

UNIVERSITY OF SOUTHAMPTON

FACULTY OF ARTS

ARCHAEOLOGY

Doctor of Philosophy

THE BRONZE CASTING INDUSTRY IN LATER PREHISTORIC SOUTHERN BRITAIN:
A STUDY BASED ON REFRACTORY DEBRIS

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III.10 BECKFORD, HEREFORD AND WORCESTER
(SO 980361; corpus no 24)

The extensive, nucleated, lowland settlement at Beckford is located on the gravel terrace of the Carrant Brook some 10km east of Tewkesbury. The hillforts of Bredon Hill, Danes Camp and Woolstone Hill are situated in the immediate vicinity. Salvage and rescue excavations began in 1972 and by the close of work in 1978, c 5.6ha had been recorded (fig III.10.1). Cropmarks similar to those excavated continue along the Carrant Brook to the north east and south west, but the precise relationship of these cropmarks to the settlement area is unknown.

Beckford belongs to that category of late iron age sites described by their size and economic importance as oppida (Champion, 1979, 374). Occupation began in the middle iron age, when a series of large ditched enclosures was constructed, each containing roundhouses, storage pit clusters and other internal enclosures. The ground plans and finds distributions suggest that each main enclosure constituted a separate, largely self-supporting unit, and there is no evidence of unit specialisation (Britnell, 1974). Interspersed among the enclosed areas were several sunken cobbled yards strewn with miscellaneous domestic debris. Evidence that craft activities took place on or near these yards is sparse. Eleven C14 dates have been obtained from middle iron age features, ranging from 460 ± 100 bc to 40 ± 70 bc (J Wills, pers comm). No dates are yet available from late iron age features.

A radical change in site layout took place during the late iron age, and this new plan continued in use into the Roman period. Again during the late iron age, new feature types, pottery styles and artefacts appeared. It is stressed, however, that these changes do not necessarily imply a period of abandonment, and occupation is believed to have been continuous from the middle iron age onwards (J Wills, pers comm). Analysis of both stratigraphy and artefacts from post-1975 excavations is still in progress.



Fig III.10.1 Plan of excavated features at Beckford
(after Britnell and Wills)

III.10.1 The metalworking evidence

Broken crucibles, mould fragments, sherds believed to be derived from furnaces or melting hearths, and occasional remains of tuyères were recovered from middle iron age, late iron age and Roman contexts at Beckford. All ceramic metalworking debris were found in secondary deposits and were not associated with other bronze casting residues (Britnell, 1974; Wills, pers comm). Reconstructable crucibles are few, but all seem to be small, and of the triangular variety common in iron age contexts. A single, almost complete crucible was recovered (samples BK 22, 23; 152115), measuring 63mm between pouring lips, and with a maximum depth of 30mm (fig III.10.2). This crucible would have held c 200cc of molten bronze when three-quarters full, and thus was suited only to the casting of pins, rings and similar small objects. Twelve crucible fragments, including the complete vessel, found in the "grain storage" pit 1521 represent the greatest concentration of refractory debris on the site (fig III.10.1). No metalworking area was located, and slagged furnace or hearth sherds, believed to have been associated with bronze casting, were found, like the crucibles and moulds, in refuse contexts. Abraded mould fragments occurred far less frequently than crucible sherds. Where matrices can be identified, these appear to have been designed exclusively to cast rings, probably associated with horse-gear.

A range of objects cast in both bronze and iron has been recovered from features of all types and periods. These objects include tools, nails, fibulae, pins, tweezers, handles and bindings. Distribution plans of the various metal artefacts are not yet available.

III.10.2 Analytical results (see Table III.10.1)

The crucibles

All crucible sherds recognised by the excavators were examined by the writer in hand specimen. Fabrics are generally fine, exceptionally sandy and invariably hard-fired. Thermal analysis of a sample from the complete crucible 152115 indicates a firing temperature in the range 1000-1200°C (C M Wilson, pers comm), and consistent fabric hardness and paste vitrification suggest this range is applicable to the rest of the assemblage. Heavy slagging often precludes the determination of fired

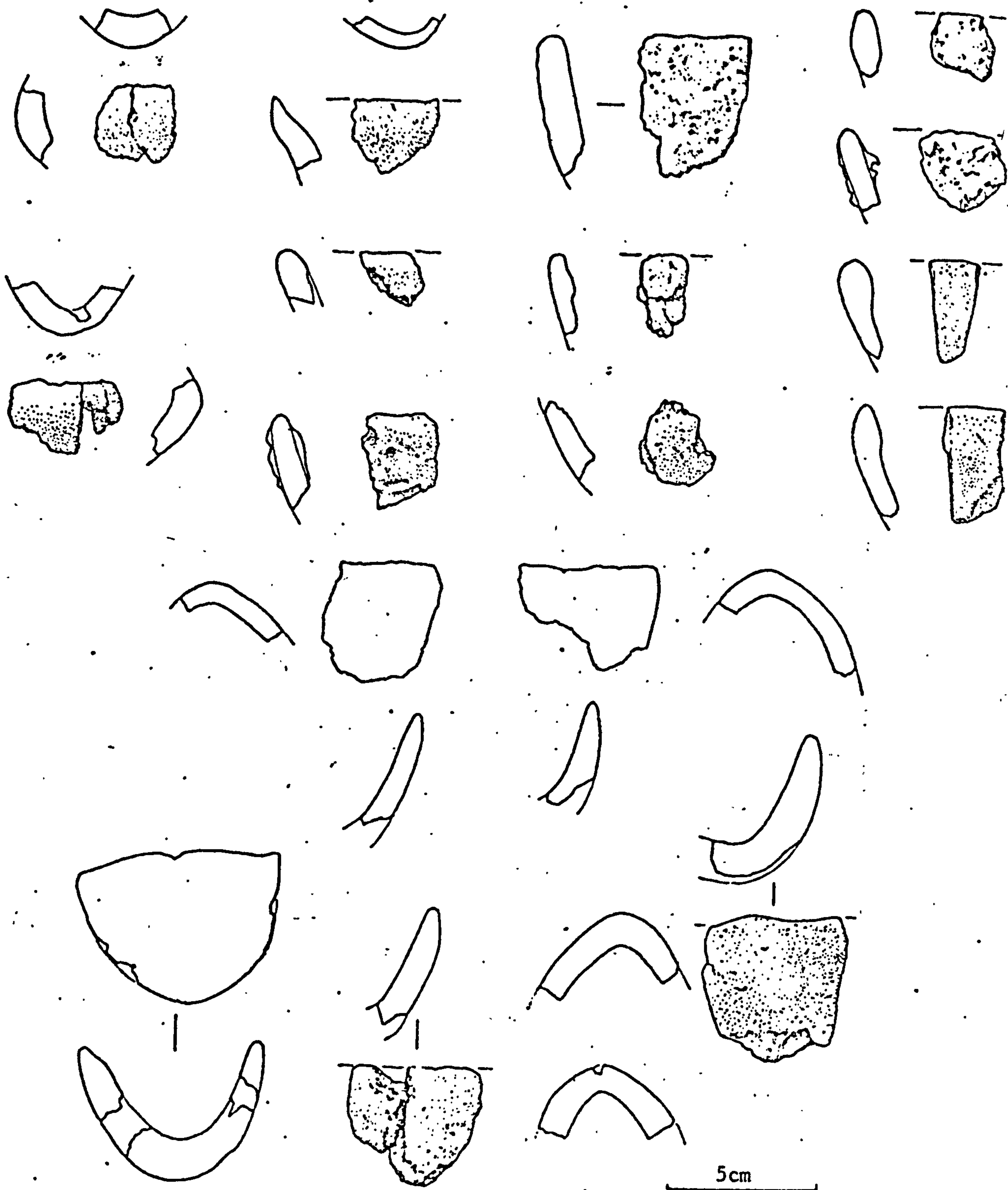


Fig III.10.2 Beckford: iron age crucible sherds (drawing provided by W Britnell).

colours, but where these can be seen, they range from pale purplish-grey, through mid-grey to black. Black cores predominate throughout the assemblage. Most samples are well-formed and smoothly finished. Fabric texture ranges from open and porous to fine and dense, although texture is often obscured by partial vitrification. In fresh fracture, organic inclusions, varying from tiny flecks of charcoal to elongate fragments up to 1.5mm in length, are clearly visible in many samples. Some sherds additionally contain a scatter of soft white inclusions which effervesce strongly with dilute HCl.

The fine-grained nature of many of the crucible sherds, and the frequent occurrence of slag penetration and vitrification rendered definitive macroscopic fabric determinations very difficult. However, a working classification was made, based on the presence or absence of organic inclusions and the occurrence of effervescent carbonate. Sherds representing the three groups thus defined (charcoal dominant; sand with ? charcoal; sand with carbonate and charcoal) were selected for thin section analysis. Microscopic examination revealed considerable technological complexity, and it was necessary to subdivide the original fabric groups.

1. Group 1: charcoal/carbon dominant (fig III.10.3)

1a (BK 17, 39a) The isotropic matrix contains abundant burnt organic material, and an extremely sparse scatter of tiny (0.01-0.02mm) quartz grains. Only six such grains are visible in sample BK 39a. Although both sherds effervesce slightly with HCl, no carbonate is visible in thin section. From examination of the matrix, it may be suggested that carbonised organic material was pounded and mixed with a small proportion of fine, silty, calcareous clay, for the preparation of this crucible fabric.

1b (BK 5, 19, 20, 21, 51b) These samples are similar in thin section to group 1a, but here the carbon has been more thoroughly pounded and no organic fragments are discernable in the matrix. Quartz grains (again 0.01-0.02mm) are slightly more abundant, suggesting the selection of a different binding clay (Plate 8a).

1c (BK 36b) The isotropic matrix of this sample contains, like group 1a, abundant powdered charcoal and occasional tabular fragments of burnt organic matter. Quartz content is similar to that of group 1b, but rare larger, rounded quartz grains are scattered throughout the matrix.

1d (BK 13) This sample is again composed of powdered charcoal mixed with clay, and no larger organic particles are present. In addition to large, rounded quartz grains, sample BK 13 also contains fragments of metamorphosed siliceous sandstone and a single subrounded grain of pale brown cryptocrystalline silica, perhaps chert.

1e (BK 15, 36a, 43, 44) This fabric represents a different preparation technique. Here, abundant tabular fragments of charcoal (to 1.0mm) have been added to a silty, almost inclusion-free clay. A sparse scatter of rounded quartz of variable size is present, together with rare, elongate fragments of microcrystalline limestone. The orientation of inclusions in this fabric suggests the vessels may have been turned or finished on the wheel.

2. Group 2: sand dominant

2a (BK 1, 7, 8, 9, 11, 14, 16, 18, 40, 49, 53) These samples are essentially composed of well-sorted quartz sand bound with a variable, but normally small quantity of slightly micaceous clay (Plate 8d). Minor amounts of carbon occur throughout, although it is not always possible to suggest whether this was accidentally or deliberately incorporated. Powdered charcoal occurs sporadically throughout the matrix of BK 1, whilst the remaining samples contain a little of this material, together with a sparse or very sparse scatter of tabular carbonised fragments rarely exceeding 0.2mm in length. All matrices are isotropic and high-temperature firing is attested by incipient liquid state sintering visible in BK 14 and 40. BK 49 is completely vitrified. Most samples contain occasional detrital minerals including tiny grains of epidote, and both microcline and plagioclase feldspar, implying a sand source of glacial origin. Grain size and density measurements show some variation within this group, suggestive of different manufacturing episodes if not of different raw material sources (fig III.10.3).

