

# **An Iron Age and Romano-British settlement and iron-working site at South Farm, Lightwater, Windlesham, Surrey: excavations 1984–92**

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## **Summary**

*Excavations led by the late Geoffrey H. Cole revealed parts of an Iron Age and Romano-British settlement with significant evidence for Iron Age iron smelting. This report provides a summary account of the excavated sequence and an analysis and discussion of the iron-working evidence. It includes summaries of the other finds (pottery, querns and building material) as well as a discussion of an Iron Age coin. The discussion includes a reassessment of evidence for Iron Age iron production in the region and an assessment of the broader context of the site.*

## **Introduction**

This paper presents a summary report on the excavation of a significant site that was investigated under the direction of the late Geoffrey H. Cole between 1984 and 1992. When the excavator died in December 2003, progress had already been made on the preparation of the site for publication, but work then came to a standstill. The first author had been in close contact with the excavator during the dig and had visited the site on a number of occasions. The excavation produced a large volume of finds, including a substantial assemblage of pottery and iron-working waste. Following discussions with the excavator about how the site might be brought to publication, he had undertaken an analysis of the pottery in the 1990s, with the archive being sent to Geoff Cole in 1998. The second author was contacted by the Surrey Heath Archaeological and Heritage Trust (SHAHT) in 2005 for advice on the interpretation and recording of metal-working residues from the excavation, at a time when the collections were under threat. In this context she initiated an assessment of that material and some scientific analyses, whilst the SHAHT catalogued the assemblage. Following discussions with the SHAHT and the Surrey Archaeological Society in 2020, it was agreed that they would work together to bring the site to publication using the available archive material and interim reports (Cole 1985; 1986; 1988; 1989). No interim reports were published on the 1990–92 seasons of excavation, and during initial work on this report, it emerged that a substantial amount of pottery from the excavations had not been included in the material studied in the 1990s. Hence, the first author has worked with the archive and also completed an assessment of that pottery in order to complete the present report. This paper is a product of that work, and should be read with the circumstances of its production in mind.

The site finds and archive are currently held by the Surrey Heath Archaeological and Heritage Trust (with the code: *Site 19*).

## **Geographical background (MM)**

The site (SU 927627) is located in the parish of Windlesham in Surrey, on the N edge of Lightwater, just to the E of the junction between the M3 motorway and the A322. It is located within land presently used as the Windlesham Arboretum (Fig. 1). It lies at c. 55m AOD on a low level plateau (formed of Eocene sands and clays collectively known as the Bagshot Beds) at the point where the

land begins to fall away to the shallow valley of the Windle Brook. This stream, which lies c. 200m to N of the excavation, flows WNW–ESE. Its valley cuts through the plateau, which is capped locally with Eocene deposits of the Camberley Sand Formation (CMBS-S), to expose sands, clays and silts of the Eocene Windle Formation (WIDS-XSZC). It is on these mixed sandy deposits that the Iron Age and Romano-British settlement lies. The valley floor immediately adjacent to the excavation is now occupied by artificial ponds, but the British Geological Survey map indicates the presence of peat deposits (of undefined geological age) along this stretch of the valley floor.

The area of the arboretum was previously occupied by South Farm and is shown as agricultural land on nineteenth-century Ordnance Survey maps. It was cultivated until it was converted to its present use in 1981. At that time, the grounds had been used as nursery gardens and intensive horticultural activities had obliterated any trace of ancient field boundaries or surface features. The cottage known as Harrishaws, which lies adjacent to the excavated site, is also shown on these maps.

In the context of late Iron Age and Roman Britain, this area lies within the territory usually attributed to the Roman *civitas* of the Atrebates, but there is comparatively little evidence for Iron Age or Roman settlement in this part of Surrey with the gap in the distribution of sites shown in the 1980s (Bird 1987, 179, fig. 7.7) also seen in the recent Roman Rural Settlement Project. (<https://archaeologydataservice.ac.uk/archives/view/romangl/map.html>). The geology of the Bagshot beds is generally seen as having very low agricultural potential (Bird 2017, 112) and, indeed, the Surrey heathlands in this area are generally assumed to have been little exploited in antiquity. In Roman Britain, the site lies c. 2.7 km S of the Roman road known as ‘The Devil’s Highway’ (Margary 1973, route 4A) on its course from Silchester (*Callewa Atrebatum*) to London (*Londinium*) via Staines (*Pontibus*). The extensive, but poorly understood roadside settlement site at Wickham Bushes (Corney and Gaffney 1983) lies on this road, c. 6.5 km to the NW of the excavation, and is probably the nearest major contemporaneous site. However, eighteenth-century records of what were clearly early Roman cremation graves found at Rapley Farm (Handasyd 1785) lie a little closer, just to the north of the point where the Roman road changes alignment. It has been suggested that the road that branches off the Roman Stane Street (Margary 1973, route 151) and runs towards the temple at Farley Heath may have continued to meet ‘The Devil’s Highway’ near the Rapley Farm site (Bird 1987, 166; Cole 1989, 4). There is no evidence to support this suggestion, but such a route on a direct line would have passed very close to the W of the excavated site. There are few other sites known in the immediate vicinity although there is some evidence of a possible Roman rural site from excavations at no. 42 London Road, Bagshot 3.3km to the NW (Cole 1994) at which a late Roman jet finger ring with Chi-Cross monogram was found (Graham 2002; also illustrated in Millett 2005, 115, illus. 94).

### **History and nature of the excavation and post-excavation work (MM)**

During 1984, following vegetation clearance and surface scraping prior to the installation of a water main, the area was field-walked by members of the Surrey Heath Group of Surrey Archaeological Society. The lower levels of three truncated pits dated by pottery to the second–third century AD were found and recorded. Subsequent field-walking in areas ploughed prior to tree planting N of the plateau edge produced scatters of third- and fourth-century pottery with worked stone. Detailed surface recording identified concentrations within the scatters and on the basis that, on a relatively level site, ploughing will not have moved finds over any great distance, a small trench was excavated over one of these concentrations. Similar pottery to that found on the surface was recovered and

the trench located a ditch dated to c. AD 250–300. A limited resistivity survey in 1985 revealed various anomalies, and this was followed-up by further trial trenching. The excavation was progressively expanded to an open area in a series of excavation seasons from 1986 to 1992 during which a total area of 6760m<sup>2</sup> was examined (Fig. 1). Across the area investigated the upper plough soil had previously been removed during the creation of the arboretum. For the excavation, a further 15 to 25 cm was removed by mechanical excavator to expose layers at the base of plough soil. Below this level, features were then excavated by hand.

The excavation was undertaken by volunteers including a large student team, with supervisors drawn from this team under the overall direction of Geoffrey Cole, who was generally present on site during the whole excavation season. In the earlier years, he undertook most of the recording himself, including drawing the excavation plans. The excavation method involved was traditional but systematic and careful, involving a combination of trowelling and the use of pick and shovels. Geoffrey Cole was himself a skilled excavator, and he insisted on careful work from his team, but there are unresolved inconsistencies in the records, especially from the later seasons of excavation when the post-excavation checking of records seems to have been less systematic. Finds were hand collected, without any use of sieving or flotation, and all finds were retained for cleaning and later study. The nature of the acidic soil on the site meant that bone survival was negligible. Similarly metal finds were absent (with the exception of three Roman coins and a gold-plated Iron Age coin). By contrast, substantial quantities of pottery and iron slag were recovered along with limited quantities of ceramic building material and some worked stone. The excavation was recorded using a single context numbering system (although in conformity with common practice at that time, numbers were not allocated to cuts, only to fills) and many of the contexts sheets had not been fully completed. The site was planned at a scale of 1:20, with locations recorded in relation to a locally established site grid marked by grid pegs around the trench. As Geoffrey Cole was a professional architectural surveyor, the accuracy of these plans and the surveying was good. The available records do not however include all the section drawings although it seems likely that these were drawn at the time.

At the time of his death, the excavator had completed a significant amount of work on analyzing the early seasons of excavation, with the majority of the contexts up to 1989 included in a draft Harris Matrix, although this had not been completed, fully checked or formatted to take account of available pottery dates. Little finds analysis had been done beyond the cataloguing and quantification of the pottery completed in the 1990s referred to above. There were however various notes of his available in the archive as well as a series of published interim reports. Since 2003 work has also been done by SHAHT volunteers on organizing the archive and collections, but aside from the research on the iron-working debris noted above, no further post-excavation analysis had been undertaken.

In approaching the problem of bringing the site to publication, it was decided to work from the work completed by the excavator on phasing, enhancing this as far as possible without a complete restudy of the site records. The main tasks in enhancement of this have been checking the matrix against the pottery data to resolve any apparent conflicts, and checking records for those contexts that did not appear on the matrix. The analysis of the 1990–92 records has been limited to assessing the pottery and attempting to link contexts to the established phasing. This approach has not been comprehensive but provides a reasonable basis for understanding this site. A completely fresh start on analyzing the site could not be justified given the amount of work that would have been required although this does mean this report is the product of the 1980s–90s. However, we

remain confident that our principal conclusions about the chronology, development and functions of the site are robust.

### **Phased description (MM)**

#### **Introduction**

There were 988 contexts recorded on the site, about half of which were either included on the draft matrix created by Geoffrey Cole or could be added to it on the basis of information from plans. When read in conjunction with the interim accounts of the site, this provides a basic stratigraphic phasing, albeit largely determined by the larger cut features and their intersections. The dates of the pottery from contexts were compared with this to provide a broad chronological framework. 411 contexts produced pottery, but many only contained a very small number of sherds that were chronologically undiagnostic. However, the pottery that comes from firmly phased contexts provides a sound basis for calibrating the stratigraphic sequence if allowance is made for intrusive material from sinkage into the top of major features as well as some residuality. The phasing that follows has been based on this evidence, and the site is described in chronological sequence. Stray finds of earlier prehistoric material (Cole 1989, 6) are omitted from this account which focuses on the Iron Age and Roman phases.

In interim accounts of the site, different systems of nomenclature were used for the six principal stratigraphic phases then recognised and also for the features and structures described. In this account, a slightly simpler phasing has been adopted and new labels have been assigned in order to achieve consistency. It should be noted that the Early Medieval phase hypothesised in the interim reports (Cole 1988, 13–16, fig. 6) can now be shown to be post-Medieval in date ([xref](#) below).

Where appropriate in this paper, original context numbers have been retained, and given in square brackets (eg. [8]) in order to facilitate direct reference back to the original site records, finds and archive. The phasing is principally based on the stratigraphic relationships between the major features (mainly ditches), with the excavated settlement having formed part of a complex enclosure system that extends beyond the limits of the trenches. Any hope of mapping this enclosure system more fully through geophysical survey is now impossible because of extensive landscaping undertaken in 1999 and the present tree cover.

The description below provides a summary of the features attributed to each phase. The dating evidence from the pottery is included in the pottery report ([xref](#)).

#### **PERIOD 1**

There are five features that can be identified with the earliest activity associated with the settlement (Fig. 2). These were only partially explored in the central area of the excavation at the bottom of a sequence of later structures (Fig. 6). It is clear that the settlement represented by these ditches was more extensive and that comparable features must have been missed across the rest of the excavated area. It is equally clear that the excavated features form part of a complex sequence, probably of enclosures, that we cannot fully disentangle so separate sub-phases have not been suggested even though not all of the Period 1 features can have been in use contemporaneously. However, the presence of a significant quantity of iron-slag shows that metal production took place in this phase which is best dated to the first century BC–first century AD.

