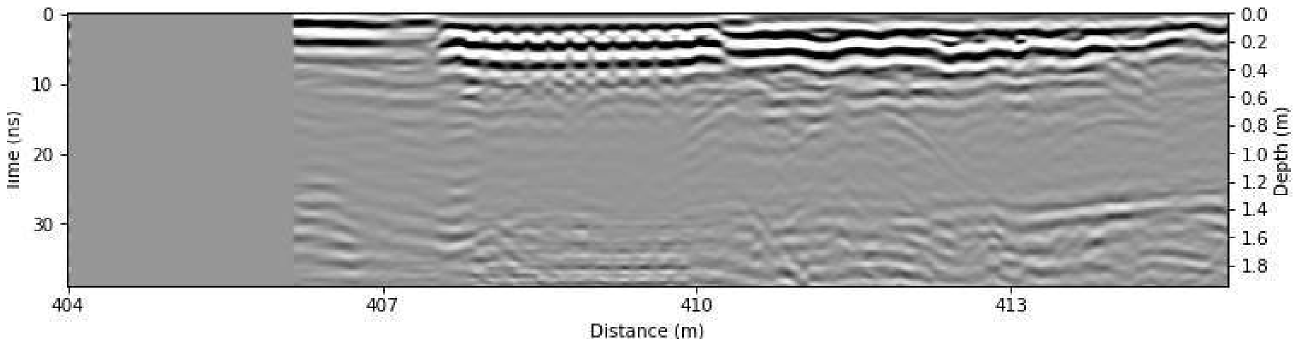


Figure B.406: Radargram at x = 311.0 m.

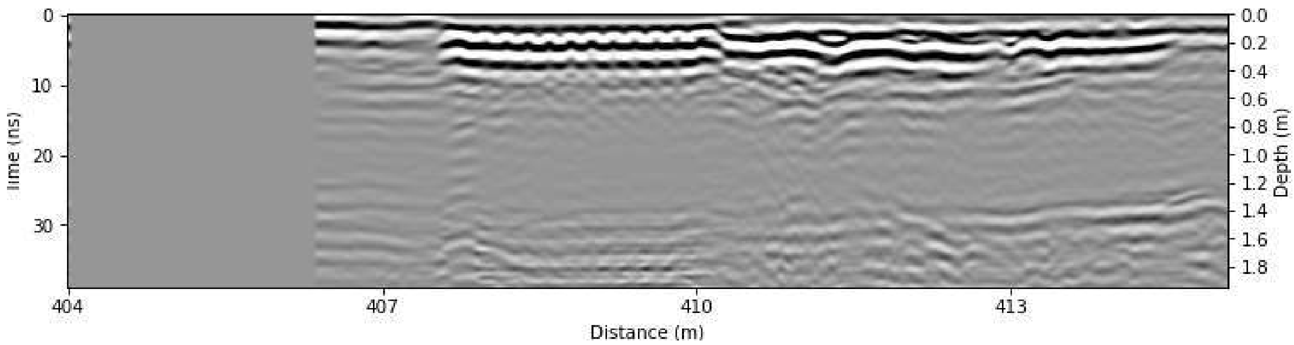


Figure B.407: Radargram at x = 311.25 m.

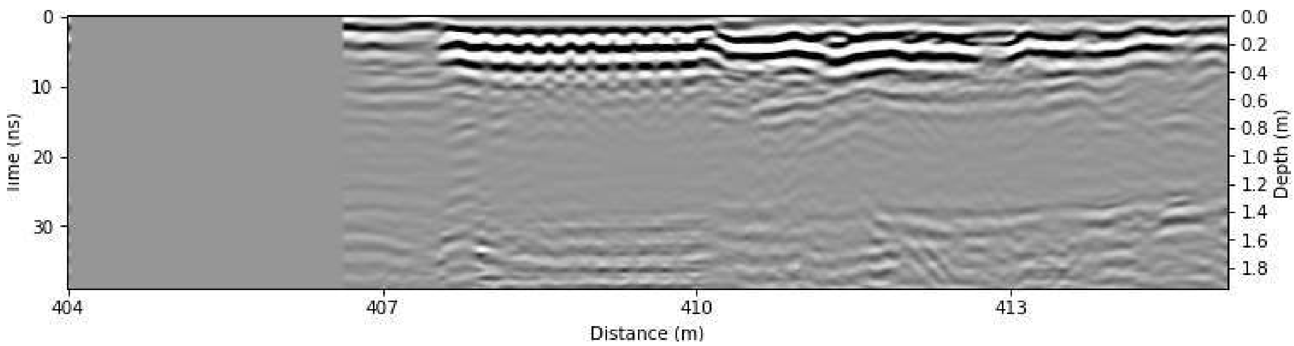


Figure B.408: Radargram at x = 311.5 m.

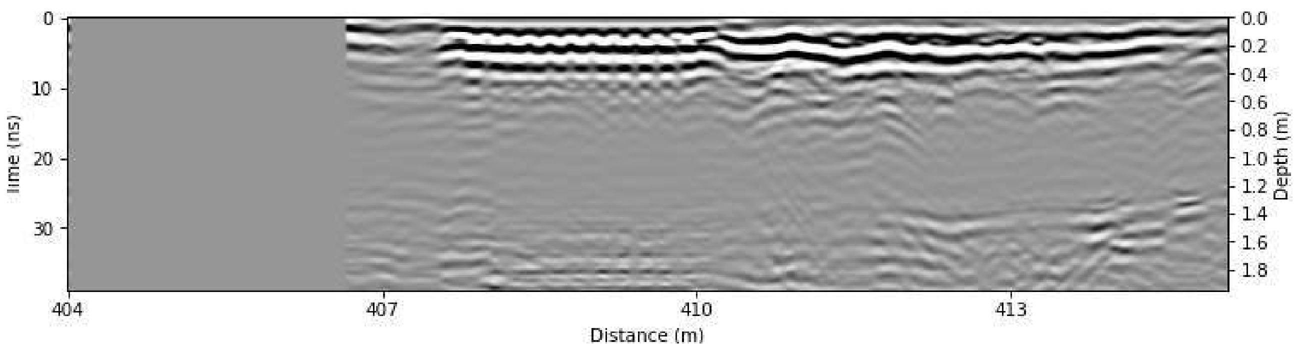


Figure B.409: Radargram at x = 311.75 m.

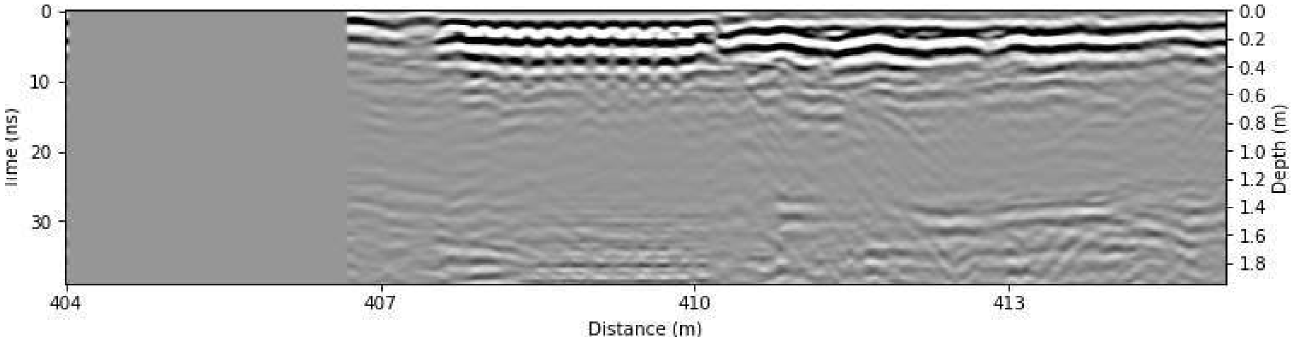


Figure B.410: Radargram at x = 312.0 m.

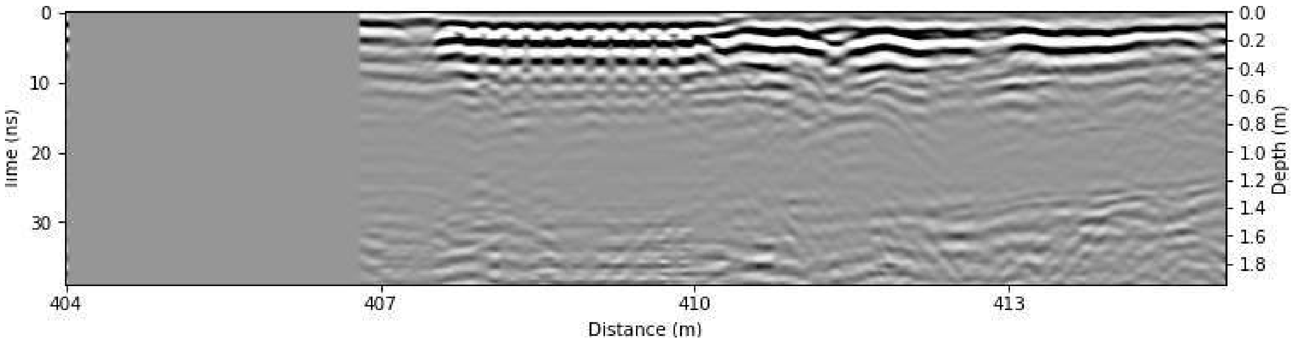


Figure B.411: Radargram at x = 312.25 m.

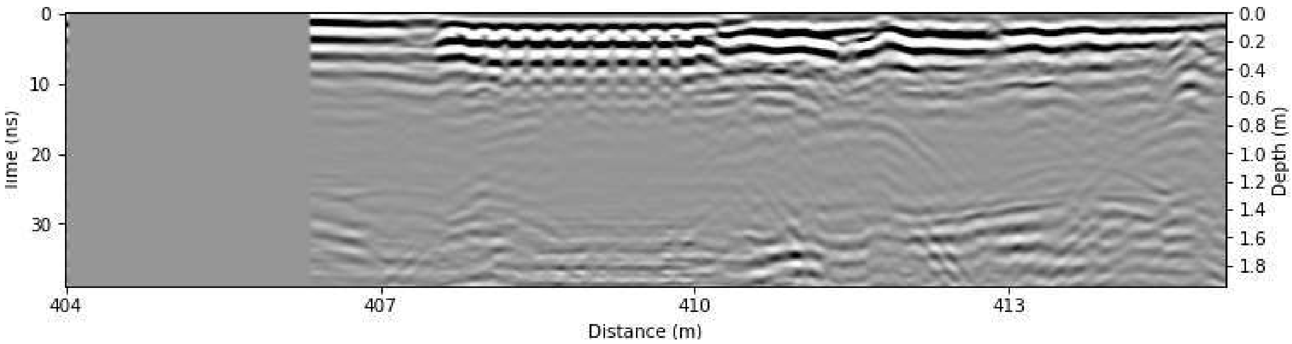


Figure B.412: Radargram at x = 312.5 m.

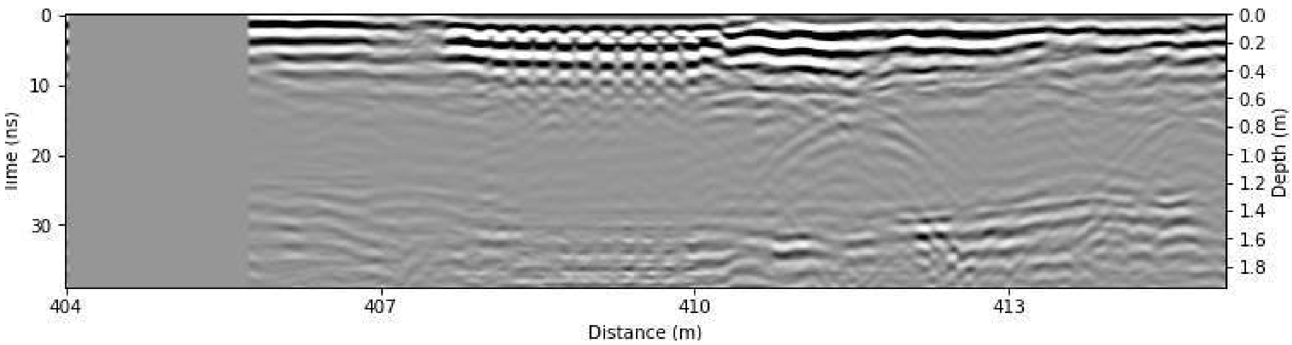


Figure B.413: Radargram at x = 312.75 m.

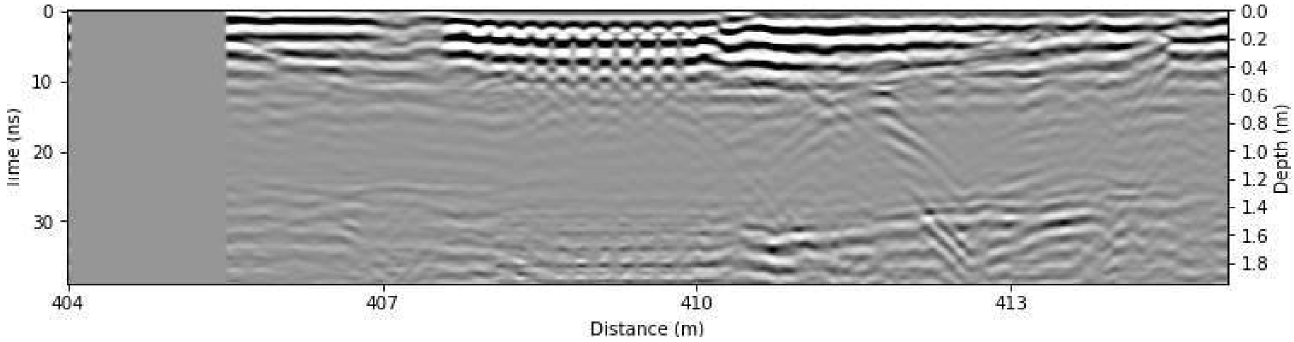


Figure B.414: Radargram at x = 313.0 m.

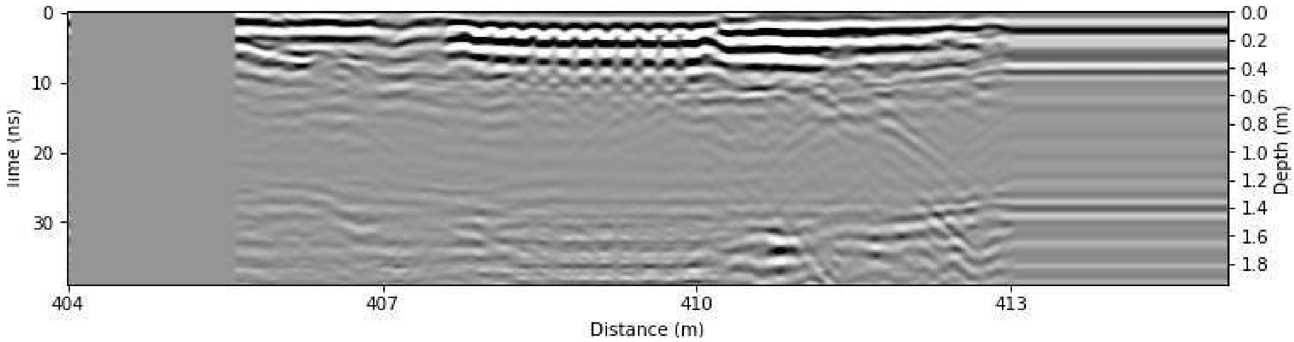


Figure B.415: Radargram at x = 313.25 m.

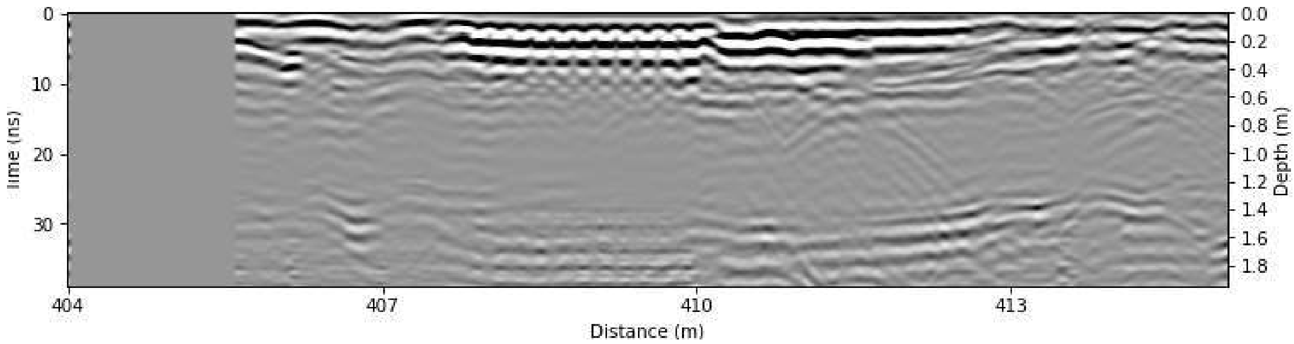


Figure B.416: Radargram at x = 313.5 m.

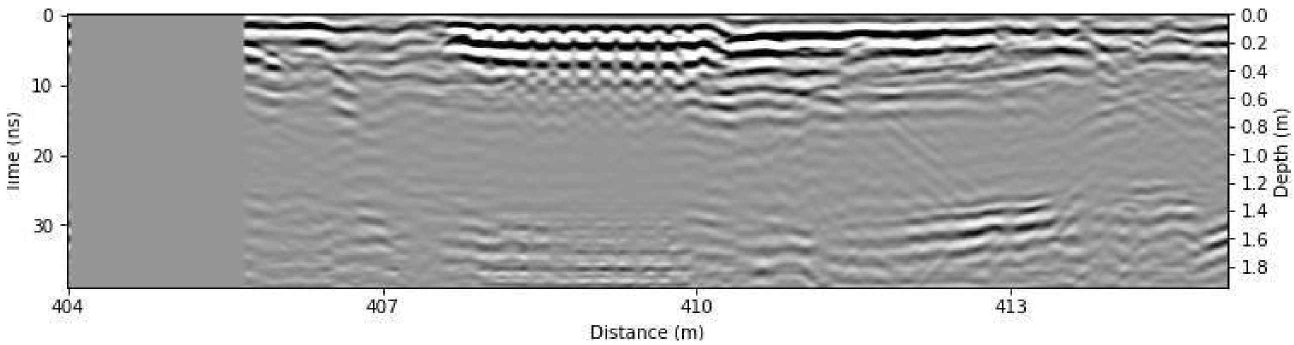


Figure B.417: Radargram at x = 313.75 m.

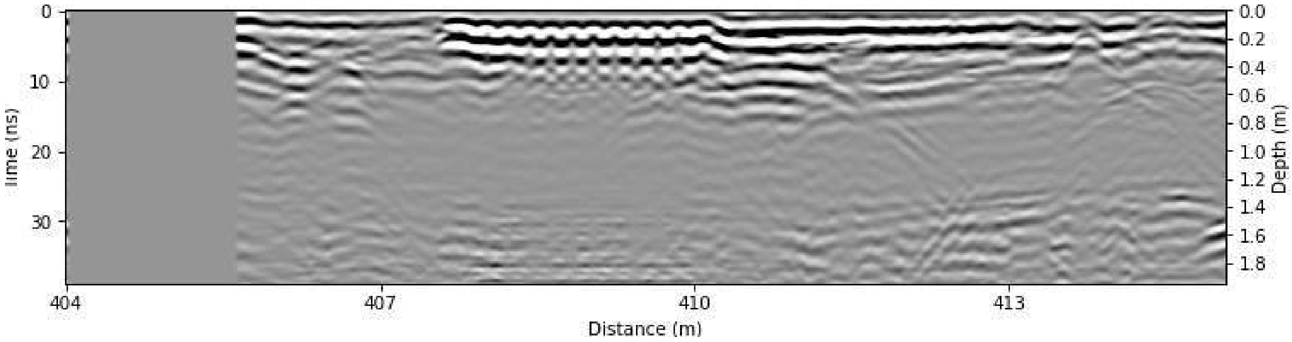


Figure B.418: Radargram at x = 314.0 m.

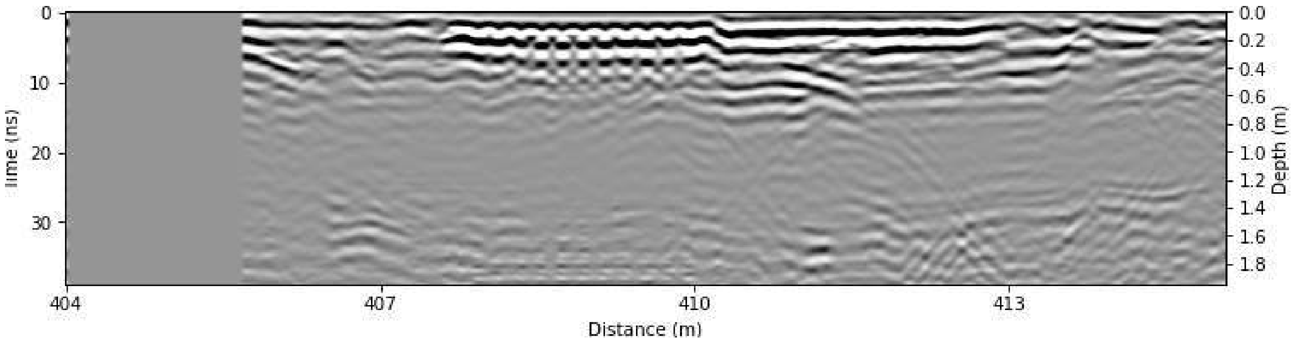


Figure B.419: Radargram at x = 314.25 m.

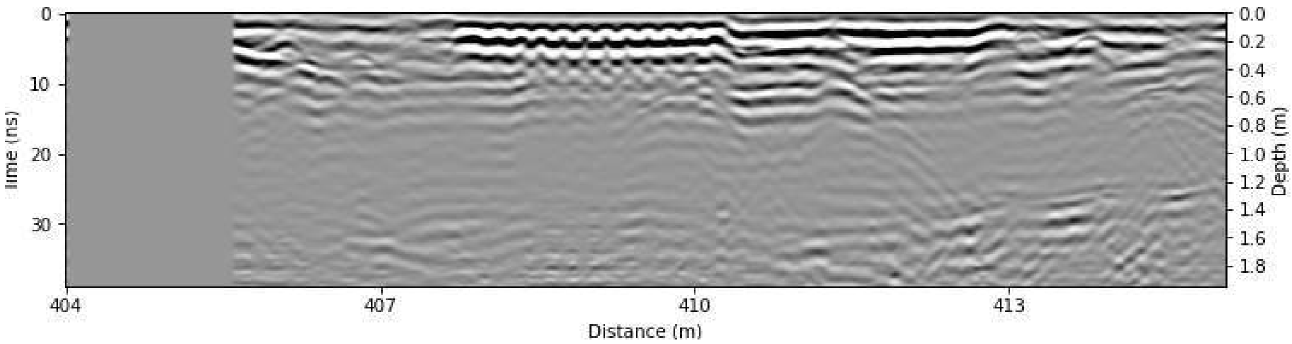


Figure B.420: Radargram at x = 314.5 m.

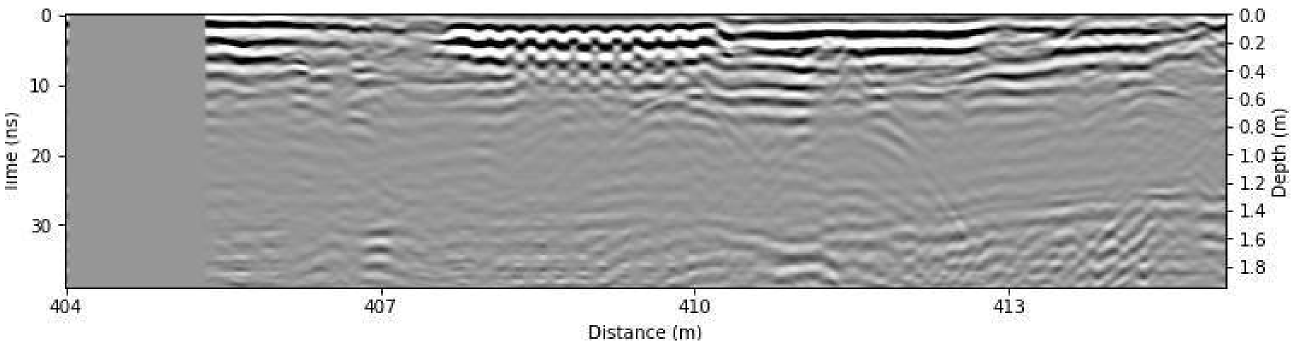


Figure B.421: Radargram at x = 314.75 m.

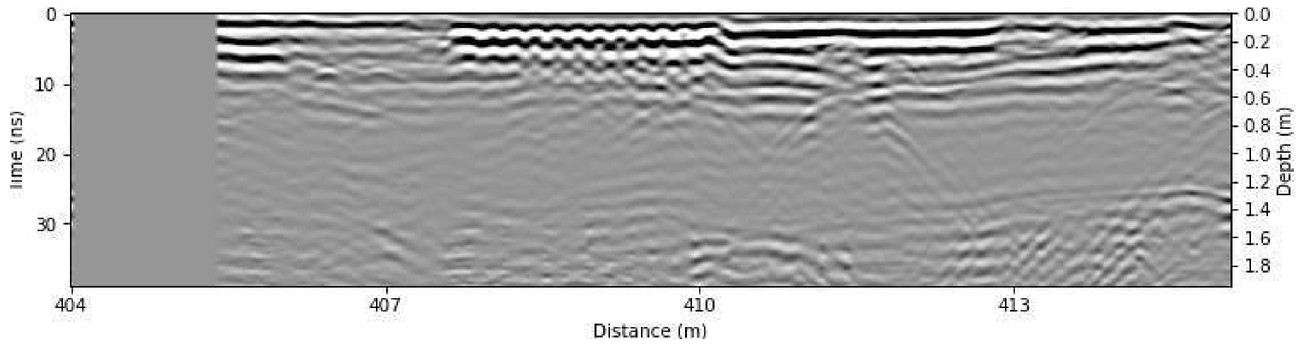
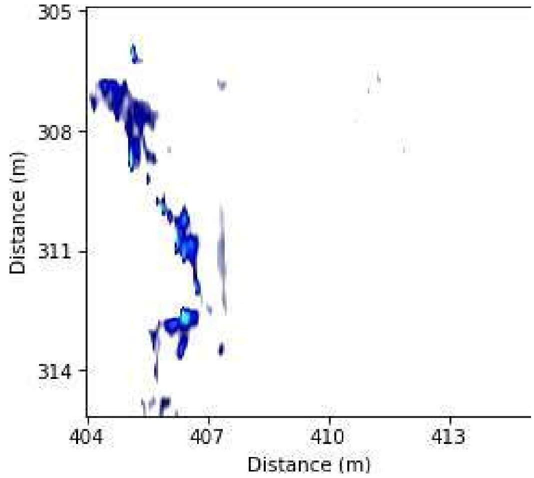
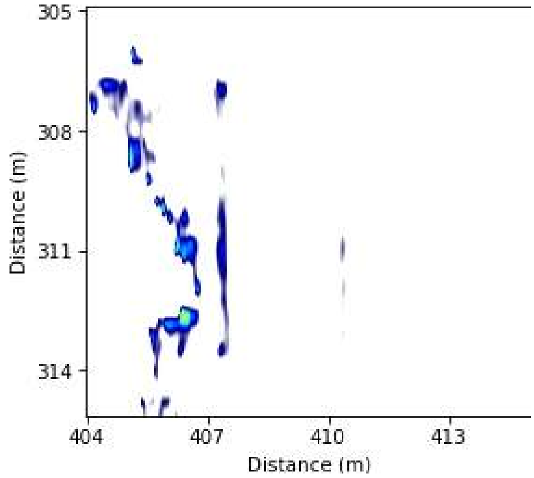


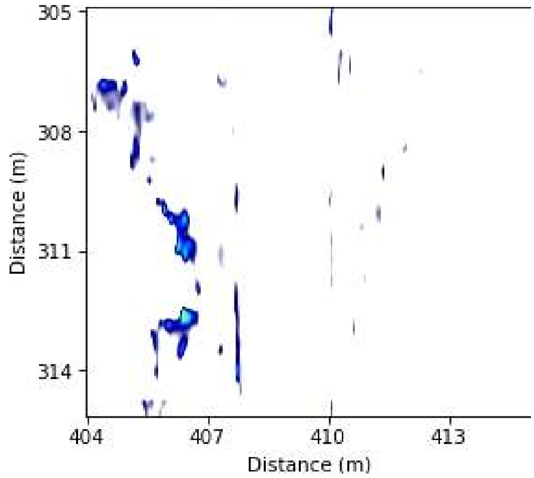
Figure B.422: Radargram at x = 315.0 m.



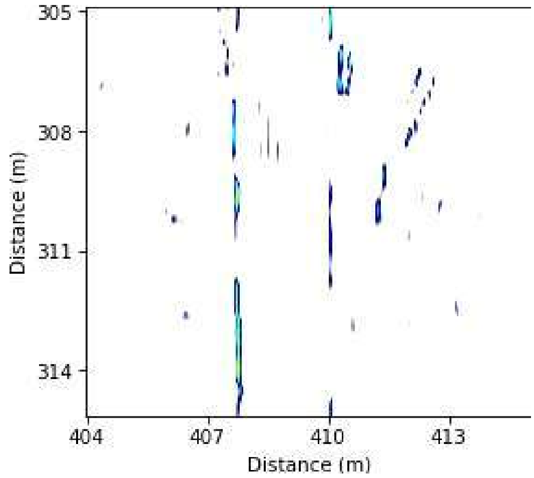
(a) Timeslice at z = 0.0 m.



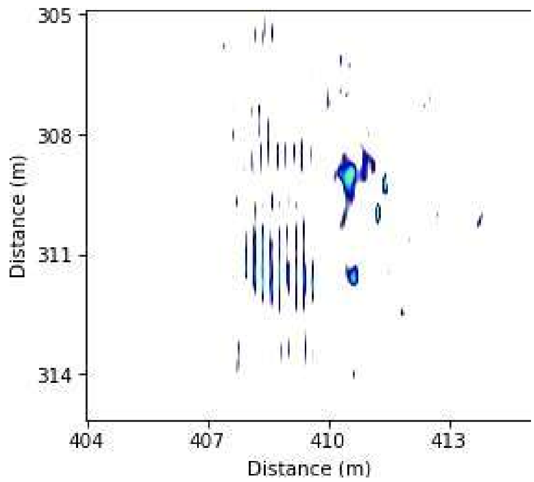
(b) Timeslice at z = 0.05 m.



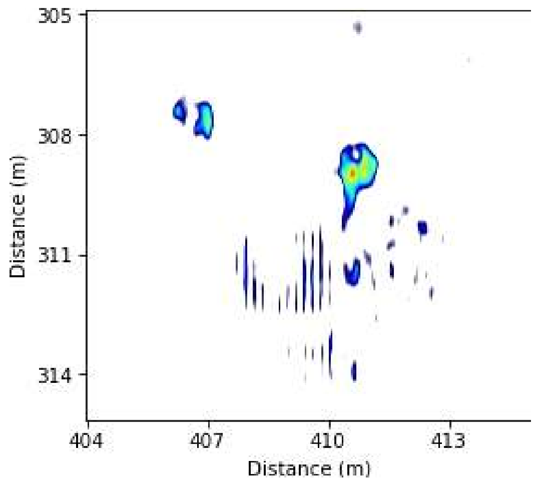
(c) Timeslice at z = 0.1 m.



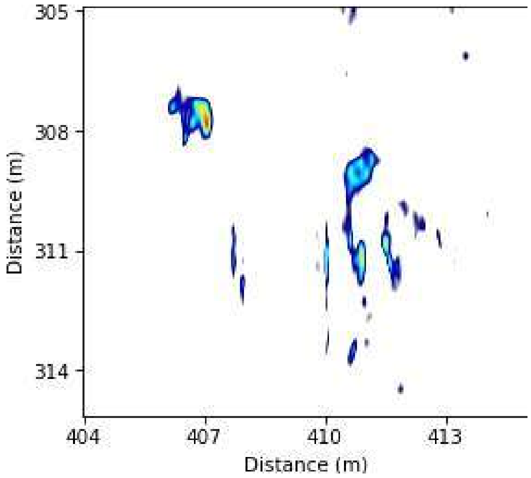
(d) Timeslice at z = 0.15 m.



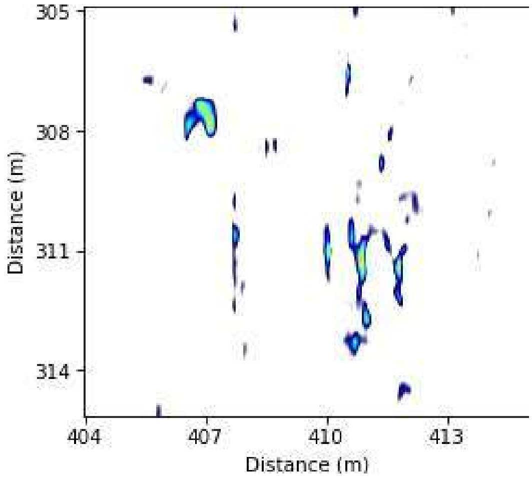
(e) Timeslice at z = 0.2 m.



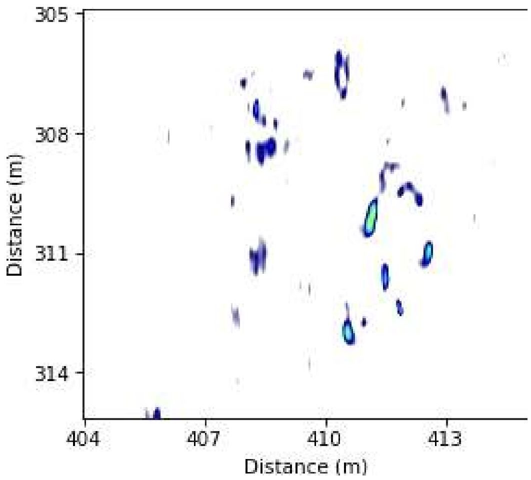
(f) Timeslice at z = 0.25 m.



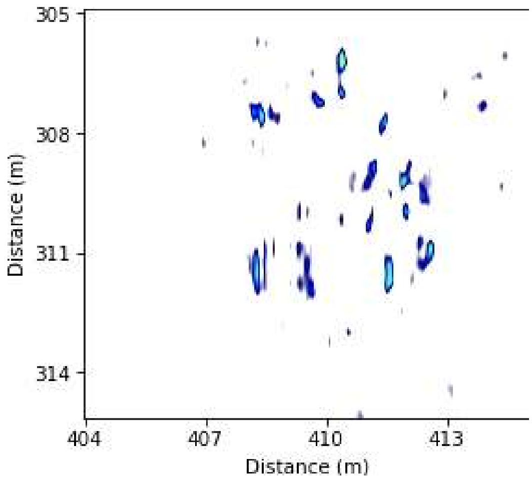
(a) Timeslice at z = 0.3 m.



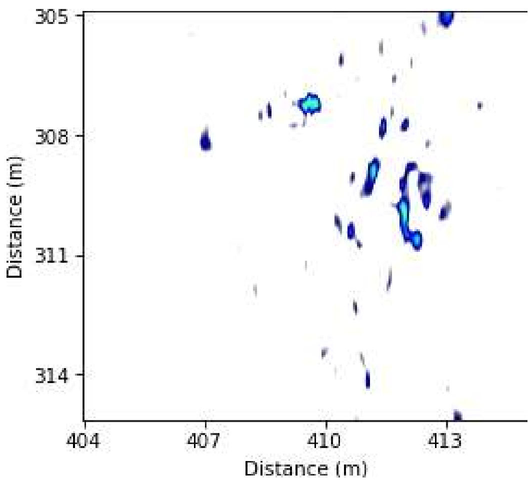
(b) Timeslice at z = 0.35 m.



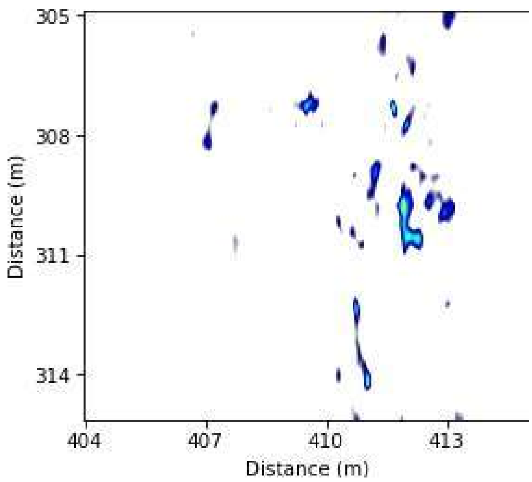
(c) Timeslice at z = 0.4 m.



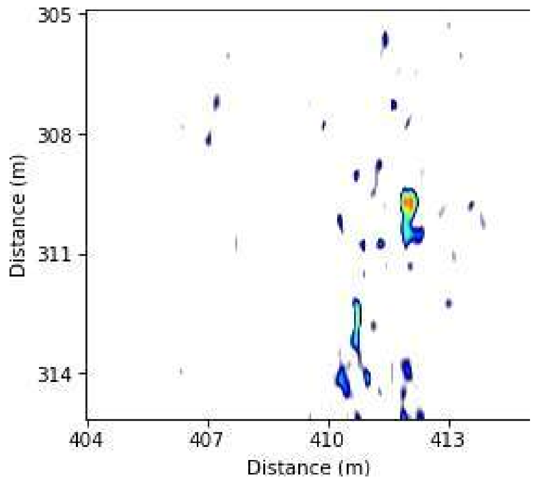
(d) Timeslice at z = 0.45 m.



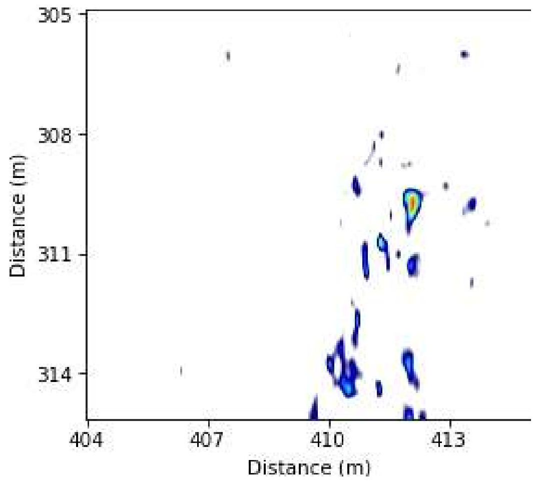
(e) Timeslice at z = 0.5 m.



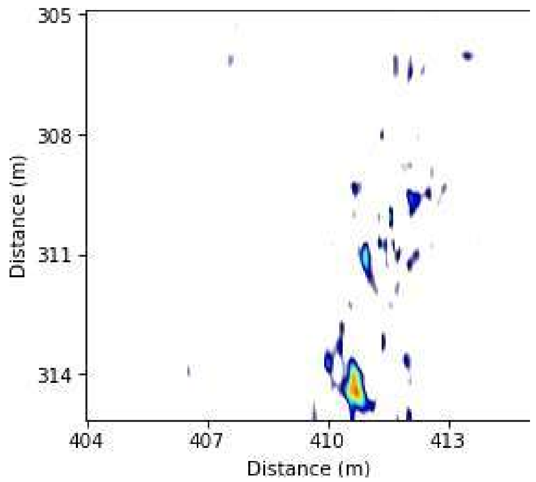
(f) Timeslice at z = 0.55 m.



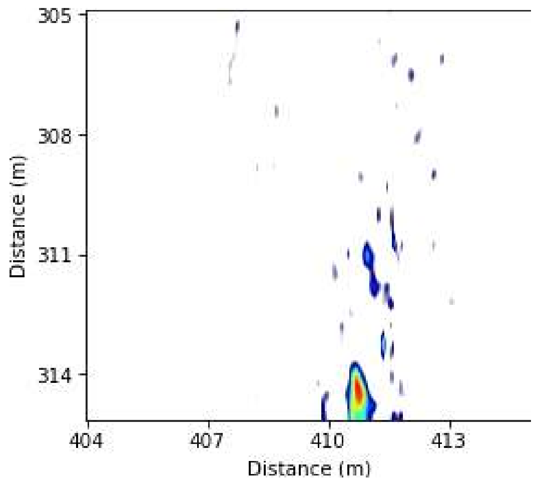
(a) Timeslice at z = 0.6 m.



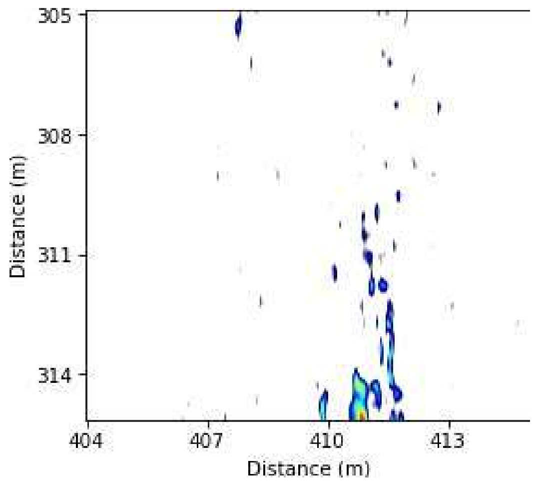
(b) Timeslice at z = 0.65 m.



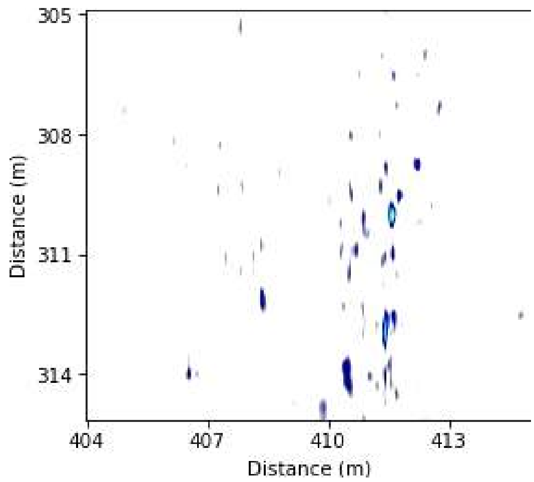
(c) Timeslice at z = 0.7 m.



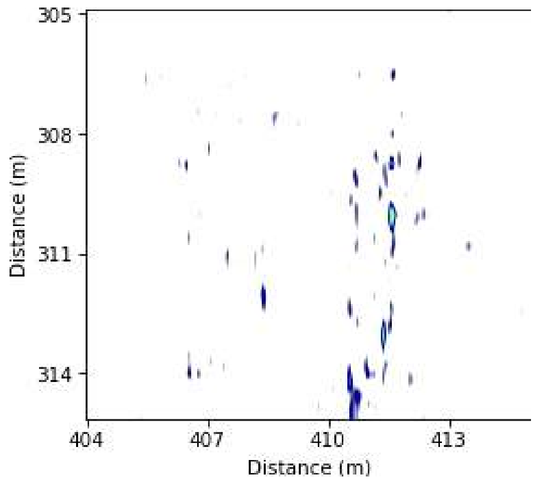
(d) Timeslice at z = 0.75 m.



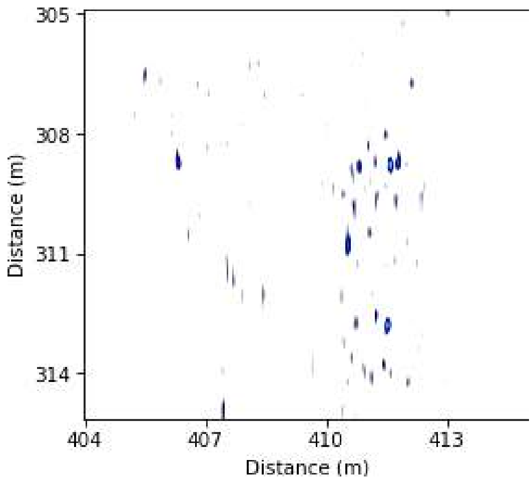
(e) Timeslice at z = 0.8 m.



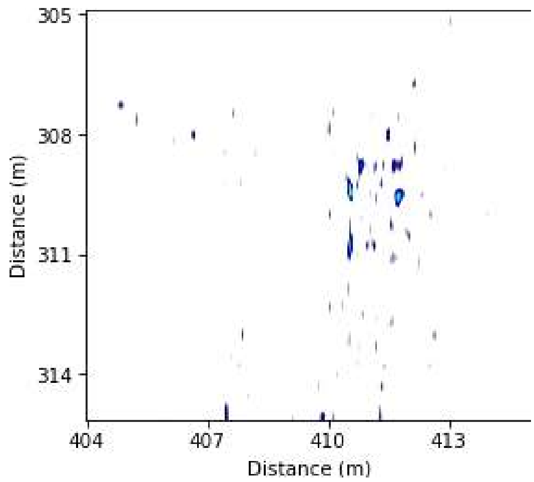
(f) Timeslice at z = 0.85 m.



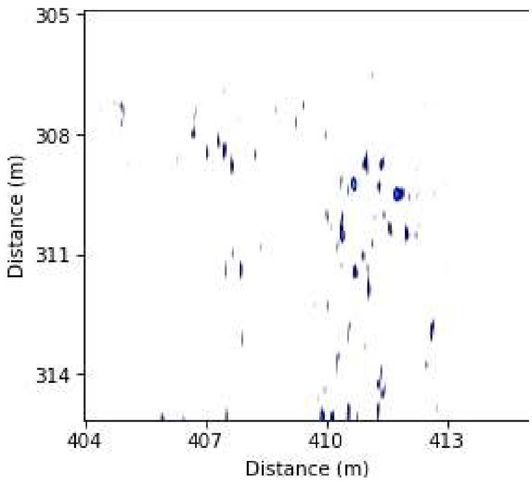
(a) Timeslice at z = 0.9 m.



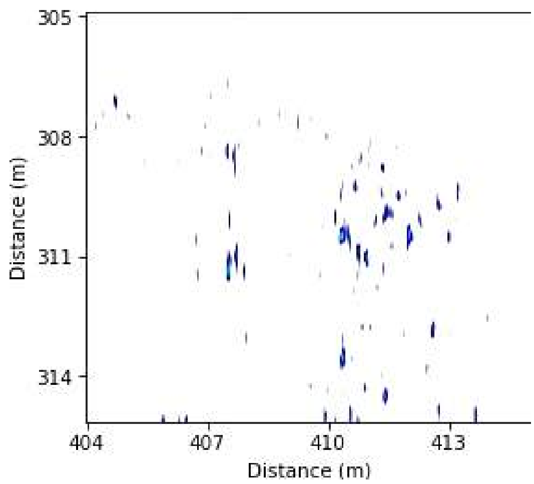
(b) Timeslice at z = 0.95 m.



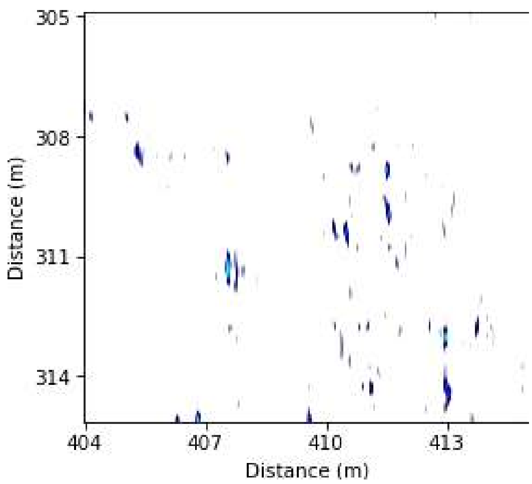
(c) Timeslice at z = 1.0 m.



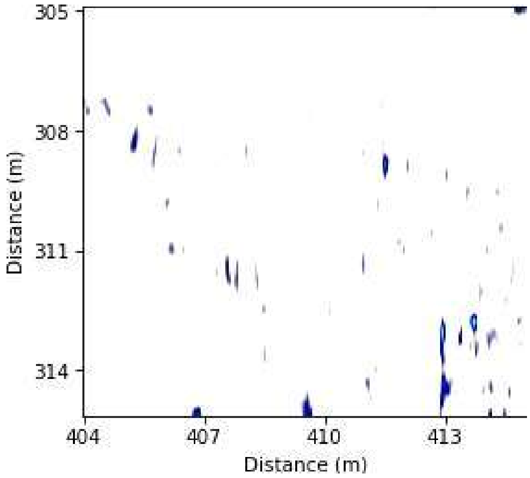
(d) Timeslice at z = 1.05 m.



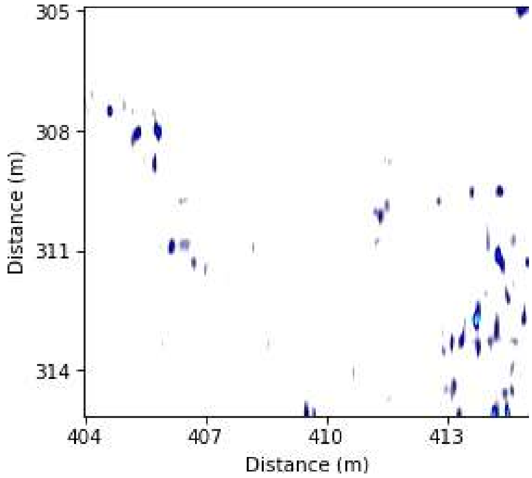
(e) Timeslice at z = 1.1 m.



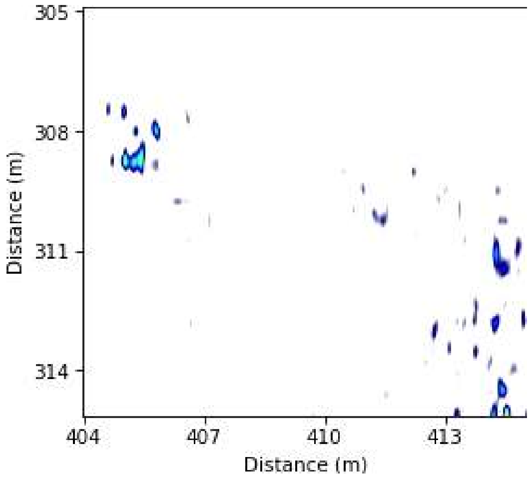
(f) Timeslice at z = 1.15 m.



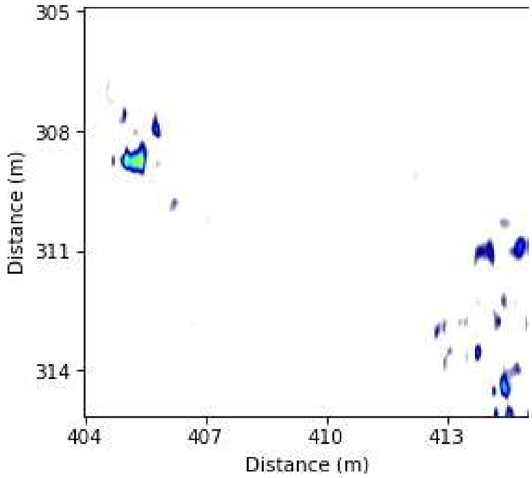
(a) Timeslice at z = 1.2 m.



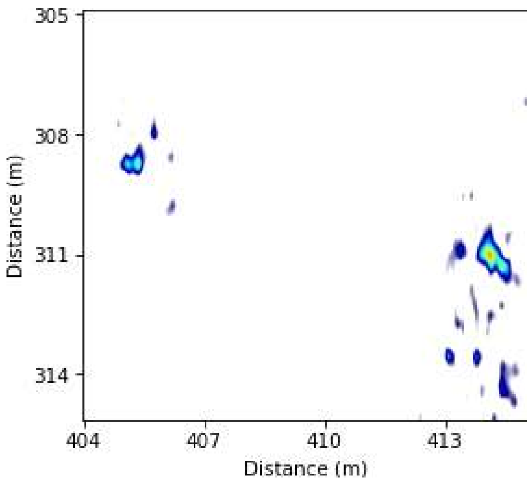
(b) Timeslice at z = 1.25 m.



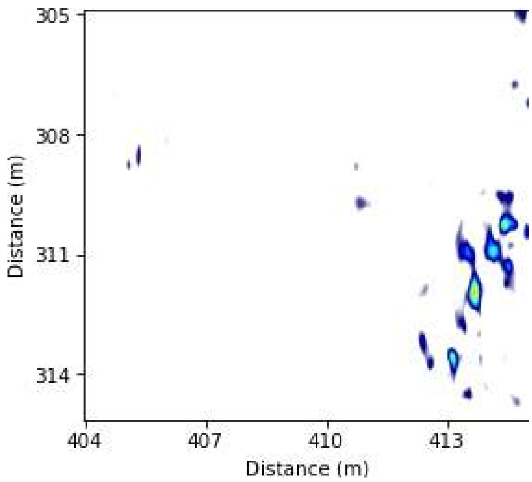
(c) Timeslice at z = 1.3 m.



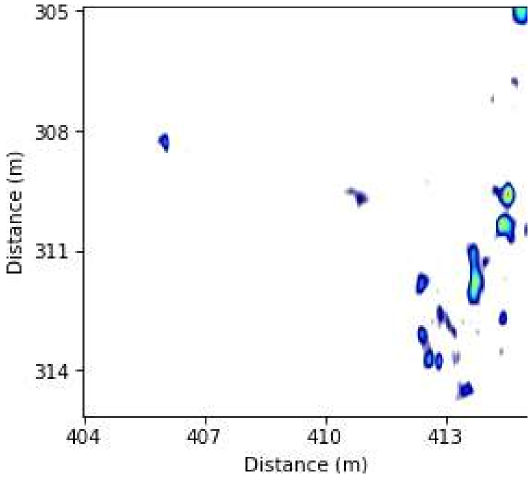
(d) Timeslice at z = 1.35 m.



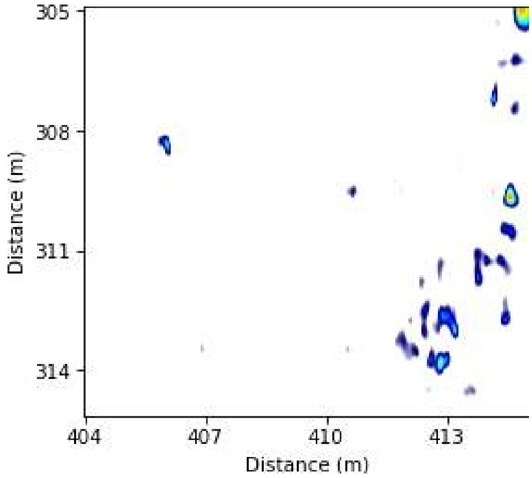
(e) Timeslice at z = 1.4 m.



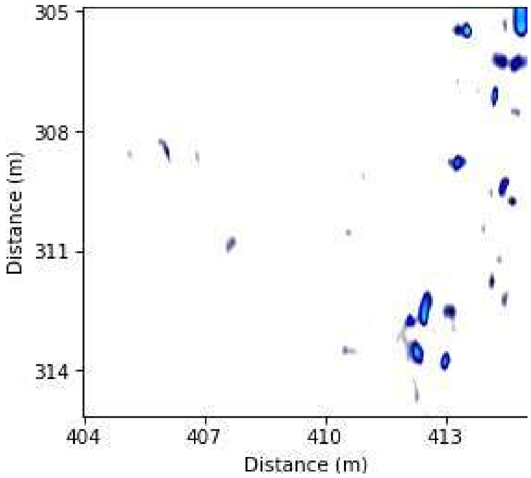
(f) Timeslice at z = 1.45 m.



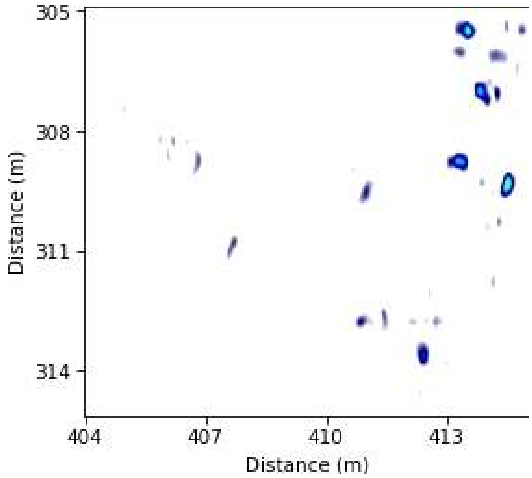
(a) Timeslice at z = 1.5 m.



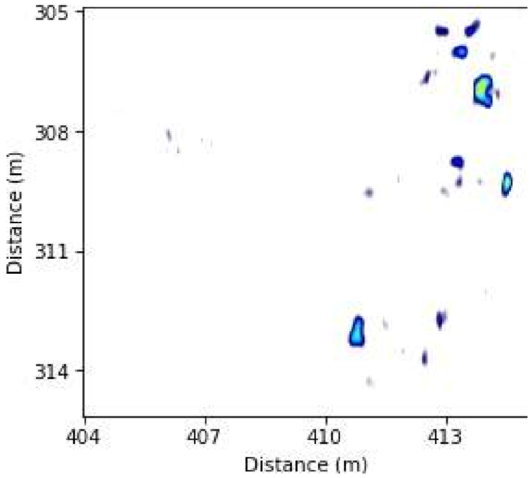
(b) Timeslice at z = 1.55 m.



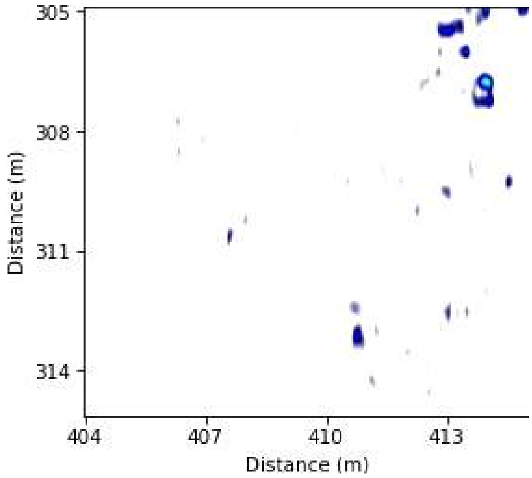
(c) Timeslice at z = 1.6 m.



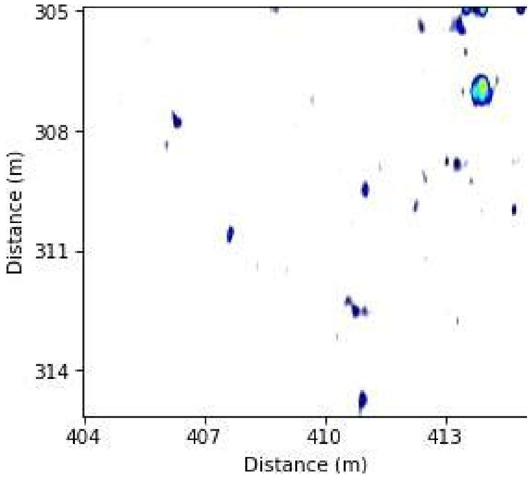
(d) Timeslice at z = 1.65 m.



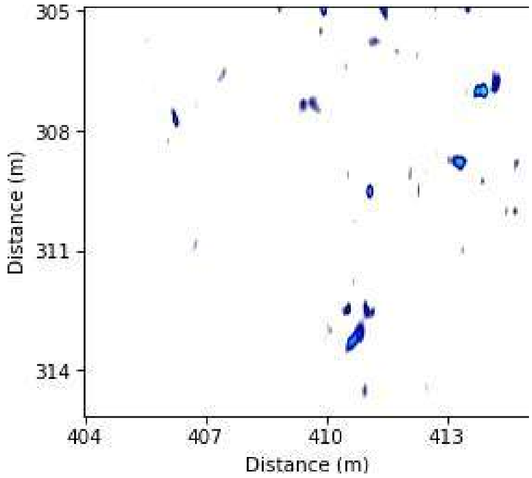
(e) Timeslice at z = 1.7 m.



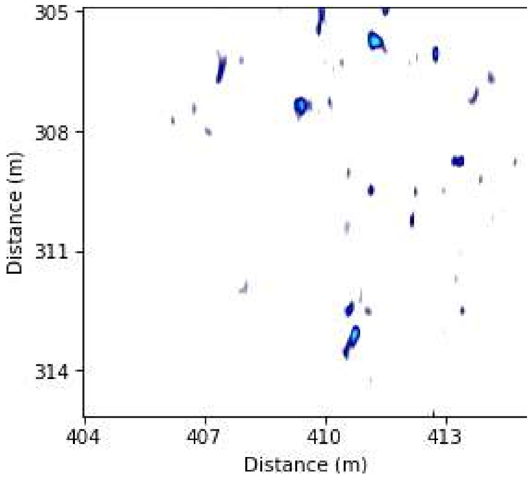
(f) Timeslice at z = 1.75 m.



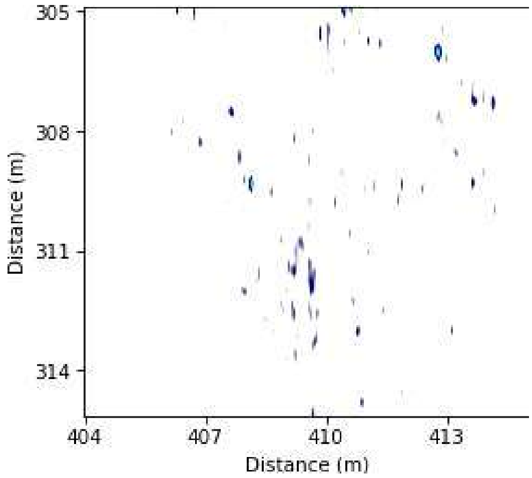
(a) Timeslice at z = 1.8 m.



(b) Timeslice at z = 1.85 m.



(c) Timeslice at z = 1.9 m.



(d) Timeslice at z = 1.95 m.

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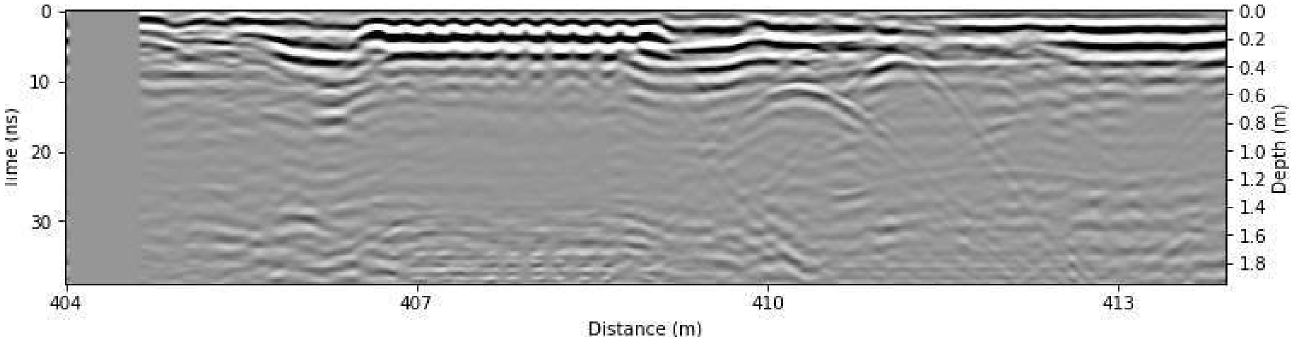


Figure B.430: Radargram at x = 328.0 m.

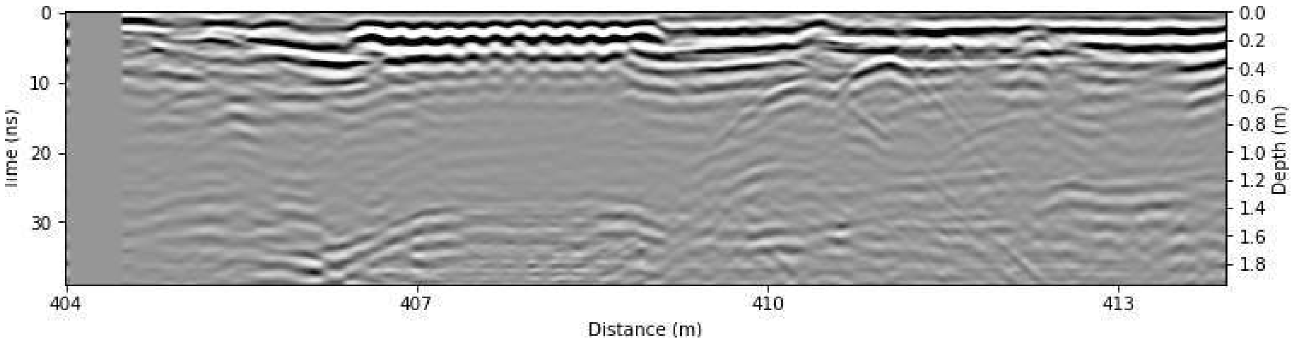


Figure B.431: Radargram at x = 328.25 m.

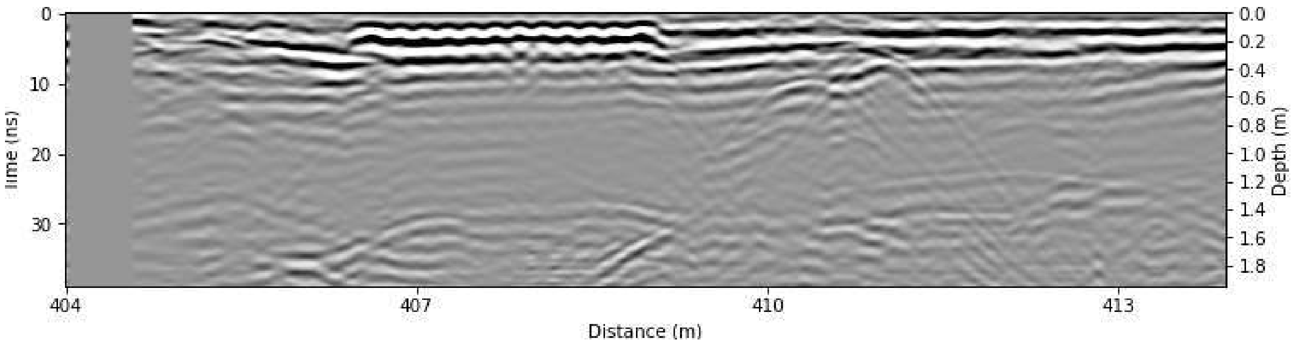


Figure B.432: Radargram at x = 328.5 m.

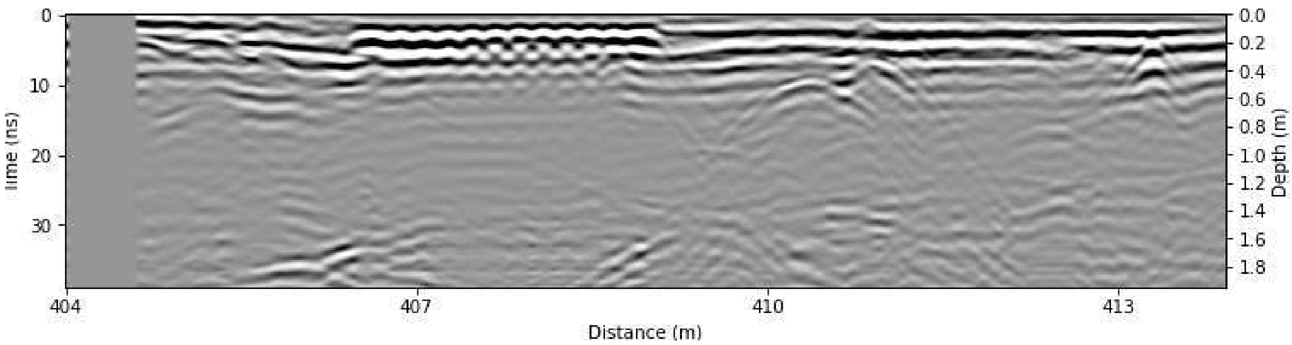


Figure B.433: Radargram at x = 328.75 m.

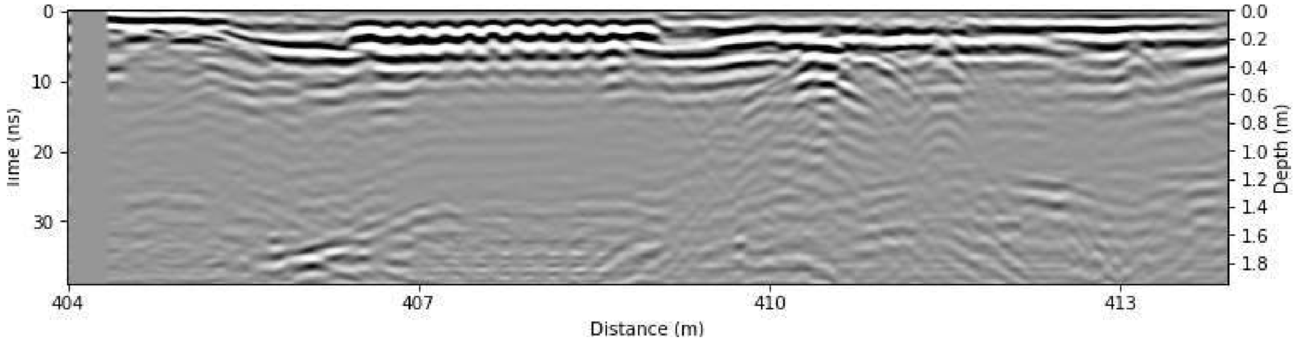


Figure B.434: Radargram at x = 329.0 m.

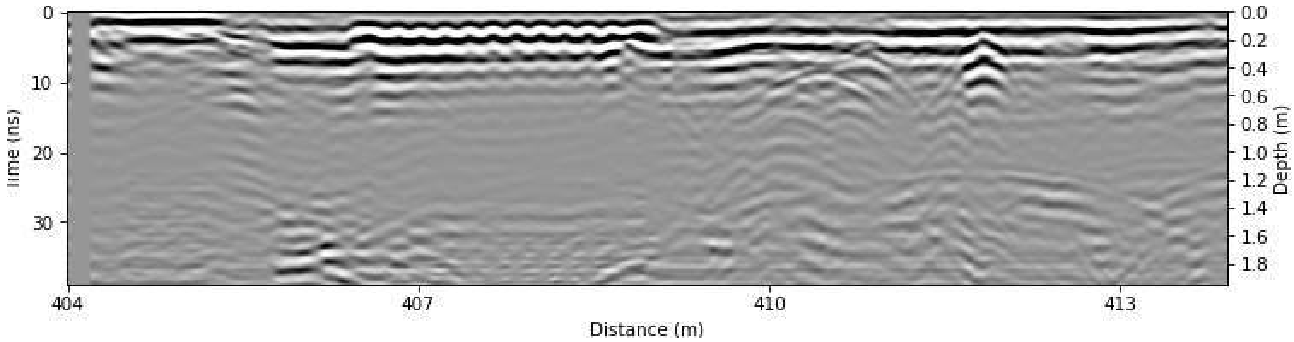


Figure B.435: Radargram at x = 329.25 m.

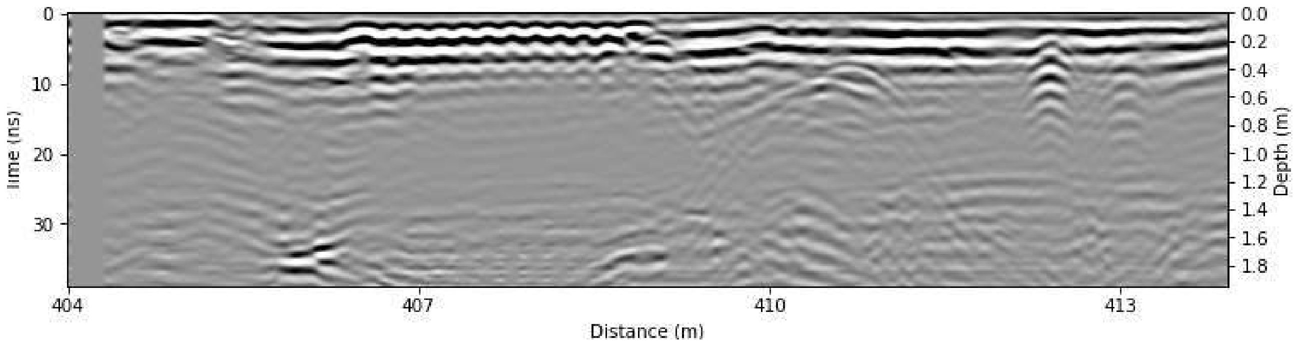


Figure B.436: Radargram at x = 329.5 m.

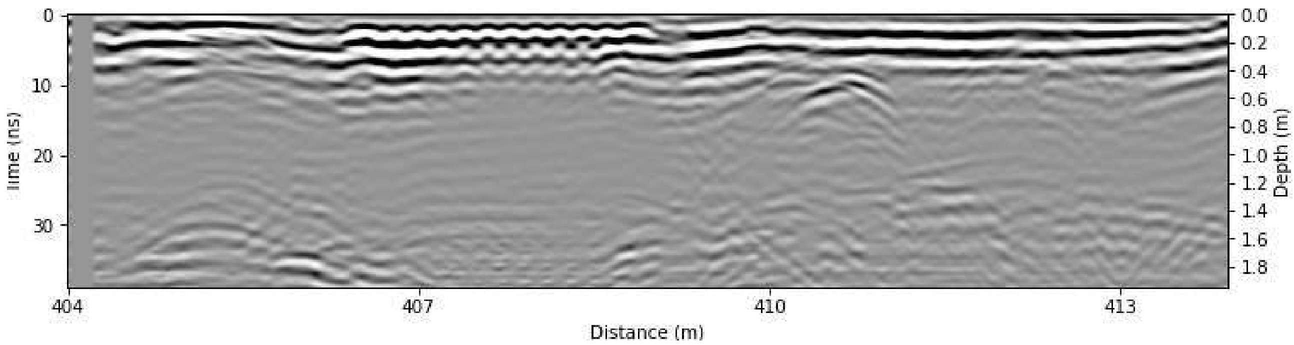


Figure B.437: Radargram at x = 329.75 m.

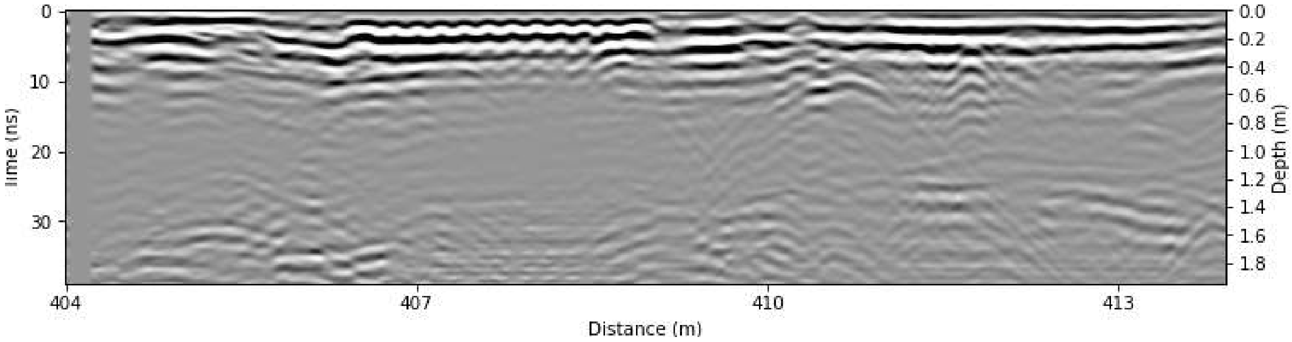


Figure B.438: Radargram at x = 330.0 m.

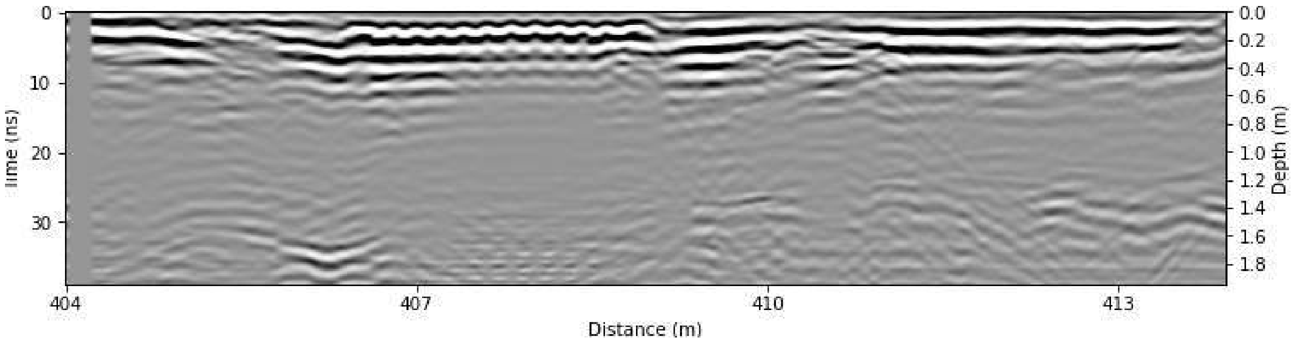


Figure B.439: Radargram at x = 330.25 m.

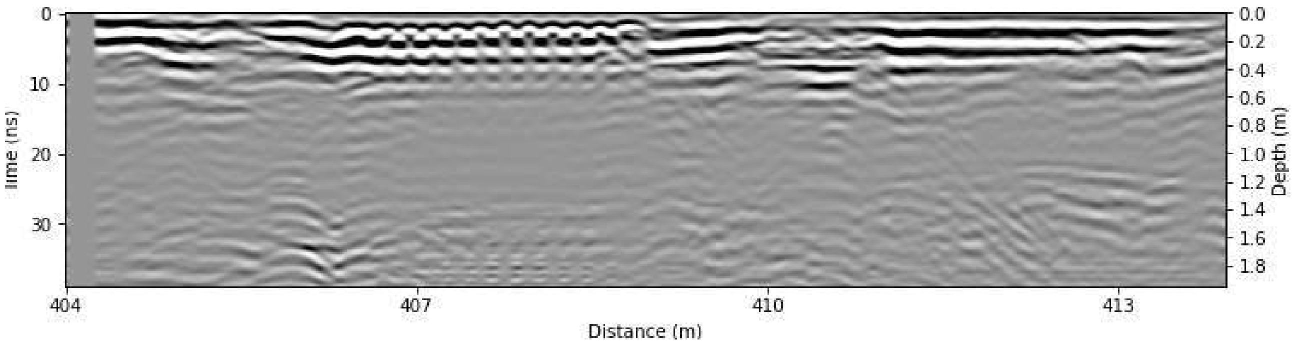


Figure B.440: Radargram at x = 330.5 m.

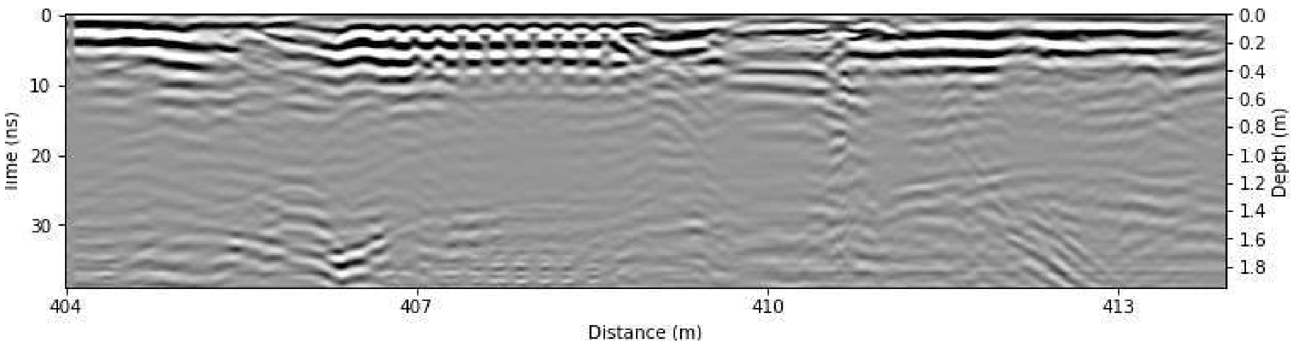


Figure B.441: Radargram at x = 330.75 m.

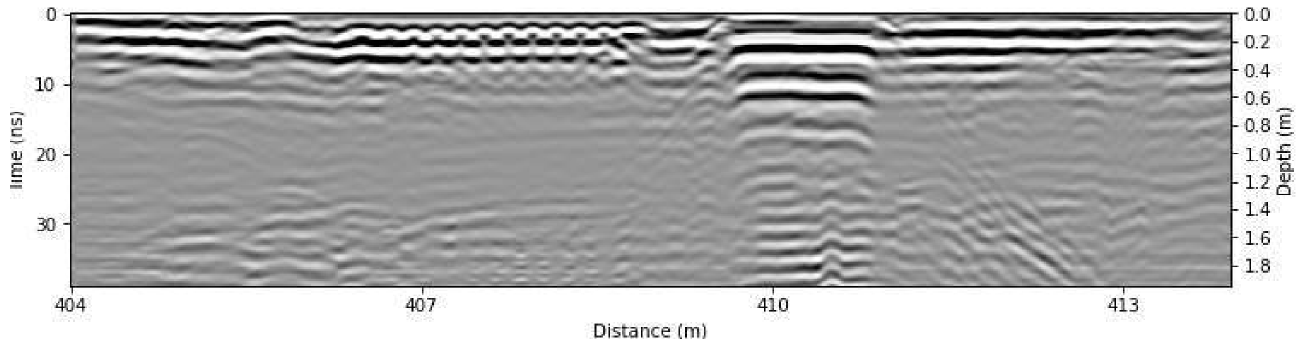


Figure B.442: Radargram at x = 331.0 m.

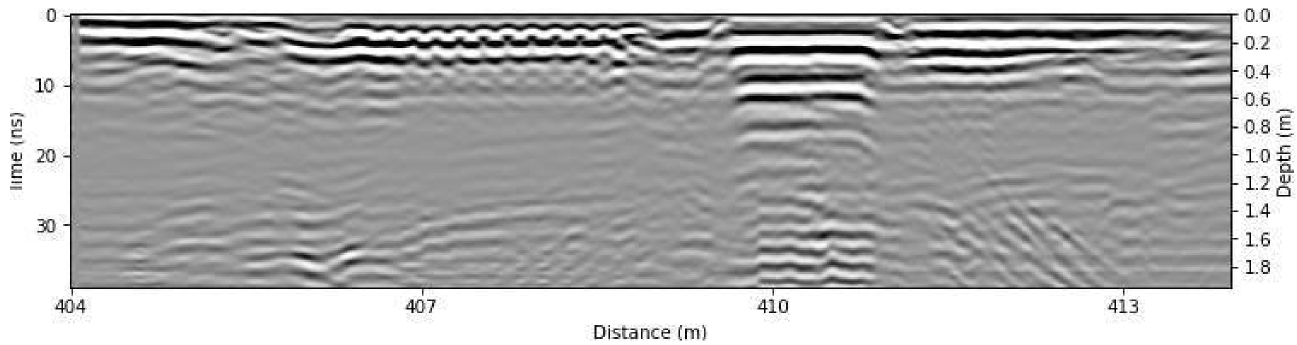


Figure B.443: Radargram at x = 331.25 m.

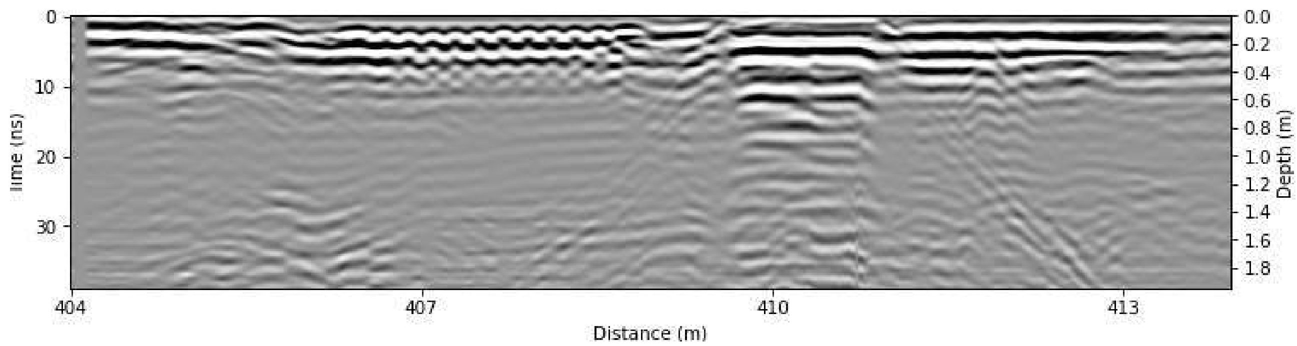


Figure B.444: Radargram at x = 331.5 m.

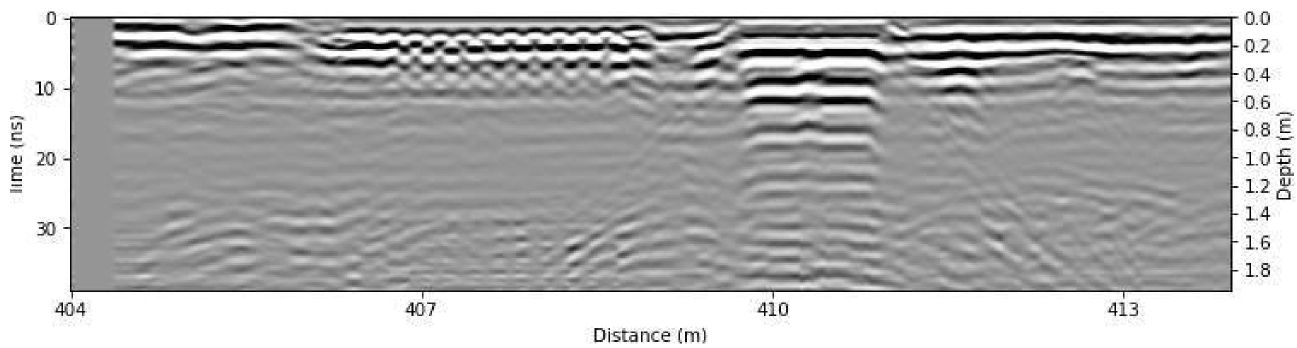


Figure B.445: Radargram at x = 331.75 m.

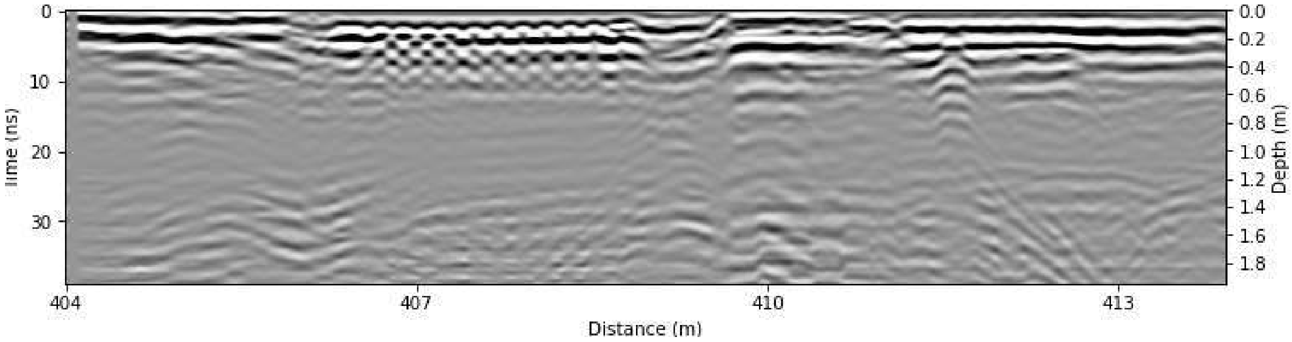


Figure B.446: Radargram at x = 332.0 m.

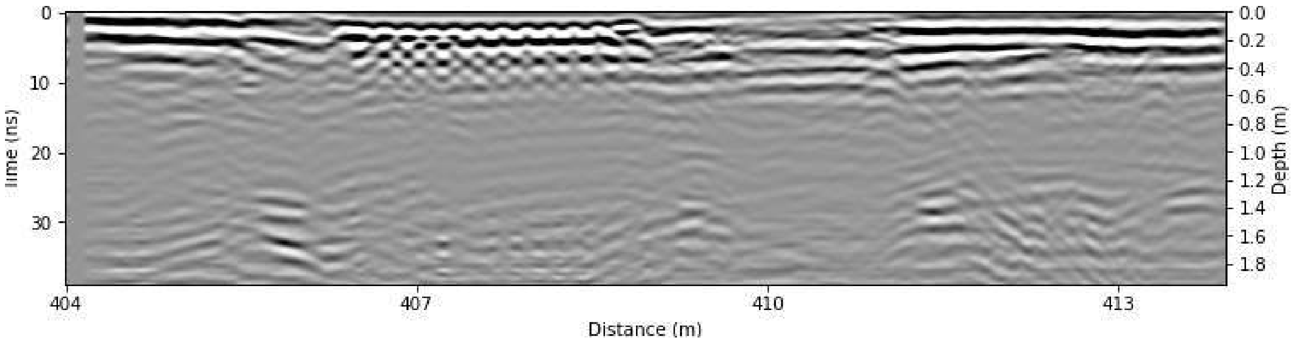


Figure B.447: Radargram at x = 332.25 m.

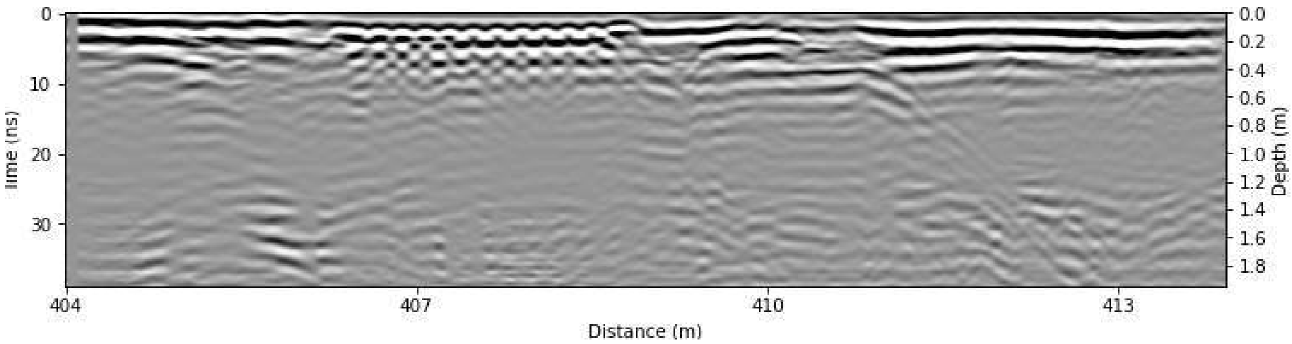


Figure B.448: Radargram at x = 332.5 m.

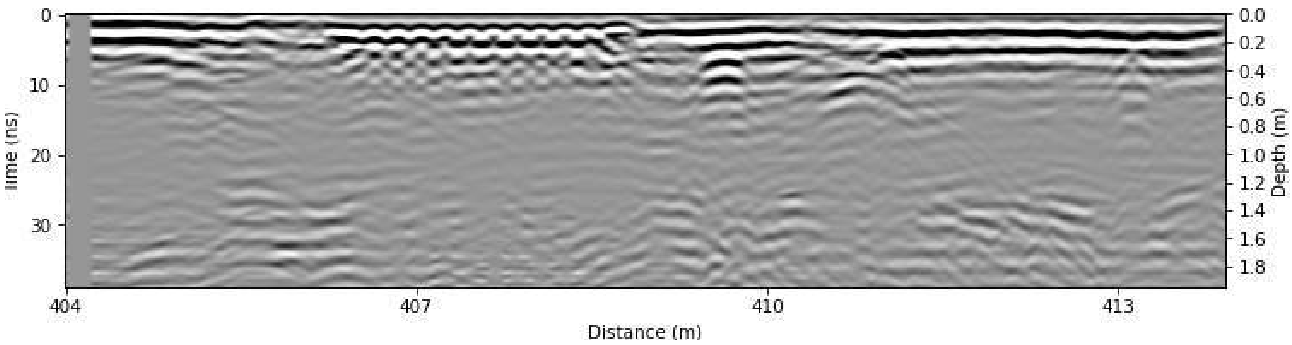


Figure B.449: Radargram at x = 332.75 m.

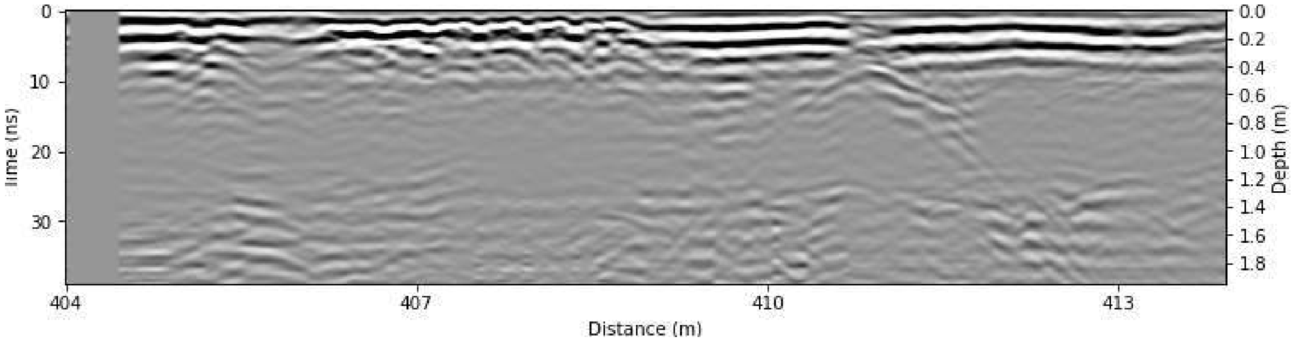


Figure B.450: Radargram at x = 333.0 m.

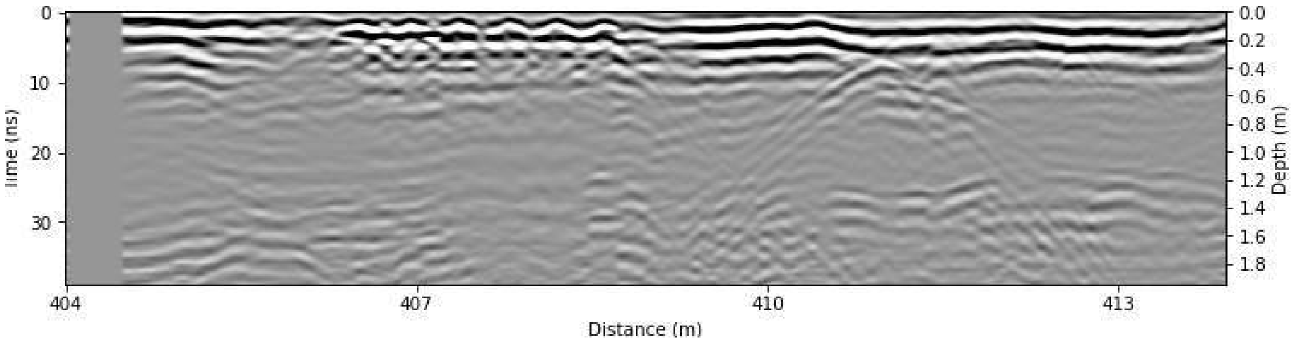


Figure B.451: Radargram at x = 333.25 m.

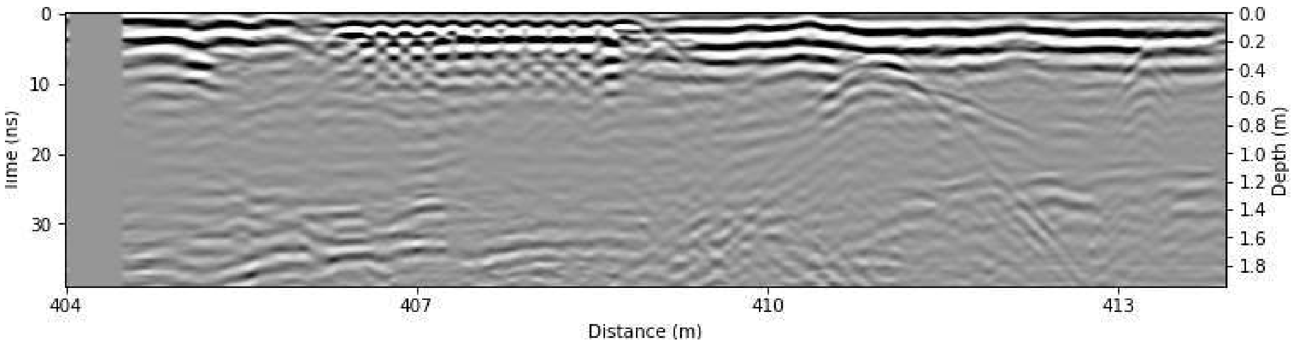


Figure B.452: Radargram at x = 333.5 m.

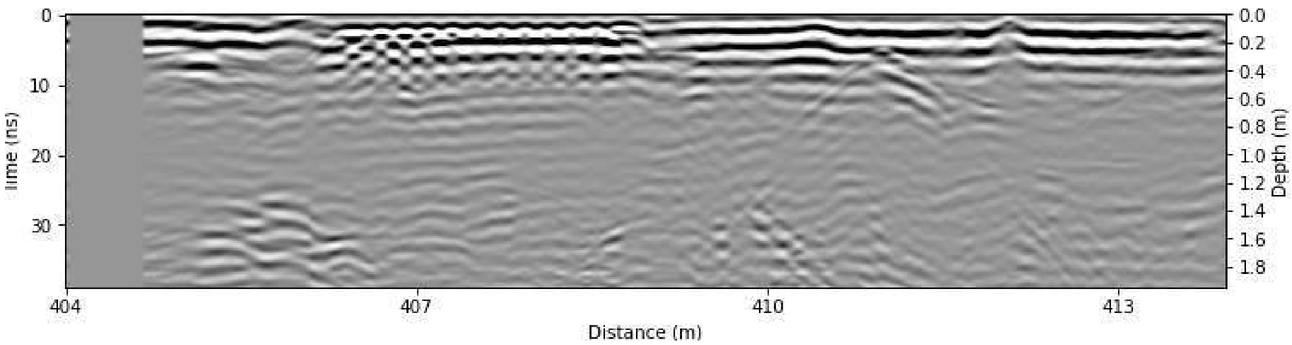


Figure B.453: Radargram at x = 333.75 m.

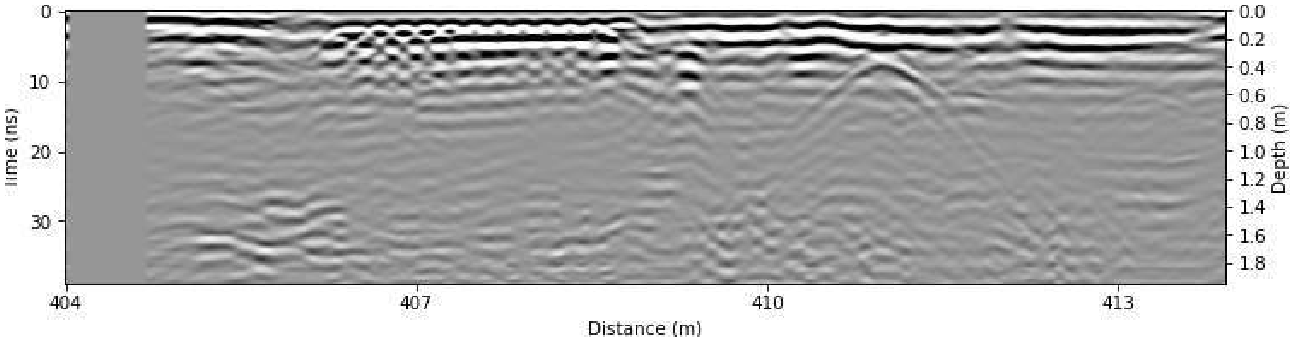


Figure B.454: Radargram at x = 334.0 m.

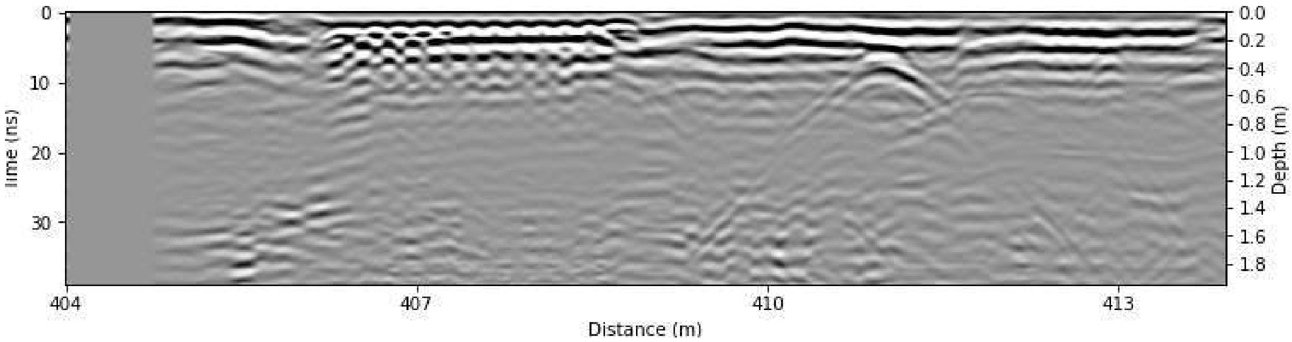


Figure B.455: Radargram at x = 334.25 m.

