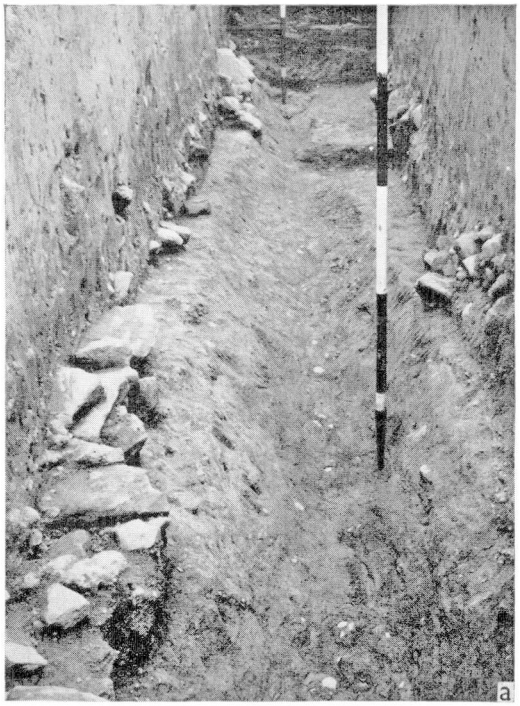
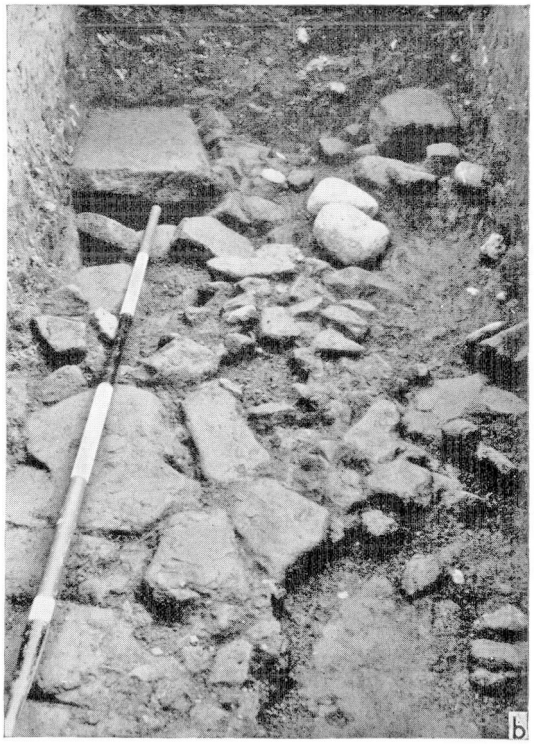
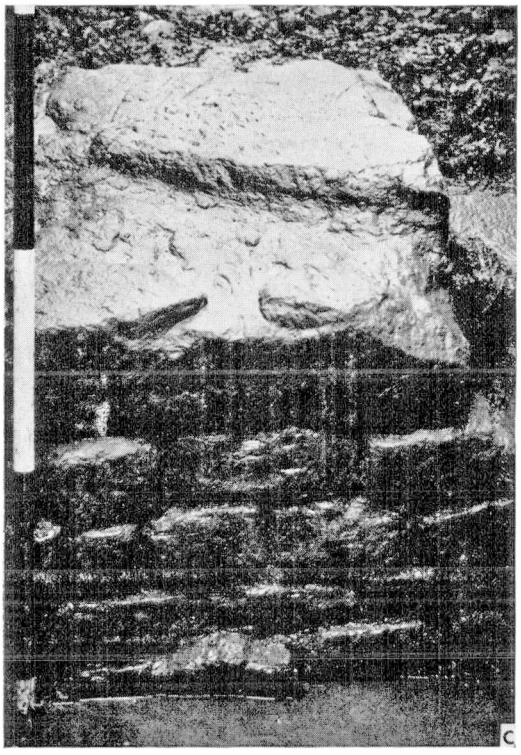
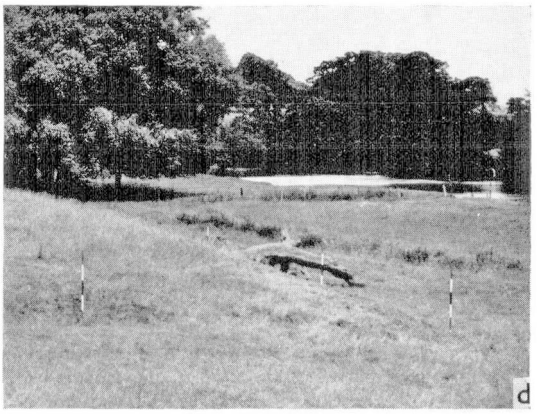
PLATE I.









Photos: Alan Wilkins.

a—Channel in natural, looking north.

b—Wall and sandstone spread in south end of trench.

c—Revetting on south side of quay.

d—Looking north onto present creek entrance.

Bronze-Worker's Hearth

By B. R. Hartley.

I. Introduction.

In the final stages of excavations on Site I of Heronbridge some selective trenching was done in Building III.[1] In one of the trenches at the west end of the building an ash layer was found lying directly on the natural clay and with it was associated a small pit. The nature of the material contained in the ash and the pit made it abundantly clear that bronze-working had been carried out on the site and, most fortunately, it proved possible to correlate this discovery with the previous one of a hearth made by Mr. W. J. Williams in one of his trial trenches of 1946 only three feet away to the north. The writer is greatly indebted to Mr. Williams for a tracing of his plan of the hearth and this is reproduced in the present paper with the later discoveries plotted in.[2]

II. The work-shop, hearth and ash layer.

By a singularly happy chance, the original trenches dug by Mr. W. J. Williams revealed not only the hearth and a sandstone platform surrounding it, but also part of an associated building. This consisted of a short length of a sleeper-beam trench, running roughly north-south, with a clay floor to the east (Plan, fig. 1). In addition, at the south end of the beam trench, at right angles to it, was a stone-built pier nearly nine inches square standing three courses high. The sleeper-beam trench, which must once have contained a wooden sole-plate, shows clearly that here stood a timber building. The stone pier is an unusual feature in such a structure but it

[1] *C.A.J.*, 39, fig. 2.

