ARCHAEOLOGICAL
SERVICES
DURHAM UNIVERSITY

on behalf of

Friends of Nine Standards

Nine Standards
Kirkby Stephen
Cumbria

geophysical survey

report 2963
July 2012

Durham University

Contents

Figures

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1. Summary

The project

1.1 This report presents the results of a geophysical survey conducted at the Nine Standards near Kirkby Stephen in Cumbria. The works comprised approximately 1ha of geomagnetic survey.

1.2 The works were commissioned by the Friends of Nine Standards and conducted by Archaeological Services Durham University.

Results

1.3 There is very little variation within the geomagnetic data and very few anomalies have been detected.

1.4 Of the anomalies detected, the small strong ones probably reflect broken parts of ferrous quarry tools, while the very weak linear anomalies are considered more likely to reflect narrow cracks in the rockhead than cut archaeological features.

1.5 No features of likely archaeological significance have been identified.

1.6 Given the results of this survey, and the unsuitability of the ground surface for some other techniques, no further geophysical survey is recommended.

2. Project background

Location (Figures 1 & 2)

2.1 The study area comprised land at the Nine Standards, located high on a pennine ridge about 5km south-east of Kirkby Stephen in Cumbria (NGR centre: NY 82488 06554). The Nine Standards comprise a row of nine drystone cairns of various shapes and sizes, some of which were rebuilt in 2005, situated just north of the summit of Nine Standard Rigg.

2.2 One geomagnetic survey of approximately 130m by 60m was undertaken, covering the cairns and their immediate environs.

1. Nine Standards, looking north-east

Research proposal

2.3 The Friends of Nine Standards (FONS) are conducting ongoing research into the cairns, specifically investigating their history, setting and purpose. This survey contributes to that research.

Objective

2.4 The principal aim of this survey was to assess the nature and extent of any sub-surface features of potential archaeological or historic significance within the study area, particularly any features that might be associated with the cairns.

Methods statement

2.5 The surveys have been undertaken in accordance with proposals agreed between Dr Stephen Walker of FONS and Duncan Hale of Archaeological Services Durham University, and with national standards and guidance (below, para. 5.1).

Dates

2.6 Fieldwork was undertaken on the 20th June 2012. This report was prepared for 26th July 2012.

Personnel

2.7 Fieldwork was conducted by Duncan Hale (the Project Manager) and Jonathan Dye, with welcome assistance from Dr Stephen Walker and James Koronka of FONS. Geophysical data processing and reporting were by Duncan Hale with illustrations by David Graham.

Archive/OASIS

2.8 The site code is **KSN12**, for **K**irkby **S**tephen **N**ine Standards 20**12**. The survey archive is retained with Archaeological Services Durham University. Archaeological Services Durham University is registered with the **O**nline **A**cces**S** to the **I**ndex of archaeological investigation**S** project (**OASIS**). The OASIS ID number for this project is **archaeol3-130967**.

Acknowledgements

2.9 Archaeological Services Durham University is grateful to the Friends of Nine Standards for facilitating this work. Photographs, other than the authors, are presented courtesy of Simon Ledingham (gyrocopter pilot) and Barry Stacey (Kirkby Stephen Tourist Information Centre), who are both gratefully acknowledged.

3. Historical and archaeological background

3.1 The origin and purpose of these cairns remains a mystery, however, a thorough study of documentary and other evidence by Stephen Walker indicates that the Nine Standards may have stood as boundary markers as early as the 12th century. The most comprehensive study of the cairns is presented in *Nine Standards: Ancient Cairns or Modern Folly?* by Stephen Walker (Walker 2008) and further information is provided on the Friends of Nine Standards website (http://www.ninestandards.eu).

3.2 In a photograph taken in early 2005 (below) there appear to be 11 possible cairns in various states of preservation.

2. Before restoration, in early 2005, looking south-south-east (© Simon Ledingham)

3.3 The five northerly cairns were reconstructed in the summer of 2005.

3. During restoration, summer 2005, looking north-west (© Barry Stacey)

4. After restoration, in late 2005, looking south-east (© Barry Stacey)

4. Landuse, topography and geology

4.1 At the time of survey the area comprised rough pasture on peaty moorland soils. However, as can be seen in the photographs (particularly 2 & 5), soil is virtually absent in places and the ground surface in parts of the survey area comprised loose, weathered rock.

