The Stones of Stonehenge Project

Investigations in the Nyfer (Nevern) valley in 2011

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(in collaboration with the SRP and SPACES projects)

Introduction

In recent years there has been renewed interest in the origins of the bluestones of Stonehenge,[1] whether in searching for their quarry sites in the Preseli hills of west Wales or developing the alternative theory that they were brought to Stonehenge by glaciers in a previous Ice Age. Despite the results of the SPACES project, there remains scepticism among certain scholars that the stones were ever moved the 180 miles from Wales to Stonehenge by human agency.

The resolution of this dilemma requires the concerted efforts of archaeologists, geologists and other scientists to identify the locations of the outcrops from which the various bluestone lithologies (dolerite, rhyolite, volcanic ash *etc*.) derive, and to establish whether these are associated with remains of Neolithic quarries. Recent geological analysis has identified highly likely sources of Stonehenge's spotted dolerite and rhyolite in outcrops at Carn Goedog and Craig Rhosyfelin respectively, together with the spotted dolerite source on Carn Menyn.

The Stones of Stonehenge Project is investigating these bluestone sources to establish whether the human agency theory can be supported and the glacial theory be rejected. If moved by human agency, it aims to explore the logistics required, the settlement context, the chronological frame, and the possible transport routes used in Neolithic quarrying and moving of the stones.

In addition, the Stones of Stonehenge Project will also seek to explore possible reasons why the 80 or so bluestones taken to Stonehenge were selected for this epic journey, by far the longest journey for megaliths anywhere prehistoric Europe. One of the theories under consideration is that the portal dolmens of the Preseli area are remains of one of the earliest Neolithic presences in Britain, thereby providing an important ancestral place of origin for the farming communities who built Stonehenge about a thousand years later.

This investigation is part of a wider study of the stones of Stonehenge, which includes investigations of sarsen quarrying in the Avebury area of Wiltshire, together with their possible route from there to Stonehenge. Those aspects are addressed elsewhere in a separate interim report (Gillings *et al*. 2011).

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[1] A 'bluestone' can be defined as 'any non-sarsen lithology employed as a Stonehenge orthostat'.

Figure 1. Locations of the three survey areas: Carn Goedog, Craig Rhosyfelin and Waun Mawn

Background

Since 2001, the SPACES project has investigated one possible source of spotted dolerite bluestones on and around Carn Meini (Carn Menyn) in the Preseli hills (Darvill and Wainwright 2002; Darvill *et al*. 2003; 2004; 2005; 2006; 2009). Their surveys and excavations have yielded a wealth of prehistoric remains that include a causewayed enclosure and a number of stone circles and rock-art sites. They have also found evidence for quarrying and pillar-stone removal at Carn Meini, although the dating and full characterisation of these activities has so far proved difficult to establish.

The case for glacial movement of the bluestones was first made over a century ago (Judd 1902). In the 1970s, Geoff Kellaway identified glacial sequences deposited on the east side of the Bristol Channel around Bristol and Bath, perhaps during the Anglian glaciation around 450,000 years ago (Kellaway 1971). He also thought that there was an even more extensive glaciation across southern England, which extended from Cornwall as far as Sussex and the English Channel during the Saalian around 300,000 years ago. Between 1990 and 2002, he revived his ideas in a modified form, suggesting that the bluestones might have been moved during a glaciation in the Pliocene, 2.47 million years ago (Kellaway 1991; 2002). The case for glacial transport was also made by the late Richard Thorpe and his team (Thorpe *et al*. 1991), and adopted by the archaeologist Aubrey Burl (Burl 2006). In 2008, Brian John, a local glaciologist, published a robust attack on the human agency theory. Within the wider world of glaciology and archaeology, however, there is little support for the glacial transport theory (*e.g.* Pitts 2001; Richards 2007) nor any convincing evidence for glaciers extending as far south as Salisbury Plain (*e.g*. Clark *et al*. 2004; 2011, Clark and Gibbard 2011; Evans *et al*. 2005). Nonetheless, there has been growing support since 2008 for the glacial transport theory.

In 2006, Olwyn Williams-Thorpe and her team from the Open University identified Carn Goedog, almost a mile northwest of Carn Meini, as the closest chemical match for many of Stonehenge's spotted dolerite monoliths (Williams-Thorpe *et al*. 2006). Ixer's research in 1996 had already confirmed that stones SH33, SH37, SH43, SH49, SH65 and SH67 (the SH33 group) were likely to come from either Carn Meini or Carn Goedog, whilst stone SH61 was likely to derive from Carn Goedog (Table 1; Ixer 1996). More recently, Ixer and Bevins (2011) have concluded that Carn Meini cannot be eliminated as the source of the SH33 group, although 'intensive sampling and detailed petrography of the other spotted dolerite outcrops in the Preseli Hills are required before a more positive assignment can be made.' (Ixer and Bevins 2011).

Stonehenge Monolith	Lithogeochemistry Thorpe *et al*. 1991	Opaque Petrography based on Ixer 1996	Lithogeochemistry plus Petrography
SH 33, 37, 43, 49, 65, 67, 61	Carn Menyn-Carn Gyfrwy or Cerrig Marchogion - Carn Goedog	Carn Menyn or Carn Goedog	Carn Goedog ± Carn Menyn
SH 62	Carn Menyn-Carn Gyfrwy or Cerrig Marchogion - Carn Goedog	Not Carn Menyn nor Carn Goedog	No match
SH 44, 45	Carn Ddafad-las	Carn Ddafad-las	Carn Ddafad-las
SH 42	Carn Breseb	Carn Goedog or Carn Breseb	Carn Breseb

Table 1: Petrographic and lithochemical matching of Stonehenge bluestones with sources (from Ixer 1996).

The outcrop of Carn Goedog was certainly quarried in recent times, when its stone was used to build the 19th-century chapel at Felindre Farchog, just over 3 miles to the north (Wainwright pers. comm.). Remains of this episode of quarrying can be seen at Carn Goedog, particularly along its southwestern edge, but it is possible that traces of earlier quarrying survive elsewhere along the outcrop's southern perimeter.

In 2009, geologists Richard Bevins and Rob Ixer identified a rhyolite bluestone source north of the Preseli hills in the Pont Saeson district, an area including specifically the impressive crag of Craig Rhosyfelin, not far from the spotted dolerite source at Carn Goedog on the northern edge of the hills, although in a much lower topographic situation. Later, they noted that SH32e, an unsampled 'rhyolite' stump within the bluestone circle, appears macroscopically to conform to a major class of debitage from Stonehenge, namely their ‘rhyolite with fabric’, that could originate from Pont Saeson (Ixer and Bevins 2011). In August 2011 Richard Bevins was able to find a precise match between this ‘rhyolite with fabric’ from Stonehenge and the northwest side of the outcrop of Craig Rhosyfelin.

Follow-up surveys by the Stonehenge Riverside Project and Dyfed Archaeological Trust in 2010 have confirmed that these two outcrops at Carn Goedog and Craig Rhosyfelin are likely quarry sites, the former associated with an unexcavated prehistoric settlement. In 2010 we identified an arc of standing stones as a possible dismantled stone circle in the vicinity at Waun Mawn, raising the possibility that some of the Stonehenge bluestones were taken from a pre-existing monument. Geophysical survey and small-scale excavation are needed to establish if this was indeed a circle and, if so, when it was built and dismantled.

There are different theories about why stones from Preseli were taken to Stonehenge. According to Darvill and Wainwright of the SPACES project, they were considered to have had healing properties, a theory based partly on Medieval legend and also on the presence of holy wells around Carn Meini (Darvill and Wainwright 2009).

Another possible theory is that the stones had ancestral significance. The area immediately north of Preseli has one of the densest distributions of Early Neolithic portal dolmens (stone-built tombs) in Britain. These monuments were erected by some of the first farmers to colonize Britain, so this area may have been considered ancestral by the Stone Age farming communities who built Stonehenge a thousand years later. Further work is needed to date the construction of portal dolmens, working on museum collections as well as initiating new fieldwork.

Research Aims

The project aims:

- To identify quarry sites from which Stonehenge bluestones (dolerites, rhyolites and other lithologies) were obtained.
- To better understand settlement and monument construction in the late 4th and early 3rd millennium BC within the Preseli region and their relationship to stone quarrying and its long-distance transport to Salisbury Plain.
- To enhance understanding of the ancestral significance of the Preseli region to late Neolithic communities through an examination of aspects of the 4th millennium BC landscape.

Research Objectives

The project’s first phase identified four main targets – the quarries (the spotted dolerite source at Carn Goedog [SN129332] and the rhyolite source at Craig Rhosyfelin [SN117362]), the settlement (SN12833328) and circular enclosure (SN1262333780) below Carn Goedog, an arc of standing stones at Waun Mawn (SN0838234046) thought to be a possible robbed-out stone circle, and the hillfort of Castell Mawr (SN1187537768) thought to be a modified Neolithic henge. In addition, geological sampling was carried out at various outcrops in order to identify other potential sources for Stonehenge bluestones within the Nevern gorge (SN118373).

Carn Goedog

The possible quarry

Carn Goedog was identified in 1996 and 2006 as the closest match for Stonehenge's stone 61 and potentially for other spotted dolerite monoliths for which Carn Goedog and Carn Meini were both close matches (Ixer 1996; Thorpe et al. 1991; Williams-Thorpe *et al*. 2006). It was inspected by the SPACES project but considered not to be suitable for immediate study because of 19th-century quarrying and because it lay outside the zone of prehistoric remains found by that project (Darvill pers. comm.).

Whereas the southwestern edge of the outcrop has been partly obscured by a dense zone of broken-up stone, no doubt part of the recent quarrying, the remainder of the south side presents a steep, near-vertical face of pillar stones. To the south of the outcrop, a long, irregular gully runs east to west. Lying within it and close to it are three recumbent pillars; the gully could have formed a stone-propping hollow in which prehistoric stone-movers loaded monoliths onto wooden sledges for transport.

Beyond the gully's west end, the ground forms a natural, stone-free terraced routeway which declines gently to the bottom of the hill. This was no doubt utilized by the 19th-century stoneworkers in taking away the dolerite blocks by cart, and may well have been modified by them into a formal access road on and off the outcrop. Whether this re-used a pre-existing prehistoric access route is not known.

Figure 2. Aerial view of Carn Goedog

The most promising area at Carn Goedog for investigation of remains of prehistoric quarrying is on the south side of the outcrop where three recumbent pillars lie at its base. This also corresponds to a zone where the basal stone clitter has apparently been cleared and lies adjacent to a clitter zone which looks to have been augmented by clearance. The site was visited in 2011 but no further work was carried out (other than identifying it for geological sampling by Richard Bevins and Robert Ixer in 2011-2012).

Figure 3: One of the potential bluestone monoliths at Carn Goedog

Carn Goedog II: the possible quarry settlement
A group of 14 hut 'circles' are located at the base of the north-facing slope of Carn Goedog at 240m above sea level (SN12833328; PRN 11506). They were first recorded in 1976 and were also investigated by Peter Drewett (Drewett 1983) and latterly Dyfed Archaeology (Murphy *et al*. 2010).

Figure 4. One of the house platforms (House A) at Carn Goedog © Dyfed Archaeological Trust

The hut remains are arranged in a linear, east-west spread along the base of the slope, with one of them built on a natural terrace higher up the hillslope. They divide into two spatially segregated groups on the basis of plan and wall structure. The nine houses to the west are small, sub-rectangular structures, ranging from 3.0m-5.0m across with walls surviving up to 0.5m high, with stone walls well bedded within soil and turf. The five building to the east are set within a partial stone-walled enclosure and consist of a circular roundhouse about 6.5m in diameter and four smaller, curvilinear and cellular structures. The walls of these buildings are formed of stones denuded of soil or turf.

These hut remains were initially considered to be Bronze Age, but the nine with sub-rectangular plans could date to the Early or Middle Neolithic. They are not square and so are unlikely to belong to the Late Neolithic (*e.g.* the square houses at Durrington Walls and Trelystan; Parker Pearson *et al*. 2007; Britnell 1984). Their north-facing location is also unusual and, combined with their close spatial relationship to the outcrop at Carn Goedog, there is reason to think they are associated with quarrying here.

The five sub-curvilinear buildings are interpreted as a roundhouse and four (or five if House 'O' is included) ancillary buildings set within a rectangular stone-walled enclosure with walls visible on the west and east sides and partially on the north side. The predominantly easterly orientations of their entrances (with one to the west) are consistent with these houses dating to the Later Bronze Age or later in the first millennium BC or AD.

Methodology

Their investigation in 2011 commenced with a detailed earthwork and topographical survey of the entire group of 15 structures, mapping the group with an EDM survey, followed by detailed earthwork plans of each building at a scale of 1:20. This was accompanied by geophysical survey (earth resistivity and magnetometry).

In future years, archaeological excavation of two of the rectangular buildings would provide evidence for dating, floor plans, patterning of interior and external activities, and environmental reconstruction.

The sub-rectilinear houses A, B, C, D, E, F, G, H and J
House A (E513, N105) is the most impressive of the sub-rectangular buildings at 7m N-S x 9m E-W, with an internal area of 4.6m N-S x 3.6m E-W. It is the third house from the west on the lower terrace. Its south end is terraced into the hillside and it has a central sunken area of 2.7m N-S x 2.3m E-W. From the relative height of its buried masonry, it is likely that this structure survives to at least 2-3 courses of walling.

House B (E489, N102) is sub-rectangular, 4.6m N-S x 3.2m E-W. It has no internal contours that indicate its interior dimensions but positions of wall stones suggest likely dimensions of 3.8m N-S x 2m E-W. It is the most westerly on the lower terrace.

