**Madeley Heath Pit SSSI: An Assessment of the potential impact of the proposed Haul Road on the Pleistocene deposits of Special Scientific Interest**

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## 1. Summary

1.1 This report presents the results of a field investigation into the potential impact of a proposed haul road on the glacial channel feature and its associated Pleistocene deposits that are the principal subject of the designation of the Madeley Heath Pit Site of Special Scientific Interest (SSSI).

1.2 The investigation comprised digging of three test pits and a ground penetrating radar survey of the route of the proposed haul road to attempt to establish the location of the channel feature and whether the proposed route is likely to impact the channel feature.

1.3 The channel feature and the sands and gravels within it were not located during the present investigation. Using the information from this investigation and previous work the position of the channel feature has been estimated. This indicates that the proposed route does not impinge on the channel feature in the area adjacent to the SSSI, though it crosses the projected line of the channel feature to the east of the former Money Lane Pit.

1.4 The proposed haul road would not impact the channel feature in the area adjacent to the SSSI. The route does run over Pleistocene deposits, including diamictons, sands and gravels. The origin, significance and precise stratigraphic relationship of these deposits to the channel feature and its contained sands and gravels is not known.

1.5 The proposed location of a permanent geological section is in an area that does not contain the channel feature and such a section would therefore be of limited value as a witness section. It would also be difficult to manage and maintain and is inconsistent with current best practice for conservation of unconsolidated Pleistocene sediments of this type.

## 2. Site background

2.1 Madeley Heath Pit Site of Special Scientific Interest (SO 958 769) is located 6km north of Bromsgrove, Worcestershire on the southern side of the Clent Hills. The site is underlain by Triassic sandstones (Bromsgrove Sandstone and Kidderminster formations), with Carboniferous and Permian rocks forming the Clent Hills to the north of the site. The ground surface at the site is around 200m OD rising to over 220m OD at the northern apex of Chadwich Lane, though the natural landscape has locally been altered by quarrying and restoration. To the north the Clent-Lickey Hills form a NW-SE trending ridge that rises to over 250m OD, with a high point of 304m OD at the Four Stones at the north western end of the ridge, some 4km north west of the site. A gap in the ridge 1.5km north east of the site that falls below 250m OD is occupied by the M5 motorway. To the south of the site the ground surface falls to below 150m OD. The site lies in the upper part of the Stour catchment, which drains into the River Severn.

2.2 Madeley Heath Pit SSSI was designated in respect of its significance for the reconstruction of Pleistocene palaeogeography in the Midlands. The former pit, referred to here as Chadwich Lane Quarry, exposed sands and gravels which occupy a deep channel cut in the Triassic bedrock. The deposits are interpreted as glacial outwash. Till and lacustrine deposits have also been observed in the pit.

2.3 The SSSI is a 2.7ha, roughly rectangular area, encompassing the eastern part of the former Chadwich Lane Quarry, but with a triangular extension along the southern boundary. Mineral extraction and restoration of Chadwich Lane Quarry has left no exposures within the former pit and there is no realistic likelihood of creating exposures of any deposits of interest that might remain. The small triangular area of the SSSI lies outside the quarried area of both Chadwich Lane Quarry and the original Money Lane Pit (Figure 1).

2.4 The Pleistocene succession at Madeley Heath was first noted by Wills (1948, p.118): "At Wildmoor… deep sand and gravel pits show 20 feet [6m] of coarse gravel overlying at least 60 feet [18m] of sand with gravelly layers banked against an irregular surface of Bunter Sandstone". The accompanying illustration (figure 5, p. 118) shows the location of Money Lane Pit within this spread of sands and gravels.

2.5 Barton (1960) described the deposits at Money Lane Pit, which lies south east of the most recently worked area (Figure 1): "thirty-five feet [10m] of false bedded sands and fine gravels are seen to fill a valley cut in the Upper Bunter Sandstone. Both sides of this channel are visible though the base is not exposed" (p.143). These sediments are overlain by "some twenty-five feet [8m] of coarse gravels" (p.144). The channel at Money Lane Pit is some 150m wide, narrowing to 90m at depth, with near vertical walls (Barton, 1960, figure 5).

2.6 Barton considered that the same deposits and channel feature were present at Madeley Heath Farm Pit and suggested that a channel could be traced between Madeley Heath Farm Pit and Money Lane Pit, extending for a distance of about 800m.

2.7 More recent investigation of the site took place in the 1980s. By this time Money Lane Pit had been backfilled. To the north of Money Lane Pit a second, larger extraction area (the 'Council Pit') had been developed, which was by then being landfilled and another extraction area to the northwest of Money Lane Pit, Chadwich Lane Quarry, was active. Maddy (1989) recorded exposures in Chadwich Lane Quarry, including a composite c. 10m section in the eastern face of the quarry (Figure 1, locations a-c) which showed c. 8m of coarse gravels overlying 2m of cross-stratified sands. Maddy (1989) also reported the presence of a diamicton (till?) unit at the site towards what was then the southern edge of the exposures (locations d and e). Goodwin (1999) reported additional clast lithological and heavy mineral data from exposures in Chadwich Lane Quarry.

2.8 The condition of Chadwich Lane Quarry in 1999 was assessed by Lewis (1999), who noted the possible position of the western margin of the channel. In 2003 Lewis (unpublished) recorded six exposures (sections 1-6) along the southern margin of the quarry to establish the stratigraphy in this part of the extraction area (Figure 1). These sections showed a different stratigraphy to that associated with the channel feature; two diamicton units were observed, which overlie sands and gravels and were overlain by sands and sand/silt facies. Triassic sandstone was recorded at elevations between 188-194m OD, so the Pleistocene deposits do not reach the same depth as those described by Barton (1960) or Maddy (1989).

## 3. Scope of the present investigation

3.1 The aim of this survey was to attempt to establish the location of the channel feature in relation to the proposed route of the haul road and to assess the potential impact of the haul road on the channel feature and the deposits contained within it.

3.2 The survey was undertaken during April and May 2016. First, three test pits were dug on 20th April, 2016 using a mechanical excavator, their locations were selected to establish the character of the Pleistocene deposits in the critical area adjacent to the SSSI. Test pit 16/2 was abandoned due to presence of back fill material and ingress of water during excavation. Test pits 16/1 and 16/3 were completed successfully. The pits were recorded and photographed and their positions surveyed using GPS (Figure 1).

