# Hagg Farm Industrial Landscape
# Fremington
# Swaledale
# North Yorkshire
# SE 05946 99141

## Archaeological Excavation

For

Northern Mine Research Society and
The Swaledale and Arkengarthdale Archaeology Group

*061-13-HS | August 2013*


**Vindomora Solutions**
Heritage Support

Office 13
Consett Innovation Centre
Genesis Way
Consett
County Durham DH8 5XP

☎: 07925635478
✉: info@vindomorasolutions.co.uk
💻: www.vindomorasolutions.co.uk


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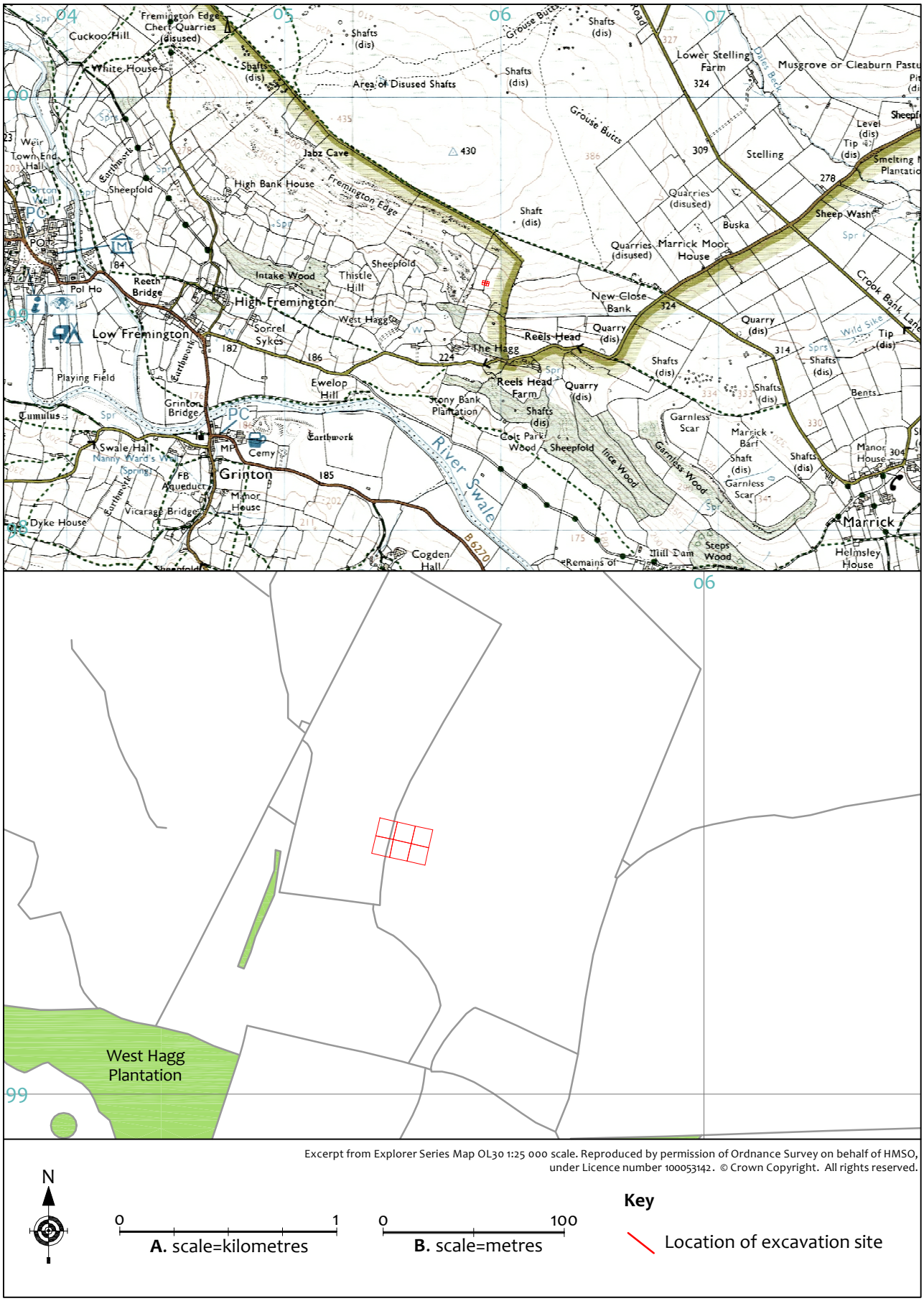



*Figure 1. Location of excavation site*

*Plate 1: The excavation underway.*

# Summary

| | |
|---|---|
| Name of location: | Hagg Farm Industrial Landscape |
| Address of location: | Hagg Farm, Fremington, North Yorkshire, DL11 6AU |
| NGR: | SE 05939 99137 |
| Clients: | Northern Mine Research Society & Swaledale and Arkengarthdale Archaeology Group |
| Project Type: | Archaeological Excavation |
| Project Code: | HFL-13 |
| Vindomora Solutions ref: | 061-13-HS |
| Report Author: | Tony Liddell |
| Report Date: | Friday, August 30, 2013 |
| OASIS ID: | vindomor1-157283 |
| Ordnance Survey Licence Ref: | 100053142 |

# Concise Summary of Report

In 2012, the Swaledale and Arkengarthdale Archaeology Group (SWAAG) led by Tim Laurie FSA identified clear evidence of lead smelting and a potential lead bale site centred at SE 05939 99137. The site was noted to be under direct risk of severe damage from rabbits, and was characterised by looking at slag and charcoal within and outside the rabbit burrows. A joint project was then set up in the summer of 2013 between SWAAG and the Northern Mine Research Society (NMRS) to archaeologically investigate the bale site, with Richard Smith of NMRS directing the fieldwork alongside Tim Laurie of SWAAG, with Tony Liddell of Vindomora Solutions providing professional archaeological recording support.

Initially, a geophysical survey was undertaken of the earthworks by Dr Robert Vernon, which identified features consistent with bale technology, including a large 'pseudohorseshoe shaped anomaly' interpreted as the remains of a lead-smelting bale along with a channel running from the bale, as well as three areas of lead slag.

The five day excavation uncovered what appeared to be a natural spring line and bank that had been filled with slag debris from hill-wash, as well as several small areas of slag deposition. Unfortunately there was no conclusive archaeological evidence of a bale being present within the excavation area. However, certain waste deposits, potential deliberate areas of hard-standing and heated natural clay geology in a test pit west of the drystone wall do suggest the presence of a smelting site (of currently unknown technology) in close proximity to the excavation site.

The upcoming evidence from the metallurgical analysis of samples taken by Richard Smith of NMRS may help interpret the deposits found on site, their chronology and the industrial processes being undertaken within the area of the excavation and on the overall site as a whole. Specifically, the excavation has confirmed the presence of a potentially early, extensive level of industrial activity (lead based) in the nearby vicinity of the studied area, with the possible smelting being undertaken west of the post-medieval drystone wall. The deposits within the main excavation area could also be interpreted as potentially belonging to a small induced draught furnace of loosely placed stones atop the existing turf, though with the lack of evidence for buried turf-lines in this area, this interpretation is uncertain.

