



Stellenbosch University – Tygerberg Campus
GROUND PENETRATING RADAR SURVEY REPORT
Hardekraaltjie Cemetery Site

15 January 2020

SEC REFERENCE NUMBER: G19105

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1. Scope of Work

Sillito Environmental Consulting (SEC) was appointed by Stellenbosch University to utilise Ground Penetrating Radar technology for the detection and location of unmarked graves at the Tygerberg Campus in Cape Town, South Africa.

The initial area to be scanned covered some 19 337 m² and formed part of a park with a vegetable garden located to the East of the hospital. Subsequently this area was reduced to 15 076 m² due to Stellenbosch University having problems in obtaining approval to access a portion of the original area to be scanned.

A report conducted in 2015 by the University of Pretoria suggests the location of the Hardekraaltjie formal cemetery in the scan area, but a more detailed assessment was required to more clearly define the extent of the cemetery. **Figure 1** below shows the location of the cemetery in relation to the hospital and surrounding area.

Figure 1. Locality Map: Google Earth location map of the Hardekraaltjie Cemetery site



2. Equipment & Methodology

The equipment used in the scan include a Geophysical Survey Systems Incorporated (GSSI) UtilityScan type Ground Probing Radar (GPR). The UtilityScan incorporates a 350 HS antenna (350 MHz) and can detect features down to 10 m below ground level.

Using GPR, it is possible to scan virtually any type of landscape, reducing the risk of disturbing heritage sensitive resources during excavation, saving both time and money.

The underground survey is carried out by trained, tertiary educated Technicians with experience of a large number of sites. Work completed to date includes surveys of over 100 sites which include refineries, service stations, fuel depots, commercial office environments, educational facilities, agricultural facilities, airports, power stations, munitions plants, road scanning for fibre optic cabling and heritage sites within South Africa.

SEC's approach is to survey the site methodically, utilising all available information to create a plan showing the location of, depth and orientation of the underground features. This is completed via the following steps:

1. Studying available documents and reports that were created previously which could provide insight on the location of burial sites.
2. Attend induction where required.
3. Complete Work Clearance Form (WCF) where applicable and obtain relevant approvals.
4. Discussions with site management regarding the boundary of the site and the probable locations of burials.
5. A site walkover, noting any restricted areas and areas that cannot be scanned due to obstructions.
6. Initial cross section scans in North-South direction and in an East-West direction to form a broad conceptual plan of the site and to understand the soil's dielectric properties.
7. Focused scanning in a tight grid using fixed pegs and twine.
8. Marking of targets using plastic markers and spray paint.
9. Capturing target locations using a handheld GPS.
10. Carrying out cross section scanning of each marked target.
11. Combining radargrams and GPS waypoints into the final report using relevant software.

3. Survey and Results

Results of the GPR scan are shown in **Figure 2** below with the numbered points reflecting likely locations of unmarked graves.

1.1 Orientation & Size

Grid scanning indicates anomalies oriented in an East-West direction. Each numbered waypoint consists of approximately three traverses of the GPR at right angles in order to get a cross section of the grave target. In SEC's experience, the three traverses across the length of a target are consistent with the size of an average grave in Cape Town (approximately 1.2 m wide x 2.7 m long). If no targets are found outside of these parameters, the anomaly is considered as a possible grave target.

1.2 Depth

Depths of grave targets were found to vary between 0.7 m and 2.3 m below ground level. Considering the age of the cemetery and the fact that graves are not always buried at a standard depth, this may be consistent with coffin burials of the time.

1.3 Anomalies

Anomalies that are consistent with grave targets can occur on site and could be due to the following factors:

- Mole burrows;
- Rocks;
- Dense, non-metal objects like building rubble;
- Compacted clay layers

With accuracy being a key objective, care has been taken to avoid these anomalies, although some may match a grave target and be considered as such.

1.4 Scan area and site boundaries

The boundary shown in red in **Figure 2** is consistent with the boundary provided to SEC as part of the original scope of works.

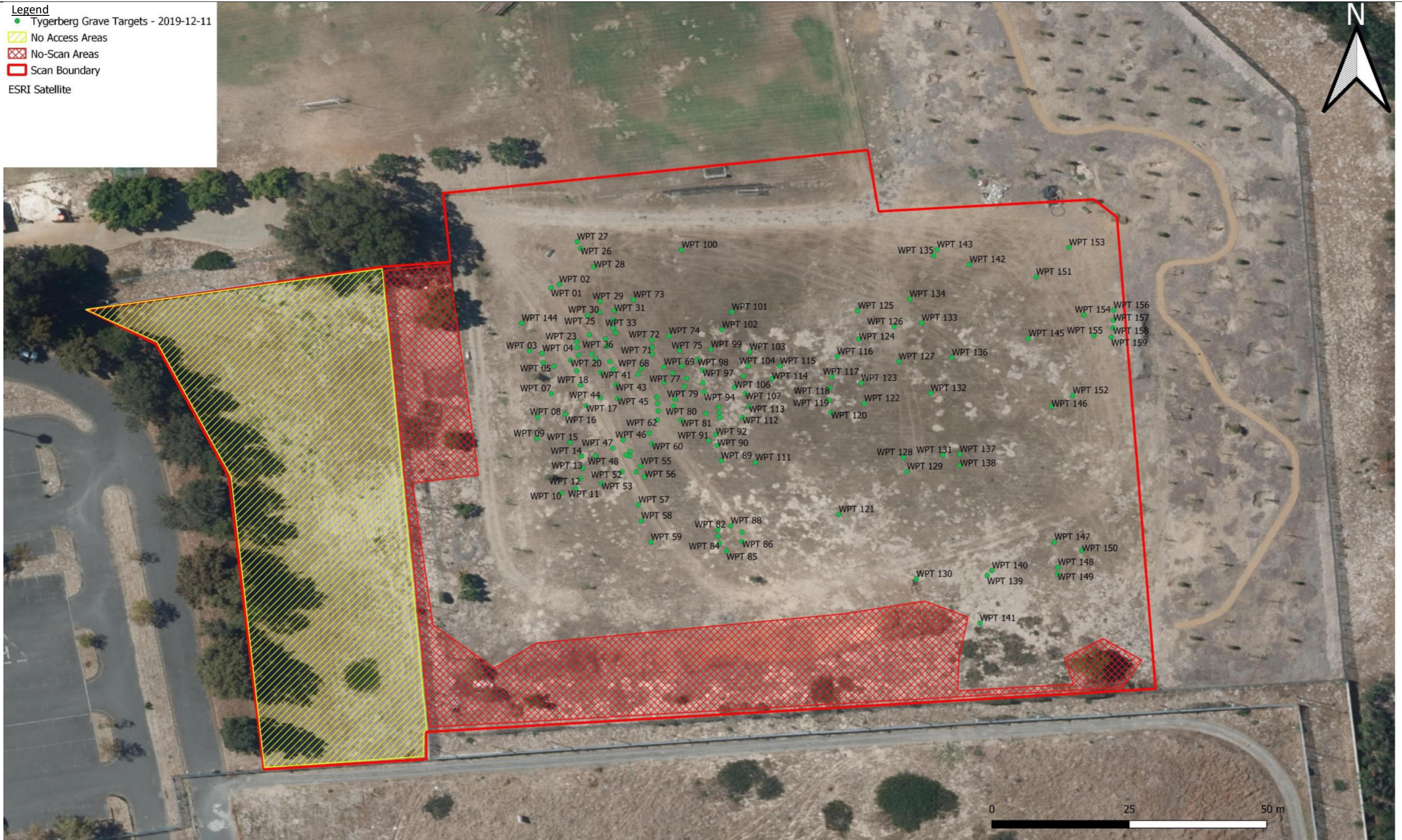
No-Scan Areas are indicated as a red cross-hatched polygon which occurred where the GPR equipment couldn't traverse it or where there were obstacles in the way such as a vegetable garden or trees.

No Access Areas are indicated as a yellow hatched polygon and shows the area where Stellenbosch University needed to get permission from the Department of Health for SEC to conduct a GPR scan, as per the communication between Meg Pittaway on the 8th of January 2020 this was not provided.

1.5 GPS Waypoints

Coordinates for all GPS Waypoints shown on **Figure 2** are summarised in **Appendix A – Coordinates** with corresponding accuracies.

Figure 2. Hardekraaltjie GIS Waypoint Map showing possible locations of graves.



4. Radargrams

Each possible grave target was scanned perpendicularly to provide a cross – section of the grave. Depths are shown on the left-hand side of the radargram and distance travelled on the bottom.

Radargram numbers match waypoint numbers in **Figure 2** and can be cross- referenced.

Likely grave targets are indicated on the radargrams as black dashed rectangles.

The radargrams for each target can be found in **Appendix B – Radargrams**.

APPENDIX A

COORDINATES

Hardekraaltjie Grave Targets GPS Waypoints			
Name	Latitude	Longitude	Accuracy (m)
WPT 01	-33.9084	18.61724	2
WPT 02	-33.9084	18.61725	2
WPT 03	-33.9085	18.61719	1.5
WPT 04	-33.9085	18.61722	1.5
WPT 05	-33.9085	18.61722	1.5
WPT 06	-33.9085	18.61724	1.5
WPT 07	-33.9086	18.61724	1.5
WPT 08	-33.9086	18.61721	1
WPT 09	-33.9087	18.61721	1
WPT 10	-33.9088	18.61726	2
WPT 11	-33.9088	18.61729	2
WPT 12	-33.9087	18.61729	1.5
WPT 13	-33.9087	18.6173	1.5
WPT 14	-33.9087	18.6173	1.5
WPT 15	-33.9087	18.61727	1.5
WPT 16	-33.9086	18.61726	1
WPT 17	-33.9086	18.61731	1
WPT 18	-33.9086	18.61729	1
WPT 19	-33.9085	18.61729	1
WPT 20	-33.9085	18.61728	1
WPT 21	-33.9085	18.61729	1
WPT 22	-33.9085	18.61729	1
WPT 23	-33.9085	18.61729	1
WPT 24	-33.9085	18.61731	0.75
WPT 25	-33.9084	18.61731	0.75
WPT 26	-33.9083	18.61729	0.75
WPT 27	-33.9083	18.61729	0.75
WPT 28	-33.9083	18.61732	0.75
WPT 29	-33.9084	18.61733	2
WPT 30	-33.9084	18.61733	1.5
WPT 31	-33.9084	18.61736	1.5
WPT 32	-33.9084	18.61736	1.5
WPT 33	-33.9084	18.61736	1.5
WPT 34	-33.9084	18.61736	1
WPT 35	-33.9084	18.61736	1
WPT 36	-33.9085	18.61734	1
WPT 37	-33.9085	18.61735	1
WPT 38	-33.9085	18.61732	1
WPT 39	-33.9085	18.61732	1
WPT 40	-33.9085	18.61735	1
WPT 41	-33.9085	18.61733	1
WPT 42	-33.9085	18.61736	0.75
WPT 43	-33.9085	18.61736	0.75
WPT 44	-33.9086	18.61733	0.75

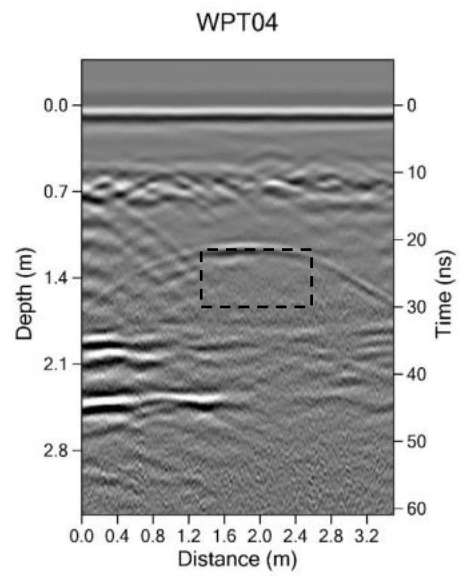
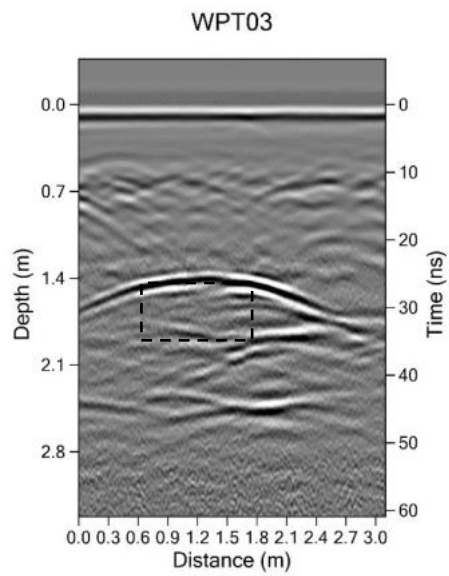
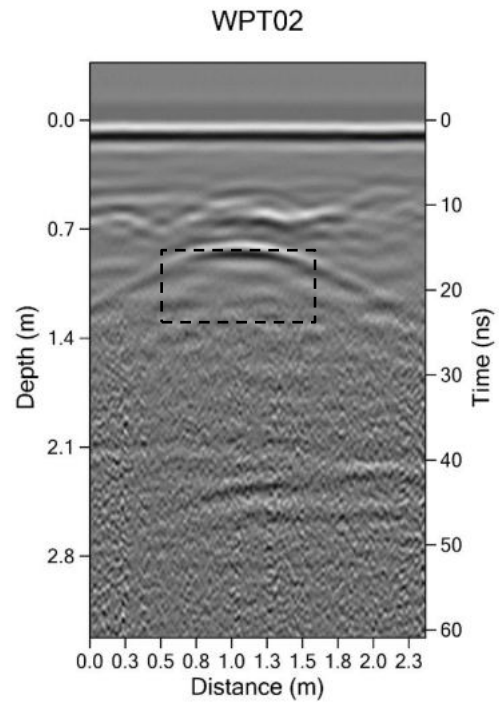
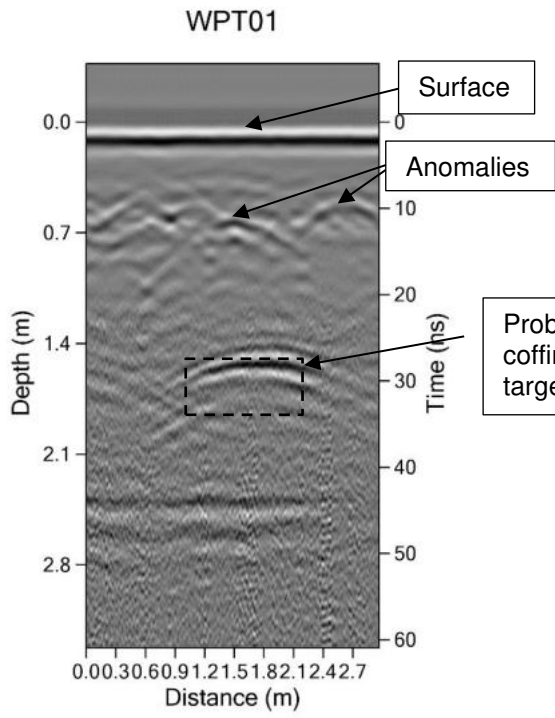
Hardekraaltjie Grave Targets GPS Waypoints			
Name	Latitude	Longitude	Accuracy (m)
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WPT 47	-33.9087	18.61736	1.5
WPT 48	-33.9087	18.61732	2
WPT 49	-33.9087	18.61739	2
WPT 50	-33.9087	18.61739	1.5
WPT 51	-33.9087	18.61738	2
WPT 52	-33.9087	18.61738	1.5
WPT 53	-33.9087	18.61734	1.5
WPT 54	-33.9087	18.6174	1.5
WPT 55	-33.9087	18.61741	1
WPT 56	-33.9087	18.61742	1
WPT 57	-33.9088	18.61741	2
WPT 58	-33.9088	18.61741	2
WPT 59	-33.9089	18.61743	1.5
WPT 60	-33.9087	18.61744	2
WPT 61	-33.9086	18.61743	2
WPT 62	-33.9086	18.61745	2
WPT 63	-33.9086	18.61745	2
WPT 64	-33.9086	18.61745	1.5
WPT 65	-33.9086	18.61744	1.5
WPT 66	-33.9085	18.61746	2
WPT 67	-33.9085	18.61741	2
WPT 68	-33.9085	18.61741	1.5
WPT 69	-33.9085	18.61746	1.5
WPT 70	-33.9085	18.61744	1
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WPT 78	-33.9086	18.6175	1.5
WPT 79	-33.9086	18.61748	2
WPT 80	-33.9086	18.61748	2
WPT 81	-33.9086	18.61749	2
WPT 82	-33.9088	18.61756	2
WPT 83	-33.9088	18.61756	2
WPT 84	-33.9089	18.61757	2
WPT 85	-33.9089	18.61758	1.5
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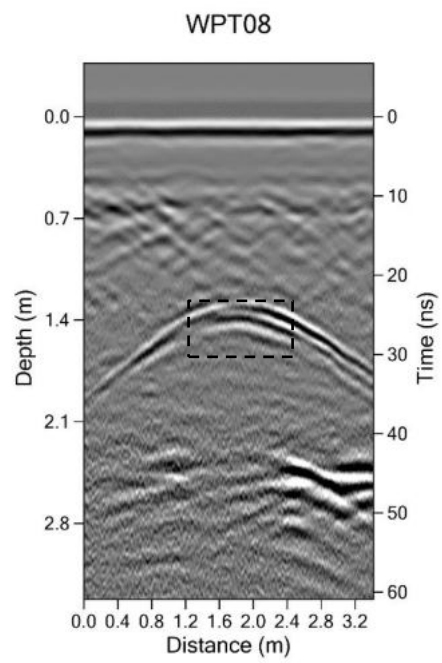
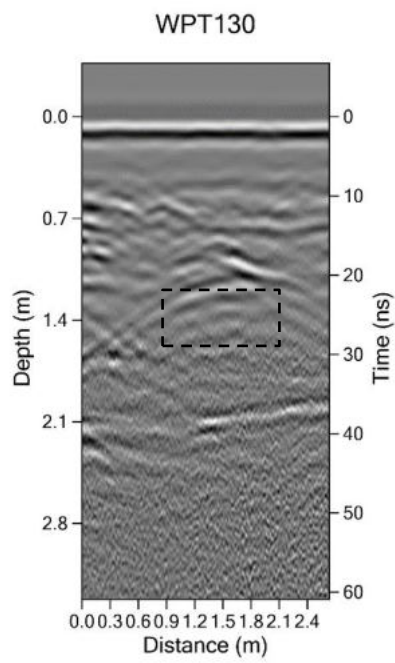
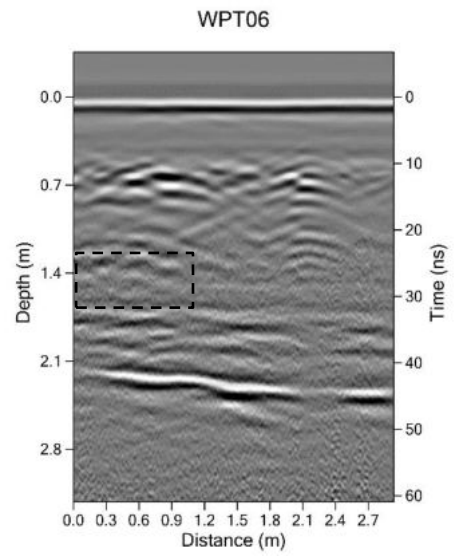
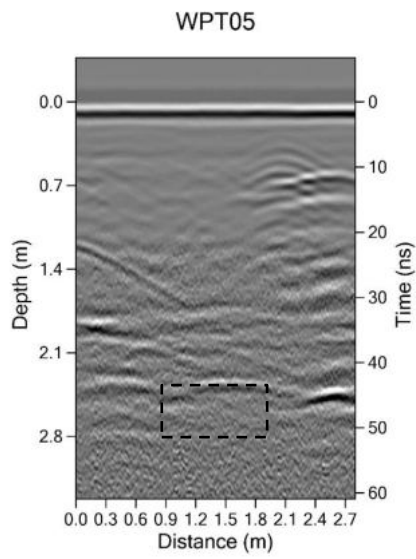
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WPT 93	-33.9086	18.61754	2
WPT 94	-33.9086	18.61754	1.5
WPT 95	-33.9085	18.61754	1.5
WPT 96	-33.9085	18.6175	1.5
WPT 97	-33.9085	18.61753	1.5
WPT 98	-33.9085	18.61752	1.5
WPT 99	-33.9085	18.61755	1
WPT 100	-33.9083	18.61749	2
WPT 101	-33.9084	18.61759	2
WPT 102	-33.9084	18.61757	2
WPT 103	-33.9085	18.61763	2
WPT 104	-33.9085	18.61762	2
WPT 105	-33.9085	18.61761	2
WPT 106	-33.9086	18.6176	2
WPT 107	-33.9086	18.61762	1.5
WPT 108	-33.9086	18.61757	1.5
WPT 109	-33.9086	18.61757	1.5
WPT 110	-33.9086	18.61757	1.5
WPT 111	-33.9087	18.61764	2
WPT 112	-33.9086	18.61761	2
WPT 113	-33.9086	18.61763	2
WPT 114	-33.9085	18.61767	1.5
WPT 115	-33.9085	18.61769	2
WPT 116	-33.9085	18.6178	2
WPT 117	-33.9085	18.61779	2
WPT 118	-33.9086	18.61778	2
WPT 119	-33.9086	18.61778	2
WPT 120	-33.9086	18.61779	2
WPT 121	-33.9088	18.6178	2
WPT 122	-33.9086	18.61785	2
WPT 123	-33.9085	18.61785	2
WPT 124	-33.9085	18.61784	2
WPT 125	-33.9084	18.61784	2
WPT 126	-33.9084	18.61791	2
WPT 127	-33.9085	18.61792	2
WPT 128	-33.9087	18.61793	1.5
WPT 129	-33.9087	18.61794	1.5
WPT 130	-33.9089	18.61796	2
WPT 131	-33.9087	18.61801	2
WPT 132	-33.9086	18.61798	2

