Further assessment of these resistivity anomalies and their correlation to the archaeological features in area A1 should be pursued through full data pseudosection inversion and careful consideration of excavation data and thorough resistivity profiling. In order to best integrate with the archaeology, it is necessary for the geophysics specialist to work closely with the archaeologists who excavated and recorded the site.

5.1.4 GPR Survey Results

Data interpretation was based on a full assessment of all geophysical data. In the case of the surface data for area A1, plough furrows and a rough survey surface have generated significant noise in the data. This noise made it more difficult to identify archaeological anomalies. After thorough investigation of the GPR surface survey data the pits were visible in three different areas of the data.

GPR data act in a similar manner to resistivity data in that possible distortions are introduced to the data with increasing depth. In GPR, features called hyperbolas are created due to the geometry of the propagation pattern of the radar waves. These hyperbolas are removed through migration, a method that effectively reduces the ‘tails’ of the hyperbolas based on a velocity curve formed by selecting representative hyperbolas across the data set. Migration has been performed on all the GPR data sets in this report.

Area A1 is a unique example of another form of data distortion caused by varying velocities of materials. GPR data are recorded as the time delay between the release of the radar signal, its penetration into the earth, reflection off of an interface of contrasting materials, and reception back at the ground surface. In the case of the pit-alignment, the pit fill contained a significant amount of water in contrast to the surrounding sandy gravel material. The velocity of a radar wave is fastest in air that has a dielectric permittivity of 1 and slowest in fresh water that has a dielectric permittivity of 81. All other materials (excepting metals) have dielectric properties in between 1 and 81. GPR profiles over the pit-alignment depict the position of the pits, not by obvious contrasts between the pit fill and gravel materials as would be expected, but by the change in the velocity of the GPR signal in the data. The changing velocity affected the position of a flat layer of stratigraphy at approximately 1m depth that can be seen across most of the survey area.

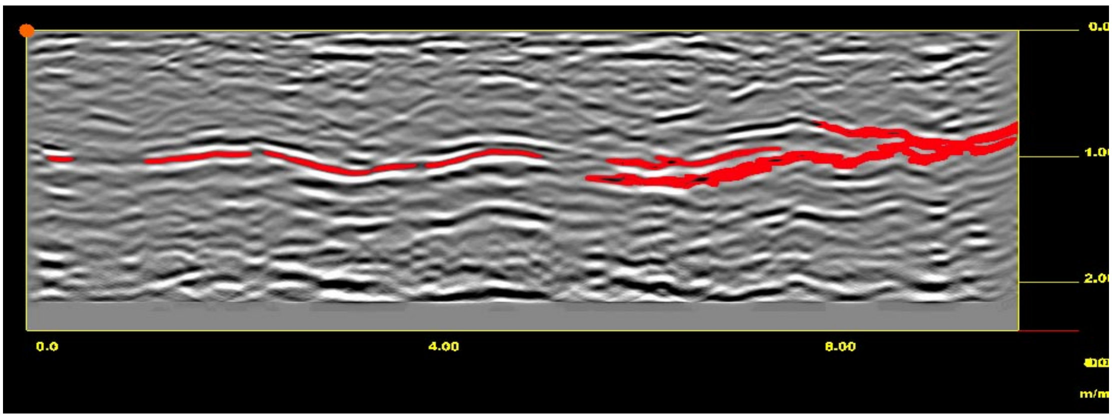

Figure 45. A1 GPR profile over the pit-alignment showing the changes in velocity of the radar wave due to saturated pit fills.

The position of the pits in this instance is centered on the lowest point in each dip in the layer highlighted in red in Figure 45. Once this change in velocities was observed, closer investigation of the data provides an intersection through the pits. This profile, however, is not obvious and if the change in signal velocity was not identified through a single layer of stratigraphy that happened to be in that particular location, these pits would be difficult to recognise.

Additionally, though the saturation of the pit fill was significant enough to affect the velocity of the radar signal in this instance, it is not guaranteed. If the area was surveyed after a long period of hot and dry weather, the results may be different.

To further investigate this type of feature GPR assessment was conducted adjacent to area A1 just after the topsoil was removed. With the pits of the alignment visible on the natural subsoil, the GPR was run over the position where the alignment would continue across the field. As many times as the GPR was run in the field over the position of the alignment, the pit features were not visible in the data in the field. The identification of this particular feature was made in the post-field data analysis.

