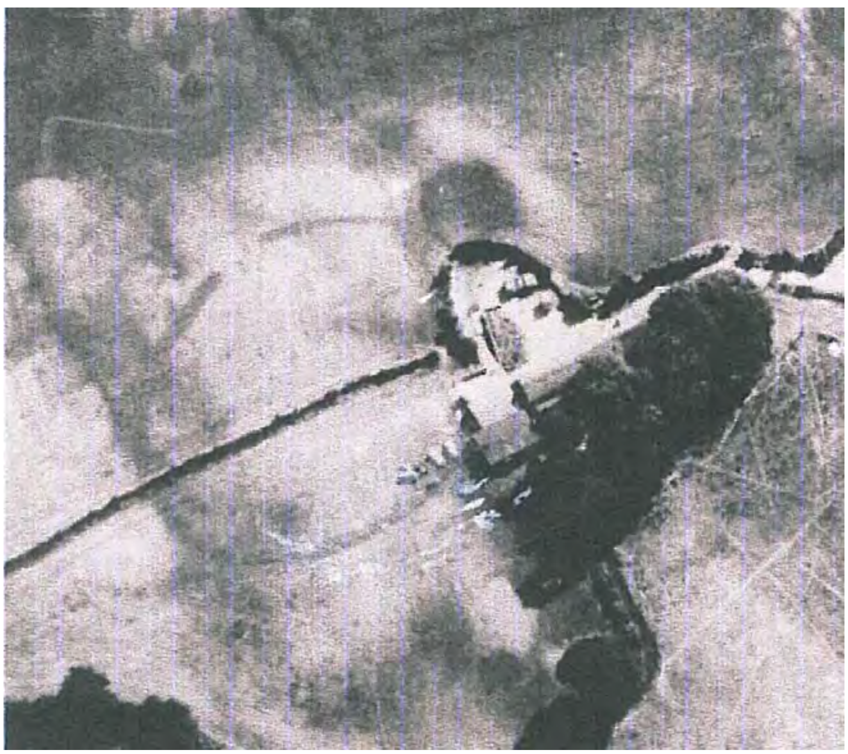
# EVALUATION EXCAVATIONS AT TYTANDDERWEN CROPMARK ENCLOSURE, BALA, MEIRIONNYDD
## EXCAVATIONS BY GWYNEDD ARCHAEOLOGICAL TRUST AND BY T. DAVIES, SHEFFIELD UNIVERSITY

**Project No. G1629**
**Report No. 767**



**Prepared for Cadw**
**December 2008**

**By George Smith, Tudur Davies and Dr J. Crowther**

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Cover picture:
Tytandderwen enclosure crop mark (Crew and Musson 1996)

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# EVALUATION EXCAVATIONS AT TYTANDDERWEN CROPMARK ENCLOSURE, BALA, MEIRIONNYDD

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# PART 1
# EXCAVATIONS BY GWYNEDD ARCHAEOLOGICAL TRUST

## 1. INTRODUCTION

This monument was completely unknown until a cropmark was identified by Chris Musson of the Royal Commission on Ancient and Historic Monuments in Wales on an aerial photograph taken by J.K.St. Joseph in the particularly dry summers of 1975 or 1976 and published in a book of recent aerial photographs of Wales (Crew and Musson 1996). It appeared to consist of a ring ditch about 60m diameter with a possible wide entrance gap on its south-east side (Fig. 4). Since the photograph was taken a hedge bank that crossed the enclosure has been removed and a barn constructed over part of the west side of the enclosure (Fig.5). Elsewhere on the floodplain, at Llanfor, closer to Bala a complex of crop marks have been recorded by the RCAHMW, comprising chiefly of the remains of several phases of Roman fort, roads and vicus but including three ring ditches thought to be Bronze Age burial monuments. Slightly to the north, on the edge of the flood plain there was also once a stone circle, known as Pabell Llywarch Hen - The Tent of Old Llywarch (a literary figure), but it was dismantled before 1914 and its exact position is uncertain (Bowen and Gresham 1967, 283).

The present work was carried out as part of a follow-up to a Pan-Wales survey of prehistoric funerary and ritual monuments for Cadw. The follow-up work in Gwynedd identified a number of sites of potentially national importance, surviving as crop marks or partial sites. These were probable Neolithic ceremonial sites, either stone circles or henges (embanked circles) all very rare in Wales. The circle at Tytandderwen was identified as possibly a Neolithic henge, its setting on a level area of floodplain, close to a river, being typical of such sites. In 2006 these sites were surveyed by geophysics, which revealed more details about them. In the case of the Tytandderwen enclosure it showed that it had a wide entrance causeway at the south, possibly t two other narrow entrances but no evidence of internal structures.

The intention in 2008 was to carry out a small evaluation excavation of the ditch in order to retrieve charcoal for radiocarbon dating and possibly artefactual dating evidence. It was carried out as a joint project with Tudur Davies of Sheffield University, as part of his doctoral research project. GAT excavated one area of ditch (Trench C) while Tudur Davies excavated two other areas, one of the main enclosure ditch (Trench B) and one of a suspected outer enclosure ditch (Trench A), seen on the aerial photograph (Fig. 4) and geophysical survey (Fig. 5). Gridded soil samples taken in 2006 were also submitted for phosphate and magnetic susceptibility analysis by Dr John Crowther at Lampeter University to provide better interpretation of the function of the enclosure.

**Acknowledgements**
Thanks go to Mr. Robert Davies of Tytandderwen for permission to carry out the excavation and for his support and assistance, also to his brother, Mr. Hywel Ll. Davies for information about the history of the farm. Thanks go also to Robert Evans of GAT, Tudur Davies and to a number of students from Bala Sixth Form College for assisting with the excavation.

## 2. TOPOGRAPHIC LOCATION AND HISTORICAL BACKGROUND

The farm lies on the flood plain of the River Dee (Afon Dyfrdwy), 2.5km to the east of Bala, 150m from the river on its southern side and on relatively level land occupying a slight promontory between the Afon Dyfrdwy and a tributary, the Afon Hirnant. The enclosure lies on a terrace about 2m above the present floodplain of the river and only 25m from a stream that may follow a former channel of the river (Fig. 4).

The field is currently permanent pasture but had been cultivated for potatoes in the 1950s and 1960s and is likely to have been used as arable land since at least the 19th century. The farmhouse of Tytandderwen was built probably in the early 19th century replacing an earlier farmhouse known as Ysgubor Isaf closer to the surviving earlier farmyard buildings. The farm was originally part of the Rhiwaedog/Rhiwlas Estate, becoming separated by inheritance within the family, and eventually sold to an Edward Roberts who sold the farm to the present owner's grandfather in about 1945. The original farmyard has expanded somewhat from that present in 1888, over part of the enclosure. However, the presence of the enclosure was unknown to the owners and no objects have ever been found that might suggest the presence of any prehistoric activity. There clearly were never any earthworks belonging to the enclosure and three field boundaries, apparently double ditch clawdd hedge banks subdivided the field in the area of the enclosure at the time of the 1888 Ordnance Survey map. These were cleared away in the 1950's to make one larger field but their lines are still visible on the geophysical survey (Figs 5 and 6).

## 3. EXCAVATION DESIGN

The original survey included a gradiometer survey and soil pitting. The gridded soil pitting showed the depth of the plough soil and the nature of the subsoil, mainly a fine gravelly silt. The gradiometer survey provided a more detailed plan of the enclosure than that shown by the aerial photographs. What appeared to be a roughly circular enclosure in fact proved to be oval in shape and some what irregular in outline. The geophysical survey did not provide any indication of the former presence of a bank, either internal or external. The absence of any evidence of a bank shows the extent of damage as a result of long continued arable cultivation. The absence also of internal features is therefore not unexpected. The aims of the excavation were limited to a brief investigation to try to ascertain the date and function of the enclosure by a single trench across the enclosure ditch. The trench excavated was close to the main southern entrance but avoiding the entrance itself, where the geophysical survey suggested that there might be some complexity. A trench (C) 10m by 1.6 metres was cut by machine across the line of the ditch to the base of the plough soil. The ditch fill was then excavated by hand.

Two other trenches were excavated in a similar manner by Tudur Davies (Part 2 below). Trench A investigated the slight curving feature seen on the geophysical survey and interpreted as a possible outer enclosure ditch concentric with the main enclosure. Another, larger trench (B) was excavated over the line of the main enclosure ditch at the north-east, to include part of the internal area where the geophysical survey indicated a feature, although interpreted as possibly a natural remnant palaeo-channel (Fig. 6).

## 4. EXCAVATION RESULTS

**Trench C** (Fig. 7)

The subsoil was red-brown, sandy fine gravel, showing a fluvial or fluvio-glacial origin and the darker fill of the ditch showed clearly. Two other small features, 111 and 113 were seen on the inner side of the ditch. 113 proved to be a natural pocket of gravel. 111 lay on the edge of the trench so was not fully revealed. Its fill was a fairly homogeneous, stone and charcoal-free gravel giving no indication that it was an artificial feature so it may have been just an animal burrow.

The uppermost fill of the ditch (103) was a reddish-brown silt similar to and continuous with the modern plough soil above. 103 only differed from the modern plough soil by the presence of a number of stones broken and altered by burning. There was also a scatter of charcoal fragments.

Below this old plough soil was a layer of similar but slightly darker and more humic material (104) which contained a considerable number of burnt stone and charcoal fragments. This layer appears to represent a long period of stability when a humic topsoil developed over the area, after the ditch had largely silted in. The top of this layer was defined by a thin lens of mottled grey-brown material, perhaps the remains of an old turf line.

Layer 105 and 106 were fine gravely secondary ditch silts, with only a few larger stones within the bottom of the ditch. These overlay a two much more stony horizons, (107) and (110) representing primary silts of the ditch, the larger stones all concentrated in the central basal scoop of the ditch.

The sides of the ditch initially were exposed as a fine clayey silt (109) but cleaning of the edges revealed that this was not subsoil but a thin horizon that seems to have been deliberately placed on the ditch sides to prevent them eroding (Figs 7 and 9). The subsoil itself at this depth was loose, fine unstable gravel and this was exposed after removal of 109. Layer 109 then covered the sides of the ditch before the more stony silt 110 started to accumulate in its base. It seems likely that 109 was deliberately laid on the ditch sides in order to stabilise the ditch sides.

The ditch overall was 1.77m deep with a slight narrow cut preserved in its base, similar to the design of a Roman fort ditch (Fig. 7). The similarity of the modern plough soil and the top ditch fill 103 suggests that at some point, the ditch had been present as a shallow linear depression. This top layer could have resulted just from continued ploughing and could have derived from an adjoining bank, but the general homogeneity of the gravel layers gives no proof one way or the other. There was no bias in the ditch silts to indicate erosion from an internal bank. This might also be inferred from the asymmetric profile of the ditch, with the ditch edge eroded on the east but not on the west, which may therefore have been protected by eroded bank material.

## 5. ARTEFACTUAL EVIDENCE

There were no artefacts apart from burnt stones, of which a sample was retained. Such stones are generally taken to represent prehistoric cooking activity and this suggests that the enclosure was used for a domestic purpose. However, the presence of burnt stones only in the layer that formed after the enclosure ditch had silted-in or in the ploughed-in layer above it suggests that the activity that created the burnt stones may have post-dated the original construction and use of the enclosure. Charcoal was found however, in all layers. Comparison of dates of charcoal from different layers of the ditch could provide an indication of the period or periods that are represented by the enclosure.

## 6. REPORT ON A SOIL PHOSPHATE AND MAGNETIC SUSCEPTIBILITY SURVEY OF THE TYTANDDERWEN PREHISTORIC CROPMARK ENCLOSURE (PRN 9982), BALA, GWYNEDD

***By:* J. Crowther (October 2008)**
Archaeological Services, University of Wales, Lampeter, Ceredigion, UK SA48 7ED

### Introduction

The present survey was undertaken to complement recent geophysical and other work in the vicinity of the Tytandderwen prehistoric (likely Early Neolithic) enclosure (Hopewell and

Smith 2007), in the hope of gaining additional insight into the nature and function of the enclosure. In total, 67 samples of topsoil were taken on a 10-m grid across the enclosure and the area immediately around it. Of these sampling points, 14 are located within the enclosure and 50 outside – the remaining 3 being on the boundary of the feature (Fig. 12). It should be noted at the outset that the results of topsoil phosphate and magnetic susceptibility surveys need to be interpreted with caution, particularly in relation to a feature of likely early Neolithic age, because of the likelihood of subsequent 'contamination' and 'disturbance' of earlier anthropogenic signatures during later phases of human activity.

Both phosphate and magnetic susceptibility are routinely determined in archaeological site investigation:

**Phosphates:** Phosphates occur naturally in all organic material (topsoil, plant tissue, excreta, bone, etc.). As they are released by organic decomposition processes, they tend to form insoluble compounds and thus become 'fixed' within the mineral fraction of soils and sediments. Many forms of human activity lead to phosphate enrichment and, under favourable conditions, this may remain detectable for $10^2$-$10^3$ years (see reviews by Bethel and Máté, 1989; Crowther, 1997; Heron, 2001).

**Magnetic susceptibility:** $\chi$ (low frequency mass-specific magnetic susceptibility) in soils and sediments largely reflects the presence of magnetic forms of iron oxide (e.g. maghaemite) – this being dependent upon the presence of iron (Fe) and occurrence of alternating reduction-oxidation conditions that favour the formation of magnetic minerals. Enhancement is particularly associated with burning, but is also caused by microbial activity in topsoils (see reviews by Clark, 1996; Scollar *et al.*, 1990). $\chi_{\mathbf{max}}$ is a measure of maximum potential magnetic susceptibility, determined by subjecting a sample to optimum conditions for susceptibility enhancement in the laboratory. In general it will tend to reflect the overall iron concentration of a sample. $\chi_{\mathbf{conv}}$ (fractional conversion), which is expressed as a percentage, is a measure of the extent to which the potential susceptibility has been achieved in the original sample, viz: $(\chi/\chi_{max}) \times 100.0$ (Tite, 1972; Scollar *et al.*, 1990). In many respects this is a better indicator of magnetic susceptibility enhancement than raw $\chi$ data, particularly in cases where soils or sediments may have widely differing $\chi_{max}$ values (Crowther and Barker, 1995; Crowther, 2003).