Two short stretches of shallow ditches, Ditches 2 and 3 aligned NE–SW, were located beneath a complex of later features. Both were cut by the more substantial Ditch 1, which was

aligned NW–SE and seems to have formed a major enclosure ditch. It was originally cut as a flat bottomed ditch c. 2.5m. wide by c. 1.5m deep and having steeply sloping sides, with reported traces of a gravel bank on its SW side. It was traced for c. 20m (but not identified beneath the later structures in the western part of the excavation although here its alignment seems to have influenced the layout of the Period 3A buildings). Its lower fills comprised layers of clean sandy silt, dirty yellow sand and fine gravel. Two fragments of pointed timber stakes were recovered from the ditch bottom. The plans show a terminal end of one phase of recutting c. 7.5m from the SE limit of the excavation. Subsequent silting and the formation of layers described as turf line were followed by two minor recuts running along each side of the original ditch. (A twentieth-century soakaway pit had been cut into the top of the ditch at the eastern limit of excavation.) To the N, two successive phases of another boundary, Ditches, 4 and 5, survived truncated by Ditch 10 of Period 3A. They were aligned NE–SW and are presumed to form the side of the enclosure formed with Ditch 1.

Although the full extent and character of the ditch remain uncertain, it seems clear that it represents part of a substantial enclosure similar to those that characterize many Later Iron Age settlement sites. The presence of domestic and iron-working debris in its infill confirms this assessment. No structures can be associated with these ditches, but given the complexity of the deposits in this part of the site and the difficulty in distinguishing early earth-cut features with few finds, we cannot be sure whether or not there were buildings associated.

## PERIOD 2

The features assigned to Period 2 (Fig. 3) are not stratigraphically related to those of Period 1, but have been allocated to this phase on the basis of their relationship with later features across the site. They are distinguished from those of Period 1 on the basis of the pottery (which suggests a date in the second–very early third century AD) and their spatial patterning. There is too little evidence to establish whether Period 2 followed directly after Period 1, or if there was a hiatus. The failure to identify Period 1 features except in a limited area at the centre of the site suggests that the sequence was more complex than presented here, whilst the wide occurrence of second-century pottery within the overall site assemblage supports the idea that use was more or less continuous.

Two groups of features have been attributed to this period, and although they are broadly contemporaneous, more refined dating has not been possible. There may be some overlap in chronology with Period 1. Close to the NE limit of excavation, Ditch 6 is aligned NE–SW, more or less parallel with Ditches 4 and 5 of Period 1. The area to the NW of Ditch 6 was marked by an area of undated small pits and post holes which suggest intensive activity. Within this group Building 1 is tentatively identified. This comprises a group of post holes and stake holes that share the alignment of the ditches and perhaps define a building c. 10m long by c. 4m wide.

Further to the W, there is little evidence for activity in this period except in the NW part of the trench. Here Ditches 7 and 8 define the three sides of a small enclosure aligned N–S, c. 12m wide and more than 10m long, with an entrance in its SE corner. Ditch 9 is probably a recut of its NW side. The S side of Ditch 7 had been recut to create a feature described as a Furnace, the centre of which utilized the disused ditch. During the excavation, this Furnace (Fig. 4) was thought to be associated with iron-smelting. However, the form of this feature is incompatible with this interpretation, and it seems more likely to have been an oven or kiln used for crop processing.

## PERIOD 3

This period marks a change in the character of the evidence from the main part of the excavated area, which is henceforth dominated by substantial domestic buildings although there is some spatial continuity with the Period 2 layout (Figs 5–9). The Period 3 features have been divided into 4 sub-phases although there is likely to be some overlap between them. As the settlement clearly extended beyond the excavated area, the sequence identified here is clearly only partial. The pottery shows that Period 3 dates from sometime probably in the early third century through to the third quarter of the fourth century. The occurrence of a coin (below, no. 3) of AD 170–71 from a Period 3A deposit, probably deposited around the end of the second century is consistent with this dating. Problems of residual and intrusive material (especially in the deposits associated with the buildings) means that precise dating of the sub-divisions of the Period are tentative.

### Period 3A

The start of this period is defined by the cutting of Ditch 10 which defines the NW and SW sides of what appears to be a rectangular enclosure, most of which lies outside the excavated area (Fig. 5). Its NW side follows the line of Ditches 4 and 5 of Period 1, perhaps following a still visible hollow. Its SW side similarly lies just to SW of Ditch 1 of Period 1, arguably indicating broad continuity of layout. This enclosure, thus lay on the edge of the plateau with the slope down to the Windle Brook on its NE flank. To its W, Ditch 11 was cut on an NW–SE alignment perpendicular to Ditch 10, which it respects and so must have been dug at a slightly later date, although pottery of the first half of the third century from their fills shows that they were broadly contemporaneous. It has an opening towards the W end of its excavated extent which provided access from the N. Ditch 11 thus probably defined a second enclosure on the plateau edge within which two successive timber buildings (Buildings 2 and 3) were located. The associated pottery shows that that they are broadly contemporaneous with Ditches 10 and 11, although some overlap between Building 2 and Period 2 is not impossible. There were also many minor features in the area around these buildings (Fig. 6), which cannot be phased but are assumed to be broadly contemporaneous, with some of the gullies perhaps representing repairs to the buildings or internal features.

Buildings 2 and 3 were sufficiently well preserved to provide good structural evidence, with a clear sequence (Fig. 6). Both were laid out on a NW–SE axis, broadly aligned with the Period 3 enclosures and with their NE walls overlying Ditch 1 of Period 1. Building 2 was represented by shallow gullies that defined its NE and SW sides and NW end. Its SE end was not identified, but it is reasonable to assume that the building was more or less symmetrical with the c. 2.5m wide gap in the SW wall representing a centrally placed doorway. If this is correct, the overall dimensions of the building were c. 14m by 8m (with the side walls slightly bowed outwards towards the centre). There was a narrow (c. 1.2m) opening in the NW gable wall, offset to one side of the axis of the building, presumably representing a further doorway. A line of three post holes along the axis of the building, marginally offset to the NE, are reasonably interpreted as supports for a ridge beam. Evidence for a series of post holes and timbers was recorded along the gully marking the SW side of the structure, which indicates that the gully formed a wall foundation. This conclusion is supported by the presence of a post hole within the gully at the NE corner. Fragments of burnt daub found in its fill suggest that the timber wall structure was plastered with a clay. Drawing this information together we can interpret Building 2 as a substantial timber-built hall, the roof of which was hung from a ridge piece and was supported on stout timbers set in the wall trenches. This form of building is common on ordinary Romano-British rural sites and was multi-purpose, with occupants living and working in the same place.

Building 3 succeeded Building 2 on an overlapping footprint. As with its predecessor, its NE and SW sides and NW end were identified, but the SE end was missing, although its position was indicated by the excavation of the S corner of the building. Floor levels had not generally survived due to ploughing, although areas of hard gravel and packed flint may indicate a crudely cobbled floor. The building was c. 16m long by c. 8m wide, with straight sides. Its structure contrasts with that of Building 2, as the roof seems to have been supported by a series of posts set on the inside edge of the gully that surrounds the building. These are well preserved on the SW side with three sandstone post-base blocks to support big posts at c. 4m centres in the middle of the structure. In each case excavation revealed traces, as charcoal stains, of a double post arrangement above the blocks with one post sitting on the post-base block and the other set to one side cutting the post packings. There was a group of smaller posts at the NW corner, c. 3.5m from the nearest post in the long wall. Assuming that paired post holes along the NE wall have been removed by Ditch 12 of Period 3B (Fig. 6), this would suggest that the roof was supported on three sets of cross frames along its axis and by the strongly timbered gable walls. The walls filling the gaps between these roof supports may simply have been screens that were not load bearing, and there is some evidence for this in the middle of the SW wall, on the inner edge of the gully, which would thus have formed a drain around the building. There is no evidence for the location of doors, but the position of the roof supports means that there could not have been an entrance in the middle of the side wall as in Building 2. The form of Building 3 is nevertheless similar to that of its predecessor, although its roof structure was different, strongly resembling that commonly seen in Romano-British aisled halls (Cunliffe 2008, 114–20; Smith *et al.* 2016, 66–67; Bird 2017, 122–25). These buildings probably represent domestic units and they are closely comparable in form and size to those found on other rural sites although these often had stone footings (Millet 2016, 708–10, fig. 34.5).

#### Period 3B

At some stage after Building 3 went out of use (and probably in the early fourth century), the area was redefined by the cutting of Ditch 12 which seems to have created a sub-circular enclosure (Fig. 7). It was originally cut with a shallow, flat bottomed profile, but the SW length had been recut into a 'V' shaped section. The uppermost fill had subsided presenting a saucer shape surface depression. A terminal was located at its SE end, but its continuation or otherwise at the NE end was not determined. It is possible that it stopped at Ditch 11 of Period 3A, which (like Ditch 10 of the same phase) may have still been visible and in use. If this were the case, then Ditch 12 may have been designed to separate off the E corner of the enclosure. Two successive shallow ditches (Ditches 13A and 13B), on a NNE–SSE alignment, crossed the enclosed area by Ditch 12. These may possibly represent gullies defining further houses but the evidence is unclear.

#### Period 3C

During this period, probably in the mid fourth century, the enclosure from Period 3B was suppressed and Building 4 was constructed in the central area of the excavation (Figs 6 and 8). This was another well-preserved timber building surrounded by a gully. It was on a new alignment, more or less N–S, and smaller than the buildings of Period 3A, measuring c. 9m by 6m. A central post hole and feature close to the axis towards the gable ends represent supports for a ridge post, whilst a series of small post and stake holes around the inner edge of the gully indicate the presence of a screen wall. Within the S part of the interior was a hollow. This was interpreted by the excavator as a later superimposed *grubenhaus*, but this seems unlikely, and given its position in relation to the gully, it is

most likely to represent the floor of Building 4. This being so, the gap between the edge of the hollow and the gully may well suggest the presence of a turf or mud-brick wall which supported the roof and was revetted by a screen wall around its exterior. As in the case of Building 3, there is no indication of the location of door openings. A domestic function seems probable, even allowing for the modest size of the building.

To the N, two Ditches, 13C and 14 respect the building, and possibly represent drains to carry water away to the N. To the E, a new boundary replacing Ditch 10 was created with the cutting of Ditch 15A which may have been a palisade trench. The fact that Ditch 15A is interrupted by House 4, indicates that it is slightly later in date.

### Period 3D

The final phase of activity identified probably dates to the third quarter of the fourth century, and seems to mark a diminution of occupation in the area excavated. The boundary marked in Period 3C by Ditch 15A was maintained with two successive recuts (Ditches 15B and 15C) with the addition of post-holes in places (Fig. 9). A narrow gap in Ditch 15B with a metallised surface marks a gateway. Elsewhere there were two trackways each defined by boundary ditches. To the N, the W part of the boundary defined by Ditch 11 in Period 3A was replaced with Ditch 16 which extended part way across the Period 3A entrance. To the N, and parallel to Ditch 16, Ditch 17 was cut defining a trackway, with surviving metallising, running along the edge of the plateau. As this part of the site was not fully excavated, it may be that this ditch replaced an earlier one, with the trackway being much longer established. Further to the S in an area without evidence for significant earlier activity, another pair of Ditches, 18 and 19 were cut, respecting the line of Ditch 15. These appear to define a trackway on an NW–SE alignment, perhaps at the S edge of the settlement.

### LATER FEATURES

The excavated area produced a significant amount of Post-Medieval material and a number of features that can be dated to this period. These include a sequence of ditches at the S limit of the excavation which can be related to the boundary beside the road that is shown on early OS Maps. There were also a series of field drains and boundary markers on NNE–SSW alignment which clearly relate to the use of the area for horticulture in the modern period.

In his interim reports on the site the excavator identified a series of timber structures represented by baulks of horizontally laid timbers as well as associated palisade trenches (Fig. 6). He believed that these dated to the Early Medieval period (Cole 1988, 13–16), but it now seems clear from the associated finds and orientation of these features that they relate to the modern use of the area as a horticultural nursery. The sleeper beams certainly supported shed floors whilst the clay lined gullies with stake holes along them, thought to have been palisades, must represent planting trenches.

