THE EXCAVATION OF THREE ROMAN BLOOMERY FURNACES AT HARTFIELD, SUSSEX

by *C. F. Tebbutt, F.S.A.*

INTRODUCTION

The site, at TQ 452 309, is on heathland known as the Cow Park which was until 1696 part of Ashdown Forest. It had been planted with conifers which were cut down during 1914-18. Its situation is halfway up a west facing slope on the east side of the Millbrook valley, after the stream has passed through the chain of artificial lakes on the Pippingford estate. At the site itself is a natural terrace which appears to have been further artificially levelled and is demarcated by distinctive surface vegetation. This consists of fine grasses in the midst of an area of coarse grass and bracken. Excavation showed that this definition coincided with heavy charcoal soil impregnation. About 36 m to the south-east is a strong spring which continued to run during the drought conditions of 1976.

The site commands distant views in all directions except to the east, and in view are Garden Hill *c.* 1250 m to the north-west, site of an Iron Age and Roman settlement,[1] Pippingford Bloomery *c.* 750 m to the west-north-west,[2] and East Wood Bloomery *c.* 950 m to the south-west.[3] All these sites are of probable first to second century AD date. Over the hill *c.* 900 m to the north-north-east is Stickridge Gill Bloomery, at TQ 456 317, as yet undated.[4] The whole area is on Ashdown Sand but presumably the iron workers obtained their mineral from pockets of iron ore derived from the once overlying Wadhurst Clay and often found locally exposed in stream beds and other cuttings, or more improbably from iron pan in the Ashdown Sand itself. A further feature of the site, on its north side, is the long straight bank of a 'pillow mound' (rabbit warren) whose south ditch just missed destroying part of the site. This is probably of late seventeenth century date.

The site seemed a promising one for excavation, being on open heath now devoid of trees and unlikely ever to have been under cultivation in modern times.[5] A long-term excavation research, currently going on under the direction of J. H. Money at nearby Garden Hill, seems to point to that settlement being some sort of centre for iron working in the Roman period and it seems likely that this site was a satellite. A working floor was revealed at 40 cm when a trial metre square was dug. Permission to dig was readily given by the army authorities, and the field section of the Wealden Iron Research Group agreed to adopt it as an excavation project.

For shelter on the site a turf hut was built, from turves stripped from the site, in the fashion of a charcoal burner's hut. As the excavation went on for more than a year we were able to experience the most extreme weather conditions that obtained on this very exposed windswept hillside, and to form a judgement as to how permanent such a hut could be and whether the work there was likely to have been continuous or seasonal.

THE EXCAVATION

After the removal of the turf, the working area was trowelled down to the level of the working floor and finally through this to the undisturbed subsoil. The working floor was easily recognised,