[2] Grateful thanks are also extended to Miss Katharine Kaine for help in the preparation of this report, to Miss M. V. Taylor who supplied various references and read the manuscript, to Mr. G. C. Boon and Mr. R. R. Clarke for information on local material, to Dr. J. O'N. Millott for a report on the coal, to Professor I. A. Richmond for many helpful comments and for reading the manuscript, to Dr. J. A. Smythe for his report on the metallic finds, to Mr. Graham Webster for putting the material at the writer's disposal, and to Messrs, R. F. G. Preston and Alan Wilkins for helpful comments.

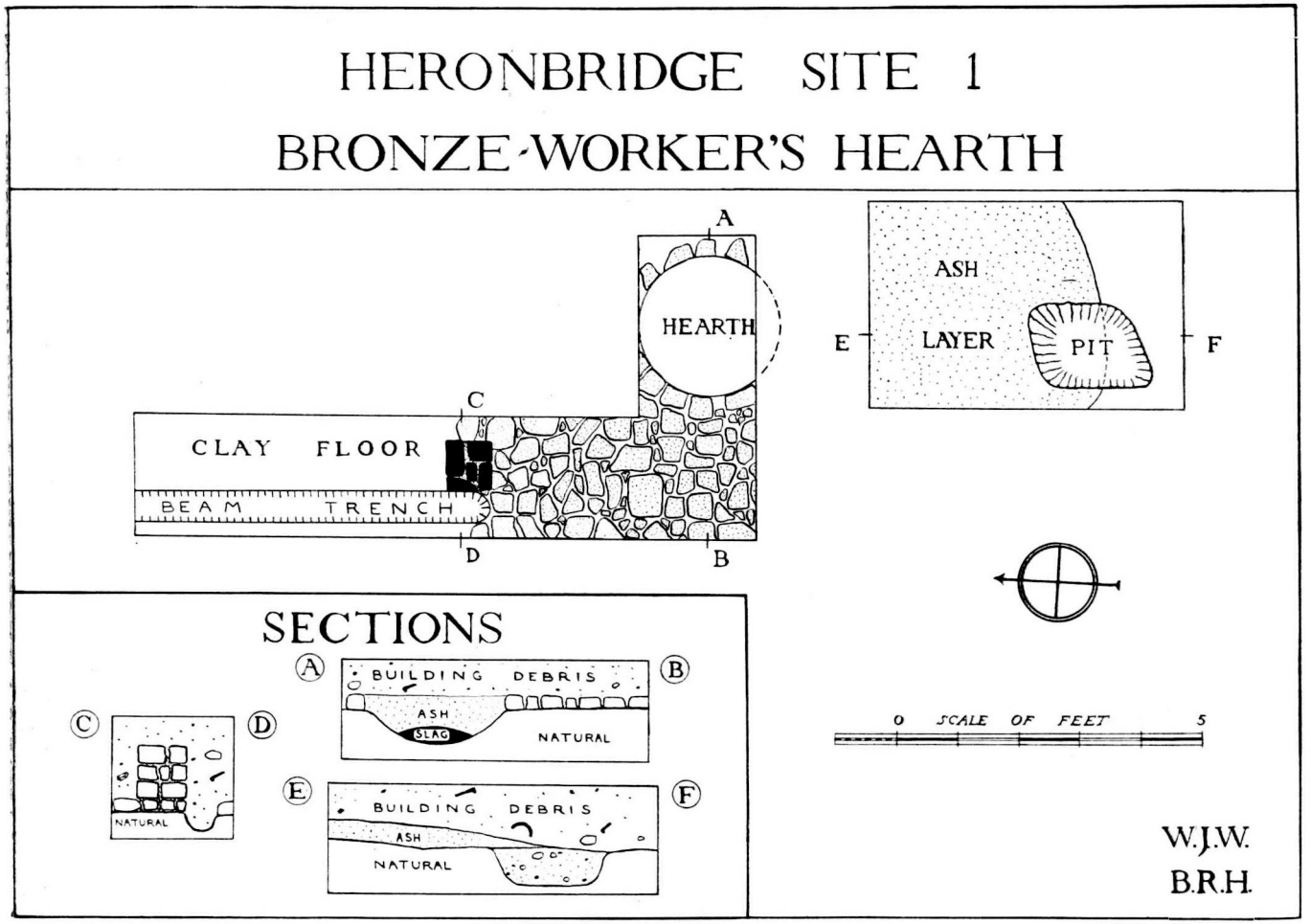

HERONBRIDGE SITE 1
BRONZE-WORKER'S HEARTH
A
HEARTH
C
CLAY FLOOR
BEAM TRENCH
D
B
ASH
E
LAYER
PIT
F
SECTIONS
A
BUILDING DEBRIS
B
ASH
SLAG
NATURAL
C
D
NATURAL
E
BUILDING DEBRIS
F
ASH
NATURAL
0 SCALE OF FEET 5
W.J.W.
B.R.H.

FIG 1

may be suggested with confidence that it served to take the weight of a wooden beam supporting the south gable of the building across an open front. It is clear, then, that the site was occupied by an open-fronted timber building of unknown size which faced south. That the building extended to the north is indisputable, while the pier and the clay floor tell us that the beam trench represents its west wall. The relations between the beam trench, clay floor, pier, and working platform prove that all belong to the same scheme, and, this being so, it seems unlikely that the timber building could have been other than the bronze-smith's workshop.

