Geophysical investigation of a bloomery at Lanlai, near Miskin (Rhondda Cynon Tâf), April 2000

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Abstract

An area of approximately 3.5 hectares in a field (Field A) between the farm of Caergwanaf uchaf and the Elai (centred on NGR [ST 045807]) was surveyed using an FM36 magnetic gradiometer and an MS2 magnetic susceptibility meter. A smaller part of the field was also surveyed with an RM4 ground resistivity meter. Part of a second field (Field B) lying adjacent to Field A on the floodplain of the Elai was also surveyed with the MS2. The topography of a wider area including both fields was surveyed by EDM, and part of the floodplain was surveyed with an EM31 ground conductivity meter.

The results suggest the presence of two iron making complexes within the survey area. That in the lower part of Field A , the original target of this survey, is interpreted to be of sixteenth century date, with two or three smelting furnaces and a probable water-powered bloom smithy. The anomalies interpreted as smelting furnaces are situated on the steep slope a few metres above the level of the flood plain, and must therefore have been manually blown. The slag dumps extend over at least 4,500 m^2. Water power may have been provided by a spring-fed pond, which partially survives in Field B.

The second site is smaller, and lies on the crest of the ridge in the upper part of Field A. The gradiometer results show several circular anomalies in the area, which are tentatively identified as hearths or furnaces. This upper part of Field A also shows a partly rectilinear system of lower magnitude gradiometer anomalies, apparently a system of enclosures. At the western edge of the survey a square feature 10m wide is oriented parallel to the probable field boundaries. The topsoil of this upper part of the field, particularly its southern half, yields abundant iron slags, both tap slags and smithing slags, and several sherds of Romano-British pottery were recovered during the geophysical survey and subsequently after ploughing. A Roman age is thus tentatively ascribed to this second site.

Introduction

The site is located (Figure 1) on the west side of the Elai (River Ely), on the low hill east of Caergwanaf uchaf and the river floodplain below. To the east side of the Elai at this point was part of Clun Park, demesnes land of the Lordship of Miskin and a medieval deer park. The Caergwanaf ridge forms the route of the old coach road from Llantrisant to Pendoylan, which is met at Caergwanaf uchaf by a minor road from the east, skirting the south-eastern margin of Clun Park and crossing the Elai by a small bridge near New Mill (usually now referred to as Miskin Bridge, but formerly known, from at least the late 17th century, as Pont Felin Newydd). An earlier crossing on this site is indicated by references in 1536/9 to *Pont Risclidog of wood* (Leland, *Itinerary*), in 1578 to the bridge of *Ridisklidoge, decayed* or of *Rhyd Sglydog* (Rice Merrick, *Morganiae Archaiographia*) and in 1588 to *Pont Rydsklidog* (Pembroke Survey of Miskin; NLW Bute MS 2361) as the southern corner of Clun Park. The ford in existence in the middle of the nineteenth century lay to the north of the bridge at New Mill, but its western approach was used as dump for construction waste which now forms a conical "tump" to the southeast of Field A.

In the 17th century the boundary of the park was described (demesnes survey of 1666; NLW Bute Box 104/4) as being along "the highway leading from Cornel y Park toward Cowbridge unto a gate near the house of James ap John, smith and from thence to the river of Ely". This line is probably that extant on the park map of 1824 (GRO D/DD BE1/2), on which the boundary passes by the site of the smithy recorded on the 19th century Ordnance Survey maps, running along the northern margin of the property now the Miskin Arms Public House, reaching the Elai about 25m above the railway bridge (220m above the road bridge). The "gate" might have been on the line of the present Miskin – Pontyclun road. It seems unlikely that these two descriptions refer to the same position of the SW corner of the park, but rather that the Cowbridge road crossed the Elai close to the position of the present road bridge, and that the corner of the park was detached to make provision for the mill race for the New Mill (Felin newydd) in the early 17th century, and which appears to have originated just above the railway bridge.

Caergwanaf uchaf is situated on the east side of a small valley running northward to the Elai. To the west of the small valley the ground is higher, before rapidly falling to west into the valley of Nant Dyfrgi, which separates the area of Caergwanaf from Talygarn to the west.

Surface finds of slag in Field A, together with old accounts of a large slag dump previously visible near the river "100 yds upstream of Miskin Bridge" (Strahan *et al.* 1904), indicated that the site was a bloomery iron smelting site of considerable significance. Field B contains traces of what appears to be a pond, probably fed by springs in the valley side above. The site was undated, but the volume and type of slag, together with the apparent use of water power, suggested a late Medieval to early post-Medieval age (15th-16th centuries). There are two other suspected 16th century bloomeries (a major bloomery at Mwyndy [ST 057815] and a smaller site at Rhiwsaeson [ST 071827], 1.5 and 3km northeast of this site respectively) in the area surrounding the iron ore outcrops in the area between Cefnyrhendy and Llwyn-saer (subsequently referred to more simply as the Miskin iron ore bodies, to differentiate them from the Llanharry bodies to the west and the Lesser Garth bodies to the east). Just across the Ely 400m to the north of the site is another early industrial complex at Hendy Isaf [ST 044812], but this may be a little younger and be a finery forge associated with a short-lived blast furnace built in the area to north, now called Talbot Green, in the 1590s. The Lanlai site is the only one of these bloomeries now in open fields.

The Lanlai bloomery was selected for geophysical survey, and this was undertaken, under the supervision of the author, as a teaching exercise (Module HS23124, Prospecting and Surveying) for the Archaeology Section, Cardiff University, between April 8th and 15th 2000.

Topographic survey (Figure 2)

A detailed topographic survey was made by EDM of an area east of Caergwanaf uchaf (Field "A") and south of the former Lanlai Farm (Field "B"; now part of the Ceulan property). The survey included some 1700 datapoints. There is no immediately adjacent benchmark for keying-in the survey to the Ordnance datum, so the recorded heights have been offset to provide a best fit between the interpreted contours and the published OS mapping.

Cartesian coordinates have been allocated to the grid system adopted for geophysical surveying. The geophysical grid was aligned on the National Grid, with the zero point on the site grid lying at [ST 04346 80608]. The grid was pegged at 20m intervals. Pegs have been left in the ground (to facilitate return to the site) where the 140N line passes into the hedges to east and west of Field A, and the grid peg [180,20] has been left in the hedge to the south of Field A. Coordinates are recorded in this report in the form [eee,nnn]. Geophysical grids were walked from the SW corner of each grid, with a northwards initial traverse.

The level of the Elai in the middle of the area at the time of survey was approximately 33m OD. The flood plain rises from around 34m towards the south of the survey to 35m at the north. The slag mounds on the floodplain rise to just under 36m OD, suggesting a build-up of 1.5 to 2m of slag. To the west of the floodplain a steep slope rises from 36 to 49m OD. The flat terrace-like hilltop east of Caergwanaf uchaf rises to just over 51m OD in the survey area, before sloping down to about 48m OD near the eastern side of the farm buildings. In the south of the area the break of slope on the eastern side of the hilltop is marked by a tree-covered gully, which extends 40m into the field before swinging E downslope. This gully is interpreted as a former sunken trackway. The hilltop is ploughed (usually shallowly) on regular basis, the lower parts of the field only occasionally.

There are three distinct mounds on the floodplain in Field A. The northern mound forms a low feature centred on [150,135] and is about 20m across. The central and largest mound is 30m in diameter centred on [190,125], with a relatively narrow ridge running towards the steep slope from [175, 110]. The smaller southern mound is centred on [180,55] and is about 30m in diameter.

To the northeast of the southern mound is a pond with a spring (centred on [196,78]). This pond has been modified by the construction of an access route for construction plant on the sewer scheme, which forms a causeway across the SE side of the pond. Local accounts suggest that this pond (or a former pond close by, see below) was one of the main village water supplies before mains water. Extending NW from the eastern side of the pond towards the northern slag mound is a slight, but distinct linear ridge ([200,82] to [180,100]).

A large modern mound, probably created during road alteration in the 1950s, occupies the area to the southeast of Field A, close to Miskin bridge. This mound appears to be situated on what had previously been the western approach track to the ford situated to the north of the present bridge.

To the north, the floodplain in Field B has an elongate pond, fed by a spring close to the farm boundary, and drained by a ditch parallel to the field boundary. The spring has two separate rises, one enclosed by a bank. The two rises lie just below a lynchet which curves into the farm boundary on the slope and runs northwards above the pond, towards the former Lanlai Farm. The pond disappears northwards, and a raised terrace cuts the angle between the lynchet and the railway line. It is uncertain whether this bank represents a pre-existing feature, or an earthwork associated with the railway. The eastern margin of the pond is marked by a slight ridge approximately 1m wide.

FM36 gradiometer survey (Figures 3 & 4)

Area: 160m x 220m, resolution 0.5 x 1m (some details at higher resolution).