In the present survey inorganic phosphate (phosphate-$P_i$) was determined (cf. total phosphate), since it is likely that any phosphate enrichment associated with the prehistoric enclosure will have been mineralised. It also eliminates the need to take into account organic phosphates present in the modern topsoil. With spatial topsoil surveys of phosphate-$P_i$ and $\chi$ it is important to investigate whether any patterns that emerge are attributable to phosphate enrichment and susceptibility enhancement, rather than to the effects of other confounding variables. Spurious patterns in phosphate can occur, for example, as a result of variability in the nature of the topsoil (e.g. in organic matter content, pH and soil texture). In the case of $\chi$, spatial variability in $\chi_{max}$ is potentially problematic. For large surveys it is not cost effective to determine $\chi_{max}$ for each sample. In these cases it is recommended that $\chi_{max}$ (and $\chi_{conv}$) determinations are made on a representative set of subsamples in order to establish the strength of the relationship between $\chi$ and $\chi_{conv}$ (Crowther and Barker, 1995). In cases where a strong relationship exists, then the 'raw' $\chi$ data can be assumed to reflect closely patterns of susceptibility enhancement across a site. Determinations were therefore made of loss-on-ignition (LOI – to estimate organic matter content), pH, maximum potential magnetic susceptibility ($\chi_{max}$) and, hence, fractional conversion ($\chi_{conv}$; Crowther, 2003) on representative samples to enable rigorous interpretation of the phosphate-P and $\chi$ survey data.

## Methods

### *Experimental design*

Determinations of phosphate-$P_i$ and $\chi$ were made on all 67 samples. In addition, pH was determined on five representative samples from across the site; LOI on 20 representative samples, comprising some with the highest and lowest phosphate-$P_i$ concentrations, and other samples that appeared to have relatively high or low organic matter contents; and $\chi_{max}$ (and $\chi_{conv}$) on 20 representative samples comprising those with the highest $\chi$ values and a range of low-moderate values.

***Laboratory methods***

Analysis was undertaken on the fine earth fraction (i.e. < 2 mm) of the samples. Phosphate-$P_i$ was determined colorimetrically, following extraction with 1N HCl; LOI (loss-on-ignition) by ignition at 375$^{o}$C for 16 hrs (Ball, 1964); and pH (1:2.5, water) using a combination electrode. A Bartington MS2 meter was used for magnetic susceptibility measurements. $\chi_{max}$ was achieved by heating samples at 650°C in reducing, followed by oxidising conditions. The method used broadly follows that of Tite and Mullins (1971), except that household flour was mixed with the soils and lids placed on the crucibles to create the reducing environment (after Graham and Scollar, 1976; Crowther and Barker, 1995).

***Statistical analysis***

Relationships between the various soil properties were examined using the Pearson product-moment correlation coefficient ($r$) and comparisons between samples from inside and outside the enclosure using *t*-tests. Of the data sets, only phosphate-$P_i$ was found to be markedly skewed and a $\log_{10}$ transformation was applied to the phosphate-$P_i$ values to increase parametricity. Statistical significance has been assessed at the 95% confidence level.

**Results**

The full analytical results are presented in Appendix 1; summary statistics in Tables 1 and Table 2; and various spatial plots and scatter diagrams in Figs. 13-18.

***General character of soils***

The soils in the vicinity of the site are developed on a low river terrace of the Afon Dyfrdwy. The site is relatively flat and the land presently used as pasture, though it may at times in the past have been used for arable. The LOI values (range: 3.73–7.63%) seem likely to be fairly typical of topsoils in this environment. The only somewhat surprising feature of these data is that the samples (110/130, 120/140 and 130/130) from the vicinity of the wet depression identified in the geophysical survey (location 11, Fig. 6), which appeared to show signs of being gleyed, are not rather more organic rich. While the soils are predominantly acidic, one sample (120/140) from the area of the wet depression has a much higher pH of 6.1. This latter result is seems likely to be attributable to the effects of recent activity, e.g. liming (or it is possible that lime has been derived from mortar used in construction or fill materials?).

***Phosphate-$P_i$ survey***

Phosphate-$P_i$ concentrations exhibit quite wide variability across the survey area (range, 0.131–1.47 mg $g^{-1}$). As might be anticipated, there is a direct correlation between $\log_{10}$ phosphate-$P_i$ and LOI (r = 0.574; $p < 0.05$), which likely in part reflects the underlying importance of organic matter as a source of inorganic phosphate. However, the relationship is clearly quite weak (Fig. 3, $r^2 = 0.298$), with variations in LOI accounting for < 30% of the variability in phosphate-$P_i$ – i.e. > 70% of the variability in phosphate-$P_i$ is accounted for by other factors.

As noted above, the phosphate-$P_i$ concentrations are quite skewed, with most of the samples having quite low concentrations. Somewhat arbitrarily, samples with concentrations of ≥ 0.750 mg $g^{-1}$ are taken here as to be indicative of some degree of phosphate enrichment. Interestingly, the spatial plot of phosphate-$P_i$ (Fig. 15) reveals that the enriched samples are all located within or in the immediate vicinity of the enclosure. In fact, the six samples with phosphate-$P_i$ concentrations ≥ 1.00 mg $g^{-1}$ are all located within the enclosure or along its edge. The occurrence of enrichment within the area of the enclosure is further confirmed by *t*-tests (Table 2), which shows that the mean concentration within the enclosure (0.810 mg $g^{-1}$)

is significantly higher ($p < 0.001$) than outside (0.458 mg $g^{-1}$). These results are certainly most encouraging in that they clearly indicate enrichment within the confines of the enclosure. It seems reasonable to assume, in the absence of evidence of later superimposed features from the archaeological record, and assuming that there has been no concentration of organic input in this area through later farming practices (e.g. positioning of animal feed trough, etc. [need to check this]), that the enrichment does relate to the original enclosure. Unfortunately, on present evidence the nature of the enrichment cannot be established (perhaps trial excavation may provide some insight). However, given that the signal remains quite strong, it seems likely that the enrichment is at least partly derived from domestic activity (e.g. midden-type deposits that would likely include bone) rather than simply the result of manuring (e.g. corralling of animals).

***Magnetic susceptibility survey***

The $\chi_{max}$ data (range, 812–2480 x $10^{-8}$ SI – a *c.* 3-fold difference) display quite wide variability, which is likely to reflect variations in Fe content across the survey area (Fig. 16). As might be anticipated, the two lowest values (< 1000 x $10^{-8}$ SI) occur in the vicinity of the wet depression and presumably reflect mobilisation and leaching of Fe as a result of gleying. Elsewhere, a band of generally higher values (> 2000 x $10^{-8}$ SI) is present down the eastern side of the survey area, the origin of which is uncertain.

By comparison, the $\chi$ data show even greater variability (range, 22–225 x $10^{-8}$ SI – a *c.* 10-fold difference). As a consequence, there is a very strong underlying relationship between $\chi$ and $\chi_{conv}$ (Fig. 6). In these circumstances, it is reasonable to assume that variations in $\chi$ recorded across the full set of 67 samples (Fig. 18) closely reflect variations in the degree of susceptibility enhancement. Under UK conditions, archaeological contexts with $\chi_{conv}$ values of > 5.00% are often taken to be indicative of burning (Crowther, 2003), which corresponds here with a $\chi$ value of *c.* 100 x $10^{-8}$ SI (Fig. 17). In topsoils, in which significant enhancement can occur through natural fermentation processes, a somewhat higher threshold of, say, 7.5% or even 10% (which correspond with $\chi$ values of *c.* 150 or 200 x $10^{-8}$ SI), may be more appropriate. Accordingly, thresholds of 100, 150 and 200 x $10^{-8}$ SI have been used in Fig. 18. From this plot it is clear that the most likely areas of enhancement (as might be associated with heating/burning) are located in the eastern part of the survey area. Of the sample points with values > 150 x $10^{-8}$ SI, two are located within the enclosure. Interestingly, one of these (180/160) has the highest $\chi$ value recorded (225 x $10^{-8}$ SI) and the other (180/180) is the point within the enclosure at which the highest phosphate-$P_i$ concentration was recorded. Overall, however, the topsoils with the enclosure do not have a significantly higher mean $\chi$ than those outside (Table 2) – i.e. evidence of burning is quite localised within the enclosure, and is not confined to the enclosure.

**Conclusions and recommendations**

Clearly, the results of topsoil phosphate and magnetic susceptibility surveys need to be interpreted with caution, particularly when associated with a feature of likely Early Neolithic age. Nonetheless, the results have generated some potentially interesting data. Of greatest interest is the phosphate survey, which has revealed quite a clear, extensive and well-defined area of phosphate-$P_i$ enrichment within the area of the enclosure. Assuming that this enrichment is contemporary with the enclosure (further checking of possible later sources of enrichment, including that from recent farming, is required to support this), then it seems likely that the phosphate has been derived, at least in part, from midden-type deposits (i.e. associated with domestic occupation), rather than simply from the corralling of animals. By comparison, the magnetic susceptibility data are much more equivocal. Two points within the enclosure do, however, show clear signs of enhancement as might be associated with heating/burning. Of these, one point (180/180) is the location within the enclosure at which the highest phosphate-$P_i$ concentration was recorded. Since grid point 180/180 was not one of the 20 soil test pits investigated on the site, it is recommended that if further trial pitting is undertaken at Tytandderwen, then this particular point should be one that is investigated.

**Table 1: Summary statistics for all samples**

| | n | Mean | Minimum | Maximum | S. Dev. |
|---|---|---|---|---|---|
| Loss-on-ignition (%) | 20 | 5.95 | 3.73 | 7.63 | 0.904 |
| pH (water) | 5 | 5.1 | 4.7 | 6.1 | 0.586 |
| Phosphate-$P_i$ (mg $g^{-1}$) | 67 | 0.549 | 0.131 | 1.47 | 0.251 |
| $\chi$ ($10^{-8}$ SI) | 67 | 109 | 22 | 225 | 39.8 |
| $\chi_{max}$ ($10^{-8}$ SI) | 20 | 1870 | 812 | 2480 | 453 |
| $\chi_{conv}$ (%) | 20 | 5.88 | 2.00 | 9.74 | 2.10 |

**Table 2: Summary statistics for samples from outside and inside the enclosure[a] and results of t-tests [b] comparing the mean values for the two data sets**

| | n | Mean[b] | Minimum | Maximum | S. Dev. |
|---|---|---|---|---|---|
| **Outside enclosure** | | | | | |
| Loss-on-ignition (%) | 14 | 5.78 | 3.73 | 7.63 | 1.01 |
| pH (water) | 3 | 5.3 | 4.8 | 6.1 | 0.72 |
| Phosphate-$P_i$ (mg $g^{-1}$) | 50 | **0.458**** | 0.131 | 0.862 | 0.153 |
| $\chi$ ($10^{-8}$ SI) | 50 | 105 | 22 | 183 | 40.2 |
| $\chi_{max}$ ($10^{-8}$ SI) | 16 | 1840 | 812 | 2480 | 491 |
| $\chi_{conv}$ (%) | 16 | 5.46 | 2.00 | 7.38 | 1.94 |
| **Inside enclosure** | | | | | |
| Loss-on-ignition (%) | 5 | 6.22 | 5.93 | 6.54 | 0.275 |
| pH (water) | 1 | 4.8 | | | |
| Phosphate-$P_i$ (mg $g^{-1}$) | 14 | **0.801**** | 0.506 | 1.25 | 0.600 |
| $\chi$ ($10^{-8}$ SI) | 14 | 126 | 80 | 225 | 37.0 |
| $\chi_{max}$ ($10^{-8}$ SI) | 4 | 1990 | 1680 | 2310 | 259 |
| $\chi_{conv}$ (%) | 4 | 7.57 | 4.76 | 9.74 | 2.08 |

[a] Of the 67 samples, three are located on the line of the boundary ditch of the enclosure and have been excluded from this analysis.

[b] Results of t-tests (in case of phosphate-$P_i$ the data were $\log_{10}$-transformed to increase parametricity) – values highlighted indicate a statistically significant difference in mean values: ** indicates difference significant at $p < 0.001$; in all other cases the difference is not significant.

## 7. CHARCOAL IDENTIFICATION

By Astrid Caseldine

Charcoal was retained as single pieces, 18 from Context 103, 16 from Context 104, 1 from Context 108 (interface between Contexts 107 and 109 and 110), 4 from 109 and 10 from 110.

5 pieces were identifiable and suitable for AMS, as in Table 3 and those from 104 and 110 were submitted for dating.

**Table 3 Tytandderwen Single pieces of charcoal suitable for AMS dating**

| ***Sample No.*** | ***Context No.*** | ***Species*** | ***weight/ grammes*** | ***No of rings*** | ***Description*** |
|---|---|---|---|---|---|
| 105 | 103 | *Alnus glutinosa* (L.) Gaertner (Alder) | 0.3756 | 4+ | Not round wood |
| 110 | 104 | *Alnus glutinosa* (L.) Gaertner (Alder) | 0.3831 | 6+ | Frag of round wood |
| 107 | 108 | *Quercus* sp. (Oak) | 0.0634 | 3+ | Not round wood |
| 108 | 109 | *Corylus avellana* L. (Hazel) | 0.1934 | 8+ | Frag of round wood |
| 111 | 110 | *Corylus avellana* L. (Hazel) | 0.2423 | 5+ | Not round wood |

Bulk samples of 10 litres each were also taken from each layer and processed by flotation for charred macrobotanical remains. These flotation samples are yet to be assessed.

## 8. RADIOCARBON DATING

Two samples were selected for dating either young wood (Sample 110) or short-lived species (Sample 111). Sample 110 was from context 104, the humic upper fill of the ditch. Sample 111 was from context 110, the primary fill of the ditch. The abbreviated results are given below and the full calibration plots in Appendix 4.