5. Gradiometer survey and ground surface

4.2 The cairns stand at approximately 640m OD at the northern end of a broad-topped ridge, Nine Standards Rigg. The land falls away fairly steeply to all sides except the south, where it rises gently to the summit of the Rigg at 662m OD. Several depressions were noted within the survey area, some adjacent to cairns, which appear to be small quarries; these presumably provided material for the cairns. A small, square, stone-lined 'shaft' is present a few metres south of the northernmost cairn.

4.3 The solid geology of highest part of the ridge is Namurian sandstone of the Pickersett Edge Grit. The site lies at the northern limit of this now isolated remnant of sandstone, where the Millstone Grit Group of Namurian mudstone, siltstone and sandstone becomes the uppermost surviving strata.

5. Geophysical survey

Standards

5.1 The surveys and reporting were conducted in accordance with English Heritage guidelines, *Geophysical survey in archaeological field evaluation* (David, Linford & Linford 2008); the Institute for Archaeologists (IfA) *Standard and Guidance for archaeological geophysical survey* (2011); the IfA Technical Paper No.6, *The use of geophysical techniques in archaeological evaluations* (Gaffney, Gater & Ovenden 2002); and the Archaeology Data Service *Guide to Good Practice: Geophysical Data in Archaeology* (Schmidt & Ernenwein 2011).

Technique selection

5.2 Geophysical survey enables the relatively rapid and non-invasive identification of sub-surface features of potential archaeological significance and can involve a suite of complementary techniques such as magnetometry, earth electrical resistance, ground-penetrating radar, electromagnetic survey and topsoil magnetic susceptibility survey. Some techniques are more suitable than others in particular situations, depending on site-specific factors including the nature of likely targets; depth of likely targets; ground conditions; proximity of buildings, fences or services and the local geology and drift.

5.3 In this instance, it was hoped that cut features such as ditches, graves or pits might be present on the site, and that evidence for other types of feature such as burnt structures (for example pyres or hearths) might also be present.

5.4 Given the anticipated depth of targets and the non-igneous geological environment of the study area a geomagnetic technique, fluxgate gradiometry, was considered appropriate for detecting the types of feature mentioned above. This technique involves the use of hand-held magnetometers to detect and record anomalies in the vertical component of the Earth's magnetic field caused by variations in soil magnetic susceptibility or permanent magnetisation; such anomalies can reflect archaeological features.

5.5 Given the uneven and rocky nature of the ground surface, both electrical resistance and ground-penetrating radar (gpr) surveys were considered impracticable here.

Field methods

5.6 A 30m grid was established across the survey area and related to Ordnance Survey National Grid using a Leica GS15 global navigation satellite system (GNSS) with real-time kinematic (RTK) corrections typically providing 10mm accuracy.

5.7 Measurements of vertical geomagnetic field gradient were determined using a Bartington Grad601-2 dual fluxgate gradiometer. A zig-zag traverse scheme was employed and data were logged in 30m grid units. The instrument sensitivity was nominally 0.03nT, the sample interval was 0.25m and the traverse interval was 1m, thus providing 3,600 sample measurements per 30m grid unit.

5.8 Data were downloaded on site into a laptop computer for initial processing and storage and subsequently transferred to a desktop computer for processing, interpretation and archiving.

Data processing

5.9 Geoplot v.3 software was used to process the geophysical data and to produce both continuous tone greyscale images and a trace plot of the raw (minimally processed) data. The greyscale images and interpretations are presented in Figures 3-4; the trace plot is provided in Figure 5. In the greyscale images, positive magnetic anomalies are displayed as dark grey and negative magnetic anomalies are displayed as light grey. Palette bars relate the greyscale intensities to anomaly values in nanoTesla.