3.3 Second, a ground penetrating radar (GPR) survey was undertaken on 11th May, 2016. Transects were positioned in order to establish whether the margins of the channel could be detected and whether the haul road was likely to impact the channel feature. The GPR survey used cart-mounted 100mhz antennae as these offer the optimum combination of depth of penetration and resolution required by the investigation and the likely geology and ground conditions.

## 4. Results

4.1 Two test pits, TP 16/1 and TP16/3, were completed and the exposed sediments were recorded (Table 1, Figure 2). Both test pits exposed a series of diamictons (poorly sorted sediments comprising cobble to clay sized material), sands and gravels, none of which resemble the deposits formerly exposed within the glacial channel feature. The brown to greyish brown diamicton is probably a glacial deposit, though a mass-movement (slope deposit) origin cannot be excluded at this stage.

4.2 Ten GPR lines were completed, totalling c. 2000m of radar data. (Figure 1). GPR lines 1, 2 and 8 were located to attempt to image the deposits in the vicinity of the haul road and the channel feature. Lines 5, 6 and 7 were located along the line of the haul road to assess whether the channel feature is present. GPR lines 9, 10 and 11 were located in the area of the former Money Lane Pit; line 9 was located to attempt to image any remaining in situ deposits between Money Lane Pit and the former Council Pit, line 10 to image any remaining deposits between Money Lane Pit and Chadwich Lane Quarry and line 11 to image any deposits along the southern margin of the pit.

4.3 The GPR results are summarised in Table 2. With the exception of lines 7 and 8, there is no indication of the channel feature in any of the GPR lines. Line 1, 2, 3 and 5 are located outside of the probable margin of the channel feature. Lines 9, 10 and 11 are located within the area of the infilled Money Lane Pit and do not reveal any trace of the channel that was formerly exposed within the pit (Barton, 1960). Lines 7 and 8 do show reflection characteristics that may indicate changes in the sub-surface consistent with the channel feature which are located in a position consistent with the projected channel alignment, based on previous observations and mapping (Barton, 1960). However, there is no indication of the channel feature in the southern end of line 6 which may also be expected to intersect the channel margin.

## 5. Assessment of potential impact of the haul road on the glacial channel feature and associated Pleistocene deposits

5.1 Based on the results of this investigation, and incorporating previous observations at the site, the likely position of the glacial channel at Madeley Heath can be estimated (Figure 1), though locational uncertainties and the overall lack of detailed stratigraphic information for the site prevent a precise reconstruction.

5.2 The channel is aligned NW-SE from Madeley Heath Farm Pit to Money Lane Pit, as first suggested by Barton (1960). It is at least 20m deep and is infilled with bedded sands overlain by coarse gravels and is at least 90m in width (Barton, 1960). The sediments infilling this channel were also present along the eastern side of Chadwich Lane Quarry (locations a-c of Maddy, 1989).

5.3 The south western margin of the deep channel feature may be located in the vicinity of the western edge of Money Lane Pit and to the east of Section 1 (Figure 1). Maddy's (1989) locations d and e are also considered to be outside the deep channel feature. South west of this line, a rather different suite of Pleistocene sediments is present though to not as great a depth comprising sands and gravels, reddish brown diamicton and greyish brown diamicton (Figure 3).

5.4 At the present time it remains unclear how these deposits relate to the channel feature and its infill of sands and coarse gravels. If the estimate of the elevation and thickness of the sediments in Money Lane Pit is correct, the deposits to the south west of the channel do not reach the same depth as those in the channel, as Triassic bedrock was observed at 198-194m OD beneath these deposits, while it may be below c.180m in the channel itself.

5.5 The north eastern margin of the deep glacial channel may lie approximately along the north eastern edge of Money Lane Pit, based on the observation by Barton (1960, figure 5) that both sides of the channel were visible at Money Lane Pit, though only low confidence can be attached to this interpretation as very little data is available and the GPR survey was inconclusive.

5.6 The potential impact of the haul road on the Pleistocene deposits at the site, in particular the channel feature and the infilling sands and gravels for which the SSSI has been designated, can be assessed with regard to the likely position of the channel which has been determined on the basis of this investigation and previous information from the site.

5.7 The route of the proposed haul road which links the new extraction area west of Chadwich Lane Quarry to the highway at Money Lane (Figure 1) is divided into five sections. Each section is evaluated in terms of whether it is within, outside or traverses the margin of the channel feature and the likely impact of the haul road on the underlying deposits (Table 3). The proposed haul road will run on the present ground surface, following stripping and storage of soils. Section D-E has been identified as a possible location for a permanent geological exposure which would require deeper excavation into the deposits.

5.8 Based on the available data, the haul road is unlikely to impact on the channel feature and its associated deposits as, for the most part, the route lies outside the probable margins of the channel feature. Section B-C does intersect the projected alignment of the channel, though at a lower elevation and some distance away from the designated SSSI. Section D-E, which runs adjacent to the southern boundary of the SSSI, is underlain by Pleistocene

deposits (as exposed in TP 16/1), however these deposits are not thought to be part of the infill of the channel feature.

5.9 Section D-E of the haul road was identified as a possible location of a permanent geological exposure. As the channel feature is not present in this area and the deposits are not representative of the infill the channel feature, creating a geological exposure in this area would be of limited value. Moreover, the difficulties of maintaining an open section in unconsolidated Pleistocene sediments would make such an exercise impractical.

5.10 The designated SSSI, which falls largely within the boundary of the Chadwich Lane Quarry, has been impacted by mineral extraction, backfilling and restoration. The small triangular area on the southern boundary of the SSSI, an area of some 0.1 ha (c. 4% of the total area of the SSSI) lies outside any of the previous extraction areas and is underlain by intact Pleistocene deposits. However, the deposits in this area, which are typified by TP16/3 and section 1, are not those associated with the channel feature (Figure 3). While this portion of the SSSI does provide a useful intact remnant of the Pleistocene deposits at the site it does not include the main interest for which the site was designated. This area will not be impacted by the haul road and is currently occupied by a small area of woodland.

**References**

Barton, M.E. 1960. Pleistocene geology of the country around Bromsgrove. *Proceedings of the Geologists' Association* 71, 139-155.

Goodwin, M.D. 1999. *Evidence for Late Middle Pleistocene Glaciation in the British Isles*. Unpublished PhD Thesis, University of Bristol.

Lewis, S.G. 1999. *Outline Survey of Madeley Heath gravel pit Site of Special Scientific Interest*. Unpublished Report for English Nature, contract no. EIT 20-08-04. 9pp.

Maddy, D. 1989. *The Middle Pleistocene development of the Rivers Severn and Avon*. Unpublished PhD Thesis, University of London.