If further work was to take place then it would be recommended to be undertaken in the fields west and north of the current excavation area.

# 1. Scope of Project

*Plate 2: The excavation of the site, looking southwest.*

## 1.1 Location

1.1.1 The site is located 1.21km east of High Fremington, 1,07km west of Marrick Moor House and 330m to the northeast of The Hagg, Fremington, Swaledale, North Yorkshire (centred at NGR SE 05939 99137). At the time of the archaeological excavation, the land-use was rough pasture, bounded by dry-stone walls.

## 1.2 Circumstances of the project

1.2.1 In 2012, the Swaledale and Arkengarthdale Archaeology Group (SWAAG) led by Tim Laurie FSA identified clear evidence of lead smelting and a potential lead bale site centred at SE 05939 99137. The site was noted to be under direct risk of severe damage from rabbits, and was characterised by looking at slag and charcoal within and outside the rabbit burrows.

1.2.2 A joint project was set up in the summer of 2013 between SWAAG and the Northern Mine Research Society (NMRS) to archaeologically investigate the bale site, with Richard Smith of NMRS directing the fieldwork alongside Tim Laurie of SWAAG, with Tony Liddell of Vindomora Solutions providing professional archaeological advice and recording support. The excavation was to be undertaken by members of SWAAG and associated volunteers. The excavation aimed to complement work undertaken on early lead smelting sites by NMRS members Richard Smith and Sam Murphy between 2001-2011.

1.2.3 Initially, a geophysical survey was undertaken of the earthworks identified by Laurie and Smith, which identified features consistent with bale technology (Vernon 2013). These features were a large 'pseudohorseshoe shaped anomaly' interpreted as the remains of a lead-smelting area with a channel running from it, as well as three areas of lead slag. The survey also produced evidence of ridge and furrow west of the drystone wall.

1.2.4 The work required the excavation of a large open area to the east of the drystone wall over the anomalies identified on the geophysics as the bale site, two test pits parallel to the wall on its east side (again targeting anomalies identified on the geophysics) and two test pits west of the wall in the improved pasture field beyond. Unfortunately, due to time constraints the full area of geophysical survey was not fully excavated, work instead concentrating on areas the site directors identified as likely platforms for lead smelting and associated processes.

1.2.5 The main aim of the excavation was to identify and categorise the technology used as very few sites of that type have been previously excavated using archaeological methods. The secondary aim of the excavation was to produce a date range within which the site was in use and also to identify the type of wood used for fuel in the process. A tertiary aim of the project was to test the veracity of using geophysical survey to identify bale and other industrial sites.

1.2.6 This report is the first of three reports being produced relating to this excavation, with the second being produced by NMRS in relation to the chemical analysis, charcoal species identification and dating of the samples taken during the field investigation, and the conclusions about the site that can be drawn from the results. The third report will be produced by SWAAG and will detail the results of a pollen sample taken during the works, again citing relevance to plants and trees contemporary with the site's working life.

## 1.3 Research agenda

1.3.1 All work in the field and during the post-excavation phase was carried out within the context of the *Yorkshire Archaeological Research Framework* (Roskams and Whyman 2007).

## 1.4 Vindomora Solutions project personnel

1.4.1 The fieldwork was undertaken by Tony Liddell. This report and associated illustrations were produced by Tony Liddell.

## 1.5 Timetable

1.5.1 The open area excavation took place between the 12th-16th August, with the report being produced for 29th August 2013.

## 1.6 Archive

1.6.1 A full archive has been compiled in line with the specification and current UKIC and English Heritage Guidelines, which will be passed to the Swaledale and Arkengarthdale Archaeology Group in due course. The project code is **HFL-13** for **H**agg **F**arm **L**eadworking 20**13.** Vindomora Solutions support the **O**nline **A**cces**S** to the **I**ndex of Archaeological Investigation**S** project (OASIS). As a result, this report will be made available to the project under the unique identifier **vindomor1-157283.**

## 1.7 Acknowledgements

1.7.1 Thanks are extended to the excavation site directors Richard Smith of NMRS (for his input during the fieldwork and reporting stage of work) and Tim Laurie of SWAAG, as well as to the SWAAG membership as a whole for their efforts during the fieldwork, and to NMRS for funding the scheme of works. Thanks also go to the landowner David Clark for allowing the excavation to take place.

# 2. BACKGROUND

## 2.1 Underlying geology

2.1.1 The solid underlying geology comprises limestone, shale and sandstone laid in near-horizontal strata. Glacial drift deposits lie above rock, forming terraces of gravels, clay, limestone and sandstone (the Askrigg Block), overlain by Devensian glaciofluvial sheet deposits of sand, clays and gravel (Countryside Commission 1998).

## 2.2 Historical background

2.2.1 This background history and its relevance to the development in question is based primarily on information stored within the English Heritage PastScape resource, alongside the North Yorkshire Historic Environment Record. The study area is set to a 500 metre radius of the excavation site (the radius has been designated as such due to the deposits located during the excavation denoting the use of buckets and barrows, thus suggesting close working).

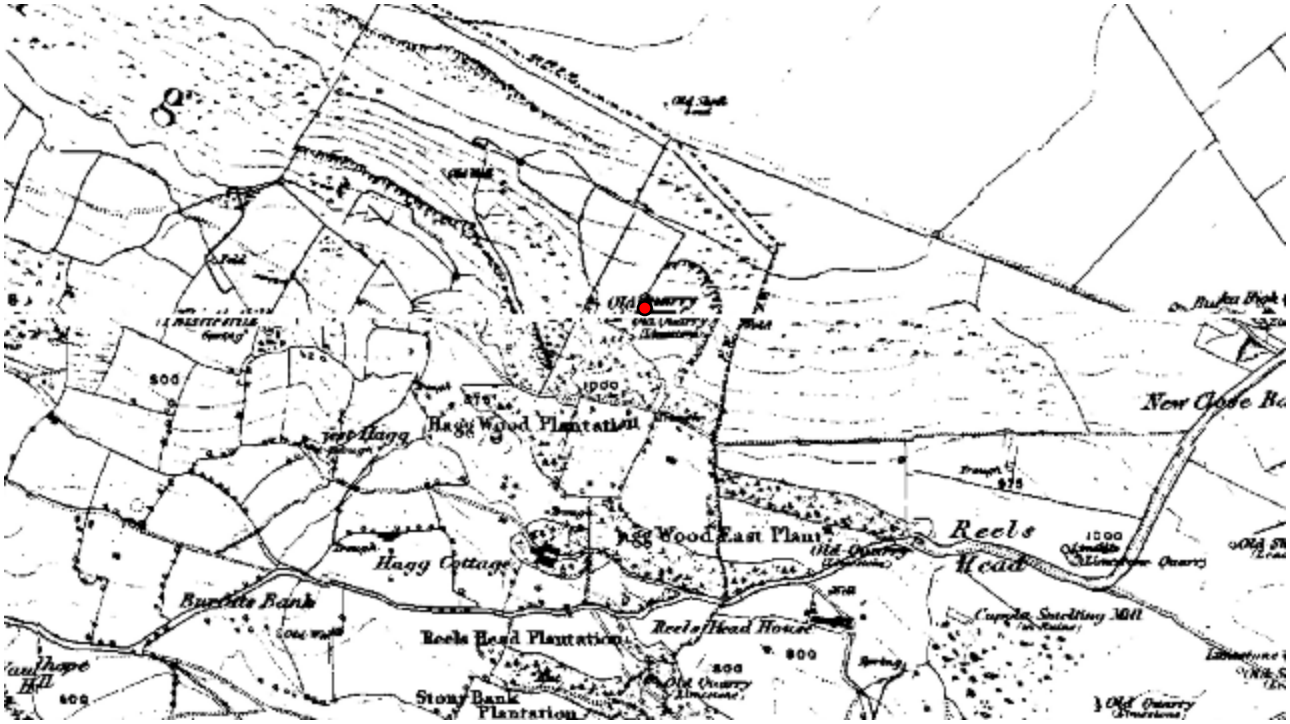
2.2.2 Prehistoric: There is no evidence for prehistoric activity within the study area.

