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Mount Pleasant, West Stafford, Dorset Report on Geophysical Surveys, March and August 2019

Neil Linford, Paul Linford and Andrew Payne

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MOUNT PLEASANT, WEST STAFFORD, DORSET REPORT ON GEOPHYSICAL SURVEYS, MARCH AND AUGUST 2019

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SUMMARY

Caesium magnetometer and Ground Penetrating Radar (GPR) surveys were conducted at Mount Pleasant, West Stafford, Dorset, to address a casework request received from the Heritage at Risk Team in Planning Group South West to map the extent and state of preservation of the main henge and ancillary scheduled monuments. The large henge enclosure comprises a ditch and outer bank defining an irregular sub-oval area situated in two arable fields, and was investigated through a previous geophysical surveys and excavation undertaken between 1969-71 together with subsequent extensive analysis of aerial photography. Vehicle-towed caesium magnetometer survey (21.5ha) revealed a wealth of geophysical anomalies that enhance known evidence from the site, including a barrow cemetery to the south east of the henge. The GPR coverage (17.9ha) indicated the depth of the deposits at the site and, in addition to complementing the anomalies identified by the magnetic survey, also identified historic plough scours in the underlying chalk in the south west quadrant of the main henge. The geophysical survey results confirm the survival of known monuments to assist with the ongoing management of the site, and supports suggestions for additional entrances to the henge together with a partial inner palisade to the north west.

CONTRIBUTORS

The geophysical fieldwork was conducted by Neil Linford, Paul Linford and Andrew Payne.

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The authors are grateful to the landowner and tenants, for allowing access to the site and timely baling of the straw to allow the completion of the survey in August 2019.

ARCHIVE LOCATION

Fort Cumberland, Portsmouth.

DATE OF SURVEY

The fieldwork was conducted between 4th to 8th March and 20th to 23rd August 2019, with the report completed on 20th December 2019. The cover image shows a view of the site from the south looking towards the Conquer barrow within the mature stand of trees on the ridge of higher ground bisecting the main henge ditch and bank.

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INTRODUCTION

Caesium magnetometer and Ground Penetrating Radar (GPR) surveys were conducted over the prehistoric remains at Mount Pleasant, West Stafford, Dorset, to address a casework request received from Planning Team Southwest to map and assess their state of preservation given continuing arable cultivation of the fields in which the scheduled monument is situated. The proposed survey was designed to improve understanding of the surviving archaeological resource and was agreed as a Planning Group casework request addressing Historic England Action Plan objective 2.2.3. "Assess the significance of our heritage to protect it better".

The Mount Pleasant late Neolithic henge enclosure (AMIE Monument HOB UID 453935; NHLE 1002463; DO 624) has been under arable cultivation for many years with no immediate prospect for change. Conquer Barrow (AMIE Monument HOB UID 453934), a substantial earthwork probably dating to the late Neolithic and currently covered with trees, is situated adjacent to the west entrance of the henge, and a number of prehistoric barrows lie to the south east (AMIE Monument HOB UIDs 1494191, 1494210 and 1494224). Aerial survey noted the continued arable regime at the site and recommended ground based geophysical survey to assess the nature and degree of survival of prehistoric archaeological remains (Barber 2014).

It was hoped that this work would address a number of concerns including: the condition of the ploughed-out henge bank; extent and depth of survival of the bank material and whether the undisturbed old land surface survives beneath it; and the survival of any shallow features in the henge interior. The relationship of Conquer Barrow to the western henge bank and ditch, and significance of the 'avenue' running northeast towards the River Frome was also of interest. Previous work at the site is summarised by Barber (2014) and many of the research questions arose through extensive excavation and previous geophysical survey conducted in 1969-71 (Wainwright 1979).

Shallow well drained calcareous silty soils of the UPTON 1 association (342a) have developed over Cretaceous Portsdown Chalk Formation formed approximately 72 to 84 million years ago (Geological Survey of Great Britain 1973; Soil Survey of England and Wales 1983). The field to the south was drilled with a cover crop during the March survey week, and in August both fields were fallow following the harvest of a cereal crop with some straw waiting to be baled restricting access in places. Diametrically opposed weather conditions were experienced between the March survey, which was cold and extremely wet, compared to a hot, dry week after an extensive period without rain in the summer.

METHOD

Magnetometer survey

Magnetometer data were collected along the instrument swaths shown on Figure 1 using an array of six Geometrics G862 caesium vapour sensors mounted on a non-magnetic sledge (Linford *et al.* 2018). The sledge was towed behind a low-impact All-Terrain Vehicle (ATV) which housed the power supply and data logging electronics. Five sensors were mounted 0.5m apart in a linear array transverse to the direction of travel and, vertically, ~0.36m above the ground surface. The sixth was fixed 1.0m directly above the centre of this array to act as a gradient sensor. The sensors were sampled at a rate of 25Hz resulting in an along-line sample density of ~0.15m given typical ATV travel speeds of 3.5-4.0m/s. As the five non-gradient sensors were 0.5m apart, successive survey swaths were separated by approximately 2.5m to maintain a consistent traverse separation of 0.5m. Navigation and positional control were achieved using a Trimble R8 Global Navigation Satellite System (GNSS) receiver mounted on the sensor platform 1.65m in front of the central sensor and a second R8 base station receiver established using the Ordnance Survey VRS Now correction service. Sensor output and survey location were continuously monitored during acquisition to ensure data quality and minimise the risk of gaps in the coverage. Elevation data recorded by the GNSS receiver mounted on the sensor platform were processed with a steerable filter, using a radius of 3.5m to highlight linear anomalies, to illustrate the variation in local topography over the site (Figure 13).

After data collection the corresponding readings from the gradient sensor were subtracted from the measurements made by the other five magnetometers to remove any transient magnetic field effects caused by the towing ATV or other nearby vehicles (see Linford *et al.* 2018). The median value of each instrument traverse was then adjusted to zero by subtracting a running median value calculated over a 72m 1D window (see for instance Mauring *et al.* 2002). This operation corrects for any remaining biases added to the measurements owing to the diurnal variation of the Earth's magnetic field. For traverses from the northern field the median filter radius was reduced to 20m to remove transient extreme magnitude anomalies caused by the electrified railway line bounding the field to the north. A histogram normalised greyscale image of the combined magnetic data is shown superimposed over the base Ordnance Survey (OS) mapping in Figure 3 and minimally processed versions of the range truncated data (±60nT/m) are shown as a trace plot in Figure 5, and a linear greyscale image following the processing discussed above in Figure 6.

Ground Penetrating Radar survey

A 3d-Radar MkIV GeoScope Continuous Wave Step Frequency (CWSF) Ground Penetrating Radar (GPR) system was used to conduct the survey collecting data with a multi-element DXG1820 vehicle towed, ground coupled antenna array (Linford *et al.* 2010; Eide *et al.* 2018). A roving Trimble R8 Global Navigation Satellite System (GNSS) receiver, together with a second R8 base station receiver established using the Ordnance Survey VRS Now correction service, was mounted on the GPR antenna array to provide continuous positional control for the survey collected along the instrument swaths shown on Figure 2. Data were acquired at a 0.075m x 0.075m sample interval across a continuous wave stepped frequency range from 40MHz to 2.99GHz in 4MHz increments using a dwell time of 2ms. A single antenna element was monitored continuously to ensure data quality during acquisition together with automated processing software to produce real time amplitude time slice representations of the data as each successive instrument swath was recorded in the field (Linford 2013).

Post-acquisition processing involved conversion of the raw data to time-domain profiles (through a time window of 0 to 75ns), adjustment of time-zero to coincide with the true ground surface, background and noise removal, and the application of a suitable gain function to enhance late arrivals. Representative synthetic profiles from the full GPR survey data set are shown on Figure 7. To aid visualisation amplitude time slices were created from the entire data set by averaging data within successive 2.5ns (two-way travel time) windows (e.g. Linford 2004). An average sub-surface velocity of 0.078m/ns was assumed following constant velocity tests on the data, and was used as the velocity field for the time to estimated depth conversion. Each of the resulting time slices therefore represents the variation of reflection strength through successive ~0.1m intervals from the ground surface, shown as individual greyscale images in Figures 4, 8, 9 and 10. Further details of both the frequency and time domain algorithms developed for processing this data can be found in Sala and Linford (2012).

Due to the size of the resultant data set a semi-automated algorithm has been employed to extract the vector outline of significant anomalies shown on Figure 12. The algorithm uses edge detection to identify bounded regions followed by a morphological classification based on the size and shape of the extracted anomalies. For example, the location of possible pits is made by selecting small, sub circular anomalies from the data set (Linford and Linford 2017).

RESULTS

Magnetometer survey

A graphical summary of significant magnetic anomalies [**m1-87**] discussed in the following text superimposed on base OS map data is provided in Figure 11.

Geological and modern activity

Amorphous areas of mixed magnetic background response [**m1-12**] extend across the ridge of high ground occupied by the henge enclosure due to the variable geology including remnants of eroded Eocene deposits that capped the hilltop. Many of the larger amorphous anomalies correspond with soil and chalk marks visible on aerial photographs (for example Wainwright 1979, 1-4; Barber 2014, Figs 8 and 9). This background variation potentially gives rise to some confusion with identification of archaeological anomalies in places.

Two weak positive linear anomalies [**m13**] and [**m14**], suggestive of non-ferrous modern services, cross the site to south of the henge and the former route of the West Stafford road produces an area of intense disturbance [**m15**] in the south west corner of the survey. Other areas of ferrous disturbance [**m16-18**] are of uncertain origin but do not appear to correlate with the previous excavation trenches. Anomaly [**m16**], directly east of the ditch of Site IV, replicates an identical response recorded by the initial magnetometer survey in advance of the excavation (Clark 1979).

Henge bank

In general the bank is most pronounced on the southern part of the circuit as a weak negative response [**m19**] and [**m20**], most probably associated with built-up chalk material in the raised earthworks here, similar to the aerial photographic evidence (Barber 2014). Localised positive pit or hearth type anomalies found within [**m19**] and [**m20**] may, possibly, be associated with pre-bank occupation on the former land surface dating to the later third millennium BC (Wainwright 1979, 70).

Immediately to the south [**m21**] correlates with the external ditch indicated on the aerial photographic evidence (Barber 2014, 23 Fig 6), with further linear anomalies [**m22**] orientated across and through the south east entrance here and a narrow ditch [**m23**] heading north into the henge interior through the gap in the main henge ditch at [**m35**] (Barber 2014, Fig 8).

It is possible that [**m22**] may represent a continuation of the ‘approach’ or ‘avenue’ to the henge from the north east (cf [**m63**] and [**m64**]), although after the break in the henge bank [**m22**] appears to merge with [**m21**] making a clear distinction between ditches and possible trackway type responses difficult when interpreting this group of anomalies. The pair of narrower ditches [**m22**] may possibly represent an attempt to block the south east entrance, perhaps contemporary with the later palisade construction, or provide a trace of earlier activity such as a "setting-out ditch" for the subsequent bank construction. The overlapping anomalies in the vicinity of the south east entrance certainly suggest a complex succession of several phases of modification.