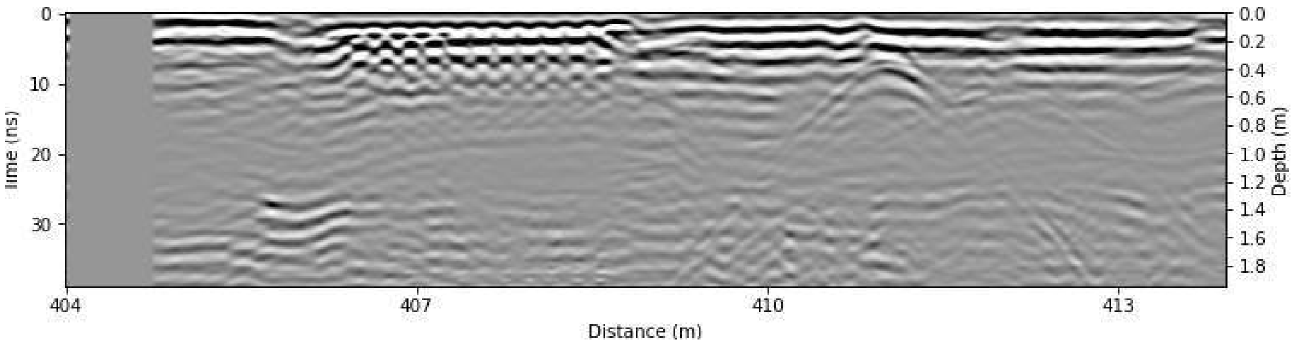


Figure B.456: Radargram at x = 334.5 m.

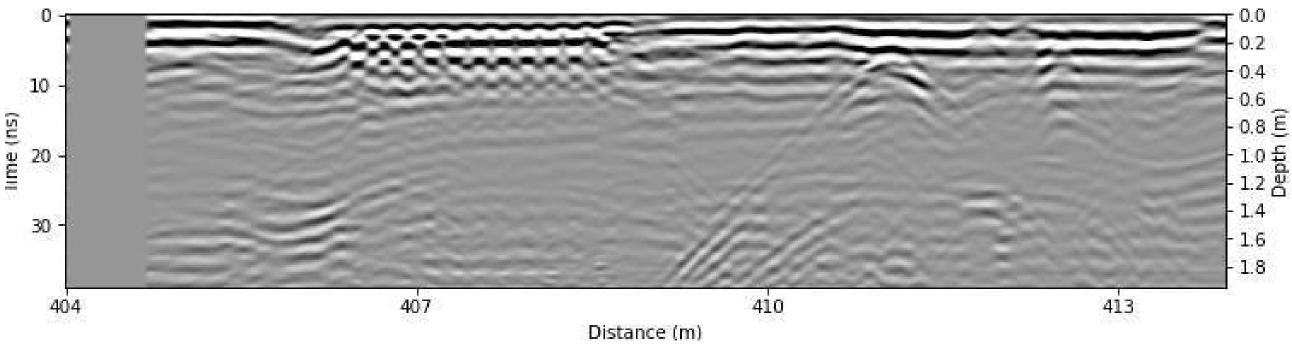


Figure B.457: Radargram at x = 334.75 m.

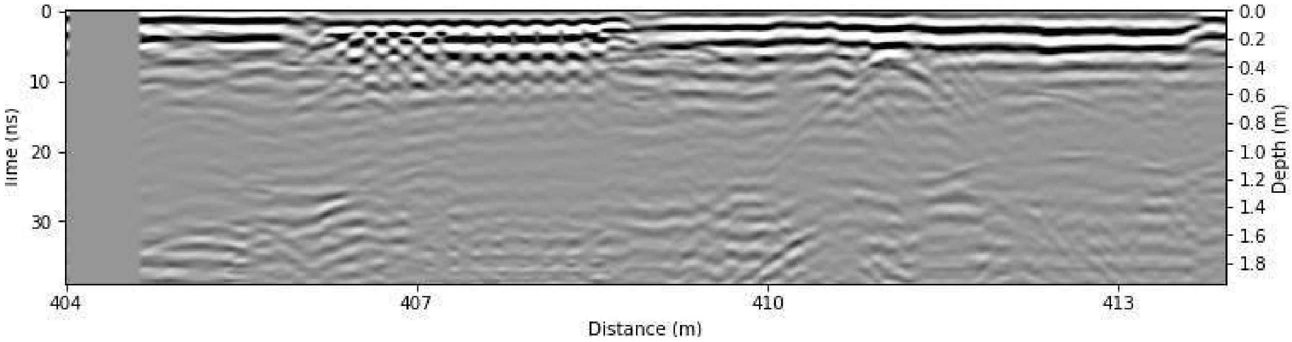


Figure B.458: Radargram at x = 335.0 m.

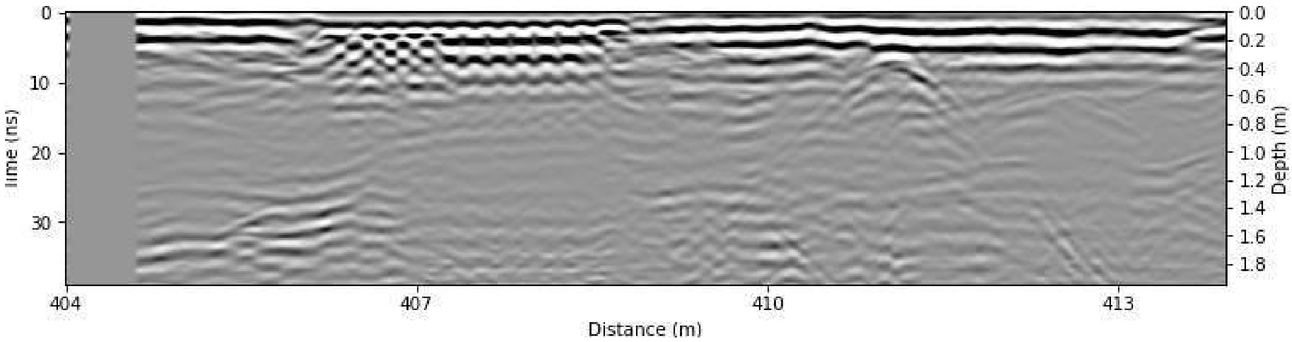


Figure B.459: Radargram at x = 335.25 m.

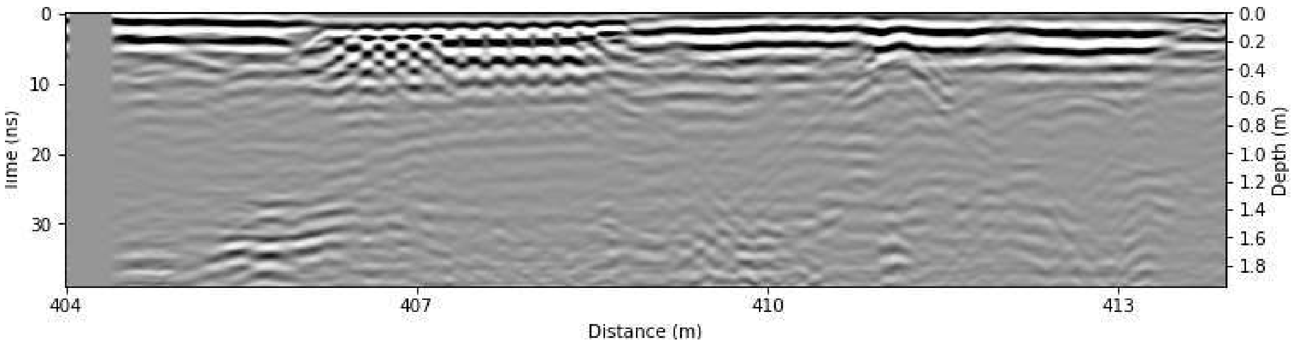


Figure B.460: Radargram at x = 335.5 m.

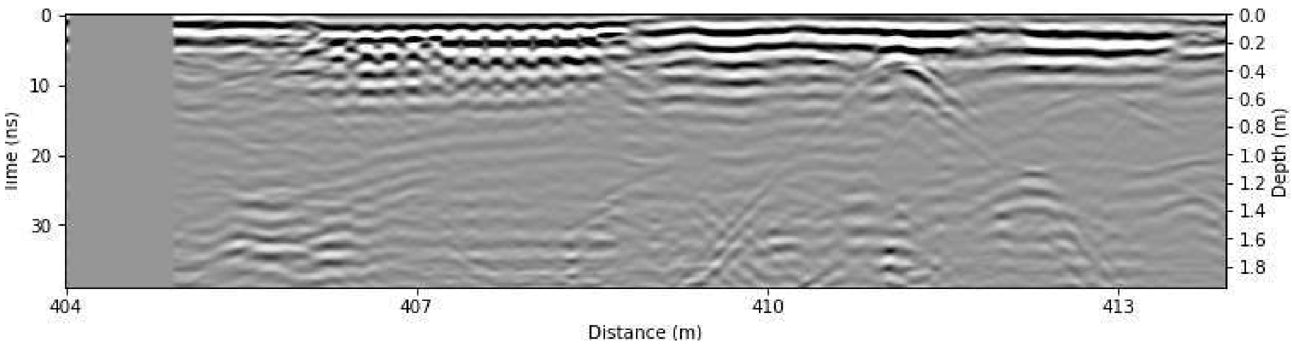


Figure B.461: Radargram at x = 335.75 m.

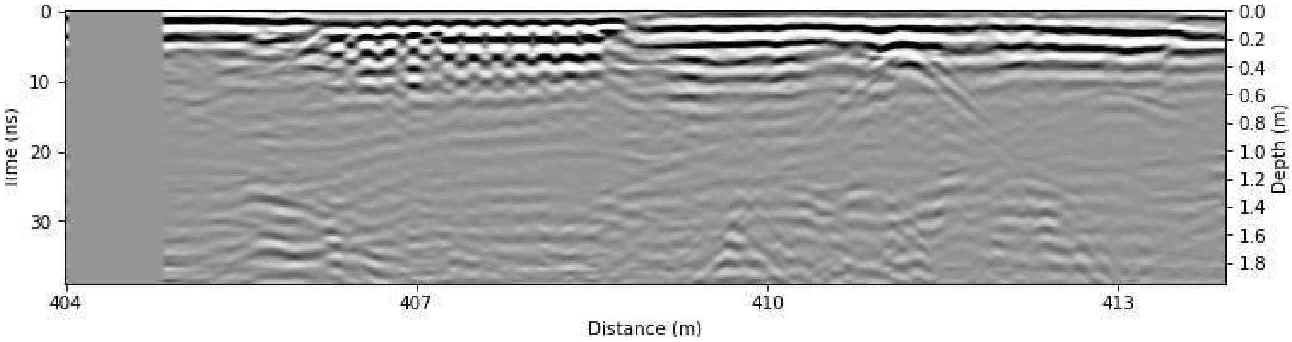


Figure B.462: Radargram at x = 336.0 m.

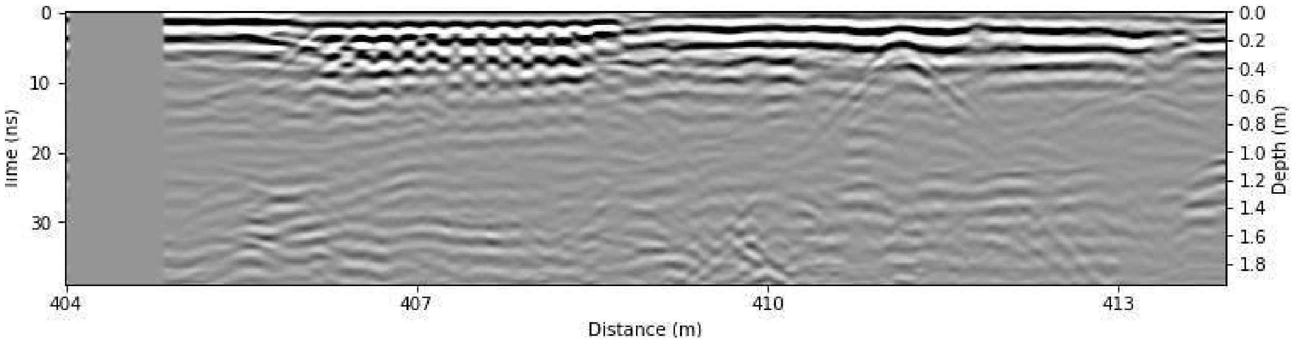


Figure B.463: Radargram at x = 336.25 m.

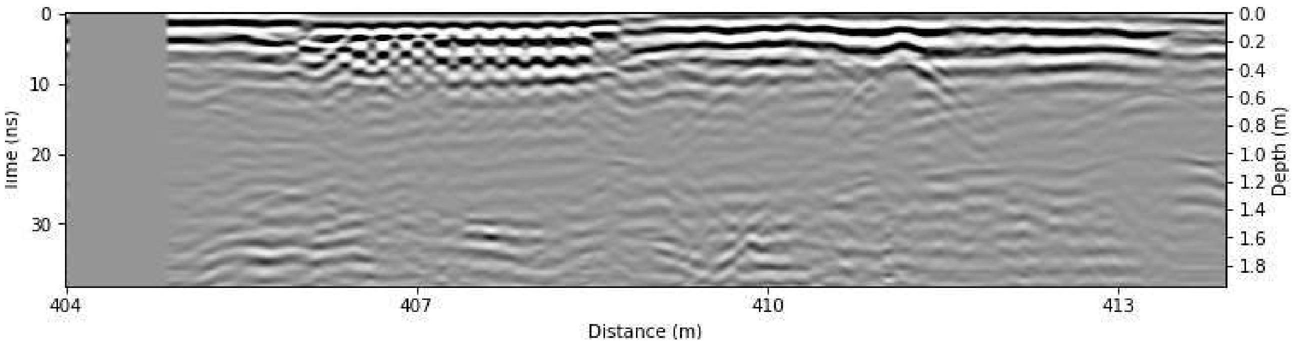


Figure B.464: Radargram at x = 336.5 m.

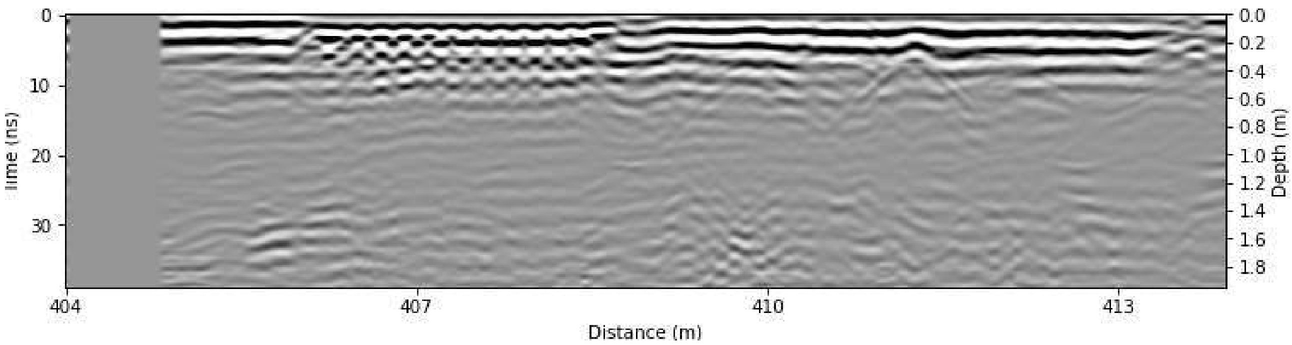


Figure B.465: Radargram at x = 336.75 m.

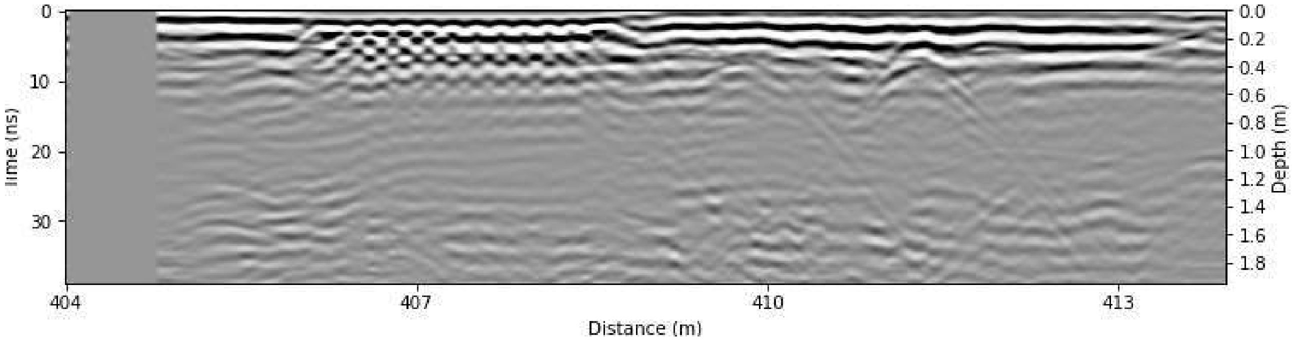


Figure B.466: Radargram at x = 337.0 m.

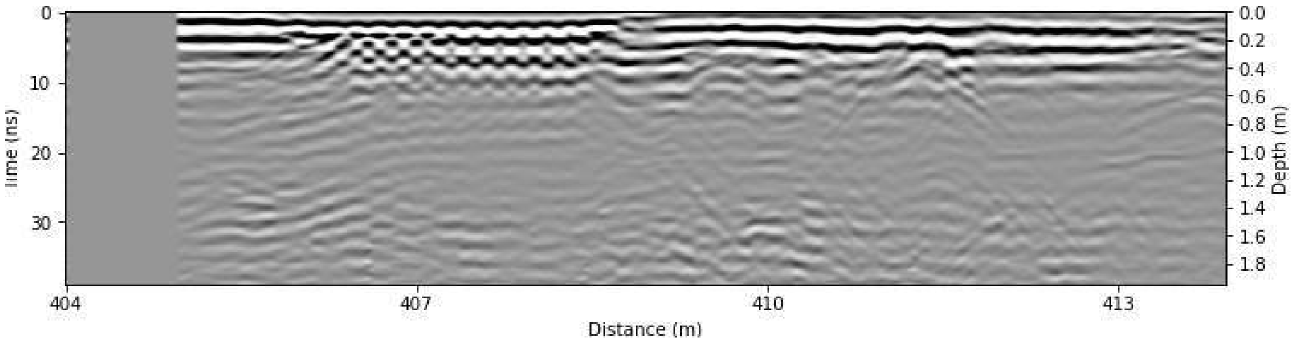


Figure B.467: Radargram at x = 337.25 m.

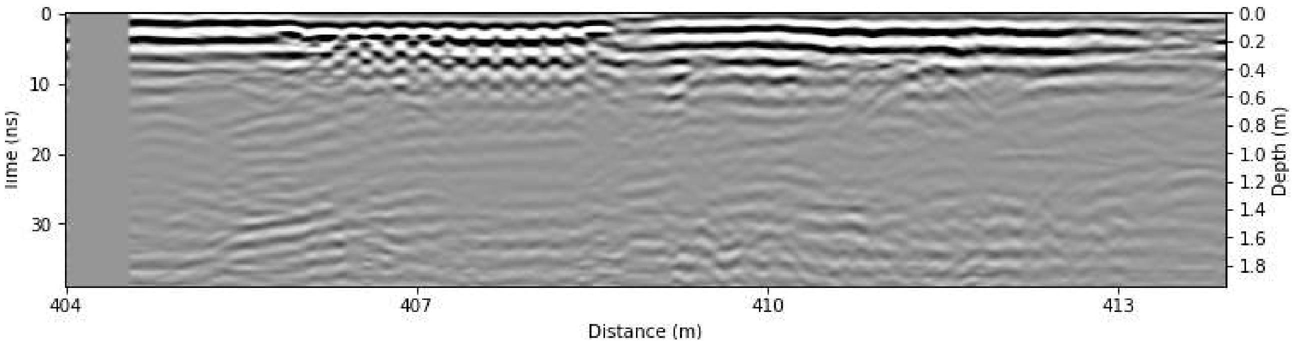


Figure B.468: Radargram at x = 337.5 m.

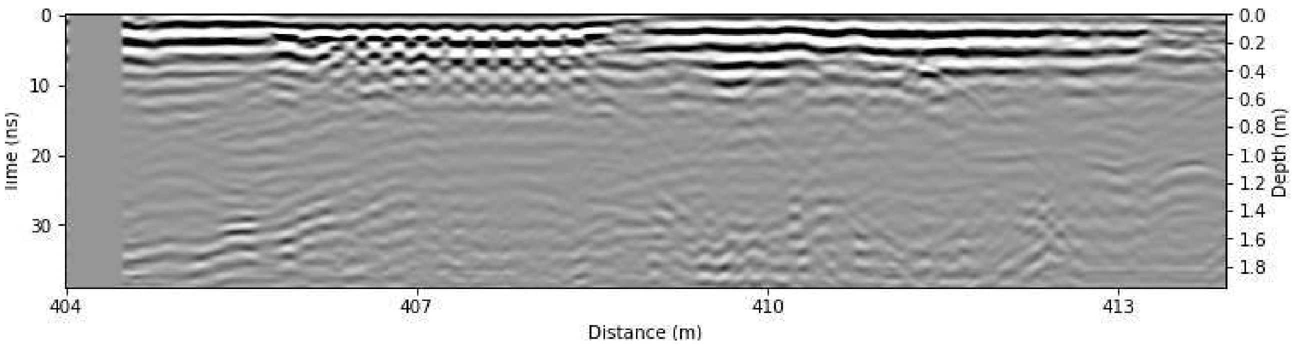


Figure B.469: Radargram at x = 337.75 m.

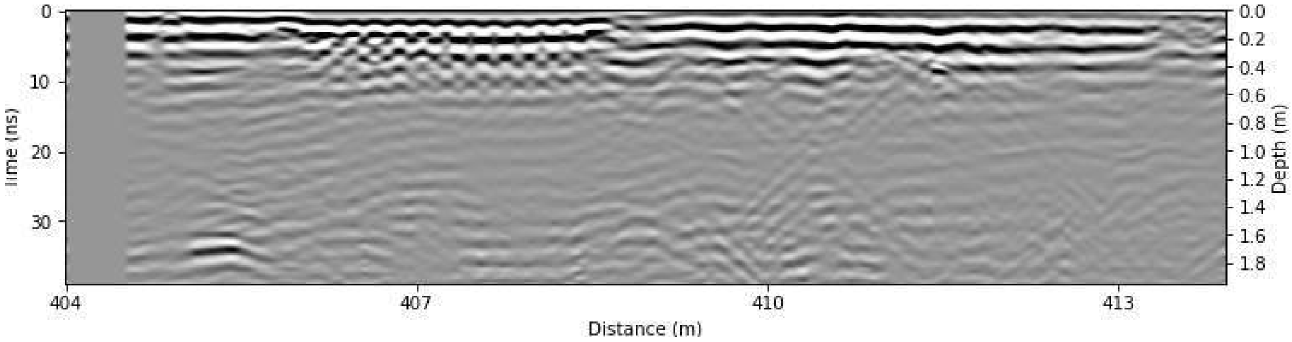
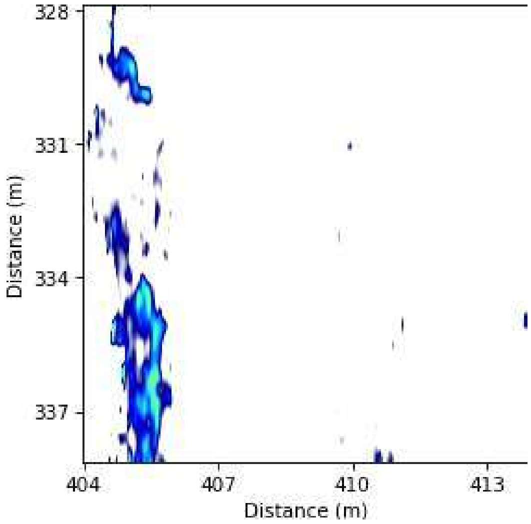
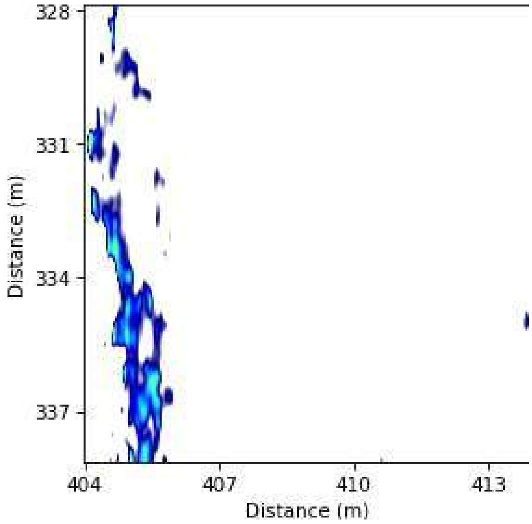


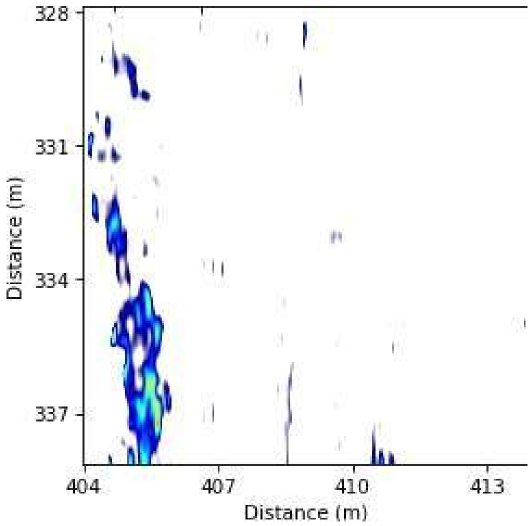
Figure B.470: Radargram at x = 338.0 m.



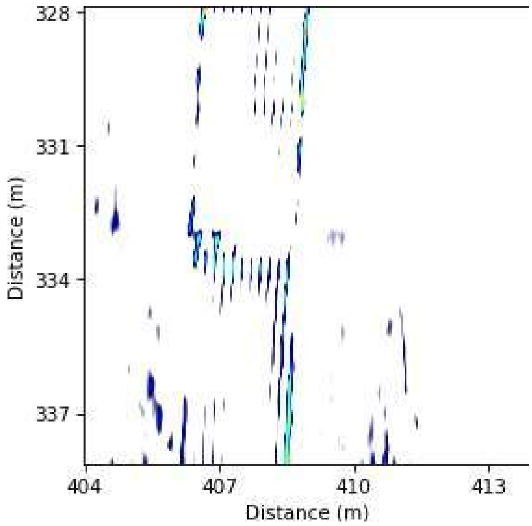
(a) Timeslice at z = 0.0 m.



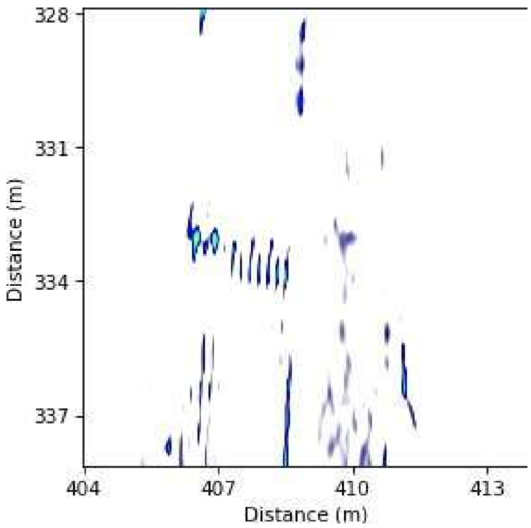
(b) Timeslice at z = 0.05 m.



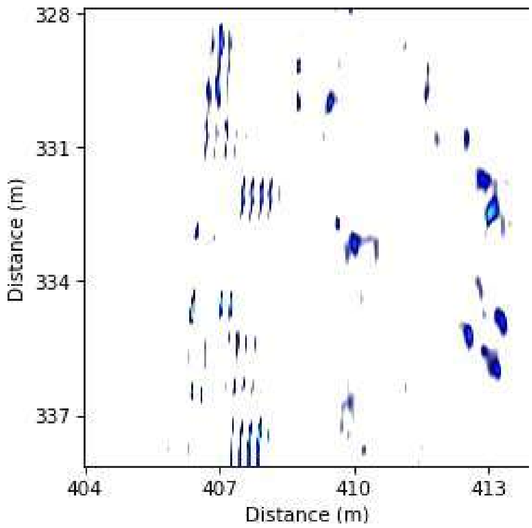
(c) Timeslice at z = 0.1 m.



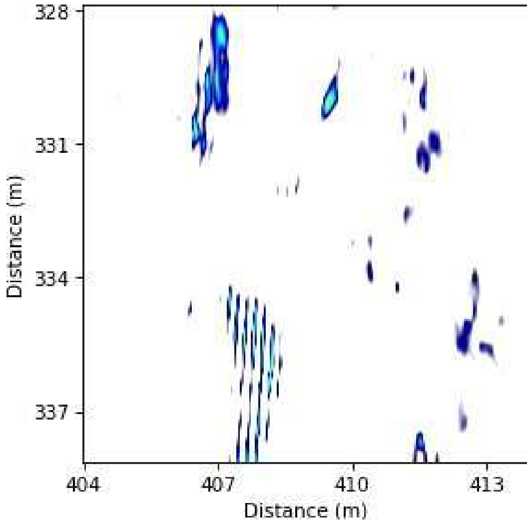
(d) Timeslice at z = 0.15 m.



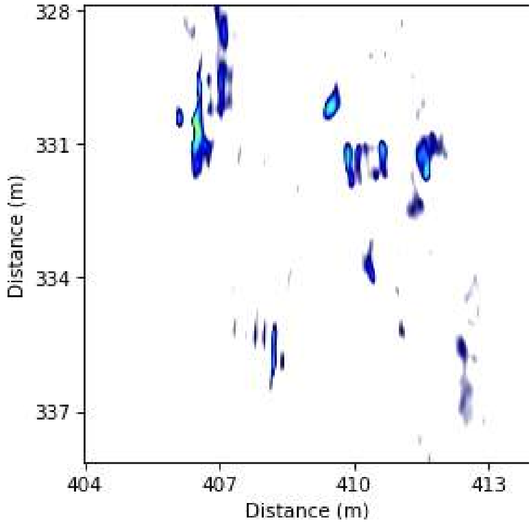
(e) Timeslice at z = 0.2 m.



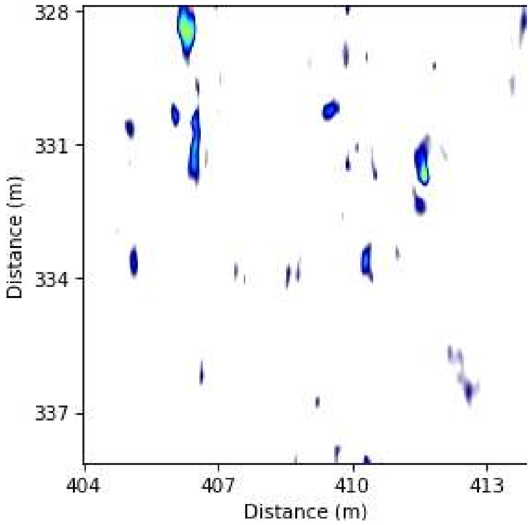
(f) Timeslice at z = 0.25 m.



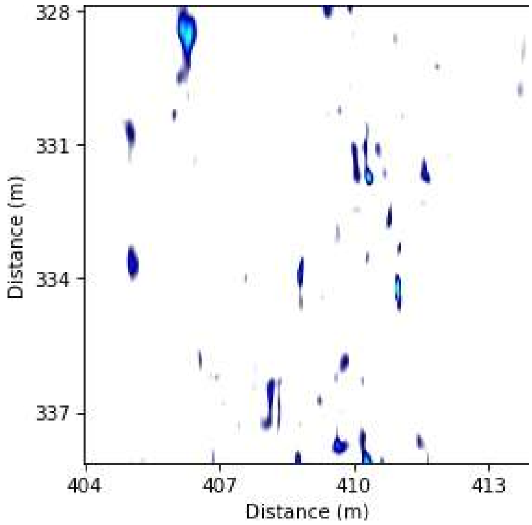
(a) Timeslice at z = 0.3 m.



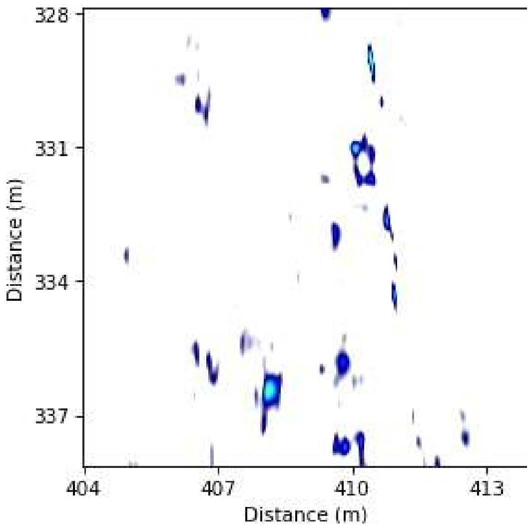
(b) Timeslice at z = 0.35 m.



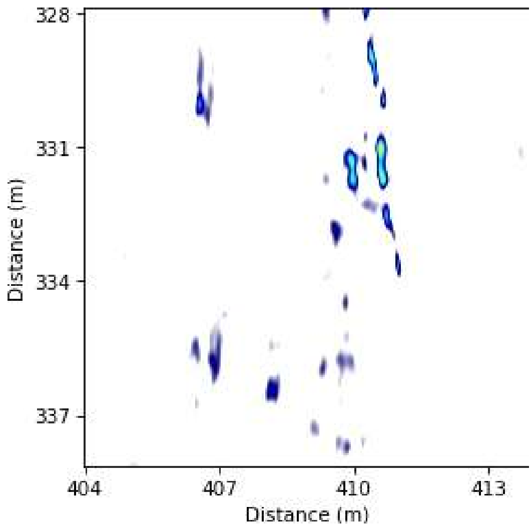
(c) Timeslice at z = 0.4 m.



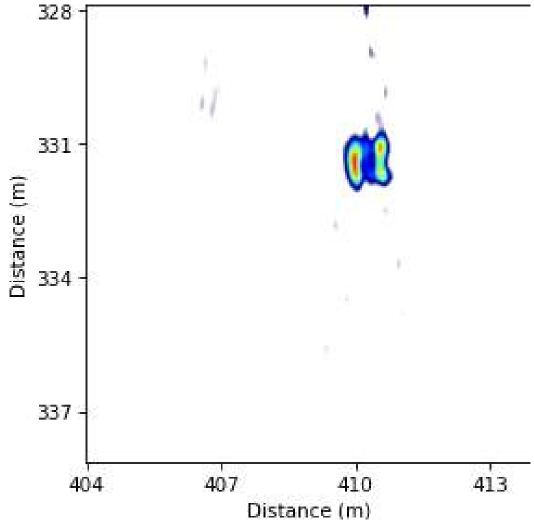
(d) Timeslice at z = 0.45 m.



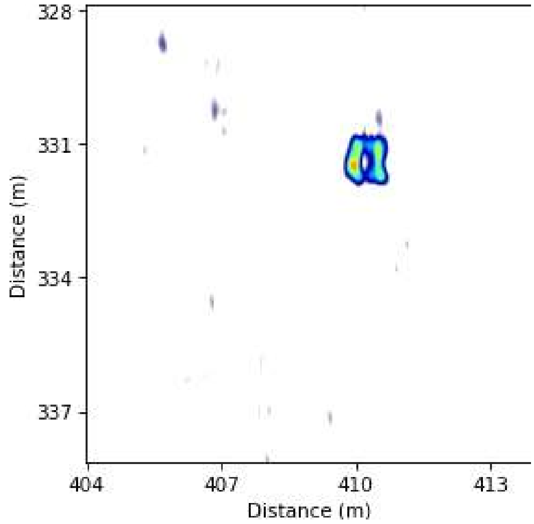
(e) Timeslice at z = 0.5 m.



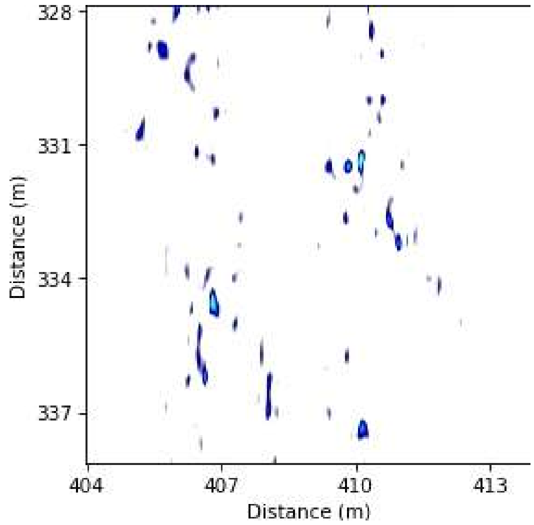
(f) Timeslice at z = 0.55 m.



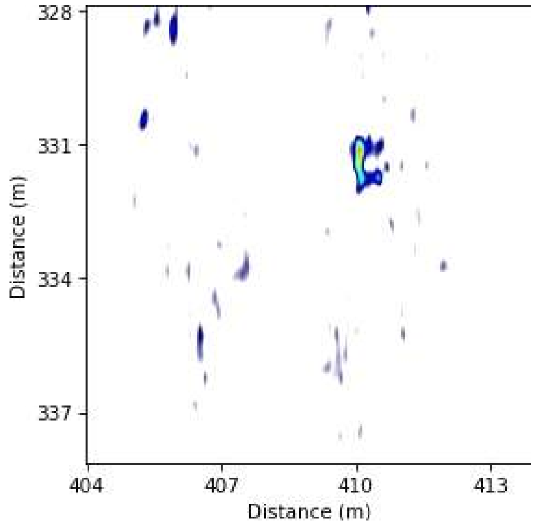
(a) Timeslice at z = 0.6 m.



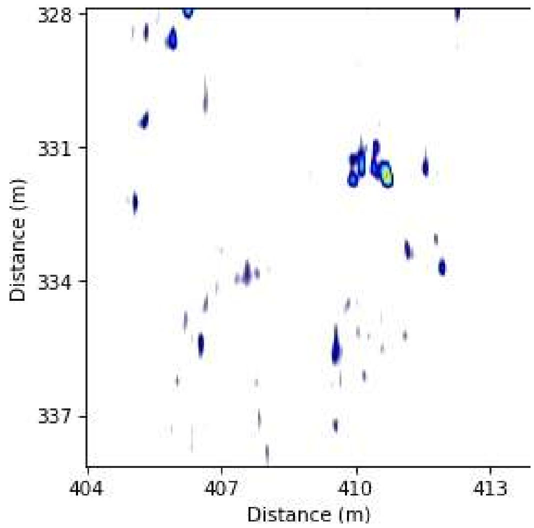
(b) Timeslice at z = 0.65 m.



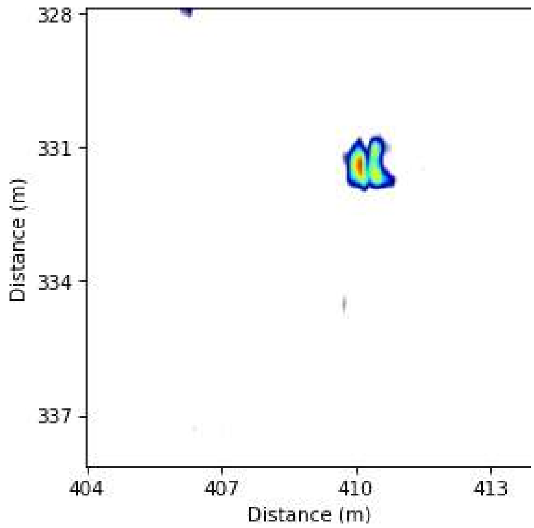
(c) Timeslice at z = 0.7 m.



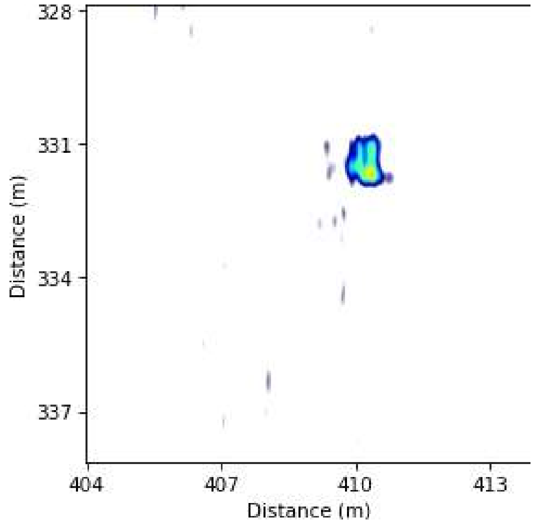
(d) Timeslice at z = 0.75 m.



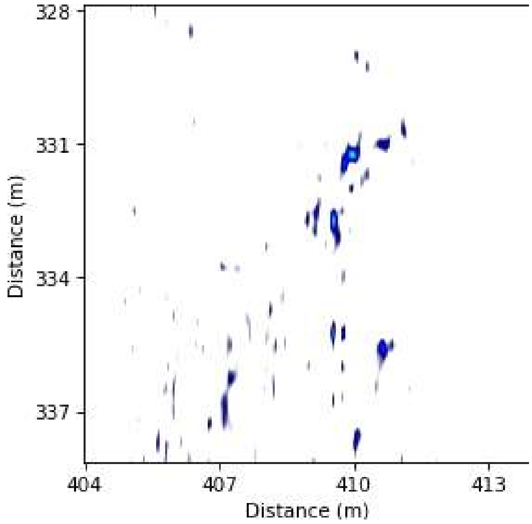
(e) Timeslice at z = 0.8 m.



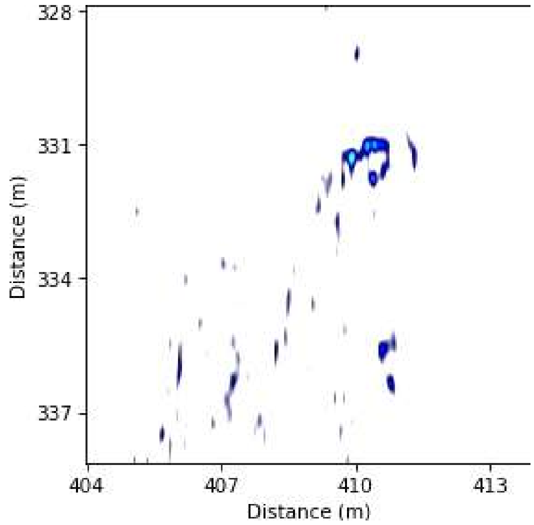
(f) Timeslice at z = 0.85 m.



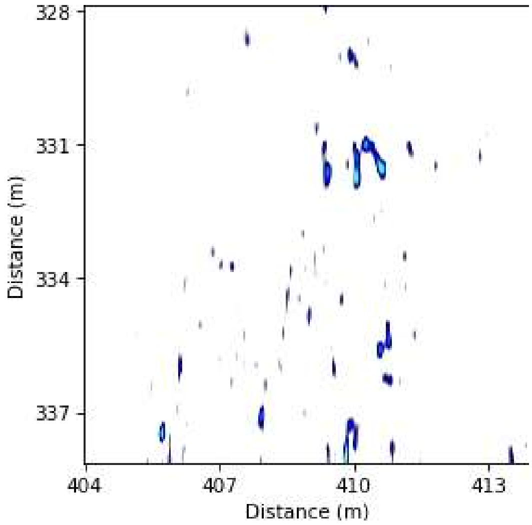
(a) Timeslice at z = 0.9 m.



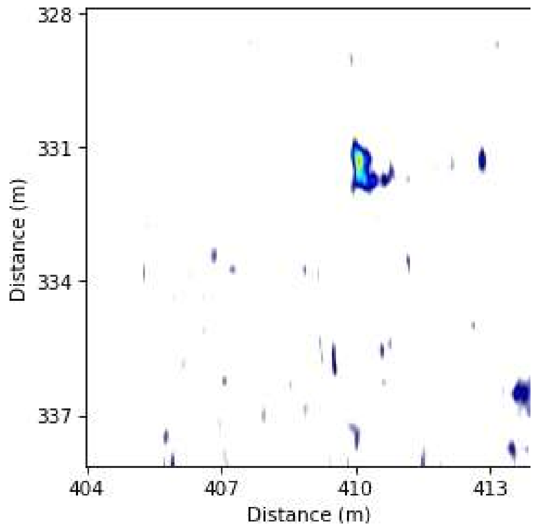
(b) Timeslice at z = 0.95 m.



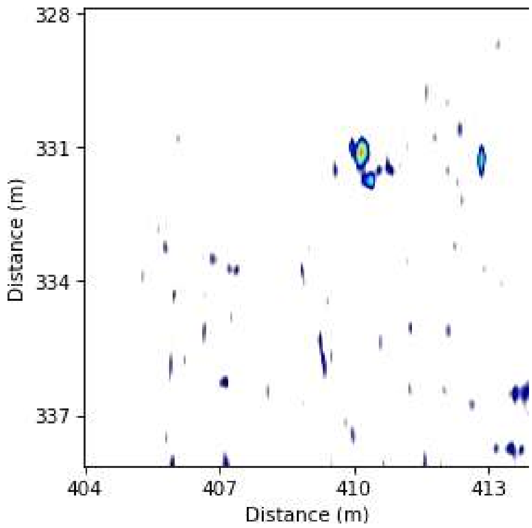
(c) Timeslice at z = 1.0 m.



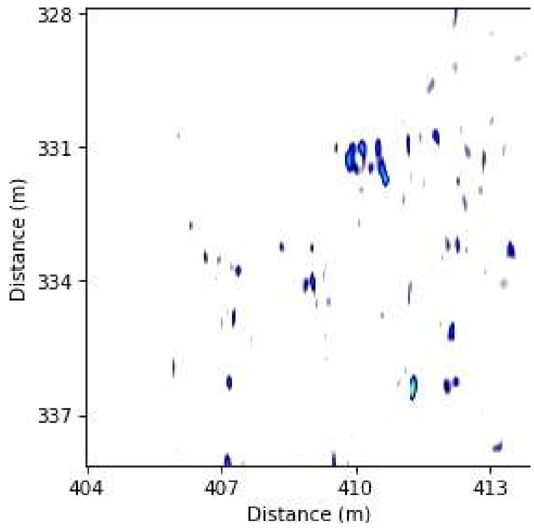
(d) Timeslice at z = 1.05 m.



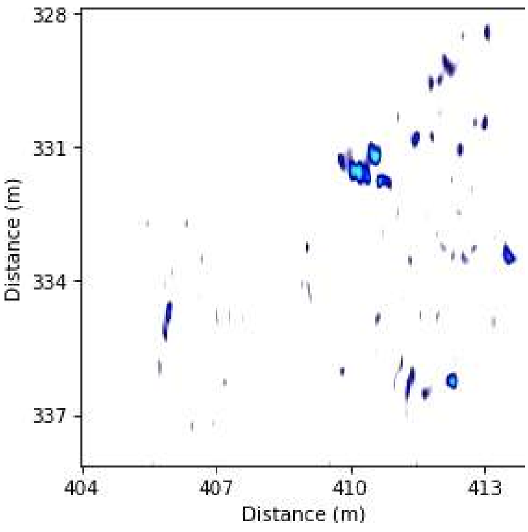
(e) Timeslice at z = 1.1 m.



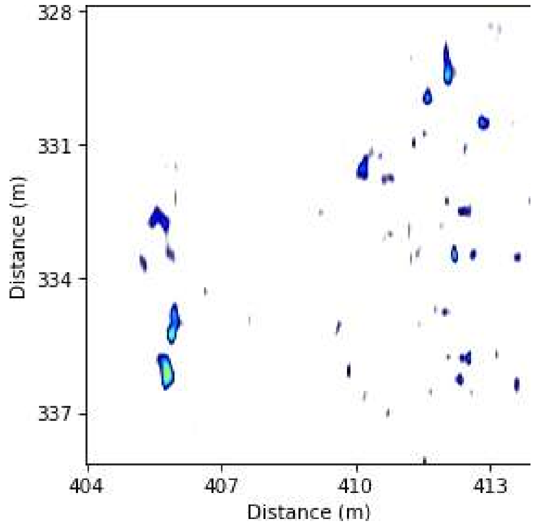
(f) Timeslice at z = 1.15 m.



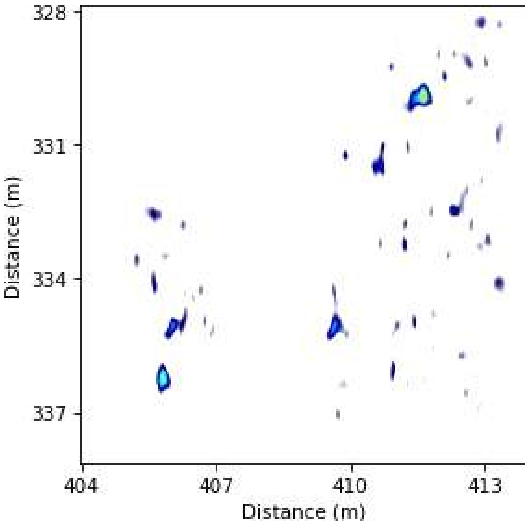
(a) Timeslice at z = 1.2 m.



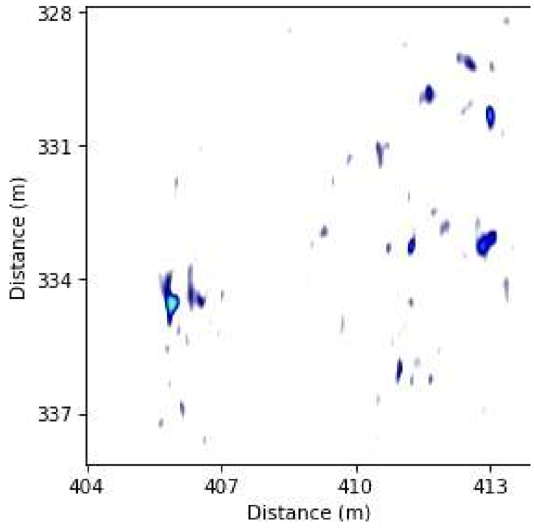
(b) Timeslice at z = 1.25 m.



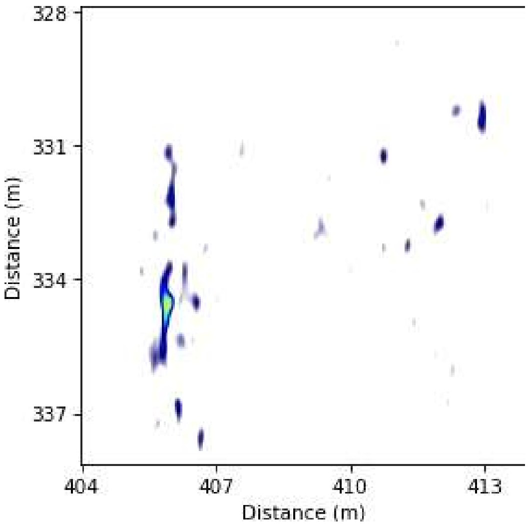
(c) Timeslice at z = 1.3 m.



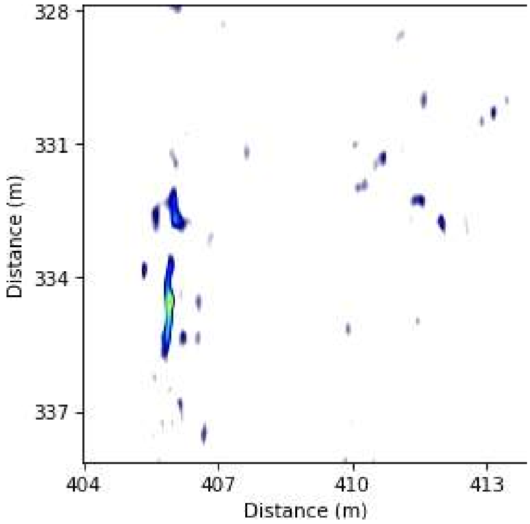
(d) Timeslice at z = 1.35 m.



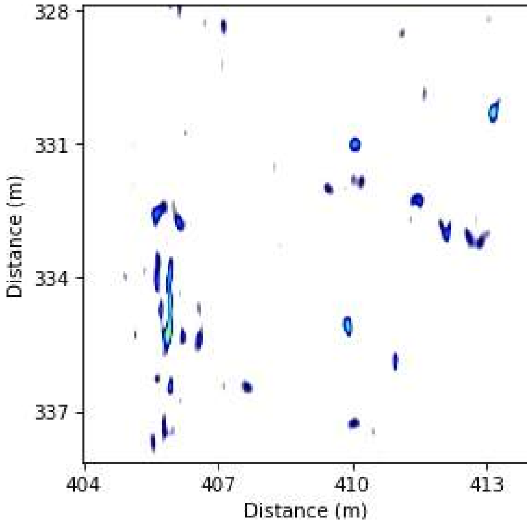
(e) Timeslice at z = 1.4 m.



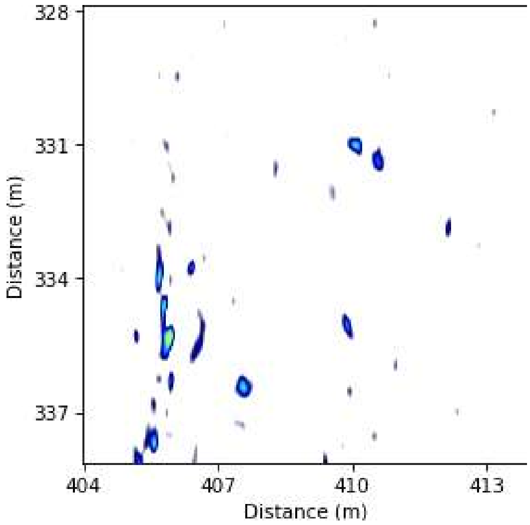
(f) Timeslice at z = 1.45 m.



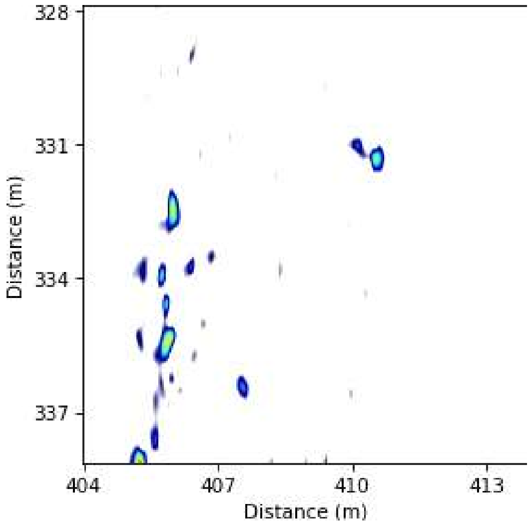
(a) Timeslice at z = 1.5 m.



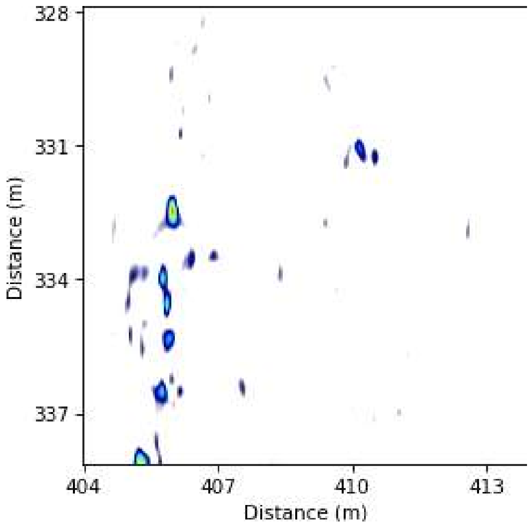
(b) Timeslice at z = 1.55 m.



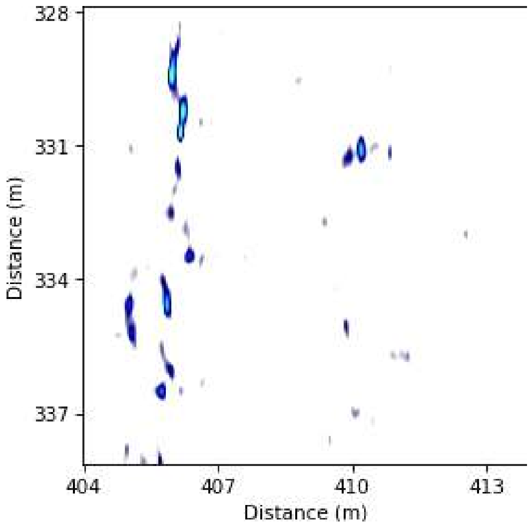
(c) Timeslice at z = 1.6 m.



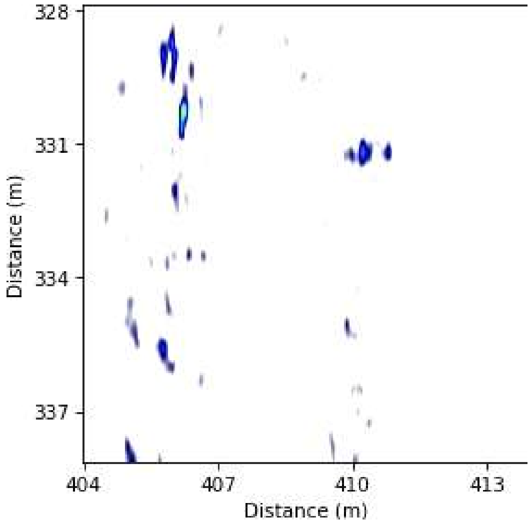
(d) Timeslice at z = 1.65 m.



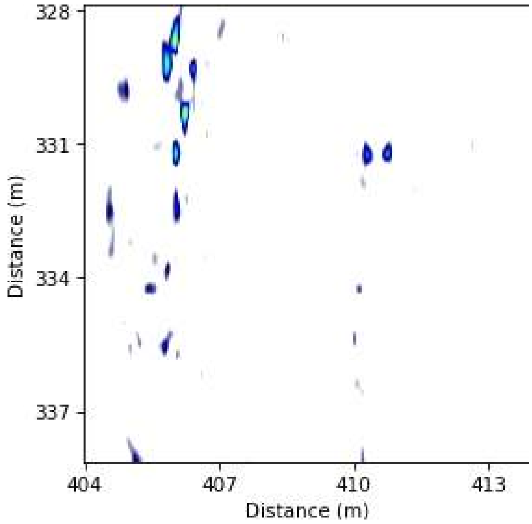
(e) Timeslice at z = 1.7 m.



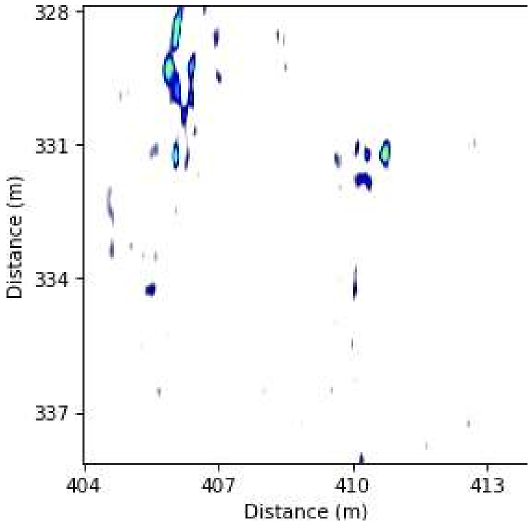
(f) Timeslice at z = 1.75 m.



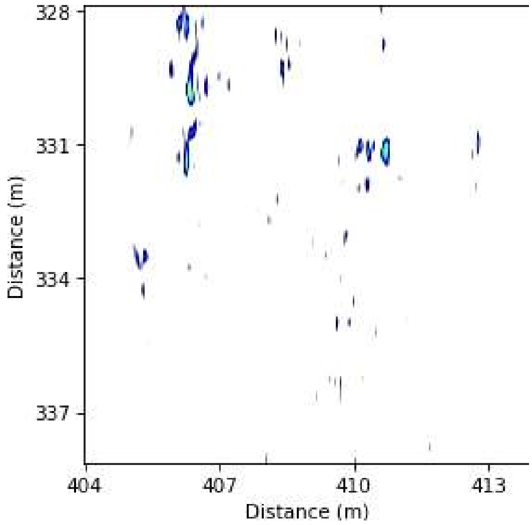
(a) Timeslice at z = 1.8 m.



(b) Timeslice at z = 1.85 m.



(c) Timeslice at z = 1.9 m.



(d) Timeslice at z = 1.95 m.

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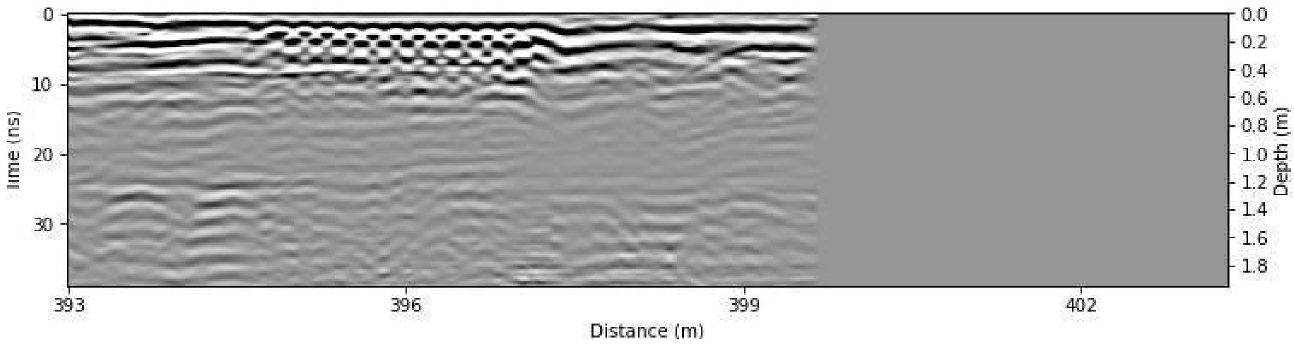


Figure B.478: Radargram at x = 373.0 m.

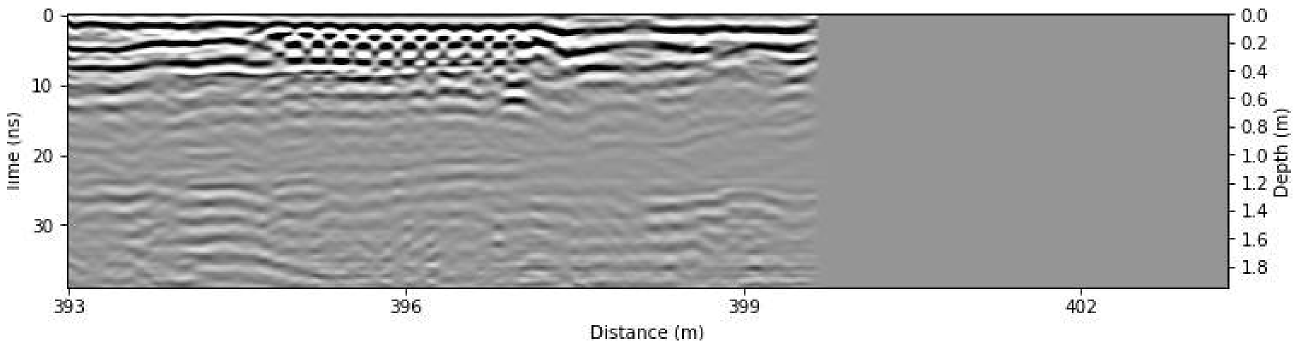


Figure B.479: Radargram at x = 373.25 m.

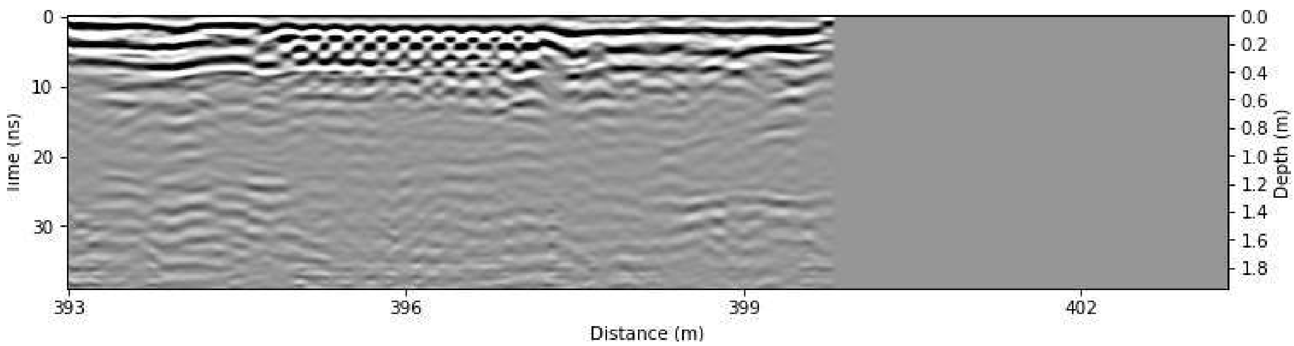


Figure B.480: Radargram at x = 373.5 m.

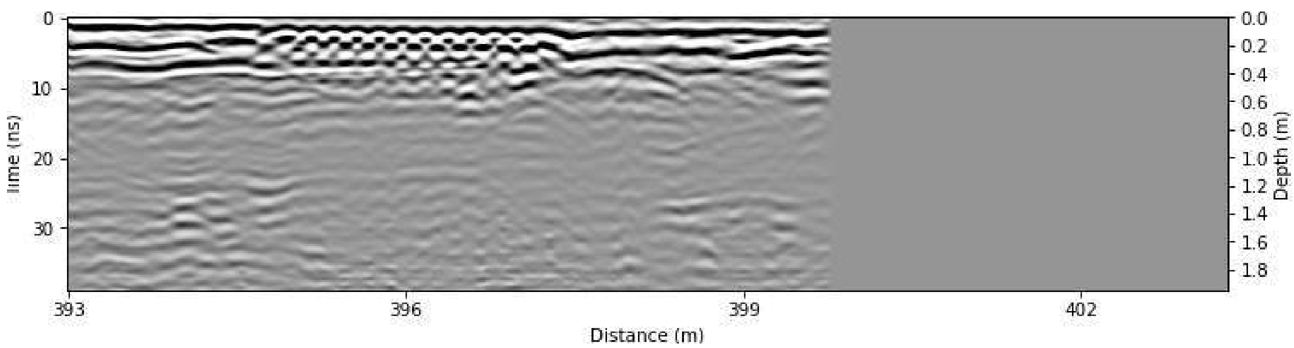


Figure B.481: Radargram at x = 373.75 m.

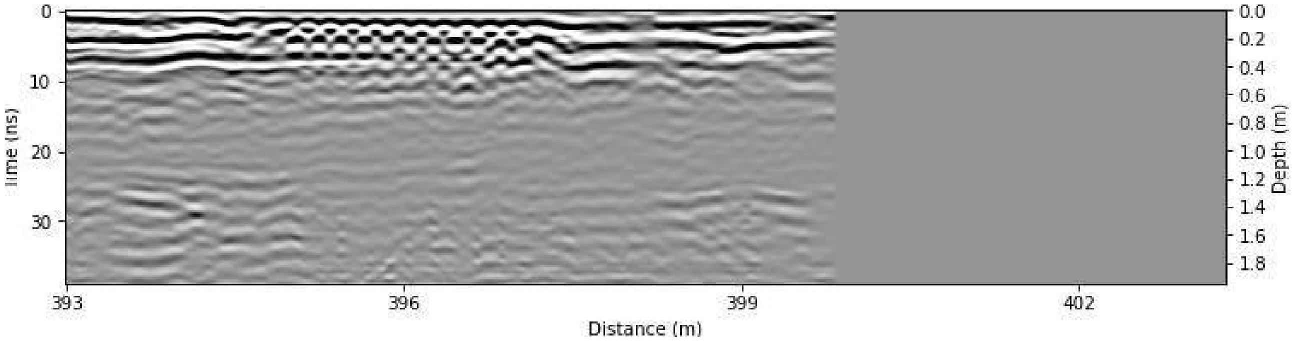


Figure B.482: Radargram at x = 374.0 m.

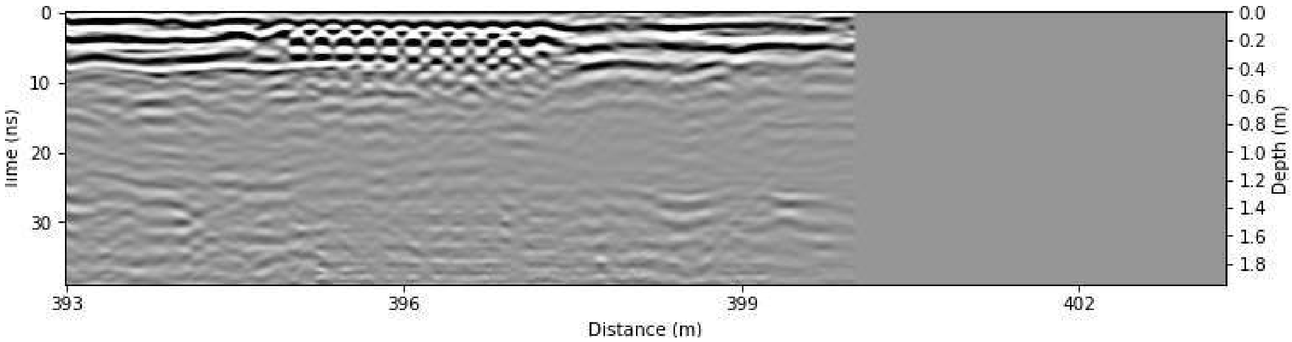


Figure B.483: Radargram at x = 374.25 m.

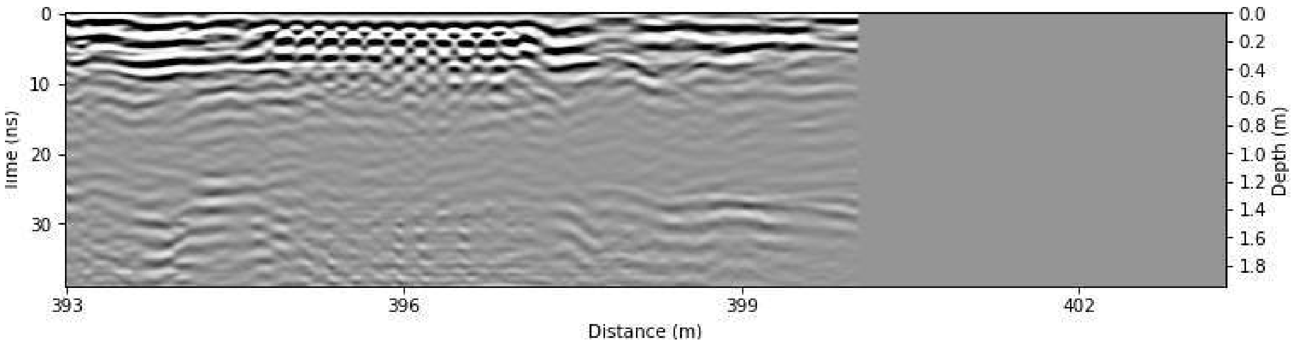


Figure B.484: Radargram at x = 374.5 m.

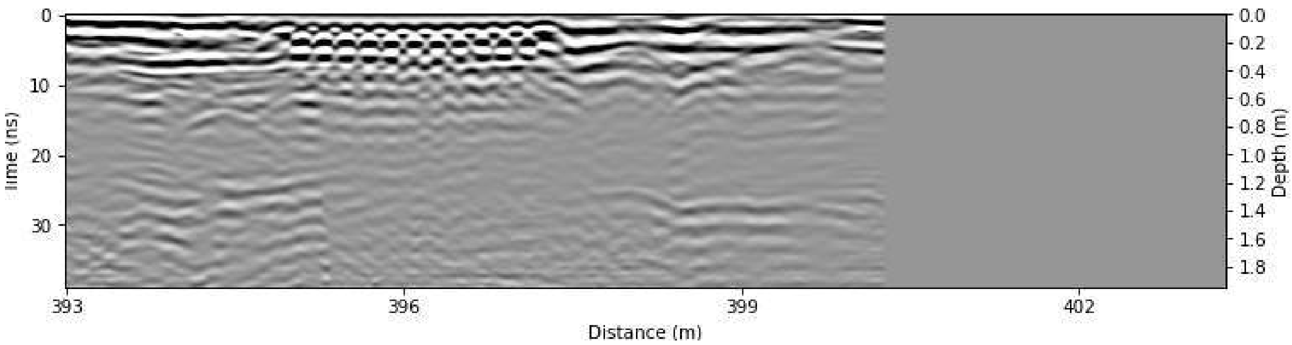


Figure B.485: Radargram at x = 374.75 m.

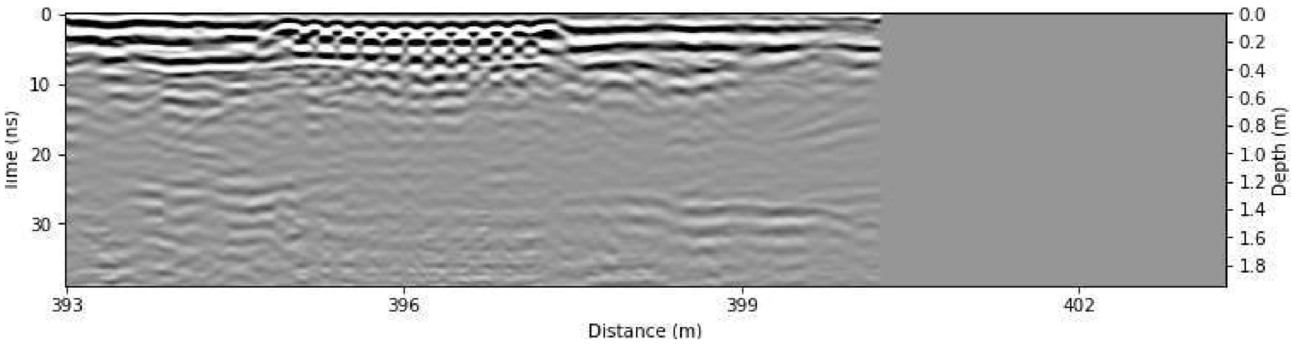


Figure B.486: Radargram at x = 375.0 m.

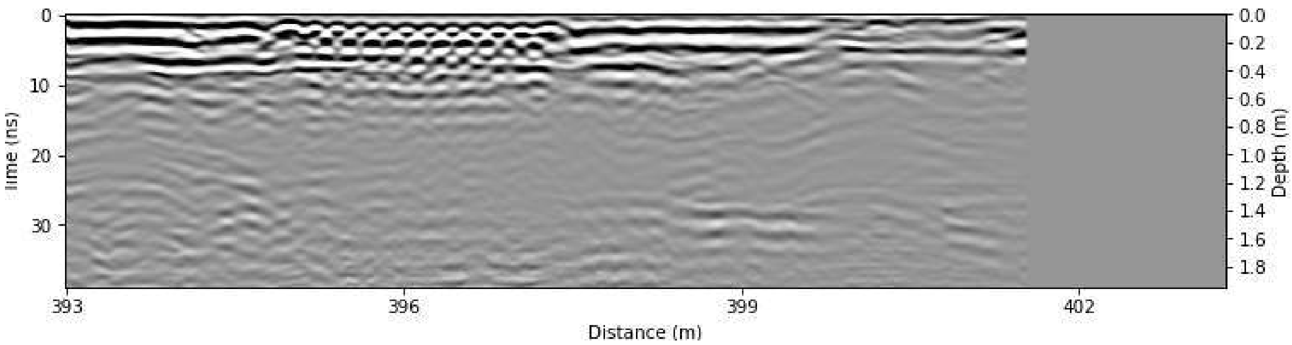


Figure B.487: Radargram at x = 375.25 m.

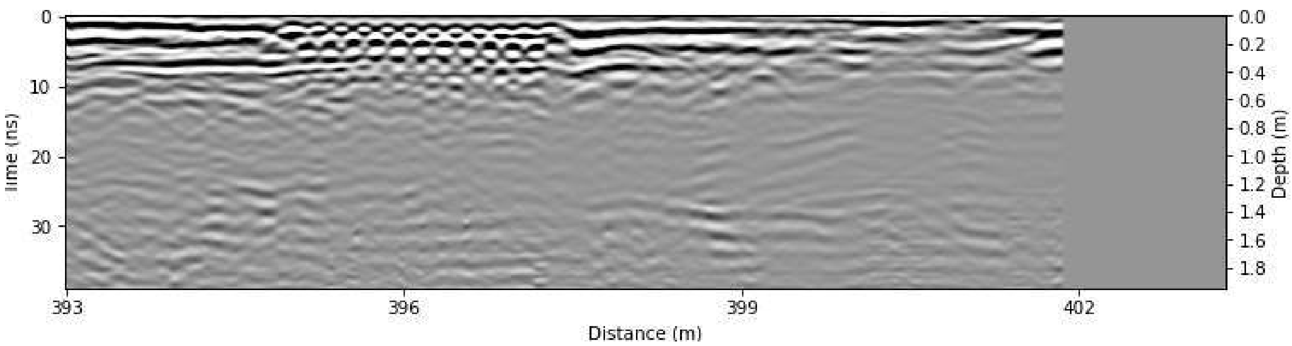


Figure B.488: Radargram at x = 375.5 m.

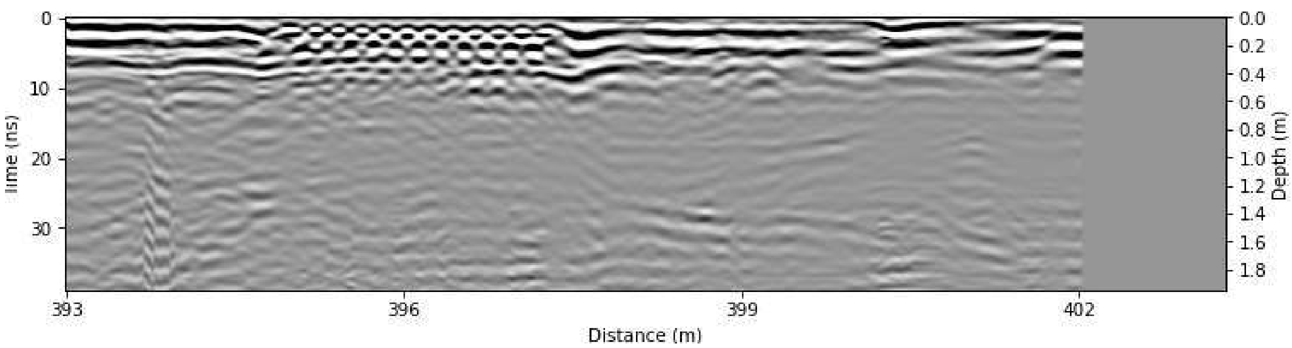


Figure B.489: Radargram at x = 375.75 m.

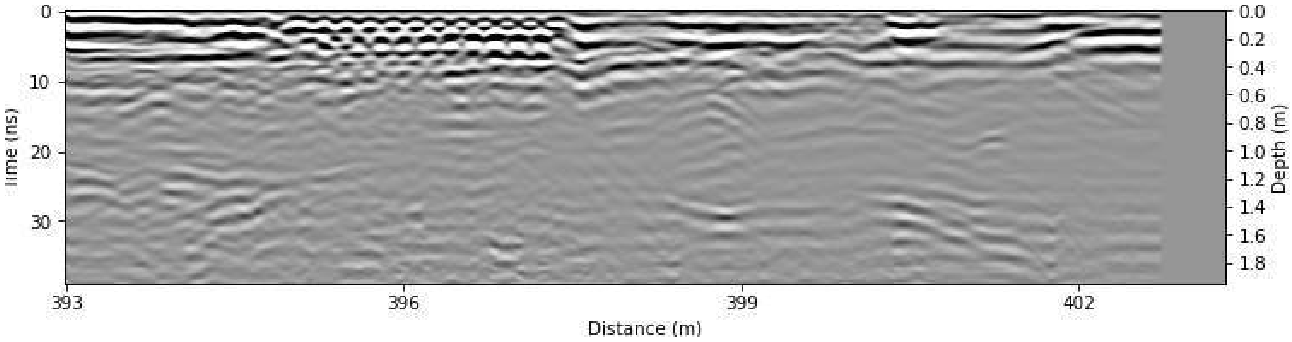


Figure B.490: Radargram at x = 376.0 m.

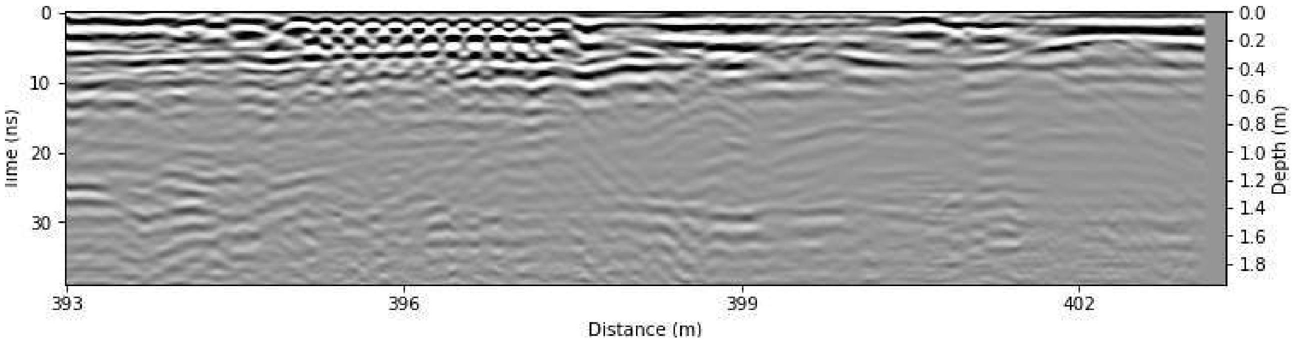


Figure B.491: Radargram at x = 376.25 m.

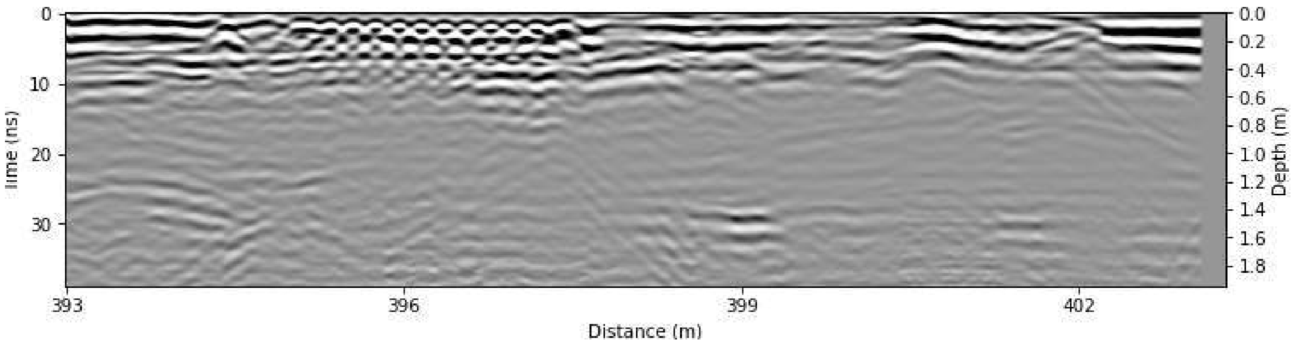


Figure B.492: Radargram at x = 376.5 m.

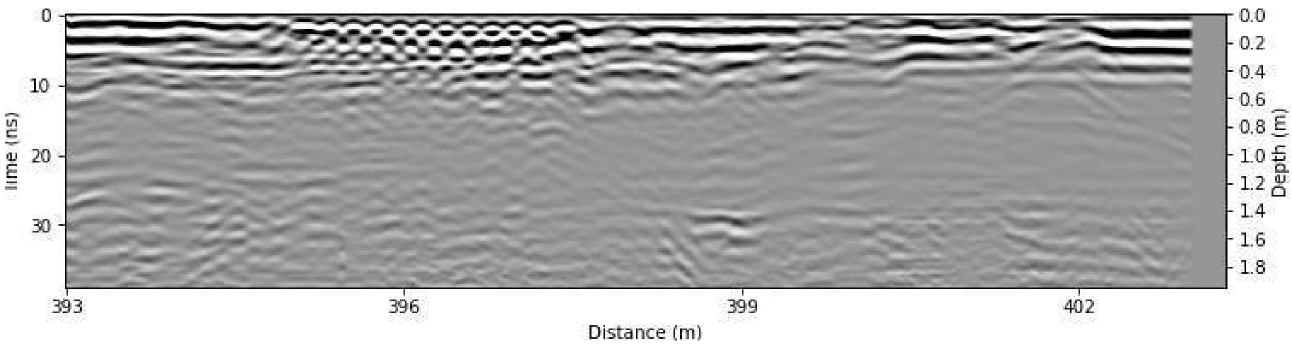


Figure B.493: Radargram at x = 376.75 m.

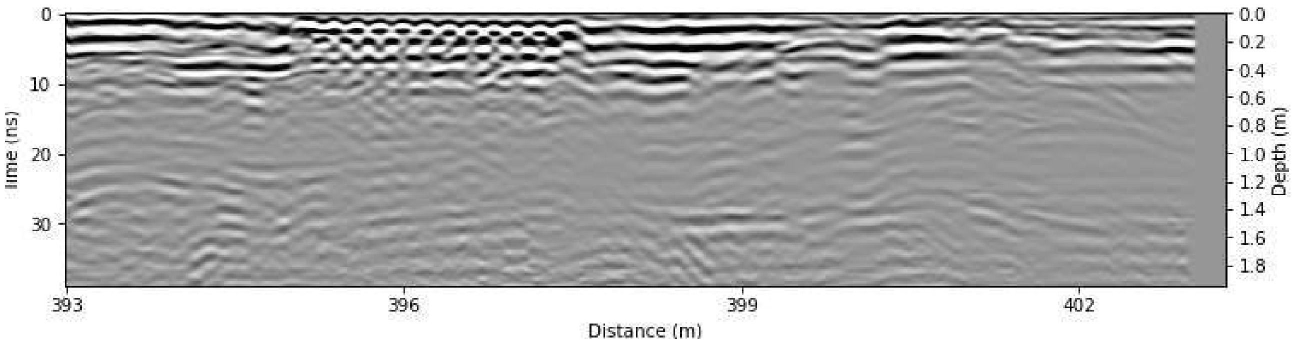


Figure B.494: Radargram at x = 377.0 m.

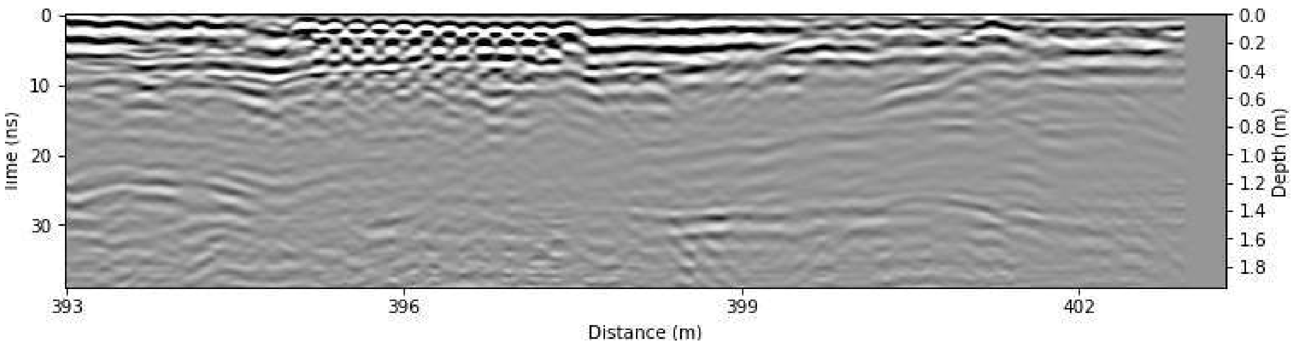


Figure B.495: Radargram at x = 377.25 m.

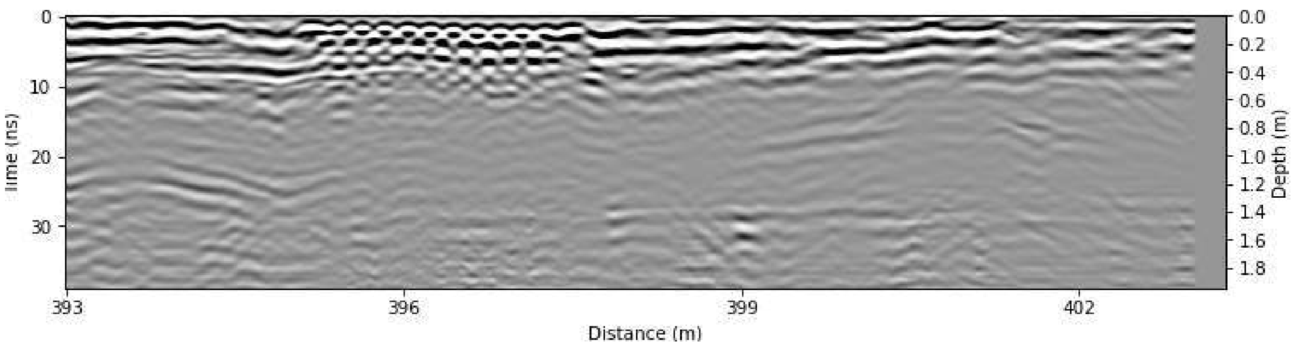


Figure B.496: Radargram at x = 377.5 m.

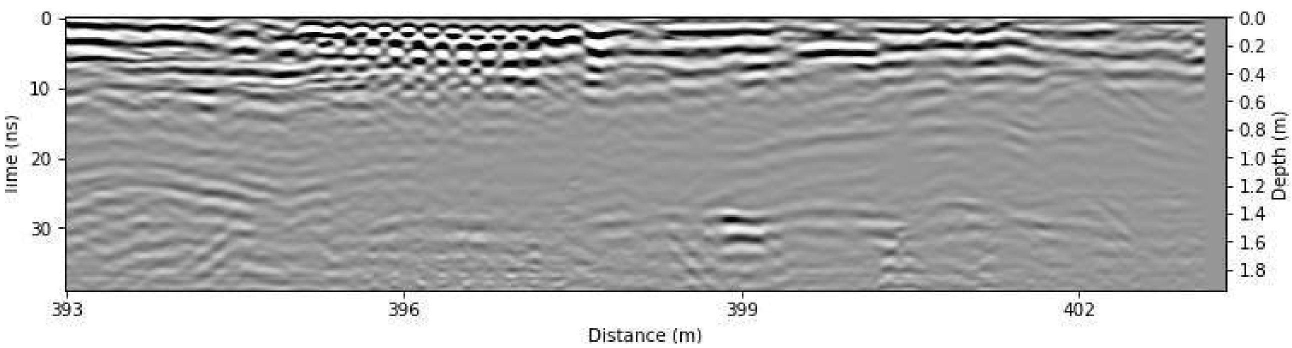


Figure B.497: Radargram at x = 377.75 m.

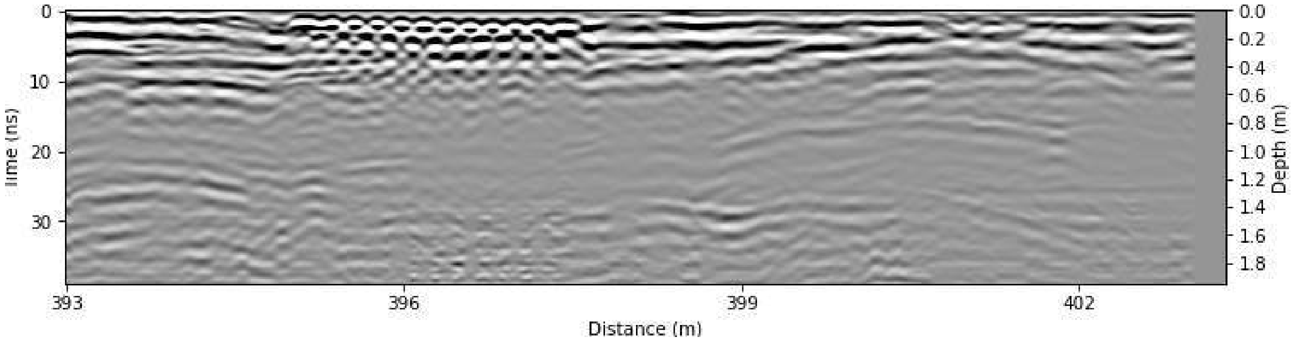


Figure B.498: Radargram at x = 378.0 m.

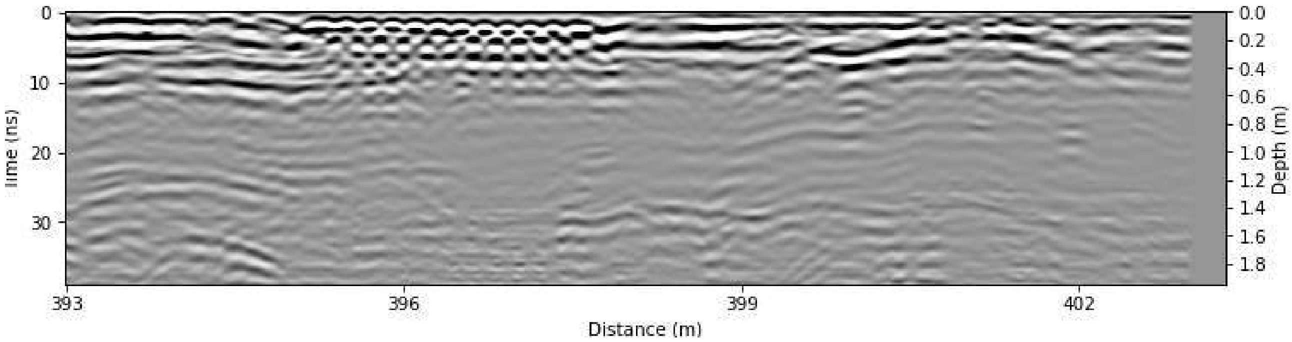


Figure B.499: Radargram at x = 378.25 m.

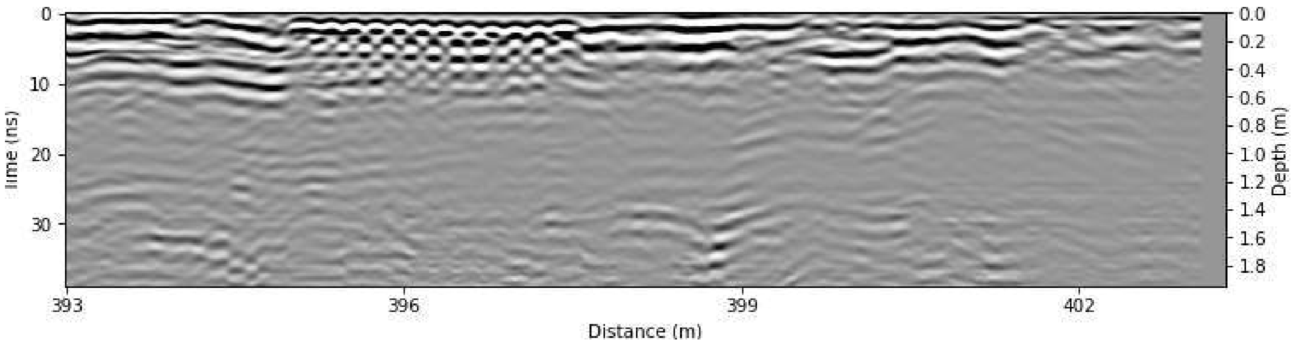


Figure B.500: Radargram at x = 378.5 m.

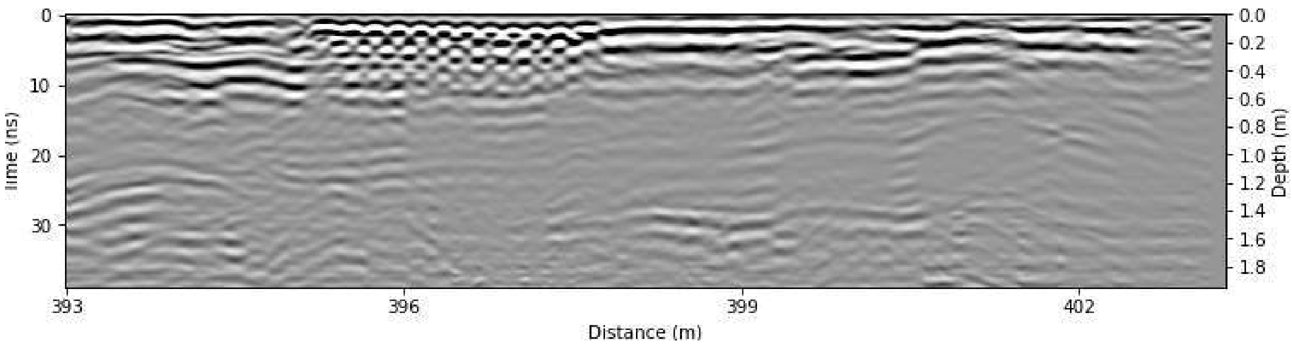


Figure B.501: Radargram at x = 378.75 m.

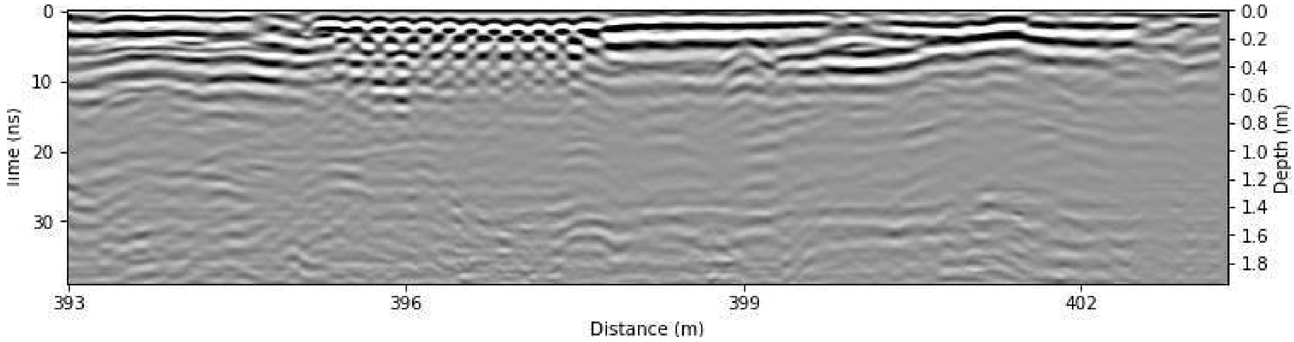


Figure B.502: Radargram at x = 379.0 m.

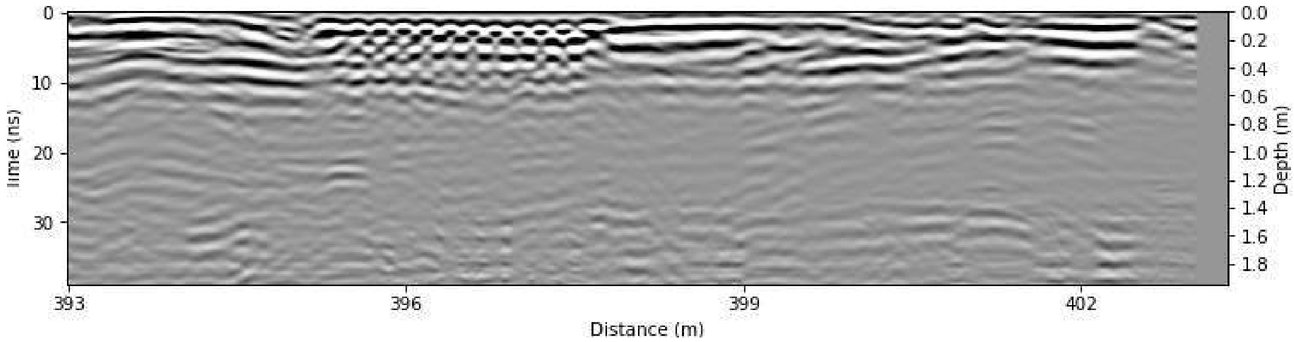


Figure B.503: Radargram at x = 379.25 m.

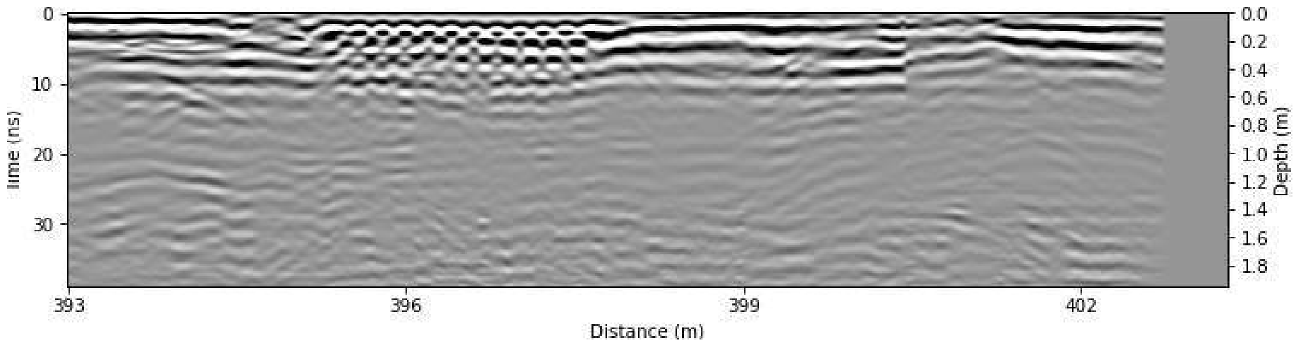


Figure B.504: Radargram at x = 379.5 m.