2.2.3 Roman: A late Roman site lies at the Hagg, 280m southwest of the excavation site. The site comprises two phases of stone-flagged roundhouses, a possible enclosure bank, substantial cobbled surfaces and flat flagged potential storage areas, with the latest ceramic material dating to AD 370. Roman glass, iron tools and Whitby jet jewelry fragments have also been unearthed. The roundhouse rubble wall material also contained galena fragments.

2.2.4 Medieval: Four identified bale sites lie approximately 230m to the north of the excavation site, shown on a map of the Copperthwaite area, *circa* 1592. The map does not show any working in the area of the excavation.

2.2.5 Post-medieval (direct relevance): A post-medieval limestone quarry is recorded as NMR SE 09 NE 18 (English Heritage PastScapes Monument No. 559961) at NGR SE 0600 9910. This quarry is recorded as disused by 1854. The site of this quarry lies 70m east of the excavation site. A second

*Plate 3. Extract from the 1st Edition Ordance Survey of 1857 showing the location of the site in relation to disused lime quarries. The site location is shown as a red dot.*



limestone quarry is recorded as NMR SE 09 NE 150 (English Heritage PastScapes Monument No. 560093) at NGR SE 0600 9919, again recorded as disused by 1854. This site lies 90m north of the excavation site.

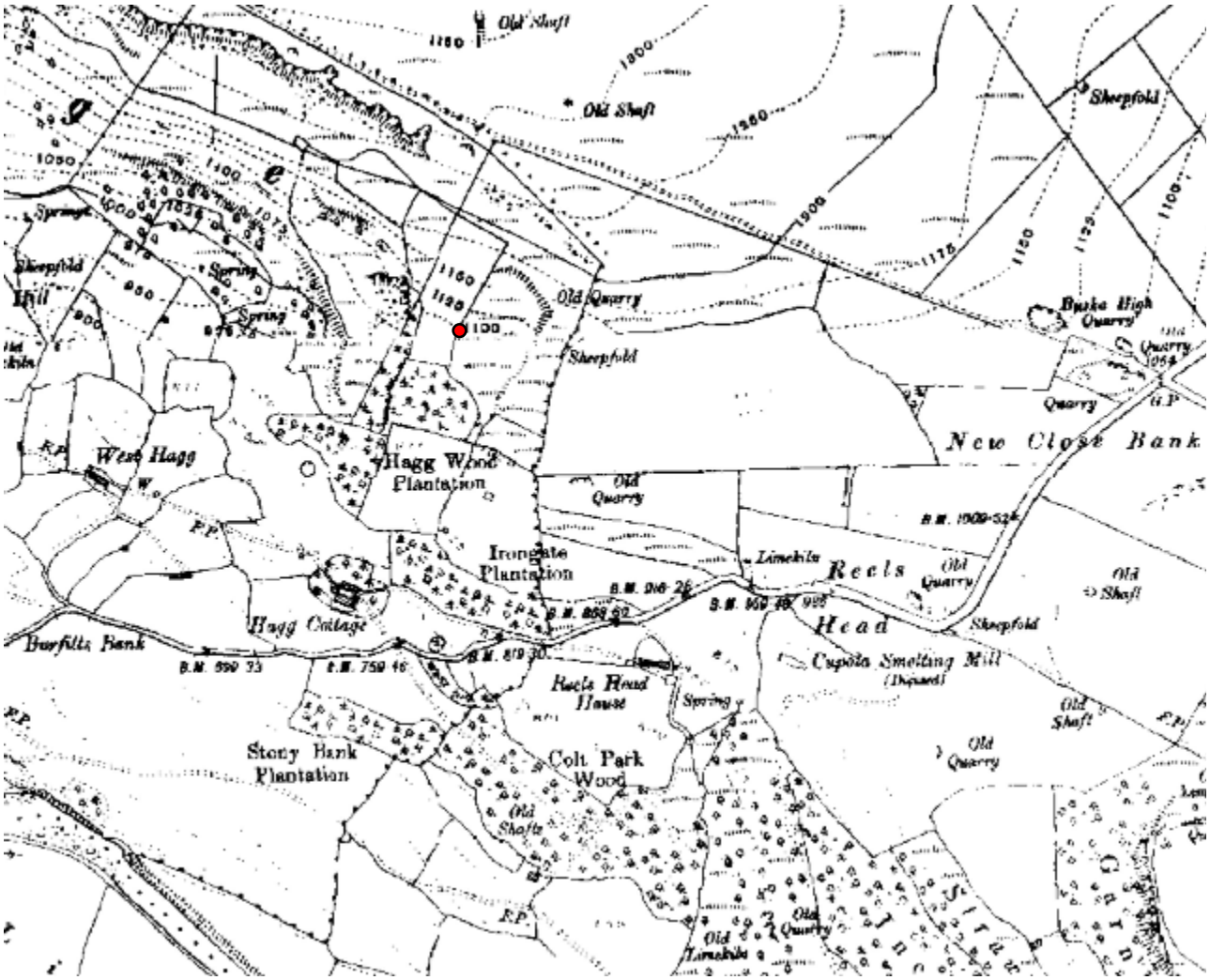
2.2.6 Post-medieval (spatial relevance): Marrick Cupola lead smeltmill lies 550m to the southeast of the excavation site. The monument (NMR SE 09 NE 22) includes the ruins of an early reverberatory smeltmill, slag tips and earthworks. The mill began smelting in 1701 and abandoned in 1723 due to legal disputes. The slag remains contain considerable concentrations of lead and other minerals due to the inefficient processes used in early reverberatory smelting.

2.2.7 290m north of the excavation site lies a disused lead extraction shaft (NMR SE 09 NE 146), again disused by the time of the production of the 1st edition Ordnance Survey map of 1857.

2.2.8 Two further disused limestone quarries lie within half a kilometre of the site, one located 440m southeast of the site with associated lime kiln (NMR SE 09 NE 21) and the other 490m south of the site (NMR SE 09 NE 37). Another quarry (NMR SE 09 NE 24) lies 615m east of the site. A post-medieval limekiln (NMR SE 09 NE 10) also lies 480m west of the excavation site.