Hardekraaltjie Grave Targets GPS Waypoints			
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WPT 134	-33.9084	18.61794	2
WPT 135	-33.9083	18.61799	2
WPT 136	-33.9085	18.61803	2
WPT 137	-33.9087	18.61804	2
WPT 138	-33.9087	18.61804	2
WPT 139	-33.9089	18.61809	2
WPT 140	-33.9089	18.6181	2
WPT 141	-33.909	18.61808	2
WPT 142	-33.9083	18.61806	2
WPT 143	-33.9083	18.618	2
WPT 144	-33.9084	18.61718	2
WPT 145	-33.9085	18.61818	1.5
WPT 146	-33.9086	18.61822	2
WPT 147	-33.9089	18.61823	2
WPT 148	-33.9089	18.61823	2
WPT 149	-33.9089	18.61823	2
WPT 150	-33.9089	18.61828	2
WPT 152	-33.9086	18.61826	2
WPT 151	-33.9083	18.61819	2
WPT 153	-33.9083	18.61826	1.5
WPT 154	-33.9084	18.61828	1.5
WPT 155	-33.9085	18.6183	2
WPT 156	-33.9084	18.61834	2
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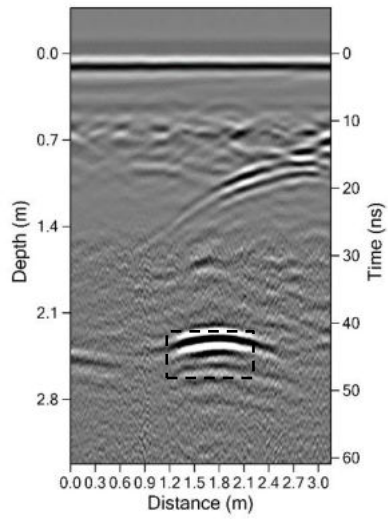
APPENDIX B

RADARGRAMS

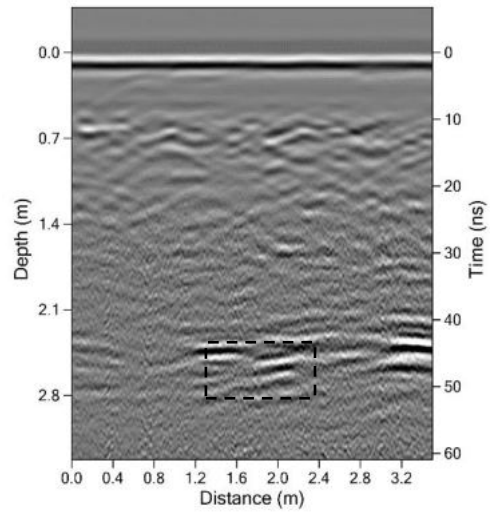




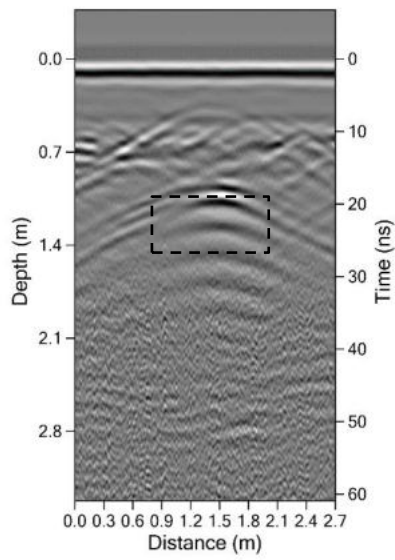
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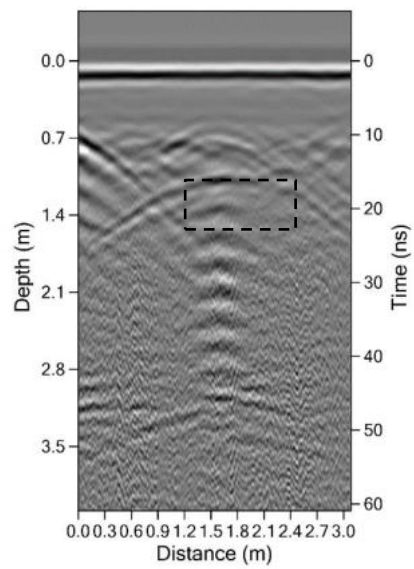
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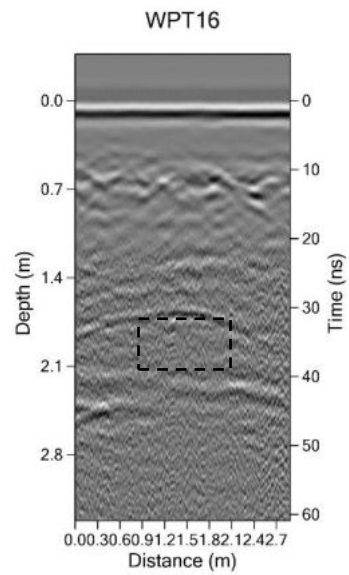
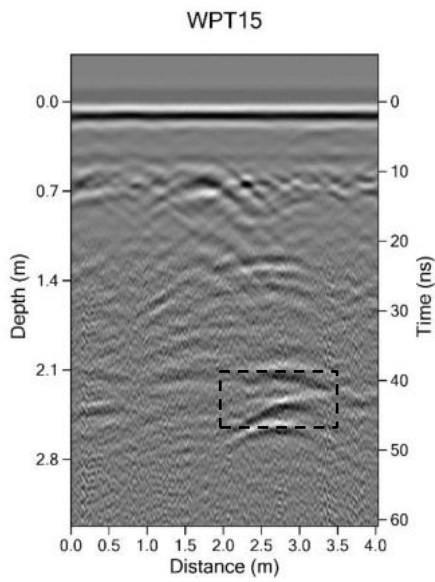
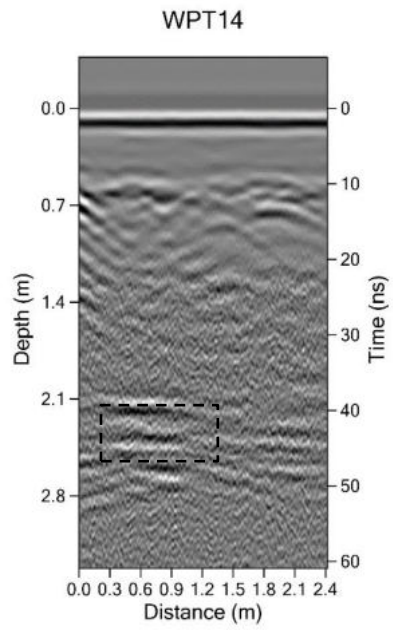
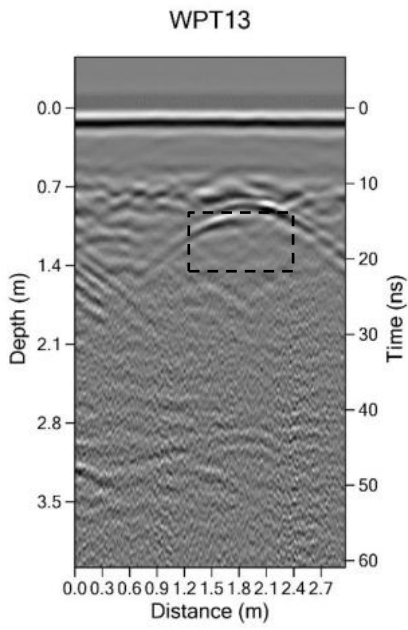


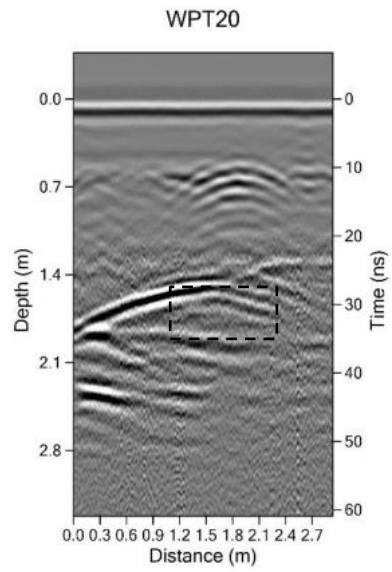
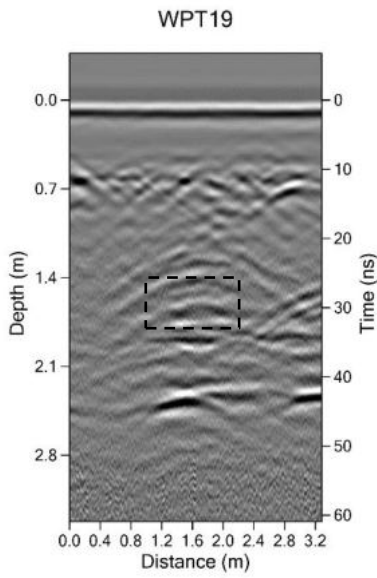
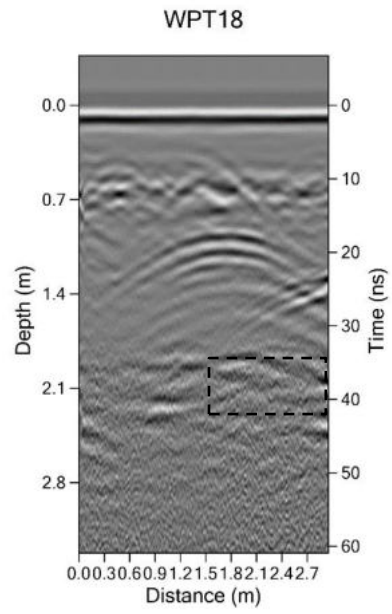
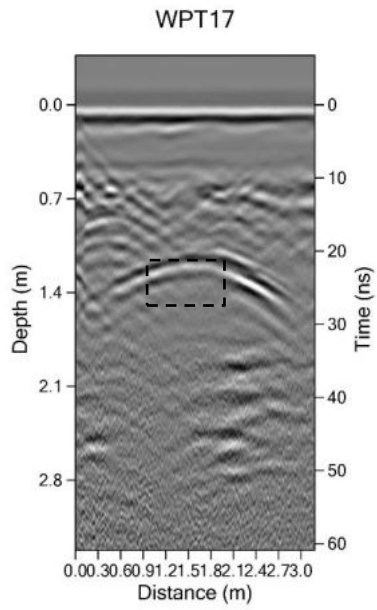
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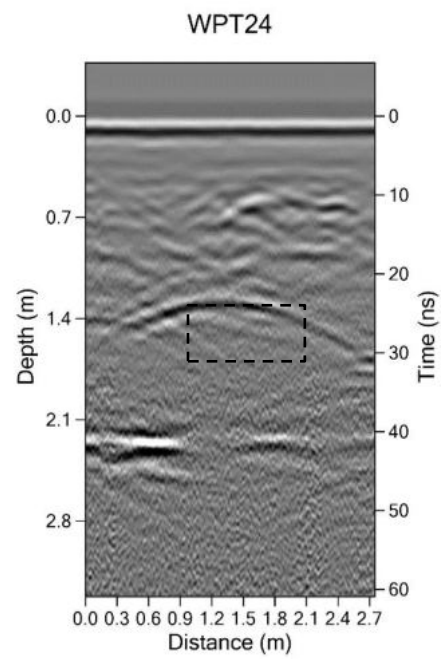
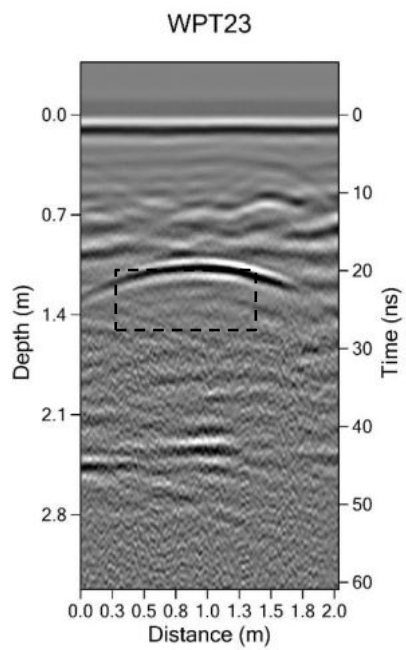
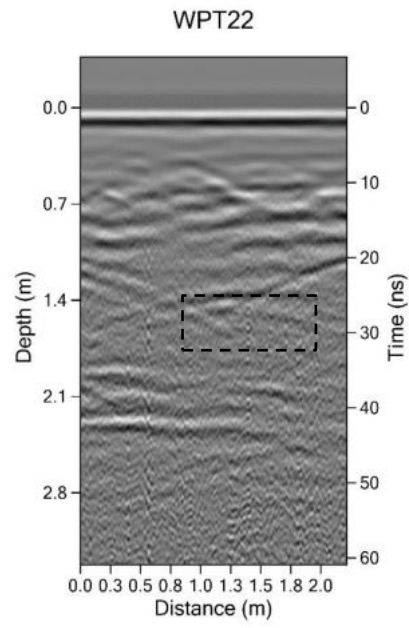
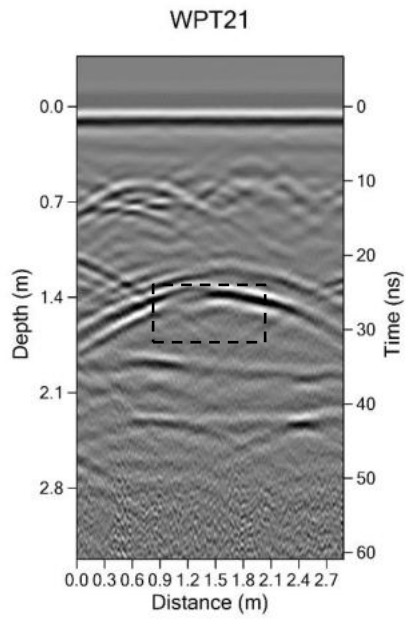


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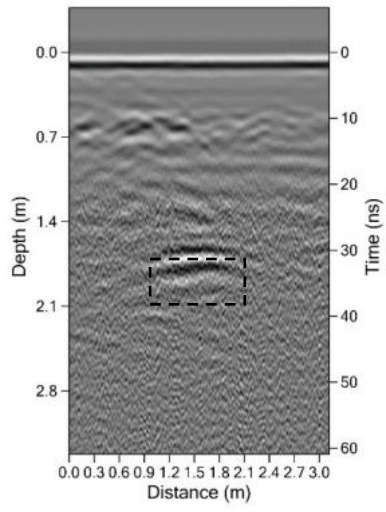




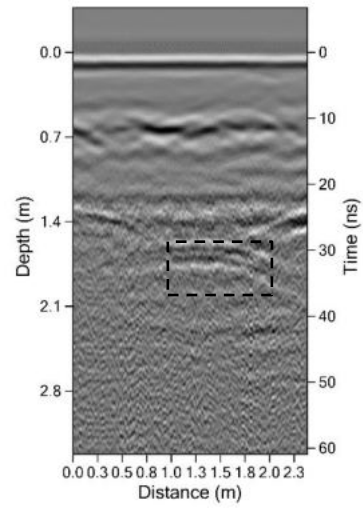




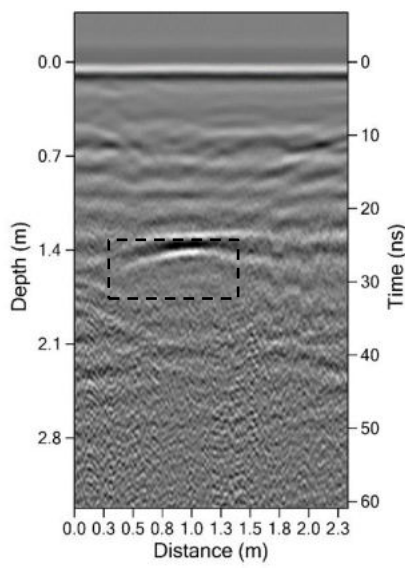
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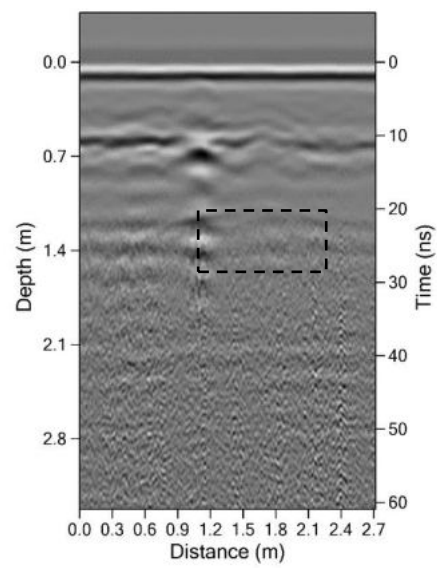
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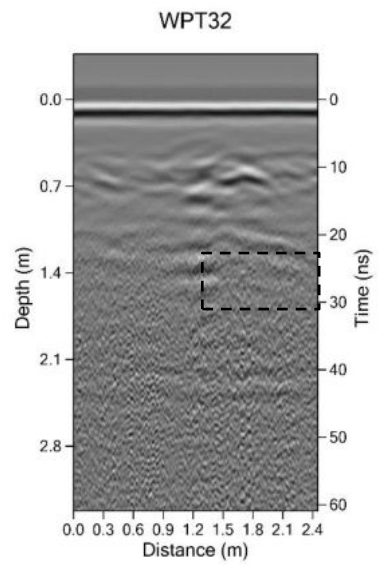
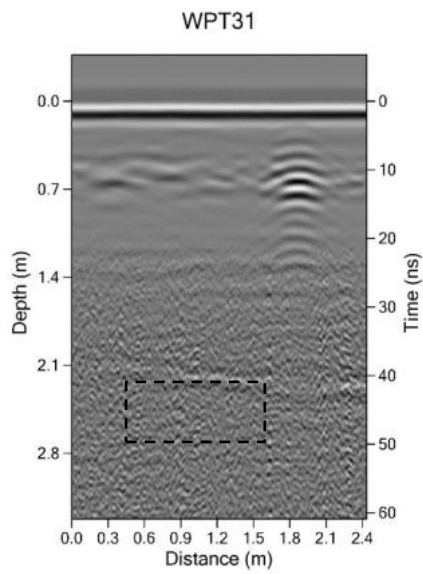
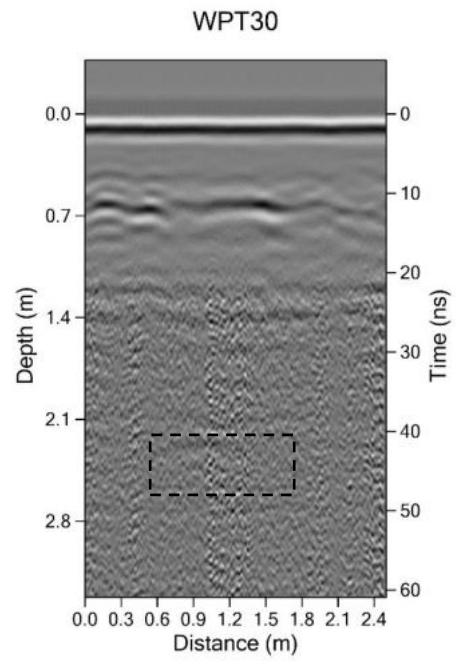
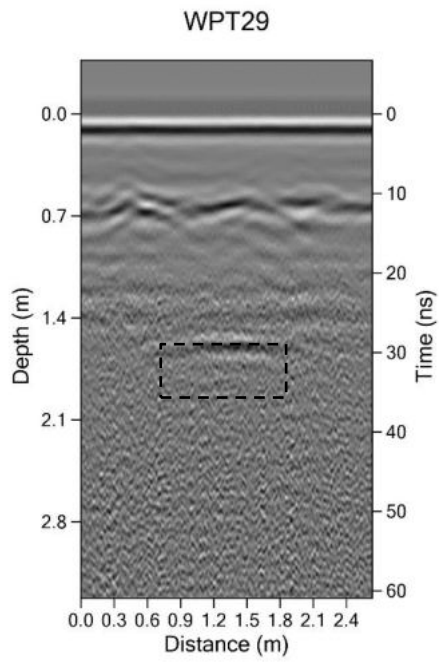