Another note for data assessment of the pit-alignment pit features is that data must be investigated carefully, with a comprehension of the depth of the plan view (or slice) being assessed and the nature of GPR data. The pits are visible in their real positions, and if one is not paying attention, below their real positions. This is the case in any survey that has similar characteristics to this one.

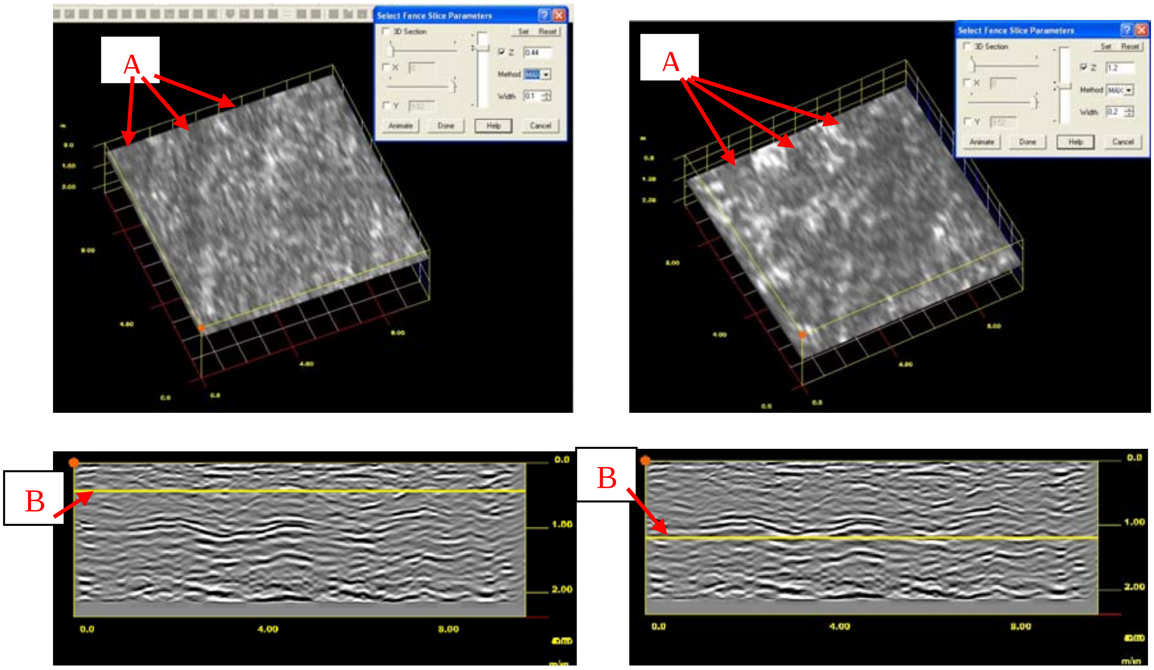

Figure 46. GPR plan views and vertical profiles detailing the pits of the pit-alignment and potential interpretation pitfalls. A. are the pit anomalies in the GPR plan views and B. shows the depth of the plan view at the position of the yellow line.

Note the image on the right in Figure 46 shows anomalies which appear below the level of the archaeological feature and could be misinterpreted.

The first clear map of archaeological features from the gravel survey is recorded in, or above, the ground coupling wave. Data have been processed so that time zero is at the very beginning of the first break to the positive peak of the coupling wavelet.

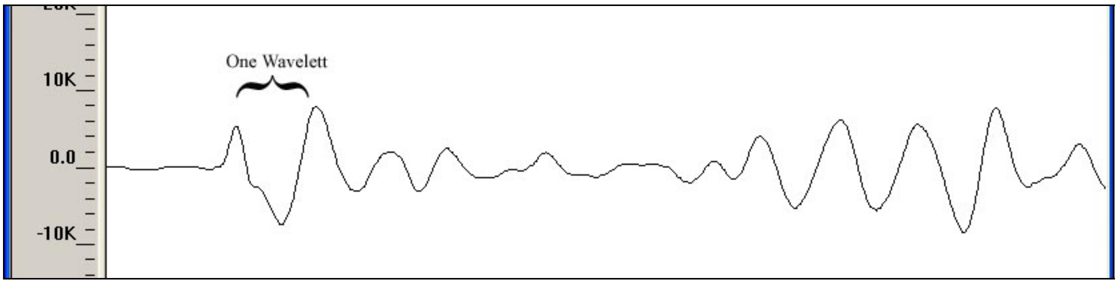

Figure 47. The ground coupling zone at the top of the GPR record measures approximately one wavelet.

