University of Exeter

Doctoral Thesis

The Medieval Iron Industry of the Weald

Centres of Production and Manorial Ironworks

Volume 1 of 2

Submitted by John Lincoln Mark Cranfield to the University of Exeter as a thesis for the degree of Doctor of Philosophy in Archaeology

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I certify that all material in this thesis which is not my own work has been identified and that any material that has previously been submitted and approved for the award of a degree by this or any other University has been acknowledged.

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Abstract

The Weald of Kent, Sussex and Surrey has long been recognised in the literature as a centre of iron production, an industry that spanned from the late Iron Age to the early 19th century. During the period of Roman occupation, evidence suggests iron was produced at some localities on an industrial scale. However, the limited archaeological evidence for its existence in the Anglo-Saxon period and its relative absence from the Domesday Book, save a single reference to a '*una ferraria*' near East Grinstead, suggests that by the 11th century iron-production in the Weald only operated on a small scale.

By the 14th century however, evidence of iron production is more apparent in the archaeological and documentary record. It is at this time that a unique collection of records, of the Tudeley Ironworks at the manor of Southfrith, Kent were created. These accounts offer a rare insight into the annual outputs of a Wealden ironworks, along with details on the site's construction, its equipment and the identity of ironworkers and woodland workers, involved in supplying the necessary raw materials and managing the furnace. At a time when plague and population loss had led to considerable uncertainty across England, Tudeley Ironworks along with its wood colliers and ore diggers, found itself in the middle of significant social changes.

While documentary evidence is scarce for the iron industry, several important accounts imply that iron was more than just a local commodity by the 14th century, but one whose trade was connected to nobility, Royalty, and the Church. Commodities such as nails, arrows, iron bars and horseshoes were transported across England and used to repair Royal houses, castles and equip Edward III's war horses, during the Scottish wars in 1327. Sites operating on a larger scale to fulfil these orders are indicated in the documentary record, which include Roffey where, in 1327, 1000 horseshoes were made. Eleven years later 6000 arrows were sent from near Horsham to the Tower of London. At times trade was controversial and in 1300 London ironmongers complained that Wealden ironworkers were selling iron strakes for cartwheels at shorter than the normal lengths.

How do these historical accounts relate to the archaeological evidence? and what was the nature of Wealden iron-production sites during this period? Excavations at Crawley have suggested it may have formed a centre of production during the medieval period, while the 1327 and 1338 references to horseshoes and arrows suggest other larger-scale production sites were also in existence. Other questions are raised over the working and spatial relationship between smelting and smithing at this time – were they separated, or did they form collaborative groups?

This thesis uses an archaeo-historical approach to identify and define centres of iron production within the Weald. Two case study sites were investigated which included Tudeley Ironworks and Roffey, both of which were recorded in documentary accounts and offered the opportunity to carry out archaeological field surveys. Site morphology and technology was investigated in both cases, using a range of methods including landscape reconnaissance survey, geophysics, fieldwalking and macromorphology. Along with site specific analysis, the wider economic landscape of both sites was investigated to identify related woodland industries that provided the necessary raw materials for these sites to operate.

Acknowledgements

Many thanks go to all the people who have helped and supported me throughout the course of this project. Special thanks go to the Wealden Iron Research Group for funding this project and to all the Committee and members who have helped and guided me, teaching me so much about the Wealden iron industry. Particular thanks go to Jeremy Hodgkinson and Jonathan Prus for the guidance and direction they have given me. It has also been such a privilege to be involved with WIRG activities and events including the fieldwork Group with Simon Stevens and Bob Turgoose and the Experimental smelt led by Tim Smith – these activities showed me the process and complexities of making iron and shaped my interpretations of the case study sites.

I would also like to thank Gerry Crawshaw for her kindness in helping me with the fieldwork at Tudeley and the many fascinating conversations we have had over its history. I will always remember the excitement of relocating Straker's site on one of the early visits we made to Tudeley.

I would like to thank Phil Henderson from the RSPB and Max Walton for their kind permission in allowing me to survey at the Tudeley Nature Reserve and Newhouse Farm.

Thanks also go to my fellow postgraduate students, in particular Ellie March and Alan Endecott for the training they have given me on geophysical surveying, ArcGIS and Geoplot. Without Ellie's expertise, half of the magnetometry results would still be upside down! To Ethan Greenwood for his help and guidance with completing the Tudeley magnetometry survey and to Hayley Hayes for her training on illustration and digitising images. Thanks also to all the academic staff at the University of Exeter, including Levi Roach, Chris Smart, Naomi Sykes, Linda Hurcombe and Sue Greaney, and the Tech team of Amy, Tereza, Steph and Sophia who have offered such valuable advice and help at various stages of this project.

I would also like to thank my Parents Don and Carolyn and Sister Rebecca for all their love and support… and their patience, especially in lockdown when their spare room, garage and polytunnel became filled with thousands of samples of slag!

While I never met them, I feel both Ernest Straker and Thomas Honywood need thanking here too, for if it had not been for their discoveries of the sites of Tudeley and Roffey, this project could not have happened.

Finally, a very special thankyou to Gill Juleff for supervising me throughout my research. She has introduced me to the world of archaeometallurgy, and the importance of slag! Her training on Exmoor showed me how much could be learned through macromorphological analysis – even though I couldn't carry many heavy sample bags! The opportunity to teach with Gill was so valuable and our conversations about her work in Sri Lanka were an inspiration and a reminder of the importance of doing archaeology for the love it.

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The Medieval Iron Industry

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Centres of Production and Manorial Ironworks

Chapter 1: The Medieval Iron Industry of the Weald - its Historical and Archaeological Context

This chapter discusses previous research into the Medieval iron industry of the Weald, both archaeological and historical, and considers the current state of knowledge that both sources of evidence present. It considers the main areas that require further research, including the development of the industry, its economic operation, how widespread it was, and whether centres of production existed – and how such centres may be defined. Finally, it calls for an archaeo-historical approach using the two case studies of Tudeley and Roffey to shed light on these debates, specifically the presence and nature of centres of production.

Chapter Contents

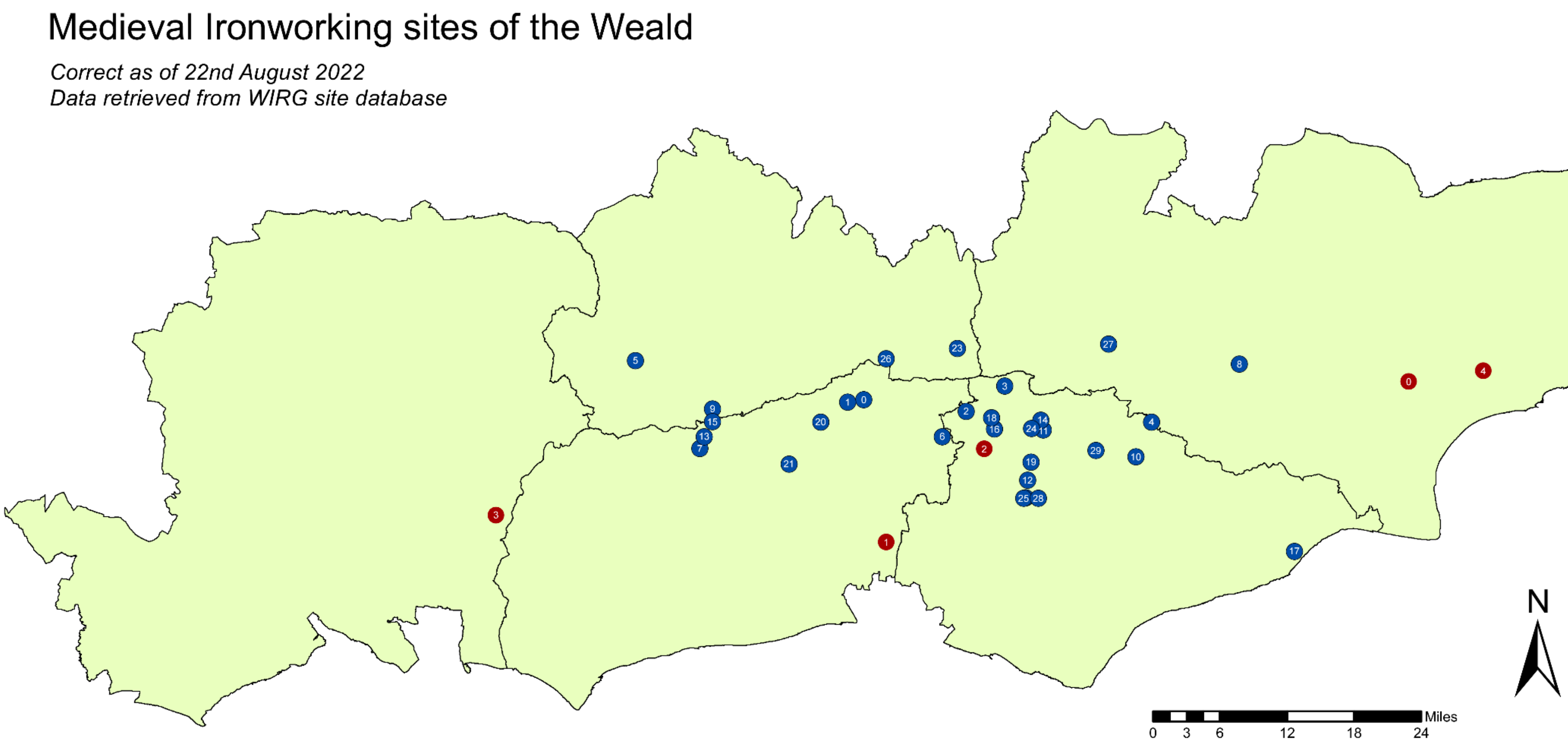
Chapter 1: The Medieval Iron Industry of the Weald - its Historical and Archaeological Context

1.1 – Introduction to iron-production in the Weald

The Weald of Southeast England, covering large parts of Kent, Sussex, and Surrey, has long been recognised as an important region for iron production. While archaeological and historical evidence shows the industry was established prior to the coming of the Romans in 43AD, and continued until the 19th Century, there remain considerable gaps in our understanding of its developmental changes and the importance it held at certain points in its long history. To assume that the industry went unchanged during this long temporal expanse would be simplistic and questions of scale and continuity remain widely debated, particularly for the period after 410AD when Roman occupation ended and up to the 15th Century, generally referred to as the early and late medieval. Over the last ninety years, various studies have sought to enhance our understanding of the industry, notably by Straker (1931), Cleere and Crossley (1995) and Hodgkinson (2008), and their work remains the most significant sources of reference on the industry. And yet these works acknowledge how the medieval period remains the most understudied, with only a handful of sites receiving detailed investigation. The iron industry at this time still poses a number of significant questions which include what happened to the industry at the end of the Roman occupation of Britain – did it continue or was it re-established, how did periods of continuity or discontinuity affect the transfer of knowledge between practitioners, and how did the industry operate from an economic perspective - were there centres of production by the 14th century, or is this a too simplistic or inaccurate interpretation? This period stands on the cusp between the preceding Roman period where documentary records do not survive, and the post-medieval period of the blast furnace technology, where our understanding is greatly enhanced by historical accounts. For the medieval Weald, records on iron working are sparse, and yet where they do exist, particularly the Tudeley accounts, they have the potential to both enhance our understanding of the archaeological record and to mislead it.

This thesis considers the nature of the iron industry by the late medieval period and seeks to answer the question of whether we can see evidence for centres of production in the historical and archaeological record, and if so, what constitutes such a centre. Two case studies are examined, Roffey Ironworks in West Sussex and Tudeley Ironworks in Kent. Each were chosen for their rare survival of historical accounts and the potential they offered for archaeological fieldwork which would enable a comparison between the documentary and archaeological data.

This chapter will consider the understanding and research that has been carried out on the medieval iron industry at the outset of this study. It will begin by looking at research into the industry from the 19th century to the present day and the theoretical and research frameworks that past scholars have applied. It will go on to consider the main documentary sources available for the period and the archaeological evidence that exists to contextualise the industry. It considers the advantages and limitations with these two sources of evidence and the broader debates with iron-working at this time, specifically the rise and existence of centres of production and the development of the industry through the course of the period. Finally, it argues a need to consider the iron industry



Anglo-Saxon Sites (Red)	Medieval Sites (Blue)		
0 – Court Lodge Farm	0 – Crawley (17 sites)	10 – Hoadley Wood	20 – Roffey
1 – Friar's Oak (bloomforge)	1 – Ifield Mill Pond	11 – Hodges Wood	21 – Southwater Street
2 – Millbrook (smelting)	2 – Brambletye Manor Farm (2 sites)	12 – Huggett's Farm	22 – Spaulines, Etchingwood
3 – Buriton Village Hall (bloomforge)	3 – Chantlers Farm	13 – Loxwood Place Farm	23 – St Margaret's Garden
4 - Lyminge	4 – Chingley Forge	14 – Minepit Wood	24 – Summersales
	5 – Coldharbour Cottage	15 – Monktonhook	25 – Tanyards Shaw / Tankards Croft
	6 – Courtlands Farm	16 – Newbridge Furnace and Forge	26 – Thunderfield Castle
	7 – Firey Field	17 – Pannel Farm	27 – Tudeley
	8 – Frittenden	18 – Parrock	28 – Warren Farm
	9 – Great Wildwood	19 – Piping Wood	29 – Wet Wood, Mousehall

Figure 1.1 – *The distribution of Anglo-Saxon and medieval iron-production sites identified within the Weald across the counties of Sussex, Surrey, Hampshire and Kent. Map compiled by the author. Base map courtesy of Digimap OS Collection. Distribution data from www.wirgdata.org.*

within the wider context of the medieval economy, in terms of trade and exchange mechanisms and its inter connections to other industries that need studying. The sites discussed in this chapter are mapped on figure 1.1.

1.1.2 – *The Weald and its landscape*

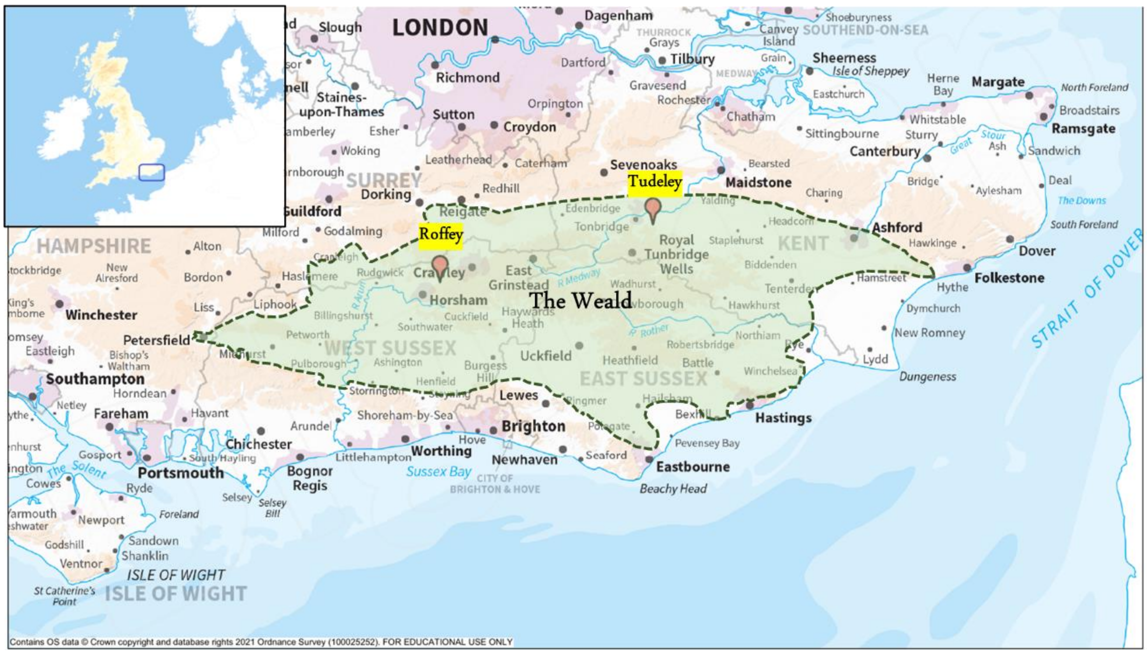


Figure 1.2 – *The location of the two case study sites of Tudeley and Roffey that form the focus of this study. Base map courtesy of Digimap OS Collection.*

The Geological setting

The Weald has a complex geology, the product of the laying down of different sediments under varying environmental conditions (fig. 1.2). These first began to form during the Cretaceous period around 140 million years ago, when the sediments that form the Wealden beds began to be deposited. At this time, the Weald formed part of a great swamp or lake in which rivers from what today forms the Thames Valley, Devon, Cornwall, and Brittany drained into. For around 20 million years these rivers brought with them sediments, initially sand, followed by finer sediments of mud and silt as the rivers became silted by the sand (Brandon 2003, 28). As these sediments accumulated, their weight caused them to compress to form the clay, siltstone and sandstone layers of

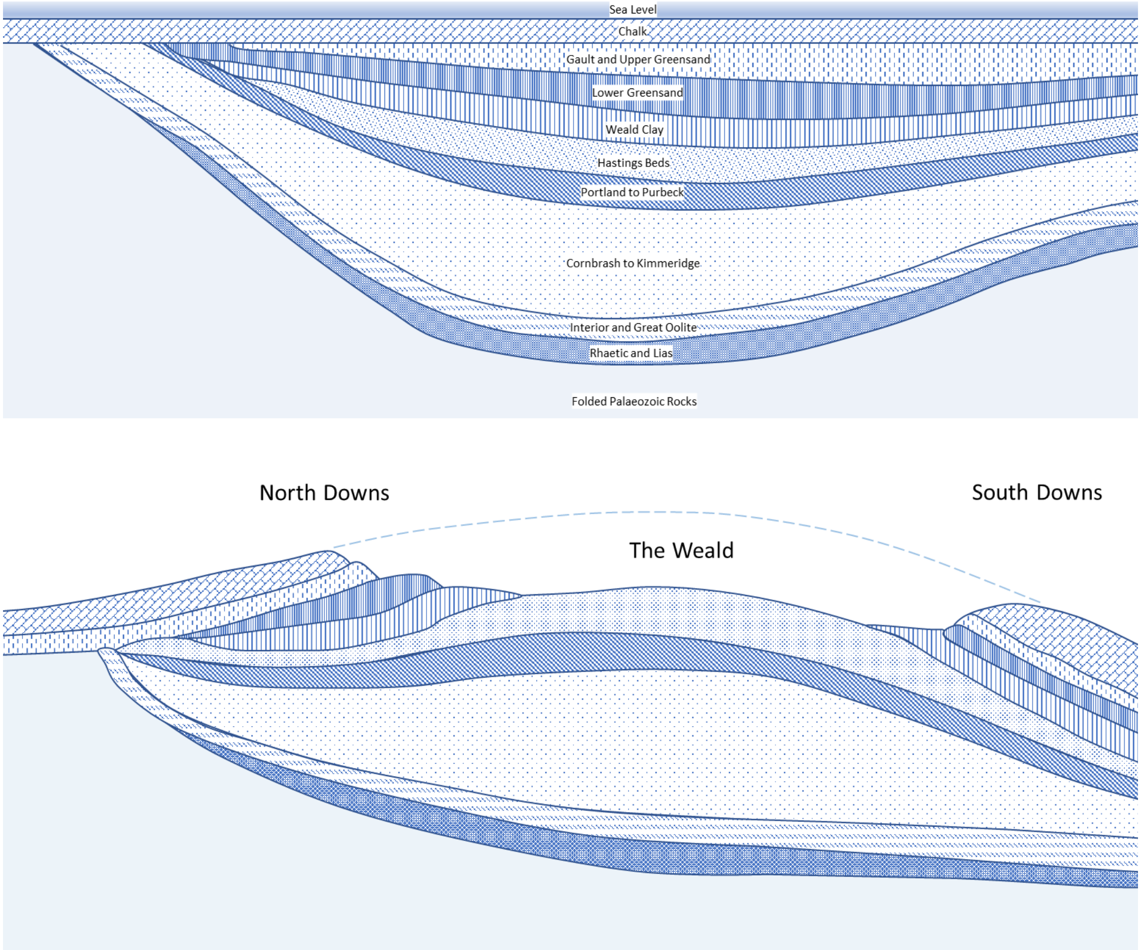


Figure 1.3 – *Sketch illustration of the geology of the Weald and its formation. Based on Brandon (2003).*

what is known as the Wealden Beds (Worssam 1983, 4-5; Brandon 2003, 28). The Wealden beds comprise the Ashdown Beds, the Wadhurst Clay and the Tunbridge Wells Sand, collectively known as the Hastings Beds, and the Weald Clay (fig. 1.3) (Worssam 1983, 4-5).

100 million years ago, sea levels began to rise, and the Weald was submerged. The sea brought with it its own sediments in the form of marine sands, that were to form the Lower Greensand, Gault and Upper Greensand, followed over the next 35 million years by accumulations of the remains of sea creatures which was to form the chalk (Worssam 1983, 5). At the time the Alps were forming 30 million years ago, the same earth movements in the form of uplift were enacting upon the Weald (AONB). This folding, called the Wealden Anticline led to the

formation of a great dome, covered by the outer strata of chalk. The crest of this chalk dome in time eroded away but remained on the outer periphery as the South Downs and North Downs, which today form the northern and southern boundaries of the Weald. The Weathering away of the chalk from the centre of this dome, left the underlying Wealden Beds exposed as the largest outcrop forming the High Weald. This in turn is encircled by smaller bands of the Lower Greensand, Gault and Upper Greensand (Worssam 1983). It was these deposits that contained the iron ores that first attracted the early metalworkers to the region.

The Environmental Setting

The great geological diversity of the Weald is reflected too within its environmental setting, with the forested area of the High and Low Weald and the chalk grasslands of the North and South Downs on its fringes (fig. 1.4). The forest has dominated much of the region's history, covering parts of the counties of Kent, Sussex and Surrey. Today many of the species that were in existence by 3000BC including oak, elm, ash, hornbeam and alder still grow within surviving patches of ancient woodland (Brandon 2003, 35). The

Figure 1.4 – *The Weald, as viewed from Ditchling Beacon on the South Downs. (Author's Image).*

expansive forest led the Saxons and Jutes to name it Weald, from the Germanic word for forest and it is highly probable that the area was seasonally exploited for the resources it contained (Brandon 2003, 3). Gardiner (2003, 154) notes that while temporary sites are likely to have existed in peripheral locations to help with acquiring valuable resources, identifying these sites which are unlikely to leave substantial archaeological traces is problematic. He notes Millbrook (discussed in Section 1.1.4) as one example of a 'temporary base for resource procurement' (Gardiner (2003, 154). Oak was of particular importance and thrives on the Wealds clay soils, important for shipbuilding and the construction of the timber framed buildings that are a familiar site in many of the Wealden villages (Brandon 2003, 8). During the medieval period, efforts were made to clear areas of the forest for agriculture and after the Norman Conquest settlements sprung up within previously forested areas. Traces of former forest that escaped clearance still survive today in remaining historic woodlands and

Figure 1.5 – *The scarp slope of the South Downs, which form the southern extent of the Weald. (Author's image).*

Figure 1.6 – *View over the Weald from the South Downs (Author's image).*

Figure 1.7 – *View towards the South Downs (Author's image).*

Figure 1.8 – *View along one of the many trackways that lead from the Weald up onto the South Downs (Author's image).*

Figure 1.9 – *Ashdown Forest in the Weald (Author's image).*

Figure 1.10 – *Views over Ashdown Forest (Author's image).*

Figure 1.11 – *A steep sided stream or 'gill', a typical feature of woodlands in the Weald (Author's image).*

wide wooded shaws on the boundaries of fields. Some of this surviving ancient woodland contain steep sided gills, where the continued action of flowing water has cut through the softer strata. The heavy clay of the Weald has long been noted for its impassibility and frequent footfall over time led to the formation of sunken tracks and parallel routeways through the forest to avoid impassable routes, with the trees on either side of such tracks touching branches to form holloways (figs 1.5-1.11).

1.1.3 – *The Production of Iron*

The term ironworking is one widely used within the literature but not always given clarity as to what specifically it is referring too. The production of iron involves a series of distinct processes that may be carried out by one or more individuals and on the same or in different localities. Juleff (pers. comm. 2019) defines it as a two-stage process, Stage 1 as the irreversible extraction of iron from its ore with the use of smelting which, assuming a successful smelt will produce a spongy mass of iron called a bloom. Stage 2 forms the refinement of this bloom into usable bar iron, which requires consolidation through re-heating and hammering to remove remaining trapped slag. This iron can then be worked by smiths to produce finished products and the re-heating of the metal enables this iron to be re-worked in the future – hence the ‘reversible process’. The archaeological evidence in the Weald for these processes is discussed in Section 4.7.1, however it is important to make this distinction here between smelting – the extraction of iron from ore and smithing – the creation of finished products from the consolidated iron. There are of course many other personnel involved in the process along with the smelter and smith. There are the ore diggers and colliers who supply the raw materials necessary for smelting to take place and ultimately the possibility of middlemen who act as go between,

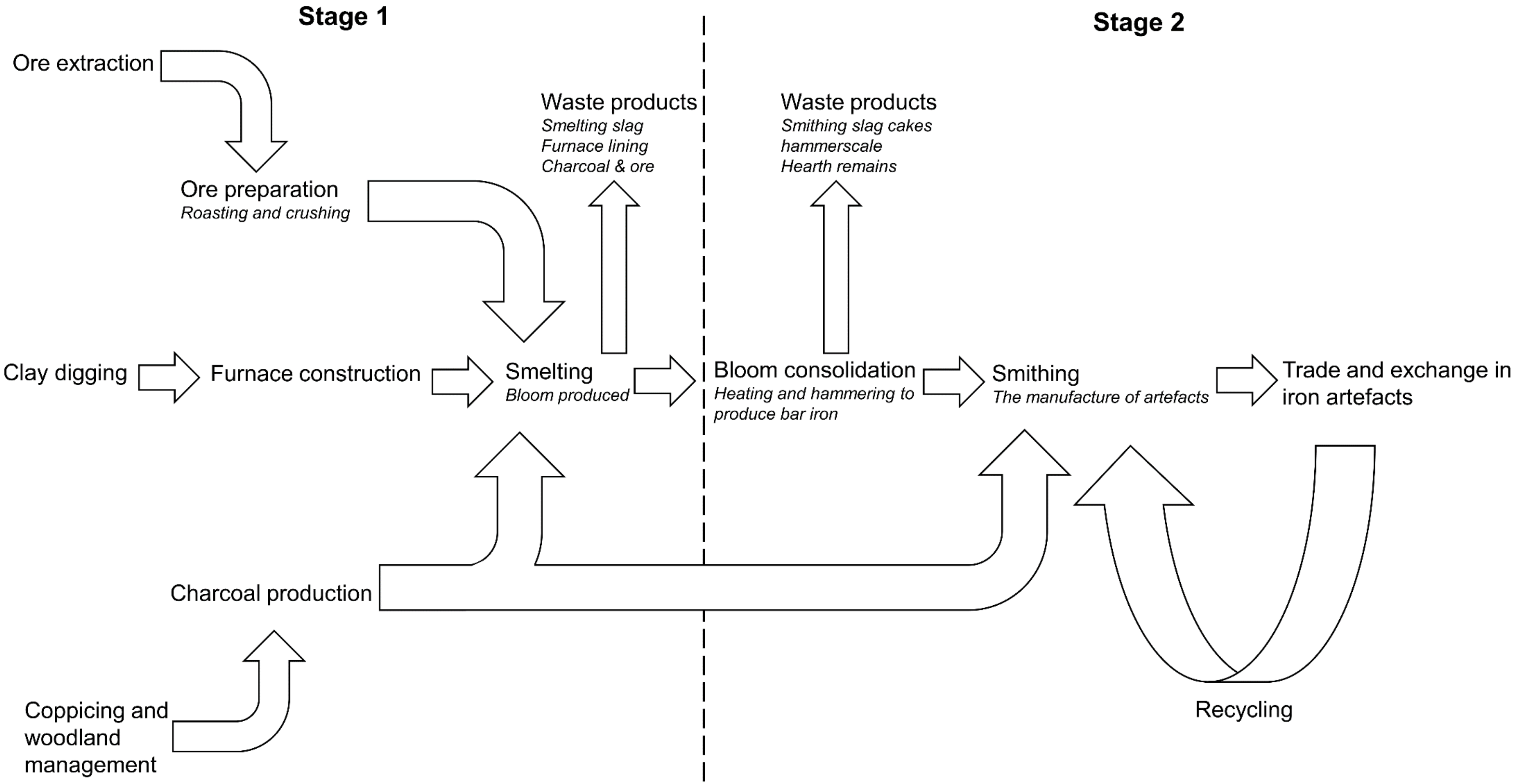


Figure 1.12 - *The stages of iron-production from the acquisition of raw materials, to smelting, refining and smithing. Processes are not necessarily confined to a single group of individuals or location. Image based on Juleff pers. comm. 2019.*

liaising with the smelters and smiths and exchanging the products of the smith within the wider economy (fig. 1.12). The term ironworking therefore encompasses many processes and will only be used when the industry in its entirety is being discussed.

1.1.4 - *Centres of Production?*

The concept of centres of iron production will be examined through the course of this thesis and a discussion on the current use of the term can be found in Chapter 7. It is important to note that the term centre of production is somewhat loaded and has been applied in archaeology to many sites and locations, not just for iron-production but also for other industries, with little attempt to fully define its meaning. The Weald as a region has been classified a centre of production in the wider research on the industry, however within the Weald at a site-specific level, the literature discusses local centres of production, in which Crawley is one example. Such centres have been defined along various attributes including spatial distribution of sites, the clustering of sites and a sites level of output, such as the apparent specialisation of products including horseshoes and arrows. The phrase centres of production has been used loosely and in many cases the author lacks close or critical examination of how they are defining the term and why any of the attributes listed above constitute a centre. Understanding the intensity and organisation of production and its social and economic implications are important and will be a theme for analysis in this study. Throughout this chapter the concept of centres of production will be examined based on the evidence presented in previous research and will begin to determine certain criteria that can be tested against the two case study sites Tudeley and Roffey, that are examined in the subsequent chapters. Such analysis will allow a critical examination of the term centres of production later in the thesis and a discussion on whether the term is applicable to iron-production in the Weald during the medieval period.

1.2 - A review of current literature and understanding

In addition to the work of Straker (1931), Cleere and Crossley (1995) and Hodgkinson (2008), the Wealden Iron Research Group (WIRG), founded in 1968 have identified many key sites with dates ranging from the Iron Age through to the early 19th century, when the industry dramatically declined. WIRG form an independent group of researchers who carry out fieldwork, excavation, and experimental smelting as well as collaborating with other societies and institutions to enhance the knowledge of the industry and publish their findings in an annual bulletin '*Wealden Iron'*, newsletters, and an online site database (Prus 2018, 11; https://www.wealdeniron.org.uk/about-wirg/). While our understanding of iron production in the Roman period has been considerably enhanced by recent studies, (Greenwood 2021), our knowledge of the medieval iron economy that followed is based on a handful of historical accounts and relatively few archaeological investigations.

It was in the mid-19th century, with the rise of the first archaeological societies that significant attention was directed towards county archaeologies, and in Kent and Sussex interest turned to the regions iron working heritage. Anthony Lower in 1849 explained in the second volume of the Sussex Archaeological Collections, how '*of the history of the trade however, little has hitherto been known*' (Lower 1849, 170). In his report, Lower outlined the discoveries by the Reverend Turner, of iron-working evidence at Maresfield, explaining '*To the Rev, Edward Turner we are indebted for the discovery of the highly interesting* *fact, that it dates so far back as the period of Roman dominion in Britain*' (Lower 1849, 170). Broad generalisations and assumptions were made in these early studies, including Lower's suggestion that '*the iron trade of Sussex was carried on uninterruptedly from Roman times till its extinction, in consequence of the failure of fuel, almost within our own recollection*.' (Lower 1849, 177). Furthermore, early investigations tended to treat sites in relative isolation, with little attention on how they fitted into a broader economic framework of local and long-distance trade and their place within settlements. Arguably this remains a significant omission in the literature on medieval ironworks.

It is notable that early research such as Lower's, focussed predominantly on the Roman industry and paid little attention to the following medieval period and no doubt reflects the lack of documentary sources that had been identified at this time. An exception to this can be found in the work of Montague Giuseppi, who, in 1913 translated and published the accounts of an ironworks at Tudeley in Kent (Giuseppi 1913; Crawshaw 2018, 7). While these accounts were incomplete, Giuseppi realised their importance in understanding medieval iron economy and the Tudeley accounts remain the most detailed documented record of an ironworks in the Weald for the 14th Century (Crawshaw 2018, 7) and indeed one of only two such sources known in Britain, with the Byrkeknott accounts (Durham) dating 50 years after Tudeley (Lapsley 1899; Schubert 1957, 125). Giuseppi treated the accounts within a historical framework, with no attention to where the ironworks were physically located, and it was another thirty years before the first attempts to link archaeological and historical evidence was to take place (Straker 1931). Since Giuseppi's translation was published, the Tudeley accounts have been quoted in most publications on the medieval iron industry of the Weald, and generally have been taken as an accurate reflection of how a 14th Century ironworks operated (Straker 1931, 34-37; Schubert 1957, 125; Hodgkinson 2008, 43-48). Even in other iron-working regions such as Northamptonshire which, like the Weald, also lacks documentary sources for the period, the Tudeley accounts have been used to illustrate details that archaeology cannot provide (Foard, 2001). In the Weald, the accounts have been compared to various excavated ironworks, including Minepit Wood in Rotherfield (Money 1971); and yet with Tudeley's physical location remaining elusive, they have never been directly compared to the archaeological site they relate to. This raises the question of how far these accounts should be used as a historical comparison to the archaeological record of other sites until the site of Tudeley Ironworks is correctly located and investigated.

One of the earliest cross disciplinary studies was by Mary Cecilia Delany in 1921. Her study into the historical geography of the Weald drew on a combination of archaeological, historical, and geographical evidence, to identify areas where iron-production predominated. Her study identified some of the key evidence for the development and scale of the industry, from the Roman period through to the end of the blast furnace era in the early 19th century (Delany 1921). Specific areas where she concluded the industry dominated included the major river valleys of the Cuckmere, Ouse, Adur and Arun and the areas where ore was easily obtainable, specifically the Hastings Beds and Weald Clay (Delany 1921, 7-8, 28-29). What was most significant here was her cross disciplinary discussion of both the historical evidence and the landscape evidence that attested to iron production. At this time few sites had been excavated, but earthworks such as bell pits were being recognised (Delany 1921, 34). Her appreciation of the wider landscape context of the industry, and

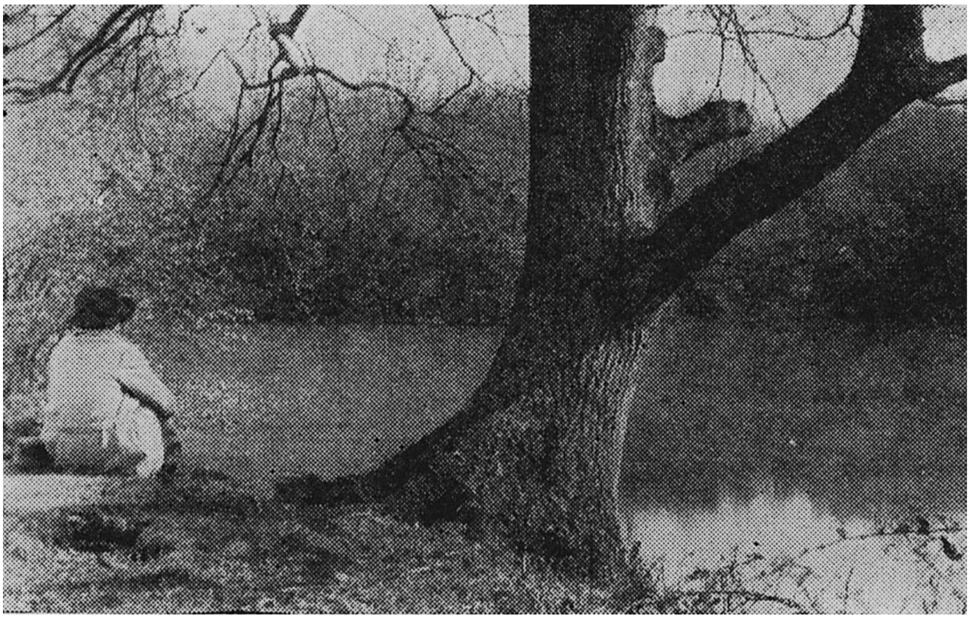


***Figure 1.13** – One of Straker's small illustrative images that he photographed during his fieldwork outings and included in 'Wealden Iron'. The image is of a marlpit at Cowden and demonstrates Straker's appreciation of other landscape features of related industries. His daughter, who may be the figure in the picture, accompanied Straker on many of his forays, driving him to remote corners of the Sussex, Surrey, and Kent countryside. Image source: Straker (1931; 107).*

the importance of not simply considering sites in isolation but as elements within a much wider economic landscape of related industries, is important, and something not always considered in other contemporary or later studies.

There were until the 1930s difficulties in determining the scale of the industry in the Weald, based on the few sites identified. It was through the work of Ernest Straker that sites began to be catalogued and assigned to time periods. Straker, a keen amateur archaeologist and historian living in Surrey in the first half of the 20th century, personally visited sites throughout the Weald to compile his gazetteer and create a topographical survey of the evidence of iron-working in his words *'from the earliest times to its cessation'* (Straker 1931, front piece) (fig. 1.13). He often followed stream beds that had cut through slag heaps, to gather data on where such sites were located. Straker also compiled a significant slag assemblage which he used to make comparisons between sites, along with a photographic record, published in his 1931 monograph '*Wealden*

Iron' (Straker 1931). While subsequent movement, and the deterioration of packaging has left Straker's slag and photograph collection muddled and largely unusable, what remains of the slag assemblage has recently been digitised for study, and '*Wealden Iron'* includes photographs and descriptions of the slag from different sites, which can be assessed. Like Delany, Straker combined archaeological evidence from his own fieldwork with the limited documentary material available to him, drawing too on the evidence of placenames to identify previously unknown ironworks and related sites. One such example of his work was his identification of the site of Tudeley, where he attempted to link the documentary accounts to evidence within the landscape in the form of cinder (slag) deposits (Straker 1931, 220; Cleere & Crossley 1985, 96). While some have criticised the way Straker identified his sites, his site catalogue, published in '*Wealden Iron'* (1931), formed the working site gazetteer until Cleere and Crossley's *'The Iron Industry of the Weald'* in 1985. Cleere and Crossley state that a considerable limitation with his work is that none of his sites can be said to be medieval with any certainty (Cleere & Crossley 1985, 96). And yet Straker made no pretence of the fact that further research was required – something that in the case of Tudeley has taken place since, with three possible sites proposed as the famous 14th century ironworks (Herbert 1986; Crawshaw 2018, 7).

Between the work of Straker and the 1980's, occasional papers were produced in the Sussex Archaeological Collections, or as monographs identifying sites of iron production from varying periods. Some of these were the outcome of the rise of rescue or developer-led archaeology, prompted by the expansion of urban centres and construction of reservoirs within the rural landscape. One of the most well-known projects at this time was the investigation into the Bewl

Valley Ironworks, led by David Crossley ahead of the construction of Bewl Water Reservoir (Crossley 1975). Crossley located the site using notes from previous fieldwork, including Straker who had recorded scatters of cinder, and from limited documentary evidence (Straker 1931; Crossley 1975, 2-6). From his excavations, Crossley identified three phases of activity on the site dating from around 1300 to its abandonment in the early 18th century (Crossley 1975, 1, 6, 16-23). This forms one of the most well-excavated medieval ironworks of the Weald, and yet still raises questions over whether the site was water-powered and how extensive the use of water-power was at ironworks of this period. There have also been greater numbers of field surveys, particularly since 1968 when the Wealden Iron Research Group (WIRG) was founded (Cleere & Crossley 1985, 97). Many of the surveys have re-investigated sites identified by Straker, while other investigations have found new locations. Like Straker's sites however, many of the ironworks that have been found, remain undated (Cleere & Crossley 1985, 97). WIRG have been active in publishing their research, with the first WIRG Bulletin appearing in 1969 (Prus 2018, 11) and this has allowed some level of periodisation and cross comparison to take place.

Cleere and Crossley produced their monograph '*The Iron Industry of the Weald'* in 1985, and while it provides a detailed overview of the state of knowledge at the time, it gives few details on medieval bloomeries or specific sites (Hodgkinson 2000, 23). In 2000, Hodgkinson was able to create a gazetteer of the known medieval sites from historical and archaeological records which included Crawley, Hartfield, Millbrook, Upper Parrock, and Horsham, many of which contained more than one bloomery (Hodgkinson 2000, 23-31). Compared to those identified from the Roman period, these represent a relatively small percentage of the overall known bloomery sites recorded on the WIRG database (www.wirgdata.org) and raises the question, was iron working less prolific during this period or have the sites simply not been identified? Hodgkinson's later monograph '*The Wealden Iron Industry'* highlights the question of why there is no evidence for ironmaking in the Weald in the first few centuries after the Romans left and that for the remainder of the period only 36 sites have been conclusively dated archaeologically as medieval. He explains that many more have the potential to be medieval but remain undated (Hodgkinson 2008, 35-48). While Hodgkinson suggests that discoveries in Crawley indicate it formed a centre of iron-making, the lack of excavation within other Wealden settlements, makes it hard to assess the extent to which Crawley was typical (Hodgkinson 2008, 42, 48).

1.3 - The Iron Industry in Context: Documentary sources

Cleere and Crossley (1985, 87) state that the considerable limitation to the study of the medieval iron industry is the relative lack of documentary sources. While there are occasional references to iron production prior to 1066, it is in the Anglo-Saxon period that sources are most sporadic. One surviving source includes a reference from 689 to the King of Kent who granted an iron mine at Lyminge to the Abbot at St Peters Canterbury (Cleere & Crossley 1985, 87). The relative absence of evidence in both historical and archaeological sources has led researchers such as Cleere, Crossley and Lower to question the extent to which the iron industry predominated during the pre-conquest period (Lower 1849, 177; Cleere & Crossley 1985, 87-88). The Domesday survey of Kent and Sussex in 1085, does little to advance our understanding of the industry. There is a reference to a 'ferraria' operating at Lavertye near East Grinstead, however this remains our only indication of the industry's existence at this early date, and it is not clear whether this is a reference to an individual ironworker, a forge, or a furnace (Cleere & Crossley 1985, 87). As Crawshaw (2022, 12) explains, *ferraria* can be translated as a forge, a smithy or forge, or an iron mine, depending on the translation followed. The uncertainty with its translation means it is hard to assess the exact nature of the reference, particularly without the identification of the site. Lower concludes that *'Iron is not mentioned in the Domesday Book suggesting ironworking if it was in existence was unimportant at this date'* (Lower 1849, 177). However, according to Brandon (1974, 79), the Sussex entries in Domesday are limited because they omit records for outlying territories that were held by manors south of the Weald, by the coast and the South Downs. When considering that access to resources, including ore sources and timber, might limit iron-working to these more northern territories, away from the manors, this may explain why we see so few references to iron production in the Domesday survey. Brandon states that this results in the Weald appearing almost empty (Brandon 1974, 79). Poor survival of manorial sources for 13th and 14th Centuries does little to enhance our knowledge of the later medieval period, with Tudeley forming the only detailed record from this time of an ironworks attached to a manor (Cleere & Crossley 1985, 93).

This is not to say that there are no records in existence. A careful study of historical sources does reveal occasional and sometimes indirect evidence of the Weald's iron-working past. There are references within manorial court rolls for example, such as for the manor of Wartling, where a Ralph Kenne 'raised under villeinage one forge' and 'gives the lord one bloom of iron which he has founded worth 2/6 to be able to work the said forge to Easter' (Hodgkinson 1996, 7). It is worth noting that this account came to light relatively recently and raises the possibility that similar accounts remain undiscovered in other court

Figure 1.14 – *A plough from the 14th century demonstrating the iron components that it contains, as referenced in inventory accounts within the Weald. Image source: Van Ness (1905: 218).*

rolls or manorial records. The estate of John de Lynleghe at Withyham is also recorded as containing a forge in 1320 (Cleere and Crossley 1985, 92). Like the Tudeley accounts, these references must be treated with some caution as they refer to specific events and single ironworks. Nevertheless, like Tudeley, they appear to have been held by a manor. The question of how these sites fit into the local or wider iron economy, and whether they can be classified as centres of production will be returned to later in the chapter.

Indirect evidence also informs us of secondary products that were most likely made within the Weald, such as an inventory from 1397 for the property of the Earl of Arundel, where agricultural items included 'a plough with all the iron furniture', a 'bushel bound with iron' at Allington, '2 harrows with iron teeth' at Northease, and a 'iron fork for dung' at Rodmell are listed, along with household items that include '2 iron candle-sticks' at Cuckfield (Salzman 1953, 41-43) (fig. 1.14). This account will be considered in chapter 7. However, it is important to note here that this demonstrates the varieties of uses iron held and its importance to other economic activities such as agriculture.

The majority of documentary material comes from the later medieval period in the 13th and 14th centuries. From this Cleere and Crossley have attempted to piece together evidence for the trade of iron and understand how the ironworks of the Weald fitted into the broader economy of England (Cleere & Crossley

1985, 88-92). The Crown was a major purchaser of iron products from the mid-13th century and into the later 14th century (Cleere & Crossley 1985, 88), however the survival of these sources may be producing a somewhat skewed picture, for it should not be assumed that this was the primary source of trade. Nails, iron rods and horseshoes are among the main products that are referred to during this period (Durrant Cooper 1865, 117; Richards 1924, 8). In 1253, the Sheriff of Sussex provided the Royal Army with 30,000 horseshoes and 60,000 nails (Straker 1931, 33), and while there are no details as to the sites these were acquired from, it implies the region was an established source of producing bulk orders of this scale. Iron tyres for cartwheels may also have been an export of the Weald, for in 1300, the Guild of Feroners in London made a complaint against the Wealden Smiths for producing tyres at too short a length. This led to the ordering of rods of standard length for the markets to check future tyre length (Straker 1931, 33). Arrows too were made in the Horsham area. However, the difficulty here is knowing whether all the accounts are referring to arrows with iron heads or if they were simply describing the wooden shafts (Cleere & Crossley 1985, 89). The 1338 Sheriff Accounts (Library roll 12 Edw III) state that 6000 arrows of 'good dry wood with heads well sharpened' were arranged to be carried from Horsham to the Tower of London, suggesting iron heads were included, but again it should not be assumed that this was the case in every reference (Durrant Cooper 1865, 117)

Figure 1.15 – *Barbed and socketed arrowhead dating from the 13th – 14th century and found in London. Representative of a possible arrow type made in the Horsham area at that time. Image courtesy of Wyatt, S (2018), Portable Antiquities Scheme.*

(fig. 1.15). Accounts from the period do on occasion make a distinction between those with or without arrow heads, such as within the Close Rolls of Edward III in March 1341, when the Sheriff of York had to supply a sheaf for the steeled arrows and one for the non-steeled arrows (see chapter 7) (transl. Maxwell Lyte 1902). This highlights the challenges with using these documents to understand the industry. In this instance we cannot be sure iron arrow points were indeed produced at Horsham, and even if they were, whether the production of arrows simply represent sporadic occurrences, for history tends to record the unusual or exceptional, and not always the norm. However, in this instance, the ability to acquire quantities large enough to fulfil such orders, however infrequent, would require the existence of established production capacity.

The presence of a murage grant made to Lewes in 1266, which allowed residents to charge tolls on every cart and horse load of iron for sale coming from the Weald, to assist with the repair of the Town Walls after the Battle of Lewes in 1264 (Straker 1931, 33), would suggest a frequent enough trade to make such tolls worthwhile. A penny toll for every cart load and half for every horse is not going to go far towards the repair of the Town Walls unless such movement of iron occurred on a regular basis. If such large amounts of iron were being transported around the region, implied by this account, it might imply the existence of production foci capable of producing such quantities. These few references raise broader questions about the Weald as to whether centres of production can be defined as locations in which specialist products were manufactured, how such centres originated and under what economic circumstances, how they functioned, and how widespread such centres were, if indeed they existed?

1.3.1 – *The Tudeley Ironworks Accounts*

While documentary sources relating to individual ironworks are generally absent for the medieval iron industry, not only for the Weald but England as a whole, two surviving accounts do offer a valuable insight into the day-to-day activities of an ironworks and their wider landscape economy. These include the Tudeley accounts from Kent and the Byrkeknott accounts from Durham (Lapsley 1899; Giuseppi 1913)

Figure 1.16 – *The Tudeley Accounts*

The Tudeley accounts (figs. 1.16-1.17), of which a transcription and translation is presented in Appendix C1, were first discovered, and published by Montague Giuseppi in 1913. They cover two periods from 1329-1334 and 1350-1354, with some occasional references after this date (Giuseppi 1913, 145). They cover a forty-year period, recording not only products of the ironworks but also the individuals involved, such as the lessees and their ironworkers or 'blowers'. While the day-to-day running of the works are recorded, they also offer a broader insight into 14th century society can be gained by studying them (Richards 1924, 15-23; Cleere & Crossley 1985, 92). The accounts formed part of the wider manorial archives of the Southfrith Estate, part of the Lowy of Tonbridge and in the possession of Elizabeth de Clare, a powerful and influential figure in medieval England (Richards 1924, 15). Richard of Tonbridge later 'de Clare' had been granted the Lowy of Tonbridge

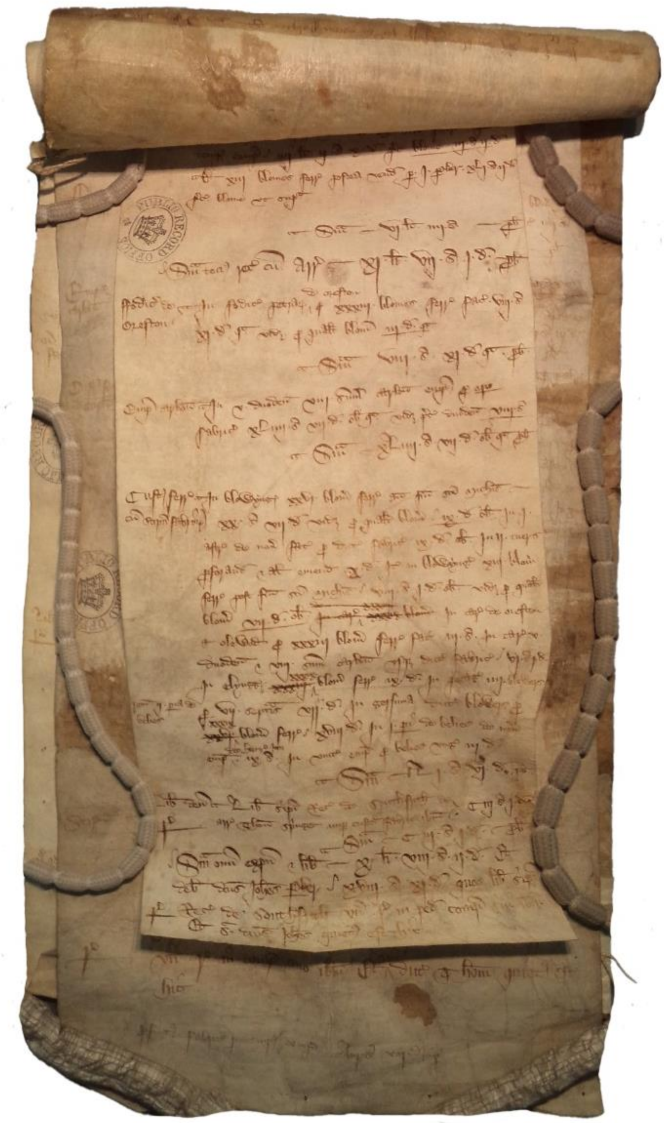


Figure 1.17 – *The Tudeley Accounts. First discovered by Montague Giuseppi in the Public Records Office among the records of the Exchequer, Giuseppi realised the importance they held to understanding the medieval iron industry. He presented them to the Society of Antiquities on 5th December 1912 explaining 'they seem to suggest a possible source material to any one who may have a mind to be the future historian of the iron industry of the Weald'. The main period of the accounts are found in a small role of parchment (above) comprising four pages of varying sizes, and written in Latin, French and Old English. Photographed by the author with kind permission of the National Archives.*

after the Norman Conquest in the 11th Century (Mortimer 1980, 121; Cole 2014, 75). The Lowy formed an area of land around Tonbridge and its castle and according to Ward (1980, 119-120), had no clear boundary, but was mixed with various holdings.

The term Lowy originates from the word 'leowe' or league, as a measure of distance and encircled around three to four miles from the castle at Tonbridge (Cole 2014, 75). The Lowy supported the maintenance, supply and defence of Tonbridge Castle, and comprised two deer parks or forests, the Northfrith and the Southfrith (Ward 1980, 122-124; Cole 2014, 75). It was said by Robert of

Torigni in the Chronicle of William of Jumièges, that upon receiving the Lowy of Tonbridge after 1066, Richard Fitzgilbert used rope to measure out his estate, so that it replicated the area of land he had held at Brionne in Normandy (Mortimer 1980, 121; Cole 2014, 75). Mortimer (1980, 121) does point out however, that if this story is true, and the later boundaries went unchanged from Fitzgilbert's original 11th century estate, the irregular shape makes it hard to determine how a rope could have been used to measure them. It was after the death of her brother Gilbert in 1314 at the battle of Bannockburn that Elizabeth inherited the Southfrith chase, which contained the Tudeley ironworks (Richards 1925, 15). Elizabeth de Clare and her Receiver (who kept the manorial records) had a great influence over the Tudeley works, particularly at times when it was run in-house by the estate. It is this manorial influence that requires analysis to establish Tudeley's importance in the wider medieval economy. Recent excavations of a medieval settlement site at Trellech in Monmouthshire, have suggested it was founded specifically as a centre to produce iron, to furnish the de Clare's army with ore brought to the site from the Forest of Dean (Evans 2016). Perhaps this site can be seen to parallel Tudeley, which was in ownership of the same family, in terms of bringing in resources from the wider landscape of the manor, a wider landscape so often forgotten in studies of ironworks and addressing this may help to place Tudeley into both a wider landscape and social context.

The Tudeley accounts provide detail on the wider resource economy that supported the ironworks, describing how resources of iron ore and charcoal were interchangeably brought to the works from within and outside the estate (Richards 1925, 19). This suggests that Tudeley was not a temporary works, making use of accessible supplies of ore, but a permanent establishment to which raw materials were brought - further supported by the account of 1354 when a building was erected at the site in 1343, emphasising its permanent nature (Giuseppi 1913, 148). Tudeley thus challenges the notion of centres of production, as while it does not represent a nucleated group of ironworks as might be the case at Crawley, it is still a centre in which goods were brought to, from within the manor and further afield. References to other ironworks in the accounts, such as one at Newefrith Juxta Bournemelne, and two in the possession of Thomas Henry, also raises the question of how these related to the Tudeley site (Giuseppi 1913, 148). Were these close to Tudeley or further away on the estate, and can their presence also be considered part of a centre of production?

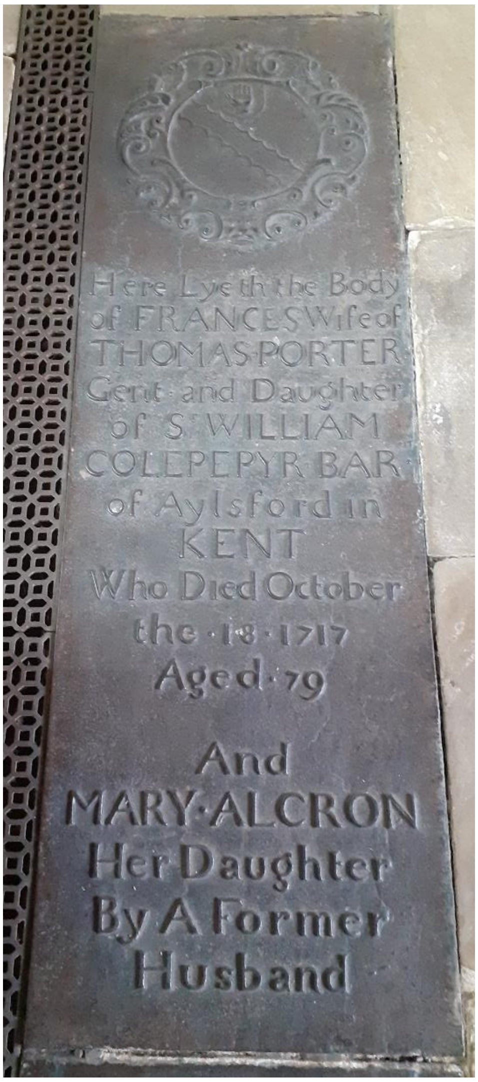


Figure 1.18 - *Cast Iron grave slab in Wadhurst Church. (Author's image).*

Contrary to any other ironworks of this period in the Weald, the Tudeley accounts offer an insight into those producing the iron and managing the works. It is these details that provide clues to the social organisation of the Wealden iron industry and the importance of kinship. Thomas Springet was the lessee of Tudeley from 1350 to 1354, while at the same time a Robert Springet, suggested by Hodgkinson and Whittick (1998, 18) to be related to Thomas, held the Newefrith ironworks, thought to be to the South of the Tudeley works (fig. 1.19). Guiseppi suggests that Richard Culpeper, keeper of the works from 1357, was part of an important local family in nearby Pembury parish, and that succeeding generations continued making iron, with the name Colepeper appearing in Kent in later centuries (Giuseppi 1912, 150; Straker 1931, 34) (fig. 1.18). It would suggest iron making was an occupation passed down within families. Perhaps when looking to define a centre of iron production research should consider the significance of family groups and kinship as a controlling factor, rather than just the distribution or density of sites. While documentary sources provide details of individuals that allow an examination of kinship, archaeological remains may offer this too, particularly the analysis of materials such as the technological waste (slag), between the sites of Tudeley and others in the vicinity, that may suggest similar processes were in use, potentially representing know-how passed down through iron-working families and kinship.

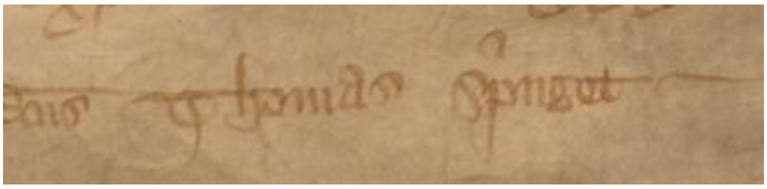


Figure 1.19 – *Record of Thomas Springet, who is listed as both lessee and Keeper of the works in various years in the accounts.*

A limitation with the Tudeley Accounts is that they are incomplete, with evident gaps between the years 1335-1349 (Hodgkinson 2008, 44). Giuseppi explains that he found them on four skins of parchment at the Public Records Office among the records of the Exchequer, and stresses that they do not belong in these records, and survived by chance (Giuseppi 1912, 145-146). Their chance survival raises questions over whether they are representative of a typical Wealden ironworks of the period, particularly when no other ironworks appear to have been recorded in this way. Other ironworks are briefly referred to within the Tudeley Accounts, and yet the absence of detailed records for these within the manorial archives raises the question of whether these had records that simply did not survive or if they were never recorded in the first place. The latter might imply Tudeley was an altogether different type of ironworks.

Prior to this project it was not possible to compare the Tudeley accounts to any archaeological evidence, since no site for the works had been conclusively identified in the field (Herbert 1986). While Straker's suggested site on the Devils Gill was a viable candidate, it had not received any form of detailed archaeological survey (Straker 1931, 220; Herbert 1986). It could not be assumed that Tudeley represented a 'typical' ironworks based on the accounts alone, and there was need to exercise caution when projecting these accounts on to other archaeological sites until the site for Tudeley had been located. Money, for example, compared Minepit Wood with Tudeley, as the sites morphology and the evidence of processes identified in his excavation including the presence of a building and ore roasting and are described in the Tudeley accounts (Money 1971, 103). Foard (2001, 86) goes further and compares calculations of the amount of charcoal required to fuel the Tudeley ironworks, to ironworks in Rockingham Forest in Northamptonshire, a completely different region of England. Money stressed the importance of identifying and investigating Tudeley, something Straker also stated in 1931, so that comparisons can be made to Minepit Wood (Straker 1931, 220; Money 1971, 103). Tudeley's production figures of between 112 and 231 blooms per annum for 1329-1334 and 39 to 252 blooms per annum for 1350-1354 (Cleere & Crossley 1995, 103), have been quoted in much of the literature on iron-working during the period, with little consideration on how representative Tudeley was. There is a need to question how far we can rely on these production figures as the 'typical' output of an ironworks. Archaeologically there seems to be considerable variation in both the scale and technology of individual ironworks, which leads us to question how far the evidence from Tudeley can be applied to other sites. The very fact that these accounts have survived while others have either disappeared or were never recorded, could indicate that the ironworks of Tudeley were somehow different. However, as Giuseppi states, the accounts appeared to have been misplaced when he found them and thus their survival may be merely accidental (Giuseppi 1913, 146). Attempting to link history and archaeological remains in the case of Tudeley is problematic and runs the risk of interpreting the archaeological evidence to fit the documentary sources or vice versa. This can be seen in the past attempts to locate the site of Tudeley on the ground, with several potential sites identified, but none conclusively linked. To avoid this, both sources of evidence should be treated with equal consideration and caution. Both will have limitations and cannot be used alone to reconstruct the operation of the ironworks. There should also be caution in projecting the Tudeley accounts onto the whole iron industry of the Weald, and assuming they are in any way typical.

1.4 - The Iron Industry in Context: The Archaeological Evidence

1.4.1 - *Continuity or re-establishment – the origins of the medieval industry*

Iron production was taking place in Britain long before the coming of the Romans in 43AD. Strabo reported in the 1st century that *'Most of the island is flat and overgrown with forests, although many of its districts are hilly. It bears grain, cattle, gold, silver, and iron. These things, accordingly, are exported from the island…'* (Strabo. Transl. Jones 1923, 255). The Roman influence however appears to have led to iron becoming a major product traded from Southern England between the 1st and 5th centuries (Delany 1921, 24; Cleere 1971, 205-

206). Hodgkinson (2008, 32) explains how a number of sites exhibit evidence of being of high importance, with large slag heaps, high status Samian pottery and permanent masonry buildings, such as at Beauport Park. What is less well understood is what happened to the iron industry once Roman control had lapsed towards the end of the 4th Century. Delany states that there is no evidence of iron-working for around 700 to 800 years after the Romans (Delany 1921, 25). Brandon however, when considering the Saxon colonisation of the Weald, suggests that there may have been some degree of continuity of Romano-British iron-working sites into the Saxon period and that the exploitation of resources in the Weald at this time was aimed at iron-mining as opposed to agriculture (Brandon 1974, 76). Delany suggests that the dense woodland of the Weald had been opened up by the Romans through clearing to make way for roads and settlements and allowed it to be exploited for its iron (Delany 1921, 10). Fleming takes a different view, believing that by the late 4th century, the Roman metal economy was disintegrating and settlements that had formed central places for the iron industry had collapsed, resulting in limited accessibility to fresh supplies of iron (Fleming 2012, 9). He argues that the resultant collapse in the Roman metal industry led to scavenging and recycling. At Bloodmoor Hill in Suffolk, scrap Roman metalwork, smithing slag and hammerscale have been found together and might suggest that during the 5th and 6th centuries iron goods were recycled, repaired, or reworked (Fleming 2012, 9- 24). Hinton (2005, 35) notes the occurrence of scrap iron as an indication that recycling of iron goods was taking place at this time. This might explain why so few Anglo Saxon bloomery sites have been found in the Weald or elsewhere in the UK and why those that have been identified, primarily

Millbrook, from the 9th century, are of a late Anglo-Saxon date (Tebbutt 1981b; 1982).

Even with the emergence of a late Anglo-Saxon iron industry, there is very little evidence for its widespread use in the Weald and indeed other regions such as the Forest of Dean, which had been concentrations in the Roman and later Medieval periods (Birch 2011, 7). Despite there being artefactual evidence of ferrous alloy objects from the period (ibid 2011, 6), there is not enough site-based evidence currently identified to suggest the economy supported full time specialists at this early date. Fleming (2012, 10, 14) argues that with the collapse of Roman control, the crippled economy was unable to support specialist metal producers, due to the absence of markets, and this ultimately over time led to the erosion of know-how and expertise. During the Anglo-Saxon colonisation of southern England, the earliest settlements were situated south of the South Downs or along the Ouse Valley, where present day settlements ending in ‘ing’ attest to their Anglo-Saxon origins. Beyond the Downs, settlement names are notably different, ending in ‘den’ ‘ley’ ‘hurst’, ‘field’ and ‘fold’, and originate as clearings within the forest which are suggested by Delany to have taken place at a later date, in the later medieval period (Delany 1921, 13-14). On the other hand, the Anglo-Saxons made use of the Weald by the 9th century, with sites such as Millbrook, situated within Ashdown Forest, providing clear evidence of Anglo-Saxon smelting (Tebbutt 1981, 17-20) (fig. 1.9-1.10). The absence of other contemporary sites to Millbrook makes it difficult to assess how widespread iron smelting was during the late Anglo-Saxon period; however, it is possible that iron-working was a seasonal activity, and likely to leave fewer archaeological traces than a permanent or long-lived production site. This is supported by Butler’s excavation of a middle Saxon settlement at Friars Oak near Keymer, at the foot of the South Downs (Butler 2000). Here, consolidation or forging slag was recovered, and while fragments of forge hearth bottoms were also found, there was no evidence to suggest smelting had taken place (Hodgkinson 2000, 41-42). Hodgkinson suggests that iron blooms may have been brought to the more highly populated settlements along the South Downs, from the Weald which lay to the north, where they could be consolidated and traded. This he suggests would account for smithing slag found at Friars oak and elsewhere, where ore is not present within the local geology (Hodgkinson 1997 (b), 5). This would certainly support the idea that iron-production at this time was a more small-scale, seasonal activity, and perhaps only carried out to meet local demand, rather than feeding into any large scale or extensive trade network. Birch (2011, 8-10), argues that iron-smelting is more likely to have been carried out outside of the main settlement, however as more archaeological investigation has been carried out within settlements, the absence of evidence is more likely to reflect an archaeological bias rather than no iron smelting took place. There has however been some limited evidence of smithing within settlement contexts such as in London, where metalworking tools, smithing hearth bottoms, hammerscale, and hearth linings have been recovered (Birch 2011, 8). Birch (2011, 9, 14) suggests future research should adopt a Scandinavian approach of considering the infield (farmstead or settlement) and the outfield (area beyond the settlement), for the outfield may be where smelting evidence lies and is supported by ethnographic parallels in Ethiopia and the Sudan. Ethnographic evidence suggests this separation can be attributed to both practical factors, such as avoiding fires and proximity to raw materials, but also for the social perception of iron-smelters, and the smiths seemingly magical ability to turn iron into artefacts, and Birch sees this as being a possible scenario for influencing Anglo-Saxon ironworks, with the lack of excavation outside settlement areas meaning these sites remain undiscovered (Birch 2011, 14). This could explain the evidence of both Millbrook and Friar's Oak, for Friars Oak can be seen as the infield settlement, where iron was brought to for smithing, while Millbrook forms the outfield area where smelting took place. The limited number of sites found from the Anglo-Saxon period does call into question how prosperous the production of iron really was at this time; However, if smelting was carried out on a more seasonal basis and if furnaces were more frequently single use in the 5th or early 6th centuries as Fleming (2012, 14) suggests, then traces in the archaeological record are likely to be more ephemeral. Furthermore, as the lack of dating evidence is a common limitation with sites recorded on the WIRG database, other undated ironworks may also have an Anglo-Saxon origin.

1.4.2 - *Anglo-Saxon Iron-production within elite settlements*

Discoveries beyond the immediate Weald at the sites of Lyminge, Canterbury and Mersham in Kent along with Ramsbury in Wiltshire are providing further evidence on the nature and location of iron-production prior to 9th century. They demonstrate the role of centres under elite, royal and monastic control in organising the production and distribution of iron and secondary products between the 6th and 9th centuries and represent a small number of settlement sites where iron-production has been investigated. Excavation at Lyminge in Kent has led Thomas (2016, 356-364) to suggest that the generally absent iron industry for this period can be found on the outlying and peripheral zones of royal and monastic centres, areas frequently unexplored in past excavation campaigns. To the south of the 8th century church and monastery, open area excavation has revealed an area of domestic and craftworking activity which appears to have been organised into activity zones from the arrangement of boundary ditches (Thomas 2016, 352-358). Here both smelting and smithing were practiced (ibid, 352-358). Lyminge parallels evidence from other sites in Kent including Mersham where the main phase of smelting and smithing appears to be contemporary with the 10th or early 11th century church of St John the Baptish to the north-east (Reynolds 2011, 380, 384). This association between iron-production and high-status settlements is also found in other regions most notably at Ramsbury in Wiltshire, which was founded as a Bishopric in AD909 (Haslam et al 1980, 1). Here iron-production was identified on the northern side of the High Street 175m from the present-day church thought to be on the site of an Anglo-Saxon cathedral (Haslam et al 1980, 1-3).

Historical evidence also attests to the importance of iron-production at these elite settlements from an early date. A charter of AD689 records how an iron-bearing estate in the possession of the royal vill at Lyminge was granted to St Augustine's Abbey at Canterbury by King Oswine (Thomas 2016, 365). This demonstrates the importance placed on such locations by the elite, something Thomas (2016, 365) attributes to a desire to control the production of iron tools. This is supported by archaeological evidence at Canterbury where the main period of ironworking, predominantly smithing, appears to have taken place between AD750 and AD850 (Donnell and Young 2015, 177). The documentary evidence also implies that there was a royal interest in iron at Mersham when in AD858 King Aethelberht is said to have turned the land into 'folkland for himself' (Reynolds 2011, 380-382). Reynolds (2011, 380) suggests the term 'folkland' in this context meant Arthelberht had imposed obligations of food rents and customary services on this land. While iron is not specifically mentioned in this account a large pit containing waste from smelting and smithing along with tap slag in three smaller pits is indicative of the presence of the industry during this period, and it can be suggested that the iron would be yet another valuable resource that was controlled (Reynolds 2011, 380-382).

It can be argued that locating iron-production at central places allowed for the control and regulation of these resources. While frequently smelting and smithing are found at separate locations and practiced by different groups of specialists, Reynolds (2011, 382) notes how both are found together on high status Anglo-Saxon sites. Controlling smelting by placing it within the confines of elite and monastic centres could ensure the smiths had a regular supply of iron (Hinton 2011, 190). Typically, one would expect ore to be smelted close to its source, however at Ramsbury, ore was transported to the furnaces from a distance of 6-7km and on some occasions from as far as 30km (Haslam et al 1980, 56; Hinton 2011, 187). A similar situation may be present at Canterbury where McDonnell and Young's (2015, 181) analysis of tap slag suggested the ore used had not come from the Weald but elsewhere in Kent, possibly from within deposits of clay-with-flint. The acquisition of ore is therefore highly suggestive of the connectedness of these sites and Hinton (2011, 187) suggests this demonstrates central production at specific locations was more important at this date than itinerant smelters smelting ore where it was found. However, this evidence raises the question of why central production was necessary. Perhaps this was a way royal centres could control the distribution of iron blooms, restricting their use to the smiths working within these settlements, while at the same time monitoring the quality of the iron. Furthermore, these central places may have enabled full-time metalworking specialists to be supported. At Ramsbury assemblages of bones and pottery alongside iron-production waste indicates people were living near the furnaces (Haslam et al 1980, 18-19), which supports the possibility that iron was produced by full-time specialists and not on a part-time basis to fulfil local demand. Haslam (1980, 56) argues that the scale and duration of the industry at Ramsbury demonstrates how iron was important to the wider economy beyond that of solely local trade, a suggestion supported by imported Rhenish lava quernstones recovered from the site which are indicative of long-distance connections. A similar imported basalt lava quern stone was recovered at Mersham (Reynolds 2011, 382) which further supports the wider trade connections these settlements had, in which iron products could be traded within.

The artefactual evidence also supports the probability of the presence of specialist metalworkers working within these elite and monastic settlements. At Ramsbury an iron strap-end inlaid with strips of silver demonstrates how smiths were skilled in not only the working of iron but in non-ferrous metals too, a specialism that allowed them to create objects from combinations of metals (Hinton 2011, 193). Other settlements also demonstrate how non-ferrous metals were worked alongside iron and include Canterbury where crucible sherds and prills suggest the production of copper alloy objects. (McDonnell and Young 2015, 167-181). However, it was found that spatially non-ferrous metalworking and ironworking were separated (ibid, 167-181) suggesting different groups of specialists were restricted to their specific metalworking craft. At Mersham, other industries appear to have operated alongside iron-production such as textile making and leatherworking indicated by items that include a bone pin beater, a loom weight, a spindle whorl, iron fibre processing teeth and an iron awl (Reynolds 2011, 382).

The technological assemblage implies that iron-production at these centres was not necessarily restricted to either smelting or smithing. While past evidence has suggested iron ore was smelted within hinterland locations close to the sources of ore (McDonnell and Young 2015, 167) the emerging evidence from these central sites contradicts this suggestion. At Lyminge both smelting (stage 1) and primary and secondary smithing (stage 2) waste has been recovered and suggest a greater intensity of iron-production between the 8th and 9th century (Thomas 2016, 356, 366). This was the case at Ramsbury when in the late 8th to early 9th century a hollow in the hillside was enlarged and used for both smelting and smithing (Haslam et al 1980, 3-5). The presence of pits containing waste from smelting and smithing at Mersham also indicates the two production stages worked alongside one another, however as no in-situ furnaces or hearths have been identified it is hard to assess how closely associated the siting of these industries were, given the possibility that slag may have subsequently been moved and re-deposited (Reynolds 2011, 380-382). This was also the case at Canterbury where no furnaces and smithing hearths were located and while the slag from smelting and smithing was recovered from three sites, the majority of material was from secondary deposition in pits and ditches and not from primary dumping (McDonnell and Young 2015, 167-181). Site 18 however did appear to have primary dumping from smithing which included hammerscale and hearth bottoms and while no smithing hearths or working floors were identified it was surmised that they were in close proximity (ibid, 177-181). While this evidence suggests smithing was an important economic activity in Canterbury between the mid-8th and mid-9th century the size of the hearth bottoms indicate that this was predominantly primary smithing to refine iron blooms, and despite the presence of a few small hearth bottoms, it indicated artifact manufacture and repair was not the primary function of the smithy (ibid, 181). Recycling may also have been practiced by smiths for at Lyminge smithing residues were in one instance associated with fragmentary iron objects (see Section 1.4.1) (Thomas 2016, 366).

The apparent technological evolution in furnace design is an important discovery at these elite settlements. While there is the limitation of identifying furnace structures at these centres, many have large assemblages of smelting slag that demonstrate the nature of furnace design (Hinton 2011, 188-189). It has been suggested that non slag tapping furnaces or ‘bowl furnaces’ were used from the end of the Roman period to the 9th century when slag tapping ‘shaft’ furnaces appear again in the archaeological record. This evolution is illustrated at Ramsbury where bowl furnaces were in use in the earlier Anglo-Saxon period before being superseded by slag tapping shaft furnaces between the 9th and 10th centuries (Reynolds 2011, 382). Here, two bowl furnaces built within shallow hollows in the ground and likely covered by clay domes with an opening at the top to allow the bloom to be removed dated to the late 8th or early 9th century (Haslam et al 1980, 19-21). By the 9th-10th century, a ‘developed bowl furnace’ with the ability to tap slag was in operation at Ramsbury and morphologically paralleled the earlier Romano British shaft furnace technology (Haslam et al 1980, 5-6). This furnace was built within an elongated hollow, with a permanent brick and clay back and a hole in the base at the front that allowed slag to be tapped (Haslam et al 1980, 24-27; Hinton 2011, 187). The furnace was used on multiple occasions which necessitated its repair and relining and the restructuring of the tapping hole all of which suggests a larger scale of operation than previously (Haslam et al 1980, 27).

Elsewhere it is possible that slag tapping furnaces were in use prior to the 9th century. At Canterbury tap slag found in deposits dating to the mid-8th to mid-9th century hints to an earlier date, while slag within deposits dating between the 6th and 9th century at Lyminge suggest that slag tapping furnaces were re-introduced even earlier (Thomas 2016, 365; McDonnell and Young 2015, 182). At Canterbury Of the 6 morphological slag types identified, ‘slag tubes’ or ‘rods’ and tap slag suggested to McDonnell and Young (2015, 179-182) that slag tapping shaft furnaces were re-introduced to the region earlier than the 9th century. Slag rods are a feature of Romano British smelting assemblages and are thought to have formed when a poker (or boring stick) was inserted to release accumulated slag from the furnace bottom (McDonnell and Young 2015, 180). As will be demonstrated in Chapter 4, these slag rods were also a feature of the Roffey assemblage that dated to the 13th century.

While slag tapping furnaces appear to have been in use in Kent at Lyminge, Canterbury and Mersham by the 9th century it raises the question of whether this represents a survival in Romano British furnace design, a localised rediscovery or a reintroduction? Arguably the evidence from these sites lends weight to each of these possibilities. Outside the region at Ramsbury there was a period of disuse in the occupation sequence of the site between the use of bowl furnaces and the slag tapping shaft furnaces which Haslam et al (1980, 30) interprets as the probable re-discovery of the earlier Roman process, although they don’t rule out the possibility of a continuing local tradition. As Hinton points out, slag tapping shaft furnaces, unlike the bowl furnaces, do not necessarily require the use of a pit to collect the slag if the slag is tapped and if the furnace was constructed on a stone platform these features could have subsequently been truncated leaving little evidence of their existence (Hinton 2011, 187). Thus, the number of slag tapping shaft furnaces at this date might be more than is currently recorded, a possibility supported by the lack of furnace structures found at many of these sites. Hinton (2011, 187) does however question whether there is enough slag evidence to support their widespread use.

If slag tapping furnaces were re-discovered or re-introduced, it raises the question of why this technological transition took place. The change in furnace design from the bowl furnace to the shaft furnace could indicate a desire to increase production as the shaft furnace enabled larger quantities of iron to be produced within a smelt (Hinton 2011, 186). On the other hand, one must exercise caution in always associating technological change with progression for other more practical factors may play an equal part in this change. For instance, a bowl furnace will typically produce smaller quantities of iron than a shaft furnace and if a settlement only needed to produce enough iron to meet the demands of a small community, then a bowl furnace would have been an adequate design to fulfil these smaller requirements. Hinton (2011, 193) states that we should not overestimate the demand for iron at this time. Therefore, a bowl furnace may be the most practical design for small communities, of which Millbrook may be associated with. If, however a settlement under royal or monastic control had a wider sphere of influence across its estate, a slag tapping shaft furnace to increase the output of iron is a more suitable choice. This argument therefore contradicts the idea that furnace type is associated with evolution, continuity or re-introduction but argues instead that furnace design is a choice made according to the specific requirements of a settlement.

The evidence from elite centres provides potential future targets for identifying evidence for Anglo-Saxon iron-production and suggests that contrary to the notion that the industry virtually died out, it instead moved to important centres that were not necessarily the same localities as the preceding Roman period. As such much of the industry may remain undiscovered within the peripheries of the modern successors to these settlements. This is not to say that ironworking did not take place in the hinterlands. While smelting to some degree did take place in these settlements, its scale varies and it seems plausible that at sites where the scale of smelting evidence was more minimal, iron was brought in from the hinterlands.

1.4.3 - *Centres of production in the archaeological record?*

As outlined in the introduction, centre of production is a term used in archaeology often with little effort to define it. There are many models in which a centre may be defined, not all of which are mutually exclusive, which can include scale of operation; the inter-reliance between practitioners; the wider trade and exchange networks beyond the centre; differentiated technologies - with individuals specialising in a specific stage in the production process such as smelters operating separate to the smiths with intermediaries liaising between the two; and sites used by successive generations, that retain memory of their association to the industry.

Excavations that have taken place in Crawley since the 1990’s have suggested iron smelting and smithing were prolific activities there during the 14th Century (Hodgkinson 1990, 2-3; 2000, 23; Stevens 1997; 2006; 2008; 2014; Saunders 1998; Cooke 2001). Most evidence has come from development-led excavations around Crawley High Street and adjoining roads, and dated through pottery (Hodgkinson 1990, 2-3; Stevens 2014). This has led to the suggestion by Hodgkinson that by the late medieval period ‘Crawley was a centre for small-scale, quasi-domestic iron trades’ (Hodgkinson 1995, 2). Cleere and Crossley (1985, 87) state that we do not see great centres of smithing during this period, unlike the preceding Roman industry, and thus would make Crawley somewhat unique. In the light of more recent evidence, the uniqueness of Crawley could be questioned and its attribution as a ‘centre’ be simply the fact that it has undergone far more extensive excavation, than other locations. To date, no other urban concentrations of medieval iron production sites have been identified, but this alone cannot be taken as evidence of their non-existence. An examination of the WIRG site database reveals clustered distributions of other ironworks that arguably could represent similar ‘centres’ such as the Upper Parrock area of Hartfield where a total of 18 sites are recorded, which led Tebbutt to conclude that this was ‘a distinct centre for ironmaking’ (Tebbutt 1975, 146-151). Defining a centre of production by the clustering of sites has limitations and assumes that the sites within the cluster were all in operation during the same period. It might instead suggest a tradition of iron-working in the same locality by successive generations (Hodgkinson 2019, personal communication). Proximity may prove to be a misleading definition of a centre, particularly when considering that Tudeley ironworks, was not alone but part of a wider manorial estate containing other ironworks that were not necessarily close to Tudeley, but still connected through the manor (Richards 1925, 22). In defining centres, it is potentially the connections between ironworks that need to be examined, as opposed to simply their proximity.

If sites such as Crawley are to be considered iron production centres, it is not only the apparent scale of the industry, which appears to stretch over much of the High Street, Ifield Road, Spencers Road and London Road, but also the variety of processes that were taking place here that add weight to this classification (Hodgkinson 2000, 23; 1989, 2; Stevens 1997; 2006; 2008; 2014; Saunders 1998; Hodgkinson 2000, 24-26; Cooke 2001). Processes at Crawley included both smelting, and smithing indicating the production of raw blooms was just part of a larger series of steps towards refined iron. This was particularly apparent at Ifield Road where both bloomery slag and forging slag were found alongside one another, together with hammerscale (Hodgkinson 2000, 25). Cleere and Crossley (1985, 93) state that normally producing blooms is seen as a rural industry taking place in the forests, while the secondary working took place in the towns and villages, and in many societies, this separation in space in apparent. However, we should not assume that the tasks of the smelter and smith were separated by space, something that is clearly demonstrated in the case of Crawley. On the other hand, the variety of stages of iron production taking place at Crawley in itself does not necessarily define it as a production centre, when considering other small-scale sites, although rare, but includes Alsted where both smelting and smithing evidence have been found from the 13th century (Cleere & Crossley 1985, 102).

Since the Tudeley accounts make no reference to the manufacture of finished products, are we to assume that Tudeley does not represent a centre of production, based on the absence of smithing? And yet if the manufacture of finished products did not take place within the Southfrith estate, it might be suggested that the iron blooms from Tudeley were not intended for use within the manor, but instead traded further afield, which in itself gives Tudeley a different status and a more central importance than an ironworks operating solely to fulfil local iron demands. It would be wrong therefore to relegate sites as potential centres on the basis of the variety of processes taking place. We know blooms were traded as were finished products and centres may have specialised in one stage of the process.

Another criterion by which a centre of production may be defined is through the evidence of specialisation, particularly in finished iron products. While archaeological evidence for product specialisation is limited for the Weald, documentary sources do reference the production of specific iron goods, which included nails, horseshoes and arrows (Richards 1925, 11). Roffey, near Horsham in West Sussex, appears to have specialised in producing horseshoes during the 14th Century, based on an account from 1327, where 1000 horseshoes were sent from the forge to the port at Shoreham (Durrant Cooper 1865, 117). Arrows are another product, with documentary evidence that Horsham may have specialised in their production (Durrant Cooper 1865, 117; Richards 1925, 11). An obvious limitation with such sources is determining whether these accounts are true evidence of full-time specialism or whether ironworks were simply meeting market demands, or specific commissions at any one time. Cleere and Crossley (1995, 88-92). have attempted to consolidate evidence for the trade of iron to understand how the ironworks of the Weald fitted into the broader economy of England. The Crown was a major purchaser of iron products from the mid-13th century and into the later 14th century (ibid), and this might suggest that such 'specialist centres' were only meeting the requirements of one-off commissions in this instance from the Crown. This evidence of one-off commissions is supported by other 13th and 14th century purchase accounts such as in 1242, when the Archbishop of

Canterbury purchased 5000 horseshoes and 10000 nails from the Wealden ironworkers (Cleere and Crossley 1985, 88). With a lack of other accounts to corroborate regular purchases, or specific details as to which forges such products were acquired from, it cannot be confirmed that these came from full-time specialists. These accounts do confirm that at least some production was aimed at meeting individual needs as opposed to regular market demands, but it seems unlikely that all the receivers of goods were frequent customers. Many of the surviving accounts refer to very specific instances where such items were required, such as for the repair of royal buildings or to furnish the army at times of war – as Cleere and Crossley (ibid) state *'the Crown made sporadic purchases'* sporadic being the key word here and not regular. This highlights how limited surviving documents have the potential to be over-interpreted, and we must not assume from them that the presence of specialists and specialist production centres was widespread within the Weald. Arguably a record for a 'Royal commission' is more likely to survive in the documentary record than a local order for iron goods, which may have not been considered important enough to record.

Care should therefore be taken when trying to project sporadic accounts onto the entire Wealden economy and assume specialists (people who specialised in one or more products, such as horseshoes, arrows or nails) and specialist centres (locations where specific products could be sourced) were in abundance. Furthermore, many of these sources date from the later medieval period, and if they are to be taken as evidence of specialist production centres, they do not inform us of the circumstances under which such centres came to exist. On the other hand, even if these accounts do reflect one-off commissions, there would still need to be the capability of meeting these production demands, not just in the requirement of skilled labour, adequate numbers of tools, and furnace capacity, but also in the acquisition of suitable amounts of raw materials. If production centres did not exist, how were such requirements met at short notice? (Hodgkinson 2019, personal communication). Regardless of whether specialist production centres were in existence and specialised in nails, iron bars, arrows and horseshoes referenced in accounts of this later period (Durrant Cooper 1865, 117), archaeologically there is no conclusive evidence for their manufacture or for specialist smithing (fig. 1.20). As Roffey is the only archaeologically known location referred to that appears to have some form of specialisation, in horseshoes, albeit based on a single account, it offers the best opportunity to test archaeologically whether centres of production were indeed home to specialists and whether this is a legitimate criteria by which such locations can be defined as centres.

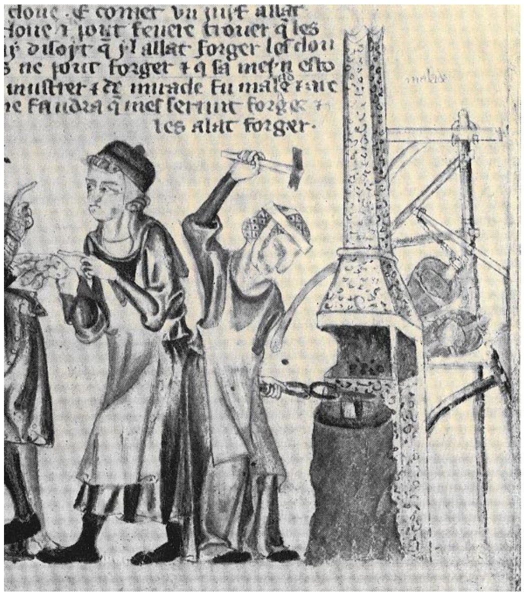


Figure 1.20 - *A blacksmiths forge dating to the first half of the 14th century illustrated in the Holkham Bible. Source: Shubert 1957; 103. From the British Museum.*

The term centre of production also implies a level of central organisation, particularly if centres did specialise in certain products, such as horseshoes at Roffey and arrows at Horsham (Richards 1925, 11). Iron production relies on a series of different processes, particularly within the early stages of producing a bloom, and include ore extraction, ore washing, roasting and finally smelting, as well as liaising with potentially separate industries such as colliers producing the charcoal fuel. If the Tudeley Accounts are representative of a Wealden ironworks, it is wrong to assume all these processes were carried out by one group of individuals and would have required organisation between different stakeholders, namely the charcoal producers, ore diggers, smelters, and smiths. Even when considering the products, there is evidence that ironworkers liaised with other craftsmen. The 1338 order for 6000 arrows (Durrant Cooper 1865) would have required cooperation between at least three industries including the fletchers for making the shafts and the smiths for the iron arrow points, and ultimately the coopers who supplied the barrel for transportation. To determine the presence of central organisation, there is a need to examine the context of individual ironworks. Tudeley was in the ownership of the Southfrith Estate and was at times directly managed by Elizabeth de Clare's overseers John de Mesynglegh, Thomas Judde and John Parker. The accounts describe how raw materials, including ore and charcoal, were brought to the site from resources within the estate, while others came from elsewhere. A site such as Roffey may have been independent and thus operated under a different mechanism to that of a manor-owned ironworks like Tudeley. The interrelationship between ironworks and other industries along with the potential external organisation this required, needs further analysis, particularly when defining a centre of production.

Centres of production may therefore be defined by various attributes including the clustering of sites, the evidence for specialisation, or that they operated under the management of a central organisation / individual. However, all these factors omit the practical, environmental variables that by and large determine the location of smelting. Fieldwalking in Upper Parrock, Hartfield has shown there to be many iron-working sites located here, which according to Tebbutt (1975) are situated on an outlier of Wadhurst Clay, which unlike the surrounding geology, contains iron ore (Tebbutt 1975, 147; Cleere & Crossley 1985, 95).

Tebbutt suggests that smelting would have been carried out close to where ore was mined and is supported at upper Parrock by evidence of ore roasting, paralleling other sites such as Minepit Wood (Money 1971, 88; Tebbutt 1975, 148). The evidence of more than one bloomery site at Upper Parrock, all interconnected by trackways (Tebbutt 1975, 148), would, like Crawley, indicate it represented an iron-working centre. However, if Upper Parrock's existence was purely as a result geological factors, can it be defined as a centre of production, which implies some form of central organisation, in the same way as other locations have been? Other centres of production according to Delany are found in the upper courses of small streams feeding into the dominant river systems, to supply water-power (Delany 1921, 9). Minepit Wood, similarly located on Wadhurst clay, is also within an area with an abundance of oak (Money 1971, 86), necessary for charcoal fuel. Again, natural determinants seem to be the dominant factors in dictating site locations. While sites reliant on natural factors do not exclude them from being centres of production, they do indicate they held a different status to others that may have been deliberately founded, such as Trellech in Monmouthshire, founded by the De Clare's, as a specialist iron working centre (Evans 2018).

The term centres of production also implies, perhaps falsely, that such centres employed ironworkers on a full-time and year round basis, and that such centres supported economies completely dependent upon the iron industry. Comparison with other regions suggests that iron smelting was carried out on a more seasonal basis, such as the Forest of Dean, where in the 13th Century, smiths and their forges were opportunistic and not fixed to specific locations (Richards 1925, 7; Foard 2001, 72). Schubert (1957, 125) explains how 13th century accounts relating to the Forest of Wensleydale, Yorkshire, describe itinerant forges as small sheds ‘without nail, bolt or wall’. An account from 1234 for Glaisdale in Cleveland records how these sheds were 20 feet long and 12 feet in width (Schubert 1957, 125). Labourers were therefore not necessarily employed as ironworkers at all times of the year, their employment was potentially highly variable depending upon supply and market demands in a given year. There is no reason why the same cannot be said for the Weald, and the smaller scale bloomery sites at Upper Parrock (Tebbutt 1975), may suggest they were only in operation for a single season or short period.

If centres were in existence by the 13th century, the circumstances under which they originated remains unclear. It is possible that they were in existence as early as the Anglo-Saxon period, and the Domesday reference to a ‘ferraria’ in the East Grinstead area (Tebbutt 1982, 31-32) could suggest it represents an early centre of production, as iron was important enough here to warrant a Domesday entry. However, can a single reference really be taken as conclusive proof of the existence of an iron economy or production centre, or was Domesday simply recording the ferraria for its abnormality? An examination of the broader historical context may provide some clues as to the prerequisites needed for centres to develop. At times the industry appears more intensive, particularly by the reign of Henry VIII, when a series of acts were passed to protect the forest from the destruction it was suffering by the ironworkers using it to fuel their furnaces, a problem that was set to continue into the reign of Elizabeth I (Delany 1921, 19-20). Furthermore, in periods of war such as those of the 14th century, there was greater demand for Wealden iron, seen in the supplies of arrows being produced for the London market (Richards 1925, 11). It was perhaps under this broader economic context that centres developed to meet the wider demands for specialist products. Such an explanation does not however consider the influence of local demands for iron, which arguably would have been more consistent across the period compared to the sporadic purchases made by the Crown. And yet the absence of local supply records poses challenges in assessing fluctuations, or increases in iron supply that may help identify dates at which economic demand was able to support the development and sustainability of such centres. The limited documentary accounts, may be creating a false impression of the scale of the industry at this time.

A critical limitation in understanding centres of production is the lack of dating evidence recovered archaeologically, particularly when assessing how such centres can be defined. Crawley is currently referenced in the literature as a centre of production based on the archaeological evidence of large-scale industrial activity, identified through a series of excavations at London Road, High Street, Ifield Road, and Spencers Road areas of the town (Stevens 1997; 2006; 2008; 2014; Saunders 1998; Hodgkinson 2000, 24-26; Cooke 2001). If scale is a defining trait, accurate chronological dating is paramount in assessing whether clusters of ironworks, present at Crawley and Upper Parrock, were in existence at the same time, or whether the evidence reflects their movement in successive rebuilding periods, or later re-establishment. There are many instances where clusters of sites have not been satisfactorily associated to one another other than by physical location, such as at Tidebrook at Mayfield, Sussex. Here, one bloomery site was dated to the late medieval period by pottery evidence, however a further concentration of bloomery slag was identified 50 metres downstream whose relationship to the first site is unclear (Hodgkinson, 1990 (2), 3). Does this second slag concentration represent another contemporary site, a movement of the original site or an earlier/later period of use? It also raises the question of how a separate site can be defined and whether a concentration of slag constitutes a separate site? This debate is examined in Section 2.5.2.

One of the considerable challenges is identifying a narrow enough date range from the pottery evidence to assign chronological sequences to sites, as medieval pottery styles were often in use over considerable periods. A 13th century pottery date is only indicative of a hundred-year period, so one cannot determine whether all 13th century sites in Crawley were contemporary with one another, when some may have had short life spans and existed 50 years apart. This has the potential to alter the interpretation of scale dramatically. At Crawley, Hodgkinson suggests that the various pits containing iron slag around Ifield Road, Spencers Road, Haslet Road, and the High Street, may not form individual sites, but believes further excavation is needed to determine their relationships (Hodgkinson 1996, 2-3). Many of the sites investigated do not produce pottery evidence, for example at Hartfield, where, in 2000, three further bloomeries were discovered, none produced dating evidence, meaning the relationship between the three could not be established (Goodall 2002, 3-5). In such instances, a more scientific dating approach, such as radiocarbon dating needs to be adopted as a means of understanding the chronological relationship between sites. However, this has not been applied extensively to Wealden iron-working sites and can be problematic. For instance, at Hartfield, a possible Anglo-Saxon bloomery was dated by C14 analysis of charcoal to 660AD-1020AD with a 95% confidence level. However, a subsequent excavation here produced East Sussex Ware pottery from the late Iron Age or early Roman period (Hodgkinson 2010, 8-9).

1.4.4 - *The need to examine associated settlements*

While smiths appear to have been based in towns and rural settlements, little is known about where the smelters resided. The settlement morphology of iron-production sites remains a considerable gap in the literature, with many reports going no further than describing the iron working processes found there. At Upper Parrock Hartfield, Blandford (2011, 5) identified two bloomery sites with a nearby circular platform with no evidence of burning, which she suggested could have been used for habitation. This would support Tebbutt's conclusion that Upper Parrock was a detached settlement from the centre of Hartfield which became settled by a community of ironworkers (Tebbutt 1975, 150). What remains unexplained here is the underlying processes by which this colonisation occurred – was it a deliberate establishment of a centre, or one that grew organically from around the 13th century, peaking during the 14th century, when the documentary evidence indicates a growing population (Tebbutt 1975, 150). Evidence appears to suggest the settlement at Upper Parrock existed until 1500, which adds weight to the suggestion that sites like Upper Parrock were permanent centres, possibly inhabited by full-time specialists (Cleere & Crossley 1985, 95). Further research is required to determine how widespread associated settlement was with ironworks and how such a centre may have operated and interacted with the broader settlement economy and this will be considered in relation to iron-production at Roffey in chapters 3 and 4.

1.5 - The Rise of the New Industry?

To determine whether Crawley can be described as a centre of production and to identify whether other such centres existed, one needs to consider how centres came to exist. This will go some way in defining what constitutes such a centre, for if the current hypothesis that the iron industry grew throughout the period is to be accepted then a ‘centre’ may have encompassed very different guises over successive centuries.

Brandon (1974, 71) explains that from the 8th Century onwards, we see an increase in the number of land charters being produced. They highlight the three main land resources that were in operation at this time and include arable and meadow, sheep pasture, and swine grazing. Perhaps what must be noted here, is the absence of any reference to iron, specifically the extraction of ore from the landscape. It can be speculated that either iron-production had ceased to operate after the departure of the Romans, or that it was operating on such a small scale that it was not considered worth recording. The small-scale nature of iron-production during the Anglo-Saxon period would appear to be supported by the archaeological evidence of the few sites have been firmly dated to this early period, with the only conclusive of these being Millbrook, located on the Ashdown Forest (Figure 1.1) (Brandon 1974, 76, Tebbutt 1982). How permanently occupied this site was, is debatable and it is possible that such sites were only used on a more seasonal basis during the summer months. They certainly do not have the same characteristics of the more established Romano British settlements (Cleere 1974). However, even some of the Roman period sites are believed to be more sporadically used to meet local iron demand (Tebbutt 1979).

The question of whether iron-production in the Weald continued after the Romans left or was re-established at a later date, has yet to be answered. Hodgkinson argues that the furnace type seen at Millbrook parallels northern European examples (Hodgkinson 2000, 28) and this would support an argument made by Fleming that iron-production died out at the end of the

Roman period and was re-introduced through continental influences (Fleming 2012). This is supported by the furnace at Millbrook dating to the 9th century, where the 'non-tapping' bowl furnace is a design distinctly different to the tapping furnaces that both proceeded and succeeded it, but morphologically parallels continental furnaces of this date (Fig. 9) (Tebbutt 1981, 17-20; 1982, 19-34; Fleming 2012). However, as the only site of certain Anglo-Saxon date within the Weald (Tebbutt 1982, 31) can one really assume that Millbrook is typical of the industry at this time? Basing theories of re-establishment or continuity on such little evidence is unlikely to lead to a satisfactory explanation, particularly given the late date of the site (Tebbutt 1982, 19) and raises further questions such as if/when were slag tapping furnaces seen on 13th and 14th century sites re-adopted or was there continuity in furnace design and slag tapping furnaces were used alongside bowl furnaces? The current absence of evidence for widespread iron-production in the Anglo-Saxon period may suggest that centres of production were a later re-introduction and not a continuation of those existing in the Roman period. Such a conclusion assumes however that all evidence of Anglo-Saxon iron-production has been found and that production centres can be defined along the same parameters as the Roman and later medieval periods. Neither of these are likely to be the case and great care needs to be taken when making assessing this intermediary period.

When considering that the reference in Domesday to a 'ferraria' operating near to East Grinstead (Cleere and Crossley 1995, 87) could be like Millbrook, within the Ashdown Forest, it is possible that this area formed an early region for the re-establishment of the iron-industry (Fig.1.21). Cleere and Crossley explain that current archaeological and documentary evidence indicates a 'northern emphasis' for the industry, however this interpretation can only be based on a few documentary sources and a small number of excavated sites (Cleere & Crossley 1985, 95). Tebbutt (1982, 32) notes that it is in the East Grinstead region where many of the earliest placenames also occur, suggesting this is an early area of settlement within the Weald and therefore likely to be the initial area of iron-working focus. References to iron-working in Domesday are rare, not just for the Weald, but in other parts of the country, thus, assuming the East Grinstead ferraria is the only one, and that this was the nucleus of the industry in the early years of the Norman Conquest may be wrong. Margaret Richards

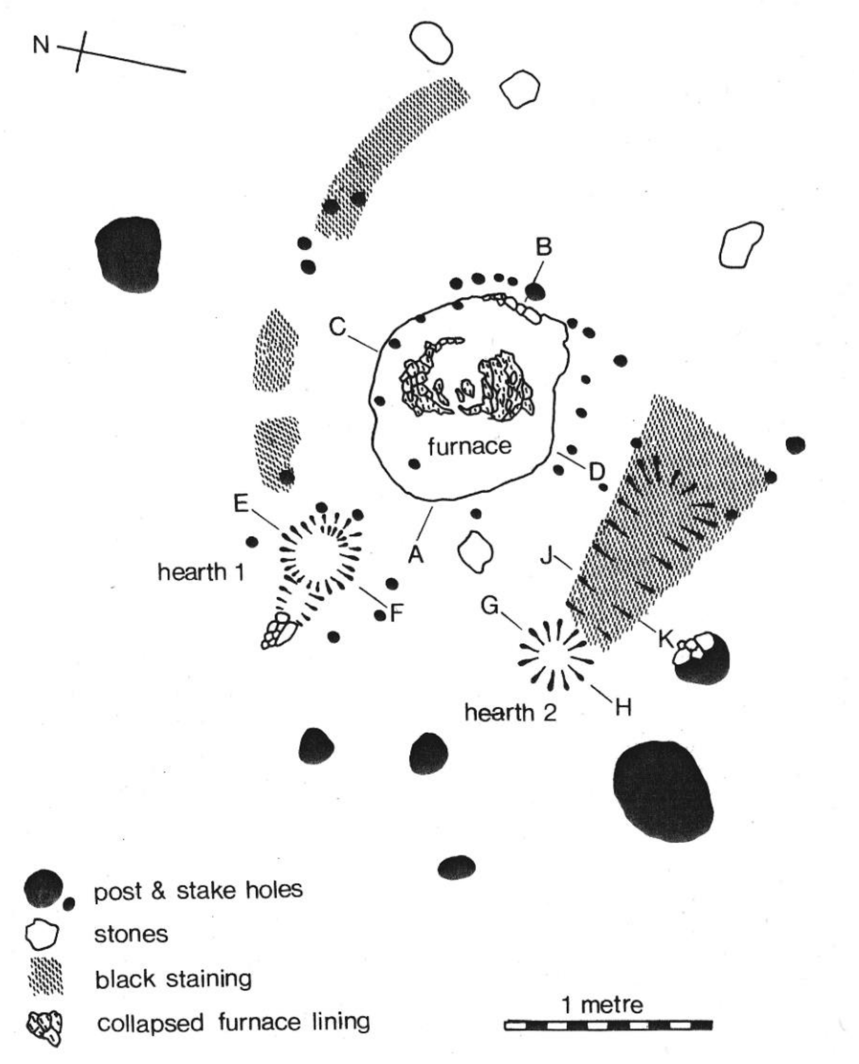


Figure 1.21 – *Millbrook on Ashdown Forest, dating to the 9th Century. Note the bowl furnace surrounded by smaller hearths. Image source: Tebbutt 1982; 24.*

(1925, 6), while admitting it is difficult to account for the absence of ironworks recorded in Domesday, does believe that Domesday would not have excluded a valuable resource like a forge or mine, had they been present. Richards also suggests that surviving accounts suggest iron was only produced to meet the requirements of their associated manors, which might explain their absence (Ibid, 6). The fact that East Grinstead was recorded however may say something about its scale or relative importance compared to others. Crawshaw (2022, 8-13) has suggested that a disputed iron mine at Lavertye, recorded in 1262, was on the same estate as the ferraria recorded in Domesday and that this estate had remained in the ownership of the same family. This potential continuity could suggest an industry of importance existed here and one that operated on a scale that remained economically viable. However, at the time of the dispute between Agnes Malameins and Isabel de Aldham, the mine had produced no profit following the death of Isabel's first husband (Cleere and Crossley 1985, 92). As the East Grinstead site has never been identified archaeologically (Pettitt et al 1970, 168), any assessment of scale is purely conjecture. Like the Anglo-Saxon period, the absence of evidence is again used as evidence of an absence of a widespread industry and yet this may prove not to be the case.

Little is understood about the driving forces behind the re-establishment of the iron industry or individuals who facilitated it. This is an area that has often been overlooked in the literature, perhaps due to limited historical sources, however for argument's sake, ironworks may be divided into three groups, none of which are mutually exclusive. These include sites controlled by a manor; sites attached to an ecclesiastical establishment; and ironworks that appear to be independent.

Beyond the Weald, Aston highlights the value iron had as a resource for monasteries, with ironworks often forming part of their landholdings (Aston 2000, 148). Abbeys, including Fountains and Byland, exploited woodland containing iron ore that they held within the Yorkshire Dales, while Flaxley Abbey held an ironworks at Elton in the Forest of Dean prior to 1154 (Aston 2000, 148). The fact that Abbeys such as Flaxley held an ironworks at such an early date may suggest ecclesiastical sites had a fundamental role in the re-establishment and growth of iron production through the 11th and 12th centuries. Cathedrals too were reliant on iron for their upkeep. At Exeter Cathedral, the Fabric accounts record how workers were paid to produce iron which in turn was used by smiths to maintain the Cathedral's structure, such as in 1318 when 120Ibs of iron was made for ironwork for the glass (Transl. Erskine 1981, 101).

In the Weald, a connection between ironworks and ecclesiastical sites is implied at Monktonhook Farm in Alford, Surrey, thought to have been a grange of Waverly Abbey. Here bloomery tap slag was found in association with 14th century pottery, suggesting a connection at this date (English 2002, 7-8). Chingley, near Tunbridge Wells in Kent, may also have formed part of the estate of Boxley Abbey (Cleere & Crossley 1985, 106-107). Bloomery slag was identified in a ditch separating the inner and outer precinct of Newark Priory, founded in the 12th century. A magnetometry survey subsequently identified four anomalies within the inner precinct, that potentially relate to industrial activity such as metalworking, but these have not been excavated and further work would be necessary to determine whether they postdate the priory (English 2009, 11-13). While English suggests it is unlikely that any furnaces would have operated in the inner precinct when the priory was active (English 2009, 12), the sites at Monktonhook and Chingley, offer the best evidence in the

Weald that some iron-working activity was under ecclesiastical control. Whether their influence contributed to the re-establishment of the industry or indeed if their ironworks can be seen as 'centres' requires further investigation.

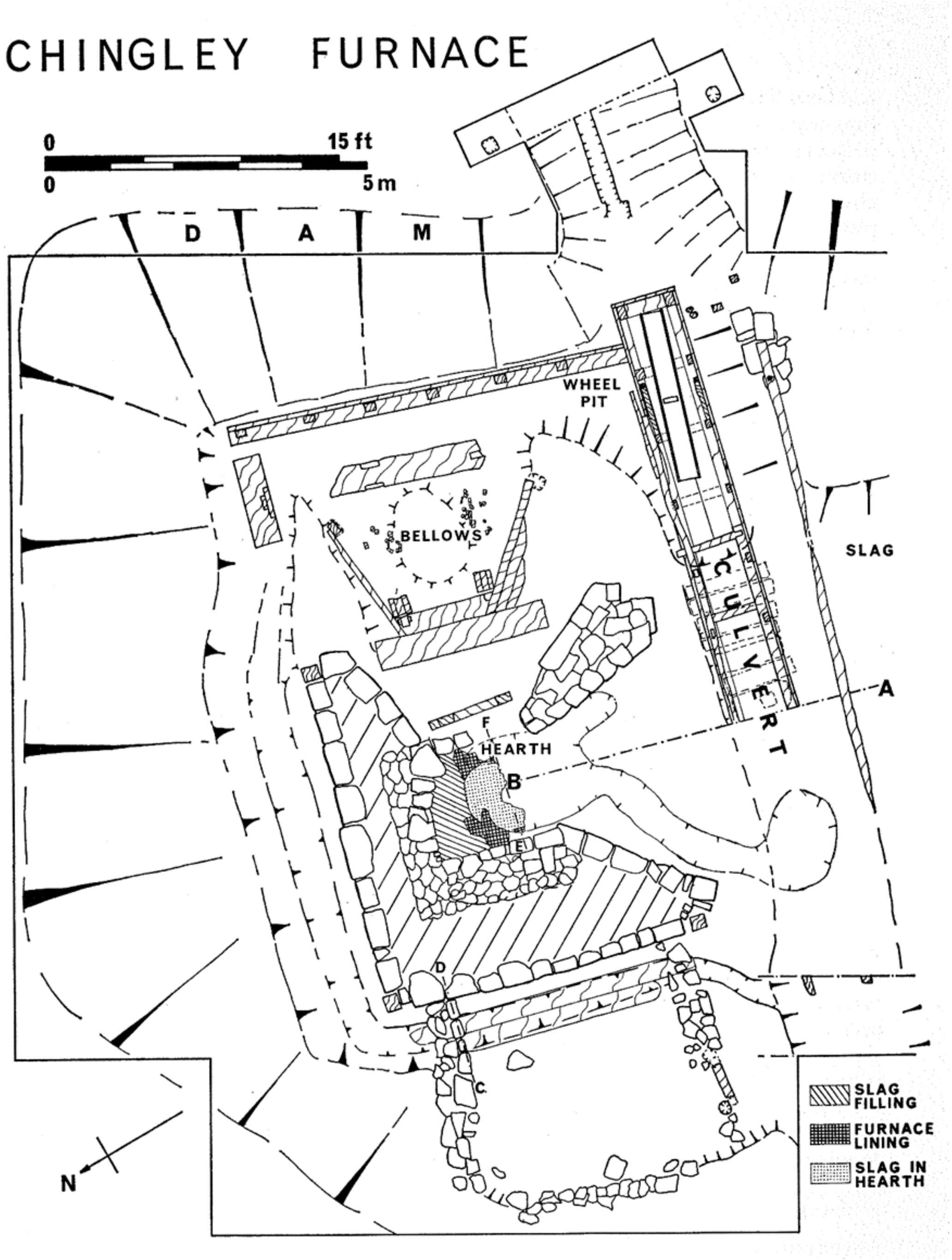


Figure 1.22 – *Chingley Furnace. Note the wheel pit alongside, suggestive of the use of water-power at the site. Image source: Crossley 1975; 31.*

A question that applies not only to the Weald but also on a national level is what led to the use of water-power at medieval bloomery sites and how widespread it was? We know that by the 16th century, early blast furnaces were reliant on water to power the larger furnaces and meet the high demand for iron. What is less well known is what facilitated the development of the blast furnace both from a technological and an economic perspective. Fleming (2012, 30) suggests that as early as the late 7th or early 8th century the site of Worgret in Dorset used water-power to operate the bellows or hammer. While this may also be true for the Weald, based on current research, water-powered furnaces developed from the 14th century, influenced by technological developments on the continent. Cleere and Crossley argue however there is not much explicit evidence for water-power in the Weald (Cleere & Crossley 1985, 106), perhaps more a reflection of the few sites that have been investigated than its lack of use. The Weald was well sourced by the rivers and tributary streams feeding into the Ouse, Medway, Arun and Adur rivers and Delany argued that centres of iron production were located within the upper courses of these streams (Delany 1921, 9). Lower (1849, 203) states that sites were chosen for their access to ore and where there was a source of water-power. While this does not necessarily mean that water was used to power the bellows, there is archaeological evidence from Chingley Forge, excavated ahead of the construction of the Bewl Valley reservoir (Crossley 1975, 6, Cleere & Crossley 1985, 107). Excavation here revealed a mill race consisting of burnt oak timbers that date of 1300 in the first of three wheel pits (Crossley 1975, 6) (figure 1.22). This could suggest that there were changes in the iron economy during the 14th century that required Wealden ironworkers to intensify production through the use of water-powered furnaces.

Evidence elsewhere in the Weald suggest other sites were water-powered. There are references made to 'pond bays' in association to medieval sites such as at Roffey, where Hodgkinson speculates that the slag found adjacent to a pond bay may suggest the site was water-powered (Hodgkinson 2000, 29, Anon 1983, 3). Similarly, at Tudeley, Straker noted the possibility of a pond bay, and yet like Roffey, it remains unconfirmed and is not supported by any references in the Tudeley accounts (Straker 1931, 220; Tebbutt 1979). On this evidence, water-power was potentially a more widely used practice during the medieval period than previously thought, and yet the lack of excavation of such sites and surviving documentary accounts means that at present this cannot be confirmed (Cleere & Crossley 1985, 107). While Chingley remains a strong candidate, a limitation with this site is that the water mill may not relate to iron-production, but the milling of grain. Scrap metal objects at the site also suggest other industries were taking place there (Crossley 1975, 14).

While there is a need to determine how widespread the use of water-power was, there is also a need to identify what economic factors led to its development and the subsequent transition to the blast furnace which is thought to have been introduced into the Weald through the influence of French immigrants who started arriving sometime before 1496 the first blast furnace was founded at Newbridge (Cleere and Crossley 1985, 113). Water-power must also be considered in association with the idea of centres of iron production. It is important to note that the bloomery evidence found at Crawley was not associated with streams or water-power. If Crawley was a centre for iron-production, the apparent lack of water-powered technology would make it somewhat old fashioned and less efficient by the 14th century. It raises the possibility that there were a greater number of bloomery furnaces at Crawley to keep up with demand for iron in the 14th century, but not necessarily representing multiple sites, while single water-powered bloomeries were still centres and had the ability to produce larger quantities of iron in their own right.

There is also the question of whether centres of production declined after the adoption of the blast furnace. At Crawley, iron working evidence does not appear to extend beyond the 13th/14th centuries, and this could also explain the abandonment of iron sites such as in Hartfield, indicating an industry moving away from centralised settlements (Cooke 2001). It is suggested that blast furnaces were constructed on the sites of earlier water-powered bloomeries, which would indicate that the more isolated bloomeries were preferentially adopted, however Chingley appears to have been abandoned soon after the middle of the 14th century and was not re-occupied until the late 16th century (Crossley 1975, 16-18). Such a gap would not imply the technological evolution of water-powered sites. The term ‘decline’ is perhaps unfairly used for this period and the course of the medieval period in the Weald should be seen as the period of evolution and experimentation (such as with water-power) that led to the great industrial age of iron-working for the Weald in the 16th to 18th centuries, when the Weald became famous for its firebacks and cannons. In other regions iron-production did decline during the medieval period. In Northamptonshire for example, iron-production all but disappeared by the 15th century, however the reasons for this remain unclear (Foard 2001, 80). This raises a question over what allowed iron-production to be sustained throughout this period in the Weald that allowed it to grow into such a successful industry in the post medieval era?

1.6 Technology and the operation of the industry

Iron smelting relies on the coming together of many separate processes to create a bloom of raw iron. Initially a site of suitable iron ore needs to be located, and the geology of the Weald was particularly favourable for sourcing such ore. Delany (1921) explained that the most significant strata that contained iron ore included the Hastings Beds and Weald Clay. Within these, carbonate ores can be found both as nodules and tabular masses, which could be accessed through mining (Leahy 2003, 111; Delany 1921, 7-8). Extraction of this ore took place during the Roman period and the same sites were often exploited in the late medieval and post medieval periods, meaning it is often hard to accurately date earthworks associated with ore mining (Cleere & Crossley 1985, 98). Multi-phases of use can result in the destruction of earlier mining phases by post medieval operations. Ore was more commonly referred to as 'mine' in the Weald and has led to many associated place names such as 'Minepit Wood' that attest to ore mining having taken place there and is supported by earthworks of bowl-shaped pits close to the smelting site (Money 1971, 88) (fig. 1.23). Archaeological reports of medieval iron-working sites in the Weald, show a correlation between sites of ore mining and proximity to smelting sites. This was found to be the case in Upper Parrock where, in Paternoster Wood, a series of hollows in a field close to where bloomery slag was found may have been mine pits (Hodgkinson 2000, 28). On the other hand, other sites such as Millbrook, appear to show a different pattern, with no apparent ore mines within the vicinity. It is possible that the source of the ore has not been located (Tebbutt 1982), however it is plausible that in some cases ore was brought in from further afield.

Figure 1.23 – *Reconstruction of Minepit Wood. Note how the furnace was enclosed and yet activity such as ore roasting took place outside the smelting enclosure. If Minepit wood represents the typical layout of the Medieval ironworks, one might expect to see something similar at the Tudeley site. Image source: Money 1971, 110.*

Charcoal was the second material needed in the production of iron as the source of fuel and required careful woodland management with the application of practices such as coppicing to produce it (Cleere & Crossley 1985, 99). Charcoal production is often given little attention in archaeological investigations, however it formed a significant industry in its own right. The Tudeley records suggest that the blowers who operated the furnace were not producing the charcoal and that this was a separate industry. In some years charcoal was produced within the manor or 'The Lady's estate' while at other times it was brought in from outside of the estate (Giuseppi 1913). While we must not assume that Tudeley was a 'typical' ironworks in the absence of an excavated site, if other full-time ironworks like Tudeley did exist, it has to be assumed that a separate charcoal industry, linked to the iron, existed as well. Earthwork surveys have identified charcoal platforms at Hartfield, with as many as 15 existing here. This would suggest the fuel was made close to where the iron was produced (Blandford 2011, 5). Paternoster Wood at Hartfield also featured ore pits, coppice stools and areas of blackened soil from charcoal burning and clearly a variety of processes were taking place at this site (Hodgkinson 1991b, 5). While mine pits typically lack dating evidence, charcoal platforms, offer the possibility of radiocarbon dating. However, the lack of excavated examples of these platforms within the Weald means their full potential remains to be utilised.

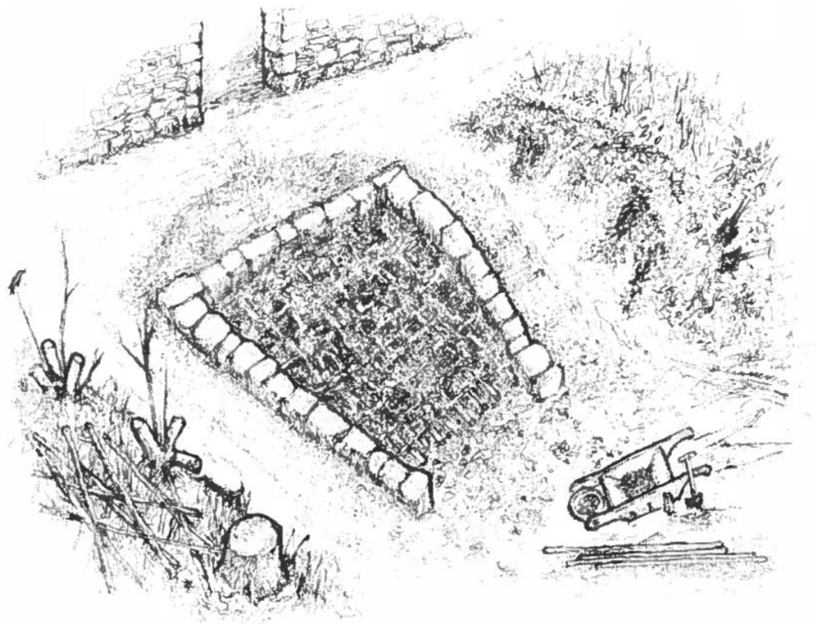


Figure 1.24 – *Medieval ore roasting hearth II, lined on three sides with stone, found at Minepit Wood. Image source: Hodgkinson 2008; 16. Illustration by R. Houghton.*

Ore preparation, in the form of roasting, appears to have been carried out close to the area of smelting in excavated examples, although not necessarily in the main areas of smelting and forging. Hodgkinson (2008, 15) suggests for safety, ore roasting may have taken place away from the main working areas at sites. Roasting and smelting furnaces alongside sheltered areas were identified at Minepit Wood, indicating that while there was a differentiation between the two processes, they took place at the same location, although ore roasting was carried out outside the main enclosure (Money 1971, 88; Hodgkinson 2008, 15). The roasting hearth (II) formed a three-sided stone platform, replacing an earlier hearth of an oval shaped hollow dug into the clay (Money 1971, 88, 92; Hodgkinson 2008,15). Roasting requires heating the ore to between 500°C and 800°C and was intended to oxidise the carbonate ore which enabled it to reduce more easily within the smelting furnace. The process also reduced the water content, made the ore more permeable to allow furnace gases to penetrate, and fractured it into a friable consistently sized charge (Money 1971, 88, 92; Hodgkinson 2008,15, Tylecote 1986, 131; Leahy 2003, 111) (fig. 1.24).

There are no descriptions of smelting furnace design within medieval documentary sources (Cleere & Crossley 1985, 100) and archaeologically only the furnace base is usually recovered during excavations, along with fragments of vitrified furnace lining. A complication with dating furnaces is that its basic design underwent little change from the late Iron Age to the late medieval periods (fig. 1.25). The exception to this is the bowl furnace, characteristic of the Saxon period and present at the 9th century site at Millbrook (Tebbutt 1982, 19-34, Leahy 2003, 114). Unlike the Roman and later medieval furnaces that allowed slag to be ‘tapped’ and run off from the furnace, the slag collected at the furnace base, forming a ‘slag cake’. The Tudeley accounts provide an insight into the day to day running of the bloomery that is not necessarily going to be evidenced archaeologically. We know for example that the bellows were operated by four blowers and that during the 14th Century, the four smiths were paid piecework and were given every seventh bloom (Cleere & Crossley 1985, 100, Straker 1931, 35). They appear to have produced around one bloom a day on average (Straker 1931, 35).

Figure 1.25 – *A typical slag tapping furnace design found on Roman and Medieval sites within the Weald, but different to the Anglo-Saxon bowl furnace which does not allow slag to be tapped but collect in the base of the furnace. This furnace was built by the Wealden Iron Research Group to carry out experimental smelts. (Author's image).*

1.7 - Routeways, trade, and interconnectivity

While clusters of sites at Crawley and Hartfield have suggested these were centres of production, there is also the question of how sites, such as Tudeley correspond with this definition, particularly when the accounts at Tudeley suggest other ironworks were situated on the Southfrith estate. Other sites such as Minepit Wood appear isolated, and yet may still have held a local significance. Money for example noted the remoteness of the 14th and 15th century ironworks at Minepit Wood, where there were no nearby public roads or tracks to the site (Money 1971, 86). It is likely that at these sites, the original access has disappeared, however the need for more research into site accessibility and inter-connectability through routeways is apparent, to develop an understanding of how economically they were linked. Crawshaw explains that such an approach is needed to clarify the location of Tudeley and has demonstrated the benefits of such an approach in her research into the Sow Track (Crawshaw 2018). With the exception of some discussion of how ironworks were linked via tracks to their sources of raw materials, previous approaches have often not included analysis of how ironworks fitted in to the broader network of routeways. Crawshaw's approach to the Sow Track therefore serves as a template of how other ironworks may have once been more interconnected.

The trade in Wealden iron could also be studied through other artefacts that show interconnections with other regions. Pottery is one possible source of evidence. At Crawley, for example, 13th century anthropomorphic jug sherds were found alongside bloomery slag not far from the High Street an area in which other iron-working evidence has been found and suggests there was some level of trade and exchange with Earlswood in Surrey where the jug was made (Gardiner 1989, 247-248). Gardiner notes how similar Earlswood type pottery has been found in Lower Parrock (Hartfield), which is again relatively close to ironworks (Gardiner 1989, 248). While such links through pottery are speculative, a more detailed analysis of pottery evidence and its origins may be significant and is carried out in relation to the pottery assemblage found at Roffey in Chapter 4. The Roffey assemblage also included an anthropomorphic jug fragment.

1.8 - The need for further research

Three primary research enquiries need addressing to further our understanding of the medieval iron industry of the Weald. These include the origins of the industry; the type and scale of sites that existed and their economic importance;

and how iron-production fitted within the broader industrial and economic landscape.

Whether the re-emergence of the industry during the Anglo-Saxon period represents a re-introduction or continuity of iron production from the Roman period remains open to debate. Caution should be taken when basing these debates on Millbrook, the only major site excavated, in the absence of other sites of this early period. While this question does not fall within the remit of this project, it does have a bearing on understanding under what circumstances there was a transition from remote rural sites like Millbrook to a potentially larger-scale urban context seen at sites such as Crawley.

On current evidence, Crawley does appear to have had an economy based on iron, however the extent to which Crawley was unique in this is uncertain. Determining how widespread sites such as Crawley were requires the examination of a comparative example, and as such Roffey, which has both documentary evidence and potential for a wider archaeological survey, is the most suitable candidate and will be carried out as part of this study. There is also a need to understand how manorial iron-working sites such as Tudeley fitted into the economy. Unlike Crawley and Roffey, Tudeley does not appear to represent a cluster of sites or production centre and yet the records suggesting it produced a bloom a day indicates specialist ironworkers were employed and it met either local or wider market requirements. Furthermore, Tudeley is the only well documented ironworks in the Weald and yet has never been conclusively identified archaeologically. Its discovery would allow a unique comparison between the historical and archaeological record and help validate the conclusions made on other medieval bloomeries that have used the Tudeley to illustrate their interpretations. Tudeley, with its references to other ironworks and related industries, also offers the opportunity to take a broader landscape approach, to understand its place within the wider economic landscape and the archaeological traces related industries have left. The same is true of Roffey, and how it relied on both resources from the wider landscape and interconnections from trade routes is important to consider and whether it displayed the same form of landscape connections as Tudeley.

1.9 - Working Hypothesis

A working hypothesis, based on the current evidence is that there were three 'site types' in existence in the Weald during the period. The first type could be termed 'centres of production', clusters of permanent ironworks sometimes within an urban context and featuring full time specialists engaging in local and long-distance trade. The documentary evidence implies Roffey may fall into this category, with its trade links to London, while the archaeological evidence for Crawley, with its density of sites may suggest this too was a centre of production. The second type could include manorial or ecclesiastical estate centres, featuring singular furnaces, which served the needs of the estate, whether monastic or secular, or a smaller local trade network. Examples of the second type may include Tudeley and Minepit Wood. The third type can be defined as non-permanent and moving around the landscape to where sources of ore, or the demand for iron, were present. These were not necessarily worked by full-time specialists and may be more characteristic of earlier periods, such as the Anglo-Saxon site of Millbrook. Later sites such as Upper Parrock may also represent this, based on the clusters of small bloomeries here, within a woodland context, and this site type may account for many of the small undated bloomeries recognised within the Weald. The third type may be comparable to movable forges observed in the Forest of Dean (Foard 2001).

These categories may be too arbitrary, and sites such as Tudeley may feature elements of both the first and second types, in that while managed by an estate, the iron exchange potentially had wider connections with other holdings by the de Clare family. An investigation thus must take into consideration each of these potential site types, to examine the extent to which these are valid classifications.

1.10 - Research questions

This project will focus on three specific research questions. Firstly, it will consider the 'types' of iron-production sites that were in existence in the Weald by the 14th century. Type here is defined along the lines of scale, morphology and the stages of iron-production taking place at a given location and uses the working hypothesis above as criteria to test case study sites against. As part of this, the question of centres of production will be considered and whether these are present within the Weald and if so, along what lines can they be defined?

The second research aim is to place iron-production within a broader economic context. This can be done at a both a settlement level looking for other industries that may have operated alongside iron-production; and from a wider landscape perspective, identifying related industries such as charcoal production and ore extraction and how these were interconnected.

Finally, the project will make a comparison between the archaeological and historical record, and the extent to which two different sources of data may complement interpretations. The scarcity of historical documents pertaining to iron-production during this period has been discussed, and the accounts of Tudeley and Roffey make these sites particularly important in conducting an archaeo-historical study to consider these research questions.

Chapter 2 – Research Strategies

This chapter begins by outlining past methodological approaches to investigating iron-production sites within the Weald, beginning with the early historical analysis carried out by Mark Antony Lower and Montague Giuseppi, through to the fieldwork of Ernest Straker and more recently Henry Cleere, David Crossley, Charles Tebbutt, Brian Herbert, Jeremy Hodgkinson, and the Wealden Iron Research Group (WIRG). It will go on to consider the two case study sites and the reasons why they were selected. Finally, there is a discussion on the methodological approaches applied to their investigation, including reconnaissance surveying, fieldwalking, geophysics and macromorphology and how these methods have been successfully used elsewhere.

Chapter contents

Chapter 2 – Research Strategies

2.1 - Introduction

Ironworking, while once a major industry in the medieval period, is an activity often overlooked historically, primarily due to the sparsity of documentary references to its technological operation and the individuals involved. Literature on ironworking often refers to the Weald as a major locus of production, and yet upon closer inspection this conclusion is largely based upon the industry that flourished in the 17^{th} and 18^{th} centuries and generally assumes that earlier periods paralleled this. While the Weald has had more research than other regions into medieval iron industry there are still questions of origins, scale of production and of the nature of iron-production site that remain not fully answered.

This thesis examines two case study sites, Tudeley and Roffey (fig. 1.1), which were identified as potentially representative of different 'types' of iron-working sites within the Weald, specifically in scale, topographic location, morphology and in the stages and processes of iron-production. The methods used to investigate these sites were adaptive both to accommodate differences between locations, and to examine and elaborate on findings from previous stages in the investigation. Methodological approaches included an initial desktop assessment to contextualise previous archaeological research and re-assess historical evidence for each site. The application of a placename survey was also important in providing indications of past land use, ownership and landscape features. This desktop and placename assessment in turn identified locations visited on reconnaissance surveys, which were used to record surface evidence of iron-production, establish the potential of sites, and examine the wider landscape context in which sites were situated. Systemised fieldwalking and earthwork surveys then assessed the extent and morphology of sites identified during the reconnaissance survey and allowed a technological assemblage to be collected for subsequent classification, while geophysical surveying using magnetometry and resistivity analysed the nature of features not necessarily visible at ground level and their spatial distribution. An overarching theme to the project was the comparison between the archaeological and historical record. Sites were selected based on their associations with surviving documentary material and the fieldwork strategies aimed to both challenge and complement the evidence these records presented.

2.2 - Past methodological approaches to ironworking in the Weald

2.2.1- *Early work*

It was in the mid 19th century that an appreciation of the Weald's iron-production heritage first began, with an initial report published by Mark Antony Lower in the 1849 volume of the Sussex Archaeological Collections, the journal of the newly founded Sussex Archaeological Society (Lower 1849). At this time, early research was generally based on fortuitous observations by local antiquarians and members of the clergy, rather than any deliberate attempt to study the iron industry within an archaeological framework. In Lower's article, he recorded how the Revered Edward Turner observed as Roman iron slag was unceremoniously removed at Maresfield by entrepreneurial Victorians, making use of it as road building material (Lower 1849, 171). Nevertheless, its discovery prompted researchers, including Lower, to consider the historical context in which the iron industry had once operated, and begin asking the research questions that future studies would seek to address (Lower 1849, 177).