2.2.9 The Haggs lie 370m southwest from the excavation site. The Haggs are Grade 2 Listed, formerly listed as Hagg Cottage and date to the early 19th century. The 1st Edition Ordnance Survey suggests a group of three dispersed buildings: however, visual inspection of West Hagg now suggests that the latter may have been rebuilt.

*Plate 4. Extract from the of 1907 Ordance Survey showing the location of the site in relation to disused lime quarries. The site location is shown as a red dot.*



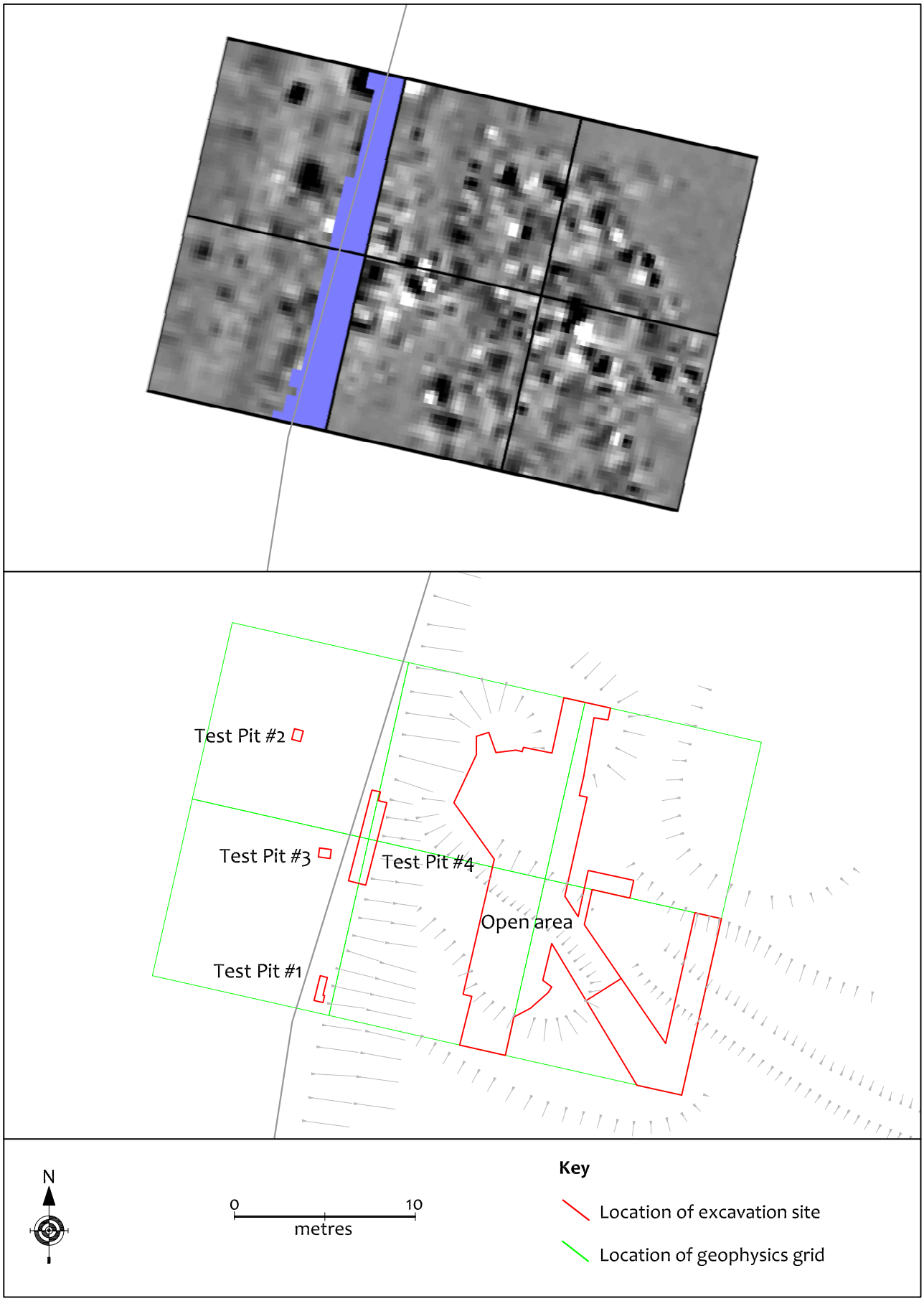



*Figure 2. Geophysical survey results (interpolated data SD -3 to +3) and excavation area*

# 3. The Excavation

*Plate 5: Excavating down to natural geological contexts.*

## 3.1 Introduction

3.1.1 The field investigation involved the observation and examination of all archaeological deposits, artefacts or horizons encountered during the excavation. The excavation work was undertaken by hand, using a variety of tools including spades, shovels, mattocks and drop-forged trowels. The turf was stripped and collected, and then replaced at the end of the excavation.

3.1.2 Recording was undertaken using pro-forma record sheets, as well as a photographic record in digital JPG format, alongside a photographic register. The photographs included a metric scale in 0.50m increments where appropriate.

3.1.3 All work undertaken was in accordance with the Institute for Archaeologists' *Code of Conduct* (2010), their *Standard and Guidance for excavation* (2008) and their *Standard and Guidance for archaeological advice* (2012).

3.1.4 The location and extent of the groundworks in relation to the geophysical survey study area can be seen on Figure 2 opposite. The excavation, including the four test pits, opened up an area of 132.7m$^2$.

## 3.2 Observed geology

3.2.1 Natural geology, context [N1] was observed at a height of approximately 334m OD. This comprised a sandy clay with sandstone and limestone inclusions. A variant of this geological context, [N2] was observed west of the wall where the material had been heated by fire and thus reddened.

## 3.3 Archaeological observation

3.3.1 Test Pit #1: Test Pit #1 measured 1.40m long and 0.4-0.5m wide in an 'L' shape, with its long axis aligned north-northeast to south-southwest. The pit was located at the top of the slope to the west of the main excavation open area, 0.7m to the east of the drystone wall and was dug to determine the extent of the packed slag layer found in Test Pit #4. A plan of this pit can be seen on *Figure 3*.

3.3.2 Beneath shallow topsoil [1] was a compacted deposit of slag [5] some 0.10m thick. This deposit was noted to run down through the northern 0.98m of the pit, before trailing off onto natural substrate {N1}, a sandy clay with sandstone and limestone inclusions.

3.3.3 The compacted slag deposit appeared to have been deliberately placed, suggesting the formation of an area of hard-standing along the top of the ridge. The deposit was seen to continue into Test Pit #4, detailed in Section 3.3.8.

3.3.4 Test Pit #2: This test pit was located 4.15m west of the drystone wall, northwest of the main excavation area to attempt to locate and identify an anomaly shown on the geophysical survey. The pit measured 0.60m long, 0.5m wide and 0.11m deep, with its long axis aligned northeast-southwest. A plan and section of this pit can be seen on *Figure 3*.