The gradiometer survey was undertaken in field "A" between Caergwanaf uchaf and the Elai, extending across the broad hilltop for 120m to the east of Caergwanaf uchaf, then dropping down the steep slope some 40m wide and 15m high to the floodplain of the Elai (of which a belt 80m wide lies west of the river in the survey area). The main survey was conducted with 1m traverse interval and 0.5m sample interval. Some details (Figure 4) were resurveyed at a resolution of 0.25m sample interval on 0.5m spaced traverses (leat area and southern furnace) or 0.25m sample interval on 0.25m spaced traverses (northern furnaces). Figure 8 shows these details superimposed on the main survey.

These three topographic elements corresponded to regions of differing geophysical signature:

1. The hilltop

The collection of gradiometer data in this area was impeded by a large dump of manure ([49,73] to [54,58]), a series of animal feeders (8,100], [6,90], [8,84],[1,86], [2,97]) a stay for a pole of an overhead cable ([100,85]) and the large quantity of ferrous materials in the hedges and structures, particularly near the farm.

The hilltop shows a fairly even background, mainly within the range ± 10nT, with a particularly smooth response from an E-W belt approximately 20m wide. The crest of the ridge is marked by a N-S belt of less homogeneous nature, with a noisy, "speckled" texture with a range of ± 20nT. In general the background is lower towards the north of the field.

Superimposed on the background are several geophysical anomalies interpreted as being of archaeological origin.

Within the noisy zone along the hilltop, there are several distinct point features. Seven such features are found in the southern section of the survey, and a further three smaller, but possibly similar features occur in the northern part. The three most prominent of the features ([56, 13], [70,20] and [74, 37]) show a central positive anomaly (maxima at 57, 124 and 62nT respectively) surrounded by weaker annular negative anomalies (minima at -18, -34, -47nT respectively). These seem likely to be hearths (or just possibly pits), and the surface scatter of iron-making slags in this area hints at the possibility they may be metallurgical furnaces.

To the east of the noisy zone, a compound linear feature runs down towards the lower part of the site. This feature is slightly variable along its length, but comprises two parallel positive linear anomalies, 5-7m apart. The western linear is typically at around +20 to +30nT at its maximum, the eastern slightly lower at +10 to +15nT. The positive linears are flanked and separated by negative linear anomalies. The western negative ranges from –10 to –26 nT, the narrow central negative ranges down to –46nT, while the lesser eastern linear is mainly –10 to –15nT.

The termination of the compound linear [81, 75] forms the apex of triangular zone of elevated noisy readings with a range of ± 50nT extending WSW for approximately 20m. The northern margin of this zone is in continuity with the northern margin of the compound linear feature to the east. The southern margin coincides with a positive linear feature 10 to 40nT above background extending SW from [81, 72] to [45, 36].

Across much of the hilltop there are also rectilinear positive anomalies with maxima in the range of 10 to 30nT above background, and where running E-W there is a negative to north of about 8nT below background.. The positive features typically show a width of about 1m. The most significant of these forms the SW side of a prominent rectangular feature. The eastern corners of this feature are at [110, 58], [124, 35], and the linear anomaly then runs NNW from the southwest corner at [104,23] to [61,113] where it makes a right angle turn to the west, but only clearly extends for 11m as far as [51, 108], although there is a slight suggestion of its prolongation as a much lower magnitude feature. At this point a second similar feature continues in a similar alignment from [50, 113] until disappearing into the area affected by the metal feeding troughs [15, 99]. The gap between these two features has the appearance of a gateway some 5m wide. A linear feature parallel to the above features runs from [45, 56] to [58, 22].

A further feature on a similar alignment is a square feature, 10m across centred on [23, 48]. This feature is defined to the N and S by features of similar size and magnitude to the linear features described previously, outside which lie broad, smooth negative anomalies some 2m wide. Outside the southeast corner of this feature are two irregular positive anomalies with maxima of around 87nT, approximately 1.5m across and surrounded by a negative anomaly with a minimum at –29nT.

At various points across the hilltop slight narrow negative linear anomalies can be observed, running in various directions. The irregular pattern suggests that these may be of geological origin.

2. The slope

The southern part of the area shows a very clean signature across the steep slope. The top of the slope was not surveyed in this area because of the tree cover around the sunken trackway.

North of the line of trees, the compound linear observed on the hilltop swings down the slope. In this area, the southern negative is –10 to –17nT, the southern positive up to 54nT, the central negative is narrow and marked, with a minimum of around -82nT, the northern positive and negative components are broad and weak (10 to 20nT, and -15nT respectively).

To the north of the compound feature, the slope area shows a zone of rectilinear features. Each sub-rectangular zone has a noisy signature of 30 to 110 nT, and they are separated by belts with smooth textures and values between –10 and –20nT, which merge into the quiet background.

There are two N-S positive linear anomalies on the upper part of the slope. These are 8 to 10nT above background and 1 to 2m wide.

The lower part of the slope is dominated by two intense features lying between 40 and 41m OD. The northern has a central positive anomaly (centred on [127,134]) with maximum of about 1800nT and an elliptical shape, 6m by 2.5m, with long axis oriented NW-SE. The positive component is surrounded by a penannular negative anomaly, broken to the SE, deepest to the northeast (-740nT).

The southern feature (centred on [130,117]) has a central positive with a “figure of eight” shape, with a maximum value of 1350nT. The narrow penannular negative anomaly has a minimum of -490nT to the east, and is again broken to the south. A small isolated positive anomaly at over 200nT lies just to the east of the northern part of the positive anomaly.

3. The floodplain

The foot of the slope of the terrace is marked by an abrupt and dramatic change to the geophysical signature. The floodplain shows a complex of features with anomalies frequently over ± 100nT. These cover an oval area 110m x 80m.

The southern part of this oval area is dominated by several major linear anomalies. The common intersection of these features at [157, 72] gives rise to some uncertainty in tracing the features from W to E. the intersection is also close to a significant positive anomaly 6m x 3m with a magnitude of around 500nT.

The most southerly of these features is a negative anomaly, curving strongly towards the north at its eastern end, with slight positive features on either side. The negative feature has a width of about 5m and a magnitude of about –25nT relative to background. Towards the west the positive features either side of the negative linear increase in magnitude, reaching values of 80nT to the south and 150nT to the north. That to the north may represent a continuation of the linear feature at the foot of the slope seen 20m further NW or possibly the continuation of the southern positive linear within the compound feature running down from the terrace above. Towards the eastern end of the negative feature there is a superimposed compound anomaly with a central negative (-990nT) with positives to the west (1600nT) and east (1330nT).

Another marked positive linear, also curving markedly north near its eastern end lies a few metres to the north. This feature is 1 to 1.5m wide, with a typical magnitude of 150 to 170nT. To its north lies a weaker negative feature, with a magnitude typically around –30nT, but locally dropping to –95nT.

The features in this area are further complicated by higher frequency effects running SW to NE, particularly clearly seen just to the west of the intersection of the linear features.

To the north of these complex linear anomalies, the only significant linear anomalies are those which bisect the oval area between [145,92] and [203,129]. These reach 270nT in the west, but values between 150 and 200nT are more common.

A lesser (80 to 100nT) linear approximately 3m wide running NW-SE between [177,112] and [198, 85] corresponds to a feature observed with the EM31 (see below) and is close to the line of the surviving topographic ridge passing on the northeast side of the spring.

The remainder of the floodplain area is marked by a noisy and elevated magnetic signature showing diffuse subcircular positive features approximately 10m in diameter.

A few features stand out as significant in this area. The highest values occur as two small oval features (2.5m x 1m) centred on 193, 102 (528nT) and 196, 101 (327nT). The higher, western anomaly has a penannular negative reaching –180nT, whereas the lesser eastern feature has a negative to the NE only (-140nT). 20m west of these two small features [173, 102] there is a subcircular feature with a ring, 5.5m in diameter, 1 to 1.5m wide, of positive anomalies ranging up to 360nT, partially surrounded by negative anomalies down to –140nT. In the area around 153,140 an arcuate zone of positive anomaly to 300nT surrounds a negative feature down to –360nT.

The eastern margin of the site, adjacent to the Elai, is marked by a pair of narrow negative linear anomalies, with a variable positive between. The negative anomalies are typically 150nT below background, are less than 1m wide and are separated by approximately 4m. They correspond to the known position of a high pressure sewage pipe.

RM4 ground resistivity survey (Figure 5)

Area: 100m x 120m (partial coverage) eastern part of Field A, 80m x 40m (partial coverage) western part of Field A, resolution 0.5 x 0.5m.

Eastern survey
The resistivity data are marred by some grids with a high proportion of false readings (generated by an instrument fault), but in general the eastern half of the site displays high measured resistance (>100Ω) on the topographic highs of the floodplain, and on the slopes, with much lower resistance (30 to 50Ω) to the south of the lake, around the pond and locally at the foot of the slope. The higher resistivity areas on the floodplain and at the foot of the slope correspond closely with the observed slag mounds.

Superimposed on these broad features are higher frequency features with curvilinear negative anomalies, magnitude 10-20Ω below background, less than 1m wide and up to 5m apart. These are particularly well imaged by shaded relief imaging of the data, or by viewing the data after application of a high-pass filter.