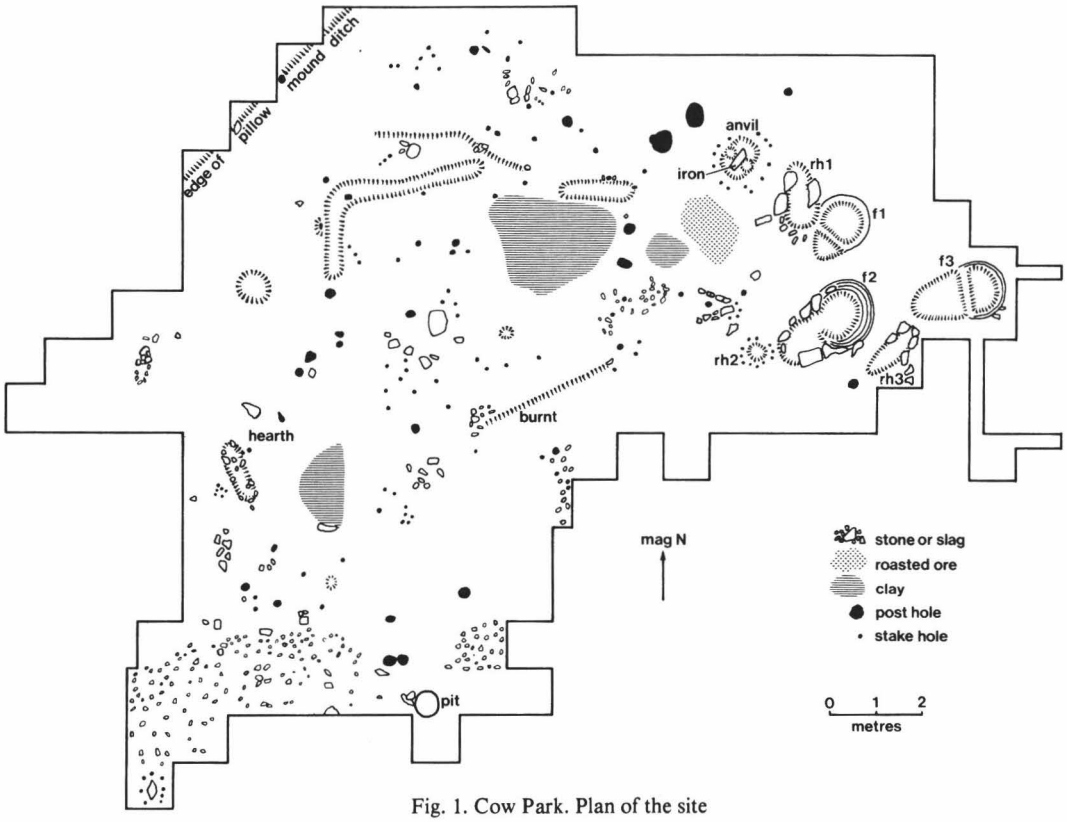

Fig. 1. Cow Park. Plan of the site

being stamped hard and containing charcoal and small slag nodules and being pierced by many apparently uncoordinated post and stake holes. In no place did the edge form a definite line, but it was easy to see when the edge had been passed. In many places lumps of slag and cinder had been dumped just outside the edge. The excavation was continued in all directions until the edge had been reached. From the plan it might appear that we had not gone sufficiently far beyond the three furnaces to be sure that there were not more in that direction. It was quite clear, however, during excavation that beyond there was a virgin area with no signs of any sort of human or industrial activity, and indeed they were on the edge of the levelled platform. Several small test holes confirmed this.

Over the main part of the area away from the furnaces the working floor was found to be covered to a depth of about 30 cm by extremely fine black soil heavily impregnated with charcoal dust and containing only quite small lumps of slag and cinder. There were, however, larger sandstone blocks lying on the actual floor. It was amongst this material that almost all the pottery, mainly in small sherds, was found. Careful examination convinced us that this soil was the waste from sieving to separate larger sized material, some of which lay round the perimeter of the site.

The Furnaces

As can be seen from the site plan (Fig. 1), all three furnaces were constructed on the extreme north-east edge of the working area, and are numbered 1-3 in order of discovery. All are of the

same type, although no. 1 and 3 approximate in shape and size and no. 2 is larger. Little of the structure has survived above ground, and none up to the height of possible tuyere insertion. Each has its accompanying reheating hearth, but of differing patterns.

The last use of nos. 1 and 3 seems to have been the same. They were left full of slag and cinder up to contemporary ground level and the superstructure was removed. In the case of no. 2 however, no solid slag was found in the interior and the superstructure had collapsed into and around the furnace. After excavation the interiors of all three filled with water during the winter but dried out in the summer.

Some sort of rainproof shelter was clearly necessary to protect the bellows operators. No sign of any such shelter structure was found. However, if the site was shortlived or seasonal, wattled hurdles would probably have sufficed and would have left no trace. It should be recorded that no sign or part of any tuyere was found in the course of the excavation.

Furnace no. 1 (Fig. 2 & 3; Plate 1)

This furnace, like the other two, was built at one end of a shallow oval pit, one end of the pit being occupied by the furnace and the other serving as the tapping pit. The lower part of the clay walls of the furnace were thus supported for about three quarters of their circumference by the solid walls of the pit. The front, facing the open pit, was supported at its base by two large equal sized and roughly shaped sandstone blocks, set in the pit sides butted together in the centre, and separated by a small aperture. As exactly the same method of construction was repeated in the front of furnace no. 3, it seems likely that it was deliberate. This aperture was clearly not a tuyere hole. No tapping arch was found in the surviving level of the furnace and it must therefore have been at a higher level, well above the aperture. When found, the aperture was blocked by solidified tap slag but could possibly have been used, in conjunction with bellows, for lighting the furnace. The two sandstone blocks formed a solid bridge across the pit on which to build the furnace front, which would probably need rebuilding each time a bloom was extracted.

When excavated, the furnace was found to be full to contemporary ground level with solid cinder which required a hammer and cold chisel to remove it. The furnace floor below the cinder was concave, following the curve of the pit sides, and was brick hard. It was noted that this floor level was below the lowest level in the tapping end of the pit.

