ARCHAEOLOGICAL EXCAVATION OF TWO LIME KILNS AT BREST CWM LLWYD, CARMARTHENSHIRE: 2014

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SUMMARY

With grant awards from the Brecon Beacons Trust and Brecon Beacons National Park Sustainable Development Fund, Dyfed Archaeological Trust (DAT) supported local volunteers and students in a community excavation of two small lime kilns at Brest Cwm Llwyd on the western edge of the Brecon Beacons National Park in Carmarthenshire.

The excavations were undertaken over a three week period between 23rd June and 11th July and were an opportunity gain a greater understanding of the history of the Black Mountain lime industry and to provide opportunities for local volunteers and schools to get hands on experience of archaeological investigations. More than fifteen volunteers took part, contributing over 307 hours of work to the project. We were also joined by four work experience students and class visits from local schools.

Lime burning in this part of the Black Mountain appears to have started at Brest Cwm Llwyd, and to have migrated eastwards along the limestone outcrop. The extent and location of limestone extraction has been dictated by a calculation of its economic use and value at various times, against ease of access, processing and transport. The use of lime for agricultural purposes did not become widespread until the late 16th century. As agricultural production developed and expanded, the use of lime steadily increased. By the late 18th century, lime had become the predominant agricultural 'fertilizer', resulting in a rapid expansion of the lime trade. New uses, markets, population and settlement growth, industrial technologies resulted in the increased quarrying of limestone and other mineral resources from new and different locations on the Mountain.

Two kilns were selected to provide evidence about how the kilns were constructed and used. Kiln A was selected as a representative example of one of the larger kilns on the north side of the road at Brest Cwm Llwyd. Kiln B was one of a group of 8 small kilns exploiting a low limestone outcrop on the south side of the road. The only datable artefacts from Kiln A were fragments of a North Devon gravel-tempered ware bowl recovered from the topsoil overlying the kiln. This type of pottery is unlikely to date to any time after the mid-18th century. Although this is not a very reliable layer from which to judge the date of the kiln, it seems likely that the Brest Cwm Llwyd workings had been largely abandoned by 1784 when the Llandovery and Llangadog Turnpike Trust stopped maintaining the road over the mountain to Brynaman.

An important factor in understanding the development of the lime industry is the development of the road network leading to and from the Black Mountain. The dating of the various road constructions helps to date the eastwards spread of the lime working. As the demand for agricultural lime grew, new roads were built to cater for the increased road traffic. In the 18th century there was only light traffic across the Mountain to Brynaman. In 1779 the Llangadog and Llandovery Turnpike Trust was created with the aim of improving the main route over the Black Mountain. The Trust repaired the roads up to the limekilns at Brest Cwm Llwyd, but by 1784 appears to have stopped maintaining the road over the mountain. In 1799 the Trust began to develop and maintain a new stretch of road running along the north side of the limestone quarries. A new Turnpike Act in 1813 allowed the Trust to build a new road across the mountain to Brynaman which was completed by 1819.

Charcoal recovered from the working floor of the drawing chamber in Kiln B has been dated to 1520 (plus or minus 29 years) i.e. somewhere between 1491 and 1549. This is an unexpectedly early date, but is by no means improbable.

The carbon dating evidence recovered from Kiln B is a significant discovery, pushing the evidence for lime burning on the Black Mountain back into the 16th century.

Clarification of the size and structure of the kilns has demonstrated the intensification of the industry, increased investment in kiln building, and more strategic and organised exploitation of the limestone. The distribution of the Kilns on Brest Cwm Llwyd (of which Kiln A is an example) suggests that with increased production came increased organisation and perhaps longer lease periods.

The results of the Brest Cwm Llwyd community excavation has successfully increased our understanding of two little-understood types of kiln, and has made a significant contribution to understanding the history and development of the lime industry on the Black Mountain. Community involvement in the project was also successful with opportunities for a wide range of people, ages and levels of experience to participate in the excavation and to learn new skills.

CRYNODEB

Yn sgil grant gan Ymddiriedolaeth Bannau Brycheiniog a Chronfa Datblygu Cynaliadwy Parc Cenedlaethol Bannau Brycheiniog, llwyddodd Ymddiriedolaeth Archaeolegol Dyfed (YAD) i gefnogi gwirfoddolwyr lleol a myfyrwyr mewn gwaith cloddio cymunedol o ddwy odyn galch bach ym Mrest Cwm Llwyd, ar ymyl orllewinol Parc Cenedlaethol Bannau Brycheiniog yn Sir Gaerfyrddin.

Cwblhawyd y gwaith cloddio dros gyfnod o dair wythnos rhwng 23 Mehefin a 11 Gorffennaf ac yn gyfle i gael gwell dealltwriaeth o hanes diwydiant calch y Mynydd Du a chyfle i wirfoddolwyr ac ysgolion gael profiad ymarferol o archwiliadau archaeolegol. Cymerodd ragor na pymtheg o wirfoddolwyr ran, gan gyfrannu dros 307 o oriau o waith at y prosiect. Cawsom gwmni pedwar o fyfyrwyr ar brofiad gwaith hefyd ynghyd ag ymweliadau o ddosbarthiadau o ysgolion lleol.

Ymddengys bod llosgi calch yn y rhan hon o'r Mynydd Du wedi cychwyn ym Mrest Cwm Llwyd ac wedi lledaenu tua'r dwyrain ar hyd y brigiadau calchfaen. Dros y blynyddoedd, cyfrifo defnydd a gwerth economaidd oedd yn gyfrifol am faint o galchfaen a gloddiwyd ac ym mha leoliad, gan ystyried mynediad at y graig, prosesu a chludiant. Ni ddaeth y defnydd o galch er dibenion amaethyddol yn gyffredin tan ddiwedd yr unfed ganrif ar bymtheg. Wrth i gynhyrchiant amaethyddol ddatblygu ac ehangu, cafwyd cynnydd yn y defnydd o galch. Erbyn diwedd y ddeunawfed ganrif, calch oedd y prif 'wrtaith' amaethyddol ac o ganlyniad cafwyd twf aruthrol yn y fasnach galch. Cafodd ei ddefnyddio ar gyfer dibenion a marchnadoedd newydd, cafwyd twf mewn poblogaeth ac aneddiadau ac o ganlyniad i dechnolegau diwydiannol newydd gwelwyd cynnydd mewn cloddio am galchfaen ac adnoddau mwynol eraill a chloddiwyd mewn rhannau newydd o'r Mynydd hefyd.

Dewiswyd dwy odyn i roi tystiolaeth ynglŷn â'r modd yr adeiladwyd yr odynau a sut y cawsant eu defnyddio. Dewiswyd Odyn A fel enghraifft o un o'r odynau mawr ar ochr ogleddol y ffordd ym Mrest Cwm Llwyd. Roedd Odyn B yn un o grŵp o 8 o odynau bach yn cloddio'r brigiad isel o galchfaen ar ochr ddeheuol y ffordd. Yr unig greiriau o Odyn a oedd yn bosib eu dyddio oedd darnau o fowlen demredig â gro o ardal Gogledd Dyfnaint, a ganfuwyd o'r uwchbridd yn yr haenen uwchben yr odyn. Mae'n debygol bod y llestr hwn yn perthyn i gyfnod cyn canol y ddeunawfed ganrif. Er nad yw hon yn haenen ddibynadwy iawn ar gyfer dyddio'r odyn, mae'n debygol y daeth y gweithfeydd ym Mrest Cwm Llwyd i ben erbyn 1784 pan roddodd Ymddiriedolaeth Tyrpeg Llanymddyfri a Llangadog y gorau i gynnal y ffordd dros y mynydd i Frynaman.

Ffactor pwysig ar gyfer medru deall datblygiad y diwydiant calch yw datblygiad y rhwydwaith ffyrdd sy'n arwain i'r Mynydd Du ac oddi yno. Mae dyddio'r gwahanol gyfnodau o adeiladu ffyrdd o gymorth wrth geisio dyddio lledaeniad y gwaith calch tua'r dwyrain. Wrth i'r galw am galch amaethyddol gynyddu, adeiladwyd ffyrdd newydd i ymdopi â'r cynnydd mewn traffig. Yn y ddeunawfed ganrif ysgafn iawn oedd y traffig dros y Mynydd i Frynaman. Yn 1779 ffurfiwyd Ymddiriedolaeth Tyrpeg Llanymddyfri a Llangadog gyda'r nod o wella'r prif lwybr dros y Mynydd Du. Atgyweiriodd yr Ymddiriedolaeth y ffyrdd i fyny at yr odynau ym Mrest Cwm Llwyd, ond erbyn 1784 ymddengys iddi roi'r gorau i gynnal y ffordd dros y mynydd. Yn 1799 dechreuodd yr Ymddiriedolaeth ddatblygu a chynnal rhan newydd o'r ffordd ar hyd ymyl gogleddol y chwareli calchfaen. Galluogodd Deddf Tyrpeg yn 1813 i'r Ymddiriedolaeth adeiladu ffordd newydd ar draws y Mynydd i Frynaman a gwblhawyd yn 1819.

Roedd y siarcol a gasglwyd o lawr gwaith y siambr dynnu yn Odyn B yn dyddio'n ôl i 1520 (+ neu – 29 o flynyddoedd) h.y. rhywbryd rhwng 1491 a 1549. Mae hwn yn ddyddiad annisgwyl gan ei fod mor gynnar, ond nid yn annhebygol o bell ffordd.

Mae'r dyddiad carbon a gafwyd o Odyn B yn ddarganfyddiad arwyddocaol, gan wthio'r dystiolaeth o losgi calch ar y Mynydd Du yn ôl i'r unfed ganrif ar bymtheg.

Dengys y gwaith o astudio maint a strwythur yr odynau bod y diwydiant wedi dwysau, gyda chynnydd yn y buddsoddiad mewn adeiladu odynau gan gloddio am galchfaen mewn modd mwy strategol a threfnus. Awgryma dosbarthiad yr Odynau ym Mrest Cwm Llwyd (gydag Odyn A yn enghraifft) bod y cynnydd mewn cynhyrchiant wedi arwain at ddiwydiant mwy trefnus a chyfnodau hirach o lesau efallai.

O ganlyniad i waith cloddio archaeoloegol gan y gymuned ym Mrest Cwm Llwyd, mae gennym well dealltwriaeth o ddwy odyn o fath a oedd yn gryn ddirgelwch cyn hynny, gan gyfrannu'r helaeth at ein dealltwriaeth o hanes a datblygiad y diwydiant calch ar y Mynydd Du. Roedd rôl y gymuned yn y prosiect yn llwyddiannus hefyd gyda chyfleoedd i ystod eang o bobl, o bob oed, rhai profiadol a dibrofiad i fedru cymryd rhan yn y gwaith cloddio archaeolegol ac i ddysgu sgiliau newydd.

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1 INTRODUCTION

Project background

In 2011 the Brecon Beacons Trust awarded a grant to 'Calch' – a partnership project between Brecon Beacons National Park Authority, Dyfed Archaeological Trust, National Museum of Wales and the Black Mountain Centre. The project included undertaking research into the history of the Black Mountain lime industry and field survey of some of the industrial remains.

Limited archaeological excavation of parts of some of the 20th century kilns within Herbert's Quarry was undertaken prior to conservation works. It was not, however, possible to investigate evidence of the early development of limeworking on the Black Mountain as part of the Calch project.

In response to expressions of interest from local volunteers and schools DAT successfully applied to the Brecon Beacons Trust and Brecon Beacons National Park Sustainable Development Fund, for funding to undertake a community excavation of two small and presumably early lime kilns at Brest Cwm Llwyd.

The excavations were an opportunity gain a greater understanding of the history of the Black Mountain lime industry and provided opportunities for local volunteers and schools to get hands on experience of archaeological investigations.

Acknowledgements

Many thanks for all those that gave their time to help in the excavations:

Laura Hinder, Victoria Jones, Amanda Davies, Ian Atkinson, Anthony May, Arthur Phillips, Rhys Long, David Long, Tony Coombe, Melanie Williams, Alice Day, Tomos Lewis, Aaron Lawrence, Harley Jenkins, Sophie Lyon; Fran Murphy, Hubert Wilson, HollyMae Steane-Price, Sarah Rees, and Toby Small.

Many thanks to the Brecon Beacons Trust and the Brecon Beacons National Park Sustainable Development Fund for funding the project.

Thanks to Dee Williams for the pottery identification.

Note on illustrations

Throughout this report digital aerial photographic images under copyright from Getmapping 2009 have been used as base images to illustrate the various industrial llandscape features discussed. These are licenced to BBNPA by Getmapping and were provided to DAT as partners in the project.

