Downside Mill, Cobham
TONY HOWE, RICHARD SAVAGE and PAMELA SAVAGE

Stratigraphic report and director's commentary, by Tony Howe

Trench 1 (figs 5, 6a and 7)
Trench 1 measured 15 x 11.8m and was positioned over the area where the resistivity survey had indicated the main body of the remains of the oval mill were sited. With such a positive result from the geophysical survey, the trench could be positioned with a good deal of accuracy. Consequently the decision was taken to ensure the trench was large enough to investigate not only the central mill structure, but also to investigate the mill races to the north and south of the artificial 'island' upon which the structure was located.

Approximately 0.3–0.4m of humic topsoil (001) was removed by machine. This layer contained large quantities of demolition rubble, almost all of which was discarded on site. However, it was immediately noted that there were also significant quantities of industrial residues within the layer, and a decision was taken to retain the more substantial examples for later examination, as potential representative examples of the industrial workings at the mill site, as opposed to simple detritus from the demolition phase.

Following machining it was clear that, as the geophysical survey suggested, the site could be broadly divided into three distinct areas: the locations of the two former mill races and the central remains of the mill building. In discussing the findings of the excavation, it is simplest to discuss each area in turn.

NORTHERN MILL RACE
A number of features were revealed upon removal of the topsoil. Highest in the sequence of these were two square cut voids [005 & 006], with a very loose rubble and soil fill at lower levels. An earlier cross-wall respected and was built around both features so it is almost certain that these two voids were very late robber cuts, where large square upstanding posts had been removed. Given the lack of lateral damage to the sides of the two cuts and the actual depth of the void areas, it is likely that the two posts had been upstanding for a considerable time, and their lower parts had been removed (probably vertically and by mechanical means) only recently. See discussion below.

The area of the northern mill race was divided by a curved-faced double-thickness brick wall crossing-structure (see below and fig 7), so therefore the deposits in this area were split into east and west sections. To the west, in the area of the two post-voids, was a sequence of demolition fills. The uppermost (002) was a fairly heavy clay layer, probably a capping deposit for the looser material lower down. Below this was a deep fill of grainy demolition rubble, containing numerous brick and tile fragments, charcoal and stones (020). This deposit was excavated down to a considerable depth (over 1m) in a sondage, where it overlay a further demolition fill (044) of a similar loose character, again packed with demolition material. This was excavated to a maximum further depth of 0.70m but could not be bottomed out, although at the lowest extent the badly damaged remains of the robbed-out northern external wall of the mill building were revealed. However, a definite irregularly-sided cut [045] became apparent as the demolition material extended over the wall and southwards into the central area of the former mill structure. It was hypothesised on site at the time that, given the extensive damage to the external mill wall and the depth of these deposits, the material was filling the former wheel pit of the mill on this channel and represented the concerted demolition effort that would have been necessary to remove the large components of the wheel and its associated mechanism for recycling or sale as scrap. This seems likely and accords with the cartographic evidence suggesting the northern wheel would be around this location, although is not possible to state this conclusively as the evaluation excavation at this point had to be curtailed due to depth and unstable demolition deposits (despite the installation of necessary shoring).

To the east of the cross-wall, further demolition deposits (008, 036 & 022) were apparent. These were of a less homogenous character than (020), and clearly were evidence for a different kind of demolition activity. Particularly in the case of (022), various distinct deposits were visible within the generally silty, grainy soil matrix, including dumps of smashed tile and brick. This had the character of either bucket- or barrow-loads of material being dumped within the area as the general

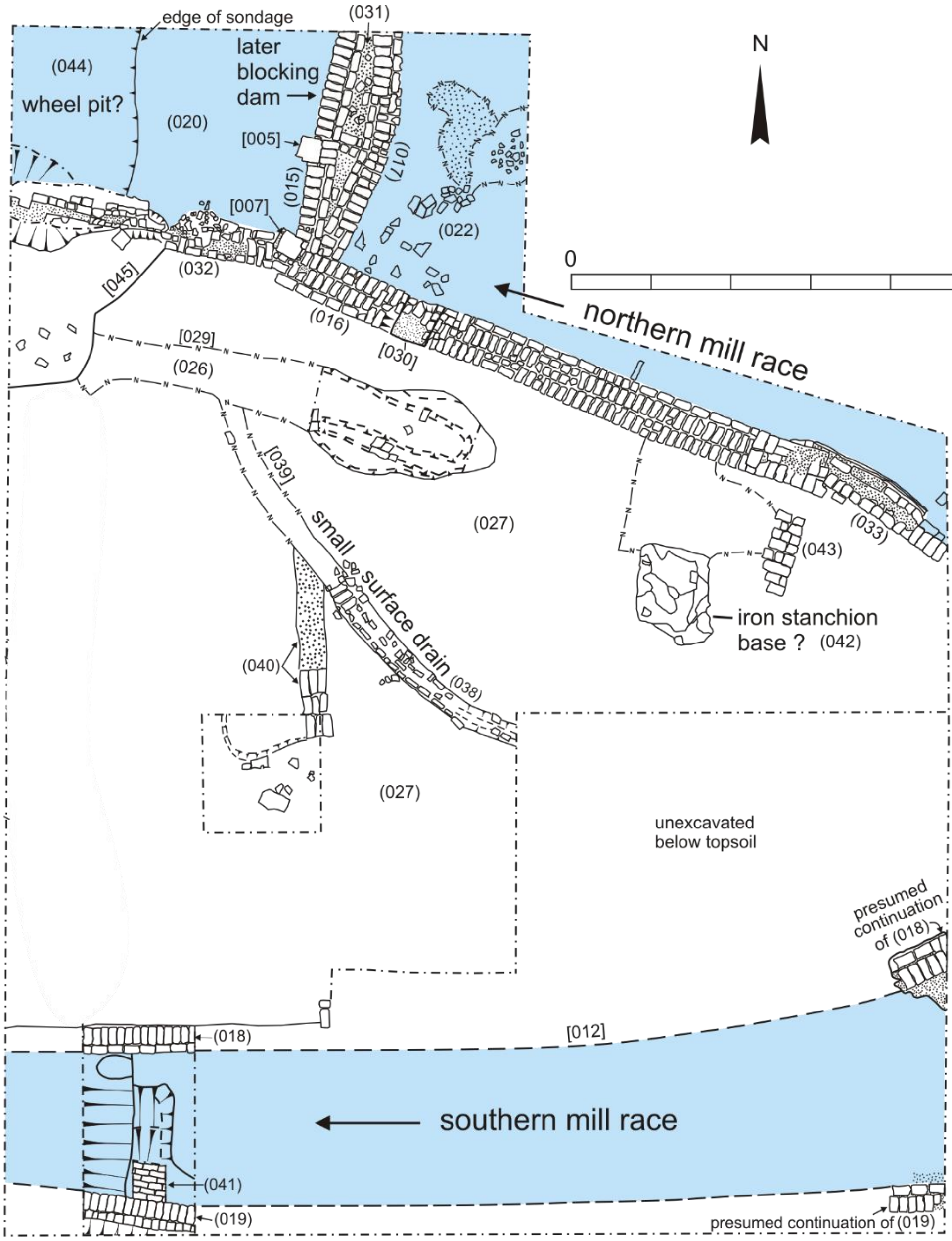

Fig 6a Downside Mill, Cobham. Plan of excavated features in trench 1 with context numbers. The blue tint shows the mill head races before they were filled in after demolition of the mill.

filling operation was taking place, with no differentiation between the material either above or below these clear dumps. The layer also contained a noteworthy amount of discarded material representativeof industrial activity, including material evidence of both the ironworking and copper-alloy casting processes. It also contained a ceramic cylindrical vessel, dated by its manufacturer's stamp to 1864–88 (see Finds report and figs 18 & 19), full of lumps of mined graphite and a manganese ore together with a graphite bar. However, this find is significantly later than any metalworking on the site. As with (020), the base of this deposit was not reached, although at its upper levels it banked over a brick robber fill (010), which lay within a distinct cut [030] in the northern exterior wall of the former mill. This provided a useful link with some of the deposits within the mill itself that might otherwise have been separated by the upstanding structural remains.

The crossing-structure that lay roughly centrally within the excavated area was composed of a straight western wall (015), which clearly had been built around the former upstanding posts (see above), a convex-curved eastern wall (017) designed to take pressure from the east, with a central packing fill of brick, tile and cement (031). The feature measured 2.90 x 1m, and was built up against (rather than keyed into) the northern mill wall at an approximate right-angle. The 1798 plan of the site suggests a bridge over the northern mill race just in front of the wheel mechanism at about this location, and the initial supposition was that this feature was the remains of the bridge foundation. However, the wall extended down as far as the excavations could reach, and it is likely that it would actually have blocked the mill race entirely, meaning it could not be associated with the operation of the mill as water would have been unable to reach the wheel. The 1839 plan of the site shows that the mill race was blocked at this point (with dry land behind to the west), so this feature must be the remains of a later retaining wall, designed to hold back the mill pond after the infilling of both the northern and southern mill races to the demolished mill. The condition of the two brick walls would support this supposition, as the eastern 'upstream' face of the eastern wall was extremely degraded and suggestive of prolonged immersion while the 'rear' western wall did not. Both were likely to have been constructed from re-used bricks. The top of the highest surviving brick course of the convex eastern wall was at 21.21m OD, closely comparable to the level of the water input from the mill-head pond into the wheel chamber of the presently surviving Raby buildings (measured at 21.22m OD). In all probability, the central fill (031) acted as the waterproofing for the structure, to prevent the continuing mill pond from leaking into the area of the backfilled former mill race and wheel pit. It is worth noting at this point that the former bridge was probably supported on the large (removed) posts in this area, the lower parts of which must have been left *in situ* as the site moved into its post-industrial phase to provide added support to the later retaining wall.