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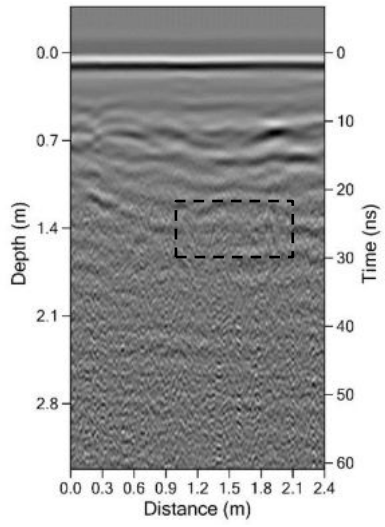


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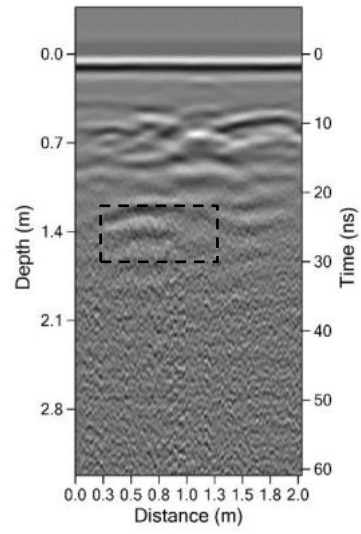




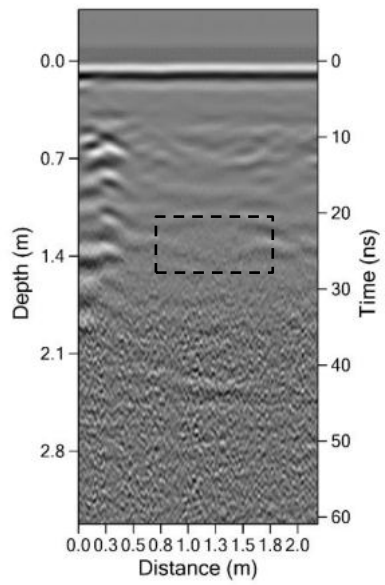
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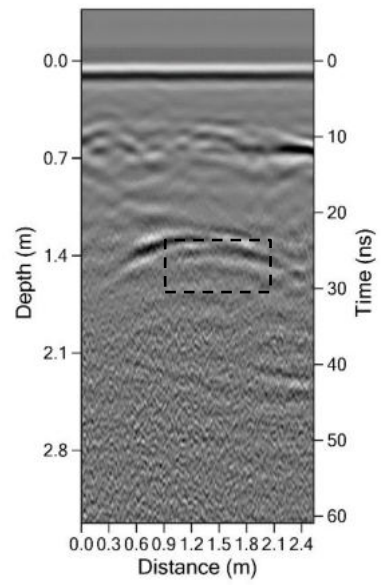
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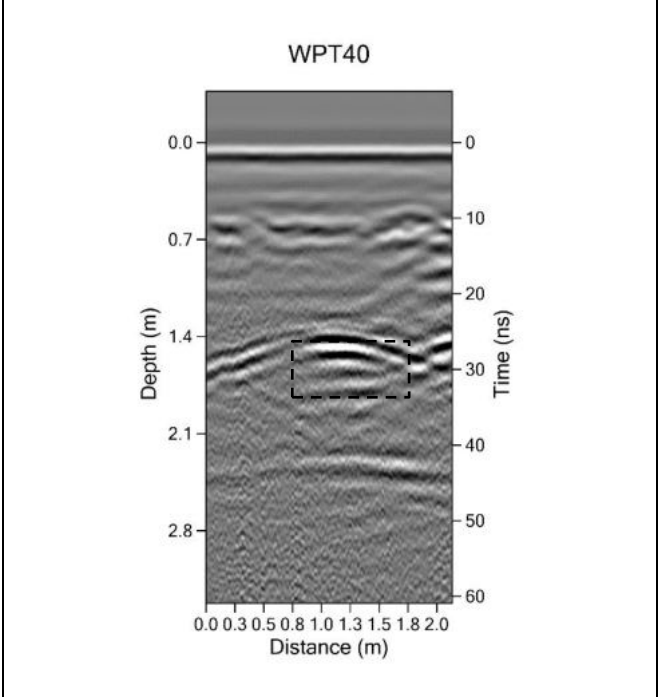
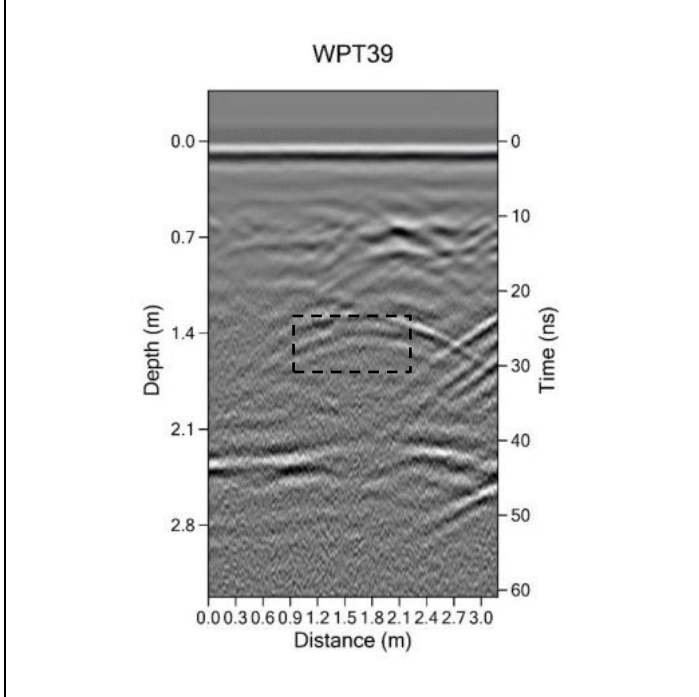
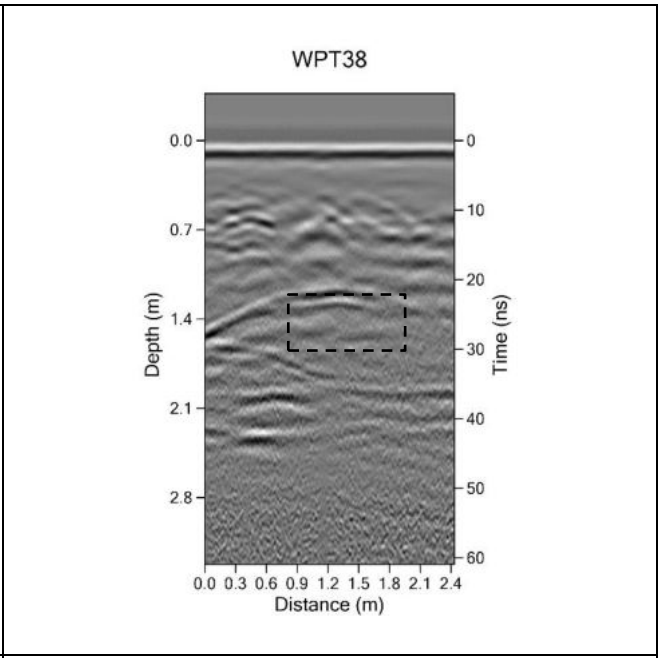
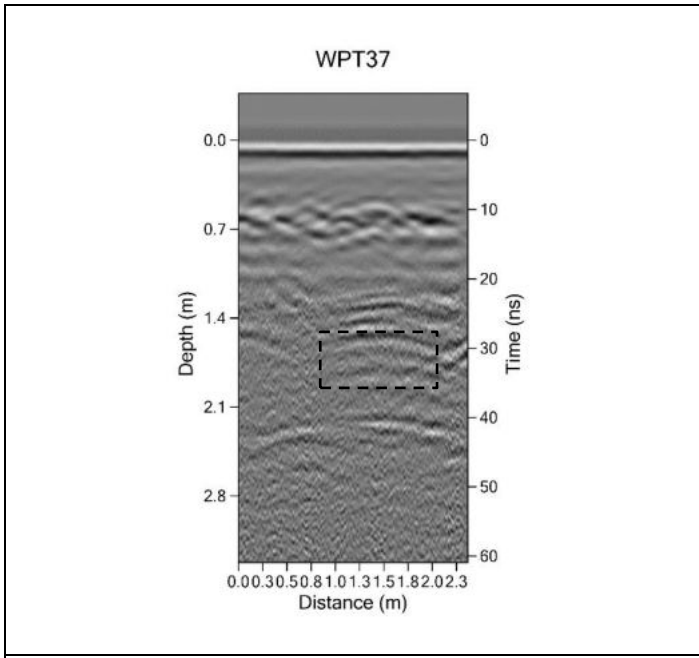


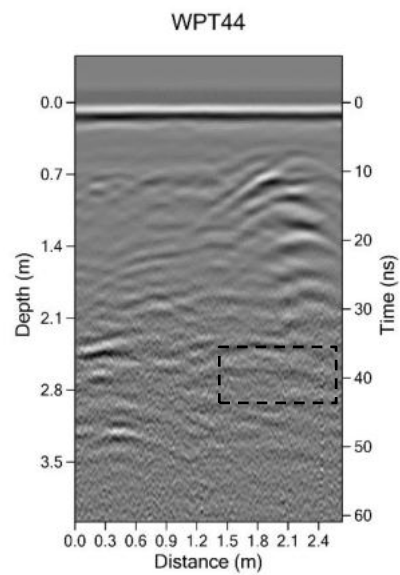
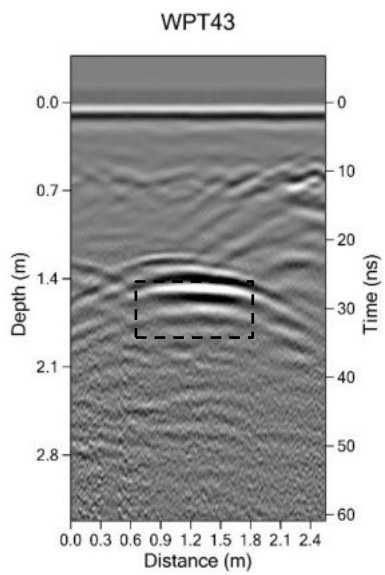
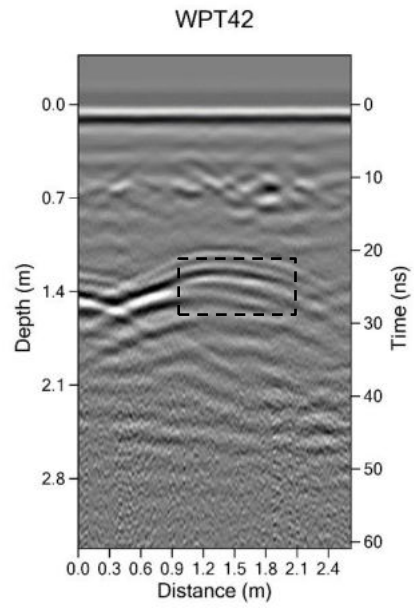
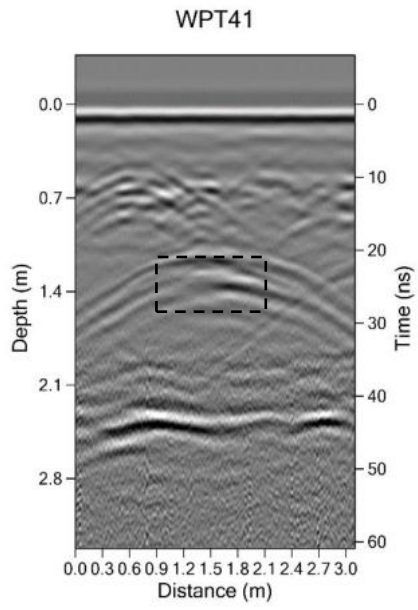
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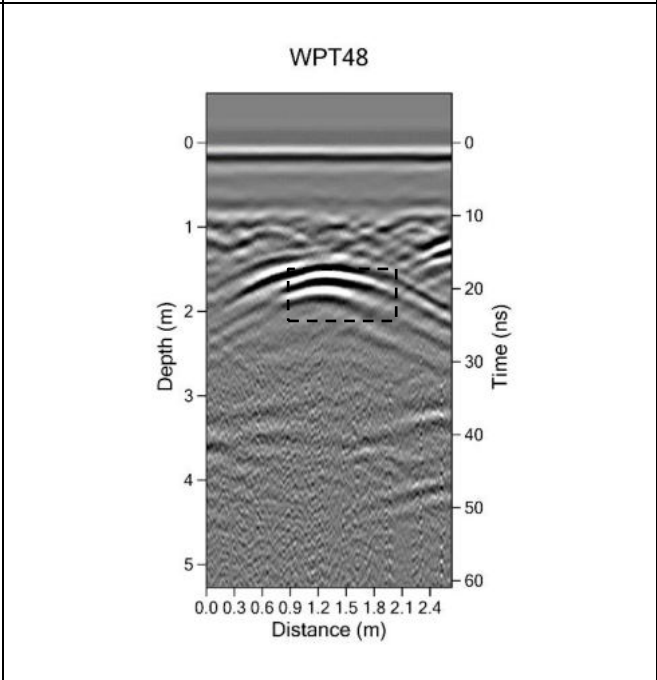
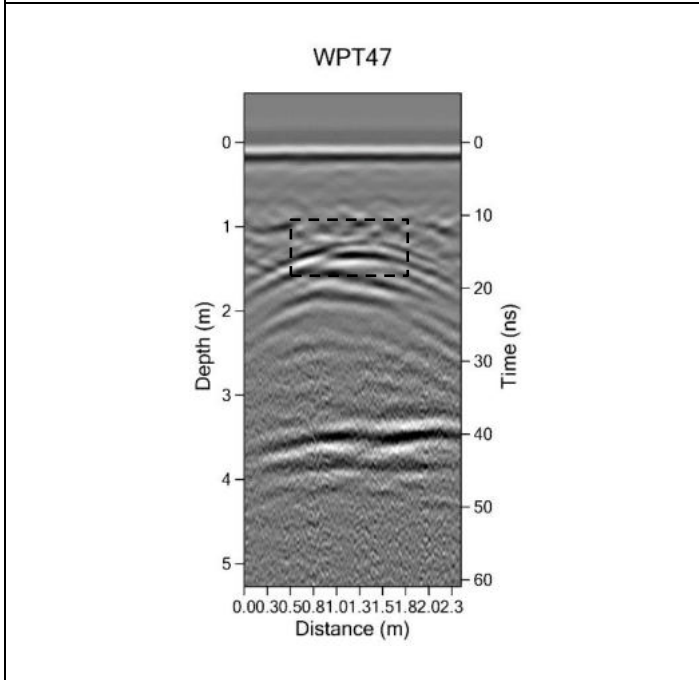
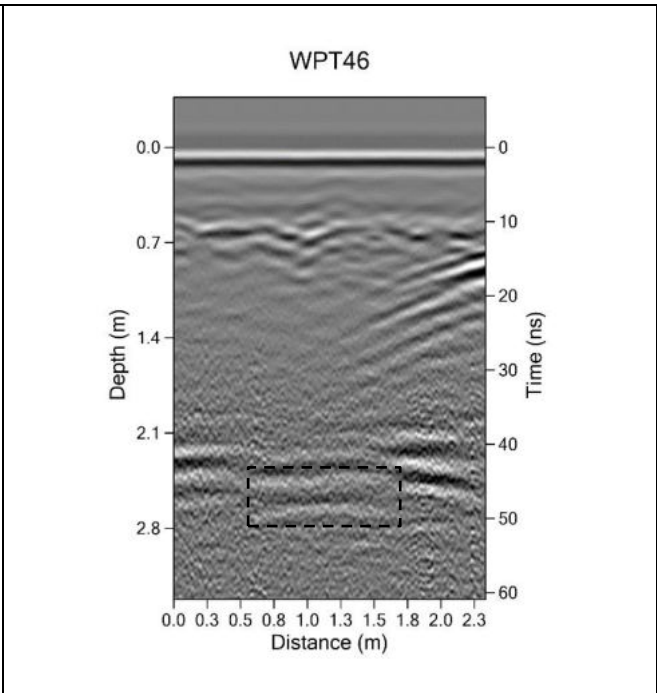
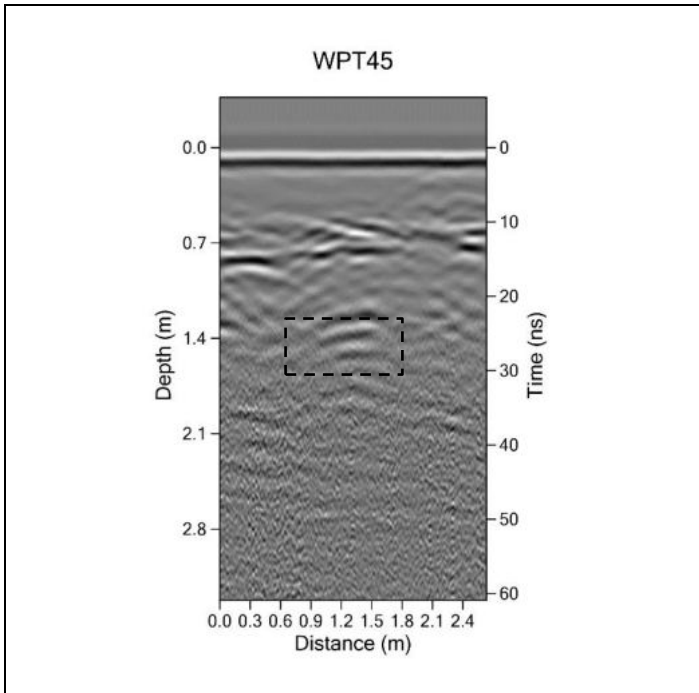


