SENSYS Geophysical Survey on behalf of SERF: Preliminary Summary of Results

9-14 February 2015

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1. Introduction

A large area geophysical survey was undertaken by SENSYS in Febtruary 2015 using their MAGNETO®MX V3 system. The front cover of the report shows the MAGNETO®MX V3 in action at Leadketty.

The areas surveyed is shown at Figure 1, which included:

- Dunning Roman Temporary Camp: field south of Kincladie Wood;
- Wellhill;
- Leadketty cropmark complex: southern field;
- Leadketty (Baldinnies Farm) cropmark complex: northern field;
- Broomhill Roman Temporary Camp; and
- Forteviot cropmark complex.

A total of 51 hectares was surveyed.

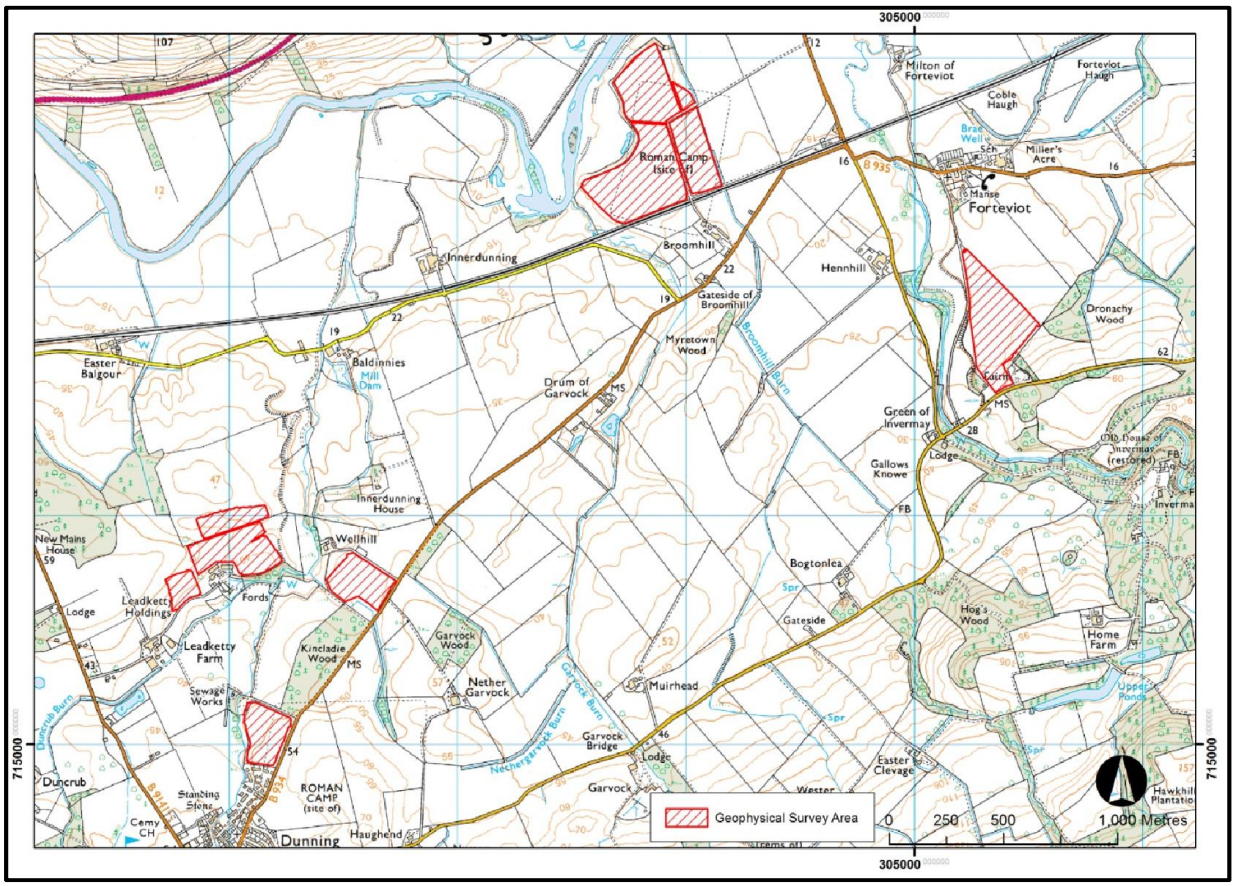

Figure 1: Areas covered by SENSYS geophysical survey.

2. Archaeological background

2.1 Dunning Roman Temporary Camp

The area targeted for the gradiometric survey was the field south of Kincladie Wood (Figure 1). Part of the Dunning Camp and other archaeological features are known from the cropmark record. SERF investigated a section of the ditch and bank within Kincladie Wood (Driscoll forthcoming), and the ditch at Pitcairns House (Campbell 2014) in 2014. The cropmarks are scheduled as an ancient monument.

2.2 Wellhill

Fieldwork was undertaken at Wellhill in 2014, which comprised of a targeted small area geophysics principally focusing on the known archaeology (cf. Wright 2014b), a programme of test-pitting in the vicinity of the pit alignment (cf. Wright 2014b); and excavation (cf. Wright 2014a).

The excavations revealed evidence of Early Neolithic, Late Neolithic and putative Bronze Age activities associated with farming settlement. In addition to the pit alignment, the features comprised of earlier linear field boundaries, ard marks, pits, stakeholes and postholes. A substantial assemblage of Early Neolithic and Late Neolithic pottery sherds was recovered from a number of the pits and postholes. The precise phasing of the events at Wellhill should be established following the completion of post-excavation tasks (Wright 2014a).

2.3 Leadketty cropmark complex

The cropmarks at Leadketty were initially recorded in 1970 by Cambridge University Collection of Aerial Photography 'CUCAP', and regular repeat flying since 1976 by Royal Commission on the Ancient and Historical Monuments of Scotland ' RCAHMS' has revealed a remarkable complex of cropmarks (Figure 2). Numerous aerial sorties have since been flown over the fields at Leadketty and Baldinnies. The fields are located on a ridge with a south-facing slope, on a terrace on the south side of the Earn valley. The complex consists of a range of sites which to date to the Neolithic and Bronze Age, although some elements are probably later prehistoric, perhaps even medieval. The cropmarks at Leadketty and Baldinnies have been scheduled as ancient monuments.