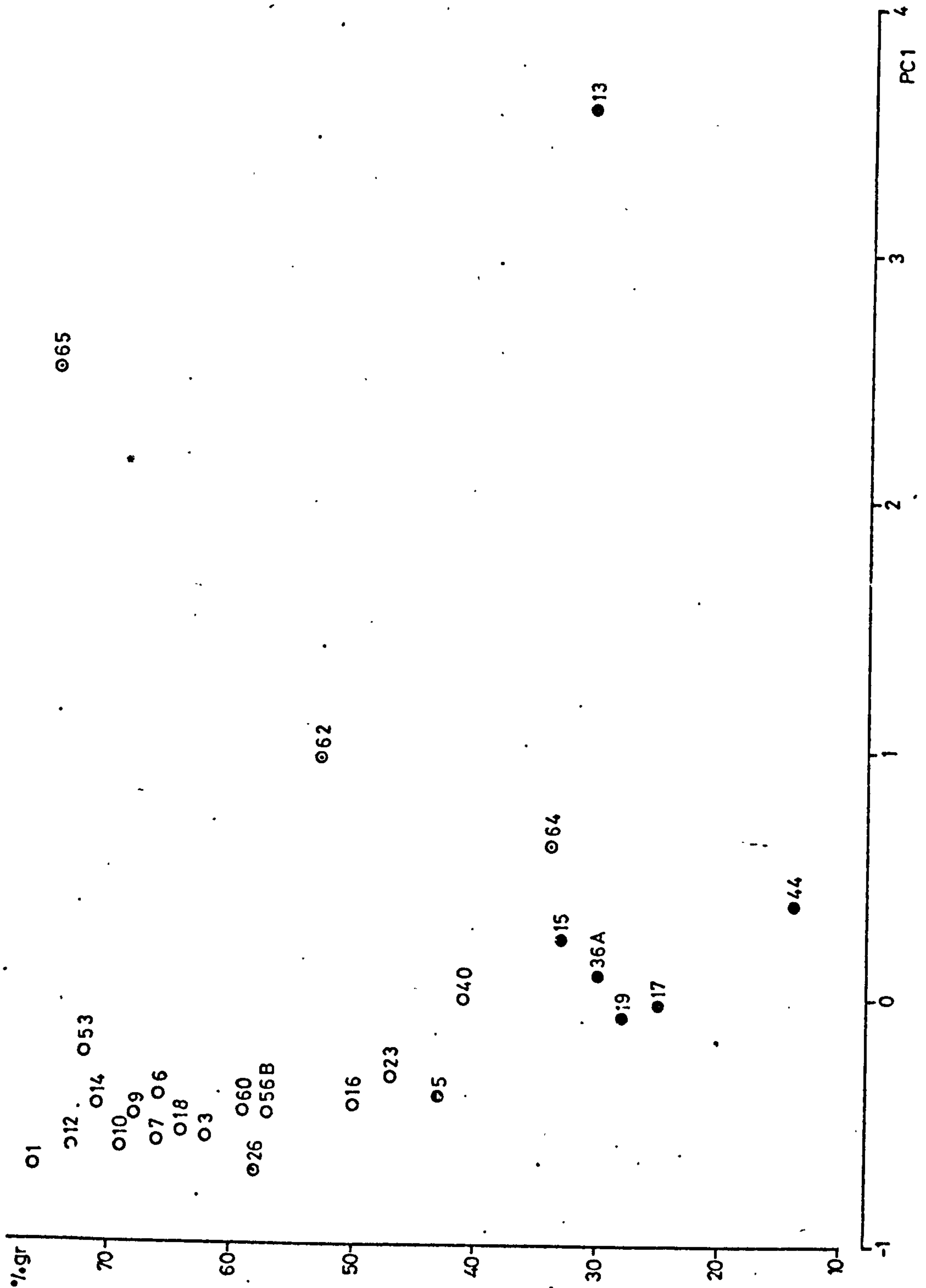


Fig III.10.3 Beckford: sand fabric (O) and charcoal fabric (●) crucible sherds, two mould (64, 65), one furnace (26) and one unidentified (62). Sherds are plotted against grain size (expressed by scores on the first principal component extracted from the ϕ^2 counts) and proportion of grains:matrix. The coarse furnace sherd BK 51c was omitted from the analysis.

2b (BK 2, 3, 4, 6, 22/23, 56) Group 2b samples again contain abundant (up to c 65%) rounded and subangular quartz sand. Grain size is generally less than 0.1mm, but larger rounded grains are visible in each section examined. These samples additionally contain an even scatter of organic material to c 0.5mm, and a little powdered charcoal is incorporated into the generally isotropic clay matrices. The group is distinguished by elongate fragments (to c 1.0mm) of yellowish cryptocrystalline limestone, which occur with similar frequency to the organic inclusions. Mica is extremely rare in these samples, and a calcareous binding clay seems to have been preferred.

2c (BK 10, 12) These samples each contain about 70% fine subangular quartz sand set in a ferruginous isotropic clay matrix. The binding clay is micaceous. Carbon is extremely rare, and the few flecks which do appear are likely to have been incorporated by accident. Patches of iron oxide and fine ferruginous clay pellets are scattered throughout both samples. Sherds 10 and 12 were found in close proximity on yard 4 and it is suggested that they may derive from the same vessel.

The moulds

Three fragments, all derived from iron age ring moulds, were analysed. Mould BK 51a is reduced throughout its thickness and appears coke-like and vitrified, indicating accidental burning. The remaining two sherds, BK 64 and 65, were designed to cast rings of different sizes. Both are well-finished; extremely hard-fired; the casting faces are reduced to dark grey, presumably through contact with the molten metal; and the outer surfaces are oxidised (BK 64 = 5YR 6/6; BK 65 = 5YR 6/4). The two unvitrified sherds represent two different mould fabrics.

1. Fabric 3 (BK 64)

This fabric is extremely fine and appears inclusionless under a 10x lens. In thin section the partially isotropic slightly micaceous clay matrix is seen to contain a scatter of mainly fine quartz grains and occasional tabular fragments of carbonised organic material. The regular form of these fragments suggests that they were deliberately

added as filler. The density of quartz inclusions is low compared to most other iron age moulds examined (fig III.10.3).

2. Fabric 4 (BK 65)

This fabric is characteristically coarser, and feels harsh to the touch. Rounded sand grains are clearly visible in hand specimen. Under the microscope, the sparse clay matrix is completely isotropic, and contains abundant ill-sorted, rounded and subangular quartz grains, some of which are heat crazed. Two tiny fragments of shale and a single (0.04mm) grain of plagioclase felspar presumably derive from the sand deposit used for the production of this mould category. The results of grain size and density analysis clearly show that this deposit was different from that exploited for sand crucible making (fig III.10.3).

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Sherd 51a was thin sectioned, and as suspected, was found to be almost completely vitrified. Inspection of the rare zones of partial vitrification, however, suggests that abundant quartz sand of a smaller grain size than that used for BK 65, was employed in the manufacture of this mould.

? Furnace (BK 37, 39b, 51c, 63, 67, 69)

Six amorphous sherds, believed to represent metallurgical furnace debris were examined for this study. Considerable variety and degrees of vitrification were observed in hand specimen. Sherd BK 69, for example, is soft and powdery, whilst BK 39b is heavily slagged. Thin section analysis confirmed a bronzeworking association for sherds BK 37, 39b and 67. All three matrices are heavily stained with copper oxides. The clay used for these pieces, together with BK 51c, closely resembles that employed for certain daub making at Beckford. Daub sample 'BAW' (all daub samples examined are numbered and kindly supplied by E Morris) and the furnace sherds are all formed from a clay containing rounded quartz sand, opaque iron ore and frequent fragments of limestone. This material is likely to be local to the site. Samples BK 63 and 69 on the

other hand are unstained and formed from a fine grained micaceous clay unparalleled among the daub sample collection. The identification of these pieces (unvitrified; matrices anisotropic) must remain in doubt.

III.10.3 Discussion

The eight Beckford crucible 'fabrics' represent as many vessel making sessions, and thus, perhaps, casting episodes. However, these eight 'fabrics' reflect but three distinct technologies. Fabrics 1a-1d are differentiated by minor variations in quartz content and the preparation of organic material. All could conceivably have been produced by one metalworker or metalworking group over a short time span. Fabric 1e has been prepared quite differently, and almost certainly represents a different, though still related, production tradition. The appearance of sand dominated Fabric 2 heralds a technological change. In J Wills' excavations, this fabric tends significantly to occur in late iron age and early Roman features ($\chi^2_1 = 15.63$), and the change would therefore seem to be chronologically rather than spatially defined:

	middle iron age	late iron age/Roman
carbon fabrics	17	3
sand fabrics	1	9

At the time of writing, detailed contextual information is not available for the debris from the area excavated by W Britnell. Fabrics 2a-2c are, like Fabrics 1a-1d, variants of the same technique, although the presence of carbonate in Fabric 2b is indicative of variable raw material exploitation.

It may thus be argued that at least two metalworking groups were active at Beckford during the middle iron age, and that the later iron age casters were versed in different production techniques. Scattered organic inclusions in Fabric 2 do, however, suggest some continuity of tradition. Exactly when the postulated carbon to sand technological change took place, and whether this was related to a hiatus in occupation, it is not possible to ascertain.

The spread of the various Fabric 1 sherds across the site suggests that metalworking took place at more than one location during the 'charcoal paste' period. In situ evidence of industrial activity, however, has not been recovered. Differently located casting facilities are unlikely to have been contemporary, unless the site produced bronze work for a wide area or to serve an extensive exchange network. The relative paucity of metallurgical finds (only c 50 crucible sherds were found over a 5.6ha excavated area) militates against this interpretation. On the basis of the available evidence, it seems likely that the Fabric 1 variants represent sequential casting episodes, and that the location of activity changed through time.

Vitrified mould sherd BK 51a was found with a Fabric 1b crucible (BK 51b) in a middle iron age boundary ditch. Mould BK 65 and crucible BK 21, again a Fabric 1b vessel, were found in association in a ditch layer above that which contained a charcoal sample dated to 220 ± 70 bc (HAR 1388). Mould fragment BK 64 predates a context dated to 310 ± 100 bc (HAR 1162). Crucible BK 13 also predates the latter context. Thus, all mould sherds examined (and hence the three mould fabrics) have middle iron age associations, although it is possible that the quartz and carbon tempered Fabric 3 was in use earlier than the sand Fabric 4, and the 'small quartz' fabric represented by sherd BK 51a.

Clays used for furnace building seem to have been obtained, like the daub, in the vicinity of the site. However, the sources of mould and crucible materials are, at present, unknown. The heterogeneity of the geology surrounding Beckford (fig III.10.4), the variety observed within the daub samples (all presumably locally derived), the difficulties encountered in characterising almost all the 41 established iron age and Roman pottery groups (Tomber, 1981a; 1981b), and the use of carbon for a substantial portion of refractory production, all combined to suggest that raw material sampling unless conducted on a massive scale, would yield no useful results.

In conclusion, the Beckford refractory assemblage has produced a certain amount of information concerning crucible and mould making during the middle and late phases of the iron age. However, a detailed assessment of bronze casting organisation at the site is beyond the bounds

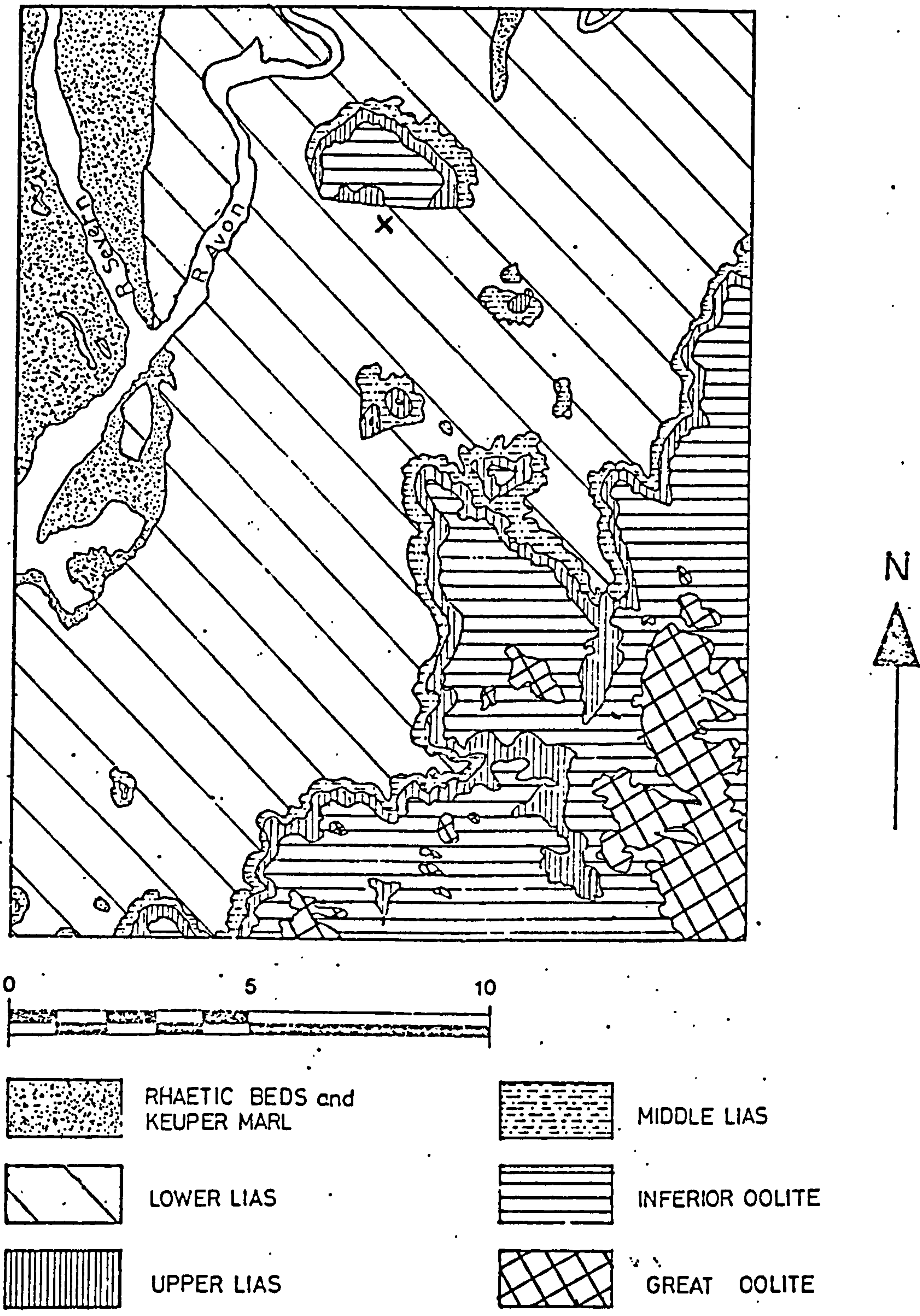


Fig III.10.4 Geology around Beckford..

of currently available archaeological evidence.