The working-floor, of roughly dressed sandstone, which surrounded the hearth ended on the north at the threshold of the smithy where it was succeeded by the clay floor. Its southern edge did not appear in either trench but must have been approximately six feet south of the threshold. Such a floor was highly necessary at Heronbridge for the natural subsoil is a boulder clay which readily becomes waterlogged.

The hearth itself was very simple, being merely a shallow circular pit two feet six inches in diameter cut some six inches into the natural clay, (fig. 1; Section A-B). Its effective depth, however, was increased to nine inches by the presence of the sandstone surround. The bottom of the hearth contained a mass of siliceous bronze slag which had no doubt accumulated over a long period through spilling of the molten metal in removing crucibles from the hearth. The upper part of the filling was primarily ash and clinker but a few lumps of baked clay were included.

That the hearth was placed outside the workshop is not a matter for surprise, as the fumes evolved would be highly noxious and, furthermore, there would be a distinct risk of fire in such a timber building. It seems probable that there would be a series of such hearths along the front of the smithy, some for smelting, some for melting the bronze, and perhaps some for preparing enamels. However, if this were so, the remainder of the battery would have been destroyed by the foundation trench cut for the central wall of the later stone building.

The simple form of the Heronbridge hearth at once calls to mind the similar ones found in the metal-workers' settlement at Wilderspool[3] and the method of smelting the bronze must have been equally primitive. The precise details of the process would depend on the type of ore being dealt with but in all probability this was first roasted in air and then transferred to the hearth and covered by the fuel. The latter would then be fired and, if need be, given air blasts from bellows placed around the edge of the hearth. The copper freed by this means from the ore would collect in the bottom of the hearth while the impurities would form an upper slag layer which could be skimmed off.[4] The copper would solidify in the bottom of the hearth in the bun-shaped mass familiar from North Wales where some smelting was apparently done at, or near, the mines.[5]

When the smith needed bronze for a casting he would place part of one of the copper cakes in a crucible, add the necessary quantity of tin and put the crucible in

[3]See *H.S.L. & C.*, N.S., 16, Plate III.
[4]*cf. Arch.*, 56, p. 289.
[5]See *B.B.C.S.*, Vol. 12, part 4 for a list of copper cakes etc found in North Wales and for Galloway see *P.S.A.S.*, LXVI, p. 343.

the hearth, probably with a loose-fitting clay lid. As in the case of smelting, the fuel would be piled up around and over the crucibles and fired. Either coal or charcoal could serve as fuel and it is interesting to find that at Heronbridge, within easy reach by river of the North Wales coal outcrops, and lying in a densely wooded area, both methods of firing were used. The melting completed, the molten bronze would be poured out from the crucible directly into the mould.

To the south of the hearth, and immediately above the natural clay was an ash layer, some four inches thick at its maximum, tapering away to an ill-defined edge at a distance of five feet or so. This layer was heavily charged with charcoal, coal, clinker, slag, and fired clay, and must represent the material raked out from the hearth. Pieces of rough clay crucibles and broken moulds which were included in it had more probably been thrown out from the workshop.

A small pit partly sealed by the ash layer (Fig. 1, Section E-F) had a sandy fill, though it, too, contained charcoal and some unburnt coal. This pit had no traces of burning on its floor or sides and perhaps it merely marks the spot at which the smith dug his clay, for the crucibles and moulds were probably made on the site and with the local clay.

DATE OF THE STRUCTURES.

The levels belonging to the large stone building, shown by earlier work to be of the mid-second century[6], had been entirely removed at this point but, fortunately, the ash layer and pit yielded a few pottery fragments of the late first or early second century (Fig. 2). This evidence, together with the fact that the layers and structures described above all rested directly on the natural clay at the Period II footings level, makes it certain that the smithy and associated material must be assigned to the first period of occupation of the site which began about A.D. 90. Further support for the dating may be derived from the presence of a crucible in a sealed deposit of the first period under Building II.[7]

III. THE FINDS.

(a) *Pottery* (Fig. 2)

From the ash layer:—

1. Flanged dish in brown fabric with mica dusting. Vessels of identical type are not recorded from the legionary depôt at Holt, but *Holt*, p. 122, no. 157 is of the same general class and the present piece was probably made there. The reconstruction is based on another dish of this type from first period levels on Site II at Heronbridge.

From the pit:—

2. Rim fragment of a hemispherical bowl in orange-brown fabric; diameter ten inches. This bowl belongs to a common class of vessel imitating Samian form 37. Such bowls are highly characteristic of first period deposits at Heronbridge (cf. *C.A.J.*, 39, fig. 9, no. 36 for instance). Again this piece is most probably from the Holt kilns (cf. *Holt*, p. 22, nos. 154-5).

[6] *C.A.J.*, 39, p. 13.
[7] *C.A.J.*, 39, fig. 9, no. 49 and *Group B*, p. 14 ff.

3. Several fragments of a flagon in red-brown micaceous fabric with a good white slip. (Not illustrated.) This fabric was used for most of the flagons found in Period I groups.