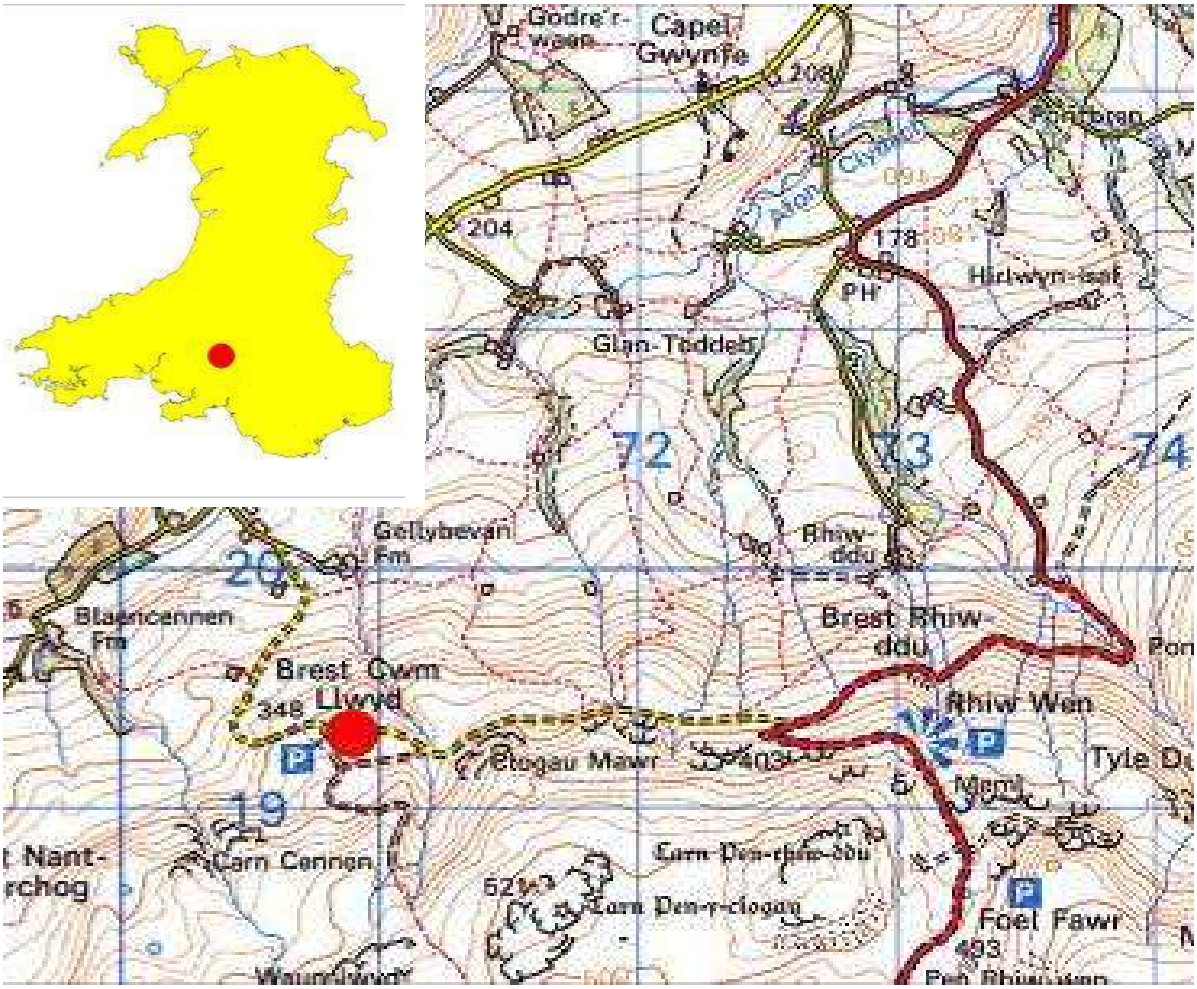


Figure 1: Location of Brest Cwm Llwyd based on 1:50000 Ordnance Survey map

Project location

On the north facing slopes of the Black Mountain, limestone outcrops form low 'steps' in the landscape as it slopes upwards towards the south. The limestone outcrop is not continuous. In several locations geological faults have moved stretches of the outcrop northwards or southwards, and have varied its elevation so that it occurs in isolated blocks (several kilometres in length) separated by other geological strata. Brest Cwm Llwyd (NGR SN7708519339) is at the west end of one such outcrop which extends approximately 3km eastwards to Herbert's Quarry on the A4069 mountain road between Llangadog and Brynaman.

The ground cover at Brest Cwm Llwyd is generally rough pasture, except on and around the limeworkings, where the grass is closely cropped by grazing sheep. The remains of numerous limekilns, spoil tips and tracks are evident as surface features in the immediate area of approximately 14 hectares.

The area is within the Brecon Beacons National Park and is part of the Mynydd Du SSSI. The land is owned by the National Park Authority.

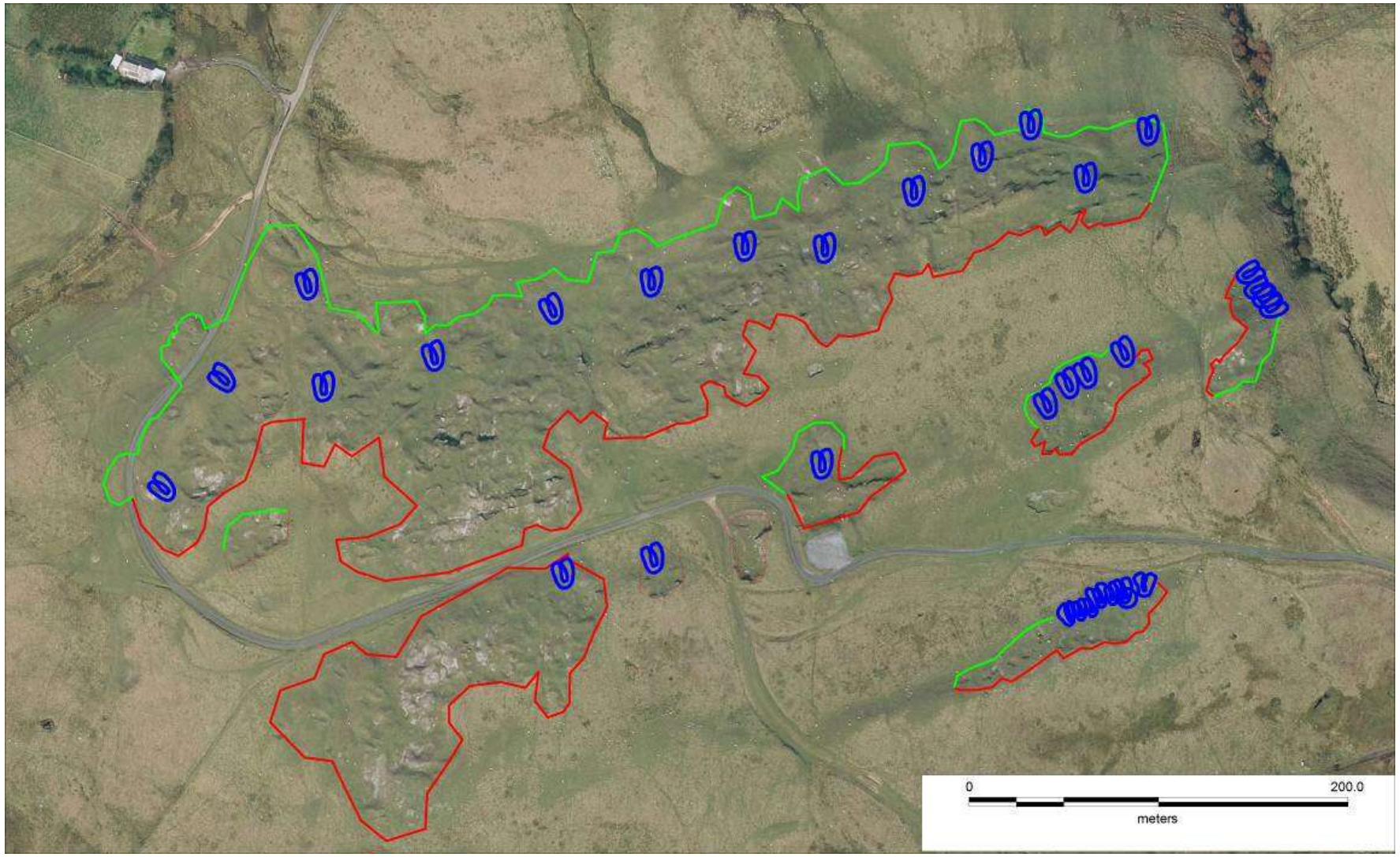


Figure 2: An aerial photograph of Brest Cwm Llwyd with the areas of limeworking indicated. The blue symbols identify limekilns. The red lines indicate quarry faces. The green lines represent the limit of spoil heaps.

2 THE COMMUNITY EXCAVATION

The excavation was undertaken over a three week period between 23rd June and 11th July. The project was open to all, and more than fifteen volunteers took part. The volunteers ranged in age from 15 to 70+ and contributed over 307 hours of work to the project. We were also joined for five days by four work experience students from Queen Elizabeth High School (Carmarthen), Amman Valley Comprehensive School (Ammanford), and Ysgol Tre-Gib (Ffairfach).

Class groups from Tre-Gib, Llandovery and Tycroes schools also visited the excavations and lent a hand. During the excavations an open day was held during the Calch Project 'Black Mountain Festival', when many people visited to see what was going on, and daily progress was reported in a 'dig diary' on the Dyfed Archaeological Trust web site.

A talk on the excavations was given as part of the Carmarthenshire Archaeology Day organised by DAT in March 2015, and other talks will be given to local communities in 2015.

Volunteers and students helped with all aspects of the excavation including digging, surveying, planning and recording, all under the supervision and guidance of Dyfed Archaeological Trust Staff.

Permission for the excavation was obtained from the Brecon Beacons National Park Authority (BBNPA) and local graziers. Since the site is located within the Mynydd Du SSSI, consent for excavation was also obtained from NRW (Natural Resources Wales).

Here are some photographs of the excavations:

3 HISTORICAL and ARCHAEOLOGICAL BACKGROUND

Burning limestone to produce lime for the manufacture of mortar and plaster was introduced to Britain by the Romans. The use of mortar in building was re-introduced to Britain by the Normans although its use was limited, primarily in constructing high status dwellings and civic and religious buildings.

The use of lime for agricultural purposes did not become widespread until the late 16th century. As agricultural production developed and expanded, the use of lime steadily increased. By the late 18th century, lime had become the predominant agricultural 'fertilizer', resulting in a rapid expansion of the lime trade.

From the early–mid 19th century onwards, the number of commercial lime kiln centres decreased dramatically. Large kiln banks grew up on the Pembrokeshire, Gower and Ceredigion coasts, together with inland quarry based kiln sites which could take advantage of the developing rail network.

Towards the end of the 19th century the large scale production of lime became centralised at a small number of major works, which could produce huge quantities of cheap lime, distributed over large areas. Small scale lime quarries and kilns also continued to be operated. By the end of the 19th century, the lime industry was in decline due to increasing costs of production and distribution, with falling demand due to depressed corn prices and the introduction of cheaper alternatives to lime, such as South American guano and chemical fertilisers. Limestone processing on the Black Mountain continued up until the late 1950s.

The pattern of lime production in south Wales divided historically into two main zones. The northeast was dominated by quarries owned by iron (and later steel) companies. Lime was transported by horse tramroads (later steam railways) south to the ironworks located at the northern margin of the coalfield and also northwards to the agricultural hinterland by a mixture of canal, horse tramroad and road transport.

The northwest limestone region possessed far fewer and less successful ironworks and fewer canals and horse tramroads. Consequently quarry and kiln ownership was more diversified and primarily supplied lime for the agricultural market. The absence of canals and horse tramroads (save for the Brecon Forest Tramroad from the upper Swansea Valley to Sennybridge) meant that the transport needs of the quarries were served solely by road transport. Consequently the seasonal agricultural lime trade markedly influenced the development of the pre-turnpike and turnpike road system for a considerable distance into the hinterland.

Other than small scale excavations of parts of three late limekilns at Herbert's Quarry undertaken as part of the Calch Project, there have been no archaeological excavations of limekilns on the Black Mountain. Few other well recorded lime kiln excavations have been undertaken in southwest Wales generally. Of most relevance are the excavations of several limekilns at Garn-Ffrwd Farm, Carmarthenshire (Manning 1996).

Brest Cwm Llwyd has, however, been included in several archaeological field surveys (Leighton 1997; Morgan 1988; Sambrook 1994), but there has been little detailed recording of the limeworkings.

Types of limekiln

It is often difficult to identify the form of a kiln from the evidence surviving above ground, especially when the structures have collapsed and grassed over. In addition, it is not always possible to accurately date a limekiln solely on the evidence of how it was constructed. The different forms and scales of kiln may reflect the resources available to the people making the lime, and the degree to which they adhere to the 'traditional ways'. It may have taken a while for new technologies and styles to have been adopted on the Black Mountain.

Despite these problems, from various field survey projects undertaken in recent years, a kiln typology for west Wales has been outlined in the appendix of an unpublished report on the excavation of limekilns at Garn Ffrwd Farm in Carmarthenshire (Manning 1996).

Broadly speaking, the design of limekilns developed in both scale and technological innovation in response to the demand for lime and the resources available to the people producing it. From the end of the eighteenth century small scale enterprises using small 'field kilns' gave way to larger production units culminating in massive 'row' kilns' representing full industrial production and fuel efficiency.

A general layout of the main features of a lime kiln is shown in Figure 3.

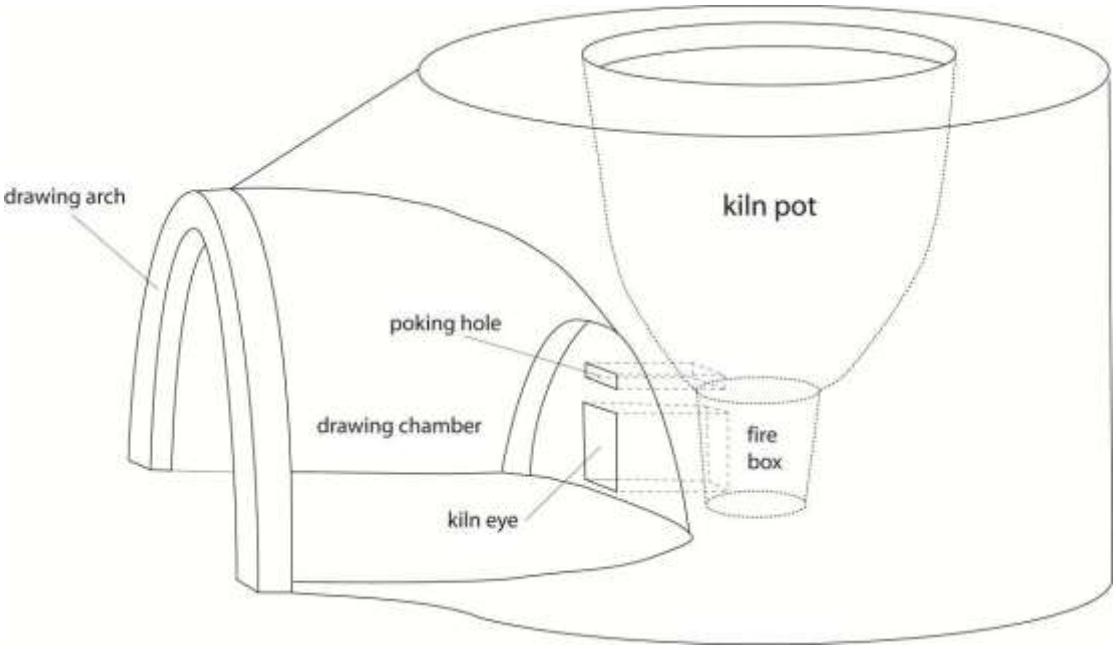


Figure 3: The main features of a limekiln

Type 1: Sod kilns. Pre 18th century

A simple type of kiln constructed close to, or on fields, where lime application was intended. From 13th century and later accounts sod kilns appear to have consisted of alternate layers of limestone and fuel covered with earth or turfs. After burning, the mound would be dismantled and ploughed directly into the soil. The nature of sod kilns makes their survival almost impossible, although fragmentary remains of linear mounds on Banc Wern-Wgan (PRN 3306) may belong to this type (Murphy and Sambrook 1994, 16).