House C (E495, N100) is sub-rectangular, 5m N-S x 4.6m E-W, with an internal area of 3.6m x 3m. It is the second house from the west on the lower terrace. Its south side is terraced into the hillside and the ground on its north side drops away almost as steeply.

House D (E524, N99) is sub-rectangular, 5.6m N-S x 3.6m E-W, with an internal area of 4.2m x 2m. It is the fourth house from the west on the lower terrace. Its south side is terraced into the hillside and its east wall is about 0.8m from the west wall of House G.

House E (E533, N105) is sub-rectangular, 4.4m N-S x 3.8m E-W, with an internal area of 2.8m x 1.8m. It is the sixth house from the west on the lower terrace. Its south side is slightly terraced into the hillside. In terms of its small size and position (immediately west of House F) it appears to be a subsidiary structure to House F,

House F (E538, N105) is sub-rectangular, 6.4m N-S x 4m E-W, with an internal area of 4.2m x 2.6m. It has a central sunken area of 2.6m x 1.6m. It is the seventh house from the west on the lower terrace. Its south side is slightly terraced into the hillside.

House G (E528, N99) is sub-rectangular, 4.8m N-S x 3.6m E-W, with an internal area of 3.7m x 2.4m. It is the fifth house from the west on the lower terrace.

House H is sub-rectangular, 6.6m N-S x 3.8m E-W, with an internal area of 4.2m x 2.3m. It is the only house on the upper terrace. It is unusually long in relation to its width, in comparison with the other sub-rectangular houses.

House J (E548, N102) is sub-rectangular, 5.8m N-S x 4.0m E-W, with an internal area of 4m x 3m. It is the eighth house from the west on the lower terrace. Its south end is terraced into the hillside. It is the most easterly of the sub-rectangular houses and is more denuded of turf along its wall lines than the others. It is the only one that lies east of the north-south field wall that otherwise separates the sub-rectangular houses from the curvilinear ones to the east.

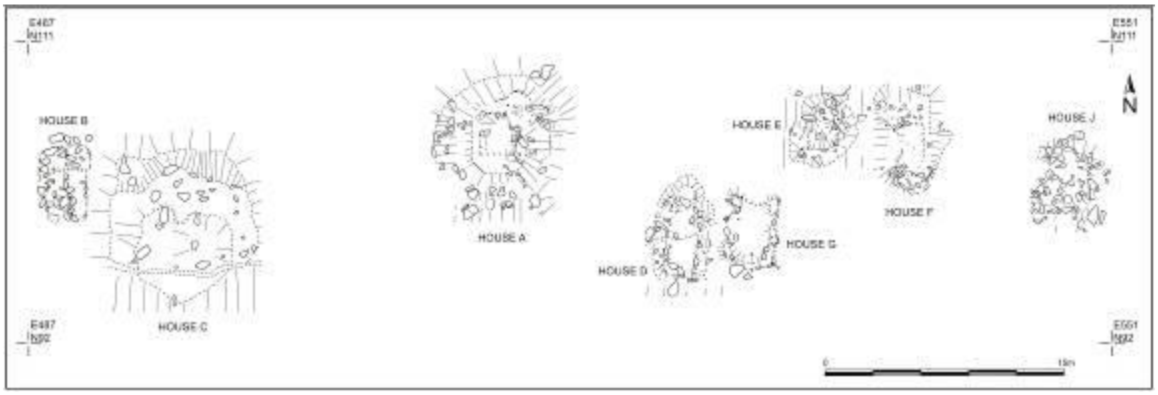

Figure 5. Houses A-G and J on the lower terrace at the foot of Carn Goedog, drawn by Irene Deluis

The curvilinear houses I, K, L, M, N (and O)
House I (E560, N90) is poorly defined by its surrounding walls but its internal area is distinctly visible as a roughly circular and level space, approximately 6.5m in diameter, largely free of stones. It lies to the west of House N, close to the southern edge of the tumbled rocks at the bottom of Carn Goedog's scree slope. Its entrance is most likely to have been somewhere on the largely stone-free east side.

House K (E577, N101) is sub-oval, 3.4m E-W x 3.8m N-S, with an internal area of 2.8m x 2.2m. It may possibly have an entrance in the southeast.

House L (E569, N93) is sub-oval, 6m NE-SW x 4m NW-SE, with an internal area of 3.8m x 2m. It may possibly have an entrance in the south. At its north end it is joined by a 1m-wide wall 2.2m long, and at its south end by a wall 1m wide and 2.6m long that joins it with House N.

House M (E574, N95) is sub-oval, 4.7m N-S x 4.6m E-W, with an internal area of about 2.8m in diameter. It appears to have an entrance on its west side. There was some confusion in allocating its identifying letter: it was initially recorded as a duplicate House K but is actually House M (M being erroneously allocated to the open space immediately east of House I).

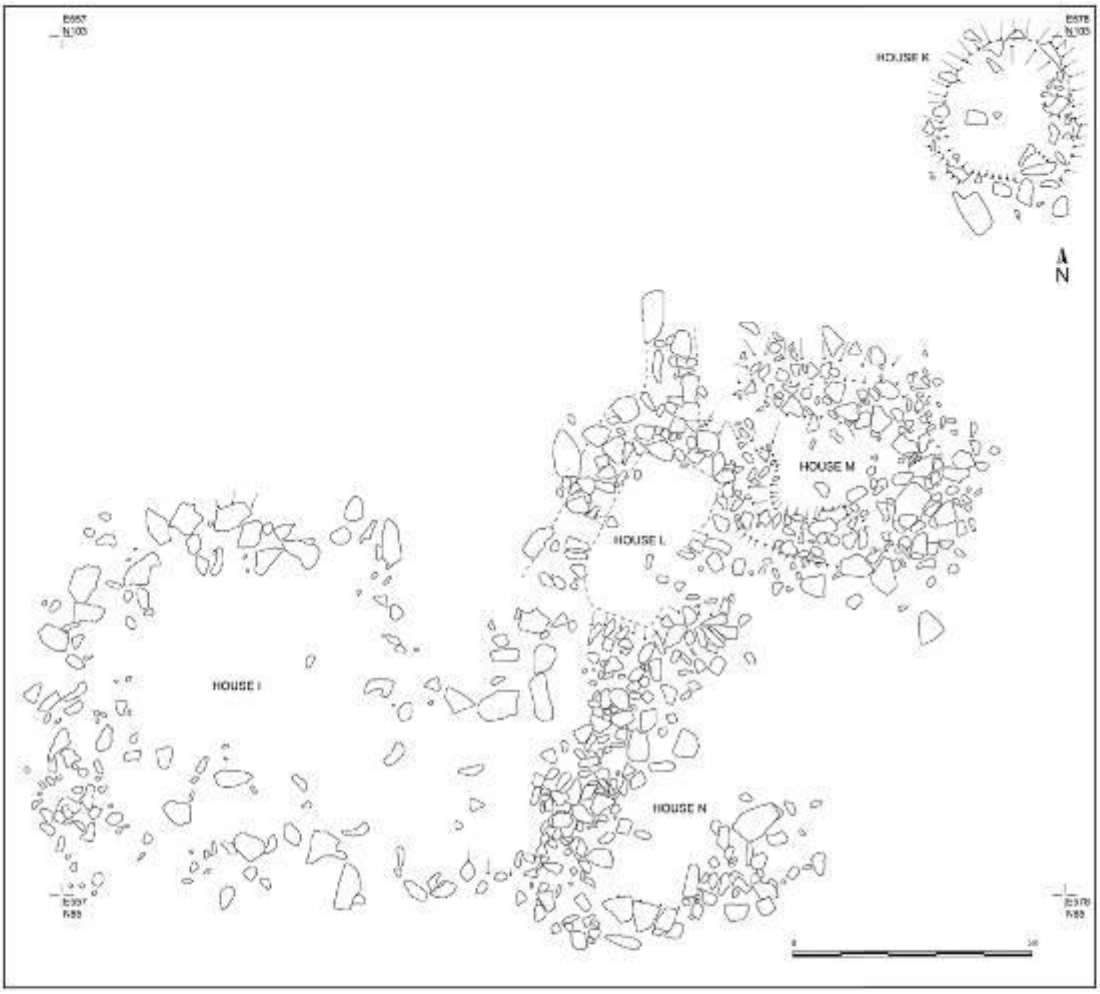

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Figure 6. The group of curvilinear houses I, K, L, M and N at Carn Goedog, drawn by Irene Deluis

House N (E569, N86) is sub-circular, about 4m in diameter, with an internal area of about 2.8m. Four stones within its southeast interior are aligned to form a rectangular corner but otherwise the distribution of fallen wall stones indicates a circular building. It is free of stones in the northeast, suggesting an entrance there. A collapsed wall on its north side links it to the south wall of House L.

House 'O' (E566, N90) consists of five large stones in an approximate semi-circle, 2.8m across, immediately outside the east of the roundhouse, House I, and west of the wall conjoining Houses L and N. It could constitute a porch area for the roundhouse but is more cautiously interpreted as a non-structural and possibly non-artificial feature.

Geophysical survey

Geophysical survey was conducted at the site on 8th and 9th September 2011. Fluxgate magnetometer survey was carried out using a Bartington 601 fluxgate gradiometer over 20m x 20m grids with readings taken at 0.25m intervals along traverses spaced 1m apart, at a resolution of 0.1nT. Earth resistance survey was conducted using a Geonics RM15 resistance meter and a PA5 electrode frame in the twin-electrode configuration, with a mobile probe spacing of 0.5m. Grids were 20m x 20m and readings taken at 1m intervals with a 1m traverse.

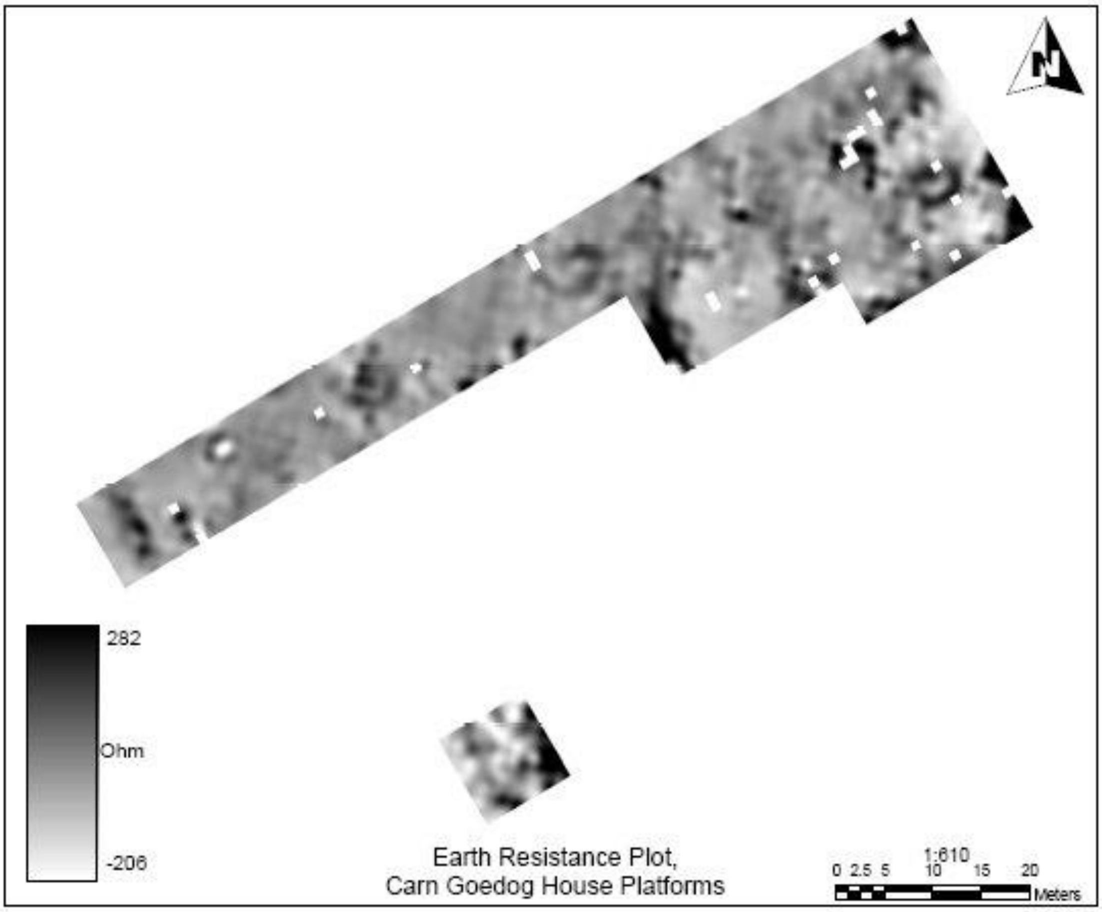

Figure 7. Carn Goedog house platforms: earth resistance survey.

The data acquired from both surveys were output to ArcheoSurveyor 2.5 for processing. The final plots were composed using ESRI ArcGIS 9.3.1. These data were subjected to minimal processing, and the resulting enhanced plots are illustrated below.

The results of the geophysical survey are inconclusive, the uneven ground and extant stones making survey in this area challenging. The earth resistance results do indicate a range of high resistance anomalies in some of the areas associated with the houses surveyed. However, it is difficult to ascertain whether these readings are solely responses to the features that can already be seen on the ground, or whether there is additional information about structure present in these results.

The fluxgate magnetometer results do not initially appear to show evidence for hearths or other burning activity. There are regions of magnetic disturbance in the area of the houses, but it is difficult to determine whether these are associated with anthropogenic activity or a reflection of the surrounding geology. Further work will be carried out on both data sets to compare the topographic and geophysical results and to try and elucidate further detail on the house platforms.