### The Finds

The nature of the soils at Lightwater meant that there was no survival of bone and only exceptional preservation of metal-work from the Iron Age and Roman periods. The finds assemblage was dominated by iron slag and pottery with occasional fragments of ceramic building material and a few items of stone.

### The Iron Age coin by Colin Haselgrove

A single Iron Age coin was found in the 1989 excavations at Windlesham Arboretum (Fig. 10). It is a plated copy in good style of a Class 3 gold stater of the North Thames ruler Addedomarus (ABC 2517; BMC 2396–2404) and weighs 1.63g. A segment of flan edge is missing, exposing the copper core, and one surface is damaged, but on both faces the types are readily recognizable:

*Obverse*: three back-to-back crescents within a six-armed wreath spiral; on gold examples, the spiral is framed by a ring of alternating pellets and ringed pellets, but on this coin – which is struck slightly off-centre – the border runs through the damaged part of the flan and is lost.

*Reverse*: horse right, with twisted mane and ringed pellet beneath the tail. Above is a motif of three radiating muzzles shaped rather like carnyx heads; above this is the legend 'AVOOO', the last three letters engraved as pellet rosettes. Below the horse is a barely visible cornucopia.

The coin is recorded on the Oxford Celtic Coin Index (<https://cci.arch.ox.ac.uk/>) as CCI 22.1299. it was recovered from an unsealed context [544] immediately below the ploughsoil.

Addedomarus probably ruled during the third quarter of the first century BC and the Class 3 staters were the last and largest of his three gold issues; over 50 reverse dies are known (Sills 2017, 519–52). The staters – and their associated quarter-stater (ABC 2529; BMC 2417–21) – occur over a large area stretching from the Essex-Suffolk coast to the Nene valley and Upper Thames basin, with the Thames forming the effective southern boundary to the distribution (Sills 2017, Maps 67–68). Only a scatter of finds is known from south of the Thames and the Windlesham coin is very much an outlier.

Dr John Sills, who has undertaken a comprehensive die study of this ruler's gold coinage (Sills 2017, 522–27), kindly examined images of the Windlesham coin and is confident that its reverse die was hubbed<sup>1</sup> from his reverse 44 and given a pseudo-legend in place of the AÐΘIIDOM/AΘΘIIDOM legend on the actual Class 3 coins. A faint outline under the 'V' on the plated coin might have been a 'Ð' or 'Θ' from the hubbed coin – as the legend is off the flan on both coins with reverse 44 (CCI 01.0005, 08.0706), we do not know which form of the letter was used. The style of the obverse die suggests that it, too, was hubbed, quite possibly from the same coin, but Dr Sills could not find an exact match; however even slight retouching would be enough to give the appearance of a different die.

SEM imaging and surface EDXRF analysis indicated that the core of the Windlesham stater was copper, not bronze, and was plated with a ternary gold-silver-copper alloy (Henderson and Brown n.d.). Given the propensity of copper to leach out preferentially compared to precious metals, the EDXRF results must be regarded with caution, but taken at face value suggest that the metal foil used for plating the core contained up to 45% gold, to which silver and copper were added in a ratio of about 2:1. If so, this would have given the coin a yellowish hue, somewhat at odds with the actual staters; these have a not dissimilar gold content (c. 40%), but on average contain more than three times as much copper as silver, giving them the reddish colour that is characteristic of later British gold coinages in general (Creighton 2000; Sills 2017). Colour differences have been noted between other plated coins and their solid counterparts (Cottam 2001, 380).

The copper core shows obvious signs of corrosion. Loss of copper though oxidation has undoubtedly contributed to the coin's very low weight (it was initially called a half-stater). Apart from one other corroded example (CCI 00.0617), previously recorded Class 3 copies weigh between 2.7–4.7g, whilst actual staters have a modal weight of 5.50–5.59g (Sills 2017, 527–28). Even when

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<sup>1</sup> ie. using an existing coin to make a new die by impressing it onto a softened metal matrix; the resultant negative image is then often touched up by hand so that it is no longer identical to the original.

new, the Windlesham coin would certainly have been distinguishable from solid gold examples by weight as well as by colour, which seems somewhat at odds with the careful reproduction of the imagery.

Plated copies of gold (and silver) coins were fairly common in Iron Age Britain, and are found in all the main series. Over 30 Addeddomaros Class 3 copies are recorded, roughly 1 for every 12 surviving solid gold coins of the type. Why and by whom these plated versions were made has been a subject of long-running debate, with explanations ranging from officially sanctioned output to contemporary illicit forgery (see Cottam 2001). Examples occur – albeit mostly in ones or twos – on Iron Age and Roman sites of all types (Haselgrove 1987, figs 7.5 and 8.7). This has led to the suggestion that – having been recognised by their users as ‘copies’ – they were treated as base metal coins (Collis 1971). This is certainly possible, particularly in the years after the Claudian invasion, when official Roman base metal coinage was in short supply, but brings us no nearer to understanding the ultimate reasons behind the practice. As Cottam (2001) indicates, the use of hubbed dies would seem to rule out the idea that the copies were struck by an official mint or moneyer, but to answer such questions successfully, a comprehensive study of the phenomenon is required.

Why (or indeed when) a copy of a North Thames gold stater should have ended up at Windlesham, well outside the primary distribution of the type, is no easier to answer. Reverse 44 is one of the earlier Class 3 dies, but our dating for Addeddomaros is approximate at best and Class 3 in its entirety may have been struck over a fairly short period (Sills 2017, 745–46). Assuming the copy was made whilst Class 3 gold was current, a date centring on the 30s BC is possible, although it might of course have arrived later. The superficial context in which the coin was recovered unfortunately offers no help. The significance of Windlesham as an iron-working centre may be relevant, although this is difficult to sustain in absence of other Iron Age coins, local or otherwise, from the excavations. Alternatively, the stater could have arrived as a by-product of political or social ties between groups on opposite sides of the Thames and indeed might have held greater symbolic significance for its recipient(s) there than it would have had in the area where the actual gold coins circulated.

Addeddomaros himself has not perhaps been given a prominent enough place in our accounts of late Iron Age Britain. Our narratives for the post-Caesar period tend to be built around Commios, who figures conspicuously in Caesar’s narrative of the Gallic War (e.g. Creighton 2000), but as Sills (2017, 746) has noted, Addeddomaros has an equally valid claim to have been the first British ruler to have inscribed his coins and moreover – if their distribution is any indicator – held sway over an area encompassing the territories of what later became two of the leading civitates of early Roman Britain, the Catuvellauni and the Trinovantes.

Addeddomaros’ coinage was struck using largely traditional imagery, but the cornucopia below the horse on the Class 3 coins, along with the adoption of legends, implies more than passing contact with the Roman world. The site of Braughing-Puckeridge (Hertfordshire) has some of the earliest Roman imports in south-east England and lies at the heart of his coin distributions; its rise as an important centre at this time may not be uncoincidental and it may even have been Addeddomaros’ seat of power and/or his mint. Under his better known successors, Tasciovanos and Cunobelinus, North Thames gold coins are found with greater frequency in areas south of the Thames, suggesting a growth of political influence in this region and/or of interest in its resources. Might the Addeddomaros coin at Windlesham have been a hint of things to come?

#### Acknowledgement:

I would like to thank Dr John Sills for sharing his invaluable knowledge of the gold coinage of Addedomaros.

#### The Roman Coins by Richard Brickstock

The three coins, rather poorly preserved, all proved to be closely identifiable in terms of mint-date, largely because, by good fortune, they all bear quite distinctive reverse types. In terms of depositional date, however, the state of preservation renders the assessment of circulation wear somewhat approximate:

Coin number 1, a fragmentary issue of the last years of Hadrian, is probably only little-worn, suggesting that it might have been deposited early in the reign of Antoninus Pius. The second coin, a *sestertius* of the first decade of Pius' reign, is probably (though not certainly) very much more worn, and thus could have remained in circulation until late in the second century or even the early-third century. The final coin, another *sestertius*, of Marcus Aurelius from AD 170–71, also appears worn, though not excessively so, once again suggesting the possibility of deposition in the last years of second century or thereabouts.

1) Ruler: Hadrian Denomination: *Dupondius* (or *As*) (fragment)

Catalogue reference: RIC 823; ed. II.3 2386

Obverse: [HADRIANVS AVG COS III PP] Head of Hadrian, laureate, right

Reverse: [PROVIDENTIA AVG SC] Providentia standing left, against column, pointing to globe and holding sceptre.

Mint: Rome Date: AD 130-38 Condition: SW(-W)/SW(-W)?

Diameter: 17.5 mm Weight: 1.6 g Die-axis: 6

Context: [627] Unphased deposit.

2) Ruler: Antoninus Pius Denomination: *Sestertius*

Catalogue reference: RIC 642

Obverse: [ANTONINVS AVG PIVS PP TRP COS III] Head of Pius, right

Reverse: [TIBERIS SC] Tiber reclining left, resting right hand on ship

Mint: Rome Date: AD 140–44 Condition: VW/VW?

Diameter: 30.5 mm Weight: 13.7 g Die-axis: 12

Context: [351] SF83. Ploughsoil.

3) Ruler: Marcus Aurelius Denomination: *Sestertius*

Catalogue reference: RIC 998

Obverse: [IMP M ANTONINVS AVG TRP XXV] Head of Marcus, laureate, right

Reverse: [FIDES EXERCITVVM SC] in exergue: [COS III] Fides standing left holding victory and legionary eagle

Mint: Rome Date: AD Dec. 170-Dec. 171 Condition: W/W?

Diameter: 29 mm Weight: 6.2 g Die-axis: 6

Context: [193] SF31. Period 3A, Building 3.

#### Summary Report on the Iron Age and Romano-British pottery (MM)

The pottery from the site was washed and marked during and after the excavation and bagged according to the excavated contexts. In the mid 1990s a study of the pottery was undertaken by

students from the University of Durham under the supervision of the author as part of an undergraduate course on the 'Archaeology of Pottery'. The objectives were (a) to establish the changing patterns of ceramic supply, and (b) to assess the date of deposition of the different context groups. The study was not exhaustive and there is no doubt that a more extended study today by a pottery specialist would provide additional information. The material and fabrics type series created are therefore retained by the SHAHT for further future analysis.

For this study, the pottery was examined context-by-context, and visually sorted into fabrics which were identified using a fabric-type series created from the site assemblage by the author in conjunction with the students. The quantities of each fabric with each context group were recorded by weight and sherd number. This information was noted on paper record sheets which were later transferred to a spreadsheet. Within each context group, rims and other diagnostic pieces were separated after initial quantification and kept on one side for subsequent study. These were examined and, where possible, the forms identified in published assemblages and typologies from the region. The information on the occurrence and dating of forms in each context was recorded on index cards and subsequently transferred to a spreadsheet. This information was then collated to provide a dating assessment. The various records, fabric descriptions and a fabric type series are kept with the site archive. A summary report providing an initial dating of the contexts was provided for SHAHT and was used by Geoffrey Cole in his analysis of the site.

When the author came to write-up the excavation much later in 2020–22, it became clear that not all the Roman pottery from the excavation had been provided for examination in the 1990s. Given the time and resources available, it was decided to examine this previously unstudied pottery on a spot dating basis. Each context was examined and a note made of the identifiable rim sherds and any other diagnostic material, as well as the broad range of fabrics. The fabrics were not quantified, but the identified rim forms were added to the previous spreadsheet. This means that we only have sample data on fabric supply (although this covers the key features and phases). In total 5499 sherds were recorded by fabric, and 395 vessels identified to form. Drawings have generally not been provided except for a sample of the Iron Age forms.

This summary report outlines the fabrics present in the assemblage and provides an assessment of the dating of the various features and phases. There is little doubt that a fuller examination of the material would refine understanding of the site, but it seems unlikely to alter our basic understanding of the site chronology or patterns in ceramic supply.