TABLE III.10.1 BECKFORD: CONCORDANCE OF REFRACTORY SHERDS

Sample number	Excavation number	Context date	Identification
BK 1	BD 380291	IA	crucible; pouring lip
BK 2	BD 152125	IA	crucible
BK 3	BD 152123	IA	crucible
BK 4	BD 381803	IA	crucible; wall sherd
BK 5	BD 385011	IA	crucible
BK 6	BD 152126	IA	crucible
BK 7	BD 152120	IA	crucible)
BK 8	BD 152120	IA	crucible) possibly the same vessel
BK 9	BD 152119	IA	crucible
BK 10	BD 380907	IA	crucible
BK 11	BD 152127	IA	crucible
BK 12	BD 380934	IA	crucible
BK 13	BD 289407	IA	crucible
BK 14	BD 152118	IA	crucible
BK 15	BD 383932	IA	? crucible
BK 16	BD 152116	IA	crucible
BK 17	BD 200103	IA	crucible
BK 18	BD 152117	IA	crucible
BK 19	BD 298430	IA	crucible
BK 20	BD 276501	IA	crucible
BK 21	BD 383200	IA	crucible
BK 22	BD 152115	IA	crucible)
BK 23	BD 152115	IA	crucible) same vessel
BK 24	BD 55106	MIA	crucible
BK 25	BD 65113B	MIA	hearth or tuyere
BK 26	BD 5596	LIA/early Roman	? hearth
BK 27	BD 5619	MIA	crucible
BK 28	BD 4860	MIA	crucible
BK 29	BD 65004	MIA	crucible
BK 30	BD 65751	? Roman	mould
BK 31	BD 5619(188)	MIA	? crucible
BK 32	BD 4847B	MIA	crucible
BK 33	BD 4846B	MIA	crucible
BK 34	BD 5619(189)	MIA	crucible
BK 35	BD 4846C	MIA	crucible
BK 36a	BD 4848D	MIA	crucible
BK 36b	BD 4848D	MIA	crucible
BK 37	BD 4846A	MIA	crucible and hearth
BK 38	BD 4848A	MIA	crucible
BK 39a	BD 4830	MIA	crucible
BK 39b	BD 4830	MIA	furnace
BK 40	BD 5596	LIA/early Roman	crucible
BK 41	BD 75966A	LIA	crucible
BK 42	BD 65634(179)	Roman	crucible
BK 43	BD 75962A	LIA	crucible
BK 44	BD 75080A	LIA	crucible
BK 45	BD 65758	MIA	crucible
BK 46	BD 65954A	Roman	? crucible
BK 47	BD 65233	MIA	crucible or tuyere? (vitrified)
BK 48	BD 6407	LIA	crucible
BK 49	BD 4801	medieval	crucible
BK 50	BD 55101(82)	MIA	slag
BK 51a	BD 4847A	MIA	crucible
BK 51b	BD 4847A	MIA	mould
BK 51c	BD 4847A	MIA	? furnace
BK 52	BD 74355C	MIA	non-refractory
BK 53	BD 5555(187)	Roman	crucible
BK 54	BD 4813	MIA	furnace and ? crucible
BK 55	BD 54122	Roman	crucible
BK 56	BD 5436(184)	LIA	crucible
BK 57	BD 55106(75)	MIA	crucible
BK 58	BD 5429(183)	Roman	crucible
BK 59	BD 75962A(249)	LIA	crucible
BK 60	BD 6407	LIA	crucible
BK 61	BD 4802	medieval	furnace
BK 62	BD 152124	IA	crucible
BK 63	BD 65045	MIA	? furnace
BK 64	BD 272506	IA	mould; rings
BK 65	BD 383236	IA	mould; rings
BK 66	BD 4847A (a)	MIA	crucible
BK 67	BD 4847A (b)	MIA	furnace
BK 68	BD 4813	MIA	crucible
BK 69	BD 4819A	?	slag + fired clay
BK 70	BD 6408	Roman	vitrified clay

OBJECT	SLIDE	X GR: MAT	NO. OF GRAINS	PHI -1 TO 0	PHI -.5 TO 0	PHI 0 TO .5	PHI .5 TO 1	PHI 1 TO 1.5	PHI 1.5 TO 2	PHI 2 TO 2.5	PHI 2.5 TO 3	PHI 3 TO 3.5	PHI 3.5 TO 4	PHI 4 TO 4.5	PHI 4.5 TO 5	PHI 5 TO 5.5	MEAN GRAIN SIZE MM.	STD DEV
MOULD																		
	64	34	83	0	0	0	0	1	4	0	1	4	8	5	24	53	.0468	.531
	65	75	92	0	0	0	0	2	2	7	12	8	10	15	11	34	.0739	1.02
N SLIDES			2															
N GRAINS			175															
CRUCIBLE																		
	1	76	50	0	0	0	0	0	0	0	0	0	12	14	32	42	.0347	.120
	10	69	66	0	0	0	0	0	0	0	0	0	8	15	30	47	.0324	.103
	12	73	72	0	0	0	0	0	0	0	0	1	3	14	32	50	.0304	.090
	13	31	104	0	0	1	0	4	5	7	7	6	7	10	13	41	.0903	1.88
	14	71	84	0	0	0	0	0	0	0	0	5	15	23	24	33	.0428	.191
	15	33	74	0	0	0	0	1	0	1	1	1	3	7	18	68	.0322	.251
	16	50	50	0	0	0	0	0	0	0	0	14	18	14	32	22	.0509	.275
	17	7	20	0	0	0	0	0	0	0	0	0	0	0	15	35	.0196	.028
	18	64	50	0	0	0	0	0	0	0	0	6	16	32	26	20	.0479	.224
	19	28	48	0	0	0	0	0	0	0	0	0	0	0	17	83	.0199	.029
	23	47	89	0	0	0	0	0	0	1	1	2	15	10	26	39	.0411	.204
	3	62	50	0	0	0	0	0	0	0	0	2	20	20	26	32	.0423	.181
	36A	30	67	0	0	0	0	0	1	0	0	3	1	1	18	75	.0262	.130
	40	41	75	0	0	0	0	0	1	3	0	1	4	19	27	45	.0470	.270
	44	14	74	0	0	0	0	3	0	0	0	0	0	5	20	68	.0350	.446
	5	43	60	0	0	0	0	0	0	0	2	3	5	10	32	48	.0345	.145
	53	72	79	0	0	0	0	0	0	1	0	0	1	10	24	63	.0271	.093
	56B	57	50	0	0	0	0	0	0	0	0	8	14	10	34	34	.0420	.196
	6	66	94	0	0	0	0	0	0	1	1	1	26	22	24	24	.0483	.253
	60	59	71	0	0	0	0	0	0	0	0	0	0	14	27	59	.0268	.064
	62	53	93	0	0	0	1	2	0	1	0	3	11	20	15	46	.0505	.708
	7	66	70	0	0	0	0	0	0	0	0	1	8	18	29	44	.0342	.118
	9	68	78	0	0	0	0	0	0	0	0	4	15	19	26	36	.0408	.176
N SLIDES			23															
N GRAINS			1568															
FURNACE																		
	26	58	69	0	0	0	0	0	0	0	0	0	9	14	33	43	.0350	.107
	51C	47	49	0	0	2	12	13	24	10	12	3	2	4	14	4	.2502	8.12
N SLIDES			2															
N GRAINS			118															
			27															
			1861															

TABLE III.10.2 BECKFORD: GRAIN SIZE STATISTICS

III.11 MEARE, SOMERSET
(ST 446423; corpus no 64)

Two areas of iron age activity at Meare in the Somerset Levels (fig III.11.1) were interpreted by the original excavators as 'Lake Villages', similar in nature to, and roughly contemporary with the nearby settlement at Glastonbury (Bulleid and Gray, 1948; Gray and Bulleid, 1953; Gray and Cotton, 1966). Bulleid and Gray explored an approximate total of 4875 sq m at Meare West and approximately 2115 sq m at Meare East during the years 1910-1956. Their findings from the latter area have not yet been published.

In 1966, Michael Avery resumed excavation at Meare East (approximately 162 sq m), and also examined a further 124 sq m of the western village. From his discoveries, Avery reinterpreted many of Bulleid and Gray's "occupation mounds" as refuse dumps, arguing that the iron age people who created these dumps would have preferred to inhabit the drier and more solid Meare island, some 100m from the "Lake Village" area (Avery, 1968; fig III.11.1). The results of recent excavations at both sites by the Somerset Levels Project (SLP) have led the investigators to reject Avery's interpretation and to reiterate Bulleid and Gray's original theory that the west village was, in fact, a habitation site (Orme et al, 1979; 1981). The majority of fifteen radiocarbon determinations obtained from wood and peat suggest occupation at Meare West during the third century BC (Orme et al, 1981, table 1), and this is corroborated by dendrochronology (Orme et al, 1981, 37).

All but three of the mounds in the western village excavated by Bulleid and Gray were underlain by substantial foundations of worked timber and brushwood, and most contained a series of hearths built on superimposed clay floors (fig III.11.2). A wealth of personal items and finds indicative of industrial activity was recovered from all areas of the site. The complete condition and fine materials and workmanship of many of these items (particularly the large numbers of fine bronze fibulae recovered) suggest accidental loss rather than deliberate discard.

Seasonal occupation, perhaps to take advantage of rich summer grazing on the flood plain was suggested by both Bulleid and Gray and by the recent SLP excavators on the basis of an almost complete dearth of evidence for wall and roof structures. "There was not even a post or stake hole to be seen. The only material that could be interpreted as house walling was the daub, and there was barely enough of this to cover a doll's house, let alone a full-size first millennium dwelling. Yet the clean and compacted nature of the central floor indicates that it was protected from the elements during occupation. We return therefore to the suggestion made by the original excavators ... that tents were in use" (Orme et al, 1981, 23).

The evidence for secure and varied subsistence, including animal husbandry and successful mixed farming, together with abundant indications of specialised industrial production, suggest, however, that

