A Middle Saxon Iron Smelting Site at Ramsbury, Wiltshire

By JEREMY HASLAM

with

L. BIEK[1] *and* R. F. TYLECOTE[2]

and contributions by

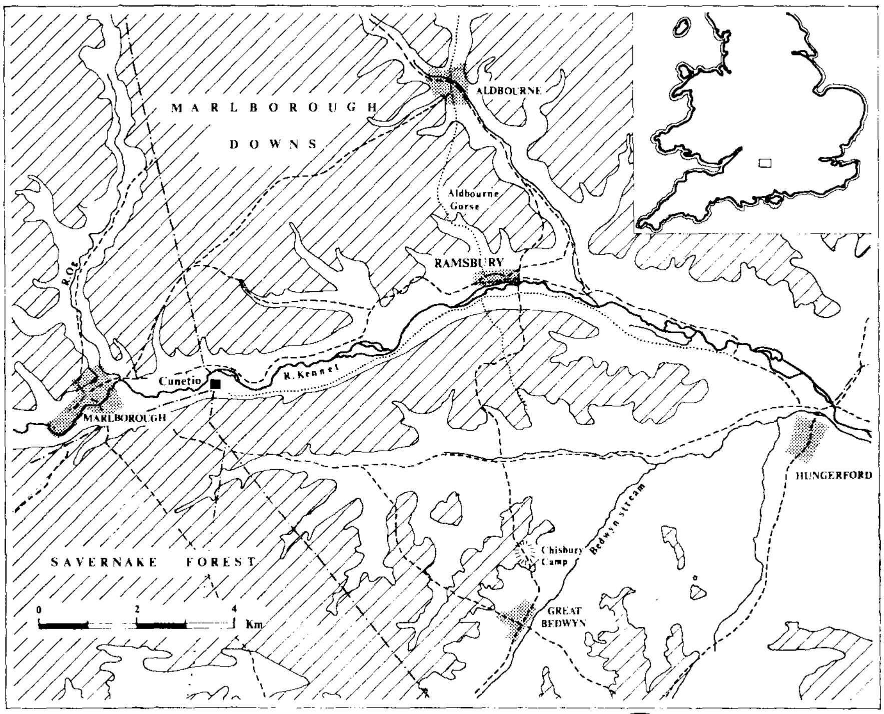
JENNIE COY, VERA I. EVISON, STEPHANIE FELLS, CAROLE A. KEEPAX, R. L. OTLET, ANDREW RUSSEL *and* DAVID F. WILLIAMS

EXCAVATIONS on a site in the High Street, Ramsbury revealed an iron smelting and smithing site datable by radiocarbon determination and analysis of the finds to the late 8th and early 9th centuries. The industrial structures consisted of bowl furnaces and associated features of at least three phases, and included a timber-framed shelter. A 'developed bowl' furnace with slag-tapping facilities was built in the last phase, and had survived to a sufficient height to exhibit an unfamiliar 'funnel' shape. Besides being unique for its date, the site is important because of its relatively good state of preservation, and because the furnaces show a sequence of technological innovation over a short period. Iron ore was brought some distance to the site. Associated finds included quantities of animal bones, as well as some pottery, bronze and iron artifacts and fragments of imported lava querns. This and other evidence hints at patronage by an important royal estate.

INTRODUCTION

Ramsbury is situated 8 km (5 miles) to the east of Marlborough in eastern Wiltshire (Fig. 1). Although today it is only a relatively small village, its chief interest in the historical period lies in its choice, together with Wells and Crediton, as the seat of one of the newly created bishoprics of the West Saxons in A.D. 909. The bishop's seat remained at Ramsbury until it was reunited with Sherborne in 1058, whence it moved to Salisbury (Old Sarum) in 1078.[3] The present church is very probably on the site of the Saxon 'cathedral', an assumption strengthened by the finding during alterations in 1891 of fragments of 9th/10th-century carved stone crosses incorporated in the fabric of the church.

The village is situated on the northern bank of the R. Kennet, where it cuts through the chalk downs in a relatively narrow flat-bottomed valley. The historical significance of Ramsbury's situation is discussed in Section 9 below. Geologically speaking (see Section 8) the site lies on a thin layer of gravelly sediment which in this area frequently consists of a mixture of high level river-gravel and Clay-with-Flints.



LOCATION OF RAMSBURY — *land over 150 metres* OD

Roman roads: *certain* ——————— *conjectured* · · · · · · · *Roman trackways* ....

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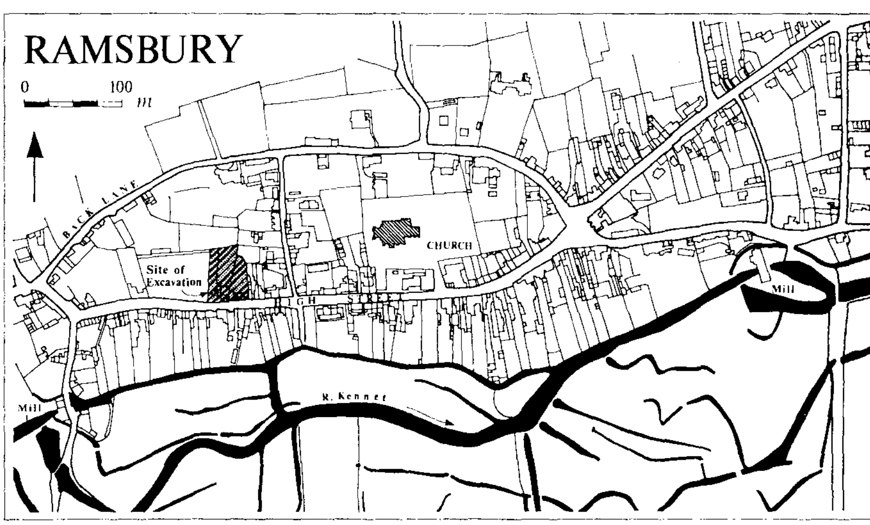


FIG. 1

Location and plan of Ramsbury, showing position of 1974 excavations

This rests on Upper Chalk. Although locally variable in composition, Clay-with-Flints appears to have been sufficiently 'clean' (i.e. free from coarse material) to provide clay for ceramics. Eocene deposits (Reading Beds, London Clay, or pipe clays within the Lower Bagshot Beds) may have been exploited for similar purposes. Concretionary iron ore was available locally, both in the Clay-with-Flints and in Eocene strata. Jurassic and Cretaceous ironstones outcropping some 30 km to the W. may have been used, but none were found on the site (Fig. 23).

The site excavated (Fig. 2) lies on the N. side of the High Street of Ramsbury on to which it fronts, approximately 175 m W. of the church. It was left vacant by the demolition of 18th- and 19th-century houses along the High Street, prior to redevelopment by the Kennet District Council. An excavation was mounted in 1974 as part of a programme of research into urban sites in Wiltshire;[4] although Ramsbury cannot be regarded as truly urban at any time in its history, its importance as an ecclesiastical centre in the late Saxon period justified an excavation within the programme.

SECTION 1: THE EXCAVATION[5]

METHOD OF EXCAVATION

No evidence of iron smelting in the immediate vicinity at any period was known before the excavation started. The discovery of the industry at Ramsbury came as a total surprise, and its gradual exploration dictated the shape and extent of the excavation.

The eastern half of the site (Fig. 2) was cleared of topsoil, and an area fronting on to the present High Street was first excavated (Area A), in the expectation of finding evidence of Saxon and medieval occupation. This located a substantial N.–S. boundary ditch (see plan, Figs. 2 and 3, and section, Figs. 8 and 9) of the 13th century. A trench 6 m × 10 m (Area B) was then opened up by machine to follow it northwards. The ditch was eventually completely excavated, and was observed to cut through thick deposits of slag and charcoal which were recognized as waste from iron smelting operations. These deposits were later found to be derived from at least three furnaces, even further to the N. The superficial garden soil E. of the ditch (Area D) was cleared by machine, and the area excavated in an unsuccessful attempt to locate the furnaces. Subsequently the area NW. of Area B (Area C) was opened by machine, and excavated by hand as a single area from the lowest level of the hill-wash which covered the site. Two major running sections were recorded across this area (using the method described by Barker[6] and Biddle[7]) as the area was stripped by hand (E.–W. section [A–B, C–D] given in Fig. 8).

Ideally the site (Areas B, C, and D) should have been stripped and excavated as one, but this was prevented by various practical problems — in particular the un-sxpected extent of the structures, and the fact that the hollow in which the iron emelting was carried out had been completely obscured by nearly 2 m of hillwash soil.

The numbering system of the site, which is retained in the report below, was kept as a single consecutive series throughout the different stages of the excavation.

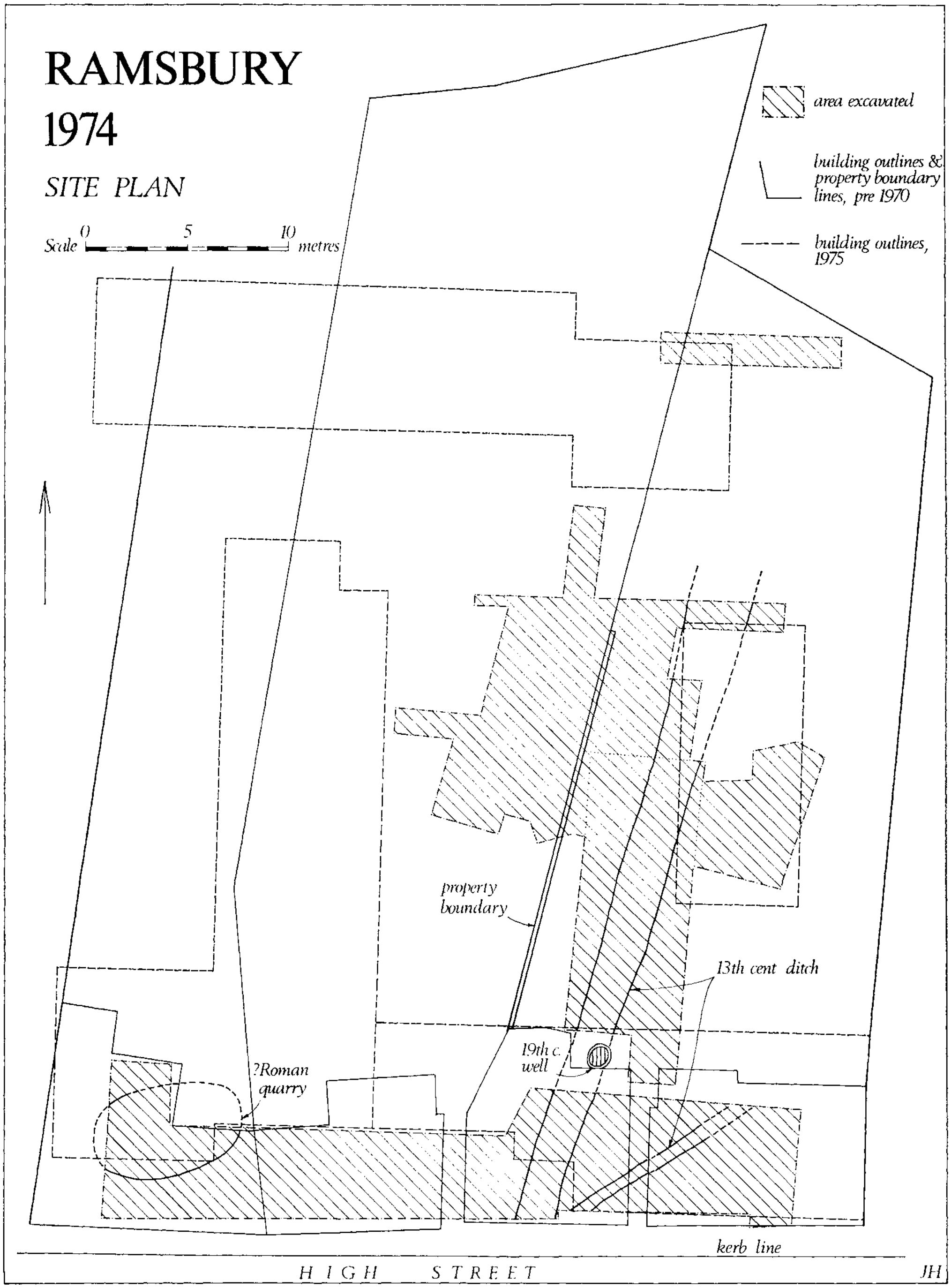


FIG. 2

Plan of site, with position of subsequent buildings. Area A to south, Area B centre, Area C to north and west, Area D to east

The same stratigraphical sequences in each of the Areas B, C, and D therefore appear as different sequences of site numbers; these are however related in the diagrammatic matrix given below (Fig. 10). Furthermore, the stratigraphic sequence for the area as a whole is broken by the subsequent bisection of the earlier iron smelting area by the 13th-century boundary ditch.

Summary of periods

The history of the site can be divided into five distinct periods (see Table 1).

TABLE 1
PERIOD CHART

Period		Date
1	Excavation of semicircular ?flint quarry (29)	?Roman
2	Excavation of a broad hollow for iron smelting and related activities divisible into 5 distinct phases (plans, Figs. 4–6)	late 8th–early 9th century
3a	Accumulation of spreads of gravel and earth over iron smelting area (58, 128, 42) over a period of time	
	Development of a topsoil (57, 130, 41, 43)	
b	Occupation on topsoil; burning of upper levels, with scatter of artifacts (plan, Fig. 3)	early 9th century
	Further accumulation of soil (55)	
4a	Accumulation of layers of earth and gravel (129, 131) over topsoil	9th–13th centuries
	Further accumulation of derived earth and gravel (35)	
b	Excavation of N.–S. boundary ditch (20)	13th century
	Further accumulation of soil (32)	
5	Laying out of High Street over S. end of 13th-century ditch. Development of houses	?16th century to present

All periods, with the exception of the first, are represented as layers recorded in the two sections (A–B, C–D [Fig. 8], and G–H [Fig. 9]), and in the plans of periods 2 (Figs. 5 and 6), and 3b (Fig. 3).

Period 1 (? Roman)

The only evidence for activity on the site in the Roman period is the large oval pit at the SW. corner (Fig. 2), which was possibly a quarry for flints. It had been cut into weathered chalk and flint, immediately overlying the undisturbed chalk, and filled with layers of gravel, flint debris and chalky sand, all apparently naturally accumulated. Only one small sherd of coarse Roman pottery was found in it, and so the exact date of its excavation remains problematical. Other Roman finds in the area are discussed below (Section 7).

Period 2 (late 8th–early 9th century)

A natural hollow in the hillside was enlarged and used as a site for iron smelting and smithing. All layers and structures, which showed several distinct phases of working, were well-preserved under about 1.5 m of earth and gravel hillwash which subsequently filled the hollow. Two round bowl furnaces, and a third 'developed bowl' furnace with facilities for slag-tapping, were associated with successive deposits of charcoal, slag and iron ore which accumulated to a depth of nearly 0.5 m in the middle of the site (Pl. I, A). These iron smelting operations form the main subject of this report (below). A number of artifacts was recovered from several layers of this period.

Period 3 (early 9th century)

3a The abandonment of iron smelting in the immediate area was followed by the accumulation in the working area of the products of natural erosion. The uppermost of the charcoal and slag layers (66 and 60) associated with the last phase of furnace 4 (61) was covered with a layer of coarse gravel (58) derived from higher up the hill to the N. A depth of about 100 mm had accumulated in the centre of Area C, gradually becoming less gravelly to the S., and disappearing completely in the middle of Area B even further to the S.

3b Layer 58 was succeeded by a thicker layer of earth (57), in which the gravel component became progressively less pronounced towards the top. After about 150 mm of this had accumulated, a fire was built on its surface, burning an irregularly-shaped area, about 3 m × 4 m, a patchy red and brown colour (see plan, Fig. 3). In the centre of the area the zone of burning extended about 100 mm downwards into the soil and was surrounded by an uneven annulus of charcoal. There were no signs of any timber structures associated with this area of burning. A few large unburnt flints (100–200 mm in diameter) scattered around the burnt soil showed no evidence of having been used as structural material (such as packing around posts).

This burnt area was, however, surrounded by occupation debris, amongst which were large numbers of bones, objects of iron and bronze, some fragments of lava quern, baked clay loomweights, chaff-tempered pottery, and a decorated bronze strapend. The distribution of the occupation debris (Fig. 3) shows that it was clearly concentrated around the fire represented by the burnt soil. The presence of some only partially fabricated iron artifacts suggests the possible presence of a forge nearby.

The area of burnt soil in the middle of Area C had subsequently become covered with a further layer of brown, slightly gravelly soil (55), 150 mm in thickness, indistinguishable from the layer of soil beneath it (57) on which the fire had been built. These two layers appear therefore to be naturally derived soil and gravel built up over a probably short timespan, only broken by a brief period of human activity.

Period 4 (9th–13th centuries)

4a The distinction between periods 3*b* and 4*a* is perhaps somewhat arbitrary. The thick layers of soil (57 and 55) containing the burnt level were succeeded by the deposition over the whole site of a layer of gravel (129 in Area D) up to 100 mm in thickness at the eastern edge of the hollow, and around 50 mm in the middle of Area C (131). This was followed by successive layers of naturally deposited earth and gravel (32) over the whole site, which appeared to continue the cycle of deposition of period 3. These layers were mostly removed by machine.

4b At some time after the deposition of the gravel layers 129 and 131 in Area D, and after a further 300 mm of earth and gravel had accumulated in the hollow, a V-shaped ditch (20) was cut diagonally NE.–SW. across the site. This attained a

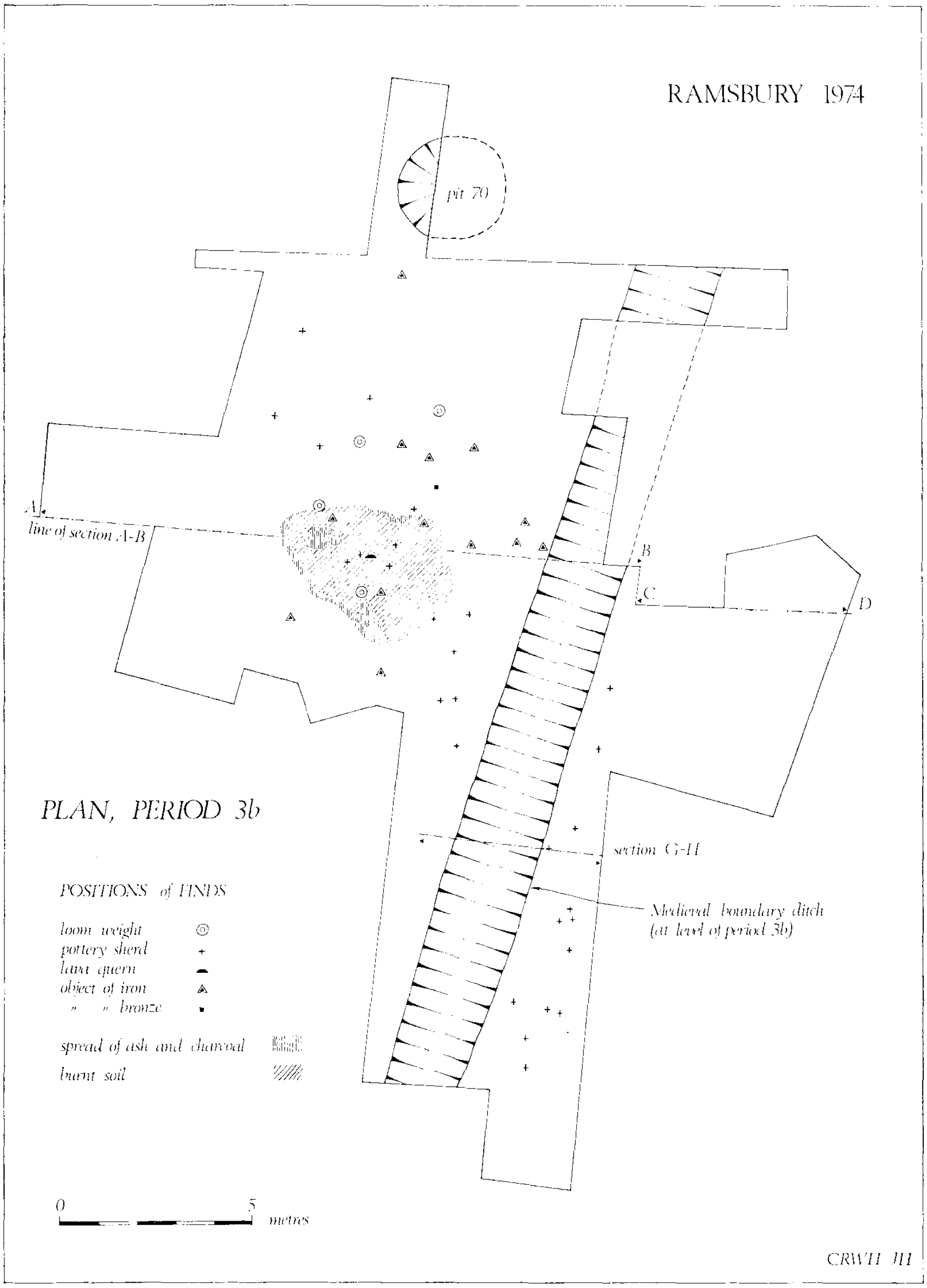


FIG. 3
Plan of period 3*b*

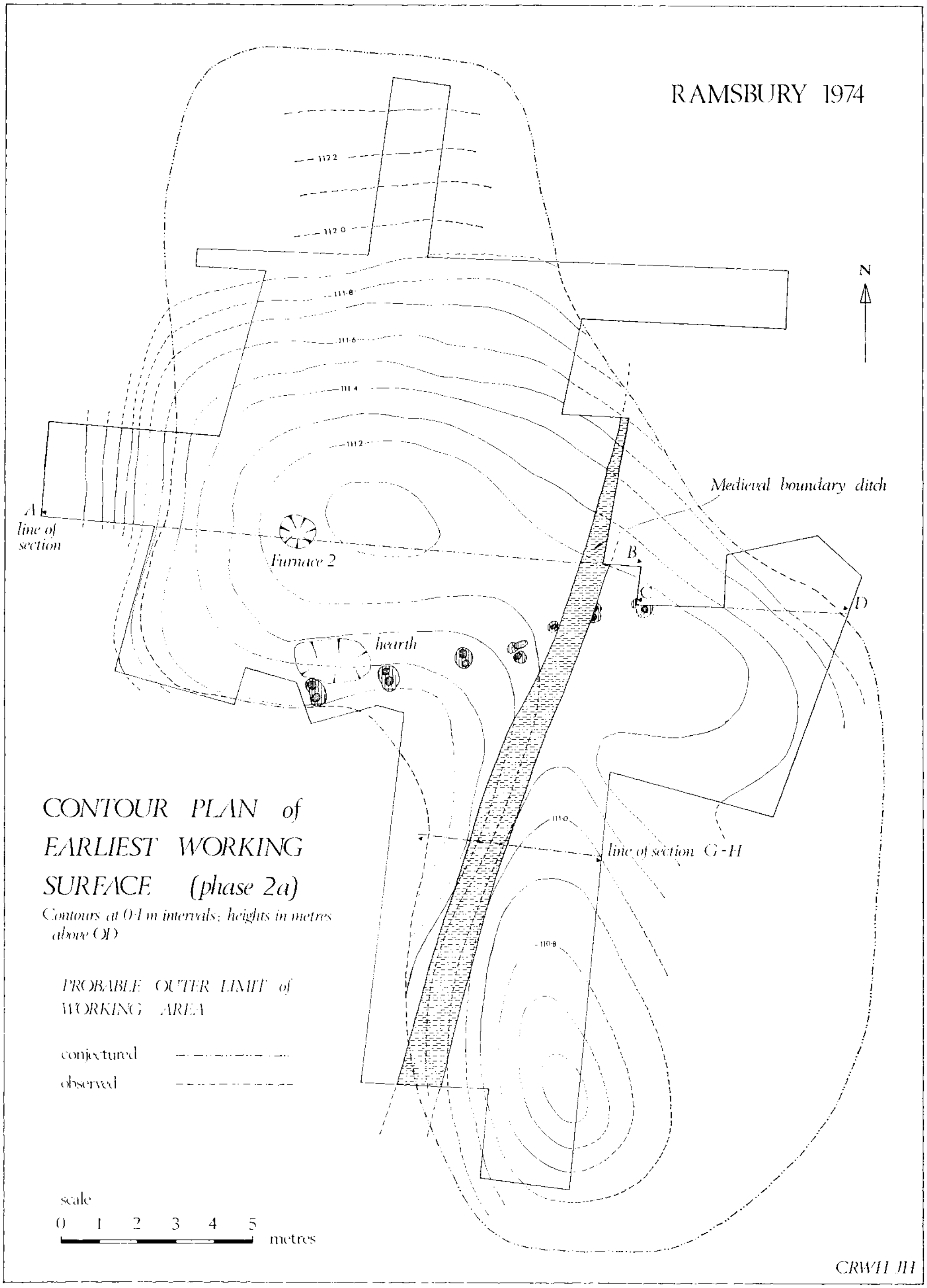


FIG. 4
Earliest working surface (period 2a): plan with contours

maximum depth of about 1.3 m, although the exact horizon from which it was cut could not be determined with absolute certainty, either in plan or in section. This ditch was completely excavated along the whole length revealed in Areas A and B, and sections recorded at various positions, two of which are given here as sections A–B and G–H (Figs. 8 and 9). A further section was obtained in a machine cut trench to the NE. of Area C; another trench was cut by machine 12 m to the N. of this, but the ditch did not apparently extend that far northwards.

The ditch was recut at least once along the same line; this recut was not however taken down to the full depth of the original ditch, implying possibly that continued silting necessitated its re-excavation from a higher level than the first. The recut was filled with a relatively uniform mixture of brown earth and many large angular flints, together with much coarse pottery of probably the early 13th century.[8] This ditch was probably joined by another smaller ditch, which contained similar pottery, on its SE. side. It is of some interest that the larger ditch continued underneath the present High Street.

After this ditch had filled up, a further natural accumulation of soil and gravel took place (32 — see section A–B, C–D, Fig. 8), almost completely filling the hollow in the hillside originally excavated for the iron smelting site.

Period 5 (post-medieval and modern)

No pits or other features earlier than the late 18th century were observed cutting into the accumulation of soil described above. These are not discussed further here.

PERIOD OF IRON SMELTING (Period 2)

The site

The site chosen for the iron smelting operations was a natural hollow lying W. of a broad low spur of the chalk downs jutting into the Kennet valley. Evidence from this excavation suggested that the hollow was further artificially terraced, particularly NW. of Area C, to provide a conveniently-shaped working area and, possibly, also living space (see contour plan, Fig. 4).

The deliberate removal of at least the original topsoil in this hollow, as well as some of the underlying natural Clay-with-Flints, created a flattish platform with steeply sloping edges at least N. and W. of Area C (see section A–B, C–D, Fig. 8). This edge was observed in the cut to the W. of Area C, and was also noticed in subsequent building operations. The area excavated archaeologically did not, therefore, completely cover the original working area of the iron smelting site. The presence of large numbers of animal bones in the NW. corner of Area C, which had evidently accumulated throughout the entire period of the smelting operations, suggests that an extension of the hollow to the NW. contained living quarters, or at least some sort of lean-to shelter, for the workers on the site. It is highly regrettable that there was neither time nor opportunity to extend the excavation even further in this direction to investigate this possibility. The probable limits of the working and possible occupation area are outlined on Fig. 4. This incorporates observations made during building operations as well as the edges observed to the NE. and E. of Area D, to the S. and W. of Area B, and to the SW. and W. of Area C.

The different phases into which the iron smelting operations can be divided are summarized in Table 2, and are more fully described in order below; plans of the various phases are drawn in Figs. 5 and 6.

TABLE 2

PHASE *A* FEATURES

Context number	Feature and function	Description/ composition	Stratigraphical relationships	Comments
97	Clay surface of working area	Spread of orange-brown clay with few flints, 60–100 mm in thickness	Covers Clay-with-Flint subsoil over Areas B, C and D. Covered with charcoal and slag of first working phase (96 and 82)	Possibly deliberately placed; ?represents a working surface
116	Bowl furnace (no. 2)	Hollow in ground, 0.85 m × 0.9 m, 0.35 m in depth from level of presumed working surface (detailed description below)	Cuts into clay surface layer 97 and into natural. Truncated by layers of phase *b* (125)	Structure and function discussed below
124	Possible bowl furnace (no. 1)	Slight scoop in ground, 0.8 m × 0.6 m, 0.2 m in depth, evidence of structure uncertain	Cut into ore roasting area (126). Covered by layers of phase *b* (82)	Function equivocal — see discussion below
126	Ore roasting area	Burnt area of clay surface (97) and subsoil, immed. covered with fragmented roasted iron ore	Area of clay layer (97) and subsoil only burnt. Covered by layers of phases *a* and *b* (82)	One of first operations in the smelting process
99	Smithing hearth	Shallow hollow in natural Clay-with-Flints, 1.8 m × 1.2 m, 0.15 m in depth, lined with thin layer of clay burnt red in patches, filled with charcoal	Cut into natural Clay-with-Flints, covered by layers of phase *b* (82). Filling covered primary packing of post holes 103 and 104, but not their pipes	Apparently in use in corner of post-built structure
103, 104 107, 108 110–114	Double post holes forming straight line (103 a triple post hole)	Packing: earth with small flints and stones. Holes for posts: fine grey-brown earth	Cut into natural Clay-with-Flints; upper levels not easily established, but covered by layers of phase *b*	The line of these post holes defines the S. edge of the working area in Area C
98	Double post hole, to N. of 104	Packing: clay and earth with much gravel. Hole for post: grey-brown earth with a little gravel. N.B. No slag present in any of these components	Ditto	Probably part of same structure as line of posts

Phase a

Clay surface. The natural Clay-with-Flints in the newly excavated hollow was surfaced, over the whole of Areas C and D and most of Area B, with a uniform and homogeneous layer of orange-brown clay (97) between 60 and 100 mm in thickness. This was probably derived from abundant deposits of Clay-with-Flints a little way up the slope to the N., but its incidental formation *in situ* cannot be ruled out. If laid deliberately, the function of this clay layer would be obscure. Its somewhat limited usefulness as a working surface was shown by the fact that it tended to become very soft and spongy after heavy rain. Furthermore, its extent was wider than the rather smaller area which must have been covered by the post-built structures described below, and was in any case soon covered up with waste products (slag, cinder and charcoal) from the operation of the furnaces. That it was a deliberate spread does, however, appear to be confirmed by the recurrence of another layer of similar clay (layer 120) overlying the first deposits of charcoal and slag. This still remained in the W. edge of Area C (125) and in Area D (120) and marked the clearance of the site and construction of a new furnace and hearth, thus defining the break between phases *a* and *b*.