Wills, L.J. 1948. *The Palaeogeography of the Midlands*. Liverpool, Hodder and Stoughton.

**Revision History**

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|---|---|
| June 2016 | Final Report submitted |
| August 2017 | Figure 1 revised to show TP16/1 and 16/3; Appendix 1, containing survey information and Appendix 2, GPR lines 1-11 added.<br>Revised report submitted. |

Table 1. Descriptions of Test pits 16/1 and 16/3.

| Depth | Description | |
|---|---|---|
| | TP16/1 | E: 395884<br>N: 276874<br>Z: 204.1 |
| 0.0 - 0.5m | Dark brown sandy SOIL. Few stones | |
| 0.5 - 0.9m | Clayey SAND, strong brown (7.5YR 4/4), few stones, stony layer towards base | |
| 0.9 - 1.15m | Reddish brown (2.5YR 4/4) clayey DIAMICTON | |
| 1.15 - 1.75m | Fine to medium reddish brown (5YR 4/4) very poorly sorted GRAVEL, with clayey matrix, massive to crudely horizontally bedded, sandstone clasts including non-durables | |
| 1.75 - 2.1m | Reddish brown (2.5YR 4/4) DIAMICTON, clasts include coal fragments | |
| 2.1 - 2.95m | Sandy GRAVEL, wet, poorly exposed, contains some sand and silty sand layers | |
| 3.0 - 3.8m+ | Greyish brown to brown (7.5YR 5/4) DIAMICTON, with red sand inclusions, clasts up to cobble sized | |
| | TP16/3 | E: 395764<br>N: 276862<br>Z: 199.7 |
| 0.0 – 0.5m | Sandy clayey reddish brown SOIL | |
| 0.5 – 0.8m | Reddish brown (2.5YR 4/4), stony DIAMICTON | |
| 0.8 – 1.3m | Stoney sandy strong brown (7.5YR 4/4) CLAY | |
| 1.3 – 2.8m+ | Greyish brown to brown (7.5YR 5/4) DIAMICTON, clasts up to cobble and boulder sized particularly around 2.5m depth, rock types include quartz, sandstone, limestone | |

Table 2. Summary of GPR lines 1-11 (Line 4 not completed). MLP = Money Lane Pit.

| Line | Length | Comment |
|---|---|---|
| 1 | 142m | • Aligned N-S across area designated for possible geological exposure of Pleistocene deposits,<br>• No indication of channel feature. |
| 2 | 175m | • Aligned NE-SW, away from haul road,<br>• No indication of channel feature. |
| 3 | 123m | • Aligned S-N, end of line is at western end of haul road,<br>• No indication of channel feature,<br>• Dipping reflectors between 95-123m along profile probably from bedding in the underlying Triassic sandstone. |
| 5 | 260m | • Aligned SW-NE along route of haul road from its western end up slope,<br>• TP16/3 at 120m and TP 16/1 at 250m along profile,<br>• No indication of channel feature. |
| 6 | 250m | • Aligned NW-SE along central portion of haul road, running downslope,<br>• No indication of channel feature. |
| 7 | 250m | • Aligned S-N along existing haul road running across projected position of the channel feature,<br>• Change in reflection characteristics at c. 120m along profile, may indicate change in geology though surface conditions (standing water, made ground) may be affecting the response. |
| 8 | 225m | • Aligned S-N, upslope, away from haul road, ends close to route, is in a position that may intersect the western margin of the channel feature,<br>• Possible change in reflection characteristics from 175-225m may indicate change in geology, and possible margin of channel feature (coincides with the mapped position of gravel outcrop of Barton, 1960). |
| 9 | 270m | • Aligned E-W, on northern edge of backfilled MLP, to locate any remaining in situ deposits,<br>• Significant signal attenuation probably caused by clay capping on old landfill site, also point reflections probably from subsurface objects or pipes,<br>• No indication of channel feature,<br>• Possible indications of original land surface between 250-270m. |
| 10 | 80m | • Aligned N-S at western edge of MLP, to locate remaining in situ sediments,<br>• Significant signal attenuation, probably resulting from clay capping and/or high water content of the ground,<br>• No indication of channel feature,<br>• Change in reflection characteristics at 40m may indicate geological feature or change in thickness of landfill/made ground. |
| 11 | 250m | • Aligned NW-SE along southern edge of MLP to locate any remaining sediments,<br>• No indication of channel feature,<br>• Changes in reflection characteristics may indicate various in thickness of landfill/made ground and presence of in situ sediments beneath made ground. |

Table 3. Assessment of the potential impact of the haul road with respect to the Pleistocene deposits at Madeley Heath. See Figure 1 for the location of the sections of the haul road. MLP = Money Lane Pit, CLQ = Chadwich Lane Quarry.

| Section | Characteristics | Impact on glacial channel feature and associated deposits |
|---|---|---|
| A-B | This section runs parallel to the alignment of the channel, ascending from c. 175m to c. 190m OD. It runs outside the probable north eastern margin of the feature and the SE end is too low an elevation to preserve the channel feature. | None. |
| B-C | This section of the haul road is aligned at 90$^{o}$ to the orientation of the channel and runs across the probable south easterly extension of the channel feature adjacent to MLP. The ground surface ranges from c. 195m to 185m OD and is high enough to suggest that channel deposits are likely to be present, though not to their full thickness. | Negligible; though route runs across projected alignment of the channel feature, it is unlikely to have significant impact. |
| C-D | This section ascends from c. 185-200m OD, parallel to the probable alignment of the channel and close to its south western margin. It is likely to be outside the margin of the channel feature, with the possible exception of the southern end. | Negligible; route possibly impinges on channel feature at southern end of this section, though unlikely to have significant impact. |
| D-E | This curved section takes the haul road into a more westerly alignment along the southern edge of CLQ. The land surface rises to over 200m OD, then descends westwards. This section is close to, but outside, the projected margin of the deep channel feature and it is underlain by the succession of gravels, sands and tills that were exposed along the southern margin of CLQ (sections 1-4) and in TP 16/1. | None. |
| E-F | This section run westwards along the edge of CLQ into the proposed extraction area descending from c. 200m to 190m OD. It lies outside the margins of the channel feature; sections 5-6 within CLQ and TP 16/3 indicate that the Pleistocene deposits consist of diamictons and sands which thin as the ground surface declines in elevation in a westerly direction. | None. |