**Sample 110**

Beta - 250544
Measured Radiocarbon Age: 1960 +/- 40 BP
13C/12C Ratio: -25.6 o/oo
Conventional Radiocarbon Age: 1950 +/- 40 BP
Analysis: AMS
Material/Pretreatment: (charred material): acid/alkali/acid
2 Sigma Calibration: Cal BC 40 to Cal AD 130 (Cal BP 1990 to 1820)

**Sample 111**

Beta - 250545
Measured Radiocarbon Age: 2290 +/- 40 BP
13C/12C Ratio: -24.3 o/oo
Conventional Radiocarbon Age: 2300 +/- 40 BP
Analysis: AMS
Material/Pretreatment: (charred material): acid/alkali/acid

2 Sigma Calibration: Cal BC 410 to 360 (Cal BP 2360 to 2300) AND Cal BC 290 to 240 (Cal BP 2240 to 2180)

## 9. DISCUSSION

The geophysical survey showed the Tytandderwen enclosure to be sub-circular with one wide entrance on the south side and possibly two narrow entrances on the north and north-east sides. Part of the enclosure at the west has been hidden under the modern farmyard so the entire layout is not known. The frequency of entrances suggested that the enclosure might be of Neolithic date, like a causewayed enclosure or even a henge. However, the excavated ditch profile is neat and vee-shaped suggesting a later prehistoric or even Roman-British date suggesting that it was a settlement and this is supported by the presence of burnt stones in the ditch fill. The geophysical survey gave no indication of the presence of a former enclosure bank, either by the presence of remains of a bank or negatively, by the location of any internal features that might respect a bank. One linear anomaly even lay where a bank would be present and this feature was identified as genuine by excavation (See Part 2, Trench B).

Trench C exposed a sufficient area on the inner side of the ditch to identify a bank if there were any preserved remains, or a ‘ghost’ feature or post-holes of revetting. Nor did the geophysical survey provide any evidence of internal features such as round-houses or hearths. In all it seems that the lack of features must be due to the soft nature of the subsoil, which has been much truncated by a long period of ploughing.

The radiocarbon dating used short-lived or young wood and the two dates provide the best evidence of the period of use of the enclosure. This indicates a construction around the 4$^{th}$ to 3$^{rd}$ centuries BC and abandonment or final use between the 1$^{st}$ century BC to the 2$^{nd}$ century AD. The 1 sigma calibration of the latter gives a date of between AD10 to AD 80 hinting that the enclosure may have been abandoned at the time of the Roman incursion into this area, perhaps when the first camp was constructed at Llanfor to the west, which predates the timber fort, the ditch of which has produced pottery of probable Flavian date (Hopewell 2007).

The soil survey provides further evidence that the enclosure was a settlement rather than as ceremonial or stock enclosure. It shows enhanced levels of phosphate within the enclosure (Fig. 15) and of possible burning within and outside the enclosure (Fig. 18). This all accords with the presence of quantities of burnt stone fragments in the ditch fill. The location of the enclosure is favourable for settlement and agriculture on level ground with deep well-drained soil but close to the river. It is not in any way a prominent position although the size and depth of the ditch suggests a partly defensive function. The main entrance is very wide for a defended enclosure but the actual entrance through the bank would have been much narrower and there are geophysical anomalies in that area that could be the post-holes for such an entrance, up to 4m wide (Fig. 5).

The geophysics shows that northern half of the internal area of the enclosure is clearly noisier in terms of minor anomalies than outside the enclosure and this can be expected to be the result of settlement activity. However, excavation of trench B (Part 2, below) showed that the natural subsoil there was rather different from that in trench C, being less homogeneous and therefore probably noisier on the geophysics. It would still be reasonable to expect the main area of settlement in the enclosure to be at the north, with perhaps with an open yard immediately within the entrance.

Small defended lowland enclosures of known or probable Iron Age to Romano-British date occur quite widely in Wales, varying in plan from sub-rectilinear to sub-circular, often known just from crop marks in Llŷn, Anglesey and the Clwyd, Dee and Upper Severn valleys. A survey of such enclosures in north-east Wales identified about 70 small enclosures varying in internal area from 0.1 to 1.2 ha but most were around 0.2ha. The same survey extended into the Upper Severn valley found most were of a similar size, around 0.4ha, most close to arable land and clustered in the vicinity of hillforts (Manley 1991). Recent aerial survey of Llŷn has identified several similar new enclosures in the lowland and more can be expected (Hopewell and Smith 2008). Assuming an internal bank the internal area of the Tytandderwen enclosure was about 0.15ha and so quite comparable to these. It also bears close resemblance to the 'rath' settlements of Pembrokeshire such as the excavated, well-preserved site of Walesland. That enclosure, which was of *c.* o.2ha internally, with a considerable bank and ditch, also had a wide-spaced entrance gap through the ditch leading to a much narrower, well-fortified gateway. Inside were 6 or 7 roundhouses that had been rebuilt several times, occupied from the 3rd century BC and refortified in the late 1st century BC (Wainwright 1971). The radiocarbon dates from Tytandderwen indicate a similar period of use but in terms of the overall pattern of known settlement of that period it is fairly isolated, with very little known settlement in east Meirionnydd. However, not far away there are two small defended hill slope enclosures at Mynydd Mynyllod and Cefn Ddwysarn and a major hillfort at Cefn Caer Euni (Fig. 19). These, with Tytandderwen can be regarded as a small group of outlying settlements belonging more with tribal groups in the Upper Dee and mid-Wales rather than inland Meirionnydd. The valley floor east of Bala has been quite intensively studied by aerial photography and by geophysics because of the presence of a sequence of Roman camps but no other Iron Age settlements have been located. However, part of the uplands to the north west at Trawscoed have been studied as part of the RCAHMW Uplands Survey and that work identified much new evidence of prehistoric and Medieval settlement (Muckle 1993) although quite different in character to the type of lowland settlement represented by Tytandderwen. It is possible that future work will show that Tytandderwen was less isolated than at present seems the case and that perhaps after the Roman occupation settlement simply moved and changed its character, rather than disappearing. Geophysical survey around the fort at Llanfor, for instance has shown the presence of extra-mural settlement, which may be native (Hopewell 2003).

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# APPENDIX 1 SOIL SURVEY ANALYTICAL DATA

| E-coord | N-coord | LOI (%) | pH (water) | Phosphate-$P_i$ (mg $g^{-1}$) | $\chi$ ($10^{-8}$ SI) | $\chi_{max}$ ($10^{-8}$ SI) | $\chi_{conv}$ (%) |
|---|---|---|---|---|---|---|---|
| 100 | 100 | 6.88 | | 0.668 | 74 | | |
| 120 | 100 | | | 0.423 | 69 | | |
| 140 | 100 | | | 0.428 | 71 | | |
| 160 | 100 | | | 0.450 | 104 | 1900 | 5.47 |
| 180 | 100 | | | 0.445 | 134 | | |
| 200 | 100 | | | 0.435 | 90 | | |
| 220 | 100 | | | 0.481 | 97 | | |
| 110 | 110 | 6.74 | | 0.421 | 76 | | |
| 130 | 110 | 5.74 | | 0.268 | 49 | 1650 | 2.97 |
| 150 | 110 | | | 0.471 | 83 | | |
| 170 | 110 | | | 0.505 | 104 | 1920 | 5.42 |
| 190 | 110 | 5.06 | | 0.293 | 113 | 1810 | 6.24 |
| 210 | 110 | 3.73 | | 0.313 | 76 | | |
| 100 | 120 | | | 0.502 | 65 | | |
| 120 | 120 | | | 0.356 | 26 | 812 | 3.20 |
| 140 | 120 | | | 0.434 | 74 | 1840 | 4.02 |
| 160 | 120 | | | 0.401 | 99 | | |
| 180 | 120 | 5.03 | 4.9 | 0.285 | 124 | | |
| 200 | 120 | 5.10 | | 0.291 | 135 | | |
| 220 | 120 | | | 0.340 | 143 | | |
| 110 | 130 | 5.71 | | 0.131 | 22 | 1100 | 2.00 |
| 130 | 130 | 5.02 | | 0.357 | 50 | | |
| 150 | 130 | | | 0.493 | 98 | | |
| 170 | 130 | | | 0.431 | 125 | | |
| 190 | 130 | 5.71 | | 0.408 | 149 | 2050 | 7.27 |
| 210 | 130 | | | 0.508 | 169 | 2300 | 7.35 |
| 100 | 140 | | | 0.228 | 23 | 929 | 2.48 |
| 120 | 140 | 5.92 | 6.1 | 0.489 | 37 | | |
| 140 | 140 | | | 0.567 | 89 | | |
| 160 | 140 | | | 0.506 | 110 | | |
| 180 | 140 | | | 0.403 | 142 | | |
| 200 | 140 | | | 0.555 | 157 | 2130 | 7.37 |
| 220 | 140 | | | 0.523 | 159 | 2270 | 7.00 |
| 150 | 150 | | | 0.620 | 101 | | |
| 170 | 150 | | | 0.619 | 149 | 1950 | 7.64 |
| 190 | 150 | | | 0.341 | 146 | 2140 | 6.82 |
| 210 | 150 | | | 0.667 | 102 | | |
| 140 | 160 | 5.94 | | 0.572 | 109 | | |
| 160 | 160 | | | 0.592 | 106 | | |
| 180 | 160 | | | 0.650 | 225 | 2310 | 9.74 |
| 200 | 160 | | | 0.462 | 116 | | |
| 220 | 160 | | | 0.373 | 148 | | |
| 150 | 170 | | | 0.668 | 84 | | |
| 170 | 170 | | | 0.595 | 136 | | |
| 190 | 170 | | | 0.602 | 133 | | |
| 210 | 170 | | 4.8 | 0.406 | 110 | | |

| E-coord | N-coord | LOI (%) | pH (water) | Phosphate-$P_i$ (mg $g^{-1}$) | $\chi$ ($10^{-8}$ SI) | $\chi_{max}$ ($10^{-8}$ SI) | $\chi_{conv}$ (%) |
|---|---|---|---|---|---|---|---|
| 140 | 180 | | | 0.807 | 80 | 1680 | 4.76 |
| 160 | 180 | 6.29 | 4.8 | 1.15 | 108 | | |
| 180 | 180 | 5.93 | | 1.25 | 165 | 2030 | 8.13 |
| 200 | 180 | | | 0.457 | 96 | 1870 | 5.13 |
| 220 | 180 | | | 0.303 | 163 | | |
| 150 | 190 | 6.54 | | 1.07 | 122 | | |
| 170 | 190 | 6.40 | | 1.07 | 136 | | |
| 190 | 190 | | | 0.650 | 160 | | |
| 210 | 190 | | | 0.527 | 127 | | |
| 140 | 200 | 6.99 | 4.7 | 1.47 | 69 | | |
| 160 | 200 | | | 1.04 | 126 | | |
| 180 | 200 | | | 0.443 | 159 | 2180 | 7.29 |
| 200 | 200 | | | 0.459 | 116 | | |
| 220 | 200 | 5.65 | | 0.186 | 183 | 2480 | 7.38 |
| 150 | 210 | | | 0.862 | 85 | | |
| 170 | 210 | 6.98 | | 0.809 | 111 | | |
| 190 | 210 | | | 0.618 | 130 | | |
| 140 | 220 | | | 0.516 | 67 | | |
| 160 | 220 | | | 0.832 | 78 | | |
| 180 | 220 | | | 0.691 | 103 | | |
| 200 | 220 | 7.63 | | 0.580 | 100 | | |

# APPENDIX 2 RADIOCARBON CALIBRATION RESULTS

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# REPORT OF RADIOCARBON DATING ANALYSES

Mr. George Smith — Report Date: 11/7/2008

Gwynedd Archaeological Trust — Material Received: 10/17/2008

| Sample Data | Measured Radiocarbon Age | 13C/12C Ratio | Conventional Radiocarbon Age(*) |
|---|---|---|---|
| Beta - 250542 | 2400 +/- 40 BP | -23.9 o/oo | 2420 +/- 40 BP |

SAMPLE : G1770CS11
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal BC 750 to 680 (Cal BP 2700 to 2630) AND Cal BC 670 to 610 (Cal BP 2620 to 2560)
Cal BC 600 to 400 (Cal BP 2560 to 2350)

---

| Sample Data | Measured Radiocarbon Age | 13C/12C Ratio | Conventional Radiocarbon Age(*) |
|---|---|---|---|
| Beta - 250543 | 2320 +/- 40 BP | -25.0 o/oo | 2320 +/- 40 BP |

SAMPLE : G1770CS12
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal BC 410 to 360 (Cal BP 2360 to 2310)

---

| Sample Data | Measured Radiocarbon Age | 13C/12C Ratio | Conventional Radiocarbon Age(*) |
|---|---|---|---|
| Beta - 250544 | 1960 +/- 40 BP | -25.6 o/oo | 1950 +/- 40 BP |

SAMPLE : G1629TT110
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal BC 40 to Cal AD 130 (Cal BP 1990 to 1820)

---

| Sample Data | Measured Radiocarbon Age | 13C/12C Ratio | Conventional Radiocarbon Age(*) |
|---|---|---|---|
| Beta - 250545 | 2290 +/- 40 BP | -24.3 o/oo | 2300 +/- 40 BP |

SAMPLE : G1629TT111
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal BC 410 to 360 (Cal BP 2360 to 2300) AND Cal BC 290 to 240 (Cal BP 2240 to 2180)

---

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the 14C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby 14C half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured 13C/12C ratios (delta 13C) were calculated relative to the PDB-1 standard.

The Conventional Radiocarbon Age represents the Measured Radiocarbon Age corrected for isotopic fractionation, calculated using the delta 13C. On rare occasion where the Conventional Radiocarbon Age was calculated using an assumed delta 13C, the ratio and the Conventional Radiocarbon Age will be followed by "*". The Conventional Radiocarbon Age is not calendar calibrated. When available, the Calendar Calibrated result is calculated from the Conventional Radiocarbon Age and is listed as the "Two Sigma Calibrated Result" for each sample.

# CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.6:lab. mult=1)

**Laboratory number:** **Beta-250544**

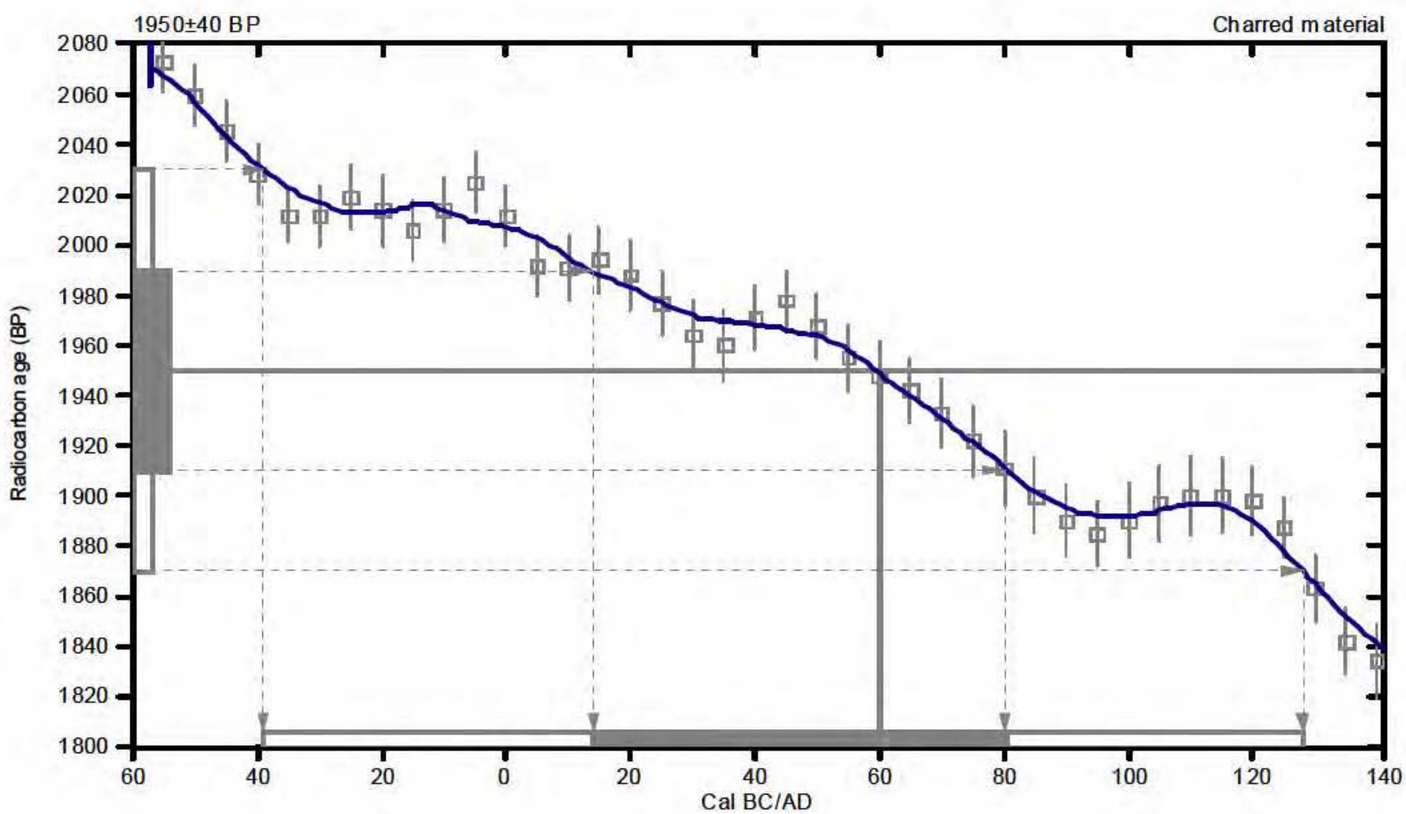
**Conventional radiocarbon age:** **1950±40 BP**

**2 Sigma calibrated result: (95% probability)** **Cal BC 40 to Cal AD 130 (Cal BP 1990 to 1820)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 60 (Cal BP 1890)

1 Sigma calibrated result: (68% probability) Cal AD 10 to 80 (Cal BP 1940 to 1870)





References:

***Database used***

*INTCAL04*

***Calibration Database***

***INTCAL04 Radiocarbon Age Calibration***

*IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).*

***Mathematics***

***A Simplified Approach to Calibrating C14 Dates***

*Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322*



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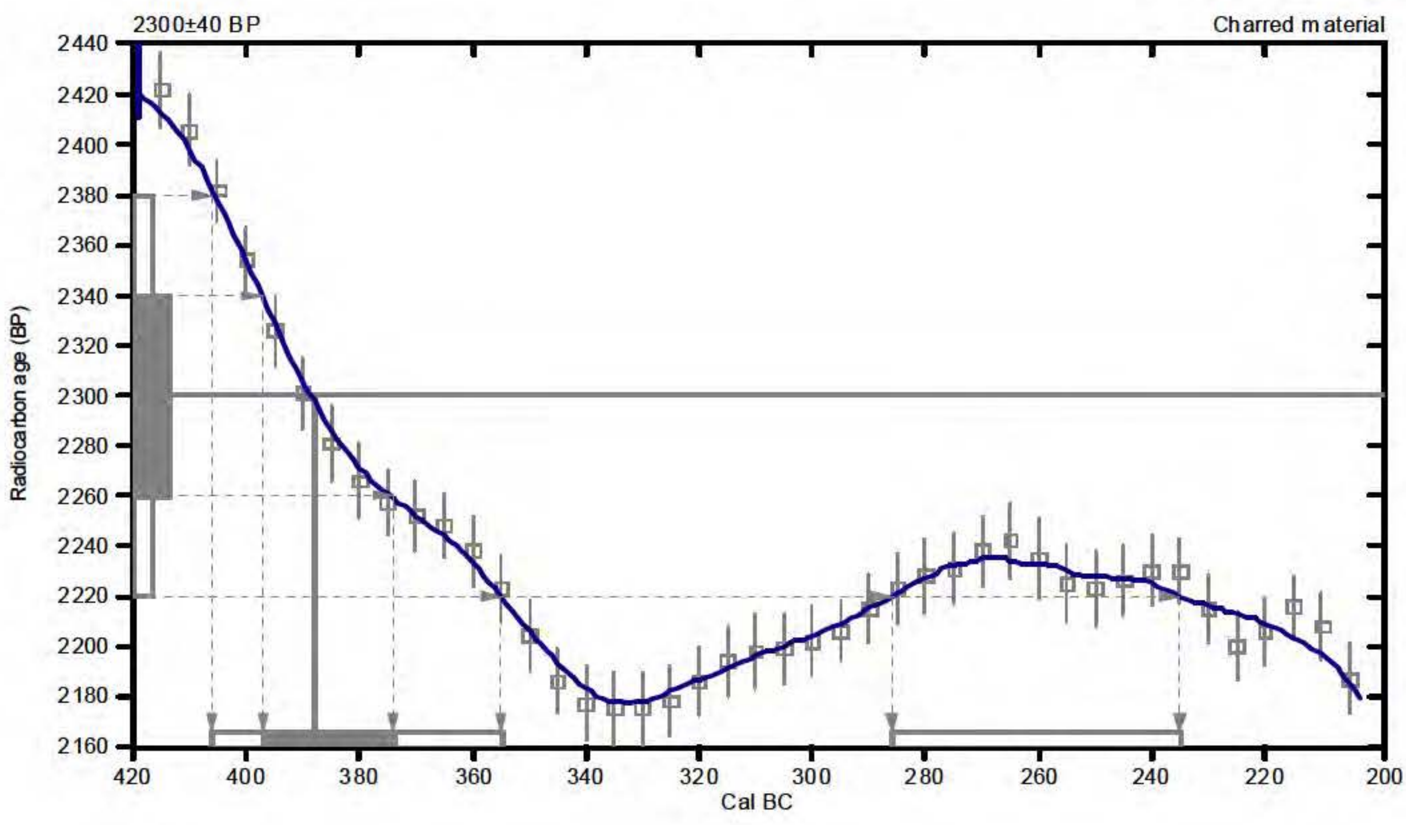
# CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.3:lab. mult=1)

| | |
|---|---|
| **Laboratory number:** | **Beta-250545** |
| **Conventional radiocarbon age:** | **2300±40 BP** |
| **2 Sigma calibrated results: (95% probability)** | **Cal BC 410 to 360 (Cal BP 2360 to 2300) and Cal BC 290 to 240 (Cal BP 2240 to 2180)** |

Intercept data

| | |
|---|---|
| Intercept of radiocarbon age with calibration curve: | Cal BC 390 (Cal BP 2340) |
| 1 Sigma calibrated result: (68% probability) | Cal BC 400 to 370 (Cal BP 2350 to 2320) |





References:

***Database used***

*INTCAL04*

***Calibration Database***

***INTCAL04 Radiocarbon Age Calibration***

*IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).*

***Mathematics***

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# PART 2
# EXCAVATIONS AT TYTANDDERWEN 2008
# By Tudur Davies, University of Sheffield
# Preliminary report

## 1. INTRODUCTION

This report provides a basic summary of the excavation undertaken at the circular enclosure at Ty-tan-dderwen (SH 95383624) from the 7th-18th of April 2008, it includes background information relating to previous research at the site, a description of the excavation methodology and a summary of the archaeological features identified.

The excavation aimed to provide dating evidence for the monument as well as establish the preservation conditions for environmental evidence at the site. The environmental information retrieved from the site is part of a larger project being carried out at the University of Sheffield, which examines diachronic changes in land use and subsistence practices in Penllyn from late prehistory into the later medieval period.

## 2. BACKGROUND

The circular enclosure at Ty-tan-dderwen, c.2.5km east of Bala was first identified by during the dry summer of 1976, when J K St Joseph took an aerial photograph of the site when it was visible as a parch mark. In 2006, Gwynedd Archaeological Trust investigated the site by undertaking a high resolution magnetometer survey (cf. Smith & Hopewell 2007) (see *Figure 1)*. This verified the presence of an oval anomaly measuring c.75x65m interpreted as a ditch. Additional possible archaeological features detected included a section of an outer defensive ditch and a narrow internal ditch. Due to the lack of obvious structures within the enclosure, Smith and Hopewell believe that the site is likely to represent either a later prehistoric cattle enclosure, or a Neolithic settlement site – which may not have left substantial traces of building activity (Smith & Hopewell 2007: 8). However, given the number of plough scars also visible in the magnetometer survey of the site, it would not be surprising if structural evidence at the site had been too heavily truncated to be visible on the magnetometer survey. As such, the site could well have been a settlement dating to the late prehistoric or even the early medieval period.

## 3. METHODOLOGY

Two trenches were opened during the excavation for the current study, namely trench ‘A’ and ‘B’ – the locations of which are displayed in *Figure 1*; this figure also shows the location of trench ‘C’ excavated by Gwynedd Archaeological Trust (GAT).

Trench A targeted the possible outer ditch identified on both aerial photographs (cf. Davies 2006) and by the geophysical survey of the monument (Hopewell & Smith 2007). Trench B was opened at the northern end of the main enclosure, targeting a section of the main enclosure ditch as well as a possible internal ditch identified by GAT’s geophysical survey (Hopewell & Smith 2007). Due to difficulties relocating the original geophysical survey grid, the trenches had to be extended to locate the targeted archaeological features. The final dimensions of the trenches measured 6.3 x 2 m (Trench A), and 13 x 6 m (Trench B) (see *Figure 2*).


Figure 1. GAT's Magnetometer survey at Ty-Tan-Dderwen and the locations of archaeological trenches

Notes:
1. Map data provided by the OS via Digimap

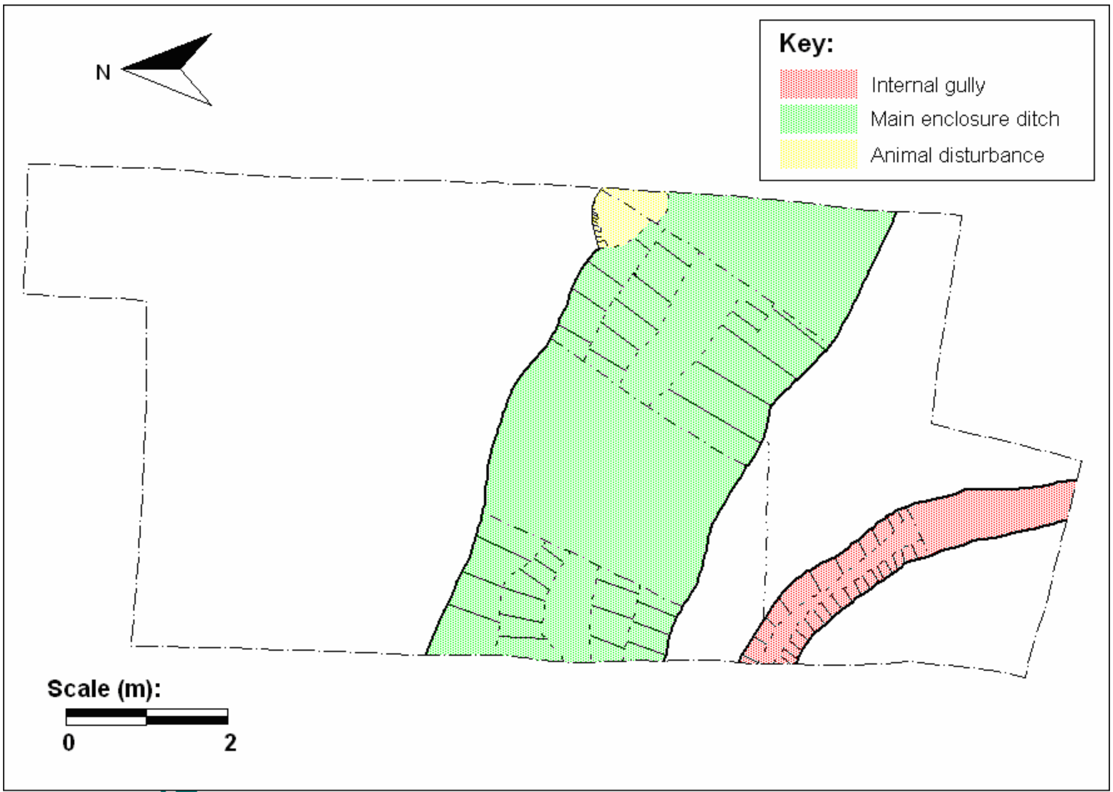


**Figure 2.** **Interpretive plan of Trench B**

The turf and topsoil of the trenches were removed by machine. All archaeological deposits identified after stripping the topsoil were excavated by hand. Written, drawn and photographic records were taken of all archaeological features identified by the excavation. Plans of the excavation were drawn at a scale of 1:20, whilst section drawings were produced at 1:10.