It was not until the early 20th century that an approach recognisable as 'archaeological' was used to investigate Wealden iron-production, principally in the work of Ernest Straker, who in his explorations of the landscape, identified and recorded surface evidence of earthworks and scatters of slag, eventually publishing a gazetteer of his findings in 1931 (Straker 1931). Straker was a pioneering figure in the identification of iron-production sites, through active fieldwork and historical research. His monograph 'Wealden Iron' for many years was the primary gazetteer on the existence of sites and set out many of the fieldwork methodologies that are still applied today by WIRG (Wealden Iron Research Group), including fieldwalks or 'forays' (fig. 2.1).

While Straker was able to identify sites he considered 'medieval', Cleere and Crossley (1985, 96) suggest a limitation to his methodological approach was that he lacked field material that allowed his sites to be dated to this period. The most notable example of this is Straker's proposed site of Tudeley where he connected the site to the Tudeley accounts based on association of location with Southfrith and Tudeley Village (see Chapter 5) (Straker 1931, 220; Cleere & Crossley 1985, 97). Straker (1931, 220) does however acknowledge the need to further examine his Tudeley site, evidently aware of how site morphology and dating evidence could provide supporting evidence.

Straker's use of placenames within his research in locating ironworks, is a method that can be highly suggestive of a site's association to iron-production (Straker 1931; Field 1993, 212). However, as Cleere and Crossley (1985, 97) explain, the use of placenames in Straker's case have not always been conclusive. They quote the case of Hammerden, near Ticehurst, where 'Cinderbanks' and 'Cinderbank Shaw' suggested nearby ironworking (Straker 1931, 297), however upon visiting the site, the material found was un-datable and there was no supporting documentary evidence. This point illustrates the limitations in relying upon one source of evidence (Cleere and Crossley 1985, 97). Placenames can have a tendency to become corrupted to a form that does not correspond to their original meaning and therefore are in themselves not conclusive proof of ironworking.

2.2.2 - *Field surveys*

Since the 1960s WIRG have built considerably on the work of Straker, and have been active in locating and recording smelting and smithing sites across the Weald. To date, identified sites number 688, however nearly half of these remain undated (wirgdata.org).

WIRG's primary approach has been the use of field surveys 'forays' (fig.2.2). Field surveys should not be confused with landscape surveys, as they are somewhat different in scale and objective. With the founding of the WIRG in 1968, a greater number of intensive field surveys across the Weald have taken place (Cleere &

Figure 2.1 – *WIRG on a foray to the site of Tudeley Ironworks in October 2021 (Authors image).*

Crossley 1985, 97). The field surveys, often referred to as ‘forays’, have involved groups of volunteers, professional archaeologists and historians, who explore the landscape and identify areas of activity. Such forays may follow streams (or ‘gills’) that at times cut through abandoned slag heaps from sites located near water sources to aid with the washing of ore (Schubert 1957, 17). In other cases, scatters of iron slag or soil marks have been identified in plough soil (Tebbutt 1975, 146). WIRG field surveys usually address one or more of four primary aims.


Figure 2.2 - *Slag recovered on a foray to Tudeley (Authors image)*

Firstly, to test the existence of an ironworks alluded to in documentary evidence; secondly, to further investigate reports of scatters of slag; thirdly, to re-examine previously discovered sites identified by researchers such as Ernest Straker, and finally to explore geologically promising areas that contain the necessary resource prerequisites for making iron. Such methods, while useful in identifying potential ironworks, are not without their limitations, primarily with the dating of the sites. The assumption that iron-production sites will follow common trends, such as placement near watercourses, also risks placing an emphasis on surveying these localities and omitting other topographical locations.

One of the larger field surveys in the Weald was undertaken by WIRG in 1976, and aimed to assess the density and dating of bloomery furnaces within a 182 km^2 area (Tebbutt 1981). Fieldwalking in this instance involved the exploration of stream valleys, a setting where previous surveys had shown was often favoured for iron-smelting. The survey demonstrated however that springs, hillsides and hilltops were occasionally used, and that geological availability of iron ore was in many cases a principal factor in determining location (Tebbutt 1981, 57). Non-typical locations also include Cinderhill at Leigh in Kent, which was found over a quarter of a mile from a stream, while at Hassocks, traces of consolidation and forging slag were found in a Middle Anglo-Saxon Settlement and yet no evidence of a bloomery or sources of ore were identified, indicating either unconsolidated blooms were brought in from elsewhere, or ore was brought in and smelted in as yet undiscovered bloomeries (see Chapter 1) (Herbert 1995, 8; Hodgkinson 1997; 2000, 41-42). These sites represent deviations on locations expected to contain iron-production evidence, and typically explored. They highlight the need for landscape surveys to be holistic, and not only focus on suspected and assumed locations of ironworks. Smelting did not necessarily always take place in the rural landscape close to water, while smithing was not necessarily confined to settlement areas. An adaptable survey strategy therefore needs to be applied, to identify the deviant as well as the expected locations. Questions also need to be asked as to why such variations are present.

Figure 2.3 – *Examples of Wealden slag typically recovered on a foray from a stream channel (Authors image)*

Slag, which is commonly recovered and therefore assumed to be an indicator of either smelting or smithing, is not easily dated (figs 2.2-2.3). It does have the ability to suggest processes in operation – smithing hearth bottoms will be different in morphology to smelting slags, while smelting slags present varying morphologies that relate to the furnace design from which they originated. A slag tapping furnace produces less viscous or runny slag and was commonly used in the Roman period, while in the non-tapping furnaces of the Anglo-Saxon period produce a cake of slag. On the other hand, tap slag is also produced in the medieval period, and thus its presence does not confirm whether the site was in operation in the Roman or medieval periods, however other attributes, such as glassy morphology does sometimes allow medieval slag to be distinguished from its Roman counterpart. Pettitt highlights how dating evidence for sites is rarely recovered (Pettitt, Archibald and Tebbutt 1970, 167). The dating of such sites is generally reliant on either the recovery of pottery, or a suitable charcoal sample that can be subjected to C14 dating, and these samples are mainly only recovered through excavation. The relatively little excavation that has taken place means that of the 688 bloomery sites identified in the Weald, predominantly through field surveys, only 197 (29%) have been dated (wirgdata.org; Pers. comm. Jeremy Hodgkinson).

2.2.3 - *Excavation*

Excavation has been more prolific since the 1960s, in part taking a research led approach through WIRG and local archaeological societies, while other projects have been development led, particularly with the growth of urban centres including Crawley. With different motivations and organisations involved, inevitably the aims of projects and the methods used have been highly variable, from basic reconnaissance surveys to extensive area excavations.

Research-led excavations

Research-based excavations have primarily been carried out by WIRG, whose field team lead a monthly volunteer excavation. These excavations tend to make use of test pits or small trial trenches rather than the large open area excavations typical of commercial and professional archaeology. Often slots will be dug through slag heaps with the aim of recovering datable pottery or charcoal that will aid with the interpretation of the size and chronology of a site. Equally, working areas including furnaces may be investigated if their positions can be located. Sometimes excavation comes as a follow up of field survey, such as in the case of the 1976 bloomery survey, where excavation was used to recover datable material from slag heaps on sites discovered during fieldwalking (Tebbutt 1981, 57-59). The excavation of slag heaps is often a primary target for research digs as they offer the most likely places to recover dating evidence such as pottery (Tebbutt 1981, 59). In the case of the 1976 project, 1m wide trenches were excavated across sections of slag heaps and as the study sought more to look at the distribution and dating of bloomery sites, as opposed to site morphology, it was considered that trenches of this size were unlikely to disturb other features, particularly furnaces, which due to their longevity of design, are harder to date (Tebbutt 1981, 59).

Other approaches have attempted to uncover the full extent of a site, such as at the excavation of three Roman furnaces in Hartfield and at Pippingford (Tebbutt 1979, Tebbutt & Cleere 1973). In both cases the supposed working areas, identified at Pippingford by a levelled platform terraced into a natural slope, had their turf removed and trowelled down to the working floor to reveal site layout (Tebbutt & Cleere 1973, 28; Tebbutt 1979, 47). Excavation at Hartfield revealed three bloomery furnaces with associated re-heating hearths, while the second found a furnace, pit, smithing hearth and slag heap (Tebbutt 1979, 48-51, Tebbutt & Cleere 1973, 28-32). Such 'area excavations' are used to identify the extent of sites, by defining its boundaries, not always possible with test pits. At Hartfield, the site edge could be recognised by the discontinuation of the working floor and the dumping of slag and cinder just beyond the boundary (Tebbutt 1979, 47-48). While this approach to excavation allows the full morphology and the extent of the site to be recorded, it has the disadvantage of being labour intensive and not always feasible in confined locations, such woodland. It also does not always allow the recovery of datable evidence. At Pippingford for example, no datable evidence was found within the open excavation of the working platform, however in the three smaller trenches dug through the slag heap, Romano-British pottery was recovered (Tebbutt & Cleere 1973, 32).

Development-led excavations

Most excavations have been commercial or rescue-led, ahead of development and with the primary aim of recording the presence of archaeological remains, as opposed to focussing on specific research questions. WIRG have been consulted at times, and have undertaken excavations, including Millbrook in 1980, where the 9^{th} Century bloomery was discovered and quickly excavated during the laying of a new pipeline across Ashdown Forest (Hodgkinson 2000, 28). The excavators had one week to excavate and record a site that gave a rare insight into the Anglo-Saxon iron industry of the Weald (Tebbutt 1982, 19). Equally, Crawley which offers substantial data on the industry in the 13th and 14th centuries within a settlement context, has almost completely been studied through developer-led excavations at various sites within the High Street, Ifield Road, Spencers Road and London Road areas of the town (fig. 2.4) (Stevens 1997; 2006; 2008; 2014;

Saunders 1998; Hodgkinson 2000, 24-26; Cooke 2001). Arguably, without the same aims as a research excavation, locations like Crawley can only be assessed through the patchwork of sites across the town, and many questions can only be addressed indirectly, such as what was the overall scale of the industry and to what extent was Crawley typical in its apparent focus on iron-production? Hodgkinson (1996, 2-3) states that for some of the excavations at Crawley, we should not assume that we are looking at separate sites. The inability to carry out research-led open area excavations, or strategically placed test pits, therefore results in an incomplete picture of the site, suggesting large scale production that may in reality consist of a small number of separate or independent sites, with no clarity on whether they are contemporaneous, contiguous or discrete.

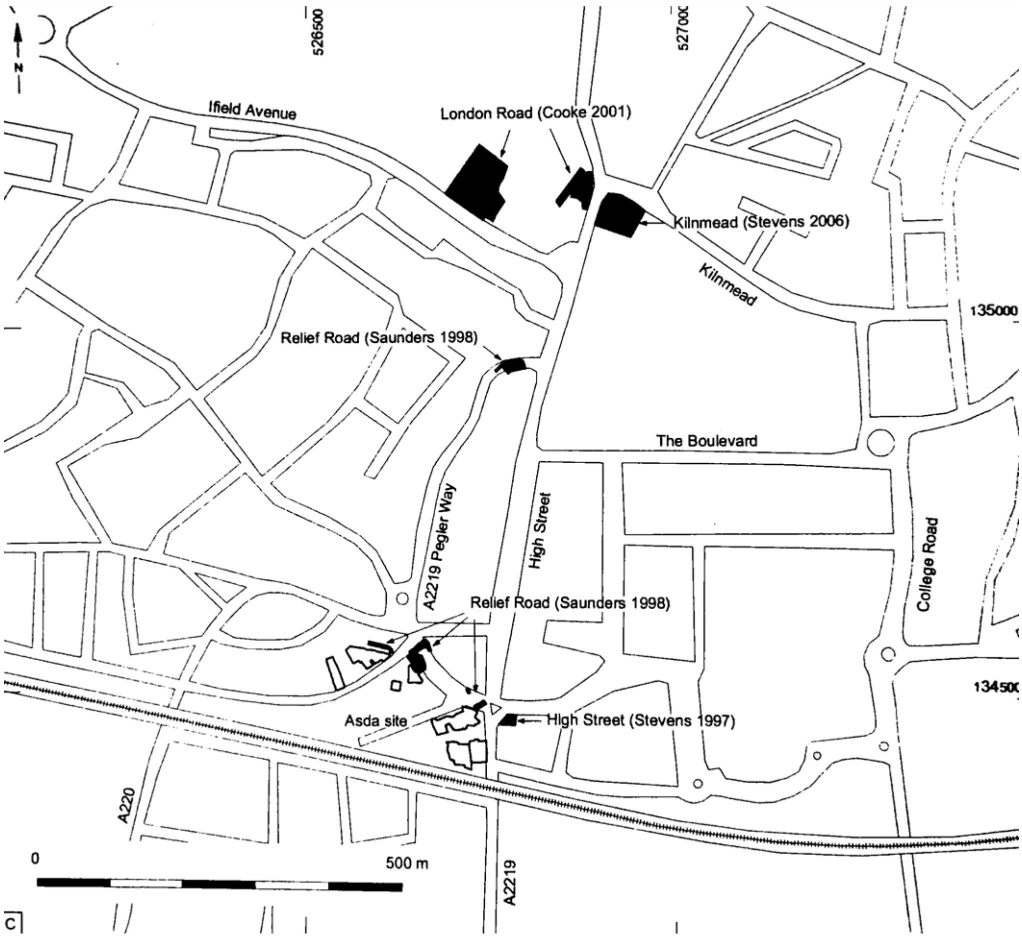


Figure 2.4 - *The distribution of excavations that have been carried out in Crawley. From Stevens (2008, 108).*

Nonetheless a number of developer-led excavations of Wealden ironworks have tended to produce detailed records and fieldwork reports. For example, Simon Stevens, a Senior Archaeologist for Archaeology South-East has supervised many of the Crawley excavations and is himself a member of WIRG, who are consulted within these projects. Others have had less success, with Roffey being an example of a short rescue excavation ahead of road widening that apart from a pottery report and site plan, produced no full excavation report for the complete site (Hodgkinson 1986, 3) and the absence of a site reports for these makes it difficult to assess the full significance of this potentially important site (see Section 3.6.6).

2.3 - Identifying case studies

To understand the nature of medieval iron-production in the Weald for this research, it was important to select case study sites that incorporated three specific elements. Firstly, the sites needed to allow both the iron-production site and the wider landscape context to be surveyed. As previous research has generally not contextualised iron-production alongside associated other industries such as charcoal production and ore extraction, or the transport of such resources, the sites needed to hold the potential for the identification of these, through a landscape reconnaissance approach. Secondly, it was important to identify site 'types' or more specifically sites that represented apparent differences in scale or morphology, that would facilitate examination of the notion of 'centres of production', and the criteria for what constitutes such a centre, if indeed they existed, to be critiqued. The initial working hypothesis based on a review of the literature was that sites could be classified into three categories – small-scale seasonal smelting sites that could represent a level of mobility; permanent ironworks attached to manors or ecclesiastical estates, potentially with both smelting and smithing in operation; and finally, ‘clusters’ of permanent full-time ironworks within an urban context, perhaps with the addition of smiths producing specialist products. The last of these categories may include sites such as Crawley, which the literature has previously termed a centre of production (Hodgkinson 2008), however it was important not to exclude the other two categories, which in themselves might challenge previous assumptions of what represents a centre. The third element that the case study sites needed to address was the relationship between archaeological and historical sources to determine whether the few ironworks that retain documentary accounts were typical, or in some way different to their unrecorded counterparts. While historical accounts of iron-production during the medieval period are rare, the exclusion of analysing the few sources that do exist, would risk losing a valuable data source, which had the potential to complement the archaeological record (Bayley et al 2008, 23).

2.3.1 - *Gazetteer of medieval ironworks in the Weald*

Initially a gazetteer of known medieval ironworks in the Weald was created, using data from the WIRG online database along with published literature including Straker (1931), Hodgkinson (2008), and the WIRG Bulletin. Compiling this data into a standardised form, enabled location, known site date, and historical and archaeological data to be considered and cross compared to look for any significant trends. The gazetteer also enabled an initial assessment of ‘site types’. While only a limited number of sites have been excavated, other sources of data such as earthwork surveys, reports of site visits, and historical accounts were used to make inferences about site morphology and scale which were included within the gazetteer. Much of the current literature classifies centres by the scale of activity, i.e., the number of ironworks that have been found there or the estimated output of a known site. However, the gazetteer considered other criteria that centres of production may be defined by, such as the level of permanence i.e., seasonal operation or the employment of full-time specialists; how far reaching its trade in iron was e.g., did it meet local demands or supply long distance markets; or the types of products it was producing e.g., was it supplying unworked blooms or were manufactured products also an output. The gazetteer also outlined potential criteria for non–centres of production, again based on scale, but also other factors such as lack of access to trade routes. The gazetteer is inevitably limited by the level of investigation that individual sites have already undergone, which varies considerably.

2.3.2 - *Case study sites*

Roffey

Based on the gazetteer, Roffey formed a suitable candidate for a centre of production if a centre is defined by scale, evidence of manufacturing specialisation and access to extended trade networks. Some documentary evidence survives for Roffey, however not to the same level of detail, recording

Figure 2.5 – *Roffey today, with much of the landscape consisting of large open arable fields. (Authors image).*

instead specific events rather than annual accounts. And yet, unlike Tudeley, the documentary evidence can be linked to a specific archaeological site (Hodgkinson 2008, 42). It is recorded in the 1327 Sheriff's accounts, that the Sheriff of Surrey and Sussex, Peter de Worldham, was allocated £4 3s. 4d for 1000 horseshoes, with an extra 3s for the carriage of the horseshoes from 'Le Rogheye', where they were made. They were then taken to Shoreham on the South Coast. At Shoreham they were packed in barrels and shipped to Newcastle-Upon-Tyne (Durrant Cooper 1865, 117; Straker 1931, 442; Hodgkinson 2008, 40).

At the supposed site of 'Le Rogheye', today spelt Roffey, to the east of the town of Horsham, limited excavation was carried out in 1985 by Horsham Museum Society. While the excavation report was unpublished, it is understood that building foundations, which possibly enclosed a smithing hearth, were uncovered (see Section 3.6.6) (Hodgkinson 2008, 40). An adjacent pond bay may indicate the use of waterpower (Anon 1983). Pottery found at the time suggests that the site was occupied from the 13th through to the 15th century, and slag scatters indicated it extended over a large area of the adjacent Cherry Tree field (Hodgkinson 2008, 40). Horsham is documented as having produced arrows during the 14th century (Hodgkinson 2008, 40) and this suggests the locality had some level of specialisation, which does not appear to be present at the smaller sites. On current evidence, Roffey would appear to be large in scale, have connections to long distance trade routes, and have engaged in the production of specialist products and therefore offers a potential candidate for a centre of production. Further work is required at Roffey to establish the extent of the site and its intensity, and how it was connected to the broader landscape and economy of Horsham (fig. 2.5).

Tudeley

The literature for both the Weald and other regions emphasised the importance of Tudeley to any study of the medieval iron industry, for its rare survival of 14th century accounts. These record the output of the works, the personnel employed, the equipment used, and significantly its economic relationship to wider industries. Previous debate over where the site was situated had led to three proposed locations since the 1930s. Straker identified the Tudeley site by a 'great deal of unusually large cinder in the bed of a small tributary rill and he made use of nearby place names such as Smithy Wood to further support his findings (fig. 2.6) (Straker 1931, 220-221). Since 1931 however, there have been further attempts in the search for Tudeley, including one made by WIRG in 1979, that relocated Straker's site, but also found another site 'The Devils Gill Bloomery' further downstream (the Devils Gill Bloomery), which Herbert later argued had an equal chance of being the Tudeley works as it too was situated on the Southfrith Estate (anon 1979, 8, Herbert, 1986, 53). WIRG, at the time of publishing their report, believed there was 'a strong possibility' that what Straker had found was Tudeley, and yet like Straker said it required excavation to recover datable evidence (anon 1979, 8). Tudeley, being part of the manorial estate of Southfrith,

Figure 2.6 - *Straker's site of Tudeley, located adjacent to the Devils Gill Stream, where slag has washed in from an adjacent tributary. (Authors image)*

offered an ideal candidate for the ‘ecclesiastical / manorial ironworks’ outlined in the hypothesis. It also allowed for a comparative study between the historical and archaeological record and for investigation into both the immediate site and wider cultural landscape (Palmer et al 1998, 16). For this to be done, the site of Tudeley had to be first confirmed and characterised, before a wider reconnaissance of the surrounding landscape to identify the related industries.

2.4 - Desk-based assessment

2.4.1 - *Archaeological and historical accounts*

It was important to consider this past fieldwork evidence and use it to compile a gazetteer of known sites (see Appendix 1), and to consider any previous work carried out on the two case study sites. Much of this previous fieldwork is recorded in Straker’s monograph ‘*Wealden Iron’* (1931); in the bulletin of the Wealden Iron Research Group – also called *Wealden Iron*, published annually since 1969, which includes field reports of work carried out by WIRG. Excavation reports published in journals such as the Sussex Archaeological Collections are also important, particularly for sites such as Crawley where a number of small- and large-scale excavations have taken place. The level of detail from these sources varies, according to the nature of work carried out. For example, the fieldwork reports from Tudeley simply described visually what was observed, but were invaluable when relocating the sites, as were Straker’s (1931, 208) descriptions and inclusion of photographs, although his Tudeley site coordinates proved to be inaccurate (see Section 5.3.3). In the case of Roffey, an excavation report had never been published and only a site plan and handwritten pottery report were in existence. The lack of a full report and survival of a finds archive from the excavation proved to be a significant limitation and it would have been a useful exercise to assess the slag assemblage recovered in 1985.

It was also important to examine the documentary sources available on the medieval iron industry and use these to provide a comparison to the archaeological data. The Tudeley accounts were examined at the National Archives, in Kew, where they were deposited along with other documents relating to the Manor of Southfrith. They primarily consist of four membranes covering the years 1329 to 1354, (Straker 1931, 34-37). It was important to examine the physical document in terms of how the parchment had been used, the format of the text, changes in writing style, the ink applied and any details such as amendments or marginal notes, that may previously have been overlooked. These accounts have in the past been analysed primarily for their written content, however taking an archaeological approach of considering the membranes as an artefact, had the potential to suggest additional details about Tudeley and why these accounts are unparalleled for both other ironworks at Southfrith and the Weald. Therefore, a comprehensive set of photographs were taken of the membranes, and included within a document that combined their transcription made by Giuseppi (1913) and translation by Anne Drewery (1996) (Hodgkinson & Whittick 1998, 20-38), which can be viewed in Appendix A2.

2.4.2 - *Placename Study*

Tithe maps and estate maps were an important source of evidence, particularly for identifying historic boundaries, placenames and landscape changes over time (fig. 2.7). Placenames can be used to indicate areas of past iron-production (Cleere & Crossley 1985, 96), and this has been an approach used in previous investigations into the iron-production landscape, most notably by Staker who researched field and woodland names associated with sites he discovered (Straker 1931). At his proposed site of Tudeley for example, his findings were supported by the site's proximity to 'Smithy Wood' and 'Blacksmith's Fields', while more recently Crawshaw identified further placenames at Tudeley from the Tithe Maps, which include 'Buddlemead', possibly where ore was once washed (Straker 1931, 220; Crawshaw 2018, 8). Such placenames provide a potential insight into industries and processes not necessarily visible archaeologically, such as the washing of ore, while names such as Wide Cinder Hams at Roffey suggest slag deposits and possible smelting. The Tithe maps and accompanying apportionment record were digitally available at the West Sussex and Kent Record offices (fig. 2.7). Consultation of these enabled field names to be plotted onto OS maps that in turn could be analysed for associations between geology, topography, land ownership and earthworks visible on LiDAR images. John Field's '*Field Names, a Dictionary'* (1972) was a valuable tool in interpreting the more obscure field names encountered, while '*A Dictionary of Sussex Dialect'* revealed the origins of specific regional names.

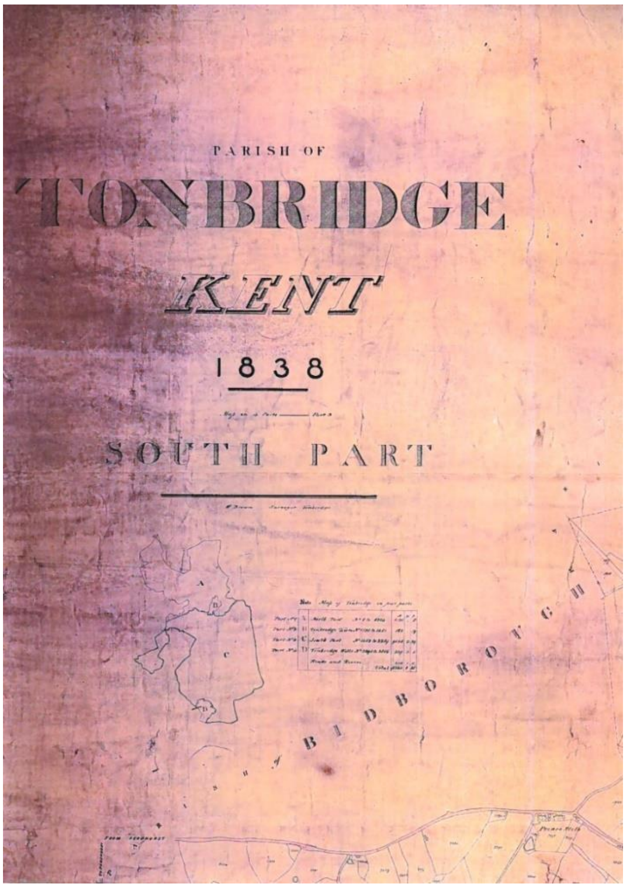


Figure 2.7 - *Tithe Maps for the parish of Tonbridge in Kent, Courtesy of Kent Archives*

There are, however, limitations in using placenames, in that in themselves they do not date a site or provide conclusive proof that iron-production took place.

Fieldnames often relate to either site specific features, such as ‘furnaces’, or processes ‘Budlets’ (washing of ore), or as physical descriptions of the topography including ‘Cinder Field’, ‘Black Earth field’ and ‘Blacklands’ (Field 1972, XVII; 1993, 212). While these may be indicative of industrial processes and can be associated with physical remains, none allow a site to be dated, however the first two fieldname types indicate that fields acquired their names when such industries were still in existence or operated within living memory of when the field was christened. The latter, on the other hand, is observational and may be referencing the fact that cinder or blackened soil may be found there as the remnants of smelting from the distant past. Further complications arise when field boundaries change, and names become associated with other fields or larger parcels of land. Some fieldnames can prove misleading and relate to ownership or activities from a later time period.

2.4.3 - *LiDAR Analysis*

LiDAR (Light Detection and Ranging) can be used to assess for potential archaeological features over large areas of the landscape (Risbol 2013, 52). LiDAR works by transmitting laser pulses between an aircraft and the ground’s surface, measuring the time lapse between transmitting and receiving the return signal. Measuring the return time of the signal allows distance to be calculated and the subsequent plotting of these signals enables a three-dimensional map of the land’s surface to be created (Opitz et al 2012, 398; Mlekuz 2013, 88; Dong 2017, 10). LiDAR is useful, for unlike aerial photography and satellite imagery, it has the ability to penetrate through surface vegetation (providing it is not too dense) and record ground features otherwise invisible in wooded areas (Opitz et al 2012, 397; Hesse 2013, 171; Risbol 2013, 52; Dong 2017, 12). LiDAR therefore can address the bias between the higher number of sites recorded on open agricultural land and those in the less accessible wooded areas (Risbol 2013, 54). Opitz et al (2012) emphasize the usefulness of LiDAR in investigating 'marginal zones' within their project in Doubs in France, where much of the landscape is forested (Opitz et al 2012, 395). They explain how within these environments, industries that are often under-represented in other surveys, can be identified, including mines, charcoal platforms, limekilns and small quarries (Opitz et al 2012, 397; Risbol 2013, 51). LiDAR therefore held considerable potential for investigating the Tudeley landscape, which was predominantly wooded, but offered the possibility of good preservation of features, albeit hidden amongst vegetation.

For this project, LiDAR data was accessible from Edina Digimap and this data was downloaded into ArcGIS. From the LiDAR maps the location of potential target features were identified prior to field visits (see 3.8 and 6.4).

Tudeley ironworks was clearly not isolated, but positioned within a wider woodland economy, both leaving potential archaeological scars on the landscape. LiDAR's ability to map these features assisted with understanding the spatial patterning of charcoal platforms and minepits along with the extinct routeways that connected them (Opitz et al 2012, 404; Hesse 2013, 180; Mlekuz 2013, 92). At Roffey, the spatial relationship of the minepits of St Leonards Forest could be assessed, and conclusions drawn on their chronology and mining practices.

There are challenges with using LiDAR data, mainly the complexities with establishing the chronology of the features visible (Opitz et al 2012, 404, Hesse 2013, 171). Mlekuz (2013) describes this as the 'messy landscape' with LiDAR showing a 'palimpsest' of activities over time (Mlekuz 2013, 88). It is this longevity of use and human impact that Risbol (2013, 54) explains is often neglected in landscape studies, and yet the landscape is continually changing, with complex meanings and layers of evidence, displayed on the LiDAR images (Risbol 2013, 55). When analysing the LiDAR data for Tudeley and Roffey, it was important to establish the chronological relationship between features which were contemporary with the medieval period. This is something that the subsequent reconnaissance survey assisted with, by visiting features identified on LiDAR to form an integrated approach. Butler (2009) was able to compare LiDAR images to the data collected in his field surveys of Pembury Walks, an area immediately south of Tudeley Woods. While the LiDAR from the Weald Forest Ridge Project only became available after the field surveys had been completed, Butler was able to show that many of the features presented on the LiDAR corresponded to those recorded in his reconnaissance survey (Butler 2009, 3-4).

2.5 - Landscape reconnaissance survey

2.5.1 - *Characterising the industrial landscape*

Following desk-based assessment the initial stage of fieldwork in this study was to establish the context in which Wealden ironworking was situated. Renfrew and Bahn (2008, 77) argue that regions in their entirety need to be studied, not just sites in isolation. Many previous landscape studies have focused less on industrial landscapes, (Palmer et al 1998, 16) and yet surveys such as the Exmoor Iron Project have demonstrated how a wider landscape approach is beneficial to the understanding of associated industries and woodland management strategies, that enabled for example the production of charcoal or procurement of ore (Bayley et al 2008, 24). Equally the Telangana Field Survey, in Southern India, carried out by Juleff and Gilmour as part of the Pioneering

Metallurgy Project (2011) used a variety of methodological approaches to characterise the archaeometalurgical landscape, including field survey, ethnographic survey and classification and scientific analysis of artefacts and technological debris (Juleff & Gilmour 2011, 7-8; Girbal 2017, 2). The project aimed to look at the nature of metallurgical evidence, its distribution both spatially and temporally, and the relationship between metallurgy and settlements, thus drawing together the region's industrial and domestic heritage (Juleff & Gilmour 2011, 8).

Within the Weald, projects such as the 'Secrets of the High Woods' carried out by the South Downs National Park Authority, have demonstrated the benefits of a wider landscape approach to interpret the woodland economy of the High Weald (Manley et al 2016). The project took a multi-period approach and identified a wide variety of features such as charcoal platforms, saw pits, banks and ditches and pillow mounds (Manley et al 2016). Smelting and smithing sites were also reliant upon other related industries, however, the literature tends not to focus too greatly on these aspects and yet, as the Tudeley accounts demonstrate, they formed an integral part of how the ironworks functioned within its landscape.

Palmer suggests a three-stage process for studying industrial landscapes. Firstly, the reason why a site was chosen for an industry needs to be established (Palmer et al 1998, 16). In the case of the Weald, most studies show iron-production primarily took place in areas where suitable deposits of iron ore occurred, such as in the Wadhurst clay. Secondly, changes through time should be interpreted, and an example might include a move to a more intensive production technique such as the adoption of waterpower (Palmer et al 1998, 16). Thirdly, spatial relationships need to be established, both with other similar sites and with the development of settlements and trade routes (Palmer et al 1998, 16). For ironworks like Tudeley, it needed to be established how it was connected to the other industries referred to in the accounts, within the context of a manorial estate and wider trade routes, something a wider landscape reconnaissance survey was able to achieve in the identification of routeways (Hodgkinson 2008; Giuseppi 1913).

2.5.2 - *Defining a site*

Prior to reconnaissance surveying, in order to identify sites of iron-production or associated industries, it was important to produce a working definition of what constitutes a site. Often the definition of a site is not considered in detail in archaeological projects, and perhaps the assumption is made that habitation or repeated activities provide sufficient classification. And yet metallurgical activity can take place away from habitation and may be transient in nature, while in other instances may retain greater permanence; a quarry may be mined for its ore over a few weeks before being abandoned, while a smelting site may be continually used in successive smelts. Juleff considered the issue of site definition, during her work in Sri Lanka and defined a site as ‘any evidence of past human activity, whether in situ or not, that gives a location, specific or general, a cultural as well as geographic significance’ (Juleff 1998, 48). She also distinguished between sites of singular activity and those of repeated activities, which helped to overcome the issues of longevity. For the purpose of investigating iron-production sites, this serves as a useful working definition. Given, in the Sydney Cyprus project, argued that a site should be viewed more as ‘an interpretative construct than a strictly observational and definitional matter’ (Given et al 1999, 23). They argued that there needs to be adequate knowledge of local patterns in artefact distribution and the use of the landscape from across space and time, for a site to be defined (Given et al 1999, 22). With this in mind, the initial reconnaissance survey for this study was of particular importance in assessing the archaeology present at each case study, and visits to other Wealden ironworks such as Parrock at Hartfield helped with the formulation of working site definitions during the course of the project.

Determining what does not constitute a site is also necessary. Does for example a single fragment of slag constitute a site?, a cluster of slag?, or slag in association with earthwork features? In the survey of the Island of Kythera in Greece, the researchers made a clear distinction between on-site and off-site artefact scatters, explaining that some studies have abandoned the concept of sites entirely in the analysis of survey data, for artefact distributions can make it difficult to make a distinction between off-site and on-site areas (Bevan and Conolly 2004, 128-129). The reconnaissance survey of Tudeley highlighted this conundrum, for while there were clusters of slag recovered at certain locations, isolated finds of slag were found in other localities. Bevan and Conolly (2004, 129) argue that associations between artefacts within clusters should be made on contextual association and composition. In other words, clusters of artefacts should not be assumed to be contemporary without first being analysed. Since many iron-production sites listed on the WIRG database, exist purely as scatters of slag, these are likely to form the main site type identified when surveying the landscape. Jeremy Hodgkinson, who has recorded many of the slag scatters on the WIRG database, generally will designate a site as a bloomery when an artefact scatter comprises several types of process waste including slag, furnace lining, roasted ore, and charcoal. He also considers evidence that these waste products were deposited near to where they were produced, to define a site (pers. comm. Jeremy Hodgkinson). Understanding the relationship between these slag scatters is important, and assumptions early on needed to be avoided. A high-density cluster of slag does not necessarily mean intensive activity but could be the result of a location being revisited on many occasions over a considerable period. Confusing this could lead to an assumption that a location formed an important permanent iron-production 'centre' when in fact the same location was continually utilised seasonally over several centuries.

A second consideration was at what point a locality could be assigned site status. In the Telangana Field Survey in India, locations were recorded, but not assigned a site status until the subsequent data analysis stages. This allowed each feature to be recorded separately, as opposed to being grouped into sites early on, and did not exclude data that was not believed to represent a site (Juleff and Gilmour 2011, 8-9; Girbal 2017, 127). Later data analysis was then carried out and locations grouped to form sites (Girbal 2017, 127). For the purposes of fieldwork, Given et al (1999, 24) defined sites identified in fieldwalking as 'Places of Special Interest' which were limited in size and in their material remains, and might include a smelting furnace, while a 'Special Areas of Interest' exhibited higher complexity such as multi-functional and multi-period sites. Such a distinction is useful for Wealden sites, particularly in distinguishing between small scatters of slag typical of seasonal smelting activities and those of permanent ironworks with greater longevity. The 1994 Castle Bytham Fieldwalking Project for example identified four slag scatters during fieldwalking, finding they varied in size from 10m to 100m in diameter, while two slag scatters had no clear foci (Bayley et al 2008, 24). In this instance, to avoid assigning all the same site status, Given's classification proves useful. Such approaches have therefore emphasised the value of not assuming what constitutes a site prior to or during fieldwork, but using the data analysis stages to make these interpretations. Inevitably, the identification of all these localities relies on archaeological material being visible on the ground surface.

The challenge is also in defining what scale of human activity constitutes this site status. Returning to Juleff's original definition, she defines a site as 'any evidence of past human activity, whether in situ or not, that gives a location, specific or general, a cultural as well as geographic significance' (Juleff 1998, 48). Renfrew et al (2008, 77) point out that attempts to reconstruct the landscape have revealed faint scatters of artefacts that will not necessarily qualify as 'sites' but still demonstrate human activity. They quote Dunnell and Dancey as defining these as 'off-site' areas based on a lower density of artefacts, but still in need of recording (Renfrew et al 2008, 77). While they emphasize the importance of recording such locations during landscape survey, there are obvious limitations in assuming lower artefact densities do not constitute sites. In the case of ironworking, a smelting site will produce quantities of slag that can be detected, while a quarry, potentially just as intensive an activity, is unlikely to produce artefactual data. Therefore, if the concept of 'sites' and 'off-site' is going to be applied when interpreting data within a landscape, perhaps these definitions need to be specific to the relative context of the region and the nature of the archaeology within it. As an example, if one were analysing settlement distributions in a region where habitation areas are characterised by densities of pottery, it might be reasonable to assume that areas of low-density pottery are off-site. An example of this might be a medieval village, where the village itself contains high pottery densities, while the surrounding fields show low density and evenly spread scatters, the outcome of manuring. Site status should therefore only be attributed once all the data is collected and the specific regional norm is understood enough for a decision for sites and off-site classifications to be assigned.

2.6 - Reconnaissance survey

Reconnaissance survey formed the initial stage of the landscape survey, whereby the character and nature of the archaeological remains were identified, mapped and catalogued in a gazetteer. Reconnaissance survey formed an important way in which local patterns can be understood and the types of features present in each of the case study sites assessed. Given explains that the challenge of investigating an unknown landscape is not knowing the number of sites or their location (Given et al 1999, 21). A reconnaissance survey was therefore a low intensity method that can quickly establish the density of archaeological remains and their morphology, prior to a more detailed surveying at individual locations.

The wider landscape survey carried out in the ‘Secrets of the High Woods Project’ used a reconnaissance approach to examine and record features of archaeological interest. Using a team of volunteers, large areas of ground could be covered, and visible features plotted (Manley 2016) and such an approach is similar to the ‘forays’ frequently used by the WIRG, which have tended to focus on streams and the immediate area surrounding them and will typically explore the wider landscape when a slag scatter is identified. Related industries will, in a number of cases, present distinctive earthworks such as charcoal platforms that are characterised by circular levelled ground with charcoal-rich soil, while smelting sites may feature mounds of slag or surface slag deposits (Bannister 2018, 68). There are limitations with a reconnaissance survey approach, namely with the identification of features and the ability to date them. Certain features will not present any above ground remains, while in other cases above ground earthworks may be obscured by vegetation.

The reconnaissance survey at Tudeley and Roffey, was modelled on that of Juleff, in that preselected areas or routes were followed each day, with any archaeological features discovered recorded within a field notebook (Juleff 1998, 48). The field notebook formed a narrative account of routes travelled and archaeological features observed, and included sketch maps, feature plans and interpretative suggestions. Along with this, standardised recording forms enabled specific data at each location to be recorded, such as GPS positions, and objective descriptive notes of features identified, and formed a means of avoiding assigning site status at this early stage. Subjective interpretations were confined to the field notebook and formed a running commentary.

Using field notebooks and reconnaissance survey forms, traverses across the landscape were made in each pre-selected area, and upon encountering a feature of either archaeological or natural significance, they were assigned a numerical feature number, based on the date of discovery (e.g. 1201191). A written description was then made along with measurements and a photographic record. GPS coordinates were taken at each feature or isolated finds-spot, to allow the distribution of features to be mapped and integrated into GIS mapping (Bayley et al 2008, 28) (fig. 2.8). GPS mapping was applied in the Sydney Cyprus Project to record 'Special Interest Areas', which produced thematic maps along with distribution of artefacts (Renfrew et al 2008, 76). As previously mentioned, it was important not to assign site status to any feature identified on the reconnaissance survey. Juleff et al recorded places of interest as 'locations', without the classification of sites during the early stages of landscape surveying, and this approach was followed here (Juleff & Gilmour 2011, 8; Girbal 2017, 127).

In the India project, locations covered anything from metalworking sites to geological features (Girbal 2017, 127), and was extended in this project to also cover isolated findspots, that may be indicative of buried remains not visible on the surface.

Figure 2.8 – *Equipment used in the reconnaissance survey of Tudeley Nature Reserve. (Authors image)*

Each case study needed to be approached differently to account for variations in scale and terrain type. Tudeley was a predominately wooded environment, and this along with the irregular deep stream valleys that ran through it, made systematic traverses non-viable. Therefore, the study area was subdivided into smaller segments that could be examined more easily during each fieldwork session. The Roffey landscape predominantly formed large open fields, and while this facilitated systematic transects in some areas, cultivation is likely to have destroyed much of the surface evidence. The size of both landscapes meant that prior to the survey, areas of interest also needed to be identified, based on the desk-based assessment, and these formed specific targets that were visited.

2.7 - Fieldwalking

Fieldwalking involves the systematic collection of surface artefacts, typically from a ploughed field, and the accurate plotting of their position on to distribution maps (fig. 2.9). While it has many advantages in the identification and investigation of archaeological landscapes, it is less frequently used in the investigation of iron-production sites. It can however address various archaeometallurgical questions, such as the size of sites, the former industrial activities that took place, and their overall distribution across the landscape (Bayley et al 2008, 24). It has practical advantages in being both cheap to undertake and can survey large areas of terrain in a relatively short period of time (Gerrard et al 2007, 124). Fieldwalking is useful for identifying sites with little documentary record alluding to their existence, such as charcoal hearths and bloomeries, typically unrecorded and temporary in their nature, and these may be identified by a surface distribution of slag, roasted ore or even charcoal (Palmer et al 1998, 79; Bayley et al 2008, 24). Furthermore, datable material such as pottery found in association with slag can

Figure 2.9 - *Fieldwalking a possible smelting site at Chailey (East Sussex) with the Young Archaeologists Club in 2015. (Authors image)*

indicate the time period a site was in operation and distinguish those of Roman origins from medieval, something the slag alone fails to do (Cleere & Crossley 1985, 97). Above all, fieldwalking is non-destructive and does not involve the excavation and ultimate destruction of the site itself.

Fieldwalking is reliant on the presence of ploughed fields or patches of bare earth whereby surface artefacts are visible and, in many cases, a standardised grid is measured out over the survey location to assist with plotting artefact distribution. A decision needs to be made early in the planning stages as to whether the fieldwalk is conducted as a systematic or unsystematic survey (Renfrew et al 2008, 78). While much of the Weald is arable, many of the iron-production sites have been found alongside streams and within woodlands and this makes the collection of artefacts in a systematic way more problematic. Forays carried out by WIRG tend to combine reconnaissance survey and fieldwalking methods in a more unsystematic approach to exploring the landscape, yet often succeed in obtaining results. As many of the Wealden iron-production sites do not appear to reside in open cultivated fields, this has a significant impact on the fieldwalking approaches that can be undertaken (Tebbutt 1981, 59), which is why artefact collection through forays have been a favoured strategy. Where it has been used in the Weald, such as in 1976 where it was applied over a large terrain, results showed that iron-production sites located on cultivated land tended to produce less dating evidence, the plough having spread much of the material (Tebbutt 1981, 59).

The ability to carry out systematic fieldwalking forms a wider issue in the study of archaeometalurgical sites. For example, systematic fieldwaking could not be applied by Juleff in her investigation of Sri Lankan ironworks, due in part to the nature of the terrain, but also from inexperienced walkers and time constraints

(Juleff 1998, 40). A systematic approach also does not account for the visibility of remains. This is discussed by Bevan and Conolly (2004, 127-128) in their survey of the Island of Kythera, Greece, where they found in instances where only 50% of the ground surface was visible, only half of the expected artefacts present tended to be recovered, and there were challenges in predicting the extent to which visibility affected recovery. These same issues were encountered at Tudeley, for the wooded terrain and limited exposed bare earth, restricted the use of a grid or the systematic recovery of material. Instead, samples had to be collected fortuitously where for instance tree throws had exposed material, or the action of water had eroded slag heaps (see Section 5.7.2) (fig. 2.10). Despite this, a useful assemblage of technological samples was recovered from the Tudeley site and Devils Gill Bloomery along with pottery dating evidence that allowed for similar analysis to the material found at Roffey (see Section 5.9).

Figure 2.10 – *Slag deposits that could be sampled from a tributary stream channel at Tudeley. Author's image.*

Bevan and Conolly (2004) distinguished between reconnaissance survey and fieldwalking methodologies. While the reconnaissance survey examined large areas of landscape for the presence of earthwork features, fieldwalking focused on localities within this wider landscape and on the systematic collection of datable and technological samples from these specific sites. This methodological distinction was applied at Roffey, for while reconnaissance survey covered large areas of the landscape and identified sites of interest, only a select few were investigated in more detail by fieldwalking and were chosen because of the potential they held for understanding iron-production and for the ability to recover technological and datable material such as slag and pottery from them.

For the selected fieldwalking location at Roffey, which covered an area designated in the reconnaissance survey as Zone 1, the open cultivated ground facilitated an integrated approach with fieldwalking and geophysical analysis. Applying the same grid arrangement of 20x20m grids to both surveys enabled the two datasets to be comparable. The larger grid system at Roffey followed similar practices to landscape projects such as Shapwick, where the field collection strategy used grids of 10x10m in which the fieldwalkers were given 20 minutes per grid square, walking along 1-2m transects to sample (Gerrard et al 2007, 127). Other projects such as the Sydney Cyprus Project, which investigated the relationship over time between the production and distribution of agricultural and metallurgical resources in the upper sections of the Kouphos River Valley, used a transect survey approach (Renfrew et al 2008, 76; Given et al 1999, 19). In this instance 50m wide transects were walked with fieldwalkers spaced at 5m to identify either artefact densities or above ground remains that were classified as 'places of special interest' (Renfrew et al 2008, 76). This approach was also used at Roffey to examine Zone 1 (the complete field) in its entirety. Transects spaced 20m apart followed the same orientation and spacing as the geophysical survey grid. This meant that the grid method could be applied to specific 'sites' within Zone 1 and collect a detailed technological assemblage, while the transect survey analysed the wider spread of material across the landscape (see Section 4.6).

2.8 - Geophysical analysis

Geophysical techniques have proved to be effective way in which archaeometallurgical sites can be explored, with resistivity, magnetometry and Ground Penetrating Radar (GPR) all having application potential to the study of metallurgical sites (Bayley et al 2008, 24). They are able to locate new sites and determine their morphology and extent. Such approaches are still somewhat underused within the Weald, however they have shown considerable potential in projects looking at the Roman iron industry such as by Greenwood (2021) and Millum (2018, 13).

2.8.1 - *Magnetometry*

Magnetometry works on the principle that past human activities will leave a magnetic trace within the ground and that variations in magnetic susceptibility can be detected and mapped with the use of a magnetometer (Banning 2002, 44) (figs 2.11-2.12). Soils contain a weak magnetic susceptibility and when placed within the Earth's magnetic field certain minerals within these soils become magnetised (David 2006, 15). Past activities may alter the magnetic properties of these soils through either disturbing or redepositing soils of different magnetic susceptibility or, through thermoremanence (Bowden 1999, 121; Gaffney & Gater 2003, 37-38). Changes in magnetic susceptibility can result from domestic activity such as rubbish dumping on a settlement site (Gaffney & Gater 2003, 38). Ditches, pits and gullies are such features that may be infilled with material of greater magnetic susceptibility to the surrounding subsoil and these subtle differences can be detected by the magnetometer, although such anomalies will typically be very weak compared to their thermoremanent counterparts (David

Figure 2.11 – *Bartington Fluxgate Gradiometer Grad601r used at both Tudeley and Roffey. (Authors image)*

2006, 15-17; Bowden 1999, 121). At Roffey (Chapter 4) and Tudeley (Chapter 5), the ability to identify potential ditches was important for establishing site layout and extent as well as wider boundaries within the landscape. There was also the high probability that any ditches and pits there might have been infilled with slag, remnants of furnace wall or charcoal which present high magnetic susceptibility.

Thermoremanence anomalies are typical of features that have been subjected to high temperatures that have heated weakly magnetic materials to above their Curie point. The Curie point will vary according to the specific minerals that are being heated (typically 500-700°c), however once this temperature is exceeded the material is de-magnetised. Upon cooling its crystals will re-magnetise and acquire a permanent magnetisation that reflects the alignment of the Earth's magnetic field at the time cooling occurred (Gaffney & Gater 2003, 37; David 2006, 16). Such thermoremanent magnetism is associated with features such as kilns and hearths as well as furnaces, which were the prominent feature that was hoped to be identified during the Roffey and Tudeley surveys (Banning 2002, 44; Gaffney & Gater 2003, 38; David 2006, 17). Slag heaps too present high magnetic anomalies, and while both sites had scatters of surface slag, it was hoped the magnetometer would detect the exact position of these slag heaps.

Within the Weald, Greenwood used magnetometry at Standen at East Grinstead and Chitcombe in Brede. As magnetometry can cover large areas of land, Greenwood (2021) could consider the full extent of both sites and demonstrate how the scale and morphology of these two Roman iron-production sites were considerably different. Other projects include the work by David Staveley and David Millum (2018) at Culver Farm at Barcombe, East Sussex, where a large Roman settlement, adjacent to the River Ouse, showed evidence of industrial ironworking and the use of slag metalled roads and tracks. Elsewhere, magnetometry has been used effectively to investigate medieval sites. Crew (2002) used caesium magnetometer and fluxgate gradiometer surveys in his investigation of 14th century bloomeries at Coed y Brenin, which enabled him to produce maps of their distribution (Crew 2002, 163). This approach has also been used in Cumbria, where along with 25 bloomery sites, other associated features including bloomery hearths, charcoal burning, and ore roasting sites have been discovered (Crew 2002, 180; Bayley et al 2008, 24). Such surveys are particularly beneficial in identifying areas of burning, typical of ironworking sites and their associated industries, without the necessity of excavation (Bayley et al 2008, 27).

Figure 2.12 - *Bartington Fluxgate Gradiometer Grad601r in action at Roffey. (Authors image)*

2.9 - Summary

The research strategies used in this study reflected a desire to apply a non-destructive methodology to the study of Tudeley and Roffey. Each method was selected to complement the other surveys and allow a comparison of the results to the historical record. While excavation is important, it was recognised that this would require an excavation area far larger than was feasible at each of the sites. In the case of Tudeley, its position in ancient woodland meant that it is both a sensitive ecological habitat and at limited risk of future destruction, either by cultivation or development. Furthermore, its position adjacent to a stream would have potentially required deep excavations through alluvial build up to reach archaeological remains. An excavation at Roffey would have resulted in the removal of agricultural land from cultivation. Equally the size of the site seen in the magnetometry results would have meant only an open area excavation would have been truly beneficial in understanding the relationship between features, an excavation approach that was not possible within the scope of this project. Each method was successful however in demonstrating the effectiveness of non-invasive methods in understanding site morphology. Even the collection of macromorphological samples and dating evidence, which typically is an objective of excavation, was achieved through fieldwalking, which in the case of Roffey allowed for the retrieval of a slag assemblage of 3940 samples with a total weight of 605kg. As the following chapters will demonstrate, reconnaissance survey, fieldwalking, geophysics and macromorphological analysis complemented one another and allowed both sites to be reconstructed, along with their associated landscapes.

Chapters 4 and 6 present the data that was collected through reconnaissance surveying, fieldwalking, geophysics and macromorphological analysis and the results of their subsequent analysis. However, a detailed discussion of the significance of each data set in understanding sites and their overall contribution to the medieval iron industry of the Weald can be found in chapters 5 and 7, reflecting the importance of each method in complementing the results of the other surveys to form an overall interpretation of Tudeley and Roffey.

Chapter Three: Roffey - The historical and landscape context of medieval iron-production

This chapter begins by examining the historical context of the Roffey Ironworks using documentary accounts and place-names to understand the importance of iron and its trade on the local and wider economy. It assesses the past investigations into iron-production here by Thomas Honywood, Ernest Straker and WIRG and the rescue excavation in 1985 which revealed evidence of a possible smithing workshop. Finally, the wider landscape of Roffey is considered using a combination of LiDAR data and landscape reconnaissance to understand the acquisition of resources needed to produce iron and Roffey's position as a potential production centre.

Chapter Contents

Chapter Three: Roffey - The historical and landscape context of medieval iron-production

3.1 - Introduction

As one of the few 14th century ironworks of the Weald that has surviving documentary accounts, Roffey was of particular importance in the comparative study of historical and archaeological resources. It also has the potential to help understand centres of production. Previous archaeological investigation had identified a site at Newhouse Farm, to the east of Roffey parish, as a likely candidate for the forge listed in 1344 and where horseshoes had been purchased seventeen years previously (Hodgkinson 1983). It was important however in the initial stage of the investigation to avoid limiting research to a site level, but to take a more wholistic approach and consider the broader archaeological and historical context of the landscape and settlement in which iron-production operated. For this, historical records pertaining not only to iron-production but also the manor of Roffey had to be assessed to determine the nature of economy and settlement in the 14th and 15th centuries. Historical sources provided valuable insights into the past economy of Roffey and the people who lived and worked there, who would otherwise be anonymous in the archaeological record. Maps and placenames were assessed, to reconstruct a subsumed landscape, today a series of expansive fields but once a complex terrain of interconnecting routeways, patchworks of field and property boundaries, and ancient woodlands and the legendary domain of dragons!

The second stage of research continued to focus on the wider medieval landscape working on the premise that the production of Edward III's horseshoes was fundamentally reliant on auxiliary industries, including ore extraction, charcoal production, and smelting, that were not all necessarily restricted to the same location or group of individuals. In the case of Roffey, the documentary accounts record the outcome of a long complex process i.e., the product of the smith. However, it was for archaeology to identify the previous stages in this chaîne opératoire through landscape reconnaissance. To reconstruct this diverse medieval landscape, its economic and social morphology, and the interconnectivity of industries that operated within it, locations were visited, and features recorded, photographed and planned.

3.2 - Location and area surveyed

Roffey, located in West Sussex, is a small ecclesiastical parish with neighbouring Colgate and a small part forms an electoral ward of Horsham. It is 4km south of the Sussex-Surrey border and 29km north of the Southcoast. The town of Horsham is 4km south-west of Roffey, while Crawley is 7km north-east. It lies within the High Weald, on the northern edge of St Leonard's Forest, which forms part of the High Weald AONB and SSSI. While St Leonard's Forest is dominated by both wood and heathland, much of the immediate landscape around Roffey is arable, with now large open fields broken by occasional wooded shaws, while to the north, south and east, large woodlands dominate, some of which were probably former attachments of St Leonard's.

Until the mid-19th century, Roffey was characterised by dispersed farmsteads and cottages bordering the Crawley Road that ran east-west through the parish. The main area of settlement was in the west, at Roughey Street, however by the second half of the 19th century settlement at Star Row and Little Haven had expanded, with the addition of a permanent Church in 1878. Today this area forms a suburb of Horsham. The main study site, designated Zone 1 (see below), was located at Newhouse Farm, in the east of the parish, at the former Roughey Street.

For the purposes of the survey, the study area, which covered approximately 20km² was subdivided into three radiating zones. These zones were somewhat arbitrary and, with the exception of Zone 1 (fig.3.1), did not conform to existing landscape boundaries. However, each zone considered the different nature of evidence that existed within the study area including iron-production, agriculture, woodland industries, and settlement. While Zone 1 formed the main study site due to the evidence of iron-production (see Chapter 4), Zones 2 and 3 (figs.3.2-3.4) addressed the immediate and wider landscape setting and the associated industries.

Zone 1

Zone 1 covered an area of 6.9ha that today forms a large arable field called Cherry Tree Field (fig.3.1). It was selected on the basis of the existing evidence of iron-production that had been identified by WIRG in 1982 and a 1985 rescue excavation (see Section 3.6). In 1844 Cherry Tree Field formed 11 parcels of land that have been subsumed over the last 150 years into one large field. Crawley Road (the A264) delineates the field's southern boundary, while the London to Horsham railway runs along the northern boundary. Crawley Road was widened and diverted in 1985 to create a bypass and this has resulted in the movement north of the south-west boundary by 32m. The eastern and western boundaries are enclosed by established hedgerows beyond which are Brook Lane to the west and Cow Lane to the east. Channells Brook flows parallel to the railway on the northern boundary and divides a small strip of meadow of 2.7ha called Long Lag. Channells Brook crosses under the railway and flows west, eventually joining the

River Arun 6km southwest, on the western side of Horsham. To the east of the field, two ponds are present, one of which is fed by the stream, and both surrounded by a small copse of trees. One pond projects out into the field by 50m and from this an earthwork gully extends south across the field to the southern boundary. A copse also follows the route of Channells Brook and grows along a steep bank that borders the stream. The overall topography of the field is undulated, with higher ground to the south and west, and a gentle slope to the centre from the east, before rising on the northern side. At the time of the survey, the field was arable and had been ploughed the previous year.

While previous research had suggested Cherry Tree Field formed the location of Matilda Bonewyk's forge recorded in 1345 and where horseshoes had been purchased in 1327 it was imperative not to assume that this was the only area of iron-production within this landscape (Lower 1849, 169-220). Indeed, Zone 1 was initially selected as the primary study site because of reports of slag discovered by Honywood (1866) and Straker (1931) (see Section 3.6), however, subsequent

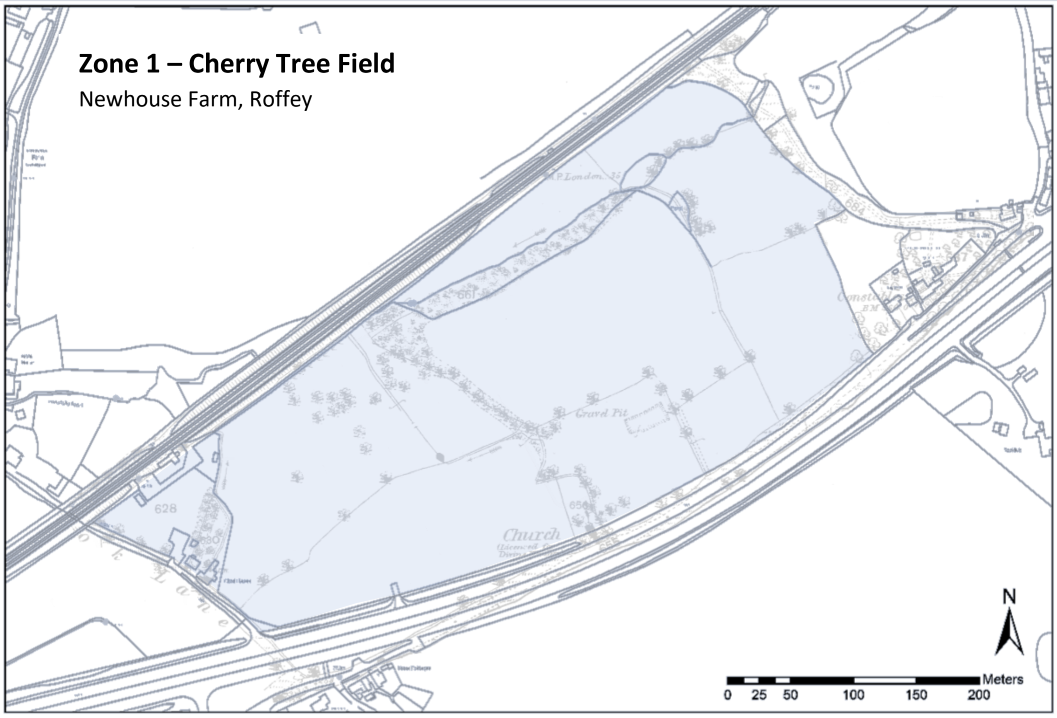


Figure 3.1 - Zone 1 at Cherry Tree Field (highlighted in blue). The current site has been overlaid onto the 1870s OS map, when Cherry Tree Field was divided into separate parcels of land. The 1985 road widening has led to the destruction of a section of the southern boundary.

examination of Honywood and Straker's records showed that while close, their site was situated 200m to the west in Zone 2.

Zone 2

Zone 2 encompassed the area immediately surrounding Zone 1, including the fields to the north, south, and west, and the footpaths routeways of Book Lane, Cow Lane, and Roughey Gate (fig.3.2). It extended further west to cover parts of Bushy Lane and the area alongside Channells Brook Stream. While Zone 2 was distinguished from Zone 1 for the purpose of survey, it must be stressed that the two were interconnected, with Zone 2 covering significant routeways which once connected Cherry Tree field to the wider landscape and evidence for a further

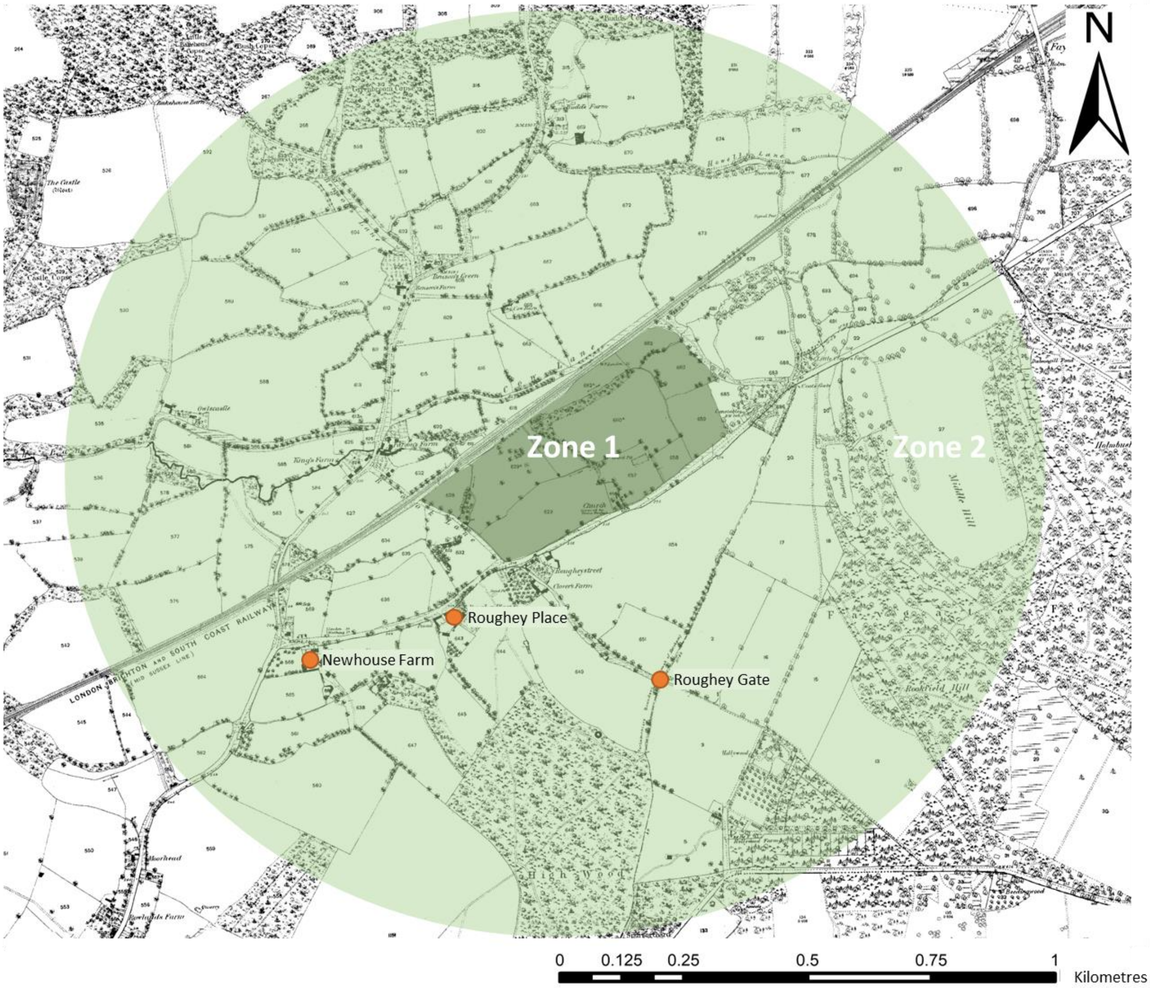


Figure 3.2 – *Map showing Zones 1 and 2 alongside the location of Newhouse Farm, Roughey Place (the site of the former manor house) and Roughey Gate, an entrance into St Leonard's Forest. Base map courtesy of Digimap OS Collections, adapted by the author.*

extension of iron-production to the north, east, south, and west. Zone 2 had to be distinguished from Zone 3, primarily due to distance, but also for the topographical differences between the arable cultivated landscape in Zone 2 and the forest of Zone 3.

Zone 3

Zone 3 began 1km from Zone 1 and primarily encompassed St Leonard's Forest to the southeast, which covers an area of approximately 31km² (Weir-Wilson 2021, 12) (figs. 3.3 and 3.4). Zone 3 was the largest zone, however only the south-eastern portion was explored in detail. Its designation draws on the work of Bevan and Conolly (2004) who explain how a distinction can be made between on-site and off-site artefact scatters. In this instance while Zones 1 and 2 could be recognised as the 'site' or more correctly the locality of multiple 'sites', Zone 3 formed the off-site zone, essentially the wider landscape where resources such as charcoal and ore could be procured. As will be seen, this characterisation of sites and placement into zones somewhat underestimates the importance of the industries of Zone 3. However, in this early stage of research, where localities were not assigned site status until subsequent data analysis (see Juleff and Gilmour 2011), Zone 3 allowed areas of this wider landscape to be considered in relation to the primary area of iron-production in Zones 1 and 2.

Not all areas within these zones were investigated. Apart from Zone 1, the other zones were limited by access or the availability of footpaths while dense vegetation coverage or modern housing development made other areas inaccessible. The combined approach of stratified zones and the targeted investigation of features within them meant that a majority of the above ground archaeology was explored and recorded during the investigation.

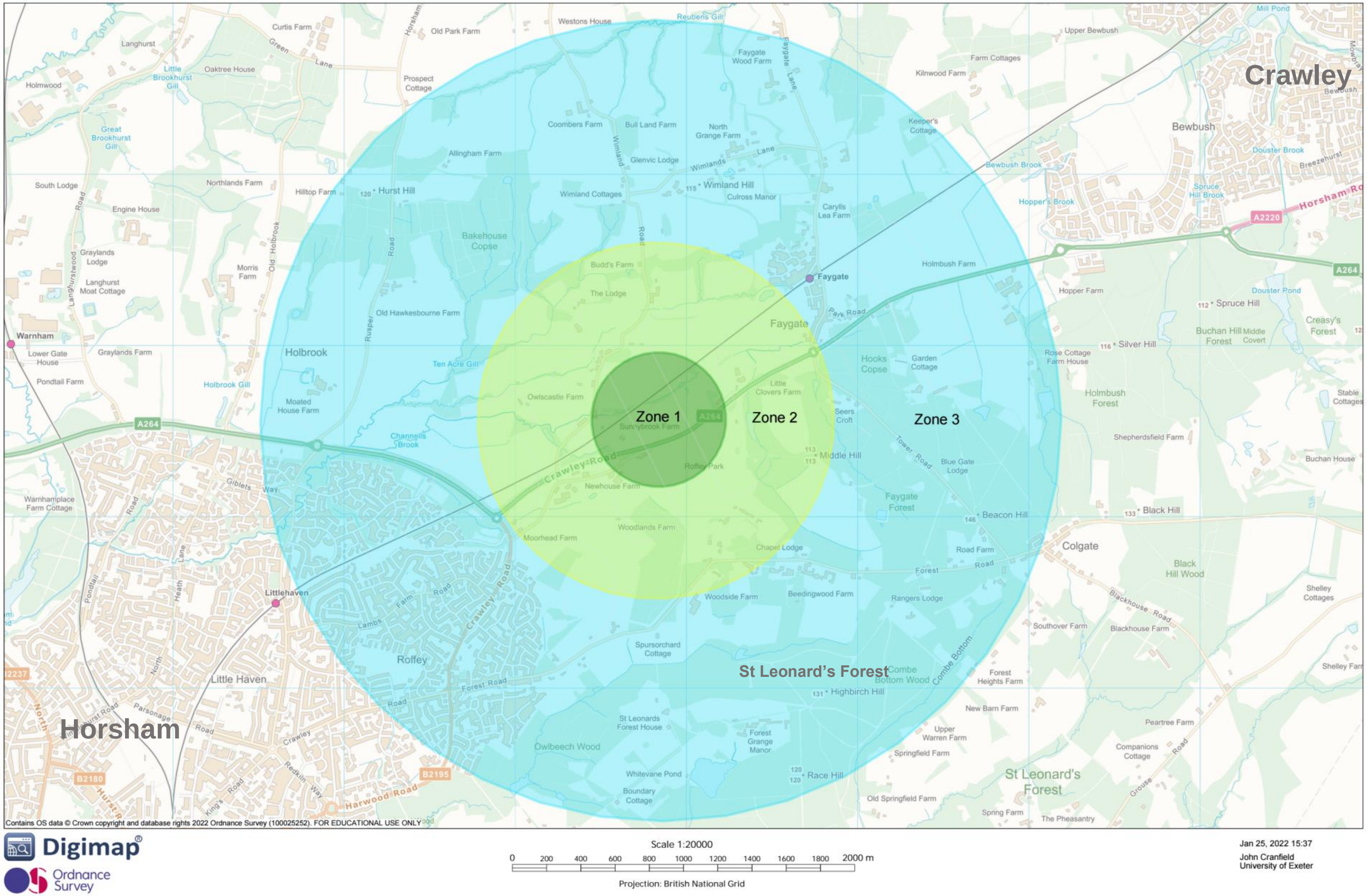


Figure 3.3 – *arrangement of the three zones used to analyse the landscape at Roffey. Zones 1 & 2 formed the primary location of iron-production. Base map courtesy of Digimap OS Collections, adapted by the author*

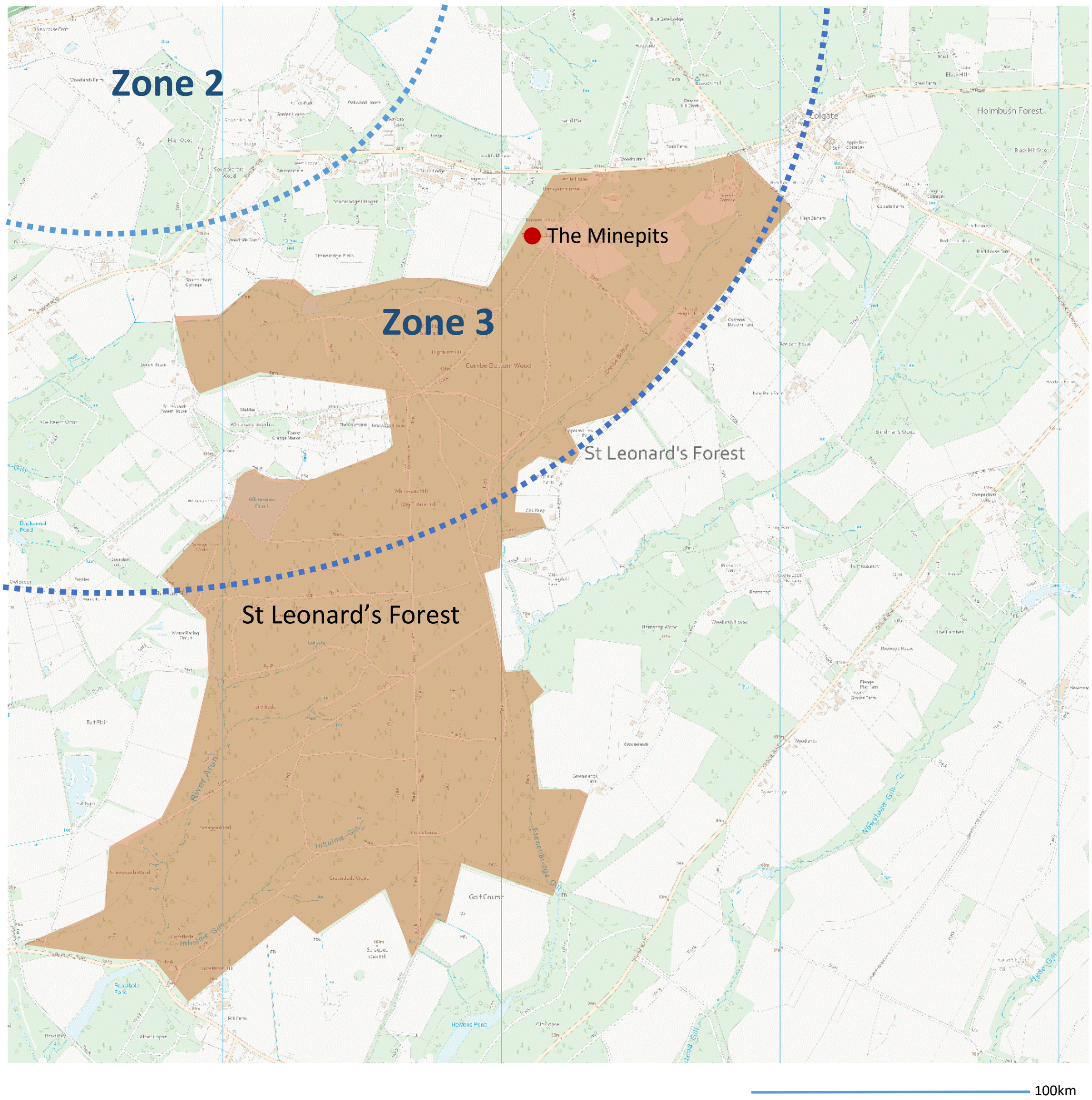


Figure 3.4 – *St Leonard's Forest in relation to Zone 3. Due to time restraints, only the northern part of the forest was investigated by the reconnaissance survey. Base map courtesy of Digimap OS Collections, adapted by the author.*

3.3 - Aims and objectives of the reconnaissance survey

Aims:

- To identify industrial, agricultural, and habitational features of the medieval landscape at Roffey, and their spatial distribution in the immediate and wider landscape setting of Cherry Tree Field (Zones 1-3).
- To understand Roffey's relationship to the wider medieval settlement and economy through historical, cartographic, and archaeological evidence.

Objectives:

- To conduct a desk-based assessment of Roffey and integrate existing historical and archaeological understanding of iron-production at Roffey into the results of a landscape reconnaissance survey.
- To examine the historical, placename and ownership records of Roffey using historical accounts, Tithe Maps and Subsidy / legal documents.
- To undertake a landscape reconnaissance survey of Roffey and the surrounding landscape and create a written, photographic, and diagrammatic record of archaeological features observed.
- To characterise the present-day flora at Roffey, to identify ancient hedgerows and boundaries.

3.4 - Methodological Approach

3.4.1 - *Desk-top assessment*

Historical sources

The desk-top assessment consulted historical, cartographical, and archaeological datasets to consider existing knowledge on iron-production in the region and contextualise it within the settlement of Roffey. Documentary accounts included Patent Rolls, Subsidy Rolls and Liberate Chancery Rolls pertaining to Roffey or Horsham, of which Roffey formed an outlying manor. Records from 1327 and 1346 documenting the supply of horseshoes and the existence of a smithy, had initially drawn the attention of previous researchers to the potential importance of Roffey as an iron-production site. However, these sources had never been considered within the broader context of the settlement, economy, or manor of Roffey. Many records have been transcribed and published on British History online, the Victoria County History, or in the Sussex Archaeological

Collections (SAC). Wherever possible original transcriptions were viewed for it was found that once published, details were on occasion changed, or assumptions made, that in turn continued to percolate into later literature that referenced the article or book, rather than the original source.

Cartographic sources

Cartographic evidence was used to study the changes to the landscape over the last 200 years and was useful in the study of field patterns and placenames. 19th Century Ordnance Survey (OS) maps helped in establishing more recent alterations to the landscape, notably the changing field patterns from 20th century agricultural mechanisation and manorial landscaping in the construction of Roffey Park. Fieldnames at Roffey were sourced from the 1844 Horsham Tithe Map where fieldnames, acreage, and ownership were recorded on the attached apportionment. Fieldnames were indicative of both iron-production and associated industries and were interpreted using John Field's Dictionary of Fieldnames (1972) and W.D. Parish's, A Dictionary of the Sussex Dialect (1875). The latter publication was particularly important for, at the time it was published, Sussex words and phrases were still in regular use and included terminology specifically applicable to fields, Sussex being an important farming county. Today many of these words have fallen out of use, and yet fieldnames such as 'Lag' or 'Leg', to give one example, prominent at Roffey, owe their origins to a specifically regional dialect not applicable in broader fieldname studies.

Archaeological reports

The desktop assessment also considered past archaeological work at Roffey, that ranged from incidental finds, observations of slag deposits and scatters, and excavations. In many instances these sources reflected evidence that no longer exists, such as a first-hand account by Mitchell (1929) of his memories of 'cinder heaps' within the landscape, subsequently quarried away in the 19th century for roadbuilding; or fieldnotes from the 1985 bypass rescue excavation, which revealed a potential smithy and hall house, all of which are now gone (Holgate 1989).

While the detail in these past archaeological reports is variable, they, along with the placename evidence and historical references, identified potential targets within the landscape that warranted further investigation through landscape reconnaissance surveying. This landscape data could in turn be assessed alongside the records of features that had once existed but had subsequently been lost, to form a wholistic interpretation.

3.4.2 - *Landscape reconnaissance Survey*

Landscape traverses

Using a similar traverse-based approach to Juleff and Gilmour (2011) (see Section 2.5.3). Five traverses were identified that generally followed existing public rights of way, covering areas of potential archaeological significance determined from the cartographic data. In traversing these routes, written and photographic records were produced, documenting the position of archaeological features. These were recorded as locations and included findspots, slag and pottery scatters, earthworks, geological features, significant flora, ancient boundaries, and routeways. It was only after the survey was completed, and these were placed in a gazetteer, that some were assigned 'site status' (Girbal 2017, 127) (Appendix B2). Several traverses were re-visited as seasonal differences in lighting conditions and vegetation coverage had an impact upon the visibility of earthworks. Diagnostic samples were also collected, such as ore, slag and pottery, and their specific locations recorded. This helped inform the subsequent locations of the fieldwalking surveys, where a more systematic collection and record of their spatial distribution was made (see Section 4.6).

3.4.3 - *Hedgerow species diversity survey*

The species diversity of hedgerows was assessed at 5 locations in Zones 1 and 2. It is argued by Max Hooper (1970) that the age of a hedgerow can be determined by the diversity of shrub and tree species present within a 30-yard stretch, with every species representing a century in the life of the hedge. While this method is more limited for hedges pre-dating the medieval period, it held the potential at Roffey to assess boundaries that were in existence at the time of the 14th century. The hedgerow diversity survey could be used in conjunction with the cartographic, geophysical and fieldwalking data to reconstruct boundaries of the past landscape and indicate the date of the tracks, roads, and fields. The presence of ancient trees, such as oak, further implies that a boundary is of a greater age and were also recorded.

3.4.4 - *Earthwork Survey*

Earthwork plans were produced at both Cherry Tree Field (Zone 1) and the St Leonard's Minepits (Zone 3) to record the pits, banks and ditches that were prominent archaeological features in these areas. The earthwork plans were compared to the geophysical and fieldwalking surveys outlined in sections 4.5 and 4.6 to aid interpretation of geophysical anomalies and artefact scatters. The earthworks in Zone 1 were plotted using a Leica GS16 GPS Rover. The GPS Rover allowed recording and storage of points to an accuracy of a few centimetres. This method worked particularly well in Zone 1 as the open terrain and limited tree cover minimised the margin of error. The position and layout of earthworks were plotted and the GPS points later downloaded onto a base map in ARC GIS, where the features could be embellished with hachures to show their shape and direction of slopes (fig. 3.59).

Since limited satellite connectivity within wooded terrains meant that the Leica had a greater margin of error, the minepit earthworks in Zone 3 were recorded using a more traditional tape measure and a sketch plan approach, measuring length, width and depths, and plotting these on a site plan that was subsequently digitised (fig. 3.47). Cross profiles were also made of two typical minepit examples, by measing depth at 10cm increments along a stringline (fig. 3.48). Inevitably the potential for human error increased with this method, however the addition of photographs and videos of the survey area meant that plans could be cross compared in the digitising stages. As the minepits in Zone 3 cover a large area of approximately 10 acres, a representative example of a group of 5 minepits was selected for detailed earthwork recording.

3.4.5 - *Classification of locations*

Using an adapted classification scheme that Dr Juleff applied in her study of Sri Lankan ironworks, landscape features were divided into four location groups, subdivided into location types (Table 1) (Girbal 2017, 132). This classification enabled a distinction to be made during the analysis stage between isolated, or groups of features, which represented sites from natural features.

Table 1 – *Location groups and types identified in the reconnaissance survey of Roffey, based on the classification scheme used by Dr Gill Juleff (Girbal 2017).*

LOCATION GROUP	LOCATION TYPE	DESCRIPTION
1. HISTORIC	settlement	Settlement location
	structure (isolated building)	Isolated building such as a house of farm building, or site of
	pottery scatter	Location of a surface pottery scatter
	field boundary	Current or extinct field boundary, defined by a fence, hedge, ditch or surviving as an earthwork.
	routeway/ track / footpath	Route consisting of a metalled or unmetalled surface, footpath or extinct trackway
2. GEOLOGICAL	ore deposit	Location where iron ore deposits may be found
	mine pits	Location where iron ore has been extracted, often from small round vertical shafts
	quarry	Location where natural resources such as stone, chalk, clay or gravel has been extracted in the past
3. METALLURGICAL	slag scatter – smelting	Distribution of smelting slag on the surface of the ground
	slag scatter – smithing	Distribution of smithing slag on the surface of the ground
4. NATURAL	River or stream	Watercourse that flows through the landscape
	Forest or woodland	An area dominated by trees and shrubs
	Copse	A small collection of trees
5. ANY	findspot	Location of an isolated find

3.5 Historical context

3.5.1 - *Introduction*

To understand the historical context of Roffey and its iron-production, it was necessary to contextualise it within the wider borough of Horsham. Roffey's early history is based on a few surviving sources and care must be taken when making broader generalisations from single references. For instance, Roffey's status in the literature as a centre of iron-production is based on two surviving accounts, and of these only the 1327 reference to horseshoe manufacture can be taken as evidence for largescale production. Other references, as will be seen, may add further weight to this status and it is hoped that this section demonstrates the important role historical approaches play in complementing, supporting, and expanding upon the archaeological narrative. These records also allow iron-production to be placed within both an economic framework and a settlement / manorial context. To examine the broader context, this section begins by considering the origins and development of Horsham (Zone 3), before discussing the historical evidence for medieval Roffey, its economy and inhabitants (Zone 1 & 2).

3.5.2 - *Horsham and its commercial importance*

Horsham itself originated, like many towns and villages within the Weald, as detached territory or deene of the manor of Washington, which lies 20km to the south. Horsham is first recorded within two Anglo-Saxon Charters of 947 and 963 (Windrum 1978, 8) and while it is absent from the Domesday Book, Windrum speculates the possibility that a reference to Soreham refers to Horsham, which indicates its established status at this date. In the 10th century manors to the south used their Wealden territories for animal pasture and Horsham's name, *Hors* =

horses and *ham* = settlement, or land on which horses were kept or bred, attests to this purpose (Mawer and Stenton 1969, 225). Horsham's association with horses was to continue into later centuries and may have influenced the iron products at the Roffey Forge. By the 13th century Horsham had been established as an urban centre, possibly founded by the Braose family after William de Braose was granted the Lordship of Horsham, as Lord of the Rape of Bramber, by William the Conqueror (Hurst 1889, 2; Lower 1870, 239). Evidence of a deliberately planned market square, a large church - rebuilt as the population grew, and references to merchants operating in the town are all indicative of Horsham's urban expansion and growing economic importance (Lower 1870, 239).

Figure 3.5 – *Medieval building from Middle Street in Horsham, believed to date to the late 15th century. It is thought that it was originally a pair of shops, although as the ground floor timbers did not survive, the current shop front is based on similar examples. The building was moved to the Weald and Downland Living Museum and reconstructed to reflect its likely original configuration (Weald and Downland Museum 2022). Author's image.*

Horsham grew commercially when it became a borough and the assize town for Sussex from 1307, and the establishment of a merchant's guild suggests it was a place of commercial importance (Windrum 1978, 9; Lower 1870, 239) (fig.3.5). This is also seen in records of fairs and markets from the 13th century, which included a Horse fair recorded from 1233, when the right to hold a fair for 3 days during the Translation of St Thomas Becket was given to William de Braose; and a cattle market (Windrum 1978, 114-115; Baggs et al 1986, 166-180) (fig.3.6). The town's proximity to St Leonards Forest, where people south of the Weald would move their livestock for grazing, would also have encouraged the growth of Horsham's livestock markets (Horsham Museum 2022). From 1279 markets were held on a Wednesday and Saturday, and in 1449 the Archbishop of Canterbury was granted the right to hold a market on a Monday at his Bishopric (Baggs et al 1986, 166-180). The proximity to Horsham and this livestock economy must be seen as an important influence over Roffey, for the breeding and trading of horses would have facilitated a market for horseshoes, while Horsham's broader connections to London would have facilitated trade opportunities beyond Roffey's local sphere.

Figure 3.6 – *Medieval stirrup discovered by Thomas Honywood in the 19th century. Honywood 1868 SAC Vol.20 196*

3.5.3 - *Roffey – manor and settlement (Zones 1 and 2)*

Roffey first appears in the documentary record at the end of the 13th century with references to 'La Rogheye' in the catalogue for ancient deeds for Sussex and a Subsidy Roll for the Villat' De Rozghee in 1296. Baggs et al (1986, 131-56) suggest settlement growth at Roffey represents ribbon development, as seen in other outlying hamlets. The Subsidy Roll of 1296 records 18 people as paying tax (see Table 3.2) and suggests a settlement here at this date (translated by Hudson 1910). A settlement was certainly in existence by 1340 when a grant was made by Robert Edyng to William le Rose of houses and curtilages in 'la Rogheye' (translated by Maxwell Lyte 1890, 359-368) and it was 5 years after this that a Smithy is first recorded. The possible location of dwellings and tenements is discussed in Section 3.7.

It was not until the 15th century that a manor was first recorded at Roffey, when it formed a sub-manor (sub-infeudation) of Chesworth, to the south-east of Horsham (Lower 1870, 246). In 1442, John Michelgrove and others levied a fine by which the manor of Roughey was settled on Thomas Hoo and his wife Alice (Translated by Salzmann 1916 b, 269-272). Seven years later in 1449 Thomas Edward granted to Thomas Hoo, John Fysshlake and John Wodye 'all his lands and tenements at Rogheye in Horsham' (Translated by Maxwell Lyte 1900, 282-293). While these sources are a century after the records of iron-production, they suggest that at an early date a manor was established and that tenements existed. The original manor house, which is thought to have stood at Roffey Place, no longer survives as it appears most of the current house was rebuilt in the 17th century (Baggs et al 1986). However Lower (1870, 246) suggests that it was once large enough to enclose a quadrangle of 120 feet and was surrounded by a moat. The position of Roffey Place, so close to the iron-production evidence is significant and raises the question of why this location was chosen, so close to the smells and noise that such an industry would have had. This might suggest iron-production had ceased by the 15th century when the manor was built.

A reference to a park existing at Roffey Manor was made in 1439, which was located within St Leonard's Forest (Baggs et al 1986, 156-166). By 1480 a Deed of gift made to Battle Abbey by Thomas Hoo records 'lands and Tenements called the Old Park and the Home Park' as part of the Manor of Rowghey (Translated by Thorpe 1835). While Baggs et al (1986) suggests this park was to the southwest of Roffey Place and by the first half of the 19th century was being repurposed into arable land, the cartographic evidence suggests that it lay to the southeast, directly south of Zone 1, where the fieldnames are indicative of the former extent of St Leonards Forest (see Section 3.7). Links between the manor and the forest may explain the position of iron-production on the periphery of this park and St Leonards Forest, with the parkland providing access to the resources of charcoal and ore contained within the forest.

3.5.4 - *Iron-production at Roffey*

The date at which iron-production began at Roffey is unknown, however, it is possible that the presence of ore was recognised as early as the 10th century and exploited seasonally when Horsham formed attached swine pasture for the manor of Washington. Evidence at Friars Oak, near Keymer, suggests this practice took place at other southern manors along the South Downs which held estates stretching north into the Weald (see Section 1.6). Roffey was attached to Chesworth manor which Baggs et al (1986, 156-166) suggests may have formed part of Washington Manor in the 10th century for both were held by the Braose family. As ore is found at Roffey and within St Leonard's Forest, there is no reason why it was not utilised, however, the challenge with identifying Anglo-Saxon smelting sites, as outlined in Chapter 1, remains true here. Roffey may have been seasonally occupied until the 13th century at which date records of assarting for arable land such as at Crockhurst and Marlpost to the south of Roffey, begin to appear in the historical record (Baggs et al 1986, 166-180). Baggs et al suggest that shaws and belts of woodland that are present across the landscape potentially represent original woodland from which the medieval assarts were made (ibid 1986, 166-180) and such patterns can be seen on the Tithe Maps at Roffey, suggesting that it too formed a clearing from the woodland.

3.5.5 - *Supplying the Kings Army*

The earliest reference to iron-production at Roffey dates to 1327, when 1000 horseshoes were purchased by the Sheriff for £4 3s 4d and taken from '*Le Rogheye (Roffey), near Horsham, where they were made, to Shoreham'* at a cost of 3s for carriage (Durrant Cooper 1865, 117). It is likely that these horseshoes, were required to supply Edward III's army during his wars with Scotland, with the Battle of Stanhope taking place in the same year. Such a substantial order requires a certain level of production capacity and could indicate a team of individuals working together to fulfil the order. It might also suggest specialisation in the production of horseshoes, particularly if the records of earlier orders of horseshoes by the Sheriff, such as in 30,000 in 1254 and 3000 in 1319/20, were also made at Roffey (fig.3.7.) (Durrant Cooper 1865, 117). While it could be argued that the 1327 order utilised 1000 stockpiled horseshoes, the fact that so many had nevertheless been retained suggests there was a ready market available for them, either locally or through wider trade networks. On the other hand, the account states that these horseshoes were placed into 14 barrels along with '*3000 others and 80,000 nails'* which raises the question of whether these too were made at Roffey, along with the nails, and stockpiled, or had come from other forges within the Weald?

Figure 3.7 – *Examples of horseshoes dating to the c.14th century. Author's image.*

In 1338, 6000 arrows, or quarrels, designed to be shot from crossbows, were sent from Horsham to the Tower of London (Lower 1870, 239). The Sheriff received £14 10s 4d to purchase the arrows, which formed 240 sheaves at 14d a sheaf. Each sheaf contained 25 arrows and the order included a cask to place them in and transport to the Tower of London (Durrant Cooper 1865, 117; Lower 1870, 239; Hurst 1889, 9). This account provides evidence for the collaboration of industries, e.g., the fletcher to make the shafts of '*good dry wood'* and the smith to produce '*heads well sharpened, called Dogebil*'. How the two trades collaborated is unclear, and we are simply told they were made 'near Horsham', which has the potential to be Roffey. Typically, at this time, fletchers supplied the shaft and the fletchings, while the purchaser would have to source the arrow from the smith or 'arrowsmith' separately. This does not appear to be the case here and raises the question of how each industry collaborated – perhaps they were based at the same location. A comparison of these orders with records from other counties in the 14th century is discussed in Chapter 7.

3.5.6 - *Local exchange*

Iron must also have been traded at a local level, which probably represented the more regular demand for smiths at Roffey. Yet records for such local trade do not survive for it tends to be either the more official or unusual instances, such as the order for 1000 horseshoes, that records were kept and retained. Nine kilometres south-west of Roffey at the Manor of Marlpost, ploughshares and horseshoes could be rented by tenants from the Lord of the manor in 1285 (Baggs et al 1986, 166-180). This reference provides indirect evidence of the types of iron products that were manufactured for local demand and highlights the value ploughshares and horseshoes had to necessitate the need to rent.

3.5.7 - *Matilda Bonewyk's smithy*

The third specific iron-production reference dates from 1344 when a Demise (to convey or transfer property) of a smithy was made to Matilda Bonewyk. The deed states:

'*Demise by Thomas Chyew de la Rogheye to Matilda, late the wife of Walter de Bonewyk, for two hundred years, of smithy with bellows, anvils, hammers &c belonging thereto, and a portion of garden adjoining, with a way to a well situate at 'La Rogheye in Horsham 3 October, 18.'* (Translated by Maxwell Lyte 1900, 282-293).

There are three important aspects to consider with this source. Firstly, was this the smithy that produced the 1000 horseshoes 18 years earlier? It is a possibility, and the fact that all the equipment is listed as multiple items and not 'a pair of bellows' or 'an anvil' may indicate a smithy with the capacity to fulfil larger orders than one meeting the needs of exclusively local demand. A comparison can be made with the equipment of a smithy 100 years later, in 1549, at the Manor of Cheseworth, 5km south-west of Roffey. Here, the Inventories of Goods &c. lists the contents of the 'Smytthys Forge' as:

'a payer of newe belowes; a cove iron; a grete andvyle; a sledge; ij. Hand hamers; ij payer tongs; one peyer of plyers; a stampe; a pounce; a horse nayle toole; a perser to make holys in horse shoys; a chesell; a shovyll for cloys; a poynttyng stethye [small anvil]; a pan to dres horssez fete; a pece of a brokyn pan; a pece of a swadyng iron; a payle; a marking iron; a small perser; a bedsted in the smythe's chamber; a perser iiij or. Square.' (Translated by Ellis 1862, 123).

While this source marginally post-dates the medieval period, the account provides a useful comparison with Roffey and an insight into the equipment a forge attached to the manor held in 1549. This account is very specific about listing the precise numbers of each item of equipment, which is typically one of each tool unlike the multiple items of equipment at the Roffey Forge. The higher number of tools is a potential indication of the larger production capacity at Matilda's smithy, which may have served broader trade networks, while the Cheseworth forge operated specifically to fulfil the requirements of the manor.

The second aspect to consider is where Matilda's smithy was located. Was it at the suggested smithy site discovered in 1985 (Section 3.6) or was it elsewhere? The placename evidence outlined in Section 3.7 sheds further light on this.

The third consideration is whether the Bonewyk family were the smiths? A Waltero Bonwyk is listed in the 1296 Subsidy Roll for the Villat' de Rozghee as paying 4s 5½d (Table 3.2) in tax and was probably either Walter the husband of Matilda or Walter's father (Translated by Hudson 1910). This suggests the Bonewyk family's early connection to Roffey, however by 1327, the family also had interests in Horsham, for the 1327 Subsidy Roll for the town lists both a Walto and Willo de Bonwyk. The 1327 Subsidy roll does not survive for Roffey, and this reference to the Bonewyks at Horsham does not necessarily mean the family had left Roffey at this date, for other surnames listed for Horsham, such as Bole, Langenhurst and Shipbourne also occurred on the earlier Roffey Subsidy. It instead suggests close connections between Horsham and Roffey at this date.

3.5.8 - *Family connections and migration*

The Bonwick family continue to be recorded in association with Roffey in later years. For example, a fine from 1381 states: *John Bonewyk of Horsham and Simon Andreu, citizen and saddler of London, and Agnes his wife; a messuage, 8 acres 3 roods of land in Roghey by Horsham; to John* (Salzmann 1916 a, 194-

200), while a William and Alice Bonwyk (William was possibly the son of Matilda) held 1 acre of arable and two gardens at Roffey in 1383 (see 3.7) (Translated by Maxwell Lyte 1915, 146-159). The family are recorded in the late 15th century in the parish including a Deed of gift in 1480 where a James Bonewike is listed as a former owner of land at Roffey (Translated by Thorpe 1835). In 1495, a Demise records pasture within 'Rowghey Park' called 'Bonewyckys' (Translated by Maxwell Lyte 1900, 282-293) suggesting the family's long connection to the area and supporting the earlier hypothesis that iron-production was placed either on the periphery or within the park that extended into St Leonard's Forest. Despite this long connection, the family were not originally from Sussex but had migrated there sometime before the 14th century from Bonwick in East Riding of Yorkshire. Bonwick, according to Reaney and Wilson (1991, 53), is a locational surname, associated with families who had originated from a specific region or settlement. The reason for the Bonwick's move south is unclear, however it is notable that other local surnames in the Horsham area, such as Seagrave (Leicestershire) suggest other families or individuals migrated south during this period.

There also appears to have been more local migration suggested by the surnames in the Subsidy roll for Roffey in 1296 which include a Thom' de Shypburn, likely to be from Shipborne in Kent, Rado atte Rye, from the Sussex coastal port of Rye and a Willmo Nyuweman, or Newman, meaning new to the area. It would suggest a certain level of mobility at Roffey during this period, and may have been influenced by the demand for tradesmen in industries such as iron, as well as connecting the settlement to other locations in the Weald.

3.5.9 - *Surnames as indications of iron-production*

The 1332 Subsidy Rolls for Horsham record a Nicho Fabro – the name Fabro, if a bye-name, suggests his occupation was a smith or wright and probably a variant on the name Faber (Weekly 1927, 15) (Table 3.2). By this date some names had become hereditary surnames, however that is not to say the occupation was not passed down from father to son (Weekley 1927; 280; McKinley 1988, 58). McKinley (1988, 228-229) suggests that occupational surnames were generally only used when a profession was distinctive, and industries such as iron-production, if widespread in Sussex, was unlikely to lead to surnames such as Faber or Ferrour. It is significant therefore that a 'Fabro' is recorded at this date in Horsham and is indicative of the settlement's links with the iron-industry. A later demise by charter of lands and tenements in Roghey in 1491 lists a Robert Smyth as one of the witnesses, and while the name is likely to be hereditary by this date, it is indicative of his ancestor's occupation (Translated by Ledward 1955, 238-251) (Table 3.2).

3.5.10 - *Surnames, bye-names and other local industries*

Other industries are suggested by both the surnames and fieldnames that survive at Roffey, the latter is discussed in Section 3.7. This was a period when surnames were not necessarily fixed but changeable according to profession – also known as bye-names. When a name can be traced through several generations, such as Bonwick, it is evident that it had become a surname. Bye-names can be linked to the occupation of the individual and 'le' can be indicative of this – for example 'Petr' le Turnour' who was listed in the 1327 subsidy rolls for Horsham was Peter the Turner. Along with Turners, other industries indicated in the Horsham subsidy rolls for 1296, 1327 and 1332 included bakers, salters, and skinners, industries to be expected in a market town. Rogo le Singar (1327 Horsham), a Singar being an entertainer at fairs and festivals is indicative of Horsham's status as a centre for such events.

At Roffey the surname Pottere appears in a Demise of 1425 and a grant of 1437. While it is likely by this later date the surname was hereditary and not related to their occupation, for William Pottere is listed as 'clerk', it is indicative of a pottery industry having existed at some point in the Horsham area (Translated by Maxwell Lyte 1890, 359-361). Other surnames appearing in Demise documents relating to Roffey include Thomas Coupere (Cooper) a barrel maker (ibid, 359-361), an industry that is referenced in the 1327 Sheriff's order for horseshoes which records the '*purchase of 14 barrels to put these horseshoes, and 3000 others, and 80,000 nails in; 4d., for wooden hoops for the barrels; 2d., for iron nails to strengthen the bottoms of the barrels; 7d., for the wages of the workmen cleaning and hooping the barrels; 14d., for the porterage of them to the ship; 100s.'* (Translated by Durrant Cooper 1865, 117). These bye-names and surnames are indicative of other manufacturing industries at Roffey and Horsham, which in the case of barrel making, was linked to the iron-industry through the export of its goods, as well as in themselves being reliant on the industry for the iron hoops and nails used in constructing the barrels. It therefore demonstrates some level of interdependency between these industries.

Bye-names also indicate the importance of the wool and cloth industry in the late 13th and early 14th century. A Willmo Cardon was recorded in Roffey in 1296. Cardon, probably a corruption of Carder, represents an occupational name for someone who carded wool (Bardsley 1901, 320). In Horsham a Willo le Dygher appears to have held the occupation of cloth dyer in 1327, while Rico le Chaloner was a manufacturer or trader of woollen goods such as blankets. This implies a symbiotic relationship between Roffey and Horsham, whereby Roffey formed the outfield settlement, supplying the raw product of wool, which in turn was sent to Horsham where it could be turned into finished products and traded. If such a relationship existed for wool, other industries such as the iron industry may have followed similar mechanisms in the transition of products such as arrows (such as those sent from Horsham in 1338) from hinterland settlements into Horsham. On this evidence it could be argued that Roffey was a production centre and Horsham a trade centre.

3.5.11 - *Woodland surnames*

Bye-names in the 1296 Subsidy Roll for Roffey reflect the forested topography of the landscape and the settlement's place on the boundary of St Leonard's Forest (Table 3.2). Johanne atte Wode for example has a name meaning 'at the wood' while Simon' atte Gate took his name from 'In the brushwood' (McKinley 1988, 151, 183), although it could be referring in this instance to a literal gate into the forest that existed at Roffey and known as Roughey Gate. Other names relate to occupations within the Forest, including Johanne Venator, Venator originating from the Latin for hunt (McKinley 1988, 280), therefore he was a 'huntsman'. Roffey's ties to the forest are therefore evident, something important in the acquisition of the raw materials of iron production.

3.5.12 - *Summary comments*

The historical sources suggest iron-production was one of several industries that existed at Roffey during the late 13th and early 15th centuries. It is significant however that only references to smithing survive and smelting is entirely absent from the documentary accounts, despite the archaeological evidence presented in Chapter 4. Roffey's interdependency with Horsham is evident and the connectivity that Horsham had through its market economy no doubt supported the manufacturing industries of iron and potentially pottery, barrel-making, wool and baking that also may have existed. Drawing on Walter Christaller's (1933) Central Place Theory, Horsham maybe seen as a central place, while hinterland settlements such as Roffey supplied the necessary resources to support its market economy.

Table 3.2 – *Subsidy roll from 1296 providing evidence of bye-names and early surnames at Roffey. These provide indications of occupations or the migrations of taxpayers at this date. Original transcription made by Hudson (1910) for the Sussex Records Society.*

Subsidy Roll of Villat' de Rozghee 1296				
Taxpayer	**Taxation**	**Surname or bye-name**	**Name type**	**Notes / surname origin.**
Simon' atte Gate	5s. 11 ½ d.	Bye-name	Topographical	Gate– topographical surname widespread in Sussex meaning 'In the brushwood' (McKinley 1988, 151, 183)
Waltero Bonwyk	4s. 5 ½ d.	Surname	Locative	Bonwick, originating as a locative surname from North Yorkshire. McKinley says it is a surname present in the Horsham area from the 14th to 17th century (McKinley 1988, 104), however the Subsidy Roll takes it back to the late 13th century in the form Bonwyk. Its presence in 13th and 14th century records is testimony to being a hereditary surname.
Hugon' de la Graue	2s. 9 ½ d.			
Rado atte Rye	3s. 7 ½ d.	Bye-name	Locative	Probably originated from the Sussex port of Rye – i.e. Rado at the Rye (from Rye)
Johanne Fentre	5s. 2 ½ d.			
Willmo le Lenwere	4s. 10 ½ d.			
Gilibro de Langeherst	6s. 2 ¾ d.	Bye-name	Locative	There are surviving placenames for Langhurst in the Horsham area, including Langhurst Lane and Langhurst Wood Road.

Table 3.2 – *continued*

Taxpayer	Taxation	Surname or bye-name	Name type	Notes / surname origin.
Willmo Nyuweman	3s. 3 ¼ d.	Bye-name	Nickname	Nyuweman = Newman or a newcomer. This is a name found elsewhere in Sussex, such as at Southerham when previous tenants had been replaced (see McKinley 1988, 56).
Hugon' de Eneworth	5s. 0 ¾ d.			
Johanne Venator'	3s. 6 ½ d.	Bye-name	Occupational	Venator originates from the Latin for hunt (McKinley 1988, 280)
Willmo Cardon	1s. 10 ½ d.	By-name	Occupational?	Cardon = Possibly an occupational name for some who carded wool or who lived on land overgrown with thistles (Ancestry)
Ad' Dragon	3s. 0 ¾ d.	Bye-name	Nickname	Dragon, probably originates as a nickname (Weekley 1927, 209; Bardsley 1901, 428)
Thom' de Shypburn	11s. 2 ½ d.	Bye-name /Surname	Locative	Probably a misspelling of 'Shipbourne' for a Thom' de Shipbourne is listed in the 1327 subsidy for Horsham. Thomas probably came from Shipbourne in Kent.
Petr' Martyn	1s. 5 d.	Bye-name /Surname		Martyn = descendant of Martin. A common surname in France (Ancestry).
Ricro Rabbe	4s. 11 ½ d.	Bye-name	Patronymic	Rabbe = abbreviation of Robert (Ancestry). i.e. son of Robert
Johanne atte Wode	3s. 1 ¾ d.	Bye-name	Topographical	atte Wode = at the wood
Robro le Bole	4s. 3 ½ d.			
Willmo de la Court	11s. 0 ¼ d.		Topographical	Court – topographical surname widespread in Sussex (McKinley 1988, 183)
TOTAL	£4 6s. 0 d.			

Note: atte = 'at the'
Surnames or bye-names of this period typically fall into four categories: patronymic, locative, topographical, occupational, and nicknames (Scott and Mittleman 1999)

3.6 - Archaeological Context

Since publication of the accounts relating to iron-production at Roffey in the SAC, several field investigations have taken place and has led to the current site at Newhouse Farm being associated with the 14th century works. It was important to review this archaeological evidence and not assume that this location was necessarily the ironworks described in the accounts. The distribution of previous discoveries was mapped (fig.3.8) to provide targets for the reconnaissance

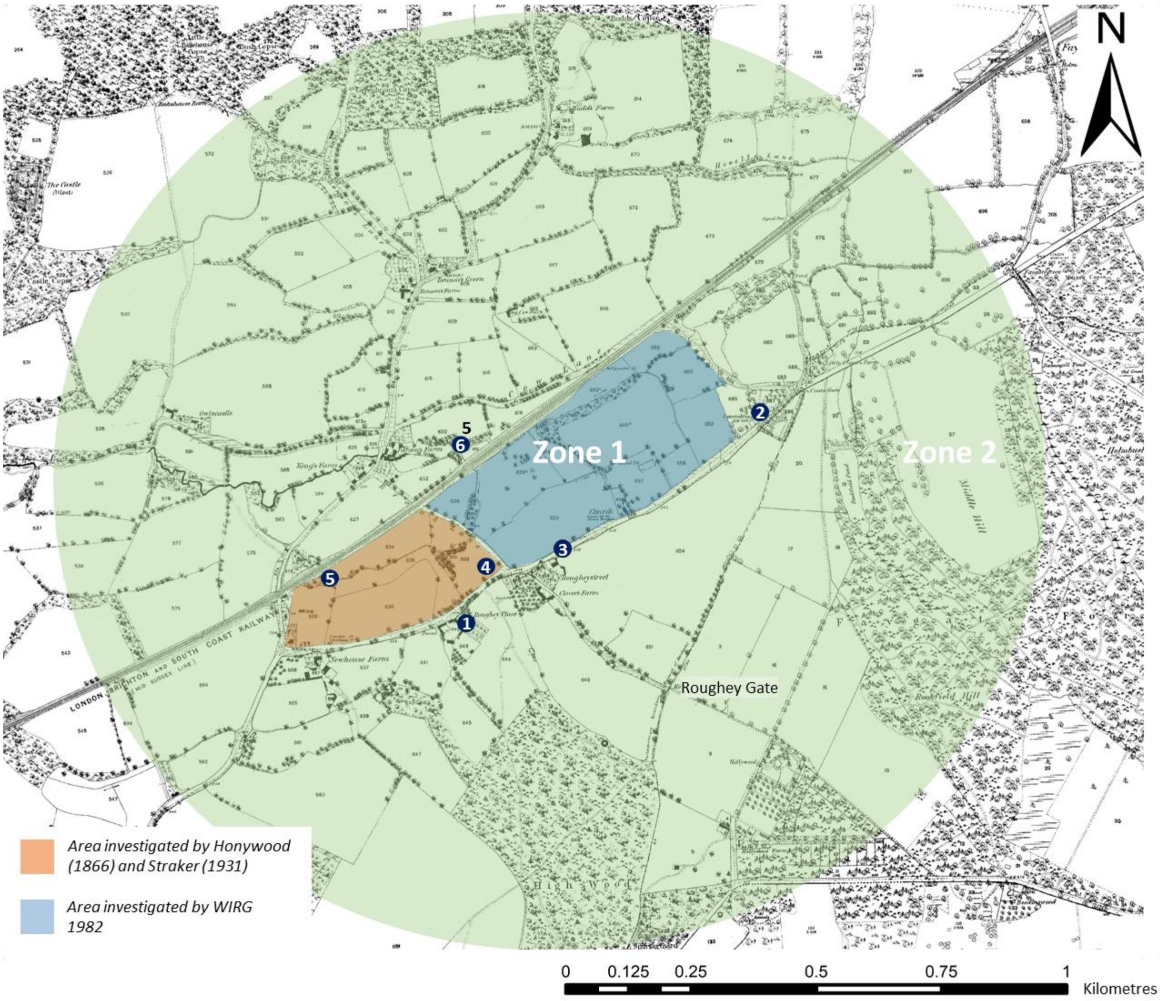


Figure 3.8 – *Previous discoveries on and around Newhouse Farm, Roffey. Base map courtesy of Digimap OS Collections.*

1. *Roffey Place. It was here that Mitchell claimed cinder heaps were located in the fields Large Cinder Hams and Small Cinder Hams between the house, in the 19th century.*
2. *Cherry Tree Inn. Mitchell describes how in the 19th century slag was dug out at the front of the house, which equated to 50 loads.*
3. *Site of a possible smiths workshop, found in 1985*
4. *Site of a medieval hall house found in the 1985 excavations*
5. *Location of slag analysed by Dr Ovenden*
6. *Location of Pond Bay identified by WIRG in 1982*

survey and locate archaeological features that were no longer visible (fig.3.8). It is worth noting the varying motivations of the previous investigations, as some were led by research, such as the investigations by WIRG, Straker and Honywood, while others, specifically the 1985 excavation, were rescue-based, and concerned more with recording a pre-defined area of the landscape before it was destroyed by development. Finally, at the extreme is excavation for profit, specifically the removal of slag for roadbuilding, which despite destroying a potentially important site, does inform us of its previous existence. This evidence combined with the new data from the reconnaissance survey aid in reconstructing the industry that once operated at Roffey in both extent, date range and morphology. The following sections are arranged chronologically in order of when research was undertaken.

3.6.1 - *Thomas Honywood's Investigation*

Thomas Honywood was one of the most famous residents of 19th century Horsham and a pioneer of local archaeological research (fig.3.9). Along with his position as Captain of the Volunteer Fire Brigade, Honywood was an inventor, photographer and accomplished amateur archaeologist where his investigations within Horsham and the surrounding countryside resulted in the excavation of barrows, the discovery of the Horsham Pottery Hoard (see Chapter 4) and the identification of prehistoric occupation at St Leonard's Forest. It was his classification of flint

Figure 3.9 - *Self portrait of Thomas Honywood from 1854. Bonhams, Public domain, accessed 18-01-23.*

implements that led him to coin the term 'Mesolithic', for he recognised that the tools in his collection were neither the oldest or youngest found and were therefore 'middle aged' flints (anon, Horsham Museum). Horsham Museum holds many of his collections of pottery and Mesolithic implements recovered that were once displayed in his personal museum at his home at Carfax.

Honywood carried out the earliest identification of artefacts relating to the Roffey ironworks, which appeared in the SAC in 1866 (fig.3.10 and 3.11). Here, he illustrated '*one of the antique hammer-heads dug up among the scoriae or slag, on the site of the Roughey Iron-works near Horsham*' (Honywood 1866, 195) (fig.3.11). Evidently the presence of slag at Roffey was already recognised by the mid-19th century and suggests that there was local inherited memory of an ironworks having existed here, for Honeywood does not claim to have discovered the lost site in his article but assumes the reader is aware of the locality. It also implies that at least more than one iron hammer had been discovered there and Straker adds that Honywood also recovered 'a pick' (Straker 1931, 442). Honywood also explains that in the same place, a '*bronze medal of excellent execution, exhibiting the head of the Magdalene in bas relief*' was also discovered (fig.3.10). This was made by Albert Durer in 1508 and may be the example currently held by the Victoria and Albert Museum, London, which was acquired by its first director Henry Cole in 1852.

Figure 3.10 – *Bronze medallion of the Magdalene by Albert Durer held at the Victoria and Albert Museum and possibly the example discovered at Roffey by Honywood in the 19th Century. Image courtesy of the Victoria and Albert Museum accessed 07/07/21.*

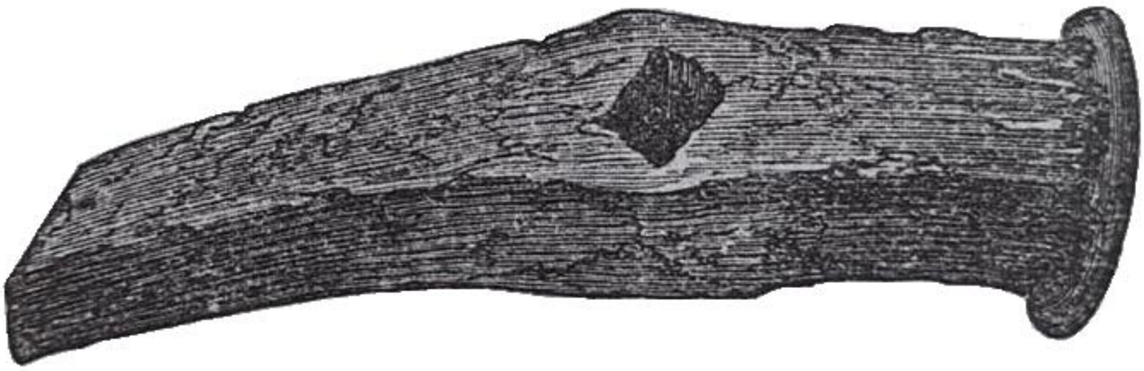
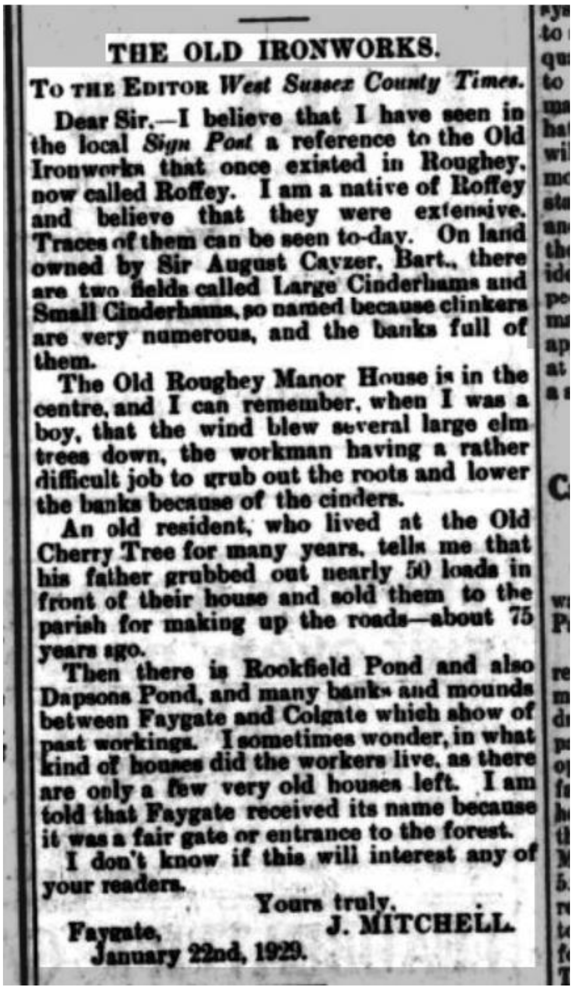


Figure 3.11 – *Hammer-head recovered at Roffey by Captain Thomas Honywood in the 19th century. From the Sussex Archaeological Collections Volume 18 pp.195*

3.6.2 - *An account by J. Mitchell*

An account of previous discoveries made at Roffey was published in the West Sussex County Times and Standard in 1929, where a Mr Mitchell described two fields called Large Cinderhams and Small Cinderhams, which are situated either side of Roffey Manor House (today known as Roffey Place) (fig.3.12). It is explained that fields took their names from the clinkers (slag) which were '*very numerous*'. One of these fields is evidently Wide Cinder Hams, referred to in the 1930s by Straker (see below), however as Roffey Manor is said to lie in the centre, it would suggest that the second location is the field to the south of



THE OLD IRONWORKS.

To the Editor *West Sussex County Times.*

Dear Sir,—I believe that I have seen in the local *Sign Post* a reference to the Old Ironworks that once existed in Roughey, now called Roffey. I am a native of Roffey and believe that they were extensive. Traces of them can be seen to-day. On land owned by Sir August Cayzer, Bart., there are two fields called Large Cinderhams and Small Cinderhams, so named because clinkers are very numerous, and the banks full of them.

The Old Roughey Manor House is in the centre, and I can remember, when I was a boy, that the wind blew several large elm trees down, the workman having a rather difficult job to grub out the roots and lower the banks because of the cinders.

An old resident, who lived at the Old Cherry Tree for many years, tells me that his father grubbed out nearly 50 loads in front of their house and sold them to the parish for making up the roads—about 75 years ago.

Then there is Rookfield Pond and also Dapsons Pond, and many banks and mounds between Faygate and Colgate which show of past workings. I sometimes wonder, in what kind of houses did the workers live, as there are only a few very old houses left. I am told that Faygate received its name because it was a fair gate or entrance to the forest.

I don't know if this will interest any of your readers.

Yours truly,
J. MITCHELL.

Faygate,
January 22nd, 1929.

Figure 3.12 – *Newspaper extract from the West Sussex County Times and Standard 22 January 1929. Courtesy of The British Newspaper Archive.*

the manor, which is otherwise unrecorded as containing slag and is indicative of a southernly extension of the area of activity (see Section 3.8.8 fig.3.85).

Mitchell also describes the presence of banks full of cinders. He claims that when he was younger (presumably the later years of the 19th century), '*the wind blew several large elm trees down*' at Roffey Manor and workmen had '*a rather difficult job to grub out the roots and lower the banks because of the cinders'*. He is not specific as to what these banks are, and whether they are field boundaries or mounds within the fields, however it could be suggested based on the presence of the slag, that these were the remains of slag heaps. While they could be redeposited slag after the period in which the ironworking was operating, slag was unlikely to have been moved very far from its source and the presence large elm trees, which can live up to 400 years, would indicate these banks of slag were of some antiquity by the 19th century. In further support of the existence of slag heaps in the 19th century, Mitchell explains how an old resident recalled his father grubbing out *'nearly 50 loads (of cinder) in front of their house and sold them to the parish for making up the roads'*. This is a practice known to have taken place elsewhere in the Weald, with Lower (1849, 171) describing how in 1844 Roman slag heaps were excavated at Maresfield for use in repairing the London Road. Mitchell says that the house was '*The Old Cherry Tree'* which is presumably the Cherry Tree Inn immediately east of Cherry Tree Field (Zone 1)

Figure 3.13 – *The Cherry Tree Inn. In the 19th century slag was 'grubbed; out from the front and sold to the parish for road building. The Cherry Tree Inn dates to the 16th century so this would indicate that the slag pre-dates this building, or that the building is contemporary with the ironworking activity. (Author's image).*

(fig.3.13). Again, the slag is unlikely to have moved far from its point of origin and may represent an eastern extension of activity.

3.6.3 - *Ernest Straker's Investigation*

Ernest Straker visited Roffey during the 1920s/30s, when compiling his gazetteer of Wealden iron sites. He describes visiting two arable fields between the Crawley-Horsham Road and railway line, which were separated by a strip of land called the Lag that had '*an abundance of cinder'.* He suggested that this was the site of the Roughey Forge (Straker 1931, 442) (fig.3.14). Again, this suggests considerable quantities of slag were present across these fields, although it is clear that these two fields were Wide Cinder Hams and Crooked Cinder Lane located between Wimland Road and Brook Lane (Zone 2) and not Cherry Tree field which is to the west (figs. 3.15 and 3.16). It is also likely that this area formed the northern of the two fields either Large Cinderhams or Small Cinderhams described by Mitchell in 1929. While there, Straker collected samples of amorphous slag, tap slag and furnace wall which are now preserved at Barbican House, Lewes (fig.3.14).

Figure 3.14 - *slag (including tap slag) and probable furnace wall recovered by Straker in his visit to Roffey in the 1930s. Now held in the Straker collection at Barbican House. Image courtesy of www.slagdata.org*

Figure 3.15 – *Crooked Cinder Lane and The Lag. Investigated by Honywood and Straker and said to contain 'an abundance of cinder' within the plough soil. To the east of the field stood the medieval hall house, excavated in 1985. A hedgerow survey of the eastern boundary suggested it was approximately 800 years old See section 3.8.6. (Author's image).*

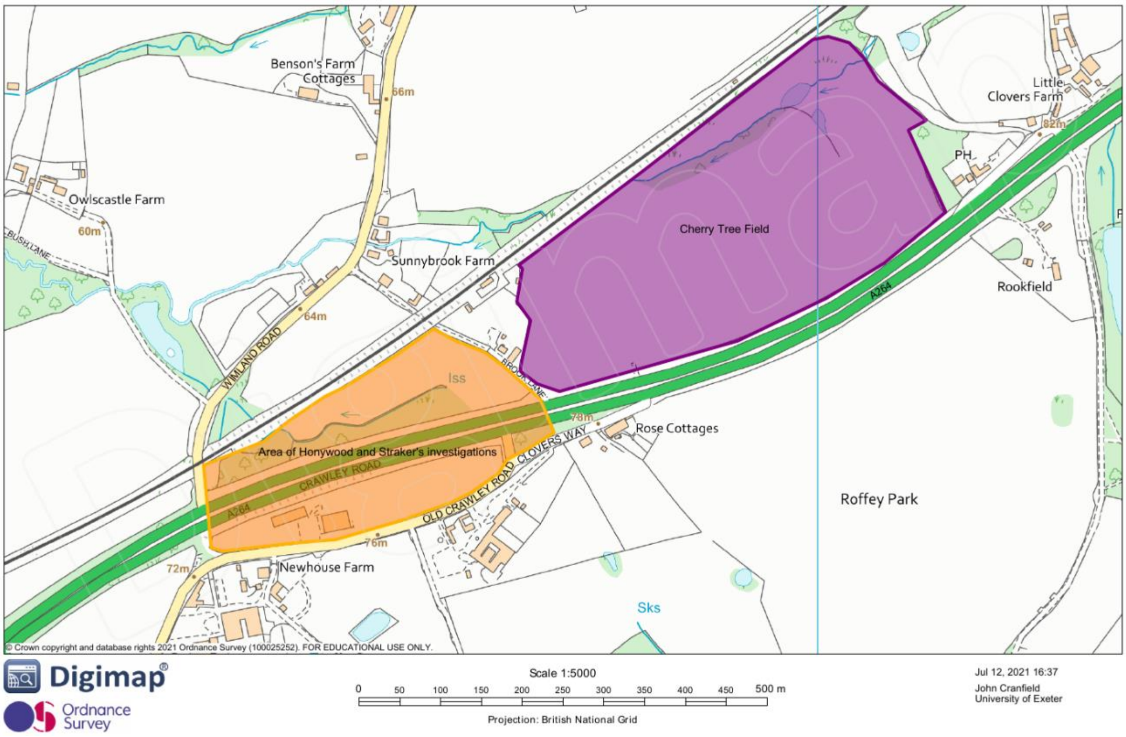


Figure 3.16 – *area (in orange) visited by Honywood in the 19th century and then again by Straker in the 1920s/30s, consisting of the fields Wider Cinder Hams, Crooked Cinder Lane, and Leman Garden. Cherry Tree Field (purple) is to the east and was visited by WIRG in 1982. The area believed at the time to be 'The Lag' described by Straker was in fact the remains of a field boundary, waterfilled at the northern end, that runs N-S at the eastern end of the field. The widening and change of route of Crawley Road (A264) in the 1980s has meant that much of Honywood and Straker's site has been built over, however parts of Crooked Cinder Lane and Leman Garden survive as a meadow. Base map courtesy of Digimap OS Collection.*

3.6.4 – *WIRG's visit in 1976 and 1982*

In 1976, WIRG visited Roffey and found slag more than '100 yards' from the samples recovered by Straker. They also found slag that Dr Ovenden at the time interpreted as 'powered bloomery cinder' within a small copse 300m to the west of Brook Lane. In November 1982 WIRG re-visited Roffey, where in Cherry Tree Field they found '*Bloomery tap slag all over the large field, more intensely at the west end and tending to be in separated groups towards the middle and east end*' (anon 1983: 2). It was also observed how this slag was found alongside iron ore (box stone) and sandstone. WIRG also reported finding Medieval pottery at the west end of Cherry Tree Field scattered amongst the slag and this included 14th century Surrey and Graffham wares (anon 1983, 2). It seems that on this visit, it

Figure 3.17 – *remains of an early field boundary in Cherry Tree field that was mis-interpreted as 'The Lag'. Part of the boundary, that once stood between Tod Field and Pasture (see figure 2) on the eastern side of what is today Cherry Tree field, is still waterlogged at the northern end, where a pond is present. (Author's image).*

was believed that Cherry Tree Field was the field visited by Straker. However, considering Straker's description and the placename survey, it is evident that Straker visited the fields to the immediate West (Wide Cinder Hams and Crooked Cinder Lane) (fig.3.16). Therefore, the field WIRG visited represented a further eastern extension of slag distribution (figs.3.17 and 3.18). At Brook House, to the north of Cherry Tree Field, a bay, 50m in length and 2m high, was found which had been cut through by Channells Brook Stream. There was a further extension of this bay at the northwest end which possibly formed a protective bank for a weir. Professor Tylecote believed that slag recovered in the stream here was forging slag and led WIRG to conclude that this was a possible site of a forge, complete with a water-powered hammer (anon 1983, 2-3).

Figure 3.18 – *the pond that marks the remaining section of the above field boundary. Author's image.*

3.6.5 - *1985 Excavation*

In 1985 the creation of the A264 bypass at Crawley Road through the widening of Crawley Road led to the truncation of the southern boundary of Cherry Tree Field and bifurcation of Wide Cinder Hams and Crooked Cinder Lane fields. Horsham Museum Society undertook a rescue excavation ahead of construction and two sites of interest were examined, these were the foundations of a small building with a possible smithing hearth at Cherry Tree Field and a Late medieval hall house at Leman Garden Field. While the hall house excavation was published in 1989, an excavation report for the building and hearth was never produced and a set of brief fieldnotes, a handwritten pottery report, location map and a single excavation plan the only records that survive (figs.3.19-3.20).

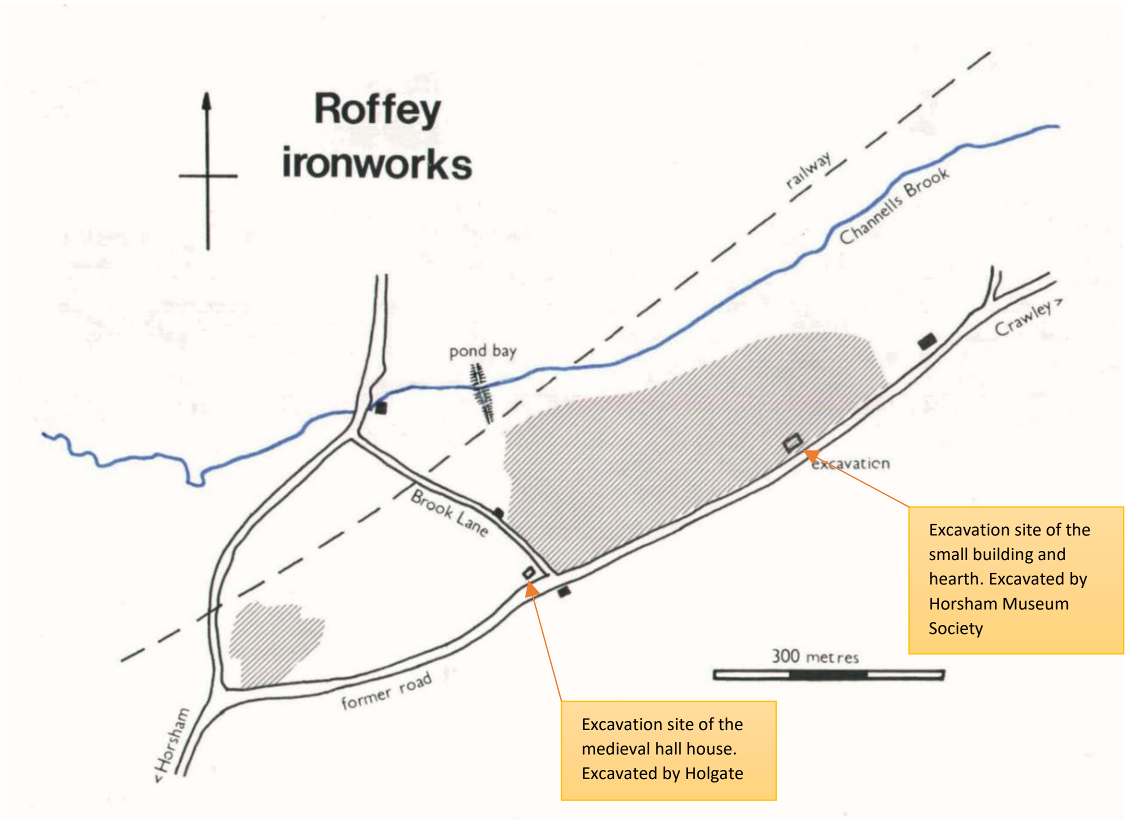


Figure 3.19 – *sketch map produced of the rescue excavation locations at Roffey, prior to the creation of the A264 bypass in 1985. Courtesy of Jeremy Hodgkinson. Original author unknown, adapted by the author.*

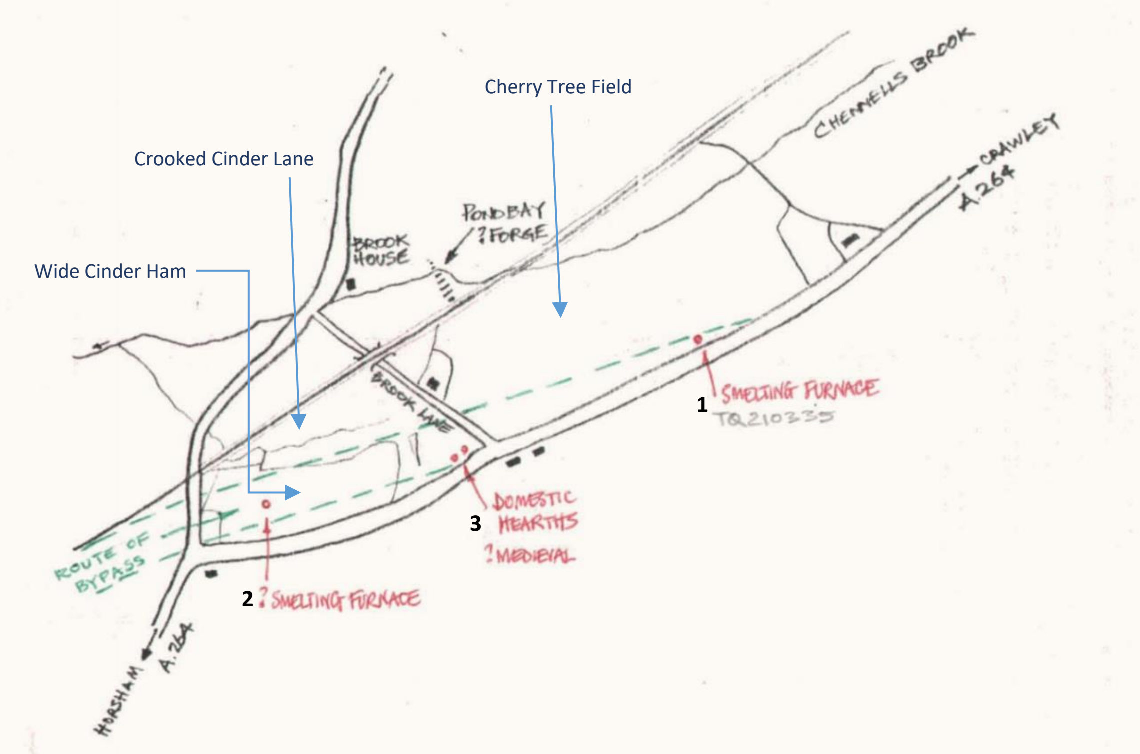


Figure 3.20 - *sketch plan produced of the rescue excavation locations at Roffey, showing the approximate positions of where features were located in relation to the route of the new bypass. The 'smelting furnace' at 1 was later interpreted as a possible smithing hearth and building and excavated by Horsham Museum Archaeological Society. There is no record of the 'smelting furnace' at 2 and its presence may have been an assumption made on the presence of slag. The 'Domestic Hearths' at 3 were excavated by Holgate (1989) and were part of a late medieval hall house. Plan courtesy of Jeremy Hodgkinson. Original author unknown.*

Fortunately, Jeremy Hodgkinson created a photographic archive of the excavation and this provides a valuable source for relocating the position of the site and record of the features uncovered (figs.3.22-3.23).