Henge ditch

The main henge ditch is defined as a series of broad positive anomalies [**m24-34**] extending around the full circuit of the enclosure, but is characterised by a very irregular and compartmentalised appearance with larger interruptions due to the entrance causeways visible at [**m35-38**].

The fragmented appearance is particularly apparent at [**m26**], where the response correlates with the excavation results (cf Wainwright 1989, 76), and also the very similar anomalies visible to the north east at [**m32**]. Further discontinuities in the ditch at [**m26**] include large post-holes and pits, a fork-shaped anomaly [**m75**] approaching the henge from the south and an amorphous area of disturbed response [**m44**] that all correspond with the aerial photographic evidence. The widths of the ditch sections vary between 10 and 14m around the circumference of the henge, appearing to be at their widest in the vicinity of the main entrance terminals [**m35-38**]. A ferrous response [**m39**] adjacent to the east ditch terminal of the north entrance is possibly related to excavation activity in trenches XXVIII, XXIX and XXX.

Palisade

The palisade appears as a narrow curvilinear positive anomaly [**m40**] largely continuous around the full circuit of the henge with narrow entrances suggested by the irregularity of the response at [**m41**] and [**m42**], in agreement with the excavation (Wainwright 1979, 48-9). Areas of ferrous response [**m43**] and [**m44**] along the palisade circuit appear to correlate with excavation trenches, although the majority of these interventions are not detected as obvious magnetic anomalies. There is no evidence for individual post-holes showing within the data, possibly because they were set into a continuous trench as excavation evidence suggests (see for instance Wainwright 1979, plate XXVIIa). The variable magnitude of response from the palisade, between 0.8 and 2.6 nT/m, also complicates interpretation and may be due to the varying methods used to dispose of the posts when the palisade was destroyed (Wainwright 1979, 237ff and Fig 99)

A possible partial section of inner palisade concentric to the main circuit [**m40**], was originally suggested by a single aerial photograph in the north west of the henge (Barber 2014, Fig. 10), and has been detected as a faint curvilinear positive anomaly [**m45**] that fades out towards the field boundary to the south and to the north as the slope steepens at around the 70m contour line. Some tentative indications for broadly concentric lines of small pits or large post-holes are found at [**m46**] and [**m47**] between the palisade trench and the south west portion of the main henge ditch. These anomalies lie beyond the excavation, although a number of larger pits in the vicinity have been recorded by aerial photography in association with a putative fifth entrance (Barber 2014, 25-6 Fig 8).

Henge interior including Site IV

A clearly defined positive response [**m48**] has been recorded over the ring ditch and entrance terminals at the north of Site IV, with some slight vestiges of internal activity including two larger pits [**m49**] associated with a later phase of Iron Age settlement that were only half-sectioned during the excavations and are therefore likely to retain some original undisturbed fill (Wainwright 1979, 9-34 Fig 18). A solution hollow excavated close to the entrance to Site IV produces a weak irregular response [**m50**] together with a narrow positive linear anomaly [**m51**] that corresponds with a known Iron Age ditch immediately to the north of the ring ditch (Wainwright 1989, 71 Fig 16). Elsewhere within the henge interior, a sparse distribution of large quarry like pits [**m52-60**] are defined by quite rounded and regularly shaped anomalies with magnitudes of response up to 3.0 nT/m, perhaps associated with quarrying for sarsen stone for the stone phase construction of Site IV (Wainwright 1979, 28-9 Fig 16). These are quite different to the broader amorphous areas of raised geomorphological response [**m1-12**] although sometimes the two groups of anomalies do occur in close proximity.

Similar large pit-type anomalies [**m58-60**] are found towards the edges of the henge interior and appear in places to merge with or be attached to the palisade trench [**m40**] which may again suggest quarrying for material as was discovered during the construction of the palisade. One of the pit-type anomalies [**m57**] replicates evidence from the original geophysical survey that was subsequently excavated in trench XXVI and revealed a 4.7m diameter oval broad-based shallow pit with Iron Age and Roman pottery sherds in its middle to lower fill, perhaps suggestive of a later prehistoric to Romano-British date (for a detailed description see Wainwright 1979, 69). It is possible that [**m57**] may well shed light on the character of the other unexcavated large rounded pit-type anomalies [**m52-60**], mostly located within and around eastern half of the henge enclosure and perhaps associated with the hilltop topography (Figure 13).

East entrance and the linear approach

A series of broad parallel irregular anomalies [**m63**] and [**m64**] correlates with the linear 'avenue' meeting the henge from the direction of the River Frome to the northeast, previously indicated on aerial photographs (Barber 2014, 35-7 Fig 13). There is a suggestion [**m63**] may continue once it reaches the outer perimeter of the henge extending between the main ditch [**m34**] and bank [**m20**] on the south east part of the circuit, towards the break in the two main sections of the bank [**m19**] and [**m20**], before exiting to the south through the gap in the vicinity of [**m22**].

Concentric outer ditches [**m65-68**] are found on the north east circuit of the henge orientated orthogonal to the direction of the avenue [**m63**] and [**m64**] but terminating before reaching it. The broad outer ditch [**m65**] has a narrow arcing anomaly [**m66**] to the south, indicating a curvilinear ditch or gully connecting to it and a second orthogonal ditch where [**m65**] terminates near the east entrance to the henge and the modern field boundary. The significance of [**m66**] is difficult to assess, perhaps either associated with the outer henge earthworks or a ditch associated with later activity. Additional linear anomalies [**m70**] and [**m71**] pass through the north east entrance suggested at [**m37**], possibly extending beyond the northwest termination of [**m65**].

Additional linear anomalies

To the south of [**m63**] and [**m64**] a pair of narrow parallel linear anomalies [**m72**], possibly representing a trackway or boundary, continue towards the henge bank [**m20**] where they are abruptly interrupted or obscured, perhaps suggesting [**m72**] may either terminate at or even underlie the bank. Very similar parallel linear anomalies are found in a short section [**m22**] between the two sections of bank [**m19**] and [**m20**], and again at [**m73**] beyond the western limit of raised bank on the south west section of the henge circuit. Anomaly [**m73**] may be associated with the line of the main henge bank, perhaps a setting-out ditch for an unfinished phase of later modification, as it appears to join the raised bank at [**m19**] with the surviving earthworks recorded by the Ordnance Survey to the south of the Conquer Barrow.

It is possible that [**m72**] and [**m73**] may represent a more recent trackway, although the geophysical response suggests a pair of well magnetised ditches cut into the underlying chalk with an overall width of 5m, perhaps uncharacteristic of an unmarked track. Unfortunately, the excavation trenches did not extend far enough out from the main henge to encounter either [**m72**] or [**m73**] to determine the significance of these anomalies. A further single narrow, weakly resolved linear anomaly [**m74**] located at the eastern end of [**m72**], but curving off at an angle to the northwest, may also be related to [**m72**].

Two subtle linear anomalies [**m75**] merging together in a fork shaped arrangement just south of [**m26**] on the southwest circuit of the henge ditch correspond with more recent aerial photography (Barber 2014, 26 Fig 8) and possibly represent access routes of unknown date between the henge earthworks.

To the south [**m75**] is apparently aligned on a large isolated pit or quarry type anomaly [**m86**], previously suggested as a possible barrow or ring-ditch from aerial photography (Barber 2014, 35 'J' on Fig 6) but this interpretation is now questioned by the geophysical survey results (see below). There is also evidence for a further possible ditch or trackway, defined by a series of narrow weak positive linear anomalies [**m76**] cutting across the henge enclosure to the northwest of [**m75**], possibly an access route of relatively modern origin as it seems doubtful that there was an additional entrance break in the henge earthworks here.

Further peripheral monuments and barrow groups

Barrow monuments to the south east of the survey coverage include [**m77**] and [**m78**] (Barber 2014,' F' and' E' on Fig 6), and a series of three smaller segmented ring-ditches or pit-circles [**m79-81**] (Barber 2014,' G', 'H' and 'I' on Fig 6) further to the south. In addition, a previously unrecognised slightly larger ring-ditch [**m82**] is found to the west of [**m79-81**] together with a ditched enclosure of inverted V-shaped form [**m83**] that appears to be associated with the southern group of ring-ditches at [**m79-82**] suggested by the alignment of the ditch components with the barrows. There are indications that [**m77**] has a multiple ring-ditch, possibly representing a multi-phased barrow, with a partially resolved inner ditch obscured by disturbance due to the modern field boundary. The ring-ditch [**m77**] may also be impacted by the course of the service pipe [**m13**], although any disturbance from this appears to be relatively minor. The newly defined ring-ditch [**m82**] appears to be continuous on its western side but the eastern half of its circuit is possibly defined by discrete closely spaced pits, the whole exhibiting a marked protrusion towards the southeast.. In addition to the newly discovered [**m82**] the segmented forms of [**m79-81**] have previously not been identified, with the exception of [**m81**] which was clearly defined in recent aerial photographs taken in the dry summer of 2018 (Kinsley 2018), and the new magnetic evidence suggests possible parallels with similar monuments found in the Stonehenge landscape (Bowden *et al.* 2015, p35-8 and Fig 3.7).

The ditch of the Conquer Barrow (Barber *et al.* 2010) is detected as a broad weak positive response at [**m84**] to the south west of the main henge ditch [**m27**], corresponding with the terminal of the barrow ditch recorded by the excavation (Wainwright 1979, 65-7 Figs 5, 21 and 37). Unfortunately, no additional information regarding the relationship between the barrow and the henge enclosure is suggested by [**m84**].

An isolated grouping of probable pits [**m85**] has been detected towards the north east of the survey coverage with an orientation that suggests these may be related to the outer henge enclosure ditches [**m65**] and [**m67**] and the avenue [**m63**] and [**m64**].

The large rounded pit-type response [**m86**] to the south west of the henge was tentatively interpreted as a ring ditch from aerial photographs, although some caution was suggested due to the small size, apparent isolation and appearance on a single photograph of particularly clear visibility (AMIE UID 1494226; Barber 2014, 23 and 35 'J' on Fig 6). The magnetic data would appear to suggest [**m86**] is more likely to relate to a large pit of unknown origin rather than a barrow or ring ditch (although see discussion of [**m75**] above).

A large sub-rectangular area of disturbed magnetic response [**m87**] is located towards the railway line outside to the north east of the henge and this may relate to a possible bomb-crater shown on the 1947 RAF vertical aerial photograph (Barber 2014, Fig 7).

Ground Penetrating Radar survey

A graphical summary of the significant GPR anomalies, [**gpr1-70**] discussed in the following text, superimposed on the base OS map data, is provided in Figure 12.