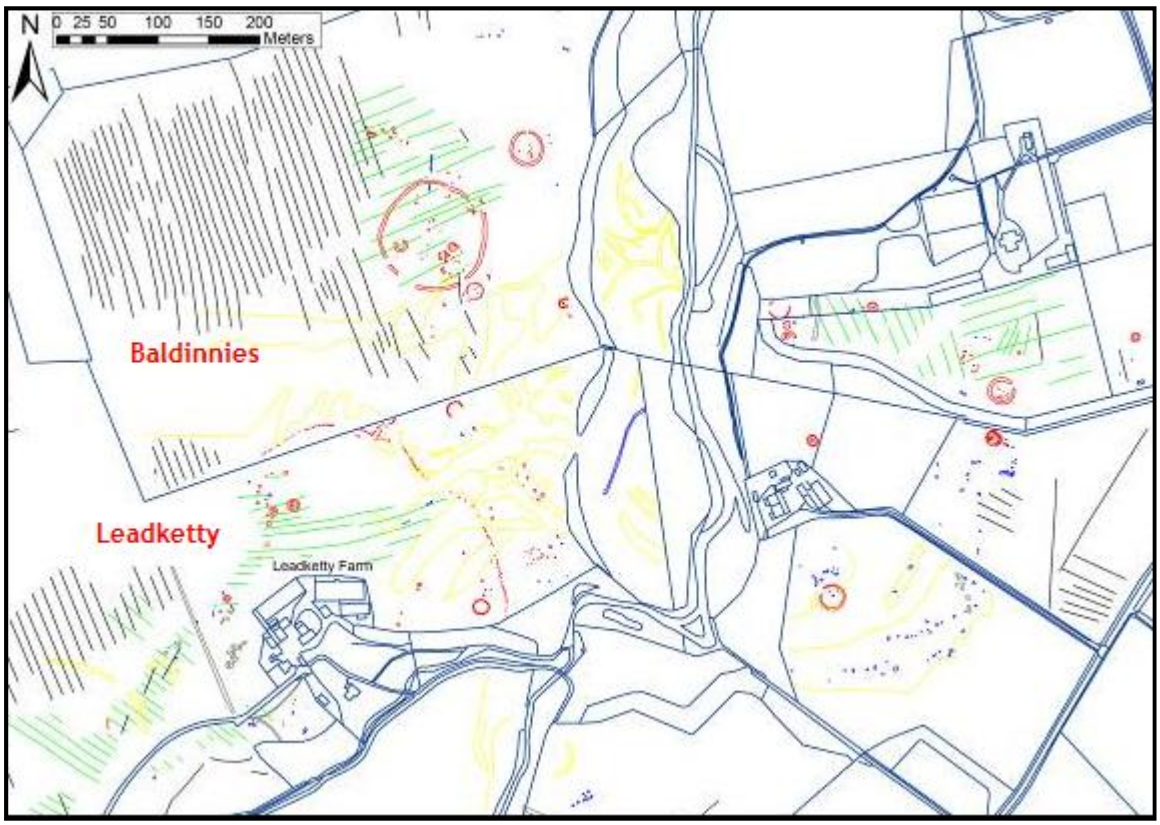

Figure 2: Transcription of an aerial photograph showing the cropmark complex at Leadketty and Baldinnies Farms (Brophy and Wright 2013). © Crown Copyright RCAHMS.

2.3.1 Leadketty: southern field

A fieldwalking programme in the 1990s organised by Perth Museum and Art Gallery 'PMAG' with Dunning Parish Historical Society included work at Leadketty. Finds included a transverse arrowhead located just to the east of the palisaded enclosure (NO01NW 131) and a small scatter of material including a flint core, flakes and quartz and agate in a field immediately south of Duncrub burn [NO01NW 155] (Hallyburton and Brown 2000; King 1993). Fieldwalking was also undertaken by a small group of Archaeology students from the University of Glasgow in the mid 2000s, with few objects found, and no indication of any clusters or concentrations of material.

In April 2012, a successful trial geophysical survey was undertaken by the SERF project [Figure 3] (cf. Maldonado and Brophy 2012). This aimed to clarify elements of the cropmark complex. Gradiometry and resistivity surveys were conducted at varying degrees of resolution and extent. This survey revealed a series of anomalies that confirmed the cropmark evidence, but suggested further features were likely to be present below the topsoil. However, some cropmark features,

such as the palisaded enclosure boundary, did not show as convincingly, or were absent.

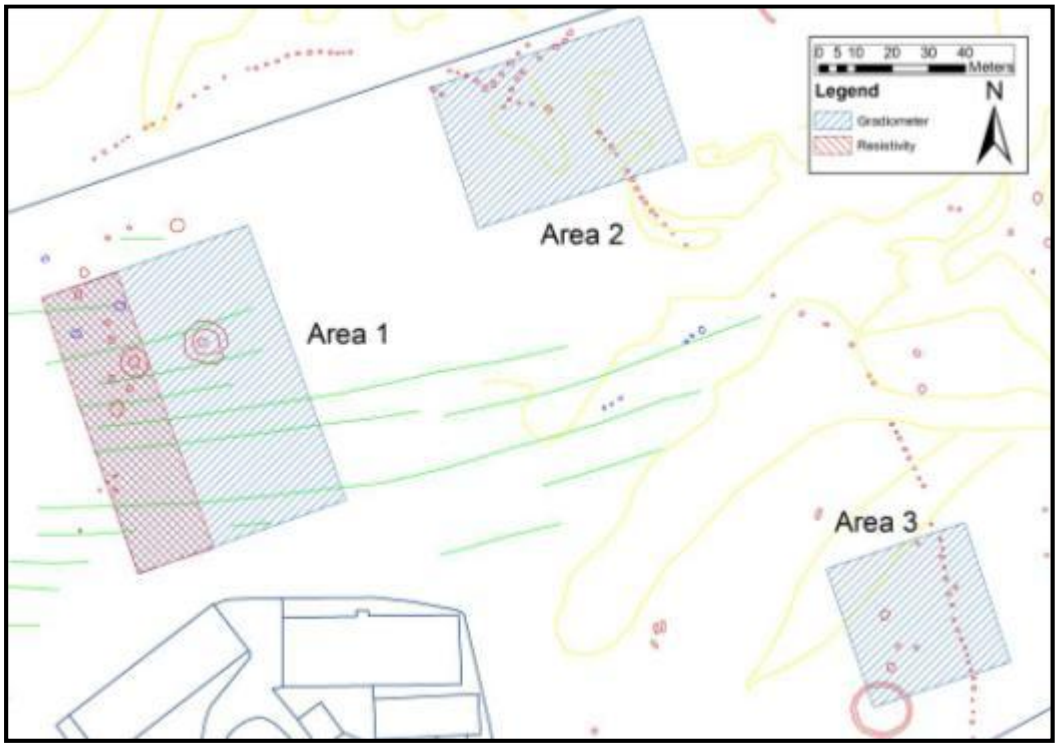

Figure 3: Plan of areas surveyed with overlain on RCAHMS cropmark transcription and Ordnance Survey map data (Maldonado and Brophy 2012).

Excavations as part of phase 2 of the SERF Project commenced in August 2012 with three trenches opened over the Leadketty cropmark complex, just north of Dunning and 4km to the west of Forteviot in Perth and Kinross (Figure 4). This complex of cropmarks has been recorded frequently since 1970 and consists of what appear to be late Neolithic and early Bronze Age monuments, including a palisaded enclosure, several mini-henges, pits, barrows, ring-ditches, and a putative causewayed enclosure. The focus in 2012 was the southerly part of this complex, with initial work focusing on comparable sites to those excavated at Forteviot previously (palisaded enclosure [LK12.3], mini-henge [LK12.2] as well as a four-poster structure [LK12.1] (cf. Brophy *et al.* 2012).

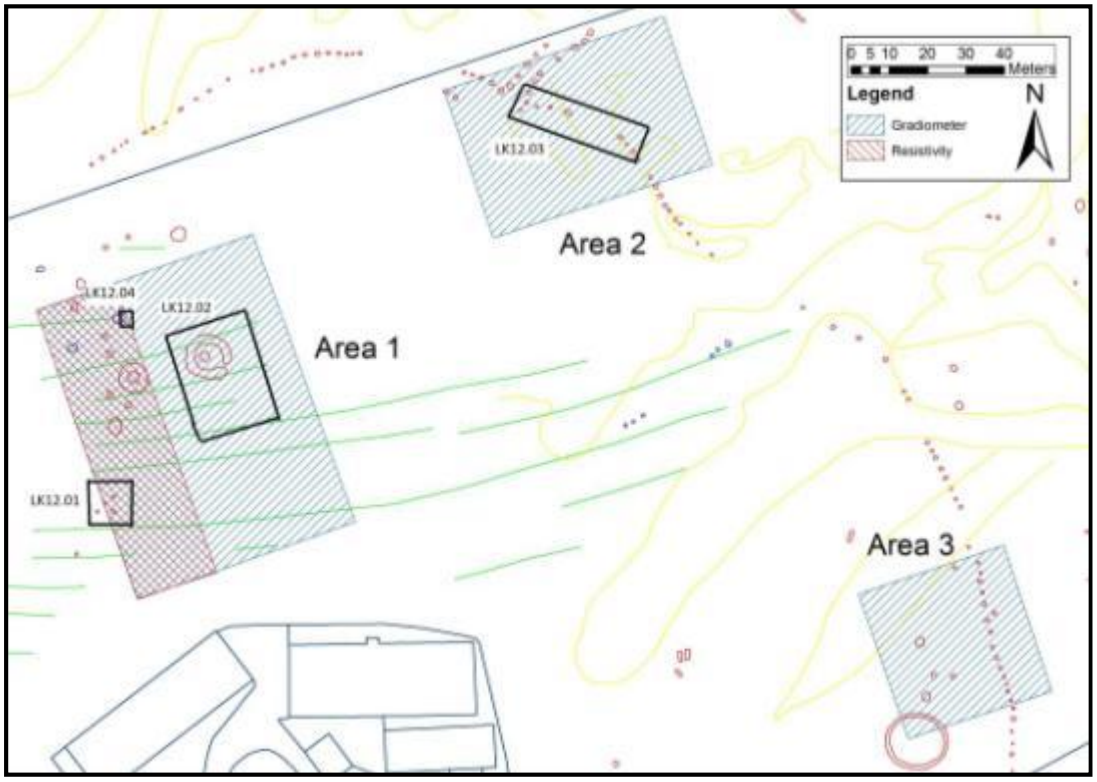

Figure 4: 2012 trench locations in relation to the cropmarks and the areas covered by geophysical survey (Brophy *et al*. 2012).