3.3.5 Natural substrate {N1} was located 0.11m below the current surface, over which was a 0.055m deep deposit of grey ashy subsoil [6]. Sealing this was topsoil and turf.

3.3.6 Test Pit #3: Test Pit #3 was located 0.7m west of the drystone wall. The pit was 0.65m long, 0.50m wide and 0.23m deep, with its long axis aligned east-west. This pit was excavated to determine whether or not the compacted slag deposits located east of the drystone wall continued to the west of the wall. A plan and section of this pit can be seen on *Figure 3*.

3.3.7 Natural substrate {N2} was located 0.23m from the current surface. This geological context was the same as {N1} barring its redder appearance, indicating either higher iron content or exposure to prolonged heat. Across the surface of the natural geology was a thin layer of charcoal [19] averaging only 0.06m thick. Over the charcoal layer was a deposit of grey-brown compact slag [18], averaging 0.044m thick. This deposit was very similar to [5] found in Test Pit #1 (Section 3.3.2) and also Test Pit #4 (Section 3.3.8) and could be the continuation of

*Plate 6. Test Pit #1 looking south*

*Plate 7. Test Pit #2 looking north*

*Plate 8. Test Pit #3 looking north*

the deposit west. Over this slag layer was a 0.03-0.11m thick deposit of grey-black ash, cinder and slag [17]. Over this was a 0.07m thick layer of stone and slag in a grey-brown sandy matrix [16]. Sealing this was a 0.02m thick deposit of ashy subsoil [6], covered by 0.04m of topsoil and turf [1].

3.3.8 Test Pit #4: This test pit was 5.2m long, 1m wide and 0.30m deep (within the associated sondage), with its long axis aligned north-northeast to south-southwest. The pit was located east of the drystone wall at the head of [**F2**] situated within the excavation area, as well as being within an area where slag had been noted on the surface. A plan of this pit can be seen on *Figure 4*.

*Plate 9. Test Pit #4 looking north, showing section*

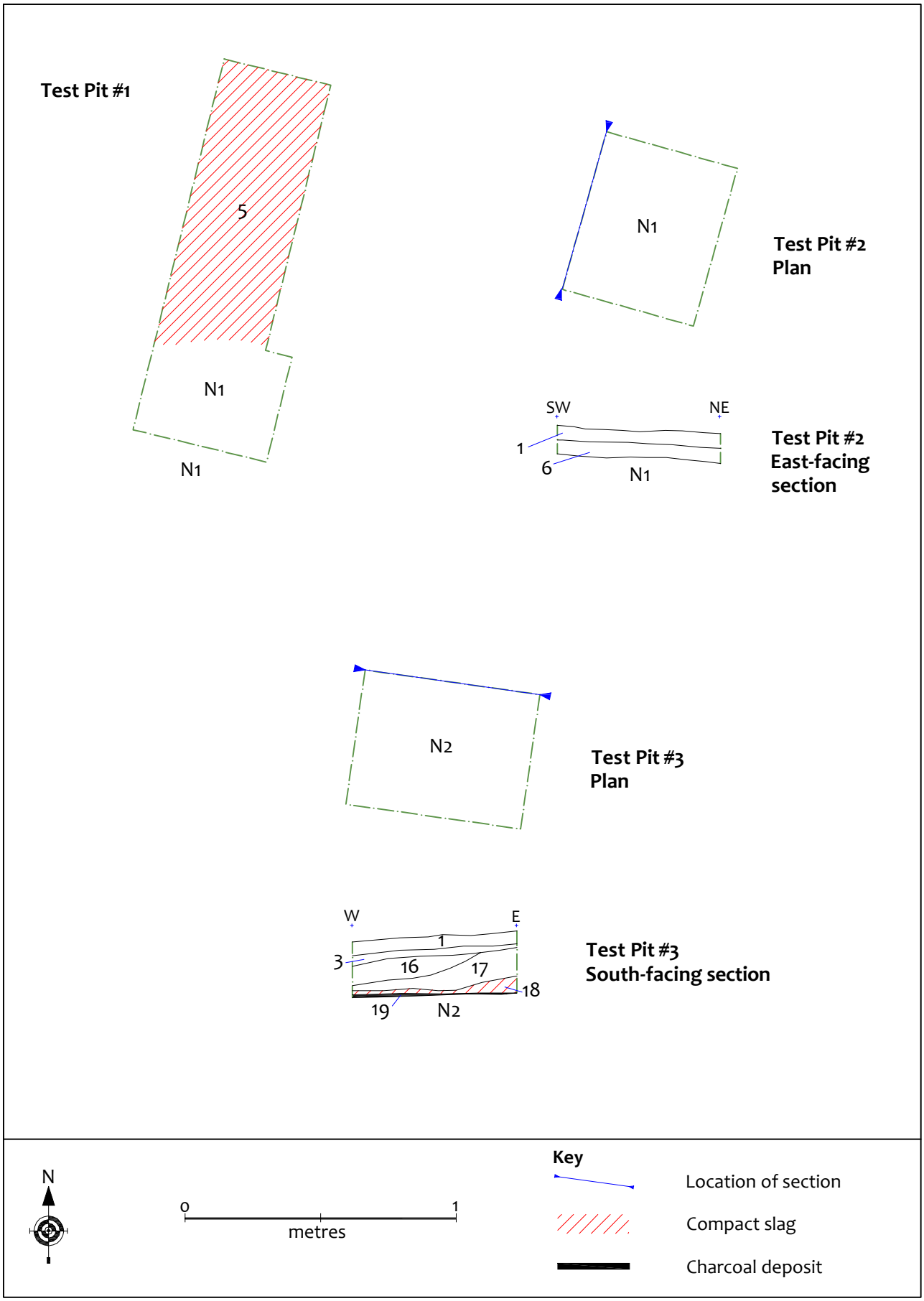



*Figure 3. Test pit #1-3 plans and sections*


*Figure 4. Test pit #4 plan and section*

3.3.9 Natural substrate {N1} was found 0.30m below the current surface. Over this was a 0.05m thick deposit of grey sandy clay [13], above which was a 0.17m thick layer of compact slag [5], the same deposit noted in Test Pit #1 (Section 3.3.2) and possibly in Test Pit #3 (Section 3.3.7). The trench was sealed by a 0.07m thick deposit of topsoil and turf [1].

3.3.10 Open Area: The open area excavation targeted the major anomalies as shown by the geophysical survey, as well as sampling the extant earthworks. The area totalled 126.6m², a plan of which can be seen on *Figure 5* opposite. The excavation produced a series of areas of interest which are summarised below.

3.3.11 In the northwest extent of the excavation, a small area of compact slag [14] similar in nature to [5] in the test pits described previously was uncovered. This deposit was found to be localised in nature, measuring only 1.6m long by 0.78m wide, and seems to indicate a barrow tipline. The deposit was only 0.07m thick, with larger lumps of slag [15] at its base. These two context numbers are likely from the same deposition layer, but were contexted separately to aid in metallurgical sample analysis. The compact slag deposit was overlain by a 0.05m thick deposit of general stone and slag detritis [26], likely wash-down of material from above. Sealing this was a 0.15m thick deposit of topsoil and turf [1]. A section through this area, Section A, can be seen on *Figure 6*.