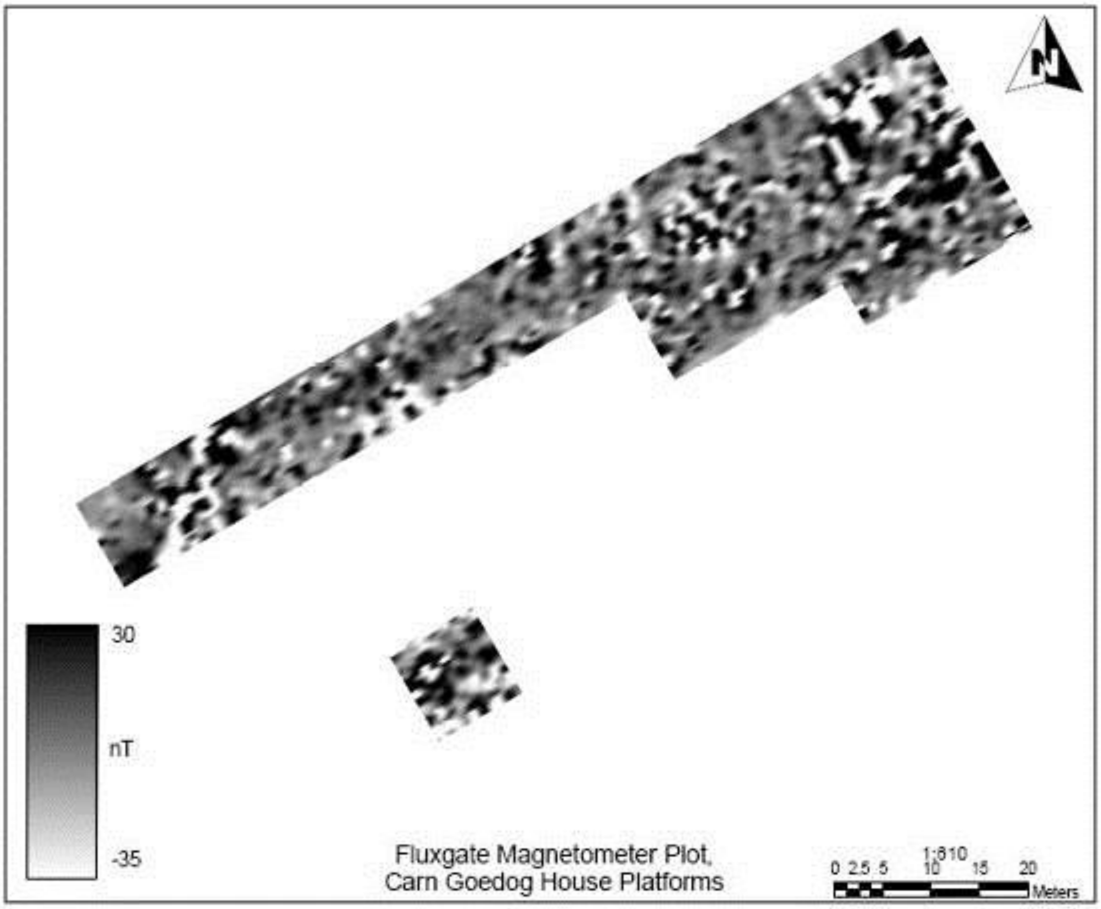

Figure 8. Carn Goedog house platforms: fluxgate magnetometer survey.

Discussion

The dimensions of Carn Goedog's sub-rectangular houses would put them at the smaller end of those for Neolithic domestic buildings in England and Wales (Darvill 1996: 88-9). However, they are of average size when compared to excavated Neolithic examples from Pembrokeshire, namely Structures 1 and 2 from Clegyr Boia at St David's (Williams 1953; Darvill 1996: 108) and eight buildings from Rhos-y-clegyrn at St Nicholas (Lewis 1974; Darvill 1996: 108). Without excavation it is impossible to ascertain the date of the Carn Goedog structures but an Early or Middle Neolithic date would be consistent with their sizes and shapes.

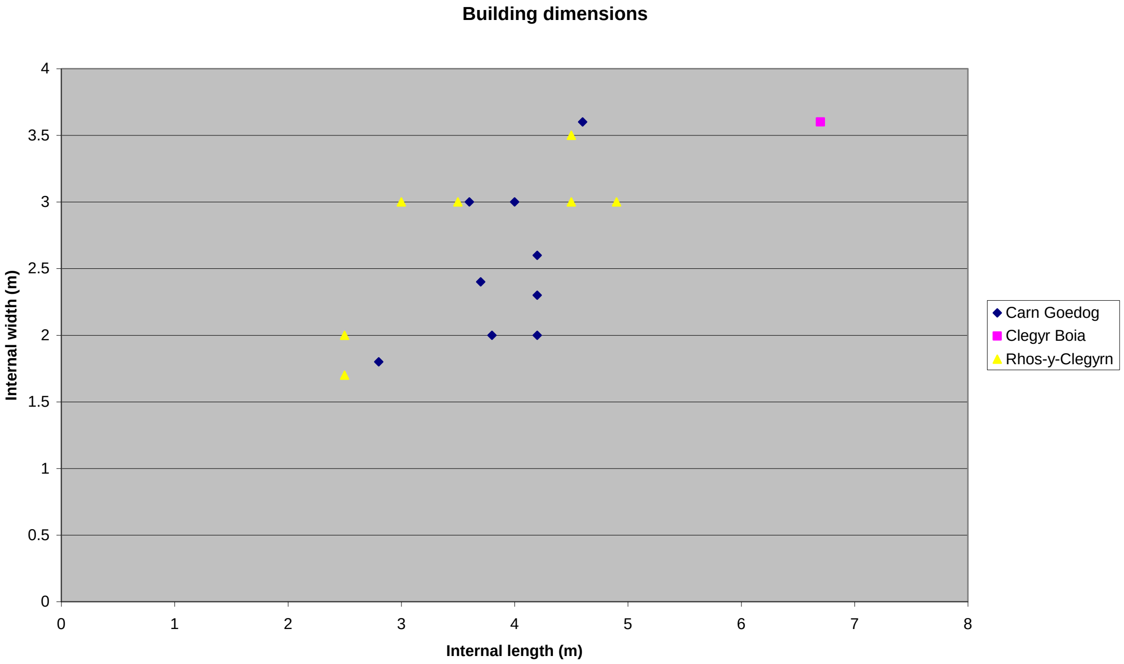

Figure 9. Dimensions of the Carn Goedog rectangular buildings, compared with those of Neolithic houses in Pembrokeshire

Carn Goedog I: circular enclosure

This site at SN1262333780 (PRN 9944) was recorded in 2009 as 'a large, well-preserved circular enclosure situated on the gentle north-facing slopes of Carn Goedog at 195m above seal level' lying within a complex of fields and other features and consisting of 'a circular enclosure, *c*.35m in diameter, defined by an earth and stone bank *c*.4.0m wide and 0.5m high.' (Murphy *et al*. 2010).

Internal features consisted only of small, irregular clusters of stones in the north and southeast, too indeterminate in plan to be interpreted as structures. A narrow entrance, less than 1m wide, on the north side appears to have been cut through the bank and may thus be secondary. There is possibly an entrance, about 2m wide, on the west side but this remains to be confirmed.

Geophysical survey

The geophysical surveys at Carn Goedog I were conducted on 8th and 9th September 2011. The fluxgate magnetometer survey was carried out using a Bartington 601 fluxgate gradiometer over 20m x 20m grids with readings taken at 0.25m intervals along traverses spaced 1m apart, at a resolution of 0.1nT. The earth resistance survey was conducted using a Geonics RM15 resistance meter and a PA5 electrode frame in the Twin-Electrode configuration, with a mobile probe spacing of 0.5m. Grids were 20 x 20m and readings were taken at 1m intervals with a 1m traverse. The data acquired from both surveys were output to ArcheoSurveyor 2.5 for processing. The final plots were composed using ESRI ArcGIS 9.3.1. These data were subjected to minimal processing, and the resulting enhanced plots are illustrated below.

The results indicated that the plan of the enclosure was not precisely circular but slightly teardrop-shaped with a slight apex at the south. They cast no further light on the possibility of an entrance on the west side. However, there is a break in the earth resistance data on the southeast side of the plot which corresponds directly to a linear magnetic feature running southeast-northwest. The fluxgate magnetometer results indicate possible activity within the central part of the enclosure. However, the exact nature of these features cannot be determined.

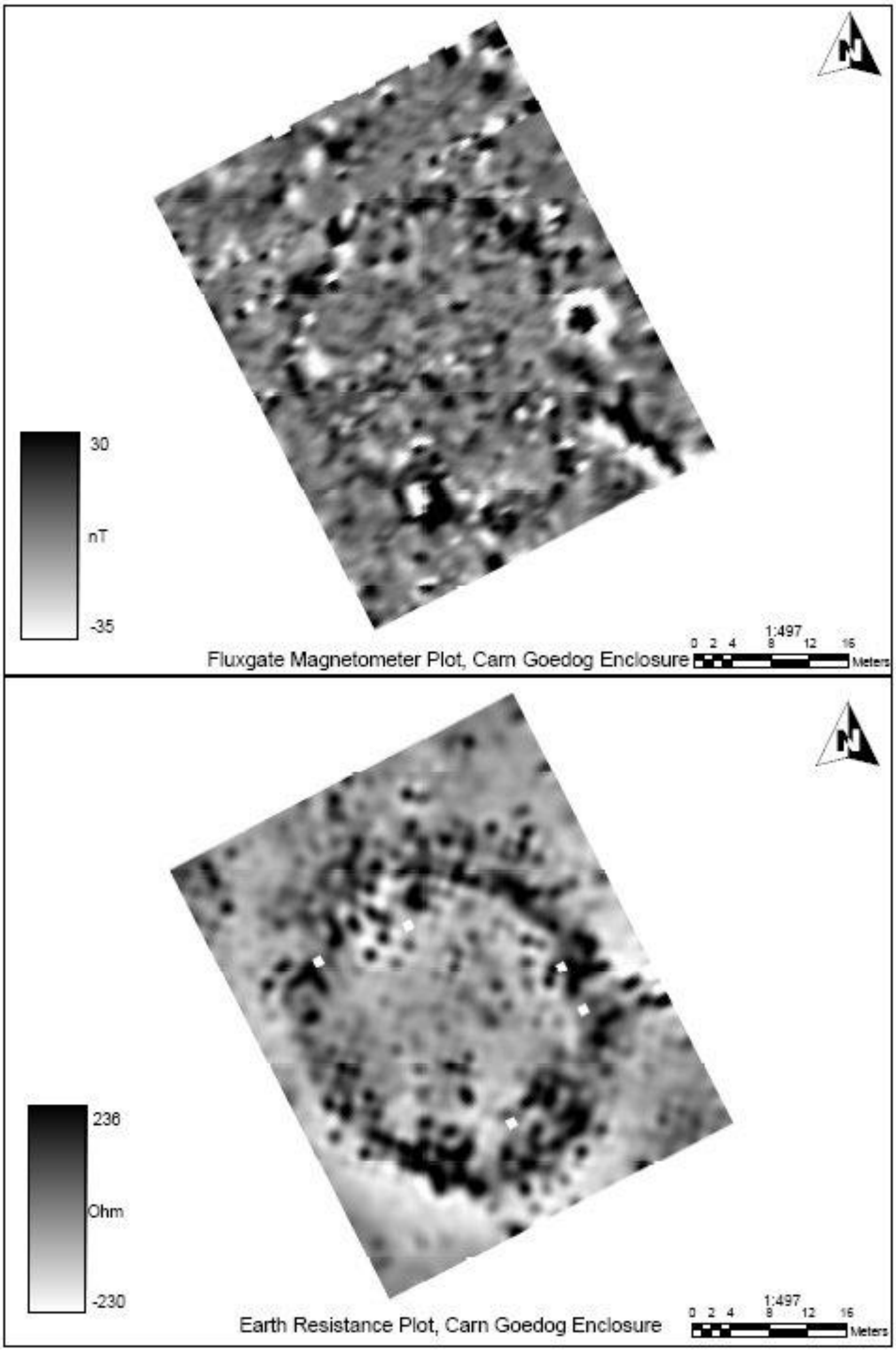

Figure 10. Carn Goedog enclosure fluxgate magnetometer and earth resistance survey.

Craig Rhosyfelin

This site, and immediately adjacent outcrops north of Pont Saeson, was first identified by Richard Bevins in 2009 as a likely source of some of the rhyolite debitage found at Stonehenge (Ixer and Bevins 2009). It matches three foliated rhyolite fragments found in the Cursus field 1km to the northwest of the monument (Ixer and Bevins 2010; Bevins *et al*. 2011), first collected by William Young and J.F.S. Stone (Stone 1947). More rhyolitic fragments were found in 2006 and 2008 by the Stonehenge Riverside Project (Ixer and Bevins 2010). It is currently thought that the remainder of the Stonehenge rhyolite sources are likely to come from the north Pembrokeshire region (Ixer and Bevins 2011).

Figure 11. Craig Rhosyfelin is the NE-SW aligned outcrop in the bottom of the Bryn valley, at the centre of the photograph (see also the frontispiece)

The rhyolite outcrop of Craig Rhosyfelin forms a dramatic ridge of pillar-like stones on the west flank of the Brynberian valley, two miles north of Carn Goedog, with which it is linked by one of the tributaries of that valley; it has potential as a prehistoric stone quarry. Its western edge is exposed as a near-vertical face by the presence of a small and short tributary valley running northwards on the west side. There are no visible earthworks around the outcrop or within its vicinity, although some of the land upstream to the north has been landscaped as the garden of a modern house. Dense stands of bracken and brambles, however, have obscured some of the ground surface nearest the outcrop's near-vertical sides.