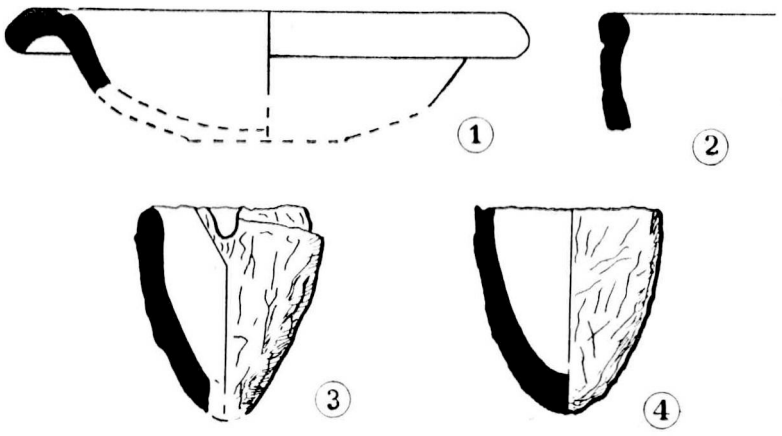


FIG. 2. Pottery and Crucibles (½)

(b) *Crucibles.*

The ash layer yielded fragments of at least ten crucibles, all of similar type. Those illustrated (Fig. 2, nos. 3 and 4) are typical of the group, being roughly formed in a porous grey fabric. Two of the pieces have simple U-shaped spouts for pouring off the metal and most are coated with a dark-green vitreous glaze formed by solidification of films of the molten bronze. The poor quality of the clay and the extreme temperatures to which the crucibles were subjected have caused bad cracking in many cases, and some of the vessels have been patched with clay.

The usual uniform grey fabric is due, no doubt, to the prolonged heating of the crucibles under the reducing conditions of the hearth. Those few fragments which show a buff fabric in places must be from vessels broken soon after they were first used.

Such crucibles are not uncommon on Romano-British sites and several examples are mentioned in the lists of sites below (p. 12 ff.) In passing, it is of interest to note that a generally similar type is still in everyday use; the rounded base aids rapid melting of the metal and lessens heat strain on the crucible.

(c) *Moulds.*

It is unfortunate that most of the moulds recovered from the ash layer were represented by mere fragments. A close study of the larger pieces, however, suggests that three main types were present.

In the first class the mould cavity approximates in form to a truncated cone with somewhat concave sides (Fig. 3, 1 and 2). In two cases the top edge of the mould is slightly rebated and the casting was evidently flanged. A bronze from a similar mould which was found in a pit on Site II had part of an iron rivet embedded in the narrow end. The other bronzes in this pit were all fittings for a small chest or box and it may plausibly be suggested that the castings from this class of mould were intended for similar use. They would serve admirably as knobs for attachment to lids or as feet.

The second group (Fig. 3, 3-7) includes moulds of varying pattern all used for casting thin plates with pierced crescentic decoration. Such pieces are commonly found with iron rivets attached and