Despite very different soil moisture conditions between the data acquisition in March and August a good response has been recorded over the site with significant reflections recorded throughout the 75ns two-way travel time window. Some radio frequency interference appeared to be associated with a mobile phone mast close to the railway line, although this had limited impact on the processed data.

The very near-surface data between 0.0 and 5.0 (0.0 to 0.19m) is dominated by the micro-topography of the field surface with a number of wheel ruts and tractor runs evident. These anomalies are more prominent in the August data set which also contains some linear responses, particularly in the field to the north, due to extant straw drying in the field prior to baling. There is also evidence for previous field boundaries and plough headlands [**gpr1-3**] known from aerial photography, and both the 1986 [**gpr4**] and an earlier pipeline to the south [**gpr5**]. To the west of [**gpr4**] between 7.5 and 12.5 (0.29 to 0.48m) a 6.5m wide easement for the pipeline is evident, although it is unclear why this does not appear along the full length within the survey area. A prominent depression immediately south of the railway line appears as a deep pit-type anomaly [**gpr6**], that correlates with a possible WW2 bomb crater at SY71159004 inferred from the aerial photography (Barber 2014).

Remarkably, some evidence for the location of the 1970-71 excavation trenches survives where the outline of Trench I (Wainwright 1979, Fig. 3) can be seen crossing the henge ditch between 10.0 and 42.5 (0.39 to 1.65m) at [**gpr7**]. The outline of Trench I is less clear beyond the ditch, but an area of high amplitude [**gpr8**] between 7.5 and 17.5 (0.29 to 0.68m) could, perhaps, represent a spoil heap, and the low amplitude rectilinear anomaly [**gpr9**] correlates with the approximate location and dimensions (7m x 7.5m) of the excavated ditch section to the south of Wainwright's Trench II. The location of [**gpr8**] is curious as it appears at a position where the henge bank is heavily eroded as a topographic feature. The large open area trench encompassing Site IV also respects the former field boundary [**gpr2**] to the east, although this appears to have been extended to follow the complete ditch circuit. Additional excavation trenches also appear as low amplitude anomalies, particularly those targeted on the palisade circuit, for example Trenches at XIV, XX and XXVI at [**gpr10-12**].

A number of low-amplitude, large pit-type anomalies [**gpr13-20**] appear from approximately 7.5ns (0.29m) onwards, although some of these expand into more extensive areas of amorphous response [**gpr21-25**] with depth. It seems likely that these anomalies represent geomorphological features, possibly Eocene clay pockets cut in to the chalk. Two of these, [**gpr15**] and [**gpr24**] in the immediate vicinity of the entrance to Site IV, were investigated during the 1970-71 excavation and were confirmed to be natural. Discrete, high-amplitude reflectors within some of these clay deposits, for example single anomalies at [**gpr13**] and [**gpr21**], and the sub-circular arrangement of response found in [**gpr23**], may possibly represent sarsen stone or chalk fragments reported to occur naturally as relicts of the Bagshot Beds in this area (Wainwright 1979, 1-4). It is difficult to determine the significance, if any, of these geomorphological anomalies although it would appear that [**gpr23**] does occupy an approximately central position within the henge as defined by the ditch and bank. Some potential misinterpretation is also possible due to the similar nature of the WW2 bomb crater [**gpr6**], although [**gpr13-25**] are not associated with any extant topographic evidence.

Two areas of linear, high-amplitude anomalies [**gpr26**] and [**gpr27**] are found between 10.0 and 15.0 (0.39 to 0.58m) to the south-west of the survey. The anomalies are approximately 1.5m wide and follow a parallel orientation separated by 4.5m. Given the shallow depth and regularity it seems likely that [**gpr26**] and [**gpr27**] might represent an agricultural pattern, possibly historic steam ploughing of the site that scoured in to the top of the chalk. It is unclear whether the limited extent of [**gpr26**] and [**gpr27**] represents a previous sub-division of the field abutting the headland at [**gpr1**] or an area of the site that, perhaps due to varying soil cover, has been more susceptible to plough scour.

From approximately 7.5ns (0.29m) onwards a series of broad, low amplitude anomalies [**gpr28-31**] define the circuit of the main henge ditch, with similar responses found in relation to the outer concentric ditches, [**gpr32**] and [**gpr33**], the partially described ditch around the Conquer barrow [**gpr34**], and the avenue or approach [**gpr35**] to the north east. The form of the main henge ditch varies from an angular outline in places to a more interrupted response of large, conjoined pits to the north. It is unclear whether sections of the ditch may, perhaps, have incorporated geomorphological features, such as clay pockets or sink holes, where these have fallen at an appropriate location on the circuit. There are also some instances, for example at [**gpr36**] where a low amplitude geomorphological anomaly appears in very close proximity to the main ditch section. The ditch section at [**gpr30**] is of interest as it appears to show a 25m wide, shallow section between 7.5 and 15.0 (0.29 to 0.58m) with evidence for a narrower profile between 17.5 and 32.5 (0.68 to 1.26m), reduced to a width of 16m (PRO_01 and PRO_02 on Figure 7). As this section of the ditch is bounded immediately to the south by a pronounced section of the bank [**gpr46**] it is possible that this represents either enlargement of the ditch to provide material for the bank or, perhaps, silting from the raised material infilling the ditch.

The two sections of outer ditch [**gpr32**] and [**gpr33**] to the north east, appear as low amplitude anomalies from 5.0 (0.19m) onwards, although [**gpr33**] is very faint compared to the corresponding magnetic anomalies [**m65**] and [**m67**], possibly due to reduced soil moisture contrasts in the lower lying areas of the survey towards the river valley. The response to [**gpr32**] shows a distinctive high amplitude layer, suggesting a more narrow lynchet type profile when compared to [**gpr29**], perhaps influenced by the steeper slope to the valley here (PRO_03 on Figure 7). The course of [**gpr33**] does not appear to follow the curve of the main henge ditch as closely as [**gpr32**] and it is possible that this is unrelated to the main monument.

Entrances across the ditch are found at the four known locations [**gpr36-39**], together with further evidence for the south western entrance [**gpr40**] suggested by Francesca Radcliffe from aerial photographs obtained during the 1990s (Barber 2014, Fig. 9). In addition, some apparent breaks occur at [**gpr41-43**] around the northern arc of the ditch, but the data is not sufficiently clear to determine whether these represent entrances or not. The causeway approach to the southeast entrance is evident as a 20m wide high amplitude anomaly across the ditch from between 7.5 and 60.0 (0.29 to 2.88m) of complex form that, in part, may be due to the underlying geomorphology. A central, 50m long linear anomaly, passes from the bank through the entrance between 10.0 and 30.0 (0.39 to 1.16m) also evident as a magnetic response [**m23**].

The banks of the henge are evident as high amplitude anomalies from 5.0ns (0.19m) onwards, but are difficult to distinguish from the reflections of the underlying chalk geology, for example at [**gpr44**] and [**gpr45**] to the north. An exception occurs to the south of the henge where three sections [**gpr46-48**] demonstrate a higher magnitude of response than either the underlying geology or other elements of the bank. Profiles through [**gpr46**] and [**gpr47**] (PRO_01 and PRO_02 on Figure 7) suggest a central high amplitude anomaly, extending to approximately 25.0ns (0.97m) with a complex distribution shown by the corresponding time slices. In both cases there appears to be a linear horizon immediately above [**gpr49**] and below [**gpr50**] the high amplitude anomaly perhaps representing an outer weathering layer and sealed land surface respectively. There is also a limited area of higher amplitude response [**gpr46**] that appears to continue beneath the basal layer.

The high amplitude response suggests a marked variation in the physical properties of the material in these sections of the bank, possibly the presence of some air-filled voids. Similar responses may be encountered over badger setts, although the extent and form suggests this is unlikely here (cf Linford *et al.* 2019), and the anomalies may instead be due to air gaps within chalk rubble used to form the bank. It is unclear from the geophysical results alone whether this is due to the differential survival of the bank deposits around the circuit or, as has been suggested elsewhere, some sections have been heightened (Barber 2014). If this is the case then the geophysical survey suggests some additional sections of modification to the bank that do not appear as areas of surface chalk scour, for example in the vicinity of the southwest entrance [**gpr48**] and, perhaps, on the bank [**gpr45**] between the two ditches [**gpr29**] and [**gpr32**] to the north east. This may, of course, also reflect the variation in vulnerability to the plough over the local topography of the monument (Figure 13).

The radar response to the palisade [**gpr51**] is more variable than the magnetic anomaly [**m40**], appearing first as low amplitude response between 7.5 and 10.0 (0.29 to 0.39m), and then more intermittently as a high amplitude reflector to approximately 15ns (0.58m). This suggests a difference in the fill of the palisade ditch with depth with, perhaps, shallow near-surface deposits of more organic rich water retentive material. In addition to the excavation trenches [**gpr10-12**] visible along the palisade circuit, a response to the recently identified inner palisade [**gpr52**] is also found between 10.0 and 17.5 (0.39 to 0.68m). Curiously, [**gpr52**] appears as a high amplitude anomaly which is more clearly visible in the data than [**gpr51**], although the extent is similar to that suggested by both the aerial photography and magnetic surveys (cf [**m45**]).

A similar, shallow low amplitude response [**gpr53**] is found over the Site IV ditch that only appears as a complete anomaly between 7.5 and 10.0 (0.29 to 0.39m). Due to the variable response to the geomorphology it is difficult to determine any pits or post holes within Site IV, although there are two high amplitude reflectors to the north, possibly associated with [**gpr24**], and similar anomalies at [**gpr54**] which appear to correlate with the presumably more recent ferrous response [**m16**]. The Iron Age ring gully within the interior of

Site IV has produced a corresponding high amplitude anomaly [**gpr55**] between 7.5 and 12.5 (0.29 to 0.48m), in good agreement with the shallow feature observed during the excavation (Wainwright 1979, Figs 18 and 19).

The parallel linear anomalies found in the magnetic survey [**m72**] and [**m73**] are replicated in the radar data as a variable ditch-type response between 5.0 and 50.0ns (0.19 to 2.4m) at [**gpr56**] and [**gpr57**]. Each of the parallel ditches is approximately 1.0m wide and the pair separated by 3.5m. Whilst a more recent interpretation cannot be entirely discounted the alignment of [**gpr56**] on the ditch and east terminal of the raised bank at [**gpr47**] is curious, as is the arc of the section [**gpr57**] to the west following the apparent circuit of the bank, although there is no convincing evidence for [**gpr56**] continuing beneath [**gpr47**]. A low amplitude anomaly [**gpr58**] partially correlates with [**m75**], together with a more rectilinear high amplitude response [**gpr59**] although it is difficult to suggest a definitive interpretation for either of these.