Western survey
The data are dominated by circular negative anomalies representing artefacts produced by the earlier positions of circular animal feeder bins towards the western end of the survey.

The data also show strong parallel linear negative anomalies, averaging 5m separation, 1.5m width and amplitude 20Ω below local background. These are tentatively interpreted as being of geological origin, but might be associated with cultivation.

Very slight negative resistivity anomalies are associated with some of the gradiometer linear anomalies crossing the area (e.g. around [50,40]), but in general the features identified by gradiometer are poorly visible to invisible in the resistivity data.

EM31 ground conductivity meter survey (Figure 6)

The EM31 survey was limited to the northern part of the floodplain area in Field A. The intention of employing this instrument capable of resolving deeper features than the other techniques, was to investigate whether there was any evidence for the proposed leat, or for any buried river channels. Both horizontal (typically biased towards features in the 0-4m range) and vertical (typically biased towards features in the 0-6m range) dipole positions were measured, with both the quadrature (a measure of conductivity) and the in-phase component (a measure of magnetic susceptibility) being recorded. Data were collected along traverses 5m apart with 2m sample interval.

Data quality is poor, largely because of the teaching element of the exercise meant this survey suffered from frequent operator changes. However, several key features are identifiable.

The quadrature (a measure of apparent conductivity) shows reasonably similar datasets for the two dipole orientations. The major difference is that the sewer is resolved as a single positive anomaly (30-45) with the horizontal dipole, but two broader positive anomalies (20-30) when the dipole was oriented vertically. In both case the area immediately north of the pond (the area of the proposed leat) is seen as a broad area of high conductivity, but it not clear to what degree the narrow linear northward continuity is an artefact. The horizontal dipole records values of around 10 on the slag mound on the floodplain, 18-20 north of the pond, and 10-12 on the slope. The vertical dipole records values of around 12-14 on the slag mound on the floodplain, 20-25 north of the pond, and 12-14 on the slope.

In both cases extreme negative values were recorded close to the fence on the north side of the field.

The in-phase component is more problematic, with the two dipole positions recording almost inverse results. With the dipole vertical a pattern of magnetic susceptibility was recorded which was very similar to that recorded by the MS2 for the surficial layer. A positive anomaly follows the low topographic bank NW from the pond from [200,80] towards [180,110]. A subrectangular area of elevated magnetic susceptibility, 10m wide, extends from this line towards [180,90]. The linear susceptibility anomaly along the bank feature turns NE at [180,110] towards [200,120]. To the north of this anomaly a region of elevated susceptibility lies between [185,120] and [185,140]. The linear anomaly between [205,95] and [205,125] might be associated with the sewer, but is probably an artefact, as is the anomalous line at 155E.

With the dipole horizontal, the features of the in-phase component in the region of the supposed leat, to the northwest of the pond, are all represented, but as negative features. Similarly, the recorded susceptibility increases moving up the slope, away from the slag mounds. It is uncertain whether there is a curious coupling between the shallow slag deposits and the horizontal dipole, or whether there was a polarity error with the equipment. The colour shading on the horizontal dipole, in phase data on Figure 5 is reversed with respect to the in-phase component from the vertical dipole, to emphasise the similarity in pattern, if not in polarity, between the datasets.

In both dipole orientations, the similarity between the in-phase component and the magnetic susceptibility measurements of the top soil with the MS2, suggests that the signal is dominated by superficial slag layer. The strong linear features, particularly those observed using the vertical dipole, would appear to be indicative of buried archaeology.

MS2 magnetic susceptibility survey (Figure 7)

The magnetic susceptibility survey was undertaken with a Bartington MS2 meter with an MS2D field coil. Traverses 80 long, 2m apart, were walked with readings taken at 2m intervals. This survey covered Field A and part of Field B.

In Field B the recorded values were extremely low. There was no evidence for metallurgical activity to the north of the Caergwanaf uchaf / Ceulan property boundary.

Very high susceptibility readings were recorded across the floodplain area of Field A. The highest values were associated with the disturbed soil above the sewer pipe trench, and around the pond. Other significant areas of elevated susceptibility were associated with the slag bank ([160,108] to[205,11]5), an area around [190,130], an area around [185,75] and a succession of lesser features corresponding, at least in part, to the slag mounds along the foot of the steep slope. Only in the central hollow (around [130,95]) were higher susceptibility soils recorded on the slope; both to the north (around the probable smelting furnaces) and to the south, the susceptibility was very low on the slope.

The upper part of Field A is clearly demarcated from the slope along a line along the north of the sunken track to [125,55] and then in a straight line to [105,135]. This line corresponds to the eastern margin of the current extent of ploughing. The area west of this line is characterised by both high susceptibility values and a more speckled susceptibility signature. This ploughed area is itself clearly divided along a line from [120,85] to the corner of the shed at [12,62]. This line corresponds to the position of a field boundary shown on the 1993 edition of the 1:10,000 OS sheet. North of this line, the susceptibility values are only mildly elevated, but to the south, particularly along the top of the ridge, the topsoil magnetic susceptibility is significantly elevated.

Interpretation (Figure 8)

The Lanlai site appears to contain two quite distinct periods of activity. In the upper part of Field A a mainly rectilinear system of enclosures is tentatively dated as Romano-British by surface pottery finds. The top of the ridge has a series of geophysical features interpreted as hearths/furnaces and there is an associated spread of both tapped smelting slag and smithing slags. Since the area of these features is bounded by some of the enclosure boundaries, and because the intensity of the magnetic anomaly associated with some of the linear features increases towards the area of the hearths/furnaces, the iron making activity on the hilltop is also tentatively dated as Romano-British.

The lower part of Field A contains a major iron making site, with rather different character. The features interpreted as the bloomery smelting furnaces lie on, or at the base of, the steep valley side. Below these smelting furnaces are dumps of smelting slags, still surviving as slight topographic features, but until the 1950s forming a complex of mounds which were levelled when the site was "improved". These mounds are clearly visible on an aerial photograph from 1946 (Figure 8; RAF CPE/UK/1871 frame 2101, 4/12/1946). The curvilinear anomalies seen in the ground resistivity survey of the floodplain are interpreted as furrows produced during the levelling process. The smelting furnaces are situated close to the natural springs arising from valley side. In the central part of the site a large bank of slag extends across the floodplain as far as the modern river bank. This feature is interpreted as forming the southern limit of the former pond extending from Field A and across Field B. It is not clear whether it formed a dam, but would also have afforded some protection from flooding to what is interpreted as the site of the bloomsmithy, in the central southern part of the complex. The geophysical features interpreted as the hearths of the bloomsmithy lie immediately to the east of bank running from the modern pond towards the western part of the central slag bank. This is interpreted as marking the eastern side of leat running southwards from the pond. The springs in Field B would have provided a water supply for the pond, but it is also possible that water was supplied from the north, either from the Elai itself, or from the tributary stream descending to the Elai at the site of the former Lanlai Farm.

As well as the iron-making sites, the geophysical surveys provide evidence for a trackway descending the slope (around [130,80]) to the floodplain down the central hollow in the valley side. This trackway is marked by a double magnetic feature, and is traceable well into the upper part of the field [80,75]. On the floodplain the course of this feature is less clear, but it appears to have a "reversed S" plan, following the base of the steep slope and passing out of the field at [200,60], presumably to a ford immediately upstream of the recent ford. As well as this trackway detectable on the geophysical survey, there is a sunken trackway passing perpendicular to the modern road northwards through the wooded belt from [135,15] to [135,60], where it swings to the east, and may be the low resistivity feature passing downslope at [140,70]. The trackway from the upper part of the field to the river is of uncertain age. It appears to impinge on the southern probable smelting furnace, it appears to end in the upper field at the margin of the early (Roman?) smelting site, and yet the intensity of the anomaly close to the pond suggests the banks were built of slag (and therefore presumably post-dates the slag dumps in this area).

More recent features are limited to the prominent anomaly from the pole stay at [100,85] and the features associated with the sewer. The sewer itself has already been described, but of significance to the interpretation of the lower part of Field A are those features associated with its construction. A track for movement of plant was constructed by creating a gap in the road hedge at about [185,20], from where the track extended in a zone about 10m wide along the margin of the field to [195,65]. Ample evidence for the disruption of the archaeology is shown by the gradiometer survey, and by the ground resistivity survey of this area. From this point the track swung to the east to cross the stream emerging from the point. A new culvert was emplaced here, and there is a bank of "made-ground" (outside the gradiometer survey area). Beyond the stream the machinery was able to access the area where the sewer pipe turns to cross the Elai [220,70].

Old maps show no pond in the position of the current pond, but instead a pond/spring 10-15m to the west. This spring fed a stream which flowed NE to the site of the present pond, before turning SE to flow towards the river along the same line as at present. This original spring seems to have been filled relatively recently, possibly at the time of the sewer scheme, and its flow directed along a pipe now visible entering the western side of the current pond. The original spring is probably represented by a penannular anomaly seen in the gradiometer data, centred on [188,75]. On the tithe map and the 1878 OS sheet, a field boundary is shown running long the line of the trackway in this area. On the 1898 OS edition, the field boundary has been replaced by a line to the north of the spring, and a path allows access to the spring from the road. The diverted field boundary ran along the linear ridge NW of the pond and substantial trees still existed along this ridge as late as the 1950s (Figure 7).