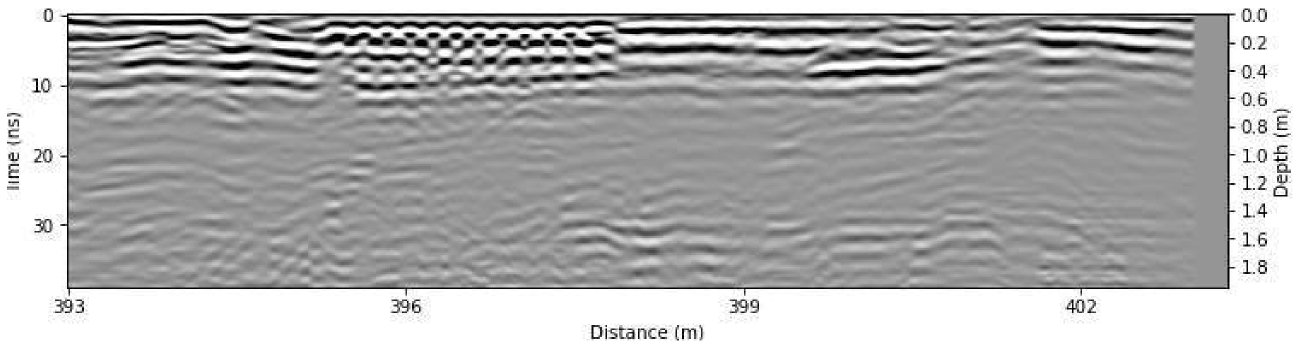


Figure B.505: Radargram at x = 379.75 m.

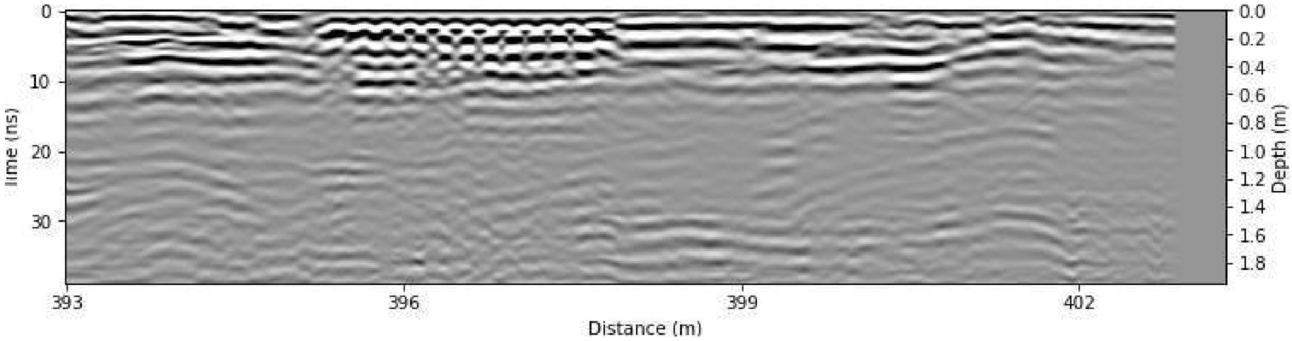


Figure B.506: Radargram at x = 380.0 m.

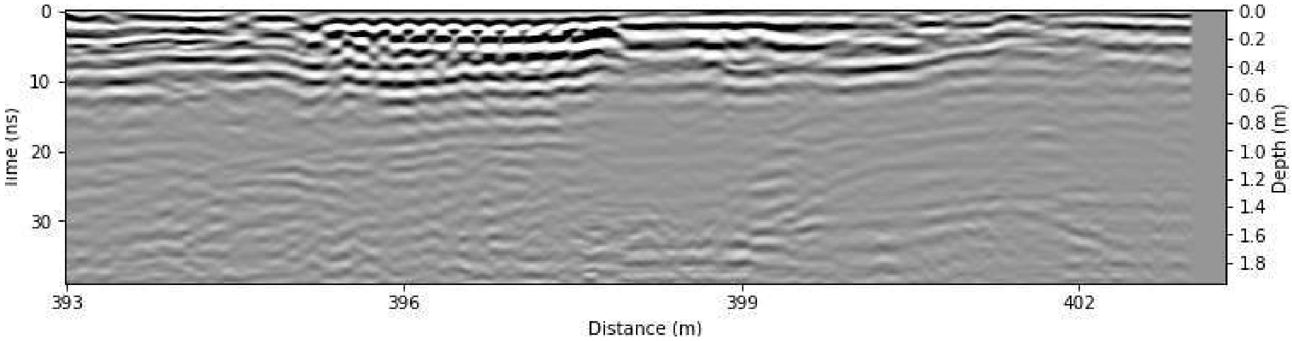


Figure B.507: Radargram at x = 380.25 m.

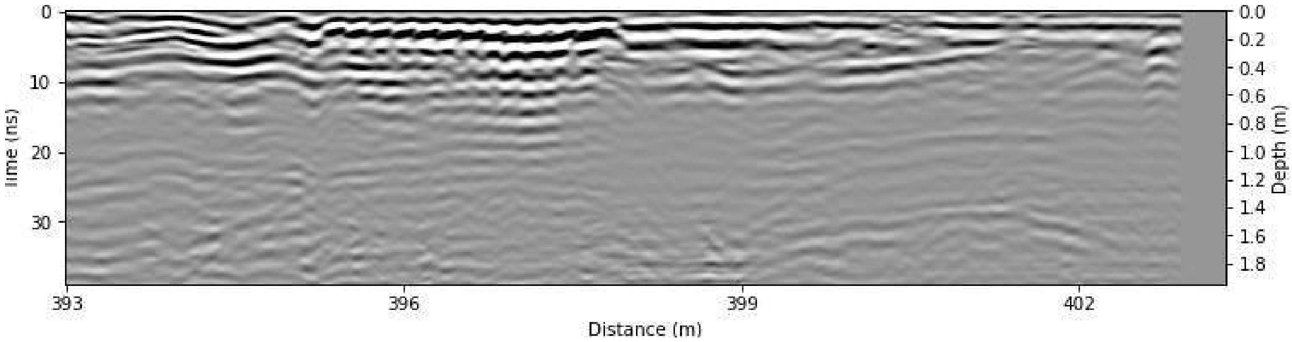


Figure B.508: Radargram at x = 380.5 m.

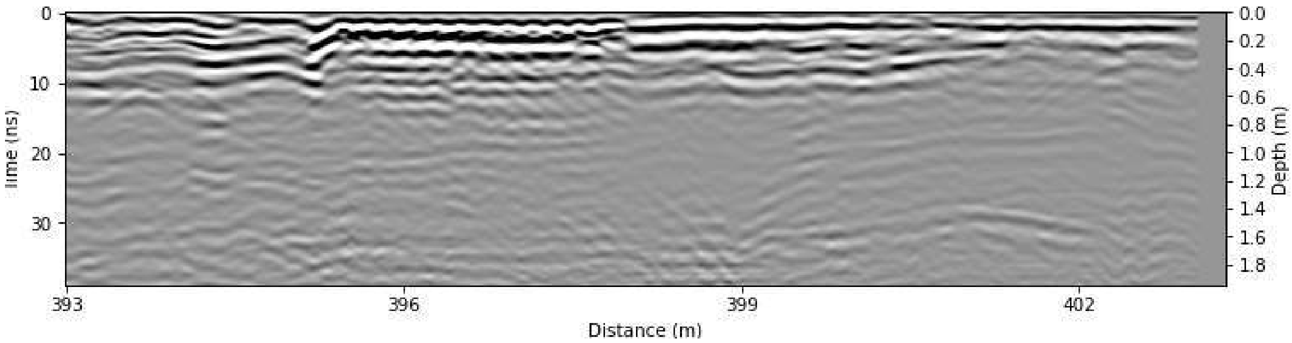


Figure B.509: Radargram at x = 380.75 m.

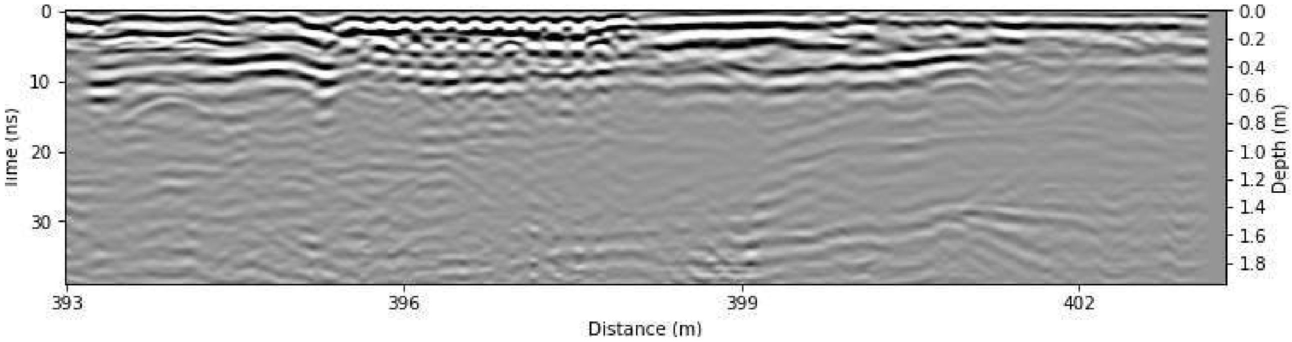


Figure B.510: Radargram at x = 381.0 m.

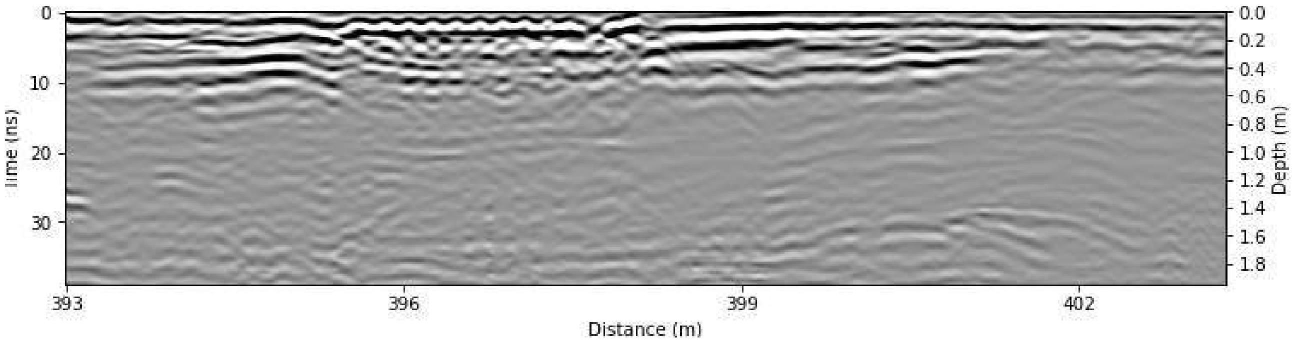


Figure B.511: Radargram at x = 381.25 m.

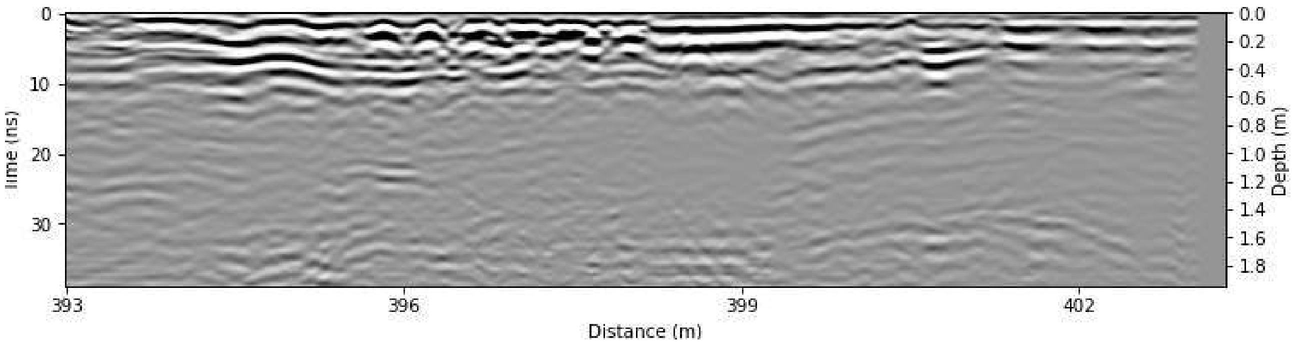


Figure B.512: Radargram at x = 381.5 m.

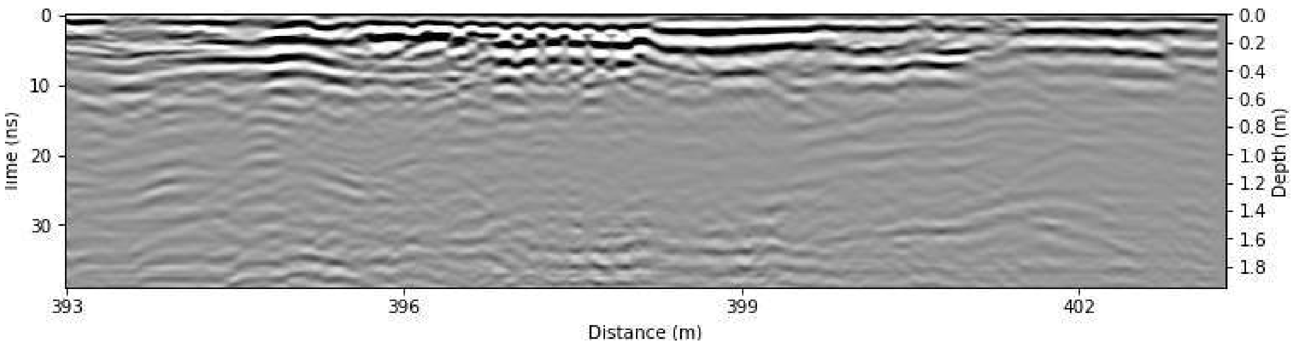


Figure B.513: Radargram at x = 381.75 m.

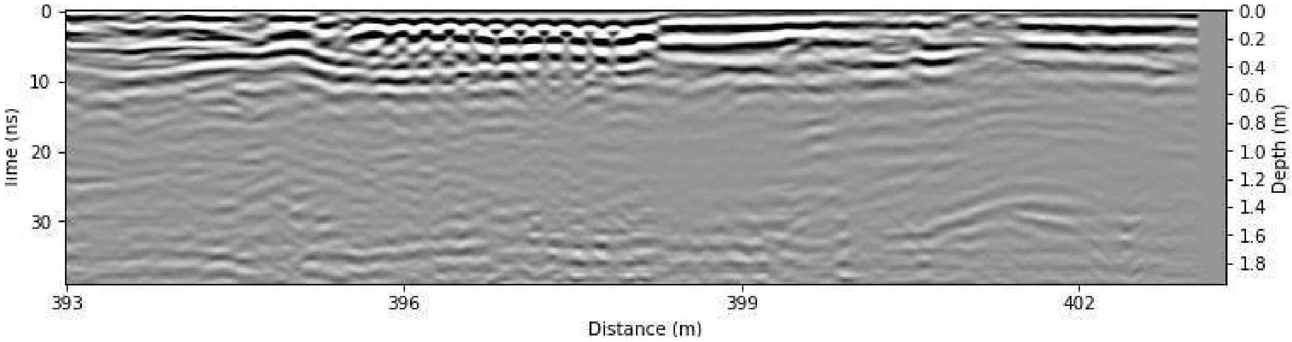


Figure B.514: Radargram at x = 382.0 m.

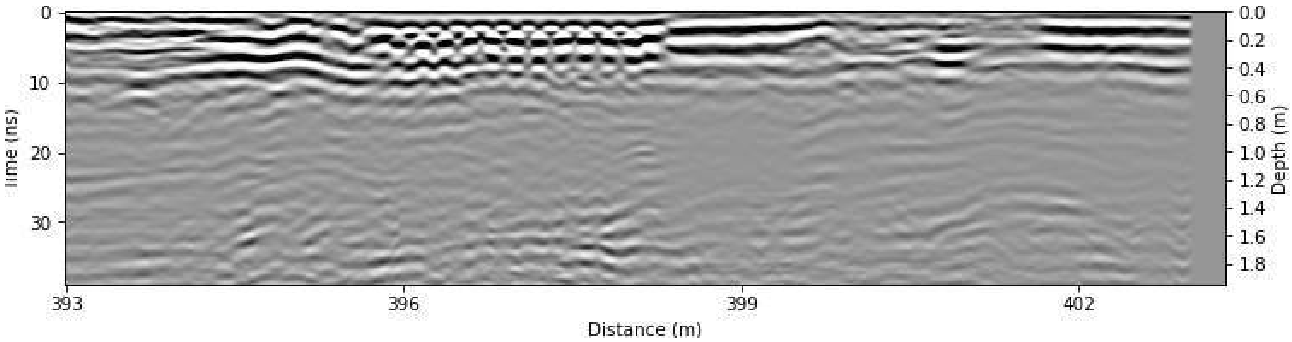


Figure B.515: Radargram at x = 382.25 m.

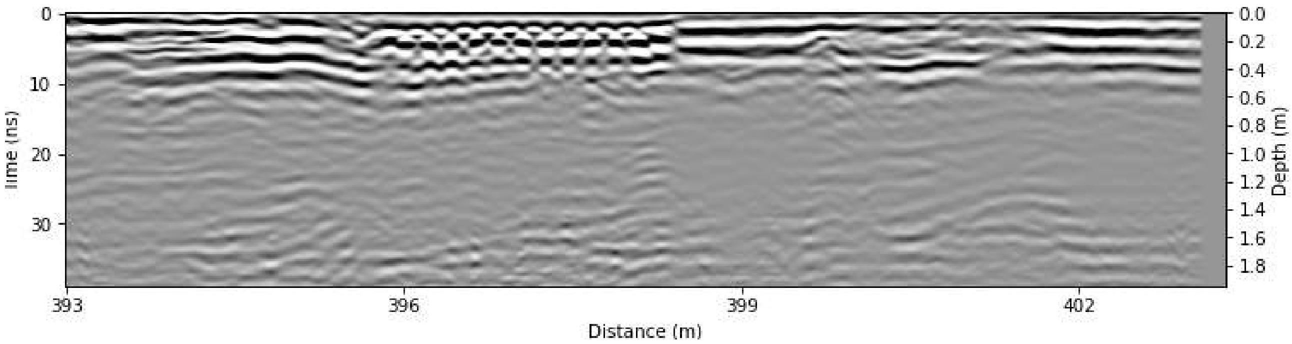
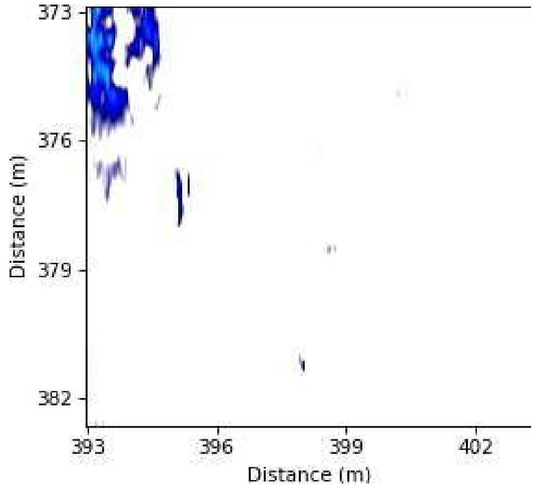
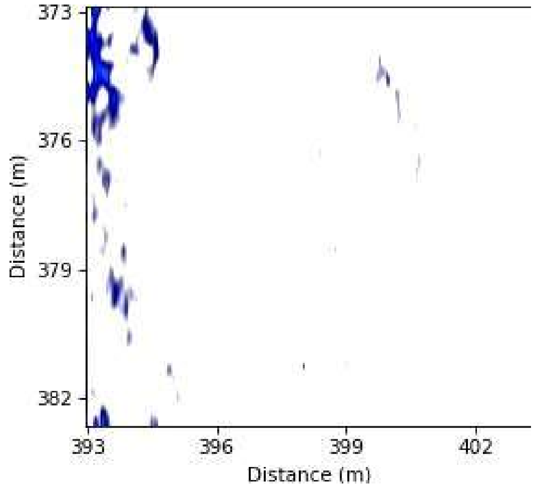


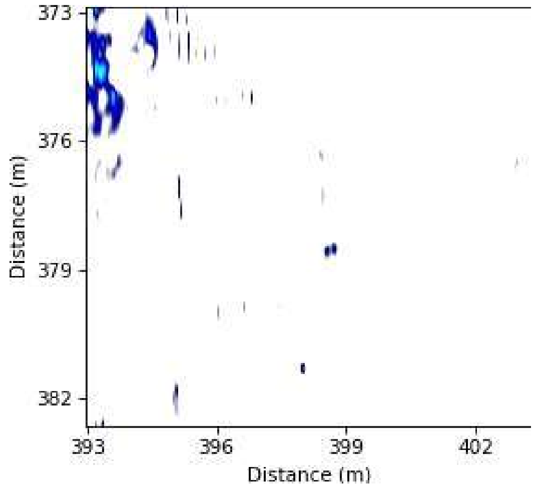
Figure B.516: Radargram at x = 382.5 m.



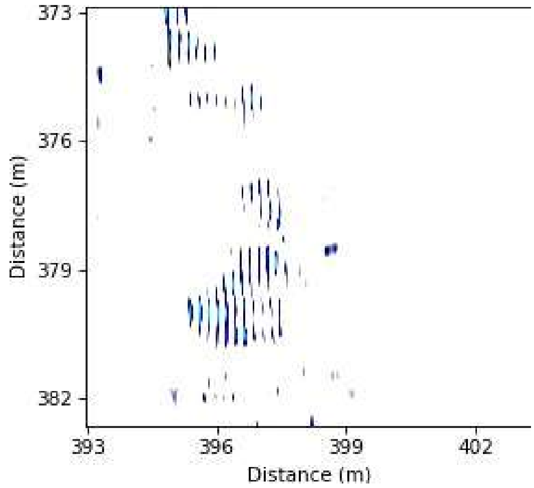
(a) Timeslice at z = 0.0 m.



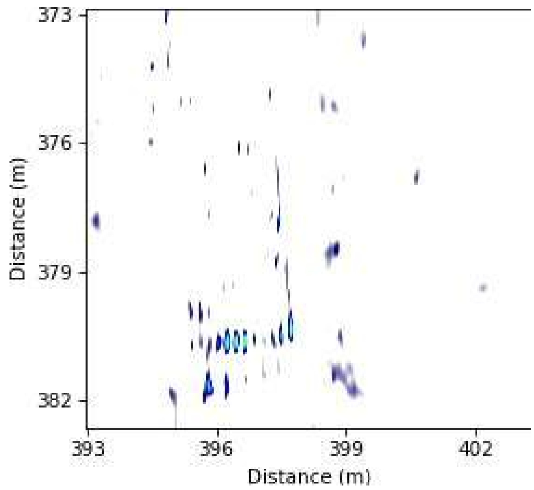
(b) Timeslice at z = 0.05 m.



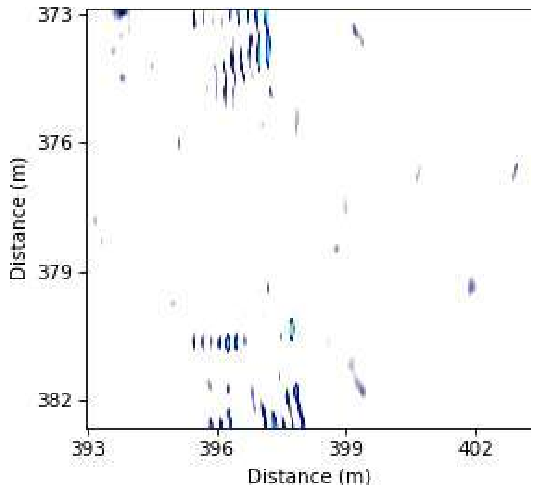
(c) Timeslice at z = 0.1 m.



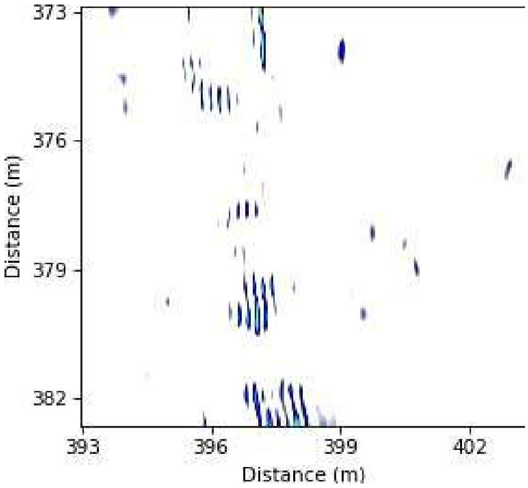
(d) Timeslice at z = 0.15 m.



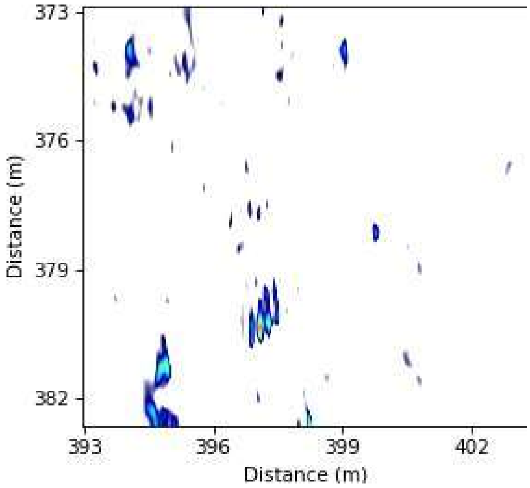
(e) Timeslice at z = 0.2 m.



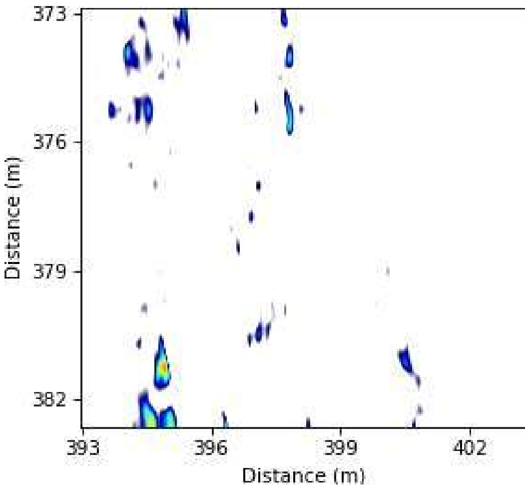
(f) Timeslice at z = 0.25 m.



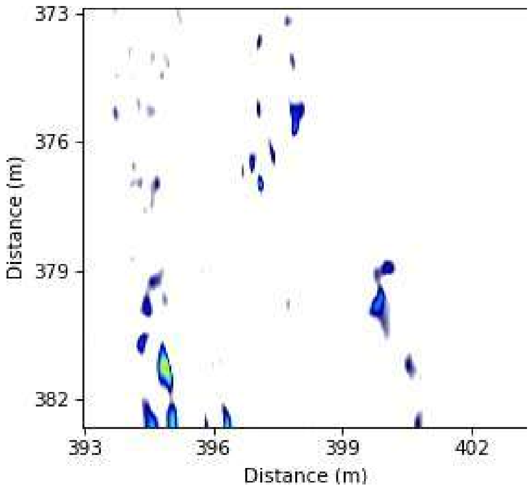
(a) Timeslice at z = 0.3 m.



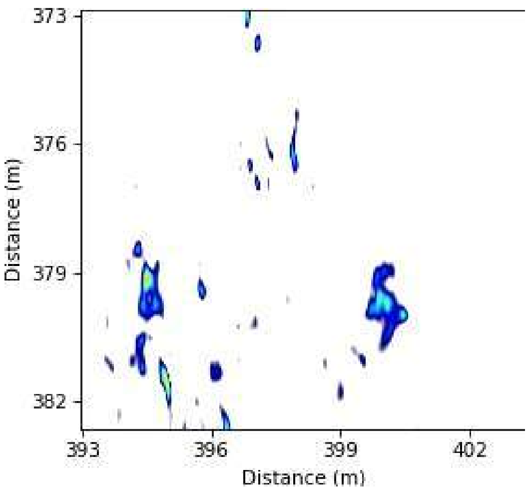
(b) Timeslice at z = 0.35 m.



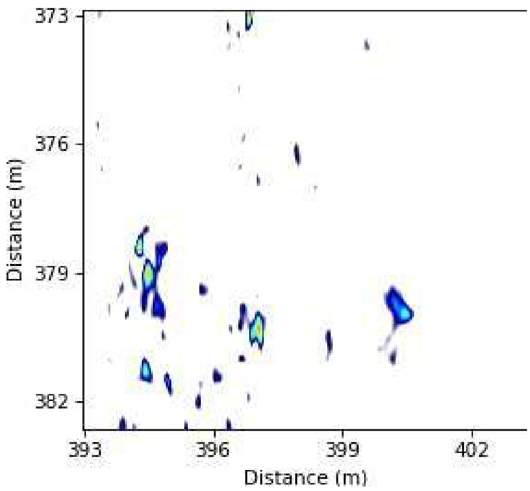
(c) Timeslice at z = 0.4 m.



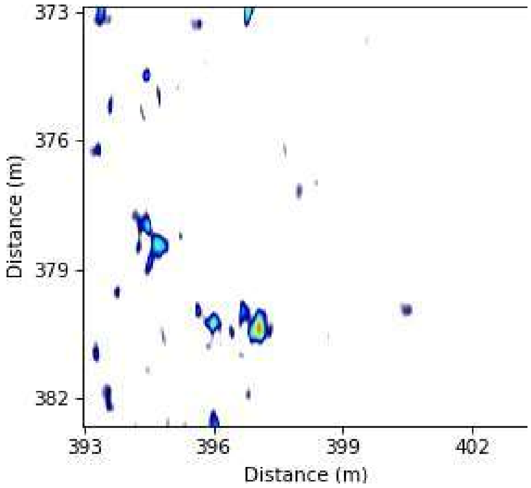
(d) Timeslice at z = 0.45 m.



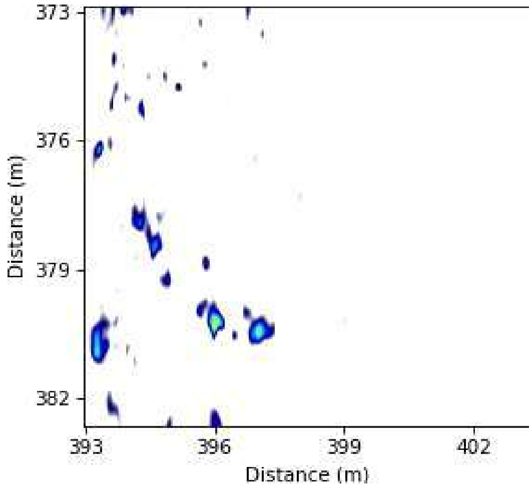
(e) Timeslice at z = 0.5 m.



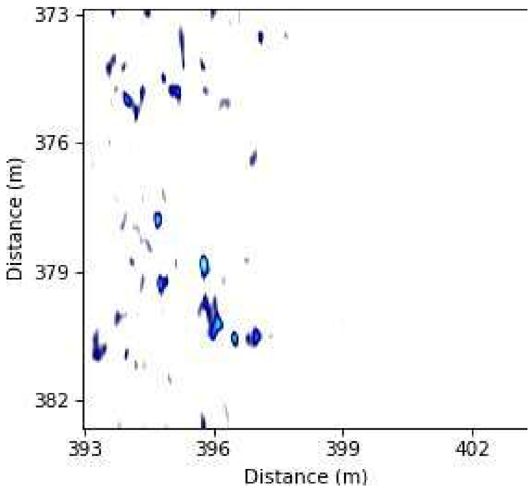
(f) Timeslice at z = 0.55 m.



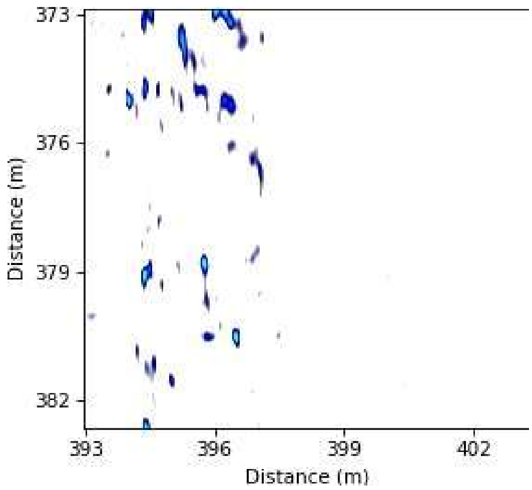
(a) Timeslice at z = 0.6 m.



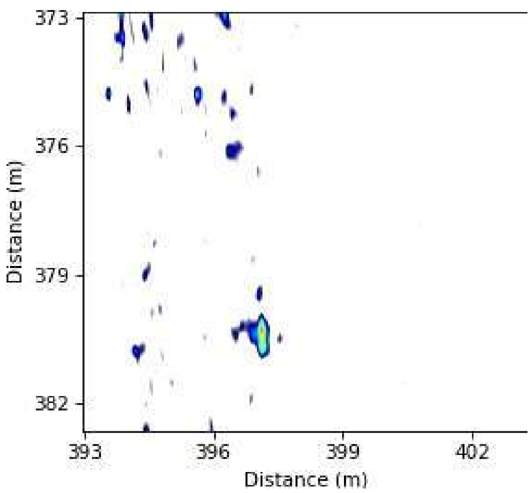
(b) Timeslice at z = 0.65 m.



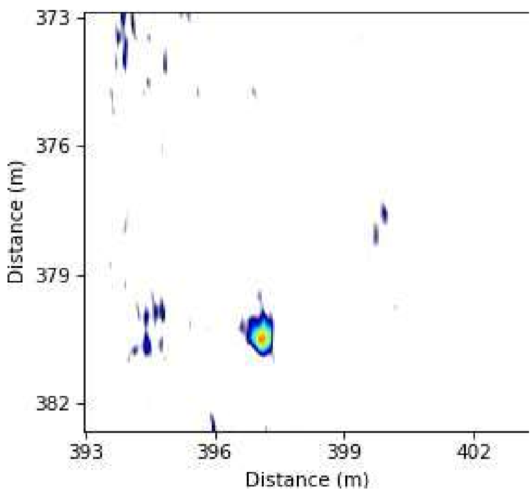
(c) Timeslice at z = 0.7 m.



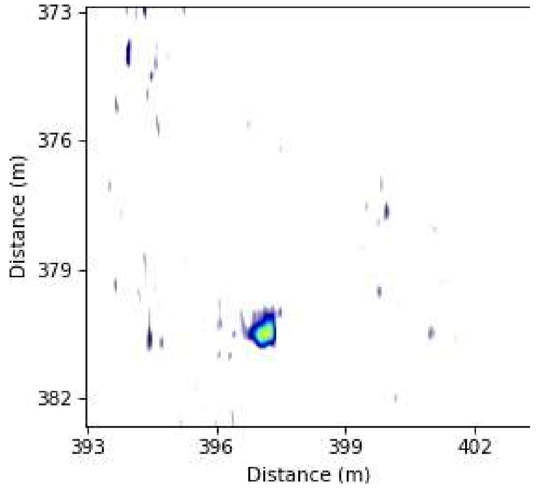
(d) Timeslice at z = 0.75 m.



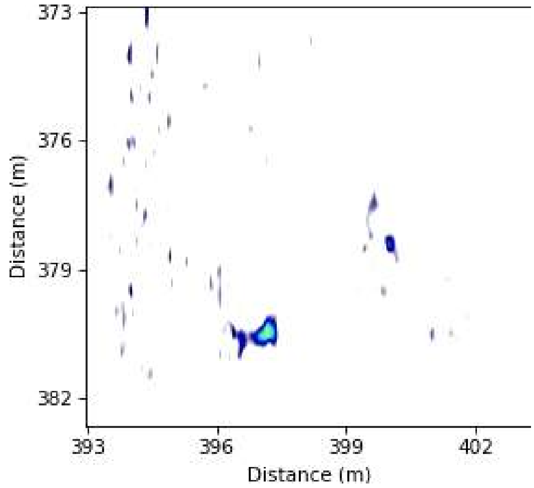
(e) Timeslice at z = 0.8 m.



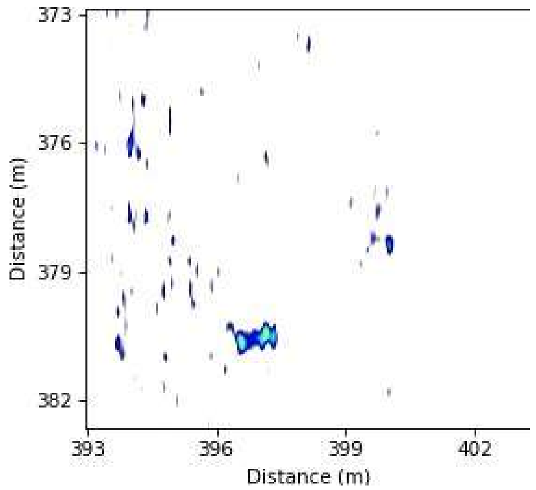
(f) Timeslice at z = 0.85 m.



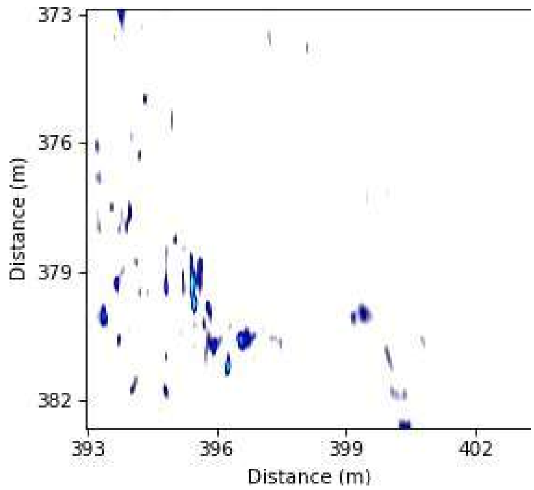
(a) Timeslice at z = 0.9 m.



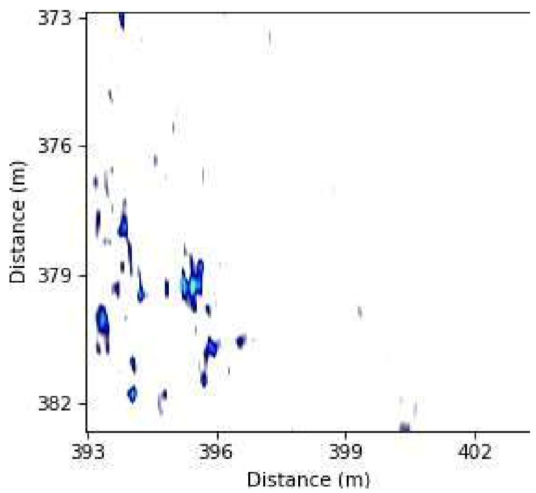
(b) Timeslice at z = 0.95 m.



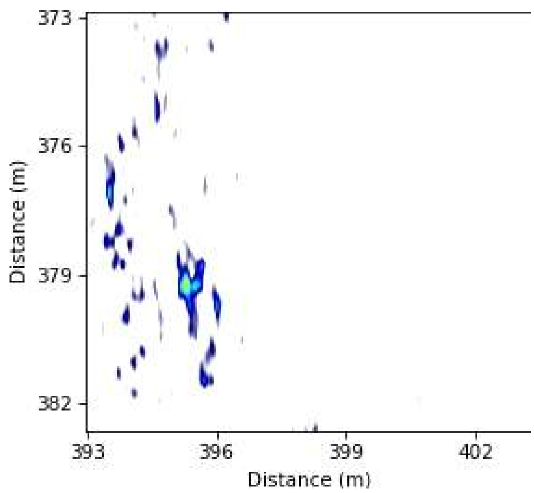
(c) Timeslice at z = 1.0 m.



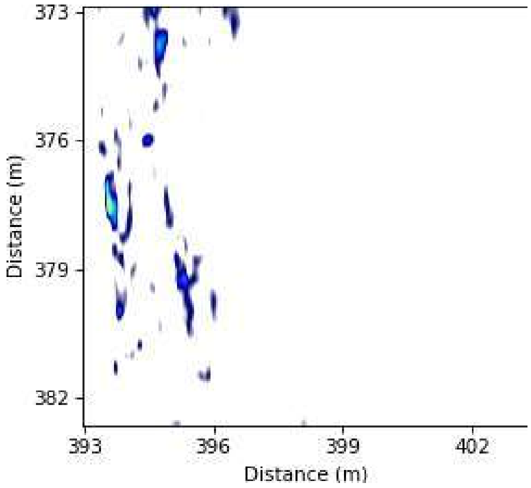
(d) Timeslice at z = 1.05 m.



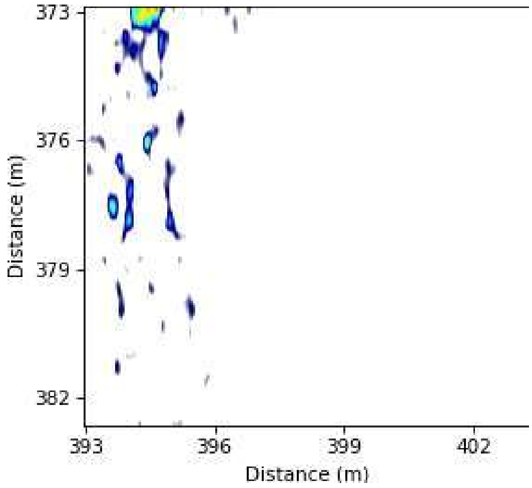
(e) Timeslice at z = 1.1 m.



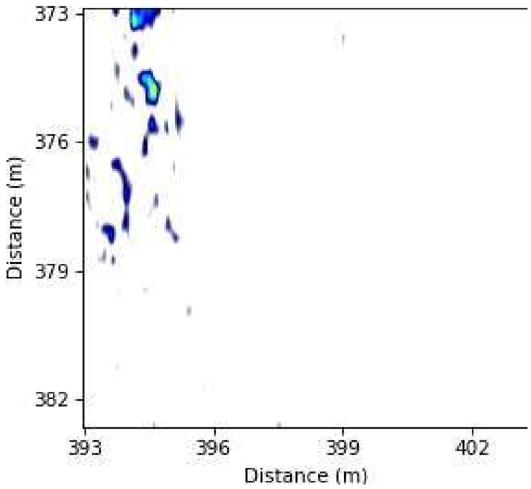
(f) Timeslice at z = 1.15 m.



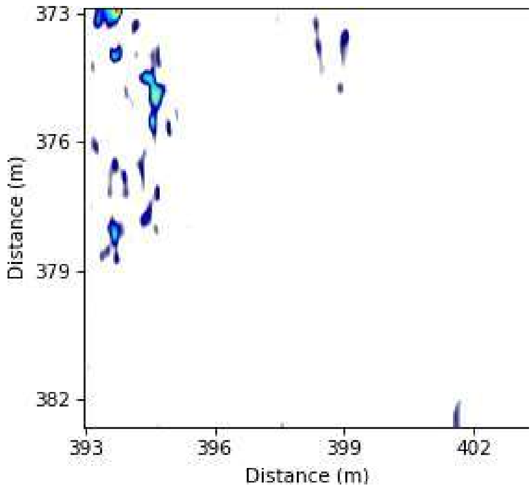
(a) Timeslice at z = 1.2 m.



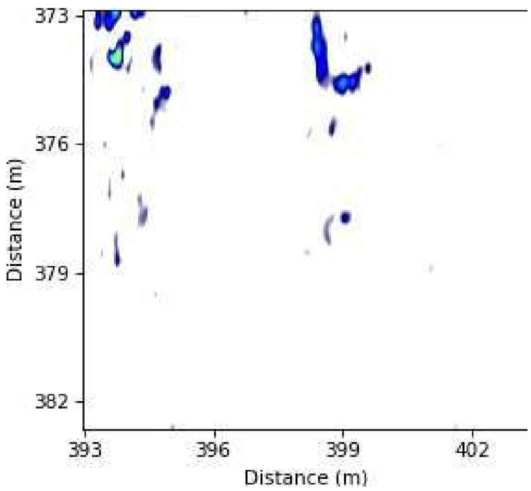
(b) Timeslice at z = 1.25 m.



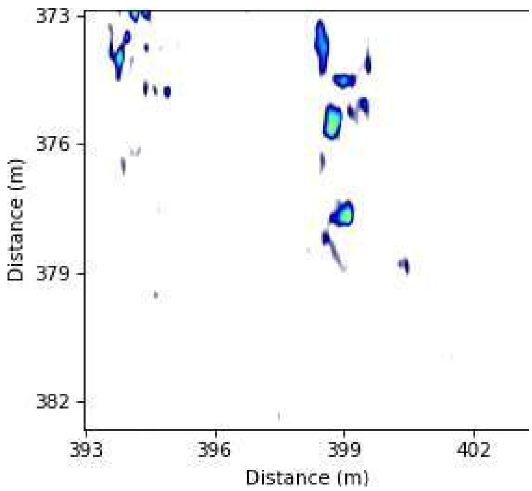
(c) Timeslice at z = 1.3 m.



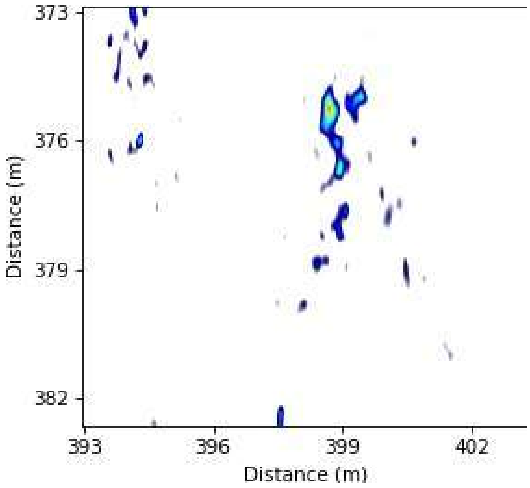
(d) Timeslice at z = 1.35 m.



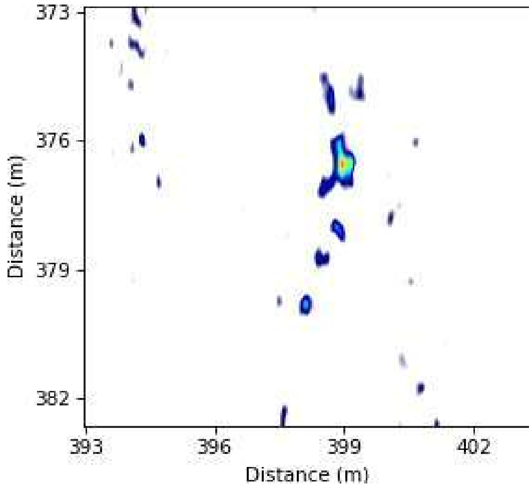
(e) Timeslice at z = 1.4 m.



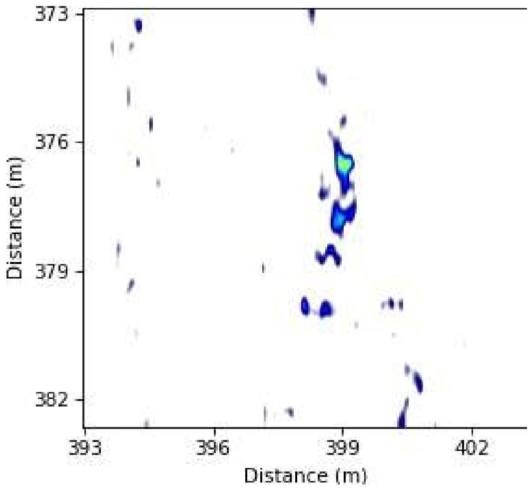
(f) Timeslice at z = 1.45 m.



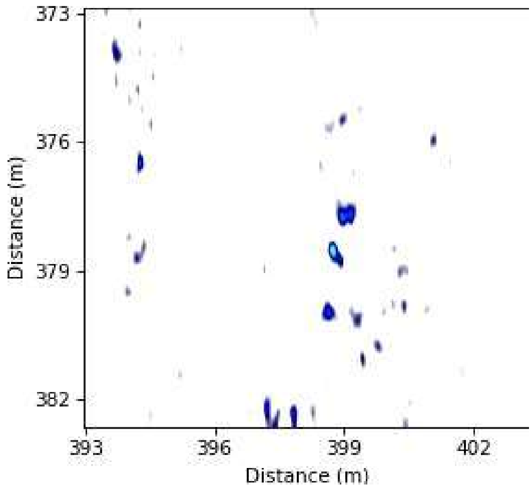
(a) Timeslice at z = 1.5 m.



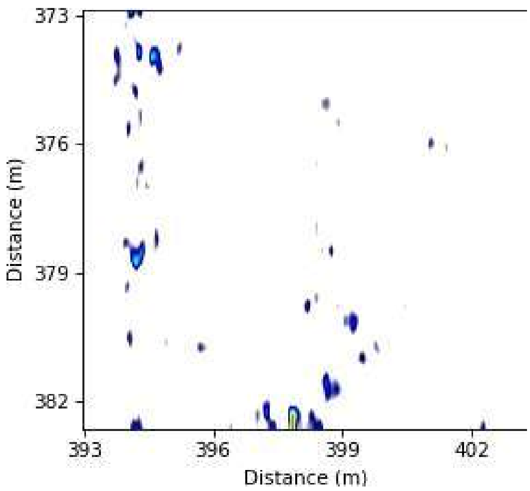
(b) Timeslice at z = 1.55 m.



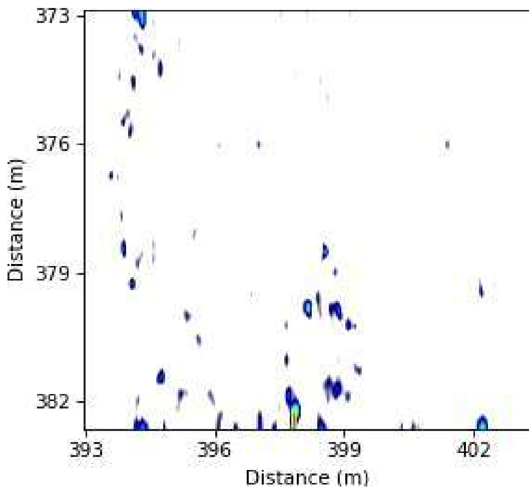
(c) Timeslice at z = 1.6 m.



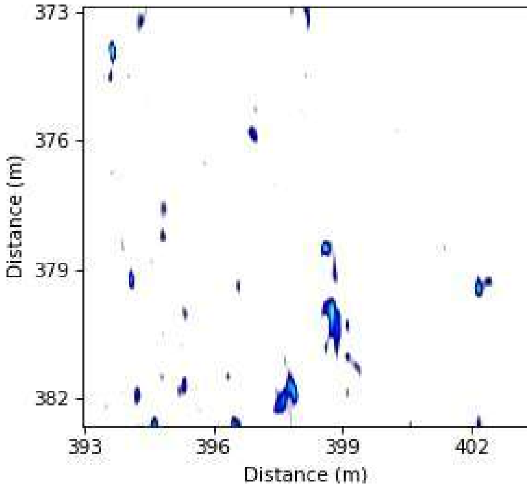
(d) Timeslice at z = 1.65 m.



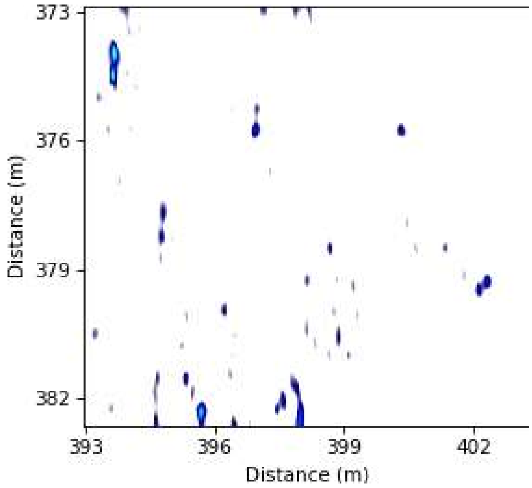
(e) Timeslice at z = 1.7 m.



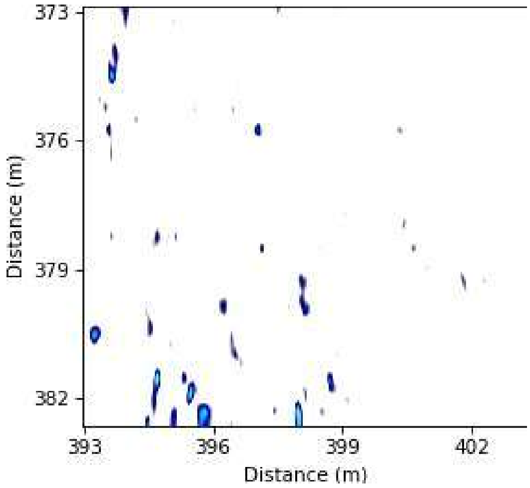
(f) Timeslice at z = 1.75 m.



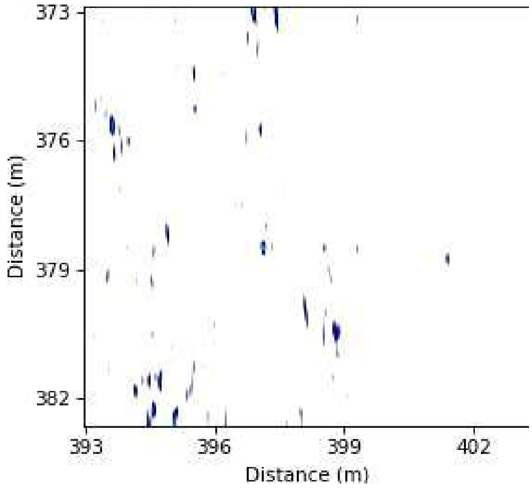
(a) Timeslice at z = 1.8 m.



(b) Timeslice at z = 1.85 m.



(c) Timeslice at z = 1.9 m.



(d) Timeslice at z = 1.95 m.

B.12 KU-TP14

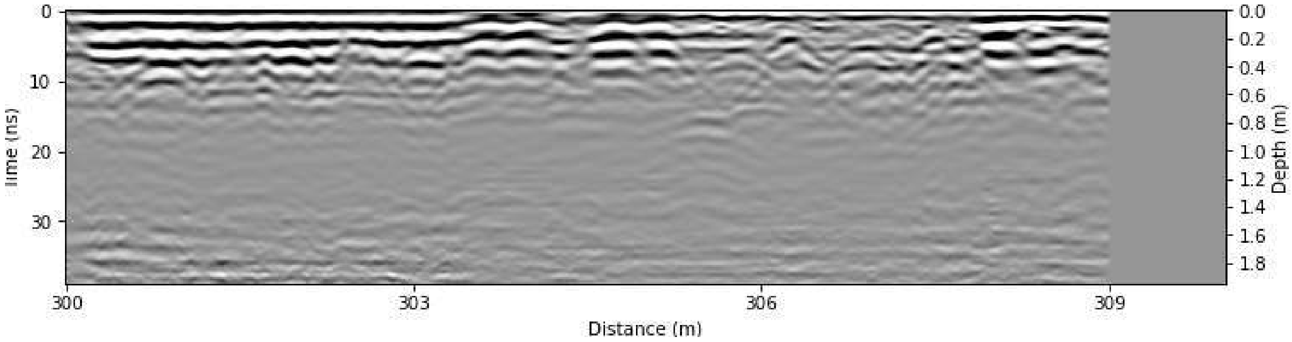


Figure B.524: Radargram at x = 51.0 m.

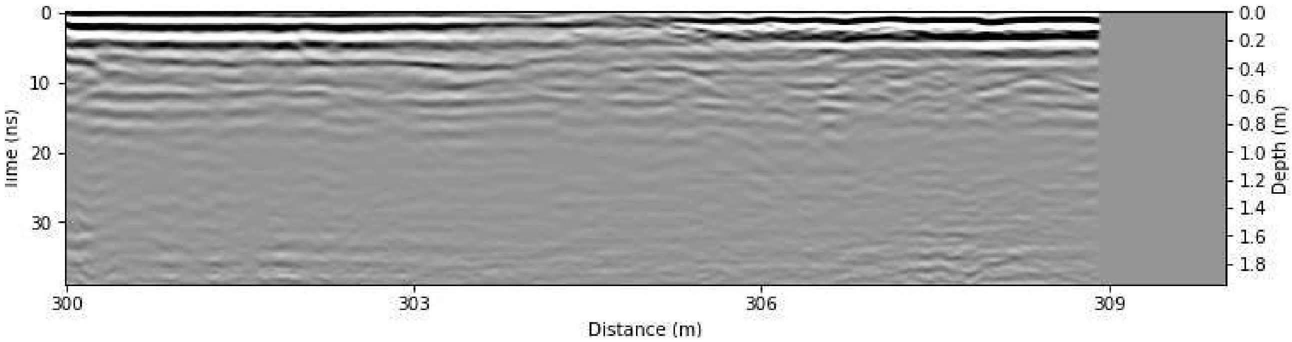


Figure B.525: Radargram at x = 51.25 m.

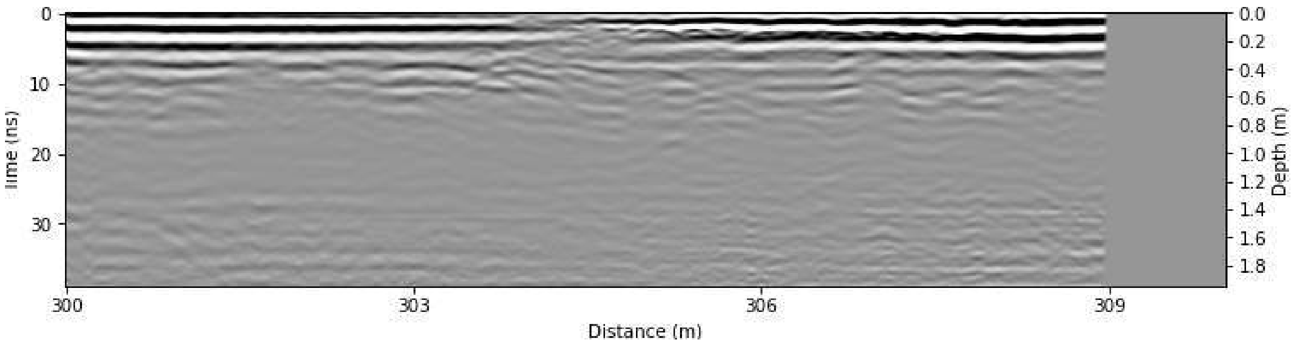


Figure B.526: Radargram at x = 51.5 m.

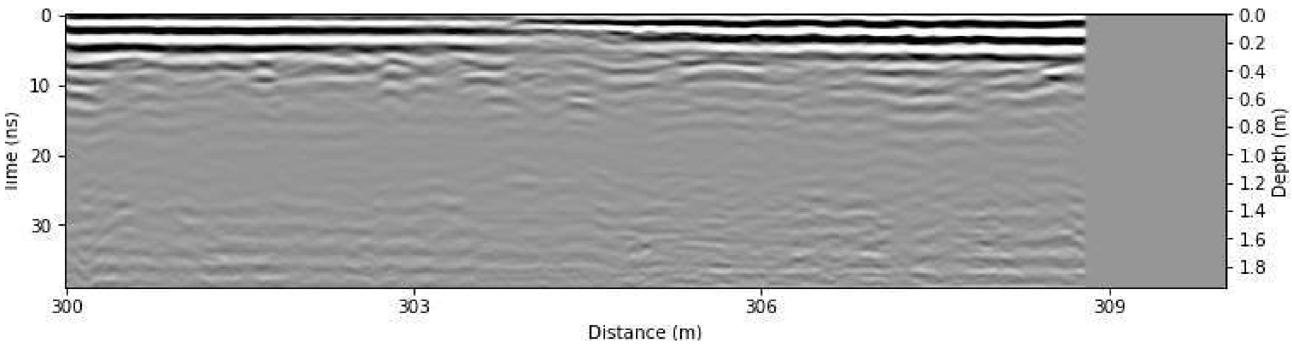


Figure B.527: Radargram at x = 51.75 m.

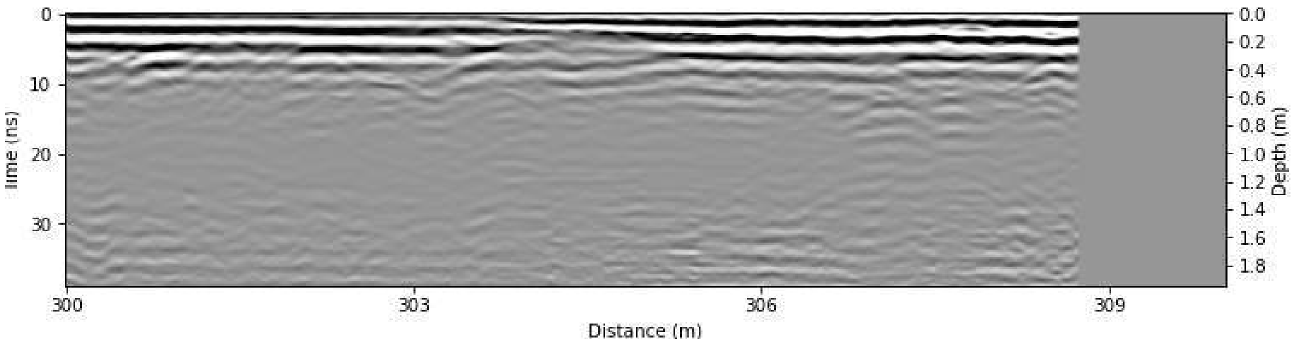


Figure B.528: Radargram at x = 52.0 m.

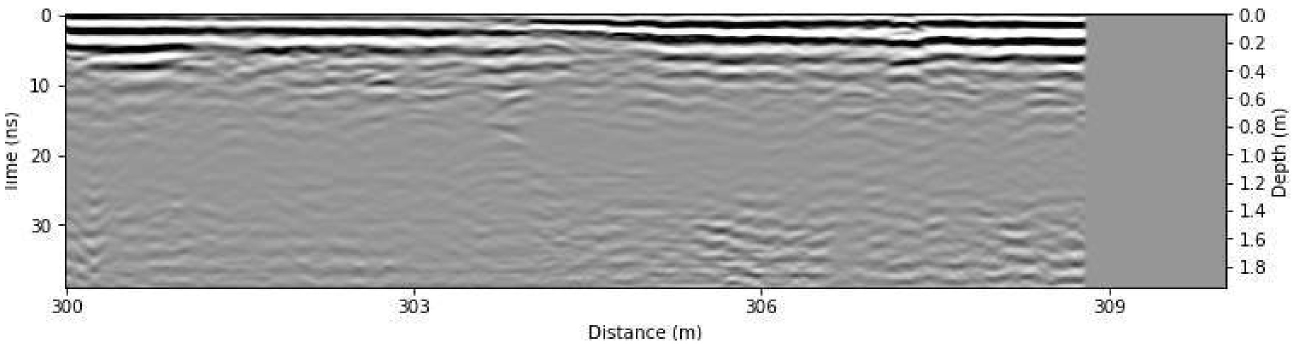


Figure B.529: Radargram at x = 52.25 m.

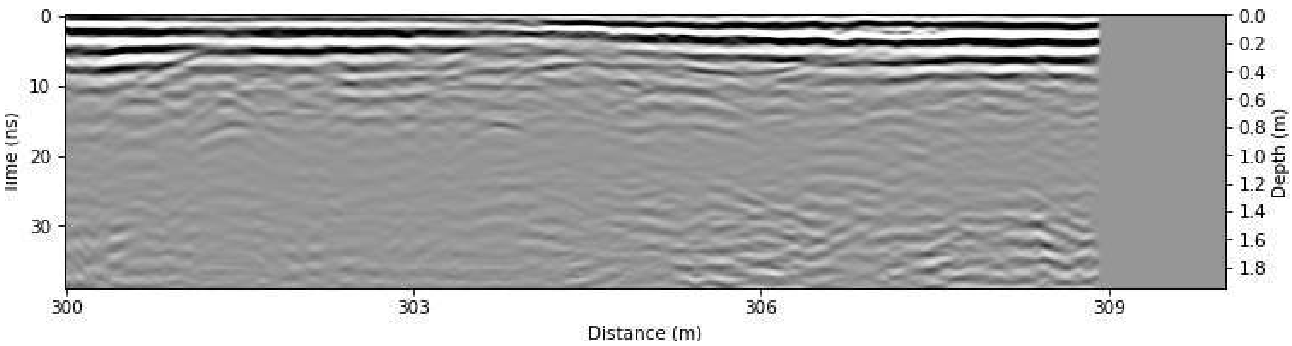


Figure B.530: Radargram at x = 52.5 m.

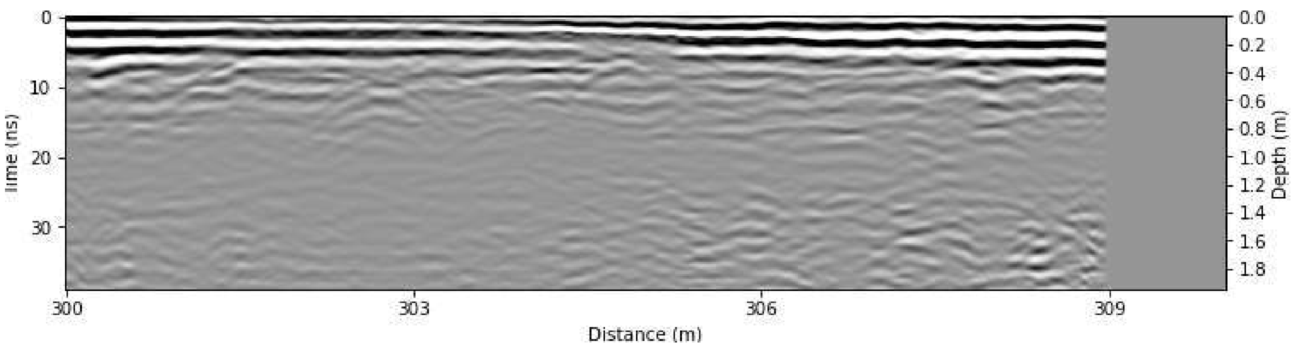


Figure B.531: Radargram at x = 52.75 m.

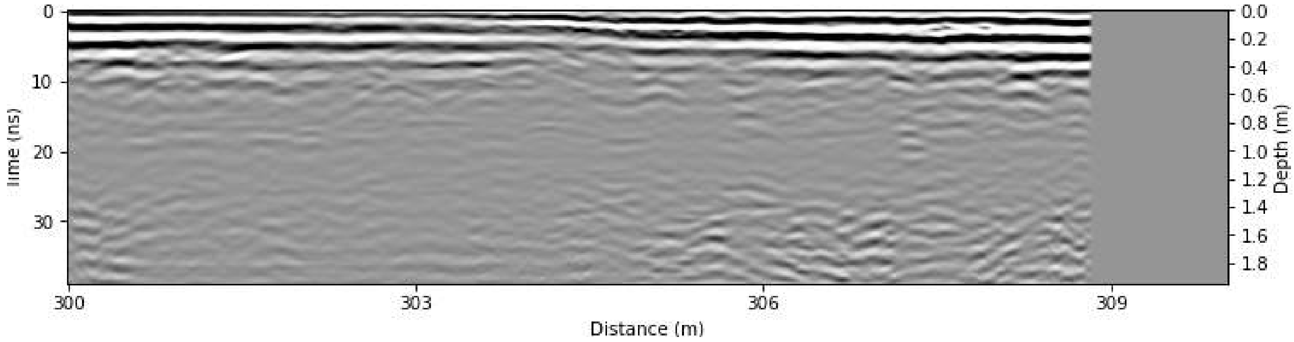


Figure B.532: Radargram at x = 53.0 m.

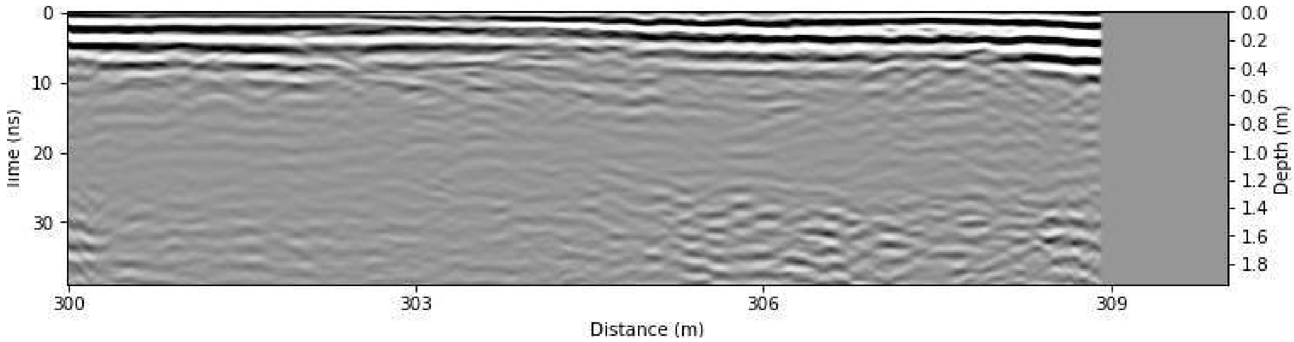


Figure B.533: Radargram at x = 53.25 m.

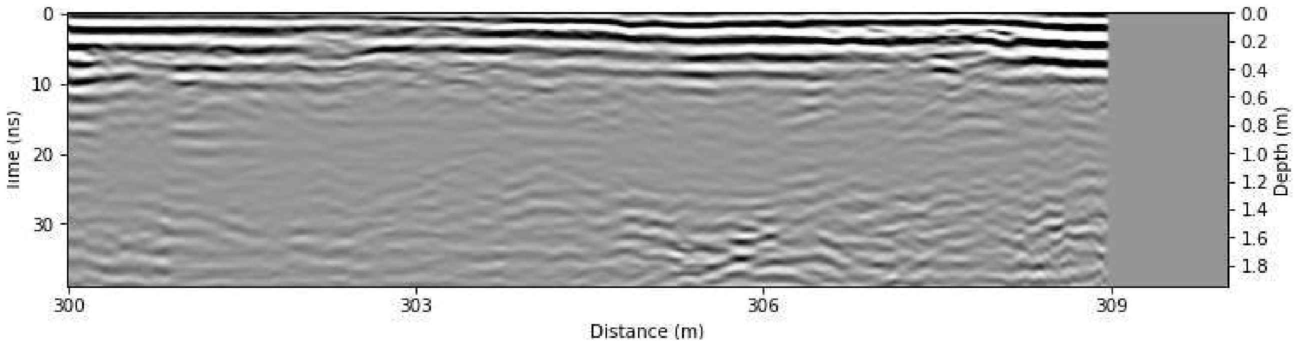


Figure B.534: Radargram at x = 53.5 m.

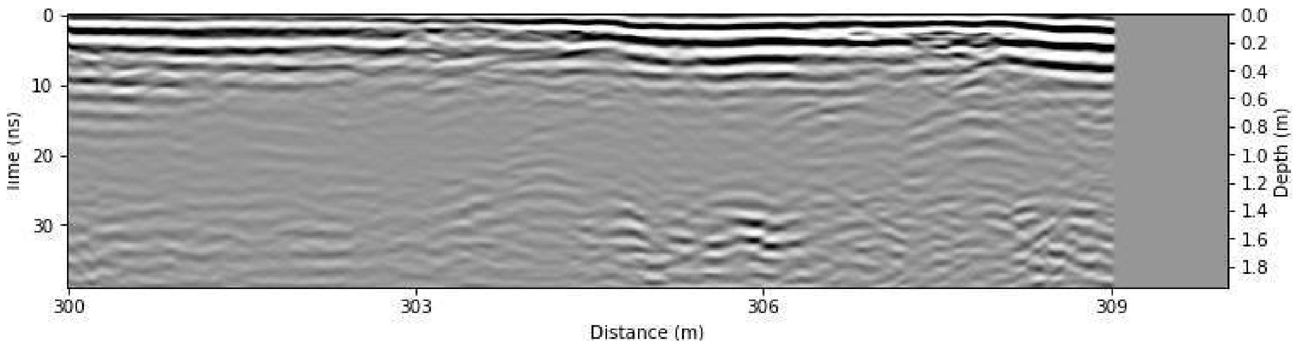


Figure B.535: Radargram at x = 53.75 m.

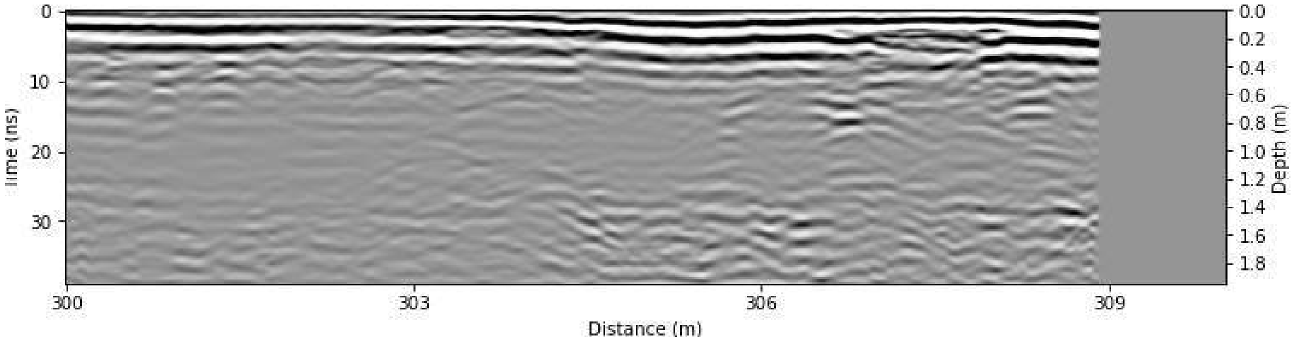


Figure B.536: Radargram at x = 54.0 m.

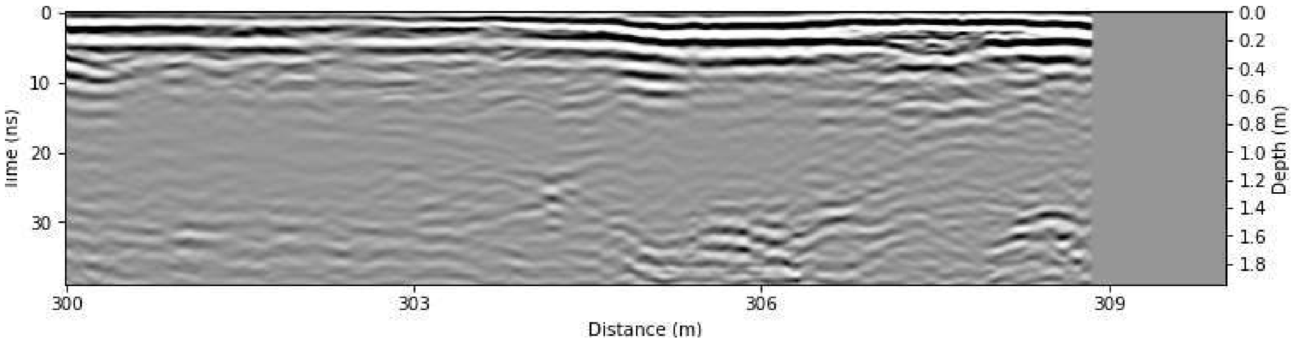


Figure B.537: Radargram at x = 54.25 m.

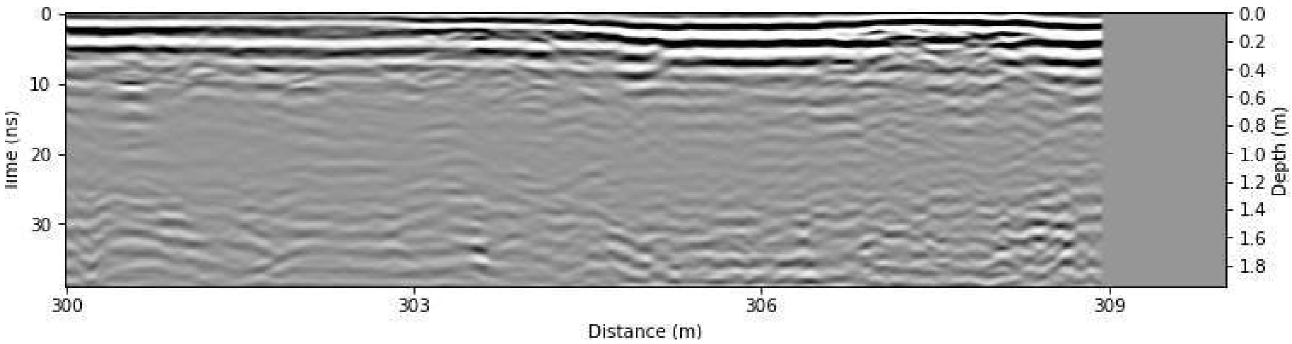


Figure B.538: Radargram at x = 54.5 m.

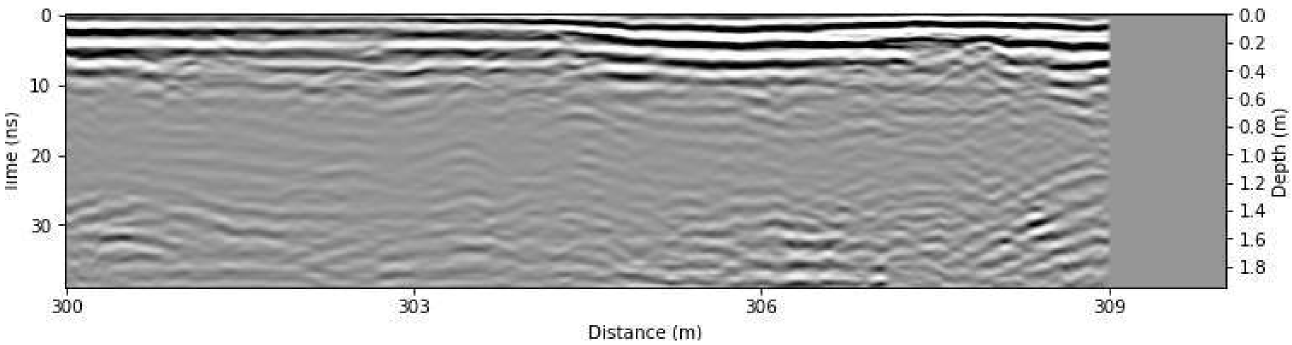


Figure B.539: Radargram at x = 54.75 m.

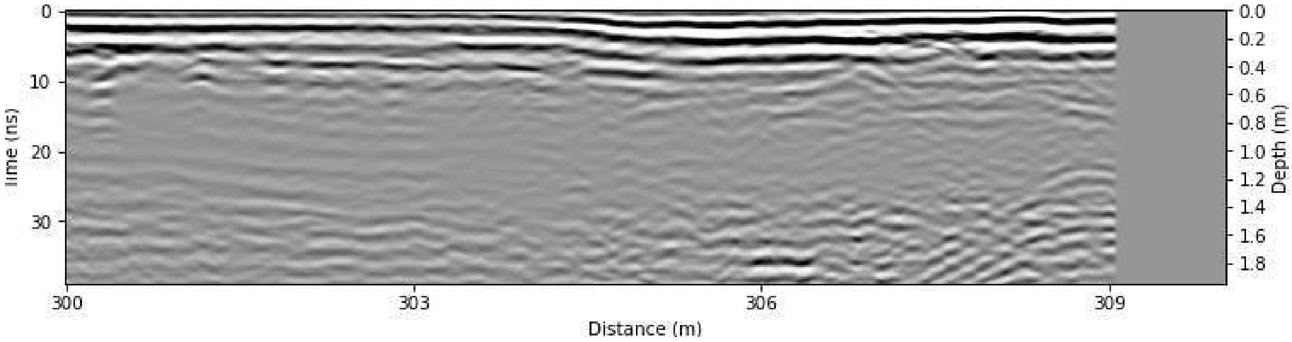


Figure B.540: Radargram at x = 55.0 m.

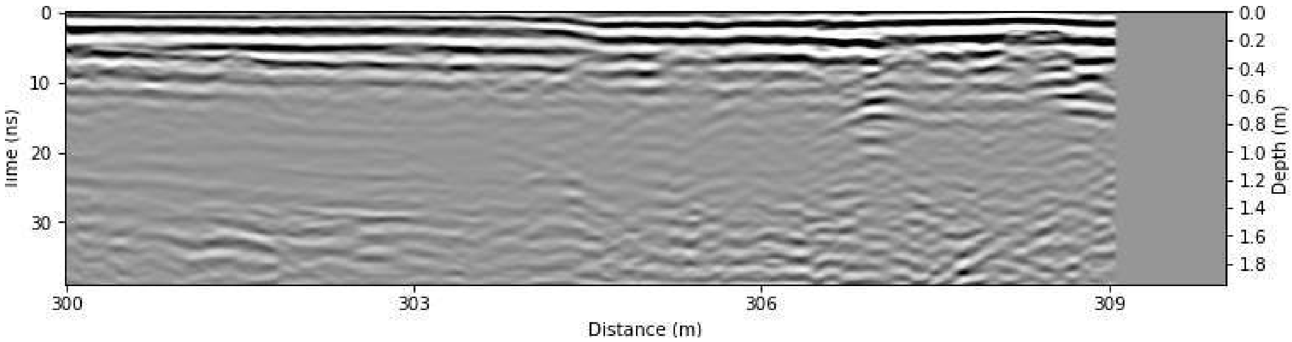


Figure B.541: Radargram at x = 55.25 m.

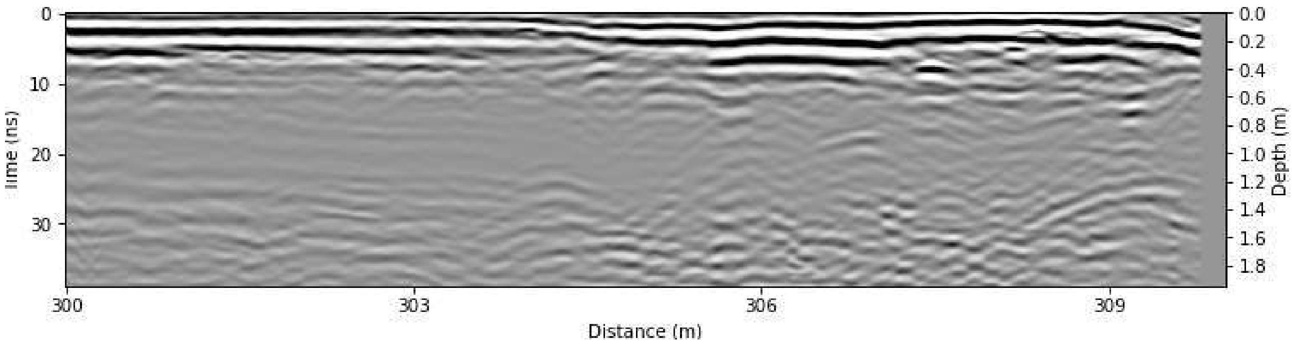


Figure B.542: Radargram at x = 55.5 m.

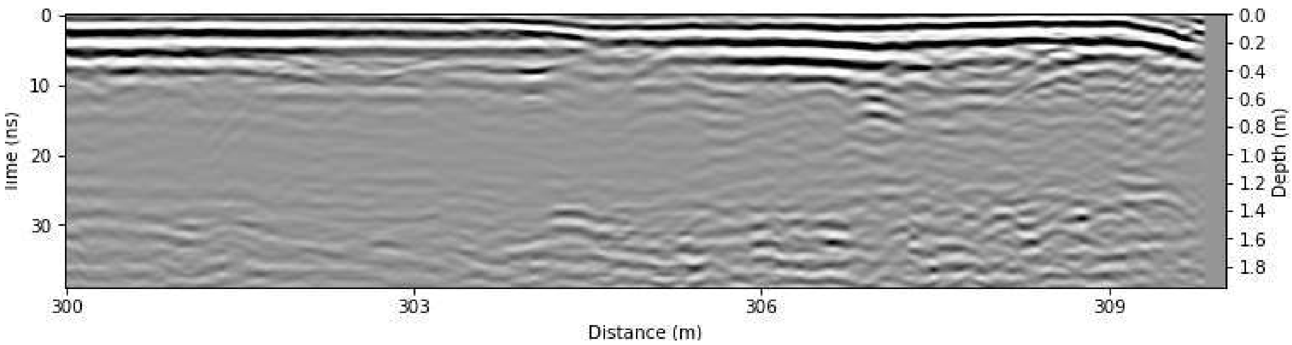


Figure B.543: Radargram at x = 55.75 m.

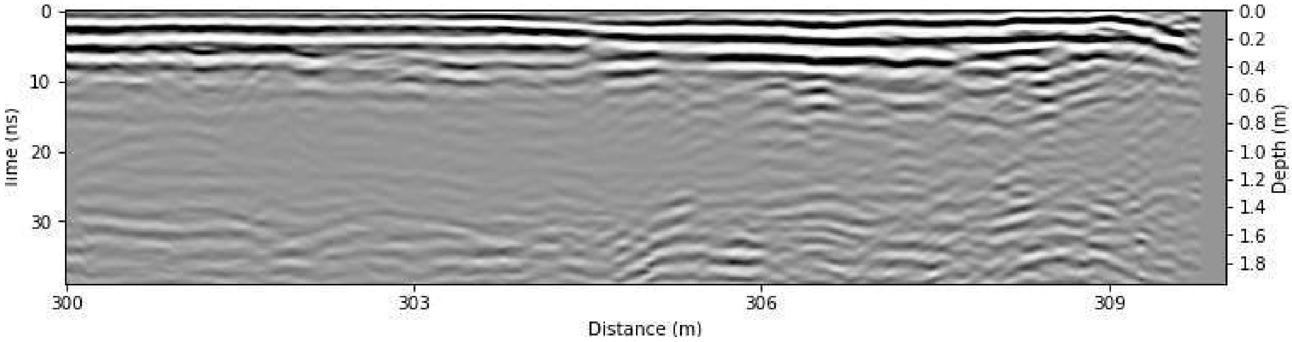


Figure B.544: Radargram at x = 56.0 m.

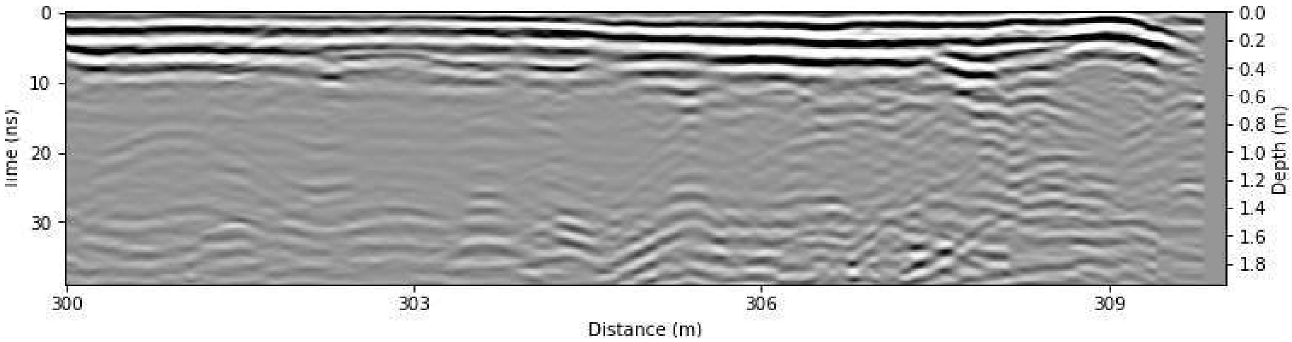


Figure B.545: Radargram at x = 56.25 m.

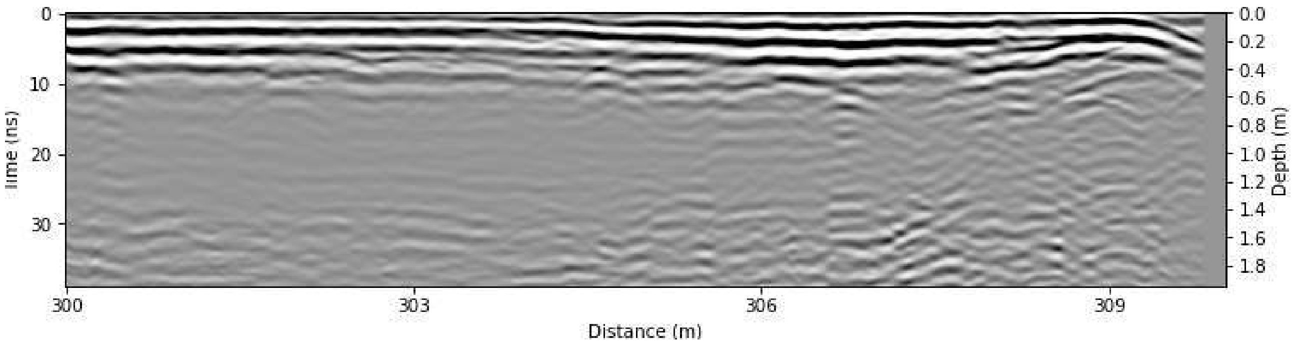


Figure B.546: Radargram at x = 56.5 m.

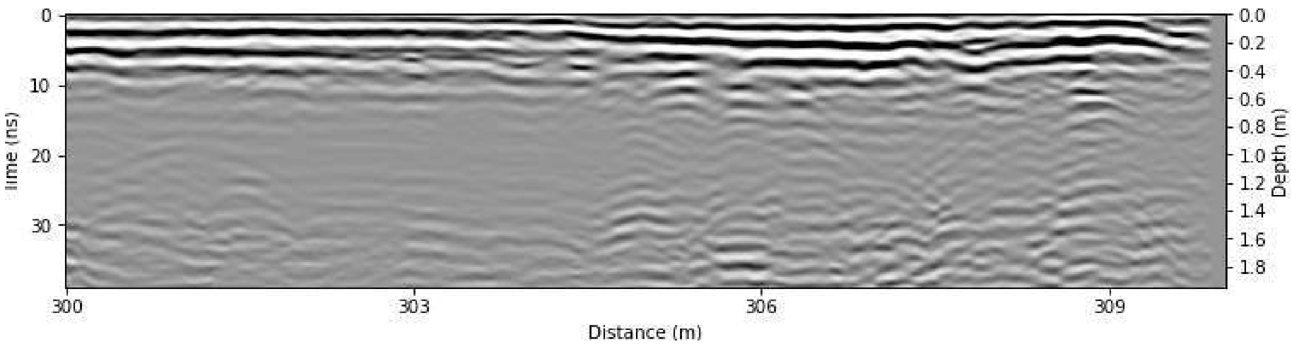


Figure B.547: Radargram at x = 56.75 m.

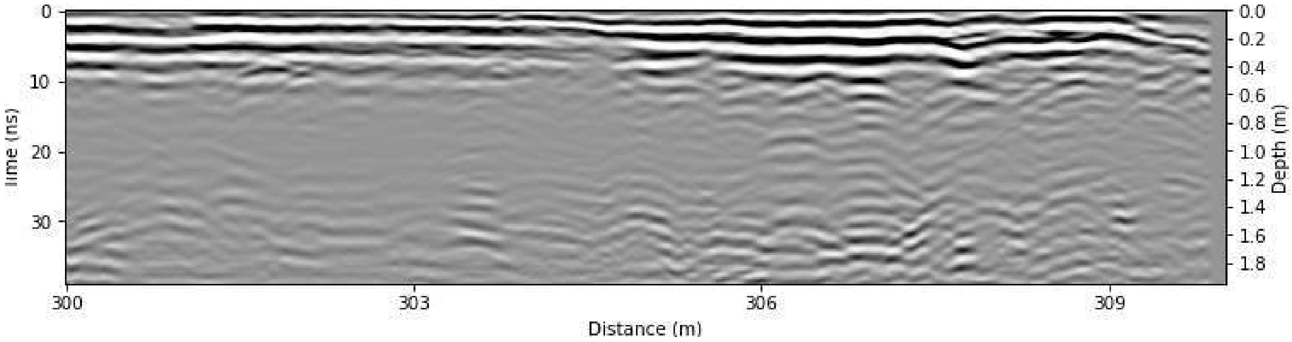


Figure B.548: Radargram at x = 57.0 m.

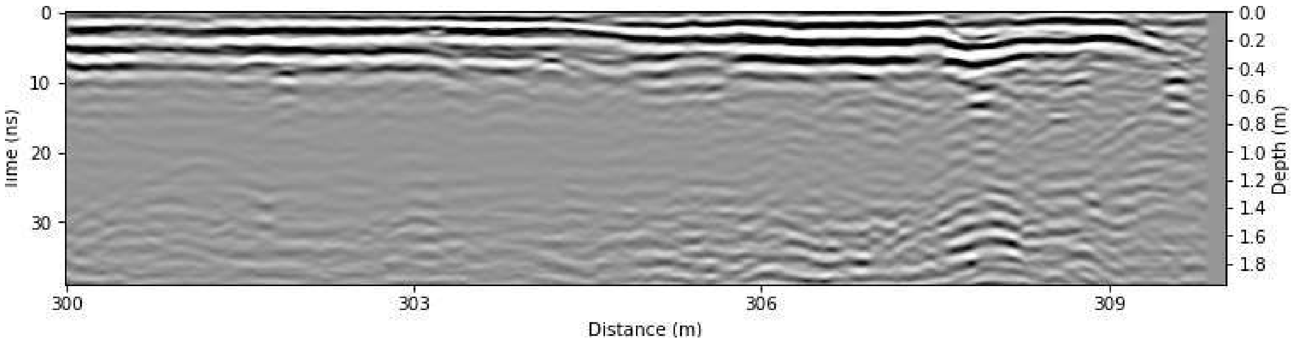


Figure B.549: Radargram at x = 57.25 m.

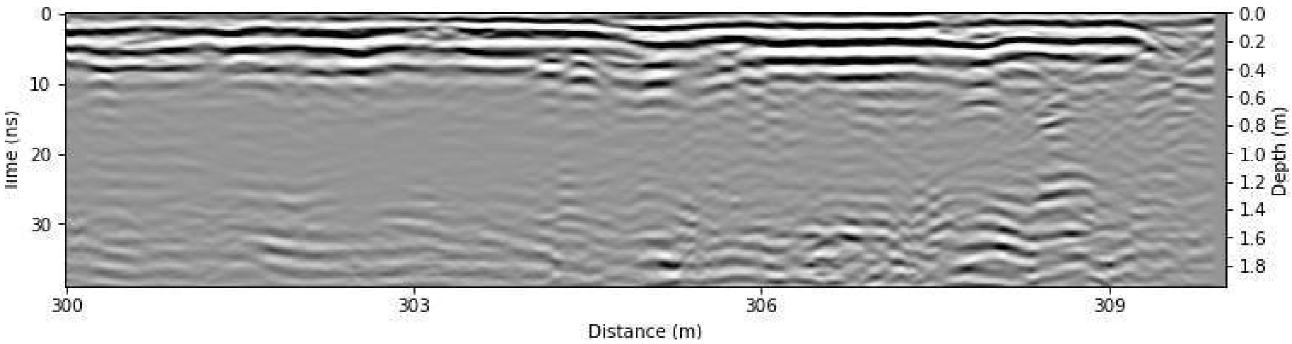


Figure B.550: Radargram at x = 57.5 m.

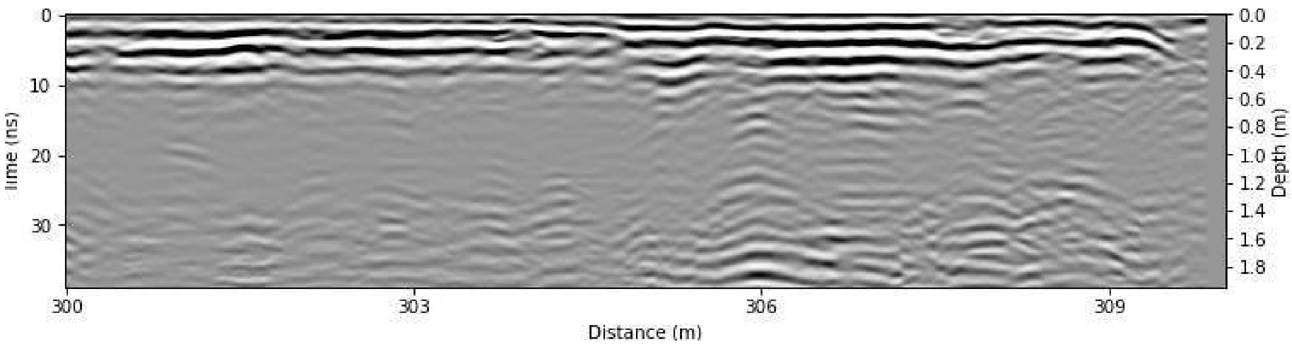


Figure B.551: Radargram at x = 57.75 m.

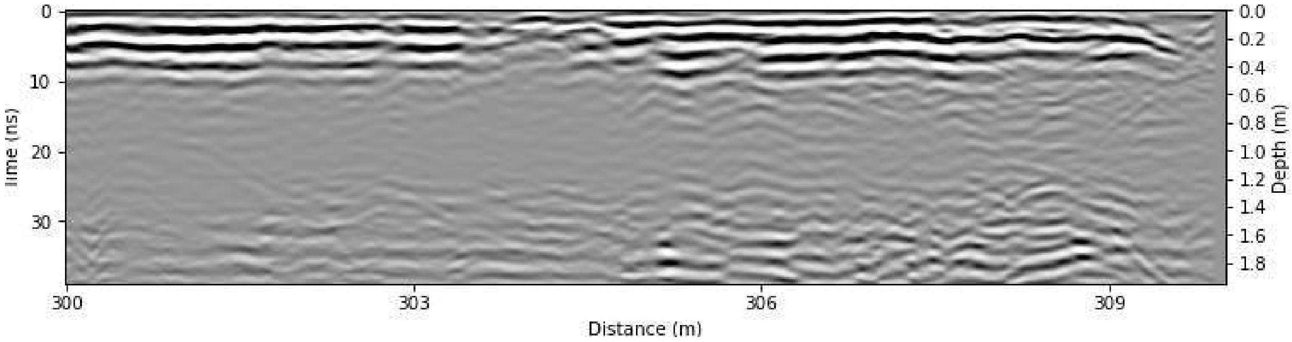


Figure B.552: Radargram at x = 58.0 m.

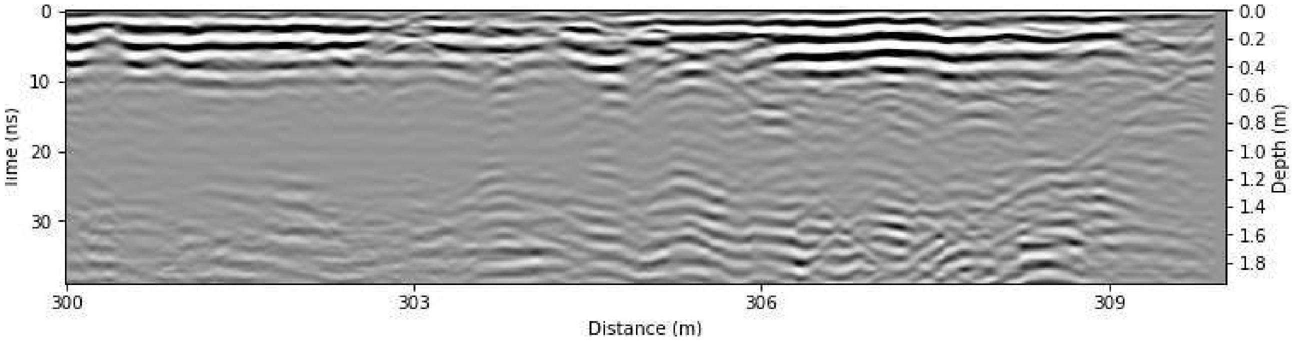


Figure B.553: Radargram at x = 58.25 m.

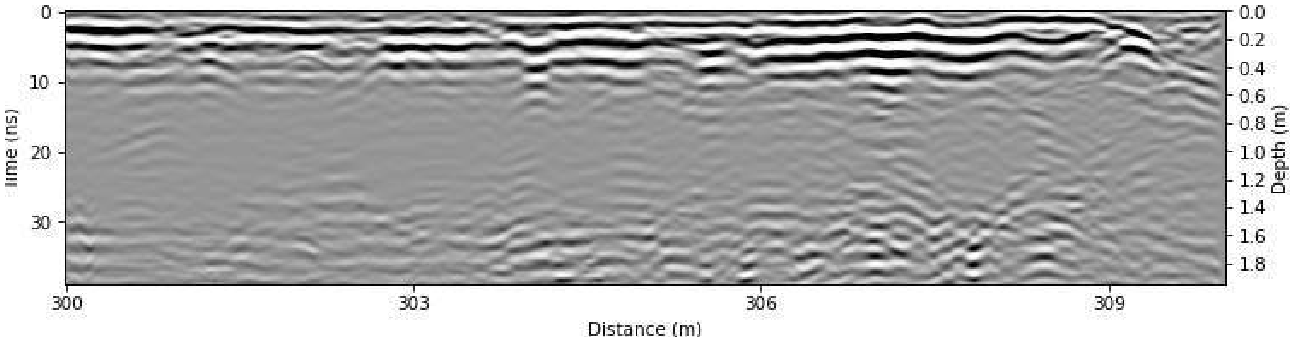


Figure B.554: Radargram at x = 58.5 m.