A circular structure constructed of earth and stone, excavated at Cefn Bryn on Gower (Ward 1983) has been interpreted as a sod kiln, but considering the absence of evidence for limestone or burnt lime within it, it is by no means certain that this was actually what the circular feature was used for.

Sod kilns are thought to have remained in use up until the late 18th century.

Type 2: Flare kiln, late 16th –mid 19th century.

Also known as field kilns, flare kilns were more permanent stone and earth built structures built in various sizes. Flare kilns contained stone built draw chambers connected to a stone built circular pot. The limestone and fuel mix was allowed to burn through and cool before the lime was extracted. They appear to have been introduced at the end of the 16th century but formed the main type of farm-based kiln until the mid-19th century.

Three main types have been recognised:

2 i) Freestanding
Freestanding structures, rectangular or horseshoe in shape. Often up to 3m in height with pot diameters ranging from 1.5 to 5m.

2 ii) Bank–set
Similar to 2 i, but cut into a steep natural bank. Often up to 5m in height, with pot diameters ranging from 1.5m to 5m, although the kiln pots can be far deeper than freestanding examples.

2 iii) 'Scoop and mound'
Similar to type 2 ii, but characterised by two draw chambers on opposite sides of the kiln. Examples vary in size from 3m to 5m in height and range in diameter from 4m to 9m.

Type 3: Perpetual kilns, late 18th century-20th century

The stone or brick built draw or perpetual kiln was introduced in the second half of the 18th century. These substantial and well-built circular or rectangular structures were well suited for commercial production as they enabled continuous loading of limestone and fuel and unloading of lime to take place at the same time. Size ranges from approximately 6m in diameter and 3m high to the giant 15m in diameter and 25m high. Two main types seem to exist:

3 i) Two opposing chambers
A fairly rare type with two chambers, contained in a free standing structure, arranged in a similar way to type 2iii.

3 ii) Partly free-standing
This common kiln type is usually partly set into natural banks or limestone outcrops with the charging platform level with the quarry floor to enable ease of loading. They usually contain a single draw chamber although some kilns contain two chambers set side by side.

At industrial scale lime production sites massive kilns of this type were often built side by side in a large block. Such 'row kilns' survive better than smaller types making them the focus of popular study and preservation. Examples can be seen at Henllys Vale and Cilyrychen Quarries.

4 INDUSTRIAL FEATURES ON THE BLACK MOUNTAIN

Turnpike roads

An important factor in understanding the development of the lime industry is the development of the road network leading to and from the Black Mountain. Lime burning in this part of the Black Mountain appears to have started at Brest Cwm Llwyd, and to have migrated eastwards along the limestone outcrop. As the demand for agricultural lime grew, new roads were built to cater for the increased road traffic.

In the 18th century the industrialisation of the Amman and Tawe area had not yet begun and there was only light traffic across the Black Mountain. Evan Jones (in Hughes 2009) recalls that until about 1808 lime from the Black Mountain was carried in wicker panniers. By this time the trade in lime was increasing and the increased traffic of carts transporting lime was damaging the already poor roads.

In 1779 the Llangadog Turnpike Trust was created with the aim of improving the main route over the Black Mountain known as the Bryn Road (Marked in blue on Figure 4). The Trust repaired the roads up to the limekilns at Brest Cwm Llwyd and Clogau Mawr, but by 1784 appears to have stopped maintaining the road over the mountain to Brynaman.

In 1799 the Trust began to develop and maintain a new stretch of road running along the north side of the limestone quarries (marked in yellow on Figure 4). Both roads are depicted as tracks on the Ordnance Survey Original Surveyors Drawings of 1811.

A new Turnpike Act in 1813 allowed the Trust to build a new road across the mountain to Brynaman (marked in red on Figure 4) which was completed by 1819. This is the same route followed by the modern A4069.

The 1825 Old Series Ordnance Survey maps depict all three roads (and others).

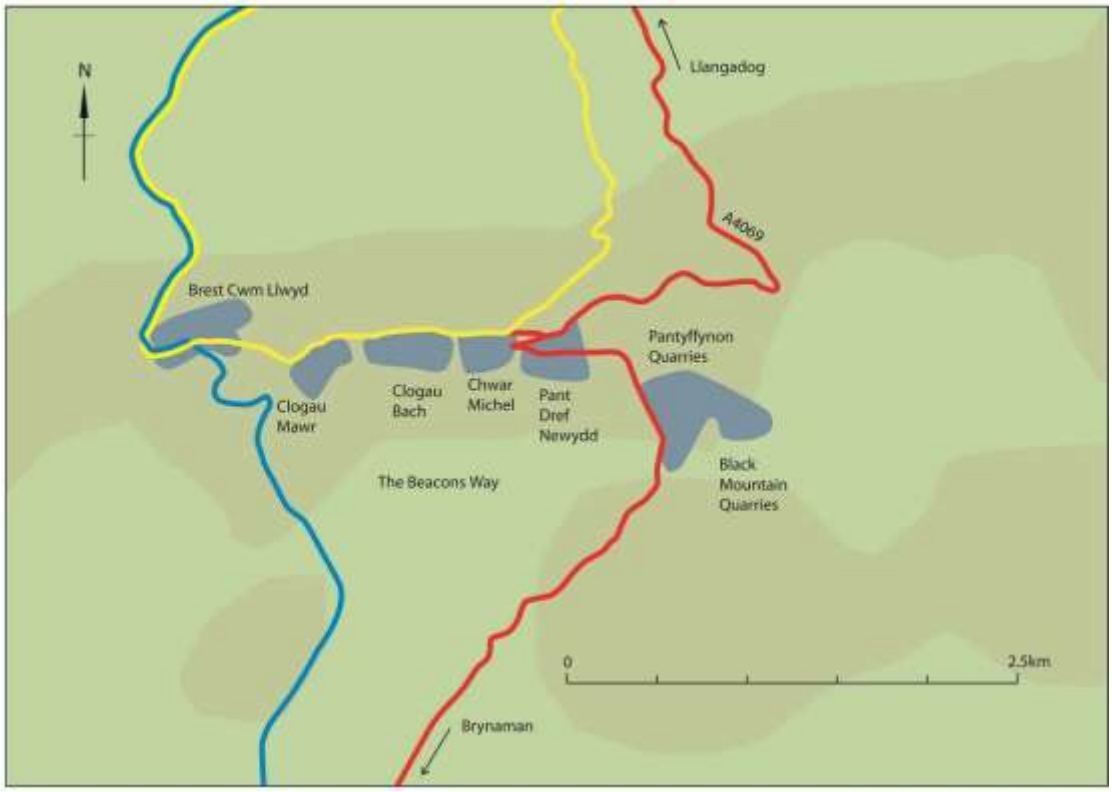


Figure 4: A plan showing the evolution of the road network and quarries on the north side of the Black Mountain.

Quarries

The Black Mountain has been used as a source of limestone and other minerals possibly since the Roman period (Cloutman 1983, 52), although there is no known physical evidence of any such Roman exploitation. There is however, plentiful physical evidence of limestone quarrying and burning from later periods. The first 'concrete' evidence for the manufacture of lime products from locally sourced limestone comes from the 12th and 13th century limekilns at Carreg Cennen, where lime mortar was manufactured for the construction of the castle.

The extent and location of limestone extraction has been dictated by a calculation of its economic use and value at various times, against ease of access, processing and transport. New uses, markets, population and settlement growth, industrial technologies and improved transport, also resulted in the increased quarrying of limestone and other mineral resources from new and different locations on the Mountain. It also made the resulting limestone industry more sensitive to the fluctuating fortunes of the markets it supplied and broader economic influences and social change.

To some extent, there have been different catalysts for exploitation of the limestone on the north side of the Black Mountain to those on the south side. On the north side of the mountain the quarries and kilns were primarily concerned with trading economic products derived from lime-burning. It was however, primarily the industrial uses (such as use of limestone as a flux in the production of iron) that stimulated the large-scale exploitation of limestone and other minerals on the southern side of the mountain.

There are extensive remains of limestone quarrying and limekilns along a 3km stretch of the limestone outcrop that forms part of the Black Mountain between Brest Cwm Llwyd and Herbert's Quarry. Generally speaking the earliest workings are to the west, with later kilns occurring as the quarrying spread eastwards.

Banc Melyn workings

The quarrying at Brest Cwm Llwyd is generally very shallow, in some cases limestone has simply been collected from surface exposures of the bedrock.

On the south side of the road is an isolated group of small, closely packed kilns associated with small areas of quarrying on a limestone outcrop named Banc Melyn (SN70921930). These may represent some of the earliest evidence of lime production on the mountain. Similar groups of kilns and quarries are identifiable in other locations where limestone outcrops are visible on the ground surface (e.g. SN70941943).

It is possible that these remains represent limeworking by local families who exploited the nearest available source of limestone on the unenclosed common land.

It is likely that these kilns and quarries were more widespread, but where later quarrying has occurred, the evidence of the earlier working has been destroyed or buried. Similar kilns and quarrying have also been identified on the southern edges of the quarries extending eastwards (Clogau Bach and Clogau Mawr). There is, however, little if any clear evidence of this type of kiln ever having been present east of Clogau Bach, perhaps suggesting that the eastern quarries were not worked prior to the development of the first Turnpike road.

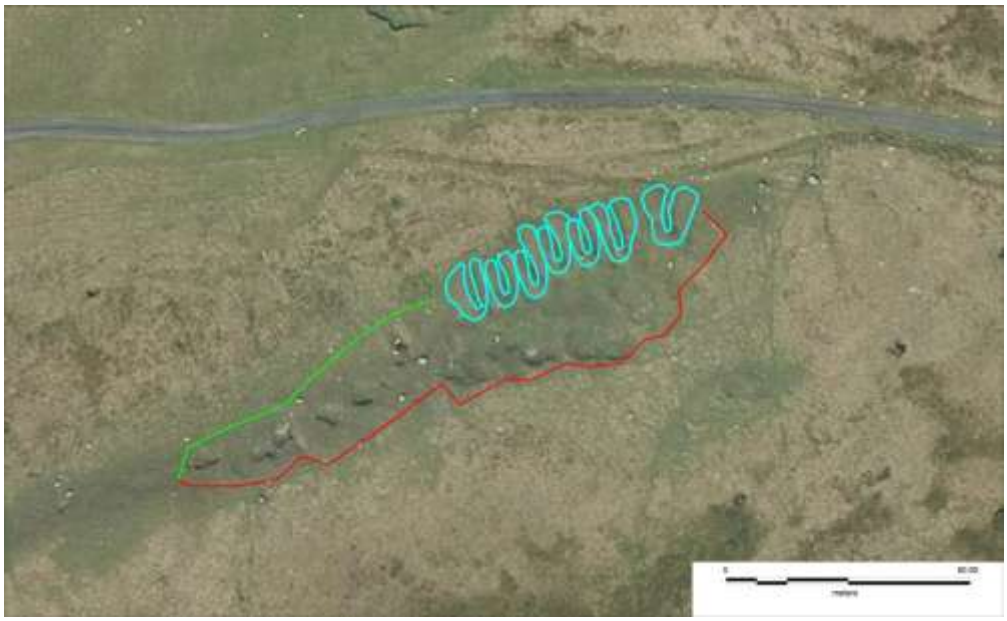


Figure 5: Traces of limeworking at Banc Melyn. The light blue horseshoe shapes mark the limekilns (see description of Kiln type 2iic, below)

Brest Cwm Llwyd

On the north side of the road that dissects Brest Cwm Llwyd there appears to be a later and more extensive phase of quarrying creating an overall impression of a haphazard landscape of tracks, spoil heaps and quarries with little evidence of organisation.

The kilns associated with these quarries are, larger, and more widely spaced (approximately 40-50m apart) than the Banc Menyn kilns, and are associated with relatively large heaps of waste lime.

These remains may represent a step up in the production of lime by local families, either to supply their own increased need or to produce a surplus for commercial distribution.

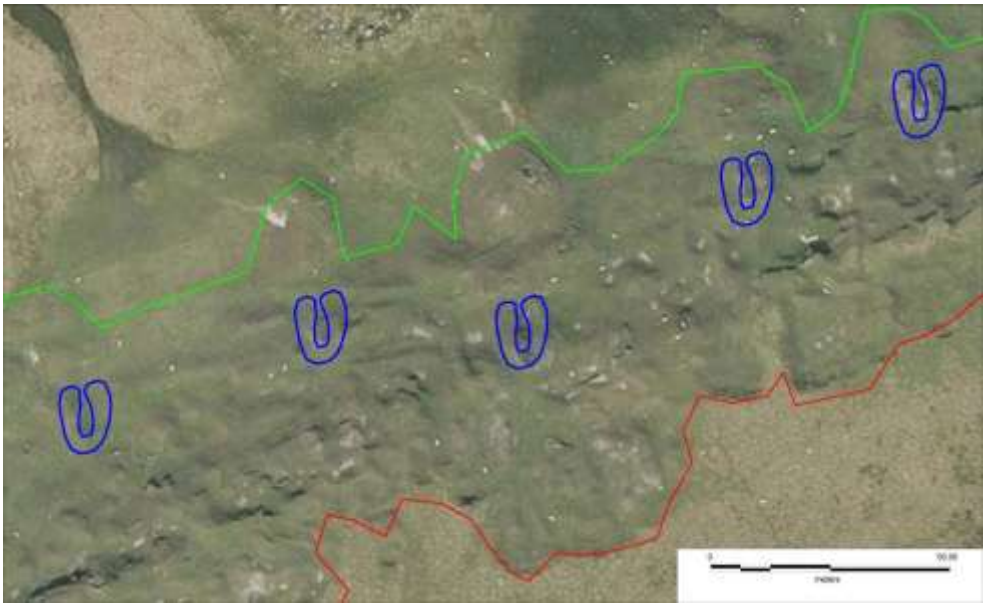


Figure 6: Kilns and Quarries at Brest Cwm Llwyd. The dark blue horseshoe shapes mark the location of the Type 2ic kilns (see below)

Although they were almost certainly present, the Ordnance Survey Surveyors Drawings (1811) and Old Series mapping (1825) do not depict quarrying at Brest Cwm Llwyd. A single 'old quarry' is depicted at Brest Cwm Llwyd on the First Edition Ordnance Survey map of 1879.