Timber structure. To the S. of Area C a line of double post holes (and one triple post hole) running NE.–SW. (103, 104, 107, 108, and 110–14), and another similar post hole to the N. of this line (98), appeared to define the S. edge of the working area (Fig. 5). In all of

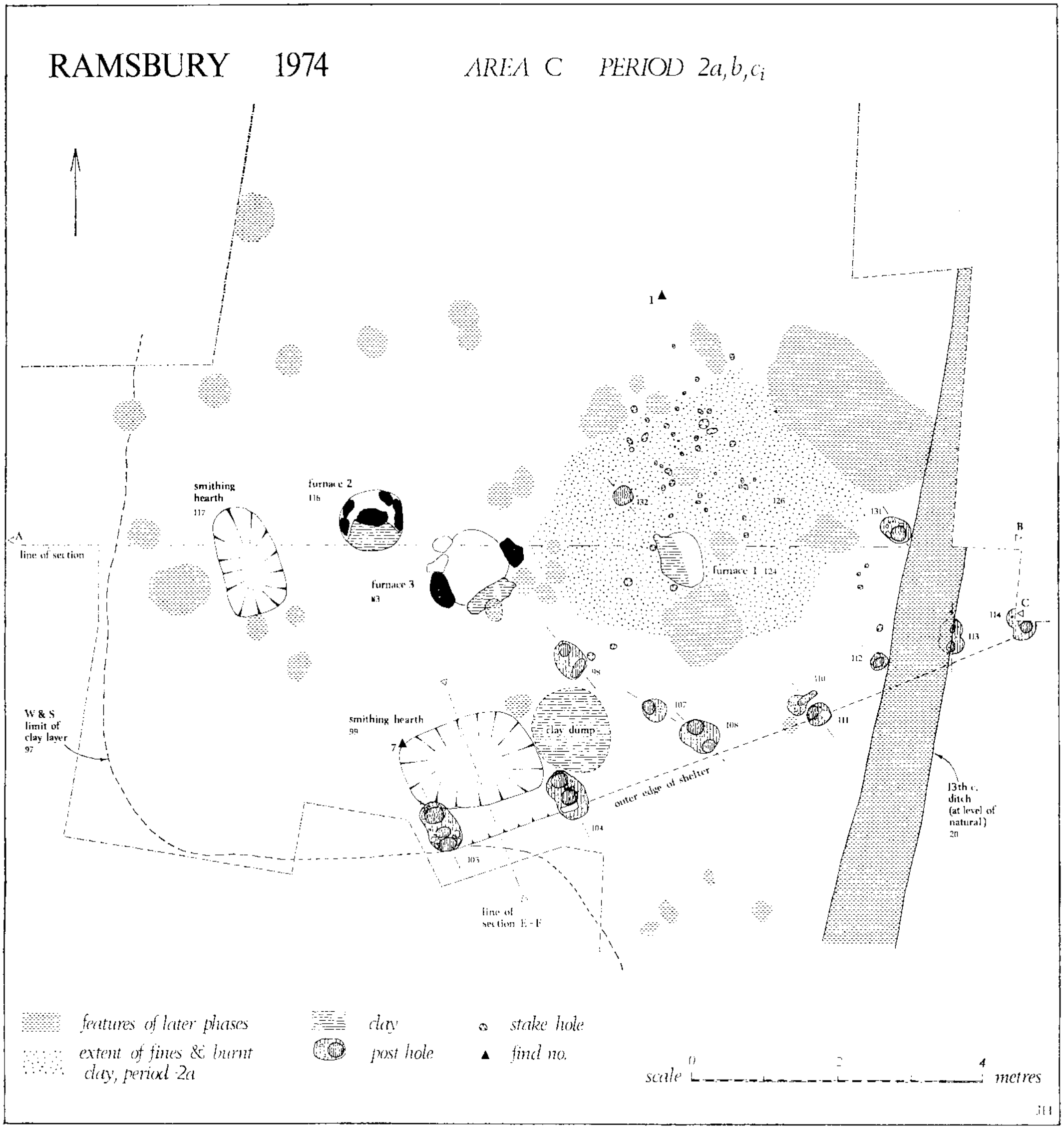


FIG. 5
Plan of features, Area C, periods 2*a*, *b* and *ci*

them the packing of the post holes (a mixture of large and small flints and earth) was clearly differentiated from the fill of the post pipes themselves, a fine grey-brown earth. The only evidence of any sill beam or other structures between the posts was a slot dug into the rising ground of the hollow between post holes 103 and 104, with a vertical side to the S. in line with the southern edges of the posts. This same edge continued around the W. side of post hole 103, although it faded out after about 1 m to the N.

It seems therefore that some of the industrial operations on the site were carried out under some sort of shelter, in all probability one open on all sides except the S. This would accord well with the distribution of animal bones, in layers of this and later phases, which were concentrated in the NW. corner of the site. The row of post holes on the S. side indicates a structure of some substance, which was no doubt intended to be permanent.

A number of stake holes of varying depth (between 50 and 140 mm from the surface of the clay layer 125) and width were concentrated in the centre of Area C, around and to the N. of furnace 1 (Fig. 5). These must represent a structure which was possibly replaced a number of times; its function is uncertain, but a bellows support is a possibility (cf. p. 29).

Bowl furnaces. The bowl furnace 2 (116) was cut into the natural Clay-with-Flints from the level of the first clay surface (97). It was truncated just above this by the second spread clay working surface of phase *b* (125) and so had lost its horizontal connexions with other features of the same phase. The deposits inside the furnace are described and discussed below (p. 21–23).

Another possible furnace of the first phase is the smaller feature (124), shown as furnace 1 in Fig. 11. It cut into the level of burnt clay and roasted iron ore described above, but was partly covered by the slag and charcoal layers of later operations. The stratigraphic evidence is equivocal, partly because the southern half of it, extending into Area B, was excavated both before the different working phases became distinguishable and before any other evidence of furnace structures was obtained. It is more fully discussed with the other furnaces below.

Ore roasting and ?charcoal burning hearths. An ore roasting hearth is indicated by a highly burnt zone without sharply defined edges, in the middle of Area C, which was covered with a layer of reddened iron ore, most of it finely divided but mixed with fragments up to 50 mm in diameter.

The clay working surface was also slightly burnt over most of Area D and in patches over the N. end of Area B. The lowest deposits on top of this layer consisted of a thick layer of finely divided charcoal, up to 80 mm in thickness in Areas B and D (51); and up to 50 mm in Area C. This deposit could either be the result of an initial phase of charcoal burning on the site, next to the ore roasting operations but outside the enclosing structure represented by the line of post holes, or it could represent the residue of fuelling operations.

Smithing hearth (Figs. 5 and 9). The presence of this hearth is indicated by a shallow depression (99), bordering upon the possible sleeper beam trench between post holes 103 and 104 on the S. edge of Area C. It was cut into the natural Clay-with-Flints, and its base was surfaced with a thin layer of brown clay which was slightly burnt red in patches. Its filling consisted mainly of small smithing waste (see Section 4) and fine charcoal (see section, Fig. 9). The apparently close conjunction of this hearth with the structural timber-work represented by the post holes 103 and 104 and the beam slot between them may seem surprising in view of the risk of fire inherent in this arrangement. Cover buildings for smithing — as opposed to smelting — are reasonable and safe, however, and their contemporaneity here is suggested by the fact that the charcoal filling of the hearth covered the filling of the post holes, but not the filling of the post pipes; it also abutted against an edge running N.–S. common to both the W. side of the post hole 103 and the W. side of the hearth hollow cut into the natural clay. There was no evidence of an anvil block (similar to the battered sarsen block used in the last phase, 2*d*).

The deposits of waste slag and charcoal from the operation of furnace 2 were spread over the whole site, comprising layers 96 in Area C and 121 in Area D (shown in section A–B, C–D, Fig. 8), and 52, 51, 50, and 19, 18, and 17 in Area B (shown in section G–H, Fig. 9).

TABLE 3
PHASE *B* FEATURES
(plan, Fig. 5)

Context number	Feature and function	Description/ composition	Stratigraphical relationships	Comments
120 125	Clay surface of working area	Spread of orange-brown clay 50–50 mm in thickness	Covers slag and charcoal layers of phase *a* (96 and 121) and bowl furnace 116	Preserved at the edges of Area C, and in Area D, otherwise worn away
83	Large bowl furnace (no. 3)	Hollow in ground, 1.1 m × 1.0 m, 0.3 m in depth from level of presumed working surface	Cuts through clay and slag layers (96 and 97) of phase *a*	Structure and function discussed below
117	Smithing hearth	Shallow elongated hollow in natural, 1.6 m × 0.8 m, 150 mm in depth	Cuts through phase *b* clay surface (97). Covered with slag and charcoal layer (82)	See Section 4
82 119 47 48	Waste products from operation of furnace	Various layers and lenses of charcoal, slag, fines and some burnt clay, up to 300 mm in depth in Area C, spread out over Area B	Covers clay surfaces 120 and 125 on periphery of site, otherwise indistinguishable from phase *a* deposits	Show cyclical pattern of deposition of charcoal, fines and slag

Phase b

Phase *b* must have followed immediately after the abandonment of furnace 2 since its remains, truncated at the level of the original working surface, were covered with a new layer of clay (125). This was similar in texture and thickness to that of the original surface. Its eastward extent is indicated by a similar clay layer (120) spread over a thin layer of charcoal in Area D (to the E. of ditch 20), and which disappeared southwards over the hollow in Area B.

Bowl furnace. On this clay surface another, larger bowl furnace no. 3 (83), was constructed immediately to the SE. of the previous one. It started as an irregular oval hollow cut into the natural Clay-with-Flints, and was found surrounded by the remains of a dome support. The structure and use of this furnace will be described more fully in the section on the furnaces, below.

Smithing hearth. A second hearth (117), 3 m to the W. of this furnace, also belonged to this phase. This was a shallow pit dug from a level above the second clay layer of phase *b* and was overlaid by further layers of slag and charcoal associated with later iron smelting. It was unlined, though its sides were burnt red in patches, and it was filled with fine charcoal and smithing waste (see Section 4).

Waste deposits. While the large bowl furnace 3 was in operation an extensive layer of slag and charcoal accumulated around it (see section, Fig. 8). This built up to a depth of

300 m in the middle of Area C, and spread into Area D (overlying the second of the clay floors [120]), as well as over Area B to the S. where it accumulated to a depth of 200 mm (47, section G–H, Fig. 9). In this area, these later deposits appeared to be separated from the underlying charcoal and slag deposits of period *2a* by local lenses and spreads of calcareous material, clay and gravel (48 and 49) and also of discarded fines (as in section G–H). The clay and gravel layers were possibly associated with the construction of this furnace. The waste layers of phases *a* and *b* (82) were, however, not distinguishable in the centre of the working area, in the middle of Area C (possibly due to the wearing away of the intervening clay layer [125] mentioned above) but could only be separated on stratigraphic grounds towards the periphery of the working areas. These layers thinned away to the N. from their thickest in the middle of Area C. A large number of bones was mixed with this layer towards the NW.

It was also very noticeable that this deposit of working waste was, especially in the area around the bowl furnaces, made up of thin layers of charcoal, fines, and slag-and-charcoal which quite clearly showed localized cyclical patterns, with charcoal at the bottom, covered with fines and with slag above. None of these individual layers or lenses was more than 20–30 mm thick; they were quite irregular in both their horizontal extent and vertical distribution. Since the excavation had to be completed quickly, there was no opportunity to record the extent of these innumerable lenses and layers in detail. It was however possible to demonstrate, and to record photographically, the existence of possibly five or six of these cycles in the 0.3 m of the deposits in the middle of Area C. This seems to support the observation of this phenomenon in waste dumps on Roman iron smelting sites,[9] though the evidence at Ramsbury is by no means as unequivocal, and in any case such phenomena cannot be seen too literally.

Timber structure. The presence of post holes was particularly difficult to detect in the slag and gravel deposits on the site, and it is therefore not certain whether the double post-built structure of the first phase continued in existence during phase *b*. It seems likely, however that since the construction and use of furnace 3 apparently followed on immediately from the previous phase, the timber building or shelter built in the earlier phase would have continued in use during phase *b*.

Phase c

The evidence for a recognizable phase succeeding the two previous ones is rather more fragmentary. The stratigraphy suggests that after the abandonment of bowl furnace 3 (83, phase *b*) the centre of industrial activity shifted, leaving the immediate area of excavation peripheral to further activity until the construction of a larger furnace (61) in this area in phase *d*.

Activities in this phase can on stratigraphical grounds be divided into three distinct sub-phases:

ci. Spread of slag and fines over much of Area C, covering furnace 3 (83).
cii. Construction of timber buildings over these layers.
ciii. Period of disuse of site, and deposition of earth and gravel layer over whole area (?by natural means).

Phase ci

The pit (45) (see Pl. II, A, and profile [Fig. 9]), cut into the natural Clay-with-Flints, was in its size and construction similar to the bowl furnace of phase *b*, though its filling was entirely different. In the corners of the pit were pairs of stake holes, about 80–100 mm in depth and filled with charcoal, which were very similar to the stake holes in the bottom and sides of both the bowl furnaces 2 and 3. The sides of this feature were also burnt red in patches. These similarities suggest that it could have been at least constructed, if not used, as a smelting furnace. Its filling, however, consisted of charcoal, slag, brown earth, burnt clay, stones and iron ore, as well as bone fragments and a chunk of *opus signinum* plaster, and a large lump of partially burnt sarsen stone, about 0.45–0.5 m in thickness

TABLE 4
PHASE *Ci* FEATURES
(plan, Fig. 5)

Context number	Feature and function	Description/ composition	Stratigraphical relationships	Comments
123	Layer of slag and extensive spread of fines	Layers 30–40 mm in thickness, covering an area of 2 m × 2.5 m (see section A–B, C–D, Fig. 8 and plan, Fig. 5	Covers the remains of bowl furnace (83)	No recognizable furnace of this phase in area of excavation
45	Pit	Sub-rectangular bowl-shaped hollow, of hemispherical section, 0.45 m in depth, cut into Clay-with-Flints; edges slightly burnt, with pairs of stake holes in four corners; mixed filling, with no recognizable internal structures, and no internal clay linings	Cut through lowest slag layers (82) and ore roasting hearth, otherwise its exact position in the stratigraphical sequence uncertain	Possibly intended to be a bowl furnace

and width. Several fragments of similar Roman plaster were used in the construction of the later furnace 4 (61). The pit was clearly cut through the lowest slag and charcoal layers, showing that it was later than the bowl furnaces of phases *a* and *b*. Its horizontal relationship with the layers of slag and fines covering the bowl furnace 3, and defining phase *ci*, could not be closely established.

Phase cii

TABLE 5
PHASE *Cii* FEATURES
(plan, Fig. 6)

Context number	Feature and function	Description/ composition	Stratigraphical relationships	Comments
72, 78 89–95 100–102 105, 106, 109, 133–135	Construction of building(s) with post holes of two types (a and b)	Post holes type a: 300–400 mm in depth, with packing of slag, earth, etc., in construction holes around posts, post pipes subsequently filled with fine earth and pea gravel	Post holes cut into slag and fines layer 123, packing around p.h. 79 covered with gravel layers 68 and 69 while post still in position	It is difficult to make any recognizable structure out of these post holes, which could represent a shelter providing quarters for a working area elsewhere
80, 81 84–86		Post-holes type b: wider than type a and shallower (100–150 mm); filling of slag, gravel and earth, no recognizable distinction between post pipes and packing in the construction holes		
88	Shallow depression	Filling of fine grey and black ash, and iron ore fines; sides unburnt	Cut into top of slag layers 123 and 82; overlain by earth layer 71 (phase *ciii*)	Function problematical

This phase is marked solely by the construction of a timber building, the post holes of which cut into the slag and fines layer of the preceding phase. The slag in the packing around these posts (in contrast to those of the first phase, which contained none), indicates rebuilding at a time when some slag was exposed. The presence of the two types of post hole (see Table 5) could be taken to indicate two different phases of building, although their general alignments are the same. The post holes of neither of the two types, however, can by themselves be made into a recognizable structure. Several of these post holes appear to have been re-excavated a number of times (especially nos. 77/78 and 80). The absence of any kind of activity associated with these structures suggests that, like the layers of the previous phase, they are associated with industrial activity outside the immediate area of

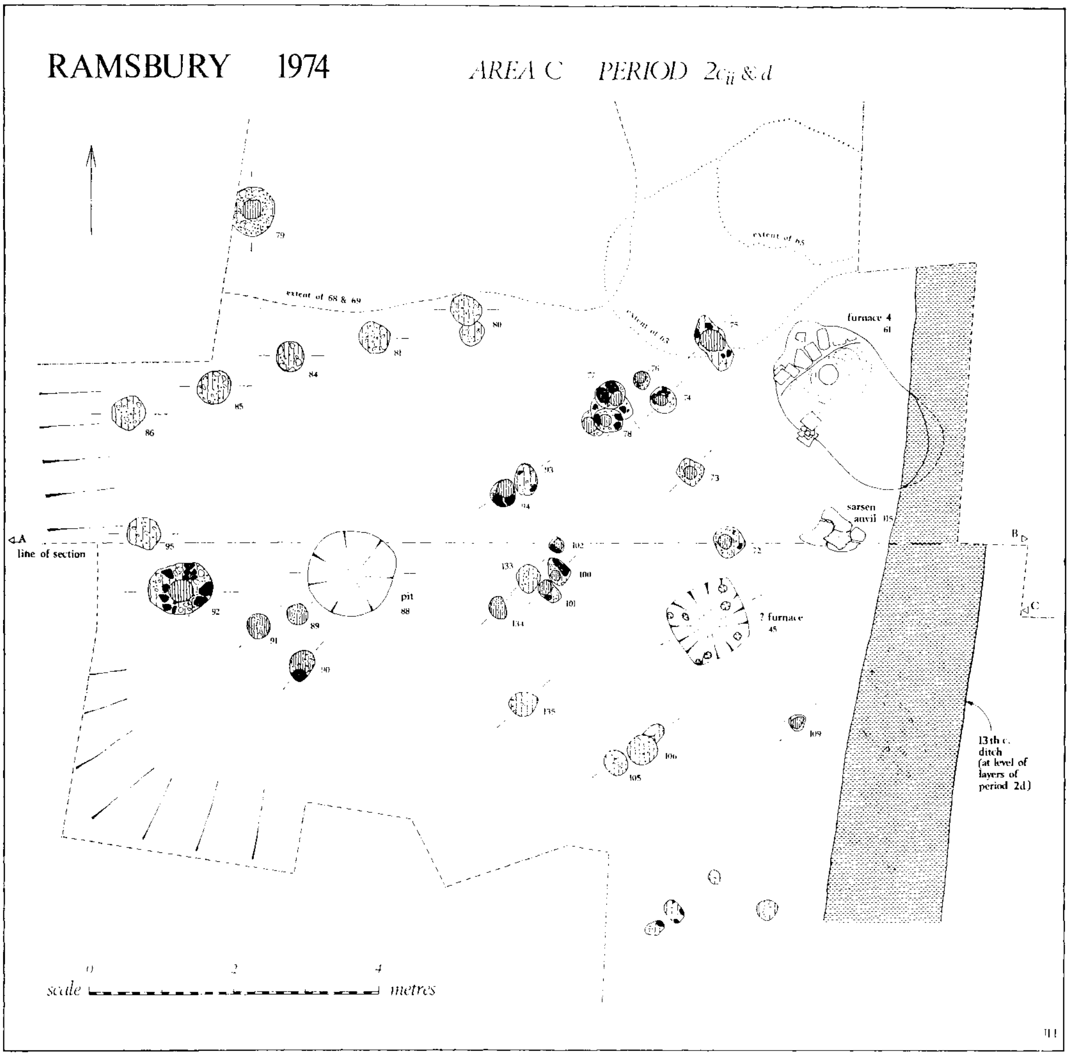


FIG. 6
Plan of features, Area C, periods *2cii* and *d*

excavation; they could perhaps represent the extension of structures situated to the NW. of Area C, which, it has already been suggested above, had possibly been used as shelters for the furnacemen.

During the period in which this post-built structure was standing some local erosion took place to the N. and NW. of Area C, depositing thick lenses of gravel and earth (68 and 69) over the filling of the construction hole 79 while the post was still in place. The survival of the southern edge of these layers suggested that they had been retained by a wall of posts standing at the time in post holes 80–81 and 84–86.

The only other feature associated with this phase was a shallow depression (88) to the W. of furnace 3 cut to a depth of 150 mm into the top part of the slag layer 82 (see section A–B, C–D, Fig. 8). No function can be suggested for this.

Phase ciii

TABLE 6

PHASE *Ciii* FEATURES

Context number	Feature and function	Description/ composition	Stratigraphical relationships	Comments
71, 67 (Area C) 59 (Area D)	Layers of gravel and earth	Even mixture of flint, gravel, and earth; built up in middle of Area C to 150–200 mm in thickness; coarse gravel built up to E. of site, in Area D (59)	Overlies all layers of previous periods, covered by slag/charcoal layers of phase *d*	Represents period of disuse of the site

This phase, which marks the disuse of the site, is represented by a layer of gravelly earth accumulated over the whole of the northern part of the excavated area, covering Area C (71 and 68), most of Area D and the northern part of Area B, and filling the post holes of the preceding phase. To the E., in Area D, a thick layer of gravel (59) was deposited over the charcoal and slag layer (119) associated with phase *b* (shown in section C–D, Fig. 8). This thinned to disappearance towards the E., and was clearly derived from the slopes to the NE. and E. by natural erosion. It could have been accumulating during the whole of phase *c*, and not only in this last period of abandonment.

It is difficult to make an accurate estimate of the duration of this period of disuse. The rate of erosion of the surrounding hillslopes — whether caused by plough-wash or soil creep — was in subsequent periods always high, and deposition in the hollow occupied by the iron-smelting site (about 1 m of gravel and earth deposits forming between the 9th and 13th centuries) correspondingly rapid. The probable rotting of the post-built structure associated with phase *cii* and the deposition of the gravel and earth layer would have taken several years.

Phase d

This phase is marked by the reuse of the immediate area of excavation for iron smelting operations.

Furnace (Pl. III, A–G). A large furnace, 4 (61), with a slag-tapping hollow to the SE., was constructed in the eastern part of Area C. It cut into the earth and gravel layer deposited over the site in the preceding phase of disuse (phase *ciii*), as well as through earlier slag layers (see section C–D, Fig. 8). It was quite clearly therefore of later date than the bowl furnaces. The details of the construction and the evidence for the method of its operation are described below (p. 24–29).

Sarsen anvil (115) (Pl. III, H). This was an irregular flattish block of sarsen stone, situated immediately S. of furnace 4 (see plan, Fig. 6), the slightly hollow centre of which was filled with a mass of slag. The fact that it was also burnt slightly red in patches and had evidently

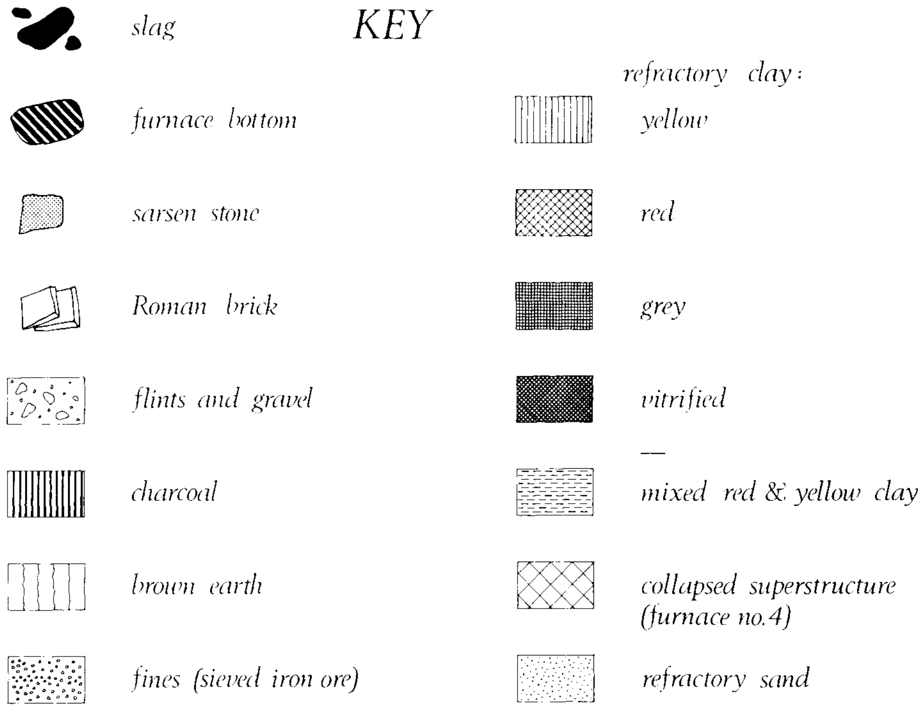


FIG. 7
Key to symbols used in Figs. 8–15

been cracked while *in situ*, suggests that it must have been an anvil block used in smithing work in this phase of the operations. There was however no smithing hearth of this phase in the excavated area; it may either have lain outside the area of the excavation to the E. of Area C, or may have been destroyed subsequently by the cutting of the 13th-century boundary ditch (20) immediately to the E.

Waste deposits. The smelting operations of the furnace in this phase created a considerable amount of waste material (see Section 4). Most of this was discarded downhill to the S. of the furnace, filling the hollow in Area B to a depth of up to 0.4 m (layer 37, section G–H, Fig. 9). A smaller amount was spread over the rest of the site (layers 66 and 60), to a depth of no more than 100 mm in the middle of Area C immediately to the W. of the furnace. In this area it directly overlay the gravelly earth accumulated during the preceding phase of disuse (phase *ciii*).

To the S., however, the slag deposits (37) overlay a layer (46) of finely fragmented charcoal, up to 40 mm in thickness, which extended as an even layer into Area D. In places, 46 was covered with a thin spread of fines. Although layers and lenses of fines were distributed unevenly through the overlying slag layer, it is still possible to see this sequence as evidence of cyclical processes, described by Cleere.[10] The beginning of smelting operations on the site (phase *a*) was in the same way marked by the deposition of a comparatively thick and pure charcoal layer (51) at the bottom of the sequence of layers in Area B (see section G–H, Fig. 9).

There were no post holes, or other signs of any timber or stone structures, associated with this phase. The last building on at least the working part of the site (in phase *ciii*) appears to have decayed during the previous period of disuse. However, the layers of slag in the NW. part of Area C still contained a large number of bones, with the occasional

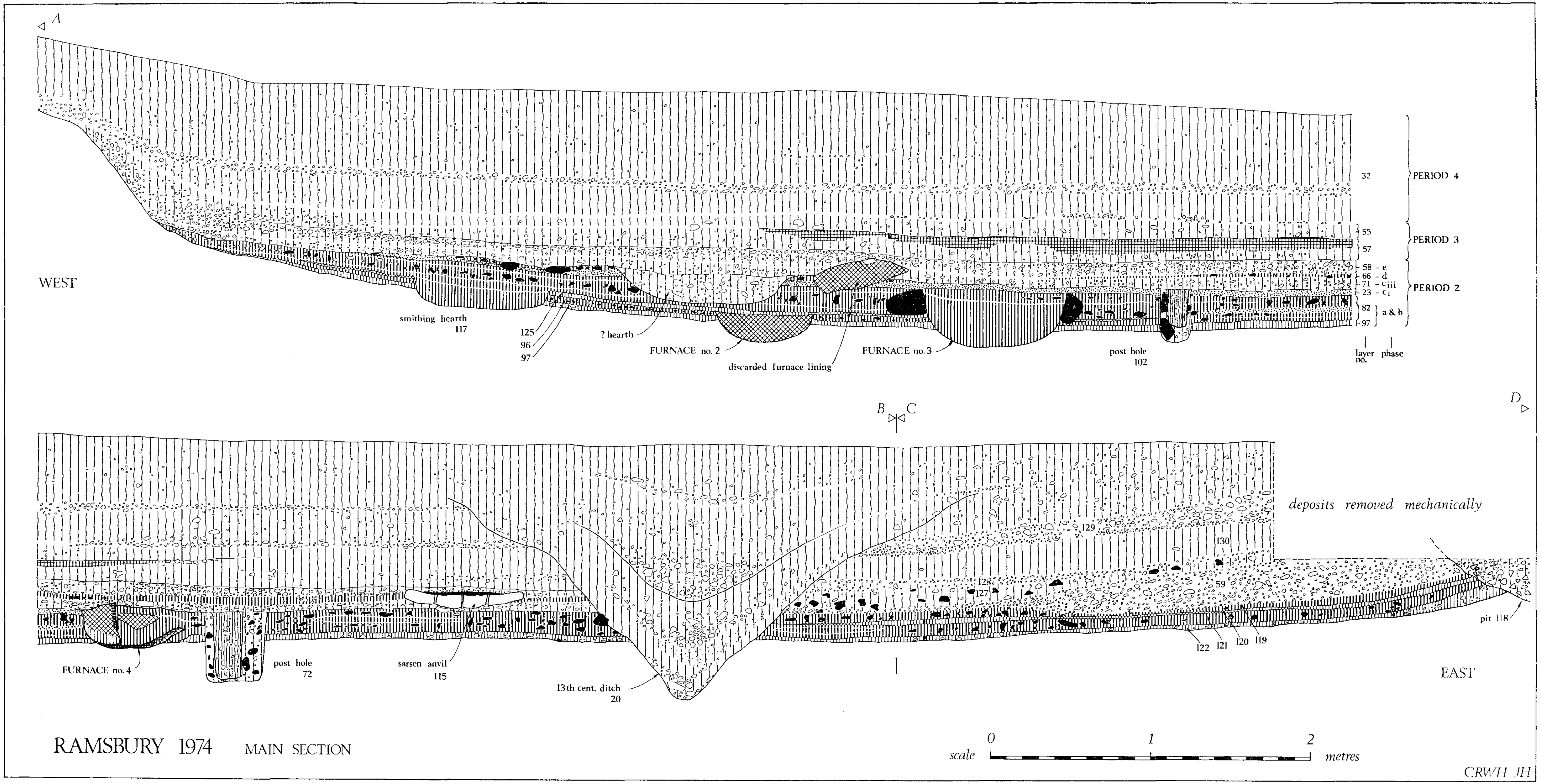


FIG. 8
East-West section A–B, C–D

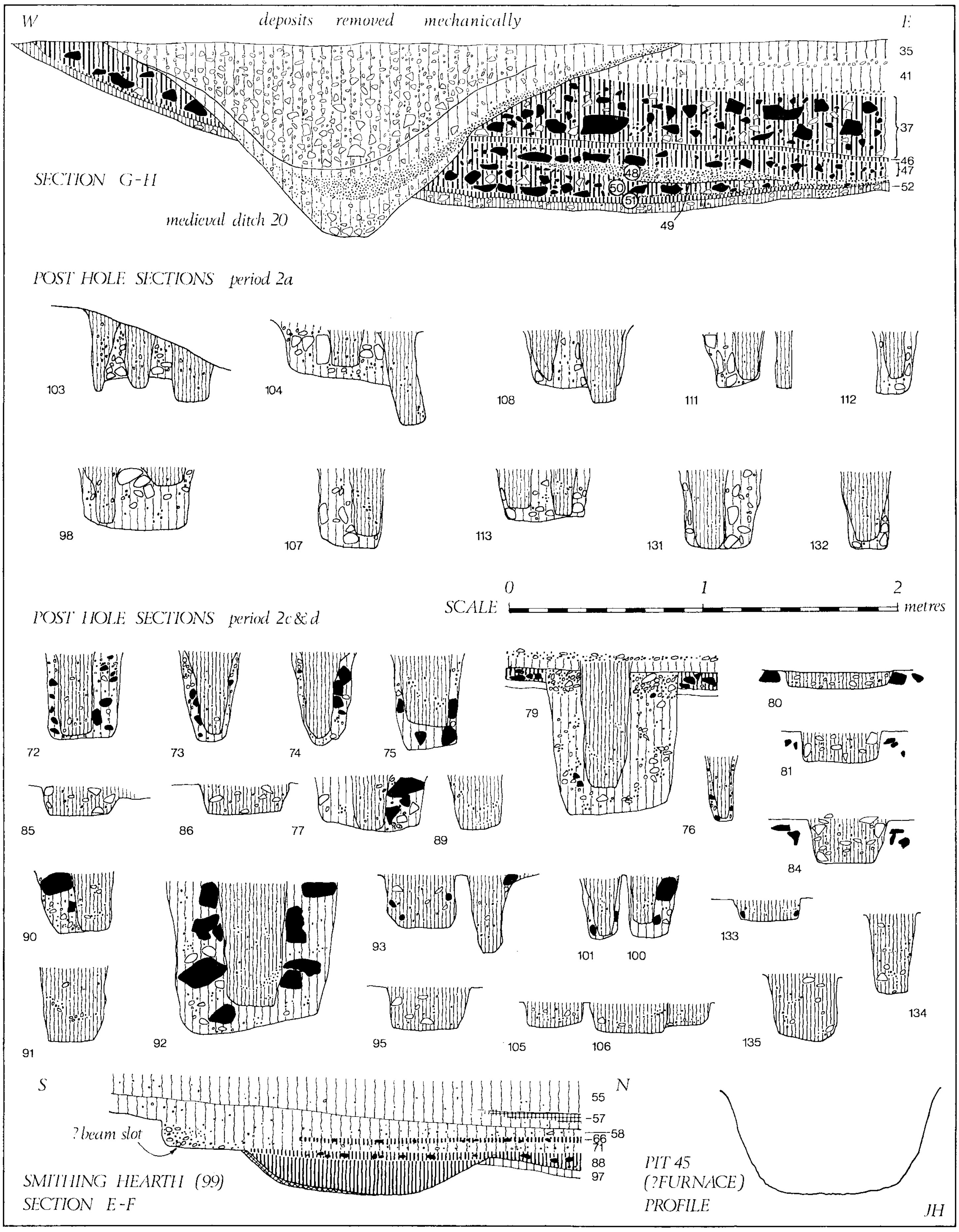


FIG. 9

Section G–H, and sections of post holes, smithing hearth (99) and pit 45

TABLE 7
PHASE *D* FEATURES
(plan, Fig. 6)

Context number	Feature and function	Description/ composition	Stratigraphical relationships	Comments
61	Furnace 4	'Developed bowl' furnace remains in a flattened funnel shape, with facilities for tapping slag into hollow to SE.	Cut into earth layer (71) of period of disuse (phase *ciii*)	Detailed description below
115	Anvil	Flat block of sarsen stone, 0.9 m × 0.6 m in width, 100–150 mm thickness, hollow central portion filled with mass of slag — surfaces burnt red and cracked while *in situ*	Bedded into earth layer (71) and surrounded by slag and charcoal	Associated smithing hearth, presumably nearby, outside area of excavation
46 36, 37 Area B	Layers of waste from operation of furnace 4	Successive deposits of charcoal, fines and slag with charcoal, Area B	Overlying slag layer (47), of phase *2b/c*	All layers contain tap slag, as contrasted with waste layers of previous phases, which contained none
66, 60 Area C		Mixed slag, charcoal, roasted iron ore and gravel, Area C	Overlying earth layers 67 and 71	
127 Area D		Slag and earth with gravel, Area D	Overlying gravel layers	

sherd of chaff-tempered pottery, suggesting that some sort of living quarters were still maintained further to the N. beyond the area of the excavation.

