2.0 Project Summary

Within the boundaries of the project, a ‘Focus Area’ encompassing an important concentration of monuments known as the ‘Catholme Ceremonial Complex’ was targeted for geophysical investigation. The Neolithic/Early Bronze Age monuments include a ‘Woodhenge’ feature comprising concentric rings of post-pits, a ‘Sunburst monument comprising a central ring ditch with radiating pit-alignments and a large ring ditch with associated linear features.

Figure 1. Oblique aerial photo with the 'Sunburst' and 'Woodhenge' monuments and pit-alignment cropmarks.

The location of these monuments is of particular archaeological significance not only because of the variety of archaeological features but also the geological nature of the area with complex river channel activity at the confluence of the Tame, Trent, and Mease Rivers.

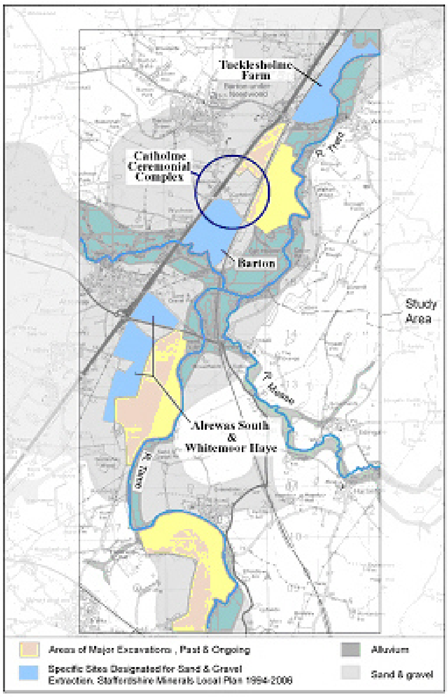

Figure 2. WRM Full Area.

Originally the 'Catholme Ceremonial Complex' was discovered as cropmarks and subsequently partially protected as a series of Scheduled Ancient Monument (SAMs). The archaeological features were described generally as a type "not readily susceptible to detection by conventional archaeological prospection techniques" (Buteux *et al*. 2002, p. 11). This description was based on the results of previous geophysical survey conducted in the Focus Area. The WRM survey objectives were to better classify the geophysical survey methods that may or may not positively identify this particular type of archaeological feature. Additionally, the project attempted to gain a more informed sub-surface view of the properties of the archaeology and how various geophysical survey methods responded to them, the aim being to better inform future archaeological investigation.

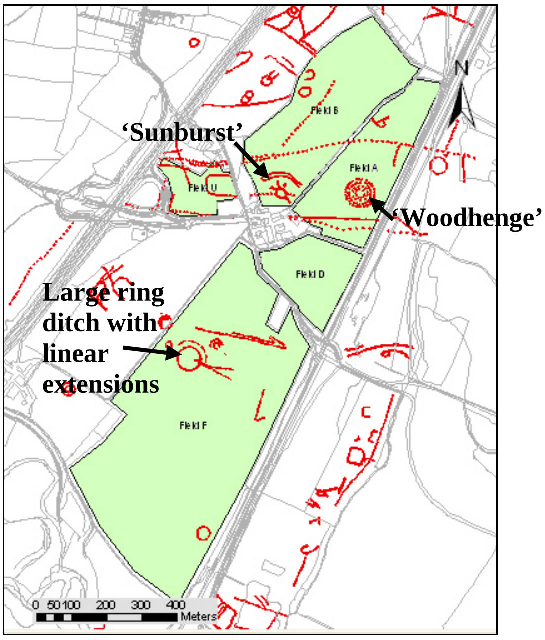

Figure 3. Geophysical survey focus area of the WRM project.

The Phase I geophysical surveys were undertaken with the aim of quickly and effectively covering large areas with conventional geophysical techniques. The surveys were successful and identified a number of anomalies, some of which were clearly archaeological. The main emphasis of the work was to classify the effectiveness of geophysical survey methods in identifying archaeological features in the Catholme area.