To the east [**gpr56**] meets the ring ditch [**gpr60**] surrounding barrow 'F' identified from the aerial photography, and the pipeline [**gpr4**] can be seen to pass straight through the barrow between 10.0 and 15.0ns (0.39 to 0.58m). Barrow 'E' immediately to the south is only partially visible [**gpr61**] and further to the south only barrow 'G' [**gpr62**] is partially covered by the radar survey. There is some evidence to support [**gpr62**] as a segmented ring ditch or, circle of pits, although the anomaly is not as fully described here as in the magnetic data (cf [**m79**]). Other elements of the ditches mapped by the magnetic survey are also replicated in the radar [**gpr63-67**] with some variation in response between near-surface high amplitude reflectors such as [**gpr63**] and some much deeper, ditch type anomalies for example [**gpr64**]. This variation in the response of ditch type anomalies has been noted across the site and may, in part, be due to concentrations of chalk rubble fill within the underlying causative features.

Between approximately 22.5 and 45.0 (0.87 to 1.74m) some subtle linear anomalies [**gpr68-70**] possibly suggest earlier enclosure or boundary ditches. As these anomalies are not replicated in the magnetic data this interpretation should, perhaps, be treated with a degree of caution.

CONCLUSIONS

Both the magnetometer and GPR surveys have successfully enhanced the existing aerial photographic and excavation evidence available for the site. In particular, more detailed mapping of the main henge ditch has confirmed its irregular, segmented nature and suggested more numerous breaks and causeways. This includes additional geophysical evidence to support the fifth entrance to the south-west and may, potentially, account in part for the later construction of the internal palisade as a more complete, enclosing structure. There is also good geophysical evidence in both the magnetic and GPR data sets to support the partial inner palisade, which has not appeared regularly on the aerial photography. Furthermore, both geophysical techniques have detected a double parallel ditch type anomaly crossing the site from east to west which in part appears to follow the circuit of the henge bank to the south of the monument, although it is obscured by the raised sections. Further investigation would be required to better understand the significance of these anomalies and how they relate to the construction of the henge.

Some greater detail has been revealed in the magnetic survey suggesting the approach trackway from the north east consists of multiple linear ditches, possibly a boundary work providing a focus for the south east entrance. However, further investigation of the approach to the henge beyond the railway line to the north would be useful to better understand the potential relationship between the monument and the river valley. Evidence for an additional ring-ditch has also been provided by the magnetic data within the barrow group to the south of the henge, together with enhanced detail confirming a number of the smaller diameter ring-ditches are pit-circles with a segmented form. Again, the survey coverage ideally needs to be extended to the south of the road, beyond the currently scheduled monument, to fully encompass the expanded barrow group indicated by the geophysical survey.

The GPR survey focused on the main henge monument and provided useful, complementary depth information. This has, for example, identified what appears to be evidence for steam ploughing scour within the southwest quadrant of the henge and can, perhaps, suggest the depth of topsoil over the site protecting the surviving archaeological remains. Unfortunately, neither geophysical technique has been able to reveal any additional evidence for the extent of the Conquer Barrow ditch in relation to the henge. Some additional survey, perhaps using earth resistance tomography profiles, may be of use here should access to the full monument be possible.

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Figure 2 Location of the GPR instrument swaths superimposed over the base OS mapping data (1:2500).

Figure 3 Linear greyscale image of the caesium magnetometer data superimposed over base OS mapping (1:2500).

Figure 4 Greyscale image of the GPR amplitude time slice from between 7.5 and 10.0ns (0.36-0.48m) superimposed over the base OS mapping data. The location of representative GPR profiles shown on Figure 7 are also indicated (1:2500).

Figure 5 Trace plot of the minimally processed magnetic data. Alternate lines have been removed to improve the clarity (1:1750).

Figure 6 Linear greyscale image of the minimally processed magnetic data (1:1750).

Figure 7 Representative topographically corrected profiles from the GPR survey shown as greyscale images with annotation denoting significant anomalies. The location of the selected profiles can be found on Figures 2, 4 and 12.

Figure 8 GPR amplitude time slices between 0.0 and 22.5ns (0.0 to 0.87m) (1:6000).

Figure 9 GPR amplitude time slices 22.5 and 45.0ns (0.87 to 1.74m) (1:6000).

Figure 10 GPR amplitude time slices 45.0 and 67.5ns (1.74 to 3.24m) (1:6000).

Figure 11 Graphical summary of significant magnetic anomalies superimposed over the base OS mapping (1:2500).

Figure 12 Graphical summary of significant GPR anomalies superimposed over the base OS mapping (1:2500).

Figure 13 Greyscale image of the local relative variation in topography superimposed over the base OS mapping (1:2500).

REFERENCES

Barber, M 2014 *'Mount Pleasant, Dorset. A Survey of the Neolithic 'Henge Enclosure' and Associated Features, '*. Historic England Research Report Series 70-2014.

Barber, M, Winton, H, Stoertz, C, Carpenter, E and Martin, L 2010 'The Brood of Silbury? A Remote Look at Some Other Sizeable Wessex Mounds' *in* Leary, J, Darvill, T and Field, D (eds), *Round Mounds and Monumentality in the British Neolithic and Beyond. Neolithic Studies Group Seminar Papers, Volume 10*. Oxford: Oxbow Books, 153-173.

Bowden, M, Soutar, S, Field, D and Barber, M 2015 *The Stonehenge Landscape, Analysing the Stonehenge World Heritage Site*. Swindon, Historic England.

Clark, A J 1979 'The Geophysical Surveys' *in* Wainwright, G J (ed), *Mount Pleasant, Dorset: Excavations 1970-71* London: Society of Antiquaries, Appendix IV.

Eide, E, Linford, N, Persico, R and Sala, J 2018 'Advanced SFCW GPR systems' *in* Persico, R, Piro, S and Linford, N (eds), *Innovation in Near-Surface Geophysics Instrumentation, Application, and Data Processing Methods* Amsterdam: Elsevier, 253-285.

Geological Survey of Great Britain 1973 Glastonbury. England and Wales Sheet 296. Solid and Drift Edition, 1:50,000 scale geology map. Ordnance Survey, Southampton for Institute of Geological Sciences.

Kinsley, A 2018. "Mount Pleasant in Wessex." Retrieved 27/11/2019, from https://www.silentearth.org/mount-pleasant-in-wessex/.

Linford, N 2004 'From Hypocaust to Hyperbola: Ground Penetrating Radar surveys over mainly Roman remains in the U.K.'. *Archaeological Prospection*, 11 (4), 237-246.

Linford, N 2013. *Rapid processing of GPR time slices for data visualisation during field acquisition*. In Neubauer, W, Trinks, I, Salisbury, R and Einwogerer, C (Editors), Archaeological Prospection, Proceedings of the 10th International Conference, May 29th - June 2nd 2013 2013 (Vienna: Austrian Academy of Sciences Press). 176-78.

Linford, N and Linford, P 2017. *The application of semi-automated vector identification to large scale archaeological data sets considering anomaly morphology*. In Jennings, B, Gaffney, C, Sparrow, T and Gaffney, S (Editors), 12th International Conference of Archaeological Prospection, 12-16th September 2017 2017 (Bradford: Archaeopress Archaeology). 138-9.

Linford, N, Linford, P, Martin, L and Payne, A 2010 'Stepped-frequency GPR survey with a multi-element array antenna: Results from field application on archaeological sites'. *Archaeological Prospection*, **17** (3), 187-198.

Linford, N, Linford, P and Payne, A 2018 'Advanced magnetic prospecting for archaeology with a vehicle-towed array of cesium magnetometers' *in* Persico, R, Piro, S and Linford, N (eds), *Innovation in Near-Surface Geophysics Instrumentation, Application, and Data Processing Methods* Amsterdam: Elsevier, 121-149.

Linford, N, Linford, P, Payne, A and Rees, L 2019 *'Low Ham Roman Villa, High Ham, Somerset: Report on Geophysical Survey, July 2018'*. Historic England Research Reports Series **72/2018**. [web page] https://research.historicengland.org.uk/Report.aspx?i=16183

Mauring, E, Beard, L P, Kihle, O and Smethurst, M A 2002 'A comparison of aeromagnetic levelling techniques with an introduction to median levelling'. *Geophysical Prospecting*, **50** (1), 43-54.

Sala, J and Linford, N 2012 ' Processing stepped frequency continuous wave GPR systems to obtain maximum value from archaeological data sets '. *Near Surface Geophysics*, **10** (1), 3-10.

Soil Survey of England and Wales 1983 Soils of England and Wales, Sheet 6 - South East England, 1:250,000 scale soil map, Lawes Agricultural Trust, Harpenden.

Wainwright, G 1979 *'Mount Pleasant, Dorset: Excavations 1970-71'*. Report of the Research Committee of the Society of Antiquaries of London.

Wainwright, G 1989 *The Henge Monuments, Ceremony and Society in Prehistoric Britain*. New Aspects of Antiquity (general editor C. Renfrew). London, Thames and Hudson.

Figure 1

MOUNT PLEASANT, WEST STAFFORD, DORSET
Location of caesium magnetometer instrument swaths, March and August 2019