## 4. RESULTS

### Trench A

After initially opening a trench measuring 4 x 2 m, no archaeological features were identified in the trench. After subsequently extending the trench by c.2 m to the Southeast, a narrow ditch c.70 cm wide and c.20 cm deep was identified immediately to the southwest of the area previously opened. The ditch was unfortunately completely removed by machine whilst extending the trench and was only recorded in section on the northwest and southeast sides of the trench (see
*Figure* **3**). This feature does correspond with the location of the ditch targeted for investigation by the trench, no additional features were identified. No datable finds were recovered from the trench that might have helped to interpret the date of the ditch. A possible function for the feature can, however, be postulated based upon the characteristics of its fill. The feature contained a single backfilled deposit and no accumulated sediments. This implies that it was either regularly cleaned out during its use, or that it was never exposed to the elements prior to being backfilled. As this feature does not appear to be a drainage feature, it may have been used as a boundary marker that possibly contained a palisade or fence – any traces of which could have been removed by the backfilling of the gully.

Figure 3 Gully seen in section of Trench A, northwest facing

**Trench B**

Both the main enclosure ditch as well as the internal ditch identified by geophysical survey was successfully identified after the removal of the topsoil from the trench, no additional archaeological features were identified. Two 2m slots were excavated across the main enclosure ditch and a third 2m slot was excavated across the internal ditch (see *Figures 4, 5* and *6*). The main enclosure ditch measured 2.8m wide and was excavated to a maximum depth of 0.80m. The sections of both slots across this ditch hint at a possible re-cut that was wider and shallower than the original cut; it is possible, however, that the ditch's appearance in section could be the result of the natural process of erosion and accumulation of sediments. The ditch had been filled almost entirely by lenses of silted gravels, with the exception of the uppermost deposit of backfilled organic rich loam. Unfortunately, no artefacts were recovered from either slot across the main enclosure ditch, charcoal was only present in its upper fill; its date is, therefore, still uncertain.

The internal ditch/gully in Trench B was curvilinear in shape, turning in a westerly direction to become almost parallel with the main enclosure ditch. It was 65cm wide and 30cm deep, and filled entirely with a backfilled deposit, implying that this feature was also never open to the elements or was cleaned out regularly whilst in use. Therefore, similarly to the gully in trench A, it is possible that this gully may have originally held a palisade or fence, either to be used as a corral within the main enclosure, or as a defensive feature for the possible northern entrance to the site. At present, it is uncertain whether this internal gully is contemporary with the main enclosure ditch. The geophysical survey suggests that it encloses a section of the site near the possible northern entrance, implying that there is a phase of the site when both features are in use. When the main enclosure ditch was originally dug, the excavated deposits presumably would have been used to create an internal bank; however, the excavated portion of the gully in trench B is separated by less than 1m to the enclosure ditch, leaving little room for a bank, if indeed the ditch and the gully were contemporary. Although no artefacts were retrieved from this feature, the backfilled deposit within the gully contained a few charcoal fragments, which may possibly be used for dating purposes and environmental analysis.

Figure 4 Western slot through the main enclosure ditch in trench B, east facing

Figure 5 Eastern slot through the main enclosure ditch, east facing

Figure 6 ‘internal gully’ in Trench B, southeast facing

## 5. REFERENCES


Davies, T. 2006. *Llanfor and the Dee Valley: Early Medieval Landscape Study*, Unpublished MA thesis for the University of Sheffield.

Smith, G. & Hopewell, D. 2007. *Prehistoric funerary and ritual monument survey: Assessment of monuments at risk in agricultural landscape – Ceremonial monuments: Henges and stone circles in North-West Wales***,** GAT Report No 663, prepared for CADW.

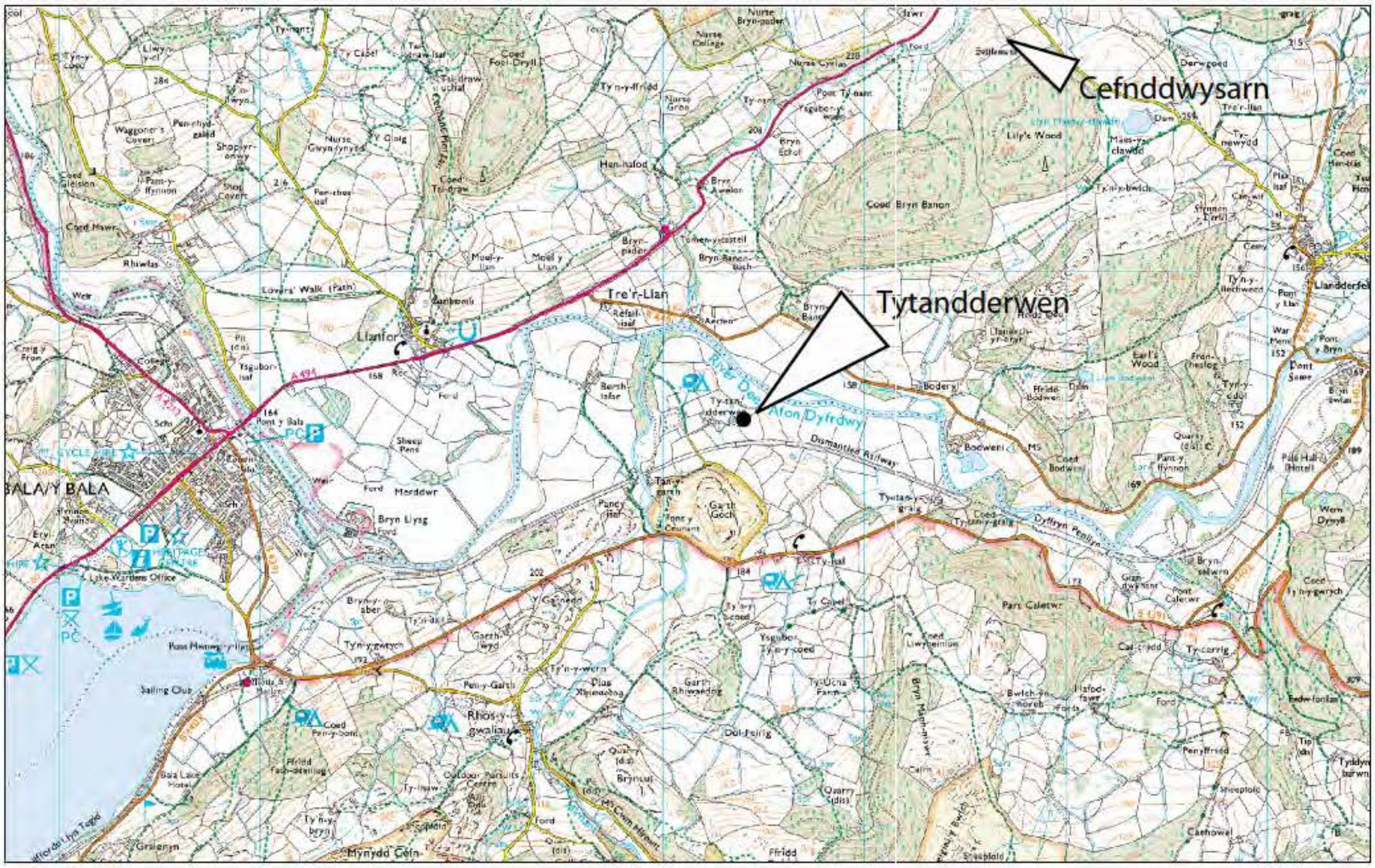


Fig. 1 Tytandderwen, Bala. Location map.

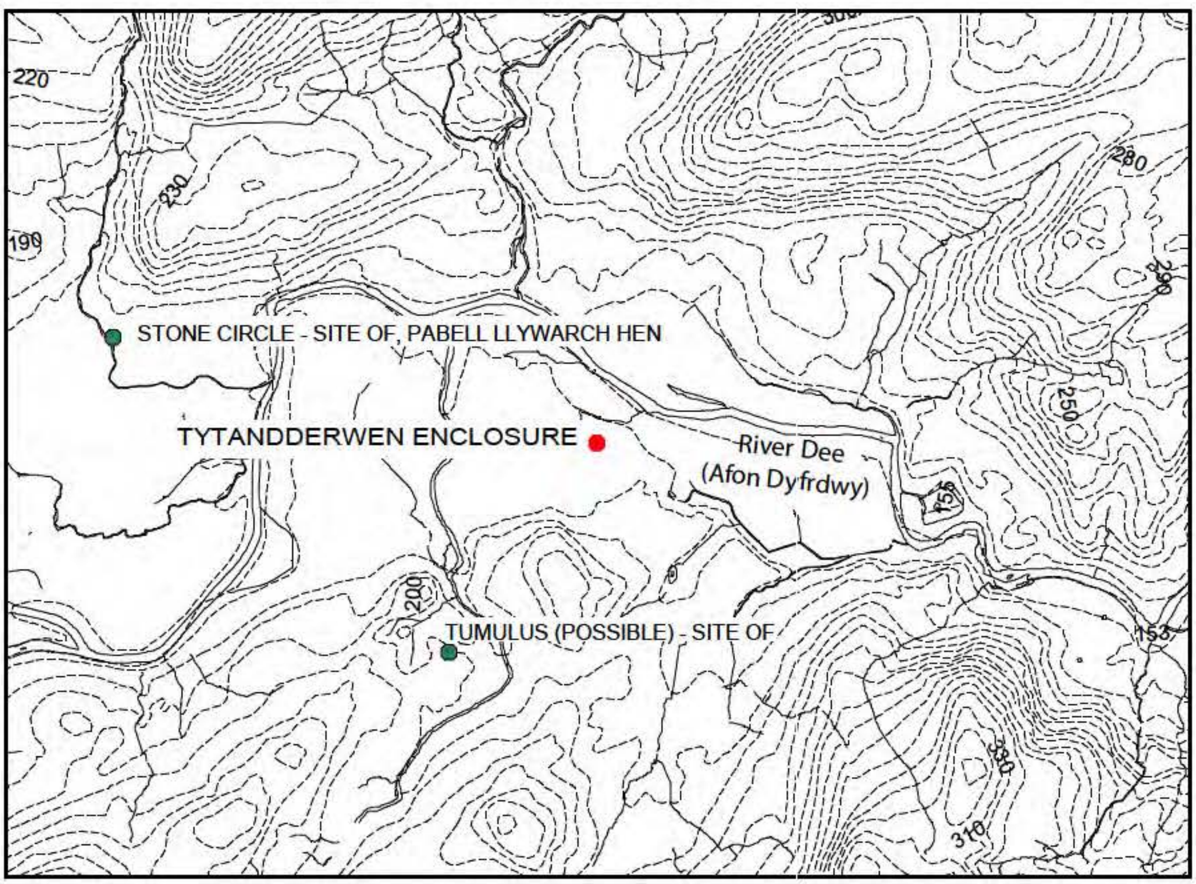


Fig. 2 Tytandderwen cropmark enclosure, Bala: Topographic location
Scale 1:25000. © Crown copyright. All rights reserved. Licence number AL 100020895

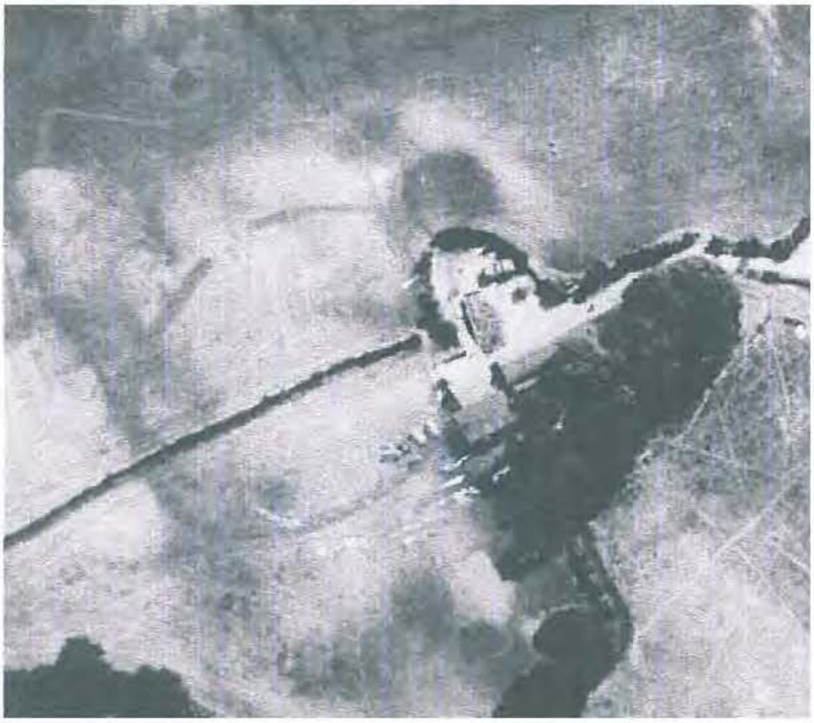

Fig. 3 Tytandderwen cropmark enclosure, Bala: Aerial photograph,
from the north-west (Crew and Musson 1996, 13). Taken before the construction of the modern barn(see Fig. 5)