The ford immediately north of the field in which the outcrop sits is known as Pontsaethgarreg ('the bridge of seven stones'). This could be a reference to monoliths found in its vicinity, and there is a very large rhyolite upright in the hedge opposite the gate to the field. Although it stands less than 2m high, its width (about a metre) and thickness (about half a metre) are similar to those of the monolith discovered in the quarry (see below); these dimensions make this upright less likely to be a gate post and more likely to be a broken prehistoric monolith.

Ixer and Bevins (in press) have established that a rock sample from the northern end of its vertical western edge (Locality 8 in the accompanying figure) provided an exact petrographical match for a number of rhyolite chips from Stonehenge. This highly distinctive texture they have called Jovian as it resembles the weather patterns on that gas giant.

Figure 12: Geological sampling points at Craig Rhosyfelin; the precise match with some Stonehenge rhyolite was found at 8.

Methodology

Investigation commenced in September 2011 with geophysical survey (earth resistivity and magnetometry) around the outcrop on all sides, down to the river, in this part of the valley bottom.

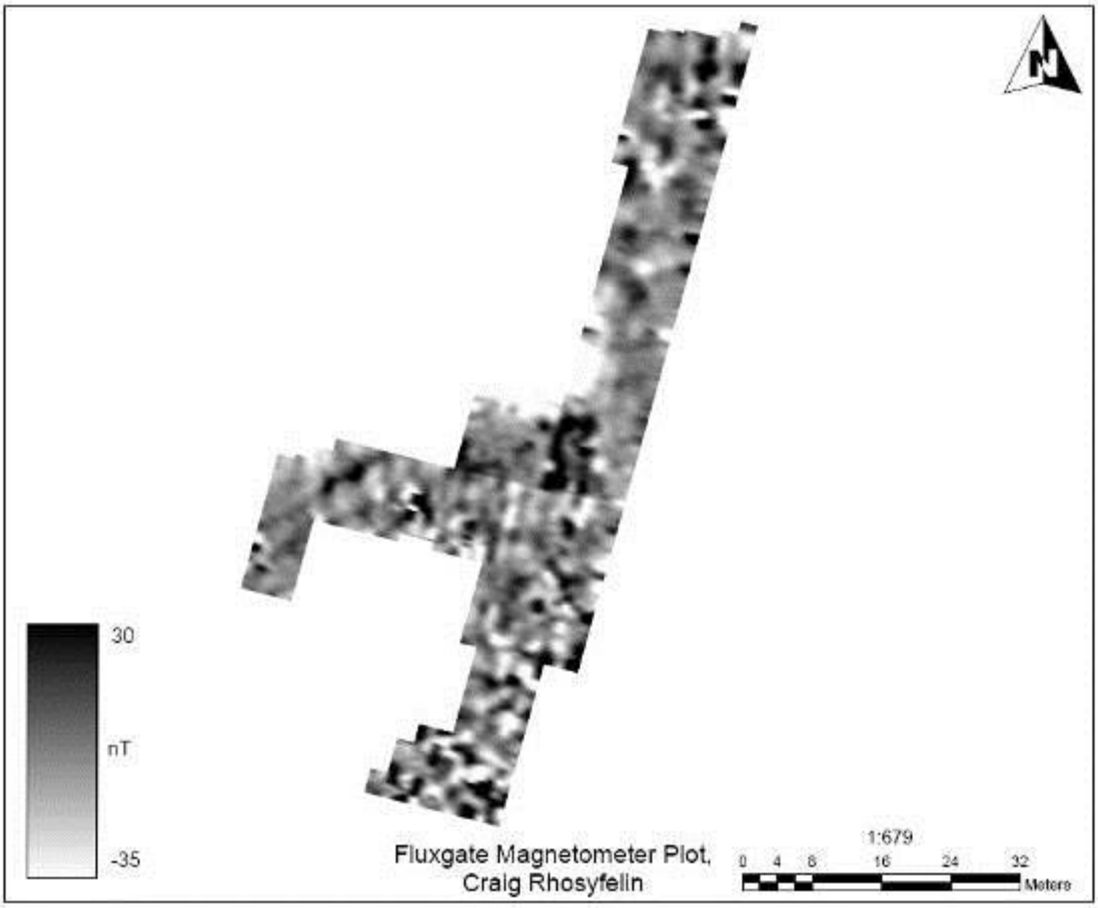

Figure 13. Results of the 2011 magnetometer survey around the Craig Rhosyfelin outcrop.

Fluxgate magnetometer survey was carried out using a Bartington 601 fluxgate gradiometer over 20m x 20m grids with readings taken at 0.25m intervals along traverses spaced 1m apart, at a resolution of 0.1nT. Earth resistance survey was conducted using a Geonics RM15 resistance meter and a PA5 electrode frame in the twin-electrode configuration, with a mobile probe spacing of 0.5m. Grids were 10m x 10m and readings taken at 0.5m intervals with a 0.5m traverse. The data acquired from both surveys were output to ArcheoSurveyor 2.5 for processing. The final plots were composed using ESRI ArcGIS 9.3.1. These data were subjected to minimal processing, and the resulting enhanced plots are illustrated below.

The earth resistance results indicate a band of high resistance readings directly adjacent to the rock outcrop. Next to this can be seen a set of low resistance readings that run southwest-northeast, and within this is a large, high resistance anomaly (highlighted on the image below). On excavation, this anomaly was found to have been produced by the rhyolite monolith. A similar high resistance anomaly lies approximately 5m to the west of this and may indicate the presence of another monolith. There are a number of smaller linear low resistance anomalies (*e.g*. running east-west) that may be associated with services from the modern house in the northwest of the plot.

The fluxgate magnetometer results are less clear, but there are a number of features that mirror the earth resistance data, and may indicate pathways associated with the use of the quarry.

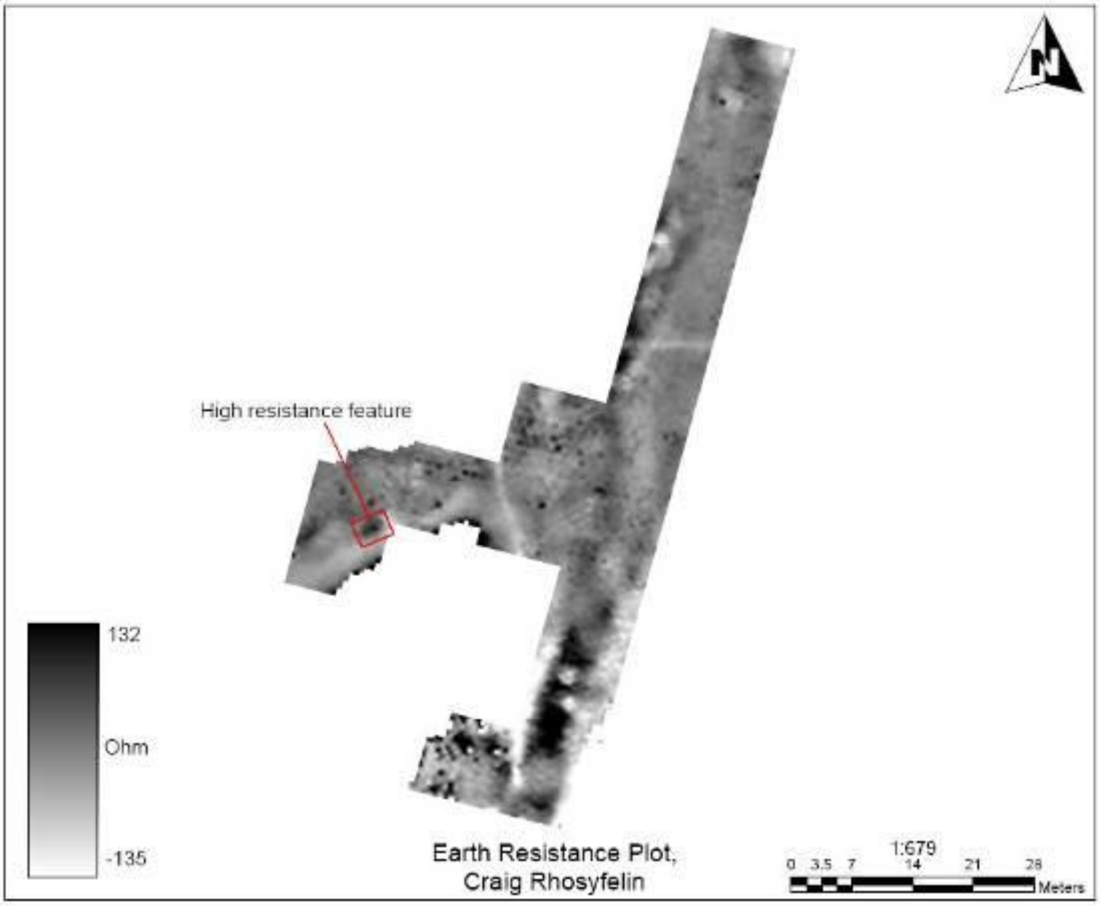

Figure 14. Results of the 2011 earth resistance survey around the Craig Rhosyfelin outcrop.

Three 1m square test pits were dug into deposits immediately west of the outcrop to identify any traces of stone working (preliminary dressing, stone-propping hollows *etc*.). An evaluative excavation of 37sq m was then carried out against the foot of the outcrop on its west side where hammerstones and a monolith were recovered. The topsoil and uppermost layers of colluvium (layers 002 and 003) were removed mostly with a JCB mini-digger, and the remainder of the deposits above the quarry floor were excavated by hand. Of those deposits likely to be contemporary with the prehistoric use of the quarry, only its buried soils (020 and 021) were removed. These were sampled for magnetic susceptibility, phosphorous and other elements and bulk sampled for flotation to recover charcoal for radiocarbon-dating.

Results of the excavation

The original ground surface northwest of the outcrop was buried beneath deep deposits of colluvium. These have sealed archaeological layers and protected the stones in them from opportunistic quarrying in the historical period; in contrast, steel wedge-made holes on the southeast side of the outcrop testify to recent quarrying on that side. The excavation trench revealed a zone of broken rhyolite blocks close to the near-vertical face of the outcrop. Beyond this, there was a stone surface covered by a buried soil. Within this, four blocks appear to have been set on edge on a northwest-southeast axis, probably to form ‘runners’, ‘rails’ or ‘guides’ for a 4m-long rhyolite monolith that lay on their north end. The monolith’s size, composition and shape indicate that it is too large to have derived from the adjacent rock face; it was most likely detached from the outcrop about 15m to the south (in the direction indicated by the axis of the stone runners). Other archaeological finds included around a dozen hammerstones, a flint flake, quartz flakes and many rhyolite flakes exhibiting evidence of knapping.

Figure 15. The rhyolite quarry under excavation before removal of the buried soil.

The quarry sequence
The floor of the quarry consisted of a spread of rhyolite blocks in both halves of the trench (context 019 in the west and 026 in the east). This petered out at the northeast end of the trench adjacent to where the outcrop terminated. Coring of deposits here, beneath the level of the rubble, revealed a dark grey-brown clay loam (0.05m thick) on top of an orange-grey-brown clay loam with fine gravel (0.06m thick) on top of chocolate brown clay loam with occasional small stones (0.06m thick) before large stones were encountered. These lowest layers were not excavated.

Figure 16. The rows of bedded pillars beneath the south end of the monolith

The earliest feature within the quarry was a group of four thin pillars of rhyolite on a northwest-southeast axis (context 028). They were 0.2-0.4m wide and the two that lay entirely within the trench were 1.5m and 1.1m long. It was clear that they were deeply bedded, perhaps in long pits as indicated by the tipping angles of smaller stones on either sides of them. Together they formed three parallel lines with an overall width of 2.1m. They terminate 2m from the southeast edge of the trench and are interpreted as the end of a series of stone runners or rails along which the monolith was manoeuvred, presumably by wooden levers.

Figure 17. One of the hammerstones (SF002) within the rubble (019).

Most of the artefacts came from within the rubble (019, 026 and 023) on the floor of the quarry. These included a hammerstone from 019 and two artefacts and a beach pebble from 026.

At first glance there is little sense of structure to the rubble (019, 026 and 023) exposed within the excavation. However, there are three zones parallel with the outcrop's near-vertical wall with distinctive differences. The zone within 1m-1.5m of the outcrop consists of stones that lie parallel with it or obliquely angled, no doubt the products of falling debris. Within 1.5-4m of the outcrop wall, many of the stones are pitched at right angles to the rock face; some towards the northeast end of the trench even appear to have been stacked. The exception to this pattern is a small group of large stones (023) in the middle of the southeast end of the trench. The third zone is a consolidated surface of small rubble, beyond 4m from the rock face, along the northeast of the monolith and extending beneath it.

There was also a marked drop of about 0.1m from the rubble (019) in the western part of the trench to the rubble (026) in the eastern part (most of the latter being buried beneath the buried soil 020). Too little of this fall between 019 and 026 was exposed within the trench but it may be the result of terracing rather than the result of an uneven gradient.