The tapping pit contained no slag or cinder but was burnt red from hot material of some sort coming from the furnace. In the furnaces no clay lining survived above contemporary ground level, but on some parts of the sides the solid slag, lining the inside of the walls, still remained at a slightly higher level.

Furnace no. 2 (Fig. 2 & 3)

This furnace was much larger than the other two and had a proportionately larger tapping pit. It also differed in other ways, particularly in its filling when it was abandoned. The bottom half of this filling, about 30 cm deep, consisted of almost pure charcoal dust among which were thinly stratified layers consisting of small pieces of clay lining and scraps of rusty slag that was fairly magnetic. Above the charcoal filling was another 30 cm thickness consisting of collapsed clay furnace wall, much of it in large pieces up to 28 cm in length. It was quite evident that, unlike the other two furnaces, here the walls had been left standing on abandonment and had collapsed naturally.

Another differing feature was in the renewal of the existing clay walls. These had been renewed four times, a new lining being applied to the old. As the broken-down above-ground walls were

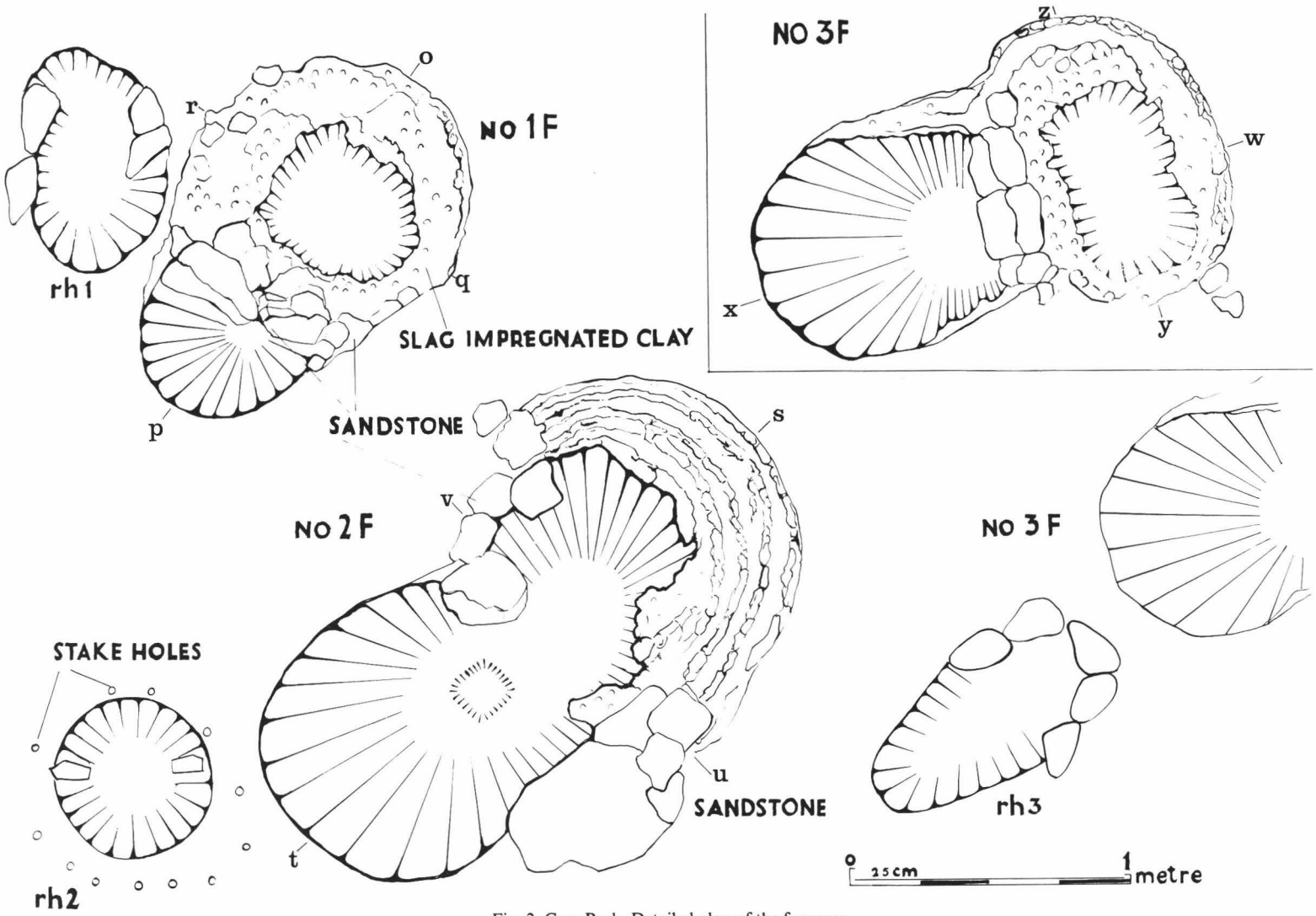

Fig. 2. Cow Park. Detailed plan of the furnaces

available for study, the method of their construction was found to be of great interest. They had been formed by putting together 'sausages' of clay (Plate 4), as in primitive pottery making, to form a wall and then plastering over the inside to provide a smooth surface. In some cases this inner lining had separated during firing and the 'sausages' were found covered by green glaze caused by the effect of smelting heat on the sand in the clay.

As in the other furnaces the brick-hard base was concave, following the curve of the pit sides, and was lower than the lowest level in the tapping pit. The front of this furnace, when found, was completely open to the tapping pit although supported by large stone blocks on each side. Indeed, the charcoal filling had flowed out into the pit, and like the furnace the pit contained no appreciable amount of slag.

Furnace no. 3 (Fig. 2 & 3; Plate 2)