Phase II investigations were focused on 'ground truthing' the results from the Phase I work. This process employed a programme of further geophysical survey, soil analysis and excavation aimed at gaining a more in depth understanding of the site. The focus was to better understand the relationship between the geophysical survey data, below-ground archaeology and soil properties as a means to enhance the interpretation of survey results, and as a guide to future geophysical practice. A study of the relationship between the processes and materials by which the deposits obtained their geophysical properties was attempted in order to better comprehend the results of the geophysical survey and plan for more informed and effective work in the future.

Six areas of significant interest were selected for intensive investigation, three 20m x 10m areas and three 10m x 10m areas. An additional four sub-areas measuring 2m x 5m were selected for further geophysical sampling, soil analysis and excavation. Intensive geophysical surveys were conducted on the ground surface in each area and repeated on the subsoil surface following the removal of the plough zone. Geophysical sampling was continued within the 2m x 5m sub-areas at 0.2m deep intervals, then excavated and planned at each exposure until the base of the archaeology was reached.

Techniques used for each survey area included magnetometry, magnetic susceptibility, resistivity and ground penetrating radar (hereafter GPR).

The results of the geophysical surveys were processed and rectified into a larger WRM geophysical GIS. The multi-layered spatial nature of a GIS was necessary for the integration not only of multiple geophysical data types and interpretations, but also of excavation information and data from soil sampling and analysis. The management of project data in a GIS was an essential step toward potential full data integration between different geophysical surveys, soil analysis results and excavation information.