*Plate 10. Deposit [14] looking northwest*

3.3.12 3.6m to the east was another compact slag deposit [22], similar in nature to both [5] and [14]. Again, this was a small deposition, 1.7m long by 0.9m wide and again may represent the contents of a wheelbarrow, and was found overlying natural sandy clay {N1}. Southeast of this compact slag deposit was a thin slag and stone 'hillwash' [20] observed overlying the natural geology. This 0.05m thick deposit was observed intermittently over a 5m area, potentially culminating in a thicker deposit, again similar to [14]. This is described below.

3.3.13 The base of a compact deposit of slag [3] was observed in a natural gulley north of clay bank [**F1**]. This deposit, 2.1m long by 0.70m wide may have been the larger material at the base end of hillwash [20] described above, or may have been another small deposit similar in nature to [14] and [22].

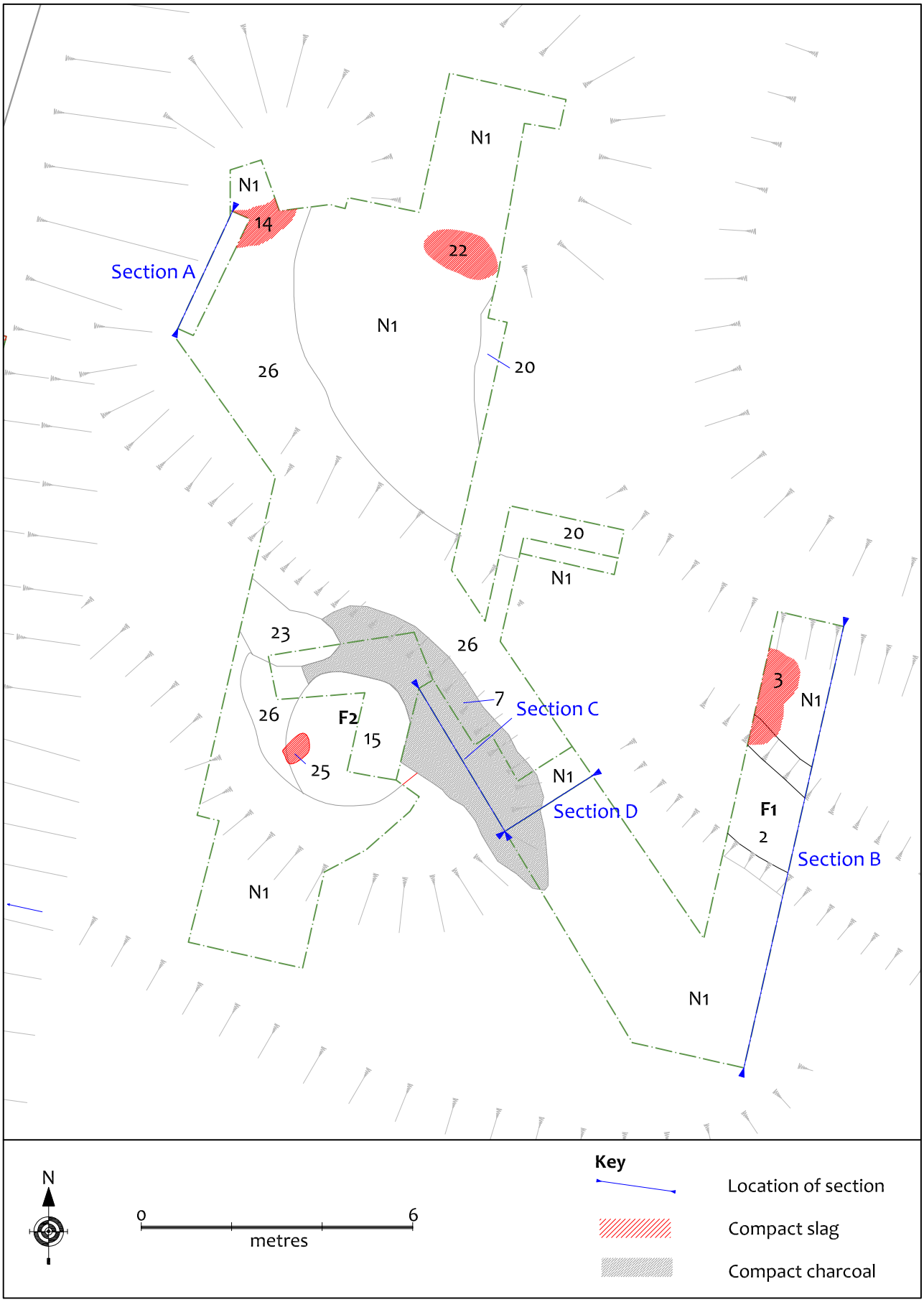
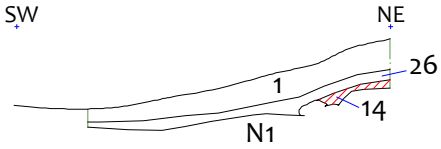
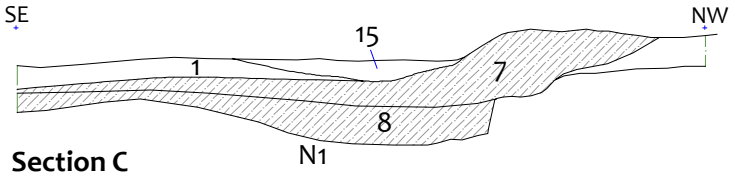


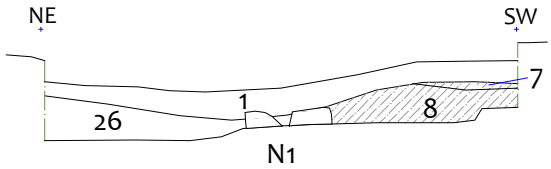

*Figure 5. Plan of open area excavation*



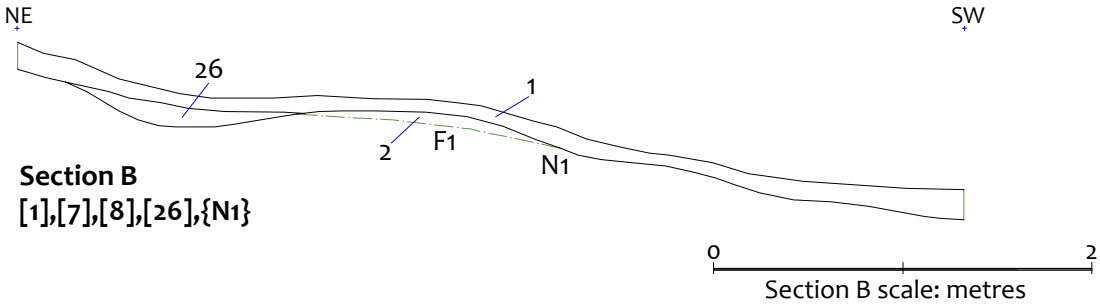

**Section A**
**[1],[14],[26],{N1}**



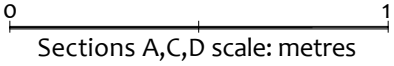

**Section C**
**[1],[7],[8],[15],{N1}**




**Section D**
**[1],[7],[8],[26],{N1}**




**Section B**
**[1],[7],[8],[26],{N1}**

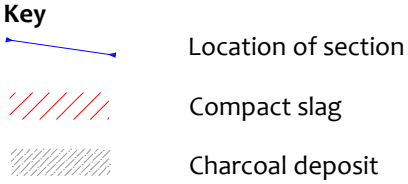




*Figure 6. Profile and sections of the open area excavation*

*Plate 11. Feature [F1] looking northeast*

The material was 0.10m thick, and covered with a c.015m deep layer of sandy-clay wash with slag and stone [26] before being sealed by a further 0.10m of topsoil and turf [1].