Lowest in the observed sequence in this area of the site was the northern wall of the mill itself (016), against which the retaining wall was constructed. This measured 7.4 x 0.60m wide, was almost perfectly straight, running roughly east–west towards the eastern, upstream apex of the mill building (which was outside the excavated area), and was well constructed from relatively fresh-looking yellow stock bricks and a strong sandy mortar. It had been quite effectively horizontally truncated during its robbing-out, although there were areas of more damage along its length, where it is thought that the machinery of the mill that formerly extended through the wall had been violently removed. However, as the wall was exposed during the excavations, it became clear that this wall was actually an extensive repair to the original mill wall, as two obviously earlier walls (032 & 033) were seen at both the ends, in the areas of the supposed former wheel pit, and towards the eastern apex of the mill island. These earlier walls both appeared to be of a similar character, measuring 0.40m wide and being constructed of red bricks with a crumbly whiter mortar than that of their later replacement. The eastern wall towards the apex of the mill (033) demonstrated a definitely chamfered external face – probably designed to accelerate the flow of water as it was directed towards the waterwheel, although the later repair structure did not replicate this, being a typical vertical wall in the observed areas. The repair wall had been directly mortared onto the earlier walls as a direct replacement it is to be assumed, although the observed external face of the easternmost early wall (033) did not exhibit particular signs of extensive damage. It is therefore possible that the mill was remodelled at some point during its operation, rather than the northern wall having failed. The two original sections of the northern mill wall were the earliest observed features in this area, as excavation ceased before their full extent could be ascertained.

SOUTHERN MILL RACE (figs 6a, 13–15)

Following the removal of the topsoil, the southern area of the site was characterised by an extensive robber deposit (003), full of broken brick and tile, with obvious mortar within the soil matrix. The layer also contained large quantities of industrial slag waste, including slag attached to architectural material where it had clearly spilled and solidified *in situ*. This would not have been re-usable and it was therefore discarded when demolition occurred. Cleaning revealed a distinct cut line [012] running east–west across the area, although becoming indistinct as it proceeded eastwards, where the rubble material appeared to spread into the area believed to comprise the central mill structure. Given the size of the area and the time constraints of the excavation, it was decided to examine the mill race in a 1.4 x 2.6m sondage, cut north−south across the former watercourse.

The uppermost robber deposit (003) extended to a maximum depth of 0.5m below its surface, and was fairly homogenous throughout, with a continuance of the extensive demolition rubble and industrial waste material. When removed, the upper surviving courses of the northern wall of the mill race (018) were revealed, with the wall clearly having been systematically and quite cleanly robbed course-by-course for the recovery of re-usable bricks. The southern wall of the mill race was not exposed until the removal of a second robber fill (014), a 0.10−0.25m deep fairly consolidated mortary deposit that lay directly below (002). The southern mill race wall (019) had again been robbed cleanly along its courses, indicating that the primary intention was the recovery of re-usable materials as opposed to simple demolition. Both mill race walls were apparently of the same construction as the earliest observed sections of the northern mill race wall, being 0.35m wide, or three bricks' widths. A small section of similar walling was observed at the surface of the excavations towards the eastern end of the trench, and is assumed to be a section of (018), although this was not confirmed during the investigation.

The mill race itself measured 1.95m wide at its maximum extent although, even within the confines of this limited investigation, it was seen to narrow noticeably towards the west, being only 1.70m where it disappeared into the section. This narrowing must have accelerated any flow of water, meaning that by the time the flow reached the wheel (presumed to be west of this point), it must have been travelling with considerable force and speed.

Between the surviving walls within the mill race were two further robber deposits − a rusty-coloured sandy layer (023) and an oxidised yellow clay (024). Deposit (023) contained further demolition rubble and industrial waste. It was extremely wet, and contained preserved leather items, although no wooden artefacts were recovered. Deposit (024) appeared to be the disturbed (and previously exposed to the air) surface of the lower deposits of the mill race. It is presumed and interpreted to be the trampled surface on which the workers stood as they undertook the demolition work. Given this disturbance, the base of the robber cut [012] has been interpreted as being below this deposit.

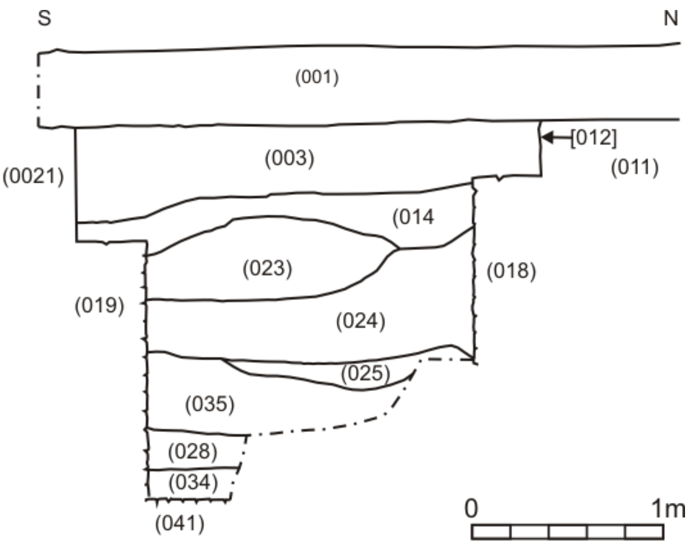

Fig 13 Downside Mill, Cobham. Southern mill race, east-facing section

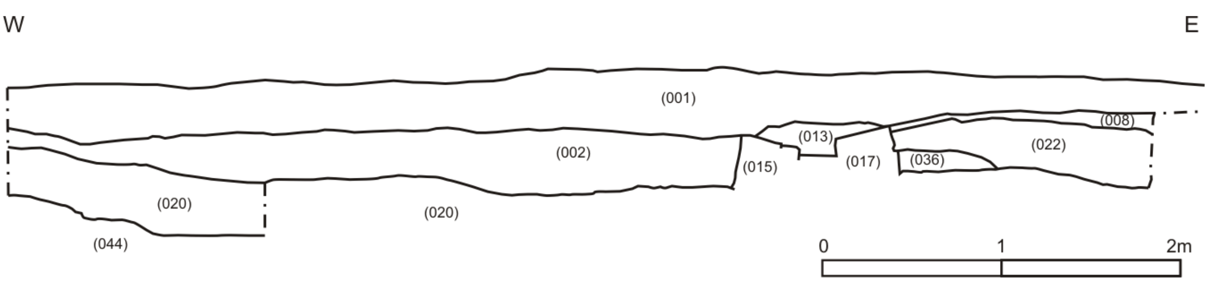

Fig 14 Downside Mill, Cobham. Southern mill race, south-facing section

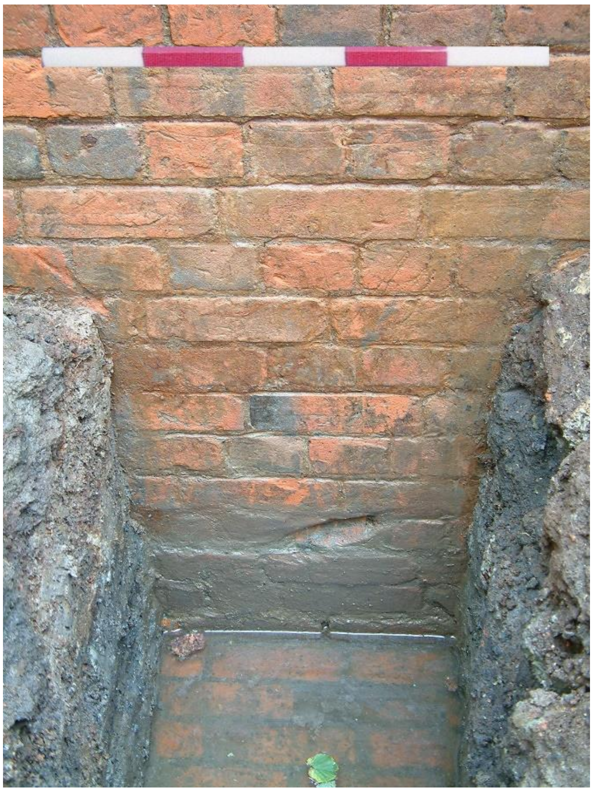

Fig 15 Downside Mill, Cobham. The remains of the southern wall (019) and floor (041) of the southern mill race in trench 1. The upper courses of this structure had been removed during demolition of the mill. The remains of ironworking hearths and floors were found in the fill of this mill race. (photograph Andrew Norris, 2008)

Below the demolition deposits, the primary fills of the mill race were revealed. Uppermost of these was a stiff blue clay (025), which appeared to have the character of a dump, but contained no was on top of an iron-panned sandy layer (026), which itself sealed two waterlogged organic layers (028 & 034). Layer (028) contained a large amount of semi-rotted organic material, with recognisable twigs and leaves within its matrix, together with the remains of freshwater clams. (034) was similarly waterlogged, but with markedly less organic material, composed primarily of a dark-grey plastic clay matrix. Excavation became difficult at this point due to the depth of the sondage and the waterlogging of the trench, and in an attempt to bottom the sequence and expose the floor of the mill race both deposits were only excavated in a keyhole towards the southern mill race wall. This was reached at a depth of *c* 2.4m from the current ground surface, and was found to be a mortared flat brick surface (041), running east−west with the line of the mill race, with the bricks laid edge-down in a stretcher bond, appearing like a wall lying flat on the floor. In the small section that could be exposed, this floor was observed to apparently continue beneath the upstanding southern mill race wall, indicating that it was the earliest part of the mill race construction. It was also the earliest confirmed feature observed within this part of the investigation, as two deposits exposed higher up by the robbing of the walls (011 & 021), were interpreted as the backfill of the artificial island on which the mill structure was built and the backfill for the southernmost mill race wall respectively. Both were therefore later than the two walls of the mill race which they abutted.

CENTRAL MILL ISLAND

The central area of the site was characterised by a confusing spread of trampled demolition deposits of differing natures. The uppermost of these (009) was a loose mixed deposit, covering a large part of the area, and extending partially into the northern mill race. The layer had obviously suffered from root damage, and in its deeper areas was removed by the initial machine clearance. The site below this layer was confusing, with a number of obvious structural features apparently poking through from lower levels, most of which features had been severely damaged. The non-structural deposits were difficult to define and this made differentiation between contexts and features difficult, although a basic sequence was established, and a few features could be properly described.

The large robber cut for the northern wheel pit ([045], see above) truncated a second, linear robber cut [029], which ran roughly east–west, parallel with the interior side of the mill wall, but about 0.70m inside it. This was filled with a ferrous silty sand, and contained notable quantities of brick and tile, as well as mortar and general stones and pebbles. A slot cut into this material was excavated to a depth of 0.40m, where the remains of an interior brick wall were revealed, just appearing from within the surrounding material that formed the interior mill surface. A small horizontal void was also revealed, which extended below this material and ended at the northern mill wall in the region of the robber cut ([030] described above); it is possible that these two features are contemporary. It seems likely that some large piece of machinery, probably with an axle and gearing system that extended through the wall, had been removed from this area. However, no further investigation could be undertaken to ascertain the full extent of the robber cut and to determine what exactly had been removed.