Phase e

This phase represents what must be a period of abandonment over the whole site. At some time after furnace 4 was used for the last time its superstructure collapsed, partly filling the tapping hollow, which was already half filled with waste products from the furnace's operation. A localized accumulation of large angular and sub-rounded flints, bones, gravel and earth (layers 65 and 63) immediately to the N. of the furnace, which appeared to be contemporaneous with its collapse, possibly indicates a brief period of occupation outside the area excavated, to the E. of Area C.

Soon after — or perhaps even during — this phase, the whole site was gradually covered with naturally accumulated spreads of earth and gravel derived from the hillside to the N. of the site, and described above as period 3.

THE FURNACES

FURNACE 1 (124) (Fig. 11)

This furnace is described first not because it is demonstrably first in a stratigraphical sequence but because it is the smallest. The simple bowl furnaces 2 and 3 (and possibly feature 45) are not only demonstrably successive, but also become larger with time (see below).

The furnace consisted of a shallow hollow scooped in the ground, cutting into the burnt floor of the ore-roasting area (126). The eastern edge consisted of a thin irregular layer of clay lining the hollow, burnt slightly red. The western edge of the furnace was defined by a vertical elongated slab of clay, 150 mm in thickness and about 100 mm in height, which was burnt hard and to a grey colour on the inside (eastern) surface. This rested on a thin layer of charcoal, separating it from the clay lining the original hollow which continued underneath it. The space between this clay slab 'wall' and the thin clay

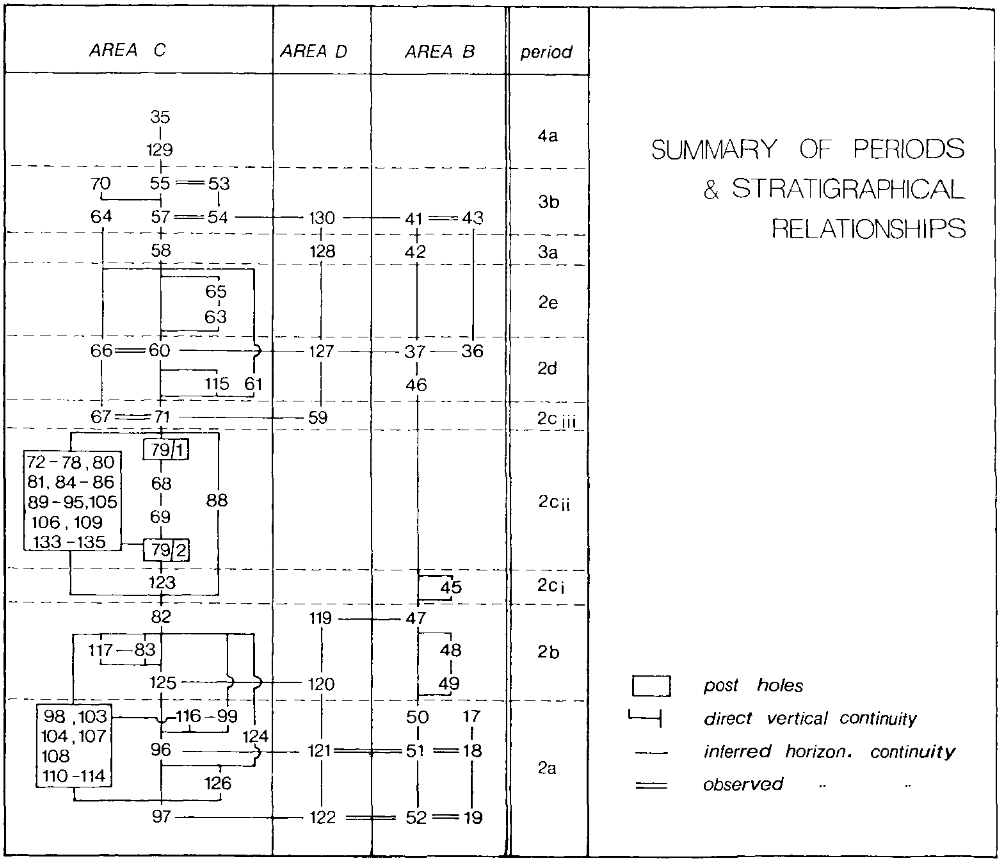


FIG. 10
Summary of periods and stratigraphical relationships

lining was filled with pure charcoal. The clay 'wall' on the western side could well be taken as the lower part of a dome support built over the furnace in the manner shown in the later furnaces.

FURNACES 2 (116) (Fig. 12; Pl. II, A–B) AND 3 (83) (Fig. 13; Pl. II, C–D)

Two sections at right angles, and two plans are given for each furnace in Figs. 12 and 13. The first plan shows the upper level of the furnaces as found, the second shows the completely excavated bowl cut into the natural subsoil, with contours at 50 mm intervals.

Method of excavation

The same methods were used in the excavation of both furnaces. They were planned at a scale of 1:5 and photographed as soon as they were revealed — by the removal in the case of furnace 2, of the second clay working surface (125), and in the case of furnace 3, of the overlying slag and fines layer (part of 82, and 123). Running sections were drawn, also at a scale of 1:5, parallel and at right angles to the line of the clay linings, as the furnaces were excavated in quadrants. At each definable horizon in the deposits, such as the addition of a new clay lining, the furnaces, completely excavated to that stage, were photographed and where necessary replanned. There exists therefore a complete series of photographs of all stages of their construction and use.[11] After all the internal deposits had been removed, a detailed contour plan of the original excavated hollow was drawn at the same scale.

Descriptions

Except in their size, the two bowl furnaces 2 and 3 were similar in most aspects of their construction and therefore, presumably, their operation. Furnace 1 also had several features in common with the two larger furnaces.

Furnaces 2 and 3 both preserved a thick build-up of superimposed clay linings on their southern sides, a lining evidently being inserted after each firing. These linings were prepared from a yellow clay which in some instances contained some sub-rounded, possibly river-washed, pebbles up to 20 mm in diameter.[12] As the plans and sections of these blocks show (Figs. 12 and 13), the clay of each relining was burnt to an identical range, from the inner to the outer edge, of vitrified through reduced hard grey, to red, pink and then unfired bright yellow. The area of greatest vitrification was concentrated at its centre, at a height above the floor of the furnace of between a half and a third of its diameter at the time of firing.[13] In few cases did the area of burning extend to the outer edges of these linings, which retained their original yellow colour (see photo of lining 3 in furnace 2, Pl. II, B; and lining 3 in furnace 3, Pl. II, D).[14] In some cases also the zones of burning did not extend to the full thickness of these linings. While in furnace 2 these linings were only applied to the southern side, in furnace 3 the successive linings, while thickest at the southern end, were spread over most of the rest of the furnace. In both furnaces, thin layers of coarse sand grade refractory material were incorporated in these linings.[15]

In both these furnaces the last firing seems to have been associated with a relining which was thicker than usual, and which extended over the whole of the base of the furnace. In furnace 2 the furnace bottom was left in position when the furnace was abandoned, leaving the burnt clay of the lining adhering to its underside; in furnace 3 the removal of the latest furnace bottom evidently caused the break-up of the last clay lining.

Superstructure. There are two possible ways in which these furnaces could have been covered. Either the hollow in the ground forming the bowl of the furnace could have had a cover of dampened charcoal or clay laid over the charge, the whole broken up after each firing to remove the bloom and the furnace bottom; or a semi-permanent dome of clay, open at the top to allow removal of the bloom and furnace bottom, could have been built over an interior framework of stakes and twigs and retained during a number of firings.[16]

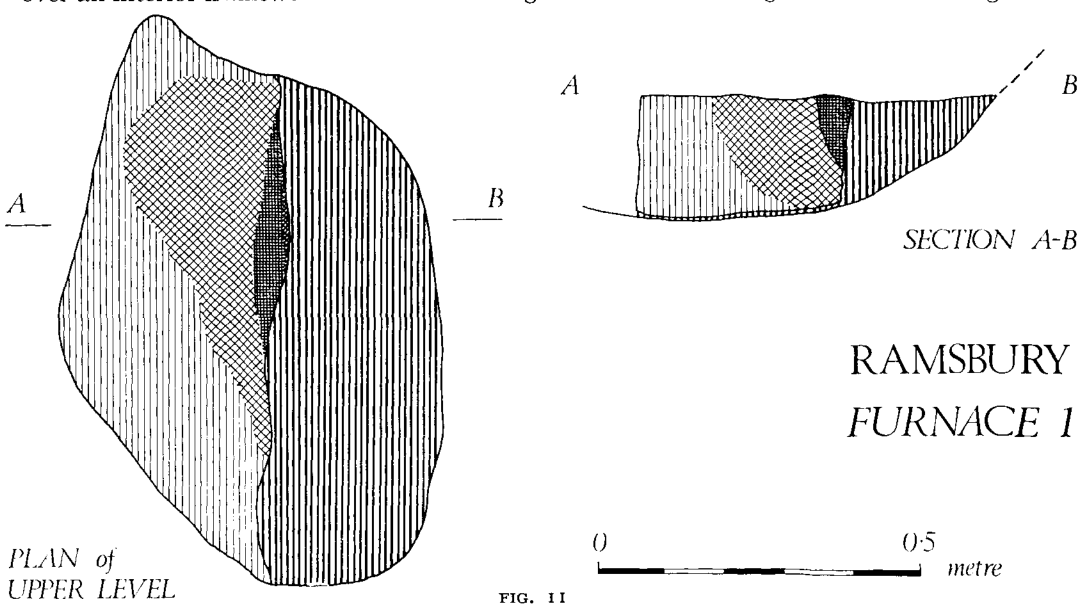


FIG. 11

Furnace 1: plan and section

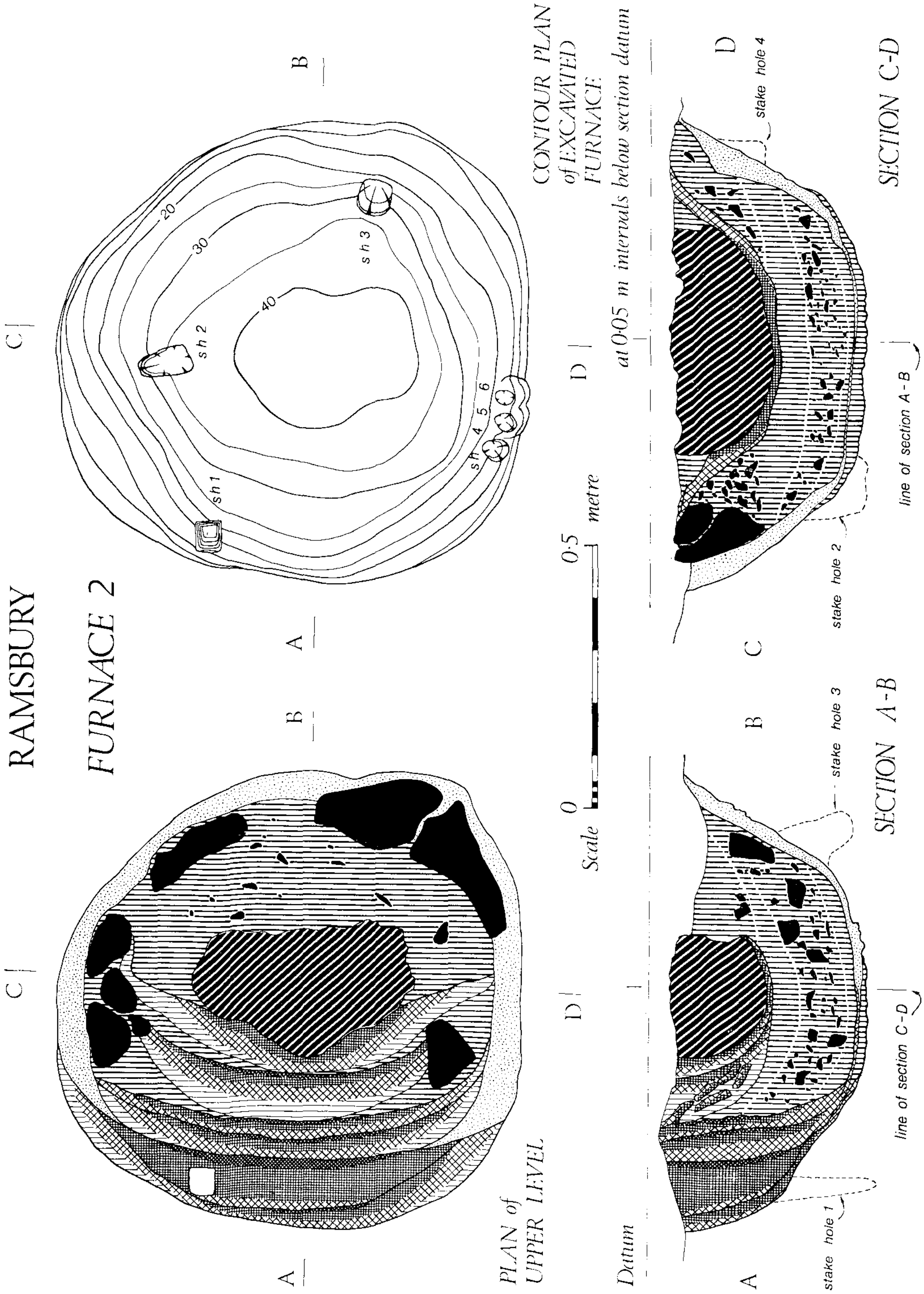


FIG. 12

Furnace 2: plans at highest and lowest levels, and two sections at right angles (same scale as Figs. 11 and 13–15)

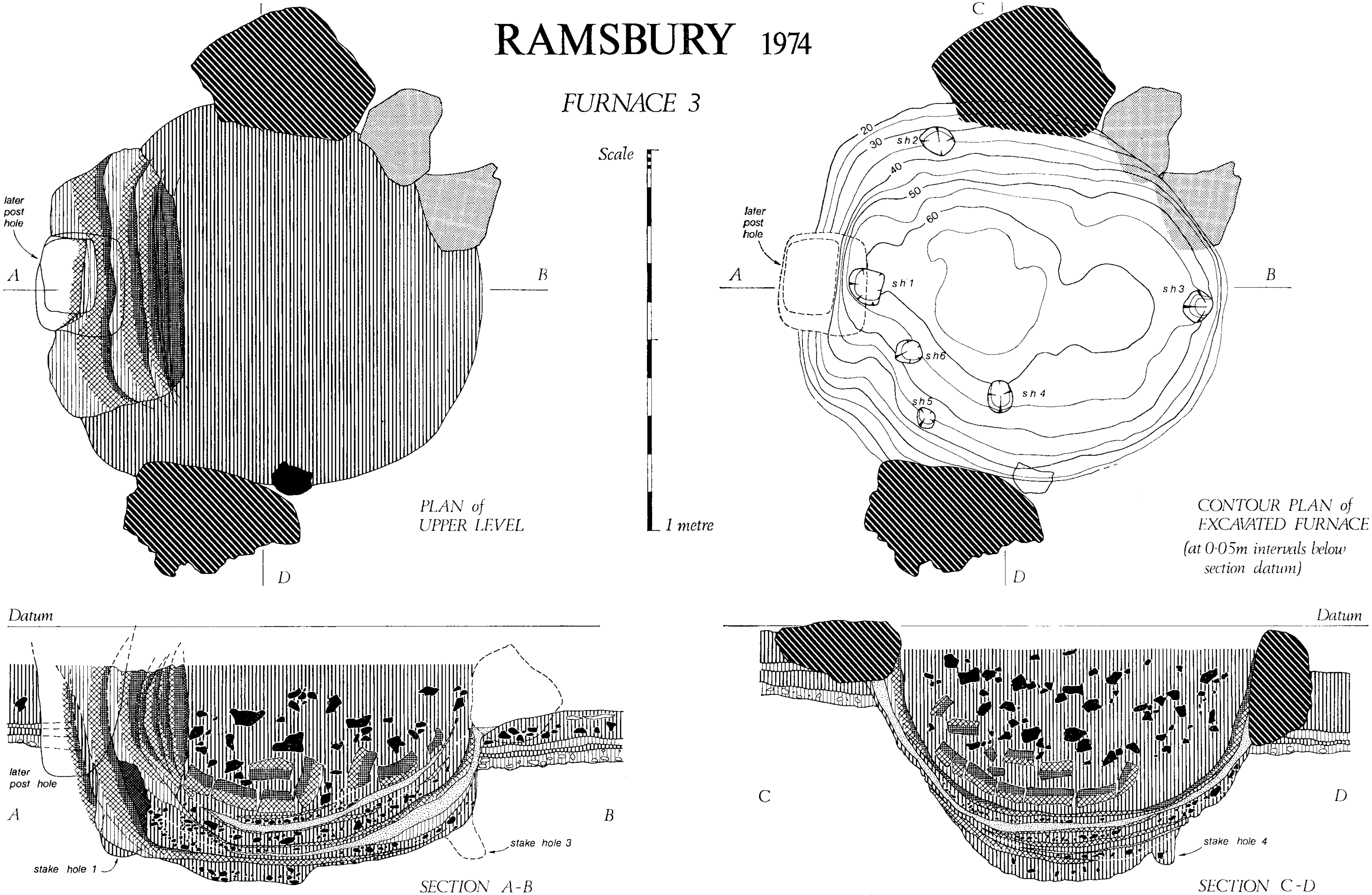


FIG. 13
Furnace 3: plans at highest and lowest levels, and two sections at right angles
(same scale as Figs. 11–12 and 14–15)

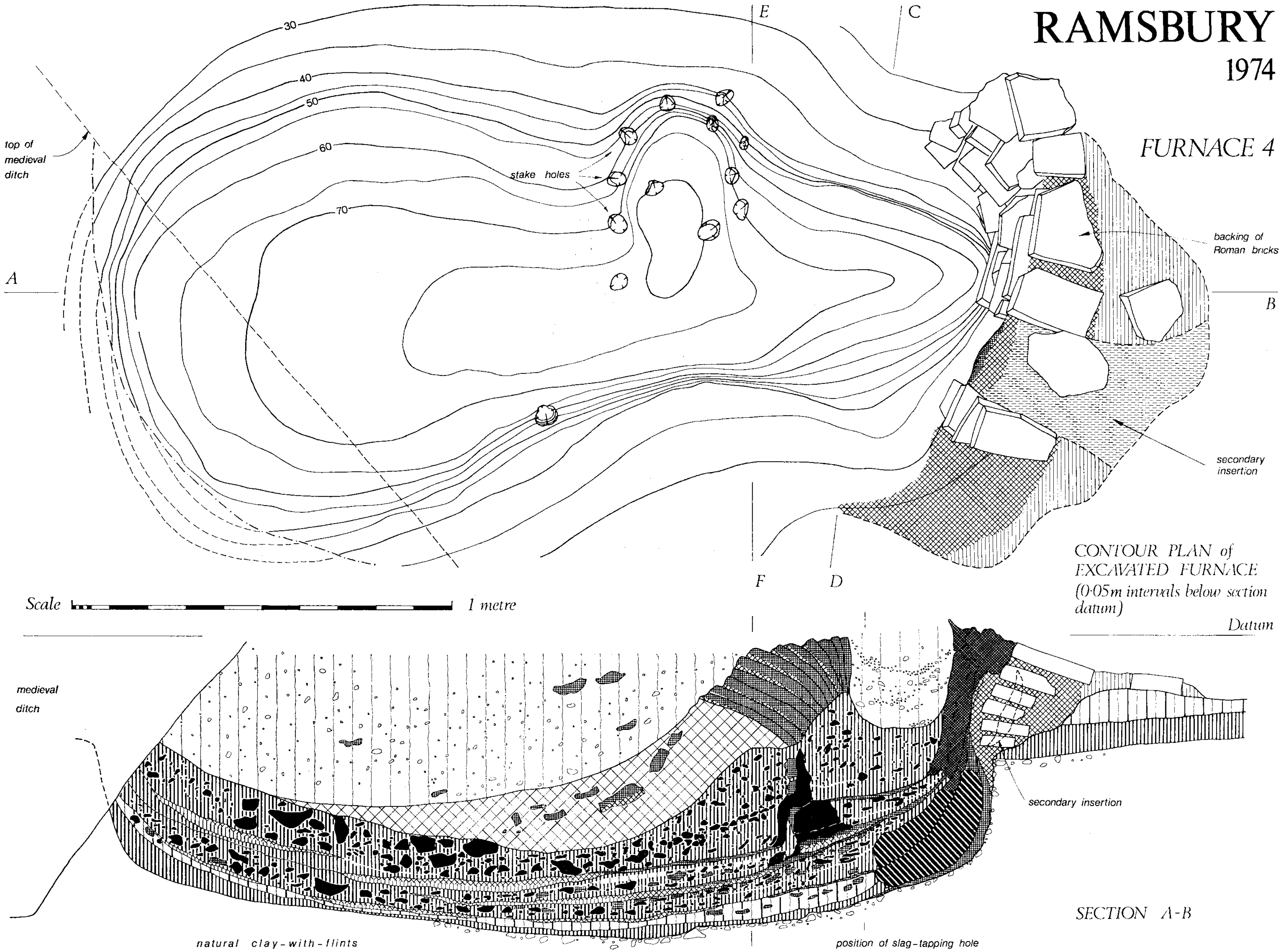


FIG. 14

Furnace 4: plan of completely excavated furnace with contours, and longitudinal (N.–S.) section through furnace and slag-tapping pit (same scale as Figs. 11–13 and 15)

That both furnaces 2 and 3 were constructed with this permanent superstructure is suggested by two main considerations. Firstly, all the stake holes observed on all sides of both of the furnaces were covered by all but the first of the clay linings and were with only a few exceptions not reused. This implies that the domes, which were initially supported by these stakes, lasted for several firings, no doubt being intended to last the life of the furnace. Once fired, there would have been no further use for extra internal support. Secondly, the fact that the clay linings within the surviving lower parts of the structure had clearly been truncated after the abandonment of the furnaces (see sections, Figs. 12 and 13) suggests that they were remnants of larger structures above the level of the working surfaces. The increase in total thickness of the linings implies therefore successive additions to a structure already in existence.

It must be concluded that both these furnaces had permanent or semi-permanent domes, built of the same clay as the surviving linings of the furnaces, and initially supported by stakes. There are indications that the dome of furnace 3 was replaced, either in whole or part, several times during the life of the furnace. The furnace bottoms and sarsen stones used around the edges of this furnace, presumably for the support of a clay superstructure, were apparently inserted after several firings had already taken place. These phases of reconstruction also explain the reuse of a few of the stake holes around the edges of furnace 3 (especially nos. 5 and 6).

It is possible to make further inferences about the nature and dimensions of the dome. Firstly, the opening at the top of such a superstructure must have been wide enough to have allowed both for the removal of the bloom and furnace bottom and for the addition of new linings after each firing. Secondly, since the bases of the furnaces, as well as the sides, were sometimes lined with clay, the internal height of the whole structure cannot have been greater than the maximum reach of a man's arm (say 0.8 m). These arguments assume that these operations were effected through the top opening. Thirdly, the inclination of the main stake holes towards the centre of the furnace (see sections A–B, furnace 2, Fig. 12, and A–B, furnace 3, Fig. 13) suggests that the superstructure cannot have been a simple straight shaft, but rather an incomplete dome with its top aperture considerably smaller than the diameter of the bowl.[17]

The use of the furnaces. The surviving linings and the other internal deposits in both furnaces 2 and 3 show that the same hollow in the ground was, in each case, fired at least seven times. In furnace 2 the combined thickness of these linings totalled over 50% of the initial width of the furnace (at the level excavated), and in furnace 3 the same accumulation totalled 30% of its initial length from N. to S. The effective volumes of the furnaces at each stage in their life are difficult to estimate; however, it is likely that at the time of the last firing both were reduced to about 25% of their original size. The size of the latest furnace bottom in furnace 2 is shown in the plan and two sections through the furnace in Fig. 12. The size of furnace bottoms reused in the construction of furnace 3 is also shown in Fig. 13, though there is no certainty that these were in fact derived from the operation of this particular furnace.

It seems however quite certain that both furnaces were used for longer than the clay linings remaining in them suggest. A block of accumulated clay linings identical to those on the S. side of furnace 3 was found discarded not far to the W. amongst the slag and charcoal waste layers (shown on section A–B, Fig. 8). Its presence shows that when the furnace had become too small its superstructure was dismantled and the accumulated linings inside the furnace pulled out and discarded, and the furnace refurbished in the same hollow. While no such discarded linings from furnace 2 were found, the presence of fragments of burnt clay linings underneath, and cut into by, the first of the linings still remaining, suggests that this furnace had also been reused in this way.

These observations provide some evidence for reconstructing the way in which these furnaces were fired. To judge by modern primitive workings, a single firing is likely to have taken from six to twelve hours, a length of time which would depend on the ironmaster's method of operation. It is now generally accepted that this process requires a forced draught,[18] but there was no evidence from the excavation of the positions of either tuyeres or bellows. It would be important to establish the actual source, and therefore the direction, from which the blast was directed on to the charge, since this would directly reflect the skill and traditional experience of the operators. In the case of the two bowl furnaces at Ramsbury, it is likely that the bellows were placed at the sides of the furnaces, pointing slightly downwards.

FURNACE 4 (61) (Figs. 14 and 15; Pl. III, A–G)

Method of excavation

The excavation of this furnace took place in two main stages. The removal of the overlying earth and gravel which covered the site after the abandonment of this furnace showed a mound of cracked grey-burnt clay apparently arranged in concentric layers around a central hollow or shaft, with a line of Roman bricks (see plan and section, Fig. 14, and Pl. III, F–G), forming its NW. side. A hollow to the SE. suggested the presence of a slag-tapping pit. A section (A–B, Fig. 14) was established on a NW.–SE. line to bisect all these features, and another (E–F) along the arbitrary line at right angles to this between the tapping hollow and the furnace structure. The deposits within the eastern half of the tapping hollow were excavated up to the longitudinal section line and drawn, and the other half then removed. The section (E–F) up against the front of the furnace was drawn and photographed. The furnace was then excavated in quadrants defined by the original longitudinal section and another (C–D, Fig. 14) laid across the central hollow of the furnace parallel with the brick 'backing' to its NW.

Excavation proceeded in stages corresponding to each relining of its interior (see description below), running sections being drawn in the manner used for the recording of the bowl furnaces and described above. Each of these separate stages was cleaned and photographed from different angles. Early in this exercise, however, part of the front of the furnace (to the SE., that is, that part forming the arch over the slag-tapping hole leading into the tapping hollow) collapsed. The section of this was therefore completely drawn, and the rest of the front removed. The photographs of most of the successive stages (Pl. III, B–G) therefore show the furnace with the front completely removed. A contour survey (Fig. 15) was made at the level of the first relining showing the shape of the interior of the bowl when fired at this stage; a second contour plan was finally made of the completely excavated structure (Fig. 14).