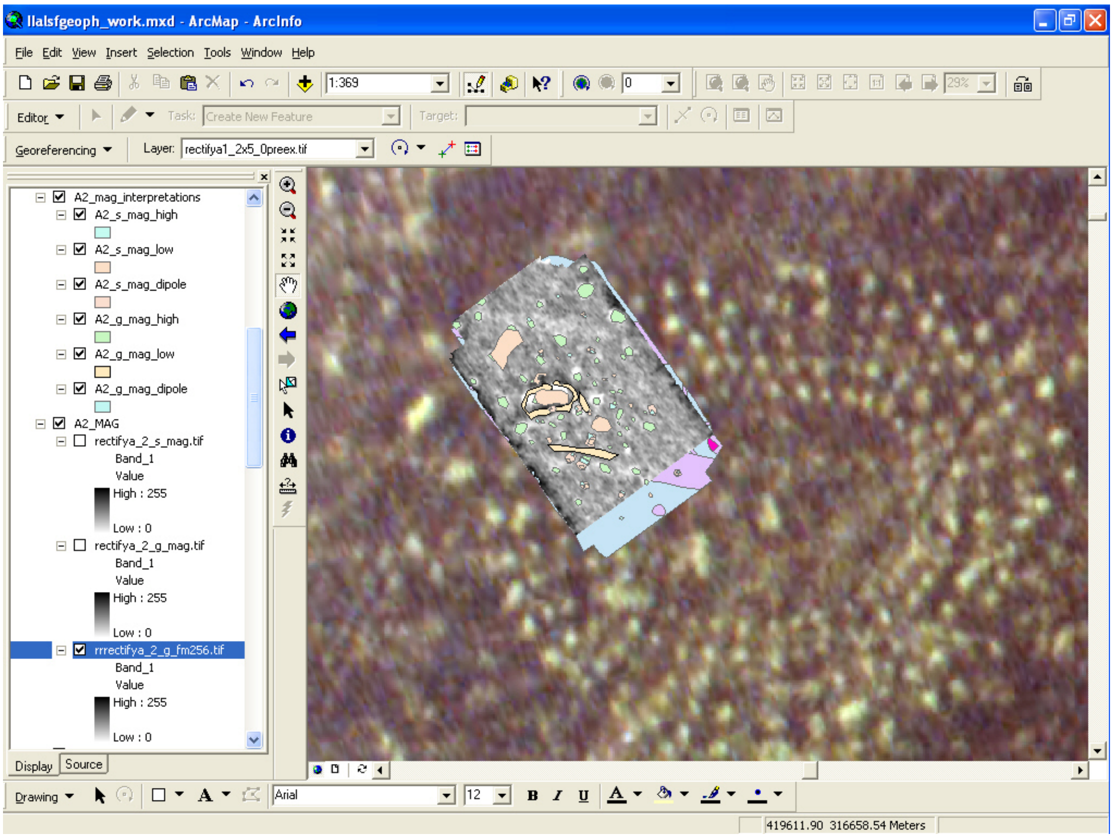

Figure 4. WRM GIS: Magnetic survey results and interpretations are overlain on rectified aerial photograph showing the 'Woodhenge' cropmark.

Data have been interpreted with an emphasis not only on the identification of archaeological features, but equally importantly, on the nature of the sub-surface response to each geophysical technique. Further investigations and analyses of the project data will provide a unique insight into the nature of the archaeology and environment and the impact of contemporary land use on it.

3.0 Review of Past Geophysical work at Catholme

Geophysical surveys have been conducted in the WRM Full Area previously as part of archaeological investigations in the early 1990s. The Focus Area, which includes the 'Catholme Ceremonial Complex', was first targeted in 1999 as part of a commercial project. This did not, however, include the areas of the three scheduled monuments (Bartlett 1999). Approximately 16ha was surveyed as part of Phase I of the WRM project during 2002-2003 (Watters, forthcoming). This survey covered broad swathes of the landscape around and over the scheduled monuments in an attempt to gather more information on the cropmark features and their surrounding environment.

3.1 Grey Literature

A general review of geophysical survey results in the Full Area indicated that potential archaeological features were successfully located, such as at Whitemore Haye (Bartlett 1998, 1995). But in general, geophysical evaluation in this region has not successfully located known cropmarks or other possible archaeological features.

Specific geophysical survey work in the Focus Area was conducted as part of an archaeological evaluation of the site extending to the north and east of Catholme Farm in August of 1999. The survey was commissioned by Phoenix Consulting Archaeology Ltd and undertaken by the Bartlett-Clark Consultancy Company on behalf of Hanson Aggregates (Bartlett 1999). The purpose was to assess whether archaeological features in addition to the known cropmarks might be identified.

Geophysical areas were located to provide an overall sample of the site and to include archaeological features which had previously been recorded as cropmarks, all bar those in the scheduled areas (Bartlett 1999). This project was undertaken mostly using magnetometry. Small areas were also covered using resistivity over selected features which had been identified previously by magnetometry. This survey did not provide conclusive results (Bartlett, 1999, p.3-4).

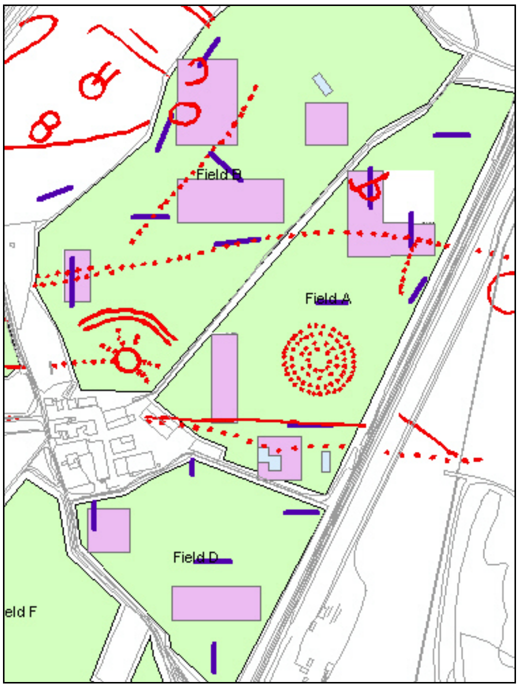

Figure 5. Previous geophysical survey (purple areas) and excavation (blue lines) in the Catholme Ceremonial Complex area.

