Stanton Drew 2010

Geophysical survey and other archaeological investigations

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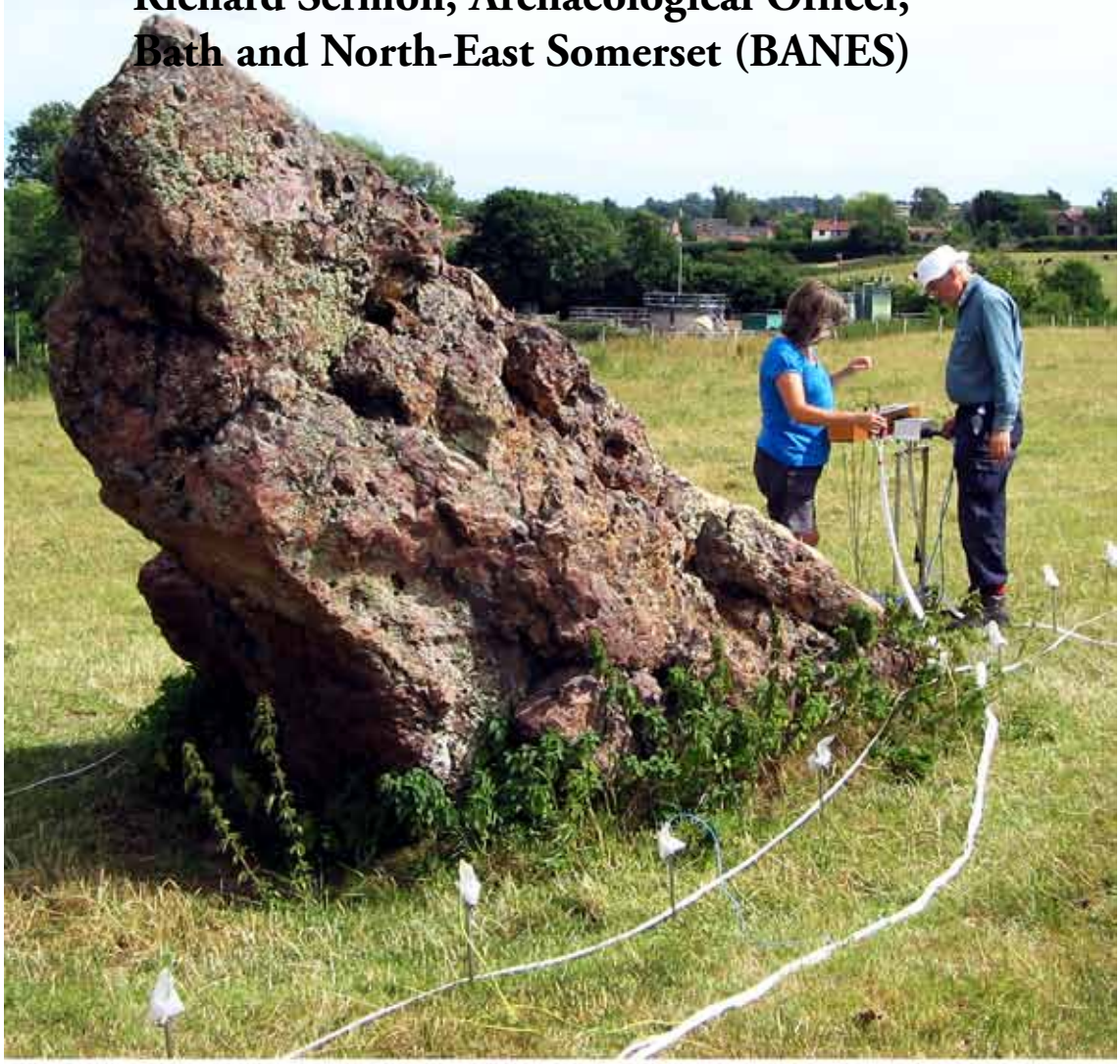
Bath and Camerton Archaeological Society

Richard Sermon, Archaeological Officer,
Bath and North-East Somerset (BANES)



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With contributions from Vince Simmonds

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Report compiled by Jude Harris

The surveys were carried out under English Heritage licences,
SAM numbers 22856, 22861, 22862 and BA44

Abstract

Bath and Camerton Archaeological Society undertook geophysical and other surveys at the stone circles at Stanton Drew, Bath and North East Somerset (BANES), between May and September 2010, in collaboration with the BANES archaeologist, Richard Sermon. The surveys were intended to enhance the knowledge gained by the work carried out the previous year.

The completion of a high data density magnetometer survey over the whole of Stone Close has added much extra detail, including a new henge entrance, posthole settings and an area of activity just outside the circle to the south-east. Use of resistance pseudosection profiles, together with an increased area of twin-probe resistance, has given a greater understanding of the underlying geology as well as sub-surface features.

In the SSW Circle, an EDM survey has shown how the circle was positioned very deliberately to occupy the small flat plateau, with views northwards across the other circles towards the River Chew, westwards to the Cove, and across the valleys to the south and east. The magnetometry survey has confirmed the results obtained by English Heritage, and may show more detail. In addition to three post circles, there are anomalies to the north west and north east of the circle, the latter may be part of an entrance. The arc of positive anomaly around the west of the circle may be part of a ditch, but it is perhaps more likely to be wall footings, especially as it shows as high resistance in the resistance survey.

At the Cove, the resistance surveys have added some reinforcement to the interpretation of a long barrow/chambered tomb, but the results are by no means conclusive. Attributes of length, width and orientation are consistent with this interpretation, and there may be signs of flanking ditches.

Other work carried out included a photographic survey of all the stones, a geological survey, and work has started in putting the monument in its geographical context. There is also an analysis of the archaeoastronomy of Stanton Drew.

In addition to recommendations for the completion of certain work within the scheduled areas, it is proposed that attention next be given to the surrounding fields to the south, and to Hautville's Quoit and the Tyning Stones.

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Preface

Our week of work at Stanton Drew in 2009 produced some very interesting results that were well-received by eminent archaeologists and the media. We were able to show that we could reproduce the English Heritage results of the previous decade, and we advanced the theory that the Cove stones had once been part of a long barrow.

However, the amount of work possible in five days, some of which was in atrocious weather for July, was very limited. It was obvious we needed to carry out more work, and so in 2010 we returned, this time for a total of sixteen days. In that time, the BACAS volunteers got through an enormous amount of work, using magnetometry, mag sus, twin-probe resistance, resistance profiling, and radar, as well as carrying out EDM surveys and overhead photography of the stones.

In this report, we have brought together the significant results from 2009 together with the new results from 2010. Vince Simmonds has produced a comprehensive contribution on the local geology and landscape. Richard Sermon has contributed a valuable re-examination of the archaeoastronomy of the site. In an appendix, John Oswin examines the results obtained by the dowser, Paul Daw.

The geophysics equipment used was that belonging to the Bath and Camerton Archaeological Society (BACAS). Some of this equipment was bought through the generosity of its members, for some we are indebted to the Heritage Lottery Fund for purchase grants.

John Richards
Stanton Drew project leader, Bath and Camerton Archaeological Society.

Acknowledgements

This report was prepared by John Richards, Richard Sermon and John Oswin, with a contribution also from Vince Simmonds. Tim Lunt, Roger Wilkes, Jane Oosthuizen, and Heidi Beck also contributed material useful to the project. The report was assembled for publication by Jude Harris.

Figures 6.1 to 6.6: Vince Simmonds.

Figure 7.3: Richard Sermon.

Figure 8.1: Chance of Chippenham.

Figures B.1 to B.3: contain plans produced by Paul Daw.

Google Earth was used to produce some of the diagrams.

Bob Whitaker was project director and Robin Holley, deputy project director. Richard Sermon, archaeologist for BANES, provided professional advice and guidance and obtained the geophysics licences from English Heritage.

The geophysical survey was conducted by John Oswin and John Richards, plus for varying times: Keegan Armstrong, Sally Churchyard, Susie Coggles, Jan Dando, Owen Dicker, Keith Dyke, Chris Garmston, Kate Henderson, David Henderson, Sonia Heywood, Christine Jones, Roger Kergozou, David Kerrison, Philipa Kohly, Dave Ladbrook, Tim Lunt, Teresa Marsh, Fiona Medland, Margaret Nuth, Jane Oosthuizen, Sue Pickering, James Robson, Vince Simmonds, Keith Turner, Gill Vickery, and Roger Wilkes. We are very grateful for all their efforts.

Thanks go to Paul Daw for providing his dowsing plans.

Thanks especially to Mr Richard Young for allowing us on his farmland, Mr John Newcombe of the Druid's Arms Inn, for allowing access to the pub garden and his private garden, and to Mr Stock and other churchwardens who allowed us access to the churchyard and let us use the church for data download.

1 Introduction

1.1 Location and sites

The village of Stanton Drew lies in northern Somerset, approximately 10 km south of Bristol city centre and 15 km west of Bath, on the south bank of the River Chew. The village comes within the unitary authority of Bath and North East Somerset (BANES). The stone circles lie mainly to the east of the village in farmland. Figure 1.1 gives detail of its location.

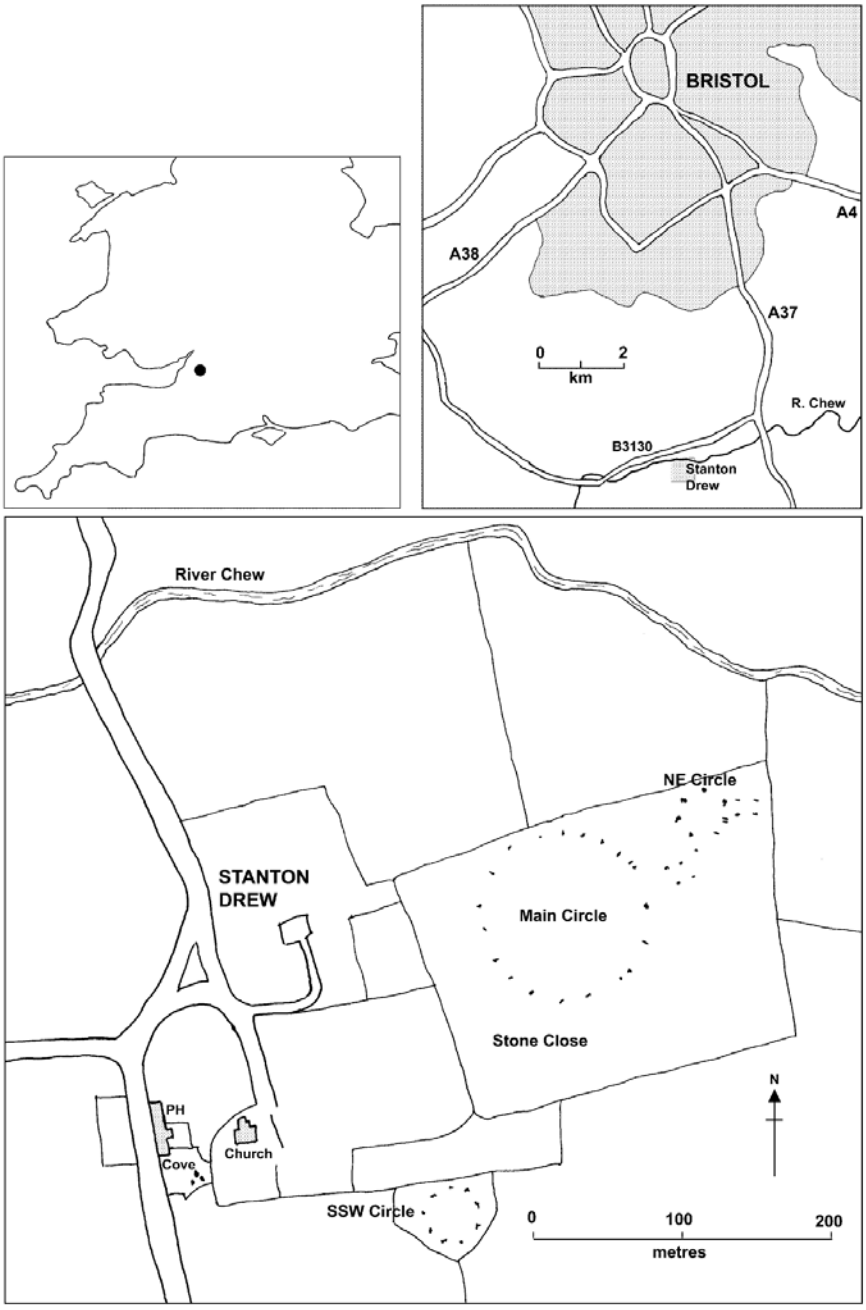

Figure 1.1 **Stanton Drew stone circles– location map**

Within the complex are three stone circles, two avenues, and a 'cove'. There are also outliers: Hautville's Quoit and the Tyning Stones.

The principal site is the Main Circle, which has an avenue leading eastwards from it.

Nearby is the North-East Circle, which has an avenue leading south-east from it. The two avenues coalesce.

The two circles and their avenues are all in one field, which is called 'Stone Close'. In a separate field is the South-South-West Circle.

West of this, in the pub garden of the Druids Arms, are the three stones known as the Cove.

Well to the west of the monument, 700 m away, there are two stones, the Tyning Stones. They are known to have been moved in recent times.

To the north-east of the monument, 500 m away across the River Chew, near the Pensford to Chew Magna road is Hautville's Quoit.

The location of these component parts are shown below in figure 1.2, a plan produced by Charles Dymond (1896), a railway surveyor, this still being the best plan of the complex. Dymond's detailed plan of the stones will be used as the location basis of this report.

Note that the field layout around the stones has changed from time to time, and the churchyard has been extended. There has also been ground infill just below the Cove. Changes in field boundaries may affect the description of the site through the various historical accounts.

1.2 Background to work

Of the three great stone circle complexes of Wessex, Stanton Drew is the least studied. Whereas Stonehenge had its Gowland, Hawley and Atkinson (Richards 2004), and Avebury had its Alexander Keiller (Murray 1999) in the early twentieth century, the stones at Stanton Drew have had no champion to investigate, restore or re-erect them. It was visited by the antiquarians Aubrey (Aubrey et al 1980) and Stukeley (Stukeley 1776) and the local Reverend John Skinner visited it at least five times in the early nineteenth century. His efforts led to the first detailed plan, produced by Crocker in 1826 for Richard Colt Hoare and included in his 'Modern Wiltshire' (Hoare 1826).

A paper and a better plan in the Archaeological Journal by William Long (1858) was the start of a period of interest until the end of the century, with the most useful inputs coming from C Lloyd Morgan (1887) on the origin of the stones and from Charles Dymond (1896) in surveying. Dymond's plan of the stones (fig 1.2) is excellent, and his numbering system for the stones has been used in this work.

Desultory research was carried out by Grinsell and others (Grinsell 1956; 1994; Grinsell and Kendal 1958; Tratman 1966) in the second half of the twentieth century, but interest in the monument was rekindled shortly after Grinsell's death as a result of spectacular geophysical survey results first proposed by Andrew Young (1996) and carried out by English Heritage (David et al 2004).

Other work has also been done recently by Jodie Lewis of Worcester University (Lewis 2001) but the site still lacks a detailed, thorough and comprehensive analysis to bring to it the knowledge and understanding it deserves.

The work reported here extends the geophysical survey beyond that of English Heritage by demonstrating the capability of newer instruments to detect and investigate more features than have been studied to date.

Members of the Bath and Camerton Archaeological Society (BACAS), in collaboration with the Bath and North East Somerset (BANES) county archaeologist, first carried out research on the site in July 2009. The geophysics work was carried out by BACAS under licences from English Heritage and was duly reported (Oswin et al 2009; Richards and Oswin 2010).

The amount of work that could be done in one week was naturally limited, but the results were

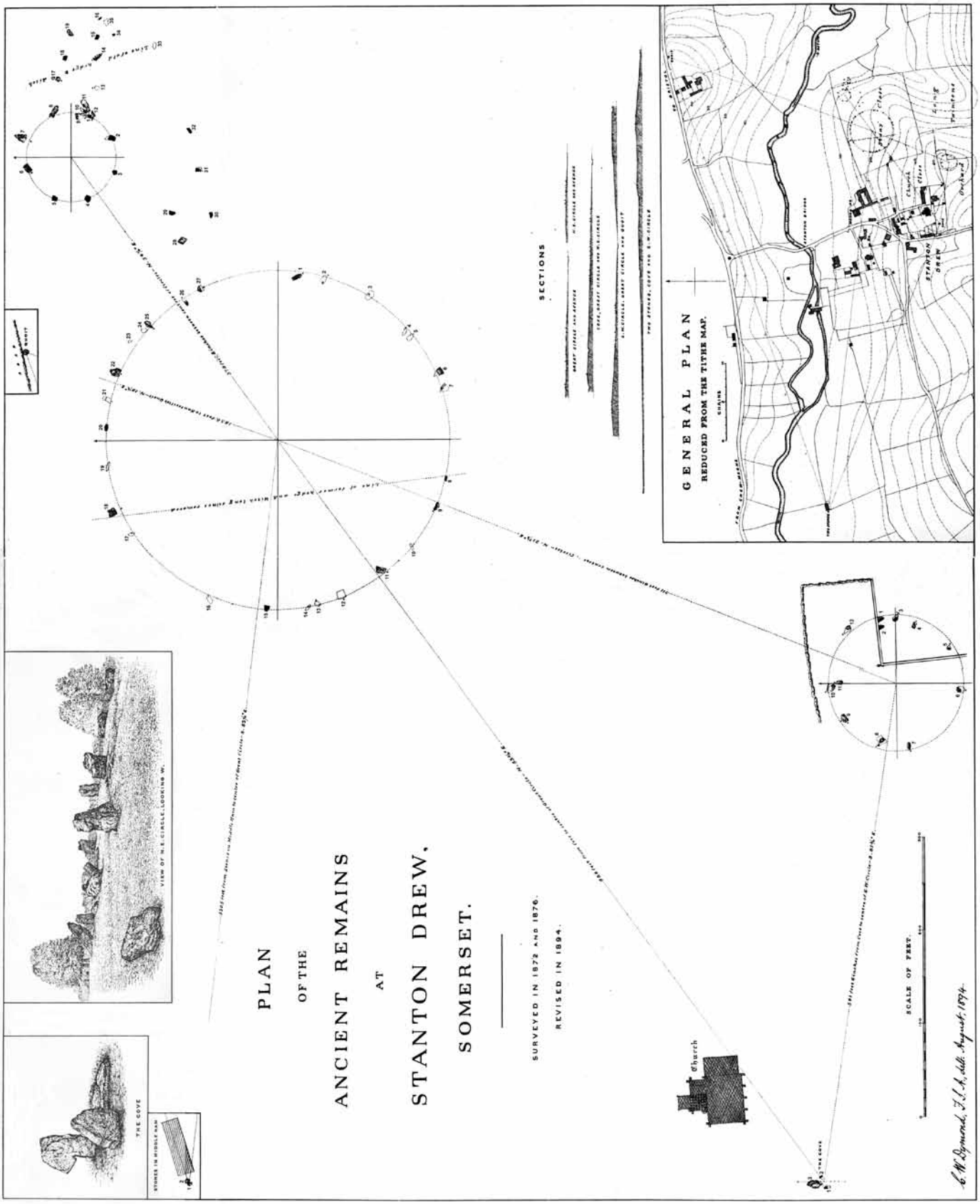

Figure 1.2 Dymond's plan and stone numbers.

well-received and it was decided to do a longer campaign of follow-up work in 2010. This is a report of that work carried out between May and September 2010.

1.3 Project Objectives

Magnetometry of the south-east quadrant of the main circle in 2009 had shown the capability of the fluxgate gradiometer used at high density to produce as good an output as the Caesium vapour magnetometer used by English Heritage in 1997, so this survey was extended to cover the whole of Stone Close. The resistance survey in 2009 had left the centre of the main circle untouched so this was also completed in 2010.

Resistance profile results of the South South-West circle in 2009 had proved intriguing, so this stone circle was subject to survey by all available means.

Profiling was extended across all parts of the site to build up a three-dimensional picture of the setting.

The acquisition of ground-penetrating radar by BACAS enabled us to try this technique to provide three-dimensional data.

An EDM survey of Stone Close and the south south-west circle provided an accurate fix in our grid for all the stones and enabled us to produce a detailed contour map of the site.

The overhead photography was extended to include all stones.

The survey at the Cove which had shown a possible long barrow was extended into the private garden of the Druids Arms Inn and also into a portion of the churchyard just beyond the wall.

1.4 Scope of report

This report describes the results of the 2010 survey and combines these with those from the 2009 to produce an analysis and interpretation of the site based on the geophysical surveys.

The surveys were carried out under English Heritage licences: SAM numbers 22856, 22861, 22862 and BA44. One of these licences authorised work on Hautville's Quoit, but time did not permit any work on this site.

Overhead photography of the stones may be included as examples in this report, but the complete set will be issued separately on media more suited to displaying and transferring photographs.

1.5 Dates

The surveys were carried out over the following dates:-
Session 1; Thursday May 27th to Tuesday June 1st (inclusive)
Session 2; Thursday June 10th to Monday June 14th (inclusive)
Session 3; Friday 16th July to Monday 19th July (inclusive)
Session 4; Sunday September 19th

In all, 16 days were worked.

1.6 Personnel

Bob Whitaker was project director and Robin Holley, deputy project director. The operation was facilitated and advised by Richard Sermon, archaeologist for BANES.

The geophysical survey was conducted by BACAS volunteers, led by John Richards, who was assisted by John Oswin.

The following joined in the survey for various amounts of time:-
Keegan Armstrong, Sally Churchyard, Susie Coggles, Jan Dando, Owen Dicker, Keith Dyke, Chris Garmston, Kate Henderson, David Henderson, Sonia Heywood, Christine Jones, Roger Kergozou, David Kerrison, Philipa Kohly, Dave Ladbrook, Tim Lunt, Teresa Marsh, Fiona Medland, Margaret Nuth, Jane Oosthuizen, Sue Pickering, James Robson, Vince Simmonds, Gill Vickery, and Roger Wilkes.

The overhead photographs were taken by Keith Turner.

2 Method

2.1 Numbering of Stones

The numbering scheme used for the stones is based on that in Dymond's plan (Dymond 1896). Dymond numbered the stones in four sequences:

- Main Circle and Avenue: 1–35
- North East Circle and Avenue: 1–19
- SSW Circle: 1–12
- Cove: 1–3

For uniqueness, we have added a prefix to each number, M, N, S and C. So M29 is Dymond's stone 29 in the avenue of the Main Circle.

We have decided to add a stone that lies within the SSW Circle and designated it S13.

One of the two stones we failed to find in 2009, M33, was visible in 2010 at its expected location, in much shorter grass. The other missing stone, M4, was not visible in 2009 or 2010.

2.2 Gridding

2.2.1 Stone Close

The grid was started from the south-east corner of a distinctive fence post with support struts on the northern side of the Stone Close field roughly in line with the east side of the Main Circle (figure 2.1). The grid was laid out along a baseline running east-west along the fence. A right angle was constructed from this to the south using a triangle of sides 40, 40, 56.56, assuming the fence line to be straight over this distance to the east. The right angle was checked at 20 m and was found to be accurate. The south line was extended by eye further south to 80 m. A central point, 80 m south of the start point, was chosen and given an arbitrary grid reference of 1000, 1000. The post in the north fence was labelled 1000, 1080. This resulted in a line of grid north at bearing 345° to true compass north. A right angle was constructed at 1000, 1000 to form an east-west line. All subsequent grids were derived from these lines.

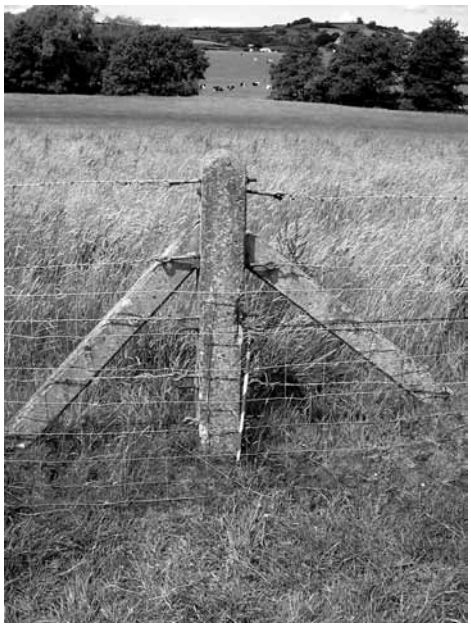

Figure 2.1 Marker by fence post where grid was started. A line was created perpendicular to the fence.

In order to provide a further reference, measurements were taken from 1000, 1000 to corners of two stones. The distance to stone M1 was 5.75 m and to stone M30 was 27.45 m. The construction is shown in figure 2.2 and the corners of the two stones are shown in figures 2.3 and 2.4. The grid is shown in figure 2.5, superimposed on Dymond's (1896) plan which was found to be very accurate.

The BACAS standard grid is 20 m square. Normally, it starts in the south-west corner with the instrument heading north. Resistance measurements are taken at half metre intervals on lines one metre apart. North and south baselines are made from coloured polypropylene 'washing' lines with markings every metre. Marked ropes are used to guide measurements. The operator walks north along a rope and back south between ropes. The first line is 1 m east of the grid corner, the last line is between grid corners. The first measurement point is 0.5 m north of the south baseline, the last is on the north baseline; thus all grids fit together without overlap.

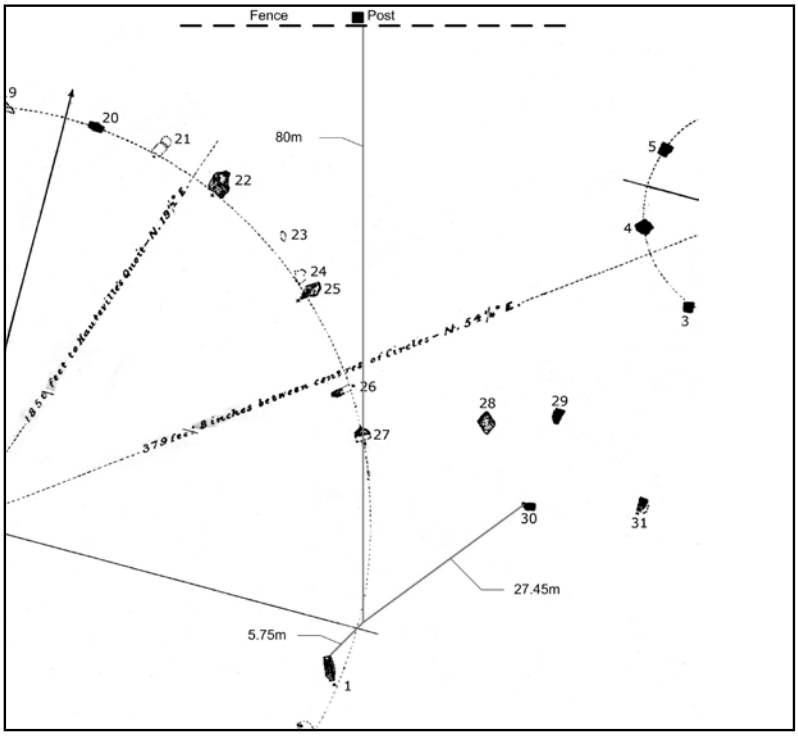

Figure 2.2 Reconstruction details of the 2009 grid using Dymond's plan.

Figure 2.3 Measuring in grid point 1000,1000 to stone M1

Figure 2.4 Measuring in grid point 1000,1000 to stone M30

For magnetometry, the same grid pattern is used, but the ropes are replaced by small 'flags' placed on the north baseline, five per grid, and tall plastic pegs on the south baseline. The operator has to set his pace right to cover the distance in the right time. Heading north, he aims either at a flag or the gap between them, and south either at a peg or the gap between. The layout of flags and pegs depends on the instrument used and the number of lines walked.

Note that for a few grids the traverse direction was changed from north-south to west-east. This was to enable the de-striping software to provide the best enhancement of the data. It was done mainly along the line of the wire fence at the north so that the wire was nearly parallel to the traverse, and the iron interference could be cancelled out to the maximum extent. It was also used on one grid on the western edge, where the line of the ditch was north-south. This was to stop the de-striping software automatically removing the ditch signal. Details of these and all grids are given in appendix A.

In 2009, one grid was subject to a full magnetic susceptibility survey, but this was at 1 m intervals, which was insufficient to show detail. In 2010, a number of 6 m squares were laid out around

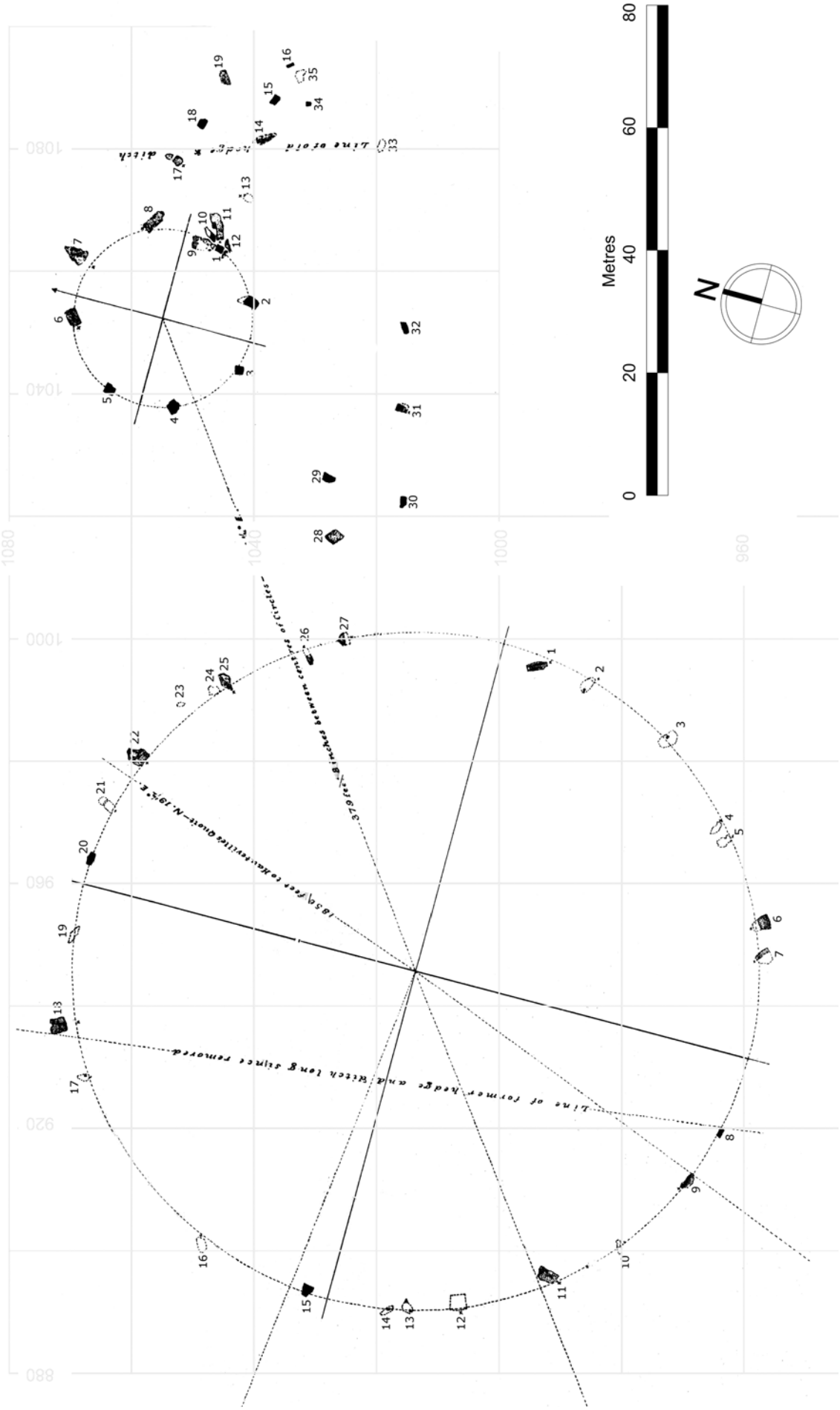

Figure 2.5 Overlay of grid in Stone Close on Dymond's plan

individual stones, with measurements made at 0.5 m intervals both east and north. Where these are shown in the analysis, they will be described by the number of the stone at their centre.

The resistivity profiler was used extensively during 2010. Often, this was in long lines constructed from concatenated sets of measurements. When these are described, the east and north coordinates of both ends will be used to delimit them. In some cases, parallel profiles were assembled into blocks to provide a three-dimensional analysis. These blocks will be described by their eastings and northings of their four corners.

A number of small areas were subject to survey by ground-penetrating radar. These areas will also be described by the eastings and northings of their four corners.

2.2.2 Gridding, South South-west Circle

The grid on Stone Close was transferred up to the south south-west circle by means of EDM, so it represents 'flat' distance rather than 'over the ground'. It was found that convenient grid points could be established at 800, 860 and 840, 860 near the north hedge of the field. These two points were measured in to semi-permanent markers, as follows:-

800, 860

- 16.00 m from northernmost post of west fence, before it joins the north fence. This proved unreliable as the post was loose, and it was supplemented by a measurement of 7.20 m from the nearest post on the northern fence.
- 24.80 m from the near north corner of the water trough on the western fence.

840, 860

- 4.62 m from the bottom hinge of the kissing gate
- 10.33 m from the northern gate post of the gate at the northern end of the east hedge.

Using these two positions, the field could be subdivided into conventional 20 m grids, both full and part. Similar conventions to those described in section 2.2.1 were used for profiling, magnetic susceptibility and radar.

2.2.3 Gridding, The Cove

During 2010, survey of the possible long barrow extended beyond the public garden of the Druids Arms into the private garden and also into the north-west corner of the churchyard. The gridding of public and private gardens could be continuous based on the 2009 grid, but extended northwards. The northern end of the 2009 grid was set at the east end of the western flower bed in the public garden, north end, just by the gate into the private garden, but at the lawn edge, not right against the fence. This is shown in figure 2.6. The baseline extended south for 29m, passing the cherry tree to the west, and meeting the southern fence. This line is shown in figure 2.7.

Figure 2. 6 North end of Cove grid in 2009.

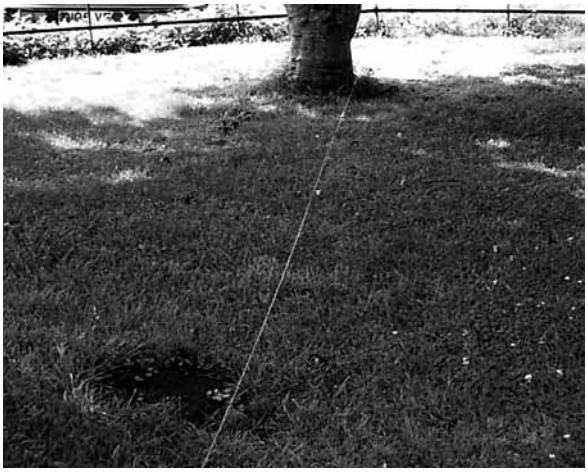

Figure 2.7 South end of Cove grid in 2009.

The 2010 grid was constructed as follows: a tape was laid along the line of the 2009 baseline, northwards from the fifth post (counting from the west end) in the metal fence on the south side of the pub garden; in 2009 and 2010 this post was marked with blue twine. A peg was inserted at the 29 m mark, and the distance of the peg measured from the posts of the entrance to the private garden. The measurements were taken to the nearest corner of each post, and the distances were 0.71 m and 1.46 m to the west and east posts, respectively. The peg was designated as 1000, 1005, so the grid point 1000, 1000 was 24 m along the tape and 5 m from the peg. The construction is shown in fig 2.8:

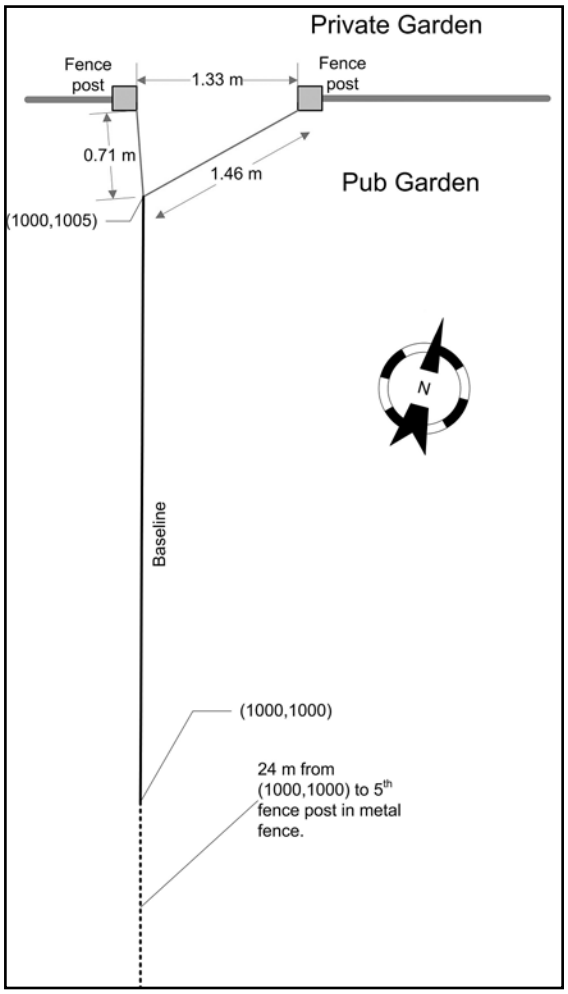

Figure 2.8 Construction of grid at the Cove.