5.10 The following basic processing functions have been applied to the geomagnetic data:

clip	clips data to specified maximum or minimum values; to eliminate large noise spikes; also generally makes statistical calculations more realistic
zero mean traverse	sets the background mean of each traverse within a grid to zero; for removing striping effects in the traverse direction and removing grid edge discontinuities
destagger	corrects for displacement of geomagnetic anomalies caused by alternate zig-zag traverses
interpolate	increases the number of data points in a survey to match sample and traverse intervals; in this instance the data have been interpolated to 0.25m by 0.25m intervals

Interpretation: anomaly types

5.11 A colour-coded geophysical interpretation is provided. Two types of geomagnetic anomaly have been distinguished in the data:

positive magnetic	regions of anomalously high or positive magnetic field gradient, which may be associated with high magnetic susceptibility soil-filled structures such as pits and ditches
dipolar magnetic	paired positive-negative magnetic anomalies, which typically reflect ferrous or fired materials (including fences and service pipes) and/or fired structures such as kilns or hearths

Interpretation: features

5.12 A colour-coded archaeological interpretation is provided.

5.13 The geomagnetic data are very consistent, providing a very 'smooth' survey image, except for a few small dipolar magnetic anomalies. Even with the image displayed at high contrast there are no anomalies which appear to reflect either cut or built features which could be associated with the cairns.

5.14 A few extremely weak and narrow curvilinear positive magnetic anomalies can be discerned in the high contrast image but these are not considered likely to reflect archaeological features; they could possibly reflect cracks or fissures in the rockhead. Positive magnetic anomalies generally reflect relatively high magnetic susceptibility materials such as sediments in cut archaeological features (ditches or pits) whose magnetic susceptibility has been enhanced by decomposed organic matter or by burning, however, the anomalies here are so narrow and weak that this interpretation seems unlikely in this instance.

5.15 Several small, discrete dipolar magnetic anomalies have been detected in the survey area. These anomalies almost certainly reflect items of near-surface ferrous debris, with little or no archaeological significance. In a few places there are small clusters of these anomalies; these typically correspond to the small hollows or quarries noted on the ground. In these instances the anomalies probably reflect broken parts of tools used to hew the rock.

6. Conclusions

6.1 A geomagnetic survey has been undertaken at Nine Standards, near Kirkby Stephen in Cumbria.

6.2 There is very little variation within the geomagnetic data and very few anomalies have been detected. The survey has produced some of the smoothest magnetic data seen by this author in 21 years.

6.3 No features of likely archaeological significance have been identified.

6.4 Of the anomalies detected, the small strong ones probably reflect broken parts of ferrous quarry tools, while the very weak linear anomalies are considered more likely to reflect narrow cracks in the rockhead than cut archaeological features.

6.5 Given the results of this survey, and the unsuitability of the ground surface for some other techniques, no further geophysical survey is recommended.

7. Sources

David, A, Linford, N, & Linford, P, 2008 *Geophysical Survey in Archaeological Field Evaluation*. English Heritage