The excavation at Cherry Tree Field is labelled as 'smelting furnace' on figure 3.20, however, on the excavation plan is recorded as a roasting furnace (fig.3.24) and as a possible hearth potentially atop a stone plinth on the WIRG site database (http://www.wirgdata.org). Although a smelting furnace and a hearth are distinctly different structures, they can be found together, where the hearth was used to consolidate blooms from an adjoining furnace. Figure 3.25 does not show a furnace and perhaps its existence was presumed from the presence of assumed smelting slag.

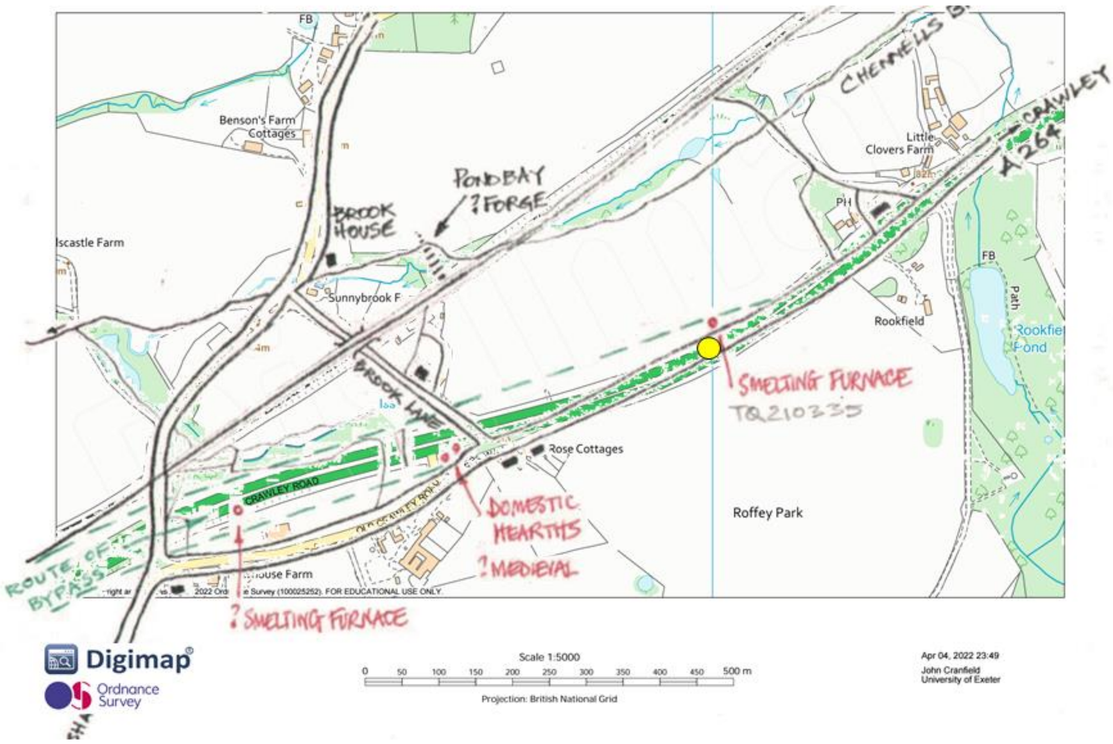


Figure 3.21 – *Sketch plan overlaid onto an Ordnance Survey map of the area. The yellow marker locates the site of the possible hearth and small building. Author of sketch map unknown, adapted by the author. Base map courtesy of Digimap OS Collection.*

The terminology used is however confusing and it is unfortunate that no samples of slag were characterised or retained for further analysis. A second 'smelting furnace' is identified to the west in Wide Cinder Hams field, however, there are no records pertaining to this from 1985. It is possible that the excavator also based this interpretation on the presence of surface slag in the area identified by Straker (1931), as the question mark on the map indicates that no specific feature was excavated.

Figure 3.22 superimposes the sketch map in figure 3.21 onto a scaled OS map. It was evident that the sketch was not completely to scale and had to be modified to gain the best fit. It does however allow the identified features to be positioned within the current landscape. The yellow marker plots the grid reference provided for the small building and hearth at Cherry Tree Field.

Figures 3.24-3.26 show a plan of the excavation of the building and possible hearth at Cherry Tree Field. The fieldnotes state that a possible plinth was found, made from sandstone embedded in clay and surrounded by burnt clay, burnt sandstone, and charcoal. Hodgkinson suggests this may have been a smithing hearth (Hodgkinson 2005, 40). The size of this hearth is shown as 1.5m by 1m. The burnt clay in the surrounding soil is also obvious from the photograph as bright orange flecks along with the slag and charcoal (figs.3.22-3.23).

The fieldnotes state that the excavated hearth corresponded to a 'dark patch' within the field and that there were other dark patches that may relate to further sites. There was also a widespread slag deposit to the east of the hearth which contained 14th and 15th century pottery and had a depth of 3 ft (approx.1m).

Figure 3.22 – *Excavation of the small building and hearth. Traces of the walls are highlighted. Photo courtesy of Jeremy Hodgkinson with annotations made by the author.*

Figure 3.23 - *The possible smithing hearth base enclosed by a small building. It can be seen how the sandstone plinth embedded in the clay stands out from the colour of the surrounding soil. Photo courtesy of Jeremy Hodgkinson.*

The foundations of the small building enclosed the hearth, which stood at the buildings north-east end. The building was aligned northeast – southwest, following the same orientation as Crawley Road immediately to the south, and the hall house to the west. It had stone footings, and it is probable that the walls were of a timber construction with wattle and daub, which might account for the fragments of burnt clay found in the wall foundations but may have also been partially open. The plan shows these walls extending northeast for 3.5m on the western side, the eastern side was however not fully excavated. It is unclear whether the walls extended as far as the hearth, however a possible trace of wall is visible in the excavation plan and the central position of the hearth against the projected end wall would make this probable and result in a building approximately 10m x 4.75m.

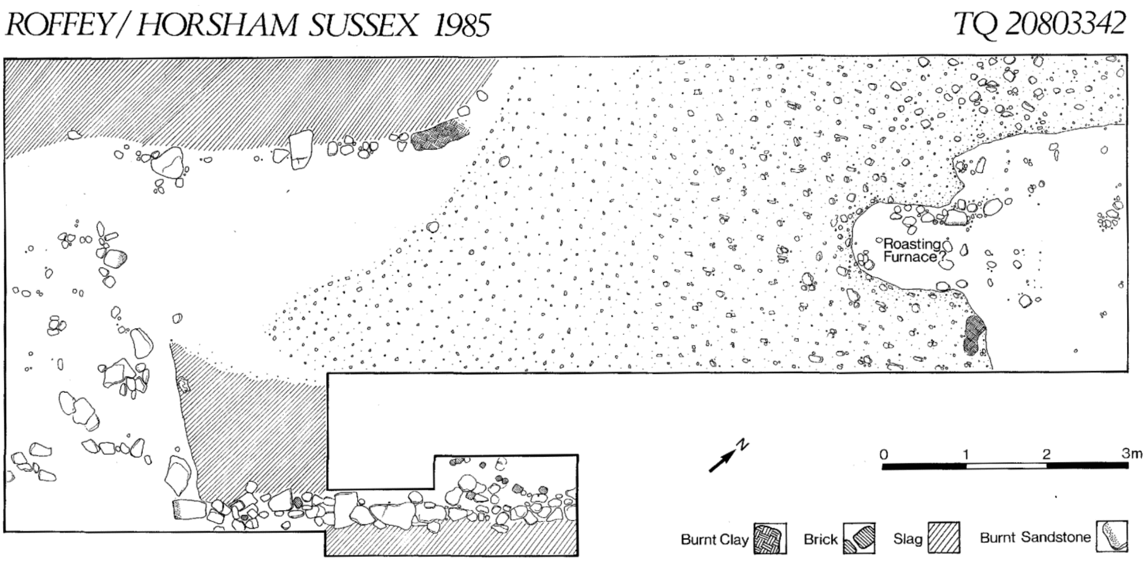


Figure 3.24 – *original excavation plan of the small building and possible hearth (labelled as 'Roasting Furnace') at Cherry Tree Field. by J Kirby.*

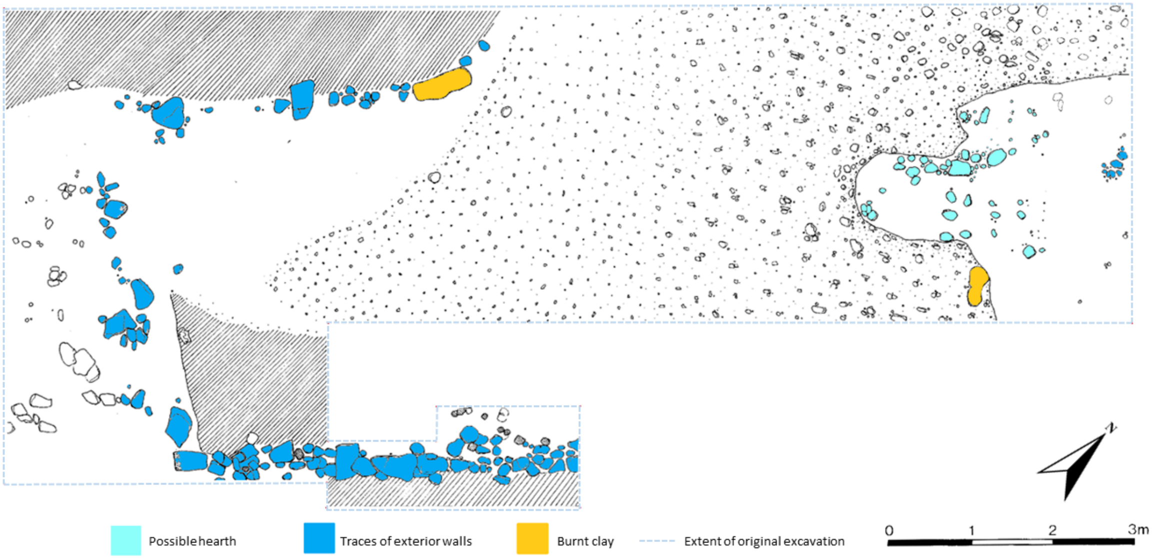


Figure 3.25 – *Plan with walls, burnt clay and the possible hearth highlighted. Original illustration by J Kirby Adapted by the author.*

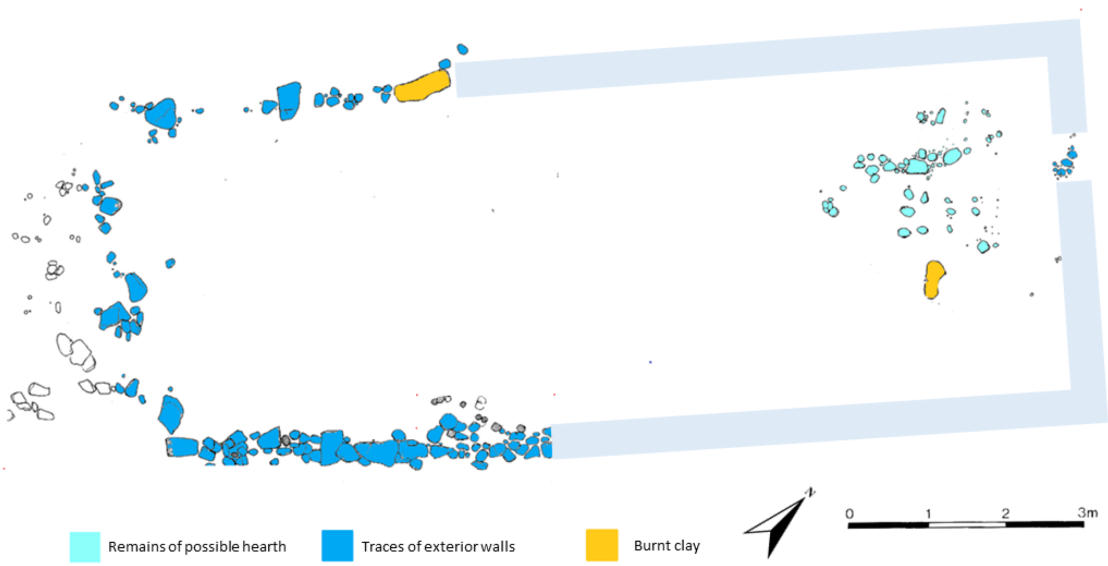
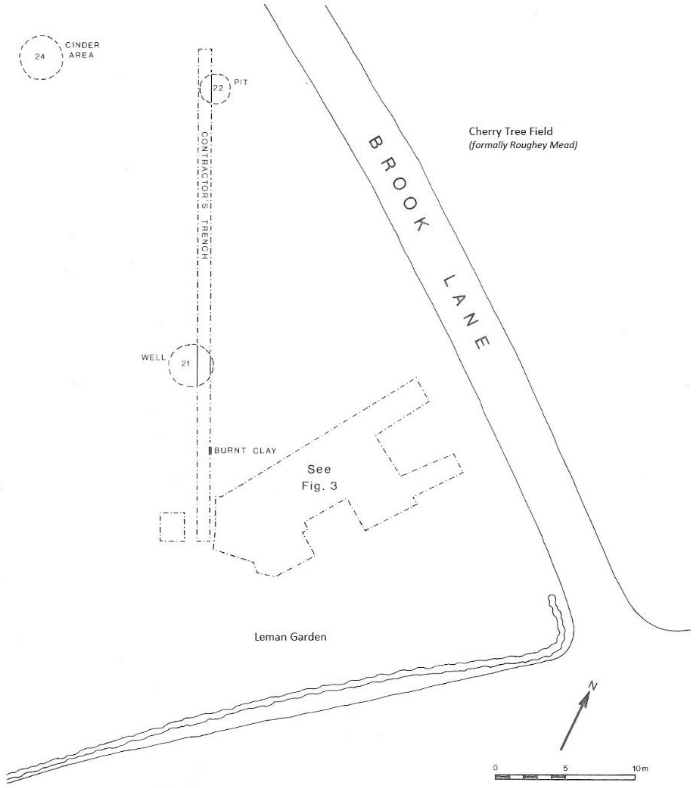


Figure 3.26 – *Projected extent of the building. Original illustration by J Kirby Adapted by the author.*

3.6.6 - *Medieval House at Brook Lane*

Figure 3.27 – *Excavation of the hall house in 1985 at Leman Garden field. Cherry Tree field can be seen in the background. Photo courtesy of Jeremy Hodgkinson.*

The foundations of a hall house were identified during the 1985 excavations in the southeast corner of Leman Garden Field (figs.3.27-3.28). It was aligned northeast-southwest, on the same alignment as Crawley Road to the south. The house was large at 14.5m x 7m and followed a typical layout, with a service bay at the southwestern end, a two-bay open hall, and parlour bay (Holgate 1989; 130). It was built of Tunbridge Wells sandstone footings with a clay floor and three hearths, one at the centre and two at the southwest end (Holgate 1989; 123, 130) (figs.3.29-3.30). The 14th to 16th century pottery recovered included fine sandy buff / orange wares and Surrey white wares and parallel the pottery assemblage from the small building and hearth and in the 2020 fieldwalk (Chapter 4) (Holgate 1989; 124-127). Holgate (1989; 130) argued that, as no chimney appeared to have been added, it was probable that the house had fallen out of use by the mid to late 16th Century. However, he did not feel there was enough evidence to say the house was associated with the period of ironworking at Roffey. While its size suggests it was the home of a merchant or yeoman (Holgate 1989; 130), its central position surrounded by evidence of iron-production may imply its owner had interests in the industry while its alignment with the road and smithy is indicative of integration within the broader settlement morphology.



Plan of the excavated area and features in the vicinity of the hall house discivered at Brook Lane from Holgate 1989, with additional fieldname annotations by the author.

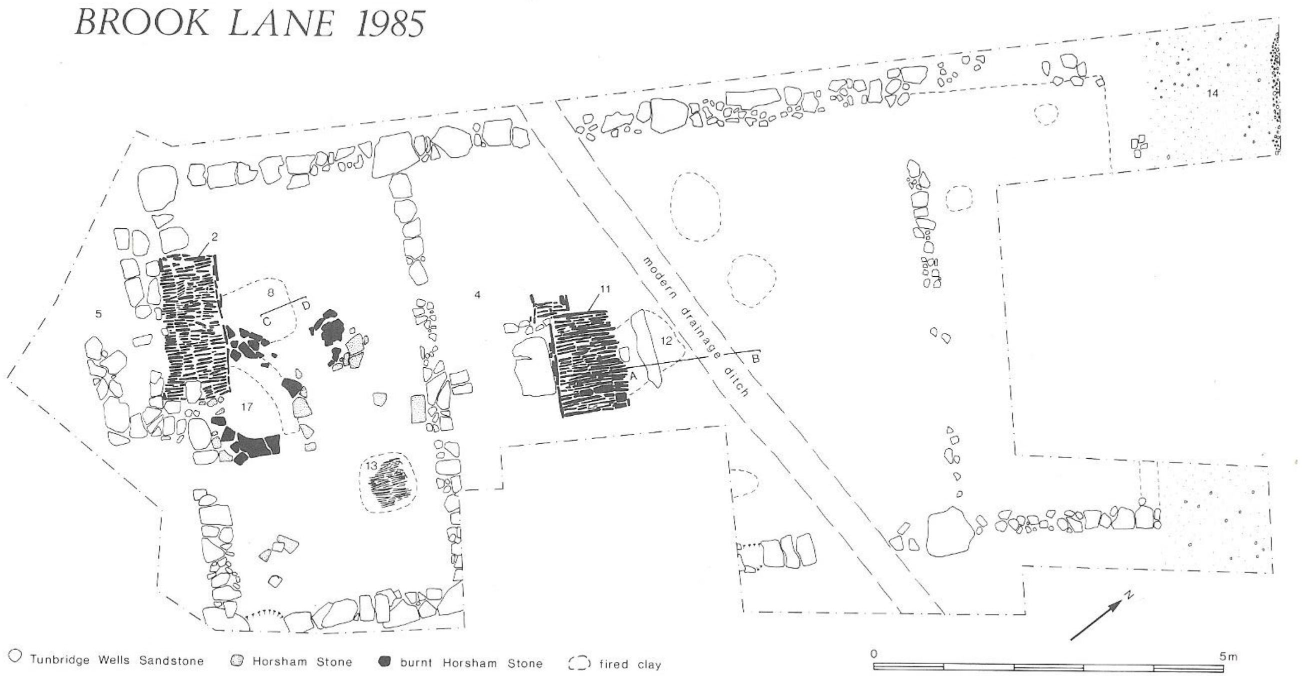


Figure 3.28 – *Excavation plan of the hall house. From Holgate 1989.*

Figure 3.29 – *A four bay medieval hall house from North Cray, Kent, now reconstructed at the Weald and Downland Museum. This example dates to c. 15th century and is of a similar configuration to the Brook Lane house with a central open hall and rooms at either end. Author's image*

Figure 3.30 – *End rooms of the open hall of the North Cray house which is divided into a buttery and pantry. The foundation evidence at Brook Lane suggested the presence separate rooms off a central hall. Author's image*

Other medieval buildings that still stand at Roffey include Brook House to the north of Brook Lane which still retains elements of its medieval origins including two bays of the medieval open hall and a crown post roof (British Listed Buildings 1980).

3.7 - Placename and land ownership survey

The 1844 Tithe map for the parish of Horsham, provides four important sources of evidence on the history of the Roffey landscape. These include the landowner, size of holding, state of cultivation, and the given names of fields, meadows, and woodland. Field (1972) argues that fieldnames can be divided into 26 categories, and in the case of Roffey, all fields surveyed could be placed within 19 of these (Table 3.3 and Appendix B1). The broader limitations of fieldnames have been discussed in Chapter 2, however, there were several specific limitations associated with Roffey that will be outlined here. In many cases the Tithe Map may be the first occasion where the names are recorded and while some names may be of great antiquity, others may represent recent additions. It appears that during the Tithe survey, fieldnames were recorded simply if they happened to be known to the occupier or landowner, and in some cases where it was unknown, 'name unknown' or simply the acreage is recorded. This is true in the case of fields owned by James Waller, where many are recorded as 'no name given', whereas those owned by the Duke of Norfolk are invariably listed with specified names (fig.3.31). It is possible that the names attributed to fields belonging to the Duke of Norfolk, who held the manor of Roffey at Roffey Place Farm, were taken from earlier manorial estate maps that were not available to other landowners such as James Waller. This suggests fields under the ownership of the Duke of Norfolk can trace the origins of their names to earlier centuries.

A second limitation is that fieldnames are only a reflection of the time in which they were recorded. The Tithe Maps were produced at a time of considerable change in agriculture, where smaller fields were being amalgamated. This can mean that as historic boundaries were lost, so too were their associated fieldnames. The removal of boundaries can also result in fieldnames that once represented small parcels of land, covering far larger areas, and causes challenges when identifying activities or features the name originally referred to.

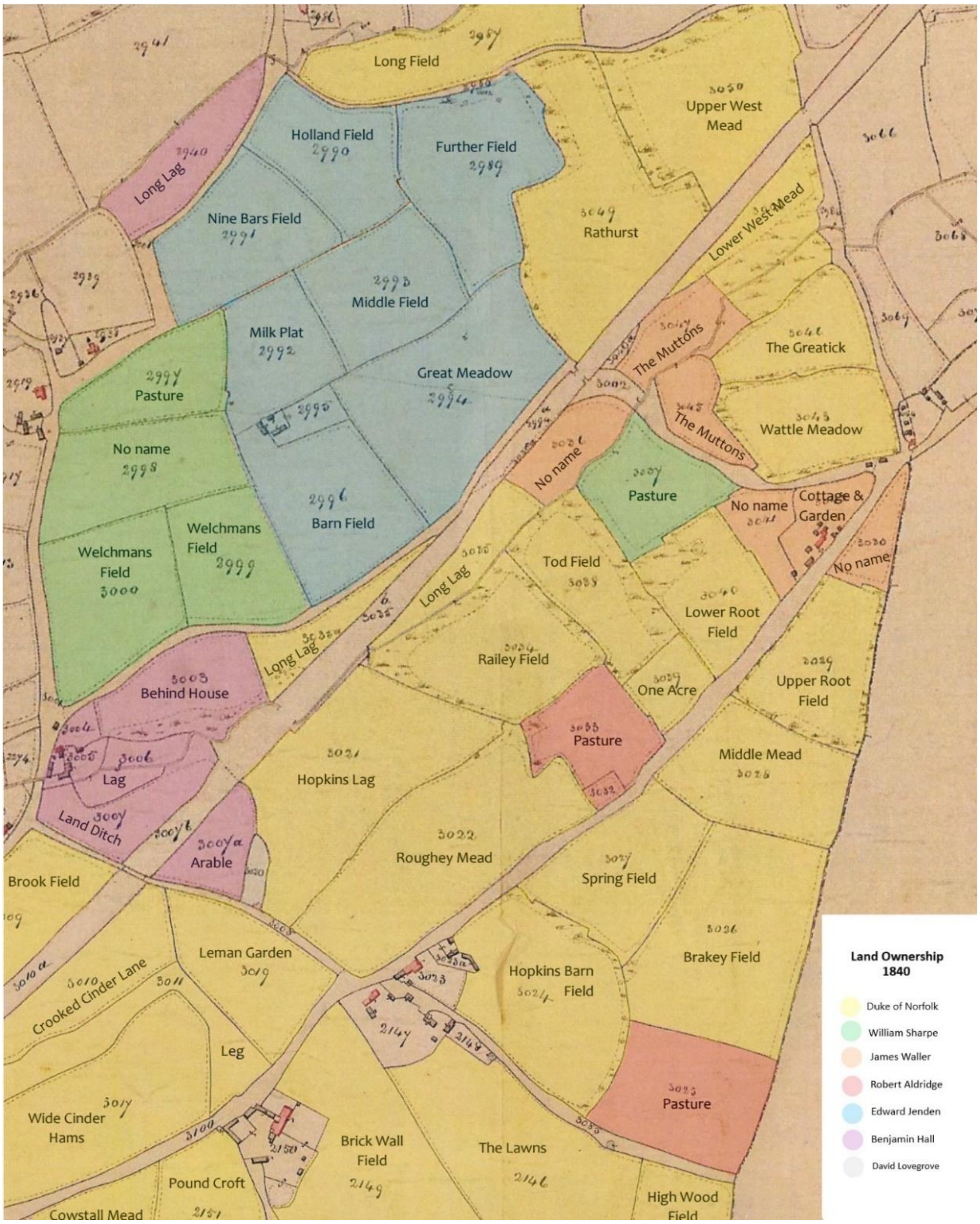


Figure 3.31 – *Roffey ownership based on the 1844 Tithe Apportionment. The Duke of Norfolk, who held the manor of Roffey, was the largest landholder, and owned many of the fields within Zone 1 and 2 that have evidence of iron production, including Roughey Mead, Lower Root Field, Crooked Cinder Lane and Wide Cinder Hams along with Upper West Mead which may have been occupied by the Bonewick's in 1383. It is notable how fields adjacent to the lanes, have different owners and is indicative of their former status as small fields and tenement plots. The difference in the survival of fieldnames may be explained by the fact that the Duke of Norfolk held the manor of Roffey, which at this time survived as Roffey Place Farm, and was tenanted by James Worsfold, who is recorded on the 1851 Census and again on the 1861 Census, when he held 150 acres (Ancestry 2022). Original map courtesy of West Sussex Record Office.*

Table 3.3 - *Classification of fieldnames at Roffey based on the categories assigned by John Field 1971. See appendix B1 for a comprehensive analysis of each fieldname.*

John Field's Classification	*Examples at Roffey*	*Zone*
1. Size Of Field	One Acre	1
	Acre Plat	2
2. Distance from the Village	Roughey Mead	1
	Holland Field	2
3. Direction	Behind House	2
	Further Field	2
	Upper West Mead	2
	Lower West Mead (see also 9)	2
	Lower Root Field (see also 10)	1
	Upper Root Field (see also 10)	2
4. Order	Middle Mead (see also 9)	2
	Middle Field (x2)	2
5. Shape	The Muttons	2
	Calves Leg	2
	Three Cornered Field	2
	Crooked Cinder Lane (see also 20)	
6. Type, Consistency and Colour of Soil	Sopers Plat (see 7 also)	2
7. Fertility Or Profitability of Land	Rathurst (see 11 also)	2
	Sopers Plat (see 6 also)	2
	Rough Field	2
8. Natural Features of Topography	Spring Field	2
	Brakey Field	2
	Lag	2
	Long Lag (x3)	1 & 2
	Holland Field (see 2 also)	2
	Long Field	2
	Leman Garden	2
	Leg	2
	Brook Field	2
9. Type Of Cultivation, Farming Practices	Pasture (x7)	1 & 2
	The Greatick	2
	Lower West Mead (see also 3)	2
	Arable	2
	Great Meadow	2
	Milk Plat	2
	The Lawns	2
	Orchard	2
	Meadow	2
	Middle Mead (see also 4)	2
10. Crops	Lower Root Field (see also 3)	1
	Upper Root Field (see also 3)	2
	Wattle Meadow	2
	Nine bars field	2
11. Wild Plants, Including Trees	Rathurst (see 7 also)	2
	High Wood Field	2
	Forest Field	2
	Alder Mead	2

Table 3.3 - *continued*

John Field's Classification	***Examples at Roffey***	***Zone***
12. Domestic and Farm Animals	Cowstall Mead	2
	Pound Croft	2
	Horse Pasture	2
13. Wild Animals	Tod Field	2
14. Buildings	Cottage and Garden	2
	Barn Field	2
	House Field	2
	Hovel Field	2
	Bakehouse Field (see also 25)	2
15. Roads, Bridges Etc.	NA.	
16. Name of the Owner	Hopkins Lag	1
	Railey Field	1
	Hopkins Barn Field	2
	Elliots Mead	2
17. Trade or Profession of the owner or occupier	Welchmans Field	2
18. Person or object maintained by the income from the land	NA.	
19. Money value of the land	NA.	
20. Archaeological features	Crooked Cinder Lane (see also 5)	2
	Wide Cinder Hams	2
21. The Supernatural, Folklore, And Folk Customs	NA.	
22. Names Of Arbitrary Application	NA.	
23. Land On a Boundary	Land Ditch	2
	Brick Wall Field	2
24. Legal Terms Etc.	NA.	
25. Industrial Use of Land	Saw Pit Field	2
	Kiln Plat	2
	Bakehouse Field (see also 14)	2
26. Games	NA.	

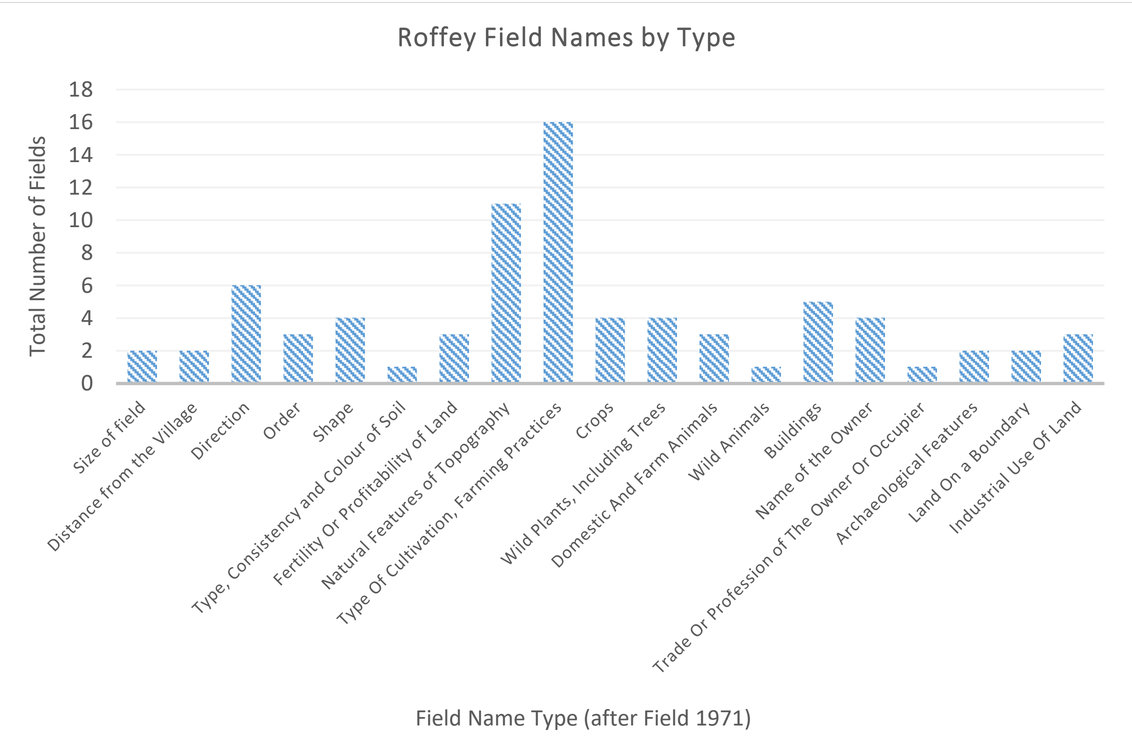


Figure 3.32 – *Total numbers of fields under each classification type. Natural features and Type of cultivation form the highest name type and there is an even spread of names that owe their origin to other factors.*

3.7.1 - *Zone 1 Placenames – Cherry Tree Field*

In 1844, Cherry Tree Field comprised 11 parcels of land dispersed between several wooded shaws and small woodlands (fig.3.33). Fieldnames were either topographical or relate to cultivation and ownership. The exception is Roughey Mead which translates as rough meadow, however in this instance probably reflects its central position within the settlement of Roffey, on the crossroad of Crawley Road and Brook Lane. Roughey is an earlier variant on the spelling of Roffey and was still used within the Parish in the 19th Century. The cottages opposite Roughey Mead were known as Rougheystreet, while Roughey Place, the early manor of the parish, stood 170m west of the field, and potentially gave Roughey Mead its name. 'Mead' is an abbreviation of meadow and would indicate that in the past this area was uncultivated pasture.

Railey Field and Hopkins Lag also relate to past ownership, however 'Lag' in Hopkins Lag is from the old Sussex dialect of Leg meaning 'a long narrow marshy meadow, usually by the side of a stream' (Parish 1875: 67). Channels Brook Stream flows to the North of this field and the meadow name suggests that, like Roughey Mead, Hopkins Lag remained uncultivated in the past and on the Tithe apportionment was still listed as pasture. The number of trees shown on 19th century OS maps also supports this uncultivated status. While little slag was found in this field during fieldwalking, there were frequent occurrences of ironstone and sandstone in this area, some displaying possible toolmarks. The tree arrangement, which on the 1879 OS map shows a circle of trees, may suggest the presence of past quarrying, with pits subsequently becoming overgrown by vegetation.

Other fieldnames in Zone 1 are topographical such as Long Lag, again relating to a long strip of meadow adjacent to Channels Brook Stream. It is worth noting however how this meadow strip, while divided into small parcels of land, forms a otherwise continuous strip of land running for 1100m between Bush and Cow Lanes on its northern boundary and Channels Brook Stream to the south (fig.3.34). The two names of Pasture, while modern in origin, do suggest that historically they remained uncultivated and may indicate these fields, at least by the 19th century, had not undergone years of potentially archaeologically destructive ploughing.

Tod field is possibly a corruption of 'Toad Field' or land in which toads were present (Field 1972, 235). It is notable how wide the shaws are on the perimeter boundary of this field in 1844, particularly on the eastern side, where a long channel earthwork still survives as an earthwork and is waterlogged at its northern end (fig.3.18). The presence of toads may suggest more of this boundary in Tod field was waterfilled at this date. The western boundary of Pasture and Railey Fields also contained a wide shaw, and a waterfilled channel marked on the OS maps. South of this boundary is Spring Field (Zone 2), suggesting the possible source of water that filled these channels.

Lower Root Field, which contained evidence of an enclosure and high quantities of slag (Chapter 4) owes it names to the growing of root crops. The 'Lower' element of its name is significant as traditionally 'lower' would be assigned to the field closest to the farmstead and as its counterpart Upper Root Field (Zone 2) is opposite on the southern side of Crawley Road it may suggest the past landholder lived to the north. Lower Root field also contained a small wood and pond in the north-west corner, and fieldwalking revealed high densities of slag here, perhaps suggesting deliberate avoidance of cultivation of difficult to plough land.

3.7.2 - *Zone 2 - Placenames*

The Iron Industry

Zone 2 contains fieldnames of industrial origin including iron production, the most notable being Crooked Cinder Lane and Wide Cinder Hams, immediately west of Cherry Tree Field. These fieldnames do not necessarily refer to ironworking having taken place here; but they acknowledge the presence of slag or 'cinder'. Crooked Cinder Lane can be interpreted as an unevenly shaped field where slag was spread or heaped (Field 1972: 45). The 'Lane' element may refer to the former existence of a routeway, or the fields narrow width. An alternative possibility is that a lane existed here that was made of slag, as was the practice within the Weald where the addition of slag to the impassable roads of heavy clay facilitated passage.

Wide Cinder Hams may be interpreted as a broad piece of enclosed land, beside a river in which slag is spread or heaped (Field 1972: 45, 96, 254-255). The 'Wide' element in the name parallels the 'Lane' element in Crooked Cinder Lane as a reference to the width of the field, thus referring separately to the wide field and the narrow field. Again, the cinder element refers to the presence of slag, however the ham suggests the existence of a river or watercourse, something that no longer exists in this instance. The 1870s OS map shows a stream or water-filled ditch running east-west between the fields, beginning at Leman Garden Field and flowing north into Channells Brook Stream. Furthermore, the two fields were separated by 'The Leg', which, following the Sussex translation of a 'long narrow marshy meadow by the side of a stream' further suggests this field's association to the water channel (Parish 1875: 67). The cinder element in these names provide a clue as to the location of where iron-production took place, or at least where the waste slag from the industry was deposited (fig.3.34). Leman Garden, immediately east of Wide Cinder Hams, has a name found elsewhere as 'Lemon' including Lemon Doles (Notts), Lemon Field (Surrey) and Lemon Head (West Riding of Yorkshire) (Field 1972: 124). Field suggests Lemon refers to land that contained artificial watercourses, deriving from the Middle English 'Leme'. This

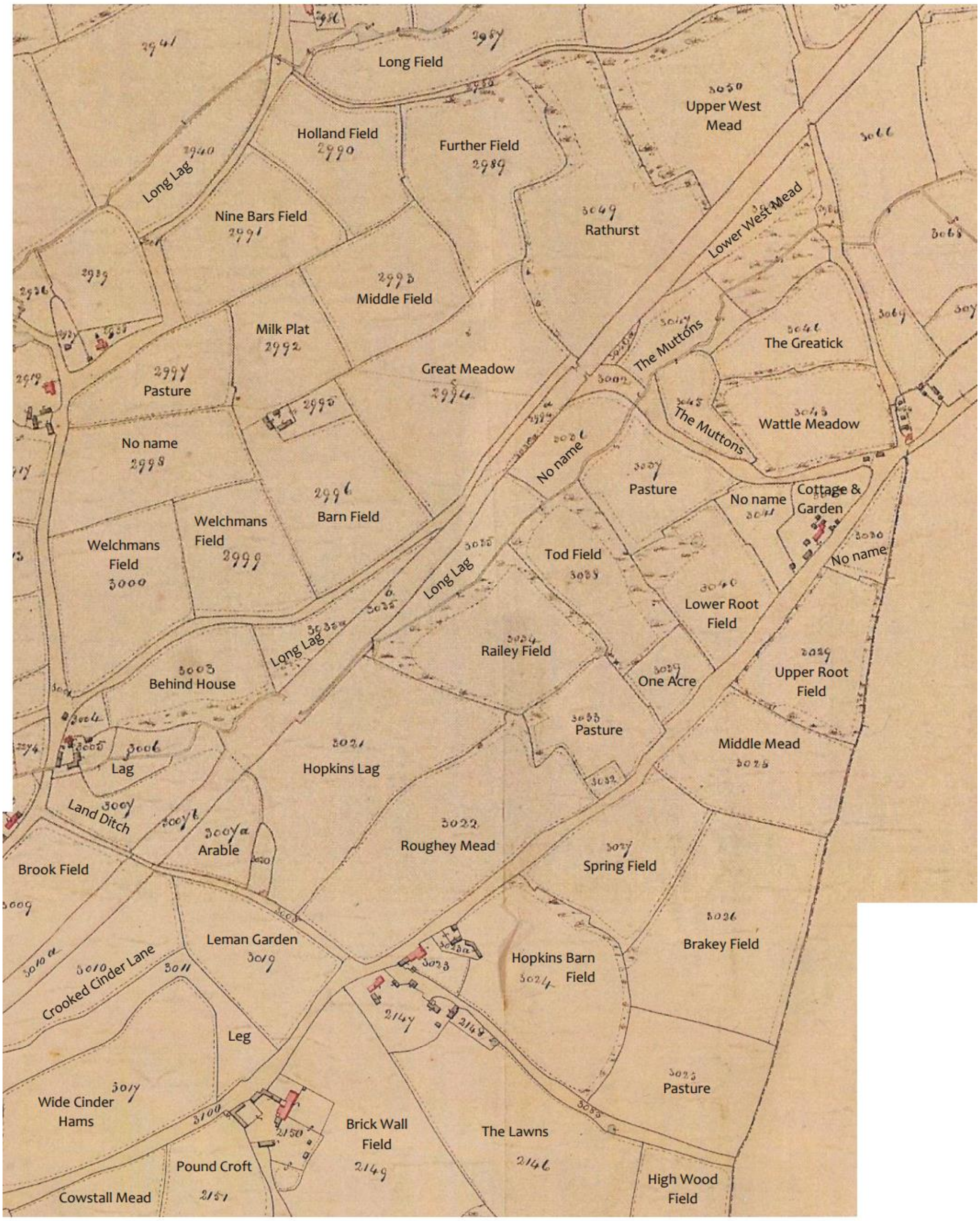


Figure 3.33 – *1844 Tithe map of the Parish of Roffey. These maps provide a valuable record of fieldnames existing in the 19th century, along with early field boundaries and ownership. Cherry Tree Field at this date formed 11 parcels of land. Map courtesy of West Sussex Record Office, adapted by the author.*

would be a plausible explanation for Leman, particularly when considering the square ponds that were in the field in the 19th century connected to the water channel. Garden refers to land that was used for horticulture (Field 1972: 86) and may refer to an adjoining garden to the medieval hall house found at the southern end of the field in 1985 (fig.3.34) (see Section 3.6.6).

The association between smelting sites and watercourses is a pattern seen across the Weald, at sites such as Tudeley and it would appear that prior to agricultural changes to the landscape, smelting at Roffey was also carried out in

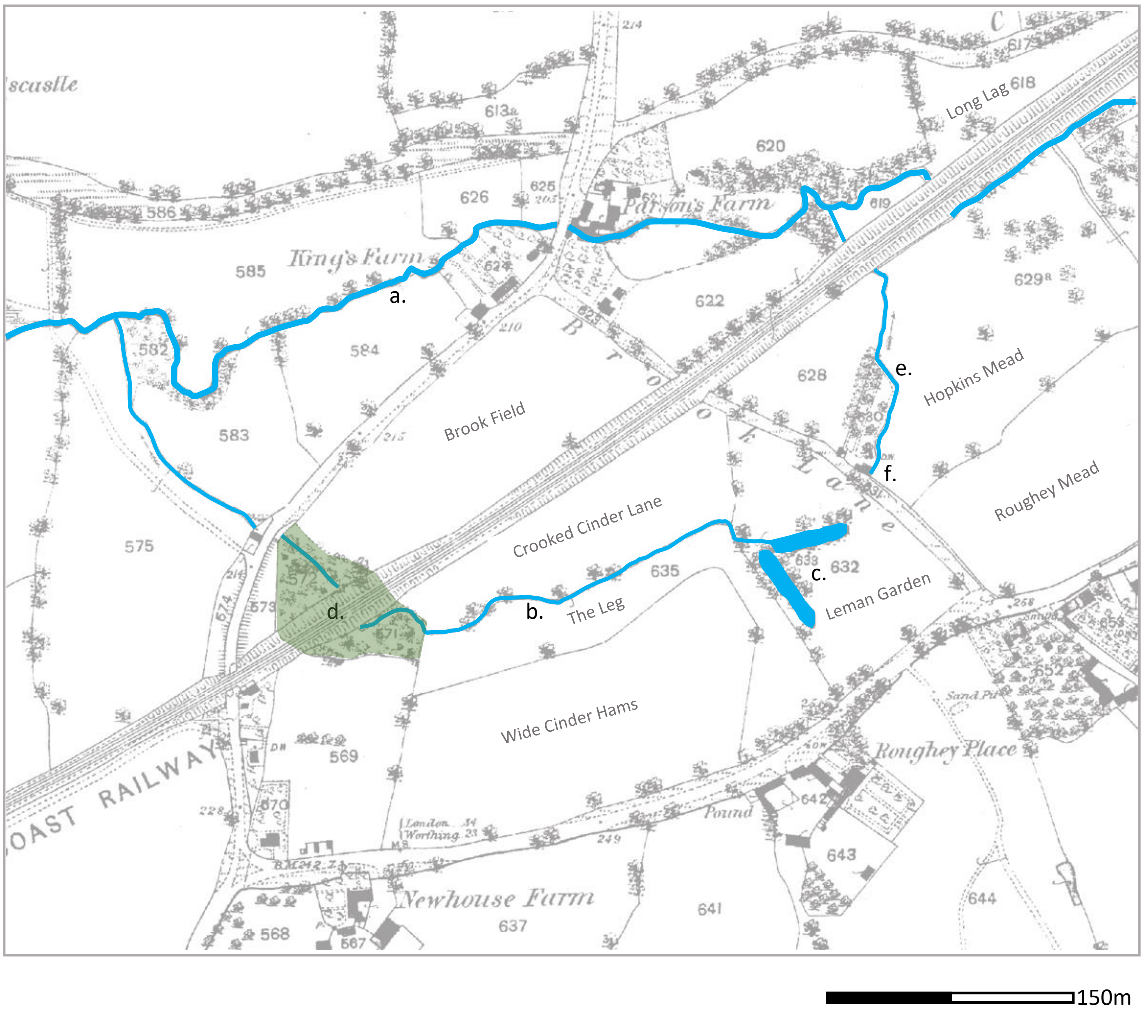


Figure 3.34 – *map of watercourses at Leman Garden Field as shown on the 1870 OS map. Channells Brook flows to the north (a) while a small tributary (b) originally flowed from two linear ponds in Leman Garden (c) and joined Channells Brook 400m north-west. Dr Overton found powered bloomery slag at a small copse that this tributary flowed through (d) which raises the possibility waterpowered bellows were utilised. A second tributary ran to the east of Zone 1 (e), near a western scatter of slag (f). Base map courtesy of Digimap OS Collections and edited by the author.*

proximity. This could also support Dr Ovenden's suggestion that slag found here was 'powered bloomery slag' having made use of waterpower.

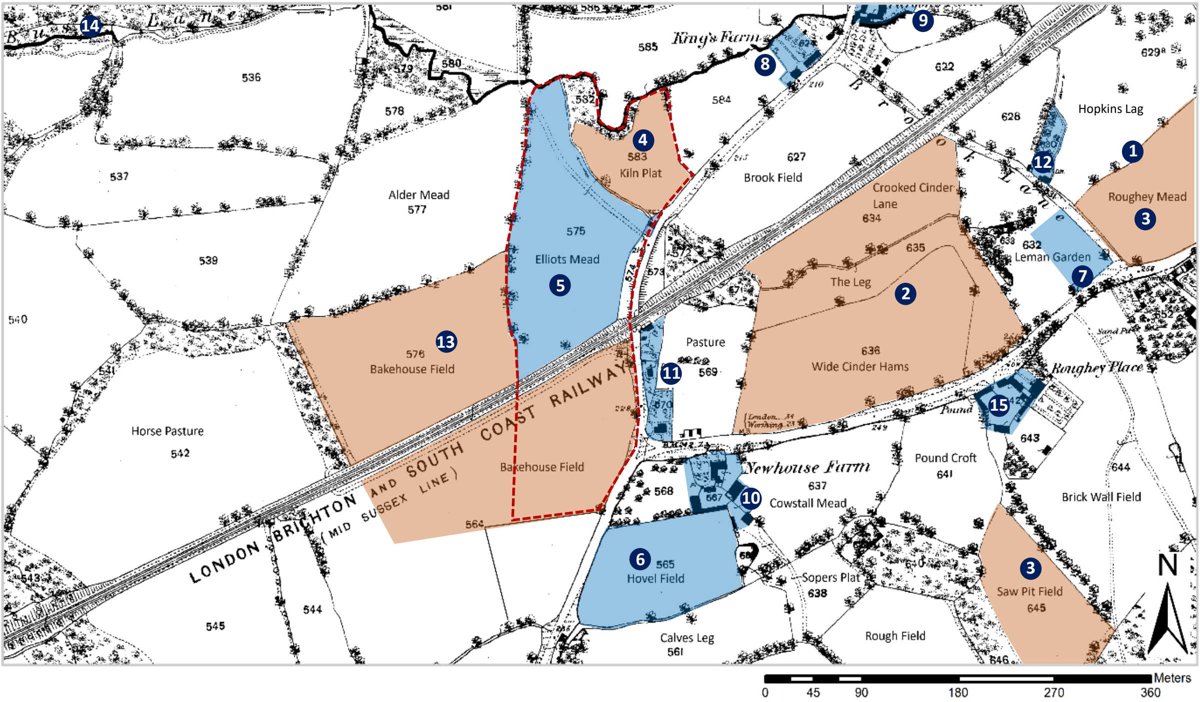
Other industries

As already emphasised, iron-production should not be studied in isolation but within the context of other industries in the landscape. These industries are alluded to in surviving placenames in Zone 2, and while, as Chapter 3 explained, fieldnames are not always easy to date, those at Roffey hold the potential to document activities contemporaneous with iron-production. Names such as Milk Plat, Cowstall Mead and The Muttons, tell of the agricultural importance of the landscape, while Welchmans Field may relate to Welsh migrants who acquired surnames from the place they had originated from (Hey 2008). There are records of Welsh residents trading cattle in the markets at Horsham during the 17th Century (Horsham Museum) and it is worth noting that the two Welchman's fields adjoin Cow Lane, Cow Barn, and Milk Plat, supporting the association with cattle.

Documentary evidence suggests Common Fields existed at Roffey by 1315, when a quitclaim of 2 acres of land by Christian de Effolde to William Urri within a field called 'le Tyghe' which was said to be between William's land, land of Thomas le Lewere and land once belonging to Richard de Effolde, suggests this field was subdivided between different landholders (Translated by Maxwell Lyte 1915, 188-204; Baggs et al 1986, 166-180). This is supported by the fieldname 'Le Tyghe' or 'The Tighe' which is a geographical name deriving from 'Tye' – a small parcel of common land near a village (Lower 1860, 359). It is uncertain where this field was situated as the name does not survive in the later Tithe apportionment. However, it can be surmised that it was not far from the settlement and emphasises the importance of the agrarian economy under a common field system at Roffey in the 14th century.

Non-agrarian industries also survive in the fieldnames. Wattle Meadow may derive from 'ridged land on which woad was grown' (Field 1972, 249). Woad was grown during the medieval period for its indigo blue dye, and the adjacent field 'The Muttons' may indicate the past existence of a wool and cloth industry here and is supported by the bye-names of taxpayers here in the 13th century (see Section 3.5.2). Bakehouse field to the west refers to a building used for the preparation and baking of bread. A lease from Cornhill in London shows the term 'bakehouse' has existed since at least 1318 and over time this was to evolve into the modern term 'bakery' (Peters Kernan 2014, 147-148; etymonline.com 2022). In 1383, a grant was made to a James Urry and his son for two crofts at La Rogheye', one of which was called 'Bakeresham' (Deeds: C.3301-C.3400). The likelihood that this was Bakehouse Field is supported by an earlier reference of 1369 of rents paid for 5 acres of pasture to the Urry family from a Henry Bussh (Sussex Fines: 41-45 Edward III), Henry possibly giving his name to Bush Copse 400m north-west of the field (fig.3.35). This suggests a medieval origin for the fieldname Bakehouse Field at Roffey and the former existence of a bread industry.

Pottery production may also have existed. There are references in the 16th century to members of the Pottere family holding property in Roffey, such as in 1540, when John Edward granted William and John Pottere 'Lands, tenements, rents and services at Rogheye' (Translated by Maxwell Lyte 1890, 359-368). The fieldname Kiln Plat may allude to a pottery kiln adjacent to Channells Brook. Fieldwalking evidence further supports the existence of the industry in Zone 1 (see Chapter 4).



Fieldnames / sites indicative of industrial activity | Fieldnames / sites indicative of dwellings | Possible Former extent of the tenement at Elyottes

1. Site of Cherry Tree Field (Zone 1)
2. Crooked Cinder Lane and Wide Cinder Hams
3. Saw Pit field – suggestive of a former woodland industry here on the boundary of St Leonard's Forest. Date however uncertain.
4. Kiln Plat – possible site of a former pottery kiln or lime kiln
5. Elliots Mead – the probable site of a tenement called Elyottes recorded in 1480 and 1481. In 1480 it was described as '*a meadow of ten acres called Elliotis'*. While its size in 1844 had reduced due to the building of the railway, if the former extent of the field is projected south beyond the railway and Kiln Plat field is included to the north, the area covers just over 10 acres as described in 1480 (see red line)
6. Hovel Field – defined by Field 1972 (110) as *'land containing a shed for implements or a framework on which a stack is built'*
7. Site of the hall house found at Leman Garden
8. Kings Farmhouse – listed as of probable 17th century date. historicengland.org.uk
9. Brook House – Medieval open hall, with two bays historicengland.org.uk
10. Newhouse Farmhouse – listed entry dates it to 17th century or earlier. It consists of a timber framed structure historicengland.org.uk
11. Cottages of uncertain date. These appear to be encroachments built on common land on the edge of Wimland Road. These had been demolished by the 1970s.
12. Clyst Hayes – 17th century timber framed house.
13. Bakehouse Field. In 1383, a grant was made to a James Urry and his son for two crofts at La Rogheye', one of which was called 'Bakeresham'. The likelihood that this was Bakehouse Field is supported by an earlier reference of 1369 of rents paid for 5 acres of pasture to the Urry family from a Henry Bussh. Bush Copse 400m away may take its name from the Bush family.
14. Bush Copse
15. Roughey Place

Figure 3.35 – *Settlement and industry at Roffey, based on fieldnames, historical records, and archaeological evidence. Base map courtesy of Digimap OS Collections and edited by the author.*

Boundaries

Placenames associated with boundaries are useful when reconstructing past land divisions and Roffey, spelt 'La Rogheye' in the 13th century, refers to a fence or enclosure (possibly rough enclosure) for roedeer (Mills 2003; 393). And it possibly derives its name from its position on the boundary of St Leonard's Forest, where deer were kept. Fieldnames also demonstrate how the boundary of the Forest was considerably closer to the south of Roffey and its ironworks than now, the most obvious being Forest Field 'land adjoining a forest' (Field 1972, 81), and High Wood Field. Spring Field can also be defined as 'land adjoining or containing a wood' (Field 1972, 215), while Brakey Field refers to the presence of the common fern *pteris aquilina*, which were called 'brakes' in old Sussex dialect and is a typical species found within forests, which, contrary to its name, was not completely wooded but a mixture of woodland and heathland (Baggs et al 1987, 12-16; Parish 1875, 21) (fig.3.36). Several of the fields close to this boundary, such as Upper Root Field, Tod Field and Railey Field retained wide wooded shaws around their boundaries in the 19th century, possible remnants of the woodland which they were cleared from (ibid 1987). The forest fieldnames all occur along the southern parliamentary boundary of Horsham. A track is shown leading to this boundary which is labelled 'Roughey Gate' on the 1870s OS map (see Section 3.8.5). St Leonard's Forest was divided into bailiwicks before the late 15th century and Roughey Gate formed one of the bailiwick gates into the forest (Baggs et al 1987, 12-16). The existence of other forest gates is preserved in the names of neighbouring parishes including Faygate and Colgate. While today the iron-production evidence at Roffey is some distance from St Leonard's Forest, these fieldnames demonstrate how, in the past, the industry once stood on the periphery, close to the gate and bailiwick boundary and ultimately the necessary resources of timber, charcoal, and ore that the woodland industries could supply. Like Tudeley, ironworking took place on this more marginal forest boundary location (see Section 6.4). To the north of Zone 2, other fields are indicative of past boundaries by their reference to distance, 'Further Field' being the most obvious, while Holland Field (Holland being a distant country), may have acted in a similar way in denoting land distant, and likely on the edge, of a farmstead, settlement, or manor. Alternatively, the name Holland occurred in the parish in the 16th century such as a Henry Holland who was employed in St Leonard's Forest by Roger Gratwick in 1588 (see below) (Langley 2014, 58).

Land Ownership

While there are no maps providing details of fieldnames from before the 19th century, there are several placenames mentioned in grants and deeds from the 14th-16th century. From these it is possible to extrapolate early versions of names that were recorded on the 1844 Tithe map. Linking these placenames to specific individuals and determining land-ownership has important bearing on understanding the nature of industries, including ironworking, that were taking place at Roffey and individuals involved. 'The Greatick' could be a corruption of a local surname Gratwick. In 1587-8, a Roger Gratwick was involved in a dispute over the tenancy of the forges and furnace at St Leonard's Forest (Langley 2014). While in this context it may have no bearing on earlier ironworking, it does imply the family's connection to iron production in St Leonard's and land at Roffey.

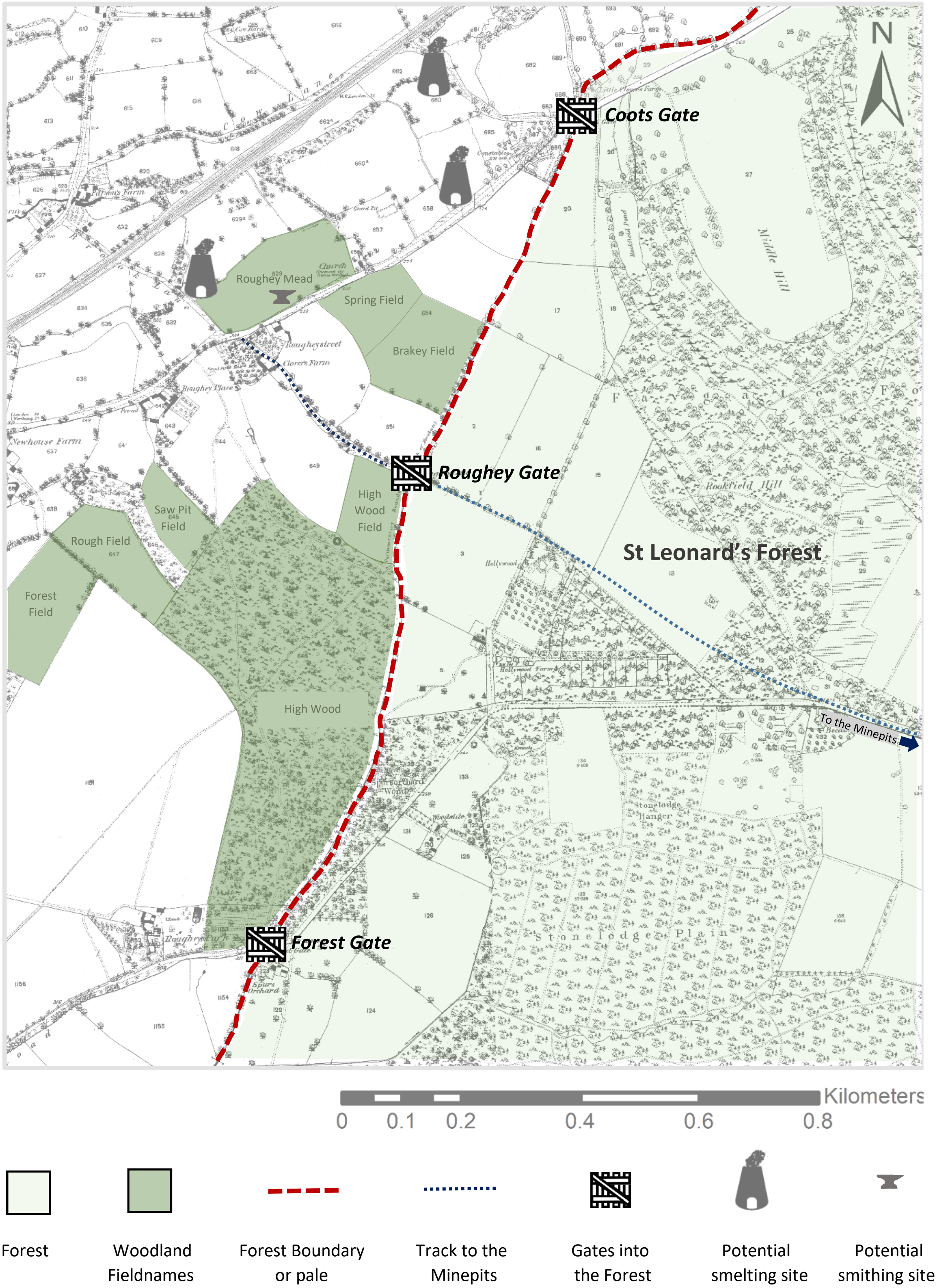


Figure 3.36 – *The former extent of St Leonard’s Forest, demonstrating the proximity of iron-production at Roffey to the forest boundary and its gates. Woodland placenames are found alongside this boundary such as Forest Field, High Wood Field, and Spring Field. Roffey Gate was a former entrance into St Leonard’s Forest and presumably the Roffey bailiwick, which was one of a series of bailiwicks the forest was divided in to (Baggs et al 1987, 12-16). This gate would have provided access to the Minepits (ore source) for the sites to the west of Zone 1, via a trackway outlined in blue. The route of this trackway is traced in section 3.8.6. Coots Gate would have allowed access for the eastern smelting sites at Zone 1. Smelting sites were therefore positioned both on the periphery of St Leonard’s Forest and close to the entrances. It can be hypothesised that a yet undiscovered smelting site is located close to Forest Gate to the south of Roffey. Base map courtesy of Digimap OS Collections and edited by the author.*

A grant made in 1383 to William Marscot from James Edyng states that ‘*a field called Westfield with meadow called Asshefold and 1 acre of arable lying in the said meadow with two gardens lying at the said field and meadow was held by William Bonwyk and his wife Alice for the life of Alice’* (Translated by Maxwell Lyte 1915, 146-159). The significance of this source is that it potentially relates to the fields Upper and Lower West Mead, which lie 150m N-W of Zone 1. In 1844,

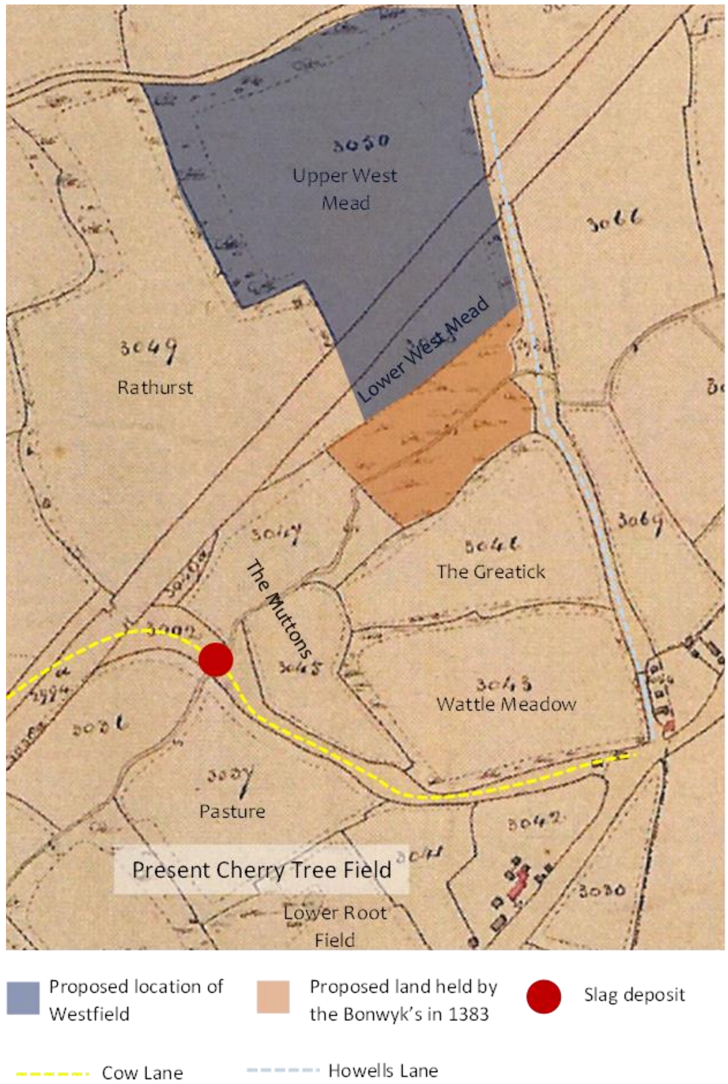


Figure 3.37 – *A possible location for the field and meadow held by William and Alice Bonwyk in 1383. Today it forms a small parcel of land called Lower West Mead of 1.4 acres south of Upper West Mead. Lower and Upper West Mead were no doubt one field before the construction of the railway. It is possible that Upper West Mead was formally Westfield recorded in the 1383 grant. Slag was identified 120m downstream of this field in the reconnaissance survey and it appeared that this been moved from further upstream. The parcel of land would have potentially been connected to the wider landscape by the adjacent Howells Lane (east) and Cow Lane (west). Map courtesy of West Sussex Records Office.*

Lower West Mead included a small enclosure of woodland of 1.4 acres, similar in size to the Bonwyks holding in 1383 (fig.3.37). The grant dates 37 years after Matilda Bonewyk was granted her forge and it is possible that William was her son. While there is no mention of a forge, Matilda had been granted a lease on the site for 200 years and is suggestive of the land’s inherited status. The presence of slag in the stream 120m west of this wooded enclosure suggests the land’s former use for iron-production and it is possible that the forge had fallen out of use by 1383 (see Section 3.8.7). The grant does however demonstrate the Bonwyk family's continued association with Roffey in the late 14th century.

Settlement and Tenements

The Tithe fieldnames also provide indications of where tenements once existed, for example, Elliots Mead (Zone 2) probably refers to a tenement called Elyottes, which was recorded in 1480 and 1481 (fig.3.41). In 1480 it was described as *'a meadow of ten acres called Elliotis'* (Translated by Turner 1865, 20-21). In 1481, William Est and Thomas Agas released their right to their lands and tenements at Roughey to the Bishop of Ely, which included Elyottes, Cokhuntys Grove, Hethelonde and Segrymes (Translated by Maxwell Lyte 1900, 282-293). The location of this field, which, alongside smaller parcels of land equate to roughly 10 acres, is immediately east of the industrial area, and may indicate settlement planning, with habitation in the west and industry to the east (fig.3.35).

3.7.3 - *Zone 3 Placenames*

While the survey of Zone 3 placenames is not comprehensive, there are several names that are important in understanding Roffey's place within the broader economy. They are divided into economic and forest industries.

Economic

Of these, Horsham is of particular importance. It forms a compound name of hors and ham meaning homestead, village, or enclosure where horses were kept or bred, thought to date back to 947AD (Mawer and Stenton 1969, 225; Mills 2003, 250). The '*Hors'* is an element found in other placenames relating to horses, such as Horsefold, Norfolk – *'ford which horses can cross'*, and Horsley, Derbyshire – *'clearing or pasture where horses are kept'* (Mills 2003, 250). Furthermore, 3.2km to the north-west of Horsham is the village of Warnham, which in 1166 was spelled Werneham and while this may originate as a homestead belonging to Waerna, an alternative translation is '*where stallions were kept'* (Mills 2003). The Horse fair recorded at Horsham in 1233 (Horsham Museum 2022) attests to the economic importance of horses to the region from an early date and supports the placename evidence of the town and Warnham. The proximity of the horse market and location of breeding may explain specialisation in horseshoes at Roffey, implied by the 1327 account. This would have provided a ready market and potentially high enough demand to explain why in 1327 the forge at Roffey was able to produce as many as 1000 horseshoes – enough for a minimum of 250 horses.

Forest industries

According to local folklore, St Leonard's Forest takes its name from an 11th century saint who was said to have come from France to defeat a dragon living within the forest, after which he resided there as a hermit. Other names are indicative of the forest's former extent, with 'gate' names occurring at Faygate, Monks Gate, Roughey Gate, Coots Gate, Colgate, and Tilgate, and referencing their former function as gates into the forest (fig.3.36). Other names found within the forest relate to former forest industries, such as 'The Minepits' where iron ore was extracted ('mine' being the Wealden name for ore), while Butler (2011) suggests Colgate, col meaning charcoal, may suggest an area of the forest where charcoal was produced.

3.8 - Landscape reconnaissance survey

3.8.1 - *Introduction*

A landscape reconnaissance survey was completed between July and December 2020. A gazetteer of the results is presented in Appendix B2 along with sample pages from the field notebook. Features identified were categorised using Juleff's location classification scheme, which divides them into metallurgical, geological, historic, and natural features. Evidence identified in the survey is discussed alongside the stage in the archaeometallurgical process they represent, beginning with the acquisition of ore, through to smelting and are considered within the context of each landscape Zone.

3.8.2 - *Ore prospecting and its extraction (Geological)*

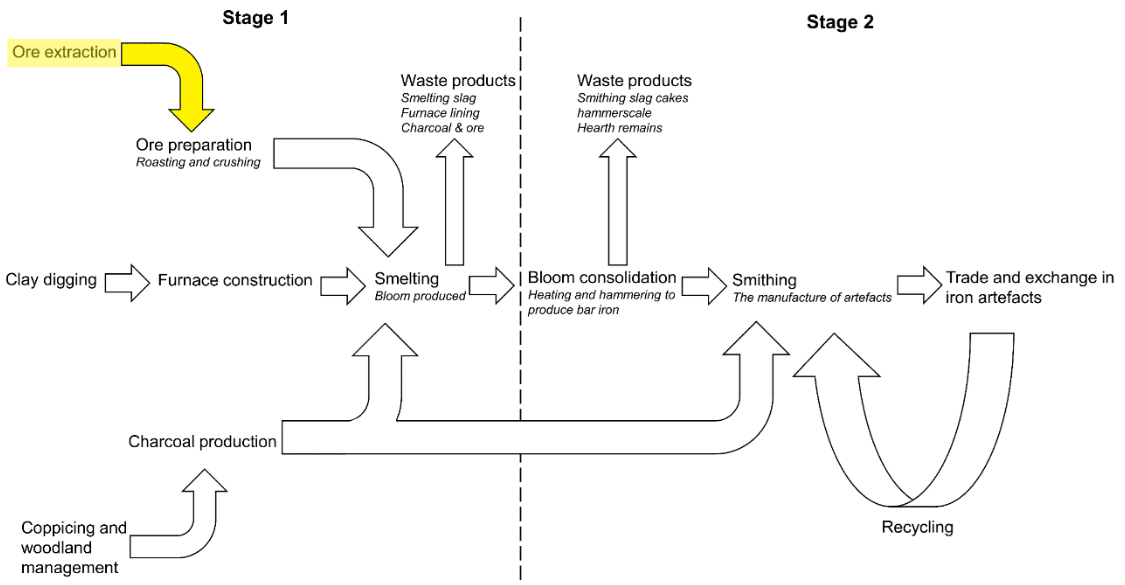


Figure 3.38 – *Iron-production process diagram high lighting the extraction of ore.*

Prior to smelting, a suitable and plentiful source of ore needed to be identified and extracted (fig.3.38). Traditionally it has been thought that furnaces were situated close to ore sources to avoid extensive carriage, also an important consideration for charcoal that is easily fractured if moved over great distances.

St Leonard's Forest (Zone 3), to the south of Roffey, is dominated by The Tunbridge Wells Sand, where the sandstone beds, separated by clay and silt contain seams of silty ironstone around 15cm thick (Worssam 1985, 26-27). Weald Clay is present north of Roffey, where ore may be found in beds within the clay below the Horsham stone (Ibid, 27). Ore appears to have been sourced in each of the three zones, however, extraction has left the most visible scars on the landscape in Zone 3, where large circular pits, known throughout the Weald as minepits, survive within St Leonard's Forest. There was more ephemeral evidence of quarrying in Zones 1 and 2, however it was not always apparent as to the motivation for the digging of these pits, be it ore extraction, marling or the creation of artificial ponds. The date they were dug is equally hard to ascertain.

Zone 3 ore extraction

Context

Evidence of quarrying was predominantly concentrated in Zone 3, with a specific focus on the northern edges of St Leonard's Forest at Colegate where distinctive bowl-shaped depressions with surrounding banks of soil give the terrain a crater-like appearance. They are located at TQ 22089 32425, 250m south of Forest Road, which runs east-west through the Forest. Here the woodland is named 'The Minepits' after the series of small to medium-sized pits across an area of approximately 0.12km^2, with a further smaller cluster of c.25 pits 0.2km to the south and 26 other locations of smaller groups elsewhere in the forest, identified by Butler (2011, 18). These pits are visible on the National LiDAR Survey, and the deeper minepits to the north are particularly prominent (fig.3.39). Past woodland clearance for agriculture is evident to the east and west of the minepits

Figure 3.39 – *LiDAR image of the St Leonard's Minepits, along with woodland trackways and boundary banks and ditches. Courtesy of The National LiDAR Survey.*

and the presence of the pits probably prevented the complete conversion of the woodland to agricultural land in this area. To the west a 14.6ha field has been cleared from the forest in the past. Parts of the minepits have subsequently been built over in the north where the Rangers Lodge now stands and it is possible that the pits extended further north into Brickyard Copse, which was an active brickworks in the 1870s, complete with a kiln and claypits. This later clay quarrying would have destroyed any earlier mining evidence that was present.

The Minepits were first recorded by Honywood in 1877, however, he believed them to be the remains of prehistoric '*dwelling-places'*

> *'In St Leonard's Forest… are a number of round basin-shaped pits; these have the name in the neighbourhood of "The Mine Pits" in allusion to the time when the iron ore was dug in this forest; but my impression is that they were not made for that purpose'* (Honywood 1877, 182).

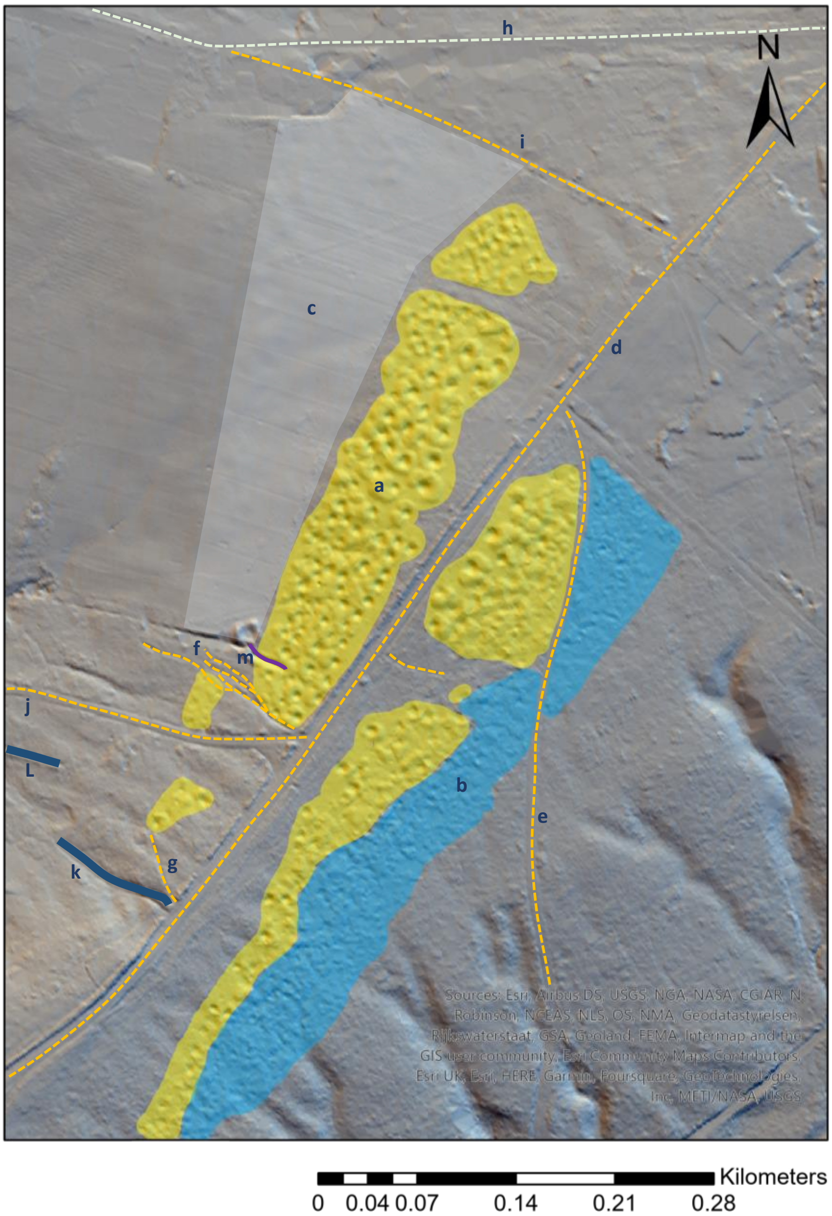
Honywood argued that their consistent circular basin shape did not conform to the morphology of other pits in the forest where iron ore had been extracted.

> *'I have several times come across spots where the miners had excavated the earth, and the iron ore had been taken away, and on one occasion I came upon one of their tools – a pickaxe of curious shape, instead of being round or oval, as in ordinary ones, is square…. Where this was found the ground was perfectly flat, and not basin-shaped'* (Ibid, 182).

While comparative examples make their purpose as minepits highly probable, Honywood's identification of other locations and pit morphologies is significant and may suggest changes in working practice in different periods, which is most notably reflected in the variation in their size. The square pickaxe, if contemporary, indicates the types of tools used by ore diggers.

Size and distribution

The minepits cover an area of approximately 12ha and lie 1.7km from Zone 1 (points a-b on fig.3.40). They are positioned either side of a track aligned north-east south-west. However, the tracks alignment appears to have shifted from a previously north-south orientation as the LiDAR (fig.3.39) demonstrates how the spacing between the pits and track is wider to the north on the western side of the track but wider to the south on its eastern side. This could suggest the pits and track are contemporaneous (figs.3.40-3.45).



a. (Yellow) – Distribution of the largest and deepest minepits of between 9-10m in width and up to 2.5m deep. These pits tend to have associated spoil heaps and are located on top of a ridge of high ground.

b. (Blue) – Distribution of smaller minepits, around 6m in width and 0.5m deep. These tend to be located of the valley sides.

c. Area of forest clearance for agricultural land. The undulated terrain shown on the LiDAR indicates this was a further area of minepits, possibly shallow examples similar to b., that have since been ploughed away.

d. Minepits track that runs NE-SW through the largest density of minepits. Possibly contemporary, however its orientation may have changed to the north.

e. Woodland track that post-dates the minepits and bisects a number of pits.

f. Braided trackway – as one track became waterlogged and impassable, a parallel track was utilised. Frequent traversing and adoption of alternative routes leads to the formation of braided trackways. These may be contemporary with the minepits.

g. Woodland track leading from the Minepits track (d) to a small group of approximately 5 minepits.

h. Forest Road – the current road running east-west through the forest. The eastern section, which follows a NW-SE orientation for 240m may have continued SE along the route of (i), and NW towards Roughey Gate and Zone 1.

i. Woodland track, possibly part of a former routeway to Roughey Gate and the iron-production sites in Zone 1.

j. Woodland track, now a modern footpath or uncertain date. This may have provided access to the later rabbit warrens in this area.

k & L. Rabbit warrens identified by Butler 2011. Possibly 17th century (Butler 2011, 33).

m. Linear channel, possibly an exploratory minepit or boundary ditch.

Figure 3.40 – *annotated LiDAR plan of the minepits. LiDAR Courtesy of the National LiDAR Project, annotated by the author.*

Other tracks, such as 'e' (fig.3.45) clearly post-date the minepits for it bisects the eastern pits. The LiDAR indicates that the minepits once extended further west, for a series of undulations are present within the field, covering an area of 7ha (fig.3.40; C and fig.3.42). This field represents forest clearance that probably took place in the 18th or 19th centuries.

Figure 3.41 – *siderite iron ore deposits found on an associated spoil heap adjacent to a minepit. Its thickness is indicative of the thin seams in which the ore is found. Pieces of sandstone, forming the waste rock or 'gangue' was also identified in these spoil heaps, but often formed small fragments of under 10cm. The larger rocks may have been removed if suitable for building material. (Author's image).*

Figure 3.42 *(left) – One of the larger minepits located on the top of the ridge of high ground. These pits were up to 9.5m wide and 2.5m in depth. The sides were once vertical but have slumped over time. (Author's image).*

Figure 3.43 *(right) – A large pit alongside its associated spoil heap, which curves around its outer edges. Typically, minepits were infilled with the spoil from adjacent pits as they were dug, however this does not appear to have been the practice with the larger minepits in St Leonard's. (Author's image).*

Figure 3.44 – *Large minepit in St Leonard's Forest (Author's image).*

Figure 3.45 – *In some instances the larger minepits were arranged in linear rows to systematically exploit the underlying deposits of ore. (Author's image).*

Generally, the pits to the west (fig.3.40 (a)) were of a greater depth than those to the east (b), some being a deep as 2.5m compared to 0.5m for those of shallower depth. The minepits generally decreased in size and depth the further east (downslope) and this difference is clear on the LiDAR image. It is possible that those at (a), being at the top of the ridge required deeper excavations to reach the underlying seams of ore and it is plausible that the ploughed-out pits at (c), also being downslope of this ridge were shallow too, making this land easier to cultivate, unlike the deeper counterparts at (a). Alternatively, this may represent changes in excavation practice, conscious effort to backfill these pits, or infill from hill-wash. Many of the westerly pits have large banks of spoil around their outer edges, often forming a curvilinear mound around half of their outer edges, whereas those in the far east show less evidence of spoil deposits (fig.3.43). Based on other minepits in the Weald, the standard practice was to infill a previously excavated spent pit with the spoil of the new pit. Over time the scar of the pit becomes visible on the surface as the infill soil settles. While this practice may have been applied at the eastern pits (b), the westerly pits are much deeper and retain their spoil heaps, suggesting inconsistencies in practice.

These inconsistencies could be attributed to different dates at which ore was mined here. Iron-production continued at St Leonard's Forest into the first half of the 17th century, at St Leonards Forge. This furnace and forge stood 3km south of the minepits, where Hawkins Pond and Hammerpond, both former hammer and furnace ponds, remain from this industry (Pearce 2011, 54). Accounts of those employed by Edward Caryll and Roger Gratwick in 1588 list workers who were involved in mining for ore (Langley 2014, 53-59), and it is probable that some of the pits at 'The Minepits' are the outcome of their labours. However, indirect documentary evidence confirms minepits existed here before the 17th

century. '*The Legend of the Dragon of St. Leonards Forest – True and Wonderful'* was published by John Trundle in 1614 and describes how *'In Suffex, there is a pretty Market-Towne called Horfam, neare unto it a forreft, called St. Leonards Forreft, and there, in a vast and unfrequented place, heathie, vaultie, full of unwholesome Shades and over-growne Hollowes, where the Serpent is thought to be bred…..'*(Oldys 1745, 108) (fig.46). While this serpent or dragon is more fanciful - a story thought to disguise smuggling operations and deter individuals from entering the forest, the description of the dragon's home makes reference to physical features of the forest terrain. The '*overgrown hollowes*' were no doubt the minepit earthworks, and yet their evident abandonment in the account dates them to before 1614. Furthermore, the loss from memory of their former use suggests a much earlier date. Later, the account describes how *'for his food is thought to be, for the most part, in a Conie-Warren, which he much frequents'* (Ibid 1745, 109). This also suggests a real location in the forest, for south of the minepits Butler (2011) recorded pillow-mounds of former rabbit warrens (see k and l on fig.3.45).

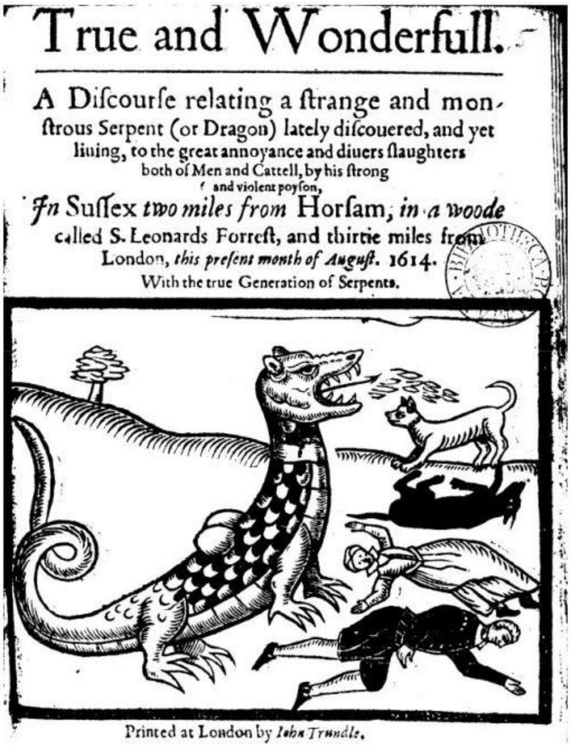
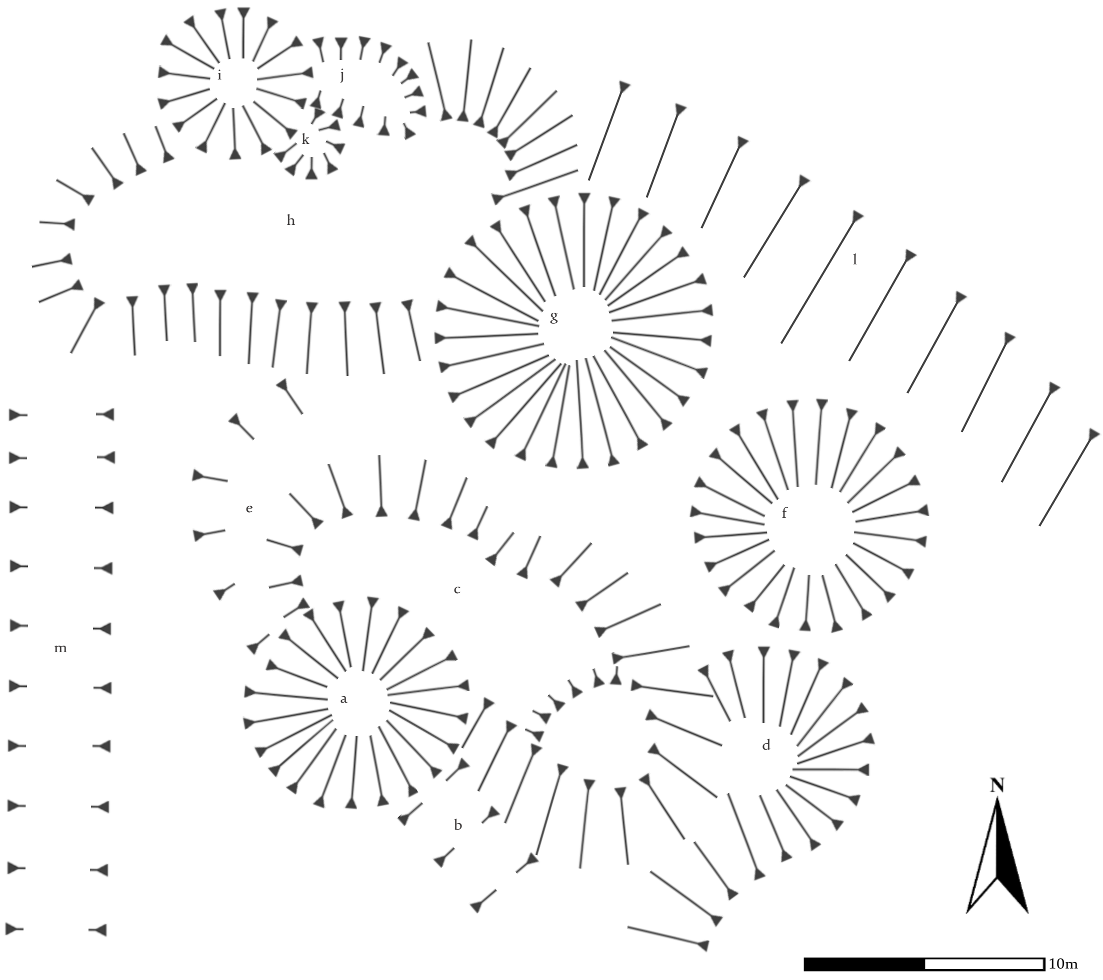


Figure 3.46 – *A pamphlet on the Dragon of St Leonard's Forest, published by John Trundle in 1614. Image source: The British Library, accessed 06/12/22.*

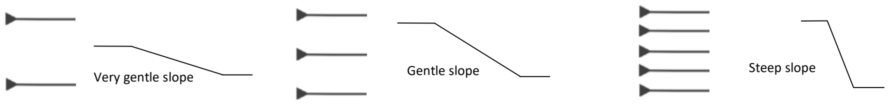
A Minepit in detail

To understand the morphology of the minepits, an earthwork survey of a group of 4 pits and their surrounding features was carried out on 2nd August 2021 (fig.3.47). While the size of individual minepits varied considerably, the selected



The Minepits in St Leonard's Forest

Horsham, West Sussex, TQ 221 323 - Surveyed 2nd August 2021, J. Cranfield



a. Minepit 1 – with an outer diameter of 9.5m from east to west with an internal base width of 7.9m. The edges of the pit have a steep slope angle. Mound 1 is directly adjacent on the north and east sides.

b. Shallow depression starting from the southern edge of Minepit 1 and continuing south-east for 4m. It has a width of 2.5m

c. Mound 1 - Oval shaped mound that surrounds the northern and eastern side of Minepit 1. It partially infills the western side of Minepit 2.

d. Minepit 2 – with an outer diameter of 5.8m from east to west, however the western side has been partially infilled by mound C so the original edge is not visible. The base has a width of 3m. The edges of the pit have a steep slope angle.

e. Shallow gully, beginning at the northern edge of Minepit 1 and curving east around the western edge of Mound 1 to Minepit 4. The external width between the top of the low bank is 8.8m, while the level ground between the banks is 1.8m.

f. Minepit 3 - with an outer diameter of 10m from east to west with an internal base width of 4.2m. The edges of the pit have a steep slope angle. There does not appear to be an associated mound.

g. Minepit 4 - with an outer diameter of 10.7m from east to west with an internal base width of 3.3m. The edges of the pit have a steep slope angle. Mound 2 is directly adjacent to the north-west.

h. Mound 2 - Oval shaped mound that surrounds the north-west side of Minepit 4 and southern side of Minepit 5. Two pits (J and K) are also present on the northern edge.

i. Minepit 5 – A smaller minepit with an outer diameter of 6.2m from east to west with an internal base width of 1.8m. The edges of the pit have a steep slope angle.

j. A shallow oval pit that appears to have been truncated by Minepit 5 K. smaller oval pit, shallow and truncated by Minepit 5.

l. Sloping bank that minepits 3 and 4 have cut into.

m. Shallow trackway of a width of 4.2m running on a north – south alignment. The current track through the wood runs a few meters to the west.

Figure 3.47 – *earthwork plan of a group of minepits and their associated spoil heaps, showing their chronological relationship with pits partially infilled by spoil from neighbouring later excavations. (Authors image).*

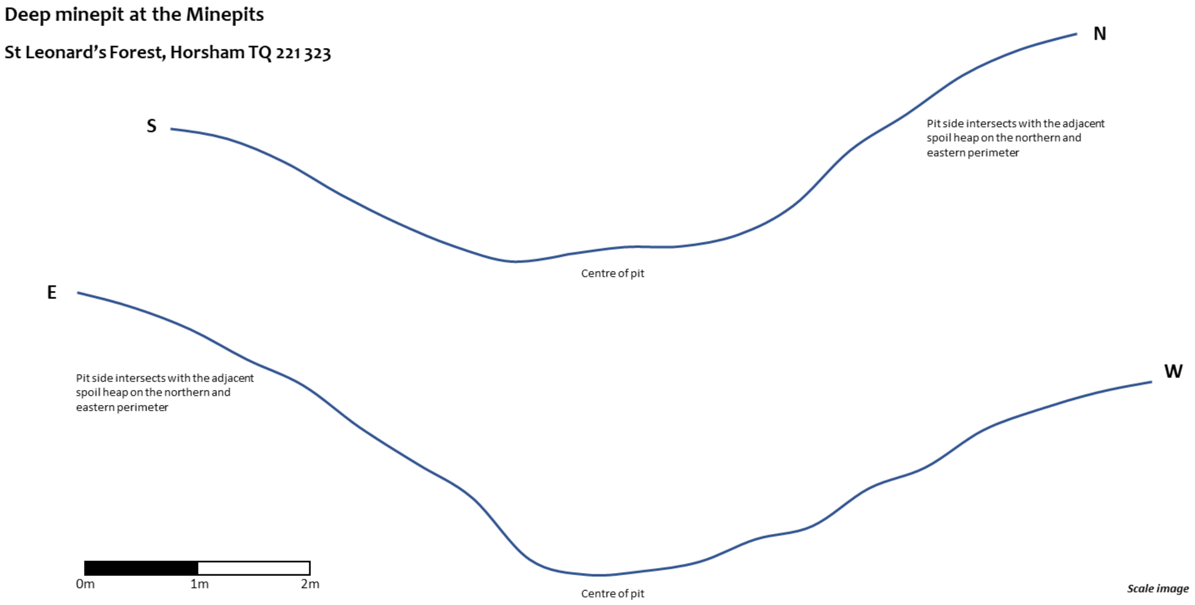


Figure 3.48 – *Profile of minepit A (figure 3.47) a typical example of a larger minepit located on top of the ridge of higher ground. This had a depth of 2.5m and width of 9.5m, paralleling other examples of the larger minepits. The sides appeared to have slumped over time. Author's image.*

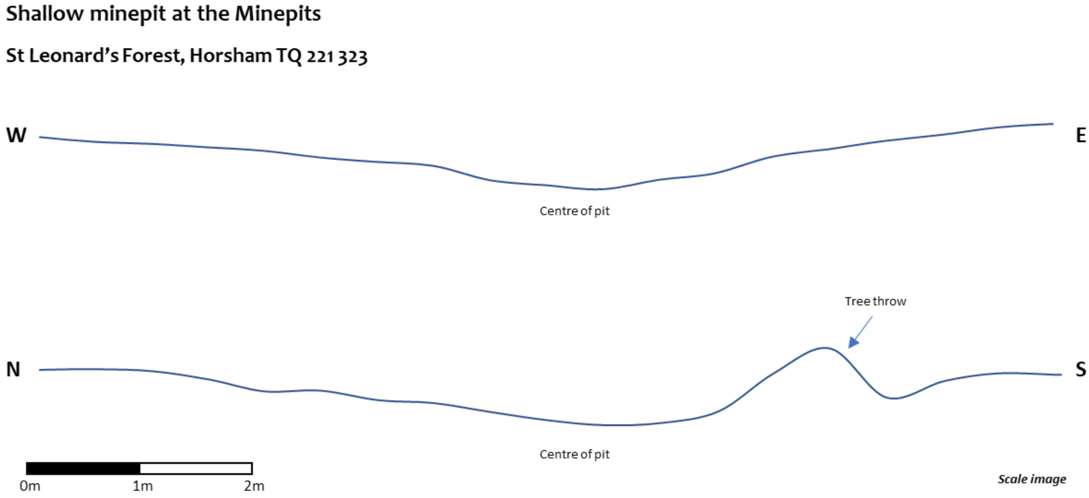


Figure 3.49 – *Profile of an eastern minepit. These were shallower in depth than those at the top of the ridge. It had a depth of 1m and a width of 8.5m. It is likely that these shallower pits were backfilled but have sunk over time as the soil settled, leaving shallow depressions. The absence of an associated spoil heap would support this. Authors image.*

survey site captured this diversity with pits varying in size from 6m to 10m in diameter, with depths of between 0.5m and 2.5m (figs.3.48-3.49). A photographic and written record and a measured sketch plan was produced, with a focus on minepit A (seen as a typical example), and its relationship with other surrounding minepits and adjacent earthworks including a spoil heap and woodland track.

Minepit A was roughly circular with steeply sloping sides that reached a central depth of 2.5m. The greatest slope height was on its eastern side, where it merged into an adjacent spoil heap. The width of pit A from east to west was 9.5 meters and 7.9 meters north to south. The sides tapered so that the pit base was 1.8m (E-W) and 2.6 (N-S) wide (fig.3.53). It is likely that the sides were once vertical, and have subsequently slumped. Erosion was present on the western side, possibly caused by a tree throw in the past. The northern and eastern side of the pit were surrounded by a spoil heap, which formed a curvilinear mound with a width of 10.7m and a level platform at its crest (fig.3.52; c). The bank tapers to an overall width of 5.8m on the northern side, with a top of bank width of 3.8m.

To the immediate east of the spoil heap, a second pit was present (*d*), and while this is similar in size to pit A, it was shallower and had been partially covered by spoil from pit A's adjacent spoil heap (fig.3.47; d). While in the Weald minepits were typically infilled by the spoil from freshly excavated pits (see Chapter 6), the banks of spoil, that surround many of the larger pits, of c.9-10m, such as pits *a*, *g* and *i* suggest this was not always practiced here. Other pits however, including *d* and *f*, had no adjacent spoil heap and their shallower depth indicates an effort to infill them. This suggests changes in practice over time, and as pit *d* (no spoil heap) is partially infilled by pit *a*'s spoil-heap, it can be surmised that the earlier practice of infilling pits was later abandoned in favour of leaving pits exposed, perhaps to mark areas that had already been exploited (figs.3.50-3.51). Butler suggests these pits were the source of ore for the 16th century St Leonard's ironworks (Butler 2011, 33). A 16th century date is likely the case for the unusually large and deeper pits seen at pit A (figs.3.52-3.54), however the earlier, smaller, or infilled pits, such as *d* may pre-date this and be contemporary with the 14th century ironworks at Roffey.

Some of the pits had access tracks 3-4m wide that formed a shallow depression on their outer edge, on the side not surrounded by a spoil-heap (Fig.3.47 (b and e) and 3.53). On occasion these existed on opposing sides and formed the means of removing the ore from the pit.

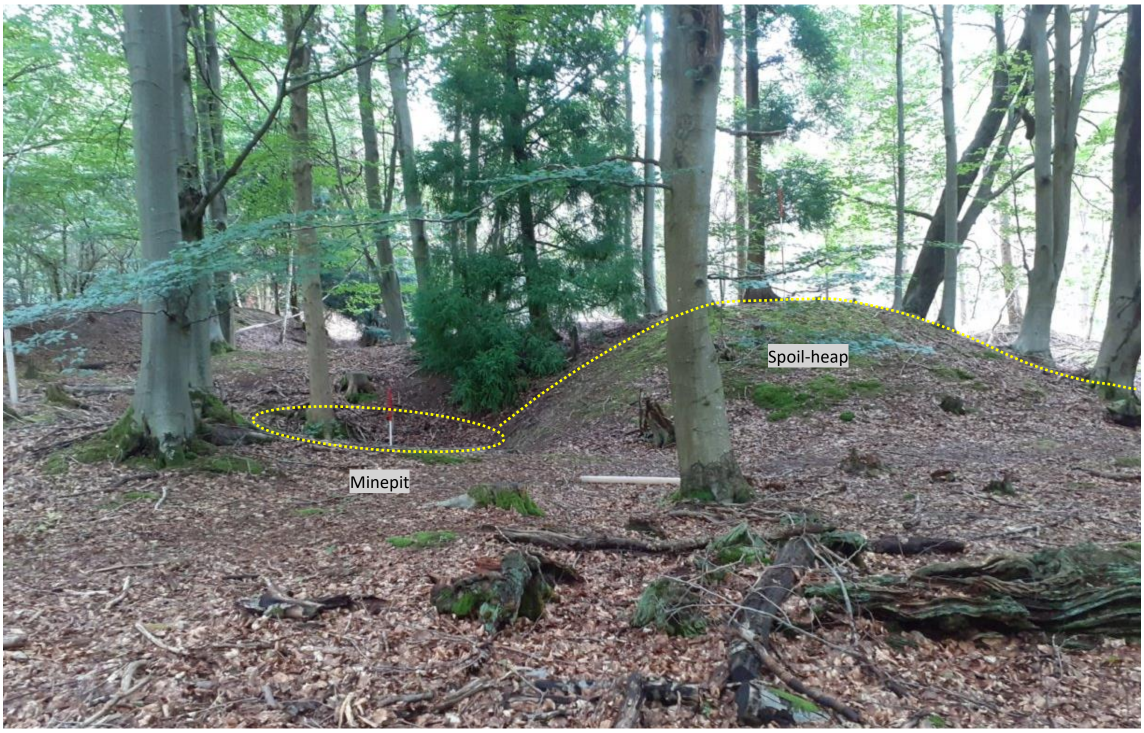


Figure 3.50 – *Large minepit A (figure 44) and its associated spoil heap. The cross-profile is illustrated in figure 3.48.*

Figure 3.51 – *Photo of minepit A from its associated spoil heap. There appears to have been no attempt to back-fill the minepit. Fragments of gangue is also present on the mound, along with ore (see figure 3.41).*

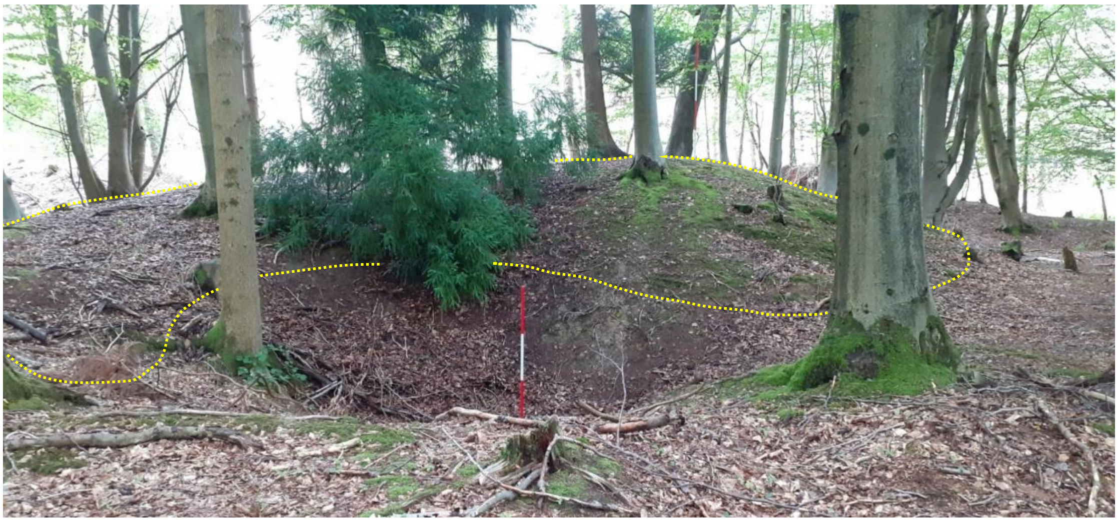


Figure 3.52 – *Spoil heap C adjacent to minepit 'a'. It encircles approximately half of the pit. (Author's image)*

Figure 3.53 – *Minepit 'a'. To the southeast and northwest of the pit, small gullies (e and b on figure 47) 2.5m wide possibly formed the access points for the removal of spoil and ore. Such channels were present in association with many of the larger pits. (Author's image)*

Figure 3.54 – *Trackway (m on figure 52) to the east of minepit 'a'. Such tracks are hard to date but may have provided access to the minepits in the past. Minepit a can be seen top right. (Author's image)*

Linear Channel

Directly south of the minepits, a linear channel runs on a N-E/S-W trajectory for approximately110m, beginning at the NS trackway in the east and becomes the boundary of the western field after 60m (fig. 3.40; m). The channel is 6.2m in width with adjacent 2.8m wide low banks on both sides. It has a roughly V-shaped profile to a depth of 1.6m, however, slumping of the outer banks means its original depth and morphology are altered (fig. 3.55 and 3.56). The highest density of minepits falls to the north of the channel, however there were 6 minepits of larger size, southeast of it, whose spoil heaps had considerably infilled this section of the earthwork for a stretch of 30m and demonstrated that the channel pre-dated the adjacent minepits. Minepits to the southwest of the channel were smaller and shallower and respected its course. Its purpose as a boundary ditch, sunken track or quarry is difficult to determine. While it is on the alignment of the southern boundary of the field to the west, it does not continue for the complete length. Nor does it appear to extend east beyond the minepit track. It is possible that it too was a minepit. It is of a similar depth and was perhaps designed as an exploratory trench to determine the presence and configuration of the ore seams before other minepits were dug, and resembles similar examples on Exmoor (fig. 3.57-3.58).

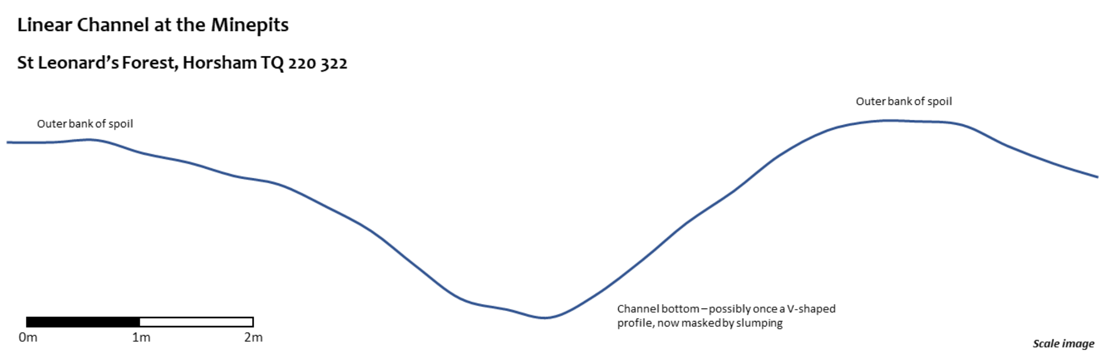


Figure 3.55 – *Cross profile of the linear channel to the south of the minepits and its adjacent banks of spoil (Author's image).*

Figure 3.56 – *V-shaped channel and associated spoil heaps on either side. It is 6.2m wide and 1.6m deep. Facing west. (Author's image)*

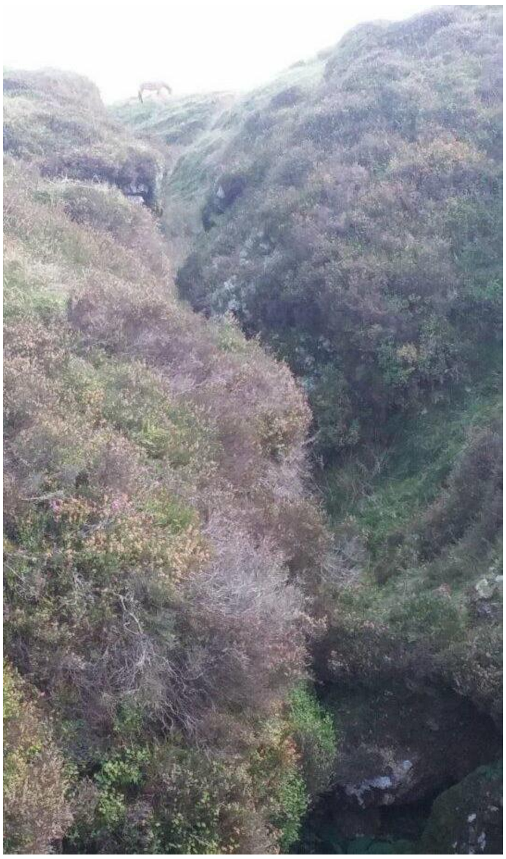


Figure 3.57 – *ore excavation channel on Exmoor, following a seam. It parallels elements of the morphology of the linear channel surveyed in St Leonard's Forest. (Author's image)*

Figure 3.58 – *V-shaped channel with minepits in the background (looking northeast). The channel had a length of 110m. (Author's image)*

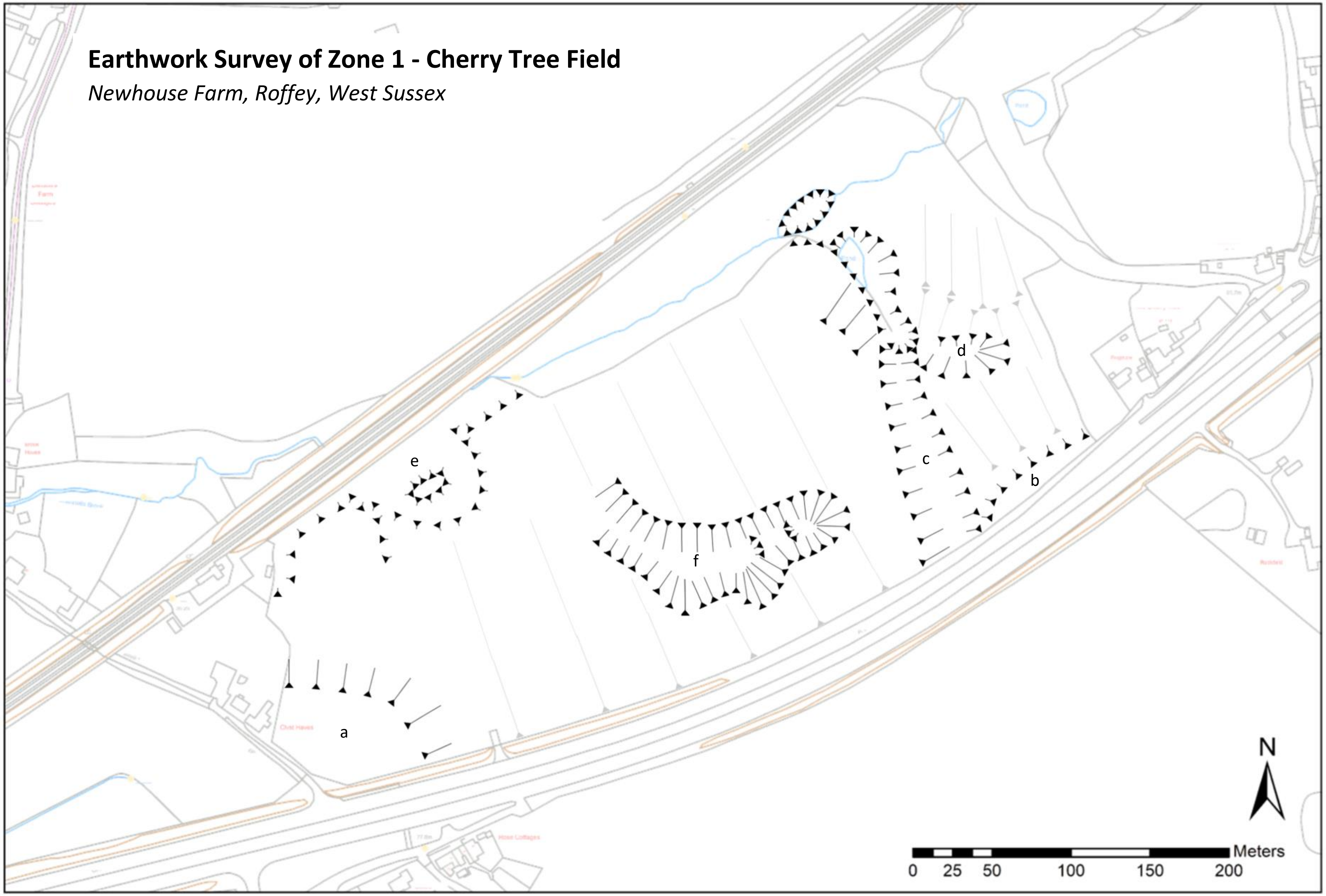


Figure 3.59 – *Earthwork survey of Zone 1. a and b show signs of platforms and are where the fieldwalking and geophysical surveys (chapter 4) show probable sites of iron production. c is a linear channel and was an existing field boundary until the mid-20th century. d was a small pond, now infilled but possibly a former quarry. f had an irregular terrain possibly as a result of former quarrying. This area was devoid of slag, however fractured sandstone was recovered here during fieldwalking. f is the remains of a gravel quarry that was active in the 19th century. Earthwork survey completed by the author. Overlaid onto current OS map courtesy of Edina Digimap.*

Zone 1 & 2

The earthwork survey of Cherry Tree Field identified undulated terrain to the north-west, covering approximately 2.4ha and is potential evidence of past quarrying (fig.3.59; e). In 1844 this formed Hopkins Mead, a meadow with a scatter of trees, and the undulated terrain may account for the lack of cultivation at this date. There was fractured sandstone and ironstone present within the plough soil here, which might represent the gangue left from quarrying. The absence of slag which contrasts to the rest of the field where it is in abundance is further evidence that this area was utilised differently (see Section 4.6).

3.8.3 - *Ore preparation*

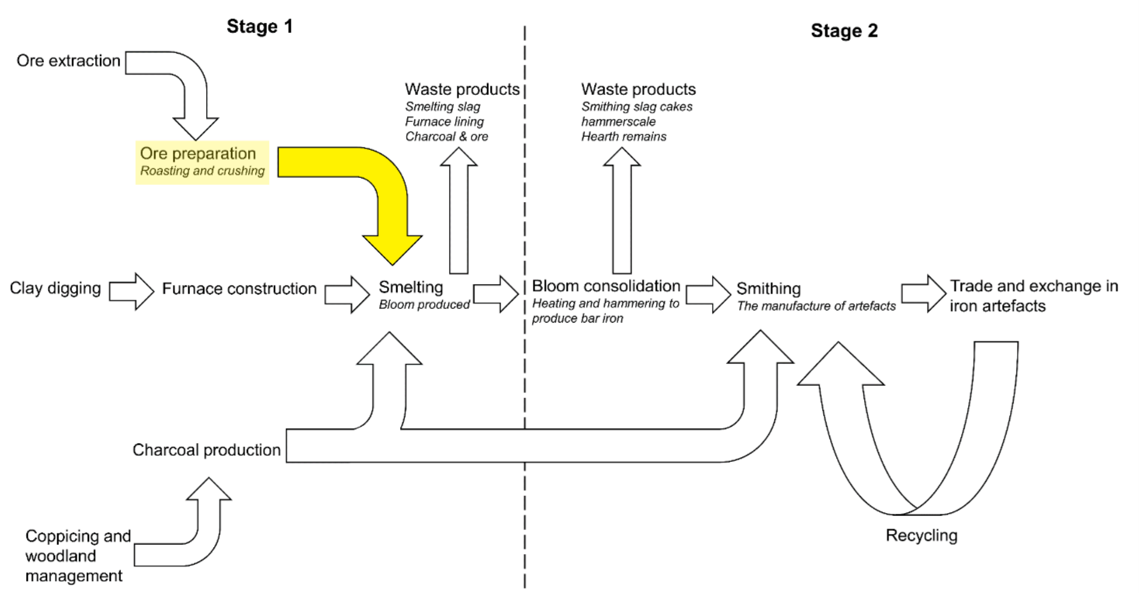


Figure 3.60 – *Iron-production process diagram showing ore preparation stages. (Author's image).*

Zone 3

While there was no evidence that ore had been roasted alongside the minepits, the spoil heaps adjacent to the pits did contain numerous fragments of sandstone, which is the debris, or unwanted material and suggests initial sorting took place here to separate usable ore from the waste that did not contain a high enough ore content to be viable for smelting (fig.3.60). Fragments of usable ore were found, which may suggest the approximate size that ore left the minepits, before being roasted and crushed closer to the smelting site.

Figure 3.61 *– Siderite ore recovered in Zone 1 at Cherry Tree Field. Fieldwalking revealed consistently-sized fractured samples c.2.5cm, some of which had a high magnetism, suggesting it had been roasted. (Author's image).*

Zone 1

Examples of unroasted and roasted ore were recovered in the plough soil at Cherry Tree Field (fig.3.61). It would suggest ore processing took place in close proximity to the smelting site and would parallel other sites such as Minepit Wood.

3.8.4 - *Coppicing and woodland management*

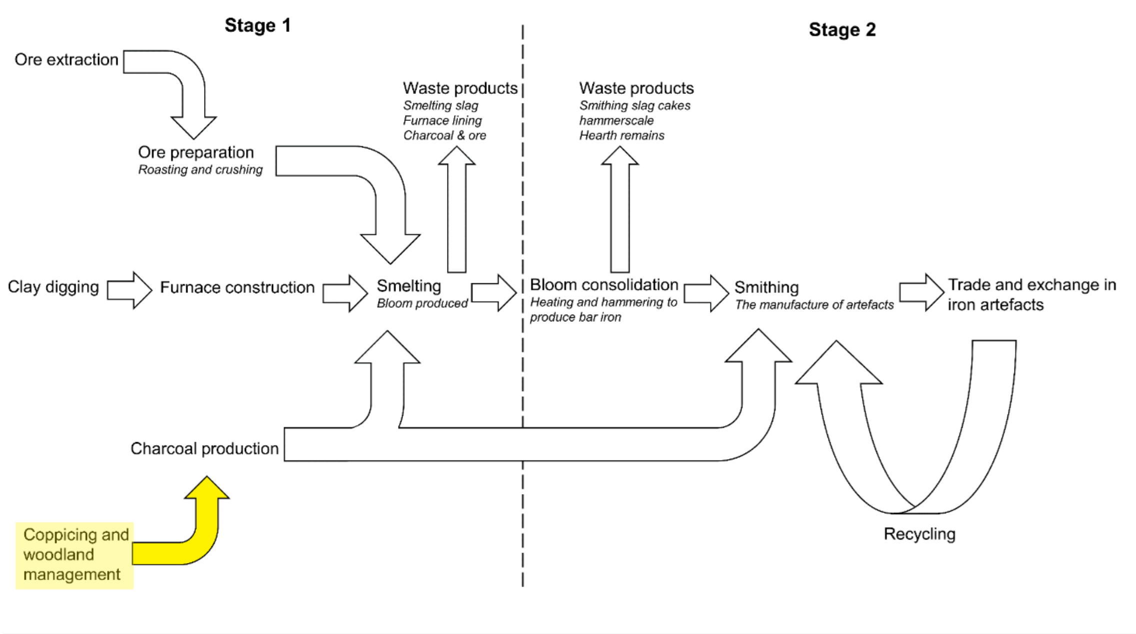


Figure 3.62 *– Iron-production process diagram showing coppicing a woodland management. An important prerequisite to produce charcoal. (Author's image).*

Wood bank and the minepits - coppicing

A wood bank was present on the western side of the minepits dividing the forest from the adjacent field (fig.3.63). A ditch, 3m wide and 1.4m deep was on the field side, while a 2m wide bank, made using spoil from the ditch, was on the woodland side. Following the typical morphology of wood banks, the feature is asymmetrical and had a steeper gradient on the field side and ran into the ditch, while a lower more gradually sloping side faced into the forest, with no ditch. The bank originally would have had a hedge on top, however today trees grow, including beech and birch. The design was intended to prevent livestock from entering the wood and damaging the valuable coppice. It was evident that the wood bank post-dated the minepits as in one instance the bank was slightly sinuous to avoid one of the smaller pits (fig.3.63). Part of the bank had infilled some of the western end of the pit. This would support the hypothesis that originally the minepits extended further west and subsequent encroachment of the forest has resulted in their infilling and conversion to arable land, with a new wood bank being constructed to delineate the new boundary.

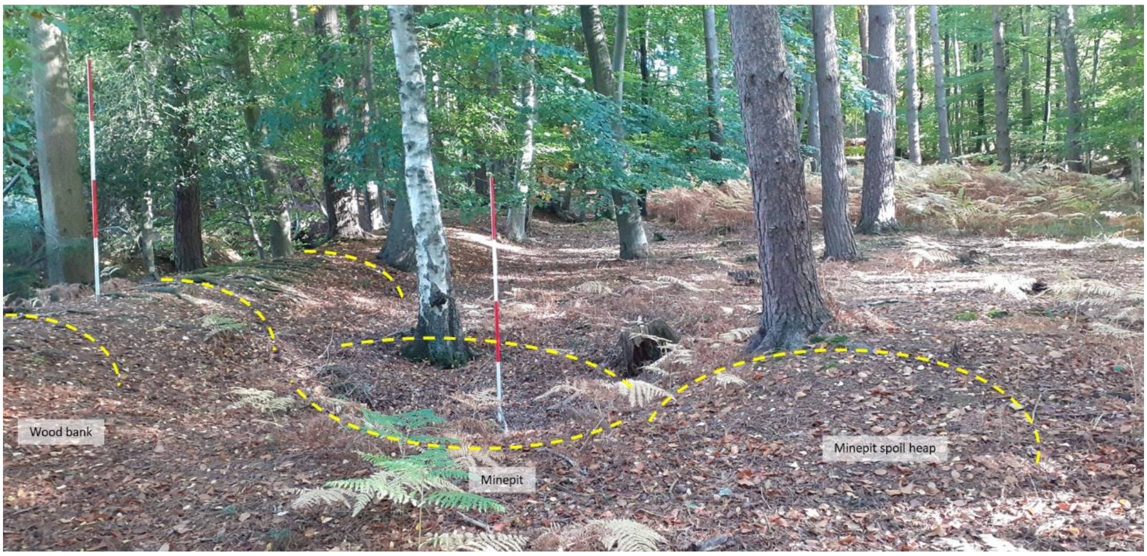


Figure 3.63 – *Wood bank to the east of the minepits. The minepits spoil bank is present on the eastern side of the pit. (Author's image).*

3.8.5 - *Clay digging and furnace construction (Geological)*

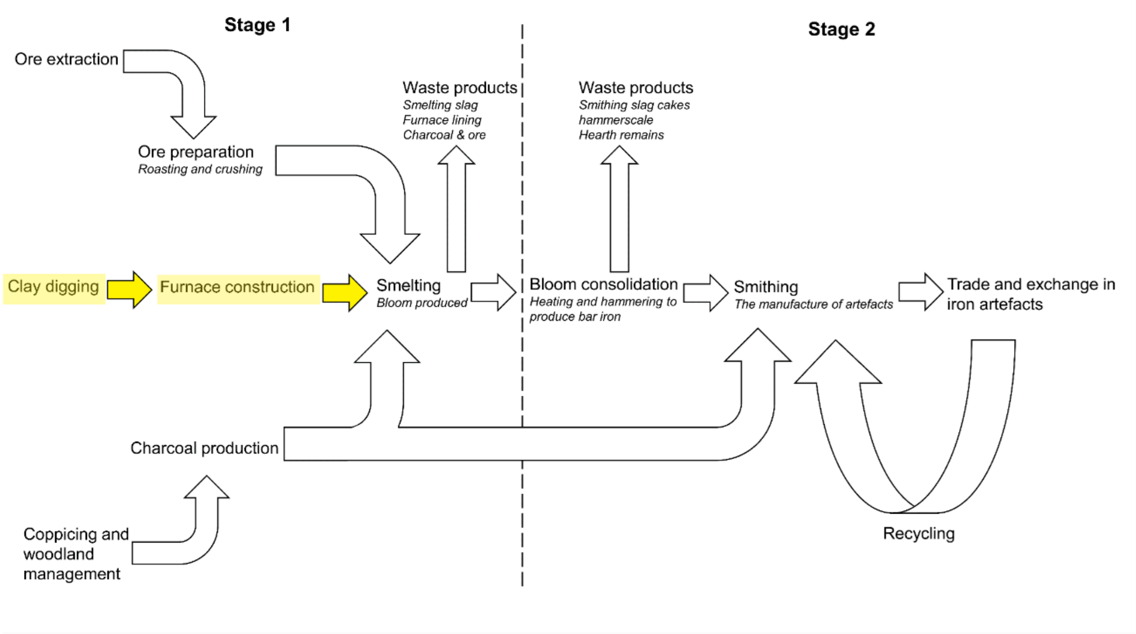


Figure 3.64 – *Iron-production process, showing the clay digging and furnace construction stages. (Author's image).*

Zones 1 and 2

It is notable on the19th century OS maps how many ponds are present within the landscape, of Zones 1 and 2, many of which owe their origin to past quarrying for products including clay, stone, marl, gravel, and ore. Even as late as the 19^{th} century there are records of gravel digging for roadbuilding in the area and the earthworks of one of these pits, which was dug between the 1840s and 1880s survives within Zone 1 (fig.3.59 and 3.64). Other pits are earlier in date, including an oval pit c.50m wide identified in the earthwork survey at 'd' in figure 3.59. This pit pre-dated the 1844 Tithe map, in which it was shown as a pond within a wooded shaw, however it had become cultivated land by 1870s (fig. 3.33). Clay would have been one potential product of a pit such as this, along with sandstone and ore. The Tunbridge Wells Sand, which forms part of the Hastings Beds (see Chapter 1) makes up the geology of Zone 1 and consists of siltstones with sandstones and clays. The main superstructure of a furnace was made of clay which was readily availability within the local landscape and meant it would not have been necessary to transport it any great distance. The fieldwalk recovered vitrified refractory material, that attests to this clay furnace structure and its distribution can be viewed in Section 4.6.

3.8.6 - *Transport*

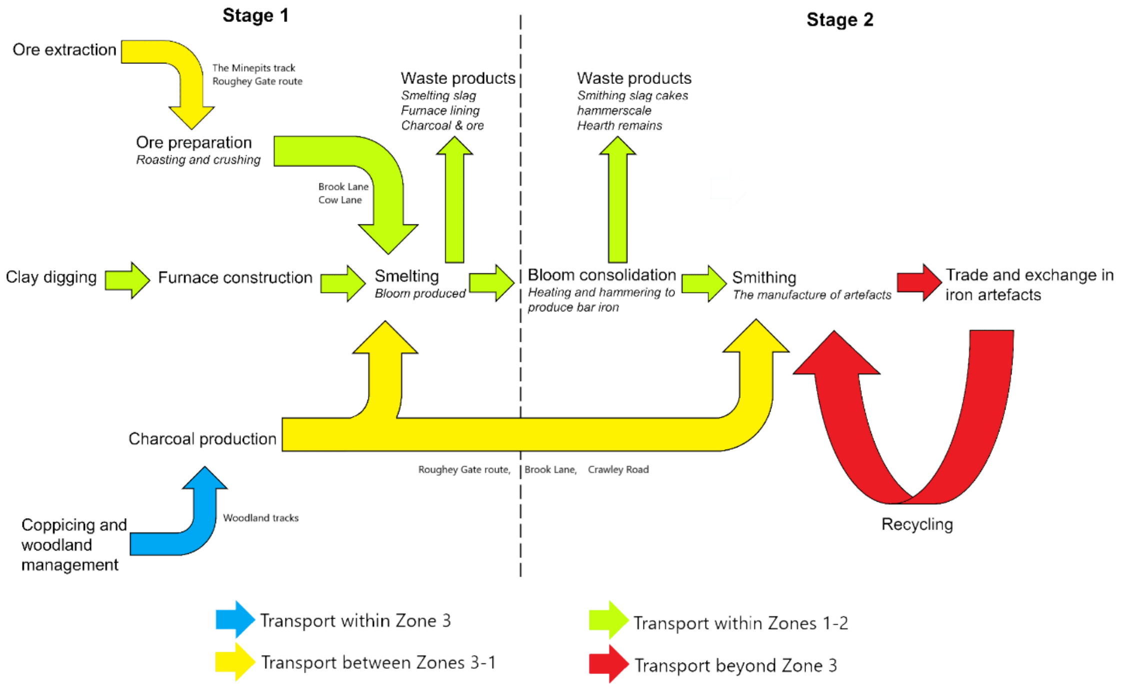


Figure 3.65 – *Evidence of transport within and between zones and the importance of routeways in connecting the individual stages of iron-production. (Author's image).*

These industries must not be viewed as isolated features within the landscape but connected by routeways (fig.3.65). Some tracks have exceptional preservation, particularly those located in Zone 3 that served the woodland industries, but never became metalled roads in later centuries. Those in Zone 2 were either metalled and have lost much of their original morphology, or are preserved as footpaths and hollow-ways characteristic of ancient routes in the Weald. Others, particularly the route from the minepits to Zone 1 have almost completely been destroyed by later landscaping and agriculture and it was necessary to use cartographic and LiDAR data to reconstruct this route.

Zone 3 – Routeways

Minepits Woodland Track

A trackway runs on a NE-SW alignment through the centre of the group of minepits (fig.3.45;d), starting from Forest Road (fig.3.45;h) and terminating in the south of the forest at Highbirch Gate, where four other tracks intersect. The track is 5.7m wide and flanked on either side by parallel banks and ditches (figs.3.66-3.68). The eastern bank is the is more pronounced at 5m wide and 1.3m high, compared to the western bank at 1.5m wide and 0.5m high and reflects how this track is terraced into the natural west-facing slope. The eastern bank had holly growing on its peak, which may be the remnants of a hedge, while beech trees grow into the side of each bank, their regular spacing suggest deliberate planting. An oak was also growing further to the south at Highbirch Gate. Parallel ditches run on both the woodland side and track side of each bank, each approximately 2m in width and of shallow depth (likely silted) (fig.3.66).