The 2009 resistance survey had been done with spare ropes which had shrunk from 20 m overall to 19.5 m length, so east-west distances were not correct and the final output plans had been modified to account for this. In 2010, the measurements in the churchyard used full length ropes, but those in the private garden also used short ropes so that they could be matched to the measurements made in the public garden.

The churchyard portion is behind a high stone wall from the pub gardens, so there was no intervisibility, and a new grid had to be established against the north-west wall. The grid in the churchyard was measured in as follows. The grid was started near a small stone outbuilding, or shed, mid-way along the western wall. A point was given an arbitrary grid reference of 1000, 1000, and measured in as 1.56 m from where the shed door abuts the wall, and 1.12 m from the hinge end of the door. A baseline, 4 m long, was placed in an easterly direction, and its end was measured as 2.55 m from the corner of the shed. The construction is shown in figure 2.9.

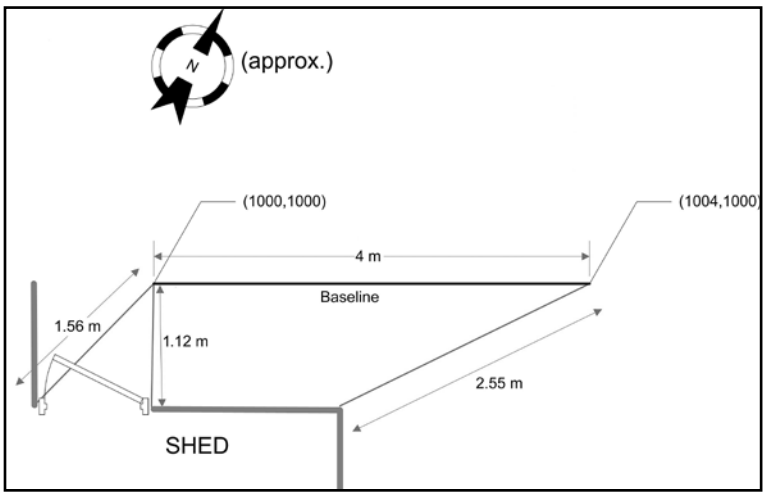

Figure 2.9 Construction of grid in the churchyard.

This grid is also used as reference for magnetic susceptibility and profiles.

An EDM survey of the public garden had been done in June 2009 and extended into the churchyard in July 2009, before any geophysics. This could not be tied into the main Stone Close grid as there were no sightlines. The new grid described here has temporarily replaced the 2009 grid. As survey work continues into the fields to the south, it will be possible in due course to link this grid and also the churchyard into the Stone Close grid. Gridding in this area is best done while the trees are bare.

2.3 Instruments and Settings

2.3.1 RM15 twin probe resistance meter

The RM15-D twin probe resistance meter was bought by BACAS with assistance from the Heritage Lottery Fund in 2008. It was set for taking readings at 0.5 m intervals, 1 m lines, zigzag, automatic triggering, and 0.5 s averaging. It was set to 1 mA, gain 10 to allow readings above 200 ohm. It was fitted with its transom for 0.5 m probe separation. This is illustrated in figure 2.10.

Figure 2.10 RM15 twin-probe resistance meter.

2.3.2 TR/CIA resistance meter and profiler

BACAS has had a TR/CIA twin probe resistance meter since 2003. It was set to 40 readings per line, 20 lines, triggering 'on insert+LCR', 0.5 s averaging. It was only used in this mode at the Cove, in public and private gardens of the inn. Although a zigzag pattern was walked, its data logger automatically sorted to series data.

In 2008, BACAS obtained a resistance pseudosection profiling kit set from TR to augment this kit. This allowed a line of nominally 30 probes set up in Wenner mode. BACAS has built its own distribution box to allow selection of appropriate probes. An extension cable has also been provided to allow the line to be extended to 32 probes, and this extended line was used on a number of occasions. Probes can be selected with 0, 1, 2, 3, 4 and 5 gaps between. With 1 m spacing used at SSW and Stone Close, this allowed a line of 29 or 31 m with spacings of 1, 2, 3, 4, 5 and 6 m, giving depths to 3 m at mid section. The device was set to manual logging, 2.5 s averaging, and 200 ohm range for profiling operations. Occasionally, different ohm ranges had to be used. Note that only 22 probes had been available in 2009.

The probe spacing could be halved to 0.5 m to provide more detail, but this shortened the space covered and reduced the depth coverage. This setting was used at the Cove.

The device in normal configuration is very similar to the RM15. Figure 2.11 illustrates the device with distribution box and probes being used for profiling.

Figure 2.11 TR/CIA resistance meter, being used for profiling.

2.3.3 Bartington 601/2 twin fluxgate gradiometer

BACAS acquired a Bartington 601/2 dual fluxgate gradiometer with assistance from the Heritage Lottery Fund in 2008. This was set to provide 8 readings per traverse, traverses at 0.5 m intervals, operating pace a sedate 1 m/s.

A zigzag pattern was walked, but the data logger automatically sorted to series data.

The instrument is illustrated in figure 2.12.

Figure 2.12 Bartington 601/2 twin fluxgate gradiometer

2.3.4 Bartington MS2 magnetic susceptibility meter

The Bartington MS2 magnetic susceptibility meter (magsus) was donated to BACAS by Professor Mark Noel of Geoquest Associates in 2009. It is a venerable machine with no data logging capability, so all results had to be written on a clipboard and typed into a spreadsheet for analysis.

In 2009, it was used to take readings at 1 m intervals, but this was not successful. During 2010, readings were taken at 0.5 m intervals and this produced more satisfactory results.

The instrument is illustrated in figure 2.13.

Figure 2.13 Bartington MS2 magnetic susceptibility meter

2.3.5 MALA X3M Ground-penetrating Radar

In late 2009, BACAS received a very generous gift of a MALA X3M ground-penetrating radar from the late Dr Philip Day of Manchester. His memory is best served by making frequent and good use of this equipment, so it was tried on various parts of the Stanton Drew sites. The radar has 250 Hz and 500 MHz transmitters. Only the 500 MHz unit was used at Stanton Drew. The device came complete with a triggering wheel, which was set to take readings every 5 cm. Spacing between lines was generally 1 m, but at the Cove, a spacing of 0.5 m was used to correspond with the profile work.

The radar is illustrated in figure 2.14.

Figure 2.14 MALA X3M ground-penetrating radar

2.3.6 EDM

Work in the churchyard and Druid Arms in 2009 used the old BACAS Wild Distomat 1600 laser theodolite. This instrument was superseded in late 2009 by a Sokkia SET5W, and the latter instrument was used to survey Stone Close, the gardens of the Druid's Arms and the South South-west Circle during 2010. This EDM does have a data recording and download facility, but this could not be operated, so data were recorded manually and transferred to spreadsheet, as before.

The EDM is illustrated in figure 2.15.

Figure 2.15 Sokkia SET5W EDM

2.3.7 Overhead photography

Each of the stones was photographed from 6 m overhead, using a commercial compact digital camera attached to a proprietary design of rig which could support the camera pointing vertically down and allow operation of the shutter from ground level. Auto focussing and taking a number of shots and selecting the best afterwards provides a versatile means of seeing the stones from an otherwise unobtainable angle. The photography rig is illustrated in figure 2.16. Where necessary, photographs could be combined into a mosaic to give greater area coverage, using commercial software.

Figure 2.16 Overhead photography rig

2.4 Software

BACAS has three field computers. These are of some age in order to have serial and parallel ports as well as USB connection. One (HP) runs Windows 98, the other (IBM), Windows 2000 Professional. Data were downloaded from each instrument into both computers. The third, an ACER running Windows 2000 Professional, is used for radar analysis only.

BACAS uses INSITE version 3 (1994) as its principal analysis software. This is now obsolete, but still preferred as visual, adaptable and simple. As it no longer talks to modern instruments, BACAS has produced in-house software to download the instruments to a folder in the computer and then import the grids into INSITE.

It is BACAS custom to display printouts of resistance with dark representing high resistance, light low resistance. This is the opposite of the convention used by English Heritage. In the Stone Close cases, colour clearly distinguishes between low readings and blank spots where the stones are. This helps to identify stone pits. When applying colour, the BACAS convention is to use 'red for resi, green for gradi'.

The downloader will communicate with Geoscan RM15 resistance, Geoscan FM256 magnetometer and TR/CIA resistance. It will allow any size of grid.
The TR/CIA resistance own software is used for downloading pseudosection profiles from the meter, and these are then processed on RES2DINV freeware.

The Bartington magnetometer has its own download software which leaves data sorted to parallel lines. This is then put through the de-striper before being mapped in INSITE.

BACAS has devised its own zero-median de-stripe software which will accept downloaded files from the Bartington or from Geoscan FM256 (BACAS has a FM256 but it was not used in this project). Once files have been through the de-stripe software, they are labelled with a prefix 'd'. The de-stripe software will function with grids of any dimensions. De-striped grids are imported into INSITE, which acts as a mapping program. The data usually needs very little extra processing.

Handwritten data from the EDM and from magsus are transcribed into an Excel spreadsheet. If the pattern is regular, contour plots can be drawn in Excel. If spacings are irregular, DPlot software is used to obtain contour plots.

Excel can also be used to display resistance and magnetometer data, but practically is limited to four grids at a time, and for half metre spacings on lines at one metre. It does have the advantage of allowing as many gradations as the colours permit, and of providing a linear scale, which, with a suppressed zero, can allow features to be presented and studied in much greater detail. The sets of four grids can be assembled into a large area composite.

Radar data were analysed using REFLEXW software. Output is presented in its 'Rainbow1' format, extending from red for very high positive return, through yellow as 'normal' to purple. This can be presented as a three-dimensional cube or as a two-dimensional slice at a nominal depth. A nominal wave speed of 0.06 m/ns has been assumed but the software has the facility to estimate wave speed from parabola shape given a strong return signal.

GIS (geographical information system) software, Global Mapper freeware has been used to produce drapes and viewsheds to assist in our understanding of the surrounding landscape.

2.5 Constraints

Time was limited in 2010 by the availability of key members of the team. A number of volunteers joined the team for varying numbers of days, and all were able to contribute to the survey. Although some had started with no knowledge of any instrument used, they were able to learn sufficiently to be able to use some of them. It may have been possible to obtain a little more data had there been more volunteer days worked, but sufficient was done to add considerably to the Stanton Drew story.

The weather was generally benign, although there were a few occasions on which heavy rain curtailed operations.

A number of the instruments were simple to use once set up. Others required more specialised operation. In particular, the radar and magnetometer were more restricted.

The magnetometer data gathering was at very high density and that contributed to the high quality of the output, especially the anomaly range was typically less than 2 nT. However, the quality of the data is only as good as the precision in setting up the grids. These were generally within 20 cm, 1%, of true. However, it also depended on the operator setting out straight baselines and walking accurately between markers at the right pace. Seeing the markers and keeping constant pace was particularly difficult during May and June when the grass was very long. However, grids could be repeated, more than once if necessary, in order to get good results.

The very small anomalies resulted in a rather untidy plot as the signal-to-noise ratio was obviously low, and this means that pattern recognition played a greater part than strong signals in interpreting the output. Most anomalies in the area of the main circle were within ± 1 nT after zero-median destripe. Figure 2.17 shows the spread of post-destripe values for 13 grids from within the main circle, including some where there appears to have been later damage to the timber rings.

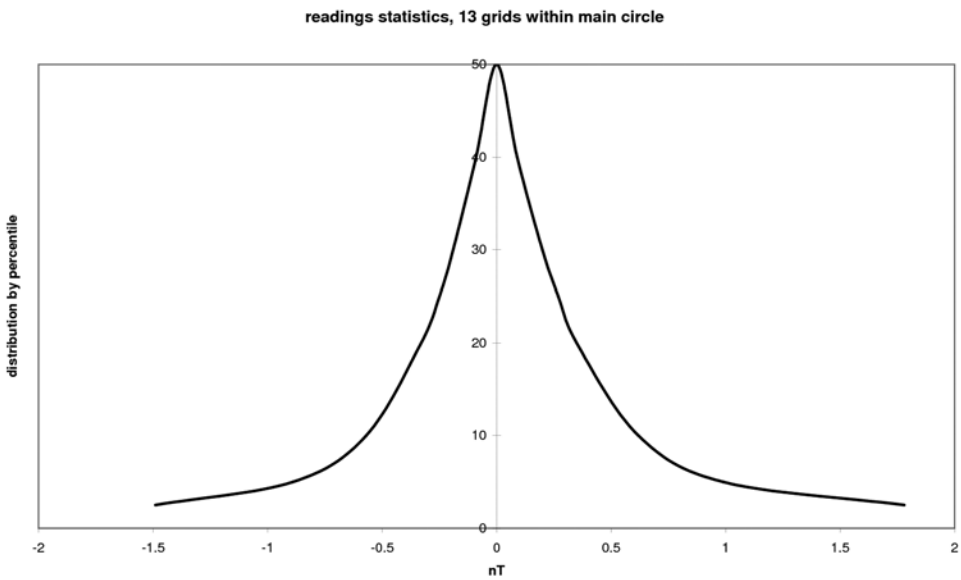

Figure 2.17 Spread of post–destripe values for 13 grids from within the main circle

The other constraint on the magnetometer was the presence of metal fences around the fields. This caused most problems along the northern edge of Stone Close, where a soft iron fence had an effect on the magnetometer over about eight metres. Grids were done traversing east-west so that the de-stripe software cold be most effective in removing its effects, but given the very small size of magnetic anomaly, this still distorted the results. In particular, the northern portion of henge ditch between stones and northern fence is distorted.

There is also a memorial sapling to the south-east of the main circle, on the ridge, and this is surrounded at a generous distance by a wire fence. This left an area approximately 20 m square which could not be surveyed, which is unfortunate as there were anomalies around it which had not been detected by English Heritage.

The profiler was used extensively. The ground was very dry and this often made it difficult to get good electrical contact from probe into ground. On one occasion, the probes were deliberately wetted, but this was not sufficient to improve matters. Sometimes, zero ohm readings were obtained and only on one occasion could that be attributed to equipment fault, so they had to be accepted although they had to be edited to a finite value or the analysis software would crash. Operator error in the profiler sequence was observed sometimes and could generally be corrected by editing the data files. Where results are particularly suspect, there is a note to this effect in this report. In one case, corruption was so severe the profile could not be used.

In general, the best view of the data output is on the computer screen and there is some loss of definition in the printing process, even when the document is printed at a high dpi rate. It is also necessary to produce a lower resolution screen version so that the document can be transmitted by email.

Setting up heights above ordnance datum had difficulties. The benchmark near the northeast corner of the church was used, but this could only just be viewed in May through a luxuriant tree canopy. Apart from the problem of transferring a height to the SSW circle, there was also a problem of the value to choose for that benchmark, as 1886 and 1934 Ordnance Survey maps gave slightly different values. It was decided to use the more recent of the values and this was converted to 52.40 m OD.

This then gave a height at 800, 860 of 54.29 m and at 840, 860 of 53.59 m. The height was also transferred down to Stone Close, giving a value at 1000, 1000 of 42.80 m and at 1000, 1080 of 40.80 m. Although this last point is the most easily identifiable on the ground, it is the least reliable for height, as a build-up of earth and grass under the fence and next to the fence post leaves some ambiguity as to the exact point to place the base of the EDM target.

3 Stone Close

3.1 Topography

EDM survey readings were taken around all stones to locate them in the grid started in 2009 (Oswin et al 2009) and at random points to build up a contour map. Data have been collected intensively at points where there are changes in slope or where there are signs of earlier field boundaries. The survey extended up to the South South-West Circle and included some points between the two fields.

There has been no collection of contour data in the fields below Stone Close, although it is recognised that the relationship of the monument to the river needs to be better understood. That is a job for the future.

Contour mapping has shown up interesting details concerning the South South-West Circle, and that is discussed in chapter 4. In this chapter, contour data will be used as a background to geophysics plans where appropriate.

3.2 Magnetometry

Stone Close was surveyed with the Bartington twin fluxgate gradiometer at high data density (8 readings per metre on traverse, traverses 0.5 m apart, 6400 data points per 20 m grid). Traverses were generally north-south, but along the northernmost line traverses were east-west to optimise the effect of the de-stripe software against the iron fence. A grid on the west side was also turned east-west so that the de-stripe software did not annul the response from the ditch.

The survey continued from the 2009 partial survey, and covered the entire field, leaving only a margin about 10 m wide along the west side and 5 m wide along the south side. South-east of the Main Circle, there is a sapling with a wire protection fence around it some 3 m square, and the interference from this meant that an area approximately 20 m square was lost.

Grids would be resurveyed if they were found on download to be of insufficient quality. The numbering sequence for grids therefore does not follow a simple pattern. Signal levels were very small, and this is considered in constraints in chapter 2. Full details of the survey are provided in Appendix A, and grid files can be made available.

The magnetometry output is shown in figure 3.1. The plan is shown again in figure 3.2, with stone positions and contours added. Note that a number of the stones can be seen as blanks against the green background in figure 3.1, but as a number are flat and sunk into the ground, it was possible to walk and survey over them and leave no blank.

The features discovered by English Heritage (David et al 2004), the nine rings of postholes and the henge ditch, show up spectacularly well, but there are a number of other features which are visible. These are indicated in figure 3.3. Numbers on the map correspond to the third figure of the paragraph numbers below.

3.2.1 There is a possible portal on the outer post ring, on the east side, pointing directly to the main avenue. However, a stone impinges on it (see figure 3.2).

3.2.2 The wide gap in the henge ditch on the eastern side is confirmed.

3.2.3 The henge ditch has been broached on the west side by a later, possibly mediaeval, track which expands in area to a small yard inside the stone circle and which damages the post holes but does not entirely obliterate them. The track continues eastwards and broaches the henge ditch in the south east before continuing to the edge of the field. David et al (2004) proposed a possible entrance through the ditch here, but we believe a trackway is more likely.

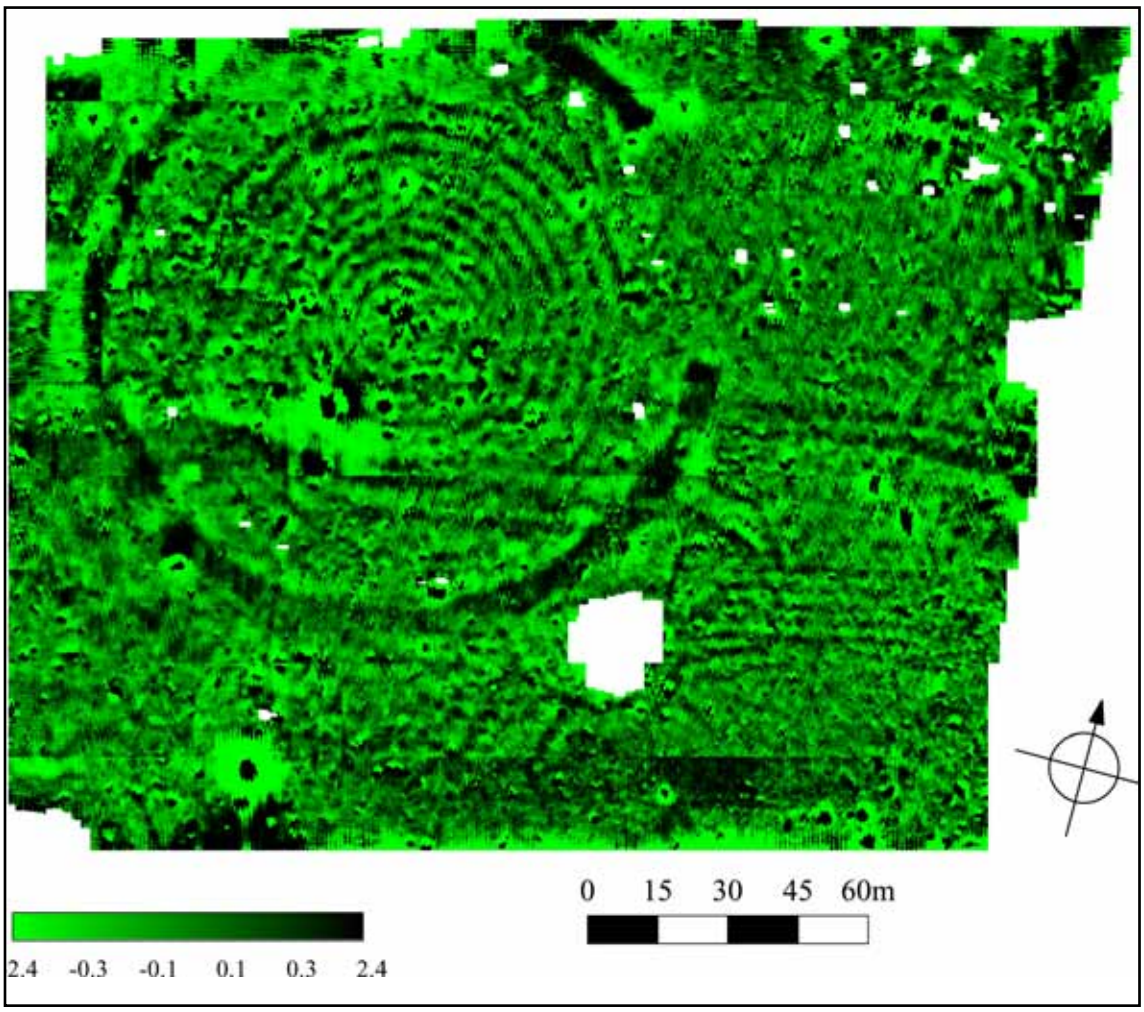

Figure 3.1 Magnetometry plot of Stone Close

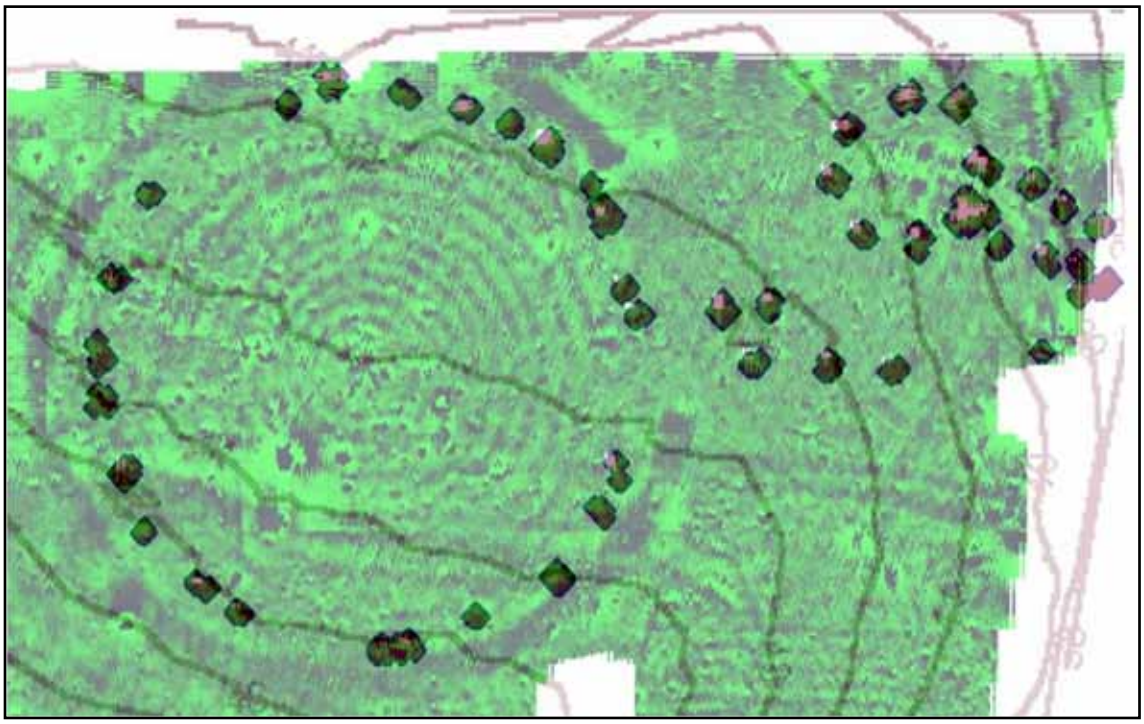

Figure 3.2 Magnetometry plot of Stone Close, with stone positions and contours added

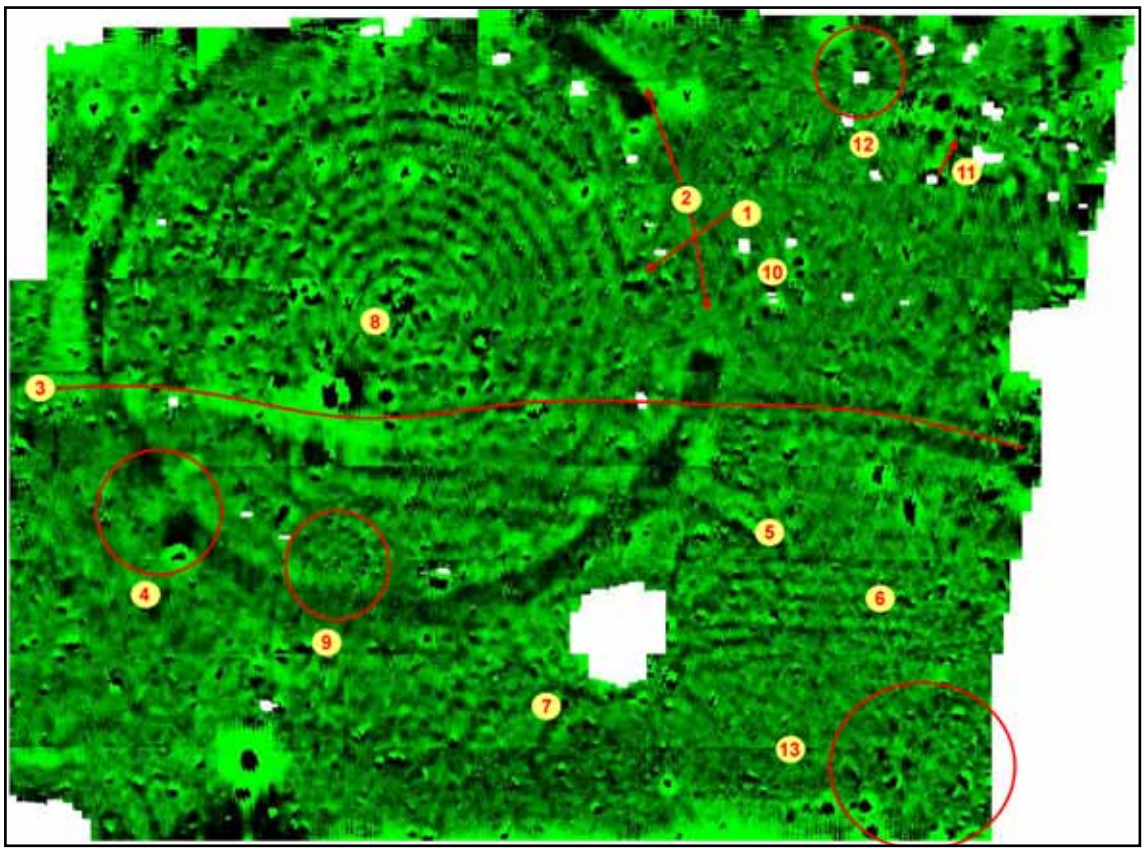

Figure 3.3 Interpretation of magnetometry results.

3.2.4 There is an entrance through the henge ditch, about 10 m wide, further to the south west, at a bearing of about 215° to true north. One of the stones of the circle (M10) sits within the line of the gap, suggesting that ditch and stones were not constructed for the same purpose or at the same time. This is shown in greater detail in figure 3.4.

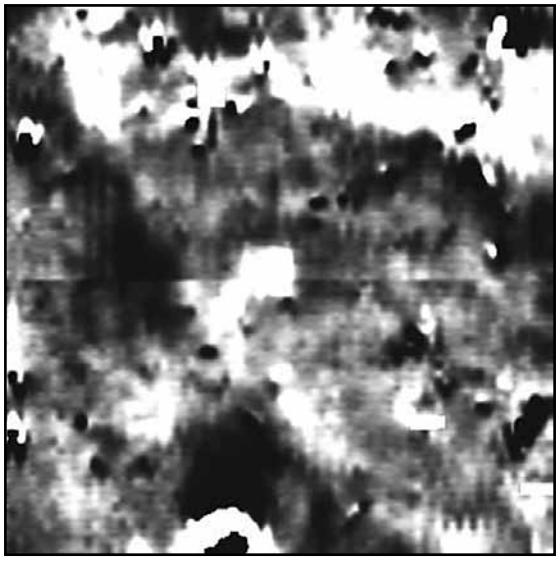

Figure 3.4 South-west 'entrance though henge ditch'.

3.2.5 There are signs of a short, wide trackway approaching the ditch in the south-east, but it does not cross the ditch.

3.2.6 This turns south into a series of east-west parallel lines, each about 4 m apart. These were observed by English Heritage in their survey (David et al 2004) but no comment was made.

3.2.7 There are a number of features not previously mentioned to the south-east of the circle. These are unfortunately truncated in survey by the presence of an iron fence around a sapling, but have the appearance of a roughly circular enclosure with radiating spokes. These look prehistoric, but need not be contemporary with the stones, and could even be mediaeval, along with features 5 and 6. These need further elucidating.

3.2.8 There are a number of postholes within the central post ring.

3.2.9 There is a possible small circle of postholes against the south edge of the ring, but these may be related more to the 'mediaeval' disturbance.

3.2.10 There are possible post settings within the main avenue.

3.2.11 The four large posts within the north-east circle are confirmed. There also appear to be pits or holes heading towards the north-east avenue from the centre, and continuing down the avenue.

3.2.12 There is an arc of possible post holes just outside the north-west stone of the North-East Circle.

3.2.13 There is a possible sub-circular post setting in the low-lying south-east corner of the field.

There are possibly other features in the plot, including part of the henge bank, and stake holes within the bank and ditch outlines, most visible in the north-western quadrant. However, given the very low levels of signal-to-noise, it is unwise to make claims for them. However, small signals can be seen by inspection of figure 3.1.

Inspection of figure 3.1 also seems to show radial bands through the post pits within the main circle, appearing like spokes of a wheel. This cannot be an effect of survey techniques as the bands continue from one grid to another without break, but the observation relies only on pattern recognition in a mass of small signals.

3.3 Magnetic Susceptibility

A number of stones were subject to magnetic susceptibility survey. Six metre square grids were set up with the stone at the centre and measurements taken at half metre intervals. Magnetic susceptibility in Stone Close was generally low and without much variation. Results are given in figure 3.5 for the stone M30 (which appears as a white area in the middle of the plot).

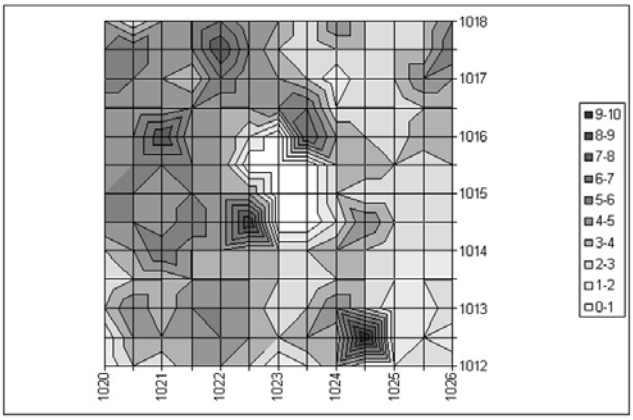

Figure 3.5 Magnetic susceptibility results for stone M30

Note that there are spots of higher magnetic susceptibility and these correspond with the possible post holes detected by magnetometry referred to in 3.2.10 above. Although other areas around

stones may show less detail, it may be worth trying magsus in the north-west quadrant of the henge bank and ditch to try to confirm the presence of post holes there.

Areas of 6 m square around stones M11 and M12 were also subject to magsus survey. However, the M12 area appeared to be heavily contaminated. Possible pits were visible around M11, but inspection of figure 3.1 shows only apparently random signals in the magnetometry, so these cannot be related to features with any confidence.

3.4 Radar

A number of rectangles were laid out for survey by ground-penetrating radar using the 500 MHz antenna. The intention was to confirm features seen by other techniques. Two were laid out in the west and south-west to pick up the henge ditch and the gap in it. One was set up to collect extra data on the posthole rings observed in magnetometry, twin-probe resistance and resistivity profiling. One covered the north-east circle.

The method was of limited success here, so detailed results are not shown, although the data will be kept in archive. The areas subject to radar survey are shown in figure 3.6 as rectangles overlaid on the magnetometry. Depth slices with most activity have been used as the overlays. The westernmost radar area shows a feature towards its south-east corner. This is stone M12, and the radar was hauled directly over it. The signal continued to a nominal depth of 1 m (assuming a wave speed of 0.06 m/ns). Wave speed calibration is possible but was not considered worthwhile from the amount of data obtained.

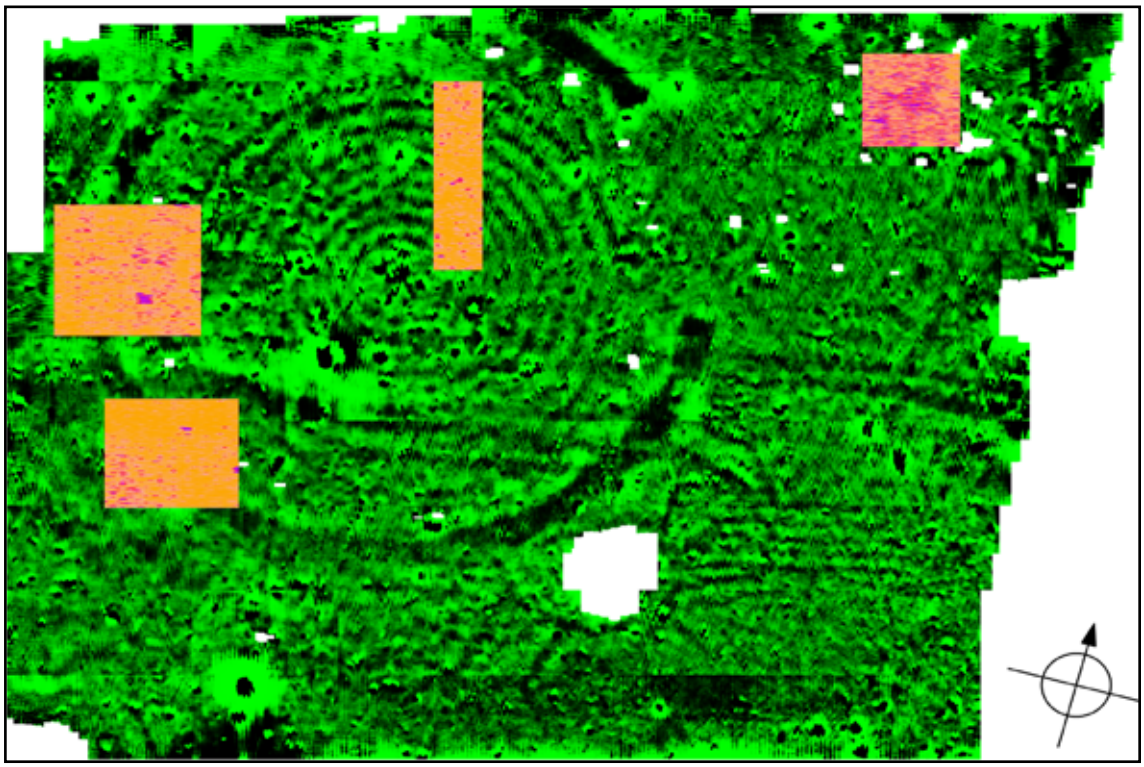

Figure 3.6 Location of radar surveys.