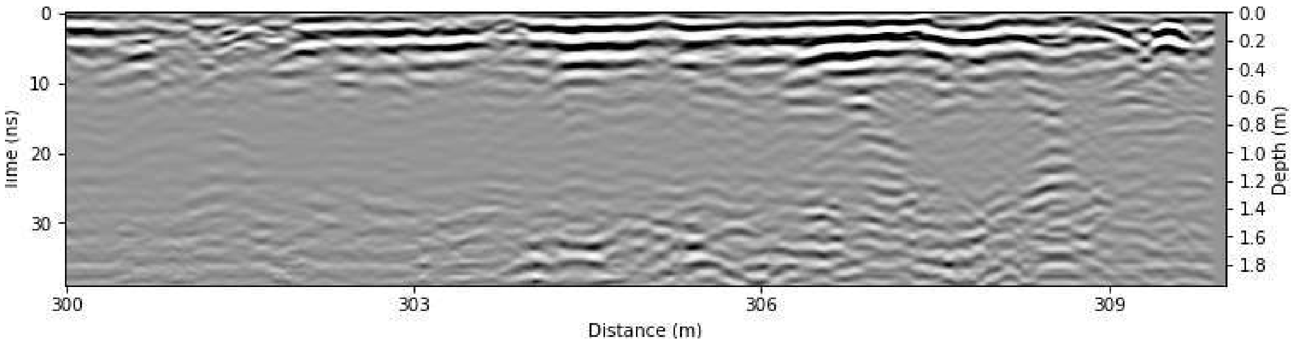


Figure B.555: Radargram at x = 58.75 m.

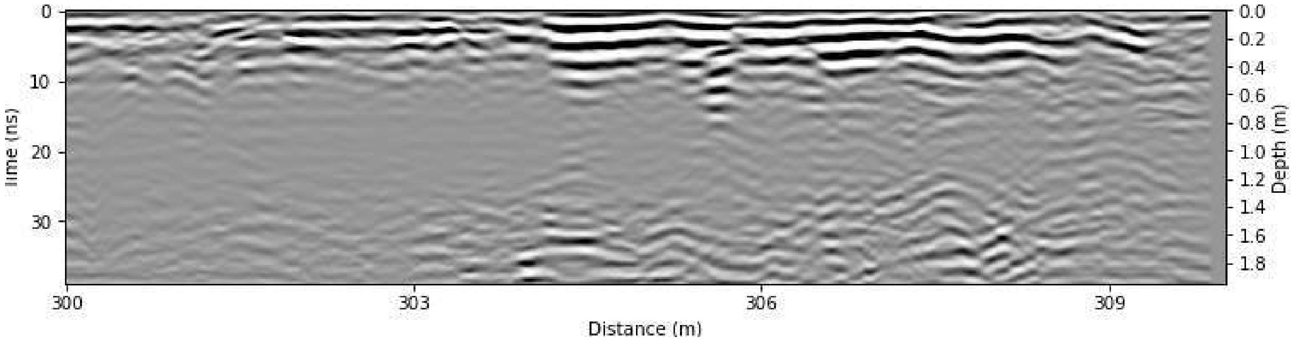


Figure B.556: Radargram at x = 59.0 m.

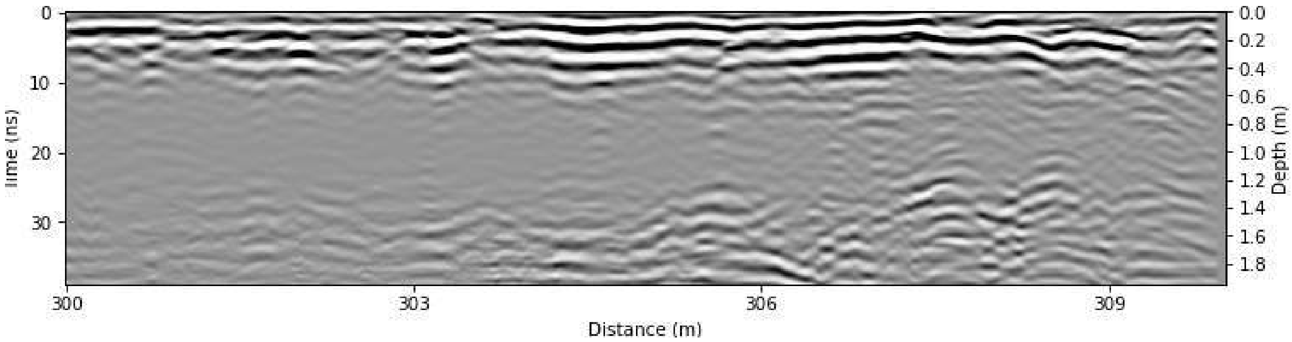


Figure B.557: Radargram at x = 59.25 m.

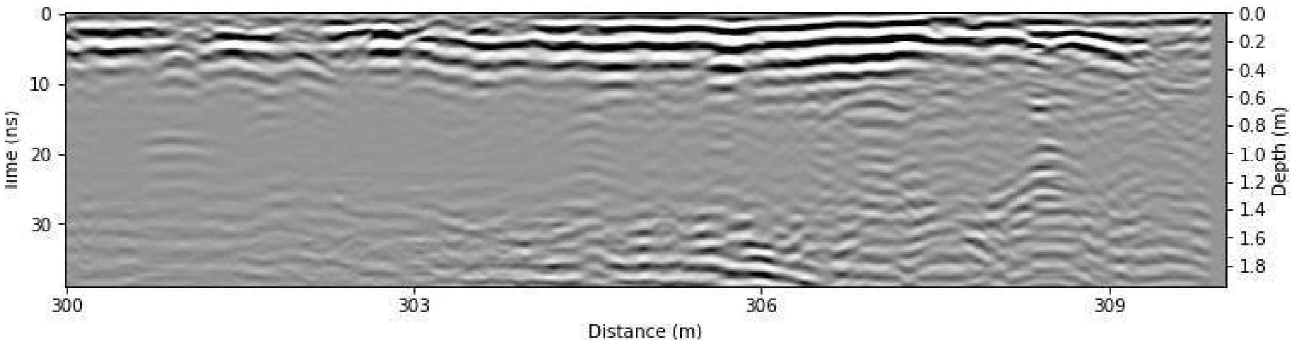


Figure B.558: Radargram at x = 59.5 m.

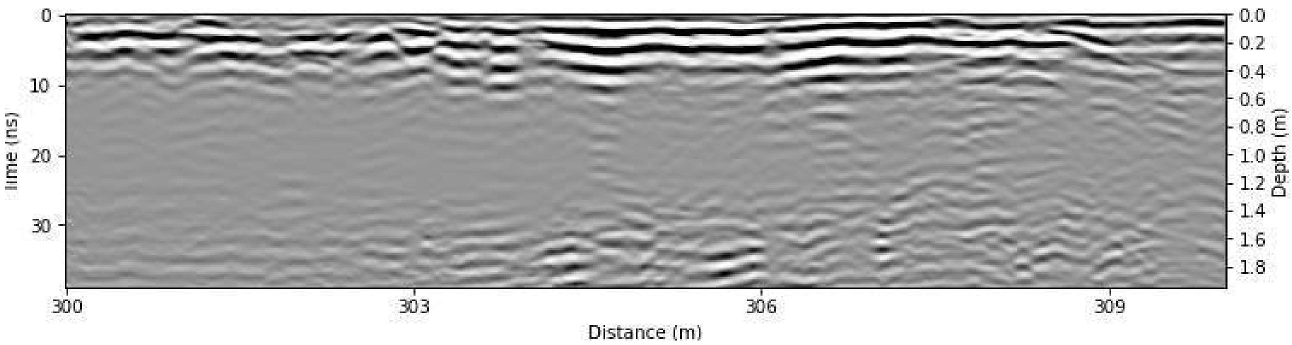


Figure B.559: Radargram at x = 59.75 m.

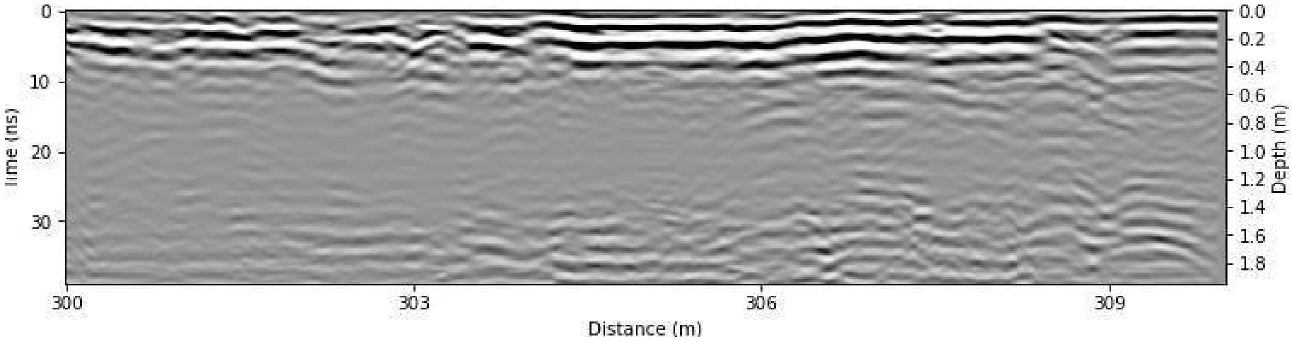


Figure B.560: Radargram at x = 60.0 m.

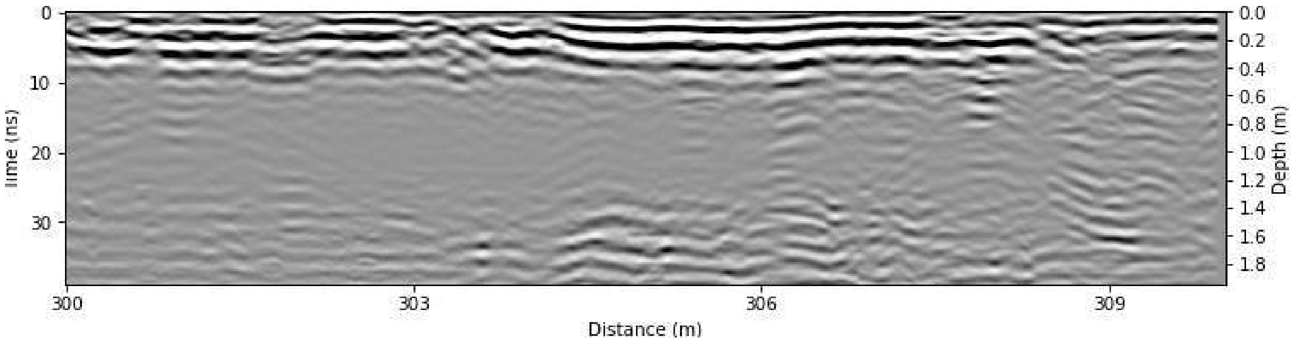


Figure B.561: Radargram at x = 60.25 m.

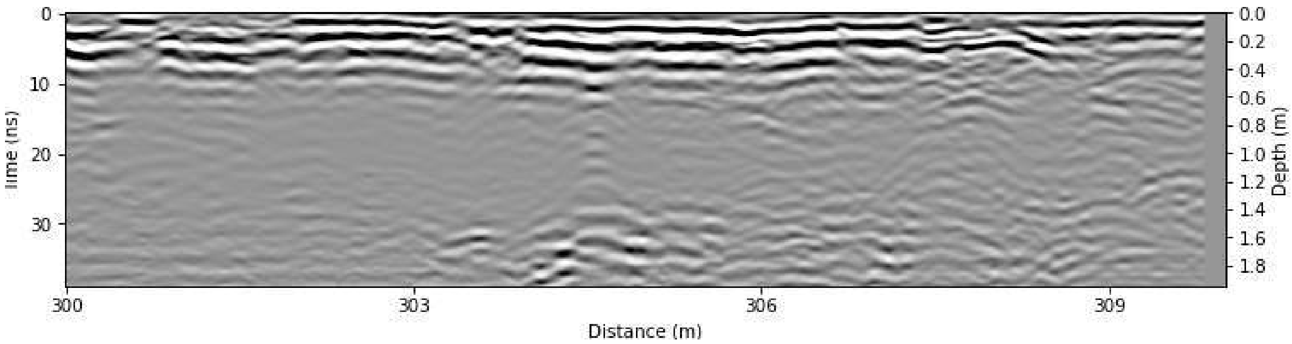
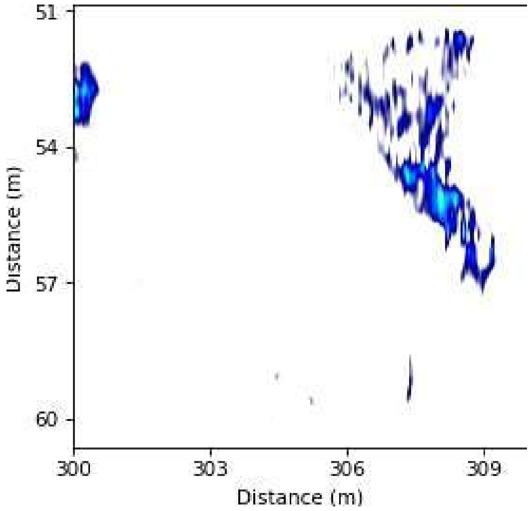
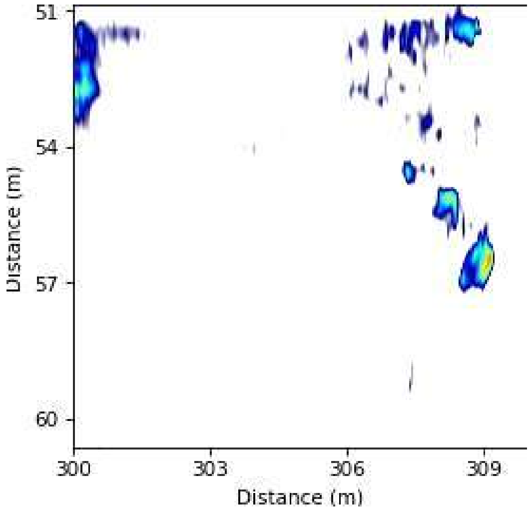


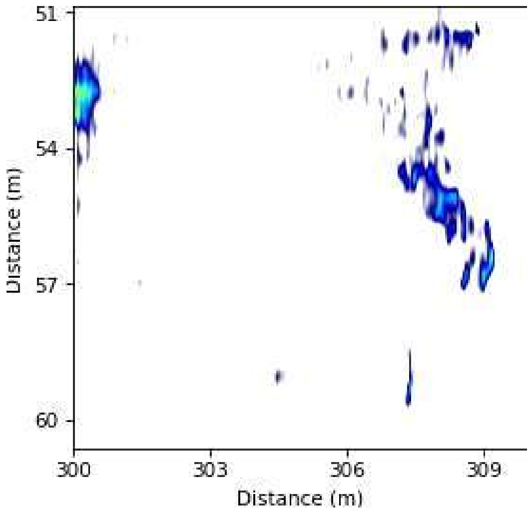
Figure B.562: Radargram at x = 60.5 m.



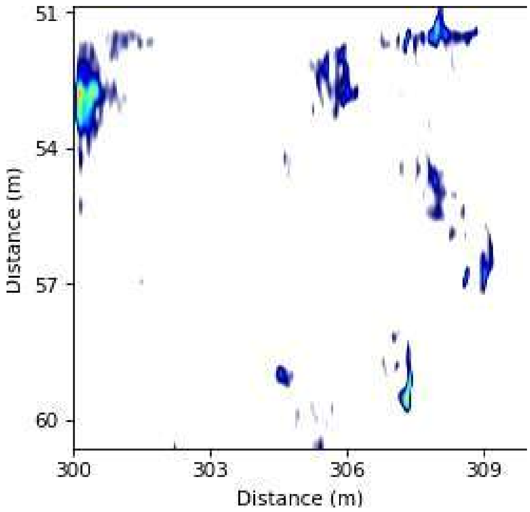
(a) Timeslice at z = 0.0 m.



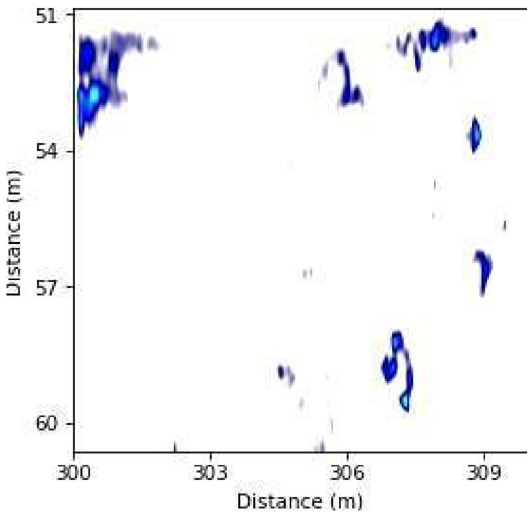
(b) Timeslice at z = 0.05 m.



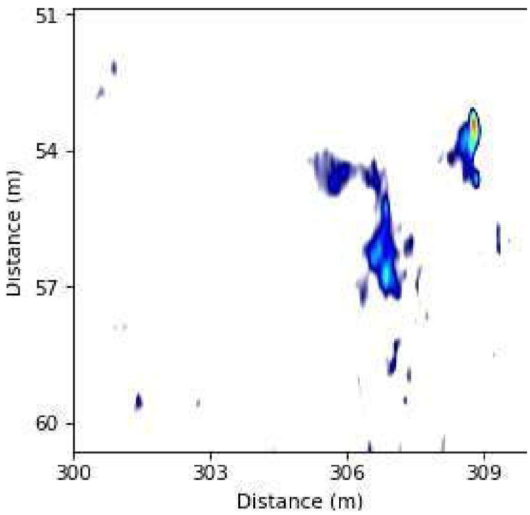
(c) Timeslice at z = 0.1 m.



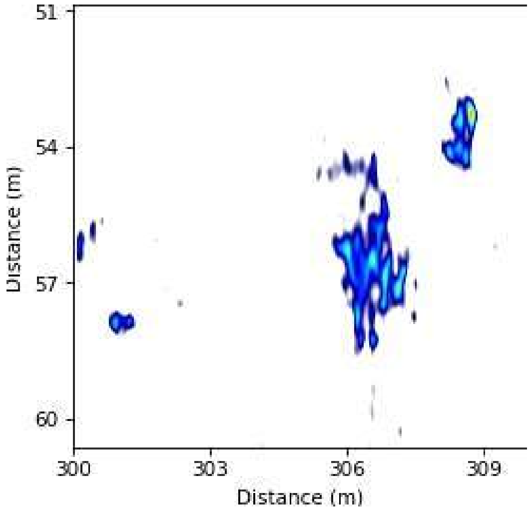
(d) Timeslice at z = 0.15 m.



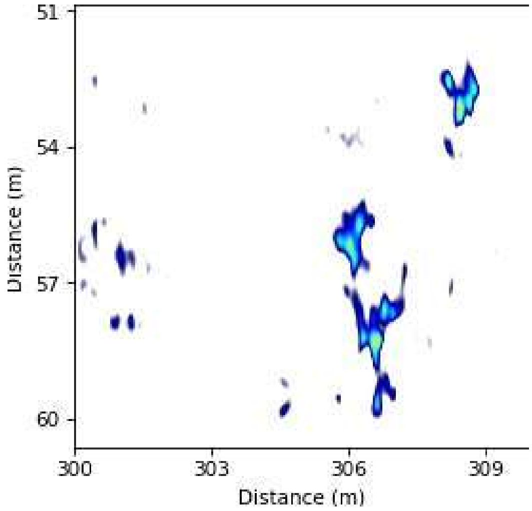
(e) Timeslice at z = 0.2 m.



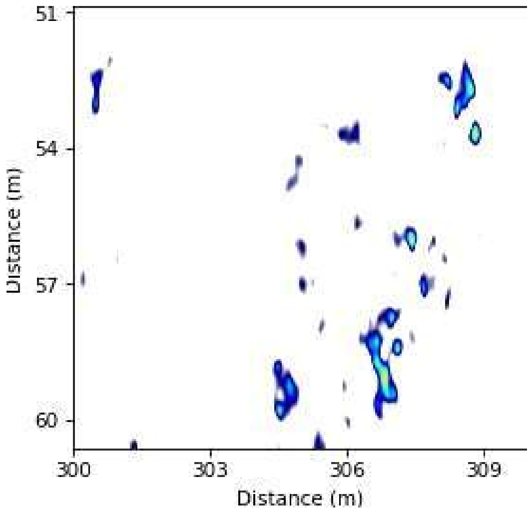
(f) Timeslice at z = 0.25 m.



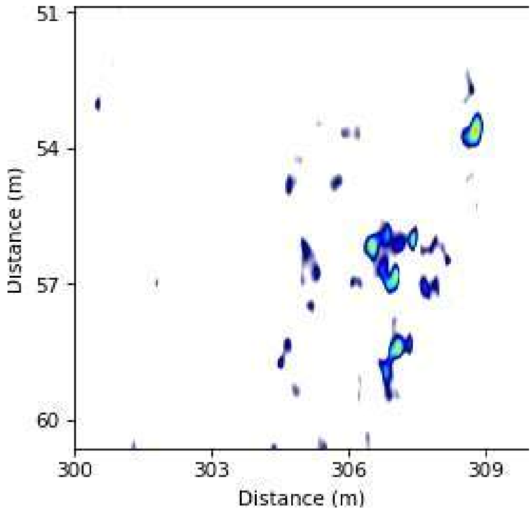
(a) Timeslice at z = 0.3 m.



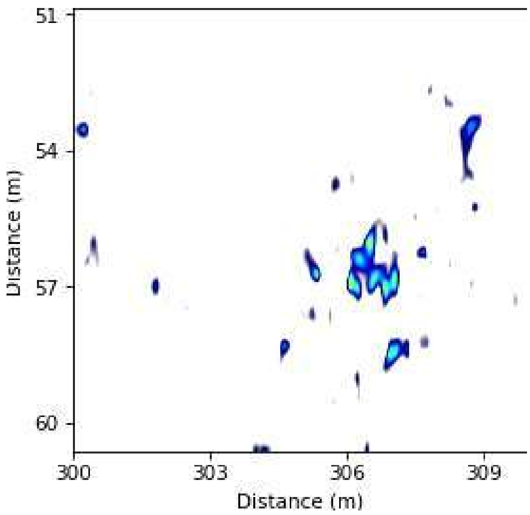
(b) Timeslice at z = 0.35 m.



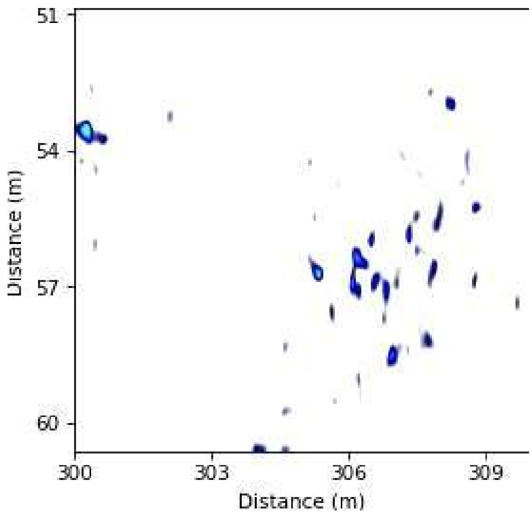
(c) Timeslice at z = 0.4 m.



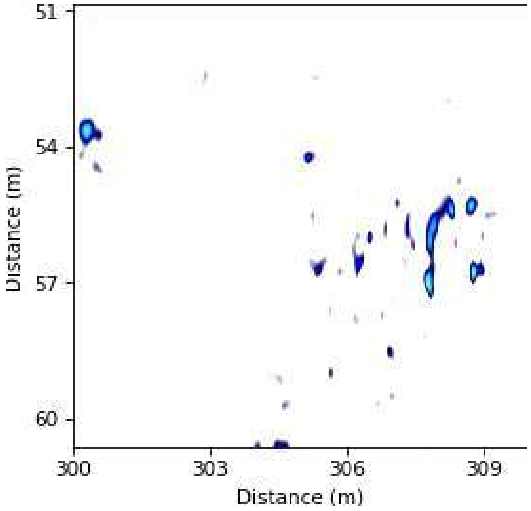
(d) Timeslice at z = 0.45 m.



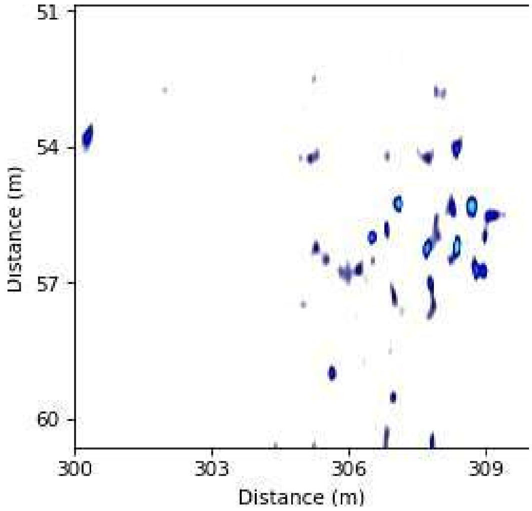
(e) Timeslice at z = 0.5 m.



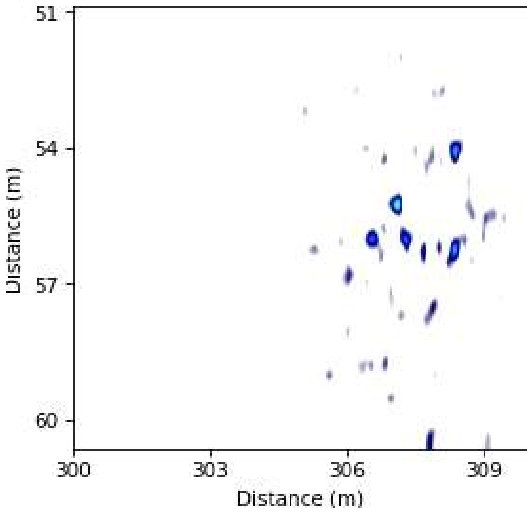
(f) Timeslice at z = 0.55 m.



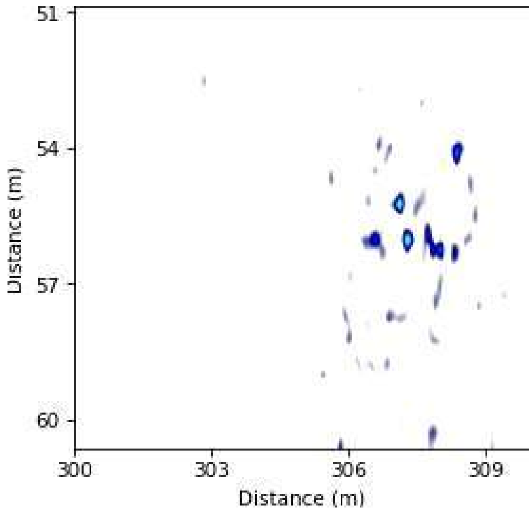
(a) Timeslice at z = 0.6 m.



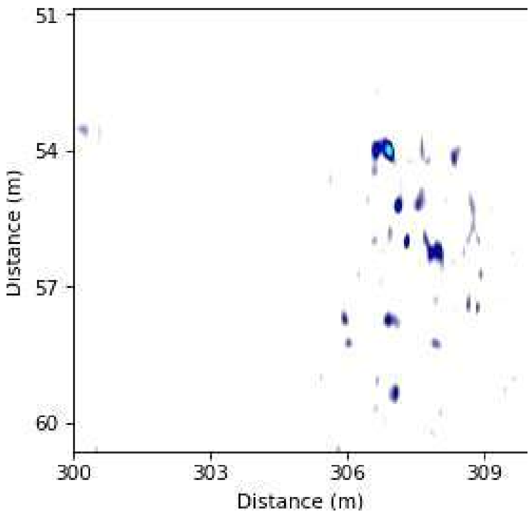
(b) Timeslice at z = 0.65 m.



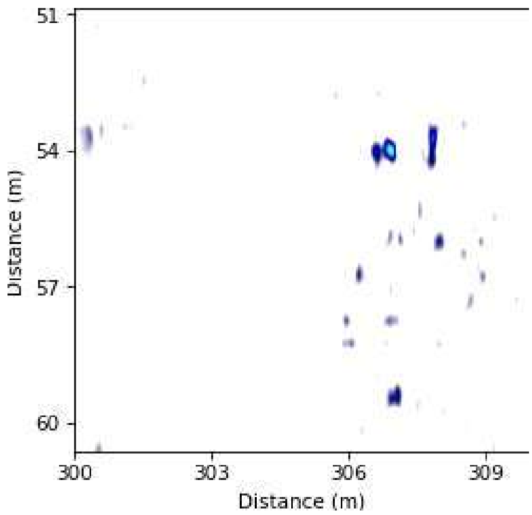
(c) Timeslice at z = 0.7 m.



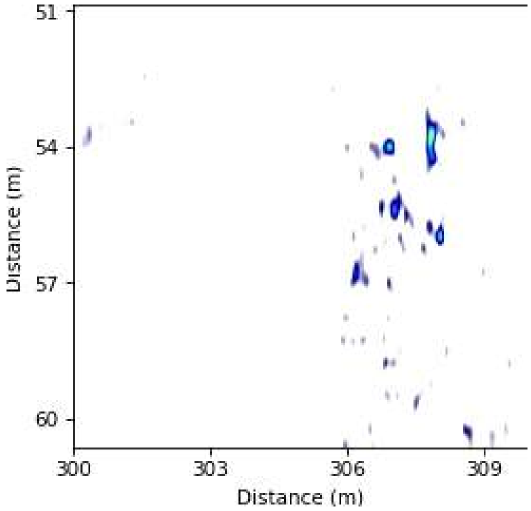
(d) Timeslice at z = 0.75 m.



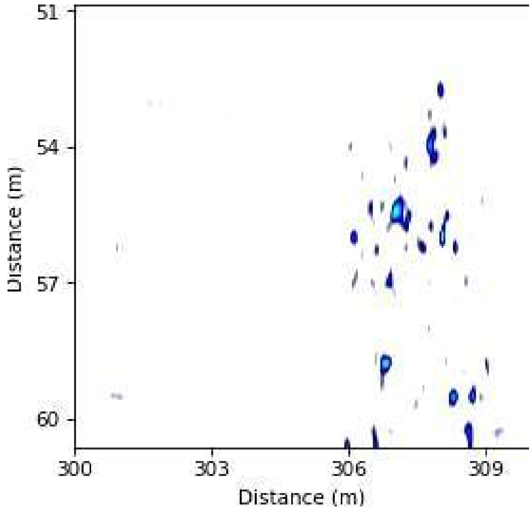
(e) Timeslice at z = 0.8 m.



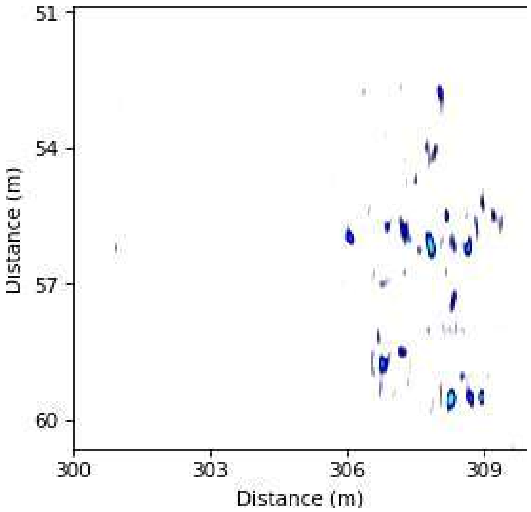
(f) Timeslice at z = 0.85 m.



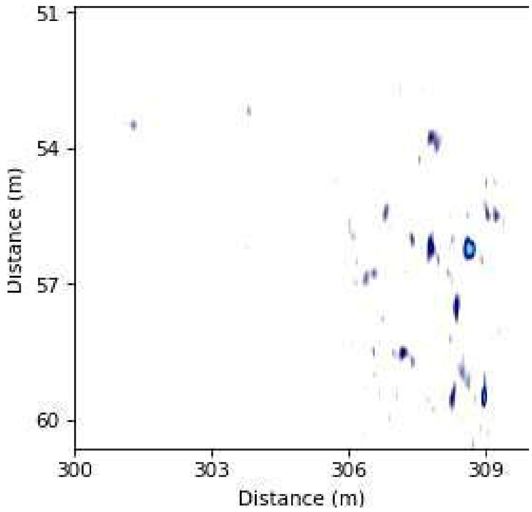
(a) Timeslice at z = 0.9 m.



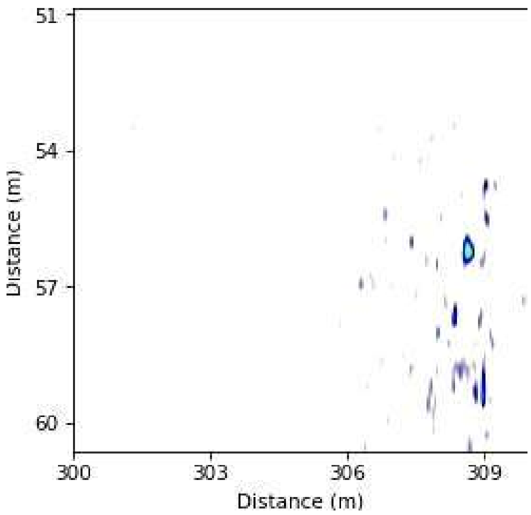
(b) Timeslice at z = 0.95 m.



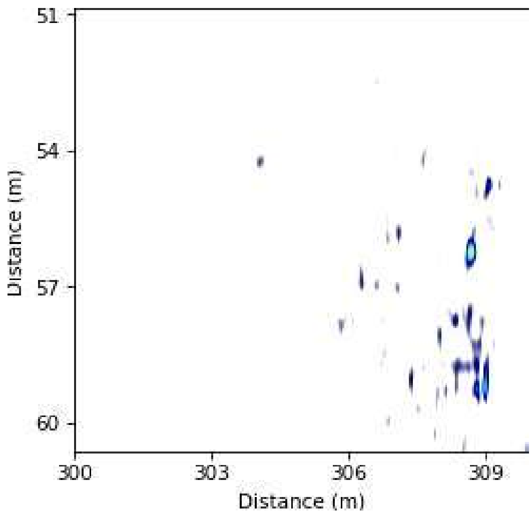
(c) Timeslice at z = 1.0 m.



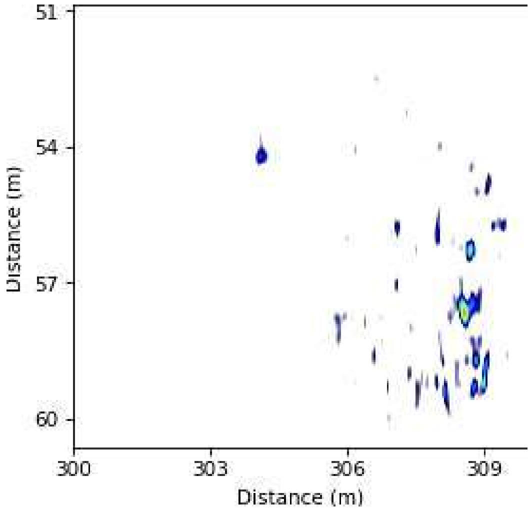
(d) Timeslice at z = 1.05 m.



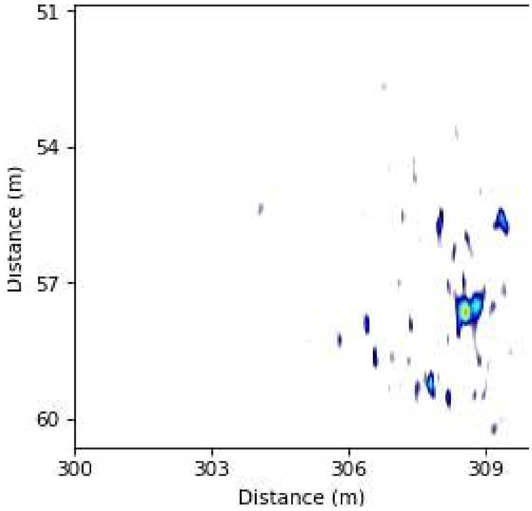
(e) Timeslice at z = 1.1 m.



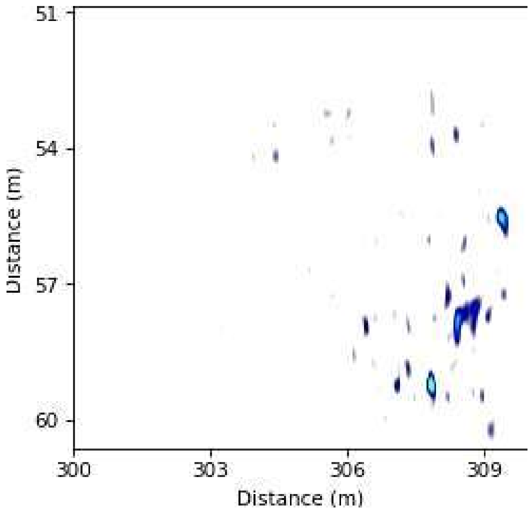
(f) Timeslice at z = 1.15 m.



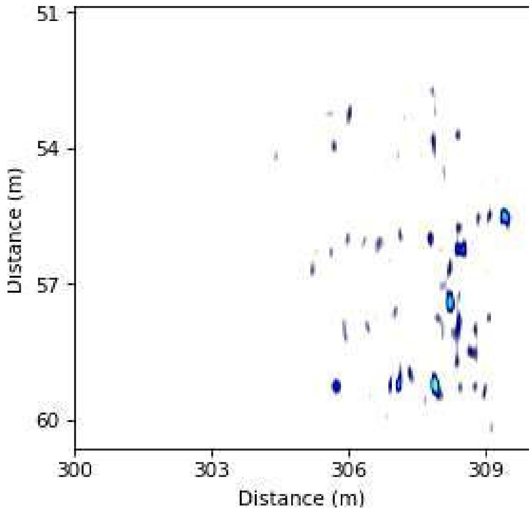
(a) Timeslice at z = 1.2 m.



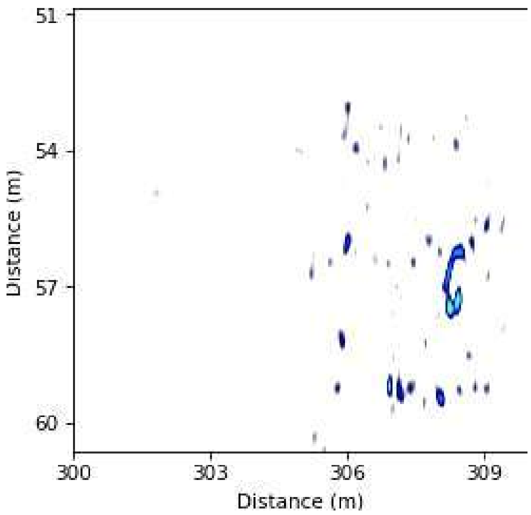
(b) Timeslice at z = 1.25 m.



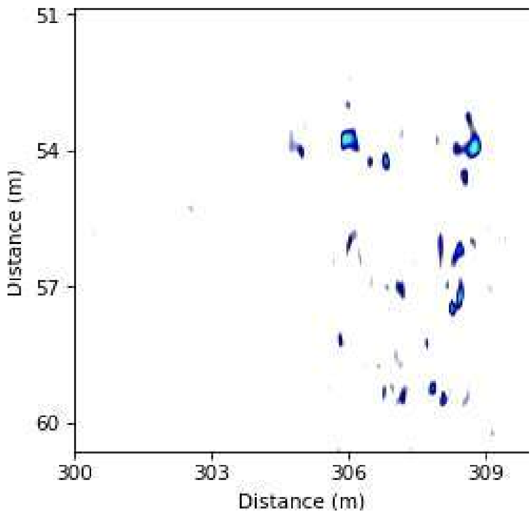
(c) Timeslice at z = 1.3 m.



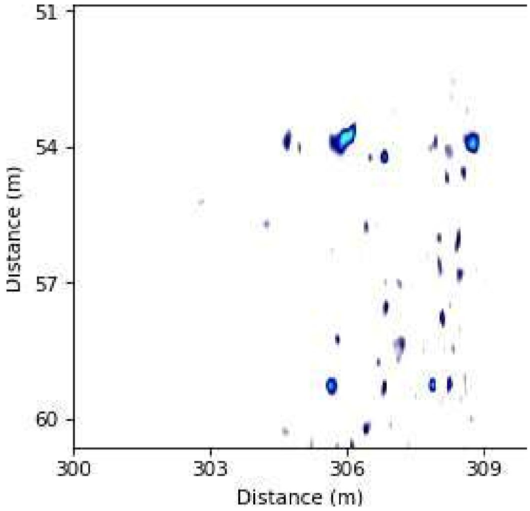
(d) Timeslice at z = 1.35 m.



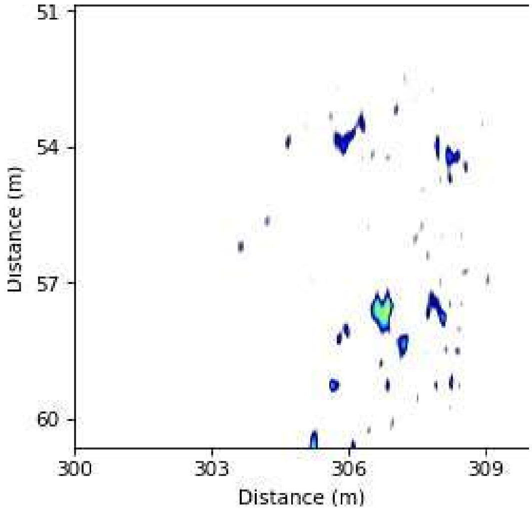
(e) Timeslice at z = 1.4 m.



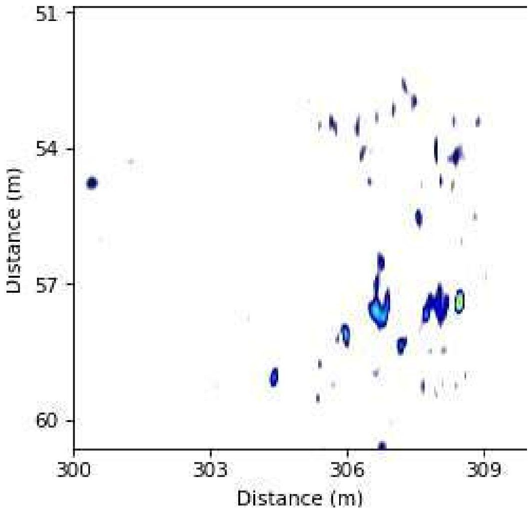
(f) Timeslice at z = 1.45 m.



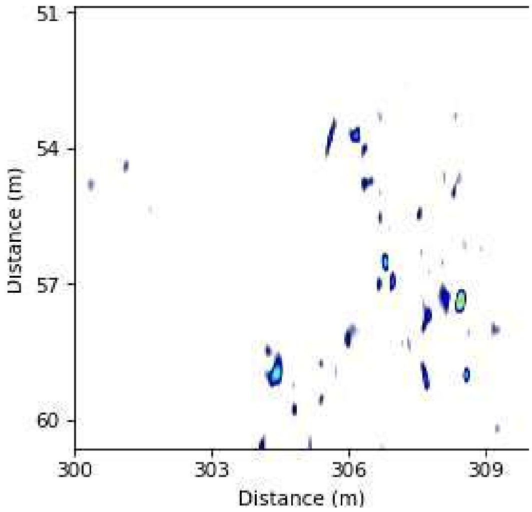
(a) Timeslice at z = 1.5 m.



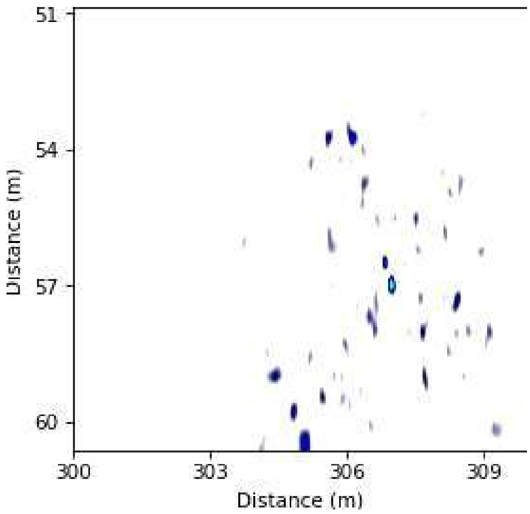
(b) Timeslice at z = 1.55 m.



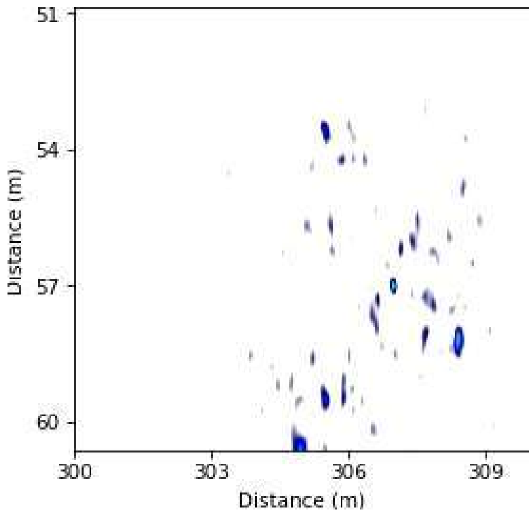
(c) Timeslice at z = 1.6 m.



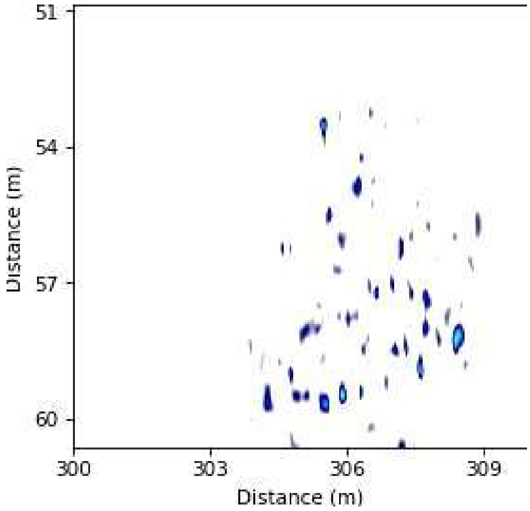
(d) Timeslice at z = 1.65 m.



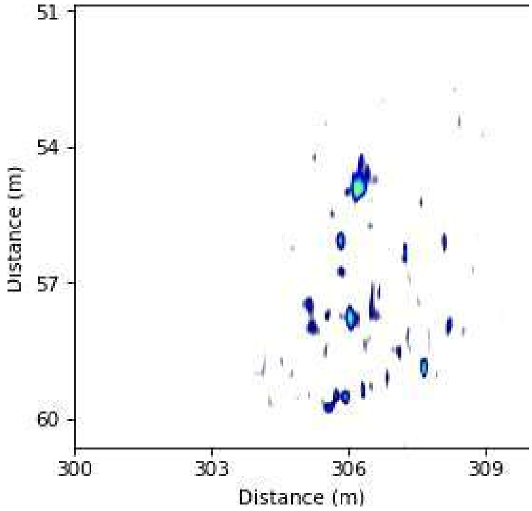
(e) Timeslice at z = 1.7 m.



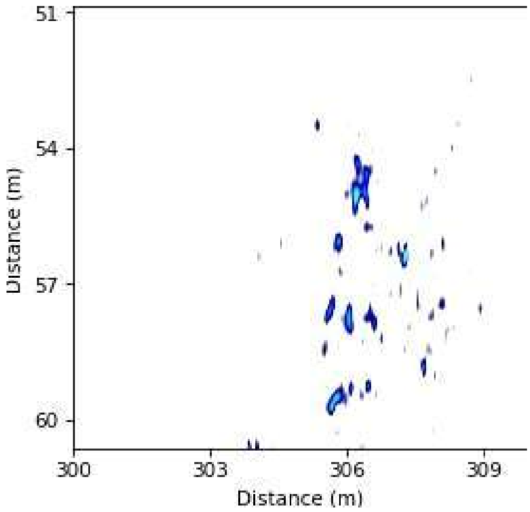
(f) Timeslice at z = 1.75 m.



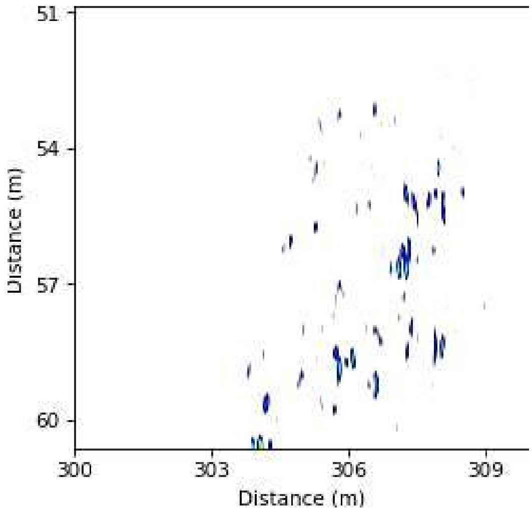
(a) Timeslice at z = 1.8 m.



(b) Timeslice at z = 1.85 m.



(c) Timeslice at z = 1.9 m.



(d) Timeslice at z = 1.95 m.

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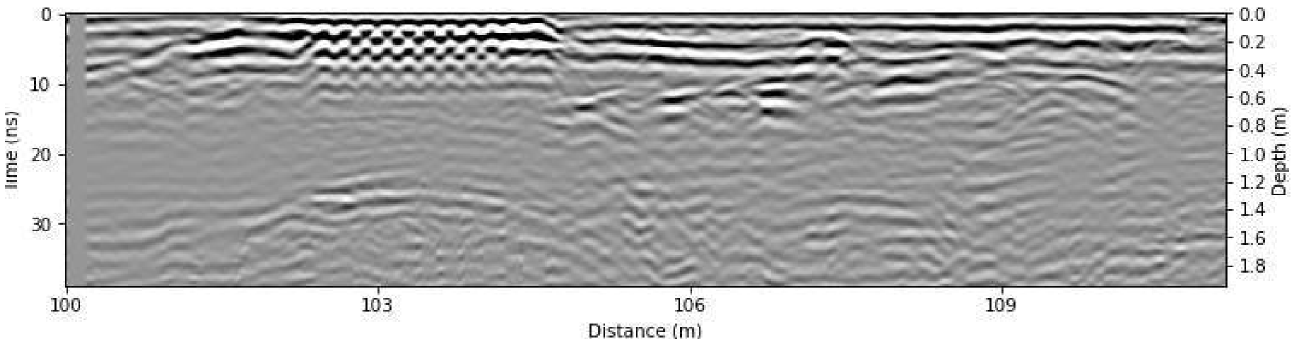


Figure B.570: Radargram at x = 71.0 m.

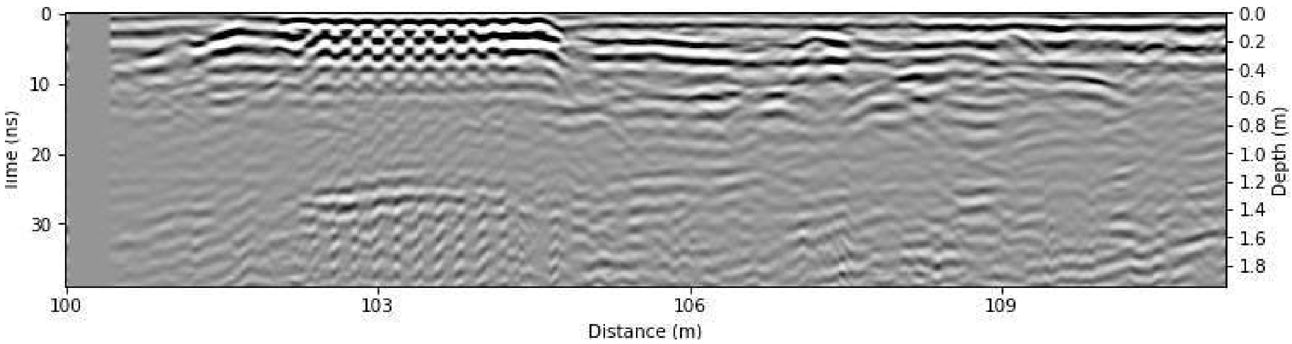


Figure B.571: Radargram at x = 71.25 m.

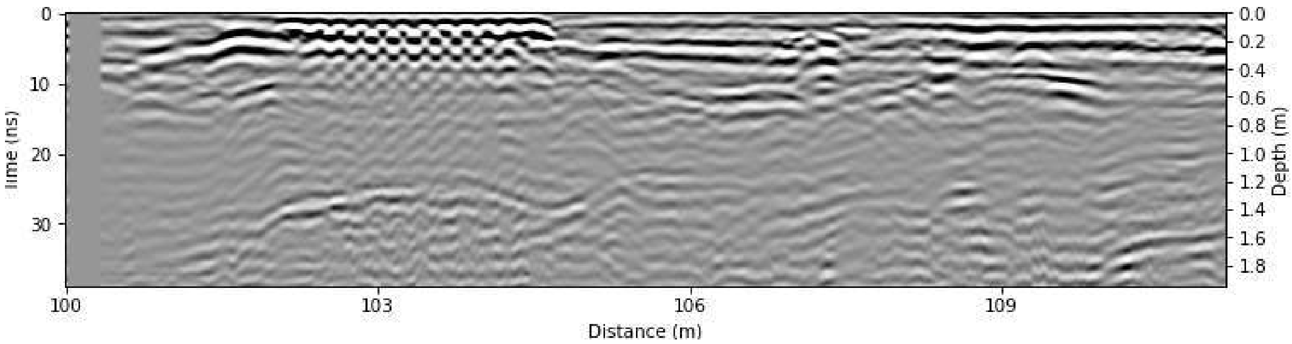


Figure B.572: Radargram at x = 71.5 m.

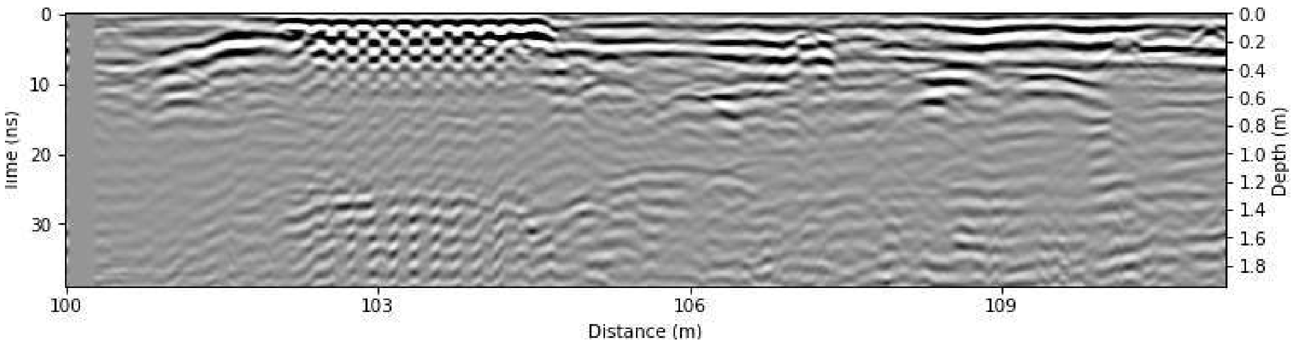


Figure B.573: Radargram at x = 71.75 m.

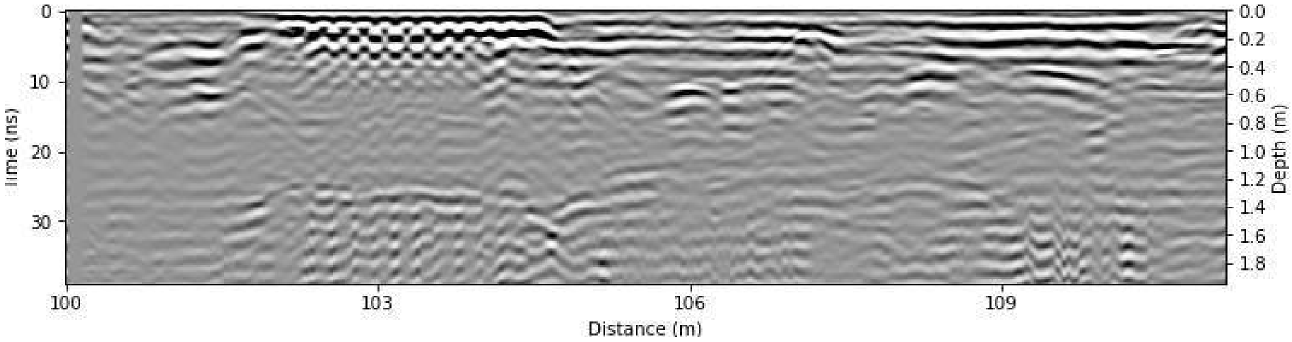


Figure B.574: Radargram at x = 72.0 m.

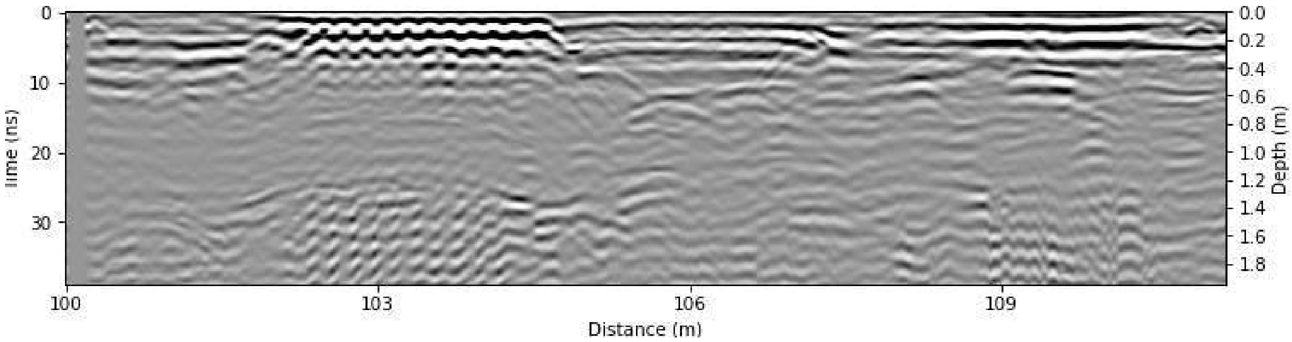


Figure B.575: Radargram at x = 72.25 m.

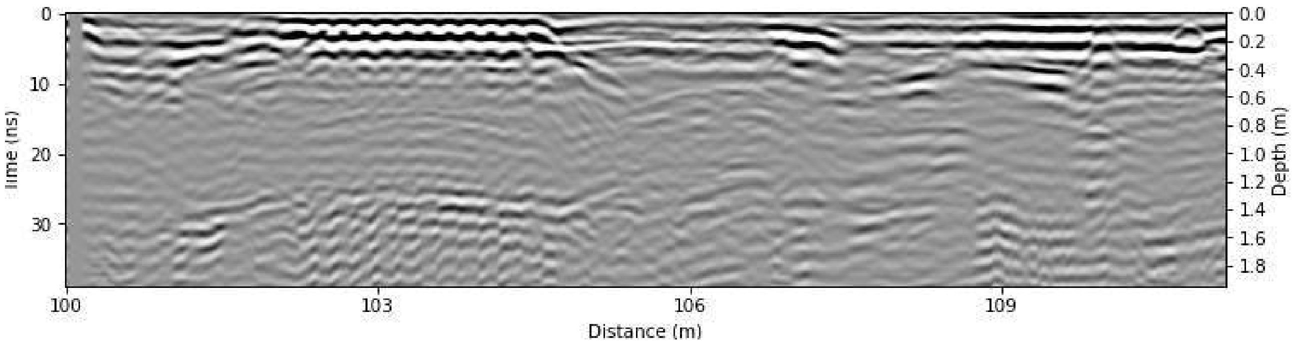


Figure B.576: Radargram at x = 72.5 m.

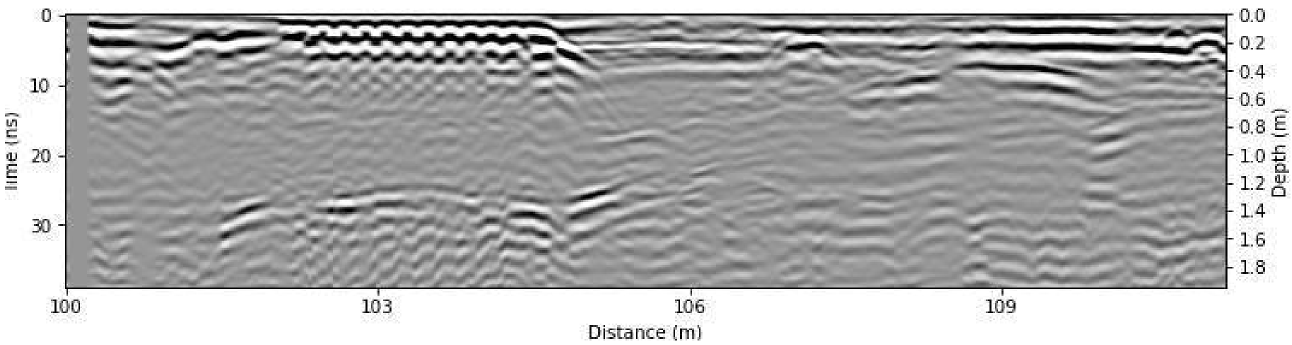


Figure B.577: Radargram at x = 72.75 m.

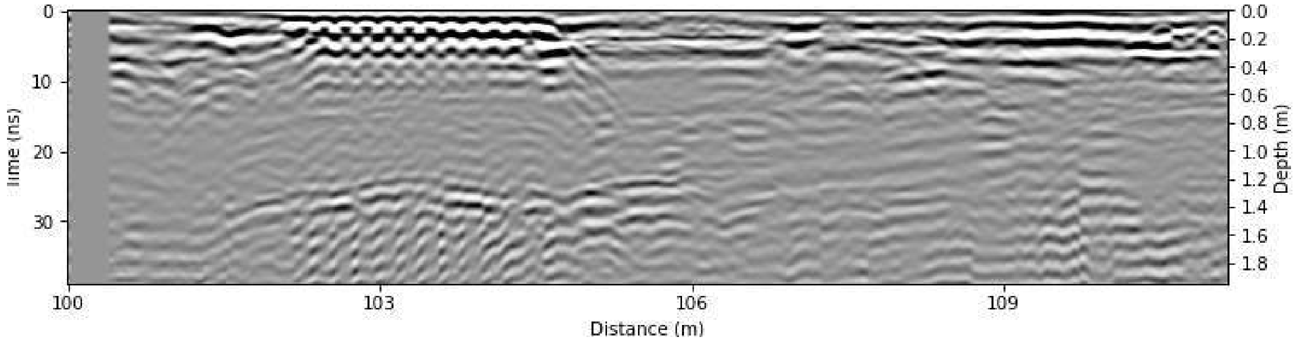


Figure B.578: Radargram at x = 73.0 m.

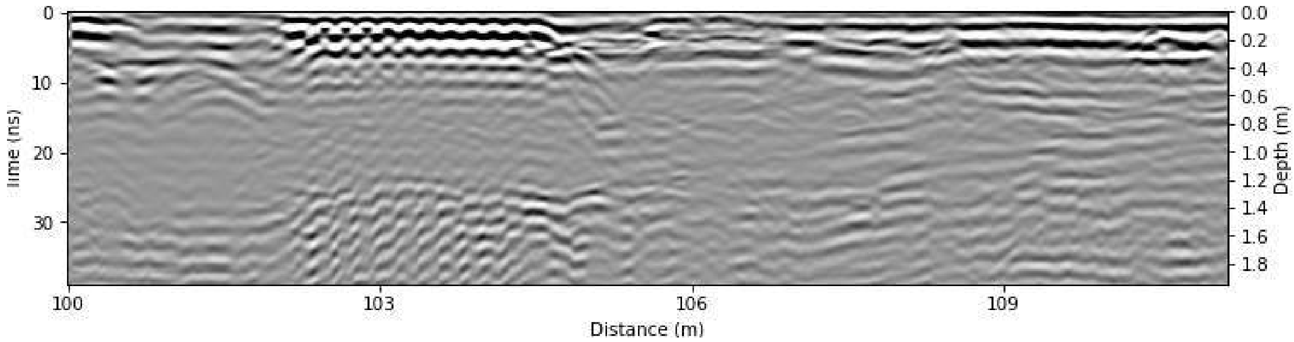


Figure B.579: Radargram at x = 73.25 m.

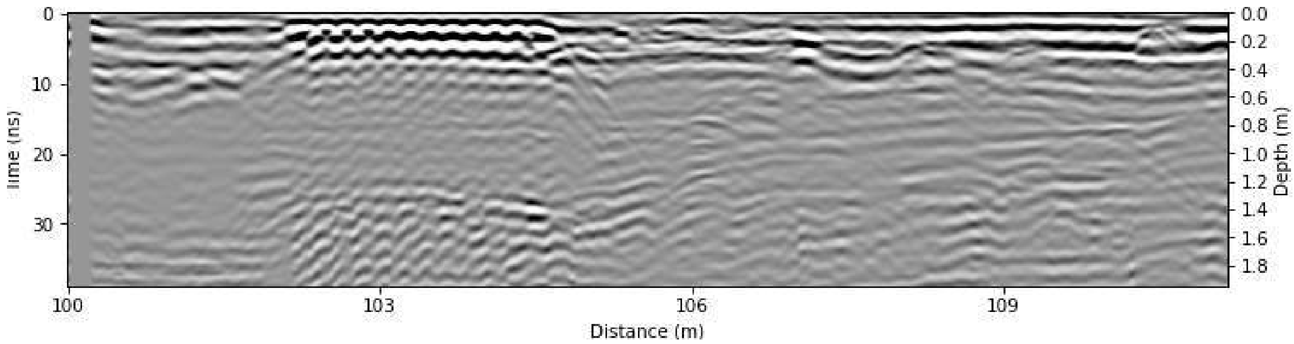


Figure B.580: Radargram at x = 73.5 m.

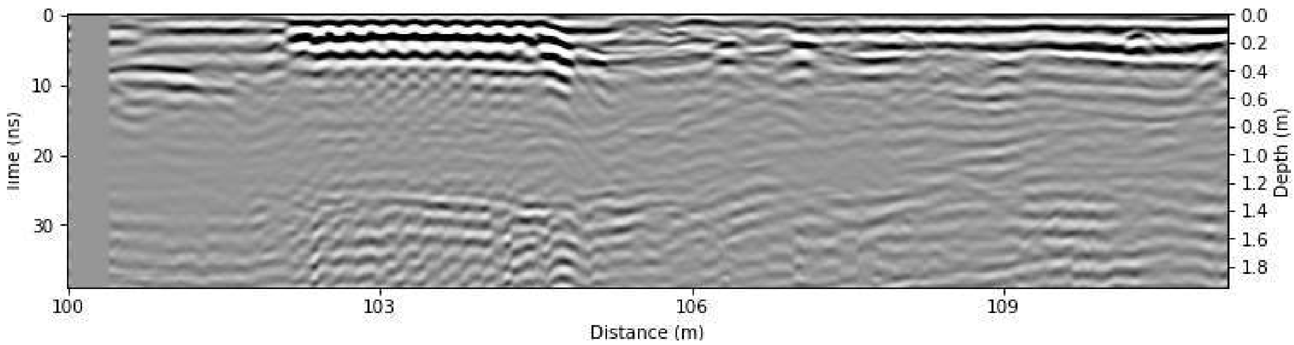


Figure B.581: Radargram at x = 73.75 m.

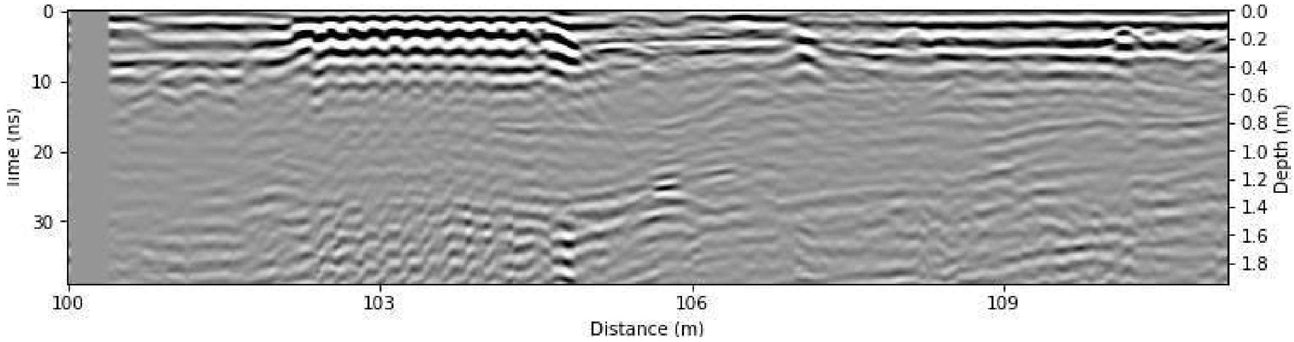


Figure B.582: Radargram at x = 74.0 m.

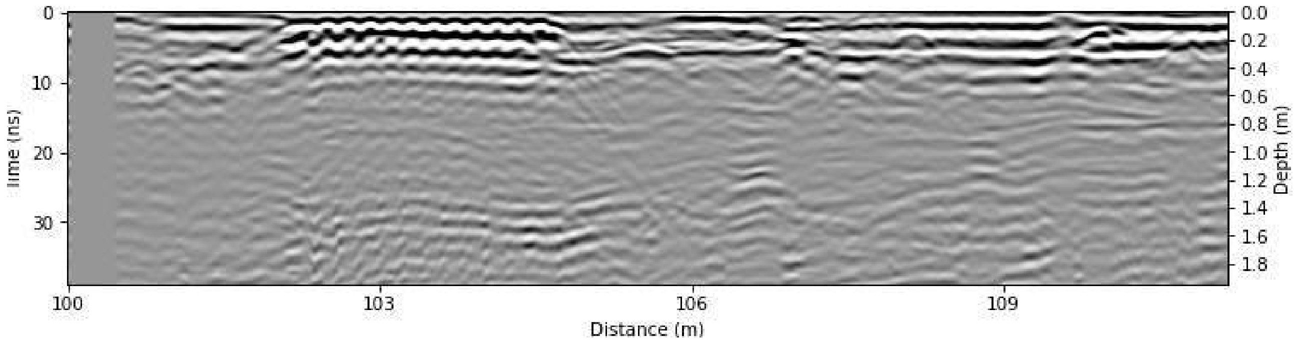


Figure B.583: Radargram at x = 74.25 m.

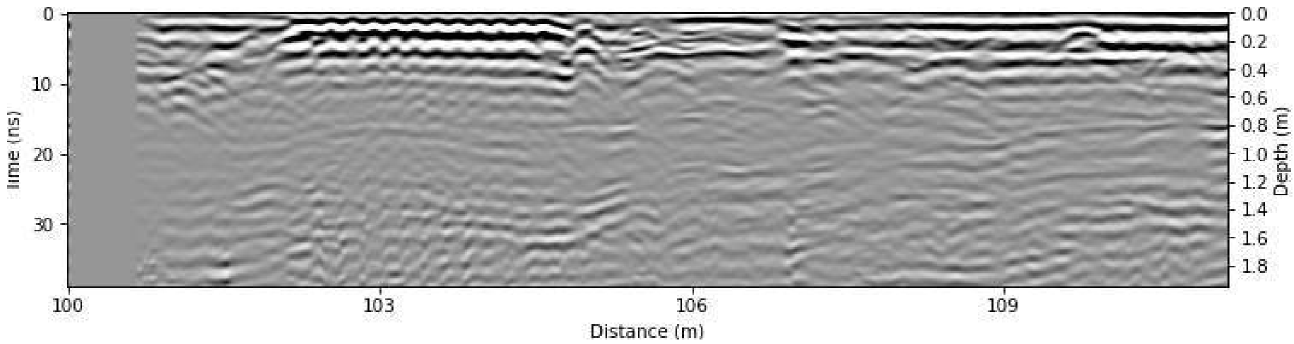


Figure B.584: Radargram at x = 74.5 m.

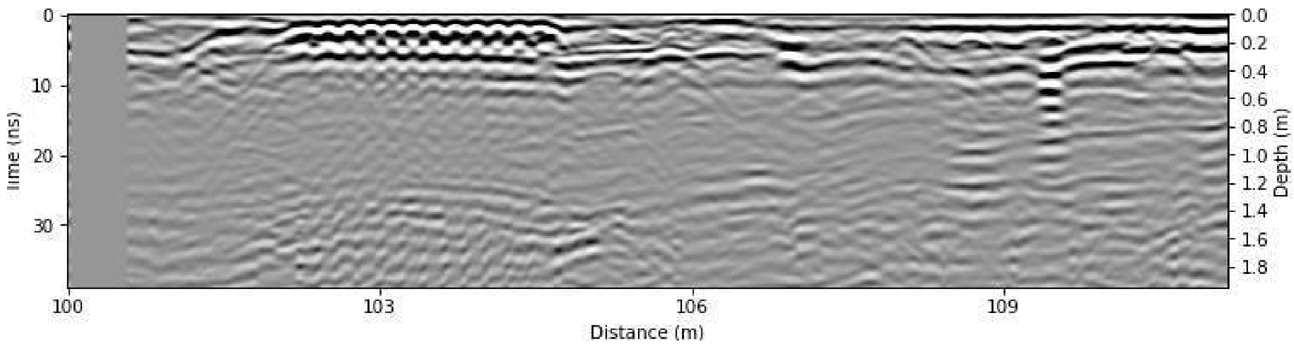


Figure B.585: Radargram at x = 74.75 m.

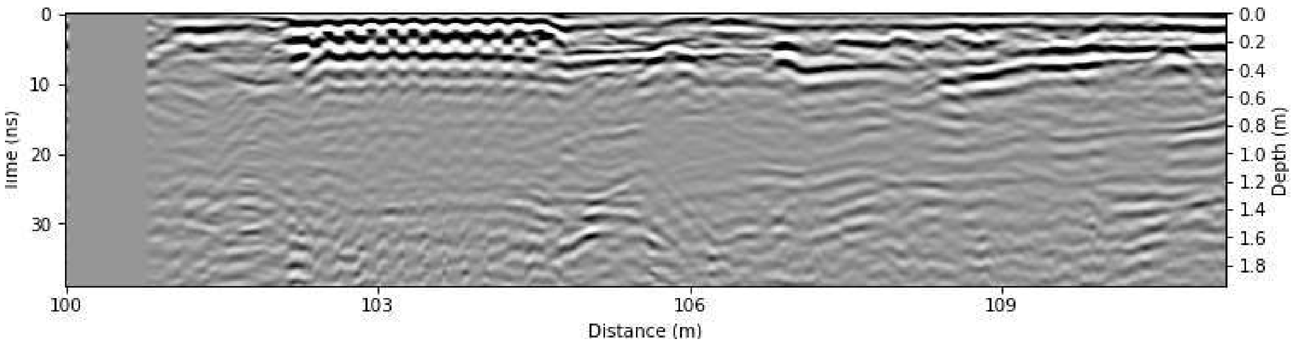


Figure B.586: Radargram at x = 75.0 m.

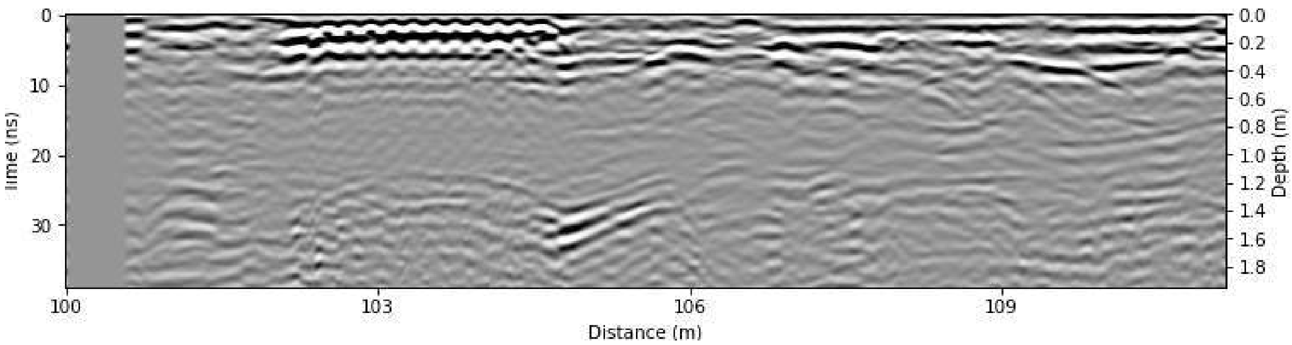


Figure B.587: Radargram at x = 75.25 m.

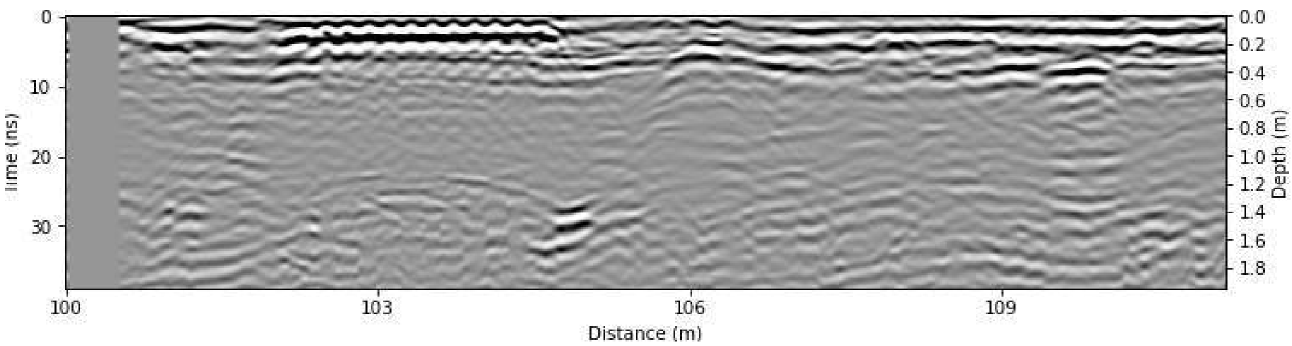


Figure B.588: Radargram at x = 75.5 m.

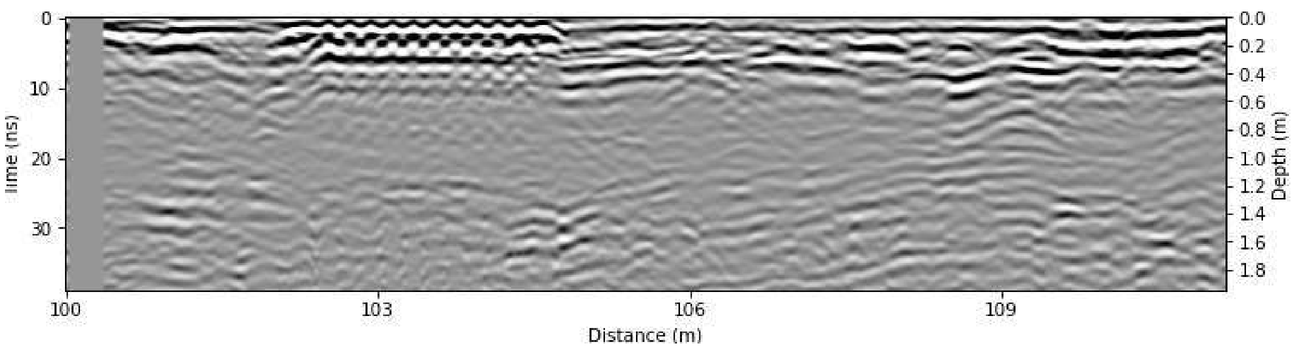


Figure B.589: Radargram at x = 75.75 m.

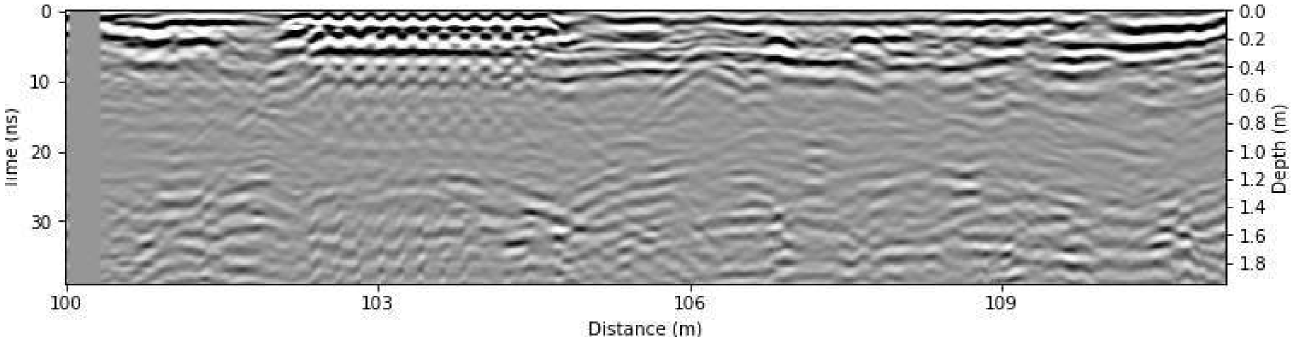


Figure B.590: Radargram at x = 76.0 m.

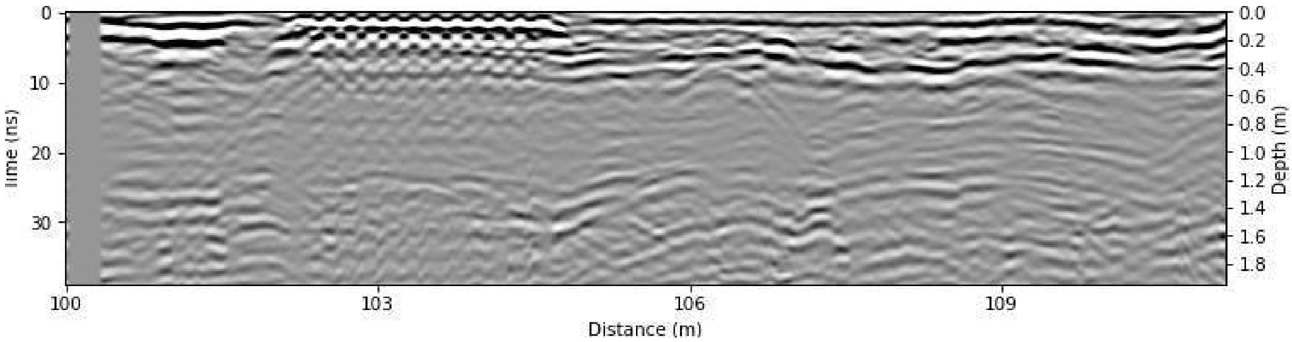


Figure B.591: Radargram at x = 76.25 m.

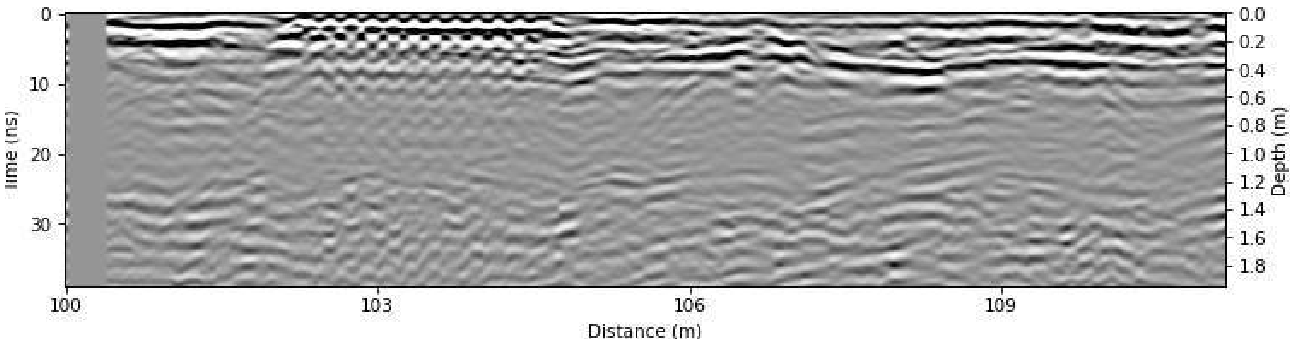


Figure B.592: Radargram at x = 76.5 m.

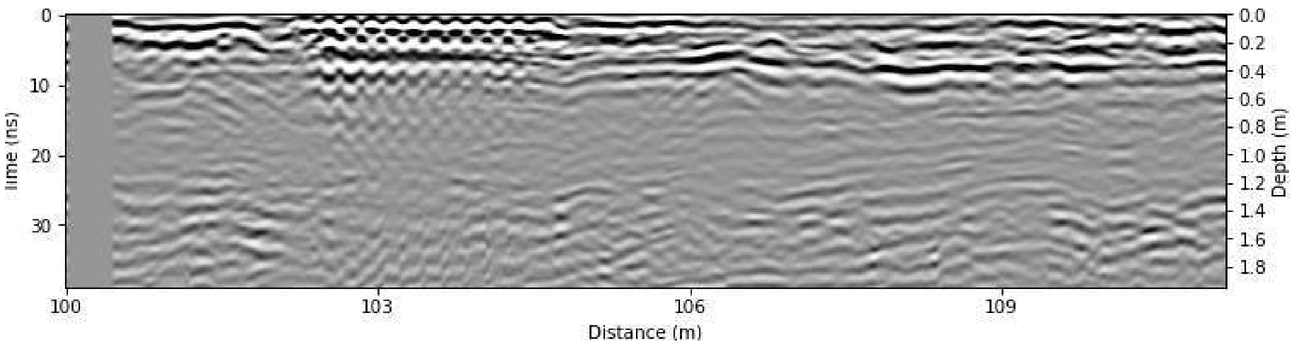


Figure B.593: Radargram at x = 76.75 m.

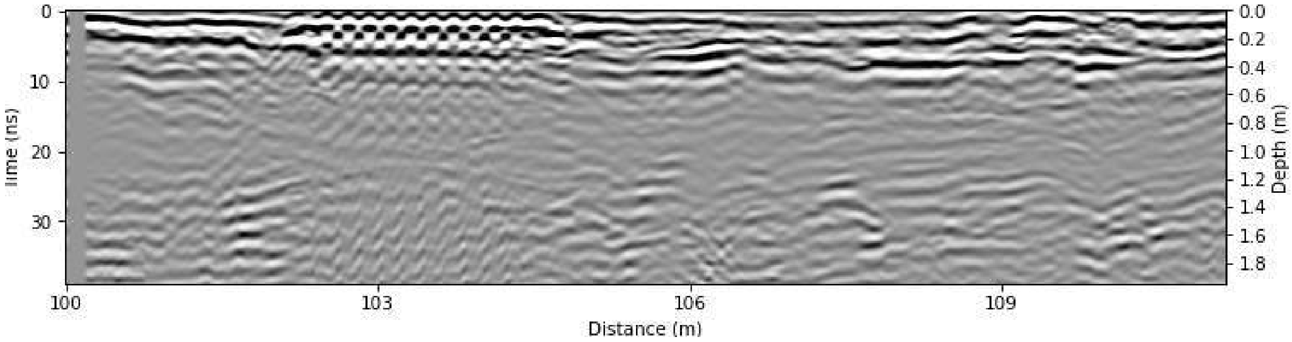


Figure B.594: Radargram at x = 77.0 m.

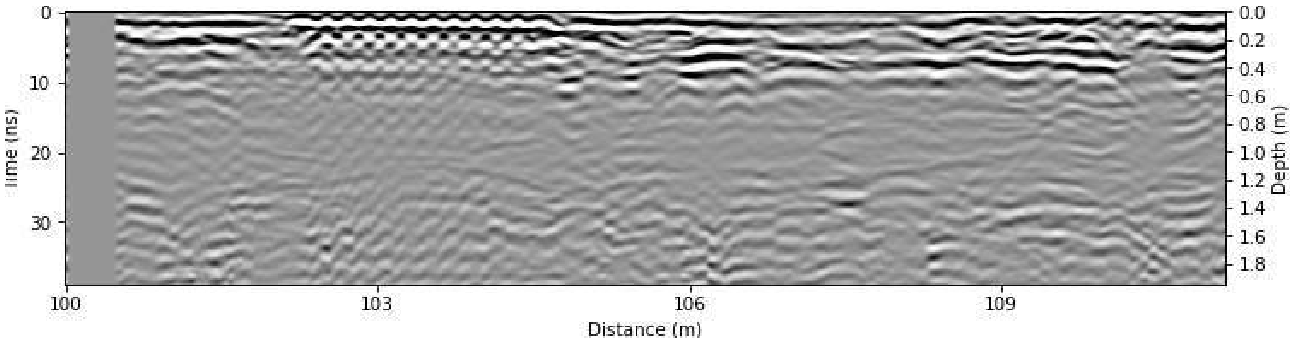


Figure B.595: Radargram at x = 77.25 m.

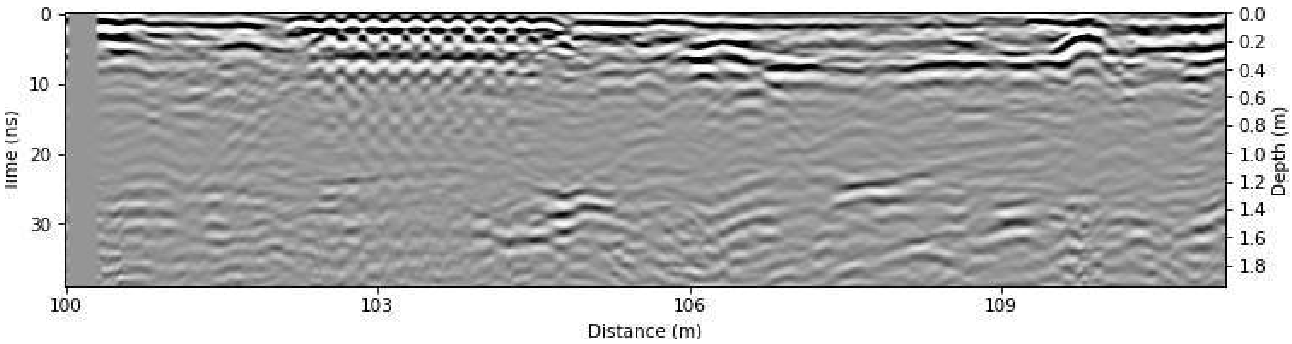


Figure B.596: Radargram at x = 77.5 m.

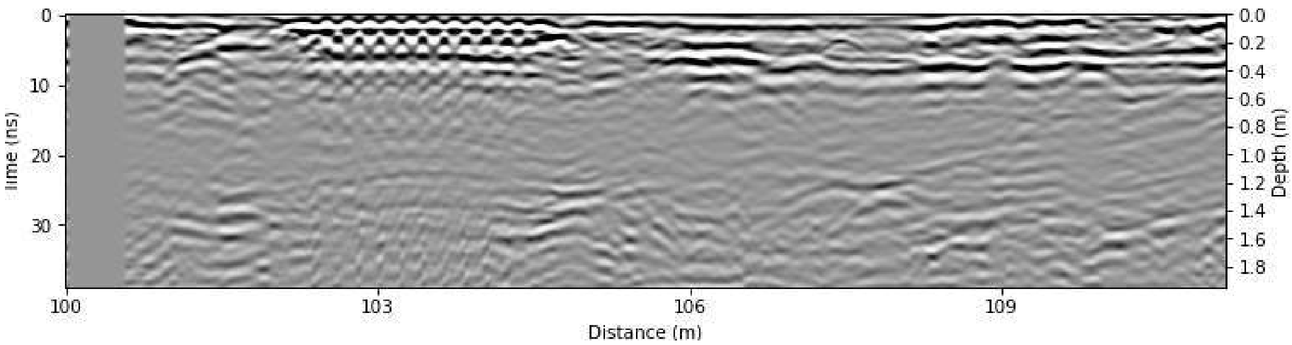


Figure B.597: Radargram at x = 77.75 m.

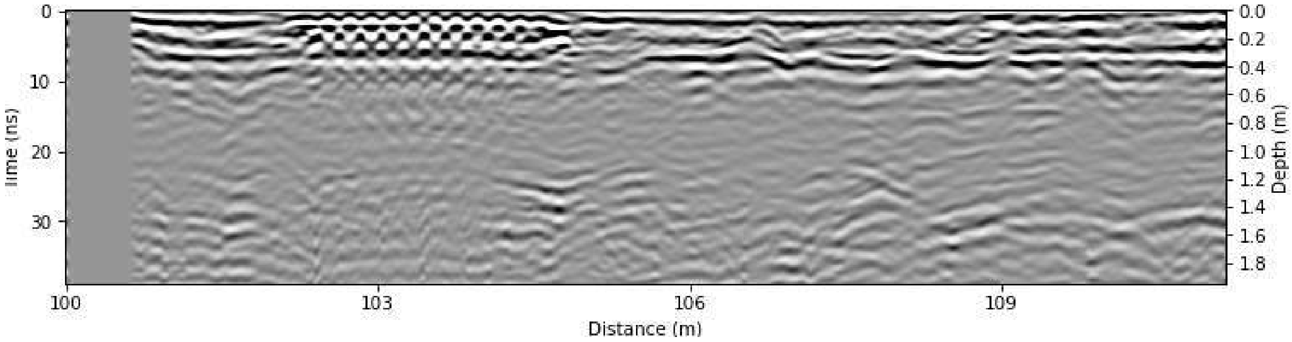


Figure B.598: Radargram at x = 78.0 m.

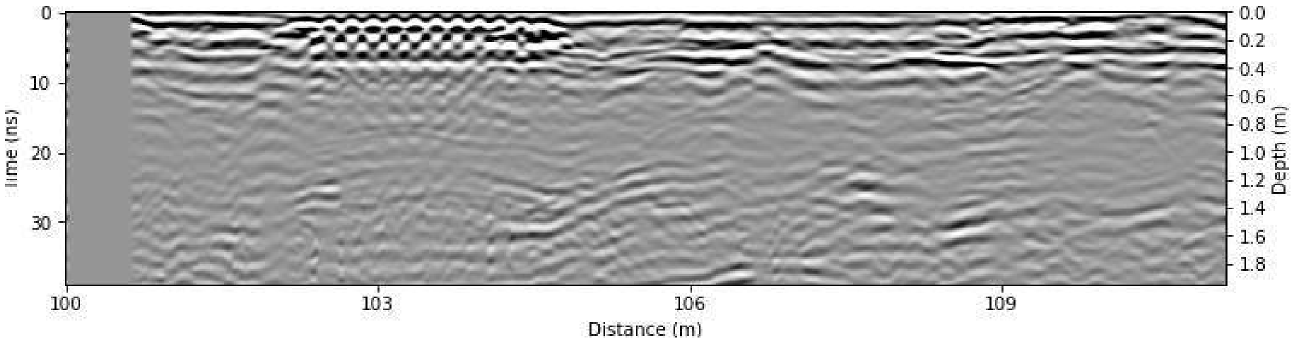


Figure B.599: Radargram at x = 78.25 m.

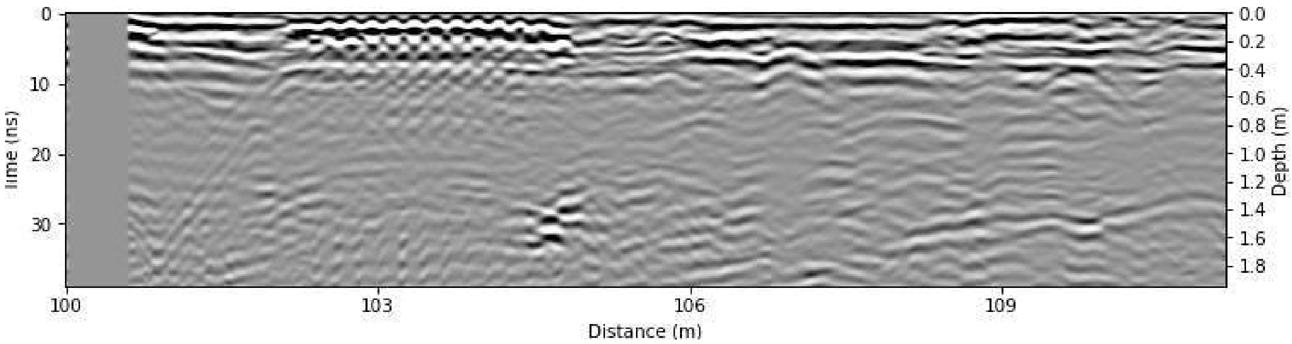


Figure B.600: Radargram at x = 78.5 m.

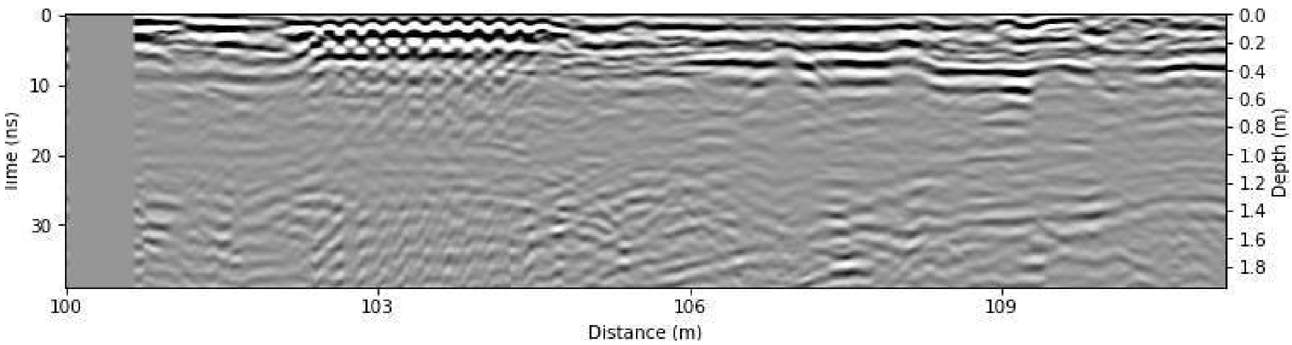


Figure B.601: Radargram at x = 78.75 m.

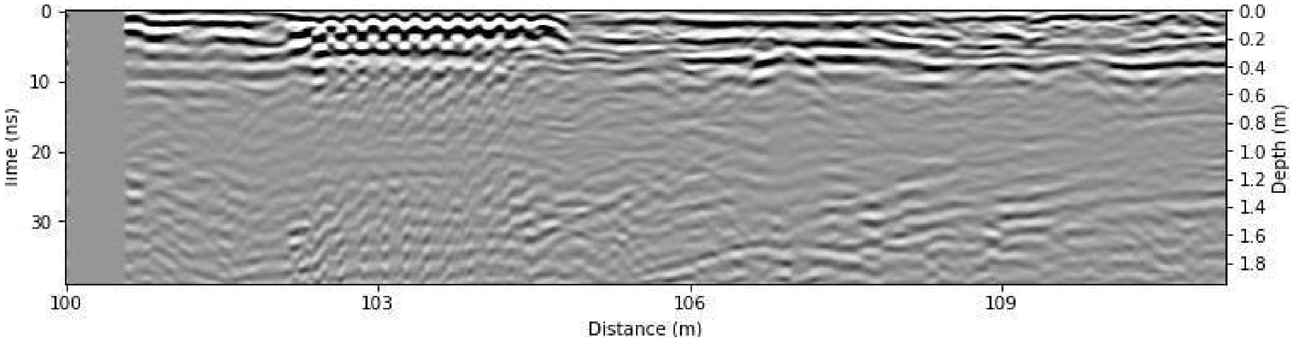


Figure B.602: Radargram at x = 79.0 m.

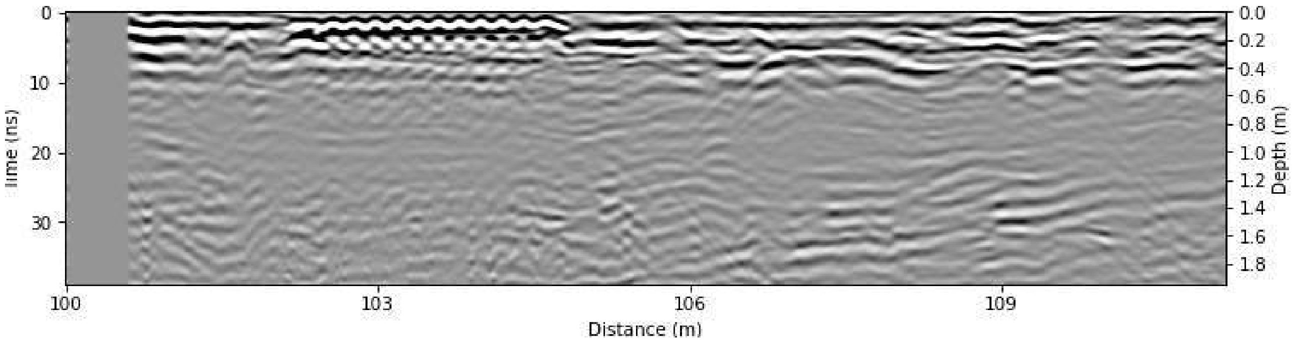


Figure B.603: Radargram at x = 79.25 m.

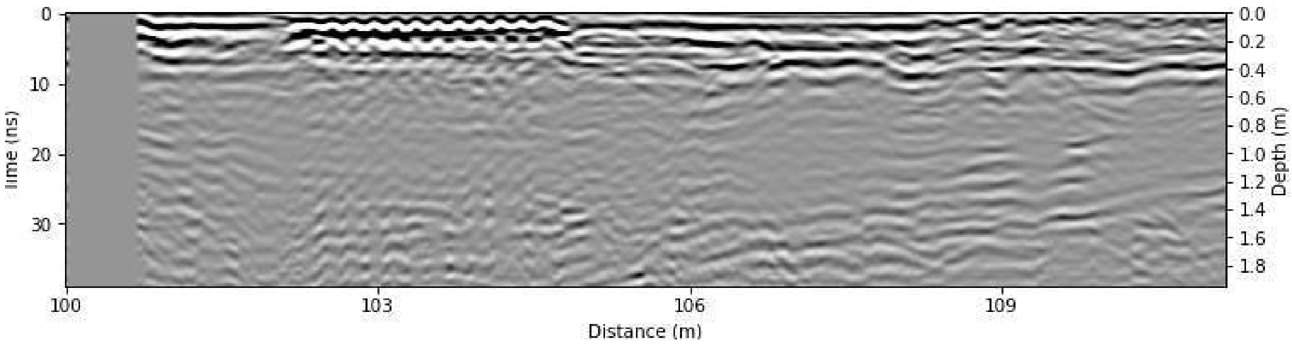


Figure B.604: Radargram at x = 79.5 m.