Figure 3.66 – *Minepits woodland track facing south. The track is terraced into the natural slope of the land. (Author's Image).*

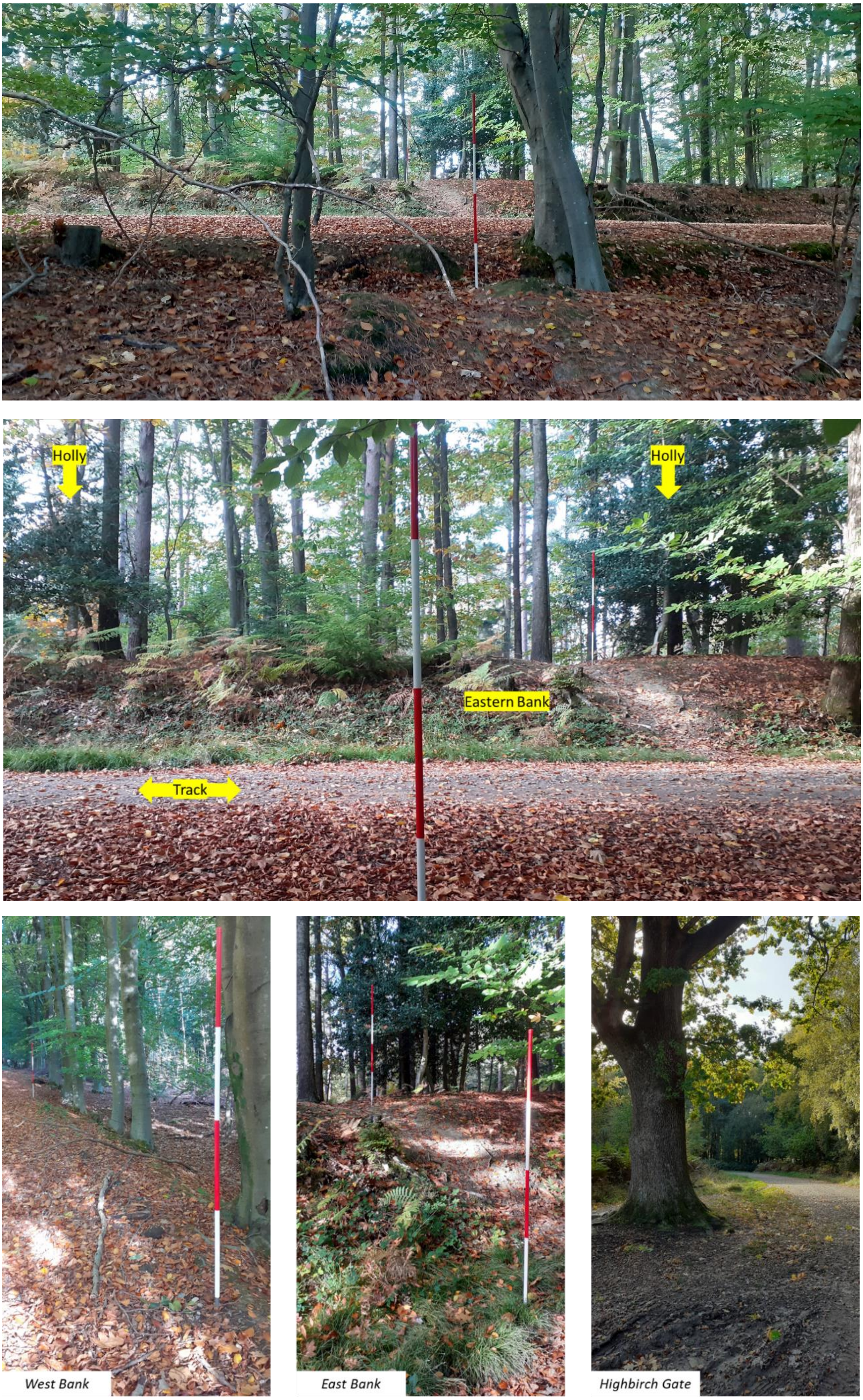


Figure 3.67 – *sections of the Minepits track, showing the eastern and western banks and ditches and traces of the possible holly hedge that ran along the top of the banks. (Author's images).*

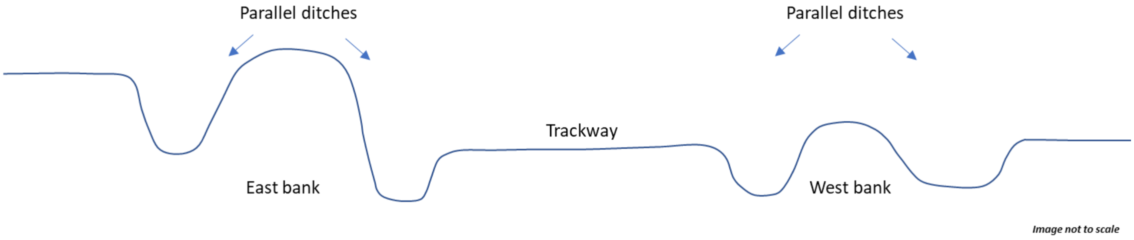


Figure 3.68 – *Sketch plan of the profile of the Minepits track, showing how it is terraced into the natural slope and flanked by banks with ditches on either side. The trackway is now metalled, however, clearly makes use of an earlier routeway that is present on the 19th century OS maps. A date contemporaneous with the minepits is hard to determine but is possible. (Author's image).*

To the north, the minepits are distributed either side of this track, and it is possible a contemporaneous date with the minepits would have allowed access to them from both the north and south. Trackways are difficult to date from earthworks alone, for they generally remain in use over long periods, with later adaptations, such as metalling, widening or diversions creating complex chronologies.

Eastern woodland track – Braided trackway

Other tracks are present throughout the forest and will have a range of dates. While the minepits track described above may have been a main source of access for ore to be transported out, a second series of tracks were recorded south of the channel earthwork running on an NW-SE alignment. Two parallel tracks were recorded 2.5m and 2.7m wide and approximately 30-50cm in depth, with a low central bank of 2.7m in width (figs.3.69-3.70). Both are sinuous and to the east, where they increase in depth, merge into one before terminating at the Minepits track (fig.3.40; f). Traces of an adjacent track were present to the north. The sinuous morphology and grouping suggest this was a routeway that moved over time as parts of the original route became impassable by the waterlogged clay soil typical to the Weald, to form a series of parallel tracks. If contemporary with the minepits, the tracks would have provided western access to the site.

Figure 3.69 – *Braided trackway running to the east of the minepits. (Author's image).*

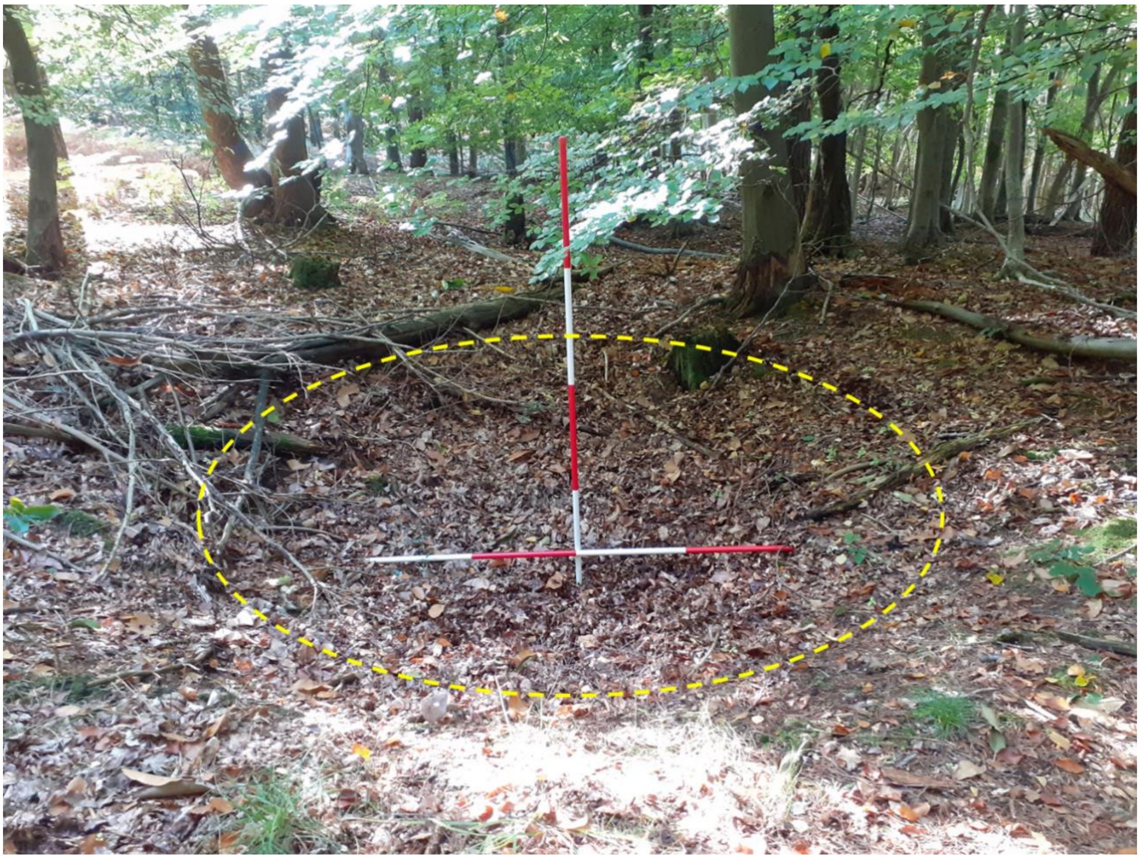


Figure 3.70 - *Adjacent minepit south of the track. Smaller size and depth with no obvious spoil heap. (Author's image).*

Zone 3-2: From the minepits to Roffey ironworks

For the ore to be brought from St Leonard's Forest to the smelting sites in Zone 1 and 2, a routeway, preferably as direct as possible, would have been necessary. This was challenging to establish through the reconnaissance survey for while there were woodland tracks surviving at the minepits, and routes directly around Zone 1 at Brook and Cow Lane, the construction of Hollywood House (and later Roffey Park) at TQ212329 had resulted in extensive landscaping at the edge of Zone 3 to create parkland, while to the north of this, in Zone 2, agricultural intensification in the 20th century had removed field boundaries and earlier routeways. Thus, 19th century OS maps and LiDAR data were therefore important to use alongside the reconnaissance survey data to reconstruct this routeway.

The 1870 OS map shows a south-eastern track extending 370m from the intersection of Crawley Road and Brook Lane to Roffey Gate. This survives as a linear earthwork depression at point 'd' on the LiDAR image (fig.3.71). The significance of the Gates into the Forest was discussed in Section 3.7.2 and the fieldnames here attest to the former forest boundary. While this section of the route has now been absorbed into adjacent fields, fragments of smelting slag were found here that may have been used for metalling (see Section 3.8.8) (fig.3.72). Beyond Roughey Gate the route follows the boundary of three fields for 220m before reaching Roffey Park and again survives in part as a linear depression (fig.3.71;c). If this route is projected on the same alignment past Roffey Park for 600m, it meets Forest Road to the South (fig.3.73). The general trajectory of Forest Road is east-west, however, for a 245m stretch at the point the Roughey Gate route is projected to meet it, it follows a NW-SE alignment, the same as the route from Roughey Gate (fig.3.71; e). There is no obvious explanation of the change in orientation for this section of road unless it incorporated a section of an earlier route. A further 220m beyond this, projecting on the same orientation, the northern minepits are reached. Here the LiDAR

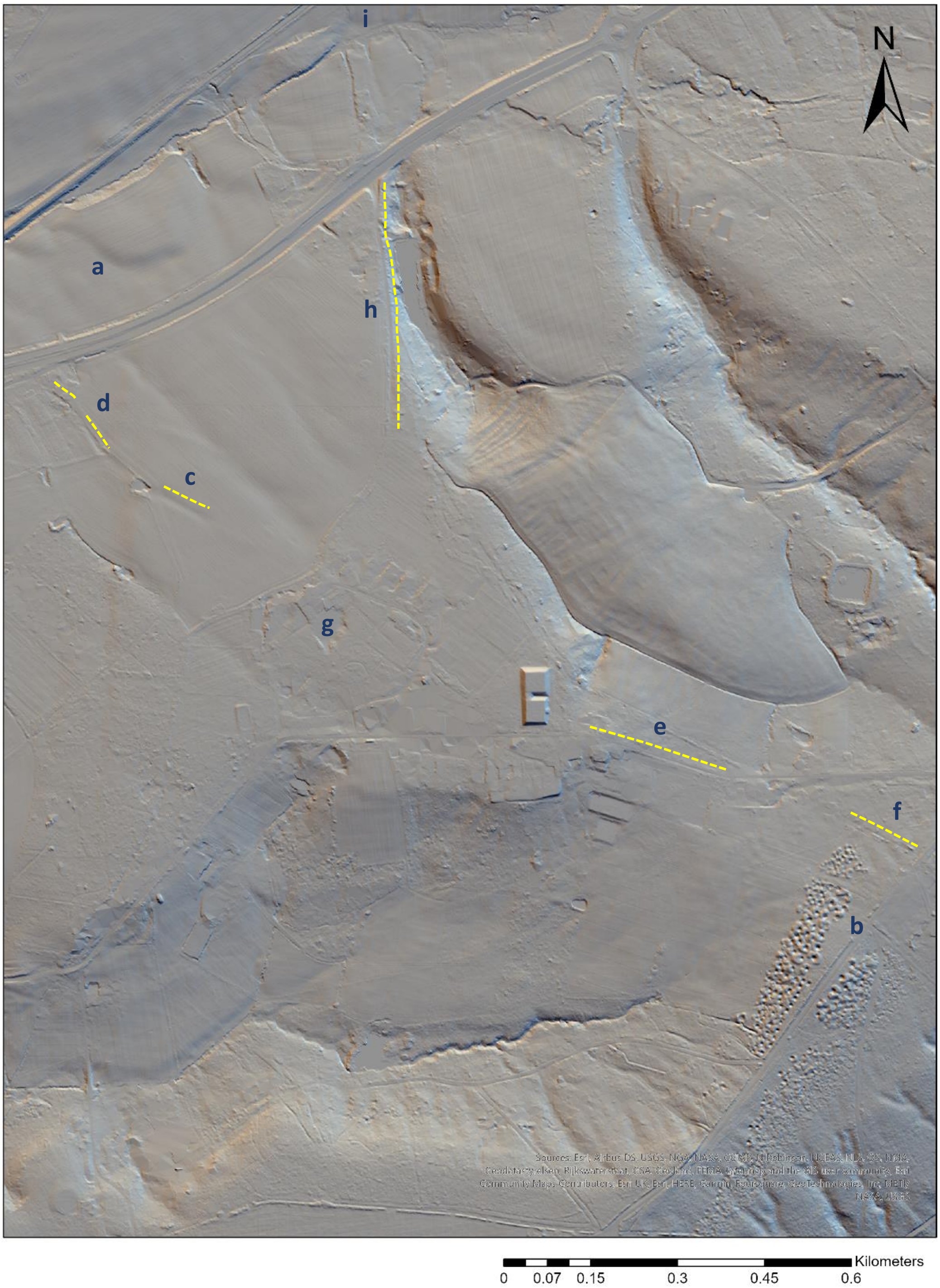


Figure 3.71 – *LiDAR image showing traces of a routeway leading from Zone 1 (a) to the minepits in Zone 3. Traces of a sunken lane survive as earthworks at c, d, and f, while a section of Forest Road (e) may also have formed part of the route (the route is marked in yellow adjacent to the earthwork). The construction of Roffey Park (g) has destroyed traces of this route. This would have once formed a trackway leading from Roughey Gate (c), one of the entrances into St Leonard's Forest, through the forest to the minepits (b). A further linear earthwork is present at h, which existed as a footpath in the 19th century. This was potentially an early diversion route to Coots Gate (i) and would have provided access to the minepits for the iron-production sites on the eastern side of Zone 1, while the continuation to Roughey Gate of the main track allowed access for the iron-production sites to the west of Zone 1. LiDAR image courtesy of the National LiDAR Survey and adapted by the author.*

shows two parallel banks of a similar width to the routeway and on the same NW-SE alignment, which in turn joins the minepits track described previously (fig.3.71;f). An additional track that may have joined the primary route from Roughey Gate, is visible as a linear depression at h on Figure 3.71. This would have led to Coot's Gate, another former entrance into the forest. The trackway therefore connected the woodland resources of charcoal and ore of Zone 3 to the smelting sites in Zones 1 and 2 and supports the likelihood that ore extraction in St Leonard's was contemporaneous with Roffey ironworks. The adjacent track (h on fig.3.71) would allow iron-production sites in the east of Zone 1 to access the forest, via Coots Gate, while those in the west would have had access via Roughey Gate. Iron-production was therefore not positioned randomly on the forest margin, but adjacent to the entrances and the tracks leading from these gates (see fig.36).

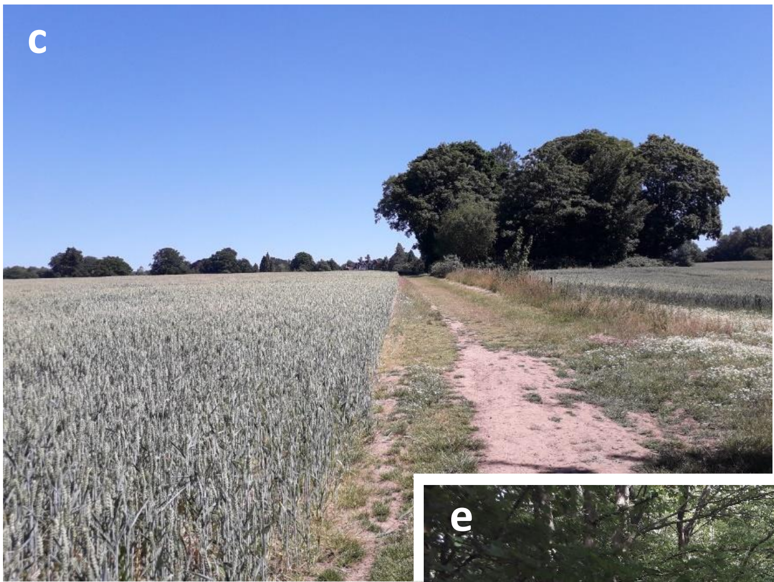


Figure 3.72 – *Routeway to the minepits leading through the former Roughey Gate (d & c). Surviving today as a footpath, this was an established routeway into the 19th century. Roughey Gate formed one of the ancient entrances or gates into St Leonard's Forest. Traces of slag was found here and may represent its re-use as metalling material. Author's image.*

Figure 3.73 – *Forest Road (e) which may have formed part of the routeway from Roughey Gate to the Minepits. Author's image.*

Zone 2 – Routeways

Brook Lane

Brook Lane runs along the Western boundary of Cherry Tree field (Zone 1) and has an overall length of 330m and is aligned north-south. It is characterised by high banks on either side, with the depth of the track increasing in the north to 3m below the field level to form a 'hollow-way' (figs.3.74-3.75). The railway line bisects Brook Lane 100m south of the lane, however, the steep-sided banks remain present either side of the railway cutting but reduce in height 80m south.

Figure 3.74 – *Brook Lane, which survives as a sunken or hollow way to the north, with banks 2.6 - 3m high on either side. Author's image.*

Cow Lane

Cow Lane formally stood 70m north of Cherry Tree Field, where it ran for 550m before turning south, crossing the railway and Channells Brook stream and following the field's eastern boundary (figs.3.76-3.77). The northern section of Cow Lane was removed by the 1970s, along with the boundaries of its neighbouring fields, however, the 1930s OS map shows it was 8-13m wide, following a sinuous trajectory from east to west between Welchmans and Barn fields (North) and Behind House and Long Lag fields (South). On the reconnaissance survey, a depression was observed running through the field on the alignment indicated by the pre-1930s maps and this too is visible on the LiDAR (fig. 3.39). It indicates that, like Brook Lane, parts of Cow Lane also formed a hollow way.

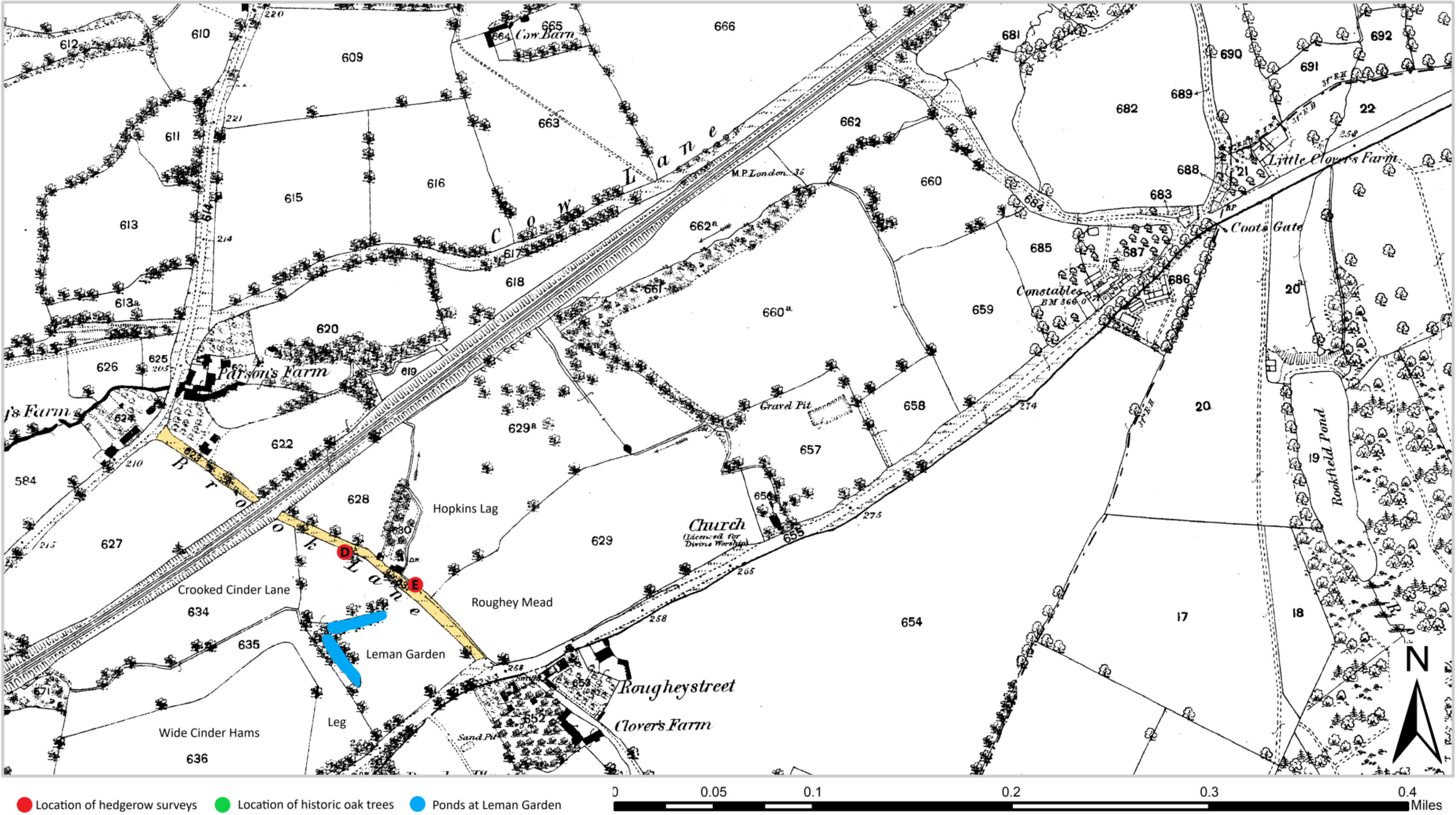


Figure 3.75 – *19th century OS map, showing the position of Brook Lane in relation to Cherry Tree Field. Historic hedgerows were surveyed at points D and E. Map courtesy of Edina Digimap and edited by the author.*

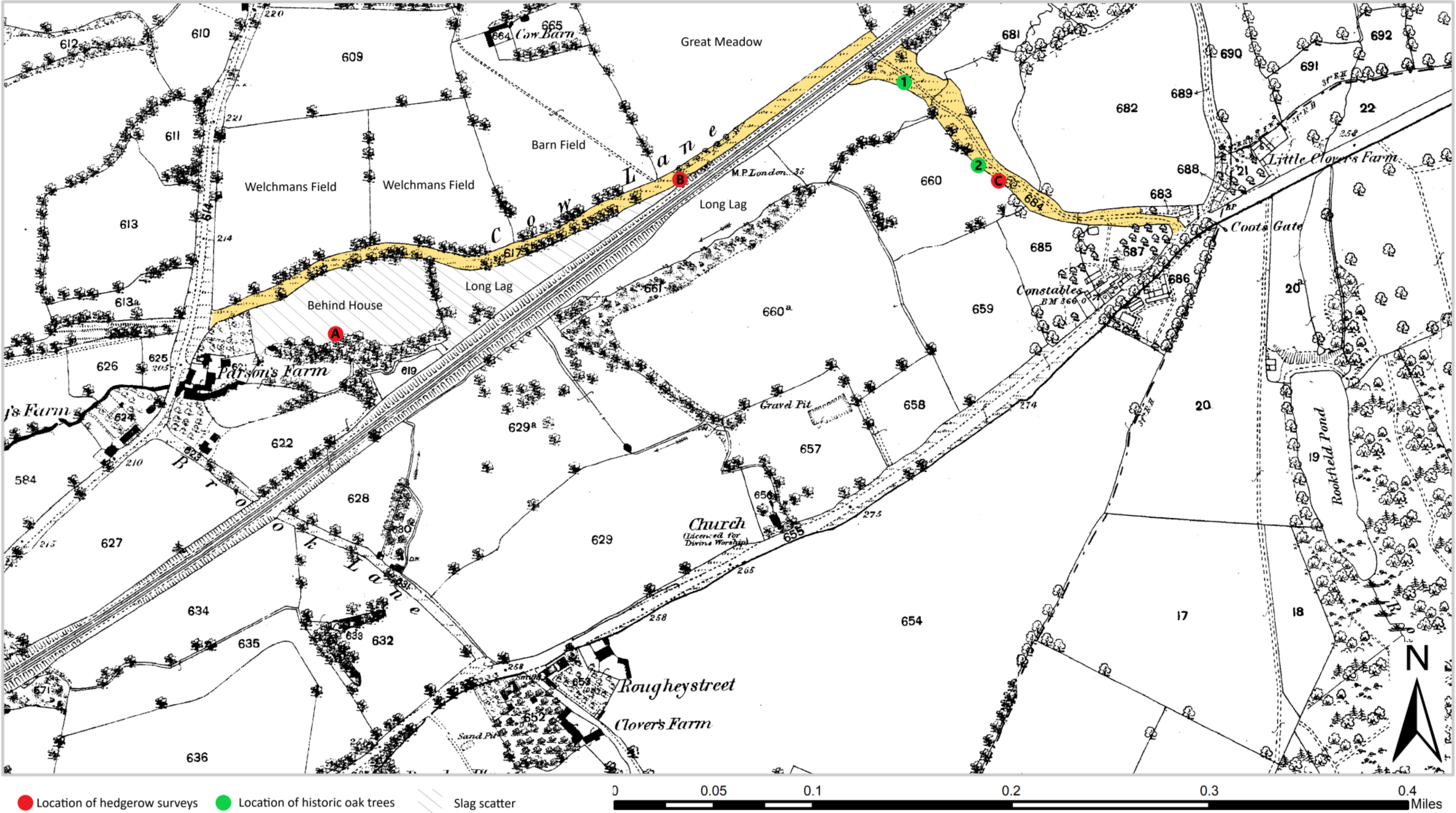


Figure 3.76 – *19th century OS map showing the route of Cow Lane. The northern section was removed during field amalgamation in the 20th century and only survives as an earthwork. The eastern section that runs alongside the eastern boundary of Cherry Tree field today forms a footpath. Two ancient oak trees are present on the western boundary of the lane (marked in green). Scatters of slag were found along the entire route of Cow Lane and was potentially used for metalling.*

Figure 3.77 – *Cow Lane, running alongside the eastern boundary of Cherry Tree Field. The track is flanked on either side by banks, topped with the remnants of hedges, which include species such as oak, holly, and hazel. The hedge on the left of the image has a predicted age of 600 years based on the hedgerow species survey. Internal ditches also border the trackway and suggest that the track was in the past used for herding livestock, as reflected in the name Cow Lane. Fragments of slag within the track and the western bank, along with the date of this hedgerow indicate it is contemporary with the iron-production activity in Zone 1 and the slag may have been used as metalling to counteract the erosion and boggy ground Wealden tracks, such as these would have faced. Wealden routeways were notorious for being impassable from the boggy Wealden clay.*

To the east by 400m, Cow Lane survives as a footpath and follows the edge of the railway line, built in the 1840s. Here a 2m wide bank and a 1.4m wide and 0.5m deep ditch delineated its northern boundary. As the ditch is on the inside of the track it indicates it was designed to prevent livestock from escaping from Cow Lane, rather than entering from the adjacent field, suggesting a former use as a drove road, presumably by its name, for cattle. The eastern course of Cow Lane, is demarcated by the remains of banks, topped with a hedge, with ditches running parallel on the inside. The lane is 10m wide at this point.

Crawley Road

Much of Crawley Road was built in the 18th century, however, the section of road west of Coot's Gate is earlier as evidenced by the field boundaries either side of it which respect its orientation. In Zone 1 at point 'a' on Figure 3.86 part of the boundary of the road was preserved in the field's southern boundary as a bank topped with a hedge, with the road standing at a higher elevation than the field. While this road may have connected Roffey to Horsham in the west, if Roffey was connected to Crawley, it must have been indirectly via Faygate.

3.8.7 - *Settlement boundaries and land division*

Over the last century many fields have been merged to create larger parcels of land ahead of agricultural intensification. This has brought with it the loss of many ancient field boundaries, most notably those that formally divided Cherry Tree field (Zone 1) into 11 parcels of land. The Tithe maps and the OS maps demonstrate how many fields in the parish retained wide wooded shaws, in many cases an indication that the field was former woodland that was cleared through the process of asserting, which began in the 13th century. The medieval pottery recovered at Cherry Tree Field and discussed in Chapter 4, suggests the fields here, some of which are shown on the Tithe maps with large shaws, were cleared by the 14th and 15th centuries (fig. 3.33). For the boundaries that still exist, specifically on the perimeter of Cherry Tree Field and those adjacent to the surrounding routeways of Brook Lane and Cow Lane, the reconnaissance survey examined these to determine the likelihood that they existed in the medieval period. While banks and ditches formed earthwork features typical of these boundaries, it was the hedges that provided potential dating evidence, through their species diversity. Based on Hooper's Hypothesis, every shrub or tree species in a hedgerow, within a 30-yard length, represents a century of its existence (Harvey 1976, 27). Therefore, in a 500-year-old hedge, one would expect to see at least 5 species. While species diversity as a measure of age must be treated with some caution, it is recognised as having higher accuracy for hedges dating from the medieval period onwards (ibid, 27). By determining which hedgerows existed, the landscape morphology, boundary layouts, and the dates of routeways could be estimated (fig.3.78 and Table 3.5).

Zone 1

While former internal boundaries had been removed to create a large open field, the hedgerows on the outer perimeter could be examined on the eastern and western boundaries. The boundary between Cherry Tree Field and Brook Lane south-west of the field (fig.3.78; E) was demarcated by a hedge raised on a low bank, with a ditch on either side. The hedge extended for 30m but had been truncated at its southern end during bypass construction, with a loss of approximately 35m of its original length. Seven hedgerow species were recorded within the hedge, of which five were tree or shrub species. Hedgerow E therefore had a minimum age of 500 years (fig.3.79). The eastern hedgerow (fig.3.78; C) also included 6 shrub and tree species, suggesting a similar date of 600 years (fig.3.80). One species was Pedunculate Oak, with two established specimens 300-400 years old dominating this boundary between Cherry Tree Field and Cow Lane (fig.3.81). Again, the hedge was on top of a bank, however there was no internal ditch.

Table 3.5 – *Species identified in the hedgerow species diversity survey and their estimated age using Hooper's Hypothesis*

Shrub or tree species present	*Hedgerow A (Zone 2 Cow Lane West)*	*Hedgerow B (Zone 2 Cow Lane east)*	*Hedgerow C (Zone 1 eastern boundary)*	*Hedgerow D (Zone 2 – Leman Garden Field)*	*Hedgerow E (Zone 1 western boundary)*
Common Hawthorn	✓			✓	✓
Holly	✓		✓	✓	✓
Hazel	✓		✓	✓	✓
Blackthorn		✓	✓	✓	
Dog Rose			✓	✓	✓
Field Maple				✓	
Common Box				✓	
Ash			✓	✓	✓
Hornbeam	✓				
Bay Willow		✓			
Pedunculate Oak	✓	✓	✓	✓	
Silver Birch		✓			
Beech	✓				
Uncertain shrub		✓			
Approximate age from Hooper's Hypothesis	*600 years*	*500 years*	*600 years*	*800-900 years*	*500 years*

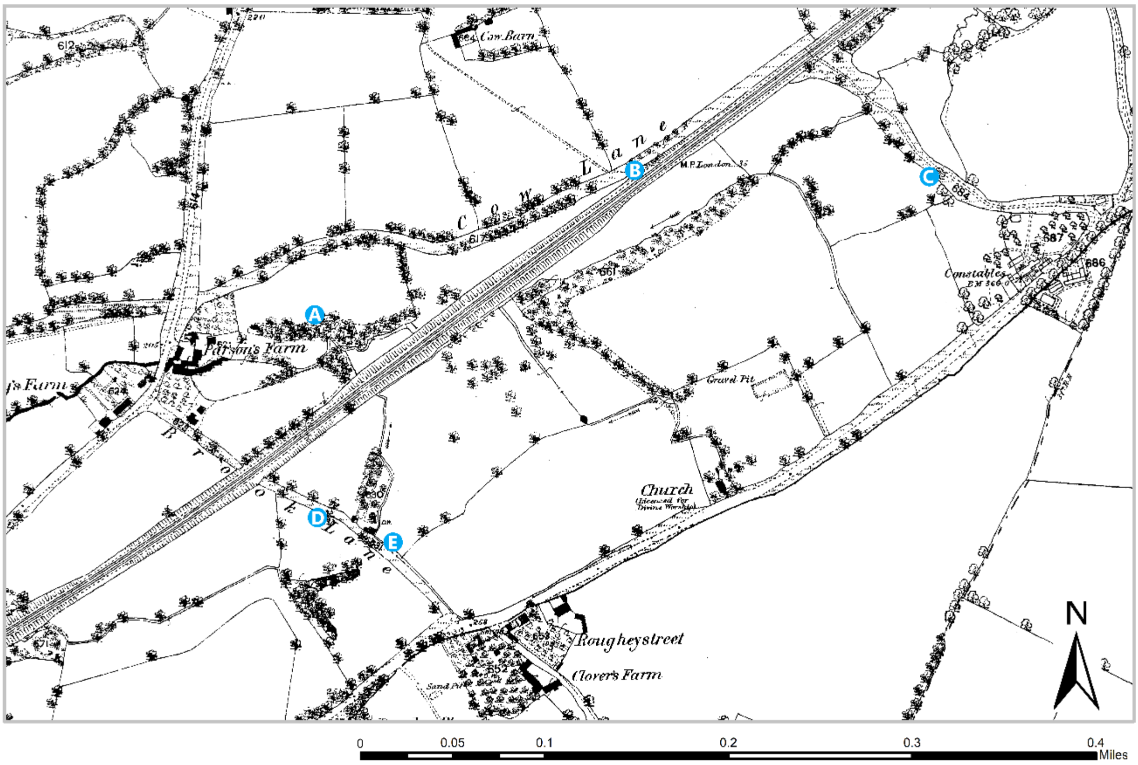


Figure 3.78 – *Hedgerows investigated in the hedgerow species diversity survey. Base map courtesy of Digimap OS Collections and edited by the author.*

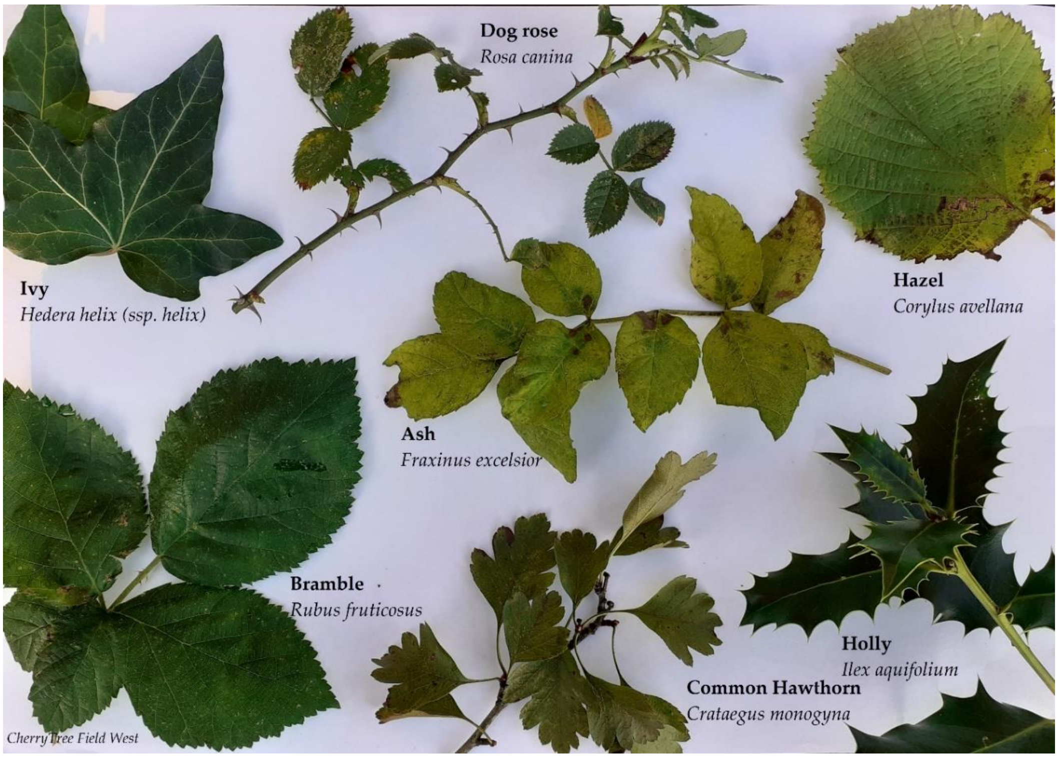


Figure 3.79 – *Species count from the western hedgerow between Cherry Tree field and Brook Lane (fig.3.78; E) which suggested an age of 500 or more years. (Author's image).*

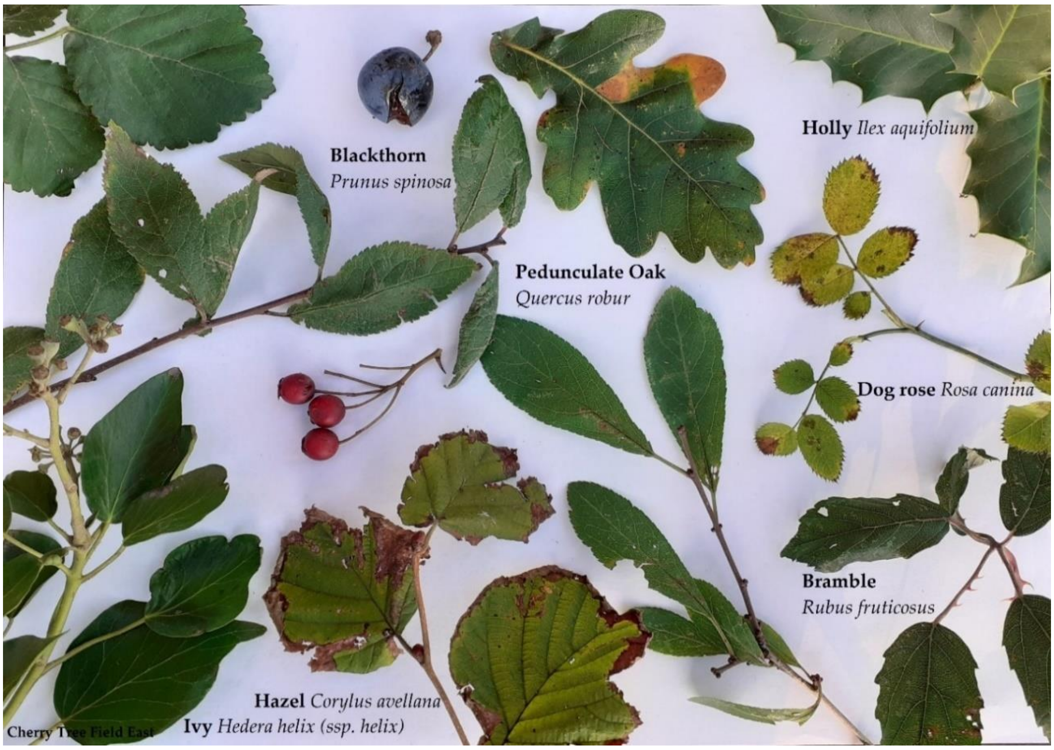


Figure 3.80 - *Species count from the eastern hedgerow between Cherry Tree field and Cow Lane (fig.3.78: C) which suggested an age of 600 or more years. (Author's image).*

Within Cherry Tree Field only one boundary earthwork remained visible, running north-south 90m west of the eastern boundary and existed as a boundary in the 19th century. The surviving earthwork formed a wide, but shallow linear channel with a varying width of c.12m that ran for 140m from the southern boundary to the copse of trees that extended into the field from the north (fig.3.78; C). This is shown as a boundary on the 1844 Tithe map and was still in existence into the early 20th century, when it was removed sometime between 1960 and 1980, leaving a northern section of 85 meters.

Figure 3.81 – *One of two ancient oaks on the boundary of Cherry Tree Field and Cow Lane. The 19th Century OS maps show established trees once dominated field boundaries in Zone 1 that disappeared in the 20th century.*

The southern boundary of Cherry Tree field had an irregular profile on the 19th century OS and Tithe maps and suggests further boundary divisions within the field once existed. This will be discussed in Chapter 4.

Zone 2

Leman Garden

The hedge between Leman Garden Field and Brook Lane (fig.3.78; D) had a species diversity of nine, although it is likely that Common Box, although native to Southern England, is a more recent edition from nearby gardens (fig.3.82). The species

Figure 3.82 – *Hedgerow on the boundary of Leman Garden field and Brook Lane (fig.3.78; D), which contained 9 tree and shrub species giving it an estimated age of 800-900 years. The hedge was sited on top of a bank that led down to Brook Lane.*

would however indicate that the hedge dates back approximately 800 years. The date range of hedges D and E (fig.3.78) would indicate that Brook Lane existed as a routeway 500–800 years ago (fig.3.83). While the hedge stands at the same elevation as the field in Leman Garden, with no apparent ditch, Brook Lane is at a lower elevation forming a sunken lane, with the hedge standing at the top of a steep bank. Hedge D (fig.3.78) would have been a boundary present when the hall house stood in the south of Leman Garden (see Section 3.6.6).

Figure 3.83 - *species count from the eastern hedgerow between Leman Garden Field and Brook Lane (fig.3.78; D) which suggested an age of 800-900 years. Author's image.*

3.8.8 - *Smelting (Metallurgical)*

Slag scatters

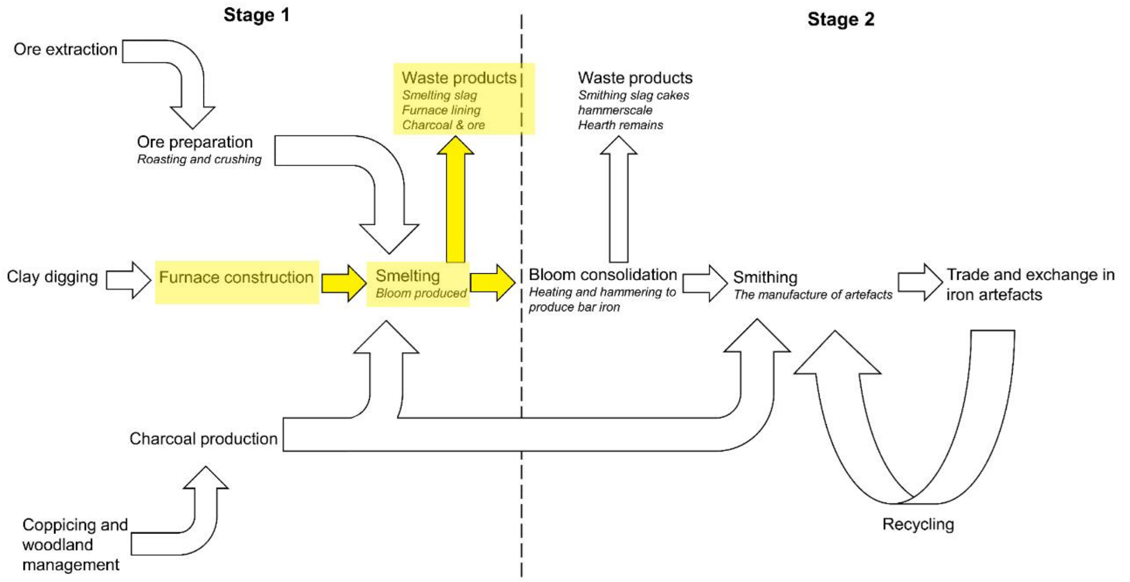


Figure 3.84 – *Iron-production process showing the position of smelting. (Author's image).*

Ten findspots of slag were identified during the reconnaissance survey of Zones 1-2 and these ranged from small slag scatters of under ten fragments, to dense concentrations of slag that were later recorded in detail by systematic fieldwalking (fig.84). While a majority of slag was identified within plough soil (Zone 1), other locations included woodlands, ditches, trackways and streams, most of these on the periphery of Zone 1. While the periphery locations yielded fewer total slags, these must not be assumed to represent chance finds or small-scale activity, for greater quantities of slag may remain buried and not exposed in the same way as the ploughing. Equally, the process of ploughing results in the fracturing of slag, and recently fractured fragments were observed throughout Zone 1. Fractured slag in a ploughed context can give the false appearance of higher quantities, compared to several large non-fractured slags found in an undisturbed ditch. Ploughing can also drag slag over considerable distances leading to a false impression of where the nucleus of activity was situated and result in a site appearing much larger than it originally was. Caution had to be exercised when recording slag scatters and it was important to collect samples to consider their size and degree of fracture as well noting specifically how densely distributed they were. Figure 94 displays the combined locations of slag scatters recorded in the reconnaissance survey alongside past discoveries.

Slag scatters – Zone 1 (fig.3.85; points 4,6,7,8,9)

The most characteristic landscape signature of smelting is slag, often abundant and typically deposited in heaps close to the smelting site. Slag heaps (or banks) were evidently still surviving at Roffey in the 19th century according to Mitchell (1929) (see Section 3.6.2). However, the reconnaissance survey failed to identify any surviving remains of these. Smelting slag was however found in the plough soil of Cherry Tree Field and will be discussed in greater detail in relation to the fieldwalking data in Chapter 4. It is important to note that Zone 1 had the highest observed number of slag scatters, comprising four distinct concentrations at the south-east, south-west, and southern boundary and the north-eastern corner of the field. Of these four concentrations, the south-east and south-west boundary locations presented the highest densities, over the widest areas of approximately 8950m^2 and 6850m^2. The earthwork survey revealed traces of platforms at these two locations (fig.3.59; a-b). While the southern boundary site had a high concentration of slag, it covered a smaller surface area and appeared to have been truncated by the road (fig.3.85; 4). The workshop and hearth identified in 1985, possibly used for smithing (see Section 3.6.5) was 6m south of this, however, the slag was predominantly from smelting and not smithing. The southern slag scatter did not extend far north (c.40-50m), however, a 19th century gravel quarry may have removed any traces of a northern spread of slag. While the north-eastern slag scatter was distributed over a wide area of c.9200 m^2 it had a sparser

1. *Wide Cinder Hams and Crooked Cinder Lane, found by Honywood and Straker to contain a distribution of slag.*
2. *Roughey Place – the fields Large Cinderhams and Small Cinderhams, which may have stood to the north and south of the house, were said by Mitchell to contain 'numerous' clinkers (slag) and banks of clinkers that elm trees grew upon.*
3. *The Cherry Tree Inn – Mitchell (1929) recalls how slag was grubbed out from the front of the house in the 19th century.*
4. *Distribution of slag (predominantly smelting) close to a potential smithing hearth found in 1985.*
5. *Slag found in Channels Brook Stream in association to a possible pond bay in 1982.*
6. *Scatter of smelting slag over an area of c.6850m² -2020 survey.*
7. *Scatter of smelting slag over an area of c.8950m² - 2020 survey.*
8. *Scatter of smelting slag over an area of c.9200m² -2020 survey.*
9. *Slag identified in the stream bed of Channels Brook, which appeared to have been eroded from upstream further to the east. – 2020 survey.*
10. *Slag present in the plough soil, possibly from metalling to Cow Lane – 2020 survey.*
11. *Slag present in the footpath and boundary bank of Cherry Tree field – 2020 survey.*
12. *Slag present in the ditches of Brook Lane – 2020 survey.*
13. *Bloomery slag (including tap slag) in the plough soil, possibly re-used as metalling for the Roughey Gate track – 2020 survey.*

Figure 3.85 – *Location of slag scatters in Zones 1 and 2, identified historically and during the 2020-21 landscape reconnaissance survey. Base map courtesy of Digimap OS Collections and edited by the author.*

density, with no obvious nucleus. Apart from this distribution in the northeast corner, very little slag was identified elsewhere along the northern boundary.

Slag scatters - Zone 2

Behind House Field & Long Lag (fig.3.85; point 5)

Both fields formally existed immediately south of Cow Lane, however, all have been combined with the fields to the north to form a single parcel of land. To the south of these fields is Channells Brook and the location of the possible pond bay identified by WIRG in 1982. From 40m into the field from the west, small quantities of slag were identified approximately 15m in from the southern field boundary where the current footpath is situated. The slag was small, typically under 5cm and dominated by 56% tap slag (Type 2 see 4.7). No specific densities were present, and the slag existed irregularly in the plough soil for approximately 300m east but did not appear to extend further north. A sample of siderite ore was found here also, 5m from the hedge.

Table 3.6 – *slag data from Cow Lane, the thickness of 7-15mm of the type 2 and the lack of subsequent laminations from other flow episodes suggest it was removed early on from the smelt. See chapter 4.*

Slag Type (See 4.7)	Count	Weight	Small	Medium	Notes
Type 1	2		1	1	Amorphous shape of Moderate to low density with external rust deposits
Type 2	6		4	2	Plano or multiple rods with a high density and thin thickness of 15-7mm. Suggestive of early flow from the furnace as no sign of laminations.
Type 4	2		1	1	Plano and high density, one with soil impressions on underside and roasted ore inclusions.
Type 5	1		1		Slag adhering to refractory material with traces of vitrification.

Cow Lane (fig.3.85; points 10 and 11)

Small fragments of slag were present both within the path that now forms the track and within the ditch and bank on the western side on the boundary of Cherry Tree Field (fig.3.86). The samples within the track were small (>5cm), however those in the ditch and bank were medium sized (>10cm). This part of the track is parallel to the section of the field where the north-eastern distribution of slag is present. While the fragments in the ditch and bank may have been removed from the plough soil over the centuries and discarded in the ditch, those in the track could have been reutilised as metalling. However, in the north small-sized slag (>5cm) was present as occasional scatters within the plough soil here and further suggests the possibility that it was used for metalling the track, for its distance from Cherry Tree Field and separation by the stream would not support its accidental movement.

Figure 3.86 – *Slag in the boundary bank between Cherry Tree Field and Cow Lane. (Author's image).*

Cow Lane Copse - The Muttons (fig.3.85; Point 9)

Within a small copse adjacent to Channells Brook Stream where Cow Lane crosses the stream, large fragments of slag (c.30cm in size) were observed lying in the stream bed (fig.3.87). These extended approximately 5 metres east up stream and were more sparsely scattered to the west. While there were some fragments within the stream bank it was not certain that this was the primary source for all the slag. It is likely they were being eroded out of the stream bank a short distance east in the copse of trees and had moved west with the direction of the current. It is also plausible that the recent construction of the footbridge led

Figure 3.87 – *Slag within Channells Brook Stream. (Author's image).*

to slag becoming exposed. Their size and density here would imply they had not travelled far from their source and their angular breaks suggested they have not been eroded through long exposure to the currents or movement downstream. As the stream flows from east to west, it is unlikely that they were associated with slag deposits found in Zone 1 Cherry Tree Field, which is downstream of this location. It therefore implies that their source is within or near this eastern copse.

Brook Lane (fig.3.85; point 12)

Slag was identified at the northern end of Brook Lane, a few meters south of the railway line and within the eastern bank and ditch that boarders the lane (fig.3.85). Their size and degree of fracture indicated that they had not been within plough soil or travelled far from their original source. It is possible that like Cow Lane, slag was used for metalling the surface of the track, which at its northern end becomes a substantial sunken lane, indicative of its frequent

Figure 3.88 – *Image of large slag found at Brook Lane. Concave convex in shape with some traces on tendrils and rust deposits. High density, weighing 4800g. (Author's image).*

use in the past. Metaling therefore would have helped mitigate wet boggy conditions as well as erosion. At its southern end, two large slags were recovered in the ditch adjacent to the south-western distribution of slag in Zone 1. The sample that was collected appeared complete and unfractured and was 265mm x 110mm weighing 4800g (fig.3.88).

Hopkins Barn Field (fig.3.85; point 13)

Smelting slag was identified in the north-western corner of what was formally Hopkins Barn Field. This slag scatter extended for approximately 100m along the field's western boundary, with plough-fractured samples small to medium in size, resembling those found in the Zone 1 slag scatters (fig.3.89). As previously discussed, this was the site of the former routeway to Roughey Gate and it is possible slag was, like Cow and Brook Lanes, deposited here as road metalling (fig.3.85). If this was the case it suggests this routeway was active at the time smelting was taking place at Roffey and supports the hypothesis that this was the route used to transport ore from St Leonard's Forest.

Figure 3.89 – *Slag within the plough soil of Hopkins Barn field, possibly used as metalling. (Author's image).*

Slag scatters – Zone 3

No slag was recovered in Zone 3, however as it was not possible to survey the entirety of this area, it cannot be discounted that ironworking did not extend beyond Zones 1 and 2. In 16th century to the south of St Leonard's Forest, two blast furnaces were in operation (see Appendix B2) and it is possible that they utilised sites of earlier iron-production (Langley 2014).

3.8.9 - *Settlement traces (Historic)*

Pottery scatters

Zone 1

Medieval pottery, including Graffham type and Surrey Whitewares, some of which were green glazed, were identified along the southern boundary of Zone 1 and concentrated at three locations, including at the south-western and south-eastern slag densities and in the centre of the southern boundary, in close proximity to the 1985 excavation. There were also 17th century salt-glaze bellarmine jug sherds recovered, concentrated on the eastern side of Cherry Tree Field close to the Cherry Tree Inn. Pottery distributions are discussed in greater detail in Section 4.8.

Zone 2

Several sherds of similar types to Zone 1 were identified in small numbers in the north-western corner of Hopkins Barn Field, directly south of Cherry Tree Field. This potentially suggests that occupation extended on both sides of the Horsham-Crawley Road. However, in the absence of a systematic fieldwalk here, patterns in distribution that might be suggestive of occupation cannot be confirmed and these may simply be traces of medieval manuring practices. No medieval pottery was recovered north at Cow Lane.

3.9 - Discussion

A combined examination of the historical and archaeological sources supports the interpretation that Roffey had an established iron industry by the early 14th

century. Each evidence type revealed both stages of the iron-production process operated at Roffey. While the surviving documentary material indicates smithing and the production of secondary products was taking place (stage two), the archaeological evidence, specifically the slag assemblages are all consistent with an assemblage expected from smelting (stage one), an industry otherwise not historically recorded. The reconnaissance survey was also able to demonstrate the importance of St Leonard's Forest as the likely source of ore and charcoal, and Roffey's former position on the periphery of the forest enabled these resources to be readily exploited and no doubt contributed to Roffey's development. The examination of the routeways showed how connected iron-production in Zone 1 was with its wider landscape and would have facilitated trade and exchange with the forest and the export of iron to the wider Weald.

The small building and hearth found in 1985 at Zone 1 is potential evidence of smithing taking place here. However, whether this was the smithy that made 1000 horseshoes in 1327 or belonging to Matilda Bonwick 17 years later is hard to ascertain, and the suggested site at Upper West Mead as the holding of William and Alice Bonwyk, in 1383, makes this a viable candidate if Matilda's land, which she was granted for 200 years, was passed through successive generations. It must also not be assumed that both references relate to the same smiths, for multiple smithing sites may have existed, particularly when considering the size of the 1327 order. It is unfortunate that no technological assemblage was retained from the original excavation of the building and hearth for more detailed assessment, however Chapter 4 goes some way to addressing this by considering the slag scatters spatially and morphologically to determine the production stages they represent, be it smelting, bloom consolidation or smithing. The slag recorded in Zone 1 and 2 was predominantly smelting slag and would imply that that both smelting and smithing operated alongside one another at the same locality. This would be somewhat unusual for the Weald, for while smithing typically took place within the settlement or urban context, smelting sites tend to be found in the hinterlands.

As to the scale of production, the documentary evidence from 1327 indicates the works here had sufficient capacity to fulfil an order of considerable size, and presumably an adequate supply of blooms or bar iron. The potential proximity of smithing to smelting would no doubt have been greatly beneficial in retaining a ready supply of iron and the four scatters of slag may indicate blooms could be sought from more than a single furnace. It must be remembered that the 1327 account is a single source and does not necessarily represent regular demand. However, if the 1338 order of 6000 arrows sent from Horsham to the Tower of London, were also made at Roffey, it does support the hypothesis that demand was more frequent, and this was a site designed to meet such high demand. Furthermore, the extensive number of minepits in St Leonard's Forest suggests a high demand for iron, although the complications with establishing an absolute chronology for these pits has been discussed.

To describe Roffey as a centre for iron-production does however omit the other related industries that also operated in close proximity. If arrows were indeed made at Roffey, arrow-making was reliant on the cooperation of two craftsmen - a smith to produce the heads and a fletcher to fashion the shafts. For the latter, archaeological evidence provides little to show this industry existed, apart from perhaps the woodland management practices of wooded banks in St Leonard's Forest where wood for the shafts could be grown. We are told that the Roffey horseshoes were placed within wooden barrels for transportation, and it is probable these were made locally, either at Roffey or Horsham, which is supported by the name Coupere (a cooper or descended from a cooper) appearing in a Demise of 1425. This is yet another industry that relied upon working conjointly with the smith to produce the iron hoops and nails to hold barrels together.

The local trade in iron and iron goods must not be ignored either, for we see in the records at Marlpost Manor how valuable items such as horseshoes were at the end of the 13th century, while tools for farmers, turners, all trades whose existence is implied by contemporary surnames, would have required a skilled and adaptable smith to produce the tools of their trades.

Both fieldnames and surnames of the Roffey subsidy rolls suggest other industries existed here during the 14th and 15th century including baking, wool and pottery. The forest is also clearly important to the inhabitants of Roffey, as evidenced by surnames such as Venator, the huntsman and atte Wode, at wood and emphasises the economic dependency the settlement had on the forest and woodland industries. The importance of the forest cannot be underestimated for, like the ore and charcoal needed by the ironworkers, other industries would have required similar supplies of charcoal for fuel, wood for arrows and barrels and clay for pottery and were probably interrelated with the iron-industry which required much the same resources.

Roffey's economic relationship with Horsham was also important and illustrated in the Subsidy rolls that show the population links that existed, with several individuals and families appearing both on the 1296 record for Roffey and in the 1327 roll for Horsham. These ties with Horsham may over time have facilitated the growth of an iron industry at Roffey, through a demand for horseshoes. Fairs and markets such as the horse fair recorded from 1233 would have provided a regular market and wider trading opportunities, enhancing Roffey's reputation as a supplier of horseshoes. Consequently, the Sheriff knew where to source his horseshoes in 1327. A symbiotic relationship between Roffey and Horsham is potentially visible in the wool industry, with surnames including Cardon at Roffey (1296) referring to the carding of wool, while the fieldname Wattle Meadow, indicates a location where woad, used in dying, was grown. At Horsham individuals with names suggestive of their occupations as a Dyer (cloth dyer) and Chaloner (manufacturer or trader in woollen goods) are recorded in 1327 and represent individuals whose trades were in the later stages of the economic process. This bears resemblance to Christaller's Central Place model (1933), whereby Horsham can be seen as the centre for producing finished goods (cloth) and its subsequent trade, while Roffey in the hinterland formed a satellite settlement, producing raw materials (wool) and processed products (the cleaned and disentangled wool) to be sent to the central place (fig.3.90).

A similar economic model may also be conjectured for the iron industry, whereby iron goods were produced and sent to Horsham for trade. A Nicho Fabro at Horsham in 1332 would also indicate trade was not restricted to finished products but also blooms or bar iron brought into Horsham as well, much like the wool. If one adds the associated forest industries into this economic model, one sees a network of interdependent localities across the landscape. In this sense, can Roffey be seen as the centre of production, while Horsham formed the centre for trade? In light of the existence of other industries, an alternative definition for Roffey is as a centre of industry, of which some industries were interrelated (e.g. smelting and smithing) or shared mutual ties (smithing and fletching). Iron therefore must be contextualised in relation to these other manufacturing

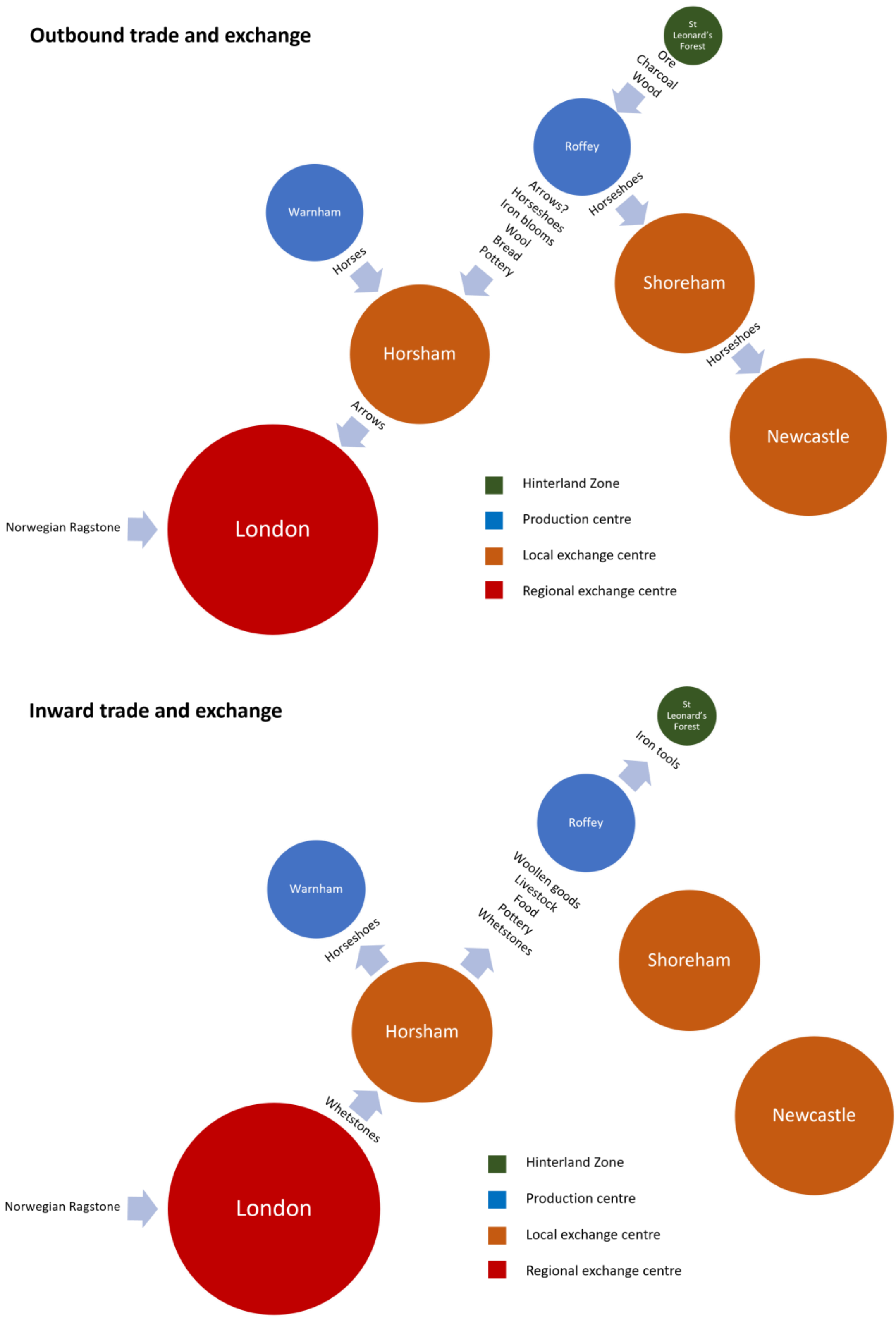


Figure 3.90 – *Economic model for Roffey demonstrated the flow of imported and exported goods. Roffey can be seen as a satellite settlement and producer of primary goods (i.e., raw materials like wool) and secondary products (i.e., horseshoes), which were then sent to the local trade centre, Horsham. Goods in Horsham could be traded in the markets to other satellite settlements, such as Warnham or more regional centres like London, where arrows for example were sent in 1338. Some raw materials brought into Horsham from the satellite settlements such as wool and potentially iron blooms were turned into secondary products before being traded. Regional centres like London, in turn could trade more exotic items with the local centres, such as Norwegian Ragstone whetstones, which subsequently could be purchased from the Horsham markets by inhabitants of the satellite settlements, including Roffey (whetstones found at Roffey are discussed in chapter 4). The satellite settlements were also reliant on their hinterlands, including St Leonard's Forest, for raw materials, while those working in the hinterlands sourced the tools of their trades from the satellite or local centres. (Author's image).*

industries, which potentially operated on a similar scale but have left little or no documentary or archaeological footprint.

Industry was not the only function of Roffey as it was also inhabited as evidenced by the number of references to tenements throughout the 14th and 15th century. Some of these, such as 'Elyottes' can be identified on the Tithe Maps nearly four centuries later, and point to a western placement of dwellings, with industry positioned to the east. Brook House and the hall house discovered in 1985 are evidence of the dwellings here, the hall house perhaps the home of a merchant (Holgate 1989), possibly a middleman in the trade and transfer of goods between Roffey and Horsham. Industry appears to have been restricted to a specific location – or 'zone' within the settlement east of the settlement evidence. Slag distributions were concentrated in Zone 1 and the immediate parts of Zone 2, but not identified beyond this. While much of the landscape has changed, early boundaries do in places survive 500-800 years on as evidenced by the hedgerow survey and allow aspects of the lost settlement morphology to be reconstructed. This will be explored further in Chapter 4.

A consideration of both the historical and archaeological evidence has demonstrated the value each brings when reconstructing the industries, settlement and economy at Roffey. While smithing forms the industry recorded in the documentary accounts, smelting has left visible archaeological traces through the abundance of slag. Other industries such as wool and baking are only discernible from the documentary and fieldname evidence. Acquisition of raw materials has left considerable scars upon the landscape in the form of minepits but remains unrecorded until this area was exploited in the 17th century to supply St Leonard's forge and furnace. It should not be assumed that the minepits relate only to this later period because of the later records, for their variation in morphology suggests temporal variation and the establishment of a routeway from Zone 1 to the pits via Roughey Gate further supports their earlier date.

3.10 - Conclusion

To conclude, the desktop assessment, placename study and landscape reconnaissance survey demonstrates how iron-production at Roffey formed part of a broader network of interconnecting industries. Its position on the boundary of the forest allowed the ironworkers to exploit the resources the forest could supply, while at the same time, be a short distance from Horsham where iron and secondary goods could be traded. Scale of production was sufficient to supply the Kings army in 1327. However, whether this level of production was consistent throughout the 14th century will be investigated further in Chapter 4. Iron was not the only industry taking place here, and it is perhaps more correct to see it as an industrial centre in a broader form than just specialising in iron. Chapter 4 considers the evidence of Zone 1 using geophysical and fieldwalking evidence to assess the scale of this industry, the nature of sites, the production processes taking place and the arrangement of the landscape.

Chapter Four – Roffey: Iron production in context

Having considered the wider landscape of Roffey in Chapter 3, Chapter 4 investigates the primary locality of iron-production at Zone 1 in order to understand the morphology of the sites here and their scale. It begins by discussing the results of a magnetometry survey followed by two fieldwalking surveys. The distribution of sites is compared with the two datasets. Finally, the artefactual remains are analysed, which include a technological and pottery assemblage along with other artefacts that provide an insight into past industries within the study zone.

Chapter contents

Chapter Four – Roffey: Iron production in context

4.1 - Introduction

Chapter 3 demonstrated how a broader perspective needs to be taken to consider iron-production sites within a wider landscape for the supply of raw materials and the networks of trade that allowed goods to be exchanged at both a local and long-distance level to be fully understood. The historical, cartographic and landscape reconnaissance evidence indicated Zones 1 and 2 were the focus of iron-production, from the densities of slag occurrences that were identified here, the placenames, and how interconnected Roffey was by associated routeways to Horsham and into St Leonard's Forest. The documentary and landscape evidence raised questions such as how the slag scatters identified in these zones relate to one another, and did they represent one large integrated complex, or separate sites? Alternately the evidence may represent iron-production sites that moved within the landscape at different periods. Furthermore, what was the nature of iron-production – did smelting and smithing operate alongside one another and if so, how were these craftsmen interlinked. Chapter 3 also raised the possibility that other industries existed at Roffey and if so, were these connected to iron-production and if so, how? Finally, how did iron-production fit in to the settlement morphology at Roffey. If Roffey is to be seen as a lost medieval village, was it also centre for industry.

This chapter focusses on the core sites identified in Zone 1 which were investigated at both a site level and in their collective spatial distribution. This involved two landscape-based approaches; geophysical surveying and systematic fieldwalking, as well as artefact characterisation, to help with determining the chronology of individual sites and the industrial processes taking place. The combination of this evidence, alongside the historical, placename and landscape reconnaissance data outlined in chapter 3, allowed the historic landscape to be reconstructed through overlaying early maps and hedgerow diversity data with the geophysical and fieldwalking survey results.

4.2 - Location

The surveys took place in the 17-acre field covering Zone 1. The geophysical survey examined an area of 8.4ha, while the fieldwalking surveys covered the entirety of the field, except for the small meadow to the north which was uncultivated. As part of the fieldwalk, two smaller areas were intensively investigated with the use of grids focussing on an area of 120m² in the east at TQ 2109 3363 and 100mx40m in the west at TQ 2067 3343 (fig.3.1).

The landowner was contacted and kindly granted permission for surveying to take place. Cherry Tree Field is typically under annual cultivation, however as land-drainage works were due to take place it had been left fallow during the 2020 fieldwork season. Covid 19 lockdown restrictions limited access to the site between March 2020 and March 2021. These restrictions also prohibited the use of volunteers; therefore all surveys were completed by the author. While this allowed for consistency of practice, it meant fieldwork took longer to conduct.

4.3 - Aims

The aim of the magnetometry survey was to:

- Identify the size and scale of ironworking activity in Zone 1 and determine how activity was distributed across the landscape.
- To identify contemporary features of the medieval landscape including extinct boundaries and other industries.

Two fieldwalking surveys were carried out, applying grid and transect approaches.

The transect fieldwalk aimed to:

- Collect and plot the distribution of surface artefacts across Zone 1 to assess their spatial patterning and chronological relationship.
- To compare artefact types, their date and distribution with the anomalies identified by the magnetometry survey.

The grid fieldwalk aimed to:

- Collect a detailed and comprehensive assemblage of technological waste and pottery samples from two specific areas of high magnetic readings identified through magnetometry, consistent with hearths and furnaces.
- To conduct morphological characterisation of the technological samples to assess the ironworking processes taking place at individual sites.
- To characterise the pottery assemblage from each site to assess their chronological relationships and the potential of a pottery industry having existed.

4.4 - Methodological approach

4.4.1 - *Geophysical survey*

Geophysical surveying was undertaken between March and July 2020, between lockdown restrictions. Initially ArcGIS was used to create a base map for the field, overlaid by a NW-SE orientated grid, subdivided into 20m x 20m apportionments.

Figure 4.1 – *Leica GPS positioner. A pre-planned grid meant that a highly accurate grid of 20m x 20m squares could be plotted across the field and marked with red tent pegs. (Author's image).*

Magnetometry had the advantage of rapid data collection and 20m x 20m grids allowed larger areas to be surveyed. The GPS grid coordinates were imported into a Leica GPS and used in the field to position the corner points of 267 individual grid squares (fig.4.1). The GPS allowed for a high degree of accuracy, with a margin of error of under 2cm, and the accurate import of the results into ArcGIS. The creation of a pre-planned grid also allowed for it to be also used for the

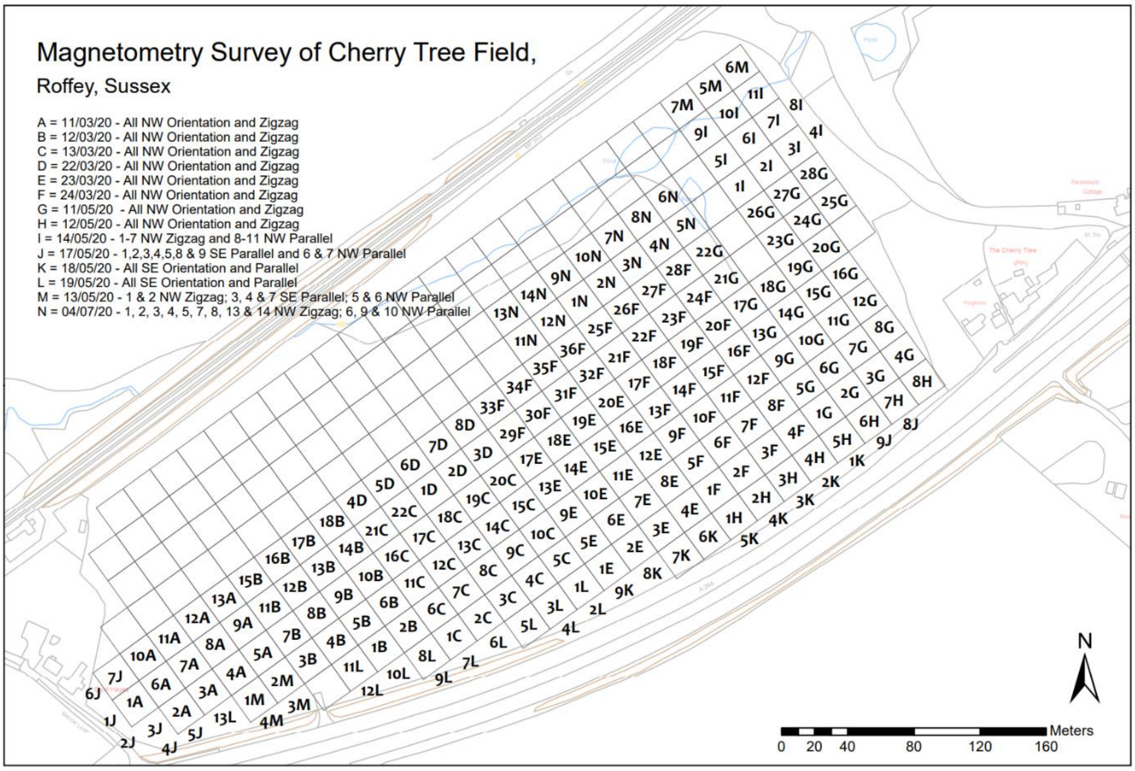


Figure 4.2 – *Magnetometry survey grid. Each day was assigned a letter and individual grids a number. A careful record was made of their positioning along with their orientation. Most grids were surveyed using zig-zag traverses on a north-west orientation, however boundary grids tended to be parallel traverses to adapt to the incomplete grids. The full results can be viewed in Section 4.5. Base map courtesy of Digimap OS Collection.*

fieldwalking survey which enabled geophysical and fieldwalking data to be integrated and the geospatial placement of features and artefacts overlain. A total of 216 grid squares were surveyed, either with full or partial coverage (fig.4.2).

A Bartington Gradiometer 601 twin probe was used for the survey. The obvious presence of ironworking activity required a higher threshold setting of 1000 Nanotesla (nT), as opposed to the customary 100nT used on typical archaeological sites (fig.4.3). There were pros and cons in setting this threshold; while it provided greater clarity for highly magnetic features such as furnaces, more ephemeral features with lower magnetic readings, such as post-holes and pits, were less easily detected. While Roffey was a site of iron-production, other industries and domestic habitation may have been present, with these activities potentially leaving more discrete geophysical footprints. This was ultimately why fieldwalking became an important auxiliary approach to detect other traces of activity within the landscape and complement the geophysical survey.

Figure 4.3 – *Magnetometry grid. The 20m grid positions were marked with red tent pegs and tapes laid out at either end. A bamboo cane was placed at the end of each traverse to act as a guide. (Author's image).*

Each grid square was surveyed using a zig-zag traverse pattern, with ten 20m traverses per grid, spaced 1m apart. The gradiometer recorded eight readings per meter with 1600 readings within a compete grid. Initially, complete grid squares were surveyed, covering the southern side and north-east corner of the field, where the higher concentrations of slag and pottery were present. The north-western corner, which had low concentrations of slag, was not surveyed due to time constraints. In addition to this, a trial survey of 20m x 60m was conducted on the north bank of Channells Brook Stream. Here the small meadow was uncultivated, so it was unclear from surface deposits whether activity extended this far north. It became apparent that some of the grids needed extending to the edges of the field to view features in their entirety and partial grids were surveyed using parallel traverses with the addition of dummy readings at the ends of the traverses where it was not possible to survey any further. A total of 72 complete and 40 partial grids were surveyed across the site. Each day the data was downloaded into Geoplot to allow the results to be assessed and inform the decision-making process on where next to extend the survey.

4.4.2 - *Systematic Fieldwalking*

Two fieldwalking strategies were applied in Zone 1 and covered grid and transect surveys. Both followed the same grid arrangement applied in the magnetometry survey. The grid fieldwalk, which systematically collected artefacts from a series of 47 20m x 20m grids, was used to investigate two significant anomalies shown on the magnetometry survey (fig.4.8), and collect pottery and a representative slag and geological assemblage for dating and morphological characterisation. The transect fieldwalk involved traversing 28 parallel rows, spaced 20 meters apart and aligned on the same NW-SE grid axis as the grid fieldwalk (fig.4.18). Artefacts were collected along 20m intervals (stints). This method aimed to examine the broader landscape, identifying not only traces of iron-production, but also ore preparation, ore mining and habitation, as well as other potential industries.

Grid Survey

The grid fieldwalk was completed in Summer 2020 and surveyed two sites of high magnetic anomalies consistent with iron-production in the southeast and southwest corners of Cherry Tree Field (figs.4.4-4.8). The south-eastern survey covered an area of 120 x 120m, while the southwestern survey covered 120 x 40m (fig.4.7). Like the magnetometer survey, each grid was walked in traverses, initially north to south, followed by east to west, to ensure an even coverage. Traversing 10 stints in each direction allowed a meter coverage either side of the fieldwalker to be surveyed (fig.4.4) and frequently as much material was recovered on the east-west traverses as the initial north-south. Some fieldwalks impose time limits on how long each grid square is surveyed, and while an experiment of 30 minutes was initially trialled, time limits were seen as inappropriate, for some grids had denser quantities of artefacts (particularly slag) than others, which took longer to collect (fig.4.6). The emphasis of the grid survey was to collect good quality and representative samples, rather than being time efficient and missing important material (fig.4.7).

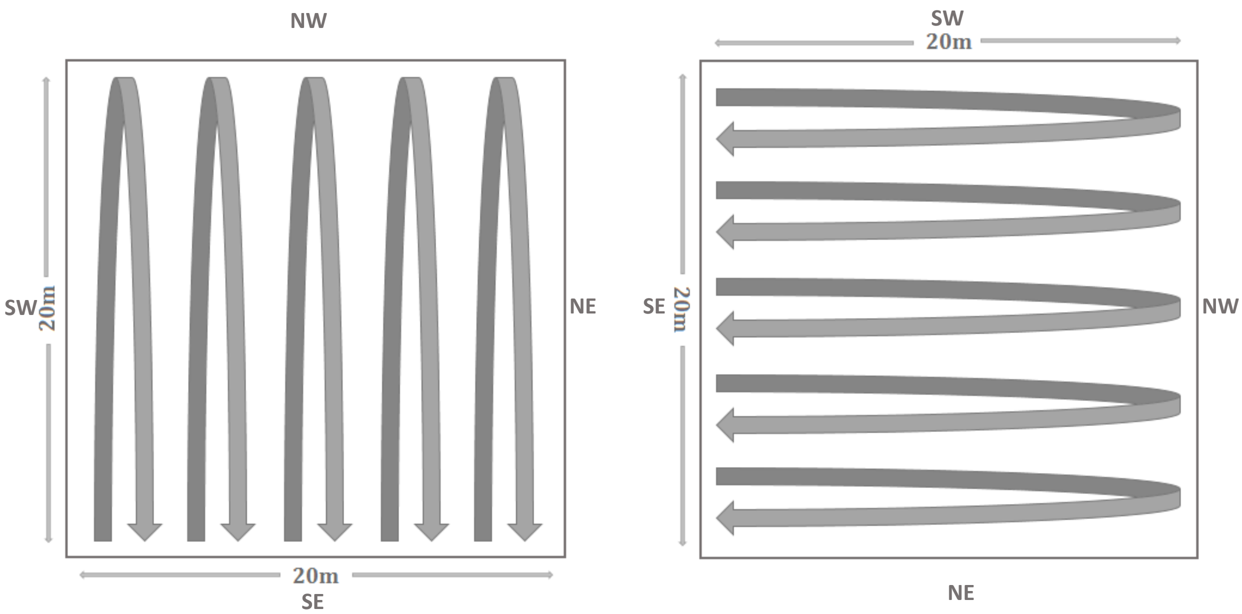


Figure 4.4 - *Arrangement of the grid traverses. Walking in 10 stints allows half a meter either side of the fieldwalker to be surveyed. Initially the grid will be walked north to south, followed by east to west, to ensure maximum coverage. (Author's image).*

Figure 4.5 - *(left) Site of the western grid fieldwalk, which covered an area 120m x 40m. Slag was dense within the plough soil, particularly in the grid squares adjacent to the western boundary. (Author's image).*

Figure 4.6 - *(right) – Some grids had high densities of slag, much of which had been fractured by the plough. The image shows slag densities (highlighted in yellow) within a meter square. The high densities necessitated a sub-sample to be collected for analysis, having weighed, and measured the complete assemblage in the field. (Author's image).*

A total collection of all slag would have been too vast to remove, wash and quantify. Other surveys have faced similar issues, particularly when assessing the usefulness in collecting undiagnostic pottery (see Gerrard et al 2007). One strategy used in pottery collection is to count the sherds present and discard all but the most diagnostic specimens. While counting the slag was possible, there was the risk some areas of the field had been more extensively ploughed in the past than others, causing a greater degree of fracture and spread of slag in these areas. Two solutions were used to mitigate this. Firstly, after slag had been collected from a given grid square, it was sorted on site into size categories of small (>5cm^2), medium (5-10cm^2), large (10-15cm^2) and extra-large (<15cm) and a count made of each group. Secondly, each size group was weighed before returning it to the grid (figs. 4.9-4.16). It was however necessary to retain a sub-sample, that was taken from the field for subsequent morphological characterisation and assess the technological processes taking place at each location. Selecting a representative sub-sample was at times problematic. Ideally a standardised sample size would be retained from each grid. Initially a 10% sample was trialled, however, it quickly became clear that in some grids, this would retain too small a sample to be representative. Therefore, sample size was decided on a case-by-case basis, with a record made of what percentage the sub-sample represented.

Figure 4.7 – *The conundrum of sub-sampling. Some grids, such as Grid 108 had a small volume of material of which a 20% sample would produce an unrepresentative sub-sample of 3 medium samples and therefore a 100% sample would be more applicable, however a 100% sub-sample of Grid 6, would produce a sample too large to process within the timeframe of the project. Therefore, adaptable subsamples had to be retained in the field. (Author's image).*

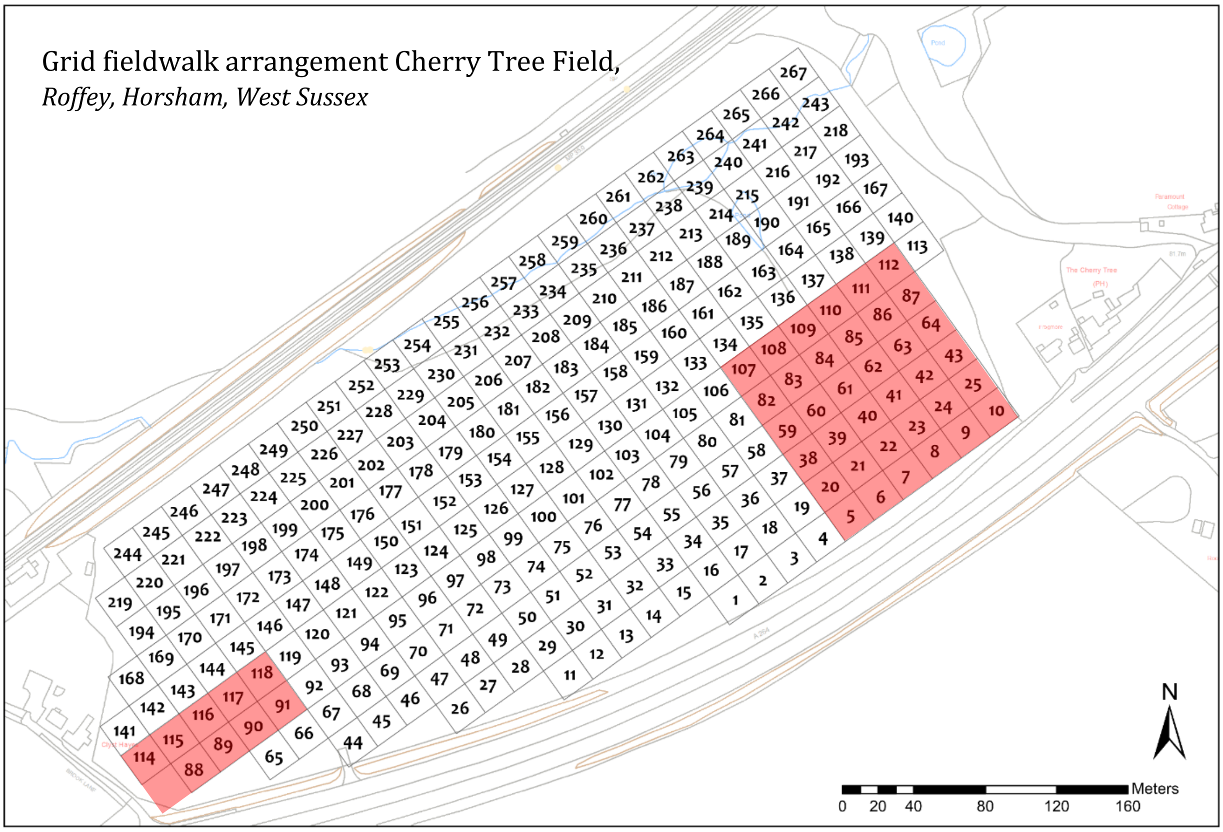


Figure 4.8 - *Grid layout of 267 20 x 20m grids across the Roffey site. Those highlighted in red were surveyed in the grid fieldwalk, based on the presence of high magnetic anomalies and slag and pottery densities. Base map courtesy of Edina OS Collection.*

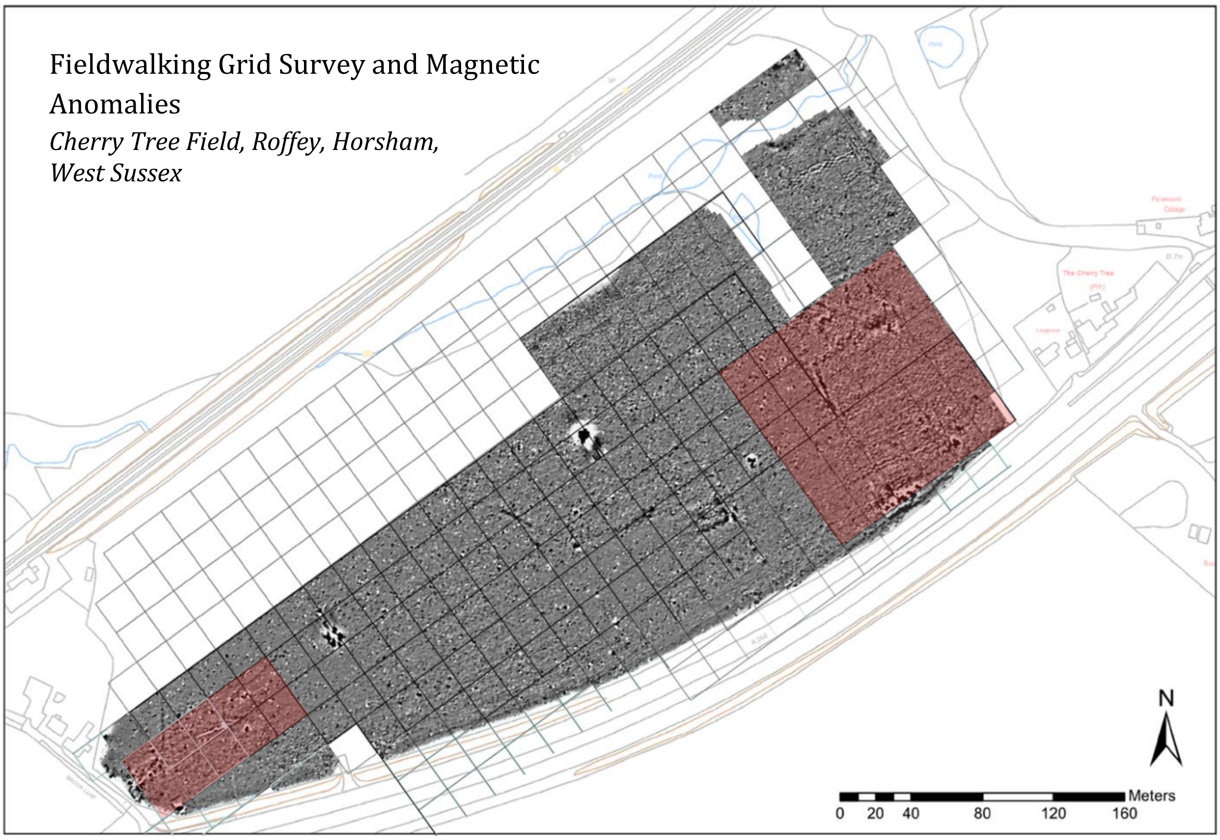


Figure 4.9 - *The two areas (red) surveyed by the grid fieldwalk based on magnetometer survey anomalies and pottery and slag scatters identified in the walkover survey. Base map courtesy of Edina OS Collection. See fig.4.45 for full magnetometry results.*

Figure 4.10 & 4.11 – *Grid set up in the southeast corner of Cherry Tree Field. 4 grids were laid out at a time using 100m tapes to demarcate the boundaries of each square. Red pegs, positioned using the Leica GPS, denoted the position of the grid within the field. (Author's images).*

Figure 4.12 (left) – *One of the many fragments of tap slag collected during fieldwalking. The majority were small and heavily fractured from their time in the plough soil. (Author's image).*

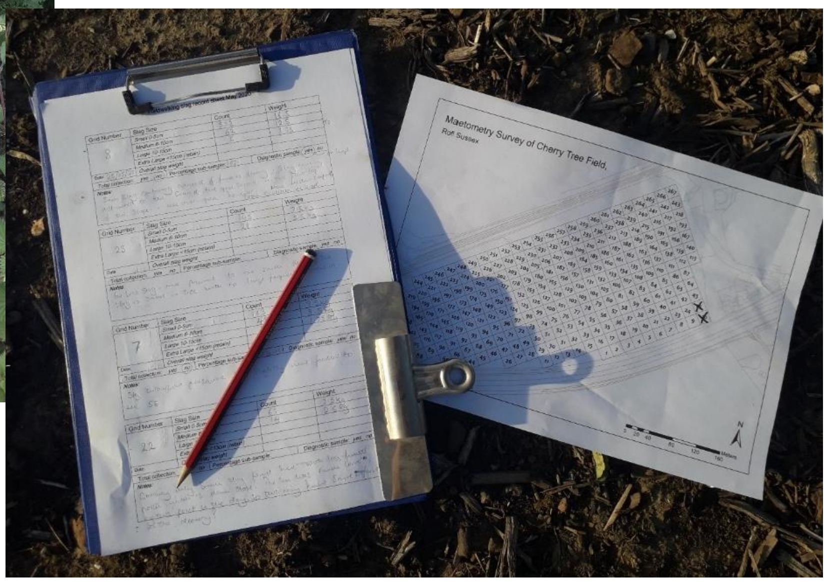
Figure 4.13 (right) – *Slag was initially collected in each grid within a bucket, before being emptied and sorted by size. Some grids produced more than one buckets worth of slag. (Author's image).*

Figure 4.14 (left) – *Using a standardised size chart, slag was sorted into size categories and each category was counted, weighed and photographed. (Author's image).*

Figure 4.15 (right) – *Photos were taken of the complete grid assemblage, sorted by size, before a sub-sample (typically 20%) was retained. The encrusted soil on the exterior of the slag meant that it was difficult to morphologically characterise the slag at this stage and therefore necessitated a sub-sample to be taken. (Author's image).*

Figure 4.17 (above) – *The slag from each grid, having been sorted into size groups was counted and weighed before a sub-sample was saved. (Author's image).*

Figure 4.16 (below) – *A recording form was used to record count, weight and observations of slag and geological material. Other artefacts were a total collection so were recorded separately. A map was used to mark the grid squares that had been surveyed. (Author's image).*



Transect Survey

The transect survey aimed to look the wider landscape of Zone 1, in which the locations surveyed by the grid fieldwalk were situated. It also enabled the more ephemeral results shown on the magnetometry data to be investigated as well as identifying other features or areas of activity that left no geophysical trace (see 4.6). The survey followed linear rows or transects laid out across the field at 20m intervals, following the same alignment as the geophysical survey (figs 4.17-4.18). Each of the 28 transects was assigned a letter and subdivided into 20m intervals or 'stints' along the x axis of the grid, each numbered by transect number and stint e.g. 'A1'. Gerrard et al (2007) suggest that by following a transect, a fieldwalker covers a 1m area either side, thus allowing, on transects spaced 20m apart, a 20% coverage of the field to be achieved. Each individual stint within the transect had a separate finds bag, and were labelled by transect and stint, starting from the south and working north. Each transect was also walked twice, south to north and north to south to account for differing light conditions. This was found to be an effective strategy as often a considerable amount of material was collected on the return stint.

Unlike the grid fieldwalk, the transect survey followed a total collection strategy (fig. 4.20). All slag, fire-cracked flint, worked flint and pottery was collected, along with any other significant finds (fig. 4.21). There was also a particular focus on the geological material present, primarily sandstone, Horsham stone and iron ore. The presence of ore had the potential to suggest areas where it may have been extracted, or processed, while the sandstone, found in seams alongside ore, might indicate waste products of mining. Some geological material showed signs of being burnt, indicating possible ore roasting, traces of which often only became apparent once the material had been washed. In practice, it was not always possible to collect every fragment of slag or rock particularly in the east of the field, where at times the slag was so dense that much of the material was either buried, or in too smaller fragments to retrieve. In these instances, as much as possible of the surface slag was collected, to ensure this dense distribution was recorded, and while slag was missed, it had a minimal impact on the overall results.

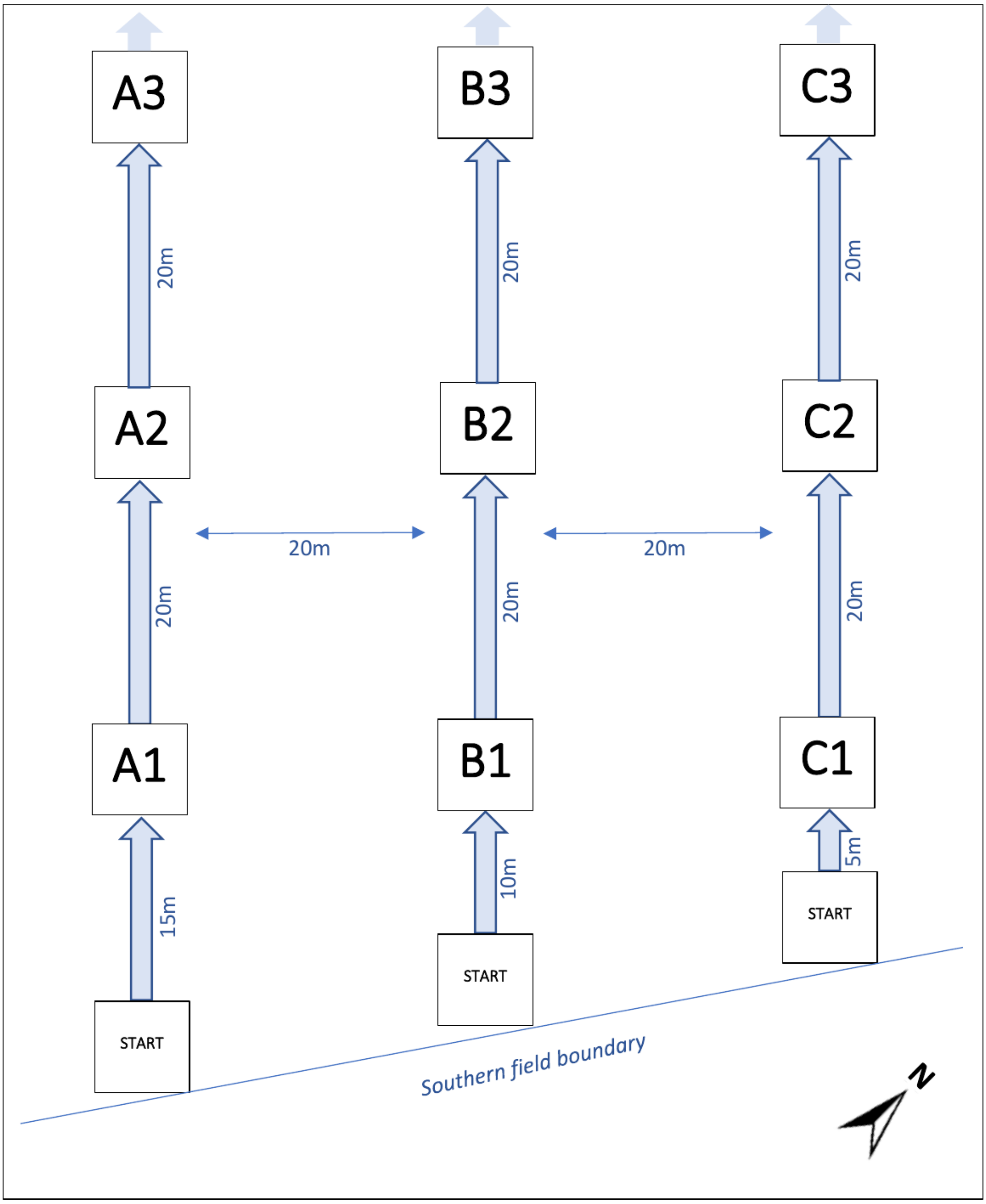


Figure 4.18 – *The transect set up, with transects spaced 20m apart. The first stint would begin on the southern boundary of the field. Since the fieldwalk made use of the existing grid layout, which did not begin directly on the boundary, the first and last stints were generally at lengths under 20m. All others were 20m in length. (Author's image).*

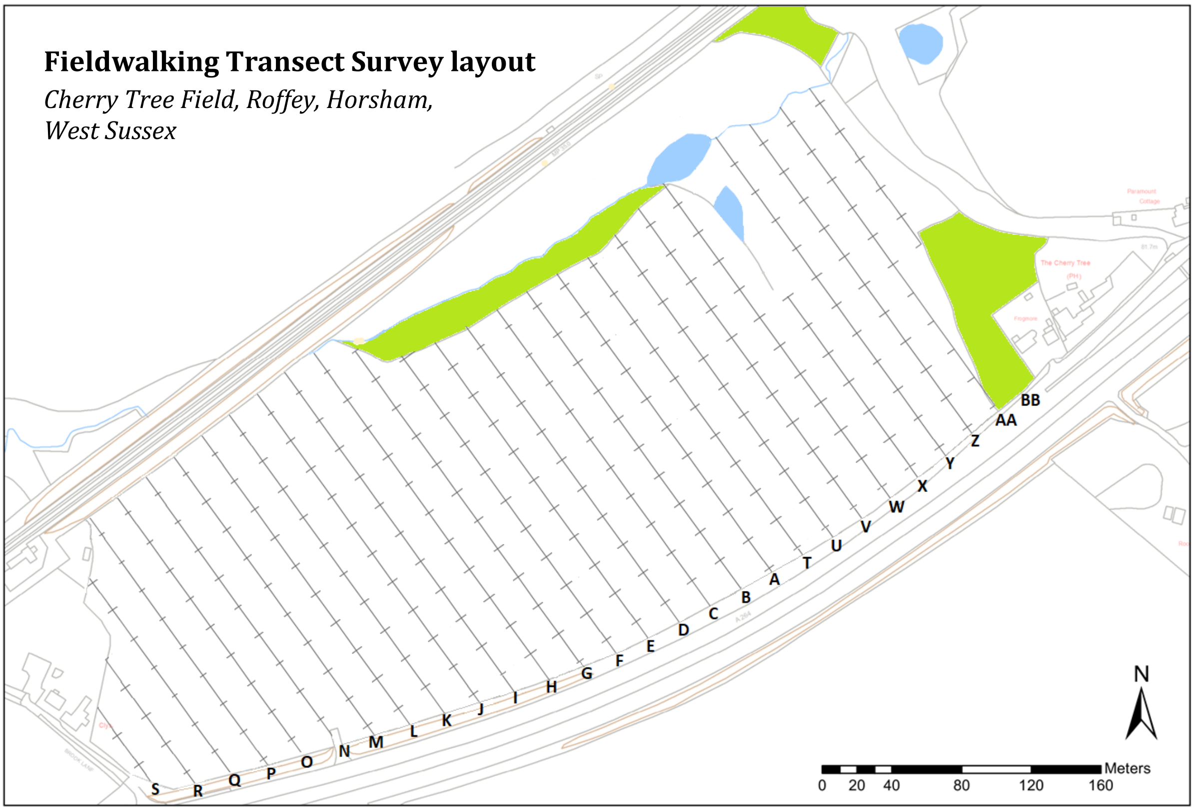


Figure 4.19 – *Arrangement of transects across Cherry Tree Field. 28 transects were surveyed, each subdivided into 20m intervals 'stints' The line breaks represent the 20m breaks. Base map courtesy of Digimap OS Collection.*

Figure 4.20 – *Transect running across the field with finds bags placed at the end of each 20m stint. Ordinary freezer bags were used because it was easier to tie the bags closed and they had greater strength in holding the slag than archaeological sample bags. The vast quantities of slag meant that some stints required multiple bags. (Author's image).*

Figures 4.21 – *Nine thousand years of occupation in Zone 1. Artefacts pre-dating and postdating the medieval period were also collected during the fieldwalk. These demonstrated the longevity of occupation at Roffey and illustrate the broader history of the landscape in the time preceding and following iron-production. These included worked flint dating 7000 years before iron was made on the site, and forms important additional evidence of Mesolithic occupation, first identified in the Horsham area by individuals such as Honywood, Attree and Piffard and Beckensall. This included small bladelets, arrowheads and the flint core (above). Later evidence of the 19th century school was also found, including marbles and an ink bottle (above), while plastic toys demonstrate the impact of the 21st century. (Author's images).*

Sample collection

In the grid fieldwalk, a 10%-20% representative sub-sample of each size category of technological waste and geological material was collected from each grid square. However, for the transect fieldwalk, a total collection approach was adopted as the transects produced a reduced quantity of material for they covered a smaller surface area than the grids. A total collection was made of all pottery in both fieldwalks, as unlike the slag, it offered the best evidence for dating geophysical anomalies and slag deposits (fig.4.21).

Figure 4.22 – *Pottery collection at the southeast corner of Cherry Tree Field. A total collection was made of the pottery as it formed the main dating evidence for occupation at Roffey. (Author's image).*

Artefacts from other periods including worked flint and pottery were also collected to enhance the understanding of changes to the landscape over time (figs.4.20-4.23). Plotting the spatial distribution of these artefacts alongside the magnetometer results, helped to determine the later or earlier date of the otherwise undated anomalies. Roffey is an important Mesolithic landscape and flint scatters in the plough soil are typically all that remain of occupation from this period. The fieldwalking produced 76 knapped flints which included

Figure 4.23 – *Mesolithic tranchet adze found on the west side of Cherry Tree Field. (Author's image).*

bladelets, arrowheads, cores and a tranchet adze, and provided an opportunity to plot the distribution of lithic artefacts over a broad area. The distribution of worked flint is presented in Appendix B4 and will be discussed in a future paper.

Contemporary metal debris was important to record from the perspective of the geophysical survey. A study by Gerrard, Caldwell and Kennedy (2015) considered how the spreading of green waste, which had been marketed as a fertiliser, had affected the geophysical results on a survey of the hinterlands of

Figure 4.24 - *17th century Bartmann or Bellarmine jug fragments recovered during the fieldwalk (top right and bottom left). The fragment bottom left is the remains of a beard from bearded man that typically features on these jugs, while the neck of the jug is shown top right. They were usually used for beer. Their high distribution on the east side of the field, closest to the Cherry Tree pub may account for their presence here and were likely to have been deposited in the field through manuring. (Author's images).*

Top left - 17th pipe bowl and medieval pottery, demonstrating the potential variety of artefacts that were recovered during the fieldwalking survey.

Bottom right - fragment of a rotary quern stone recovered during the fieldwalk. Finds like this formed important evidence of other industries taking place within the landscape, in this instance agriculture.

Lufton Roman Villa. They concluded that interference from metal that caused speckled magnetometry anomalies meant subtle geophysical anomalies were not visible in the results (Gerrard et al 2015, 140). Modern metal artefacts were identified in the Roffey fieldwalk, some of which originated from litter from the adjacent A264 or broken farm implements, and these no doubt have impacted on the geophysical survey and may account for some of the isolated magnetic spikes. It also gave an insight into the impacts our society is leaving behind in the archaeological record and highlights the need not only to consider the ways rubbish is polluting the oceans, but also the countryside (figure 4.24).

Figure 4.25 – *Fieldwalking produced evidence that helped to determine post-medieval features identified in the magnetometry survey. In the above example, a square anomaly (top left) was present in the centre of the site. Fieldwalking produced no slag in this area, however there were fragments of concrete suggesting the feature was modern. Later map comparison revealed how an early electricity pylon had stood there and that the concrete was remnants of its base (bottom right). (Author's image).*

4.4.3 - *Artefact processing and technological analysis*

Washing and bagging

Initially all slag, geological material and pottery samples had to be separated, washed and re-bagged, ready for analysis, which was carried out off-site. Washing was particularly important for slag samples to allow morphological characteristics to be recognised as encrusted soil meant that colour, inclusions, impressions, porosity, and density were not visible. Often it was only through washing that slag could be distinguished from remnants of furnace lining or amorphous geological material. All slag was scrubbed, rinsed and left for up to a week to fully dry, before being transferred into strong rubble bags and stored prior to characterisation (figs 4.25-4.33).

Classification of technological material

A technological classification scheme was used to categorise the 47 grid square bags of slag, refractory material and geological samples and transect fieldwalk samples (see Appendix B5). This proforma was based on one used by Juleff (2016) on Roman and Medieval iron-production sites on Exmoor. Some adaptations were made to the classification to accommodate regional and site-specific differences, particularly geological. Slag was separated into 'types' based on distinct morphological differences and while some slags occasionally overlapped between types, they broadly fitted within ten groups. Similarly, geological material was assigned to one of 5 groups. A typological reference collection was created of each individual type to compare samples to (fig.4.34). A description of each slag type can be found in Table 4.1 and the technological classification scheme in Appendix B5.1.

Figure 4.26 *(left) - Unwashed slag. While washing all the slag took considerable time, the morphological characterisation of the slag was reliant on identifying characteristics such as colour, porosity, impressions, and inclusions, that could not otherwise be determined from the mud covering the slag. (Author's image).*

Figure 4.27 *(right) - Washing station. The slag, refractory and geological samples were scrubbed in a bucket of water before being given a final rinse in clean water. They were then placed on drying trays before being re-bagged into clean bags to await morphological analysis. (Author's image).*

Figure 4.28 *(left) - Technological samples drying and arranged in order along the transect. Those in the foreground were recovered from the southern side of Cherry Tree Field, while those at the back were from the north. One can see how the quantity of slag reduces further north and this was characteristic of the majority of the transects. Geological samples were however often greater in number in the stints to the north. (Author's image).*

Figure 4.29 *(right) - Samples drying in trays. Pottery, flint and other small finds were separated from the technological samples at the washing stage, as these could not be washed with the use of a scrubbing brush but had to be gently cleaned in a separate process to avoid damage. Metal finds were left unwashed. (Author's image).*

Figure 4.30 - *Recently washed slag compared to washed and dried slag. It was apparent during the washing process that wet slag was often easier to determine the morphological characteristics, such as colour and inclusions. While it was impractical to analyse the slag while wet, an adapted methodology could consider this in future projects. During the original collection of the slag, on wet days the slag stood out more clearly against the soil than on bright sunny and dry days. (Author's image).*

Figure 4.31 and 4.32 – *After the samples had been left to dry, they were re-bagged either in rubble bags for the large grid samples or finds bags for the smaller transect samples. (Author's image).*

Figure 4.33 - (above) Sacks of technological samples recovered from the grid fieldwalk. Due to the weight of material rubble bags were used for storage.

Figure 4.34 - (left) Transect fieldwork rows were bagged in individual finds bags and collectively stored in a designated sack for each transect. (Author's images).

Figure 4.35 – *A typological assemblage was created for slag and geological samples based on their morphology. They were labelled for easy reference. If a new type was identified that did not correspond to any existing sample in the collection, it was classified as an additional type and the sample added to the typological collection. A total of 10 types of slag were identified and 5 geological types. (Author's image).*

Having been sorted into types, a written and photographic record of size, overall weight, shape, colour, texture, inclusions, density, surface and underside impressions, porosity, magnetism, and fracture was created (figs 4.35-4.43). Wherever possible this data was recorded quantitatively, to allow comparisons to be made between data sets, however, a written observation record was also produced describing the overall characteristics of the assemblage, distinguishing features, and patterns.

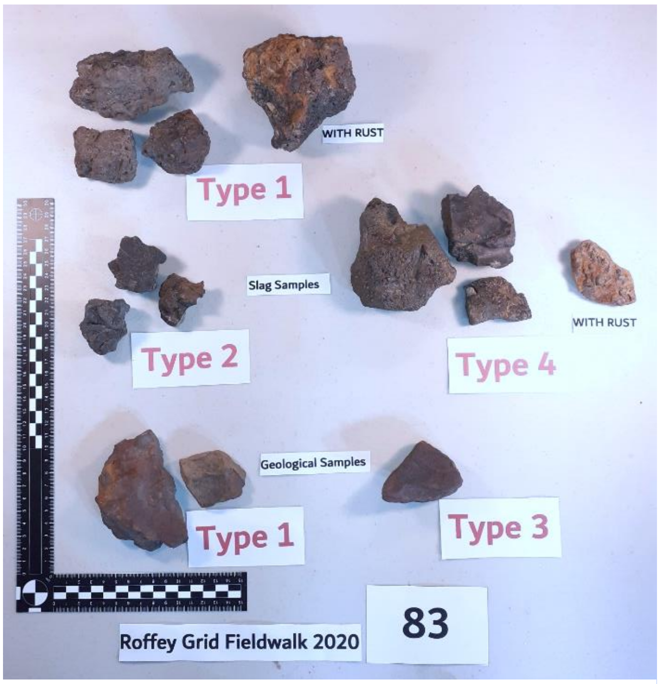


Figure 4.36 – *Example of a photograph made of the sub-samples retained from a grid sample. These were also photographed in case finds were mislaid from their associated finds bags. (Author's image).*

Pottery was sorted by ware type, which predominantly included orange/buff wares and Surrey White Wares, along with post-medieval salt glaze. Count, size, weight, sherd type and colour were all recorded, including vessel type if this could be identified.

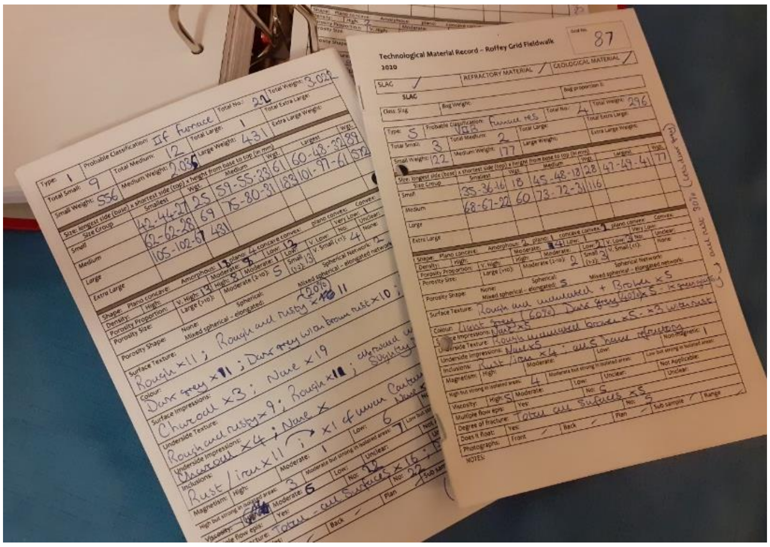


Figure 4.37 – *Technological sample recording forms. (Author's image).*

Figure 4.38 *(left) - A tray of stint samples from the transect fieldwalk before sorting. Each transect would have around 11 individual bags from each stint. Each bag would be sorted into geology, fire cracked flint, brick and tile, refractory material and slag. Slag would in turn be further sorted into slag types. Pottery, worked flint and small finds were removed at the washing stage and processed separately. (Author's image).*

Figure 4.39 *(right) - After sorting into their respective types, an overall photograph was taken to record the collective group. (Author's image).*

Figure 4.40 *(left) - Photographs of each individual slag and geology type were also made to record a higher degree of morphological detail that would not be visible in the larger photograph. A photographic record of each assemblage of slag and geological material was also created for future interpretation and cross examination of slag types. (Author's image).*

Figure 2.41 *(right) – All samples were sorted into size categories of Small >5cm, Medium 5-10cm, Large 15cm and Extra-large <15cm. Geological samples were sorted in the same way. (Author's image).*

Figure 3.42 *(left) – all samples were weighed initially as a total of the overall grid / transect stint, then by their individual size groups and finally examples of the small, medium, and largest within each. (Author's image).*

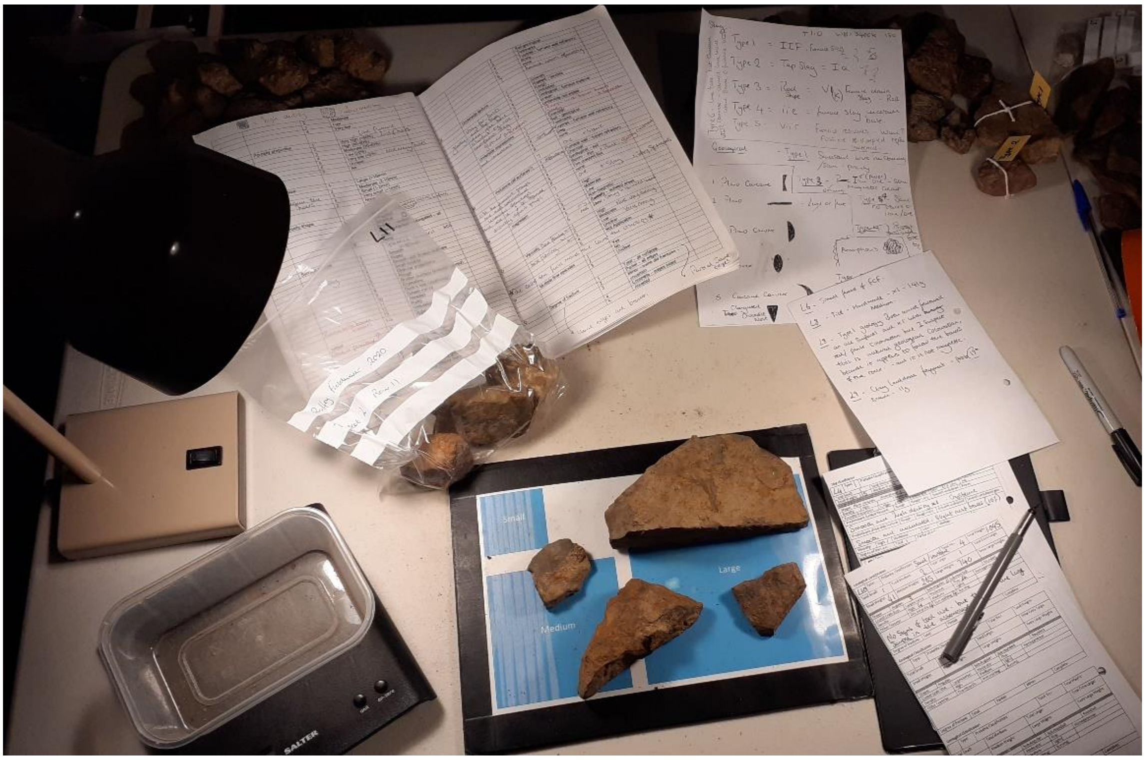


Figure 4.43 – *Grid survey technological recording form. A similar form was used for technological waste recovered during the transect fieldwalk, however with a reduced number of analytical categories. (Author's image).*

Figure 4.44 - *After analysis, material was placed back within the sack or finds bag and the sack marked with a yellow tag to show that it had been analysed. Each sack was clearly marked with the site, date and grid or transect number. The sacks then went into storage so that should subsequent analysis be necessary, the material could be easily retrieved. For the grid samples a representative sub-sample of material was retained to be used to determine the significance of each slag and geological type as well as being available for further analysis such as XRF. (Author's image).*

4.5 - Geophysical Survey - Interpretation of Primary Dataset

4.5.1 - *Introduction*

The raw unprocessed data for the magnetometry survey is presented as a shade plot in Appendix B3. The results were processed using Geoplot by Zeroing the mean traverse, interpolating the data and clipping it to a range of -20 to 20 (fig.4.45-4.46). The application of different shade plot colour palates afforded certain features, particularly discrete anomalies, greater visual clarity and are presented in Appendix B3. Figure 4.47 shows an interpretation of the anomalies, which have been assigned colour classifications to denote anomaly type which included dipolar discrete, dipolar scatter, positive linear, negative linear and positive discrete anomalies each of which are discussed below. Of these, the dipolar anomalies are most likely the sites of furnaces, hearths, slag heaps and kilns, while positive linear anomalies which were typically ditches, provided evidence for former land-divisions.

4.5.2 - *Dipolar discrete anomalies*

Dipolar anomalies are characterised by high positive and negative magnetic readings and are typically associated with intense burning from hearths, kilns or furnaces; or ferrous material such as slag deposits. Furnaces and kilns will leave similar magnetic readings, while ploughing can distort the size and shape of features, such as slag heaps, and both these limitations were evident at Roffey. Despite this, dipolar anomalies consistent with exposure to heat or retaining high magnetism can be divided into furnaces and hearths, slag deposits and a possible kiln site (Fig.4.47; green).

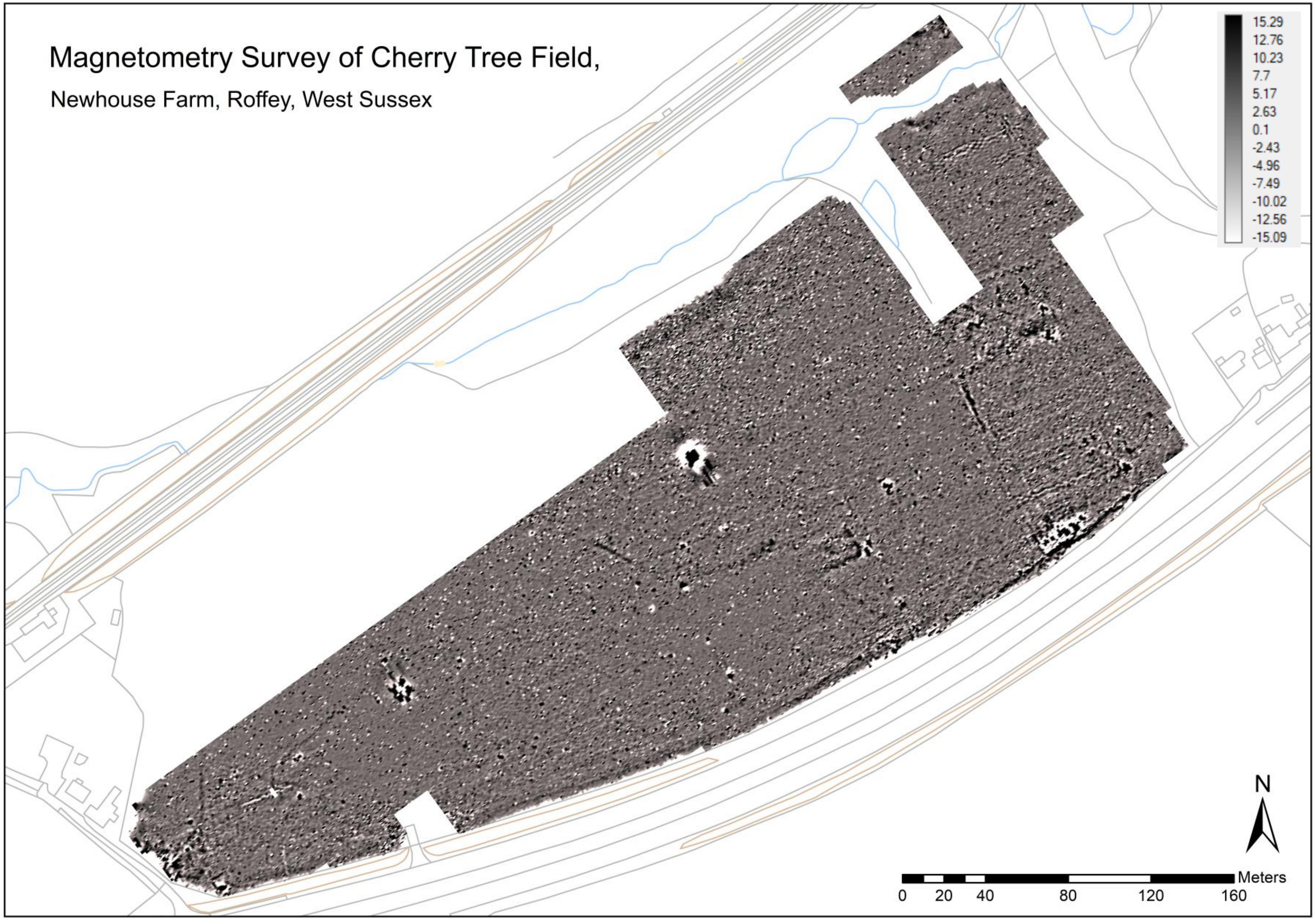


Figure 4.45 – *Magnetometry survey of Cherry Tree Field (Zone 1) completed in 2020. The data has been clipped to a range of -20 to 20. Author's image overlaid on a map courtesy of Digimap OS Collection.*

Figure 4.46 - *Overlay of the magnetometry results onto an aerial image of Zone 1. Parch marks in the north can be seen to conform to magnetic anomalies. Aerial base map courtesy of Digimap OS Collection, magnetometry results (Author's image).*

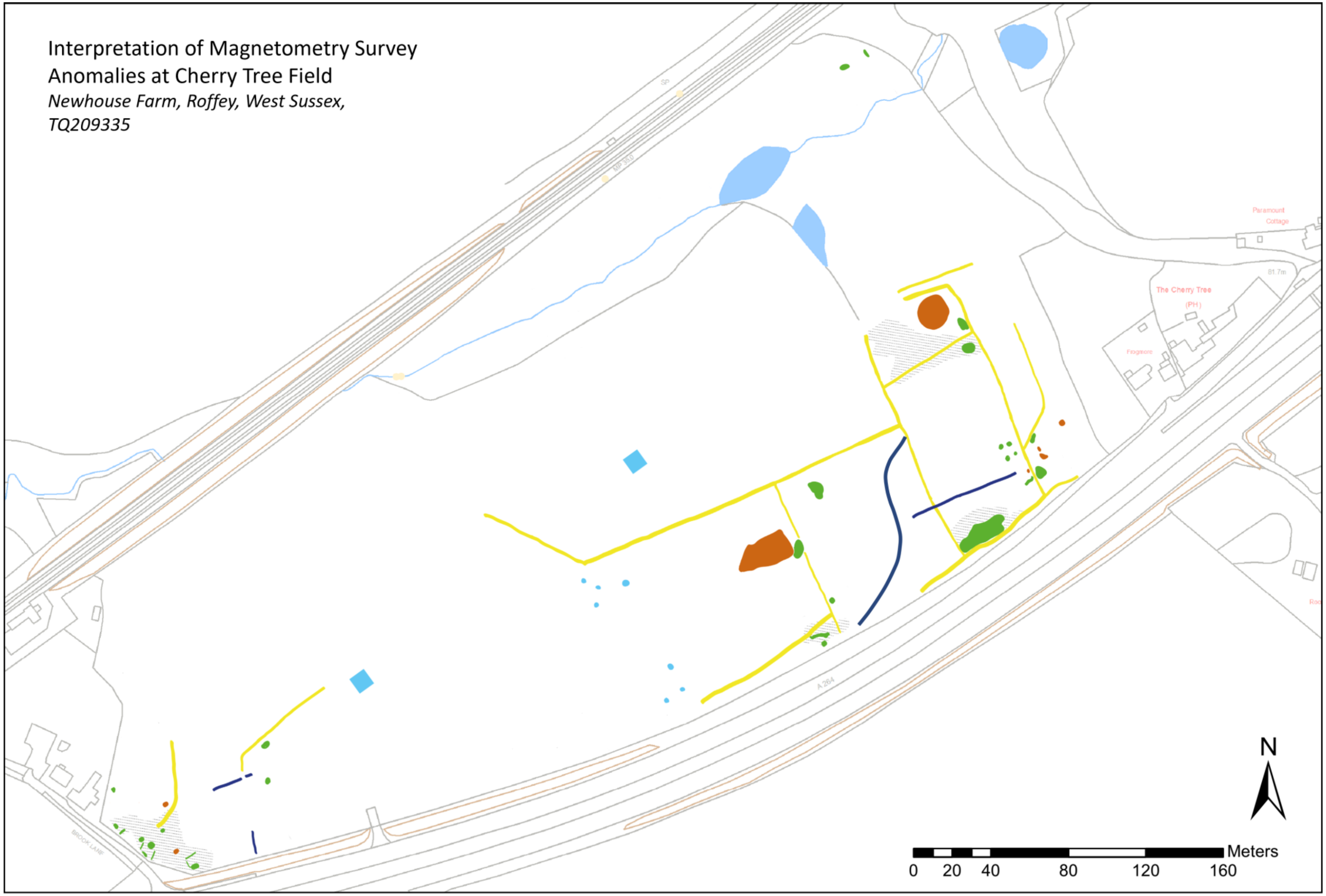


Figure 4.47 – *Interpretation of the Roffey magnetometry survey based on anomaly type. Green = discrete dipolar anomalies, yellow = positive linear anomalies, dark blue = negative linear anomalies, orange = positive discrete anomalies, grey = dipolar spread, light blue = modern features. Base map courtesy of Digimap OS Collection, overlay is the author's image.*

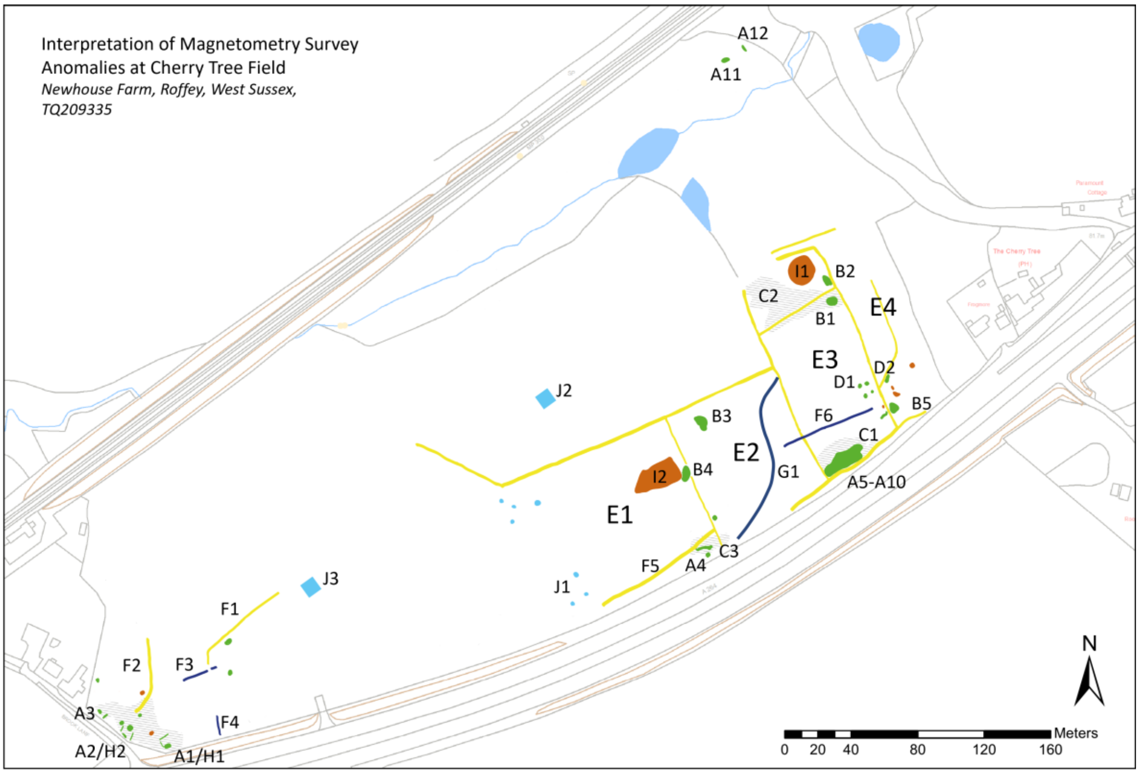


Figure 4.48 – *Interpretation of magnetometer data with feature numbers referred to in the text. Base map courtesy of Edina Digimap*

Furnaces and hearths

Ten anomalies across Zone 1 were interpreted as either smelting furnaces or hearths, and included three in the south-western corner, one on the southern boundary and six on the south-eastern boundary (fig.4.48; green A1-A10). Those in the south-west (Fig.4.49; A1-A3) are separated by 20m and appear to have been enclosed, or partially enclosed within structures, based on adjacent positive linear anomalies of possible beam slots or stone footings. The dipolar anomalies at A1 and A3 display high magnetic readings of up to 660nT and 614nT which is characteristic of the intense heat left by furnaces and are similar to readings of Roman furnaces identified by Greenwood (2019, 142) at Chitcombe. Anomaly A2, although of a lower magnetism (54nT), was approximately the same size as A1 and A3 and also enclosed by linear anomalies, suggesting it too was a furnace or hearth. These anomalies are located alongside high densities of smelting slag in the plough soil (see Section 4.6), supporting their interpretation as furnaces.