Note that there does seem to be a lot of extra detail shown in the north-east circle, and figure 3.7 shows slices at 0.14, 0.65 and 1.1 m for comparison. At shallow depth, there is a hard return in the north-east. This is next to a fallen stone, and suggests there may be more beneath the surface. At moderate depths, just below half a metre, activity is greatest with a number of small objects forming patterns in the centre of the circle. By 1.1 m depth there is little, except for possible deep stones towards the south of the circle.

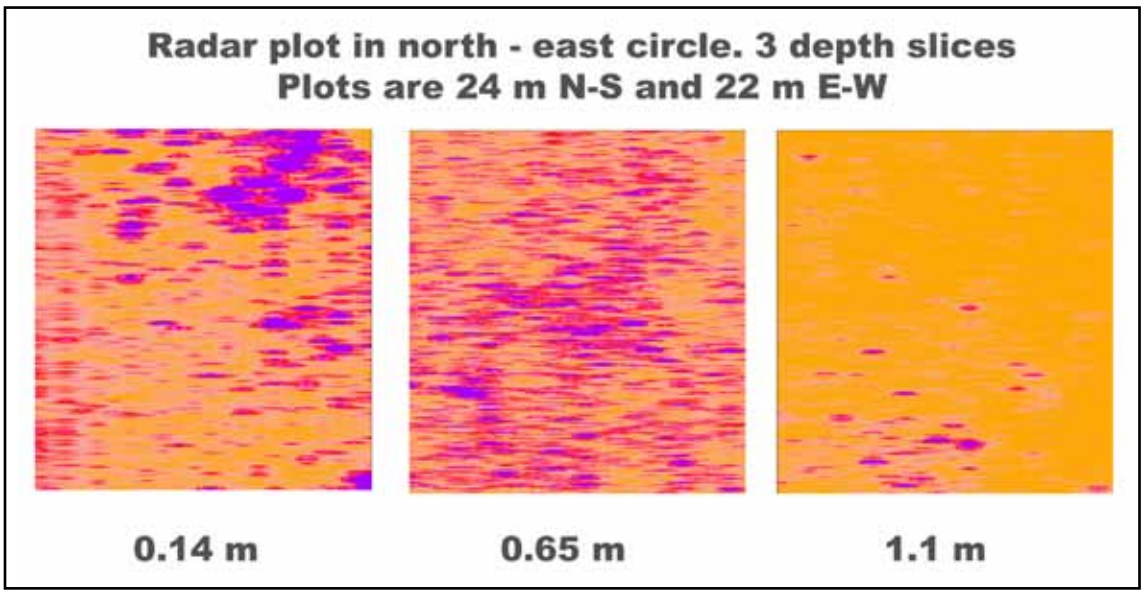

Figure 3.7 Radar slices at 0.14, 0.65 and 1.1m, in NE Circle.

3.5 Twin Probe Resistance

The survey started in 2009, using the RM15, was extended to complete the area inside the main circle, and it was also continued to the south and east (figure 3.8), but the field has not been completed. The method has been useful in observing some archaeological features although the underlying geology makes the results 'rather noisy'. There appear to be traces of the post-medieval field boundaries, running north-south and east-west. There may also be some signs of the henge 'ditch' around the main circle.

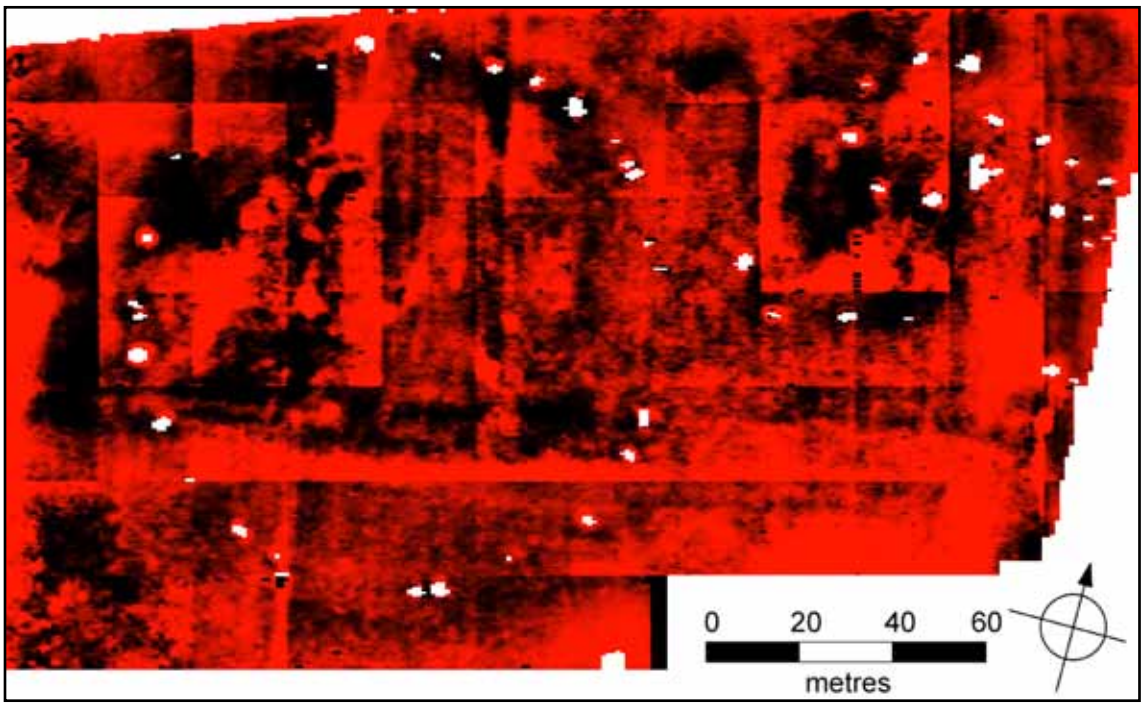

Figure 3.8 Resistance plot of Stone Close.

3.6 Resistivity Profiling

Two very long profiles were performed: one running south-north (designated 940E) and the other west-east (1020N) across the whole of Stone Close (see figure 3.9). The profiles were created out

of shorter profiles, 31 m in length, with probes at 1 m intervals, and overlapping by 5 m, and then combined using the RES2DINV software package.

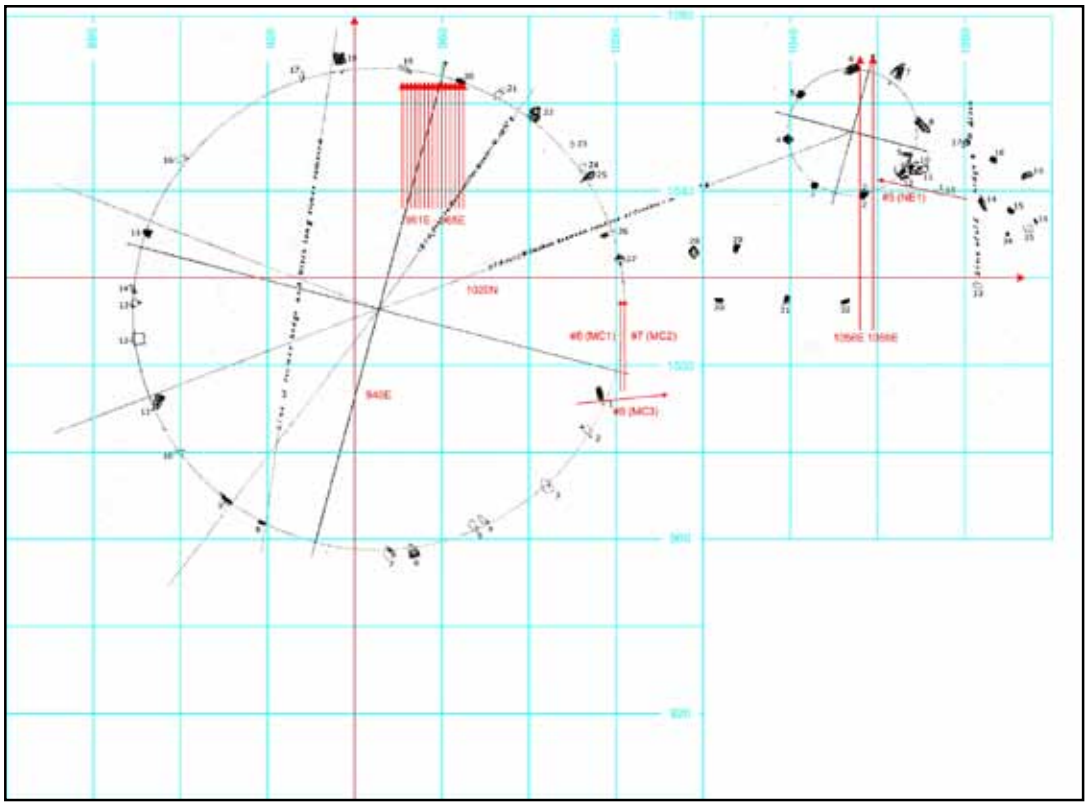

Figure 3.9 Location of resistance profiles in Main Circle area.

Figure 3.10 shows the two profiles, combined with the interpretation of the magnetometry at the corresponding grid lines, in order to show where the post rings and ditch occur.

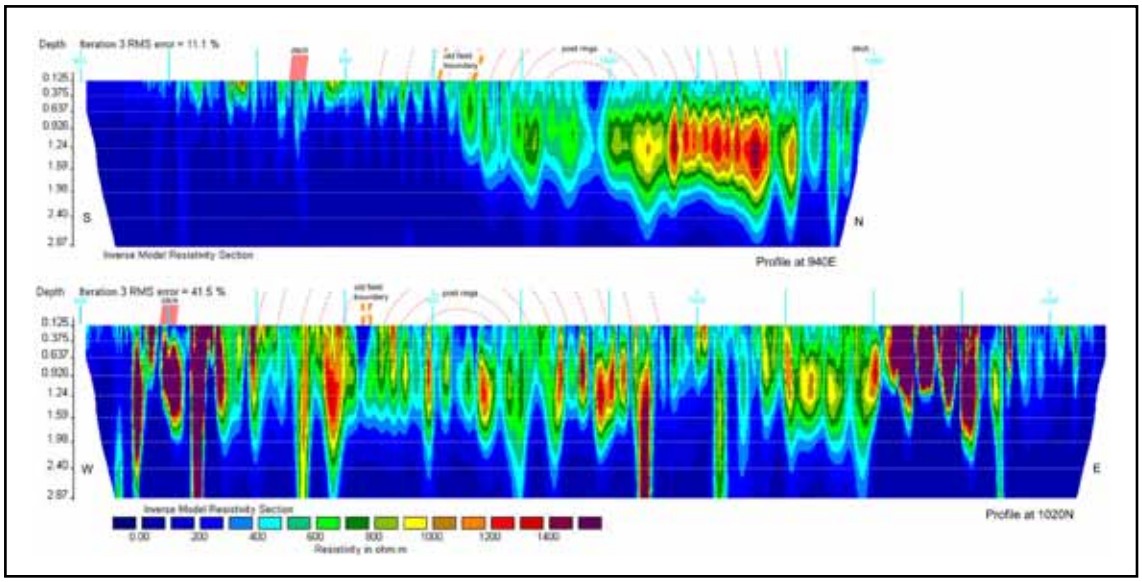

Figure 3.10 (top) Resistance profile from (940, 900) to (940, 1080) and *(bottom)* resistance profile from (860, 1020) to (1094, 1020), overlaid on magnetometry interpretation.

The south-north profile ran from (940, 900) to (940, 1080), a distance of 180 m (figure 3.10 top, and shown as 940E in figure 3.9). It shows a transition from low to higher resistance after 85 m (985N) as it crosses an old field boundary, and a low resistance 'hole' at 117 m (1017N). The high and low resistance bands from 130m to 165m (1030N to 1065N) may be revealing information about the post rings.

The west-east profile ran from (860, 1020) to (1094, 1020), a distance of 234 m (figure 3.10 bottom, and shown as 1020N in figure 3.9). This shows a more complicated picture, with bands of high and low resistance. There is a possibility that the low resistance bands between 40 m and 130 m (900E and 990E) correspond to the post rings visible in the magnetometry, as shown in figure 3.1. Those between 10 m and 30 m (870E and 890E) may be providing information about the henge ditch and bank, while those from 160 m to 200 m (1020E to 1060E) lie within the main avenue, and could be showing features there, as discussed in 3.2.10. The low resistance band between 62m and 66m (922E and 926E) corresponds to an old field boundary.

Two additional long profiles were carried out, each of 63 metres in length running parallel 3 metres apart, either side of stone N2 (figure 3.11). The first ran from (1056, 1008) to (1056, 1071), and is labelled as 1056E in figure 3.9. The second ran from (1059, 1008) to (1059, 1071), and is labelled as 1059E in figure 3.9.

The profiles cross the Main Circle avenue between 1014N and 1030N. The stone N2 occurs between 1038N and 1042N. The rest of the distance to 1071N lies within the NE Circle.

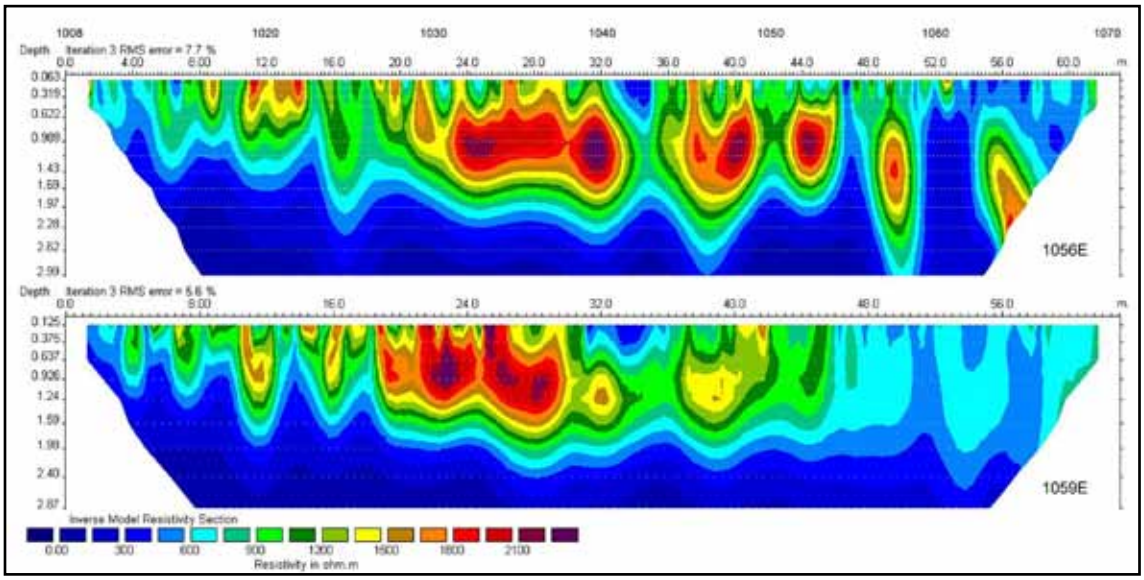

Figure 3.11 (top) Resistance profile from (1056,1008) to (1056, 1071) and (bottom) resistance profile from (1059, 1008) to (1059, 1071).

There is a lot of high resistance between the avenue and stone N2 (1020N to 1038N) in both profiles. Inside the NE Circle, there are possible buried stones at (1056, 1048), (1056, 1053), and (1056, 1058).

There is one area within the Main Circle where the post rings seem to show up in the twin-probe resistance (figure 3.12 left) as well as the magnetometry (figure 3.12 right). It is half of a grid cell, 10m x 20m, and it is faint, but it is the only place it happens. The half grid cell is located between (950, 1040) and (960, 1060).

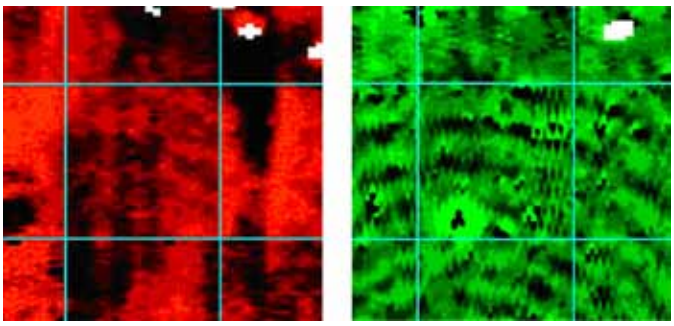

Figure 3.12 Resistance and magnetometry plots for cell (940,1040) - (960,1060).

In order to examine this area more closely, 15 profiles were done of 30 probes each, 1 metre apart, and running south-north. They were parallel, at 1 m spacing. The following plan (figure 3.13) shows where these profiles were located, marked as 951E-965E.

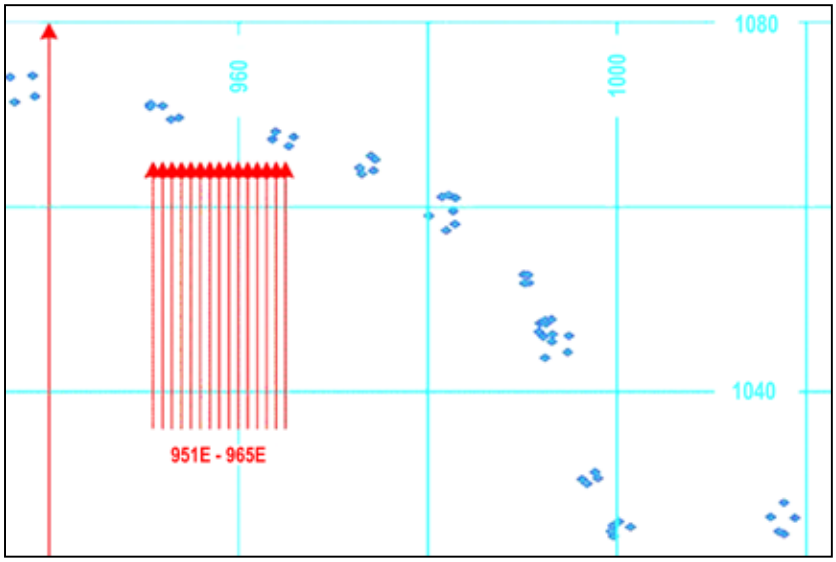

Figure 3.13 Location of resistance profiles 951E – 965E. The blue dots show stone locations.

The results were post-processed to extract resistance values and then recombined to create horizontal slices at different depths. This showed at least three parallel bands of high resistance, with the low resistance in-between corresponding to the line of the post circles. This is most evident at a depth of about 1.2 m. The following diagram (figure 3.14) shows a horizontal contour map at this depth (the red dashed lines show the position of the post circles). There are a few possible post-hole locations, with 3 or 4 along the 956E line.

The earlier GPR results (David et al 2004) did indicate individual pits with a depth of 1.4m, so our depth of 1.2m is comfortably inside that range.

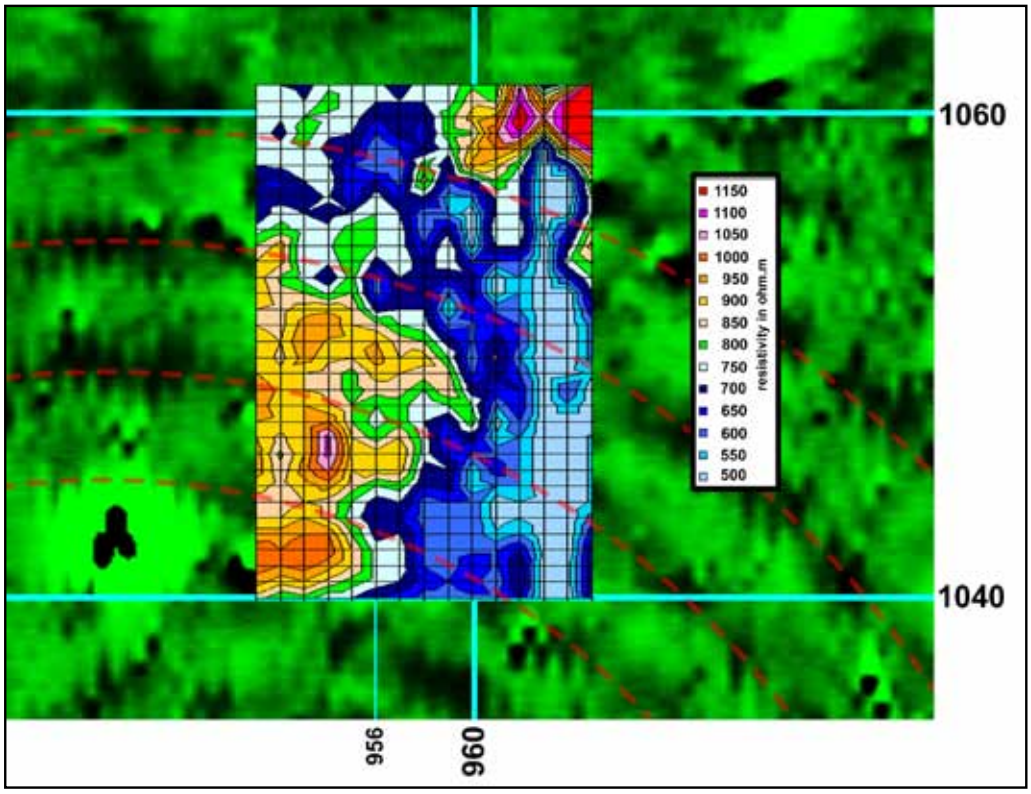

Figure 3.14 Resistance plot at depth of 1.2m with post circles superimposed.

3.7 Discussion

Magnetometry across the whole of Stone Close has revealed interesting results. It has confirmed the main conclusions of the English Heritage team, the nine post rings, the encircling ditch and large entrance, in the Main Circle, and the four possible post holes in the NE Circle, and has added more detail and additional features. Changes in field layout over time have complicated the picture, and it is necessary to be cautious about which features are contemporary with the stone circles, and which are later.

The second possible entrance through the ditch has been 'repositioned' by us further to the south west (3.2.4). It seems likely that the position suggested by English Heritage is actually the place where a later trackway or field boundary crossed the ditch line. The entrance in our results looks very convincing. English Heritage surveyed part of the Main Circle with a high resolution caesium gradiometer, but only covered the area of the second entrance with a lower-resolution device which did not provide the detail that we have been able to obtain. The bearing of the entrance from the circle's centre, at 215° to true north, does not appear to align with either the Cove or the SSW Circle, lying approximately midway between them, nor does it seem to align with the NE Circle. Whether there is any astronomical significance is discussed in chapter 7.

Paragraphs 3.2.1 and 3.2.4 both seem to indicate stones being in awkward places both for a possible portal to the timber circles and for the south-west entrance to the henge ditch. This would suggest that the construction of the stone circle was contemporary with neither of these structures. There must be a chronological sequence between stones, timber and ditch. If we assume the timber circles were earliest, the stone circle may have been followed by the henge, and each may have had a separate time of functioning.

The possible circular enclosure with radiating 'spokes' (3.2.7) is intriguing, and it is a pity that the survey could not be completed in that area. The enclosure, if that is what it is, is some 34 m east-west by 26 m north-south. It is tempting to suggest a Bronze Age or Iron Age date: filling in the missing piece would be desirable.

There are a number of areas where we have postulated additional postholes (3.2.8–3.2.13). These could be targets for future high resolution investigation.
The use of magnetic susceptibility has not been a great success on this site, but it has added useful data in some cases, and it is a useful low skill, low priority task. One problem has been the small areas surveyed, which is a function of the fine spacing and the need to write and transcribe data, but it should not be dismissed. In particular, the north-west area, where the stone circle seems to be incomplete, could be surveyed, and this should be extended to cover the area of the ditch and bank, where magnetometry appears to show possible stake holes.

Radar was found to have limited benefits, though it did seem to show some activity at moderate depths in the NE Circle.

Also of limited value was the use of twin-probe resistance. The underlying geology in Stone Close makes it difficult to identify features, but the post-medieval field boundaries do appear in places, and the henge ditch may also be visible.

Resistivity profiling, on the other hand, does appear to be giving interesting results, although it is a very time-intensive technique.

We experimented with two very long profiles, north-south and east-west, across the field. It is possible that the variation they reveal is showing information concerning the post rings and henge ditch. The bands of high and low resistance may be lining up with these features, but some further work would be required to establish any statistical significance. The old field boundaries do seem to be apparent, especially in the east-west profile. The north-south profile shows a transition from

low to higher resistance as it crosses an old field boundary. This could be where soil had built up as colluvium on the north side, or it could just be that mediaeval people knew exactly where to put a hedge to get the best of their fields.

The investigation of the area within the Main Circle where the twin-probe resistance appears to be giving evidence of the post circles gave promising results. Twin-probe resistance gives only average resistance values through the volume of soil beneath the probes on the frame. Here, profiling has been used to obtain many more data values at differing depths, and then recombined to give a set of horizontal slices. This gives a plot of resistance values at different depths that may reveal a more detailed picture than is available with traditional methods.

It has been suggested that the visibility of post rings in the magnetometry can be explained by the typical magnetic signature of pits, with magnetic enhancement caused by the burning of posts in situ, raising the magnetic susceptibility of their surrounding soils, or, the action of soil bacteria causing the accumulation of biogenic magnetite in the post pipes (David et al 2004). It has been assumed that there is an absence of any similar anomalies in the twin probe resistance results. However, it seems possible that such anomalies can be discerned in a very limited part of the site. If this is so, it raises the obvious question of why these are visible in only one small area. It may be that the background geology that is so apparent across the site is sufficiently uniform in this one area to permit the post rings to show through.

However, this will remain speculative without excavation. It would be desirable to repeat the profiles with 0.5 m spacing of the probes to attempt to obtain more detail. It might be possible to repeat the data collection at a different place within the Main Circle to see whether there was any sign of post holes at depth that are not discernible in the twin probe resistance plot.

We are limited in the amount of analysis we can carry out with the RES2DINV software. We are using the free demonstration version, which does not permit the export of all the data produced by the inverse transform, so our post-processing has been based solely on the data displayed on the screen in which each cell can have one of only sixteen values. A full licence should enable the export of data with much better resolution, but at $2,700 is beyond any budget currently considered for this work.

4 South South-West Circle

4.1 Topography

The South South-West Circle sits on top of the hill above Stone Close. Visual connection is obscured today because of hedges; it is possible to see down to the Main and North-East Circles from the northern edge of the SSW Circle, but not from its centre.

The grid established on Stone Close was extended up to the SSW Circle by EDM and it was possible to set out a baseline 800, 860 to 840, 860, 6 m south of the northern hedge of the field. A detailed EDM survey was carried out on the SSW Circle field as well as on Stone Close, and a few points were also taken on the grass between the two fields.

The EDM survey indicated that the centre of the SSW Circle space is very flat and level, as if forming a deliberate platform. The stones to the south and east tumble off down steep sides of this platform. The platform extends to the west of the circle.

Figure 4.1 shows the positions of stones and the contours of the hill top. Figure 4.2 shows the contours of the whole area, including Stone Close, plotted at 0.1 m intervals. This is too fine for normal use, and the straight lines joining the two areas are extrapolation caused by a lack of data points, but it does show spectacularly how the northern hill side slopes up to the very flat plateau.

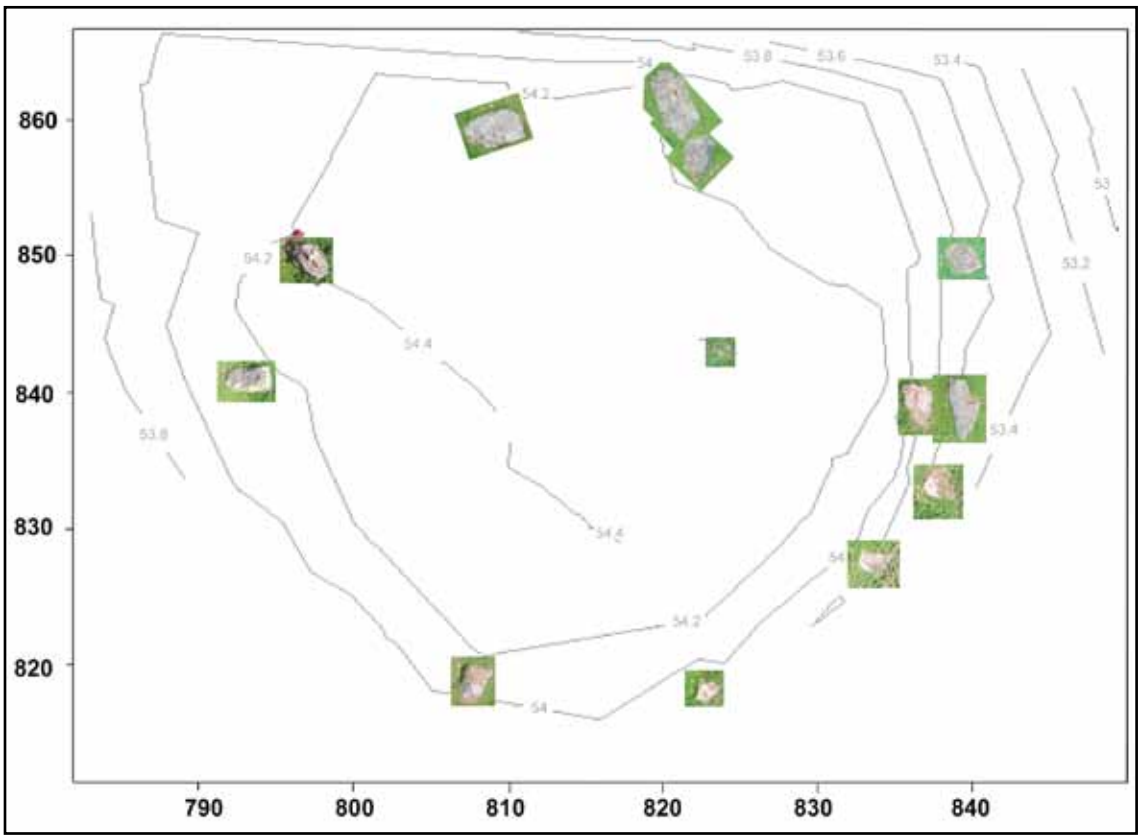

Figure 4.1 Contour plot of SSW Circle with stone photos superimposed.

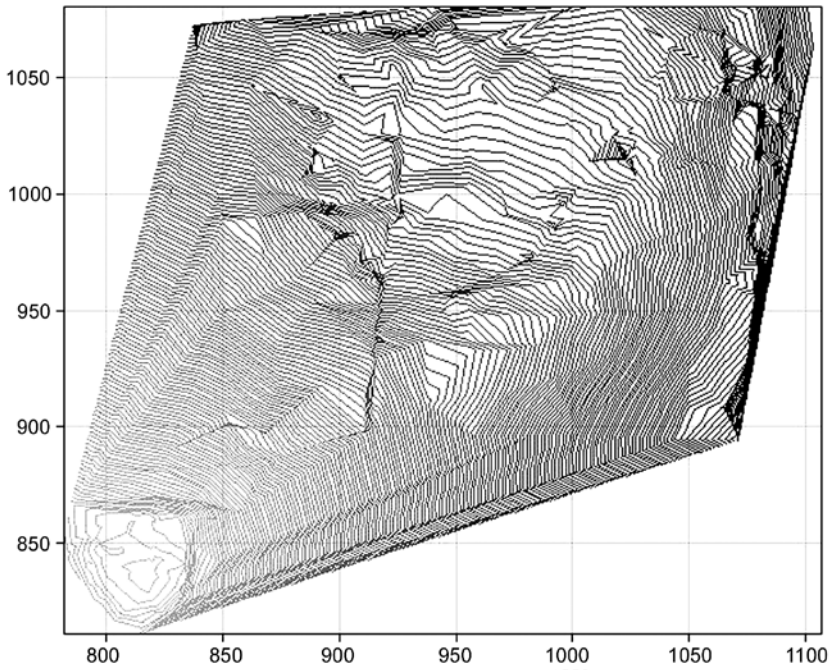

Figure 4.2 Contour plot of SSW Circle and Stone Close

The stone in the circle's interior in figure 4.1 is one that has been mentioned by some sources, but usually considered to not form part of the monument. It lies flush with the ground, and appears to be of the same type of stone as the ones in the Cove. We have given it the designation, S13 (figure 4.3).

Figure 4.3 Stone S13 (20 cm divisions)

4.2 Magnetometer survey

The survey was carried out at high density; 8 readings per metre, half metre line separation. Metal fence, gates and a water trough restricted the approaches to the edge of the field, as did the rough vegetation and steep slopes around the south and east sides. The northernmost four grids were not attempted as they were but six metres from baseline to hedge (with wire fence embedded). This was a pity as some archaeology has been missed. If possible, these grids may be done at some time, but traversing east-west in order to get some complete lines, and in a way which lets the de-stripe software work to best effect.

The magnetometer survey is shown in figure 4.4. It is shown in green so that the stones show clearly as blanks where readings were not taken. Some of the stones were right on the edge of the survey area. The stone (S13) newly observed within the circle does not show as a blank as it was possible to walk over it. The magnetometry with stones and contours imposed is shown in figure 4.5.

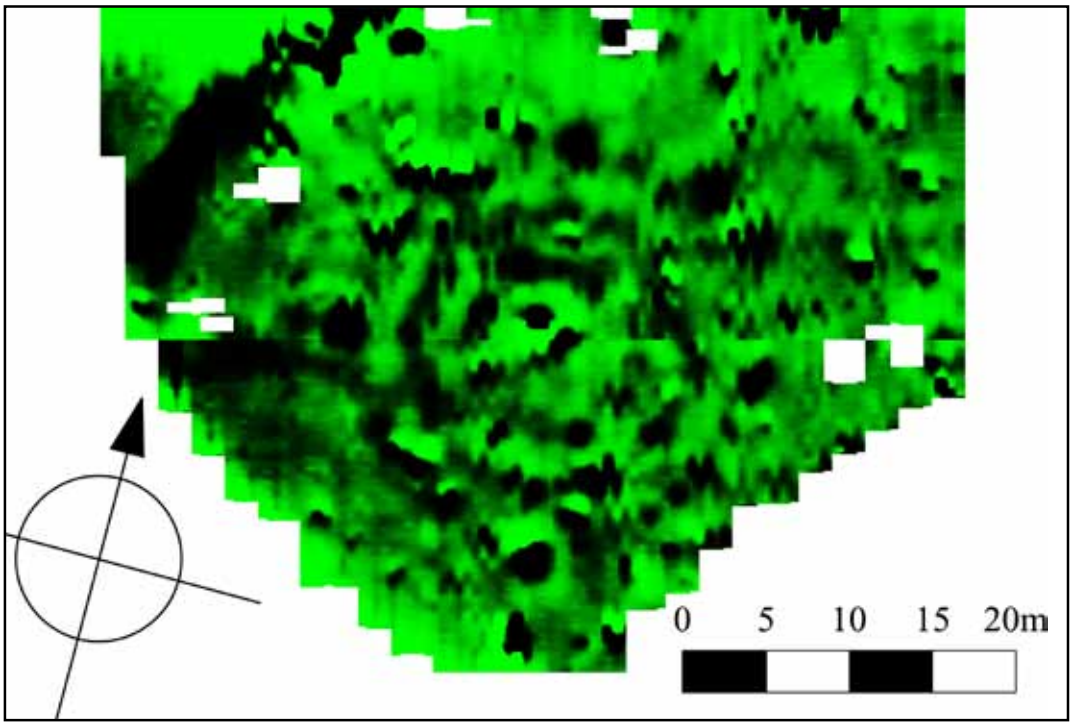

Figure 4.4 Magnetometry plot of SSW Circle

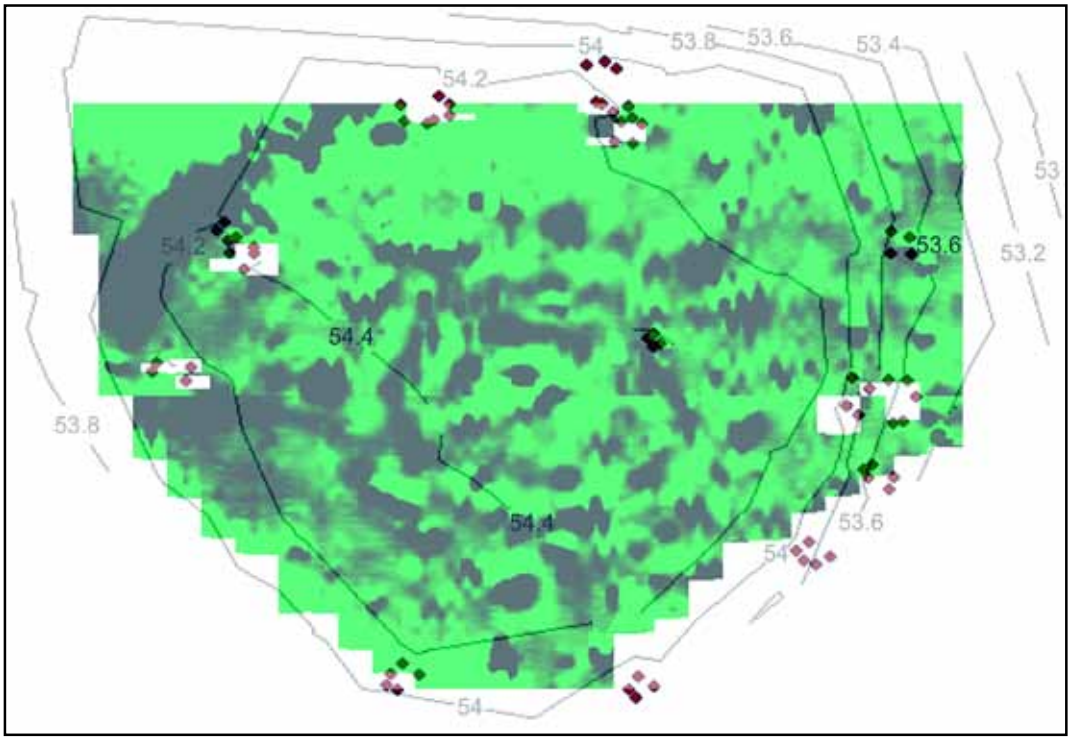

Figure 4.5 Magnetometry plot of SSW Circle with contours superimposed

Three circles of magnetic anomaly show within the stones. These generally show as rings of post holes, but are not always resolved into discrete signals, particularly in the middle ring. However, given the very low signal-to-noise ratio at this site, that may be a limitation of the method. The outer ring appears to have more prominent features in the north-east, possibly a portal. At the centre of the circles are at least two extra post holes. There is also a strong discrete anomaly in the north-west near the stones. This differs little from the original English Heritage survey (David et al 2004), but may show more detail.