Both the Brest Cwm Llwyd and Banc Melyn limeworkings are associated with numerous rough tracks leading to and from the kilns. When maintenance of the roads was taken over by the Llangadog and Llandovery Turnpike Trust in 1779 the route through this landscape was 'fixed' and is now followed by the present day minor road.

Clogau Mawr Quarry

At the nearby Clogau Mawr Quarry both the kiln types present at Brest Cwm Llwyd are also present and the pattern of quarrying seems equally haphazard, but more intensive or prolonged. The earlier (light blue) kilns are associated with shallower quarrying compared to the later (dark blue) kilns.

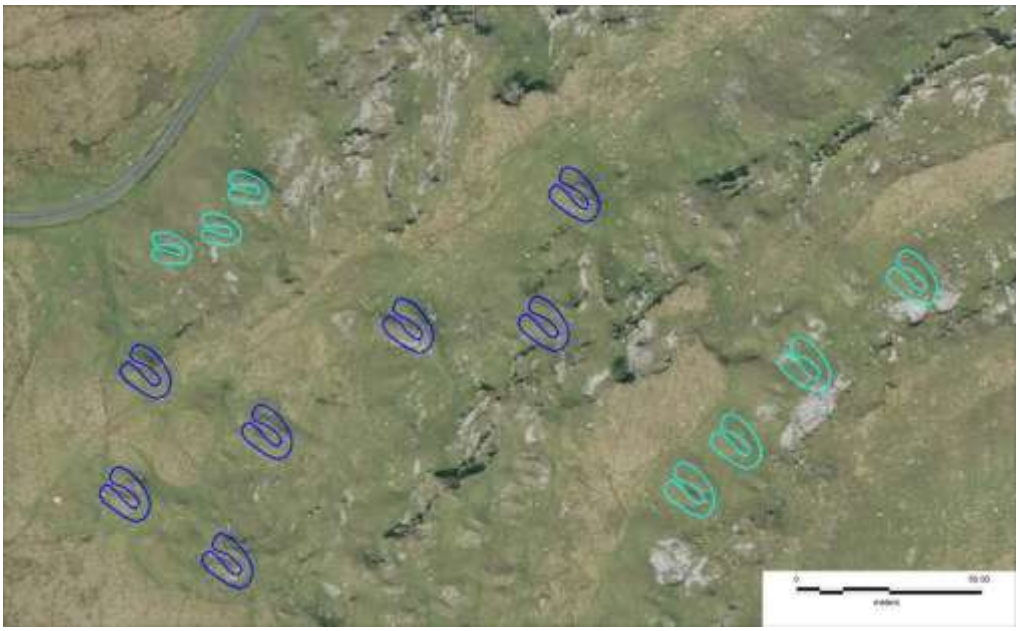


Figure 7: Part of Clogau Mawr Quarry.

Clogau Bach Quarry

Quarrying at Clogau Bach appears to be more organised, with clear demarcation between quarries and their associated kilns. Again, the highest and earliest workings are furthest from the road. The later quarries are nearer the road. More significantly a different form of masonry-built kiln is present, and for the first time the foundations of a cottage are found adjacent to the top of the kiln. Also for the first time the later kilns are associated with distinctive semi-circular spoil tips and loading platforms adjacent to the base of the kiln. These differences mark another step up in kiln design and technology.

Figure 8: Part of Clogau Bach Quarry with blue symbols marking the early kilns (Type 2ib) and the pink marking the later kilns (Type 2ia) and quarries.

Chwar Michael

A little further east, at Chwar Michael, there is little if any clear evidence of the earlier kiln types. This may suggest the eastern quarries were not worked prior to the development of the Turnpike roads.

Figure 9: Part of Chwar Michael with Type 2ia kilns only present.

Pantyffynon Quarry

Further east again, the Pantyffynon Quarries are larger, well defined and associated with fewer, larger kilns with substantial spoil heaps. Each kiln is also associated with a stone-built building. This represents the height of organised and efficient lime production.

Figure 10: Part of Pantyffynon Quarry with blue symbols marking the locations of kilns and huts.

Limekilns

On the Black Mountain there are a large number of intermediate kiln forms spanning the transition from Flare kiln to Perpetual kiln (but without examples of the massive 'Row kilns'). These intermediate forms of limekiln have been relatively neglected and the process of their evolution has become obscure. The Black Mountain limekilns therefore represent a unique assemblage of potentially national importance.

The following kiln type descriptions adopt the typology outlined in an appendix to the Garn Ffrwd Farm excavation report (Manning 1996). Where new kiln types have been identified additional type subdivisions have been created.

Examples of what are thought to be the earliest kilns are often built furthest away from the roads, suggesting that they may pre-date the turnpike era road improvements, and may have relied primarily on pack horses for transport. Later kilns types are more clearly associated with tracks and roads.

The following kiln types have been identified on the Black Mountain:

20th century limekilns (Type 3iia)

These kilns at Herbert's Quarry were in use up until the late 1950s. They both incorporate concrete in their construction. The kiln bowls are lined with furnace bricks and the lime is collected in rail mounted drams, from enlarged hearths.

These kilns could be operated continuously and can therefore be considered to equate to Perpetual Kiln Type 3 ii. Closer investigation however, shows that these are in fact 19th century kilns (Type 2 ii) that have been modernised and re-faced with stonework or shuttered concrete. It is not however clear whether they remained in use over the years and were periodically modified, or whether the kilns were re-built in the 20th century following a period of abandonment.

The fact that existing earlier kilns were modified, rather than investing in a bank of row kilns, is a reflection of the economic factors and the resources available to the kiln operators in the 20th century.

Kiln 1

Kiln 22

Kiln 1: modified interior

Figure 11: 20th century limekilns (Type 3iia)

19th century limekiln (Type 2ii)

This 'D'-shaped kiln type does not have a furnace brick lining, and it only has a small hearth (just visible at the ground level in the photo below) from where the lime was removed. Only one example (Kiln 4) survives in relatively complete and unmodified condition in the Black Mountain Quarries.

These larger kilns are usually built immediately adjacent to the road or track and are associated with low 'loading platforms' (where the lime was put into waiting carts). These kilns are also associated with large semi-circular piles of waste lime, opposite the kilns on the other side of the track.

Each kiln is also associated with a small building used for storage and in which workers would stay during the lime burning season.

Although it is possible that these kilns could be run perpetually, in practice, they probably were not, and therefore most likely equate to a Type 2ii Flare Kiln. The historic photograph below (Parry-Jones, 1948) taken prior to 1948, shows an unmodernised 19th Century limekiln apparently still in use on the Black Mountain.

A 19th century kiln at Pantyffynon Quarry

A C19th limekiln on the Black Mountain. Apparently still in use in the C20th

Interior of a 19th century kiln at Pantyffynon Quarry

Figure 12: 19th century limekilns (Type 2iia)

Possibly Early 19th century limekiln (Type 2iia)

These masonry constructed kilns are less well preserved, so it is difficult to distinguish them from Kiln type 2ii. There do, however, appear to be several differences, especially in their height and the size of their working chambers. These kilns all appear to have been cut into the hill slope, presumably this helped support these large capacity kilns, and helped retain heat within them.

These kilns may date from earlier in the 19th century, either just after or just before the construction of the turnpike road (now the A4069) in 1819.

Like the 19th century Type 2ii Flare Kilns, these earlier 19th century kilns are usually built immediately adjacent to the road or track and are associated with low 'loading platforms' (where the lime was put into waiting carts) and large semi-circular piles of waste lime. Each kiln is also associated with a small building used for storage and in which workers would stay during the lime burning season.

Figure 13: Possibly Early 19th century limekilns (Type 2iia) in Pantyffynon Quarry

Late 18th/early 19th century Kilns (Type 2ia)

These masonry constructed kilns are smaller in capacity that the kilns in Herbert's Quarry. They are found in the earlier quarries to the west (Chwar Michael and Clogau Bach). The pots are not lined with furnace bricks and the interior working chamber appears to be quite small. These kilns are built out from the hill slope (unlike the later, larger kilns) and therefore most closely equate with Kiln Type 2i. They do, however, have 'loading platforms' and spoil heaps, similar to (but smaller than) those associated with later kilns. At least one example (in Clogau Bach) is associated with a 'kiln keeper's cottage'. These kilns are generally located lower down the hill slopes, but above the level of the turnpiked roads.

Figure 14: Possibly Early 19th century limekiln (Type 2ia) in Clogau Bach

18th century limekilns (Type 2ib)

This type of kiln is present primarily at Brest Cwm Llwyd and Clogau Bach. This kiln type has previously been tentatively identified as possible clamp kiln (Type 1) however, the kilns are more substantially constructed from earth and rubble stone and are built out from the hill slope. They therefore equate more with Type 2i.

The kilns are often associated with spoil heaps, but of different character to those associated with later kilns. There is no evidence of loading platforms or 'keeper's cottages'. These kilns tend to lie between the later roadside kilns and the earlier kilns further up the slopes

This kiln type is less well preserved so it is much more difficult to establish the form of this kiln type from the visible remains and to compare them exactly with the later kilns. For this reason one of these kilns at Brest Cwm Llwyd was targeted for excavation.

Figure 15: 18th century limekiln (Type 2ib) at Clogau Mawr

Possibly Early 18th century limekilns (Type 2iic)

These appear to be the smallest, and presumably earliest, types of kiln on the Black Mountain. They are often arranged close together in rows, dug into the hill slope. Their spoil tips form distinctive horseshoe shapes, making the kilns appear similar in appearance to Type 2ib. Type 2iic kilns, however, are smaller, appear to be shorter-lived, and have smaller spoil heaps. These kilns tend to lie furthest away from, and probably pre-date, the roads leading to the quarries. From the available above ground evidence this kiln type has previously been tentatively identified as a clamp kiln (Type 1), although, being bank-set, it seems more likely to be an early example of Type 2ii. To clarify how this kiln type differs from others, an example was excavated as part of this project.

Figure 16: An early? 18th century limekiln at Brest Cwm Llwyd

5 RESULTS

Two kilns were selected for excavation in the hope that they would provide datable evidence about how the kilns were constructed and used. Kiln A was selected as a representative example of one of the larger kilns on the north side of the road. Kiln B was one of a group of 8 small kilns exploiting a low limestone outcrop on the south side of the road.

T-shaped trenches were opened on each kiln, with de-turfing and excavation all undertaken by hand. Standard excavation and site recording methods were used including ground survey, photography, scale drawing and written context records.

Figure 17: The locations of Kilns A and B

Kiln A (Drawings 1 to 5; Appendix A)

Kiln A is one of a group of at least 8 similar kilns on the north side of the road (Figures 6 and 16).

The kiln is built out from the hill slope as a free standing structure (Photo 1), with a ramp or charging platform connecting the top of the kiln with the adjacent limestone quarry and trackways associated with each kiln.

Prior to the excavation several large boulders of non-limestone rock visible on the top of the substantial kiln mound suggested the kiln was constructed from local millstone grit boulders and had a very large kiln pot. Although the excavation demonstrated that the kiln was actually smaller than anticipated, the overall size of the structure made it impossible to fully excavate it. It was never-the-less possible to clarify how it was constructed, and how it compared to other types of kiln in the area.

Photo 1: Kiln A at the start of the excavation

Following the removal of the turf it became apparent that the large rocks visible on the surface were not in fact part of the kiln pot. Instead, the outside, and periphery of the mound appears to have been clad with large boulders to strengthen the outside of the mound (Photo 2). The mound itself appears to be primarily constructed from compacted soil and stone fragments (see Photo 3) built up in layers. The soil mound effectively supported the kiln structure and provided insulation to improve the efficiency of the lime making process.

Photo 2: Large rocks on the outside of the kiln

Photo 3: The top of the soil core of the kiln mound

The excavations suggested that there was a backfill deposit (1011, 1004) between the kiln mound and the masonry kiln structure (1009). The soil adjacent to the kiln structure was heat affected to a reddish brown hue. The backfill does not appear, however, to have been contained within a formal 'cut' (1017). Instead the appearance of the deposits, which contain periodic lenses of lime (1005, 1002 etc.), suggests that the kiln, drawing chamber and compacted soil mound were constructed simultaneously. An arc of white lime (1010) marked the uppermost surviving part of the kiln pot (Photo 4).

Photo 4: The arc of lime indicating the top of the kiln structure

The kiln pot was filled with lime waste and collapse stone rubble derived from the collapsed upper parts of the kiln (Photo 5). It was not possible to excavate the entire pot to reveal the fire box and kiln eye.