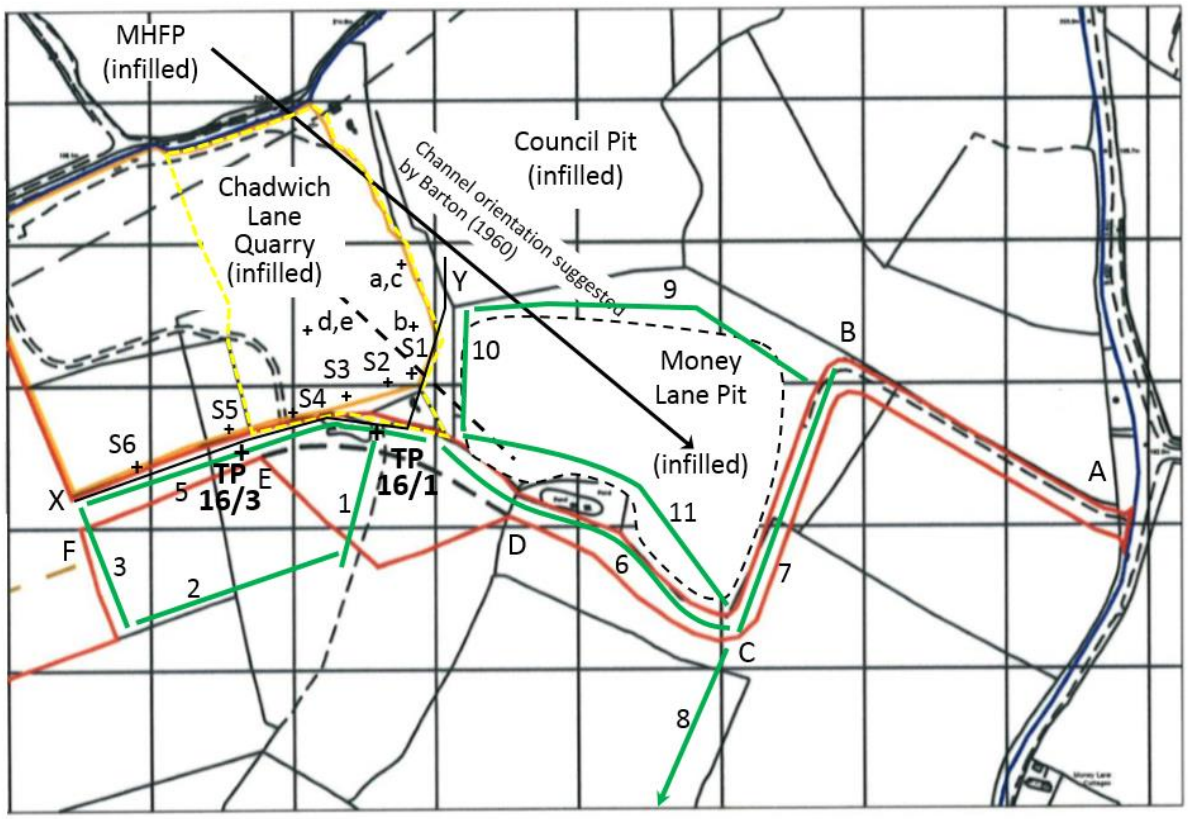



Figure 1. Location of former extraction areas at Madeley Heath, showing position of geological sections a-e (Maddy, 1989) and S1-6 from previous studies and TP16/1 and 16/3 from this investigation. The route of the haul road is outlined in red, haul road sections are marked A-F, GPR survey lines 1-11 are shown in green, black line X-Y is the line of the cross section shown in Figure 3, yellow dashed line is the boundary of the SSSI. Black dashed line is estimated position of the south western edge of the channel feature.

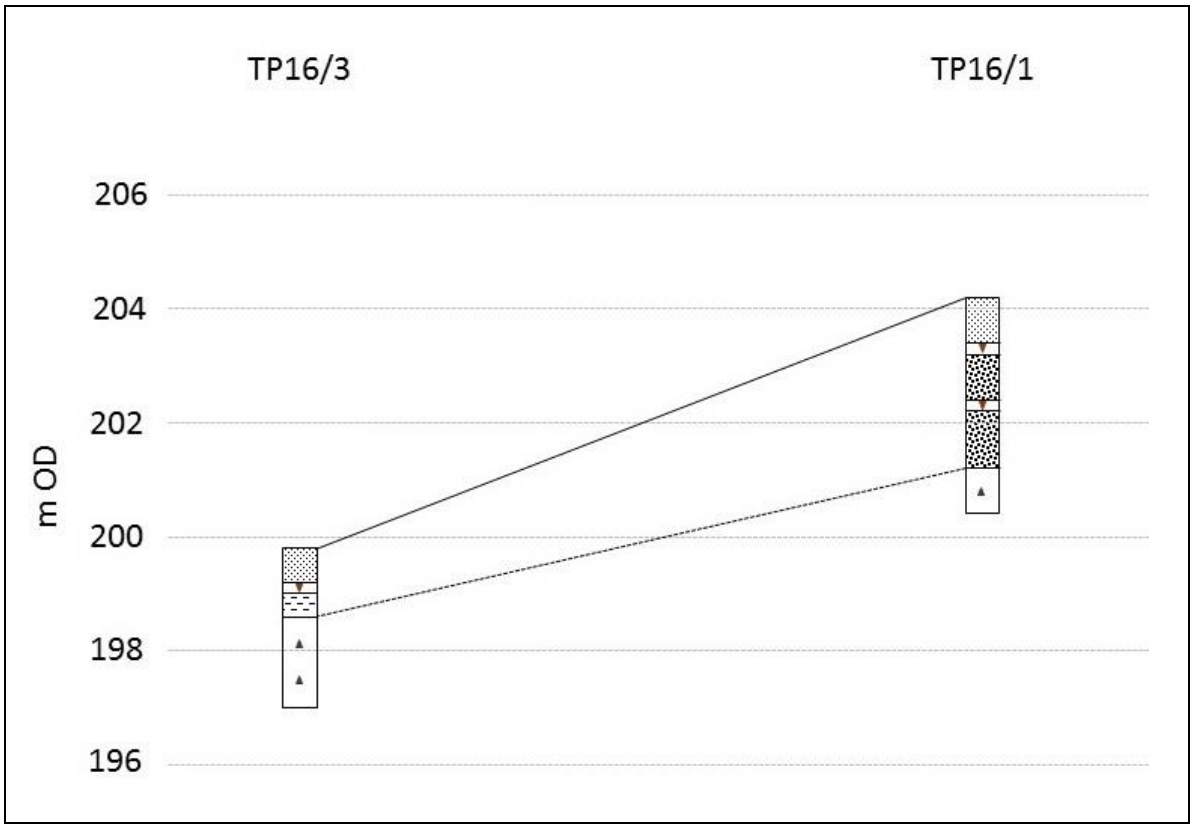



Figure 2. Sedimentary logs of TP 16/1 and 16/3.