Towards the area of the wheel pit robbing, the linear cut [029] truncated an apparent drain within the surface of the floor. This comprised two unmortared brick edging walls (038) running south-eastwards in a slightly curving direction, with the remains of a brick capping still evident in one area. The feature measured 3.2 x 0.15m wide, and was of a fairly rudimentary construction, suggesting it was not intended to channel water under any force. It is possible that it was not actually intended to channel water at all, as the feature had no constructed base. This would have led to water leaking into the underlying material and would have reduced its flow. However, the feature could have acted as a ventilation channel for the interior of the mill or some part of the mechanism. This is a hypothesis that would require more detailed examination in the future, and perhaps comparison with more complete or well-documented structures of a similar date and purpose.

The 'drain' cut [039] survived to a greater extent than the structural remains, extending to 5.4m before continuing into an unexcavated area of the site. It was particularly shallow – only about 0.10m in depth, but quite clearly truncated the remains of an internal cross-wall foundation (040), which r an north–south within the central area. Very little of this feature remained, although a single course of bricks remained *in situ* towards its southern end, showing that it was constructed in a stretcher bond. The wall was three bricks wide (0.30m) and based on a thin mortar spread of the same width.

The interior of the mill (ie the area between the northern wall (016) and the southern robber cut [012]), was filled with a firm, compacted clay surface (027), upon which the mortar base for the internal wall was laid. This material appeared to extend across the area, although, to the west of the site, it was heavily trampled, indistinct, and badly truncated, probably through the robbing of both wheel mechanisms. It was also unclear whether this was the same material as 011 described above in the southern mill race, although they did appear similar. However, it was apparent that this material was not the primary fill of the mill interior – as noted above where robbing had intruded into the material, former walls were seen within this at lower levels. Also, 027 was firmly banked up against the northern mill wall (016), which as described previously was an obvious repair or remodelling.

Two additional features towards the east of the excavated area were also noted. A large ferrous 'stanchion base'(?) and a brick surface – possibly the remains of a floor – both seemingly intruding from lower down in the sequence. Layer 027 remained unexcavated so this could not be confirmed (both features may have subsided into the underlying material to create this impression), although the relationships of both features with (027) were rapidly tested on the site through limited hand excavation towards the conclusion of the investigation, so the supposition that both were earlier has some support.

The 'stanchion base' (042) measured roughly 1.4 x 0.95m and was heavily rusted, to the point where it appeared more as an iron lump, with no discernible structure being ascertained. It was possible that the feature represented a dump of ferrous material rather than any structural remains. However, the character of the material was unlike any of the industrial residues encountered elsewhere on the site, and within the irregular edges of the feature was the suggestion that before decay it had been a square feature probably acting as a support for a large post or a now-removed piece of machinery. The 'floor' remnant (043) measured 1.0 x 0.40m, and could perhaps have been the remains of a wall running north–south, although the upper surface did not seem to have been mortared, suggesting that there were no upper courses that had been lost. It was also fairly irregular on its western edge, implying the former presence of its continuation in this area, although the eastern edge was more firmly straight, so the interpretation of this feature should perhaps remain open. Between this 'floor' and the 'stanchion base' a coppery discoloration of the surrounding deposit (027) was noted, but investigations in the trench had to cease at this point, so no further clarification of any of the features described could be gained.

Trench 2 (figs 5, 16−17)
Trench 2 was designed to be a much simpler evaluation investigation, and was accordingly on a significantly smaller scale, measuring only 2.85 x 1m. This was located to the west of trench 1 across the tailrace in the grounds of Emlyn Lodge, the area that cartographic study suggested would be in the location of the former large dwelling house shown on the Raby plan. Specifically the trench was placed in the supposed region of the north wall of the property, which the 1798 plan of the site suggested would have a bay projection along its length. Excavation found that 0.10−0.15m depth of humic topsoil (2001) sealed a compacted subsoil (2002) containing small amounts of stone and brick fragments. A thin ashy spread (2007) covered a compacted layer composed of crushed brick, flint and mortar (2004), itself sealing an earthy soil. Both layers were slightly domed in profile, and were contained within a shallow cut [2003], the full extent of which was not fully exposed in the investigation. A yellowish clay − presumed to be the natural substrate − was situated below this and seen across the entire length of the trench, at a maximum depth of only 0.35m below current ground surface. No evidence for structural remains or any sign of their former presence in the shape of robber trenches was apparent, with the domed profile, compacted nature and ashy surface of the recorded features suggesting that what had been revealed were the remains of a garden path rather than any structural foundation. A paucity of material suggestive of the demolition of a large building supported the conclusion that this trench was located neither over the remains of Raby's former dwelling, nor close to it.

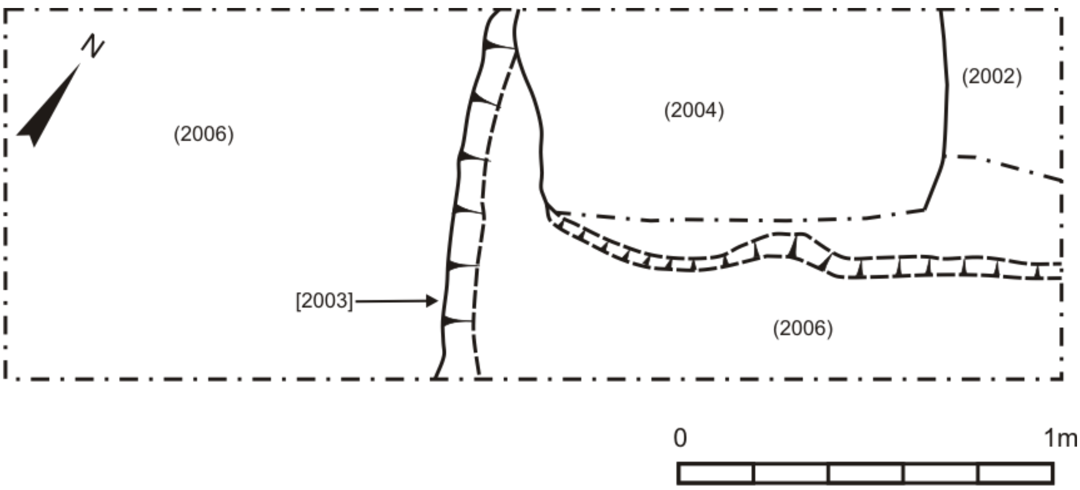

Fig 16 Trench 2 plan

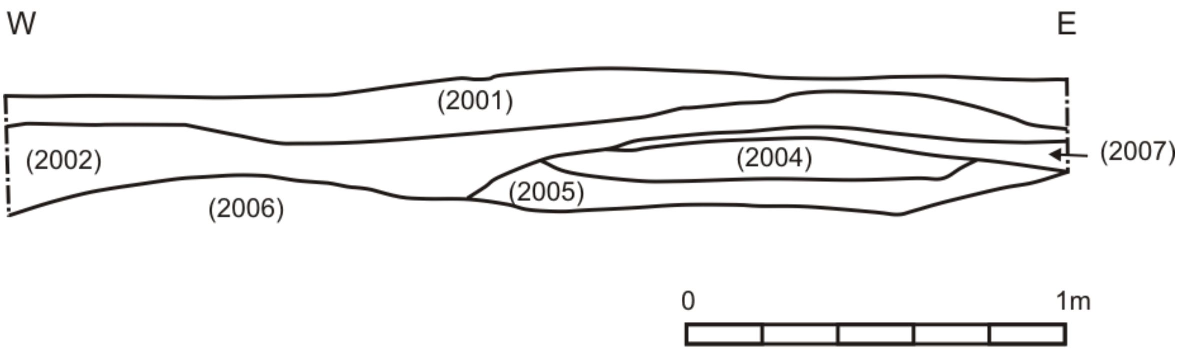

Fig 17 Trench 2, north-facing section

Discussion and general observations

For such a relatively limited investigation, which has revealed a fairly simple sequence of deposits, the excavations at Downside have raised some interesting issues that warrant further consideration.

The demolition deposits within the northern mill race were separated by the curved cross-wall (015/017). The 1839 map showing the site quite clearly demonstrates that by this date the mill structure has been removed (no buildings are visible), although its shape in plan is still discernible within the landscape. However, the mill race is only shown as blocked and dry to the west of the cross-wall on this map − to the east is the dammed remnant of the mill race, presumably acting more as an ornamental feature alongside the garden by this date. Assuming that the cross-wall revealed during these investigations is indeed the same wall acting as the retaining wall for the dammed mill race on the 1839 map (it seems to be in the correct location), then there are at least two distinct episodes of demolition on the site, as the dumped deposits to the east of the cross-wall must date from a period after this map was produced and the western portion of the mill race was entirely filled in. By implication, this could also raise the possibility that the demolition material to the east of the cross-wall (deposits 008, 036 & 022) was actually from elsewhere on the site, and may not entirely represent demolition material from the former mill structure. It was noted during the excavation (and described previously) that the deposits in this area were of a different character to those behind the cross-wall to the west. It is likely, therefore, that while the western deposits demonstrate a concerted episode of large-scale dismantling and demolition of a single structure (the mill), those to the east are indicative of a slightly less concerted demolition effort, with material being imported in small dumps from perhaps a number of different and disparate locations and former structures until the silted-up portion of the mill pond was finally infilled between 1885 and 1896. The primary focus of the site then appears to shift away from industrial production and was tidied up accordingly. It is worth noting also that indications from within the former mill structure suggest two phases of robbing (robber trenches were seen to be discernibly superimposed), although further examination over a wider area would be needed to phase this supposed episodic robber activity more confidently.

Using the 1839 map as an historical reference, it can be seen that the southern mill race was completely blocked by this period. The deposits revealed in the examination of this area were similarly indicative of two distinct phases, although in this case, they are of disuse followed by demolition. The demolition deposits here most probably relate primarily to the removal of the mill race walls, although there is much additional industrial waste of enormous research potential within the demolition debris, as has been outlined above. It is likely that the robbing of the walls for re-usable bricks was quite a simple task here, with walls being lowered systematically to a point where the then base of the presumably drained watercourse (ie the level where the robbers were standing) was approached, whereby robbing became markedly more difficult and was abandoned.