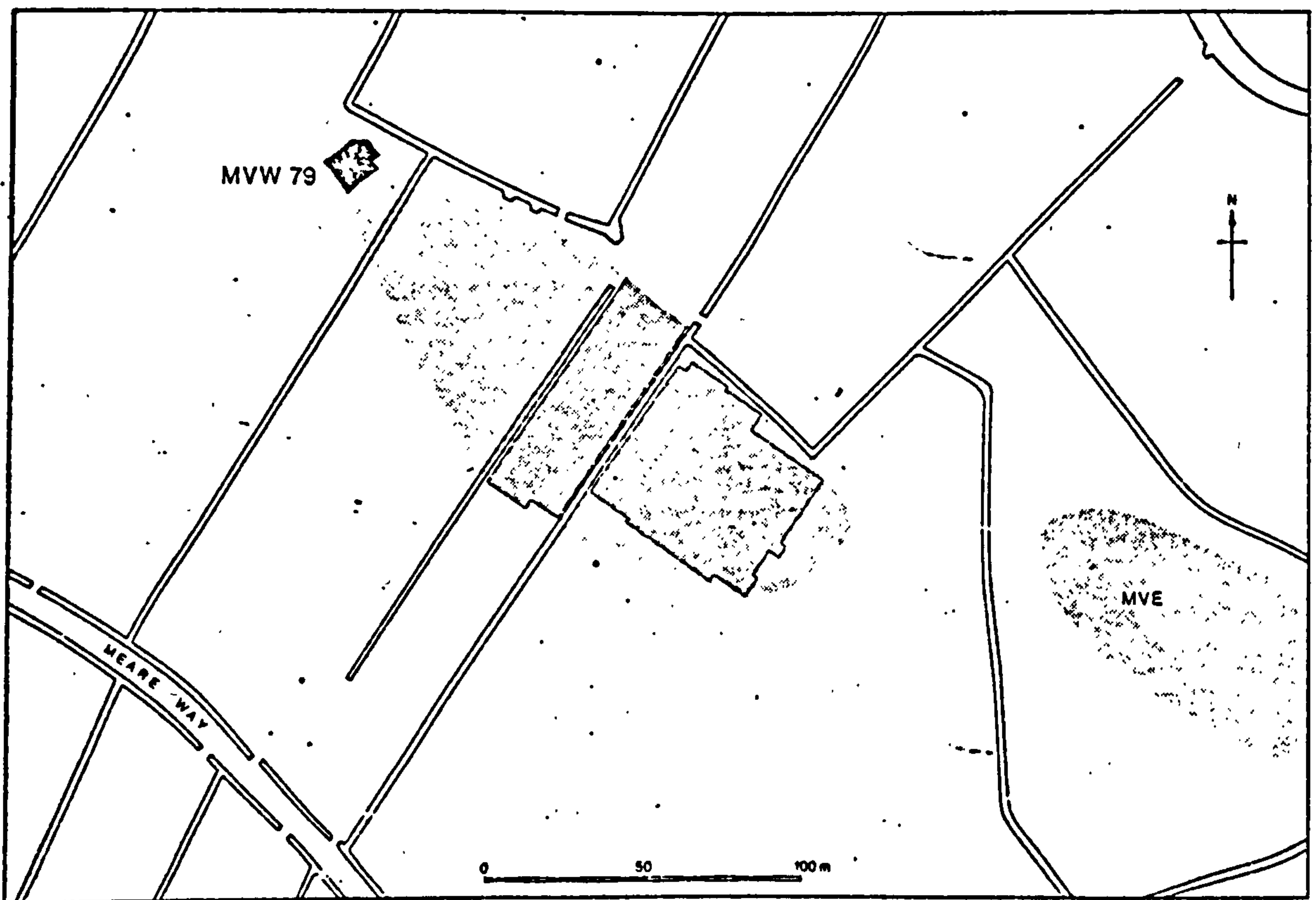
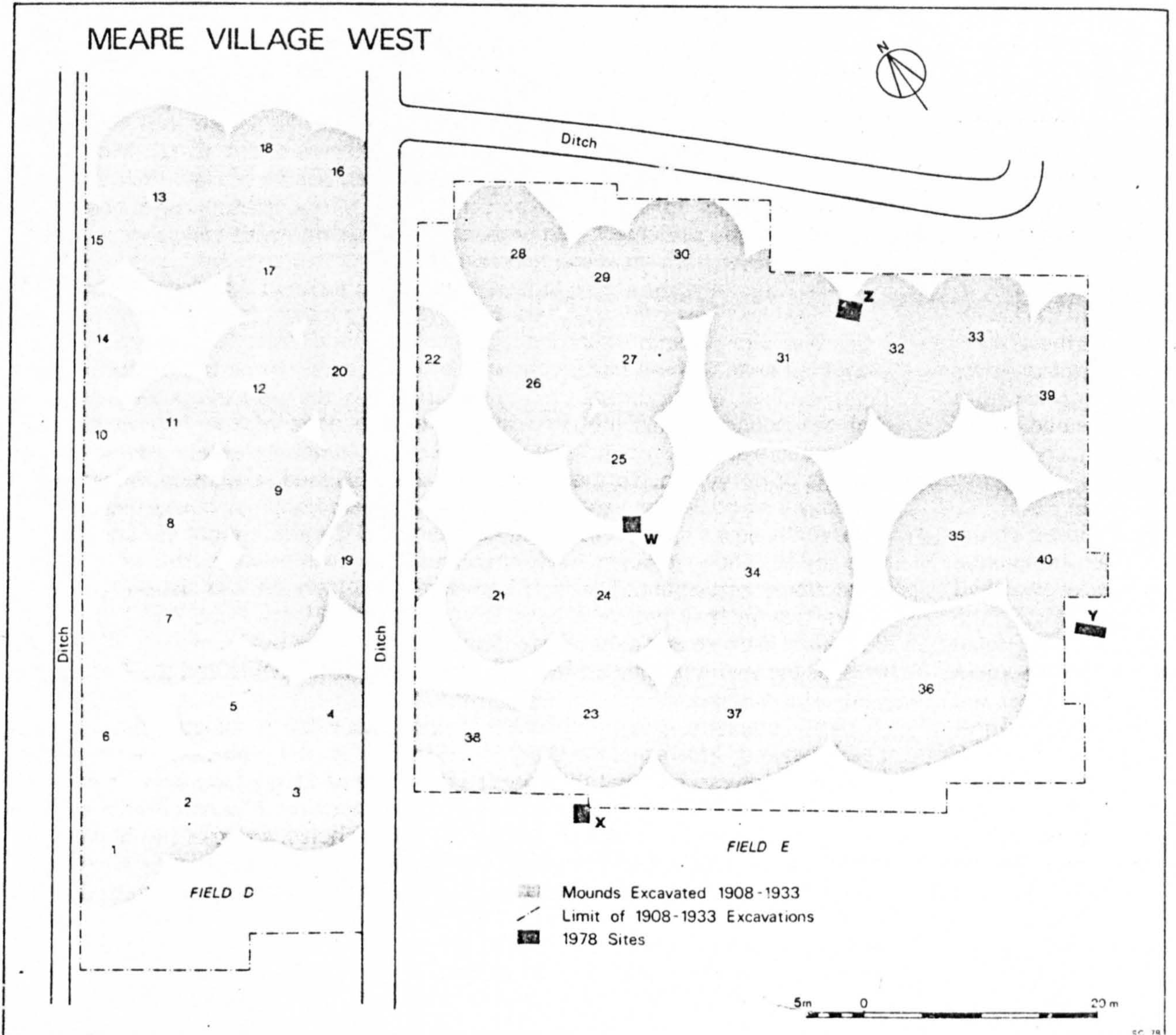


Fig III.11.1 East and West Villages at Meare (light shading), with areas excavated on the western village by Bulleid and Gray (centre) and SLP (MVW 79) indicated by darker shading. Meare Way marks the north east edge of Meare island. (after Orme et al, 1981).



Meare Village West. The eastern end of the village excavated by Bulleid and Gray, showing mound numbers and the location of the 1978 sites.

Fig III.11.2 (after Orme et al, 1979)

the site cannot reasonably be interpreted as the summer home of a transhumant people. Even part-time industrialists would hardly have selected the summer months when pastoral and agricultural activities were at their peak, to conduct intensive craft operations. Bronze casting, glass making, bone and antler working and spinning and weaving on a massive scale would have been much more suitable winter occupations. It has recently been suggested that Meare West was a seasonal meeting and market place for a number of communities, each bringing their own category of specialists to the site. "The abundance of food and goods is a function of the meeting place, which allows trade and feasting and fosters the manufacture of a wide range of goods for redistribution" (Orme et al, 1981, 69). Goods for redistribution, however, would more logically have been produced at the manufacturers' home base. It is easier to imagine artisans carrying finished products to a periodic market, than to envision the transportation of all necessary raw materials for pottery making, metalworking or glass production.

Whilst the 'market place' theory cannot be entirely rejected, a further interpretation is possible. I would suggest that the excavated areas at Meare West represent part of a permanent settlement, perhaps of short duration, where craft activities played an important role in the economy. The massive timbers used in the substructure, and the frequent provision for mortice and tenon joints, allow for the possibility that the inhabitants lived in timber-framed houses. When the settlement was abandoned, for whatever reason, these structures could have easily been dismantled and moved to another location. The flooring sections, subsided, and covered with peat, clay and occupation debris, would not have been so readily accessible, and thus were abandoned in situ. This interpretation, albeit tentative, forms the basis for the following discussion of bronze working at Meare.

III.11.1 The metalworking evidence

Crucible sherds are known to have been recovered from seventeen of the 40 mounds excavated by Bulleid and Gray at Meare West (Gray and Bulleid, 1953, 253-58). A further four mounds produced evidence of casting activity in the form of bronze slag or dross (fig III.11.3). Refractory debris are strewn seemingly at random across the site, and

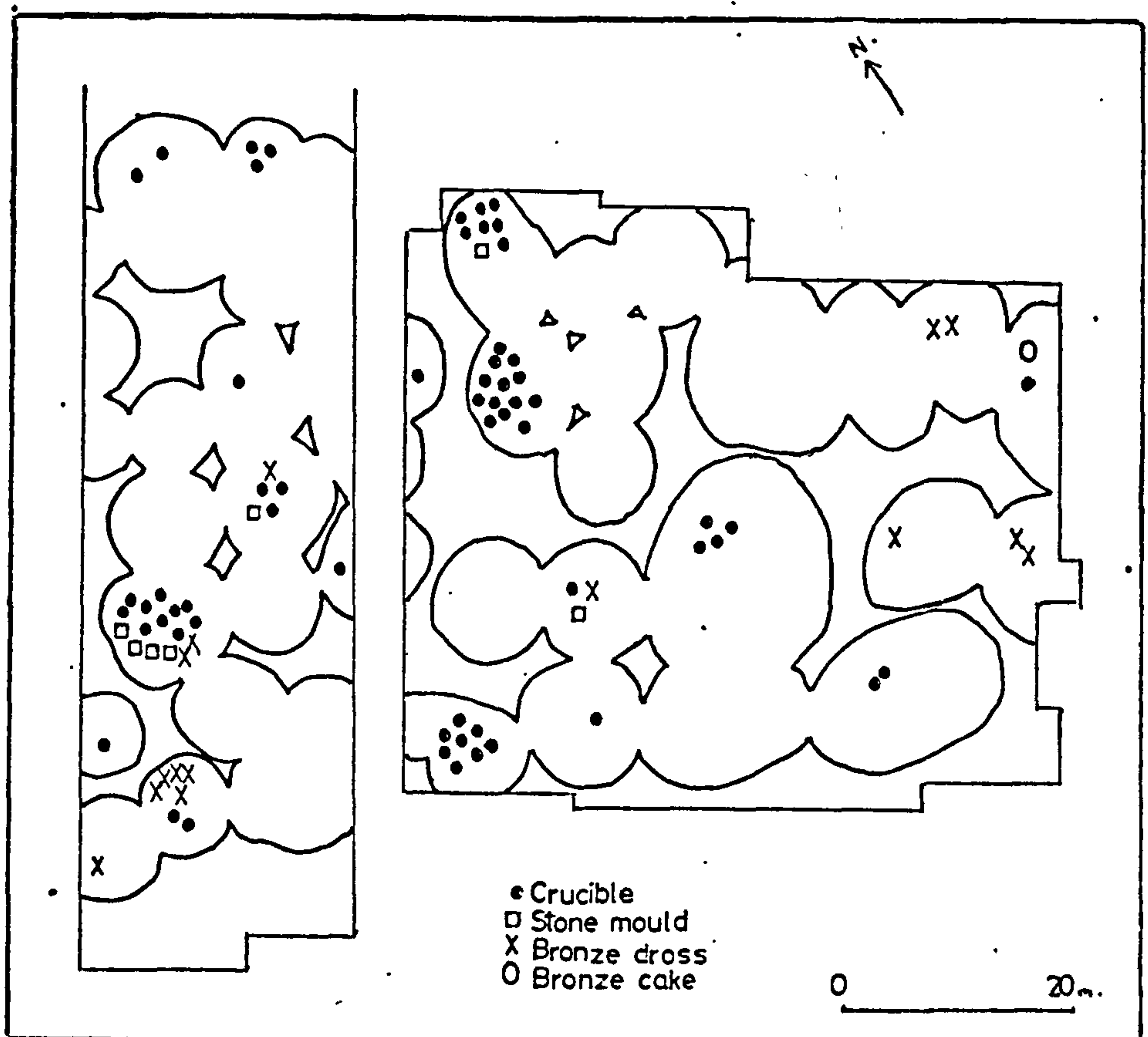


Fig III.11.3 Location of smithing debris at Meare West (data after Bulleid, Gray and Cotton)