Following the geophysical survey a series of trial trenches was excavated. These were located over possible anomalies which had been highlighted in the geophysical data, over known cropmarks and in unrelated areas to provide a measure of control. Some geophysical anomalies were identified positively as archaeological features but, in general, the geophysical survey did not contribute significantly to the archaeological project (Hughes and Coates 1999).

3.2 ALSF WRM Phase I Investigations

Phase I investigations were implemented in order to study a number of aspects of the archaeological landscape. These included specific archaeological monuments and the impact of modern land-use and hydro-geological patterns on the state of archaeological preservation.

3.2.1 Phase I Geophysical Survey Goals and Methodology

Geophysical surveys were conducted with the aim of:

- Non-invasive mapping and identification of archaeological features.
- The establishment of methodologies for effective geophysical mapping.
- Assessing the impact of contemporary land-use.
- Contributing to a larger dynamic landscape model for a better understanding of the site and the human use and occupation of the area over time (Watters, *forthcoming*).

Resistivity, magnetometry and GPR techniques were each employed in the geophysical mapping of the project area. Magnetometry and resistivity were selected on the basis that they are the most commonly used techniques employed in most archaeological investigations, and were also readily accessible. GPR was used because it was an appropriate method to employ in this environment and has often been overlooked in British archaeological investigations. Data collection began with a resistivity survey in April 2003, since this method typically takes up to twice as long as the other methods to conduct. A magnetometry survey followed in June 2003 and GPR survey in October 2003.

A review of the grey literature which related to the Full Area showed that most archaeological investigations were conducted in the field on the basis of the location of known cropmarks. The geophysical survey of the Focus Area was also based on the location of the cropmarks. As with previous projects, one of our primary objectives was to establish whether we would be able to map the cropmarks and other features, whilst the process of mapping these features was itself assessed.

The area covered during Phase I of this project was more extensive than is usual in order that more of the landscape could be mapped than the isolated 'postage stamp' areas more conventionally targeted. The project coverage totaled *c*.26.5ha, resistivity survey measuring *c*.13ha, magnetometry survey *c*.10ha and GPR *c*.3.5ha.

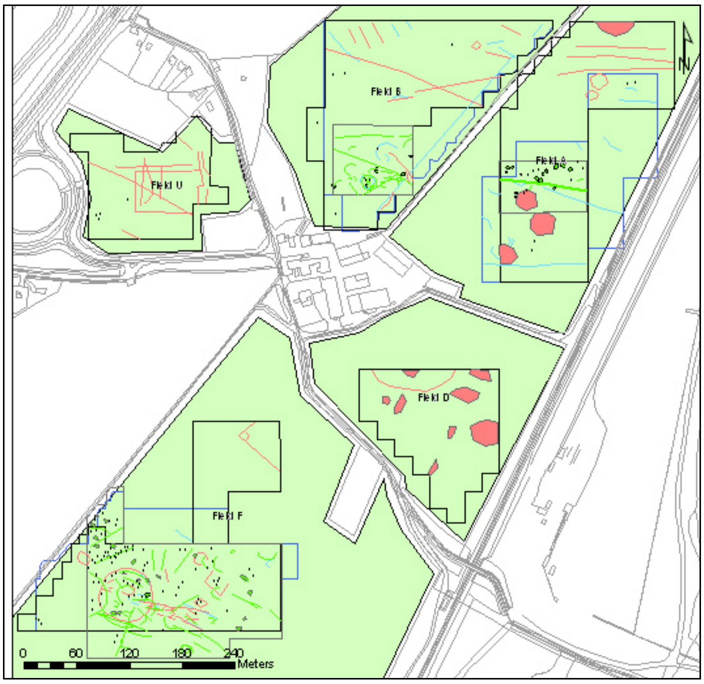

Figure 6. Phase I geophysical survey areas and interpreted anomalies.