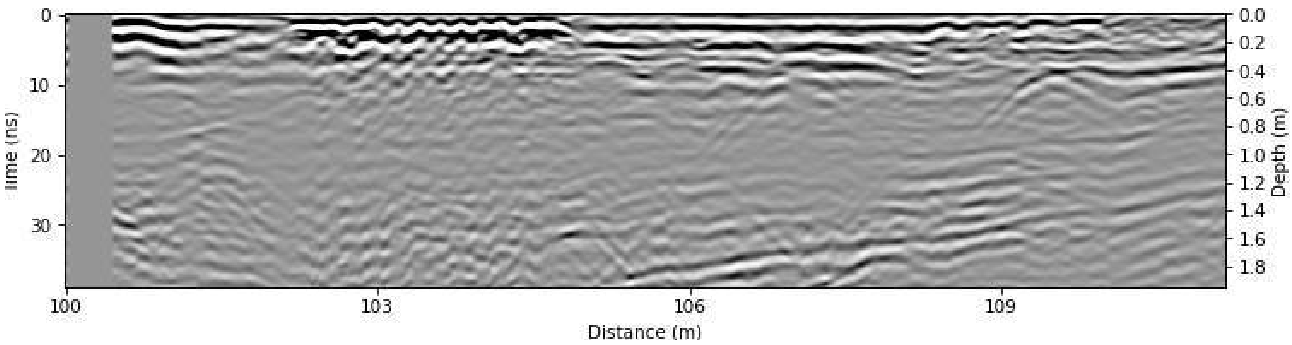


Figure B.605: Radargram at x = 79.75 m.

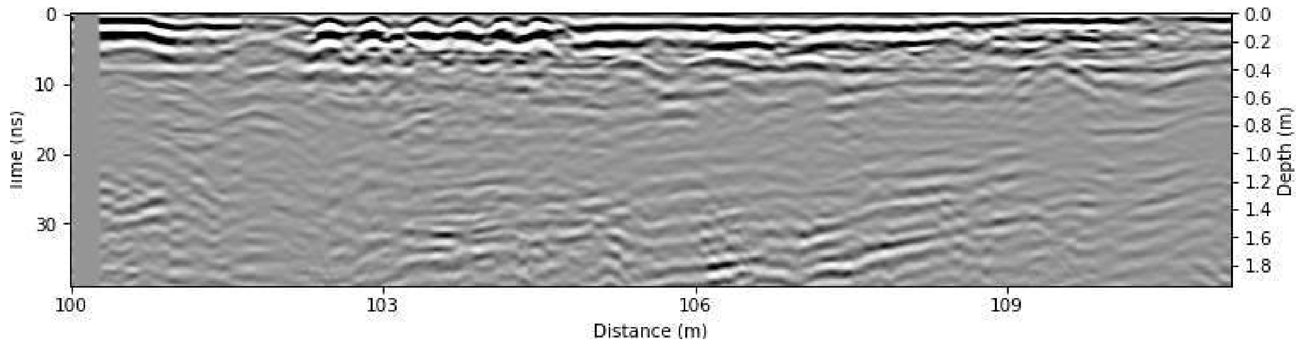


Figure B.606: Radargram at x = 80.0 m.

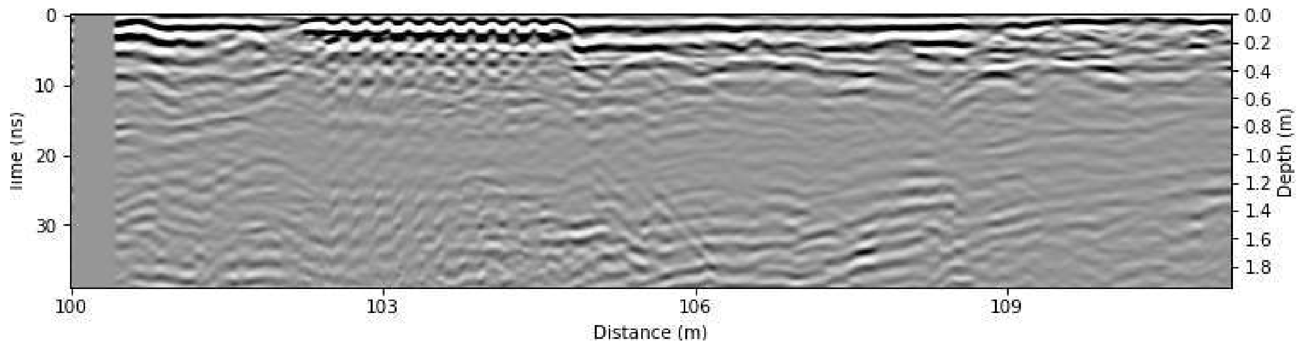


Figure B.607: Radargram at x = 80.25 m.

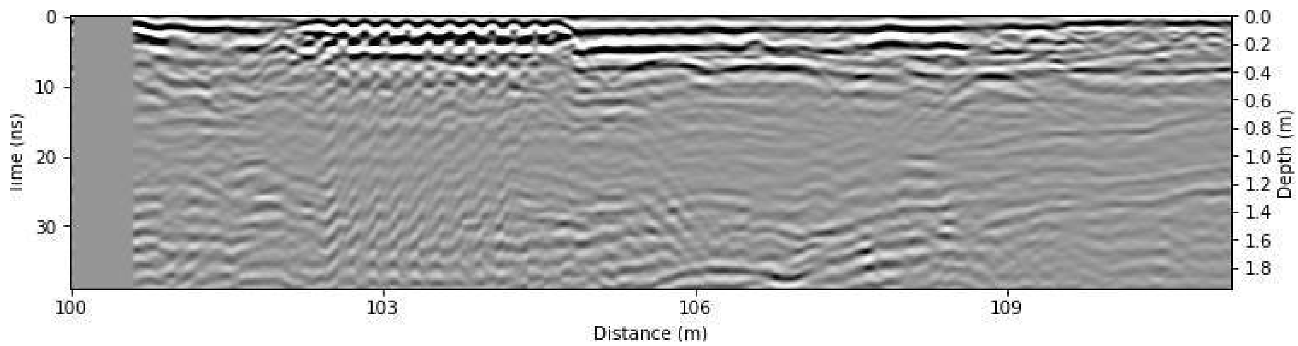


Figure B.608: Radargram at x = 80.5 m.

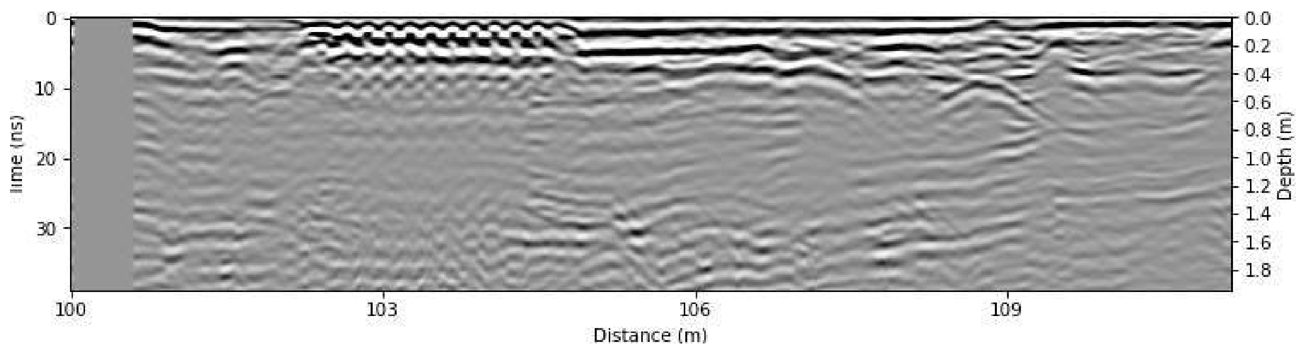


Figure B.609: Radargram at x = 80.75 m.

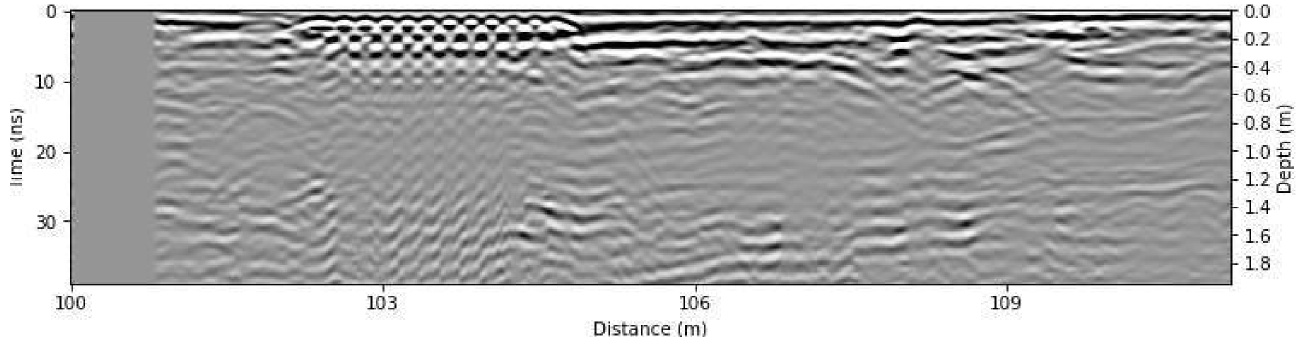
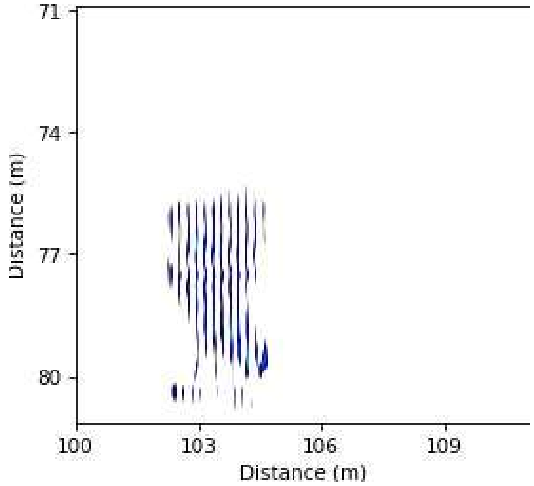
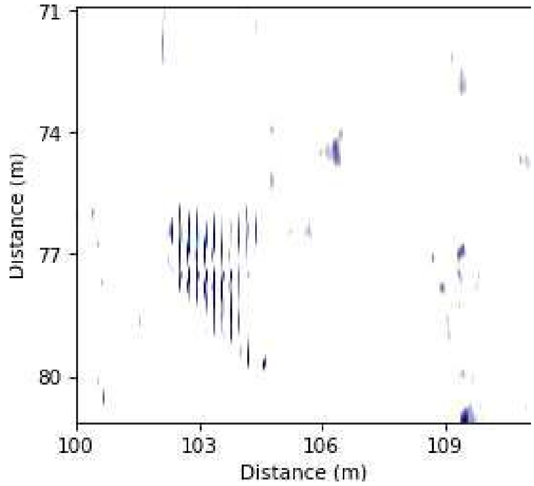


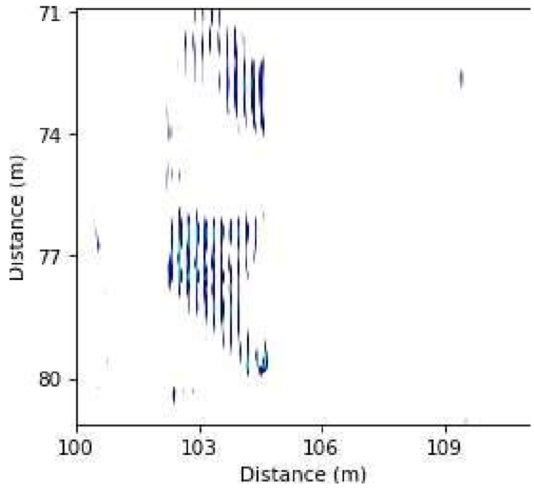
Figure B.610: Radargram at x = 81.0 m.



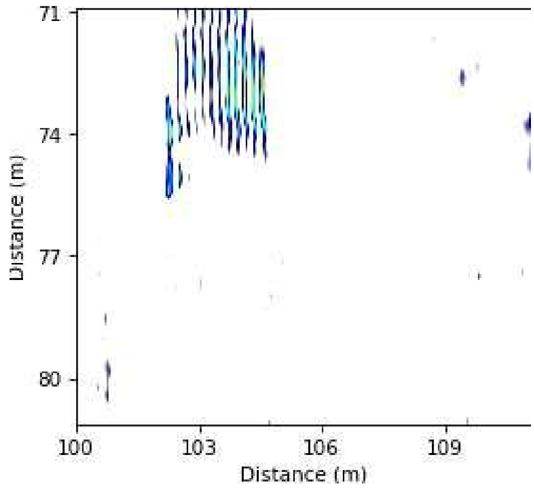
(a) Timeslice at z = 0.0 m.



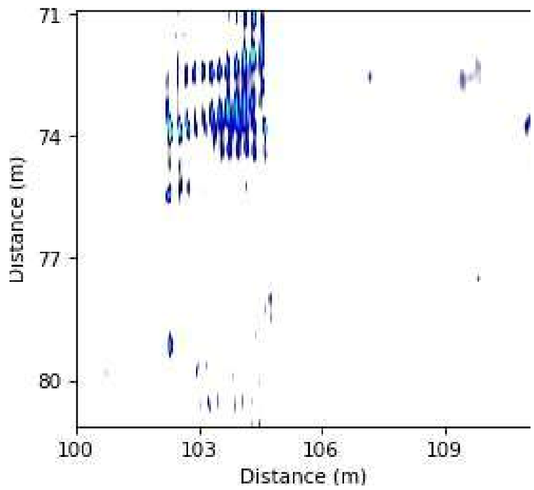
(b) Timeslice at z = 0.05 m.



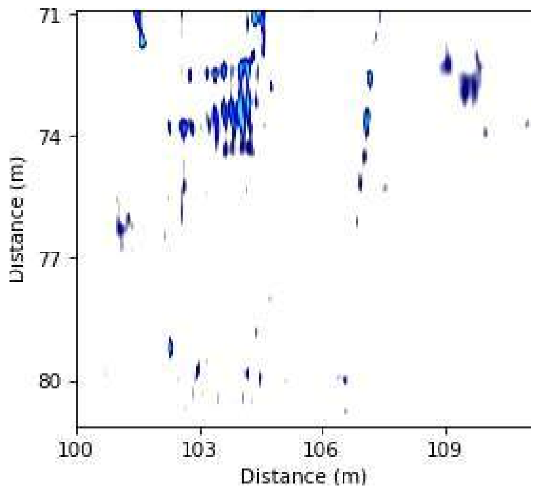
(c) Timeslice at z = 0.1 m.



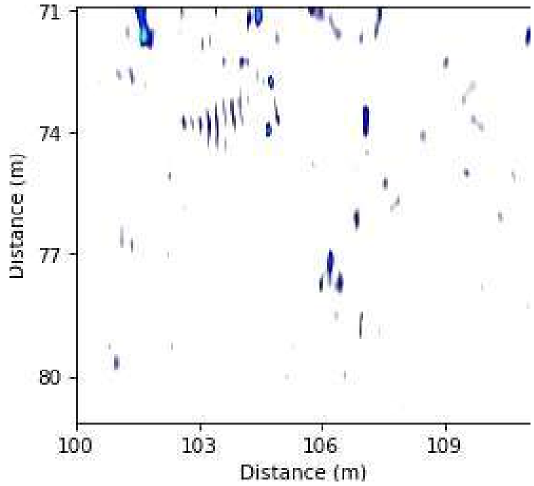
(d) Timeslice at z = 0.15 m.



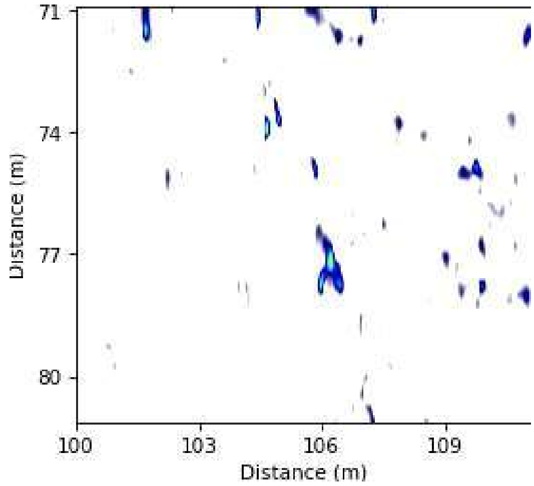
(e) Timeslice at z = 0.2 m.



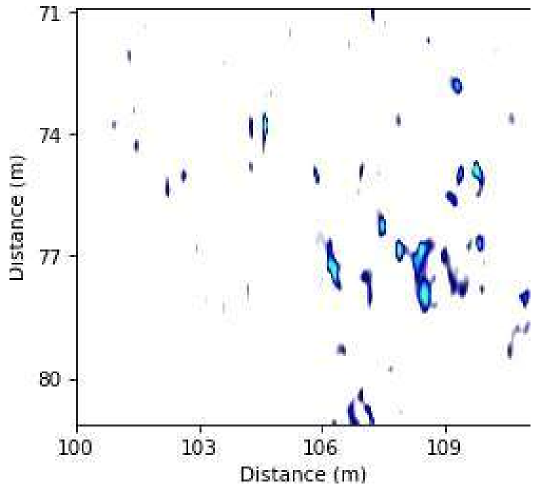
(f) Timeslice at z = 0.25 m.



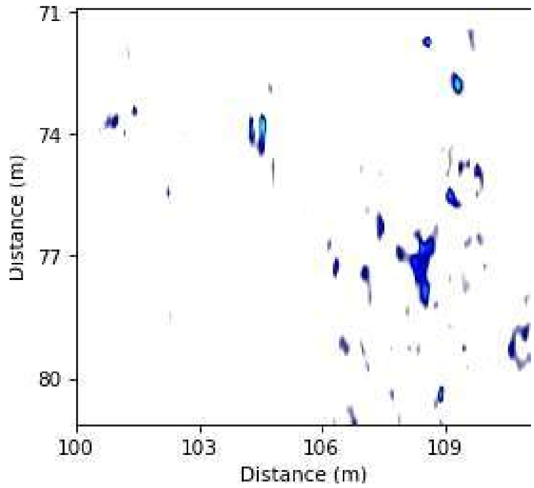
(a) Timeslice at z = 0.3 m.



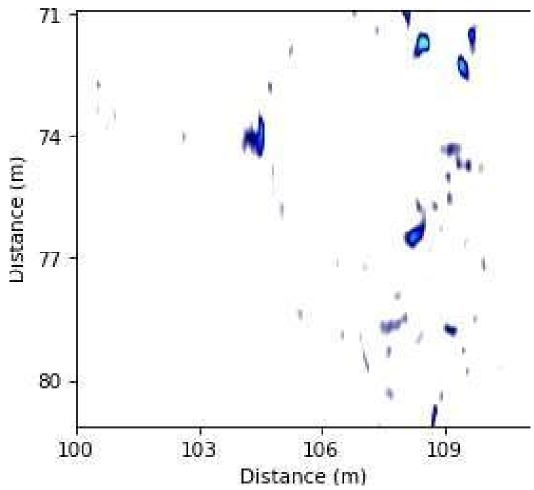
(b) Timeslice at z = 0.35 m.



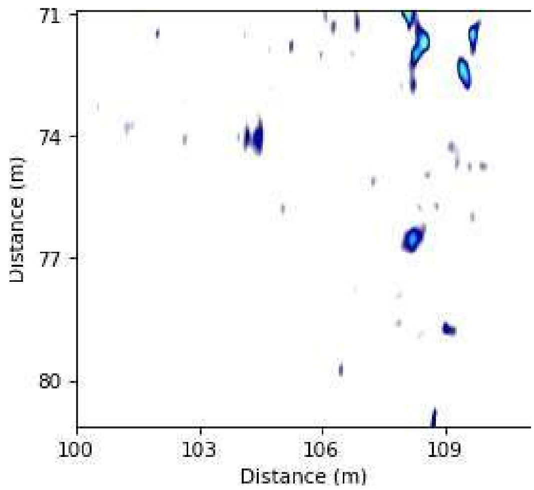
(c) Timeslice at z = 0.4 m.



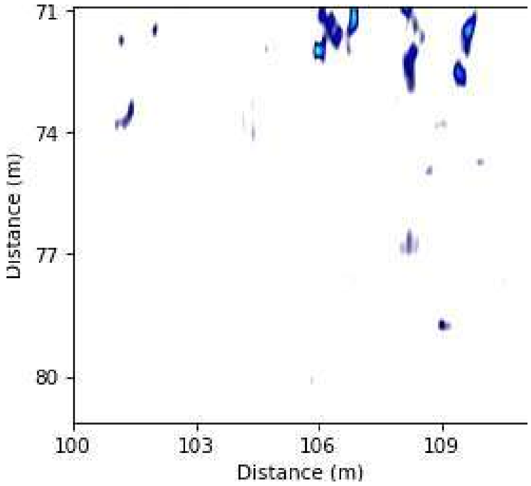
(d) Timeslice at z = 0.45 m.



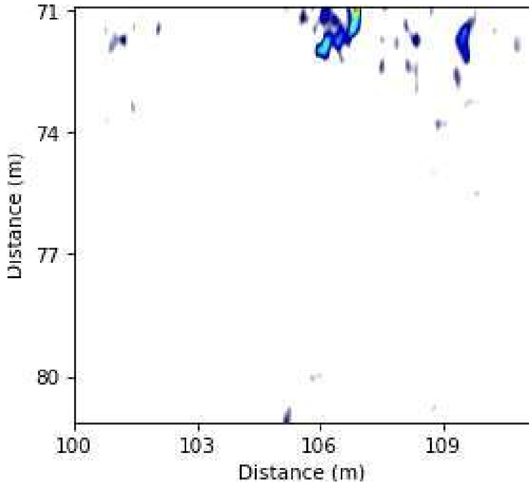
(e) Timeslice at z = 0.5 m.



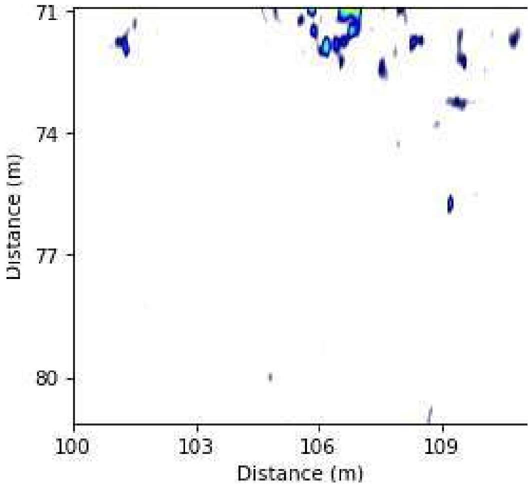
(f) Timeslice at z = 0.55 m.



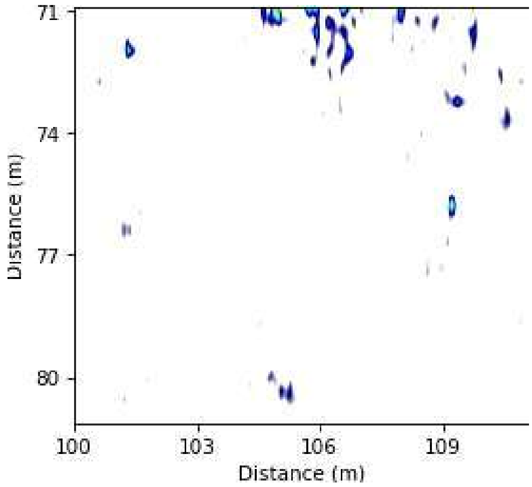
(a) Timeslice at z = 0.6 m.



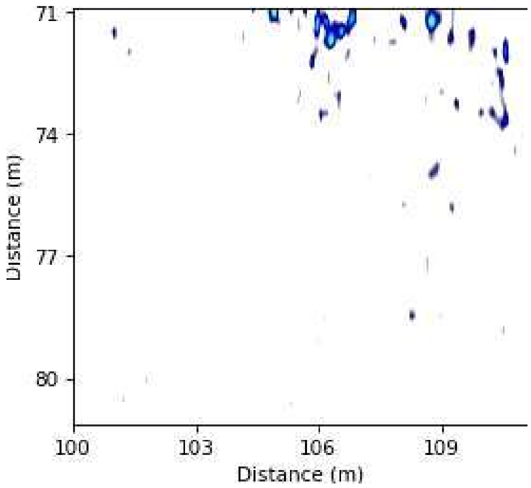
(b) Timeslice at z = 0.65 m.



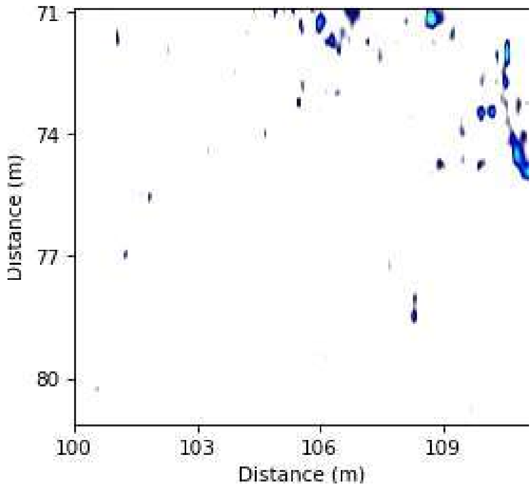
(c) Timeslice at z = 0.7 m.



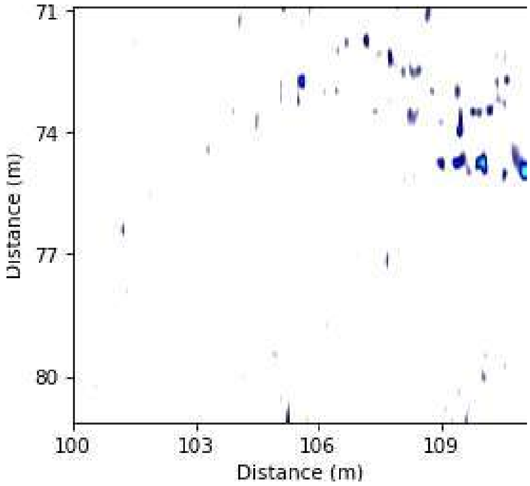
(d) Timeslice at z = 0.75 m.



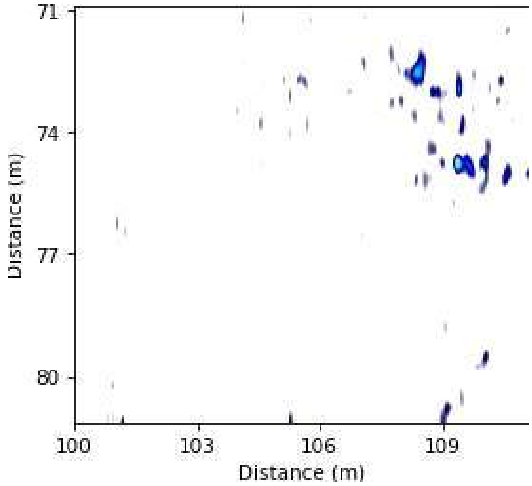
(e) Timeslice at z = 0.8 m.



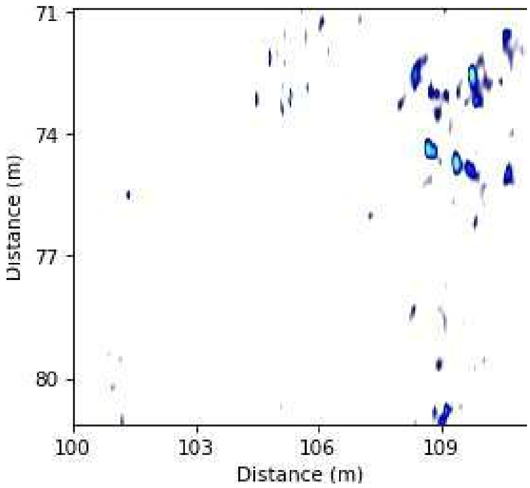
(f) Timeslice at z = 0.85 m.



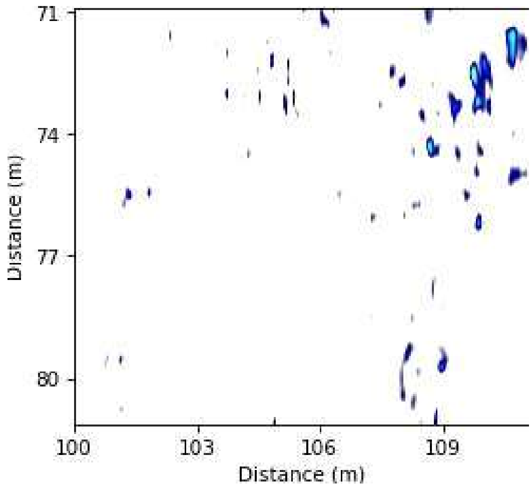
(a) Timeslice at z = 0.9 m.



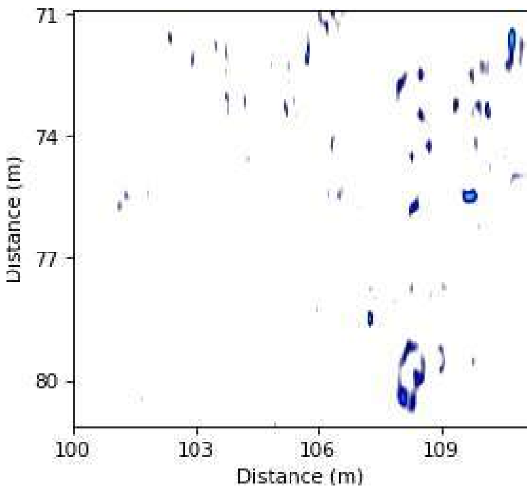
(b) Timeslice at z = 0.95 m.



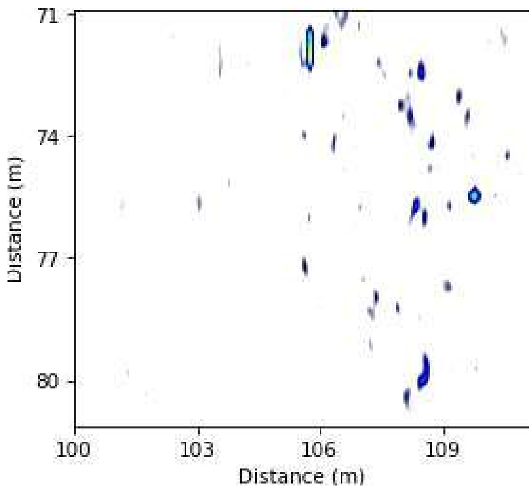
(c) Timeslice at z = 1.0 m.



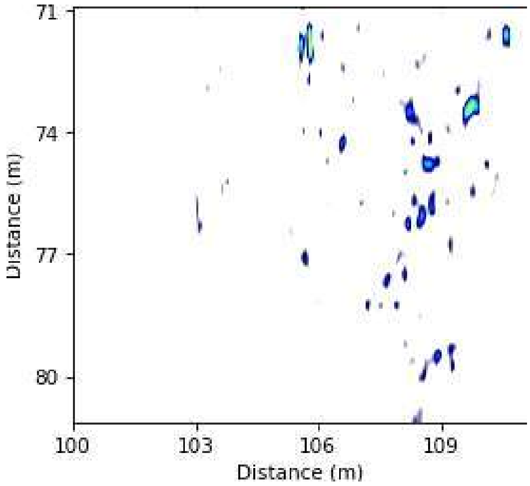
(d) Timeslice at z = 1.05 m.



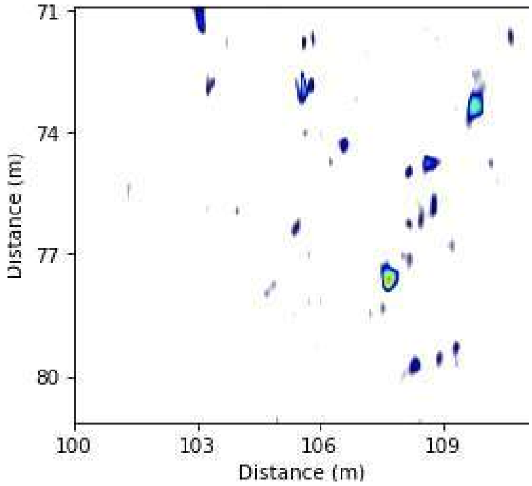
(e) Timeslice at z = 1.1 m.



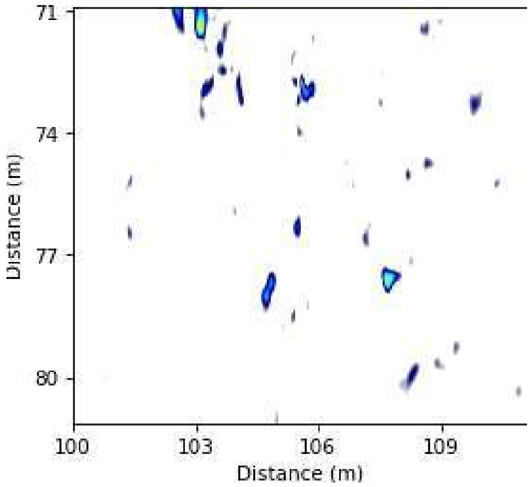
(f) Timeslice at z = 1.15 m.



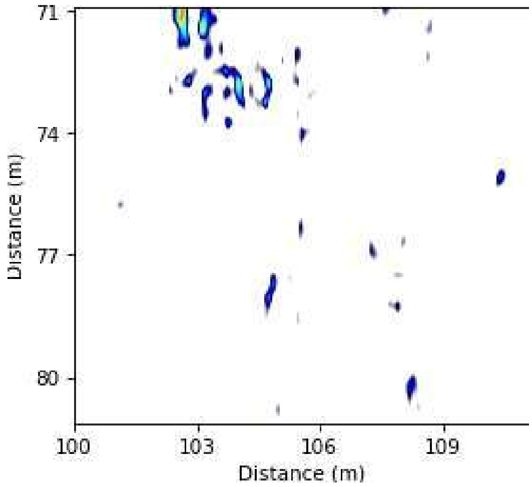
(a) Timeslice at z = 1.2 m.



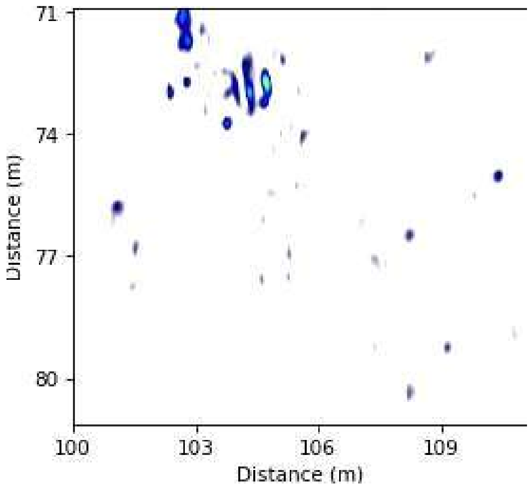
(b) Timeslice at z = 1.25 m.



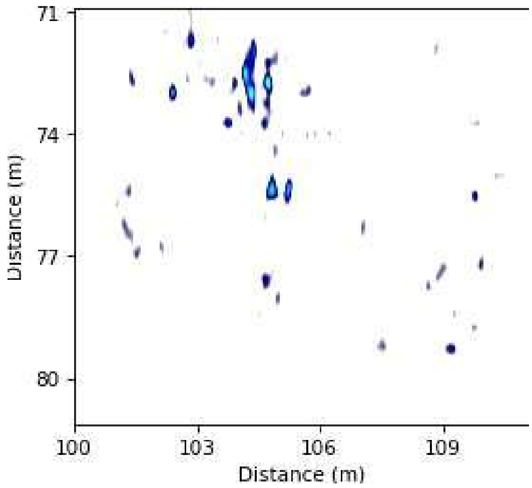
(c) Timeslice at z = 1.3 m.



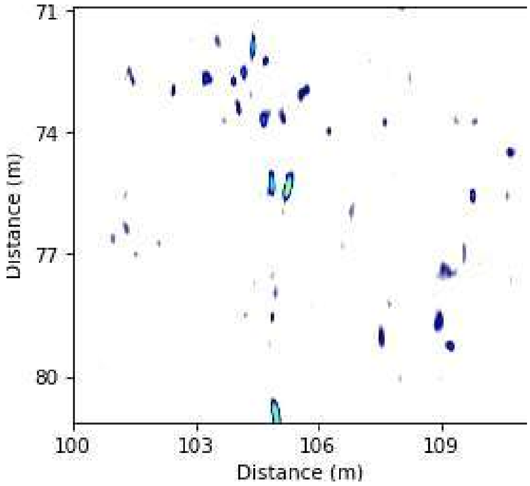
(d) Timeslice at z = 1.35 m.



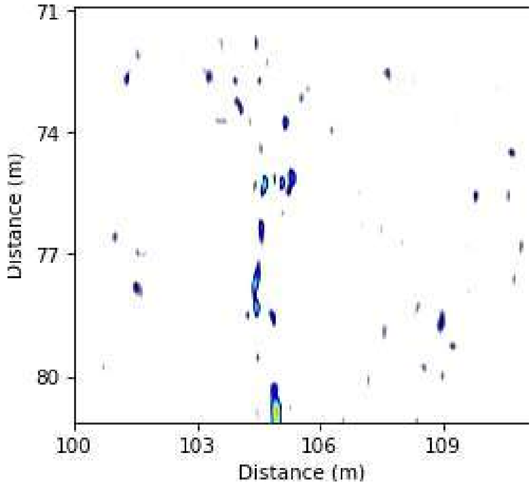
(e) Timeslice at z = 1.4 m.



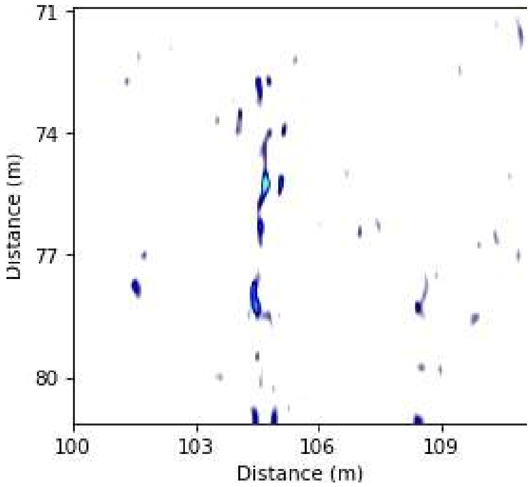
(f) Timeslice at z = 1.45 m.



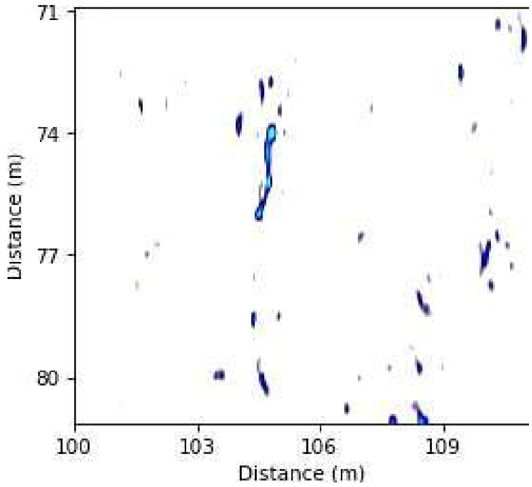
(a) Timeslice at z = 1.5 m.



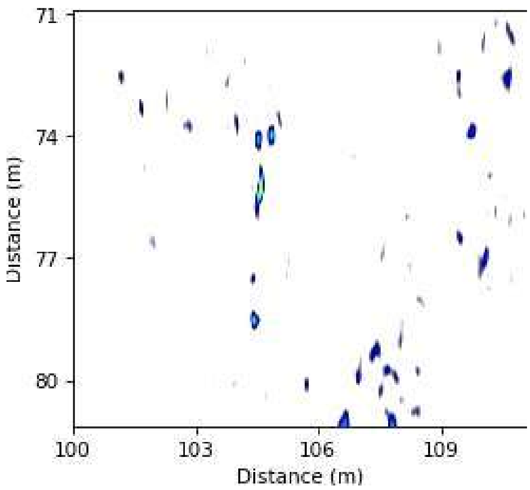
(b) Timeslice at z = 1.55 m.



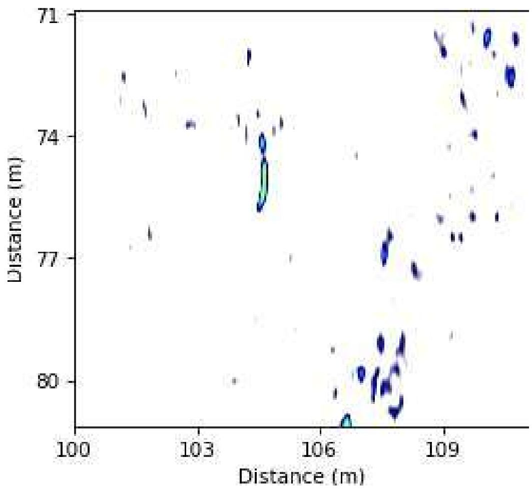
(c) Timeslice at z = 1.6 m.



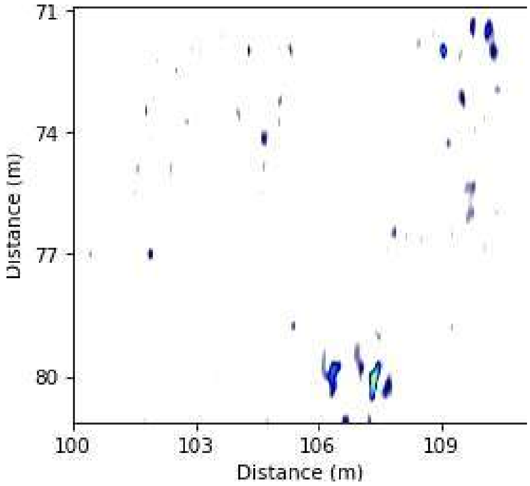
(d) Timeslice at z = 1.65 m.



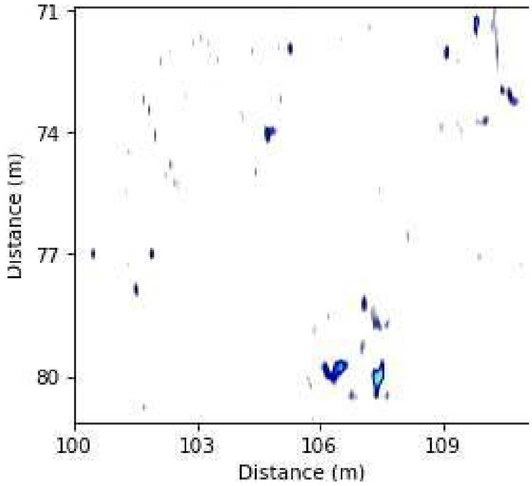
(e) Timeslice at z = 1.7 m.



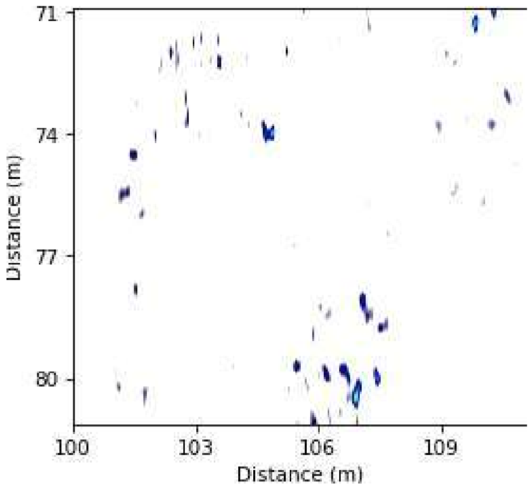
(f) Timeslice at z = 1.75 m.



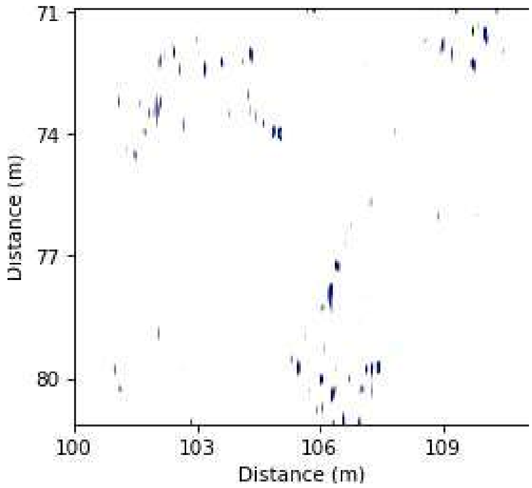
(a) Timeslice at z = 1.8 m.



(b) Timeslice at z = 1.85 m.



(c) Timeslice at z = 1.9 m.



(d) Timeslice at z = 1.95 m.

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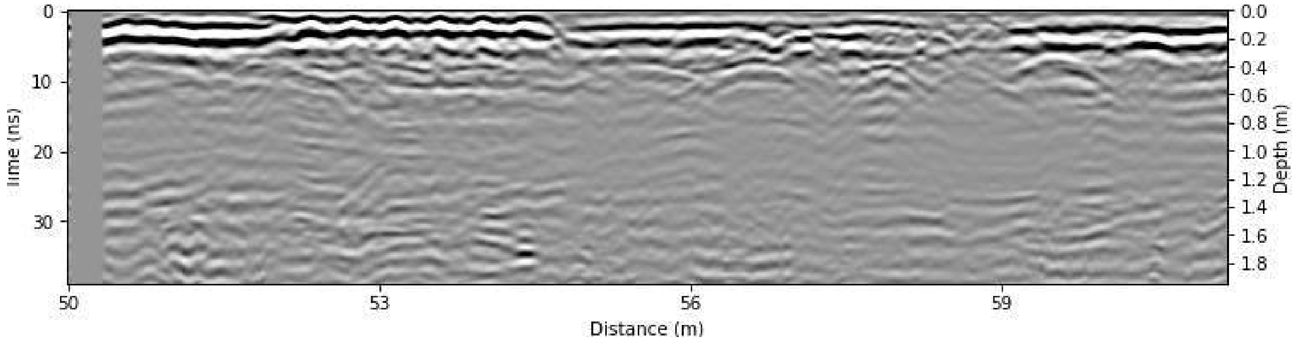


Figure B.618: Radargram at x = 20.0 m.

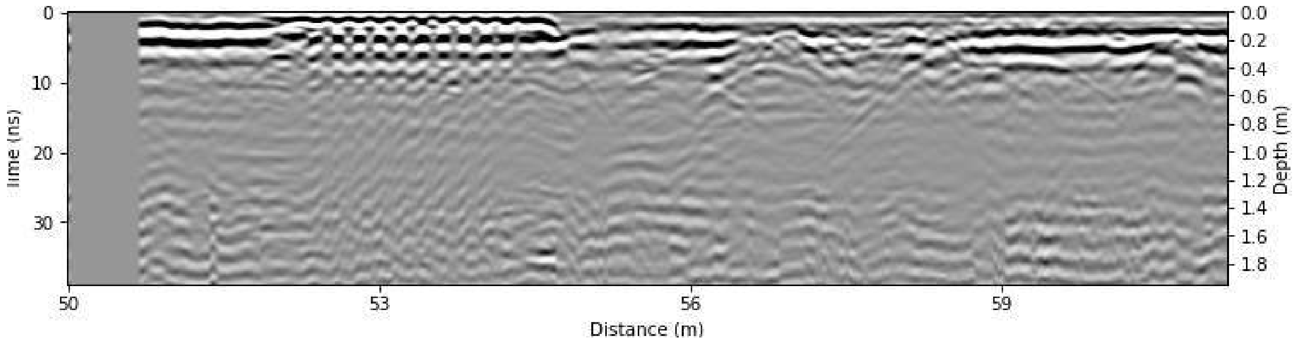


Figure B.619: Radargram at x = 20.25 m.

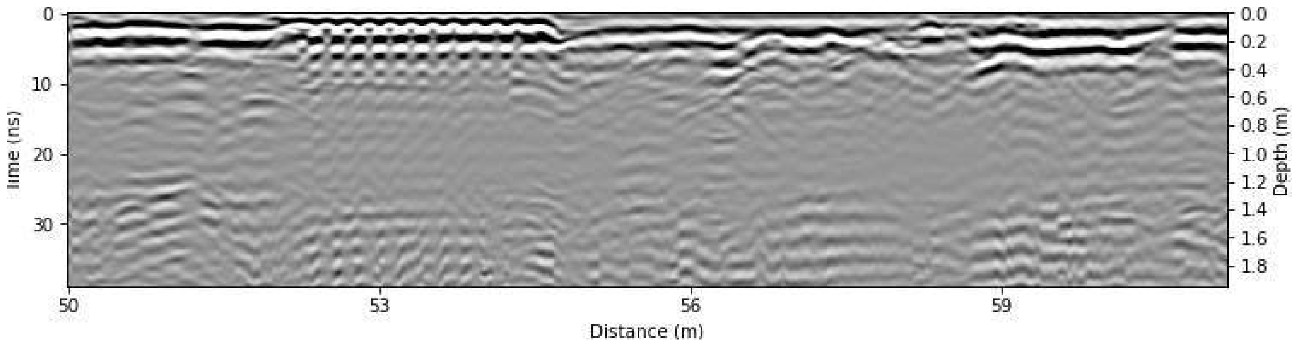


Figure B.620: Radargram at x = 20.5 m.

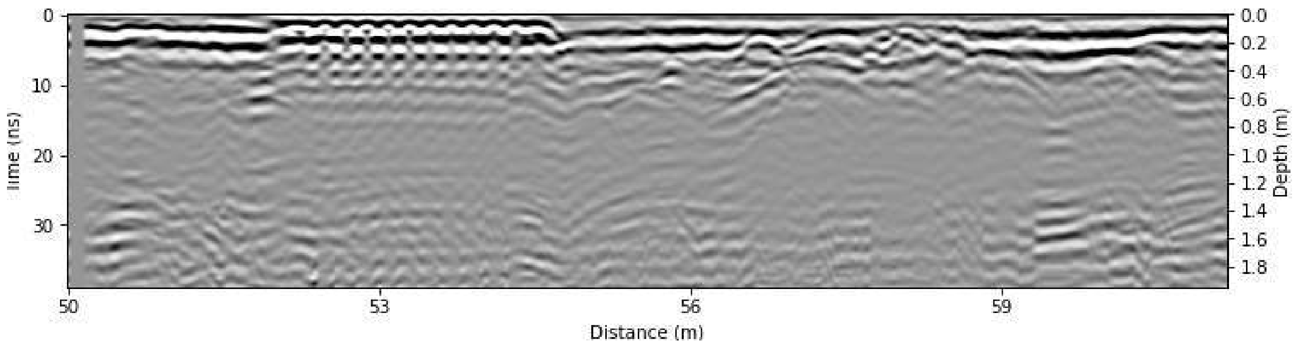


Figure B.621: Radargram at x = 20.75 m.

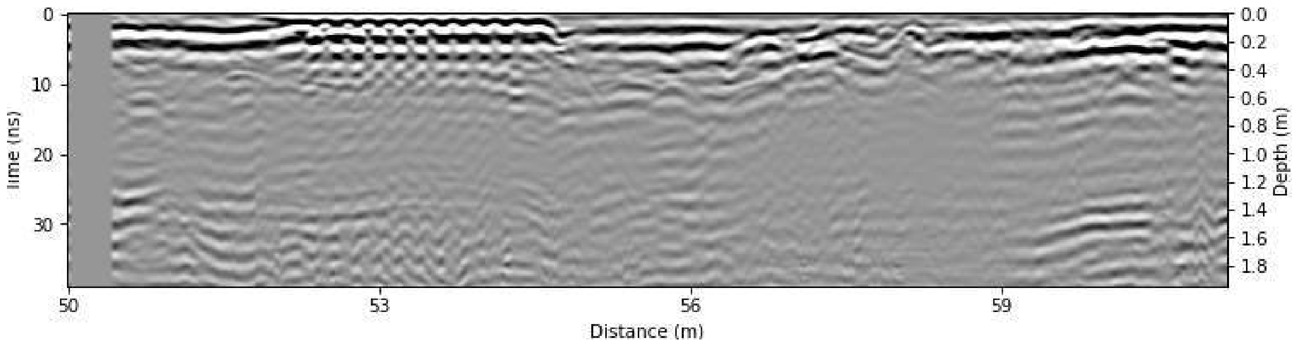


Figure B.622: Radargram at x = 21.0 m.

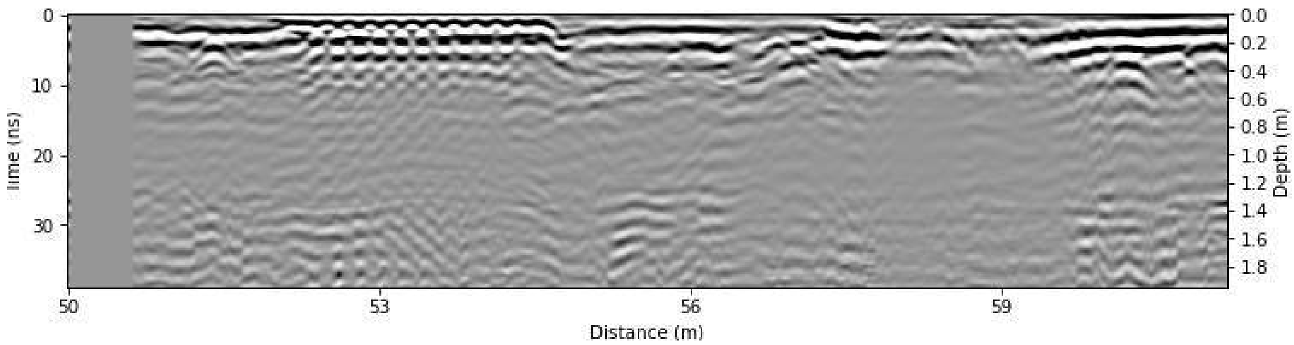


Figure B.623: Radargram at x = 21.25 m.

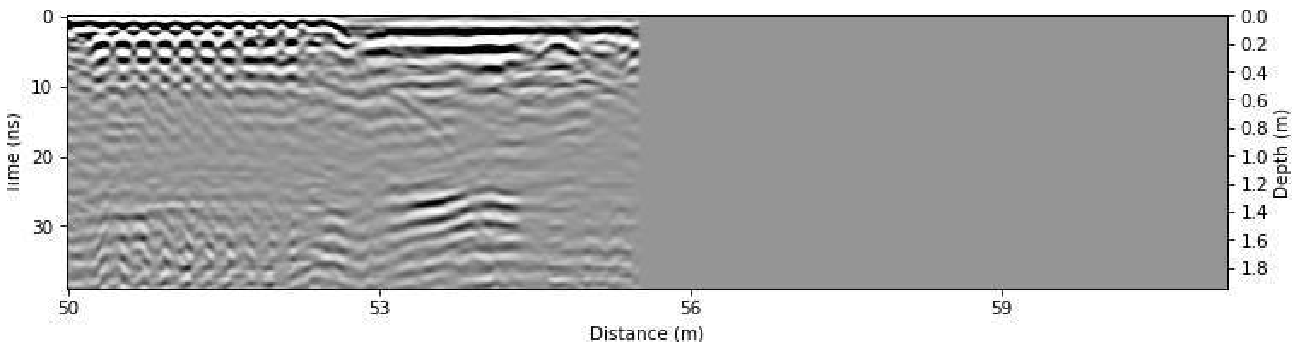


Figure B.624: Radargram at x = 21.5 m.

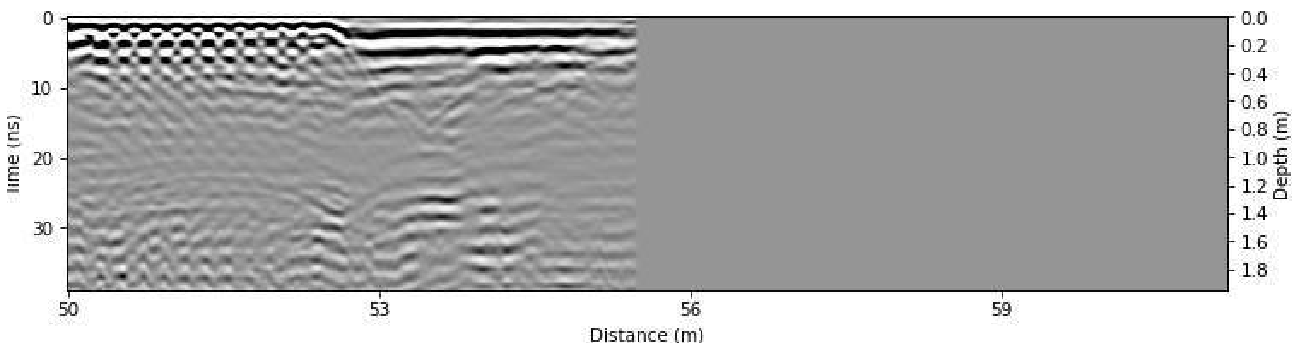


Figure B.625: Radargram at x = 21.75 m.

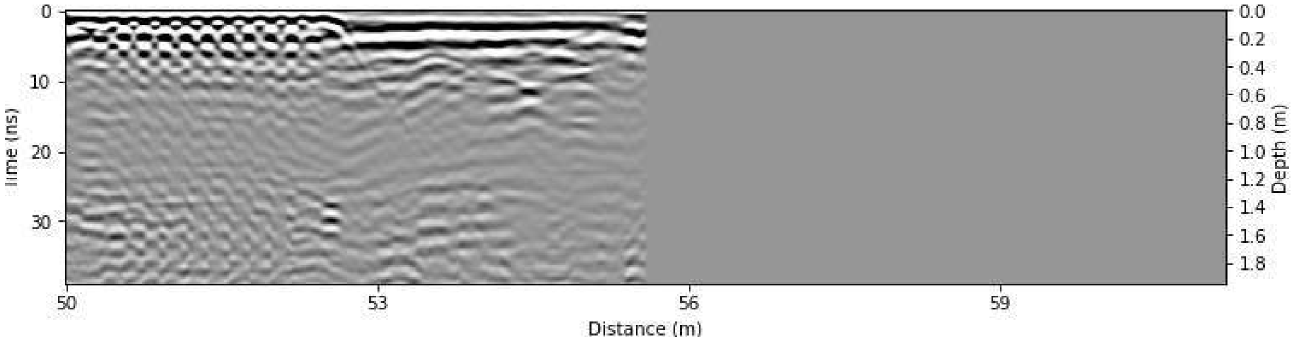


Figure B.626: Radargram at x = 22.0 m.

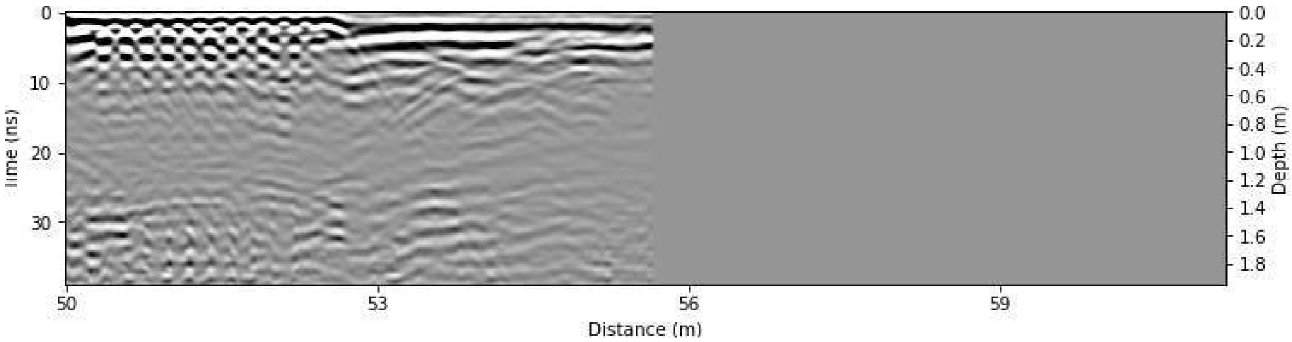


Figure B.627: Radargram at x = 22.25 m.

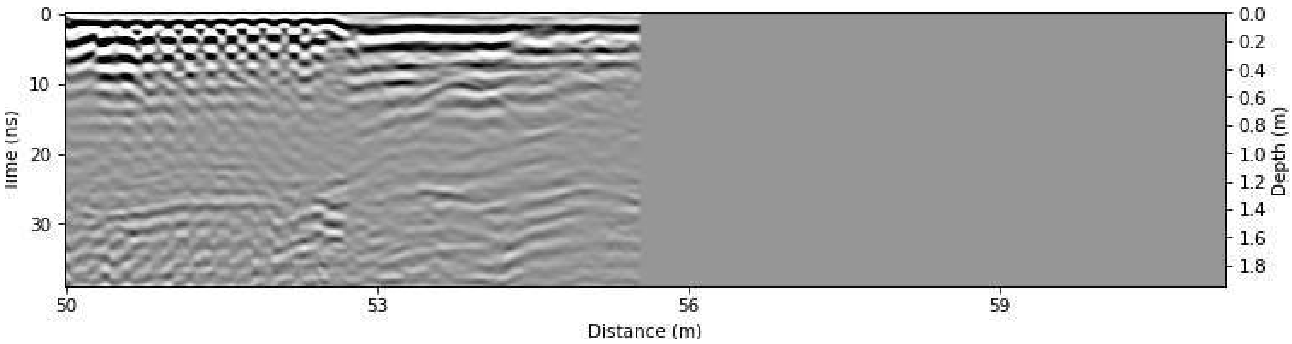


Figure B.628: Radargram at x = 22.5 m.

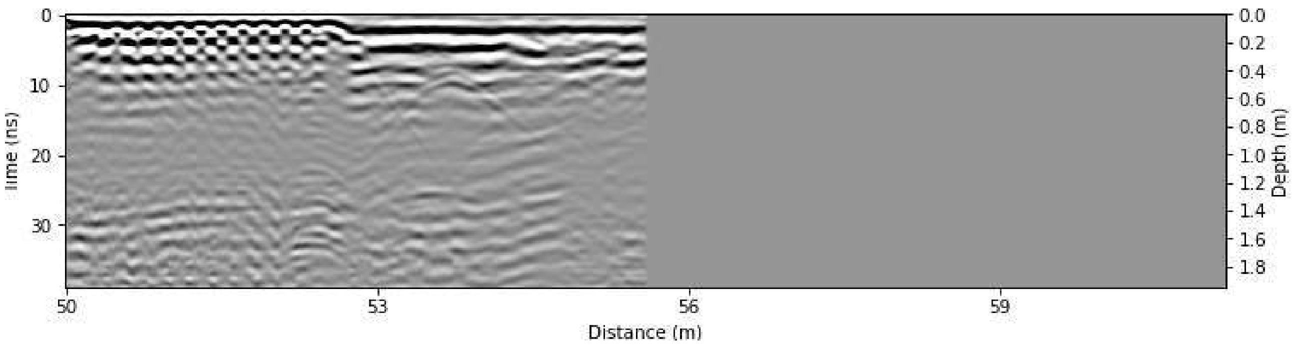


Figure B.629: Radargram at x = 22.75 m.

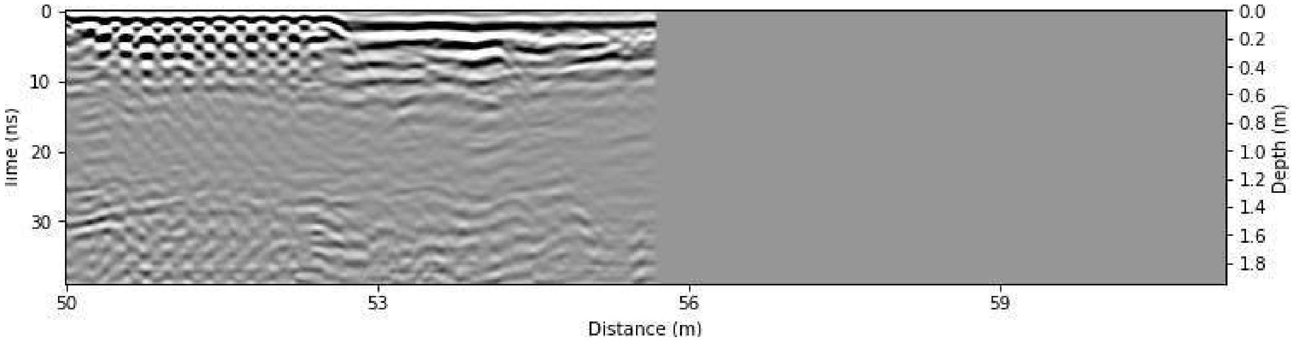


Figure B.630: Radargram at x = 23.0 m.

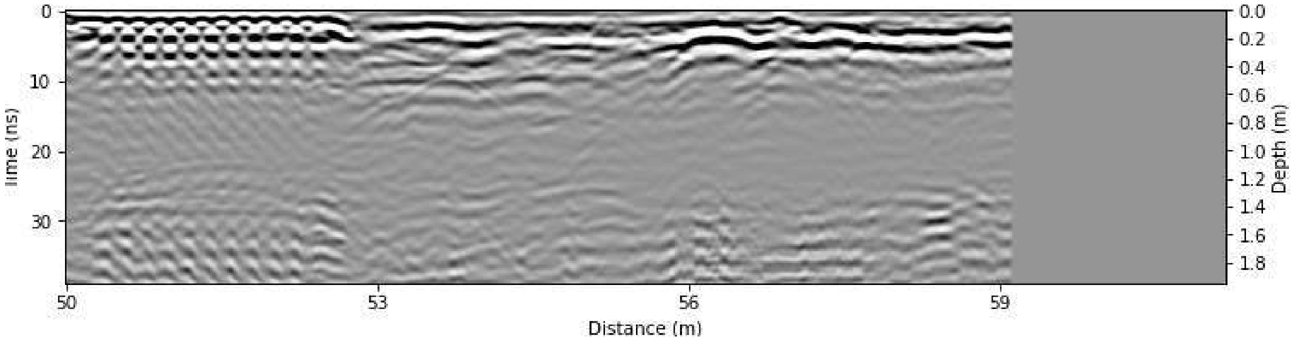


Figure B.631: Radargram at x = 23.25 m.

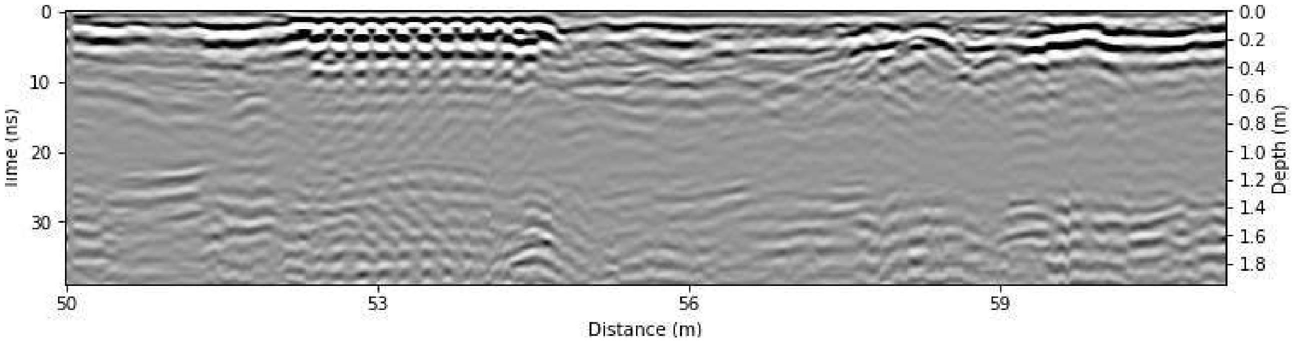


Figure B.632: Radargram at x = 23.5 m.

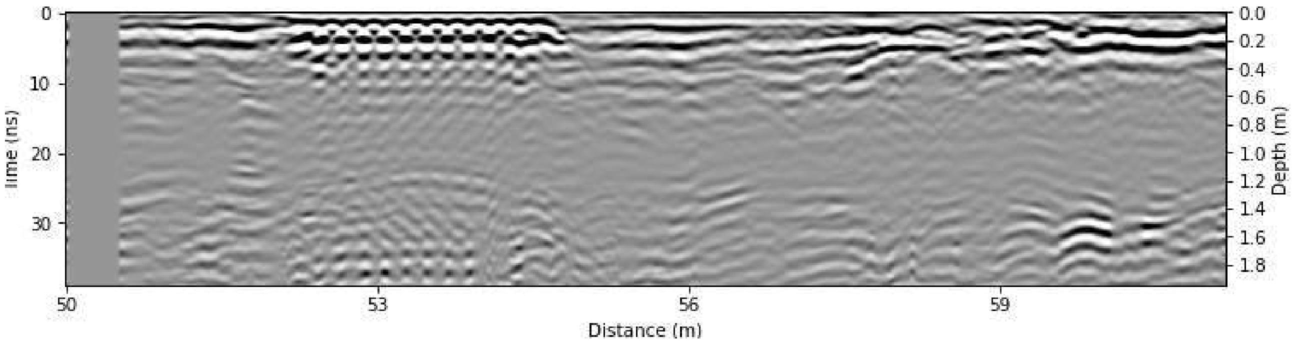


Figure B.633: Radargram at x = 23.75 m.

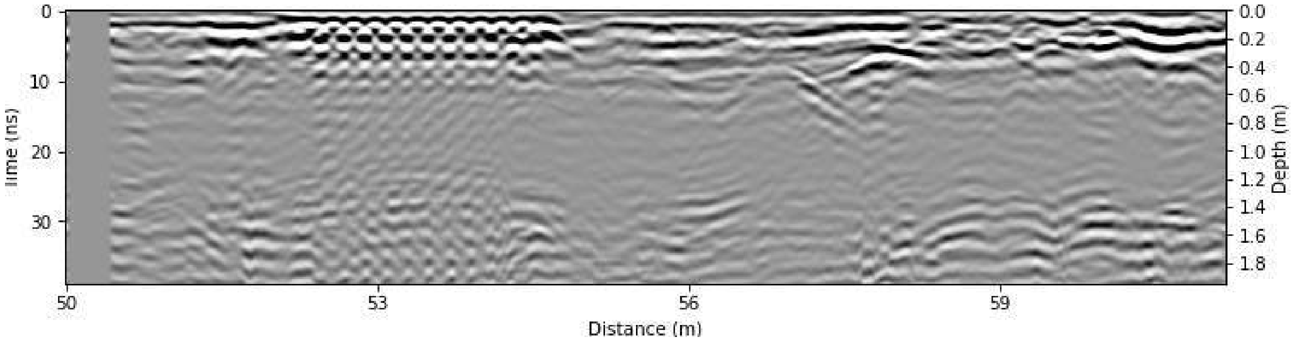


Figure B.634: Radargram at x = 24.0 m.

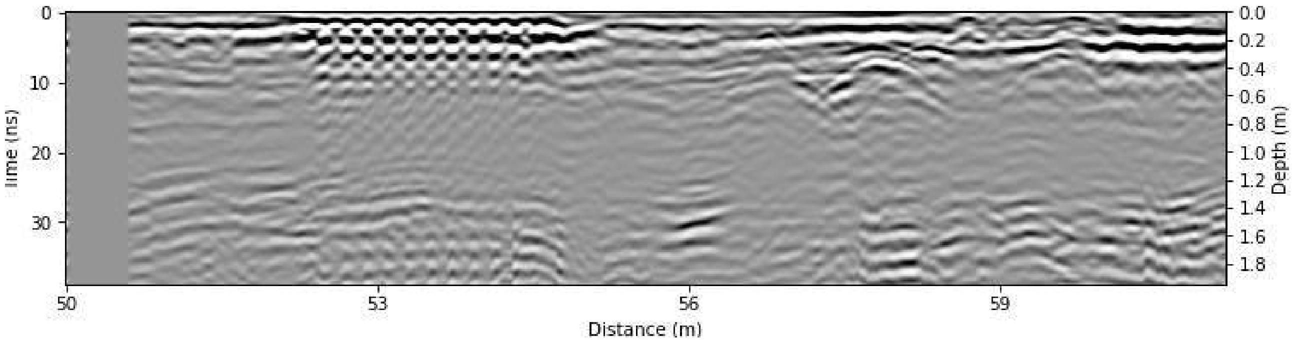


Figure B.635: Radargram at x = 24.25 m.

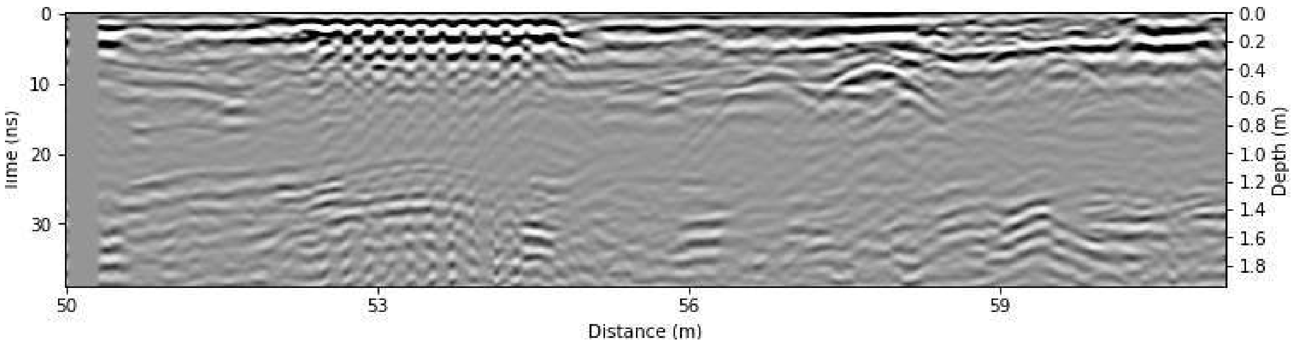


Figure B.636: Radargram at x = 24.5 m.

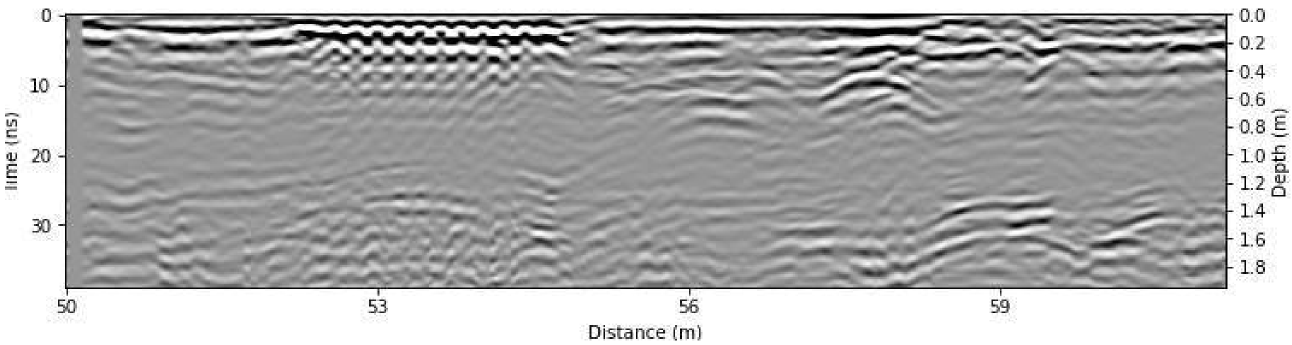


Figure B.637: Radargram at x = 24.75 m.

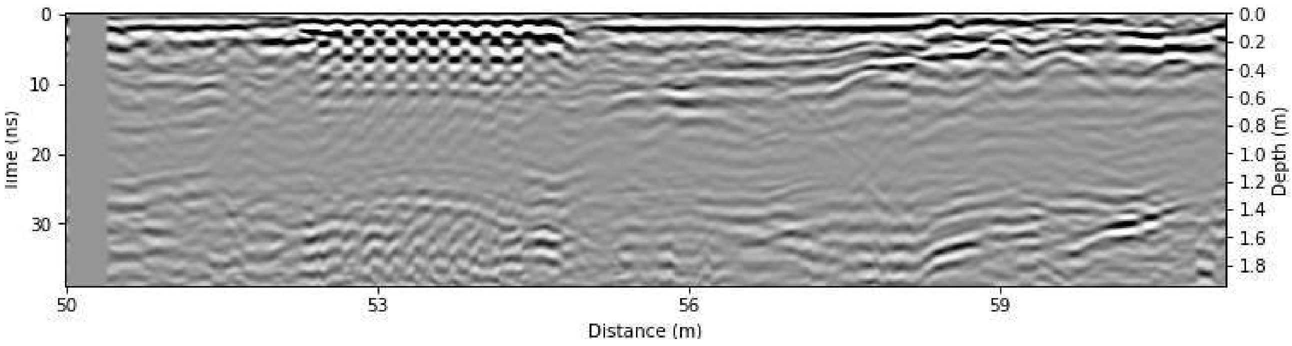


Figure B.638: Radargram at x = 25.0 m.

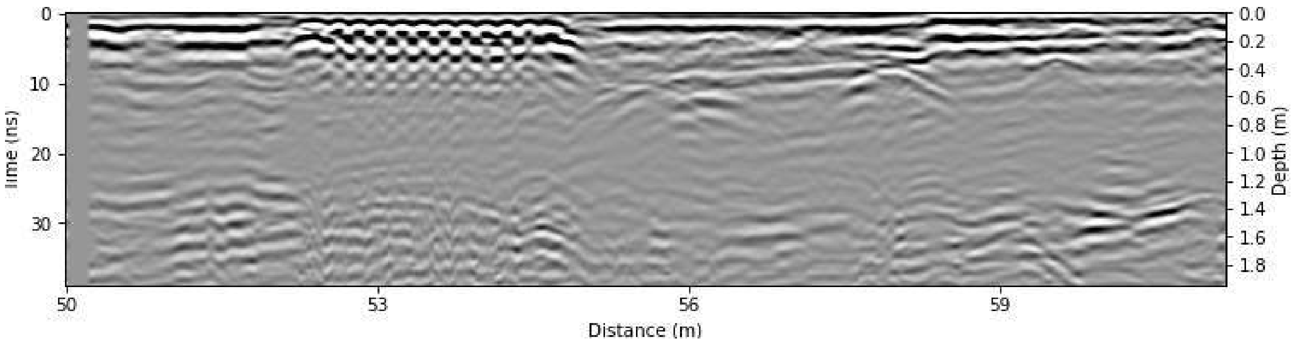


Figure B.639: Radargram at x = 25.25 m.

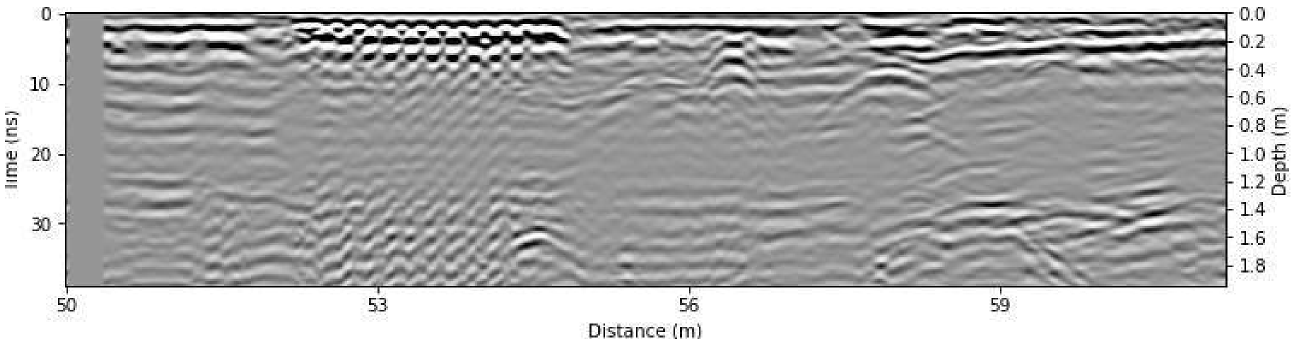


Figure B.640: Radargram at x = 25.5 m.

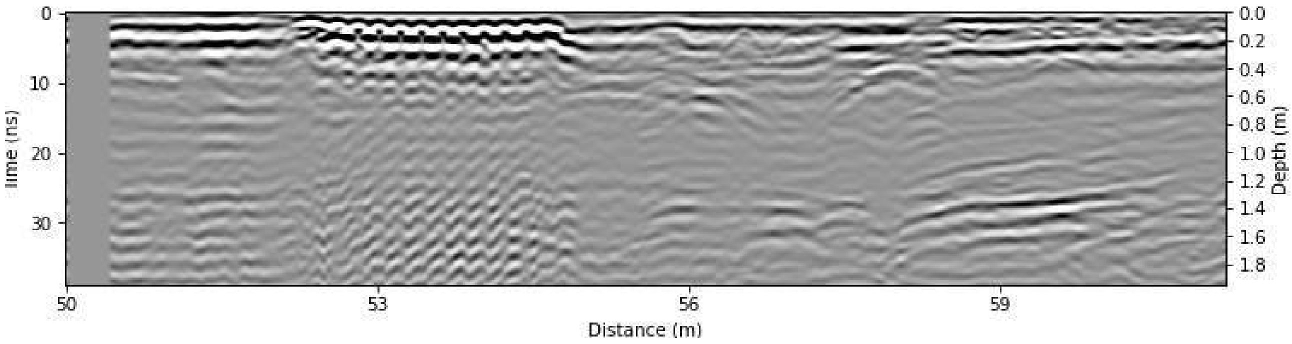


Figure B.641: Radargram at x = 25.75 m.

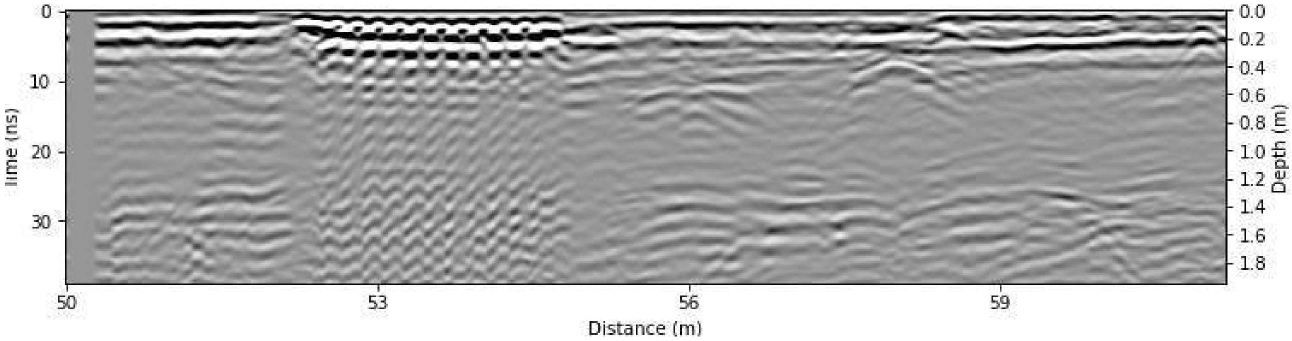


Figure B.642: Radargram at x = 26.0 m.

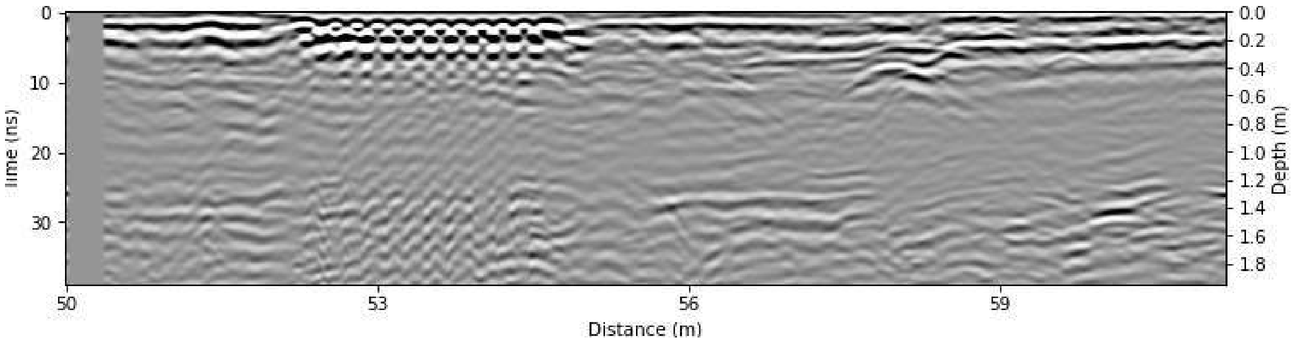


Figure B.643: Radargram at x = 26.25 m.

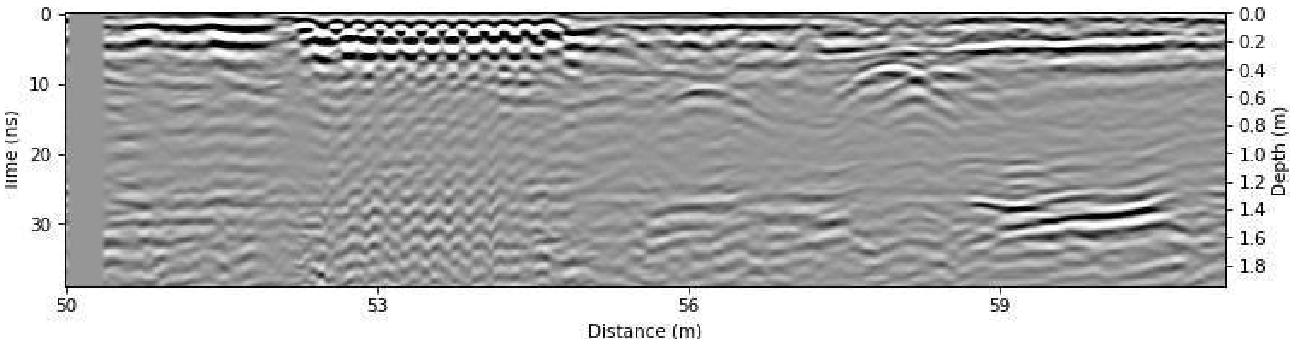


Figure B.644: Radargram at x = 26.5 m.

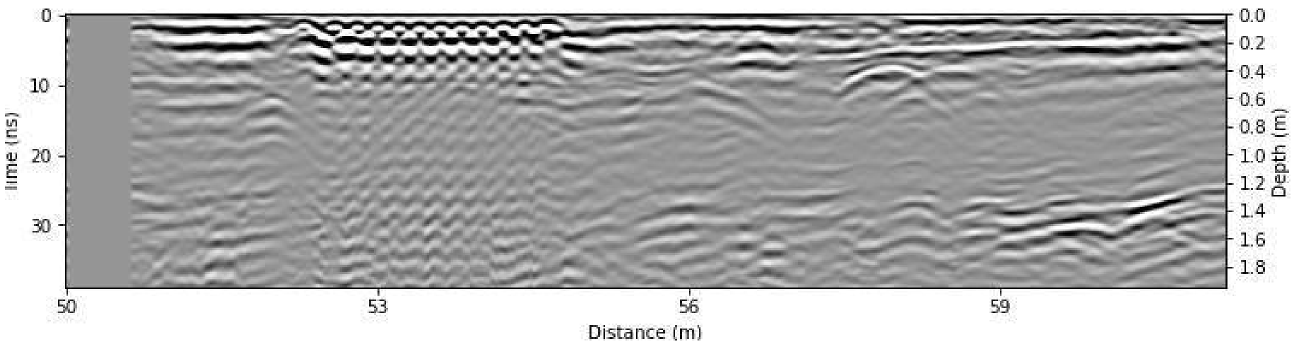


Figure B.645: Radargram at x = 26.75 m.

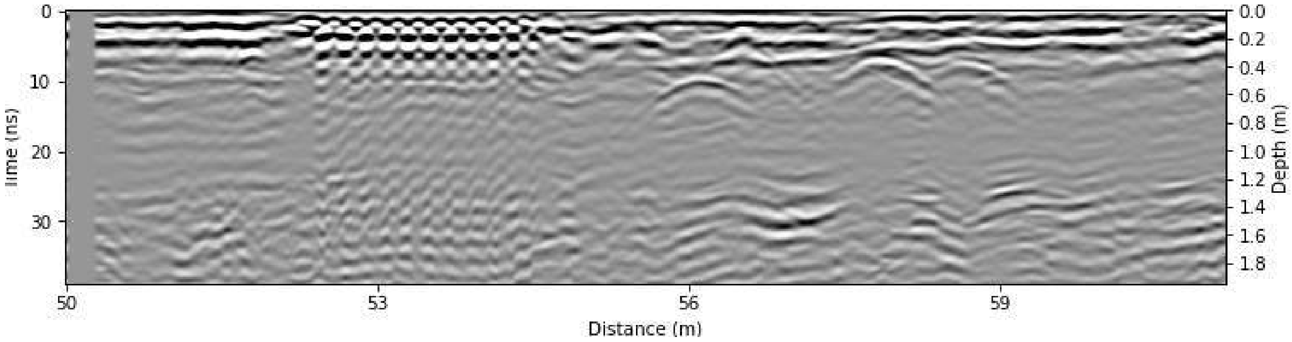


Figure B.646: Radargram at x = 27.0 m.

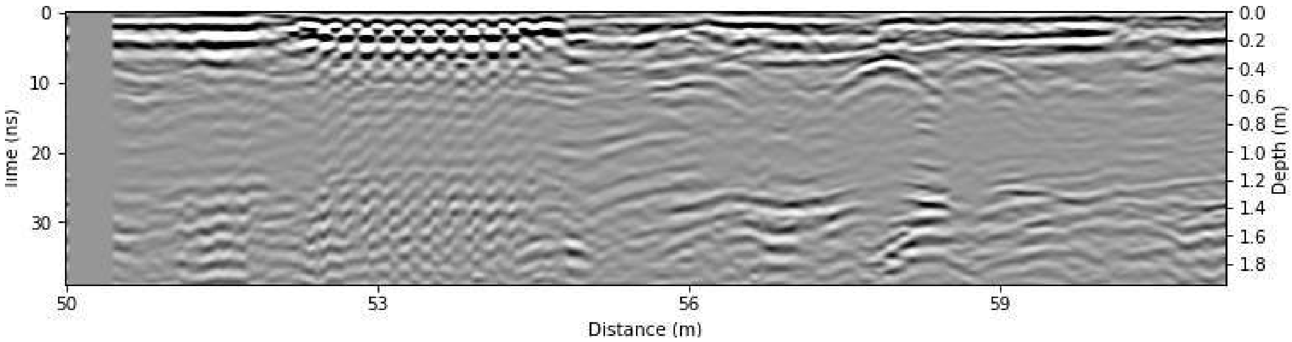


Figure B.647: Radargram at x = 27.25 m.

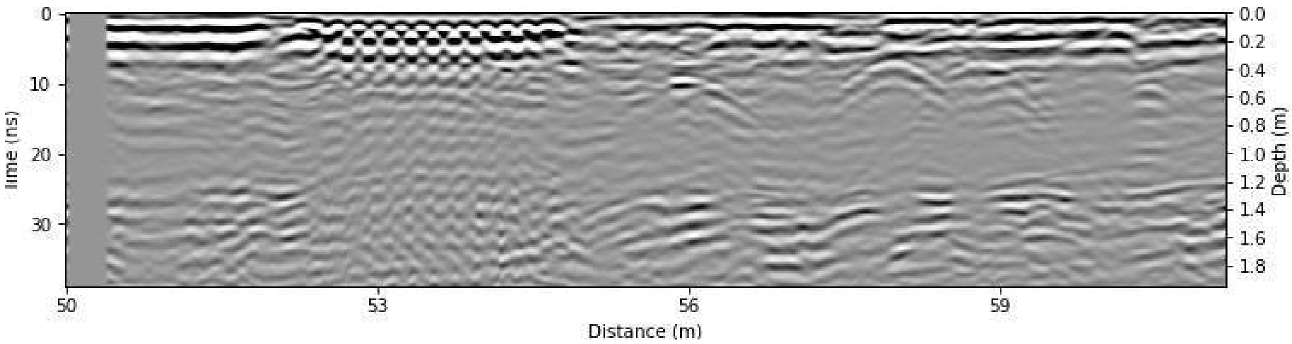


Figure B.648: Radargram at x = 27.5 m.

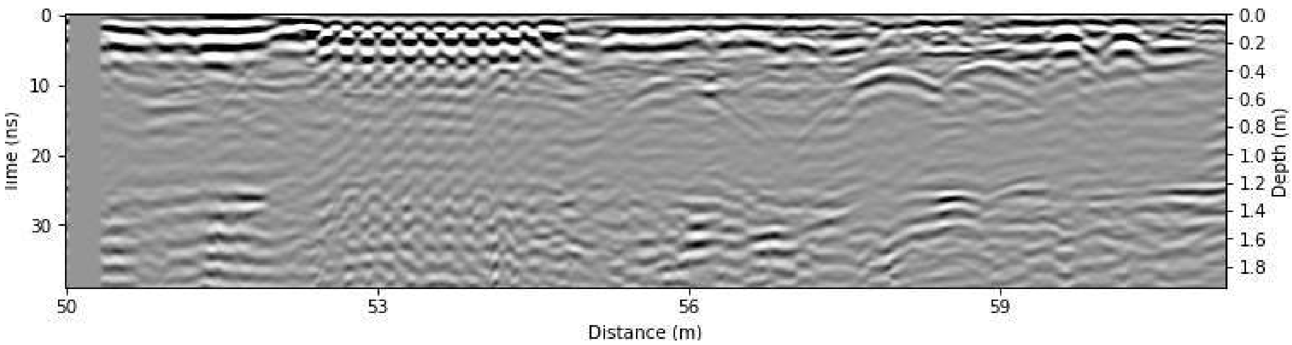


Figure B.649: Radargram at x = 27.75 m.

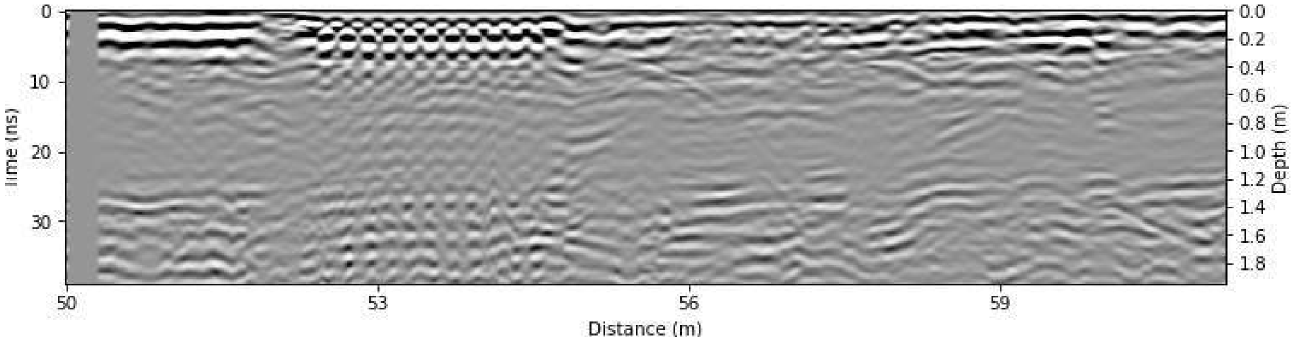


Figure B.650: Radargram at x = 28.0 m.

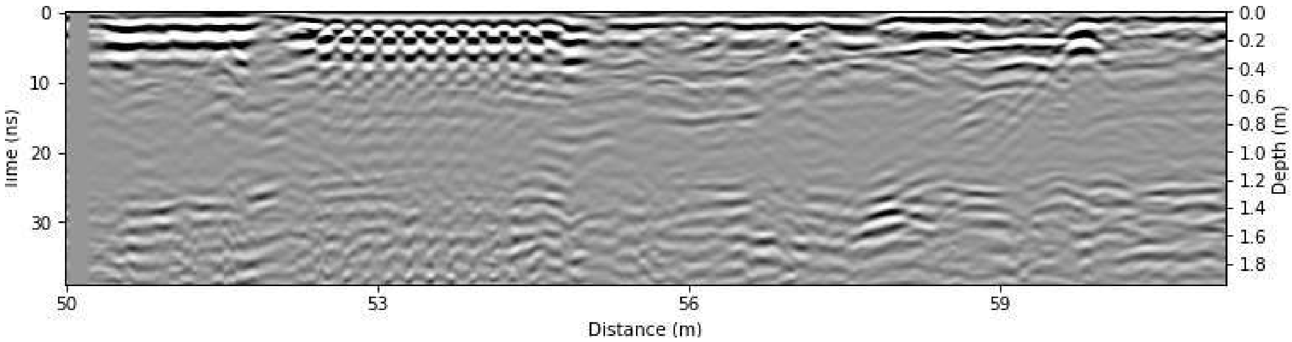


Figure B.651: Radargram at x = 28.25 m.

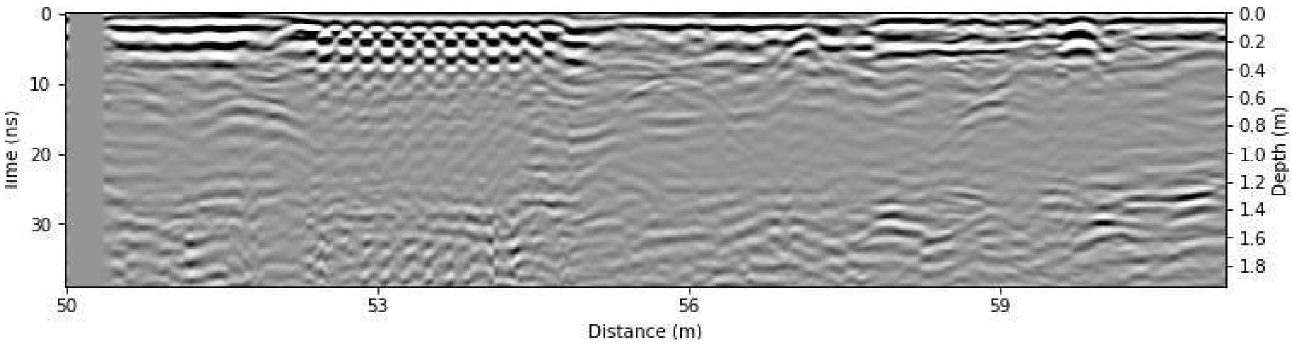


Figure B.652: Radargram at x = 28.5 m.

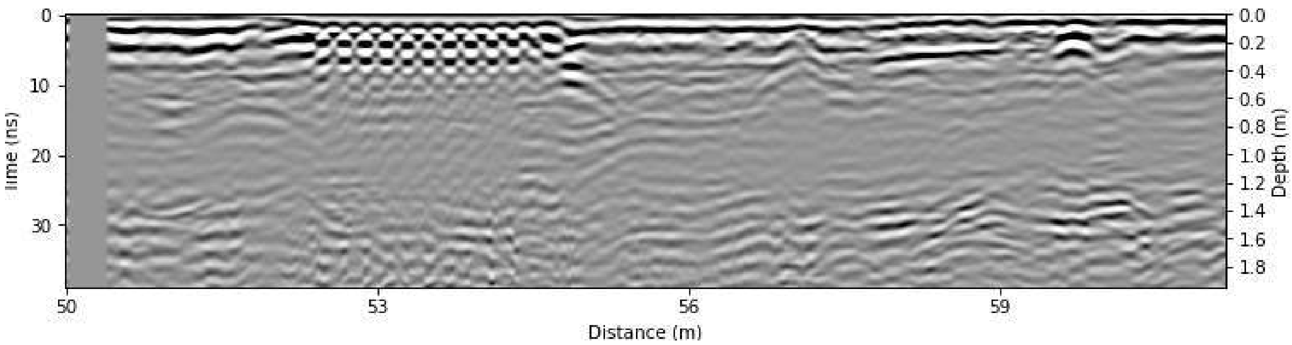


Figure B.653: Radargram at x = 28.75 m.

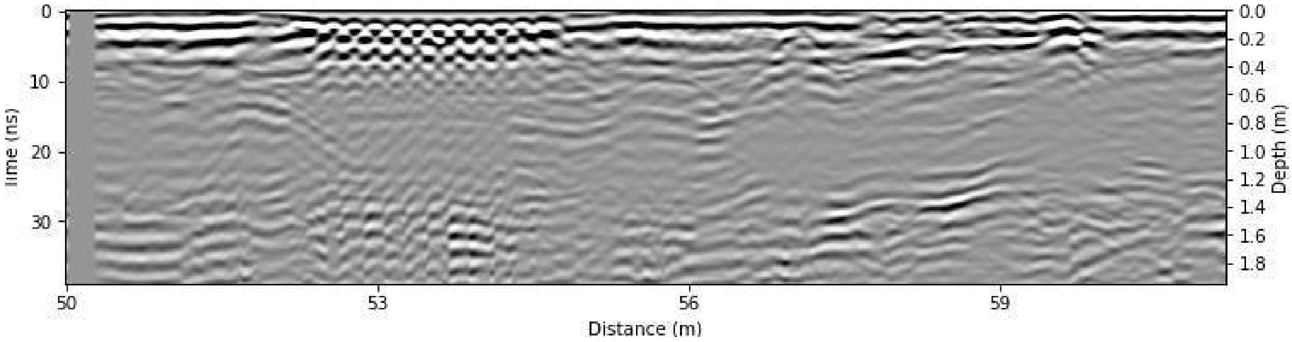


Figure B.654: Radargram at x = 29.0 m.