Around the west side of the stones, is an arc of positive anomaly, and this also shows in David et al (2004), but it is masked by iron as it heads round. It may also continue to the north of the stones, but this is also masked by iron signals. This would appear at first to be a ditch but comparison with

resistance (see sections 4.3 and 4.4) suggests that it may be wall footings. Note that this feature cuts the stones off from the small portion of the flat platform to the west.

4.3 Resistance Survey

The complete field was subject to twin-probe resistance survey using the RM15. The result is shown in figure 4.6. The plot is based on red so that the stones can be seen as blank spaces. Apart from features, the area in the south of the circle appears to show lower general resistance than the northern half.

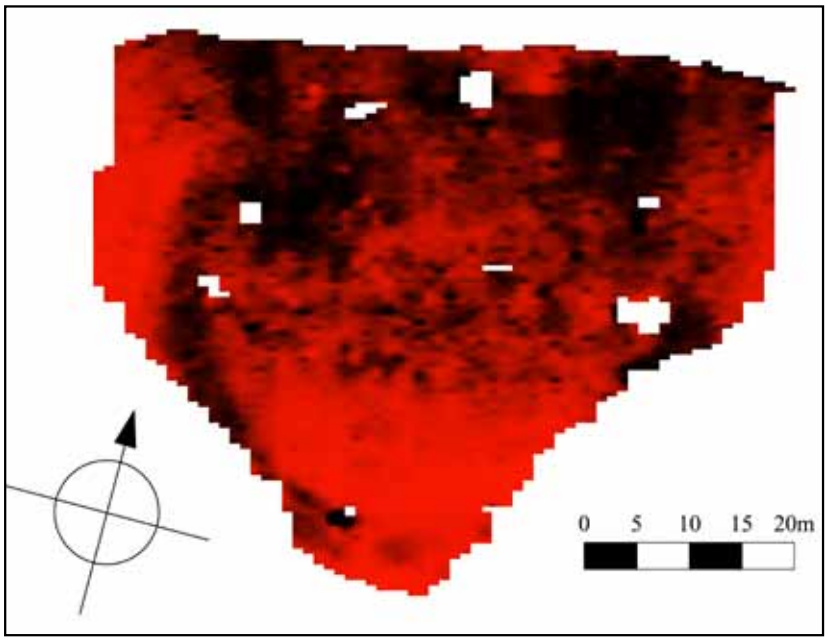

Figure 4.6 Resistance plot of SSW Circle

There are signs of a ring of high resistance in the middle of the circle, and the arc to the west is clearly visible as higher resistance.

The resistance plot has also been re-drawn, colour coded to show much greater detail of resistance change as figure 4.7. In this case, the far north-east grid has been omitted. The areas of low and high general resistance can be picked out clearly, and so can the arc, the possible footings of a wall discussed in section 4.2. The footings become lost in the general area of high resistance to the north. There is finer detail in the centre of the circle. This generally shows small patches of higher resistance.

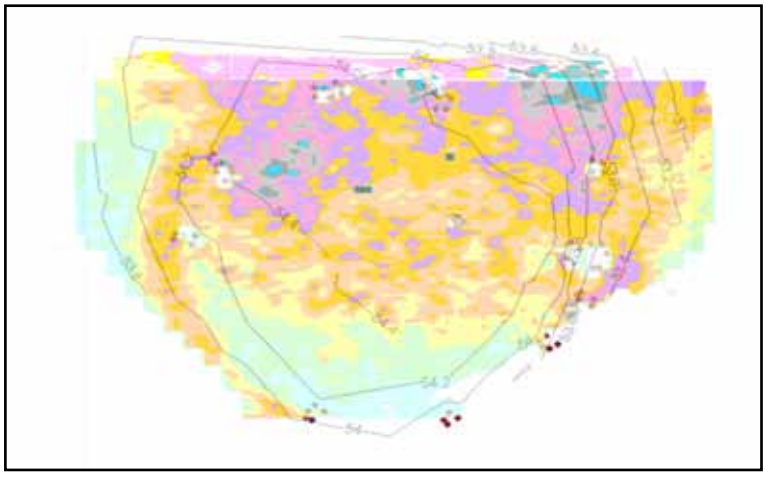

Figure 4.7 Linear resistance plot of SSW Circle

A small area of higher resistance towards the north-east may indicate a missing stone site.

4.4 Resistance Profiling

The pseudosection profiles of the SSW Circle carried out in 2009 seem to suggest much stone underlying the area of the ring (but with soil below, see figures 4.8 and 4.9), suggesting that the ring may be more complex than initial appearance suggests. However, limitations of time restricted the study to the two radial profiles shown here, and it was decided this work could benefit from a more systematic and extensive approach with more profiles used to build a comprehensive 3D picture to aid understanding and interpretation of the Circle.

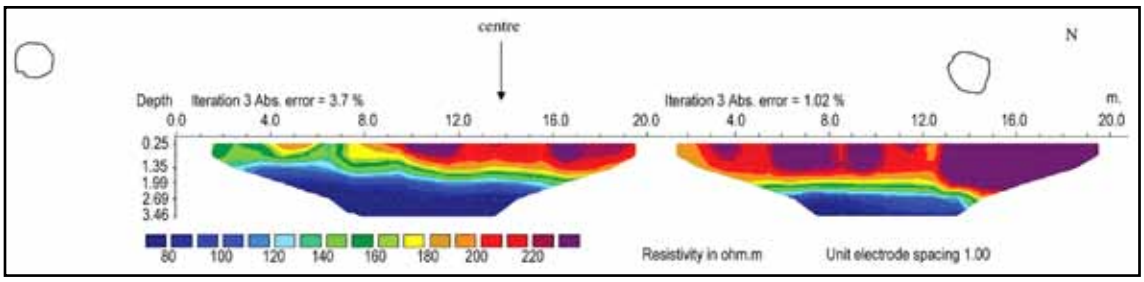

Figure 4.8 SSW Circle, pseudosection profiles, north transect

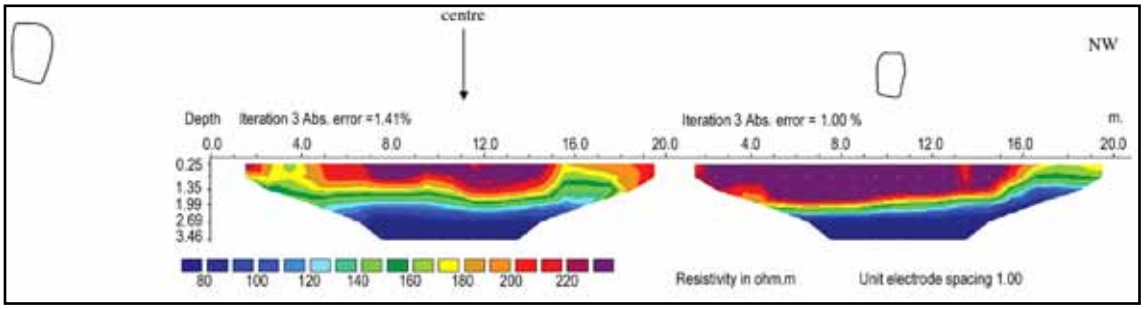

Figure 4.9 SSW Circle, pseudosection profiles, north-west transect

Sixteen radial resistance profiles (figure 4.11), each of 32 probes with 1m separation, were carried out across the circle, aligned to the cardinal and ordinal points of the grid compass, and centred on (816, 840). Each pair of profiles in the same direction overlapped by 14 m (or more) and was combined to create eight profiles as shown in the following table 4.1. Two pairs had greater overlaps because of the site boundaries. One profile was found to have corrupt data and so was not usable.

Start E	Start N	End E	End N		
S-N	816	816	816	864	
W-E	792	840	840	840	
SW-NE	799.03	823.03	832.97	856.97	
SE-NW	831.56	824.44	799.03	856.97	16m overlap
ESE-WNW	838.17	830.82	793.83	849.18	Not usable, as wnw profile data damaged
SSE-NNW	824.80	818.75	806.82	862.17	15m overlap; dog-leg round stone at 43m and 44m
SSW-NNE	806.82	817.83	825.18	862.17	Dog-leg round stone at 3m.
WSW-ENE	793.83	830.82	838.17	849.18	

Table 4.1 Start and end coordinates of radial resistance profiles in SSW Circle

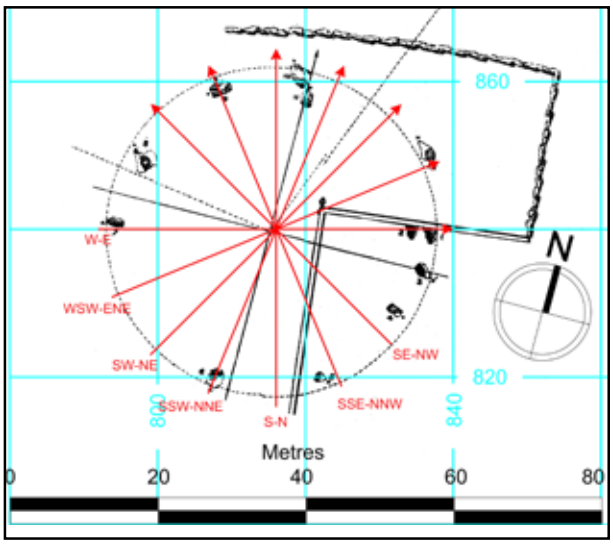

Figure 4.10 SSW Circle, location of radial profiles

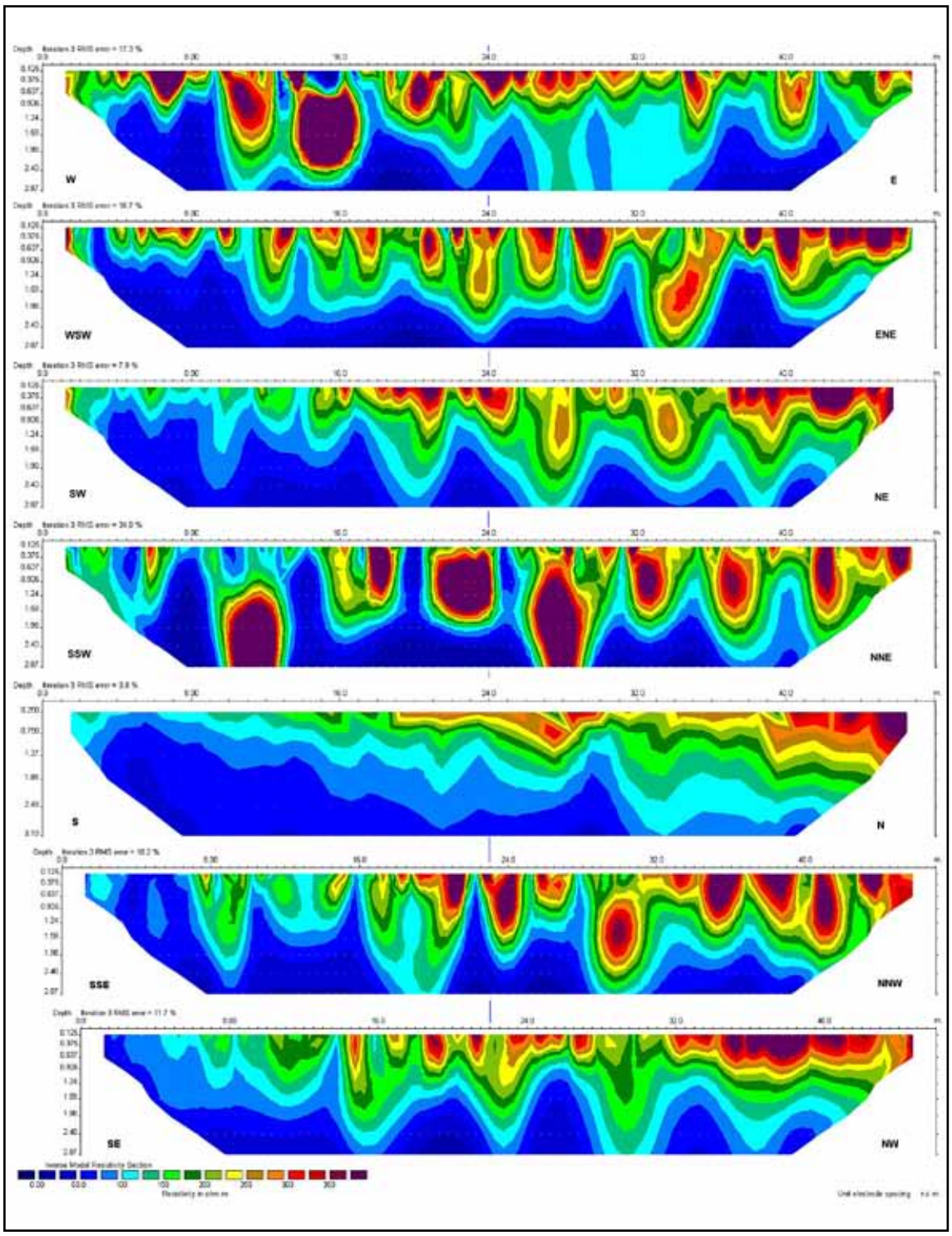

Figure 4.11 SSW Circle, radial profiles

There are more high resistance areas in the north half of the circle. The alternation of high and low resistance areas along each profile may bear some relation to the post circles, but there is no definite correlation. There are some possible buried stones, e.g. 15m along the W-E profile, at 11m, 22.5m and 27.5m along the SSW-NNE profile, and 30m along the SSE-NNW profile.

Further profiles were performed (figure 4.12):

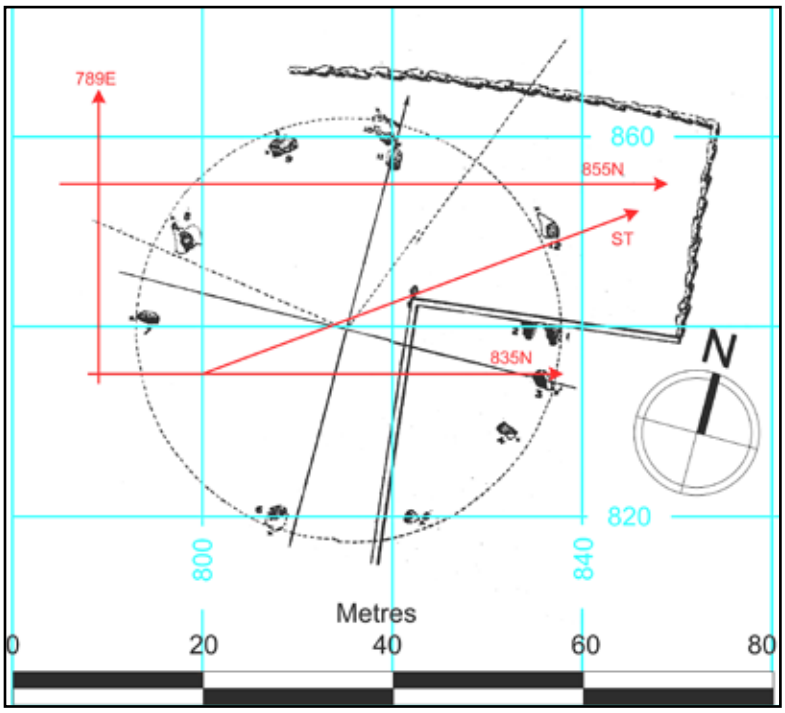

Figure 4.12 SSW Circle, location of other profiles

• **789E:** *(figure 4.13)* running south-north outside the west side of the circle to see if there was any sign of a ditch, from (789, 834) to (789, 865).

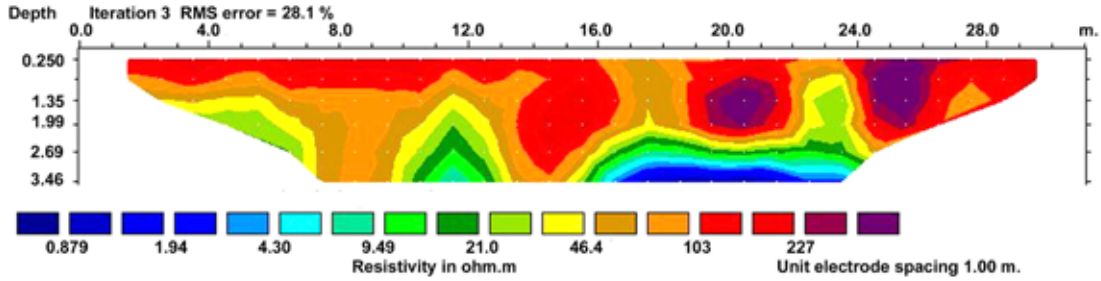

Figure 4.13 SSW Circle profile 789E, from (789, 834) to (789, 865).

The results were inconclusive; there was nothing to indicate a ditch, but the band of high resistance near the surface could represent wall footings.

• **855N:** *(figure 4.14)* running west-east outside the north side of the circle, from (785, 855) to (849, 855).

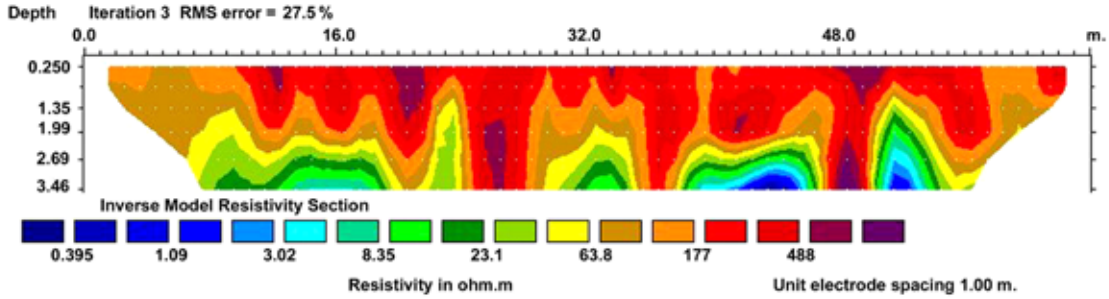

Figure 4.14 SSW Circle profile 855N, from (785, 855) to (849, 855).

This profile ran across an area of higher resistance, and no features were apparent.

• **835N:** *(figure 4.15)* running west-east across the circle just south of the centre, from (788, 835) to (838, 835).

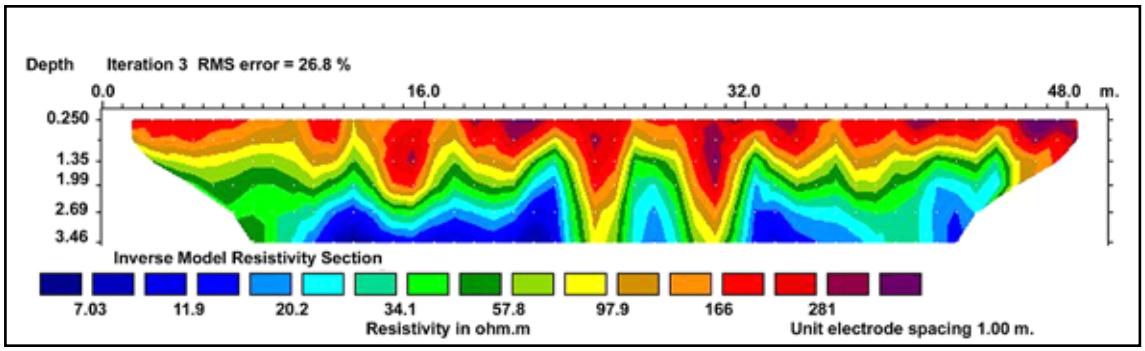

Figure 4.15 SSW Circle profile 835N, from (788, 835) to (838, 835).

It was hoped that this profile would show the ditch/wall at the west (left) end and pick up the post circles. There is an area of high resistance at the left end, and variation across the profile, but again there were inconclusive results.

• **ST:** (figure 4.16) running across stones S12 and S13, from (800, 835) to (846, 852).

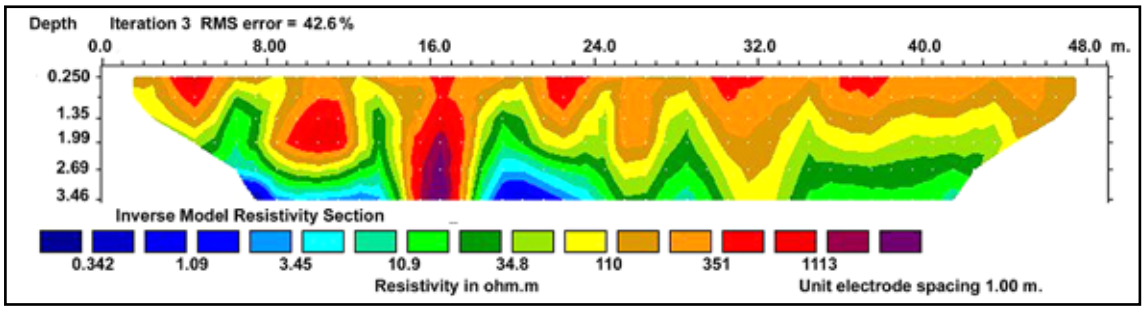

Figure 4.16 SSW Circle profile ST, from (800, 835) to (846, 852).

The profile crossed stone S13 at 23m-24m, and stone S12 at 39m-40m. There is a high resistance area that corresponds to S13, but the area closest to S12 seems to be a metre out.

4.5 Radar

A survey of a rectangle filling the centre of the circle was intended using the radar. This would have been 30 m east-west by 25 m north-south, but there was some data corruption towards the end of the survey and only 24 m of the east-west coverage could be used. This is shown overlaid on the resistance and magnetometer plots in figure 4.17. The depth slice is at 0.45 m nominal. Depth slices at 0.45 and 0.75 m are shown side by side for comparison in figure 4.18. The radar pictures show anomalies corresponding to the post hole/stone features seen in resistance and magnetometer.

Two 38 m long lines of radar were threaded between stones from 796, 825.5 to 797, 863.5 to try to identify the arc. Unfortunately, this proved too limited an area to get a plan that could be interpreted, although a little detail could be seen in depth profile. This leaves the nature of the arc still unresolved.

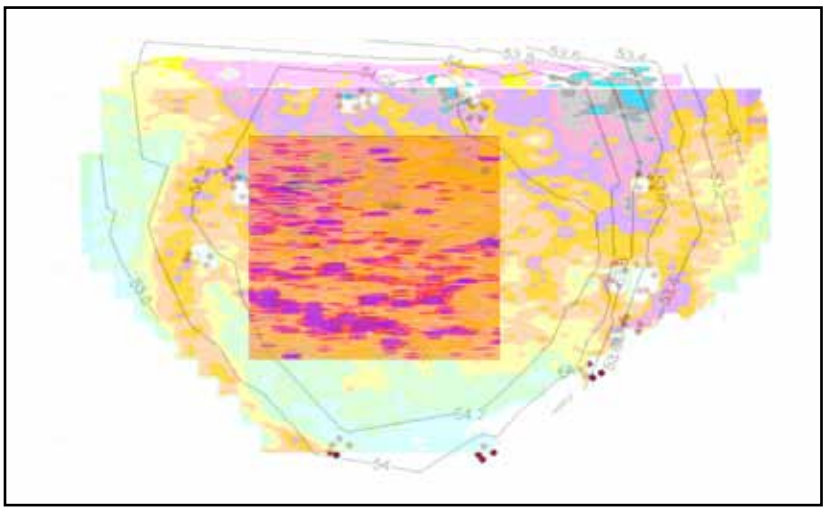

Figure 4.17 Radar survey results overlaid on linear plot of resistance survey results.

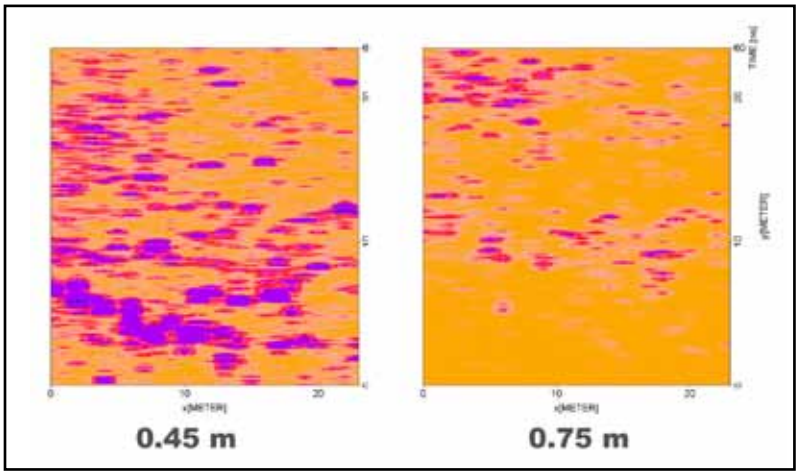

Figure 4.18 Radar survey results: 0.45m and 0.75m depth slices.

4.6 Magnetic Susceptibility

Plots of magnetic susceptibility surveys around stones S12 and S13 are shown in figure 4.19, each being a 6 m square with the stone at the centre.

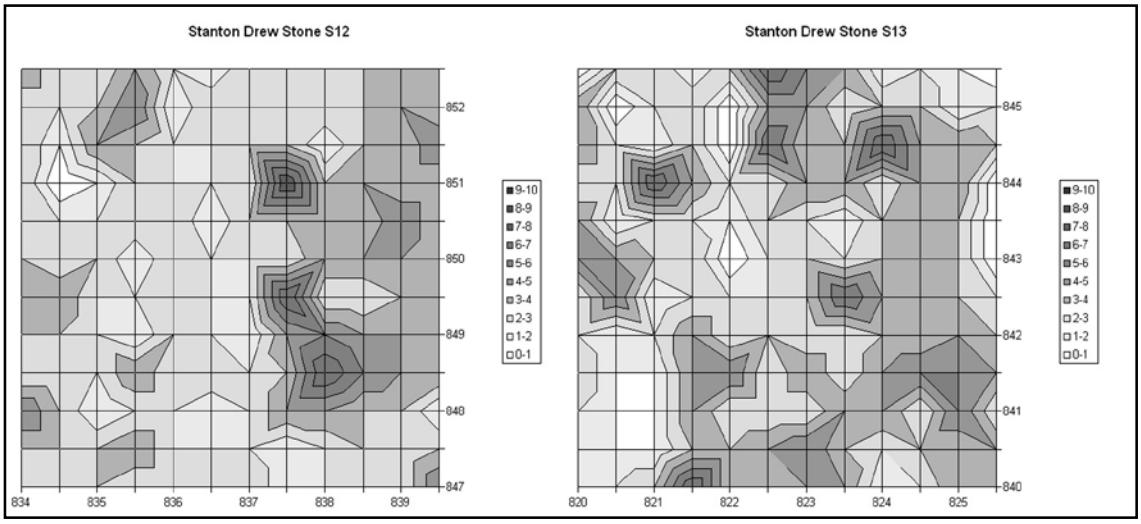

Figure 4.19 Magnetic susceptibility results for stones S12 and S13.

4.7 Discussion

In 2009 we managed to spend just one morning on the SSW Circle, doing four resistance pseudo-section profiles with no clear-cut result. We wanted to devote considerably more time to the circle in 2010 and do some extensive surveying. This we have achieved, but the results are still not clear-cut.

We have taken the liberty of increasing the number of stones on the SSW Circle site by one by including S13 within the circle. Although it does not appear to have any geometric relationship to the circle, it does resemble the other stones and we believe it is worth including.

The most striking thing about the EDM survey is how flat the site of the circle interior is, and it reinforces the opinion that the circle was positioned very deliberately to occupy the small plateau, with views northwards across the other circles towards the River Chew, westwards to the Cove, and across the valleys to the south and east.

Both radar and magnetic susceptibility surveys were not particularly valuable on this site.

The magnetometry survey has confirmed the results obtained by English Heritage, and may show more detail. In addition to three post circles, there are anomalies to the north west and north east of the circle; the latter may be part of an entrance. The arc of positive anomaly around the west of the circle may be part of a ditch, but it is perhaps more likely to be wall footings, especially as it shows as high resistance in the resistance survey.

The southern half of the circle shows generally lower resistance than the northern half. This may be due to a greater soil depth, and it has been suggested that this could indicate levelling of the plateau in order to construct the circle. However, Stukeley's 1723 drawing of Stanton Drew (Stukeley 1776) shows the circle divided across the middle by a hedge running east-west, with an orchard covering the northern half. A similar transition from low to higher resistance occurs in Stone Close at an old field boundary, so the suggestions given in section 3.7 also apply here: it could be where soil had built up as colluvium on one side, or it could just be that mediaeval people knew exactly where to put a hedge to get the best of their fields.

Small patches of high resistance occur in the centre of the circle. These seem to correspond with higher magnetometer signals, so these may represent stone rather than post holes.

The site was subjected to extensive resistance profiling. There is a lot of variation, which could be explained by there being a lot of rocky material or buried stones, but the picture is generally confusing. There are some good candidates, though, that can be identified for buried stones.

5 The Cove and Churchyard

5.1 Topography

The Cove lies at the western edge of a ridge which extends from the South South-West circle. Intervisibility between Cove and stone circles may have existed in prehistoric times but is now disrupted by the church and buildings of Church Farm.

To the west of the stones is a small flat terrace which drops sharply to the car park of the Druids Arms, but this is recently made up ground, and nineteenth century maps show cottages at road level here. Indeed, the pub was part of these cottages originally and the sharp drop to the back of the pub from its private garden indicates the earlier topography. The baseline used for the geophysical survey was taken as the join between natural and made up ground level, and no work was carried out to the west of this line.

A survey of the pub beer garden had been done before the 2009 geophysical surveys, and this was extended into the churchyard (Oswin et al 2009) but this gave little information about the monument. It was the resistance survey which showed archaeology extending north from the stones and probably continuing into the private garden of the pub.

The resistance survey was continued into the private garden in September 2010 and the beer garden was subject to re-survey so that data from the private garden could be added. This second survey entirely replaces the 2009 survey, using different grid coordinates and is based on the baseline forming grid north rather than on magnetic north. This leaves it closely aligned to the Stone Close grid. For details, see Chapter 2. The intention eventually is to incorporate the Cove into the Stone Close grid, and this can be done when the field to the south is surveyed. Until then it can only be linked by values obtained from hand-held GPS and this is limited to 5 m accuracy.

A small portion of the churchyard was also subject to resistance and magnetic susceptibility survey, but this was not included in the EDM survey as a high stone wall completely blocked the sightlines. This area can also be linked into the Stone Close grid for the field to the south. Full EDM survey of the churchyard and farm is not recommended as ground levels have been heavily disturbed since mediaeval times.

The stones are at about 51 m above O.D., so about a metre lower than the flat plateau of the South South-west circle. Beyond the north end of the pub private garden, the ground falls away steeply. This is probably also an effect of later disturbance but the ground level was probably originally falling gently to the north. The monument as delimited by the resistance survey appears to be fairly level, but on the edge of the hill with a sharp drop to the west and with a view into the dry valley to the south. The land immediately south of the beer garden slopes gently to the south but is now covered in asphalt, so preventing further study.

5.2 Magnetic Susceptibility

Conventional magnetometry was tried in the 2009 survey but was defeated by the proximity of a lot of iron work. However, magnetic susceptibility survey proved useful and appeared to produce a pattern which was an inverse of the resistance survey (low resistance gave high susceptibility). The magnetic susceptibility survey was continued in 2010 both in the churchyard and also in the pub private garden.

The 2009 survey was done at nominal 0.5 m intervals on traverses 1 m apart, using shrunken ropes where the nominal 0.5 marks were approximately 0.45 m apart. Similar ropes were used in the private garden so that the plots were could be aligned more exactly but the survey in the churchyard used full length ropes with marks actually 0.5 m apart. As these could only be mapped onto the area

as discrete blocks, all the data could be made valid in spatial terms by adjusting the width of the areas to the west of the churchyard wall. The 2010 surveys both in the churchyard and the private garden took readings at 0.5 m nominal spacings on traverses 0.5 m apart.

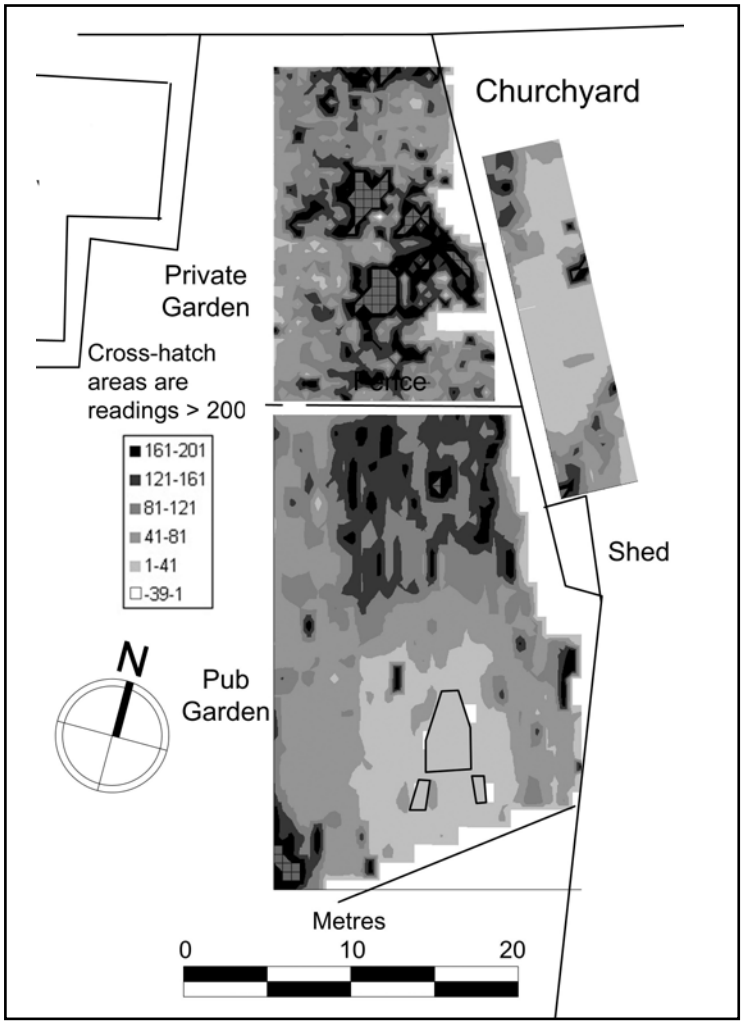

Figure 5.1 Magnetic susceptibility plots of the beer garden and private garden of the pub, and the churchyard corner.