This furnace resembles no. 1 in both size and condition when abandoned, being full to contemporary ground level with solid cinder requiring a hammer and cold chisel to remove it. As in no. 1, two roughly shaped sandstone blocks with a slight aperture between them formed the foundation for the front wall. The main difference between this furnace and no. 1 was in the tapping pit. When it was already half filled with a mixture of charcoal and loose slag pieces, liquid slag had run into it from the furnace forming a solid layer. This seems to have flowed from above the two stone blocks, to which some still adhered. The aperture between the blocks was also filled. This slag layer was at a lower level than that inside the furnace.

Like the others, the furnace base was concave and lower than that of the tapping pit.

The Reheating Hearths (Fig. 2)

Each of the three furnaces had beside it a reheating hearth (marked rh on the plan) of which little remained but a burnt red hollow in the subsoil; this may have originally had low clay surrounding walls. As with the furnaces, the hearths associated with furnaces nos. 1 and 3 were similar but that belonging to no. 2 was quite different in shape and construction.

Hearth rh 1 Associated with Furnace 1. This appeared to have occupied part of an already much burnt and larger hollow area, perhaps the vestigial remains of an earlier furnace, on the west side of Furnace 1. It had two large sandstone blocks on its west side and one on its east side, and was elongated in shape. It contained much charcoal and fragmented cinder.

Hearth rh 2 Associated with Furnace 2. As this furnace differed from the other two, so this hearth was quite unlike the others both in construction and position. It was circular in shape and placed just off the end of the tapping pit. It consisted of a heavily burnt hollow, round which a clay wall had been built. This could be inferred from the circle of small reinforcing peg or stake holes which survived.

Hearth rh 3 Associated with Furnace 3. This hearth was narrow and pear-shaped and had large sandstone blocks round its broad north-east end. A post hole just off its opposite end might have had some connection with a bellows support, but was not paralleled in the other hearths.

The Smithy Area (Plate 3)

About 2 m north-west of Furnace 1 was undoubtedly the site of the smithy area, where blooms extracted from the furnaces were forged. This comprised one, and probably three, anvils. A shallow