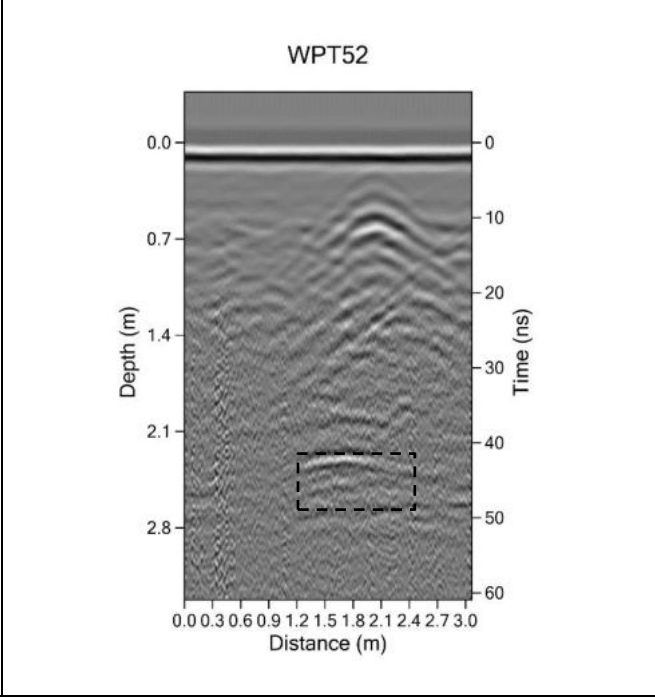
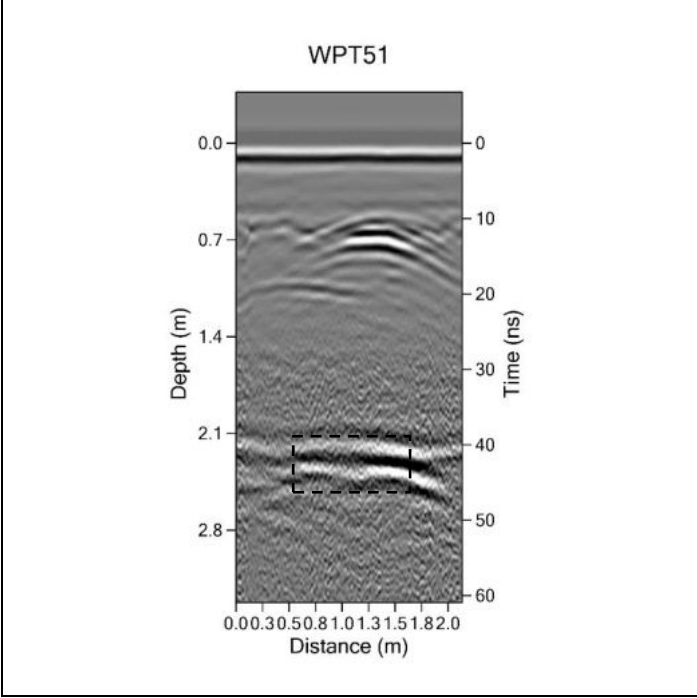
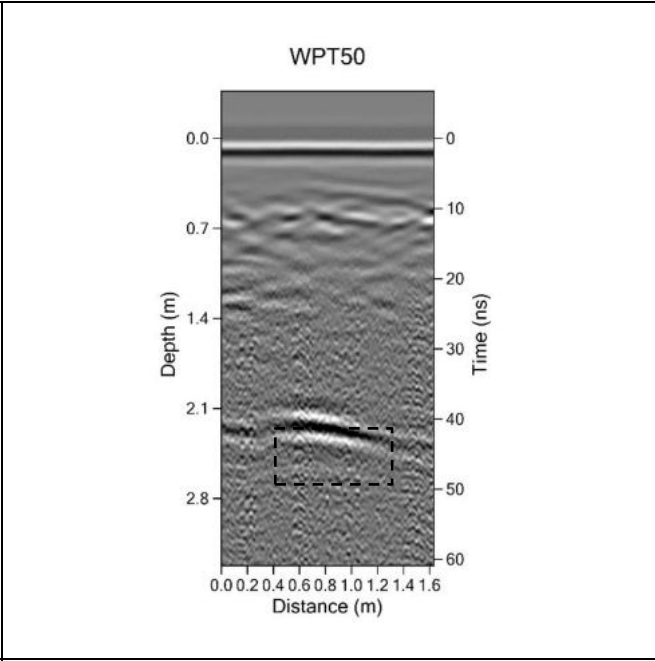
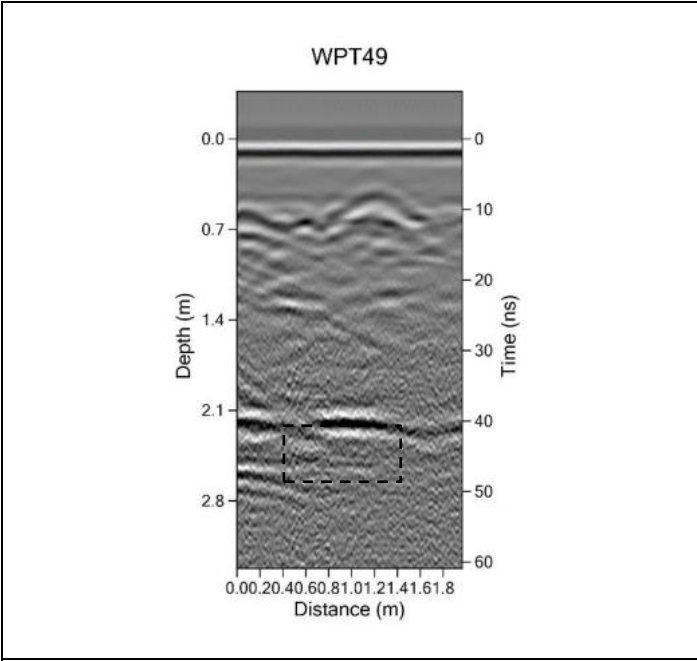
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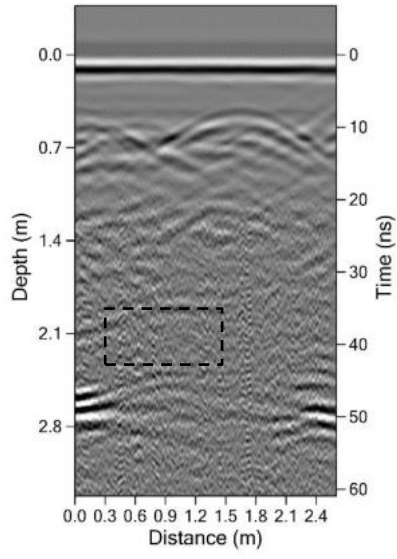




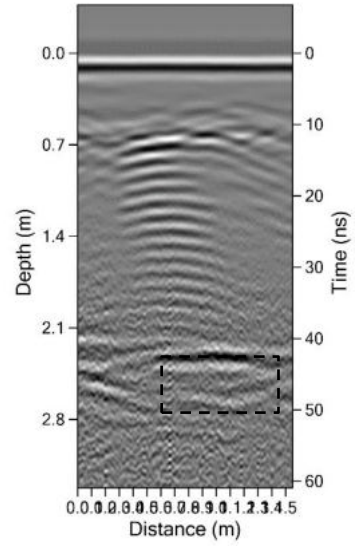




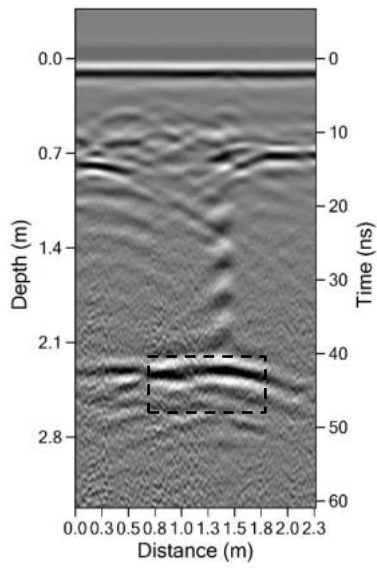
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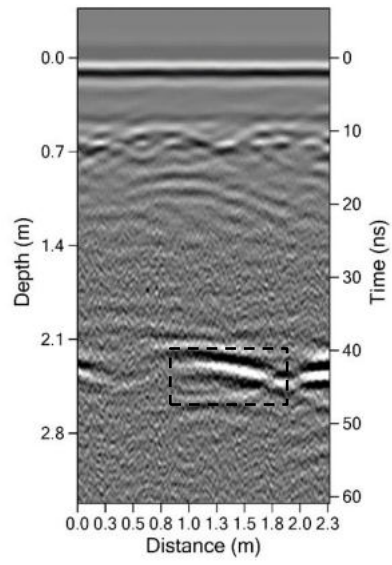
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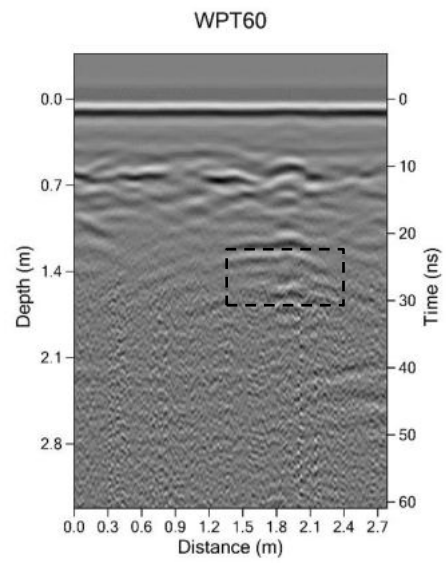
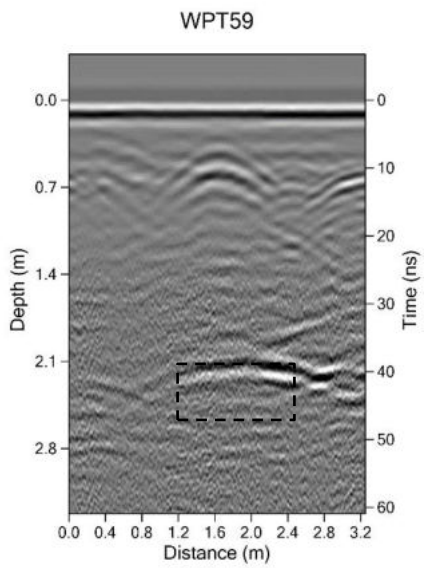
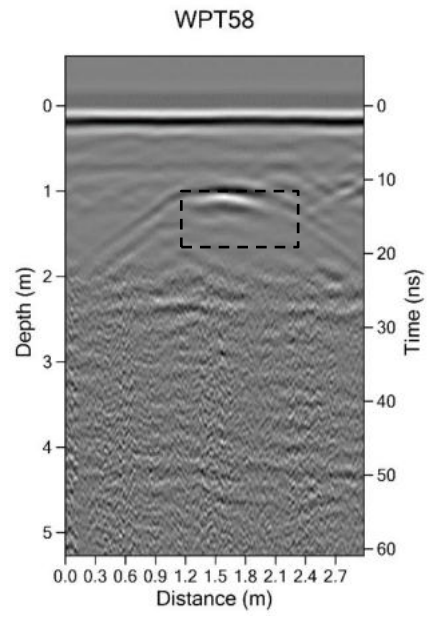
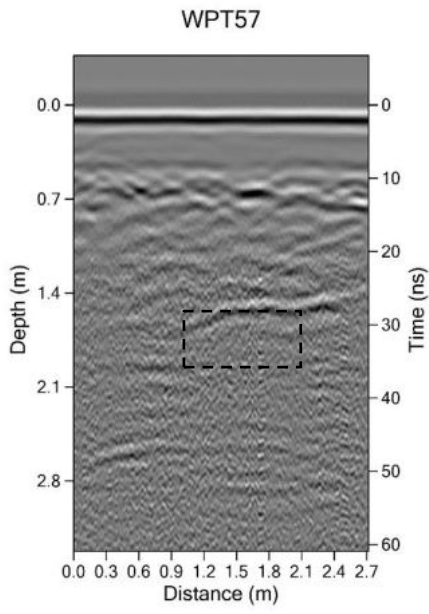


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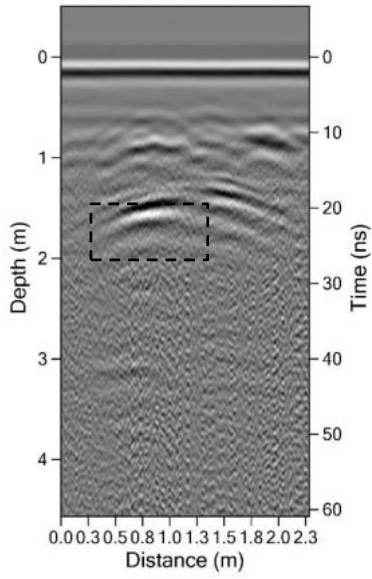


WPT56

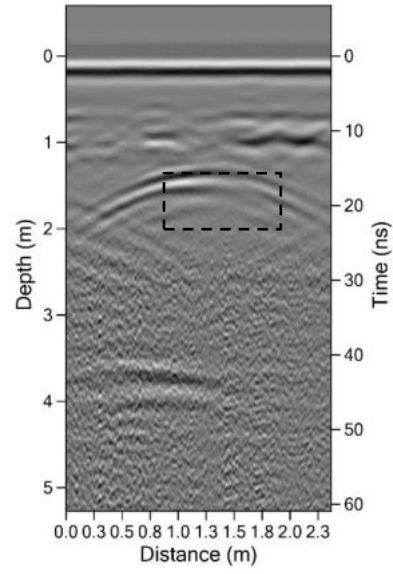




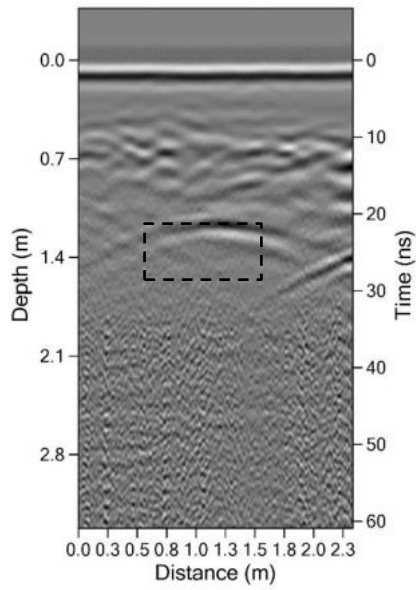
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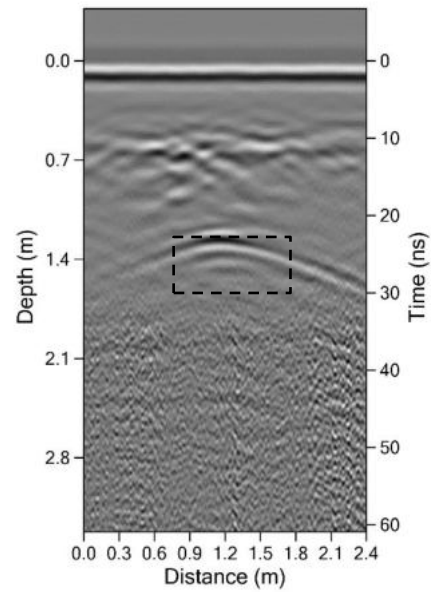
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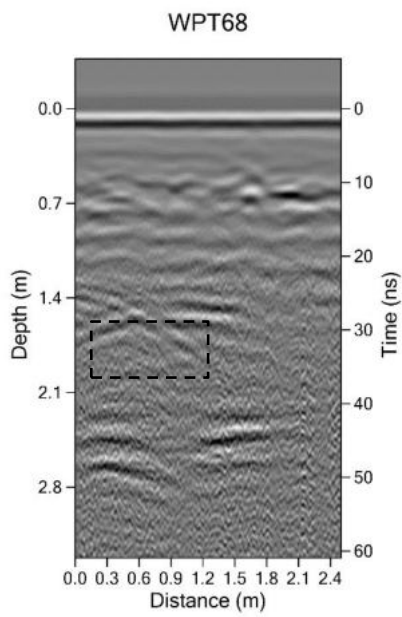
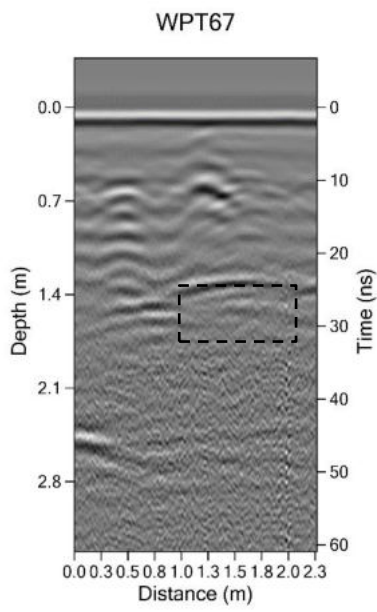
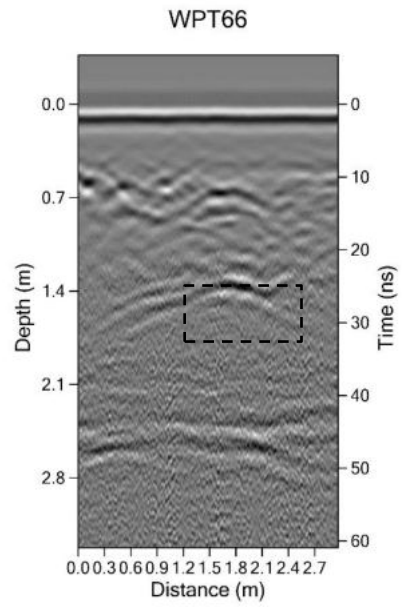
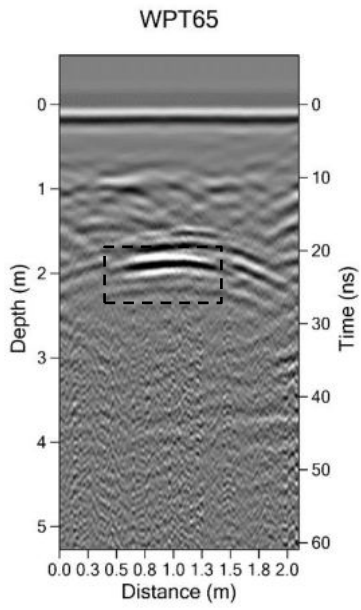