The lower deposits within the southern mill race were completely different, being heavy clay-based material with waterlogging and good organic preservation. They almost certainly formed during a period when the water within the stream was standing and most likely stagnant, as the force of water required to turn a waterwheel would surely not allow for the formation of such material. This suggests that prior to the demolition of the mill, there was a considerable period when the use of this channel had been abandoned and the southern watercourse stood unused and silted up. There is good documentary support for the demolition of the mill taking place no later than 1814, so for these deposits to form, some appreciable time before this the mill (or at least the southern mill race) must have ceased to function.

It is worth considering this possibility in the light of the condition of the northern wall of the mill building. The newer section of this wall had been directly mortared onto the earlier walls as a direct (and more robust) replacement for the earlier structure. It was assumed that this was a repair; however, the observed external face of the easternmost earlier wall (033) did not exhibit particular signs of extensive attrition, so at least in the investigations carried out in 2008, there was little evidence that this wall had actually required such a substantial repair. It is possible that the mill wall was deliberately demolished and then strengthened and remodelled (it is on a straighter alignment to the earlier walls) to accommodate a larger and more extensive series of industrial mechanisms, rather than the northern mill wall having failed at some point and required repair. This could also imply a change in use for the mill, with a different manufacturing process being employed, which could relate to the apparent abandonment of the southern mill race as well. This hypothesis would be convincing were it to be firmly supported by documentary evidence for manufacturing processes at the site. Indeed, there is enough evidence to suggest that an examination of the surviving documentary material for such indications would be of considerable value when and if the site is reinvestigated. The alternative, and perhaps more conventional explanation – that the northern wall failed and required replacing – seems unlikely, given that the documentary sources clearly indicate that the mill was in operation for a limited period, perhaps 40−45 years at most. This surely would not have been long enough for such significant structural damage to be caused to the northern wall to the point where it required such an extensive repair, even if the entire force of the watercourse was diverted down the northern mill race as the state of the deposits to the south suggested. It seems even more unlikely when it is considered that this supposed 'failure and repair' event would probably have had to occur some time before 1806, the date when Raby got into financial difficulties and probably would have been forced to decline the expense of such a substantial repair in order to keep the structure functional.

The general array of finds from the site – brick and tile, broken ironwork and industrial residues − is perhaps not unexpected. The distinct lack of pottery found during the excavations is worthy of comment and probably reflects the non-domestic nature of the site, although with the suggestion that demolition material may have been imported from elsewhere greater quantities might have been expected. The leatherwork, which was not anticipated, reflects the good preservation of organic material in the southern mill race arising from the suspected change of use discussed previously. Although the artefacts themselves are unremarkable, their survival is not, and any further exploration of the site should anticipate not only the recovery of similar material and make provision for its examination, but also for the study of the environmental data that the site will contain as this could give valuable insights into the workings of the site while in use, and the environment in which the mill was operated and manned.

The quality and quantities of the industrial residues that were recovered have proved to be of considerable significance, representing a range of manufacturing processes, some of which do not seem to meet the standard classification types currently in use. The residues have now been analysed by the specialists at the English Heritage laboratories and compared with those from other sites (including from Raby's contemporary ironworking site at Coxes Lock in Addlestone). There is potential for further study, with particular reference to collating the archaeological material with the documentary records, which has been identified as a national priority for archaeometallurgical research in the recent *Framework* (Bayley *et al* 2008, 69).

Given the limited nature of a training excavation and the unexpected quantity of metallurgical finds, the evaluation excavation failed to answer a number of the original research aims. The period of Raby's occupation of the site was clearly apparent through the remains of the mill and mill races, and the implications of these discoveries have been discussed above. At few points though did the investigations approach archaeological deposits that could have revealed insights into either the original construction of the mill site (only the walls at the time of the final demolition were revealed), or examine materials below these that would have provided the information regarding the formation process of either the mill 'island', or the extensive mill races surrounding it. However, it can be confidently suggested that were further investigations to take place on the site such evidence would be likely to be forthcoming, as the preservation of the remains overall was found to be remarkably good. Specifically, further work is needed to understand the sequencing and dating of the northern and southern mill races, particularly changes introduced to the structure by Raby after his acquisition of the mill in 1770. The northern mill race appears to be wide, even if by the time of the 1798 plan the original broad wheel, implied by the width of the mill race, had been removed and replaced by a narrower wheel. The southern mill race was found to be of a different and wholly coherent design, with facing brick walls and base constructed in a single phase of works, perhaps as a replacement for an earlier mill race in that position (it was not feasible to investigate this possibility during the excavation).

The work failed to reveal any evidence in the second trench for the site of Alexander Raby's dwelling. This trench had been placed following consideration of the 1798 plan and its 'best fit' with a modern survey of the site, but only an apparent former garden pathway was uncovered. It is known that after Raby's time the road from Downside Mill to Downe Farm was relocated from the east of

Raby's dwelling to the west and it is possible that groundworks during this period removed all traces of the foundations of Raby's house. Two resistivity surveys carried out in the garden of Emlyn Lodge during the training excavation revealed no clue as to the location of Raby's dwelling house.

The investigations also failed to reveal any trace of pre-industrial medieval activity. With the excavations being fairly limited this is perhaps unsurprising, and it is likely that Raby's large-scale works at the site had removed all traces of prior activity. However, the complete absence of even the slightest piece of residual medieval material either from the site or the surrounding area is of some concern when the supposed medieval activity here is considered. Although it remains possible that such medieval activity occurred on this site, it may be argued that the documented medieval mill at Cobham was located elsewhere.

Conclusions

The site at Downside Mill has clearly demonstrated that a good deal of material survives, and that this material exists in a very good state of preservation. Indeed, the excavation showed that the below-ground structures remain intact. As an industrial manufacturing site of the late 18th–early 19th century, it is located well outside the northern power base of the industrial revolution, and has the potential to provide valuable insights into the industrialisation of Surrey and the south-east of England during this period. As a site owned and operated by an upper-middle-class entrepreneur, it is typical of the kind of premises that such individuals favoured and which contributed much to the innovation and experimentation apparent at the time. However, it is almost certainly unique in having been operated for such a limited period and then almost immediately demolished, and for the evidence to survive undisturbed by the later development, alteration or ruination that affects many sites of a similar character or age. While the possible medieval origins of milling on the site remain obscure, this investigation has shown the site contains information on the industrial period that has the potential to address some further specific specialist research questions regarding the industrial processes of the period.

It is hoped that a future – and perhaps more specialist – examination of the site might be possible, and the fairly detailed breakdown of the deposits encountered during this investigation given in this article, and the order in which they are presented, have been designed specifically with a future study of the site in mind. Any such investigation should be carried out only with specialist archaeometallurgical input, preferably from the project design stage, with considerable provision for both environmental and industrial residue sampling and analyses, as it is likely that such study could contribute to our overall understanding of the subject. Site-specific research aims should include addressing the possibility and implications of the theorised separate demolition episodes in the first instance but, perhaps primarily, to establish a sequence of operation for the mill to ascertain whether the hypotheses regarding the abandonment of the southern mill race and the technologically-driven remodelling of the structure can be borne out by further evidence. Against the background of rapid technological change at the time, it is possible (although perhaps wishful thinking), that a process developed at the site itself could have necessitated such changes, and that the archaeological record might be able to support this.

Any future work should concentrate on the changing hydrology – natural and man-made – of the site (it would be useful to be able to date construction of the massive embankment) and detailed exploration of the southern mill race, to establish its sequencing in the development of the site and preferably its dating.

Comparative studies with other sites of a similar period will also continue to be important. While much has been learnt nationally during the period of post-excavation analysis from 2008 to 2013 about the technological transition of the late 18th century ironworking processes, including from scientific analysis, comparative studies and documentary research, it is clear that archaeological examination of Downside Mill has much to offer, and that its continuing investigation has the potential to be of considerable benefit.

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The finds, by Richard Savage and Pamela Savage

POTTERY

Very little pottery (as distinct from ceramic building material) was recovered from either trench; all sherds were post-medieval in date. In trench 1 the earliest sherds were a chip of green-glazed fine whiteware (possibly EBORD) (2g) and a chip of Frechen Stoneware (2g), both in the demolition layer (009) above the central 'island' of the site of the mill. None of the remaining diagnostic sherds from trench 1 is likely to pre-date 1800 and many are post-1830. The one vessel worthy of a fuller mention is a cylindrical white ceramic vessel found in context 022. This has been identified and dated from the manufacturer's stamp, 'Bailey & Co, London' impressed in an oval cartouche, as a product of the Fulham Pottery when run by Charles Bailey between the years 1864 and 1888 (information on Fulham Pottery & Cheavin Filter Co retrieved from http://www.gracesguide.co.uk/index.php?title=Fulham_Pottery_and_Cheavin-Filter_Co&oldid=907132, following a suggestion by David Dungworth). This cylindrical vessel of unglazed stoneware contained a mixture of mined graphite and a manganese ore together with a graphite bar (figs 18 & 19). The vessel and its contents had not been subjected to heat and its purpose and use remain obscure.

Figs 18 (above) and 19 (below) Cylindrical vessel of unglazed stoneware containing a mixture of mined graphite and a manganese ore together with a graphite bar

In trench 2 context 2006 contained four small sherds of tin-glazed ware, three badly abraded of 17th century date and one possibly a little later. The other diagnostic sherds from the trench were 18th century or later in date.

CLAY TOBACCO PIPES

In trench 1 the demolition layers above the central 'island' of the mill site and the upper layers of the fills of the mill races contained a small number of clay tobacco pipe fragments, including two fluted bowls, one from 003 with the initials 'I I' on the heel and the other from 020, both dated to the 19th century. One flattened heel was found in 008 and another heel in 023. That from 020 had the initials 'I W' on the heel.

In trench 2 fragments of clay tobacco pipe stem were found in contexts 2002, 2004 and 2006. In addition, a bowl dated to after 1830 was also recovered from 2006.
A full list has been deposited as part of the site archive.

GLASS

Of the total of 1.7kg of glass recovered from trench 1 more than half (926g) came from context 008. This context included fragments from at least six 19th century bottles weighing 854g with most of the remaining glass in this context consisting of very small fragments of window glass. Fragments of earlier green bottles came from 002, 009 and 023, but in aggregate these weighed only 126g. Most of the other glass from trench 1 consisted of very small fragments of window glass.

The only glass from trench 2 came from 2004 and consisted of many small fragments of highly degraded window glass weighing in aggregate 6g.