The geophysical survey conducted over the five fields of the Focus Area revealed many geophysical anomalies. One objective of the survey was to determine whether the known cropmarks could be detected by non-invasive means. The ring ditch of the 'Sunburst' monument in Field B was mapped definitively as was almost the entire group of cropmark features in Field F. Field A produced some good results over the pit-alignment in the north, but failed to produce positive results for the cropmarks which correspond with the 'Woodhenge'.

The survey in the Focus Area successfully mapped many known cropmarks as well as a number of new potential archaeological anomalies. This research provided a thorough assessment of basic geophysical methodologies in general use in the field.

The results of the survey contained some surprises and posed interesting questions which perhaps challenge present archaeological practices.

In addition to mapping the cropmarks, the GPR survey provided a geophysical profile of the Focus Area. This three dimensional perspective provided the opportunity for analysis of the effects of modern and past land-use on the archaeological resource. It provided information which suggested the 'Sunburst' monument in Field B had been directly affected by more recent land-use, probably from the medieval period onwards, as evidenced by remnants of possible ridge and furrow.

Analysis of the GPR results in Field F provided information that present and past land-use appeared not to have directly impacted upon the buried archaeological resource. Field F may well therefore contain the best preserved archaeology.

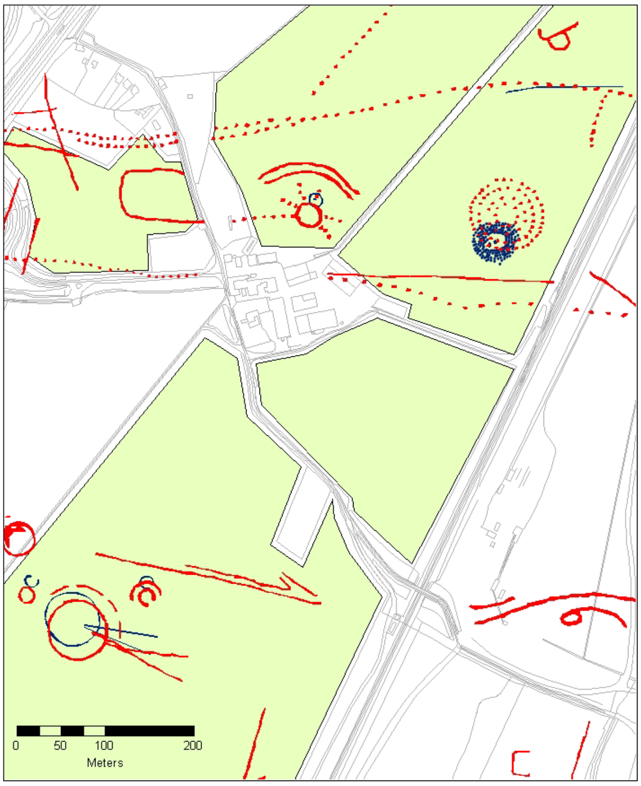

Figure 7. Re-digitised cropmark features in blue.

3.2.2 Comparison to Grey Literature

The results of the extensive survey undertaken as part of the WRM project was compared with the results of earlier geophysical surveys, both in the Focus Area and the Full Area. The earlier surveys were undertaken mostly as part of commercial projects. A review of the relevant grey literature revealed that while some of this work was effective in identifying archaeological targets only a small proportion of the overall work done might be described as successful and most employed only a single technique, on a limited scale.

A number of factors might explain the variable results revealed in the review of the grey literature:

- Technique used (resistivity, magnetometry, *etc*).
- Geology and soils.
- Feature properties.
- Ground conditions (for example saturation).
- Extent of coverage.
- Data sampling intervals/rates.
- Processing, analytical and display techniques.