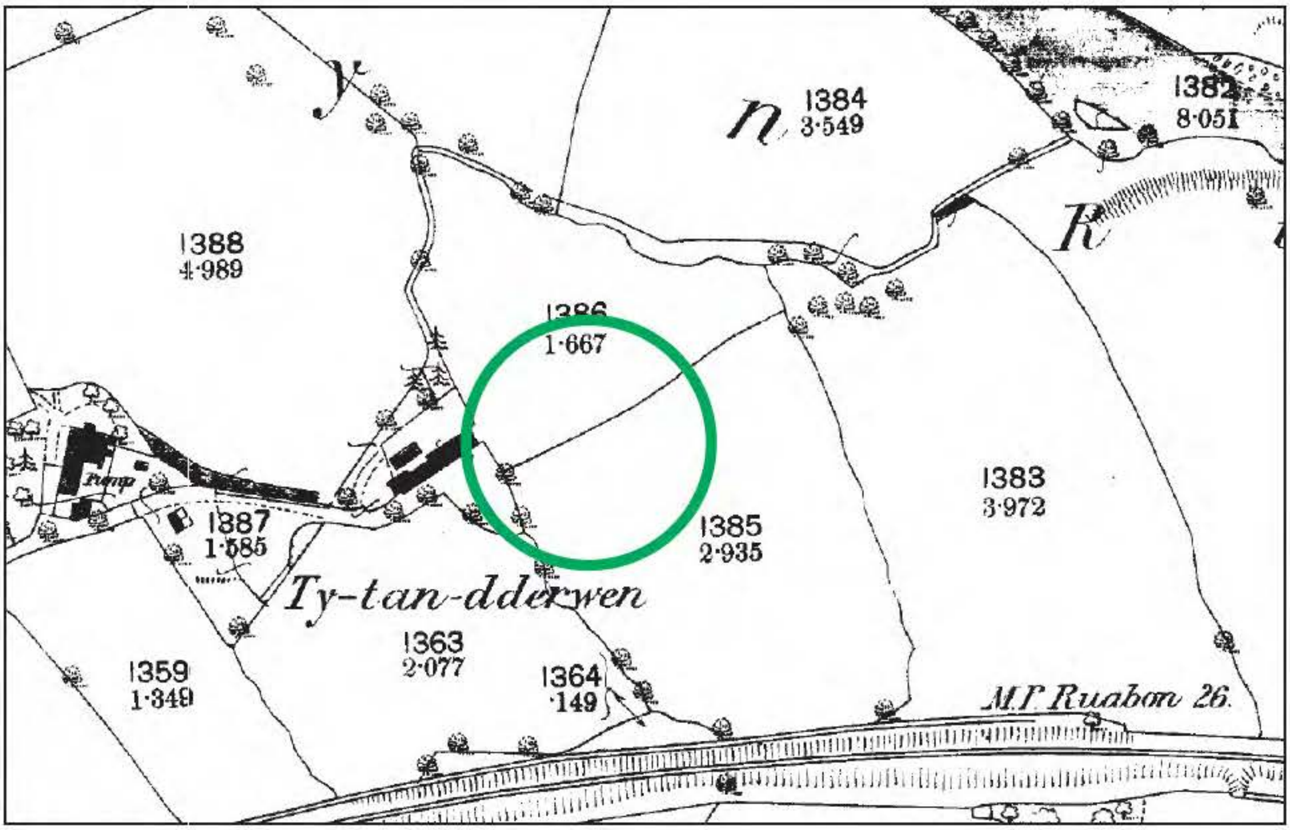


Fig. 4 Tytandderwen 1888 Ordnance Survey 1:2500 (not to scale)
annotated to show the location of the cropmark enclosure

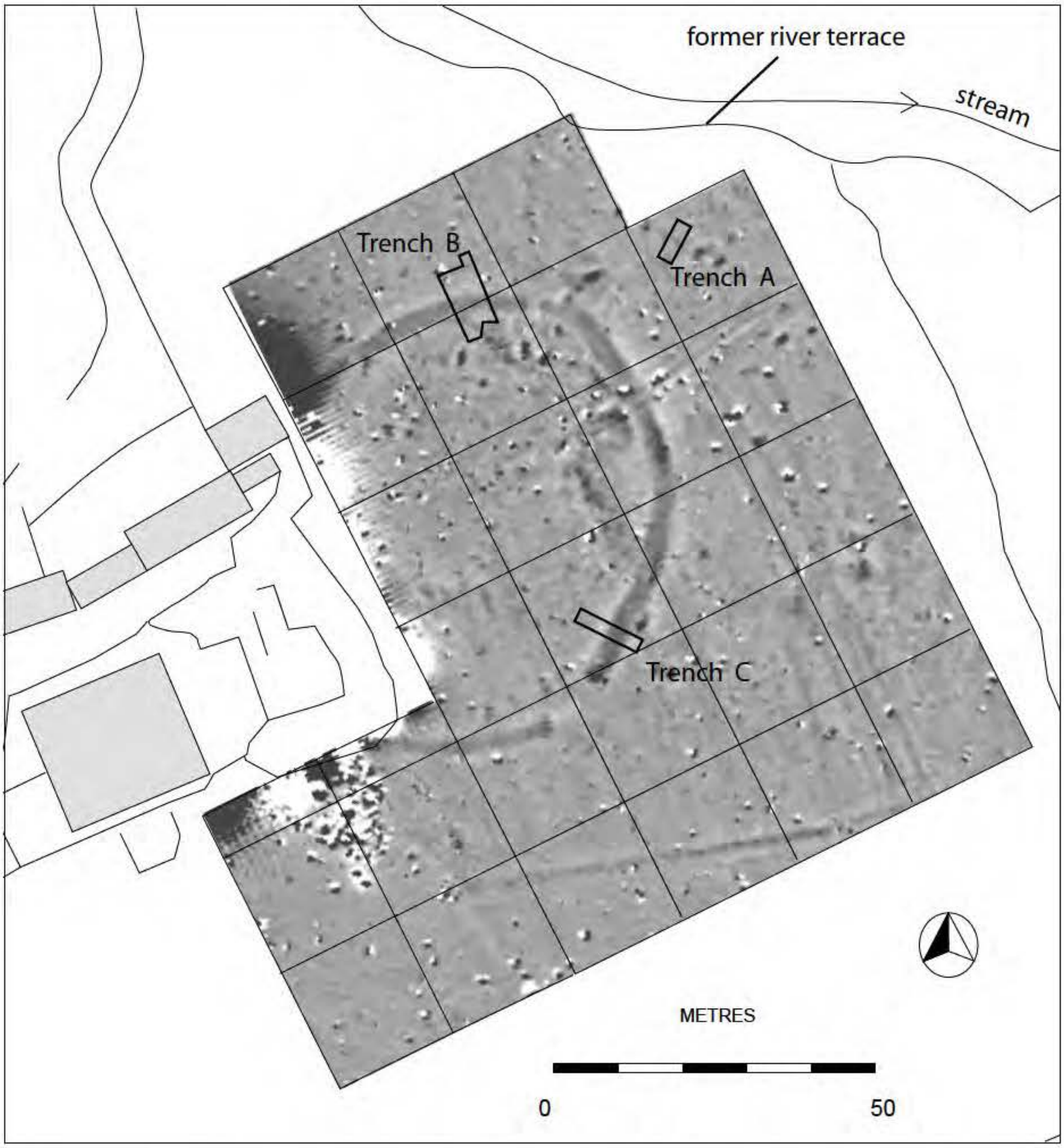


Fig. 5 Tytandderwen cropmark enclosure, Bala: Location of the excavation trenches in relation to the geophysical survey, 2006

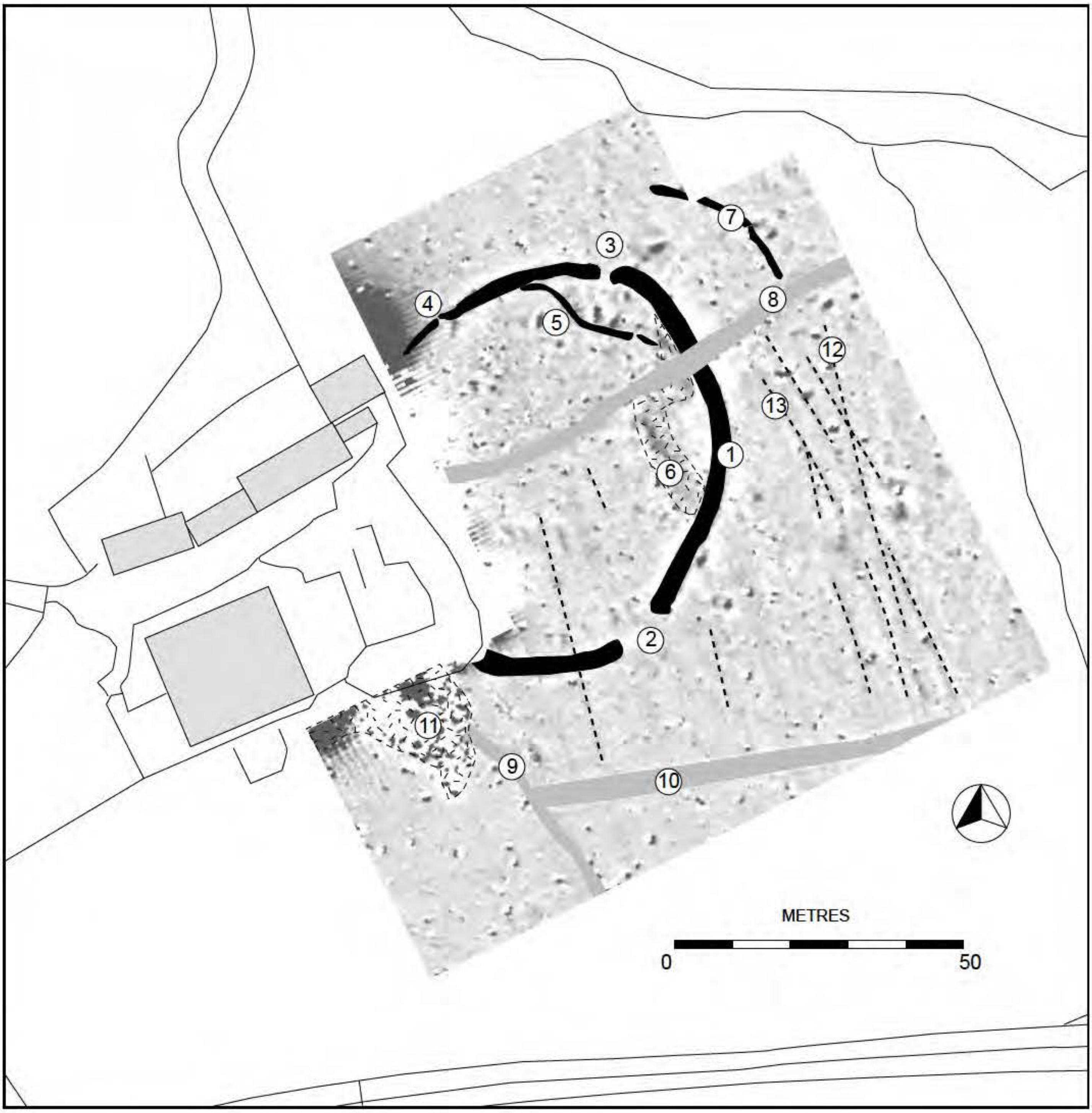


Fig. 6 Tytandderwen, Bala,
PRN 9982 Gradiometer Survey: Interpretation plan

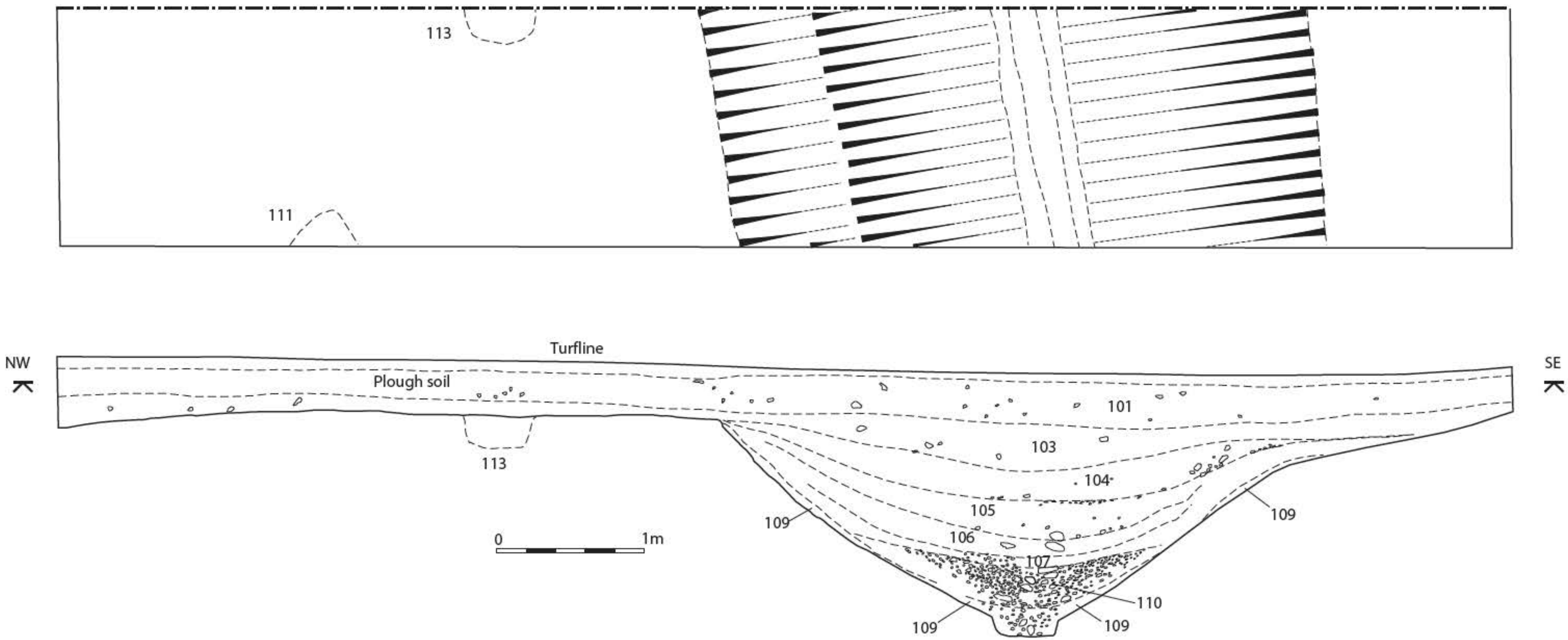


Fig. 7 Trench C: Plan and section

Fig. 8  Trench C. Enclosure ditch after removal of ploughsoil. !m scales

Fig. 9  Trench C.  Enclosure ditch after excavation to top of clay lining (109). 2m and 1m scales

Fig. 10 Trench C. Enclosure ditch after excavation to subsoil. 1m scales

Fig. 11 Trench C. Enclosure ditch after excavation to subsoil, after partial drying.
1m scales