The ground coupling zone, otherwise known as the 'dead zone', is believed not to record valid information of the survey near surface. In the case of the A1 gravel survey one wavelet is 4 ns, or approximately 0.17m. One would assume that approximately the top 0.17m of the GPR record would not provide valid data.

GPR data processing involves a number of nearly automatic steps during post-processing that include correction of time 0 (placing 0 at the true top of the survey surface) to filtering and gain adjustment. Typical work post-field includes spot checking of vertical profiles to make sure data are valid across the site then batch processing and creation of 3D cubes. Once the data are processed and in the 3D cube format data assessment begins.

Because of the nature of this project, data were viewed in the field daily both to assess data quality and to obtain information to help position further survey areas for the subsurface and 2m x 5m sub-area locations. During preliminary review data were not processed but just viewed in 3D cubes. The phenomenon of mapping through the direct coupling was discovered during this process.

Plans of each area with a 0.01-0.02 slice thickness at the very surface of the GPR record show changes in the direct wave amplitude due to variations of the surface dielectric (Chanzy 1996). This occurs because the very first (or top) part of the direct coupling is most sensitive as it is the superposition of the airwave and ground wave. When data were later adjusted to time 0 in post processing following normal time 0 guidelines, this detailed map of the archaeological record disappeared from the GPR data. Thus an adjustment was made to the time 0 process to include the direct wave amplitude, the difference not having a significant effect on the depth conversion for the rest of the data.

Though the true location of time zero is debated within the GPR community, the peak of the first positive lobe of the ground coupling wavelet is the standard time 0 position used in the concrete assessment industry (GSSI training manual).

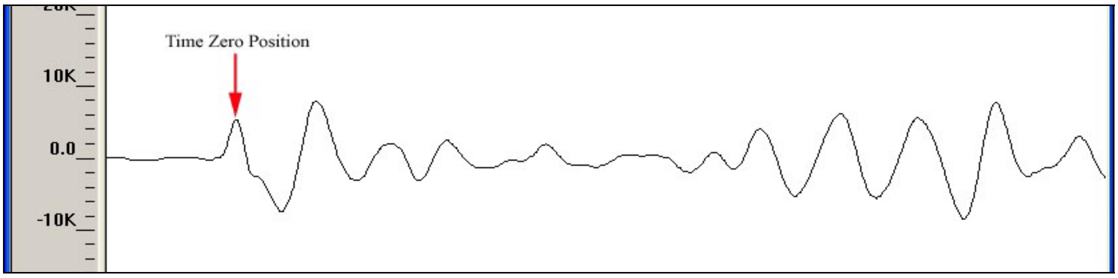

Figure 48. Time zero position for GPR trace.

Due to the new formatting of the SIR3000 GPR computer, the surface pulse is set down to 10% of the total selected range. This enabled the coupling image to be discovered.

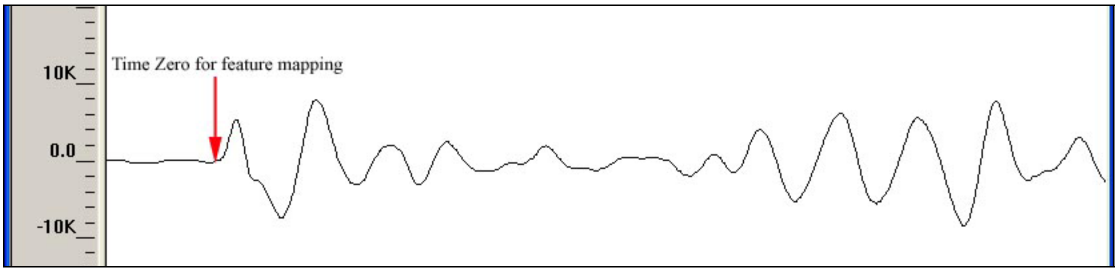

Figure 49. Adjusted time 0 setting to include the direct wave amplitude.