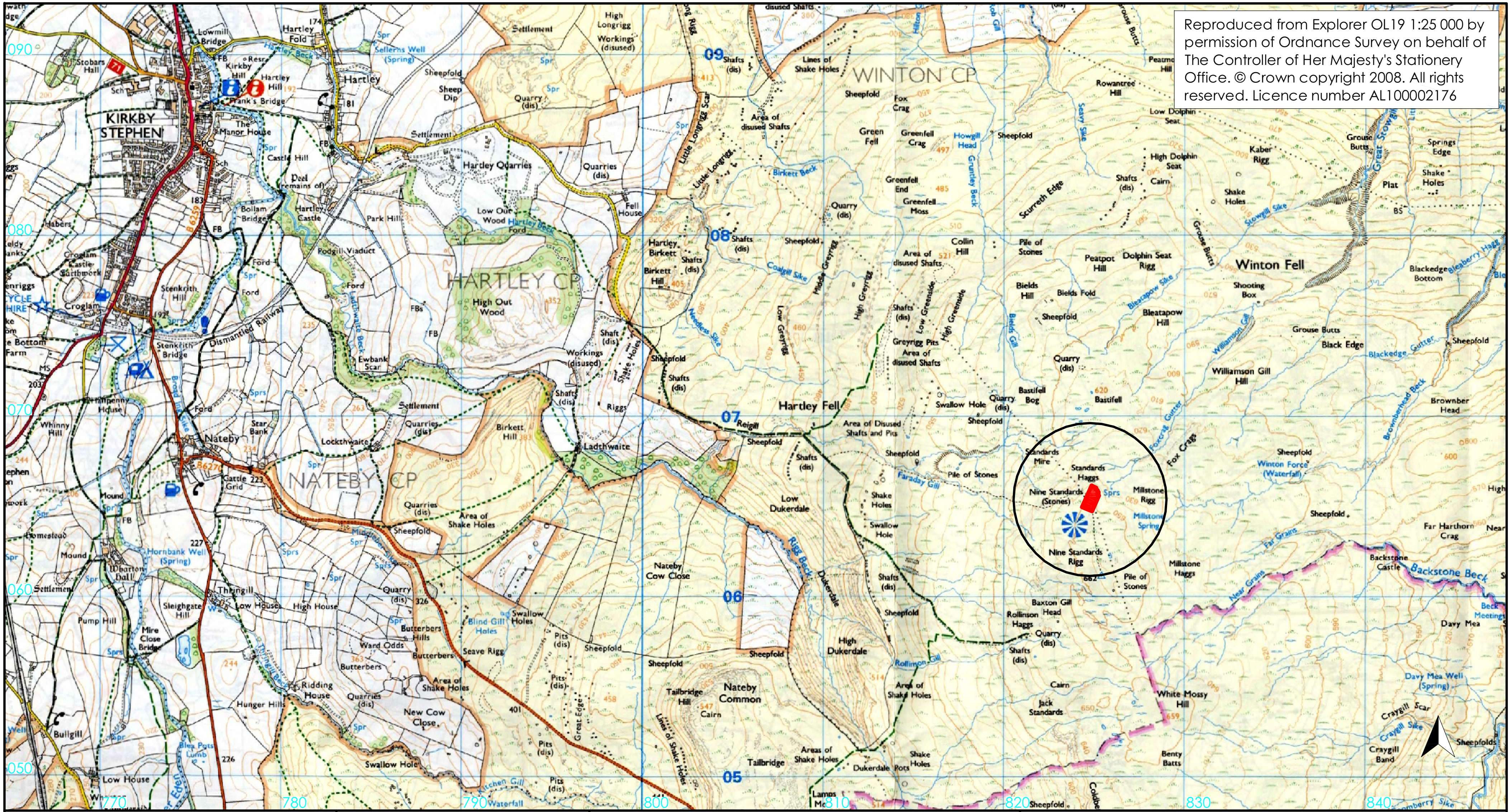
Friends of Nine Standards website http://www.ninestandards.eu

Gaffney, C, Gater, J, & Ovenden, S, 2002 *The use of geophysical techniques in archaeological evaluations*. Technical Paper **6**, Institute of Field Archaeologists

IfA 2011 *Standard and Guidance for archaeological geophysical survey*. Institute for Archaeologists

Schmidt, A, & Ernenwein, E, 2011 *Guide to Good Practice: Geophysical Data in Archaeology*. Archaeology Data Service

Walker, S, 2008 *Nine Standards: Ancient Cairns or Modern Folly?* Hayloft, Kirkby Stephen