Photo 5: The fill of the kiln pot

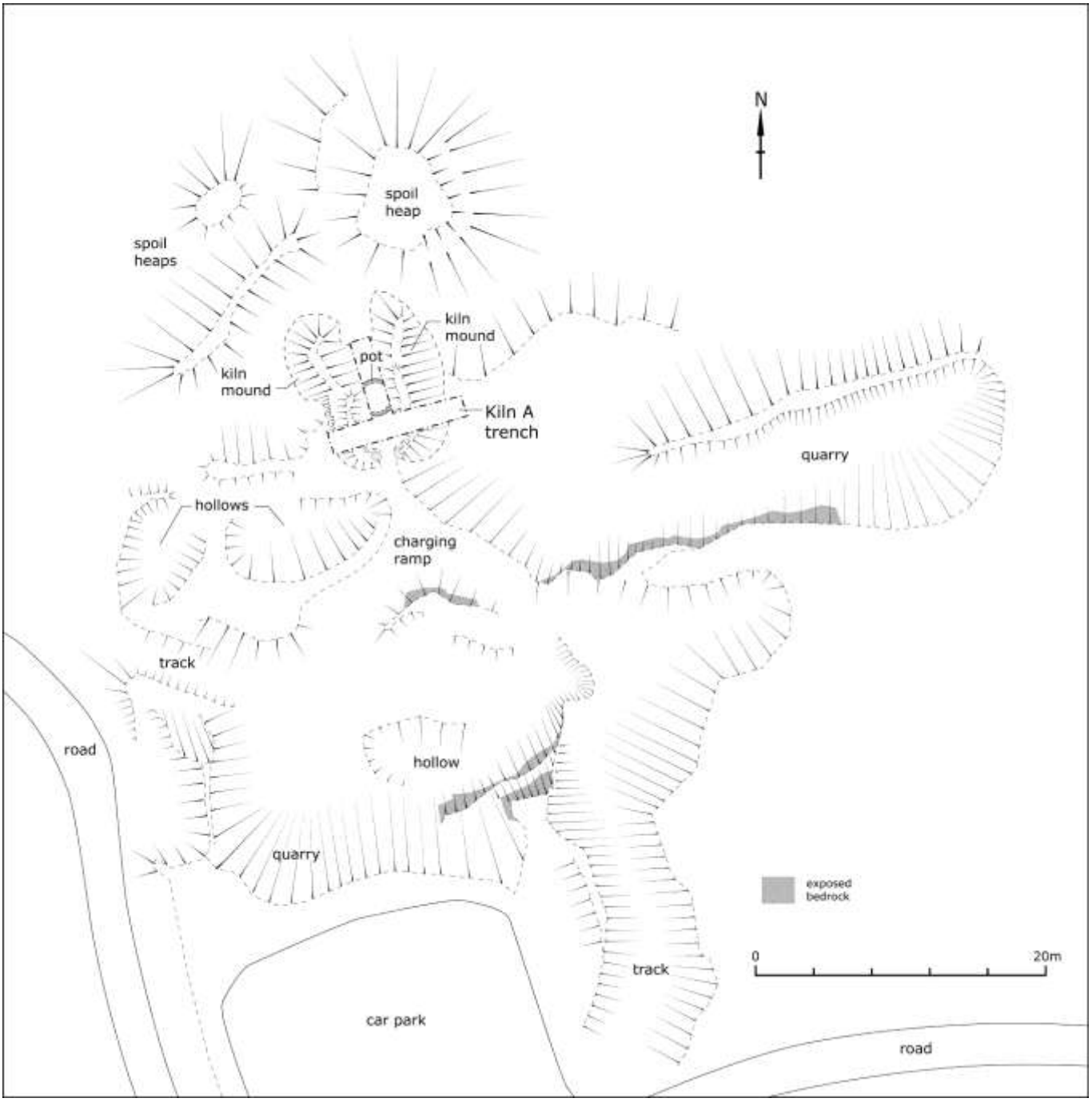
From the excavated evidence the kiln appears to be relatively well built (compared to Kiln B) and a more substantial structure (Photo 6). The kiln walls were 45cm thick.

Photo 6: The inside face of the kiln pot

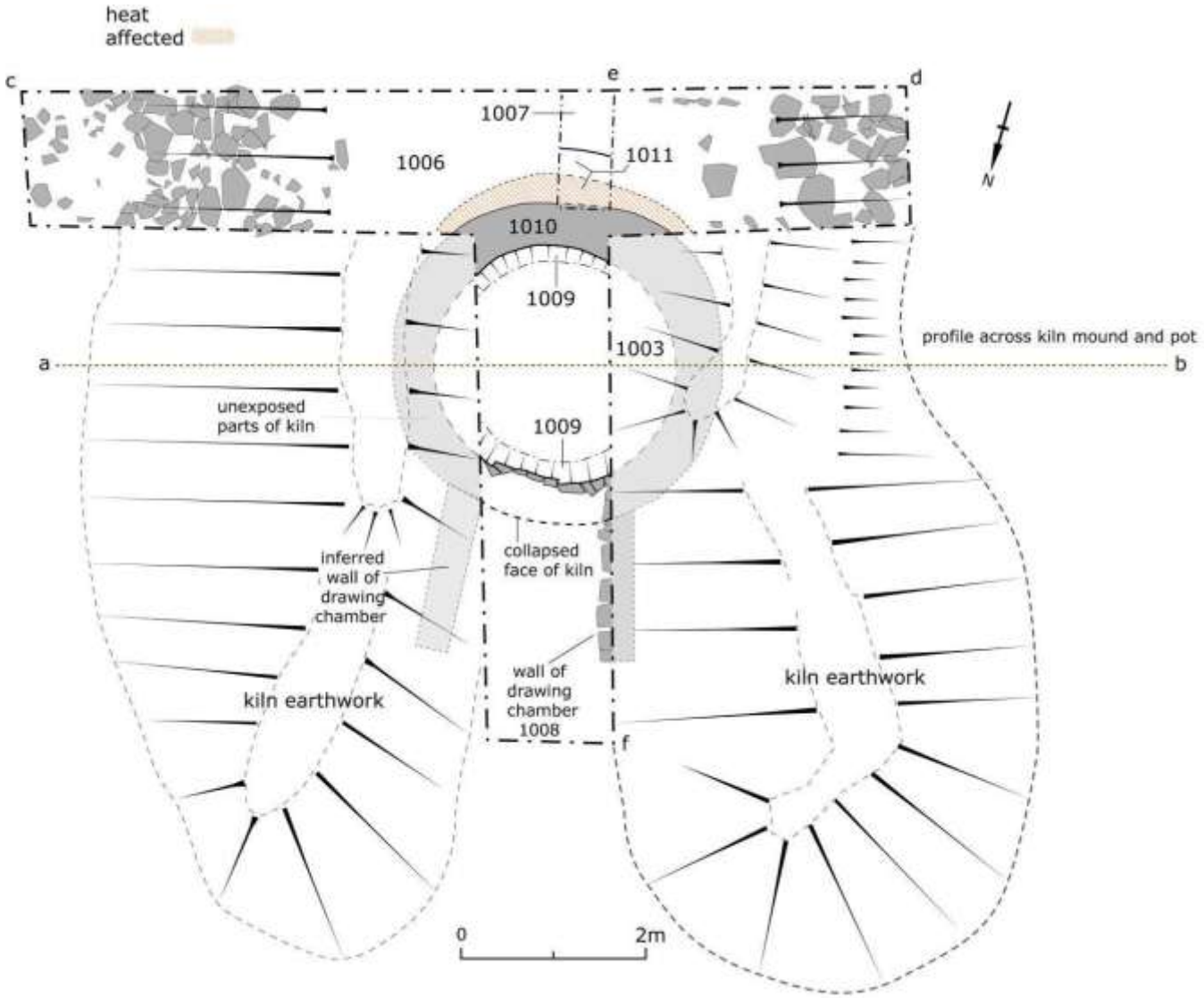
Although it was not possible to entirely excavate the contents of the kiln pot and drawing chamber, or to reveal the kiln eye, sufficient of the structure was exposed to enable the diameter of the kiln to be established and for other measurements to be estimated. The kiln pot was 2.60m in diameter and an estimated 3.20m deep.

Photo 7: The west wall of the drawing chamber

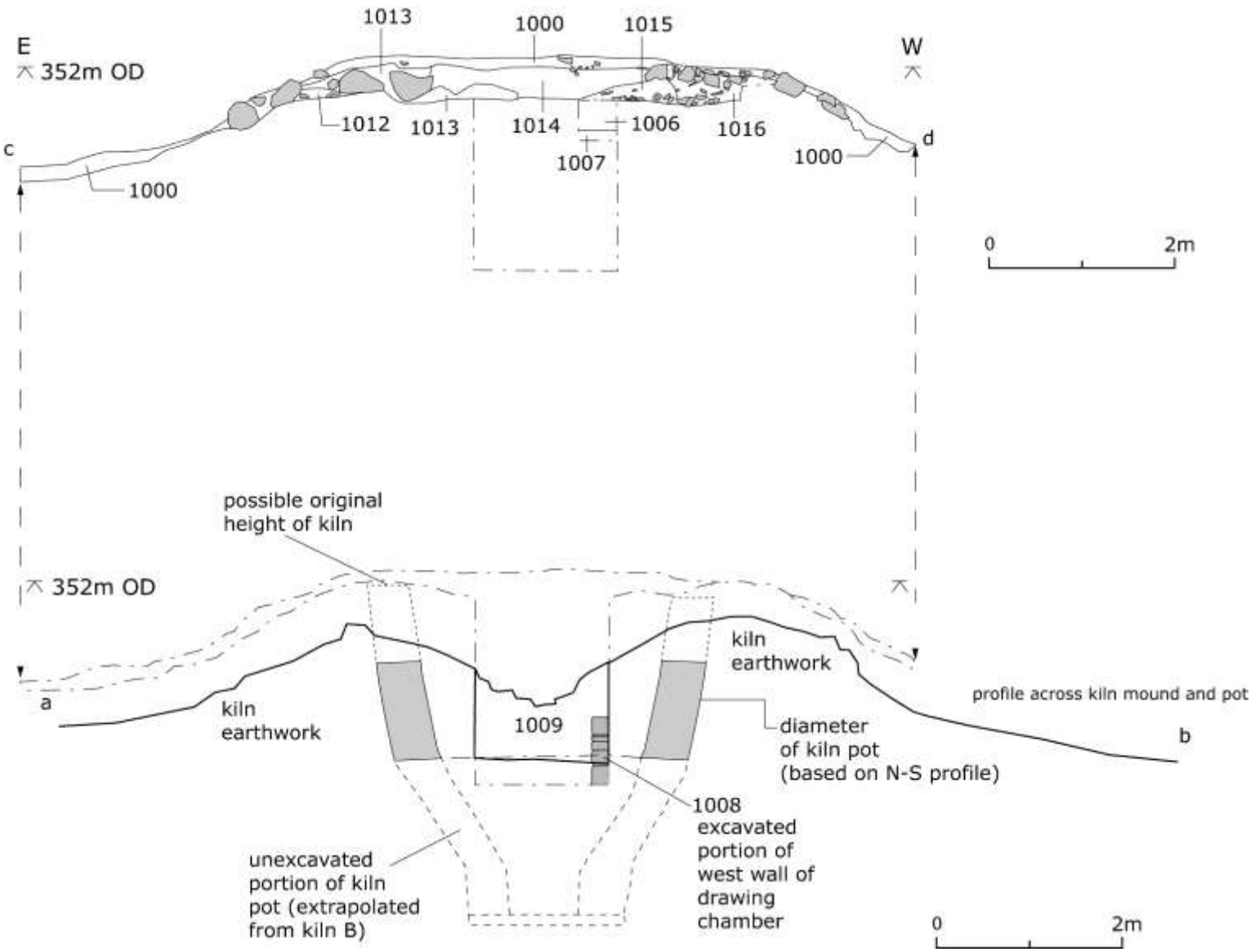
At the front of the kiln, the face of one wall of the drawing chamber (Photo 7) was revealed (1008). The width of the chamber could not, however, be ascertained. Nor was it possible to reveal the kiln eye. The drawing chamber is estimated to be about 2.2m long. The kiln is also associated with a distinctive pattern of spoil tips of waste material from the lime making process. Similar patterns of spoil heaps are associated with the other kilns of this type.



Drawing 1: A plan of the kiln and its associated features

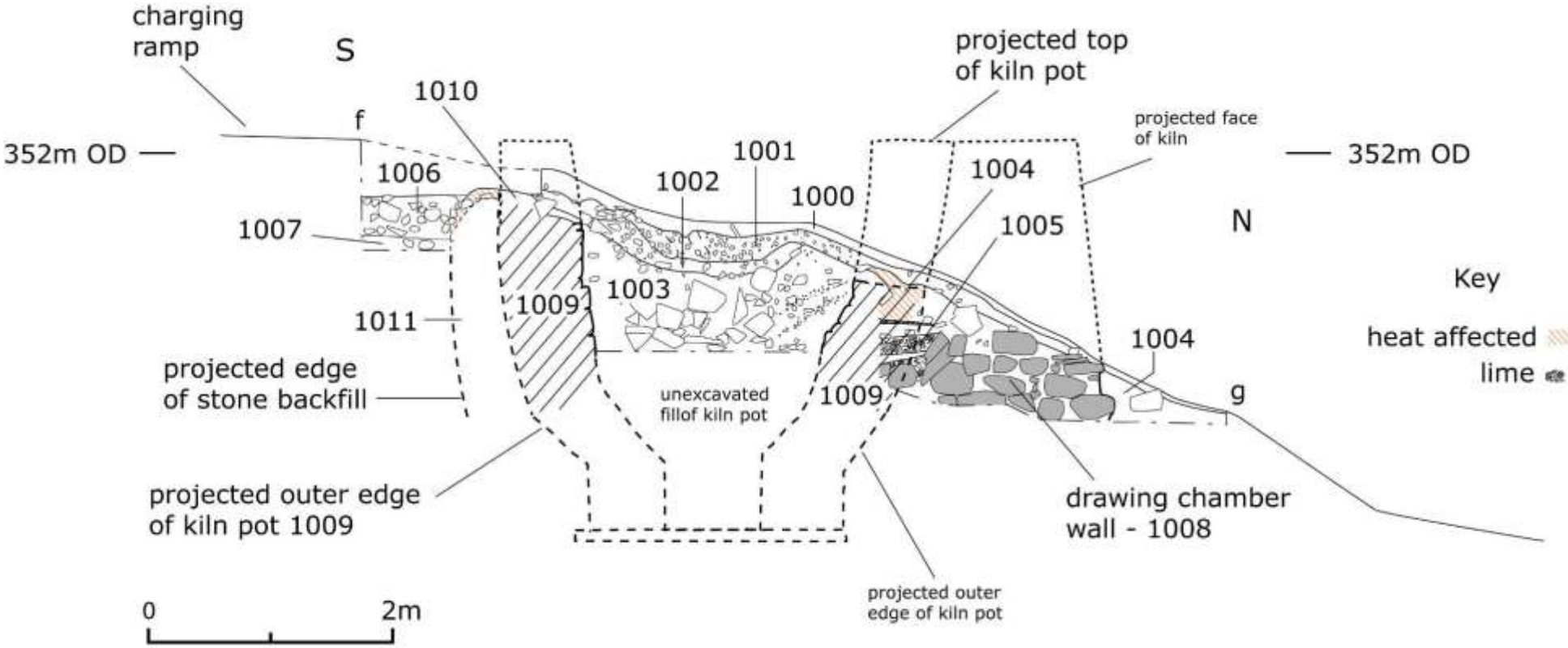


Drawing 2: A plan of Kiln A



Drawings 3 and 4: Cross sections through Kiln A

c –d represents a profile across the kiln mound; a – b provides a profile and projected profile through the kiln pot



Drawing 5: North-south sections through Kiln A

Kiln B (Drawings 6 to 10; Appendix A)

Kiln B was one of a group of about 7 similar kilns arranged side by side along a low north facing, east west aligned outcrop of limestone. Kiln B was the second kiln from the east (Photo 8 & Drawing 6). It was noticed that as the kilns extend towards the west, their spoil tips become less substantial, and that that there are several small scoops that appear to be the locations of limekilns that were planned, but never constructed.