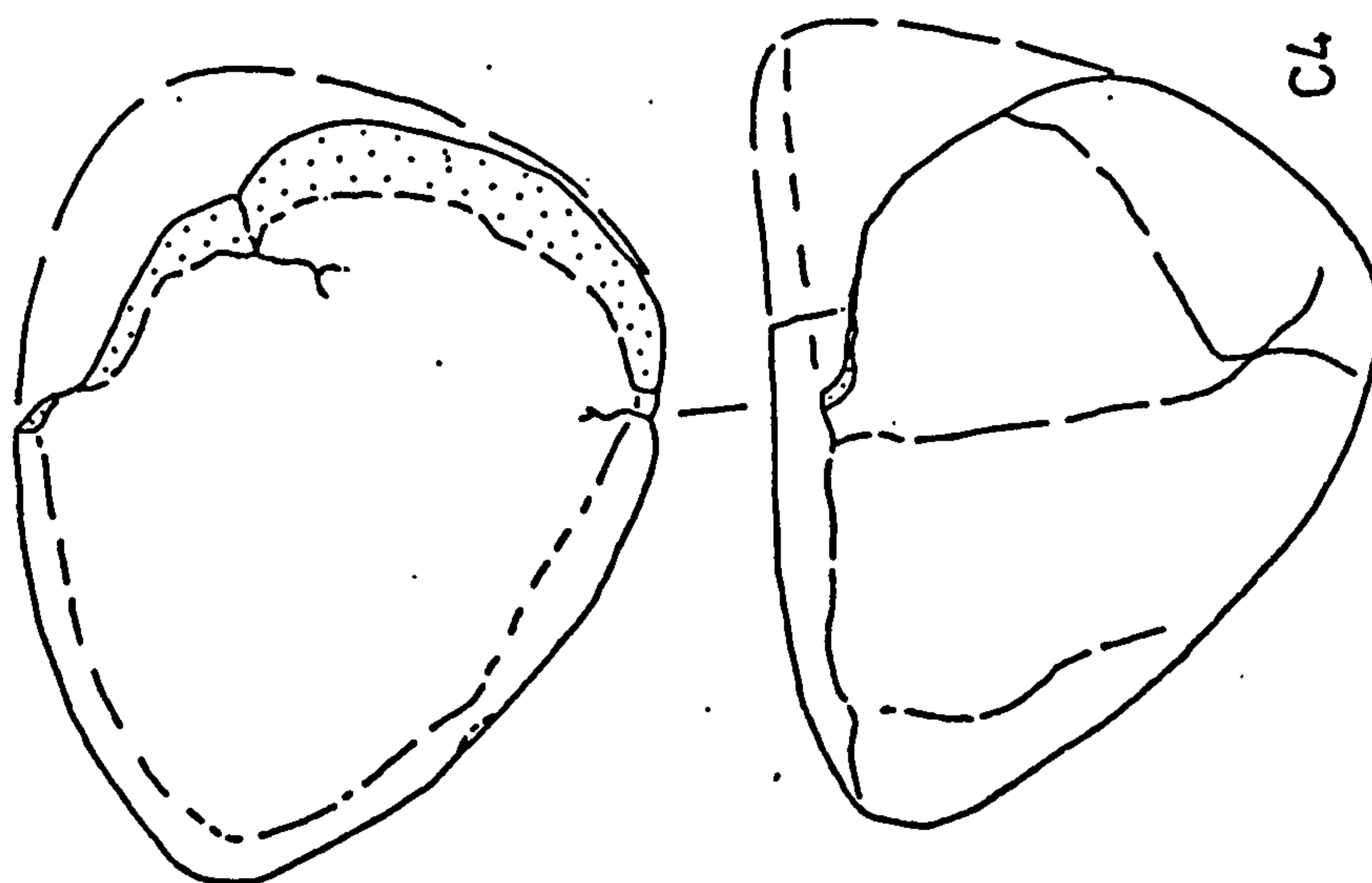
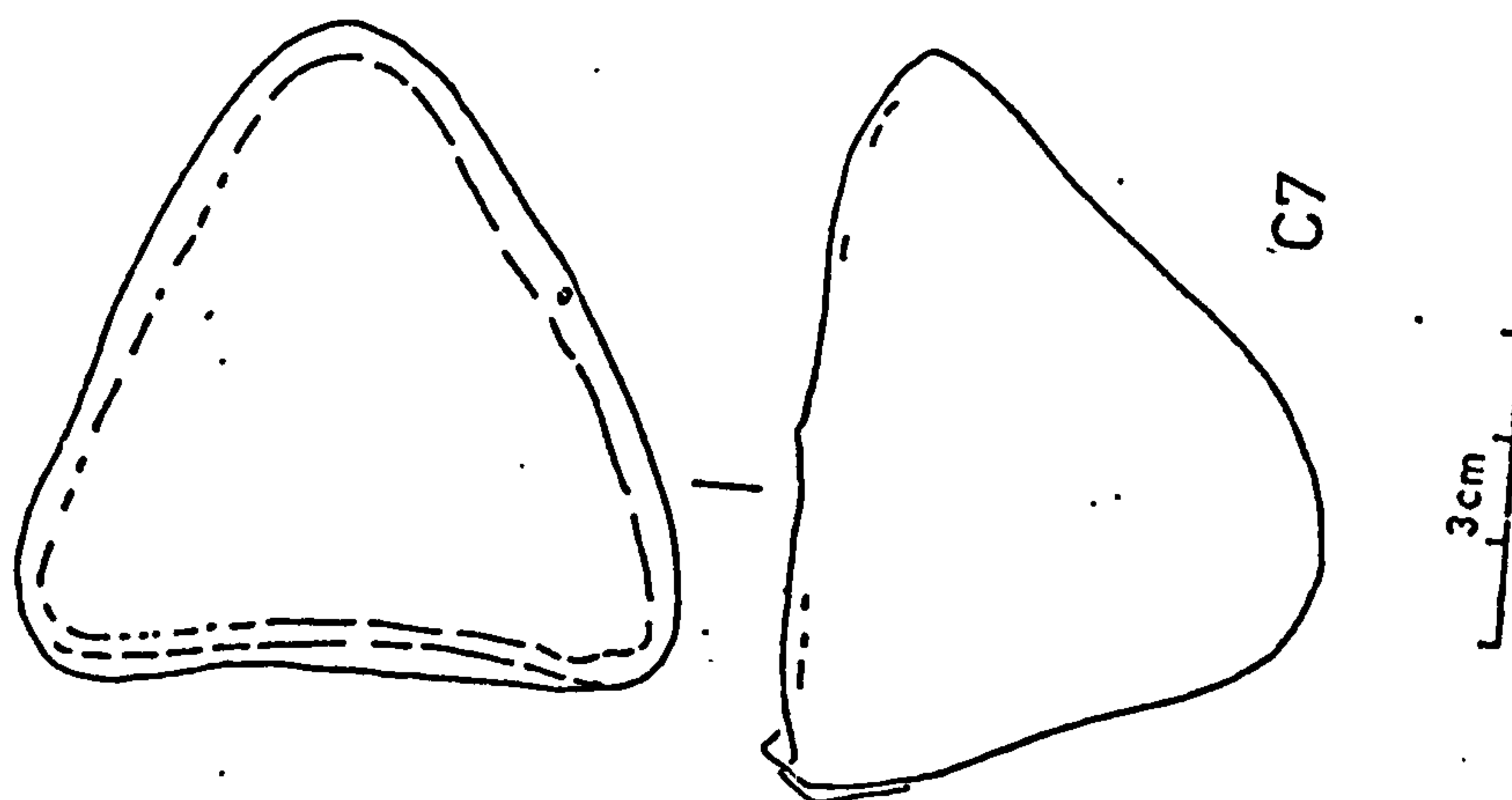
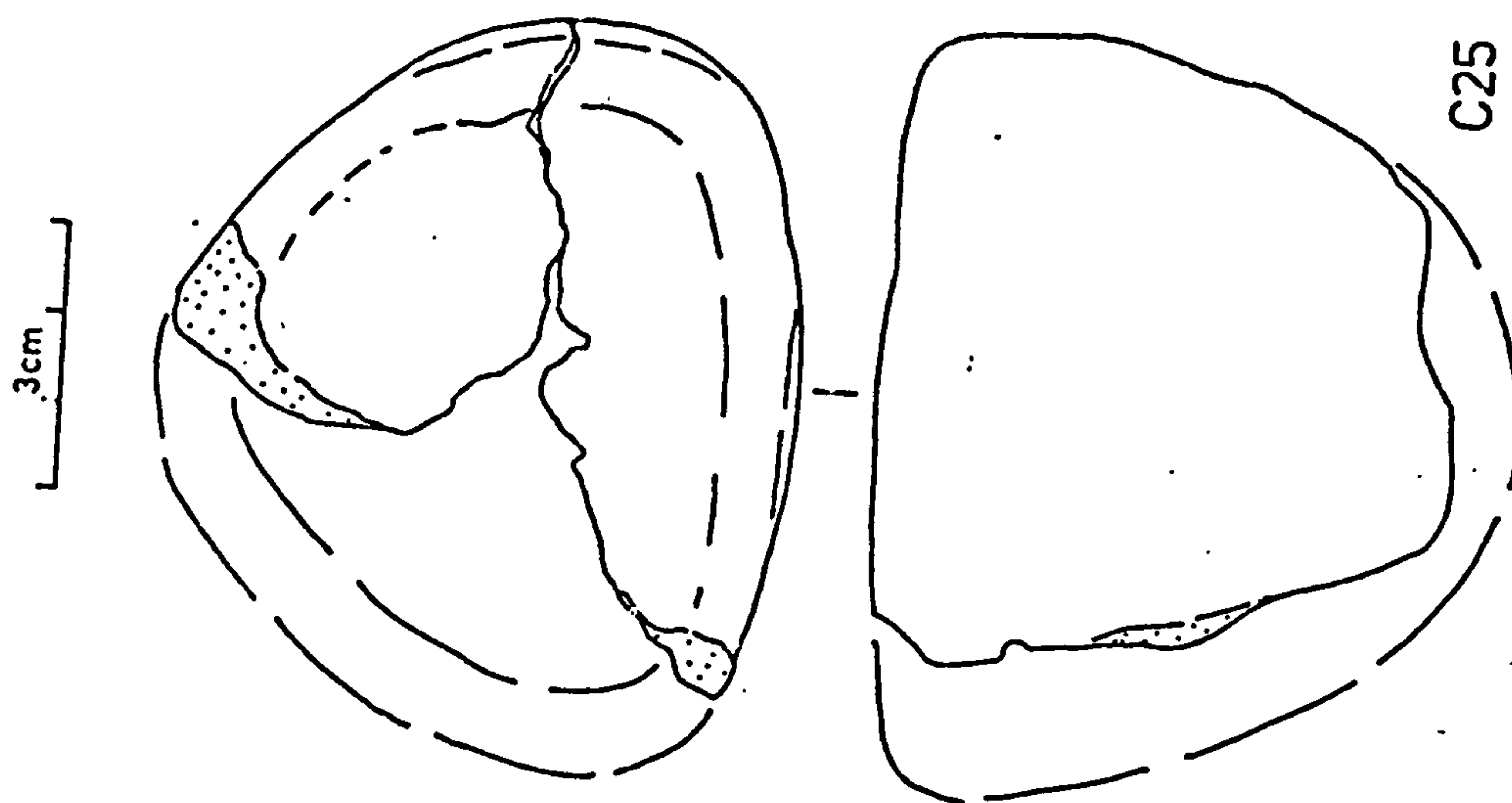


Fig III.11.4 Crucibles from Meare West.

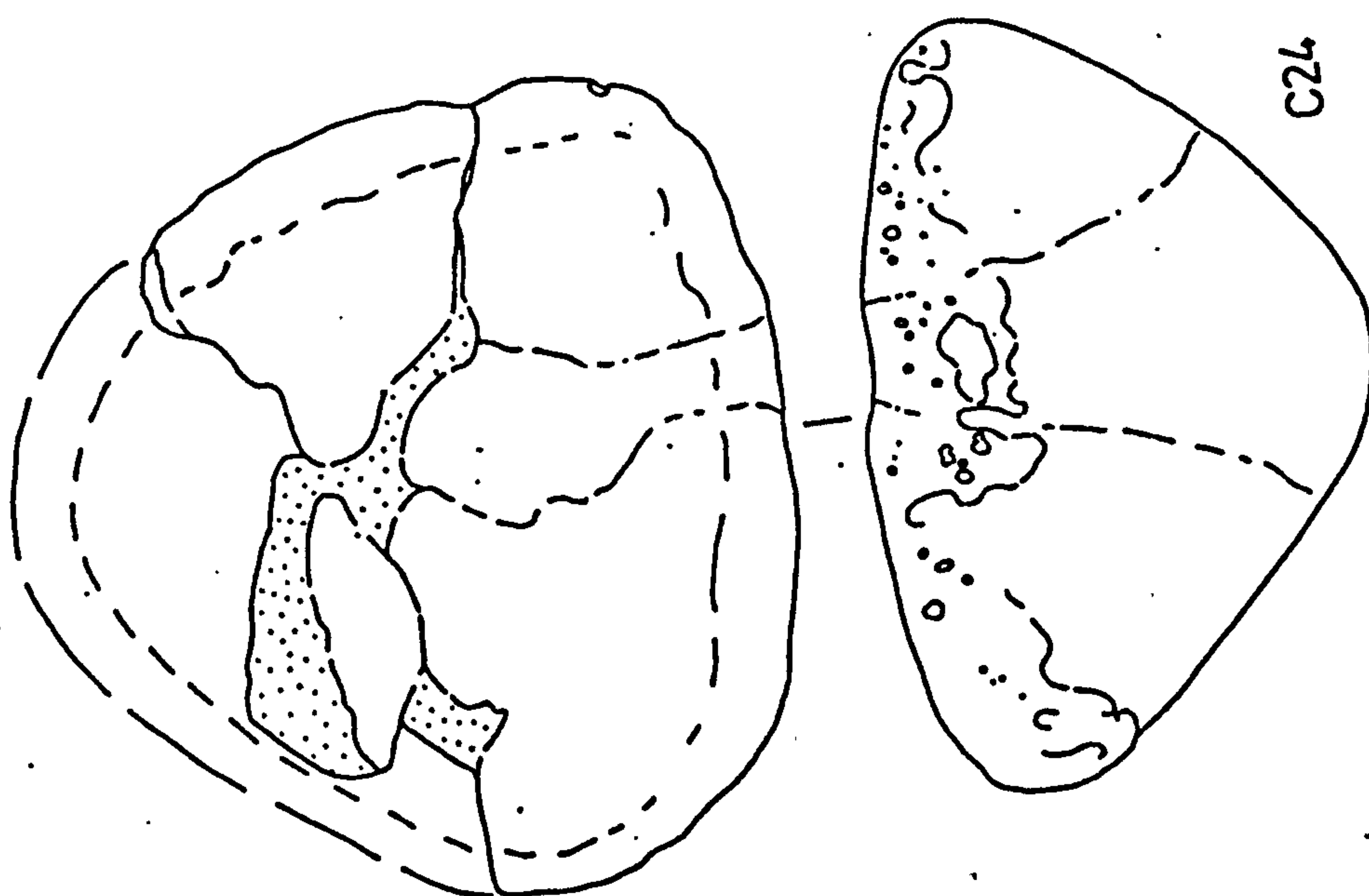
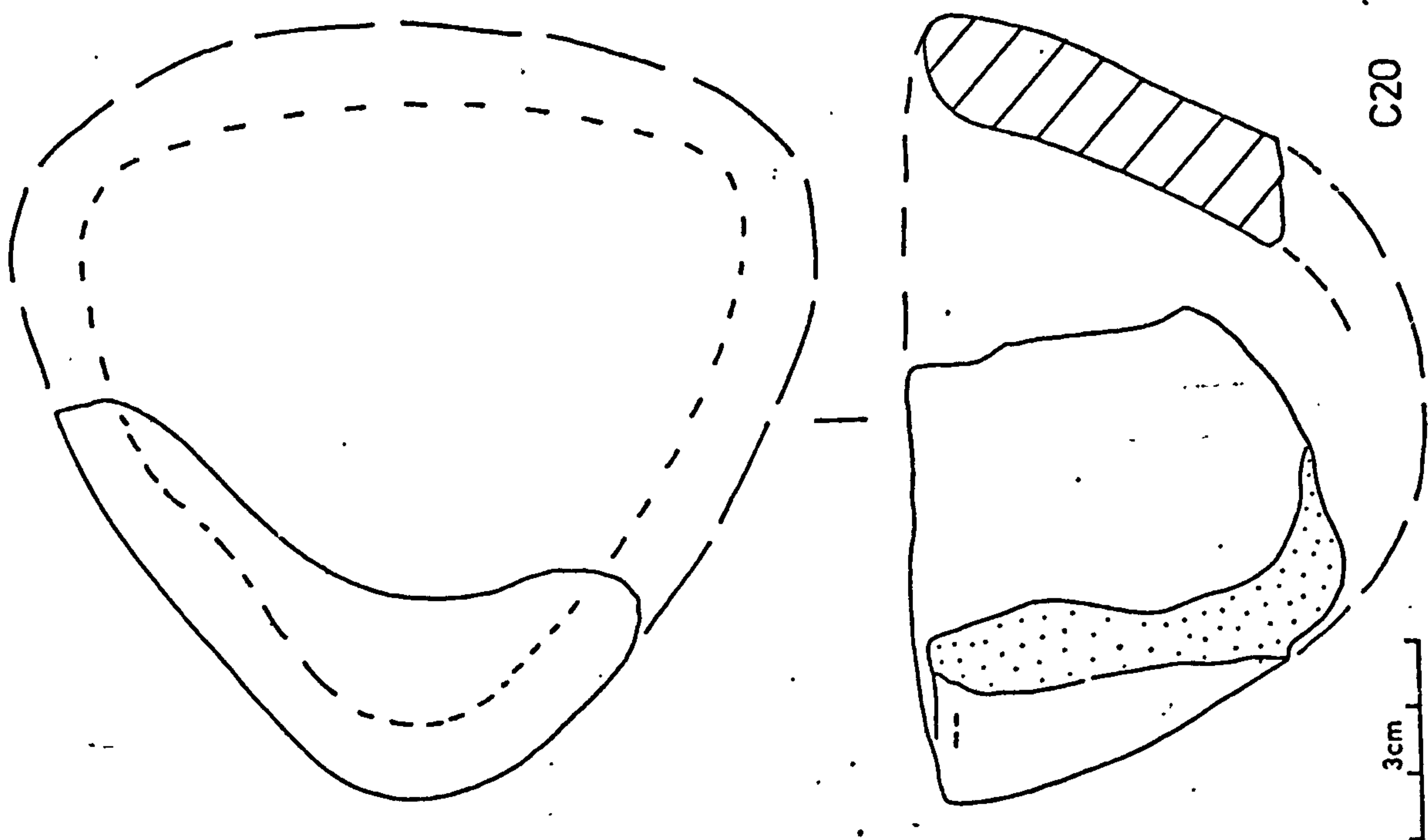