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report 2963

Figure 1: Site location

site location

0 1.5km
scale 1:30 000 for A4 plot

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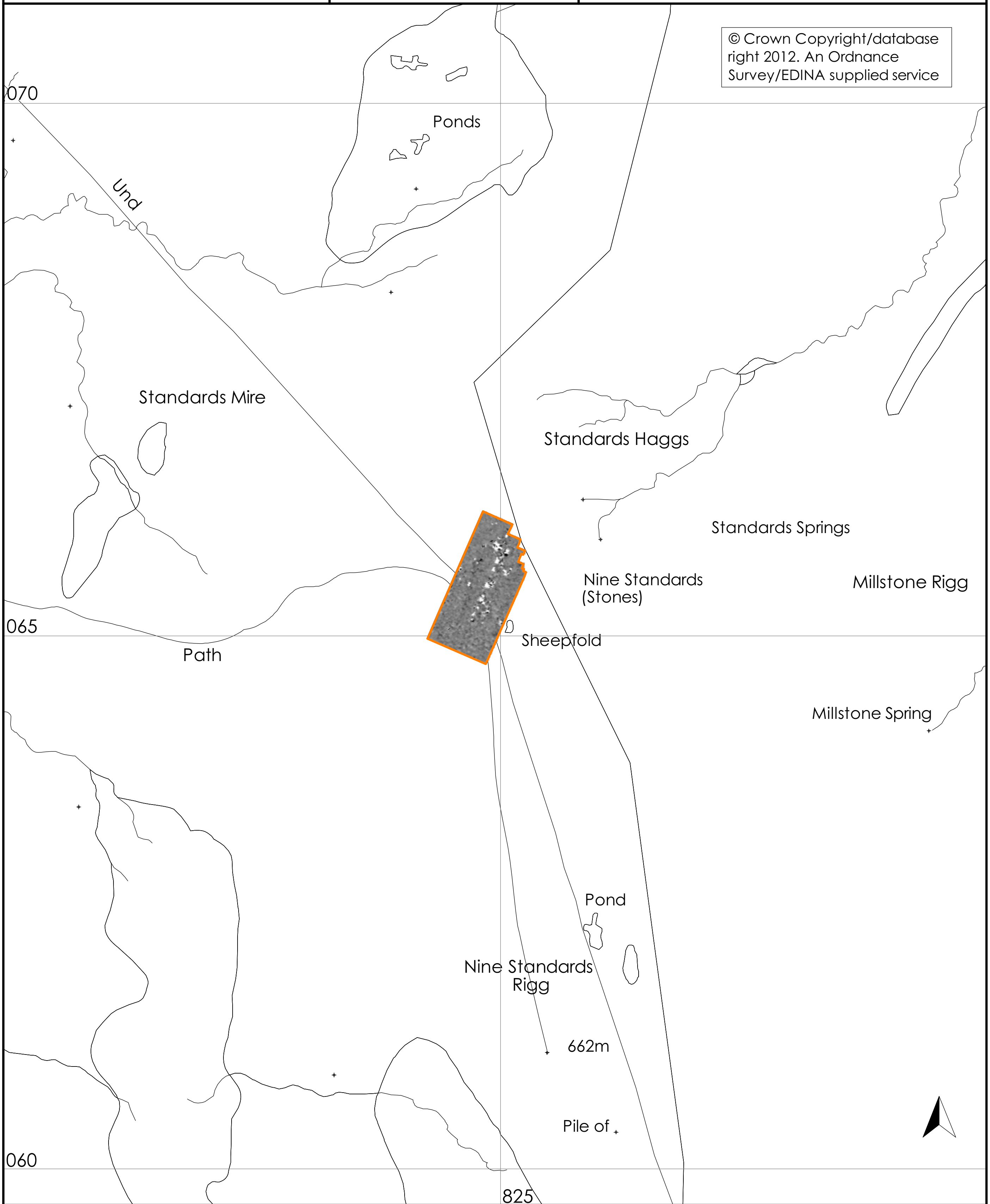
Nine Standards
Kirkby Stephen
Cumbria