A composite of the three magsus surveys is shown in figure 5.1. These are assembled in their correct ground positions and show the outline of the monument continuing from where it was observed in the pub garden in 2009 on into the private garden and into the edge of the churchyard. Note that the area in the private garden does not give a clear view as the results, particularly around the centre of the garden, are contaminated by the presence of very high readings, probably caused by buried iron.

5.3 Ground-penetrating radar

Following on from the 2009 survey, particularly the profiling, a set of profiles were set up immediately west of the Cove, using half-metre spacing between probes in any profile, and also between profiles. This was in the hope of getting a detailed picture of the stone structure beneath the surface. The profiles will be discussed later in this chapter. The area was also investigated by radar at 500 MHz, and as this is a much quicker method, the area was extended to the north as far as the edge of the lawn, and to the west, to the baseline, giving a rectangle covered of 24.5 m by 8.5 m. Spacing between radar tracks was also set at 0.5 m to mimic the profiles. All of the individual profiles, profile area and radar area are shown against the resistance plot in figure 5.2.

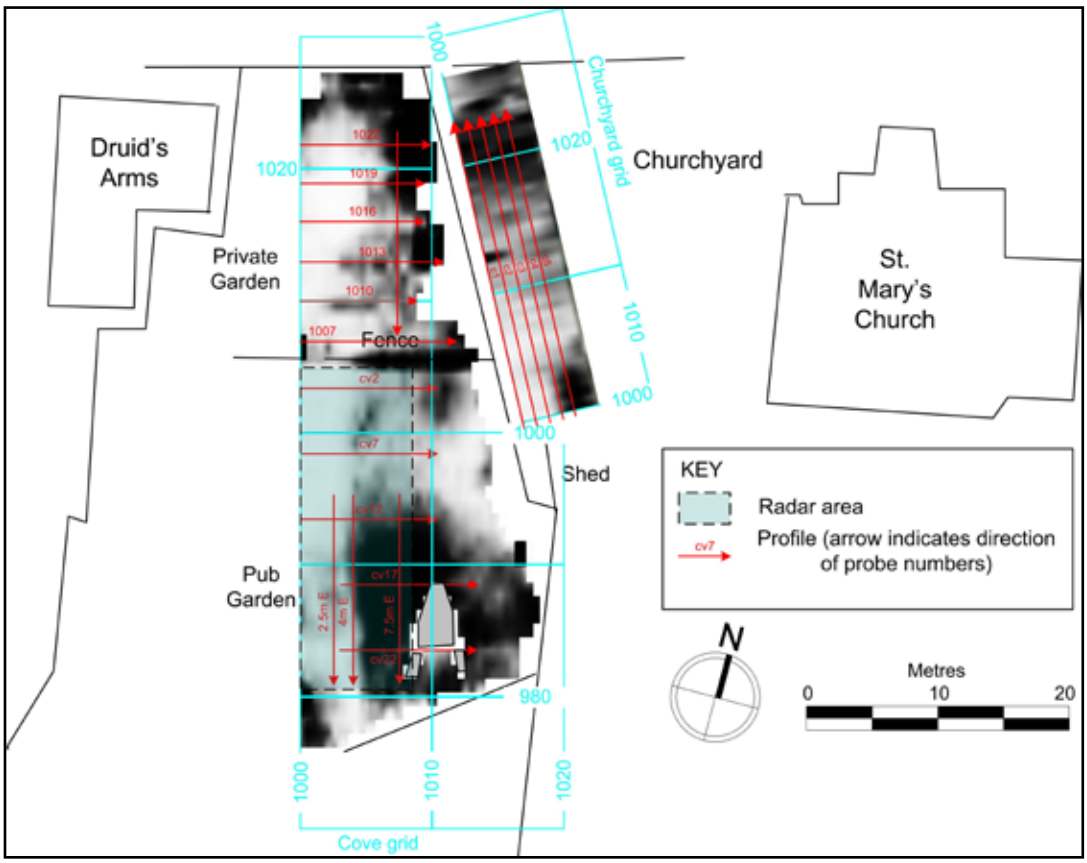

Figure 5.2 Profiles, profile area and radar area overlaid on resistance plot.

All that was detected was found to be very shallow. The radar depth slice for 0.145 m (nominal, based on 0.06 m/ns wave speed) is shown in figure 5.3. The red area possibly indicates the top of the stone structure, the yellow (surrounded by red) may indicate the presence of the ditch. By 0.75 m, the plot was almost blank.

Figure 5.3 Radar depth slice, 0.145 m.

5.4 Resistance

Resistance was plotted in 2009 in the beer garden using the TR resistance meter and had to be conducted with spare ropes which had shrunk to 19 m length, so that a nominal 0.5 m mark was actually about 0.45 m. When the private garden was surveyed in late 2010, the same meter was used and shrunken ropes were also used so that the grids could be joined up.

A small portion in the north-west corner of the churchyard was also surveyed during 2010 but this used the full length ropes and used the RM15 meter. This did not pose any problems of compatibility as the plots could not be joined directly. A high stone wall separates pub garden from the churchyard so there was no visual contact possible between the two sites and no continuity of grids could be established.

Figure 5.4 shows the resistance plot obtained from INSITE for the pub garden (both parts) and figure 5.5 shows the plot with the churchyard portion added. The outline of the possible barrow can be seen continuing into the private garden of the pub and a possible eastern portion with some ditch showing in the churchyard. The strong dark straight line is the concrete fence base between the beer garden and private garden in the pub, and the rectangular image in the private garden is the base of an old hut. The dark area around the edge is wall tumble. The high resistance anomaly halfway along the west side of the churchyard plot, about 2 metres long, is a grave with a covering stone. The ground has been scarped steeply to the north of the garden and churchyard so no further detail could be expected there.

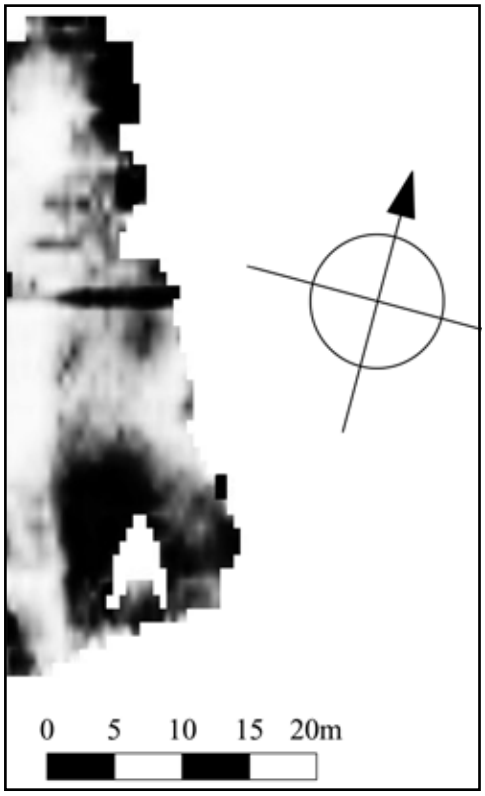

Figure 5.4 Resistance plot in INSITE entire pub garden.

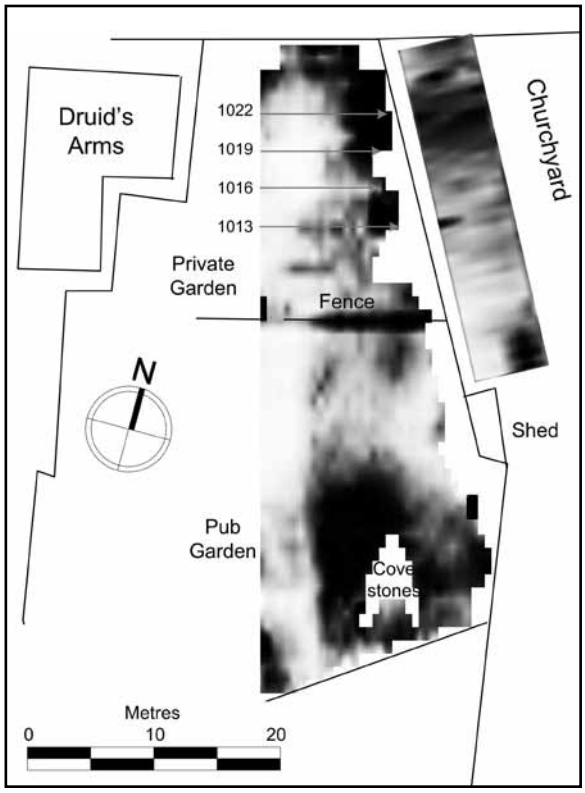

Figure 5.5 Resistance plot in INSITE of pub garden and for churchyard portion.

The resistance plot of the area is also shown in colour in high resolution for combined area in figure 5.6. This gives a clear enough image to give credibility to the theory that there was a long barrow here.

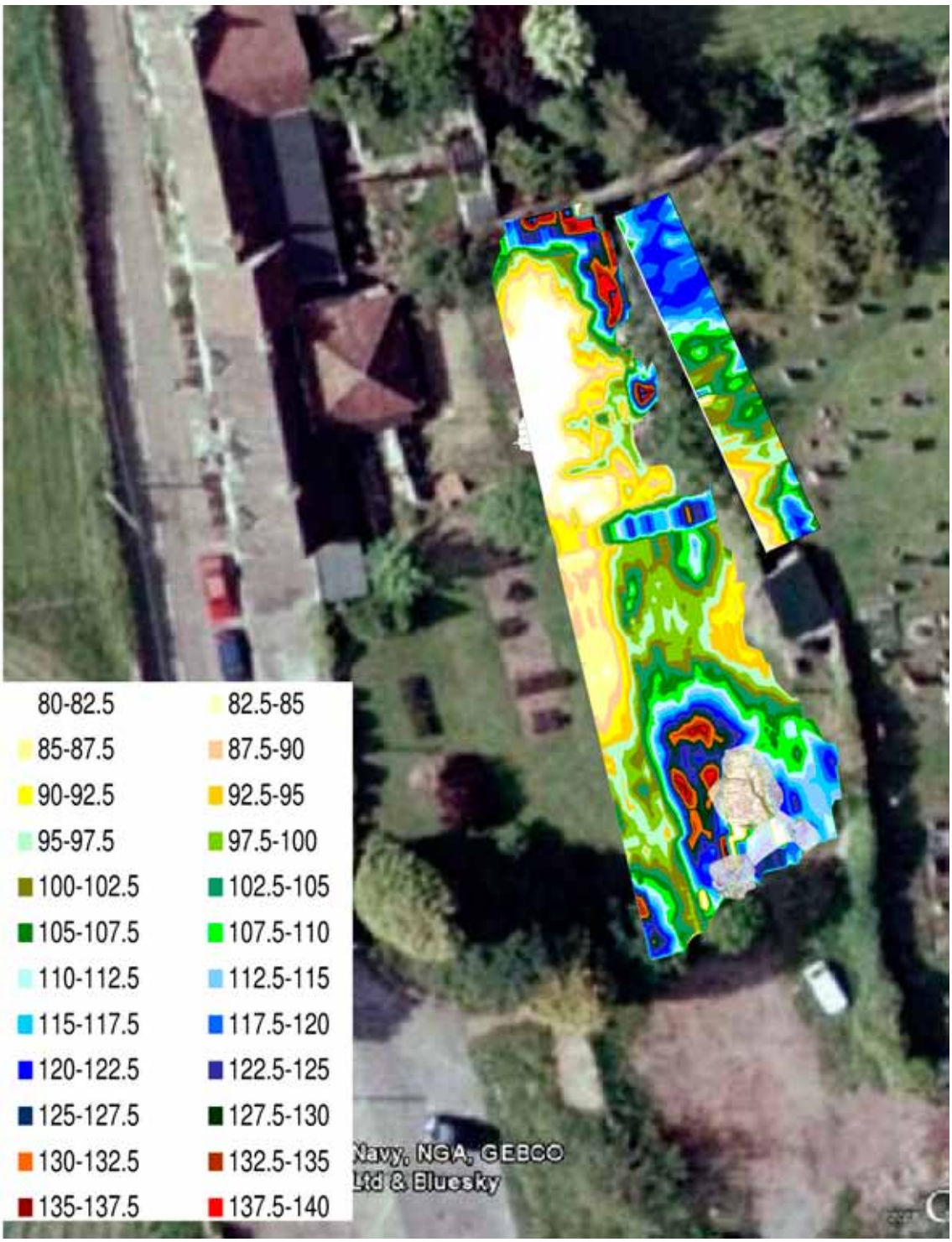

Figure 5.6 Detailed colour resistance plot of the cove, including pub gardens and churchyard.

5.5 Profiling

The profiling had given spectacular results in 2009, and the profiles (after reprocessing to obtain better definition) are repeated here as figure 5.7. The location of these is shown in figure 5.2. These start at the north end of the monument, the first three (cv2, cv7, cv12) coming south at 5 m intervals. the fourth (cv17) just clipping the north end of the prostrate stone and the last one (cv22) threaded between the standing and prostrate stone. The last two were offset east from the base line by 3 m, whereas the northern three started on the baseline. The southern two clearly show a large stone structure just to the west of the stones, and some form of reduced structure continues to the north.

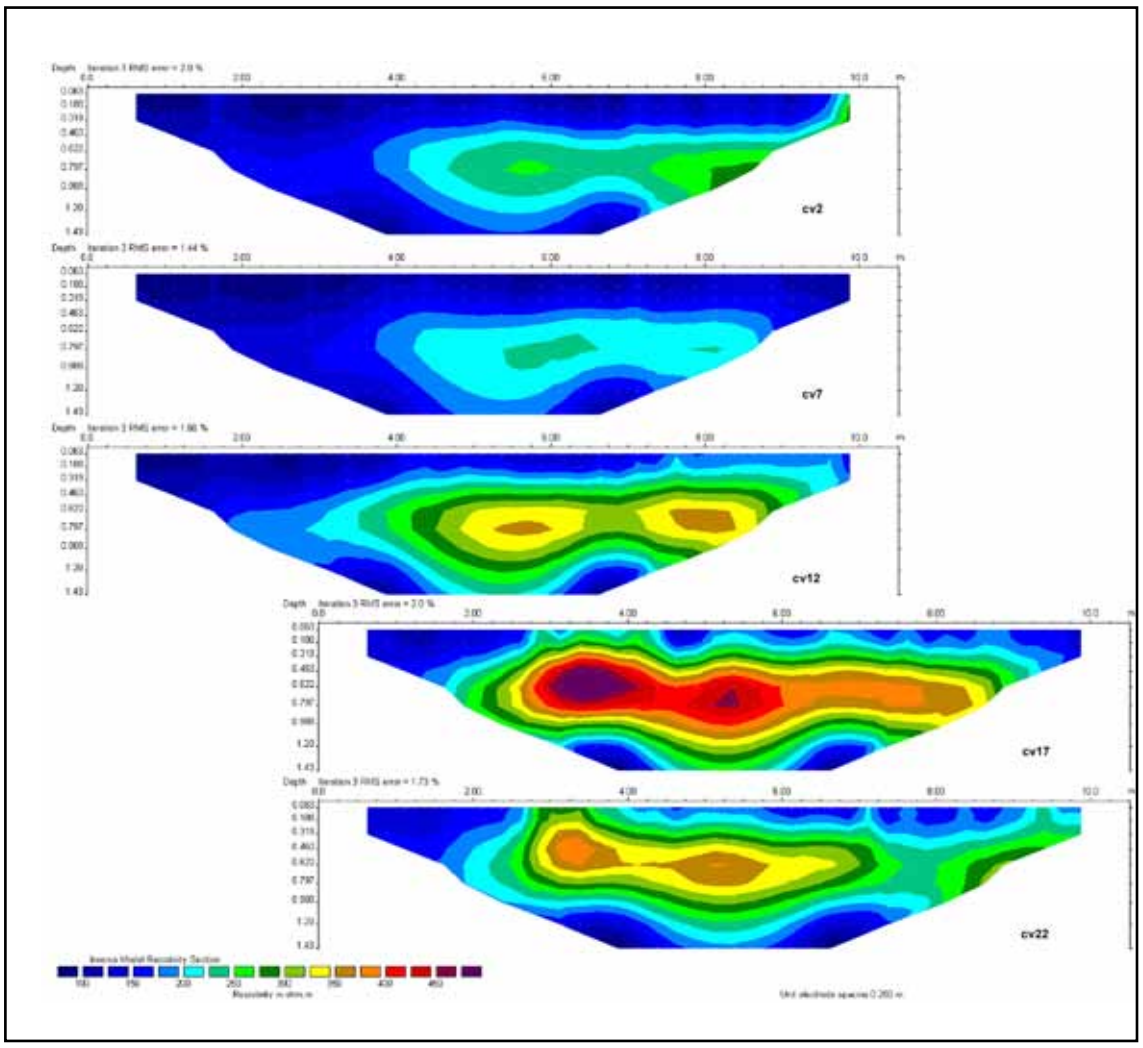

Figure 5.7 Profiles recorded in 2009.

As part of the 2010 research, a block of profiles was done immediately west of the stones. These were done north-south in a block using half metre probe spacing, with profiles 0.5 m apart. Twelve profiles were taken each with 30 probes, giving a block 14.5 m by 5.5 m. This covered the area 1007.5, 995; 1007.5, 980.5; 1002, 980.5; 1002, 995.

The ground was very dry in late May 2010 and it proved difficult to get good reliable electrical contact between ground and probe, even after deliberate wetting, so a few readings had to be edited to give good values. Figure 5.8 shows three of the profiles, those at 7.5 m east, where there is strong evidence of a stone layer; 4m east, where the layer is breaking up; and at 2.5 m, where there are a few intrusions, but the stone layer is now absent. Note that this is not the same colour contour scale used in figure 5.7. The high resistivity appeared to continue right to the surface in the dry time of 2010, whereas in 2009, the high resistivity patch had some low resistivity soil above it.

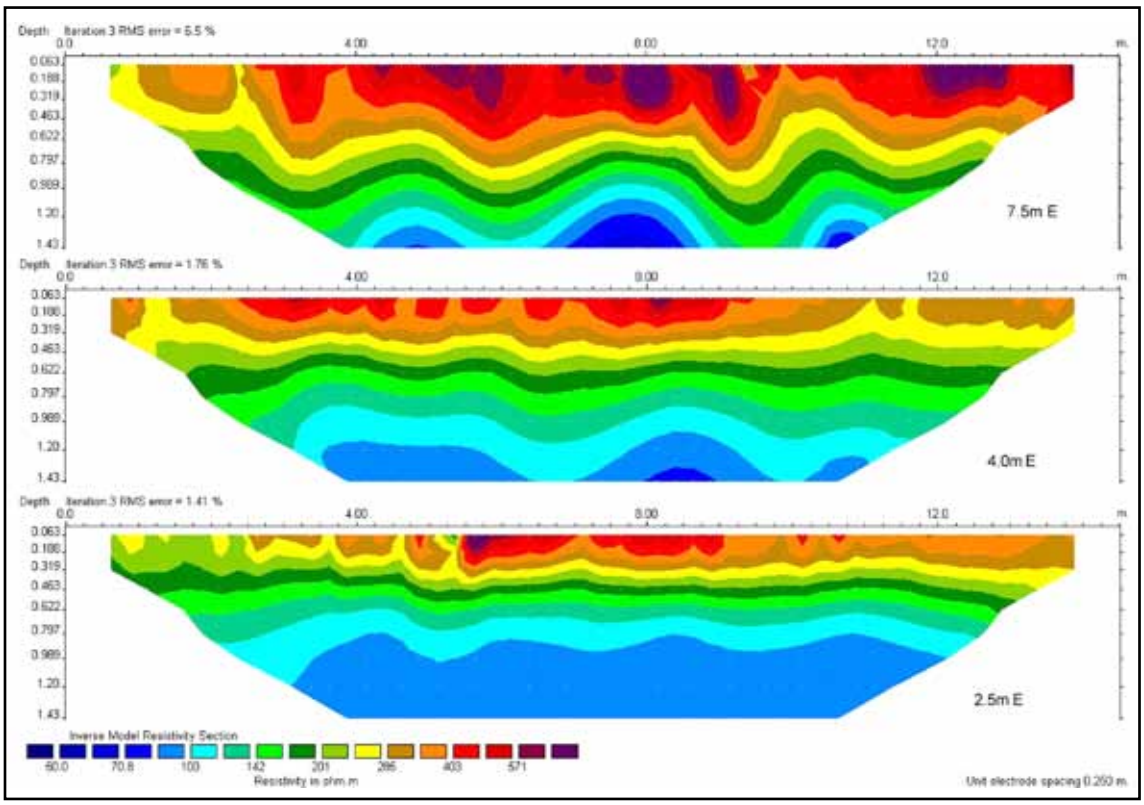

Figure 5.8 North-south profiles from the block, at 7.5, 4 and 2.5 m east of baseline respectively.

BACAS has developed software for combining a set of adjacent profiles to form a three-dimensional block, providing they all share the same colour contour profile, and slicing through at given vertical points to give a series of depth slices. The depth slices for this block at 30 cm and 90 cm are shown in figure 5.9. The area of masonry close to the surface can be seen clearly as a dark patch on the eastern side in the 30 cm profile, with low resistivity to the west, where there may be a ditch. By 90 cm depth, the high resistivity patch has all but disappeared, indicating that the stone structure is less than a metre in thickness.

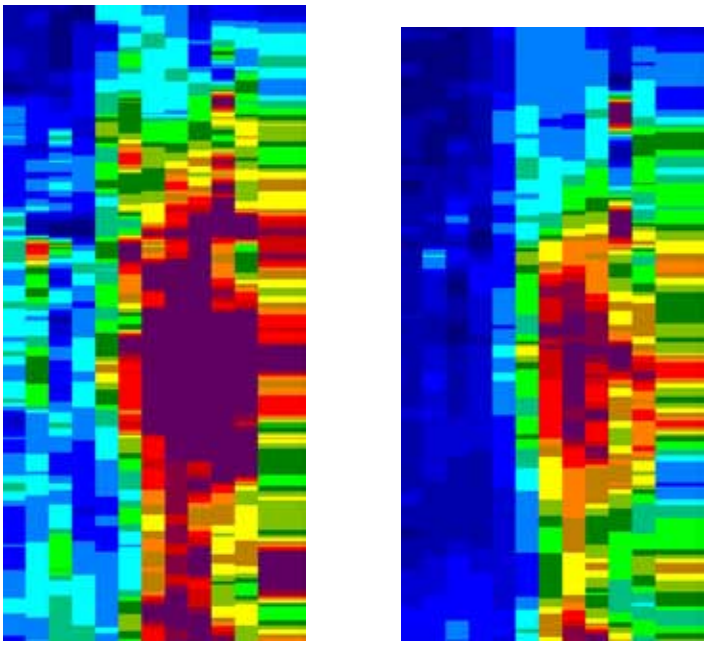

Figure 5.9
(a) Depth slice at 30 cm. (b) Depth slice at 90 cm.

Additional profiles were carried out in the private garden. Six profiles were carried out running west-east, starting at the baseline, using 0.5m spacing, at 1022N, 1019N, 1016N, 1013N, 1010N and 1007N. The profiles were restricted in length by the width of the garden. The results are shown in figure 5.10.

A final profile was carried out running north-south using all 32 probes at 0.5m spacing, from (1007.5, 1023) to (1007.5, 1007.5). The results are shown in figure 5.11.

The possible ditch can be seen clearly in the profiles from 1022N to 1013N, from the baseline to up to 7 metres in. There is then a high resistance area which could represent the core of the long barrow. The north-south profile shows this high resistance area, 0.4 to 1 metres below the surface.

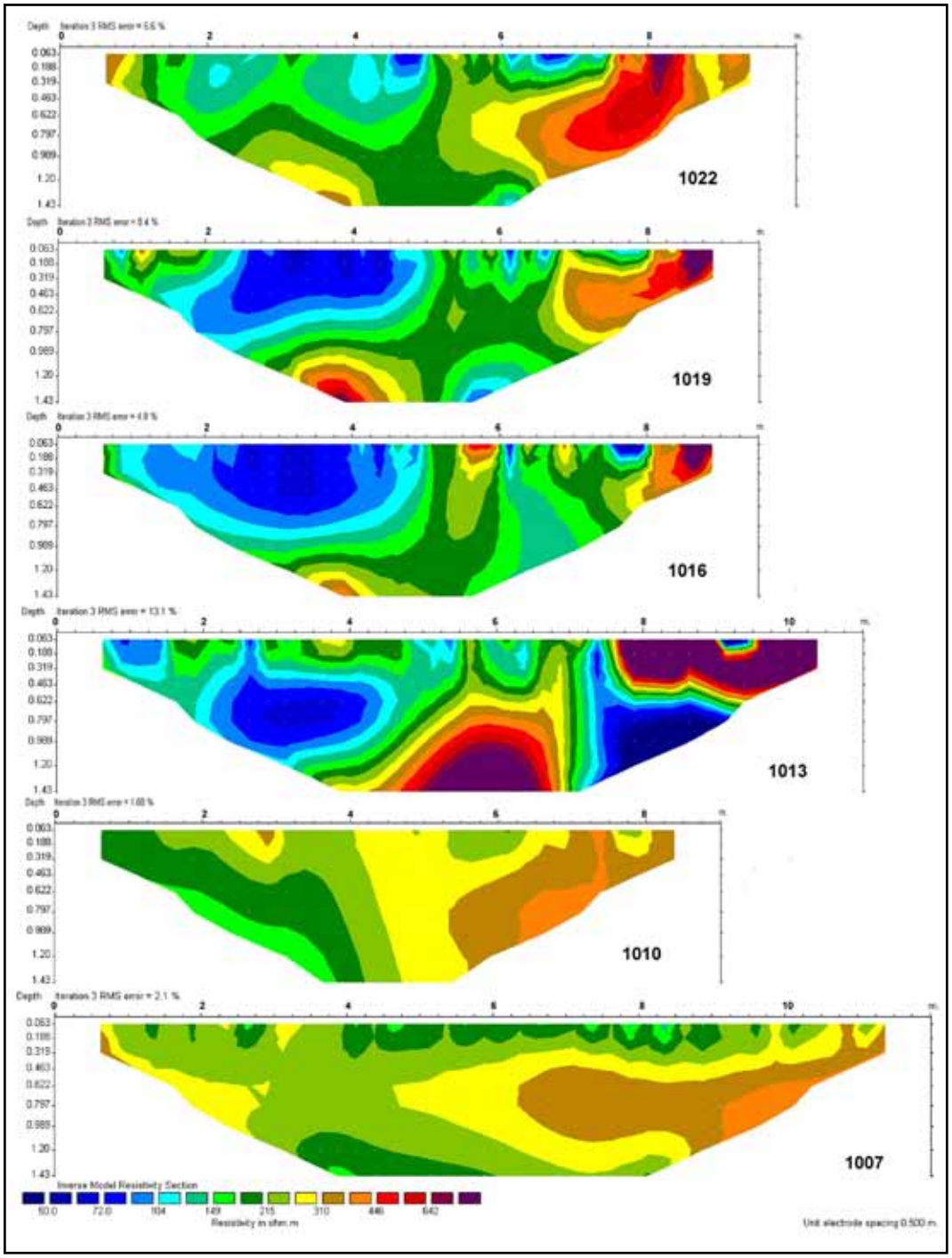

Figure 5.10 Profiles from the private garden (west-east)

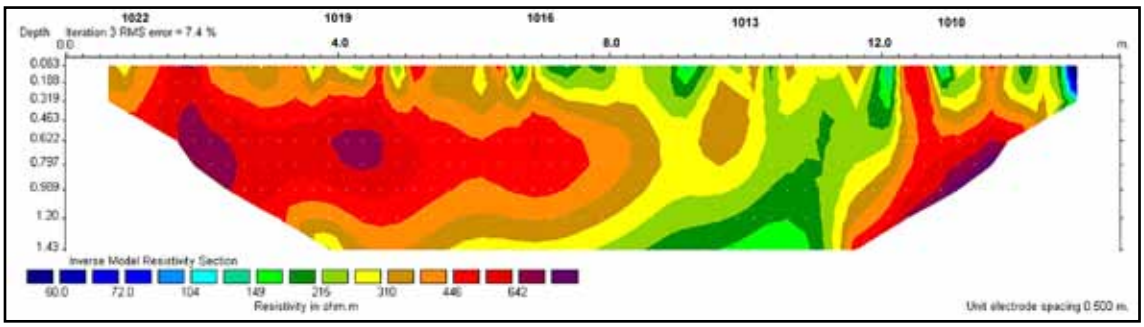

Figure 5.11 Profile from the private garden (northsouth) from (1023, 1007.5) to (1007.5, 1007.5).

Five profiles were carried out in the churchyard, each using 25 probes at 1 m spacing, and these are shown as c1- c5 in figure 5.2. On the churchyard grid, the first profile ran from (1000, 999.6) to (1000, 1023.6) and the rest were parallel at 1 m intervals, so the last profile started at (1004, 999.6). The results are shown in figure 5.12.

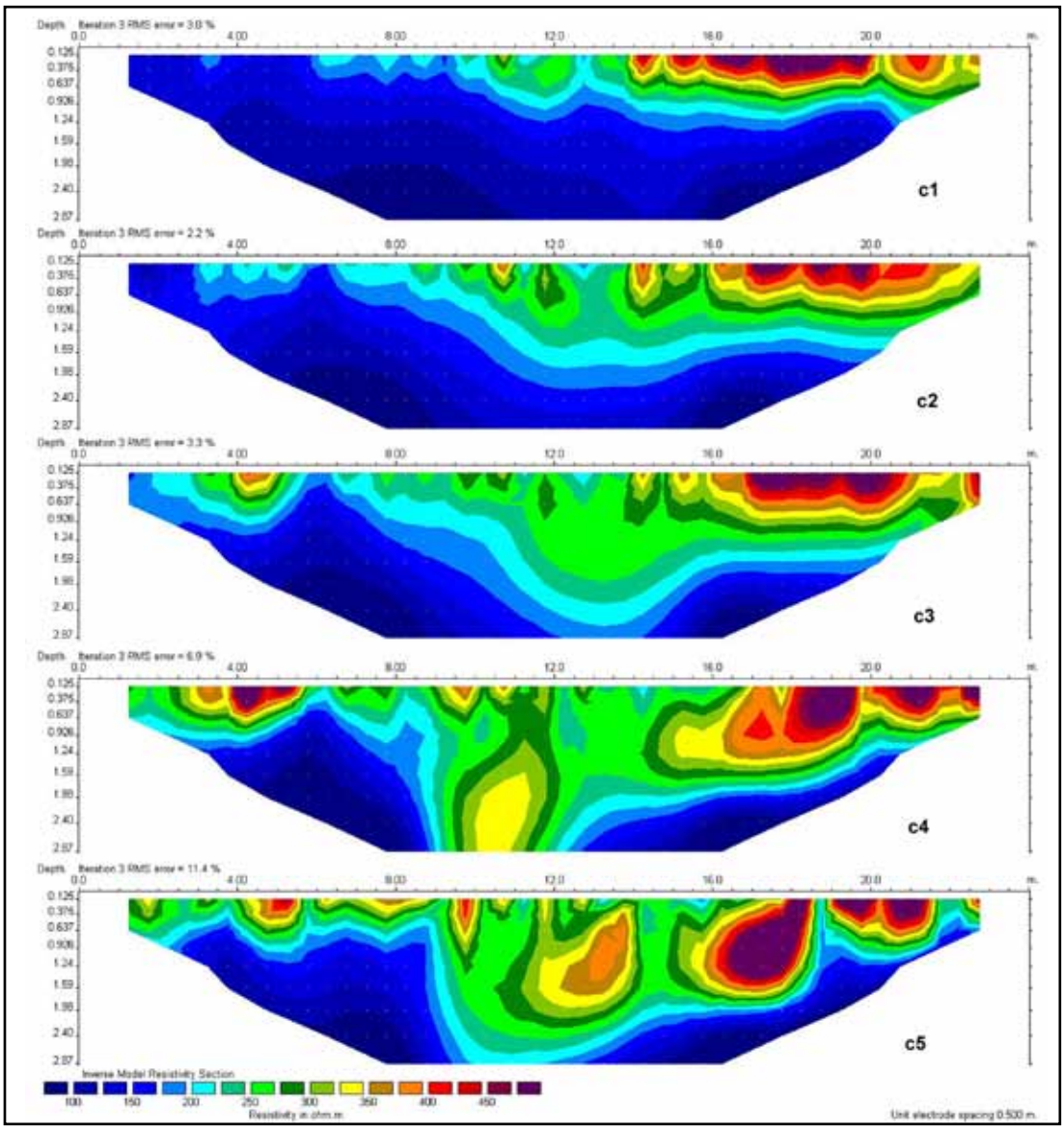

Figure 5.12 Profiles from the churchyard

Resistance can be seen to be generally higher towards the northern (right-hand) end of the profiles. It is interesting to note that the high resistance area in the south-east corner of the churchyard resistance survey (see figure 5.5), which corresponds to the first 9 metres of profiles c3, c4, and c5,

appears to be quite shallow, about 60 cm, and the area beneath has a sharp boundary evident in c4 and c5. It is possible this shows a filled-in ditch or quarry.

5.6 Discussion

Work during 2010 has not managed to demonstrate conclusively that a long barrow/chambered tomb underlies The Cove, but the results have generally reinforced this interpretation.

If this is a long barrow, its orientation, with the proximal end pointing between SE and SSE, occurs in nearly a fifth of Cotswold-Severn long barrows (Darvill 2004: 98). The length would have been over 40 metres; the average length of long barrows is 47 metres (Lynch 1997: 21). The resistance patterns obtained in the churchyard and private garden appear to show signs of quarry ditches to the sides of the structure. There is a similarity to the resistance results reported by Marshall for Cotswold long barrows (Marshall, 1998). This applies both to the basic structure of the barrow, and also to the possibility of a ditch beside it.

There is no visible sign of a mound at the Cove, but it is not unknown for long barrow mounds to have been completely eroded, usually by ploughing. Some long barrows have only been discovered by aerial photography revealing crop marks or soil marks (Featherstone et al 1999; Griffith 1990), including the well-known example of Fussell's Lodge (Darvill 1996: 155–157). However, the implication is that the mound has completely eroded away leaving no obvious trace around the stones themselves.

It is also very possible that the geophysics is showing something other than a long barrow: it could just be natural geology or, perhaps more likely, the result of the ground being levelled up, with soil being added along the west side to create a wider terrace.

The Cove stones used to stand in an orchard, according to the OS 1:2500 map of 1885 and Donne's map of Bristol (1773); tree roots could have caused some disturbance to any archaeology. The private garden was contaminated with wall tumble and shed footings, and beyond its north end, the land has been terraced away in the neighbouring garden.

6 The Geology and Landscape

Vince Simmonds

Archaeologists are becoming increasingly aware that monuments help to shape the perception of landscape, possibly altering both the form and content of a landscape; helping to promote and create senses of time, place and notions of identity and belonging (Goldhahn 2008: 57). It is then feasible that monuments were constructed to occupy a permanent place in the landscape and were intended to exert an influence on any future occupants of that landscape.

The visibility of the monument site at Stanton Drew from the surrounding countryside might have been an important factor in the location of the site. Higher ground surrounds the low ground of the River Chew basin where the stone circle site is situated and an approach from a low level would have meant that the site could not be seen, the seclusion giving a sense of privacy. The Great Circle and Northeast Circle and associated Avenues occupy a place on a slightly elevated terrace above the river where the basin widens between the forty metre contour line before narrowing considerably to the northeast of the site. It is possible this widening of the basin was a significant factor in the placement of these particular monuments; consider the approach from an upstream direction following a narrow channel then a widening of the basin, perhaps flooded, and the monument situated on a raised terrace above the water. Streams enter the main river here from Dundry and Norton Malreward to the north and from the Stanton Wick area to the south. During the Neolithic many sites were placed close to rivers, water sheds and water sources as can be seen at Stanton Drew.