2.3.2 Leadketty: northern field (Baldinnies Farm)

Neolithic pottery was recovered during the fieldwalking organised by PMAG in the 1990s (King 1993). Fieldwalking over a small area of approximately 7000m^2 of the field at Baldinnies was carried out in March 2013. There was a paucity of finds which included a flint scraper and a flint blade (cf. Wright 2013).

In April 2013, a geophysical survey was undertaken by the SERF project (cf. Poller 2013) over and around the causewayed enclosure. As in 2012 at the southern field, the survey sought to clarify elements of the cropmark complex. Gradiometry and resistivity surveys were conducted at varying degrees of resolution and extent. This survey revealed a series of anomalies that confirmed the cropmark evidence, but suggested further features were likely to be present below the topsoil. However, some cropmark features did not show as convincingly, or were absent (Figure 5).

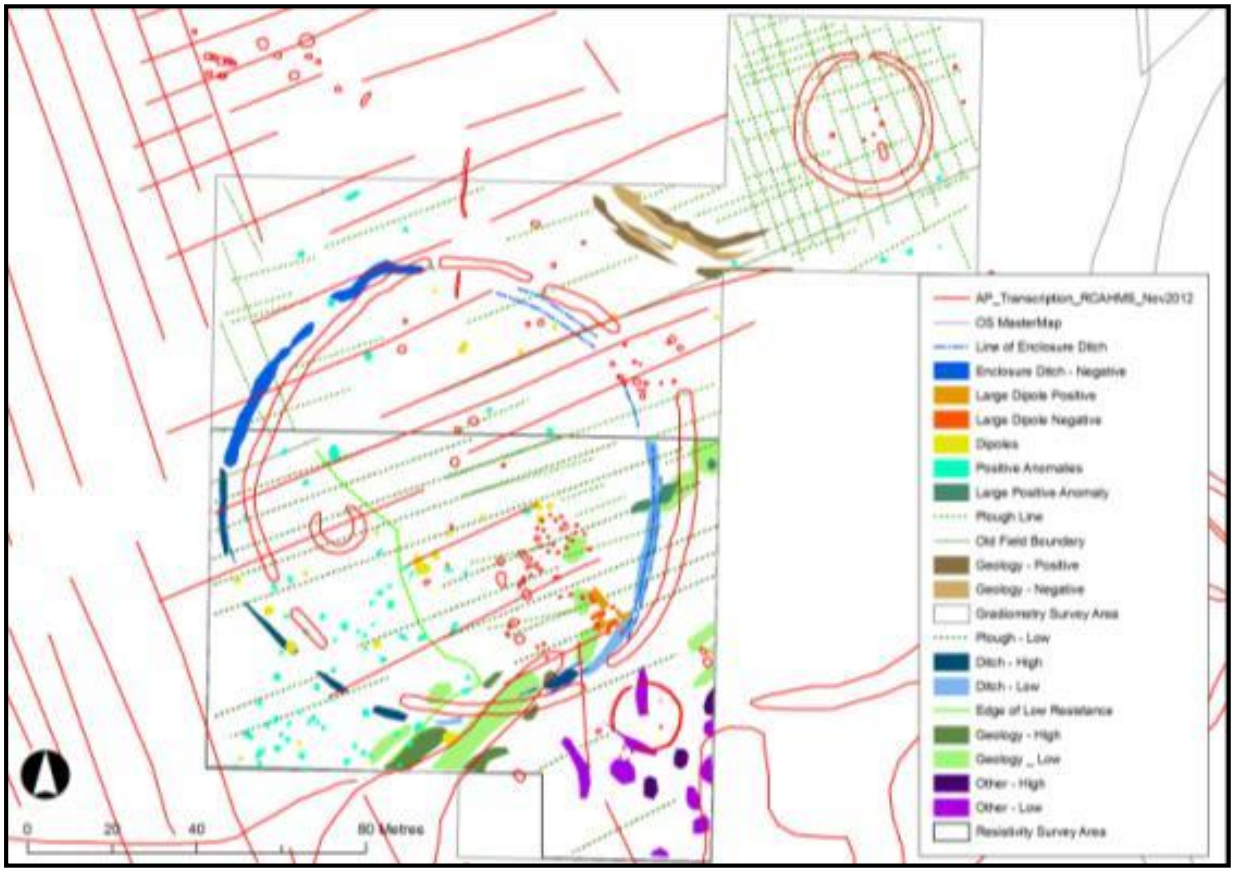

Figure 5: Interpretation of gradiometric and resistivity data overlain with aerial photographic transcription [RCAHMS] (Poller 2013).

The focus for the SERF excavations in 2013 was the putative causewayed enclosure immediately to the north of the late Neolithic complex that we investigated in the summer of 2012. The excavations were inconclusive, although we were able to shed light on the nature of the features causing the cropmarks, and identified multiple features that had not previously been recorded. It is hoped post-excavation analysis will provide a chronology for what we found, and offer a better understanding of this enigmatic enclosure (cf. Brophy and Wright 2013).

2.4 Broomhill Roman Temporary Camp

The Broomhill Roman Camp and other archaeological features are known from the cropmark record (Figure 6).

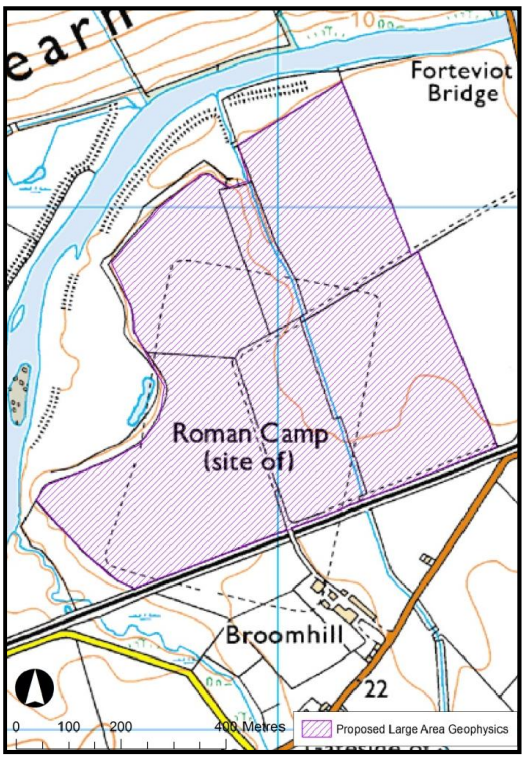

Figure 6: Map showing extent of Broomhill Roman Temporary Camp to be surveyed.

2.5 Forteviot

A targeted gradiometric survey was undertaken in 2010 (Figure 7). It was completed in three stages to:

- record the geophysical response of the cropmark features;
- identify potential archaeological features not identified in the cropmarks;
- more accurately identify the location of the trenches;
- valuate gradiometric responses;
- identify potential archaeological features not identified in the cropmarks, exploring the archaeological potential,
- record the geophysical responses of small features, such as post-holes, identified as cropmarks,
- further evaluate gradiometric responses (cf. Poller 2010).