WPT63

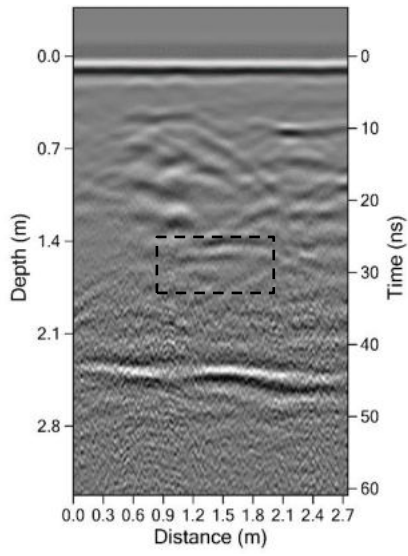


WPT64

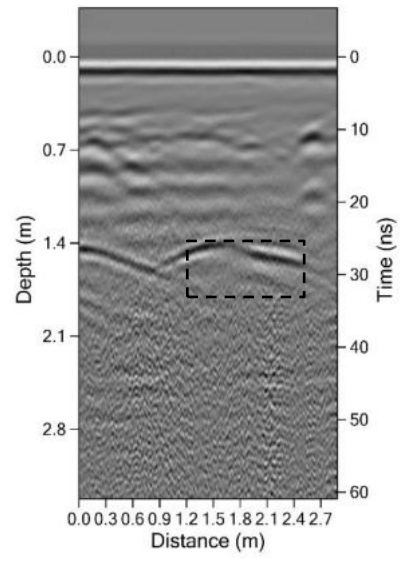




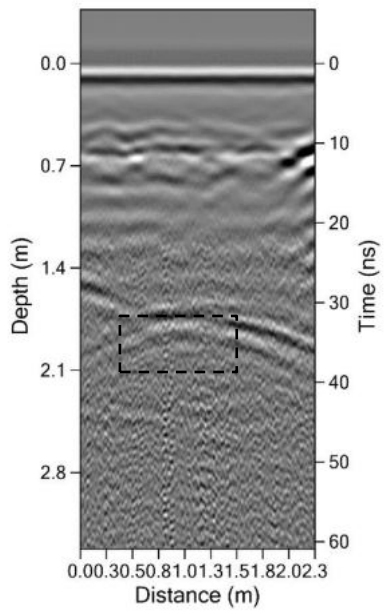
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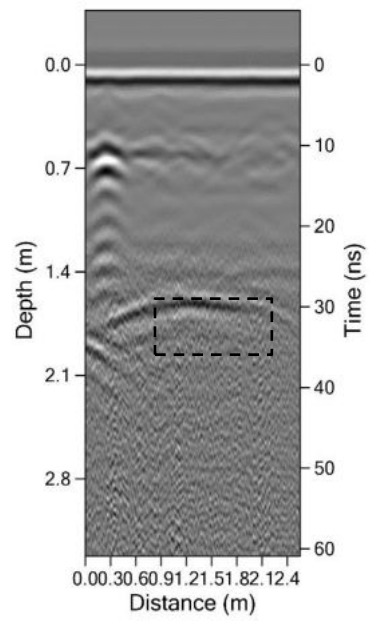
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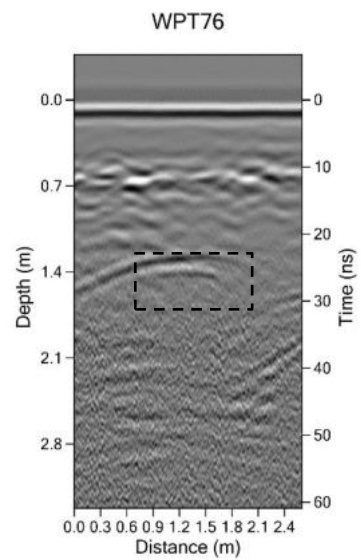
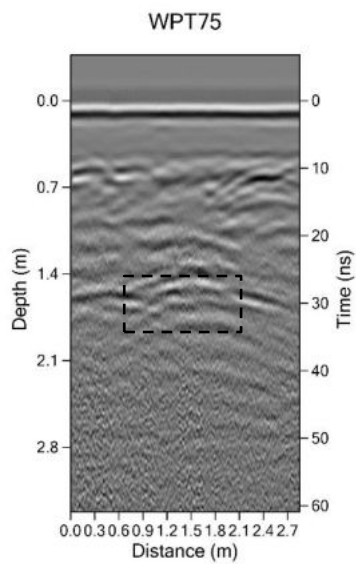
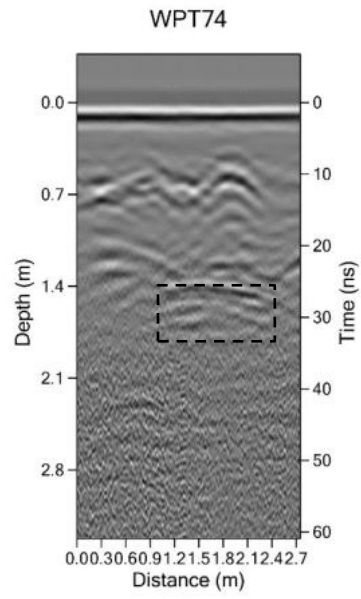
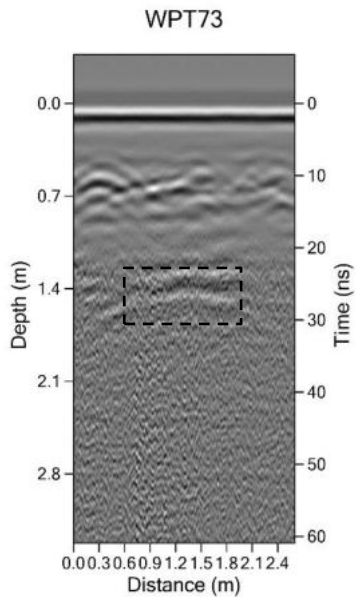


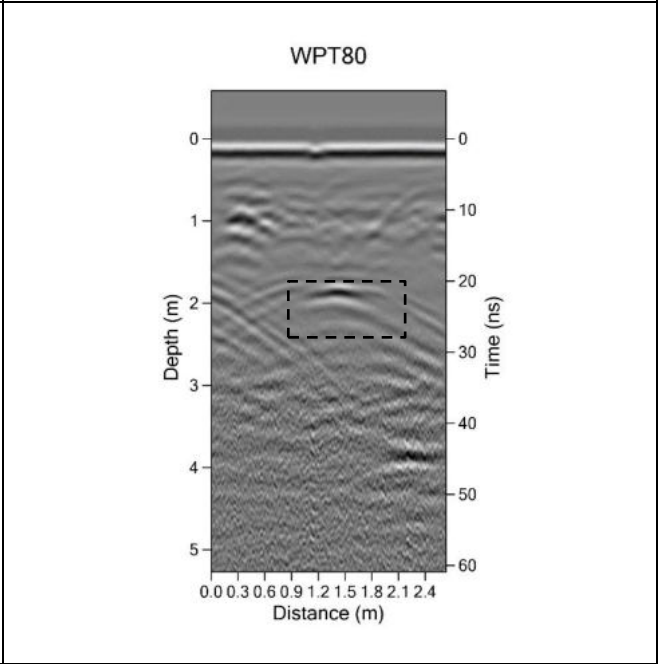
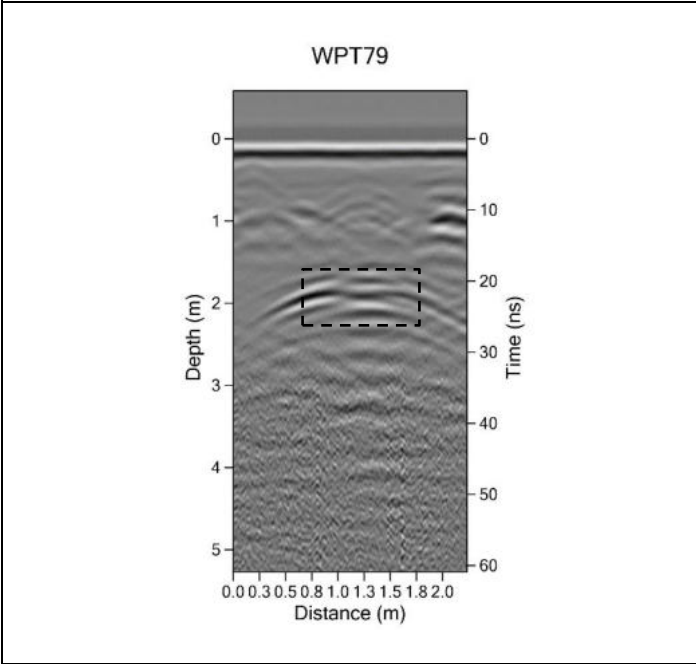
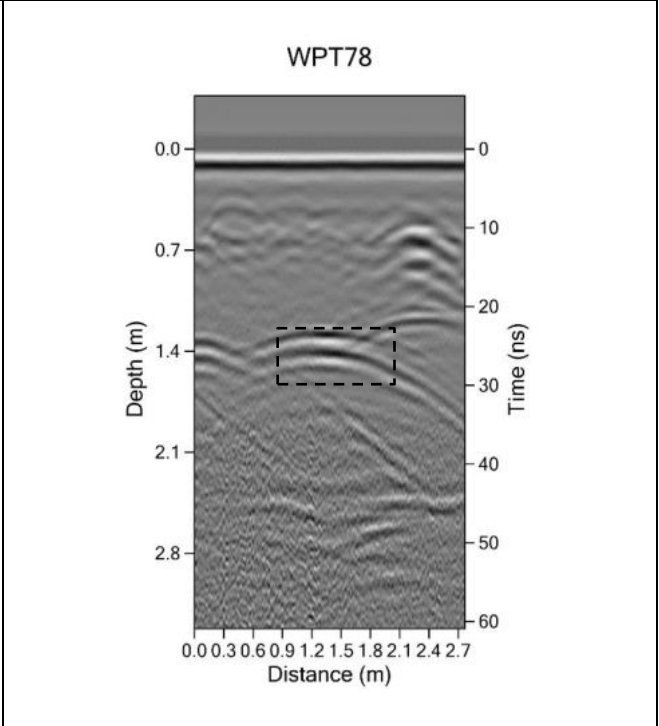
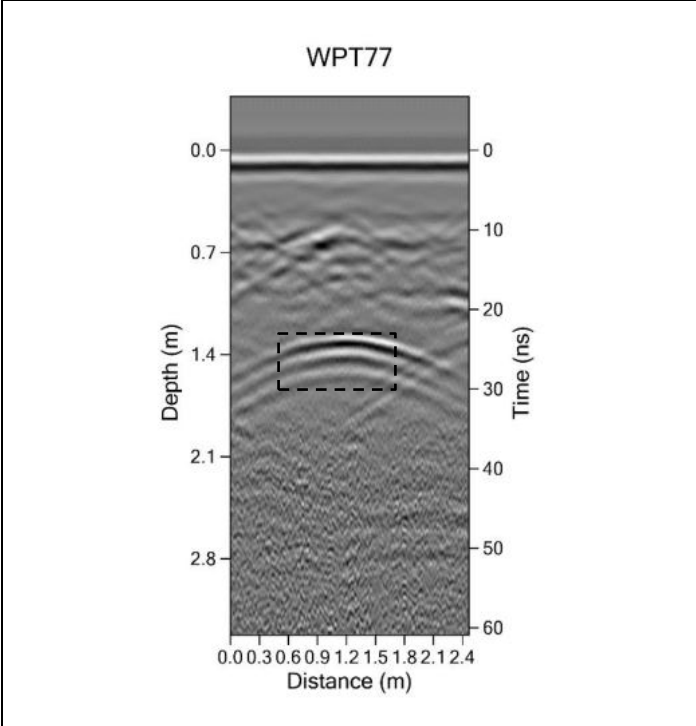
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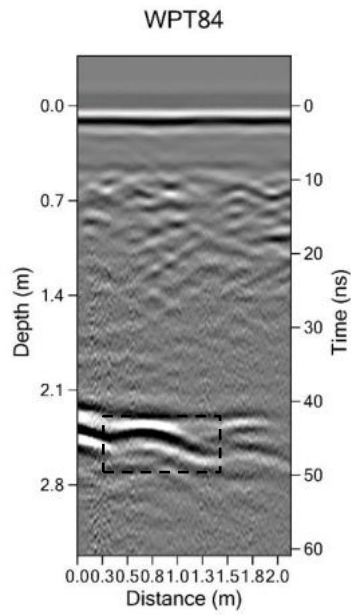
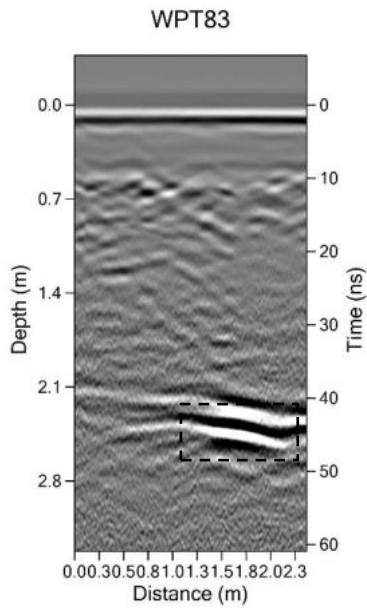
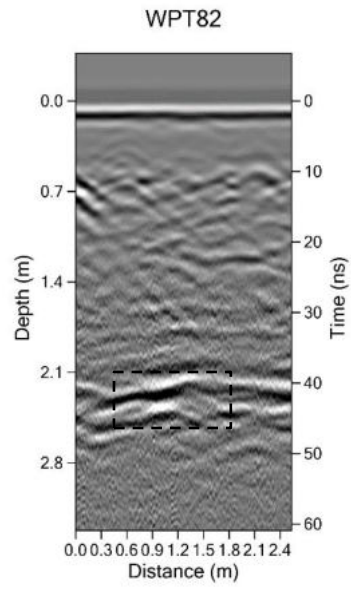
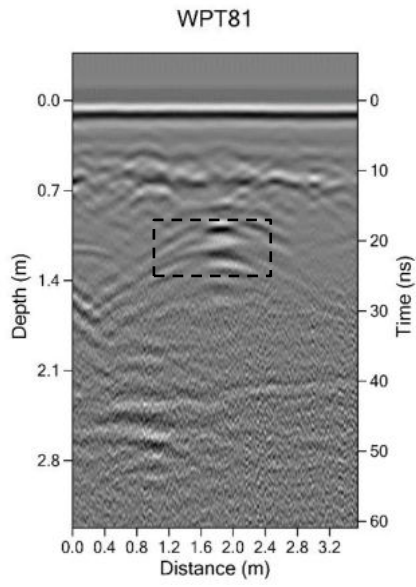


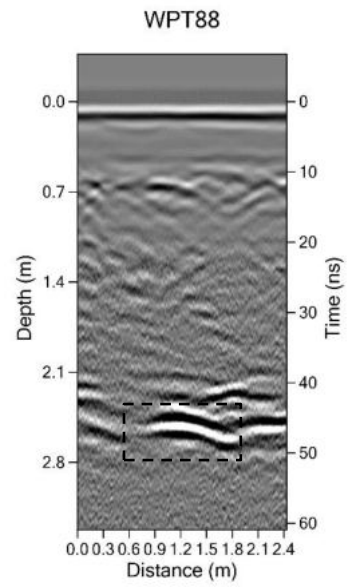
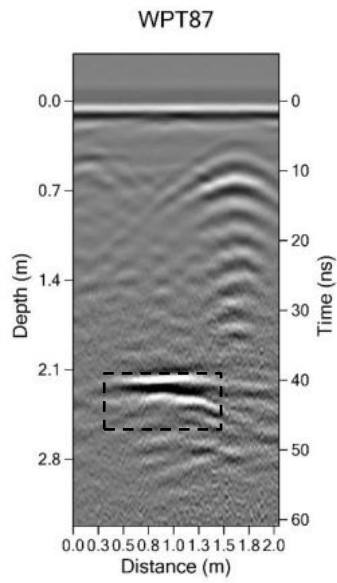
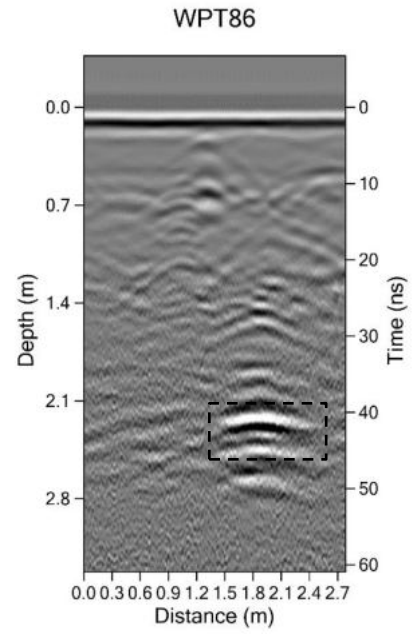
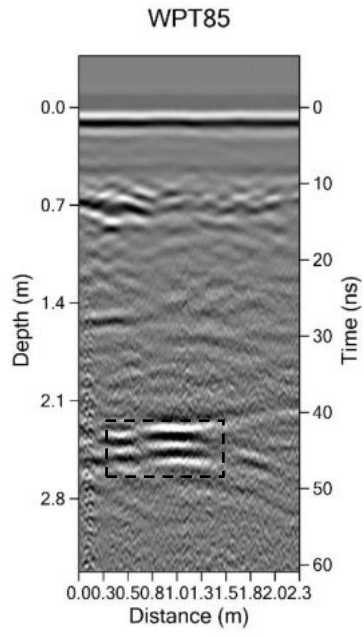
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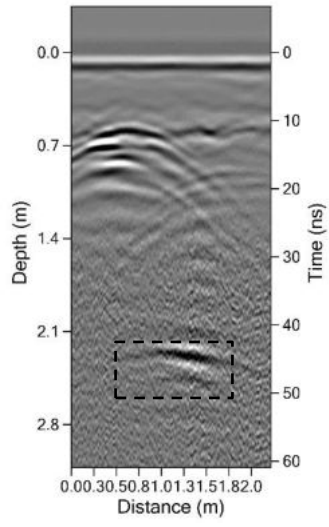




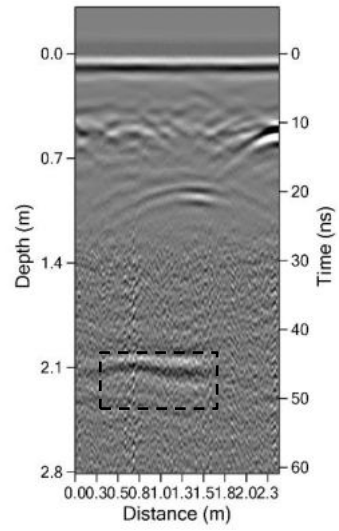




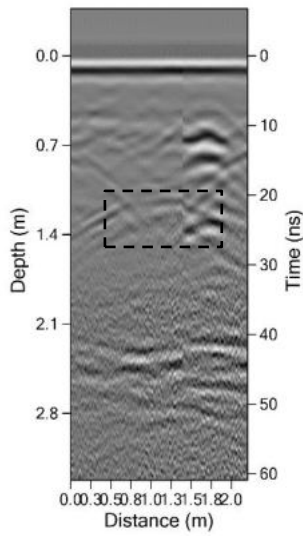
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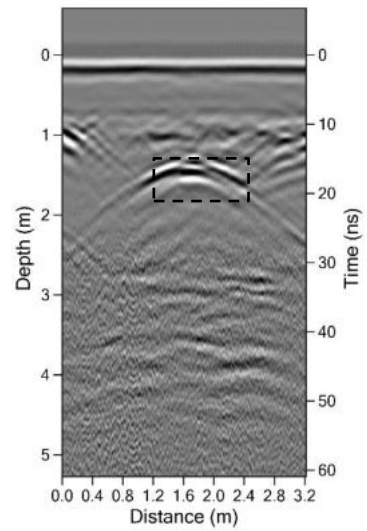
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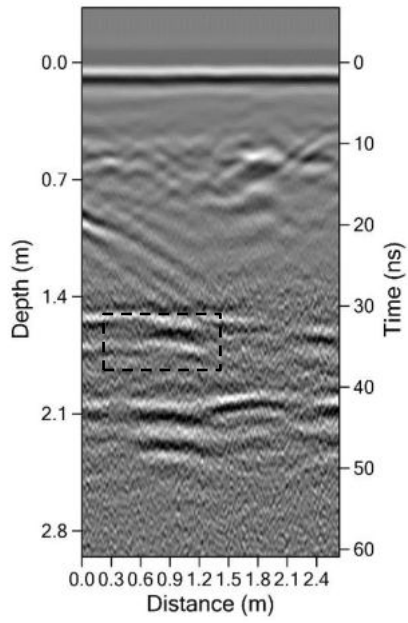
WPT91