Fig III.11.5 Crucibles from Meare West.

aside from a concentration of eight crucible sherds and two almost complete vessels, and the remains of four putative stone moulds, from Mound VII, no focus of metallurgical activity may be observed (fig III.11.3).

All crucibles from Meare are deep and steep-sided in form. No shallow, open vessels such as those common at nearby Glastonbury were recovered. Considerable variation is observed, however, in size, rim form and wall thickness (figs III.11.4-5). In addition to crucibles, Bulleid and Gray also recorded furnace material, part of a tuyère, and stone mould fragments. Aside from the metalworking debris from Meare West described in the published report, some 50 unnumbered and unprovenanced refractory fragments, known to have come from the site, are stored in Taunton Castle Museum.

Evidence of casting activity was also recovered at Meare East. From this area of the excavations came six certain and five possible crucible sherds, including three rim fragments (Table III.11.2). Unfortunately, little contextual information was recorded by Bulleid and Gray, and only C6 is securely stratified, in floor 2 of Mound XXVIII (M Avery, pers comm). No refractory sherds have been recovered from the SLP excavations at Meare.

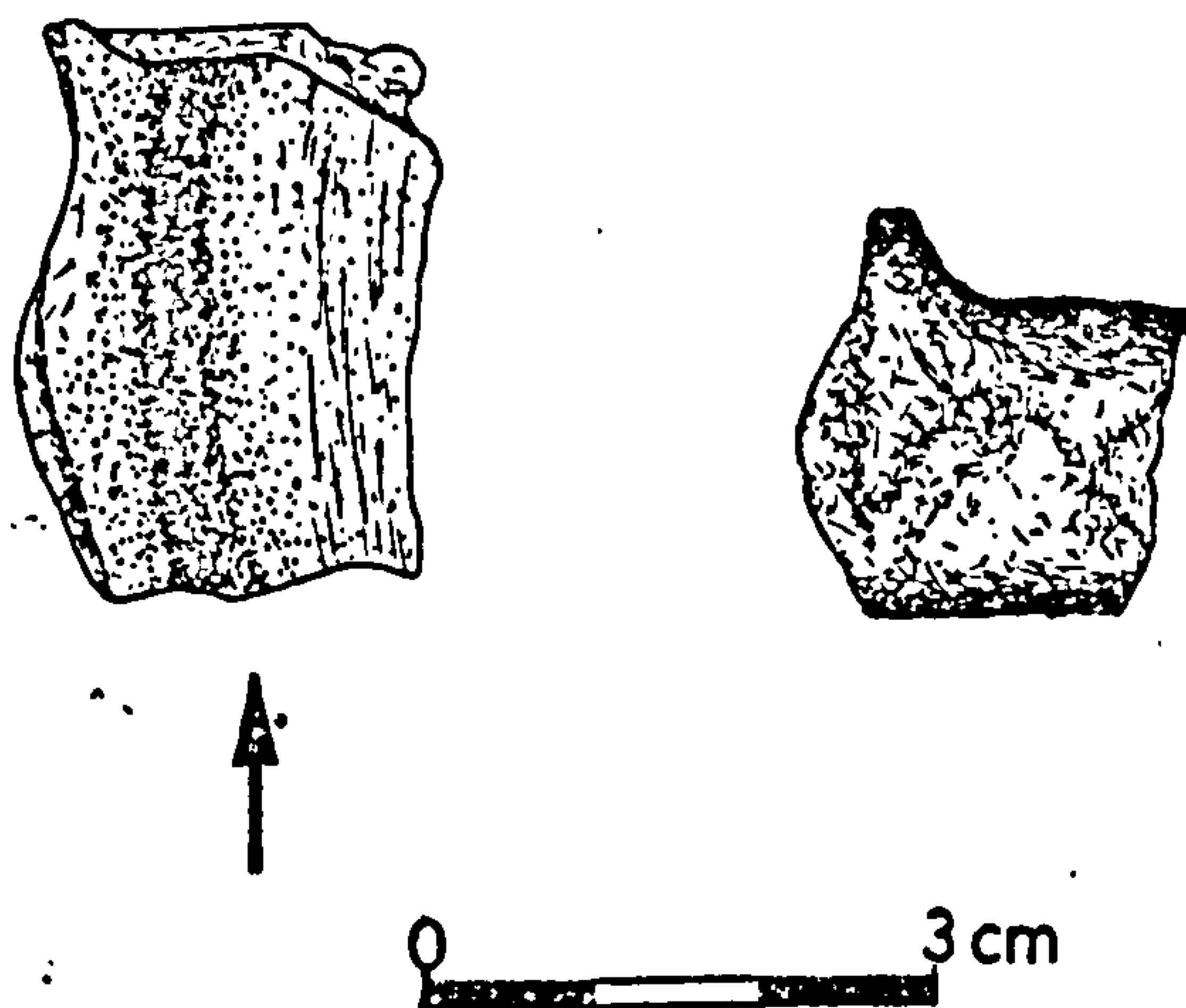


Fig III.11.6 Fragment of greisen mould from Meare West, Mound XXVIII (Somerset Co Museums OS.AA.1/352; Imp Petrol no Som 148). Shading in section indicates extent of heat-altered stone.

III.11.2 Analytical results (see Tables III.11.1-3)

Crucibles C24 and C25 from Mound XXVI were chemically analysed by J A Smythe of King's College, Newcastle on Tyne. The main aim of this analysis was to determine the nature of the metal being melted, but the results also indicated to Dr Smythe that the crucibles were made of a "good refractory clay" (Smythe, quoted in Bulleid and Gray, 1953, 254).

All refractory debris from Meare which could be located (including the unconected material) were examined by the writer in hand specimen, and 36 sherds representing crucible, and possible tuyère, mould and furnace were selected for thin section analysis. In this report, Meare East specimens are labelled MRE.E, those from the west village being given the simple prefix MRE.

The crucibles

The Meare crucibles are clearly divisible into two fabric groups broadly similar in composition to those described from Beckford (Ch III.10, above). The chief constituent of Fabric group 1 is carbon, whilst crucibles representing Fabric 2 are composed essentially of quartz sand (fig III.11.7). An unusual rectangular container (MRE 31 from Mound XXIII) identified as crucible by Bulleid and Gray, was rejected as a refractory vessel on the basis of fabric analysis. The silty, ferruginous clay is inclusionless save for a sparse scatter of poorly-sorted quartz and a single ragged (1.5mm) fragment of chalk.

1. Fabric 1a (MRE 2, 15b, 21a, 21b; sherds tentatively assigned but not thin sectioned: MRE 1, 19, 20)

Fabric 1a sherds vary in thickness from 10mm to 15mm. The majority are heavily slagged on their outer surfaces and MRE 2 is partially vitrified. All are completely black throughout their thicknesses, and no inclusions are visible under a 10x lens. Cut faces feel powdery and deposit a black smear on the fingers during handling. Under the microscope, Fabric 1a is seen to consist almost exclusively of fine, dense carbon. Very rare quartz grains (0.01-0.04mm)

are visible in all samples. This fabric is identical in all respects to Beckford Fabric 1a (see page 331), and represents the same technology. Well-powdered carbonaceous material, perhaps charcoal, has been mixed with a small quantity of silty binding material.

2. Fabric 1b (MRE 32, 33, 35, 37a, 37b, unmc; tentatively assigned but not thin sectioned: MRE 22, 36, 38)

Superficially, sherds in Fabric 1b closely resemble those representing Fabric 1a. The black Fabric 1b sherds, however, are extremely hard and fractured surfaces feel gritty and exceptionally sharp to the touch. Rare opaque grains of quartz or quartzite are visible in hand specimen. Microscopic examination suggests that approximately equal parts of sand (containing quartzite, sandstone with siliceous cement and a little ? chert) and pounded ? charcoal were mixed together and consolidated with a binding medium. Quartz sand grains are subrounded, and vary from 0.01 to 0.25mm. Fragments of quartzite and sandstone are generally slightly larger, reaching 0.5mm across. The carbon present in Fabric 1b has not been so carefully prepared as that used for Fabric 1a crucibles, and the outline of individual fragments can be traced in all section (Plate 8b).

3. Fabric 1c (MRE 23b, 28)

The two sectioned samples representing this fabric are again extremely hard-fired and completely black throughout their thickness. These samples, however, feel sandy, and rubbing a cut surface easily detaches sand grains. Sand is just visible with a 10x lens, otherwise the sherds appear inclusionless. Under the microscope, this fabric closely resembles Fabric 1b, but the sand selected for 1c crucibles is obviously from a different source. All quartz grains are rounded, with a bimodal size distribution (see Table III.11.4). No quartzite or chert is present, and only a single grain of sandstone appears in each section. A similar technology to that represented by 1b is suggested, but here the constituent carbon has been slightly better prepared. Very few discrete ? charcoal fragments can be discerned.

4. Fabric 1d (MRE 25, unmD)

These two thick-walled sherds are again completely black and very hard-fired. Both are slagged, and the rim sherd MRE 25 is partially vitrified around the inner rim-edge. In texture, the sherds feel slightly finer than Fabric 1c. Quartz sand is easily visible in hand specimen. Microscopic examination reveals a somewhat different preparation technique. The proportion of poorly sorted sand to carbon is much higher than in any other Fabric 1 samples. Discrete tabular carbon fragments are scattered throughout both thin sections, and although fine carbon is present in the matrix, the brownish colour of the binding clay is clearly visible in plain light. Without a lengthy and complex series of experiments, the precise method of preparation of this crucible fabric cannot be ascertained. However, it may be suggested that a small quantity of roughly crushed carbonaceous material was added to sand similar to that selected for Fabric 1b crucibles, and that these two elements were mixed with a higher percentage of clay than that used to bind the remaining Fabric 1 vessels.