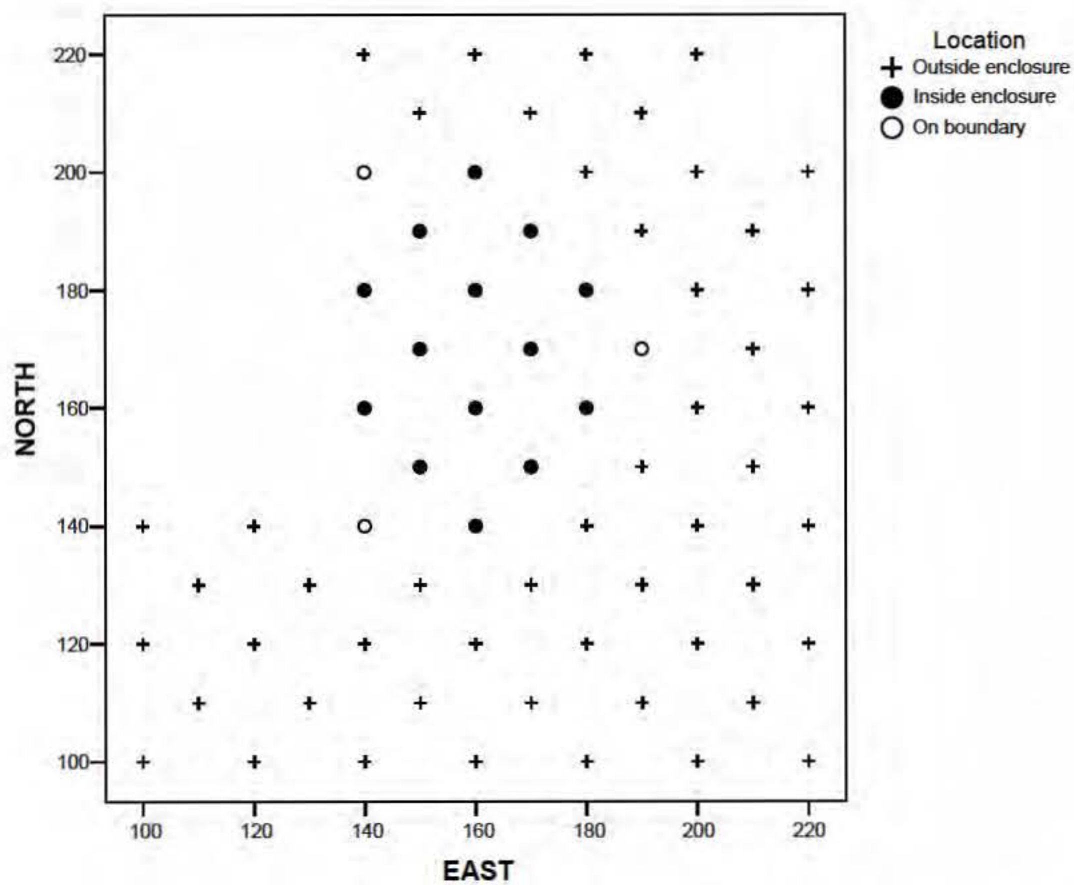


**Fig. 12:** **Location of sampling points in relation to the enclosure**

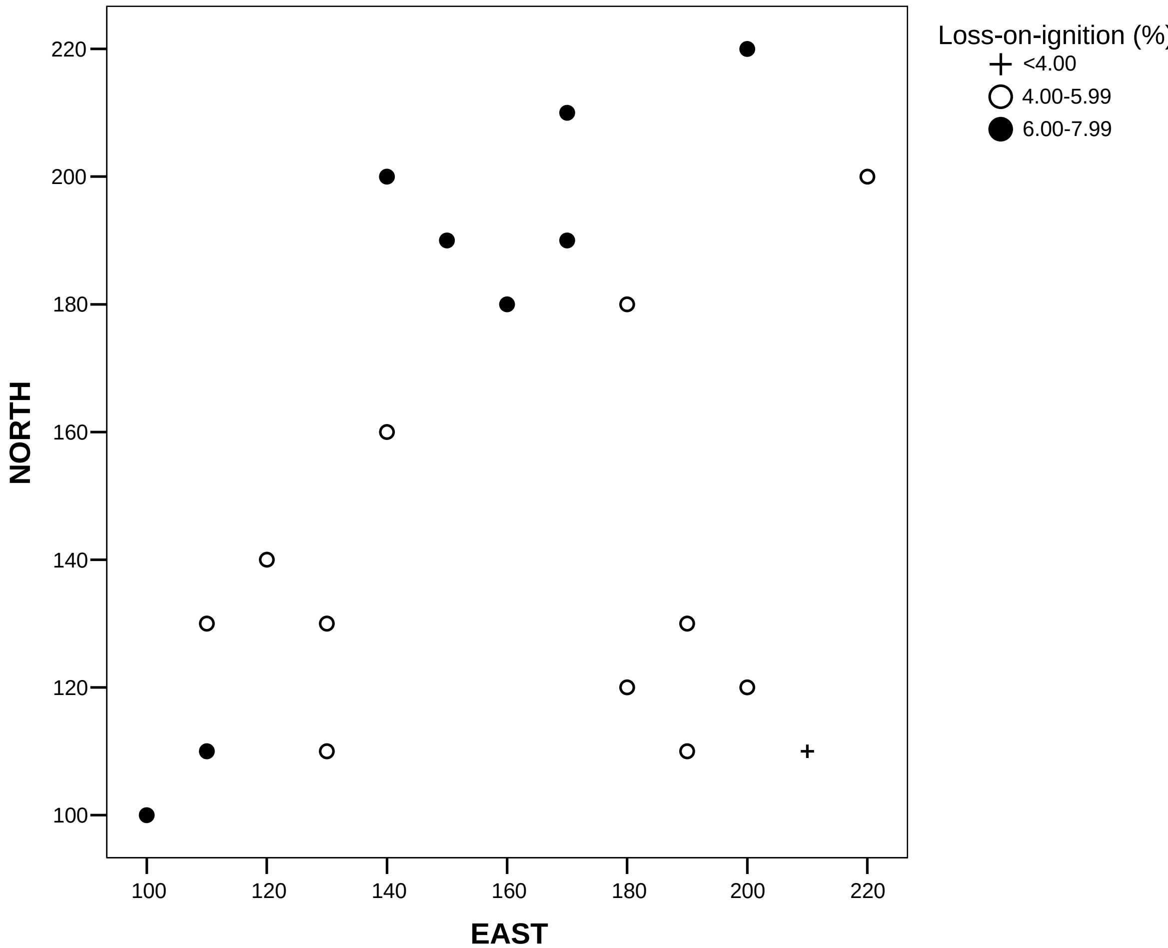


**Fig. 13: Plot of loss-on-ignition data (%) for 20 representative samples**

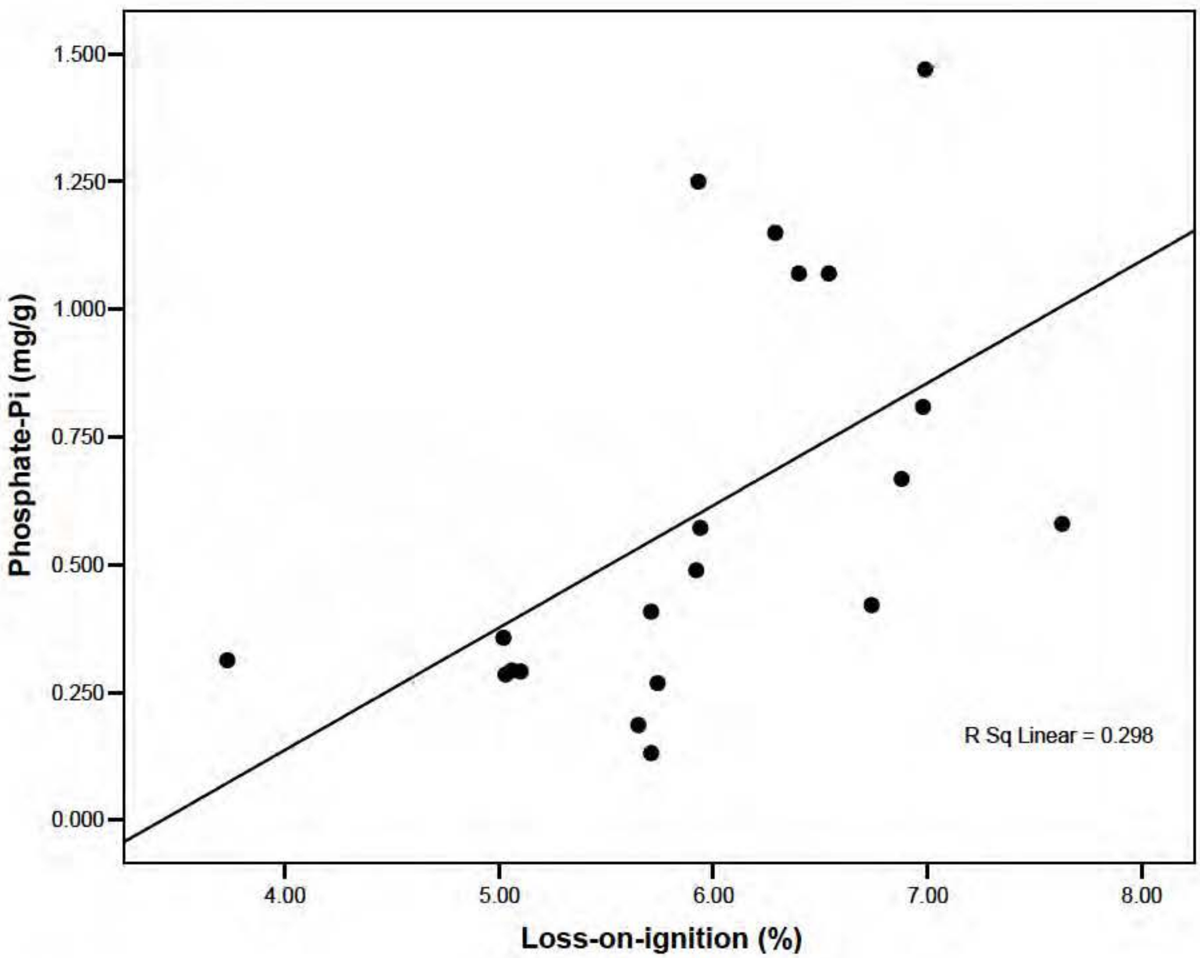


**Fig. 14: Relationship between phosphate-Pi and loss-on-ignition (LOI) based on 20 representative samples for which LOI was determined (N.B. For illustrative purposes untransformed phosphate-$P_i$ data are presented)**