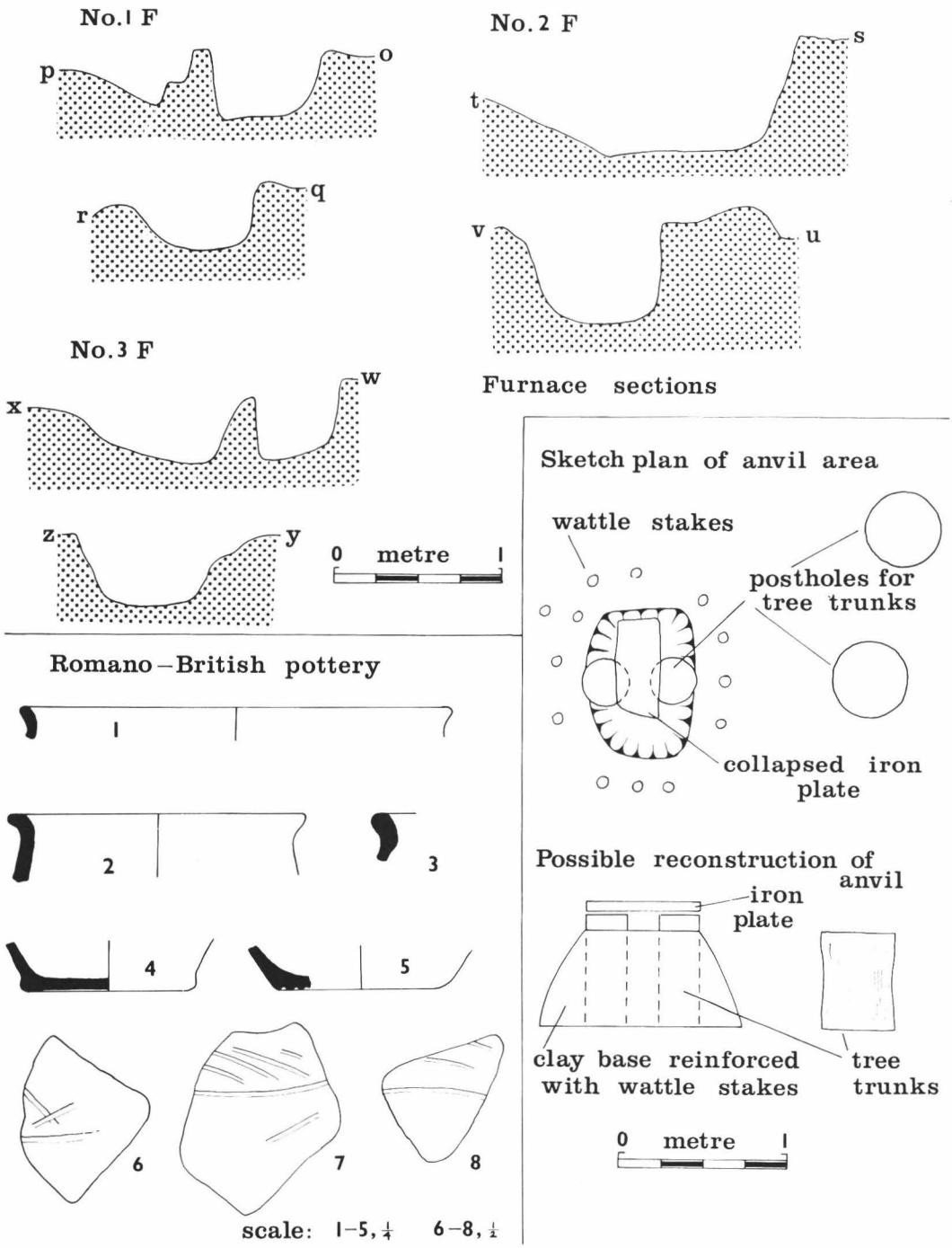

Fig. 3. Cow Park. Furnace sections and pottery

rectangular hollow contained, close together, two shallow postholes; fallen across them could be seen the 'ghost' of a thick rectangular iron plate. Although this was barely more than a staining of rust, it was still faintly magnetic over much of its surface and could be measured as 23 cm broad, 59 cm long, and 4 cm thick. Surrounding this assemblage were a circle of stake or peg holes which I interpret as having held wooden reinforcing rods for a solid clay base, stabilising the two posts supporting a flat-topped anvil. A suggested reconstruction of this anvil appears in Fig. 3. Somewhat similar flat-topped Roman anvils are illustrated in plates 5 and 6. There was a scatter of magnetic hammer scale on the working floor surrounding the anvil. It might be argued that a smith standing outside a clay base as suggested above would be too far away from the anvil. However it must be remembered that a red-hot bloom, direct from the furnace, would have a large bulk of slag attached and this would scatter widely at the first blow of the hammer. A long-handled hammer and tongs would probably be necessary for this work.

It will be seen from the plan that there were two large postholes about 1 m north-west of the above anvil. These again were surrounded by hammer scale and I suggest that they were part of the smithy. The holes were only 20 cm deep and there was no sign of a clay base, but it seems likely that the posts either supported smaller anvils or were used without a metal top, as blacksmiths still do today for some operations.

This, as far as I am aware, is a unique find in relation to iron smelting in this country.