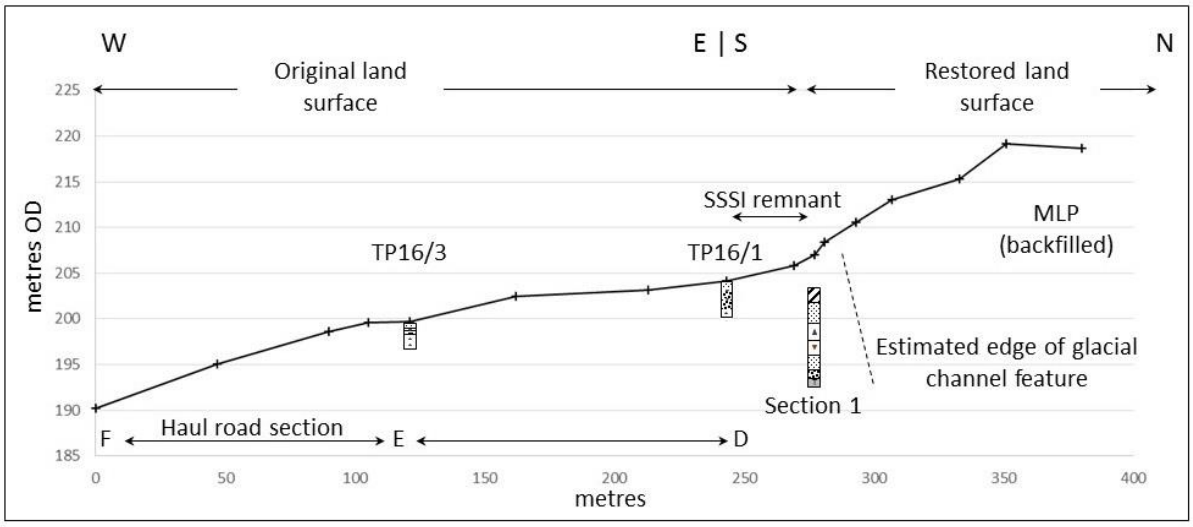
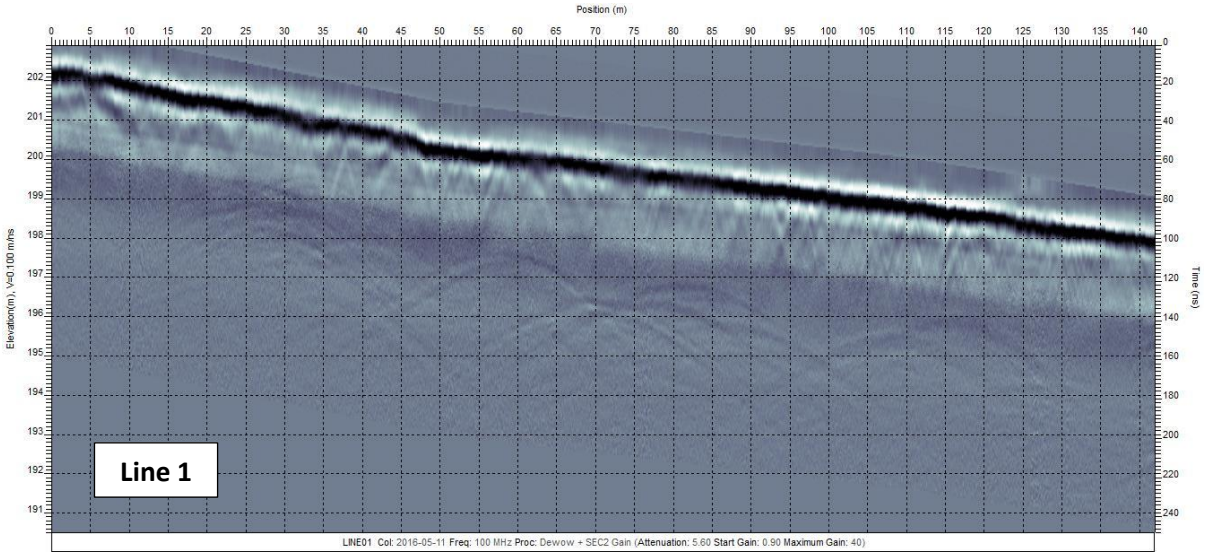


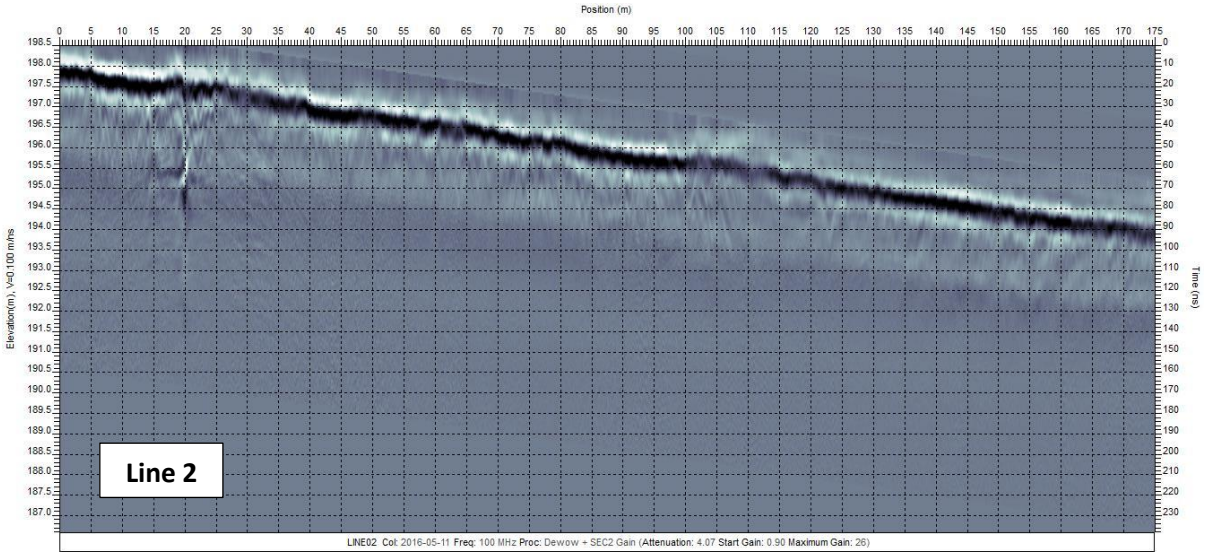

Figure 3. Cross section X-Y, see Figure 1 for location.