Old cartographic and aerial photographic evidence indicates a former field boundary ran along the foot of the steep slope to the north of the trackway. This boundary formerly included the large tree surviving in the centre of the field. The hedge was removed during the 1950s, when the site was levelled. The hedge was downslope of the smelting furnaces, and may have influenced the potential survival of archaeological remains in this position.

The geophysical survey thus provides evidence that the lower site had three smelting furnaces, lying on the slope above a water-powered bloomsmithy. The situation of the smelting furnaces precludes their use of water power, and they must have been blown manually. In contrast, the geophysical survey suggests that a water-powered bloomsmithy may well have existed lower down on the floodplain.

Discussion

The possible Romano-British smelting site in the upper part of Field A is the second such site in the district. Young & Macdonald (1998) reported on slag dumps of probable Romano-British age immediately to the south of the Bute Mine site, 1km NE of Lanlai. At neither site is the age established with certainty. Despite the several references to "Roman" mining and smelting in the antiquarian literature, there has been little firm evidence of Roman smelting in the area. Recent excavations at Bear Barn, Cowbridge, produced abundant evidence for smithing (including probable bloomsmithing), but no evidence for primary iron production.

The probable 16th century iron mill complex is one of several sites interpreted to be of this age, in the area surrounding the Miskin iron ore bodies. The documentary evidence suggests rediscovery of the iron ores in August 1531, during a search for lead in Clun (sometimes Glinnog or Gylynog) Park commissioned by Henry VIII (Public Records Office PRO SP1/66/262). The iron ores were smelted locally, using manually blown furnaces, and the blooms shipped to Bristol. There is no direct documentary evidence for the continuance of the smelting during the later 1530s, but Leland states that "There is now yren made in one of these parkes named Glinnog" in his itineraries dating to between 1536 and 1539. The right to mine and smelt the iron was granted in a lease of 1540 (PRO C82/769 and C66/697) to a William Kendall (an entrepreneur from Launceston, Cornwall), and it came to be held by John Sadler (Alderman of the City of London, and an important member of the Company of Drapers), who apparently made considerable outlay on the operation. The lease included the right to construct a water powered iron mill or mills in, within three miles of, Clun Park. The extensive case in Chancery (PRO C1/1062/1-3) between Kendall and Sadler was resolved in 1544, when the judgement of the Chancellor (PRO C78/1/74) seems to make reference to only a single iron mill. The Lanlai site, together with those at Mwyndy and Rhiwsaeson, lies within the three mile limit of the 1540 lease. Of the 16th century iron working sites identified to date, only the Hendy Isaf site actually lies within the bounds of Clun Park. Although the main features at Hendy Isaf may be later, it is possible that this is the site of the 1530s bloomery. If the singular iron mill of the 1544 document is reliable, then it would appear likely that some of the identified sites post-date 1544. The reversion of this lease is included in the 1546 lease of the lordships of Miskin, Glynrhondda, Miskin Forest and the borough of Llantrisant to William Herbert (later Earl of Pembroke). No evidence for iron making appears in the manorial survey of 1570, but in 1578 Rice Meyrick, in *Morganiae Archaiographia,* states that "Yren is made on the south part of the hill wherupon Llantrissent is builded". Meyrick also mentions, speaking of Glamorgan in general, "wherein lie many fforests and woodes wherof many in our daye about iron milles were spoyled and consumed". By the early 1560s the first blast furnaces had been constructed in the Taff Valley (Riden 1982). On balance, therefore, a date for the Lanlai bloomery within the period 1540-1570 seems likely. Only Lhuyd's *Parochialia* of about 1697 makes subsequent reference to iron-making in the area describing "Iron mines under the town of Llantrissent at Pont y Velin newidd"; but this does not necessarily imply that the mines were active at this date.

The geophysical data also supply information on the state of preservation of the archaeology. The upstanding features in the lower part of Field A were levelled during the early 1950s. The ground resistivity provides good evidence for the nature of that levelling. The areas of elevated topsoil magnetic susceptibility may, in part, also be indicators of disturbance. The clear-cut nature of much of the gradiometer data from the same area, however, suggests the damage may be relatively superficial. An area of particular concern are the significant negative resistivity features shown impinging on the areas of both the northern smelting furnaces. The lack of any susceptibility features in this area, may indicate however, that the furnace remains themselves have not been disturbed. In the upper part of Field A, the topsoil magnetic susceptibility provides evidence of plough damage to the underlying archaeology, particularly along the crest of the ridge in the southern half of the field.

Acknowledgements

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STRACHAN, A. & CANTRILL, T.C. 1904. The geology of the South Wales Coalfield. Part VI. The country around Bridgend. Memoir of the Geological Survey of Great Britain.

YOUNG, T.P. & MACDONALD, P. 1998. Miskin, School Road. *Archaeology in Wales*, **37** (for 1997), 79.

Figure Captions

Figure 1. The location and topography of the Clun Park area, shown as a shaded relief image illuminated from NW. The image is overlain by an indicator of steepness of slope, indicted by shades of green starting at 40; these areas are likely to have included many of the sites of charcoal production. Elements of the 16th century geography are also included, including the town of Llantrisant, the main roads and Clun Park. The paler tone in the north of the park is that area already enclosed as farmland by this time. Also shown are the locations of known or probable iron mines, the bloomeries of Lanlai and Mwyndy (yellow dots), the Felin fawr and Felin newydd mills (brown dots), the Hendy forge (grey dot) and the probable Bryn Rhydd blast furnace (dark blue dot).

Figure 2. Topographic survey of the site.

Figure 3. FM36 magnetic gradiometer survey results. Results processed in Geoplot, then kriged in Surfer to generate a smoother image. Left: colour scale clipped at +/- 100nT, right: colour scale clipped at +/- 10nT

Figure 4. FM36 magnetic gradiometer detailed survey results. Results processed in Geoplot, then kriged in Surfer to generate a smoother image. Colour scale clipped at - 200nT / +600nT.

Figure 5. RM4 ground resistivity survey results. Note that the two sections of the survey are displayed in different grey tone scales. Intense speckled areas are due to instrumental error. Data developed in Geoplot before being transferred to Surfer for kriging to produce a smooth image.

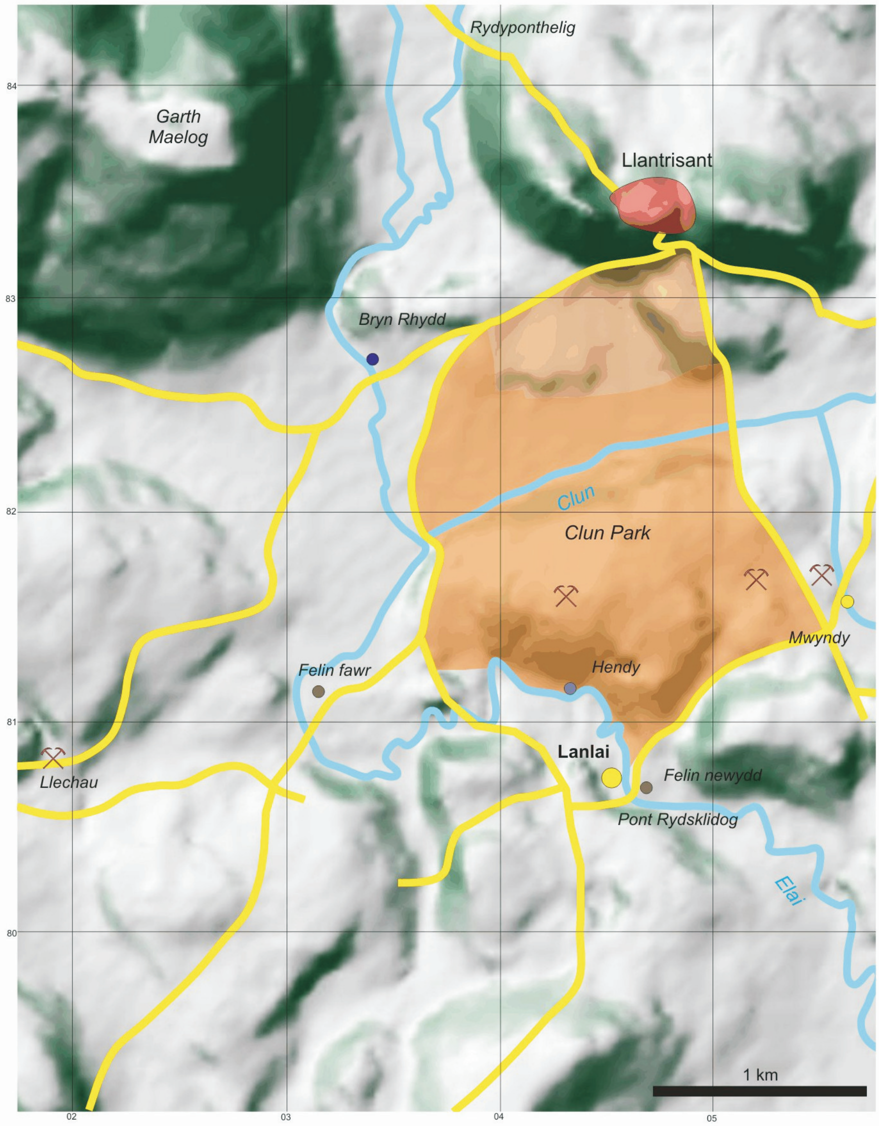
Figure 6. EM31 results. Note that the colour scale of h-i is inverted with respect to v-i.