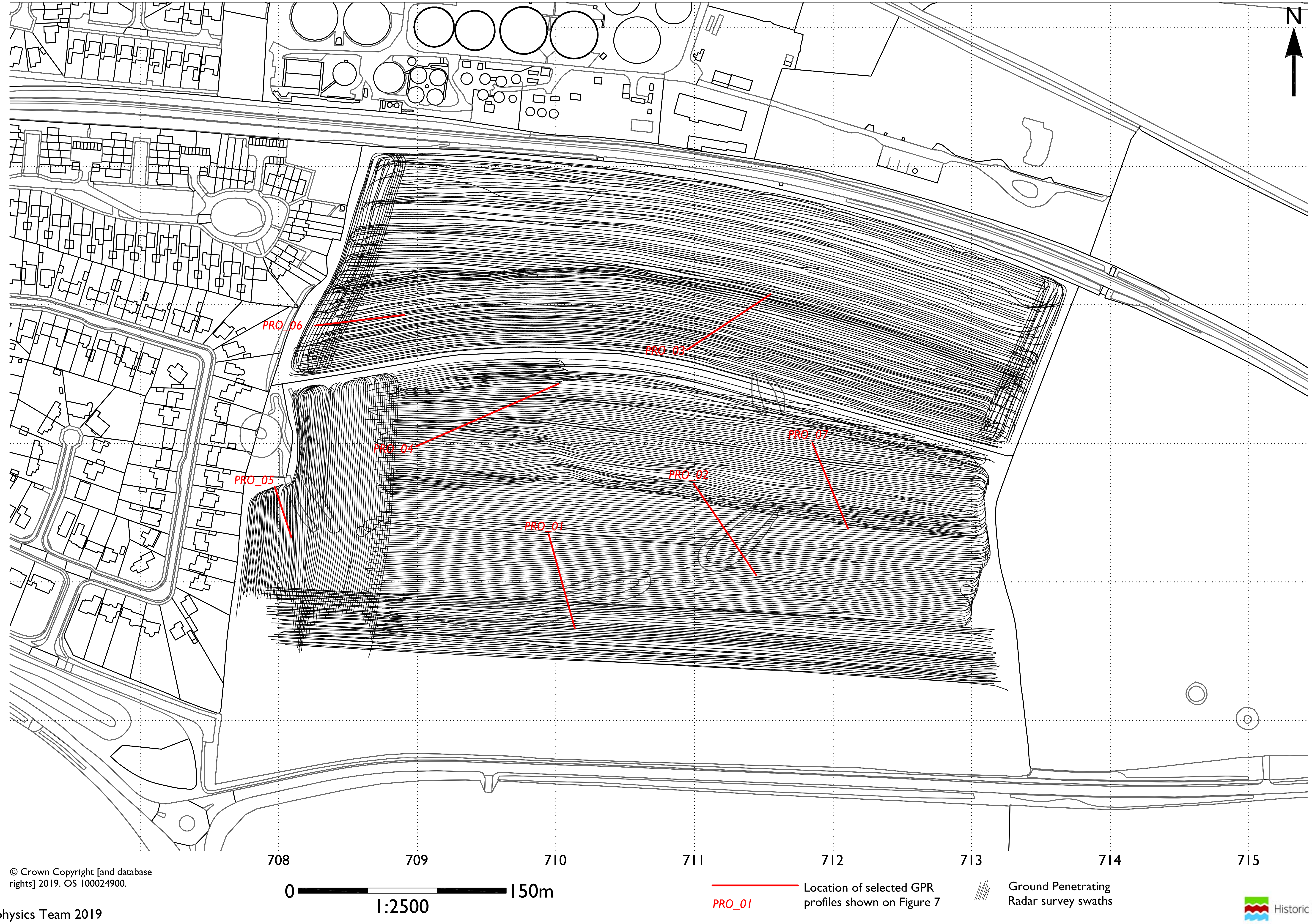
SY7089

Geophysics Team 2019

Historic England

MOUNT PLEASANT, WEST STAFFORD, DORSET
Location of GPR swaths, March and August 2019

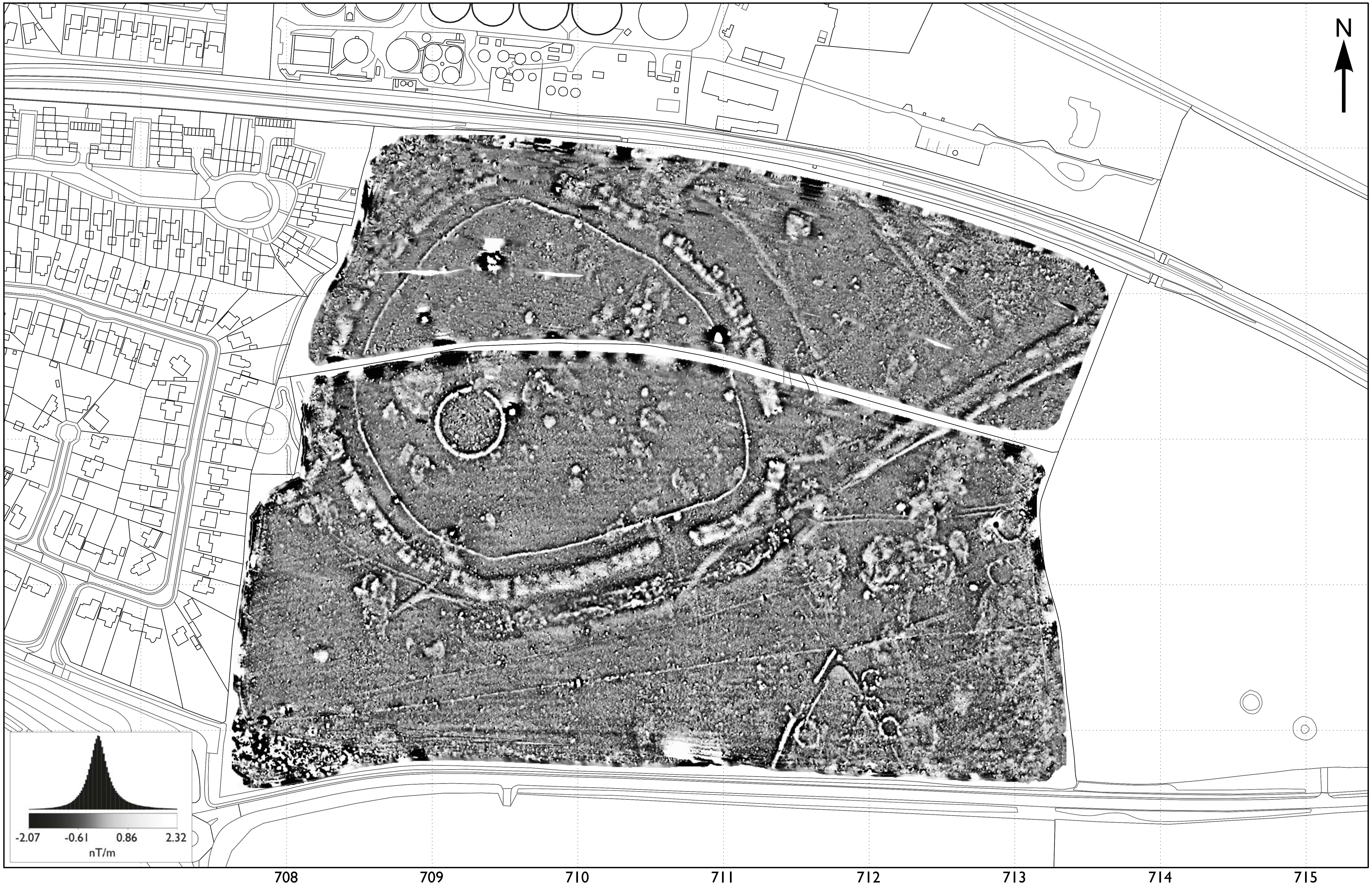
Figure 2



Geophysics Team 2019

Historic England

MOUNT PLEASANT, WEST STAFFORD, DORSET
Location of caesium magnetometer survey, March and August 2019



Geophysics Team 2019

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MOUNT PLEASANT, WEST STAFFORD, DORSET

GPR amplitude timeslice between 7.5 and 10.0ns (0.36 to 0.48m), March and August 2019

Figure 4

SY7089

0 150m

1:2500

PRO_01 Location of selected GPR profiles shown on Figure 7

Low High relative reflector strength

Geophysics Team 2019

Historic England

MOUNT PLEASANT, WEST STAFFORD, DORSET Caesium magnetometer survey, March and August 2019