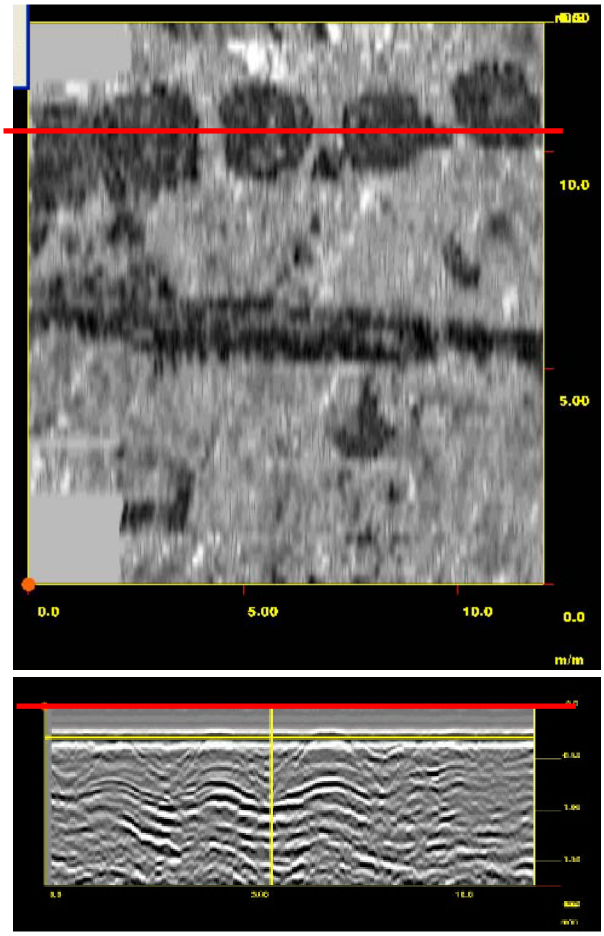

Figure 50. A1 GPR slice at time zero. The red line in the top image designates the position of the vertical profile at the bottom.

The results included at the very top of the scan in the data enables the generation of a map of surface dielectrics reflecting the details of the archaeological features. The first mapping of the pit-alignment was in the coupling wave of the radar survey, directly on the surface of the gravel as can be seen in the figure above. These data represent the moisture difference between the humic pit-fill and the sandy gravel background geology.

The second manner through which the pit-alignment pits were mapped was through the definition of the pit edges and changing velocities visible in the radar profiles and plan. Viewing the profiles adds further understanding to the plan and provides further detail of the archaeological features.