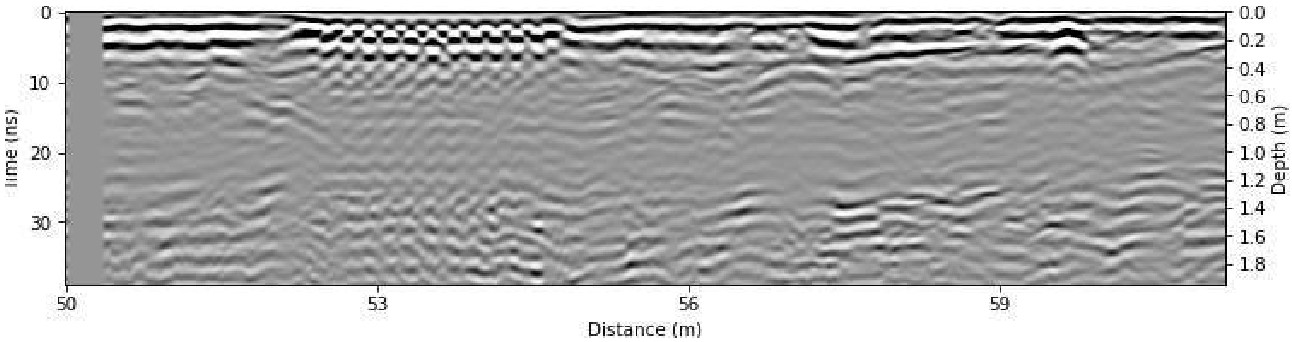


Figure B.655: Radargram at x = 29.25 m.

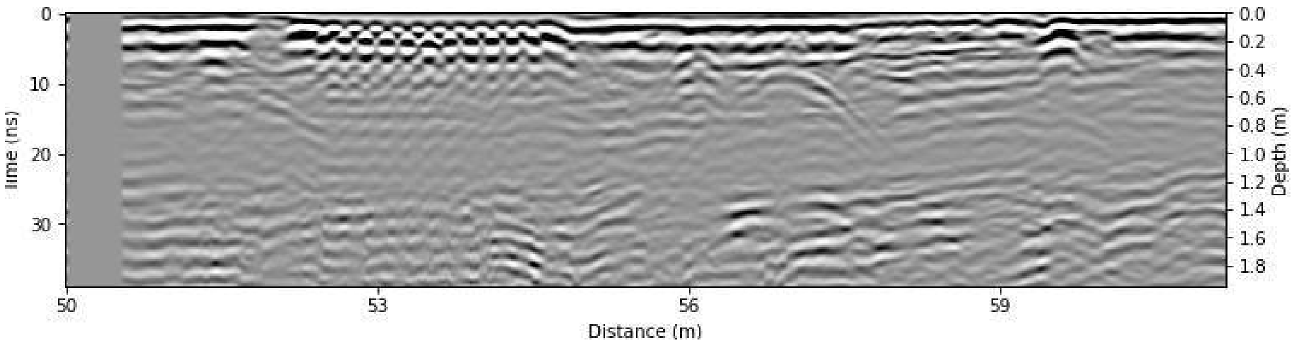


Figure B.656: Radargram at x = 29.5 m.

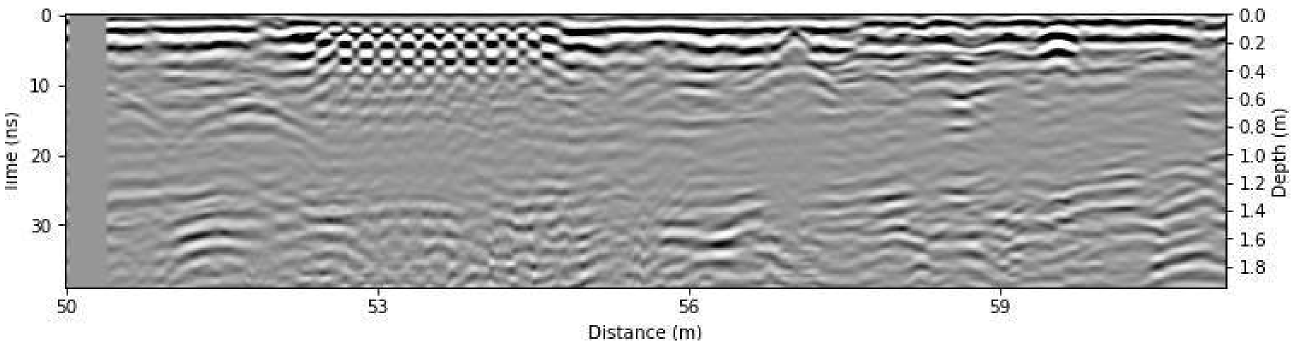


Figure B.657: Radargram at x = 29.75 m.

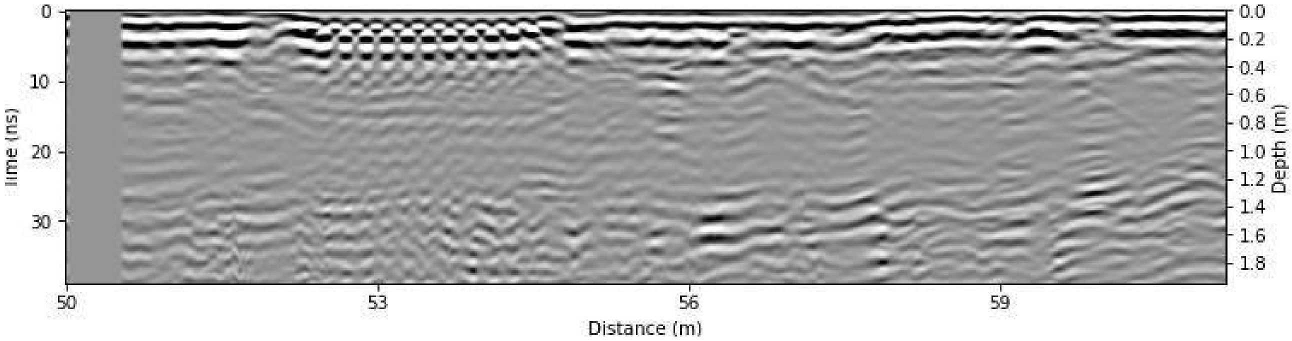
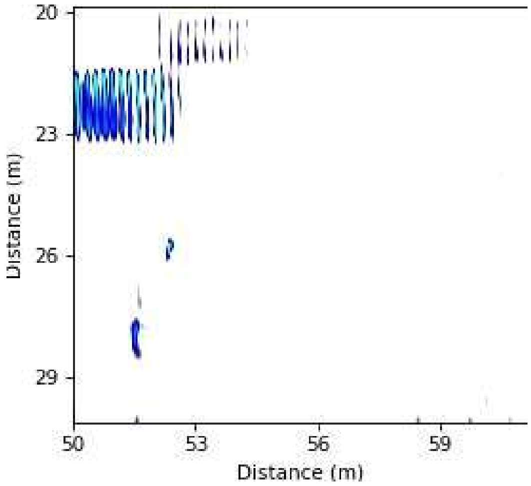
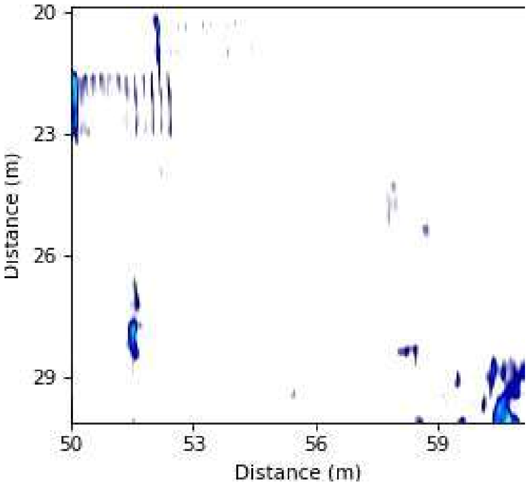


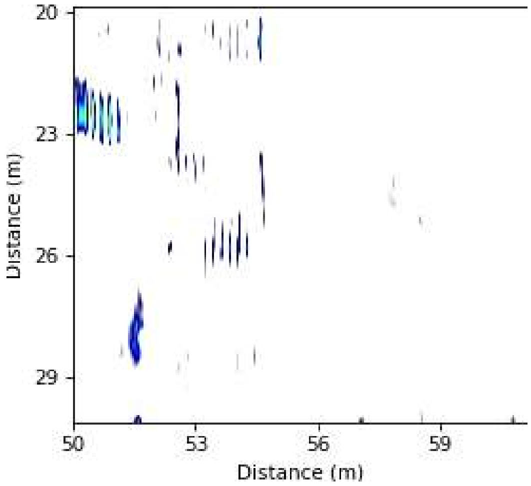
Figure B.658: Radargram at x = 30.0 m.



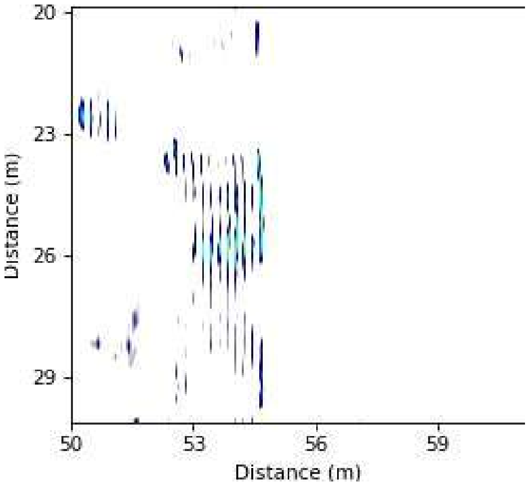
(a) Timeslice at z = 0.0 m.



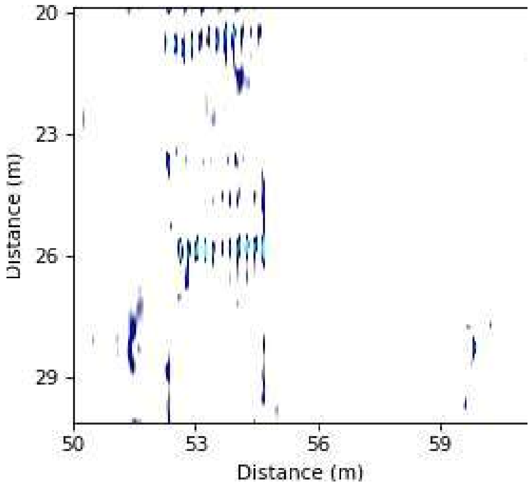
(b) Timeslice at z = 0.05 m.



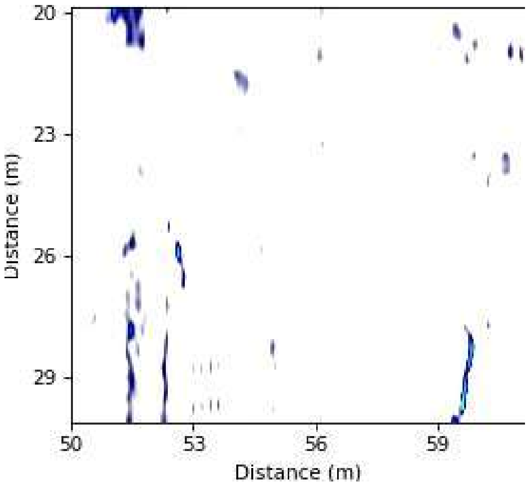
(c) Timeslice at z = 0.1 m.



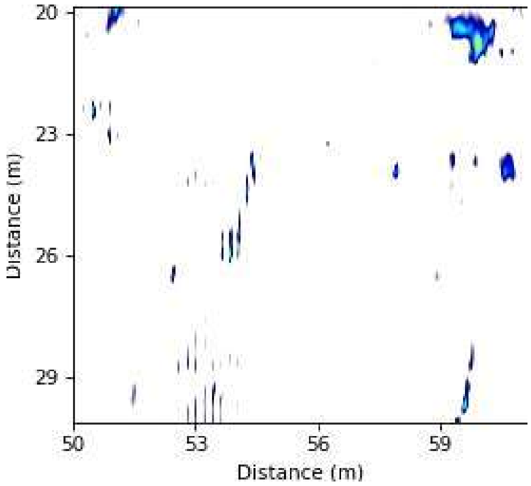
(d) Timeslice at z = 0.15 m.



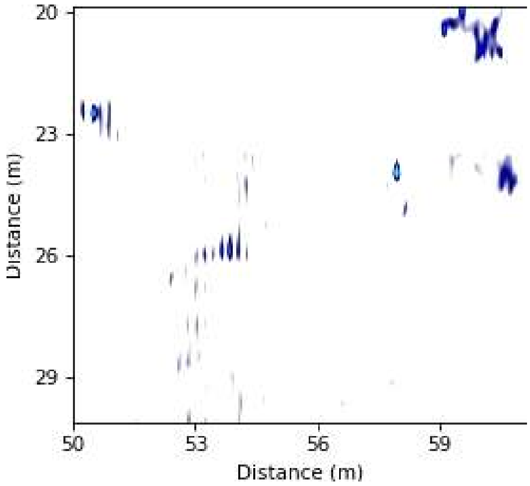
(e) Timeslice at z = 0.2 m.



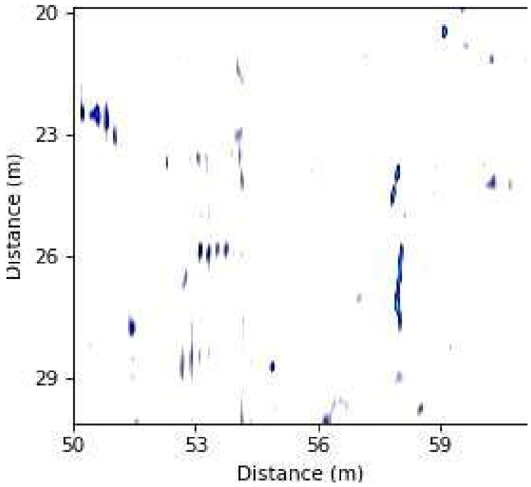
(f) Timeslice at z = 0.25 m.



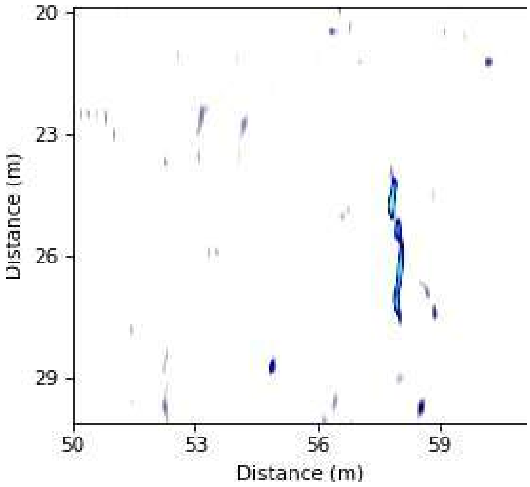
(a) Timeslice at z = 0.3 m.



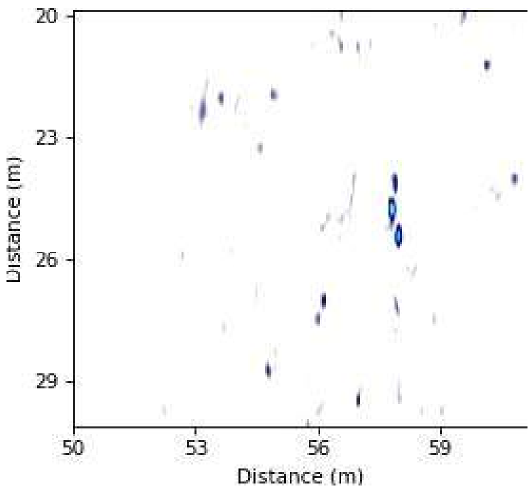
(b) Timeslice at z = 0.35 m.



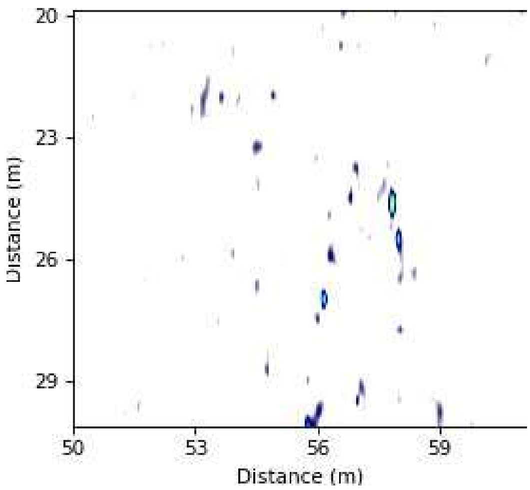
(c) Timeslice at z = 0.4 m.



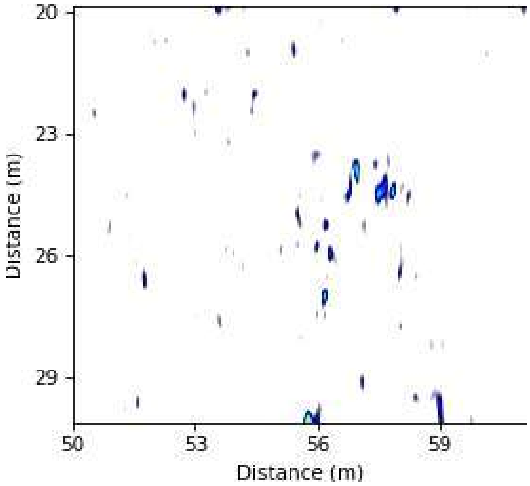
(d) Timeslice at z = 0.45 m.



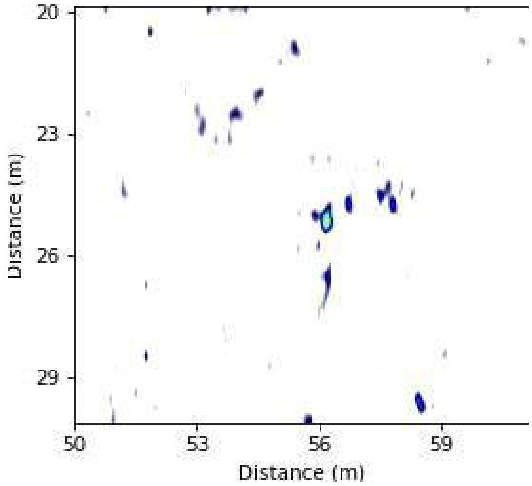
(e) Timeslice at z = 0.5 m.



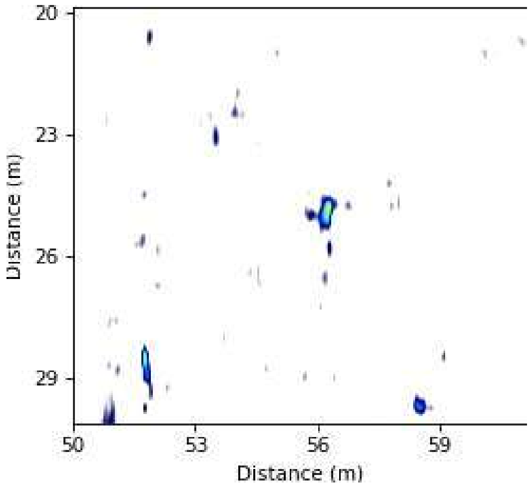
(f) Timeslice at z = 0.55 m.



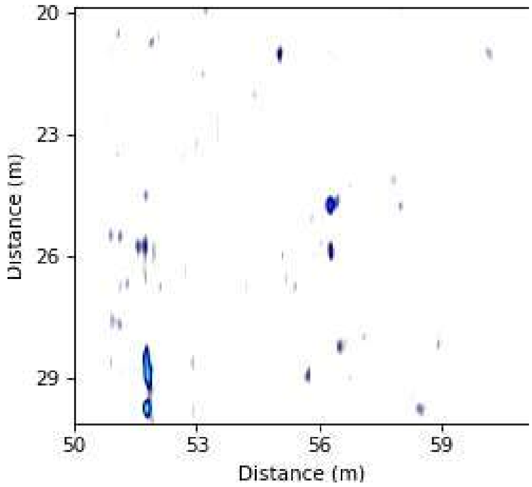
(a) Timeslice at z = 0.6 m.



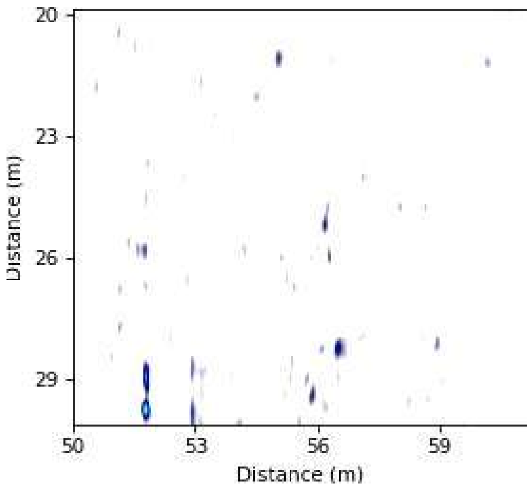
(b) Timeslice at z = 0.65 m.



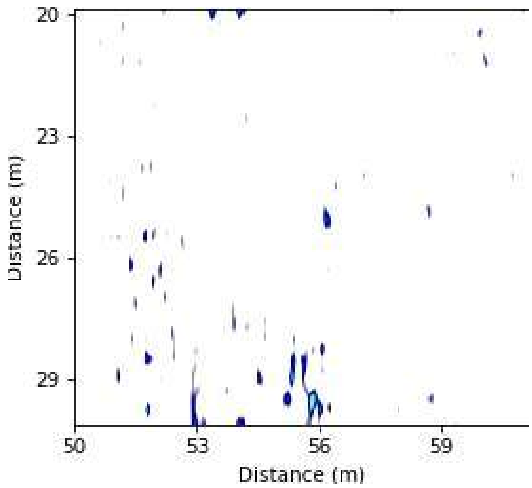
(c) Timeslice at z = 0.7 m.



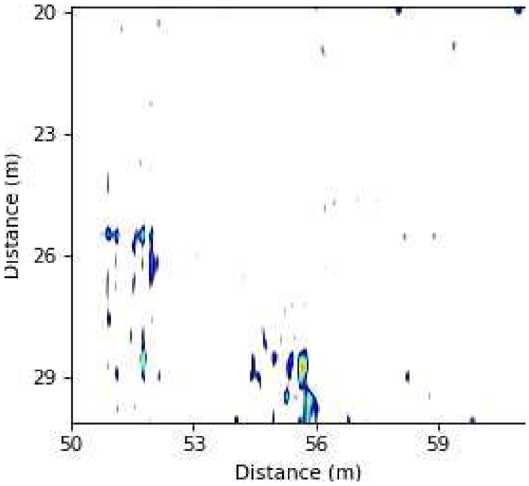
(d) Timeslice at z = 0.75 m.



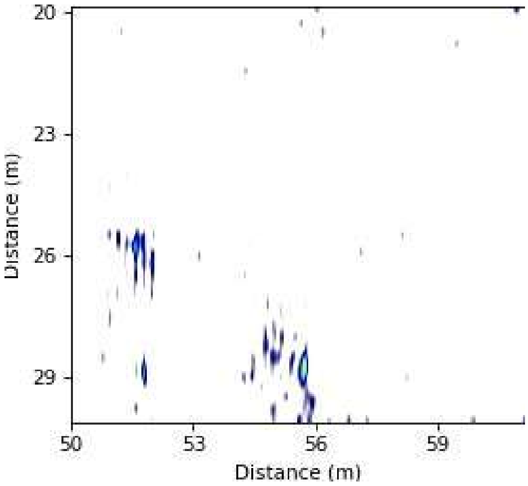
(e) Timeslice at z = 0.8 m.



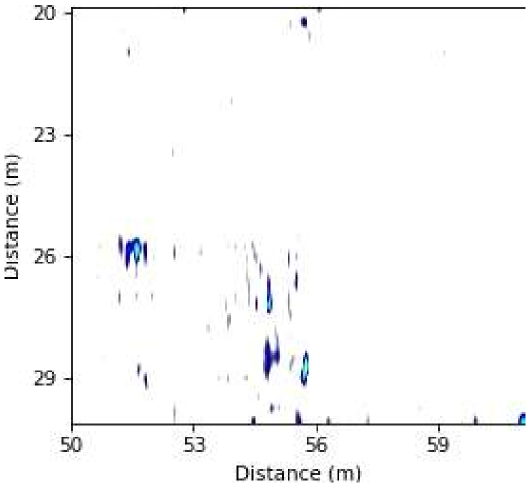
(f) Timeslice at z = 0.85 m.



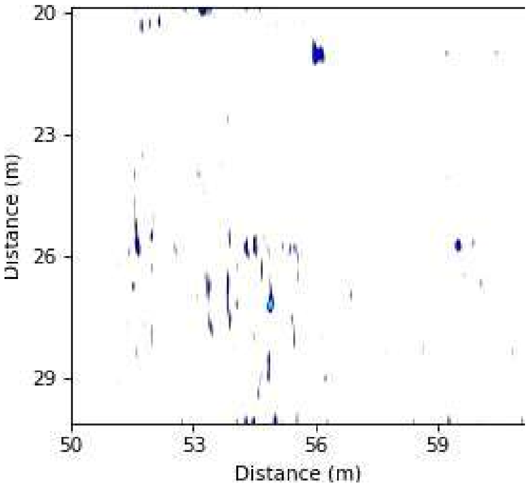
(a) Timeslice at z = 0.9 m.



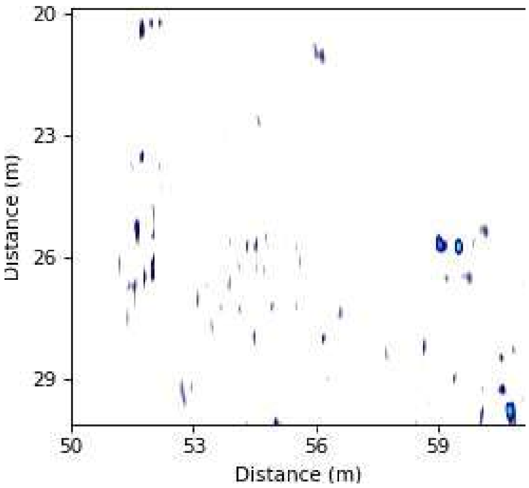
(b) Timeslice at z = 0.95 m.



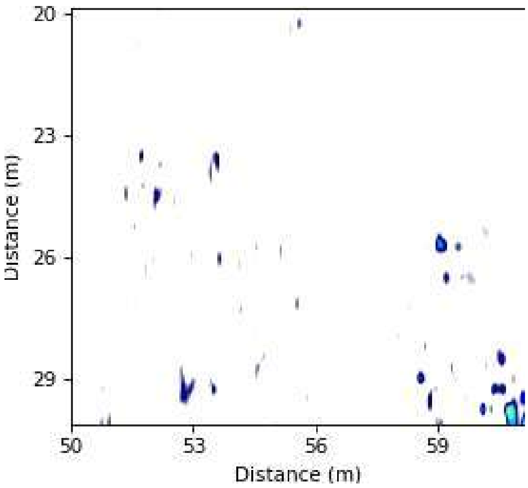
(c) Timeslice at z = 1.0 m.



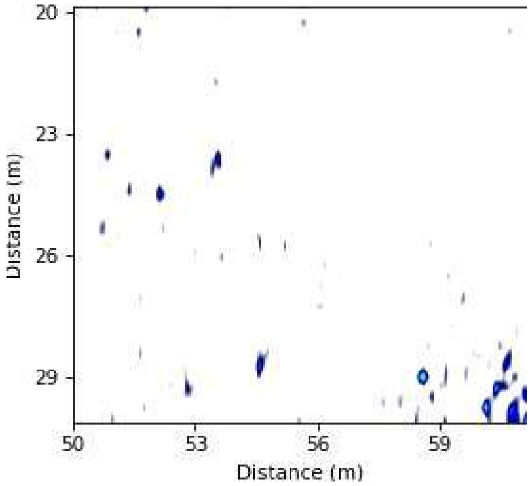
(d) Timeslice at z = 1.05 m.



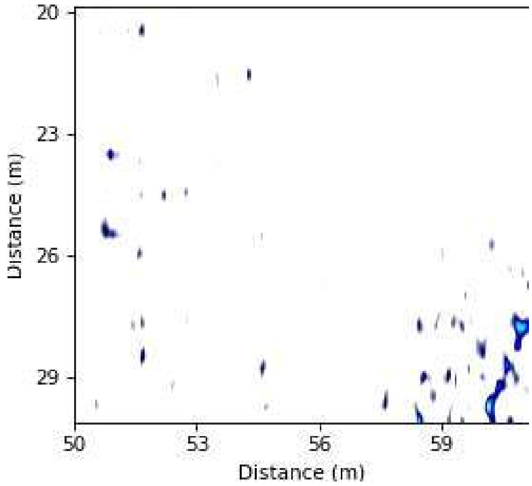
(e) Timeslice at z = 1.1 m.



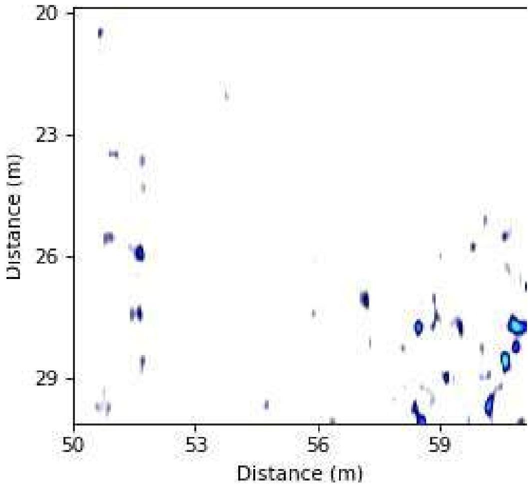
(f) Timeslice at z = 1.15 m.



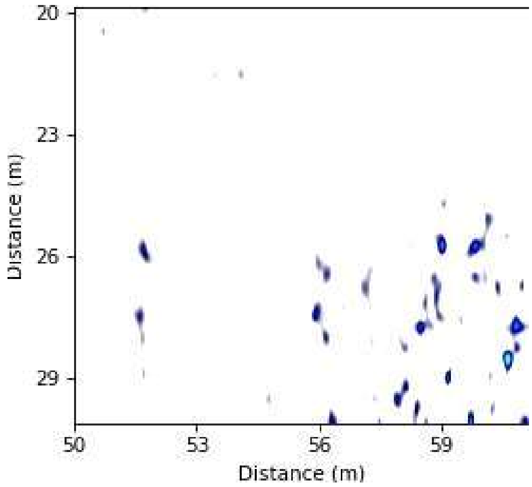
(a) Timeslice at z = 1.2 m.



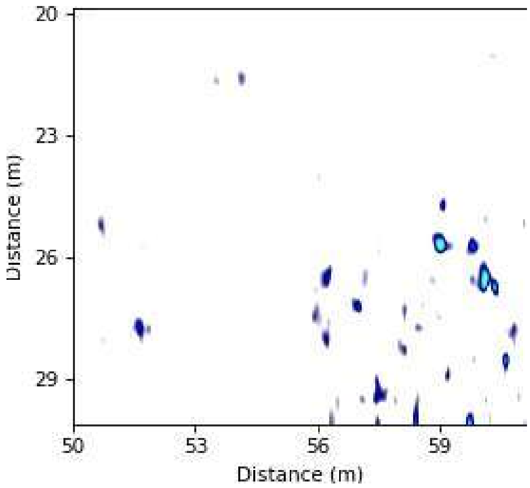
(b) Timeslice at z = 1.25 m.



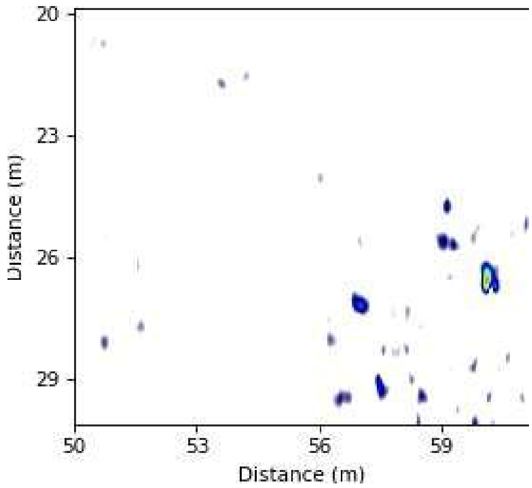
(c) Timeslice at z = 1.3 m.



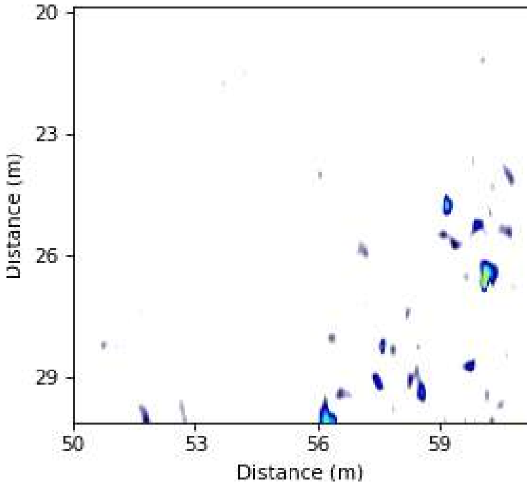
(d) Timeslice at z = 1.35 m.



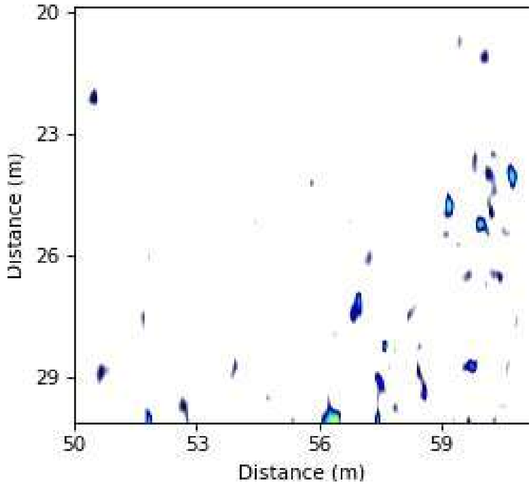
(e) Timeslice at z = 1.4 m.



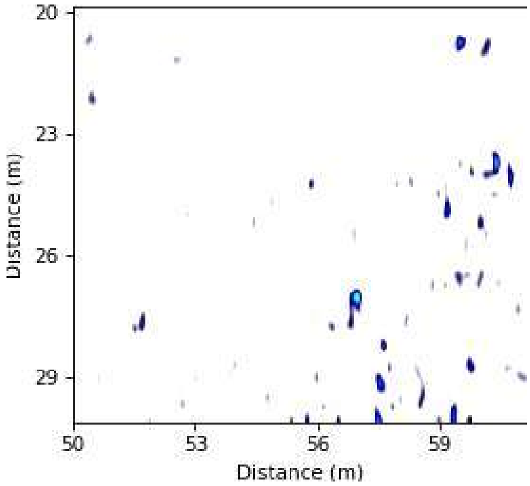
(f) Timeslice at z = 1.45 m.



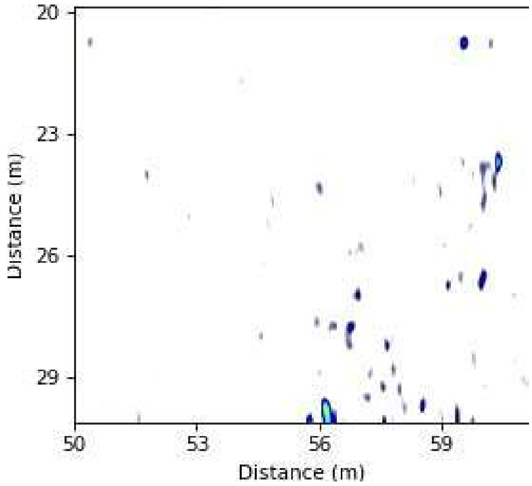
(a) Timeslice at z = 1.5 m.



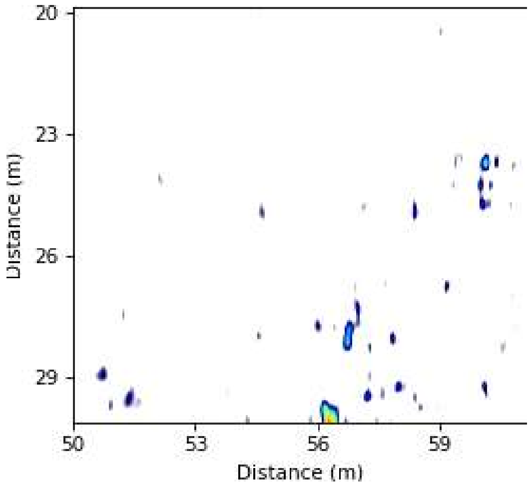
(b) Timeslice at z = 1.55 m.



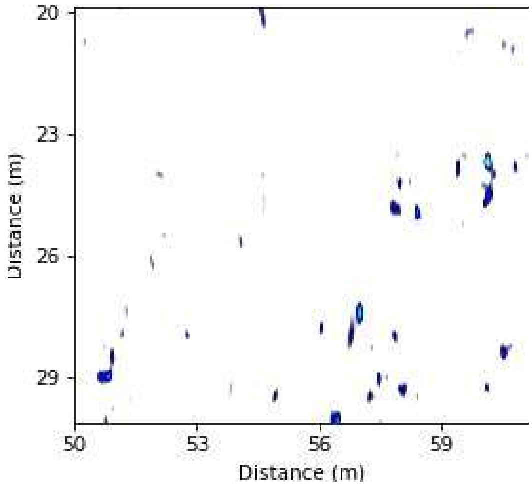
(c) Timeslice at z = 1.6 m.



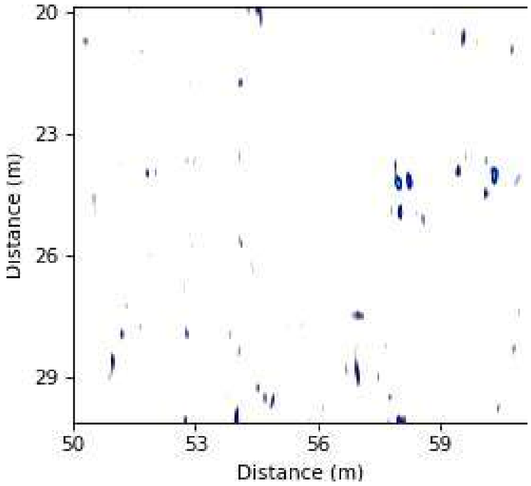
(d) Timeslice at z = 1.65 m.



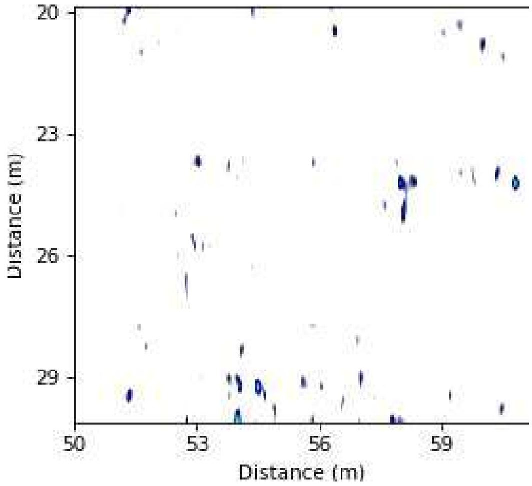
(e) Timeslice at z = 1.7 m.



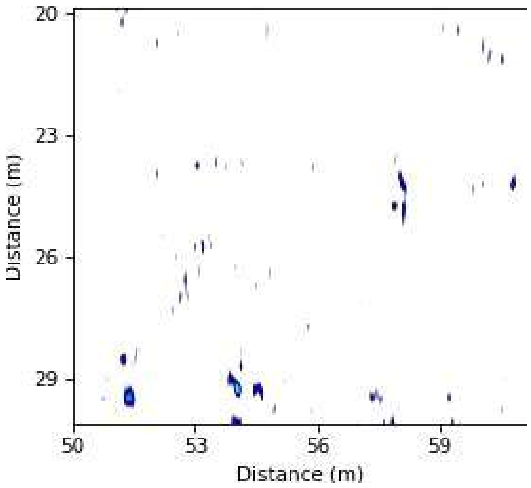
(f) Timeslice at z = 1.75 m.



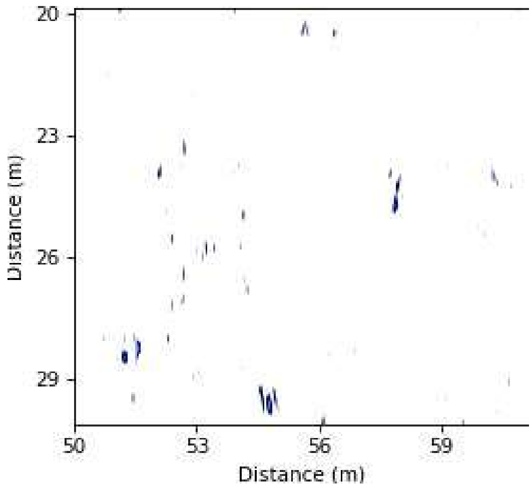
(a) Timeslice at z = 1.8 m.



(b) Timeslice at z = 1.85 m.



(c) Timeslice at z = 1.9 m.



(d) Timeslice at z = 1.95 m.

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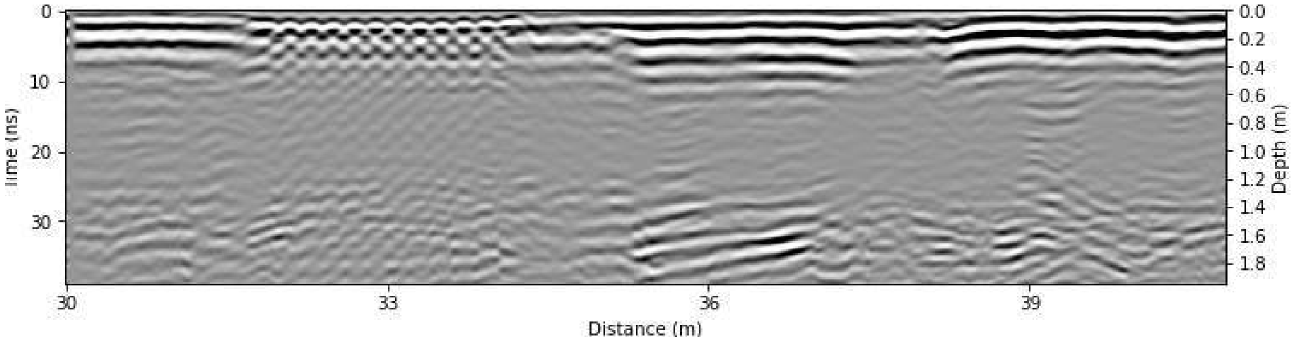


Figure B.666: Radargram at x = 90.0 m.

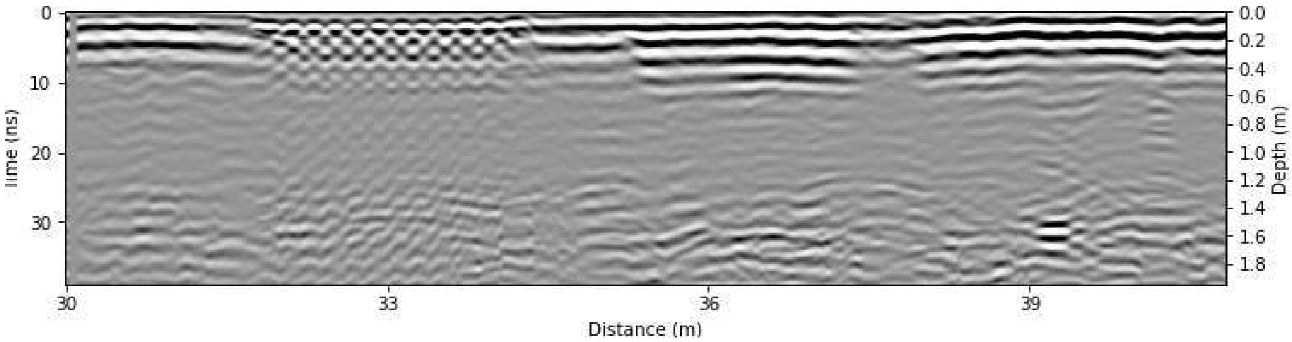


Figure B.667: Radargram at x = 90.25 m.

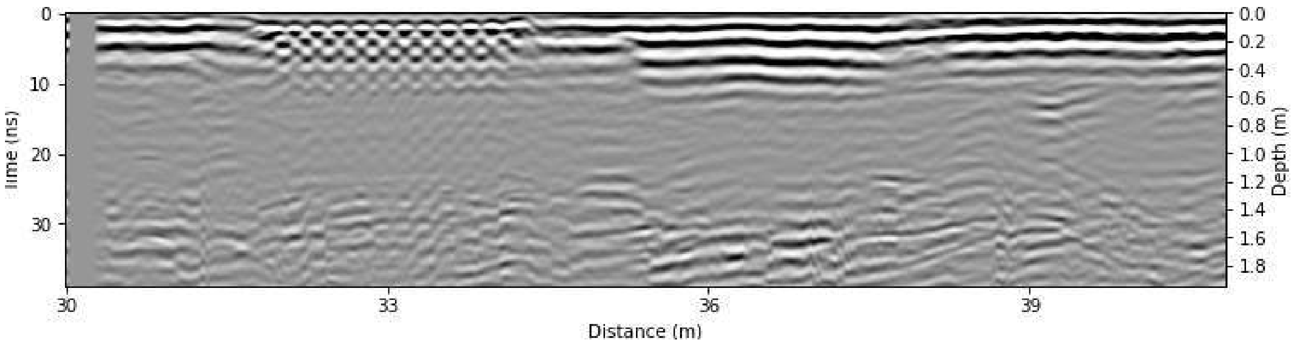


Figure B.668: Radargram at x = 90.5 m.

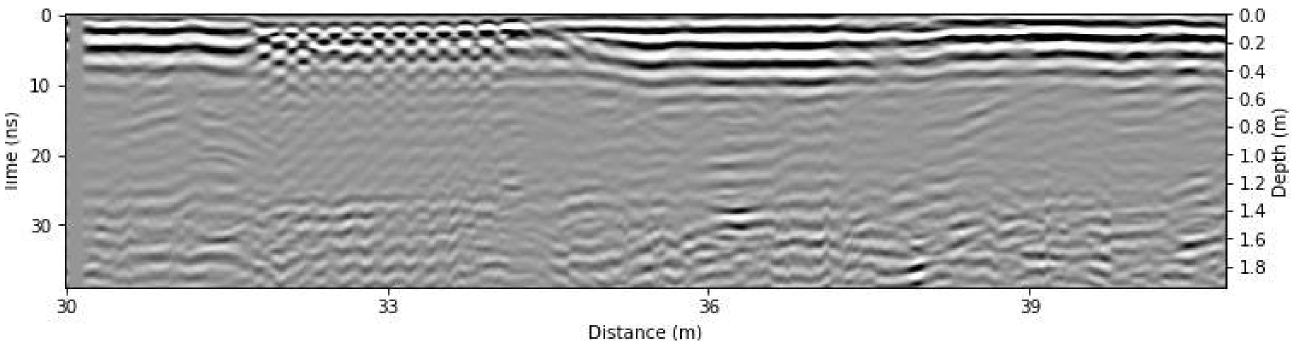


Figure B.669: Radargram at x = 90.75 m.

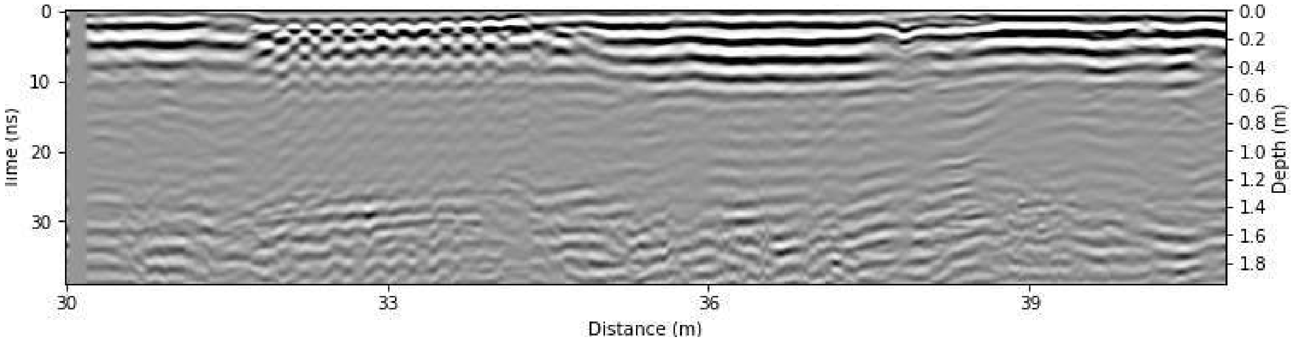


Figure B.670: Radargram at x = 91.0 m.

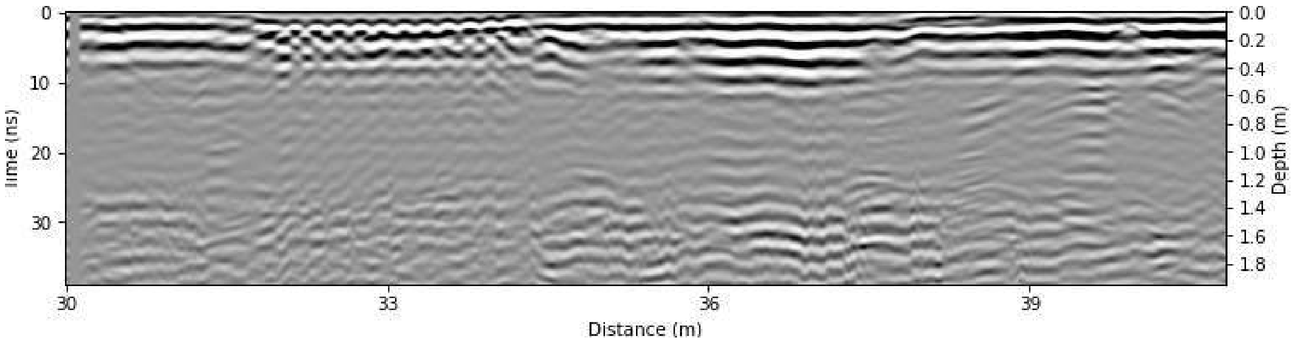


Figure B.671: Radargram at x = 91.25 m.

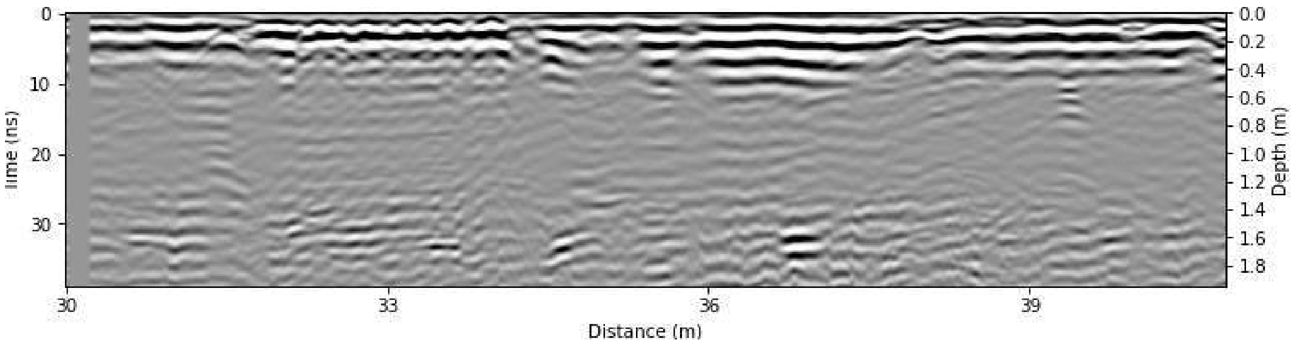


Figure B.672: Radargram at x = 91.5 m.

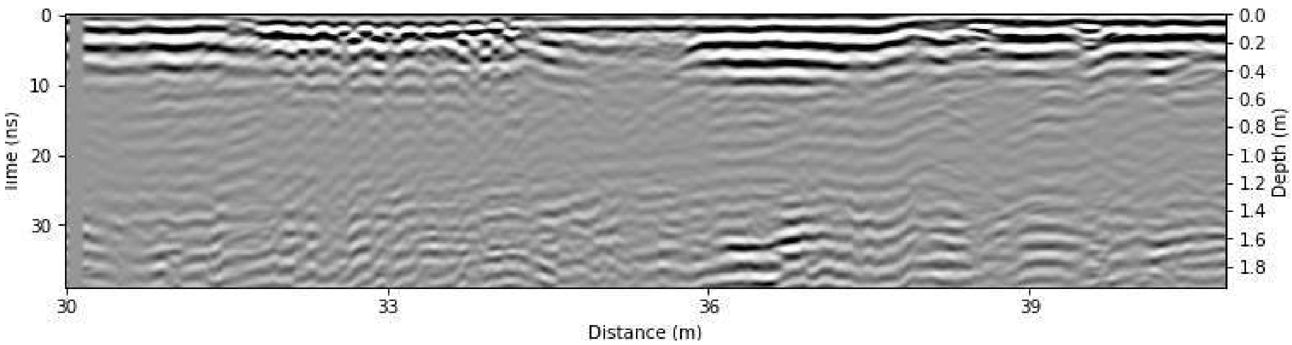


Figure B.673: Radargram at x = 91.75 m.

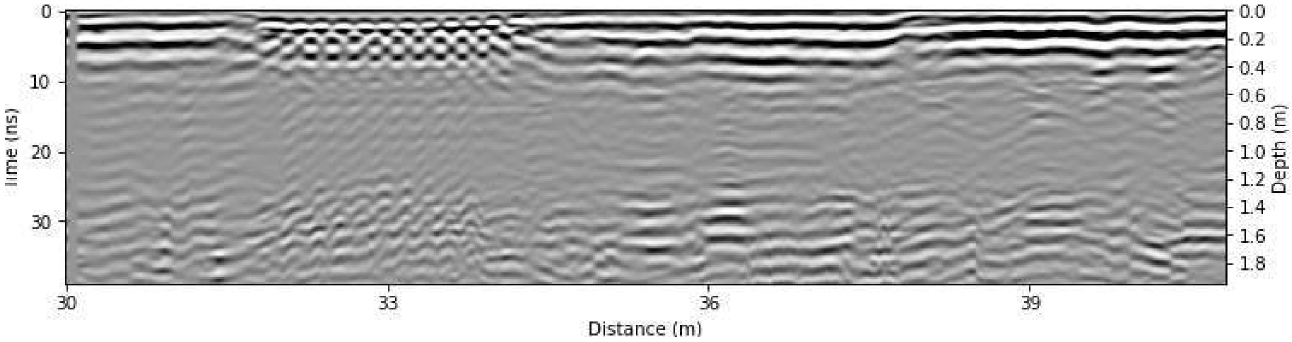


Figure B.674: Radargram at x = 92.0 m.

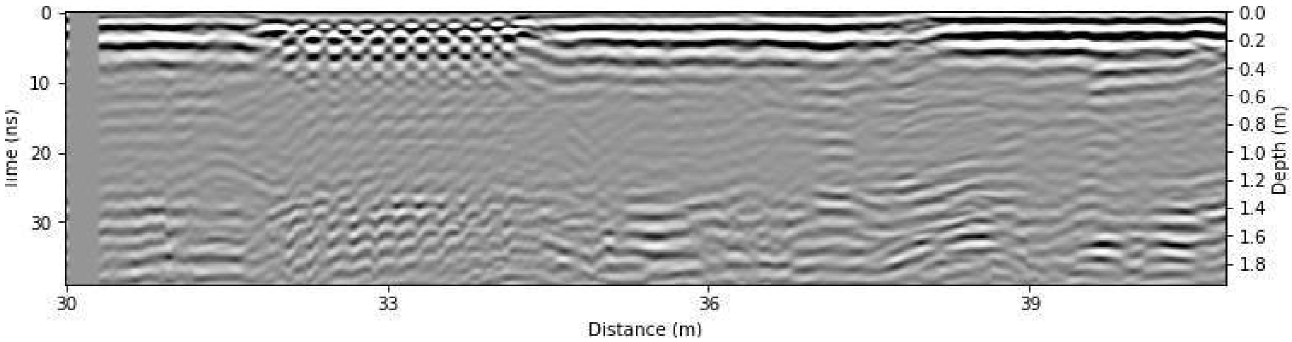


Figure B.675: Radargram at x = 92.25 m.

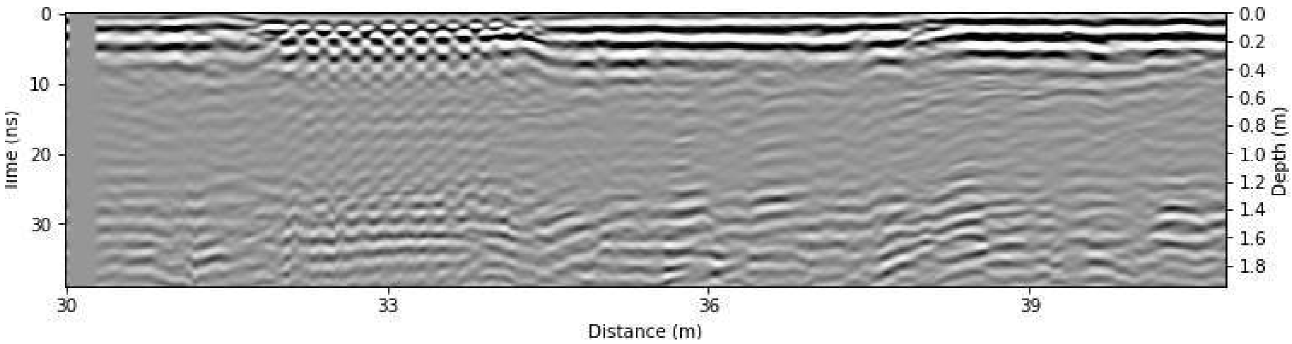


Figure B.676: Radargram at x = 92.5 m.

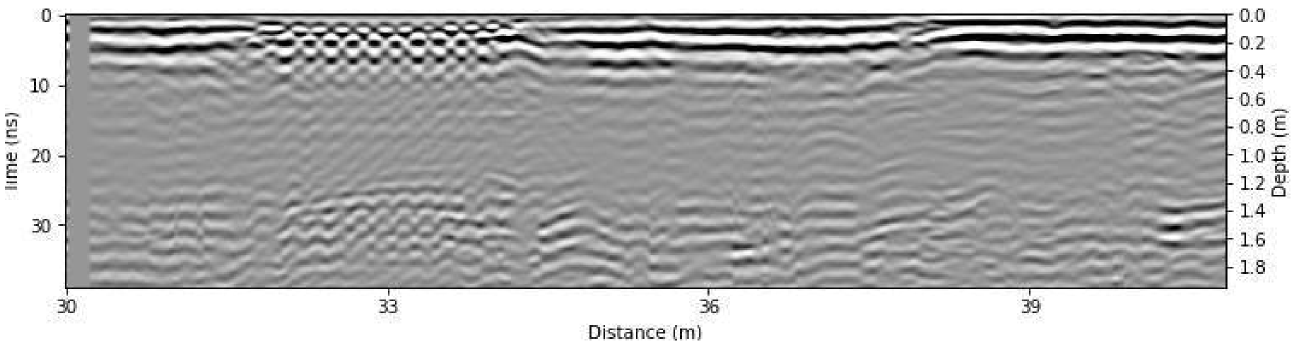


Figure B.677: Radargram at x = 92.75 m.

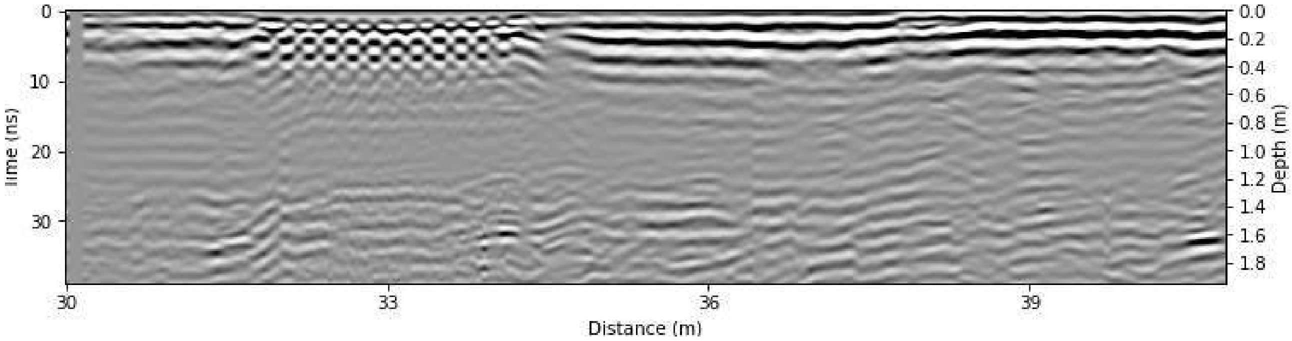


Figure B.678: Radargram at x = 93.0 m.

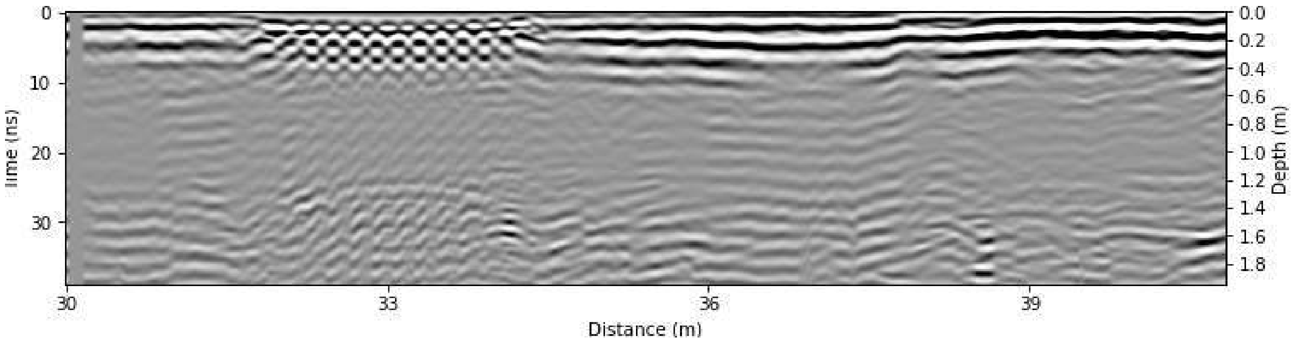


Figure B.679: Radargram at x = 93.25 m.

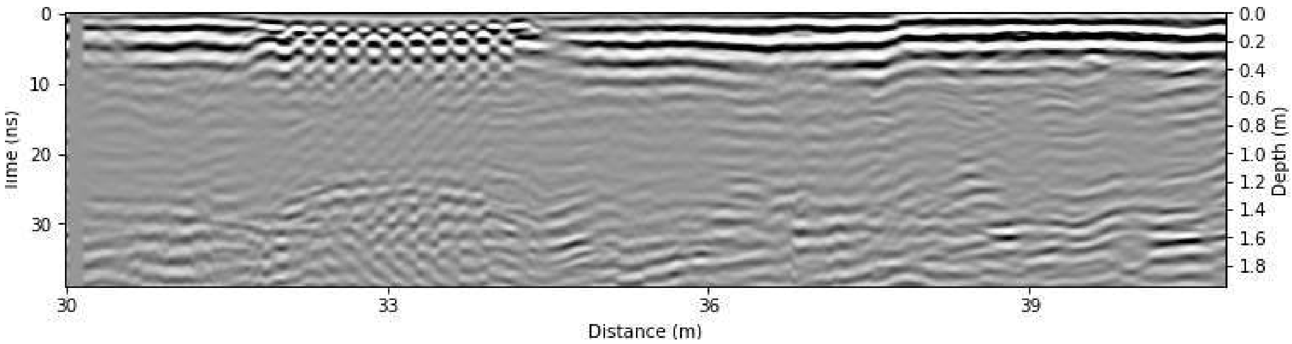


Figure B.680: Radargram at x = 93.5 m.

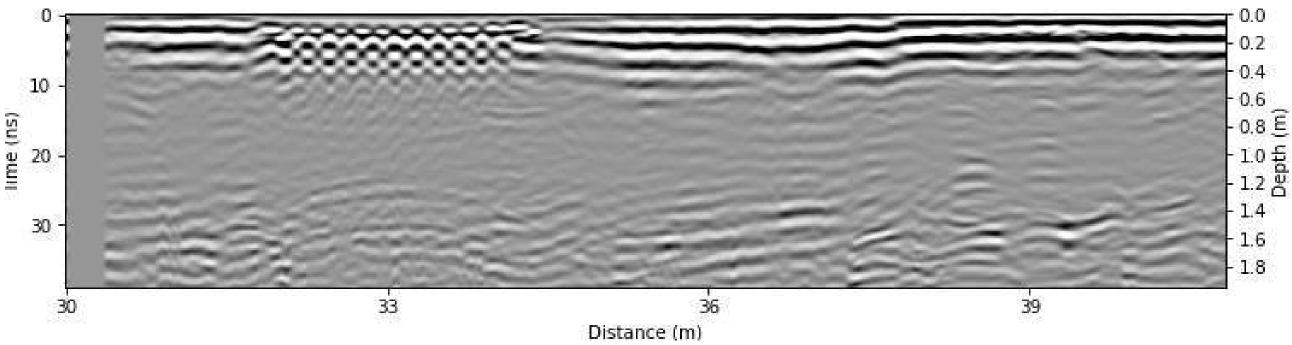


Figure B.681: Radargram at x = 93.75 m.

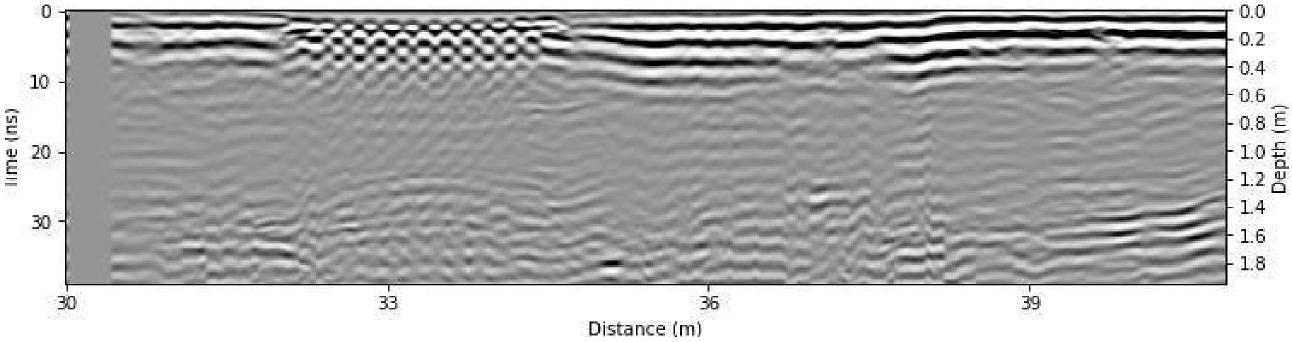


Figure B.682: Radargram at x = 94.0 m.

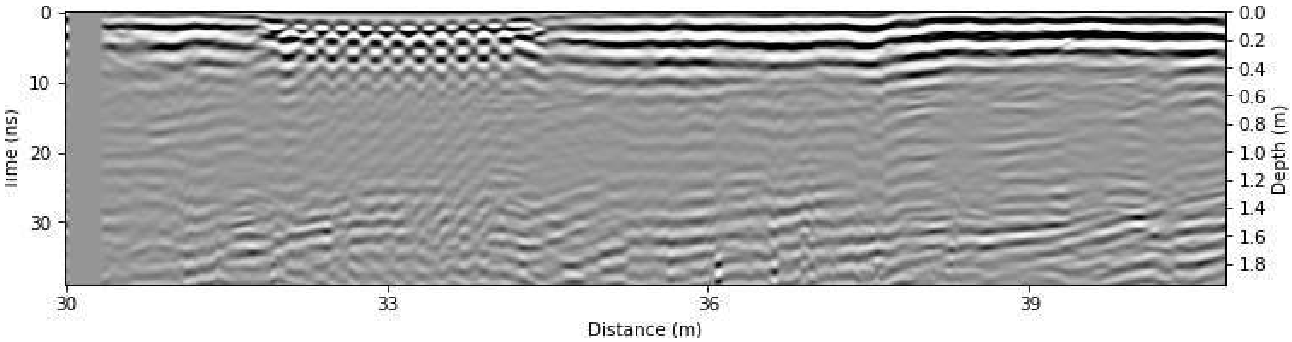


Figure B.683: Radargram at x = 94.25 m.

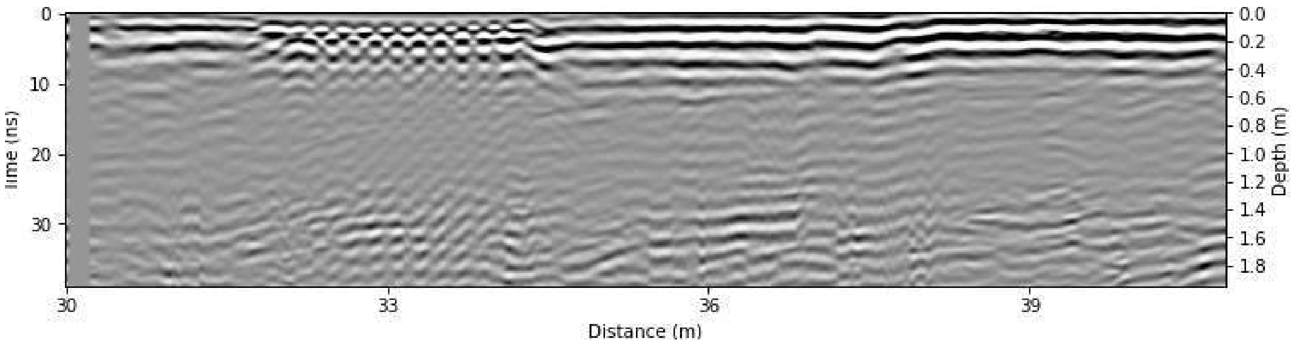


Figure B.684: Radargram at x = 94.5 m.

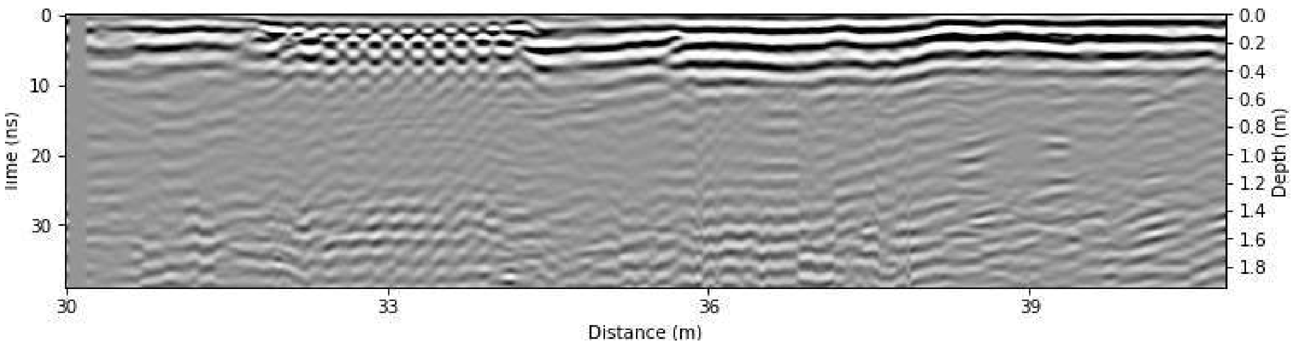


Figure B.685: Radargram at x = 94.75 m.

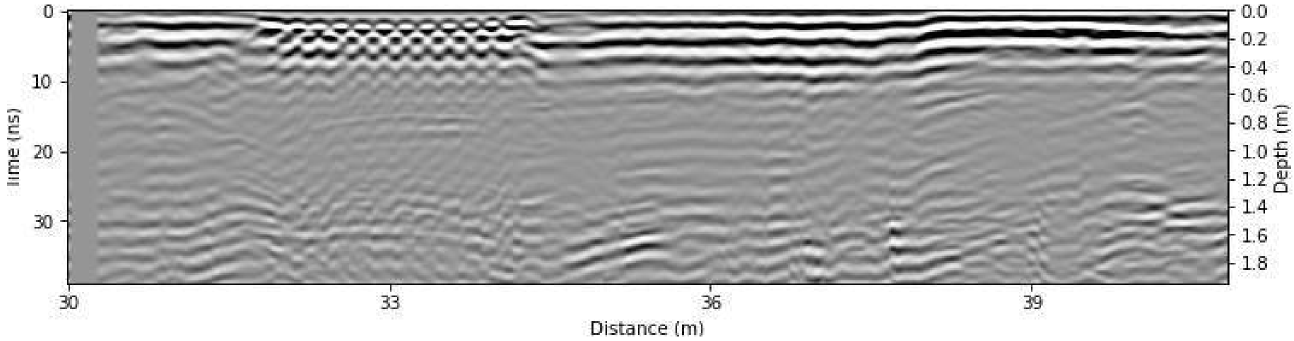


Figure B.686: Radargram at x = 95.0 m.

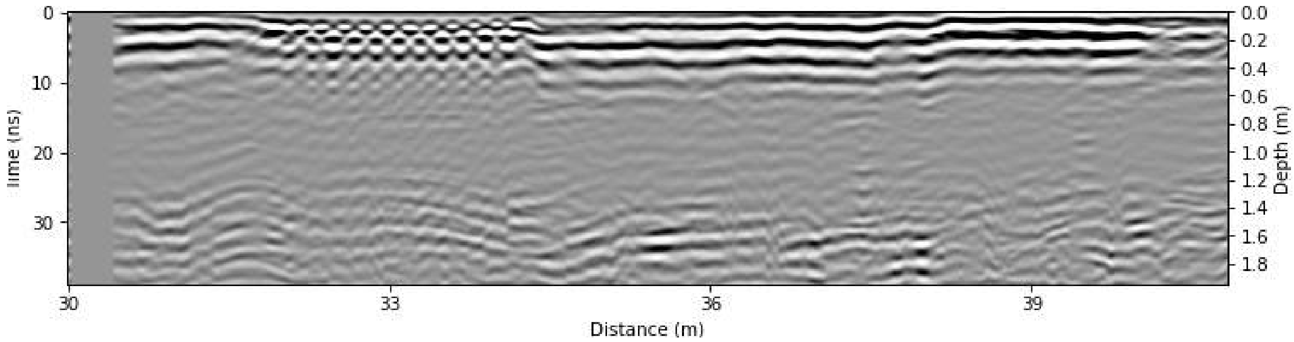


Figure B.687: Radargram at x = 95.25 m.

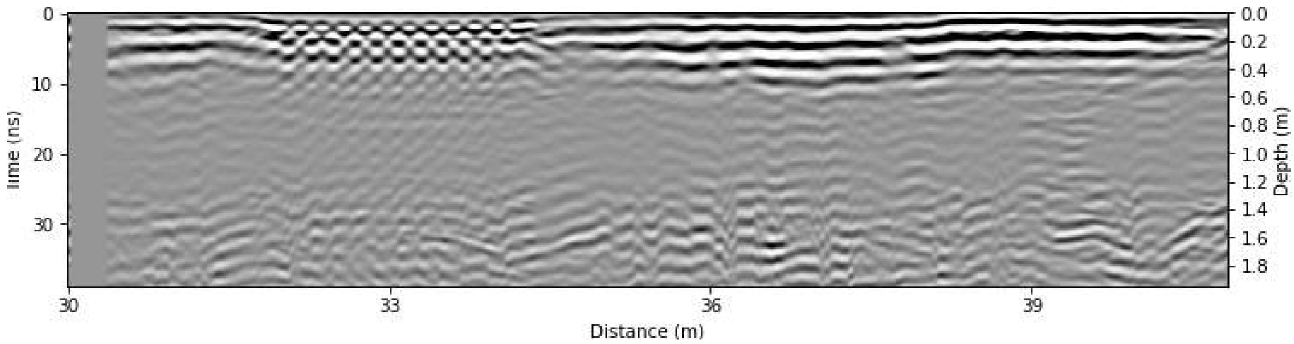


Figure B.688: Radargram at x = 95.5 m.

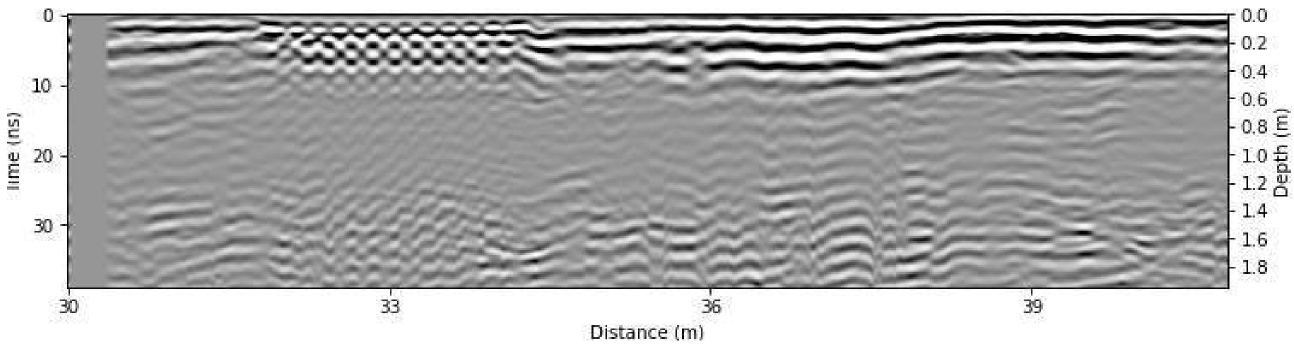


Figure B.689: Radargram at x = 95.75 m.

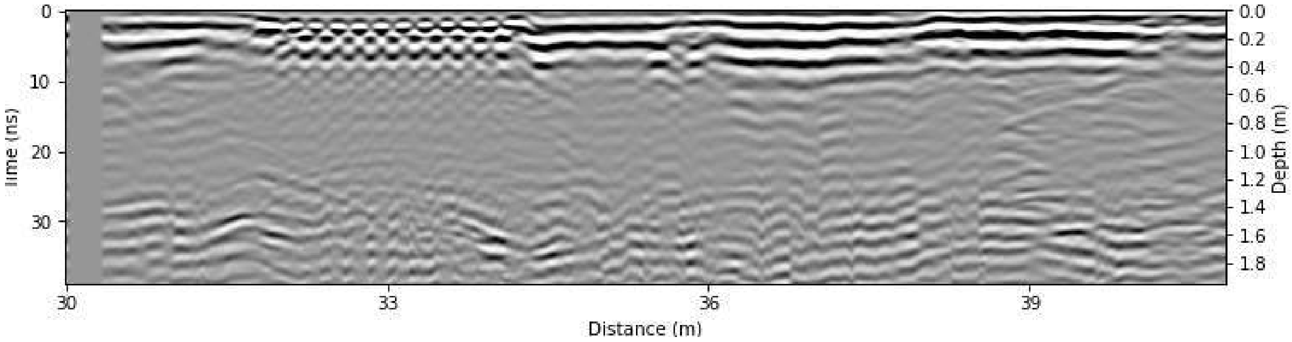


Figure B.690: Radargram at x = 96.0 m.

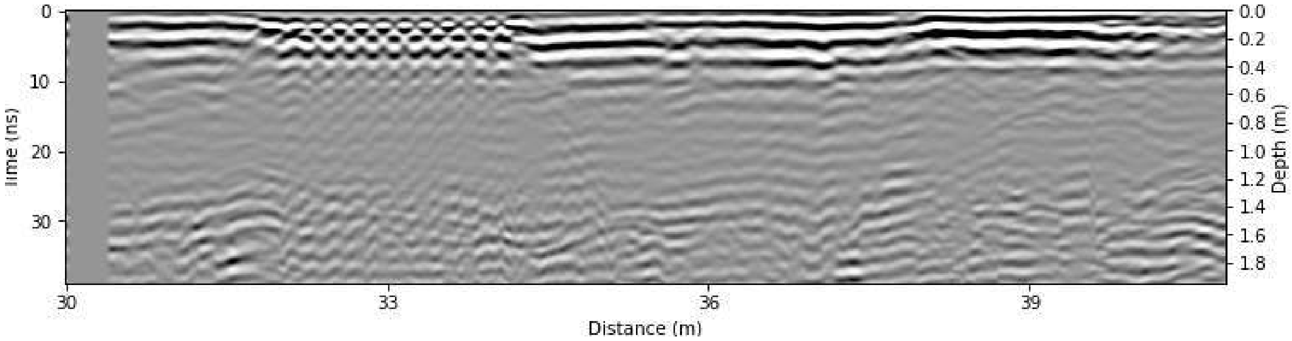


Figure B.691: Radargram at x = 96.25 m.

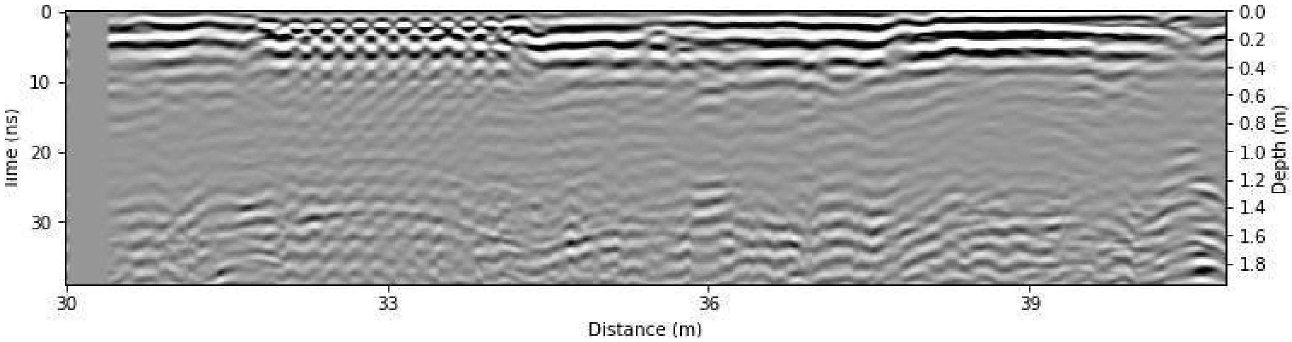


Figure B.692: Radargram at x = 96.5 m.

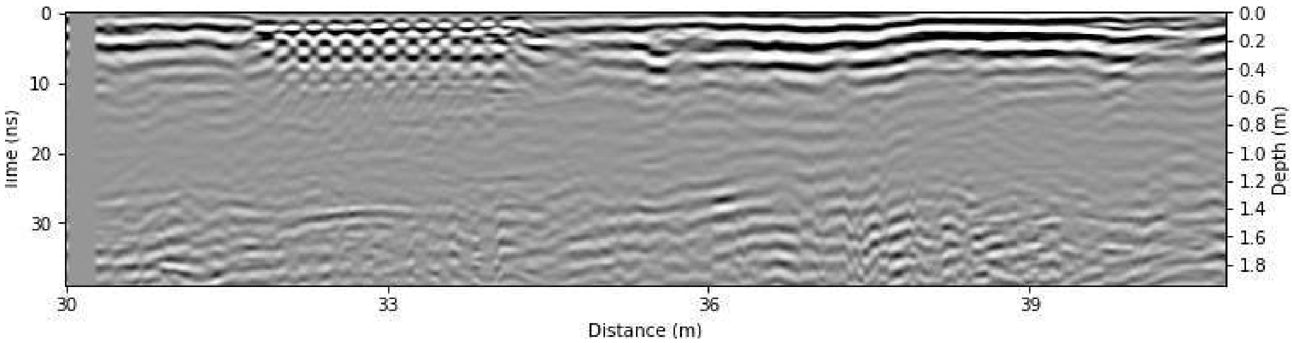


Figure B.693: Radargram at x = 96.75 m.

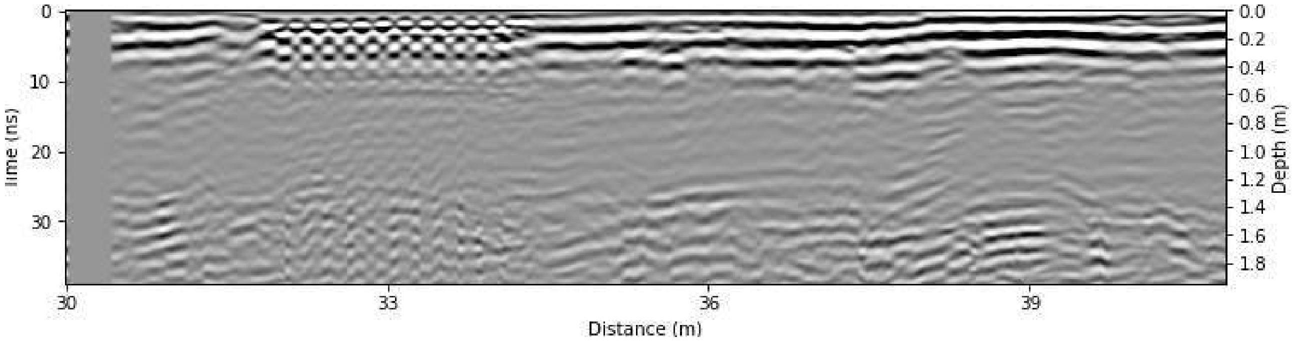


Figure B.694: Radargram at x = 97.0 m.

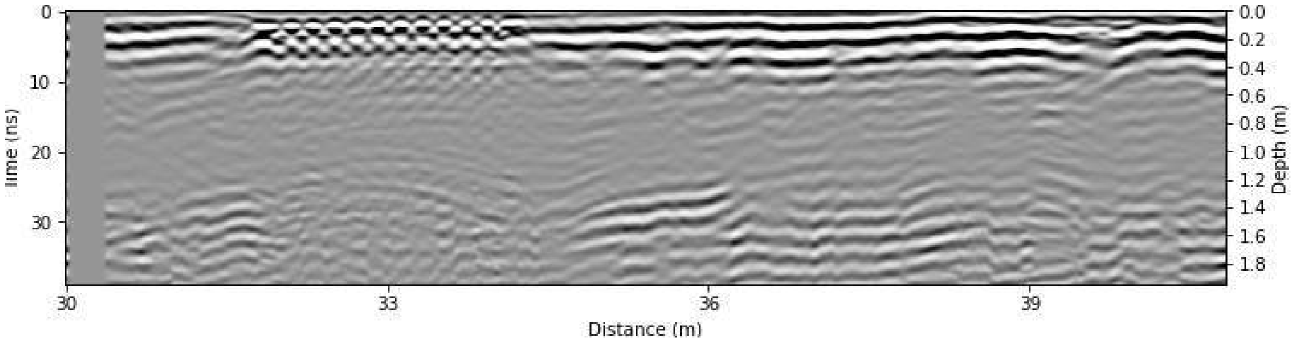


Figure B.695: Radargram at x = 97.25 m.

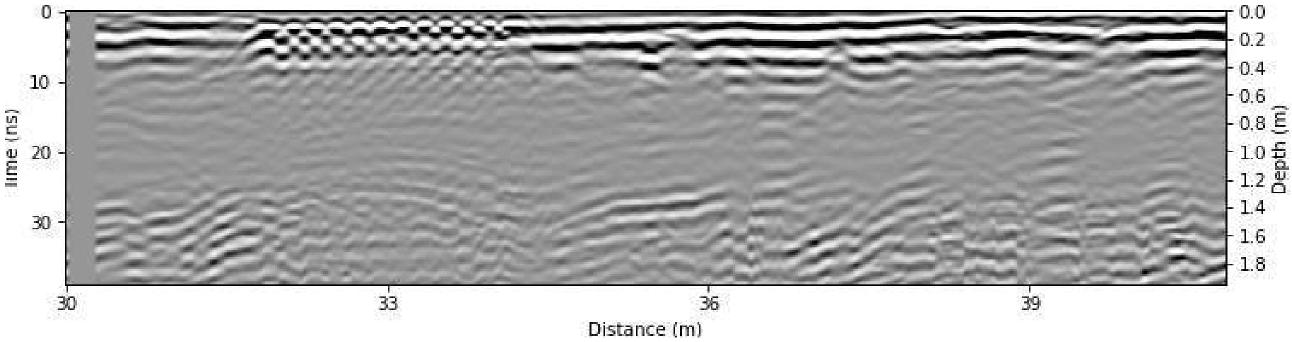


Figure B.696: Radargram at x = 97.5 m.

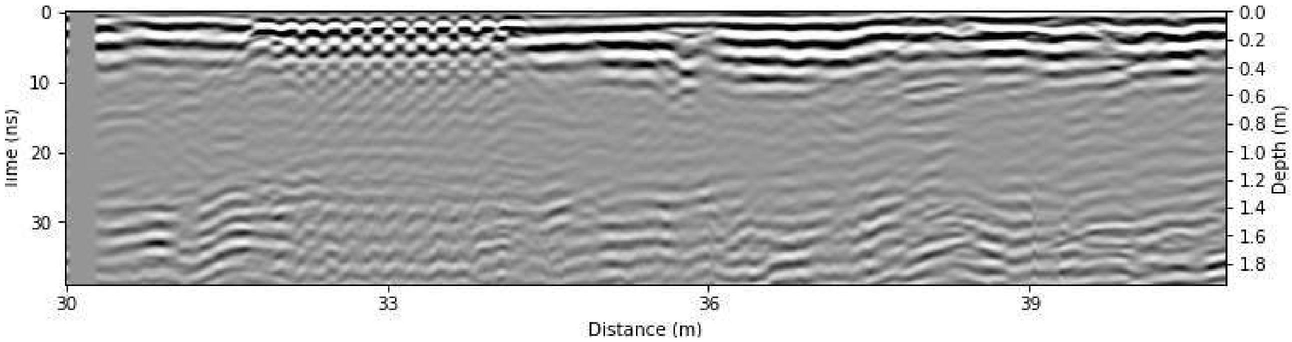


Figure B.697: Radargram at x = 97.75 m.

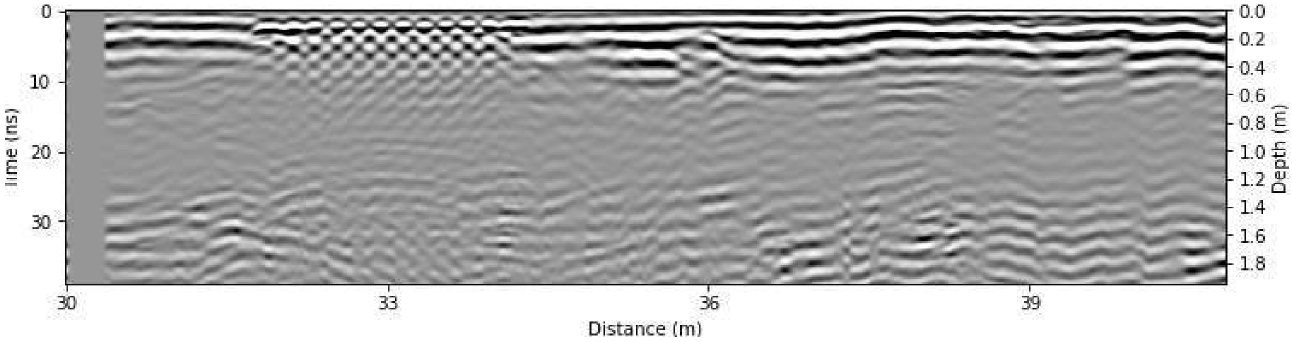


Figure B.698: Radargram at x = 98.0 m.

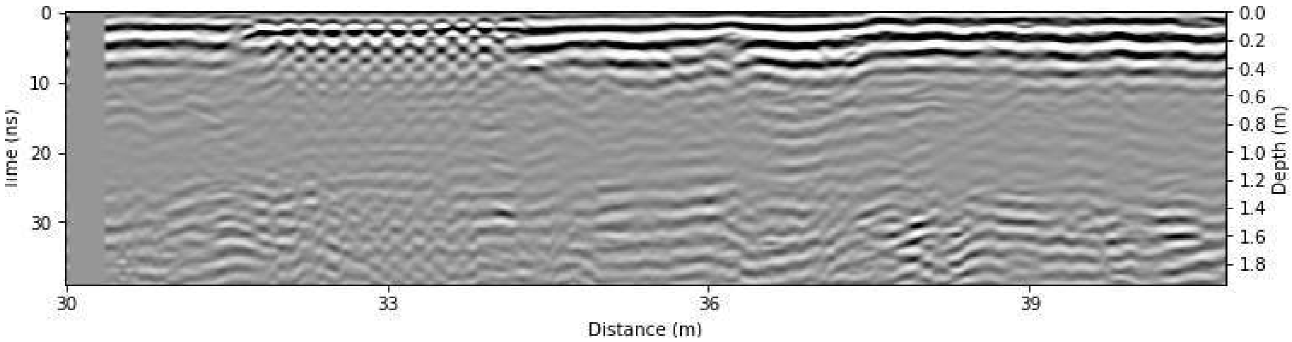


Figure B.699: Radargram at x = 98.25 m.

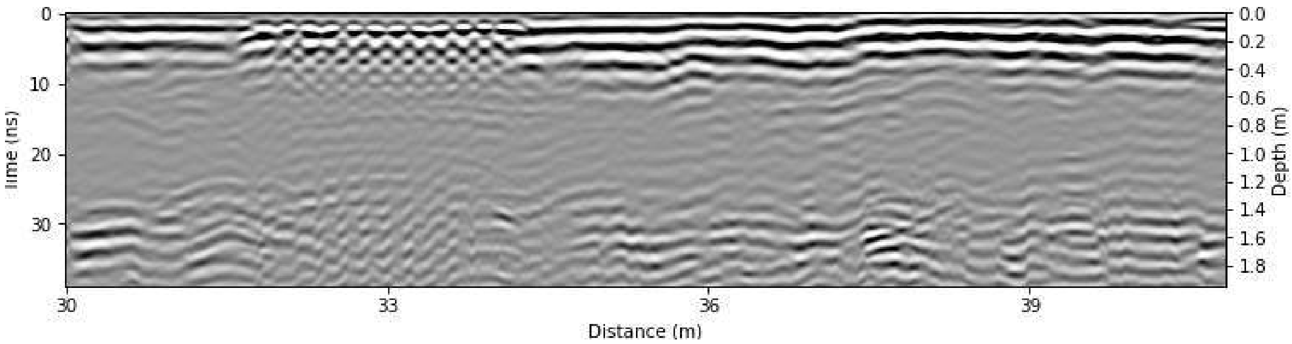


Figure B.700: Radargram at x = 98.5 m.

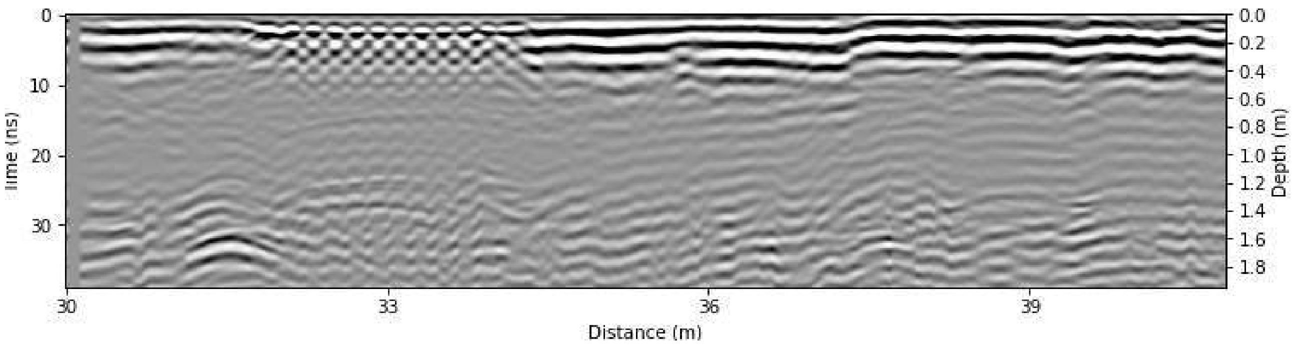


Figure B.701: Radargram at x = 98.75 m.

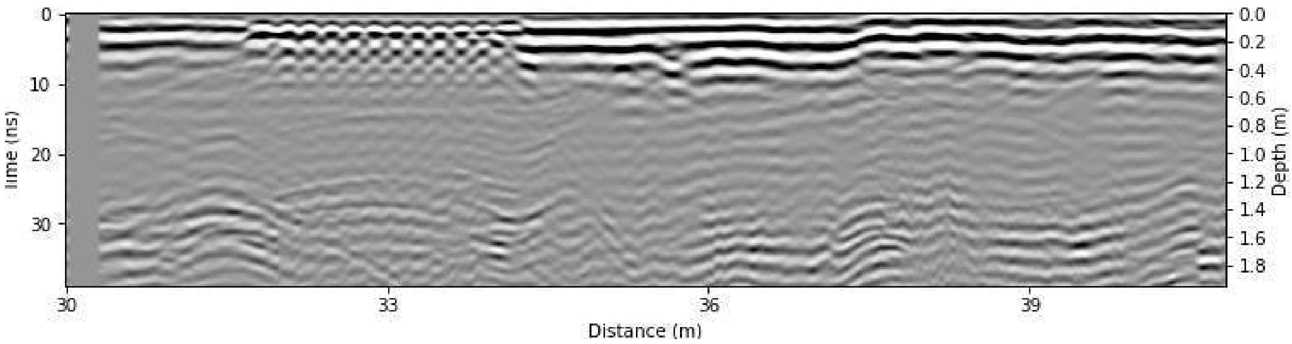


Figure B.702: Radargram at x = 99.0 m.

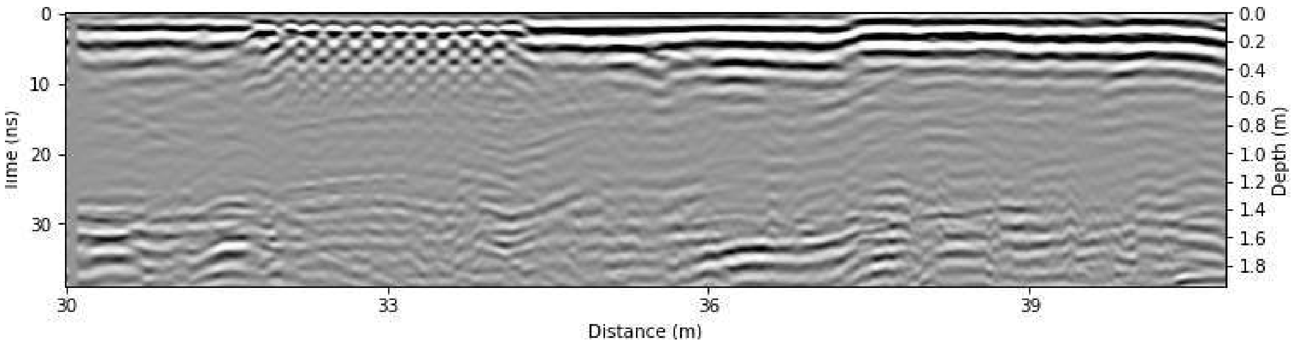


Figure B.703: Radargram at x = 99.25 m.

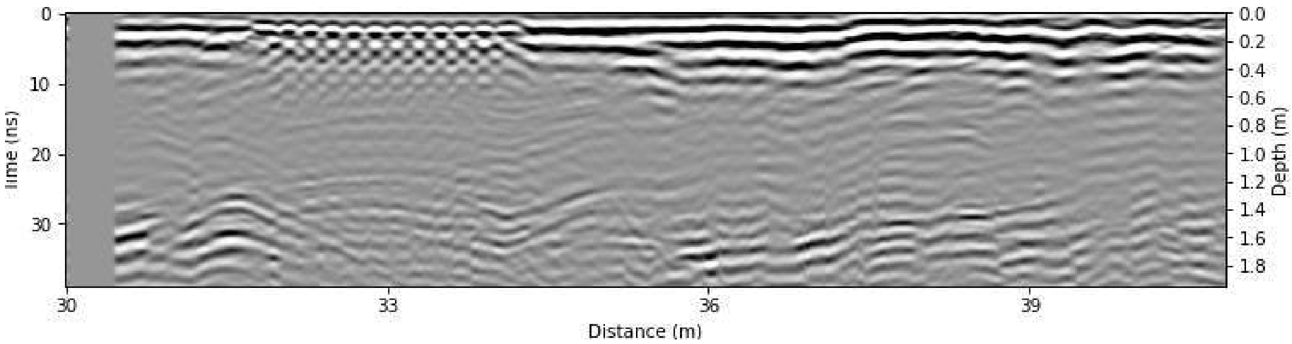


Figure B.704: Radargram at x = 99.5 m.

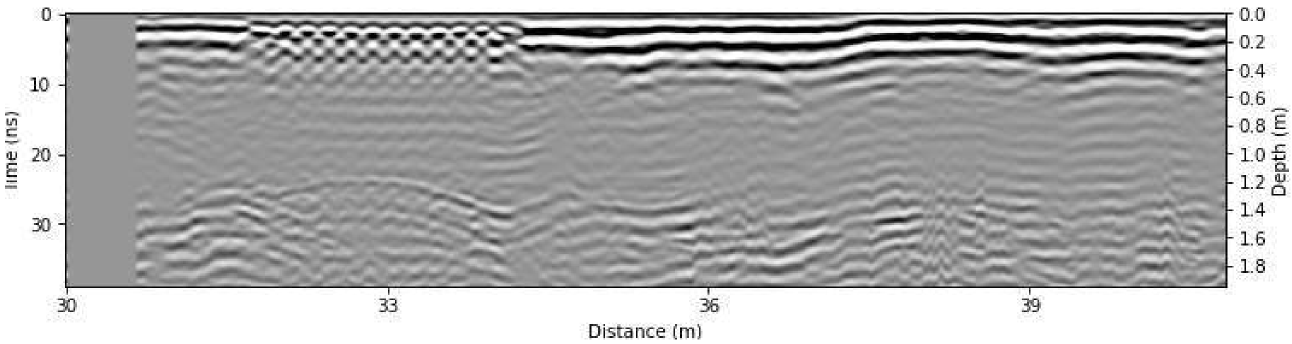


Figure B.705: Radargram at x = 99.75 m.