3.3.3 Phase I Conclusions

Two key points emerge from the results of Phase I geophysical investigations:

- The ring ditches in Fields B and F responded differently to resistivity and magnetic survey, but similarly to GPR. The ring ditch in Field B was clearly located with GPR and magnetic survey methods whilst the ring ditch in Field F was located by GPR and resistivity survey. The questions that arise from these results are:

    I. Why was the ring ditch in Field F located with the resistivity method whilst that in Field B was not?

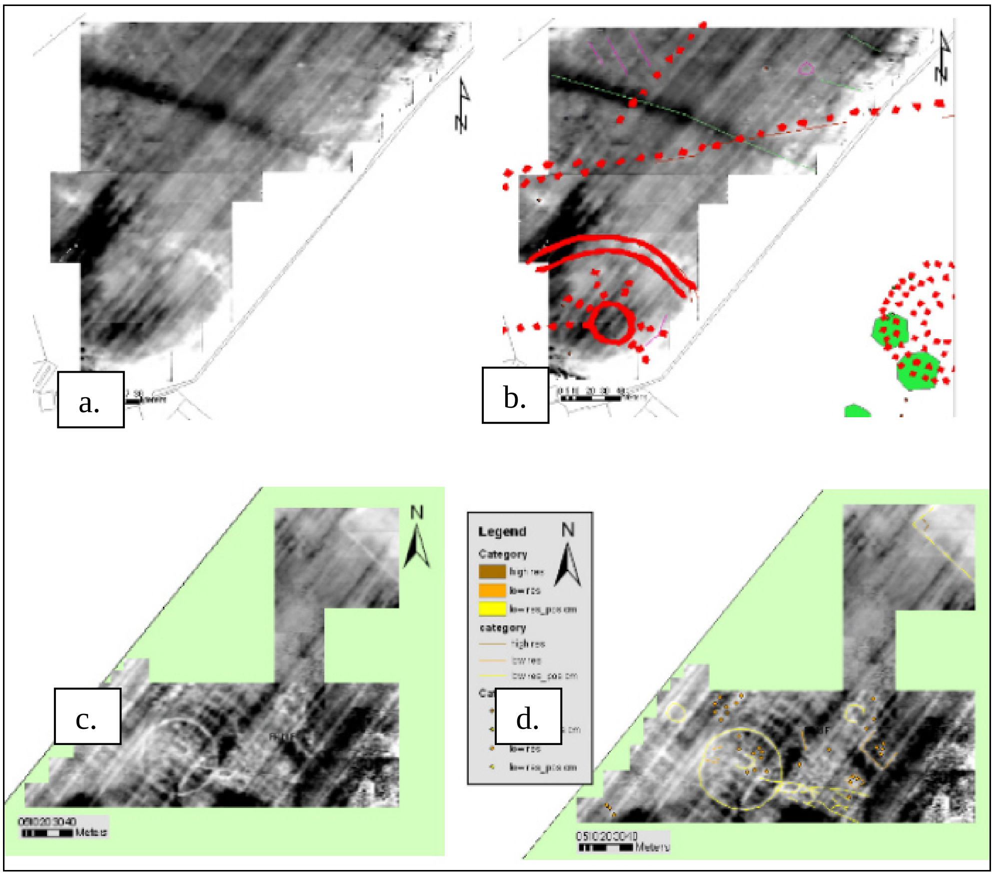

Figure 8. Resistance survey results over the 'Sunburst' (a. and b.) and large ring ditch (c. and d.) monuments.

The contrast in resistivity survey results in this instance could be explained by the possible difference in ground saturation during data collection. The resistivity data for Field F was collected during rain while Field B was very dry during data collection. If this is the explanation, why did GPR work effectively in both cases? It is often dependent upon the same site properties as resistivity, for example saturation which enhances the contrasts in dielectric properties. GPR and resistivity clearly differ enough in their sensitivity to different physical properties such that they do not always respond in the same manner to ground conditions.

II. Why did the ring ditch in Field B appear as a strong anomaly in the magnetic data - although there were some very weak signatures in places - whilst the ring ditch in Field F did not appear so clearly?