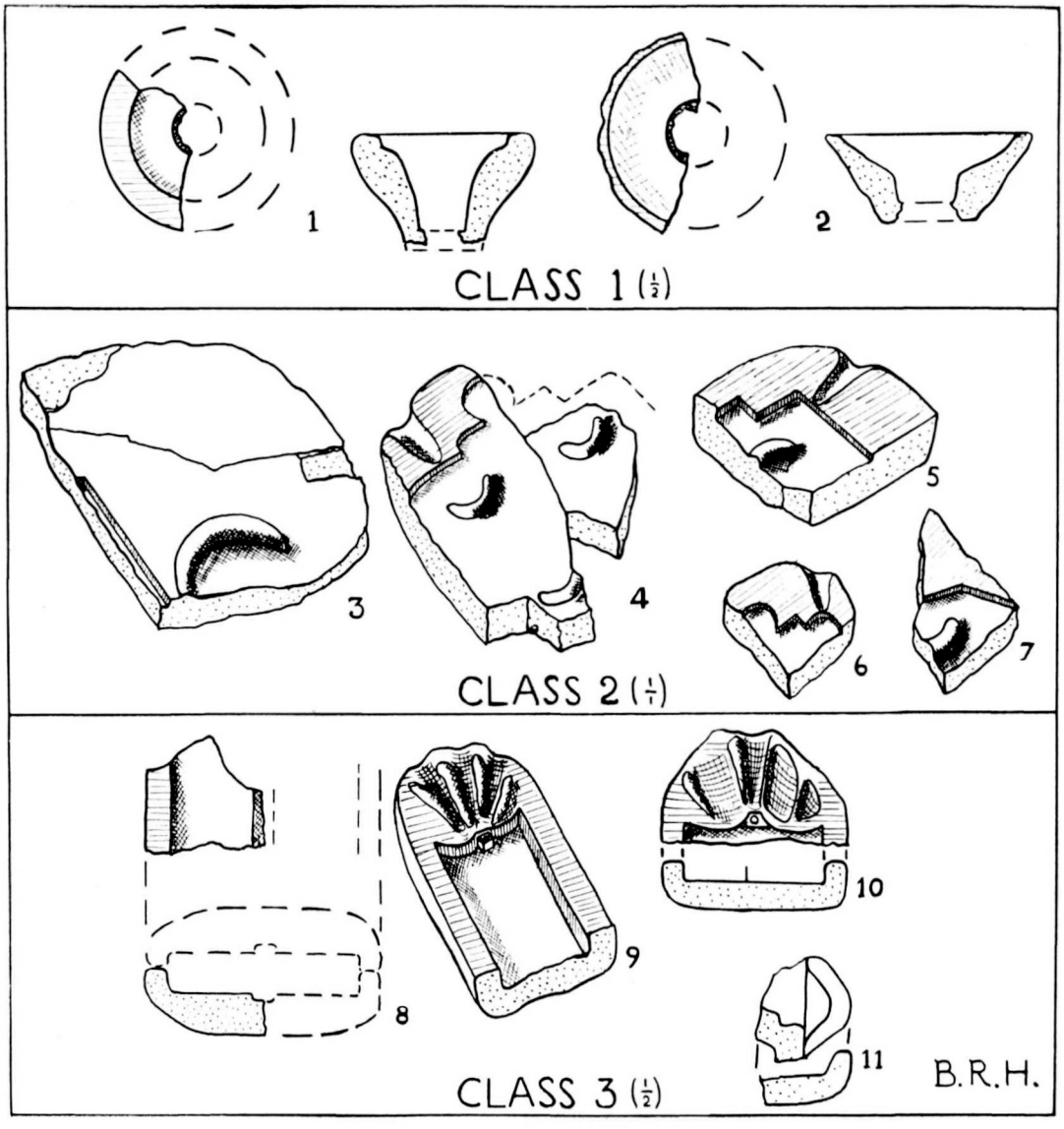


FIG. 3. Bronze Workers' Moulds

it is often held that they were intended to decorate leather work.[8] They are, however, also suitable for use on wood and, in view of the fact that the castings from the first class of moulds have such an association, this may well have been their purpose. The probability of this view is increased by the fact that the only finished product of the smithy which was found may also have been intended for the embellishment of a wooden chest or the like.[9]

The third class of moulds (Fig. 3, 8-11) is of an entirely different kind and no satisfactory explanation of their use can be given. As the drawings show, the casts would be bars with rectangular cross-sections, some with medial ribs.

[8]See, for instance, *Richborough* IV, Plate LI, 180; LII, 192 etc.
[9]See p. 10 below.

Moulds of the first group are complete in themselves but those in the second and third classes are clearly half-moulds as they have ingates or pour-holes for the metal. None of the moulds has signs of the tenon and mortice arrangement often used[10] and we must assume that the two halves were held together by wire or clay seals during the casting.

The method of making simple moulds of this kind is reasonably obvious, the reader is referred to the clear account given by Messrs. Curle and Crae with which there is no reason to disagree.[11] The moulds can never have been used for more than one casting each, as they would have to be broken to release the cast, a fact which explains the fragmentary condition of the pieces found. In fabric the moulds closely resemble the original state of the crucibles, though their inner surfaces are black, suggesting that the ferric oxide of the clay was reduced during the casting. The outer surfaces retain the buff fabric also seen in those of the crucibles which were broken soon after their original firing. The softness of the mould fabric shows that they were merely baked at low temperature before use.

After the bronze castings were released from the moulds they would require finishing by filing and polishing. At this stage, too, any enamelling of the objects would be done. Though, as yet, we have no evidence that this process was carried out at Heronbridge the possibility should not be excluded.

The technique of moulding bronze was, of course, already ancient by Roman times and prehistoric moulds in both clay and stone are commonly found. While stone moulds were undoubtedly used in Roman Britain when clay was scarce and the local outcrops of rock were suitable,[12] clay moulds are rather more common and we may instance those from *Segontium*[10] and Traprain Law[13] as typical examples. Some of the pieces from the latter site are complete, or nearly so,and give a good idea of the general form of such moulds. Further complete examples are known from Germany, though these apparently belong to the fifth century migration period.[14] Various Romano-British sites which have produced moulds are listed below.[15]

(d) *Metal object.*

The only metal object found was a small bronze-strip of rectangular section (2mm. by 1.5 mm., more than 8 cm. in length). Two fragments obtained from the ash were in a remarkably mint condition and were undoubtedly made by the smith. The purpose of such a strip is not clear, though, as Professor Richmond suggests, it would be suitable for use in inlay work. It is clear from the shape of cross-section that we are not dealing with a pin.

Dr. J. A. Smythe kindly examined one of the pieces and reports as follows:—

"The metal is in good condition. Chemical analysis shows it to be a bronze containing Cu 88.5, Sn 10.8 (total 99.3 p.c.). This is confirmed by the micro-section, for the metal has the structure of the *alpha* solid solution of copper and tin. This in the cored condition, the cores, along with minute particles of non-metallic impurities, being disposed in bands parallel to the edges of the wire, i.e. normally to the deforming pressure. Though, presumably, the metal has been annealed after hammering to bring it into shape, there are no signs of recrystallisation. I have noted this "lack of completion of the structural changes which accompany cold-working, followed by annealing" as a characteristic of Roman wrought alloys (*Univ. Durham Phil. Soc.* 1938, IX, 390) and have given analyses and micro-graphs of such alloys, almost identical with the present ones.

Bronze of this composition (Bell Metal) was generally favoured for making objects to be wrought, and it contains about the maximum amount of tin consistent with easy working.

No lead is visible in the microsections and none was found by chemical test."

[10] *e.g. Segontium*, fig. 81.
[11] *P.S.A.S.*, l, p. 124.
[12] See, for instance, *P.S.A.L.*, XXII, plate facing p. 38.
[13] *P.S.A.S.*, XLIX, p. 191 and fig. 39; L, p. 124 and fig. 37; LIV, p. 81 and LVI, fig. 14.
[14] *S.J.*, IX, Taf. 23 and p. 46.
[15] p. 12.

(e) *Slags.*

The bronze slag found in the hearth and throughout the ash amounted to several pounds weight. Typical specimens were submitted to Dr. Smythe who reports:—

"Two pieces, 19 and 31 grams in weight, quite similar in appearance, containing a fair amount of the green carbonate of copper (malachite) and a little of the blue carbonate (azurite).

On a casual glance they look like mineral specimens, but on closer inspection it is obvious that they are furnace products, for they contain fused slaggy material and a few small fragments of charcoal. As the carbonates of copper lose water and carbon dioxide, leaving black oxide of copper, at a comparatively low temperature (*ca.* 300°C), it is clear that their presence here is due to post-smelting changes, such as take place when metallic copper is exposed to atmospheric weathering agents.