Photo 8: Kiln B before excavation, facing south.

Photo 9 shows the kiln as a small dimple with the shallow quarrying in the background and two finger-like spoil heaps in front of the kiln. Several large rocks visible at the surface hint at a masonry structure below the turf.

Photo 9: Kiln B after removal of turf. Looking north. 1m scale.

A 'T-shaped' trench was hand excavated, revealing a large amount of stone rubble. The soil inside the kiln in the centre of photo 10 is dark grey, while to the sides the natural soil is a reddish brown.

Photo 10: Kiln B backfill of kiln pot, looking north. 50cm scale

As more soil and rock was removed, the curve of a masonry kiln structure was revealed (2009, 2010). Part of the fill of the pot was removed to provide a cross section through the deposit. The fill (2002) appears to have resulted from the gradual collapse of the upper parts of the kiln pot structure, and quarry waste, rather than intentional backfilling (Photo 11). The kiln pot walls (2009 &2010) were approximately 0.25m thick.

Photo 11: Kiln B. Kiln pot fully excavated, facing north. 20cm scale. The upper parts of the kiln pot and the stonework above the kiln eye (north of the scale) may have been repaired and rebuilt several times.

The kiln pot (Photo 12) appears to have been built within a recess (2013) excavated into the slope of the limestone outcrop, with stone rubble and chippings packed around the outside of the kiln to support it. The side walls of the draw chamber appear to extend beyond the outcrop (2007 & 2008).

The lower fills of the kiln (Photo 13), especially within the fire box at its base, consisted of hardened waste lime from the last time the kiln was used.

Photo 12: Kiln B. Kiln 'eye' (hearth). Facing south (20cm scale). The void may have been a 'poking hole' or an opening for an iron grate. Below the void the firebox opening is blocked by solidified lime. Beneath the scale is a 'hearthstone'.

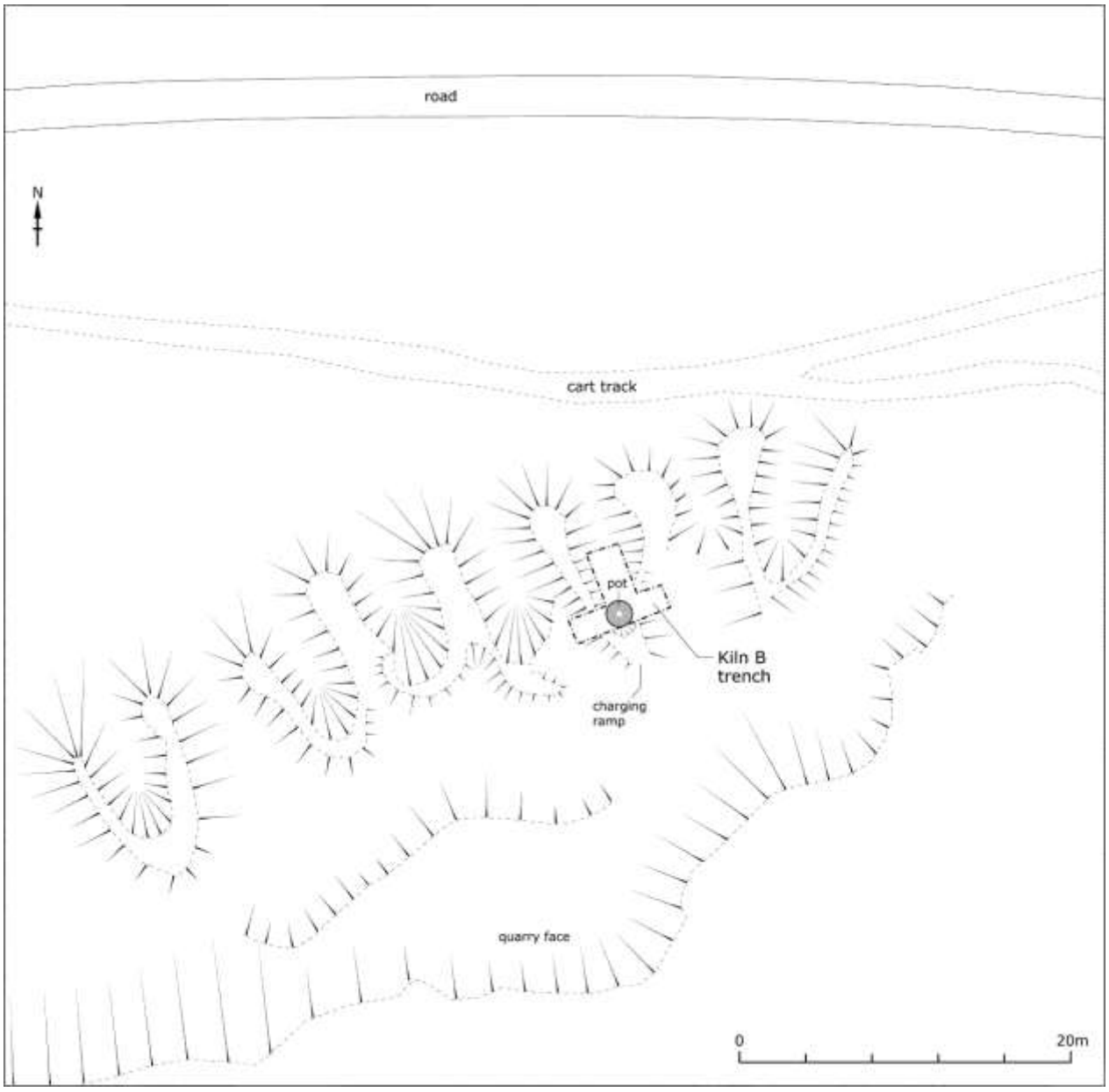
Photo 13: Kiln B. Drawing chamber after removal of rubble collapse. Looking west. 2m and 1m scales. Note the curve of the drawing chamber wall.

In front of the kiln are the remains of a working area referred to as the 'drawing chamber', where lime was drawn from the kiln (Photo 14). When complete the drawing chamber would have had a corbelled roof to protect the lime from rain (so as to prevent the lime from slaking). The surviving excavated evidence suggests the drawing chamber would have been approximately 1.5m long, and 1.6m wide at the front of the kiln, with the side walls curving inwards towards the kiln eye. The original height of the drawing chamber is uncertain, but on the available evidence must have been less than two meters high. Several large flat stones were found in the rubble collapse within the drawing chamber, presumably the remains of the collapsed roof and side walls.

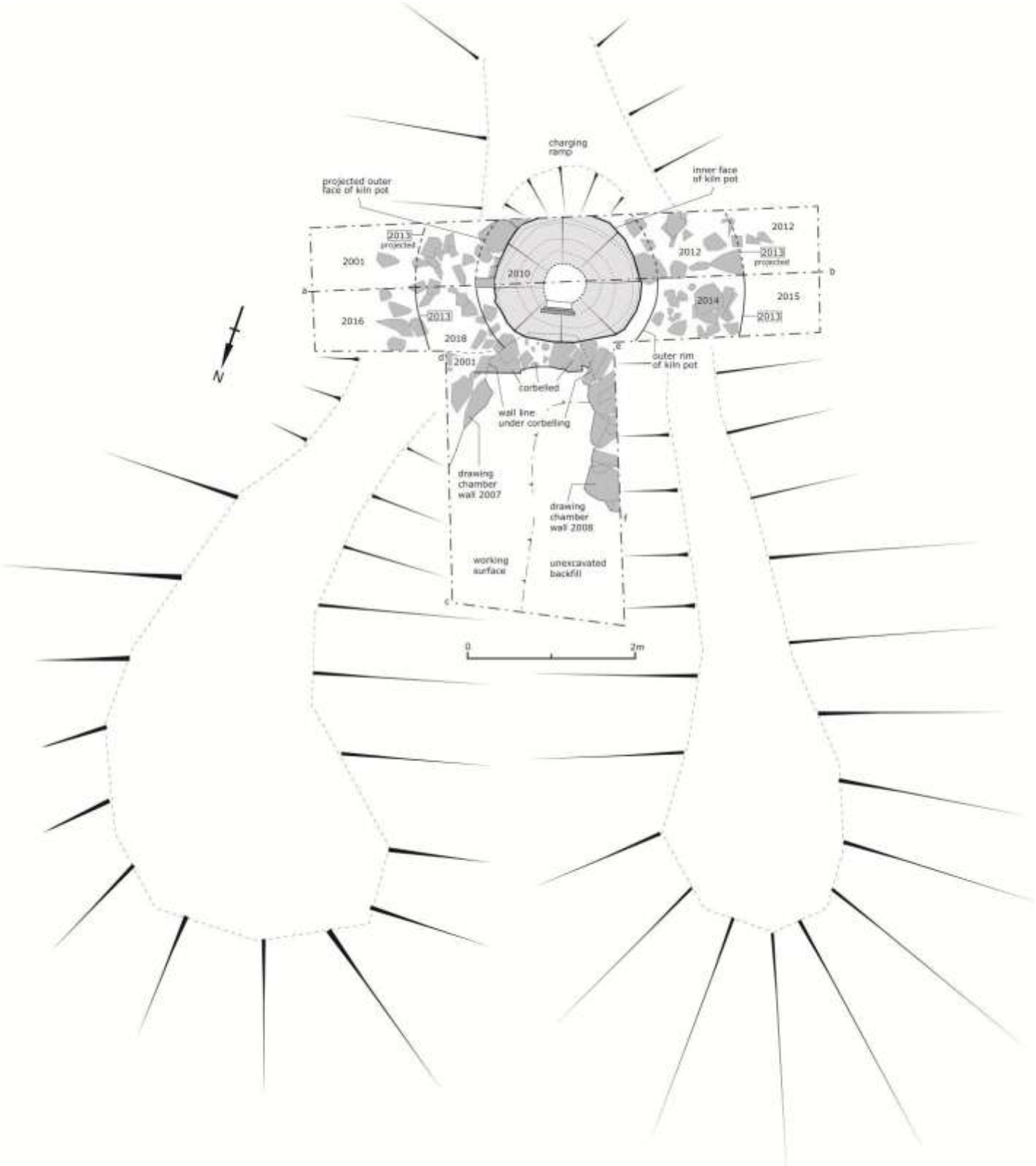
Photo 14: Kiln B. Drawing chamber showing cross section through layers of concreted lime waste, looking west. 1m scale.

Beneath the rubble collapse were several layers of concreted waste lime approximately 0.40m thick (Photo 15). It seems unlikely that this depth of waste material would have been allowed to accumulate during the working life of the kiln if it was necessary to maintain a practical working area within the chamber. It may therefore be that the lime was shovelled out from the top of the kiln, and the draw chamber was solely for regulating the flow of air into the kiln. Fragments of charcoal recovered from the lower working surface (2005) was sent for carbon dating.

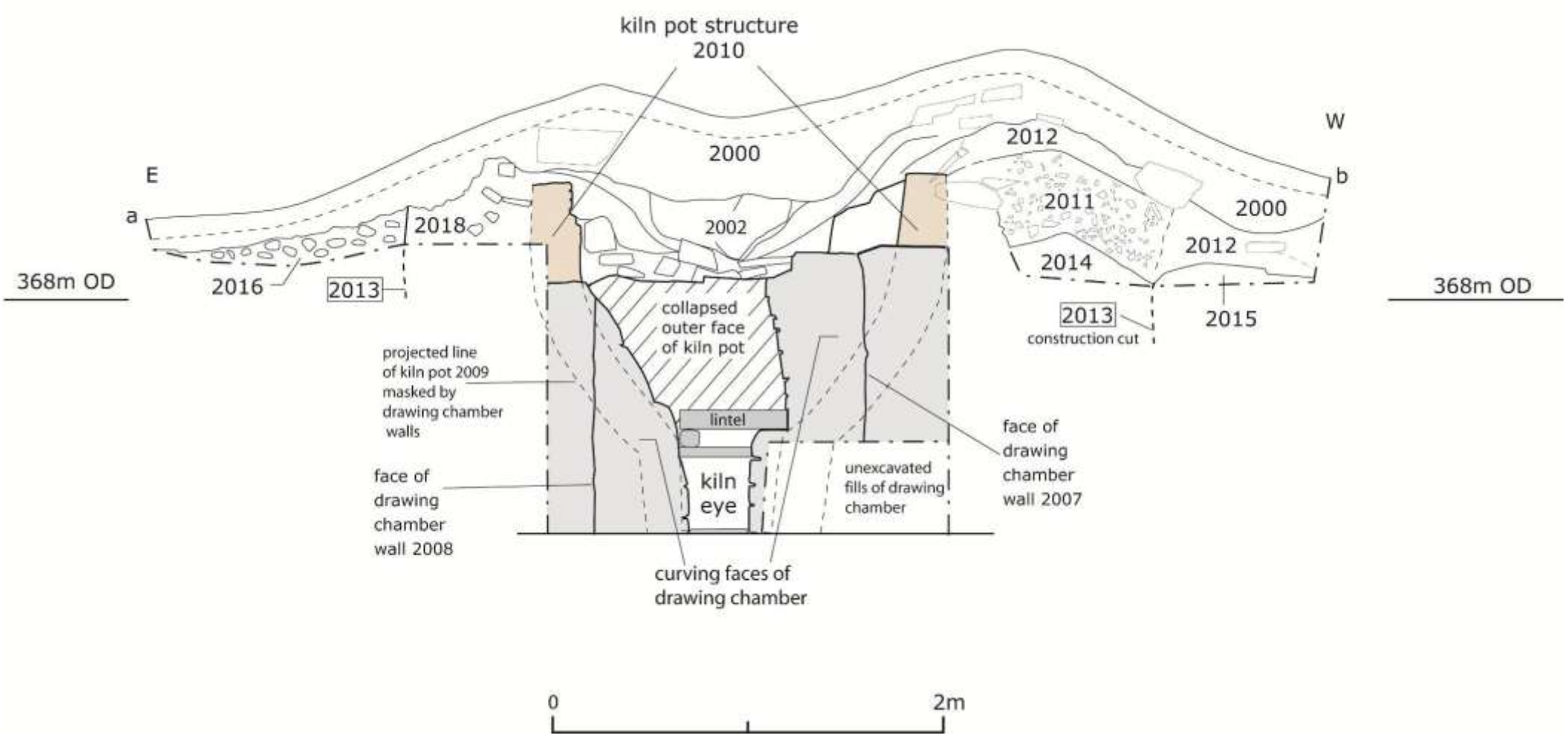
Waste lime was dumped on either side of the approach to the charging arch, (either from the top of the kiln or from the drawing arch), eventually resulting in the distinctive post abandonment horseshoe shaped earthwork of this type of kiln.