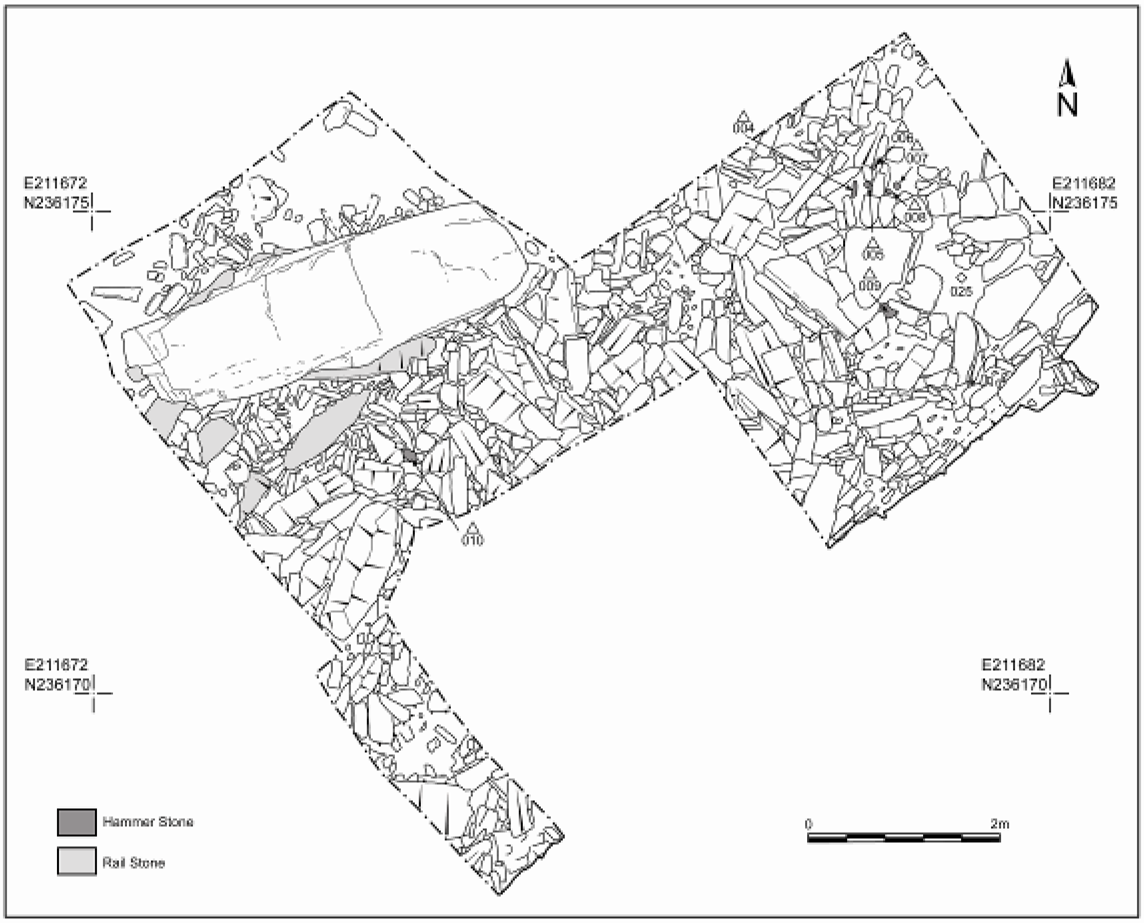

Figure 18. Plan of the quarry floor after excavation of its buried soil, drawn by Irene Deluis

Within the 3m-long x 1m-wide part of the trench against the rock face in the southeast, there was a pocket of dark brown-black clay loam (018) in a loose fill with small ‘slates’ of rhyolite. Because of the narrowness of the trench at this point, it was impossible to establish whether this was part of a linear feature running parallel with the outcrop or a small pit little bigger than the 1m-wide excavation trench. It was set into larger rubble on both sides (northeast and southwest). It pre-dated the upper colluvium (002=017) but could not be related stratigraphically to other layers lying upon the rubble (019, 026 and 023).

Figure 19. The rhyolite monolith.

The monolith
The rhyolite monolith (007) is 4.10m long, up to 1.25m wide and 0.54m thick. It lies with its top downhill towards east-northeast at an angle of about 30° to the stone runners on which its west-southwest basal end rests. Whilst its thickness is relatively even, its width varies; it is mostly about 1.1m wide for most of its length and is about 1m wide at its base. Its top end, lying downhill, is naturally weathered indicating that the monolith was detached from the top of the outcrop. Its basal end, lying uphill, is unweathered and fractured, indicating that it has been snapped off from the outcrop.

The monolith lies with its unweathered face (*i.e*. that side that was prized from the bedrock) lying upwards, indicating that it has been moved from the rock face through 90° in the vertical plane and then rotated through 120° in the horizontal plane. On the basis of the height of the outcrop adjacent to the stone, as well as the width of its jointing and the degree of faulting there, it is certain that this monolith was detached from further along the outcrop to the south. The orientation of the stone runners would suggest these led to a point about 15m beyond the southeast end of the excavation trench.

Other than having been split from the parent outcrop, the monolith has no evidence of working other than two possible flake scars on the upper surface of its southeast corner. These derive from flakes (0.05m x 0.10m wide by 0.05m long) that have been struck across (not along) the foliations, leaving the negative depressions of bulbs of percussion. There are two curious parallel gouges on its north side about 0.08m apart and 0.10m long, running across the grain of the rock. They are slightly wider at the bottom (nearest the ground) and narrow to points at the top.

The buried soil

Most of the north/northeast end of the trench was covered with a thin buried soil (020), about 0.1m or less to the west and increasing to 0.2m thick near the outcrop where it appears to have formed from a dense mat of vegetation and organic matter against the vertical side of the outcrop, much as a similar horizon does today above the colluvium here, due to the growth of bracken and the accumulation of dead organic matter at the base of the outcrop. In the south end of the trench, around and beneath the monolith, there were very few patches of buried soil (021), most of them being to the west of the monolith. In both cases (020 and 021) the buried soil was a black-brown clay silt with occasional stones and charcoal flecks, although it contained no artefacts.

The buried soil probably accumulated after the quarrying. Some of it lay in a pocket (019) on top of the likely cuts for the stone runners beneath the monolith. Other pockets lay beside and even beneath the monolith but these soils could have developed long after the quarry was abandoned and before the onset of colluviation.

Sampling of the buried soil was carried out on a 0.5m x 0.5m grid (a method established for sampling prehistoric house floors; Smith *et al*. 1998); quantities of phosphorous and other elements were recorded using a portable XRF machine whist samples were taken for soil magnetic susceptibility (environmental sample group 005). The extensive buried soil in the northern half of the trench was gridded into 1m x 1m blocks and 100% bulk sampled for flotation to recover charcoal, charred plant remains and micro-debris (environmental samples 006-023). Two further bulk samples for flotation were taken, one (environmental sample 024) from the pocket of 021 southeast of the monolith, and the other (environmental sample 025) from the lower component of 020 in the north of the trench where it was sealed beneath a flat slab and unaffected by any worm action.

On the western edge of the excavation adjacent to the southwest side of the monolith, the buried soil was cut by a shallow scoop 0.18m deep and over 1.5m north-south. This was filled with dark-grey brown silt loam (027) with mixed-in gravel and small stones set in angular positions. No clear evidence of a cut was obtained and this has more the appearance of a churned up and disturbed surface against the north corner of the monolith. It might conceivably have been caused by attempts to shift the stone or, since it post-dates the formation of the buried soil, it may be the result of much later disturbance prior to colluviation.

The colluvial sequence

The quarry deposits and buried soil were covered by a deep sequence of colluvial layers, between 1m and 1.4m deep. These deposits were deepest along the west side of the trench furthest from the outcrop.

The basal colluvial layers formed multiple lenses of loam and gravel, thinner than the layers of colluvium at the top of the sequence. These were particularly dense and complex in the northwest half of the trench, petering out within three metres of the outcrop. This particularly noticeable on the west side of the monolith where colluvial layers were thick and stony, indicating that much subsoil was being displaced from the western edges of this small valley.

The lowest layer of colluvium was a thin spread of gravel (context 015; up to 0.04m thick) within the north end of the trench where it lay upon a patchy lens of brown-grey clay directly on the buried soil (020) of the quarry floor. It probably equates to a similarly patchy gravel layer (027) in the northwestern edge of the trench on the west side of the monolith (007).

Layers 015 and 027 were covered by a 0.1-0.3m thick layer of mid brown silt loam (008 in the east and 024 in the west). Within the northern part of 008=024, within its upper component, there were two dense but shallow deposits of charcoal (context 009, environmental sample 001, 1m x 0.35m; and context 010, 0.25m x 0.11m).

Layer 008=024 was covered by layer 022 (largely stone-free mid-brown clay) in the northwest and by yellow-brown gravel (006) beneath grey-brown silt loam (005) in the northeast end of the trench. A sample of charcoal (environmental sample 004) was taken from the basal component of 022 immediately north of the monolith. A spread of flat rhyolite slabs on the top of layer 022 were concentrated against the northwest side of the monolith but were probably deposited by natural agency.

Layer 022 was overlain by a sequence of layers – 013, 012 and 011 – in the west corner of the trench, of which 012 is equivalent with 005 in the north. Layer 013 was a gritty sand with small-medium sized stones; its clay content increased with proximity to the monolith. Above it, layer 012 was a thin layer of largely stone-free black clay loam, probably a buried soil. Layer 011 was a sandy, gritty silt loam with small stones that can be equated with layer 005 in the north end of the trench.

The uppermost layers of colluvium were a band of grey-brown silt loam (003) up to 0.2m thick, beneath a thicker layer of orange-brown loam (002). These two layers were hard to differentiate in the northwest part of the trench. In the south end of the trench, 002 was equivalent to 017 which lapped against rubble (023). A charcoal sample (sample 003) was taken from layer 003 whilst 002 contained sherds of 19th century ceramics. The uppermost layer was topsoil (001) covering the entire trench, with 016 being part of it in the southwest against the rock face. A similar layer of black organic soil (014) within a cleft in the rock face in the northwest contained a flint flake at its base.

Worked stone and imported stone

This report summarizes the results of the preliminary analysis of the stone tools and debitage recovered during excavations at Craig Rhosyfelin in 2011. The aims of this assessment were threefold: a) to assess the nature of the material collected, b) to establish the actual number of stone tools and debitage present, and c) to provide an initial indication about the character of activities taking place at this site. The identification of manufacturing and use wear was based on the macroscopic examination of objects with a hand-lens (8-15x magnification) under artificial light.

Assemblage composition

Out of the collected material, nineteen objects were identified as worked or possibly worked and one object was identified as unworked but imported onto the site. The assemblage consists mainly of flakes of different sizes, nine objects in total (45% of the assemblage): six rhyolite flakes (from contexts 002, 008, 027), one retouched flint flake (014), and two flakes struck from a possible siltstone or fine sandstone (002). In addition, there was a thin fragment of rhyolite ca. 30 cm long with two possible flake scars, which possibly represents the distal proportion of a large broken flake (008). Most of the rhyolite flakes are of small to medium size and show a clear bulb.

The flint flake (SF001) is of light grey varying to light brown colour and has a plunging profile and crushed butt. One small area of the dorsal surface of the flake is highly weathered and has the appearance of abraded beach flint. The flint is weathered and has natural flaws running through it. The dorsal surface has multidirectional flake scars, while the distal end of the flake has a small area of steep angle retouch. An additional artefact worthy of description is the large rhyolite flake from (008). The flake is ca. 30 cm in length and survives complete. The main indications of the piece being a flake are a slight bulb, and a convincing flaking angle between the butt and the ventral surface of the flake. The flake has weathered margins and a weathered dorsal surface, suggesting that it is a primary flake struck from the weathered outer face of the a block of rhyolite. A large notch has been removed from one lateral margin of the flake.

The second most common category in the assemblage was that of hammerstones with varying degrees of use. The most convincing example (SF002) comes from context 019 and is a medium-sized quartzite hammerstone (Figure 1). This hammerstone is a water-rolled cobble, acquired from a river/stream, and is roughly egg-shaped in plan and ovate in section. It has percussive wear on both ends and on much of the circumference of the body. There is a possibility that the wear on the body is in fact manufacturing wear that relates to an attempt to create a waisted area to facilitate hafting. Another possible hammerstone comes from context 026 (SF008); it is an irregular shaped quartz cobble with a tiny area of crushed grains. Another three objects have been identified as possible hammerstones: a medium sized quartz stone with a small pitted/crushed area from context 011; an elongated cobble of grey sandstone with well cemented grains, one end of which has a removal from a possible percussive activity; and, a quartz cobble from context 017 that seems to have some crushed areas but the surface is heavily weathered and this makes secure identification difficult. A less convincing example of a possible hammerstone comes from context 002 and it is a medium sized sandstone cobble with a possible flake removal near one end.

Within the assemblage two objects have been identified that show evidence for grinding/abrasive activities. The first is a possible flat abrader/abrading tool made of fine sandstone that comes from the colluvium. It is almost rectangular in plan and flat in section. One flat surface is smoothed in places and has levelled grains while both opposed surfaces have multidirectional scratches/striations. The second example comes from context 026 (rubble) and is a fragment of a stone with one flat surface that seems to have levelled grains (SF006); the flat surface contrasts with the other uneven natural/weathered surfaces of the stone. The levelling of the grains could have resulted either intentionally through use as a grinding/abrasive tool or unintentionally through friction caused by contact with another hard surface such as another stone (a possibility to consider is whether this could have happened during the rolling of the monoliths). In addition to these two examples, a further cobble was recovered that seems to have smoothed grains in places on one margin and on one body surface that comes from context 016. The cobble is elongated and could have come from a beach.

Among the objects recorded there was also a natural elongated cobble (SF004) with elliptical section that has no visible wear on any of its surfaces. Most likely it is a beach cobble that has been introduced to the site. It was found in context 026 (rubble).