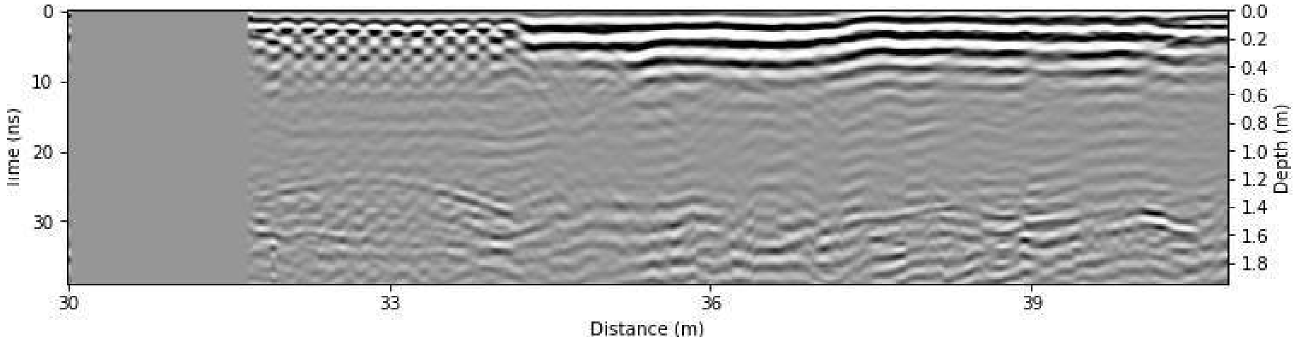
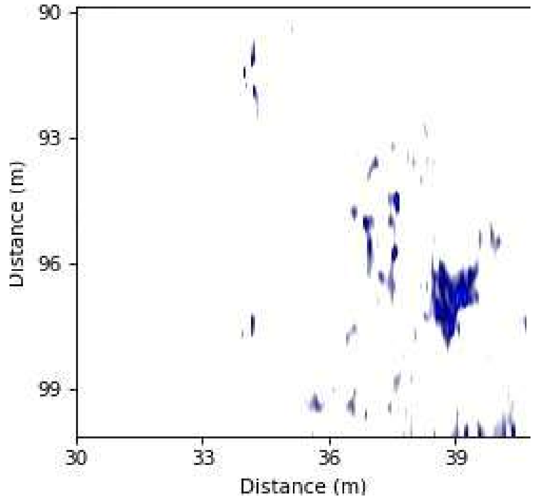
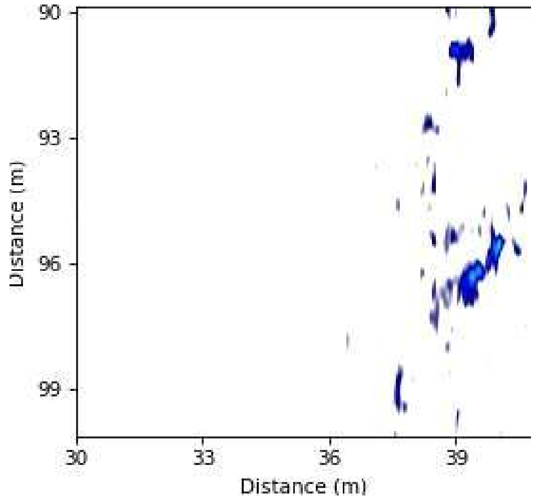


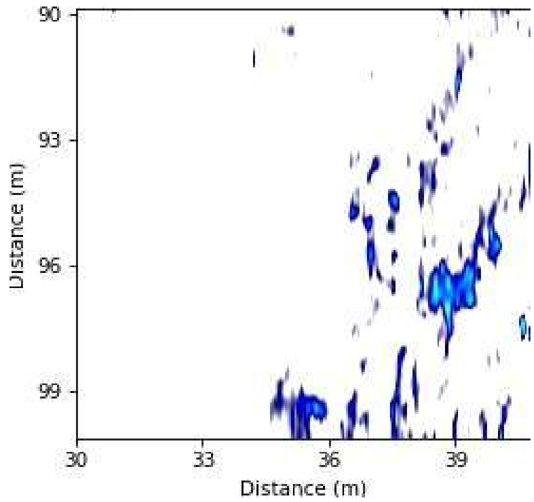
Figure B.706: Radargram at x = 100.0 m.



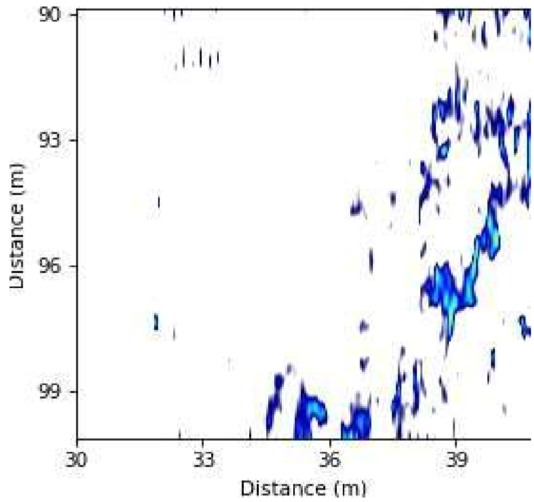
(a) Timeslice at z = 0.0 m.



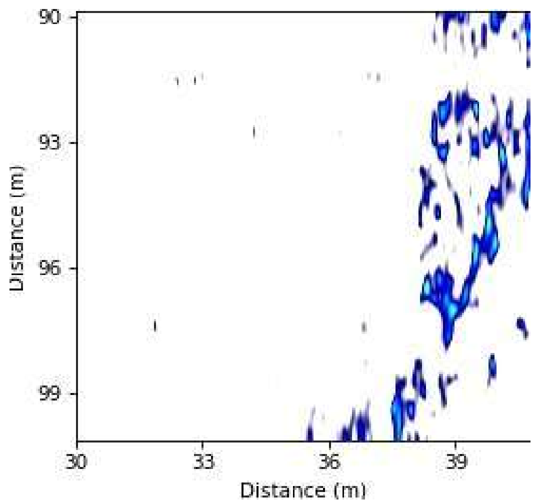
(b) Timeslice at z = 0.05 m.



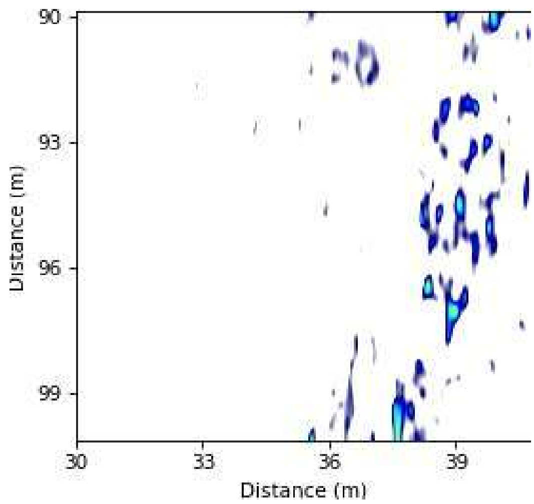
(c) Timeslice at z = 0.1 m.



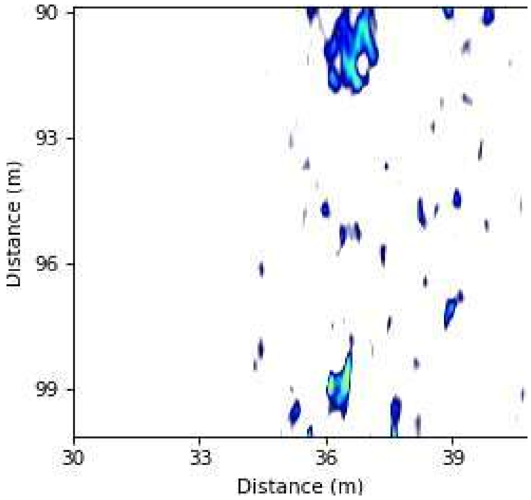
(d) Timeslice at z = 0.15 m.



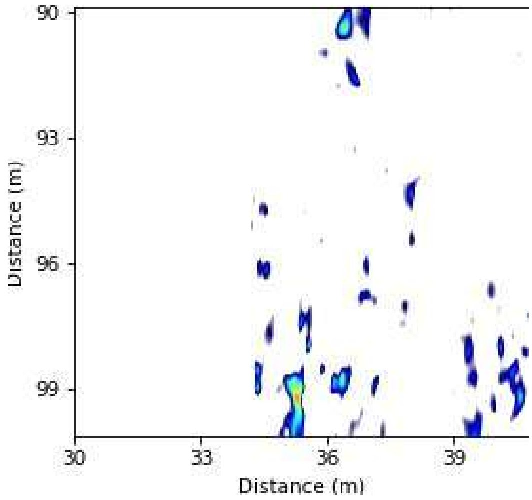
(e) Timeslice at z = 0.2 m.



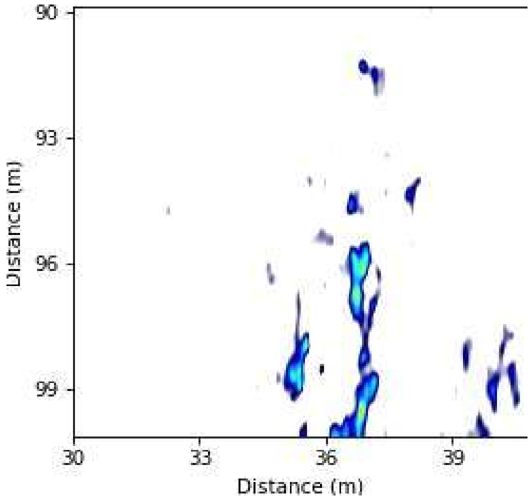
(f) Timeslice at z = 0.25 m.



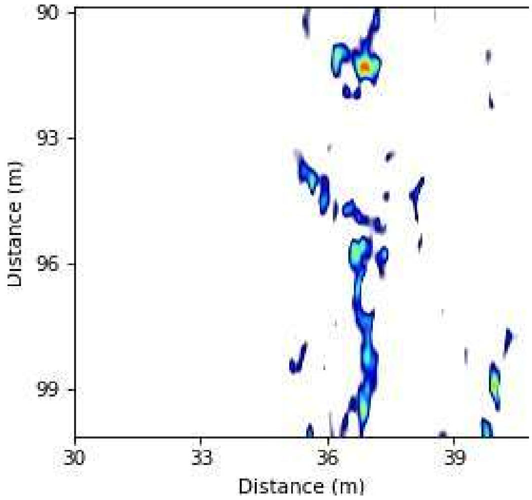
(a) Timeslice at z = 0.3 m.



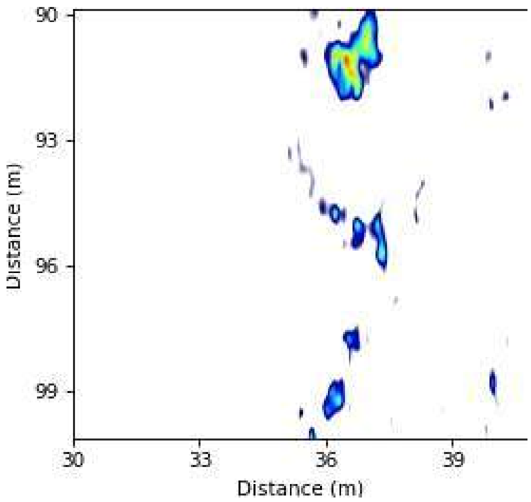
(b) Timeslice at z = 0.35 m.



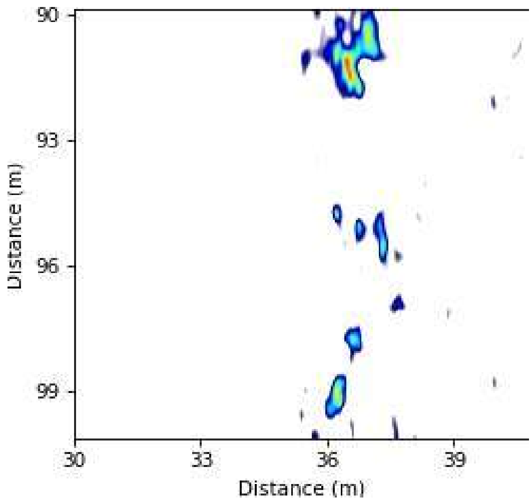
(c) Timeslice at z = 0.4 m.



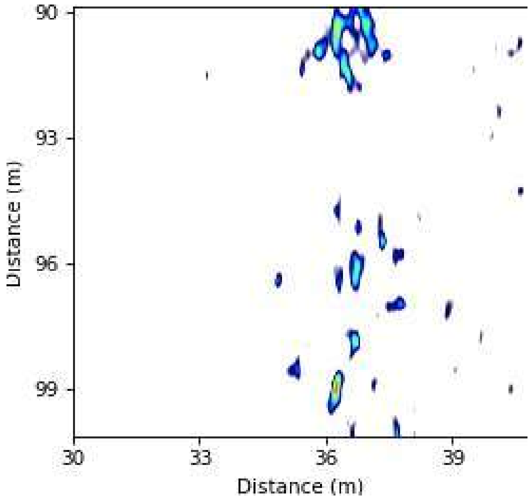
(d) Timeslice at z = 0.45 m.



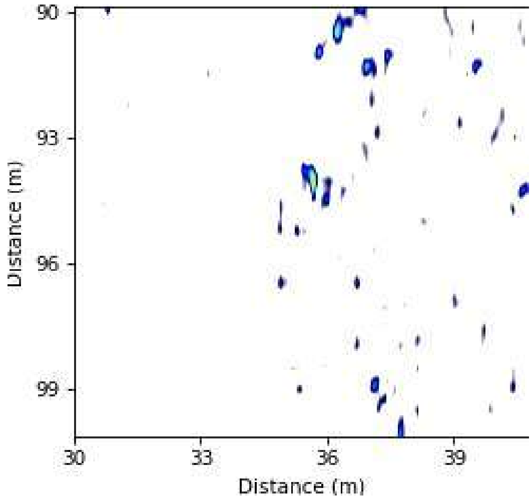
(e) Timeslice at z = 0.5 m.



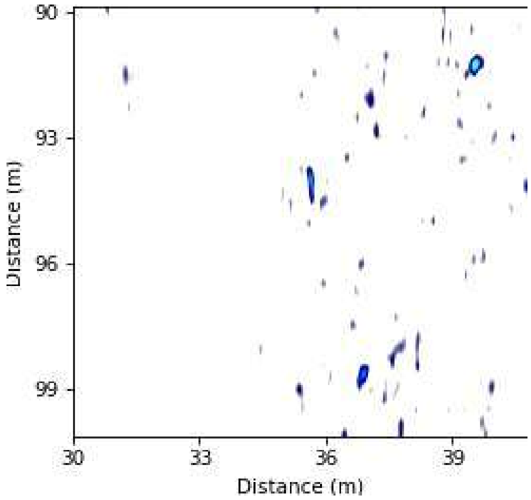
(f) Timeslice at z = 0.55 m.



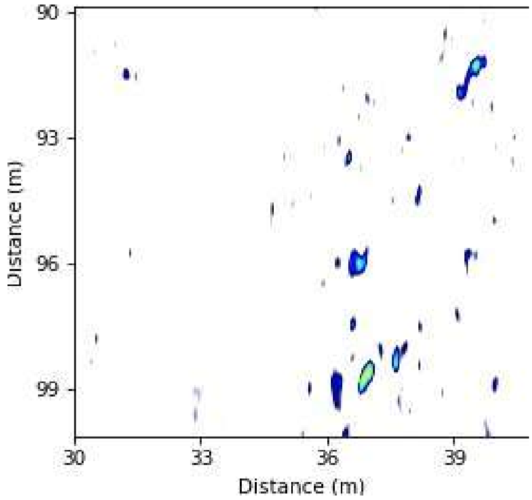
(a) Timeslice at z = 0.6 m.



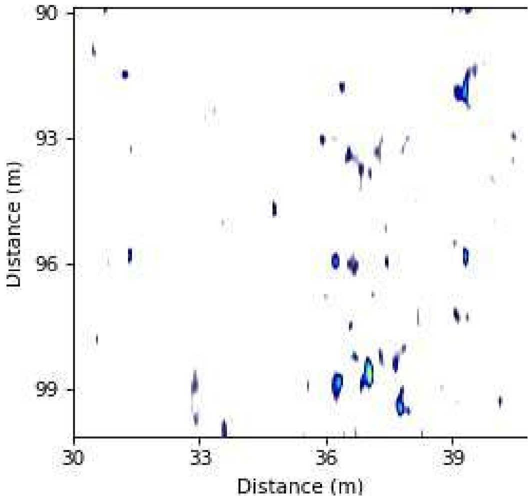
(b) Timeslice at z = 0.65 m.



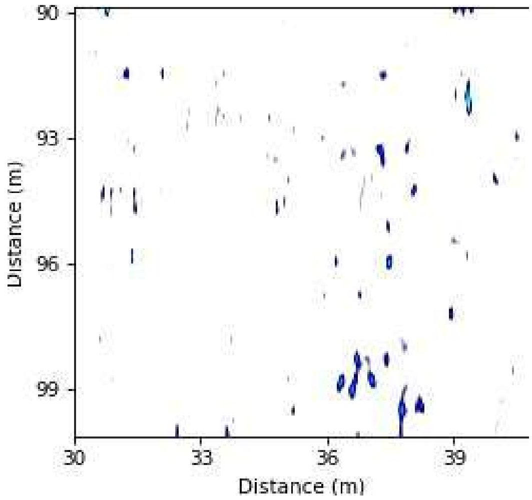
(c) Timeslice at z = 0.7 m.



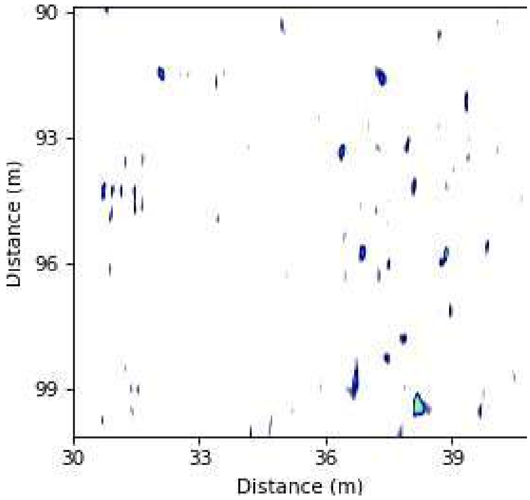
(d) Timeslice at z = 0.75 m.



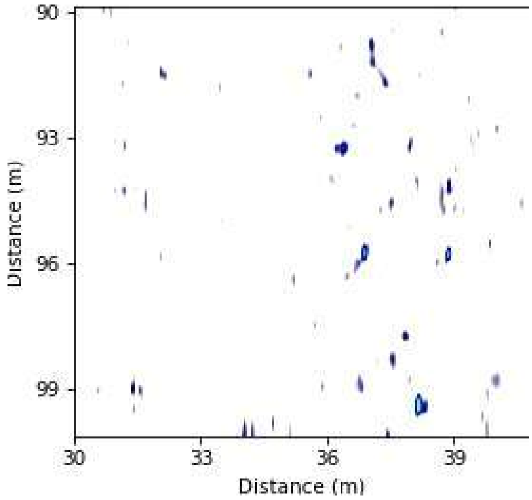
(e) Timeslice at z = 0.8 m.



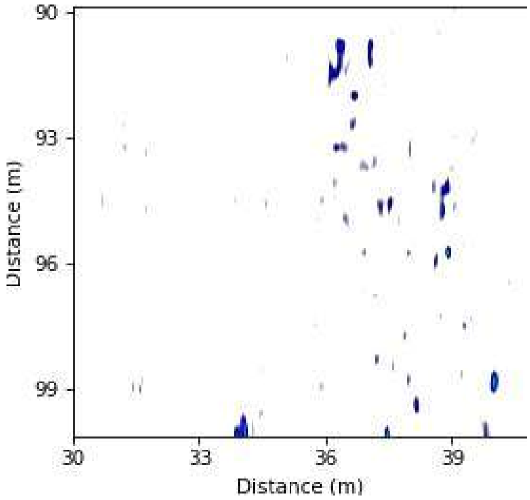
(f) Timeslice at z = 0.85 m.



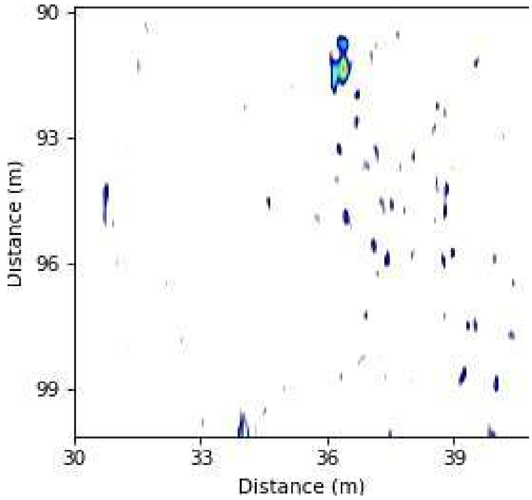
(a) Timeslice at z = 0.9 m.



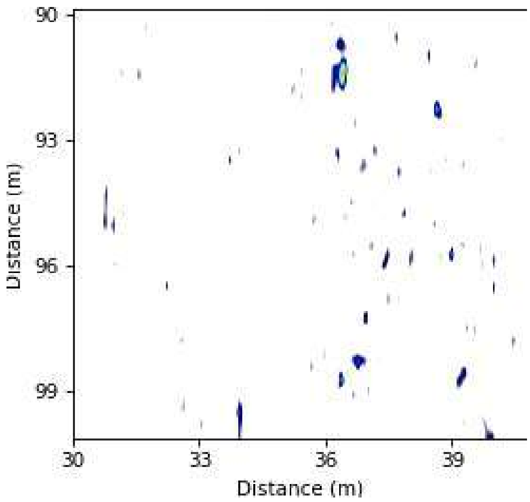
(b) Timeslice at z = 0.95 m.



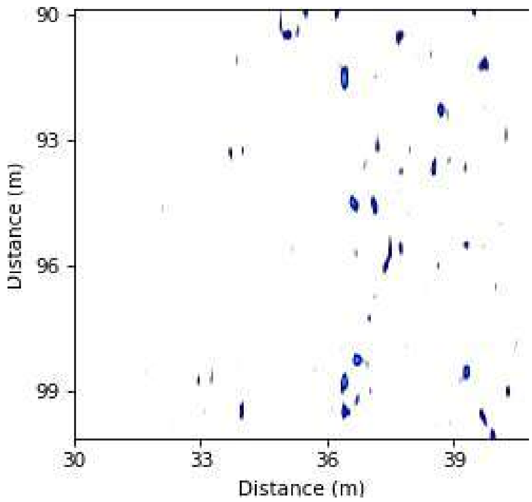
(c) Timeslice at z = 1.0 m.



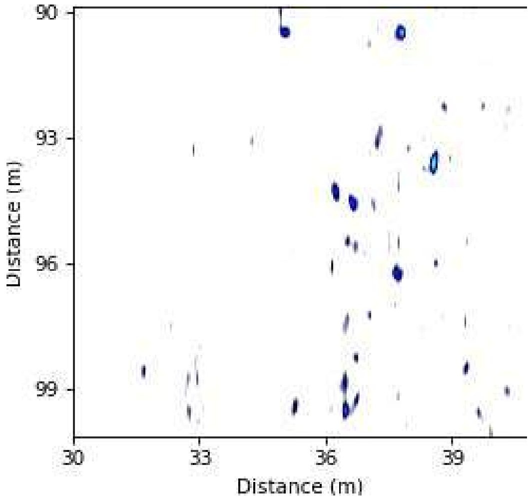
(d) Timeslice at z = 1.05 m.



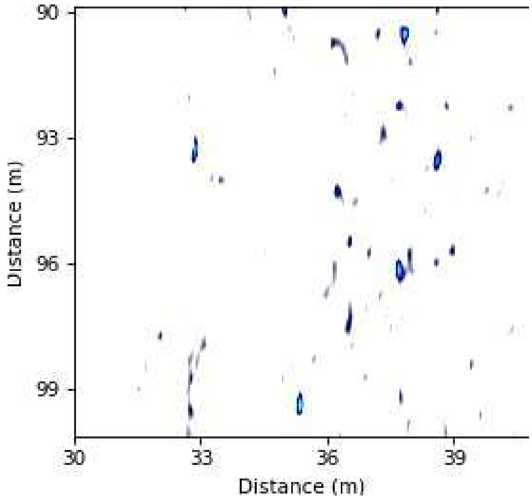
(e) Timeslice at z = 1.1 m.



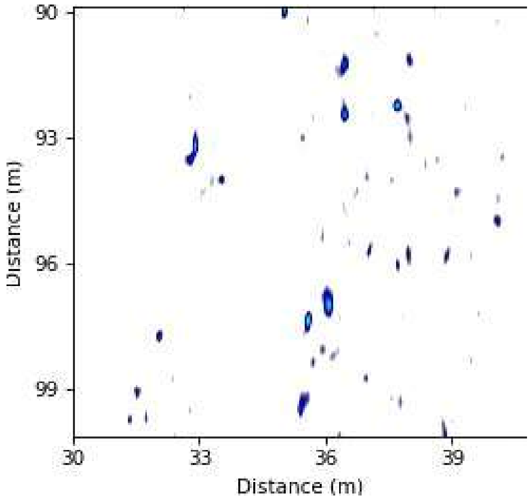
(f) Timeslice at z = 1.15 m.



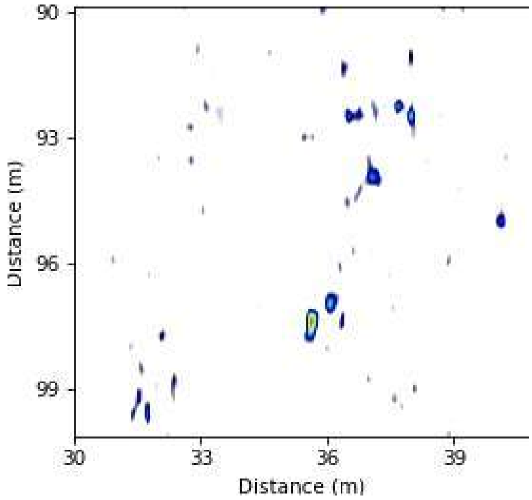
(a) Timeslice at z = 1.2 m.



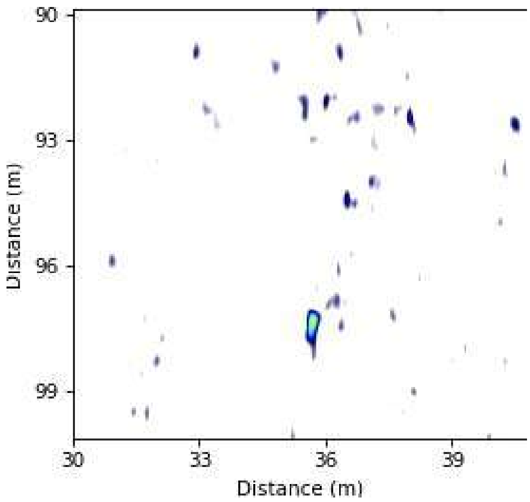
(b) Timeslice at z = 1.25 m.



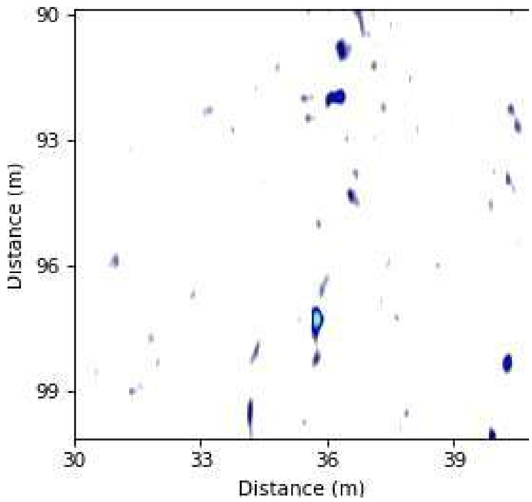
(c) Timeslice at z = 1.3 m.



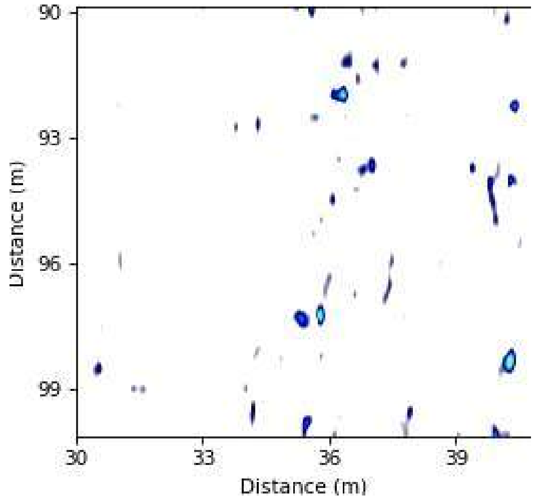
(d) Timeslice at z = 1.35 m.



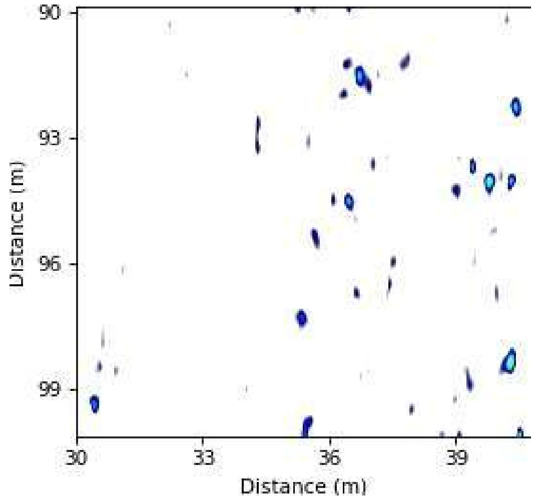
(e) Timeslice at z = 1.4 m.



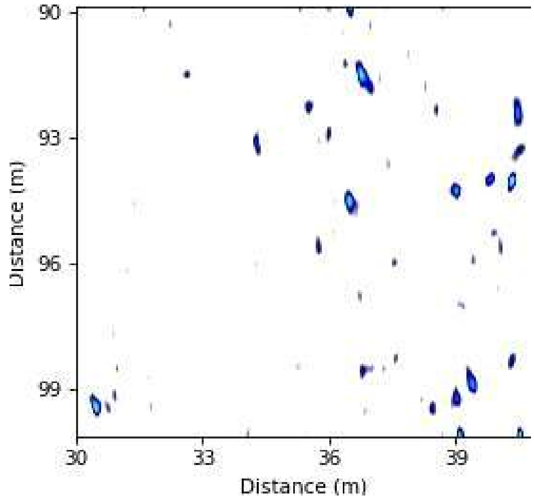
(f) Timeslice at z = 1.45 m.



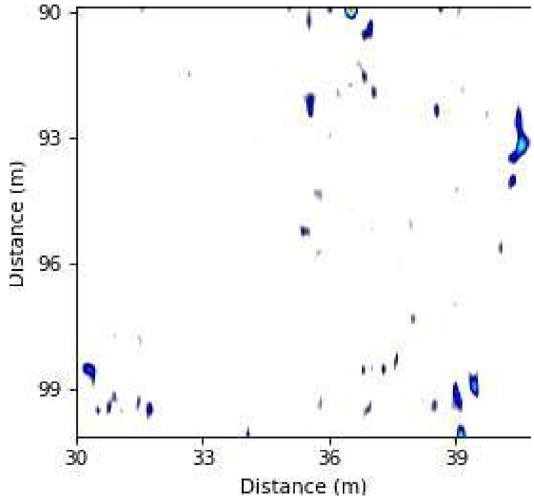
(a) Timeslice at z = 1.5 m.



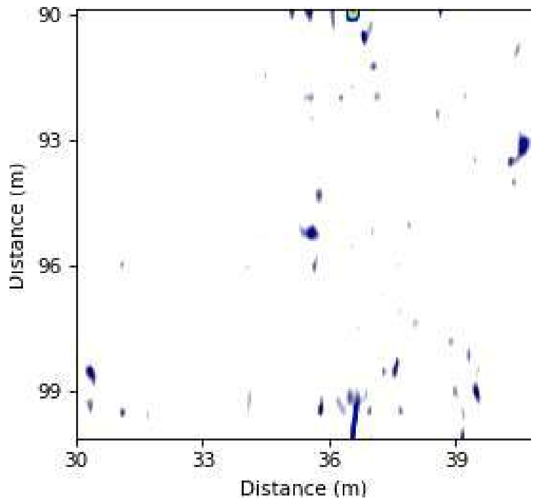
(b) Timeslice at z = 1.55 m.



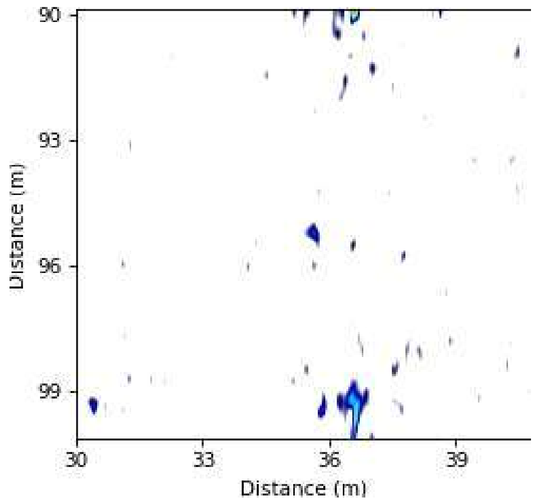
(c) Timeslice at z = 1.6 m.



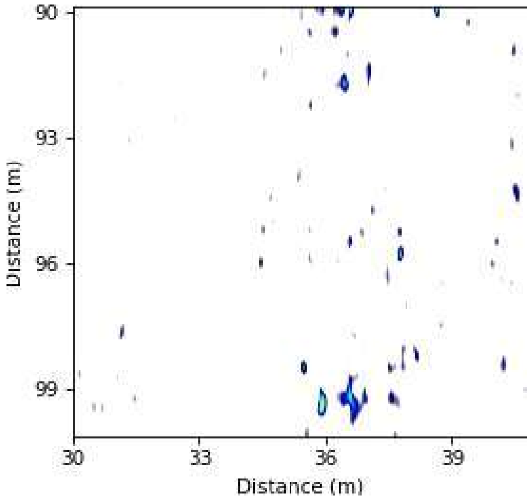
(d) Timeslice at z = 1.65 m.



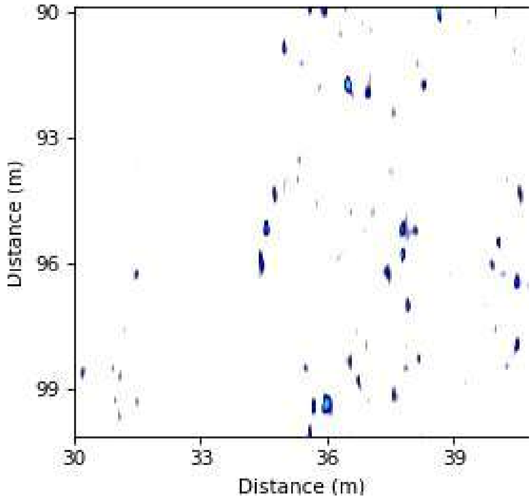
(e) Timeslice at z = 1.7 m.



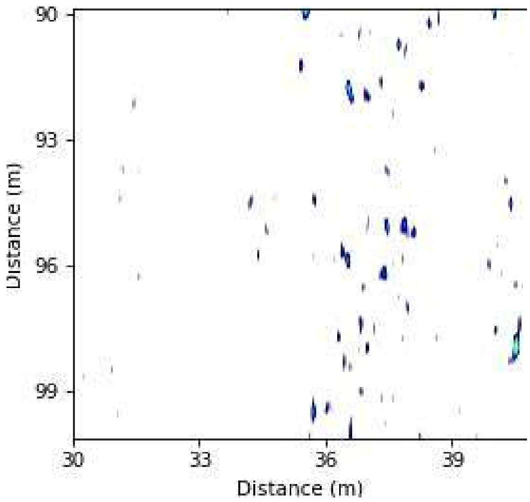
(f) Timeslice at z = 1.75 m.



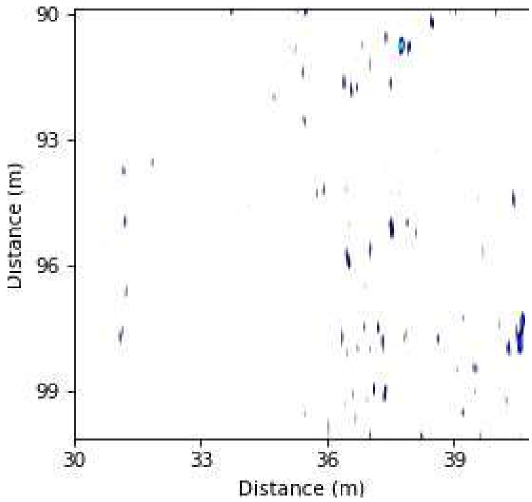
(a) Timeslice at z = 1.8 m.



(b) Timeslice at z = 1.85 m.



(c) Timeslice at z = 1.9 m.



(d) Timeslice at z = 1.95 m.

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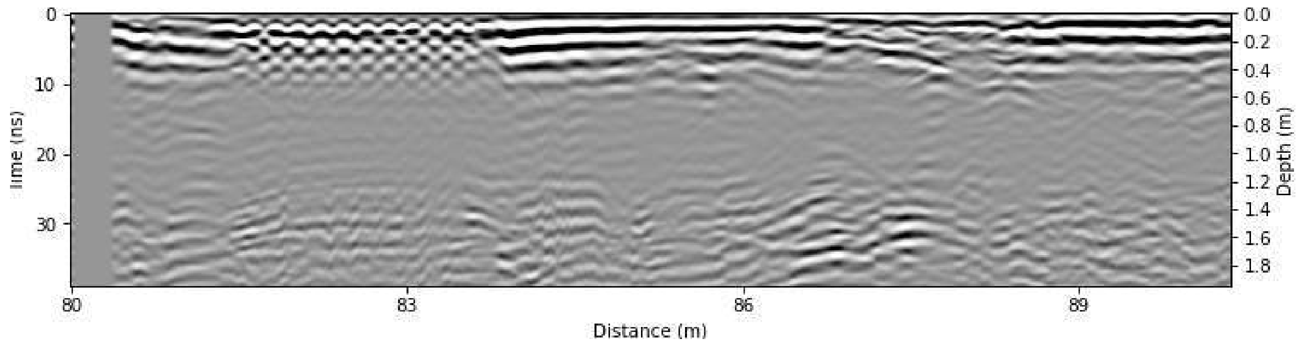


Figure B.714: Radargram at x = 30.0 m.

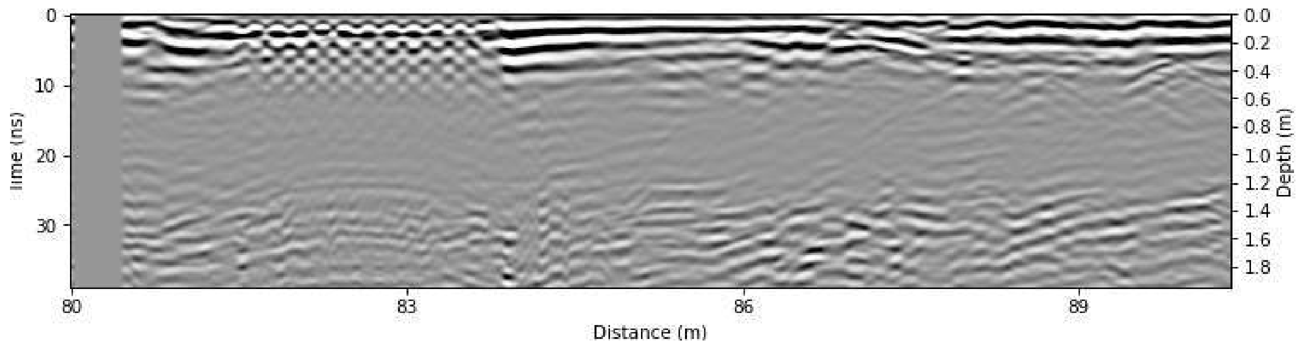


Figure B.715: Radargram at x = 30.25 m.

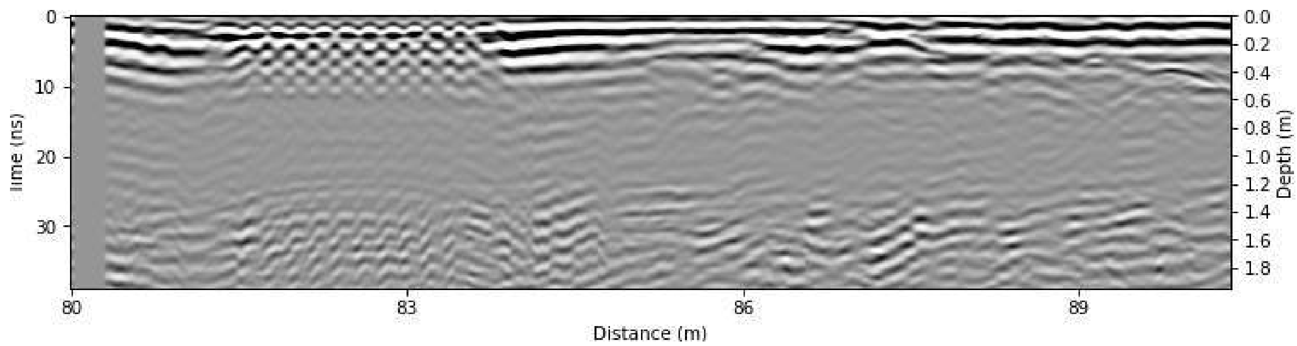


Figure B.716: Radargram at x = 30.5 m.

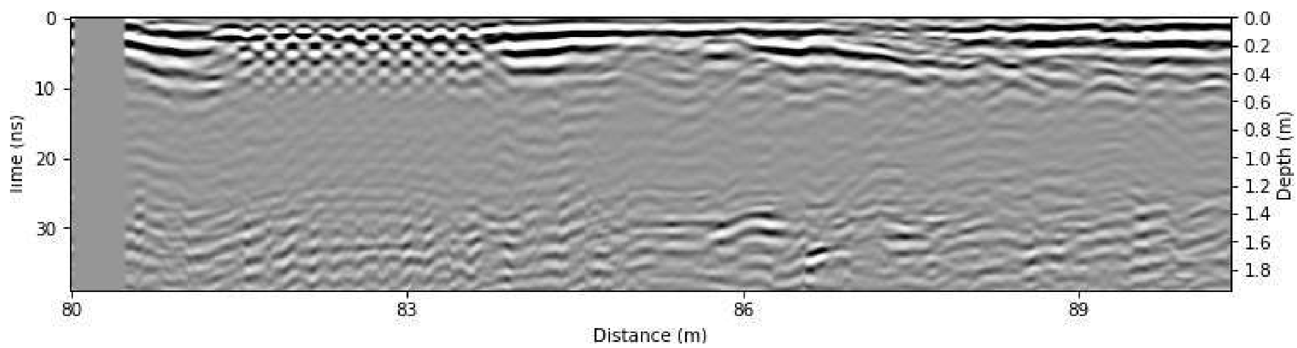


Figure B.717: Radargram at x = 30.75 m.

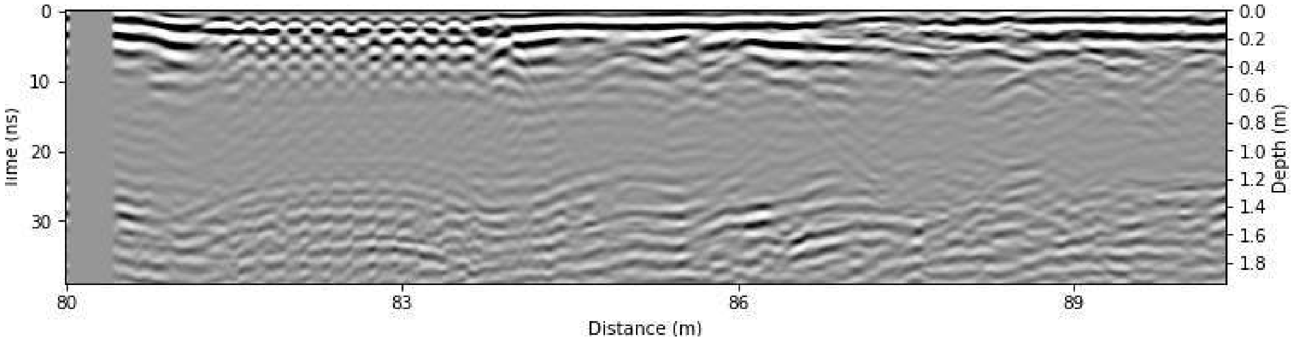


Figure B.718: Radargram at x = 31.0 m.

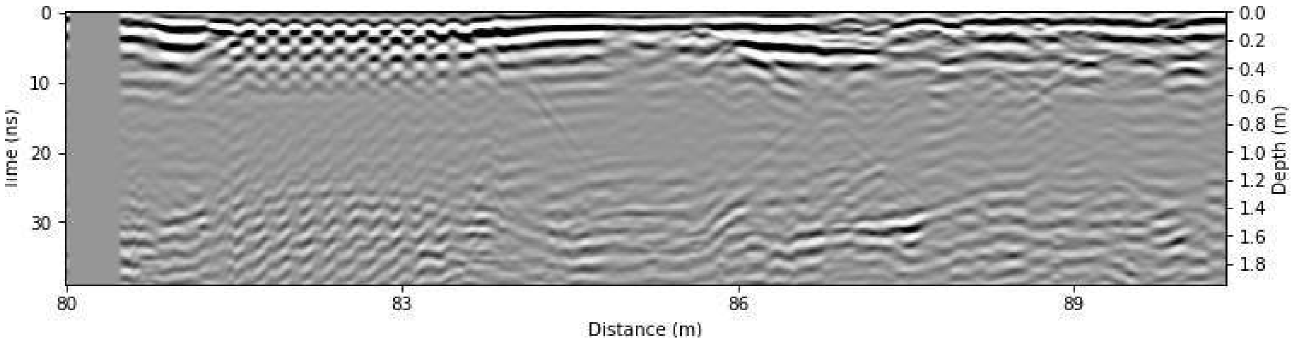


Figure B.719: Radargram at x = 31.25 m.

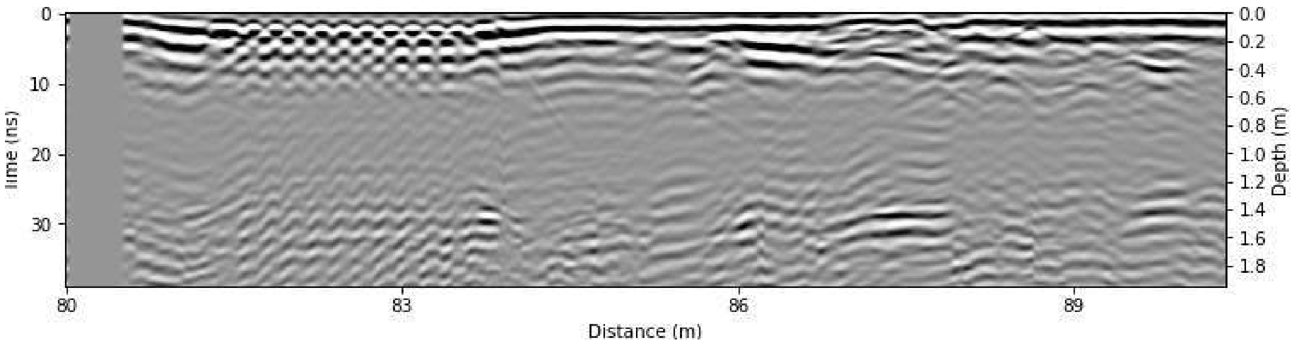


Figure B.720: Radargram at x = 31.5 m.

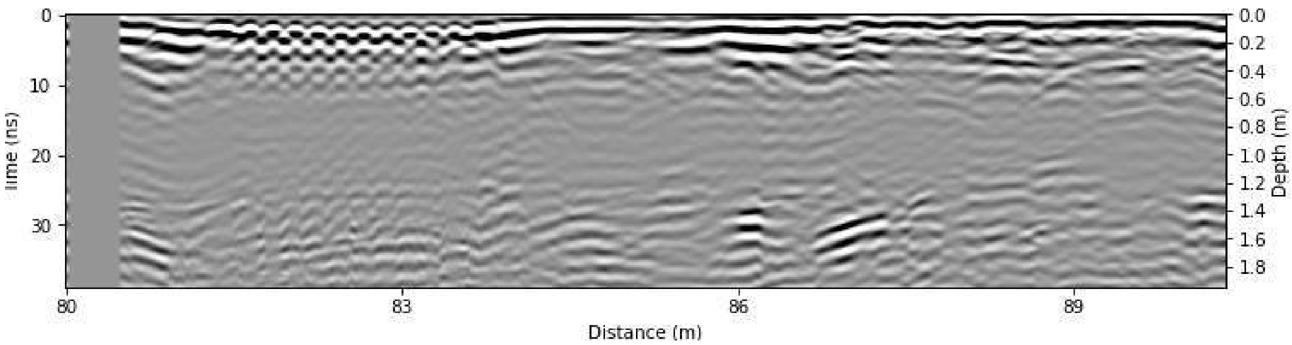


Figure B.721: Radargram at x = 31.75 m.

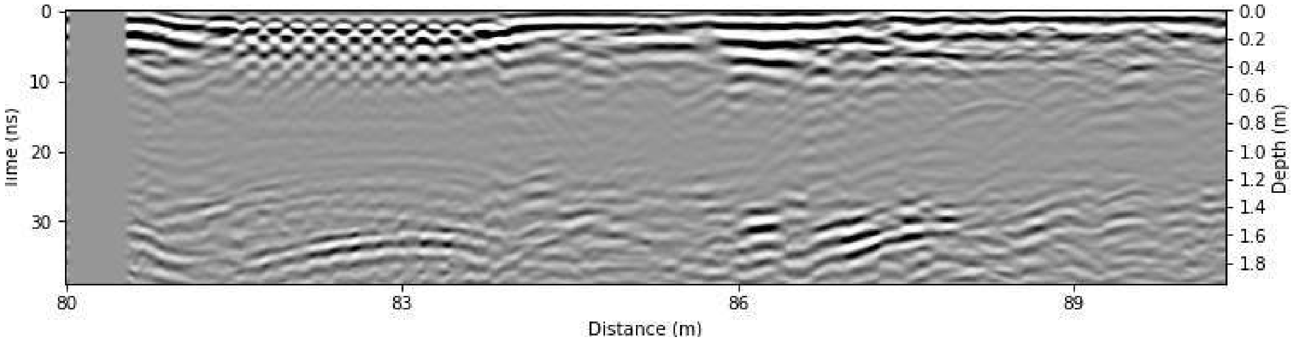


Figure B.722: Radargram at x = 32.0 m.

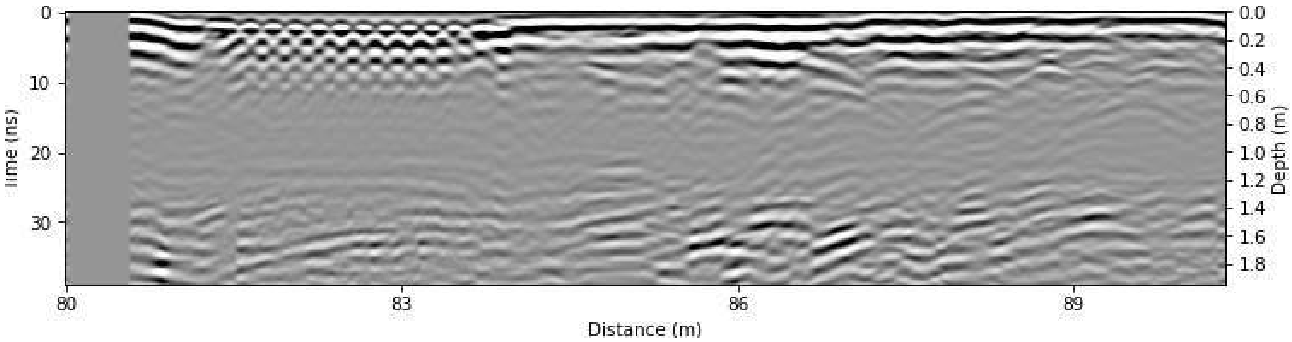


Figure B.723: Radargram at x = 32.25 m.

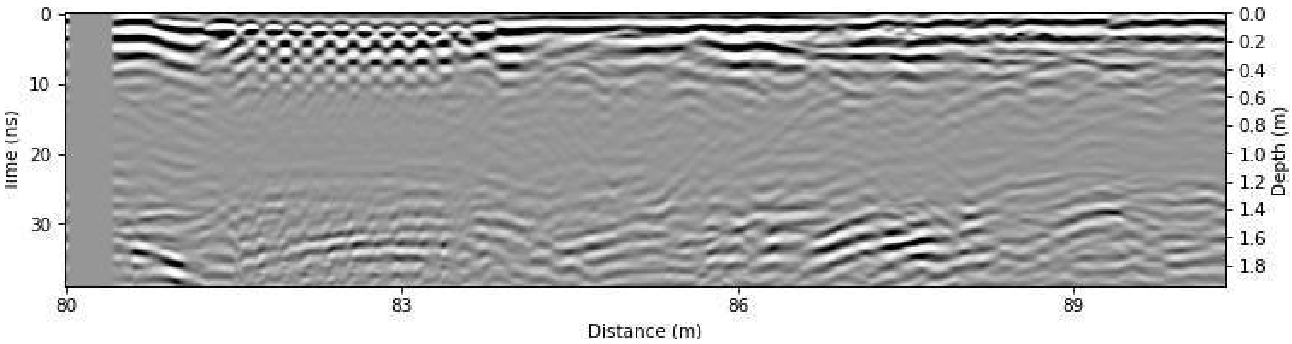


Figure B.724: Radargram at x = 32.5 m.

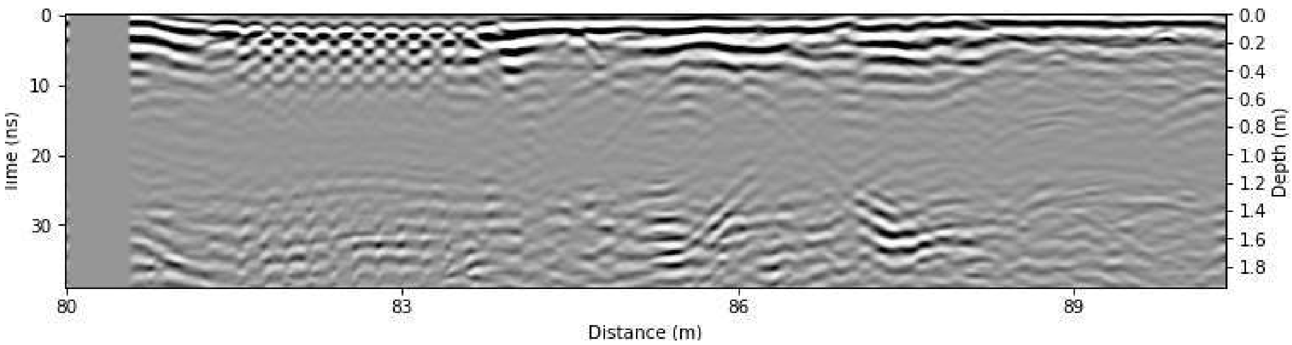


Figure B.725: Radargram at x = 32.75 m.

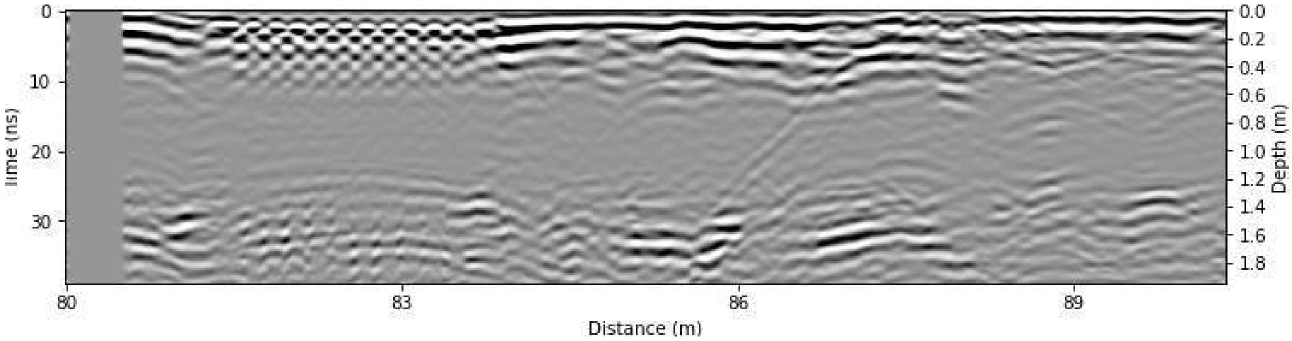


Figure B.726: Radargram at x = 33.0 m.

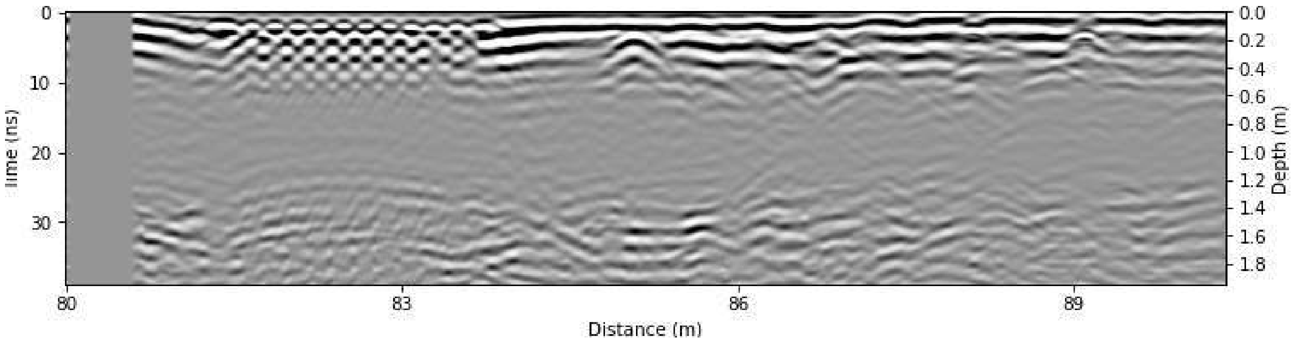


Figure B.727: Radargram at x = 33.25 m.

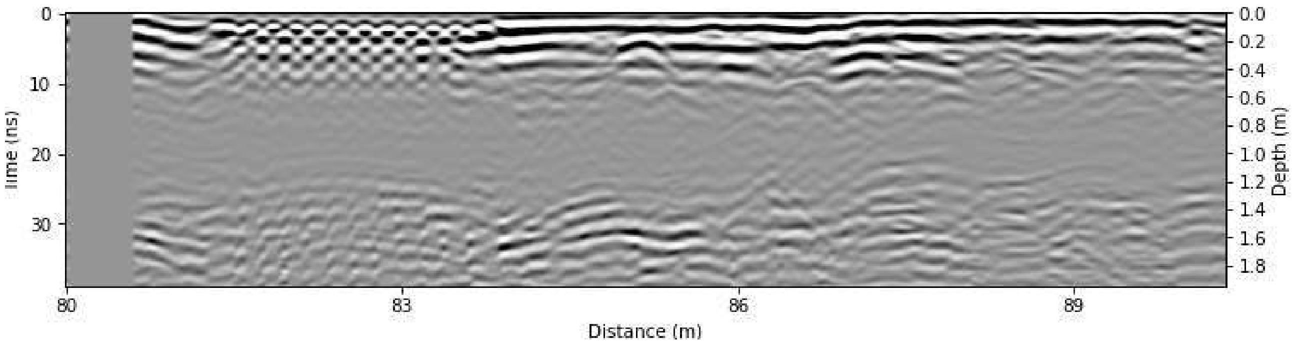


Figure B.728: Radargram at x = 33.5 m.

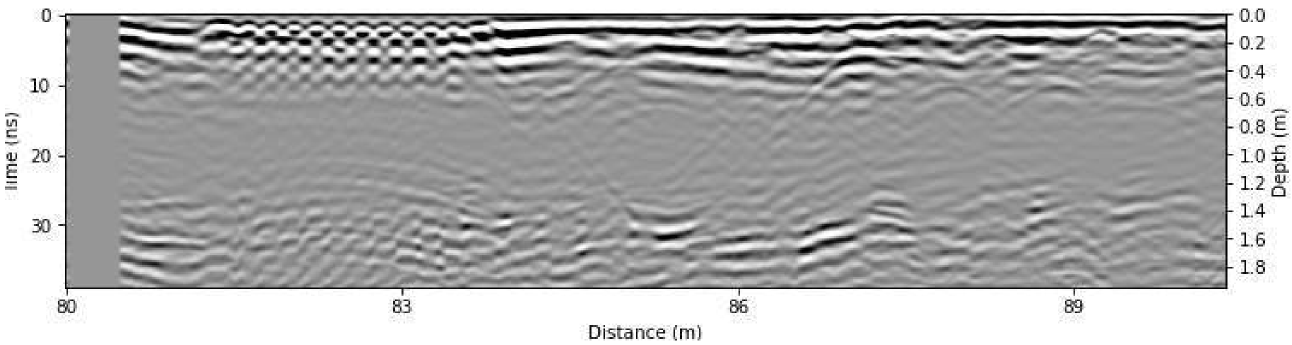


Figure B.729: Radargram at x = 33.75 m.

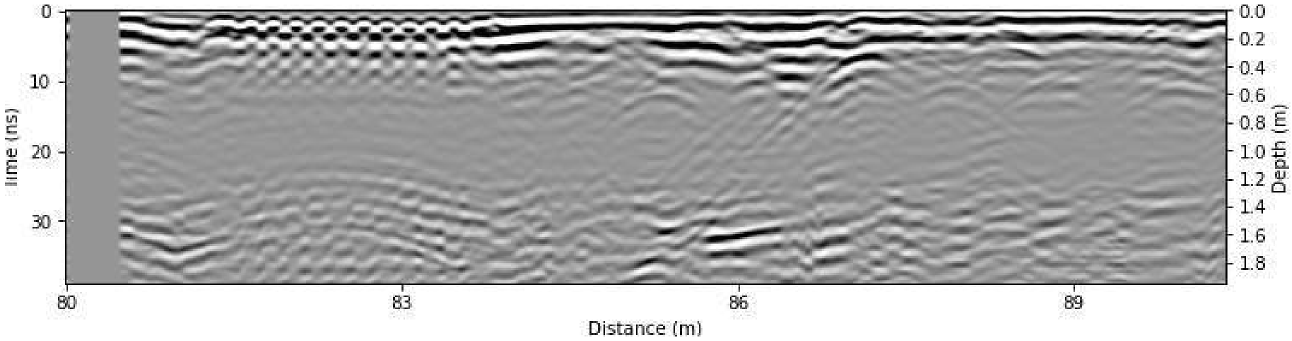


Figure B.730: Radargram at x = 34.0 m.

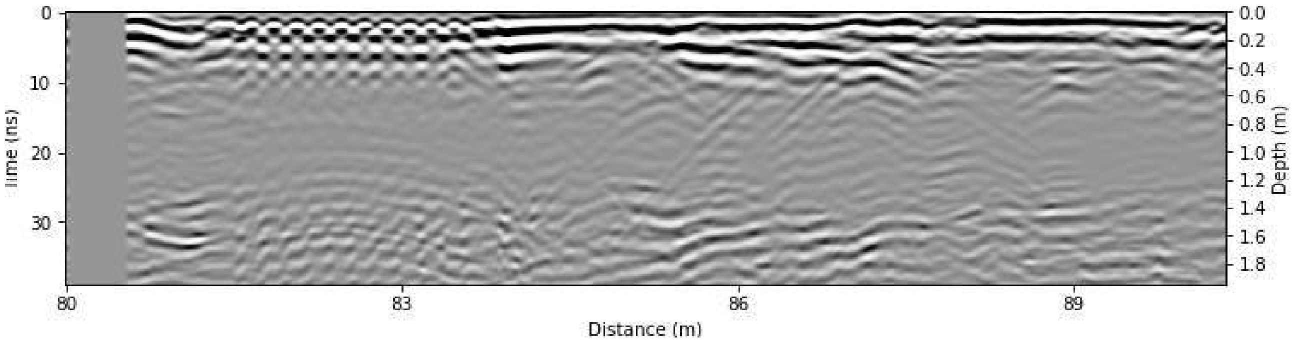


Figure B.731: Radargram at x = 34.25 m.

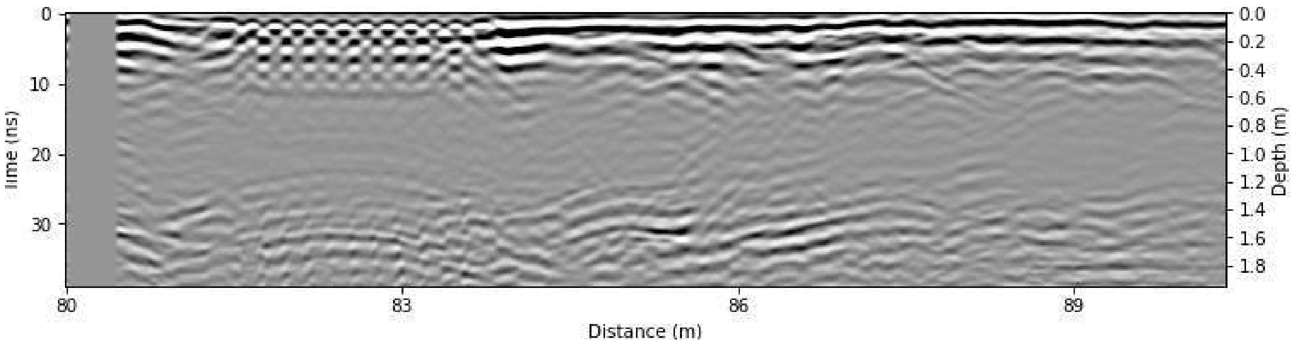


Figure B.732: Radargram at x = 34.5 m.

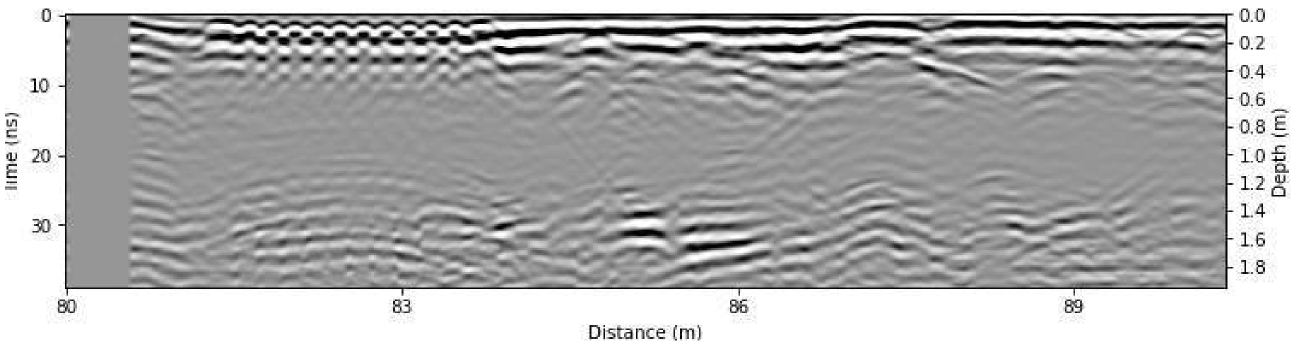


Figure B.733: Radargram at x = 34.75 m.

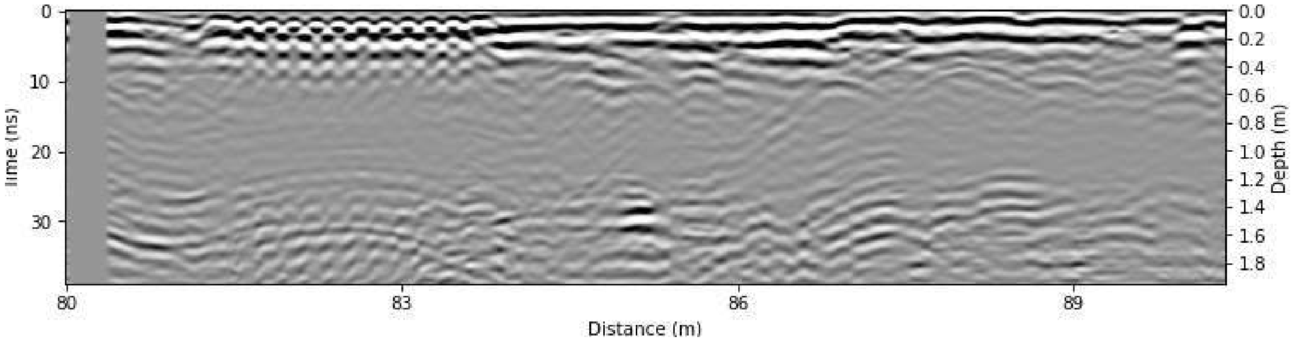


Figure B.734: Radargram at x = 35.0 m.

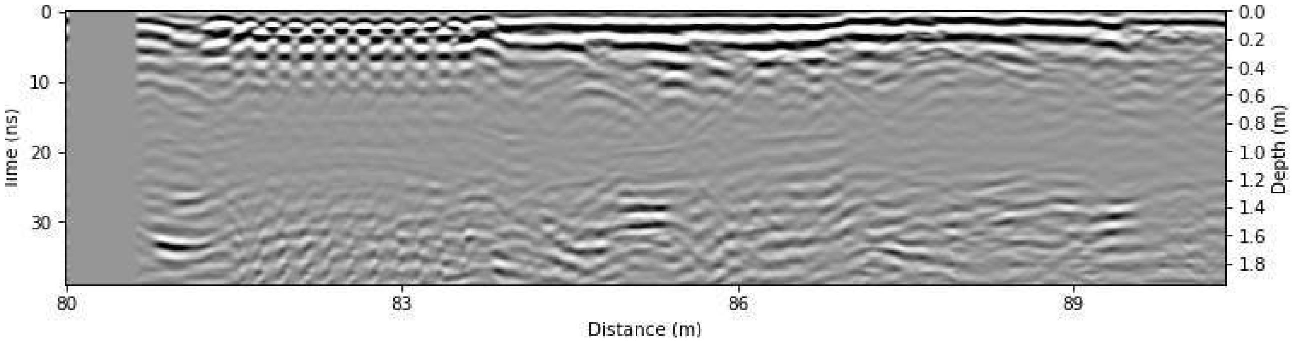


Figure B.735: Radargram at x = 35.25 m.

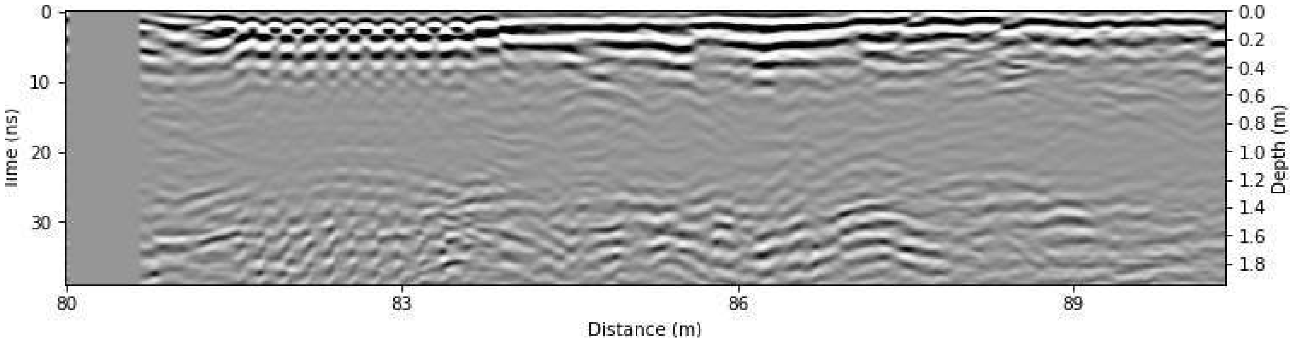


Figure B.736: Radargram at x = 35.5 m.

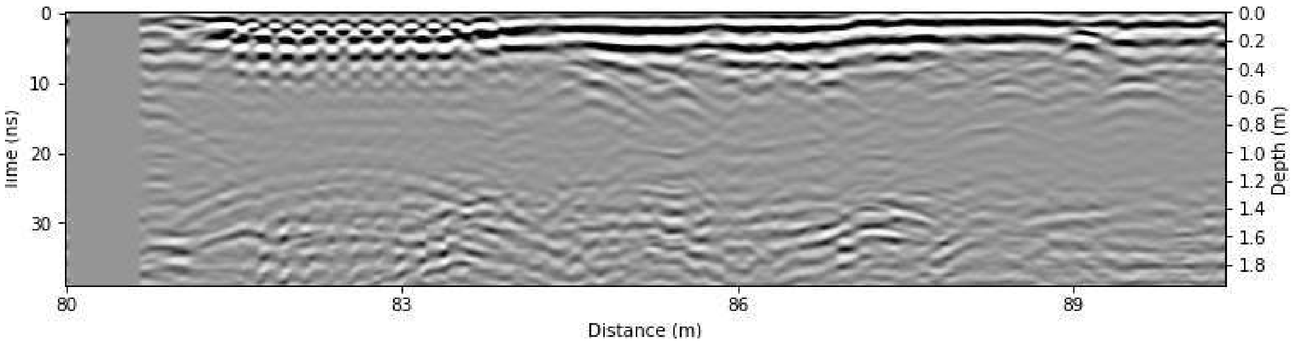


Figure B.737: Radargram at x = 35.75 m.

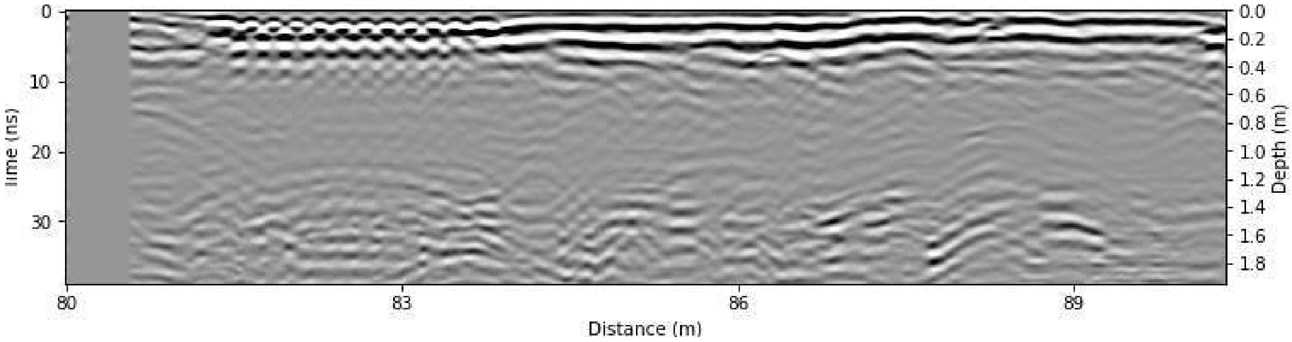


Figure B.738: Radargram at x = 36.0 m.

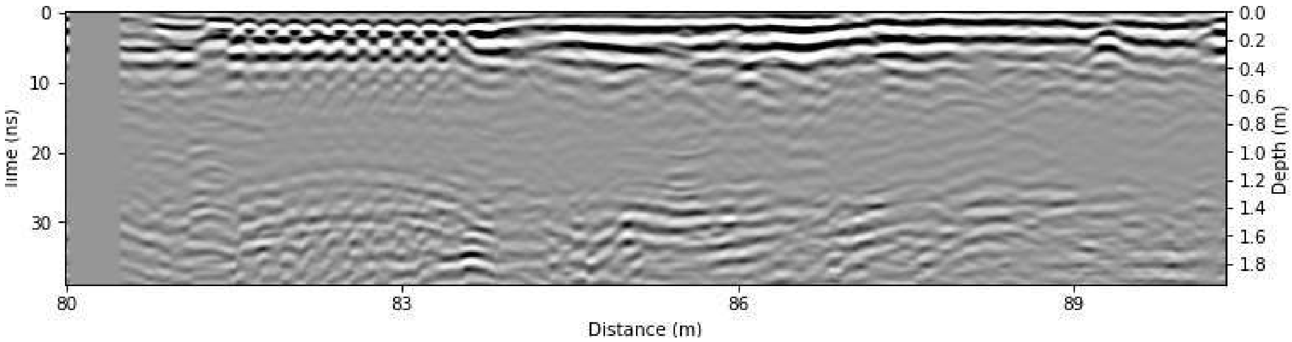


Figure B.739: Radargram at x = 36.25 m.

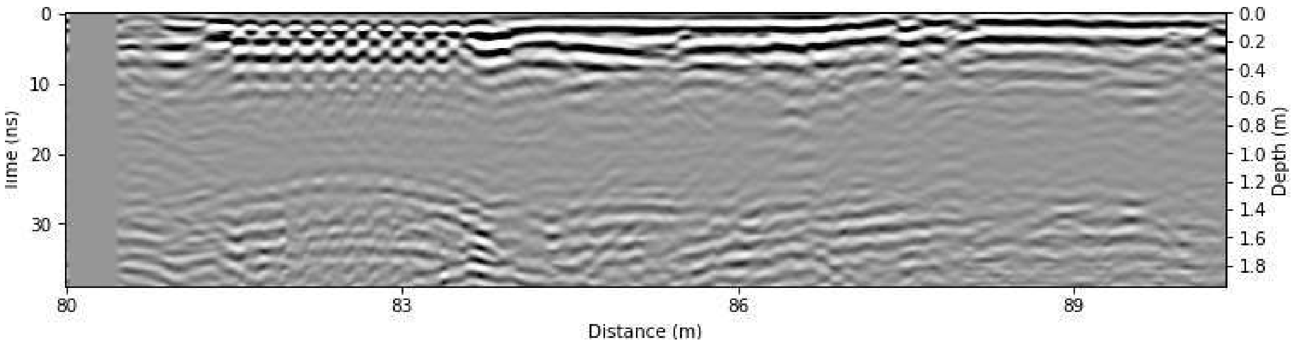


Figure B.740: Radargram at x = 36.5 m.

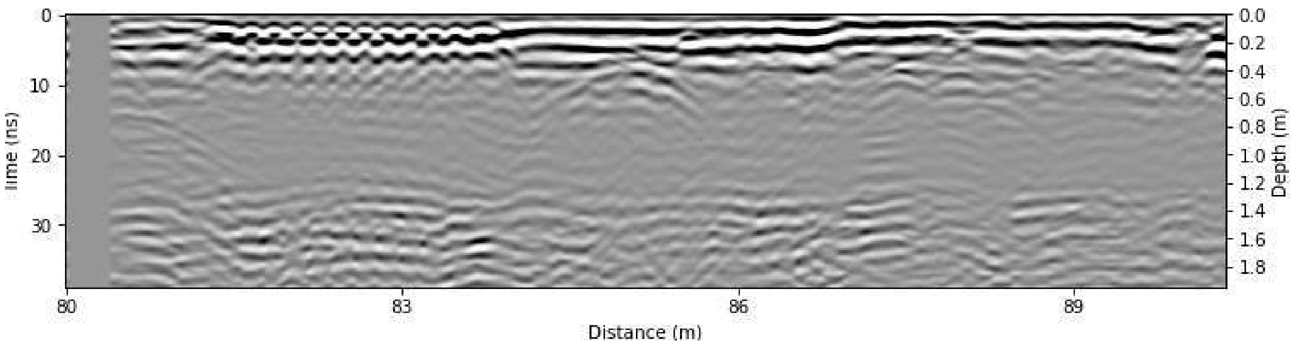


Figure B.741: Radargram at x = 36.75 m.

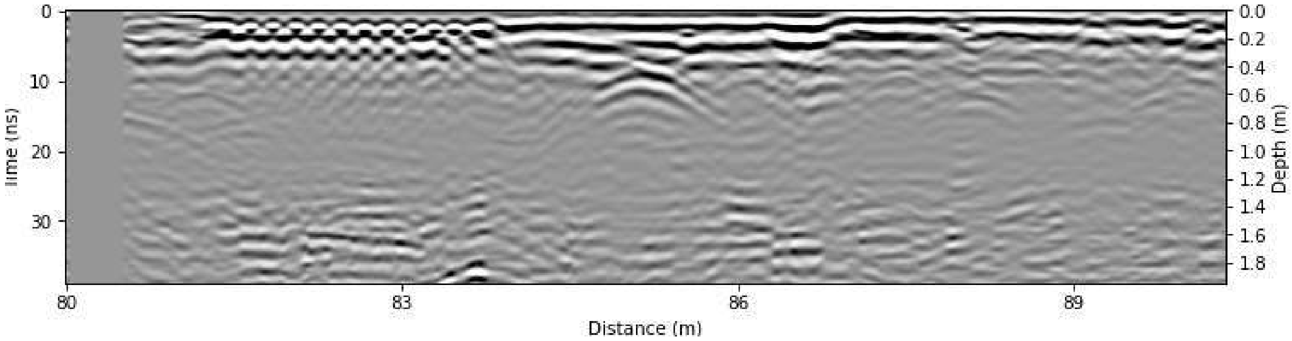


Figure B.742: Radargram at x = 37.0 m.

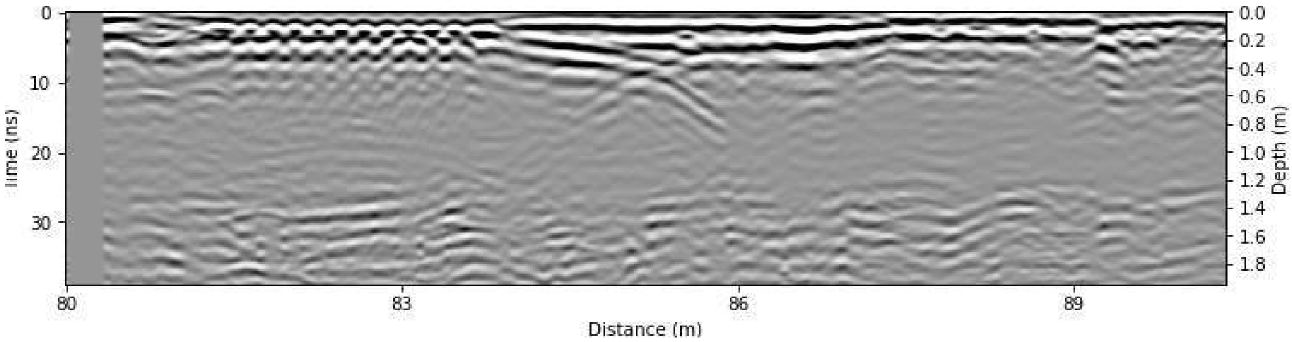


Figure B.743: Radargram at x = 37.25 m.

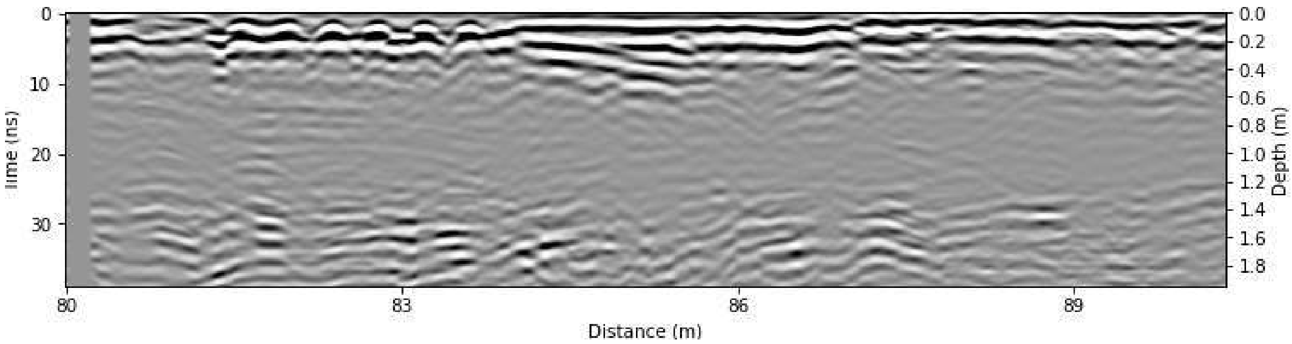


Figure B.744: Radargram at x = 37.5 m.

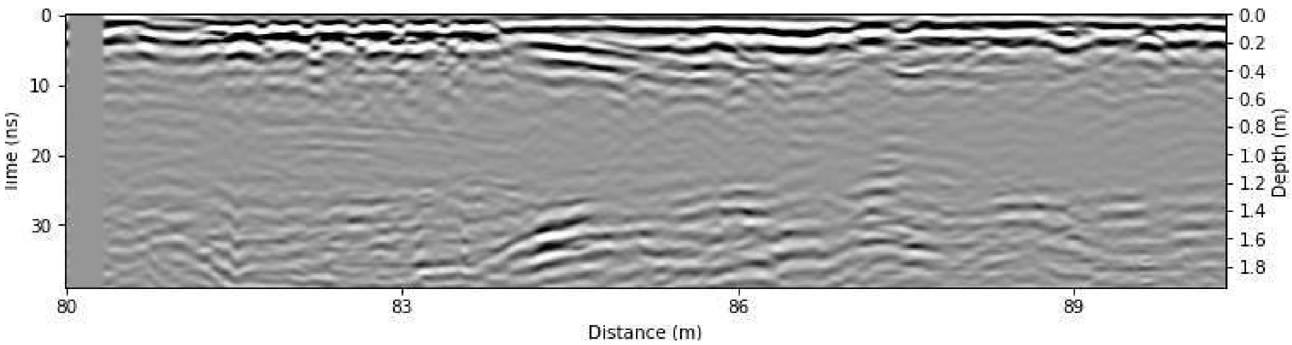


Figure B.745: Radargram at x = 37.75 m.

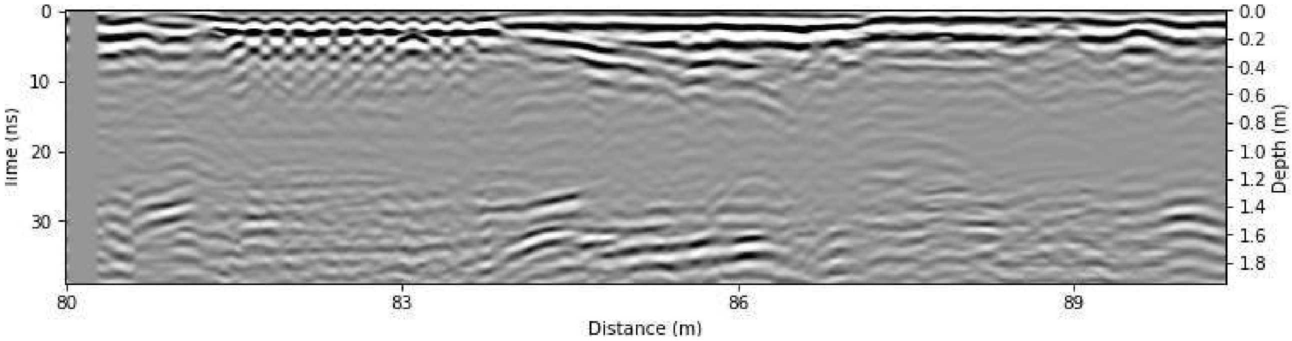


Figure B.746: Radargram at x = 38.0 m.

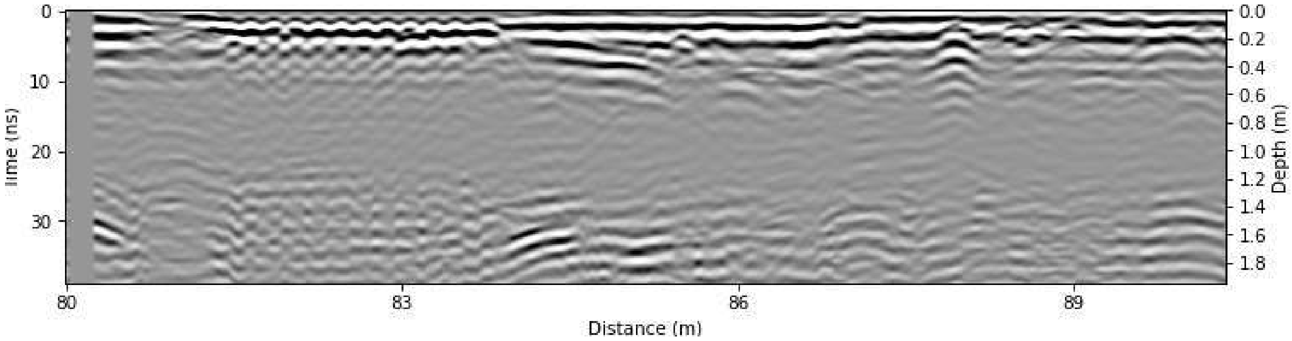


Figure B.747: Radargram at x = 38.25 m.

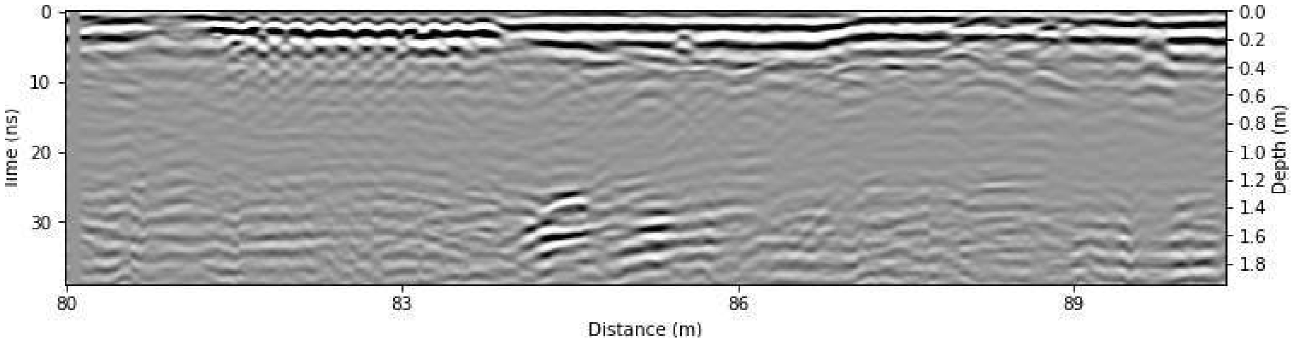


Figure B.748: Radargram at x = 38.5 m.

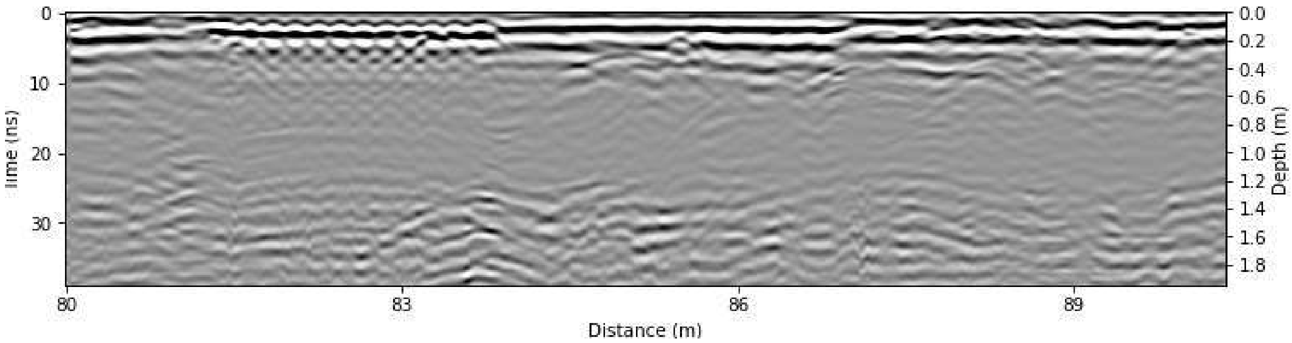


Figure B.749: Radargram at x = 38.75 m.

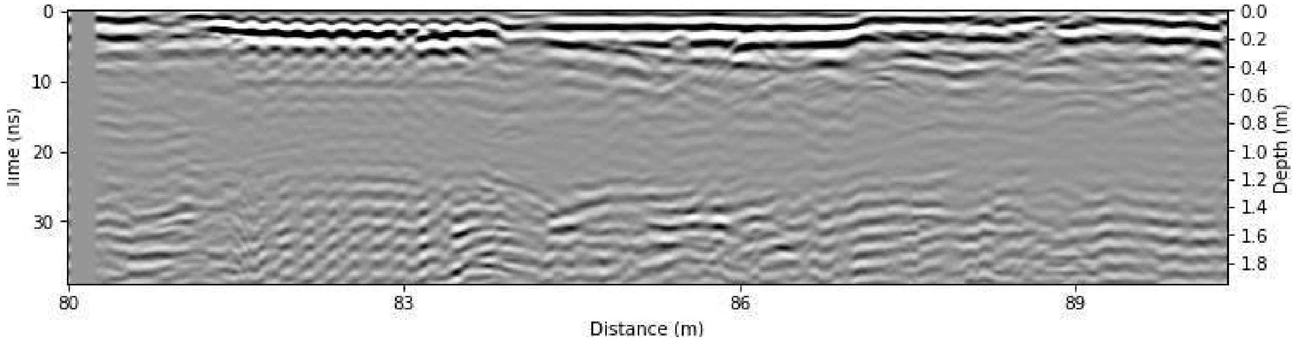


Figure B.750: Radargram at x = 39.0 m.

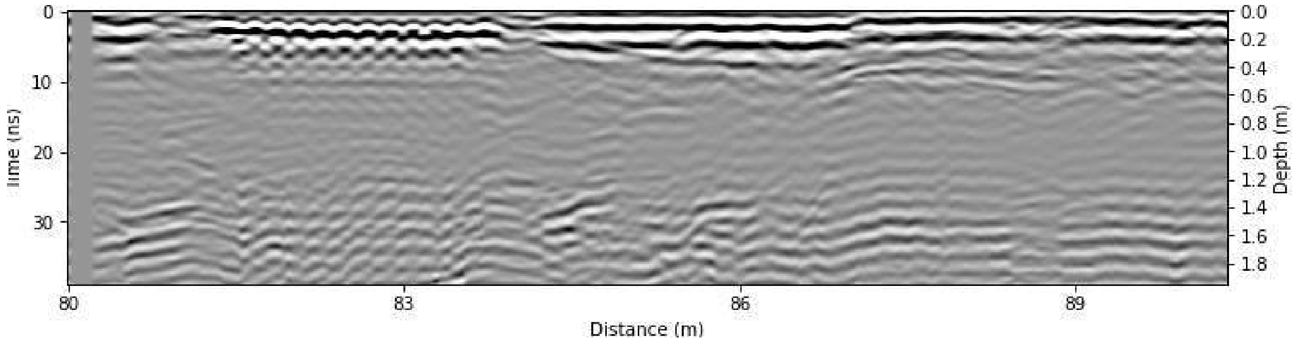


Figure B.751: Radargram at x = 39.25 m.

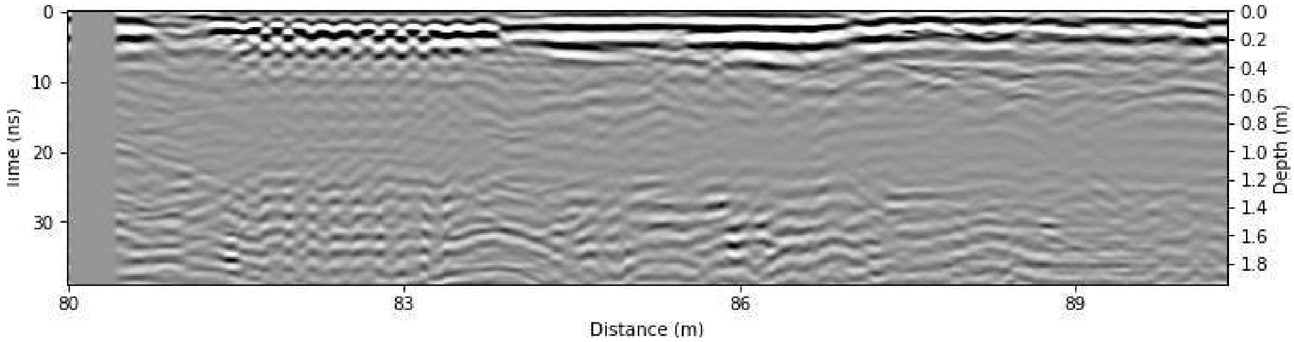


Figure B.752: Radargram at x = 39.5 m.

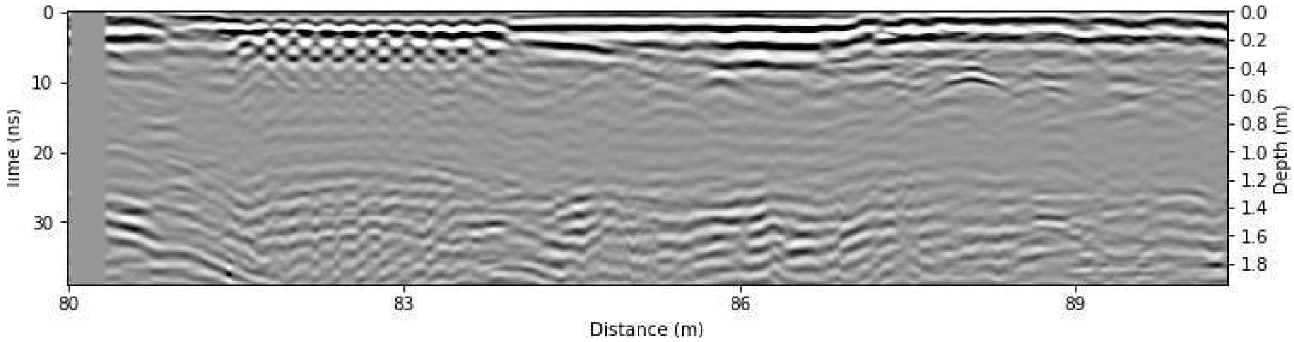


Figure B.753: Radargram at x = 39.75 m.

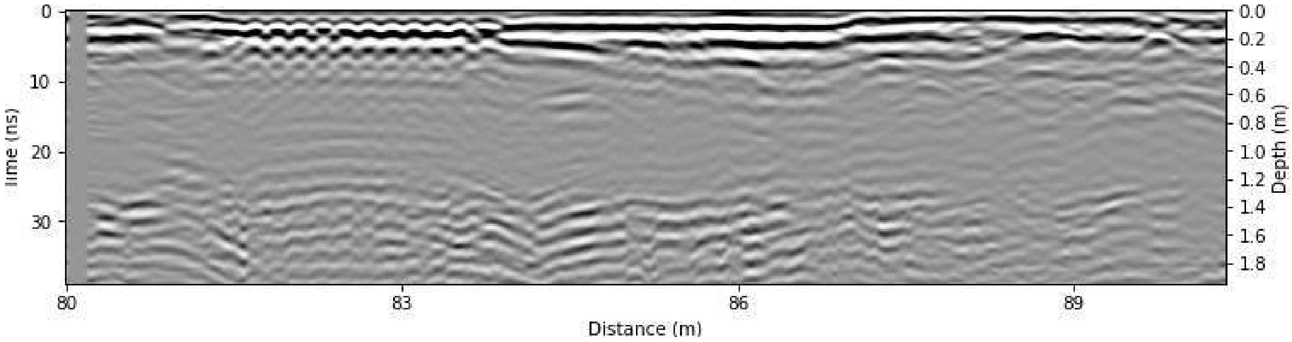
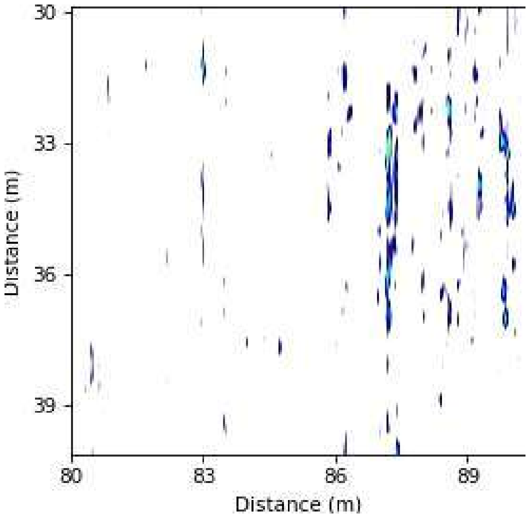
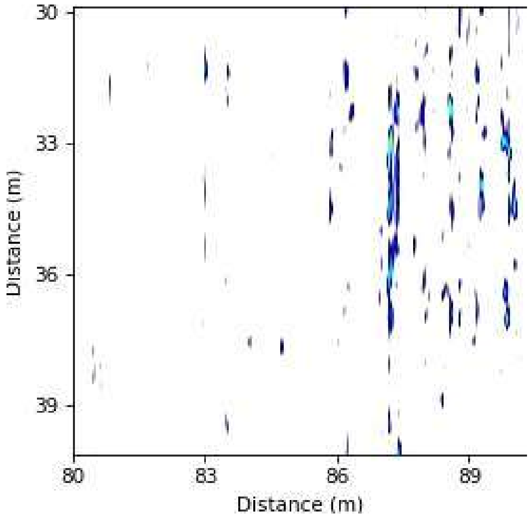


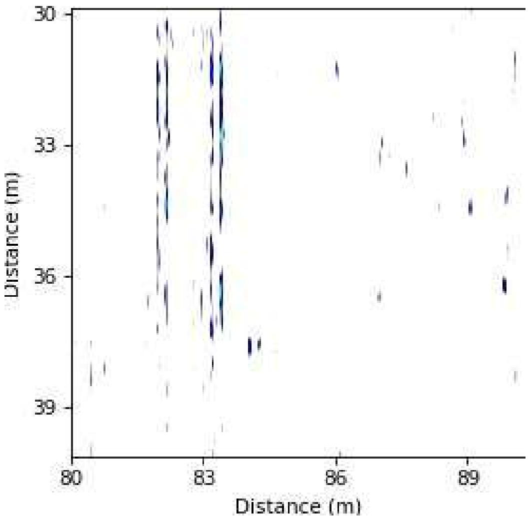
Figure B.754: Radargram at x = 40.0 m.