Figure 7. MS2 topsoil magnetic susceptibility survey. Note the extremely non-linear colour scale.

Figure 8. Comparison of FM36 data (see also Figures 3 and 4) with an aerial photo (RAF CPE/UK/1871 frame 2101, 4/12/1946) taken before the levelling of the site on the floodplain in Field A.

Figure 9. Summary of geophysical results (left) and enlarged detail of simplified interpretation of the lower part of field A. The grey tones on the geophysical summary relate to data from the magnetic survey, yellow to features from the electro-magnetic survey.

Figure 1


Rydyponthelig
Garth Maelog
Llantrisant
Bryn Rhydd
Clun
Clun Park
Mwyndy
Hendy
Felin fawr
Lanlai
Felin newydd
Pont Rydsklidog
Llechau
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1 km
84
83
82
81
80
02
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04
05

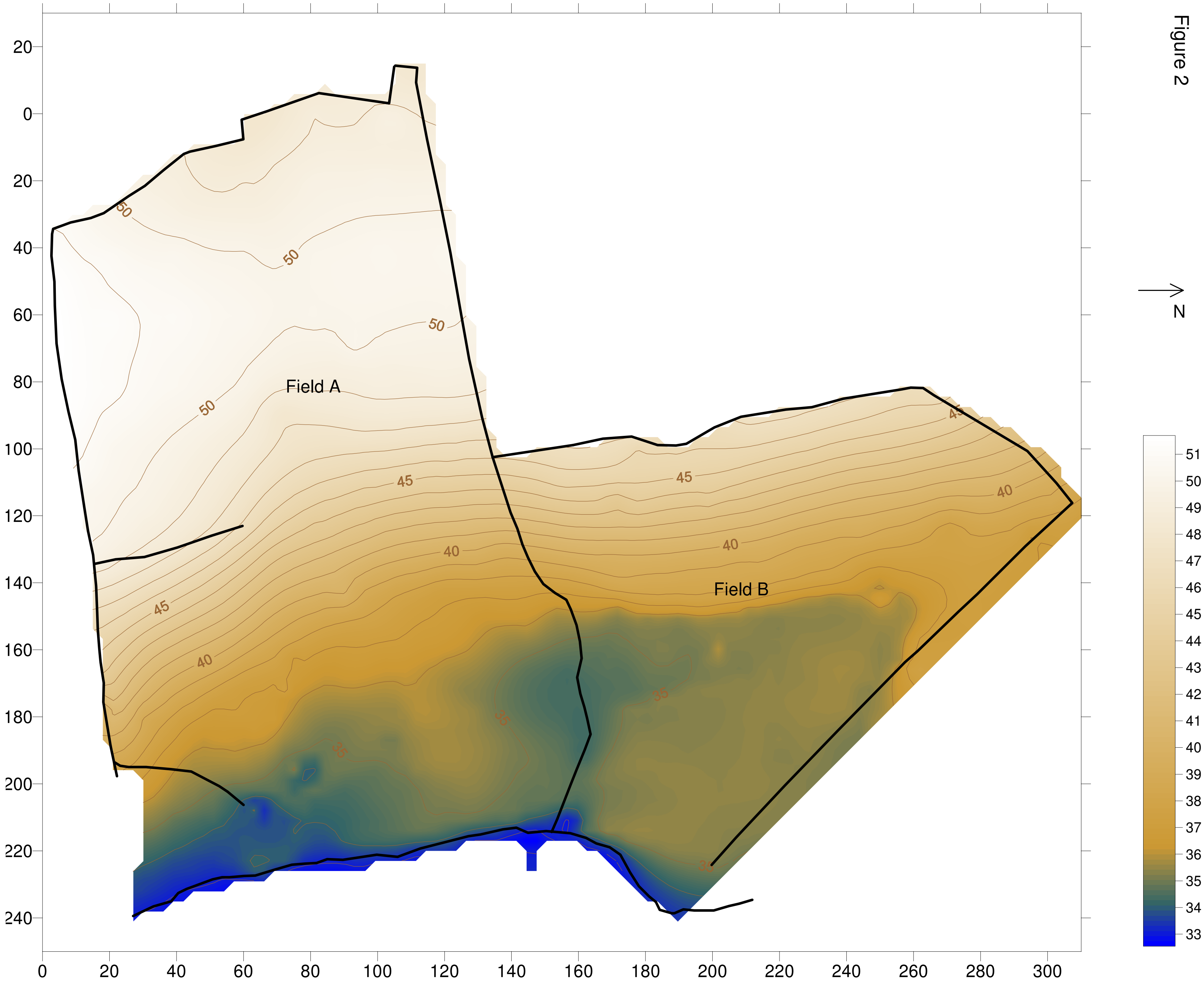
Field A
Field B
N
50
45
40
35
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300
20 0 20 40 60 80 100 120 140 160 180 200 220 240
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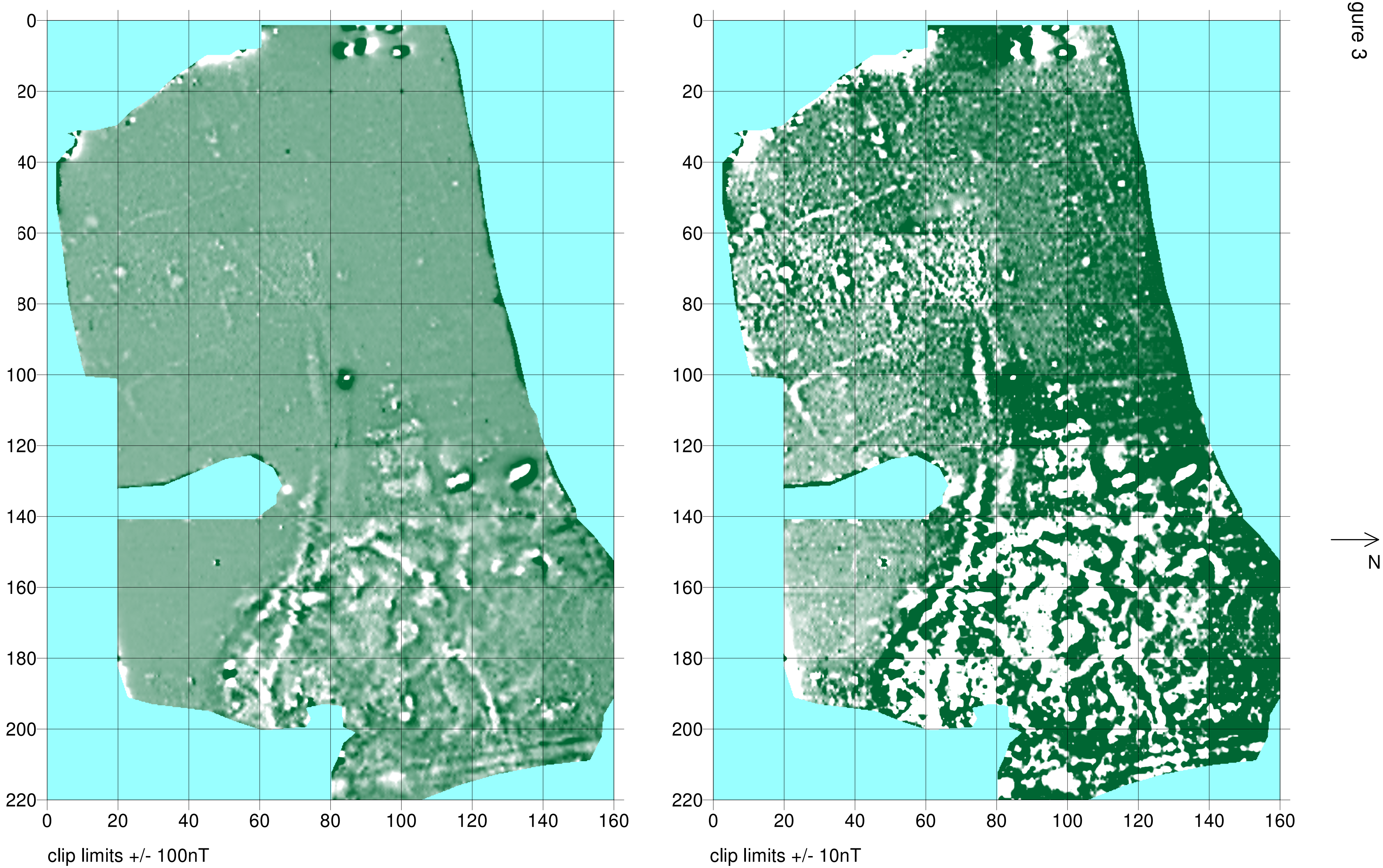
Figure 2