Object Type	Frequency	%
Flake	8	40.0
Retouched flake	1	5.0
Hammerstone	1	5.0
Possible hammerstone	4	20.0
Natural cobble	1	5.0
Possible grinding/abrasive tool	1	5.0
Possible flat abrader	1	5.0
Indeterminate	3	15.0
Total	**20**	**100.0**

Table 1. Frequency of object categories within the recorded lithic assemblage.

Recovery contexts

As clearly highlighted in Table 2, the vast majority of the material comes from the sequence of colluvial layers and only four objects come from the quarry sequence (contexts 019 and 026). Currently all the recognised flakes come from the various colluvial layers, with four out of nine flakes coming from the upper colluvium (002).

In the case of hammerstones, the most convincing example (SF002) comes from the quarry sequence (019) as also does another possible quartz hammerstone (SF008) that derives from layer 026.

Discussion

The assemblage from the excavations at Craig Rhosyfelin is small and, whilst it includes convincing examples of flakes (of rhyolite and flint) and a small number of hammerstones, it also includes several objects that can only be identified as ‘possible’ artefacts. The latter group consists primarily of possible hammerstones. The lack of a larger number of potentially quarry-associated artefacts reflects two factors. Firstly, the excavations revealed, but did not remove the primary rubble contexts on the site and hence the majority of the excavated deposits date to the period after the actual quarrying activities. Secondly, the assemblage does not currently indicate either heavy flaking of rhyolite *(i.e.* the number of flakes at present is relatively small) or heavy use of hammerstones (*i.e*. the hammertones have light wear on them). In relation to this latter point it should be understood that the rhyolite monolith itself only has minimal indications of having been flaked or physically "quarried" out of the outcrop. Instead, the monolith has been removed from the outcrop using the natural fracture planes that run horizontally through the rock and the natural foliation which also runs horizontally through the rock, but perpendicular to the fracture planes. Hence, further excavation is required to assess what tool kit or techniques such as fire-setting would have been required to remove monoliths from the outcrop. The current understanding is that this may have been quite minimal.

In addition to the above, there are also some issues of artefact identification which are worth noting. Firstly, the flaking properties of rhyolite need to be assessed when considering the assemblage of flakes. In order to aid the identification of the rhyolite flakes from the site, a limited rhyolite knapping experiment was undertaken on the material from the outcrop. The rhyolite is fine-grained and the experiment confirmed that the material does fracture sub-conchoidally. Flaking the material does require a good flaking-angle and does leave recognisable features (mainly a bulb of percussion and, to a lesser extent, subtle ripples of percussion). However, the flaking properties of the stone differ according to the direction of the removing blow in relation to the natural foliation of the rhyolite. In essence, when the removing blow is struck across the foliation the flake tends to form regular flaking features, when the blow is struck in line with the foliation the force of the blow tends to follow the foliation splitting the flake off along the existing planes of foliation. In the latter case the flake was less likely to form a bulb and the resultant flake was on occasion impossible to tell apart from rhyolite that had flaked off from the outcrop due to natural weathering and thermal shock (as this also tends to occur along natural lines of foliation).

The second issue that warrants discussion is the difficulty of identifying quartz hammerstones. Quartz occurs naturally within the rhyolite outcrop and outside of cobbles retrieved from the nearby river quartz is probably the most abundant rock in the vicinity of the outcrop that would have been suitable for use as hammerstones. The problem is that the identification of percussive wear on quartz is particularly difficult due to the natural structure of the mineral. The character of quartz is such that natural unworked surfaces can appear crushed and pitted, whilst surfaces used for percussive activities can appear smooth and unworked (Anderson-Whymark pers. comm.). Due to these difficulties, a conservative approach should be taken to the identification of quartz hammerstones.

In summary, the assemblage from the 2011 excavations indicates evidence of the flaking of rhyolite, the use of hammerstones in percussive activities and some limited grinding/abrasive activities. These activities would fit within the milieu of practices that might be expected to take place around the quarrying of stone, however, further excavation is necessary to more fully characterise the nature of those activities and the material residues which they can be expected to have generated.

Figure 20: Quartzite hammerstone SF002 from context 019.

Context * Object Type Crosstabulation

Context	Object Type								Total
	flake	retouched flake	Hammer-stone	possible hammerstone	grinding/ abrasive tool	possible flat abrader	natural cobble	Indeterm inate	
011	0	0	0	1	0	0	0	0	**1**
014	0	1	0	0	0	0	0	0	**1**
016	0	0	0	0	0	0	0	1	**1**
017	0	0	0	1	0	0	0	0	**1**
019	0	0	1	0	0	0	0	0	**1**
002	4	0	0	0	0	0	0	1	**5**
025	0	0	0	1	0	0	0	0	**1**
026	0	0	0	1	1	0	1	0	**3**
027	1	0	0	0	0	0	0	0	**1**
008	2	0	0	0	0	0	0	1	**3**
Colluvium	1	0	0	0	0	1	0	0	**2**
Total	**8**	**1**	**1**	**4**	**1**	**1**	**1**	**3**	**20**

Table 2: The distribution of the lithic assemblage by context.

Carbonised plant remains
This report summarises the results of a preliminary assessment of 23 flotation samples collected during excavations at Craig Rhosyfelin. A total volume of 313.5 litres of soil was processed. Of the samples submitted for assessment, 20 were systematically recovered using a grid system from a spread of material containing charcoal (context 020). Three small samples were also collected from more discrete patches of charred material (contexts 009, 003 and 022). The samples were processed for charred plant remains and wood charcoal using a water separation machine. Floating material was collected in sieves of 1mm and 300µm mesh, and the remaining heavy residue retained in a 1mm mesh. The flots and heavy residue were air dried with the heavy residue being sorted by eye for organic remains and artefacts.

The samples were assessed in accordance with English Heritage guidelines for environmental archaeology assessments (English Heritage 2002). The main aim of this assessment was to determine the concentration, state of preservation and suitability for use in radiocarbon dating of any archaeobotanical material present within the samples. A further aim was to evaluate the potential of this material to provide evidence for the nature of the local environment, as well as for the utilisation of that environment by the people present at the site.

A preliminary assessment of the samples was made by scanning under a binocular reflected light microscope (x7-x45) and recording the abundance of the main classes of material present.

Material represented
Charcoal was present in varying quantities in every sample. A particularly large quantity of charcoal was present in sample 001 (from context 009) which contained well over 100 fragments of both >2mm and >4 mm charcoal. Round wood of *c*.2mm diameter was also present in moderate quantities in the majority of samples and numbered more than 30 fragments in sample 001 (from context 009) as well as in samples 014, 020, 021 and 022 (from context 020). Some of this round wood material resembled knobbly twigs. Also frequently present were small charred, <1mm twigs, roots or stems.

Wild plant seeds were also relatively well represented, present in all but three of the samples and numbering more than 30 in three. Species noted as present included lesser stitchwort (*Stellaria graminea* L.), bugle (*Ajuga* sp.) and plantain (*Plantago* sp.), along with docks (*Rumex* sp.), goosefoot (*Chenopodium* sp.) and pea family (Fabaceae). Lesser stitchwort, bugle, and plantain suggest a grassy environment, and many of the goosefoots and docks are associated with open ground, waysides and waste ground. A further class of wild seeds which represent edible foods were bramble (*Rubus fruticosus* AGG.), raspberry (*Rubus idaeus* L.) and wild strawberry (cf. *Fragaria vesca*). All three would have been common throughout the British Isles, growing in a variety of habitats including woodland clearings, hedgerows, waysides and open ground (Stace 1997). A single grain of hulled barley (*Hordeum* sp.) was also present in sample 015 (020).

Other plant material included hazel nutshell, which was present as < 5 *c*.5mm diameter fragments in five of the samples with only sample 023 (020) containing more than ten fragments. Charred rhizome material was present in around half of the samples with samples 007 and 009 both from context (020) containing more than ten fragments. Tubers identified as lesser celandine (*Ranunculus ficaria* L.) were present in sample 025 (020). A couple of fragments of probable charred fruit flesh (*cf.* Rosaceae pericarp) were present in samples 007 and 016 (both from context 020) and one or two thorns were present in five of the samples.

Discussion and recommendations for further work

A range of charred plant material was found to be present in samples from the site. This included wood charcoal, *c*.2mm round wood, <1mm twigs, roots or stems, wild plant seeds, rhizome material, hazel nutshell and a hulled barley grain. The presence of charred material such as small twigs and stems as well as wild seeds indicates that preservation of plant material by charring at the site is relatively good. Material such as seeds and round wood would be especially suitable for radiocarbon dating purposes due to their short life but sufficient material for dating was present in almost every sample.

The presence of small charred twigs, roots and stems along with larger charcoal fragments probably indicates the use of this material as kindling for lighting fires. This kindling may have included bramble and raspberry stems because seeds from these species, along with unidentified charred thorns, were also present. The presence of possible wild strawberry seeds as well as hazelnut shells, however, suggests that the bramble and raspberry seeds represent part of a suite of collected wild food resources. Identification and analysis of the charcoal assemblage would provide evidence for which woody species' were utilized as fuel. In either case, raspberry fruits ripen in late summer and early autumn after which they fall to the ground (Pokorný 1995), suggesting that activity at the site was being carried out at this time of the year. It is also possible, however, that fires were being set on areas where the berries had fallen or been dispersed by animals, although this would seem unlikely. Berries may also have been preserved as fruit leather (Mears and Hillman 2007) and been eaten at the site at a different time of year, although the chances of whole seeds entering fires would also seem unlikely if this were the case.

Wild berry seeds and hazelnut shells are frequently recovered from Neolithic archaeological sites indicating the common utilisation of wild food resources at this time (Moffett *et al*. 1989). Charred rhizome fragments may also represent the use of tubers for food or may also have been used as tinder, or uprooted accidentally along with other material that was to be used as tinder. The single charred hulled barley grain indicates the use of cereal crops. Barley is also relatively frequently represented on British Neolithic sites, although often, as here, in low densities. This is likely to be related to cereal grains being a resource intended for consumption rather than waste product such as hazelnut shells or fruit pips which are more likely to have been discarded onto fires (Jones and Rowley-Conwy 2007).

Full sorting of all the samples where wild seeds were noted as present would be recommended in order to recover rare types not noted during scanning and provide a full record of the wild species represented. It is possible that additional evidence for edible wild foods may be recovered. It would also be recommended that full sorting of samples where rhizome fragments were present be carried out.

Identification of the wood charcoal present would also hopefully establish whether the bramble and raspberry seeds may have been attached to stems burnt as kindling as well as which other plant species were utilised for fuel. Analysis of the wood charcoal and wild plant seeds would also provide further evidence for the nature of the local environment. Sufficient wood charcoal fragments were present in samples 007, 009, 015, 016, 020 and 021 (from context 020) to provide a reliable species list of woody plants utilised for fuel at the site (Stuijts 2006). As a minimum, identification of 100 charcoal fragments from one of these samples would be sufficient, but a comparison of material in two of the samples would be useful. Sufficient fragments were also present in sample 1 (from context 009) and analysis of this sample would also provide a useful comparison with context 020.

The most suitable charred material for radiocarbon dating would be material that has a short life prior to charring such as round wood, hazelnut shell and seeds. The use of the round wood fragments for dating would be recommended due to their presence in the majority of the samples and number of fragments available. The small quantities and therefore weights of the hazelnut shell and seeds may risk not enough material being present for dating.

The geological composition of the monolith

A small fragment from the monolith was detached and two polished thin sections prepared in the National Museum of Wales. The fragment measured 96mm x 34mm x 10mm.

Figure 21. The position of the rock sample taken from the monolith

Macroscopical description
The rock is a yellowish grey (5Y 9/1 on the Geological Society of America rock-color chart), homogeneous rhyolite with a pervasive foliation associated with a fine-scale lensoidal fabric. Rare, sub-rounded to lensoidal microtonalite clasts are up to 2mm in diameter whereas abundant quartz-chlorite lenses are 0.2mm – 0.4mm in length.

Microscopical description
In thin section the rock is foliated with an associated lensoidal fabric including minor amounts of lensoidal titanite. Very fine-grained quartz layers alternate with slightly coarser grained chlorite-rich layers. The fine-grained quartz carries small quartz mosaic and quartz-chlorite lenses, rare, small, feldspar microliths up to 100 x 20µm in size that are aligned along, or at high angles to, the foliation, and radiating titanite spheres comprising acicular crystals.

Lenses and clasts of microtonalite comprise plagioclase densely intergrown with lesser amounts of chlorite, brown radiating titanite, and irregular and lath-shaped titanite and TiO_2 minerals. Locally the microtonalite has polysynthetically twinned plagioclase microphenocrysts or has been intensely silicified by fine-grained quartz or is cut by green to brown chlorite veinlets. Elsewhere, small feldspar aggregates are also interpreted as microtonalite.

Lenses are common and comprise intergrown quartz-chlorite, titanite-quartz/feldspar, where titanite rims enclose quartz/feldspar; or quartz/feldspar mosaics, where feldspar rims enclose quartz mosaic cores (some with titanite).

Very thin sinuous, stylolite-like quartz veinlets cross cut the foliation at very high angles. They comprise fine-grained quartz mosaics within thin chlorite rims. Locally chlorite forms thin layers along the foliation.

Euhedral to rounded, 30 – 80 but up to 180µm diameter, unzoned zircon is uncommon as is 10 - 40 but up to 80µm long, pale coloured TiO_2. Some of the longer laths may be rutile.

Titanite is present as 5 – 10 but up to 40µm diameter titanite spheres comprising radiating acicular crystals within fine-grained quartz layers or more commonly as 20 –80 but up to 200µm white, poorly crystalline aggregates.