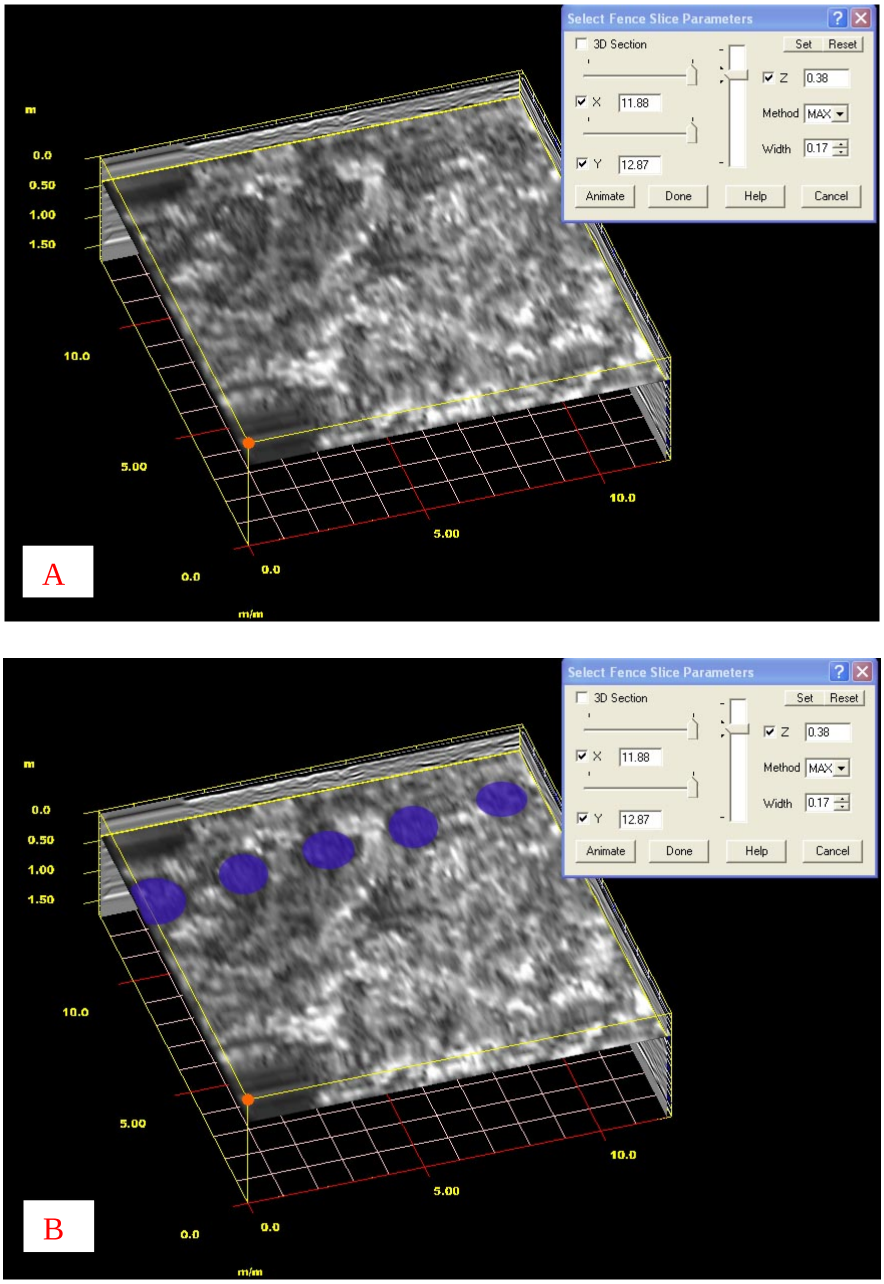

Figure 51. GPR plan map showing pit-alignment anomalies (blue) in A1.

Further details such as different deposits within the pits may have contrasting dielectric properties that are mapped in profile and through plan views. Detail on pit edges can be seen in profiles.

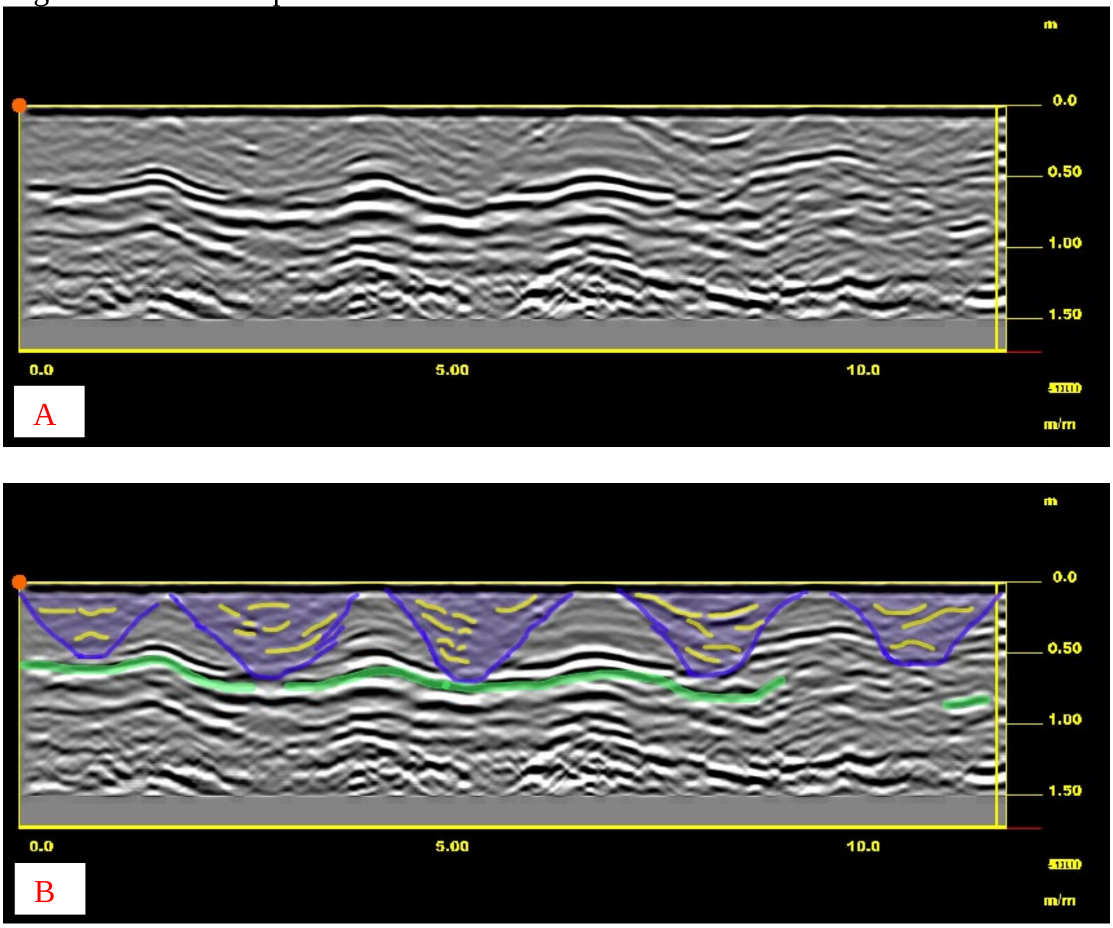

Figure 52. GPR profile across pit-alignment in A1. A is a processed profile and B is the same profile with preliminary interpretations.