A sample made from both specimens contained Cu 33.2, Pb 8.3 p.c., both reckoned as metals. Sections under the microscope do not show shots of metallic lead. This metal must therefore be present as silicate in the slag; the oxide equivalent of the lead being 8.9 p.c., one may say that, roughly, there is 31 p.c. of slag in the black patches which separate the areas rich in copper.

These copper-rich areas show an interesting structure, the metal being fairly evenly dispersed and the fragments separated from one another by cuprite (cuprous oxide) and malachite, and the whole are enveloped by a reddish band of cuprite, fringed in turn by a greenish-blue band of malachite and azurite. It is evident that each copper-bearing area was originally a uniform mass of metallic copper, and that the metal has undergone, by long exposure to air and percolating water, conversion by oxidation into cuprite, which has in part passed by hydration and carbonation into the green and blue carbonates.

From these observations it seems clear that these slags were originally produced by the smelting of copper-lead ores and consisted of metallic copper and lead-bearing slag. Later, as the result of long weathering, a large amount of the slag was converted into the oxidised minerals cuprite and the two basic carbonates of copper.

Copper-lead ores of the type smelted here are to be found in abundance at places no great distance away, e.g. Alderley Edge, Llanymynech and Anglesey."

In addition, the ash layer contained two or three pieces of iron slag suggesting that the bronze-smith also worked in iron to some extent. It is possible, however, that these came from some nearby building yet to be discovered. It is, of course, quite usual to find evidence of various forms of metal-working on the same site, Wilderspool and Tiddington for instance come to mind.

Dr. Smythe also examined one of these pieces of slag and writes:—

"This is a uniform black slag, somewhat vesicular, very hard and distinctly magnetic. It is gelatinised by concentrated hydrochloric acid. Analytical determination of the chief constituents gave: SiO_2, 21.3, Al_2O_3, 8.6, FeO 64.2, CaO 1.8 p.c. (total 95.9). It does not contain copper or lead.

It is thus a slag of the diferrous silicate type and, under the microscope, shows well developed crystals of Fayalite in a glassy groundmass. Comparision of structure and composition with Roman bloomery slags from Elmswell, Wookey Hole and the Weald brings out very close similarity, and there can be no doubt that it is a product of the smelting of iron ore by the bloomery process."

(f) *Coal.*

The ash layer and pit, described above, contained several pieces of unburnt coal and carbonaceous shale. These were submitted to Dr. J. O'N. Millott of the National Coal Board Scientific Department who kindly sent a detailed report as follows:—

"The specimens, which were in the form of small lumps, weighed 59.7 gm. and consisted of 20.8 gm. of coal and 28.9 gm. of carbonaceous shale. The coal was mainly bright and fairly

hard; on breaking across it was seen to contain much vitrain. Both the pieces of coal and shale were coated with a thin argillaceous deposit, brownish-pink in colour and presumably derived from Triassic strata or the overlying Glacial Drift. The appearance of the coal, especially on breaking, did not suggest material which had been exposed as long as 1,800 years. If, however, the specimens had been partially or completely immersed in water for any length of time this would account for their fairly fresh condition.

A sample of the coal was subjected to proximate analysis with the results given below:—

Air-dried coal	*per cent.*
Moisture	12.9
Volatile matter less moisture ...	33.1
Fixed Carbon	48.1
Ash	5.9
Volatile matter in dry, ash-free coal ...	40.8
Character of coke	Powder

A further sample of the coal was subjected to microspore examination by Miss M. Butterworth who reports on this aspect as follows:—

"The microspore assemblage includes *Endosporites zonalis* and *Reticulati-sporites mediareticulatus* (which are common) and *Reticulati-sporites tortuosus*, indicating that the original coal was from an horizon above that of the mid-*modiolaris* zone marine band. The scarcity of *Spinososporites spinulistratus* and presumed absence of *Densosporites solaris* and *Endosporites costatus* suggest that it is from an horizon below the lower limits of the *similis-pulchra* zone. About 50 per cent. of the spores were of D1 type (*Raistrick*) and about 17 per cent. were A types (*Raistrick*) indicating that although the coal was mainly bright (clarain and vitrain) some dull coal (durain) was present."

The results of these analyses may be considered against the probable background of the coal which would suggest derivation from an outcrop in Lancashire or North Wales.

If the seam in question formed part of the North Wales sequence then, from the microspore evidence, it would probably have been the Denbighshire Main, Pin or Crown. In Flintshire the Pin and Crown are equivalent to the Brassy and Buckley King seams respectively; it could not have been a seam at a lower horizon. The Main, which is, of course, the thickest and most important seam in North Wales, outcrops at several points in the vicinity of the River Dee and its estuary, notably in the district between Hawarden and Queensferry; it also outcrops between Ewloe and Buckley, near Bagillt and further south near Coed Talon and Ffrith.

If, on the other hand, the seam formed part of the Lancashire sequence, then it would most probably be one in the Pemberton Series, which are equivalent to the Higher and Lower Florida coals of the St. Helens district. The nearest outcrops of these seams are immediately south of the town of St. Helens and at Whiston near Prescot".

It will be seen from the above report that the Heronbridge coal may have come from either North Wales or Lancashire. In view of the distances involved and the connection of the site with the Dee it is probable that North Wales was its source. As it is not possible to pin-point one particular outcrop, the question of transport to the site is complicated and this difficulty is increased by our ignorance of the Roman roads leading to North Wales. While the coal could have been carried by road, using pack-horses for instance, it is perhaps more probable that the coal came to Heronbridge by river. In the present state of our knowledge of the Heronbridge site it is not desirable to discuss this question at length, but it may be pointed out that one of the suggested outcrops (Coed Talon) offers the possibility of water transport in small boats down the Alyn to the Dee and so to Heronbridge without the use of road at all. It is probable that derivation from any of the estuary outcrops would involve carriage of the coal from Chester to Heronbridge by road.