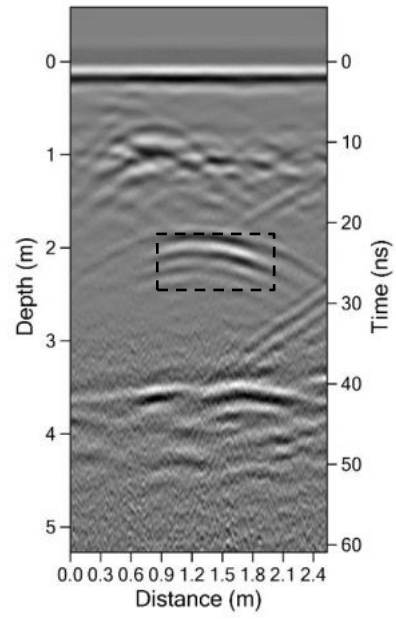
WPT92



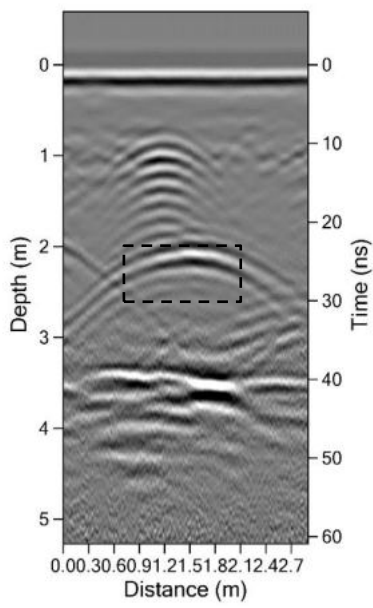
WPT93



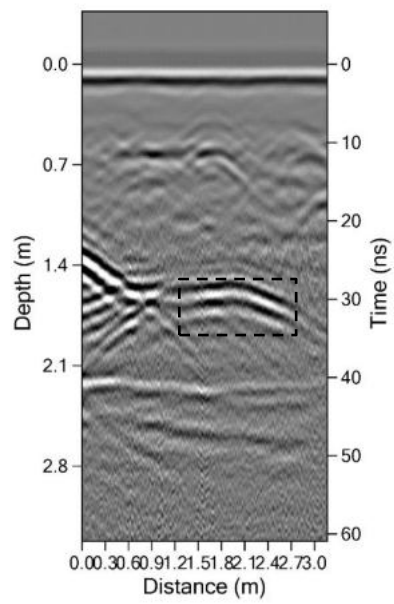
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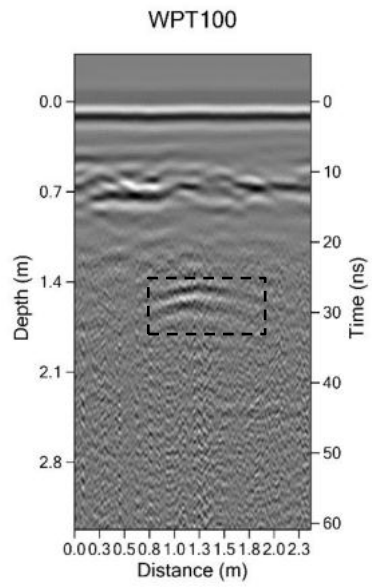
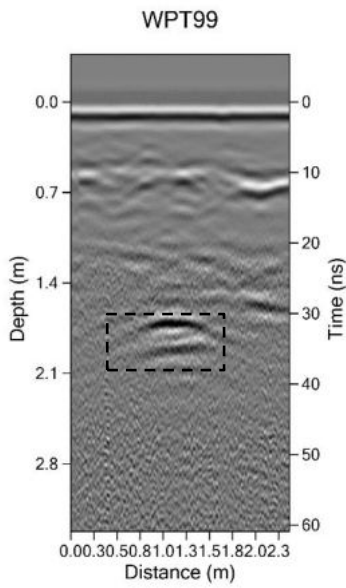
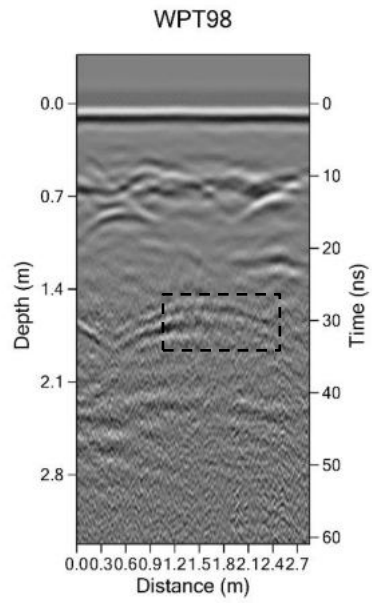
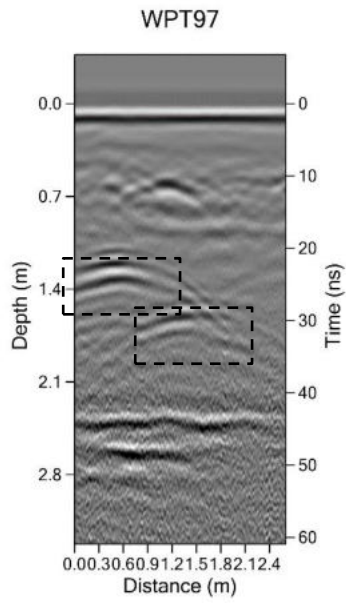


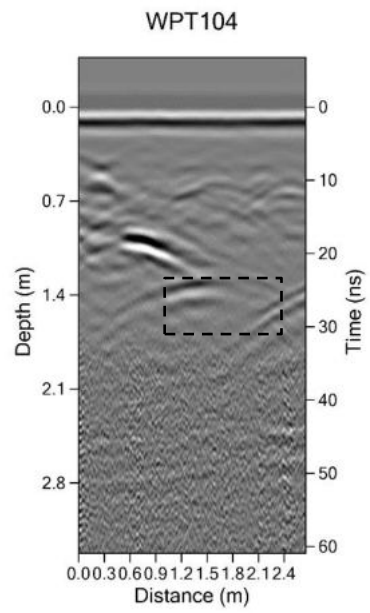
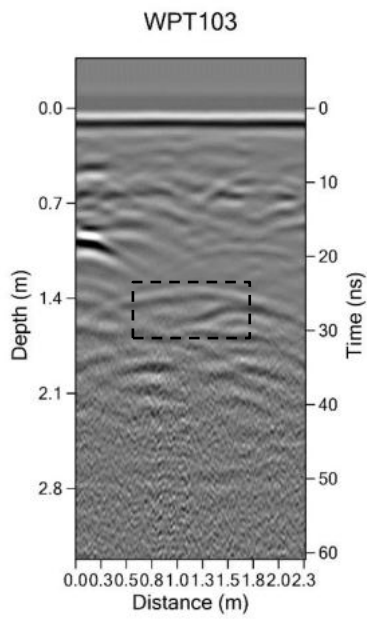
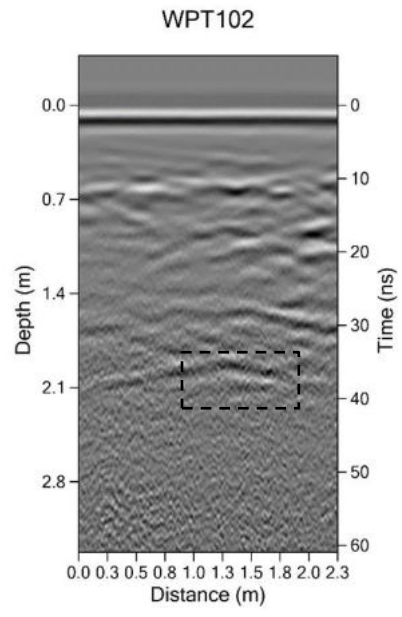
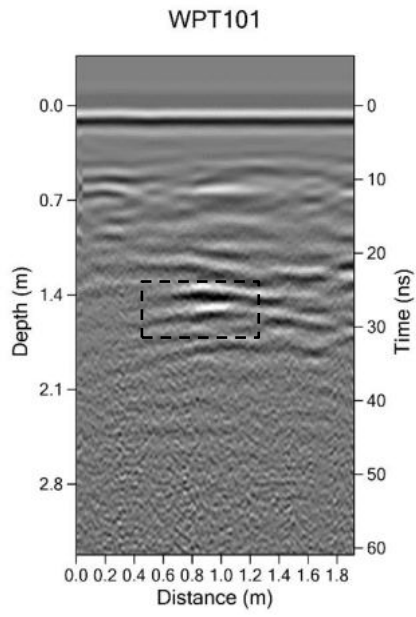
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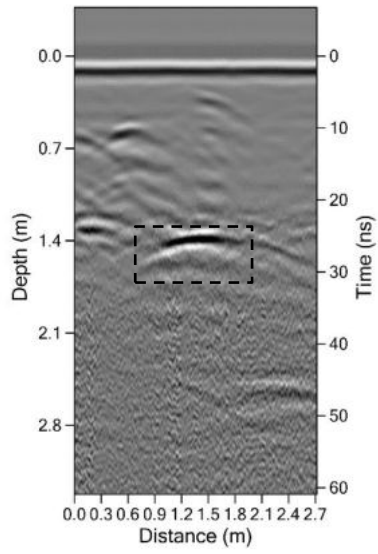
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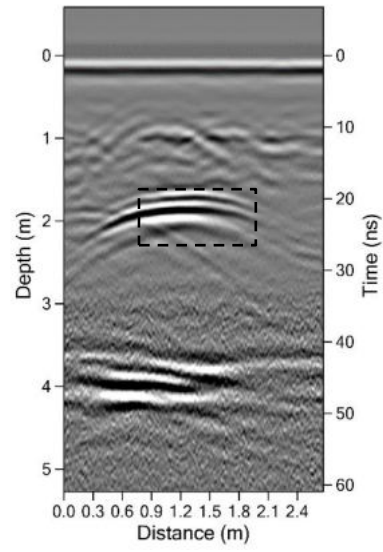




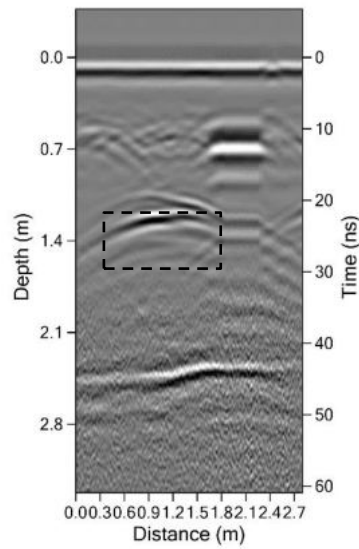
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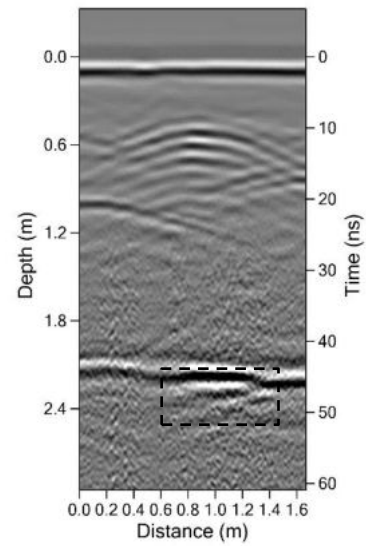
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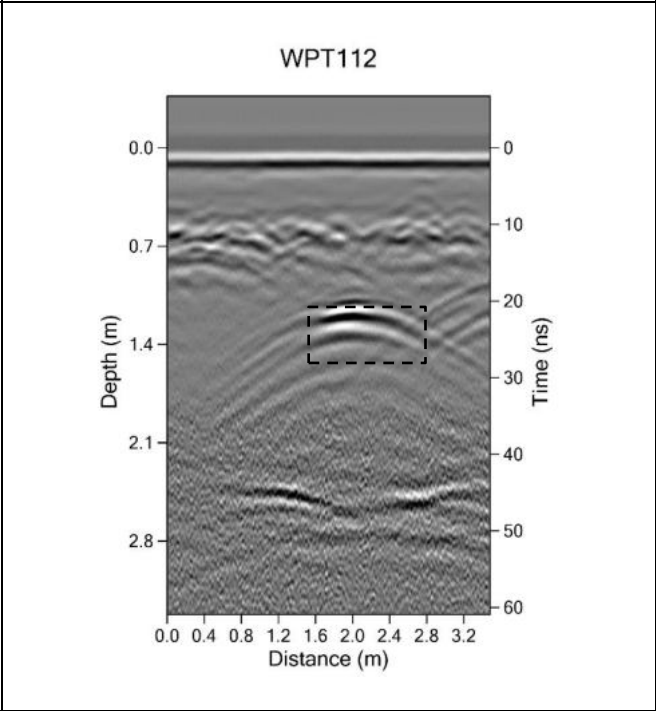
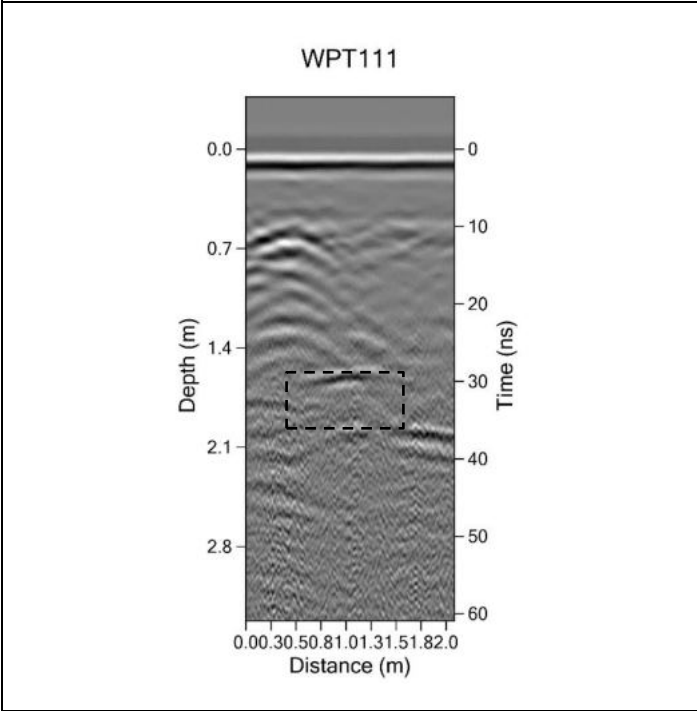
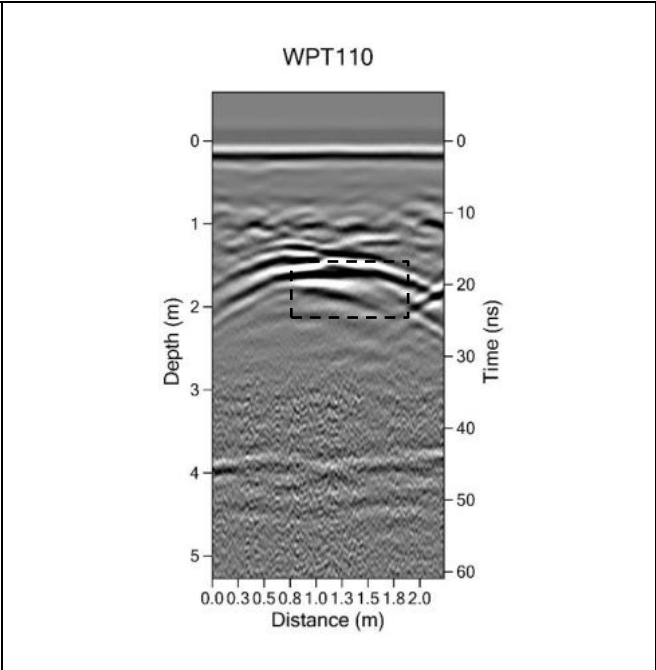
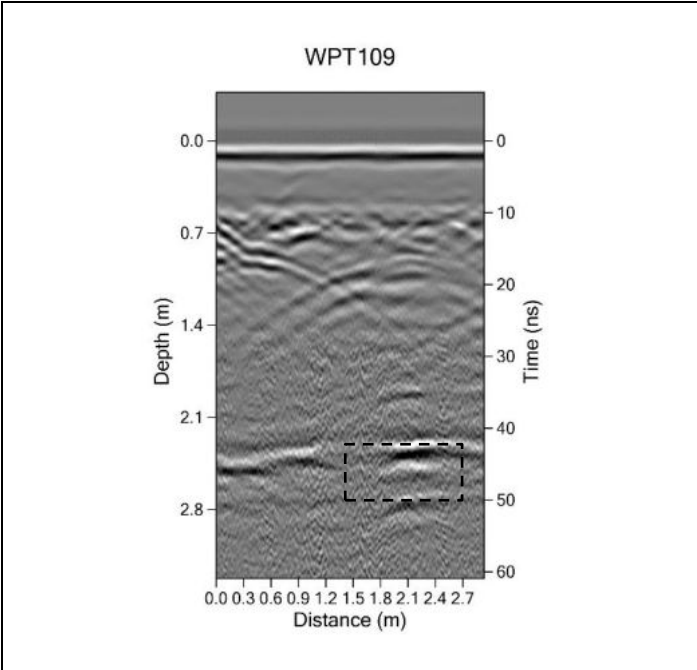


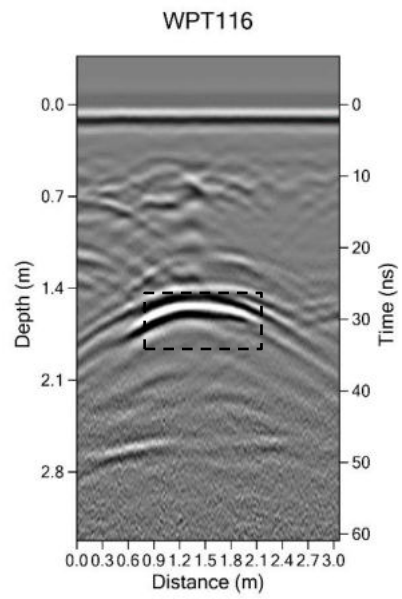
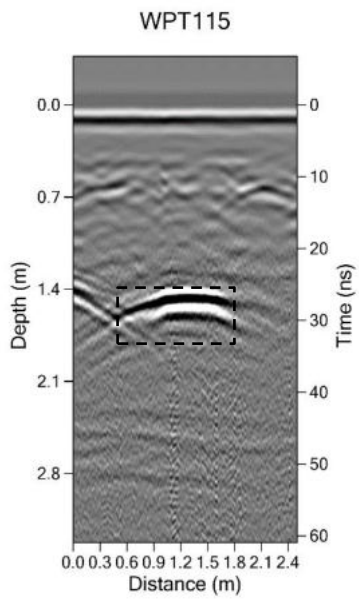
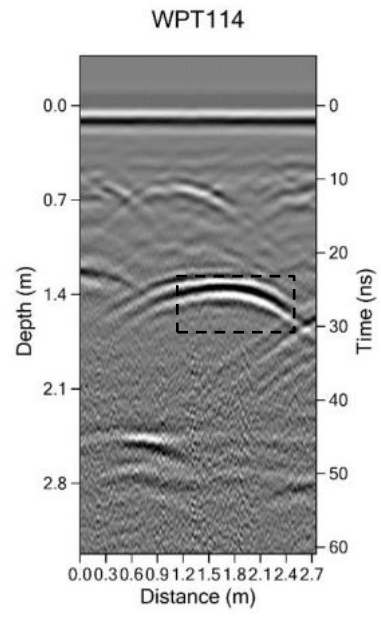
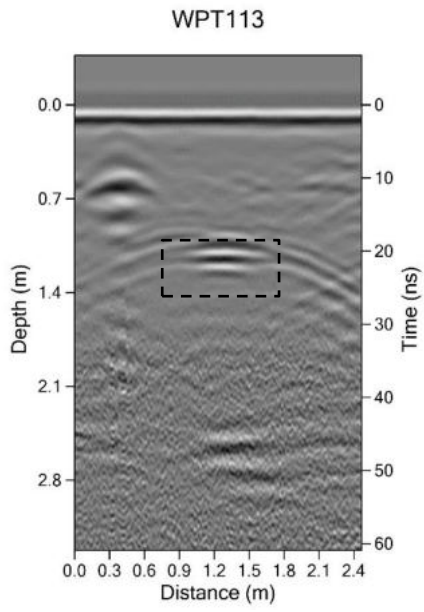
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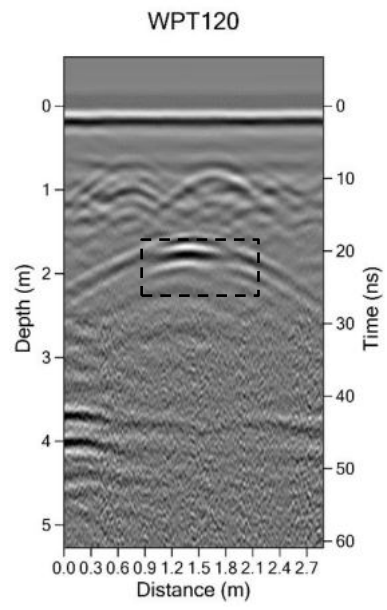
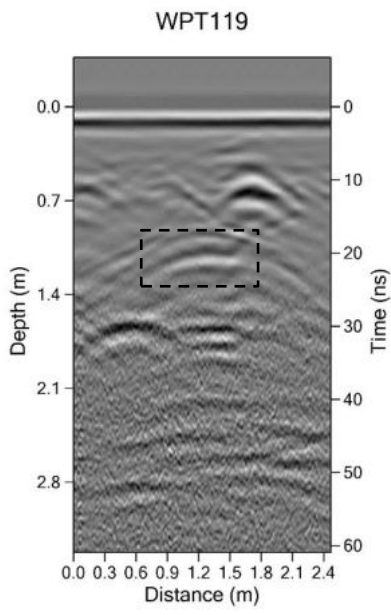
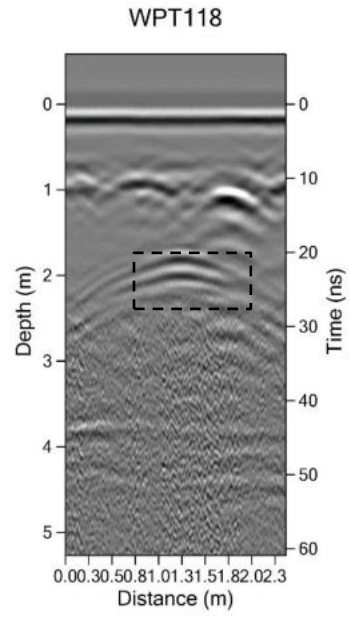
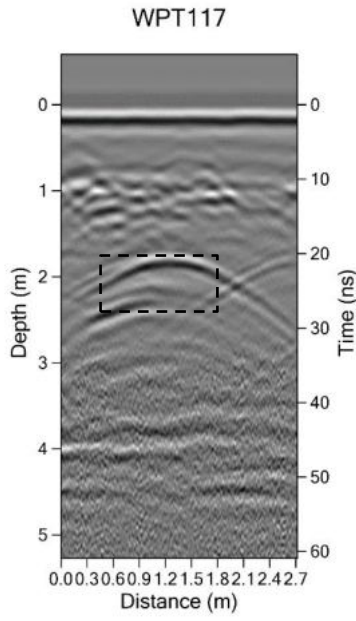