## The fabrics

The following fabrics were identified (for descriptions see appropriate references) as summarized in Table 1:-

### 1. Coarse wares

*Farnham ware* (Lyne and Jefferies 1979; Millett 1979; Millett and Graham 1986). Mason and Spencer 2020 fabrics AHSU & AHFA (not differentiated).

*Tilford ware* (Clark 1949; Millett 1979; = Portchester D ware - Tyers 1996, 194–95). Mason and Spencer 2020 fabric PORO.

*Brockley Hill ware* (= Verulamium-region white ware - Tyers 1996, 199–201). Mason and Spencer 2020 fabric VRW

*Black Burnished 1*, Dorset origin (Tyers 1996, 182–86). Mason and Spencer 2020 fabric BB1.

*Other coarse wares* (undifferentiated; sources not identified)

### 2. Fine wares

*South Gaulish samian ware* (Webster 1996, 13)

*Central Gaulish samian ware* (Webster 1996, 13-14)

*East Gaulish samian ware* (Webster 1996, 14)

*Oxfordshire colour coated ware* (Young 1977).

*New Forest ware* (Fulford 1975). Mason and Spencer 2020 fabric NFCC.

*Nene Valley ware* (Howe *et al.* 1980; Tyers 1996, 173-75). Mason and Spencer 2020 fabric NVCC.

*Much Hadham ware* (Tyers 1996, 168-69)

*Other fine wares* (undifferentiated; sources not identified)

### 3. Mortaria

*Oxfordshire mortaria* (Red ware) (Young 1977). Mason and Spencer 2020 fabric OXRC.

*Mancetter mortaria* (Tyers 1996, 123–25).

*Other mortaria* (undifferentiated; sources not identified)

### 4. Iron Age hand-made fabrics

*Iron Age (1)*: Colour neutral to brown (on exterior); rough surfaces with some signs of smoothing on the interior surfaces and burnish on exterior. Well-fired with hackly fracture. Abundant, well-sorted fine inclusions comprising rounded white quartzite and sub-angular clear quartz grains. Hand-made.

*Iron Age (2)*: Colour brown; rough surfaces. Well-fired with hackly fracture. Frequent inclusions of coarse angular flint fragments and finer grog. Hand-made.

[Intrusive material mainly comprised sherds of Post-Medieval fabrics from kilns on the Surrey/Hampshire border.]

|                         | Period 1  | Period 2  | Period 3A  | Period 3B  | Period 3C | Period 3D |
|-------------------------|-----------|-----------|------------|------------|-----------|-----------|
| Farnham (AHSU & AHFA)   | 108 (23%) | 332 (85%) | 2137 (85%) | 1290 (75%) | 328 (82%) | 11 (73%)  |
| Tilford (PORD)          |           |           | 36 (1%)    | 67 (4%)    | 21 (5%)   |           |
| Brockley Hill (VRW)     |           | 4 (1%)    | 1 (0%)     |            | 2 (0.5%)  |           |
| Black Burnished 1 (BB1) |           |           | 17 (1%)    | 7 (0.4%)   |           |           |
| Other coarse            | 351 (75%) | 15 (4%)   | 81 (3%)    | 275 (16%)  | 28 (7%)   | 2 (13%)   |
|                         |           |           |            |            |           |           |
| Samian (SG)             |           | 2 (0.5%)  | 13 (0.5%)  |            | 3 (0.8%)  |           |
| Samian (CG)             |           | 2 (0.5%)  | 12 (0.5%)  | 9 (0.5%)   | 1 (0.3%)  |           |
| Samian (EG)             |           |           | 1 (0%)     | 3 (0.2%)   |           |           |
| Oxfordshire             |           |           | 21 (1%)    | 17 (1%)    | 7 (2%)    |           |
| New Forest (NFCC)       |           |           | 20 (1%)    | 1 (0.1%)   |           |           |
| Nene Valley (NVCC)      |           |           |            | 1 (0.1%)   |           |           |
| Much Hadham             |           |           | 3 (0.1%)   | 2 (0.1%)   |           | 1 (7%)    |

|                                        |          |         |          |          |          |        |
|----------------------------------------|----------|---------|----------|----------|----------|--------|
| Other Fine                             | 1 (0.2%) | 32 (8%) | 136 (5%) | 49 (3%)  | 4 (1%)   | 1 (7%) |
|                                        |          |         |          |          |          |        |
| Oxfordshire <i>mortaria</i> Red (OXRC) |          |         | 7 (0.3%) |          |          |        |
| Mancetter <i>mortaria</i>              |          |         | 5 (0.2%) |          | 4 (1%)   |        |
| Other <i>mortaria</i>                  |          |         |          | 1 (0.1%) |          |        |
|                                        |          |         |          |          |          |        |
| Iron Age hand-made (1)                 | 1 (0.2%) | 4 (1%)  | 7 (0.3%) |          |          |        |
| Iron Age hand-made (2)                 | 5 (1.1%) |         | 7 (0.3%) |          | 1 (0.3%) |        |
|                                        |          |         |          |          |          |        |
| Total                                  | 466      | 393     | 2504     | 1722     | 399      | 15     |

Table 1: Quantities of Pottery Fabrics by Period (number of sherds)

### The forms

The forms present are detailed in the site archive and noted where appropriate in the dating summaries below.

### Dating summary

The detailed evidence for the dating of assemblages is given in the site archive. The following provides a summary based on the overall date-range of the fabrics and forms present in the Periods and principal features.

#### Period 1

Only two features of this period (Ditches 1 and 5) produced pottery, with the assemblage dominated by coarse wares many of which were not sourced. There were only a few sherds in clearly hand-made fabrics in distinctively Iron Age forms, but these included several vessels (Fig. 11) which are in the tradition of middle to later Iron Age pottery from the region. Vessels of this form certainly originate in the middle Iron Age, perhaps in the 3<sup>rd</sup> century BC (eg. Whittringham and Edwards 2018, 67–72, fig. 3), but in the N Hampshire region they continued in use down to the first century AD (cf. Thompson 1983, 185, fig. 23; 1984, 56, figs 6-7; Sanigar and Andrews 2020, 234). The examples from Lightwater may indicate activity from the Middle Iron Age onwards, but the occurrence of later fabrics suggests that the Period 1 features span the first centuries BC/AD. Such a chronology would be consistent with the dating of the unstratified Iron Age coin (see Haselgrove above). Excluding a couple of intrusive items, the latest forms from this period are generally consistent with the period ending around the end of the first century AD, comprising bead-rim and necked jars.

#### Period 2

The only good assemblage of pottery from this period comes from Ditch 6, and is dominated by Farnham ware with a few sherds of samian. Apart from a couple of intrusive sherds of Oxfordshire fine ware, it is consistent with a date in the second and perhaps very early third century AD. The forms represented are predominantly jars (bead-rim, necked and cordoned, plus some imitation BB1 forms), and bowls (so-called Atrebatian bowls, carinated bowls, and early flanged bowls).

#### Period 3A

There is a much larger assemblage from this period, from a series of features including those associated with Buildings 2 and 3. Fabrics and forms are more diverse than in the previous periods and seem compatible with a wholly domestic assemblage. With the exception of some forms that are probably intrusive (mostly coming from shallow deposits associated with Building 3), the assemblage is compatible with a date in the third to very early fourth century. Given the chronology of the later phases, it is most likely to date to the third century. Pottery supply continued to be dominated by Farnham ware products, with only a very small proportion of fine wares and other non-local wares. There is also a significant quantity of earlier material, presumably residual.

#### *Period 3B*

This assemblage is also large with very little to distinguish it from that of Period 3A. There are few forms that are exclusively fourth century and a date early in that century seems likely. Occasional sherds of Tilford ware (PORD) that should be dated to after AD 320 come from contexts where they may be intrusive, but their presence may suggest that the period continued a little after this date.

#### *Period 3C*

The assemblage from this period is smaller, but is also very similar in composition to that of Periods 3A and 3B. The occasional form should date to after the first quarter of the fourth century so a mid-fourth century date is likely.

#### *Period 3D*

Only a small group of pottery came from this period, and it is very mixed with significant residual material. This may imply that any focus of domestic occupation had moved away from the excavated area. There is nothing of the forms from this phase to indicate a date after the middle decades of the fourth century. The occurrence of dateable forms from the site as a whole indicates that activity probably ceased in the third quarter of the fourth century.

### Discussion

As might be expected in this area, the overall assemblage is dominated by Farnham wares except in Period 1. The low numbers of imported fabrics and fine wares as well as the range of forms suggest a site of comparatively low status. Nevertheless, the range of non-local fabrics indicates some participation in longer distance networks from at least the first/second century AD onwards. In this context the presence of material from areas to the north is perhaps notable. The range of forms demonstrates that the site was in occupation from the later Iron Age (probably first century BC) until the third quarter of the fourth century A.D. The volumes of pottery dateable to the Iron Age–second century AD may indicate a lower intensity of activity during that period, but may equally be a result of the smaller volumes excavated in the earlier phases. Although there is a relatively large number of earlier Roman forms from the site as a whole, the main emphasis is on the third and fourth-century types. There is little material dateable to the second half of the fourth century, with small amounts perhaps indicating some decline in this period, although we may again note the limited volume of excavated features of the latest phase.

### **The Ceramic Building Material (MM)**

A small assemblage of Roman-period building material was recovered, most of which was unstratified. The only stratified pieces came from contexts dated to Period 3A ([186] Building 3), Period 3B ([125] Ditch 12) and Period 3D ([538] Ditch 15C). Another sherd from the top of Ditch 1 [421] of Period 1 is intrusive. There were 8 identifiable fragments that came from *tegulae*, as well as

single pieces of *imbrex* and comb-decorated flue tile. This indicates that the CBM was not in use for the roofing of the excavated buildings, but was more probably used for other occasional purposes.

### **The Querns** by Ruth Shaffrey

An assemblage of seven querns was found at Site 19 at Lightwater. These have been recorded with the aid of a x10 magnification hand lens and are reported on in full here. All the querns are fragmentary and were recovered from features of mid to late Roman date or are from unphased contexts. They are all described as querns, but two examples have lost their circumference and as their size cannot be determined, they could be from either querns or millstones.

Lodsworth stone is the dominant stone type, accounting for six of the seven querns. Two of these are upper stones of flat-topped Sussex type, which is the typical form for this lithology (Shaffrey and Roe 2011, 317). One is broken along its lateral and perforating handle socket (SF 3). Three fragments are lower stones, of which one fragment from Ditch 12 [213] has a grinding surface dressed with harped grooves. These are of particular interest because querns of this stone type were only very rarely grooved. Two other examples with harped grooving are from Silchester and Richborough in Kent (Shaffrey 2003a; personal observation). The significance of the grooving is unclear, and the stone could be from either a rotary quern or a millstone. It may indicate that the stone was used for something other than cereal grinding.

Lower stones were also found in Ditch 6 [623] and Ditch 15C [377]. That from Ditch 15C has a pronounced lip around the spindle hole, a common feature of Lodsworth stone querns, but unlike the example above, both of these have the usual pecked surfaces.

The sixth quern of Lodsworth stone is a fragment of which the only original surface that survives is the grinding surface [523]. This may have originated as an upper rotary quern but the dished worn surface is consistent with use as a shallow mortar/grinding stone.

The seventh quern is made of sarsen [344] (Fig. 12). This is a fragment of large lower rotary type. The circumference does not survive, but the polish towards the edge of the fragment is typical of that seen on the outermost 20mm of grinding surfaces and the quern was therefore probably not much bigger than the surviving 460mm diameter. The grinding surface of the quern has rotational grooves that are variable in depth, and which appear to have been caused through use rather than being a deliberate addition to the grinding surface. Such grooves are typically seen on querns and millstones of coarser-grained and more open-textured sandstone such as Millstone Grit, where grains that are plucked out from the stone as it wears probably became trapped between the stones. Sarsen is too fine-grained and well-cemented for this to happen, and the grooves are therefore probably a result of the quern having been used to grind a harder substance than cereal grains.