Figure 3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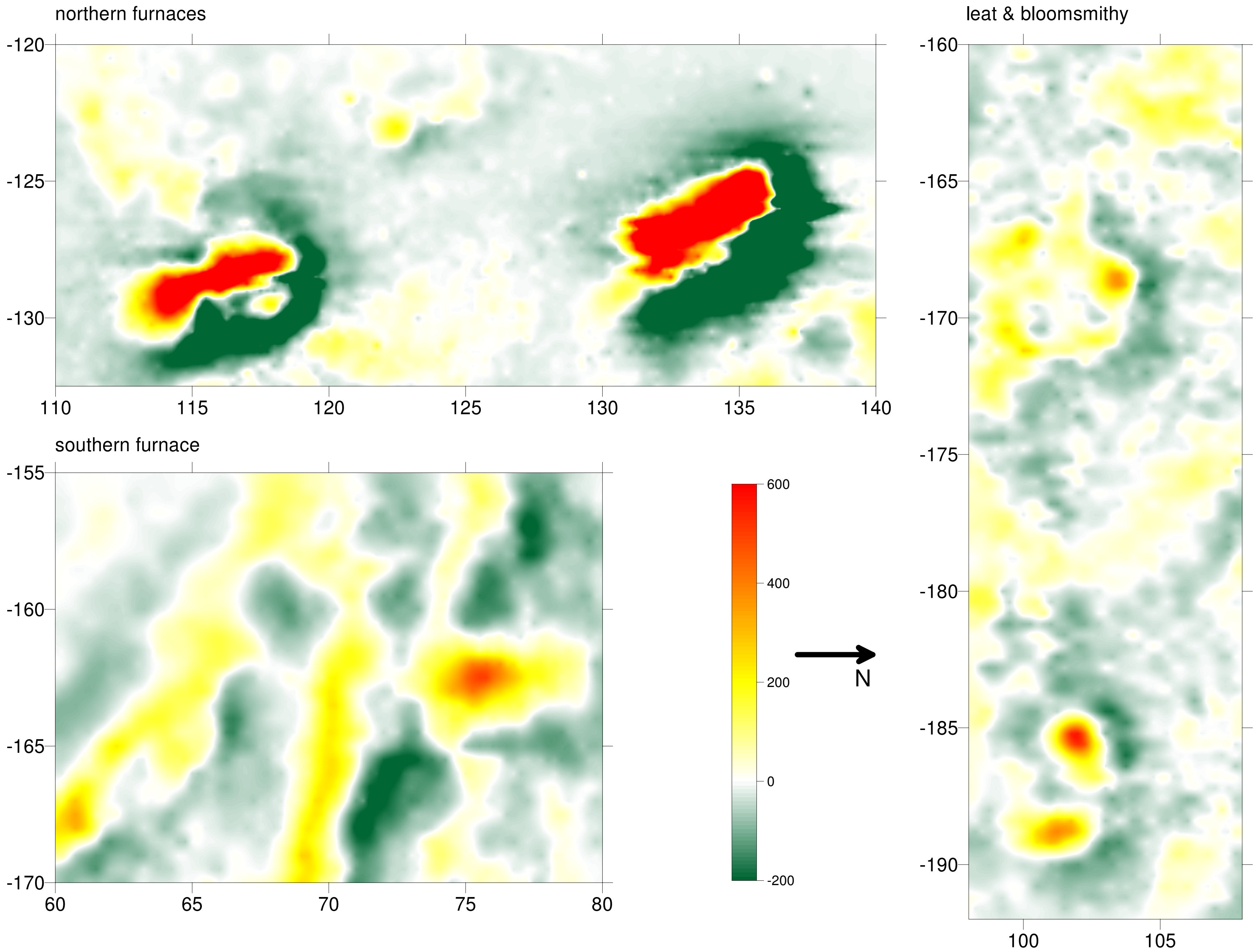
clip limits +/- 100nT
clip limits +/- 10nT
N


northern furnaces
-120
-125
-130
110
115
120
125
130
135
140
southern furnace
-155
-160
-165
-170
60
65
70
75
80
600
400
200
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leat & bloomsmithy
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-170
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-185
-190
100
105