Figure 5

Trace plot of minimally processed data

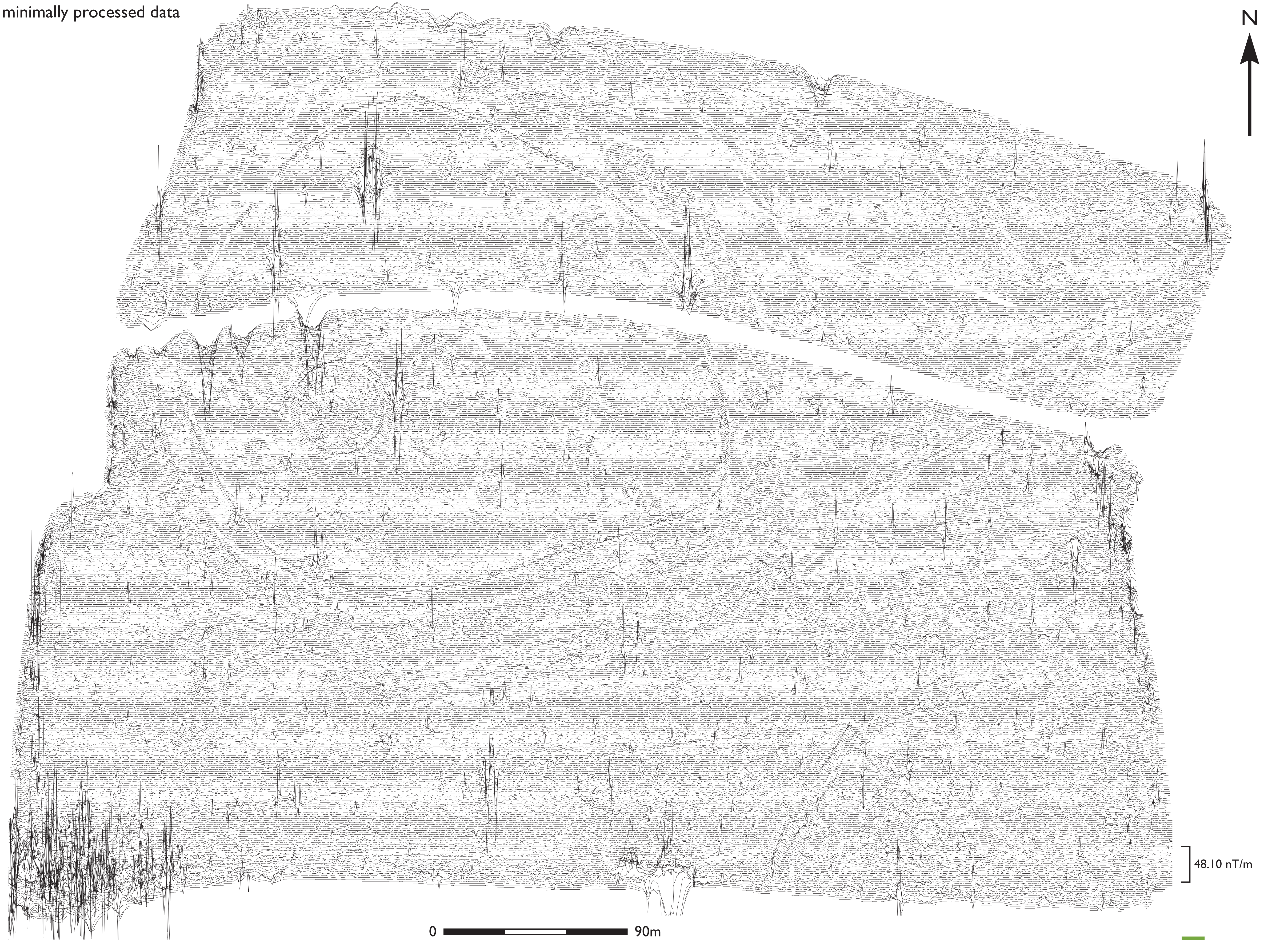

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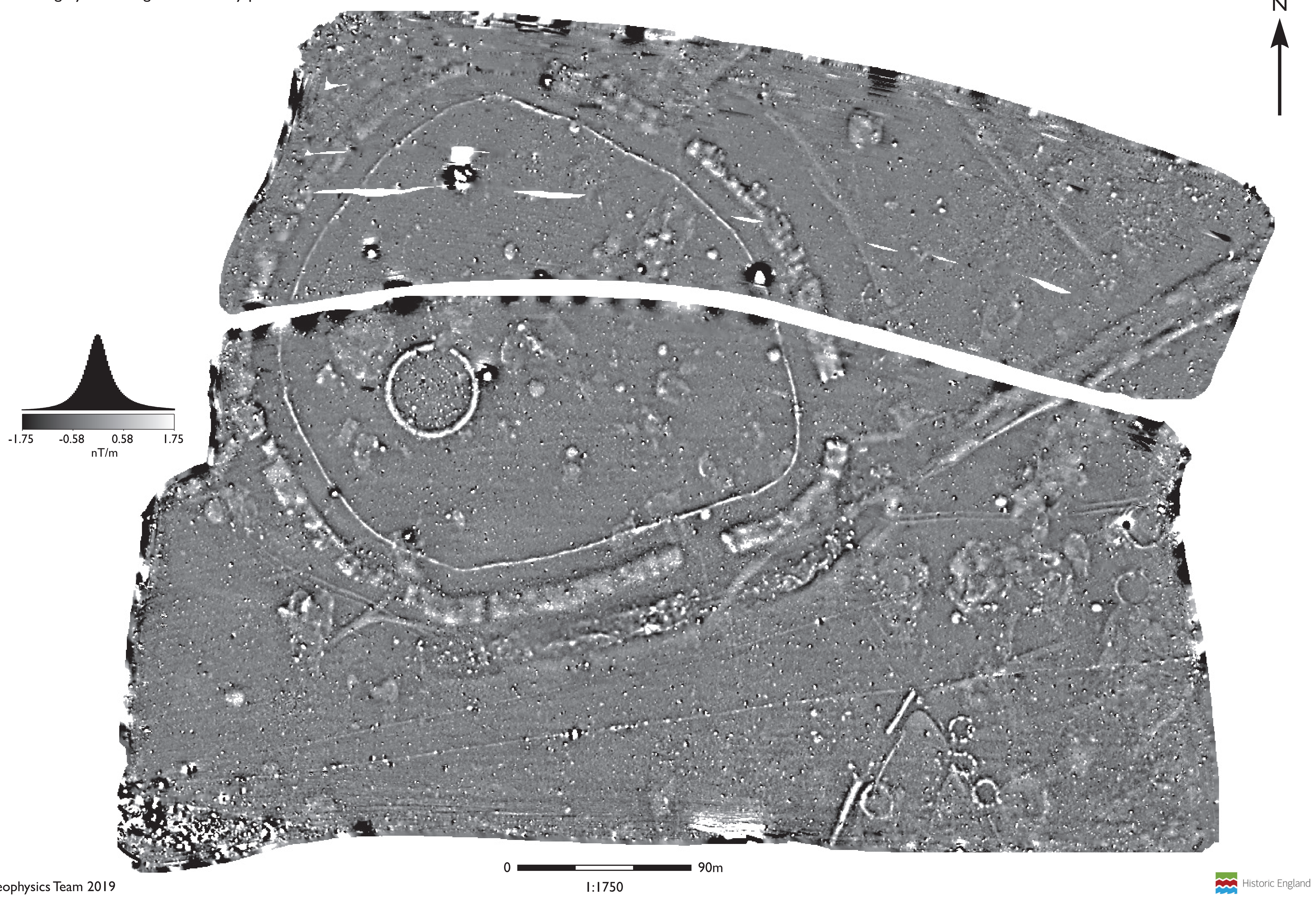
Figure 6

MOUNT PLEASANT, WEST STAFFORD, DORSET Caesium magnetometer survey, March and August 2019

Linear greyscale image of minimally processed data



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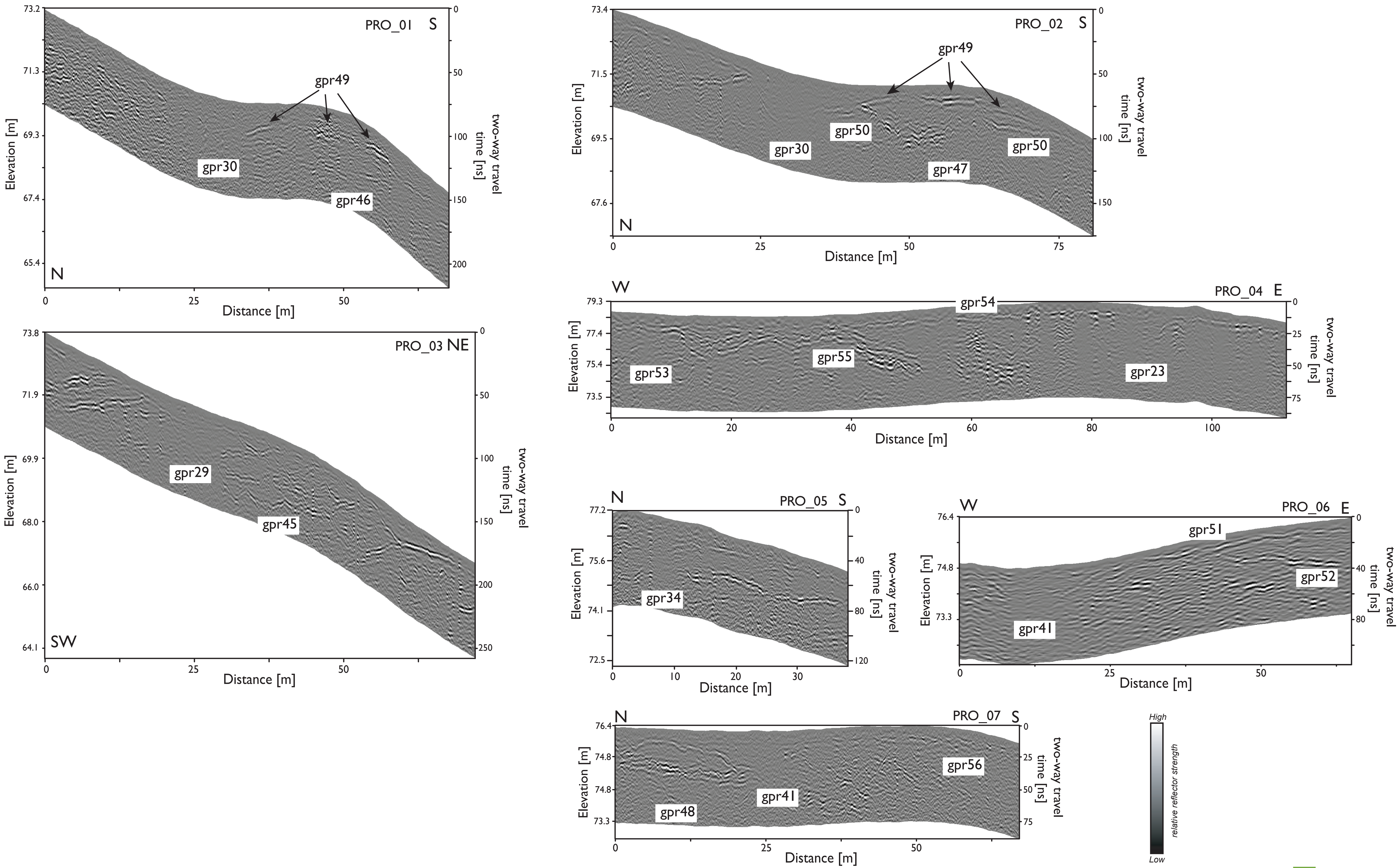
MOUNT PLEASANT, WEST STAFFORD, DORSET

Figure 7

Topographically corrected GPR profiles, March and August 2019



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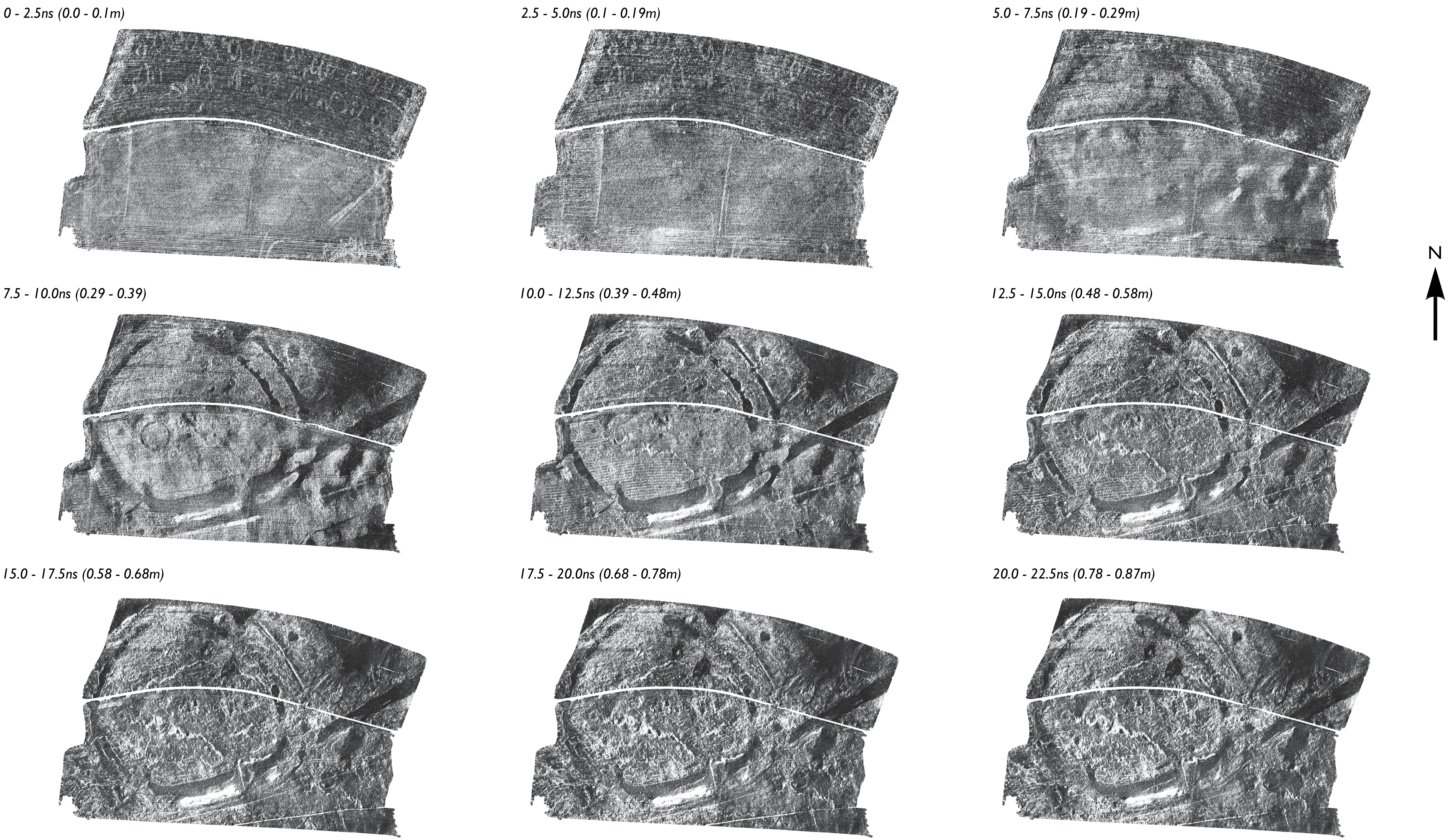
MOUNT PLEASANT, WEST STAFFORD, DORSET