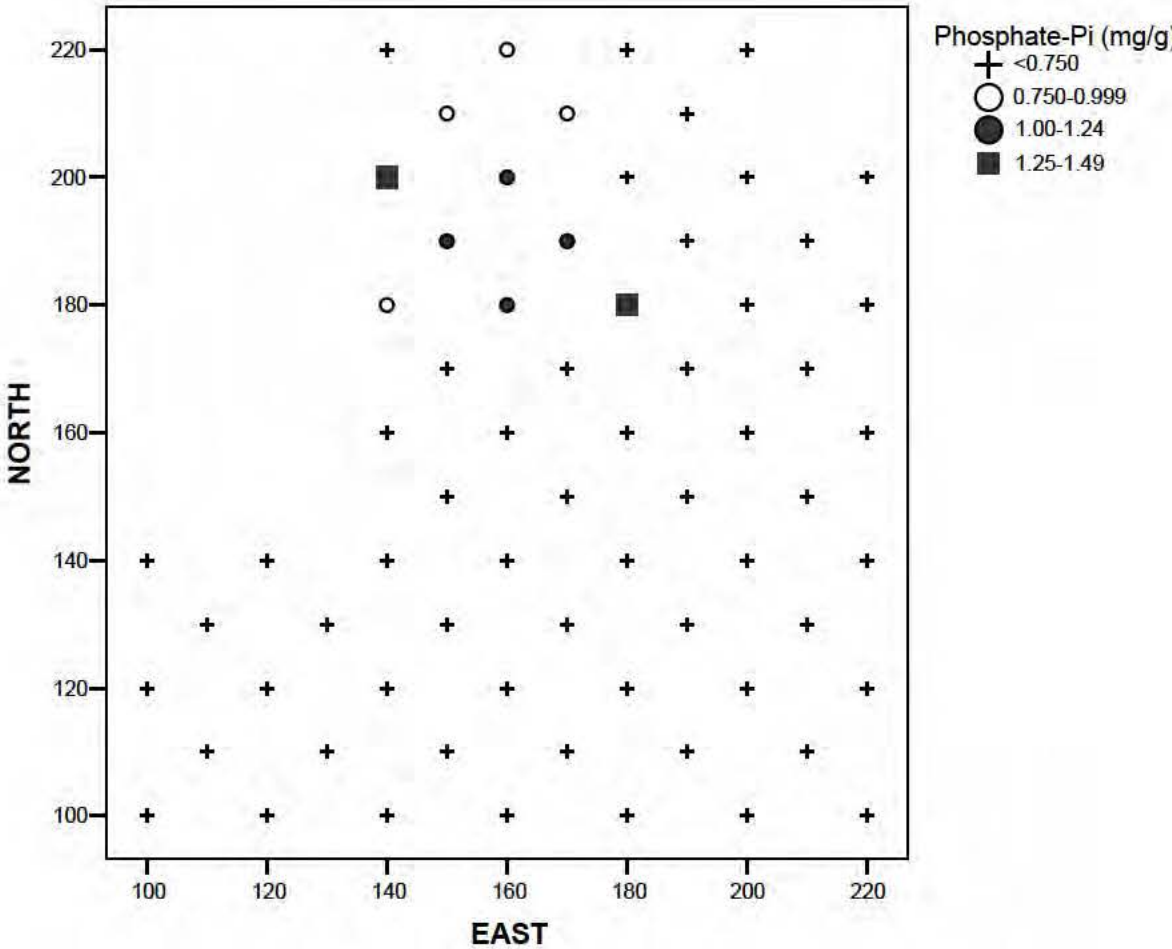


**Fig. 15: Spatial plot of phosphate-Pi concentrations**

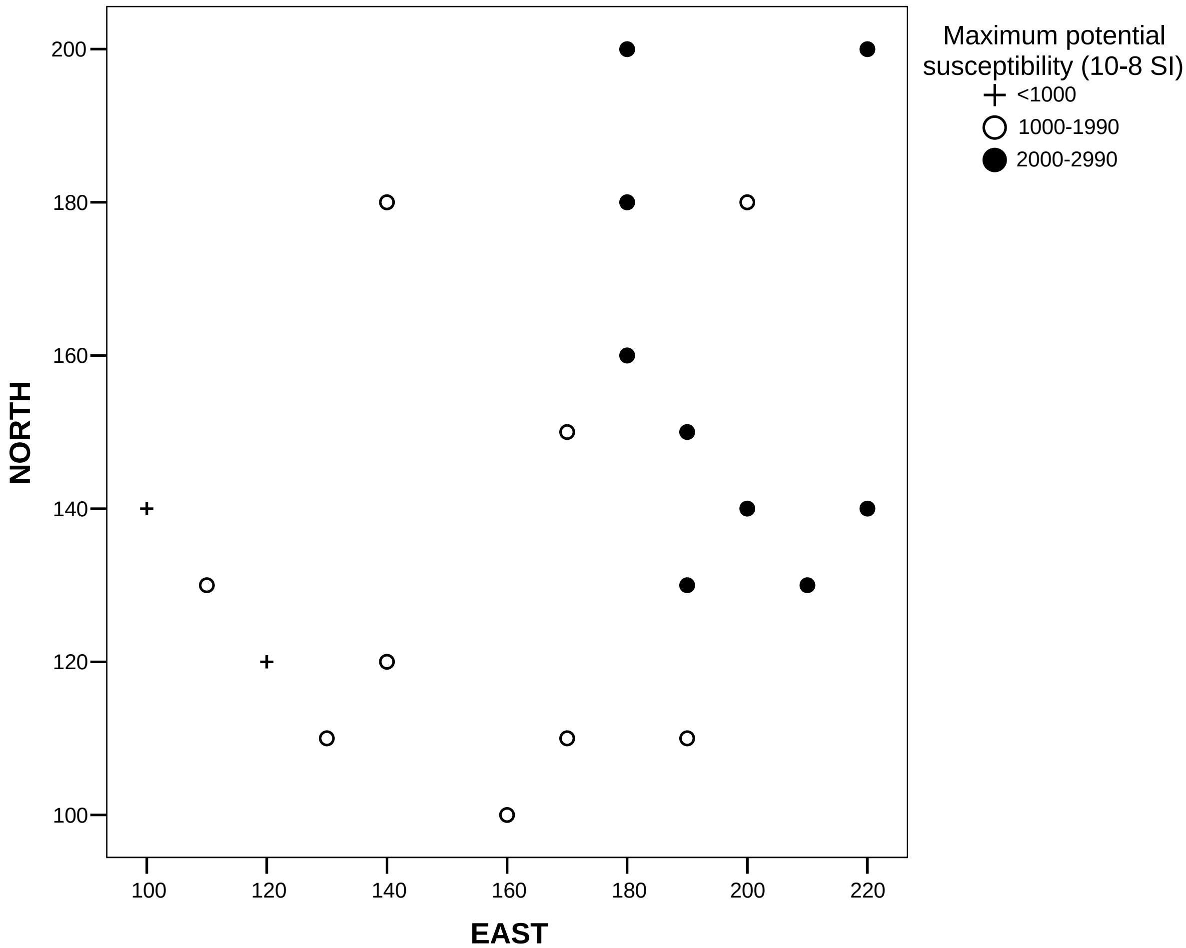


**Fig. 16: Plot of maximum potential magnetic susceptibility data ($\chi_{max}$, $10^{-8}$ SI) for 20 representative samples**

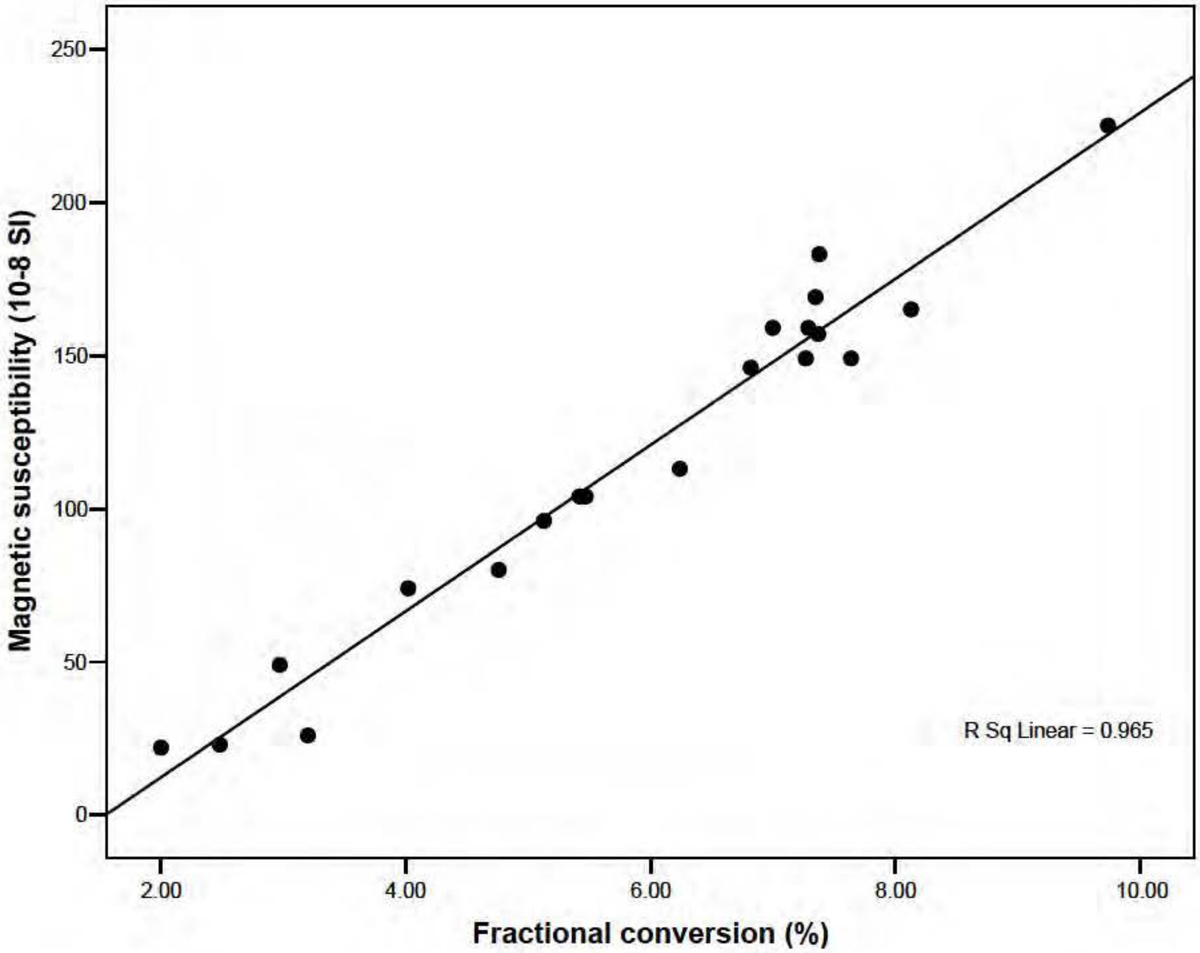


**Fig. 17: Relationship between magnetic susceptibility ($\chi$) and fractional conversion ($\chi_{conv}$)**

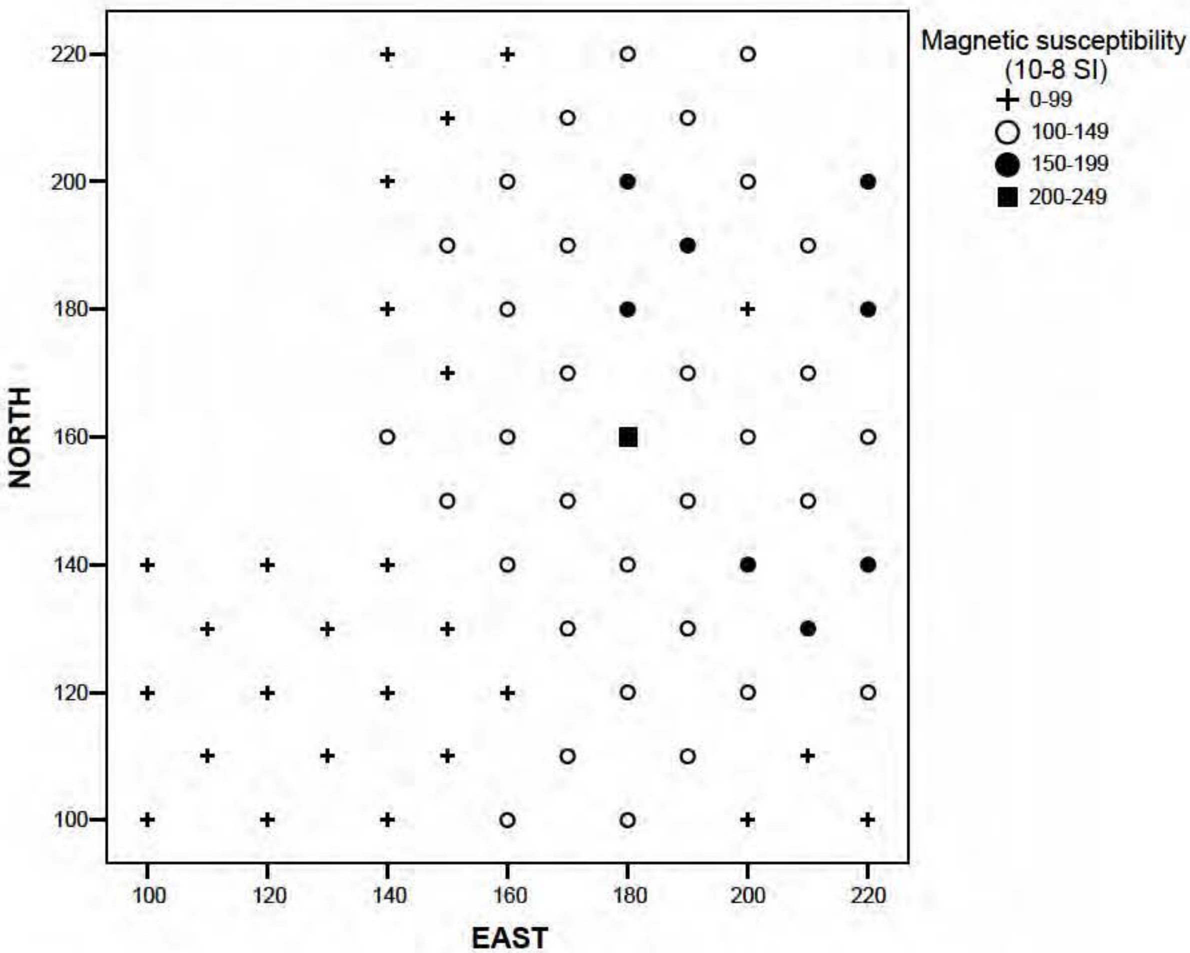


**Fig. 18: Spatial plot of magnetic susceptibility ($\chi$) values**

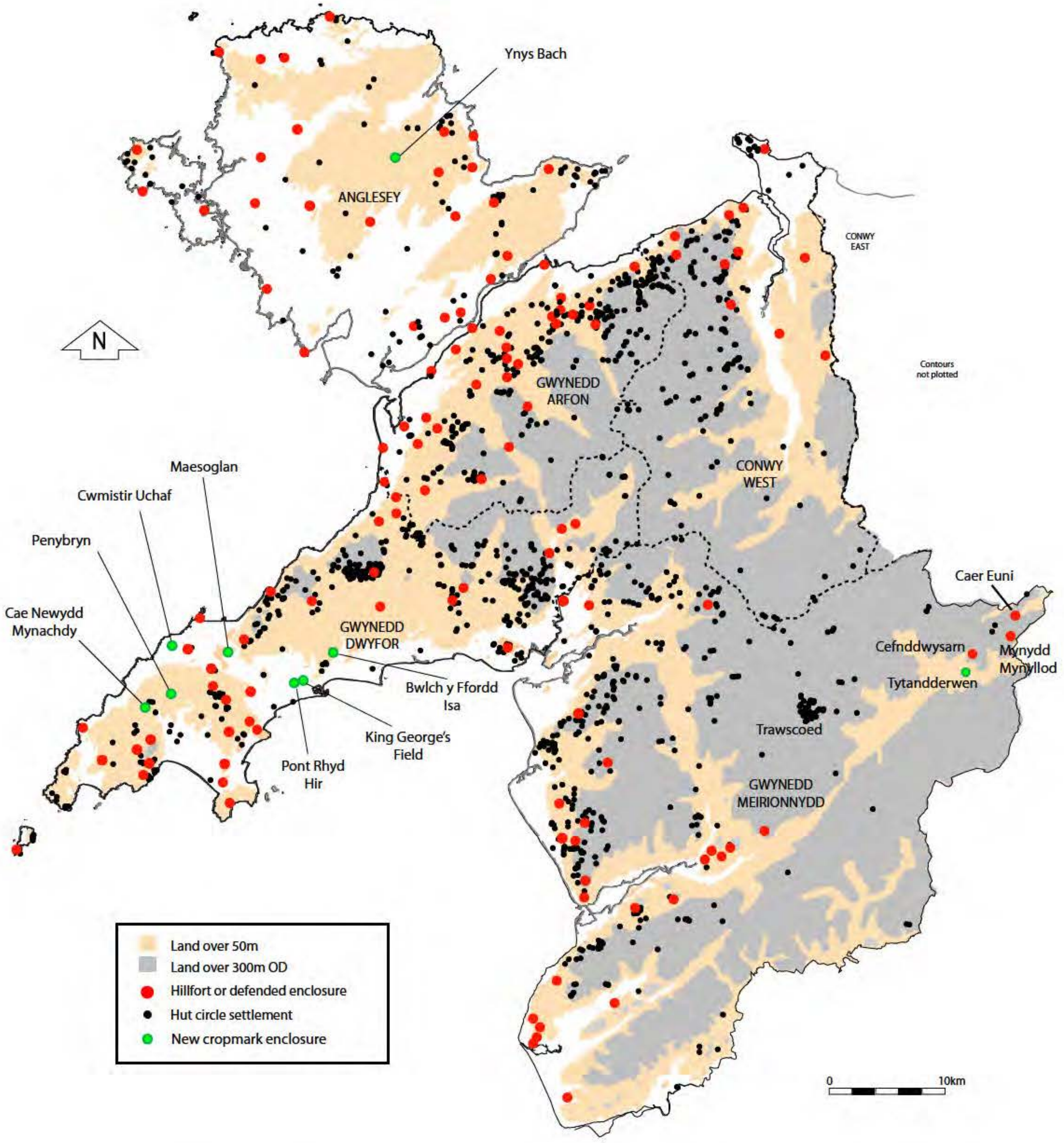


Fig. 19 The location of the Tytandderwen enclosure and of cropmark enclosures surveyed in 2007-8 in relation to the distribution of all known prehistoric defended and undefended settlements in north-west Wales

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