Description

The furnace was built as an elongated hollow on a NW.–SE. axis, 0.65 m in depth (see Pl. III, A and G), and cut through the earth and gravel of the period of disuse of the site (phase *2ciii*) and into the slag layers of phases 2*a* and *b* (shown in section C–D, Fig. 15). The end to be used for tapping the slag had been widened to an oval shape (see Pl. III, A). The head of the furnace at the NW. end was merely a narrow U-shaped channel at the head of which was constructed a curved wall of Roman bricks (see plan, Fig. 14; and Pl. III, F and G). This structure was bonded with clay, forming a mass about 0.3 m in thickness, 1 m in length and 0.3 m in height. Clay was also plastered over the inner face of the bricks originally to a depth of about 30–50 mm, and also over the inner face of the basal hollow at the head (the NW. end) of the furnace, giving a somewhat concave shape at the back (see section A–B, Fig. 14). This lining was carried around the sides of the hollow and in an arch over the front (conforming approximately to the shape defined in the contour plan, Fig. 15) creating an open 'bowl' in the shape of a funnel compressed along the longitudinal axis of the furnace. The arch made over the front of the furnace by this original lining had, however, either collapsed or been destroyed by later operations, and its exact configuration can therefore only be conjectured. It is clear though that this must have formed the tapping hole for the removal of liquid slag into the hollow to the SE.[19]

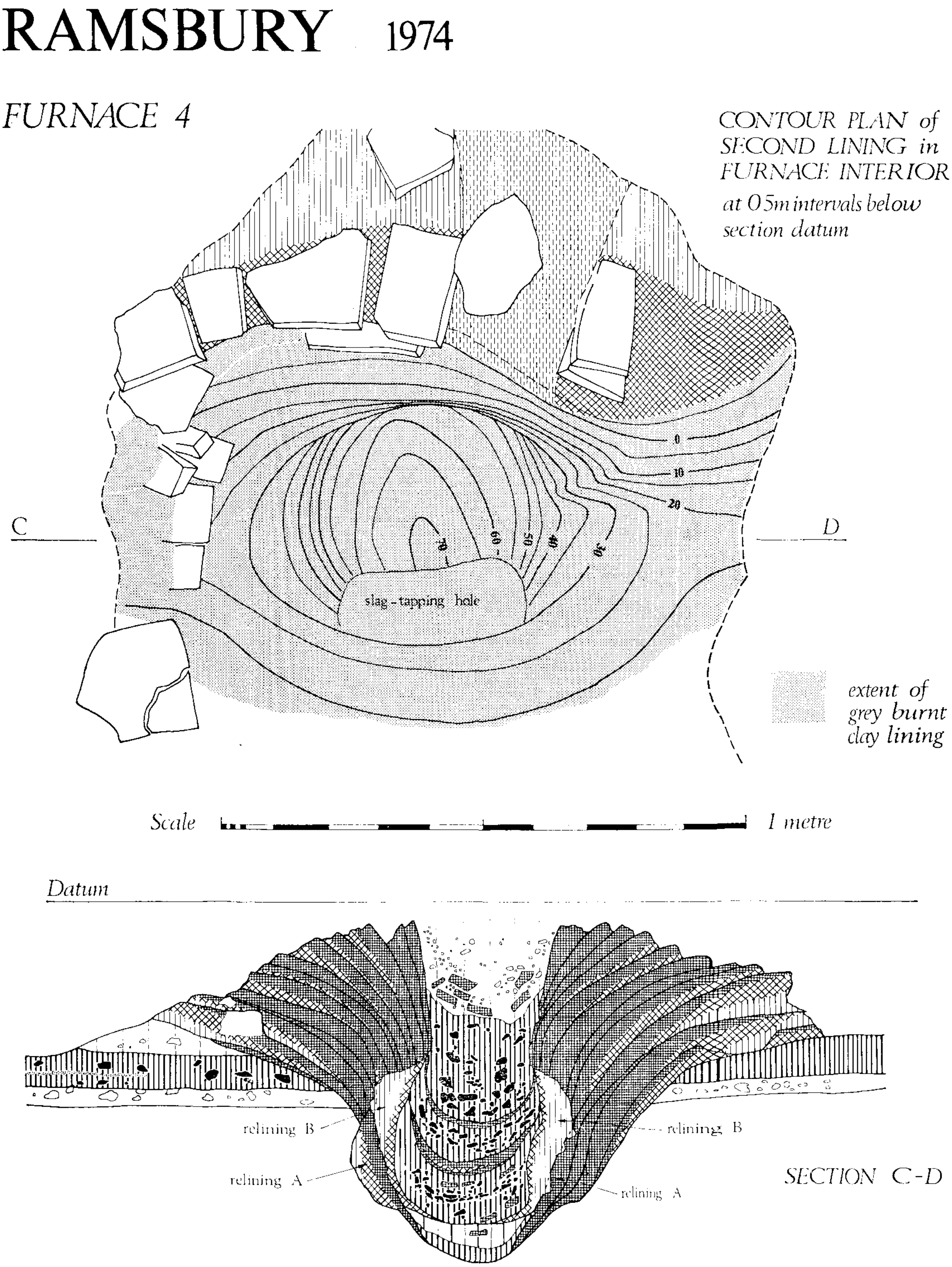


FIG. 15

Furnace 4: plan of furnace interior (at level of lining 2) with contours, and lateral section through furnace showing superimposed linings (same scale as Figs. 11—14)

Several phases of firing are shown both in the gradual build-up of successive clay linings inside the bowl of the furnace, as well as in the alternation of thin layers of red- and grey-burnt clay and charcoal in the slag-tapping hollow. The internal stratigraphy of the furnace showed, however, that the tapping hollow had been cleaned out more than once, whereas the interior of the bowl was relined without the removal of earlier linings (see Table 8 below). These successive applications of clay inside the funnel of the furnace resulted in a contraction in its internal volume, and led to the formation of a tall cylinder reminiscent of a furnace shaft. The thickness of the zones of grey-burnt clay was usually about 30–40 mm; underneath this zone, where the clay lining was thick enough, the clay was a red colour. Only in a few places, in the thickest parts and towards the outer edges, did the clay still retain its unburnt yellow colour (see section C–D, Fig. 15).

The whole area of the surfaces of each of these layers was burnt hard and to a dark blue-grey colour. The north-eastern part of the surface of layer 2 (Fig. 15) had burnt grey even where it curved away from the furnace to the N., showing reducing conditions here also. The implications of this for the determination of the form of the superstructure are brought out below. As with the earlier bowl furnaces, it was the back of the furnace which was the most completely vitrified; the total thickness of the vitrified clay linings there only reached 70 mm half way up, but was about 130 mm at the top.

At probably a late stage in its life a modification was made to the lining of the back of the furnace. A channel or tunnel was cut from the exterior through the brick lining (marked 'secondary insertion' on the plans, Fig. 14) into the bowl of the furnace, and part of the vitrified lining at its back replaced with another roughly rectangular section of clay. The space behind this relined portion of the back of the furnace was filled with alternating layers of brick fragments and mixed, probably derived, red and yellow clay.

Slag-tapping hole. At least twice during its life the area of the furnace around the tap hole was completely restructured. The dome was cut away from the direction of the tapping hollow, and the sides relined with fresh yellow clay. The sequence of events can be clearly reconstructed from the deposits inside the tapping hollow, as follows: the first restructuring (marked AA in section C–D, Figs. 14 and 17) is contemporary with the fifth relining. On the SW. side this relining had been inserted in a cavity cut right into the side of the furnace, obliterating all the earlier furnace linings which, on the opposite side, still remained in position. This must have been one of the stages at which the slag-tapping hollow was completely cleaned out, since the bottom layer of charcoal shown in section C–D is plainly later than this episode. Towards the end of the life of the furnace the tap hole was again restructured and the channel from it to the tapping hollow relined with more yellow clay (marked BB in section C–D, Figs. 15 and 17). This latter relining was reinforced with broken Roman bricks incorporated into it at many points, and was burnt red on its inside faces to a depth of 20 mm. The tapping hollow must again have been cleaned out thoroughly at this stage.[20]

The furnace had evidently been fired about five times after this phase, until the last bloom was taken out and the structure abandoned. The successive layers of clay and charcoal with slag appear to have built up inside the furnace and slag-tapping hollow to a depth of about 150 mm; in this thickness it is possible to recognize a clear cyclical arrangement of successive deposits of:

(i) A thin layer of clay.
(ii) Charcoal with a little admixed slag.
(iii) Mixed slag, charcoal, burnt clay fragments and some brown earth.

The cycle was repeated at least three and possibly four times. This could be interpreted as representing successive stages of:

(i) Lining the tapping hollow to take the molten tap slag.
(ii) Smelting and the deposition of waste.
(iii) Partial dismantling of the superstructure and its refurbishing with a new clay lining.

These layers are described below. Layer numbers (a–z_b) correspond with those in Figs. 16 and 17.

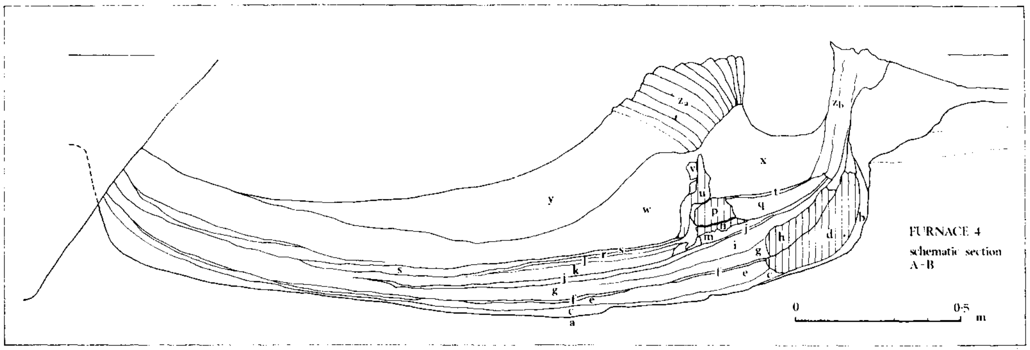


FIG. 16
Furnace 4: schematic longitudinal section as in Fig. 14 (see Table 8 in text)

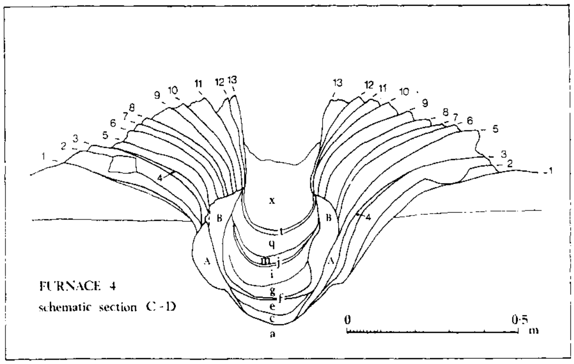


FIG. 17
Furnace 4: schematic lateral section as in Fig. 15 (see Table 8 in text)

A curious feature, which did not seem to be directly related to the main part of the furnace structure, was the markedly vertical-sided hollow in the SW. side of the slag-tapping pit. It was surrounded by a total of twelve stake holes, 40–50 mm in width, cut from different levels, though forming a roughly oval shape in plan (Fig. 14 and Pl. III, A). The hollow, and the stake holes themselves, were filled with almost pure charcoal. The whole was covered over with parts of the clay linings associated with both episodes of the restructuring of the tap hole of the furnace described above (A–A and B–B on section C–D, Fig. 8). This feature, including the stakes inserted in the stake holes, must therefore have been replaced or have gone out of use at an early stage in the use of the furnace. It will be suggested below that this formed part of the substructure of a bellows support.

Discussion

The design of this latest furnace showed a number of innovations over that of the earlier bowl furnaces. The inclusion of provisions for tapping slag introduced an altogether new factor, requiring a frontal arch which could be temporarily blocked and opened when the slag was liquid enough to run out. That it was the weakest part of the whole is shown by the fact that this area of the furnace had to be rebuilt at least twice. The addition of a permanent brick and clay backing to the furnace is also an advance in technique in response to the rather larger scale of operations which the slag tapping allowed.

TABLE 8

LAYERS WITHIN FURNACE 4

(Figs. 14–17)

Cycle	Layer	Layers in tapping hollow	Layer	Layers inside furnace	Comments
1	a	Natural clay bottom of hollow burnt red	b	Clay inserted around NW. end of furnace underneath and overlapping brick backing	Clay lining inserted after tapping hollow cleaned out. Layers immediately overlay first replacement lining in slag-tapping channel (AA in section CD, Fig. 15) and clay lining in interior of furnace
	c	Fragmented slag and charcoal	d	Large furnace bottom still *in situ*	
	e	Earth, burnt clay and charcoal	——→	(Continues into furnace)	
Probable considerable discontinuity (see discussion below)					
2	f	Thin patchy clay burnt red	——→	(Continues into furnace)	Contemporary with relining of slag-tapping hollow for second time (BB in section CD, Fig. 15)
	g	Fragmented slag and charcoal	h	Furnace bottom still *in situ*	
	i	Charcoal and slag mixed with earth and burnt clay	——→	(Continues into furnace)	
3	j	Clay (showing zones becoming more highly burnt towards furnace centre)	——→	(Continues into furnace)	
	k	Charcoal and slag			
	l	Earth and fragments of slag and burnt clay			
4			m	Clay, burnt red and grey	
			n	Formation of slag lump at position of slag-tapping hole	
			p	Slag lump solidified in position at exit of slag-tapping hole	
	r	Thin charcoal layer	q	Fragmented slag and charcoal	
5	s	Clay (showing zones becoming more highly burnt towards furnace centre)	t	Thin clay layer	Layer t continuous with inner face of slag and clay lump (z_b) at head of furnace against Roman bricks
			u	Formation of slag lump in position of slag-tapping hollow (v) showing solidified run into tapping hollow	
			v	Burnt clay surrounding slag lump (u)	Remains of slag-tapping hole still *in situ*
	w	Fragmented slag and charcoal	x	Fragmented slag and charcoal	Layers left after removal of bloom from furnace, and tap slag from hollow
	y	Fragmented grey and red burnt clay			Represents collapse of superstructure after abandonment of furnace
			z_a	Successive clay linings of interior of furnace	Represent build-up of deposits inside furnace
			z_b	Semi-vitrified clay, mixed with slag	

The final shape of the furnace, after the addition of thirteen new linings to its interior, was clearly far removed from its original design, ending up more nearly like a shaft furnace than a developed bowl furnace. Even in the final phases of operation the bloom must still have been removed by levering from above rather than by extraction through the tap hole. This was certainly the case after the last firing, when the tap hole had become blocked with the solidified slag (layer u) discovered still in position. This process contrasts clearly with the true Roman shaft furnaces in which the bloom and furnace bottom were invariably removed from the base through the tap hole. Although the furnace had been cleaned out a number of times, large lumps of slag in the bottom of the furnace had not been removed. The stratigraphical evidence (see Table 8) suggests that these were left after the firings following the relining of the slag-tapping channel.

Superstructure. Any reconstruction of the form of the superstructure must be based on the following observations. Firstly, the excavation of the earliest of the clay layers built up against the backing of Roman bricks and clay on the northern side of the furnace showed the charred remains of three stakes incorporated into it. These pointed up at an angle towards the rear centre of the furnace structure (Pl. III, G). Like those in the initial construction of the bowl furnace superstructres, these stakes must have provided support for a superstructure intended to be permanent. Secondly, the disposition and extent of the burnt clay linings inside the furnace (see Fig. 15 for the extent of lining no. 2) show that there must have been three apertures, apart from the slag-tapping hole and the top vent: one each at the W. and E. sides (on the line of section C–D, Fig. 15) and another in the front (to the S.) situated *above* the slag-tapping hole. Only with these apertures would it have been possible to reach into all the parts of the furnace without breaking open at least part of the superstructure. The distance from the bottom of the furnace to the side and front openings cannot therefore have been greater than about 0.8 m, the reach of a man's arm. The upper part of the superstructure would have been relined, if necessary, from the top vent.

The apertures at the side would have provided openings for the insertion of tuyeres. The existence of a further aperture at the front, with the bellows operated from the western side of the furnace, is suggested by several considerations. Firstly, the concentration of stake holes on the western side of the slag-tapping hollow near the furnace (Fig. 14) can best be interpreted as the remains of a support for a part of the structure whose operation required extra stability. Excavation on the line of section E–F suggested that the original stakes could well have been capped by some Roman bricks, the whole probably encased with clay. Secondly, the interpretation of this as a bellows support explains the marked asymmetry of the plan of the furnace: the N.–S. axis of the furnace proper is aligned with these inferred bellows on the edge of the slag-tapping hollow, rather than with the long axis of the tapping hollow itself.

Evidence has already been given that the tapping hole was restructured at least twice (section C–D, Fig. 15), and that its level at the final firing was about 350 mm higher than at the beginning of the furnace's life (see section A–B, Fig. 14). The possible renewal of the front bellows support structure during the life of the furnace must also have accompanied the renewal of the tap hole, and with it at least a part of the superstructure's front (as shown by the build-up of linings on the S. side of the furnace, shown in section A–B, Fig. 14). At possibly the same time as one of the phases of renewal of the superstructure, the back of the furnace was broken into (the 'secondary insertion' in Fig. 14; see also above), either to act as a secondary or replacement blast aperture, or more probably to repair some of the interior lining of the back of the furnace. Whatever its function, it was blocked up before the end of the furnace's life.

CONCLUSIONS

The stratigraphic relationships of at least the three larger furnaces demonstrate a clear sequence of construction and operation, from which certain inferences can be drawn concerning the development of industrial processes on the site.

The larger furnaces, 2, 3, and 4, clearly represent two stages in a line of technological advancement. The latest furnace, 4, was constructed from the beginning to provide slag-tapping facilities, a development of fundamental importance.[21] The short period of disuse of the immediate area of excavation (period 2*ciii*) was terminated by ironmasters who knew of the developed bowl furnace — either from a continuing local tradition, here temporarily eclipsed, or more probably from the rediscovery of a process lost since the end of the Roman period. This development also embraced the knowledge that smaller furnaces would have been more efficient. Even the bowl furnaces 2 and 3 would have operated quite satisfactorily after the build-up of linings inside them. The latest furnace, 4, was built from the start with a smaller volume than the bowl furnaces, and was clearly worked until the relinings had decreased the volume to a point where the furnace was no longer useable. In its final stages it would have operated rather like a shaft furnace, with a narrow and probably cylindrical shaft, 250 mm in diameter, which might possibly have reached a height of about a metre.

The close similarities in basic methods of construction and relining of all the furnaces might be taken to suggest that the principles learnt in the operation of the bowl furnaces were applied after no great lapse of time to the design and construction of the more efficient unit represented by the latest furnace. Since Ramsbury is the first site to produce evidence of any early 9th-century developed tradition of iron smelting in England, it might even be that this was a new discovery at the time, worked out by an intelligent appreciation of new possibilities always inherent in basic techniques. The furnace complex at Ramsbury is therefore important both in its own right, and as an indicator of the possible significance of Ramsbury in the 9th century, which will be discussed in Section 9 below.

SECTION 2: THE ARTIFACTS

The artifacts comprised four main groups:

1. Pottery, both Saxon and Roman.
2. Clay loomweights.
3. Imported lava querns.
4. Objects of metal (bronze and iron).

POTTERY (Fig. 18)

Thirty-six sherds of Saxon pottery were recovered, all of them small, which represent a minimum number of twelve vessels, five represented by a single sherd each. All are from hand-made vessels varying from 4 to 10 mm in thickness, unevenly fired to shades ranging from orange to dark grey, and tempered to varying degrees with chaff. Occasional fragments of flint are probably naturally occurring inclusions in the clay. Half the vessels were burnished on the exterior, from the basal angle upwards, sometimes carried over to the interior of the rim. Some are clearly from quite substantial vessels: one rim (Fig. 18, no. 1) has an approximate diameter of 180 mm, and some of the sherds are from vessels with an even larger body diameter.

Twenty-four of the sherds, representing ten vessels, were from period 3*b* layers 55 and 41, associated with loomweights, lava querns and many of the metal objects (see below), including the two strapends. Eleven sherds, representing two vessels, came from period 2*a*

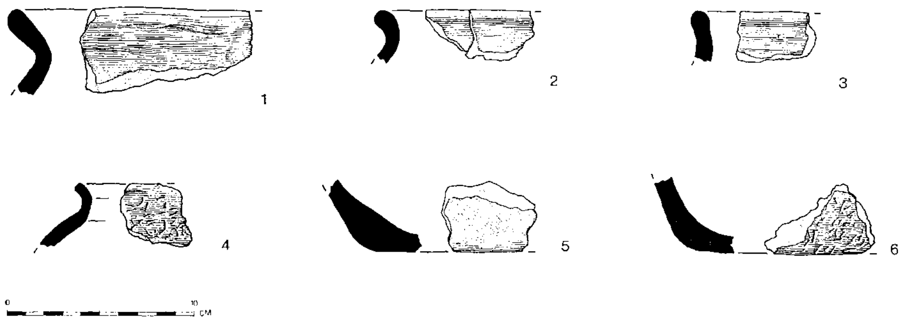


FIG. 18
Pottery (Periods 2 and 3*b*): 1–4, rims; 5, 6, bases. Scale 1 : 4

layer 97. One sherd from period 2*a* layer 121 came from a vessel of which five sherds were found in 3*b* layers. There is no evident pattern of variation in vessel types through the period sequence. Since, however, it is argued that the period of use of the site was comparatively short, the pottery forms a single group which other evidence (see Section 6) suggests falls into the late 8th and early 9th centuries.

As a group this pottery is comparable to much of the 5th to 8th-century material recently recovered from Saxon domestic sites in Swindon Old Town (17 km to the NW.).[22] Many of these vessels are larger than those from Ramsbury, and the earlier ones in particular are rather more carefully made. The finds from Ramsbury carry this pottery-making tradition into the early 9th century,[23] though on a level of sophistication which contrasts unfavourably with the earlier material from Swindon. Fabric 1 at Ramsbury (see Table 9) has been identified at Swindon.

LOOMWEIGHTS (Fig. 19)

Two complete and two partially complete loomweights were recovered from layer 55 (period 3*b*). They are of the standard size or shape. All four are in fabric 1 with the addition

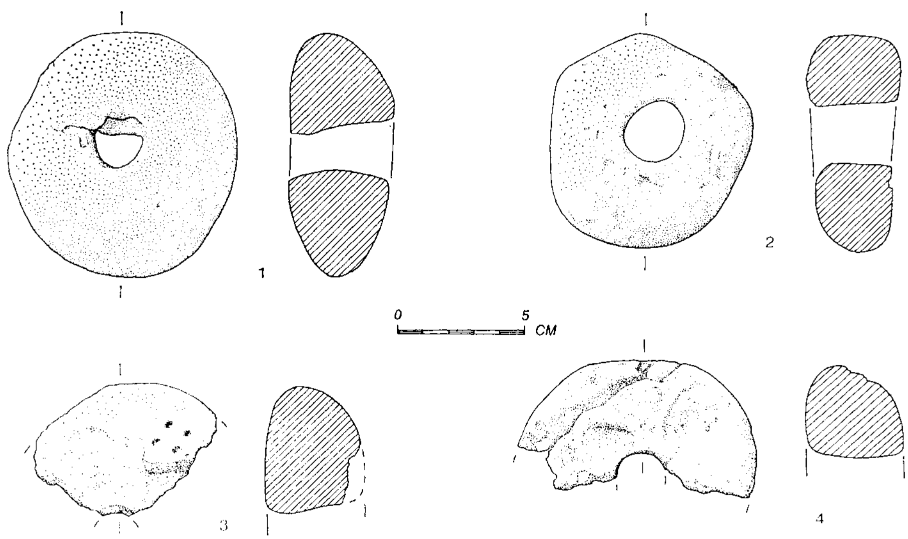


FIG. 19
Loomweights (period 3*b*). Scale 1 : 3

of flint fragments (samples 14–17, Table 9 below). Number 4 bears the impressions of large rounded stones on its surface, no. 2 has a few burnt out impressions of vegetable matter on the surface, while no. 3 has four holes arranged in a square made by a pointed stick with five sides.

PETROLOGICAL REPORT. By ANDREW D. RUSSEL (*Dept. of Archaeology, University of Southampton*)

The pottery, loomweights, six fragments of brick and one piece of fired clay were examined X-radiographically (at the Ancient Monuments Laboratory), macroscopically, and microscopically. The X-radiographs suggested a division into two fabrics on the presence or absence of iron ore (opaques) and this was confirmed by thin-sectioning seventeen samples.

The sherds were also examined under a binocular microscope which revealed a minimum number of twelve vessels, with five vessels each represented by a single sherd.

Six fragments of fired clay were analysed. Five fragments in fabric 1, with a hard, well fired, badly wedged light orange and pink oxidized fabric, probably represented Roman bricks. The sixth (sample 8) was reduced grey on one side, black on the other. Pieces of iron ore or slag adhered to the black surface, which also bore the impression of burnt-out plant material. This was probably part of a furnace lining.

TABLE 9
ANALYSIS OF CERAMICS

	FABRIC 1													FABRIC 2			
Material	Pottery						Fired Clay	Brick (Roman)		Loomweights				Pottery			
Sample number	1	2	3	4	6	13	8	9	10	14	15	16	17	5	7	11	12
Layer	55	41	121	97	97	41	55	55	55	55	55	55	55	55	41	41	55
Iron ore	×	×	×	×	×	×	×	×	×	×	×	×	×				
Mica	×	×	×	×	×	×	×	×	×	×	×	×	×				
Chalk				×	×	×				×	×	×	×				
Collophane				×	×					×							
Organic material	×	×	×	×	×	×								×	×	×	×
Well-sorted quartz	×	×	×	×	×			×	×	×	×	×	×				
Unsorted quartz						×	×							×	×	×	×
(× = present)																	

Fabric 1 is probably from the clay source nearest to the site. The loomweights were made in this fabric, and one would expect them to be made from the most convenient clay, as it is only needed for its weight, and its firing and working characteristics are not important. The most likely source is the Clay-with-Flints which underlies and surrounds the site (see Fig. 24). This clay is formed from Eocene deposits that have been leached down and redeposited around the flints of the dissolved chalk below them.

Fabric 2 had no distinguishing characteristics microscopically so a heavy-mineral analysis was conducted with one sherd from vessel 10 (sample 12). This yielded Tourmaline, Andalusite and Zircon in approximately equal quantities, with Kyanite and Staurolite present. This points to a Tertiary deposit, and Clay-with-Flints and Reading Beds have this mineral suite. The lack of chalk in the fabric, and the unsorted quartz, make the Reading Beds the most likely source. Deposits of these are noted as outliers of the Clay-with-Flints to the S. and E. of Ramsbury, the nearest being just S. of Chilton Foliat in Brickkiln copse (SU 321695), within 5 km of Ramsbury.

LAVA QUERNS (not drawn). By DAVID F. WILLIAMS (*DoE Ceramic Petrology Project, University of Southampton*)

Several small fragments (from period 3*b*, layer 55) and one large fragment (unstratified) of querns were composed of a grey, fairly coarse, vesicular basaltic lava, containing conspicuous dark phenocrysts of augite. In thin section the most prominent minerals are green or occasional colourless clinopyroxene, mainly augite, set in a groundmass of small lath-shaped crystals of andesine/labradorite felspar, opacite and some xenomorphic nepheline. The composition and character of the minerals is paralleled in the basaltic lavas of the Mayen-Niedermendig area of the Eifel region, and the Ramsbury lava querns were undoubtedly imported from this part of Germany. It is difficult petrologically to differentiate between a source at Mayen or Niedermendig, though on archaeological grounds it seems likely that the early date of the Ramsbury samples indicates that they originated from the Bellerberg lava flow near Mayen.[24]

The significance of these finds is discussed below (Section 9).

OBJECTS OF BRONZE AND IRON

Description and discusssion. By VERA I. EVISON (*Birkbeck College, University of London*)

Bronze objects (Fig. 20)

Key (no 1) (see also Pl. I, B, c). The head of this bronze key is in the shape of a pointed oval, and this is one of the forms common in the Carolingian period on the Continent and in Scandinavia, although the oval is usually a metal contour only, or ornamented with

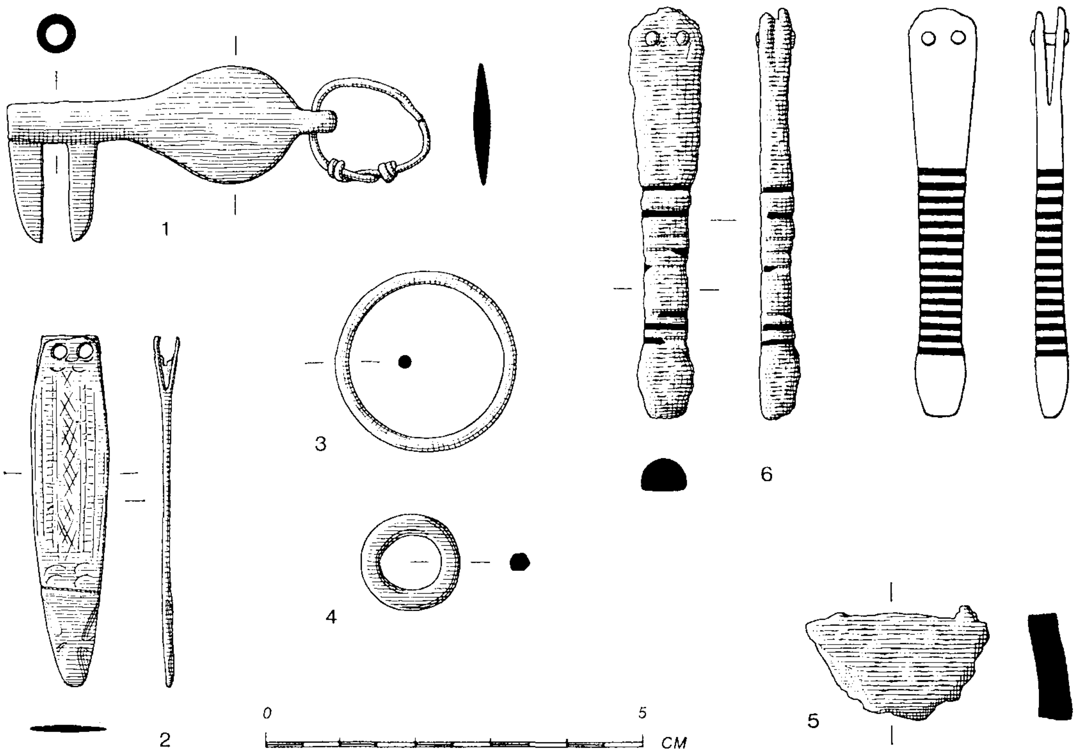


FIG. 20

Objects of bronze: *1*. Key (Context 82, period 2*b*. See also Pl. I, B, c); *2*. Strapend (57, 3*b*. Pl. I, B, b); *3*. Ring, rounded section (50, 2*a*); *4*. Ring, hexagonal section (55, 3*b*); *5*. Scrap (100, 2*cii*). Object of iron: *6*. Strapend, inlaid with silver (55, 3*b*. Pl. I, B, a). Scale 1:1

openwork designs.[25] Some small bronze keys with solid heads are known in England, however, two from Whitby, and one from Finsbury Circus, London.[26] On two of these the head is more angular or lozenge-shaped, but the third one is a more regular oval. The small suspension loop at the top on all four is cast at right angles to the plane of the head, and this appears to be a peculiarity of Anglo-Saxon keys,[27] for on continental keys the loop, when present, is in the same plane as the head. The wards of the keys from Whitby and Finsbury Circus are more complicated, with projections on the wards. The two extensions of the Ramsbury key ward, however, are simple, and in a good state of preservation so that it is certain that nothing has been lost by wear or decomposition. A precise date cannot be arrived at, but occurrence at Whitby puts the type between A.D. 657 and 867, and as the expanding wire suspension loop on the Ramsbury key is the same as many encountered in pagan period graves, the earlier part of this two-century span is to be preferred.