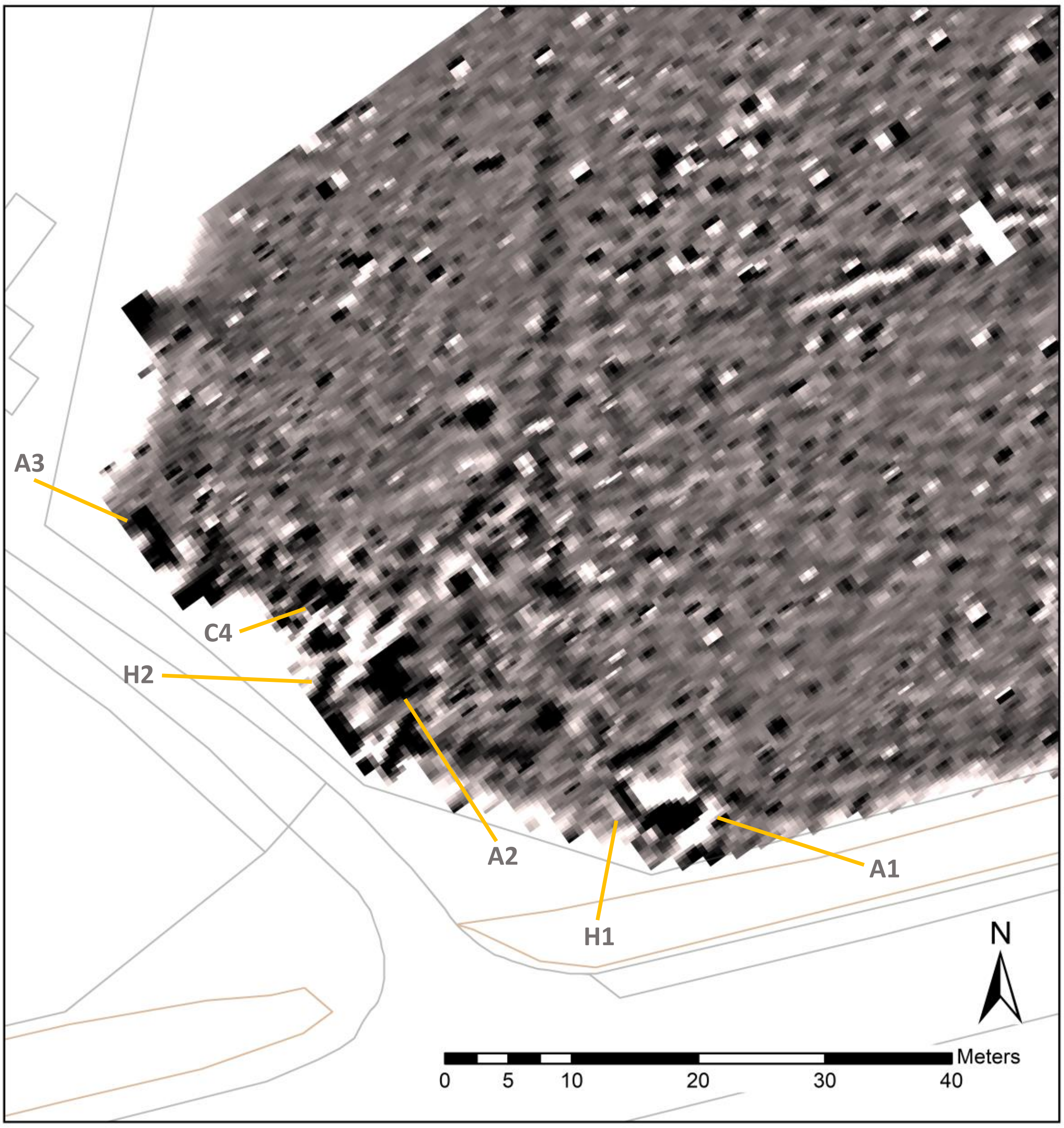


Figure 4.49 – *Dipolar anomalies of possible furnaces or hearths at the south-western corner of Zone 1. Anomalies A1 and A2 appeared to be enclosed by structures (H1 and H2) based on adjacent linear anomalies. Anomaly A3 may also have been enclosed. It is possible that these were partially open sided structures similar to the building identified by Money (1971) at the 14th Century ironworks at Minepit Wood.*

On the south-eastern boundary of the field, parallel to the road, an area of highly magnetic anomalies covers an area of 30x15m. Within this, 6 distinct dipolar anomalies are present with readings ranging from 108-637nT. Of these A5 and A7 have readings up to 577nT and 637nT which are consistent with furnaces and is supported by a high density of smelting slag in the above ploughsoil. Anomalies A6 (108nT), A8 (218nT), A9 (267nT) and A10 (209nT) had lower readings but

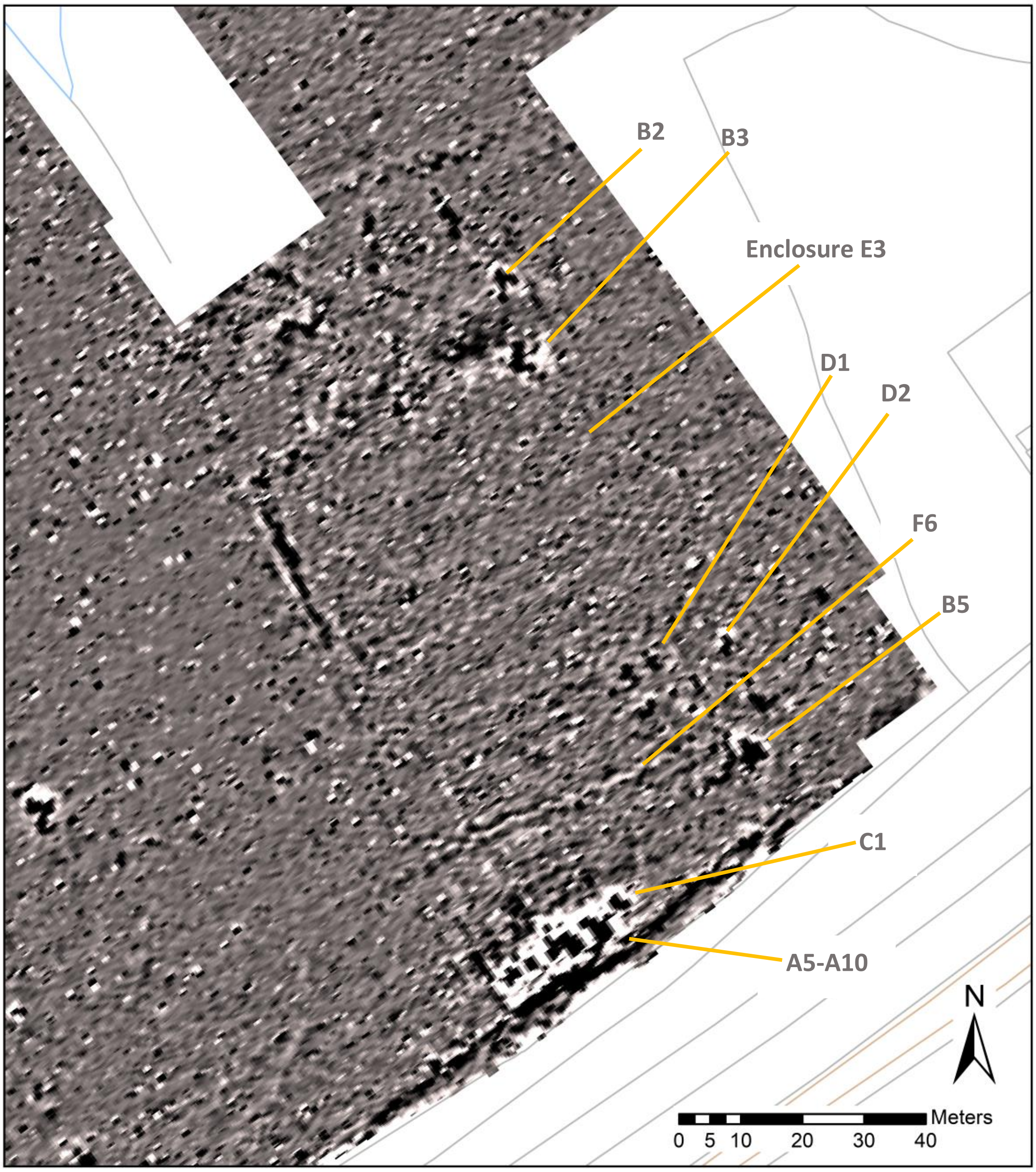


Figure 4.50 – *Magnetometry data for the south-east of Zone 1 showing an enclosure (E3) and furnace anomalies to the south-western corner (A5-A10). To the north-east a potential slag deposit is present (B5) and above this a possible pottery kiln and waster pits (D1-D2). The enclosure may have been further sub-divided to the south by a E-W linear boundary F6. Base map courtesy of Digimap OS Collection and magnetometry results by the author.*

may also represent furnaces, perhaps demonstrating a succession of furnaces rebuilt on the same site over successive periods (fig.4.50). Alternatively, furnaces here may have been truncated by ploughing and material spread masking their true morphology, while some of these anomalies may also be slag deposits adjacent to the furnaces.

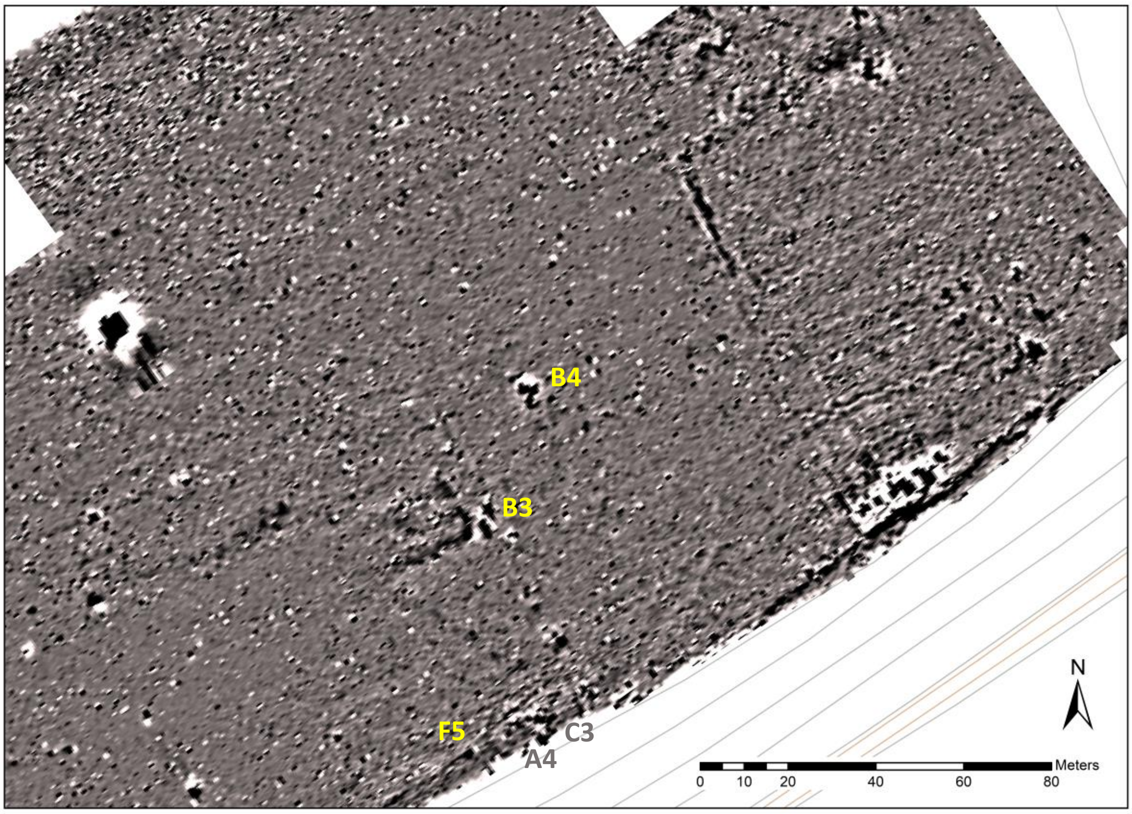


Figure 4.51 – *Southern dipolar anomalies (A4) enclosed by boundary F5. Possible slag deposits exist at B3 and B4 to the north. Base map courtesy of Digimap OS Collection.*

Other possible furnace of hearth sites included an anomaly measuring up to 126nT on the southern boundary, 330m from anomalies A1-A3 (fig.4.51; A4). A linear anomaly approximately 8m long and up to 139nT is immediately north of this and could be an associated slag deposit. Both are enclosed by a NE-SW aligned ditch to the north (fig.4.51; F5). The readings of these features are lower than the other potential furnaces, however this area corresponds to a further density of surface smelting slag, suggesting they relate to smelting, and a further continuation of activity here may lay closer to the road to the south and out of the survey grid. Two further anomalies to the far north within the meadow on the northern bank of Channels Brook may also relate to iron-production, however their low readings of 70nT and 62nT make their exact nature uncertain (fig.4.51; A11-A12).

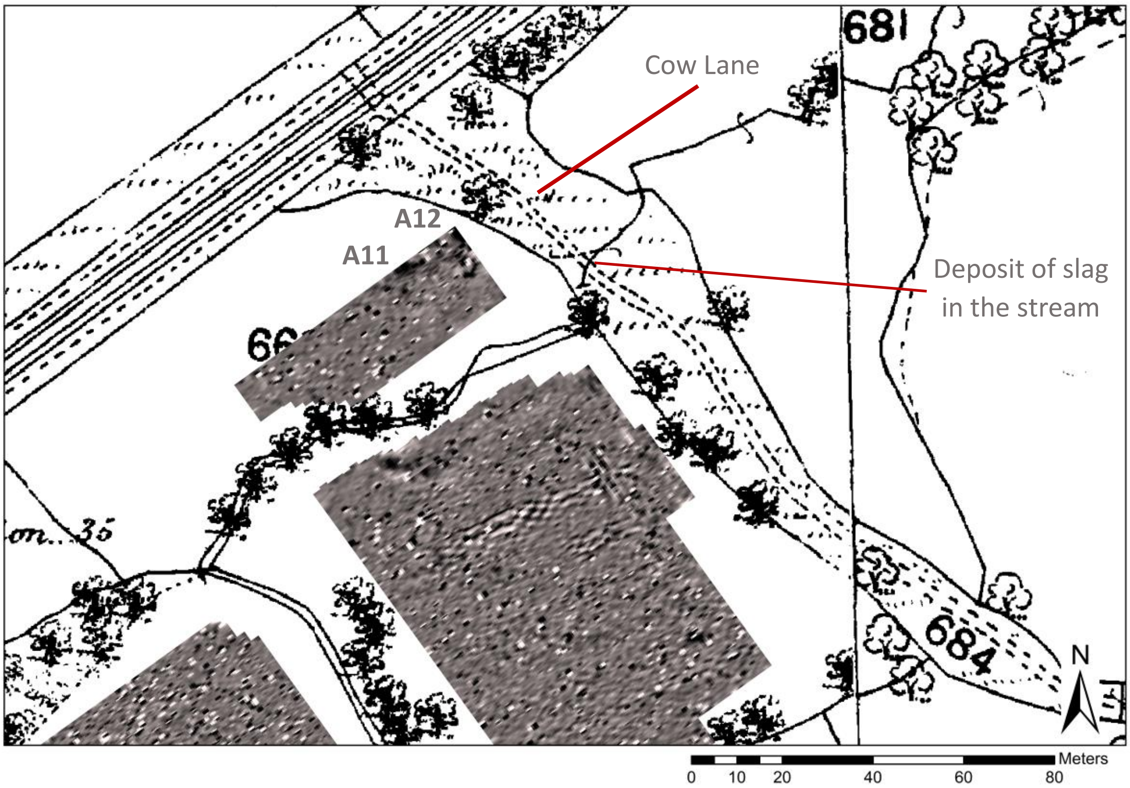


Figure 4.52 – Possible furnace or slag deposit anomalies of A11 and A12 located at the north of Zone one on the northern bank of Channels Brook stream. The reconnaissance survey identified a deposit of slag in the stream approximately 20m east, suggesting iron-production took place in the vicinity. OS 1870 base map courtesy of Digimap OS Collection.

Slag deposits (primary deposits)

Mitchell (1929) described how 'banks full of [clinkers] (slag)' once stood in the fields to the west of Zone 1 indicating that slag heaps were present in the landscape until the late 19th century (see Chapter 3) (fig.4.53). He also recorded how a buried deposit of 'nearly 50 loads' 'was grubbed out' at The Cherry Tree which stands 80m east of the site. It can therefore be assumed that some of the dipolar anomalies represent similar buried slag deposits, particularly given the overlying densities of surface smelting slag identified alongside each of these anomalies during fieldwalking. Five anomalies (figs.4.50-4.51; B1-B5) are suggested to be primary deposits of slag, and all have relatively narrow range (lower) maximum magnetic readings of between 48-57nT (B2, B4, B5), while B1 and B3 increase to 105nT and 77nT. They also display consistency in their size and shape, forming irregular ovals of widths and lengths varying from

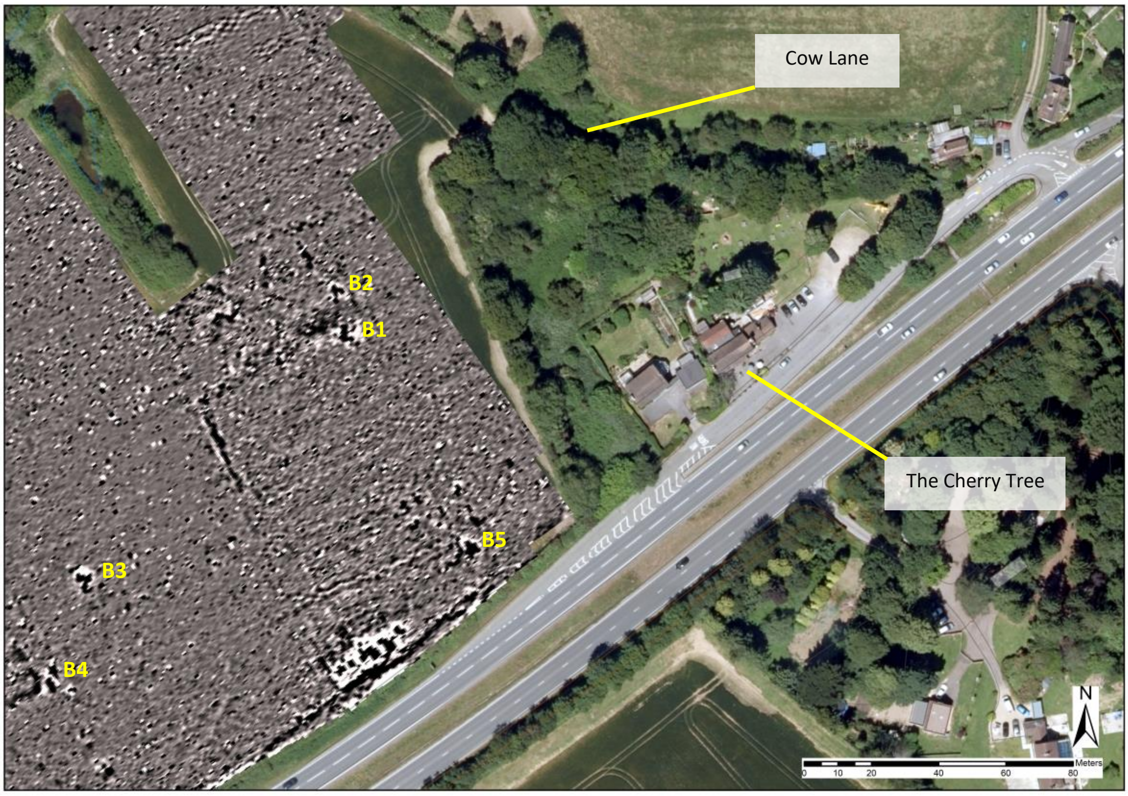


Figure 4.53 – *Aerial image of Zone 1 showing the position of the potential slag deposits to The Cherry Tree (Public House), 80m to the east, where Mitchell (1929) recorded how 'nearly 50 loads' of slag 'was grubbed out' and sold to the parish for road building, during the mid-19th century. Its proximity to Zone 1 demonstrates a further eastern continuation of iron-production, possibly a neighbouring ironworks that stood close to the Cherry Tree. Aerial image courtesy of Digimap OS Collection, magnetometry results collected by the author.*

approximately 5-10m. All but B3 are close to former boundaries that are visible as positive linear anomalies. The association between deposits of slag and boundaries is supported by Mitchell's recollection of when several large elm trees blew down the workmen had 'a rather difficult job to grub out the roots and lower the banks because of the cinders', - the 'several' elm trees suggesting he is referring to a tree lined boundary. If anomalies B1-B7 are in-situ primary deposits, and not secondary deposition from later clearing and dumping of slag on the margins of fields, it suggests the adjacent boundaries are contemporaneous with iron-production. Anomaly B5 is 25m east of the potential furnaces of A5-A10 and would support an association, while B4-B5 are 40m and 60m north of anomaly A4. Anomalies B1 and B2 appear more isolated but are adjacent to mixed dipolar scatters and a former pond, which may be masking the presence of any furnaces that existed nearby.

4.5.3 - *Dipolar scatter (secondary deposits)*

Dipolar scatters, caused by the secondary deposition of highly magnetic material, in this instance slag, was most apparent in four locations (figs.4.49-4.51; C1-4). All were adjacent to the suggested smelting sites of A1-A10 or the slag heaps of B1-B2 and reflect technological deposits, primarily slag, that have been truncated and spread through ploughing. These deposits typically extended under 10m from the primary anomaly, however at C2 adjacent to the slag heaps of B1-B2, and area of approximately 40x60m with a spread of material to the west of the slag heaps. In 1848, this area had been covered by a wooded shaw and pond, the shaw possibly developing on less-productive land not cultivated due to the slag (see Chapter 3).

Pottery kiln

Pottery kilns produce similarly high readings to furnaces due to the intensity of heat they produce and distinguishing between the two thermoremanent features in magnetometry data alone can be challenging. However, the subsequent fieldwalking survey suggested a group of 5 anomalies (fig.4.50; D1-D2) related to pottery production. These features lie 20m NE of furnace anomalies A5-A10 and include a group of 4 positive discrete anomalies which appear to be pits, approximately 1-5m in diameter with readings up to 72nT. East of this by 12m is a dipolar anomaly 3m in diameter and measuring up to 142nT representing a probable site of a pottery kiln. The high density of Ware 1 pottery along with wasters and possible kiln furniture, coupled with a reduced density of slag (compared to the furnace and slag deposit anomalies), suggest these anomalies relate to pottery production rather than ironworking. Pottery densities adjacent to D1 anomalies indicate they were rubbish pits for wasters, the upper levels now truncated by ploughing. These pits were positioned alongside a kiln at D2. Pottery production is discussed further in Section 4.9.

4.5.4 - *Positive linear anomalies*

Ditches and enclosures

A series of positive linear anomalies of probable ditch cuts were identified across Zone 1 and pertain to former boundaries that once subdivided the now large field. Ditches with fills of highly magnetic material, such as slag are some of the clearest anomalies and were particularly concentrated to the east where five complete or partial rectilinear enclosures are visible (fig.4.54;E1-E5). Of these, E3 is the most complete at 90x60m and aligned NW-SE. The southern and western ditches are well defined, and probably reflects a fill of re-deposited slag from the adjacent furnace site (A5-A10) in which it encloses, with readings up to 162nT. The remains of the western boundary of this enclosure also survive as an earthwork depression (see fig.3.) and remained an intact boundary until the 20th century. The eastern boundary of E3 is more discrete, measuring approximately 2m in width with lower magnetic readings of up to 24.6nT. However, the fieldwalking evidence suggests this eastern boundary fell out of use at an earlier date and may have therefore experienced a longer period of plough damage.

Figure 4.55 shows an overlay of an 1870 OS map on the magnetometry results and demonstrates how many of the positive linear anomalies were field boundaries still in existence into the 19th century. These include enclosures E1 and E2 although magnetometry showed the northern boundary of E2 (a field called One Acre in 1848) had moved 30m south from its former position in line with the northern boundary of E1 (named Pasture). E1's northern boundary

Figure 4.54 – *Overlay of the magnetometry interpretation on the original data to show the positions of enclosures E1-E5 (yellow). Base map courtesy of Digimap OS Collection.*

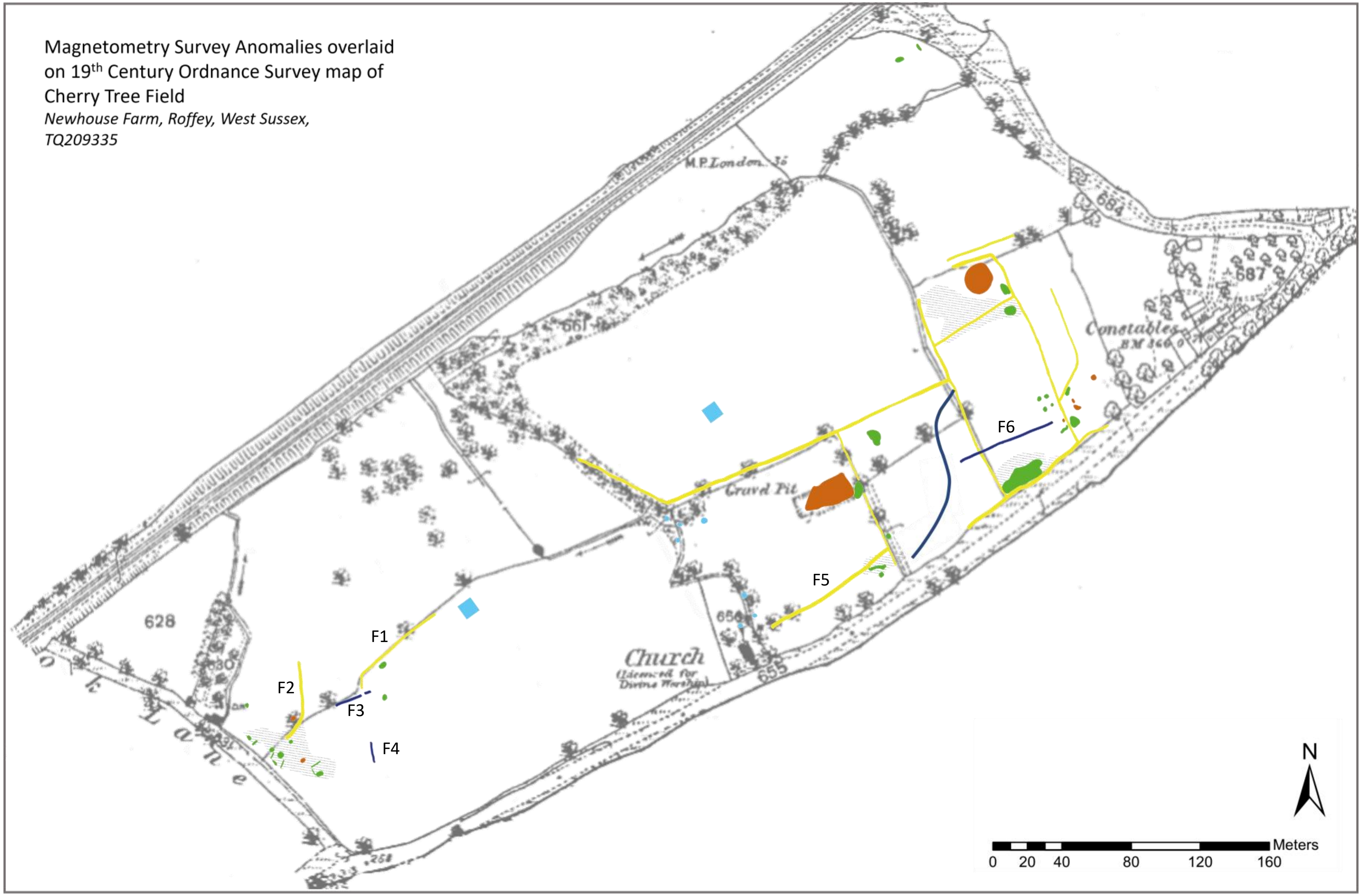


Figure 4.55 – *The magnetometry interpretation overlaid on the 1870 Ordnance Survey map of Roffey. It can be seen how many of the positive linear anomalies correspond with boundaries that were in existence in the 19th century, but probably of much earlier date. Boundary anomalies are labelled F1-F6. OS base map courtesy of Digimap OS Collection.*

originally continued west to form the boundary between Roffey Mead and Hopkins Lag and survived in part as a linear anomaly for 55m with readings between 5.5-12nT with occasional spikes up to 77nT (fig.4.55;F1-F2). A further continuation runs 45m further west (F2), which following its former trajectory on the OS map, would have separated the smelting sites of A2 and A3. It is argued in Section 4.10 that Roffey Mead was once 3 parcels of land, and this is supported by F4, a negative linear anomaly with readings of -12 to 3nT and potentially a ditch infilled with rubble. It survives to a length of 17m, however a projected trajectory of its northern orientation places it in line with a sharp bend in the northern boundary F1, visible in both the magnetometry data and OS map. This would appear to be an early subdivision Roffey Mead, predating the 1840s. The further N-S divisions radiating from this northern boundary in E1-E2 combined with the enclosures of E3 and E4 are suggestive of small plots of land or tenements running north from the road.

Two smaller enclosures appear to have been subdivided in the south of E1 and E3 where in the case of E1 a boundary 20m north from the roadside boundary enclosed an area 92x20m (fig.4.56). Traces of the northern boundary (F5) of this small enclosure are depicted on the 1870s OS map as a row of three trees, however the remainder of this boundary had disappeared by this date. Similarly, a negative linear anomaly (F6) 30m north of the southern boundary within enclosure E3 might indicate a smaller sub-enclosure of 50x30m. Both sub-enclosures contained smelting anomalies and are adjacent to the road, and plausibly represent roadside tenement plots.

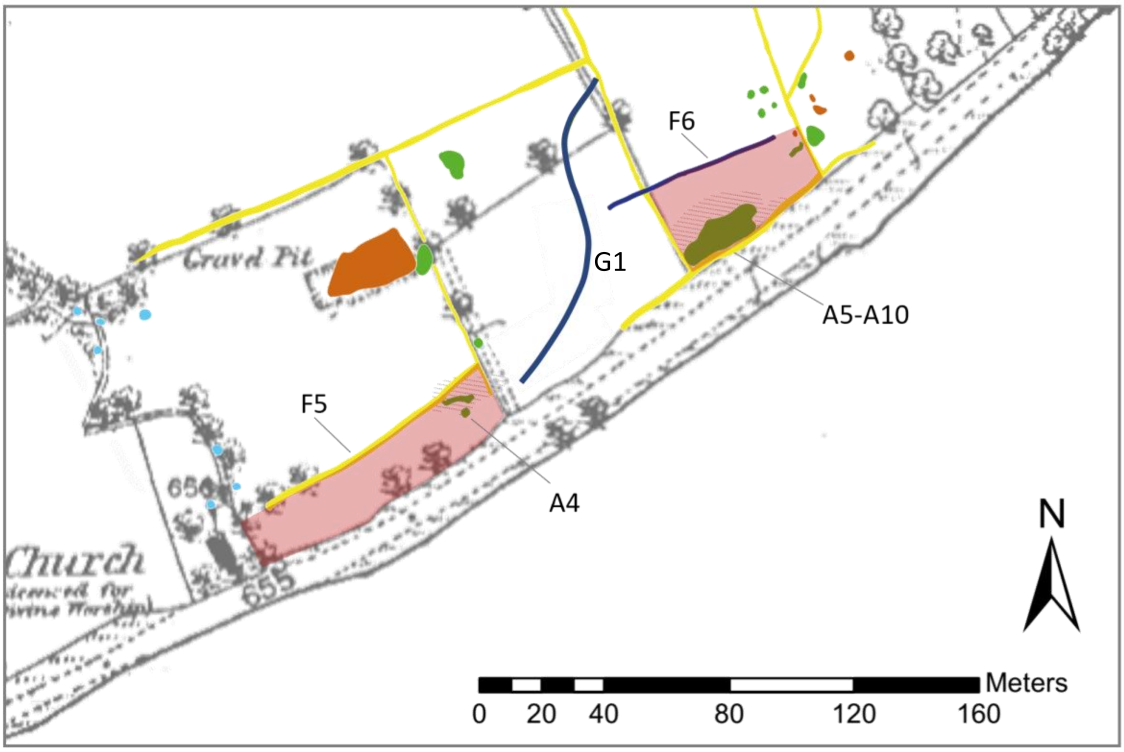


Figure 4.56 – *Roadside enclosures highlighted in red and suggested by linear anomalies F5 and F6. Overlying the anomalies on to the 1870 OS map, traces of the earlier boundary of F5 survived as a row of 3 trees. Smelting evidence was found in both smaller enclosures. It might suggest these represent roadside tenement plots used for industrial activities. Author's image, base map courtesy of Digimap OS Collection.*

4.5.5 - *Negative linear anomalies*

Trackways

A negative linear anomaly (Fig.4.56; G1) runs on a sinuous northern trajectory for approximately 70m within enclosure E2. This had readings between -8.3 to 10.3 and may be a former bank, drain or track, however if a track it is uncertain what it led to and why it has an s-shaped morphology.

4.5.6 Positive discrete and negative discrete anomalies

Structures

The two furnace anomalies A1 and A2 to the west of Zone 1 were enclosed on two sides by linear anomalies (Fig.4.49; H1-H2). H1 consisted of two linear anomalies that formed a right-angled feature, 6m E-W (21nT) and 3m N-S (40nT) enclosing the furnace or hearth anomaly of A1, located at its southern end. H2 features two parallel anomalies of 5m and 4m in length with readings up to 36nT and spaced 6.5m apart. Here the furnace or hearth (A2) stood at the northern end. Anomaly A3 may have also been enclosed as a 4m linear anomaly lies south A3 but no parallel anomaly to the north was detected. These are interpreted as the remains of structures with either stone foundations on which a wooden superstructure was constructed, or possibly beam-slots of compacted slag. Both structures are roughly orientated NW-SE and are 10m apart (fig.4.57). The absence of return walls on their eastern sides may indicate they were partially open. Their southern sides fell outside the survey grid and therefore their full length (and their end walls) was not ascertained.

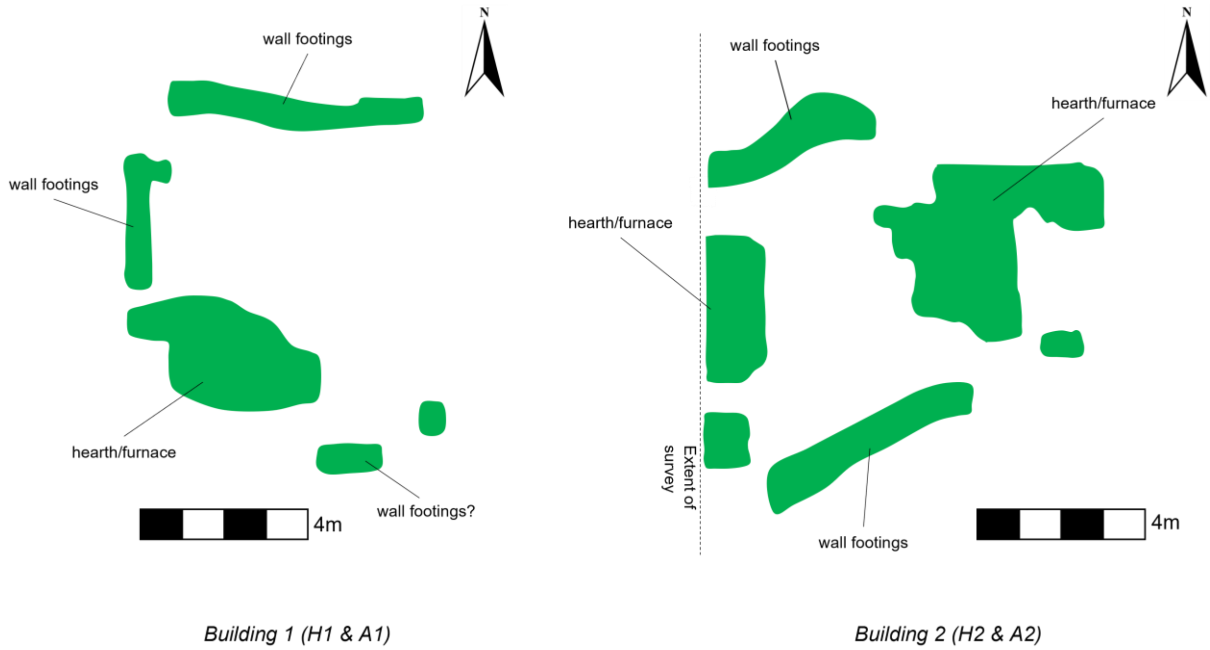


Figure 4.57 – *Outline of the possible structures of H1 and H2 enclosing the furnace or hearth anomalies of A1 and A2. Excavation would be necessary to determine the exact nature of these features, however they may have formed partially open structures enclosing a furnace, similar to the building at Minepit Wood (Money 1971). (Author's image).*

4.5.6 - *Post Medieval anomalies*

Anomalies relating to 19th and 20th century features were also identified which included the foundations of a corrugated iron building built in 1856 and used as a church and school along with its associated well (fig.4.58), and a 19th century gravel quarry dug between 1840 and 1870 (fig.4.59; J1-I1). While these features are unrelated to iron-production, they do serve as case studies for the use of magnetometry in identifying more recent archaeology. It is also important to consider the potential impact of these had on earlier archaeological remains, specifically the gravel quarry (H2) which was dug adjacent to a potential slag heap at B4 and may have destroyed a further eastern continuation. Fieldwalking identified 20th century metal debris within the field, consisting of broken farm machinery or litter from the adjacent road to the south. These may account for some of the magnetic spikes, particularly those to the north of the site where surface slag was less numerous (see section).

Figure 4.58 – *The Tin Tabernacle from South Wonston, Hampshire shows how the 'iron church' at Roffey would have once appeared (see figure 4.59). Author's image.*

4.5.7 Discussion

The magnetometry data shows that iron-production took place in at least three locations across Zone one, particularly focused in the south which include an eastern, western, and southern site (fig.4.48). Added to this the smithing site identified in 1985 all were positioned close to Crawley Road to the south. Two further anomalies indicate smelting to the north-east of the field, and while these anomalies were associated with smelting slag, they are more likely to represent slag deposits than the sites of furnaces, which presumably lay outside the survey grid. Of the three localities identified on the southern boundary, the western and eastern sites have left the most visible anomalies. In the east, which appears from the results to be the larger site (although ploughing may have spread material over a wider area),

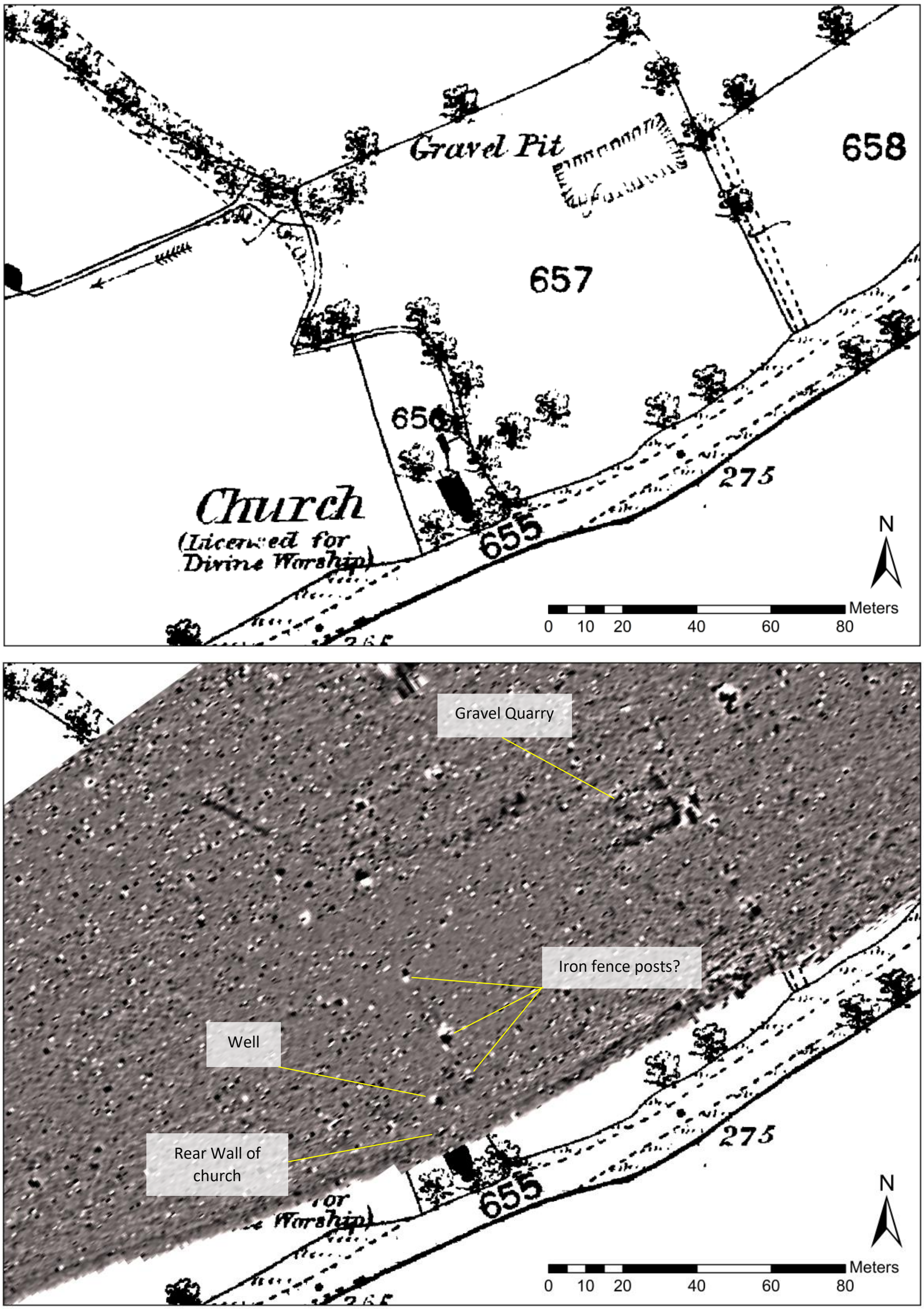


Figure 4.59 – *More recent anomalies in Zone 1 associated with the 19th century iron church and gravel quarry. Iron churches or 'tin tabernacles' were kit built corrugated iron structures built to accommodate growing church congregations in the 19th century (Cranfield 2022, 15). The church was identified as magnetic 'spikes' from its rear wall, associated wall and probable bases of iron fencing surrounding the plot, within the magnetometry data. Dorothea Hurst described the church in 'The History and Antiquities of Horsham' (1889) saying 'This part of the parish being a long distance from any church, a small iron one was erected on a piece of ground given for this purpose by the Duke of Norfolk. This building cost about £200, which was generously subscribed by a few individuals, and is capable of containing about ninety persons. It was opened by a full church service on Easter Sunday, 1856. It is now used as a school.' (Hurst 1889: 147). Fieldwalking revealed evidence of the former school in artefacts that included a stoneware inkwell and a collection of marbles (see fig.4.21). Base map courtesy of Digimap OS Collection.*

5 dipolar anomalies respect the orientation of the road and the enclosure of E3, in which they are situated. Enclosure E3 may have once been further subdivided and smelting separated from a pottery production site 20m north. While the potential furnaces appear to respect this enclosure and suggest both are contemporary, it does not explain why the slag deposit of B5 lies immediately outside the eastern boundary. However, if these enclosures were former tenement plots, it is possible that the neighbouring tenement was also an iron-production site.

The western site appears to focus around three furnaces or hearths, two of which appear to have been enclosed within buildings potentially around 6-6.5m by 3-5m in size, the furnace of hearth at their northern or southern ends. Their size and layout are similar to the possible smithing workshop building identified to the east in 1985 which was approximately 10x4.75m and had a hearth at the north-eastern end (Kirby 1985). Structures H1 and H2 may also have been used for smithing, with anomalies A1 and A2 representing hearths, although the technological assemblage recovered here during fieldwalking was dominated by smelting slag, which makes them equally likely to be furnaces. Furthermore, Young's suggestion (2012; 1) that waist level smithing hearths were in use during the medieval period raises the question as to the level of thermoremanent impact this heath design would have on the magnetism of the soil. The group of stones found at the suggested hearth in the building found in 1985 could suggest this was a waist level hearth. Hammerscale around the smithing hearth might be expected to cause higher magnetic readings. The linear anomalies interpreted as footings for these buildings might, like the smithing building, have been sandstone blocks.

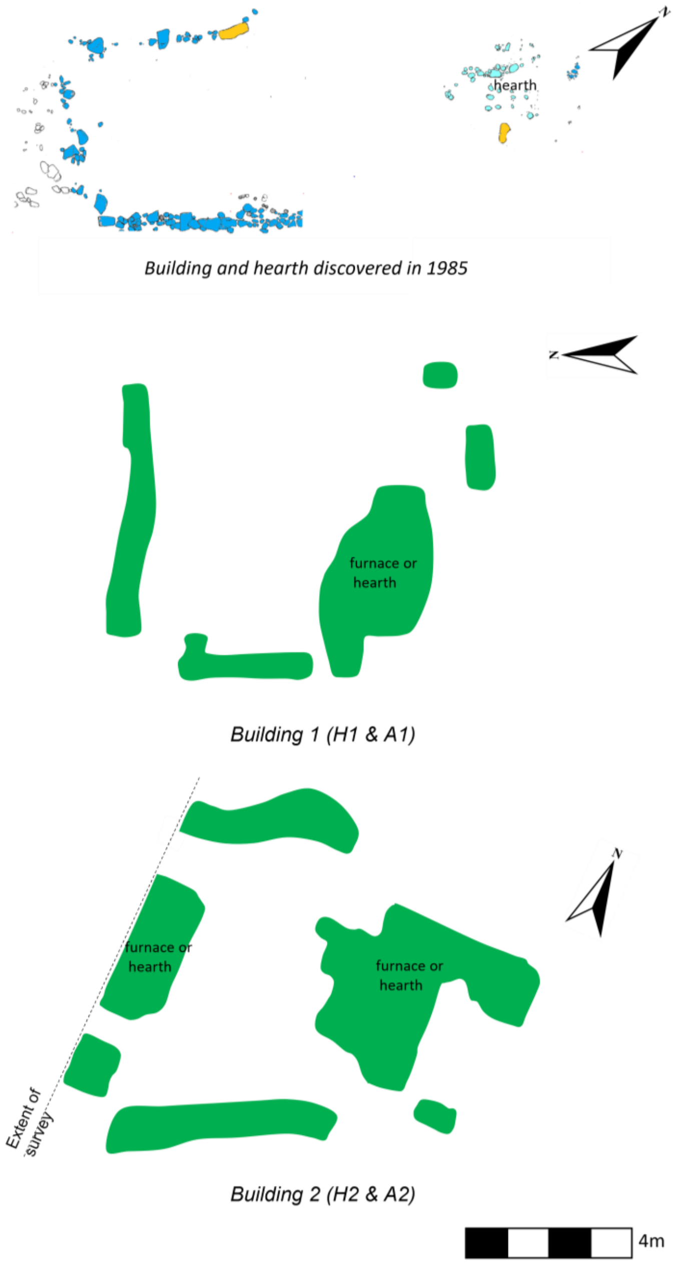


Figure 4.60 – *Comparison (scaled) between the possible building anomalies H1 and H2 and the smithing workshop excavated in 1985. Excavation plan from 1985 (top image) courtesy of J Kirby (1985). Images below by the author.*

A potential parallel for these buildings can be seen in the blacksmiths shop in Southwater, a parish 8km southwest of Roffey and preserved at the Weald and Downland Museum (figs.4.61-4.63). The earliest reference to a smith at Southwater dates from 1346, two years after the reference to Matilda Bonwyk's smithy at Roffey, when a 'Walter le Smyth 'be' Suthwatre of the county of Sussex' is recorded in the Calendar of Patent Rolls (Maxwell Lyte 1903, 495). While the current building dates to the 19th century, it is reasonable to suggest that such

Figure 4.61 – *Smithy from Southwater, West Sussex. Timber frame with roughly hewn weather boarding. (Author's image).*

smithies, once found in many Wealden parishes, changed little in their form from their medieval predecessors. The Southwater Smithy was timber framed with roughly hewn planks forming weatherboarding on the outside, with a tiled roof. The buildings length of 7.5m with a width of 3.5m is very similar to H1 and H2 at Roffey. Double doors were positioned on the end wall of the building, which meant this end wall could be open to the elements. The hearth is however placed centrally to allow room for a chimney and pair of bellows on its lefthand side. While in the buildings at Roffey the hearths/furnaces appeared to have been placed towards the end however the full extent of these buildings was not determined and there may have been space at the rear or to the side.

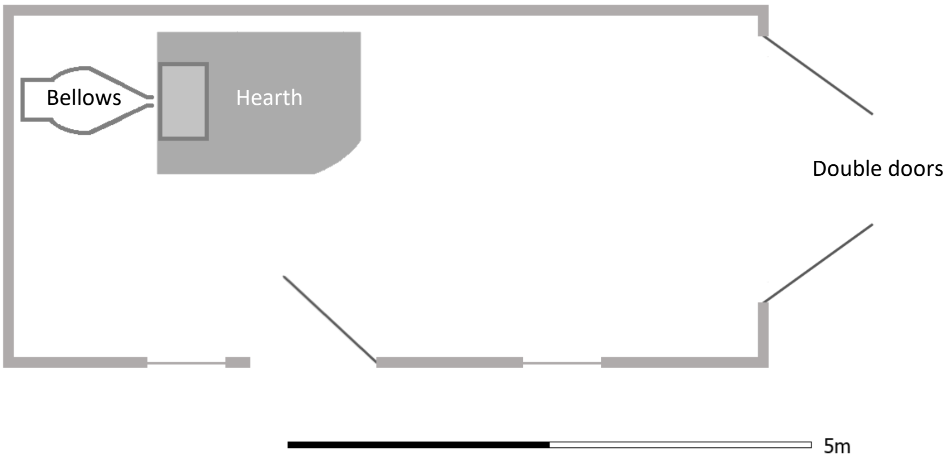


Figure 4.62 – *Sketch plan of the Southwater Smithy showing the heath to one corner and double doors along the side wall, possibly a similar building to those identified at Roffey. (Author's image).*

Figure 4.63 – *The interior of the Southwater smiths. While the building dates to the 19th century it reflects a building tradition seen throughout the Weald and likely to be similar to its medieval predecessors. (Author's image).*

4.5.8 - *Summary*

The magnetometry survey has enabled the mapping of Zone 1 to be carried out and an accurate positioning of sites of iron-production, other industries and past boundaries that indicate a roadside industrial settlement of individual tenement plots. Magnetometry alone however does not allow the full nature of the anomalies to be clarified, as illustrated by the collection of buildings at the western end, which could be hearths or furnaces, both of which leave similar dipolar readings. Fieldwalking was therefore applied on the same grid layout to compare surface artefact scatters to the magnetometry results and was to demonstrate how the two methods can be applied together to understand a wider landscape.

4.6 - Systematic Fieldwalking

4.6.1 - *Introduction*

Fieldwalking, while once a frequently used method in British archaeology has dwindled in its use in more recent years due to the frequent use of double cropping of arable land, limiting surveying to narrower windows of opportunity. Fortunately, Zone 1 was left fallow for the 2020 season allowing a survey window between March and September. Fieldwalking is also rarely applied to iron-production sites, or at least in a systematic grid or transect arrangement, instead generally taking the form of a walkover survey whereby the positions of observed slag scatters are recorded on maps. The two fieldwalking surveys in Zone 1 aimed to extend the scope of analysis that fieldwalking data could provide, through a combination of two methodological approaches; the grid fieldwalk and transect fieldwalk. As well as plotting the distribution of technological and geological samples, the survey had a secondary aim of collecting a detailed technological assemblage, for morphological characterisation (see Section 4.7).

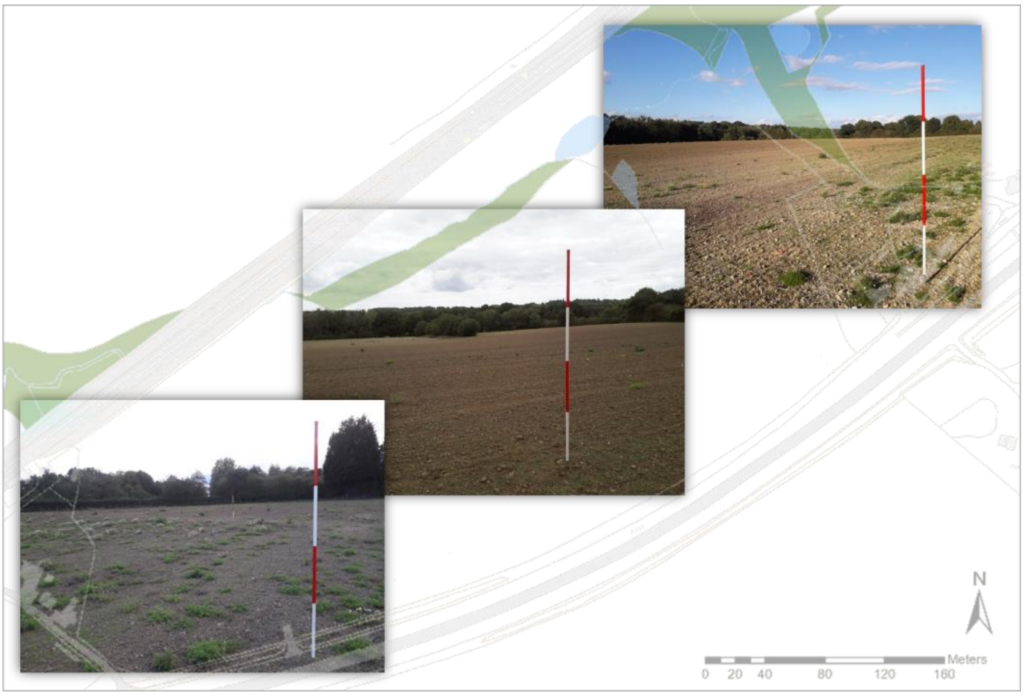


Figure 4.64 – *Field conditions at Zone 1. Base map courtesy of Digimap OS Collection, photos by the Author.*

4.6.2 - *Field conditions*

The field had been ploughed in the previous year and the soil remained exposed after the last harvest. On the first site visit on 20th February 2020, it was noted how weathering had exposed surface artefacts including slag and pottery. High densities of slag were observed during the reconnaissance survey along the southern boundary, in the east and west corners and to the north-east of the field (see Chapter 3). These artefact scatters corresponded to the high magnetic anomalies interpreted as furnaces and slag heaps. Covid 19 Lockdown restrictions delayed the survey by two months and meant that areas of the field, particularly the central and western side, had become more heavily overgrown by weeds in the intervening months (fig.4.64).

4.6.3 - *Approach*

The initial grid surveys focussed on the highly magnetic anomalies in the East which covered enclosures E3 and E4 and the associated smelting anomalies of A5-A10 and pottery production site D1-D2 (hereafter called the eastern grid); and the anomalies to the west including A1-A3 and the potential structures of H1-H2 (hereafter called the western grid). In July 2020 after the field had been harrowed, the entirety of the field (Zone 1) was surveyed using transects to assess the overall artefact distribution.

4.6.4 - *Technological waste types*

Technological waste collected during the fieldwalk consisted of smithing and smelting slags and refractory material. This material was later categorised into 6 main types by their morphological differences, during macromorphological analysis. These are discussed in detail in Section 4.7 however Table 4.1 summarises the 6 types and their origin in the iron production process. The overall distribution of each type is presented in figures 4.66-4.69 using data from the transect fieldwalk, while maps comparing the eastern and western grids are presented in Appendix B4.1.

Table 4.1 - *Summary of slag types, their associated process and their count and weights*

			Grid survey totals				**Transect survey totals**	
Slag type	Associated process	Classification	Eastern grid total	Weight	Western grid total	Weight	Total	Weight
Type 1	Smelting	Furnace slag undiagnostic	462	57.8kg	178	16.6kg	1036	237.3kg
Type 1 with rust	Consolidation/smithing	Consolidation slag / smithing slag	72	14.2kg	25	2.5kg	70	10.9kg
Type 2	Smelting	Tap slag	272	18.6kg	117	7.9kg	596	64.9kg
Type 3	Smelting	Rod-shaped slag	15	1.3kg	2	0.4kg	7	2kg
Type 4	Smelting	Furnace base slag	288	39.3kg	103	10.8kg	584	107.5kg
Type 5	Smelting and/or smithing *(Strictly speaking not slag but vitrified refractory material from furnace or hearth linings)*	Furnace residues	45	7.1kg	12	0.7kg	56	5.1kg
TOTAL:			**1154**	**138.2kg**	**437**	**38.9kg**	**2349**	**427.8kg**

Note: *the data for the eastern and western grids represents a sub-sample from the field, which varied between grid squares but was typically 20%. The transect total represents a total collection.*

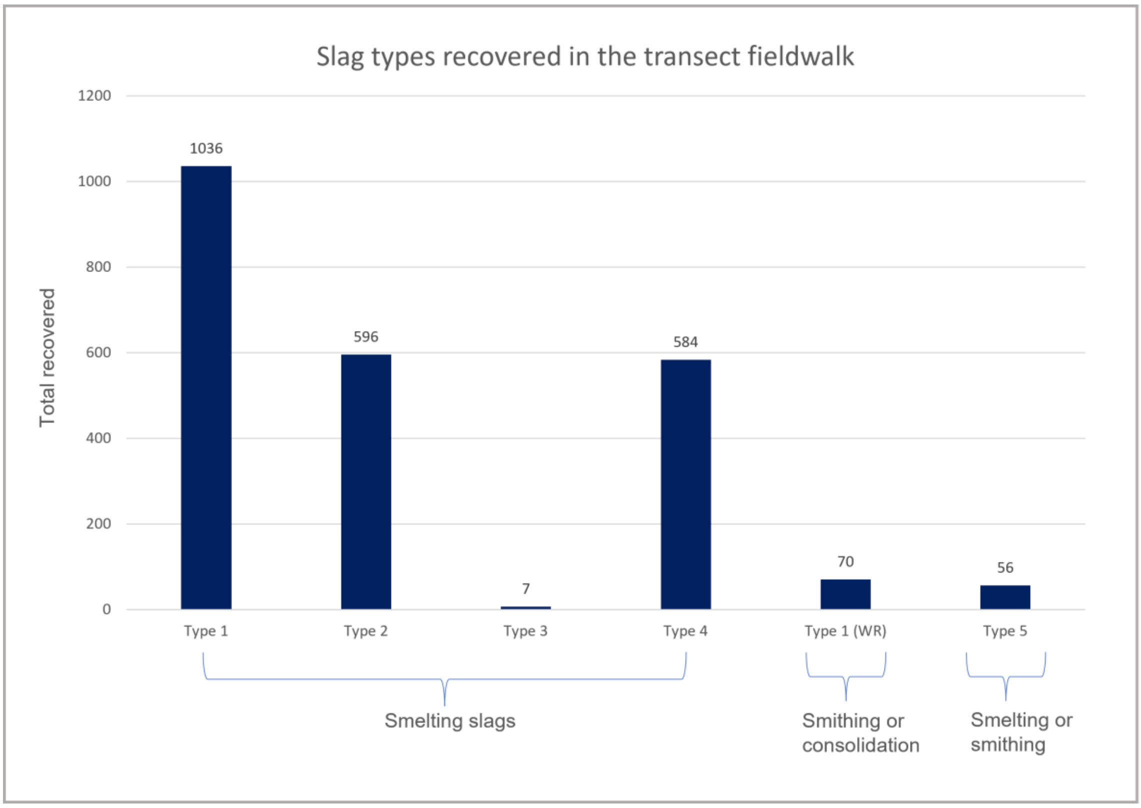


Figure 4.65 – *Total quantities of each slag type recovered in the transect fieldwalk.*

4.6.5 - *Transect Fieldwalk – The distribution of smelting slag*

Type 1 – amorphous furnace slag

The transect fieldwalk produced 1036 examples (237kg) of amorphous furnace slag (Type 1) which equated to 44% of the total sample. The greatest distribution of Type 1 was in the east of Zone 1 and was at its highest density along the southern boundary adjacent to the road (fig.4.66). Figure 4.66 shows that while this eastern distribution covered an area of approximately 200m², there are five distinct points of higher density within it (fig.4.66; *a*-*e*). Densities '*a'* and '*b'* are adjacent to the southern boundary separated by 40m and each cover an area of 40m², with a maximum of 30 samples recorded in the densest transect. The densities correlate with the positions of the magnetometry anomalies A5-A10 (*a*) and B5 (*b*) (fig.4.48), which are interpreted as smelting furnaces and a slag deposit. The identification of amorphous smelting slag in these areas further confirms their interpretation, while their separation also suggests they represent two distinct features.

Three further points of high density are evident approximately 100m N-W (fig.4.66; *c*-*e*). Density '*c'* is downslope and within a N-S aligned linear earthwork from a former field boundary (see fig. 3.59). The highest density was 24 samples and are likely to be associated with the dipolar scatter readings from the probable spread of slag from anomalies B1 and B2 (fig.4.48). Densities *d* and *e* are smaller, and while the position of *e* correlate with magnetometry anomaly B3, suggesting underlying deposits of slag, *d* does not appear to overly a magnetic anomaly.

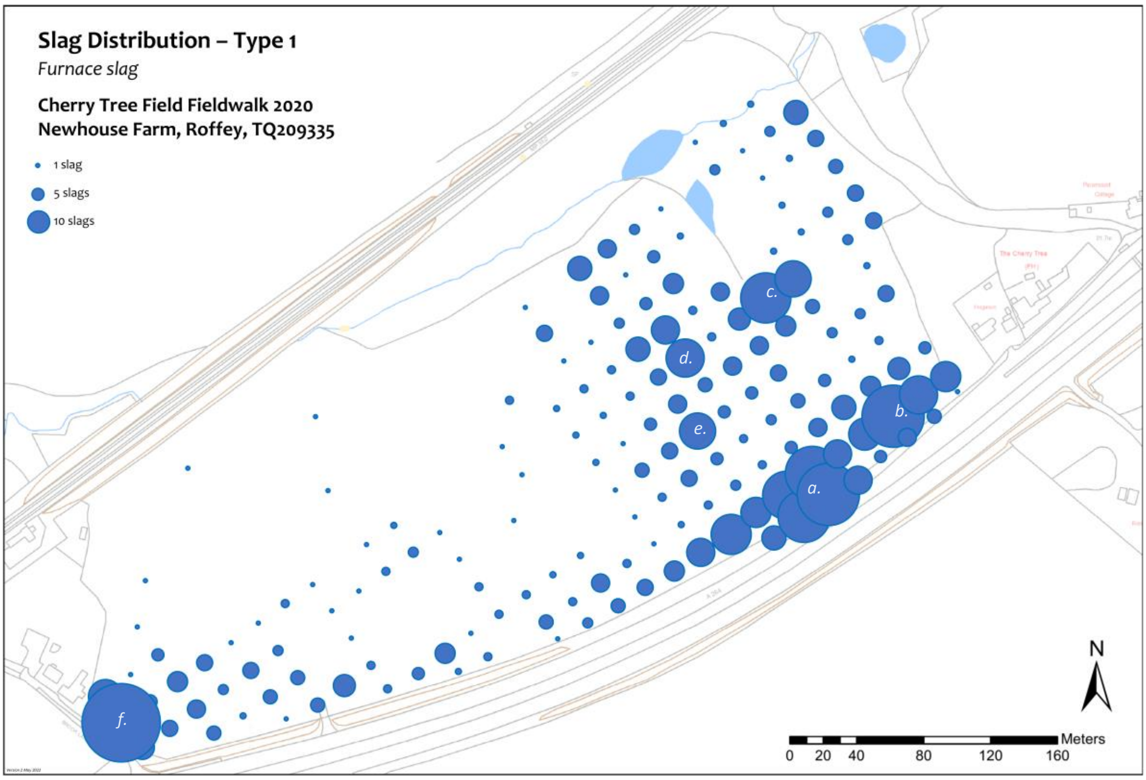


Figure 4.66 – *Distribution of amorphous furnace slag (type 1) which had 6 areas of high-density a-f. Base map courtesy of Digimap OS Collection, overlaid with the author's data.*

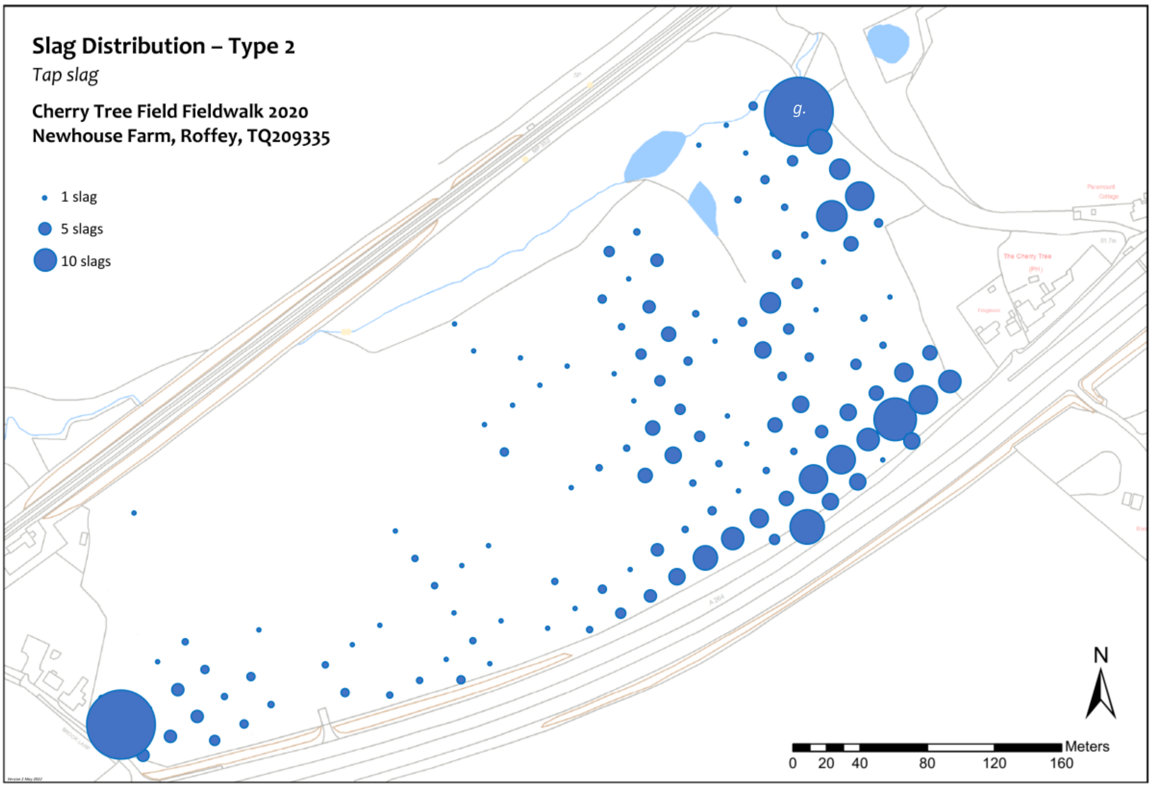


Figure 4.67 – *Distribution of tap slag (type 2) which had four areas of high density at a, b, f and g. Base map courtesy of Digimap OS Collection, overlaid with the author's data.*

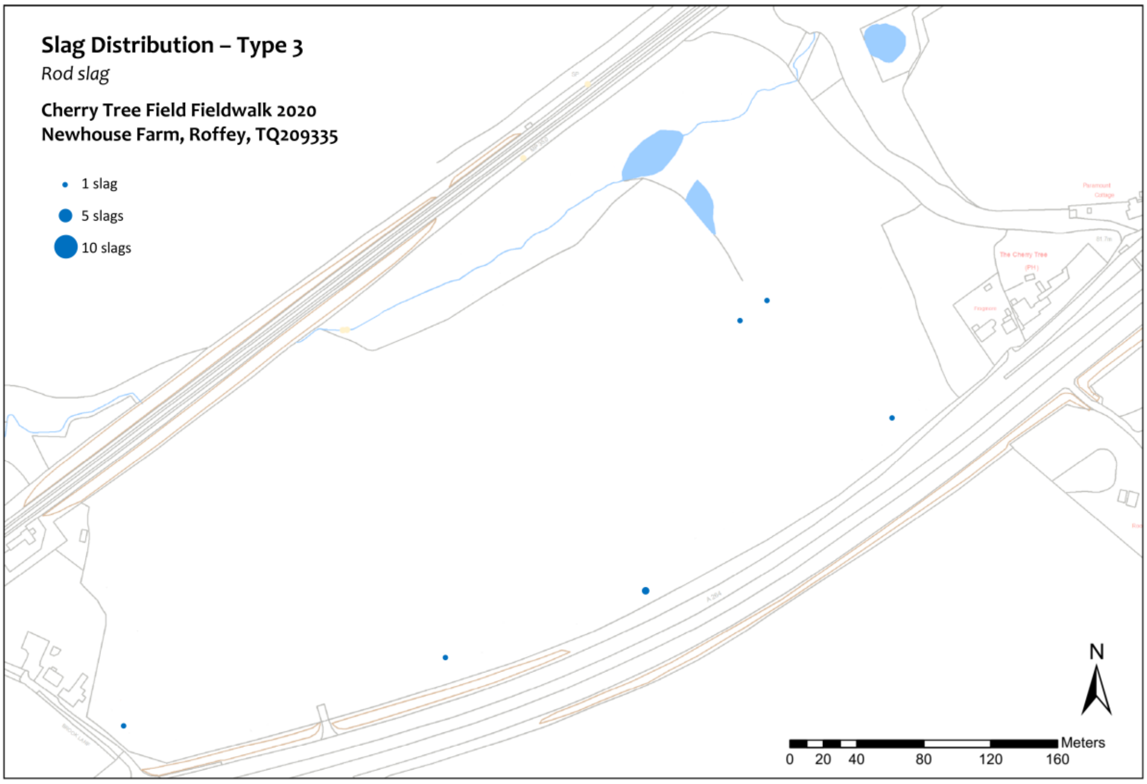


Figure 4.68 – *Distribution of rod slag (Type 3) which showed no specific distribution patterns on account of the small number of samples recovered. Base map courtesy of Digimap OS Collection, overlaid with the author's data.*

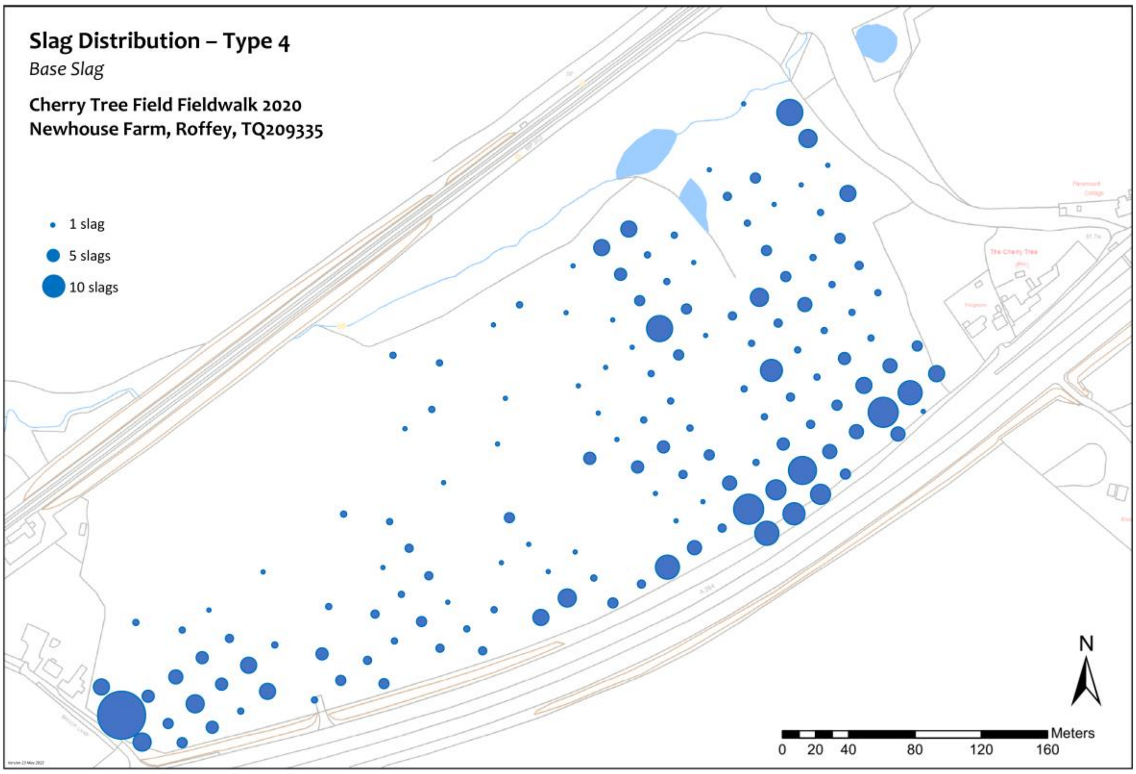


Figure 4.69 – *Distribution of furnace base slag (type 4) which had four areas of high density at a, b, f and g. Base map courtesy of Digimap OS Collection, overlaid with the author's data.*

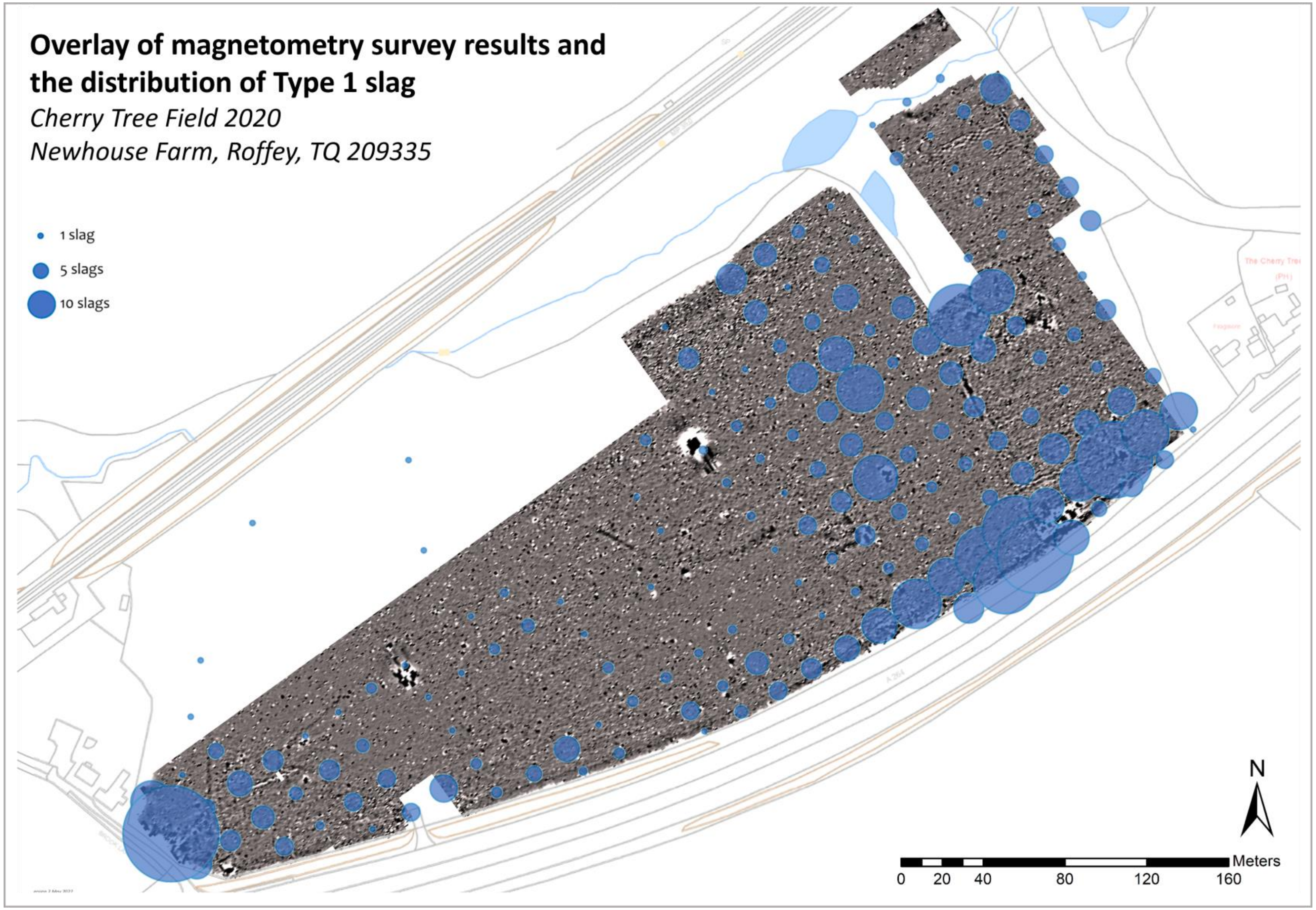


Figure 4.70 – *Overlay of the distribution of type 1 slag onto the magnetometry survey results for Zone 1. Base map courtesy of Digimap OS Collection, overlaid with the author's data.*

The southwestern corner at point *'f'* contained highest single density of Type 1 slag from across the site at 39 samples. The majority of the samples were concentrated within a single 20m stint and unlike densities *a* and *b,* material had not been spread greatly by ploughing. There was therefore a sharp reduction in recovery rate of 39 to 6 samples between the stint at *'f'* and its neighbour 20m to the east from. The presence of smelting slag here supports the probability that anomalies A2 and A3 are the sites of furnaces (fig.4.48; A2-A3). It was notable however that relatively little Type 1 slag was associated with anomaly A1, despite it morphologically appearing very similar to anomaly A2. This might suggest either it held another function such as a smithing workshop, or that its placement close to the boundary has meant ploughing has been limited and underlying deposits remain undisturbed.

Type 2 – Tap slag

Tap slag (Type 2) is formed when slag is released from a furnace and has a characteristic 'runny' morphology. A total of 596 samples were recovered in the transect fieldwalk equating to 25% of the overall sample (fig.4.67). Like the amorphous furnace slag, tap slag had a higher distribution in the east of Zone 1. The specific density points showed some variation, for although the densities of a and b, which had high quantities of Type 1 slag, remained at reduced quantities of up to 16 and 20 samples, densities *c d* and *e* were not present. The highest density, point '*g*' (fig.4.67) was in the N-E corner of Zone 1, adjacent to Channells Brook stream. Here a single stint produced 33 samples. Density *'g'* does not however correlate with any magnetometry anomalies, however as previously suggested, anomalies A11-A12 (fig.4.48) to the north of the stream, may relate to industrial activity to the east and outside of the survey grid, which might also account for density *'g'*. The presence of tap slag suggests iron-production in this area was smelting and that the furnaces were of the slag tapping type. To the west of the Zone 1, density *'f'* also had a high density of tap slag at 33 samples and further supports the probability that anomalies A2 and A3 were slag tapping furnaces.

Type 3 – Rod slag

Type 3 slag or 'rod slag' accounted for the smallest quantity of smelting slag at 7 samples or 0.3% (fig.4.68). This slag is suggested to have been formed in the aperture left by a boring stick when this was driven through the tapping arch to tap the slag. The small numbers recovered limits a detailed assessment of its distribution, however, like types 1 and 2 it was predominantly found along the southern boundary of the field and at slag densities *b* and *f*.

Type 4 – furnace base slag

Type 4, furnace base slag, which solidified in the base of the furnace, follows very similar distribution patterns to Types 1 and 2, and like type 2 comprised 25% of the transect sample (fig.4.69). There were 5 points of higher density which were the same as *a, b, d* and *f* in Type 1 and *f* and *g* in Type 2. The highest density, with 23 samples, was identified in the south-west corner, and like the previous types, had a confined distribution to within 20m.

Type 5 – vitrified refractory material

Type 5 was strictly not a slag but the vitrified clay lining of either a furnace or smithing hearth. This type formed a small percentage of the overall technological sample at 2.4% (fig.4.71). There were no specific densities present of Type 5, although there was a greater distribution on the east of Zone 1 and along the southern boundary. In most stints, refractory material only occurred as single samples or occasionally two and this is probably due to its more friable nature, making it unlikely to survive in the plough soil. It is also possible some of this material originates from other structures such as pottery kilns, however no samples were found overlying the possible kiln anomalies and waster pits at D1 and D2 (fig.4.70).

Overall distribution of smelting slags

While a general scatter of smelting slag covered much of Zone 1, particularly in the east, smelting slags were broadly located in seven points of high density. Of these points *a, b* and *f* (fig.4.66) contained all prominent slag types and corresponded to underlying magnetic anomalies (fig.4.70). The slag suggest smelting was carried out within these areas, with a particular focus along the roadside. The densities of *d* and *g* did not correspond to underlying anomalies and appeared to be dominated by specific slag types, such as tap slag at density g. This phenomenon is harder to account for, however it is possible they relate to activity outside of the survey grid, or alternatively are the result of more heavily fractured slag that has resulted in a higher count. The north-west corner, covering approximately 2ha was almost completely devoid of slag, while the centre of Zone 1 also featured relatively low quantities compared to the east and west. This supports the magnetometry survey that iron-production was concentrated in the east and west and predominantly sited along the roadside and may suggest the north-east of Zone 1 was not inhabited during the medieval period.

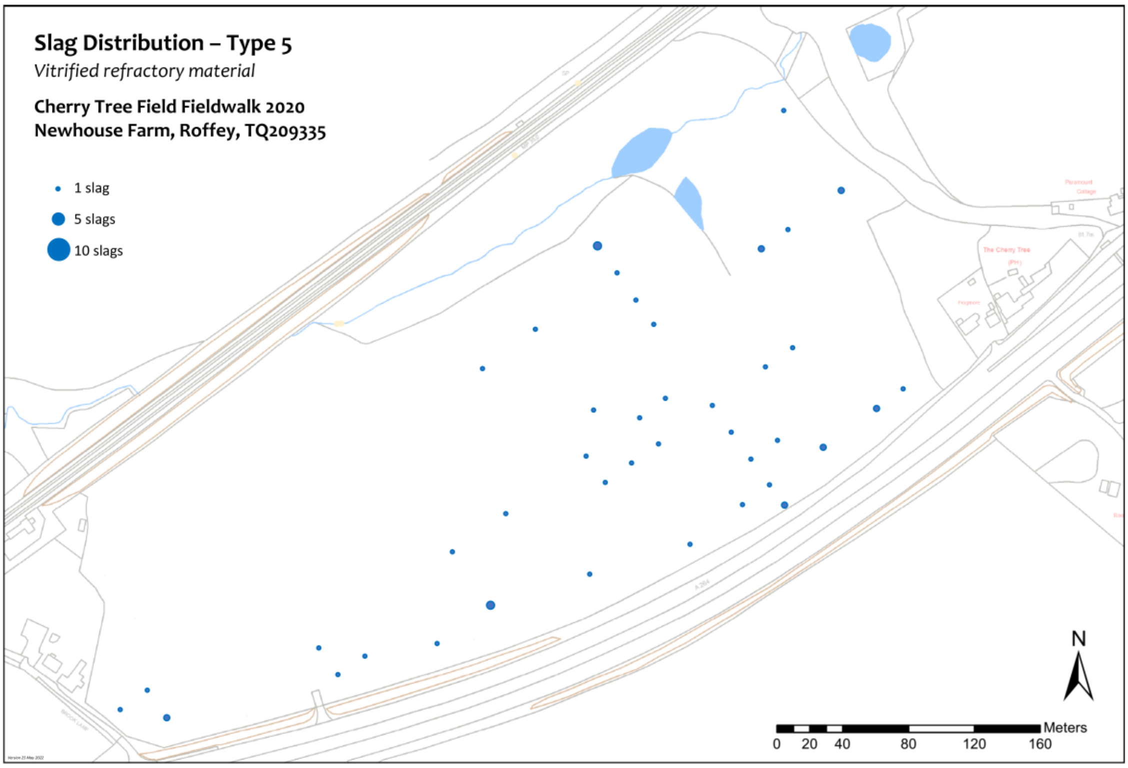


Figure 4.71 – *Distribution of vitrified refractory material (type 5) Base map courtesy of Digimap OS Collection, overlaid with the author's data.*

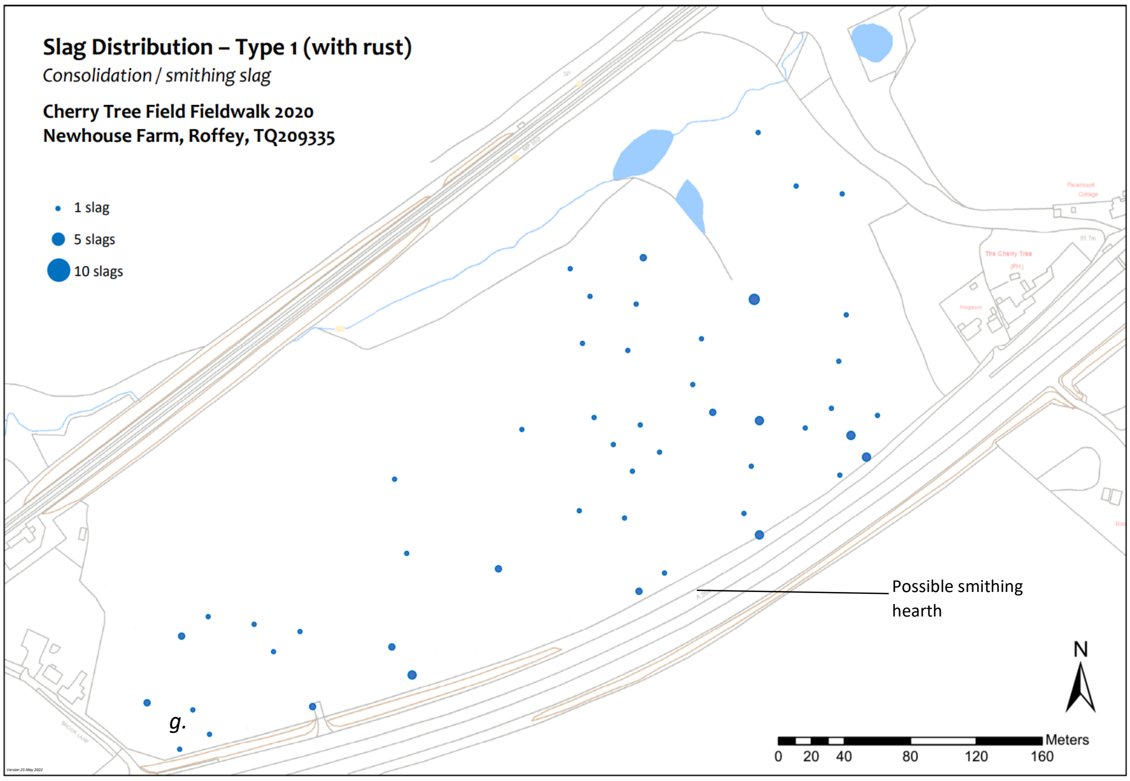


Figure 4.72 – *Distribution of consolidation/smithing slag from primary or secondary smithing. Base map courtesy of Digimap OS Collection, overlaid with the author's data.*

4.6.6 - *Transect Fieldwalk – The distribution of smithing slag*

Type 1 (With Rust)

At the time of its discovery, Type 1 with rust (WR) slag was considered to be a sub-type of Type 1 amorphous furnace slag with a rustier outer surface. However, subsequent macromorphological analysis indicated it related instead to either bloom consolidation (primary smithing) or secondary smithing and it is unfortunate that its name does not fully distinguish it as a separate type. It is referred to from this point on as type 1(WR). Overall, it formed only 3% of the slag recovered in the transect fieldwalk, totalling 70 fragments. There were no large densities, apart from a slightly higher quantity in the previous densities identified of *a, b* and *c*. There was also a slightly higher density of 5 samples on the southern boundary close to the site of the possible smithing hearth excavated in 1985 (fig.4.72). Furthermore, the type 1(WR) slag identified in the west at *'g'* was found close to anomaly A1, which did not appear to have a high density of smelting slag. While it is possible A1 is a smithing hearth, the quantities of slag are still very low. The identification of smithing slag does suggest primary and/or secondary smithing took place in Zone 1 as well as smelting.

Grid fieldwalk

A detailed assessment of the morphology of the slag types recorded during the grid fieldwalk is discussed in Section 4.7. The distribution of each slag type mirrored that of the transect fieldwalk is presented in Appendix B4 and will not be discussed in detail here.

4.7 - Characterisation of the technological assemblage

4.7.1 - *Introduction*

Investigations of iron-production sites will typically retrieve a detailed sub-sample of technological material depending on the sampling strategies adopted. In subsequent analysis this material is characterised, sorted into types, and used to evaluate production stages and the scale of the industry at a site. Temporal changes will also be considered by assessing material in the vertical profile of stratigraphic layers. While technological material recovered through fieldwalking is often not subjected to the same level of macromorphological analysis and frequently recorded generically as 'bloomery slag' or 'blast furnace slag', it is argued here that the same analytical methods used on an excavation assemblage can be applied and conclusions made on process type, technology used, and scale of production. This section considers the slag assemblage collected in the Grid fieldwalks over the eastern and western geophysical anomalies. Initially the physical attributes of the slag were used to assign the material to types, following similar criteria used in the classification of slag in the Exmoor Iron Project. Further attributes are discussed including viscosity, slag inclusions and magnetism. The section concludes by comparing the assemblage with material generated in an experimental smelt, to identify techniques, equipment and the origin of slag types.

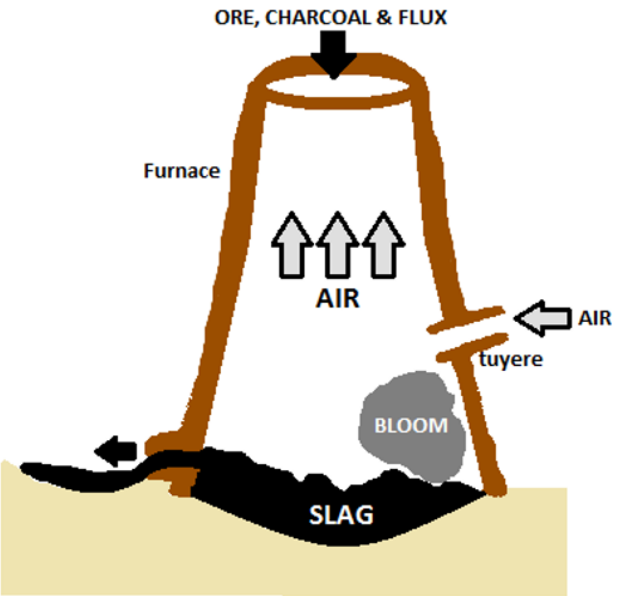


Figure 4.73 – *Bloomery furnace demonstrating the inputs and outputs of smelting. (Author's Image)*

4.7.2 - *Slag Types and their formation*

Ten slag types were identified in the Roffey assemblage based upon their morphology. Of these, 6 types dominated in the assemblage and can be attributed to specific production stages and formation in different parts of the furnace or smithing hearth. The following discussion with focus on the 6 main types. Of the types identified, Types 1 to 4 can be attributed to smelting (stage 1), while Type 1(WR) is the product of primary and/or secondary smithing (stage 2). A detailed discussion of their formation is provided in Section 4.7.3, however below is a brief overview of the morphology of the principal types and their formation in relation to iron-production.

Smelting and its slag

Figure 4.74 - *Building a furnace at Cranbourne by daubing clay (the furnace lining) around a forming mould. The clay in this instance was tempered with straw and sand, but tempers can also include small stones (Dungworth et al 2012) and crushed furnace linings from earlier furnace structures. (Author's image).*

The bloomery (or direct) process required the use of furnaces to extract iron from its ore by smelting, followed by subsequent refinement by primary smithing before the iron could be used in artefact manufacture (secondary smithing) (Dungworth et al 2012, 1; McDonnell 1995, 1). The furnace is typically made of clay and cylindrical or domed in shape and 1-2 meters high. Its design allowed temperatures exceeding 1300°C to be reached and a reducing atmosphere achieved (McDonnell 1995, 1). After a furnace has been pre-heated,

Figure 4.75- *Charging the furnace – alternate loads of charcoal and prepared ore (possibly through roasting) are placed into the top of the furnace. The fuel to ore ratio is important. As the charcoal burns and the ore reduces, further charges are added. (Author's image).*

it is charged with prepared ore (often roasted and broken) and charcoal at a predetermined ratio through an opening at the top (Smith 2013, 102; Juleff 1998, 184) (figs 4.73-4.75).

The size and ratio of the ore and charcoal is an important consideration and has a critical impact upon the operation of the furnace (Tylecote 1986, 131-132). Sufficient charcoal is needed for the reactions in the furnace to take place and the more charcoal that is added, the more carbon monoxide is produced. Initially as the charcoal burns it produces carbon dioxide. This exothermic reaction generates the necessary heat to raise the temperature of the furnace. An excess of burning charcoal is necessary for the carbon dioxide to become carbon monoxide. This endothermic reaction both removes heat and produces the carbon monoxide needed to take the oxygen from the ore in the reduction reaction (Juleff). The fuel ore ratio will be dependent upon furnace design and working conditions, along with established practices used by smelters (Juleff *pers. comm.*). During experimental smelts conducted by Juleff in Sri Lanka (1998, 180-188), the weights used in the ore to fuel ratio varied from 1:0.74 to 1.5:1, while WIRG applied a 1:1 ratio at their experimental smelt at West Dean (Smith 2013, 102).

Air also needed to be pumped into furnace with the use of bellows which forced the air through tuyeres (or blow holes) in the lower section of the furnace wall. Tuyeres are rarely found on medieval bloomery sites, however clay examples have been identified in Roman contexts, and by Juleff in Sri Lanka (Juleff 1998) (fig.4.76). The Tudeley accounts list Tuyeres made from iron, however whether these were common in the 14th century is uncertain. As air was pumped into the furnace, the internal temperature increased however a temperature gradient is present between the top of the furnace and the core of the combustion zone in front of the blowing hole. Temperatures may therefore be anything from 1300°C in the core of the combustion zone, to 500°C in the top of the furnace (Juleff *pers. comm*.). As the ore descends through the furnace, it reduced to particles of iron surrounded by slag. Upon reaching the core of the combustion zone above the tuyere, the increased temperature caused the particles to coalesce and weld to one another and form a bloom (Cleere and Crossley 1985, 45). In terms of the chemical reaction, as air is pumped into the bottom of the furnace, the charcoal within the furnace fully reacts with it and combusts. This creates the hot combustion zone at the bottom of the furnace. However, the reduction reaction takes place higher up in the furnace within the

Figure 4.76 - *Left a tuyere embedded in the wall of an experimental bloomery furnace. Right, a Sri Lankan tuyere made of fired clay. The Tudeley accounts record how the tuyeres were made of iron. (Author's images).*

temperature gradient. Here, the charcoal above the combustion zone creates the carbon monoxide which in turn reacts with the iron ore (Juleff *pers. comm*.). The reaction reduces the ore and leads to the separation of oxygen (O) from the iron oxide which combines with the carbon monoxide (CO) to create carbon dioxide (CO_2). The iron is left to form the bloom, while gangue, which includes remaining minerals within the ore including quartz and silica, melts to form liquid slag. A significant amount of iron oxide is also lost in the slag, however this loss is a necessary in the process to separate the slag from the iron (Schubert 1957, 26). The slag is a silicate and has a high melting point. It is necessary therefore to lower the melting point of the slag to separate it from the iron. To achieve this half of the iron goes into the slag to form an iron silicate which has a lower melting point of 1100-1200°C (Juleff *pers. comm*.). As the furnace will never achieve the temperatures required to melt iron (1500°C), the iron remains in a solid state, however the lower melting point of the iron silicate (slag) allows it to become liquid and separate from the iron (Herbert 1985, 23; Hodgkinson 2008, 23; Juleff *pers. comm*.). The chemical reaction in the furnace can be summarised as:

Combustion zone

$C + O_2 = CO_2$

$CO_2 + C = 2CO$

Reduction zone

$3Fe_2O_3 + CO = 2Fe_3O_4 + CO_2$

$Fe_3O_4 + CO = 3FeO + CO_2$

$FeO + CO = Fe + CO_2$

Slag formation

$2FeO + SiO_2$ (+ other impurities within the ore) = Fe_2SiO_4

The outcomes

Iron = Fe

Slag = Fe_2SiO_4

As the iron forms the high temperature causes it to become softer and it will coalesce under the tuyere, where it begins to form a bloom (Juleff *pers. comm.*; Cleere and Crossley 1985, 45). As the smelt progresses, the bloom continues to grow as further iron particles coalesce. Eventually the air flow from the tuyere is compromised and the bloom can be removed (Dungworth et al 2012, 2) (fig.4.77).

Figure 4.77 - *Iron bloom from an experimental smelt at Pippingford. The bloom still retains a lot of slag and must be further refined before the iron can be utilised. (Author's image).*

Slag is the second output of the furnace which comprised both the non-iron elements or 'gangue' from the ore, as well as iron oxide (FeO) (McDonnell 1995, 1; Schubert 1957, 26). The lower melting point of slag (1100 -1200°C) means that unlike the iron, it forms a liquid state as it descends through the furnace and achieves the physical separation of iron from waste (Juleff pers. comm.). Most of the internal slag coalesces into large accumulations of 'furnace slag' (Crew 1995, Dungworth et al 2012, 2). It is this furnace slag that much of the Type 1 slag can be attributed to. Crew (1995, 3) suggests that this amorphous slag can form more than 50% of a slag assemblage, and at Roffey was the dominant type recovered at 40% (fig.4.78).

Figure 4.78 - *Raking out the furnace through the tapping arch to remove the bloom along with slag that has solidified within the furnace. At Roffey this furnace slag was classified as Types 1 and 4. (Author's image).*

Some slag pooled as liquid in the bottom of the furnace and could be periodically released or 'tapped' through an opening in the furnace wall called the tapping arch, although in non-tapping furnaces it collected in the base of the furnace (Cleere and Crossley 1985, 46; McDonnell 1995, 1). Tapping furnaces produced 'tap slag' with a distinctive ropey texture and runnels testifying to its liquid state as it flowed before solidifying (fig.4.79). Tap slag accounts for Type 2 slag within the Roffey assemblage. The release of the slag from the tapping arch was achieved with the use of a boring stick, driven into the previously blocked tapping arch (Juleff 1998, 82). Slag that solidified within the boring hole formed a cylindrical shaped, accounting for Type 3. Hodgkinson (2008, 24) explains that such slags are frequently found on bloomery sites, usually with a diameter of 10-20mm and around 100mm in length. The social significance of Type 3 slag is discussed in Chapter 6 in relation to ethnographic parallels.

Figure 4.79 - *Solidified Tap slag having flowed from a gap underneath the blocked tapping arch. This was classified as Type 2 in the Roffey assemblage. (Author's image).*

Figure 4.80 - *Cross profile of a partially dismantled furnace. The vitrification and adhering slag to the furnace lining were classified as Type 5 slag within the Roffey technological assemblage. Archaeologically very little of the superstructure of furnaces tend to survive. (Author's image).*

Slag also collected in the base of the furnace to form a 'furnace bottom' and in some instances furnaces were designed with an internal pit to collect this slag (Cleere and Crossley 1985, 46). These furnace bottom slags, typically plano-convex in shape were classified as Type 4.

Furnace base slags have the potential to reflect the former size and shape of the bottoms of furnaces (Juleff *pers. comm*.). However, the fractured state of these slags at Roffey made this hard to assess.

Furnaces had a limited economic life and would have required regular repair to the clay lining and eventual total replacement. Type 5 forms the remnants of these structures, the majority of the sample comprising the vitrified clay often with adhering slag from their former position within the furnace. Figure 4.80 shows the cross section of a partially dismantled furnace after a single smelt and it can be seen how the high temperatures have vitrified the internal walls. The ability to tap the slag did prolong the life of a furnace by preventing internal build-up of slag. However, in time the high temperatures would inevitably weaken and crack the clay superstructure beyond economic repair.

Primary and secondary smithing and its slag

A bloom must be refined by primary smithing before the iron is in a usable state to manufacture objects (Young 2012, 1). Frequently the first stage of refinement or primary smithing, will take place immediately after smelting, while the bloom is still hot enough to work. The bloom may be reheated within a hot forge or by placing it back on embers from the furnace (figs 4.81-4.82). The successive heating of the bloom to over 1000°C liquifies the slag and softens the iron so that as it is hammered the iron is

Figure 4.81 - *Consolidation hearth or string hearth, used to re-heat the bloom prior to hammering in the primary smithing stage. (Author's image).*

Figure 4.82 - *Consolidating the bloom into workable iron through a combination of heating and hammering. Slag can be seen around the consolidated bloom, having flaked, or been driven off during the hammering. (Author's image).*

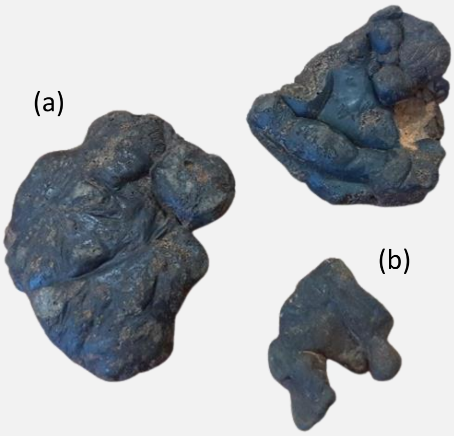
consolidated and slag is squeezed out (Bray 2006, 61). Expelled liquid slag often flies out as small droplets of spherical slag (Starley 1995, 1).

Secondary smithing where the refined iron is forged into artefacts takes place in a smithing hearth or blacksmith forge and will also generate slags (fig.4.83). While quantities of slag produced in bloom consolidation (primary smithing) can be substantial, secondary smithing frequently produces far less as much of the slag has already been removed (Juleff *pers. comm*.). A significant proportion of smithing slag is therefore comprised of iron oxide. As the iron is heated in the hearth, its surface oxidises, however this oxide separates as the iron is hammered and creates 'flake hammerscale' which subsequently falls into the hearth. Secondary smithing assemblages will as a result be dominated by hammerscale (McDonnell 1991, 1-6; Young 2012, 2; Juleff *pers. comm*.). The hammerscale, typically 1-3mm in size, reacts with materials within the hearth and forms slag of two morphological types; plano-convex hearth bottoms and amorphous lumps of smithing slag (McDonnell 1991, 3; Starley 1995, 1; Young

2012, 2). Smithing hearth bottoms typically form below the blowing hole (tuyere) where the hearth is at its hottest and the smith has optimum heat for working the iron (McDonnell 1991, 6; Crew 1996, 1). McDonnell (1991, 6-8) argues that the morphology of smithing slags may vary according to where they formed within the hearth as some react with the hearth lining, while others have a higher proportion of iron oxide. The length of time the slag is left in the forge to accumulate before being removed by the smith will also affect their size and thus the size they reach is largely determined by individual practice (Juleff *pers. comm*.). In the Roffey assemblage primary and secondary smithing slag was classified as Type 1(WR) with rust (i.e., amorphous slag but with a distinctive rusty appearance). The corrosion products and their high magnetism, reflects iron bloom inclusions fractured during primary smithing, or flake hammerscale from secondary smithing (Crew 1996, 1). It was not possible to distinguish between the primary and secondary smithing examples, however primary smithing slag will typically be greater in size and weight compared to slag generated in secondary smithing (although this is somewhat dependant on iron quantities, slag contents, and frequency at which a hearth was cleared) (Crew 1996, 1).

Figure 4.83 - *Secondary smithing taking place at a smithing hearth within a blacksmiths shop. (Author's image).*

Table 4.2 - *Slag types recovered from Roffey and their morphological characteristics.*

Slag Type	Description	
Type 1	**Furnace slag undiagnostic** *This slag solidified as amorphous lumps within the furnace. It is typically low to moderate density, has a very high porosity proportion from trapped gas bubbles and a high degree of fracture, from removal from the furnace and its friable nature.*	
Type1(WR)	**Primary and/or secondary smithing slag** *Originally this was classified as a subtype of type 1 for is amorphous shape, however re-assessment in the analysis process indicates it is slag from primary smithing (consolidation) of the bloom or slag from secondary smithing (making and repairing artefacts). It tends to be moderate density with a moderate to high porosity proportion. It is also highly magnetic from bloom or hammerscale inclusions. WR stands for 'with rust'.*	
Type 2	**Tap slag** *Slag released from the tapping arch of the furnace during a smelt. They can form cakes representing multiple flows (a) or are found as small single runs, possibly having escaped through cracks in the tapping arch (b). Typically, the upper surface retains the solidified runs of successive flows, while the underside may have impressions of the ground surface or pit that the slag flowed into, along with inclusions of ore, refractory material and charcoal dropped around the outside of the furnace. The majority of examples have a low viscosity and high density with moderate to very low porosity proportion. They tend to only be fractured on their outer edges but have a preserved upper and lower surface. Many are magnetic and have a magnetism concentrated on the upper surfaces where the slag runs are visible.*	(a)  (b)
Type 3	**Rod-shaped slag** *Cylindrical slag occurring in small numbers. It is suggested that this slag formed within the boring hole left from when the boring stick was inserted through the tapping arch, to inspect the furnace and release slag. The liquid tap slag eventually solidified and blocked this hole to leave slag of this morphology. It tends to have a moderate to high density and moderate to high porosity proportion.*	

Type 4

Furnace slag base

This was slag that collected in the base of the furnace. Unlike type 1 it has a distinct plano (a), plano-convex, or concave-convex (b) morphology, while some have a curved outer edge possibly from solidifying against the internal wall of the furnace. This slag is typically high to moderate density, with variable porosity proportion and fracture on the edges, where presumably it was broken to remove it from the furnace. Unlike tap slag it has moderate to high viscosity but still has charcoal and ground surface impressions on its underside.

(a)

(b)

Type 5

Furnace residues (vitrified refractory material and furnace lining)

While this is not only slag but also refractory material from the superstructure of the furnace, slag was often found adhering to one side. It is commonly found as amorphous lumps, however plano, plano-concave and plano-convex examples are present in the assemblage and may show the original curvature of the furnace walls. They are often moderate density and highly fractured. The adhering slag was often very corroded and rich in iron oxide. Traces of glassy vitrification is present in association to the clay in some instances.

Note: The full classification scheme can be found in Appendix B5.1

4.7.3 - *Slag types and technology at Roffey*

The grid fieldwalk, which covered the eastern and western geophysical anomalies, analysed an assemblage of 1591 slags with a combined weight of 177kg. This data is shown in tables and is presented by number of slags rather than weight, although these weights are available in Appendix B5.2 The decision to analyse by count was made as different slag morphologies will vary by weight and subsequent analysis may give a disproportional representation to heavier slag types. Dividing this slag into the five primary types, Furnace slag (Type 1) was the most numerous at 640 samples or 40% of the assemblage. Tap slag (Type 2) and furnace base slag (Type 4) were the second largest types at 389 samples (25%) and 391 (25%). As all three types form the waste of smelting, they show that smelting took place in both the east and west of Zone 1, and that

Table 4.3 – *Slag totals by type and their percentage of the total subsample from each grid*

	Smelting slags					Smithing slag	
Count	*Type 1*	*Type 2*	*Type 3*	*Type 4*	*Type 5*	*Type 1(WR)*	*Total*
Overall total	640 **40.2%**	389 **24.5%**	17 **1.1%**	391 **24.6%**	57 **3.6%**	97 **6.1%**	1591
Eastern Grid	462 **40%**	272 **23.6%**	15 **1.3%**	288 **25%**	45 **3.9%**	72 **6.24%**	1154
Western Grid	178 **40.7%**	117 **26.8%**	2 **0.5%**	103 **23.6%**	12 **2.8%**	25 **5.72%**	437

Table 4.4 – *Slag totals by weight and their percentage of the total subsample from each grid*

	Smelting slags					Smithing slag	
Weight (kg)	*Type 1*	*Type 2*	*Type 3*	*Type 4*	*Type 5*	*Type 1(WR)*	*Total*
Overall weight	74.4 **42%**	26.5 **15%**	1.8 **1%**	50 **28.2%**	7.8 **4.4%**	16.7 **9.4%**	177.1
Eastern Grid	57.8 **41.8%**	18.6 **13.5%**	1.3 **1%**	39.3 **28.4%**	7.1 **5.1%**	14.2 **10.2%**	138.2
Western Grid	16.6 **42.7%**	7.9 **20.3%**	0.4 **1.1%**	10.8 **27.7%**	0.7 **1.8%**	2.5 **6.4%**	38.9

furnaces in both locations were of the slag tapping variety. Unlike the Tudeley assemblage, Type 1, amorphous slag that solidified within the furnace and removed after the smelt, accounted for a higher proportion than Type 2, the slag that was tapped in liquid form from the furnace during the smelt. At Tudeley type 2 accounted for 91% of the assemblage (see 5.8.3). This could suggest a less sophisticated furnace technology was in use at Roffey, whereby the furnaces had to be emptied frequently of slag build up, an undertaking that would inevitably have damaged the structure. A greater build-up of slag in the furnace would also have compromised its effectiveness (Juleff *pers. comm*.). However, while this might be true if the assemblage was devoid of Type 2, the presence of tap slag shows that at least at some point in its history, the smelters made use of this furnace design. The presence of tap slag also has implications about how the furnace was operated such as the type of ore used and the ratio of ore and charcoal, which will affect the viscosity of the slag (Juleff *pers. comm*.). Consideration of the density and fracture of amorphous furnace slag (Type 1), shows how 89% of samples had a moderate to low density thus making it more susceptible to fracture. In 76% of cases this fracture occurred on all outer surfaces, causing the amorphous morphology. Tap slag (Type 2) in contrast to this with a high density in 83% of samples while fracture was limited to all or part edges (55% and 45%) but typically not the upper or lower surfaces. The Type 1 count is therefore likely to reflect a greater degree of fracture, broken both during its removal from the furnace and during attrition and exposure in the plough soil, and is therefore not an indication that furnace technology was different to other 14th century works like Tudeley (Table 4.6). The fractured nature of Type 1 samples also means other slag types may be present within the Type 1 assemblage but unidentifiable if they too are in a heavily fractured condition.

Furnace bottom slag (Type 4), formed 25% of the total grid sample. In 45% of samples, it was plano in shape, however unlike the tap slag which were also frequently plano in 60% of samples, the furnace bottom slag had no runnels or ropey texture on its upper surface characteristic of the tap slag that flowed from the furnace (Cleere and Crossley 1985, 46). Typically furnace bottom slags are plano-convex when complete, retaining the curvature of the furnace base and can provide indications of the furnace diameter, however as they are frequently broken during their removal from the furnace after the smelt, this shape is lost (Juleff *pers. comm*.). This is likely to be the case in the Roffey examples as a plano-convex shape was only present in 17%, although the size of small (38%) and medium (59%) samples means they are too small for this shape to be recognised (Table 4.5). Types 2 and 4 each represent a quarter of the assemblage at 24.4% and 24.5%. The addition of amorphous furnace slag (Type 1) however, which as discussed probably represents a disproportionate number due to their level of fracture, would nevertheless suggest that more slag solidified within the furnace than was tapped.

A total of 57 samples of furnace lining (Type 5) were identified. While Type 5 is not technically slag but vitrified clay, it often had slag adhering to one side and is collectively referred to here as refractory material. The sample only constituted 3.58% of the overall sample. This may be explained by its less robust nature, with 67% of Type 5 showing total fracture. Ploughing is likely to have destroyed much of this material, and it is also possible clay from redundant furnaces was crushed and re-used in the building of their successors. Of the 57 samples 8.8% were concave-convex, probably retaining the curvature of the furnace.

The presence of consolidation/smithing slag in the assemblage (Type 1(WR)), suggests both stage 1 (smelting) and stage 2 (smithing) were carried out in Zone

1. Smithing slag is created when slag impurities remaining within the iron bloom are separated in the refinement stage, through heating and hammering. Slag trapped within the bloom is expelled and collects in the base of the smithing hearth and in time builds up to form a cake (Juleff *pers. comm.*). This can occur both in the initial bloom consolidation stage and in later smithing. While the cakes often form a plano-convex ‘bun’ shape (ibid), 71% in the assemblage were amorphous, a probable reflection of post-depositional fracture. However, 28% were plano, concave-convex, plano-convex, or convex, which may reflect the shape of the original hearth. Type 1(WR) comprised 6% of the sample and was amorphous in 71% of instances and had total fracture in 91% of cases. While some examples may fall into the Type 1 category, Type 1(WR) was distinguished by its rusty appearance, where iron had oxidised, their moderate to high density (60% and 12%) and their high or high but isolated magnetism (40% and 17%). These are typical traits of consolidation and smithing slag.

The percentages of each slag type are presented in table 4.3 for the eastern and western grids. It is significant how each slag type was recovered in similar percentages between the eastern and western grids, and the greatest difference was in Type 2 slag, which was only 3% higher in the western grid. All other types had a difference of 1% or less. Just how usual the proportions of slag types are at other Wealden sites is hard to ascertain without the same classification scheme being applied. However, if the Roffey percentages are compared with the Tudeley assemblage where tap slag dominated, slag percentages would appear to vary between ironworks, perhaps reflecting different working practices, the ore to fuel ratios or the ore used. If the western and eastern grids were separate bloomeries, as the spatial distribution data suggests, the similarities in slag type proportions could indicate the standardisation of practice, similar furnace design or the use of similar sources of ore between the two sites. As both sites at Roffey were likely using the same source of ore, a similarity in slag type ratios might be expected. A discussion on skills, working practices and the secrets of making iron is made in Chapter 7, however if the similarities of slag types do equate to skills and technology between these two sites, these may be attributes of shared knowledge, standardisation of practice and skilled personnel who consistently obtained the same outcomes in the smelting operation (in iron produced as well as slag) which arguably may be seen as indications of a centre of production.

4.7.4 - *Viscosity*

Tap slag (Type 2), had the lowest viscosity with 97% of samples presenting low viscosity, with the upper surface of the majority having a ropey texture of slag runs (Table 4.9). The low viscosity demonstrates how the slag was tapped from the furnace through a tapping arch at the base. In many examples the runs were smooth and suggests it flowed from the furnace at a high velocity and indicates there was a good separation of slag from the iron within the furnace (Juleff *pers. comm*.). Multiple flow episodes dominated, while only 35% had single flows. While laminations caused by the accumulation of flows may have been fractured by ploughing at Roffey, the majority only demonstrated a couple of flow episodes for the undersides of 49% of examples had soil impressions from where when had solidified on the grounds surface therefore confirming their original thickness. It is probable that these flows are the outcome of single smelts, and that tap slag was regularly removed between smelting episodes. The Roffey Type 2 assemblage contrasts to the tap slag from Tudeley, where as many as 5-6 slag flows were present and had resulted in slags of greater thickness.

Table 4.5 – slag shape

Type	Slag shape ***(as % of total assemblage)*** *nd=not detected*									Total no.
	Plano concave %	**Amorphous %**	**Plano %**	**Concave convex %**	**Plano convex %**	**Convex %**	**Single rod %**	**Multiple rod %**	**Elongated %**	
Type 1	0.9	73.4	12.5	7.0	4.0	2.3	0.2	nd	0.9	640
Type 1(WR)	0.0	71.1	13.4	7.2	6.2	2.1	0.0	nd	0.0	97
Type 2	1.0	10.0	59.6	6.2	6.7	2.3	6.7	4.4	3.1	389
Type 3	nd	nd	nd	nd	nd	nd	88.2	5.9	5.9	17
Type 4	0.8	7.2	45.8	16.9	16.6	7.4	nd	nd	5.4	391
Type 5	1.7	50.9	33.3	8.8	1.8	1.7	nd	nd	1.7	57

Type	**Slag shape** *(as % of **Eastern Grid** assemblage) nd=not detected*									Total no.
	Plano concave %	**Amorphous %**	**Plano %**	**Concave convex %**	**Plano convex %**	**Convex %**	**Single rod %**	**Multiple rod %**	**Elongated %**	
Type 1	1.3	74.7	12.1	4.3	4.1	2.4	0.2	nd	0.9	462
Type 1(WR)	nd	73.6	11.1	6.9	5.6	2.8	nd	nd	nd	72
Type 2	1.1	9.2	66.2	6.3	5.5	1.5	4.4	3.3	2.6	272
Type 3	nd	nd	nd	nd	nd	nd	86.7	6.7	6.7	15
Type 4	0.7	6.6	45.5	21.2	14.2	7.3	nd	nd	4.5	288
Type 5	2.2	44.4	40.0	8.9	nd	2.2	nd	nd	2.2	45

Type	**Slag shape** *(as % of **Western Grid** assemblage) nd=not detected*									Total no.
	Plano concave %	**Amorphous %**	**Plano %**	**Concave convex %**	**Plano convex %**	**Convex %**	**Single rod %**	**Multiple rod %**	**Elongated %**	
Type 1	nd	70.2	13.5	10.7	2.3	2.3	nd	nd	1.1	178
Type 1 (WR)	nd	64.0	20.0	8.0	8.0	nd	nd	nd	nd	25
Type 2	0.9	12	44.4	6	9.4	4.3	12	6.8	4.3	117
Type 3	nd	nd	nd	nd	nd	nd	100.0	nd	nd	2
Type 4	1.0	8.7	46.6	4.9	23.3	7.8	nd	nd	7.8	103
Type 5	nd	75.0	8.3	8.3	8.3	nd	nd	nd	nd	12

Table 4.6 – *slag fracture*

Slag Type	**Fracture** *(as % of* ***total*** *assemblage) nd=not detected*				Total no.
	Total - all surfaces fractured %	**Partial - all edges fractured %**	**Partial - some edges fractured %**	**Complete - edges intact %**	
Type 1	76.4	21.1	2.2	0.3	640
Type 1 (WR)	90.7	7.2	1.0	1.0	97
Type 2	nd	54.5	45.0	0.5	389
Type 3	nd	17.6	82.4	0.0	17
Type 4	1.3	83.6	14.8	0.3	391
Type 5	66.7	33.3	nd	nd	57

Slag Type	**Fracture** *(as % of* ***Eastern Grid*** *assemblage) nd=not detected*				Total no.
	Total - all surfaces fractured %	**Partial - all edges fractured%**	**Partial - some edges fractured %**	**Complete - edges intact %**	
Type 1	73.8	22.7	3.0	0.4	462
Type 1 (WR)	93.1	5.6	1.4	nd	72
Type 2	nd	58.8	40.8	0.4	272
Type 3	nd	20.0	80.0	nd	15
Type 4	1.7	81.9	16.0	0.3	288
Type 5	66.7	33.3	nd	nd	45

Slag Type	**Fracture** *(as % of* ***Western Grid*** *assemblage) nd=not detected*				Total no.
	Total - all surfaces fractured %	**Partial - all edges fractured %**	**Partial - some edges fractured %**	**Complete - edges intact %**	
Type 1	83.1	16.9	nd	nd	178
Type 1 (WR)	84.0	12.0	nd	4.0	25
Type 2	nd	44.4	54.7	0.9	117
Type 3	nd	nd	100.0	nd	2
Type 4	nd	88.3	11.7	nd	103
Type 5	66.7	33.3	nd	nd	12

Table 4.7 – *slag density*

Slag Type	Density *(as % of **total** assemblage) nd=not detected*					Total no.
	High	Moderate	Low	Very low	No data	
Type 1	7.7%	39.2%	50.6%	2.3%	0.2%	640
Type 1 (WR)	12.4%	59.8%	27.8%	nd		97
Type 2	83.8%	13.4%	2.8%	nd		389
Type 3	41.2%	52.9%	5.9%	nd		17
Type 4	37.9%	43.7%	17.1%	0.8%	0.5%	391
Type 5	14%	59.7%	24.6%	1.8%		57

Slag Type	Density *(as % of **Eastern Grid** assemblage) nd=not detected*					Total no.
	High	Moderate	Low	Very low	No data	
Type 1	6.3%	39.6%	51.3%	2.6%	0.2%	462
Type 1 (WR)	5.6%	59.7%	34.7%	nd		72
Type 2	81.6%	15.4%	2.9%	nd		272
Type 3	40%	53.3%	6.7%	nd		15
Type 4	33.7%	43.8%	21.2%	1%	0.4%	288
Type 5	13.3%	64.4%	22.2%	nd		45

Slag Type	Density *(as % of **Western Grid** assemblage) nd=not detected*					Total no.
	High	Moderate	Low	Very low	No data	
Type 1	11.2%	38.2%	48.9%	1.7%		178
Type 1 (WR)	32%	60%	8%	nd		25
Type 2	88.9%	8.6%	2.6%	nd		117
Type 3	50%	50%	nd	nd		2
Type 4	49.5%	43.7%	5.8%	nd	1%	103
Type 5	16.7%	41.7%	33.3%	8.3%		12

Table 4.8 – *slag porosity*

Slag type	**Porosity** *(as % of **total** assemblage) nd=not detected*							Total no.
	Very high	**High**	**Moderate**	**Low**	**Very low**	**None**	**No data**	
Type 1	53.3%	27%	15.3%	2.7%	0.5%	nd	1.3%	640
Type 1 (WR)	16.5%	24.7%	29.9%	16.5%	10.3%	2.1%		97
Type 2	1%	6.9%	29%	34.7%	26.7%	1.5%		389
Type 3	11.8%	35.3%	52.9%	nd	nd	nd		17
Type 4	10.7%	28.9%	36.1%	21.2%	3.1%	nd		391
Type 5	5.3%	17.5%	26.3%	33.3%	17.5%	nd		57

Slag type	**Porosity** *(as % of **Eastern Grid** assemblage) nd=not detected*							Total no.
	Very high	**High**	**Moderate**	**Low**	**Very low**	**None**	**No data**	
Type 1	55.2%	25.5%	14%	2.8%	0.7%	nd	1.7%	462
Type 1 (WR)	20.8%	27.8%	37.5%	8.3%	5.6%	nd		72
Type 2	1.5%	7%	28.7%	33.1%	28.3%	1.5%		272
Type 3	13.3%	33.3%	53.3%	nd	nd	nd		15
Type 4	13.5%	33.3%	34%	15.6%	3.5%	nd		288
Type 5	4.4%	22.2%	20%	31.1%	22.2%	nd		45

Slag type	**Porosity** *(as % of **Western Grid** assemblage) nd=not detected*							Total no.
	Very high	**High**	**Moderate**	**Low**	**Very low**	**None**	**No data**	
Type 1	48.3%	30.9%	18.5%	2.3%	nd	nd		178
Type 1 (WR)	4%	16%	8%	40%	24%	8%		25
Type 2	nd	6.8%	29.9%	38.5%	23.1%	1.7%		117
Type 3	nd	50%	50%	nd	nd	nd		2
Type 4	2.9%	16.5%	41.8%	36.9%	1.9%	nd		103
Type 5	8.3%	nd	50%	41.7%	nd	nd		12

Table 4.9 – *slag viscosity*

Slag type	**Viscosity** *(as % of **Total** assemblage) nd=not detected*			Total no.
	High	**Moderate**	**Low**	
Type 1	75.3%	22.5%	2.2%	640
Type 1 (WR)	93.8%	6.2%	nd	97
Type 2	3.1%	0.3%	96.7%	389
Type 3	11.8%	70.6%	17.7%	17
Type 4	44.3%	36.1%	19.7%	391
Type 5	91.3%	7%	1.8%	57

Slag type	**Viscosity** *(as % of **Eastern Grid** assemblage) nd=not detected*			Total no.
	High	**Moderate**	**Low**	
Type 1	72.5%	24.9%	2.6%	462
Type 1 (WR)	91.7%	8.3%	nd	72
Type 2	4.4%	0.4%	95.2%	272
Type 3	6.7%	73.3%	20%	15
Type 4	40.3%	38.9%	20.8%	288
Type 5	93.3%	4.4%	2.2%	45

Slag type	**Viscosity** *(as % of **Western Grid** assemblage) nd=not detected*			Total no.
	High	**Moderate**	**Low**	
Type 1	82.6%	16.3%	1.1%	178
Type 1 (WR)	100%	nd	nd	25
Type 2	nd	nd	100%	117
Type 3	50%	50%	nd	2
Type 4	55.3%	28.2%	16.5%	103
Type 5	83.3%	16.7%	nd	12

Table 4.10 – *slag inclusions*

Slag type	Inclusions *(as % of **Total** assemblage) nd=not detected*					Total no.
	Ore %	Charcoal %	Refractory %	Iron / rust %	No inclusions %	
Type 1	3.6	4.5	9.5	31.6	57.2	640
Type 1 (WR)	2.1	21.7	25.8	53.6	12.4	97
Type 2	31.4	4.4	25.5	17	42.9	389
Type 3	17.7	0	5.9	47.1	29.4	17
Type 4	28.1	3.1	16.1	23.8	44.8	391
Type 5	1.8	1.8	96.5	63.2	1.8	57

Slag type	Inclusions *(as % of **Eastern Grid** assemblage) nd=not detected*					Total no.
	Ore %	Charcoal %	Refractory %	Iron / rust %	No inclusions %	
Type 1	3.7	5.8	11	34	53.5	462
Type 1 (WR)	2.8	25	31.9	43.1	12.5	72
Type 2	34.2	0.7	31.3	19.9	38.6	272
Type 3	13.3	0	6.7	46.7	33.3	15
Type 4	27.4	3.8	17.7	23.6	43.4	288
Type 5	2.2	2.2	97.8	66.7	2.2	45

Slag type	Inclusions *(as % of **Western Grid** assemblage) nd=not detected*					Total no.
	Ore %	Charcoal %	Refractory %	Iron / rust %	No inclusions %	
Type 1	3.4	1.1	5.6	25.3	66.9	178
Type 1 (WR)	0	12	8	84	12	25
Type 2	24.8	12.8	12	10.3	53	117
Type 3	50	0	0	50	0	2
Type 4	30.1	1	11.7	24.3	48.5	103
Type 5	0	0	91.7	50	0	12

Table 4.11 – *slag magnetism*

Slag type	**Magnetism** *(as % of **Total** assemblage) nd=not detected*								Total no.
	High	**High (isolated)**	**Moderate**	**Moderate (isolated)**	**Low**	**Low (isolated)**	**Non-magnetic**	**No Data**	
Type 1	2.3%	13.1%	5%	19.7%	17.8%	21.4%	20.5%	0.2%	640
Type 1 (WR)	40.2%	16.5%	9.3%	15.5%	8.3%	9.3%	1%		97
Type 2	4.1%	15.4%	14.4%	29.6%	13.9%	13.6%	9%		389
Type 3	nd	5.9%	17.7%	5.9%	23.5%	29.4%	17.7%		17
Type 4	1%	14.3%	7.7%	17.4%	21%	19.7%	18.9%		391
Type 5	12.3%	31.6%	1.8%	12.3%	14%	17.5%	10.5%		57

Slag type	**Magnetism** *(as % of **Eastern Grid** assemblage) nd=not detected*								Total no.
	High	**High (isolated)**	**Moderate**	**Moderate (isolated)**	**Low**	**Low (isolated)**	**Non-magnetic**	**No Data**	
Type 1	3%	11%	5.2%	21.2%	20.1%	18.4%	20.8%	0.2%	462
Type 1 (WR)	33.3%	13.9%	12.5%	18.1%	11.1%	9.7%	1.4%		72
Type 2	5.5%	14.3%	16.2%	24.3%	15.8%	15.1%	8.8%		272
Type 3	nd	6.7%	20%	6.7%	26.7%	20%	20%		15
Type 4	1.4%	12.9%	9.4%	16.3%	22.6%	19.1%	18.4%		288
Type 5	15.6%	33.3%	nd	13.3%	15.6%	13.3%	8.9%		45

Slag type	**Magnetism** *(as % of **Western Grid** assemblage) nd=not detected*								Total no.
	High	**High (isolated)**	**Moderate**	**Moderate (isolated)**	**Low**	**Low (isolated)**	**Non-magnetic**	**No Data**	
Type 1	0.6%	18.5%	4.5%	15.7%	11.8%	29.2%	19.7%		178
Type 1 (WR)	60%	24%	nd	8%	nd	8%	nd		25
Type 2	0.9%	18%	10.3%	41.9%	9.4%	10.3%	9.4%		117
Type 3	nd	nd	nd	nd	nd	100%	nd		2
Type 4	nd	18.5%	2.9%	20.4%	16.5%	21.4%	20.4%		103
Type 5	nd	25%	8.3%	8.3%	8.3%	33.3%	16.7%		12

4.7.5 - *Inclusions*

Table 4.10 shows the percentages of predominant inclusions present within each slag type. For the most numerous types (1,2 and 4), between 40% and 60% had inclusions of ore, charcoal, refractory material and rusty inclusions. Ore, which ranged in colour from dark brown to red, was most abundant in types 2 (31%) and 4 (28%) and its colour suggests it had been intentionally roasted in preparation for smelting. In both types the ore was concentrated on the underside of the slag and probably adhered to the Type 2 as it ran over dropped fragments on the periphery of the furnace, whereas those in Type 4 are likely to be partially reduced ore from within the furnace. The absence of many large inclusions of ore, with the majority of inclusions being under 5mm, may suggest either the ore was crushed to a fine consistency before being placed in the furnace, or the smelters were fastidious in avoiding wastage. Only 3.6% of amorphous furnace slag (Type 1) contained ore inclusions.

Charcoal inclusions were only present in between 0 - 4.5% of slags for all types, except for Type 1(WR) (primary and secondary smithing slag), where 22% of samples contained charcoal. Crew (1996, 1) explains how smithing slag forms not at the bottom of the hearth, but adheres to the hearth wall, under the tuyere, and rests on the bed of charcoal. This results in the charcoal becoming trapped in the base of the smithing hearth cake. This therefore supports the interpretation that this slag type can be attributed to smithing although whether this was primary or secondary smithing is unclear. Primary smithing slag tends to be of greater size and heavier than secondary smithing slag, and as 60% of Type 1(WR) samples were medium sized between 5 -10cm^2, this would suggest they represent the waste from bloom consolidation (although there are multiple variables that can affect the size of slag of both smithing stages, see Crew 1996, 1).

Refractory inclusions of clay from either the furnace or the unblocking of the tapping arch were recorded in all slag types although only as smaller percentages in Type 1 (9.5%) and Type 3 (5.9%). A quarter of Type 2 tap slag had refractory inclusions, that probably originated from the opening the tapping arch. However, the western site had a lower percentage of Type 2 slag with refractory inclusions (12%) compared to the eastern site (31.3%) which may suggest variations in furnace design, the robustness of the clay superstructure, or the number of times the furnace structure was repaired or replaced before fracturing under the extreme temperatures. The 25.8% of examples of smithing slag (Type 1 (WR)) probably represents cases where the smithing hearth cake formed against the clay hearth wall, however, once again the quantities of refractory inclusions were lower on the western site.

The elevated presence of iron is indicated by corrosion products on the surface of the slags. This was observed in all types but was highest in Type 1(WR), Type 3 (47.1%) and Type 5 (63.2%). While 53.6% of Type 1 (WR) had conglomerates of corroded iron deposits, all examples had traces of surface corrosion, indicative of a high iron content. This can be attributed to either primary smithing when small fragments of bloom became detached during consolidation and subsequently entrapped in the slag. Type 5 The smelting slags that had corrosion deposits reflects the iron oxide (Fe_2O_3) content in the slag. The similarity in percentages of corrosion deposits, between the eastern and western grids would indicate similar technology and processes were used between the two locations.

4.7.6 - *Magnetism*

Magnetism was divided into low, moderate and high, based upon the strength of the magnets pull upon the sample (Table 4.11). These were also recorded where magnetism was isolated, probably reflecting internal inclusions of bloom fragments or isolated ore inclusions that had become magnetised through roasting. Type 1(WR) presented the highest magnetism with 57% retaining either high or high isolated magnetism. Slags from smithing are frequently magnetic and this is sometimes due to inclusions of iron bloom fragments or hammerscale, depending on whether they originate from primary or secondary smithing (Crew 1996, 1). This is supported by the high percentage with corrosion deposits outlined above. The magnetism in smithing slag differed significantly between the eastern and western sites. A total of 60% of samples from the western site had high magnetism compared to 33% in the east. The overall high magnetism would indicate a more homogenous morphology that may form in slags created in secondary smithing through the build-up of hammerscale in the hearth. Isolated magnetism could potentially be attributed to primary smithing when a sample is heterogeneous and has random inclusions of iron bloom. Therefore, the higher percentage in the west is a potential location where secondary smithing took place.

The smelting slag had either moderate or high isolated magnetism. Type 2 had 29.6% with a moderate magnetism which was frequently isolated to the upper surface, perhaps indicating that later flows of slag from the furnace had a higher iron oxide content that the earlier flows (presumably since more iron had been separated by this stage in the process).