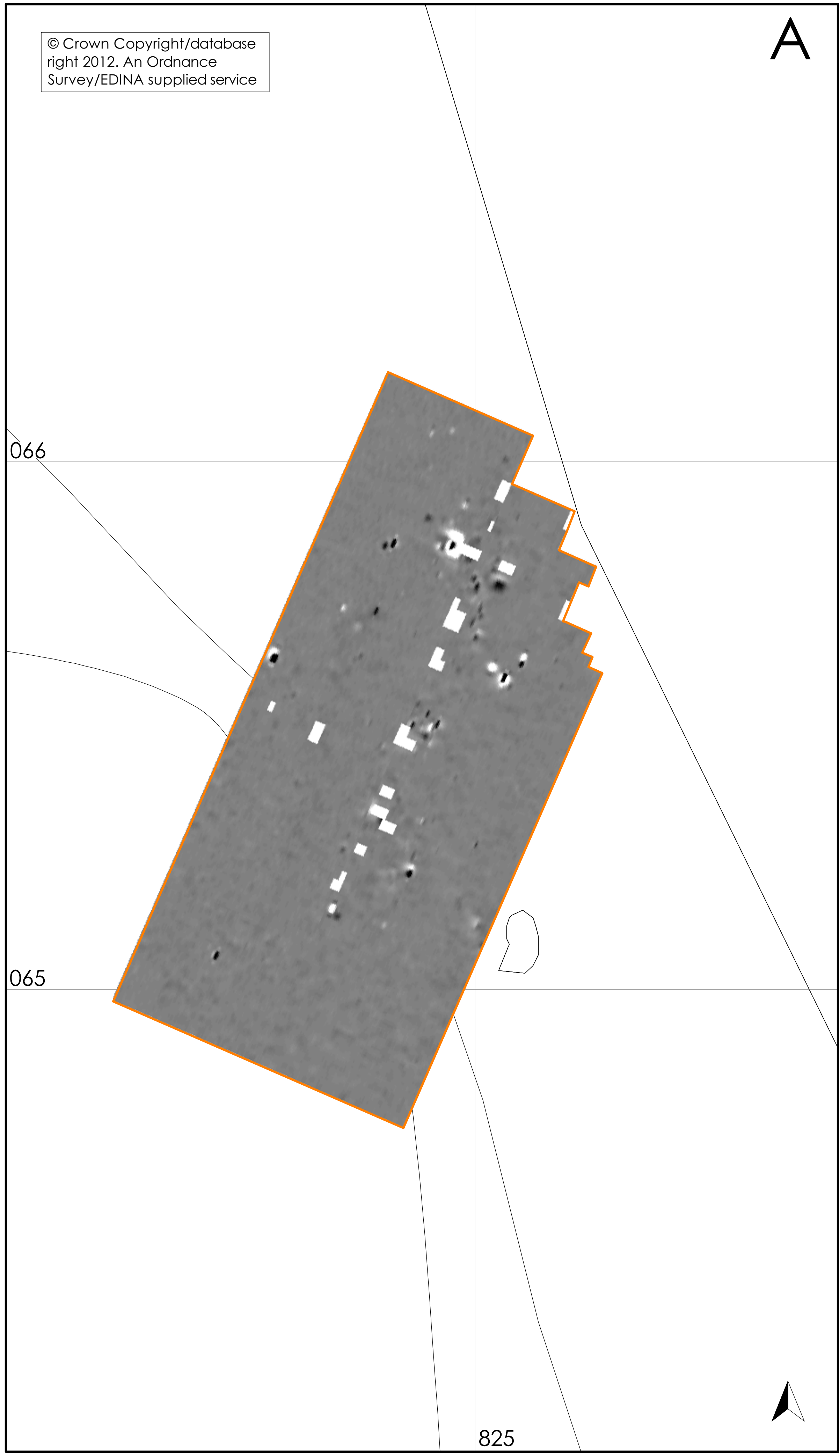
geophysical survey
report 2963

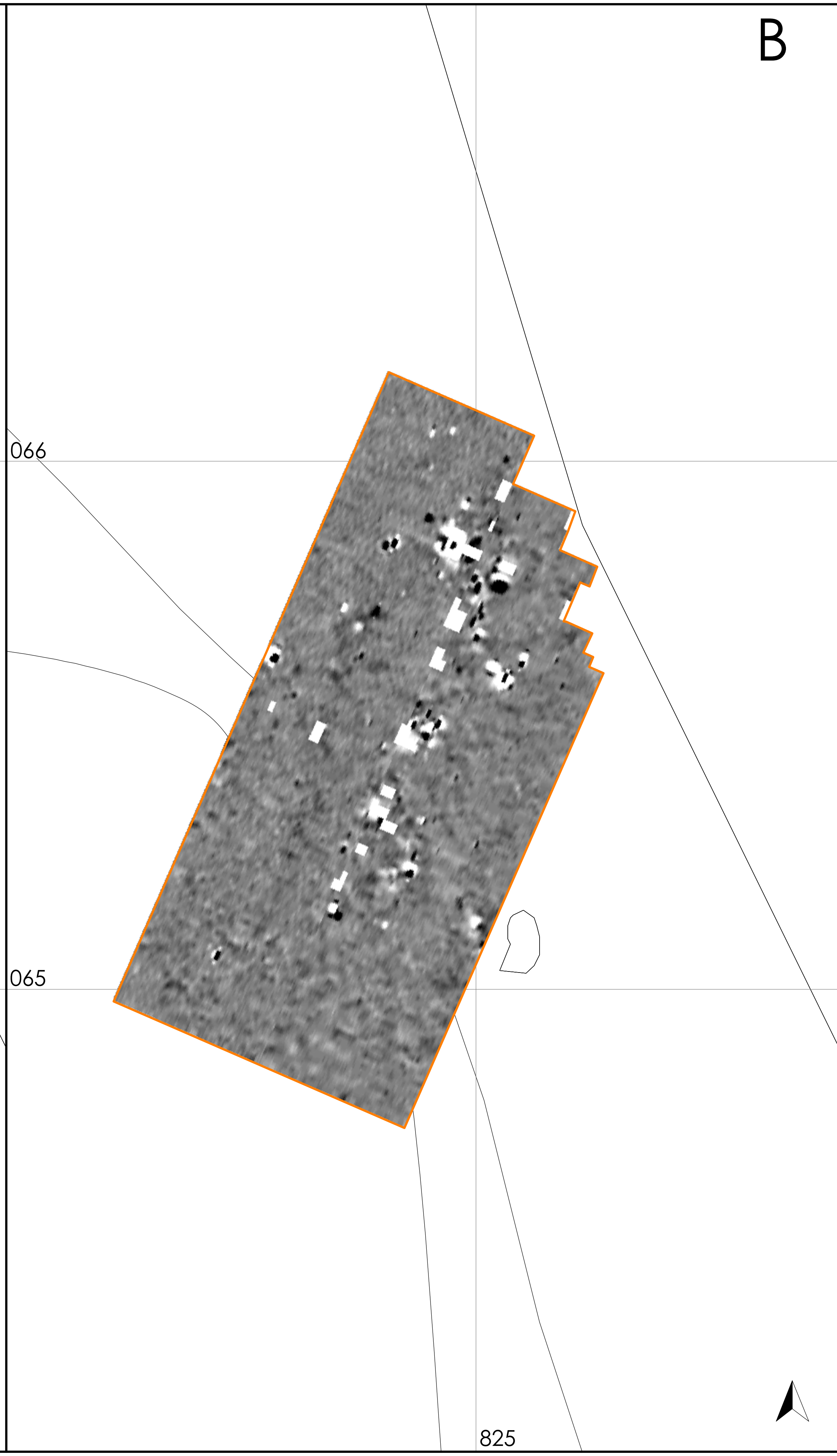
Figure 2: Survey area



survey area

0
250m
scale 1:5000 for A4 plot





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Nine Standards
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Cumbria