Strapend (no. 2) (see also Pl. I, B, b). This strapend is one of the series well known and firmly dated at least to the period between the middle of the 9th century and the beginning of the 10th century.[28] The coin evidence associated with the type at Sevington, Trewhiddle, Talnotrie and Cuerdale shows that the oval form, widespread throughout Britain, was in use during this half century. No doubt some were also manufactured after this date, and at the other end of the scale it now seems to be possible to distinguish some examples of the 8th century, e.g. at Walton, Bucks.,[29] deriving from forms probably in use at the end of the pagan period. An 8th-century style of animal ornament has been noted by E. Bakka on the strapends from Østebø, Rogaland, Norway and York.[30]

The shape of the Ramsbury strapend does not conform fully to the wide oval shape of the Walton type, but its other characteristics are similar. The size is much the same, and the shape differs only in having a shallower curve to the sides and a less pointed animal head terminal. Like the Walton piece and the others of its kind, the animal head is rather flat and featureless, and the decoration of the main part is geometric and simple. A middle panel of crosshatching is enclosed within a pair of barred borders. It is possible that these incisions wre intended to provide a backing for the application of a silver decorative sheet — in fact it is possible that one was originally applied, but that constant wear has disposed of all sign of it and has worn the bronze surface nearly smooth. Arc stamps near the perforated end represent the trilobed palmette present in relief on some of the more ornate strapends as at Whitby.[31] The double row of inverted arc stamps above the animal head represent the lunate ears in relief on these specimens.[32] Arc stamps are used in this way on the butt end on some of the Walton type, e.g. on one from ?Felixstowe in Norwich Museum. Three other strapends are sufficiently similar to be regarded as products of the same workshop as the Ramsbury strapend. One was found at Bradwell in Essex.[33] All the features of this are the same except that there is a triple row of arc stamps for the ears, and the borders of the hatched middle panel are composed of arc stamps instead of straight lines. It is said to be inlaid with silver. One with arc stamps representing both ears and palmette was found in the cemetery at Saffron Walden, Essex.[34] Another was found more recently at St Neots, Hunts., and this also has double arcs denoting ears as on the Ramsbury strapend. It was stated that the St Neots strapend could be assigned typologically to the 10th century.[35] However, there is no feature on any of these four bronze tags which could be regarded as definite proof of a date before, during or after the period of the second half of the 9th century when the more ornate kind is known to have been in use. In fact, the existence referred to above of a comparably simple series with geometric decoration in the 8th century would appear to attract them towards that grouping. Against this reasoning it might perhaps be proposed that the borders of the middle panel of the Ramsbury strapend which are divided into squares might be an imitation of the coarse beading found in some, e.g. from Whitby,[36] but this could be dismissed as improbable for the resemblance is but faint and the lines are straight and make no attempt to follow the curve of the outer edge as do the beaded borders. None of the features or associations mentioned above, therefore, provide a precise date, and for all of these strapends the 8th century is just as likely as the 9th.

The two *bronze rings* (nos. 3–4) are types often found in pagan graves where they were used for suspension of keys, etc.

Iron objects. By VERA I. EVISON

Strapend (no. 6) (see also Pl. I, B, a). This is the first iron strapend inlaid with another metal to be found, but it will hardly be the last now that radiography is being applied extensively to excavated ironwork. The only similarities to the other strapend are in size and the vague shape of an animal-head terminal. For the rest, the sides are more or less straight, the section is flat near the split end and semi-circular in the middle where it is inlaid with transverse silver strips over the upper surface (see below, p. 40). Regarding technique, silver inlay on bronze strapends is fairly common at this period, and silver, bronze and copper inlay was currently used by Anglo-Saxon smiths on ironwork such as seaxes.[37] While the oval form of the other strapend discussed above is peculiarly Anglo-Saxon, a form with parallel sides, although sometimes still with an animal-head terminal, was favoured on the Continent and in Scandinavia. There are also a few in this country.

Two rather more ornate strapends with straight sides were found at Bledlow, Bucks., and Winchester, Hants.[38] Another with facetted cross section found at Meols, Cheshire, has been compared with one in the National Museum of Ireland,[39] and these two match the strapend from ?Goswick,[40] in having a single rivet hole, an animal head at each end and facetted middle. The strapend from St Mary's Abbey, York,[41] shares these features, but they are carried out in a more rounded relief. Other related straight-sided strapends occur abroad, with animal-head terminals in Iceland, and transverse moulding at Birka.[42] A related kind of strapend from Meols is close to the Ramsbury inlaid strapend as half of the middle part is taken up with transverse moulding.[43] A strapend in Chichester Museum is flat and expands at the butt, but the middle part is narrower and semi-circular in section, and finishes in an animal head. Even closer is a neatly-made strapend from Caistor-by-Norwich in Norwich Museum with an animal head terminal, flat butt end with one rivet hole, and the middle part semi-circular in section with transverse moulding. A fair match to this was found in grave 1059 at Birka,[44] and another of the same type, together with related versions without zoomorphic terminals, occurred at Hedeby.[45] The Borre type animal-head terminal of some of the Hedeby tags established their Scandinavian origin.[46] One simple strapend without an animal head found at Hedeby retains its casting marks, which suggests that this particular variety was being made at that site.[47] A bronze strapend closely similar in size and form to the Ramsbury example was found at Cheddar, and this is attractively designed with a finely-shaped animal-head terminal and an elegant biting animal on the flat section near the butt.[48] Two simplified versions with a pair of rivet holes in a flat butt end and transverse markings on a rounded middle part were found at Portchester and Maxey,[49] the Portchester example showing indications of an animal-head terminal. Many of these strapends, like the iron one from Ramsbury, show transverse line decoration which might be a legacy from an early stage of construction when the strapend consisted of two pieces of metal bound together by twine or wire, with the material of the strap held in between.

This Ramsbury strapend is no more closely datable than the other, although it is more likely to belong to the 9th century in view of the types of animal ornament on comparable pieces. It is associated on the one hand with a type with parallel sides and zoomorphic terminal found in areas of Viking contact — in Yorkshire, Cheshire, Ireland and Iceland, and on the other hand with a simpler variant of semi-circular section found further south in this country at Caistor-by-Norwich, Chichester and Portchester. Both these types turn up in the trading stations of Hedeby and Birka. The makers of strapends in Viking and Anglo-Saxon territories were obviously well aware of each other's merchandise.

The rest of the iron can be divided into groups of tools, utensils, fittings, and unfinished objects or scrap. The recognizable items have forms that hardly change over the

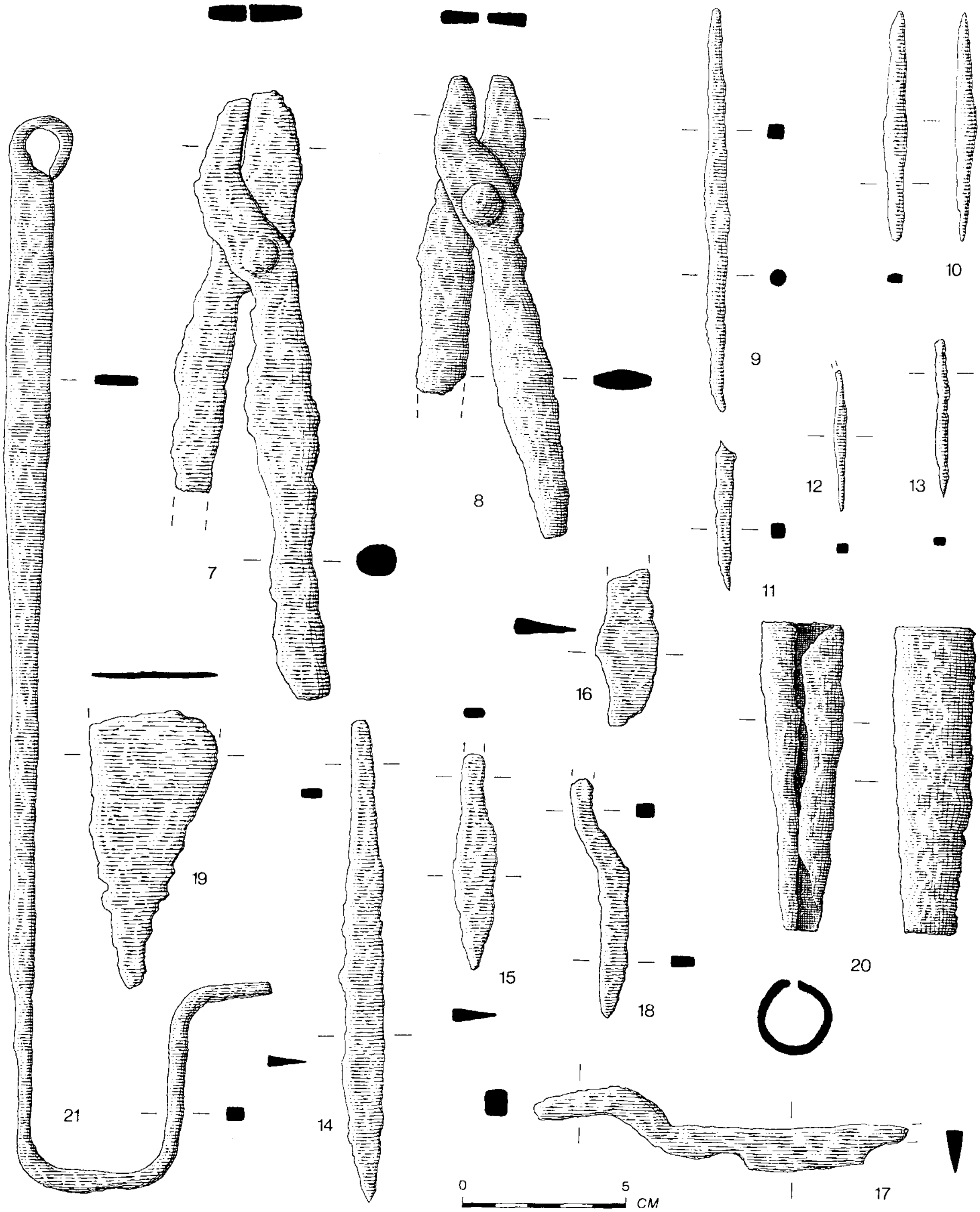


FIG. 21

Objects of iron: *7.* Pair of tongs (Context 82, period 2*b*); *8.* Incomplete pair of tongs (55, 3*b*); *9.* Awl (55, 3*b*); *10.* Awl (37, 2*d*); *11.* Awl (55, 3*b*); *12.* Awl (60, 2*d*); *13.* Awl (71, 2*ciii*); *14.* Knife (55, 3*b*); *15.* Knife (45, 2*ci*); *16.* Knife (55, 3*b*); *17.* Drawknife (43, 3*b*); *18.* Drawknife fragment (37, 2*d*); *19.* Scraper (82, 2*b*); *20.* Ferrule (67, 2*ciii*); *21.* Pot hook (63, 2*e*). Scale 1 : 2

centuries, so that they cannot be precisely dated. Many of them can be traced in the Roman and later medieval periods, and some have been found in Saxon contexts.

TOOLS

A pair of tongs (no. 7) with a long grip, suitable for working hot metal. Similar tongs are known from Roman Britain, and a variety from Viking contexts.[50] A Saxon one was found at Shakenoak, and one occurred in a pagan Saxon male grave at Sibertswold in Kent (grave 115) with a spear, shield and knife.[51] The two parts of the head of the Ramsbury tool are of different shape and of unequal length, and the tongs must have been used for some specialized purpose.[52] A different form of unpivoted spring tongs are amongst the river finds from Old London Bridge,[53] and it has been noted that fire-tongs are amongst the tools listed in the *Gerefa* as being necessary on an estate.[54] Number 8 is another, incomplete *pair of tongs*.

There are several *awls* (nos. 9–13), and these are known from other Anglo-Saxon contexts, e.g. Shakenoak.[55] Two with the wooden handles still attached were found at York.[56]

Knives (nos. 14–16). Knives of the kind at Ramsbury are commonly found in pagan Anglo-Saxon graves as personal possessions of men, women and children. The three found here might be regarded as tools; the long slender shape of no. 14 and the diminutive size of no. 15 suggests that they were designed for specially delicate work.

Drawknives (nos. 17 and 18). Two drawknives from Anglo-Saxon contexts have been noted to date, from Sandtun in Kent, and possibly from Westley Waterless, Cambs.[57] The Sandtun drawknife is a type which has the tangs curved away from the blade. No details of the fragments from Westley have been published, and its size makes its identification as a drawknife doubtful. Various kinds occur in graves of the Merovingian and Viking periods in Norway, and one illustrated by Petersen from Markestad, Vang, Hedmark[58] has tangs in the same line as the blade, the same positioning as on the Ramsbury knife. Possibly the bent iron bar (no. 18) is a partly made, broken drawknife.

Possibly a *scraper* (no. 19) — compare a similar object from Shakenoak[59] in a late 4th-century deposit.

Ferrule (no. 20) for a wooden pole, probably part of a tool. The ferrule is conical and unwelded, flattened sideways at the tip, cf. ferrules from Shakenoak.[60]

UTENSILS

A long hook with suspension ring (no. 21) might have been the lowest element of a *pot holder chain*, a piece of kitchen equipment which altered little from the Iron Age to the medieval period. Some have been found in pagan Anglo-Saxon graves, for example at Holborough, Kent.[61]

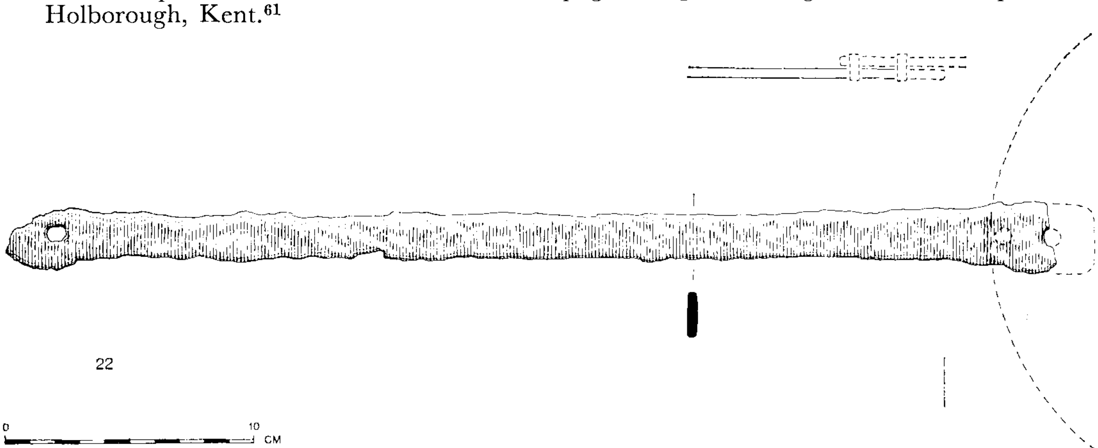


FIG. 22

Iron frying-pan handle (Context 57, period 3*b*). Scale 1:3

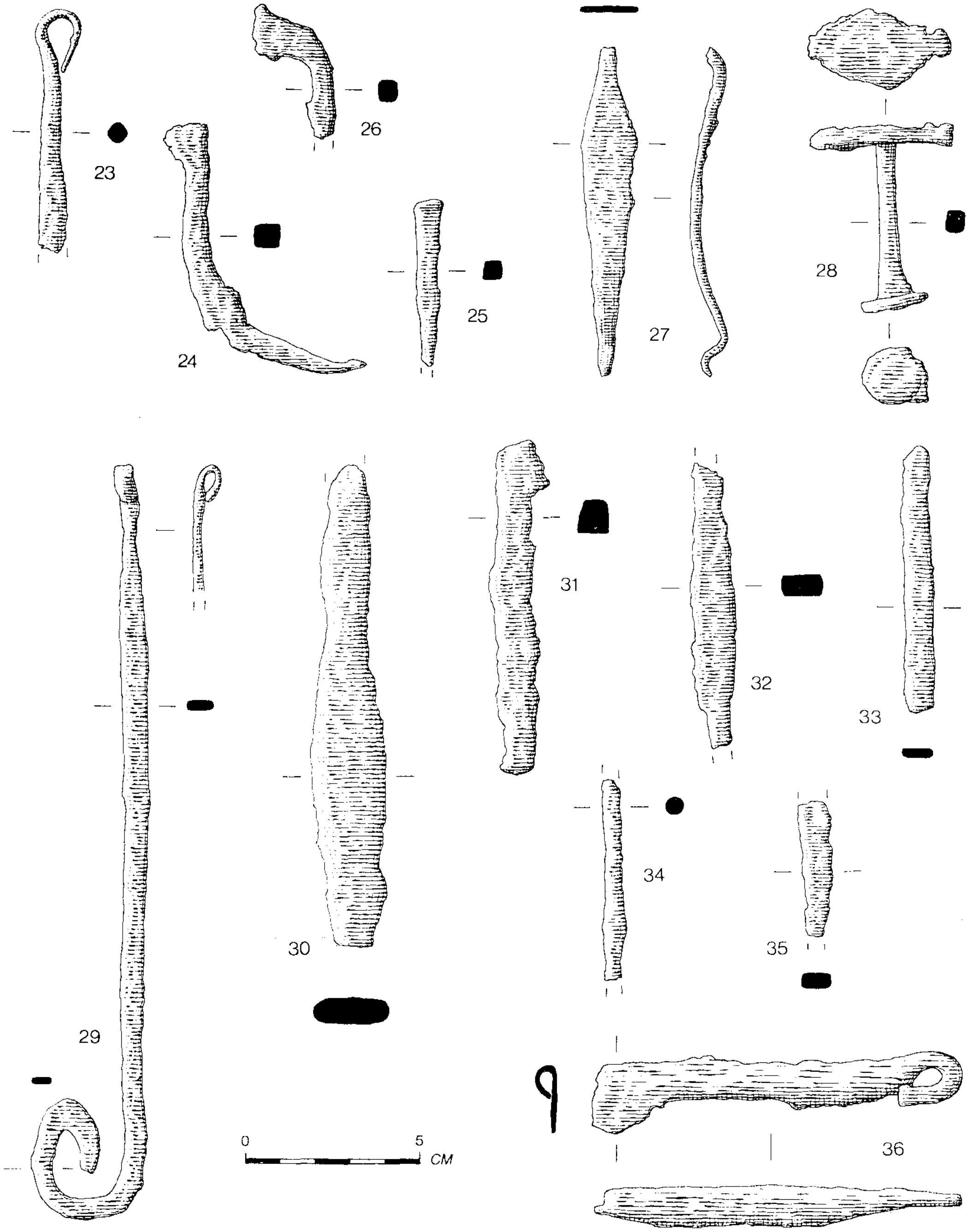


FIG. 23

Objects of iron: *23*. Clapper of a cowbell (Context 57, period 3*b*); *24*. Nail (55, 3*b*); *25*. Nail (55, 3*b*); *26*. Nail (60, 2*d*); *27*. Curved fitting (55, 3*b*); *28*. Clench bolt (55, 3*b*); *29*. Bar with loops (55, 3*b*); *30–35*. Unrecognizable objects (43, 3*b*. 71, 2*ciii*. 71, 2*ciii*. 58, 3*a*. 55, 3*b*. 58, 3*a*); *36*. Knife or cleaver with hollow handle (55, 3*b*). Scale 1 : 2

A hook closely resembling this one in form was found by Lethbridge at Shudy Camps (grave 76) where it was taken to be a key. As, however, it was found with a large iron ring, about nine inches of iron chain and a second iron rod, these various items must have been joined together, making up a pot-holder chain over 70 cm long.[62]

The long iron bar perforated at one end (no. 22) was riveted to iron sheet at the other end, and so could have been the handle of a *frying pan*. Many of these have been found in Viking and earlier graves in Norway, and the pan is sometimes quite flat, as this one would have been.[63]

Part of a *clapper from a cowbell* (no. 23), cf. Shakenoak.[64]

There are various *fittings* probably for use on wooden objects, on houses or boats, for example *nails* (nos. 24–26) and a *curved fitting* (no. 27). A *clench bolt* (no. 28) with hemispherical head and diamond-shaped rove is similar to rivets used at Sutton Hoo for the boat in Mound 2,[65] and for the ship in the ship burial.[66] The Ramsbury clench bolt penetrated wood 45 mm thick, and this roughly corresponds to the span of some of the Sutton Hoo rivets. This kind of rivet seems to have been in more general use in woodwork of the Saxon period, however, for it was noted in graves at Bifrons in Kent, presumably as coffin fastenings.[67] Use in the construction of large timber houses is illustrated by the positions of such rivets along the walls of Buildings A 1(c) and A 3(b) at Yeavering. These buildings belong to Phase V A.D. 651–*c*.685, and the clench rivets used there penetrated wood from 1½ in. (38 mm) to 3¾ in. (95 mm) thick.[68] Isolated clench rivets have turned up in other settlement sites, in a pit at Cox Lane, Ipswich,[69] and at Site 11 at Southampton.[70]

A *bar* (no. 29) with a loop at one end and an ornamental scroll at the other is similar to a modern window fitting, that is, it could have been used for pushing open a shutter or for some such function. An identical bar found in a sealed Saxon pit containing a well at Portchester Castle was described as a latch lifter, but this is unlikely as the ornamental scroll forms a grip and the opposite end is turned over at right angles into a ring for attachment to another fitting.[71] The Portchester fitting belonged to Phase 3c of the pit when the well was falling into disuse, and which is ascribed to the ninth century.[72]

A *handle* (no. 36), with a terminal suspension loop, for some kind of *knife*. The handle is constructed of rolled sheet iron, which continues in one piece to form the blade. This construction can be seen in Roman knives and cleavers from Housesteads,[73] but it does not yet seem to have been found in Saxon contexts.

A number of the unrecognizable items have the appearance of being partly-made objects, for example, nos. 31 and 33, and no. 30 which might have been destined to become a spear-head. Unfinished articles also formed part of the hoard of iron of the Viking period which included a seax, a bearded axe, chisels, etc., on the site of a probable burnt rectangular house at Crayke, Yorkshire.[74]

Metallographic, chemical and microscopical examination. By R. F. TYLECOTE (*Institute of Archaeology*), M. CORFIELD (*Conservation Officer, Area Museums Service, Wiltshire County Council*), L. BIEK (*DoE Ancient Monuments Laboratory*) and S. R. WYLES (*Laboratory of the Government Chemist*)

Three of the 'bronze' and eight of the iron objects were selected for metallographic examination. Small samples were cut, mounted and examined in the usual way, and in addition the mount of the three 'bronze' samples was studied under the analytical scanning electron miscroscope (SEM).

'BRONZE' OBJECTS

1. Key with hollow shank, on wire loop.

A piece was removed from the head. In the unetched state it showed evidence of slag or sulphide inclusions. It is lead-free. After etching there were signs of quite severe surface corrosion penetrating the deformation markings. Over most of the section it shows a typical annealed structure of an alpha solid solution, but there are traces of the residual as-cast cored structure. There is a little of the delta tin-rich constituent, showing that the annealing treatment has not been sufficient to dissolve all this phase. The hardness is 114 HV, which reflects the cold work. This appears to be a worked bronze with a tin content of the order of 5%, there being no significant quantity of zinc present. This key is clearly a casting which has been finished off by annealing and some cold work.

2. Decorated strapend.

Traces of leather still remain between the two halves of the divided end.

3. Ring with rounded section and soldered ends.

There is a line of porosity just under the surface. It is lead-free. Etching proved much more difficult than on the key (no. 1), so it must have a much higher zinc content, therefore qualifying as a brass rather than a bronze. It shows a fully annealed, twinned structure with equiaxed grains and no coring. There is no sign of final cold work. The surface porosity was explained by dezincification leaving precipitated islands of copper-rich material with a hardness of less than 51 HV (25 g). The general hardness was 87 HV. This is clearly a piece of annealed brass with a higher zinc content but less than 30%. SEM analysis shows tin to be absent, and suggests a copper:zinc ratio of the order of 2:1.

5. Bronze fragment.

This appears to be a piece of scrap metal. It suffers from severe intercrystalline corrosion, with slag/lead within the grain boundary corrosion deposit. The grains are equiaxed and there seem to be traces of markings due to deformation which would have accelerated the corrosion. These were accentuated throughout on etching and it is clear that this piece has been heavily cold worked, as reflected by the hardness of 178 HV in the centre of the residual grains. The structure indicates a cold-worked alpha solid solution in a *c.* 10% tin bronze (from SEM analysis).

DISCUSSION

As in material from Helgö,[75] there is a high zinc content in copper-base metal from Ramsbury. The brasses and the ternary copper–zinc–tin alloys, known as gunmetals, make their appearance in the Roman period,[76] but are much rarer in immediate post-conquest Britain. It is clear from the extent of the corrosion penetration that the soil conditions were not very benign and, as usual, it is the worked structures that have suffered most. The key has been finished by planishing, so that quite a lot of cold work shows in the microstructure. This would no doubt have given a stronger and more durable key, although there is little or no sign of use in its well-made and crisp outline.

IRON OBJECTS

6. Decorated strapend.

The inlaid silver strips are on average 0.5 mm wide but show variations in width, both along their length and between themselves, from 0.3 mm to 0.7 mm. Only the curved front of the strapend is inlaid, with separate strips clipped neatly over the plain flat back, where they show rounded ends. They are laid at a slight angle that is noticeable particularly in the three lowest strips surviving. This may have been intentional, suggesting a more elaborate (and expensive) design with a single continuous strip wound round the strapend in a spiral. The x-radiograph shows thirteen certain grooves, with a possible one at top and bottom. Nine of these grooves contain silver, three of them complete strips, the rest parts or traces.

9. Awl.

A section was cut through the middle of no. 9. The section showed a diagonally-placed layer of pearlite enclosed by ferrite-and-pearlite with a widmanstatten structure. The dark etching pearlite or bainite, which was not resolvable and therefore not very slow-cooled, had a hardness of 370 HV. The high-carbon central zone shows little evidence of slag lines in its well-defined borders; but the lower-carbon zones are unlikely to be products of decarburization. This tool would seem to be an example of intentional steeling.

12. Awl.

This showed ferrite with areas of ferrite-and-pearlite, with much fine slag. The pearlite was not resolvable, which shows relatively fast cooling. The hardness of the ferrite is 205 HV, which suggests a fairly high phosphorus content.

14. Tanged knife.

A section was cut through the centre of the blade of what was clearly a very well heat-treated knife. This showed it to be an example of Tylecote Type B,[77] with a steel edge welded to a mainly ferrite back. The cutting edge is tempered martensite with a hardness of 830 HV, joined with a wide ferritic zone through which carbon had diffused to give some martensite with a hardness of 270 HV. One side of the back is ferrite with a hardness of 200 HV, while the other is ferrite-and-pearlite with a hardness of 178 HV.

17. Drawknife.

This rectangular sectioned tool has been steeled by welding-on a piece of steel to one geed retaining the square section. The steel has been heat-treated to give tempered martensite with a hardness of 740 HV, and the rest of the tool is ferrite with some pearlite in places. The hardness of the ferrite is 165 HV which suggests the presence of some phosphorus. There are some signs of 'white lines' at the junction of the steel and iron but much less than in the case of no. 14.

18. Drawknife.

Unlike the above, this was not a steeled tool. Like awl no. 9 this could be divided diagonally, giving a ferritic area with some pearlite in places in which the ferrite had a hardness of 234 HV, and another area in which there was some carburization of the ferrite and which had been subsequently quenched to give a dilute martensite with a hardness of 312 HV. Whether this had been done deliberately is not certain but it would certainly make one of the right-angled edges more useful as a scraper.

21. Pot hook.

A piece was removed from the largest cross-section near the middle of the length. It consisted of ferrite-and-pearlite with about 0.2% carbon for the most part, with areas of pure ferrite. The latter has a hardness of 200 HV. The pearlite was lamellar to spheroidal suggesting slow cooling through the 700°C range. It is unlikely that it was in the 600–700°C temperature range during use; but if it was, this would be another way in which such a structure could be developed.

25. Square-sectioned headless nail.

This has a banded structure of ferrite-and-pearlite alternating with pure ferrite. The hardness of the latter is 160 HV. The ferrite-and-pearlite contains about 0.1% carbon.

28. Clench bolt.

A piece was removed from the shank. This had a very variable but most probably accidental structure. There were areas of ferrite with a hardness of 185 HV; there was some ferrite-and-pearlite, some of which seemed to have been quenched to give martensite or bainite with a hardness of 330 HV.

DISCUSSION

The ferrous tools show a generally high level of workmanship. One of the awls (no. 9) seems to have been intentionally steeled but not heat-treated, at the centre at least. The cutting knife (no. 14) was steeled and heat-treated to give a very hard edge. One of the drawknives (no. 17) was likewise steeled and heat-treated to give a good scraping edge. Many of the cutting tools appear to have been properly heat-treated, while the rest of the ironwork has the usual structures associated with heterogeneous bloomery iron.

Of course one cannot say that this material was made at Ramsbury, but the moderate phosphorus content that is clearly present — probably about 0.2% — would fit one of the nearest types of ore body at Seend which has about 0.64% P_2O_5.[78]

SECTION 3: THE ANIMAL BONES

By JENNIE COY (*DoE Faunal Remains Project, University of Southampton*)

A detailed analysis of the material in the Saxon deposits from periods 2 and 3*b* was undertaken and results compared with those from Saxon Southampton (Hamwih), an urban site of contemporary date. Period 4*b* produced a much smaller mixed sample and was studied in less depth.

METHODS OF ANALYSIS

Identifications were taken to species where possible; otherwise the wider categories shown in Table 10 were used. Categories for least identifiable bones are on the left and those for the most identifiable on the right. Fragments from large species may be identified at three levels:

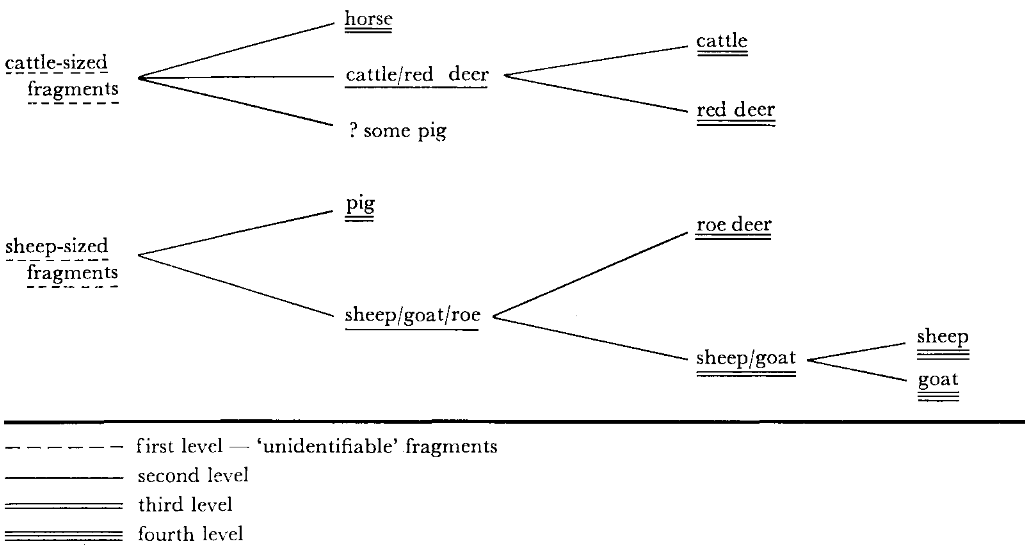
(i) They can be classified as 'cattle-sized fragments' when it cannot be ascertained easily whether they come from horse, cattle, or red deer (although such fragments are not identifiable to species, the anatomical elements can often be identified).

(ii) They can be classified as 'large artiodactyl', which at Ramsbury means cattle/red deer.