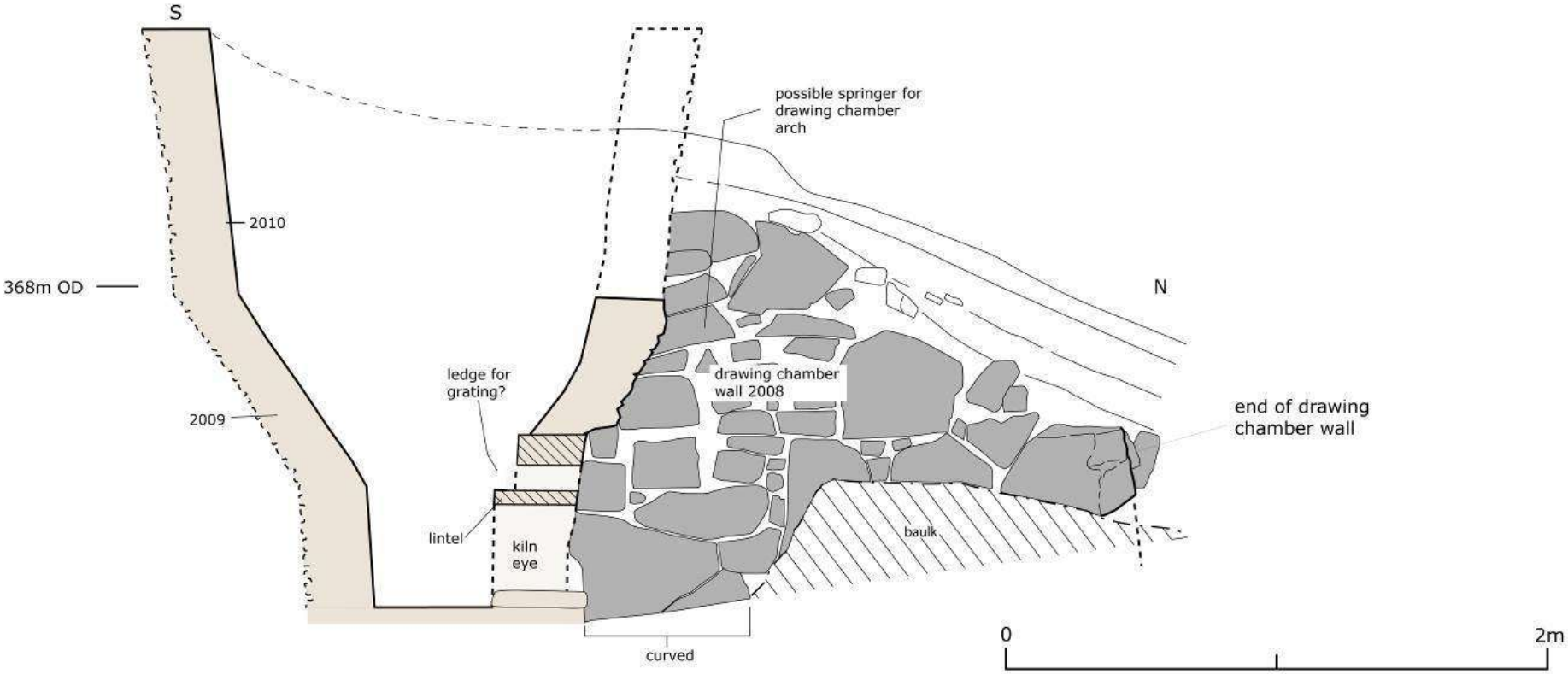
Drawing 6: A plan of Kiln B and its associated features



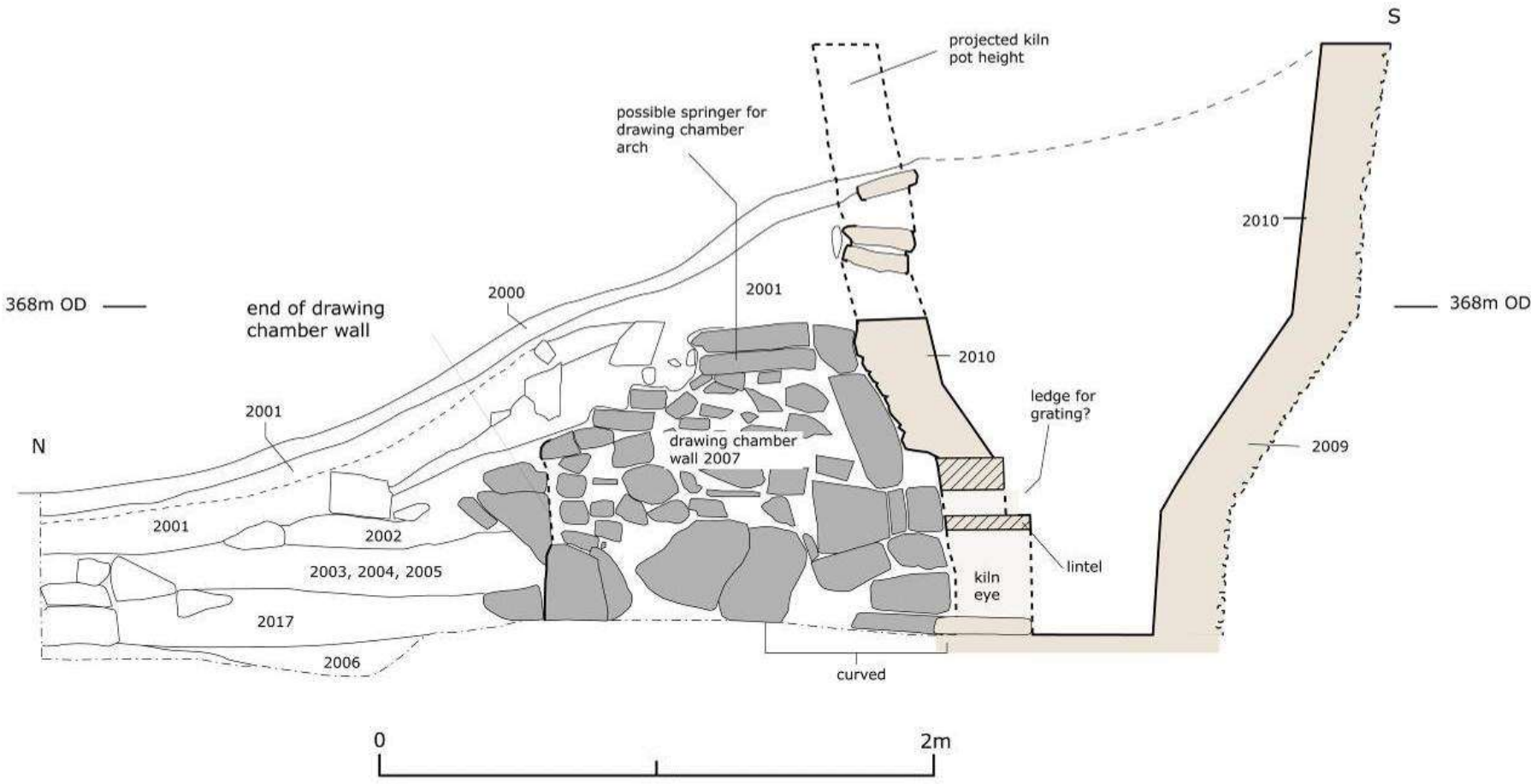
Drawing 7: Plan of Kiln B



Drawing 8: Cross section through Kiln B



Drawing 9: Cross section through Kiln B, western section of trench



Drawing 10: Cross sections through Kiln B, eastern section of trench

Comparison of the two kilns

Kiln B

Despite the insubstantial appearance of the kiln from its surface remains, the excavation has shown that the kilns represented by Kiln B are not clamp or Sod kilns (as has previously been suggested).

Based upon the typology refinements by Manning (1996) this kiln is most similar to a small example of a Type 2iic flare, pot or field kiln with a single draw chamber and kiln eye, all constructed from local stone rubble. The kiln was obviously intended for repeated (but periodic) use, and was still in a usable condition when it was abandoned. The appearance and condition of the kiln pot suggested it may have been repaired at least once.

Using the formula for calculating the volume of a cone (Volume $=h\prod r^2/3$), the approximate radius of the kiln pot as 0.8m and the approximate height as 1.70m (to the level of the fire box), the volume of Kiln B can be calculated to be $1.14m^3$. This amount of lime could be transported in a small farm cart.

The drawing chamber for Kiln B is quite small, and may not have been a practical space from which lime could be extracted from the kiln. Instead, the chamber may only have been used to daw air into the kiln. Once cool the lime was probably dug out from the top of the kiln, with the waste material being barrowed away on either side, eventually forming the fingers of spoil.

The fingers of spoil associated with each kiln are small, suggesting that lime production was small scale and short lived. Likewise, the kilns are located immediately next to each other, and the area of quarrying associated with each kiln is small, suggesting that it was not anticipated that the kilns would be used long enough for the area of quarrying to need to be expanded.

Each kiln may have been operated by an individual family to produce lime for their own purposes. New kilns may have been built as the demand for lime increased. Alternatively, the kilns may have all been operated by the same family at the same time to enable more lime to be produced (reflecting an increase in the amount of land being cultivated), or perhaps in order to supply other farmers with lime.

The Kiln B group may have been abandoned in favour of larger single kilns (such as Kiln A) in a more productive location.

Kiln A

Like Kiln B, Kiln A has a masonry built kiln structure intended for repeated use.

Based upon the typology refinements by Manning (1996) this kiln is most similar to a small example of a Type 2ib flare, pot or field kiln with a single draw chamber and kiln eye, all constructed from local stone rubble. There are, however, several differences between the two kiln types. Kiln A is significantly larger than Kiln B, and it is built out from the hillside, rather than terraced into it.

Using the formula for calculating the volume of a cone (Volume $=h\prod r^2/3$), the volume of Kiln A can be calculated to be $5.6m^3$ (approximately five times the capacity of Kiln B. The kilns of the group represented by Kiln A are widely spaced reflecting the need for a larger area of quarrying to supply each kiln.

The spoil tip associated with Kiln A is also different to those of Kiln B. The larger drawing chamber of Kiln A, and its greater height, made it a more practical space for extracting the lime through the kiln eye. As a result, the spoil tip is separate from the kiln and has formed a different shape.

Kiln A therefore represents a step up in the scale of lime production, probably replacing the Kiln B phase. The regular spacing of the kilns may also suggest that the area allotted to each kiln and quarry was regulated by the landowning estate through leases.

The next step up in the scale of lime production is represented by kilns in the Clogau Bach and Clogau Mawr Quarries.

Dating the kilns

Dating evidence for the limekilns was at a premium. The only datable artefacts from Kiln A were fragments of a North Devon gravel-tempered ware bowl recovered from the topsoil overlying the kiln. This is one of the more common types of this pottery, and is a long-lived form frequently found in rural and urban assemblages in south & west Wales. A 17th/18th century date is usually given to these types - being the period when North Devon wares flood the Welsh market. The pottery is unlikely to date to any time after the mid-18th century (Dee Williams pers. comm.).

The pottery was found in the topsoil overlying the kiln. Although this is not a very reliable layer from which to judge the date of the kiln, taking into account the entirety of the characteristics of the limeworking complex, and what is documented about the evolution of the road network in the vicinity, it seems likely that the Brest Cwm Llwyd workings had been largely abandoned by 1784 when the Llandovery and Llangadog Turnpike Trust appears to have stopped maintaining the road over the mountain to Brynaman in favour of a new road running along the limestone outcrop, to serve the lime industry.

No datable artefacts were recovered from Kiln B. Some fragments of charcoal were, however, recovered from the working floor of the drawing chamber. Unfortunately, if the kiln dates from after the mid-1600s, Carbon 14 dating can only provide an approximate calibrated date of somewhere between 1650 and 1955. A carbon sample was nevertheless submitted.

Very surprisingly, the results of the analysis suggest that the kiln dates from 1520 (plus or minus 29 years) i.e. somewhere between 1491 and 1549! (SUERC – 58183 (GU36491); Appendix B) Some caution is often applied to carbon dates which could theoretically be taken from old wood potentially cut many years prior to its use as fuel, but taken at face value, although this is a surprisingly early date, it is by no means unlikely.

There are few documentary sources relating to lime burning. George Owen notes in his late 16th century *Description of Pembrokeshire* that 'lyminge hath been more used within these thirtie or fortie years than in times past'. He also describes the process of lime-burning:

> 'this limestone beinge digged in the quarey in great stones is heawen lesser to the biggnes of a mans fist and lesse, to the end they might the sooner burne throwe, and beinge heawed smale the same is putt into a kill (kiln) made of wall sixe foote highe fowre or five foote broade at the bryme but growing narrower to the bottom havinge two lope holes in the bottome which they call the kill eyes, in this kill first is made a fier of coales which is laid in the bottome of the kill filled with these smale hewed peeces of lymestones, and then fier beinge geaven, the same burneth for the space of …… and maketh the lymestones to become mere red fierye coales which being don and the fier quenched the lyme so burned is suffered to coole in the kill and then is drawen throwe these kill eyes, and in this sorte is carried to the

> land where it is laied in heapes and the next showre of rayne maketh it to molter and fall into dust which they spreade on the lande.'