The SSW Circle occupies a rather different place in the landscape in comparison to the Great Circle and Northeast Circle complex. The SSW Circle is situated in a more prominent position on a brow and commands a wider and more panoramic view of the surrounding countryside particularly when looking to the west along the valley towards the Severn Estuary where the high ground of Blackdown and the Mendip Hills is clearly visible. The different positioning of the SSW Circle might suggest a differing thought process or even a different period of construction.

As the perception and cognition of landscape is altered by the construction of a monument, then the actual physical landscape is also altered. The monument becomes part of the landscape while the landscape then becomes materialized in the monument. The materials that are used to construct the monument might have been selected and gathered from specific sources within the landscape and are incorporated into a new form as part of the monument. The social and ritual performance of monument construction can alter entire landscapes (Goldhahn 2008: 59).

When considering the monuments at Stanton Drew, their place within the landscape, of which they have become a part, is a significant factor. This also applies to the individual stones that remain a part of that landscape. When describing the geology and landscape of the stones and surrounding areas it is with these considerations in mind.

The Stanton Drew Stone Circles complex is situated on the south side of the River Chew where the underlying rocks are of the Mercia Mudstone Group of Triassic Age. These beds occupy most of the upper basin of the River Chew and it is a gently rolling landscape of a modest elevation. The strata of the Mercia Mudstone Group (formerly called Red or Keuper Marl) consists largely of red dolomitic siltstone and mudstone (Green 1992: 80) and this in turn overlies unconformably Supra-Pennant Measures from the Upper Coal Measures of Carboniferous age below at an unspecified depth. The red mudstones commonly have small patches, streaks and occasional bands of grey and grey-green, the colour differences are inferred to be the result of the oxidation state of the constituent minerals (Green 1992: 81). Where there are extensive outcrops of Coal Measures, such as those found at Pensford, there is a marginal facies comprising soft red and fawn calcareous sandstones that have resulted from the erosion of the older rocks (Green 1992: 81). The Mercia Mudstone Group was deposited in a mudflat environment in three main ways; the settling-out of mud and silt in temporary lakes, rapid deposition of silt and fine sand by flash floods, and the accumulation of wind-blown dust on the wet mudflat surface (Chandler and Forster 2001: 16).

To the east of the site are the more sharply contoured Coal Measures of Carboniferous Age, through which the river cuts a valley through the villages of Pensford, Woollard, Compton Dando and beyond (Lloyd Morgan 1887: 44). During the Lower Carboniferous, sedimentation and uplift resulted in land creation where the coal-forming swamps and forests became established. The climate during this period would most likely have been warm with a relatively high rainfall resulting in a high water table and these were ideal conditions for coal to be formed. The sedimentation of the Coal Measures was cyclical: periods of organic deposition, followed by flood events; mud and sands were then deposited until the swamp conditions were re-established and vegetation grew. Eventually during the Upper Carboniferous there was general uplifting with folding and erosion of the surrounding areas followed by a widespread change in sedimentation patterns. Marine flood events ended and a deltaic sediment, comprising coarse-grained grey, current-bedded sandstone, known as the Pennant Formation was laid down in a belt across the district (Green 1992: 52). The main Coal Measure deposits including the Pennant Formation lie to the east of Stanton Drew and there is also a thin tongue of Pennant Formation to the south around Stanton Wick. It is noteworthy that during their excavations at Chew Valley Lake in the 1950's Rahtz and Greenfield (1977) found several examples of pennant sandstones being utilized.

To the west of Stanton Drew are Broadfield Down, comprising limestone and fringed to the east by Dolomitic Conglomerate, and Leigh Down, comprising Dolomitic Conglomerate where there is evidence of some silicification in the curiously altered Lias or Rhaetic Harptree Beds. To the south and southwest lie the Mendip Hills comprising mainly of limestone and Old Red Sandstone, but fringed near East and West Harptree by beds of Dolomitic Conglomerate of both silicified and un-silicified types and Rhaetic Harptree Beds (Lloyd Morgan 1887: 44–45). The Dolomitic Conglomerate has in many cases undergone considerable secondary changes (Green and Welch 1965: 64–65). This is particularly noticeable in the Harptree area where the rock has been silicified probably by metasomatism, a metamorphic process whereby rocks are affected by a combination of heat, pressure and fluids in which the chemical composition of the rock is altered significantly, most usually as a result of fluid flow. Lloyd Morgan (1887: 45) comments that heated waters have seemingly dissolved any limestone clasts and the spaces left have been partially or completely filled with crystallised quartz (figure 6.1).

Figure 6.1 Quartz geodes in silicified Dolomitic Conglomerate- Northeast Circle.

At the end of the Carboniferous and into the Permian there came the cataclysmic earth movements of the Variscan Oregeny (Green 1992: 67) when the Mendip and surrounding area was uplifted, folded and eroded. During the Permian and Triassic the climate was dry for long periods and weathering quickly eroded the cover of Upper Carboniferous sediments from the summits exposing the limestone beneath. The rainwater run-off that resulted from the lack of vegetative cover caused flooding, and further rapid erosion transported pebbles and boulders of limestone and sandstone down the slopes; this debris became deposited at the base of the major gorges and slopes. These

pebble bed and scree deposits formed the Dolomitic Conglomerate, so called because of the high dolomite content of the rock (Hardy 1999: 73). Within the conglomerate the degree of roundness of the clasts and their size gives some indication to the amount of transportation that has occurred and the energy required for transport prior to deposition.

To the north of the Stone Circles is the elevated outlier of Dundry, the upper part of which comprises Inferior Oolite of Jurassic Age overlying Lias beds (Lloyd Morgan 1887: 44).

Marine conditions during the Jurassic period were marked by a gradual deepening of the sea leading to the formation of the Inferior Oolite in a shallow shelf sea. There are numerous gaps in the succession indicating there were interruptions and/or modifications by frequent earth movements. On the eastern part of Dundry Hill the Upper Inferior Oolite rests directly on Upper Lias, in which sandy ferruginous beds and hard limestones with limonitic ooliths typify the Dundry rock type. An oolith is a spherical granule formed by concentric accretions of thin layers of mineral around a core (Green 1992: 117). There is a significant area of landslip around the slopes of Dundry Hill just below the summit which may have produced blocks of the Inferior Oolite material.

Immediately to the north of the Stanton Drew Stone Circles is a narrow band of alluvium of Pleistocene and Recent age. This alluvium represents the course of the River Chew which seems to have been restricted by the topography to a relatively narrow channel near to Byemills Farm. Prior to the construction of Chew Valley Lake there was anecdotal evidence of commonplace extensive flooding of the area, in particular at Stanton Drew and further down river at Woollard (Rahtz and Greenfield 1977: 6).

Oolitic Limestone *Jurassic age*

At the Stanton Drew site at least four principal rock types have been identified and are briefly described below as an Oolitic Limestone of Jurassic Age circa 205–142 Ma (figure 6.2). These rocks are a pale grey-yellow colour, although this is difficult to fully distinguish due to a substantial lichen cover. The surface of the blocks resembles a limestone pavement and there are numerous natural cup-shaped depressions and pits that partly fill with water. At many rock art sites flat slabs of stone are found that are open to the elements and after rain, any cup-and-ring marks fill with water; also rocks with natural cup marks are often utilised for the same effect. It could be that places where rocks ran with water or held water were culturally significant in many ways (Fowler and Cummings 2003: 10). It is possible that some of these limestone slabs at Stanton Drew were not intended to stand or were intended for use as capstones.

Figure 6.2 Oolitic Limestone, Great Circle.

Silicified Dolomitic Conglomerate *of Triassic Age, circa 248–205 Ma*

These rocks have a wide range of colours from pale pink to orange-pink with some bright, sometimes ochreous orange, through to dark rust, and purple-red blotches, the red and orange colour is indicative of the mineral iron content of these Triassic rock types (figure 6.3). The rocks have a glassy, metallic appearance and feel and the surface has been described as pitted, pock-marked, frothy, knobbly and gnarly. There are abundant quartz geodes that make many of the stones sparkle, William Stukeley (cited in Lloyd Morgan 1887: 39) remarks that "it shines eminently and reflects the sunbeams with great lustre". Quartz was a highly significant and regarded material in prehistory as indicated through its use in various monuments (Lewis n.d.). There are some silicified fossil fragments from the remains of limestone clasts within the conglomerate. The varying clasts range from sub-rounded to sub-angular, fine to coarse gravel to pebble and cobble size. The majority of the stones have a substantial cover of lichen with some moss and grass.

Figure 6.3 Silicified Dolomitic Conglomerate, North East Circle.

Dolomitic Conglomerate *also of Triassic Age*

This is a weathered pale grey-pink and has a lesser degree of silicification (figure 6.4). The varying clasts range from rounded to sub-angular fine to coarse gravel, pebbles and cobbles of limestone and sandstone. There are also some silicified fossil fragments from the remains of limestone clasts within the conglomerate and the stones again have a substantial cover of lichen.

Figure 6.4 Dolomitic Conglomerate, The Cove.

Pennant Sandstone *of Carboniferous Age circa 354–290 Ma*

These rocks are of a pink to fawn colour and distinct bedding layers are clearly visible, in particular cross-stratification which is typical of material that has been laid down in deltas (figure 6.5). There is a layer of sub-rounded to rounded fine to medium gravel of quartz.

Figure 6.5 Pennant Sandstone, Great Circle.

Within the Great Circle the vast majority of visible stones comprise a silicified Dolomitic Conglomerate, with the remaining other rock types comprising Oolitic Limestone, Pennant and a Dolomitic Conglomerate that has a lesser degree of silicification. The stones that form the Northeast Circle and the Avenues comprise mostly silicified Dolomitic Conglomerate and a small number of Oolitic Limestone. The orange to rust-red colours of the silicified Dolomitic Conglomerate do not look out of place at Stanton Drew, matching well with the local red sandy soils and the Triassic Mercia Mudstone that underlies the monument site. The majority of the stones in the SSW Circle comprise silicified Dolomitic Conglomerate, although at least one stone is of the local sandstone, possibly from the sandstone bands that are found within the Mercia Mudstones of this area and are visible in the local environment. The stones used in the construction of 'The Cove' comprise a Dolomitic Conglomerate that has been silicified but to a lesser degree. Within some of the limestone clasts are the silicified fossil remains of Siphonodendron, a rugose coral of Lower to Upper Carboniferous age (Black 1970). In the light some of the silicified clasts within the Dolomitic Conglomerate can be seen to sparkle due to the quartz crystallisation. The stones of the cove lack the vivid oranges and rusty-reds of the more silicified rocks found within the Circles and Avenues and they are greyer in colour.

Soil samples

During the geophysical survey of the Druids Arms back garden three disturbed soil samples were taken from that location and particle size distribution determined with some limited analysis for chemical factors including iron, phosphate, organic matter and pH levels to give an indication of the underlying geology and soil characterization. There are many different methods for the determination of particle size but these generally split into three main groups. Sieving involves the physical separation of grain sizes through a stack of sieves of reducing mesh size down to a minimum of 63 microns. Whilst smaller mesh sizes can be used to quantify the silt fraction down to 5 microns the time investment required means that one of the other techniques is normally used for the fine fraction. Sedimentation is usually carried out on the passing 63 micron fraction (silt and clay) after the sand has been quantified by sieving. It uses the principle that coarse particles separate out of a suspension quicker than fine particles. The clay and silt content is measured by either drawing off samples by pipette or using a hydrometer to measure suspension density over set periods of time (SASSA 2007). For the samples analyzed from Stanton Drew the hydrometer method was used to determine the fine fraction.

The particle size proportions of the samples taken are presented in Table 6.1; SDDA 1 and 3 consist mainly of a medium sand grain size 52% to 59% with silt/clay ranging 24% to 25%, coarse sand and gravel comprise the remaining portion; whereas SDDA 2 has a finer, more even range of medium sand 21%, fine sand 40% and silt/clay 29% the remaining portion, again comprises coarse sand and gravel. The reddish-brown to red colour and a sand content ranging from 64% to 72% that is comprised of a mainly fine and medium grain size suggests that the origin of the soil is a result of the weathering and erosion of the underlying Triassic strata of Mercia Mudstone, where there is found locally a marginal facies comprising soft red and fawn calcareous sandstone bands. These sandstones can be seen in a road cutting 500 metres to the south of the Stone Circle complex (figure 6.6). Also heading from the village hall and going westwards along the same outcrop as the Stone Circle complex runs the aptly named Sandy Lane.

Figure 6.6 Sandstone exposed in a roadside cutting at NGR ST 5960 6056. Weathering and erosion of the material is apparent.

The soil descriptions for the SDDA samples indicate that the gravel fraction contains some weathered red sandstone material that has probably remained relatively close to its source, whereas the finer material might suggest colluvial deposition. The existing ground surface of the garden area was strewn with a variety of building debris and several bonfire sites; generally there was ≈ 100mm of grass and topsoil over the survey area and it is likely that the material tested had been previously disturbed as the samples contained brick fragments and charcoal. Without further testing the depth of any disturbance cannot be established. It might be that material excavated during construction of buildings, etc. has been levelled across the garden area leading to the possibility of an older ground surface below, careful hand-augering around the garden area might prove beneficial in establishing the depth of any disturbance.

Sample	Location (NGR)	Cobbles (%)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
SDDA 1	ST59744/63128	0	6	Coarse: 9	16	6
0.25m		-	-	Medium: 59	-	-
		-	-	Fine: 4	-	-
SDDA 2	ST59743/63131	0	7	Coarse: 3	18	11
0.35m		-	-	Medium: 21	-	-
		-	-	Fine: 40	-	-
SDDA 3	ST59744/6312	0	12	Coarse: 3	13	12
		-	-	Medium: 52	-	-
		-	-	Fine: 9	-	-

Table 6.1. Summary table of the particle size proportions for the samples taken at 3 locations from the rear garden of the Druids Arms, Stanton Drew (as a consequence of rounding, totals may not equal 100). Each location was determined using a hand-held Garmin etrex GPS (accuracy ±5 metres).

Samples SDDA 1, 2 and 3 were also analysed for iron content, pH and soil organic matter plus water soluble phosphate. The results are presented in Table 6.2 with the soil descriptions of the samples. The iron content of the samples SDDA in general range from 13580 to 23950mg/kg; this might, as previously mentioned be due to an underlying outcrop of sandstone closer to the surface. Analysis of exposed sandstone along the roadside may give an idea of base levels of iron content to be expected, although weathering at the surface might influence the results. The pH level of the SDDA samples was on the alkali side of neutral ranging 7.2 to 7.9, while the phosphate analysis at the limits of detection tested was inconclusive, all samples recording less than 10mg/l. The soil organic matter determined in the SDDA samples ranged from 0.9% to 1.6%; which might be expected from a disturbed soil where the topsoil has been mixed into the sub-soil but still falls into the category whereby soils with organic matter less than 3.5% are considered erodible (Allen 1991: 43).

Sample	Soil description	iron (mg/kg)	pH (unit)	soil organic matter (%)	water soluble phosphate (mg/l)
SDDA 1 0.25m	Brown very slightly gravelly, slightly silty, very slightly clayey SAND. Sand is mostly medium with slight coarse and fine grain size. With fragments of burnt material (charcoal) and brick.	23950	7.2	1.6	<10
SDDA 2 0.35m	Red-brown very slightly gravelly, slightly silty, slightly clayey SAND. Sand is mostly fine and medium with some very slight coarse grain size. Gravel is sub-angular to sub-rounded, fine to coarse red sandstone (weathered).	16470	7.9	1.1	<10
SDDA 3 0.30m	Red-brown slightly gravelly, slightly silty, slightly clayey SAND. Sand is mostly medium with slight fine and very slight coarse grain size. Gravel is sub-angular to sub-rounded, fine and medium red sandstone (weathered/soft). With some organic content (charcoal).	13580	7.9	0.9	<10

Table 6.2. Summary of chemical analyses results and soil descriptions of samples SDDA 1, 2 and 3 from the rear garden of the Druids Arms at Stanton Drew.

Although these results may give some indications as to the local geology it should also be noted that the sample size is very small and as a consequence the results should be seen as inconclusive. In order to fully understand the soil composition a comprehensive sampling strategy would need to be undertaken across the full extent of the site, out into the surrounding area and for a representative range of samples to be collected and analysed for a wider range of particle size distributions and trace elements would provide the basis for an interesting research project.

7 Monument Alignments and Astronomy

Richard Sermon

7.1 Archaeoastronomy at Stanton Drew

It was the famous Bath architect John Wood the Elder (1704–1754) who first identified the two 'recognised' alignments at Stanton Drew: (a) from the centre of the SW Circle through the centre of the Great Circle to Hautville's Quoit, and (b) from the Cove through the centre of the Great Circle to the centre of the NE Circle (Wood 1749: II 147–59). These alignments were later confirmed by Professor Conwy Lloyd-Morgan in his detailed study published in 1887. At about the same time Charles Dymond carried out the first accurate survey of the monuments, but dismissed any astronomical alignments as 'mere coincidence' (Dymond 1896: 28). His survey was based on the village tithe map and a local datum on the southern bank of the River Chew (NE of Stony Close). However, his bearings have an error of approximately 1.36° degree to Ordnance Survey (OS) Grid North, which in turn has an error of 0.44° to True North (see table 7.1).

From	To	Distance (ft)	Bearing
Great Circle	Quoit	1856.00	19.50
SW Circle	Great Circle	711.50	21.67
Cove	Great Circle	988.00	53.75
Great Circle	NE Circle	379.67	54.25
Cove	SW Circle	541.50	98.25
Great Circle	Tyning Stones	3305.00	276.75
Great Circle	Avenue	–	70.00
NE Circle	Avenue	–	101.00

Location	Height (ft)	Diameter (ft)
Great Circle	19.00	368.00
SW Circle	56.75	145.00
NE Circle	10.75	97.00
Quoit	39.50	–
Cove	49.17	–
Tyning Stones	6.25	–

Table 7.1 Dymond's survey with heights above local datum.

Sir Norman Lockyer carried out the first examination of any astronomical alignments at Stanton Drew, but did not actually visit the site (Lockyer 1909: 167–78). Dymond provided Lockyer with copies of his earlier plans and level sections, whilst Lloyd Morgan provided additional observations made by himself and a Mr. Morrow (see table 7.2). Whilst Lockyer's declinations are not entirely accurate, he suggested four possible alignments. The first two were from the centre of Great Circle to Hautville's Quoit, and from Centre of SW Circle to the centre of Great Circle. These he pointed out were too far north for a solar or lunar alignment and could only have been aligned with a rising star. The star he identified was Arcturus with the two different alignments being in response to the star's decreasing declination in the night sky, caused by the earth's axial precession. From this he concluded that the Great Circle must have been built before the SW Circle. The third alignment Lockyer identified was from the centre of the Great Circle (or from the Cove) to the centre of the NE Circle with the summer solstice sunrise. The fourth alignment was from the centre of the Great Circle along its Avenue with the May and August sunrise. However, no explanation was offered for the orientation of the NE Circle along its Avenue.

	Azimuth / Declination				Horizon Morrow	Alignment
	Morrow		Lockyer			
Centre of Great Circle to Hautville's Quoit	17.98	Not given	17.00	+38.98	2.38	Arcturus 1690 BC
Centre of SW Circle to centre of Great Circle	19.85	Not given	20.00	+37.45	1.73	Arcturus 1410 BC
Centre of Great Circle or Cove to NE Circle	53.00	+22.73	51.00	+23.81	1.08	Midsummer Sunrise
Centre of Great Circle along its Avenue	68.72	Not given	65.00	+16.33	0.63	May/August Sunrise
Centre of NE Circle along its Avenue	96.13	–4.04	101.00	–5.83	1.67	Not given

Table 7.2 Lockyer's suggested astronomical alignments based on Morrow's survey.

Alexander Thom (Thom 1967: 100) identified a winter solstice alignment – presumably from the centre of the NE Circle to the Cove, and a new alignment with the southern major lunar standstill moonset (see table 7.3). However, it is not clear whether this lunar alignment was measured from the centre of the NE Circle to the centre of the SW Circle (Azimuth 211°), or along the southern edge alignment of the three stone circles (Azimuth 210°) previously identified by John Wood the Elder (Wood 1749: II 147–59).

Azimuth	Horizon	Declination	Alignment
232.7	1.6	21.2	Sun
052.7	1.3	22.9	Not given
211.4	1.7	30.9	Moon

Table 7.3 Thom's suggested astronomical alignments at Stanton Drew.

7.2 Geophysical Survey Results

In 1997 English Heritage carried out a detailed magnetometer survey of the three stone circles at Stanton Drew. The survey identified a large circular ditch or henge monument around the Great Circle with a wide gap in the circuit aligned broadly with the NE Circle, and nine concentric rings of large post-holes within the stone circle itself. The 1997 survey also identified a circular feature around the SW Circle and three internal rings of post-holes, whilst the NE Circle was found to contain four large pits, one located in each quarter of the circle (Linford, 1997; David 1998; David et al 2004).

Further resistivity and magnetometer surveys were carried out by BACAS and BANES in 2009 and 2010, which confirmed the previous English Heritage results and identified traces of a mound running northward from the Cove. As a result it has been suggested that the upright stones of the Cove might be better explained as the south-facing portals or façade of a chambered Neolithic tomb similar to the Stoney Littleton long barrow near Wellow, thus making the Cove the focus and earliest part of the whole Stanton Drew complex (Oswin, Richards and Sermon 2009). The most recent survey has revealed another narrower entrance (causeway) through the Great Circle ditch with two large termini, and its centre at an azimuth of approximately 215° (close to stone M10).

7.3 Reconsidering the Solar and Lunar Alignments

Lockyer's suggested star alignments should be treated with some caution. Due to the earth's axial precession (a gradual shift in the earth's axis relative to the celestial sphere over a 26,000 year cycle) many stars will have moved in and out of alignment with the monuments at Stanton Drew.

However, the star Arcturus (identified by Lockyer) could not have been aligned with any of these monuments during the Late Neolithic to Early Bronze Age (3000 to 2000 BC) when the stone circles are thought to have been constructed. At that time Arcturus' declination was between 45° and 40° with its path being circum-polar and not falling below the local horizon. Furthermore, a distant marker like Hautville's Quoit is of little use as an event marker when it is so far below the horizon, particularly for night time observations. If indeed marking the position of a rising star it could only serve as the long term 'memory' of a past horizon event. Whilst Lockyer's avenue alignments are of interest, their orientation may be better explained in relation to the local landscape, providing a physical and ritual connection with the River Chew. Alexander Thom's possible southern edge alignment of three stone circles is again of interest, but may be coincidental given that the 'centre to centre' alignment of the NE Circle and SW Circle provides a better alignment with the southern major lunar standstill moonset.

There are 30 possible 'centre to centre' alignments between the six prehistoric monuments at Stanton Drew (see figure 7.1). These monuments include the two Tyning Stones that formerly stood at Middle Ham. They were recorded as part of Dymond's survey and whilst they still appear on the Ordnance Survey, have in recent years been removed (Oswin et al 2009: 3). It is not certain whether the Tyning Stones actually formed part of the Stanton Drew complex, and therefore their results should be treated with some caution. In this study these 30 alignments have been designated A01–A15 for those with azimuths (bearings) between 0° and 180°, and their reverse alignments designated B01–B15 with azimuths between 180° and 360°. Stanton Drew lies at a latitude of 51.37° North and longitude of 2.57° West. At this location the correction for OS Grid North to True North is –0.44°. All azimuths given in subsequent tables are measured in relation to True North, and as far as possible are based on the same monument centres as Dymond's survey (see table 7.4).

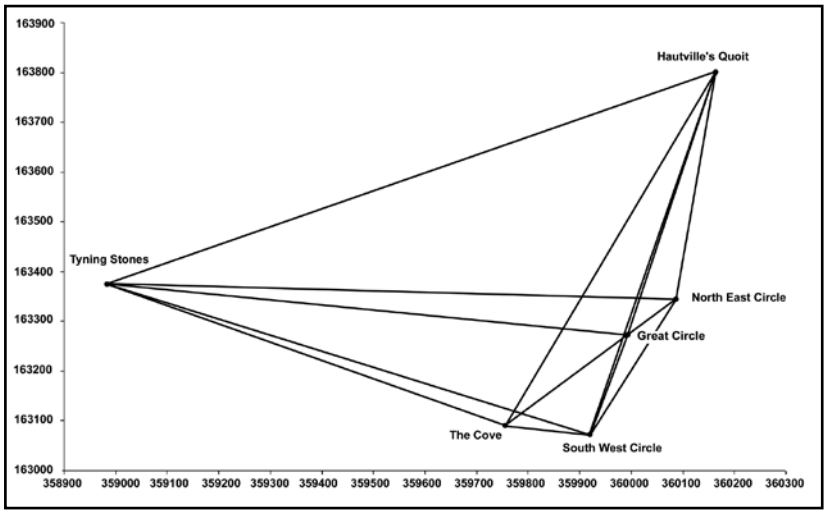

Figure 7.1 Centre alignments of the Stanton Drew monuments (Ordnance Survey grid)

Monument Centre	OS Grid Reference	Height OD
Hautville's Quoit	ST 60166 63800	49.62
Great Circle	ST 59994 63275	42.45
North-East Circle	ST 60088 63345	40.05
South-West Circle	ST 59919 63070	54.02
The Cove	ST 59756 63091	53.15
Tyning Stones	ST 58982 63375 *	38.68
Stoney Littleton Long Barrow	ST 73481 57221	82.00

Table 7.4 Locations and heights above OD of the monument centres at Stanton Drew and the Stoney Littleton long barrow.

In addition to the above 'centre to centre' alignments, the stones that define the three circles each have a different azimuth/alignment when viewed from their respective circle centres (see figure 7.2). The Great Circle has 27 possible stone alignments and an avenue centre alignment (designated C01–C28). The NE Circle has 8 possible stone alignments and an avenue centre alignment (designated D01–D09), whilst the SW Circle has 12 possible stone alignments (designated E01–E12). These stone circle alignments have again been based on the same circle centres as Dymond's survey. Table 7.5 lists the location of each stone within the Stanton Drew complex using Dymond's stone numbers for reference (an asterix indicates locations and heights estimated from Dymond and the Ordnance Survey).

Stone	Monument	OS Grid Reference	Stone	Monument	OS Grid Reference
Q1	Hautville's Quoit	ST 60166 63800	N1	NE Circle	ST 60101 63339
M1	Great Circle	ST 60049 63270	N2	NE Circle	ST 60095 63331
M2	Great Circle	ST 60048 63261	N3	NE Circle	ST 60083 63330
M3	Great Circle	ST 60043 63246	N4	NE Circle	ST 60074 63339
M4	Great Circle	ST 60031 63234 *	N5	NE Circle	ST 60074 63349
M5	Great Circle	ST 60030 63233	N6	NE Circle	ST 60084 63359
M6	Great Circle	ST 60018 63223	N7	NE Circle	ST 60094 63361
M7	Great Circle	ST 60013 63221	N8	NE Circle	ST 60103 63351
M8	Great Circle	ST 59983 63220	N9	NE Avenue	ST 60102 63341
M9	Great Circle	ST 59974 63223	N10	NE Avenue	ST 60103 63341
M10	Great Circle	ST 59960 63231	N11	NE Avenue	ST 60106 63340
M11	Great Circle	ST 59952 63241	N12	NE Avenue	ST 60103 63337
M12	Great Circle	ST 59944 63254	N13	NE Avenue	ST 60111 63337 *
M13	Great Circle	ST 59942 63261	N14	NE Avenue	ST 60121 63336
M14	Great Circle	ST 59940 63264	N15	NE Avenue	ST 60127 63336
M15	Great Circle	ST 59939 63278	N16	NE Avenue	ST 60134 63335
M16	Great Circle	ST 59942 63297	N17	NE Avenue	ST 60113 63349
M17	Great Circle	ST 59963 63323	N18	NE Avenue	ST 60121 63347
M18	Great Circle	ST 59970 63329	N19	NE Avenue	ST 60129 63345
M19	Great Circle	ST 59985 63331	S1	SW Circle	ST 59939 63075
M20	Great Circle	ST 59998 63332	S2	SW Circle	ST 59937 63075
M21	Great Circle	ST 60008 63332	S3	SW Circle	ST 59940 63070
M22	Great Circle	ST 60017 63329	S4	SW Circle	ST 59937 63064
M23	Great Circle	ST 60027 63324	S5	SW Circle	ST 59930 63053
M24	Great Circle	ST 60031 63320	S6	SW Circle	ST 59917 63049
M25	Great Circle	ST 60033 63318	S7	SW Circle	ST 59898 63065
M26	Great Circle	ST 60040 63306	S8	SW Circle	ST 59900 63074
M27	Great Circle	ST 60044 63301	S9	SW Circle	ST 59907 63087
M28	GC Avenue	ST 60060 63307	S10	SW Circle	ST 59917 63091
M29	GC Avenue	ST 60069 63311	S11	SW Circle	ST 59919 63088
M30	GC Avenue	ST 60069 63299	S12	SW Circle	ST 59936 63086
M31	GC Avenue	ST 60084 63303	C1	The Cove	ST 59754 63089
M32	GC Avenue	ST 60097 63306	C2	The Cove	ST 59757 63092
M33	GC Avenue	ST 60124 63316	C3	The Cove	ST 59755 63093
M34	GC Avenue	ST 60129 63330	T1	Tyning Stones	ST 58981 63375 *
M35	GC Avenue	ST 60132 63334	T2	Tyning Stones	ST 58983 63376 *

Table 7.5 Locations of the Stanton Drew stones (Ordnance Survey grid references).

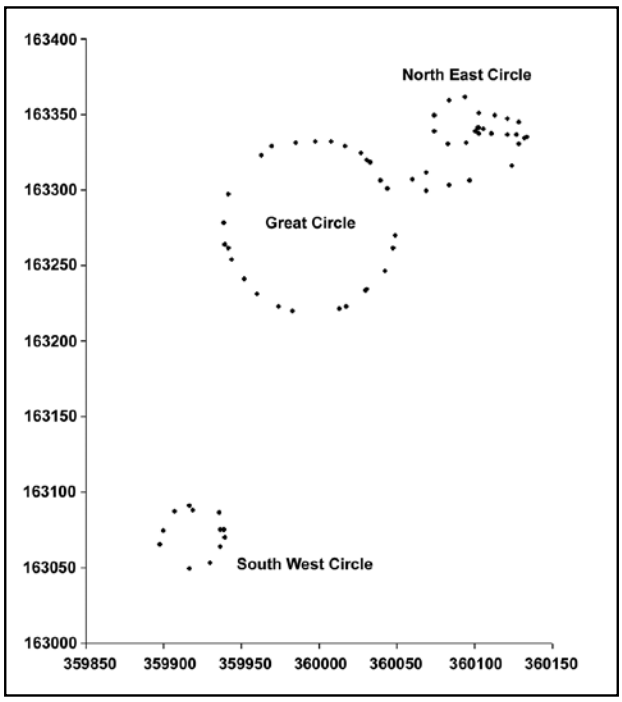

Figure 7.2 Stanton Drew circle and avenue stone locations (Ordnance Survey grid).

Given the possibility that the Cove may be the remains of a Neolithic long barrow, this study includes the Stoney Littleton long barrow near Wellow (51.32° North and 2.38° West), a chambered megalithic tomb in which the central passage may also have a solar alignment (Grinsell 1982). The results table at the end of this chapter (see table 7.10: columns 1–6) shows the azimuths and altitudes/horizons for all the above alignments. This data was captured using MapInfo GIS software and aerial photographs to establish the OS grid coordinates for each of the stone and monument centres to within 1m. The monument centre heights and near horizons heights within the village were established by field survey using a dumpy level and bench marks at the St Mary's Church and Quoit Farm (52.43m and 50.72m OD). The azimuths for each possible alignment were calculated from their viewing point (position 1) and object point (position 2) grid coordinates using basic trigonometry and a correction from OS Grid North to True North of –0.44°. Likewise the monument centre to centre altitudes (elevations) were calculated from their distance and relative heights using basic trigonometry, having added an estimated observer's eye level of 1.55m to the viewing point height. However, the majority of these altitudes fall below the local horizon, or have negative values because the viewing point (position 1) is higher than the object point (position 2). For these alignments the altitude has been recalculated to that of local horizon above the object point using OS contour data and an altitude correction for the Earth's curvature of –0.0045° per kilometre to the horizon. The visible horizon from each of the monument centres was also confirmed by observation and high resolution digital photography.

Formula 1: Atmospheric Refraction

$$R = P\,(0.1594 + 0.0196a + 0.00002a^2) \,/\, [(273 + T)\,(1 + 0.505a + 0.0845a^2)]$$

a = Altitude measured in degrees
P = Barometric Pressure in millibars (average sea-level pressure 1013.25 mbar)
R = Refraction measured in degrees
T = Temperature in Celsius (SW England mean annual temperature 11°C)

Formula 2: Solar or Lunar Azimuth

$$\cos(A) = [\sin(\delta) - \sin(\phi)\,\sin(a + p - R)] \,/\, [\cos(\phi)\,\cos(a + p - R)]$$

a = Altitude
A = Azimuth
ϕ = Latitude (Stanton Drew: 51.367° N)
p = Parallax (solar 0.002° or lunar 0.95°)
δ = Declination (geocentric solar or lunar declination)

In order to establish which of these alignments could have had any solar or lunar significance in Late Neolithic to Early Bronze Age some further work is required. Firstly it will be necessary to calculate the degree of atmospheric refraction for the horizon altitudes below 15° (formula 1: Ofek 1998), and secondly correct for solar or lunar parallax because these altitudes are observed from the earth's surface (topocentric) rather than the earth's centre (geocentric). It is then possible to calculate the azimuth of the sun or moon at any given latitude and altitude from its past or present declination 'celestial latitude' (formula 2: Wood 1978: 63–5). The angle between the earth's axis and the sun's ecliptic plane is known as the obliquity of the ecliptic and gradually oscillates between about 22.1° and 24.5° over a 41,000 year cycle. As a result, during the Late Neolithic and Early Bronze Age the summer solstice sun rose and set about 1° further north, and at the winter solstice rose and set about 1° further south than it does today (Ruggles 1999: 19–24; Ruggles 2009). Table 7.6 shows this effect at Stanton Drew assuming a level horizon of 1° altitude (+ 0.002° solar parallax and –0.40° atmospheric refraction).

	Year	Azimuth	Declination
Summer Solstice Sunrise	AD 2000	51.40	+23.43
	2500 BC	50.37	+23.98
Winter Solstice Sunrise	AD 2000	130.54	–23.43
	2500 BC	131.61	–23.98
Winter Solstice Sunset	AD 2000	229.46	–23.43
	2500 BC	228.39	–23.98
Summer Solstice Sunset	AD 2000	308.60	+23.43
	2500 BC	309.63	+23.98

Table 7.6 Azimuths and declinations of solstice sunrise and sunset in 2500 BC and AD 2000.

Thus the obliquity of the ecliptic (presently 23.43°) determines the maximum and minimum declinations of the sun at the summer and winter solstices. Halfway between these two extremes are the spring and autumn equinoxes where the sun's declination is 0°. These events divide the solar year into four quarters, which may be further subdivided by the cross-quarter days where the sun's declination can be calculated by the formula ± (ε sin 45°). In addition, the angle between the sun's ecliptic plane (ε) and the moon's orbital plane (*i*) is 5.14°. Therefore the declination of the moon at the major and minor lunar standstills (lunastices) can be approximated by the formulas ± (ε + *i*) and ± (ε – *i*). However, a further complication is introduced by minor perturbation (Δ), which can alter the moon's maximum and minimum declinations by as much as ± 0.15°. Unlike the solstices which occur on an annual cycle, the major and minor lunar standstills occur on an 18.6 year cycle. Table 7.7 shows the declinations (δ) of the sun and moon at the solstices, cross-quarter days and lunar standstills from 4000 BC to 1000 BC (based on Wood 1978: 67–9 and Table 4.1):

Year (±10)	Ecliptic (ε)	Solstices (δ)	Cross Quarter Days (δ)	Lunar Standstills	
				Major (δ ± Δ)	Minor (δ ± Δ)
4000 BC	24.11	± 24.11	± 17.05	± 29.25	± 18.97
3500 BC	24.07	± 24.07	± 17.02	± 29.21	± 18.93
3000 BC	24.03	± 24.03	± 16.99	± 29.17	± 18.89
2500 BC	23.98	± 23.98	± 16.96	± 29.12	± 18.84
2000 BC	23.93	± 23.93	± 16.92	± 29.07	± 18.79
1500 BC	23.87	± 23.87	± 16.88	± 29.01	± 18.73
1000 BC	23.81	± 23.81	± 16.84	± 28.95	± 18.67

Table 7.7 Declinations (geocentric) of the sun and moon at the solstices, cross-quarter days and lunar standstills from 4000 BC to 1000 BC.