The dominance of Lodsworth stone at Lightwater is typical of late Iron Age and Roman assemblages in this region with querns of Greensand, mainly Lodsworth stone, by far the most dominant in towns and other occupation sites south and east of Silchester (Shaffrey 2021, fig 5). Rotary querns of sarsen are unusual with only a handful of other examples from the region. A probable rotary quern roughout was found in Datchet some 15km to the north-east (Shaffrey 2003b) and two sarsen rotary querns were found at Ewell, 28km to the east, including one of comparably large diameter (Huson 1995, 14; Shaffrey 2017, 263). Sarsen rotary querns have also been found in Roman features on a small number of sites to the west including in Reading, at Silchester, and in Basingstoke (Shaffrey 2003a, 158; Moore and Jennings 1992, 97; Williams 2010, 35; Williams 2011, 75; Wooders 2000, 387).

The querns range from 360–460mm in diameter and are therefore all of domestic, hand-operated size. Querns are usually assumed to represent cereal processing either for flour or for malt, and this is probably true for the Lodsworth stone examples of typical form. They were not necessarily used for their primary purpose on this site, however, and may have been brought here as rubble, with hard stone being a valuable commodity in its own right. The wear on the sarsen quern, however, and the unusual grooving on one of the Lodsworth stone querns hints at the possibility that one or more of the querns was used for processing other materials. This use remains unexplained but is unlikely to have been associated with ore preparation.

#### Catalogue of querns

1. Upper rotary quern. Lodsworth stone. Quarter fragment of flat-topped type. The grinding surface is pecked with rotational wear and some polish on the outermost 20mm. The upper surface is flat and roughly tooled. The edges are damaged and crudely chipped. The centre is missing. Measures 370mm in diameter x 21-38mm in thickness. Weighs 1455g. SF77 [344]. Unphased occupation level.

2. Lower rotary quern. Lodsworth stone. Fragment of disc type with a slightly convex grinding surface with harped grooves, with 8+ and 12+ grooves in each harp. The lower surface is crudely pecked. The circumference and centre are absent. Measures 41mm in thickness. Weighs 1491g. Ditch 12 [213]. Period 3B. Early 4th century.

3. Upper rotary quern. Lodsworth stone. Fragment of flat-topped type with a slightly concave grinding surface dressed with pecking and now with light rotational wear. The circumference is straight and pecked and the upper surface is flat and pecked. The centre is absent. The quern has broken along a lateral perforating handle socket of 18mm depth. Measures c. 400mm in diameter x 17-58mm in thickness. Weighs 1870g. SF3. Building 4 [12]. Period 3C. Early 4th century.

4. Lower rotary quern. Lodsworth stone but coarser grained than typical. Fragment of disc type with slightly sloped pecked grinding surface with some smoothing across the chert inclusions, pecked vertical edges, and flat very roughly tooled base. The centre is damaged. Measures c 360mm in diameter x 68mm in maximum thickness. Weighs 1159g. SF111. Ditch 6 [623]. Period 2. 2nd-early 3rd century.

5. Mortar/grinding stone. Lodsworth stone. Fragment of highly smoothed dished stone, 14mm deep at the deepest point. All the other faces are damaged, but the smooth wear is consistent with use as a mortar/grinding stone. Possibly a reused fragment of dished upper rotary quern. Fragment measures 110 x 110 x 110mm. Weighs 1483g. SF99. [523]. Unphased.

6. Lower rotary quern. Sarsen (Fig. 12). Fragment of tapered type with slightly sloped grinding surface, flat and roughly worked base. The eye is circular and cylindrical and measures 80mm in diameter. The grinding surface is differentially worn so that it is smoothed towards the circumference and rougher towards the centre. There are rotational grooves, which are variable in depth, and which appear to be caused through use. The circumference does not survive but the grinding surface is polished right at the broken edge and there is 20mm of smoothing suggesting the measured diameter is very close to the original size. Measures 460mm in diameter x 64-86mm in thickness. Weighs c. 7kg. SF78. [344]. Unphased occupation level.

7. Lower rotary quern. Lodsworth stone. Centre fragment with a pronounced lip around the spindle hole measuring 30mm in height and 110mm in diameter. The lip is pecked all over suggesting it was maintained as a deliberate feature. The rest of the grinding surface is also pecked and slightly angled with some rotational wear. The edges are missing. The spindle hole is fully perforated, circular but slightly angled/irregular in profile. It measures 30mm in diameter. Measures >300mm in diameter x 75mm in thickness. Weighs 1534g. SF85. Ditch 15C [377]. Period 3D. Mid 4th century.

8. Uncertain. Pale-brown quartzitic sandstone. Broken stone with one very smooth curved outer edge. Possible originated as a grindstone. Weighs 1250g. [747]. Unphased.

### **The Metal-working evidence (SP)**

Over 4 tonnes of slag was excavated at Lightwater, indicative of metalworking on a substantial scale. A proportion (1.16 tonnes) was weighed and catalogued by SHAHT before being reburied near the boundary of the cottages at the site, and another 1.18 tonnes was retained and catalogued separately; but the nature of the remaining slag recovered, and the extent of the slag spread outside the excavation area, is not known. The slag catalogues were created by members of SHAHT.

| <b>Period</b>          | <b>Feature</b> | <b>Weight of slag</b> |
|------------------------|----------------|-----------------------|
| 1                      | Ditch 1        | 53.975kg              |
|                        | Ditch 5        | 42.971kg              |
| Period 1 total         |                | 96.946kg              |
| 2                      | Ditch 6        | 36.025kg              |
|                        | Building 1     | 0.521kg               |
| Period 2 total         |                | 36.546kg              |
| 3A                     | Ditch 10       | 266.081kg             |
|                        | Ditch 11       | 127.44kg              |
|                        | Building 2     | 6.285kg               |
|                        | Building 3     | 146.545kg             |
| Period 3A total        |                | 546.351kg             |
| 3B                     | Ditch 12       | 166.194kg             |
|                        | Ditch 13A      | 0.21kg                |
|                        | Ditch 13B      | 1.05kg                |
| Period 3B total        |                | 167.454kg             |
| 3C                     | Ditch 13C      | 0.18kg                |
|                        | Ditch 14       | 0.395kg               |
|                        | Ditch 15A      | 239.727kg             |
|                        | Building 4     | 123.74kg              |
| Period 3C total        |                | 364.042kg             |
| 3D                     | Ditch 15B      | 66.728kg              |
|                        | Ditch 15C      | 108.84kg              |
|                        | Ditch 16       | 6.5kg                 |
|                        | Ditch 17       | 43.16kg               |
|                        | Ditch 18       | 0.28kg                |
|                        | Ditch 19       | 0.85kg                |
| Period 3D total        |                | 226.358kg             |
| Later & unphased total |                | 1123.625kg            |

|            |  |            |
|------------|--|------------|
|            |  |            |
| Site total |  | 2561.322kg |

Table 2 Summary of the quantities of iron slag by feature

### Iron-working Background

Iron smelting uses high temperatures and a strongly reducing atmosphere to extract iron metal from iron-rich minerals. In the Iron Age this took place using bloomery smelting technology (Paynter 2006; Tylecote *et al.* 1971; Sauder 2013; Crew 1991; Young 2020). Although furnace shafts rarely survive, they were clay-built, and sometimes constructed within a pit or against a bank. Furnaces burned charcoal fuel and were probably bellows-blown, and the smelt produced a spongy mass of iron or 'bloom', which formed in the hottest part of the furnace, just below the bellows blowing hole. Some of the ore, fuel ashes and furnace lining combined to form a liquid slag that separated from the metal and collected at the bottom of the structure (Clough 1985; Tholander 1987). In Iron Age furnaces, the slag drained into a pit below, forming large slag masses, furnace bottoms (FBs) or slag blocks. Alternatively, it could be released or raked out hot by opening the furnace belly or some combination of these methods. By contrast, in the Romano-British period, slag was tapped through a tapping arch, cooling with a flowed morphology resembling lava (tap slag), which is readily recognizable.

After smelting, the bloom was forged to consolidate and shape the metal. Forging /smithing also generated diagnostic slag waste, hammerscale and smithing hearth bottoms (SHBs), but in smaller quantities. It is likely that blooms were consolidated immediately following smelting, to save on the fuel and labour required for reheating. Ironworkers may have made trade bars or billets on site as well (the primary stage of smithing) (Crew 1994; Hingley 1990); the presence of contemporary smithing waste at a smelting site is usually interpreted as evidence of bloom compaction and/or primary smithing (Crew 1986; 1989; Hanworth and Tomalin 1977; Young 2020; Paynter 2007a). Potentially an ironworker could also produce objects at the smelting site (secondary smithing), but equally iron billets could be transported to settlements elsewhere for further working. Secondary smithing includes the production of items from stock metal, recycling and repairing objects, and is a common at settlement sites of all periods.

### Smelting at Lightwater

Waste slag from smelting, the process of extracting iron metal from the ore, dominated the retained assemblage. This included very large slag blocks or furnace bottoms, ranging from 10kg to 80kg in weight, as well as numerous fragments of these. This type of slag is characteristic of non-tapping or slag-pit smelting furnaces; although there are some runs and prills of slag, there is no typical tap slag as would be produced by a tapping furnace. A proportion of the slag assemblage is undiagnostic and could not be confidently attributed to any category.

### *Furnace construction and operation*

No smelting furnace remains were found but the slag morphology gives an indication of how they were constructed. The furnaces were each built over a pit, with a shaft built above, which may have been slightly domed and potentially cut into a bank at the base. The furnaces would have been bellows blown through a blowing hole near the base of the shaft, as the forced draught enables higher temperatures to be reached. Impressions in the slag indicate that the pit beneath the furnace was initially packed with organic material before the furnace was charged. During smelting the pit

gradually filled with slag that drained from the furnace above, spreading through the pit as the organic material burnt away. The slag cooled in the pit forming the large masses or furnace bottoms of the type dominating the Lightwater assemblage.

The intact furnace bottoms from Lightwater share several features (Figs 13–14). The larger ones are broadly rectangular in shape but with rounded corners. They have sharply-cut parallel, near vertical sides and a consistent depth of about 0.2m. The base is flat and the top is often level, sometimes slightly concave, probably from the bellows blast since the pit was located directly under the shaft. Many of the slag masses had protrusions at one of the shorter ends with adhering clay at the same end, and this may be the side where the blowing hole was located. This is the region of greatest heat, which has caused part of the furnace shaft to erode creating the protrusion, and accelerating the reaction of the slag and clay. This feature tended to be exaggerated on one side, suggesting that there was only one blowing hole in most cases. The sides and underneath of the slag masses sometimes show the outline of flattened prills of slag. These are from the early stages of the smelt, as the first dribbles of slag started to flow into the pit where it cooled quite quickly, becoming viscous, and failing to wet the sides of the pit. Many of the slag pieces contain large mineralized fragments of wood or angular voids showing that the pits were packed with split wood before smelting, which has later burnt or rotted out. More rarely, long thin impressions of cereal can be seen, making up the pit packing material (Paynter 2007b).