5. Fabric 2a (MRE 16, 17a, 24a, 29a, E2, unmA, unmB; tentatively assigned but not thin sectioned: MRE 26, 29b)

A wide range of vessel sizes was produced in Fabric 2a. Sherds vary in fired colour from light grey to black, and are often friable as a result of the high density of quartz, quartzite and sandstone clearly visible in hand specimen. Under the microscope, all matrices are isotropic and all samples are carbon-free. These crucibles are formed from subangular and rounded quartz sand varying in size from 0.01 to 0.35mm. Larger grains (c 0.5mm) of quartzite and sandstone with both ferruginous and siliceous cement are common in all sections examined. Cryptocrystalline silica, perhaps chert, is rare. Grain density varies from 68% (E2) to 79% (16)

6. Fabric 2b (MRE 11, E3, E4; tentatively assigned but not thin sectioned: MRE 18)

These thin-walled sherds are all mid-grey in colour, and both MRE 11 and E3 show evidence of patchy surface oxidisation (5YR 6/6). All

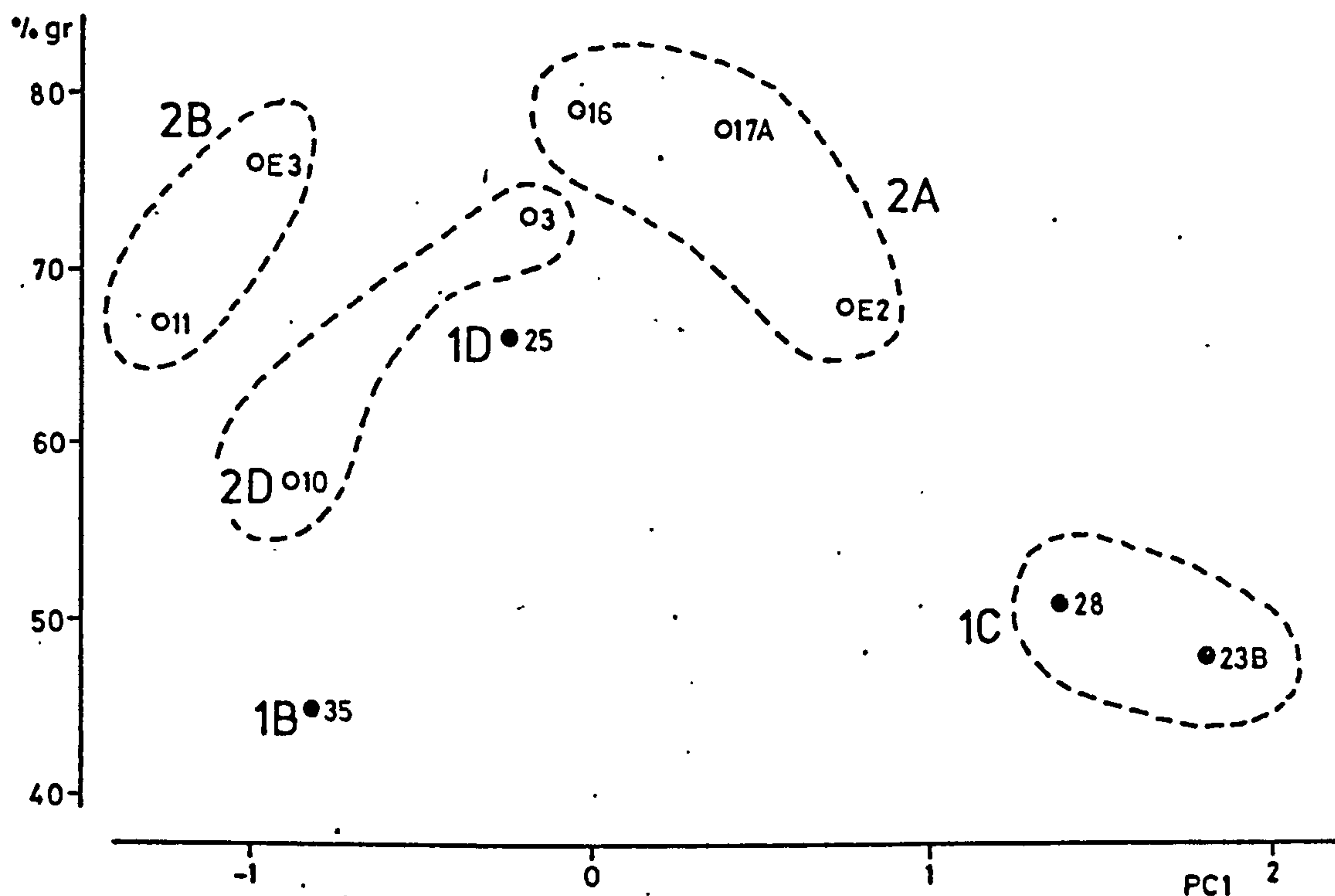


Fig III.11.7 Crucible sherds from Meare, plotted against grain size (expressed by scores on the first principal component extracted from the ϕ counts) and proportion of grains:matrix. 1 (●) are carbon fabrics, 2 (○) sand.

feel fine and sandy to the touch, and appear otherwise inclusionless save for a rare glint of mica. Under the microscope, Fabric 2b is seen to consist of a high tenor (67-76%) of fine subangular quartz sand set in a partially isotropic (E4 is completely isotropic) clay matrix. Threads of mica are present though rare in all samples. Quartz sand rarely exceeds 0.1mm, and no sandstone, quartzite or other minerals are present in any of the sections examined.

7. Fabric 2c (MRE 5, 17b; tentatively assigned but not thin sectioned: MRE 6, 8, 9)

These purplish-grey, extremely hard-fired sherds are distinguished by a fine silty matrix in which a scatter of hard white inclusions is clearly visible. Thin section examination reveals that a small quantity of sandstone, rounded quartz and quartzite (all c 0.5mm), has been added to a fine silty clay. Textural analysis was not possible as slag penetration and partial vitrification has obscured the margins of the fine matrix grains.

8. Fabric 2d (MRE 3, 1c; tentatively assigned but not thin sectioned: MRE 27)

Macroscopically, these two sherds are distinguished from Fabric 2c by a denser surface appearance and sandier texture. A similar scatter of opaque white inclusions is visible in hand specimen. Rare rounded grains of red-brown iron ore are visible on the surface of the unusually shaped sherd MRE 3. Thin sectioning shows a similar suite of large siliceous inclusions to that present in Fabric 2c. Matrix quartz grains, however, are clearly distinguishable, generally angular and well-sorted. A few flecks and tabular fragments of carbon are present in this fabric, but not in sufficient quantity to suggest deliberate addition.

The moulds

A stone mould fragment, possibly for casting ingots from newly alloyed metal, was recovered in Mound XXVIII (fig III.11.6). Brief descriptions of six stone moulds appear in the published report (Table III.11.3), but the example from Mound XXVIII is not included. None of the moulds is illustrated, and none can, at present, be traced. From the published descriptions, however (assuming that the artefacts have been correctly identified as refractories), the Meare stone moulds would seem to be of a type represented by two valves found in an iron age or Roman posthole at Dinorben (Guilbert, 1979).

The mould from Mound XXVIII has been carved from a light greenish-

brown rock which appears to be composed essentially of white mica. The matrix face has been blackened during the casting process. The mould was thin sectioned by the CBA Implement Petrology Committee as part of a long-term programme of stone artefact analysis (Som 148). Under the microscope, the mould is identified as a greisen and is seen to consist of small plates of muscovite mica intergrown with minor amounts of quartz. Topaz, an almost constant accessory in the metasomatic greisens of Cornwall (Nockolds et al, 1978, 32) is absent, and a different granitic area must be suggested as the source of this distinctive pneumatolysed rock. Greisen is porous, comparatively soft and easy to carve, hence the selection of this rock type for mould production.

A possible clay mould fragment was recognised during a search through uncontexted and unidentified ceramic debris from Meare West. Although insufficient remains to permit identification of the object cast, this small fragment of fired clay bears distinct impressions suggestive of a cire perdue casting mould. In hand specimen, the fragment closely resembles crucible Fabric 2a. Under the microscope, this sherd is seen to consist exclusively of rounded siliceous grains, tightly packed in an isotropic, carbonaceous clay matrix. The grains are generally larger than those present in the crucible samples, and sandstones and quartzites are more common. Rare, subangular fragments of cryptocrystalline silica are also present.

The remaining refractory and possibly refractory artefacts

Two numbered sherds believed to represent tuyère were examined, together with a slagged, unnumbered fragment of similar form. The best preserved of these sherds, MRE 15a (from Mound XIX), is heavily slagged and almost completely vitrified. Hand specimen and thin section examination, however, suggests that this artefact was formed from sand, rather than a carbon compound. The unnumbered sherd consists almost entirely of slaggy minerals, predominantly fayalite, indicating a possible association with iron rather than bronzeworking. The final 'tuyère' sample D12 is very fragile and formed from a fine, silty clay, which appears virtually inclusionless under the microscope. The identification of this object must remain in doubt.

Three oxidised fragments, possibly representing the remains of melting furnaces, were examined. One of these, MRE 24b, was found with crucible MRE 24a in Mound XXVI, one (MRE 23a) with crucible 23b, again in Mound XXVI, and one (MRE 39) in Mound XXXIV. The excavation report describes the fragments which include sample MRE 23b as "a quantity of burnt waste, mostly clay to which vitreous material is attached in considerable quantity on some pieces", and the group from which sample MRE 39 was drawn as "indeterminate pieces of clay or slag " (Gray and Bulleid, 1953, 258). In thin section, samples MRE 23a and 24b are seen to contain a high tenor of fine (to 0.08mm) quartz, and rare grains of sandstone set in a ferruginous, slightly micaceous clay matrix. Considerable rounded grains of iron ore are present in both samples. Both MRE 23a and 24b are sufficiently refractory to have served some purpose in the metalworking process, although that purpose cannot be defined with certainty. Sample MRE 39, on the other hand, contains few inclusions among which fragments of limestone and fossil shell are clearly visible. This sherd is unlikely to have had metalworking associations.

Sample 6 from Meare East consists of several formless fragments of black, slaggy material. These were examined and a single sherd thin sectioned to test the possibility that a crucible is represented. In thin section, MRE.E 6 contains abundant rounded quartz grains set in a carbonaceous clay matrix. The sample is almost entirely vitrified. Heavy slag penetration confirms that the sherds were connected with metalworking at Meare, but further identification is not possible.

III.11.3 Resource ecology and raw material analysis

The "good refractory" materials observed by Smythe and as seen in the thin sections described here, are not available in close proximity to Meare Lake Village. Clays locally available to metalworkers at nearby Glastonbury would also have been accessible to the craftsmen operating at Meare. However, as is demonstrated below, these raw materials would not have been suitable for refractory production. The clay and sand resources around the Lake Villages were sampled and tested by J Bailey (1981) in connection with a study of the coarse pottery from the two sites (Ch III.12, below). These resources are discussed in the following chapter.

Like the Glastonbury crucibles, those from Meare exhibited no appreciable colour change when refired to 1100°C in an oxidising atmosphere. It is suggested that at both sites, the white fire-clays of the Bristol Coal Measures were exploited for refractory manufacture. The occurrence of fire-clays in the Coal Measures and the sampling strategy adopted are described below (Ch III.12). The five Coal Measures clays obtained from the Nettlebridge-Blacker's Hill area (SOM 21-25) were compared with the Meare refractories. Of these samples, SOM 25 from Blacker's Hill (Coalpit Heath soil complex) most closely resembled the crucibles, particularly Fabric 2a. Fine grained quartzite and sandstone, similar to that observed in the crucible sherds, are present throughout the clay sample. However, unlike the crucibles, this clay is exceptionally ferruginous, and contains only a moderate amount of quartz sand. A related fire-clay deposit to that represented by SOM 25 is suggested as the source of at least Fabric 2a.

The occurrence of sandstone and quartzite in the Meare carbon fabrics again indicates the Coal Measures as a source of binding clay and/or sand fillers. However, as noted above, complex and lengthy experimentation would be required to define the precise nature and proportions of material constituents, and the methods used in production.

No source can be suggested for the slightly micaceous, sandy Fabric 3. However, as no mica is present in any of the Coal Measures samples, it is clear that this fabric is derived from a different geological formation. It is possible that sand may have been added to a cleaned Lias clay for the production of Fabric 3 crucibles, but once again, experimentation and further sampling is necessary to test this theory.

III.11.4 Discussion

The eight crucible fabrics identified at Meare suggest a considerable period of casting activity involving two different refractory technologies. Four different carbon crucible fabrics and four of sand composition were recognised. It would, however, seem that the sand selected for Fabrics 2a b and c, and that present in Fabrics 1b, c and d were collected from closely related source areas. This suggestion is

based on the consistent occurrence within these fabrics of rounded grains of quartzite, sandstone and, more rarely, chert. If, indeed, the same ~~and~~ sources were favoured, this indicates some continuity of tradition overriding a change (be this change functionally or chronologically defined) in crucible technology.

Other than in the case of Fabric 3 crucibles, it is not possible to ascertain the precise nature of the binding material. A micaceous clay was used in the production of Fabric 3 vessels, which are further distinguished by the absence of inclusions other than fine angular and subangular quartz sand. It is clear that different raw materials were exploited for Fabric 3 crucible preparation. This may possibly reflect the presence of a 'different' smithing group at Meare. It is interesting that of the four sherds examined from Meare East, two are of this Fabric 3.

The range of crucible fabrics recovered from Meare bears a remarkable similarity to that identified at the middle/late iron age site at Beckford (Ch III.10, above). At Beckford, however, as far as is known, all crucibles were of small capacity, and no large, thick-walled specimens were recorded. A further important difference between the refractories from the two sites concerns the nature of the binding material. At Beckford, both the carbon, and most of the sand based crucibles were bound with a calcareous clay, and limestone fragments appear in several fabric types. Although the precise composition of the binding material used at Meare is unknown, it was certainly non-calcareous. It would seem that related technologies were operative at both sites, but the possibility that a central producer was supplying refractories to both metalworking groups can be discounted.

At Beckford, the change from carbon based to sand refractories would seem to be chronologically defined. However, at Meare, a similar sequence can only be hypothesised. The stratigraphy at Meare is not properly understood, and furthermore, detailed contextual information concerning refractory deposition is lacking. The only series of Meare radiocarbon dates is derived from the SLP trench located some 100m from the area examined by Bulleid and Gray which produced the Meare West refractory debris. In the absence of date range, detailed contextual information, and well defined stratigraphy it is not possible to propose

a chronological sequence for metalworking technology at Meare.