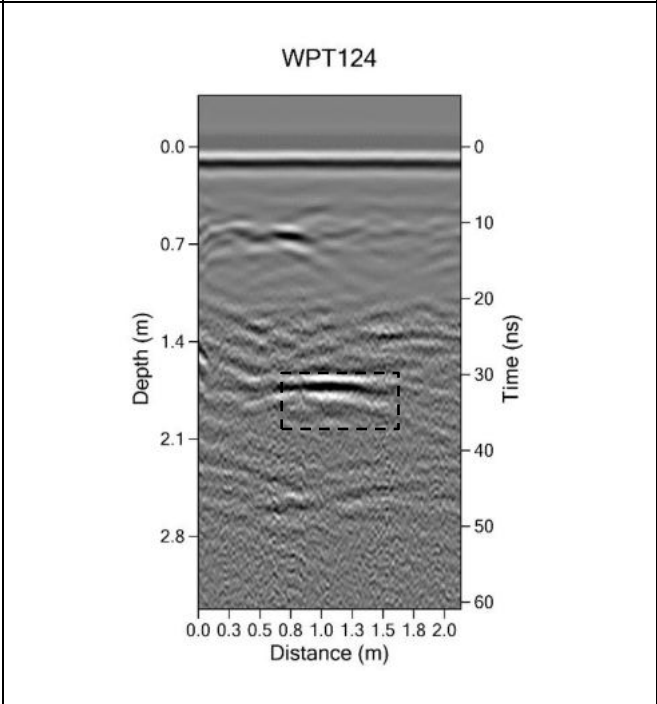
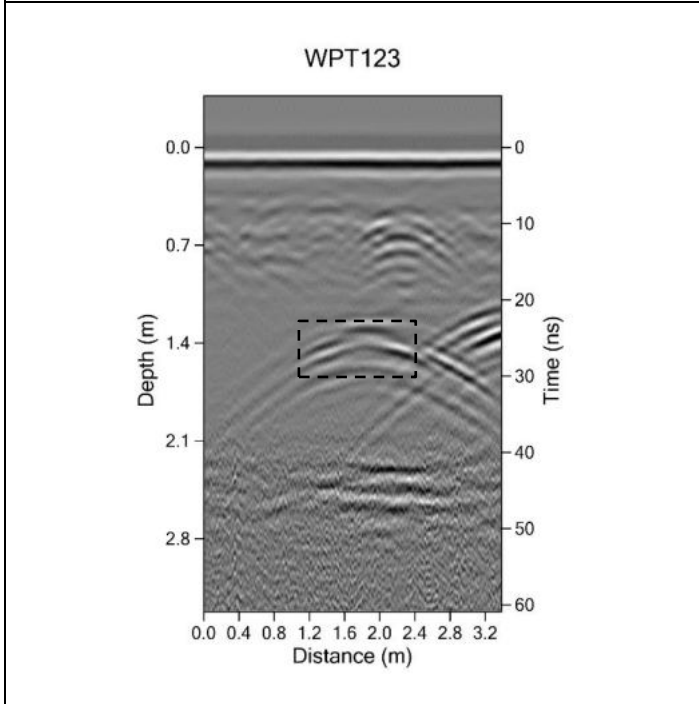
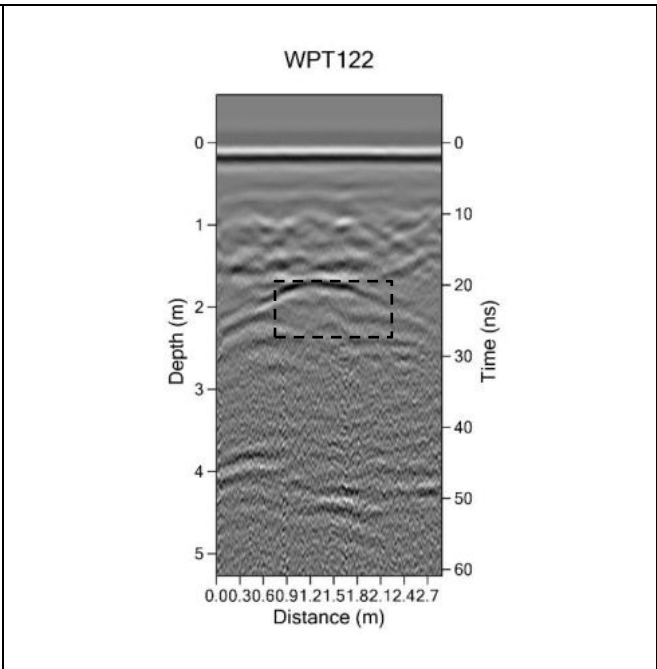
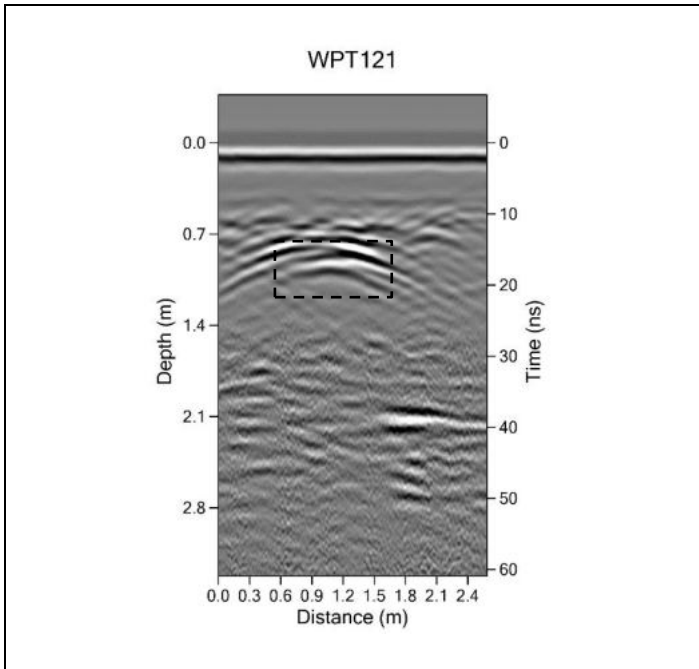
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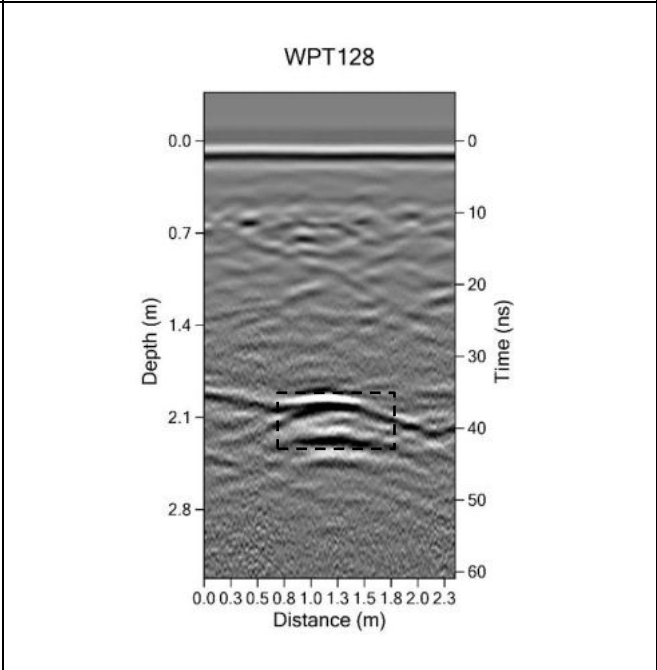
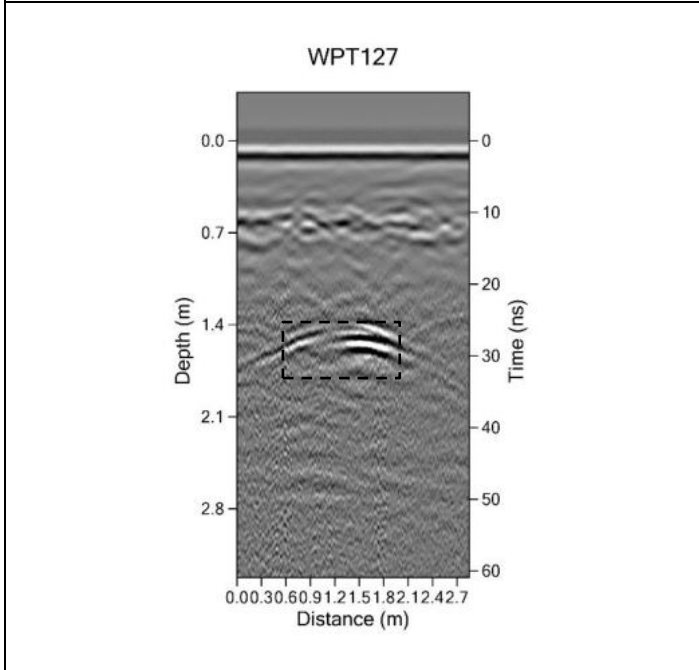
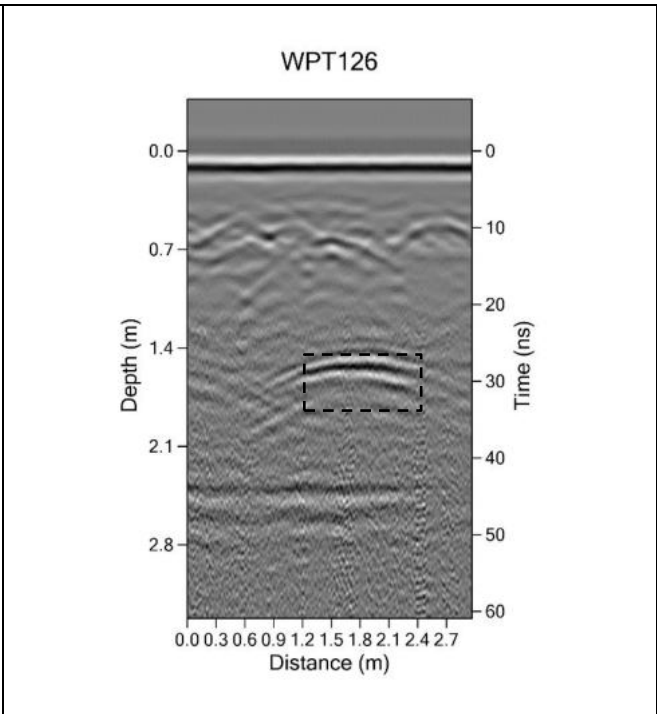
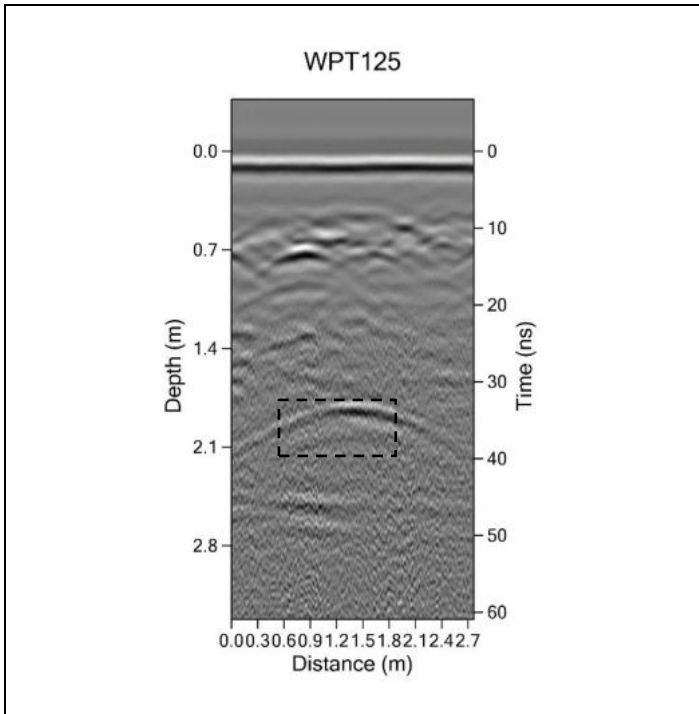


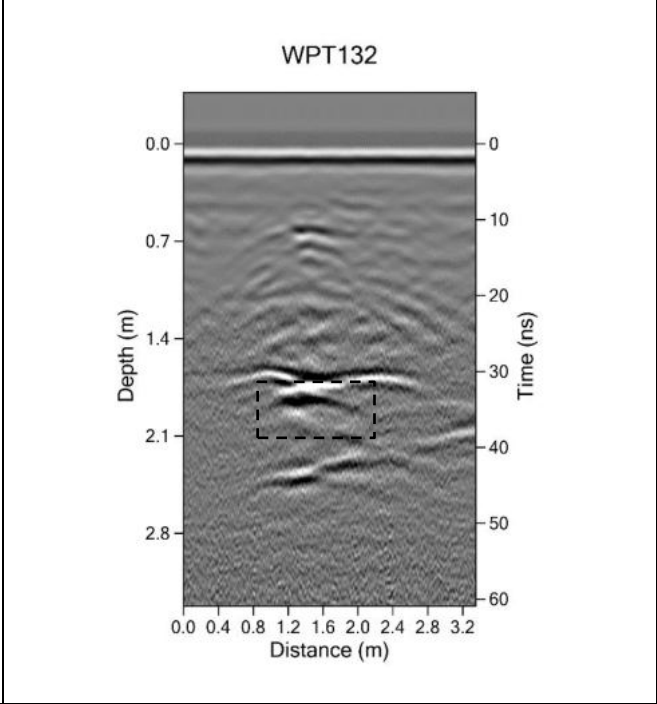
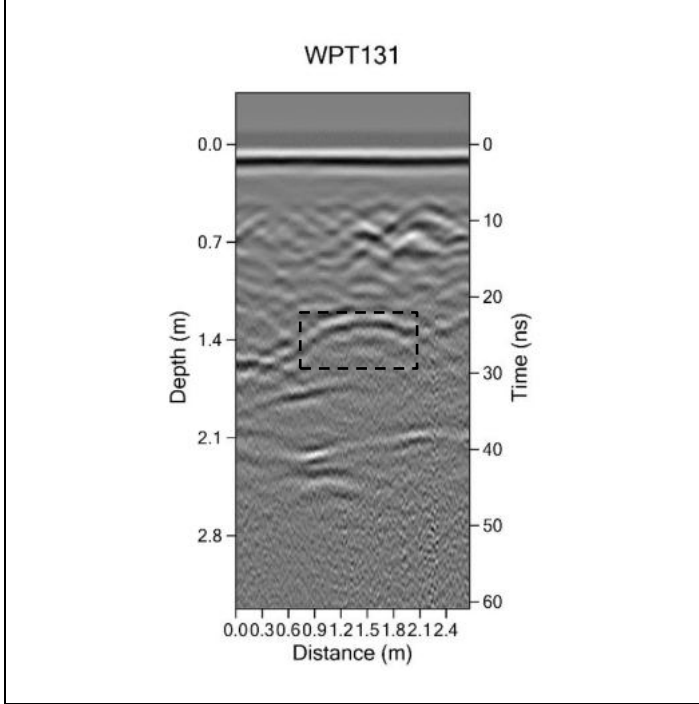
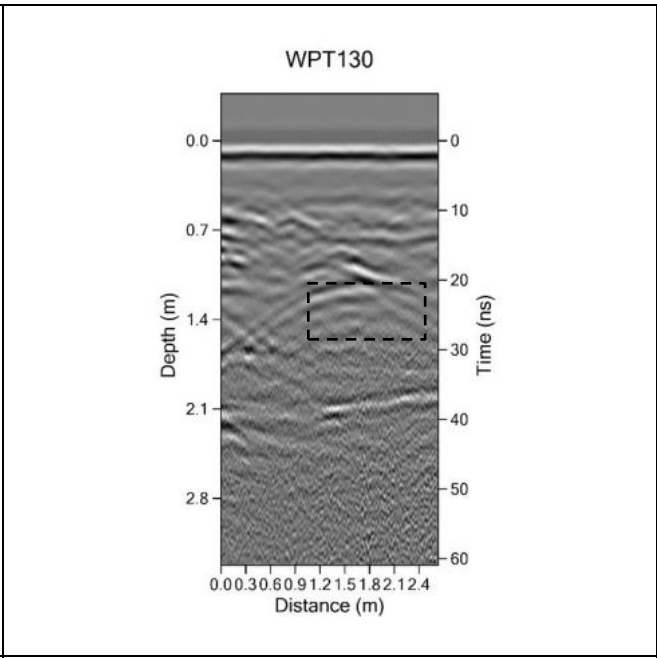
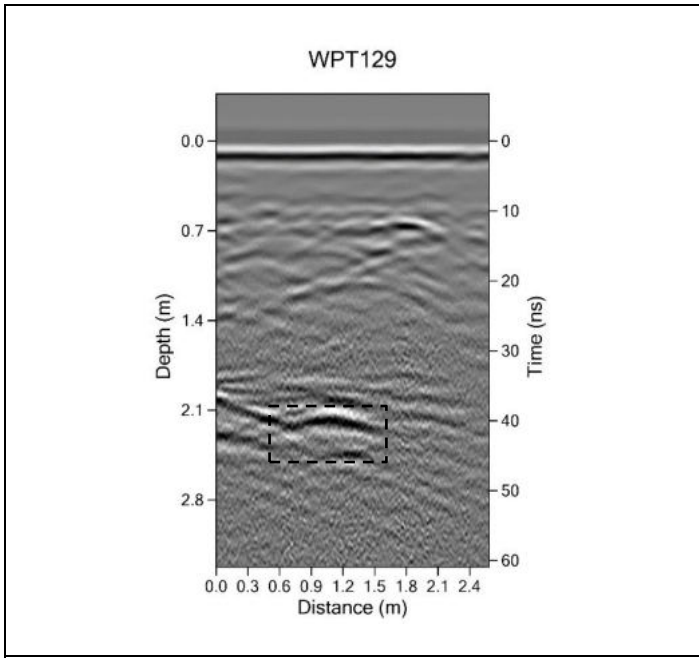