Remainder of the Working Area

On the remainder of the working area there was little to indicate what actually took place at a particular spot, or where possible buildings, shelters or windbreaks were situated. The relatively few postholes, occurring in no particular pattern, and the large number of stake holes suggest temporary buildings. Supplies for the furnaces were however quite definitely represented by heaps of clay for construction and repair, and roasted ore brought in from elsewhere, there being no sign of roasting on the site.

The hearth on the south-west showed no signs of intense heat and was thus probably for domestic cooking. Some irregular hollows suggest soakaway drains, but in each case they had been filled to make a level floor above. On the north side were some changes in floor level along fairly straight lines. Here there had evidently been barriers, as the floor colour was different on each level.

The small group of postholes on the extreme south were outside the working area and I suggest they held tethering posts for pack animals.

Construction, use and type of furnaces

From the description of the furnaces given above, it is obvious that, while differing in size, and in spite of the fact that no part of any one of them has survived above ground level, they are all of similar construction and type. Below ground they are all constructed at one end of an oval pit, with the original furnace base at the bottom of the pit and at a lower level than its opposite end into which slag was tapped. Had smelting taken place at this floor level, no slag could have been made to run into the tapping end. Furthermore, no tapping arches have survived and therefore they must have been placed above ground level. This fact is borne out in no. 3 furnace where slag can be seen to have flowed from above over the large stones forming the front of the furnace, leaving tap slag adhering to the stones. At this furnace tap slag also remained in the tapping pit, confirming its function. The condition of the furnaces when found would explain this apparent inconsistency. Each furnace was filled up to ground level, nos. 1 and 3 with slag and no. 2 with charcoal, and by using this higher level as a base molten slag could have been run out into the tapping pit.

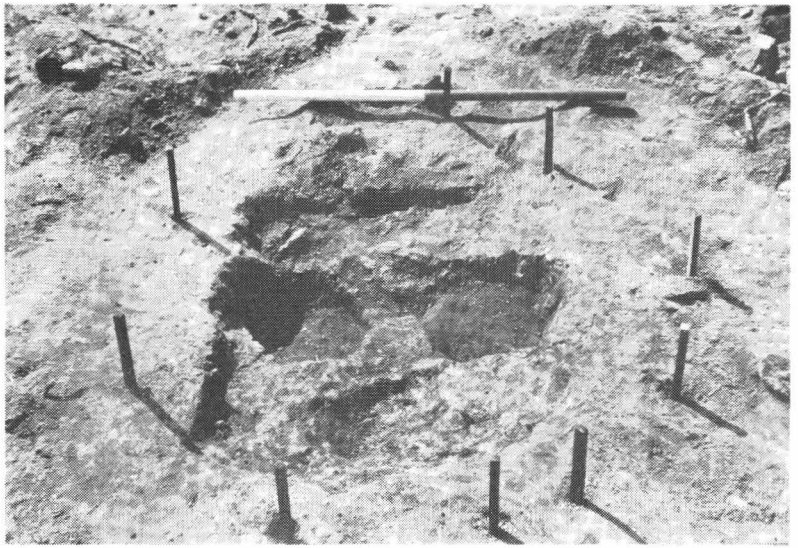

Plate 3. Cow Park. Anvil site; scale 1 m

Plate 4. Cow Park. Section of No. 2 furnace wall, showing coil construction

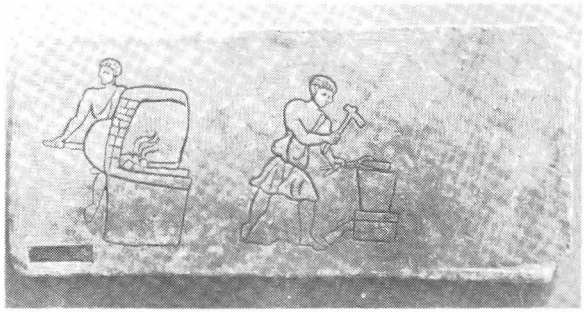

Plate 5. Graffito showing Roman blacksmith's workshop; from the catacomb of Domitilla, Rome; showing tree-trunk as anvil

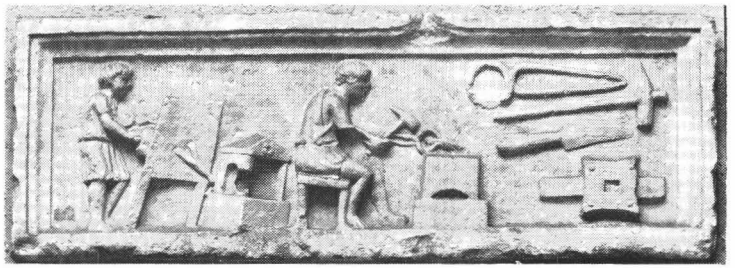

Plate 6. Roman blacksmith's workshop showing an iron plate as anvil. (Relief from Aquiliea; cast in Museo della Civilta. Rome)