There are now two possible approaches we can take in comparing these geocentric solar and lunar declinations with the possible monument alignments at Stanton Drew, both of which have been employed in this study and the results used as a check against the other:

1. Calculate and compare the geocentric alignment declinations (corrected for solar or lunar parallax and refraction) with the geocentric solar or lunar event declinations (formula 3).

2. Calculate and compare the topocentric alignment declinations (corrected for refraction only) with the topocentric solar and lunar event declinations (formulas 4 and 5).

Formula 3 **Geocentric Alignment Declination**

$$\sin(\delta) = \sin(\phi)\sin(a + p - R) + \cos(\phi)\cos(a + p - R)\cos(A)$$

Formula 4 **Topocentric Alignment Declination**

$$\sin(\delta t) = \sin(\phi)\sin(a - R) + \cos(\phi)\cos(a - R)\cos(A)$$

Formula 5 **Topocentric Solar or Lunar Declination**

$$\sin(\delta t) = \sin(\phi)\sin(a) + \cos(\phi)\cos(a)\,\frac{\sin(\delta) - \sin(\phi)\sin(a + p)}{\cos(\phi)\cos(a + p)}$$

δ = Geocentric Declination (viewed from the earth's centre)
δt = Topocentric Declination (viewed from the earth's surface)

Note: Formula 5 (topocentric target declination) is derived by substituting cos(A) from formula 2 into formula 4. However, any correction for atmospheric refraction (R) can be omitted from formula 5 as it is already accounted for in formula 4 (topocentric alignment declination).

Solar or Lunar Event c. 2500 BC	Geocentric Declination	Parallax	Topocentric Declination		Azimuth	
			Altitude 0°	Altitude 3°	Alt. 0° Ref. 0.57°	Alt. 3° Ref. 0.24°
Northern Major Moonrise	+29.12	0.950	+28.28	+28.30	39.54	45.58
Summer Solstice Sunrise	+23.98	0.002	+23.98	+23.98	48.44	53.75
Northern Minor Moonrise	+18.84	0.950	+18.06	+18.08	59.41	64.08
Cross Quarter Sunrise	+16.96	0.002	+16.96	+16.96	61.35	65.97
Equinox Sunrise	0.00	0.002	0.00	0.00	89.29	93.46
Cross Quarter Sunrise	–16.96	0.002	–16.96	–16.96	117.05	121.88
Southern Minor Moonrise	–18.84	0.950	–19.63	–19.65	121.71	126.83
Winter Solstice Sunrise	–23.98	0.002	–23.98	–23.98	129.69	135.41
Southern Major Moonrise	–29.12	0.950	–29.98	–30.01	141.98	149.57
Southern Major Moonset	–29.12	0.950	–29.98	–30.01	218.02	210.43
Winter Solstice Sunset	–23.98	0.002	–23.98	–23.98	230.31	224.59
Southern Minor Moonset	–18.84	0.950	–19.63	–19.65	238.29	233.17
Cross Quarter Sunset	–16.96	0.002	–16.96	–16.96	242.95	238.12
Equinox Sunset	0.00	0.002	0.00	0.00	270.71	266.54
Cross Quarter Sunset	+16.96	0.002	+16.96	+16.96	298.65	294.03
Northern Minor Moonset	+18.84	0.950	+18.06	+18.08	300.59	295.92
Summer Solstice Sunset	+23.98	0.002	+23.98	+23.98	311.56	306.25
Northern Major Moonset	+29.12	0.950	+28.28	+28.30	320.46	314.42

Table 7.8 Solar and lunar event declinations (geocentric and topocentric) at Stanton Drew c. 2500 BC, and their azimuths assuming a local horizon of 0° and 3° altitude.

The three stone circles at Stanton Drew are thought to have been constructed during the Late Neolithic to Early Bronze Age between 3000 and 2000 BC. Table 7.8 shows the geocentric solar and lunar event declinations at around 2500 BC, and their topocentric declinations and azimuths at Stanton Drew assuming a local horizon of 0° and 3° altitude. The results table at the end of this chapter (see table 7.10: columns 8–10) shows the topocentric and geocentric declinations for each of the possible monument alignments at Stanton Drew, all of which have been corrected for atmospheric refraction. It will be noticed that the difference between any topocentric alignment declination (column 8) and its respective geocentric declination corrected for solar parallax (column 9) is negligible, because the distance of the earth from the sun is so great that it results in only 0.002° parallax. In contrast the difference between any topocentric alignment declination (column 8) and its geocentric declination corrected for lunar parallax (column 10) is far more significant, because the moon is so close when viewed from the earth's surface it can result in as much as 0.95° parallax. These alignment declinations have then been compared with their respective topocentric and geocentric solar or lunar target declinations (see table 7.8), and those identified with differences of less than 5 degrees (see table 7.10: columns 11–12). As a final check on the validity of these results the horizon height for each alignment was increased and decreased by ± 5m (the OS contour data intervals), and found to have a negligible effect on the comparison between the alignment and target declinations (column 12).

7.4 Conclusions and Future Work

These results broadly agree with those of Alexander Thom and suggest that three of the possible monument 'centre to centre' alignments at Stanton Drew were with the summer solstice sunrise (A07–A09), southern major lunar standstill moonset (B05 and B06) and winter solstice sunset (B07–B09) (figure 7.3). However, when alignments B07–B09 are recalculated to take account of lunar parallax they provide far a better alignment with the southern minor lunar standstill moonset. Whilst any alignments with the Tyning Stones should be treated with caution, until further work has proven whether or not they formed part of the Stanton Drew complex, their alignments to and from the NE Circle (A11 and B11) provide the best correlation with the Spring/Autumn equinox sunrise and sunset.

Figure 7.3 Photograph of sunset viewed from centre of NE Circle (16th December 2010).

The stones that make up the three circles, and the centre lines of the two avenues, each have a different azimuth when viewed from their respective circle centres. Whilst these alignments for the Great Circle (C01–C28), NE Circle (D01–D09) and SW Circle (E01–E12) are of considerable interest, we must exercise caution. A significant factor affecting their azimuths is uncertainty about the precise location of the circle centres, but is less significant for the wider monument 'centre to centre' alignments (A01–A15 and B01–B15). It is often difficult to determine the exact centre of a large circle, which would have been a significant problem in the Neolithic period, unless a centre

'stump' had been left in place (Heggie 1981). Furthermore, we cannot be certain that all the stones are in their original locations, a problem which is particularly true of the SW Circle.

The topocentric alignment declinations (see table 7.10: column 8) have been corrected for atmospheric refraction, but not solar or lunar parallax, and so can be compared with stellar declinations for possible star alignments (see table 7.9). However, any such coincidences should again be treated with caution. Due to the earth's axial precession many stars will have moved in and out of alignment with the monuments at Stanton Drew, and so have not been considered in this study. Aubrey Burl, one of the leading authorities on archaeoastronomy, is quite adamant that "there is little evidence for stellar alignments in Britain and Ireland" (Burl 1983: 12). Perhaps of more interest are possible landscape and monument targets on the skyline such as Maes Knoll, Publow Hill, Round Hill and in particular Priddy Circles (alignment B05).

The 2010 geophysical survey of the Great Circle carried out by BACAS has revealed a second narrower entrance through the outer ditch that was first identified by English Heritage in 1997. This newly discovered entrance (causeway) appears to be defined by two large termini of the ditch, and has a central azimuth when viewed from the Great Circle centre of approximately 215° (close to stone M10, alignment C19), which with a horizon of 2.21° (the garden of Church Farmhouse) would in about 2500 BC have been within 2.5 degrees of the southern major lunar standstill moonset (Azimuth 212.5°).

Star	Constellation	Declination						
		4000 BC	3500 BC	3000 BC	2500 BC	2000 BC	1500 BC	1000 BC
Arcturus	Boötis	+49.87	+47.85	+45.55	+43.08	+40.45	+37.73	+34.97
Vega	Lyra	+47.62	+45.88	+44.30	+42.88	+41.65	+40.60	+39.75
Deneb	Cygnus	+37.13	+36.68	+36.45	+36.37	+36.62	+37.02	+37.62
Capella	Auriga	+20.05	+22.82	+25.60	+28.37	+31.10	+33.75	+36.27
Castor	Gemini	+19.55	+22.10	+24.48	+26.67	+28.62	+30.30	+31.65
Pollux	Gemini	+17.48	+19.93	+22.20	+24.27	+26.07	+27.57	+28.75
Regulus	Leo	+21.80	+22.85	+23.57	+23.90	+23.87	+23.48	+22.72
Spica	Virgo	+18.22	+16.60	+14.72	+12.60	+10.30	+7.82	+5.22
Altair	Aquila	+13.60	+11.75	+10.10	+8.72	+7.58	+6.72	+6.15
Procyon	Canis Minor	–2.90	–0.72	+1.23	+2.97	+4.45	+5.65	+6.55
Aldebaran	Taurus	–10.62	–7.85	–5.07	–2.30	+0.40	+3.05	+5.58
Betelgeuse	Orion	–12.75	–10.05	–7.45	–4.97	–2.63	–0.47	+1.45
Bellatrix	Orion	–16.57	–13.80	–11.10	–8.48	–5.98	–3.63	–1.47
Antares	Scorpio	+1.38	–1.33	–4.10	–6.88	–9.65	–12.35	–14.95
Sirius	Canis Major	–28.60	–26.38	–24.35	–22.50	–20.87	–19.45	–18.28
Rigel	Orion	–31.07	–28.33	–25.67	–23.10	–20.65	–18.35	–16.22

Table 7.9 Declinations for 16 of the brightest stars visible in Neolithic and Bronze Age Britain.

Geophysical survey work has greatly increased our knowledge and understanding of the Stanton Drew complex, but as always poses more questions than it answers. The monuments were almost certainly constructed and developed over a long period of time. If the Cove is indeed a long barrow, this would be the earliest monument dating to between 3500–2500 BC. This megalithic tomb would have contained the community's ancestor, and therefore formed a focus for their later monument building. The Great Circle may have started out as a class II henge monument, which at some point had a series of massive concentric post settings constructed within, similar to the monuments at Woodhenge and Durrington Walls in Wiltshire and Mount Pleasant in Dorset. The three stone circles and two avenues are thought to have been constructed between 3000–2000 BC, with their alignments: (a) SW Circle – Great Circle – Hautville's Quoit, and (b) Cove – Great Circle – NE Circle, showing a clear plan to connect these monuments in a physical and ritual landscape, and possibly with heavens through

solstice and lunar standstill alignments. The two avenues again appear to provide a ritual and physical link with the natural features in the landscape – the River Chew. Nevertheless, questions still remain about the precise phasing of the monuments at Stanton Drew, in particular the post settings, which would have obscured observations from and through the Great Circle. Future research could usefully examine the outlying Hautville's Quoit to establish the full extent of the monument, and the Tyning Stones to examine whether or not they formed part of the Stanton Drew complex.

No	Position 1	Position 2	Position 3	Azimuth	Altitude	Refraction	T Dec.	G Dec. SP	G Dec. LP	Nearest S/L Target	Dif.
A01	NE Circle	Quoit	Hammerhill	9.29	2.62	0.26	+40.38	+40.38	+41.32	Out of range	> 5
A02	Great Circle	Quoit	Hammerhill	17.70	2.27	0.28	+38.43	+38.43	+39.35	Out of range	> 5
A03	SW Circle	Quoit	Hammerhill	18.25	1.68	0.33	+37.67	+37.68	+38.59	Out of range	> 5
A04	SW Circle	Great Circle	Hammerhill	19.65	1.70	0.33	+37.34	+37.34	+38.25	Out of range	> 5
A05	Cove	Quoit	Guy's Hill	29.60	1.77	0.32	+34.23	+34.23	+35.11	Out of range	> 5
A06	SW Circle	NE Circle	Guy's Hill	31.13	2.09	0.30	+33.96	+33.96	+34.83	Out of range	> 5
A07	Cove	Great Circle	Publow Hill	51.85	0.87	0.42	+23.07	+23.07	+23.87	Summer Solstice Sunrise	< 1
A08	Cove	NE Circle	Publow Hill	52.14	0.87	0.42	+22.91	+22.91	+23.71	Summer Solstice Sunrise	< 2
A09	Great Circle	NE Circle	Publow Hill	52.88	1.10	0.39	+22.73	+22.73	+23.53	Summer Solstice Sunrise	< 2
A10	Tyning Stones	Quoit	Belluton	69.81	0.68	0.45	+12.63	+12.64	+13.39	Cross Quarter Sunrise	< 5
A11	Tyning Stones	NE Circle	Pensford	91.11	1.04	0.40	–0.19	–0.19	+0.56	Equinox Sunrise	< 1
A12	Tyning Stones	Great Circle	Pensford	95.20	1.10	0.39	–2.68	–2.68	–1.94	Equinox Sunrise	< 3
A13	Cove	SW Circle	Pensford	96.90	1.18	0.38	–3.67	–3.67	–2.93	Equinox Sunrise	< 4
A14	Tyning Stones	SW Circle	Pensford	107.59	1.31	0.37	–10.13	–10.12	–9.37	None	> 5
A15	Tyning Stones	Cove	Pensford	109.71	1.24	0.37	–11.46	–11.46	–10.7	None	> 5
B01	Quoit	NE Circle	White Cross	189.29	1.12	0.39	–37.3	–37.3	–36.36	Out of range	> 5
B02	Quoit	Great Circle	Highfields	197.70	1.10	0.39	–35.81	–35.81	–34.88	Out of range	> 5
B03	Quoit	SW Circle	Highfields	198.25	1.10	0.39	–35.68	–35.68	–34.76	Out of range	> 5
B04	Great Circle	SW Circle	SW Circle	199.65	2.63	0.26	–33.72	–33.72	–32.8	Southern Major Moonset	< 4
B05	Quoit	Cove	Priddy Circles	209.60	1.05	0.40	–32.27	–32.27	–31.38	Southern Major Moonset	< 3
B06	NE Circle	SW Circle	SW Circle	211.13	2.20	0.29	–30.53	–30.53	–29.65	Southern Major Moonset	< 1
B07	Great Circle	Cove	Cove	231.85	1.74	0.32	–21.48	–21.48	–20.68	Southern Minor Moonset	< 2
B08	NE Circle	Cove	Cove	232.14	1.58	0.34	–21.48	–21.48	–20.67	Southern Minor Moonset	< 2
B09	NE Circle	Great Circle	Cove	232.88	1.58	0.34	–21.08	–21.08	–20.28	Southern Minor Moonset	< 2
B10	Quoit	Tyning Stones	Nempnett Farm	249.81	0.65	0.45	–12.29	–12.29	–11.53	Cross Quarter Sunset	< 5
B11	NE Circle	Tyning Stones	Winford	271.11	1.05	0.40	+1.2	+1.2	+1.94	Equinox Sunset	< 2
B12	Great Circle	Tyning Stones	Winford	275.20	0.99	0.40	+3.71	+3.71	+4.45	Equinox Sunset	< 4
B13	SW Circle	Cove	Winford	276.90	0.90	0.41	+4.68	+4.69	+5.43	Equinox Sunset	< 5
B14	SW Circle	Tyning Stones	Chew Hill	287.59	1.35	0.36	+11.66	+11.66	+12.42	None	> 5
B15	Cove	Tyning Stones	Chew Hill	289.71	1.51	0.34	+13.09	+13.09	+13.85	Cross Quarter Sunset	< 4

No	Position 1	Position 2	Position 3	Azimuth	Altitude	Refraction	T Dec.	G Dec. SP	G Dec. LP	Nearest S/L Target	Dif.
C01	GC Centre	M20	Maes Knoll	3.57	2.92	0.24	+41.22	+41.22	+42.17	Out of range	> 5
C02	GC Centre	M21	Hammerhill	13.36	2.36	0.28	+39.45	+39.45	+40.38	Out of range	> 5
C03	GC Centre	M22	Guy's Hill	22.63	2.71	0.25	+37.53	+37.53	+38.43	Out of range	> 5
C04	GC Centre	M23	Guy's Hill	33.52	2.89	0.24	+33.78	+33.79	+34.65	Out of range	> 5
C05	GC Centre	M24	Guy's Hill	38.99	2.59	0.26	+31.1	+31.1	+31.94	Northern Major Moonrise	< 3
C06	GC Centre	M25	Settle Hill	41.76	2.26	0.28	+29.5	+29.5	+30.33	Northern Major Moonrise	< 2
C07	GC Centre	M26	Belluton	55.58	1.02	0.40	+21.18	+21.18	+21.97	Summer Solstice Sunrise	< 3
C08	GC Centre	M27	Belluton	62.08	0.78	0.43	+17.28	+17.28	+18.06	Cross Quarter Sunset	< 1
C09	GC Centre	GC Avenue	Belluton	68.63	0.66	0.45	+13.32	+13.32	+14.08	Cross Quarter Sunset	< 4
C10	GC Centre	M1	Pensford	94.75	1.63	0.33	–1.95	–1.95	–1.2	Equinox Sunrise	< 2
C11	GC Centre	M2	Pensford	104.09	1.69	0.33	–7.66	–7.66	–6.91	None	> 5
C12	GC Centre	M3	Stanton Wick	120.18	1.65	0.33	–17.2	–17.2	–16.42	Cross Quarter Sunrise	< 1
C13	GC Centre	M4	Red Hill	137.49	2.00	0.30	–25.91	–25.9	–25.07	Winter Solstice Sunrise	< 2
C14	GC Centre	M5	Red Hill	138.96	2.15	0.29	–26.45	–26.45	–25.6	Winter Solstice Sunrise	< 3
C15	GC Centre	M6	Round Hill	154.78	2.44	0.27	–32.34	–32.33	–31.43	Southern Major Moonrise	< 3
C16	GC Centre	M7	Round Hill	160.17	2.42	0.27	–33.9	–33.89	–32.98	Southern Major Moonrise	< 4
C17	GC Centre	M8	SW Circle	190.87	2.56	0.26	–35.55	–35.55	–34.61	Out of range	> 5
C18	GC Centre	M9	SW Circle	200.59	2.56	0.26	–33.55	–33.55	–32.63	Southern Major Moonset	< 4
C19	GC Centre	M10	Church Farm	217.25	2.21	0.29	–28.06	–28.06	–27.21	Southern Major Moonset	< 2
C20	GC Centre	M11	Churchyard	230.57	2.00	0.30	–21.92	–21.92	–21.11	Winter Solstice Sunset	< 3
C21	GC Centre	M12	Church Lane	246.78	1.39	0.36	–13.42	–13.42	–12.65	Cross Quarter Sunset	< 4
C22	GC Centre	M13	Court Lodge	254.49	0.72	0.44	–9.39	–9.39	–8.64	None	> 5
C23	GC Centre	M14	Court Lodge	258.04	0.64	0.45	–7.29	–7.29	–6.54	None	> 5
C24	GC Centre	M15	Winford	272.68	1.00	0.40	+2.14	+2.15	+2.89	Equinox Sunset	< 3
C25	GC Centre	M16	Blacklands	292.49	2.17	0.29	+15.32	+15.33	+16.08	Cross Quarter Sunset	< 2
C26	GC Centre	M17	Blacklands	326.70	3.30	0.22	+34.27	+34.27	+35.13	Out of range	> 5
C27	GC Centre	M18	Blacklands	335.59	2.84	0.25	+37.11	+37.11	+38.01	Out of range	> 5
C28	GC Centre	M19	Maes Knoll	350.43	2.61	0.26	+40.33	+40.33	+41.27	Out of range	> 5

No	Position 1	Position 2	Position 3	Azimuth	Altitude	Refraction	T Dec.	G Dec. SP	G Dec. LP	Nearest S/L Target	Dif.
D01	NE Centre	N7	Guy's Hill	20.11	3.08	0.23	+38.63	+38.63	+39.54	Out of range	> 5
D02	NE Centre	N8	Pensford	67.76	0.79	0.43	+13.95	+13.96	+14.72	Cross Quarter Sunrise	< 4
D03	NE Centre	NE Avenue	Pensford	95.76	1.64	0.33	–2.57	–2.56	–1.82	Equinox Sunrise	< 3
D04	NE Centre	N1	Pensford	114.33	1.84	0.32	–13.67	–13.67	–12.9	Cross Quarter Sunrise	< 4
D05	NE Centre	N2	Red Hill	152.99	2.32	0.28	–31.88	–31.87	–30.98	Southern Major Moonrise	< 2
D06	NE Centre	N3	Highfields	197.99	1.47	0.35	–35.34	–35.34	–34.42	Out of range	> 5
D07	NE Centre	N4	Court Lodge	246.36	0.88	0.42	–14.13	–14.13	–13.36	Cross Quarter Sunset	< 3
D08	NE Centre	N5	Blacklands	285.50	1.95	0.31	+10.91	+10.91	+11.66	None	> 5
D09	NE Centre	N6	Maes Knoll	343.61	2.57	0.26	+39.04	+39.04	+39.97	Out of Range	> 5
E01	SW Centre	S12	Lypiatt	46.29	0.82	0.43	+25.9	+25.9	+26.72	Summer Solstice Sunrise	< 2
E02	SW Centre	S2	Lye Hill	74.03	0.23	0.52	+9.66	+9.66	+10.42	None	> 5
E03	SW Centre	S1	Lye Hill	75.52	0.32	0.50	+8.84	+8.84	+9.59	None	> 5
E04	SW Centre	S3	Pensford	89.56	1.17	0.38	+0.89	+0.89	+1.63	Equinox Sunrise	< 1
E05	SW Centre	S4	Pensford	107.99	0.13	0.54	–11.45	–11.45	–10.69	None	> 5
E06	SW Centre	S5	Red Hill	146.65	2.14	0.29	–29.74	–29.74	–28.87	Southern Major Moonrise	< 1
E07	SW Centre	S6	White Cross	185.00	1.24	0.37	–37.59	–37.59	–36.64	Out of Range	> 5
E08	SW Centre	S7	Nempnett Farm	256.16	0.63	0.45	–8.45	–8.45	–7.7	None	> 5
E09	SW Centre	S8	Chew Hill	281.45	0.77	0.43	+7.39	+7.39	+8.14	None	> 5
E10	SW Centre	S9	Blacklands	324.34	1.85	0.31	+31.87	+31.87	+32.73	Northern Major Moonset	< 4
E11	SW Centre	S10	Maes Knoll	354.12	2.32	0.28	+40.42	+40.42	+41.37	Out of Range	> 5
E12	SW Centre	S11	Maes Knoll	359.56	2.60	0.26	+40.97	+40.97	+41.92	Out of Range	> 5
SL	Passage	Baggeridge Belt	Baggeridge Belt	135.89	3.84	0.20	–23.47	–23.47	–22.63	Winter Solstice Sunrise	< 1

Table 7.10 Topocentric and geocentric declinations for each of the possible monument alignments at Stanton Drew, corrected for atmospheric refraction.

8 Previous Archaeology at Stanton Drew

The first mention of an archaeological find at Stanton Drew is by an anonymous source writing in 1666 or later: "... (a stone) being newly fallen, in the Pitt, in which it stood, were found the crumbes of a man's bones, and a large horse-bell, with a skrew as the stemme of it" (Hearne 1725: 507). This is reminiscent of the discovery of the barber-surgeon's remains under a stone at Avebury (Smith 1965: 177–8).

There have been changes to the stone circles in the last few centuries. Aubrey (Aubrey et al 1980: 47) wrote in 1664 that the villagers break the stones with sledges to get them out of the way, and he was told they were much diminished in the last few years. Later, the villagers would tell Seyer (1821) that a century earlier many stones were broken up to mend the roads. However, the villagers then seem to have decided to leave the stones alone, and Long (1858) said it did not appear that any stones had vanished since Stukeley's visit in 1723. The John Woods, father and son, the Bath architects, visited the site (Wood 1749), (Wood 1765). John Wood, the son, claims to have carried out an accurate survey. His text does indeed support this, but his diagrams are fanciful, being aimed at proving his intent.

Some stones were toppled deliberately. It seems this was also done at Avebury in medieval times and the stones left lying on the surface; other stones were buried in pits. The purpose cannot have been simply to clear the land for cultivation as it was not particularly effective, and it is assumed there was a superstitious motive (Smith 1965: 176, 179–80).

Very few of the stones stand erect, and some stones have fallen within the last 300 years. At the time of Musgrave's visit in 1718 there were seven stones standing in the North-East Circle, but three had fallen by 1740 (Dymond 1896: 6). Dymond (1896: 15) claims that none of the stones seem to have been packed into place with rubble, sitting merely in holes dug in the natural soil, so it is perhaps no surprise that so many lie prostrate. However, it is quite possible that some of the stones, for example M12, were never erect but were originally placed lying flat. This stone is directly opposite the point where the avenue meets the main circle. Animals digging burrows in the soft earth may have caused some stones to topple. In 2009, there was a large burrow, probably dug by foxes, under stone N8; fortunately not one of the erect stones.

There have been several attempts to find buried stones at Stanton Drew. When William Stukeley visited with John Strachey in 1723, he remarked that some buried stones were easy to detect because grass would not grow on top for lack of earth. Some might be found by stamping on the ground or by thrusting an iron rod into the ground (Stukeley 1776). Strachey managed to find buried stones using his sword (Burl 1999: 52). Seyer (1821: 93) and Long (1858) also maintained that buried stones could be detected by parch marks. Seyer (1821: 93–94) must have probed for stones because he claimed some were underground, "but certainly there". It seems Dymond (1896: 11) did some digging as well as probing: "the positions of several stones which had been buried for generations were ascertained, and their outlines traced with a probe, where they could not easily be exposed by the spade". Six were recorded: M4, M23, M24, M33, M35, and N13 (of these, all but M4 and M33 were visible at the surface in 2009; M33 reappeared in 2010 when conditions were drier and the grass considerably shorter, but M4 is still elusive).

The Reverend John Skinner is known from his writings to have visited Stanton Drew at least five times, but it appears that his only active contribution to the archaeology of the place was in persuading Sir Richard Colt-Hoare to let his surveyor prepare a plan of the site, which appears in the Stonehenge section of his work (Hoare 1826).

Following Dymond's paper, which he published privately and only in limited number, very little was done for a century. The site had been considered for excavation by Harold St George Grey and the Age of Stone Circles Committee in 1909, but ironically, it was dropped from the list as there was

no sign of a ditch being present (Pitts 2001). This may have saved it from the restorations accorded to such sites as Avebury, Stonehenge and Ring of Brodgar. Desultory work continued, mainly in the nineteen fifties and sixties.

Grinsell and Kendal (1958) carried out some systematic probing and auguring in 1954. They covered an area from the lowest known stones in each avenue, eastwards towards the river. They found no stones. Some very soft mud was found 2 feet down in various places east of the old hedge line, and they speculated that any stones that were there may have sunk downwards through the river alluvium. They did find two stones in the Main Circle. One of them was approximately 7.5 feet by 3.75 feet, 68 feet from the next stone eastwards and 27 feet from the north end of avenue. This was a stone noted by Seyer, but later rejected as non-existent by Dymond. The second stone was found southwards, towards stone M1. Grinsell (1958) described the site in his book on Wessex. He noted the absence of barrows in the vicinity (p71) and provided an illustration of the Cove in its setting, then in an orchard. However, Stanton Drew figured but little in his account of his work (Grinsell 1989).

Tratman (1966; 1968) probed for Grinsell and Kendall's two buried stones and, at first, thought he had found them. He tried plausible spots in gaps between other stones and found a hard layer at a depth between six inches and two feet, but he was not able to trace stone outlines, except for where there were prone stones, partly visible. He then tried probing extensively between stones M18 and M20, and found the hard layer everywhere. Applying more pressure, he found he could break through to softer soil below. It seems there is a hard layer across a large area, though he could not detect it on the south side of the avenue. Returning to Grinsell's buried stones, he was able to break through the hard layer, except for one area about two feet square, so he concluded the stones did not exist. The hard layer could be an iron pan, two to six inches thick, about 1 foot down on average.

Field boundaries have changed over the years. At one time, the Main Circle lay in three fields; the North East Circle had a ditch and hedge running across one side; and the SSW Circle was divided into two: an apple orchard and pasture (Stukeley 1776; Seyer 1821). The North East Circle has also been in an orchard (Scarth 1867) but the tithe map of 1840 shows just one large field stretching down to the river. Stone Close has been ploughed in the past: when Aubrey visited, it was under corn (Aubrey et al 1980). In addition to the orchards, large trees also grew in the area and these will have destroyed most of the archaeology where they stood: a very large old elm tree was removed from near the centre of the Main Circle in 1963 (Tratman 1966).

The monument has been scrutinised for astronomical alignments since the inception of the subject by Norman Lockyer (1909) although he admitted he had not visited the site and was just working from plans. It was also studied by Thom (1967) who curiously used a survey by Preest rather than one of his own. A later survey (Thom et al 1980) was quite clumsy. He did however note (Thom 1971) that the south south-west circle had stones within its main ring, which was unusual. He also commented that the site made a poor observatory because the skyline would have been wooded. The effect of Heggie's book (Heggie 1981) was to pour cold water on Thom's hypotheses although Thom's work was appreciated by Michell (1982). Heggie also pointed out the difficulty in knowing the location of the centre in a large ring such as Stanton Drew.

A number of possible alignments are mentioned by Burl (2005). That from the north-east circle to the south south-west circle may work in theory, but in practice, the latter circle is not easily visible and the sightline is disrupted by the main avenue, even if it is below the horizon. Burl also discussed the avenues in a separate work (Burl 1993) but that was not in their context as part of the stone circle complex.

John Barnatt (1989) included Stanton Drew in his documentary survey but did not contribute any new material.

Like the NE and SSW Circles, the Cove once stood in an orchard (Stukeley 1776; Collinson 1791; Grinsell 1958). The eastern half of this orchard was used to extend the churchyard in 1903 and the remainder, containing the Cove, was extended northwards by adding some land behind the Druid's Arms pub. Comparison of the Ordnance Survey 1:2500 maps for 1885 and 1962 shows the change in field and churchyard boundaries, and a plaque in the church records: "On Octr. 20th 1903 an addition to the Churchyard of 1 Rood 12 Perch was consecrated. The cost amounting to £246 : 2 : 5 was defrayed by Parishioners and Friends.".

Traces of a sunken stone, to the southern side of the Cove's fallen stone, were found by Dymond (1896: 12–13), who thought it might be the root of the fallen stone. Dymond and the Reverend Perfect also dug a few holes, two to three feet in depth, in the area, and between the southern edges of the standing stones. In all of them he found pieces of breccia and white sandstone in the soil towards the bottom of the holes. In one of them he found a fragment of a medieval church tile about two feet from the surface. There was no charcoal, or any sign of a fourth stone on the southern side. Burl (1999: 52) thinks Dymond and Perfect found holes that had been dug by treasure seekers.

Dymond (1896: 30) considered whether the Cove was a ruined dolmen and decided it was unlikely. Grinsell (1956) did not believe it could be part of a chambered long barrow, on the basis the space between the standing stones was too large. Presumably he was considering the Cove as a possible chamber; as a forecourt there would be no such limitation.

The three stones of the Cove are Dolomitic breccia, only two other stones, M2 and S12, are the same type (Lloyd Morgan 1887).

Hautville's Quoit is described by Aubrey as being 10 feet 16 inches (sic) long, 6 feet 6 inches broad, and 1 foot 10 inches thick (Aubrey et al 1980). Stukeley (1776) said there were two quoits, half a mile either side of the bridge. He gives the size of the Quoit as thirteen feet by eight feet by four feet. As it could not possibly have grown in size, the most likely explanation is that he got the two stones confused (Burl 1999: 55). Part of the stone was broken off in 1836, and it is now about 2.2 metres long (Grinsell 1994). Roger Mercer (1969) carried out a resistivity survey and excavation to try and find the original location of the Quoit, but failed to find any stone socket. Note that geophysical equipment at that time was quite primitive and a more intensive survey with modern equipment might yield more information.

Jodie Lewis (2001: 137) has named Stukeley's second quoit, the Tollhouse Stone. It no longer exists, but she thinks it was once about 500 metres north-west of the Main Circle.

Lewis (2001: 187–188; 2005) carried out fieldwalking in the field to the north of Stanton Drew. She found flints dating from the Late Mesolithic or Early Neolithic through to the Early Bronze Age. A geophysical survey of the field opposite the Druids Arms by Andrew Young is supposed to have found a settlement site, but of Iron Age/Romano-British date. As yet, we have been unable to obtain this geophysics image.

The first geophysical survey at Stanton Drew was one of resistivity started by Professor L S Palmer in 1961. He was unable to complete owing to ill-health, and after his death the University of Bristol Physics department declared the results "essentially negative" (Tratman 1966). After Mercer's unsuccessful resistivity survey at Hautville's Quoit, the next attempt was in 1997 when two sample areas were surveyed in Stone Close (David et al 2004). The results were considered disappointing and had no correlation with the surprising and spectacular magnetometry results that showed the nine concentric rings of probable post-holes and an encircling ditch.

The first magnetometry survey was in the Main Circle using Geoscan fluxgate gradiometers, based on a project design by Andrew Young (Young 1996; Pitts 2001; David et al 2004). This showed the

inner circles of postholes, and other posthole features but with limited clarity. Part of the main circle was resurveyed with a Scintrex Smartmag SM4 Caesium magnetometer, which is fifty times more sensitive. This allowed resolution of the rings into individual anomalies.

Four pit-like anomalies were found in the North East Circle. There were occasional large anomalies caused by magnetic debris. One of these lay 20 metres south west of the Main Circle centre, and could be where the old elm was removed in 1963. Nothing of interest was found in the fields to the north and east of Stone Close.

In 2000, magnetometry and resistivity surveys were carried out in the SSW Circle. The high resolution fluxgate gradiometer survey revealed three concentric rings of anomalies. The resistivity survey showed a partial circuit of raised resistance, with both 0.5 metre and 1 metre probe spacings. The anomaly was three to five metres wide, just outside the stones on the southern side. As this ought to be a ditch, an explanation was needed. It was suggested that there might be a relatively coarse ditch filling, or an unusual link between seasonality, capillary action and texture.

A resistivity survey was also carried out in 2000 over the western perimeter of the Main Circle, using both 0.5 metre and 1 metre probe spacings and a narrower sampling interval. The results were again disappointing, showing neither ditch nor pit circles. Within the Main Circle, the resistance response was 'rather noisy'.

Nothing was found by either magnetometry or resistivity in the north east sector of the Main Circle, so it was suggested that this may be the location of an entrance. There were suggestions from the magnetometer survey that the main entrance to the Main Circle was in the North-East sector of the ring.

Ground-penetrating radar was trialled in both circles in Stone Close. It was only successful in the Main Circle where it succeeded in detecting the pits.

The only book available which is devoted to the site was published by a local author (Strong 2008) in 2008.

In 2009, a local newspaper published claims by a dowser, Paul Daw, a surveyor by profession (Chew Valley Gazette 2009) of a number of extra features which had not been detected by geophysical or other means. Mr Daw has provided copies of his plans to BACAS and these are compared with magnetometry in Appendix B. Amongst others was a claim that the avenue extended east towards the river and a photograph by Burl (2000) would support this claim. It does not show in the magnetometry survey of 1998, but that area has buried iron water pipes which disrupt the picture. He also claimed extra pit features around the circumference of the main circle and an entrance through the henge ditch in the south-west quadrant. A full comparison of Daw's dowsing plots and magnetometry is given in Appendix B of this document. Overall agreement between the two methods was not good.

Also in 2009, the authors of this report had the opportunity to carry out geophysical survey. This was of limited duration, but its major finding was that the Cove may have been the site of a long barrow, which extended north along the garden of the Druids Arms Inn (Oswin et al 2009). A comparison was drawn with the portal of the long barrow at Lugbury in Wiltshire, which is shown in figure 8.1. For direct comparison, the Cove is shown in figure 8.2. The results also demonstrated the capability of discrimination of post holes using modern fluxgate technology at high data density and the value of resistance measurements in understanding the geology on which the stones sit.