### Smithing at Lightwater

It is difficult to identify evidence of smithing, the process of shaping iron, at smelting sites because smithing waste is a smaller proportion of the assemblage overall and often fragments more quickly. For example, at the Late Iron Age smelting site at Stockbury, Kent, diagnostic smithing slag was 5wt% of the assemblage (Girbal 2019) and at the Romano-British smelting and smithing workshops at Westhawk Farm, Kent, diagnostic smithing slag was 4wt% of the total assemblage (Paynter 2007a). Several possible smithing slags were picked out from a small sample of the retained Lightwater assemblage however, due to their bowl-shape, smaller size and shallower depth, and rusty or concreted appearance (Fig. 15) (see Table 3). All were from unphased or Period 3A contexts, so their association with the earlier smelting is assumed but not certain (see Phasing and distribution). These cover a very similar size range (448g to 2350g, mean 1160g) to ones from Hartshill Copse, which Young (2020) argued were a product of consolidating large blooms and therefore larger than a typical assemblage from a secondary smithing site (where smithing hearth bottoms are typically under 800g, with many less than 250g).

| Context | Weight of SHBs (g) | Context description | Phasing   |
|---------|--------------------|---------------------|-----------|
| [52]    | 608, 640           |                     | Unphased  |
| [720]   | 1307               | Ditch 10            | Period 3A |
| [283]   | 1311               |                     | Unphased  |
| [237]   | 637                |                     | Unphased  |
| [741]   | 309 (partial)      |                     | Unphased  |

Table 3 Contexts containing possible smithing slag, and the weight of identifiable smithing hearth bottoms (SHBs)

### Phasing and distribution

The slag was found across the excavated area in contexts of all phases, mainly deposited in ditches and gullies; none was found *in situ*. In these circumstances it is not possible to undertake a detailed examination of the distribution of different types of waste by phasing and site location, but contexts with an excess of 50kg of recorded slag are listed in Table 4, with context information where known, and these range from the 2nd to the 4th century AD.

| Context | Slag (kg) | Context description                                           | Period   |
|---------|-----------|---------------------------------------------------------------|----------|
| [567]   | 147.55    | Ditch 15A                                                     | 3C       |
| [127]   | 104.75    | Unphased: Layer in vicinity of Buildings 2/3/4                | 3        |
| [141]   | 101.51    | Unphased: Layer in vicinity of Buildings 2/3/4, beneath [127] | 3        |
| [945]   | 97.56     | Unphased: associated with [754] (redeposited)                 | Later    |
| Surface | 88.01     | Unstratified                                                  | Later    |
| [428]   | 86.45     | Ditch 15A (associated post hole)                              | 3C       |
| [390]   | 86.1      | Modern: (in vicinity of Building 3 – probably redeposited)    | Later    |
| [538]   | 83.41     | Ditch 15C                                                     | 3D       |
| [494]   | 78.65     | Building 3 (post hole packing)                                | 3A       |
| [139]   | 73.66     | Unphased: Layer in vicinity of Buildings 2/3/4, beneath [127] | 3        |
| [125]   | 65.95     | Ditch 12                                                      | 3B       |
| [662]   | 63.75     | Ditch 10                                                      | 3A       |
| [128]   | 57.04     | Building 4                                                    | 3C       |
| [1]     | 55.28     | Unstratified                                                  | Later    |
| G1/E1   | 54.29     | Unphased                                                      | Unphased |
| [172]   | 52.92     | Ditch 10                                                      | 3A       |
| [143]   | 52.34     | Unphased: Layer in vicinity of Buildings 2/3/4, beneath [127] | 3        |

Table 4 Listing the weight of slag by context ordered in decreasing weight (combined retained and reburied slag) and provisional phasing

Despite most of the slag being recovered from Romano-British contexts, it was also reportedly present in the earliest features at the site from Period 1, including multiple pieces over 4kg in weight, described as smelting lumps or having some evidence of prills consistent with smelting (Table 5). The slag morphology at Lightwater is also consistent with the non-tapping slag assemblages from surrounding Iron Age sites, whereas typical Roman tap slag is absent. From the slag morphology and chemistry, it is most likely therefore that the smelting activity at Lightwater took place in the Iron Age but for an unknown duration. The most intensive activity was probably in the Late Iron Age (by comparison with the activity at surrounding smelting sites like Sadler's End), but ceasing sometime in the 1st century AD. The slag has been moved and redeposited often in the past, during Romano-British occupation as well as more recent horticultural landscaping.

| Description | Contexts | Total weight (kg) |
|-------------|----------|-------------------|
| Ditch 1     | [121]    | 8                 |
|             | [145]    | 14                |
|             | [328]    | 7.2               |
|             | [330],   | 7.4               |

|         |        |     |
|---------|--------|-----|
| Ditch 5 | [335]  | 4.3 |
|         | [478]  | 7.2 |
|         | [421]. | 8.6 |
|         | [423]  | 22  |

Table 5 Period 1 contexts containing in excess of 4kg of slag

From Period 1, the largest lumps of probable smelting slag recorded were 12kg and 7kg in [145] and [421] respectively, but there were no larger examples so, it is possible that there was some adaptation of the smelting process over time, with the smelting capacity gradually increasing. This cannot be investigated further at Lightwater because very few of the Iron Age features were excavated and none of the slag from them was retained but there are contemporary smelting sites where the technology was modified over time. At nearby Sadler's End it appeared that earlier furnaces were single use and smaller, whereas the latest furnace was used repeatedly and larger (Lewis *et al.* 2013), and similar chronological developments have been noted at Wakerley in Northamptonshire (Jackson and Ambrose 1978; Cowgill and Gale 2007).

Probable examples of smithing slag were also recovered from Romano-British contexts, often re-used in the vicinity of Buildings 2, 3 and 4 (see Table 6). The date of this smithing activity is therefore uncertain but is assumed to be associated with the LIA large-scale smelting at the site.

| Context | Weight (g)    | Context description                                  | Period |
|---------|---------------|------------------------------------------------------|--------|
| [52]    | 608, 640      | Unphased: Layer in vicinity of Building 3            | 3      |
| [720]   | 1307          | Unphased: post hole packing associated with Ditch 10 | 3A     |
| [283]   | 1311          | Unphased: post hole in vicinity of Buildings 2/3/4   | 3A–3C  |
| [237]   | 637           | Unphased: in vicinity of Buildings 2/3/4             | 3A–3C  |
| [741]   | 309 (partial) | Unphased: associated with Ditch 15B                  | 3D     |

Table 6 The weight of individual probable smithing hearth bottom slags by context and phasing

## Raw materials, by-products and products

### Clay

At Lightwater, the clay used for furnace construction was very silica-rich, in common with furnace linings from other Iron Age and Romano-British smelting sites, which usually contain in excess of 80wt% silica (for examples see Paynter 2006). Silica-rich clay is able to withstand smelting temperatures but is also easily fluxed by iron oxide to form a fluid slag, which will separate cleanly from the iron bloom. An example adhered to furnace bottom smelting slag from Lightwater contained 84wt% silica and another from nearby Hartshill Copse contained 86wt% silica, the remainder in both cases was made up of small amounts iron, alumina and potassium oxides (Young 2020).

### Slag

The smelting slag has an extremely high phosphorus content. This is not due to the post-burial environment because the phosphorus is incorporated into several phases in the slag microstructure (Table 7). Although the ashes from the charcoal fuel contain phosphorus, this would contribute only

a very small amount to the total, and therefore the bulk of the phosphorus must be derived from the ore. Although only a small number of samples were analysed, the results were consistent with each other and with contemporary assemblages from nearby, so are thought to be representative (see below, Lightwater in regional context).

| Context |        | Na <sub>2</sub> O | MgO  | Al <sub>2</sub> O <sub>3</sub> | SiO <sub>2</sub> | P <sub>2</sub> O <sub>5</sub> | SO <sub>3</sub> | K <sub>2</sub> O | CaO  | TiO <sub>2</sub> | MnO  | FeO   |
|---------|--------|-------------------|------|--------------------------------|------------------|-------------------------------|-----------------|------------------|------|------------------|------|-------|
| [567]   | Slag   | 0.35              | 0.34 | 1.72                           | 22.35            | 6.51                          | bd              | 0.42             | 1.70 | 0.12             | 0.50 | 65.90 |
| [678]   | Slag   | 0.69              | 0.46 | 3.29                           | 28.07            | 4.87                          | bd              | 0.49             | 1.13 | 0.15             | 0.65 | 60.00 |
| [567]   | Lining | 0.22              | 0.43 | 3.32                           | 83.89            | 1.67                          | 0.51            | 1.46             | 0.34 | 1.14             | 0.16 | 6.84  |

Table 7 Analyses of smelting slag and furnace lining from Lightwater by SEM-EDS, average of 8 analyses each for the slag samples, two for the lining, normalized, bd = below detection limit. [567] Ditch 15A, Period 3C; [678] unphased

### Ore

Iron ores are common and geographically widespread. There are numerous historically well-known rock iron ore sources (Groves 1952; Salter and Ehrenreich 1984; Tylecote 1990) but lesser known, secondary ores were also exploited in the past, for example layers or nodules of bog ore or iron pan can precipitate from iron-bearing water (Clogg 1999; Young 2010). These rich and accessible sources of iron appear to have been the dominant resource in the Iron Age. Bog ore can precipitate in different types of deposit, including sands and gravels as here, and have variable compositions (Thelemann *et al.* 2017) but elevated levels of phosphorus or manganese are key indicators.

Where bog ore and iron pan contain elevated phosphorus, it is carried through into both the metal and slag during bloomery smelting (Crew 1991; Piaskowski 1989), resulting in a phosphoritic iron alloy and phosphorus-rich slag. Like steel, phosphoritic iron is harder than plain iron, and can be hardened further by working the metal, but becomes brittle in some circumstances. Analyses of slag waste show that most ore sources exploited in the Iron Age contained some phosphorus suggesting that secondary bog, or iron pan, ores were very widely used (Crew 1991; Paynter 2006; Young 2010). The smelting slag from Iron Age sites in the region around Lightwater, and including the analysed samples from Lightwater itself, contains the highest level of phosphorus so far detected in smelting slag from England (Paynter 2006; Lewis *et al.* 2013). Peat is recorded in the area of the Windle Brook, immediately north of the excavation, indicating that appropriate conditions exist nearby for the formation of bog ore (see General Introduction above).

### Iron alloys

The very high phosphorus levels in the smelting slag from Lightwater show that the ironworkers there were making phosphoritic iron. Ehrenreich (1985) studied over 500 iron artefacts from sites in the south of England and found that iron became more widely used around the middle Iron Age, generally coinciding with an increased incidence of phosphoritic iron (containing more than 0.08wt% of phosphorus); potentially this can be linked to the increased exploitation of bog ore. Ehrenreich also found that different types of alloy were used for particular objects; there were phosphoritic iron ploughshares and adzes, but no swords, daggers or chariot tyres. By about 400BC, large hooked cutting blades were made from phosphoritic iron whereas smaller ones tended to contain less phosphorus, and by 300-100/50BC more than half of the objects studied were of phosphoritic iron. Further evidence for the local production of phosphoritic iron can be found through studying

currency bars. These have different sizes and forms, which demonstrate the quality of the metal for shaping, and each type tends to have a specific regional distribution. The chemistry of the metal and slag in the bars can often be linked to the ores available in the area where they are found (Hedges and Salter 1979, Paynter 2013, Crew 1994). Crew's Type M or 'Datchet' bar have been found near to Lightwater (Crew 1994), and examples from Reading were found to contain slag with higher phosphorus concentrations than any others so far analysed (Hedges and Salter 1979), consistent with a local origin and the production of phosphoritic iron for wider trade.

## Discussion

### *Scale of each smelt*

The size of individual slag masses can provide an indication of the scale of each smelt. At Lightwater pieces of slag were weighed individually during recording, which allows the weight of individual fragments from the examined sample to be plotted (Fig. 16). Sometimes there are a range of different sizes and morphologies of furnace and smelting slag at a single site because ironworkers often returned to an ore source over a long period, and the smelting process might change over this time (Jackson and Ambrose 1978; Cowgill and Gale 2007; Lewis *et al.* 2013) but at Lightwater the intact slag masses are fairly consistent in size. The duration of each smelt was dictated by the capacity of the slag pit, since once the pit was full, the blowing hole would become obstructed, so consistency in the size of the pit was important.