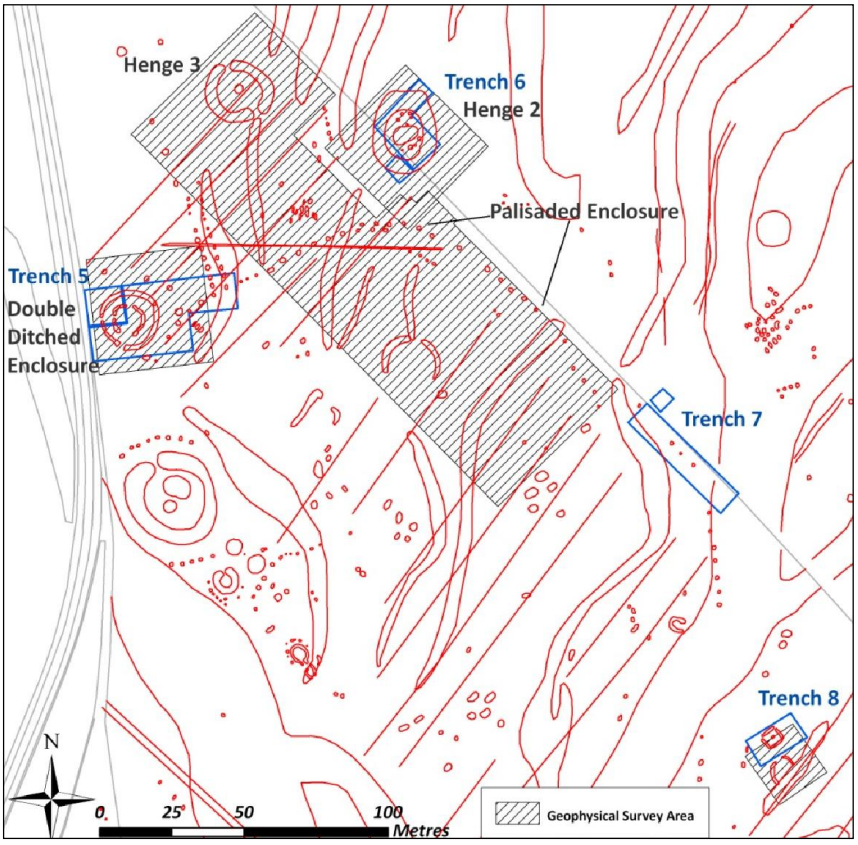

Figure 7: Location of Geophysical Survey in relation to Excavation Trenches and Aerial Transcription of Features © Crown Copyright RCAHMS [spatially readjusted by SERF based on excavation results] (Poller 2010).

Excavations were undertaken each year from 2007 to 2010 (Figure 8). They comprised of investigations of the:

- entrance avenue of the palisaded enclosure (cf. Noble and Brophy 2007);
- henge monument and timber circle (cf. Noble and Brophy 2008);
- henge and cist burial (Brophy and Noble 2009);
- double enclosure complex (cf. James and Gondek 2010);
- palisaded enclosure [adjacent to double enclosure] (cf. Gould 2010);
- multi-phase ceremonial monument [henge 2] (cf. Brophy and Noble 2010);
- western boundary of the palisaded enclosure (cf. MacIver 2010); and
- Pictish cemetery (cf. Campbell 2010).

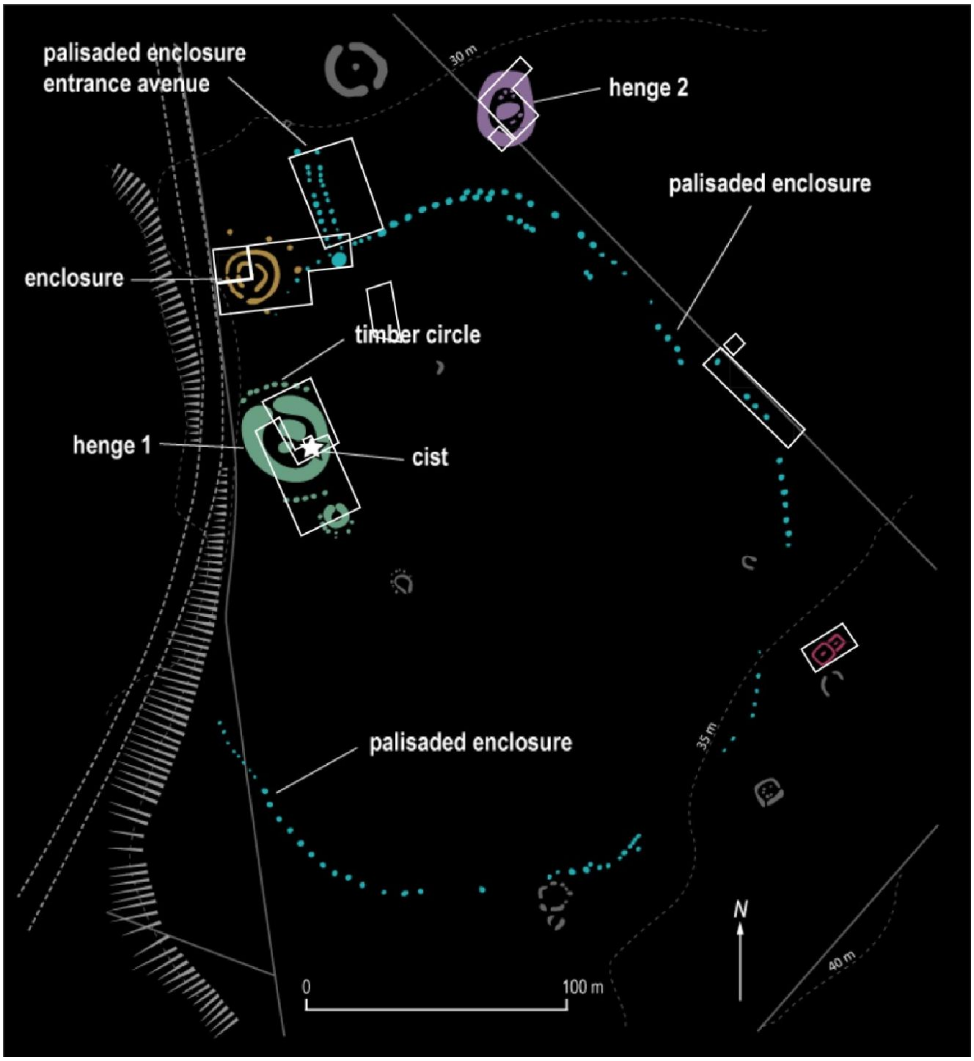

Figure 8: Transcription of sites at Forteviot from aerial photograph and location of trenches for excavations 2007-10, inclusive.

3. Aims and objectives

The specific aims of the SENSYS geophysical survey are to:

- establish the magnetic character of the known archaeological features;
- compare the results to the small scale targeted surveys undertaken previously;
- compare the advantages of a gradiometric survey over the cropmark record;
- determine if there are any archaeological features which are unknown in the cropmark record;
- locate activity areas within the Roman Camps, e.g. ovens as possible targets for future excavations; and

- characterise the edges of ditches of the Roman Camps.

4. Methodology

The MAGNETO®MX V3 system consists of a wheeled adjustable trailer, which accommodates the multiple magnetic survey probes with up to 16 gradiometers; maximum width 3.85m and a GPS (global positioning system) to locate the survey readings. The trailer was attached to a quad bike (maximum length 4.50m) and pulled across the area to be surveyed. This is a rapid non-invasive survey system, meaning no part of the equipment is inserted into the ground and that it is designed to cause minimum disturbance.

The location of the readings would be recorded using an on-board GPS system with a base station set up next to the survey area.

5. Data processing methodology

SENSYS technical staff processed the data and delivered the results to SERF as processed greyscale TIFF images. These images were georeferenced to the OS grid. The data was filtered and processed through MatLab and then imported into dedicated MAGNETO software for georeferencing and interpolation. The grid distance was 200mm.