Figure 4

Figure 5

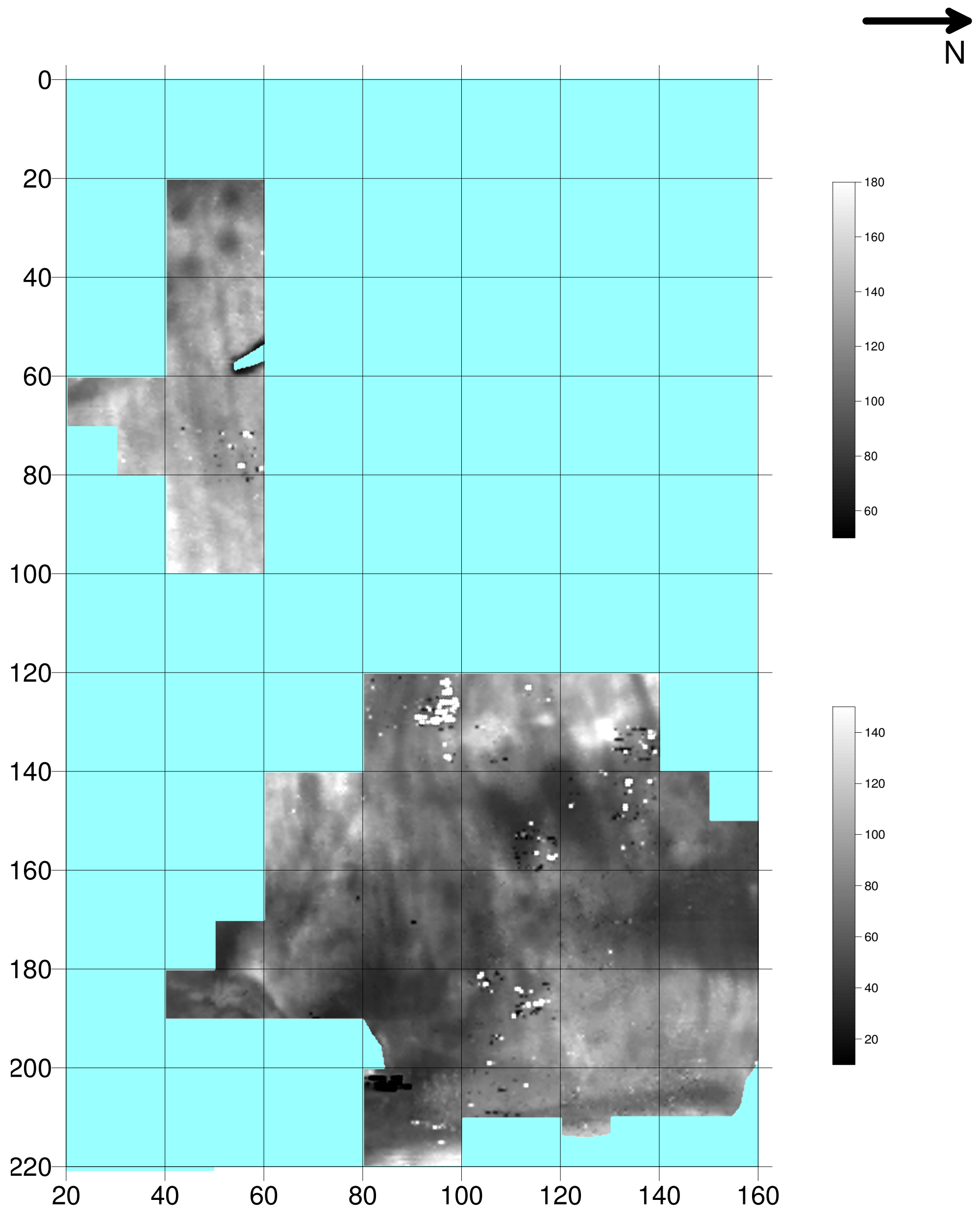

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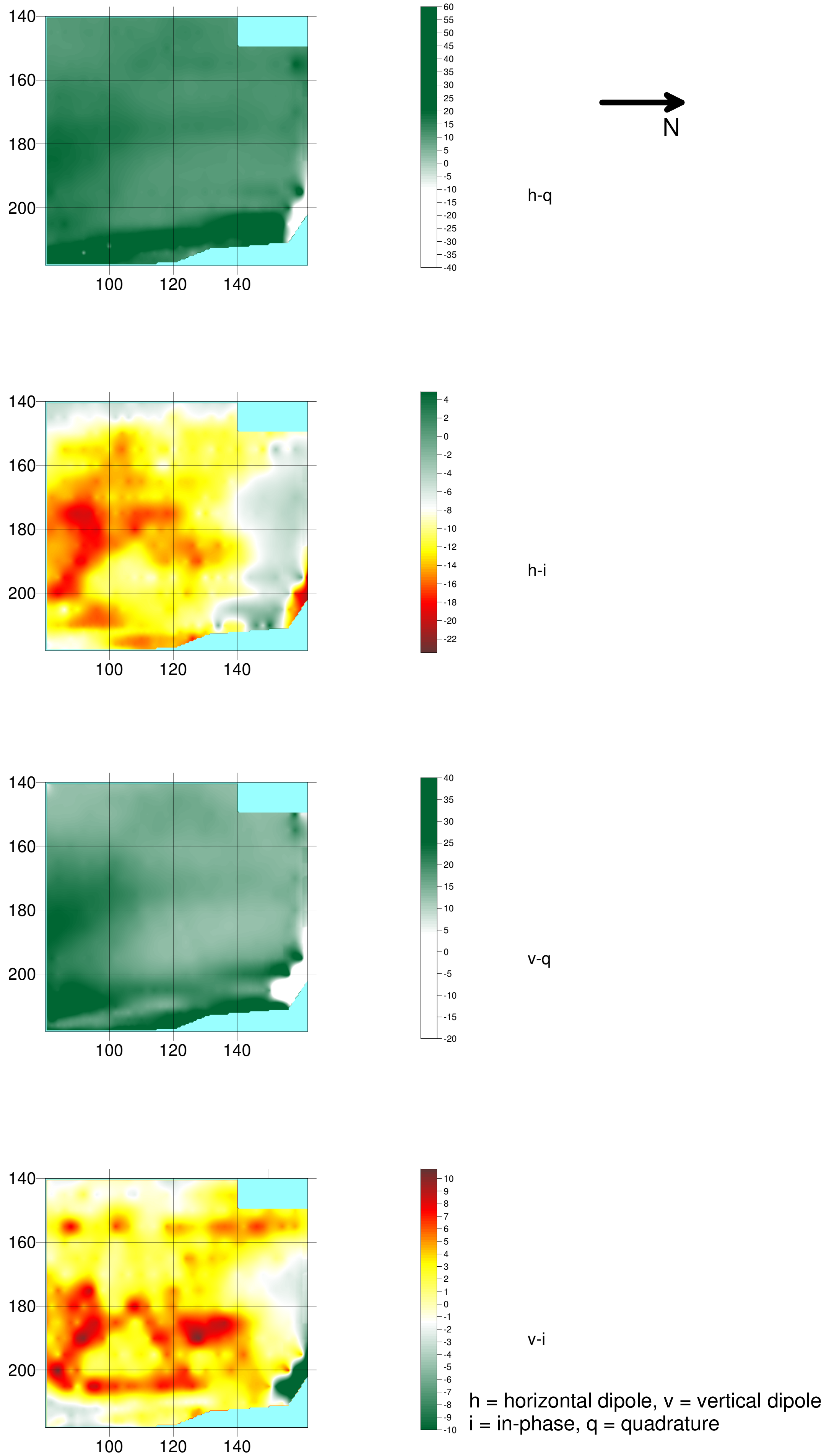
Figure 6


140
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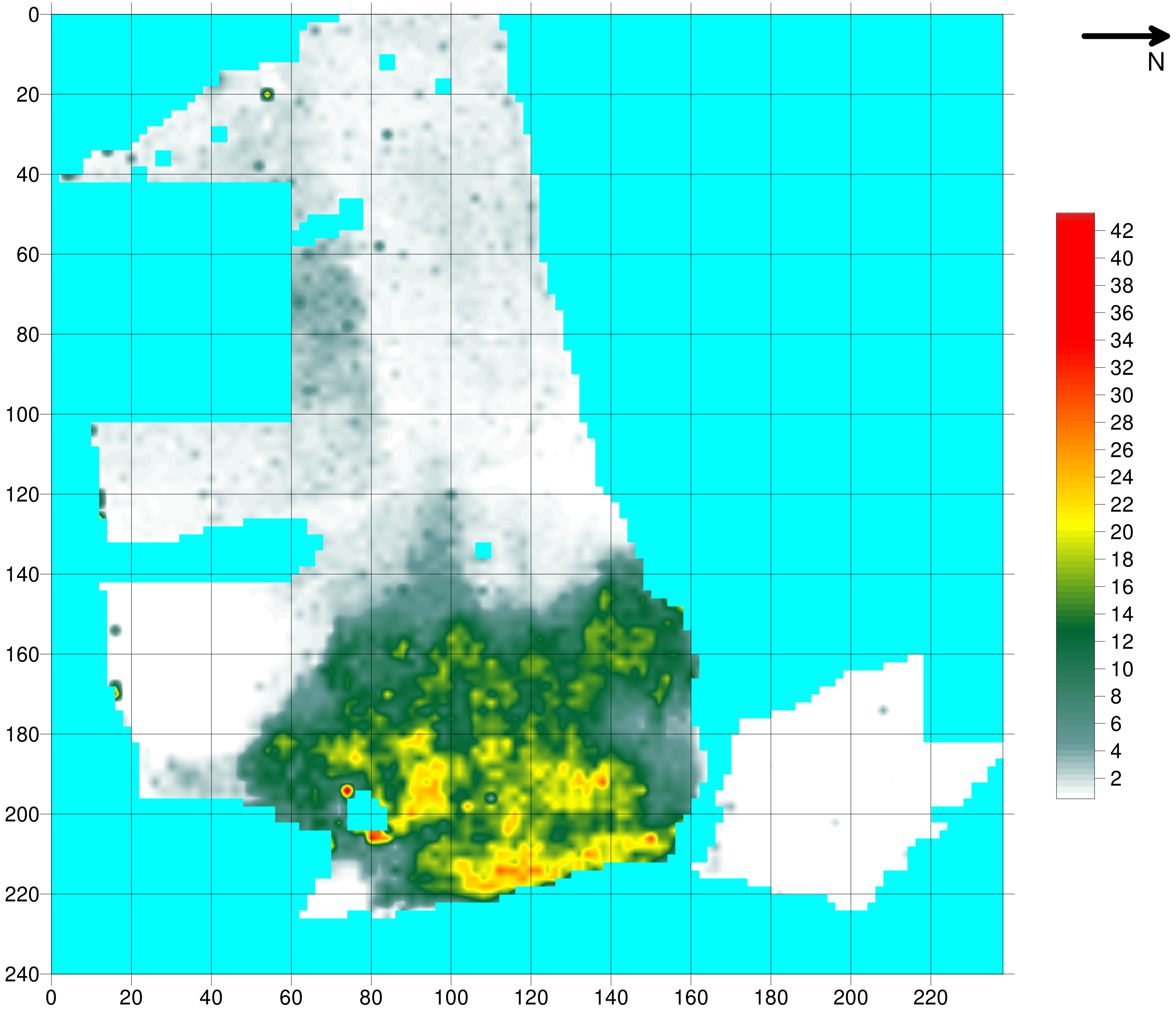
60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40
N
h-q
4 2 0 -2 -4 -6 -8 -10 -12 -14 -16 -18 -20 -22
h-i
40 35 30 25 20 15 10 5 0 -5 -10 -15 -20
v-q
10 9 8 7 6 5 4 3 2 1 0 -1 -2 -3 -4 -5 -6 -7 -8 -9 -10
v-i
h = horizontal dipole, v = vertical dipole
i = in-phase, q = quadrature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42
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38
36
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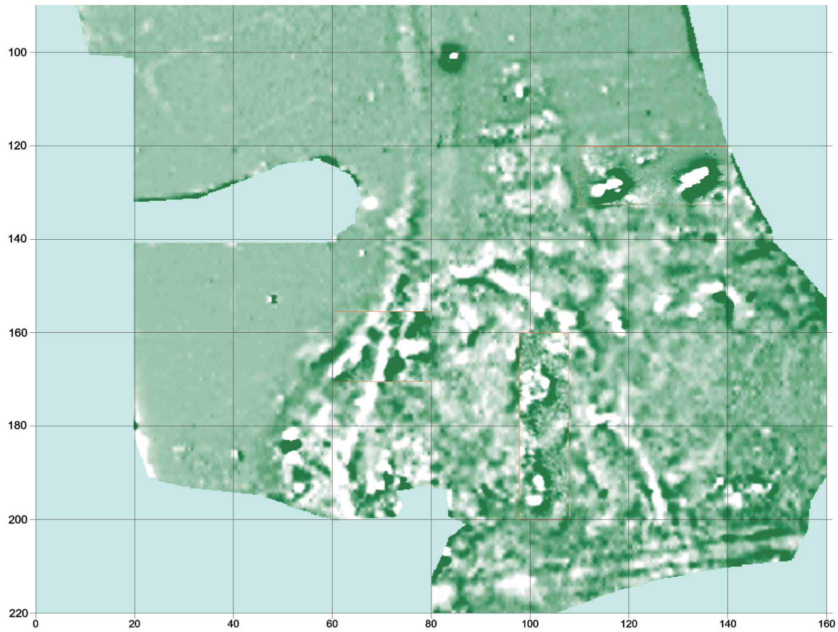
Figure 7