3.3.14 Feature [**F1**] was a clay bank, 2.9m wide that ran into the excavation area from the southeast corner. The bank, observed to be probably a utilised spring bank, was comprised of extremely compact baked and weathered clay [2]. The clay was noted to be baked by exposure rather than deliberate firing, suggesting that the bank had been exposed and used potentially as a dry working area, path or hard-standing. The bank was covered by a 0.13m thick of topsoil and turf [1] and had a potential gully on its north side, approximately 2.4m wide and 0.23m deep. This gulley contained a spread of wash deposit [26] as well as slag deposit [3] mentioned above. However, there was no indication that the gulley had been maintained or cut by man. The west facing section of [**F1**], Section B, can be seen on *Figure 6*.

3.3.15 Feature [**F2**] was a large heap of slag and stones located in the southwest of the excavation area. The heap was seen to run from the base of the hill scarp to the west where it was 5.5m wide, running out 13.7m where it had widened in a 'bulb' shape to 6.47m. 47% of the overall area of the heap was excavated, revealing a number of thin strata of material.

3.3.16 Beneath 0.06m of topsoil and turf [1] was 3.5m diameter spread of loose grey ash, slag and stone [15]. The deposit averaged 0.12m thick, beneath which were a number of lenses of charcoal [9, 10, 24] and hillwashed clay [23], each very thin averaging 0.04m thick. To the west of the heap was a buildup of hillwash including irregular sized stones [26] (some of the stones appeared to be reddened and fire-cracked and had the potential of deliberate, now disturbed, placement) and to the southwest was a small area of compacted baked clay and slag [25] 0.55m long, 0.30m wide and 0.05m thick.

3.3.17 To the east of the main waste heap was a shallow gulley, presumably natural (possibly an old spring line) which had been filled through weathering with general hillwash [26] including sandy clay deposits, stones, charcoal flecks and slags of various sizes. However, a substantial charcoal layer was noted directly to the east and southeast of the heap, filling the gulley with the hillwash. This charcoal deposit [7] was noted to mainly comprise charcoal dust, with a number of large chunks of branches and roots. The deposit was noted to begin on the top of the spoil heap, beneath the edge of dumped deposit [15] and ran downslope to the east and southeast for 6m.

*Plate 12. Feature [F2] looking east, post-excavation and showing animal burrow disturbance*

The deposit may have continued for at least another 1.5m, extrapolated from the staining in the unexcavated (but topsoil stripped) area to the south of the heap, but was not present at the southeast extent of the excavation. Stratigraphically, this was the earliest charcoal deposit on the heap, with natural clay {N1} beneath, and followed the slope of the naturally terraced clay geology. The deposit, as can be seen on Section C and D on *Figure 6* varied in thickness from 0.02m to 0.35m and at its base was a concentrated area of large charcoal fragments, labelled context [8] to allow for easier analysis during the sampling process. This deposit averaged 0.15m thick and butted onto a natural terrace in the clay at the base of the heap. Of further interest is the location of the charcoal [7/8] deposit, with its area of deposition and buildup suggesting possible dumping from the east, rather than from the slopes to the north and west.

3.3.18 To the east of charcoal deposit [7/8] was a buildup of hillwash [26] including a line of stones initially thought to have potentially been placed, as they formed an edge to the spread of the charcoal. This can be seen on Section D, *Figure 6*. Upon excavation however, it seemed that these stones were just heavier material at the base of the wash, fallen into a line with the contour of the natural gulley, which the charcoal then came to rest against over time.

## 3.4 Artefacts

3.4.1 Two sherds of late medieval pottery were retrieved from the topsoil in the main open area excavation. Unfortunately, this was not a sealed context and thus cannot be used to date the use of the site. The pottery was of a grey fabric with a brown exterior surface partially glazed with olive green. The interior of the sherds were badly degraded and no detail could be ascertained. A likely date for the sherds is *circa* AD 1550-1700.

*Plate 13. NMRS' Richard Smith taking samples for metallurgical testing from the spoil heap deposits*

## 3.5 Identified contingencies

3.5.1 No human remains were found within the excavation area.

3.5.2 One deposit was deemed suitable for environmental analysis. This deposit [8] was primarily comprised of peat and charcoal dust with root and branch fragments, and has been taken by SWAAG for analysis by Durham University, in order to determine tree and pollen species present in the sample. The results of this sample will be published by SWAAG at a later date.

3.5.3 Samples were taken by NMRS from the following deposits for carbon dating: [7], [8], [9], [10], [11] and [24]. Samples were also taken by NMRS from the following deposits for metallurgical analysis: [1], [5], [14], [15], [21] and [25]. The results of these samples will be published by NMRS at a later date.

3.5.4 No artefacts recovered were deemed to be categorised as Treasure Trove.

3.5.5 No artefacts recovered were deemed to be of archaeological interest and worth examination by a specialist.

*Plate 14. The main heap [F2] looking east*

*Plate 15. Detail of slag [25], photo courtesy of Richard Smith © 2013*


*Plate 16. Feature [F2], uncovering the extent of the charcoal deposits*

# 4. Conclusions

## 4.1 Conclusions

4.1.1 In 2012, the Swaledale and Arkengarthdale Archaeology Group (SWAAG) led by Tim Laurie FSA identified clear evidence of lead smelting and a potential lead bale site centred at SE 05939 99137. The site was noted to be under direct risk of severe damage from rabbits, and was characterised by looking at slag and charcoal within and outside the rabbit burrows. A joint project was then set up in the summer of 2013 between SWAAG and the Northern Mine Research Society (NMRS) to archaeologically investigate the bale site, with Richard Smith of NMRS directing the fieldwork alongside Tim Laurie of SWAAG, with Tony Liddell of Vindomora Solutions providing professional archaeological recording support.

4.1.2 Initially, a geophysical survey was undertaken of the earthworks identified by Laurie and Smith, which identified features consistent with bale technology, including a large 'pseudohorseshoe shaped anomaly' interpreted as the remains of a lead-smelting site along with a channel running from it, as well as three areas of lead slag.

4.1.3 The five day excavation uncovered what appeared to be a natural spring line and bank that had been filled with slag debris from hill-wash, as well as a large lead-working area and several small areas of deposition, equating to barrow and bucket loads of slag spoil being unloaded within the excavation area.