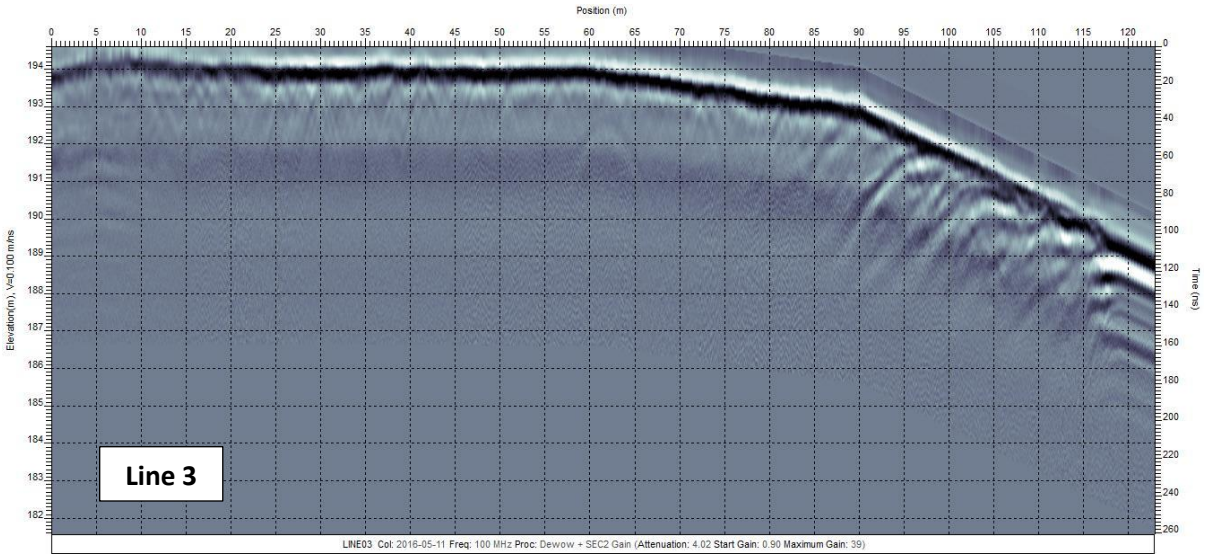
**Appendix 1. Locations of TPs16/1 and 16/3 and GPR survey lines.**

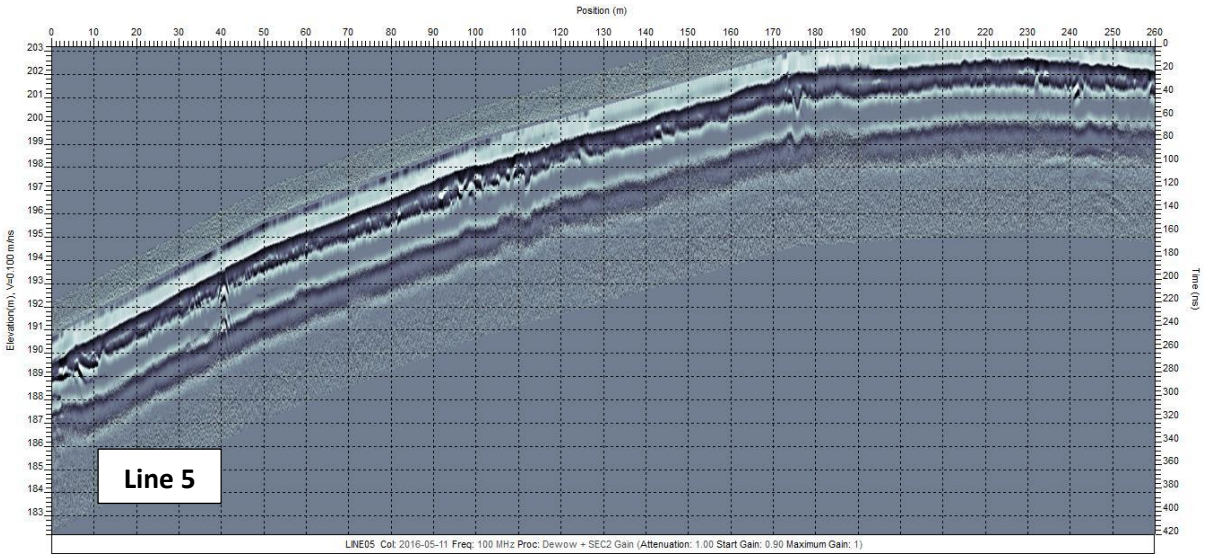
| Point | E | N | Z |
|---|---|---|---|
| TP16/1 | 395883.740 | 276874.175 | 204.116 |
| TP16/3 | 395763.000 | 276862.000 | 199.700 |
| LINE 1 Start | 395882.785 | 276869.895 | 202.936 |
| LINE 1 end/LINE 2 start | 395855.141 | 276768.451 | 198.539 |
| LINE 2 end/LINE 3 start | 395684.836 | 276733.195 | 194.628 |
| LINE 3 end | 395651.137 | 276819.142 | 189.579 |
| LINE 5 start | 395651.867 | 276814.857 | 190.232 |
| LINE 5 end/LINE 6 start | 395884.010 | 276867.666 | 202.695 |
| LINE 6 end/LINE 7 start/LINE 8 end/LINE 11 end | 396100.123 | 276732.782 | 188.595 |
| LINE 7 end | 396176.021 | 276915.416 | 193.768 |
| LINE9 start | 396149.281 | 276916.996 | 200.932 |
| LINE 9 end | 395920.349 | 276954.381 | 217.598 |
| LINE 10 start | 395920.748 | 276956.743 | 217.822 |
| LINE 10 end/LINE 11 start | 395921.176 | 276884.379 | 206.388 |