The data processing consisted on the following steps:

- All areas were checked and the co-ordinates were corrected. The median was moved within a window size of 1000 samples.
- Broomhill, Forteviot and Wellhill fields: Some tracks of data (channel numbers 1, 2, 15, 16) were removed because data overlapped with adjacent tracks.
- Dunning Roman Temporary Camp: Data of channel 13 had been removed due to a defective cabling of that sensor that day.
- Leadketty southern field (large area): Some tracks of data (channel numbers 1 and16) were removed because data overlapped with adjacent tracks.
- Leadketty southern field (small area): Some tracks of data (channel numbers 1, 2, 15 and 16) were removed because data overlapped with adjacent tracks. Data of channel 13 had been removed due to a defective cabling of that sensor that day.
- Leadketty northern field (Baldinnies Farm): All data had been removed except the data from channel numbers 3, 7 and 13 due to the bad conditions of the field and the data from other sensors turned were unusable.

6. Preliminary results

6.1 Dunning Roman Temporary Camp

The ditch of the Roman Temporary Camp is visible as a subtle magnetic linear feature, about 2.5m wide, running approximately north to south across the survey area. This feature corresponds well with the cropmark recorded on aerial photographs. Bands of slightly positive magnetism to the east of the ditch, running from the NNE to the SSW, are likely the traces of a palaeochannel, also visible on the aerial photographs. A very narrow positive linear anomaly just to the east of this is likely to be the remains of an old fence line. Another narrow linear anomaly towards the W of the survey area, aligned roughly north to south, may also be an old fence line (Figures 9 and 10).

Throughout the survey area there is a scattering of strong magnetic anomalies, many of which may be igneous stone or metallic objects. Towards the north-west corner of the survey area a concentration of strong magnetic anomalies increase and reflects buried rubbish, i.e. part of an old village dump.

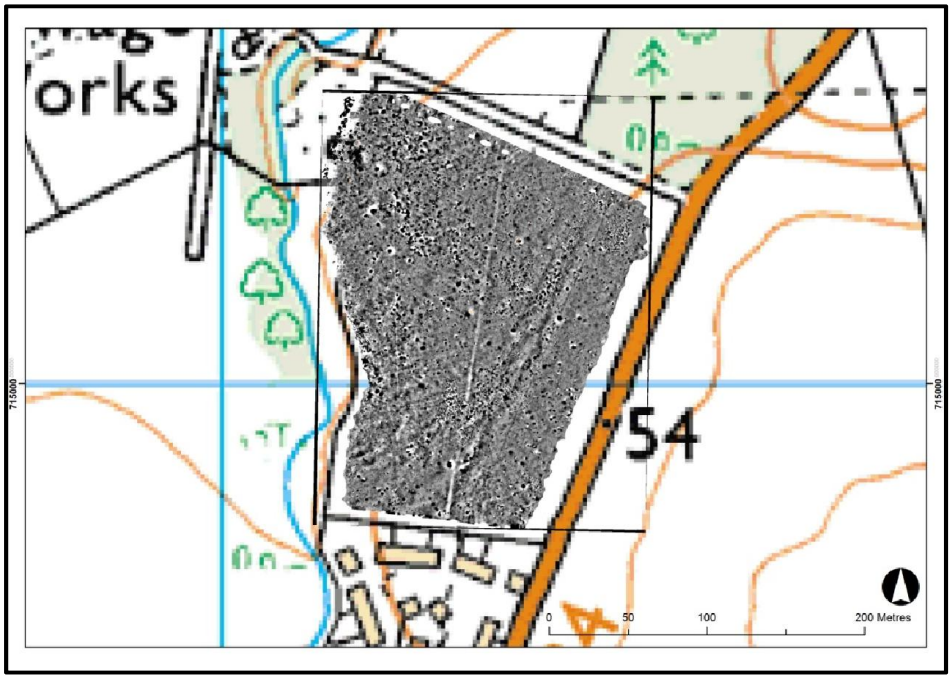

Figure 9: Results of geophysical survey after initial processing of raw data.

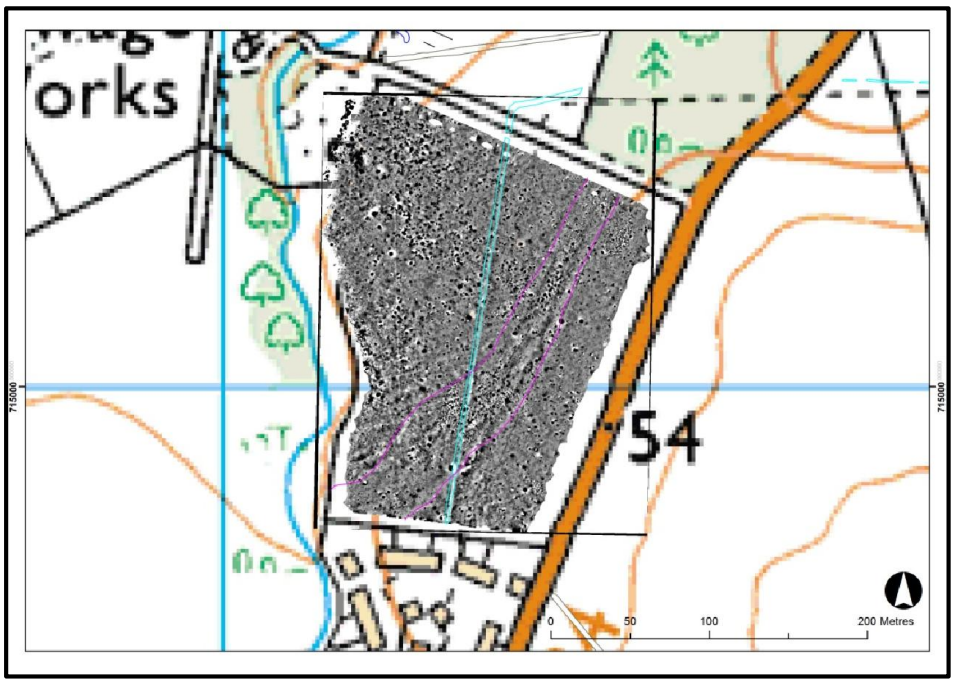

Figure 10: Results of geophysical survey after initial processing of raw data with aerial photograph transcription.

6.2 Wellhill

The results of this survey show a change in the underlying geology. About 75m west of the B934 there is a linear feature with diffuse edges. To the west of this line the general character of the field is more magnetically 'noisy', with some very strong anomalies. Many of these anomalies will be from deposits of gravels and stone within this area, different from the more neutral background readings of the area to the west.

A narrow positive linear anomaly, 50m in length, stretching from the bend in the southern end of the field may be the remains of a drain or a modern agricultural feature. Roughly 10m to the north-east of this linear anomaly is a strong magnetic curvilinear feature, which may have archaeological significance.

Throughout the west part of the field the trenches excavated by SERF in 2014 are visible as rectangles with negative magnetic edges. To the north-west of trench WH14.2 there are several magnetic dipoles, perhaps igneous stone or iron objects (Figures 10 and 11).

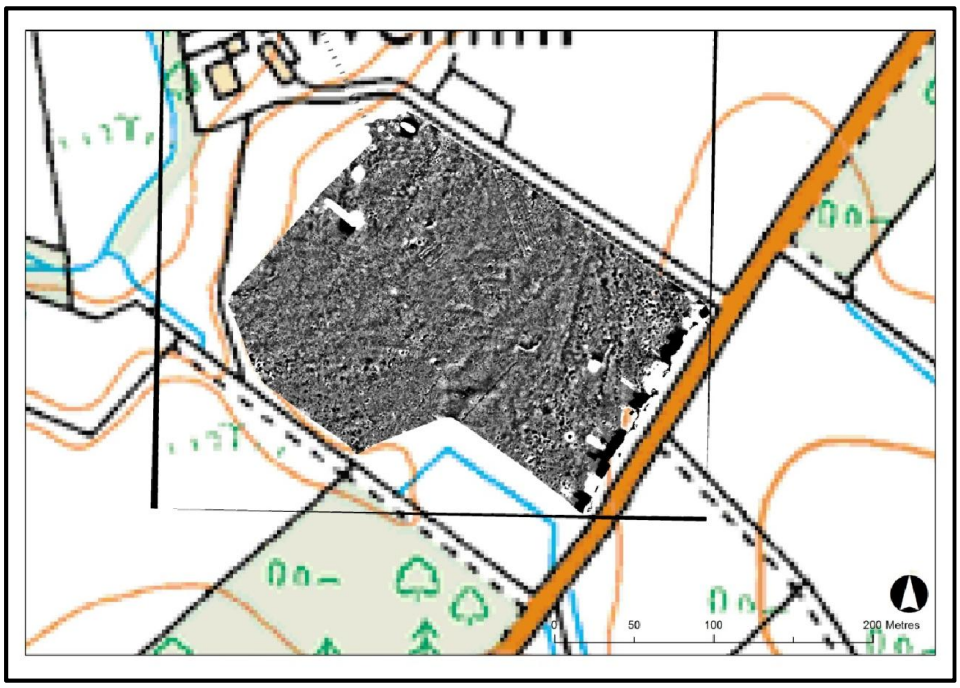

Figure 11: Results of geophysical survey after initial processing of raw data.