4.7.7 - *Experimental comparison*

It is useful to examine the assemblage in relation to experimental smelting as indications of different methodological steps within the process. WIRG carry out experimental smelts at Pippingford on Ashdown Forest in a furnace morphologically similar to excavated examples (Smith 2013). A smelt on the 14th May 2022 allowed a photographic record to be made and observations on the slag morphologies produced and at what stage, which could be compared to the Roffey assemblage.

The furnace made use of a tapping arch at the front which had been blocked by clay. Immediately to the front of this tapping arch was a shallow pit, intended to catch escaping slag (fig.4.84). It was notable how this pit contained debris from charging the furnace including small fragments of ore and charcoal, which had collected here as alternating charges of both were loaded in the top of the furnace and smaller particles missed their intended target. To break the tapping arch, an iron rod was driven though it to create a small hole approximately 70mm wide

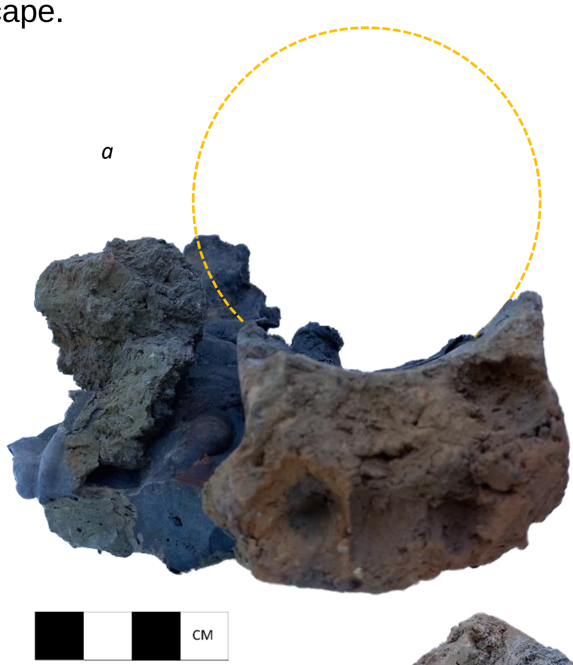
Figure 4.84 - *The furnace is charged with ore and charcoal. At the base of the furnace the tapping arch is blocked with clay and a small pit to catch tapped slag dug adjacent to the arch (yellow). This pit collects the early runs of tap slag (Type 2) that escape through cracks in the tapping arch. (Author's image).*

Figure 4.85 - *Types 2 and 3: A boring stick is inserted through the tapping arch. (Author's image).*

(figs 4.85-4.86). The social significance of this 'boring stick' is discussed in Chapter 5. Fragments of the fractured refractory material from the tapping arch collected within the tapping pit. The hole left by the boring stick allowed liquid tap slag to escape into the pit (Juleff 1998, 82). Some solidified as single runnels while others collected in the pit as a small 'cakes' of slag, more typical of the Roffey assemblage and not like the thick cakes identified at Tudeley (fig.4.86). The small single runnels were very friable and low density, fracturing as they were knocked away from the boring hole (fig.4.87a). They are therefore unlikely to survive in quantity within a ploughed field, although several of these isolated runnels were recovered particularly in the north-eastern corner of the site. These likely represent either early flows or final trickles in tapping.

While no significant quantities of tap slag were produced in this smelt, the slag that was produced ran into the tapping pit whereby the fragments of charcoal, ore and refractory adhered to it. These adhered most densely to the undersides, but in some instances were entrapped on the upper surface too as further sections of the tapping arch fractured. Once cooled, the refractory material easily broke away from the slag and would unlikely survive in the plough soil in its original quantities in the examples at Roffey particularly in examples in figure 4.89.

However, they demonstrate how the undulated texture seen in many of these examples were created. In some tap slag examples from Roffey, large voids recorded as 'large broken bubbles' were recorded on the upper surfaces, however as figure 4.88b demonstrates, these could just as easily have been where refractory inclusions were once present. During the smelt, the tapping pit was cleared several times which prevented the build-up of thick slag cakes such as those at Tudeley. The fewer flow episodes and narrower thickness of samples of Type 2 at Roffey therefore suggests the regular clearing away of slag was practiced here and is suggestive of furnaces with enough capacity to produce large quantities of slag that required frequent clearing to allow further slag to escape.



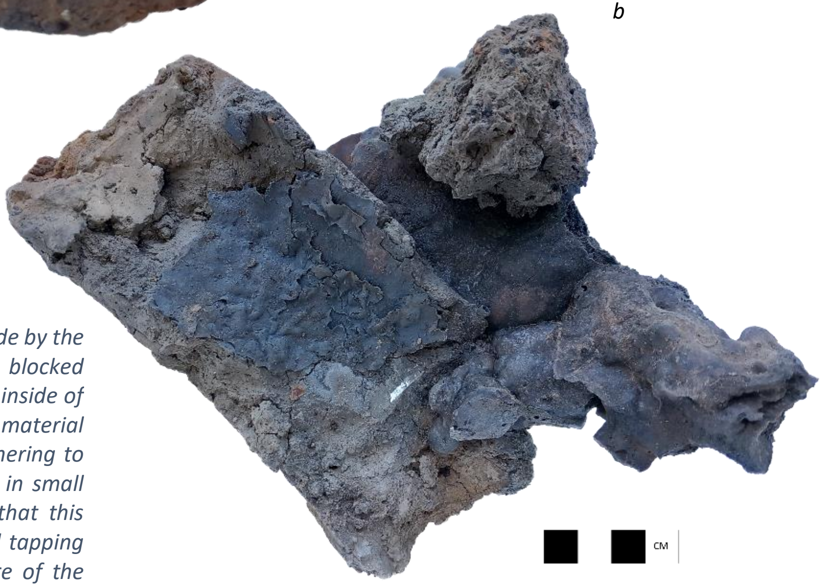


Figure 4.86 - *Traces of the hole made by the boring stick driven through the blocked tapping arch. Slag adhering to the inside of this hole can be seen in b. Vitrified material and clay lining often with slag adhering to one face was recovered at Roffey in small amounts (3.58%) and it is likely that this originated from either the blocked tapping arch or the internal superstructure of the furnace. (Author's image).*

Figure 4.87 - *Runs of tap slag are released, in some cases solidifying as vertical flows (a), while others amalgamate in the tapping pit (b) (see below). Further flows accumulate in the pit leading to the formation of slag cakes demonstrating layers of flows. The morphology of type 2 slag at Roffey suggest these were removed during the smelt. However, at Tudeley flows of tap slag were allowed to build up into thick cakes, possibly over several consecutive smelts. Refractory material from the tapping arch adhere to the base of the slag. Some slag solidifies in the hole left by the boring stick to create Type 3 rod slag. (Author's image).*

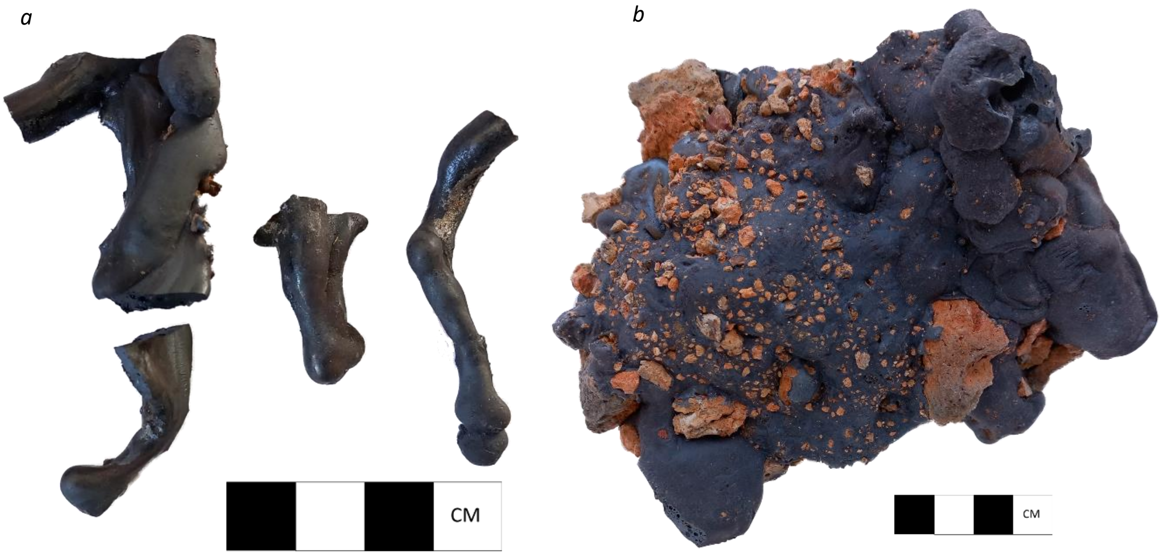


Figure 4.88 - *Tap slag. Some solidifies as vertical runnels (a) while heavier flows accumulate within the tapping pit. The examples in 'a' were easily fractured and may not survive well within plough soil. Both types were recovered at Roffey, although 'b' was more numerous. Refractory inclusions from the broken tapping arch became embedded in the upper and underside surfaces of the slag in 'b' and may explain why some examples from Roffey had large cavities on their upper surfaces, marking the former positions of refractory inclusions. (Author's image).*

Figure 4.89 - *Examples of Type 2 slag recovered from Roffey. Many of the examples only showed 2-3 flows, unlike the large cakes of slag at Tudeley. They would suggest that like the experimental smelt, tap slag was removed from the tapping pit during the smelt, preventing the formation of large slag cakes. Slag 'a' appears to retain the lower edge of the hole made by the boring stick and like Type 3 slag, solidified in the hole. (Author's image).*

Figure 4.90 - *The boring stick was used to fully open the tapping arch which released mixtures of unburnt charcoal and amorphous slag, at Roffey classified as Type 1. (Author's image).*

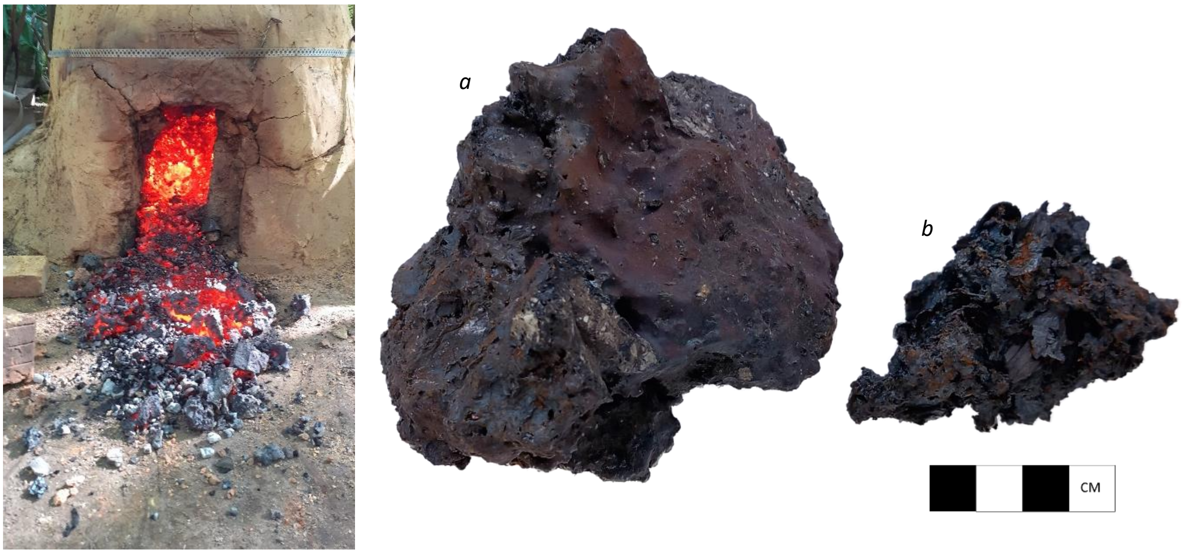


Figure 4.91 - *Slag remaining in the furnace solidifies to form Type 4 furnace bottom slag with a plano or plano-convex morphology. Other slag collects as amorphous lumps heterogeneous in nature with low to moderate density and some containing high inclusions of charcoal (b). This slag is raked out through the tapping arch causing further fracture.*

When a reducing temperature had been achieved and the bloom was formed – presumably in the past indicated by the purple flame at the top of the furnace and visible at the base, the tapping arch was completely unblocked (figs 4.90-4.91). In the Weald, lumps of clay with fingerprints have been found on bloomery sites and interpreted as the clay used for blocking the tapping arch. They often have a vitrified surface of green glaze from contact with wood ash on the furnace interior (Cleere and Crossley 1985, 50). It is likely that some of the Type 5 examples from Roffey are from the tapping arch, while others were internal furnace lining and sometimes have vitrified slag and corroded iron on one surface (fig.4.92).

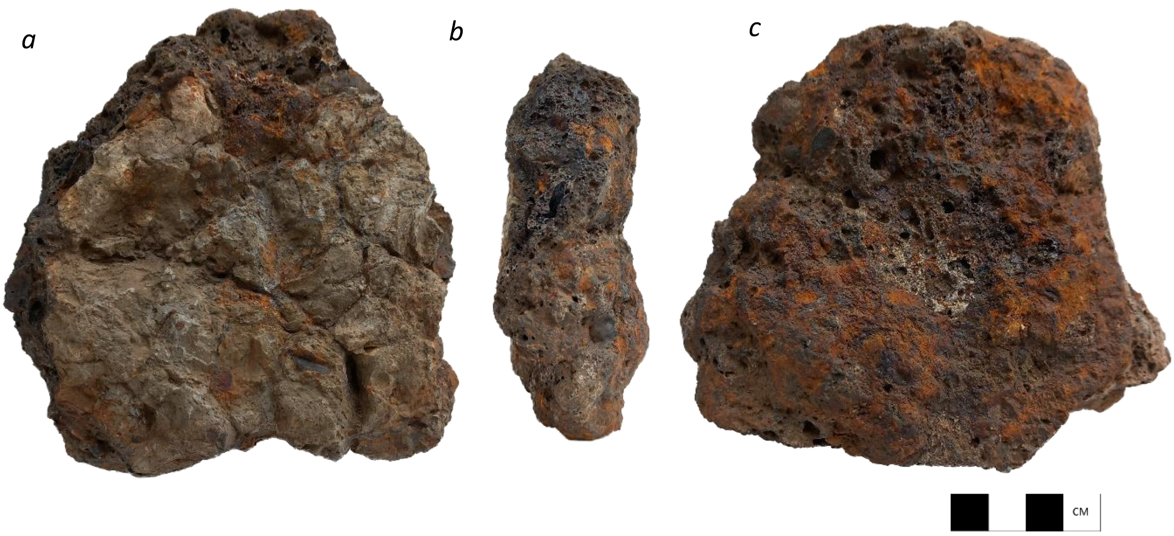


Figure 4.92 – *Type 5 slag from Roffey. One surface typically is comprised of refractory material from the superstructure of the furnace or blocked tapping arch (a). The interior face (c) often has vitrification, adhering slag and a high magnetism. The profile (b) shows the concave-convex shape of this sample, possibly retaining the curvature of the furnace. (Author's image).*

The contents of the furnace, which included the bloom and furnace slag was raked out through the open arch. The slag here was amorphous, moderate to low density and with high porosity, typical of the Type 1 at Roffey. It was also notable how this slag was rich in charcoal inclusions that made some fragments friable – it could be seen how in a ploughed context, the structure of this slag, weakened by the charcoal inclusions (figs 4.91 and 4.93-4.95), would be easily fractured into the amorphous state seen in the examples at Roffey. This material quickly removed along with unburnt charcoal and dumped approximately 20m away in a heap containing slag from previous smelts. If similar practices were used at Roffey, and had the slag heaps remained intact, recognisable strata of slag types might have been visible with Type 2 and 3 subsequently overlaid by Types 1 and 4.

Figure 4.93 - *Tap slag with refractory material from the tapping arch adhering to the underside (a). It can be seen how the slag has a smooth undulated texture which parallels examples from Roffey (below). B and d show evidence of soil adhering to the underside which was also seen as impressions in Type 2 and 4 slag at Roffey, the soil presumably wearing away over time. (Author's image).*

Figure 4.94 - *The underside of tap slag examples from Roffey. The smooth undulated texture parallels the experimental samples above and indicates that in the same way this slag once had refractory material adhering to its underside. 25.5% of the Roffey Type 2 assemblage had refractory inclusions remaining within the slag, while other inclusions such as ore also dominated (31.4%). (Author's image).*

Figure 4.95 - *The bloom is consolidated, and slag is driven off and build up within the hearth to form consolidation slag or primary smithing slag. This was recorded as Type 1 (WR) (right) at Roffey and constituted 6.10% of the assemblage. (Author's image).*

4.8 - Artefactual evidence of iron-production

Fieldwalking recovered several artefacts that appear to have an association with iron-production in Zone 1. They included a sandstone slab, possibly the remains of a former hearth and whetstones, a tool used by smiths.

4.8.1 - *Possible sandstone hearth stone*

Five fractured pieces of fine-grained sandstone were recovered, to the south of the Eastern fieldwalking grid, overlying anomalies A5-A10. Each had been fashioned into slabs of varying thickness from 25-42mm. Five of the thicker fragments came from the same slab and displayed recent fracture on their outer edges (fig.4.96). Gashes on the upper surfaces are likely to have been the result of plough damage, however the absence of abrasion on their underside, suggests that until recently this slab had remained in situ, and their close spatial distribution over an area of 10m² indicated ploughing had not dragged them far from their original context. The upper surfaces of the five slab fragments also had burnt discolouration and soot. The potential smithing hearth found in 1985 was interpreted as a hearth set on a sandstone plinth. The sooting and thickness of the fieldwalk examples, along with their proximity to furnace anomalies, could suggest they too were part of a heath plinth or possibly a stone base on which the furnaces were built on.

Figure 4.96 – *Sandstone slab fragments, possibly the stone base of a raised hearth or a plinth a furnace was built on. (Author's image).*

4.8.2 - *Whetstones*

Three incomplete whetstones were recovered from two locations within the survey grid (fig.4.97). Whetstones 1 and 3 were found within the western grid, while Whetstone 2 was recovered in the eastern grid, adjacent to anomalies A5-A10. Whetstones, used for the sharpening of blades, are often hard to date with any precision and changed little in their design from the Roman period through to the post medieval period. However, in the case of these examples, their association with broadly 14th and 15th century pottery would indicate that they too are contemporary with the medieval occupation of the site. Whetstone 1 is made of a fine-grained sandstone and is conical in shape, while Whetstones 2 and 3 are trapezoidal and made from schist, probably Norwegian Ragstone.

The fine-grained sandstone of Whetstone 1 was potentially sourced locally from one of the sandstone outcrops near Horsham. There is a widespread distribution of sandstone whetstones originating from the Weald, found throughout Roman Britain and on the continent in both military and urban contexts (Reniere et al 2018, 314-329). A Wealden whetstone industry appears to have continued into the medieval period for at Anglo-Saxon sites including West Stow, Suffolk and Sutton Courtenay, Berkshire examples of whetstones believed to have been made of Kentish Rag stone have been identified (Evison 1975). Allen (2014) however has argued that some Roman whetstones previously identified as Kentish Rag, may instead be sandstones from the Weald which may be true for the Anglo-Saxon examples.

Norwegian Ragstone, used in Whetstones 2 and 3, became the most widely used stone source for whetstone manufacture during the medieval period (Moore 1978, 70-72). Their discovery is indicative of the wider connections Wealden ironworkers had with medieval Europe to obtain goods from greater distances most probably through down-the-line exchange. The importance of Horsham as a local exchange centre is discussed in Chapter 3, and its connections with London which in turn had trade links with Scandinavia, no doubt facilitated the movement of such goods to periphery settlements such as Roffey.

The economic and social significance of whetstones can also be considered. The 1344 account of the smithy at Roffey omits any reference to whetstones within the inventory of equipment. The fact that the arrows supplied from Horsham had to have ‘heads well sharpened’ demonstrates the need for whetstones within a smithy (Lower 1870, 239). Andrews-Sanchez (2017) suggests whetstones were not commonly used in the finishing stages of newly forged blades, with more efficient grindstones instead being employed by smiths. However, for small items such as arrows, whetstones would have been more practical. The association of whetstones with smiths is recorded in contemporary accounts where they were used to punish individuals accused of lying. In 1371 a London smith named Nicholas Mollere was ‘…*condemned to the pillory and to have a whetstone hung from his neck for spreading false reports touching merchant strangers being allowed to trade as freely as freemen*…’ (Translated by Sharpe 1905; 283-288).

Their absence from historical inventories may suggest they were personal objects belonging to the smiths themselves and not part of the communal equipment of the forge. Medieval whetstones have been found with perforated holes, enabling a cord to be attached for carrying and safe storage, while other Roman and Viking examples are incised with Latin or Runic inscriptions. They are also found as grave goods such as an elaborately carved example from Sutton Hoo (Evison 1975, 75-83). Their status as personal possessions and use in the punishment of smiths emphasise their symbolic nature and role in defining the identity of smiths which takes them beyond simply utilitarian items.

Figure 4.97 – *Whetstones recovered during fieldwalking at Roffey. Whetstone 1 is made of a fine-grained sandstone and is conical in shape, 35mm long and tapering in width from 30mm to 26mm. Whetstones 2 and 3 however are trapezoidal in shape and made from schist stone, probably Norwegian Ragstone. Whetstone 2 is 96mm long, 44mm wide and 40mm at its narrowest point, where prolonged use has worn the stone along its vertical edge. Its thickness is 11mm and has a slightly curved profile. Whetstone 3 has a length of 56mm and a width of 43mm. Its varying thickness ranges from 25mm to 19mm, which again indicates use wear. (Author's image).*

4.9 – Pottery evidence

Pottery was also collected during fieldwalking and classified into four wares which were based on the classification scheme used by Holgate in the 1985 excavation at Roffey. Table 4.12 and figure 4.99 provide a description of each type and the totals recovered. Of the four main wares, wares 1 and 2 predominated and will be presented here.

Table 4.12 - *pottery types identified at Roffey, based on the classification scheme used by Holgate in 1985*

		Total sherds recovered		
Ware type	**Description (from Holgate 1985)**	1985 excavation	2020 Grid fieldwalk	2020 Transect fieldwalk
Ware 1	Fine sandy buff or orange wares, often including small flecks of mica; includes painted wares and wares with internal and/or external yellow-green glaze.	197	693	114
Ware 2	Fine sandy white wares, including wares with internal and/or external green glaze. These sherds are Surrey White wares, referred to as 'Coarse Boarder Ware' Date range: Late 14th century - 15th century.	159	181	55
Ware 3	Fine sandy wares. These sherds represent Cheam white ware Date range: Late 14th century - 15th century.	2	2	0
Ware 4	Fine sandy white wares with internal and external green glaze. These sherds are 'Tudor green' wares. Date range: late 14th century - early 16th century.	37	7	1

4.9.1 - *Ware 1*

The most numerous ware recovered from each fieldwalk and the 1985 excavation was Ware 1 characterised as fine sandy buff or orange wares. The grid fieldwalk produced the highest count equating to 79% of the total. Its distribution is plotted on figure 4.98 and 4.100 and shows the greatest distribution was in the east of Zone 1 where a high density of up to 20 sherds was present 20m north of the southern boundary and close to the anomalies of D1 and D2. Smaller densities were present along the southern boundary and to the west of Zone 1, where smelting anomalies A1-A3 were located, and apart from the north-eastern corner, the north of Zone 1

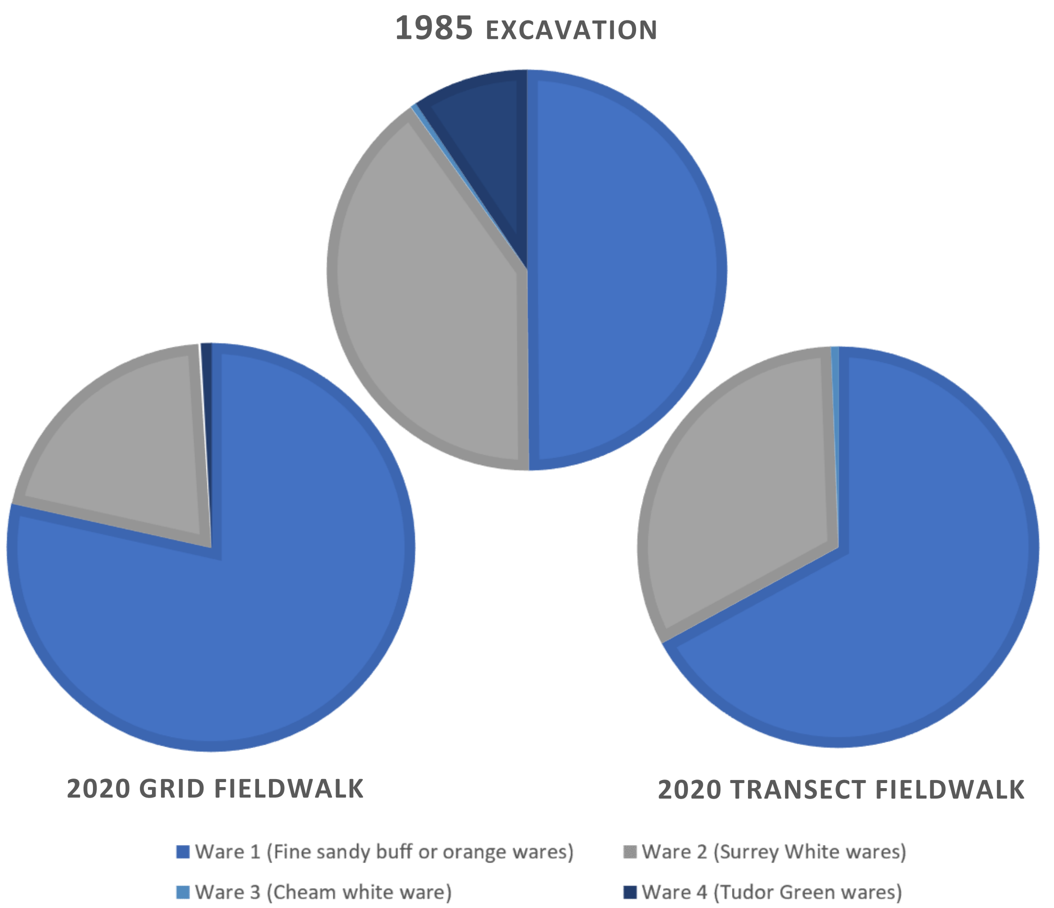


Figure 4.98 – *The four principal pottery wares recovered in in Zone 1 and their percentages in the 1985 excavation and 2020 fieldwalking surveys. (Author's image).*

was devoid of pottery. Body sherds formed the highest sherd type recovered, which is to be expected, however the 25 handles recovered, suggests jugs and pitchers comprised a large proportion of this assemblage (figs 4.103 and 4.106). In total, 37% of the samples recovered from the grid fieldwalk had internal or external glaze, frequently mottled green, while 48 examples were decorated often with incised lines, combing, thumb prints, and in two examples the applied figurine, typical of 'face jug' forms (figs 4.105 and 4.107). Holgate (1985) interpreted the Ware 1 recovered in the 1985 excavation as Graffham ware, a local pottery that is thought to have been made 32km southwest of Roffey (Aldsworth 1990). Evidence of pottery manufacture in the assemblage may however suggest some of this ware was produced at Roffey.

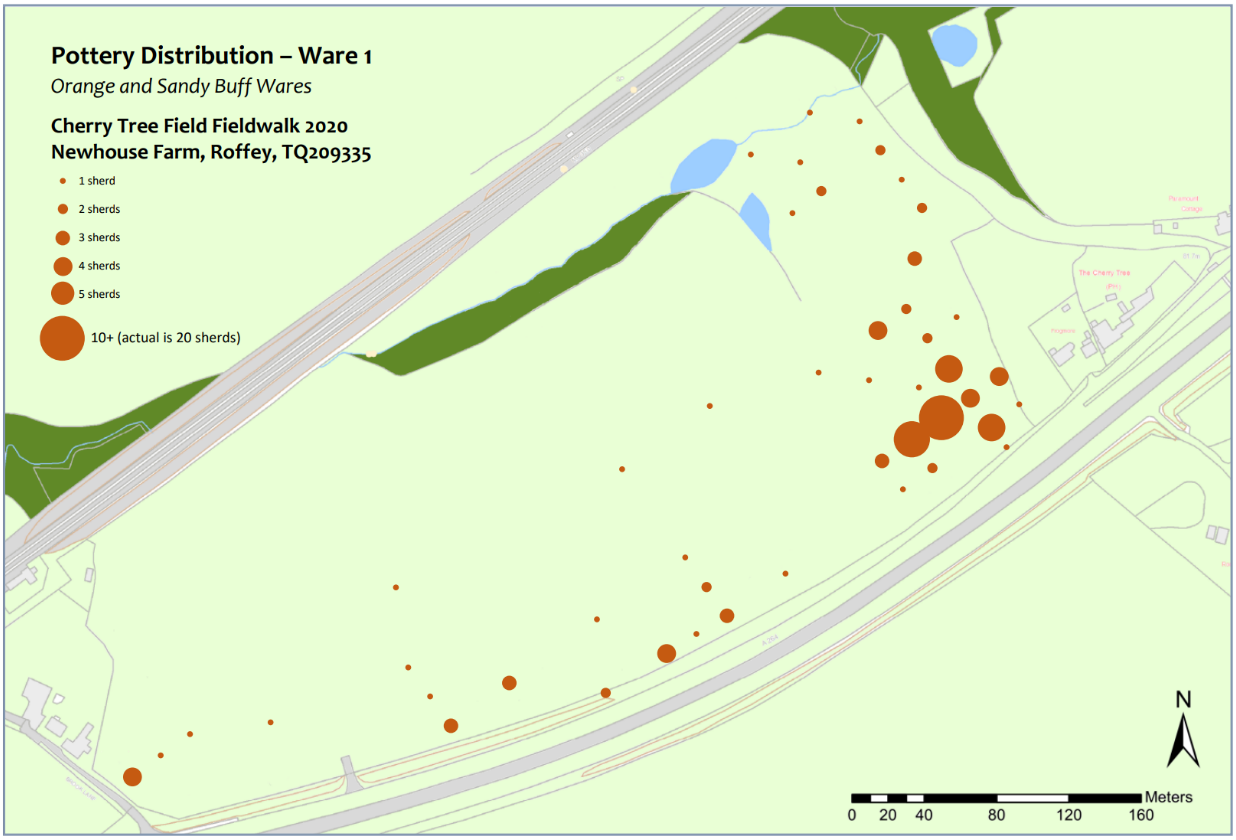


Figure 4.99 – *Distribution of Fine sandy buff or orange wares, Ware 1, from the transect fieldwalk. A high density is visible in the south-east of Zone 1, where up to 20 sherds were recovered. Author's data overlaid on Digimap OS Collection base map.*

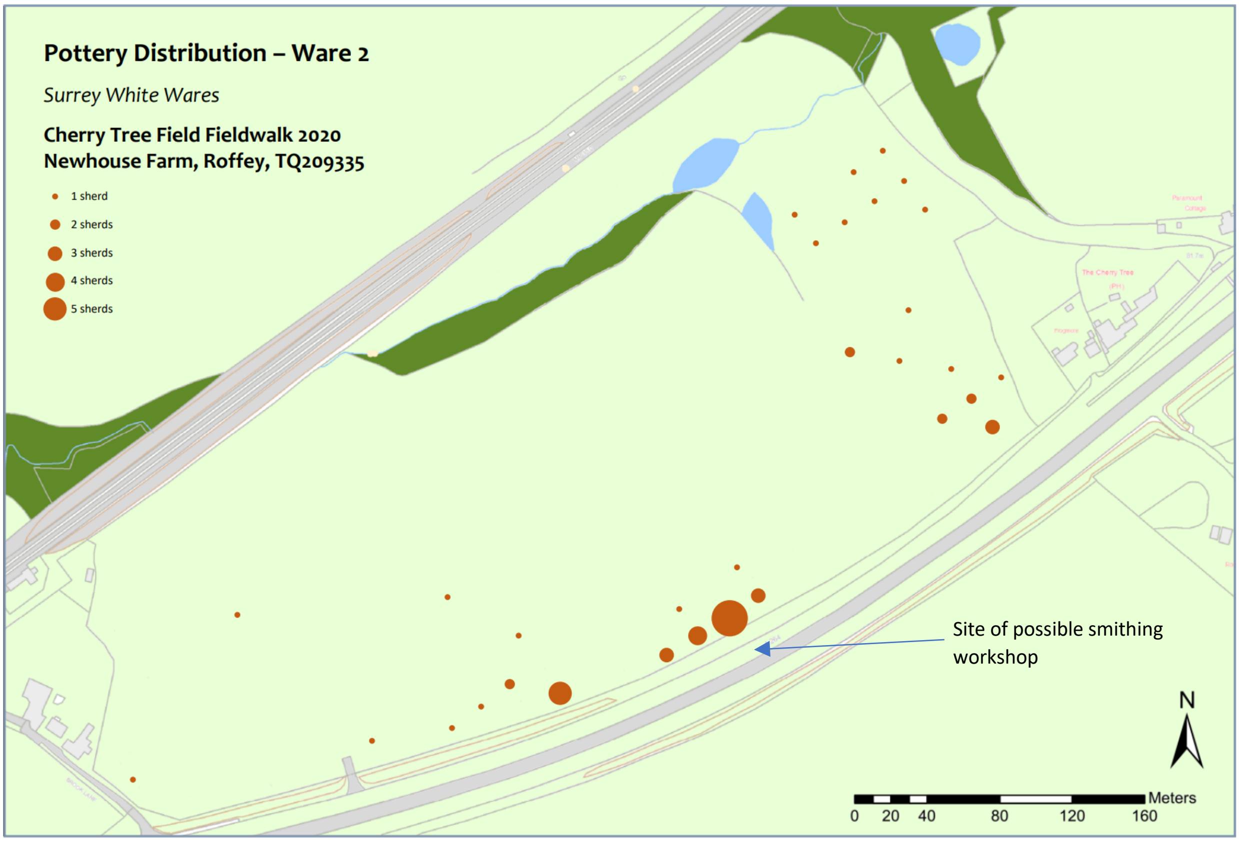


Figure 4.100 – *Distribution of Fine sandy white wares of the Surrey White wares or 'Coarse Boarder Ware' variety from the transect fieldwalk. These have a greater distribution to the southern boundary of Zone 1 and are likely to be the result of occupation along the roadside. Author's data overlaid on Digimap OS Collection base map.*

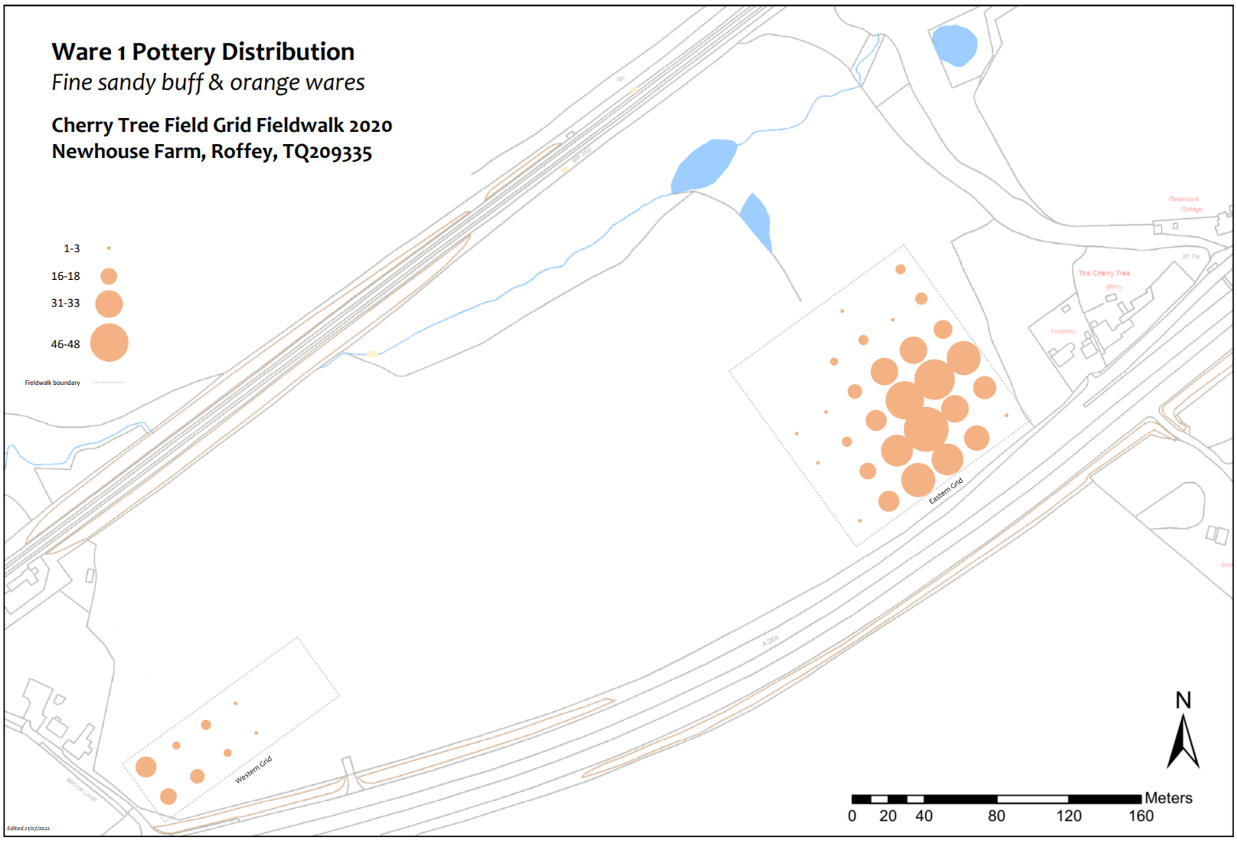


Figure 4.101 – *Grid fieldwalk distribution of Ware 1 pottery sherds. Author's data overlaid on Digimap OS Collection base map.*

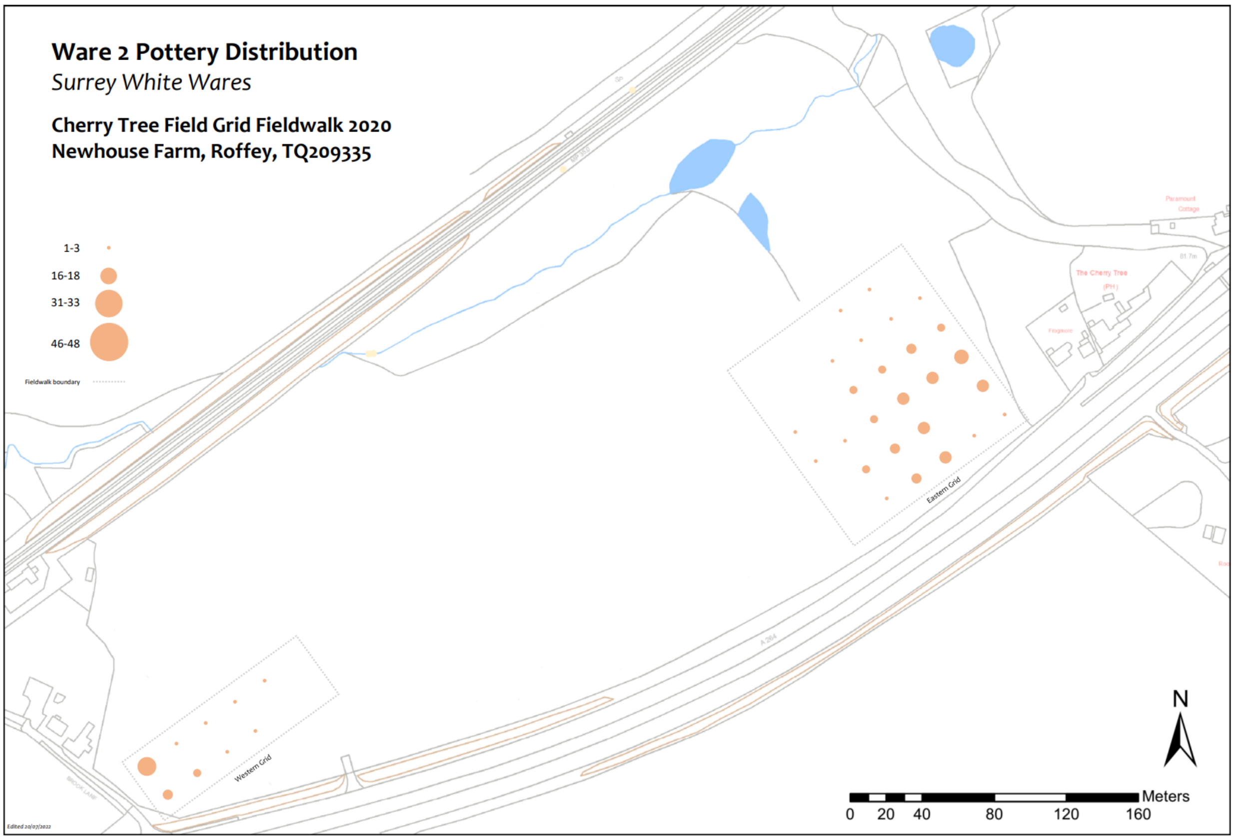


Figure 4.102 – *Grid fieldwalk distribution of Ware 2 pottery sherds. Author's data overlaid on Digimap OS Collection base map.*

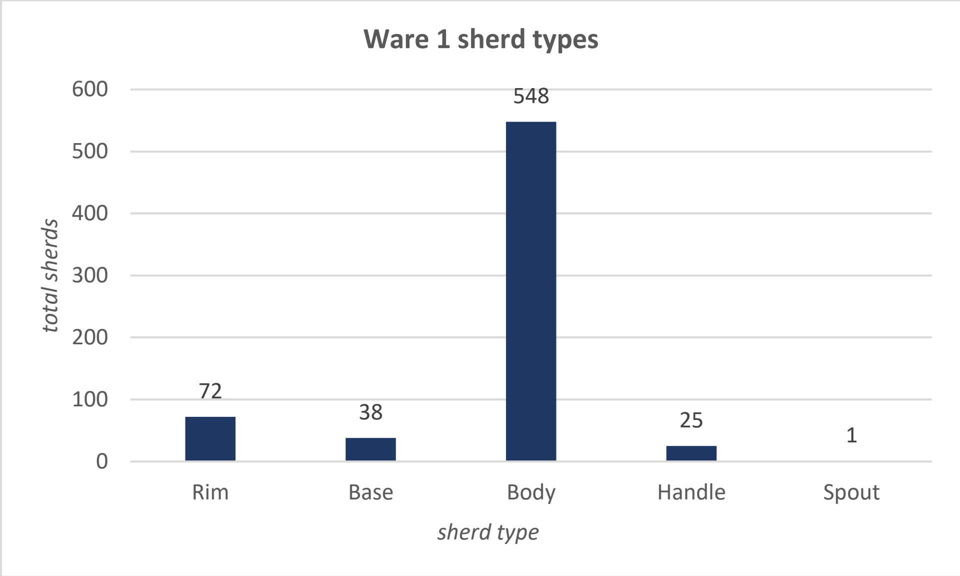


Figure 4.103 – *Ware 1 sherd type recovered in the 2020 grid fieldwalk. (Author's image).*

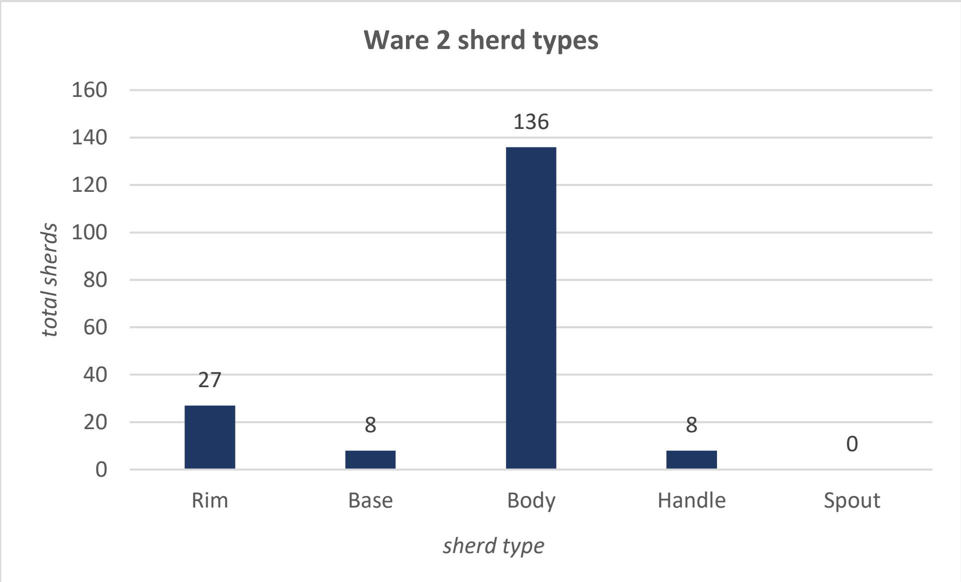


Figure 4.104 – *Ware 2 sherd type recovered in the 2020 grid fieldwalk. (Author's image).*

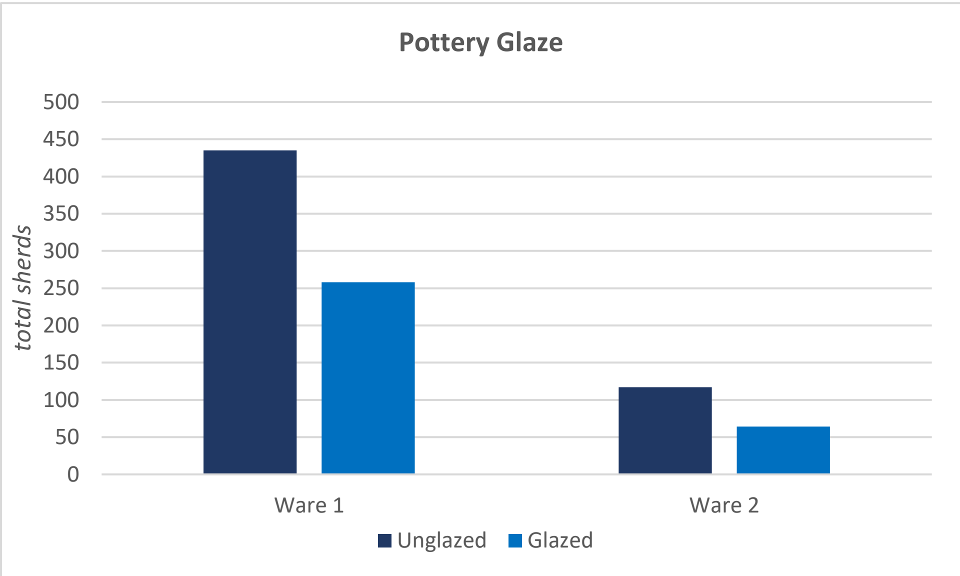


Figure 4.105 – *Quantities of glazed and unglazed sherds recovered in the 2020 grid fieldwalk. (Author's image).*

Figure 4.106 – *Jug and pitcher handles from wares 1 and 2 recovered in the 2020 grid fieldwalk. (Author's image).*

4.9.2 - *Ware 2*

A total of 181 sherds of Ware 2 pottery was recovered from the grid fieldwalk and 55 from the transect fieldwalk (fig.4.99). This ware is classified as fine sandy whitewares called Coarse Boarder Wares and was made in Surrey (Holgate 1985). In the grid fieldwalk the assemblage was dominated by body sherds, while 55% of sherds had an internal and/or external glaze, typically green (fig.4.105 and 4.108). Their overall distribution was concentrated on the southern boundary of the field with a smaller scatter in the north-east. The highest density was on the southern boundary adjacent to the smithing site where up to eight sherds were recovered. Only one sherd was recovered in the transect fieldwalk over the western anomalies of A1-A3 and three sherds were found close to anomaly A5-A10 in the east, with a sparser distribution to the north with no large densities.

Figure 4.107 – *Ware 1 sherd with mottled green glaze from a medieval face jug. It's nose, mouth and protruding chin can be seen. (Author's image).*

A similar pattern is present in the grid fieldwalk data which shows an even distribution of Ware 2 across the eastern grid, with no specific densities associated with underlying anomalies (fig.4.102). This distribution is more consistent with agricultural manuring practices than domestic rubbish dumps. In the western grid however, a density of 19 sherds were found close to anomaly A2. As the date range for this ware is late 14th to 15th centuries, this suggests the smelting sites of in the west of Zone 1 (anomalies A1-A3) and the smithing site on the southern boundary, were still in operation during this period. However, the even distribution and lack of densities found in the east of Zone 1 implies the smelting site here (anomalies A5-A10) had fallen out of use and the land had become cultivated by the late 14th century. This raises the possibility that not all the iron-production sites across Zone 1 were contemporary and that some were abandoned earlier than others.

Figure 4.108 – *Green glazed examples of Ware 1, some with incised decoration of parallel lines. Recovered during the grid fieldwalk. (Author's image).*

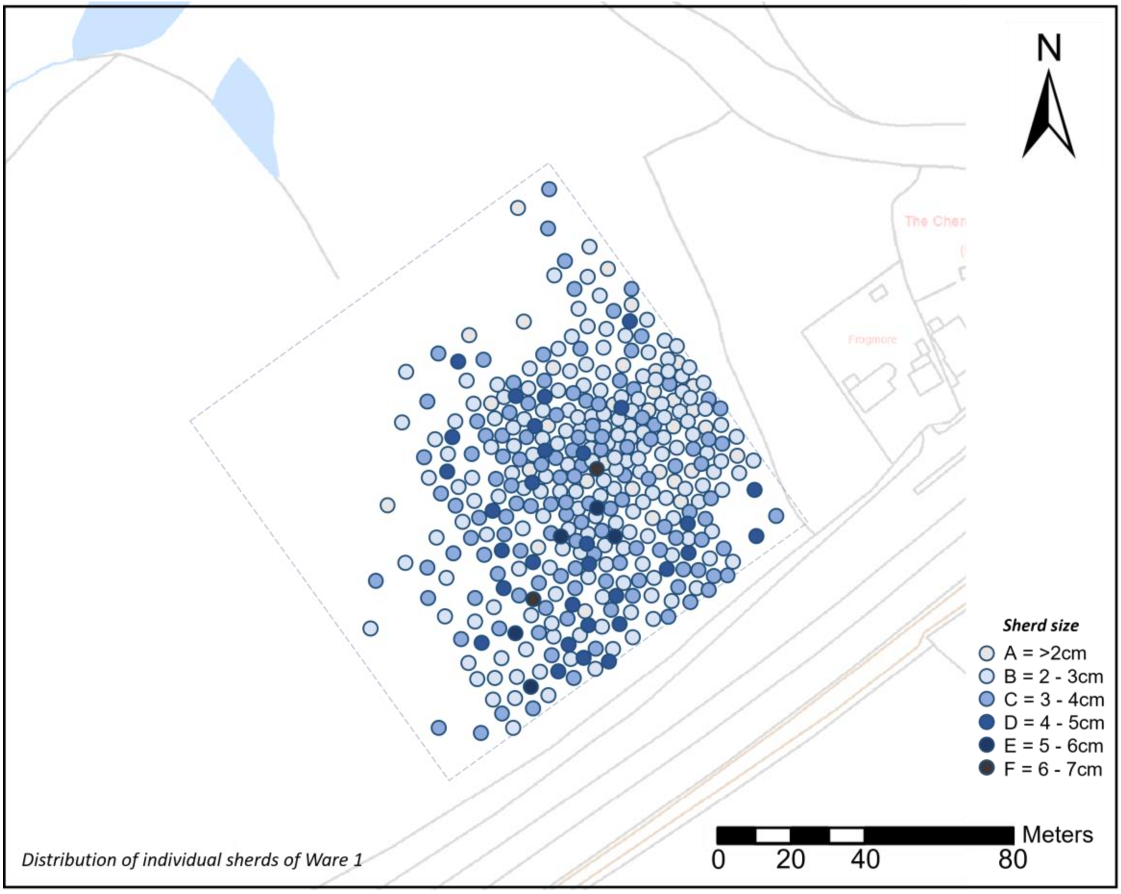


Figure 4.109 – *Distribution of individual unglazed sherds of Ware 1 to show size distribution. Author's data overlaid on Digimap OS Collection base map.*

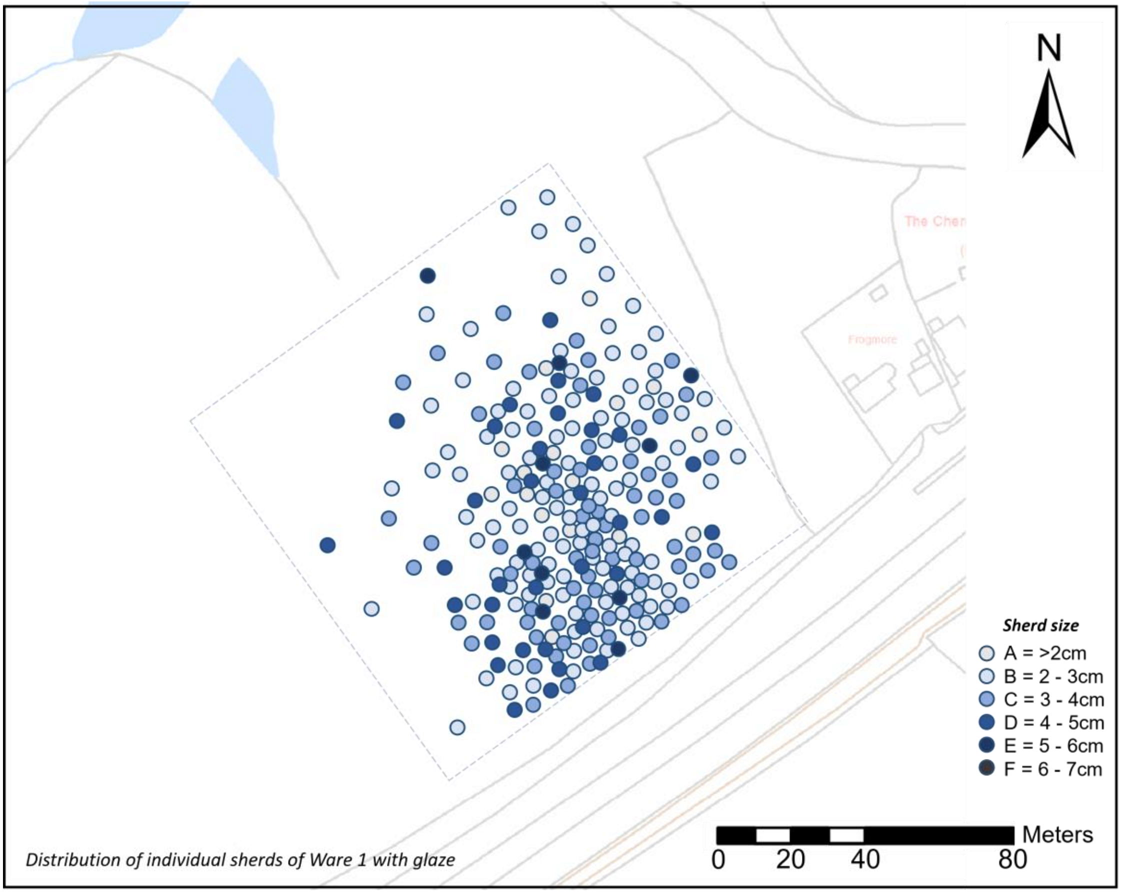


Figure 4.110 – *Distribution of individual glazed sherds of Ware 1 to show size distribution. Author's data overlaid on Digimap OS Collection base map.*

4.9.3 - *Pottery production*

The high densities of Ware 1 pottery in the east of Zone 1 indicated that this originated from an underlying deposit far larger than a domestic rubbish dump.

Figure 4.111 – *Pottery wasters recovered in the east of Zone 1 alongside high densities of Ware 1 pottery sherds. (Author's image).*

Figures 4.99 and 4.101 showed that unlike the even distribution of Ware 2, Ware 1 had a nucleus of high density in the east, which began to steadily decrease after a 20m surrounding radius. Pottery size of the glazed and unglazed examples of Ware 1 is plotted on figures 4.109 and 4.110. On the hypothesis that larger sherds are likely to represent more recent disturbance of in-situ archaeological deposits, it can be seen that broadly speaking unglazed sherds, over 3cm in size, had a more nucleated density 40m north of the southern boundary. This density overlies the highly magnetic anomalies of D1 and D2.

Figure 4.112 – *Possible kiln furniture. A clay block used for supporting the pots during firing. (Author's image).*

The glazed sherds however are more densely concentrated within an area of 40m² adjacent to the southern boundary with many of the larger sherds were not associated with D1 and D2. The high sherd count of unglazed Ware 1 in association to the underlying anomalies may indicate that this was the site of a pottery kiln and these sherds represent the pots that failed, the wasters. There were also obvious wasters within the assemblage that were recognisable by their distorted shape (fig.4.111). Their distribution on Figure 4.114 also overlies anomalies E3 and E4. A small trapezoidal shaped piece of pottery was also recovered which is interpreted here as a piece of kiln furniture, used for supporting pottery within a kiln (fig.4.112).

The high number of handles in the assemblage from jugs and pitchers may be suggestive one of the main outputs of the kiln. These handles had a distinctive incised 'dashed' pattern along the handle, which parallels similar jugs, uncovered by Thomas Honywood in the 19th century, known as the Horsham Pottery Hoard (Honywood 1868) (fig.4.113). This raises the possibility that the hoard represents vessels that were originally sourced from Roffey. Six sherds once forming chimney pots were also recovered and may have been, yet another product produced in the kiln. To find this number of sherds from such a rare pottery type, would be unusual and therefore supports the probability that these were further wasters (fig.4.115).

Figure 4.113 – *Left: jug and pitcher handles recovered from Roffey with a distinctive incised 'dashed' pattern which parallels some of the jugs recovered in the Horsham Hoard. Right: one of the vessels found by Honywood in the Horsham Pottery Hoard, with a similar dashed handle decoration. (Author's images). The Horsham Pottery Hoard is on display in Horsham Museum.*

The high density of pottery along with the wasters and possible kiln furniture suggests anomalies D1-D2 are the remains of a pottery kiln and associated waster dumps. Their proximity to the smelting anomalies of A5-A10 raises the question of whether they were in operation during the same period, possibly on adjacent tenement plots.

Figure 4.114 – *Distribution of potter wasters at Roffey using grid and transect fieldwalk data. The highest density overlies anomalies E3 and E4. Author's data overlaid on Digimap OS Collection base map.*

4.10 - Domestic activity

Evidence also indicates a domestic sphere to Roffey. Along with the pottery, of which the Ware 2 sherds indicate habitation along the roadside, other items show how individuals once lived here. This included an oyster shell, which although hard to date, may indicate trade and exchange with the coast. A rotary quernstone is suggestive of the community's agricultural dependency (fig.4.117). When one considers the strict control enforced by manors on the use of querns, with many tenants expected to use the lord's mills where they were charged tolls (Walts 2002, 40). At Hangleton (Sussex) the discovery of broken fragments of quern stone were possibly evidence of their deliberate destruction by manorial officials (ibid, 40). Therefore, the existence of a quern at Roffey gives a sense of a community somewhat on the margin of society and outside of its control.

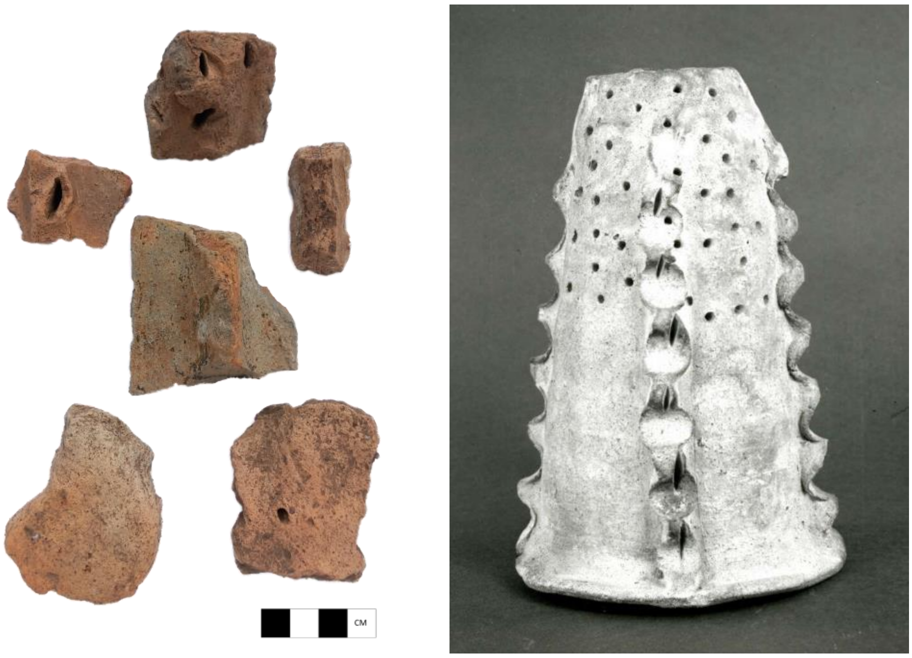


Figure 4.115 – *Chimney pot sherds recovered in the Roffey fieldwalk (left) alongside a complete example found at Cissbury by Dr Gideon Mantell (right). Courtesy of www.britishmuseum.org (Accessed: 29/07/2022).*

Figure 4.116 – *Smooth edged stone not found in the local geology. Possibly used in leatherworking. (Author's image).*

Figure 4.117 – *Rotary quern stone of possible Medieval date. This example was dressed in the segmented style (Cambridge Archaeology Field Group 2019). (Author's image).*

Figure 4.118 – *Lead offcuts of uncertain age, but possibly indicate of other industries at Roffey. (Author's image).*

4.11 - Reconstructing lost boundaries through fieldwalking evidence

Firecracked flint or calcined flint was a biproduct of spreading of lime on fields, a common agricultural practice of the 18th century. Chalk was burnt in lime kilns before being spread on the land to increase fertility, and with-it flint occurring naturally within the chalk was also burnt, giving it the distinctive white and cracked appearance. The firecracked flint distribution, while post-medieval, does provide information on the early field arrangements and boundaries that existed in the 18th century but had disappeared by the time of the 1844 Tithe Map. Figure 4.119 overlays the flint distribution and the Tithe Map. The presence of firecracked flint in the centre of Roughey Mead but absent on the eastern or western sides suggest the fields were once subdivided into smaller parcels of land, with only certain fields undergoing agricultural improvement through liming. The significance of the earlier subdivisions suggested the presence of further smaller tenement plots bordering the road that survived into the 18th century.

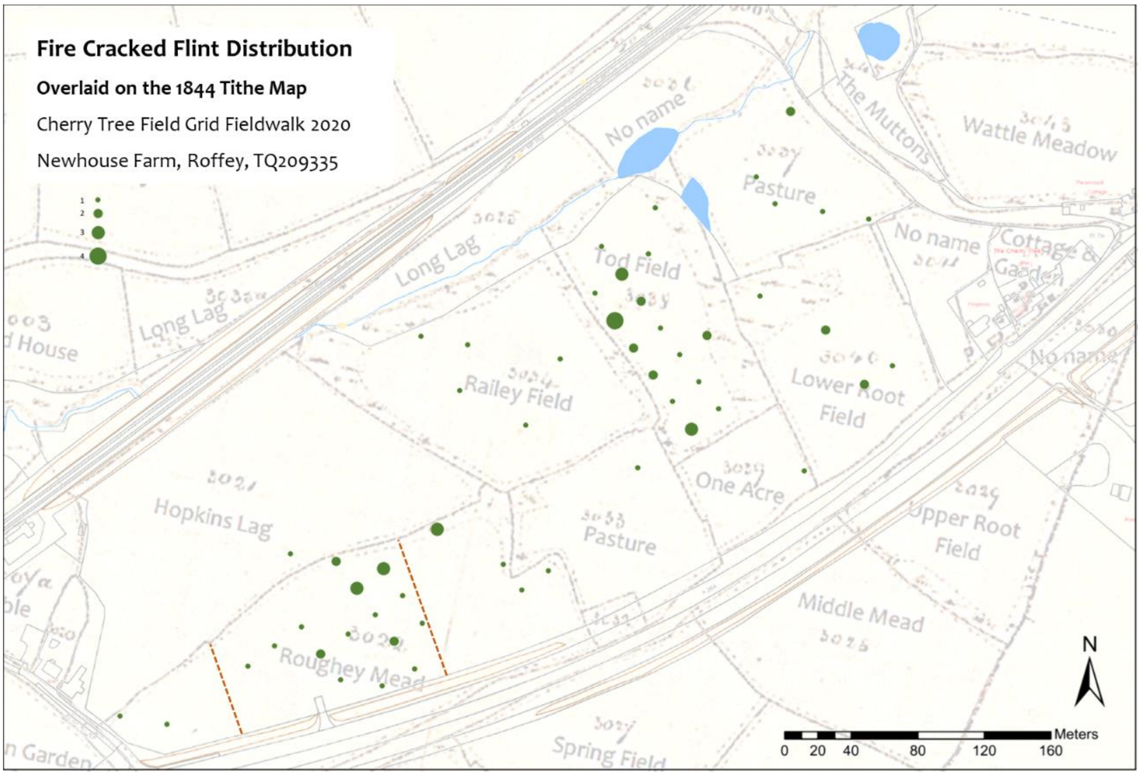


Figure 1.119 – *Distribution of firecracked flint over the 1844 Tithe Map. Base map courtesy of West Sussex Records Office and Digimap OS Collection.*

4.12 - Discussion

Both the geophysical and fieldwalking surveys were able to reveal the extent of past activity across Zone 1, both complementing one another and providing contrasting insights into the spatial distribution and past morphology of iron-production sites. The artefact analysis provided further evidence on the chronological relationship of features and scale of iron production across Zone 1 as well as indicating the presence of other industries.

The spatial distribution corresponded to the data of the reconnaissance survey which indicated a southern focus in activity and smaller scale activity to the north-east. A comparison of the slag distribution found that typically high densities of slag in the plough soil corresponded to the position of magnetic anomalies on the geophysical data. Ploughing had evidently truncated underlying deposits and led to the spread of slag over larger areas, particularly in the east of Zone 1, and less so to the west. Ploughing had however not resulted in the complete displacement of slag, and high densities still attested to the localities they had originated, while the magnetometry results and the relative clarity they showed for ditches, furnaces and slag heaps suggest relatively good preservation of the underlying features.

Five localities of iron-production are discernible from both data sets, the most prominent of which were the eastern and western sites, investigated with the grid fieldwalk. Of these, the eastern site appears the largest and placed within a rectangular enclosure, with high magnetic anomalies consistent with slag deposits and furnaces in the south-west corner. The western site is smaller, concentrated to an area of c.40m2 and producing a lower volume of slag in a more confined distribution. However, the western site may have benefitted from infrequent ploughing compared to the eastern site and its former name Roughey Mead, indicates that it remained an uncultivated meadow for much of its history. Conversely, the eastern site was previously part of Lower Root Field, where root crops were presumably once grown and thus was more vulnerable to the plough. At the western site, anomalies consistent with furnaces or hearths, were positioned within 2-3 small rectangular structures, which mirrored the proportions of the small building and smithing hearth identified in 1985. These structures do not immediately front on to Crawley Road but instead boarder Brook Lane on their western side.

The technological assemblage was dominated by smelting slag and suggest both the anomalies in the west (A1-A3) and the east (A5-A10) are associated with smelting. Smithing or consolidation slag however showed no obvious densities indicative of sites, although their presence here along with whetstones does support the likelihood that consolidation or secondary smithing was taking place within Zone 1. As smithing typically produces reduced quantities of slag compared to smelting, the small percentage recovered should not be taken as evidence that this industry operated on a smaller in scale. The presence of the excavated smithing workshop approximately 140m west of the smelting anomalies in the east and 350m from those in the west, suggest that smelting and smithing operated alongside one another, although the distribution of Ware 2 pottery may indicate smelting in the east ceased at an earlier date. It is also possible that anomaly A1, in the west, is associated with smithing based on the absence of overlying smelting slag. Future excavation of these sites would help to establish their exact nature and a more precise chronological relationship.

It is clear however that iron-production was not the only industry in Zone 1. The presence of other industries is to be expected, particularly those that relied on similar natural resources needed to make iron. In the case of pottery production, which appears to have taken place in the east of Zone 1, clay would have been sourced locally and potentially from the same sources as the iron ore. Collaboration between industries is probable. In the case of the St Leonard's Forest minepits, clay is present within the neighbouring strata to ore, and it seems unlikely that a local pottery industry would not make use of this otherwise waste product of ore extraction.

Both industries may have used the same trade networks, both at a local and regional level, through the markets at Horsham. Indeed, the whetstones are evidence of Roffey's connections to wider trade for the two made of schist had likely come from London where the stone was imported from Scandinavia. If such trade links existed, it raises the question of the impact they had on industries at Roffey. Pottery was no doubt in demand locally and the Horsham pottery hoard is possibly an example of wares brought in from Roffey, based on the similarity of the jug handles. Much of this orange and buff ware has been interpreted as Graffham ware, and yet it might be surmised that some of this regional pottery originated from Roffey. Other products such as the chimney pots, would have commanded a more niche market and were destined for higher status dwellings. Was this a market that the Roffey smiths also utilised? When considering the Crowns purchases of iron from the Weald in the 13th century for repairing castles (Hodgkinson 2008, 38) and the possibility Roffey was a supplier, one can ask whether higher status building materials such as chimney pots were also sourced here?

It is important to also consider the morphology of the landscape to understand the relationship between the industrial sites. The cartographic and documentary evidence in Chapter 3 along with the geophysical and artefactual evidence here suggest the existence of a series of roadside tenement plots, some of which may have been those referred to in accounts in the 14th and 15th century. Several of these plot boundaries survived in the 19th century field patterns, while the magnetometry survey and fieldwalking data identified the existence of others, such as the eastern enclosure where the eastern site was situated and the subdivision of Roffey Mead. These eastern boundaries were still in existence by the 16th and 17th centuries, based on the later pottery distribution (see Appendix B4). They show that the smelters and smiths were not located in isolated locations, but positioned within a settlement context and associated with other industries. This may arguably have still formed a marginal location, both on the boundary of the forest and outside the town of Horsham. It does however support the notion of a centre of production, but on the evidence of other industries, it would be wrong to limit this description to iron alone. A centre of industry is perhaps a more fitting interpretation.

Chapter 5: Tudeley Ironworks - The Historical and Archaeological context of a Manorial Ironworks

This chapter begins by examining the Tudeley Accounts and the context in which they were discovered. It goes on to discuss the previous archaeological research that has been carried out to locate the site of the Tudeley Ironworks and makes the case for the site identified by Ernest Straker for being that of Tudeley. A magnetometry survey is then used to investigate Tudeley's site morphology, while macromorphological analysis of slag samples recovered from the site enables an understanding of technology and processes. Finally, the archaeological evidence is compared to the Tudeley Accounts to build a wholistic picture of the site, its equipment and Tudeley's importance as a manorial ironworks.

Chapter contents

Chapter 5: Tudeley Ironworks - The Historical and Archaeological context of a Manorial Ironworks

5.1 - Introduction

Historical records and accounts of ironworking are rare for the Weald during the medieval period, generally surviving as occasional references to the purchases of iron or iron products, or as records for the digging of ore 'orestone'. The Tudeley accounts on the other hand are unique in providing a more detailed record of an ironworks in the 14th century, not just of its iron outputs, but also of the personnel, equipment, site construction and associated industries (Appendix A2). Today, Tudeley is a small village on the outskirts of Tonbridge in Kent, within the High Weald (fig.5.1). The accounts were first identified by Giuseppi in 1912, in the Public Records Office, consisting of 'a little roll of four separate accounts, on as many small skins of parchment, of the ironworks at Tudeley in Kent' (Giuseppi 1913, 145). Giuseppi recognised the significance they held for the study of the medieval iron industry and since their publication in *Archaeologia* in 1913 there have been attempts to relocate the site of Tudeley, initially by Ernest Straker in the 1930s and subsequently by the Wealden Iron Research Group (Straker 1931; Tebbutt 1979). Several candidates were put forward as the site of Tudeley Ironworks, however the absence of dating evidence or detailed surveying led to debate over its exact placement. Its identification therefore held considerable potential in advancing the understanding of the Wealden iron industry in the 14th century and providing a unique comparison between the archaeological and historical records.

The accounts suggest Tudeley was somewhat different to Roffey, both in location and scale of production. In the 1930s Ernest Straker identified a bloomery site on

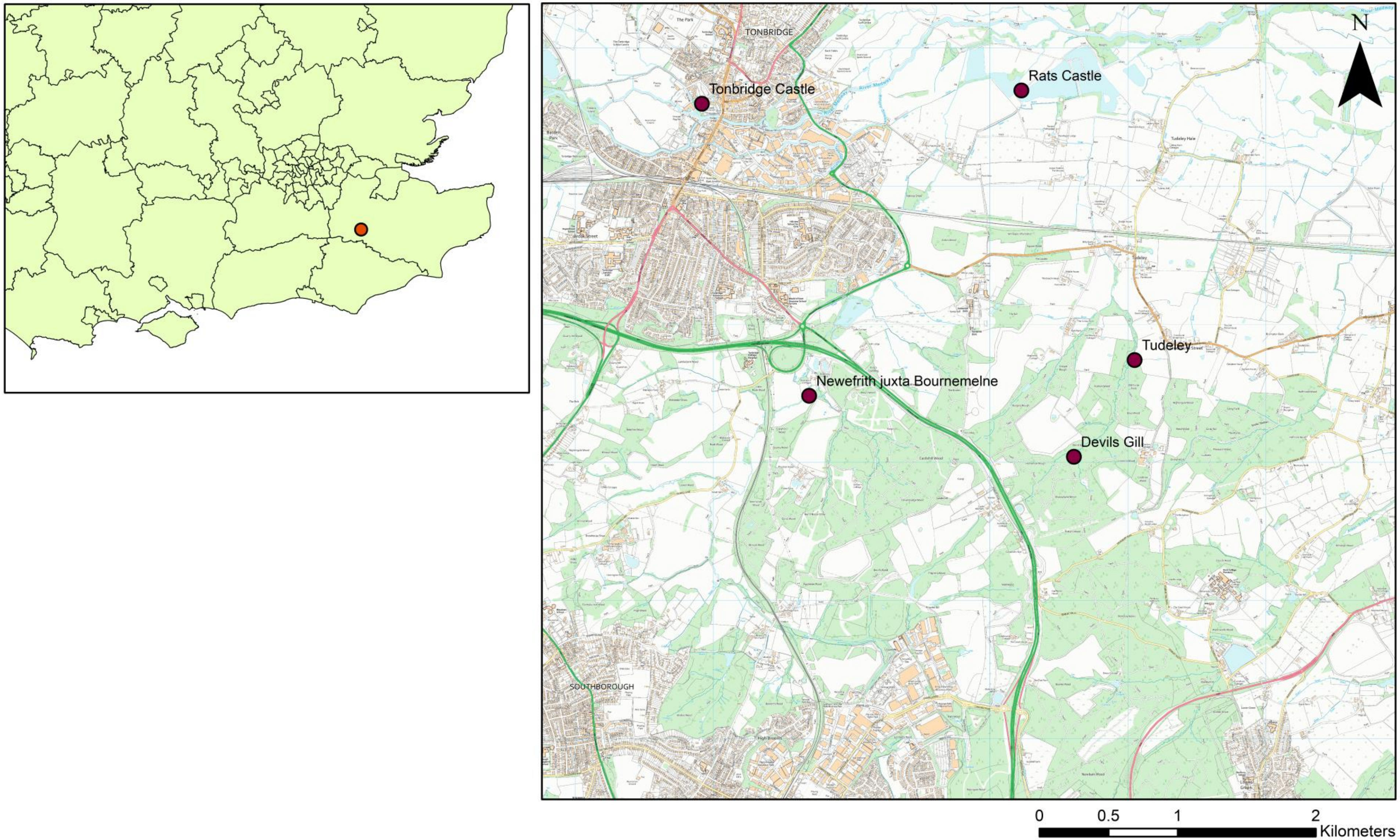


Figure 5.1 – *The location of the site of Tudeley Ironworks first identified by Straker (1931). The larger map also shows the position of other ironworks in the area, of which Rats Castle and the Devils Gill Bloomery have in the past been put forward as potential candidates for the location of the Tudeley Ironworks. These other sites are discussed further in chapter 6. Base map courtesy of Digimap OS Collection.*

the northern edge of Smithy Wood, today part of Tudeley Woods Nature Reserve, and about half a mile south of Tudeley parish (Straker 1931). In terms of location, Straker's site was the most viable candidate and therefore important to both relocate and determine whether it was the site recorded in the 14th century accounts. An initial reconnaissance survey was used to find the site and assess the nature, preservation, and extent of the archaeological remains, prior to a wider landscape reconnaissance survey across Tudeley Woods Nature Reserve to identify other iron-production sites and associated industries (Chapter 6). The layout of the site was subsequently assessed using geophysical surveying, while a macromorphological and elemental assessment of slag gave insights into the technology and processes used and possible scale of production.

This chapter considers the historical and archaeological context of Tudeley Ironworks, drawing on evidence from the desktop assessment of previous investigations and the 14th century accounts. Using an archaeo-historical approach, a comparison is made between the archaeological and historical evidence in Section 5.8 to consider questions of scale, technology, and site morphology, considering these as potential parameters defining centres of production. The landscape in which Tudeley Ironworks was situated is also crucial in understanding the economic significance of Tudeley as a component within the wider manorial landscape of related woodland industries, and this is discussed in Chapter 6.

5.2 - The Study Area

Tudeley Woods Nature Reserve is located on the northern edge of the High Weald, to the west of Kent. It lies 6.5km north-east of Tunbridge Wells, and 3.6km south-east of Tonbridge of which the Castle was the former centre of the Lowy between the 11th and 14th centuries (Ward 1980). The reserve is now in the ownership of the Hadlow Estate and jointly managed with the Royal Society for the Protection of Birds (RSPB), who kindly granted permission for the survey. Tudeley Woods covers approximately 85 acres and forms part of the High Weald AONB. Much of the landscape is comprised of ancient woodland and characterised by coppiced hazel along with oak and plantations of horse chestnut. Areas of heathland are also present further south at Pembury Walks. Woodlands to the north are managed under the reserve and include Old Furze Field, Rushpit Wood and Boys Wood, which were collectively known as 'Smithy Wood' prior to the 1890s (fig.5.6). Nightingale Wood and Reed Wood lie to the east, beyond an

Figure 5.2 - *Tonbridge Castle, once the centre of the Lowy of Tonbridge within which Southfrith formed one of its two deer parks. Records show that the castle had a blacksmith and while no records survive of where the iron from Tudeley was taken, potentially some of the iron being produced in Southfrith was brought to Tonbridge. (Author's image).*

Figure 5.3 – *The Devils Gill stream. Gill or ghyll is a local term for a steep-sided stream, a feature characteristic of the Weald. (Author's image).*

ancient north-south track which once formed the eastern boundary or Pale of the Lowy of Tonbridge (see Section 6.9). Limekiln Wood, Crabtree Wood, Brakeybank Wood and Potter’s Wood, are to the south, with the Brakeybank trail forming an open access footpath for visitors. Pembury Walks, Pembury Wood and Newbars Wood are to the far south, beyond Dislingbury Road (fig.5.6).

Figure 5.4 - *The River Medway, flowing just south of Tonbridge Castle and the parent river for the Devils Gill. (Author’s image).*

Steep-sided streams, known locally as ‘gills’, flow throughout the area. At Tudeley Woods the principal watercourse is the Devils Gill, that flows for 1.5km through the reserve eventually reaching the River Medway 1.9km north (figs.5.3-5.5). It is said to take its name from the fiery glow emitted by the former charcoal burning along its banks. The Devils Gill has four tributaries that, like the mainstream, are frequently dry in the summer months. It is along this gill that both Straker’s proposed site of Tudeley and the Devils Gill bloomery are located. Much of the reserve was surveyed in this study to look at the wider landscape context of Tudeley and is discussed in Chapter 6, however this chapter

Figure 5.5 – *A sunken lane running through coppiced woodland in the south of the reserve at Pembury Walks. (Author’s image).*

will focus specifically on the site of Tudeley Ironworks at TQ620447 on the northern boundary of Tudeley Nature Reserve, at the former Smithy Wood (fig.5.6).

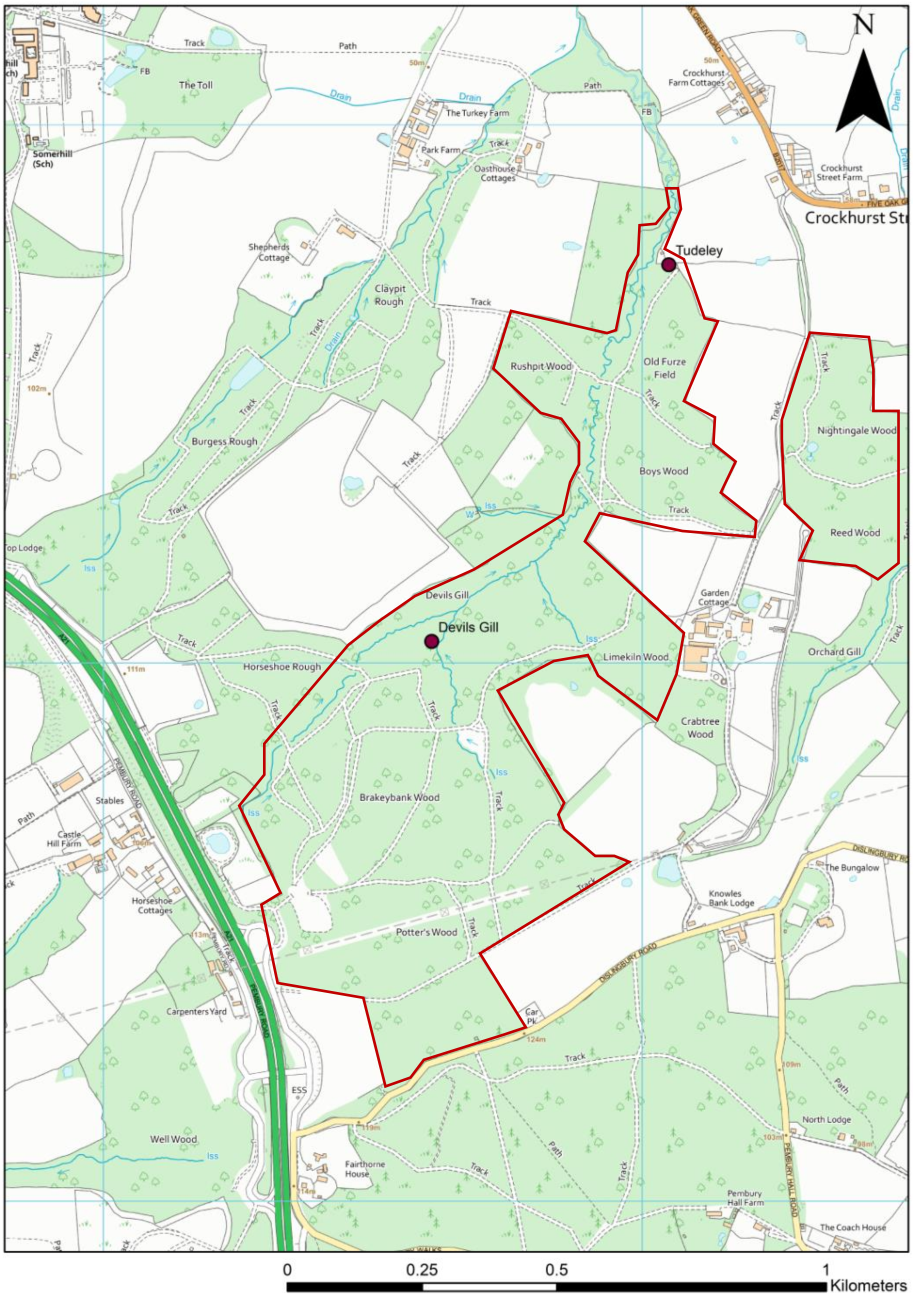


Figure 5.6 – *Extent of wider landscape reconnaissance survey showing the positions of Straker's proposed site of Tudeley Ironworks and the Devils Gill Bloomery. The red line defines the area studied in the reconnaissance survey. Base map courtesy of Digimap OS Collection.*

5.3 - Historical Context

5.3.1 - *Discovering the accounts*

The Tudeley accounts were discovered by Montague Spencer Giuseppi at the Public Records Office (PRO) in 1912. In 1891, Giuseppi began his career as a Junior Clerk at the PRO at the age of 22 and one of his early duties was to move records from their former homes at Rolls Yard, Rolls Chapel and Rolls House into new purpose-built buildings, part of the PRO (Jamison 1953, 2). At the time when the nation's archives were being transferred to the PRO and it was possibly under these circumstances that the Tudeley accounts came to light. Despite their placement in the records of the Exchequer (an archive typically concerned with Royal revenues), Giuseppi (1913, 146) realised the Tudeley accounts did not originally belong there but were instead manorial records from the manor of Southfrith (fig.5.7). Giuseppi went on to become a fellow of the Society of Antiquaries in 1895 and it was here that on the 5th of December 1912 he presented his transcription of '*Some Fourteenth-Century Accounts of Ironworks at Tudeley, Kent'* which was subsequently published the following year in *Archaeologia* (Giuseppi 1913) (fig.5.8).

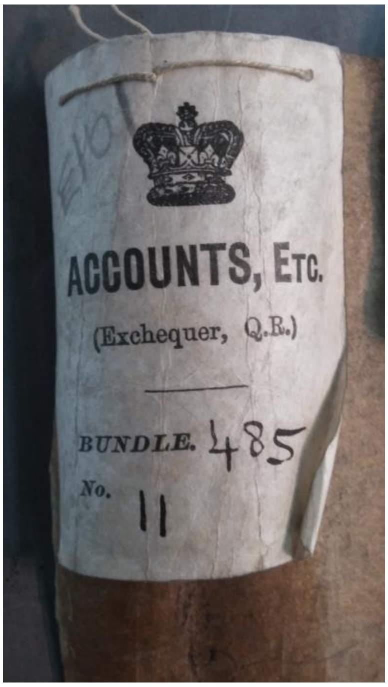


Figure 5.7 – *Public Records Office label attached to the Tudeley Accounts denoting its place in the records of the Exchequer. Photographed by the author with kind permission from the National Archives.*

5.3.2 - *The Lowy of Tonbridge and the de Clare's*

Tudeley Ironworks was located within the 'Chase' or manor of Southfrith, that is, the southern portion of the Lowy of Tonbridge. Tonbridge had been granted to

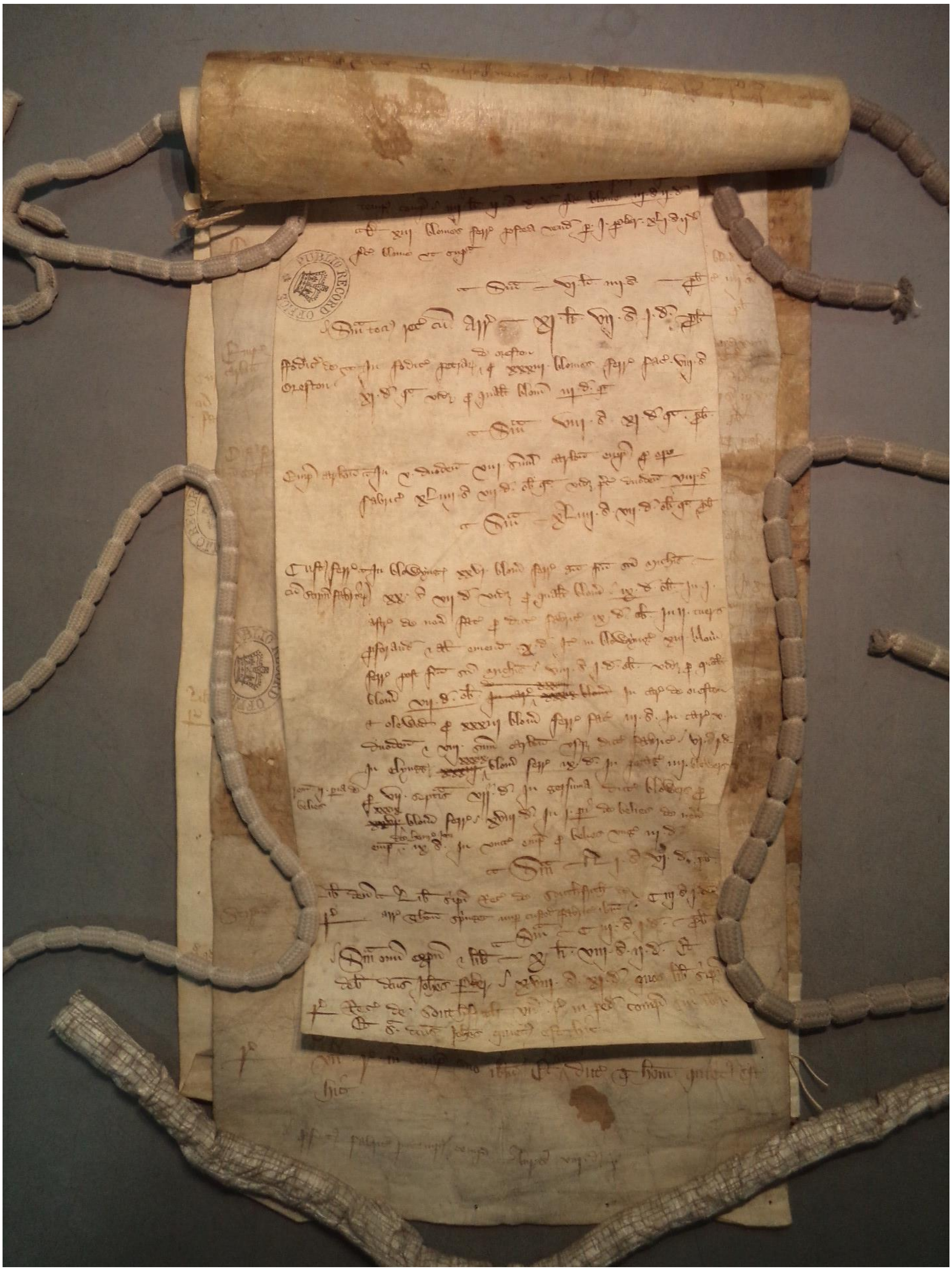


Figure 5.8 – *one of the four membranes that make up the Tudeley accounts from the period 1350-1354. The text was written in a mixture of Latin, French and old English and included many notes within the margins, crossings out and corrections. These have been included in the transcription, translation, and photographic record in Appendix A2. Text was also present on both sides of the membranes. Some of the text had faded over time, however the majority was legible. Today the accounts are kept in the National Archives at Kew and the author is grateful to them for allowing access to the documents and a photographic record to be made. Photographed by the author with kind permission from the National Archives.*

Richard FitzGilbert (later de Clare) by William I following the Norman Conquest (Hasted 1798, 196-255). A motte and bailey castle was built at a strategic position on the River Medway to assist with the defence of the south and to form an administrative centre for the estate at Tonbridge (Ward 1962, 210). The Lowy that surrounded the castle stretched for 5 miles to the north and south and 6 miles east and west, forming demesne land designed to support the castle in both upkeep and militaristic aid (Ward 1962, 221, and 1980, 120). It also held a judicial function, being outside the jurisdiction of the county sheriff, and included its own court (Ward 1980, 129). William of Jumieges claimed that FitzGilbert received the manor in compensation for the loss of his father's castle at Brionne, and the area of the Lowy was said to replicate the size of the former Normandy territory (Dumbreck 1958, 138; Ward 1980, 123). The boundary of the new Lowy at Tonbridge had, according to Lambard, been carefully measured using a length of rope (Dumbreck 1958). It is clear, however, that the Lowy neither formed a continuous area of land or regular boundary, as is demonstrated on Hasted's map of 1780 (Ward 1962, 211) (fig.5.10).

Figure 5.9 - *A mezzotint of Elizabeth de Clare created in 1714 by John Faber from an earlier portrait. Courtesy of the National Portrait Gallery.*

The Lowy contained two deer parks or Chases - the Northfrith and the Southfrith. Following the death of the Gilbert de Clare at the battle of Bannockburn in 1314, his lands were split between his three sisters and co-heirs Eleanor, Margaret and Elizabeth de Clare (Giuseppi 1913, 147) (fig.5.9). After the death of Elizabeth's husband John de Burgh, the Earl of Ulster in 1313, Elizabeth re-married Theobald de Verdum. However, following his death six

● Approximate position of Tudeley Ironworks

Figure 5.10 – *Edward Hasted's map of the Lowy of Tonbridge c.1798 published in 'The History and Topographical Survey of the County of Kent'. The Northfrith is shown to the top of the map above Tonbridge and Tonbridge Castle, the former centre of the Lowy. The River Medway flows east to west across the centre of the map, passing to the south of the castle. Southfrith Chase is to the south, below Somerhill, a later manor built on the former manor of Southfrith in the 17th century (Hasted 1798). It can be seen how forested Southfrith remained by the 18th century. The position of Tudeley Ironworks on the eastern boundary (Pale) of Southfrith is evident. Woods Gate is shown to the south-east of the map as another gate into Southfrith. A larger version of the Southfrith portion of the map can be found in chapter 6. With thanks to Exeter University Digital Humanities Department for assisting with the creation of a high-resolution photograph of Hasted's original map. This copy of the map was discovered in Sydney, Australia.*

months later, Edward II sought to arrange a marriage alliance between Elizabeth and court favourite Roger Damory (Ward 2014, XV). This meant that the delay in the partitioning of Gilbert's estates could be resolved and on 15th November 1317 Elizabeth received her inheritance, which included lands in Dorset and South Wales and a significant portion of the Honour of Clare (Ward 2014, XV). As part of the Honour of Clare, Elizabeth inherited the Southfrith Chase while Hugh de Audley, who was married to Elizabeth's older sister Margaret, gained Tonbridge Castle and the Manor of Tunbridge, along with Northfrith (Ward 2014, XV; Hasted 1798, 196-255). After the death of her third husband, who had been involved in the Marcher rising, Elizabeth, as a result of the rising, found herself imprisoned, with her property confiscated (Ward 2014, XVII). While her estates were later restored to her, she took a vow of chastity, which Crawshaw (2018, 7) suggests enabled her to avoid further marriage alliances.

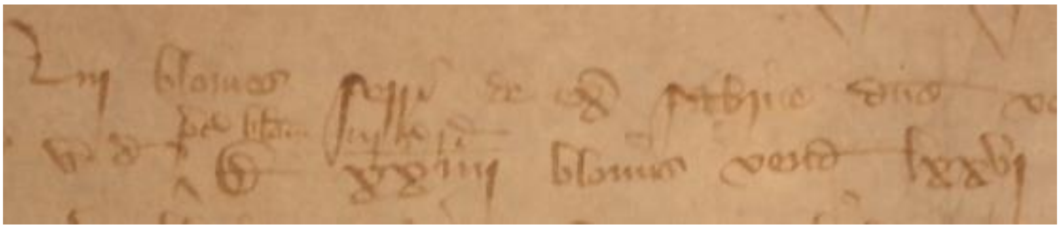


Figure 5.11 – *Elizabeth de Clare is referred to in various years of the accounts such as in the above 1352 membrane which states '53 blooms of iron of the issue of the lady's works'. Photographed by the author with kind permission from the National Archives.*

Elizabeth was to become one of the most powerful individuals of the 14th century and styled herself 'Lady of Clare' (ibid, 7). She is of considerable importance to Tudeley, which is on occasion referred to as 'the lady's works', while the forest in Southfrith in which Tudeley Ironworks is situated, is described as 'the lady's wood' (figs.5.8 and 5.11).

5.3.3 - *Tudeley Ironworks*

It is within this manorial context that the Tudeley Ironworks were situated and the influence that Elizabeth de Clare had over Southfrith and her connections to her other estates must be remembered when considering the potential wider significance of iron-production (fig.5.12). The Tudeley accounts form part of a larger set of records created by the chamberlains of Southfrith, including Richard de Gofherst in 1329, John of Mesynglegh in 1331 and Thomas Judde in 1350. Their role was to collect the issues of the Chases on behalf of Elizabeth and keep detailed records (Ward 1962, 220). Giuseppi's attention was first drawn to '*a little roll of four separate accounts, on as many skins of parchment'* (fig.5.8). These record expenditure for the years 1350 to 1354, and while they provide the most detailed account for each of these years, an earlier period between 1329 and 1334 also exist as separate documents to the roll, along with an inventory relating to the re-building of the works in 1343 and a lease agreement made to Richard Colpeper in 1354.

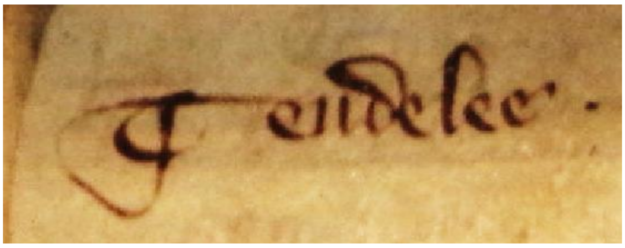


Figure 5.12 - *Tudeley as it appears in the accounts.*

Written in a combination of Old English, French and Latin, the Tudeley accounts are by no means a complete record. However, the meticulous recording of blooms produced and sold, expenditure on fuel and raw materials, equipment, re-building the works, the Keepers of Tudeley and the wages paid to their workers or 'foreblowers' (*Forblouweris)*, along with individuals of other industries, the accounts provide a rare insight into the output, technology, related industries and social hierarchy of a Wealden ironworks in the 14th century. Hodgkinson and Whittick (1998) have demonstrated their value in showing the rise in costs of iron, charcoal, ore, and wages, either side of the Black Death of 1348. Between the 1330's and 1350's the average price of blooms increased from 1s 4d to 3s 5d, something which they attribute to the reduced population of ironworkers after the Black Death and the increased demand for iron from those who survived

(Hodgkinson and Whittick 1998, 15). The accounts are now held in the National Archives at Kew and were photographed by the author in April 2019 (fig.5.8). Appendix A2 combines a transcription of the accounts made my Giuseppi (1913) with a translation by Anne Drewery in (1998) and presents these alongside the photographic record to allow the idiosyncrasies of the original formatting to be compared to a more legible text. Quotations and extracts from this transcription and translation are referred to throughout chapters 5 and 6 (figs. 5.12 and 5.13).

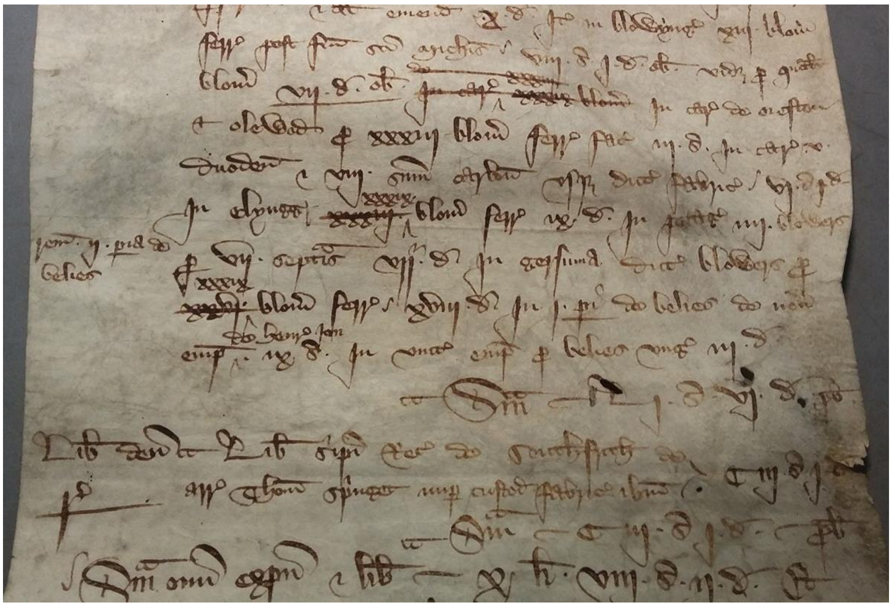


Figure 5.13 – *extract of the membrane from 1353 which shows the margin notes and frequent crossings out and amendments that are found throughout the accounts. Photographed by the author with kind permission from the National Archives.*

5.4 - Archaeological Context – previous research

Ernest Straker in his 1931 monograph 'Wealden Iron' identified the first potential candidate for the physical site of the Tudeley Ironworks. He said that it had taken him several years to locate the site, but eventually did so on the Devil's Gill which runs south to north, to the west of Tudeley Parish, before reaching the River Medway. Straker's site lies approximately half a mile south-west of the pre-Norman church of All Saints, Tudeley. Straker described how he found a '*good deal of unusually large cinder in the bed of a small tributary rill*', something also noted by Tebbutt, when he re-located the site in March 1979 (Straker 1931, 220, Tebbutt 1979, 8) (fig.5.16). Tebbutt observed how the stream contained large deposits of 'cinder' that had washed down from the tributary stream that cut a deep bed of the cinder (Tebbutt 1979, 8). He also noted how further 'cinder and tap slag' was scattered over the field to the east of the site, something he attributed to the removal of slag from the ironworks to a track east of the field (Tebbutt 1979, 8). Earthworks were observed at the site by Straker, in the form of a small rectangular depression close to the stream, which he suggested may have been associated with the forge (Straker 1931, 220). Tebbutt on the other hand did not appear to have observed this but did identify a possible 'levelled platform and small circular depression resembling a mine pit' on a 'tongue of land' between both streams and it is probable that the circular depression was the same feature Straker recorded fifty years earlier (Tebbutt 1979, 8). Both Straker and Tebbutt were unable to recover dating evidence that could confirm whether the site was medieval in date.

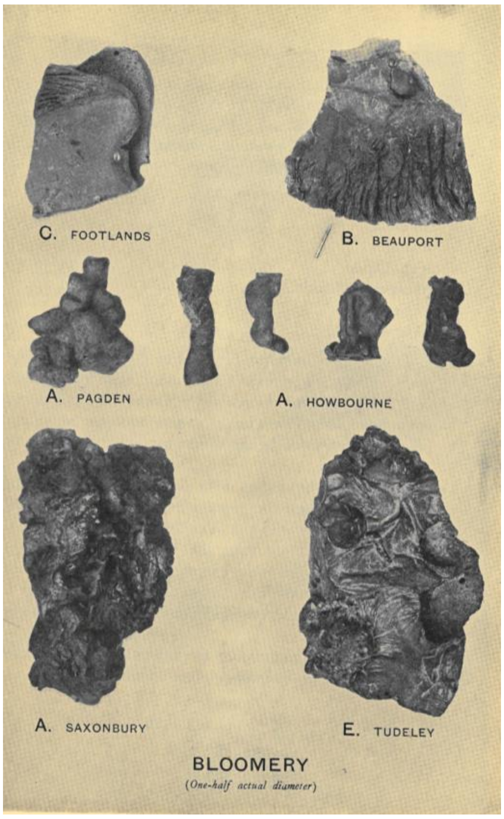


Figure 5.16 – *Examples of slag collected and published by Straker in his monograph Wealden Iron (1931; 93). E shows an example from Tudeley of tap slag which forms the most frequent morphological type found on the site (see Section 5.8.3).*

The site of Tudeley Ironworks therefore remained unsubstantiated. Questions were also raised over the quantities of surface slag visible which suggested a smaller scale operation than indicated by the accounts (Herbert 1986). Since Straker's discovery, other candidates for Tudeley Ironworks have been suggested, including Rat's Castle (Herbert 1986, 52-53, Hodgkinson 1998) and the Devils Gill Bloomery, discovered 900 metres upstream of Straker's site

(Herbert 1986, 53) (fig. 5.1). Furthermore, the wider economic landscape around Tudeley, which the bloomery relied upon for ore and charcoal, had never been investigated, and yet the ancient woodland that covers much of the landscape offered considerable potential in preserving evidence for these industries and allowing comparisons to be made with the references to these in the accounts. There was also a need to understand the relationship between Straker's proposed Tudeley site and other known ironworks including the Devils Gill Bloomery (fig.5.6). Other ironworks on the Southfrith Chase are recorded, including two possible furnaces or 'fabrica' in 1350, formally leased to a Thomas Harry (Giuseppi 1913, 148). It was evident therefore that Tudeley formed part of a wider woodland economy and iron-production network.

5.5 - Aims

The primary aim of the reconnaissance survey was to relocate Straker's site and assess the likelihood that it was Tudeley Ironworks. This required recovering datable evidence and a technological assemblage to assess technology and scale of production. Site morphology also needed to be assessed so that this could be considered alongside the references in the accounts that document the structural features of Tudeley, such as the building and hearths recorded in the 1350s. An overall aim was to link the site to the wider landscape, for based on the evidence from Roffey, this wider landscape is an integral part of the definition of a centre of production (see Chapter 6).

5.6 - Methodological approach

Reconnaissance surveys allowed a written and photographic record to be made of above ground archaeological features including pits, tracks, banks and slag scatters over an area of 1ha at the Tudeley site applying a similar approach to the Roffey reconnaissance survey. The results of these surveys can be found in Appendix C1. The site thought to be Tudeley Ironworks was visited on a number of occasions to take account of seasonal variations in vegetation coverage and periods when the Devils Gill stream and its tributary were in spate. These visits formed part of the wider reconnaissance survey across a total of 60ha, to assess the woodland archaeology, the results of which are discussed in Chapter 6. On one visit to the site a technological assemblage of 20 samples of slag were collected from a tributary stream that had eroded a slag heap. While this was a small sample compared to the Roffey assemblage, only limited quantities were obtainable, and advice was sought from WIRG on what would be considered a representative sample. The samples were analysed using the same macromorphological parameters as the Roffey assemblage.

While site morphology is typically assessed through excavation, the site's location within ancient woodland and a Nature Reserve meant excavation was not permissible. Furthermore, the site's position within a stream valley would have required deep excavations to account for centuries of hill-washed soil. While trial trenches had the potential to recover dating evidence and identify features such as furnaces and slag heaps, they would ultimately not allow the entirety of the site layout and the relationship between features to be fully assessed. An open area excavation would not have been practical given the density of trees. However, the fortuitus bisection of a slag heap by a tributary stream meant that a representative technological assemblage could be obtained along with pottery dating evidence. To assess the overall site morphology, a magnetometry survey was used, which is non-destructive and was successful in locating areas of high magnetism associated with possible furnaces and slag deposits, along with an outer boundary ditch suggesting the extent of the site.

The following sections outline the results of the landscape reconnaissance and geophysical surveys and the macromorphological assessment of the technological assemblage. A comparison is then made between these findings and the Tudeley accounts, also drawing on evidence from the excavation of the 14th century ironworks of Minepit Wood (Money 1971) and the records of the 15th century ironworks at Byrkeknott in 1408 (Lapsley 1899) to serve as a comparison.

5.7 - Landscape Reconnaissance Survey

5.7.1 - *Landscape context*

The site (at TQ 620 447) is positioned on the eastern bank of the Devils Gill and the confluence of a tributary stream, matching the description of the tributary 'rill' described by Straker (1931). It was visited between February 2019 and March 2022 and a detailed record were made of archaeological features present over an area of approximately 200x150m. These are summarised in Appendix C1

Figure 5.17 - *Photograph of Straker's site of Tudeley on the Devils Gill in circa 1931 (left) (Straker 1931, 221) compared to the site in February 2019 (right) (Author's image).*

along with the features identified in the wider reconnaissance survey. Features are categorised as watercourses, working platforms, pits, slag deposits and boundaries and their position is shown on a sketch map (fig. 5.18).

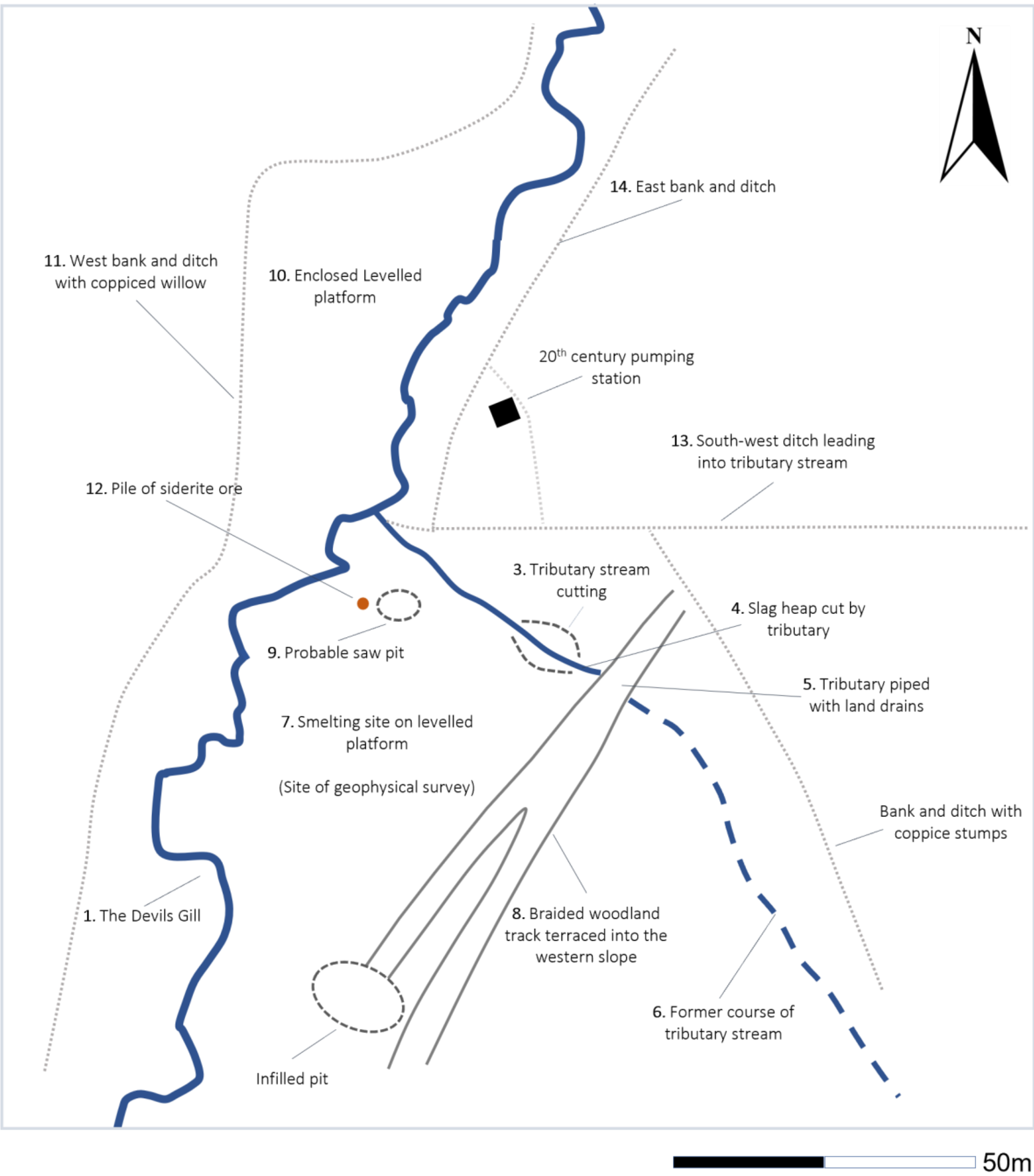


Figure 5.18 – *Sketch map of the survey area of Straker's proposed site of Tudeley Ironworks, created by the author, and based on 19th Century OS mapping and LiDAR data courtesy of Digimap OS Collection. The ancient woodland had allowed excellent preservation of earthworks including pits, terraced tracks, platforms, enclosure banks and ditches as was also evident in the magnetometry data Section 5.7.*

5.7.2 - *Slag deposits*

The majority of the slag present on the site was at the confluence of the Devils Gill and the eastern tributary stream (fig.5.18;1-6). Straker had recorded how there was 'a good deal of unusually large cinder in the bed of a small tributary rill' (Straker 1931, 220) and this confluence matched his description (fig.5.19). Slag was present in the tributary stream bed running for approximately 50m east from the confluence to a point where slag could be seen eroding both banks of the stream. The slag included large samples, measuring up to 300mm (see Section 5.8). It was apparent that at 50m upstream a deposit of slag had been bisected and that when the stream was in spate during the winter months or after heavy rainfall, water had gradually eroded material and moved it downstream. Tebbutt came to the same conclusion, stating that the tributary 'cuts through a deep bed

Figure 5.19 – *The confluence of the Devils Gill and the eastern tributary stream. Over time slag had been eroded from deposits stretching 50m along the tributary and these had gradually been washed to the west and eventually deposited within the main stream. (Author's image).*

Figure 5.20 – *Tributary stream flowing east to west to meet the Devils Gill stream. Slag can be seen in the bed of the channel that has been eroded from a deposit 50m east See fig.5.18; 6. (Author's image).*

of large cinder, some of which has been washed down into the main stream' (Tebbutt 1979, 8). The largest slags were closest to this deposit, while those at the confluence were typically smaller and probably fractured by the wash of the stream. The course of this tributary evidently postdates the slag deposit, and while the LIDAR suggests it is a natural watercourse, evidence of fragments of land drain within the channel indicate its course has been artificially modified. This modification probably occurred in the 19th century, and it is possible that it was at this date that the slag deposit was cut through, for water would generally flow around an obstacle like slag rather than through it (Fig.5.18;5 and 5.20-5.21). The profile of this slag deposit in the stream bank can be seen in figure 5.22.

Figure 5.21 – *Slag deposit cut by the tributary stream, 50m from the confluence with the main stream. Moss covered slag can be seen eroding out of the northern and southern banks. The deposits reach a depth of 45cm. See fig.5.18; 4. (Author's image).*

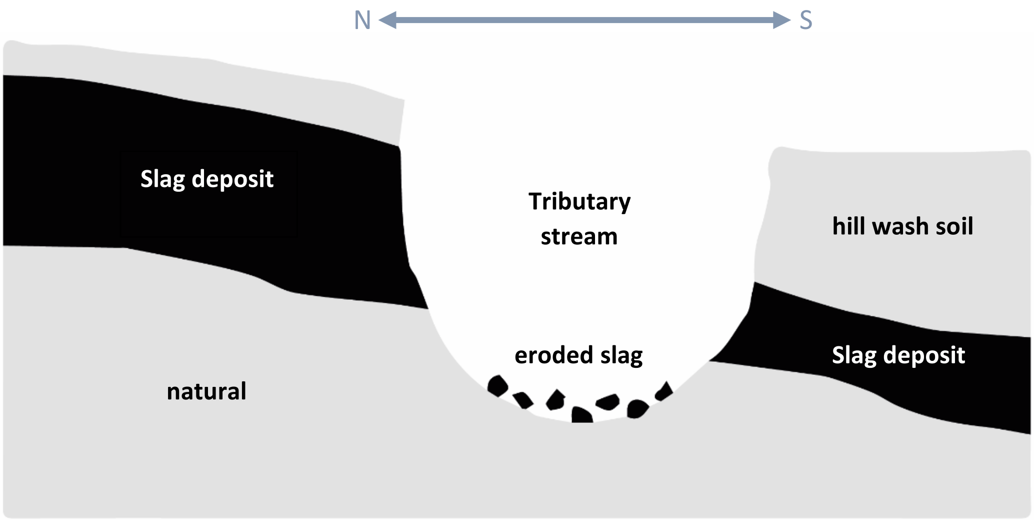


Figure 5.22 – *Sketch cross-section of the tributary stream (fig.5.21) and the approximate shape of the slag deposit which, based on the vertical profile, has greater hill washed soil to the south bank (right) than the north bank (left) and possibly indicates the slag deposit thins out. (Author's image).*

There was 45cm of soil above this slag on the northern bank, which was topped by an ash tree whose roots grew amongst the slags. Similarly, slag was present in the southern bank although here the overlaying hill washed soil was deeper, suggesting a graduated profile to what was evidently a slag heap (fig.5.22-5.23). The magnetometry survey showed that the deposit continued for approximately 2m to the south and 1m to the north indicating that most of deposit had been eroded by the tributary (see Section 5.8, fig.5.61). A further anomaly on the magnetometry data, possibly a smaller deposit of slag, was present 10m west along the tributary, which might also account for some of the slag within the channel. However, this feature was not visible in the channel section (fig.5.57).

Figure 5.23 – *Vertical profile of the slag deposit in the southern bank of the tributary stream. Approximately 50cm of soil lay above the slag on this side. (Author's image).*

Slags were also present approximately 100m to the north of the site in the stream bed of the Devils Gill. However, these represented isolated finds and are likely to have been orginally washed from the confluence. No slag deposits were found to the south of the confluence, suggesting after smelting, slag was deposited away from the stream. Had the tributary not eroded the slag deposit, there would have been little in the way of surface evidence to suggest the site had been used for iron-production and therefore raises the possibility that other sites that remain buried were situated along the banks of the stream.

5.7.3 - *Working platforms*

East Bank platform (fig.5.18; 7-8)

Immediately to the south of the slag deposit there was an area of relatively level ground, possibly a deliberately levelled platform, now covered by coppiced hazel (fig.5.24). The area extended approximately 30x30m and was delineated by a NE-SW aligned track to the south-east, which had a low bank 0.5m in height (which may or may not be contemporary), and the Devils Gill to the north-west (fig.5.18;7-8). Occasional surface scatters of slag were observed across this platform, but these were not numerous. The relatively level terrain and the proximity of the slag heap suggested this platform could have been the main working area for the site and this was later confirmed by the magnetometry survey (see Section 5.8). Access to the working area could be gained via the track to the east (fig5.18;8) (discussed in detail in Chapter 6, Section 6.8.2). The site's proximity to the stream and elevated position above stream level would provide the works with a source of water without significant risk of flooding.

Figure 5.24 – *East bank platform of relatively level ground, with only a slight westerly gradient towards the Devils Gill. Subsequent geophysical survey showed this area contained anomalies consistent with furnaces and slag deposits, contained within a ditched enclosure. (Author's image).*

West bank platform (fig.5.18; 10-11)

A second levelled platform to the immediate north on the west bank of the Devils Gill measured 60x25m (fig.5.18;10-11). This was delineated by the stream to the east and a boundary bank and ditch to the west, that dog-legged around the levelled platform. While no slag was identified across this platform, a patch of charcoal rich soil to the south might indicate a former charcoal clamp or storage area was located here. The absence of slag indicates smelting was restricted to the eastern bank of the stream. However, given the potential depth slag deposits could be buried, iron-production within this enclosure cannot be discounted on lack of surface slag.

5.7.4 - *Boundary earthworks*

Northern Boundary Bank and Ditch (fig.5.18; 13-14)

To the North of the tributary stream, there was a bank and ditch running on a N-S alignment (fig.5.25). This may be a field ditch delineating the northern boundary of Smithy Wood. An artificial bank also ran along the edge of the stream on the eastern bank, terminating at this N-S bank and ditch (fig.5.18;13-14). Both are likely to be post medieval woodland boundaries, however the presence of small samples of slag (>5cm) in and around the N-S ditch could suggest smelting or at least the deposition of waste continued further north beyond the tributary stream (fig.5.25).

Figure 5.25 - *Bank and ditch delineating the northern boundary of Smithy Wood. Evidence of slag was present in and around the ditch, suggesting the ironworking activity extended as far as this point or that waste was deposited in the vicinity. (Author's image).*

Western boundary (fig.5.18; 11-12)

On the western bank of the Devils Gill, a 2m wide ditch flanked by 40cm high parallel banks ran on a north-south alignment (fig.5.18;11-12). Several coppiced hedgerow varieties grew on top of the banks, including ash and field maple. The boundary followed the western bank of the Devils Gill, frequently little over a meter from the course of the gill. However, upon reaching the western platform (see above) its route deviated

Figure 5.26 – *Boundary on the west bank of the Devils Gill, enclosing a levelled platform. (Author's image).*

Figure 5.27 – *Boundary on the west bank of the Devils Gill, enclosing a levelled platform, showing the parallel banks on either side of the ditch. (Author's image).*

to the east by 30m before returning on a southern trajectory for 60m to define the platform's western extremity after which point it continues to run parallel with and close to the stream (figs.5.26-5.27).

5.7.5 - *Pit (fig.5.18; 9)*

A cigar shaped pit was identified 2m from the eastern bank of the Devils Gill (fig.5.18;9). It was 4.4x2.2m with a depth of 0.8m (fig.5.18;9). This is likely to be the pit recorded by both Straker and Tebbutt (fig.5.28). This pit is interpreted as a sawpit and is discussed in relation to other sawpits identified in the wider reconnaissance survey in Chapter 6.

5.7.6 - *Siderite ore stack (fig.5.18; 12)*

Southwest of the sawpit by 1.2m, a stack of four partially buried flat stones were visible. They were grey blue in colour and varied in size from 16x14cm to 20x12cm and 12x5cm (based on their exposed surfaces) - the fourth stone was too buried to accurately measure. Their tabular morphology suggests they are siderite ore, which is found locally within the Wadhurst clay. To the south of the

Figure 5.28 – *Sawpit identified on the east bank of the Devils Gill at the Tudeley site. An earthwork plan of this can be found in Chapter 6 fig.6.30. (Author's image).*

Tudeley site by 100m, siderite ore was exposed within the streambank at a depth of approximately 2.8m and had in places been quarried (see Chapter 6, 6.9.2). The fractured edges and stacked arrangement of the examples here is artificial. It is possible that they were excavated and dumped here during the construction of the adjacent sawpit, and suggests the sawpit was dug to a depth of at least 2.8m, at which point the sawyers hit the ore seam. Alternatively, they may have been intended for the use in the furnace and could represent the upper layer of a much larger buried deposit (fig.5.18;15). The decision was made not to uncover these stones, as this survey was intended to be non-invasive, however, future excavation and analysis could help determine their origins/ purpose and extent.

Figure 5.29 – *one of the exposed stones of grey colouration, a typical feature of siderite ore. The sawpit lay 1.2m east and it is possible that they were excavated during the construction of the pit. (Author's image).*

5.7.7 - *Pottery dating evidence*

Two sherds of pottery were recovered from the bottom of the tributary stream, 2m from the truncated slag deposit (fig.5.30). Both appear to have been eroded from this deposit recently, as their edges lacked the level of abrasion expected with repeated contact with water (fig.5.31). The first sherd was from a pitcher (jug) forming the handle 11cm in length and is dated by Luke Barber to c.1350-1450 (Barber pers com 2019). The second smaller sherd dates to c.1250-1400 (Barber pers com 2019). Significantly, pottery is rare in the Weald from this period, as the pottery industry diminished after the Black Death in 1348 (Barber pers comm 2019). Pottery is also infrequently recovered on medieval iron-production sites. The accounts for 1350-51 record 'a clay pot bought to carry water' costing 1d and it is possible that this handle was once part of a similar pot (fig.5.32). While the pottery alone does not prove this was the site of Tudeley Ironworks, it's discovery within the slag deposits is evidence that the iron-production here dates to the 14th century.

Figure 5.30 – *the sherd of pottery discovered within the tributary stream. This was the first pottery evidence recovered from the site and its date range of c.1350-1450 fits the date of the Tudeley account. It was evident that, like the surrounding slag, it had eroded from the slag deposit 2m to the east. (Author's image).*

Figure 5.31 - *Pottery fragment recovered from the eastern tributary dated c.1350-1450. It consists of a fragment of handle attached to part of the main body of the vessel. The sherd is 115mm long and 88mm wide. The sherd is 5mm thick, while the handle is 6mm thick. The handle has a series of 9 indentations arranged in two rows of three, while the bottom row features just two indentations on either edge of the handle. One indentation from the row above is present where the break has occurred. Several parallel lines extend down the handle, which appear to be from where the potter shaped the handle in its manufacture. The underside of the handle has 14 impressed dots within the clay, more randomly placed than the incised indentions on the outer face of the handle, and appear to be deliberate, perhaps to aid with grip. The sherd is light greeny grey in colour with some dark discolouration to the inside and the underside of the handle, which may be the result of staining from the soil and slag that it was associated with. (Author's image).*

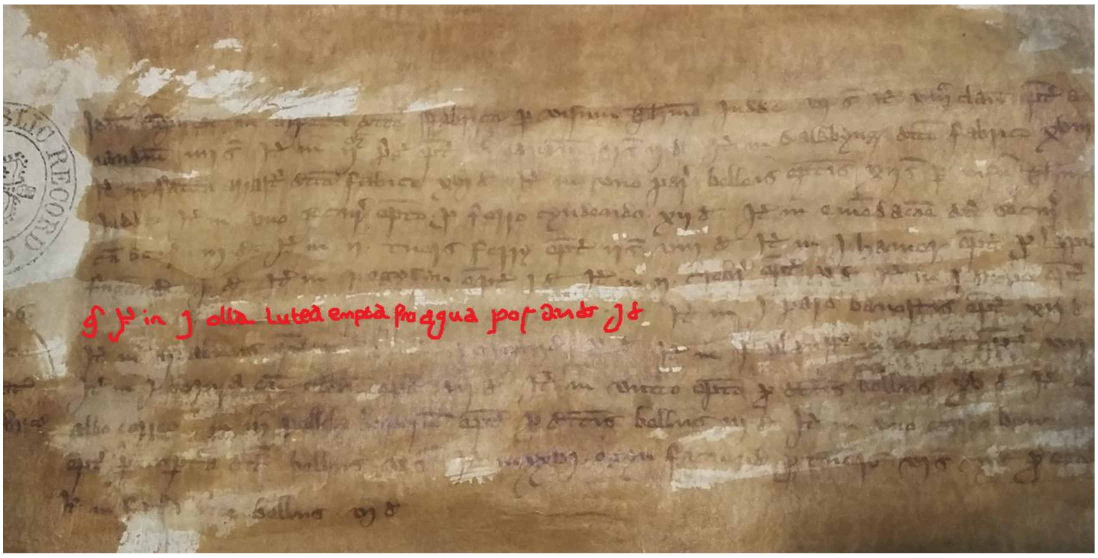


Figure 5.32 - *Extract from the Tudeley Accounts from 1350-1, where a 'Item in j olla lutea empta pro aqua portanda jd' or a 'pot for carrying water' is recorded as being purchased for the works, held at that time by Thomas Spinget. Other items of equipment are listed for the same year. The pot is mentioned in the later account of 1354 as equipment remaining at Tudeley Ironworks. It can only be speculated whether the sherd found amongst the slag (fig.5.31) came from the pot described in 1350. However, the inclusion of a pot to carry water within the accounts demonstrates the importance it held in the equipment used by the smelters. Photographed by the author with kind permission from the National Archives.*

5.8 - Geophysical survey - Magnetometry

A Bartington Gradometer 601 twin probe was used to carry out a magnetometry survey of the proposed site of Tudeley Ironworks on 6th-7th March 2020. Magnetometry has been shown on sites such as Chitcombe to have considerable potential for identifying metallurgical sites (Greenwood 2021). Features such as furnaces, hearths and slag heaps on iron-production sites display high magnetic readings, as do ditches, pits or trackways that frequently contain re-deposited technological waste.

5.8.1 - *Survey Location*

The survey was carried out on the eastern bank of the Devils Gill, where deposits of slag eroding from the eastern tributary stream indicated the proximity of iron-production. It was decided to survey the immediate area around the tributary to establish the location of potential furnaces, hearths, and slag heaps as well as the extent of activity.

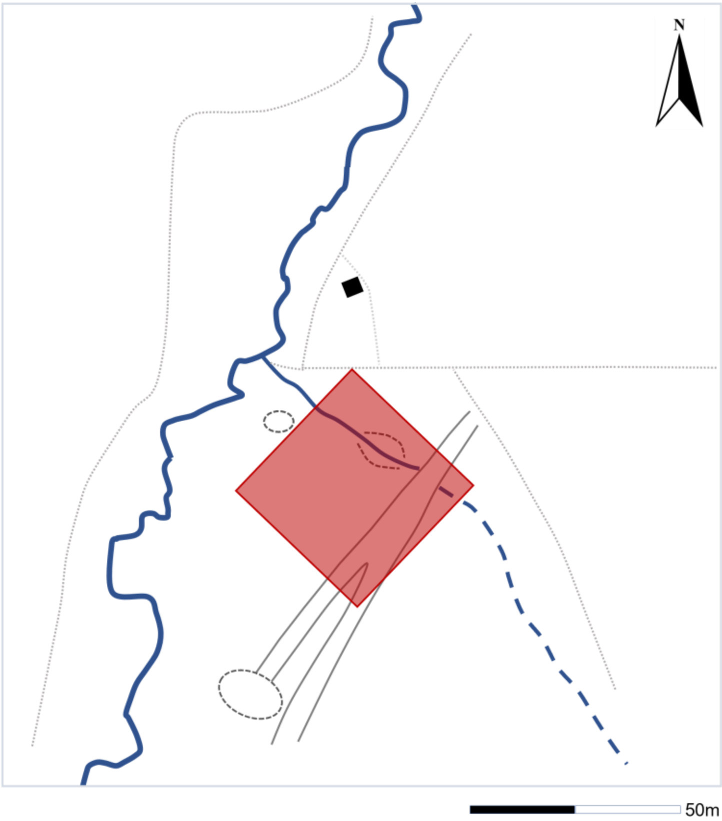


Figure 5.33 – *Area covered by the magnetometry survey in relation to the Tudeley site sketch plan. The survey area was 40x40m and subdivided into 10x10m grid squares. The survey covered either side of the tributary stream and the bisected slag deposit. Plan based on LiDAR and cartographic data from Digimap OS Collection and traced by the author.*

5.8.2 - *Methodological approach*

The wooded terrain, along with the steeply-sided stream and tributary channels, restricted the survey area to 40x40m. The use of 10x10m grids made working between the vegetation more manageable. On the supposition that the focus of the site lay close to the slag heap, and levelled platform south of this, the initial survey area of 30x30m targeted these features. However, the grid was subsequently extended by 10m to the south and east to trace the extent of anomalies. Dummy readings were inputted over the tributary stream and in areas of dense vegetation, however most of the survey grid was recorded. The survey

Figure 5.34 - *The magnetometer took readings 0.5m either side of both sensors and meant each 10m grid was surveyed through 5 traverses on a parallel north-east alignment. Trees, vegetation, and the tributary stream meant that dummy readings had to be inputted within some traverses. To allow for the dummy readings a 'point plot' approach was taken, where readings were manually recorded every 25cm along the traverse demarcated by a tape measure. This meant 4 readings were taken per meter. The ability to input dummy readings was particularly important in grids 5-7 that covered the tributary stream and involved surveying as far as the southern edge of the stream channel, and walking around to the opposite bank (dummying out the appropriate number of readings) to continue to the end of the grid – a process that was particularly time consuming. Laying out tape measures along the traverse intervals of 1m, 3m, 5m, 7m and 9m, meant that readings could be accurately taken at 25cm intervals, totalling 40 readings per traverse, 200 readings per grid square and 3200 readings across the entirety of the site. (Author's image).*

was completed parallel, with 4 readings per meter along 5 traverses on each grid. Like the Roffey survey, the detection limit was set to 1000nT (Greenwood 2019, 193-194). The results of the survey can be found in figures 5.55-5.61 and Appendix C2.