(iii) They can be taken to species where anatomical distinctions exist.

Division of material from Melbourne Street, Hamwih, at Southampton Archaeological Research Committee did not include classification to the cattle/red deer level as all large artiodactyl remains were normally cattle bones.[79] At Ramsbury red deer was much more common and many specimens were so large that they could not always be reliably separated from cattle.

TABLE 10
LEVELS OF IDENTIFICATION



Sheep-sized fragments show similar problems — at Ramsbury, roe deer was quite common so that a small artiodactyl category (sheep/goat/roe) was necessary for fragments not easily separable between the three species. There was no fallow deer bone at Ramsbury and the majority of pig bone could normally be distinguished because of its distinctive anatomy.

All fragments were recorded by layer for species, element, butchery, texture, pathology and fusion. Measurable material and jaws from the layers were then amalgamated for each period. Full records are kept at the DoE Faunal Remains Project, University of Southampton. Bones of each species were weighed by layer so that comparison could be made with weighed material from Hamwih.

Measurements were taken according to the methods of Von den Driesch[80] and the major points of comparison with the Statistical Appendix for Hamwih[81] are made in the text.

Calculations of minimum numbers of individuals were not made except for mandibles. Instead another method was tried for overcoming the problems of differential fragmentation. Each fragment was scored as a whole bone, half a bone, more than half or less than half — 1.0, 0.5, 0.75 and 0.25 respectively — and results summed for each anatomical element of each species.[82] Thus results for cattle femur of 1, 0.5, 0.25, 0.25 would be equivalent to two femora. These 'whole bone equivalents' (WBE) should avoid the false picture generated by excessive fragmentation of one species or of one type of bone.

Small skull fragments were scored 0.05. These methods are crude but give more information than a fragment count and are more reliable than minimum number calculations.

OVERALL RESULTS

Altogether 7,685 fragments were identified to species or ascribed to one of the categories mentioned in the previous section. Twice as many fragments as were identified to species could only be ascribed to level 1 or 2 categories (Table 11a). But the weight of this fraction is considerably less than that of the specifically identified fraction (Table 11b). When the WBEs are considered it is clear that the actual bulk of bone at identification levels 1 and 2 is only about a third of that identified to species. Nevertheless this is a considerable quantity, and the significance of methodology must be fully realized if comparisons are to be made between sites either for specific ratios (as is frequently done) or for domestic:wild ratios. These problems of intersite comparison are more fully discussed in another paper.[83]

The distribution of these fragments between the various wild and domestic species is shown in Table 12 for the late 8th-century period 2; in Table 13 for the 9th-century period 3*b*; and in Table 14 for period 4*b*. This separation into domestic and wild species may not be 100% accurate for a number of reasons discussed later.

It must be realized that to use any of these percentages out of context is misleading as they relate to their totals. Assessment of the relative role of pig within the major domestic stock or the relative value of domestic animals within the 'edible' fraction, for example, would involve new calculations. The actual results are included so that this can be done.

TABLE 11

DISTRIBUTION OF FRAGMENTS, WEIGHTS AND WHOLE BONE EQUIVALENTS

	Identified to species at levels 3 and 4	LEVEL 2		LEVEL 1		TOTALS
		Cattle/ red deer	Sheep/goat/ roe deer	Sheep-sized fragments	Cattle-sized fragments	
A. *No. fragments*						
Period 2	1,032	132	10	678	522	2,374
Period 3*b*	1,489	133	0	1,748	1,559	4,929
Period 4*b*	270	11	2	26	73	382
TOTALS	2,791	276	12	2,452	2,154	7,685
B. *Weights* (g)						
Period 2	38,026	4,767	90	2,478	4,675	50,036
Period 3*b*	30,013	4,330	0	4,870	16,870	56,083
Period 4*b*	7,661	303	20	375	2,173	10,532
TOTALS	75,700	9,400	110	7,723	23,718	116,651
C. *Whole bone equivalents* (WBE)						
Period 2	429	67	4	30	26	556
Period 3*b*	517	42	0	87	78	724
Period 4*b*	99	4	2	2	4	111
TOTALS	1,045	113	6	119	108	1,391

TABLE 12

SPECIES REPRESENTATION — ALL METHODS — PERIOD 2

DOMESTIC ANIMALS

	Number of fragments	%	Weights (g)	%	WBE	%
Horse*	64	6.7	5,795	16.3	40	10.5
Pig*	249	26.1	3,870	10.9	90	23.4
Cattle*	339	35.6	21,205	59.7	137	35.5
Sheep/Goat* TOTAL	247	25.9	4,310	12.1	85	22.0
above includes:						
Sheep	*54*	*5.7*	*1,300*	*3.7*	*33*	*8.7*
Goat	*9*	*0.9*	*597*	*1.6*	*6*	*1.6*
Dog	2	0.2	97	0.3	1	0.2
Domestic birds*	52	5.5	213	0.6	32	8.3
TOTALS	953	100	35,490	100	385	100

WILD ANIMALS

	Number of fragments	%	Weights (g)	%	WBE	%
Beaver	6	7.6	177	7.0	4	8.7
Fox	9	11.4	46	1.8	6	13.9
Badger	2	2.5	30	1.2	2	4.0
Red deer*	20	25.3	1,817	71.6	10	23.1
Roe deer*	42	53.2	466	18.4	22	50.3
TOTALS	79	100	2,536	100	44	100

* Butchery evidence in this species.
Note: Although calculations were carried out with much greater accuracy all results are rounded off.

TABLE 13

SPECIES REPRESENTATION — ALL METHODS — PERIOD 3*b*

DOMESTIC ANIMALS

	Number of fragments	%	Weights (g)	%	WBE	%
Horse*	204	14.2	8,020	27.6	83	16.7
Pig*	353	24.6	3,390	11.6	108	21.8
Cattle*	447	31.1	14,355	49.4	133	26.8
Sheep/Goat* TOTAL	307	21.4	2,900	9.9	91	18.3
above includes:						
Sheep	*29*	*2.0*	*430*	*1.5*	*6*	*1.2*
Goat	*10*	*0.7*	*400*	*1.4*	*7*	*1.3*
Dog	24	1.7	170	0.6	18	3.7
Cat	2	0.1	10	<0.1	2	0.6
Domestic birds*	99	6.8	217	0.7	61	12.2
TOTALS	1,436	100	29,062	100	497	100

TABLE 13 (continued)

WILD ANIMALS

	Number of fragments	%	Weights (g)	%	WBE	%
Fox	5	9.4	60	6.3	5	23.5
Red deer*	16	30.2	610	64.1	2	11.1
Roe deer*	31	58.5	275	28.9	10	50.6
Wild bird	1	1.9	6	0.6	3	14.8
TOTALS	53	100	951	100	20	100

* Butchery evidence in this species.
Note: Although calculations were carried out with much greater accuracy all results are rounded off.

TABLE 14

SPECIES REPRESENTATION — ALL METHODS — PERIOD 4*b*

DOMESTIC ANIMALS[84]

	Number of fragments	%	Weights (g)	%	WBE	%
Horse	12	4.6	910	12.0	5	5.1
Pig	44	16.8	515	6.8	16	16.5
Cattle	99	37.8	4,888	64.6	35	36.0
Sheep/Goat TOTAL	96	36.6	1,187	15.7	37	38.0
above includes·						
Sheep	*10*	*3.8*	*340*	*4.5*	*6*	*6.2*
Goat	*2*	*0.7*	*82*	*1.0*	*2*	*2.1*
Dog	5	1.9	60	0.8	2	2.1
Domestic birds	6	2.3	6	0.0	2	2.1
TOTALS	262	100	7,566	100	95	100

* Butchery evidence in this species.
Note: Although calculations were carried out with much greater accuracy all results are rounded off.

The distribution of fragments between the different skeletal elements of the various species is not given here but detailed analysis of such results was attempted. Observed relative frequencies (by WBE) of the different skeletal elements were compared with expected frequencies. Results for each bone were compared with those for tibia as the bone whose frequency was most consistently linked to sample size. With such a small sample and the problem of modern breaks, results were difficult to interpret. There was however rather a high frequency of cattle mandible fragments and an overall paucity of toes.

The writer considers that results from such fragment analyses are strongly linked with identifiability and differential preservation. Interpretation of carcass usage is therefore very difficult but it might be possible with larger samples studied in this way from other sites and by inter-site comparison to come to some important conclusions concerning this. Similar techniques were used with minimum numbers at Haithabu.[85]

THE DOMESTIC MAMMALS

1. HORSE

There were 268 fragments of horse from periods 2 and 3*b* at Ramsbury compared with 49 from Melbourne Street, Hamwih, although the latter yielded approximately eleven times the amount of bone. At Hamwih horse gave a relative frequency of 0.1% of the main domestic animal bones (horse, cattle, pig, ovicaprid) by fragment count. At Ramsbury it formed 7% in period 2 and 14% in period 3*b*. In period 2 there were nine occurrences of butchery on horse bones but only one such occurrence in period 3*b*. Many of the horse bones like those of the other species were burnt or chewed, the latter not necessarily by humans.

The Ramsbury horse bones gave withers height estimates ranging from 121 to 140 cm (*c.* 12–14 hands). The upper part of this range corresponds with the very few results obtained from Melbourne Street but there were two humeri in layer 37 (Ramsbury, period 2) which gave withers heights of 121–23 cm (*c.* 12 hands). Modern ponies are usually 14 hands 2 inches or less although some breeds of pony may contain larger individuals. The majority of the withers height calculations at Ramsbury and at Hamwih therefore represent horses of pony size. The two small humeri at Ramsbury represent very small horses. Small horses may also have been present at Hamwih as some of the Hamwih bones too broken to give height information were small.

In the Iron Age a wide size range of horses was kept in Wessex[86] as on the Continent,[87] but generally continental sites contemporary with Ramsbury show horses either at the larger end of the range shown here or much larger.

There was evidence of butchery on both smaller and larger horse humeri in period 2. None of the smaller bones at Ramsbury was anatomically closer to donkey than horse. Such butchery might only mean that horses were fed to dogs as they are today but the presence of these fragments alongside food remains with not necessarily more evidence of chewing makes it likely that they were eaten by people.

A collection of horse teeth in layers 55 and 57 (period 3*b*) showed horses of a wide range of ages.[88] A rough array of these teeth into age groups follows:

Approximate age in years	5	5–10	10–15	15–20	20 +
Number of teeth	2	3	5	13	8
Minimum no. horses represented	2	3	4	6	3

At Melbourne Street all horse remains were from mature animals and we suggested that horses were only brought into Hamwih when of working age. The best age for working is usually reckoned to be 5–12 years but many horses work for much longer and here all age groups are represented, including young ones. The ratio of horse bones showing exostosis (bony outgrowths) or more severe cases of fusion between neighbouring bones was less than 1 in 14 but compared with the incidence of pathological alterations in the other species this was quite high. Such changes are often seen in animals which are subjected to heavy strain.

2. PIG

The pigs formed a higher proportion of the domesticated animal bulk than at Melbourne Street. The animals were small, like the Melbourne Street pigs, and from their long-bone and third molar measurements were obviously domestic stock with no evidence for cross-breeding with wild boar which might still have been living in the area (there were three fragments tentatively ascribed to wild boar, *Sus scrofa*). Lower third molars averaged out at a total length 30.7 mm compared with the Melbourne Street average of 31.1 mm. The low variation coefficient and deviation that they showed suggests that these teeth represent fairly consistent pig populations. The 8th- and 9th-century pigs show no significant differences. Remains of an individual pig in layer 58 (period 2) with a lower third molar length of 37.5 are conceivably from a wild or cross-bred animal, as this is outside the Hamwih range.

Of the pig upper canines found, 10 were from males and two from females. Lower canines are not so easy to sex since those of castrated males may not be distinguishable from those of females. The lower canines fell into two size groups — thirteen into the presumed male group and twelve into the female or castrate group. Most mandibular fragments, however, could not be sexed as they were too fragmentary. The results from top and bottom jaws certainly seem at odds, but not necessarily so if we presume that most of the second group of lower canines belonged to castrates and the first group either to entire males or those in which castration had been too late to have had an effect on the growth of the canines.

The total Saxon collection showed a fairly even killing pattern according to tooth eruption and wear but the overall picture was only based on 49 jaws and is heavily affected by eleven immature jaws from layer 55 in period 3*b*. If these are left out as an atypical occurrence, the result is a peak killing period slightly later than that at Melbourne Street when the third molar is in full wear. Probably only a few pigs were more than two or three years old.

The only withers height obtained was 77 cm from a radius in period 2 and compares with the highest value obtained for Melbourne Street. Although these pigs were smaller and shorter in the leg than wild boar they were not very much so. They were however much modified from their original ancestor by their shorter jaws and smaller teeth. Such changes had already occurred in Britain in prehistoric times. By modern standards they were very small.

3. CATTLE

The proportion of fragments of the major domestic species which could be accurately identified as cattle was around 35% for period 2 and slightly less for period 3*b*. This is a much lower figure than for the Hamwih sample where values of 49.2–54.3% were obtained for the Melbourne Street sites, although higher values would result if all level 2 identifications were included, bringing the value for cattle to 45% for period 2 and 40% for period 3*b* (Table 15).

There was one skull from a naturally hornless animal. Hornless cattle appear in Wessex at least as early as the Iron Age.[89] Apart from the hornless individual all the animals were medium- or long-horned.[90] Some of the horn cores showed saw marks. Of the measurable horn cores nine were assessed as male but the thinness of the wall suggested that all but two were probably from castrates. One was probably from a cow. Some of the horn cores were bigger than anything yet found at Hamwih. The only whole horn core in this series (judged to be from a bullock) measured 290 mm along the outer curvature.

Cattle ages from teeth show two slight peaks as at Melbourne Street — one at a stage when the second molar was not yet in wear. The Melbourne Street peak may be slightly later but the Ramsbury sample is small. This stage corresponds to an age of anything from six months to one-and-a-half years according to modern data. The second peak is at a stage when the third molar had come into full wear and a similar peak occurs at Melbourne Street. It will not be clear whether these peaks represent exactly the same stage of development until a more detailed analysis (perhaps involving tooth sectioning) is attempted for the two sites.

All cattle long-bone measurements are within the range of the Melbourne Street bones and often show an equally large coefficient of variation suggesting quite a wide range of cattle sizes — possibly at least partly due to castration. The withers height value for a femur was 108 cm and those from metapodials ranged from 103 to 128 cm, well within the ranges obtained overall for Melbourne Street, and comparable with contemporary continental cattle, being on the whole larger than the Iron Age cattle of Wessex.

4. SHEEP AND GOATS

These two species together account for about a quarter of the total domesticated animal bone. Many of the pieces are so fragmentary that it is difficult to assess the ratio of the two species but goat seems to be of far less importance than sheep. Melbourne Street figures show a higher proportion of ovicaprid — ranging from 25% to 37%.

The goat horns were exploited for horn artifacts. The cores were mostly very large, upright and straight and from males comparable in size with those from Melbourne Street. Six measurable horn cores fit the supposed male distribution from that site and one is more likely to have been from a female. The very few measurable long bones were larger than anything found at Melbourne Street with the exception of a metatarsus shorter than the Southampton range — it has a total length of 117 mm and gives the only goat withers height estimation (62 cm), but the other larger bones show that there must have been some much bigger goats than this.

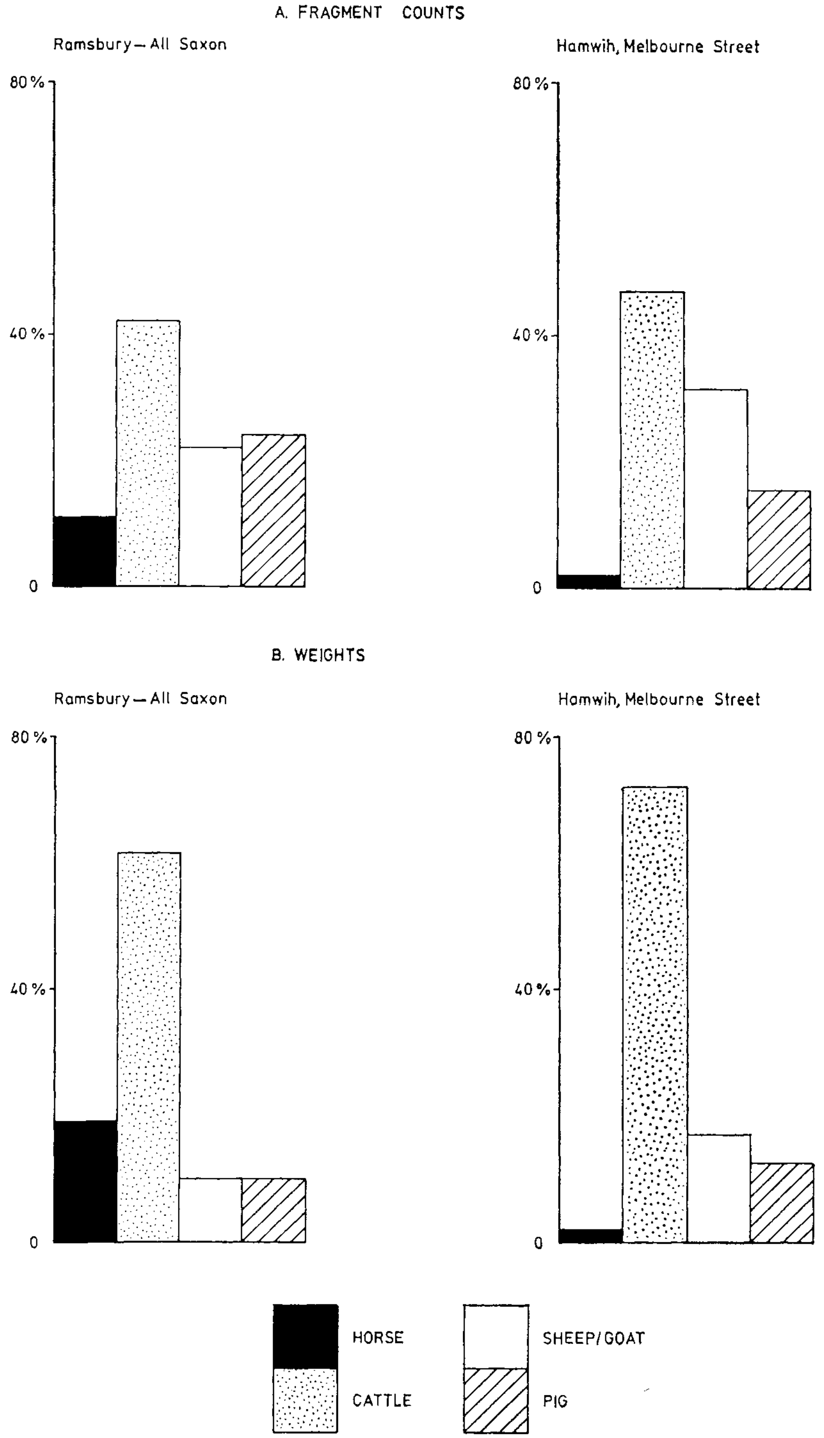
The sheep were probably on the whole smaller than the goats — withers height estimations of 60 and 62 cm were made from a metacarpus and radius respectively. This compares with an overall height range for Melbourne Street of 50 to 71 cm and is about equal to the Melbourne Street mean. Measurements of the Ramsbury sheep long bones generally fit this picture, falling in the middle of the Melbourne Street ranges.

Of the sheep horn core fragments examined, sixteen were probably from rams, with no evidence of the depressions and weakenings of the core thought to indicate castration.[91] There was one other small horn core which could have come from a castrate and five probably from females.

Taking all the 50 ovicaprid mandibles together, which is all we can do as sheep and goat mandibles are not really separable, there is a peak at Ramsbury when the third molar is in full wear in both Saxon periods, the sheep probably being two years old or more at death. No sheep with the

TABLE 15

DISTRIBUTION OF FRAGMENTS AND WEIGHTS OF THE MAJOR DOMESTIC SPECIES AT RAMSBURY AND HAMWIH



third molar in heavy wear (as occasionally seen at Hamwih) were found at Ramsbury, and at Hamwih there is evidence that more young stock was slaughtered.

5. DOG

The dog bones were few and fitted within the ranges for Saxon dogs.[92] In layer 55 (period 3*b*) there were eighteen dog bones, from at least three individuals, including a very straight, large humerus and well-sculptured ulna which looked especially wolf-like, but there were no wolf-like jaw fragments and Dr Juliet Jewell of the British Museum (Natural History) suggests that they could as well represent a large well-exercised dog.

6. CAT

Cat was represented by only two bones.

THE WILD MAMMALS

1. BEAVER, *Castor fiber*

The beaver remains were all from period 2. There was an immature skull in layer 64, a mandible (probably from the same individual) in 58, a radius in 65, and a tooth in 68. Probably at least two individuals are represented.

The skull has knife marks, made during skinning, on the frontal bones and zygomatic arch.

2. FOX, *Vulpes vulpes*

A very small amount of material from red fox was found in period 2 (layers 58, 64, 65 and 66) and period 3*b* (layers 55 and 57, and pit-filling 70/1). The two bones in layer 57 are from different individuals.

3. BADGER, *Meles meles*

There were three bones, all in period 2 — two from layer 58 and one from 60.

4. RED DEER, *Cervus elaphus*

Remains of this large deer were probably not always 100% separated from those of cattle as explained above. There was very little red deer antler in the bone samples although the bones were large enough to have come from stags.

The age frequency of the small sample of jaws is shown in Table 16a.

5. ROE DEE, *Capreolus capreolus*

Separation of these bones from those of sheep and goat was simpler and the comments for red deer do not apply to the same extent to the separation of roe deer bones. This small deer was even better represented than red deer although each individual would only have provided a fraction of the meat that would be provided by a large red deer stag. There was a slightly higher incidence of both deer in period 2 than in 3*b*.

The jaw fragments of roe deer are put into age categories in Table 16b which shows a peak of young roe deer one-to-two years old.[93] This peak and the fair number of zero-to-one year-olds no doubt represents the relatively inexperienced young animals which would fall to the hunters but could indicate deliberate choice to provide the most tender meat.

There are five roe deer antlers; one a fair specimen with much pearling, from an older buck.

THE BIRDS

1. DOMESTIC FOWL

Cocks, hens, capons and small fowl the size of modern bantams are all represented as at Melbourne Street. There was a high proportion of immature fowl bones.

2. GOOSE

An almost entire skeleton was found in layer 121 (period 2). Geese represented are large, and anatomically indistinguishable so far from the wild greylag, *Anser anser*, but must have been domestic.[94]

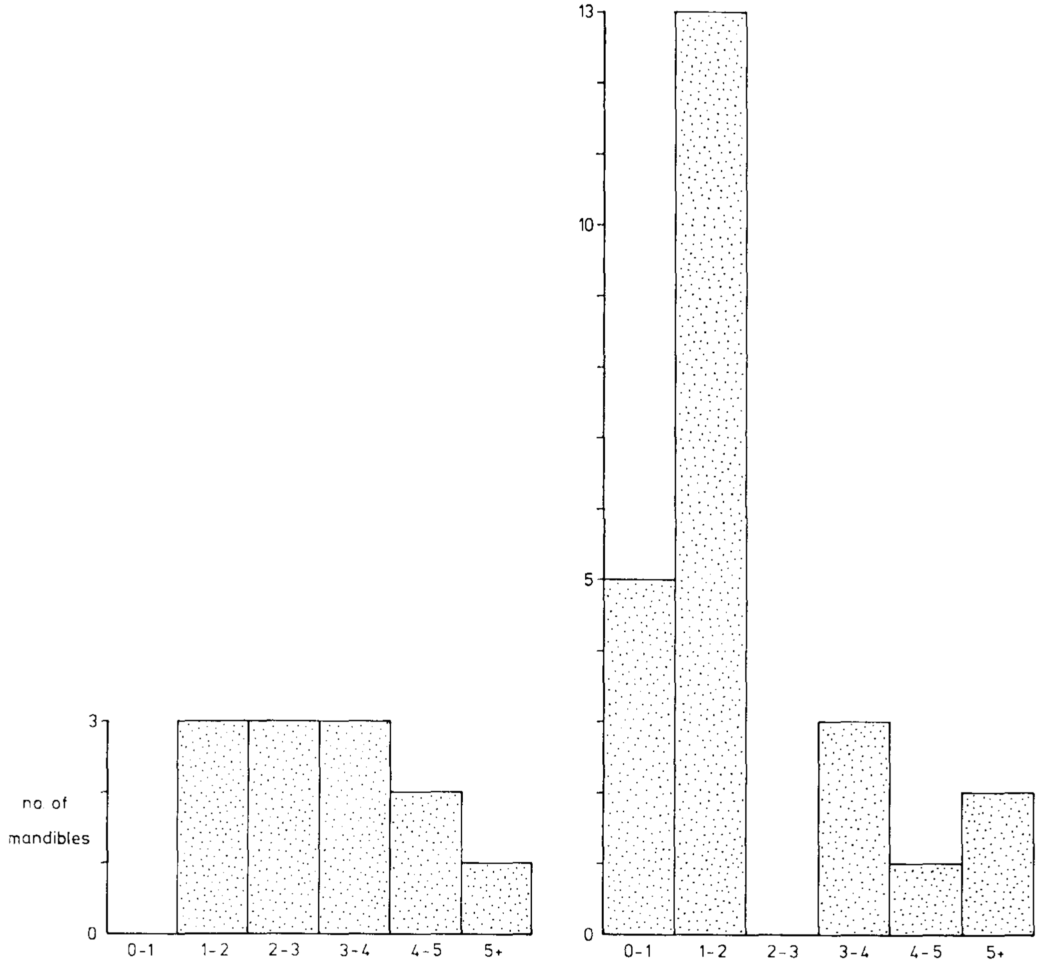
3. DUCKS

The few bones of duck, all from period 3*b*, could either belong to the wild mallard, *Anas platyrhynchos*, or to an unspecialized domesticated form.

4. THE WILD BIRDS

Only five bones of wild species were found — humerus, ulna and radius of a red kite, *Milvus milvus*, in layer 37 (period 2); a humerus of the common snipe, *Gallinago gallinago*, in layer 55 (period 3*b*); and a humerus fragment of peregrine falcon, *Falco peregrinus*, in period 4*b*, probably from the smaller male.

TABLE 16



a. AGE FREQUENCY — RED DEER

b. AGE FREQUENCY — ROE DEER

DOMESTIC/WILD RATIOS

The methods used for calculating such ratios are fully discussed elsewhere in relation to Hamwih and Ramsbury results.[95] A range rather than a single figure is given for each method in Table 17 using the results for periods 2 and 3*b* only. The lower figure for wild includes all level 2 identifications as cattle or sheep/goat. The higher figure includes them as roe and red deer and is far less likely but theoretically possible. Results for period 2 give a slightly higher proportion of wild (minimum value 6.7%). The true value lies somewhere within this range. Pigs and ducks have all been included in the figures for domestic animals.

Even on the minimum values the proportion of wild animals by fragment count is 6.7% for period 2 and 3.3% for period 3*b*. The figure for wild animals for Melbourne Street was originally quoted as less than 1% although further work has shown that the role of fish in the diet may have been considerable. Obviously wild mammals were exploited to a greater extent at Ramsbury, some for skins rather than food.

Variation in the domestic/wild ratio is small in period 3*b* when results from the various layers are compared (2–4% minimum values for wild animals). It is greater in period 2 (0–15% minimum values for wild animals). Layers 60, 64 and 65 are especially rich in wild species with layers 58 and 66 not far behind. These are the layers containing most of the beaver, fox and badger bones.

TABLE 17

WILD/DOMESTIC PERCENTAGES AS A RANGE FOR THE THREE METHODS

	WILD		DOMESTIC	
	min.	max.	min.	max.
% By fragments	5.0	14.6	85.4	95.0
% By weight	5.9	16.4	83.6	94.1
% By WBE	6.0	16.9	83.1	94.0

CONCLUSIONS

This is a very interesting sample of mid Saxon animal bones from a rural settlement. Domestic horses, cattle, sheep, goats, pigs, dogs, cats, chickens, geese, and probably ducks were kept. The bones provide an adequate sample to draw some parallels with the much larger collection from Saxon Southampton. On the whole the domestic stock at Ramsbury was similar to that at Southampton but there are some interesting differences.

There is more evidence for horse at Ramsbury including some bones from small horses of about 12 hands. There is slightly more pig bone at Ramsbury by proportion, with more evidence of young pig. The sheep bones were mostly from mature animals. This may mean that sheep were mainly kept for wool and milk and only normally eaten when they did not do well or were barren. The horn core evidence for goats and sheep is difficult to interpret and the large number of large male horn cores in some deposits may only mean that these were selected for horn removal.

There is a suspicion that cattle were at a good size for eating slightly earlier than at Southampton. This certainly fits the fact that land around Ramsbury is of a higher grade than that around Southampton Water. There must also have been extensive woodlands and available browse as we can see by the presence of roe deer and beaver. The wide river valley of the Kennet at this point would also explain why beaver was still there in mid Saxon times when its bones do not occur on other sites of this period.

During the collection of timber for the iron-working process the workers would have had close contact with the woodland and its creatures and they and all the local people were probably orientated towards the woodland environment as well as the downland. There is evidence that long-legged, long-jawed, active dogs were kept. We cannot know whether the ironworkers themselves caught wild animals and whether they were allowed to do so. It would seem to be an easy matter for them to have done so during the course of their work, especially if they were allowed to keep suitable dogs.

Deer, beaver, badger and fox would have provided skins and there is evidence that the beaver at least *was* skinned. The slight reduction in the proportion of wild fauna from period 2 to period 3*b* may even be linked with a reduction in the extent of the immediate woodlands themselves but more evidence is needed. There are no beaver remains in period 3*b*. Both the ironworking activities and the action of beavers may have been contributory factors in such a decline. As far as the writer knows this is the latest archaeological record of beaver for Wessex so far. Some beaver bones from Wirral Park Farm, Glastonbury, may be later.[96]

SECTION 4: IRONWORKING RESIDUES

By L. BIEK (*DoE Ancient Monuments Laboratory*) *and*
STEPHANIE FELLS (*Department of Metallurgy, University of Aston in Birmingham*)

The material available for examination was of four main kinds — fragments of ore, smelting slag, smithing slag and furnace lining. In addition the fillings of several features had been sampled, and some of them were found to contain small debris of the same nature, mixed with some other related material and finely divided charcoal. Representative specimens have been X-radiographed, thin-sectioned and chemically analysed. The work is part of a larger project, and will be fully published elsewhere. A summary of the main findings so far is given below, specifically as they relate to Ramsbury.

The ore is dealt with in Section 8. With one exception all the specimens examined, roasted as well as unroasted, are the same; the siderite was therefore clearly utilized and not, like the single ferruginous sandstone fragment, present merely because it had been rejected. Smelting slag was found in several forms which were in many cases more or less clearly related to position in the furnace — or, 'tapped', outside — and thus to the amount of heat (temperature × time). But in general it has not so far been possible reliably to classify all the smaller and more shapeless pieces in this way, or sometimes even to be certain that they were due to smelting rather than smithing. From theoretical equivalents for a relatively high-grade ore, as reflected in modern experimental 'bloomery' furnaces, it seems probable that the production of one weight-unit of iron metal was accompanied by as much as some ten units of smelting slag, and only *c.* 0.01 units (a hundredth) of smithing slag.