Within the microtonalite clasts 10 - 20µm long pale coloured TiO_2 minerals are rare but, titanite is present as 20 - 80µm diameter brown, radiating aggregates, as 80 - 120µm long laths and as irregular, poorly crystalline masses; some titanite may have pseudomorphed primary iron titanium oxide minerals. Limonite occurs as rare, 20µm diameter pseudomorphs after pyrite.

The lithology is clearly a Pont Saeson rhyolite as defined by Ixer and Bevins (in press). However it does not have the classical 'Jovian' texture typified by Locality 8 (Ixer and Bevins in press) but is what they have termed 'sub-Jovian'. However, this variation is of little significance as it merely reflects the degree of lithological variability identified within the outcrop.

Field samples collected at Craig Rhosyfelin for detailed petrography

Thirteen samples were collected by Richard Bevins from the northwest face of Craig Rhosyfelin on the 14th September 2011 for further detailed petrographic analysis of the variations present in the rhyolite lithology which composes the crag. This work will be undertaken by Rob Ixer and Richard Bevins.

The samples were collected in a traverse from Locality 8 of Ixer and Bevins (in press) southwestwards for a distance of 38.2m. In addition, a single sample was collected from the summit area of the crag at it northeastern end.

Figure 22. The geological sampling transect at Craig Rhosyfelin

Sample details are presented in the table below.

Craig Rhos-y-felin sample collecting, September 2011		
Traverse locality number	**Distance SW from locality 8**	**NMW field no.**
	metres	
13	1.5	5447
14	2.7	5448
15	4.1	5449
16	4.8	5450
17	6.0	5451
18	7.0	5452
19	9.8	5453
20	12.8	5454
21	20.5	5455
22	27.6	5456
23	35.8	5457
24	33.0	5458
25	38.2	5459
Crag summit sample	**Grid ref.**	
26	SN 11673 36156	5460

Conclusion

The excavation demonstrates unequivocal evidence for the prehistoric quarrying of Stonehenge-sized monoliths from a source that can be matched definitively with the 'rhyolite with fabric' recovered from Stonehenge. It should be possible to date the stratigraphic sequence within the quarry with radiocarbon determinations on charcoal from the buried soil and lower colluvium, although these deposits are likely to have formed after the period of the quarry's use and are stratigraphically later than rubble layers that contain hammerstones.

Continued support of the glaciation theory – that the bluestones were brought to Stonehenge, or towards it, by glaciers of a previous Ice Age – now requires special pleading for the unlikely coincidence that a source of rocks used at Stonehenge just happened to be the precise site of a prehistoric quarry where Stonehenge-sized monoliths were extracted.

The more likely hypothesis is that this was one of the quarries that produced monoliths, some of which ended up at Stonehenge. As a result, it has a number of interesting implications that cast doubt on conventional interpretations of the bluestone route to Stonehenge.

Firstly, it indicates that one or more monoliths from this quarry were taken northwards down the Nevern valley. From there, the stones could have been floated around the Pembrokeshire coast or, as we favour, dragged eastwards by land along the glaciated valleys of South Wales towards Usk, the Severn estuary and the Somerset Avon. This raises the possibility that all the bluestones were taken on a route(s) different to the conventional one of moving southwards off the Preseli Hills to Milford Haven and beyond.

Secondly, it shifts the potential ‘centre of gravity’ of the bluestone sources from the top of Preseli to its northern edge where the tributaries of the River Nevern rise. It may be one of several quarries that lie in an area of about 20sq km from the northern edge of the Preseli Hills (Carn Goedog, Carn Breseb and Carn Ddafad-las) to the Nevern gorge below Castell Mawr (see below).

Thirdly, it raises the possibility that the bluestone quarries were providing monoliths made of a variety of lithologies for one or more local stone circles, and that it was these stone circles – rather than the monoliths themselves – that were taken to Stonehenge. This raises the possibility that one or more dismantled stone circle sites remain to be discovered in the upper reaches of the Nevern valley.

The Craig Rhosyfelin quarry, particularly with further excavation, will also provide insights into methods of quarrying, manoeuvring and transporting bluestone monoliths. The stone ‘runners’ beneath the southern end of the monolith can help us understand how it was guided downslope from the point on the outcrop where it was detached. The large chocking stone wedged beneath its east side may provide a clue to how it was raised off the ground. The drop in the height of the quarry floor just north of the monolith may relate to the transfer of the stone onto a wooden cradle and rollers. It may just be possible to answer technical questions about how Stonehenge’s bluestones were quarried and moved.

Waun Mawn arc of standing stones

This monument, located at national grid reference SN0838234046, was included in the Pembrokeshire inventory of the Royal Commission on the Ancient and Historical Monuments of Wales, after a site visit in June 1914 suggested that a previously-recorded standing stone formed one element of a circle of which there were five remaining stones (RCAHMW, 1925).

If Waun Mawn was once a stone circle, it is possible that it was robbed of its monoliths by prehistoric people who transported them to Stonehenge. Of all the stone circles in Preseli (Darvill and Wainwright 2003), this is the only one (if, indeed, it was once a circle) whose surviving standing stones are comparable in size to those at Stonehenge; the others have stones that are generally smaller.

Figure 23. Waun Mawn, showing the four former standing stones; the area to be surveyed is that shown to the south of the stones (as well as smaller areas to the east, west and north)

The single erect monolith and three nearby prostrate stones together form part of the northern arc of the hypothesized stone circle, and a fifth scarcely visible stone is presumed to be located on the opposite side to the south. From the positions of these stones, the diameter of the stone circle was initially estimated to be 46m (RCAHMW 1925: 258-259). In his review of the circular megalithic monuments in Wales, Grimes (1963) listed the stone setting at Waun Mawn as a doubtful or negative site, rather than an authentic stone circle, and subsequent synoptic reviews of megalithic sites in Wales either do not mention the site at all (Thom et al., 1980; Williams, 1988) or include only summary attributes of the circle (Burl, 1976).

Grimes (1963, p.150, also see his Fig. 36) stated that the four aligned stones (one erect and three prostrate) "lie on a flat arc the chord of which measures about 150 ft., but the disturbed character of the site gives this figure little meaning". In a footnote to this description Grimes mentions a fifth very small stone located to the west of the alignment, but he does not refer to the small stone to the south described in the entry in the Royal Commission inventory. Burl (1976:371) included Waun Mawn in his gazetteer of British stone circles, classifying the site as a destroyed or unrecognisable circle and also reporting its diameter as "45.7?" metres, most likely a direct transcription from the Royal Commission's estimate of 150 feet. However, this estimated diameter is far too small to fit the broad curvature of the circle as depicted by Grimes (1963: Fig. 36, see below) and confirmed by inspection of current aerial photographs. The diameter of the putative circle can be estimated geometrically from the chord length (150 feet) and segment height (21 feet) taken from Grimes' plan. From the intersecting chord theorem Diameter =

[(Chord Length)^2 ÷ (4 x Segment Height)] + Segment Height, giving an estimated diameter of 289 feet, a value that is consonant with the *c*.100m diameter recorded in Coflein, the online data from the National Monuments Record of Wales (RCAHMW 2010).

Superimposition of the plan of the Waun Mawn circle on the plan of the Aubrey Holes at Stonehenge shows a striking match. Not only is the estimated diameter of the Waun Mawn setting very close to the 286 feet measured diameter of the Aubrey Hole circuit (Cleal *et al*. 1995), but the spacing between the four principal stones at Waun Mawn follows a regularity that appears to correspond to double the spacing between the Aubrey Holes at Stonehenge. When plans of the monuments are superimposed to the same scale the positions of each of the four stones of the Waun Mawn setting closely matches the corresponding position of an Aubrey Hole, with successive gaps from east to west of one, one and five Aubrey Hole spacings holes between the Waun Mawn monoliths.

Methodology

Although Waun Mawn was included in the Open University's petrological survey (Thorpe *et al*. 1991), the poor visibility conditions during their survey prevented them from establishing whether its stones were of spotted dolerite or plain dolerite. Further non-invasive investigation in 2011-2012 by Richard Bevins should establish their geological provenance.

A geophysical survey was conducted at Waun Mawn (12th-14th September 2011) outside of the scheduled area around the arc of stones in order to identify possible former stone positions. Fluxgate magnetometer survey was carried out using a Bartington 601 fluxgate gradiometer over 20m x 20m grids with readings taken at 0.25m intervals along traverses spaced 1m apart, at a resolution of 0.1nT. Earth resistance survey was also conducted using a Geonics RM15 resistance meter and a PA5 electrode frame in the twin-electrode configuration, with a mobile probe spacing of 0.5m. Grids were 10 x 10m and readings were taken at 0.5m intervals with a 0.5m traverse. The data acquired from both surveys were output to ArcheoSurveyor 2.5 for processing. The final plots were composed using ESRI ArcGIS 9.3.1. These data were subjected to minimal processing, and the resulting enhanced plots are illustrated within the text.

The results from the Waun Mawn geophysical were inconclusive, and do not give definitive evidence for a surviving circle of stone holes. The earth resistance data has a number of high resistance anomalies, but it is likely that these are a product of the surrounding geology rather than being indicative of any stone-packed stone holes.

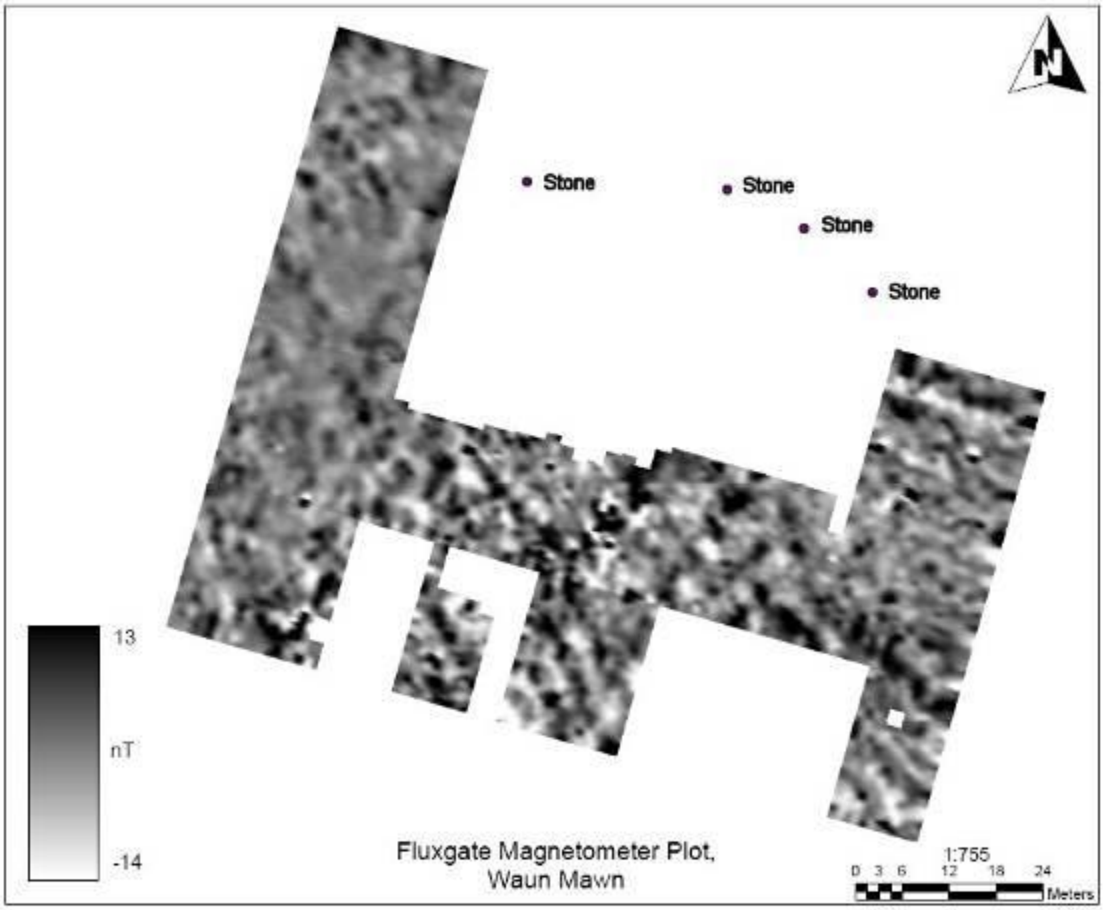

Figure 24. Fluxgate magnetometer plot of Waun Mawn.