5.8.3 - *Interpretation of primary data set*

Hearths and furnaces

Across the site, nine positive discrete anomalies are interpreted as the remains of furnaces or hearths and are highlighted in green on Figure 5.61 and numbered 1-9. They all display magnetic dipoles characteristic of the intense heat created by furnaces and have readings that measure up to 228-271nT in anomalies, 1,2,3,4 and 6, while anomalies 5 and 7 are higher at 647nT and 469nT. Anomaly 8 is of lower magnetism at 139nT with these readings more comparable with the slag deposit (fig.5.61; 9). However, it was not possible to survey the full extent of Anomaly 8 and it could conceivably represent a spread of material associated with Anomaly 7. The absence of ground disturbance through ploughing has meant that, unlike Roffey, the anomalies retain a defined shape and size, and their separation demonstrates a clear spatial arrangement. Their size is relatively uniform. Anomalies 1-3 are between 2.5m and 3m in diameter, while 4-8 range between 2.5m and 4m. These diameters are unlikely to represent the original size of the furnaces or hearths, as the heat they once generated is likely to have altered the magnetic field around them. The anomalies do however suggest that the sizes of furnaces or hearths lay within these ranges.

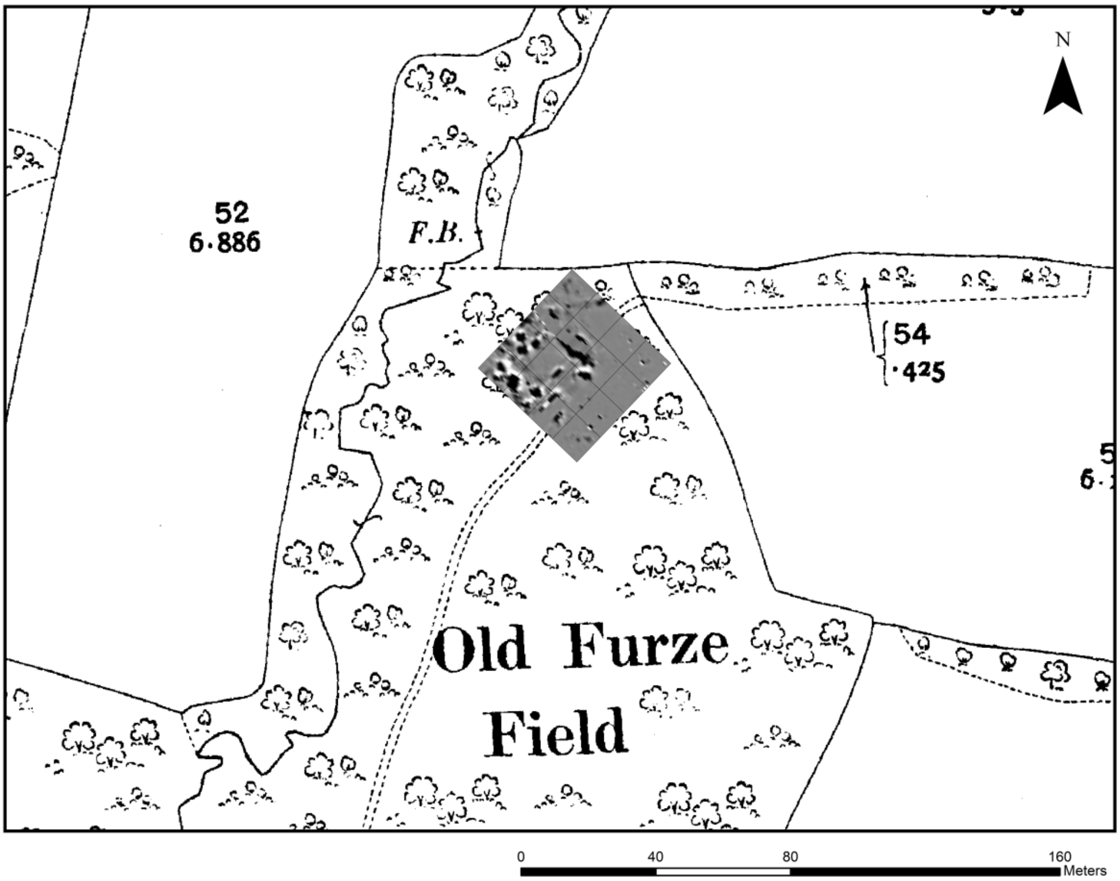


Figure 5.55 – *Magnetometry survey results overlain on a 19th century OS map of the field. Base map courtesy of Digimap OS Collection.*

Figure 5.56 – *Magnetometry survey results overlain on an aerial image of Smithy Wood. Aerial image courtesy of Digimap OS Collection.*

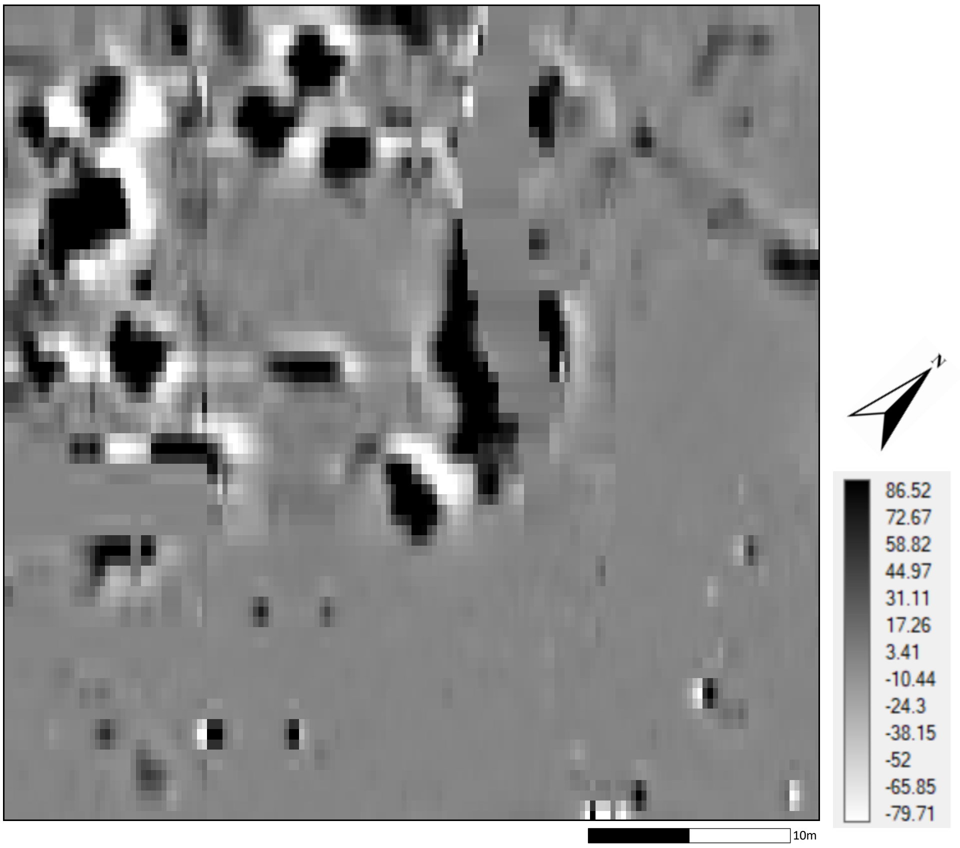


Figure 5.57 – *Magnetometry survey results. These have been processed by zeroing the main traverse, interpolating and clipping to a range of -100 to 100nT. These have been presented as a shade plot 'Grey 08'. (Author's image).*

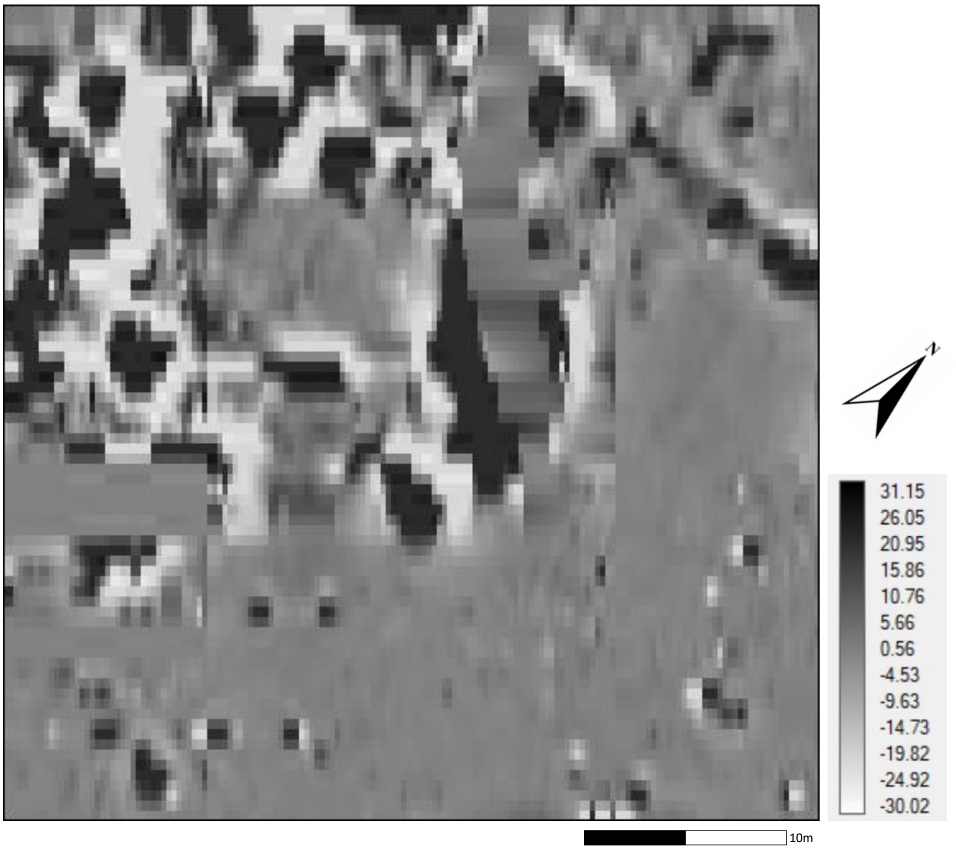


Figure 5.58 - *Magnetometry survey results. These have been processed by zeroing the main traverse, interpolating and clipping to a range of -20 to 20nT. Presented as a shade plot 'Grey 08'. Clipping the data displays the perimeter ditch with greater clarity. (Author's Image).*

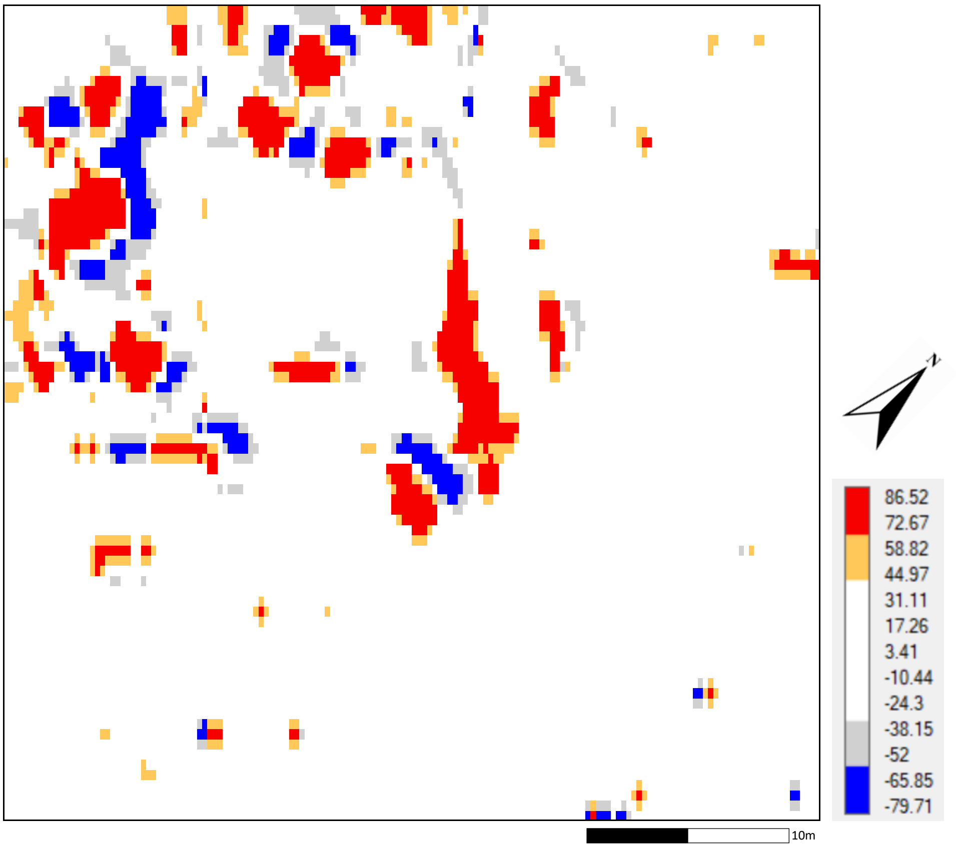


Figure 5.59 - *Magnetometry survey results. These have been processed by zeroing the main traverse, interpolating and clipping to a range of -100 to 100nT. Presented as a shade plot 'Grey 14'. This clearly shows the highly magnetic readings associated with furnaces, hearths, and slag deposits. (Author's Image).*

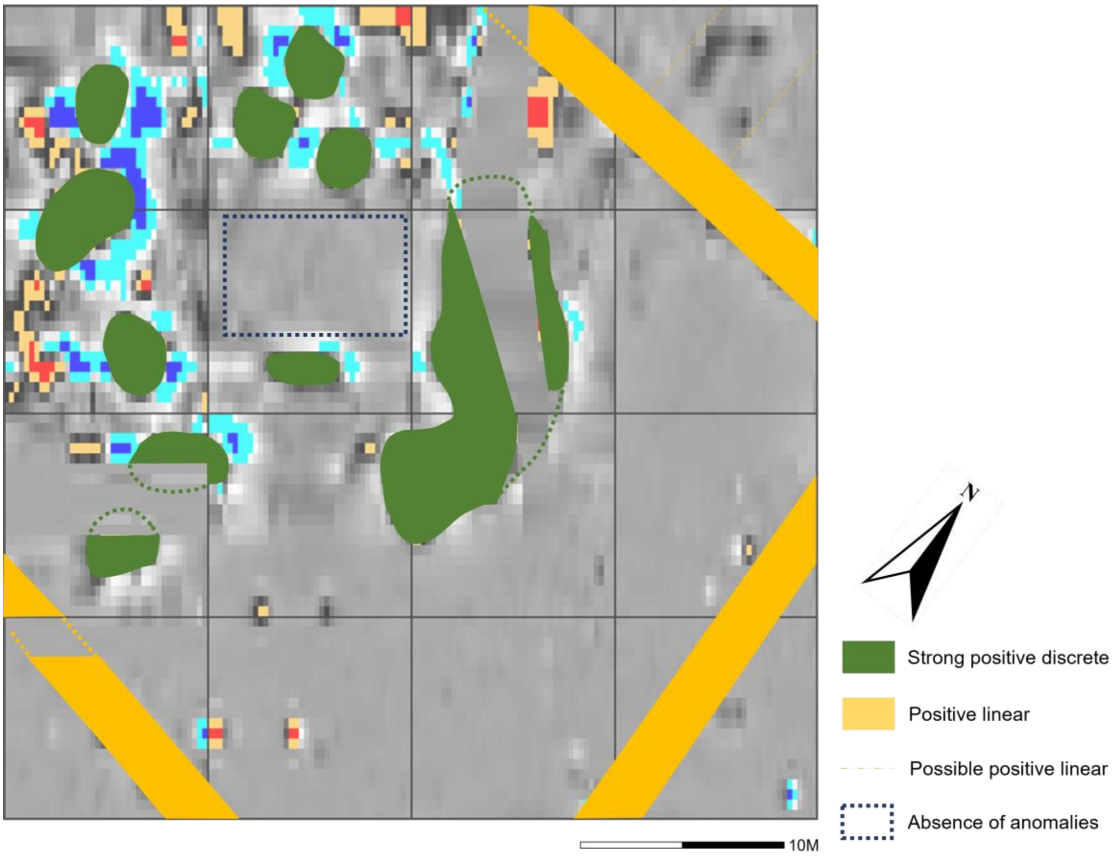
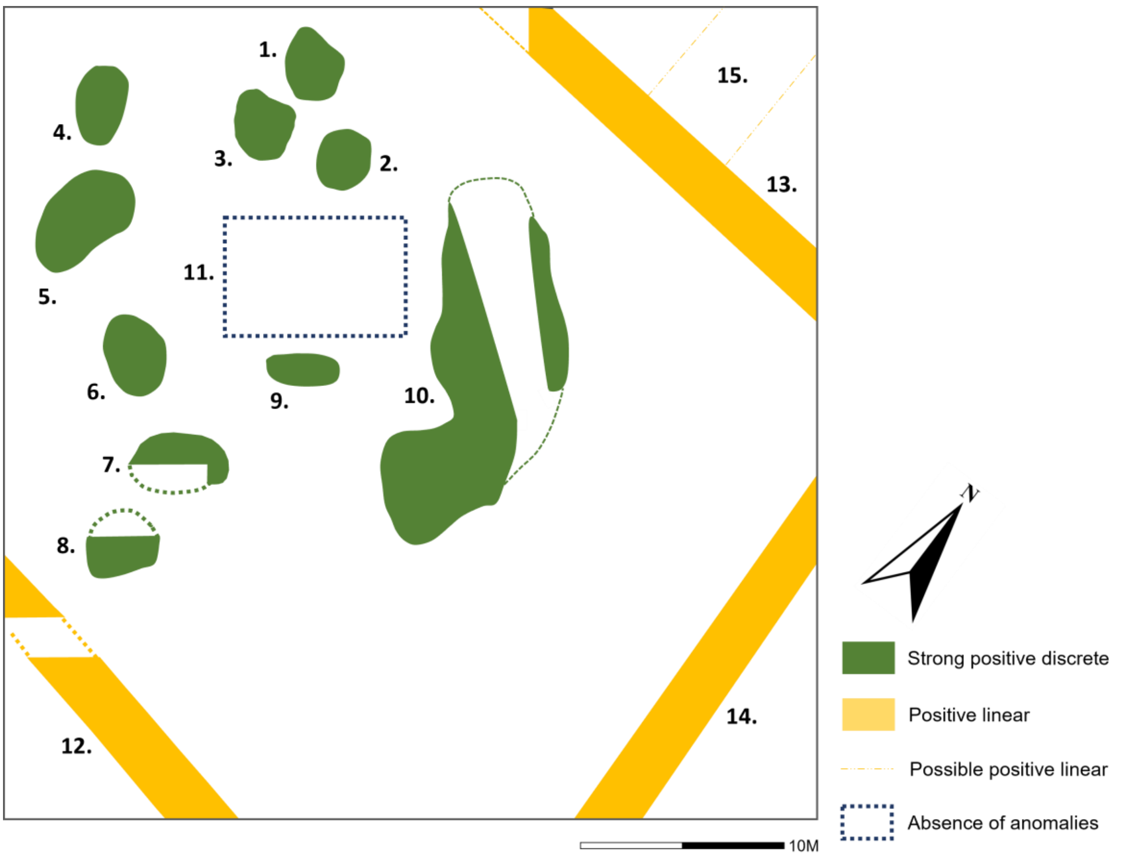


Figure 5.60 – *Interpretation of the magnetometry results based on anomaly type. (Author's Image).*



1-9 – Furnace or hearth anomalies.

10 – Slag deposit (as confirmed by erosion through the centre by the tributary stream).

11 – Probable site of the building/structure based upon the absence of magnetic anomalies in an area otherwise dominated by activity.

12-14 – Perimeter ditch appearing to form a sub-rectangular enclosure.

15 – possible area metalled by waste slag, maybe an entrance track.

Figure 5.61 – *Interpretation of the Tudeley magnetometry results based on anomaly type. The numbers given to each feature are referenced throughout this section. (Author's image).*

The spatial positioning of the furnaces or hearths is also significant and is particularly clear on the shade plot of Grey 14, where highly magnetic readings are displayed in red (fig.5.59). Anomalies 4-8 (fig. 5.61) are orientated east-west in a linear arrangement that respects the alignment of the perimeter boundary ditch (fig.5.61; 12), while anomalies 1-3 in are clustered and yet still appear to respect the overall site arrangement in their separation from anomalies 4-8, the perimeter ditch, and the central area absent of anomalies (11) where a structure may have stood (fig.5.61; 11).

A smaller dipolar anomaly, approximately 1m in width, is located close to the centre of the site (fig.5.61; 9). While this anomaly is likely to be associated with a feature generating high temperatures, it would appear too small to be a furnace. It measures up to 169nT and while it could be a deposit of slag, it is more likely, given its position within the activity area, to be a hearth and possibly associated with a structure at 11. It must not be assumed that all 9 furnaces and hearths were operating at the same time. It is more likely they represent contiguous phases in which furnaces were rebuilt adjacent to their predecessors. It is also possible some furnaces were rebuilt in the same position as earlier furnaces, which might account for the wider spread in anomalies 4 and 5 (fig.5.61).

Primary technological deposits

Anomaly 10 (fig.5.61) is interpreted as a primary deposition of technological waste, predominantly slag. This area was initially identified in the reconnaissance survey, where a deposit of slag had been eroded by the tributary stream exposing slag in the section of both banks (see Section 5.7.2). The deposit was primarily composed of predominantly Type 2 slag, with no evidence for the structural remains of a furnace, leading to the conclusion it was a buried slag heap. The magnetometer survey was able to reveal its extent, and showed it continued 6m N-S and approximately 14m E-W. The deposit is larger than any of the interpreted furnaces or hearths and is very roughly oval in shape. It had readings of up to 168nT and 294nT and was positioned on the northern side of the site, 7m from the nearest furnace/hearth anomaly. The tributary stream had eroded most of the centre of the deposit and while the course of this tributary postdates the slag, it is unclear how the watercourse came to bisect the slag heap, given water would naturally flow around such a compacted obstacle. It might suggest sections of this tributary channel are artificial and deliberately dug in later centuries to facilitate drainage from neighbouring fields. The high quantities of slag within the stream bed are testament to the erosion that this slag deposit has subsequently experienced.

Secondary technological deposits

It is possible that some secondary deposits of technological material had been deposited in the perimeter ditches (fig.5.61; 12,13 and 14), based on irregular high magnetic ‘spikes’ of up to 115nT within these linear anomalies. Slag had also been re-deposited within the tributary and main streambed through the erosion of the slag heap (fig.5.61; 10). The absence of further slag heaps would suggest either they are located outside the survey area, or that slag was removed from the enclosure, either during the period of operation, or in later centuries. Tebbutt identified slag in the field immediately to the east and it is possible that slag was deposited there and has subsequently been spread through cultivation. No above ground slag heaps were present on the site, however, while Anomaly 10 was buried, it is probable that it once stood above ground and was possibly removed when the tributary stream was excavated through its centre. Hill-wash is also likely to have led to the further burial of the slag heap.

The relative absence of high magnetic spikes across the site, particularly in the east, suggests the area has undergone limited post depositional disturbance, such as through cultivation. This would indicate that soon after the abandonment of the ironworks the land regenerated into woodland, which it remains today.

Positive linear anomalies

Three positive linear anomalies were identified to the north, east, and south of the survey grid and are highlighted in yellow (12,13 and 14). These linear anomalies are particularly clear when the data is clipped to a range of -20-20nT (fig.5.58). Those to the north and south (fig.5.61; 12&13) are on an east-west alignment, and an eastern linear anomaly runs north-south (fig.5.61; 14). While the intersections of the three anomalies lie beyond the survey grid, it is probable that they form three sides of an enclosure ditch defining the perimeter of the site and enclosing the industrial activity. The working area enclosed by the perimeter ditches would have been approximately 30m N-S and 35m or more E-W. These linear anomalies are characteristic of cut features, in this instance ditches, which are approximately 2.5m wide (although excavation would confirm their exact width). Magnetic readings are lower compared to the anomalies associated with iron-production, ranging from 10nT to 19nT. However, there were several spikes up to 73nT and 115nT, such as to the east of 13 and scattered along 14 and these are likely to represent small deposits of technological waste infilling the ditches. Despite this, redepositing of slag and other waste does not appear to have led to the complete infilling of these ditches, which would have resulted in a more defined feature with similar readings to the slag deposit (fig.5.61; 10). Therefore, it would seem these ditches were continually maintained during the life of the ironworks, and probably facilitated drainage, important given the proximity to the stream.

As slag had not been used to any great extent to infill the ditches post-abandonment of the site, it suggests they were left to silt up naturally. Furthermore, the tributary stream bisects the western end of the northern ditch of the enclosure (fig.5.61; 13), showing the course of this tributary post-dates the construction, use and abandonment of the enclosure. While the western side of the enclosure was not visible in the results, it is conceivable that the Devils Gill, which flows c.30m west, formed the western boundary and that diches 12 and 13 joined the stream to allow water collected by the ditches to drain into it.

Possible structures

As the Gradiometer was set to 1000nT, features within lower magnetic ranges associated with structures, such as postholes, are unlikely to be visible in the data. The accounts for 1343 record the construction of a timber framed building at Tudeley and based on the comparable site of Minepit Wood, this building is likely to have stood in close proximity to the furnace. An area of 10x8m (fig.5.61; 11) had low magnetic readings of between -3 and -10nT and stood out in the shade plots by the absence of magnetic features, in contrast to the immediate surroundings (Fig.5.57). Furnace/hearth anomalies 1-3 were 2m north-west, while 4-8 were 3-4m SW (fig.5.61; 1-8). The slag deposit (fig.5.61; 10) curved around the northern and eastern edges, while the smaller possible hearth (fig.5.61; 9) was immediately south-east. The absence of features suggests the construction of hearths and furnaces deliberately avoided this area and provides a viable candidate for the site of the building, which is also supported by its proximity to the activity areas.

5.8.4 - *Discussion*

The magnetometry survey revealed a smelting site consisting of furnaces, hearths, a slag heap, and potential building, all within a rectangular ditched enclosure and possibly accessed by a track on the northern side. The ditches enclose an area of approximately 1050m², arranged on a NS-EW alignment. Activity was concentrated in the west of this enclosure, where eight probable furnaces or hearths were positioned. It is unlikely that all eight were in existence at the same time, and the anomalies probably reflect successive rebuilding phases and the construction of replacement furnaces. Five furnace/hearths are roughly aligned along the southern boundary ditch, while a group of three anomalies cluster to the N-W of the possible built structure. The positions of hearths and furnaces may have been determined by the prevailing south-westerly wind direction, which had would have blown smoke (and potentially harmful carbon monoxide produced by the furnaces) towards the site of the possible building if anomalies 4-8 were furnaces/hearths away. However, if anomalies 1-3 were furnaces their position to the west would have meant carbon monoxide would blow away from the enclosure and not over the building and working areas, located north and east. It might suggest anomalies 4-8 were hearths, which apart from smoke did not pose a risk from carbon monoxide and anomalies 1-3 were the sites of furnaces. The considered and planned arrangement of the site is also supported by the absence of furnace/hearth anomalies in the northern or eastern areas of the enclosure, which were instead used for depositing slag.

The building is likely to have stood in the centre of the enclosure (fig.5.61; 11), 10m from the southern and northern boundaries and close (but downwind) of the furnaces and hearths to the south and west. Its potential site was defined by the absence of anomalies over an area of c.10x8m and based on the excavated structure at Minepit Wood which was 11mx8-7m, a building of similar proportions could conceivably have existed here (Money 1971, 94). The rectangular enclosure and building at its centre demonstrate a deliberately planned arrangement to the site. Furnaces and hearths underwent periods of rebuilding and their positions changed over time. However, they continued to acknowledge the position of the building, the perimeter ditch and their predecessors, therefore demonstrating the longevity of these features in defining the site's layout throughout its working life.

5.9 - Technological material

5.9.1 - *Introduction and background*

While the Roffey fieldwalking survey retrieved a large sample of technological material for classification, a fieldwalking survey was not possible at Tudeley and therefore sample collection was limited to the exposed slag deposits eroded by the tributary stream (fig.5.20-5.23). Unlike the Roffey assemblage however, this material had not been subjected to centuries of ploughing and remained as large samples, with limited fracture, and could be more readily classified.

5.9.2 - *Methodological approach and sample collection*

Slag was present for 50m along the length of the tributary stream between the slag deposit and its confluence with the Devils Gill. The erosion of slag from the slag deposit by the tributary stream meant that samples could be readily collected (fig 5.18; 4). Samples closer to the slag deposit were larger in size and had been subjected to less fracture and abrasion as they had recently fallen into the watercourse. A total of 21 samples were collected and effort was made to retain a representative assemblage of the types of slag morphology present. Larger slags were favoured in the sample selection as these retained more visible attributes for characterisation. Geological material was also collected from the tributary stream and included siderite ore and cyrena limestone, although these comprised only two samples and are discussed in Section 5.8.4.

Samples were washed off site before being characterised using the same classification scheme as the Roffey assemblage (Appendix 5.1).

5.9.3 - *Macromorphological analysis of technological material*

A summary of the results of the macromorphological analysis is shown in Table 5.1. A representative sample of the slag recovered is photographed in figures 5.62-5.65. The slag was categorised by their morphology into three types using the same types as at Roffey, including types 1, 2 and 4. A discussion on the origins of each slag type can be found in Section 4.4.3.

Type 2 – Tap slag

Of the assemblage, Type 2 slag was the most numerous recovered, comprising 91% of the sample. Morphologically these slags corresponded to typical tap slag examples, with the upper surfaces of the majority (94%) presenting low viscous 'ropey' runnels of multiple flows (fig. 5.62). Of the 19 Type 2 samples, 17 were high density, with moderate to no porosity, which parallels the tap slag found at Roffey. Unlike the Roffey examples, the Tudeley Type 2 slag was of greater thickness, exceeding 90mm in some examples, with accumulated laminations representing multiple flow episodes. A total of 11 of these samples demonstrated 2-3 flow episodes, possibly the outcome of a single smelt in which slag was tapped from the furnace at intervals long enough for earlier flows to cool (fig.5.63). However, 6 examples showed between 4 to 6 flows had occurred, which might suggest consecutive smelts took place that allowed slag to build up. This is supported by one example where splashes of liquid slag had solidified on the upper surface, something only possible had the underlying slag been sufficiently cooled (fig. 5.65).

Table 5.1 - *Summary of the macromorphological analysis of 21 slag samples from Tudeley Ironworks. The classification scheme used in the macromorphological analysis is the same applied to the samples from Roffey and described in Section 4.4.3 and can be found in Appendix B5.1.*

	Type 1 slag: *Amorphous furnace slag*	**Type 2 slag:** *Tap slag*	**Type 4 slag:** *Furnace bottom slag*
Total no. samples	1	19	1
Total weight	2.6kg	26.2kg	1.7kg
Average Weight of a slag sample	2.6kg	1.4kg	1.7kg
Shape	amorphous = 1	amorphous = 1 plano-convex (plano base) = 4 plano-convex (convex base) = 9 concave-convex (convex base) = 1 plano = 2 concave-convex (concave base) = 1 convex = 1	plano-convex (plano base) = 1
Density	moderate = 1	moderate = 2 high = 17	high = 1
Porosity Proportion	Moderate porosity = 1	no porosity = 1 very low porosity = 4 low porosity = 7 moderate porosity = 4 high porosity = 3	Low porosity = 1
Predominant surface texture	Rough = 1	smooth and ropey = 10 smooth and ropey with broken bubbles = 8 rough fractured and ropey = 1	rough undulated = 1
Surface impressions	no impressions = 1	Charcoal impressions = 2 slag splash marks = 1 no impressions = 16	no impressions = 1
Prominent underside texture	rough and ropey = 1	rough = 7 rough with ground surface impressions = 11 smooth and ropey = 2	rough and ropey = 1
Underside impressions	Charcoal impressions = 1	charcoal impressions= 9 ground surface impressions = 12 no impressions = 5	no impressions = 1
Inclusions	white refractory / chalk = 1 refractory material = 1 rusty deposits = 1	white refractory / chalk = 6 refractory material = 8 ore = 1 roasted ore (red) = 16 rusty deposits = 5 geological material = 2	refractory material = 1 roasted ore (red) = 1 fractured slag = 1
Glassy morphology	yes = 0 no = 1	yes = 7 no = 12	yes = 0 no = 1
Viscosity	Moderate viscosity = 1	Low viscosity = 18 Moderate viscosity = 1	Moderate viscosity = 1
Multiple flow episodes	unclear = 1	Two flows = 5 three flows = 6 four flows = 2 five flows = 3 six flows = 1 unclear = 2	unclear = 1
Degree of fracture	partial some edges = 1	partial some edges = 13 partial all edges = 5 total fracture = 1	partial all edges = 1
Note: *Type 3 and 5 slag was not present within the assemblage*			

The majority of Type 2 slag was plano-convex in shape and had wedge-shaped profiles, with one end of greater thickness than the other (figs 5.62-5.65). Of the 19 samples, 6 (32%) had a plano base, while a greater proportion of 12 (57%) had a convex base. The convex base suggests the slag was tapped into a bowl shaped hollow or 'tapping pit' adjacent to the tapping arch of the furnace where slag was released. The wedge-shaped profiles suggest this tapping-pit had moderately sloping sides and a central depth of at least 90mm. Slag was evidently allowed to build up within the pit over successive tapping episodes before the solidified 'cake' was removed.

Both the thickness and estimated width of many of the examples indicated they would have formed large slag cakes in their unfractured state. The fact that they were discarded only 10m from where the furnaces stood, is perhaps a reflection of their weight and an avoidance in moving them far. Impressions of the ground's surface on 12 examples show this pit was not lined, but bare earth, and the 9 slags with charcoal impressions, 8 with refractory inclusions, and 17 with ore inclusions demonstrate how waste from the furnace collected within this tapping pit. This was a phenomenon observed in the Pippingford smelt, where fractured refractory material from the blocked tapping arch that had been broken by the boring stick, collected in an adjacent pit and subsequently adhered to the underside of the tap slag as it flowed over the debris (see Chapter 4 fig.4.88). Two examples preserved an impression of the outer edge of the tapping pit and allowed an approximate measurement of the size of the pit to be made, which had a diameter of approximately 460mm (fig. 5.64).

Furnace slags - Type 1 and Type 4

Amorphous furnace slag (Type 1), which solidified within the furnace, is represented by only one example in the assemblage (5%). This was however one of the larger fragments, at 2.6kg nearly double the average weight of the tap slag. Its amorphous shape and rough texture also parallel Type 1 slag at Roffey, although here the greater size reflects better preservation conditions. Furnace base slag (Type 4) also originated within the furnace as slag that collected in the furnace base and was removed at the end of the smelt. Juleff explains that furnace base slags often have a plano-convex ‘bun’ morphology, which this example has, although fractured at its edges (Juleff *pers. comm*.). The inclusions of refractory material and partially reduced ore reflect fine residues of waste within the furnace, and additional inclusions of fractured slag suggest the furnace was not fully emptied of slag between smelts.

Glassy morphology

In the 21 samples, 7 tap slag samples (33%), had black glassy traces. The glassy traces often appeared in fractured runnels overlaying earlier flow episodes. Glassy black slag has been found elsewhere in the Weald, such as at Minepit Wood, also dated to the 14th century, and here it was found to have a high lime content (Money 1974; Cleere and Crossley 1985, 49). It has been suggested that shelly Cyrena limestone was added to the furnace as a flux by medieval smelters, as the lime content (CaO) helped remove the silica gangue and reduce the loss of iron oxide to the slag (Cleere and Crossley 1985, 49). A sample of shelly limestone was recovered amongst the slag in the tributary stream, which might support the use of fluxes at Tudeley. It is worth noting that very few glassy slag examples were found at Roffey, however this may be a reflection of differences in the silica content of the ore used between the two sites.

Inclusions

Inclusions were present in all 21 samples, and were generally found in the underside surface of the slags. Ore was the most numerous, recorded in 18 samples, particularly in tap slag examples (Type 2). Sixteen tap slags had red ore inclusions, either from unreduced ore from within the furnace or from fragments, dropped around the perimeter of the furnace during charging, which had subsequently become embedded in the slag as it flowed from the furnace (fig. 5.65). The red colouration of the ore inclusions is typical of siderite ore that

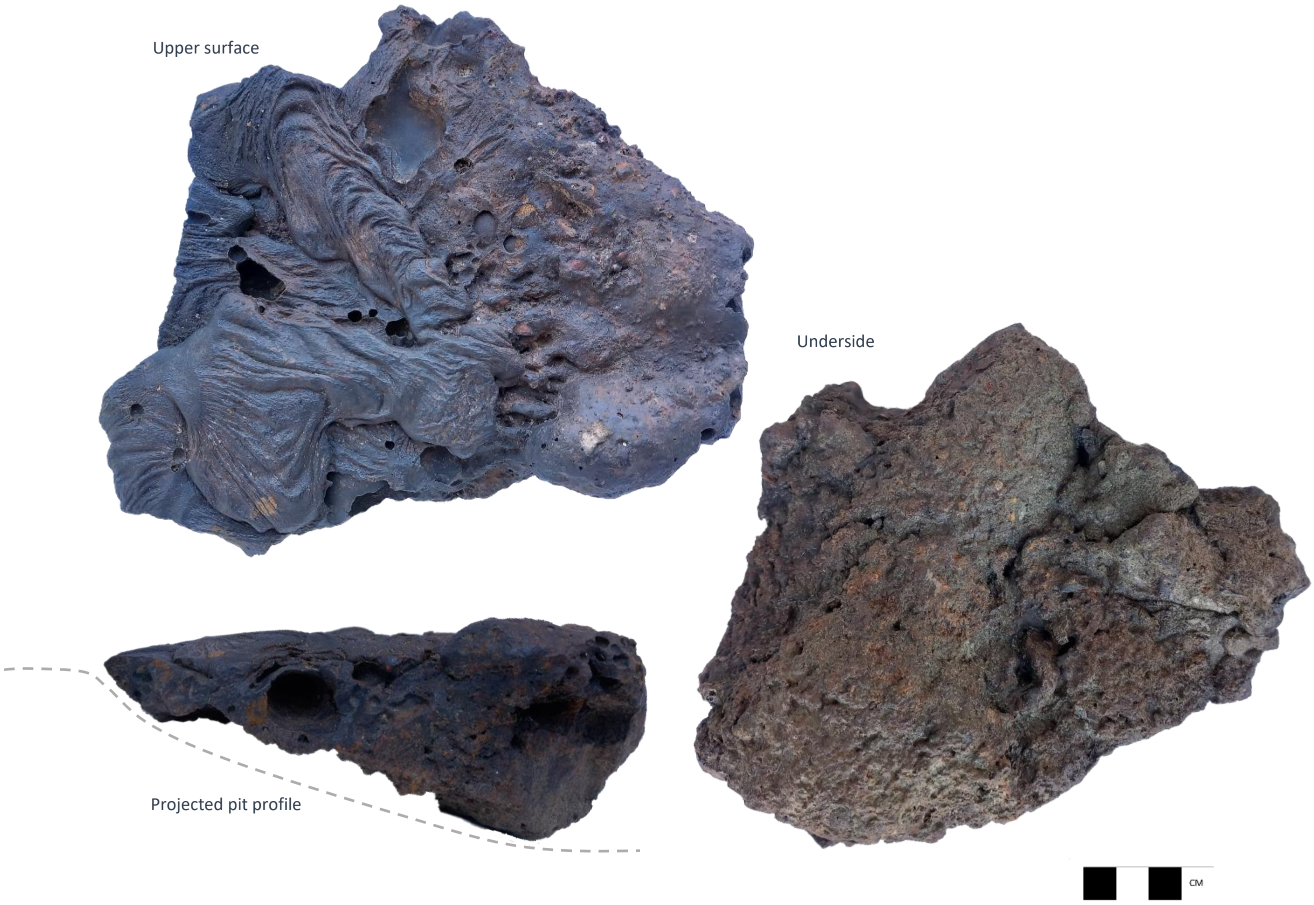


Figure 5.62 – *Slag sample 10 showing the runnels and ropey upper surface characteristic of the Type 2 slag. The sample had a wedge-shaped profile, suggesting it had flowed into a pit with moderately sloping sides, resulting in the greater thickness of slag closer to the centre of the pit and shallower at the opposite end where it had solidified at the edge of the pit. It had evidence for at least 3-4 flow episodes. (Author's images).*

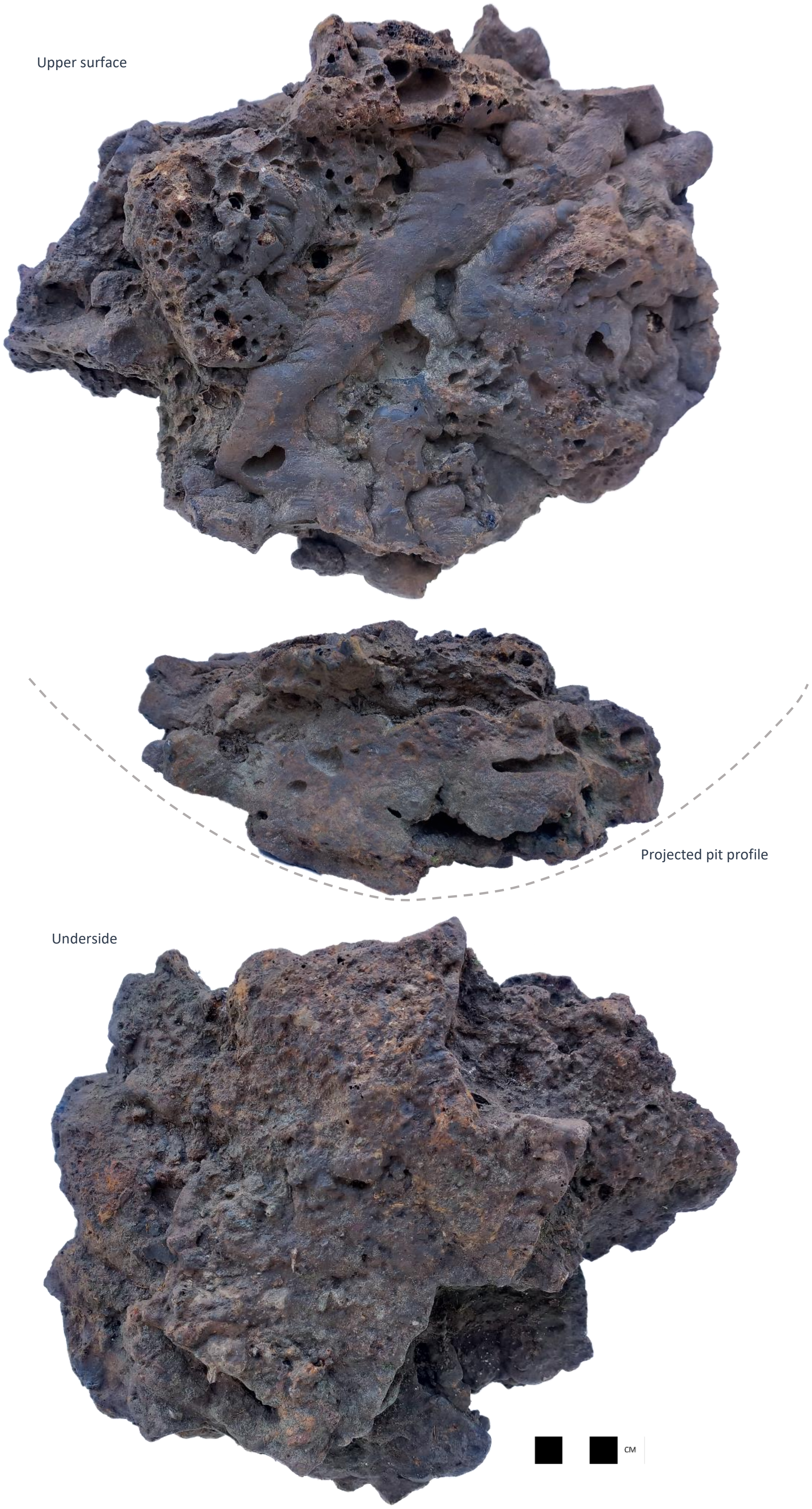


Figure 5.63 – *Sample 20. This sample has the typical plano convex morphology with the convex base. Its thickness would suggest it formed within the centre of the tapping pit. It also had laminations suggesting a minimum of 5 flow episodes, possibly from more than one smelt. (Author's images).*

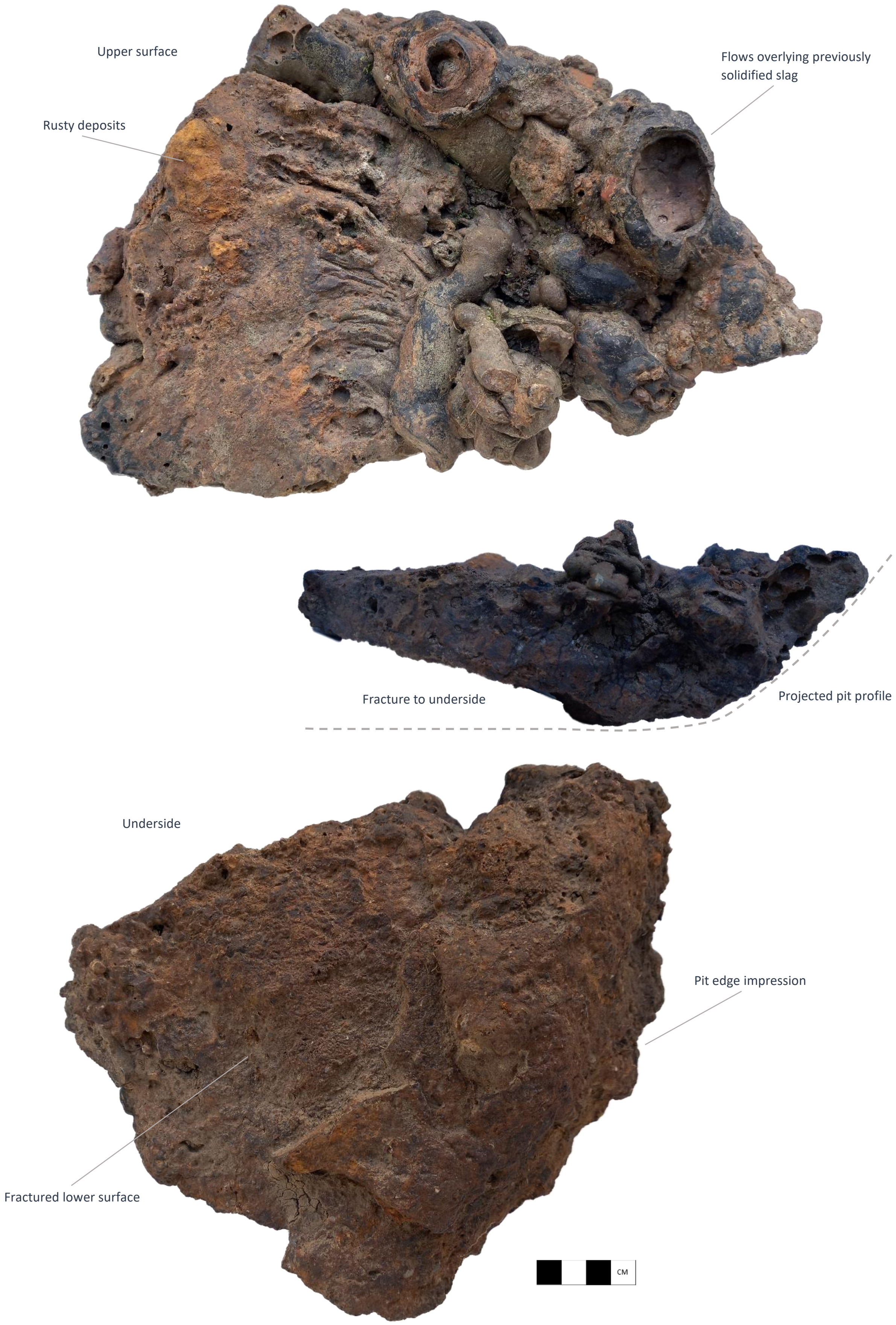


Figure 5.64 – *Sample 13. The sample had 5 flow episodes and on one side preserved the impression of the outer edge of the pit suggesting a diameter of 460mm. Large runnels had solidified on already cooled slag from earlier flows. The upper surface also had rusty deposits. (Author's images).*

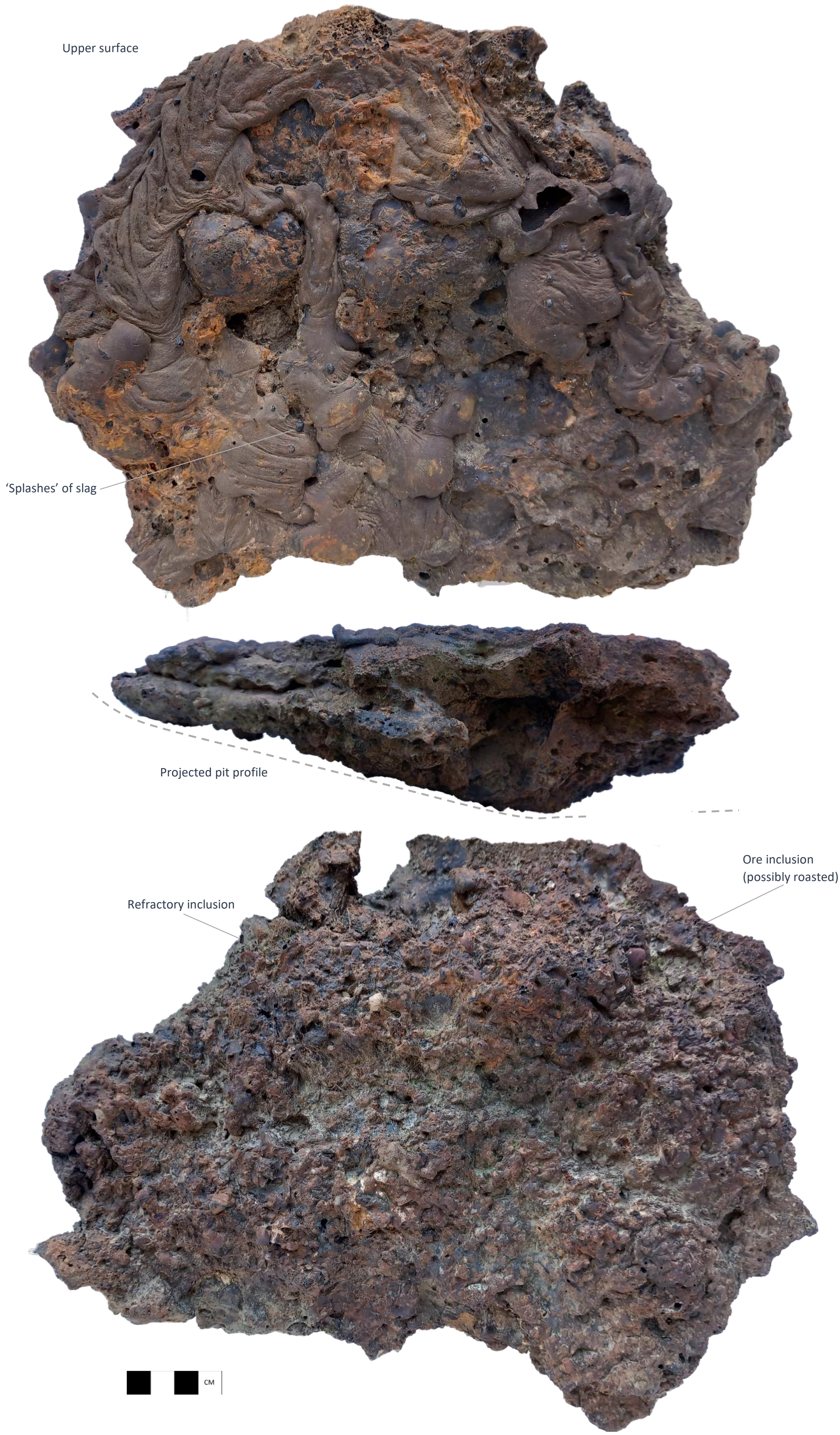


Figure 5.65 – *Sample 12. A total of 2 flow episodes are present, along with 'splashes' of slag on the upper surface which must have occurred after the underlying layers had cooled. The underside has inclusions of refractory material and ore, which has possibly been roasted. (Author's images).*

has been roasted and is similar to the large sample of roasted ore found in the tributary stream amongst the slag (fig. 5.66) (Smith 2013, 100). Refractory material was also present as inclusions. In some instances these refractory inclusions are orange, while in others they are grey or white. The preponderance of refractory inclusions within the tap slag, particularly on the underside, is to be expected, for as the blocked tapping arch was opened, fragments of this clay lining would have collected within the bottom of tapping pit that the slag flowed into (see Chapter 4 Section 4.7).

Rust deposits were present on the upper surfaces of 6 examples (29%) and may reflect iron oxide contained within the slag, which after 670 years and submergence underwater in the stream, has resulted in their corrosion or from mobile iron in the water depositing on the surface.

5.9.4 - *Geological material*

Two Geological samples were also recovered from the tributary stream and had possibly been originally deposited with the slag in the deposit (fig. 5.61; 10). They included a nodule of siderite ore and a piece of shelly limestone.

Siderite ore can be found in nodular form or as seams within the Wadhurst Clay, and examples of these thin seams of c.3cm were exposed in the eroded stream bank to the south of the site and are discussed in Chapter 6. Ore is often roasted prior to being placed in the furnace as this process converts it from a carbonate to an oxide, which aids its reduction (Hodgkinson 2008, 15). Siderite ore is naturally grey-green in colour. However, after roasting, its colour changes to red or purple and it will typically become magnetic (Smith 2013, 100; Cleere and Crossley 1985, 35). The roasting process will increase the porosity of the ore and drive off internal moisture (Schubert 1957, 17; Smith 2013, 100). The process of driving off of the moisture can cause the ore to fracture into smaller nodules, which can then be easily broken down further by hand (Cleere and Crossley 1985, 35; Smith 2013, 100). Breaking the ore into smaller particles increased its surface area which increases reduction rates in the furnace (Cleere and Crossley 1985, 35).

The example of siderite ore from Tudeley was notable for its red to purple discolouration, and magnetism, both of which are typical traits of ore that has been roasted (Smith 2013, 100) (fig. 5.66). Its outer surface was completely fractured giving it an amorphous shape and it remained in a friable state, with parts of its outer surface continuing to flake off. These attributes support the conclusion that it had been roasted (ibid, 100). It was unclear whether the surface fracturing had also been caused by breaking into favourably-sized lumps for the furnace. Its size and weight of 135x55mm and 1.8kg, is larger than the ore charge used in the WIRG experimental smelt at West Dean, which was 10mm in diameter (ibid, 100). However, as working methods vary between smelters it is possible charging larger pieces of ore into the furnace was an accepted practice at Tudeley.

Figure 5.66 – *Nodule of roasted siderite ore recovered amongst the slag deposits in the tributary stream. Its red to purple colour along with its fractured and friable outer surface indicate that it had been roasted. (Author's image).*

An example of cyrena limestone, was recovered from the tributary stream and can be recognised by its inclusions of fossilised cyrena shells (fig. 5.67). Like the siderite ore, seams of limestone also occur in the Weald Clay (Brandon 2003, 16). While there are natural deposits within the local geology of Tudeley, as evidenced by fragments identified within the plough soil in surrounding fields, it is also possible that limestone was deliberately collected and added to the furnace as a flux. Evidence of possible tool marks along two edges of the sample, possibly caused by a metal spike or pick, may support its deliberate collection. The use of lime as a flux in the Weald requires further research and will not be discussed here. It is worth noting however that at Minepit Wood, shelly limestone was also identified, some of which contained iron oxides (Money 1971, 101). Cleere and Crossley (1985, 13) suggest that in some instances siderite ore crystalised in the interstices between the shells contained within the limestone. Money (1971, 104-105) suggests that while there is evidence limestone was added to the furnace at Minepit Wood, he believes it to have been through accidental inclusion rather than deliberate practice. The geological association between the siderite and the limestone is potentially a more likely explanation for the discovery of the limestone at Tudeley and it may have been erroneously brought in with the ore and discarded during ore sorting.

Figure 5.67 - *Cyrena limestone with inclusions of fossilised Viviparus shells. Two edges (one visible in the top of the photograph) had small 'nicks' which had possibly been caused by a metal spike or pick, possibly when adjacent ore deposits were extracted. Similar tool marks have been found on examples of quartz from ore extraction on Exmoor, the quartz being the county rock found alongside the ore and subsequently discarded (Juleff 2019 pers comm). The iron staining present on the sample suggests it was in strata near the ore seams. (Author's image).*

5.10 - Discussion – reconstructing Tudeley Ironworks

5.10.1 - *Introduction*

The site of Tudeley Ironworks had to conform to three criteria. Firstly, the site needed to lie within the boundaries of Southfrith (mapped in Figure 6.5). Secondly, it had to be within proximity of Tudeley parish in order to have obtained its name. Tudeley parish is listed in Domesday as 'Tivelele' however by the early 12th century when it was recorded in the Textus Roffensis (Rochester Book) the more recognisable 'Theudelei' was used (Hasted 1798, 256; Ward 1932, 45). The similarity in spelling to 'Teudele', in the 1330s Tudeley Ironworks accounts, limits the likelihood that other similarity named places existed within or close to Southfrith Chase and therefore this restricts the ironworks location to the north-eastern boundary of Southfrith which lies adjacent to Tudeley parish. Finally, the site needed to have been in use during the 14th century when the accounts were made. Straker's site met each of these criteria, being both within Southfrith and 0.7km from Tudeley. The pottery evidence indicated a period of occupation of between 1250-1450. Furthermore, the magnetometry survey identified an enclosure, furnaces, slag deposits and probable site of a building that demonstrate Straker's discovery of slag within the stream was not isolated re-deposited slag, but part of a primary slag deposit associated with an adjacent smelting site of probable 14th century date. It can therefore be concluded with reasonable certainty that this was the site of Tudeley Ironworks recorded in the accounts.

Confirming this to be the site of Tudeley Ironworks allows a comparison to be made between the documentary accounts and the archaeological record. Table 5.2 shows extracts from the accounts that provide evidence for the layout of the works, iron-production processes and the equipment used. These records are used in conjunction with the archaeological evidence outlined in the previous sections to discuss the site morphology, the building, technology, and the tools used. Parallels are also drawn from the Byrkeknott accounts, transcribed by Lapsley in 1899 and partially translated by Myers (1969). Like Tudeley, the Byrkeknott forge, located in Weardale, Durham, benefits from the rare survival of records dating from 1408 which form a weekly account of expenses associated with the forge (Lapsley 1899, 509). These make a particularly useful comparison to Tudeley, for they record the construction of a building and furnaces along with the equipment used and the personnel managing the forge. Comparative evidence can also be used from the excavated site at Minepit Wood, discussed in Chapter 1, to compare the sites layout, the building and its furnaces.

5.10.2 - *Site layout*

The magnetometry survey showed the working area sat within a rectilinear ditched enclosure c.35m n-s and probably of similar width from E-W, which was aligned N-S. The entrance was probably on the southern or eastern boundary, at the end of a woodland track terraced into the sloping gradient of the land (see Section 6.9.2). At the centre of the enclosure stood the building possibly aligned on the same orientation as the enclosure. South of this building stood a line of 3-4 probable hearths, spaced 2-3m apart and respecting the alignment of the enclosures southern ditch. Adjacent to the NW side of the building were a cluster of 3 furnaces, each retaining distinct circular dipolar anomalies in the magnetometry data. Slag was dumped 6m to the east of the furnaces in a large heap that spread 17x6m, although some was evidently removed from the site and dumped in Batchelors Field to the east (as identified by Tebbutt 1979, 8). Slag

Table 5.2 – *Extracts from the Tudeley Accounts 1329-1354 relating to the site of the works including the building, technology and equipment. The accounts were transcribed by Giuseppi (1913) and translated by Anne Drewery in 1998 and published in Wealden Iron by Hodgkinson and Whittick (1998). The full accounts can be viewed in Appendix A2.*

Date	Keeper	Bloom total	Building	Furnace / hearth	Bellows	Equipment
1329-1330	Richard de Gothurst (Keeper of the Chase).	194 blooms.		In digging stones for 194 blooms with carriage of them to the hearth 40s. – Hearth could be furnace. The word used was 'furnum'.	In repairing tools with grease bought for the bellows 20d.	Ditto.
1331-1332	John de Me[synglegh], (Chamberlain).	224 blooms.		In carriage of them [ore] to the hearth 12s 2¼ d. Hearth could be furnace. The word used was 'furnum'		In the repair of various tools of the said works 2s;
1332-1333	John de Mesynglegh, (Chamberlain).	231 blooms.		In carriage of them [ore] to the hearth 11s 6d. Hearth could be furnace. The word used was 'fernum'.	In grease bought for greasing the bellows 3d.	In the repair of various tools of the said works 2s.
1333-1334	of John de Mesynglegh, (Chamberlain). Sir Thomas de Gedewerth (6 months from March).	112 blooms (under the manor).		In carriage of them to the hearth 5s 7 ½d. Hearth could be furnace and is spelt fabricam. In burning the stones for the blooms 2s 3d. In mending the tuyere 8d.		
Building inventory 1343			In two carpenters hired for 22 days for doing carpentry of the works at Tudeley, taking 7d a day 12s 10d. In making 1400 feet of board for the roofing of the said works, at 5d a hundred5s 10d. In two men making laths and stanchions for the same, one day 5d. In 3800 nails for the same at 2½d a hundred 7s 11d. In 1500 prignails for the walls of the said works 10½d. In carrying the timber for the same 8d. In [under]pinning and plastering the walls, in all 1s 6d. In hooks and rings [for gates/door-hangings] for the said works 4d.			

Table 5.2 – *continued*

Date	Keeper	Bloom total	Building	Furnace / hearth	Bellows	Equipment
1350-1351	Thomas Springet, keeper of the works of Tudeley.	247 blooms.	He accounts for carpentry of the said works by the view of Thomas Judde 6s. Item 800 nails bought for the same 4s. Item 2000 prigs bought for the same 2s 2d. Item in daubing the works 18d. Item in a lock and key bought 3d.	Item in making the hearth of the said works 16d. Item in two tuyeres of iron bought 2s 8d.	Item in a pair of bellows bought 12s, by the view of Thomas Judde. Item in grease bought for the said bellows 15d. Item in white leather and 3 hareskins bought for the bellows 3d. Item a new ox-hide bought for covering the bellows 5s. Item in making 26 egyn for the tuyeres 6s 6d, at 3d an ege. Item in making the bellows 6d.	Item in an axe bought for splitting iron 12d. Item in mending the axe with steel 3d. Item in a hammer bought to break stones 1d. Item in an egyson bought 1d. Item in two sieves bought 5d. Item in a scope bought 1¼d. Item in a clay pot bought to carry water 1d. Item in a pair of bannasters bought 12d. Item in two troughs bought to carry stones 5d. Item in a hand cart bought 7d.
1352	Thomas Springet, keeper of the works of Tudeley.	143 blooms of iron. For graynes of iron sold 3d.		In making 9 tuyers of iron 2s 3d.	In grease bought to grease the bellows 6d. In leather bought for the said bellows 1½d.	In trimming the works axe with steel to split iron 6d. In mending a works sieve 1d.
1353	John Parker, keeper of the works there (Tudeley) for seven weeks.	39 blooms.		In making the hearth anew for the said works 9½d. In piercing and mending two tuyeres 10d.	In the new purchase of a pair of bellows from Henry Jon 9s. In grease bought to grease the bellows 3d. There remain in the said works two pairs of bellows.	
1354	Thomas Springet, keeper of the works.	138 blooms.	a lock and key.	in mending the 4 tuyeres during the same time 12d. In mending 4 tuyeres 12d.	Of the leather of an old pair of bellows sold 6d. In leather bellows bought 12d; in nails bought for them 8d. In making the said bellows ~~8d~~ 6d. In grease bought for them. In one white hide bought for making bellows 3s 6d. In brakyng (braking / cutting?) it 6d.	In mending an augisen 2d. In a pair of iron tongs called loves bought 2s 6d. In a pair of coddes bought 12d. In a pair of codd bought 12d. In a sieve bought ~~3d~~ 2½d. In mending an axe on [several] occasions ~~4d~~ 2d. In a trey for bringing in stones 1½d. There remain in the works two pairs of bellows, an axe for splitting iron, an andiron, a pair of tuyeres, a hammer for breaking stones, a sieve, a scope (scoop?), a clay pot for carrying water, a pair of bannasters, two trays for carrying stones, a hand barrow, a lock and key.
Lease to Richard Colpeper 1354	Richard Colpeper.		Elizabeth de Bourg will maintain and make the building of the works at her own costs during the term. A lock with a key (3d).	Two tuyeres (12d).	Two pairs of bellows (13s 4d).	An axe for splitting (scindendo) iron (3d), An andiron (angire) (8d), A hammer (1d), A sieve (1d), A pair of tongs (loves) (2s 6d), Two troughs for bringing in stones (1d). All of which Richard Colpeper will return at the end of the term or satisfy Elizabeth de Bourg for their price at her choice.

was also deposited within the perimeter ditches, probably after the abandonment of the site.

The accounts provide no information on the layout of the Tudeley works but record features contained within it which included a building, hearths (which appears to have also included furnaces), and bellows. The position of these features can however be suggested from the magnetometry data outlined above. Parallels can also be drawn from the excavation of the 14th century smelting site at Minepit Wood in Rotherfield 15km to the southwest. In 1324-25 Richard de Groshurst was the Chief Forester of both the Chase of Tonbridge and the Chase of Rotherfield in Sussex, which was also held by the de Clares as a private Hundred (Ward 1962, 199, 220). Four years later, in the first year of the Tudeley Accounts when the works were under the management of the manor, de Groshurst, who completed the account, was listed as '*keeper of Lady Elizabeth de Burgh, lady of Clare's chase of Southfrith'.* Further research is needed to clarify whether the site at Minepit Wood fell within the Rotherfield Chase, however the nearby placename of Parkgrove could suggest it was. If the site did lie within the Rotherfield Chase, de Groshurst's direct involvement at Tudeley Ironworks and his links to Rotherfield raises the possibility that both Tudeley and Minepit Wood shared similar characteristics in size and site morphology.

The excavation of Minepit Wood by James Money (1971) identified two phases of activity (Money 1971, 92). In the second phase the works were substantially re-modelled and enlarged which included the construction of a timber framed building around a newly built furnace (ibid 1971, 92). This re-development at Minepit Wood would parallel the documentary evidence from Tudeley, where an inventory of 1343 records the construction a new timber framed building, which took 22 days to complete, which suggests it was relatively substantial and built to a level of permanence. Further rebuilding work at Tudeley, with the addition of a new hearth (probable furnace), also took place in 1350-51.

Cleere (1971, 92) suggests that the enlargement of the Minepit Wood site in the second phase, along with the construction of the building, is evidence of a change in its status to a more settled site (Money 1971, 92). This appears to be the case at Tudeley as while the magnetometry results showed no evidence that the size of the enclosure around Tudeley had undergone expansion, the very existence of these ditches along with the construction of the building in 1343, are suggestive of a shift towards greater permanence.

The layout of the working area of Minepit Wood into distinct activity ‘zones’ of ore roasting, smelting, resource storage and slag disposal is indicative of a planned approach in its construction, rather than organic growth over time. This too is reflected in the magnetometry data of Tudeley, where the building appears to have been placed within the centre of the enclosure, equidistant from the northern and southern boundary and out of the wind from the furnaces in the west. Hearths were potentially placed to the south (based on the spread of the anomalies here), while slag was deposited in the east. Even when structures such as the furnaces were rebuilt, the magnetometry results suggest they were constructed in the same area and adjacent to their predecessors, such as the group of three furnace anomalies in the west of the enclosure.

In the case of the Byrkeknott forge, Lapsley suggests that Bishop Langley, the Bishop of Durham, built Byrkeknott to smelt his own iron from the ore mines within his county palatine (Lapsley 1899, Myers 1969, 1005). Like Tudeley and Minepit Wood, there appears to have been careful consideration given to the sites layout for the accounts record how John Gyll the ‘smithman’ and Thomas Chyld visited another ironworks at Blakamore for three and a half days *'…to see another forge, so that the craftsmen who were making this forge could the better inform themselves about the building of it…*' (Myers 1969, 1006). The importance of planning in the site layout cannot be underestimated and it is clear at Tudeley that the position of each feature corresponded to practical considerations, for the furnaces were downwind of the site to limit the risks of poisonous carbon dioxide blowing over the working area; the building was in the centre so that resources and tools within it could be easily accessed, and the slag was dumped at the eastern end, near the probable entrance so that it could be easily carted off site. The Byrkeknott accounts demonstrate that layout considerations were important in the planning process and that collaboration and the sharing of knowledge between ironworkers played a significant role in the decision-making process. This is a scenario highly probable in the Weald and might explain similarities in site layout between Tudeley and Minepit Wood.

If there was a shift to more permanent planned sites, as the evidence from Tudeley suggests, it raises the question of what led to this shift and at what date this occurred? The complication is knowing what came before the more permanent sites. The first phase of activity at Minepit Wood included an ore roasting hearth and furnace, both of which were covered by the later furnace and hearth from the second period (Money 1971, 90). Perhaps the absence of a building at this time indicates it only operated on a season basis. Schubert (1957, 125) suggests two types of bloomery sites existed in medieval England and included 'itinerant' forges that were small and could be moved to new locations and 'great forges' that were permanent and larger in scale. The suggestion of movable ironworks offers one scenario for how sites such as Tudeley may have functioned prior to becoming more permanent, and such movable ironworks may account for some of the smaller undated bloomery sites listed on the WIRG database (www.wirgdata.org). At Tudeley, ore and charcoal were brought to the works annually and while both were obtained in some years from the manor, the carriage expense that they incurred suggests they still had to be transported from a distance. Perhaps one explanation for the establishment of Schubert's 'great forges' such as Tudeley, was in the effort to centralise production through the establishment of permanent works. This might be because of an increased demand for iron, particularly after the Black Death in 1348, when the price of blooms increased (Hodgkinson and Whittick 1998, 15). However, if increased demand for iron is a factor that led to the establishment of permanent works, the fact that a building was constructed at Tudeley five years before the Black Death suggests the demand for iron occurred earlier.

5.10.3 - *The building*

The construction of the building at Tudeley is first recorded in an inventory of 1343, when two carpenters were hired for 22 days for '*doing carpentry of the works at Tudeley'.* It was later refurbished or rebuilt in 1350-51. Similarly, a carpenter and his assistant were employed in the construction of the Byrkeknott forge, which was built of timber with a turf roof (Lapsley 1899, 510, 512). The list of materials purchased shows the building at Tudeley had a roof made from 1400ft of board, and that the walls were constructed from stanchions (uprights) and laths, which were made by two men in a day. At total of 3800 nails are listed and 1500 prignails '*for the walls of the said works'*. Prig-nails are recorded in 1301-2 at Pevensey Castle in East Sussex where they were used in *'pannelling the hall and chambers and walls'* (Bowden et al 2019, 80) and therefore their specific use in walls may be assumed, while nails held the roof together. The building was also underpinned and plastered (or 'daubed') during repairs in 1350-

51. Being timber framed, it is unsurprising that the magnetometry survey found little trace of this structure, although its location was suggested by the area absent of magnetic anomalies at the centre of the enclosure. The reference to underpinning, may indicate stone footings were used below a timber frame and wattle and daub superstructure, which would parallel the building at Minepit Wood which had a course of sandstone slabs defining the walls (Money 1971, 95). An indication of the building's length is suggested by the 1400ft of board purchased for the roof, which if this was pitched, and that 700ft was used on either side, could conceivably cover a building up to 35ft (10.7m) in length (assuming a uniform length was used that subdivides 700ft into a whole number (i.e. 700÷20=35). Of course, the width of these timbers is unknown, as is the roof configuration. However, the area absent from anomalies is approximately 10x8m, which supports the suggestion of a building this size, as does the building at Minepit Wood which was 11x8-7m, although this was only partially roofed (Money 1971, 94).

The building at Minepit Wood was used both to house the furnace and to store roasted ore and charcoal (Money 1971, 94). The stockpiling of fuel and ore along with the storage of tools listed at Tudeley was evidently an important function of the building, blooms too may have been stored here. In 1343 the building was fitted with 'hooks and rings for gates and door hangings' and further references to a lock and key appear in 1350 and 1354, demonstrating the value of its contents, and suggesting that there were periods of time when the works were not in use (Hodgkinson and Whittick 1998, 11).

The building was re-furbished in 1350-51 when 6s was spent of carpentry and came at a time when works were undergoing substantial refurbishment with a newly built hearth (furnace) and the purchase of many new items of equipment such as bellows. In this year '2000 prigs' were purchased, compared to the 1500 prignails bought 'for the walls' in the original 1343 construction. A further 800 nails were also bought, and 18d spent on 'daubing'. The increased number of prig nails and nails might indicate a need to secure the building at this time perhaps to protect stockpiled ore and charcoal and is further indicated by the purchase of a lock and key. It might also suggest the building was re-configured and that it had been partially open sided in earlier years, in a similar arrangement to the building at Minepit Wood. Perhaps the movement of the furnace, rebuilt in the same year, from the southern side of the building to the western side (or vice versa) required previously open sides to be enclosed. No reference is made to the building prior to 1343 and either its construction in this year marked the replacement of an earlier structure or it is further evidence of the changing nature and permanence of the site.

5.10.4 – *Technology, tools and practice*

Despite the placename Smithy Wood, it is apparent from both the accounts and the technological assemblage that Tudeley Ironworks was restricted to smelting. The magnetometry results suggest the smelting furnaces were located in the west of the enclosure, where 3 circular anomalies each c.2.5-3m in diameter were present. Their size is similar to the furnace built in the second period at Minepit Wood, which had a diameter of 1.8m (Money 1971, 98). Further furnaces may have also been present along the southern boundary, although these could also have been hearths, particularly Anomaly 5 which have a broader magnetic spread consistent with the movement of a hearth over time. It is unlikely that all furnaces existed at the same time and instead represent a series of replacement structures built alongside their predecessors. The accounts record two periods in which the furnaces were re-built in 1350-51 and 1353 where 16d and 9½d was spent on '*making the hearth of the said works'* or '*in making the hearth anew'* and only suggest a single furnace existed at any one time.

Their spatial positioning does appear to respect sites of previous furnaces and constructing a new furnace adjacent to its predecessor had the benefit of allowing smelting to continue until the building of the new furnace was completed and its clay walls had sufficiently dried. While this would account for two anomalies, the regular spacing of the three furnaces to the west of the site might suggest memory of where previous structures had stood with a deliberate avoidance of rebuilding on the same site. Juleff (*pers. comm.*) points out that there is very little evidence of special treatment for furnaces after they have fallen out of use, despite the smelters reliance of them for their livelihood. Many appear to have been left to collapse or were demolished. If there was a taboo at Tudeley on rebuilding a furnace on the site of its predecessor, this could imply respect was given to these structures and they remained standing beyond their functional lives. Of course, a functional explanation is also possible and previous furnaces may have been left to fall down to avoid the need for demolition. This would however conflict with evidence from Minepit Wood, which showed the new furnace of Period II was built on top of the earlier furnace (Money 1971, 90).

It is possible that the furnaces 1-3 (fig.5.61) may have been partially covered with a hood or shelter similar the furnace at Minepit Wood (Money 1971, 96). This would be supported by the furnaces proximity to the proposed site of the building, which could have partly enclosed them. Covering the furnace would help to prolong its life, particularly in periods when it wasn't in use, by protecting it from the elements. The WIRG experimental furnace at Pippingford has a hood that can be lowered over the furnace when it is not in use, and it is plausible that a similar structure existed at Tudeley.

Covered or not from the elements, the furnace would still have required regular repair and rebuilding between smelts. The accounts record two expenses for its rebuilding, if one assumes that 'the hearth' is referring to the furnace. The recorded dates are 1350-51 and 1353 which might suggest the lifespan of the furnace was around two years, although it is possible these expenses relate to the combined total of mending and rebuilding the furnace across the year. The magnetometry data would suggest that as many as 5 furnaces may have been built on the site during the period it was occupation (which assumes anomalies 5, 7, 8 and 9 were hearths), however excavation would be needed to clarify this.

The predominance of tap slag showed that the furnaces at Tudeley were of the slag tapping type and had the technological advantage of allowing slag to be removed during the smelt instead of building up within the furnace superstructure. As a result, the furnace could be re-used in subsequent smelts and over an extended period before requiring repair or replacement (Juleff pers. comm. 2023). The successive smelts are evident in the multiple flows that has resulted in thick samples of tap slag. Hodgkinson suggests that the works were producing one bloom a day (Hodgkinson & Whittick 1998, 12). An intensity of production on this scale would have afforded little time for the repair and rebuilding of furnaces and the dominance of tap slag within the assemblage indicates that a significant proportion of slag was removed by tapping.

Between 1329 and 1334 the term 'furnum' 'fernum' or fabricam is used in the accounts to describe 'the hearth' also translated as 'oven' in which the ore was brought to be burnt. For example in 1329-30 an expense is recorded for

> *'…digging stones [ore] for 194 blooms with carriage of them to the hearth 40s; in burning them (elendis) 3s 6d, at 2s per 100'*

while ‘burning them’ could be referring to the roasting of ore, a process known to have happened at Tudeley from the presence of roasted ore samples, this reference it is more likely to be referring to the burning – or smelting of the ore in the furnace. Therefore ‘furnum’ ‘fernum’ or ‘fabricam’ were an earlier term used for the furnace. This is further supported by the account of 1331-32 which states

> *‘In carriage of them [ore] to the hearth 12s 2 ¼ d [?];*
> *In blowing them 4s 6d, at 2s per 100;’*

the ‘blowing’ element further supporting the likelihood that this was the furnace. Again, it is referred to singly suggesting only one furnace existed on site at any one time. Hodgkinson and Whittick (1998,12) note that only four blowers, responsible for working the bellows, are recorded in the 1350s and working in pairs on alternate shifts would make one furnace more probable.

Tuyeres

The accounts provide more detail on the related furnace equipment, namely the bellows and tuyeres. Tuyeres made of iron are recorded between 1333 and 1354 and appear to have required frequent repair or replacement. There is also variation in their costs and the number the works held. For example, 8d was spent on mending ‘the’ tuyere in 1333, while in 1352 it cost 2s 3d to make 9 tuyeres. Since the accounts list two pairs of bellows in 1353 and 1354 it is probable the blowers used both to eject air into the furnace, thus requiring a pair of tuyeres. The higher numbers appear to relate to years, or the years following, a high yield of blooms and therefore suggest they needed frequent repair, described as ‘piercing’ or replacement.

Bellows

The bellows are recorded in all years except 1333-4, and typically refer to their manufacture, maintenance, or repair. In 1350-51 when the works were refurbished, individual components used to make the bellows are listed including: *a pair of bellows bought 12s, grease bought for the said bellows 15d, white leather and 3 hareskins bought for the bellows 3d. and a new ox-hide bought for covering the bellows 5s, in making 'facture' the bellows 6d*. What is significant is the considerable expense the bellows incurred. It also suggests the bellows were bought in 'kit form' although the expenses of leather may relate to repairs throughout the year. Leather was evidently valuable for in 1354 the leather from an old pair of bellows was sold for 6d. As the replacement leather cost 12d, the value of the old leather had only reduced by half in its working life and was serviceable enough to sell. Bellows also appear to have been regularly replaced, and in 1353 new bellows were purchased from a Henry Jon for 9s, presumably a replacement for the second pair of bellows, the first having been replaced 2 years previously. A 'pair of bannasters' '*j pare banostis'* is also listed in ***, however their function is less clear. The authors Great Grandmother, who lived on the Kent/Sussex boarder use to describe the bellows used on the hearth as having '*bad leather but the bannasters were still good'.* It is possible that bannasters is a local term for the wooden boards and handles that form the outer frame of the bellows. An alternative explanation is given in Section 6.6.1.

The boring stick

At Tudeley, the inventory of equipment in 1350-51 listed the purchase of an 'egyson' bought for 1d '*Item in j egyson empto j d'*. A direct translation of 'egyson' is not possible and it must either be a forgotten regional term for an item of equipment, or a very specific tool used in smelting. It is plausible that an egyson was a 'boring stick', a long rod used to piece the tapping arch at the front of the furnace and release (tap) the liquid slag. To support this, in the same year it is recorded that 6s 6d was spent on making 26 egyn for the tuyeres, costing 3d an ege. Hodgkinson and Whittick (1998, 10, 19) suggest (based on a suggestion by Arne Solli) that these could be rods used to retain a clear airway through the tuyeres, based on Solli's suggestion that 'eg' in Scandinavian refers to a wooden or oaken rod. The similarity in name between egyn and egyson would imply that both held a similar function and the egyn were rods for clearing slag from the iron tuyeres, while the egyson was a rod for piercing the tapping arch to release the slag.

The practice of blocking the furnace arch with sand and then releasing slag with a boring stick has been recorded in ethnographic accounts from Sri Lanka by Ananda Coomaraswamy (1956) and Juleff (1998). In the interviews conducted by Juleff (1998, 108) it was recorded how a stick made from a kappetiya branch was inserted through the sand that blocked the front arch of the furnace and as the stick was removed, slag flowed through the remaining hole. Juleff also identified this process within the verses of '*Treading the Bellows'*, a song recalled by D.K. Ranhavadiya and sung by his father and uncle, the last smelters in the hamlet of Veralugasmankada. The verses include

Figure 5.68 - *Use of a boring stick, photographed by the wife of Ananda Coomaraswamy in c.1908 in a village ironworks in Sri Lanka. The significance of the boring stick in this photograph was recognised by Juleff (1998) as one of the boring sticks referenced in the song 'Treading the Bellows'. Image courtesy of Coomaraswamy (1956) plate LIII.*

the line '*The pointed boring-stick - bring it here to the sand'* (ibid 1998; 122). The specific reference to this practice within the song, which was sung in rhythm to the bellows, highlights its importance in the smelting process. Coomaraswamy (1956), in his visits to the region, witnessed the use of a boring stick at an ironworks in the early 20th Century, a practice that is likely to have remained unchanged from earlier times (fig. 5.68).

'Treading the Bellows' emphasises the symbolism attached to the release of the slag through lines such as '*you were asked to cry'* which is a reference to the furnace appearing to cry as the flow of slag escaped (Juleff 1998, 122). It raises the possibility of similar symbolism being attached to this process by the Wealden smelters. Arguably this might be reflected in the 'son' element of 'egyson' possibly a corruption of the old English 'sunne' or 'the Sun'. Removing the boring stick from the tapping arch would release both light and heat from the furnace, both properties of the Sun, and may account for the 'son' element of the tools name (fig. 5.69).

Figure 5.69 *– use of a boring stick at the Pippingford experimental smelt and the release of heat and light. (Author's image).*

The broader universality of the use of a 'boring stick' is suggested by the Type 3 cylindrical rod slag found at Roffey. It may have formed as liquid slag flowed through the aperture left as the rod was removed from the tapping arch and as it solidified a cylindrical or rod-shaped morphology was created. One example had a diameter of 320mm and length of 720mm, with sand impressions on the outer surface. The use of a boring stick in the Weald demonstrates the skill and learned practice by the smelters in knowing when the furnace had reached the sufficient temperature for slag to be tapped.

5.10.5 - Summary

The addition of the archaeological evidence to the documentary accounts has allowed for a more detailed assessment to be made of the morphology and processes of a 14th century manorial ironworks. While the accounts record the works equipment and output, all of which are lost archaeologically, the archaeological evidence is able to reveal the planned layout of the enclosure, the furnaces and slag heaps and how Tudeley presents similarities to other 14th century ironworks including Minepit Wood. As will be seen in the following chapter, a combined analysis of the accounts and reconnaissance survey allows the Tudeley ironworks to be placed into a broader landscape context of associated industries, demonstrating that this site was by no means isolated.

Chapter 6 – The Wider Landscape of Tudeley

This chapter examines the broader landscape context of Tudeley Ironworks to consider its place within Southfrith Chase and its relationship with other woodland industries. The results of a landscape reconnaisance survey are used in conjunction with the Tudeley Accounts to investigate former industries including charcoal production and ore digging. The use of LiDAR and landscape surveying has allowed the physical remains of these industries to be mapped and their spatial relationship with the Tudeley site to be examined.

Chapter Contents

Chapter 6 – The Wider Landscape of Tudeley Ironworks

6.1 - Introduction

The Tudeley accounts outlined in Chapter 5 not only provide a rare insight into the workings of a 14th century ironworks, but also demonstrate how iron-production fitted into a broader economic landscape of interrelated industries and craftsmen that included wood-colliers, stone diggers, leatherworkers, carpenters, and smiths. Thomas Springet, Richard Colpeper and their personnel were also not alone in producing iron but had neighbouring smelting sites across the Southfrith Chase (Giuseppi 1913). These other works are afforded far less recognition in the documentary records, however archaeology, as this chapter will demonstrate, has the ability to shed further light on their place within this industrial landscape. The term ‘industrial landscape’ paints a false picture of the woodland industries that worked sustainably with the environment to produce the materials needed to make iron unlike the irreversible environmental damage seen within industry in later centuries and today. Strategies such as coppicing were used to manage timber supplies to produce charcoal and ensure that woodland was allowed to regenerate for future harvests; while ore was strategically dug, and the pits backfilled to mitigate the scars left upon the landscape. One must picture a landscape utilised by succeeding generations, applying methods past down over time to maintain a landscape that continued to be managed in much the same way until the coming of 19th century industrialisation.

Having assessed the industries described in the accounts, a reconnaissance survey was carried out on the ground in summer 2019 to identify archaeological evidence for their presence and determine whether other iron-production sites could be located. While iron-production was nucleated at a centralised locality at

Roffey and raw materials were brought to these sites from a wider landscape (see 3.8), this does not appear to be the spatial distribution at Tudeley, where the accounts suggest smelting sites were scattered throughout the forest from which they obtained raw materials, while smithing took place elsewhere within settlements such as Tonbridge. However, differences in spatial patterning and the separation of smelting and smithing sites does not necessarily exclude Tudeley from being classed as a production centre.

This chapter will initially examine the historical and landscape evidence for the acquisition of the resources needed to make iron and will then consider other ironworks across the manor and the relationship these had with Tudeley. It integrates both the historical and archaeological evidence to demonstrate the importance of both in producing a holistic understanding of this woodland economy.

6.2 - Methodological approach

The methods applied to investigate the Tudeley landscape replicate those used at Roffey, however on a smaller scale. It was decided to restrict the survey to the landscape around Tudeley Ironworks, within the boundary of Southfrith, which was mapped using Hasted’s map of the Lowy of Tonbridge (fig. 6.1). Today much of the woodland to the south of the Tudeley site, collectively known as the Tudeley Woods Nature Reserve, is managed by the RSPB, who kindly gave permission for reconnaissance surveying over an area of 1.44 km². The terrain was challenging due to thick vegetation coverage and steep sided gills (streams) and their tributaries, so conventional linear traverses were not possible. Instead, the wood was divided into three zones and each section searched wherever terrain conditions allowed. Particular attention was given to the gills, where the possibility of identifying eroded slag deposits was present. A bloomery site 770m south of the Tudeley site had been identified by WIRG in 1979 and was targeted for re-assessment. LiDAR images were also consulted to identify further targets, including minepits, charcoal platforms, and sawpits that were subsequently 'ground-truthed' in field visits (fig. 6.3). During the survey, features were photographed and a written description made along with their spatial position and is presented in Appendix C1. The landscape data was compared with the Tudeley accounts, and the historical evidence for each industry is shown in Table 6.1.

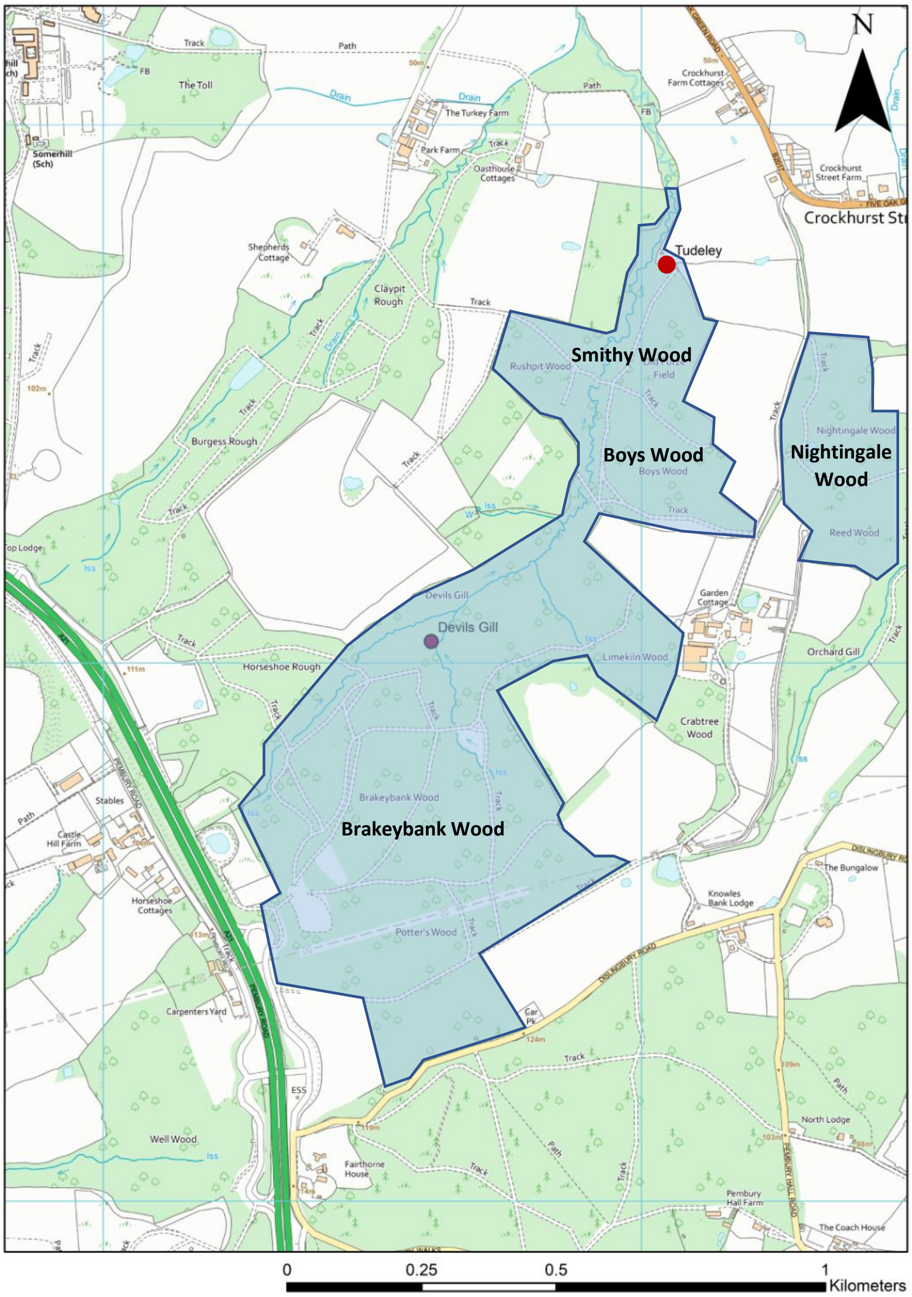


Figure 6.1 – *Survey area (blue) at the Tudeley Woods Nature Reserve, with the positions of Tudeley Ironworks and the Devils Gill Bloomery marked. Base map courtesy of Digimap OS Collection.*

Table 6.1 - *Woodland resources recorded in the Tudeley Accounts 1329-1354. Translation made by Ann Drewery 1998.*

Date	Charcoal	Ore	Wood
1329-30	28s for dead wood in Southfrith sold for making charcoal for blowing the said blooms. In 36 tens of charcoal bought for making the said blooms £6 6s (at 3s 6d per ten).	In digging stones for 194 blooms with carriage of them to the hearth 40s; in burning them (elendis) 3s 6d, at 2s per 100.	28s for dead wood in Southfrith sold for making charcoal for blowing the said blooms.
1331-32	In [41 tens] of charcoals bought, each ten containing 24 quarters, for making the said blooms [and] burning them £6 13s 3d, at 3s 3d per ten; In the carriage of them to the works 13s 8d, at 4d per ten.	In digging stones for 224 blooms of iron 40s 4d, at 18s the hundred. In carriage of them to the hearth 12s 2 ¼ d. In blowing them 4s 6d, at 2s per 100;	
1332-33	In 7 ½ tens of charcoals bought for making the blooms and burning the stones, besides 34 tens made from the lady's wood, 30s, at 4s per ten. In the carriage of the said 34 tens of charcoal from the lady's wood to the works 11s 4d at 4d per ten.	And for 12s for stones sold for 300 blooms of iron, at 4s a hundred. In digging stones for 231 blooms of iron 41s 6 ½ d, at 18s the hundred. In carriage of them to the hearth 11s 6d, at 5s the hundred. In burning the stones 4s 7 ½ d, at 2s the hundred.	
1333-34	In 20 dozens of charcoals for the said blooms, with carriage to the works 76s 8d, at 3s 10d a dozen.	And for 20s for stones sold for 400 blooms this year, at 5s a hundred. He accounts in digging stones for making 112 blooms as above 22s 6d, at 20s the hundred. In carriage of them to the hearth 5s 7½d, at 5s the hundred. In burning the stones for the blooms 2s 3d, at 2s the hundred.	
1350-51	Item in two sieves bought 5d. Item in a scope bought 1¼d. Item in a pair of bannasters bought 12d. In 16 dozen of charcoal bought 116s (106?) 8d, at 6s 8d the dozen. In 24 dozen of charcoal bought £9 12s, at 8s the dozen, bought from the lady's wood with Thomas Judde by the view of John Parker. In carriage of the said 40 dozen of charcoal 23s 4d, at 7d the dozen. He answers for 40 dozen charcoal received from purchase as appears by a tally against John Parker the forester.	Item in two troughs bought to carry stones 5d. Item in a hand cart bought 7d. He accounts for payments for digging stones for the said ~~247~~ 252 blooms ~~66s 2½d~~ 68s, at 27s for 100. For digging stones for the 158 blooms which remain in stock to next year 41s, at 27s for 100. To the stone-digger by contract made by Thomas Judde for a tunic 5s. In the carriage of 250 stones and olwode 20s, at 8s for 100. In burning the said stones 5s, at 2s for 100. He accounts for stones called orston received from digging in the forest for 405 blooms as below. Of which he accounts in the making of ~~247~~ 252 blooms of iron as above; and there remain stones called orston [sufficient] for 158 blooms in stock upon next years's account as below.	In the carriage of 250 stones and olwode 20s, at 8s for 100 He answers for 40 dozen charcoal received from purchase as appears by a tally against John Parker the forester.
1352	In mending a works sieve 1d. In 22 dozen and 11 seams of charcoal bought in the lady's chase £9 2s 3d, at 8s a dozen. In carrying 22 dozen and 11 seams of charcoal to the works 13s 3¼d, at 7d the dozen. Of purchases for making iron in the lady's forest 22 dozen 11 seams of charcoal. Of which in the cost of making 143 blooms 20 dozen and 11 seams. And there remain 2 dozen of charcoal <checked>.	In mending a works sieve 1d. In digging stones for making 87 blooms of iron 21s 9d. For the carriage of the said stones 6s 8d, at 8s for 100. In burning 143 blooms 2s 9d. Of the remaining orston for making 68 blooms; of the digging of stones of orston for making 87 blooms. Sum – orston for 155 blooms <checked>.	

Table 6.1 - *continued*

Date	Charcoal	Ore	Wood
1353	In 5 dozen (and) 8 seams of charcoal bought for the work of the works 44s 7¾d, at 8s the dozen. In the carriage of 5 dozen and 8 seams of charcoal to the works 6s 1d. There remains 2 dozen of charcoal. Of purchase for making iron in the lady's wood 5 dozen and 8 seams of charcoal. Sum 7 dozen and 8 seams. Checked. Sum 6 dozen and 13 seams; and there remain 9 seams of charcoal for next year. Checked.	In digging stones of orston for making 33 blooms of iron 8s 11¼d, at 3¼d for each bloom. In the carriage of oreston and olewod for making 33 blooms of iron 3s. Of the remains orston for making 12 blooms of iron; ~~the purchasing~~. Of digging stone of orston in the lady's forest during the said time for making ~~52~~ 33 blooms of iron. Sum of orston per 45 blooms. Checked. Of which in the costs of making the above 39 blooms of iron 39 blooms of orston. Sum 39, and there remains orston for making 6 blooms of iron. Checked.	In the carriage of oreston and olewod for making 33 blooms of iron 3s.
1354	In 14½ dozen and 5 seams of charcoal bought in the lady's forest 118s 10d, at 8s the dozen. In 8 ½ dozen of charcoal bought in the neighbourhood 68s, at 8s the dozen. In 2 dozen and 5 seams of charcoal bought in the neighbourhood at various prices 17s 3d. Sum - £10 4s 1d. checked. In the carriage of 8½ dozen of charcoal bought in the neighbourhood to the works 9s 11d, at 14d a dozen. In the carriage of 14½ dozen and 5 seams of charcoal bought in the forest to the works 8s 8d, at 7d a dozen. In a sieve bought ~~3d~~ 2½d. For the carriage of 2 dozen and 5 seams of charcoal bought in the neighbourhood to the works 22½d. ***Stock*** [charcoal] of remains 9 seams. Of purchase in the lady's wood during the time of this account 14½ dozen and 5 seams. Of purchase in the neighbourhood 8½ dozen before the view of the account and 2 dozen and 5 seams after. Sum 26 dozen and 5 seams checked. Of which in the costs of making 138 blooms of iron during the time of this account 24 dozen and 5 seams. Sum 24 dozen and 5 seams; and there remain 2 dozen of charcoal checked; which remains are delivered to Richard Colpeper in part of the contract of 50 dozen annually. a pair of bannasters (probably a type of basket for carrying charcoal).	In digging stones of orston for making 122 blooms of iron 32s 10½d, at 3¼d for each bloom. In digging stones of orston for making 16 blooms of iron 4s 4d, at 3¼d for each bloom. Sum 37s 2½d. checked. In the carriage of orston (ore) and olwode (oldwood) for making 138 blooms of iron 10s 6d. In a sieve bought ~~3d~~ 2½d. In a trey for bringing in stones 1½d. ***Stock*** And there remains orston (ore) for making 6 blooms of iron; of digging stone of orston in the lady's forest during the time of this account for making 138 blooms. Of which in the costs of making the above 138 blooms of iron 138 blooms of orston. Sum 138 blooms; and there remains orston for making 6 blooms of iron checked. Which remains are delivered to Richard Colpeper in part of the contract of 300 of oreston annually. Remaining in the works: a hammer for breaking stones, a sieve, a scope (scoop?), two trays for carrying stones, a hand barrow.	In the carriage of orston (ore) and olwode (oldwood) for making 138 blooms of iron 10s 6d.
1354 *Tudeley Works Lease to Richard Colpeper*	Richard Colpeper to have sufficient wood for making 50 dozen of charcoal (carbona), and that by the view and livery of the chamberlain of Southfrith for the time being, by a tally to be made between them.	Richard Colpeper to have orston for 300 blooms which he will dig at his own cost and shall be the subject of a tally by the chamberlain as for the wood. Two troughs for bringing in stones (1d).	Richard Colpeper to have by estimation 12 cartloads of burning-wood (elyngwode) by the livery of the said chamberlain.

6.3 - Aims

The aim of the reconnaissance survey was to place Tudeley Ironworks within the broader woodland economy of the Lowy of Tonbridge. It sought to identify associated industries, boundaries and routeways to reconstruct the medieval landscape of Southfrith and compare this evidence to the historical record.

6.4 - Landscape context: LiDAR and place-name analysis

The 1838 Tonbridge tithe apportionment preserves place-names and field-names indicative of former woodland industries, including iron-production, timber resource exploitation, and quarrying. While assigning dates to these names remains complex, the plotting of their distribution suggests activity zones (fig.6.2). Those associated with iron-production include Blacksmiths field and Smithy Wood and while Blacksmiths field might relate to a later roadside blacksmith's shop to the east of the field, Smithy Wood and its proximity to Tudeley Ironworks suggests an association with the site. Field-names, particularly those containing 'pit', to the east and west of Smithy Wood refer to the quarrying of marl, clay, and stone. While no names specifically reference woodland industries, some provide clues as to the former morphology of the woodland. Brakey (Brakeybank Wood) and Rough (Horseshoe Rough and Burgess Rough) indicate farmland that subsequently developed into woodland and may indicate that the Lowy was un-forested at times (Bannister 2007, 43).

The LiDAR data, discussed throughout the following sections, is also indicative of activity zones (figs. 6.3-6.5). Eleven charcoal platforms were identified, predominantly situated to the south on a spur of land between the Devils Gill Stream (north) and tributary streams (east and west). These were interconnected via access tracks which allowed both the haulage of timber to the clamp and for

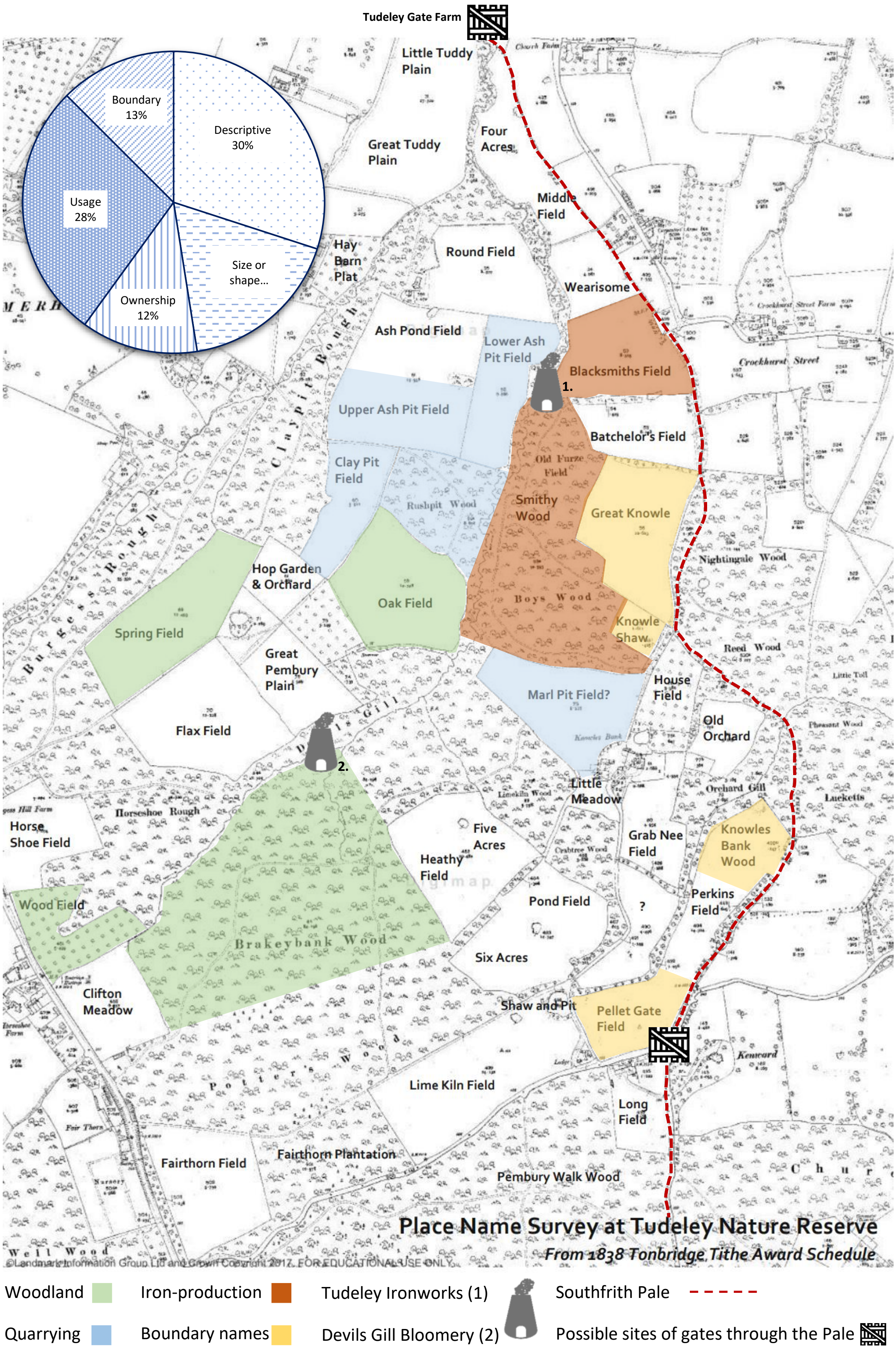


Figure 6.2 – *Distribution of field and woodland names taken from the 1838 Tithe Apportionment for Tonbridge Parish. Activity zones are visible, particularly concerning quarrying and iron-production, while boundary and gate-related fieldnames appear on the periphery of the projected course of the Pale (boundary) of Southfrith (fig. 6.5.1). The course of the Pale is based on Edward Hasted's map of the Lowy of Tonbridge c.1798 that can be seen in figure 6.8. Base map courtesy of Digimap OS Collection.*

the charcoal to be removed. Minepits, were present in four areas, all in close proximity to the Devils Gill or a tributary and spatially separate to the charcoal platforms. These minepits were also accessed via woodland trackways which were in some instances terraced into the sloping terrain. The two largest distributions of minepits were in the south, including the Devils Gill Minepits (Fig.6.5 A and B). Further north, a north-south trackway appears to connect Tudeley Ironworks to two further areas of minepits, along with the larger pits of uncertain age in Nightingale Wood (Fig. 6.5; C-F). Twenty-six larger pits are visible and are likely to be the result of digging for clay or marl. While the minepits are scattered throughout the landscape, they are more densely distributed either

Figure 6.3 – *Complete LiDAR image of the study zone, which is outlined in green. LiDAR data courtesy of Digimap OS Collection.*

side of the Pale in the east (fig.6.5 G). Their date range is probably diverse, however, it is notable that those in Nightingale Wood, outside of the Pale, are connected to the Tudeley site via a western trackway and thus potentially contemporary (fig.6.5 F).

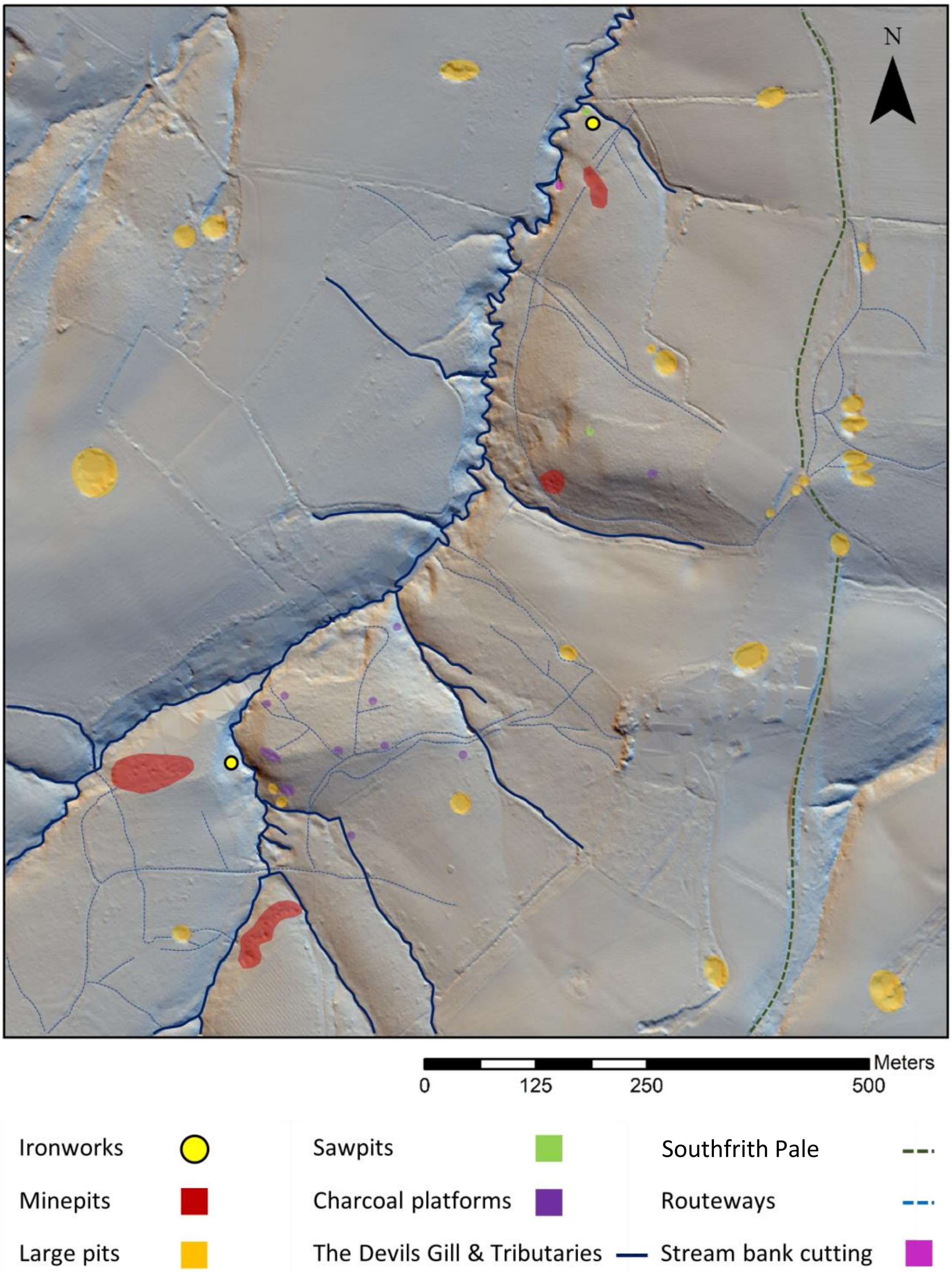


Figure 6.4 – *Interpretation of the LiDAR data. It can be seen how charcoal platforms fall within a distinct area between two tributaries and the main stream. These are interconnected via access tracks and while their date is uncertain, the Tudeley accounts for the years 1332-33 record how charcoal was acquired from Southfrith. Quarrying is also prevalent inside and outside of the Pale. The Minepits (red) form specific clusters, with the Devils Gill featuring 27 or more individual pits. These too are connected via trackways along with the larger pits (yellow). Two sawpits are present (green) including one in the centre of Boys Wood. LiDAR data courtesy of Digimap OS Collection*

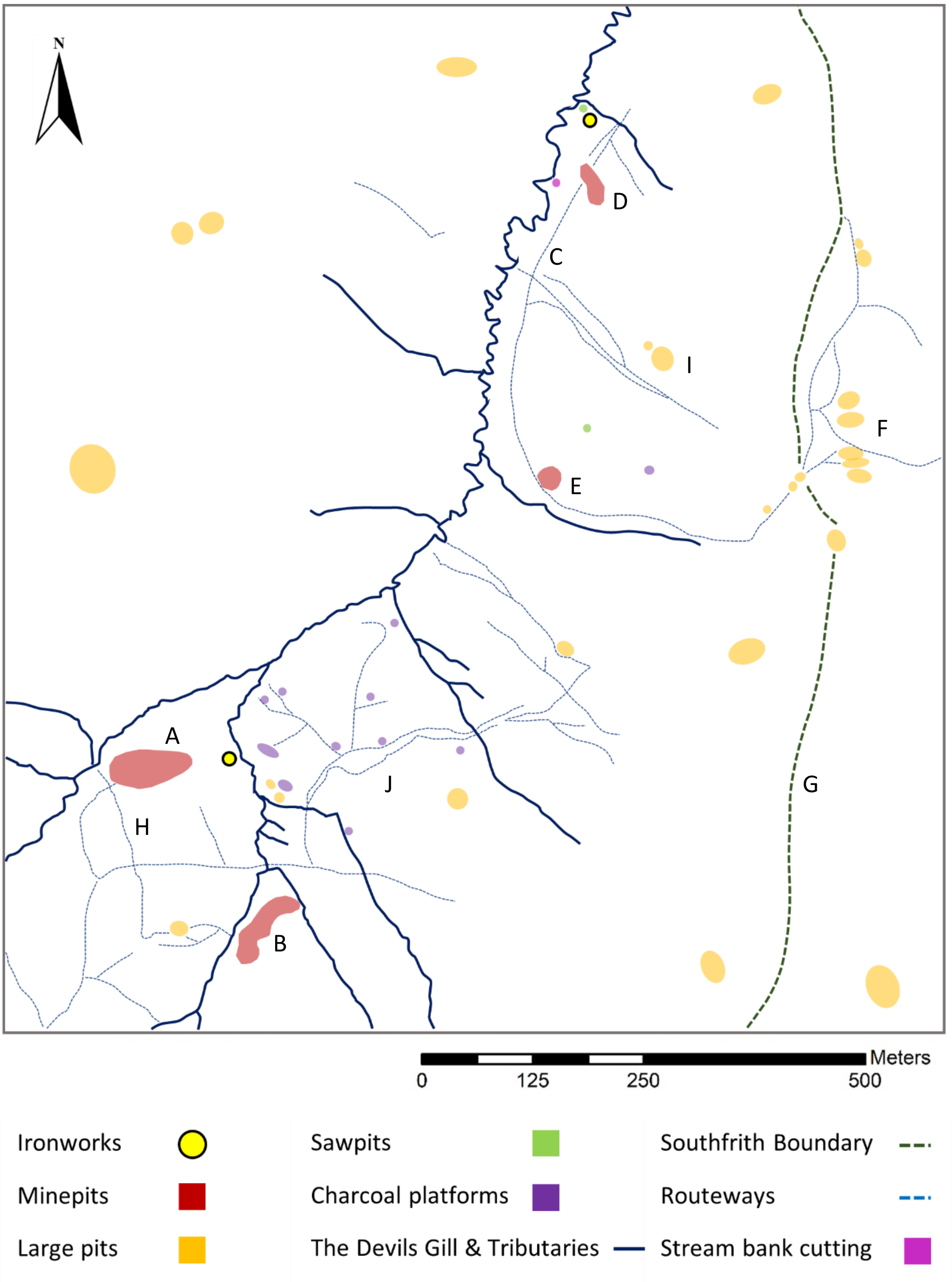


Figure 6.5 – *Author's interpretation of the LiDAR data and the features that were ground-truthed.*

A – Devils Gill Minepits

B – Second area of southern minepits

C – Tudeley woodland track

D – Possible minepits at Tudeley

E – Further possible minepits

F – Large pits in Nightingale Wood

G – Southfrith Pale

H – Coppice boundary

I – Boys Wood Pits

Original LiDAR data courtesy of Digimap OS Collection

6.5 - 'Beating the bounds' – Defining the Southfrith boundary

6.5.1 - *Historical evidence for the Pale*

As discussed in Chapter 5, Tudeley Ironworks sat within the Manor or 'Chase' of Southfrith, which at the time of Gilbert de Clare had been one of two expansive hunting forests (chases) for the Lowy of Tonbridge. Following Gilbert's death, Southfrith was allotted to Gilbert's sister Elizabeth as part of her inheritance (Bannister 2009, 9-10; Hasted 1798, 230). Unlike a 'forest', where the Crown retained hunting rights, a 'chase' formed a private forest created by the nobility and governed by its own laws (Cantor and Hatherly 1979, 71). Cantor and Hatherly make the distinction between forests and chases that were unenclosed, from parks, which were enclosed with a Pale. A Pale marked the boundary of a deer park typically with a large bank topped with a high fence of oak stakes fixed to a rail along with an internal ditch to prevent the escape of livestock, typically fallow deer (Rackham 1986, 125-145; Cooper 2014, 10-11).

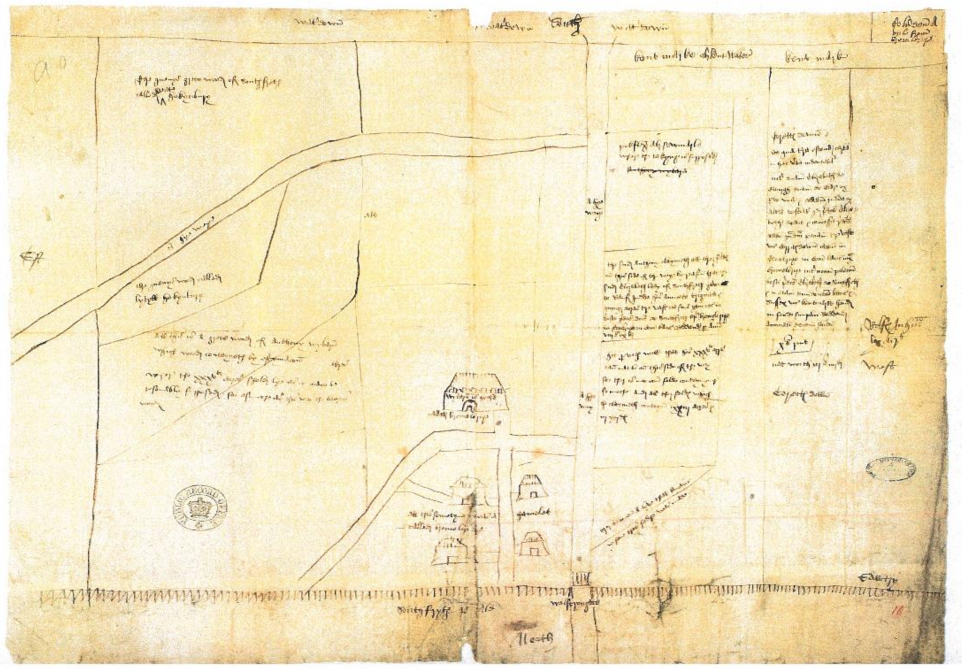


Figure 6.6 – *Sketch map of Southfrith created in 1519 showing the Pale along the bottom edge of the map. Courtesy of Mitchell & James (2014, 24-25)*

Despite Southfrith's status as a Chase, it too was at some point enclosed by a Pale, which was in existence by 1519 when it was recorded on a map created following a land dispute (Mitchell & James 2014, 24) (fig.6.6). Southfrith's Pale, illustrated along the bottom of the map, is depicted as a series of alternating vertical and horizonal posts with a rail along its top and matches the typical form described by Rackham (1986). A gate is also shown and connected to a routeway leading into the Chase (fig.6.7). The position of former gates survive in place-names along the Pale and include Tudeley Gate Farm, 870m north of Tudeley Ironworks and Pellet Gate Field, 1.1km south, each spaced 2km apart. References to the boundary also survive in field-names along the Pale, including Knowle, found in three instances as Great Knowle, Knowles Bank Wood, and Knowle Shaw which describe land with 'hillocks' potentially acknowledging the presence of a former bank to the Pale (Field 1972, 119). The bank element in 'Brakeybank' Wood may also refer to the same earthwork (see yellow in fig.6.2).

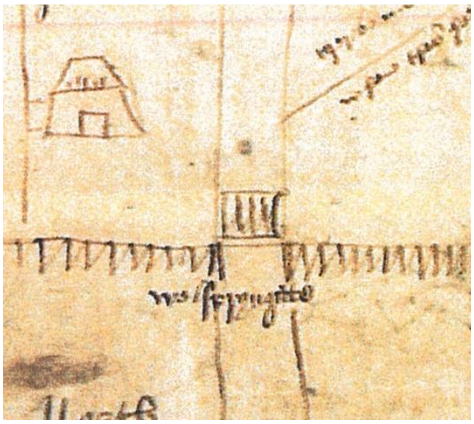


Figure 6.7 – *The Southfrith Pale depicted with a gate leading into the chase. Courtesy of Mitchell & James (2014, 24-25).*

Edward Hasted's map of the Lowy of Tonbridge shows the Southfrith Pale in c.1798, which Dumbreck (1958, 145) believes remained a substantially accurate depiction of the Lowy's extent (fig.6.8). This boundary has been transposed onto an OS map and demonstrates how Tudeley Ironworks and the suggested site of the contemporary works of Newefrith juxta Bournemelne are positioned on peripheral localities within the Chase close to the Pale, their marginal location on the forest boundary paralleling the iron-production evidence at Roffey (fig.6.9).

● Approximate position of Tudeley Ironworks

Figure 6.8 – *'The South Frith' as shown on Edward Hasted's map of the Lowy of Tonbridge c.1798 and published in 'The History and Topographical Survey of the County of Kent'. Tonbridge Castle, the former centre of the Lowy which included the hunting parks of Northfrith and Southfrith, can be seen to the north of the map. Southfrith Chase is below this and Somerhill, a later manor built within the former Chase (or manor) of Southfrith in the 17th century is to the north (Hasted 1798). It can be seen how forested Southfrith remained by the 18th century, particularly towards the eastern boundary where Tudeley was sited. Tudeley Ironworks was positioned close to the eastern boundary of Southfrith (called the Pale). Bournmill, possibly the site of Newefrith juxta Bournemelne, another ironworks recorded in a lease to Robert Springet in 1340, is situated on the western boundary of Southfrith (Giuseppi 1912, 147-8). Robert Springet was probably related to Thomas Springet who leased the Tudeley Ironworks (ibid 1912). Woods Gate is shown to the south-east of the map as another gate into Southfrith. The full map of the Lowy can be seen in Chapter 5. With thanks to Exeter University Digital Humanities Department for assisting with the digitisation of a high-resolution image of Hasted's original map.*

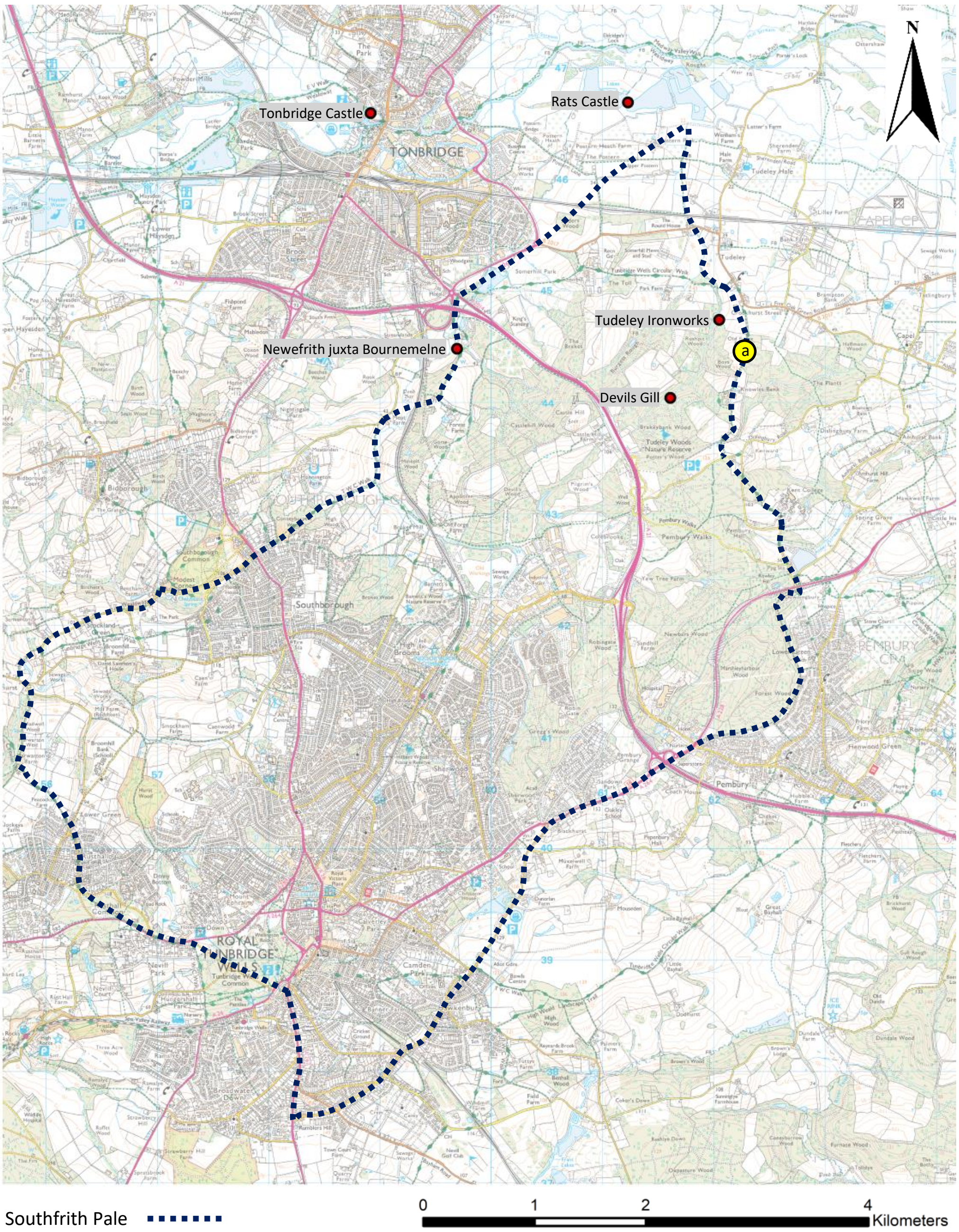


Figure 6.9 – *The position of the Southfrith Pale based on Hasted's 18th century map of the Lowy of Tonbridge (fig. 6.8), transposed onto the modern landscape. The former perimeter is not always discernible due to subsequent landscape changes and in these instances a hypothesised route had to be adopted. The position of potential medieval ironworks has been plotted and it can be seen how Tudeley and Newefrith juxta Bournemelne are positioned on peripheral locations. Rats Castle falls outside of the Southfrith Pale in Northfrith. The section of the eastern boundary at 'a' was recorded during the reconnaissance survey in 2019. Base map courtesy of Digimap OS Collection.*

6.5.2 - *Archaeological evidence for the Pale*

While it must not be assumed that the Southfrith Pale went unchanged between the 14th and 18th centuries, the earthwork evidence identified in the reconnaissance survey would suggest the eastern section of the boundary, 270m

Figure 6.10 – *Pale, forming the Southfrith boundary on the western side (right), the boundary consisted of a double bank and ditch. A track runs to the east of the pale and therefore outside of the Southfrith Chase. To the east of the track, a less substantial ditch and bank is present, delineating the modern field on this side. (Author's image).*

east of Tudeley Ironworks, retained its original position (fig. 6.5; G). This stretch of the Pale is on a north-south alignment and consisted of a double bank and ditch, the banks either side of the ditch. A narrower ditch further east, marked the boundary of an adjacent field, while a trackway runs between the two for 250m (fig.6.10). The Pale continued as a depression within the fields to the north, curving on a north-western trajectory and is clearly visible on the LiDAR imagery (fig.6.11). The LiDAR shows traces of a bank here and although this is substantially ploughed away, an adjacent ditch is more apparent on its western side. This morphology supports the likelihood that this was the Pale, for the ditch on the inside of the Pale would have prevented game from escaping the Chase.

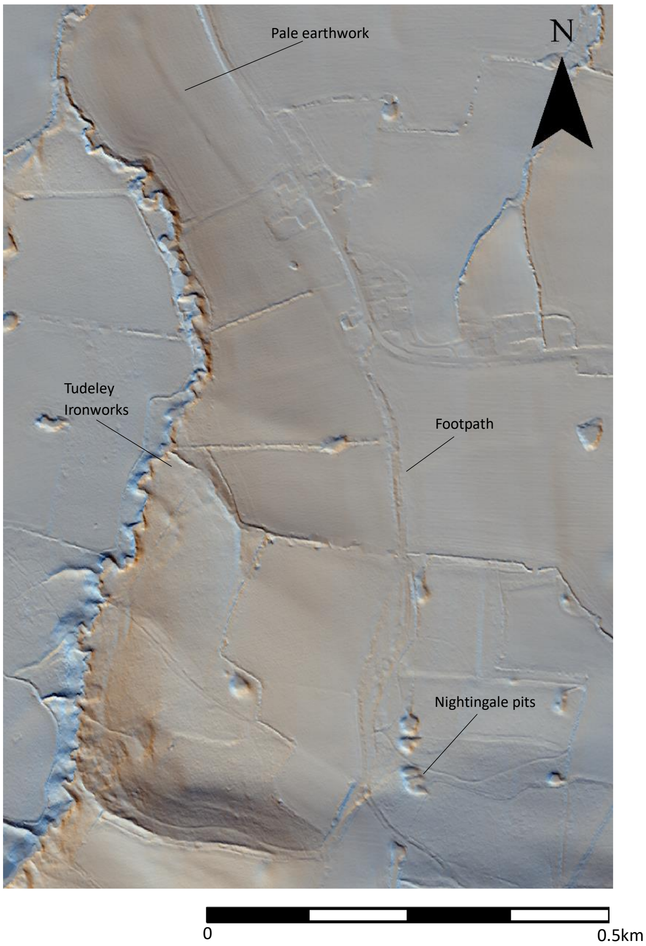


Figure 6.11 – *LiDAR of the Southfrith Pale to the east of the Tudeley site. LiDAR data courtesy of Digimap OS Collection.*

While the Chase and its Pale retained the necessary game for hunting including fallow deer, red deer, swine and hares, it would have held other agrarian and economic functions as well including grazing, and timber harvesting from pollarding and coppicing (Rackham 1986, 125). As will be seen at Southfrith, charcoal making, quarrying and iron-production were all practiced within the bounds of the Pale and formed an integral part of an interlinked woodland economy, maintained by the manor and its overseers.

6.6 - Charcoal Production

6.6.1 - *The historical evidence for making charcoal and a calculation of weights used at Tudeley Ironworks*

In each of the years recorded in the accounts, charcoal (and its carriage) is listed as the major expenditure, which Hodgkinson and Whittick (1998,14), calculates formed 40% of costs to the works between 1329-34 and 1350-54. The accounts record the total charcoal used and what remained in stock as well as recording how may blooms were produced each year. While the weights of charcoal supplies are recorded in tens, quarters, seams and dozens the modern equivalent to these weights have previously not been calculated. Using Zupko's (1985) study of weights and measures in medieval England it has been possible to interpret the weights of charcoal supplied to the works at Tudeley and from these the average quantities of charcoal required within a smelt can be deduced.

The importance of charcoal to the furnace is evident within the accounts, and it is referred to between 1329 to 34 as '*charcoal bought for making the said blooms*'. It was also used for roasting the ore *'…burning the stones'* (1332-33). The weight of charcoal purchases is recorded for each year, however, calculating weights from medieval records is hindered by the use of non-standard units of measurement that varied on a temporal and regional level (Zupko 1985, XI).