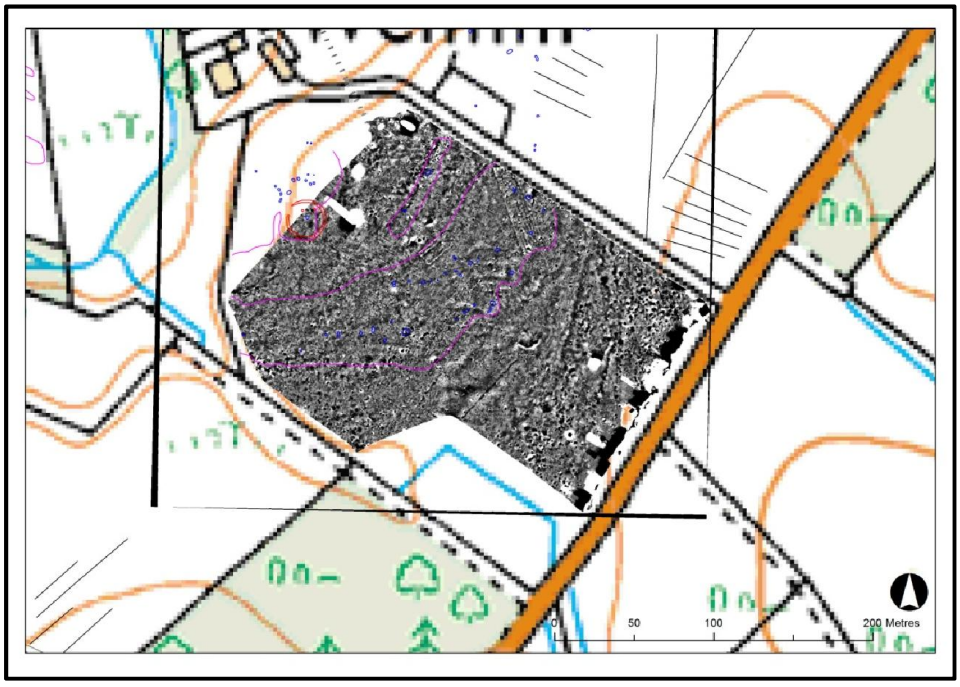

Figure 12: Results of geophysical survey after initial processing of raw data with aerial photograph transcription.

6.3 Leadketty southern field

Two areas were surveyed in the southern field of Leadketty (Figures 13 and 14).

In the large area there is a 4m wide positive curvilinear anomaly in the north-east corner. This feature runs into a big gully and corresponds to an underlying watercourse. To the north-east of this feature there are several large positive circular anomalies, varying in size from 4m to 1m in diameter, which may be of archaeological significance. In this area there is also are two strong positive and negative features on either side of the gully, which may be a highly ferrous objects or igneous stone excavated from the gully.

No anomalies could be discerned to directly correspond to the large palisaded enclosure identified on aerial photographs. The henge and circular enclosure in the centre of the palisaded enclosure are situated within an area of distinct magnetism, with some clear edges but the individual monuments are not distinguishable.

In the southern end of the survey area there is an incomplete circular feature of positive magnetism 12m in diameter within a ditch varying in width from 0.7m to 1.0m.

In the north-west corner of the large survey area and the northern end of the smaller survey area the general character of the results is magnetically 'noisier', with scattered readings of discrete anomalies. These readings correspond to a change of topography and perhaps reflect a stonier geology.

In the eastern end of the smaller survey area is a response that is composed of positive and negative readings generally forming a circular feature. This may be of archaeological significance.

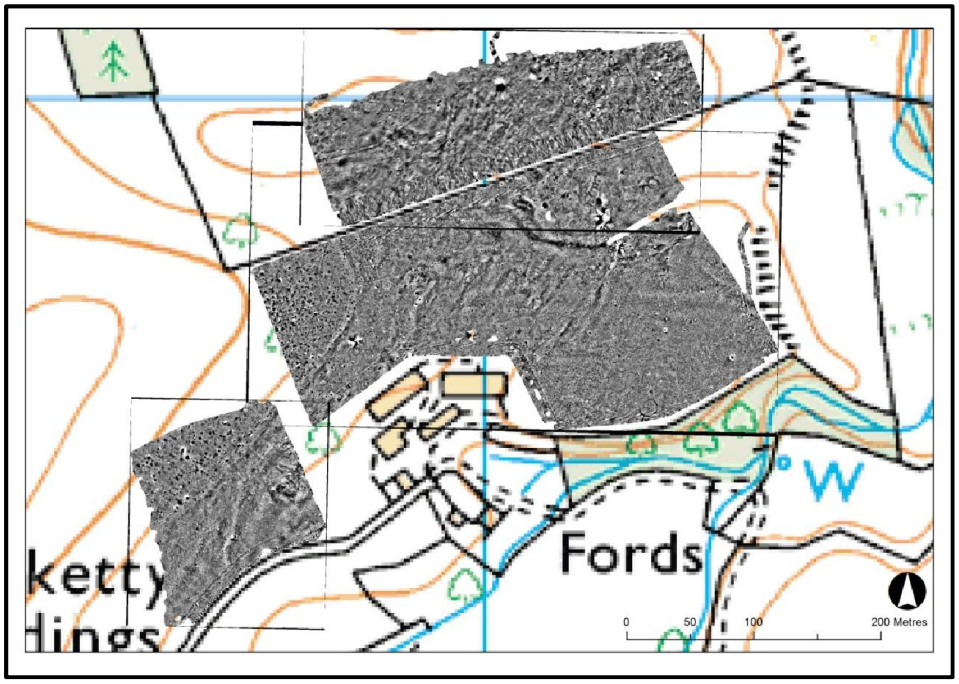

Figure 13: Results of geophysical survey of the southern and northern fields at Leadketty after initial processing of raw data.

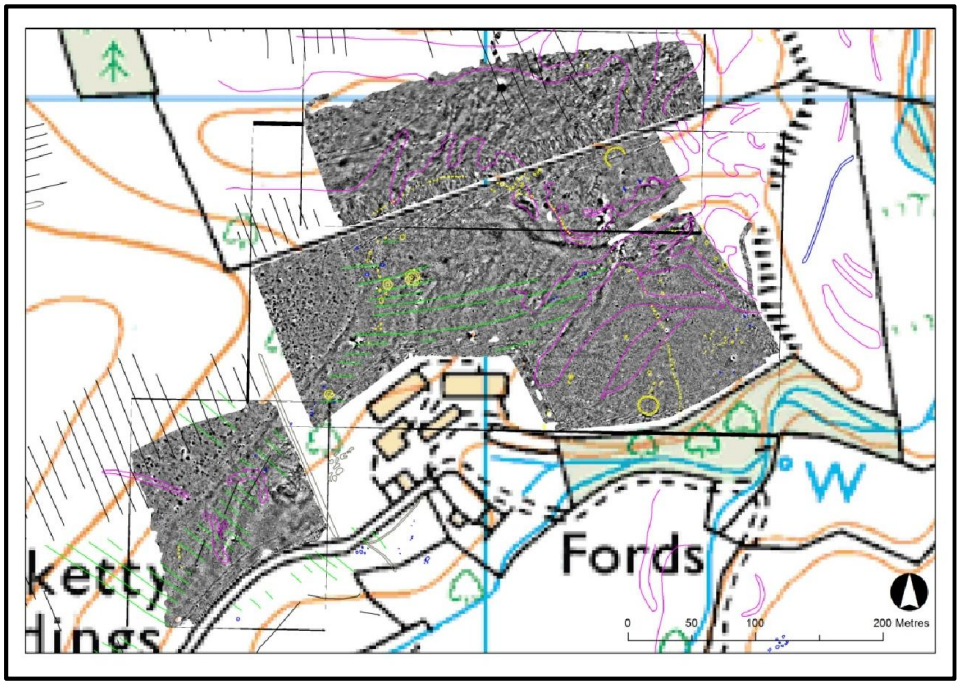

Figure 14: Results of geophysical survey of the southern and northern fields at Leadketty after initial processing of raw data with aerial photograph transcription.