CERAMIC BUILDING MATERIAL

The upper layers of trench 1 consisted of demolition and infill layers containing a great number of tile and brick fragments and no attempt was made to collect or retain these systematically. Most of the material was discarded on site with some representative pieces being retained in the site archive. At the end of the excavation sample bricks were taken from the walls (010, 015, 016, 017, 032, 033 and 043). All these bricks are in shades of red and of nominal size 9 x 4¼ x 2½ inches, they do not have frogs and all except that from wall 003 are well fired with clean cut edges and faces. The samples have been deposited as part of the site archive. No brick samples were taken from the walls of the southern mill race (018 and 019) that were apparently built in a single operation with the sloping floor of the mill race.

FLINT

Some twenty possibly worked flints were collected during the excavation. Seventeen of these were examined by Roger Ellaby and three by the Surrey County Archaeological Unit. Three pieces were determined to be natural starch fractures and all the remaining pieces were considered to be natural flakes of bladelet form. All have been discarded.

LEATHER

A number of pieces of worked leather were found in the waterlogged conditions of 023. The larger pieces consisted of the buckle and strap end of a leather belt and the sole and upper of one or two boots or shoes. Drawings of these items have been deposited as part of the site archive. An attempt was made to preserve these pieces by freeze-drying but this was unsuccessful.

BONES

Few fragments of bone were retrieved from across the site. All but one were small fragments. The only significant bone fragment came from trench 2 (2002), being a ring of about 5cm in length (weighing 185g) sawn from a cattle long bone.

SHELLS

A small number of marine shells were found, principally oysters (in 001, 003, 008 and 023), slipper limpets (in 008 and 022) and a single limpet (in 008).

WOOD AND TIMBER

Waterlogged twigs and fragments of worked timbers were recovered from fill 028, deep in the southern mill race. These decayed before analysis was possible and have been discarded.

METALWORK

(i) General

The demolition and infill layers contained a great deal of miscellaneous metallic, mainly iron, items, many clearly from the demolition of the mill building that formerly stood on the site. Three highly-corroded buttons were recovered from 003. Details of the weights of material recovered are included in the site archive. The least diagnostic pieces were discarded while photographs were taken of the more identifiable pieces and these have been deposited as part of the site archive. The photographed items were later reburied on the site (at the express wish of the landowner). With the volume of metallic debris in trench 1 it was not possible to use metal detecting as an aid during excavation.

(ii) Remains of iron and copper industrial processes

The discovery of so much material from the dismantling and demolition of the iron and copper works, principally as infill in the southern mill race, had not been anticipated and no specific sampling strategy was in place. During the autumn of 2008 a MAP2-style assessment of the 55kg of initially retained material was commissioned from Dr David Starley and a copy of his report containing a listing of the material is included in the site archive. Dr Starley recommended further analysis as the material was in his view of potential national significance in understanding more about important technological changes in the iron industry in the last quarter of the 18th century. This suggestion was confirmed by Dr David Cranstone and, as a result, Dr Barney Sloane of English Heritage agreed that the archaeometallic samples should be analysed by Dr David Dungworth and Dr Sarah Paynter (later joined by Matt Phelps, a research student) at the English Heritage laboratories at Fort Cumberland, Portsmouth. The material was compared with that from other sites and this phase of the work ran from 2009 through to November 2013, resulting in the revision of the prevailing views of the technological processes involved. The final report (Dungworth, *et al* 2013) – particularly with regard to the processing of iron – is included as Annex A in Howe *et al* (2017). The report by Starley gives additional details related to the processing of copper, including a 'skull' of copper processing residues from a ladle and 'rails' for the casting of copper objects.

(iii) The Paddock, Emlyn Lodge

Metal detecting in this area, part of Raby's 'Pleasure Grounds' attached to the dwelling house, revealed a number of 20th century items, including a dog whistle, a Second World War cap badge, a live tracer cannon shell (probably discarded from the test-firing of guns by a Second World War USAF bomber taking off from Wisley airfield) and most of a set of Slazenger 'tennis pins'. These, with the exception of the tracer shell that was taken away by a bomb disposal unit, have all been retained by the landowner. The only significant artefact for the purposes of the present report is a lead cloth seal identified by Geoff Egan as coming from the Greenwich Naval Hospital; at the time only the second of this type of seal to have been discovered in Cobham (a third has subsequently been found elsewhere in Cobham). It may well have sealed a bag of old clothing/cloths sent to be reprocessed at the Downside flock mill in the years after 1818. The first example to be found was described (Egan 1999, 192−5) as bearing a stamp with a shield: having on a field of horizontal hatching a cross with a crown at the centre and an anchor in each angle, with two crowned, fish-tailed supporters, and as a crest a naval crown surmounted by two union flags saltirewise, with the arms being identified by Barbara Tomlinson (National Maritime Museum). The lead cloth seal found during the metal detecting in The Paddock has been donated by the landowner and now forms part of the site archive at Elmbridge Museum.

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The Assessment of Metalworking Debris from Downside Mill, Cobham, Surrey (DMC08)

David Starley Archaeometallurgy Report 04/08

Introduction

Excavation on the site of Alexander Raby's late eighteenth to early nineteenth century Downside Mill, Cobham, Surrey was carried out as a training excavation by Surrey Archaeological Society in summer 2008. This report was undertaken by David Starley, external metalworking specialist in November 2008 as part of a MAP2 post-excavation assessment. The total 55kg of debris retained was examined, classified, and categorized into the main identifiable industrial processes. These processes included copper melting and casting, the conversion of pig iron to wrought iron and the hot working of iron.

Historical Background to the Site

The earliest date for a mill at Down is given as 1331 when it was a corn mill; by 1565 the mill was decayed and repaired. It is described as being a corn and paper mill in 1720 and a paper mill in 1728. In 1733 the paper mill was destroyed by fire (probably by arson) and was rebuilt in that year. It was thereafter in use as a paper mill until 1770 when it was acquired by Alexander Raby, who converted it for the purposes of his iron manufacturing business (Crocker). Raby was clearly an industrialist of wide commercial interests, having previously inherited his father's business in the Weald for the casting of bronze and iron cannon (Hodgkinson 2000). Raby had been interested in setting up smelting, casting and refining iron businesses (together with coal mines and canals) in Llanelli in South Wales since at least 1796; he sold his 'iron mills' at Down in 1806 when he relocated entirely to South Wales. The Down mills were sold again in 1809/10. The iron-working structures within the mills at Down had been dismantled by 1814, and thereafter the surviving mills were used first for flock manufacture and then as a timber sawmill (Taylor 2000; Crocker 2000).

The Downside mill was acquired by Raby in 1770 and initially used for the working of iron. A detailed plan of the site, dated probably to about 1798, includes a copper foundry and a complex which Crocker (2000) refers to as the heart of the iron mill. Three waterwheels here serve a women's shop, cutting house, break house, tilt, forge and iron foundry. Crocker suggests that this building housed furnaces for melting pig iron, presumably for conversion to wrought iron, also that the presence of the women's shop may indicate their role in cleaning the metal prior to tinning. Also of interest on this plan is a group of 'penns' for the storage of charcoal, coal and coke and a coke house, presumably for the conversion of coal to coke. Other indicators of production activities include the description that accompanied the sale notice of 1809 (Taylor 2000) which include *an iron mill, two large anchorsmith's shops (one adapted for a mill), an iron foundry, a forge and three smith's shops*.

The apparently detailed description of the complex is not entirely unambiguous. There is a general assumption that the foundry served to refine cast iron, *i.e.* to decarburise the otherwise brittle alloy into malleable, wrought iron. However, the exact process for doing so is not suggested although there were several variations in operation during the dates of operation of the site. There is also no mention of documentary evidence that might suggest whether or not the casting of cast iron was carried out on this site although this would also fit the term foundry. By the end of the eighteenth century, the use of cupola furnaces allowed small batches of pig iron to be melted for the production of cast iron goods, of the type that may have been highly saleable products of Raby's ironmongery interests in London.

Excavation Methodology and Initial Results

The archaeological input to the site in 2008 consisted of a nine day training excavation directed by Tony Howe. Details were provided by Richard Savage, the overall Project Director. Intervention included the cutting of sections across two mill races that had been backfilled probably in or before 1814 (Taylor 2000). One of these was reported to contain *a lot of iron slag, together with what are apparently parts of demolished furnaces or iron 'working floors'. Other parts of the site yielded copper slags, some showing the shape of the crucibles in which they had been melted.* (Savage, R, pers. com.)

Methodology for assessment

All industrial debris provided by The Surrey Archaeological Society was visually examined. This amounted to three boxes of finds, together with two buckets each containing a single large block of debris. It had been intended to classify all material into the standard categories used by the former English Heritage Ancient Monuments Laboratory. In the event only a minority of the debris matched these standard categories and new terms were coined to match the visual appearance. Visual observation of the exterior was backed up by examination of fresh fracture surfaces, the use of a geological streak plate and magnet. Table 1 presents a summary of these findings, based on the categories.

Table 1. Downside Mill: Summary of evidence for specific metallurgical activities by context.

Context	Activity	No. of Instances	Weight (g)
001	copper alloy casting	3	1368
001	copper or Iron casting?	1	125
001	probably finery	2	227
001	undiagnostic Iron working	1	75
001	probably metallurgical	1	105
001	other	1	29
001	total	9	1929
002	undiagnostic Iron working	2	110
002	probably metallurgical	1	35
002	total	3	145
003	copper alloy casting	3	177
003	probably finery	10	11830
003	iron smithing	1	1721
003	undiagnostic Iron working	2	268
003	probably metallurgical	2	3724
003	high temperature	4	1252
003	rolling or construction	1	142
003	other	4	1996
003	total	27	21110
004	undiagnostic Iron working	2	757
004	other	3	291

Table 1. Downside Mill: Summary of evidence for specific metallurgical activities by context.