Furthermore, not all weights listed in the accounts are immediately identifiable, including 'tens' and 'dozens' but can be calculated by their subdivision weights which included quarter weights and seams, whose weight is known from other contemporary records (see Zupko 1985). Between 1329 and 1333, charcoal was sold in 'tens' decena of which we are told in 1331-32 that each ten contains 24 quarters (quarteria). The spelling quarteria was in use between the 14th and 17th century and equated to 28Ibs, or a ¼ hundredweight, a hundredweight being 112Ibs (Zupko 1985, 337). The weights of charcoal for 1329-1333 can therefore be calculated as:

number of tens x 24 (quarters) x 28 (Ibs)

Applying this calculation would give the following weights (table 6.2):

Table 6.2 – *Calculated charcoal weights for the years 1329-33*

	Recorded Data		Analysis			
Year	**Recorded quantities**	**Charcoal Remaining**	**Charcoal Weight in quarters**	**Charcoal weight in hundredweight (cwt)**	**Charcoal weight in pounds (Ibs)**	**Metric conversion (kg)**
1329-30	36 tens	0	864	216	24192	10973
1331-32	41 tens	0	984	246	27552	12497
1332-33	7½ tens		180	45	5040	2286
	34 tens made of wood from the manor		816	204	22848	
	Total: 41½ tens	0	996	249	27888	

In 1333-34 and then again between 1350-54, charcoal was recorded in dozens (duodena) and subdivided into seams (summagia). While the accounts do not record how many quarters comprised a dozen, Zupko (1985) states that a seam, from the latin 'summiga', was equivalent to a quarter (28 Ibs). Logically a dozen would equal 12 seams, however in other industries a dozen is not always a standard measurement, illustrated by the 'baker's dozen' of 13, and this was clearly the case with charcoal. The 1354 account can be used to calculate how many seams make a dozen, and calculate their weight, for it states that in the stock of charcoal there were 9 seams remaining from the previous year, 14½ dozen and 5 seams acquired from the manor, 8½ dozen purchased from the neighbourhood along with a further 2 dozen and 5 seams also from the neighbourhood. This totalled 26 dozen and 5 seams of charcoal. The total of the seams is 19, therefore, to create the additional dozen whilst leaving 5 seams, 14 seams must equate to a dozen. The record of 1353 when the works purchased 7 dozen and 8 seams, of which 6 dozen and 13 seams were used and 9 seams remained in stock confirms 14 seams to a dozen was consistent between years:

> 7 dozen – 6 dozen = 1 dozen 8 seams – 13 seams = 5 seams.
>
> The 5 seams have to be subtracted from the remaining dozen to leave 9 seams so by adding it back means a dozen has to be equivalent to 14 seams

While calculating the price of a seam against the cost of a dozen in 1353 also demonstrates this:

> 1 shilling = 12 pence, so 8 shillings = 96 pence. 44 shillings = 528 pence + 7¾ pence = 535.75 pence
>
> 96 pence x 5 dozen = 480 pence. 535.75 – 480 leaves 55.75 pence remaining ÷ 8 (seams) = 6.9 pence a seam.
>
> If a dozen costs 96 pence, a seam at 6.9 pence is 7.2% of the cost of a dozen.
>
> 7.2% of 14 seams is 1 seam.

Therefore, a ‘colliers dozen’ in the 14th century was equivalent to 14 seams (or quarters) which, with a weight of 28Ibs per seam, means a dozen weighed 392 Ibs or 98 cwt. The following weights of charcoal can therefore be calculated for the years 1333-1354 (Table 6.3).

Table 6.3 – *Calculated charcoal weights for the years 1333-53*

Year	Recorded Data		Analysis			
	Recorded quantities	Charcoal remaining for the next year (lbs)	Charcoal Weight in Seams (equivalent to quarters)	Charcoal weight in hundredweight (cwt)	Total weight in pounds (lbs)	Charcoal used
1333-34	**Total:** 20 dozen	0	280	70	7840	20 dozen = 7840 lbs
1350-51	16 dozen		224	56	6272	
	24 dozen from the manor		336	84	9408	
	Total: 40 dozen	½ dozen = 196 lbs	560	140	15680	39½ dozen = 15484 lbs
1352	**Total:** 22 dozen 11 seams	2 dozen = 784 lbs	319	79.75	8932	20 dozen 11 seams = 8148 lbs
1353	5 dozen 8 seams		78	19.5	2184	
	2 dozen *(from previous year)*		28	7	784	
	Total: 7 dozen 8 seams	9 seams = 252 lbs	106	26.5	2968	6 dozen 13 seams = 2716 lbs
1354	14½ dozen 5 seams from the manor		208	52	5824	
	8 ½ dozen from neighbourhood		119	29.75	3332	
	2 dozen and 5 seams also bought in the neighbourhood		33	8.25	924	
	9 seams remaining from the previous year		9	2.25	252	
	Total: 26 dozen and 5 seams	2 dozen = 784 lbs	369	92.25	10332	24 dozen and 5 seams = 9548 lbs

Note: *Calculated on a dozen being 28 quarters and a seam being 2 quarters for this provides even figures likely to be applicable of the time and supports the calculation of a seam made from the accounts in 1354.*

Each unit of weight can be summarised as (table 6.4):

Table 6.4 – *Summary of the weight equivalents for charcoal purchases at Tudeley.*

Weight measurement	Weight equivalent	Weight in pounds (lbs)
Ten	1 ten = 24 quarters	672 lbs
Quarter	¼ of a hundredweight	28 lbs
Hundredweight (cwt)	x4 the weight of a quarter	112 lbs
Dozen	1 dozen = 14 seams or 14 quarters	392 lbs
Seam	1 seam ≈ 1 quarter	28 lbs
Note: *The rounded figures for dozens and seams are the most likely weights and have been used in the above calculations.*		

As the accounts record both the total charcoal used and what remained in stock, as well as the number of blooms produced annually, this enables an approximation to be made of the average weight of charcoal used per smelt. However, it is not always clear whether the charcoal was used solely to produce the bloom or whether the annual total was also used to roast the ore and fuel a hearth for bloom consolidation. In 1332-33, 41 tens (12.5 Tonne) of charcoal were used for making the blooms (in the furnace) and 'burning' them (consolidation),

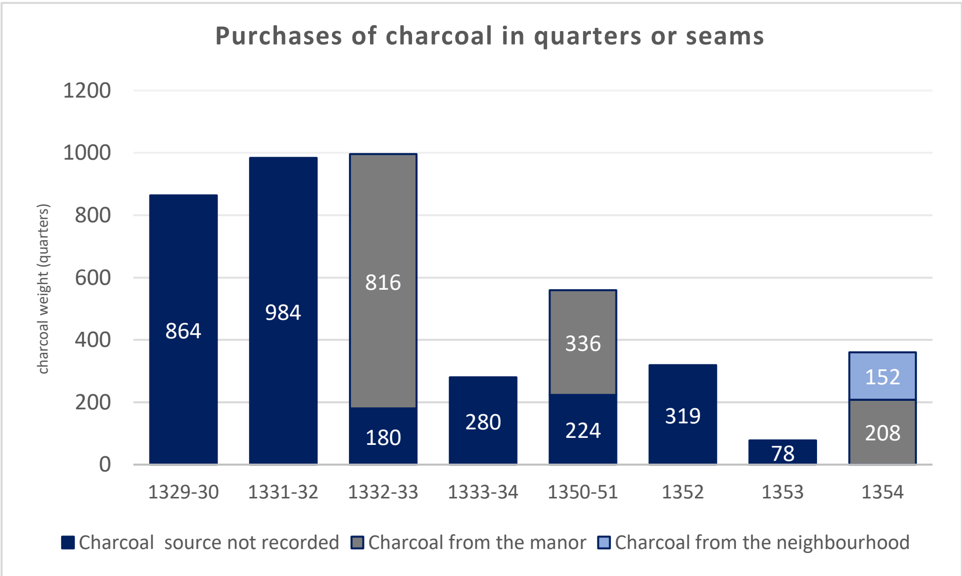


Figure 6.12 – *Purchases of charcoal by Tudeley Ironworks between 1329-1354 and where the charcoal was sourced. Note: remaining charcoal from previous years is excluded. 56 quarters remained from the previous year in 1353 and 18 quarters in 1354. Derived from Tudeley accounts in Appendix A2.*

so it is uncertain exactly what ratio was used in both processes. In 1333-34 charcoal was used for both making the blooms and roasting the ore. The subsequent years only associate the charcoal with bloom production, however the probability that it was also used in associated processes is high.

Table 6.5 – *Summary of charcoal bought, used and the blooms produced against the period the ironworks were in use.*

Year	Records				Analysis		
	Period the works were leased	Charcoal Bought (quarters)	Charcoal used for blooms	Blooms produced in the year	Estimated charcoal per bloom (quarters / seams)	Estimated charcoal per bloom (lbs)	Estimated charcoal per bloom (kg)
1329-30	11 months	864	864	194	4.5	126	57kg
1331-32	12 months	984	Uncertain[1]	224	4.4	123.2	56kg
1332-33	12 months	996	Uncertain[2]	231	4.3	120.4	55kg
1333-4	6 months[3]	280	280	112	2.5	70	32kg
1350-51	41 weeks	560	553	252	2.2	61.6	28kg
1352	28 weeks & 2 days	291	291	143	2	56	25kg
1353	Unspecified 7 weeks[4]	97	97	26 13	2.5	70	32kg
1354	25 weeks	341	341	138	2.5	70	32kg

Notes:

1 - In 1331-32 the 41 tens of charcoal are used for making the blooms and burning them, presumably using a hearth to consolidate them, which also required charcoal

2 - 1333-34 the charcoal was used for both making the blooms and burning the stones (roasting the ore)

3 - From March 1334 the works were leased to Sir Thomas de Gedewerth. The 112 blooms recorded were produced before this between 29th September 1333 and March 1334.

4 - John Parker held the works for 7 weeks between September and November 1353 in which time 13 blooms were made after 29th September. 26 blooms were however made before the 29th September over an unspecified period. The charcoal was however used for all 39 blooms in both periods.

Table 6.5 gives the estimated charcoal used per bloom (either in smelting or other processes). In the WIRG experimental smelt at Pippingford, 15-20kg of charcoal is typically used in the furnace (Wealdeniron.org.uk) and this quantity is comparable to bloom production between 1333 and 1354, where the average charcoal used was 29.8kg, which assumes some was also used in ore roasting and consolidation.

This may of course also suggest a larger furnace capacity than the experimental example at Pippingford, which has a height of 1m and an internal diameter of 0.3m (Smith 2013, 99), or variations in wood used to make the charcoal (with some tree species having a faster burn rate). While the higher quantities of charcoal recorded in earlier years (1329-33) may indicate a yet larger furnace size, if the charcoal required in other processes is subtracted from the totals, they would be more comparable to the later period.

There are several findings worth noting in the charcoal quantities shown in table 6.5. Firstly, the increase or decrease in quantities correlates with the number of blooms produced in a year. While this correlation may appear obvious, it suggests there was limited stockpiling between seasons (although some did occur) and would also indicate the careful calculation of specific ratios of charcoal needed to produce a bloom. This is also seen in the ore, where purchases were measured by the number of blooms it could produce. This is supported when considering the approximate weight of charcoal used in each smelt (table 6.5), where, between 1333-1354, the weight of charcoal calculated for individual smelts annually never varies by more than 7kg. Three of these years have the same average weight of 32kg, despite different numbers of blooms being produced. The uniformity of weights could suggest a specialist workforce and standardisation of practice, whereby known ratios of charcoal and ore were placed within the furnace. Those working at Tudeley were reliant on the success of the smelt and the input of charcoal and ore represented considerable investments. Therefore, the development of a standardised methodology is a logical step to minimise failure, but also highlights Tudeley's role as a specialist production centre. The deviation between the blooms produced and charcoal purchased (fig.6.13) is far closer between 1352-54 than 1329-33, which potentially indicates a move to greater efficiency in response to a time of rising ore and charcoal prices.

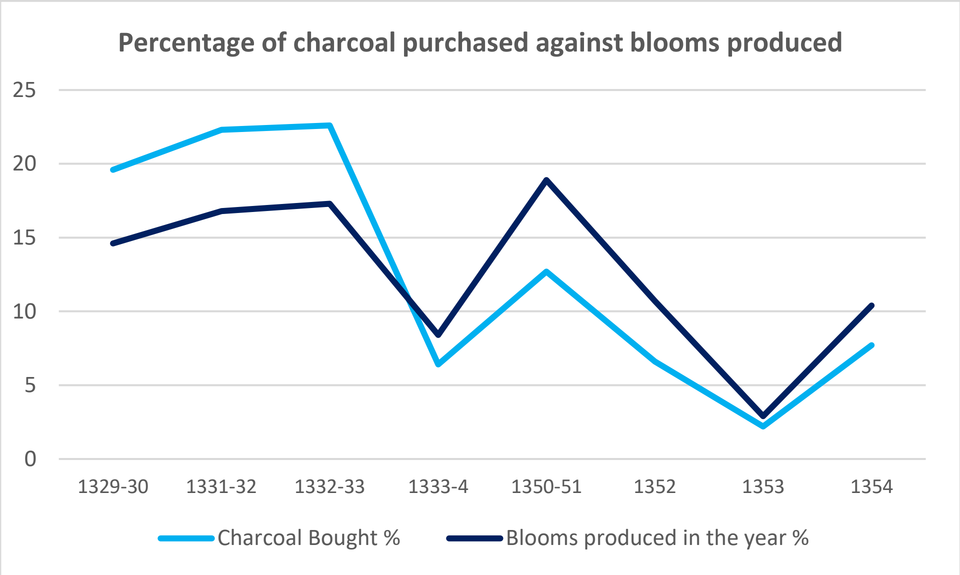


Figure 6.13 – *Correlation between the percentage of charcoal purchased and the percentage of blooms produced. Data derived from the Tudeley Accounts Appendix A2.*

Charcoal was sourced from both Southfrith and beyond the Chase (fig.6.12). In some years it is not specified where it came from, however, the lack of cost of carriage, as in 1329-30 when 36 tens of charcoal were bought for making the 194 blooms, might imply this charcoal was produced in the locality, as externally sourced charcoal incurred a carriage cost that is recorded in the accounts in the 1350s. In other years, including 34 tens for 30 shillings in 1332-3, charcoal was specifically recorded as coming from the '*lady's wood'* or '*lady's forest'*, the lady being Elizabeth de Clare. Charcoal from the lady's wood was also recorded in 1350-1 and 1354 where it constituted 60% and 58% of the total purchased for those years. Its highest purchase was however in 1332-33 when it formed 82% of the total. The distance it was brought within the manor is not clear although as the cost of carriage in 1332-3 was over a quarter of the overall cost of the charcoal, it is unlikely to have been close to the ironworks.

In 1354 charcoal was bought both from the '*lady's forest*' and '*in the neighbourhood*' at 8 shillings a dozen from both sources. Transport however was 7 pence a dozen from the Chase, while the charcoal bought elsewhere cost 14 pence, suggesting it had travelled twice the distance. The fact that charcoal was brought to the works from a distance can be taken as evidence of both Tudeley's central importance and its permanence. Cooper and Juleff's experiments on the effects of transportation on charcoal have found that fracturing during carriage over as little as 2km considerably altered the size ratios of a load, while at 10km the percentage of large charcoal was significantly reduced through breakage increasing the percentage of less desirable small and fine charcoal (Cooper and Juleff 2020, 7-10). The fact that charcoal was brought in from a distance shows it was not always possible to source charcoal locally from the Chase, which would have avoided both the risks of degradation on transport and added financial costs, and would imply a reason behind this. Coppicing cycles might be one explanation, which although not a practice recorded in the accounts, is documented elsewhere in the later 14th century (Madera et al 2017, 5). Coppicing cycles can vary between 7 and 25 years, and therefore if this was practiced in the Chase, charcoal sources may not always have been available in a given year (Bannister 2007, 44). This would be supported by the approximate 3-year intervals between the acquisition of charcoal from the manor. The acquisition of charcoal therefore implies both connectivity between the ironworks and wood-colliers within and outside the Chase and the use of woodland management strategies.

Old wood and living wood

Along with charcoal, Olwode is also recorded as an item that Hodgkinson and Whittick (1998,9) suggest could be old wood or fallen branches. In total 28 shillings were also paid for dead wood in Southfrith which was sold for making charcoal for blowing the said blooms and may have been the same thing. The wood of dead branches and fallen trees is regularly referred to within accounts of the medieval period, for it was abundant within woodlands and forests and was an ideal resource for charcoal production (Schubert 1957, 87-88). The inclusion of dead wood within the accounts indicates its importance as a resource at Southfrith, unlike 'living wood' which is not mentioned until 1332-33 when 34 tens of charcoal was '*made from the lady's wood*' – and while this does not specify whether this was dead or living wood, a further distinction was made in 1354 when Richard Colpeper was allowed 'sufficient wood for making 50 dozen of charcoal' as well as '*12 cartloads of burning-wood (elyngwode)*' and supports this distinction between the two wood sources. The importance of this distinction may suggest a shift in woodland management techniques in the later period such as the adoption of coppicing whereby trees could be cut and allowed to naturally regenerate. Schubert argues that during the 13th century strategies were implemented to help preserve depleting woodland resources, which included coppicing (ibid 1957, 114).

Making charcoal

While the accounts do not describe the method of making charcoal, Biringuccio writing in 1540 on the art of metallurgy describes two methods applied during the period. One involves digging a pit and filling it with '*broom roots or small pieces of chestnut or some other wood*'. The top of the pit was then covered with fern, broom and then earth. Biringuccio states that this method produces charcoal that is harder and smaller, and while these properties make it a suitable fuel for a smiths forge, he says it is not useful for smelting, for its hardness means it does not burn in the same way as charcoal made in a pile (clamp) (Biringuccio 1540, 178-179). However charcoal was made using the pit method in Sri Lanka, so it its use is likely to vary by region (Juleff 1998)

Figure 6.14 - *Crushing the charcoal into a smaller charge. The sieve in the background was used to separate larger fragments for further processing. Sieves could also be used to separate the fines. (Author's image).*

The second method Biringuccio records involves the creation of a pile (fig. 6.15):

'*a level place is chosen convenient to the wood…if the bed is not level, it is made so, and is given a round form. Four large poles are set up in the middle in a square, or three in a triangle…Then proceed around these, covering them upwards, circle by circle, with all your cut wood and with clumps split into smaller pieces, building it in the form of a round pyramid or a haystack…when the pile has been made, it is well covered all over the outside with fern leaves and broom and then on top of these, it is plastered well from the top with good, firm earth*…' (Translated by Mudd 1942, 177)

Evidence suggests the construction of a charcoal pile is the most likely method applied by the colliers at Southfrith. This is supported by the earthwork and LiDAR evidence discussed in Section 6.6.2 and earthworks elsewhere in the Weald, including Darwell near Brightling (Prus 2005).

The inventory of the works in 1350-51 lists equipment used to process charcoal, which include two sieves, a scope (probably a scoop) and a pair of '*bannasters*'. Experimental smelting by WIRG has demonstrated how a charcoal charge of a

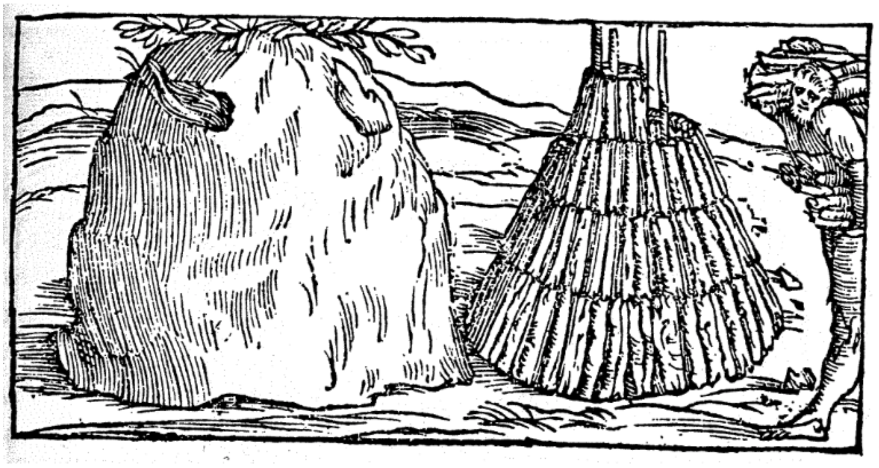


Figure 6.15 – *Charcoal piles described in 1540 by Vannoccio Biringuccio in his Pirotechnia. After the wood was stacked, it was covered in a layer if fern leaves and broom and plastered in earth. The earthwork and LiDAR evidence at Tudeley suggests a similar practice, as opposed to burning charcoal within a pit (Image courtesy of Mudd H.S. 1942; 177).*

maximum size of approximately 30mm allows gas to pass through the furnace bed (fig.6.14) (Smith 2013, 102). To achieve this, the charcoal must be fractured and sieved to remove the fines (ibid 2013, 102) (fig. 6.14). The presence of a sieve would therefore indicate similar practices were applied at Tudeley, to maximise the effectiveness of the smelt and avoid wastage of charcoal. A scoop was used to charge the charcoal (and ore) into the top of the furnace, a tool custom-made for the job, with a long arm and large enough carrier to hold the charge (Chapter 4, fig.4.75). Such a tool may have held a specified volume that enabled standardised amounts of ore and charcoal to be added over the duration of the smelt. At the West Dean experimental smelt, 1kg charges of ore and charcoal were added in 20-minute intervals over 4 hours (Smith 2013, 102). A bannaster is potentially a variant on the word banastrum, first recorded in 1307, as a basket for charcoal (Latham 1975). While an alternative definition is given in Section 5.8.4, it demonstrates a possible method by which charcoal could be moved around the site, perhaps carried on an individual's back with straps. A handcart was also purchased in 1350-1, which may have aided with bringing charcoal to the site from the charcoal hearths.

6.6.2 - *Charcoal Production – the archaeological evidence*

Charcoal was an important fuel in iron-production for its ability to burn at high temperatures of over 1000°C able to generate significantly higher temperatures than wood within a furnace (O'Sullivan and Downey 2009, 23, Armstrong 1978). It was produced by restricting the air supply to burning wood, which prevented it from completely combusting, and allowed moisture to be driven off (O'Sullivan and Downey 2009, 23). As the historical evidence in Section 6.6.1 showed, this was achieved by constructing a kiln or clamp (Armstrong 1978; Blandon 2003, 72; Bannister 2007, 48; O'Sullivan and Downey 2009, 23; Blandford 2016, 95). In the latter method, the central pole was removed to form a flue by which the wood could be lit, the flue aperture then sealed once the wood was alight (O'Sullivan and Downey 2009, 23).

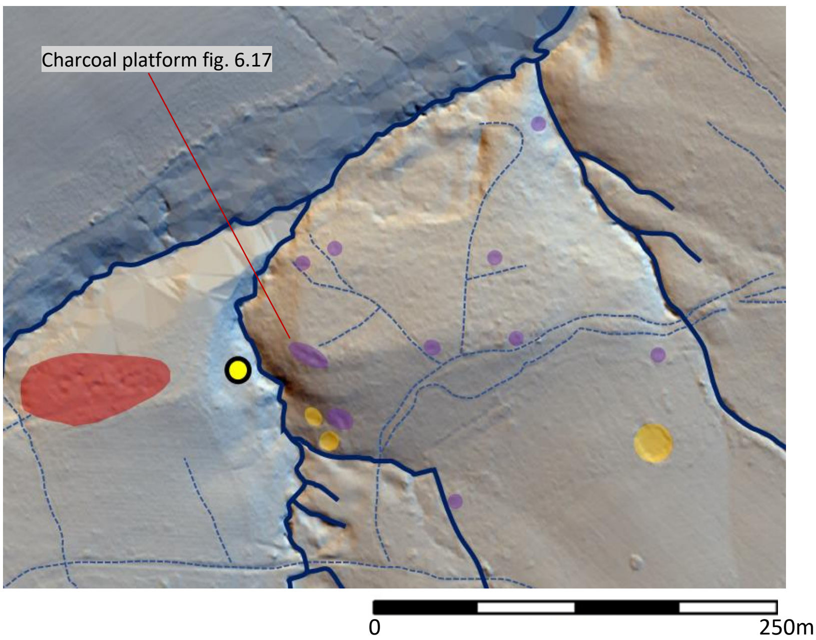


Figure 6.16 – *locations of charcoal platforms (purple) at Tudeley Nature Reserve. The example identified in the reconnaissance survey (figs. 6.17-6.19) is shown. LiDAR data courtesy of Digimap OS Collections.*

Charcoal production sites can be characterised by circular or oval platforms with a hearth or pit, typically 4-5m in diameter (Bannister 2007, 48-9; Blandford 2016, 95). On sloping ground, these platforms may be terraced into the slope with a 0.25-0.5m high bank at the rear and a level surface produced by moving the excavated soil to the front (Bannister 2007, 49; O'Sullivan and Downey 2009, 23).

Charcoal platforms are notoriously difficult to identify through fieldwork, often existing as discrete earthworks. Blackened charcoal-rich soils which can form layers 400mm thick are however a characteristic feature of these sites (Bannister 2007, 49; Prus 2005, 26). Within the study zone 11 probable charcoal platforms were identified on LiDAR (fig.6.16 and 6.5; J). However, of these only one was identified in the survey and located on the eastern bank of a tributary to the Devils Gill (2009194). Here a kidney shaped platform was terraced into the natural west-facing slope leading down to the stream (figs.6.17-6.19). The platform was 6m in

Figure 6.17 - *A levelled ovoid platform, terraced into the natural west facing slope leading to a tributary stream, is demarcated by the dashed line. The soil at this point was heavily blackened and contained fragments of charcoal.*

diameter and had a sinuous low rear bank to the east, from terracing into the natural slope and bringing spoil forward to level the adjacent platform to the west. Its irregular shape may represent two platforms and indicates a pair of clamps stood side by side, as shown in Biringuccio's illustration (fig.6.15). Charcoal-rich soil on the platform confirmed it was used for charcoal production. While the platform conforms to Biringuccio's 'pile type' of charcoal clamp, without radiocarbon analysis it remains impossible to date, for while the accounts record the acquisition of charcoal in 'the lady's forest' during the 14th century, the rusting remains of charcoal drums elsewhere in Brakeybank and Nightingale Woods attest to how charcoal was produced here as late as the 20th century (fig.6.19).

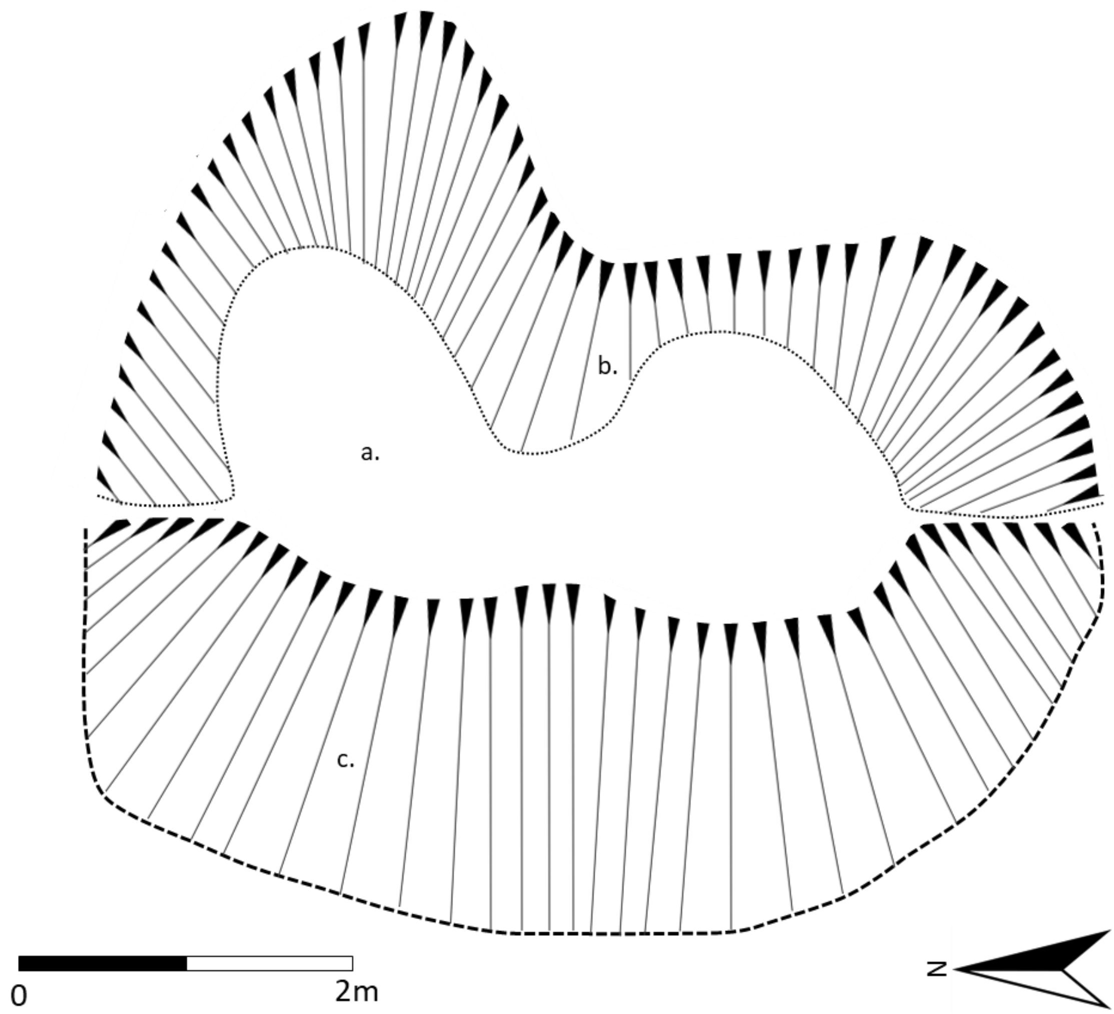


Figure 6.18 – *charcoal platform recorded at TQ 6166 4400 on the Devils Gill. A levelled platform with a diameter of 6m at (a) had been created by terracing into the western slope, which had left a low sinuous bank (b). The natural slope continued at (c). The presence of two oval platforms may suggest two clamps stood side by side. (Author's image).*

LiDAR shows how the 11 platforms formed a zone of activity over an area of 4ha. All were near trackways, which had been created to facilitate the movement of timber to the clamp and subsequent removal of the charcoal. All but three were within 50m of a stream, an association also seen at Darwell, where it is suggested water was used to end the burn by reducing the charcoal's temperature and to drive off remaining oxygen within the clamp (Prus 2005, 27; Blandford 2016, 96). Since the Devils Gill and its tributaries are frequently dry during the summer months, it would suggest that, like Darwell, charcoal production was a seasonal industry, practiced in the winter and spring, which would coincide with the coppicing season (Ibid 2005, 27; Ash and Barkham 698, 1976). It is said that the 'Devils Gill' gained its name from the fiery glow that was emitted along the streambank, during the burning of the charcoal (and most likely also smelting). As the platform is smaller in size than the 20th century drum burners, it is probable this charcoal platform is earlier in date. Its proximity to the Devils Gill Bloomery, which lay 50m west on the opposite bank also supports an association between the two. The wood-colliers who managed the charcoal clamps would have remained on site for several months at a time, supervising the burn, in a process that would have taken up to six days to 'chark' (Blandon 2003, 72; Prus 2005, 33). Blandon (2003, 72) suggests they lived within conical huts made from poles, brushwood and turves. And yet it is notable how an industry, judging by the

Figure 6.19 - *Charcoal clamp dating from the 20th century, demonstrating the continued exploitation of the woodland around Tudeley for fuel and the resulting complications when dating charcoal platforms. (Author's image).*

supplies of charcoal recorded in the Tudeley accounts, that must have dominated the woodland landscape during the 14th century has left little archaeological trace. However, further work has the potential to identify other charcoal platforms and produce a more comprehensive chronology and typology for their use here, using radiocarbon dating.

6.7 - 'Wood' and Woodland management

6.7.1 - *The historical evidence*

The production of charcoal relies on a consistent supply of wood or 'underwood' and therefore we can infer from the accounts that various woodland management strategies were deployed to meet the demands of the wood-colliers. Two types of woodland resources need to be considered in the medieval period. These include 'timber', which was used for beams and planks in construction and represents an irregular demand, and 'wood' used for logs, poles, fencing stakes, tools, and charcoal, and was in regular demand (Rackham 1986, 67: Squires 2004, 142). Timber is produced from the slow growing great oaks or elms ideal for timber framed buildings, whilst fast growing wood could be produced through management strategies such as coppicing (see Section 6.7.2) (Rackham 1986, 67).

The accounts make no reference to woodland management strategies other than that charcoal was made in various years from wood from 'the lady's wood'. In 1329, 28 shillings was spent on 'dead wood' in Southfrith, which was used to make charcoal for 'blowing' the blooms. Dead wood can include tree stumps, branches, twigs, bark, and heart wood as well as wood within the canopy of trees (West and White 2011, 2). Its use for charcoal is therefore indicates the care and management of the woodlands and the diverse use of its resources. The management of the woodlands fell to Richard de Groshurst who, in 1324, was the Chief Forester for the Chase of Tonbridge and for the de Clare's other Chase at Rotherfield (Ward 1962, 220). It was at Rotherfield that the 14th century bloomery site of Minepit Wood was located and the similarities to Tudeley were noted in section 5.8 and there is the potential that de Groshurst was involved in both sites. In the 1329 Tudeley accounts, de Groshurst was referred to as '*Keeper of the Chase*' and therefore had interests in both the woodland management of Southfrith and its iron-production.

A Forester is again recorded in 1350-51 when 40 dozen charcoal was purchased '*as appears by a tally against John Parker the forester*' and demonstrates the forester's involvement in the production of charcoal. The surname or byname of Parker is also significant for it specifically refers to a keeper of a chase, forest, park, or warren and is an occupation that Bardsley (1901, 230-1) identifies in other surnames including Forester, Chaser and Warren. While in this instance John may have taken his surname from his role at Southfrith, it is also possible that the name had become hereditary at this date and that this was an occupation passed down through generations of his family.

It is plausible that woodland management strategies were used at Tudeley to manage both timber and wood resources needed for industries across the Chase. The woodland may have been divided into timber trees and underwood, the underwood being utilised by the wood-colliers for charcoal. Coppicing as a management strategy has been practiced since the Neolithic but is first recorded historically in 1384 (Madera 2017, 5). The process involves the cutting back of trees to ground level causing them to rejuvenate by sending up shoots from the remaining stump to produce a coppice stool. In time, these shoots will reach a suitable size to be harvested again, often within regular cycles of 7-25 years

(Rackham 1986, 65; Bannister 2007, 44). Using the data on charcoal weights discussed in Section 6.6.1, estimates can be made of the area of land that was coppiced to produce the charcoal required annually at the Tudeley Ironworks. In a 15-year coppicing cycle, ash, hazel and oak can produce around 2.5 tonnes of underwood per hectare (Prus 2005, 32). Armstrong (1978) suggests the ratio of conversion from wood to charcoal is between 5-7 of wood to 1 of charcoal (ibid 2005, 32). Taking the upper figure, the annual charcoal can be estimated by:

calculated weight of charcoal (Tonnes) x 7 ÷ 2.5 = hectare total

This would suggest that between 7.3 and 29.1 hectares was coppiced in 1332-3, 1350-51 and 1354 from the manor for the Tudeley works (Table 6.5). For comparison, the calculated 12.2ha of coppice in 1350-51 would cover nearly one third of the study zone (fig. 6.20). These coppice calculations are somewhat hypothetical, for cycles will vary by the growth rate of individual tree species and environmental conditions (Bartlett 2011, 14). Furthermore, Rackham suggests medieval coppicing cycles were shorter than later periods, occurring every 5-7 years, which again would impact upon the above calculation (Rackham 1986; Prus 2005, 31). However, it highlights the volume of timber

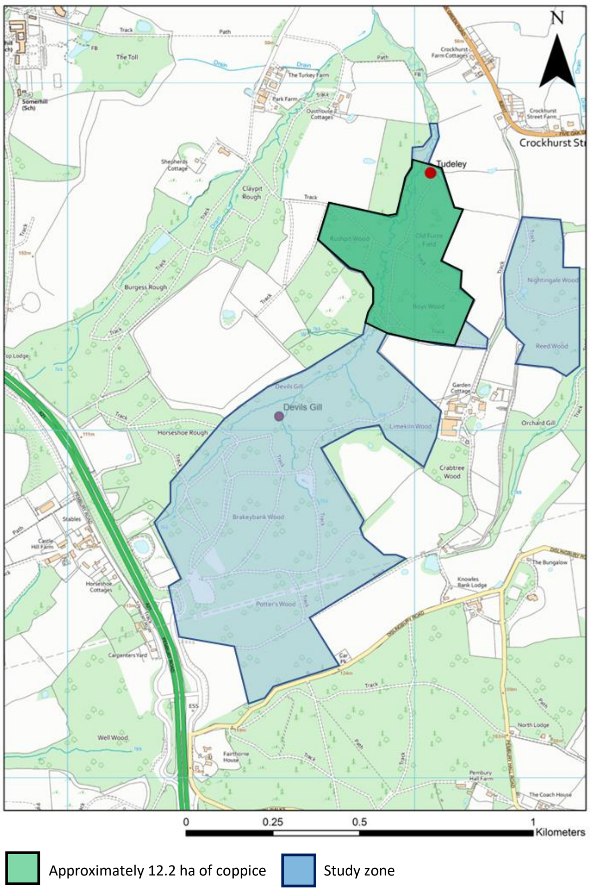


Figure 6.20 – *A visual representation of the approximate area of coppice needed (12.2 ha) to produce the charcoal purchased from the manor in 1350-51. Base map courtesy of Digimap OS Collection.*

needed from this landscape for Tudeley's charcoal supply, and the careful management required to ensure the regularity of this underwood.

'Olwode' is recorded in 1350, 1353 and 1354 as being purchased, alongside the ore where in 1353 for example 3 shillings was spent on the '*carriage of orestone and olewod for making 33 blooms*'. It is possible that this olewode was the same as dead wood and was used to make charcoal, possibly at the Tudeley site. Its

Table 6.6 – *Recorded quantities of charcoal supplied to the Tudeley Ironworks (calculated previously in section 6.6.1) against the estimated weight of wood required by the wood-colliers to produce it.*

Year	**From Records**	**Analysis**			
	Recorded charcoal quantities	Equivalent weight in kg	Weight converted to Tonnes (=1000kg)	Estimated Weight of wood required to make the charcoal in Tonnes	Total Hectares needed to supply the wood
1329-30	**Total:** 36 tens	10973	11	77	30.8
1331-32	**Total:** 41 tens	12497	12.5	87.5	35
1332-33	7½ tens	2286	2.3	16.1	6.4
	34 tens made of wood from the Chase	10364	10.4	72.8	29.1
	Total: 41½ tens	12650	12.7	88.9	35.6
1333-34	20 dozen	3556	3.6	25.2	10.1
1350-51	16 dozen	2845	2.9	20.3	8.1
	24 dozen from the manor	4267	4.3	30.4	12.2
	Total: 40 dozen	7112	7.1	49.7	19.9
1352	22 dozen 11 seams	4051	4.1	28.7	11.5
1353	5 dozen 8 seams	991	0.9	6.3	2.5
	2 dozen *(from previous year)*	356	0.4	2.8	1.1
	Total: 7 dozen 8 seams	1346	1.4	9.8	3.9
1354	14½ dozen 5 seams from the manor	2642	2.6	18.2	7.3
	8 ½ dozen from neighbourhood	1511	1.5	10.5	4.2
	2 dozen and 5 seams also bought in the neighbourhood	419	0.4	2.8	1.1
	9 seams remaining from the previous year	114	0.1	0.7	0.3
	Total: 26 dozen and 5 seams	4687	4.7	32.9	13.2

association with ore and not the charcoal, which was recorded as a separate item indicates that it originated from the same site as the ore, perhaps as deforested trees taken down to make way for mining.

6.7.2 - *Woodland management – the archaeological evidence*

Hazel coppice stools were a characteristic feature of the woodland at Tudeley however, the longevity of coppicing practices makes their dating hard to ascertain. Over-cutting of wood at Southfrith appears to have become a problem by the mid-16th century when a royal commission in 1555 investigated the woodcutting activities of Davy Willard, the ironmaster at Postern Forge, and observed '*how the woods already cut are closed and fenced for their continuance'* and shows attempts were made at this date to enclose areas of coppice from deforested areas (Chalklin 2004, 100-101). It is therefore possible some of the coppice visible today dates to this period, however, it does not exclude its presence at an earlier date.

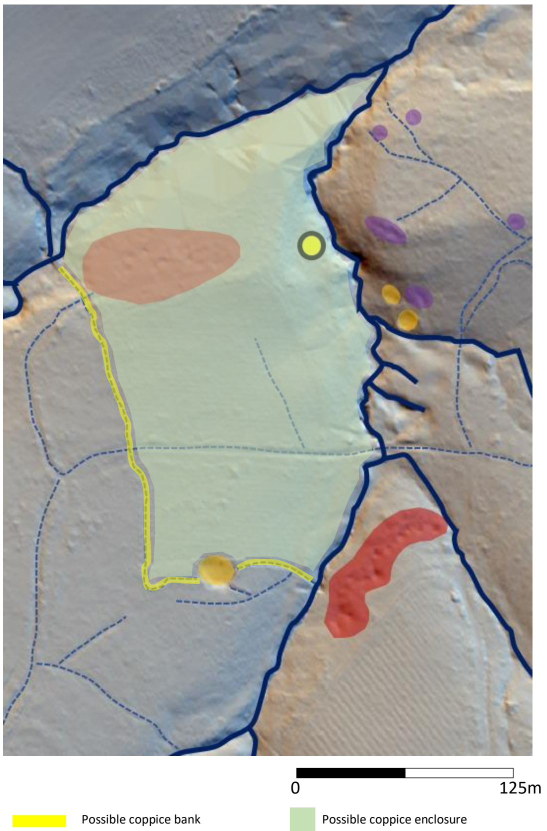


Figure 6.21 – *Route of possible coppice bank and the area of 3.9 hectares it enclosed, as it appears on LiDAR imagery. LiDAR data courtesy of Digimap OS Collections*

The sub-division or 'compartmentation' of coppice woods meant that coppice stumps were protected in the early stages of growth. This was achieved through the construction of ditches and earth banks topped with hedges designed to prevent deer and other livestock from entering (Rackham 1986 125-126;

Armstrong 1978). A possible internal coppice bank was visible at point H on the LiDAR (fig.6.5), running on a NW-SE alignment for 125m from the Devils Gill, before turning east towards a tributary stream approximately 250m east close to a second set of minepits (fig.6.5 B). This earthwork consisted of two parallel banks, each 1.2m wide, and a shallow central ditch (fig.6.21-6.22). Its exact purpose is unclear, and it could plausibly be a wood track connecting the minepits. However, similar earthworks have been observed by Bannister in the Weald (2007, 47) and she suggests they were former coppice divisions or extinct field boundaries. Assuming the Devils Gill and its tributary were used as natural boundaries to the north and east, this would have enclosed an area of c.3.9ha. Compartmenting woodland with these boundaries meant that during the coppicing cycle different enclosures could be harvested on a rotation. At Saffron Walden, Essex, the park was sub-divided into 17 quarters in 1336 and allowed for the sale of 10 acres of underwood each year (Rackham 1986 126).

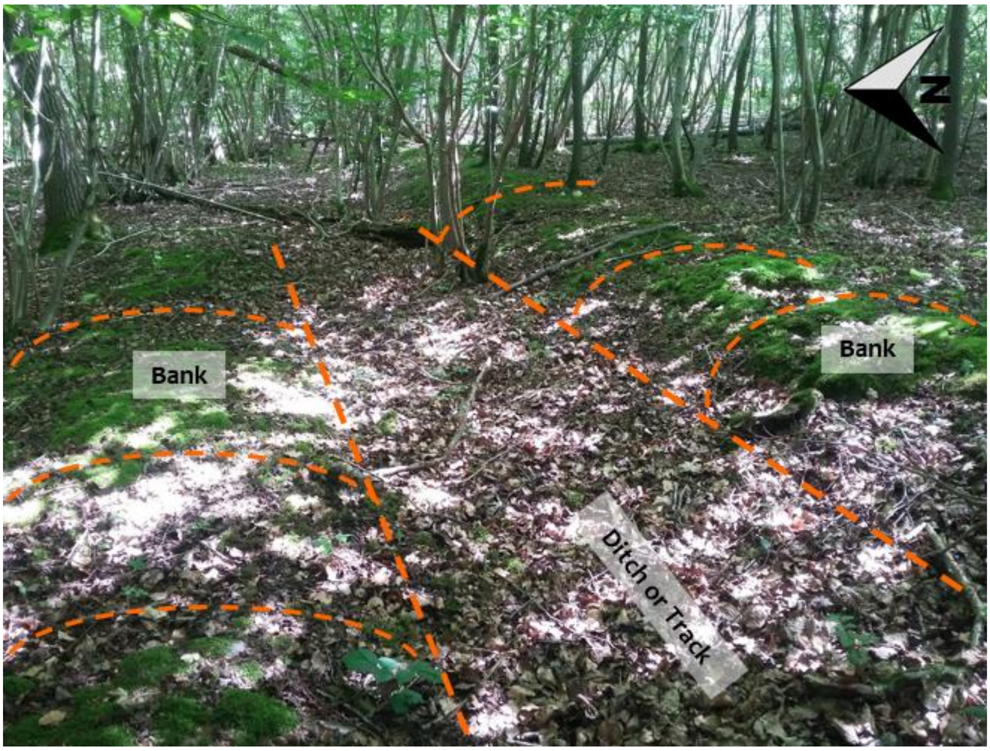


Figure 6.22 - *Remains of a NW – SE woodland boundary or possible track. It's absence from early maps suggests it pre-dates the 19th century. It has a bank on either side. The NW end terminates alongside the minepits. It is possibly an internal coppice boundary. (Author's image).*

Woodbanks were also a means of delineating the boundary of woodland and preventing the encroachment of livestock. Typically, these boundaries can be 6-12m in width with an internal bank and a ditch on the outside of the wood (Rackham 98-100) (fig.6.23). These were identified

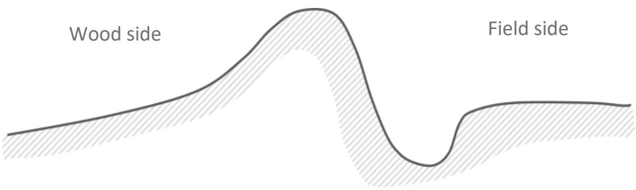


Figure 6.23 – *sketch profile of a woodbank based on Rackham (1986, 99) (Author's Image).*

to the north of the reserve on both the eastern and western boundaries of Smithy Wood. On the western bank of the Devils Gill, a ditch (2m wide) and bank (1.4m wide) followed a north-south trajectory, although its sinuous course means it runs alongside the stream bank to the north but diverting west further south to enclose a small platform on the opposite bank to the Tudeley Ironworks (fig.6.24). The remains of a laid hedge grew on top of the bank which included coppice stools of hazel, ash, and field maple.

Figure 6.24 - *Woodbank on the western bank of the Devils Gill. A coppiced field maple and ash can be seen growing on top of a bank while in front of this, on the outside of the wood is a heavily silted ditch. The yellow line highlights the typical woodbank profile this earthwork has. (Author's image).*

On the eastern boundary, a large, six-stemmed coppice stub of pedunculate oak stood atop a woodbank, its large base formed by repeated felling and re-growth suggesting considerable age (Madera 2017, 6) (fig.6.25). Stubs are created when a tree is coppiced at a hight of 1m resulting in a short trunk and crown of branches and were used to mark boundaries and referred to as 'marker trees' (Bannister 2007, 44). These boundaries demonstrate the importance of coppicing within the immediate landscape of Tudeley Ironworks and further analysis through a hedgerow survey may shed more light on their date.

Figure 6.25 - *An abandoned pedunculate oak coppice stub growing on a woodbank on the eastern boundary of Smithy Wood, approximately 180m south-east of the ironworking site at Tudeley. (Author's image).*

6.8 - The use of timber resources

6.8.1 - *'Timber' - The historical evidence for timber processing*

As well as charcoal, earthwork evidence demonstrated how timber had also been a valuable resource at Southfrith in past centuries, with the identification of three sawpits. In the accounts of 1343, when the ironworks were rebuilt, 5 shillings 10 pence was spent on *'making 1400 feet of board for the roofing of the said works'* 5 pence to employ two men for a day to make *'the laths and stanchions for the* *same'*, and 8 pence for *'carrying the timber'*. While it is not recorded where the timber came from, it can be speculated that it came from Southfrith. It is also feasible that the timber was planked on site into the 1400 feet of board.

6.8.2 - *'Timber' – The archaeological evidence for timber processing*

Figure 6.26 – *Reconstructed sawpit at the Weald and Downland Living Museum. The sides of the pit in this instance were boarded, while above the pit stood a frame to support the timber. (Author's image).*

The reconnaissance survey identified three sawpits across the study zone. Sawpits were used to process felled trees into planks and are frequently situated close to where the trees were felled (Bannister 2007, 47). A rectangular trench would be dug, and a frame erected to support the timber, which would be cut by two sawyers, one standing within the trench and the other outside the pit on the frame, each supporting a handle at either end of the saw (figs.6.26-6.27). Associated earthworks consist of elongated depressions around 3x1m with a spoil mound about 0.5m high to one side, which, if built on a slope was deposited downslope to create levelled ground (Bannister 2007, 48).

Figure 6.27 *(right) – Reconstructed sawpit. This example was covered by a timber framed building suggesting longevity of use. It is unclear how long the sawpits remained in use for at Tudeley. They may have been reused over successive seasons or dug temporarily to process timber felled from an adjacent tree. (Author's Image).*

Sawpits

The remains of a possible sawpit were identified in the centre of Boys Wood (2810191) 350m south of Tudeley Ironworks (fig.6.28 and fig.6.5 I). The pit, which was oval and 3.2x5.8m in size, was visible on the LiDAR image of the woods (figs.6.28-9 and 6.5 K). It had a depth of 0.7m and the excavated spoil had been deposited downslope of the west facing slope it was built into, to create a levelled working platform. The central position within the woods of this isolated sawpit is

Figure 6.28 *(left) – Sawpit located at the centre of Boys Wood. Scale = 1m (Author's Image).*

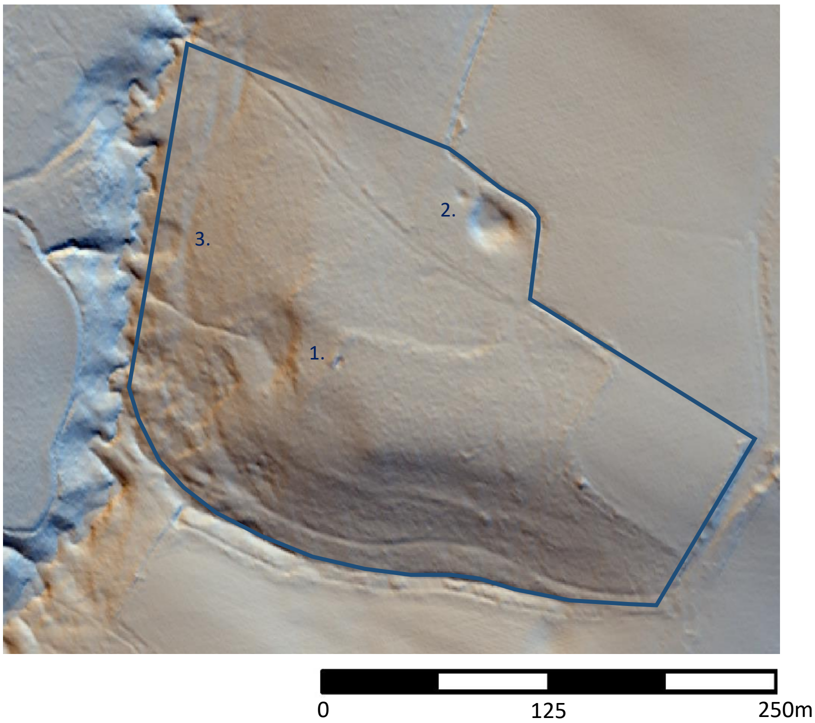


Figure 6.29 – *(right) LiDAR of the sawpit in Boys Wood (1.). The large pits in Boys Wood are located to the north (2) while the north-south track that heads north to the site of Tudeley Ironworks is to the west (3). LiDAR data courtesy of Digimap OS Collections*

significant and may suggest timber was regularly brought here rather than processed where it was felled, requiring the construction of a new pit each time.

A second sawpit was identified on the east bank of the Devils Gill at the Tudeley site, on the southern side of the confluence between the slag filled tributary stream and the Devils Gill (2708191). It was of similar dimensions to the Boys Wood example, at 4.4x2.2m in size, with a depth 0.8m and oval shape (fig.6.30). Erosion to the former vertical sides had left both sawpits with a 'cigar shaped' morphology and a shallow depth. The example at the Tudeley site is probably the *'small rectangular depression'* recorded by Straker (1931, 220) and the *'small circular depression'* found by Tebbutt (1979, 8). Sawpits are difficult to date, and little archaeological research has been carried out to establish an exact chronology. While the pit at Tudeley may not be contemporary with iron-production, the timber carried to the works in 1343 could feasibly have been planked into the 1400 feet of board on site in a sawpit like these examples.

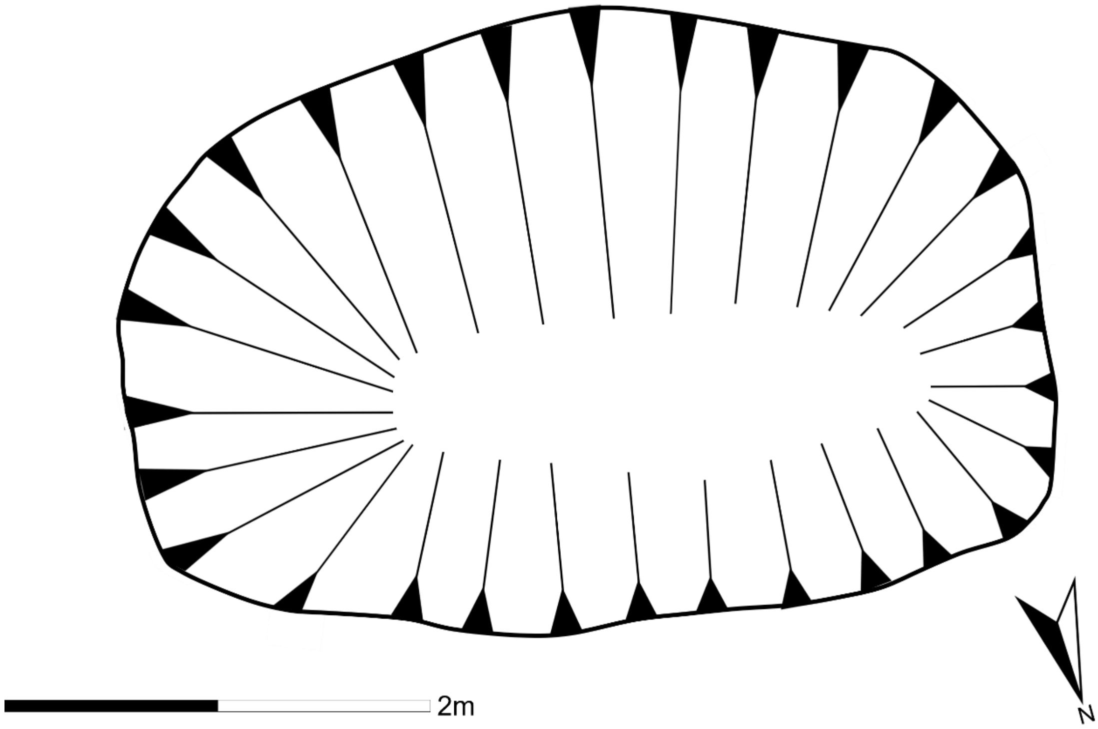


Figure 6.30 – *Earthwork survey of the probable sawpit at the Tudeley Ironworks site, between the Devils Gill and the confluence of the eastern tributary stream. It is cigar-shaped, elongated with curved ends on a roughly east-west alignment. (Author's Image).*

6.9 - Ore acquisition

6.9.1 - *The historical evidence for ore acquisition*

Ore is recorded in each year of the accounts, interchangeably referred to as 'stones' or 'oreston'. Expense is generally divided into the cost of digging the ore, its carriage to the works, and 'burning' (roasting) it. Ore was not recorded by weight, but by the number of blooms a given purchase could produce. However, experimental smelting, using the weights of charcoal calculated in Section 6.6.1 may in future allow the ore weight to be determined by adding different ratios of ore to the volumes of charcoal. Figure 6.31 shows the calculated cost of ore per bloom, which includes the cost of carriage and of burning it. Its price rose by 31% after the 'Second Pestilence' of 1348, however, within the two periods either side of the Black Death costs remained relatively stable, varying by no more than 13% between years 1329-1334 and 7% after 1350.

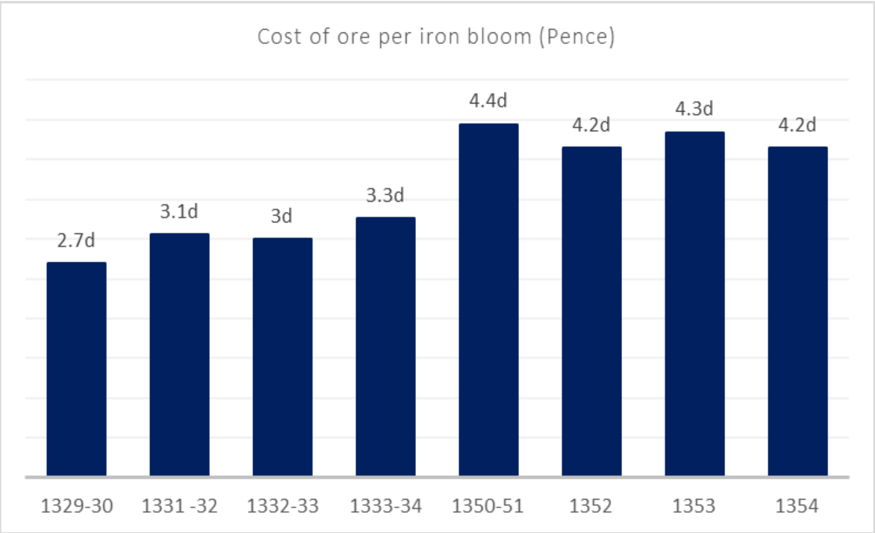


Figure 6.31 - *Calculated cost of ore per bloom, including the cost of digging the ore, its carriage and roasting it. Note: the accounts for the years 1353-54 do not record the cost of roasting the ore. Derived from data in Appendix A2.*

Ore was sourced from an unspecified location/s between 1329 and 1334, although the relative stability in costs during this period (which is also seen after 1350 when it was sourced from Southfrith) suggests a regular source, although whether this was Southfrith is unclear. In 1350-51, stones for 405 blooms were *'received from digging in the forest'* and were therefore sourced from Southfrith. Ore digging was evidently a separate industry and not one carried out by smelters at Tudeley, for in the same year a tunic was provided '*to the stone-digger by contract made by Thomas Judde'*, the term 'stone digger' distinguishing this individual in his role, much like the smelters were recorded as 'fore-blowers'. Between 1353 and 1354, ore was dug in '*the lady's forest'* and the 1354 lease made to Richard Colpeper entitles him to '*300 of oreston annually'* again from Southfrith (fig.6.32).

In 1354 the digging of 'stones of orestone' is divided into two entries, despite both costs equating to 3¼ pence a bloom and having been supplied from the lady's forest. One explanation for this distinction might be that they were acquired from different locations at Southfrith as new areas were exploited. Another possibility is that ore was acquired in bulk and that the records of ore from year to year do not represent the total of piecemeal purchases across the year, but a single bulk purchase and that in 1354 extra was required necessitating a separate record. This is supported by records of remaining stocks of ore which in 1350-51 comprised 158 blooms worth, 1353 6 blooms worth, and 1354 a further 6 blooms worth. Furthermore, the 1330s accounts imply surplus ore was sold by the Tudeley works including 300 blooms worth in 1332-33 and 400 blooms worth in 1333-34. The bulk purchasing of ore has implications about the frequency of ore digging, which may not have been a fulltime industry, but one carried out seasonally to supply the ironworks at the start of the year. Allowing ore to weather (e.g., in a stockpile), has the additional benefit of making it more friable (WIRG 2003). Therefore, a bulk purchase would have benefitted the smelters, while surplus stock could be saved for the following season or traded with other ironworks. The trade in ore with other ironworks is discussed further in Section 6.9.1.

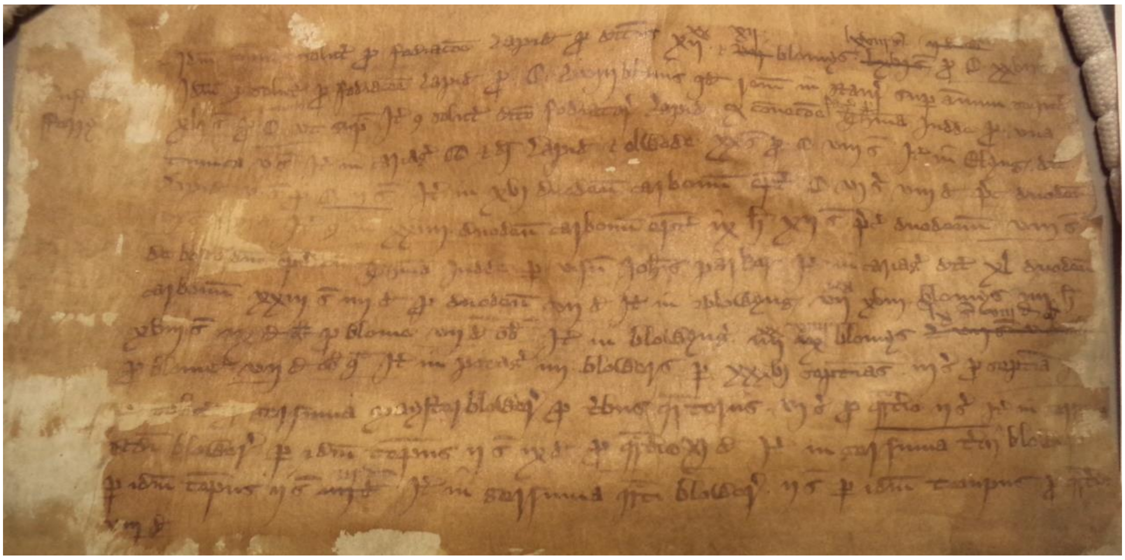


Figure 6.32 – *Extract from the account of 1350-51 which records the expenses of the various processes associated with ore and charcoal acquisition: '…He accounts for payments for digging stones for the said ~~247~~ 252 blooms ~~66s 2½d~~ 68s, at 27s for 100. For digging stones for the 158 blooms which remain in stock to next year 41s, at 27s for 100. To the stone-digger by contract made by Thomas Judde for a tunic 5s. In the carriage of 250 stones and olwode 20s, at 8s for 100. In burning the said stones 5s, at 2s for 100. In 16 dozen of charcoal bought 116s 8d, at 6s 8d the dozen. In 24 dozen of charcoal bought £9 12s, at 8s the dozen, bought from the lady's wood with Thomas Judde by the view of John Parker. In carriage of the said 40 dozen of charcoal 23s 4d, at 7d the dozen…' Photographed by the author with kind permission from the National Archives.*

The ore was subsequently taken to *'the hearth'* and burnt. The burning or roasting of ore is a practice which drives off moisture from the ore, while carbonates are converted to their oxides, before the ore is broken and placed in the furnace. This process is possibly recorded as *'conflandis'* (1331-2) translated as 'melting' or a more accurate translation being 'heating' or 'burning'; 'combustis' (1332-3) translated as 'by burning'; or 'elendis' (1329-30) which probably translates as 'burning' but could equally be 'to be sifted' or 'be eliminated' for there is a similar Turkish word for this 'elendi' and may relate to sorting the ore for purity and quality. Alternatively burning the stones may simply be referring to the smelting of the ore within the furnace (fig.6.33). However, the record of '*7½ tens of charcoals bought for making the blooms and burning the stones*' in 1332-3 does appear to make a distinction between smelting (making the blooms) and ore roasting (burning the stones) and if so, shows that both processes used the same fuel supply, presumably at the same location. This would parallel the evidence of an ore roasting hearth at Minepit Wood (Money 1971). An expense for ore roasting was not recorded in the later years of 1353 and 1354 and might imply it was carried out by the smelters themselves.

Figure 6.33 – *Biringuccio's 1540 illustration of 'Miners' tools, ore barrows, and baskets'. Biringuccio says '…powerful tools are required, like large hammers and iron picks, long thick crowbars, mattocks and strong spades, picks both with and without handles, and similar iron tools, all of fine and well-tempered steel…' (Mudd 1942, 24). The Tudeley accounts record various tools used by the works to process the ore which included 'two troughs bought to carry stones' and 'a hand cart' bought in 1350-51 and a 'hammer for breaking stones' in 1354. Image courtesy of Mudd (1942, 24).*

6.9.2 - *Ore acquisition – the archaeological evidence*

The geology of the Tudeley landscape was favourable for the exploitation of ore which could be extracted from both the Wadhurst Clay and Tunbridge Wells Sand that forms the mixed geology here. The ore comprises an iron carbonate called siderite and is found as nodules or thin seams in the lower strata of the Wadhurst Clay or within bands of clay in the Tunbridge Wells Sand (Hodgkinson 2008, 10). The reconnaissance survey identified eight locations that had evidence of past quarrying where ore and/or other minerals were obtained. These included minepits of a similar morphology to those in St Leonard's Forest (see Section 3.8), while others took the form of large pits which are frequently identified in the literature as marlpits but may have served other functions. Quarrying was also more opportunistic and involved excavating into the side of stream banks where ore seams had been exposed. Figure 6.34 and the LiDAR (fig.6.5) show their distribution across the study zone.

Devils Gill Minepits

Minepits were located on a spit of land between the confluence of the Devils Gill and a tributary stream, 25m from the Devils Gill Bloomery

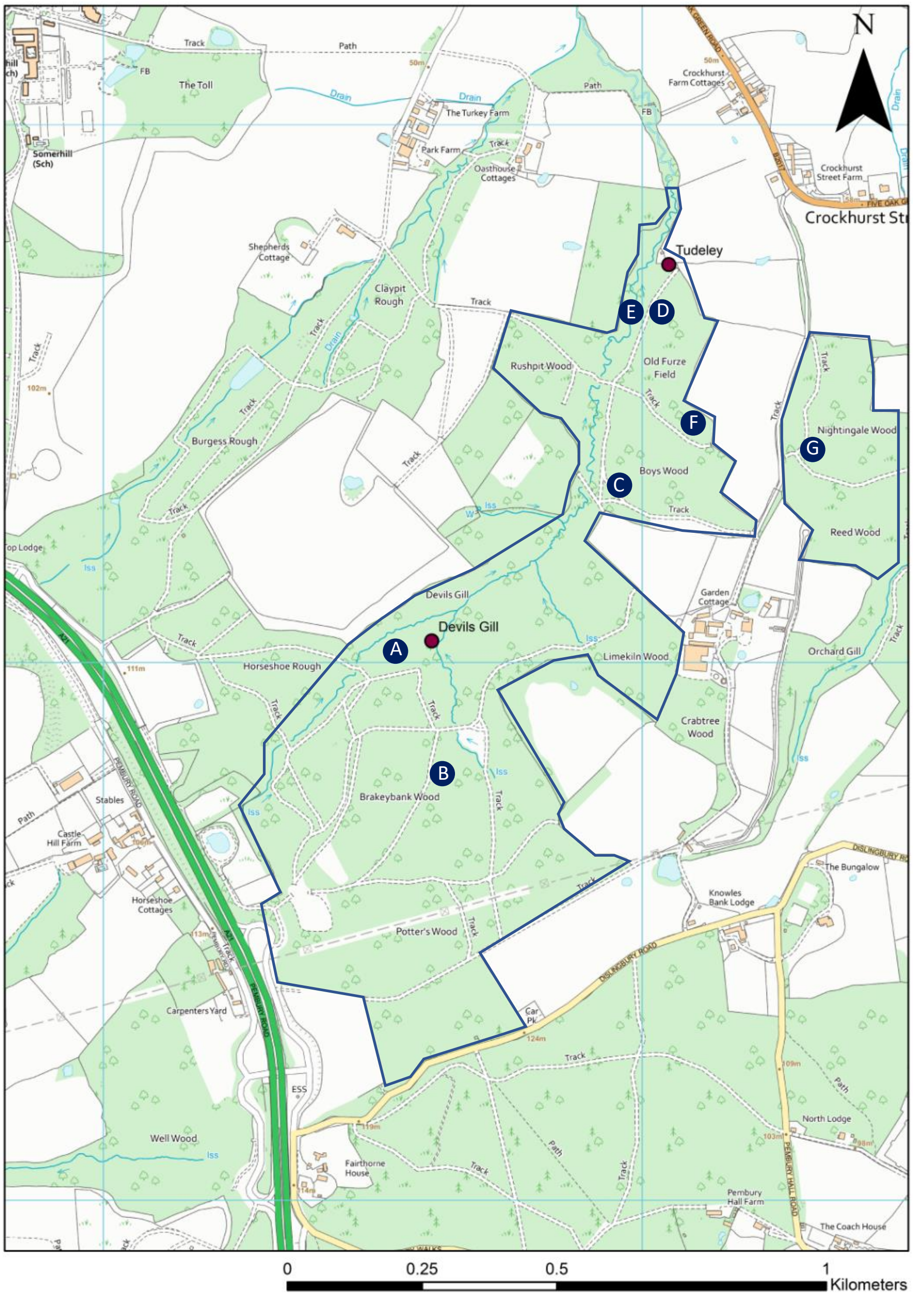


Figure 6.34 – *Survey area (blue on the map) at the Tudeley Woods Nature Reserve, with the positions of quarries identified during the reconnaissance survey. The sites of Tudeley Ironworks and the Devils Gill Bloomery are marked in red. A-D = minepits, E = stream bank cutting, F-G large pits probably dug for marl. Base map courtesy of Digimap OS Collections.*

site. A total of 27 individual 'shaft' minepits were observed here across the eastern bank of the Devils Gill, however there are likely to be many more obscured by vegetation. The majority were around 5m in diameter and 1m in depth, however there was some variation. Unlike the linear rows of pits recorded at St Leonard's Forest (3.8), there was no systematic placing of individual shafts and several of the pits intersected one another (fig.6.35-6.36). Unlike the St Leonard's minepits, there appears to have been an effort to backfill these pits after they had been exhausted of ore as there was little evidence of the crescent shaped spoil heaps typical of the St Leonard's pits. The shafts would have been excavated down to the ore seam and subsequently backfilled with the spoil from the previous shaft. Over time as the ground settled, this left shallow circular depressions, which in most cases at the Devils Gill, were around 1m deep. Geologically the minepits lie on a geological contact of the Wadhurst Clay and Tunbridge Wells Sand, both of which contain seams of siderite ore.

Figure 6.35 - *Minepit measuring 5m across and one metre deep. The bottom is now full of dead wood. Behind this minepit further pits can be seen. Once one shaft was dug, the spoil was used to fill in the previous pit. Over time as the soil settled, a depression earthwork would appear. (Author's Image).*

Figure 6.36 - *Three minepits at the Devils Gill that intersect with one another, following seams of siderite ore. (Author's Image).*

Ore seams were exposed in the stream bank 750m north at a depth of 2.8m (see below), however similar minepits at Sharpthorne, also on Wadhurst Clay reached depths of 20m to exploit 7 seams of ore (Hodgkinson 2008, 11) so it is possible those at the Devils Gill could have reached similar depths.

These minepits resemble similar examples at other Wealden sites, such as at Tugmore Shaw in Hartfield and at Sharpthorne, where radiocarbon dating indicated they dated from late 12th and 13th centuries (Hodgkinson 2008, 12-13). Hodgkinson suggests that the system of using shafts to extract ore was more favoured in the Middle Ages as a way of preserving agricultural land whereas in the Roman period larger quarries were used (ibid 2008, 12-13). It is therefore plausible that the Devils Gill minepits are of a medieval date rather than Roman. Based on the minepit’s proximity to the Devils Gill Bloomery, it would seem likely that these formed the source of ore for this site as well as potentially being the ore source described as located in ‘the lady’s wood’ for Tudeley Ironworks.

The Devils Gill minepits are visible on the LiDAR and stand out as a cluster of circular depressions (figs 6.5-6.6). A further group of approximately 21 pits are located 150m south-east, adjacent to a tributary stream and following a linear NE-SW trajectory. These could not however be ground-truthed due to vegetation coverage.

Tudeley mine pits

A series of four shallow pits, between 3.8m and 11.5m in diameter, with a depth between 1m and 0.15m, were identified 60m south-east of the Tudeley site. These are also visible on the LiDAR (fig. 6.5; D). Their shallow nature made it hard to determine their exact function, and it is possible that they simply represent tree hollows; and yet their size in all but depth parallels the minepits recorded 750m to the south. They are adjacent to a trackway that is terraced into the west-facing slope which continues north terminating 50m east of Tudeley Ironworks (fig. 6.37 and 6.5; C). This track continues south 350m before diverting east through Boys Wood and reaching the Southfrith Pale, potentially connecting the Tudeley site to both the minepits and the larger pits recorded in Nightingale Wood (see below).


Figure 6.37 – *North-South trackway running to Tudeley Ironworks and terraced into the west facing slope of the woodland. (Author's Image).*

Stream bank quarry cutting

The deep vertical bank of the Devils Gill, had in places exposed the rock strata on sections of its bank. This was particularly evident at TQ619446, 100m south of the Tudeley site where seams of sandstone, Wadhurst clay and siderite ore had been exposed on the western bank (figs 6.38-6.40). The siderite ore formed a seam 33mm thick between layers of Wadhurst clay, and eroded sections of siderite lay fractured within the stream bed (fig. 6.39). This seam had been exploited on the eastern bank leaving a rectangular cutting extending for 4.8m along the bank and 5.3m east away from the stream. From the top of the bank, the cutting had a depth of 2.8m but remained 1m higher than the stream bed, reflecting the need to only excavate as far as the level of the ore. The Wadhurst clay seam above the siderite would also have been a useful secondary product suitable for furnace construction.

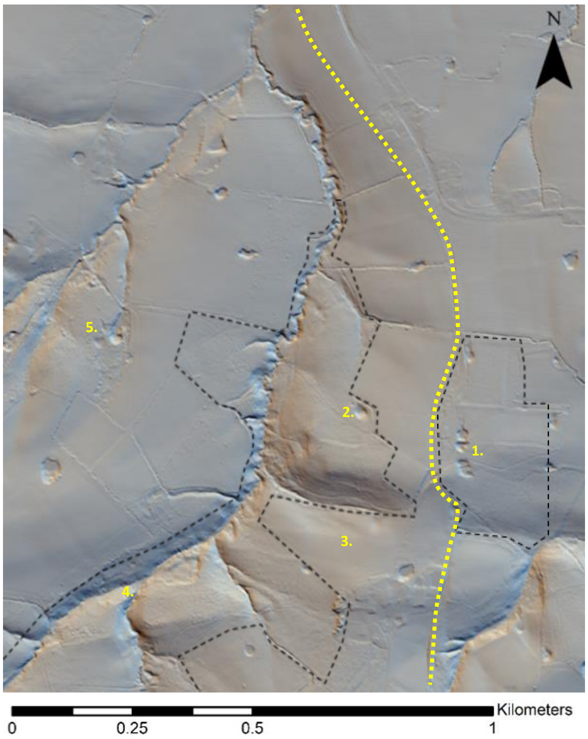
Figure 6.38 – *The western bank of the Devils Gill Stream opposite the stream bank cutting (fig.6.40). The seam of siderite ore can be seen projecting from the lower bank as a thin seam of c.3cm in width with fractured outer edges (see arrow). Overlying this are seams of Wadhurst clay and sandstone. (Author's Image).*

Figure 6.39 –*Fractured fragment of the seam of siderite ore exposed on the western bank of the stream, below a layer of Wadhurst clay. This piece had been eroded out of the bank and lay on the stream bed. It is likely that erosion of the stream bank and the resulting exposure of these seams first attracted the smelters or ore diggers to the locality, where they excavated the eastern bank to exploit the continuation of this ore. (Author's Image).*

Figures 6.40 - *Excavation into the east bank of the Devils Gill, forming a rectangular cutting 4.8x5.3m. Seams of siderite ore are exposed within the steep side stream channel on the western bank, and it is likely this cutting exploited the continuation of the ore to the east. (Author's Image).*

Larger Pits

Larger pits, ranging in size from 20m-60m, were recorded during the reconnaissance survey and are particularly visible on the LiDAR (fig. 6.41). They are likely to have been excavated across different periods and for a variety of purposes including clay, marl, brickmaking, stone, and it is also possible some were exploited for more than one mineral, making use of each geological strata encountered. Fifteen were located close to the Southfrith Pale, of which those in Nightingale Wood were among the largest. Here a series of five oval pits, each around 20x10m, were arranged parallel on a north-south alignment and connected to the Pale (60m west) via woodland tracks (fig. 6.5; F). Three of these pits appeared to have been dug into the base of a larger quarry and may indicate a secondary re-working of the pit, perhaps to extract a lower mineral seam such as iron ore. While the date of the pits is unknown, an established oak tree grew in the centre of the two parallel pits, suggesting they fell out of use at least prior to the 19th century.



1. *Series of 5 pits adjacent to the Southfrith Pale in Nightingale Wood*
2. *Two pits to the north of Boys Wood*
3. *Marl Pit Field – recorded on the 1838 Tonbridge Tithe Map.*
4. *Two further pits directly north of the Devils Gill minepits*
5. *Pits probably used for clay (not accessible) as suggested by the name 'Claypit Rough'.*

Figure 6.41 *(left) – Location of large pits surveyed across the study zone (outlined in black). The Southfrith Pale is displayed in yellow. LiDAR data courtesy of Digimap OS Collections*

These pits fall outside the Southfrith Pale. However, it is possible that ore was brought in from outside of the Chase, potentially from sources such as these, as the early years of the accounts, 1329-35, do not record the ore source.

A similar pit was recorded 200m west on the northern boundary of Boys Wood 18x20.5m which stood alongside a much smaller pit 4m to the west (fig. 6.42 and 6.41 (2)). It is likely that many of these larger pits were used for marl, a chalky clay that was extracted to improve acidic topsoil and is a practice recorded from the 13th century (Rackham 1986, 370-371). This use is also indicated by field-names such as Marl Pit Field directly south of the pits in Boys Wood. Others were probably for clay, particularly those shown on the LiDAR to the west, where the place-name 'Claypit Rough' suggests their purpose.

Clay

Clay is one resource that is not directly recorded in the accounts, despite its importance in the construction of furnaces and hearths. Specific references to

Figure 6.42 - *Facing south, the largest of the pits in Boys Wood, on its northern boundary. The pit resembles those recorded in Nightingale Wood. (Author's Image).*

furnaces are also absent from the accounts which suggests either they were robust and required infrequent replacement or, more likely they were rebuilt and repaired on a regular enough basis using materials at hand, and therefore not considered an expense necessary of record. However, in 1350-51, 16 pence was spent on *'making the hearth'* and again in 1353, 9½ pence was spent on *'making the hearth anew'*, which is possibly a reference to the furnace which would have required clay in its construction although alternatively it could be referring to a consolidation hearth. In 1350-51, when the works were rebuilt, 18 pence was spent on 'daubing the works', which again may have required clay. It is evident however that these expenditures are related to labour in completing these tasks rather than the materials. Clay was presumably acquired locally and incurred no cost, and it is plausible that overlaying seams of clay removed during ore digging in the forest were one such source.

6.10 - Ironworks in the landscape

6.10.1 - *historical evidence for other ironworks*

The survival of the Tudeley accounts risks over-emphasising the importance of Tudeley as an ironworks. The manorial records show other works existed which, while only briefly mentioned, were not necessarily any different in size or importance. In 1340 for instance a lease for an ironworks at Newefrith juxta Bournemelne was made to Robert Springet for £3, 6 shillings and 8 pence, which Giuseppi points out was of a greater value than the annual rent for Tudeley at 1 shilling in 1346 (Giuseppi 1912, 147-8). This might suggest this works at Bournemelne had a higher production capacity or was in a more favourable location. Today Bournemill is 2km south-east of Tonbridge and assuming the works were located here, the proximity to the town may have provided an additional trade advantage.

In 1332-33 stones (ore) for 300 blooms were sold from the Tudeley works and again in the following year when stones for 400 blooms were sold. Since the output of blooms at Tudeley for these years at 231 and 112 was lower than the potential output of the ore sold, it would imply the ironworks in receipt of this ore had a higher production capacity than Tudeley. Furthermore, the sale of ore (at presumably a loss) of what appears to have been surplus stock, at a lower price than the cost of ore purchased to make the blooms at Tudeley, would imply in these years Tudeley was less successful, perhaps as a result of competition with other works. Table 6.7 shows the cost of the ore per bloom for Tudeley and the cost of the ore per bloom for the surplus sold, and demonstrates a percentage difference in price of 126-120%. Assuming the ore was sold to a single works, and that the receiver used the entire of the stock in a single year, it might indicate a works with a capacity to produce more than 1 bloom a day, and thus a higher annual output than Tudeley. It is also possible that alongside smelting, Tudeley roasted ore as a secondary industry and traded this prepared ore to other ironworks. This might account for the sales of ore listed in 1332-33 and 1333-34.

Table 6.7 – *Author's calculation of the average cost of ore per bloom at Tudeley and the cost per bloom of ore sold, presumably as surplus, to other ironworks.*

Years	Cost of ore for Tudeley Ironworks	Blooms made at Tudeley	Average ore cost per bloom	Price of surplus ore sold by Tudeley	Potential blooms made from surplus	Average cost of ore per bloom
1332-33	41 Shillings 6 ½ pence	231 blooms	2.2 pence	12 Shillings	300 blooms	0.5 pence
1333-34	22 Shillings 6 pence	112 blooms	2.4 pence	20 Shillings	400 blooms	0.6 pence

The final reference to other ironworks comes in 1350, the year following the Black Death. Giuseppi (1912, 148) explains how the manorial records for Southfrith show several holdings that are unoccupied at this date as a consequence of 'the pestilence'. These included two 'fabrica' or ironworks of which Thomas Harry had formerly been the tenant. The rent on both was 1 shilling, which matches the rent of Tudeley (ibid 1912, 148). While this suggests the size and capacity of the Tudeley works was of no great difference to other ironworks within the Chase, it does show that certain ironworks were linked to one another under the management of the same keepers, in this instance Thomas Harry. While archaeologically, we view Tudeley as a 'site' or a single entity, this may not be a true reflection of its place within the landscape and the possibility that it was linked to other ironworks throughout Southfrith must be considered. The likelihood that Thomas Springet, keeper of Tudeley was related to Robert Springet of Newefrith juxta Bournemelne, provides one such mechanism (kinship) by which ironworks may be linked.

6.10.2 - *Other Ironworks – the archaeological evidence*

Other furnaces and forges in the vicinity are recorded in the 16th and 17th centuries, including Postern Forge (1553), Southfrith Furnace and Forge (1552-1575), Barden Furnace and forge (1574), Old Forge Southborough (1553) and Vauxhall Furnace (1552) (Chalklin 2008, 99-104; Cleere and Crossley 1985, 312-362). It is possible they were built on the sites of earlier ironworks, particularly in the case of Vauxhall Furnace, which may have been the site of Newefrith juxta Bournemelne recorded in 1340, However other works such as Postern Forge, built in 1553 appear to have been newly founded (Chalklin 2008, 99-100). Rats Castle Forge, which lacks supporting documentary evidence, was suggested by Cleere and Crossley (1985, 352) to be of a similar date to Postern and Old Forge, as one of five ironworks leased by David Willard in 1553. Herbert (1986, 52) however noted the presence of *'a great deal of bloomery-type slag'* possibly a water-powered bloomery from the presence of a tailrace and suggested it was a candidate for the site of Tudeley Ironworks (Herbert 1986, 52). The location of Rat's Castle, outside of the Southfrith boundary and at a distance of 1.6km from Tudeley Parish makes it unlikely to be the site of Tudeley. Furthermore, if Rats Castle was waterpowered, there is no reference to waterpower within the Tudeley accounts. It could however be one of the other works that are referred to in 1350 belonging to Thomas Harry.

A second ironworks of possible medieval date was south and within the study zone at TQ 6165 4395, 800m upstream of Tudeley Ironworks, on a spit of land where a tributary joins the Devils Gill Stream. The Devil's Gill Bloomery was first identified by WIRG in 1979 as part of their search to re-locate Straker's proposed site of Tudeley (Tebbutt 1979). The bulletin of that year describes how *'a small bloomery site was found at the top of a steep bank on the left bank of the* *stream…with slag spilling down the long bank into the stream'* (Tebbutt 1979, 8). In a subsequent article, Herbert (1986, 53) speculated that if Devils Gill Bloomery *'was on the Clare estate in the 13th century, it has equal claim to be the Tudeley bloomery'*. It was important to re-visit this site to ascertain its full extent, date, its connectivity with the surrounding landscape and resources, and its relationship to the ironworks discovered by Straker.

The Devils Gill Bloomery

The site recorded by Herbert was located a few meters south of the confluence of the Devils Gill and a tributary stream, both of which formed deep channel cuttings and natural boundaries within this landscape (fig. 6.43). The Devils Gill

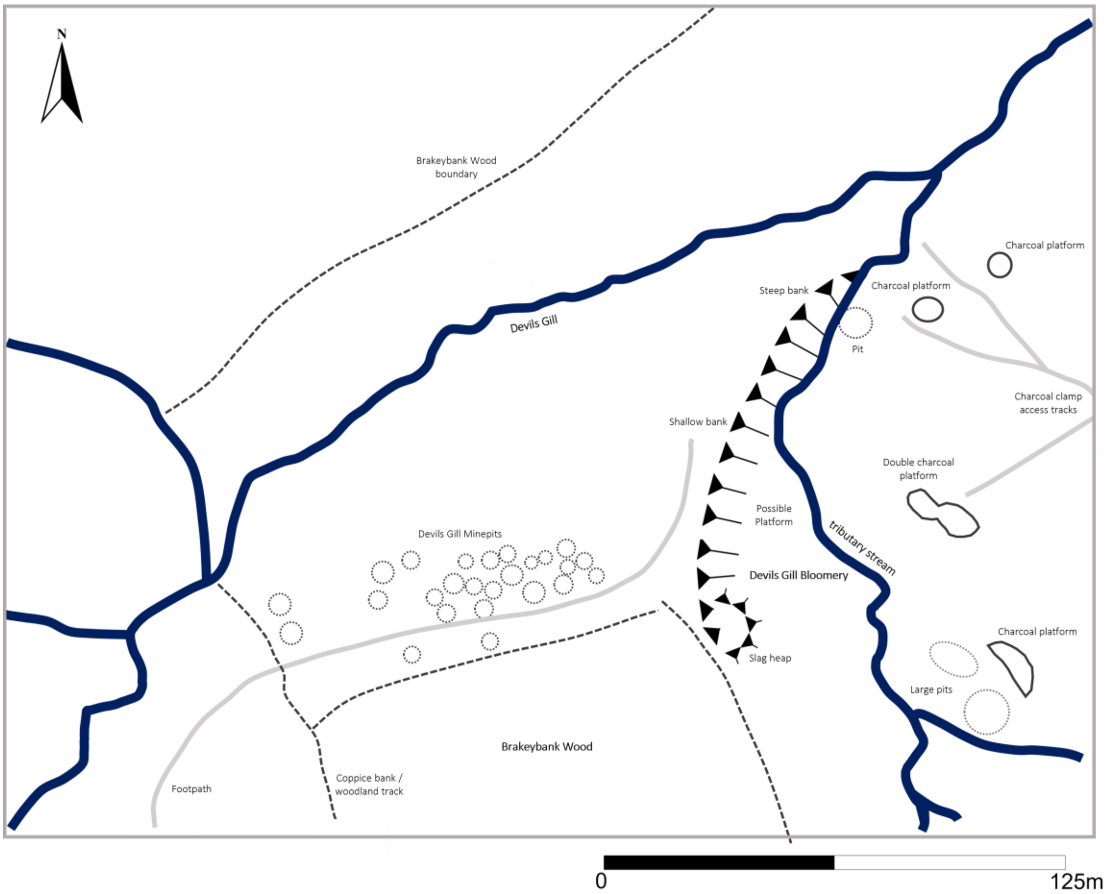


Figure 6.43 – *Sketch plan of the site of the Devils Gill Bloomery, located at TQ 6160 4400. The site is situated between the Devils Gill to the west and a tributary stream to the east, where a slag heap is present along with a platform at the stream edge. The Devils Gill minepits are present 50m west, while to the east on the opposite bank of the tributary, at least 10 charcoal platforms were visible on the LiDAR, and one (labelled as double charcoal platform) was identified in the reconnaissance survey. The coppice bank described in section 6.7.2 is 130m to the south-west. Sketch plan based on LiDAR data from Digimap OS Collections.*

minepits, also situated between these two streams, are 40m west of the site. Towards the confluence there is a steep bank to the west which ran down to the tributary. On the surface of this bank were small and medium sized slag fragments, possibly the remains of a slag heap at the top of this bank. At 40m south, the tributary meandered east and the gradient of the steep bank decreased to form a level platform bounded by a shallow bank on the western side and the tributary to the east which continued to form a deep channel. The level ground stood above the level of the stream encompassing an area of 6.3x9.6m (fig. 6.44). Deliberate levelling may have once taken place; however, it may simply reflect an opportunistic utilisation of level ground as a working platform. To the west of the platform, the remains of a slag heap were identified, which supports the likelihood of a furnace/s in the vicinity.

Figure 6.44 - *Facing East. Possible working platform at the Devils Gill Bloomery. The Devils Gill stream is in the foreground of the photograph (east) while the slag heap is to the west behind the platform. (Author's Image).*

The slag heap covered an area of 10x11m, over a projection out from the low bank in the west, possibly formed by buried deposits of slag, that terminates

Figure 6.45 - *(left) A tree throw reveals more deposits of slag from a greater depth. These samples are larger and suggest larger slag fragments were dumped here rather than being carted away. (Author's Image).*

Figure 6.46 - ***(right)*** *Further fragments of slag across the surface of the bank. They probably represent the erosion of a slag heap here. (Author's Image).*

18m from the stream channel (figs 6.43 and 6.45-6.46). Either the slag had been deposited against the low bank, or it had been tipped from the higher ground above, which would suggest the furnaces were further west. Slag had been exposed by a tree throw and the assemblage was characterised by numerous small fragments of smelting slag, 2-5cm in size, and less frequent medium and large slags. The slag deposits continued westwards, scattered across a more gently sloping bank beyond the level ground.

The majority of slag was Type 2 tap slag and had typical liquiform appearance with runnels (fig. 6.47). One fragment had vitrified as a vertical flow from the tapping hole, resembling tap slag examples from the Pippingford experimental smelt (Section 4.7.7). Others formed small 'droplets', possibly from early runs of

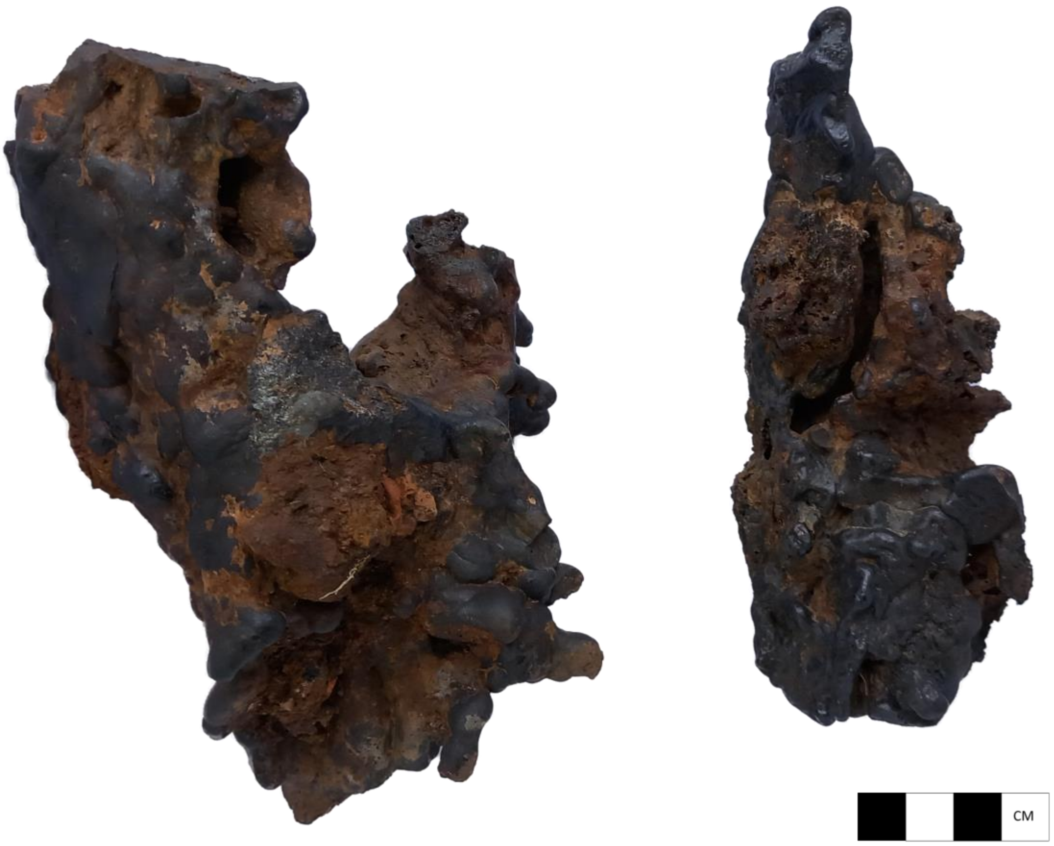


Figure 6.47 – *Tap slag that appears to have run out of the furnace from an elevated position before solidifying and mirrors examples from Pippingford experimental smelt. (Author's Image).*

slag escaping through cracks in the furnace or its tapping arch. Vitrified clay was also found with a glassy surfaces in colours varying from olive green to dark purple. Cleere and Crossley (1985, 50) suggest this clay, found on other Wealden sites, may have formed part of the material used to block the tapping arch of the furnace and that the glazing was caused through contact with very alkaline wood ash on the interior of the furnace (fig. 6.48). A single fragment of roasted ore was found on the exposed slag head with a red surface discolouration suggesting ore roasting took place here.

Figure 6.48 – *vitrified refractory material, with green glaze possibly caused with contact with alkaline wood ash within the furnace. (Author's Image).*

6.11 - Discussion

The combined use of historical and archaeological evidence has demonstrated how Tudeley Ironworks formed part of a landscape of interconnected industries and skilled personnel. it is easy to overlook the skillset of the wood-colliers and stone diggers who were as equally specialist in their industries as the smelters and smiths were in theirs. A charcoal clamp, while on the face of it a rudimentary structure, required care in its construction to be suitably airtight and allow wood to carbonise but not to burn. Such a process could easily go awry, and the slightest oversight result in the loss of several tons of valuable coppiced wood, grown and cared for over as much as 20 years, along with several days of labour. This, like smelting, was a process that had little margin for error. Likewise, the stone diggers needed meticulous knowledge of the landscape to know where best to extract the ore, no doubt recognising clues such as exposed seams in stream banks. Underestimating the quantity of ore that could be procured in a season would have had a knock-on effect on the annual bloom yield of the ironworkers and in turn their purchases of charcoal. These woodland industries were both labour intensive and unforgiving when conditions were unfavourable and the symbiotic relationship that they had with one another meant all faced collective risk.

Skills would have been passed through generations, with family groups such as the Springet family engaged in producing iron. This is something also reflected in the surname of John Parker, the Forester – probably inheriting his surname from his father, grandfather, and even great-grandfather, who like him were employed in the management of the forest. It could equally likely be a name John, acquired from his role of 'Forester' at Southfrith, demonstrating the impact woodland industries had on the very identity of the those employed in the Chase. Other individuals remain anonymous in the accounts, for example the unnamed ‘Stone digger’ in 1350-51, while other craftsmen, such as Henry Jon the bellows maker is specifically named in 1353. Could this suggest some degree of hierarchy between industries and personnel throughout the Chase? If the definition of a centre of production is viewed from a social perspective, then social differentiation based upon one’s profession is arguably a defining trait.

Seasonality was evidently a factor all industries had to consider, for woodland management strategies such as coppicing and charcoal-making were limited to the winter months. Ore too appears to have been dug seasonally, judging by the evidence of large orders and not piecemeal purchases in the Tudeley accounts. The ironworks across the Chase therefore had to either stockpile enough fuel and ore to see them through a season or else trade with other works, something recorded in 1332-1334 at Tudeley. In these years the smelters at Tudeley presumably made a loss on the ore they sold, which cost the recipient far less per bloom than the Tudeley Works had initially paid for it. We must consider under what circumstances this occurred. Was it an over-estimation of predicted bloom output on the part of the ironworks or did an unanticipated change in circumstances affect their capacity? Collaboration between ironworks is probable when considering family groups working in the industry, such as the Springet family with a Robert Springet leasing the forge at Newefrith juxta Bournemelne in 1340 and Thomas Springet as keeper of the works of Tudeley In 1350 (Giuseppi 1912, 147-8).

The existence of other ironworks is of particular importance in the classification of centres of production. The documentary evidence indicates that at least 3 other works were contemporaries of Tudeley. It must not be assumed that Tudeley was of any greater importance than the others based on the survival of the documentary accounts, for it appears Newefrith juxta Bournemelne was the more valuable works, commanding a rent of £3, 6 shillings and 8 pence in 1340, compared to the 1 shilling at Tudeley 6 years later (Giuseppi 1912, 147-8). Furthermore, if the sales of ore from the Tudeley works in 1332-1334 went to one buyer, it would suggest the receiver operated a works with a far higher production capacity than Tudeley and potentially more than a one furnace in operation. Thomas Harry leased two ironworks suggesting an element of entrepreneurship of tennants to maximise output of iron, however their equal rent to Tudeley suggests they were both of a comparable size.

The reduced lease of Tudeley in 1346 could however be evidence for a fall in demand for iron at this time. The 'Second Pestilence' appears to have left the two 'fabrica' of Thomas Harry unworked by 1350 (Giuseppi 1912, 148) and demonstrates the detrimental impact that external factors had upon industries at Southfrith. Despite this, the average cost of blooms at Tudeley increased from 1s. 4d (1330s) to 3s. 5d (1350s) (Hodgkinson and Whittick 1998, 15), showing at least some works benefitted from an increase in the demand of iron after the Black Death – although this went hand in hand with a rise in the price of charcoal and ore.

To summarise, the documentary and archaeological evidence collectively illustrate the industrial heritage of Southfrith in the 14th century. While the historical sources tell us of a charcoal industry and ore digging and reveal the names of those employed within the Chase, individuals who typically would remain anonymous archaeologically; it is the addition of the reconnaissance survey that allows the physical remains of these industries to be identified. The pits, platforms, overgrown coppice stumps, and long forgotten routeways form the lasting evidence for these trades. The complexities of dating such features is a challenge for these may have been created in succeeding centuries after the Tudeley Ironworks had been forgotten. It highlights the need for further research into their chronology through consideration of their morphological characteristics and with the assistance of radiocarbon dating in the case of charcoal platforms. Nevertheless, these earthworks, whenever they date to, show these industries existed here and reflect traditions passed down through generations of forest workers.

Chapter 7: Centres of Production – Tudeley and Roffey a Comparative Perspective in relation to Wealden Iron-Production

7.1 - Introduction

This project has sought to demonstrate how the combined use archaeological and historical evidence can provide insights into Wealden iron-production in the 14th century. While archaeological evidence informs us on the site morphology, the technology used and the ironworks place within, and reliance upon, the wider landscape economy; documentary accounts allow us to associate these remains to the smelters and smiths and the products they made. They also enable an assessment to be made of the broader economic, social, and political importance iron and its trade had upon medieval England. The existence of an iron industry in the Weald by the 14th century, which the accounts record supplied both local and distant market demands, raises the question of the nature of these production sites. While the term ‘centres of production’ can be used to describe these sites, this project has demonstrated these centres can not necessarily be defined under a standard set of criteria. As previously discussed, the term ‘centre of production’ conjures up images of industrialisation, mass production, consistent outputs and a specialist workforce. The term impresses the notion of universal traits between centres in terms of their morphology, size and location. The dictionary definition of a centre is ‘a nucleus or focal point’ and ‘a place devoted to a specified activity’ (Schwarz 1999, 166). While each are valid, the evidence from Roffey and Tudeley Ironworks calls for a more nuanced definition, beyond one that simply considers economic parameters of scale, industrialisation and specific activities, and does not assume that every centre conformed to the same set of defining criteria.

This is not to say economic parameters in defining centres of production are not important. Clearly in their simplest form, Tudeley and Roffey both existed to produce iron and meet a specific demand, be it at a local level or national level tied in with wider political or military events. And yet both sites differ somewhat in their scale and output. The archaeological evidence demonstrated Roffey's nucleated morphology suggestive of a community of ironworkers engaged in specific stages of the production process, which included smelting and smithing. Tudeley on the other hand was far smaller in scale and its workers were only employed in producing the iron blooms. However, Tudeley's connections to other ironworks through trade and family groups and its placement within a manor meant it formed part of a wider dispersed network of smelting sites with the smiths in the early part of the 14th century based at Tonbridge. On economic parameters alone, the dictionary definition of a centre of production is too vague and neglects the other aspects of these sites that gave them prominence. While frequently in archaeology production centres can only be defined on economic grounds, from the landscape traces, site morphologies and artefactual evidence that remains, the historical accounts preserved for Tudeley and Roffey allow further dimensions of these sites to be studied. These include the relationship to other industries and the kinship ties and social hierarchy that existed between the personnel. Arguably had Tudeley been found as an unrecorded site, its central importance within the manorial economy of Southfrith may have gone unrecognised and its personnel forgotten.

This chapter will make a comparison between Roffey and Tudeley Ironworks to define centres of production both at an economic level but also by the social dynamics both sites present. The survival of the accounts means that unlike other contemporary ironworks, the social aspect of ironworking can be incorporated alongside an economic assessment.

7.2 Defining a centre of production: an economic perspective

Processes

As the process diagram illustrated (see Chapter 1 fig.1.12), iron-production is split into a two-stage process of smelting and smithing, each encompassing various stages and skillsets. It must not be assumed that both stages were undertaken by the same individuals, or at the same location. Considering location, smelting in the case of the Tudeley site was relatively remote, distant from nearby settlement and at the edge of the Southfrith Pale. Tudeley's site can be seen as a marginal location, not just in terms of its physical placement but also from a societal perspective, away from people and invisible within its landscape. Other Wealden smelting sites show a similar 'marginal' pattern, for instance Newefrith juxta Bournemelne, also within Southfrith, was positioned on far western edge of the Pale, while Minepit Wood was only accessible by a remote track (Money 1971). The Devil's Gill Bloomery is even more isolated and set deep within the forest. It is perhaps the secluded nature of these works, hidden amongst the forest along narrow streams, that led to more fanciful placenames such as 'The Devil's Gill' by those outside the Chase and restricted in access by its Pale. They potentially observed the smoke emitted from the furnaces or the glow of the hearths through the trees.

Of course, such marginal locations can be interpreted on practical considerations, for being located close to the resources on which the smelters relied upon has obvious advantages. However, the 1334 accounts at Tudeley record the purchase of charcoal from the neighbourhood, and therefore outside of the manor and indicates supplies such as fuel were still brought to the site from greater distances. Furthermore, ore still had to be brought nearly a kilometre from the minepits in the south. On this basis the argument that smelting sites were selected for their proximity to resources is only half the story, for if materials were brought to Tudeley, there is no reason for it not to have been built closer to settlement. The same is true at Roffey, for like Tudeley it lay on the margins of the forest and the routeways leading from the site to the St Leonard's Minepits 1.6km away are testament to the bringing in of resources.

There therefore must be other reasons for the marginality of smelting sites and raises the question of if, and how, these hidden ironworks can be considered centres of production? Perhaps they cannot, or at least not on their own, for it is clear from both the Tudeley accounts and the landscape evidence at Roffey, that iron-production formed part of a wider series of connected industries that included coppicing, charcoal production, and ore extraction. Smelters were by no means alone in their forest settings, but worked alongside the foresters, colliers, stone diggers and sawyers who in turn relied upon the forest and its resources for their livelihoods. These were skilled workers who held mutual dependency on their neighbouring industries, for if the stone digger failed to locate a suitable seam of ore, no iron could be smelted, while if the colliers charcoal clamp failed, several years of carefully managed woodland resources would be wasted, and the furnaces could not be fuelled. Furthermore, an absence of iron would impede the work of the smith and ultimately the production of the iron picks, shovels and saws required by the stone diggers, sawyers and colliers. The impact of the Black Death on the population of these skilled woodland workers is only too obvious from the Tudeley accounts and the resulting inflation in the costs of raw materials that resulted. To omit iron production sites as centres of production simply on their marginal location would be wrong, for the forest and forest margins where these sites were located were not the tranquil landscapes we see today, but alive with interconnected and inter-reliant industries of skilled personnel, applying careful management practices to sustain the resources they relied upon. These may not be 'centres of production' in the over industrialised sense outlined at the beginning of this chapter, but arguably represent centres of production in accordance with the needs of the time.

Smelting is however only half of the process to achieving the horseshoes and arrows recorded at Roffey and Horsham. As noted previously, smithing is frequently separate in both location and personnel, to that of smelting. Smithing sites are frequently found within settlement zones and arguably the more 'visible' locations. The distinction between smithing and smelting is clearly illustrated in the Lowy of Tonbridge where ironworks such as Tudeley restricted its operation to smelting, while smithing is recorded at the heart of the Lowy at Tonbridge Castle. Here in 1325, it had its own forge containing '*6 bellows in bad repair, 6 sets of tuyeres, 3 hammers, a chisel, an anvil, another chisel, a two-pronged instrument, a spike or punch, an iron basin for iron, an iron file and branding iron with which to mark the Kings cattle'* (Translated by Page 1932, 386). The Castle's central position within the Lowy is important in understanding the wider function of iron-production to the manor. The Castle would have facilitated its trade and exchange and allowed the re-distribution of iron products made by the smiths to across the de Clare's estates. The stockpiling of iron at castles is also recorded at Pevensey Castle, where in 1301 hinges for doors and windows were made '*from iron found stored in the castle'* (Salzmann 1906, 14). If a centre of production is defined by its broader connections beyond local exchange, in this instance it encompasses not a single site like Tudeley, but the collective sites across the Lowy, while the castle formed the point at which iron was collected and re-distributed.

Middlemen

Tonbridge Castle not only functioned as a place in which the product of the smith could be made and redistributed, but also as a central collection point for the blooms, which in turn were processed and re-distributed. It is recorded that in 1323 '*26 pieces of unworked iron called blomysen (blooms)' were consolidated into 423 bars of piece iron and sent to Porchester* (Translated by Page 1932, 386). This is suggestive of the economic mechanisms for the trade and exchange of iron within a manorial context. While it could be argued the Castle represents the 'central place' in this instance, perhaps a more fitting description of its role was as a middleman facilitating the collection of iron from across the Castle estates and redistributing it into the hands of the smiths and ultimately wider exchange networks.

The importance of middlemen is easy to overlook, particularly during a period when so few historical sources record their existence. However, their presence is suggested in 1337 when the horseshoes sourced from Roffey were brought to Shoreham and added to '*3000 others and 80000 nails'* (Durrant Cooper 1865, 117). It is not recorded where the 3000 other horseshoes came from, but it is possible they represent the collective total from several ironworks in the Weald rather than the output of a single smith, and if so, such a collection would have required an intermediary – the middleman, to facilitate their acquisition and re-distribution. It is plausibly middlemen that maintained trade an exchange networks of iron blooms between the smelters and the smiths both at a local and regional level. Further evidence for their existence comes from a murage grant of

1266 that entitled residents in the town of Lewes to raise tolls on the iron coming in from the Weald to pay for the repair of the town walls following the Battle of Lewes two years earlier. The toll meant that every cart '*laden with iron…for sale'* paid one penny, and every '*horse-load of iron'* paid ½ penny (Lower 1849, 177). It seems unlikely that a smelter would stockpile their iron to the extent they filled cart loads, for while buildings such as the one at Tudeley would have enabled the securing of some blooms, retaining a large stock is somewhat of a risk. This therefore supports the likelihood that middlemen, or traders, collected iron from bloomeries across the Weald and took it to Lewes, where either it was traded to smiths or perhaps taken on to the coast. Even until more recent centuries, the Weald was noted for its inaccessible terrain, impassable roads and remote isolated settlements and it is within this context that middlemen forming the intermediaries in the movement of iron from smelter to smith would have been of particular value.

Collaboration with others

The symbiotic relationship between smelting and smithing is well illustrated within the Lowy of Tonbridge. In 1323 it is recorded that '*26 pieces of unworked iron called blomysen (blooms)' were consolidated into 423 bars of piece iron at the castle* (Translated by Page 1932, 386). While it is not recorded where the blooms were sourced, Tudeley and other ironworks throughout the Lowy are obvious candidates, particularly given that in the years 1329-1334, Tudeley was under the management of the manor. On this evidence, Tonbridge might be seen as a centre of production for smithing, with smelting sites like Tudeley forming satellite production sites. However, this is arguably too simplistic and the broader function of the Castle and its Lowy need to be considered. Ward (1980, 129) explains that a castle was reliant upon its Lowy to supply the necessary goods and services to support it. Goods in this instance included iron brought from the Lowy to maintain the Castle, however iron would have been part of a wider array of goods and services.

While smelting and smithing were separated by location at Tudeley, this does not appear to be the case at Roffey, where evidence in Zone 1 showed smelting and smithing coexisted within a nucleated settlement context. This is not to say they were all operating as a single collective enterprise. The evidence of former roadside tenement plots suggests smithing and smelting formed separate industrial sites on several of these tenements. It is highly probable however that there was some level of collaboration, for while smelters and smiths still represented distinct trades, their proximity would have allowed the smelters a ready market for their blooms and the smiths a nearby source of iron. Smelters were just as dependant on the smiths for their tools as the smiths were for the iron to make them, as illustrated by the lists of iron tools and building materials recorded in the Tudeley accounts – these were not made by the smelters from their blooms, but bought in as finished goods. The benefits of smelters and smiths working alongside one another might also have enhanced the reputation of the settlement at Roffey as the place to go to source iron and iron goods. An urban parallel of this would be the ‘quarters’ in towns which today form locations distinguished by the prevalence of a certain industry. In these instances, traders mutually benefited from the shared reputation and therefore the formation of clusters – or ‘centres’ of ironworkers may have allowed for similar benefits.

Roffey and Tudeley therefore present somewhat different patterns. Tudeley’s existence, at least at an early date, was tied to the wider requirements of the manor, with a symbiotic relationship between it, the other dispersed ironworks and the Castle smiths. Roffey however formed a nucleated centre in which neighbouring smelters and smiths could work alongside one another, trade, and benefit from a shared reputation. Cooperation would have had many mutual benefits for Roffey, particularly for sourcing raw materials from St Leonards Forest and in fulfilling large orders. Arguably the need to supply 1000 horseshoes in 1327 represents an order far too large for an individual smith to fulfil in a limited time frame. Of course, stockpiling of goods may have taken place, and yet it is difficult to understand why such a stockpile would have originally been kept and if so, where would these iron goods be stored – an important consideration considering their value of £4 3s. 4d (Lower 1849). When one considers that in 1329-1330 the issue of the Tudeley Works came to £8 3s 8½d, the 1000 horseshoes from Roffey equate to roughly half a year's earnings, which would seem a considerable value for a single smith to be stockpiling. At the very least, a large order such as this would also need an equally large supply of iron blooms, and to assume this came from the stockpiling of many valuable iron blooms, seems just as improbable. It must also not be assumed that the record of 1327 was the only order for horseshoes, particularly when considering the probability that the order for 6000 arrows in 1338 'made near Horsham' were also made at Roffey (Durrant Cooper 1865, 17). The arrows were purchased for £14 10s. 4d., which also represents a cost exceeding the amount a single fletcher and smith is likely to have produced. It therefore is more likely that these orders are the output of several smiths and smelters, who could be called upon to collectively fulfil the required amounts.

The terminology used in the 1327 order also supports the notion that it was made by a cooperative of individual smiths rather than at one independent works, for it states the horseshoes were transported from '*Le Rogheye, near Horsham, where they were made*' (Durrant Cooper 1865, 17). The use of 'Le Rogheye' is important here for had they come an individual smith we might expect them to be named rather than the settlement. It is far more suggestive of a place, or 'centre' in which iron and iron products were produced. Furthermore, the archaeological evidence, in particular the small workshop buildings identified in the west of Zone 1 and the smithing workshop excavated in 1985, are too small to suggest workshops with the capacity to fulfil large orders but support the notion of small-scale smelting and smithing working collectively to fulfil regular or irregular large orders.

To understand the frequency of orders for iron goods and the importance potential centres such as Roffey had in fulfilling them, it is worth considering the wider documentary evidence on supply and demand of arrows across medieval England (fig. 7.1). The Close Rolls of Edward III record various orders issued to the Sheriffs throughout England for the second half of the 14th century, instructing them to deliver sheaves of arrows to the Tower of London. The first consideration is whether these arrows were supplied with or without iron heads. While this detail is not always clear, some accounts are specific such as in February 1371 when the Sheriff of York was ordered to supply arrows with '*good and seasoned wood and not of green wood'* and *'to be made ready with steel heads'* (Translated by Maxwell Lyte 1911, 207-212). A close roll of 1341 distinguishes between '*steeled arrows'* and *'non-steeled arrows'* while the Sheriff of Gloucester for this year was expected to supply '*1000 sheaves for arrows'*, listed separately from the '*2000 heads for arrows'* (Translated by Maxwell Lyte 1902, 46-58). Of the three orders presented in Table 7.1, The Sheriff for Surrey and Sussex was among those expected to supply the higher orders of up to 1000 sheaves by 1371, slightly more than the 800 in the 1360s (Translated by Maxwell Lyte 1911, 207-212; 1909, 9-

19). Seven other Sheriffs also had to supply up to 1000 sheaves, however of these it is only Surrey and Sussex that supplied arrows for all three dates (ibid). The high orders are suggestive of the regional importance of the Weald in producing arrows and of an active iron industry supplying goods destined for wider exchange networks. It is within this context that the necessity of production

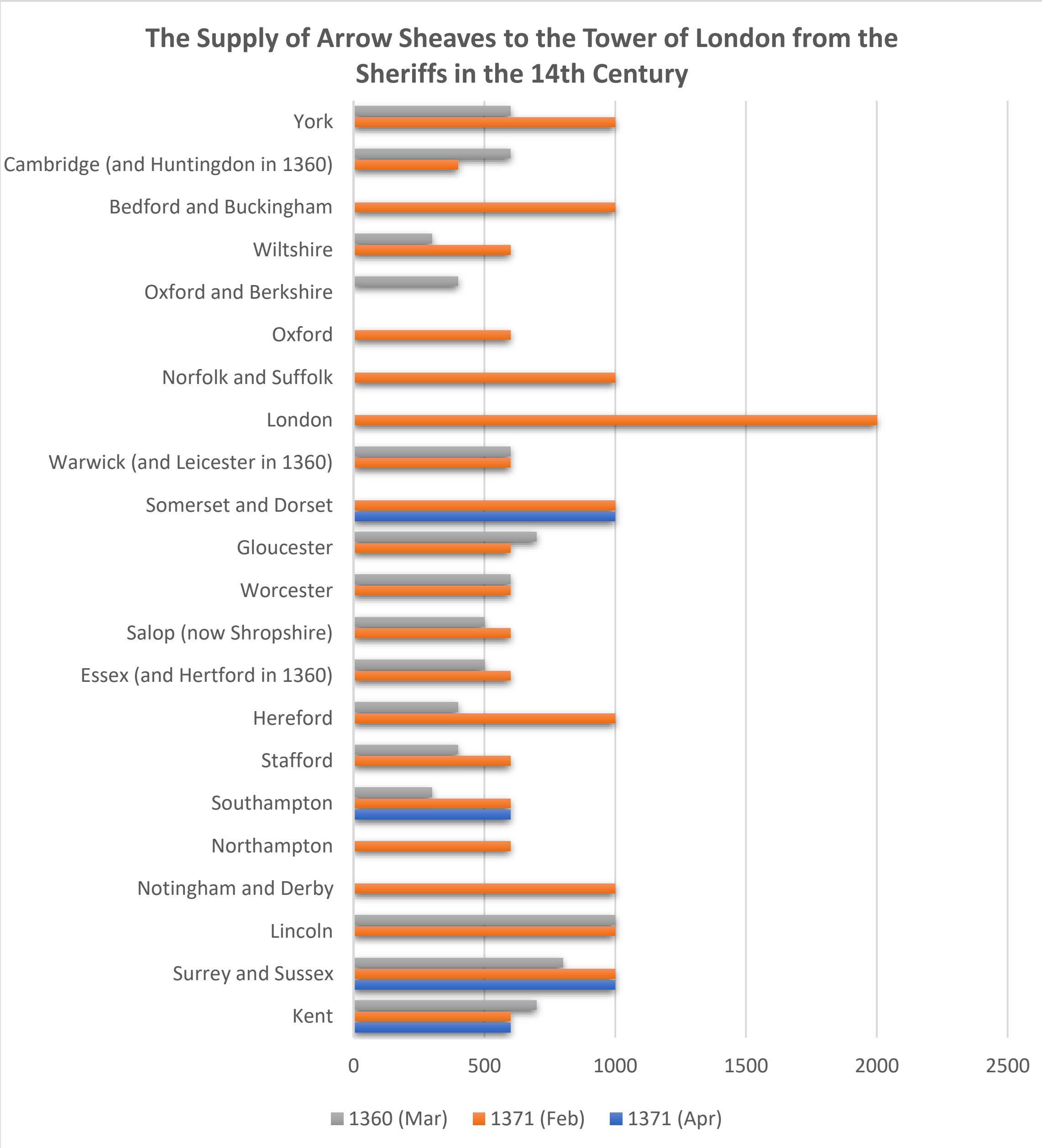


Figure 7.1 - *The supply of arrows to the Tower of London by the county Sheriffs. Other orders exist for 1341 and October 1369, however these do not specify all the counties that contributed. Data translated by: Maxwell Lyte 1911 207-212 and Maxwell Lyte 1902, 46-58.*

centres such as Roffey for militaristic goods including arrows and horseshoes becomes clear and there are obvious logistical benefits in focussing production at a single locality.

It is evident that these orders were if considerable importance for it is stated in 1371 '*if all those arrows be not made of seasoned wood and be not brought to the Tower by the date assigned, the king will cause the sheriff's lands, goods and chattels to be seized'*, while in 1369, failure to fulfil these orders would have resulted in the Sheriff's arrest and imprisonment (Translated by Maxwell Lyte 1911, 207-212; 1911, 57-58). Arrows therefore had to be of the highest quality and obtainable from a reliable source for it was in the Sheriff's best interest that this was achieved. The Sheriffs in February 1371 were allowed 4 months in which to fulfil this order, which for the Sheriff of Surrey and Sussex was 1000 sheaves (ibid 1911). With so much importance placed on the delivery of these arrows, one can see why an iron-production centre like Roffey would have held particular importance and renown. The frequency of these orders would also have facilitated the need for production centres, for in April 1371, the Sheriffs of both Kent and Surrey and Sussex were issued with yet another order to supply 600 and 1000 further sheaves by the second week of June (Translated by Maxwell Lyte 1911, 291-293). The 1338 order of 6000 arrows from Horsham were also destined for the Tower of London and the account states this was comprised of 240 sheaves containing 25 arrows (Lower 1870, 239; Hurst 1889, 9). Assuming the number of arrows per sheave remained the same, the 1000 sheaves recorded in the later orders would total 25000 arrows. Therefore, the numbers required and the time frame in which to supply them, would have necessitated either large scale production or collaborative working beyond that of local capacity. Furthermore, if places such as Horsham (which in the 1338 reference may have been Roffey), only supplied up to a quarter of an order of 1000 sheaves, it is probable that more than one centre existed and was used to acquire the necessary amount.

However, the evidence from the orders of arrows again highlights the need for collaboration of ironworkers with other industries. In the same way the Tudeley smelters relied on the colliers and stone diggers, the production of arrows also necessitated the working together of different craftsmen. Arrows, while reliant on smiths for their iron-tips, also needed wooden shafts, feathers for the fletching and a fletcher to assemble the components. The records suggest that on some occasions only components of arrows were required and presumably assembled by London fletchers. For example, in 1417, The Sheriffs of Kent and Surrey and Sussex, along with others, were ordered by the King that '*six wing feathers [had] to be taken of every goose…. Fittest for new making of arrows for the King's use'* (Translated by Stamp 1929, 335-336). Whether complete or in component form, the 1338 order of arrows still needed 6000 shafts. Two scenarios may be surmised that either the iron heads of arrows were made at Roffey, and the shafts were made elsewhere, and each brought to a central place for assembly (which might explain why the record states the arrows were made 'near Horsham'); or, Roffey was more than a centre for iron, but also a centre for other industries that included fletching, the fletchers working with the smiths to make the arrows. The latter would seem more likely and is supported by the pottery production evidence recovered at Roffey demonstrating other industries co-existed alongside the smelters and the smiths. In this sense a more accurate term for locations such as Roffey would be 'centres of industry' where iron was made alongside other commodities.

The ultimate destinations of these iron products which included the Tower of London for the 1338 arrows and Newcastle-upon-Tyne for the horseshoes from 1327 (Durrant Cooper, 1865) emphasise the sphere of trade Roffey as a production centre held. It would be wrong however to assume Tudeley as a manorial ironworks held less of a sphere of influence. Assuming that the '26 pieces of unworked iron' recorded in 1323 in Tonbridge Castle, came from works such as Tudeley, we know that the iron, having been consolidated into 423 bars of piece iron, was sent to 'Porchester' (Portchester) (Page 1932, 386). In 1325, 7000 iron nails and 7000 iron clenches for shipbuilding were also made at the castle and were again sent to Portchester (ibid). Portchester is 105km south-west on the coast and it is possible the order travelled by sea, having first been sailed down the River Medway. The size of the orders, like those of Roffey, indicates a relatively large scale of production that the castle forge was capable of, as well as the quantities of iron blooms needed to be supplied from the Lowy.

The permanence of these sites is an important consideration. The term 'centre of production' assumes a continued existence over a relatively long period, and yet their presence is likely to have been highly variable according to changing economic conditions. The Black Death caused considerable disruption to the iron industry, most notably in the price of iron and the raw materials needed in its production, which is clearly demonstrated in the Tudeley Accounts between 1330 and 1350 (Cleere & Crossley 1985, 93). The Black Death, which arrived in the Southwest of England in the summer of 1348, rapidly spread across the country over the following two years (Dyer 2002, 271; Aberth 2005, 2). Analysis of manorial records have shown that average mortality rates of tenants were between 40 and 70% (Dyer 2002, 272; Aberth 2005, 3). Cleere and Crossley state that the resulting reduction in population meant that available labour was reduced, and former ironworkers were attracted to the now vacant farms, which ultimately resulted in the rising price of remaining iron (Cleere & Crossley 1985, 93-94). At Tudeley the price of iron rose from 1s 4d to 3s 5d, with prices in the 1350's 156% higher than the pre–Black Death period (Hodgkinson and Whittick 1998, 15). By the time of the 'Second Pestilence', blooms from Tudeley were selling for three times as much as the previous period (Straker 1931, 36). This evidence would suggest not only that the Wealden iron industry was greatly influenced by changing market demands brought about by wider social changes, but that the ironworkers themselves were able to exercise a certain level of social mobility, choosing to move into agriculture or demand higher prices for their products. With such economic variability, it is questionable whether the economy was able to support centres of production on a long-term basis, and perhaps sites such as Crawley and Roffey represent ironworkers taking advantage of specific periods of demand, where it was profitable to produce iron, but not permanent centres with any great longevity. This would be supported by the documentary sources that imply sporadic purchases of iron, meeting specific demands.

Evidently the life of ironworks was determined by both the demand for iron and the availability of ironworkers. This is illustrated in the Southfrith records where in 1349 at the time of the Black Death, two ironworks which had formally been leased to Thomas Harry were absent of a tenant (Giuseppi 1913, 150). While Tudeley was to survive this first period of plague, by 1362, a year on from 'the Second Pestilence' the records record how '*the farm of Teudelee lately leased to Richard Culpeper together with wood and orestone bought for the same he answers nothing this year for default of a farmer and workman by reason of the Second Pestilence'* (ibid, 151). Clearly external factors did influence the survival of these sites for in 1374-5 it was recorded that '*the farm of the Tudeley ironworks yields nothing*' and after that, there is no further reference to Tudeley (ibid, 151).

7.3 - Centres of production - The Social Dimension

While economic factors play a significant part in defining centres of production, the importance of the individual, family and kin groups, social hierarchy and the sharing of knowledge, and the influence these had on the day-to-day organisation of iron-production sites must not be discounted from this definition. It is arguably the social dynamics of iron-production that are most difficult to identify within the archaeological record, and therefore frequently leads to more functional and economic interpretations of the practice. Juleff (1998) demonstrated the importance of the social dimension in iron-production through her ethnographic and experimental research in Sri Lanka. Her observations of the role of hierarchy, of learned practice and of family groups are ideas that can be applied to the Weald, particularly at sites such as Tudeley, where the historical accounts allow research to go beyond archaeological anonymity and reveal the people who worked there.

The status of ironworkers can be considered and the part their occupation played in defining their identity. As was seen in Chapter 3, bye-names, that developed overtime into hereditary surnames, frequently reflect the occupation of an individual, and occupations that often remained within family groups over successive generations. John Parker for example appears to have gained his surname from his role of forester for the Southfrith Chase, while Johanne atte Wode and Johanne Venator at Roffey suggest they both held occupations relating to St Leonard's Forest (McKinley 1988, 183, 280). However, the extent to which iron-production is reflected in the surnames appears more limited. While smith is a frequently occurring surname, McKinley (1988, 228-229) notes its scarcity in the Weald and attributes this to the widespread industry that existed and the preference for surnames relating to less common occupations. Smithing however only equates to the second stage of the production process, and one must question whether smelting can be seen within the surname record too. The only smelter named in the Tudeley accounts was John Tubb, described as the ‘Master-blower’ in the 1354. His surname however suggests he, or more likely a previous generation of his family, were coopers not smelters (Ancestry 2023). While this indicates that mobility between industries was possible at this time, it does not suggest one’s status as a smelter was reflected in their name. On the other hand, the term ‘smith’ may have been a more interchangeable term in the 14th century, and one also used for those employed as smelters.

There does appear to be a hierarchical distinction between smelters and smiths, which is emphasised by the visibility and invisibility of the location of both industries. A similar situation is apparent in Sri Lanka, where both smelters and smiths formed separate communities, with the smelters considered of lower status (Juleff 1998). This is arguably reflected in the Weald by the emphasis on smiths and their products within the documentary record. At Roffey for example the records all pertain to the products made by the smith and yet the archaeological evidence shows smelting was just as important here.

Smiths were clearly able to obtain high status positions in medieval society as illustrated in the case of Henry of Lewes. By 1259 Henry was the Kings master smith and produced ironwork for projects including the tomb of Henry III in Westminster Abbey (Schubert 1957, 142). By the end of his life, he owned property in London, Lewes and Seaford, which demonstrates his considerable wealth (ibid). There are further indications of differences in status between industries suggested within the Tudeley accounts in the anonymity of individuals. For example, the maker of the bellows in 1353 is recorded by name as a Henry Jon while the stone digger is simply referred to by his profession.

The Tudeley accounts also suggest a level of hierarchy existed between the smelters, that was based upon their role within the operation or management of the works. At Tudeley, the works were under the management of the Keeper of the Southfrith Chase Richard de Grothurst, Elizabeth de Clare's chamberlain for Southfrith, John de Mesynglegh or simply the 'Keeper of the works' Thomas Springet and John Parker, all of whom managed the works on behalf of the manor at different dates. There were also periods when the works were leased out by the manor such as to Sir Thomas Gedewerth in 1334 for half a year, and to Richard Colpeper for three years in 1354. While these individuals oversaw the management of the works, it was the four skilled personal who operated the furnace and are referred to as the 'blowers'. The status of the blowers is highlighted by the bonuses they received, for instance in 1350-51 the master-blower received 6 shillings for three quarters of the year, while for the same period, the second blower received 2 shillings 9 pence, the third blower 2 shillings 3 pence, and the fourth blower 2 shillings. Their differing status is not only reflected in their title, such as 'master-blower' but also their rate of pay, with the 'master-blower' paid three times as much as the fourth blower. While the increased pay may be expected for the master-blower in his presumed role of overseeing the smelt, the circumstances under which the second, third and fourth blowers should be paid differing amounts is not obvious, if it is assumed they all were responsible for operating the bellows. Perhaps their job status was dependant on length of their service and that the second blower for instance had greater experience than the third and fourth blowers. Equally some of the blowers may have had extra responsibilities, such as repairing and re-building the furnace, as seen in the Byrkeknott accounts where 'the smithman' was responsible for building the furnaces (Translated by Myers 1969, 1006). The assigned roles and status of the blowers at Tudeley shows organisation and management, arguably important traits within a centre of production.

The importance of kin and family groups is arguably a key factor in the concept of centres of production. Making iron takes considerable skill and know-how and, as experimental archaeology has demonstrated, is a process that can easily go wrong if the vital variables are not maintained. The level of input in time and resources meant the medieval smelters could not afford to get it wrong. Knowledge of furnaces, their construction and operation were no doubt skills passed down within family groups and such a scenario may account for some of the universality of practice seen within the technology and processes between sites. The use of the boring stick seen in the Type 3 slag at Roffey and the possible explanation of an egyson at Tudeley is perhaps one such example. We know from the Byrkeknott accounts that collaboration and sharing of knowledge did take place during this period when it came to setting up new ironworks, and this practice may account for the similarities in site design between Tudeley and Minepit Wood (Lapsley 1899).

7.4 - Summary

To summarise, the evidence from Roffey and Tudeley indicate two types of ironworks existed in the Weald by the 14th century. These included dispersed smelting sites such as Tudeley, some of which were attached to manors; and groups of smelters and smiths working within nucleated settlements alongside other industries. Both in their own way were centres of production in the sense they were locations in which materials were brought in and that specialist tasks were undertaken. Both were also sites in which collaboration played an important role both between industries and between smelters and smiths. Tudeley and Roffey were also sites that fulfilled local and regional trade demands, although it is likely that the majority of Tudeley's iron was used on a local level and within the manor. Their primary difference was morphology with Tudeley forming part of a wider dispersed group of ironworks which at times supplied the castle smith at Tonbridge, while at Roffey smelters and smiths along with potters and possibly fletchers, worked alongside one another within an industrial settlement.

7.5 - Future research

It is hoped that this project has demonstrated the benefits of an archaeo-historical approach to the study of medieval iron-production and shown how non-invasive methods to investigate archaeological remains have considerable benefit. As technology has evolved, such as with the use of LiDAR, digital mapping and geophysics, greater insights can be made in the study of large areas of the landscape, arguably covering greater areas than the extent of a typical research excavation. Magnetometry allowed environments as diverse as a large open field to densely growing woodland to be mapped and reveal the morphology and layouts of Roffey and Tudeley. Tudeley was only discovered by the chance phenomena of a slag deposit being eroded by a tributary stream and it raises the probability that other sites lie across Southfrith with no surface slag evidence of their former existence, and it is here that further magnetometry surveys could be used in the future to systematically assess their spatial distribution.

Despite the greater application of technology, traditional methods such as fieldwalking have also demonstrated their potential in obtaining a detailed assemblage of technological samples and complementing geophysical techniques. Of these, the transect approach is best suited for the rapid assessment of wide areas of land and identifying ‘sites’, while the grid method allows for a comprehensive artefactual assemblage to be collected from individual sites. The use of a standardised macromorphological classification scheme on other Wealden sites would in future assist in the comparison of technology and processes between locations. While fieldwalking is effective within a wooded environment, the evidence from Roffey suggests further sites may be found on cultivated land, particularly along roadside locations.

Excavation has the potential to take the study of Roffey and Tudeley further, particularly in establishing their origins and development, as well as their subsequent abandonment. Roffey is arguably at a greater long-term risk given its position within an annually cultivated field, while Tudeley can remain indefinitely, under the protection of ancient woodland and within the nature reserve.