IV. SUMMARY AND GENERAL REMARKS ON HERONBRIDGE

The evidence so far obtained from the site suggests that it was first occupied in the last decade of the first century. Then, or shortly later, a bronzesmith came to the site and set up in trade, in part as least, as a manufacturer of decorative fittings for wooden chests. His smelting hearth was of simple open type and he used the technique of casting bronzes in clay moulds.

The curious combination of timber and stone construction of the workshop associated with the hearth has since been paralleled by other buildings of the earliest period and we may now be reasonably sure that construction in timber was the normal building method on the site at that time. The anomalous use of stone in a building of the first period on Site I was a consequence of the work carried out in it, for this apparently called for the provision of heat on a considerable scale.[16]

Though we now have evidence of both metal-working in bronze and iron and also of agricultural activity[17] in the initial phase of occupation, it cannot yet be said that a clear picture of the site as a whole has been obtained. In future, attention must be directed to some of the major problems of the site, such as the nature and date of the most unusual earthwork occupying its south-east quarter and to the position of Heronbridge as a possible riverside port. The presence of what appears to be a silted channel with stone-revetted sides between Sites II and III may well have an important bearing on this last point and a report on a preliminary investigation of this appears in this Journal.

V. NOTES ON BRONZE-WORKING IN ROMAN BRITAIN.

It is an indisputable fact that bronze-working held an important place among Romano-British industries.[18] One aspect of the subject—the manufacture of cauldrons—has recently received attention from Professor C. F. C. Hawkes,[19] but, in general, we have little detailed knowledge. Much importance evidenct undoubtedly lies unpublished in our museums and until this has been surveyed it is, perhaps, unwise to make generalisations on the subject. These notes are accordingly confined to a few tentative points.

As the lists of sites (p. 12) show, much of our evidence of the industry comes from the Highland zone or its fringes, thus supporting Collingwood's view that the bronze-working was largely confined to the north and west. This is readily understood when we remember that the sources of copper lie in these areas.[20] On the other hand, Collingwood's belief that the manufacture of bronzes was 'probably carried out in most towns of any size' does not seem to be in accord with the evidence as yet. One of the peculiarities of Romano-British towns is that they do not, in general, produce evidence of industry at all, except for pottery manufacture in some

[16]*C.A.J.*, 39, fig. 2, VII and IX.
[17]*C.A.J.*, 39,, p. 13, note 10.
[18]*Collingwood and Myres*, p. 234.
[19]Grimes, W. F. (Ed.), *Aspects of Archæology in Britain and Beyond*, p. 172 ff.
[20]*ibid.*, p. 174.

cases. Apart from Caistor-by-Norwich (p. 12), only a few crucibles can be listed from towns in the south and east, and these suggest no more than casual small-scale bronze-working. Most of the sites listed below are rural and some, such as Traprain Law or Lydney (before the fourth century), scarcely Romanised. This suggests that we should look on bronze-working as being largely the prerogative of the country folk, the survivors of the strong pre-Roman tradition of metal-working. In all probability, the industry was carried on in the main by individuals working on a small scale. On the other hand, we have clear evidence of a few larger communities such as those at Wilderspool, Tiddington, Weston-under-Penyard, and perhaps Heronbridge, amongst whom bronze-working seems to have had its place, though usually it was subordinate to iron-working.

Of the economic side of the bronze-industry we know little. Here, a detailed study of local brooch variants and their distribution would undoubtedly help. Even on the more primitive sites we find some Roman pottery and on other sites, such as Heronbridge, we find not only Romano-British coarse-ware in abundance but also great quantities of imported Samian which clearly implies a measure of trade with the larger local markets. In many cases it may well be that the bronze-industry was regarded as an economic supplement to farming, which would help to tide over poor seasons, and which could be pursued in the intervals between the main activities of the farm.

Evidence of military bronze-working is surprisingly meagre and, so far, only *Camulodunum*, *Segontium*, Templeborough and Holt can be listed as having yielded any. While no doubt much equipment was imported, this fact raises the question of bronze-making for the army by local civilians. The finds at Stanwix and Brough-under-Stainmore, which include military equipment, may well have a significance here, for these are believed to have come not from the forts but from the *vici*. On the analogy of pottery, it might be expected that the legions would have their own metal-working depôts in the first century. It is interesting to note in this connection that the depôt of the XXth Legion at Holt, though primarily concerned with making tiles and pottery, has produced some evidence of bronze-working. Legionary manufacture of pottery at Holt stopped in the early second century (probably under Hadrian *c.* A.D. 125) and at that time we find a new type of coarse pottery coming into use in the fortresses and forts of the north. As this was presumably the result of a deliberate change of policy towards local industries it is possible that we may find the same applying to bronzes.

The few obvious points raised in these brief notes serve to show how little we know of Romano-British bronze-working. Such evidence of the industry as we have is widely scattered in many publications and museums and so an attempt has been made here to bring it together. The lists of sites given are unlikely to be complete and it should be noted that coin-moulds have not been included as they afford no proof of a bronze industry as such.

LIST A. SITES WHICH HAVE PRODUCED CLEAR EVIDENCE OF BRONZE-WORKING.

1. TRAPRAIN LAW (HADDINGTON)

A native hill site, Traprain Law was occupied into the Roman period and bronze-working is well attested by the large number of moulds[21] and crucibles[22] discovered.

2. TEMPLEBOROUGH (YORKSHIRE)

Several crucibles were found by May, one with 'adherent bronze'. One of the crucibles[23] was found inside the fort but the find spots of the others are not recorded. Scrap bronze, slag and waster castings are illustrated in the report.[24]

3. WILDERSPOOL (CHESHIRE)

Several hearths similar to the Heronbridge one were uncovered by May.[25] Crucibles containing bronze and slag with a high copper content are also recorded.[26] The site was originally an auxiliary fort but it later became a metal-workers' settlement in which iron-smelting held an important place.