Context	Activity	No. of Instances	Weight (g)
004	total	5	1048
006	structural	1	31
006	total	1	31
008	copper alloy casting	1	76
008	probably finery	3	146
008	undiagnostic Iron working	2	1104
008	probably metallurgical	1	256
008	high temperature	2	189
008	assay?	1	29
008	other	2	43
008	total	12	1843
009	copper alloy casting	3	474
009	probably finery	3	253
009	undiagnostic Iron working	1	63
009	high temperature	1	2
009	other	1	169
009	total	9	961
020	copper alloy casting	3	295
020	probably finery	3	18222
020	other	3	288
020	total	9	18805
022	copper alloy casting	3	265
022	probably finery	1	8
022	high temperature	1	75
022	assay?	2	315
022	other	3	390
022	total	10	1053
023	copper alloy casting	1	15
023	finery/Copper alloy casting	1	6320
023	probably finery	2	76
023	undiagnostic Iron working	1	734
023	high temperature	2	451
023	total	7	7596
024	other	1	20
024	total	1	20
035	probably finery	1	20
035	undiagnostic Iron working	1	14
035	wire drawing?	1	15
035	total	3	49
037	other	1	48
037	total	1	48
All		97	54638

Classification of debris

Some forms of slag are visually diagnostic, providing unambiguous evidence for a specific metallurgical process. As noted above, much of the material from Downside Mill derived from processes little studied archaeometallurgically and less assurance can be given on which particular process gave rise to the material. Other debris, although more frequently encountered, is less distinctive and it is not possible to determine which metallurgical, or other high temperature process, it derives from. The assemblage from Downside mill includes a major component of slag deriving from the refining (decarburisation) of cast iron together with more limited quantities of material relating to the casting of copper and the hot working (forging) of wrought iron, together with a large quantity of material that could derive from these or other metallurgical processes.

1. Diagnostic – iron refining

The most distinctive form of slag found on site was classified as **flowed fayalitic plate slag** and **flowed fayalitic slag.** This debris closely resembled **tap slag**, the waste product associated with traditional bloomery iron smelting. However, unless a previously unknown furnace lies on this site or material has been raided from old slag heaps, this material is much more likely to be the waste product from iron refining, probably a finery. It is of predominantly fayalitic (iron silicate) composition, is dense and solidifies with a rope-like flowed morphology on its upper surface, from where it has been tapped from the hearth. The difference between the two is based purely on morphology, the plate having solidified in thin sheets. Of a similar composition were **fayalitic runs,** which had the form of small dribbles of fayalitic slag, sometimes with a flattened surface on one side. These had sometimes been mis-labelled as metal or lead, presumably owing to the metallic sheen on their surfaces. A single, but massive, **fayalitic block** with convex bottom, flowed top and flat side, the latter perhaps from cooling in contact with a metal plate. Composition appeared to vary from predominantly fayalite of the flat side to more cindery and iron rich on the other. The block resembles an oversized smithing hearth bottom, but in this context its origin is probably from a finery or perhaps re-heating hearth. Finally, of the many pieces of metallic ferrous debris, a very porous form was termed **iron rich mass**, which may be a fragment of an unconsolidated loup from a finery hearth.

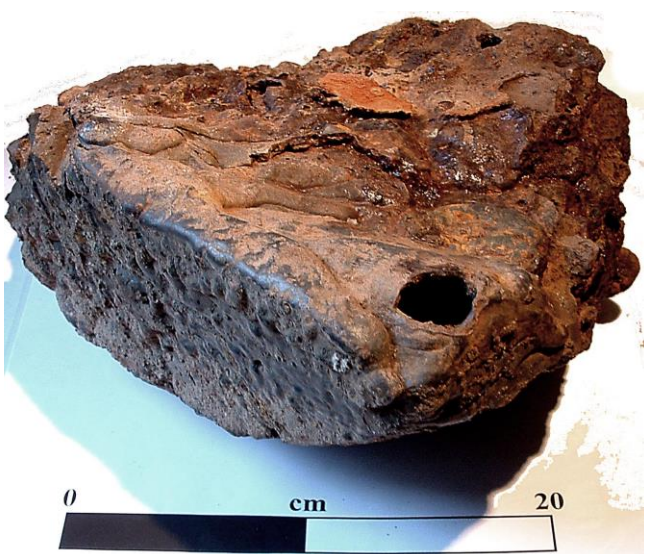

Plate 2. Fayalitic block from context 020. Probably the best indication of a finery or similar process for converting pig iron to wrought iron

2. Diagnostic – iron smithing

Evidence for iron smithing comes in two forms; bulk slags and micro slags. Of the bulk slags, the most easily recognisable are **smithing hearth bottoms**, which have a characteristic plano-convex section, typically having a rough convex base and a vitrified upper surface which is flat, or even slightly hollowed as a result of the downward pressure of air from the tuyère. Compositionally, smithing hearth bottoms are predominantly fayalitic (iron silicate) and form as a result of high temperature reactions between the iron, iron-scale and silica from either the clay hearth lining or possibly sand used as a flux by the smith. Only one example was found at Downside mill, in context 003. Attached to this piece of debris were fragments of **flake hammerscale**. This material consists of fish-scale like fragments of the oxide/silicate skin of the iron dislodged during working. It is normally regarded as an excellent indicator- not only that smithing took place but, because the small fragments collect on the smithy floor, of the location of the activity. However, given the evidence that refining took place on site, it is known that the finery hearth tended to be lined with hammerscale and therefore the material my have been moved around the site or imported to it.

Also to be noted, because of its absence, **spheroidal hammerscale** results from the solidification of small droplets of liquid slag expelled during hot working, particularly when two objects are being fire-welded together or when a slag-rich bloom of iron is first worked into a billet or bar, or of relevance to this site, when a loup from the finery is consolidated. A strategy for collecting evidence of these two forms of evidence should be put into practise during any future excavations.

3. Diagnostic - copper casting

Of several categories of metallic waste the semicircular-sectioned **copper-alloy runners** provide some of the clearest evidence of on-site casting. In addition, a **copper–alloy skull** is a shallow lens of metal that has solidified in the base of a crucible of ladle. The **copper-alloy fragments** were also often in the form of spills and dribbles. Several fragments of used **mould** fabric were identified (previously labelled as 'sand floor'). **Copper-alloy dross** was a less dense form of slag with a distinctive green colouration. In addition some of the types discussed below as 'undiagnostic' showed traces of copper corrosion products on there surface and were used as supporting evidence of non-ferrous working, although the possibility of contamination of iron working slags (for example when brazing) should also be considered.

5. Undiagnostic – ferrous metalworking

The category **undiagnostic ironworking** slag is normally a major component of any smithing or smelting assemblage. With only a tiny amount from this site, it will not be discussed further. **Iron-rich slag** was a little more common, but this could easily have derived from either smithing or refining. It is recognized by its significant content of iron not chemically combined as silicates, but visible as rust-orange coloured hydrated iron oxides and iron hydroxides. Certain pieces of 'slag' were shown by their cracked surfaces and testing with a magnet, to contain significant amounts of metallic iron. These **iron lumps** are likely to be either waste fragments from the consolidation of iron loups or part smithed artefacts. The tendency for some of the larger masses to fragment on cooling gives rise to the category of **dense iron working.**

6. Undiagnostic – iron or copper casting

This is a much less certain category created to explain what appeared to be blast furnace slag, but which for this site has, more cautiously, been termed **glassy slag.** Whilst some of this is black other fragments were liverish red coloured suggesting copper contamination. It is possible that the material relates to the fluxing of melts of cast iron or copper alloy.

7. Undiagnostic – probably metalworking

Several of the categories of material can be produced by a wide range of high temperature activities and are of little help in distinguishing between these processes.

Material listed as **vitrified hearth/furnace lining** may derive from either iron working or from non-ferrous metal working, although there was a lack of brightly coloured glazes which would provide a clearer indication of the latter. It forms as a result of a high temperature reaction between the clay of brick lining of the hearth/furnace and the alkali fuel ash or fayalitic slag. The material may show a compositional gradient from unmodified fired clay or brick on one surface to an irregular cindery material on the other. An associated material classed as **cinder**, comprises only the lighter portion of this, a porous, hard and brittle slag formed by the reaction between the alkali fuel ash and fragments of clay that had spalled away from the heath/furnace lining, or another source of silica, such as the sand sometimes used as a flux during smithing.

8. Undiagnostic – high temperature
The small amount of **fired clay** without any surface vitrification, found within the assemblage could have derived from structures associated with metallurgical purposes, or from those used for other high temperature activities. **Coal** was also grouped under this activity, as was its hard brittle waste product **light clinkery slag** and the possibly non-metallurgical **burnt stone.**

9. Assaying
This activity is based on some unusual **ceramic** fabrics. Two examples of hard fired ceramic tiles resembled modern geological streak plates and another unusual, cylindrical vessel containing what appears to be crushed slag or perhaps a shale-like coal. Their purpose is uncertain but some materials testing of raw materials or waste products is suggested.

10. Wire Drawing
Given the possibility of this activity on site some fragments of **wire,** were given an activity category of their own.

11. Rolling or Construction
As above, a section of strap iron classified under **ferrous off-cut** might represent a product of the iron mill.

12. Other material
This includes material such as **architectural ceramic** (slate, tiles, brick, etc) which might be associated with Raby's Mill, or other phases of occupation of the site. The same applies to **mortar**, although some fragments of slag coated with mortar, cannot pre-date the operation of the iron mill. A **number** of artefacts do not appear to have any relevance to the metallurgical process and a fragment of **aluminium sheet** is clearly intrusive.

Conclusions

The assessment of metalworking debris from Downside mill, Cobham, Surrey examined a total of 55kg of debris. The assemblage includes a major component of slag deriving from the refining (decarburisation) of cast iron together with more limited quantities of material relating to the casting of copper and the hot working (forging) of wrought iron, together with a large quantity of material that could derive from these of other metallurgical processes.

Refining.
This term is used generally to cover several processes for the conversion of carbon-rich pig iron (*i.e.* cast iron in ingot form) into low carbon wrought iron - a material which unlike cast iron is malleable and suitable for hot or cold forging, rolling, slitting, wire drawing etc. Until about the time of Raby's establishment of the mill at Downside the dominant method for achieving this was the charcoal fired finery process, either with or without a separate (coal/coke fuelled) reheating hearth. However about this time reverberatory furnaces started to be used in what is known as the puddling process. The advantage of the reverberatory furnaces lay in the separation of metal from fuel which allowed the use of coal or coke rather than charcoal. The waste products from both processes are likely to be morphologically similar. Potentially they may be distinguished by chemical analysis (Killick and Gordon 1987) although the distinction may not be immediately obvious (Starley 1999).

Although a large proportion of the refining evidence, termed *flowed fayalitic plate slag* and *flowed fayalitic slag* closely resembles the waste product associated with traditional bloomery iron smelting, no such activity is known in this area and the material is compositionally and morphologically consistent with finery slags. Less open to confusion is the massive, fayalitic block with convex bottom, very similar to blocks from known finery sites in the Pays de Bray of France (Phillipe Dillman pers. comm.). The block's clearly defined flat side suggests that solidification took place in contact with a metal plate, as were used to line finery hearths. However, as mentioned above other variations of refining processes, in use at this time might give similar looking material.