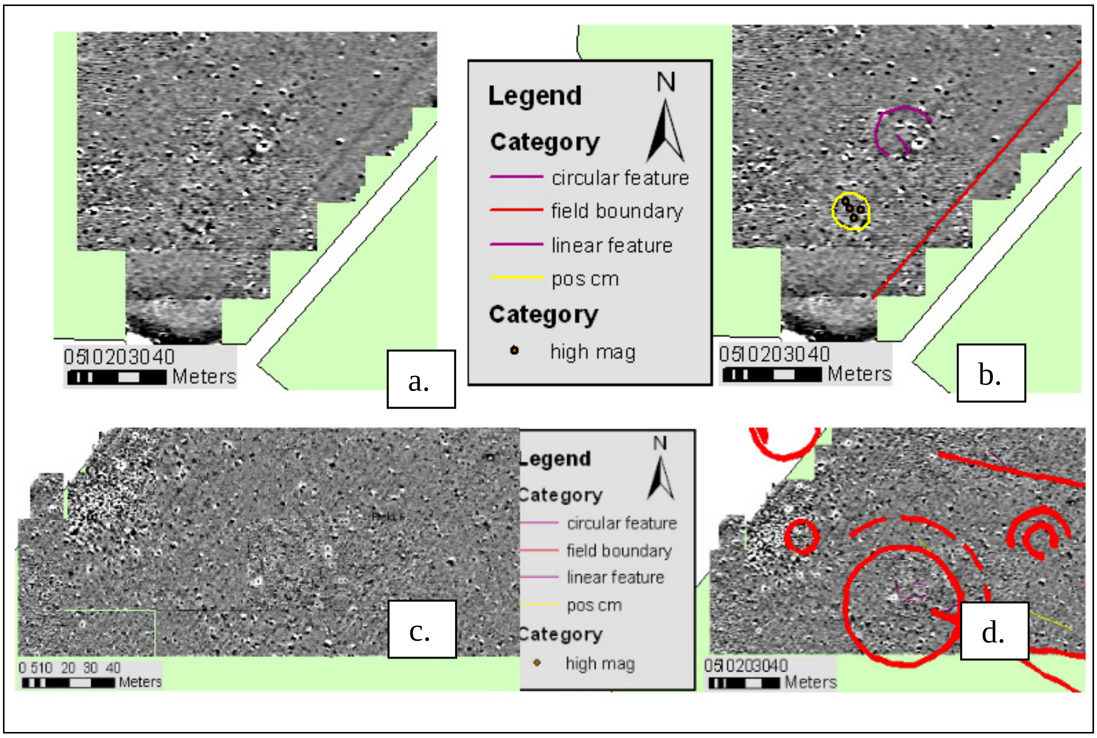

Figure 9. Comparison of magnetic survey results for the 'Sunburst' (a. and b.) and large ring ditch monuments (c. and d.).

This could be explained with reference to the remanent magnetism of the ploughed soil which is characteristic of recent ploughing events. If a field is surveyed by magnetometry soon after ploughing the remanent magnetism may still be relatively strong in the topsoil and may overshadow underlying magnetic features. Alternatively the variable results may have been a product of different fill compositions in the ring ditches in each of the fields.

- All three survey methods failed conclusively to map any features of the ‘Woodhenge’ monument.