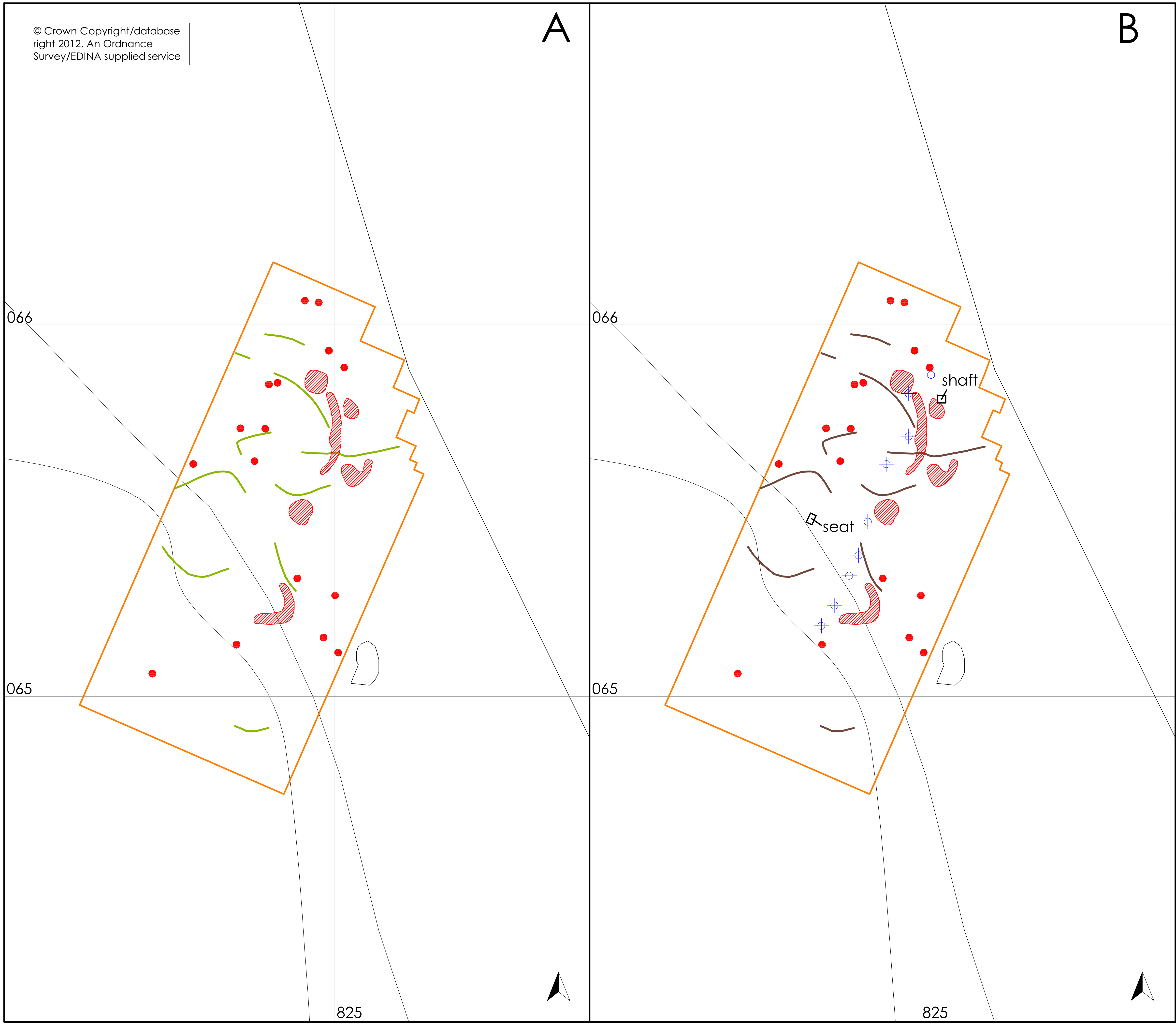
geophysical survey
report 2963

Figure 3: Geomagnetic survey

0 50m
scale 1:1000 for A3 plot

A
magnetic survey
-5 nT 5

B
magnetic survey
-1 nT 1



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Kirkby Stephen
Cumbria

geophysical survey
report 2963

Figure 4: Geophysical and archaeological interpretations

0 50m
scale 1:1000 for A3 plot

magnetic survey

A geophysical interpretation

dipolar magnetic anomaly

positive magnetic anomaly

negative magnetic anomaly

B archaeological interpretation

soil-filled feature

ferrous materials

cairn

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Cumbria

geophysical survey
report 2963

Figure 5: Trace plot of geophysical data