## Appendix 2. GPR results from Madeley Heath, Lines 1-11 (Line 4 not completed), 100mhz.




Position (m)
Elevation(m), V=0.100 m/ns
Time (ns)
Line 5
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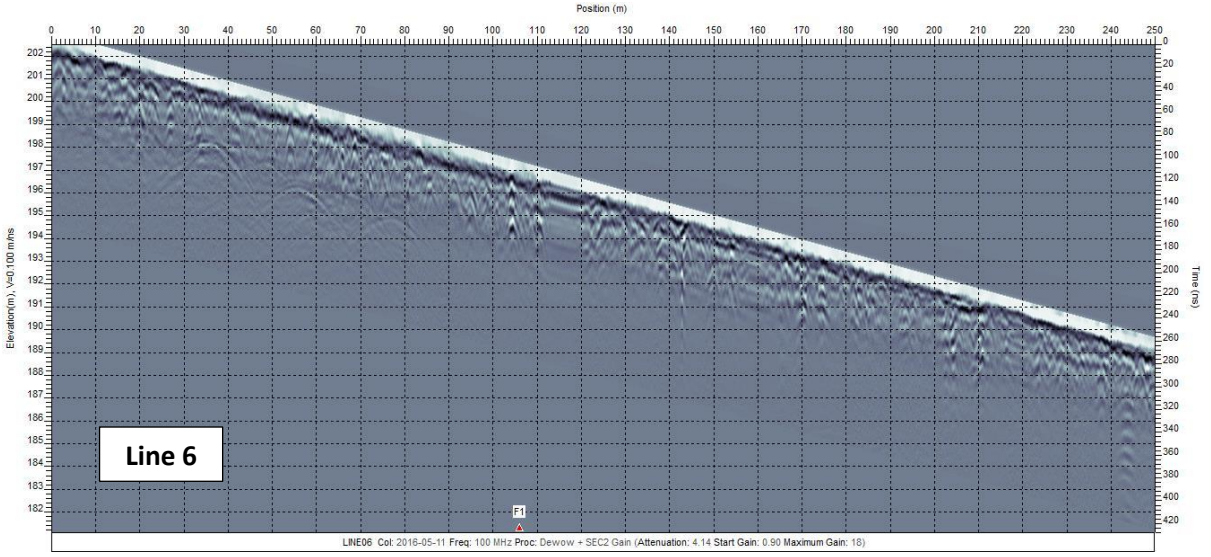
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F1
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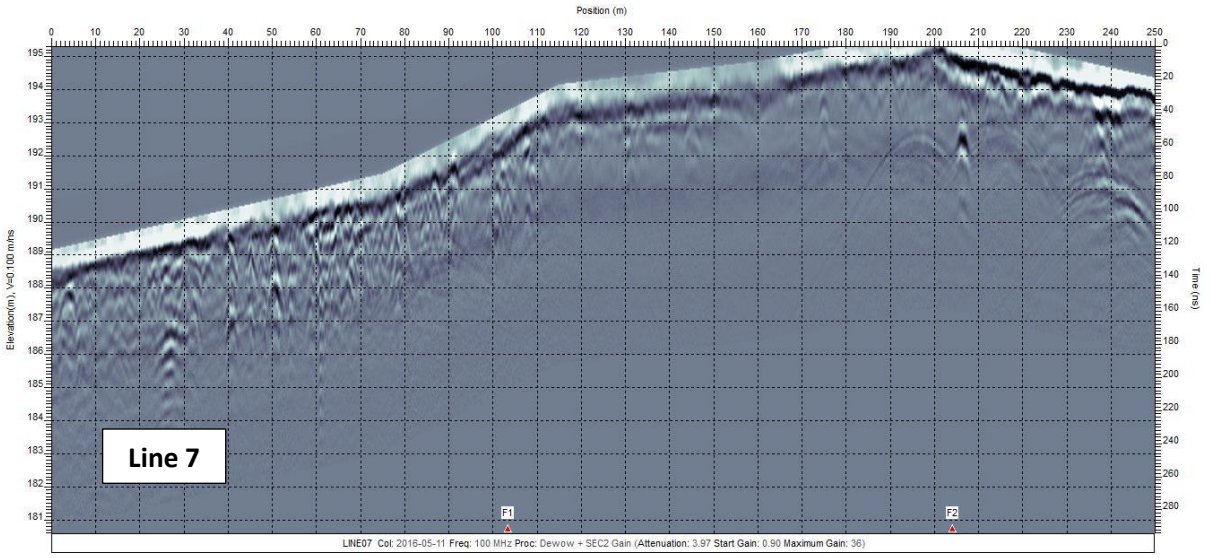
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Time (ns)
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F1
F2