4. HERONBRIDGE (CHESHIRE)

See the detailed report above (pp. 1-11). Bronze-workers' hearths, slag, moulds and crucibles belong to the period A.D. 90-140.

5. HOLT (DENBIGHSHIRE)

The site, a works depot of the XXth Legion, has yielded fragments of at least three bronze-workers' crucibles, one with adhering bronze.[27]

6. SEGONTIUM (BANGOR, CAERNARVONSHIRE)

A clay mould found inside the fort has been published.[28] In addition, the museum on the site contains a crucible similar to the Heronbridge ones and there is also part of a second mould.[29]

7. WROXETER (SHROPSHIRE)

Numerous crucibles and some hearths of the late first or early second century were found Bushe-Fox.[30] Bronze-working is further attested by an iron die used for embossing plates of the metal.[31]

8. CAISTOR-BY-NORWICH (NORFOLK)

A bronze-worker's furnace with an associated ash layer containing crucibles and moulds has been found.[32] The material, as yet unpublished, is in Norwich Museum.[33]

9. LYDNEY (GLOUCESTERSHIRE)

A bronze-smelting hearth, slag, and part of a lead die which may have been used for making brooch moulds, are recorded.[34] Many brooches of local type are included in the various collections from this site.

The industry is believed to have been practised before the end of the second century. Whether this be so or not, it clearly belonged to a period when Roman influence was slight.

[21] *P.S.A.S.*; XLIX, p. 191 and fig. 39; L, p. 124 and fig. 37; LIV, p. 81 and fig. 11, 18-21; LVI, fig. 14.
[22] *P.S.A.S.*; L, fig. 36, 1 and 2; LVII, p. 206.
[23] *Templebrough*, Plate XVC.
[24] *ibid*, Plate XVI, 10, 13, 17 *etc.*
[25] *H.S.L. & C.*, Vol. 16, Plate III.
[26] *Wilderspool*, p. 75.
[27] *Holt*, p. 124.
[28] *Segontium*, fig. 81.
[29] Similar to Heronbridge Class I—see p. 5 and fig. 53.
[30] *Wroxeter I*, Plate III, fig. 2; *Wroxeter* II, p. 11.
[31] *Wroxeter*, IV p. 216 and Plate 52.
[32] *J.R.S.*, XXIX, p. 214.
[33] Mr. R. R. Clarke most kindly answered enquiries about this.
[34] *Lydney*, p. 15 ff.

10. LANSDOWN (SOMERSET)

Excavations at the north end of Lansdown in the early part of this century produced several Lias-stone moulds including some for the casting of mirror handles.[35] Various other moulds were found but these clearly were not for bronzes but most probably were used in the beating out of pewter vessels.[36]

The coins from the site range in date from the mid-second to the late fourth centuries. There seems, however, to have been some pre-Roman and early Roman occupation and while it is possible that the moulds belong to this, as Professor Haverfield thought, the forms of the probable pewter moulds suggest a late Roman date for the industries.

11. KEYNSHAM VILLA (SOMERSET)

A small crucible and a mould for casting a 'pendant or ornament ' were found.[37]

12. CAMULODUNUM (ESSEX)

The Sheepen site produced considerable quantities of slag and bronze clippings found in association with military equipment.[38] These belong to Period IV and are regarded as evidence of the hasty manufacture of arms in the face of the rebellion of A.D. 61.

13. RICHBOROUGH

'Copper slag, bronze runnings and pieces of small crucibles' have been found associated with iron-slag and a lead pig of Nerva.[39] An unfinished brooch is also recorded.[40]

LIST B.—PROBABLE AND POSSIBLE SITES.

1. BROUGH-UNDER-STAINMORE (WESTMORLAND)

Flawed castings and unfinished bronzes have been 'washed out of the river bank at the Brough camp.'[41] The brooches are all of second century type.

2. KIRKBY THORE (WESTMORLAND)

Kendal Museum contains 'fused ore' from the site. Many brooches have been found, all apparently of second century date.[42]

3. STANWIX (CUMBERLAND)

Flawed castings and scrap bronze were found embedded in peat near the site of the fort.[43] It was thought by Collingwood that these had been washed by floods from buildings in the *vicus* of the fort. The bronzes include sword scabbard fittings and other military pieces, as well as brooches. The associated pottery belonged to the first half of the second century.

4. BROUGH (YORKSHIRE)

Scraps and clippings of bronze, slag, and clinker were found in a building inside the town in a deposit not later than Trajan. The material was associated with a simple hearth, but this does not look like a metal-worker's furnace.[44]

5. ELMSWELL (YORKSHIRE)

A piece of a small crucible was found in Pit 2 but no other evidence of metal-working was noted.[45]

[35] *P.S.A.L.*, XXII, (first) plate facing p. 38 and see *P.S.A.S. (Bath)*, 1904-8, p. 119 f, 157, 164 ff, *etc.*
[36] *P.S.A.L.*, XXII, (second) plate facing p. 38.
[37] *Arch.*, 75, p. 132—not illustrated, no further details given.
[38] *Camulodunum*, pp. 91, 335 ff.
[39] *Richborough I*, p. 13.
[40] *ibid.*, Plate XII, 5.
[41] *C. & W.*, iii, p. 70 ff. ; xxxi, p. 81.
[42] *Westmorland*, p. xli.
[43] *Ant. J.*, xi, p. 37 ff.; *C. & W.*, xxxi, p. 69 ff.
[44] *Brough* 1937, p. 205.
[45] *Elmswell* 1938, p. 31.