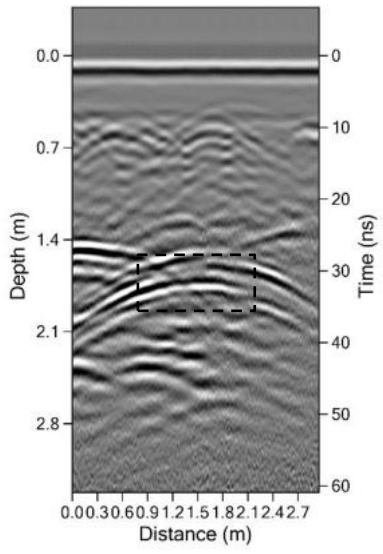




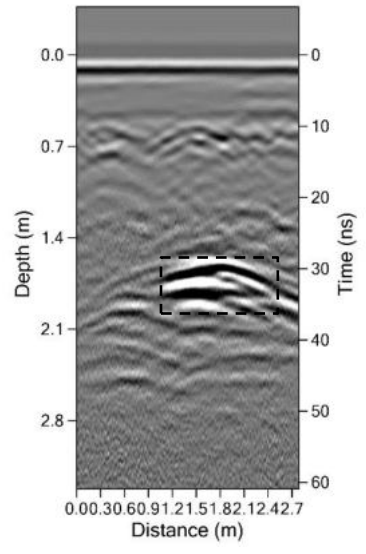




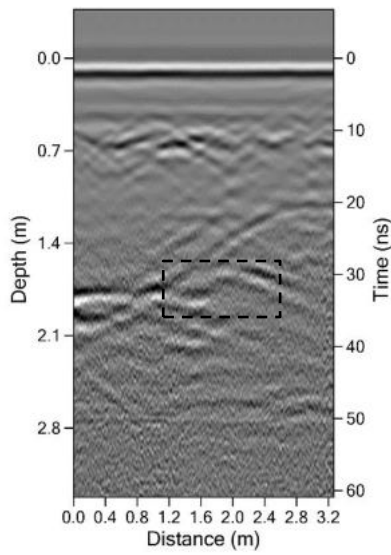
WPT133



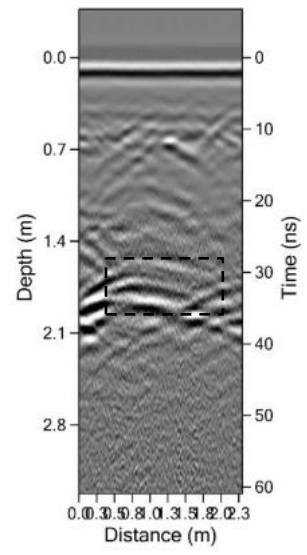
WPT134



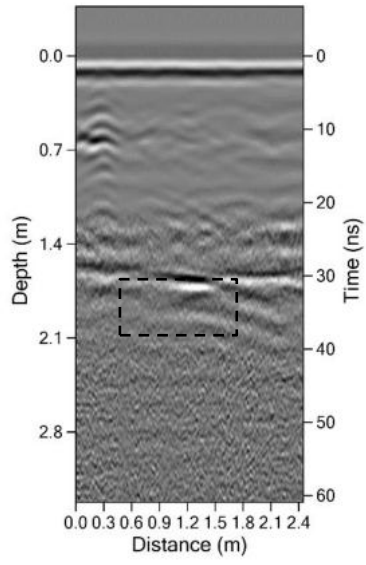
WPT135



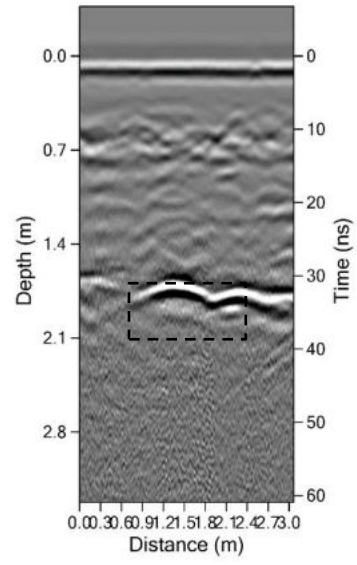
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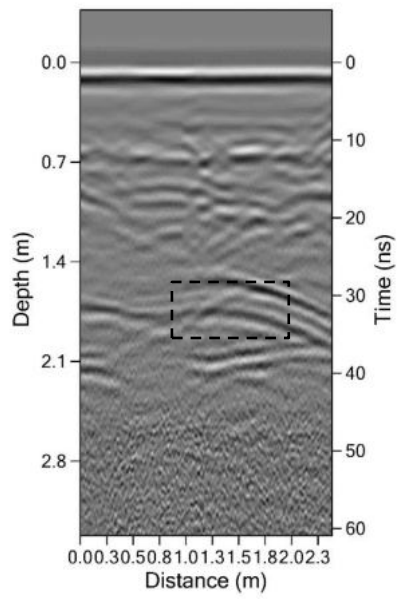
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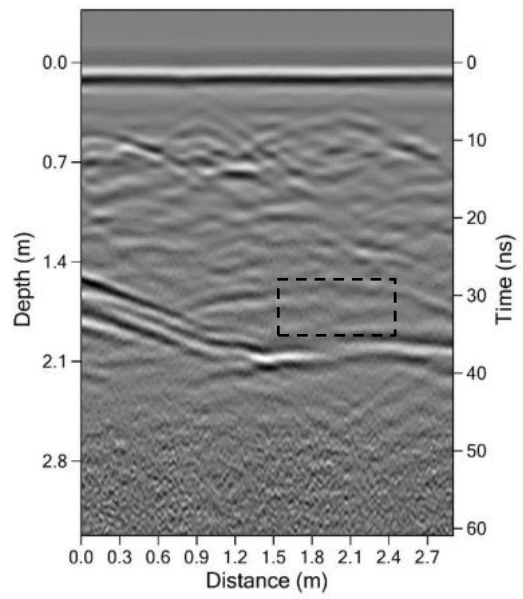
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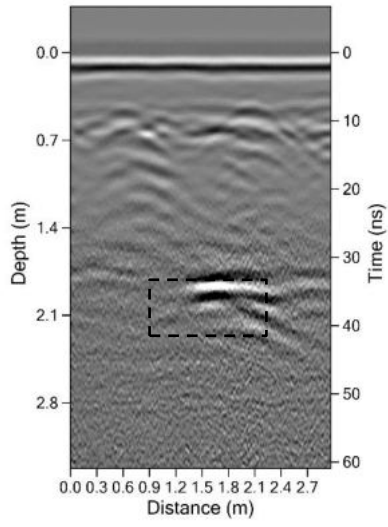
WPT139



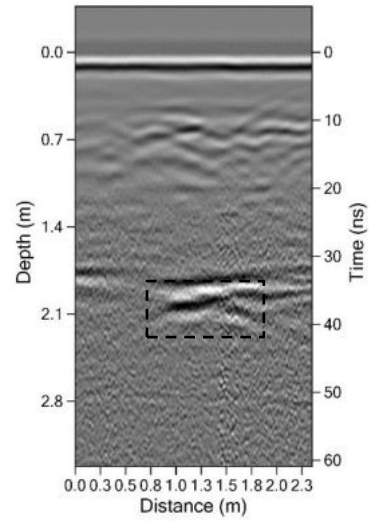
WPT140



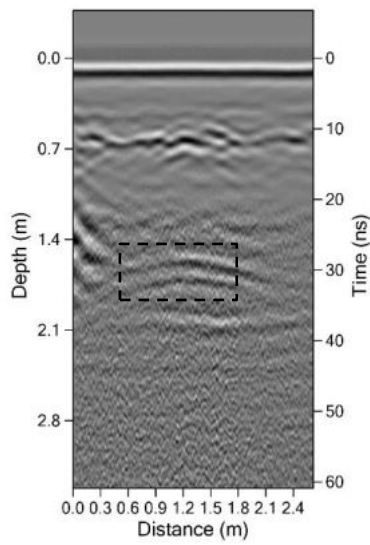
WPT141



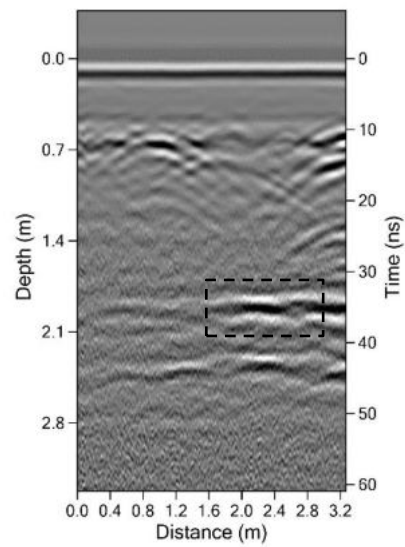
WPT142

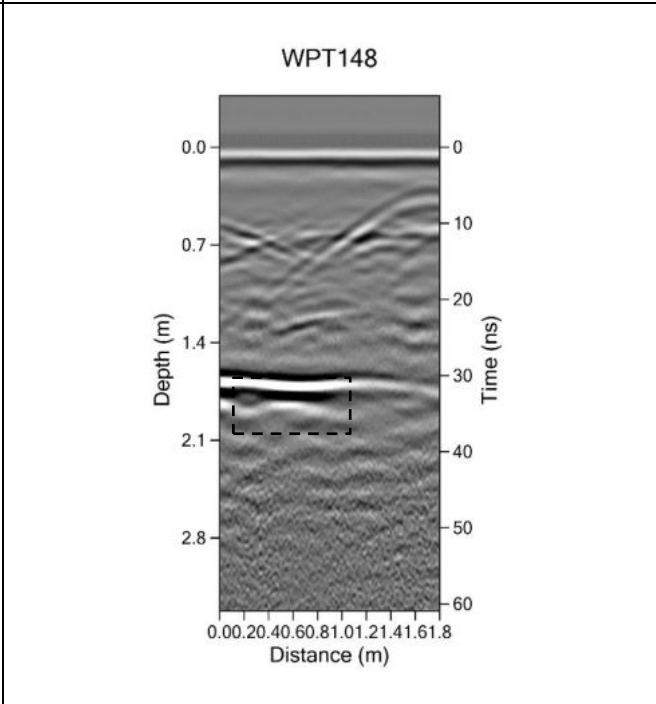
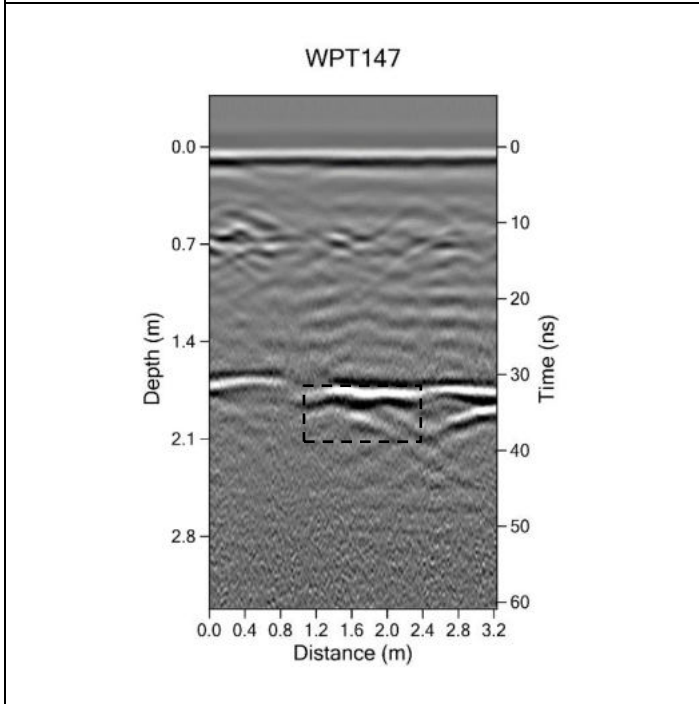
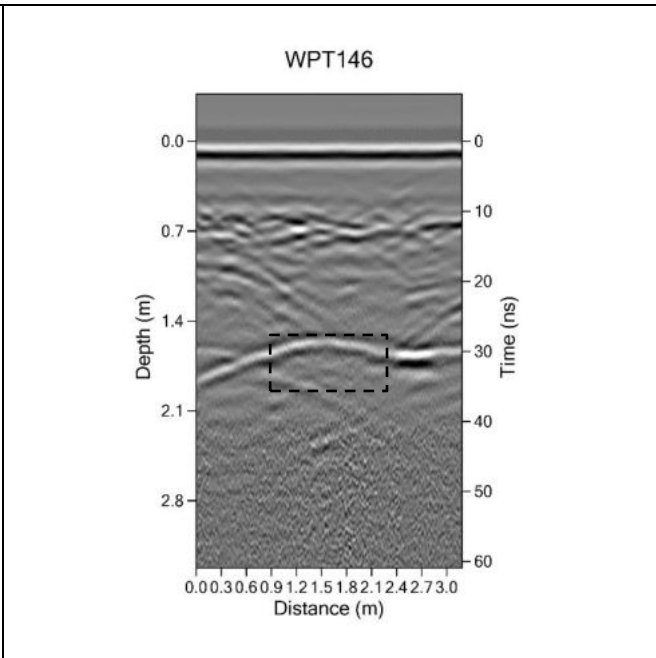
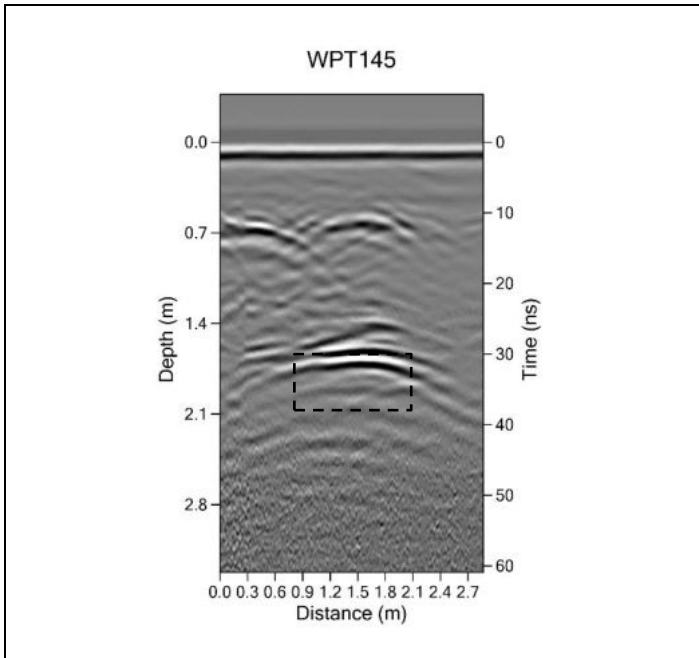


WPT143

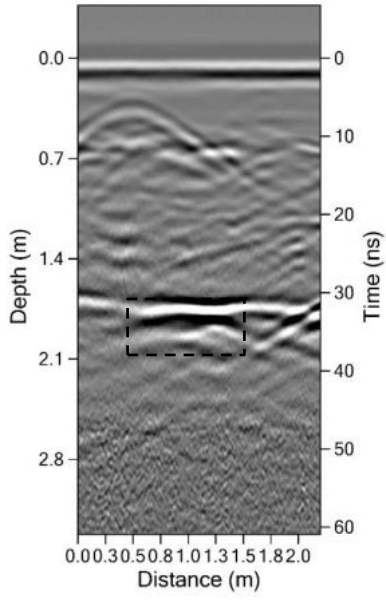


WPT144

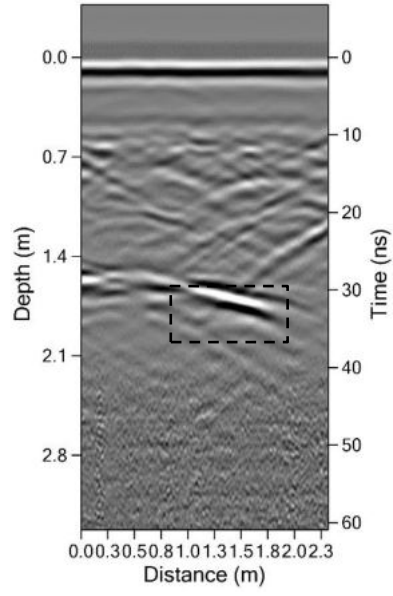




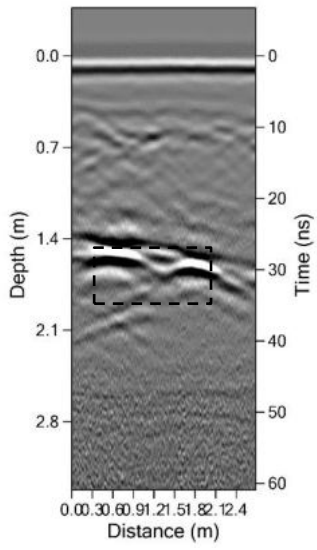
WPT149



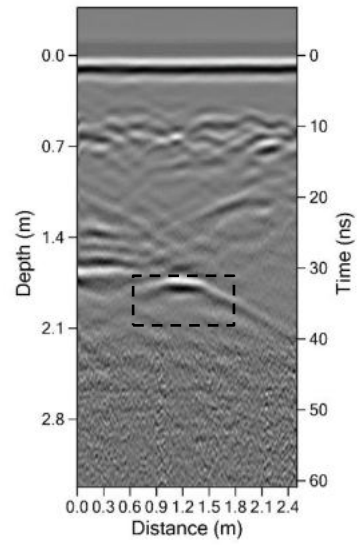
WPT150



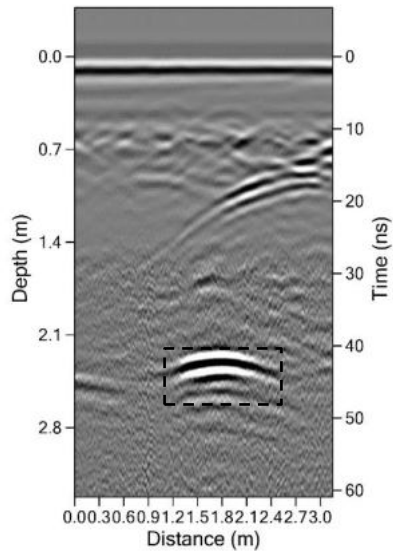
WPT151



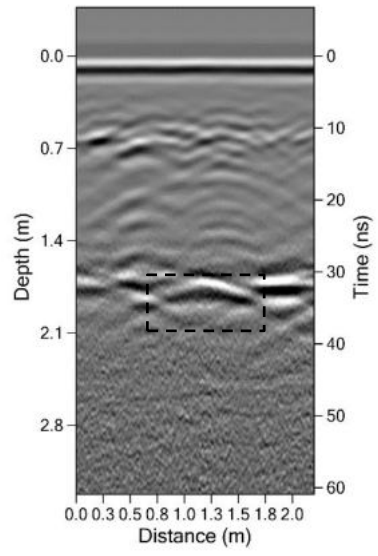
WPT152



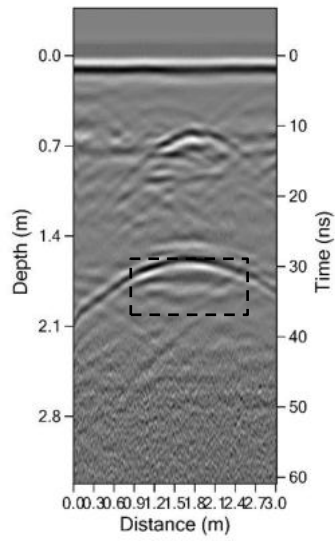
WPT153



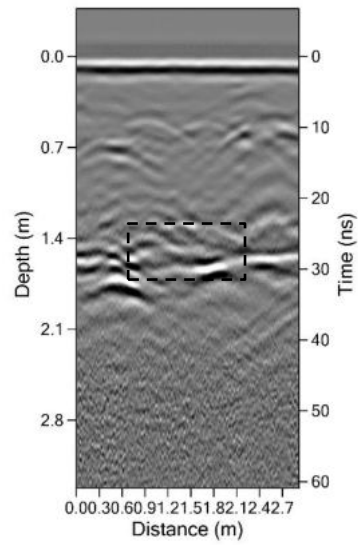
WPT154



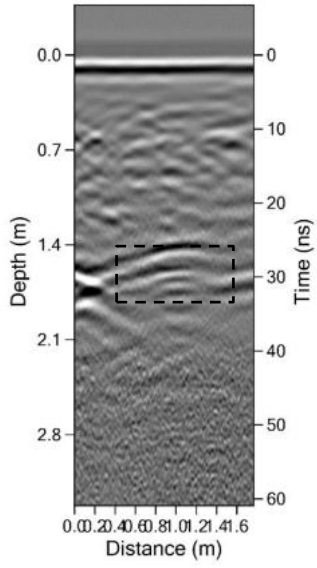
WPT155



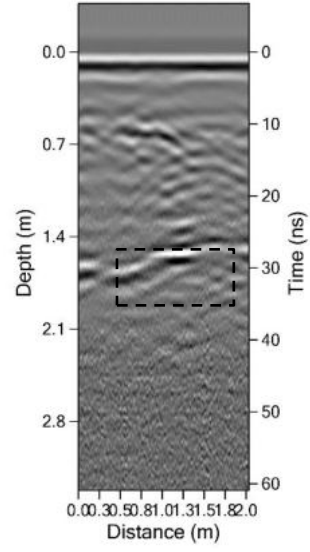
WPT156



WPT157



WPT158



WPT159