Copper-alloy casting
The presence of metallic debris in the form of (half filled) runner fragments, spills, dribbles and a skull of residual metal from the base of a crucible or ladle, together with green, copper corrosion-stained, slag, gives firm indication of the casting of non-ferrous metal. Perhaps more importantly fragments of a clay/loam mould, one a rim fragment with a diameter of about 50cm provide evidence of the casting of sizable objects. However, there is no clear evidence of the means of melting the metal, whether it be on a small scale in crucibles or larger scale in a reverberatory furnace.

Iron smithing
One of the better forms of evidence for the hot working (forging, smithing) of iron is hammerscale – the flakes of oxide that fall from the surface of iron and the spheres of slag squeezed from it's interior. It might be expected that with a collection policy that concentrated on bulk slags, and archaeological contexts containing secondary deposits, little of this material might have been retained. However, some was found, concreted to larger fragments. There is some reason for caution, hammerscale was used to help build up the base of finery hearth and therefore may not be simply a dumped waste product. A single smithing hearth bottom was identified. However the size of this was small enough

that it might derive from a small blacksmiths hearth rather than a more ‘industrial’ scale process. Possible products of the mill may be represented by finds of wire and strap iron.

Evidence for other processes

As mentioned above, there had been no suggestion, from those who studied the documentary evidence that the iron foundry, marked on the 1798 and listed in the 1806 sales document, might relate to the reheating and casting of cast-iron, although the smaller scale cupola furnaces had by this time enabled small batches of pig iron to be melted for the production of cast iron goods. Prior to this the trade would have been based at the primary smelting blast-furnaces. A range of architectural and domestic products might have provided a welcome addition for Raby’s ironmongery retail interests in London. No debris unambiguously supported this process, although it was thought that the *glassy slag* might be related to the fluxing of liquid metal, either copper-alloy or cast iron. Perhaps future excavations might recover metallic casting waste similar to that for the copper alloys.

Assaying

In addition to the diagnostic evidence many fragments of debris indicated a sophisticated operation, consistent with a period of industrial development. One example is the carefully fitted brick lining of furnaces, although apparently not of a refractory fabric. More enigmatically a ceramic vessel of unusual cylindrical shape and white fabric, marked ‘Bailey & Co London’ and containing pulverised slag, or possibly a shaley coal may have been used for testing the raw materials or waste products of the operation. Two hard-fired ceramic tiles, resembling geologists streak plates, may provide further evidence for such ‘assaying’.

Fuel

A less satisfactory aspect of this assessment, particularly in the light of the 1798 plan’s depiction of coal, coke and charcoal ‘penns’, has been the relative absence of evidence for the fuels used, which would help distinguish process such as fining from puddling. Coal was occasionally found, together with some of the typically clinkery waste from the use of mineral fuels, but never unambiguously, physically attached, to the diagnostic waste products. The difficulty may lie in the secondary nature of the deposits which had allowed the more fragile fuel remains to be weathered away

No attempt has been made to study the distribution of the debris on site – little information was supplied to the specialist, beyond the fact that one section of a mill leat produced much slag and a different area yielded copper slags. The significance of the finds is likely to be somewhat limited by the apparently secondary nature of at least the first of these contexts, finding such material in direct association with structures shown on the detailed plan, would have painted a more convincing picture of activities on the site. However, given the necessarily limited nature of the training excavation, the examination has provided a very useful indication of processes and indeed the potential of the site for any future investigation.

Suggestions for Future work

Given the importance of the metallurgical industries at the date of Raby's Mill, a surprisingly small amount of archaeological investigation has been undertaken outside a couple of major sites. It is not known whether further work is intended at this site, if so then targeting the different structures, might help to determine their function more precisely, assuming that all evidence was not removed in their conversion to other industries. It is unlikely that bulk debris will remain *in situ*, but microslags, such as hammerscale may well provide much evidence if a suitable sampling strategy is devised (Starley 1999).

Whether any further, analytical, work is done on the material collected in the 2008 season depends to some extent on the possibility of further excavation and recovery of material. However, it is thought that chemical analysis and microstructural examination might prove illuminating. In particular the following should be addressed:

- Fayalitic block

Partial sectioning to optically identify any entrapped fuel residues and metal prills in the microstructure. Compositional analysis, such as X-ray fluorescence (XRF) analysis or SEM based EDX analysis for sulphur, potassium and sodium levels as potential indicators of coal/coke fuelled reduction process.

- Flowed fayalitic slag

Compositional analysis, as above.

- Smithing hearth bottom

Microstructural and compositional investigation to compare with probable finery slag.

- Copper casting waste, including mould fragments

Compositional (XRF) analysis of cleaned surfaces to determine alloys being cast.

- Glassy slag

Compositional analysis to identify non-ferrous traces.

- Slag from within ceramic vessel

Compositional analysis to confirm visual identification of this material.

- Ceramic vessel and 'streak plates'

Consultation with appropriate specialists.

Retention of finds

Surrey Archaeological Society's policy for the retention of industrial debris is not known. It is strongly recommended that all debris is retained, as a relatively rare example of an assemblage from this little studied, but crucial period of industrial expansion.

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Appendix Full Listing of Metalworking Debris by Context

Box	Con-text	Labelled	Slag type	Wt (g)	Comments	Process	Fuel	Cu Alloy
4	001	area of copper	Cu-alloy skull	465	Metallic residue from crucible or ladle?	Cu alloy casting	no	yes
4	001	area of copper	Cu-alloy lump	28		Cu alloy casting?	no	yes
3	001	copper slag	Irregular fayalitic lump	875	With green copper corrosion products	Cu alloy casting?	no	yes
4	001	industrial waste	glassy slag	125	Very much like blast-furnace slag. Some black other with deep red coloration, suggestive of copper content	Cu or Fe casting?	no	yes
3	001	metal-slag	flowed fayalitic slag	45		prob. finery	no	no
3	001	metal-slag	iron rich mass	182	Porous. Possibly unconsolidated fined iron	prob. finery	no	no
3	001	metal-slag	vit. hearth/furnace lining	105		prob. metallurgical	no	no
5	001	mortar	mortar	29		structural	no	no
3	001	metal-slag	Irregular fayalitic lump	75		undiag. Fe working	no	no
4	002	slag	cinder	35		prob. metallurgical	no	no
4	002	slag	ferrous lump	74		undiag. Fe working	no	no
4	002	slag	undiagnostic ironworking	36		undiag. Fe working	no	no
5	003	metal	Cu-alloy ring	8	Artefact not waste product	artefact	no	no
5	003	fibrous substance	mineral-preserved textile	37		artefact	no	no
5	003	metal	Cu-alloy runner	101		Cu alloy casting	no	yes
5	003	metal	Cu-alloy fragment	26		Cu alloy casting?	no	yes
5	003	metal	Cu-alloy frags	50		Cu alloy casting?	no	yes
3	003	slag	burnt stone	553		high temperature	no	no
5	003	coal	coal	170		high temperature	coal	no
3	003	slag	fired clay	34	Grey, fired in reducing atmosphere	high temperature	no	no
3	003	slag	light clinkery slag	495	Coal inclusions	high temperature	coal	no
4	003	slag	smithing hearth bottom	1721	plano convex block (190x150x70) with attached hammerscale	iron smithing	no	no
3	003	small lead	fayalitic runs	36	Small dribbles of fayalitic slag, 1 side flat	prob. finery	no	no
4	003	slag	fayalitic runs	63		prob. finery	no	no
3	003	metal-slag	flowed fayalitic plate	1802	Resembling bloomery tap slap with ropey surface	prob. finery	no	no
3	003	slag	flowed fayalitic plate	2434		prob. finery	no	no
3	003	slag	flowed fayalitic slag	828	Porous	prob. finery	no	no
3	003	slag	flowed fayalitic slag	732		prob. finery	no	no
4	003	slag	flowed fayalitic slag	2321	Resembling bloomery tap slap with ropey surface	prob. finery	no	no
5	003	slag	flowed fayalitic slag	340		prob. finery	no	no
5	003	metal	flowed fayalitic slag	131		prob. finery	no	no
3	003	slag	iron rich mass	3143	Possibly unconsolidated fined iron	prob. finery	no	no
4	003	slag	vit. hearth/furnace lining	2521		prob. metallurgical	no	no
5	003	slag	vit. hearth/furnace lining	1203	Back comprises red fired brick	prob. metallurgical	no	no
3	003	metal-slag	Fe off-cut	142	Ferrous strip, 135x25x4mm. ? Strap/hoop iron	rolling or construction	no	no
5	003	? flue tile	architectural ceramic	636	Large fragment of curved tile, no surface modification	structural	no	no
5	003	mortar	slag coated in mortar	1315		structural	no	no
3	003	metal-slag	ferrous lump	162	Irregular shape	undiag. Fe working	no	no
3	003	slag	iron rich slag	106		undiag. Fe working	no	no
5	004	metal	Fe object	17		artefact	no	no
5	004	metal	sheet Al fragment	4	intrusive	intrusive	no	no
5	004	cobble	architectural ceramic	270	Fragment of bevel edged blue brick	structural	no	no
5	004	slag	dense ironworking slag	354		undiag. Fe working	no	no
3	004	slag	iron-rich cinder	403		undiag. Fe working	no	no
5	006	Mortar ?sand floor	stone	31	mortar covered	structural	no	no
5	008	copper handle	Cu-alloy off-cut	19		artefact	no	yes
5	008	slate	ceramic	29	distinctive ceramic tile/plate 41x80x6mm. Purpose unknown	assay?	no	no
3	008	copper ore	Cu alloy dross	76		Cu alloy casting?	no	yes
3	008	clinker	clinker	80	Dark, brittle and porous	high temperature	coal/ coke	no
5	008	coal	coal	109		high temperature	coal	no
5	008	metal	fayalitic runs	2		prob. finery	no	no
5	008	metal	flowed fayalitic plate	115		prob. finery	no	no
4	008	slag	flowed fayalitic slag	29	Resembling bloomery tap slap with ropey surface	prob. finery	no	no
4	008	slag	vit. hearth/furnace lining	256	Glazed brick	prob. metallurgical	no	no
5	008	slate	slate	24		structural	no	no
4	008	slag	iron-rich cinder	604	With attached flake hammerscale	undiag. Fe working	no	no