Figure 52 presents a GPR profile across the pit-alignment. The top image (A) is processed data (time zero correction, horizontal background removal, migration) and the image on the bottom (B) has preliminary interpretations of the GPR anomalies in this profile. The green line represents the layer of stratigraphy that reflects the changing velocity of the radar wave due to the contrasting dielectric properties of the pit fill (a higher dielectric due to water content slows the signal down therefore creating a dip in the contrasting linear surface below) and the surrounding sandy gravel material. Blue areas define the pits and pit edges. The yellow lines define layers of materials within the pit features defined through contrasting dielectrics.

Further investigations into the pit fill materials with the integration of excavation records, other geophysical data responses (one 2m x 5m sub-area sectioned one of the pits) and the results from the soil sampling work should provide a more detailed picture of the actual structure of the pits and their fills.

5.1.5 A1 2m x 5m Sub-area

5.1.5.1 Magnetic Susceptibility

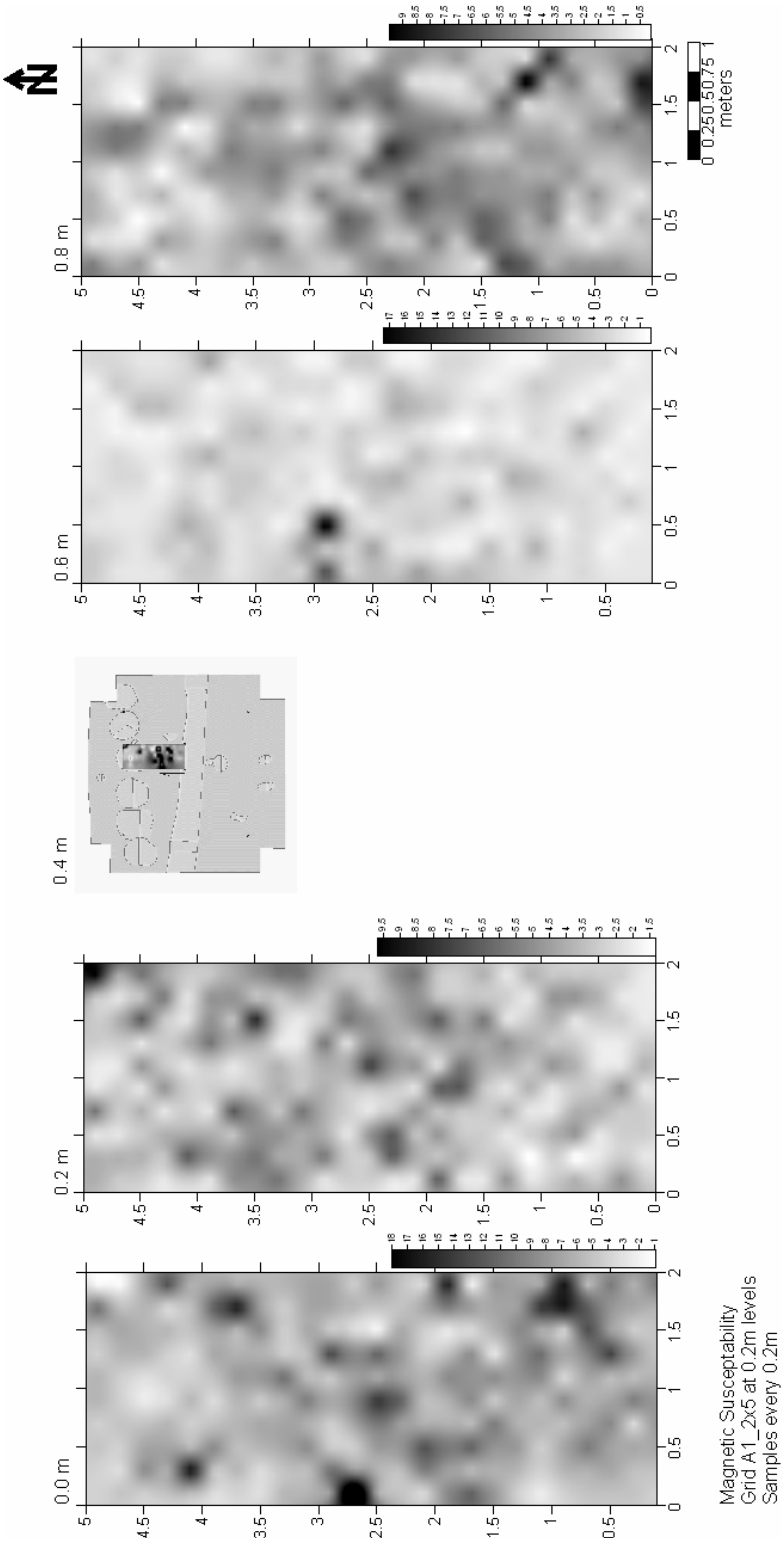

Figure 53. A1 2m x 5m magnetic susceptibility survey results.

The magnetic susceptibility maps do not reveal clear anomalies that can be related to the archaeology in A1.

5.1.5.2 Resistivity

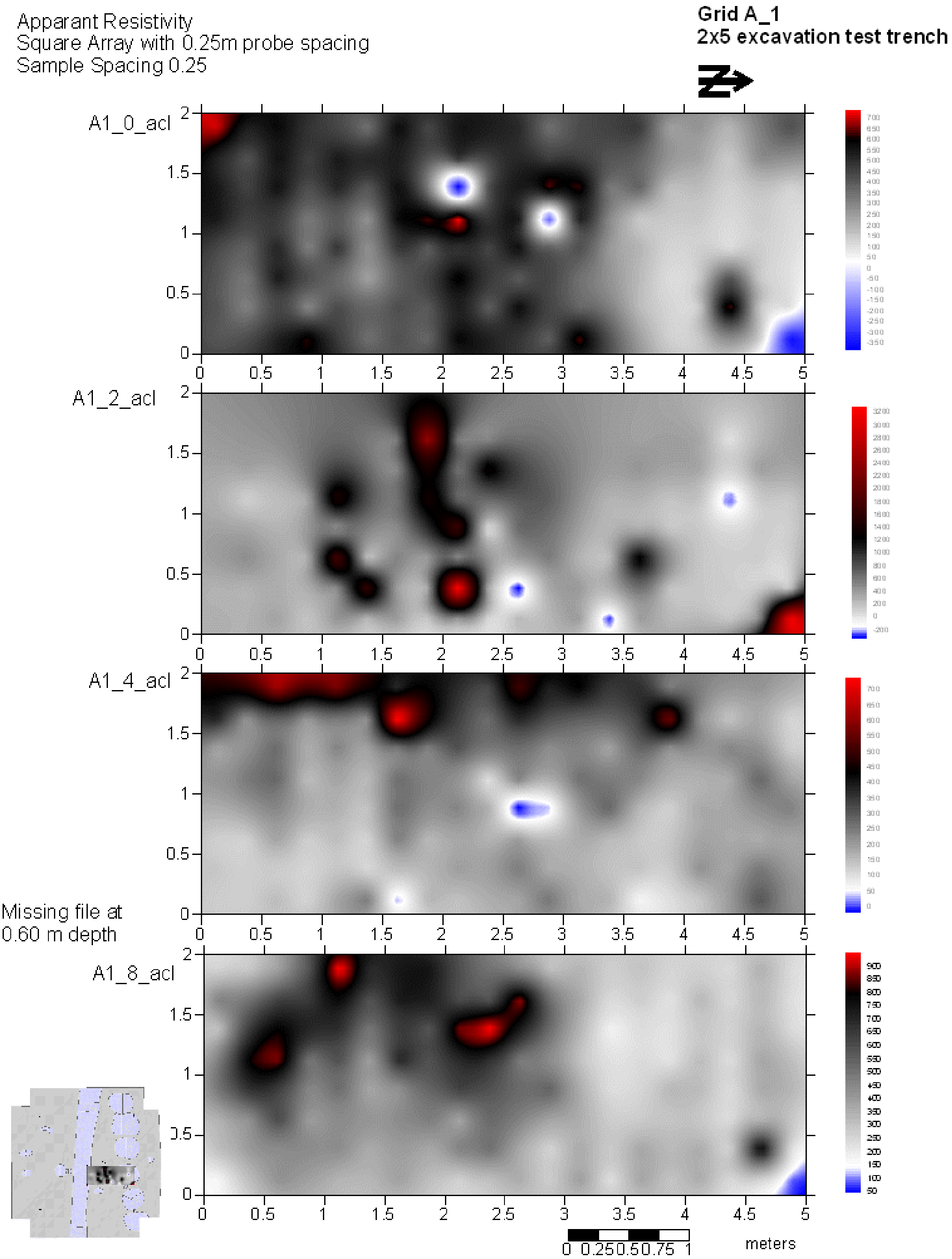

Figure 54. A1 2m x 5m sub-area resistivity survey results.