The smelts that fully filled the pit have created a series of small plateaus in the graph (Fig. 16), reflecting the capacity of the pit dug; most are under 30kg. A substantial proportion of furnace bottoms fall between 10 and 30kg. Some furnace bottoms have not completely filled the pit (they are less thick or have an uneven far edge) or they have fragmented at some point in the past. In other instances, the smelt has run at a slightly lower temperature, and the resulting mass is full of voids so again has a lower weight. The dimensions of some of the furnace bottoms from this range are given in Table 8 and are reasonable for a single smelt: at nearby Fleet Hill (3rd–4th century BC) the slag masses were up to 20kg (Hardy and Young 2019), an example from Hartshill measured 500mm x 420mm x 200mm thick and weighed 33.8kg (Huvig *et al.* forthcoming; Young 2020), and the largest block from Sadler's End, Sindlesham was 30kg and measured 390mm x 260mm x 290mm. Half (by count) of the recorded fragments from Lightwater are under 7.5kg, and this will include many smithing slags, as well as fragmented furnace bottoms, most undiagnostic slag and pieces of furnace structure.

Some variation in the size and morphology of furnace bottoms from a site is to be expected, even if smelting activity is short-lived; differences in the charge, conditions and duration of each smelt affect the size of the furnace bottom produced. Also, most bloomery furnaces from the Late Iron Age show signs of repeated repair and re-use (McDonnell 2015; Lewis *et al.* 2013; Girbal 2019) and chemical erosion during each smelt, or damage when removing the furnace bottom afterwards, will gradually enlarge the pit. So, the slag masses produced by a given furnace might naturally increase with each smelt until such point as the furnace is abandoned and a new one built. A small number of the Lightwater slag masses are double the typical size however, which cannot be explained by any of these scenarios. Such extremes are not unknown, and a similar range of slag masses was found at Welham Bridge, in Yorkshire (Clogg 1999), tentatively dated to the 3rd to 5th centuries BC. The majority were around 360 mm across weighing about 13 kg, but many larger examples, the biggest 74 kg, were also recovered, which is very similar to Lightwater.

| <b>Context</b>              | <b>Weight (kg)</b> | <b>Width (mm)</b> | <b>Length (mm)</b> | <b>Depth (mm)</b> |
|-----------------------------|--------------------|-------------------|--------------------|-------------------|
| [560] unphased              | (partial)          | 170               | 240                | 170               |
| Unknown                     | 9.5                | 230               | 250                | 200               |
| Unknown                     | 9.8 (partial)      | 220               | 220                | 200               |
| [567] Ditch 15A, Period 3C  | 10.95              | 270               | 260                | 150               |
| [737] unphased              | 17.11 (partial)    | 270               | 300                | 160               |
| Unknown                     | 18.2               | 270               | 300                | 200               |
| Unknown                     | 20.65              | 320               | 430                | 160               |
| Unknown                     | 29.55              | 290               | 370                | 200               |
| [567A] Ditch 15A, Period 3C | Lab                | 240               | 340                | 190               |
| Unknown                     | 37.35              | 370               | 420                | 180               |
| [567]                       | 62.6               | 350               | 500                | 200               |
| Unknown                     | Sectioned          | 360               | 270 (halved)       | 200               |

Table 8 The weight and dimensions of a selection of large furnace bottoms from the retained assemblage.

Several of the massive (~70kg) furnace bottoms appear to have two concave areas on the surface, probably corresponding to two blowing holes (Fig. 15), so these large examples may be from two smelting events, where a second furnace pit was built adjacent to another and the furnace bottoms fused, or where a previously formed slag block was dragged only partially clear of the pit and a second slag block formed adjacent and adhered to it. These double furnace bottoms would have been difficult to move once formed, so may represent the end of the furnace's life or where a season of activity was drawing to a close. An alternative is that the double furnace bottoms could be the product of a larger furnace, operated with two blowing holes and producing two blooms. There are some examples of very large tapping bloomery furnaces in the Romano-British period with multiple blowing holes, but there has been no clear evidence of dual blowing holes from Late Iron Age furnaces yet (Crew 1998).

### *Conclusions*

Iron smelting took place at Lightwater in the Iron Age on a large scale for an unknown duration, but probably concentrated in the period 200 BC until sometime in the 1<sup>st</sup> century AD, probably ceasing before the Romano-British phase of the site. The ironworkers smelted a high-grade bog ore found in the immediate vicinity, producing phosphoritic iron and phosphorous-rich slag waste. No furnace remains were found but the slag morphology shows that non-tapping, slag pit furnaces were used, fuelled with charcoal, using a siliceous clay for the furnace lining, and bellows blown through a single blowing hole. The slag drained into a pit beneath the furnace, initially packed with split wood and cereals or grasses prior to smelting. The furnaces were probably slightly longer on one axis and the internal diameter was of the order of 0.2m to 0.4m, but they would have had thick walls and were probably re-used and repaired. Although other types of furnace may have been used earlier in the site occupation, there is not clear evidence for this. Bloom compaction and possibly the initial stages of smithing also took place at the site. The small number of very large slag masses are most probably fused blocks from two smelting events, or less likely the product of a furnace with two blowing holes (as no evidence for the latter has been observed at comparable sites in the area). Each smelt generated between 12 and 30kg of slag therefore the 4 tonnes of slag from Lightwater would

represent at least 130 smelts (see Scale of iron production, below). Very few Iron Age features were revealed and identified in the excavations, and most of the slag had been re-used or redeposited, so little is known about the nature of the site in the Iron Age, but it appears to have been largely industrial in purpose and was producing iron to export further afield.

### **Discussion and conclusions (MM and SP)**

The excavation at Lightwater provides new information that contributes to understanding of the Iron Age and Roman periods in the area around the Surrey/Hampshire/Berkshire border. Inhospitable soils and past human exploitation has led to the development of heathlands in this area today, and the evidence from the Iron Age and Roman periods suggests that it was only settled at a low density then, with evidence of few settlement sites (xref above). Although this may be partly the result of a lack of research in an area which has been assumed to have been thinly occupied, there are good reasons for believing that its past exploitation was different from adjacent areas that were agriculturally rich and densely occupied (Smith *et al.* 2016, 78–90). Despite the limitations of the excavation, the site does both contribute to knowledge of the region and raise questions for future research on several topics, especially the nature of the settlement, its networking, and the context of iron production.

There seems little doubt that the excavation failed fully to explore the extent of the earliest phases of the settlement and there are also doubts about the chronology of Period 1. There may have been activity from the Middle Iron Age (possibly third century BC), but the balance of evidence indicates that the excavated Period 1 features were infilled in the first centuries BC/AD. The Period 1 features must have extended further than revealed by the excavation, and their intercutting perhaps implies a prolonged sequence. There is sound evidence for the deposition of iron smelting slag in the Period 1 deposits, providing confirmation of its early date, but we should be aware of the possibility that it was residual in even these deposits, with production actually predating the excavated ditches. This seems unlikely, but in the absence of a programme of radiocarbon dating of material associated with the slag, we cannot be certain.

The subsequent phases were more fully mapped in the excavation, and give a better indication of the nature of the settlement. It is clear that the excavated elements form parts of a system of ditched enclosures, like those that occur frequently across the landscape of much of lowland Britain in later Prehistory and the Roman-period (eg. Bird 2017, figs. 6.3–6.6). These have been referred to as ‘complex farmsteads’ by the Roman Rural Settlement Project, which has mapped their distribution and discussed their occurrence in developer-funded archaeological projects in this region (Smith *et al.* 2016, 28–33, fig. 2.13; 84–90). The evidence from the excavation is spatially limited and it is clear that the settlement was more extensive.

The local topography demonstrates that the site was situated on the edge a plateau beside the valley of the Windle Brook but above the poorly drained soils in the valley floor. It is notable that this type of location is shared with the medieval villages along this valley, which were also constrained by the same local environmental factors. The other known Iron Age and Roman-period sites in the area, at London Road, Bagshot (Cole 1994) and Rapley Farm (Handasyd 1785) are also similarly located. Limited excavation at the former suggests a similar type of settlement to that at Lightwater (D. Graham, pers. comm.). It is unclear whether our site was separated from others along the valley or whether, as on the margins of some other river valleys, there was a more or less continuous series of connected enclosed settlements or even what amounts to a linear enclosure system (cf. Taylor 2007, 25–26). This question will only be resolved by further fieldwork in the area.

Whatever its exact form, the Lightwater site appears consistent with a pattern of site morphology that is now emerging in SE England, where it is notable that complex farmsteads are more frequent in the London basin than in adjacent regions (Smith *et al.* 2016, fig 4.10), perhaps because of tighter environmental constraints in areas of poor drainage where settlement was focused in more limited areas. In the particular context of Lightwater, with the presence of bog-iron ore indicated by the peat deposits on the valley floor, there was an additional incentive for a focus on this location during the Iron Age, and potential to re-use the waste slag in subsequent periods.

The margins of the Windle Valley also provided a natural communication route, and it seems likely that the trackway at the N edge of the excavation in Period 3D represents one manifestation of this. There is nothing from the excavation that resolves the question of whether the Roman road from Stane Street towards Farley Heath continued northwards and passed nearby (xref above). In any case, a focus on such a road fails to take full account of the existence of networks of routeways that will have linked sites, and formed the principal connections within the settlement network. Such a route connecting the Lightwater site with the roadside nucleus at Wickham Bushes on the road from London to Silchester (xref) undoubtedly existed even though not yet mapped.

The information we have about the character of the Iron Age and early Roman phases of the site is limited as we have only incomplete evidence from its ditches. The Iron Age coin suggests that there were connections to areas N of the Thames (xref), and this is perhaps supported by the sources of later non-local pottery (xref). This does not of course preclude links in other directions, indeed the early Roman pottery certainly illustrates supply from the Alice Holt/Farnham area a little distance to the SW. By contrast, the excavation provides insights into the character of the site in the mid Roman-period especially with the unusually well preserved evidence of Buildings 2, 3 and 4. The associated finds assemblage indicates that we are dealing with a settlement of comparatively low social status. There are non-local ceramics and a range of fine wares, but these are limited in number and the overall form assemblage also supports this conclusion (cf. Evans 2001). This emphasises the importance of the evidence from the timber buildings, since well-preserved examples of lower status timber buildings is comparatively rare in Roman Britain (Smith *et al.* 2016, 64–65). The buildings themselves are well-built, and show some similarities to aisled halls. Although the latter are often dismissed as barns, they are actually complex and spacious structures that are more likely to have been generally used for communal purposes and habitation, often with high status aspects (Wallace 2018). The Lightwater buildings are smaller and less elaborate, but would nonetheless have required a considerable amount of timber and some structural sophistication. They were almost certainly used as general purpose structures with people living, working and perhaps also keeping livestock and agricultural products in them. This continued the Iron Age tradition of communal space, represented by earlier round-houses. The probable use of earth walls in Building 4 is very unusual and deserves particular note.

What distinguishes the Lightwater site from most other known sites is its role in iron production which is discussed further below. This also raises two broader questions about the context and local environment which have a key bearing on the interpretation of the settlement itself. First, what are the implications of iron production for understanding exploitation of the local environment, and second, what was the economic role of the site in the Roman period after iron production had ceased? The presence of bog-iron ore indicated by local peat deposits is of course key to the development of iron production in the pre-Roman period, but this industry also required charcoal as fuel, and there is a very strong likelihood that this was the product of active woodland management, with coppicing to ensure supplies (Halkon and Millett 1999, 222–23). The character of

the local heathland soils would have allowed them to be exploited for this purpose, and indeed this was perhaps optimal given their poor arable potential. We lack good evidence to confirm this, but it is a subject which could be further investigated in the future. If we are correct in concluding that woodland management and charcoal production was important in the Iron Age, it may be that it continued to be important for the economy, after iron production ceased, in the Roman period. In a comparable context in East Yorkshire, iron production was replaced by pottery manufacturing, also a high temperature technology requiring the woodland resources (Halkon and Millett 1999, 226–28). This substitution does not seem to have happened at Lightwater, but the continuation of woodland exploitation with the production of charcoal is certainly likely, providing at least part of the economic foundation for the Roman-period settlement. Although not often discussed, timber and charcoal were important in the ancient economy, and their supply in particular to urban centres will have been important (Allen *et al.* 2017, 230–34). Whether production from this area supplied just more local centres including Staines and Silchester, or reached further remains unknown (cf. Veal 2012). Given the local environment, it seems unlikely that arable agriculture played a significant role in the economy of the settlement, but this does not preclude a mixed farming economy including animal husbandry using pasture on the valley floor as well as pannage within managed woodland. The presence of querns shows that cereals were being processed (xref), although these need not have been grown locally.