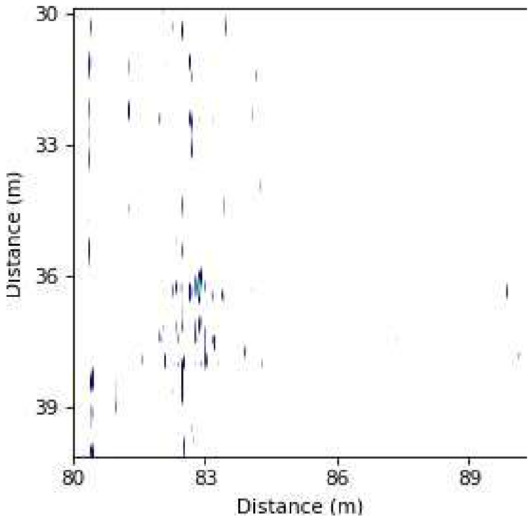
(a) Timeslice at z = 0.0 m.



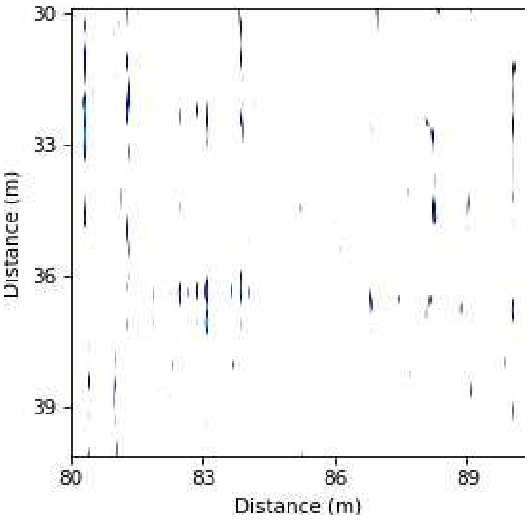
(b) Timeslice at z = 0.05 m.



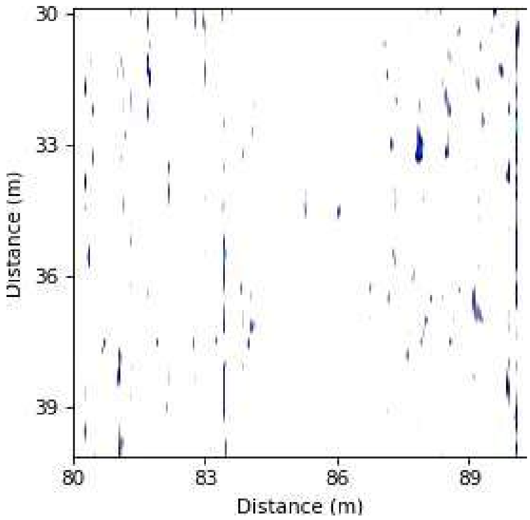
(c) Timeslice at z = 0.1 m.



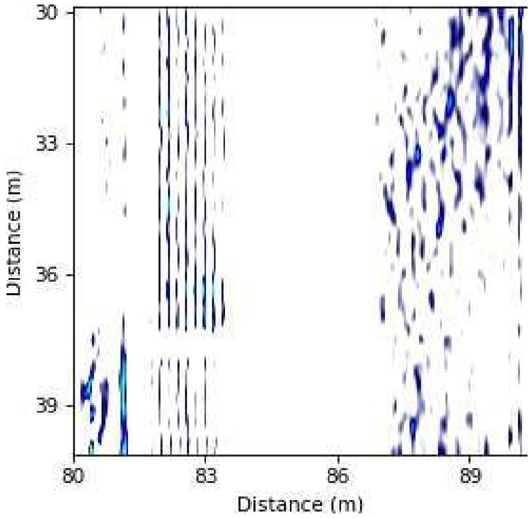
(d) Timeslice at z = 0.15 m.



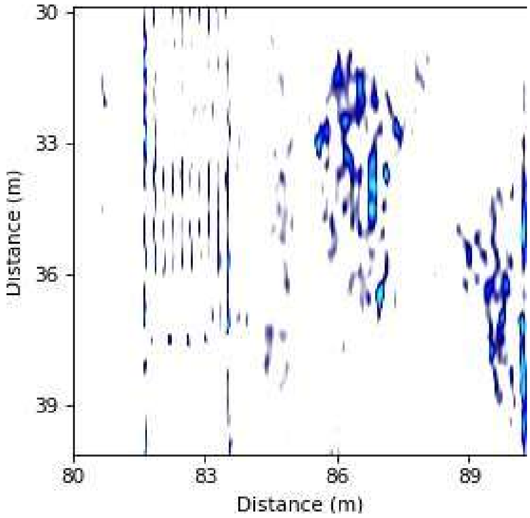
(e) Timeslice at z = 0.2 m.



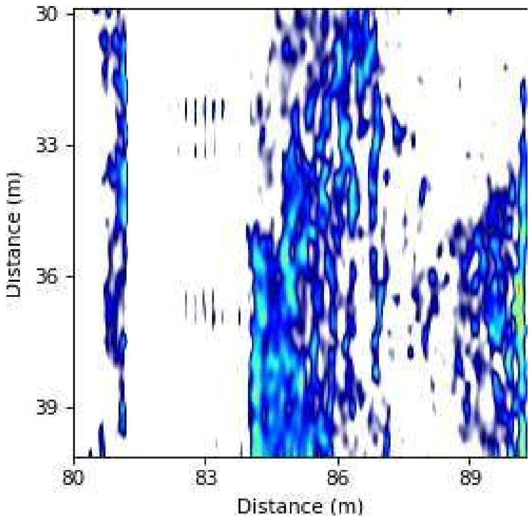
(f) Timeslice at z = 0.25 m.



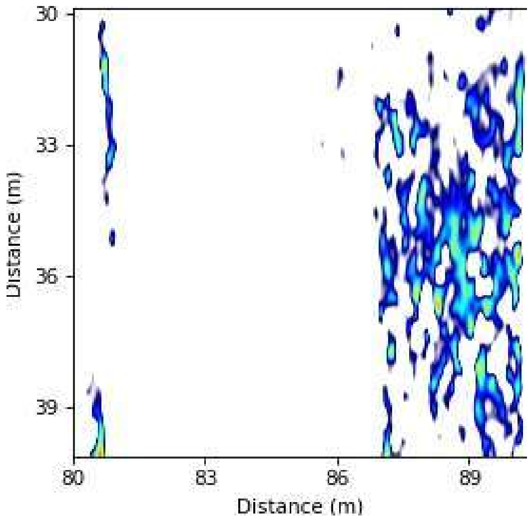
(a) Timeslice at z = 0.3 m.



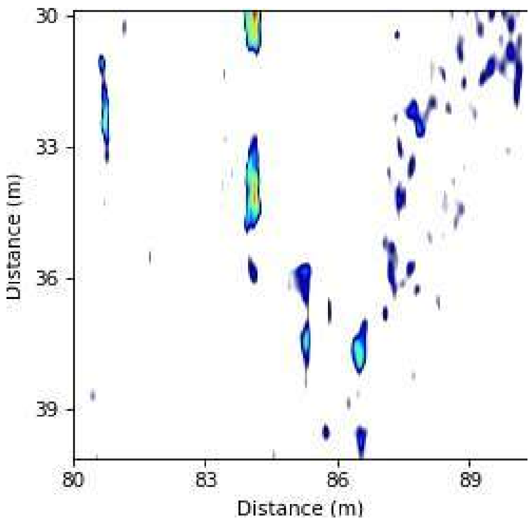
(b) Timeslice at z = 0.35 m.



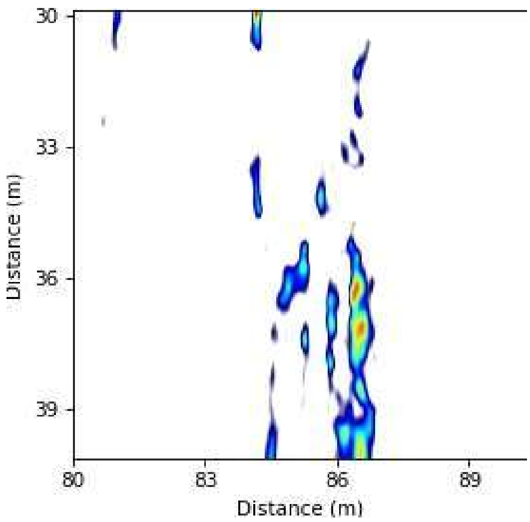
(c) Timeslice at z = 0.4 m.



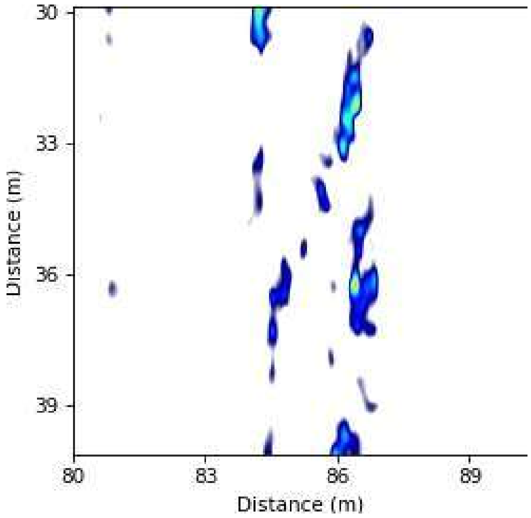
(d) Timeslice at z = 0.45 m.



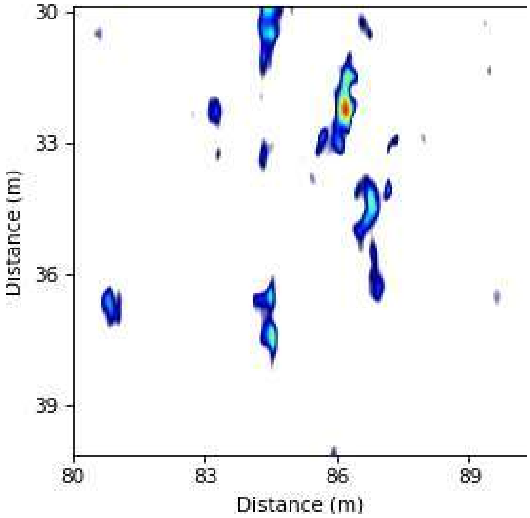
(e) Timeslice at z = 0.5 m.



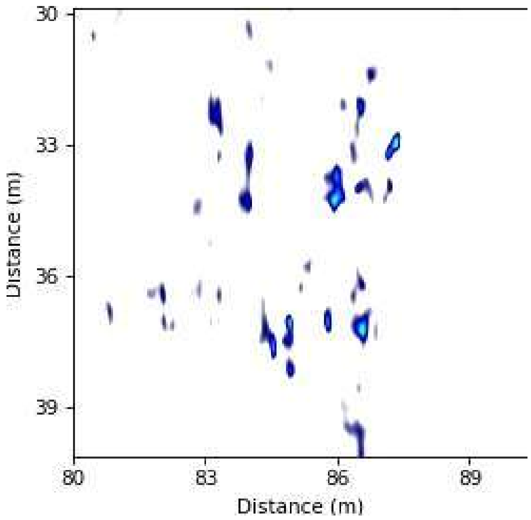
(f) Timeslice at z = 0.55 m.



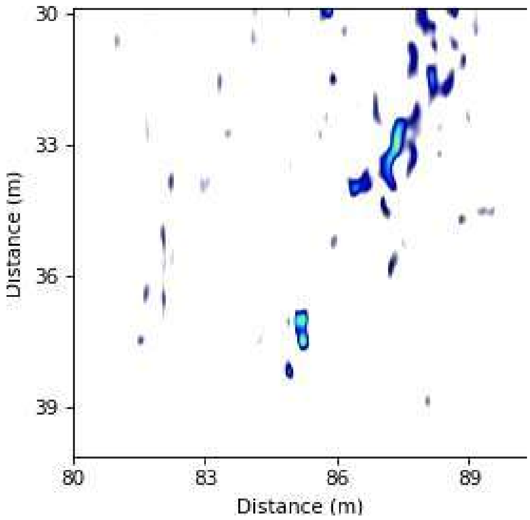
(a) Timeslice at z = 0.6 m.



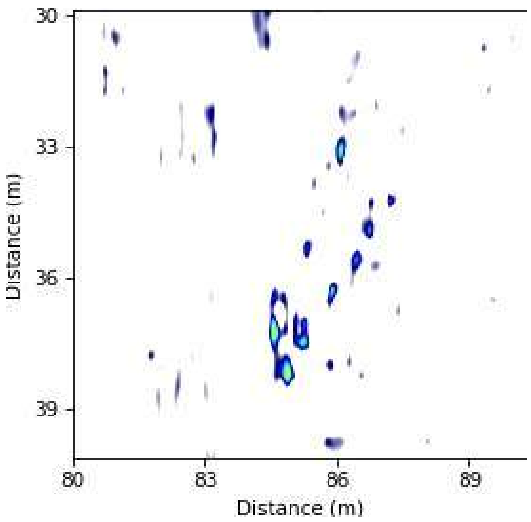
(b) Timeslice at z = 0.65 m.



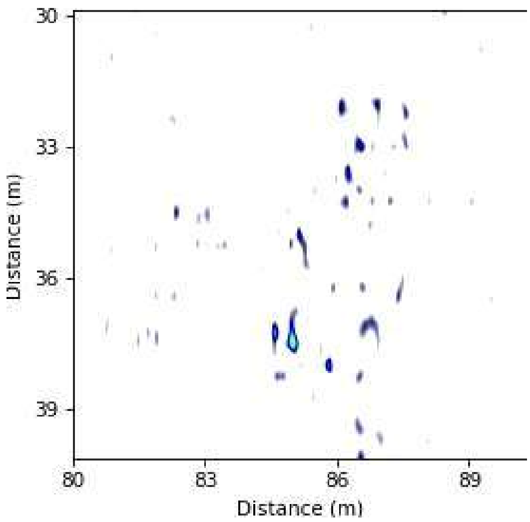
(c) Timeslice at z = 0.7 m.



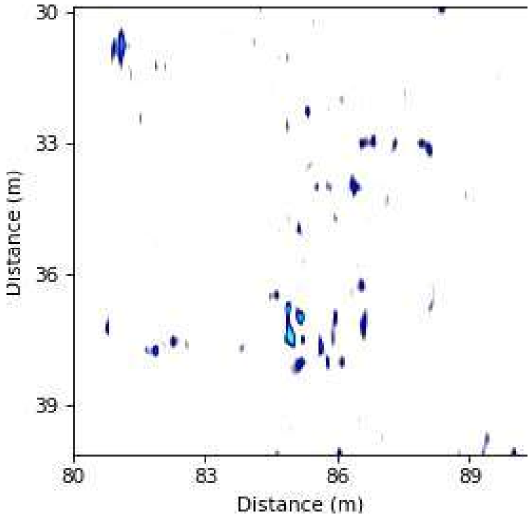
(d) Timeslice at z = 0.75 m.



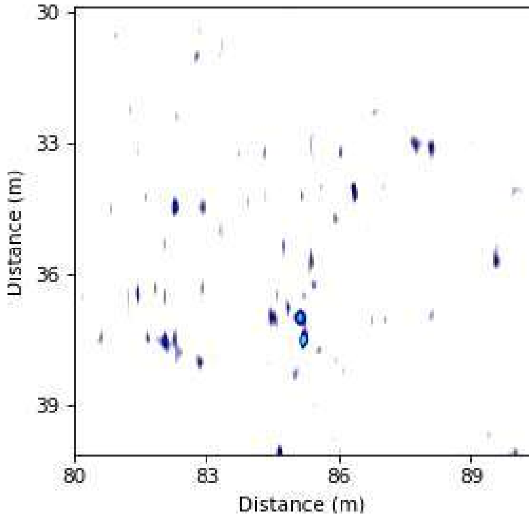
(e) Timeslice at z = 0.8 m.



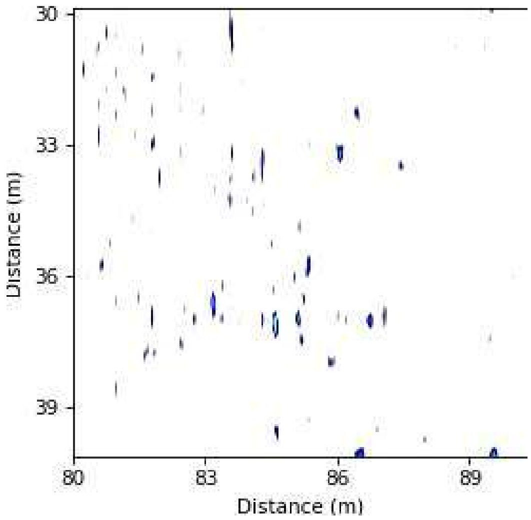
(f) Timeslice at z = 0.85 m.



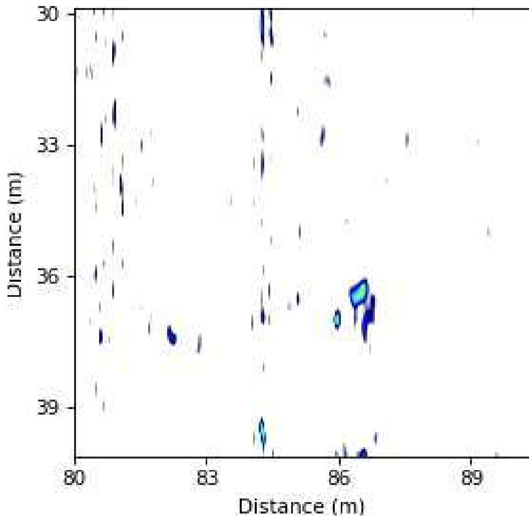
(a) Timeslice at z = 0.9 m.



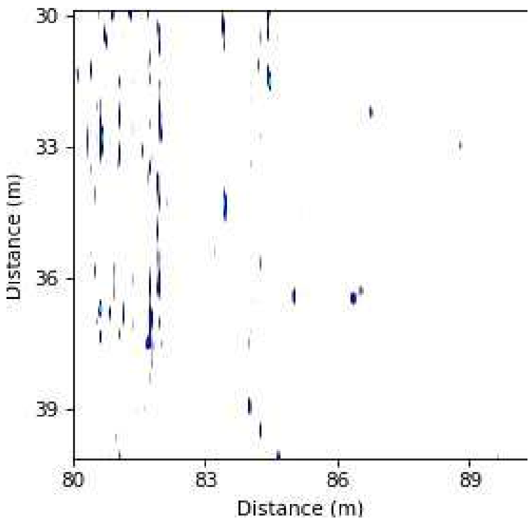
(b) Timeslice at z = 0.95 m.



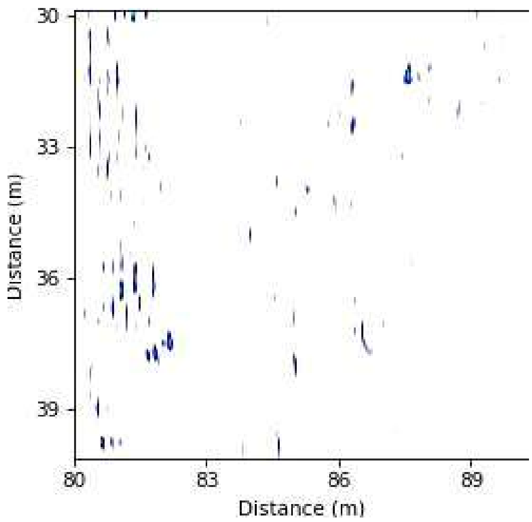
(c) Timeslice at z = 1.0 m.



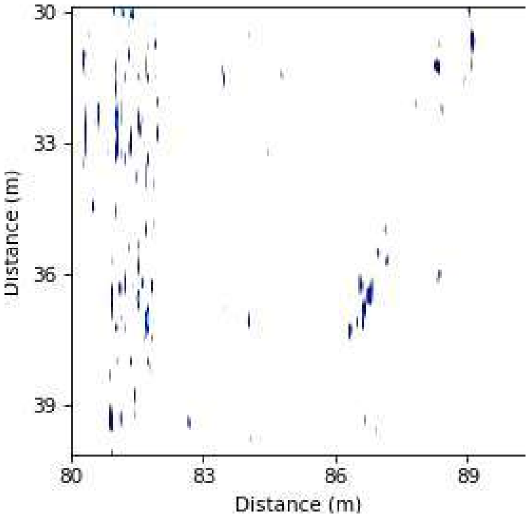
(d) Timeslice at z = 1.05 m.



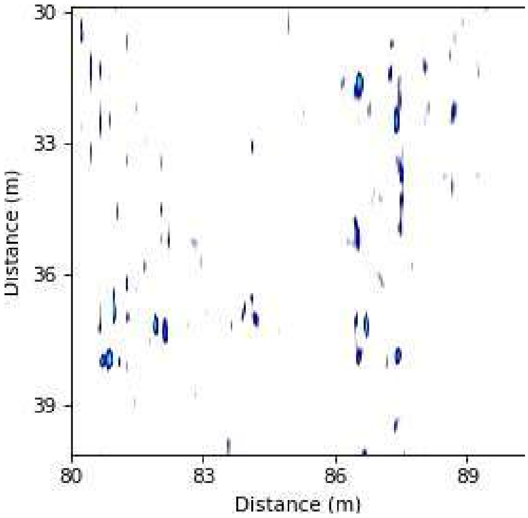
(e) Timeslice at z = 1.1 m.



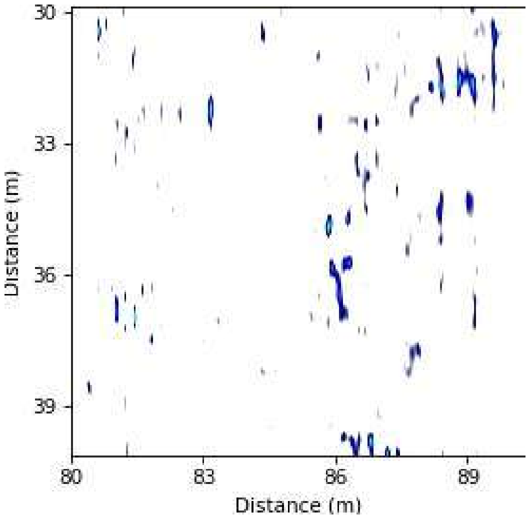
(f) Timeslice at z = 1.15 m.



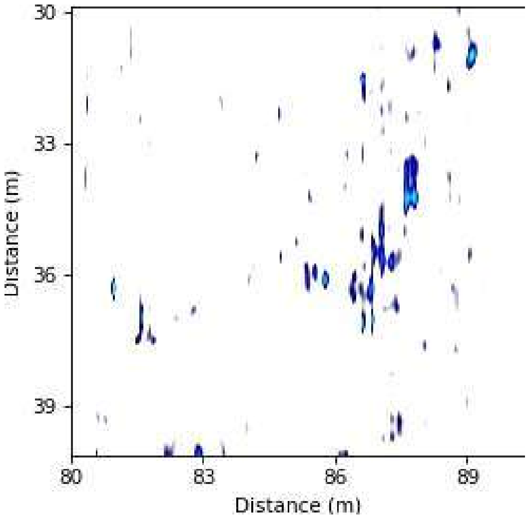
(a) Timeslice at z = 1.2 m.



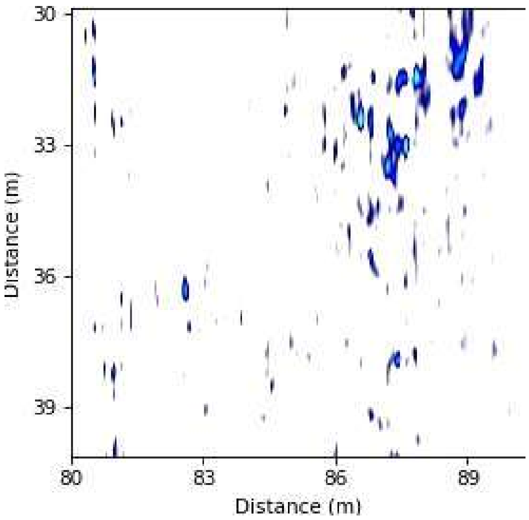
(b) Timeslice at z = 1.25 m.



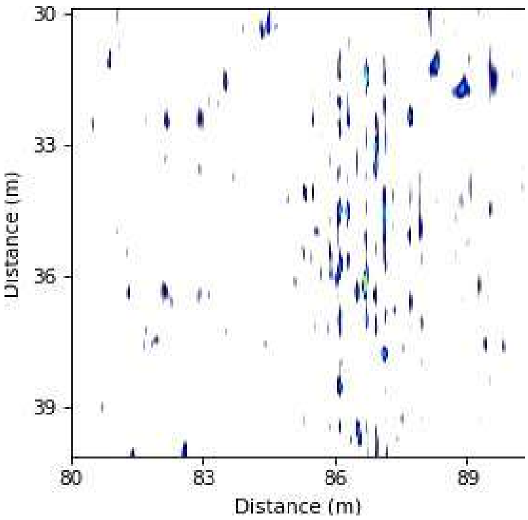
(c) Timeslice at z = 1.3 m.



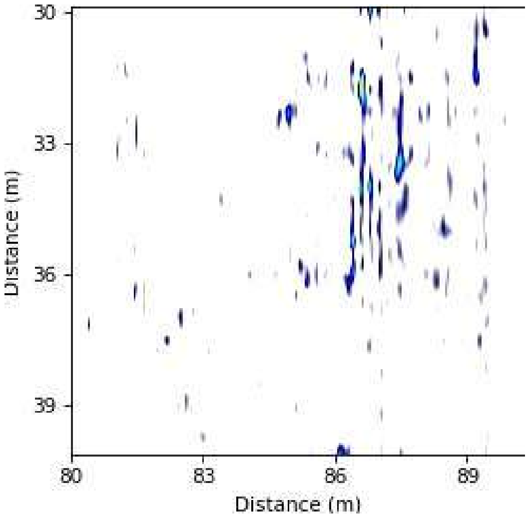
(d) Timeslice at z = 1.35 m.



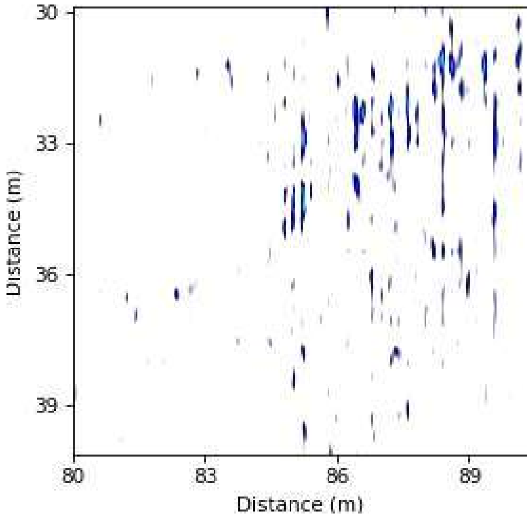
(e) Timeslice at z = 1.4 m.



(f) Timeslice at z = 1.45 m.



(a) Timeslice at z = 1.5 m.



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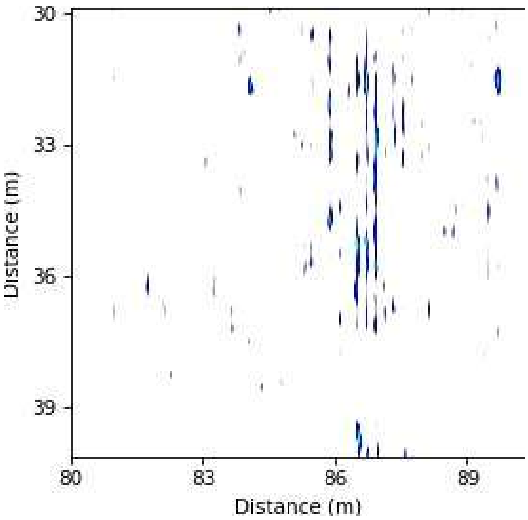

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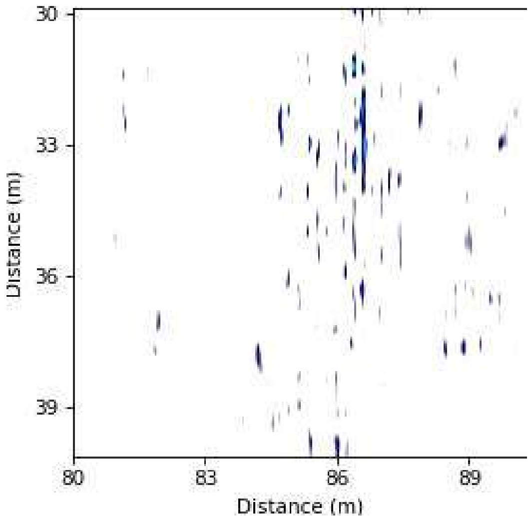

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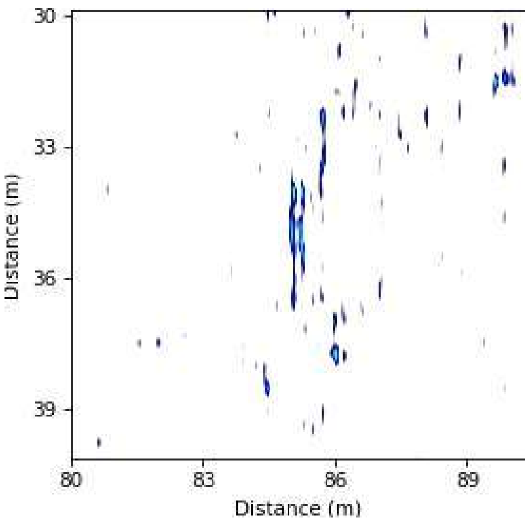

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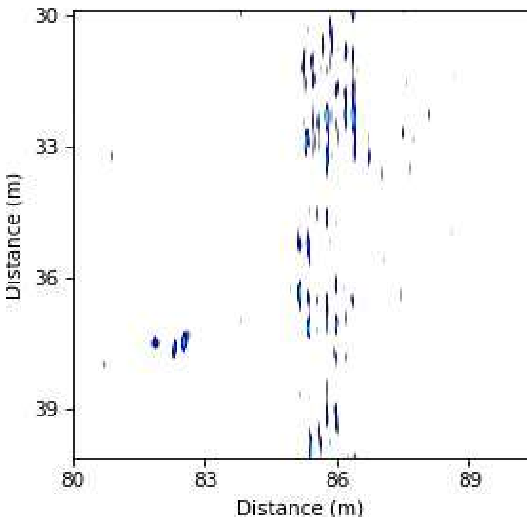

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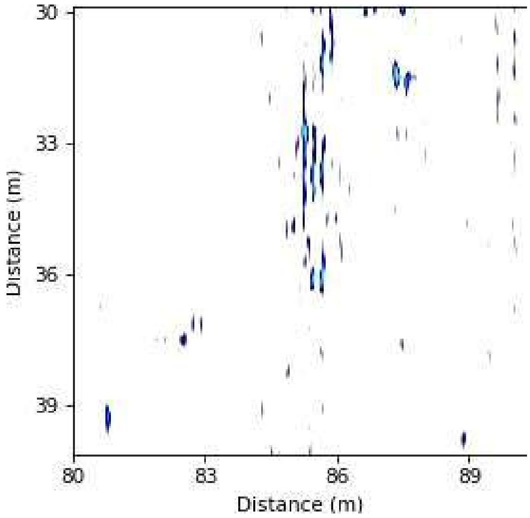

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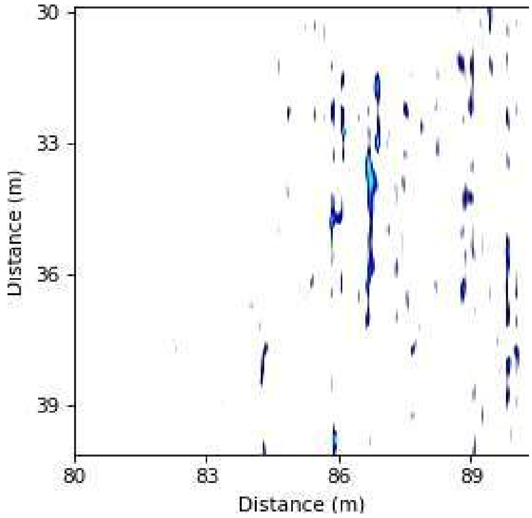

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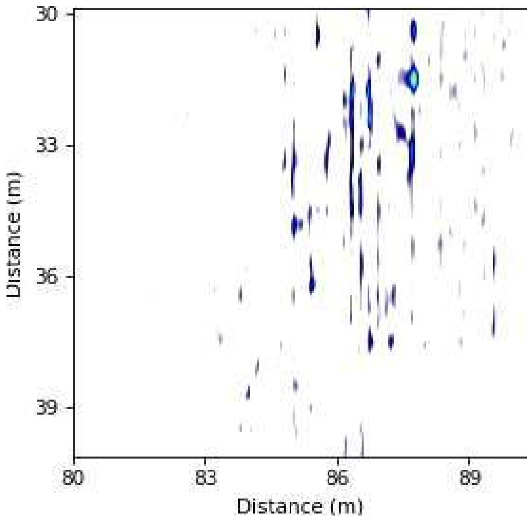

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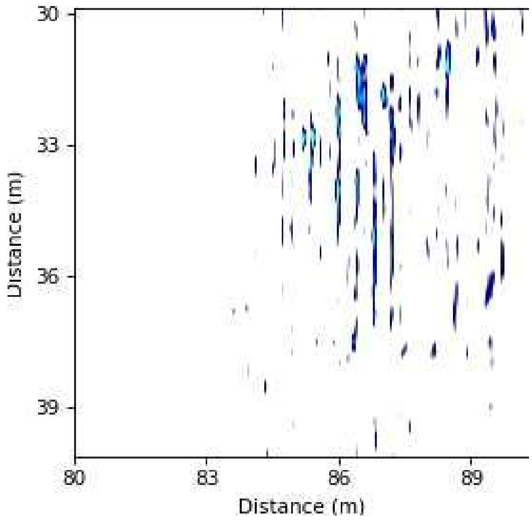

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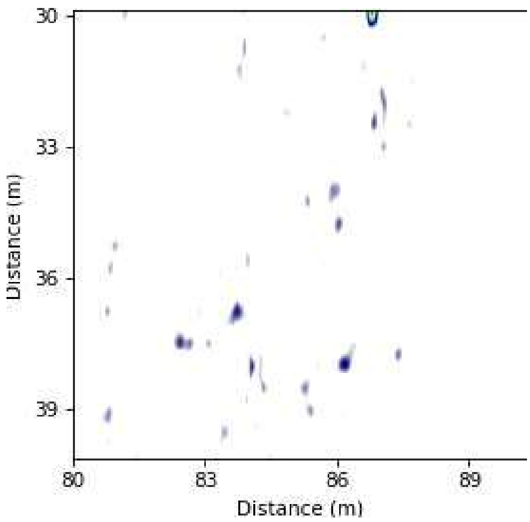

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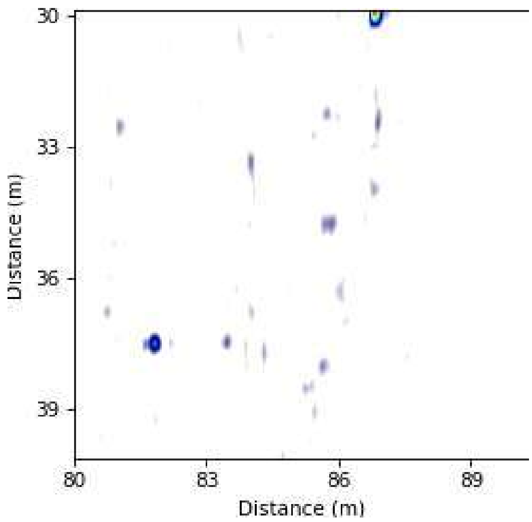

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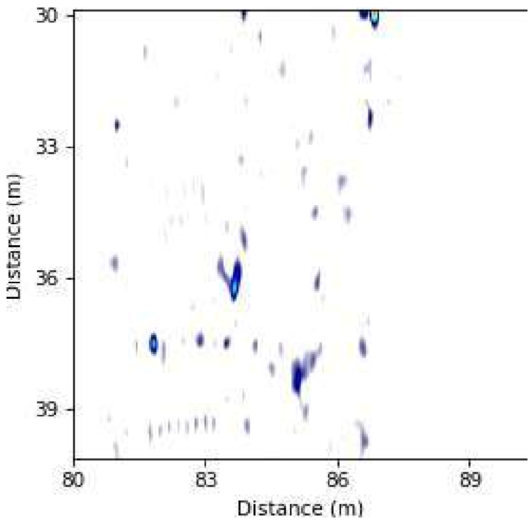

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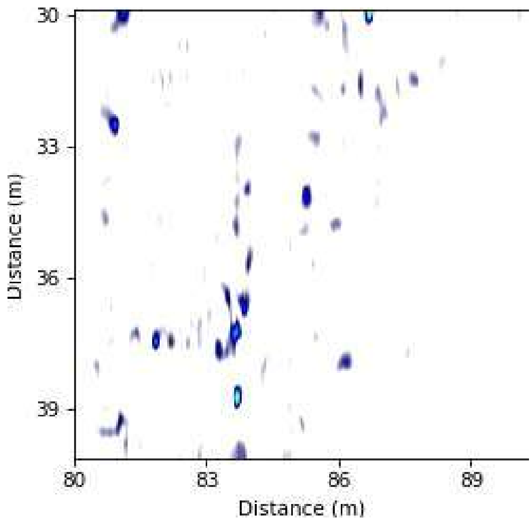

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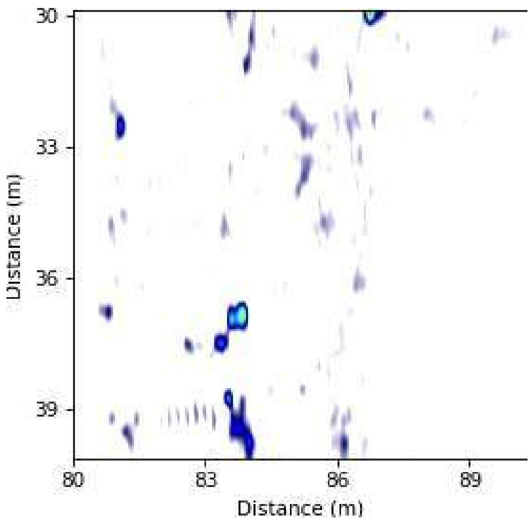

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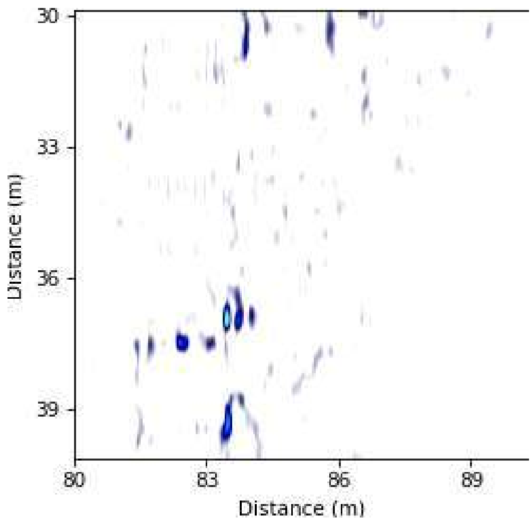

(d) Timeslice at z = 2.25 m.

Appendix 8: Transport for NSW Unexpected Heritage Item Procedure

Transport
Roads & Maritime
Services

Unexpected Heritage Items

Heritage Procedure 02

November 2015

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Contents

Please note

This procedure applies to all development and activities concerning roads, road infrastructure and road related assets undertaken by Roads and Maritime.

For advice on how to manage unexpected heritage items as a result of activities related to maritime infrastructure projects, please contact the Senior Environmental Specialist (Heritage).

1 Purpose

This procedure has been developed to provide a consistent method for managing unexpected heritage items (both Aboriginal and non-Aboriginal) that are discovered during Roads and Maritime activities. This procedure includes Roads and Maritime's heritage notification obligations under the *Heritage Act 1977* (NSW), *National Parks and Wildlife Act 1974* (NSW), A*boriginal and Torres Strait Islander Heritage Protection Act 1984* (Cth) and the *Coroner's Act 2009* (NSW).

This document provides relevant background information in Section 3, followed by the technical procedure in Sections 6 and 7. Associated guidance referred to in the procedure can be found in Appendices A-H.

2 Scope

This procedure assumes that an appropriate level of Aboriginal and non-Aboriginal heritage assessment has been completed before work commences on site. In some cases, such as exempt development, detailed heritage assessment may not be required.

Despite appropriate and adequate investigation, unexpected heritage items may still be discovered during maintenance and construction works. When this happens, this procedure must be followed. This procedure provides direction on when to stop work, where to seek technical advice and how to notify the regulator, if required.

This procedure applies to <u>all</u> Road and Maritime construction and maintenance activities

This procedure **applies to**:

- The discovery of any unexpected heritage item (usually during construction), where Roads and Maritime does not have approval to disturb the item or where safeguards for managing the disturbance (apart from this procedure) are not contained in the environmental impact assessment.
- All Roads and Maritime projects that are approved or determined under Part 3A (including Transitional Part 3A Projects), Part 4, Part 5 or Part 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act), or any development that is exempt under the Act.

This procedure must be followed by Roads and Maritime staff, alliance partners (including local council staff working under Road Maintenance Council Contracts, [RMCC]), developers under works authorisation deeds or any person undertaking Part 5 assessment for Roads and Maritime.

This procedure **does not** apply to:

- The legal discovery and disturbance of heritage items as a result of investigations being undertaken in accordance with OEH's *Code of Practice for the Archaeological Investigation of Aboriginal Objects in NSW* (2010); an Aboriginal Heritage Impact Permit (AHIP) issued under the *National Parks and Wildlife Act 1974*; or an approval issued under the *Heritage Act 1977*[1].
- The legal discovery and disturbance of heritage items as a result of investigations (or other activities) that are required to be carried out for the purpose of complying with any environmental assessment requirements under Part 3A (including Transitional Part 3A Projects) or Part 5.1 of the EP&A Act.
- The legal discovery and disturbance of heritage items as a result of construction related activities, where the disturbance is permissible in accordance with an AHIP[2]; an approval issued under the *Heritage Act 1977*; the Minister for Planning's conditions of project approval; or safeguards (apart from

[1] RMS' heritage obligations are incorporated into the conditions of heritage approvals.
[2] RMS *Procedure for Aboriginal cultural heritage consultation and investigation* (2011) recommends that Part 4 and Part 5 projects that are likely to impact Aboriginal objects during construction seek a whole-of-project AHIP. This type of AHIP generally allows a project to impact known and potential Aboriginal objects within the entire project area, without the need to stop works. It should be noted that an AHIP may exclude impact to certain objects and areas, such as burials or ceremonial sites. In such cases, the project must follow this procedure.

this procedure) that are contained in the relevant environmental impact assessment.

All construction environment management plans (CEMPs) must make reference to and/or include this procedure (often included as a heritage sub-plan). Where approved CEMPs exist they must be followed in the first instance. Where there is a difference between approved CEMPs and this procedure, the approved CEMP must be followed. Where an approved CEMP does not provide sufficient detail on particular issues, this procedure should be used as additional guidance. When in doubt always seek environment and legal advice on varying approved CEMPs.

3 Types of unexpected heritage items and their legal protection

The roles of project, field and environmental staff are critical to the early identification and protection of unexpected heritage items. **Appendix A** illustrates the wide range of heritage discoveries found on Roads and Maritime projects and provides a useful photographic guide. Subsequent confirmation of heritage discoveries must then be identified and assessed by technical specialists (usually an archaeologist).

An ‘unexpected heritage item’ means any unanticipated discovery of an actual or potential heritage item, for which Roads and Maritime does not have approval to disturb[3] or does not have a safeguard in place (apart from this procedure) to manage the disturbance.

These discoveries are categorised as either:

(a) Aboriginal objects

(b) Historic (non-Aboriginal) heritage items

(c) Human skeletal remains.

The relevant legislation that applies to each of these categories is described below.

3.1 Aboriginal objects

The *National Park and Wildlife Act 1974* protects *Aboriginal objects* which are defined as:

“*any deposit, object or material evidence (not being a handicraft made for sale) relating to the Aboriginal habitation of the area that comprises New South Wales, being habitation before or concurrent with (or both) the occupation of that area by persons of non Aboriginal extraction, and includes Aboriginal remains*”[4].

Examples of Aboriginal objects include stone tool artefacts, shell middens, axe grinding grooves, pigment or engraved rock art, burials and scarred trees.

✋ **IMPORTANT!**

<u>All</u> Aboriginal objects, regardless of significance, are protected under law.

If any impact is expected to an Aboriginal object, an Aboriginal Heritage Impact Permit (AHIP) is usually required from the Office of Environment and Heritage (OEH)[5]. Also, when a person becomes aware of an Aboriginal object they must notify

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[3] Disturbance is considered to be any physical interference with the item that results in it being destroyed, defaced, damaged, harmed, impacted or altered in any way (this includes archaeological investigation activities).
[4] Section 5(1) *National Park and Wildlife Act 1974*.
[5] Except when Part 3A, Division 4.1 of Part 4 or Part 5.1 of the *EP&A Act* applies.

the Director-General of OEH about its location[6]. Assistance on how to do this is provided in Section 7 (Step 5).

3.2 Historic heritage items

Historic (non-Aboriginal) heritage items may include:

- Archaeological 'relics'
- Other historic items (i.e. works, structures, buildings or movable objects).

3.2.1 Archaeological relics

The *Heritage Act 1977* protects *relics* which are defined as:

"*any deposit, artefact, object or material evidence that relates to the settlement of the area that comprises NSW, not being Aboriginal settlement; and is of State or local heritage significance*"[7].

Relics are archaeological items of local or state significance which may relate to past domestic, industrial or agricultural activities in NSW, and can include bottles, remnants of clothing, pottery, building materials and general refuse.

IMPORTANT!

All relics are subject to statutory controls and protections.

If a relic is likely to be disturbed, a heritage approval is usually required from the NSW Heritage Council[8]. Also, when a person discovers a relic they must notify the NSW Heritage Council of its location[9]. Advice on how to do this is provided in Section 7 (Step 5).

3.2.2 Other historic items

Some historic heritage items are not considered to be 'relics'; but are instead referred to as works, buildings, structures or movable objects. Examples of these items that Roads and Maritime may encounter include culverts, historic road formations, historic pavements, buried roads, retaining walls, tramlines, cisterns, fences, sheds, buildings and conduits. Although an approval under the *Heritage Act 1977* (NSW) may not be required to disturb these items, their discovery must be managed in accordance with this procedure.

As a general rule, an archaeological relic requires discovery or examination through the act of excavation. An archaeological excavation permit under Section 140 of the Heritage Act is required to do this. In contrast, 'other historic items' either exist above the ground's surface (e.g. a shed), or they are designed to operate and exist beneath the ground's surface (e.g. a culvert).

[6] This is required under s89(A) of the *National Park and Wildlife Act 1974* (NSW) and applies to **all projects** assessed under Part 3A, Part 4, Part 5 and Part 5.1 of the *EP&A Act*, including exempt development.
[7] Section 4(1) *Heritage Act 1977*.
[8] Except when Part 3A, Division 4.1 of Part 4 or Part 5.1 of the *EP&A Act* applies.
[9] This is required under s146 of the *Heritage Act 1977* and applies to **all projects** assessed under Part 3A, Part 4, Part 5 and Part 5.1 of the *EP&A Act*, including exempt development.

Despite this difference, it should be remembered that relics can often be associated with 'other heritage items', such as archaeological deposits within cisterns and underfloor deposits under buildings.

3.3 Human skeletal remains

Human skeletal remains can be classed as:

- Reportable deaths
- Aboriginal objects
- Relics

Where it is suspected that less than 100 years has elapsed since death, human skeletal remains come under the jurisdiction of the State Coroner and the *Coroners Act* 2009 (NSW). Under s 35(2) of the Act, a person must report the death to a police officer, a coroner or an assistant coroner as soon as possible. This applies to all human remains less than 100 years old[10] regardless of ancestry. Public health controls may also apply.

Where remains are suspected of being more than 100 years old, they are considered to be either Aboriginal objects or non-Aboriginal relics depending on the ancestry of the individual. Aboriginal human remains are protected under the *National Parks and Wildlife Act 1974*, while non-Aboriginal remains are protected under the *Heritage Act 1977*.

The approval and notification requirements of these Acts are described above in sections 3.1 and 3.2. Additionally, the discovery of Aboriginal human remains also triggers notification requirements to the Commonwealth Minister for the Environment under s 20(1) of the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Cth).

IMPORTANT!

All human skeletal remains are subject to statutory controls and protections.

All bones must be treated as potential human skeletal remains and work around them must stop while they are protected and investigated urgently.

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Guidance on what to do when suspected human remains are found is in **Appendix E**.

[10] Under s 19 of the *Coroners Act 2009*, the coroner has no jurisdiction to conduct an inquest into reportable death unless it appears to the coroner that (or that there is reasonable cause to suspect that) the death or suspected death occurred within the last 100 years.

4 Responsibilities

The following roles and responsibilities are relevant to this procedure:

Role	Definition/responsibility
Aboriginal Cultural Heritage Advisor (ACHA)	Provides Aboriginal cultural heritage advice to project teams. Acts as Aboriginal community liaison for projects on cultural heritage matters. Engages and consults with the Aboriginal community as per the Roads and Maritime *Procedure for Aboriginal Cultural Heritage Consultation and Investigation*.
Aboriginal Sites Officer (ASO)	Is an appropriately trained and skilled Aboriginal person whose role is to identify and assess Aboriginal objects and cultural values. For details on engaging Aboriginal Sites Officers, refer to Roads and Maritime *Procedure for Aboriginal Cultural Heritage Consultation and Investigation*.
Archaeologist (A)	Professional consultant, contracted on a case-by-case basis to provide heritage and archaeological advice and technical services (such as reports, heritage approval documentation etc). Major projects with complex heritage issues often have an on call Project archaeologist.
Project Manager (PM)	Ensures all aspects of this procedure are implemented. The PM can delegate specific tasks to a construction environment manager, Roads and Maritime site representatives or regional environment staff, where appropriate.
Regional Environment Staff (RES)	Provides advice on this procedure to project teams. Ensuring this procedure is implemented consistently by supporting the PM. Supporting project teams during the uncovering of unexpected finds. Reviewing archaeological management plans and liaising with heritage staff and archaeological consultants as needed.
Registered Aboriginal Parties (RAPs)	RAPs are Aboriginal people who have registered with Roads and Maritime to be consulted about a proposed Roads and Maritime project or activity in accordance with OEH's Aboriginal cultural heritage consultation requirements for proponents (2010).
Senior Environmental Specialist (Heritage) (SES(H))	Provides technical assistance on this procedure and archaeological technical matters, as required. Reviewing the archaeological management plans and facilitating heritage approval applications, where required. Assists with regulator engagement, where required.
Team Leader - Regional Maintenance Delivery (TL-RMD)	Ensures Regional Maintenance Delivery staff stop work in the vicinity of an unexpected heritage item. Completes Unexpected Heritage Item Recording Form 418 and notifies WS-RMD.
Technical Specialist	Professional consultant contracted to provide specific technical advice that relates to the specific type of unexpected heritage find (eg a forensic or physical anthropologist who can identify and analyse human skeletal

	remains).
Works Supervisor - Regional Maintenance Delivery (WS-RMD)	Ensures Regional Maintenance Delivery staff are aware of this procedure. Supports the Team Leader - Regional Maintenance Delivery during the implementation of this procedure and ensures reporting of unexpected heritage items through environment management systems.

5 Acronyms

The following acronyms are relevant to this procedure:

Acronym	Meaning
A	Archaeologist
ACHA	Aboriginal Cultural Heritage Advisor
AHIP	Aboriginal Heritage Impact Permit
ASO	Aboriginal Site Officer
CEMP	Construction Environment Management Plan
OEH	Office of Environment and Heritage.
PACHCI	Procedure for Aboriginal Cultural Heritage Consultation and Investigation
PM	Project Manager
RAP	Registered Aboriginal Parties
RES	Regional Environmental Staff
SES(H)	Senior Environmental Specialist (Heritage)
TL-RMD	Team Leader – Regional Maintenance Division
RMD	Regional Maintenance Delivery
RMS	Roads and Maritime
WS-RMD	Works Supervisor - Regional Maintenance Division

6 Overview of the Procedure

On discovering something that could be an unexpected heritage item ('the item'), the following procedure must be followed. There are eight steps in the procedure. These steps are summarised in **Figure 1** below and explained in detail in Section 7.

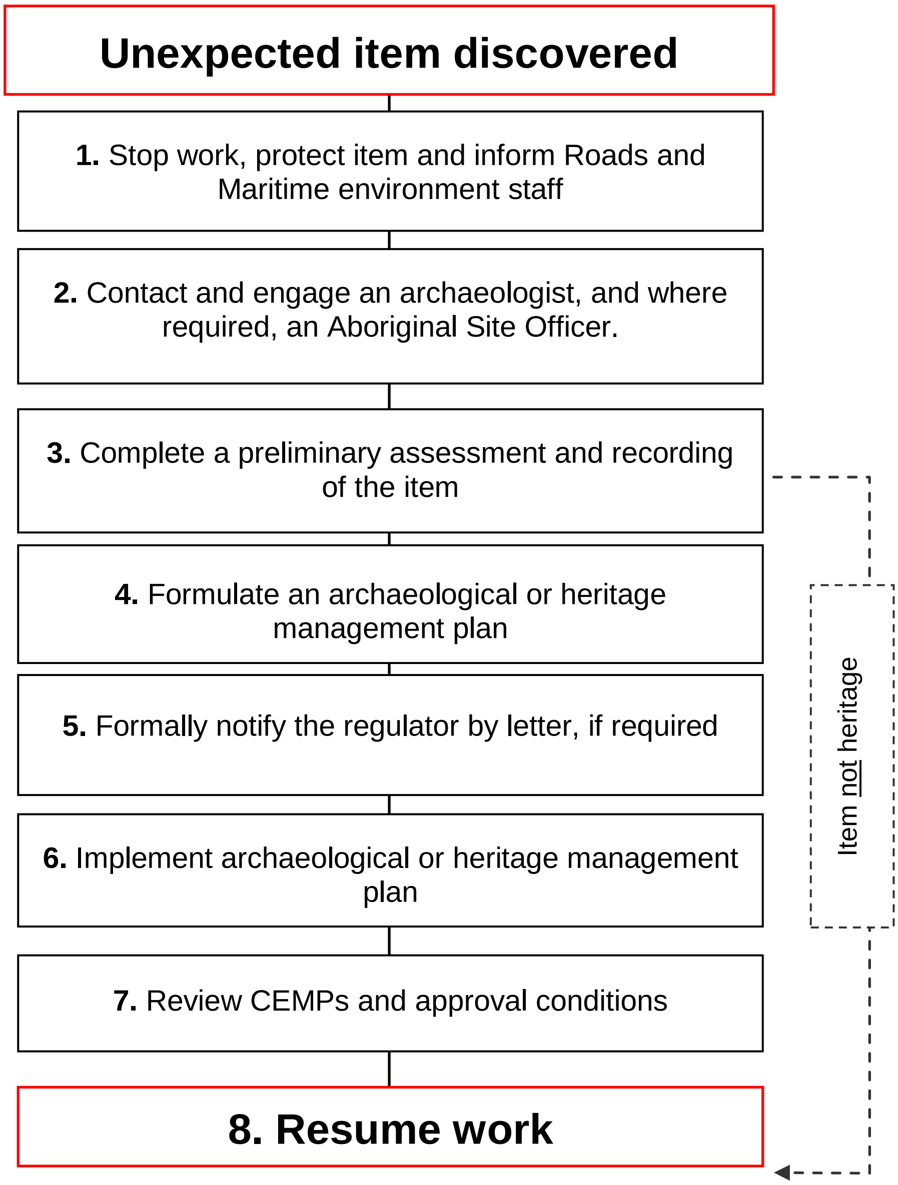


Figure 1: Overview of steps to be undertaken on the discovery of an unexpected heritage item.

✋ **IMPORTANT!**

RMS may have approval or specific safeguards in place (apart from this procedure) to impact on certain heritage items during construction. If you discover a heritage item and you are unsure whether an approval or safeguard is in place, STOP works and follow this procedure.

7 Unexpected heritage items procedure

Table 1: Specific tasks to be implemented following the discovery of an unexpected heritage item.

Aboriginal Cultural Heritage Advisor (ACHA); Aboriginal Sites Officer (ASO); Archaeologist (A); Project Manager (PM); Regional Environment Staff (RES); Registered Aboriginal Parties (RAPs); Senior Environmental Specialist (Heritage) (SES(H)); Team leader – Roads and Maintenance Division (TL - RMD); Works supervisor – Roads and Maintenance Division (WS - RMD).

Step	Task	Responsibility	Guidance & Tools
1	**Stop work, protect item and inform Roads and Maritime environment staff**		
1.1	Stop all work in the immediate area of the item and notify the Project Manager or Team Leader-RMD. (For maintenance activities, the Team Leader is to also notify the Works Supervisor-RMD)	All	**Appendix A** (Identifying Unexpected Heritage items)
1.2	Establish a 'no-go zone' around the item. Use high visibility fencing, where practical.	PM or TL-RMD	
1.3	Inform all site personnel about the no-go zone. No further interference, including works, ground disturbance, touching or moving the item must occur within the no-go zone.	PM or TL-RMD	
1.4	Inspect, document and photograph the item using 'Unexpected Heritage Item Recording Form 418'.	PM or TL-RMD	**Appendix B** (Unexpected Heritage Item Recording Form 418) **Appendix C** (Photographing Unexpected Heritage items)

Step	Task	Responsibility	Guidance & Tools
1.5	Is the item likely to be bone? If **yes**, follow the steps in Appendix E – 'Uncovering bones'. Where it is obvious that the bones are human remains, you must notify the local police by telephone immediately. They may take command of all or part of the site. If **no**, proceed to next step.	PM or WS-RMD	**Appendix E** (Uncovering Bones)
1.6	Is the item likely to be: a) A relic? (A relic is evidence of past human activity which has local or state heritage significance. It may include items such as bottles, utensils, remnants of clothing, crockery, personal effects, tools, machinery and domestic or industrial refuse) and/or b) An Aboriginal object? (An Aboriginal object may include a shell midden, stone tools, bones, rock art or a scarred tree). If **yes**, proceed directly to Step 1.8 If **no**, proceed to next step.	PM or WS-RMD	**Appendix A** (Identifying heritage items)
1.7	Is the item likely to be a "work", building or standing structure? (This may include tram tracks, kerbing, historic road pavement, fences, sheds or building foundations). If **yes**, can works avoid further disturbance to the item? (E.g. if historic road base/tram tracks have been exposed, can they be left in place?) If **yes**, works may proceed without further disturbance to the item. Complete Step 1.8 within 24 hours. If works cannot avoid further disturbance to the item, works must not recommence at this time. Complete the remaining steps in this procedure.	PM or WS-RMD	**Appendix A** (Identifying heritage items)

Step	Task	Responsibility	Guidance & Tools
1.8	Inform relevant Roads and Maritime Regional Environmental Staff of item by providing them with the completed ‘Form 418’.	PM or WS-RMD (RES)	**Appendix D** (Key Environmental Contacts)
1.9	Regional Environmental Staff to advise Project Manager or Works Supervisor whether RMS has an approval or safeguard in place (apart from this procedure) to impact on the ‘item’. (An approval may include an approval under the *Heritage Act*, the *National Parks and Wildlife Act* or the *Planning and Assessment Act*). Does RMS have an approval, permit or appropriate safeguard in place to impact on the item? If **yes**, work may recommence in accordance with the approval, permit or safeguard. There is no further requirement to follow this procedure. If **no**, continue to next step.		
1.10	Liaise with Traffic Management Centre where the delay is likely to affect traffic flow.	PM or WS-RMD	
1.11	Report the item as a ‘Reportable Event’ in accordance with the Roads and Maritime *Environmental Incident Classification and Reporting Procedure*. Implement any additional reporting requirements related to the project’s approval and CEMP, where relevant.	PM or WS-RMD	RMS Environmental Incident Classification and Reporting Procedure
2	**Contact and engage an archaeologist and, where required, an Aboriginal site officer**		
2.1	Contact the Project (on-call) Archaeologist to discuss the location and extent of the item and to arrange a site inspection, if required. The project CEMP may contain contact details of the Project Archaeologist. OR	PM or WS-RMD (A; RES; SES(H))	Also see **Appendix D** (Key Environmental Contacts)

Step	Task	Responsibility	Guidance & Tools
	Where there is no project archaeologist engaged for the works, engage a suitably qualified and experienced archaeological consultant to assess the find. A list of heritage consultants is available on the RMS contractor panels on the Buyways homepage. Regional environment staff and Roads and Maritime heritage staff can also advise on appropriate consultants.		Buyways
2.2	Where the item is likely to be an Aboriginal object, speak with your Aboriginal Cultural Heritage Advisor to arrange for an Aboriginal Sites Officer to assess the find. Generally, an Aboriginal Sites Officer would be from the relevant local Aboriginal land council. If an alternative contact person (ie a RAP) has been nominated as a result of previous consultation, then that person is to be contacted.	PM or WS-RMD (ACHA; ASO)	
2.3	If requested, provide photographs of the item taken at Step 1.4 to the archaeologist, and Aboriginal Sites Officer if relevant.	PM or WS-RMD (RES)	**Appendix C** (Photographing Unexpected Heritage items)
3	**Preliminary assessment and recording of the find**		
3.1	In a minority of cases, the archaeologist (and Aboriginal Sites Officer, if relevant) may determine from the photographs that no site inspection is required because no archaeological constraint exists for the project (*eg the item is not a 'relic', a 'heritage item' or an 'Aboriginal object'*). Any such advice should be provided in writing (eg via email) and confirmed by the Project Manager or Works Supervisor - RMD.	A/PM/ASO/ WS-RMD	Proceed to Step 8
3.2	Arrange site access for the archaeologist (and Aboriginal Sites Officer, if relevant) to inspect the item as soon as practicable. In the majority of cases a site inspection is required to conduct a preliminary assessment.	PM or WS-RMD	
3.3	Subject to the archaeologist's assessment (and the Aboriginal Sites Officer's assessment, if relevant), work may recommence at a set distance from the item. This is to protect any other archaeological material that may exist in the vicinity, which has not yet been uncovered. Existing protective fencing established in Step 1.2 may need to be adjusted to	A/PM/ASO/ WS-RMD	

Step	Task	Responsibility	Guidance & Tools
	reflect the extent of the newly assessed protective area. No works are to take place within this area once established.		
3.4	The archaeologist (and Aboriginal Sites Officer, if relevant) may provide advice after the site inspection and preliminary assessment that no archaeological constraint exists for the project (*eg the item is not a 'relic', a 'heritage item' or an 'Aboriginal object'*). Any such advice should be provided in writing (eg via email) and confirmed by the Project Manager or Works Supervisor - RMD.	A/PM/ASO/ WS-RMD	Proceed to Step 8
3.5	Where required, seek additional specialist technical advice (such as a forensic or physical anthropologist to identify skeletal remains). Regional environment staff and/or Roads and Maritime heritage staff can provide contacts for such specialist consultants.	RES/SES(H)	**Appendix D** (Key Environmental Contacts)
3.6	Where the item has been identified as a 'relic', 'heritage item' or an 'Aboriginal object' the archaeologist should formally record the item.	A	
3.7	The regulator can be notified informally by telephone at this stage by the archaeologist, Project Manager (or delegate) or Works Supervisor - RMD. Any verbal conversations with regulators must be noted on the project file for future reference.	PM/A/WS-RMD	
4	**Prepare an archaeological or heritage management plan**		
4.1	The archaeologist must prepare an archaeological or heritage management plan (with input from the Aboriginal Sites Officer, where relevant) shortly after the site inspection. This plan is a brief overview of the following: (a) description of the feature, (b) historic context, if data is easily accessible, (c) likely significance, (d) heritage approval and regulatory notification requirements, (e) heritage reporting requirements, (f) stakeholder consultation requirements, (g) relevance to other project approvals and management plans etc.	A/ASO	**Appendix F** (Archaeological/ Heritage Advice Checklist)
4.2	In preparing the plan, the archaeologist with the assistance of regional environment staff must review the CEMP, any heritage sub-plans, any conditions of heritage approvals, conditions of project approval (and or Minister's Conditions of Approval) and heritage assessment documentation (eg Aboriginal Cultural Heritage Assessment Report). This will outline if the unexpected item is consistent with previous heritage/project approval(s)	A/RES/PM	**Appendix F** (Archaeological/ Heritage Advice Checklist)

Step	Task	Responsibility	Guidance & Tools
	and/or previously agreed management strategies. The Project Manager and regional environment staff must provide all relevant documents to the archaeologist to assist with this. Discussions should occur with design engineers to consider if re-design options exist and are appropriate.		
4.3	The archaeologist must submit this plan as a letter, brief report or email to the Project Manager outlining all relevant archaeological or heritage issues. This plan should be submitted to the Project Manager as soon as practicable. Given that the archaeological management plan is an overview of all the necessary requirements (and the urgency of the situation), it should take no longer than two working days to submit to the Project Manager.	A	
4.4	The Project Manager or Works Supervisor must review the archaeological or heritage management plan to ensure all requirements can reasonably be implemented. Seek additional advice from regional environment staff and Roads and Maritime heritage staff, if required.	PM/RES/SES(H)/ WS-RMD	
5	**Notify the regulator, if required.**		
5.1	Review the archaeological or heritage management plan to confirm if regulator notification is required. Is notification required? If **no**, proceed directly to Step 6 If **yes**, proceed to next step.	PM/RES/SES(H)/ WS-RMD	
5.2	If notification is required, complete the template notification letter.	PM or WS-RMD	**Appendix G** (Template Notification Letter)
5.3	Forward the draft notification letter, archaeological or heritage management plan and the site recording form to regional environment staff and Senior Environmental Specialist (Heritage) for review, and consider any suggested amendments.	PM/RES/SES(H)/ WS-RMD	

Step	Task	Responsibility	Guidance & Tools
5.4	Forward the signed notification letter to the relevant regulator (ie notification of relics must be given to the Heritage Division, Office of Environment and Heritage (OEH), while notification for Aboriginal objects must be given to the relevant Aboriginal section of OEH). Informal notification (via a phone call or email) to the regulator prior to sending the letter is appropriate. The archaeological management plan and the completed site recording form must be submitted with the notification letter. For Part 3A and Part 5.1 projects, the Department of Planning and Environment must also be notified.	PM or WS-RMD	**Appendix D** (Key Environmental Contacts)
5.5	A copy of the final signed notification letter, archaeological or heritage management plan and the site recording form should be kept on file by the Project Manager or Works Supervisor- RMD and a copy sent to the Senior Environmental Specialist (Heritage).	PM or WS-RMD	
6	**Implement archaeological or heritage management plan**		
6.1	Modify the archaeological or heritage management plan to take into account any additional advice resulting from notification and discussions with the regulator.	A/PM or WS-RMD (RES)	
6.2	Implement the archaeological or heritage management plan. Where impact is expected, this would include such things as a formal assessment of significance and heritage impact assessment, preparation of excavation or recording methodologies, consultation with registered Aboriginal parties, obtaining heritage approvals etc, if required.	PM or WS-RMD (RAPs and RES)	PACHCI Stage 3
6.3	Where heritage approval is required contact regional environment staff for further advice and support material. Please note time constraints associated with heritage approval preparation and processing. Project scheduling may need to be revised where extensive delays are expected.	PM/RES/WS-RMD	
6.4	For Part 3A/Part 5.1 projects, assess whether heritage impact is consistent with the project approval or if project approval modification is required from the Department of Planning and Environment. Seek advice from regional environment staff and Environment Branch specialist staff if unsure.	PM/RES	

Step	Task	Responsibility	Guidance & Tools
6.5	Where statutory approvals (or project approval modification) are required, impact upon relics and/or Aboriginal objects must not occur until heritage approvals are issued by the appropriate regulator.	PM or WS-RMD	
6.6	Where statutory approval (or Part 3A/Part 5.1 project modification) is not required and where recording is recommended by the archaeologist, sufficient time must be allowed for this to occur.	PM or WS-RMD	
6.7	Ensure short term and permanent storage locations are identified for archaeological material or other heritage material is removed from site, where required. Interested third parties (eg museums or local councils) should be consulted on this issue. Contact regional environment staff and Senior Environmental Specialist (Heritage) for advice on this matter, if required.	PM or WS-RMD	
7	**Review CEMPs and approval conditions**		
7.1	Check whether written notification is required to be sent to the regulator before re-commencing work. Where this is not explicit in heritage approval conditions, expectations should be clarified directly with the regulator.	PM	
7.2	Update the CEMP, site mapping and project delivery program as appropriate with any project changes resulting from final heritage management (eg retention of heritage item, salvage of item). Updated CEMPs must incorporate additional conditions arising from any heritage approvals, and Aboriginal community consultation if relevant. Include any changes to CEMP in site induction material and update site workers during toolbox talks.	PM	
8	**Resume work**		
8.1	Seek written clearance to resume project work from regional environment staff and the archaeologist (and regulator, if required). Clearance would only be given once all archaeological excavation and/or heritage recommendations (where required) are complete. Resumption of project work must be in accordance with the all relevant project/heritage approvals/determinations.	RES/A/PM/WS-RMD	
8.2	If required, ensure archaeological excavation/heritage reporting and other heritage	PM/A/WS-RMD	

Step	Task	Responsibility	Guidance & Tools
	approval conditions are completed in the required timeframes. This includes artefact retention repositories, conservation and/or disposal strategies.		
8.3	Forward all heritage/archaeological assessments, heritage location data and its ownership status to the Senior Environmental Specialist (Heritage). They will ensure all heritage items in Roads and Maritime ownership and/or control are considered for the Roads and Maritime S170 Heritage and Conservation Register.	PM/SES(H)/ WS-RMD	
8.4	If additional unexpected items are discovered this procedure must begin again from Step 1.	PM/TL-RMD	

8 Seeking advice

Advice on this procedure should be sought from Roads and Maritime regional environment staff in the first instance. Contractors and alliance partners should ensure their own project environment managers are aware of and understand this procedure. Regional environment staff can assist non-Roads and Maritime project environment managers with enquires concerning this procedure.

IMPORTANT!

Roads and Maritime Services staff and contractors are not to seek advice on this procedure directly from the Office of Environment and Heritage without first seeking advice from regional environment staff and heritage policy staff.

Technical archaeological or heritage advice regarding an unexpected heritage item should be sought from the contracted archaeologist. Technical specialist advice can also be sought from heritage policy staff within Environment Branch to assist with the preliminary archaeological identification and technical reviews of heritage/archaeological reports.

9 Related information

Contact details: Senior Environmental Specialist (Heritage), Environment Branch, 02 8588 5754

Effective date: 01 February 2015

Review date: 01 February 2016

This procedure should be read in conjunction with:

- Roads and Maritimes' *Heritage Guidelines 2015.*
- Roads and Maritime Services *Environmental Incident Classification and Reporting Procedure*
- Roads and Maritime's *Procedure for Aboriginal Cultural Heritage Consultation and Investigation*
- RTA *Environmental Impact Assessment Guidelines.*

This procedure replaces:

- Procedure 5.5 ("*unexpected discovery of an archaeological relic or Aboriginal object*") outlined in the RTA's *Heritage Guidelines* 2004.

Other relevant reading material:

- NSW Heritage Office (1998), *Skeletal remains: guidelines for the management of human skeletal remains*.
- Department of Environment and Conservation NSW (2006), *Manual for the identification of Aboriginal remains.*
- Department of Health (April 2008), *Policy Directive: Burials - exhumation of human remains*[11]*.*

[11] http://www.health.nsw.gov.au/policies/pd/2008/pdf/PD2008_022.pdf

Appendix A

Identifying Unexpected Heritage Items

The following images can be used to assist in the preliminary identification of potential unexpected items (both Aboriginal and non-Aboriginal) during construction and maintenance works. Please note this is not a comprehensive typology.

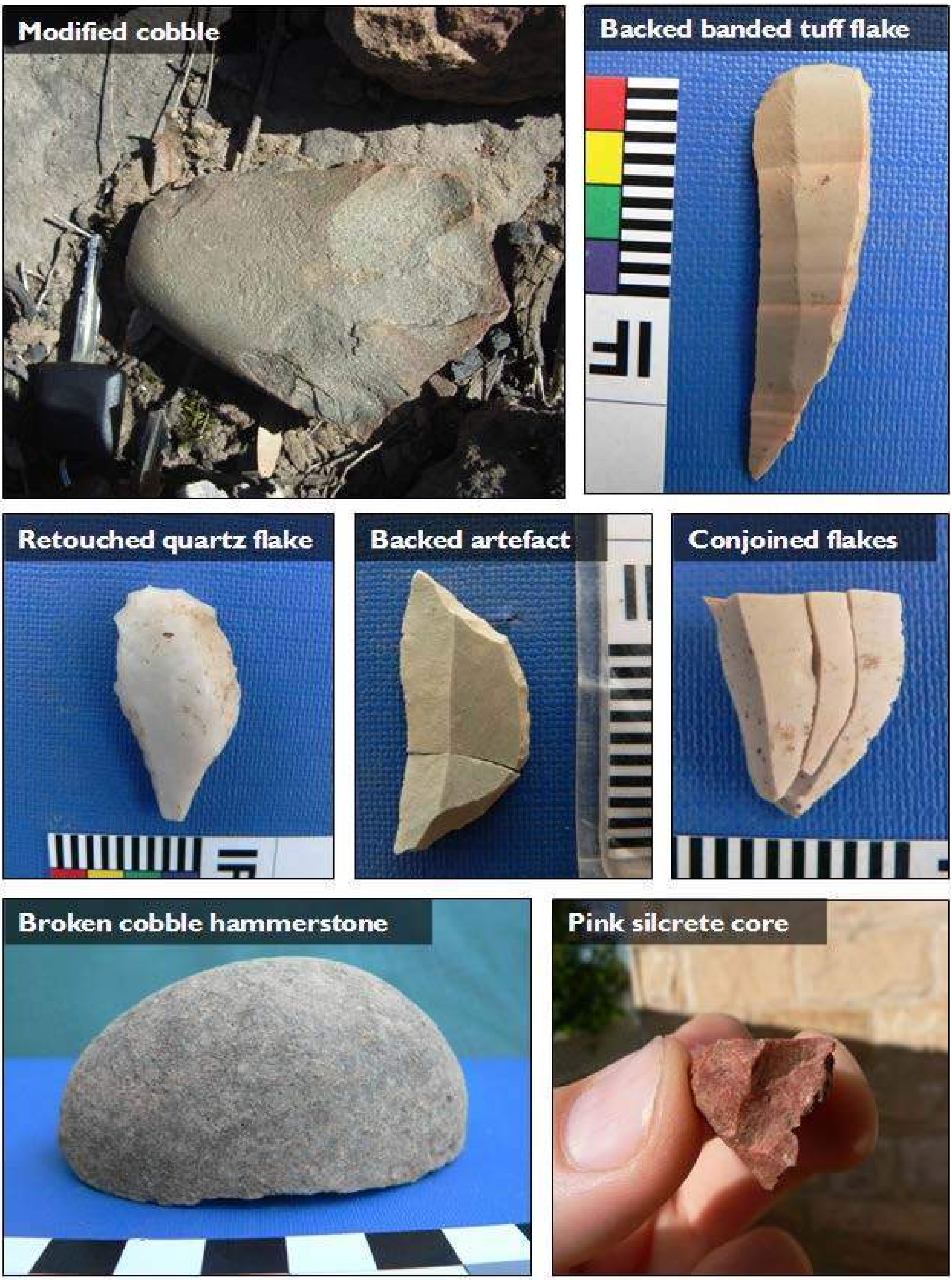
Top left hand picture continuing clockwise: Stock camp remnants (Hume Highway Bypass at Tarcutta); Linear archaeological feature with post holes (Hume Highway Duplication), Animal bones (Hume Highway Bypass at Woomargama); Cut wooden stake; Glass jars, bottles, spoon and fork recovered from refuse pit associated with a Newcastle Hotel (Pacific Highway, Adamstown Heights, Newcastle area).

Top left hand picture continuing clockwise: Woodstave water pipe with tar and wire sealing (Horsley Drive); Tram tracks (Sydney); Brick lined cistern (Clyde); Retaining wall (Great Western Highway, Leura).

Top left hand picture continuing clockwise: Road pavement (Great Western Highway, Lawson); Sandstone kerbing and guttering (Parramatta Road, Mays Hill); Telford road (sandstone road base, Great Western Highway, Leura); Ceramic conduit and sandstone culvert headwall (Blue Mountains, NSW); Corduroy road (timber road base, Entrance Road, Wamberai).

Top left hand corner continuing clockwise: Alignment Pin (Great Western Highway, Wentworth Falls); Survey tree (MR7, Albury); Survey tree (Kidman Way, Darlington Point, Murrumbidgee); Survey tree (Cobb Highway, Deniliquin); Milestone (Great Western Highway, Kingswood, Penrith); Alignment Stone (near Guntawong Road, Riverstone). Please note survey marks may have additional statutory protection under the *Surveying and Spatial Information Act 2002*.

Top left hand corner continuing clockwise: Remnant bridge piers (Putty Road, Bulga); Wooden boundary fence (Campbelltown Road, Denham Court); Dairy shed (Ballina); Golden Arrow Mine Shaft.



Top left hand corner: Culturally modified stone discovered on Main Road 92, about two kilometres west of Sassafras. The remaining images show a selection of stone artefacts retrieved from test and salvage archaeological excavations during the Hume Highway Duplication and Bypass projects from 2006-2010.

Appendix B

Unexpected Heritage Item Recording Form 418

Transport Roads & Maritime Services	**Unexpected heritage item recording form**	[redacted]

[redacted]

Date:		**Recorded by:** (Include name and position)	
Project name:			

Description of works being undertaken (eg Removal of failed pavement by excavation and pouring concrete slabs in 1m x 1m replacement sections).	
Description of exact location of item (eg Within the road formation on Parramatta Road, east bound lane, at the corner of Johnston Street, Annandale, Sydney).	

Description of item found (What type of item is it likely to be? Tick the relevant boxes).

A. A relic	☐	A 'relic' is evidence of a past human activity relating to the settlement of NSW with local or state heritage significance. A relic might include bottles, utensils, plates, cups, household items, tools, implements, and similar items.
B. A 'work, building or structure'	☐	A 'work' can generally be defined as a form infrastructure such as tram tracks, a culvert, road base, a bridge pier, kerbing, and similar items.
C. An Aboriginal object	☐	An 'Aboriginal object' may include stone tools, stone flakes, shell middens, rock art, scarred trees and human bones.
D. Bone	☐	Bones can either be human or animal remains. **Remember that you must contact the local police immediately by telephone if you are <u>certain</u> that the bone(s) are <u>human remain</u>**s.
E. Other	☐	

Provide short description of item (eg Metal tram tracks running parallel to road alignment. Good condition. Tracks set in concrete, approximately 10cms (100 mm) below the current ground surface).	

Sketch
(Provide a sketch of the item's general location in relation to other road features so its approximate location can be mapped without having to re-excavate it. In addition, please include details of the location and direction of any photographs of the item taken).

Action taken (Tick either A *or* B)

A. Unexpected item **would not** be further impacted on by works ☐

Describe how works would avoid impact on the item. (eg The tram tracks will be left *in situ*, and recovered with road paving).

B. Unexpected item **would be** further impacted on by works ☐

Describe how works would impact on the item. (eg Milling is required to be continued to 200 mm depth to ensure road pavement requirements are met. Tram tracks will need to be removed).

[redacted]

Project manager / works supervisor signature	

Appendix C

Photographing Unexpected Heritage Items

Photographs of unexpected items in their current context (*in situ*) may assist heritage staff and archaeologists to better identify the heritage values of the item. Emailing good quality photographs to specialists can allow for better quality and faster heritage advice. The key elements that must be captured in photographs of the item include its position, the item itself and any distinguishing features. All photographs must have a scale (ruler, scale bar, mobile phone, coin) and a note describing the direction of the photograph.

Context and detailed photographs

It is important to take a general photograph (Figure 1) to convey the location and setting of the item. This will add much value to the subsequent detailed photographs also required (Figure 2).

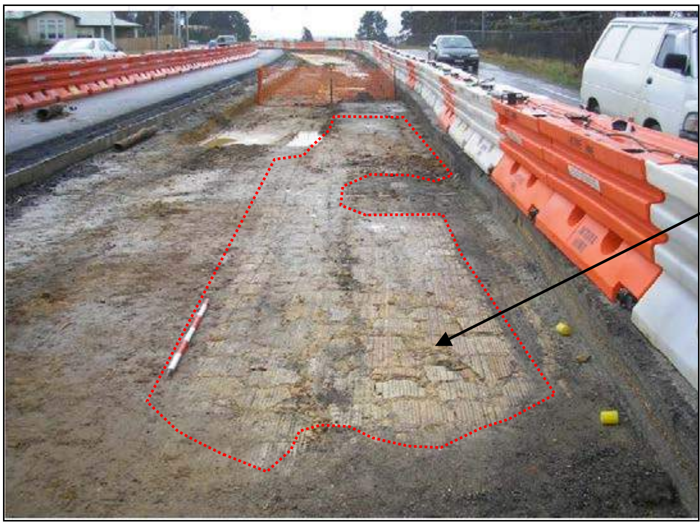


Figure 2: Close up detail of the sandstone surface showing material type, formation and construction detail. This is essential for establishing date of the feature.

Figure 1: Telford road uncovered on the Great Western Highway (Leura) in 2008.

Photographing distinguishing features

Where unexpected items have a distinguishing feature, close up detailed photographs must be taken of this, where practicable. In the case of a building or bridge, this may include diagnostic details architectural or technical features. See Figures 3 and 4 for examples.

Figure 3: Ceramic bottle artefact with stamp.

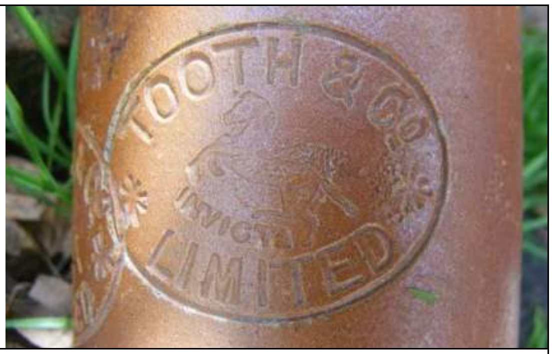


Figure 4: Detail of the stamp allows '*Tooth & Co Limited*' to be made out. This is helpful to a specialist in gauging the artefact's origin, manufacturing date and likely significance.

Photographing bones

The majority of bones found on site will those of be recently deceased animal bones often requiring no further assessment (unless they are in archaeological context). However, if bones are human, Roads and Maritime must contact the police immediately (see Appendix F for detailed guidance). Taking quality photographs of the bones can often resolve this issue quickly. Heritage staff in Environment Branch can confirm if bones are human or non-human if provided with appropriate photographs.

Ensure that photographs of bones are not concealed by foliage (Figure 5) as this makes it difficult to identify. Minor hand removal of foliage can be undertaken as long as disturbance of the bone does not occur. Excavation of the ground to remove bone(s) should not occur, nor should they be pulled out of the ground if partially exposed. Where sediment (adhering to a bone found on the ground surface) conceals portions of a bone (Figure 6) ensure the photograph is taken of the bone (if any) that is not concealed by sediment.

Figure 5: Bone concealed by foliage.

Figure 6: Bone covered in sediment

Ensure that all close up photographs include the whole bone and then specific details of the bone (especially the ends of long bones, the *epiphysis*, which is critical for species identification). Figures 7 and 8 are examples of good photographs of bones that can easily be identified from the photograph alone. They show sufficient detail of the complete bone and the epiphysis.

Figure 7: Photograph showing complete bone.

Figure 8: Close up of a long bone's epiphysis.

Appendix C

Key Environmental Contacts

Key environmental contacts

Hunter region	Environmental Manager (Hunter)	4924 0440
	Aboriginal Cultural Heritage Advisor	4924 0383
Northern region	Environment Manager (North)	6640 1072
	Aboriginal Cultural Heritage Advisor	6604 9305
Southern region	Environmental Manager (South)	6492 9515
	Aboriginal Cultural Heritage Advisor	4221 2767
South West region	Environment Manager (South West)	6937 1634
	Aboriginal Cultural Heritage Advisor	6937 1647
Sydney region	Environment Manager (Sydney)	8849 2516
	Aboriginal Cultural Heritage Advisor	8849 2583
Western region	Environment Manager (West)	6861 1628
	Aboriginal Cultural Heritage Advisor	6861 1658
Pacific Highway Office	Environment Manager	6640 1375
Regional Maintenance Delivery	Environment Manager	9598 7721
Environment Branch	Senior Environmental Specialist (Heritage)	8588 5754

Heritage Regulators

Heritage Division Office of Environment and Heritage Locked Bag 5020 Parramatta NSW 2124 Phone: (02) 9873 8500	Department of the Environment (Clth) GPO Box 787 Canberra ACT 2601 Phone: (02) 6274 1111
Office of Environment and Heritage (Sydney Metropolitan) Planning and Aboriginal Heritage Section PO Box 668 Parramatta NSW 2124 Phone: (02) 9995 5000	Office of Environment and Heritage (North Eastern NSW) Planning and Aboriginal Heritage Section Locked Bag 914 Coffs Harbour NSW 2450 Phone: (02) 6651 5946
Office of Environment and Heritage (North Western NSW) Environment and Conservation Programs PO Box 2111 Dubbo NSW 2830 Phone: (02) 6883 5330	Office of Environment and Heritage (Southern NSW) Landscape and Aboriginal Heritage Protection Section PO Box 733 Queanbeyan NSW 2620 Phone: (02) 6229 7188

Project-Specific Contacts

Position	Name	Phone Number
Project Manager		
Site/Alliance Environment Manager		
Regional Environmental Officer		
Aboriginal Cultural Heritage Advisor		
Consultant Archaeologist		
Local Police Station		
OEH: Environment Line		131 555

Appendix E

Uncovering Bones

This appendix provides Project Managers with (1) advice on what to do when bones are discovered; (2) guidance on the notification pathways; and (3) additional considerations and requirements when managing the discovery of human remains.

1. First uncovering bones

Stop all work in the vicinity of the find. All bones uncovered during project works should be **treated with care and urgency** as they have the potential to be human remains. Therefore they must be identified as either human or non-human as soon as possible by a qualified forensic or physical anthropologist. These specialist consultants can be sought by contacting regional environment staff and/or heritage staff at Environment Branch.

On the very rare occasion where it is *instantly obvious* from the remains that they are human, the Project Manager (or a delegate) should **inform the police by telephone** prior to seeking specialist advice. It will be obvious that it is human skeletal remains where there is no doubt, as demonstrated by the example in Figure 1. Often skeletal elements in isolation (such as a skull) can also clearly be identified as human. Note it may also be obvious that human remains have been uncovered when soft tissue and clothing are present.

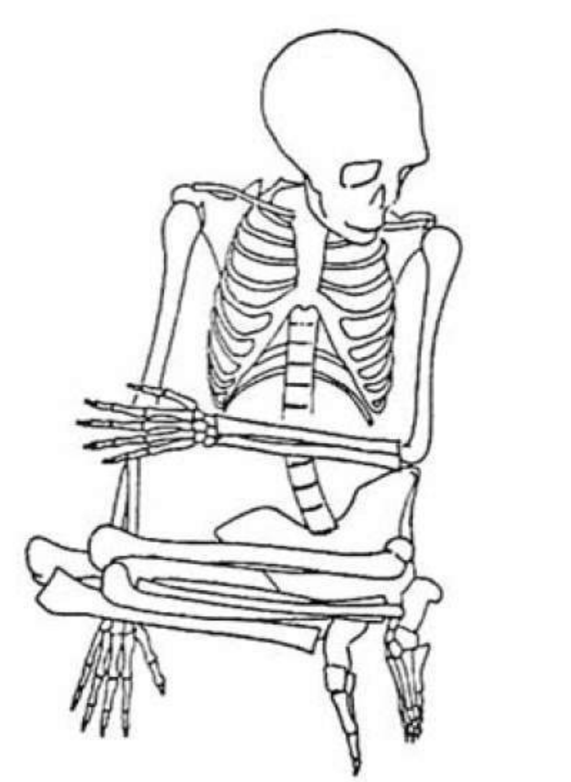


Figure 1: Schematic of a complete skeleton that is 'obviously' human[12].

Figure 2: Disarticulated bones that require assessment to determine species.

This preliminary phone call is to let the police know that Roads and Maritime is undertaking a specialist skeletal assessment to determine the approximate date of death which will inform legal jurisdiction. The police may wish to take control of the site at this stage. If not, a forensic or physical anthropologist must be requested to make an on-site assessment of the skeletal remains.

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[12] After Department of Environment and Conservation NSW (2006), *Manual for the identification of Aboriginal Remains*: 17.

Where it is not 'obvious' that the bones are human (in the majority of cases, illustrated by Figure 2), specialist assessment is required to establish the species of the bones. Photographs of the bones can assist this assessment if they are clear and taken in accordance with guidance provided in Appendix C. Good photographs often result in the bones being identified by a specialist without requiring a site visit; noting they are nearly always non-human. In these cases, non-human skeletal remains must be treated like any other unexpected archaeological find.

If the bones are identified as human (either by photographs or an on-site inspection) a technical specialist must determine the likely ancestry (Aboriginal or non-Aboriginal) and burial context (archaeological or forensic). This assessment is required to identify the legal regulator of the human remains so **urgent notification** (as below) can occur. Preliminary telephone or verbal notification by the Project Manager or regional environment staff is considered appropriate. This must be followed up later by Roads and Maritime's formal letter notification as per Appendix G when a management plan has been developed and agreed to by the relevant parties.

2. Range of human skeletal notification pathways

The following is a summary of the different notification pathways required for human skeletal remains depending on the preliminary skeletal assessment of ancestry and burial context.

A. Human bones are from a recently deceased person (*less than* 100 years old).

> **☑ Action**
> A police officer must be notified immediately as per the obligations to report a death or suspected death under s35 of the *Coroners Act 2009* (NSW). It should be assumed the police will then take command of the site until otherwise directed.

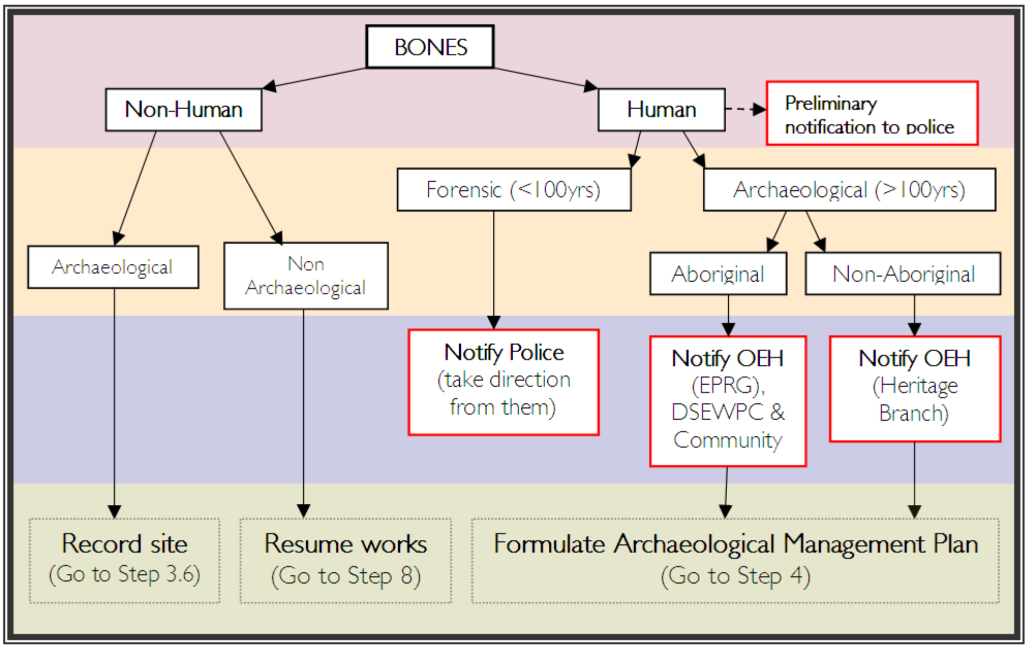
B. Human bones are archaeological in nature (*more than* 100 years old) and are likely to be *Aboriginal* remains.

> **☑ Action**
> The OEH and the RMS Aboriginal Cultural Heritage Advisor (ACHA) must be notified immediately. The ACHA must contact and inform the relevant Aboriginal community stakeholders who may request to be present on site. Relevant stakeholders are determined by the RTA's *Procedure for Aboriginal Cultural Heritage Consultation and Investigation*.

C. Human bones are archaeological in nature (*more than* 100 years old) and likely to be *non-Aboriginal* remains.

> **☑ Action**
> The OEH (Heritage Branch, Conservation Team) must be notified immediately.

The simple diagram below summarises the notification pathways on finding bones.



After the appropriate verbal notifications (as described in B and C), the Project Manager must proceed through the *Unexpected Heritage Items Procedure* to formulate an archaeological management plan (Step 4). Note no archaeological management plan is required for forensic cases (A), as all future management is a police matter. Non-human skeletal remains must be treated like any other unexpected archaeological find and so must proceed to recording the find as per Step 3.6.

3. Additional considerations and requirements

Uncovering archaeological human remains must be managed intensively and needs to consider a number of additional specific issues. These issues might include facilitating culturally appropriate processes when dealing with Aboriginal remains (such as repatriation and cultural ceremonies). Roads and Maritime's ACHA can provide advice on this and how to engage with the relevant Aboriginal community. Project Managers, more generally, may also need to consider overnight site security of any exposed remains and may need to manage the onsite attendance of a number of different external stakeholders during assessment and/or investigation of remains. Project Managers may also be advised to liaise with local church/religious groups and the media to manage community issues arising from the find. Additional investigations may be required to identify living descendants, particularly if the remains are to be removed and relocated.

If exhumation of the remains (from a formal burial or a vault) is required, Project Managers should also be aware of additional approval requirements under the *Public Health Act 1991* (NSW). Specifically, Roads and Maritime is required to apply to the Director General of NSW Department of Health for approval to exhume human remains as per Clause 26 of the *Public Health (Disposal of Bodies) Regulation 2002* (NSW)[13]. Further, the exhumation of such remains needs to consider health risks such as infectious disease control, exhumation procedures and reburial approval and registration. Further guidance on this matter can be found at the NSW Department of Health website.

In addition, due to the potential significant statutory and common law controls and prohibitions associated with interfering with a public cemetery, project teams are

[13] This requirement is in addition to heritage approvals under the *Heritage Act 1977*.

advised, when works uncover human remains adjacent to cemeteries, to confirm the cemetery’s exact boundaries.

Appendix F

Archaeological Heritage Advice Checklist

The following checklist can be used by the Project Manager and the archaeologist to ensure all relevant archaeological issues are considered when developing the management plan required at Step 4 of this procedure.

An archaeological or heritage management plan can include a range of activities and processes, which differ depending on the find and its significance.

	Required	Outcome/notes
Assessment and investigation		
• Assessment of significance	Yes/No	
• Assessment of heritage impact	Yes/No	
• Archaeological excavation	Yes/No	
• Archival photographic recording	Yes/No	
Heritage approvals and notifications		
• AHIPs, Section 140, S139 exceptions etc	Yes/No	
• Regulator relics/objects notification	Yes/No	
• Roads and Maritime's S170 Heritage and Conservation Register listing requirements	Yes/No	
• Compliance with CEMP or other project heritage approvals	Yes/No	
Stakeholder consultation		
• Aboriginal stakeholder consultation requirements and how it relates to RTA *Procedure for Aboriginal Cultural Heritage Consultation and Investigation* (PACHCI).	Yes/No	
• Advice from regional environmental staff, Aboriginal Cultural Heritage Advisor, Roads and Maritime heritage team.	Yes/No	
Artefact/ heritage item management		
• Retention or conservation strategy (eg items may be subject to long conservation and interpretation) • Disposal strategy (eg former road pavement) • Short term and permanent storage locations (interested third parties should be consulted on this issue).	Yes/No	
• Control Agreement for Aboriginal objects.	Yes/No	
Program and budget		
• Time estimate associated with archaeological or heritage conservation work.		
• Total cost of archaeological/heritage work.		

Appendix G

Template Notification Letter

PASTE INTO RMS LETTER TEMPLATE

"[Select and type date]"

[Select and type reference number]

[Select and type file number]

[Insert recipient's name and address, see **Appendix D**]

[Select and type salutation and name],

Re: Unexpected heritage item discovered during Roads and Maritime Services project works.

I write to inform you of an unexpected [select: relic, heritage item or Aboriginal object] found during Roads and Maritime Services construction works at [insert location] on [insert date]. [Where the regulator has been informally notified at an earlier date by telephone, this should be referred to here].

This letter is in accordance with the notification requirement under [select: Section 146 of the *Heritage Act 1977* (NSW) <u>or</u> Section 89(A) of the *National Parks and Wildlife Act 1974* (NSW) **NB:** There may be not be statutory requirement to notify of the discovery of a 'heritage Item that is not a relic or Aboriginal object].

NB: On finding Aboriginal human skeletal remains this letter must also be sent to the Commonwealth Minister for Sustainability, Environment, Water, Populations and Communities (SEWPC) in accordance with notification requirements under Section 20(1) of the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Cth).

[Provide a brief overview of the project background and project area. Provide a summary of the description and location of the item, including a map and image where possible. Also include how the project was assessed under the *Environmental Planning and Assessment Act 1979* (NSW) (eg Part 5). Also include any project approval number, if available].

Roads and Maritime Services [*or contractor*] has sought professional archaeological advice regarding the item. A preliminary assessment indicates [provide a summary description and likely significance of the item]. Please find additional information on the site recording form attached.

Resulting from these preliminary findings, Roads and Maritime Services *[or contractor]* is proposing [provide a summary of the proposed archaeological/heritage approach (eg develop archaeological research design (where relevant), seek heritage approvals, undertake archaeological investigation or conservation/interpretation strategy). Also include preliminary justification of such heritage impact with regard to project design constraints and delivery program].

The proposed approach will be further developed in consultation with a nominated Office of Environment and Heritage staff member.

Please contact me if you have any input on this approach or if you require any further information.

Yours sincerely

[Sender name and position]

[Attach the archaeological/heritage management plan and site recording form].

About this release

Reference number	RMS 12.003 **|** PN 285 P02
Title	Unexpected Heritage Items Procedure
Parent procedure	RMS Heritage Guidelines
Prepared by	Environment Officer (Heritage) Gretta Logue Environment Officer (Heritage) Daniel Percival
Approved by	Manager Environmental Policy, Planning and Assessment Michael Crowley
Document location	Objective - SF2013/153770 / Unexpected heritage items procedure.doc
Document status	Version 1.0, 16 March 2015

Version	Date	Revision description
1.0	01/11/11	First issue
Revised	23 July 2012	Amended to reflect that (a) unexpected finds do not include items covered by a relevant approval; (b) Aboriginal people must be consulted where an unexpected find is likely to be an Aboriginal object; (c) the Department of Planning and Environment must be notified in accordance with Step 5 of this procedure for Part 3A and Part 5.1 projects.
Revised	09 October 2013	Amended to clarify that the procedure applies to all types of unexpected heritage items, not just archaeological items. The procedure introduces the term 'Historic Items' to cover both 'archaeological relics' and 'other historic items' such as works, structures, buildings and movable objects. The title of the document has been amended to better reflect this clarification.
Revised	16 March 2015	The procedure was streamlined to address all project types including maintenance works. The separate maintenance procedure (formerly Appendix B) was removed. Names and titles updated throughout.

Your comments and suggestions to improve this or any of the Heritage Guidelines and associated documents may be sent to:

Senior Environmental Specialist (Heritage)
Environmental Policy, Planning and Assessment
Environment Branch, Roads and Maritime Services
Level 17, 101 Miller Street
North Sydney, NSW 2060
Ph: 8588 5726

rms.nsw.gov.au

heritage@rms.nsw.gov.au

Customer feedback
Roads and Maritime
Locked Bag 928,
North Sydney NSW 2059

NSW GOVERNMENT | Transport Roads & Maritime Services

artefact

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