6.4 Leadketty northern field (Baldinnies Farm)

The survey of the northern field at Leadketty was halted when it was clear the freshly ploughed surface was causing difficulties in acquiring the data (Figures 13 and 14).

Nonetheless, the results that could be used showed an angled linear feature, comprised of two parallel lines. This may be the remains of an old fence line or agricultural feature.

Two positive circular features with the survey are may be pits or geological features. A large dipole within the centre of the survey area is likely an iron object or igneous stone.

6.5 Broomhill Roman Temporary Camp

The survey of the Broomhill Roman temporary camp covered four separate fields. The results of the survey highlight the remains of a once dynamic palaeo-fluvial environment of the Earn. Curvilinear and sinuous bands that criss-cross the fields are the remains of palaeo-channels.

The ditch of the temporary camp was largely defined by a narrow negative band, approximately 2m in width. The ditch does not appear continuous within the survey area. At several points the ditch was not clearly discernible across or within the course of palaeochannels. The north-west corner of the Roman Temporary Camp is characterised by a more positive band of magnetism.

Within this NW area and also in the south-west corner there are narrow irregular linear features of negative magnetism that cross the ditch of the Roman Temporary Camp. Some of the smaller linear features relate to frost shattering or fluvial activity and are geological, but the wider features may be routeways or other dug features from unknown time periods.

In the south-west corner of the survey area there are two very strong magnetic features (about 100m apart). There are two further similar strong magnetic anomalies to the NNE. These features are roughly regularly spaced and may have archaeological significance, perhaps reflecting either a metal deposit or perhaps even metalworking areas (Figures 15 and 16).

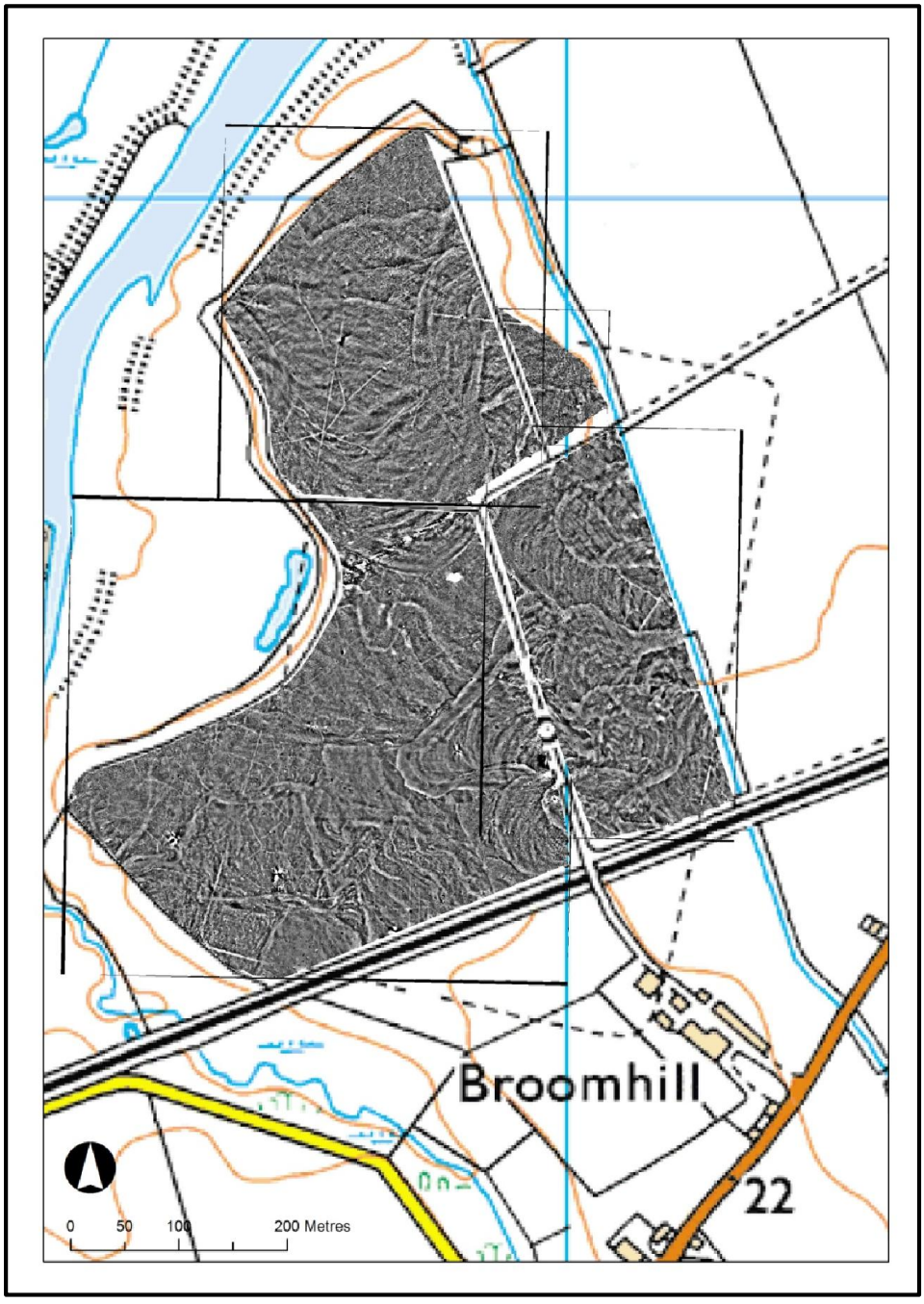

Figure 15: Results of geophysical survey after initial processing of raw data.