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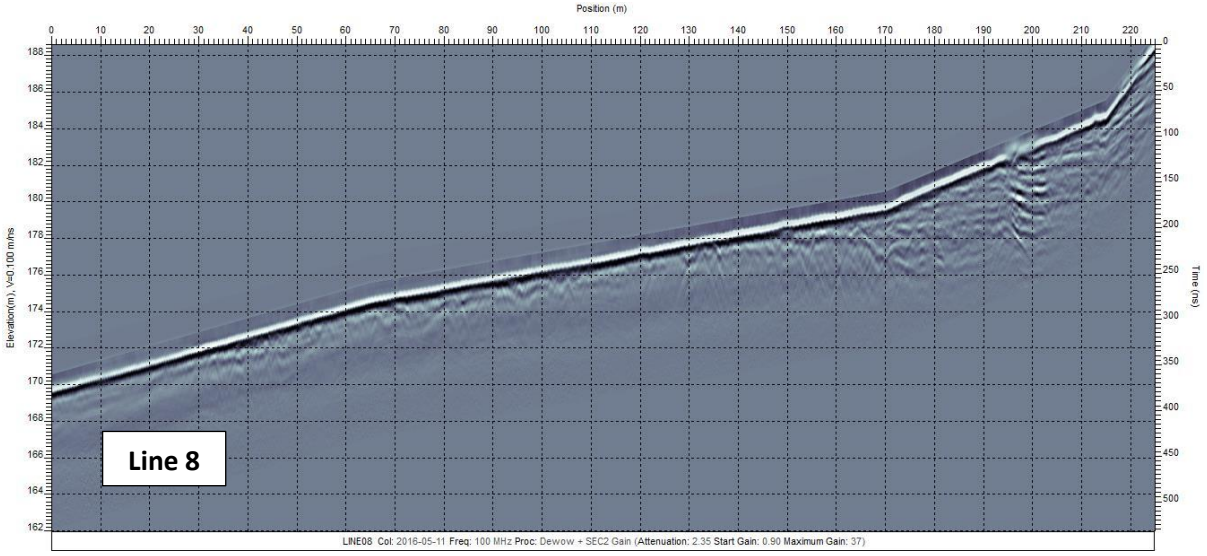
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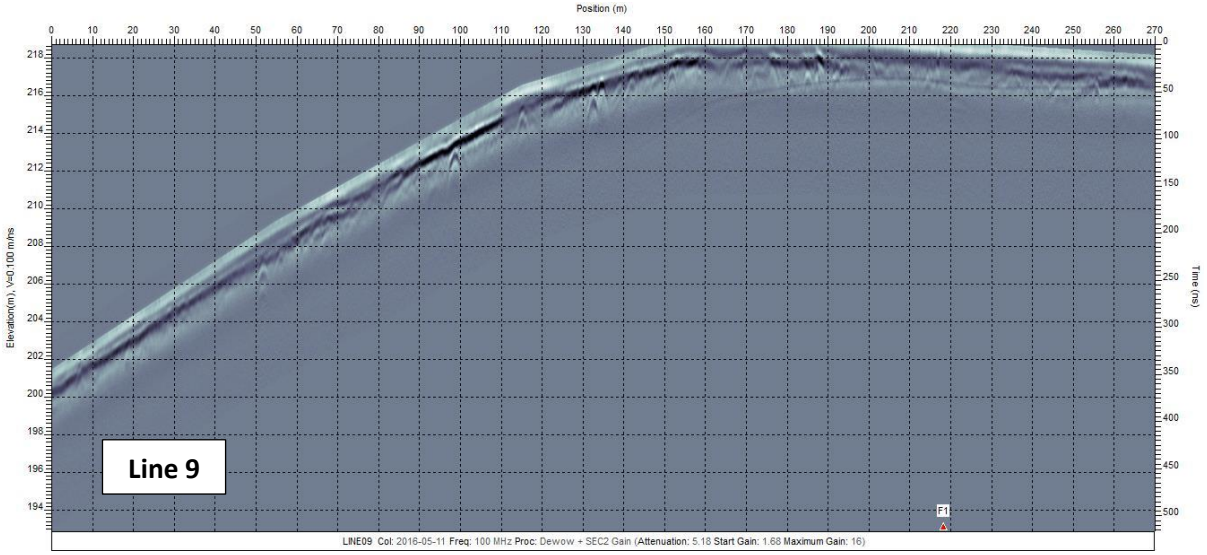
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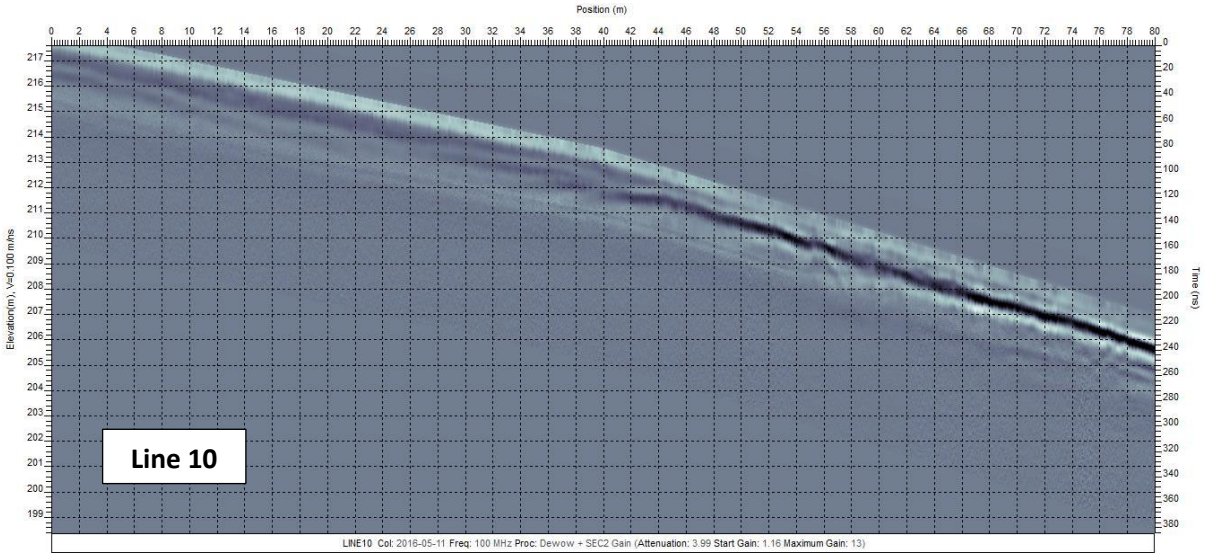
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Time (ns)
Line 10
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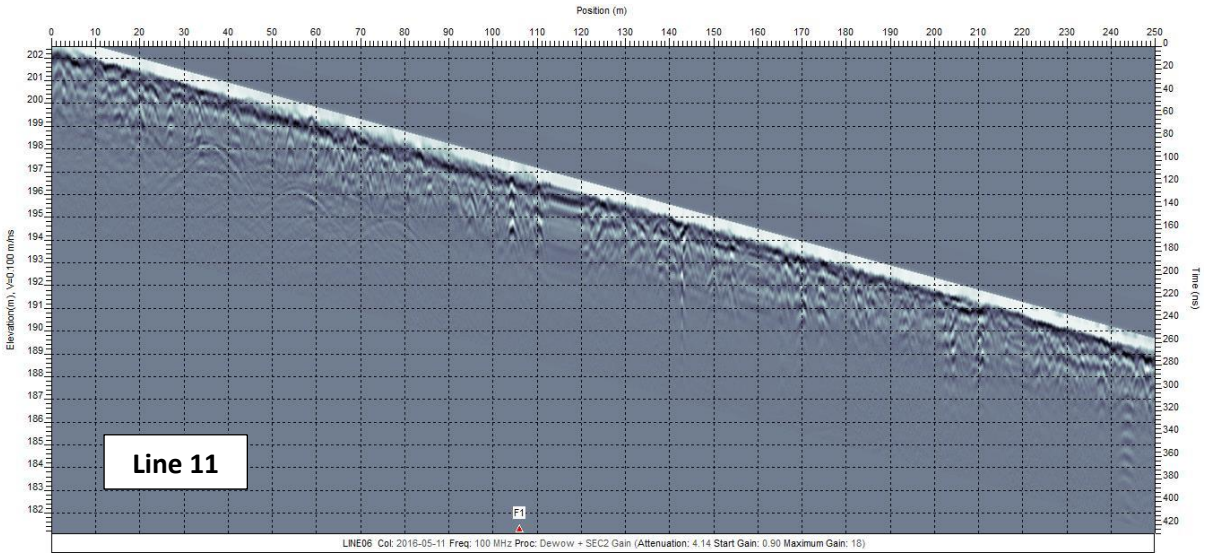
Position (m)
Elevation(m), V=0.100 m/ns
Time (ns)
Line 11
F1
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