Organisation

Until much more research has been done on the iron industry in the central Weald in Roman times, ideas as to possible organisation must be mainly speculative. We know from the research of Mr. H. Cleere that such organisation almost certainly did exist in the eastern Weald under the direction of the Classis Britannica.[10] Elsewhere some different organisation obtained. At the nearby Garden Hill settlement have been found signs of luxury living and iron working contemporary with the operation of this site.[11] On present evidence, everything points to Garden Hill being an organisational centre in the charge of a highly paid official controlling a number of sites such as the one we have excavated.

Subsequent history

Interesting developments obviously took place very soon after the iron making operations ceased, of which there is the following evidence. First, it is obvious that the amount of slag remaining is very small and in no way commensurate with the work that had been done. For instance there is much less than that remaining at Pippingford Bloomery[12] where there was only one furnace, which had not been relined. Secondly, all over the western half of the working area the floor was covered, to a depth of 30 cm, by waste from sieving slag to discard the charcoal dust and small pieces. This was done before turf had time to cover the abandoned site. Just over 2 km to the east is the Lewes to London Roman road across Ashdown Forest,[13] the course of which can still be traced by the bloomery slag used as a surface. I suggest that this was the destination of most of the slag produced here.

Dating

The two sources of dating are the pottery and archaeomagnetic measurements. From these it would appear that no precise date can be assigned to the furnaces but that they can safely be placed within the period A.D. 50-155.

SPECIALIST REPORTS

The Pottery (Fig. 3)

This was kindly examined by Dr. M. G. Fulford who reported as under:—'All but one sherd belongs to the East Sussex/Wealden group of grog-tempered largely hand-made wares. The body sherd (from a flagon) is wheel-thrown and in yellow sandy fabric. The collection could quite happily be lost among the Garden Hill material.[14] The Newhaven material also offers a good comparative collection.[15] As to date, this is very difficult. The one wheel-thrown sherd suggests a post-conquest date, but grog-tempered wares, which one might have supposed died out early in the Roman period, continue well into the second century if not beyond (see Garden Hill). One or two body sherds seem to have 'eye-brow' decoration which continues at least to the Neronian-Flavian period.'[16] Dr. Fulford went on to say that his first choice of date would be the second half of the first century, and secondly $c100 \pm 50$ (A.D.).

Archaeomagnetic Measurements

Samples were taken by A. J. Clark of the Ancient Monuments Laboratory, D. o. E., using the disc method *(Journal of Archaeological Science,* forthcoming), and measured under the direction of M. Noel in the Department of Geophysics and Planetary Physics, University of Newcastle upon Tyne.

Two sets of samples were obtained. Both were orientated by theodolite, using in the first case a timed sun shot, and in the second the built-in magnetic compass of the theodolite. The first set was taken in continuous heavy rain which flooded the lower parts of the furnaces so that it was only possible to sample the upper walls of Furnace 2 a succession of heavily burnt clay linings encrusted with slag. Ten samples produced a mean direction of Declination $7.4° \pm 6.1°$ E; Inclination $63.5° \pm 2.8°$ (single standard error; normalised to Meriden). On a later and drier occasion, a group of 11 samples from the floors of Furnaces 2 and 3 produced a mean direction of Declination $0.6° \pm 5.1°$ E; Inclination $65.7° \pm 2.2°$.

The second sample fits satisfactorily to the Romano-British directional curve as at present known, and indicates a date within the range A.D. 60-160; the first set is slightly displaced to the east of the curve and, although it overlaps the second set, on its own would suggest a range of dates entirely within the second century. Most of the error in both sets is due to the spread of declination values, and there was one explicable wild value in each set tending to separate them: one, a sample of iron slag, and the other incorrectly reassembled after breakage. Excluding these, the inclinations are much more precise and both sets are in good agreement, the overall mean being $64.6° \pm 0.9°$. Magnetic refraction—distortion of the magnetising field by the structure itself—should not have affected the inclination of the first set, which were taken mainly from the east end of the furnace but the second set, from the floors, could have been slightly shallow.[17] However,

the small standard error of the combined values shows that this effect must be minimal, and, accordingly allowing a very small bias for this, the inclination values indicate a date in the range A.D. 120-155.