Figure 8



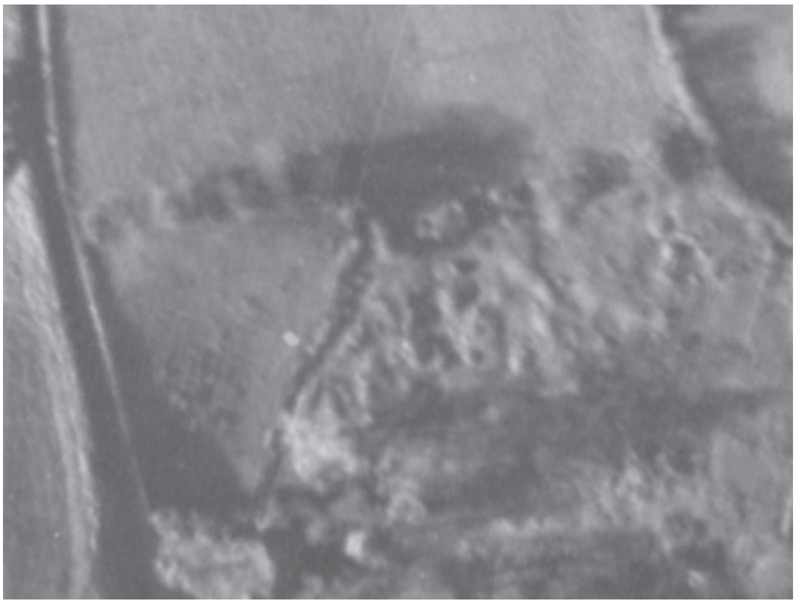
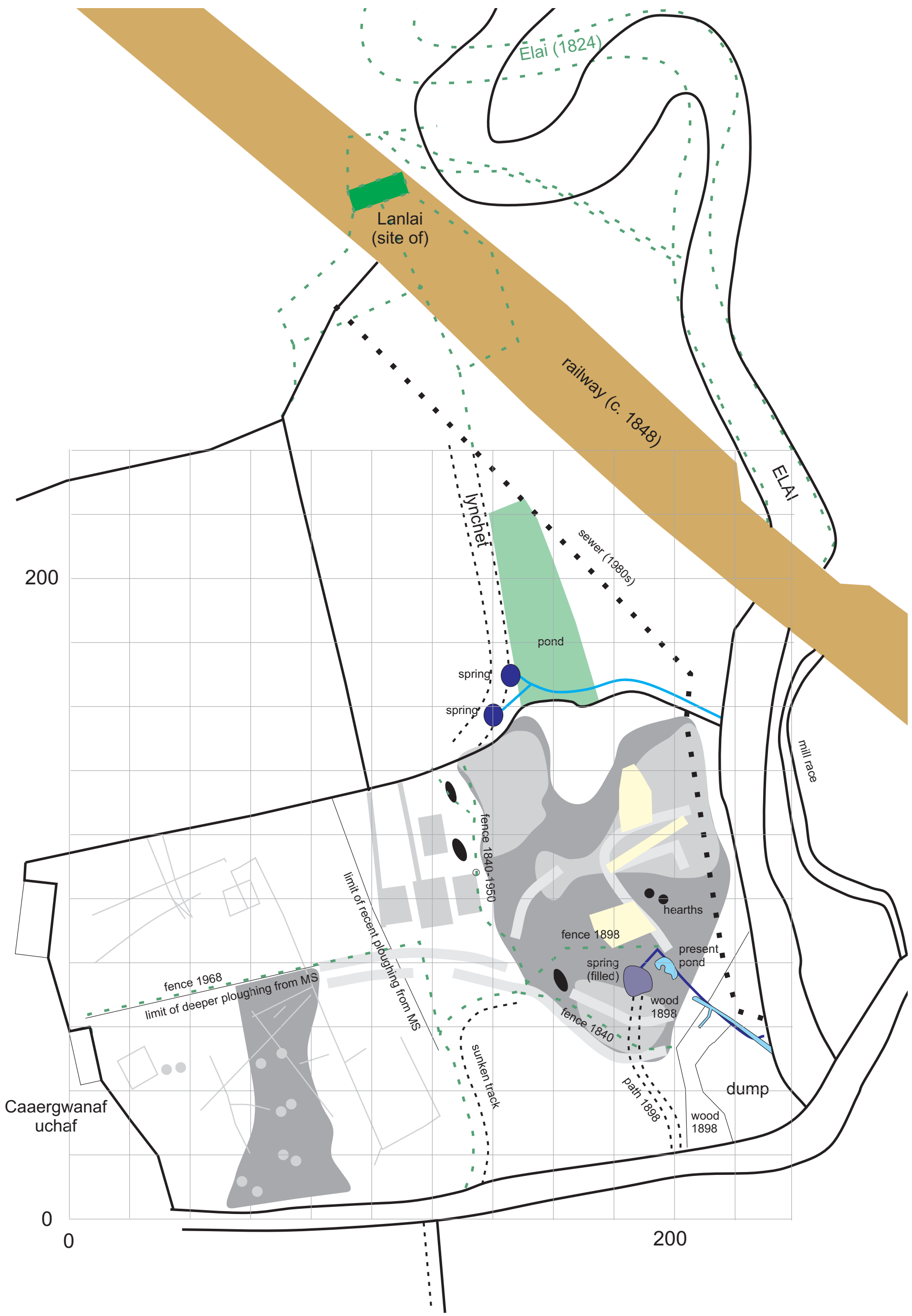
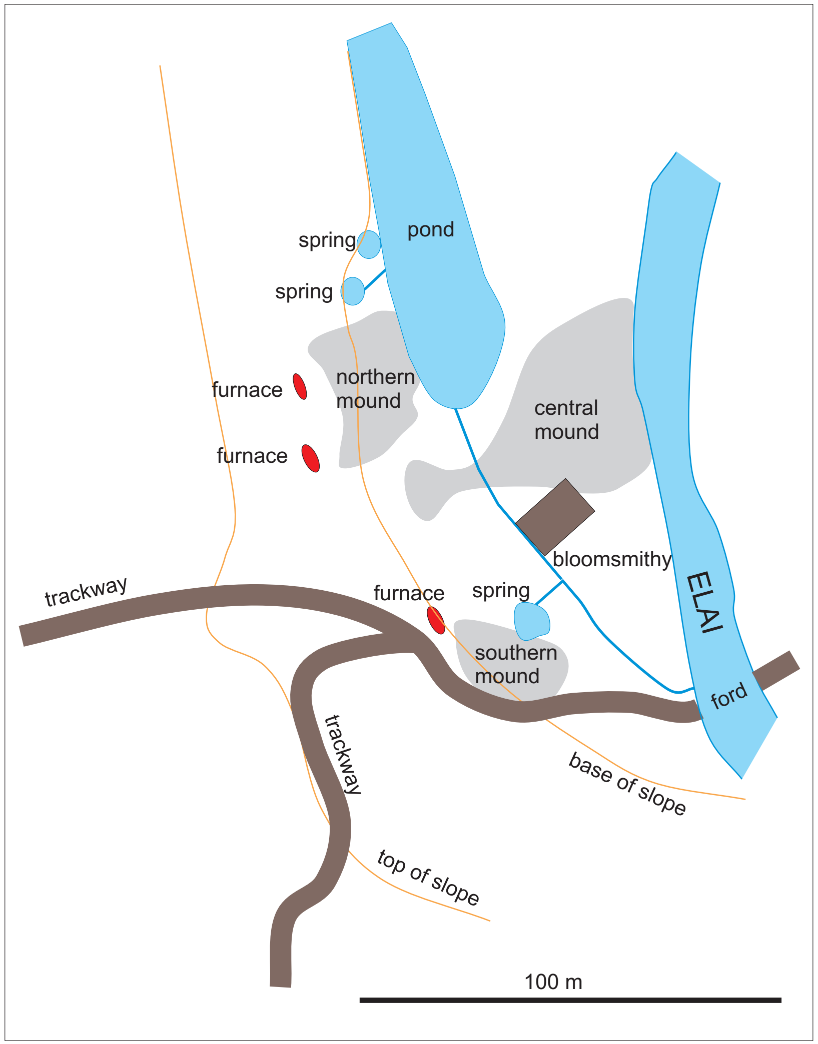


Figure 9



Elai (1824)
Lanlai
(site of)
railway (c. 1848)
ELAI
lynchet
sewer (1980s)
pond
spring
spring
mill race
fence 1840-1950
limit of recent ploughing from MS
hearths
fence 1898
present
pond
spring
(filled)
wood
1898
fence 1840
fence 1968
limit of deeper ploughing from MS
sunken track
path 1898
dump
wood
1898
Caaergwanaf
uchaf
200
0
0
200



spring
pond
spring
furnace
northern
mound
central
mound
furnace
bloomsmithy
ELAI
trackway
furnace
spring
southern
mound
ford
trackway
base of slope
top of slope
100 m