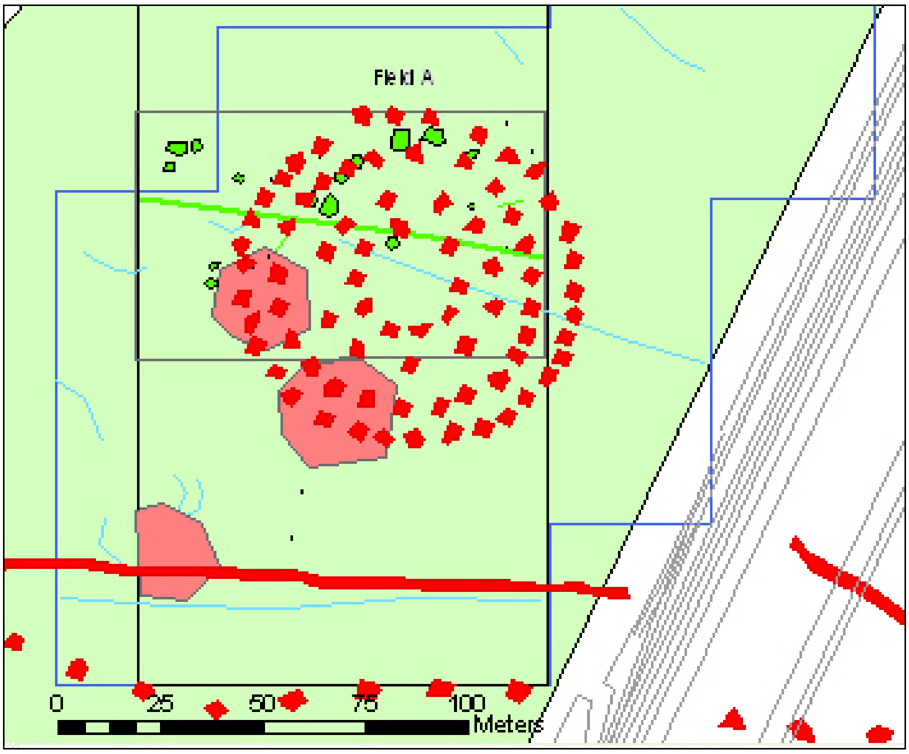

Figure 10. Phase I geophysical survey interpretations for the 'Woodhenge' monument. GPR (green), resistance (pink) and magnetic (blue).

Examination and rectification of oblique aerial photographs relocated the ‘Woodhenge’ feature. Magnetic and GPR surveys do not record any obvious archaeological anomalies in the newly positioned location of the ‘Woodhenge’ monument. The area of high resistivity that is in this area is most likely geological in nature.

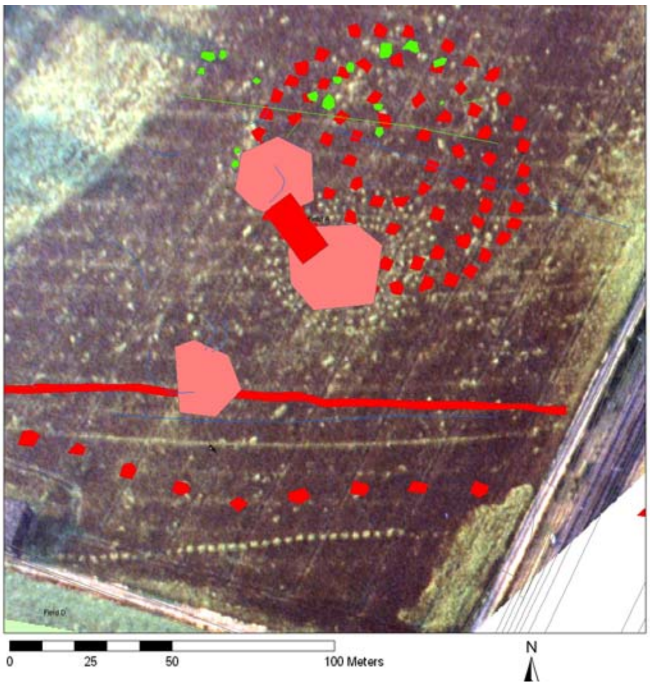

Figure 11. Re-assessment of the correct positioning of the cropmark data positions the 'Wood henge' feature over a probable geological resistance anomaly.

Location of the ‘Woodhenge’ monument could have failed for a number of reasons:

- Physical properties: The features of the ‘Woodhenge’ may have been too small to be located with the sampling methods utilised in this survey.
- The properties of the ‘Woodhenge’ monument were perhaps not detectable with the techniques employed.
- The sampling methods utilised for data collection may not have been robust enough for these types of features.
- The archaeological features may have been severely damaged by past and/or contemporary land-use.

Answers to these questions could only be achieved through further geophysical survey data analysis, additional geophysical survey, soil analysis and excavation.