GPR amplitude time slices between 0.0 - 22.5ns (0.0 - 0.87m), March and August 2019

Figure 8



Low *High*
relative reflector strength

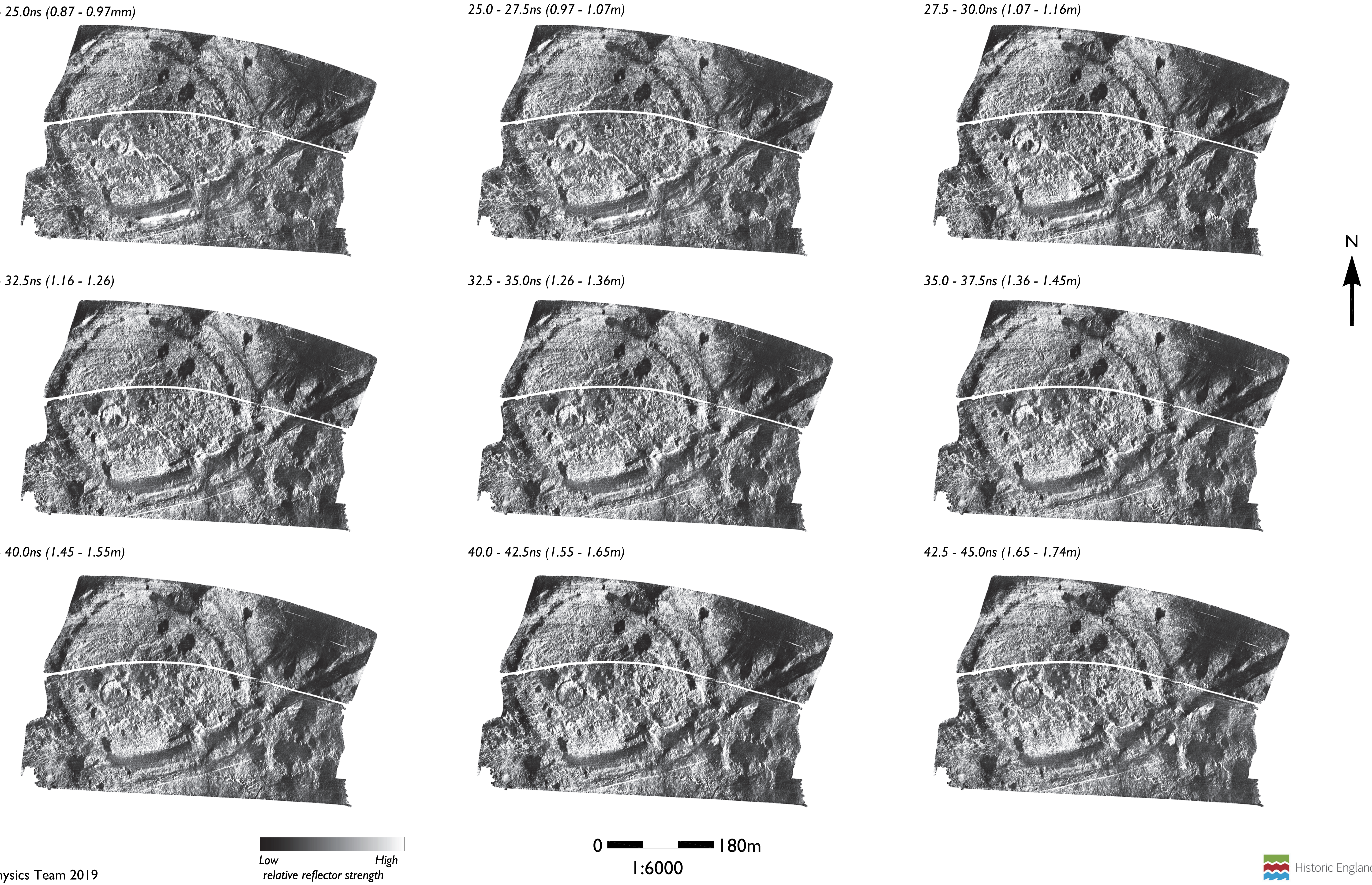
0 180m
1:6000

Geophysics Team 2019

Historic England

MOUNT PLEASANT, WEST STAFFORD, DORSET
GPR amplitude time slices between 22.5 - 45.0ns (0.87 - 1.74m), March and August 2019

Figure 9



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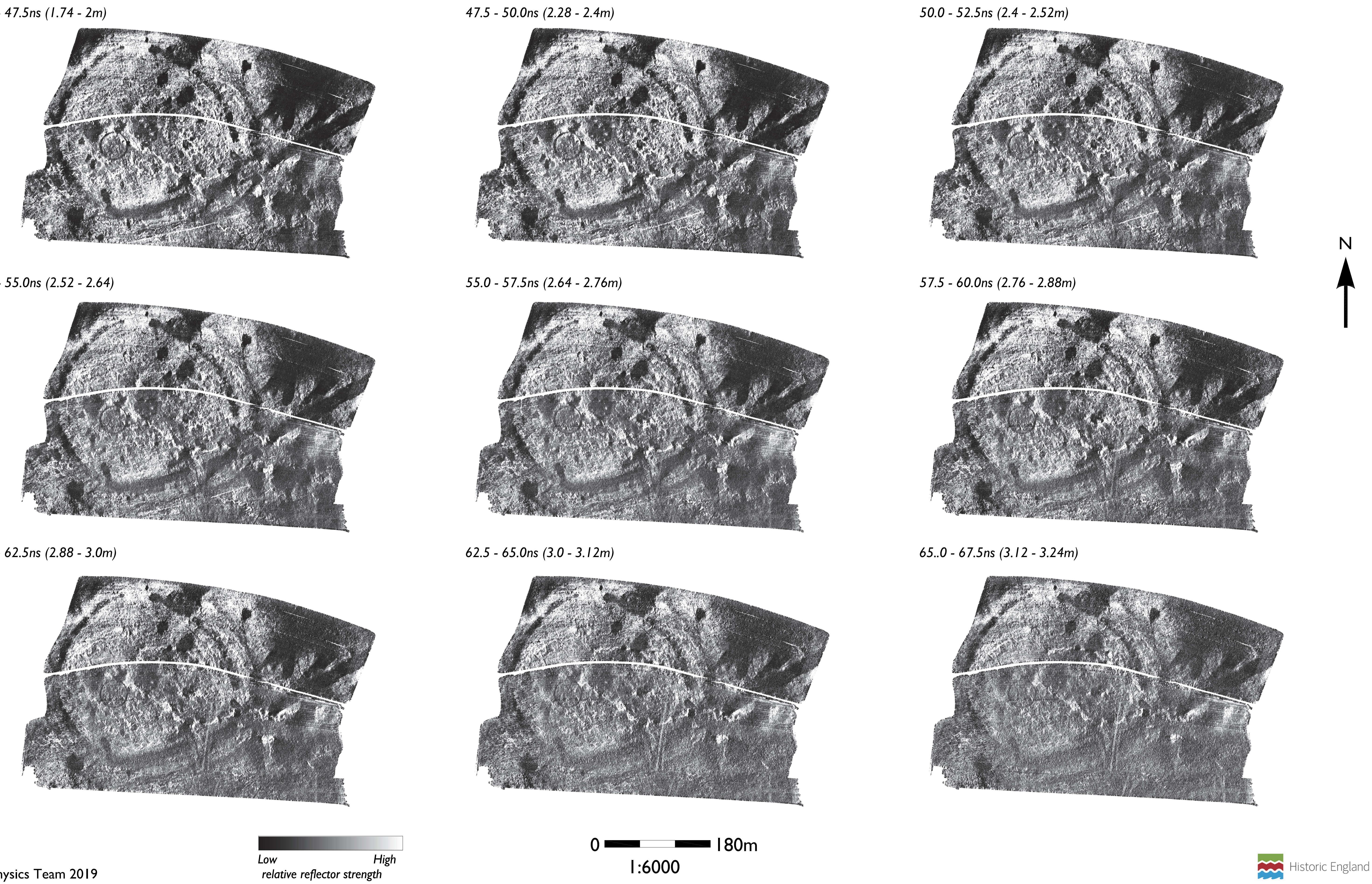
MOUNT PLEASANT, WEST STAFFORD, DORSET
GPR amplitude time slices between 45.0 - 67.5ns (1.74 - 3.24m), March and August 2019