The work described in this report is the continuation of that 2009 survey.

Figure 8.1 The false portal of Lugbury long barrow

Figure 8.2 The stones of the Cove can be compared with the Lugbury portal. Had the recumbent not fallen, the two structures would have looked similar.

9 Discussion and Recommendations

9.1 Discussion

Stanton Drew has received very little attention over the last century or more, compared to other major stone circles such as Avebury, Stonehenge and Brodgar, so little was known prior to the geophysics work that started in 1997. However, that may be to the advantage of this site; the archaeology will not be masked by reconstruction or exploratory diggings.

Some of the work reported here has just repeated the spectacular geophysical surveys by English Heritage in 1997 and after, but this has been necessary because of data incompatibility. However, this survey has now advanced the picture beyond their work. In particular, the completion of a high data density magnetometer survey over the whole of Stone Close has added much extra detail, including a new henge entrance, posthole settings and an area of activity just outside the circle to the south-east.

Use of the profiler has given us a three-dimensional view through the ground. The sections produced, together with the increased area of twin-probe resistance, are giving us a greater understanding of the underlying geology as well as of sub-surface features.

In the SSW Circle, the EDM survey has shown up how flat the site of the circle interior is, and reinforces the opinion that the circle was positioned very deliberately to occupy the small plateau, with views northwards across the other circles towards the River Chew, westwards to the Cove, and across the valleys to the south and east.

The magnetometry survey has confirmed the results obtained by English Heritage, and may show more detail. In addition to three post circles, there are anomalies to the north west and north east of the circle, the latter may be part of an entrance. The arc of positive anomaly around the west of the circle may be part of a ditch, but it is perhaps more likely to be wall footings, especially as it shows as high resistance in the resistance survey.

At the Cove, the resistance surveys have added some reinforcement to the interpretation of a long barrow/chambered tomb, but the results are by no means conclusive. Attributes of length, width and orientation are consistent with this interpretation, and there may be signs of flanking (quarry) ditches, but the absence of any visible evidence above ground is, of course, the main difficulty.

We have included a very detailed and precise alignment survey for the monument, and concluded that there are possible astronomical alignments to the north-east with the midsummer sunrise, and to the south-west with the midwinter sunset and southern major and minor moonsets.

The survey of the Stanton Drew complex needs to be made as complete as possible, but we also need to look outside its immediate bounds. This should start with the fields immediately south of the church and circles, but also be extended to cover the Tyning Stones, Hautville's Quoit, and areas where flint scatter suggests there might be signs of habitation.

Work has started in putting the monument in its geographical context, and this is based both practically on perambulation but also 'virtually' by computer. There is plenty more to do yet.

9.2 Recommendations

Work is generally complete within the scheduled areas but if opportunity permits, any further surveys which may elucidate the monument should be done.

9.2.1 The twin-probe resistance should be continued to the southern hedge of Stone Close, especially in the area south-east of the main circle where magnetometry has identified new finds.

9.2.2 The area where the post pits appear to show in twin-probe resistance should be subject to higher density survey.

9.2.3 The magnetometry in the South South-West circle should be extended as near as possible to the northern hedge.

9.2.4 If possible, the iron fence around the memorial sapling could be removed for one day only and replaced afterwards, so that the magnetometer survey could be completed in this area of significant activity.

9.2.5 If the opportunity arises, more stone positions may be subject to magnetic susceptibility survey, but larger survey areas are needed, particularly in the north-west quadrant of the main circle, where there appear to be stake holes in the ditch and bank of the henge.

9.2.6 Beyond the area so far surveyed, it is important to extend both EDM and magnetometer surveys to the south. This is best done from the South South-West circle as heights and grids already known can be extended westwards and then southwards into that field. There are also points in this field where the EDM could be set to survey in the Cove, and possibly the churchyard too, so they are all then related to the Stone Close grid. The field to the south-east of the South South-West circle can either be gridded and subject to EDM survey from the southern end of the south-west field, or the survey may be extended through the gate at the north-east corner of the circle field. The area between South South-West circle and Stone Close also needs EDM survey in more detail, so that the contour plot software does as little extrapolation as possible. The fields are shown in figure 9.1.

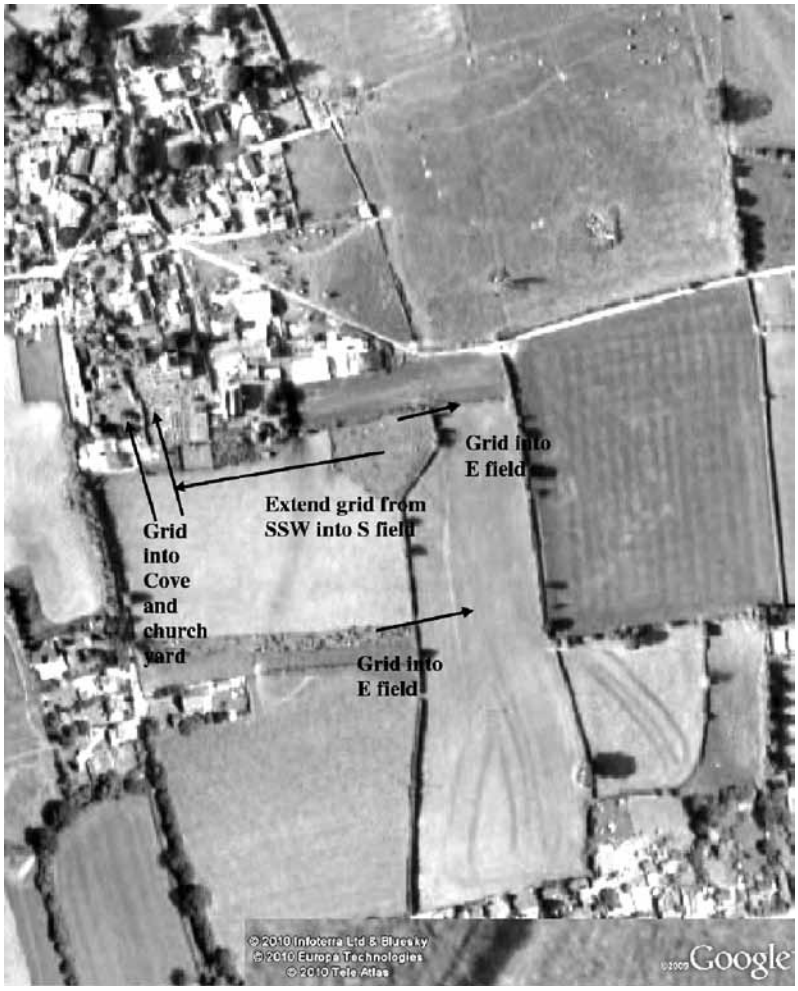

Figure 9.1 Projected work in surrounding fields

9.2.7 These two fields should also be subject to magnetometer survey. This can be done more rapidly at normal data density (4 readings per metre, 20 lines) and it would be possible to re-survey any grid at high density (8 readings per metre, 40 lines) if it shows patterns of interest. The two grid sizes can be combined with INSITE. It is not known at present if there is any archaeology within these two fields and it is a matter of priority to establish whether or not there is, and also whether it is likely to be contemporary with any phase of the monument.

9.2.8 Any survey of these fields, both EDM and magnetometer, is best done in the winter months when the fields do not have a use for grazing or growing grass. It is also easier to use the EDM when the trees are leafless.

9.2.9 Further afield, the area around the Tyning Stones should be investigated if access can be arranged. It is known that they have been moved in living memory, but they have not been moved far, and Dymond's plan shows their original position. It may not be possible to link to the Stone Close grid. It is possible that magnetometry could reveal more about the ground where they stood, possibly to find out whether they were set there intentionally as part of another monument or whether they were abandoned.

9.2.10 Hautville's Quoit was not explored in 2010, even though we had a licence for it, as we did not have the resources. However, it should be inspected and subject to whatever survey is appropriate in 2011.

9.2.11 It is also worth considering magnetometer survey of any fields known to contain flints in any number within a kilometre or so, if access can be arranged, to see if they show signs of any monuments which may be related to the circles. Indeed, survey of the surrounding area, even at lowest level, can yield beneficial insights, such as sightlines.

9.2.12 Work must also be continued to understand the setting of the stones in the landscape. We have begun to construct computer viewshed models and these can be refined. However, much more groundwork needs to be done yet. This includes walking around the area and seeing how it is observed from locations round about. Often the stones may be behind the hill or the village, but the church tower is a good marker, indeed it is the only church tower in that part of the Chew Valley. The site needs to be viewed from the hills all around, but also from the river valley itself, particularly where it emerges from the defile down to Pensford.

9.2.13 It is also important to look out from the stones themselves. We need to build panoramic photographs of the surrounding territory from the centres of both the Main and South South-West circles. These can be compiled from individual, aimed shots and software available to build panoramas. It would then be a good idea to use the EDM at both of these centres to measure the bearing and the angle of elevation of the horizon to understand further its setting.

9.2.14 Ideally, there would also be a LIDAR survey of the immediate area, but that is well beyond the financial scope of this project. It is a pity that the LIDAR survey of Mendip stopped a little distance short to the south.

9.2.15 How old is the Cove and is it the site of a long barrow? What is the chronological order of the monuments? Were the timber circles and main circle contemporary? Did the henge ditch come afterwards? Was the north-east circle later than the main circle? Is the South South-West circle the original or a successor? These are key questions that have to be answered before there can be any great advance in the understanding of this monument, but we are not going to be able to solve them by geophysical survey alone.

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Appendix A Details of Gridding

A1 Stone Close

A1.1 Magnetometer

Data from the grids used in magnetometry can be made available on appropriate media for interested parties, but that is only useful if they can then be put together in the right order to re–form the survey plan. Figure A1 contains the details which enable the Stone Close grids to be rebuilt.

Note that as individual grids contained much more data than conventionally, 6400 measurements per 20 metre grid, the Main and North-East Circle portions of the field were set up as separate sites. The line of division was 1020 E. However, grid numbers did not overlap so they could be merged into a single site providing computer and software has the capacity to do so.

BACAS uses INSITE software to produce the geophysics plans. This is now obsolete, but in-house software provides the necessary extra facilities. INSITE is still preferred because of its versatility in placing grids on the plan and its useful pictorial response to grid placement.

Data are first downloaded from the Bartington magnetometer using its own software, which also reduces it to parallel data from the zigzag pattern walked. After that, the grids are fed through a BACAS proprietary zero median de-striping package before they are imported into INSITE. Both raw and de-striped data are retained, but only the de-striped data are imported into INSITE. Raw data contains the prefix 'm'; de-striped data contains the prefix 'd'. INSITE does not recognise prefixes, so it is essential to use only those grid numbers prefixed by 'd'.

Good quality data collection was considered paramount, so if grids were found to have been walked incorrectly, or inadvertently contaminated with iron signals or otherwise corrupted, they would be re-walked and given a new grid number, so numbers shown on the plan, figure A.1, are not sequential. Numbers do however increase in order with progress. The pattern in figure A.1 may look odd, but the order in which the grids were done depended on priority, what other work was happening, and which part of the field was gridded out currently, rather than on a neat geometrical sequence. Sometimes, a new set of numbers would be started in order to ensure there could be no overlap.

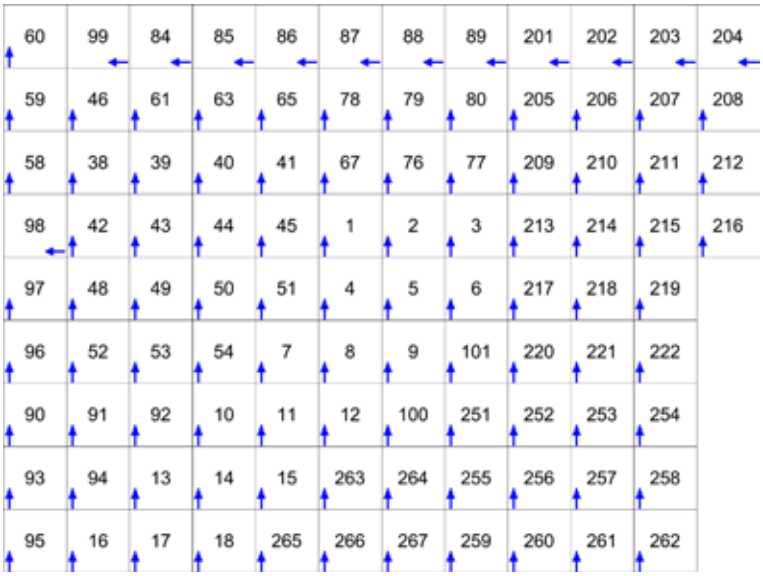

Figure A1 Magnetometry grid numbering in Stone Close

The magnetometer grids walked by BACAS form squares of 20 m sides. It is our convention to start in the south-west corner, traversing north. We start one line in from the west edge of the grid, so that the final line is down the east edge of the grid. We also start one mark up from the south baseline and finish on the north baseline. This way, all our grids abut each other without overlap or hiatus.

For a few grids, the walking procedure was rotated, the start being in the south-east corner, traverse west.

INSITE is able to cope with this. The grids done in this fashion were 99, 84–89, and 201–204 along the northern edge so that the de-stripe software could have maximum chance of removing effects of proximity to an iron wire fence. One grid, 98, on the western edge was also rotated. This was so that the de-stripe software did not remove magnetic signal from the ditch, where it was almost constant over the length of a traverse. The ditch signal thus crossed traverses and was not annulled by the way that software works. These grids can be identified on figure A.1 by the position and direction of the arrow in each grid. The arrow shows start position and direction of first traverse.

The grids took readings at eight per metre on each traverse, traverses 0.5 m apart, resulting in 40 lines of 160 points, 6400 in total per grid.

A1.2 Magnetic Susceptibility

Magnetic susceptibility did not follow the formal grid pattern, apart from one square tried in 2009. In 2010, grid squares were set up around any stone targeted such that they had sides of 6 m. Sides and baselines were also measured as squares would not have to abut neighbours. The squares were however set square to the axes of the main grid.

Readings were taken at half metre intervals on traverses half a metre apart, giving a maximum extent of 169 readings, less those which the stone itself obscured. The grids are referred to by the number of the stone that was enclosed in the grid.

A1.3 Twin probe resistance

Twin probe resistance used the same grid layout as magnetometry, although the sequence was different. During 2010, the gap inside the main circle was filled in, extra grids were done down the western edge of Stone Close (the survey stopped typically 10 m short of the western boundary) and extra grids were added to the east, south of the avenues.

Grids were started in the south-west corner, with the first traverse heading north. Readings were taken at half metre intervals along lines which were 1 m apart, giving 800 readings per grid. The work was done with a RM15, so grids need to be entered into software in zigzag mode.

One grid done in 2009, grid 30, came out faulty for the final few lines, but its output is included in the INSITE plan. The grid number pattern is shown in figure A.2.

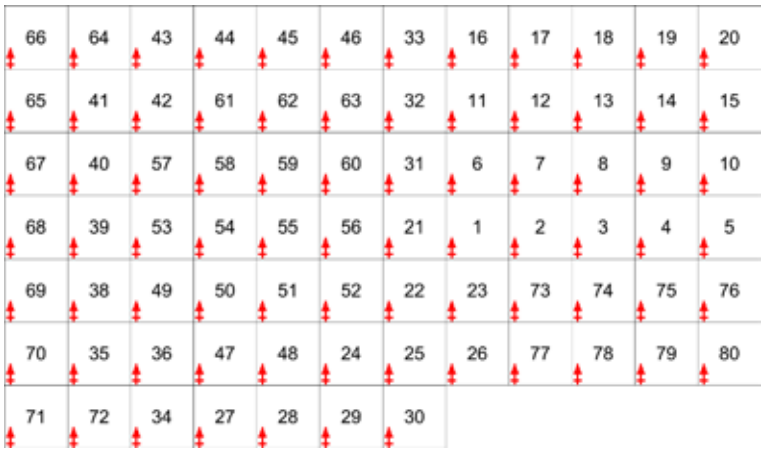

Figure A2 Twin-probe resistance grid numbering in Stone Close

A1.4 Resistivity Profiles

These are recorded according to the grid coordinates at their ends, or the grid coordinates at corners if they were assembled into a three-dimensional block.

A1.5 Ground-penetrating Radar

Rectangles were laid out to fit the area to be surveyed, typically 25 m north-south, 30 m wide. The radar surveys started at the south-west corner with the first traverse heading north. Recording was set to 1 per 0.05 m spacing. The 500 MHz probe was used. Traverses were 1 m apart, and were recorded in a zigzag pattern. Alternate lines need to be reversed in direction in processing.

Areas subject to survey by radar are identified by the grid coordinates at the corners.

A2 South South-West Circle

A2.1 Magnetometer

Grids were extended up from Stone Close to the circle by EDM, and convenient stations were found at 800, 860 and 840, 860 towards the top of the field. Normal 20 m grids were laid out from these. There was considerable interference from iron objects and fences so the peripheries lay beyond magnetometer survey. Indeed, the four northern partial grids could not be done as they were typically only 6 m wide and terminated by an iron fence in the hedge. If the opportunity arises, these may be attempted later by walking east–west traverses and using the de-striping software to remove the influence of iron as much as possible.

The grids were surveyed as in Stone Close, starting in the south-west and traversing north. Readings were taken at 8 per metre, with traverses 0.5 m apart, giving 6400 readings per grid. A zigzag pattern was walked, but the Bartington download software automatically sorts this to parallel tracks. The grid pattern is shown in figure A.3. Note that in one version where all circles were combined on one plot, these six grids were re-numbered as 501 to 506.

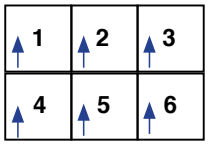

Figure A3 Magnetometry grid numbering at SSW Circle

A2.2 Magnetic Susceptibility

Grids, 6 metres square, were laid out and surveyed around selected stones in a pattern similar to that used in Stone Close.

A2.3 Twin Probe Resistance

This used the same grid as magnetometry, although not necessarily in the same order. The four northern partial grids were included, although the far north-east partial grid has not been included in the multi-colour plot.

Grids were started in the south-west, first traverse north, readings at 0.5 m along traverses, traverses 1 m apart, giving 800 readings per grid. The RM15 was used so the data are in zigzag configuration. The grid pattern is shown in figure A.4.

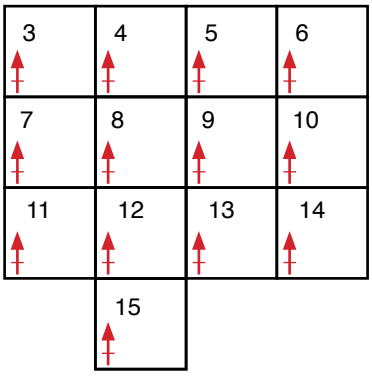

Figure A4 Twin-probe resistance grid numbering at SSW Circle

A2.4 Resistivity Profiles

A set of radial profiles was taken, centred on 816, 840 and these were joined to form a set of spokes, to gain an idea of the inner features of the circle. This was not very successful however, but individual profiles from this set are used where they provide useful data. Note one profile from ESE to WSW was corrupted beyond retrieval and cannot be included in the set. Other profiles were taken along grid lines. Any profile is identified by its start and end coordinates, or a three-dimensional block by its corner coordinates.

A2.5 Ground-penetrating Radar

An area was laid out for radar, 30 m wide, but the data in the last few runs were corrupted, so only 24 lines were good. The 500 MHz head was used, traverses zigzag and 1 m apart, readings 0.05 m spacing. The area is identified by the coordinates of the corners of the area of good data. The start is at the south-west corner.

A pair of traverses 38 m long was done just to the east of the main block as they could be fitted between stones. It was hoped to pick up the curving feature and help to identify it but the area was too narrow to give a good picture. This area is also identified by its corner coordinates.

A3 The Cove

Magnetometry in the Cove area was unsuccessful in 2009, so was not used further.

A3.1 Twin-probe Resistance

The 2009 grids were redefined and given new coordinates (see 2.2.3), and extended north into the pub's private garden. Because of the shape of the area, it was found best to start at the north-west corner, first traverse to the east, and this pattern was continued in 2010. As shrunken ropes had been used in 2009, they continued to be used in the private garden so that the grids matched each other dimensionally. Readings were taken at nominal 0.5 m intervals along a traverse, traverses 1 m apart, giving 800 readings per complete grid. The TR meter was used, walking a zigzag pattern, but this automatically sorts the data to parallel tracks. The grid pattern used is given in figure A.5.

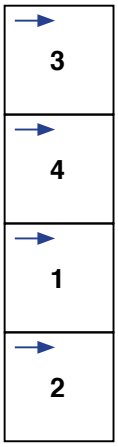

Figure A.5 Twin-probe resistance grid numbering at the Cove

The survey was extended into the churchyard, but a high stone wall separates the two and the two plots could not be connected in any useful way. These were therefore treated as a separate site but the outputs can be viewed together by overlaying the two sites on a map or aerial photograph.

Grids in the churchyard were laid out parallel to the wall, and it was found best to set the start at the south-west with the first traverse heading north. Readings were taken at 0.5 m on traverses, traverses 1 m apart, giving 800 readings per complete grid. The RM15 was used, so data are zigzag. Full length ropes were used for these measurements, so the lateral scale does not need to be adjusted. The grid layout is shown in figure A.6.

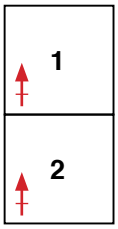

Figure A.6 Twin-probe resistance grid numbering in the churchyard

A3.2 Resistivity Profiles

A series of profiles were done with the probes at 0.5 m spacing, and lines 0.5 m apart, in order to derive detail of the high resistance patch immediately next to the stones. This covered the area 1007.5, 995; 1007.5, 980.5; 1002, 980.5; 1002, 995.
Profiles were also taken in the private garden at 1007N, 1010N, 1013N, 1016N, 1019N and 1022N, all starting at 1000E. A north-south profile was also taken at 1007.5E, from 1023N to 1007.5N.

A separate grid was set up in the churchyard (see 2.2.3). On the churchyard grid, the first profile ran from (1000, 999.6) to (1000, 1023.6) and the rest were parallel at 1 m intervals, so the last profile started at (1004, 999.6).

A3.3 Ground-penetrating Radar

A set of profiles were also taken in the public garden of the pub with the radar, using the 500 MHz head, readings 0.05 m along traverses, traverses zigzag, spaced 0.5 m apart. Using the pub garden grid, the area covered was defined by coordinates 1007.5, 1004; 1007.5, 980.5; 1000, 980.5; 1000, 1004.

A3.4 Magnetic Susceptibility

Magnetic Susceptibility readings were taken using the same grid as twin-probe resistance. All points were taken, even on baselines. In the pub gardens, that in the public garden was done in 2009 and used 0.5 m nominal readings on the shrunken ropes, traverses 1m apart. That in the private garden used readings 0.5 m nominal apart, traverses at 0.5 m.

That in the churchyard used readings on full length ropes 0.5 m apart, traverses at 0.5 m interval.

The three blocks have to be joined by overlay on map or aerial photograph, although the grids in pub private and public gardens are contiguous.

Appendix B Comparison of Dowsing with Magnetometry

Following publication in the local newspaper (Chew Valley Gazette 2009), Mr. Daw demonstrated his techniques and presented copies of his plans of various putative stone circles in the area to BACAS to allow comparison. These have been scanned or photographed so that they can be handled digitally and magnetometer results overlaid. During the course of the 2010 surveys, enough magnetometer data has been amassed to allow a sensible comparison.

Figure B.1 shows a comparison of inner detail within the main circle, with magnetometer results in green laid over the dowsing plan. Dimensions and orientation have been adjusted to give the best possible fit between the two plots as they did not overlay perfectly.

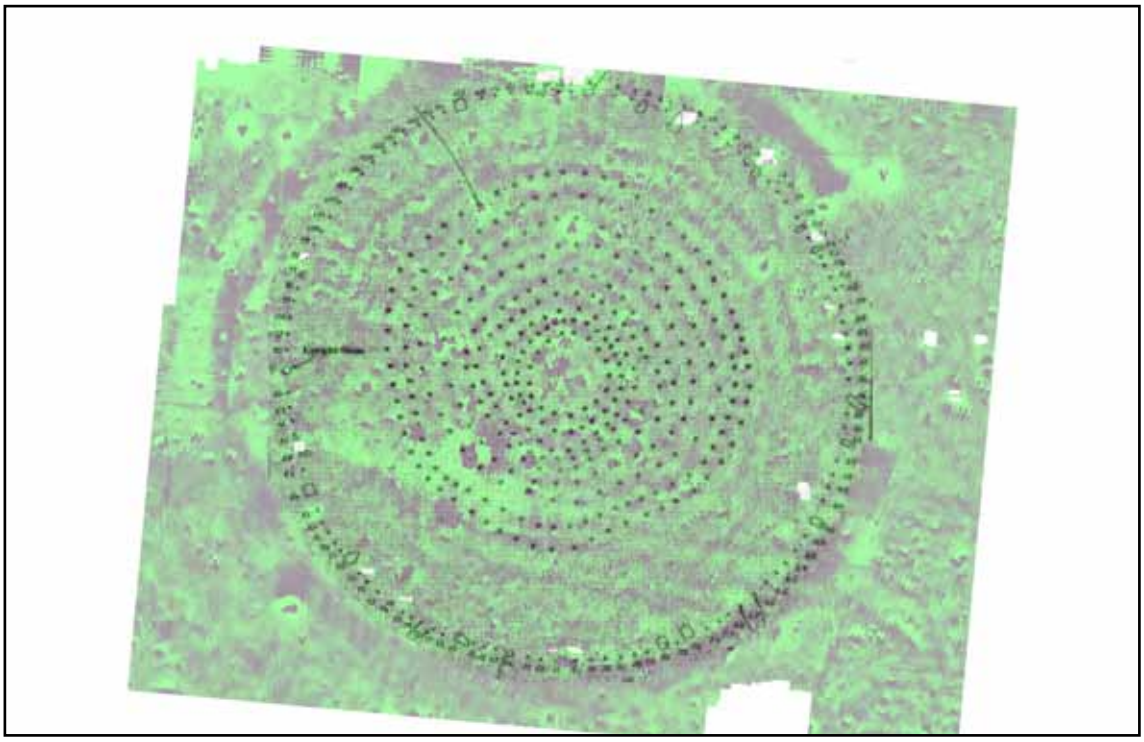

Figure B.1 Comparison of dowsing and magnetometry within the main circle.

Dowsing shows a continuous ring of closely spaced pairs of pits around the circumference of the stones. Magnetometry shows some features which may be pits around the circumference, but these are larger than, and not as frequent, as dowsing suggests. Dowsing shows a plain area at the centre, surrounded by nine rings of post pits with irregular spacing between them and a non-circular shape. Magnetometry shows a busy centre, possibly including a square post setting. Some signals may indicate other forms of disturbance such as metal or uprooted trees. It shows the post rings as circular and evenly spaced and extending well beyond those shown by dowsing. Ring 7 of magnetometry corresponds with ring 9 of dowsing. Both methods seem to show damage to the rings to the south-west of centre.

Figure B.2 shows a comparison of all stones and features in Stone Close. Again, it is a best fit between the two plans. Mr Daw's plan also extended east of Stone Close and suggested an avenue continuing towards the river. This area was not surveyed by BACAS, and indeed the earlier English Heritage survey (David et al 2004) showed much interference from metal pipes in that region. However, there is some corroborative evidence for a continuing avenue (Burl 2000: 149). The magnetometry survey showed significant activity just to the south-east of the main circle. It is not known whether Mr Daw surveyed this area in detail, but it does not show on the dowsing plan.

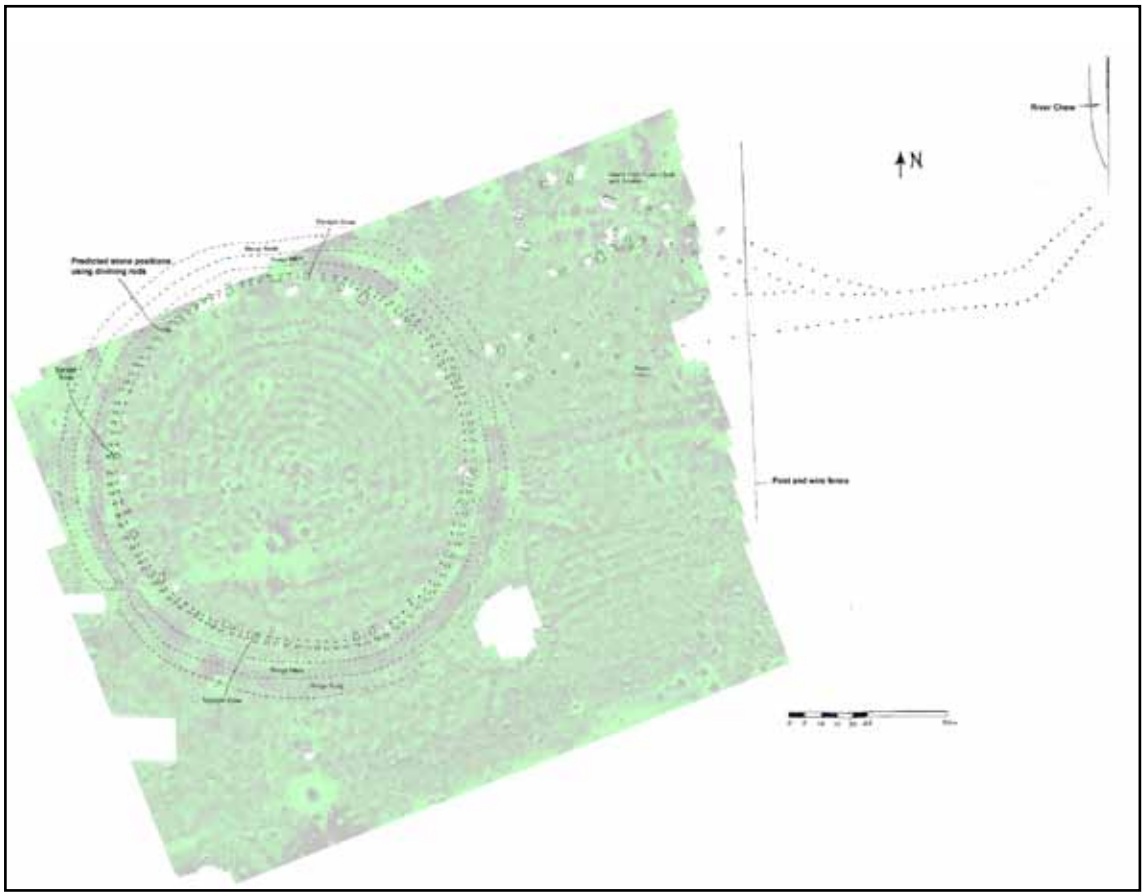

Figure B.2 Comparison of dowsing and magnetometry over Stone Close.

Dowsing shows a bank and ditch around the stones of the main circle. These are almost continuous apart from small gaps in the east and the south-west. Magnetometry indicates a wide ditch but cannot indicate a bank clearly, although it shows a few possible post holes within the area any bank would occupy. Magnetometry shows a complete break in the bank to the east, stretching from an alignment with the avenues past the line to the north-east circle, to a point in the north-east which is immediately opposite the south–western entrance shown by magnetometry. Note that the south-west entrance shown by dowsing does not show the same entrance as the magnetometry, but the point where a mediaeval track breaks through the ditch. However, it does not show the point in the south-east where the same track breaks out of the ditched area.

Figure B.3 shows a comparison of the South South-West Circle results. This uses the later version of the dowsing plot, which includes internal stake holes apparently not detected on the first try. Dowsing shows a continuous sub-circular ring of stone positions following within the circumference of the stone 'circle', and three concentric rings of stake holes, although these do not match those detected by magnetometry.

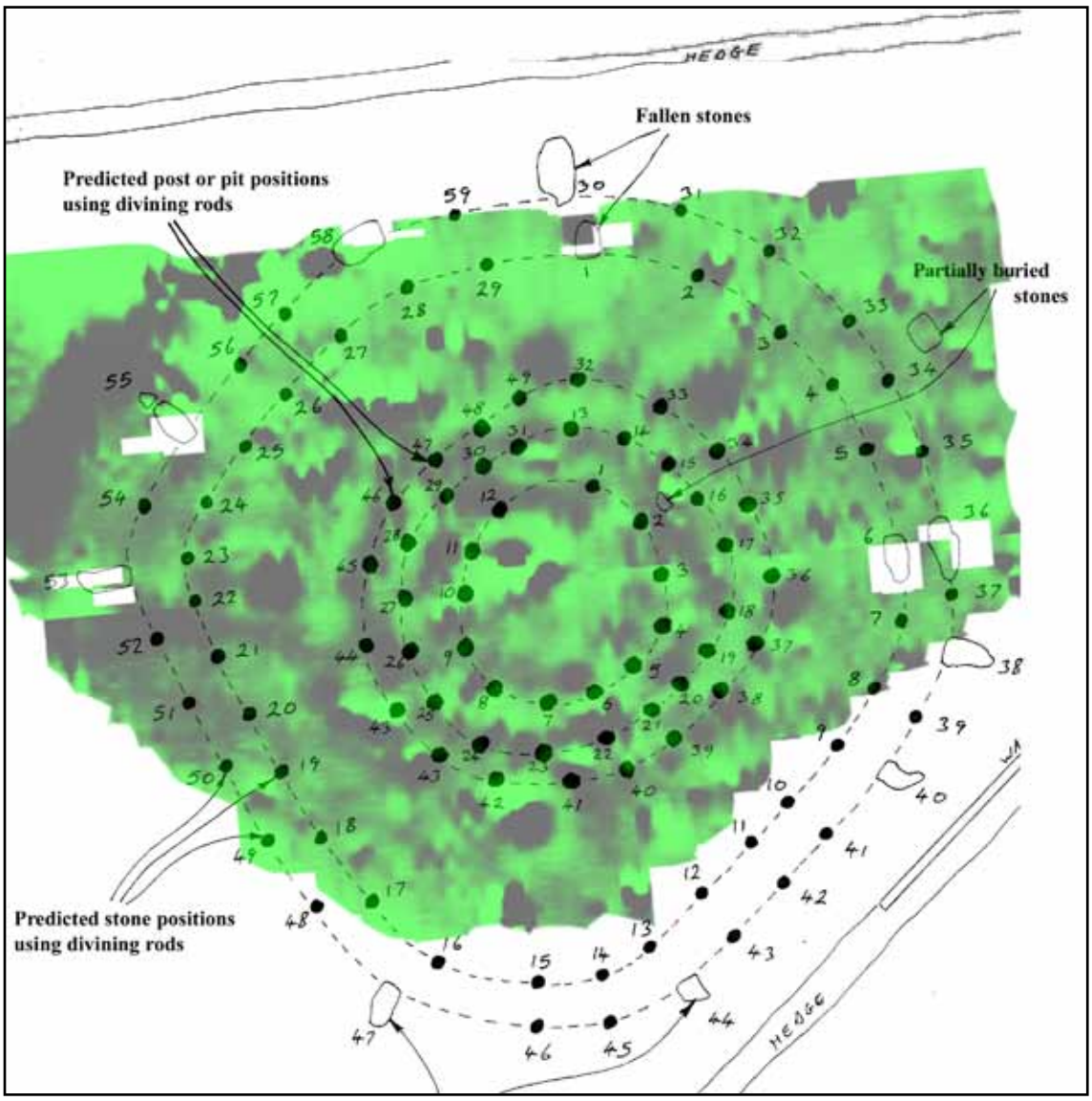

Figure B.3 Comparison of dowsing and magnetometry in the south south -west circle.

Geophysics, both magnetometry and resistance, has shown the circle to be much more complex, particularly inside. Magnetometry showed a central four-post structure and rings of post holes, and an external curving anomaly. The latter gives a ditch-like signal, but may well be wall footings as it also shows in resistance. All of these features were also observed by English Heritage (David et al 2004). It is therefore assumed that Mr Daw was aware of these features at the time of his survey.

Dowsing is not consistently detecting the same features as magnetometry. Mr Daw was reasonably thoroughgoing and rigorous in his survey, but appears to have managed only limited concurrence with the methodical high data density magnetometer survey. Dowsing may therefore be a first qualitative indication that there may be magnetic anomaly nearby, but it cannot be relied on as an alternative.