Box	Con-text	Labelled	Slag type	Wt (g)	Comments	Process	Fuel	Cu Alloy
4	001	area of copper	Cu-alloy skull	465	Metallic residue from crucible or ladle?	Cu alloy casting	no	yes
4	001	area of copper	Cu-alloy lump	28		Cu alloy casting?	no	yes
4	008	slag	iron-rich cinder	500		undiag. Fe working	no	no
5	009	non-ferrous metal	Cu alloy casting runners	285	Semi circular section	Cu alloy casting	no	yes
5	009	non-ferrous metal	Cu-alloy frags	183	Includes casting waste	Cu alloy casting	no	yes
5	009	slag	irregular fayalitic lump	6	With copper alloy corrosion	Cu alloy casting?	no	yes
5	009	coal	coal	2		high temperature	no	no
5	009	non-ferrous metal	fayalitic runs	1		prob. finery	no	no
5	009	slag	flowed fayalitic plate	2		prob. finery	no	no
5	009	industrial waste	flowed fayalitic plate	250		prob. finery	no	no
5	009	mortar	mortar	169		structural	no	no
5	009	slag	iron rich slag	63		undiag. Fe working	no	no
5	020	?metal dish	Fe object	64	Fragment of circular artefact with raised rim	artefact	no	no
5	020	? Glass	glass	10	Opalised	artefact	no	no
5	020	? sand floor	mould fragments	206	Clay/loam mould fragments, hardened not fully fired, grey fabric. Rim section of one indicated a diameter of c 500mm	Cu alloy casting	no	yes
3	020	slag	Cu alloy dross	85		Cu alloy casting?	no	yes
5	020		Cu alloy dross	4		Cu alloy casting?	no	yes
1	020		fayalitic block	1513 0	Large block (270x300x140mm) with convex bottom, flowed top and flat side (? From contact with metal plate). Flat side fayalitic other side more cindery and iron rich	prob. finery	no	no
3	020	slag	flowed fayalitic plate	449		prob. finery	no	no
3	020	slag	flowed fayalitic slag	2643		prob. finery	no	no
5	020	? Mortar	architectural ceramic	214	Fragment of hollow square, sectioned pipe/flue	structural	no	no
5	020	?copper or bronze handle			Not seen by D. Starley			
5	022	?nails & ?copper/bronze	Fe object	334	Nails	artefact	no	no
5	022	pot and contents	ceramic	242	Thin walled, cylindrical vessel. 62mm dia. x 150mm high with darkened rim. Stamped "Bailey & Co London". Possible laboratory apparatus. Contained uniformly crushed slag gravel.	assay?	no	no
5	022	pot and contents	ceramic	73	Rectangular ceramic plate/tile. 155x38x7.5mm. Pierced twice at one end. Laboratory apparatus?	assay?	no	no
5	022	metal ?bronze	Cu alloy fragment	234	Casting runner, semi-circular section	Cu alloy casting	no	yes
5	022	?nails & ?copper/bronze	Cu-alloy fragment	18	Dribble from casting	Cu alloy casting	no	yes
5	022	worked copper or bronze	Cu-alloy fragment	13		Cu alloy casting?	no	yes
5	022	coal	coal	75		high temperature	coal	no
5	022	? metal run-off	fayalitic runs	8		prob. finery	no	no
5	022	mortar	fired clay	48		structural	no	no
5	022	mortar	mortar/plaster	8		structural	no	no
5	023	mortar ?sand floor	Mould fragments	15		Cu alloy casting	no	yes
2	023		vit. hearth/furnace lining	6320	Large frag. (330x220x100mm). Vitrified surface without non-ferrous corrosion products. Back closely fitting, unmortared, oxidised fired brick (end on 55x100mm)	finery/Cu alloy casting	no	no
5	023	clinker	clinker	25		high temperature	coke	no
5	023	coal	coal	426		high temperature	coal	no
5	023	metal	fayalitic runs	23		prob. finery	no	no
5	023	metal	flowed fayalitic plate	53	Very thin(1-3mm) sheets	prob. finery	no	no
4	023	slag	iron-rich cinder	734	With attached flake hammerscale	undiag. Fe working	no	no
5	024	metal	Fe object	20		artefact	no	no
5	035	non-ferrous metal	Fe object	15	Wire, possibly from production process	? Wire drawing	no	no
5	035	lead	fayalitic runs	20	Drips and runs	prob. finery	no	no
5	035	non-ferrous metal	Fe lump	14		undiag. Fe working	no	no
4	037	slag	architectural ceramic	48	Overheated	structural	no	no
	All			54638				

DOWNSIDE MILL, COBHAM, SURREY: CONSULTANT'S OPINION

This report forms a second opinion on *The Assessment of Metalworking Debris from Downside Mill, Cobham, Surrey (DMC08)* (Starley n.d.), by David Starley for Surrey Archaeological Society; it is prepared at the request of Surrey Archaeological Society. It is informed by Starley n.d., by Crocker 2000 and Taylor 2000 (as referenced by Starley), and by the present author's experience as an archaeological consultant to various excavations and research projects on 18th and 19th century ironmaking. I should note that, as an archaeologist rather than an archaeological scientist, I am not competent to comment on the details of scientific methodology.

The 1790s (?) map used by Crocker, Taylor, and Starley as a major primary source contains some unusual terminology, and all three modern sources contain some misunderstandings of technology. To comment briefly

- The term *iron foundry* refers specifically to the melting of cast iron and casting into objects; misuse for a conversion forge is unlikely, and foundries separate from blast furnaces were common from the early 18th century onwards. At this date, the iron could be melted in either a *cupola furnace* (a small vertical shaft furnace, fuelled with coke and blown by an air blast) or an *air furnace* (a boxlike rectangular reverberatory furnace, fuelled with coal with no powered air supply but a substantial chimney to provide draught); a large foundry would contain both. The small footprint of the Cobham foundry and the presence of the 'coak house/coke oven' suggests a cupola.
- The term *forge* normally refers to the conversion of cast iron to wrought iron (which includes hot-working), though it can refer simply to hot-working of wrought iron from elsewhere (mainly a later usage – I have little doubt that this is a conversion forge). Until the mid 18th century, the process involved charcoal-fuelled finery and chafery hearths (both requiring an air blast), and a heavy water-powered 'helve' hammer. Processes from c 1750 to c 1800 were much more varied: the finery process was modified by the use of a *refinery* or *running-out fire* to remove silicon from coke-smelted pig iron before fining, and/or a reverberatory *balling furnace* for reheating the fined iron; a wide series of processes involving coal-fuelled reverberatory furnaces and/or rolling rather than hammer-forging were tried out, of which the best known is 'stamping and potting' (widely used from the 1770s to c 1800) – some of these processes involved 'piling' of part-processed iron on ceramic tiles or plates; Cort's puddling and rolling process, using a reverberatory *puddling furnace* and grooved rollers to hot-work the iron into bars, was developed in the 1780s but not perfected until the 1790s – it required large quantities of coal, and of power for the large rolling mills required.
- Until the mid 18th century, the air blast for finery/chafery and cupola furnaces was normally supplied by bellows blowing directly into the hearth/furnace, but by 1770 the use of blowing cylinders would be normal; the 'cylinder race' on the 1790s plan confirms that they were used in the forge and/or foundry at Cobham
- Tinplating used wrought (not cast) iron plates; high-grade charcoal-smelted and –fined wrought iron was preferred until well after 1800. The plates were rolled, cut (using powered shears) and rerolled in packs, before pickling and tinplating. Given the presence of Tinmans Row, interpretation of the 'Women's Shop', 'Cutting House' and perhaps 'Break House' as for tinplating is a plausible

suggestion (though requiring more proof before it should be confidently accepted; smaller-scale tinning of iron and/or copper-alloy artefacts is also possible). A 'tilt' is normally a centre-pivoted powered hammer, lighter and faster than the forge 'helve' – this could be used in tinplating, or in other fabrication. However the 1790s plan may not use the term in its precise technical sense, so caution is required.

- The 'Mill' is probably a rolling mill, though other interpretations are possible (and any tinplate manufacture may have used a smaller and lighter rolling mill in the forge/tilt building). Rolling mills were very power-hungry; 18th century mills often had separate waterwheels, on opposite sides of the building, to power the upper and lower rollers, though more sophisticated arrangement were becoming normal by c 1800.

Starley's report forms a very competent assessment-level study of what is clearly an unusual assemblage. As a contribution to discussion, I would suggest that:

- **Fayalitic slag**: in this context the material seems almost certain to derive from iron refining rather than bloomery smelting. In future work, considerable attention should be paid to relating it in detail to the range of processes potentially used in the period – as well as composition and mineralogy, physical form (such as the distinction between plate and non-plate morphology) may be important here
- **Spheroidal hammerscale**: Starley is right to stess the importance of a careful pre-agreed sampling strategy in any further excavations, and of close liaison between the field team and the specialist.
- **Glassy slags**: An obvious possibility is that these may derive from cupola remelting; the slags from this process have not yet been clearly categorised
- **Assaying**: An alternative interpretation is that the ceramic tiles could relate to the piling of part-processed iron in some variants of later 18th century refining technology, referred to in several contemporary accounts but not currently well understood. Similarly, the cylindrical vessel may be a 'pot' from the stamping and potting process. However the small size of these objects suggests that Starley's interpretation may well be correct.
- **Rolling or construction**: Again, Starley's interpretation may well be correct, and strip for hoop-making was one of the major products of late 18th century rolling mills. However, reverberatory furnaces (of all kinds) were normally bound externally with iron strapping to resist thermal expansion; other hearths, furnaces, and chimneys were also sometimes strapped.

Opinion

The development of the foundry, forge, and fabrication sectors of the iron industry in the later 18th and early 19th century was of crucial importance to industrialisation generally, and its understanding is still constrained by the limited historical evidence. This latter is probably only a selective record of the range of processes actually used, and the field archaeological and archaeo-metallurgical remains even of the documented processes have not yet been clearly identified and 'calibrated' to their source-process. This has been identified as a major national priority for research in the Historical Metallurgy Society's research framework (Bayley et al 2008, 61-2, 68). The existing assemblage assessed by Starley, and both the field remains and the assemblages and samples from any future site investigations, are therefore very clearly of national importance. I therefore strongly support Starley's argument for full archaeo-metallurgical study of the existing assemblage, and would actively support proposals for further work on the site (potentially as a major reseach project), provided that adequate specialist inputs into both the fieldwork and the post-excavation programme are built into the project design and costing.

David Cranstone

13/05/09

Reference

Bayley J, Crossley D, and Ponting M (eds), 2008. *Metals and Metalworking: a research framework for archaeometallurgy* (London: Historical Metallurgy Society Occasional Publication No 6)