Analysis of Roasted Clay-ironstone, by Dr. P. Ovenden

Adhering clay was carefully removed from the lumps of ironstone which were crushed to give a representative sample (20 g). This was rendered further to pass 63u. An aliquot of the sample (1 g) was ignited at 950 deg. C. to constant weight and a portion (0.1 g) dissolved in a mixture of hydrochloric and hydrofluoric acids. Excess fluorine was taken up with trimethyl borate and the following components determined by atomic spectrometry.

Component	%	
SiO_2	5.57	
$A1_2O_3$	3.39	
Fe_2O_3	80.6	
CaO	1.73	
MgO	2.44	
MnO	1.99	
K_2O	.093	
Na_2O	.007	
TiO_2	.29	
P_2O_5	1.05	
SO_3	.12	
H_2O, CO_2	2.93	*(Loss in weight)*

Dr. R. F. Tylecote comments on the above analysis as follows:—

'This is very good quality and must have been well roasted to give such a low LOI. Is it magnetic?[18] The quality is given by the low total $SiO_2+A1_2O_3+CaO+MgO$. The MnO will have replaced some iron in the slag, and I would expect the iron to have contained about 0.1-0.2% phosphorus.This would have made it a relatively poor metal for conversion to steel.'

Plant Remains

A series of soil samples were taken by Mrs. P. Hinton at varying levels over the working area near the furnaces. Unfortunately reliable results were negative.

Charcoal

A number of samples of charcoal were taken from inside Furnace 2, the working floor between the furnaces, and a post hole in the anvil area. They were examined by Ms. C. R. Cartwright who identified all as oak (*Quercus* sp.).

ACKNOWLEDGEMENTS

It is a pleasure to acknowlege the help and assistance of so many people, especially the Army authorities for permission to dig and Messrs. A. and R. Morriss who discovered and informed me of the site and afforded access. Among many members of the Wealden Iron Research Group who worked there I must mention R. Adams, L. Batchelor, P., D. and S. Combes, V. and B. Herbert, S. and G. Swift and M. Tebbutt.

I am grateful for advice generously given by Dr. R. F. Tylecote and Mr. H. Cleere, and for specialist reports from Dr. R. M. Fulford, Dr. P. Ovenden, Mr. A. J. Clark, Ms. C. R. Cartwright and Mrs. P. Hinton. Drawings were contributed by Mr. R. Cottingham, Miss L. Funnell and Mrs. M. Tebbutt, and photography by Mrs. E. Crossley and Mr. D. Combes.

The finds will be deposited at Barbican House Museum, Lewes.

[1] C. F. Tebbutt, 'Garden Hill Camp, Hartfield' *Sussex Archaeological Collections,* Vol. 108 (1970), 39-49.

[2] C. F. Tebbutt, 'A Romano-British Bloomery at Pippingford, Hartfield' *Sussex Archaeological Collections,* Vol. 111 (1973), 27-40.

[3] *Wealden Iron. Bulletin of the Wealden Iron Research Group,* 7 (1974), 11.

[4] *Ibid* 20.

[5] Except for the 'pillow mound' the only evidence found of other human activity on the site was a thin scatter of flint flakes, probably belonging to the Neolithic or Bronze Age.

[6] J. H. Money, 'Iron Age and Romano-British Iron Working Site in Minepit Wood, Rotherfield, Sussex' *Historic Metallurgy,* Vol. 8, 1—20.

[7] See note 2.

[8] H. F. Cleere, *Antiquaries Journal,* Vol. 52 (1972), 8-23.

[9] See notes 2, 3.

[10] *Archaeological Journal,* Vol. 131 (1974), 171-199.

[11] J. H. Money, 'Garden Hill' *Current Archaeology,* Vol. 41, 185-8, and forthcoming.

[12] See note 2.

[13] I. D. Margary, *Roman Ways in the Weald* (London 1965), 124.

[14] See note 11.

[15] Martin Bell, 'The Excavation of an Early Romano-British Site at Newhaven, Sussex' *Sussex Archaeological Collections,* Vol. 114 (1976), 259-62.

[16] See note 15.

[17] Aitken, M. J. and Hawley, H. N., 'Archaeo-magnetism: evidence for magnetic refraction in kiln structures' *Archaeometry,* Vol. 13, 83-85.

[18] Other samples of this ore were highly magnetic.