All kinds of slag are therefore considered together here in an attempt to suggest rough production figures (Table 18). The volume of slag is derived from the records of excavated layers, accounting for 37 m³, which includes the amount presumably removed in the 13th entury by excavating the ditch. The weight is calculated from this volume, assuming that *c.* 75% of it was slag of specific gravity *c.* 4. The figures indicate an activity equivalent to several decades of furnace operation for the excavated area.

TABLE 18

QUANTITIES OF MATERIAL DUE TO IRONWORKING ACTIVITIES IN PERIOD 2

	Phases *a* and *b*	Phase *d*	TOTAL
Weight of slag retained (kg)	7	110	117
Volume of slag layers estimated (m³)	27	10	37
Weight of slag estimated (tonnes)	*c.* 80	*c.* 30	*c.* 110
Weight of iron estimated (tonnes)	*c.* 8	*c.* 3	of the order of 10

The fragments of furnace lining examined in thin section showed a remarkably high sand content, largely quartz, but little or no signs of fusion or glassy phases. Some small patches of a euhedral cubic phase, possibly magnetite, were seen but these may be due to natural occurrence in the sand. Little brown acicular crystals of (?)mullite would seem to suggest temperatures in excess of *c.* 1150°C.

The most striking form of smelting slag was a 'cinder' found in large lumps, up to half a metre long and some 200 mm high and wide, with a highly 'viscous' surface texture. None were *in situ* but the slag 'supports' in furnaces 2 and 3 (Figs. 12 and 13) were of this kind. In polished section the cinder has a typical 'bloomery' structure of relatively large fayalite laths (*c.* 50%) with abundant characteristic rounded wüstite dendrites (*c.* 40%), in a glassy matrix. There is also a small amount of secondary wüstite in the glassy phase.

By contrast, a thin section across a finger-like stalactitic drip shows rather smaller euhedral and somewhat blocky crystals of fayalite. There is some 5% of opaque cubic phase — possibly magnetite oxidized from wüstite, to judge by its distribution, clustering round voids. The larger of the fayalite crystals and some clear patches of glass show wüstite dendrites. All this is consistent with relatively rapid cooling of a homogeneous fluid slag, and would occur on tapping, outside the furnace, or in drips from hot zones within. A particularly fine specimen of tap slag, representing the final stage of flow from the tap hole of furnace 4 into the hollow below, was found in position (Fig. 14). It has the appearance of ropy lava.

Another contrast was provided by many typical plano-convex 'buns' of smithing slag. Two representative specimens measured 120 mm and 140 mm (over half remaining) across their quite uniform maximum diameter. They showed the characteristic, slightly convex 'plane' top surface and 'ghost' macrostructure of agglomerated driblets. As expected, none were found *in situ* but confirmation of actual smithing areas came in a different way from features 99 (Fig. 9) and, less definitely, 117 (Fig. 5). Samples taken as 'charcoal' from these 'hearths' in fact turned out to contain a greater (99) or smaller (117) amount of 'mineral matter' (see Sections 5 and 6). The highly magnetic portion in each case was found to consist largely of typical flakes ('hammerscale'), and (once molten) prills, of magnetite.

Despite the absence of any hard-fired clay walls or well-consolidated floors one needs to accept features 99 and 117 as reasonably definite 'smithing hearths'. Further support for smithing on site is provided by the 'unrecognisable' objects noted in Section 2. However 'underdeveloped' Saxon smelting processes may appear compared with late Roman practice, Saxon smithing techniques would seem to have been superior over the whole range, not only in the obvious field of patternwelding but even in the mundane areas of utensils and, especially, tools (Section 2). It is therefore particularly important to find just how primitive the forges really were.

SECTION 5: CHARCOAL IN METALWORKING CONTEXTS

By CAROLE A. KEEPAX (*DoE Ancient Monuments Laboratory*)

Sampling

Random soil samples of charcoal-rich material were collected by the excavator. Samples 780061 and 780063 were large fragments picked out from the deposits. Most of these pieces were identified. Samples 780060 and 780062 were larger and included mineral material. These were dry sieved for 40 minutes with a sieve shaker into 5.6, 3.35, 2.36 and 1.7 mm size grades.

Identifications

780060 (context 61, from the latest phase of interior of furnace 4). This was the most charcoal-rich sample. At least 150 fragments were examined from each size grade. These were mainly oak (*Quercus* sp.). The 5.6 and 2.36 mm sieves each produced one fragment of ash (*Fraxinus excelsior* L.), and the 1.7 mm sieve one fragment of hazel/alder (*Corylus/Alnus* spp.). All the material was apparently from fairly mature timber or branches (no curvature was observed on the growth rings).

780061 (context 61, period *2d*, slag and charcoal deposits associated with furnace 4). The sample consisted entirely of oak from fairly mature timbers.

780062 (context 99/1, hearth). The sample consisted largely of mineral deposit, with only a small amount of charcoal. This was all oak from fairly mature timbers. The contents of the 1.7 mm sieve were not examined.

780063 (context 83, furnace 3). The sample consisted entirely of oak, mainly from mature timbers, with some possibly from a twig or small branch.

Three of the charcoal samples sent to AERE Harwell were also examined, with results as follows:

750341 (context 50, Harwell ref. 1606). Mature timbers and branches of oak and hazel.

750337 (context 83, furnace 3, Harwell ref. 1609). Mature timbers and branches of oak and hazel.

750339 (context 61, furnace 4, Harwell ref. 1607). Mature timbers and branches of oak, willow (*Salix* sp.) and possibly maple (*Acer* sp.).

TABLE 19

RADIOCARBON MEASUREMENTS

HAR-no.	Age (bp)	Calibrated age (BP)	Date range (A.D.)	Site period	Site no.	Site context	Material	Identification (C. A. Keepax)
1606	1170 ± 70	1140 ± 75	735–885 (810)	*2a*	50	Slag and charcoal deposits, area B (beginning of smelting)	Charcoal	Oak (*Quercus* sp.) from fairly large timbers; hazel (*Corylus* sp.) — few firs
1704	1070 ± 70	1045 ± 75	830–980 (905)	*2a*	51	Charcoal layers, area B (beginning of smelting)	Soil with charcoal	Too finely divided for identification
1609	1180 ± 70	1150 ± 75	725–875 (800)	*2b*	83	Charcoal deposits in interior of furnace 3	Charcoal	Oak, hazel — large timber
1626	1130 ± 70	1105 ± 75	770–920 (845)	*2b*	117	Filling of hearth, area C (associated with furnace 3)	Charcoal	
1607	1320 ± 70	1290 ± 75	585–735 (660)	*2d*	61	Lowest level of stake hole in furnace 4	Charcoal	Oak, willow (*Salix* sp.), ?maple (*Acer* sp.) — large timbers
1608	1090 ± 80	1065 ± 85	800–970 (885)	*3b*	41	Soil layer, area B (later than furnace 4)	Charcoal	Oak, hazel, maple — large timbers

SECTION 6: DATING

By R. L. OTLET (*Radiocarbon Laboratory, AERE Harwell*)

Six samples from different features were measured, as set out in Table 19. It is seen that the ranges of each date result overlap even at the one standard deviation level. However, no trend is observed which might be associated with the archaeological assignment of time phases. It is inferred that the overall time span is short in comparison with the radiocarbon measurement reproducibility ($\pm$ 70–80 years). In other words, the observed stratigraphical differences between the three principal periods of ironworking represent relatively short time intervals, not significant compared with the spread of the radiocarbon results.

Statistically, the result for HAR-1607 cannot be rejected out of hand. It must, therefore, be accepted as an outlier of the $\pm$ 70-year standard deviation distribution. Its specific value is, however, not relevant to the phase assignments.

It is suggested that the best interpretation would be obtained by taking all the results as a single group. This gives an overall weighted mean of 1160 $\pm$ 35 bp which represents the central activity date. Calibration of this result on the basis of the recommendations of P. E. Damon *et al.* in 1972[96a] yields a calendar date of A.D. 820 $\pm$ 45. More detailed interpretation is probably not justified, although it is tentatively suggested that the overall spread on the results shows the period of activity as unlikely to have been greater than 100 to 200 years.

Comment (by J. Haslam): This would accord with the expected date range of the few datable artifacts, in particular the two strapends (Section 2 above). Strapend no. 2 could be placed as early as the 8th century, while having parallels also in the 9th, and strapend no. 6 is possibly of the 9th century. Many of the other metal objects, as well as the pottery, loomweights and lava querns, while undatable in themselves, would fit well in a site of this period.

SECTION 7: SOURCE OF THE ROMAN BRICKS

By JEREMY HASLAM

As described above, several bricks of Roman origin were incorporated into the lower part of the northern side of the superstructure of furnace 4 (Fig. 14; Pl. III, F and G), and in a few other places in the front of the structure and the reconstructed slag-tapping hole. Large fragments of Roman *opus signinum* mortar were also incorporated behind (north of) the brick superstructure. Other mortar and brick fragments were in pit 45, and there were several sherds of pottery and brick fragments scattered throughout the site. The pottery spanned the 2nd to the 4th centuries.[97] There was also a number of shaped blocks of tufa, also presumably of Roman origin, from various layers.

The use of bricks in the structure of the furnace suggests an appreciation of their refractory properties. They must have been obtained from a Roman building nearby. The scatter of the Roman finds and building material around the site, taken with the find of two coins from the garden of Mr C. E. Blunt immediately to the north,[98] suggests the former presence of a building, probably a farmhouse or villa, in the immediate vicinity, whose remains were robbed in the 9th century. This has been shown as such in Fig. 25.

SECTION 8: POSSIBLE SOURCES OF IRON ORE

By STEPHANIE FELLS (*The University of Aston in Birmingham*)

The iron ore found on site mainly consists of nodules of siderite microsparite containing approximately 5% very fine quartz sand; their boxstone-like weathering pattern is the result of partial oxidation to moderately-/poorly-crystalline goethite. Chemical analysis showed the ore to contain between 0.29 and 0.48% phosphorus, and 0.37 to 0.41% manganese. In addition, Kevex analysis indicated a trace of aluminium, suggesting a small proportion of clay minerals.

Concretionary ironstones have been recorded from Eocene strata (especially the Reading Beds and Lower Bagshot Beds), the nearest sizeable outcrops of which lie 5 km S. of Ramsbury (see Fig. 24). The stratigraphically younger Clay-with-Flints also contains local developments of ferruginous nodules, and Osborne-White notes[99] that 'a good deal of concretionary iron ore', formed *in situ*, was exposed in old diggings in Savernake Forest, 6–7 km SW. of the site.

A single piece of sandstone found on site proved geologically distinctive. The coarse and well-rounded quartz grains cemented by purplish iron oxides are regionally unique to the Lower Greensand, which outcrops some 30 km to the W., around Seend (see Fig. 24).[100] There are more iron-rich lithologies within this formation which could have provided a further ore source, but no such iron-rich material was discovered in the excavation (see also Section 2, final paragraph). The occurrence of material from the Seend area suggests that another source of siderite microsparite nodules, namely the Red Nodule Beds of the Upper Oxford Clay,[101] could also have been utilized. These also outcrop some 30 km W. of Ramsbury (see Fig. 24).

No specimens matching the lithology of the well-known Upper Oxfordian Westbury and Marston ironstones were encountered at Ramsbury.

SECTION 9: THE SITE IN ITS CONTEXT

By JEREMY HASLAM

One of the most significant aspects of the site, apart from the technological considerations already discussed, is that iron ore was transported to it, some perhaps from a considerable distance (see Section 8). Instances of the carriage of iron ore for long distances, often over water, are known from other Dark Age and early medieval sites off the coast of Ireland and the Hebrides. In contrast to Ramsbury, however, these were usually small 'domestic' sites.[102] The historical implications of these considerations are brought out below. Some indication of the means of transport of the ore is suggested by the horse bones from the site, which not only form a larger proportion of the total assemblage as compared with those from Saxon Southampton, but also show a higher incidence of pathological alterations indicating that the animals had been subject to heavy strain (see Section 3).

The scale and duration of the industry, discussed above in Section 4, would support the contention that it must have played an important part in the economy of a comparatively wide region, and that it provided the raw material for more than merely local trade. This suggestion is strengthened by the finds of several fragments of imported Rhenish lava querns. These are at present the only such excavated finds from Wessex, apart from those from Saxon Southampton (Hamwih).[103] The evidence from this latter site for the existence of workshops making finished querns from imported raw materials[104] suggests that the Ramsbury querns were traded by means of the direct route from Southampton northwards to Oxford and Northampton (now the A34), which passes Ramsbury only 20 km (12.5 miles) to the east, and which was certainly in existence at this time.[105] An alternative, though less likely, source would have been through London, and up the Thames and Kennet rivers, reflecting the Mercian control of London and the Thames valley in the late 8th and early 9th centuries.

The assemblage of bones from the site (see Section 3), in particular the presence of Red and Roe deer, and the increase in the ratio of pig to sheep and the lower proportion of cattle compared with the material from Saxon Southampton, suggests that there were large tracts of woodland in the immediate vicinity of Ramsbury. That the ironworkers engaged in hunting in these woodlands is suggested by the presence of 'large well-exercised dogs'. These pieces of evidence suggest that the large tracts of Clay-with-Flints over neighbouring hills (Fig. 24) were in the middle Saxon period largely, if not completely, covered with woodland. This was

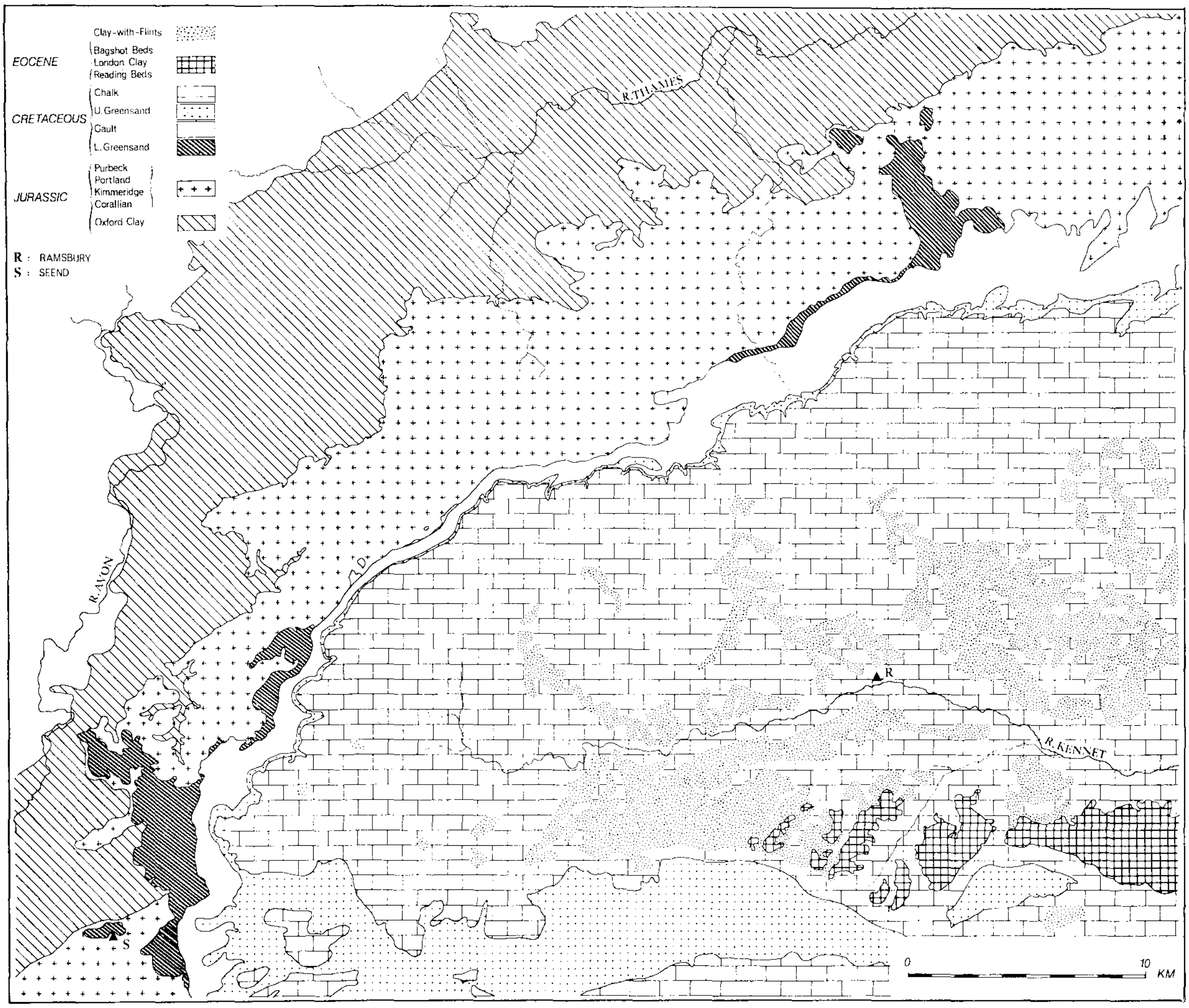


FIG. 24
Geology of area around Ramsbury

presumably the source of the necessarily large quantities of charcoal used on the site (see Section 5); it consisted at least in part of oak, and was probably a mixed forest of oak and hazel. The valleys too must have been at least partly wooded, as is suggested by the presence of beavers (see Section 3), and by the use of the occasional alder and willow branches for charcoal for use in smelting (see Section 5). Savernake Forest, the present remnant of the royal forest on this area of the Clay-with-Flints, must at this period therefore have formed an important element in the royal estate(s) suggested (below) as being centred on Ramsbury and its neighbour Bedwyn. It is also suggested that the existence of these estates was one of the main factors in the location of the iron industry at Ramsbury. The presence of dense forest cover has already been put forward as the reason both for the termination of the east end of Wansdyke on the western edge of the forest in the pagan Saxon period, and of the loss of the courses of the Roman roads leading south through the forest from Cunetio in the 5th or 6th century.[106] It may be concluded therefore that Savernake Forest was the one element in the historic landscape whose continuity throughout all the post-Roman period can be demonstrated with certainty.

The origins of Ramsbury

There are perhaps four factors which mark out Ramsbury as being a settlement of more than ordinary interest in the Saxon period. In the first place, the presence anywhere in Britain of an iron smelting industry using developed techniques in the early 9th century is at present sufficiently unusual to demand a historical explanation; secondly, that the iron ore was transported to the site (see Section 8) further emphasizes its special significance; thirdly, the unusual presence of imported lava querns points to the importance of the site. And fourthly, the choice of Ramsbury as the seat of a bishop in the early 10th century implies its special status at this period.

At the time of Domesday, the bishops of Salisbury, the direct successors of the bishops of Ramsbury, owned a 90 hide estate which comprised the manor and Hundred of Ramsbury, and it has been inferred[107] that this estate was given by the king for the newly created bishopric of Ramsbury in *c.*909. The close adherence of ecclesiastical administration to royal administration in the Saxon period would suggest that Ramsbury was at this time a *villa regalis*, the centre of a royal estate which included the later Hundred. However, the curious shape of Ramsbury Hundred and its physical relationship to the parish of Aldbourne (*A* on Fig. 25), which was in the king's hands at the time of Domesday, suggests that the Ramsbury estate was separated from a much larger royal estate which included not only Aldbourne but also the parishes of Ogbourne and Preshute,[108] both of them in royal hands in the late Saxon period,[109] as well as Mildenhall.[110] The foundation of the late Saxon town of Marlborough in probably the 10th or early 11th century, its parish carved out of the larger parish of Preshute, certainly suggests that the latter was in royal hands at this time. It is suggested that an explanation for these observations lies in the possibility that Ramsbury, like its neighbours Great Bedwyn, Kintbury and Lambourne (discussed below), was throughout the Saxon period the centre of a 'multiple estate' whose origins can be taken back to the late Roman period, if not to the pre-Roman Iron Age.

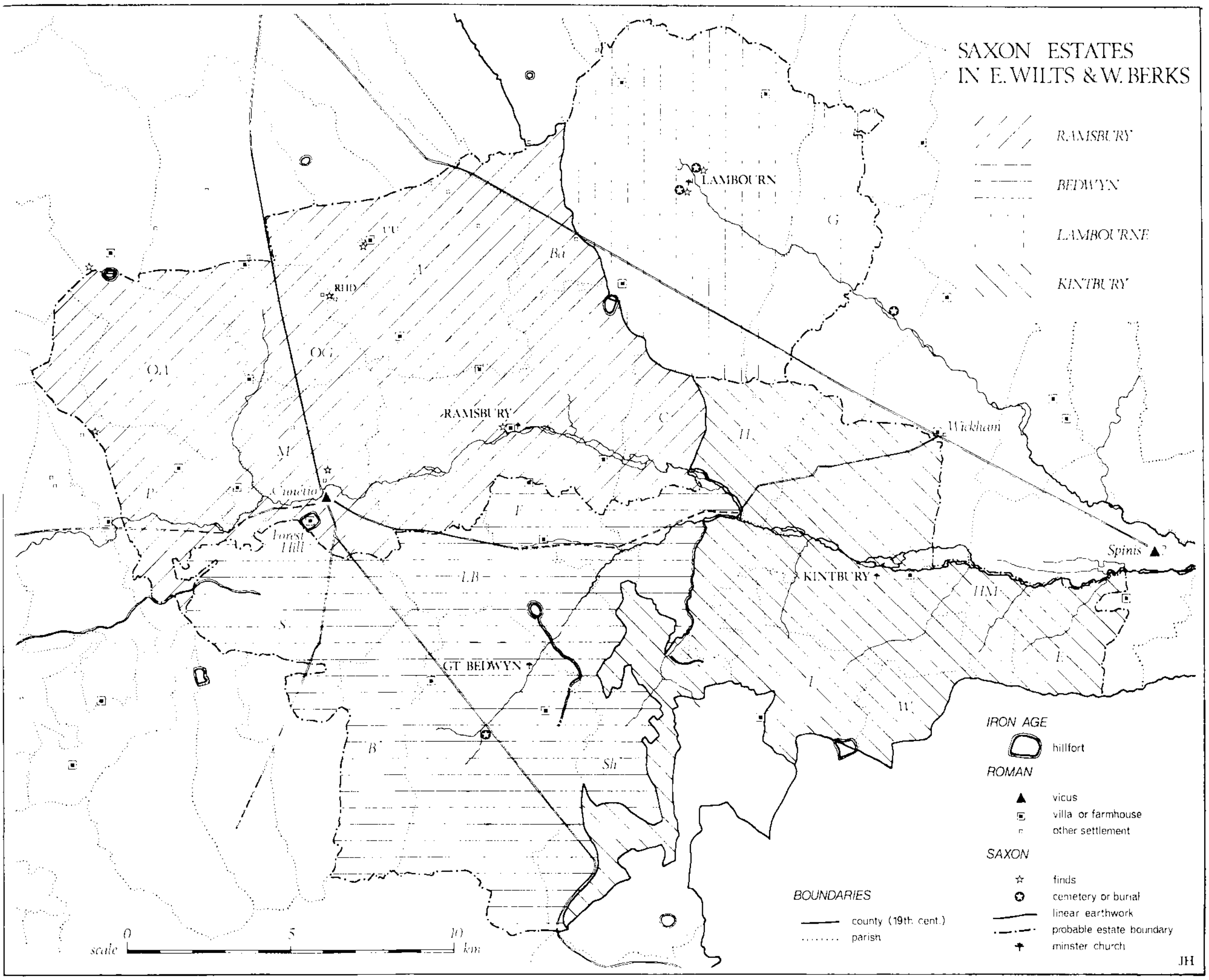


FIG. 25
Saxon estates around Ramsbury in eastern Wiltshire and western Berkshire

There are several lines of argument which suggest that Ramsbury was the centre of this estate, not least of which is the fact that it was chosen as the seat of the bishop. It is, like Kintbury, situated in the Kennet valley, and perhaps more importantly, lies close to the Roman fortified *vicus* of Cunetio only 6 km to the south-west. Cunetio was itself the successor as the focus of its area to the late pre-Roman Iron Age hillfort at Forest Hill Farm[111] 1 km to its south-west. The new fortress at Cunetio was a route centre from soon after the Roman invasion;[112] it developed through the Roman period as a modest *vicus*, and was very probably refortified in the Theodosian reorganization of 367.[113] The concentration of Roman villas around Cunetio (Fig. 25) marks its immediate environs as being a highly organized agricultural region, comparable to the environs of Bath and Sandy Lane (Verlucio),[114] and to Cirencester,[115] where intensive exploitation may have been associated with the marketing and distribution facilities afforded by the existence of the town, and of its more general Romanizing influence.

There are possibly two distinct but interrelated factors in the development of the area in the late Roman and immediately post-Roman periods which have bearing on the question of the origin of Ramsbury. Firstly, Cunliffe has put forward a model of the economic and social changes that affected the late Roman landscape[116] which perhaps provides a clue to subsequent developments through the Saxon period. He has suggested that the decrease in population in the 4th century led to the conversion of marginal land from arable to sheep pasture; this in turn resulted in further depopulation of the countryside, and significantly, in both the increase in size of some villa estates at the expense of others and the concentration of resources at a few estate centres. The collapse of the market economy in the early 5th century, and the end of industrial mass production, must have forced the already large estate centres into a state of virtual self-sufficiency. The significance of this development is that precisely the same pattern of large estates becomes recognizable again in the later Saxon period. It therefore seems more reasonable to suggest, as an explanation for this situation, a direct process of survival and active continuity in estate utilization from the Roman to the Saxon period, than to infer any intervening process of metamorphosis.

The second development is suggested by a model for the transition of Roman to Anglo-Saxon Winchester put forward by Biddle, who has suggested that a ruling element which emerged from the mercenary presence in Winchester in the late 4th century assumed 'power and territorial control from the last remnants of the Romano-British administration, supplanting the social order which it had been their first duty to defend'.[117] Although the interpretation of some of the evidence on which this hypothesis is based has been brought into question,[118] the recent find of a military belt buckle of Hawkes's type IIA at Cunetio[119] might suggest that this town could also have survived through the support of 'mercenaries' (whatever their precise origins) as some sort of political focus after the general collapse of the Roman industrial economy. Even if this were not so, the survival of a strong British element in the Kennet valley (both in W. Berkshire and E. Wiltshire) after the early 5th century[120] would have encouraged stability in agricultural production in the immediate region. If this were so, the large agglomerated estates of the later Roman period, existing — perhaps even thriving — through the 5th century in a state of enforced self-sufficiency, would have had little incentive to alter either their organization or their boundaries relative to one another.

Some local support for this general model is possibly given by the relationships of the parishes of Aldbourne (*A* on Fig. 25) and Ramsbury, suggested above as being parts of a larger whole. A striking feature of the former is the concurrence, on the hilltop site of Upper Upham (*UU* on Fig. 25), of the remains of Roman buildings comprising a fair-sized settlement with Iron Age and Roman field systems, the find of a late Roman military belt buckle, and of a now deserted medieval village which was mentioned in a charter of 955 as Uphammere.[121] It is a strong possibility that this settlement was the centre of a Roman estate which survived as such well into the Saxon period, its boundaries represented by those of the parish of Aldbourne, of which it is the approximate centre.

If this model of the organization of the area — whether it was political and military, or merely geared to the practical maintenance of its agricultural resources — is correct, it would not be surprising to find it attractive to Saxon settlers. Recent evidence has in fact suggested a phase of Saxon penetration from the upper Thames valley to southern Wiltshire (itself also a highly Romanized area and the focus of a British presence in the 5th century) by way of the Kennet valley around A.D. 500.[122] It seems clear from the foregoing arguments that one of the factors influencing this migration would have been the relative prosperity of the Kennet valley area itself, and, as has been suggested, the presence there of a working agricultural system. The cross-valley dykes in both the Kennet and Bedwyn valleys (Fig. 25), though undated, could not unreasonably be interpreted as attempts to prevent this penetration, and if this is accepted, in themselves constitute evidence of the organization of the resources of the area in the 5th or 6th century.

If, therefore, Saxons had gained political control of the area by the early 6th century, there is little reason to suppose that they would have had an immediate impact on the large-scale organization of rural estates, which had perhaps been fossilized by this time for over a century. On the other hand, there is equally no reason why the Saxons should have maintained a political or any other sort of presence at Cunetio itself. If such a presence was maintained in the area it seems probable that it would have shifted to the nearest and largest estate centre. The proximity of Ramsbury to Cunetio, the presence there of a probable Roman villa[123] and presumably a late Roman estate centre, and its position in the probable avenue of Saxon penetration up the Kennet valley, all suggest that it could well have become the focus of the area in succession to Cunetio, and could have taken on some of the administrative functions of the former late Roman and sub-Roman town, subsequently becoming a *villa regalis* on the consolidation of the West Saxon kingdom. The probability of this process is certainly strengthened by its later choice as the bishop's seat.

The shift of focus in the 5th century from a late Roman town to a nearby estate centre or *villa regalis* is mirrored in a number of other places in England.[124] Perhaps of more significance for the present arguments, though, is the evidence which shows that the same processes as have been described for the Ramsbury area operated in adjacent estates. It can be suggested that at least three other estates developed near the Kennet valley in much the same way, with estate centres at Great Bedwyn, Kintbury and Lambourn, the latter two in western Berkshire (Fig. 25).[125]

The estate centred on Bedwyn in the Saxon period is given in a charter of 968[126] whose bounds define an area which includes the parishes of Great Bedwyn, Grafton, Tidcombe, Burbage, and North and South Savernake (outlined in Fig. 25). An area corresponding to the parish of Little Bedwyn and Froxfield was alienated by Cynewulf, King of the Saxons in 778.[127] Before this date, therefore, a large tract of land in royal hands shared a common border with a similar large royal estate to the north with its centre arguably situated at Ramsbury. The function of Great Bedwyn as the centre of this estate is demonstrated firstly by the presence there of a minster church, with outlying chapelries which included Little Bedwyn,[128] secondly by its status as the head of its Hundred (Kingwaston), recorded in the 13th century,[129] and thirdly, by the reference in a 13th-century source (which, as Stenton argued,[130] preserves an original core of truth) to Bedwyn as being the 'metropolis' of Cissa, a *subregulus* in the period 672 and 686 of much of Berkshire and Wiltshire.[131]

Clearly therefore Bedwyn was an important *villa regalis* at the head of a large estate at a period when Ramsbury, it has been argued, had a similar function. The situation of Bedwyn close both to Chisbury hillfort (Cissa's burh), guarding one of the main routes along which Saxon penetration of southern Wiltshire is likely to have taken place, and to the Bedwyn Dyke,[132] a cross-valley dyke possibly built to prevent this penetration, point to its importance in the immediate post-Roman period. Its proximity to a number of Roman villas (Fig. 25),[133] as well as to the late Iron Age hillfort at Chisbury, also suggests that Bedwyn was at or near the centre of an estate whose extent had changed very little since the late Iron Age. Furthermore, that pre-Roman estate boundaries survived within this estate is suggested by the fact that the parish boundaries in these areas almost entirely ignore both Roman roads and Saxon defensive earthworks (both Wansdyke and the Bedwyn Dyke), following in contrast ridgeways and the alignments of hilltop dykes. The observation of similar relationships has led both Gelling in western Berkshire, and Bonney in southern and central Wiltshire, to the conclusion that many of these boundaries are of pre-Roman origin.[134]

Remarkable parallels to the Bedwyn and Ramsbury estates occur in adjacent royal estates centred on Kintbury and Lambourn, lying to the south and north of the Kennet in western Berkshire (Fig. 25). The whole of the Hundred of Kintbury has always been a royal hundred,[135] and borders on both the Roman site at Speen (Spinis), as well as Wickham, which Gelling has suggested is a very early English settlement bearing a special relationship to a Roman *vicus* (probably at Speen).[136] The high incidence in Kintbury Hundred of Celtic names[137] indicates the survival of a British population in the area into the Saxon period, and therefore, as with the areas around both Ramsbury and Bedwyn, the existence of a population with strong British identity in the 5th century. As with Ramsbury, it seems reasonable to infer the continuity around Kintbury of the later Roman estate pattern through the 5th and 6th centuries, and the transference at an early date of the administrative functions of Speen and/or Roman Wickham to the site at Kintbury. Certainly by the early 10th century Kintbury was a *villa regalis* and the possessor of a minster church[138] as well as the head place of a hundred, and it was in a similar topographical position to Ramsbury. Its proximity to a Roman villa immediately to its east reinforces the inferences from its later Saxon history of its importance as an estate centre in the early and middle Saxon periods.