Figure 10



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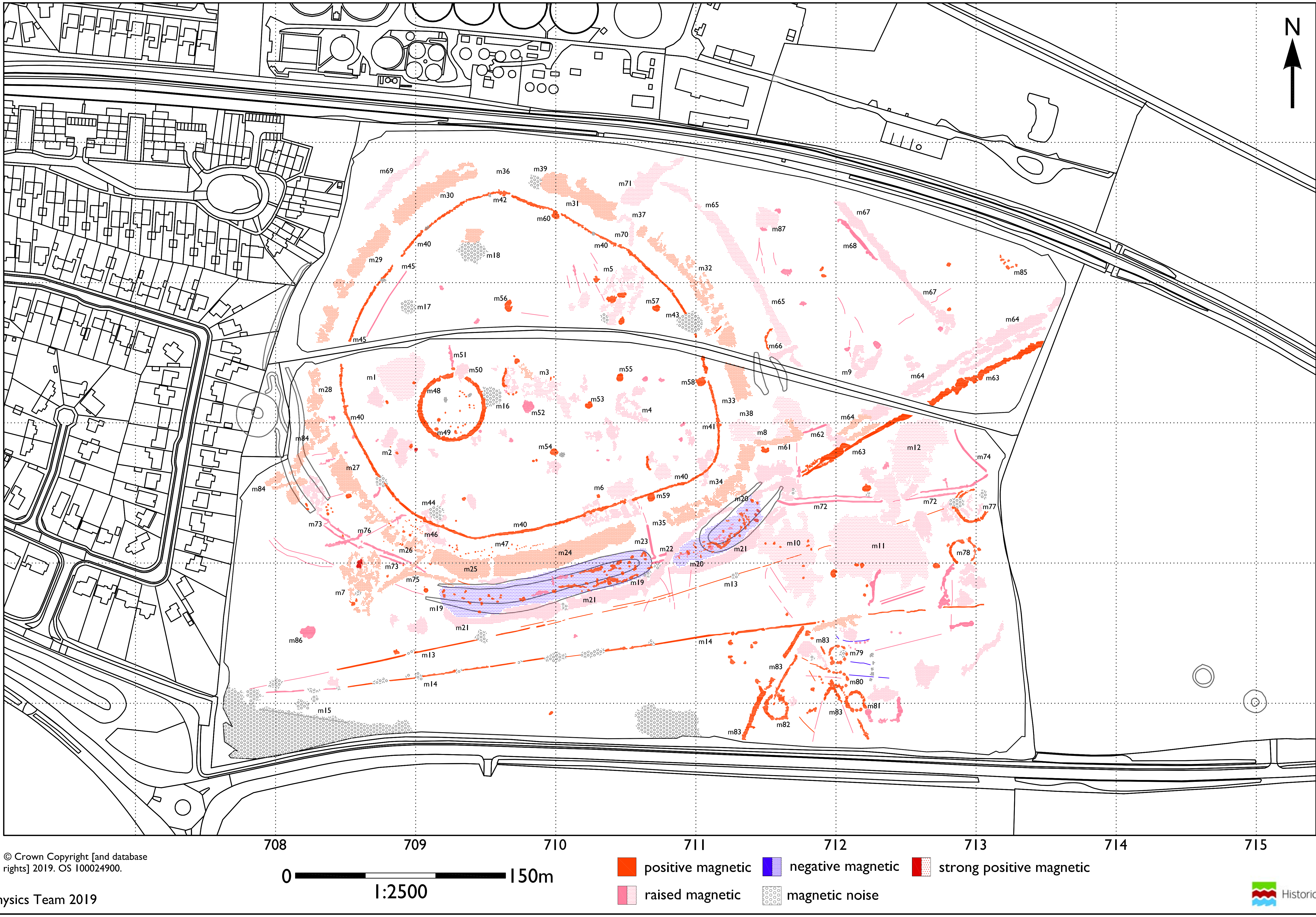
MOUNT PLEASANT, WEST STAFFORD, DORSET
Graphical summary of significant magnetic anomalies, March and August 2019

SY7089



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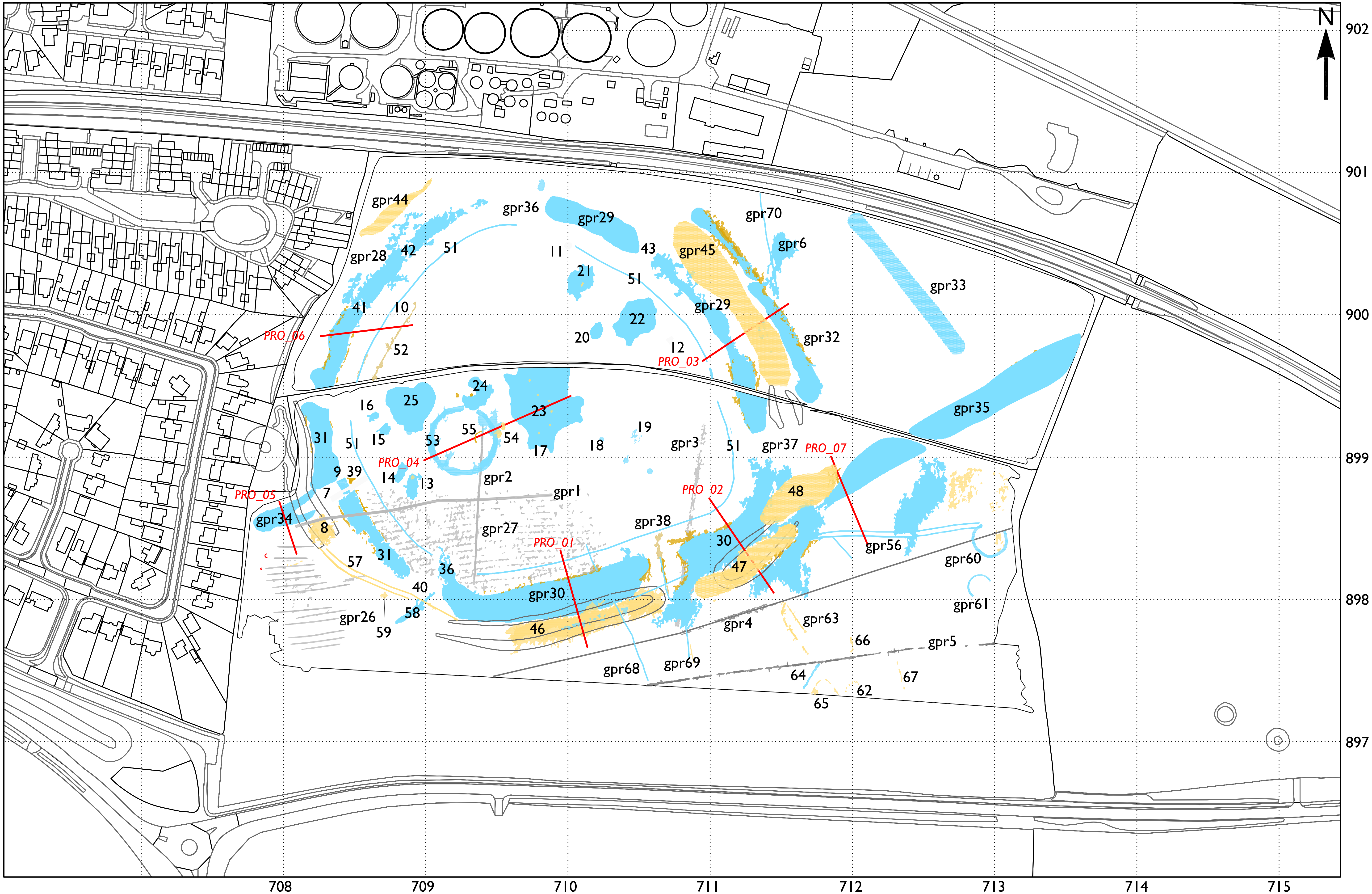
MOUNT PLEASANT, WEST STAFFORD, DORSET

Graphical summary of significant GPR anomalies, March and August 2019

Figure 12

SY7089



0 150m

1:2500

PRO_01 Location of selected GPR profile shown on Figure 7

low amplitude reflectors

high amplitude reflectors

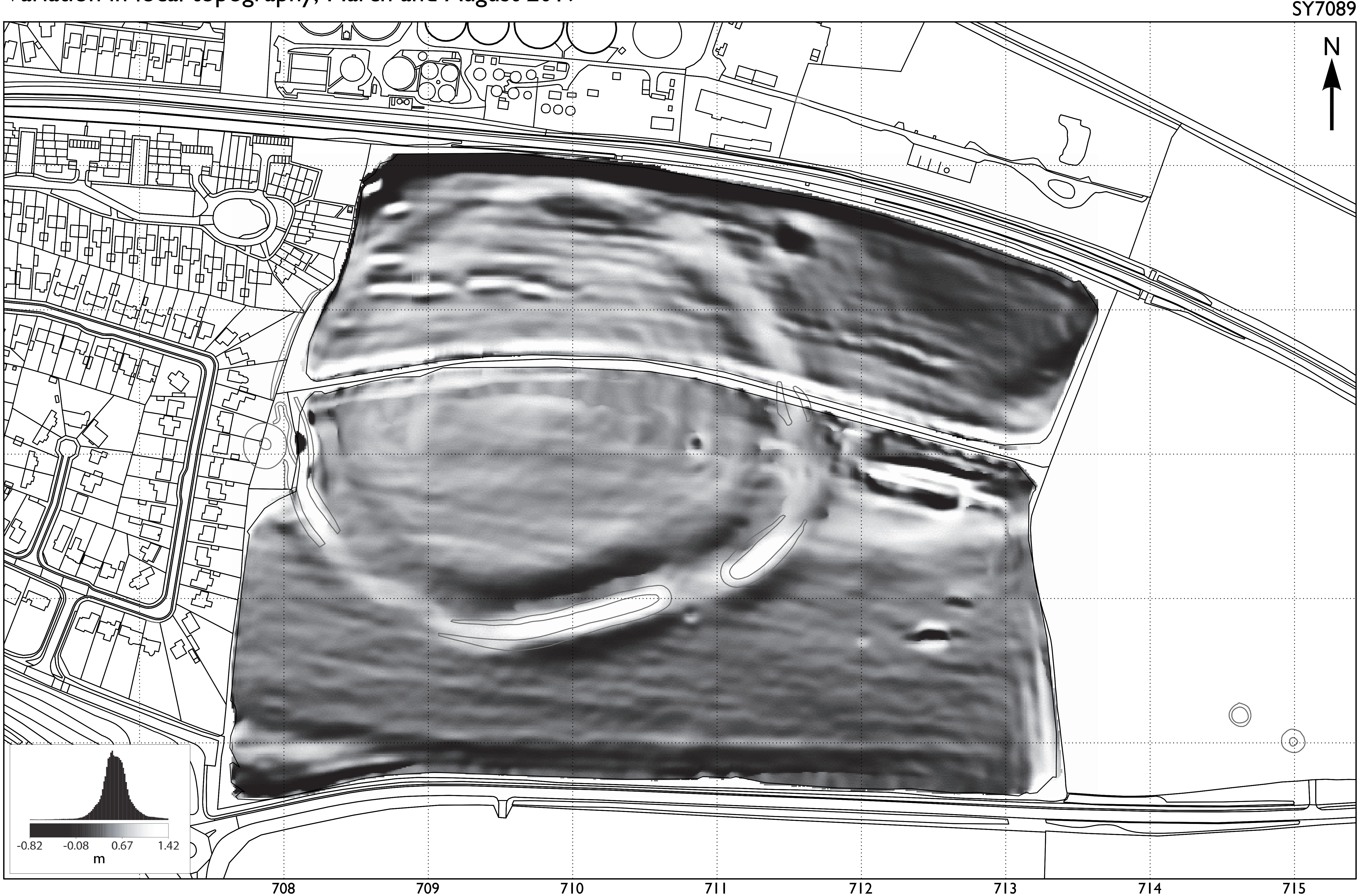
anomalies of known or recent origin

Historic England

Geophysics Team 2019

Figure 13

MOUNT PLEASANT, WEST STAFFORD, DORSET
Variation in local topography, March and August 2019



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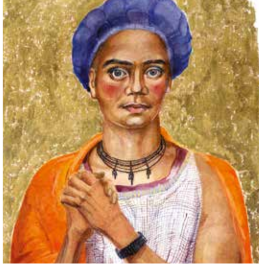



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