The apparent resistivity maps do not reveal clear anomalies that can be related to the archaeology in A1.

5.1.5.3 Dielectric Permittivity

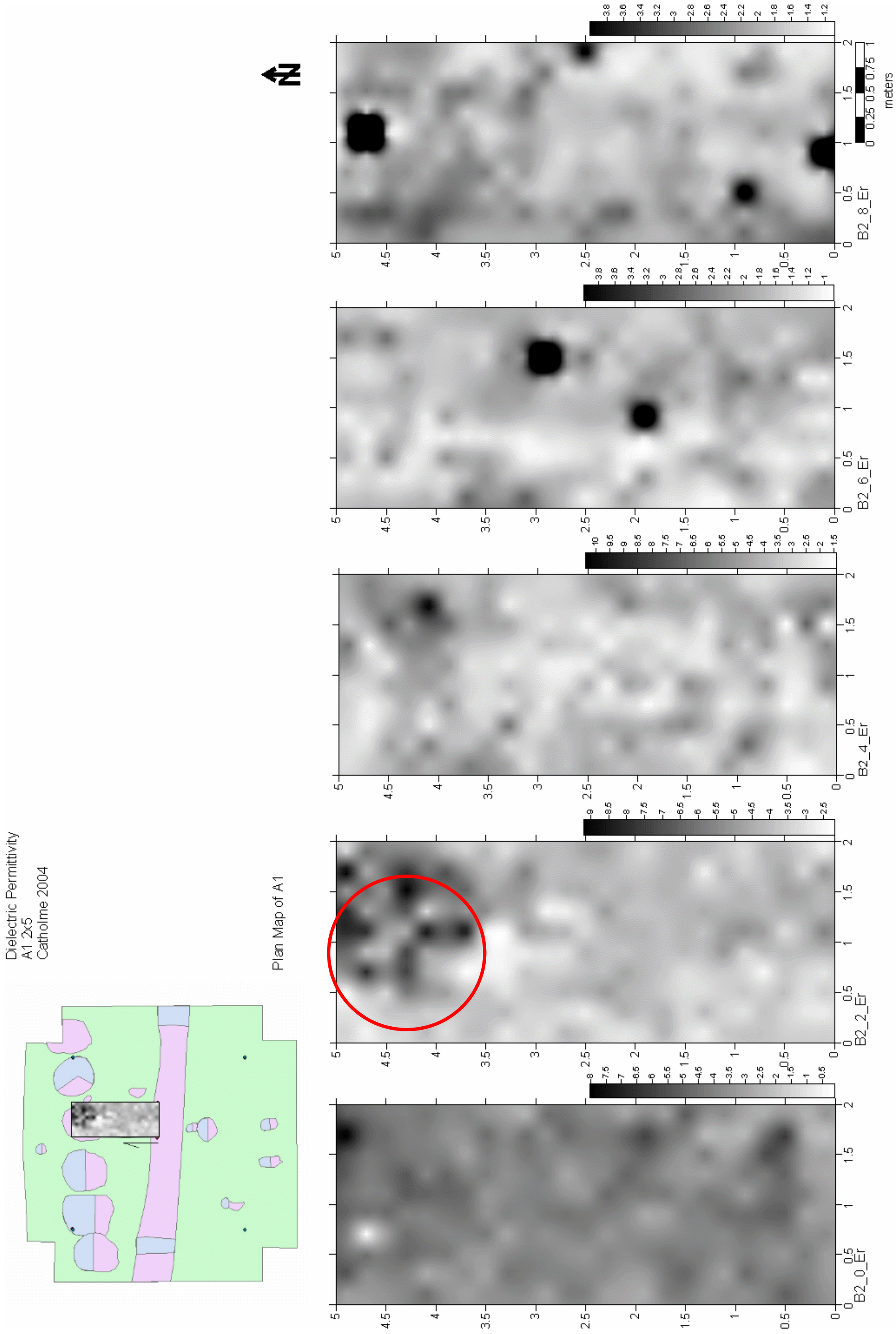

Figure 55. A1 2m x 5m sub-area dielectric permittivity survey results.

The best representation of the pit is mapped in the dielectric permittivity at 0.2m depth, outlined in red above.