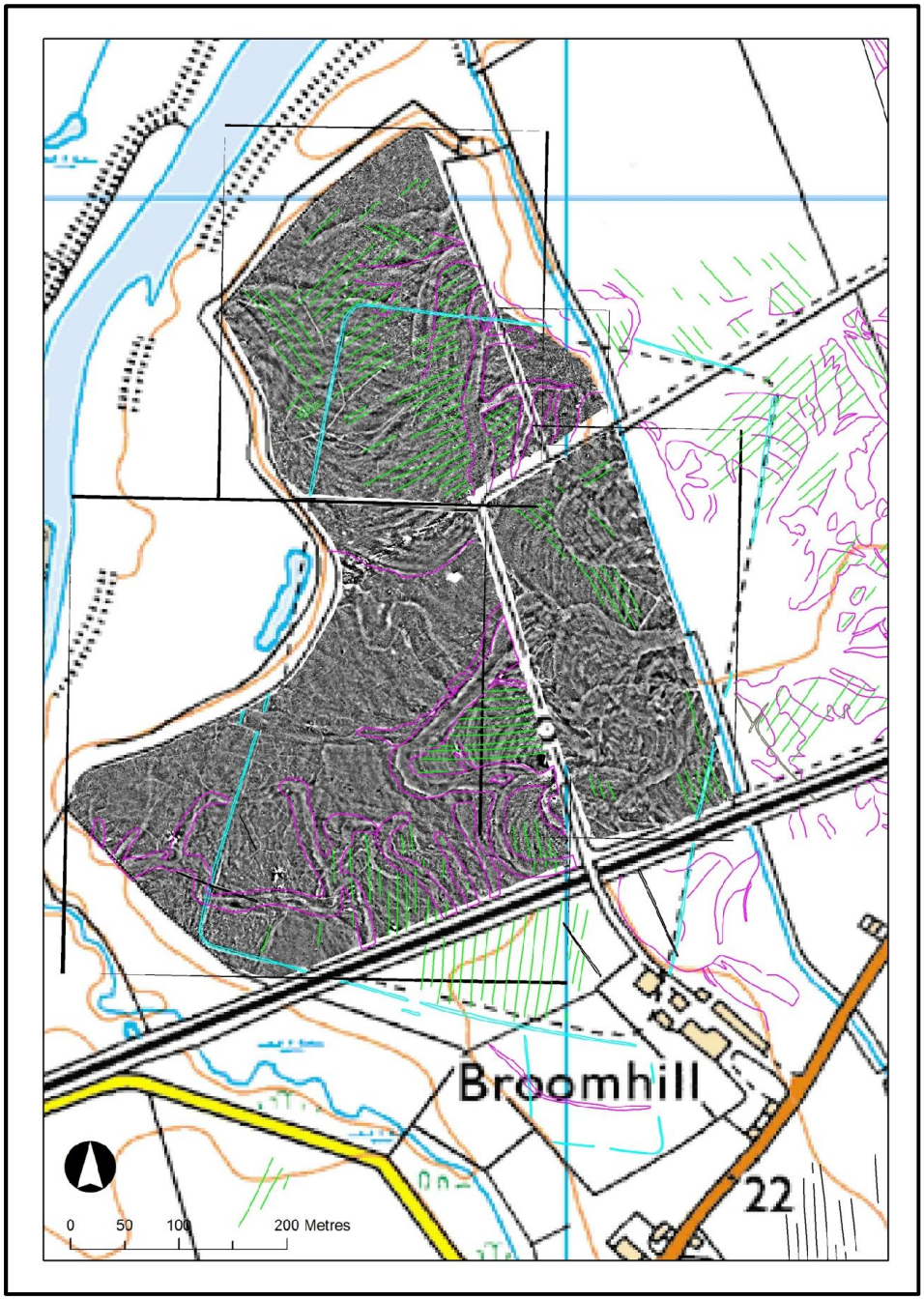

Figure 16: Results of geophysical survey after initial processing of raw data with aerial photograph transcription.

6.6 Forteviot

The large prehistoric enclosures and henges identified on the aerial photographs are visible on the results of this survey. The ditch and a central feature within the henge in the northern end of the field appear clearly as negative magnetic anomalies. The double enclosure is visible as a single ditch with the igneous stone

producing a strong positive response. The large henge to the south of this has a more variable response, perhaps reflecting the stony infill of the upper layers and backfill disturbance from excavation. The mini-henge has a negative magnetic signature.

Surrounding the large henge, and perhaps in alignment with the igneous stone in the double enclosure, there is a roughly curvilinear arrangement of discrete strong magnetic anomalies. These may be settings of igneous stones or metallic objects. Three further strong magnetic anomalies are recorded towards the south-west corner of the field.

In the extreme southern end, near the quarry, the responses are very strong and variable, probably reflecting igneous stone near the ground surface. The subtle undulating linear feature in the south-west corner of the survey area corresponds to the base of the slope and change in geology (Figures 17 and 18).

Figure 17: Results of geophysical survey after initial processing of raw data.

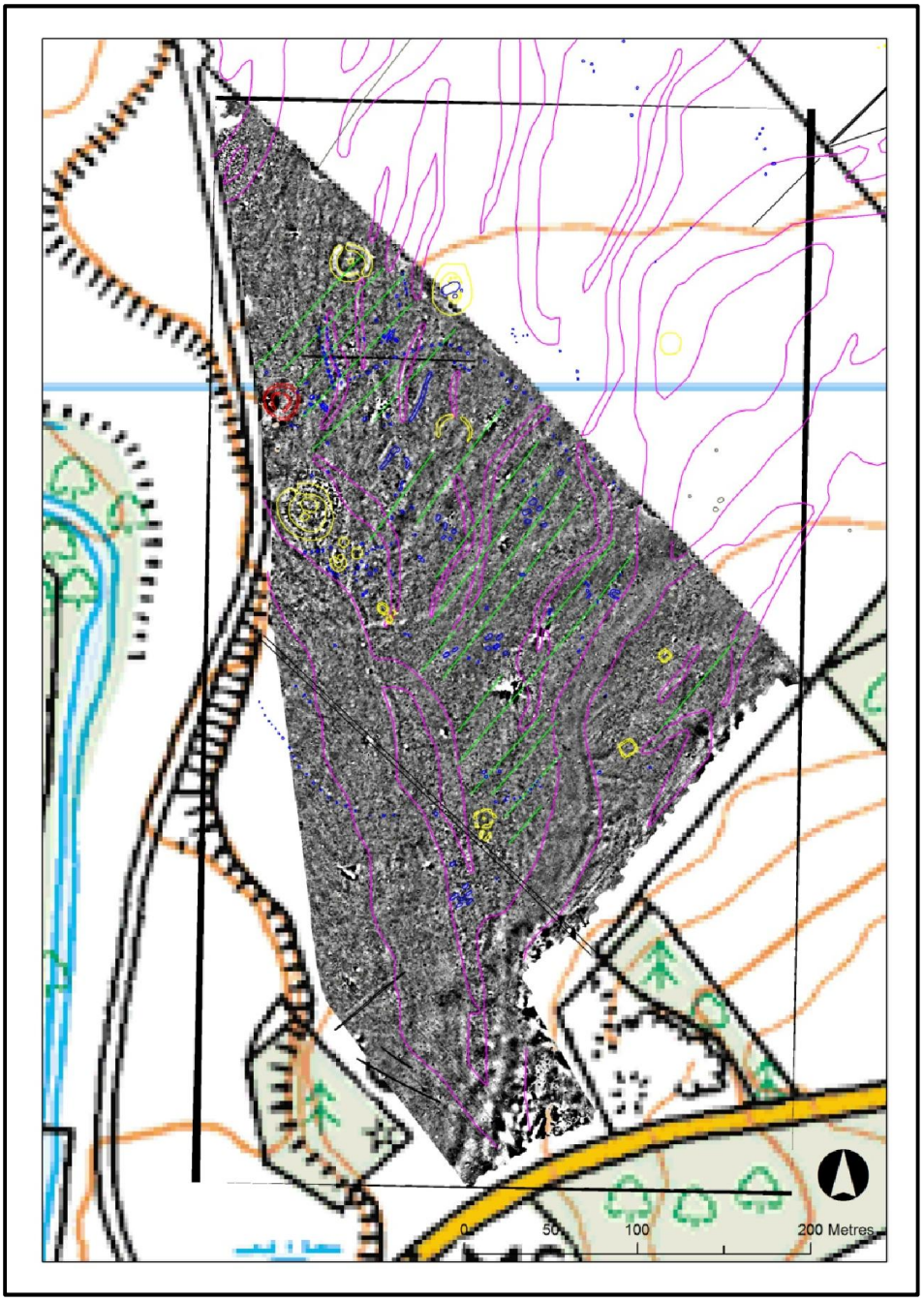

Figure 18: Results of geophysical survey after initial processing of raw data with aerial photograph transcription.

Summary

Consistent with the results from other surveys conducted at Forteviot and Leadketty, archaeological features are generally difficult to distinguish from the geological background readings. Furthermore, all of the fields surveyed have been

heavily ploughed. Plough lines are visible throughout all the survey areas and therefore the archaeological features have been greatly disturbed.

Fully detailed reports on the SENSYS geophysical survey will be prepared for publication in the respective SERF monographs.

Acknowledgements

Thank you to Gert Petersen and Gorden Konieczek of SENSYS, also special mention must be made of Ian Phillips whose help with the logistics of moving the MAGNETO®MX V3 from location to location was simply incalculable. Profound thanks must go to Oliver Lewis and the SMC team at Historic Scotland who managed to turn around five project designs and SMC applications in short order.

Finally, many thanks must go to the landowners, namely Alexander Dewar, Gavin Drummond, Simon Howie, Colin MacGregor, Stuart McLaren and David Myles for their support of the SERF Project, and their gracious permission to allow us to undertake the survey.

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