4.1.4 Unfortunately there was no conclusive archaeological evidence of a bale being present within the excavation area, though the excavation did find several areas of widespread lead-smelting activity in the form of deposits of slag and charcoal. The most significant metallurgical feature uncovered was a large heap of material near the centre of the site with the presence of reddened, fire-cracked stones alongside slag trapped between stones suggesting the possibility of some kind of smelting being undertaken in this area. However, the underlying clay shows no signs of extensive baking, although a very small amount of baked clay, some adhering to reddened stone and slag. It is not known if the existing grass/topsoil acted as an insulating layer but this is an aspect which could be studied further. A theory put forward by Richard Smith of NMRS is that this is what remains of a charcoal-fired, wind-blown furnace of loosely-placed stones atop the then-existing turf. Any stone structure may well have been disturbed to recover lead and robbed for walling at a later date (some stones in the drystone wall to the west have slag splashes). If so, such a furnace could have been used to treat lead slags produced by primary bales sited to the west of the wall or on top of Fremington Edge.

4.1.5 Alternatively, the heap may have been a slag dump but again the evidence for this is inconclusive. It would be reasonable to expect that slags from elsewhere were brought here to just about the only pool of water on this side of the fell. They would have been crushed to liberate entrained lead prills and the residue dumped at the nearest point to where the washing was carried out. While there is no standing water at the excavated channel now, water was seen to pool within it when the natural clay substrate was disturbed during excavation: it is possible that enough water could be accumulated to create a pool which was enough for the purpose, but again no evidence of the pool was encountered during the works on site.

4.1.6 The large charcoal deposit [7/8] over and down the side of the main heap had clearly been brought to the site for a purpose, likely that of fuel for lead smelting. The charcoal had been placed in the hollow area presumably to minimise wind losses, and whilst there is a possibility that the charcoal was intended for use in processes other than lead smelting (due to its close proximity to the limestone quarries) it seems unlikely. The results of the samples taken from this deposit by NMRS should give us a date which could aid in tying the deposit to the industrial processes taking place,

as an early date could aid in the consolidation of the wind-blown lead furnace theory, while a post-medieval date would likely tie the deposits to later industrial activities.

4.1.7 There is evidence to indicate that smelting was taking place west of the drystone wall. This comes from the deliberately placed and packed slag deposits along the hill ridge edge and the sparse underlying charcoal. The slags seem to be a deliberate attempt at creating a hard-standing, presumably for the collection of primary slags for reworking at the base of the slope. The very thin layer of grey ashy subsoil found in Test Pits #2 and #3 may be the result of spreading lime or limestone during later land improvement. The drystone wall itself appears on the 1st Edition Ordnance Survey map of 1857, but not on the 1820 Tithe map and clearly post-dates the metallurgical deposits along the hill ridge.

4.1.8 With reference to the geophysics, it seems that the survey detected the presence of the hard-packed slag deposits, such as the hard-standing on top of the hill ridge. This aspect of the work however needs further discussion with those who carried out and interpreted the geophysics survey.

4.1.9 To conclude, the excavation has confirmed the presence of a potentially early, extensive level of lead-based industrial activity within the excavation area. The presence of compact slag and evidence of possible burning to the west of the wall suggests that smelting may have taken place there. This is clearly an area worthy of further investigation. Within the excavation area however, the most significant metallurgical feature of the site cannot be satisfactorily explained by the result of the excavation and the nature of the site remains inconclusive.

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# APPENDIX 1: DATA TABLES

## Context index

| Context | Type | Description | Initials | Date |
|---|---|---|---|---|
| 1 | Deposit | Topsoil and turf | TL | 13/8/13 |
| 2 | Deposit | Baked clay bank | TL | 13/8/13 |
| 3 | Deposit | Slag | TL | 13/8/13 |
| 4 | Natural | Natural sandy clay + stones [N1] | TL | 13/8/13 |
| 5 | Deposit | Compact slag | TL | 14/8/13 |
| 6 | Deposit | Ashy subsoil | TL | 14/8/13 |
| 7 | Deposit | Charcoal | TL | 14/8/13 |
| 8 | Deposit | Charcoal | TL | 14/8/13 |
| 9 | Deposit | Charcoal | TL | 14/8/13 |
| 10 | Deposit | Charcoal | TL | 14/8/13 |
| 11 | Deposit | Charcoal | TL | 14/8/13 |
| 12 | Deposit | Rubble and topsoil mix | TL | 15/8/13 |
| 13 | Deposit | Grey sandy clay | TL | 15/8/13 |
| 14 | Deposit | Slag | TL | 15/8/13 |
| 15 | Deposit | Grey ash, slag and stone | TL | 15/8/13 |
| 16 | Deposit | Grey-brown sandy matrix with stones and slag | TL | 15/8/13 |
| 17 | Deposit | Grey-black ash, cinder and slag | TL | 15/8/13 |
| 18 | Deposit | Grey-brown slag, similar to (5) | TL | 15/8/13 |
| 19 | Deposit | Charcoal | TL | 15/8/13 |
| 20 | Deposit | Slag and stone wash | TL | 15/8/13 |
| 21 | Deposit | Slag material | TL | 15/8/13 |
| 22 | Deposit | Slag and stone | TL | 16/8/13 |
| 23 | Deposit | Sandy clay lense | TL | 16/8/13 |
| 24 | Deposit | Charcoal lense | TL | 16/8/13 |
| 25 | Deposit | Baked clay and slag | TL | 16/8/13 |
| 26 | Deposit | Mixed hillwash, stones, slag, sandy clay | TL | 16/8/13 |
| N1/N2 | Glacial geology | Sandy clay with stones/Heat-reddened sandy clay | TL | 16/8/13 |

## Samples

| Sample | Context | Type | Description | Type | Analyst |
|---|---|---|---|---|---|
| 1 | 7 | Deposit | Charcoal | Charcoal dating | NMRS |
| 2 | 8 | Deposit | Charcoal | Environmental | SWAAG |
| 3 | 9 | Deposit | Charcoal | Charcoal dating | NMRS |
| 4 | 10 | Deposit | Charcoal | Charcoal dating | NMRS |
| 5 | 11 | Deposit | Charcoal | Charcoal dating | NMRS |
| 6 | 5 | Deposit | Compact slag (TP #4) | Metallurgical | NMRS |
| 7 | 1 | Deposit | Topsoil and turf (TP#4) | Metallurgical | NMRS |
| 8 | 15 | Deposit | Grey ash, slag and stone | Metallurgical | NMRS |
| 9 | 8 | Deposit | Charcoal | Charcoal dating | NMRS |
| 10 | 14 | Deposit | Slag | Metallurgical | NMRS |
| 11 | 21 | Deposit | Slag material | Metallurgical | NMRS |
| 12 | 24 | Deposit | Charcoal lense | Charcoal dating | NMRS |
| 13 | 25 | Deposit | Baked clay and slag | Metallurgical | NMRS |
| 14 | 25 | Deposit | Red stone with baked clay and slag | Metallurgical | NMRS |
| 15 | 25 | Deposit | charcoal and slag | Metallurgical | NMRS |