The Hundred of Lambourn has already been pointed out as being an example of a large discrete estate which has survived in all probability from the Iron Age.[139] The parish of Lambourn has always been a separate Hundred (the parish of East Garston was only separated from it in the 11th century) — a fact which in itself would indicate that its centre was a *villa regalis*.[140] It was mentioned in King Alfred's will, and was royal demesne in 1086. Both Roman and early Saxon occupation material has been found near the village,[141] and through its southern part runs the Roman road from Speen to Wanborough, which its boundaries do not follow. There is therefore good reason to infer the continued existence of this estate from the late Roman period, if not earlier. Since this time it has undergone less change than the three estates centred on Ramsbury, Bedwyn and Kintbury.

There were therefore at least in the later Saxon period four contiguous royal estates spanning the Kennet valley and fertile chalk lowlands which it is reasonable to suggest had at this time been in existence as discrete estates since the late Roman or early post-Roman period. They occupied a tract of country in which there is evidence both of a high density of Roman settlements, ranging in significance from a fortified town and route centre downwards, and of the survival of a British population through the 5th century. There seems no reason to suppose that the capacity of this population to manage the resources of these estates was in any way inferior to that of their Roman predecessors. It can be suggested therefore that the origin of these four estates lay at the very latest in the agglomeration of smaller Roman villa-estates into larger units which must have survived as self-sufficient entities virtually unchanged until the same pattern once again becomes visible in the evidence of their refragmentation from the 8th century onwards.[142] The centres of these Roman estates can also be seen as developing into *villae regales* arguably at an early date on sites which bear a direct topographical relationship to their Roman predecessors. Indeed, it is only by supposing the existence of these *villae regales* at Ramsbury and Bedwyn by the late 9th century that it is possible to place in context both the foundation of the bishop's seat at Ramsbury in 909, the reuse of Chisbury hillfort as a burghal hidage fortress[143] not very much earlier, and the development at Bedwyn of a small urban centre from probably the late 9th or early 10th century.[144]

Further support is given to this hypothesis by the names of these places. All four have incorporated at some time the name element *-bury* or *-byrig*. Gelling has remarked of Kintbury (*Cynetanbyrig*, *c.*935, 'fortified site on the river Kennet') that it is one of only five examples in Berkshire where the *-burh* element has the sense of 'fortified dwelling';[145] Lambourn is described in a charter of 1030 as *byri haeme tun*;[146] Ramsbury is first mentioned in 947 as *Rammesburi*, 'Raven's burh';[147] and Bedwyn was, as already mentioned, in more than one way closely connected to Chisbury hill-fort (*Cissanbyrig* — early 10th century). If the last element in the name Kintbury refers to the existence of a fortified (presumably royal) residence, a situation paralleled in other references which go back to the reign of King Ine,[148] then there is some reason for supposing that it has the same meaning in the other names.[149] At Lambourn there is a possibility that the physical existence of this fortified unit has survived in the present topography.[150] If Cissa's 'metropolis' were situated at Bedwyn in the late 7th century, it seems not unreasonable to suppose that the name *Cissanbyrig*, applied in the 10th century to the hillfort when it became a burghal hidage fortress, could have referred at a rather earlier date to the *villa regalis* at its foot. Finally, at Ramsbury, there is no prehistoric fortified hilltop nearer than Membury fort, 5 km to the north-west; one is therefore forced almost by default to suggest that the last element in its name refers in fact to a fortified royal residence which, as has been argued, is very likely to have been in existence there from at least the time of the formation of the West Saxon kingdom.

If therefore Ramsbury was in the early 9th century an important *villa regalis*, the long-established head of an extensive estate, it is not difficult to see why an iron smelting industry should have been set up there. Its establishment at Ramsbury must be seen as an attempt to meet the demands for iron artifacts by a large and very probably fully worked estate — an exercise, in fact, in efficient estate management. It is only surprising that evidence of similar activity of earlier and later periods was not found on the site, for there is no reason, given the full utilization of such estates throughout the Saxon period,[151] why their demand for iron products should not have been as great for instance in the 7th century as it clearly was in the 8th or the 9th.

The evidence cannot unfortunately establish unequivocally whether the iron, or the artifacts made from it, was or was not used on this estate alone; whether it was a commodity which was traded between different estates; or whether there was a widespread distribution of the products of the industry through a centrally placed market. What can be suggested however is that the type of estate of which Ramsbury and the other places discussed above were examples, would very likely have been a centre both for manufacture and for the secondary processing of agricultural products, as well as being a centre for at least local redistribution, even if only surplus products of the estate.[152] Such centres would therefore have had many of the functions which in a developed form would be considered as characteristic of urban communities.

It is perhaps no accident that almost without exception the many small towns which emerge in the south and west of England in the late 9th and 10th centuries, of which Great Bedwyn is a perfect example, developed on ancient royal estates either at or near the original estate centres.[153] Ramsbury demonstrates archaeologically the reality of such economic developments a century earlier than the period to which the beginnings of urbanization (in centres away from major coastal towns such as Hamwih) is usually assigned. Perhaps therefore the origin of many of the later Saxon urban centres lies not in the deliberate foundation by royal authority of new 'towns' on virgin sites where no trade had existed before (such as could possibly be said for instance of Cricklade or one or two other burghal hidage burhs, or for many medieval new towns), but rather in the gradual development, perhaps by royal encouragement, of functions which had already been characteristic in one form or another of settlements at the centre of large royal estates for several centuries.

NOTE

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NOTES

[1] Ancient Monuments Laboratory, Department of the Environment.

[2] Professor of Archaeometallurgy, Institute of Archaeology, University of London.

[3] *V.C.H. Wilts.*, II (1955), 27–30.

[4] The excavation was supported by the Department of the Environment through the Wiltshire Archaeological Committee. The excavator (J.H.) is grateful to the officers of both bodies (in particular Christopher Young and Desmond Bonney) for support given during the excavation. He also thanks the Libraries and Museums Department of the Wiltshire County Council, and Bill Ford and Mike Corfield, for help during the excavation and for the supply of materials and conservation work on the finds on its completion. Further

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[5] Finds and excavation records are deposited in Devizes Museum.

[6] P. Barker, 'Some aspects of the excavation of timber buildings', *World Archaeology*, 1, no. 2 (1969), 233.

[7] M. Biddle and B. Kjolbye-Biddle, 'Metres, areas and robbing', *World Archaeology*, 1, no. 2 (1969), 212.

[8] This will be described elsewhere.

[9] H. Cleere, 'Cyclical operations at Roman bloomeries', *Bull. Historical Metallurgy Group*, 5, no. 2 (1971), 74–75.

[10] Ibid.

[11] These are deposited with the excavation records in Devizes Museum.

[12] This clay appears to contrast visually with the dull brown colour of the natural Clay-with-Flints, though the analysis of a sample of furnace lining (Section 2 below) shows it to have been made from this local clay. The possibility remains that two sources of clay were utilized, a non-local clay probably without chalk being used for some of the furnace linings.

[13] This corresponds well with the model deduced from practical experiments in bowl furnaces of this type and described by Tylecote (R. F. Tylecote, *Metallurgy in Archaeology* (1962), 185–86). The use of clay relinings within iron-smelting furnaces of this type has been recorded from Iron Age and Roman examples (A. Fox, 'Excavations at Kestor', *Trans. Devonshire Assoc.*, 86 (1954), 21–62; Tylecote, ibid., 228; D. A. Jackson and T. M. Ambrose, 'Excavation at Wakerley, Northants. 1972–75', *Britannia*, 9 (1978), 151–66).

[14] This is demonstrated particularly well in the colour slides taken at all stages of excavation of the furnaces (see note 11, above).

[15] Microscopical examination by Justine Bayley at the Ancient Monuments Laboratory showed this material to have had a significant content of flint, the rest comprising some quartz sand, some clay in lumps or aggregates, and finely divided charcoal. Part of the clay component was reduced-fired, but much was hardly heated at all. It seems probable that the flint, in particular, was chosen (and even crushed) and incorporated to improve the refractory properties of the furnace linings.

[16] The term 'dome' in this context means a shell, self-supporting when fired, with a hole at the top, which covers the furnace like a matching inverted bowl.

[17] Observations on present-day primitive furnaces and on the firing of experimental examples have shown that such furnaces will only work if the top hole is not too large, and if they are built with a certain minimum ratio of height to diameter.

[18] Tylecote, op. cit. note 13, 201; H. Cleere, 'The classification of early iron-smelting furnaces', *Antiq. Jnl*, 52 (1972), 8–15.

[19] In Roman furnaces, where the bloom and furnace bottom were removed from the front, the frontal arch was always the most vulnerable part of the furnace, and often rebuilt (cf. Jackson and Ambrose, op. cit. note 13). Although in this furnace at Ramsbury the bloom and furnace bottom were probably removed after each firing from the top aperture, this area was restructured twice (see below, p. 26).

[20] See comments in note 19 above.

[21] Tylecote, op. cit. note 13, 241, 254, 266; Cleere, op. cit. note 18, 20.

[22] I am grateful to Caroline Washbourne who has kindly discussed this material with me.

[23] This contrasts with the end date of the late 7th–early 8th century for this pottery from Saxon Southampton and southern Hampshire (P. E. Holdsworth, 'Saxon Southampton, a new review', *Medieval Archaeol.*, 20 (1976), 51). Further groups from Wiltshire of the same general type, one from Ogbourne St George, only 7 km NW. of Ramsbury, have been described by Fowler (P. J. Fowler, 'Two finds of Saxon domestic pottery in Wiltshire', *Wiltshire Archaeol. Mag.*, 61 (1966), 31–37). The Swindon finds are to be published by Caroline Washbourne.

[24] M. Biddle, 'The excavation of a Motte and Bailey Castle at Therfield, Hertfordshire', *J. Brit. Archaeol. Assoc.*, 27 (1964), 82. See also J. Parkhouse, 'The Dorestadt Quernstones', *Berichten van de Rijksdienst voor het Oudheidkundig Bodemonderzoek*, 26 (1976), 181–89.

[25] B. Almgren, *Bronsnycklar och Djurornamentik* (1955), tables I–III and plates.

[26] Ibid., 106, fig. 7–8, E25, E33 and E34, table II, G6; *Archaeologia*, 89 (1943), 66, figs. 17, 2, and 5.

[27] Almgren, op. cit. note 25, 28; D. M. Wilson, *Anglo-Saxon Ornamental Metalwork 700–1100 in the British Museum* (London, 1964), 57.

[28] Ibid., 27–29, 62–63.

[29] *Records of Buckinghamshire*, XX, pt. 2 (1976), 247–48, fig. 39, 1, pl. V, lower left.

[30] E. Bakka, 'Some English decorated metal objects found in Norwegian Viking graves', *Årbok for Universitetet i Bergen, Hum. Ser.* (1963), 1, 40, figs. 38–39; *Archaeologia*, 97 (1959), 77, fig. 10, 2.

[31] *Archaeologia*, 89 (1943), 57, fig. 11, 1, 9, 10 and 14.

[32] Ibid., fig. 11, 5 and 6–12.

[33] *Report of the Colchester and Essex Museum 1947/8*, 27, pl. IX, 5.

[34] *Antiq. Jnl*, XLIX (1969), fig. 3, 1.

[35] *Proc. Cambridge Antiq. Soc.*, LXIV (1973), 95, fig. 18, 8.

[36] *Archaeologia*, 89 (1943), fig. 11, 2.

[37] *Berkshire Archaeol. Jnl*, 61 (1963–64), 28–36.

[38] *Antiq. Jnl*, XXII (1942), 221, fig. 32; *Archaeol. Jnl*, CXIX (1962), 186–87.

[39] *Trans. Hist. Soc. Lancashire and Cheshire*, 112 (1960), 12, fig. 4c.

[40] Wilson, op. cit. note 27, pl. XVII, 12.
[41] In the Yorkshire Museum, York.
[42] K. Eldjarn, *Kuml og Haugfé* (1956), 337, fig. 155; H. Arbman, *Birka*, I (1940), taf. 86, 4 and taf. 87, 2.
[43] *Trans. Hist. Soc. Lancashire and Cheshire*, 112 (1960), fig. 4, 6.
[44] Arbman, op. cit. note 42, taf. 86, 6.
[45] T. Capelle, *Der Metallschmuck von Haithabu* (1968), taf. 24, 3–5.
[46] Ibid, taf. 24, 4.
[47] H. Jankuhn, *Die Ausgrabungen in Haithabu* (1943), 114, abb. 43b; Capelle, op. cit. note 45, 75, taf. 24, 3–5.
[48] P. Rahtz, *The Saxon and medieval palaces at Cheddar* (B.A.R. British series 65, 1979), fig. 95, 90.
[49] B. Cunliffe, *Excavations at Portchester Castle.* II, *Saxon* (1975), 216, fig. 136, 52; *Medieval Archaeol.*, 8 (1964), 62, fig. 17, 1.
[50] R. G. Collingwood and I. Richmond, *The Archaeology of Roman Britain* (1969), pl. XX, v; J. Petersen, *Vikingetidens Redskaper* (1951), fig. 61, 5; J. Graham-Campbell and D. Kidd, *The Vikings* (1980), fig. 71.
[51] A. C. C. Brodribb *et al.*, *Excavations at Shakenoak*, III (1972), fig. 42, 192; B. Faussett, *Inventorium Sepulchrale* (1856), pl. XV, 2); D. M. Wilson (ed.), *The Archaeology of Anglo-Saxon England* (1976), 264, fig. 6, 6.
[52] Cf. W. H. Manning, *A catalogue of Romano-British ironwork in the Museum of Antiquities, Newcastle upon Tyne* (1976), fig. 14, 51.
[53] R. E. M. Wheeler, *London and the Vikings* (1927), fig. 1, 15.
[54] P. V. Addyman, 'Archaeology and Anglo-Saxon Society', with a note by I. H. Goodall on iron tools, *Problems in Economic and Social Archaeology*, ed. G. de G. Sieveking, I. H. Longworth and K. E. Wilson (1976), 319–20.
[55] Brodribb, op. cit. note 51, fig. 52, 315.
[56] R. A. Hall (ed.), *Viking Age York and the North* (C.B.A. Research Report, No. 27, 1978), fig. 26, 3 and 4.
[57] M. Claus, W. Haarnagel and K. Raddatz, *Studien zur europäischen Vor- und Frühgeschichte* (1968), 148, fig. 2, g; Wilson, op. cit. note 51, 257, fig. 6, 2g.
[58] Petersen. op. cit. note 50, fig. 116.
[59] A. C. C. Brodribb *et al.*, *Excavations at Shakenoak*, IV (1973), fig. 59, 416.
[60] Ibid., fig. 59, 409–12.
[61] *Archaeol. Cantiana*, LXX (1956), 132, fig. 13, 2.
[62] T. C. Lethbridge, *A Cemetery at Shudy Camps, Cambridgeshire* (1936), 23, fig. 11.
[63] Petersen, op. cit. note 50, 419–21, fig. 223; Graham-Campbell and Kidd, op. cit. note 50, 193, item 42.
[64] Brodribb, op. cit. note 51, 90, fig. 39, 166.
[65] R. Bruce-Mitford, *The Sutton Hoo Ship-burial*, I (1975), 121, fig. 80.
[66] Ibid., fig. 279.
[67] G. Baldwin Brown, *The Arts in Early England*, III (1915), 150, pl. XI, 6.
[68] B. Hope-Taylor, *Yeavering. An Anglo-British centre of early Northumbria* (Department of the Environment Archaeological Reports No. 7, 1977), 193, fig. 91.
[69] S. E. West, 'Excavations at Cox Lane (1958) and at the Town Defences, Shire Hall Yard, Ipswich (1959)', *Proc. Suffolk Inst. Archaeol.*, XXIX (1963), 274, fig. 54, 16.
[70] P. V. Addyman and D. H. Hill, 'Saxon Southampton: a review of the evidence, part 2', *Proc. Hampshire Field Club*, XXVI (1969), 65, fig. 24, 5.
[71] Cunliffe, op. cit. note 49, 197, fig. 130, 8.
[72] Ibid., 88–89.
[73] Manning, op. cit. note 52, fig. 22, 131, 135 and 137.
[74] *Yorkshire Archaeol. Jnl*, 34 (1939), 273–81.
[75] K. Lamm, *Jnl Hist. Metallurgy Soc.*, 7 (2) (1973), 7.
[76] Tylecote, op. cit. note 13, 55, table 7.
[77] G. Beresford, *The medieval clay-land village* (Society for Medieval Archaeology, Monograph No. 6, 1975), 81.
[78] Tylecote, op. cit. note 13, 180 and table 64. See also Section 8.
[79] J. Bourdillon and J. Coy, 'The animal bones', P. Holdsworth, *Excavations at Melbourne Street, Southampton, 1971–76* (London, C.B.A. Research Report No. 33, 1980), 79–121.
[80] A. von den Driesch, *Das Vermessen von Tierknochen aus vor- und frühgeschichtlichen Siedlungen* (University of Munich, 1976).
[81] Available from S.A.R.C., 25A Oxford Street, Southampton.
[82] N. J. L. Griffith, The animal bones from Knight's Enham, Andover (Report to the Ancient Monuments Board Laboratory, no. 2430, 1976).
[83] J. Coy, 'The role of wild fauna in urban economies in Wessex', *Environmental archaeology in the urban context*, eds H. Kenward and A. Hall (C.B.A., forthcoming).
[84] The only remains of wild animals were red deer (4 fragments), roe deer (2 fragments), badger (1 fragment) and peregrine falcon (1 fragment).
[85] H. Reichstein und M. Tiessen, 'Materialen zur Kenntnis der Haustiere Haithabus', *Berichte über die Ausgrabungen in Haithabu*, 7 (1974), 9–101.
[86] R. A. Harcourt, 'The animal bones', G. J. Wainwright, *Gussage All Saints, Dorset* (London, DoE, 1979), 153.
[87] J. A. Boessneck, 'Die Tierknochenfunde aus dem keltischen Oppidum von Manching', *Die Ausgrabungen in Manching*, 6 (Wiesbaden, 1971), 201.
[88] Using Joest's method described by K. H. Habermehl, *Die Alterbestimmung bei Haustieren, Pelztieren, u. beim jagdbaren Wild* (1961).

[89] For example the All Canning's Cross skull: P. L. Armitage and J. Clutton-Brock, *Jnl Archaeol. Science*, 3 (1976), 333.
[90] Ibid., 331.
[91] T. Hatting, 'The influence of castration on sheep horns', *Archaeozoological Studies*, ed. A. T. Clason (1975), 345–51.
[92] R. A. Harcourt, *Jnl Archaeol. Science*, 1 (1974), 151–75.
[93] Tooth eruption and wear data are taken from Habermehl's work, op. cit. note 88.
[94] For a detailed discussion of Saxon geese, see Bourdillon and Coy, op. cit. note 79.
[95] Coy, op. cit. note 83.
[96] Miss Jane Hassall excavated these from levels which mostly produced 11th and 12th-century pottery, but with an admixture of residual material which makes the dating of the beaver bones far from sure: T. C. Darvill and J. P. Coy, *Proc. Somerset Archaeol. and Nat. Hist. Soc.* (forthcoming).
[96a] P. E. Damon, A. Long and E. I. Wallick, 'Dendrochronological calibration of the carbon-14 time scale', *Proc. Eighth International Conference on Radiocarbon dating*, 1972.
[97] I am grateful to Bernard Philips for examining this material and giving me the benefit of his advice.
[98] The coins, of *c.* A.D. 268–70, and *c.* 307 are in the possession of Mr Blunt. I am very grateful to him for this information.
[99] H. J. Osborne-White, *The Geology of the Country around Marlborough* (Mem. Geol. Surv. Eng. & Wales, 1925), 80.
[100] G. W. Lamplugh, *The Geology of the country south and east of Devizes* (Mem. Geol. Surv. Eng. & Wales, 1905), 12. The deposits at Seend were quarried both in the Roman period and more recently (*V.C.H. Wilts.*, IV (1955), 250–52). Recent pits at NGR ST 937610 and ST 941611 show these outcrops clearly.
[101] W. J. Arkell, 'The Upper Oxford Clay at Purton, Wilts., and the zones of the Lower Oxfordian', *Geol. Mag.*, LXXVII, no. 3 (1941), 161–72; W. J. Arkell, *The Geology of the Country around Weymouth, Swanage, Corfe and Lulworth* (Mem. Geol. Surv. Eng. & Wales, 1947), 34.
[102] Tylecote, op. cit. note 13, 261–64.
[103] Parkhouse, op. cit. note 24, 187 and fig. 7.
[104] J. Parkhouse, 'Anglo-Saxon commercial connections with the continent with special reference to . . . basalt quernstones . . .' (unpublished M.A. thesis, Dept of Archaeology, Univ. of Manchester, 1977). I am grateful to Mr Parkhouse for allowing me to read his thesis.
[105] Addyman and Hill, op. cit. note 70, 81.
[106] A. and C. Fox, 'Wansdyke reconsidered', *Archaeol. Jnl*, 115 (1960), 16–18, 42.
[107] R. R. Darlington, 'Introduction to the Wiltshire Domesday', *V.C.H. Wilts.*, II (1955), 42–112.
[108] *OG* and *P* on Fig. 25.
[109] Darlington, op. cit. note 107, 62; H. C. Brentnall, 'The origins of the parish of Preshute', *Wiltshire Archaeol. Mag.*, 53 (1950), 295–310. See however comments about the possible Roman origin of Aldbourne parish below.
[110] *M* on Fig. 25. Land in both Mildenhall and Bedwyn was given by Cynewulf, king of the West Saxons, to his thegn Bica, between 757 and 786 (H. P. R. Finberg, *The early charters of Wessex* (1964), 71).
[111] B. W. Cunliffe, *Iron Age Communities in Britain* (1974), 262, fig. 13, 23; F. K. Annable, 'A bronze military mount from Folly Farm', *Wiltshire Archaeol. Mag.*, 70/71 (1975–76), 126–27.
[112] B. W. Cunliffe, 'Iron Age and Roman periods', *V.C.H. Wilts.*, I, ii (1973), 440.
[113] F. K. Annable, 'A late bronze buckle fragment from Cunetio', *Wiltshire Archaeol. Mag.*, 70/71 (1975–76), 128.
[114] Cunliffe, op. cit. note 112, 448.
[115] R. Reece, 'From Corinium to Cirencester — models and misconceptions', *Studies in the archaeology and history of Cirencester*, ed. A. McWhirr (B.A.R. British series 30, 1976), 70–71.
[116] Cunliffe, op. cit. note 112, 455–57.
[117] M. Biddle, 'Winchester, the development of an early capital', *Vor- und Früh-formen der europäischen Stadt im Mittelalter*, ed. H. Jankuhn, W. Schlesinger and H. Steuer (1973), 239.
[118] See comments and further references in T. Dickinson, 'British Antiquity', *Archaeol. Jnl*, 134 (1977), 407–408 and 135 (1978), 339–40.
[119] Annable, op. cit. note 113, 127–29.
[120] M. Gelling, *Place-Names of Berkshire* (English Place-Name Society, vols XLIX–LI, 1973), 800–12.
[121] For Roman remains, see *V.C.H. Wilts.*, I, i (1957), 22–23; for later discoveries: Wilts. Co. Council Sites and Monuments Record; belt buckle: *V.C.H. Wilts.*, I, ii (1973), 462; deserted medieval village: W.C.C. Sites and Monuments Record; placename: *The Place-Names of Wiltshire*, ed. J. E. B. Gover, A. Mawer and F. M. Stenton (English Place-Name Society, vol. XVI, 1970), 293.

An interesting parallel is the association on another nearby hilltop site (Round Hill Down, Ogbourne St George — *RHD* on Fig. 25) of the remains of a Roman building or settlement (WCC Sites and Monuments Record) and Saxon chaff tempered pottery (Fowler, op. cit. note 23, 31–32).
[122] C. J. Gingell, 'The excavation of an early Anglo-Saxon cemetery at Collingbourne Ducis', *Wiltshire Archaeol. Mag.*, 70–71 (1975–76), 93–98.
[123] See Section 7.
[124] For instance the shift from Cambridge to Chesterton, Great Casterton (Rutland) to Hambleton (C. Pythian-Adams, 'Rutland reconsidered', *Mercian Studies*, ed. A. Dornier (1977), 75), Caistor-by-Norwich to Thorpe, near Norwich (J. Campbell, 'Norwich', *Historic Towns Atlas*, ed. M. Lobel, vol. 2 (1975), 2 and note 18), and, nearer to hand, Ilchester (Somerset) to Somerton.

[125] Similar survivals of Roman and earlier estates into the Saxon and later periods occur in Wiltshire for instance at Bradford-on-Avon and Westbury (J. Haslam, 'Saxon Towns in Wiltshire', *The Development of Anglo-Saxon Towns in Southern England*, ed. J. Haslam (forthcoming)) and in several instances around Cirencester (T. Slater, 'The town and its region in the Anglo-Saxon and medieval periods' in McWhirr (ed.), op. cit. note 115, 86–89). Several of these were the centres of early Hundreds, the sites of both Iron Age hill-forts and early minster churches, and situated on royal estates. See other examples cited in P. J. Fowler, 'Agriculture and rural settlement', Wilson (ed.), op. cit. note 51, 31–44.

[126] O. G. S. Crawford, 'The Anglo-Saxon bounds of Bedwyn and Burbage', *Wiltshire Archaeol. Mag.*, 41 (1922), 282–92.

[127] Ibid., 292–97.

[128] H. C. Brentnall, 'Bedwyn in the 10th century', *Wiltshire Archaeol. Mag.*, 52 (1948), 363.

[129] H. Cam, 'Manerium cum Hundredo: the Hundred and the Hundredal manor' (1932), reprinted in *Liberties and Communities in Medieval England* (1944), 68 and note 14.

[130] F. M. Stenton, *The early history of Abingdon Abbey* (1913), 17–18.

[131] Ibid., 18; Gelling, op. cit. note 120, 841. A contrary opinion was given by Gover, Mawer and Stenton (op. cit. note 121, 335), who stated that 'this story does not belong to the older stratum of Abingdon tradition, and has no historical value'. It is quite clear, however, that Stenton himself (op. cit. note 130, 18) regarded the outlines of the story as reflecting historical realities.

[132] Fox and Fox, op. cit. note 106, 18–20.

[133] Cunliffe, op. cit. note 112, 431, 436.

[134] Gelling, op. cit. note 120, 809; D. J. Bonney, 'Early boundaries in Wessex', *Archaeology and the Landscape*, ed. P. J. Fowler (1972), 168–86. Further instances have been reviewed by Fowler (op. cit. note 23, 36–44). That the Bedwyn estate outlined in Fig. 25 more or less corresponds with the catchment area of the Bedwyn stream suggests that it is of some antiquity, like similar early estates which followed natural watersheds — for instance around Cirencester (Slater, op. cit. note 125, 87), in Rutland (C. Pythian-Adams, op. cit. note 124), and like the kingdom of the Hwicce (W. J. Ford, 'Some settlement patterns in the central region of the Warwickshire Avon', *Medieval Settlement*, ed. P. Sawyer (1976), 278–79).

[135] *V.C.H. Berks.*, IV (1924), 156, 206–207.

[136] M. Gelling, 'English place-names derived from the compound *wicham*', *Medieval Archaeol.*, 11 (1967), 89, 96; Gelling, op. cit. note 120, 802–803.

[137] Ibid., 804.

[138] Op. cit. note 135, 207.

[139] Gelling, op. cit. note 120, 810.

[140] Cam, op. cit. note 129.

[141] G. Astill, *Historic Towns in Berkshire: an archaeological appraisal* (1978), 37.

[142] An opposite view is put forward with regard to the villa estates around Cirencester, where Reece postulates (op. cit. note 115, 74–75) that the run-down of the villas led to a dispersion of the farmworkers, leading in turn to a break-up of single estates into smaller units. However, the evidence for the survival of large estates does seem to be strong (see note 112), and it seems probable, in explanation, that political forces concentrating estates into large units, were more powerful than economic forces leading to the fragmentation of estates into smallholdings.

[143] N. P. Brooks, 'The unidentified forts of the Burghal Hidage', *Medieval Archaeol.*, VIII (1964), 75–78.

[144] J. Haslam, *Wiltshire Towns, the archaeological potential* (1976), 23. Brooks has suggested (op. cit. note 143, 76–79) that Bedwyn became a town because of its proximity to the burghal hidage fortress at Chisbury. However, both the construction of the fortress and the development of the town must be seen as being a direct result of the presence at Bedwyn of a *villa regalis* which was already ancient by the late 9th century, rather than that the presence of the burh was the cause of the growth of the town.

[145] Gelling, op. cit. note 120, 313, 923.

[146] Op. cit. note 135, 251.

[147] Gover, Mawer and Stenton, op. cit. note 121, 287–88.

[148] Brooks, op. cit. note 143, 83.

[149] The same inference can be made in the case of Bucklebury, Berks., an important *villa regalis*, the centre of a Domesday Hundred (*V.C.H. Berks.*, III (1923), 275–76) and a probable centre for late Saxon trade (Astill, op. cit. note. 141, 6–7; J. Richards, *The archaeology of the Berkshire Downs* (1978), 55); its name is one of the five in Berkshire containing the *-bury* name element which Gelling regards (op. cit. note 120, 923) as having the meaning of 'fortified dwelling'. Other instances in the area of the *-bury* element referring to royal dwellings include Kingbury Street, Marlborough, Kingsbury Square, Wilton (Haslam, op. cit., note 144, 41 and 67), and Kingbury, Old Windsor (*Medieval Archaeol.*, 2 (1958), 183–85; Astill, ibid., 70).

[150] Astill, op. cit. note 141, 37–38 and fig. 13.

[151] P. H. Sawyer, *From Roman Britain to Norman England* (1978), 144–49.

[152] A further example of such a concentration at this period is shown by the mills and buildings at Old Windsor attached to an important royal residence and estate (*Medieval Archaeol.*, 2 (1958), 183–85).

[153] J. Tait, *The Medieval English Borough* (1936), 50; H. Loyn, 'The origin and early development of the Saxon borough with special reference to Cricklade', *Wiltshire Archaeol. Mag.*, 58 (1961), 7–15; D. Hill, 'Trends in the development of towns during the reign of Ethelred II', *Ethelred the Unready*, ed. D. Hill (B.A.R. British series 59, 1978), 222.