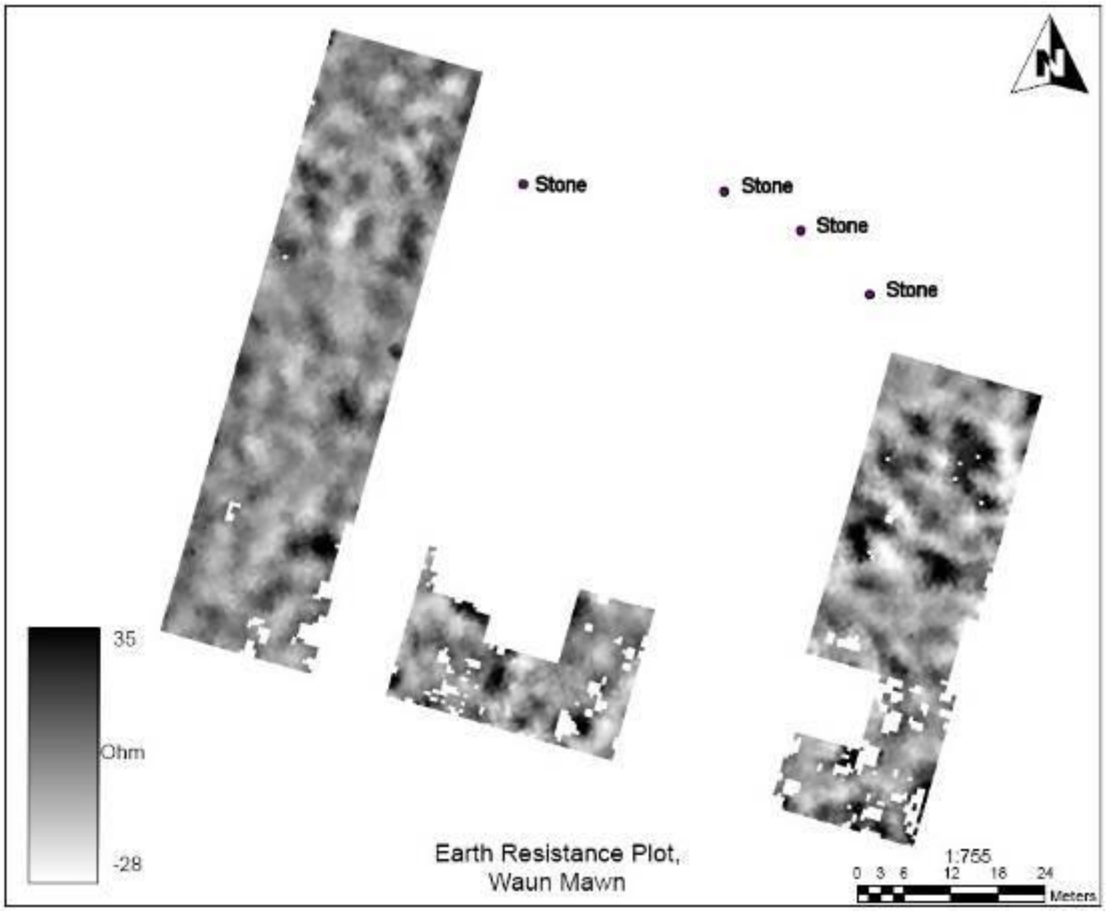

Figure 25. Earth resistance plot of Waun Mawn.

Castell Mawr

This impressive hillfort (SN1187537768; NPRN304047) of 1.52ha lies above the confluence of the Afon Nyfer (River Nevern) and the Afon Brynberian, just a mile north of Craig Rhosyfelin and three miles north of Carn Goedog. It is recorded by the RCAHMW as follows (Wiles 2008):

'Castell Mawr is generally considered to be a later prehistoric settlement enclosure, possibly of two phases, although it has been suggested that it is an earlier ritual or ceremonial henge enclosure reused in the Iron Age. The site was subject to partial geophysical survey in 1988.

The monument occupies the gently rounded summit of a hill. It consists of a 1.3ha oval enclosure defined by: a slight inner bank; a broad and shallow ditch; a prominent outer bank, preserved as a hedgerow and apparently ditched. There entrances on the north-west and east. The interior is subdivided by a curving west-facing rampart and ditch cutting off the 0.7ha eastern part of the enclosure. No entrance between the two divisions has been identified.

The character of the main enclosure, with a strong outer bank over-shadowing the weaker inner bank, has prompted the suggestion that it represents a Neolithic henge. In support of this flints have been found within the enclosure. However, the prominence of the outer bank may be a product of its reuse as a hedgebank and flints continued to be used into the historic period.'

It has also been described by Murphy *et al*. (2007) as follows:
'Castell Mawr is a bivallate hillfort located on a rounded high hilltop at c.145m above sea level. It is egg-shaped, measuring internally c.130m southeastnorthwest and 130 southwest-northeast. The inner bank rises up to 1m above the interior and 2m above a wide shallow ditch. The outer bank rises up to over 3m above the exterior ground surface and in places dominates the inner bank. A field bank runs along the crest of the outer bank. The outer ditch is now virtually ploughed out. The original entrance faces east, at the point of the 'egg', and is a simple gap through the ramparts. In addition there is a modern break through the rampart on the southeast side and a breach through the outer bank on the north side. A boomerang-shaped rampart running north-south, which rises 1.3m above its east side and 2m above the west over a shallow ditch, divides the
interior.'

In the wake of geophysical survey in 1988, Mytum and Webster reinterpreted Castell Mawr as 'a Late Neolithic or Early Bronze Age hengiform enclosure, partially re-used in the Iron Age or Romano-British period by an enclosed farmstead in the eastern part of the interior' (2003: 2). Their geophysical survey included both earth resistivity and magnetometry as well as soil magnetic susceptibility. Although magnetometry produced disappointing results, perhaps due to problems with the magnetometer, the other two methods revealed evidence to support their notion that this was a henge. In particular, there was no indication from resistivity or magnetic susceptibility of an external ditch and they concluded that 'it can be confidently assumed that no such feature existed' (2003: 4).

Figure 26. Castell Mawr from the air, photographed by Toby Driver (RCAHMW).

The resistivity survey covered much of the hillfort's interior but revealed few previously undetected features other than a circular anomaly about 65m in diameter (not mentioned in their report) in the centre of the hillfort. This might be interpreted as a geological formation on the crown of the hill but it is placed slightly off-centre to the southeast of the summit. There remains the intriguing possibility that this circular anomaly is the residue of a robbed-out stone circle.

Investigation in 2011

A site visit in 2011 yielded observations that could be used to both support and undermine the theory that Castell Mawr was a henge remodelled as a hillfort. The following aspects do not conform with the 'modified henge' theory:

1. The greater height of the external bank (up to 3m) than the internal bank (up to 1m) does not impede the hillfort's defensibility, since the domed topography of the interior provides sufficient height to allow clear views over the defences to the land immediately outside.

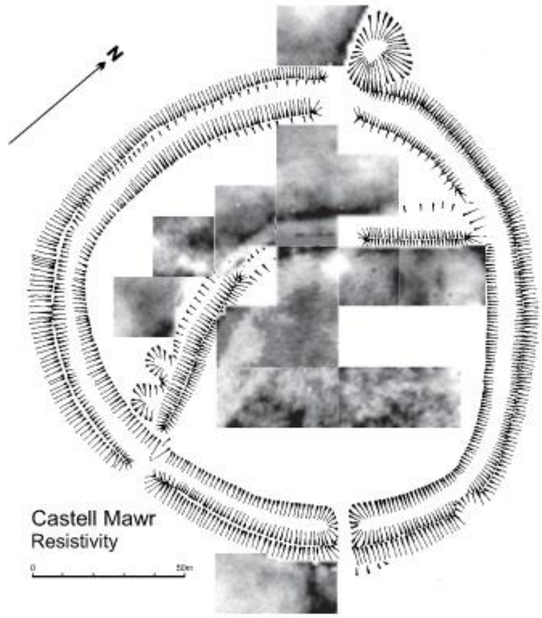

Figure 27. Earth resistivity survey results at Castell Mawr in 1988 (Mytum and Webster 2003)

2. The external bank has been built up with later deposits, including a field wall, which give it a misleadingly tall recorded height of 3m. In many areas, especially on the west, it stands little over a metre once the stone wall is accounted for.
3. There are signs of an external ditch in places, though these are admittedly slight and uncertain.
4. Hilltops are unusual locations for henges (though there are exceptions).

The following aspects support the 'modified henge' theory:
1. The great mass of the external bank can only have been built with sediment obtained from the wide inner ditch. If there was an external ditch, it was never substantial.
2. Exposure of the external bank's exterior face – along the south and southeast lengths of its circuit – by cattle erosion demonstrates that its primary fill of light brown-yellow sediment stands to a height of about 2m. It is then capped by dark brown sediment, indicating a second phase of construction with sediment that has a higher humic content (*i.e*. obtained from shallower digging than the initial bank fill).
3. Similar exposure by cattle erosion along the north terminal of the former east entrance of the hillfort shows that the light brown-yellow sediment of the primary bank construction does not extend to the end of the north terminal. This makes the initial entrance likely to have been 7m wider on its north side. If the entrance was symmetrical to the earthwork (*i.e*. at its east apex), then the monument's initial phase had an entrance about 20m across, too wide for a hillfort.

Future investigation of Castell Mawr should include recording of the exposed external bank and Optically Stimulated Luminescence Dating (OSL) of the different construction layers to establish whether the light brown-yellow sediment of the primary bank is of Neolithic origin. If results are positive, then Castell Mawr would be the largest henge known in Wales, even larger than Henges A and B at Llandygai in North Wales (Lynch and Musson 2004).

In the longer term, more precise dating of Castell Mawr's sequence with radiocarbon determinations would be desirable, together with characterization of its Neolithic period of use.

Possible monolith quarries in the Nyfer gorge

Ixer and Bevins/Bevins and Ixer's most recent research into the geology of Pembrokeshire indicates that the Fishguard volcanics, to the west of the Nyfer valley, are unlikely to have been sources for the Stonehenge monoliths made of altered volcanic ash, calcareous ash, rhyolitic ignimbrite and of the varieties of rhyolite not present at Craig Rhosyfelin. Instead, they favour the Nyfer gorge, immediately below Castell Mawr, as a likely location for such rocks to be found.

A preliminary visit in September 2011 by Mike Parker Pearson, Colin Richards and Roger Doonan revealed the likely remains of two megalith quarries within this gorge. One of these lies directly above and north of a waterfall (SN117373) and the other is also on the north bank, further east where the gorge narrows (SN118372). At this latter site, one of the outcrops has a portal-shaped hollow in the rock face where a large pillar stone appears to have been removed. The riverside in this area has been built up with a level platform of boulders; these may be a former riverbed through which the river has cut but they might also be the humanly constructed surface of a quarrying area for easy removal of monoliths. Samples from these two putative quarry areas are currently being analysed, and further survey is planned for the future.

Figure 28. Part of the eastern of the two likely monolith quarries in Nevern gorge.

Conclusion

This first season of research in the Nevern valley has demonstrated enormous potential for future research into the origins of Stonehenge's bluestones and the reasons for their being taken to Stonehenge. The results of each component of the field investigation undertaken during 4-16 September 2011 are as follows:

1. Geophysical and earthwork surveys of remains at the foot of Carn Goedog have mapped structures that may be related to the hypothesised prehistoric monolith quarry on this outcrop. Nine of the buildings are consistent with Early-Middle Neolithic house plans though selective excavation is necessary to establish if this is so.

2. Craig Rhosyfelin has proved to be a prehistoric monolith quarry at the precise spot identified geologically as a source for Stonehenge bluestone. Further excavation will provide more evidence for the methods of quarrying and moving bluestones.

3. Geophysical survey of Waun Mawn's arc of standing stones has failed to identify associated stone holes that might show that these were the remains of an otherwise dismantled stone circle. Although such remains might not be visible from earth resistivity or magnetometer survey, the remote siting of Waun Mawn, high on Preseli and 5km west of the suspected sources of bluestones, makes it an unlikely candidate for a dismantled bluestone circle transported to Stonehenge.

4. The previous identification by Harold Mytum and Chris Webster (2003) of Castell Mawr as a Neolithic henge (later modified for use as a hillfort) is supported. Limited field investigation in future years could test and hopefully confirm this identification. New geophysical surveys within its interior and environs may help to locate dismantled bluestone circles that may have been built in this area.

5. Field prospection along the north bank of the Nevern gorge, below Castell Mawr, revealed two possible monolith quarries in an area where sources of various volcanic-derived bluestones are suspected. This evidence includes a possible stone platform associated with the easternmost quarry's riverside location.

The 2011 fieldwork has helped us to further develop a theory about the ancestral significance of Pembrokeshire's bluestones for understanding the purpose of Stonehenge. Within this framework, Stonehenge is interpreted as a monument celebrating the unification of the peoples of southern Britain, with the stones of sarsen and bluestone symbolizing the ancestries of the most ancient and powerful groups among these earliest farmers. The people of the Nevern valley would thus have been those inhabitants of western Britain considered to have the most ancient Neolithic origins, as made visible by the density of Early Neolithic portal dolmens and other chambered tombs within this region. A new twist to this theory is the possibility that the Nevern people's ancestral status and political power were demonstrated by one or more bluestone circles, and that it was these that were taken to Stonehenge, thereby installing the great monument(s) of this polity within the most central place of power in the landscape of British prehistory. In this way, the massed public work of moving the bluestones 180 miles to Salisbury Plain around 3000 BC further embodied the celebration of unification between the western and eastern British.

Further fieldwork will enable us to assess the strengths and weaknesses of the three competing hypotheses developed to account for the presence of the bluestones at Stonehenge. Should further megalith quarries be identified at geologically pinpointed bluestone sources, then the 'glaciation' hypothesis can be finally discarded. Should the monolith quarries be identified on the lower ground of the Nevern catchment (at the spotted dolerite sources of Carn Goedog, Carn Breseb and Carn Ddafad-las, as well as the rhyolite source at Craig Rhosyfelin and the volcanic sources in Nevern gorge) rather than on top of the Preseli Hills at Carn Meini, then the association with springs and holy wells implied by the 'healing' theory can be challenged.

This new research within the upper reaches of the Nevern valley has the potential to reposition the investigation into Stonehenge's bluestones, from the high ground on top of the Preseli Hills to the lower ground of the Nevern valley. Also in view is the possibility that the Nevern valley was the focus of a Neolithic polity whose power and ancestral authority were embodied in what may turn out to be Wales' largest henge as well as in one or more stone circles – dismantled and taken to Stonehenge – whose remains may await discovery in the vicinity of that henge, if not within it.

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