Finally in this context, it is worth considering how far the community in this area might have been marginalised within society. Heathland and woodland environments are often seen as socially marginal, and there is some ancient evidence that those associated with iron production were themselves seen as mysterious because of their control over altering the nature of matter and thus having divine connections (Hingley 2006, 217). Although this is clearly speculative, it may provide some context for understanding the underdeveloped character of this part of the country.

### *Scale of iron production*

Experimental work using bloomery furnaces based on archaeological examples has provided estimates of the losses at each stage of smelting and smithing (Crew 1991; 1994; Sauder 2013; Tylecote *et al.* 1971; Paynter 2007b). The results of these experiments can be used to estimate the scale of iron-working at Lightwater based on the amount of slag waste found, albeit an underestimate as the site was not fully excavated. Only 40% of the iron (as Fe) available in the ore is reduced to metal; a large proportion is lost to the slag. The later losses during consolidation and smithing of the bloom may have been in the order of 40wt% (of the available metal) from ore to bloom, 50wt% from bloom to billet, and 30wt% from billet to bar. A smelt resulting in a 13kg slag block would produce enough iron for a 1.8kg billet or a 1.3kg bar, whereas a smelt producing 30kg of slag could result in an 8.4kg bloom, a 4.2kg billet or 3kg bar (Paynter 2007b) and would consume at least 60kg of ore, 60kg of charcoal plus a pit full of split wood each time. These estimates all vary considerably depending on the richness of the ore, the smelting conditions and the skill of the ironworkers; for example Young (2020) estimated a bloom size 3 times as big for a 30kg slag mass. Blooms in excess of 8kg are difficult to work however (Sauder 2013), which may have acted as a natural upper limit unless a larger bloom was required for a specific purpose. It has been proposed that currency bars, a form of trade iron in the 2nd and 1st centuries BC and weighing from 0.15 kg to 2 kg, may each be the product of a single smelt, reduced in mass by subsequent smithing (Crew 1994). The 4 tonnes of slag recorded from Lightwater would represent at least 130 smelts, producing iron blooms of perhaps 4 to 9 kg each, totalling 560kg of useable iron, or 224kg of bar iron,

equivalent to over 100 large, heavily forged currency bars but it is worth noting that the recorded slag is only a proportion of the waste present the site and so the scale of production would have been even larger, and also depended on the ore quality and the efficiency of the smelting and smithing processes.

#### *Character of the iron-working site*

Very few of the Iron Age features at Lightwater were revealed but some idea of the site character at that time can be gleaned from comparison with other similar sites. Evidence of small-scale or episodic smelting tends to be associated with smaller settlements and enclosures, such as Hartshill in Berkshire (Collard *et al.* 2006; Huvig *et al.* forthcoming); West of Leda (Diez and Booth 2006), Hawkinge (Paynter 2002) in Kent; and St Ann's Heath (Lambert 2009), Thorpe Lea (Starley 1998) and Brooklands (Hanworth and Tomalin 1977) in Surrey. With larger smelting operations however, furnaces and slag dumps are situated very close to the ore source where the alternative, of moving the huge quantities of ore required, would be a major undertaking. These focussed industrial operations have shown little evidence of any other kind of contemporary activity, such as at Sadler's End, Sindlesham (Lewis *et al.* 2013), and possibly Stockbury (Girbal 2019) and Welham Bridge (Clogg 1999) (the latter being smaller area excavations). The scale of smelting at Lightwater in the Late Iron Age suggests this site was also industrially focussed.

Some Iron Age iron-working sites have evidence for the spatial division of activities and sometimes associated structures. At Brooklands in Surrey the smelting and smithing were divided between two areas of the open settlement (Hanworth and Tomalin 1977); at Stockbury (Girbal 2019) smithing slag was found in the slag heaps immediately next to the smelting furnaces suggesting immediate bloom compaction; at Prior's Hall, Corby (Hall 2006) hammerscale was found associated with a three-sided beam trench with corner post-holes near to one of the surviving furnaces; at Sadler's End, Sindlesham (Lewis *et al.* 2013) a post-hole structure was tentatively associated with smithing; at Crawcwellt and Bryn y Castell in Wales, smithing debris was associated with structures (Crew 1986; 1989) and at North Cave (McDonnell 1988) and West of Leda (Diez and Booth 2006) smithing waste was interspersed with smelting debris. The date of the smithing activity at Lightwater is uncertain but it has resulted in fairly large smithing hearth slags, perhaps indicative of bloom consolidation and primary smithing to produce trade iron, but this could not be associated with a particular structure or area of the site. There was no clear evidence to indicate secondary smithing (the manufacture of objects) so the iron produced may have been mostly traded or transported elsewhere for further forging.

#### *Lightwater in regional context*

Since the excavations at Lightwater, numerous Iron Age smelting sites have been identified along the Thames valley, straddling north Hampshire, Berkshire and Surrey (for example Ford *et al.* 2013; Huvig *et al.* forthcoming; Lambert 2009; Munday 2018; Lobb and Morris 1993; Paynter 2006; Preston 2013; Taylor and Ford 2019, Table 3.1; Young 2006). These often have evidence of smaller-scale smelting through the Iron Age but a few, such as Fleet Hill, Folly Court, and Brooklands (Hanworth and Tomalin 1977; Young 2012; 2018) have evidence of larger scale ironworking activity. By the 2nd or 1st centuries BC there was intensive smelting activity at several sites in the area, which led to the formation of over 4 tonnes of slag at Lightwater and approximately 20 tonnes at Sadler's End Sindlesham (Lewis *et al.* 2013) (Fig. 17). The scale of the industry, particularly in the 2nd and 1st

centuries BC/1st century AD, is such that phosphoritic iron from this area could have been traded further afield, contributing to the increased incidence of phosphoritic iron particularly amongst larger artefacts of the period (Ehrenreich 1985).

When only a few sites were known from this area, they were grouped together as the 'Tertiary sands' region (Salter and Ehrenreich 1984; Paynter 2006). More recently many more sites have been added, and it has been possible to refine this further (Hardy and Young 2019; Young 2018). The vast majority of the sites are clustered around an outcrop of the Bracklesham Group, the Bagshot formation shown approximately outlined in Fig. 17, which is roughly centered on Lightwater. As well as the central sites (including Lightwater), there are others towards the NE edge (including Brooklands and Thorpe Lea) and many towards the NW periphery (including Sindlesham and Heckfield) (Young 2020). Table 9 includes sites where in excess of 25kgs of slag were recovered, or where the slag was analysed. Where there are published analyses, all of these sites have produced phosphorus-rich slag (Table 9) indicating that phosphorus-rich bog ores were smelted. Bog ores are so called because they are often found in boggy areas or floodplains. Many of these smelting sites are located on areas of sand and gravel deposited by rivers, together with floodplain alluvium and bogs depositing peat; Young (2020) noted the spatial relationship between some smelting sites and peaty deposits.

| Site                     | Slag (kg)          | P <sub>2</sub> O <sub>5</sub> (wt%) | MnO (wt%) | Reference                                                      | Approx. Date                    |
|--------------------------|--------------------|-------------------------------------|-----------|----------------------------------------------------------------|---------------------------------|
| Fleet Hill Farm          | 108                | 2–5.5                               | <0.4      | Hardy and Young 2019                                           | Mid Iron Age                    |
| Amen Corner              | 15                 | 3–6                                 | <0.2      | Lovett 2017                                                    | Mid Iron Age                    |
| Heckfield                | 7                  | 1–6                                 | <0.8      | Dungworth 2007<br>Munday 2018                                  | Mid Iron Age                    |
| Manor Farm               | 6                  | 1.8–5.5                             | <0.22     | Platt 2013                                                     | Mid Iron Age                    |
| Three Mile Cross         | 12                 | 1.79                                | <0.4      | Ford <i>et al.</i> 2013                                        | Mid Iron Age                    |
| Whitehall Aborfield      | 53                 | -                                   | -         | Pine 2003                                                      | Late Iron Age to Romano-British |
| Folly Court, Wokingham   | 800                | 1.5–3.5                             | <2.2      | Young 2018                                                     | Mid to Late Iron Age            |
| Sadler's End, Sindlesham | 1300 (est. 21,000) | 1.5–3                               | <0.2      | Lewis <i>et al.</i> 2013                                       | Early to Late Iron Age          |
| Crosfields               | 6                  | 2.7–4.4                             | <0.6      | Taylor and Ford 2019                                           | Mid to Late Iron Age            |
| Riseley                  | 27                 | 2.4–2                               | <0.1      | McDonnell 1984<br>Lobb and Morris 1993<br>Taylor and Ford 2019 | Mid Iron Age                    |
| Lightwater               | 4,000              | 4.8–6.5                             | <0.65     | This article                                                   | Late Iron Age to Romano-British |
| Brooklands               | 47                 | 1.8                                 | -         | Hanworth and Tomalin 1977                                      | Early to Late Iron Age          |
| Thorpe Lea               | 27                 | 1.5–7                               | 0.7       | Starley 1998                                                   | Late Iron Age to Romano-British |

Table 9 Nearby sites shown on Fig. 17 with smelting evidence, indicating the amount of slag found and the phosphorus and manganese content, where given. The analyses are by different methods, but phosphorus is consistently elevated. Not all of the slag is diagnostic of smelting and the excavations are of variable areas but the large scale of activity at some sites is immediately apparent.

The substantial industry smelting phosphorus-rich bog ores in the Thames valley region (Lewis *et al.* 2013) disappeared by the Roman period, and this is also the case for the comparable Iron Age industry in the Humber wetlands (Clogg 1999; Halkon 2011). From the 1st century AD, lower grade rock ores, like the Wealden siderite, start to be exploited in Britain (Paynter 2006; Cleere and Crossley 1995) and these dominate throughout the Roman period. With the transition to typical Roman practices, there is a marked disjunction in the ores exploited.

Given the substantial scale of phosphoritic iron production at Lightwater, a last issue to consider is the nature of organization and control of iron production. The excavated site at Lightwater was one of a series regionally that must have provided a significant supply of metal, and given the scarcity of the material and the effort needed to produce it, this must represent a considerable economic asset. Furthermore, knowledge of both how to find ore deposits and the technology of production would themselves have had considerable social value. This may have been especially true for the ironworkers in this area where phosphoritic iron was produced, which requires particular skill to work. We do not know how this wealth and knowledge worked, whether they were controlled, and if so by whom, but this does not mean that the questions are unimportant. As noted above, this area can to some extent be viewed as marginal, both in terms of its ecology and in relation to the likely social boundaries between Iron Age communities. This might suggest that those exploiting the iron resources were themselves marginal. However, if they were free from outside control and able to sell metal freely, one might have expected to see evidence for the accumulation of wealth within their settlement. It could thus be argued that the absence of evidence for such wealth at Lightwater implies that the site was controlled by people based elsewhere, whether nearby or at some distance. This itself raises important questions which should be considered further as the archaeology of the region is explored in the future.

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### **References**

#### *Abbreviations:*

ABC = Cottam *et al.* 2010

BMC = Hobbs 1996

RIC = H. Mattingly and E.A. Sydenham *Roman Imperial Coinage* Vol. 2 (Vespasian–Hadrian), 1926 and Vol. 3 (Antoninus Pius – Commodus), 1930

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