Limestone quarrying and burning on the unenclosed areas of the limestone ridge was carried out on a small scale by freeholders and tenant farmers as a common right. A survey of the Duchy of Lancaster's lands in Wales from 1609 records the burning of lime on Mynydd Mawr common:

> 'Wee saye that there are coales founde wrought and digged in the sayed common called Mynith Mawre the use whereof the sayed tenaunts of the sayed commote and theare auncestors and those whose estate they have severally have in and to theare sayd severall tenements by themselves and theare under tenants have severallye and respectively hadd for all the tyme whereof the memory of man ys not to the contrary for necessary ffyre and burninge of lyme as part of theire freehoulde and appurtenaunte to their sayd severall tenements'. (Rees 1953, 300)

Landlords were well aware of the mineral resources on their estates and controlled the extraction of limestone and production of lime through clauses in tenancy agreements and the issuing of leases. A document of 1744 records a yearly payment to the Golden Grove estate for 'the liberty of erecting a limekiln and quarrying of stones on that part of a common called Great Mountain known by the name Castell y Garreg' (CRO Cawdor 64/6618). A rental agreement of 1648 shows the production of lime as a duty of a tenancy: 'Thomas Walter- 2 capons, 2 hens, 2 loads of coale 2 of lime' (CRO Cawdor Vaughan 112/8399).

While this small-scale production was presumably ostensibly for use by the tenants on the farm for domestic use (as mortar and limewash) and agricultural purposes (as fertiliser), a proportion of it no doubt was sold on for profit. In 1755 on the Black Mountain 'the homagers were engaged in secretly burning lime and selling it without the lord's licence' and a year later there were tenants 'who are so audacious as to burn lime and to sell it out of the lordship's' (Jones 1963).

Coal began to be used for lime burning, glass making, etc. in the late medieval period. Possibly the earliest references to its industrial use in Wales is in "Industry before the industrial revolution" (Rees 1968) who suggests coal was used in lime burning from around the 16th century, along with slightly later abortive attempts to set up glass manufacture in Wales *c*.1620. The use of coal for iron smithing commenced even earlier.

This C14 date is probably the earliest definite date for the use of coal for lime burning in Wales and, save for unrecorded but inevitable use of coal for iron smithing, is among the earliest evidence for the use of Welsh coal for purposes other than domestic fuel or export.

6 CONCLUSIONS

The community excavation has successfully increased our understanding of two little-understood types of kiln, and has made a significant contribution to understanding the history and development of the lime industry on the Black Mountain.

The carbon dating evidence recovered from Kiln B is a significant discovery, pushing the evidence for lime burning on the Black Mountain back to the 16th century.

Clarification of the size and structure of the kilns has demonstrated the intensification of the industry, increased investment in kiln building, and more strategic and organised exploitation of the limestone.

The row of kilns on Bank Melyn (of which Kiln B is one), appears to demonstrate the gradual expansion of kilns along the outcrop, culminating towards the east with some intended locations for kilns that were never built. The small capacity of these 16th century kilns, suggests small scale production of lime. However, whether the group represents a single season of lime production, as part of a single lease, or several small leases in one location remains uncertain. It is also unclear whether the group of kilns represent a single year's production, or expansion over several years.

The ceramic dating evidence associated with Kiln A is broadly in support of limestone processing at Brest Cwm Llwyd having expanded significantly in the early to mid-18th century. The distribution of the Kilns on Brest Cwm Llwyd (of which Kiln A is an example) suggests that with increased production came increased organisation and perhaps longer lease periods.

The results of the Brest Cwm Llwyd community excavation would undoubtedly be of use in interpreting and understanding the development of limeworking in other locations on the Black mountain.

7 REPORTING AND ARCHIVING

Scope of the Project

The project objectives were:

- To undertake small excavations to characterise and date two different types of limekiln identified at Brest Cwm Llwyd;
- To increase understanding of the development of the lime industry on the Black Mountain;
- To engage local communities in the exploration of their cultural heritage.
- To produce an archive and report of any results.

A written Scheme of Investigation (WSI) outlining the excavation processes was agreed with the BBNPA archaeologist, and all necessary permissions from the landowner (BBNPA), local graziers and NRW (SSSI consent), were obtained prior to commencement of the excavation.

The small project archive will be stored at the DAT offices in Llandeilo.

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APPENDIX A: Context descriptions

Kiln A context descriptions

Context number	Context type	Context description
1000	Turf line	Turf.
1001	topsoil	Mid grey brown silty loam with small and medium angular blocks of gritstone and hard concretions of lime and powdered lime all the way through the deposit.
1002	Lime waste/mortar backfill	Pale/mid brown silt mixed with a large quantity of crunchy powdered lime and small angular stones.
1003	Rubble backfill within kiln pot	Loose very mixed deposit of large angular gritstone blocks, medium sized angular gritstones and powdered crunchy lime deposit. Also some heat reddened sandy silt.
1004	Backfill between kiln structure 1009 and construction cut 1011	Dark brown fairly compact silty sand with a few small and medium stones. Heat affected and reddened towards kiln edge
1005	Lime mortar layers within 1004	Bands of light brown loose mortar within the backfill around the kiln structure.
1006	Kiln mound material	Compacted mid brown sandy silt with medium and small angular stones and lime throughout.
1007	Kiln mound material	Compact mid brown sandy silt with some medium stone. No lime. Not fully excavated.
1008	West wall of drawing chamber	Constructed from large irregular un-dressed, angular boulders with smaller packing stones between. Random coursing. East wall of chamber not revealed by the excavation. Upper courses, evidence of a corbelled ceiling and the outer face of the kiln pot have all been lost as a result of collapse of the structure. It was not possible to reveal the drawing eye of the kiln.
1009	Kiln masonry structure	The upper portion of the inside of the kiln pot was revealed during the excavation. The masonry consisted o
1010	Lime mortar deposit above kiln structure 1009.	Decayed lime. Remnant of mortar bedding for masonry of kiln structure.
1011	Backfill behind kiln structure	Dark brown fairly compact silty sand with numerous small and medium stones. Heat affected and reddened towards kiln edge.
1012	Kiln mound material	Soft, mid reddish brown silty clay with fragments of white mortar less than 1cm in diameter.
1013	Kiln mound material	Loose white mortar.
1014	Kiln mound material	Bands of light brown loose mortar with narrower bands and lenses of friable mid brown silt between.
1015	Kiln mound material	Soft, mid-brown silty clay with fragments of white mortar less than 1cm in diameter. And angular stones from 4cm to 12cm in length.
1016	Kiln mound material	Friable dark brown silty soil containing white mortar up to 5cm diameter and angular stones up to 6cm long.
1017	'Cut' for kiln structure	Cut containing backfill between the kiln structure and the kiln mound structure.

Kiln B context descriptions

Context number	Context type	Context description
2000	Topsoil layer	Loose, mid grey-brown clay (20%) silt (80%) with frequent limestone fragments. Maximum 0.20m thick.
2001	Weathered limestone layer beneath layer 2001	Loose, mid grey-brown humic loamy matrix with frequent limestone chippings. Maximum 0.15m thick.
2002	Rubble collapse of drawing chamber roof and kiln pot within drawing chamber	Loose light grey mortar and silt matrix among stone rubble, including flat slabs from ceiling. Maximum 0.60m thick.
2003	Burnt lime waste deposit below 2002, within drawing chamber	Loose, crumbly, pale pinky grey decayed mortar with small stone fragments & coal and lime flecks. Maximum 0.15m thick.
2004	Trampled lime working surface within the drawing chamber, below 2003	Yellowish off-white hard lime with small stone fragments and charcoal flecks.
2005	Kiln waste deposit below 2004	Hard off-white/pale yellow concreted lime with small stones. 0.35m thick.
2006	Primary floor of drawing chamber	Mid pinkish clay (30%) silt (70%) with small stone, coal, charcoal and mortar fragments.
2007	West wall of drawing chamber. Originally supporting corbelled roof	Random coursed rough stone, earth and lime mortar bonded. Approximately 1.80m long and 0.30m wide excavated to maximum depth of 1.35m.
2008	East wall of drawing chamber. Originally supporting corbelled roof	Random coursed rough stone, earth and lime mortar bonded. Approximately 1.80m long and 0.30m wide excavated to maximum depth of 1.35m.
2009	Kiln pot structure	Roughly coursed mortared stone tapering from maximum diameter of 1.85m (essentially circular) to a hearth 0.50m in diameter and 0.50m deep. Total depth of kiln approx. 2.0m (top meter is 2010). Kiln eye blocked with hardened lime. Void above may be a 'poking hole' or to insert grill to support limestone charge.
2010	Kiln rebuild(above 2009)	Possible repair to top 0.5m of kiln structure. Stones are smaller, less heat affected and there is more soil than mortar in the bonding material. Random coursing.
2011	Backfill behind repair 2010	Mixture of red sandy clay-silt and stone fragments. Possible packing material to support kiln repair 2010.
2012	Packing stones/tumble above 2011	Larger stones on top of 2011. Either packing to prevent erosion of outside of kiln structure or collapsed kiln structure. All in a loose soil matrix.
2013	Cut for kiln	Partially excavated presumed cut for kiln structure.
2014	Bedrock	Natural limestone bedrock.
2015	Natural? scree chippings above 2014	West side of kiln
2016	Weathered limestone cobbles above 2014	East side of kiln
2017	Natural subsoil (outside kiln)	Natural reddish-brown clay silt subsoil outside the limits of the drawing chamber (and beneath working surface 2006.

APPENDIX B: Radiocarbon certificate

23/02/2015

Laboratory Code: SUERC – 58183 (GU36491)

Site Reference: BCL14

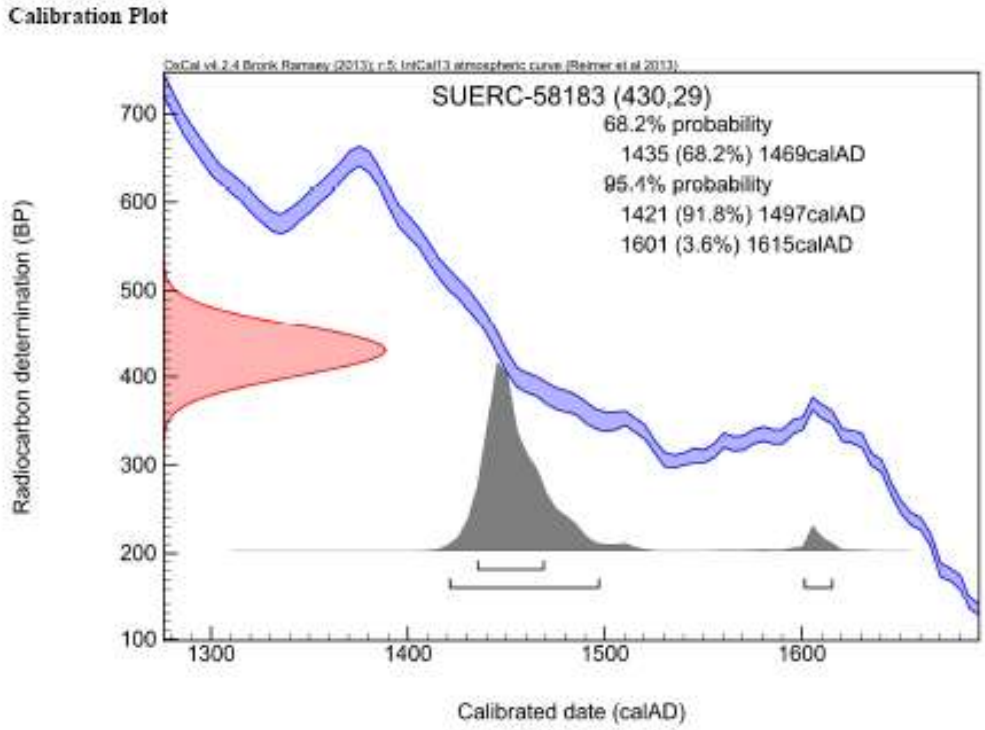
Context reference: 2005

Sample reference: 1

Material: Charcoal (unidentified sp.)

$\delta^{13}C$ relative to VPDB:-28.3%

Radiocarbon Age BP: 430+/- 29



The above ^{14}C age is quoted in conventional years BP (before 1950AD). The error, which is expressed at the one sigma level of confidence, includes components from the counting statistics on the sample, modern reference standard and blank and the random machine error. The calibrated age ranges are determined from the University of Oxford Radiocarbon Accelerator Unit calibration program (OxCal4)

ARCHAEOLOGICAL EXCAVATION OF TWO LIME KILNS AT BREST CWM LLWYD, CARMARTHENSHIRE: 2014

RHIF YR ADRODDIAD / REPORT NO. 2015/6
RHIF Y DYGWILLIAD / EVENT RECORD NO. 107702

Paratowyd yr adroddiad hwn gan /
This report has been prepared by: **Duncan Schlee**

Swydd / Position: **DAT Archaeological Services Project Manager**

Llofnod / Signature  Dyddiad / Date: 27/02/2015

Mae'r adroddiad hwn wedi ei gael yn gywir a derbyn sêl bendith /

This report has been checked and approved by: **James Meek**
ar ran Ymddiriedolaeth Archaeolegol Dyfed Cyf. /
on behalf of Dyfed Archaeological Trust Ltd.

Swydd / Position: **Head of DAT Archaeological Services**

Llofnod / Signature ....  Dyddiad / Date: 27/02/2015

Yn unol â'n nôd i roddi gwasanaeth o ansawdd uchel, croesawn unrhyw sylwadau sydd gennych ar gynnwys neu strwythur yr adroddiad hwn

As part of our desire to provide a quality service we would welcome any comments you may have on the content or presentation of this report

ymddiriedolaeth archaeolegol

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