When the Meare refractories are compared with those recovered at Glastonbury Lake Village, some similarities and some differences may be observed. A sand technology was operative at both sites and one Glastonbury fabric contains some organic inclusions. However, no true carbon crucibles were used at Glastonbury. Fabric analyses point to the refractory clays and gannister beds of the Bristol Coal Measures as the raw material source for sand based crucibles at both sites. However, mineralogical differences suggest that different areas of these deposits were exploited. Furthermore, although deep, triangular crucibles are common to both sites, open, shallow vessels are unique to Glastonbury.

No ceramic mould material was recovered at Glastonbury, and despite a thorough search through the unidentified ceramics from Meare only a single clay mould fragment was recognised. Environmental conditions at both sites are ideal for mould preservation. If mould fragments had been discarded in the village areas, these would have been trampled, intact, into the peat, and so recovered during excavation. As virtually none was found, it is suggested that at Meare, as at Glastonbury, metalworking took place outside the excavated areas, perhaps on the nearby high ground of Meare island. Serviceable refractories would have been curated in the smiths' living quarters between casting episodes, and this would explain the presence of crucibles and reusable stone moulds in settlement contexts.

Spatial analysis of crucibles at Meare West shows that each of the identified carbon fabrics has an almost exclusive distribution (fig III.11.8a-c). This would tend to suggest localised changes in metalworkers' living quarters, perhaps related to the inauguration of new master smiths, each developing and slightly modifying a traditional technology. Very little overlap between sand-based and carbon crucibles can be discerned, suggesting that the two formulae were not in use at the same time (fig III.11.8d).

Similar crucible fabrics identified at both Meare West and Meare East suggest a continuity of smithing tradition and provide some support for Avery's contention that the two areas were, in fact, components of a

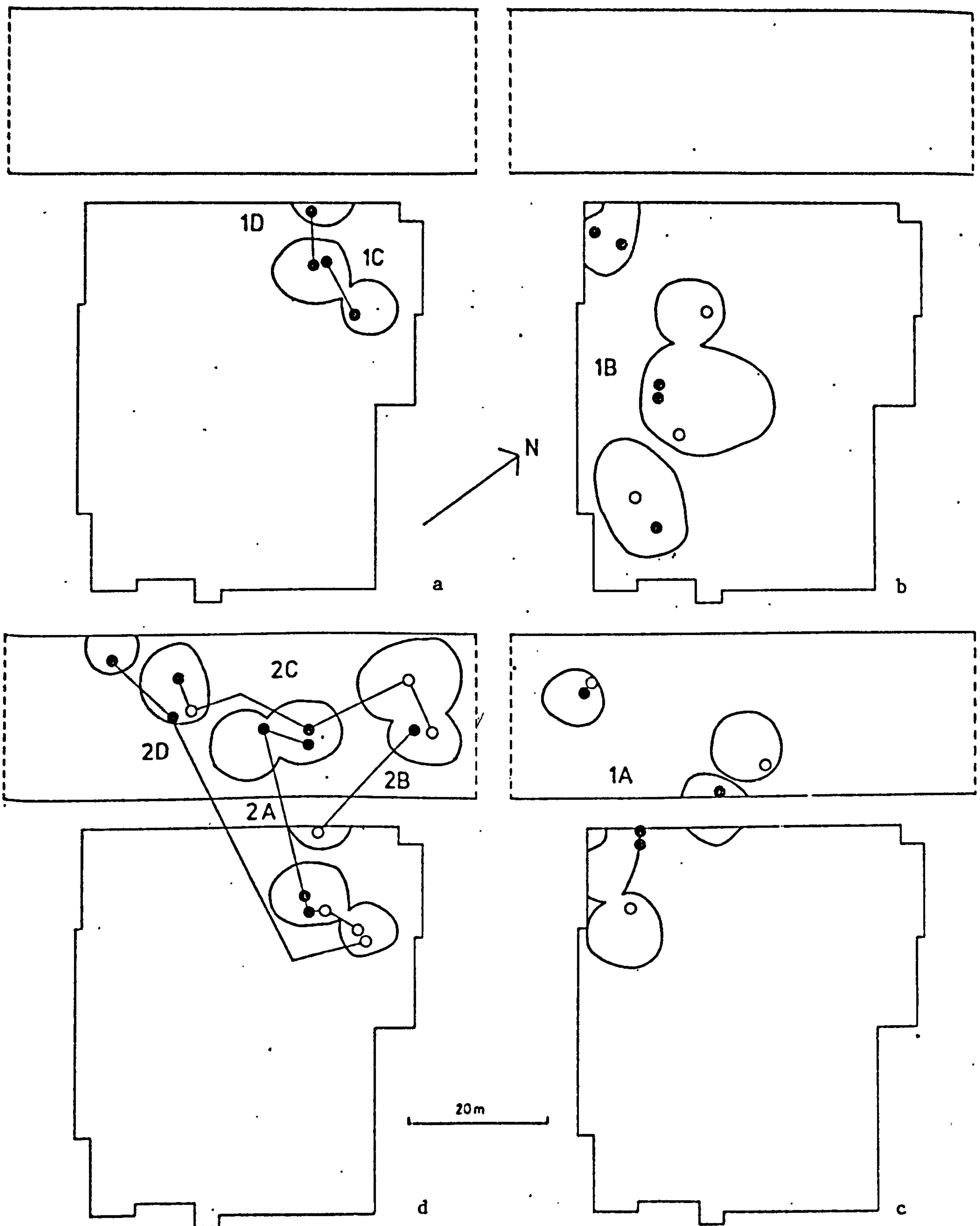


Fig III.11.8 Distributions of crucible fabrics at Meare West.
 ● = thin sectioned sherd, ○ = sherd assigned macroscopically.

single activity complex (Avery, 1968). Of the refractories recovered at Meare East (Table III.11.2), only the indeterminate sherd MTE.E 6 was securely stratified (Avery, pers comm). The small quantity of refractory evidence and the lack of published details concerning the east village in general, preclude any further discussion, at present, of the metalworkers in this area of the site.

Finally, attention must be drawn to the presence of the single sherd of cire perdue casting mould and fragments of possibly seven stone moulds at Meare. If the functional identification of the only examined stone mould is correct, one interpretation is that at least some of the smiths at the site were involved in sheet metalworking. Smelted copper and alloying material (indeterminate objects of both tin and lead have been found: Gray and Bulleid, 1953, 249-52) would be melted together in a crucible, and the resultant metal cast into 'blanks' in preparation for hammering and beating. A considerable number of hammerstone^s has been found in various areas of the village (Gray and Cotton, 1966, 373-76), but the association of these artefacts with metalworking is purely conjectural. Many sheet bronze items were recovered at Meare (Gray and Bulleid, 1953, 203-32) but there is no conclusive evidence proving that these were actually produced on the site. A second interpretation is that Meare smiths participated in a system of metal exchange. In this case, raw smelted metal would have been brought to the site, alloyed and cast into circular ingots for trade to metalsmiths (casters and/or sheet metalworkers) located elsewhere.

The identification of a mould of greisen is interesting and poses more questions concerning the organisation of bronzeworking at Meare. Although a Meare smith may have travelled a considerable distance (the Dartmoor metamorphic aureole, a possible source of greisen, is some 150km from the site) to obtain an easily carved or 'special' rock, the possibility that the mould was brought to Meare by an itinerant smith cannot be discounted.

The single fragment of cire perdue clay mould denotes complex casting activity near the site. Thus although some Meare smiths seem to have been involved in ingot production and/or sheet metal working,

some practised direct artefact casting. The clay mould matrix cannot be identified, but it is possible that at least a portion of the numerous cast bronze objects recovered (Gray and Bulleid, 1953, 203-52) were manufactured by local smiths.

TABLE III.11.1 MEARE: CONCORDANCE OF REFRACTORY SHERDS (WEST VILLAGE)

Sample number	Published number	Mound number	Identification	Present location
MRE 1	C1	II	crucible	Taunton
MRE 2 *	C2	II	crucible	Taunton
MRE 3 *	C3	VI	crucible	Taunton
MRE 4	C4	VII	crucible (restored)	?
MRE 5 *	C5	VII	crucible (6 frags)	Taunton
MRE 6	C6	VII	crucible	Taunton
MRE 7	C7	VII	crucible	?
MRE 8	C8	XVIII	crucible	Taunton
MRE 9	C9	XIII	crucible	Taunton
MRE 10 *	C10	VII	crucible	Taunton
MRE 11 *	C11	XVIII	crucible	Taunton
MRE 12	C12	XIII	crucible	Taunton
MRE 13	C13	XIX	crucible	?
MRE 14	C14	IX	crucible	Taunton
MRE 15a *	C15	XIX	tuyère	Taunton
MRE 15b *	C15	XIX	crucible	Taunton
MRE 16 *	C16	IX	crucible	Taunton
MRE 17a *	C17	XII	crucible	Taunton
MRE 17b *	C17	XII	crucible	Taunton
MRE 18	C18	XXI	crucible	Taunton
MRE 19	C19	IX	crucible	Taunton
MRE 20	C20	XXIII	crucible	Taunton
MRE 21a *	C21	XXXVIII	crucible	Taunton
MRE 21b *	C21	XXXVIII	crucible	Taunton
MRE 22	C22	XXIV	? crucible	Taunton
MRE 23a *	C23	XXVI	? furnace	Taunton
MRE 23b *	C23	XXVI	crucible	Taunton
			also 5 other crucible sherds, 2 sherds vitrified clay and 1 pot sherd in bag	
MRE 24a *	C24	XXVI	crucible	Taunton
MRE 24b *	C24	XXVI	? furnace	Taunton
MRE 25 *	C25	XXVI	crucible (vessel + 6 sherds)	Taunton
MRE 26	C26	XXIX	crucible	Taunton
MRE 27	C27	XXIX	crucible	Taunton
MRE 28 *	C28	XXIX	crucible	Taunton
MRE 29a *	C29	XXVI	crucible	Taunton
MRE 29b	C29	XXVI	crucible	Taunton
MRE 30	C30	XXXIX	crucible	?
MRE 31 *	C31	XXIII	non-refractory	Taunton
MRE 32 *	C32	XXXVIII	crucible	Taunton
MRE 33 *	C33	XXXVIII	crucible	Taunton
MRE 34	C34	XXXVIII	crucible	?
MRE 35 *	C35	XXXVI	crucible	Taunton
MRE 36	C36	XXXVI	crucible	Taunton
MRE 37a *	C37	XXXIV	crucible	Taunton
MRE 37b *	C37	XXXIV	crucible	Taunton
MRE 38	C38	XXXIV	crucible	Taunton
MRE 39 *	C39	XXXIV	? tuyère and formless lumps	Taunton
MRE 40	C40	XXXIV	crucible	Taunton
MRE D1	D1		slag	Taunton
MRE D12 *	D12		tuyère	Taunton
MRE unmA *			crucible	Taunton
MRE unmB *			crucible	Taunton
MRE unmC *			crucible	Taunton
MRE unmD *		XXII	crucible	Taunton
MRE mould *			? mould	Taunton

* = thin sectioned

TABLE III.11.2 MEARE EAST: CONCORDANCE OF REFRACTORY SHERDS

Sample number	Excavation number	Identification and stratification (from Gray's notebook)
MRE.E 1 (not located)	C1.EV	"Piece of a crucible. Found in the black earth under the clay of Md. XXI, 11' N. of the c.p. 1936 (on edge of mound)"
MRE.E 2 *	C2.EV	"Piece of a crucible. Found in Md. XVII in black earth under floor i, 16' E. of the c.p. 1938"
MRE.E 3 *	C3.EV	"Small piece of crucible. Found in Md. XXIV, 2' N. of c.p. 1938"
MRE.E 4 *	C4.EV	"Several pieces of a crucible. Found below the hearths in the black earth, Md, XXX, 3' N.E. of c.p., 1948"
MRE.E 5 (not located)	C5.EV	"Fragment of crucible. Found thrown out from Md. XXX, 1949 (approx. 4½' N.W. of c.p.)"
MRE.E 6 *	C6.EV	"Fused pieces of crucible. Found on floor ii, Md. XXVIII, 10' S.W. of c.p. 1952"

* = thin sectioned

TABLE III.11.3 MEARE WEST: CERTAIN AND POSSIBLE STONE MOULDS

(except for the last piece, all information is abbreviated from Gray and Cotton, 1966, 371-72)

Number	Material	Shape	Provenance
S21	Soft, clayey, ochreous limestone. Lower Lias, Polden Hills	Max dimension 31cm; block with rounded margins, with circular depression	Mound VII
S27	Compact, fine-grained, grey sandstone. Old Red Sandstone	Max dimension 25cm; disc-shaped, with round depression, which appears to have been burnt	Mound VII, in black earth under floor i
S28	Soft, clayey limestone. Lower Lias, Polden Hills	Max dimension 28cm; oval disc-shaped, semicircular notch at one end; flat upper face shows signs of fire over 2/3 of area	Mound VII, in fire-ash on SW side of the tilted hearth
S34	Sandstone	Max dimension 20cm+; part of mould, probably for bronze mirror; darkened by heat	Mound VII
S39	Shelly limestone. Lower Lias, Polden Hills.	Max dimension 24cm; circular slab with 3 notches, showing signs of burning	Mound IX, in black earth under clay
S59	Limestone	Max dimension 17cm; chipped circular depression, similar to S31 and S34	Mound XXIV
-	Greisen, 7 Dartmoor granite massif (Som 148)	Small fragment from near edge of circular mould, diameter of casting c 18cm (fig III.11.6)	Mound XXVIII

TABLE III.11.4 MEARE: GRAIN SIZE STATISTICS

[illegible]

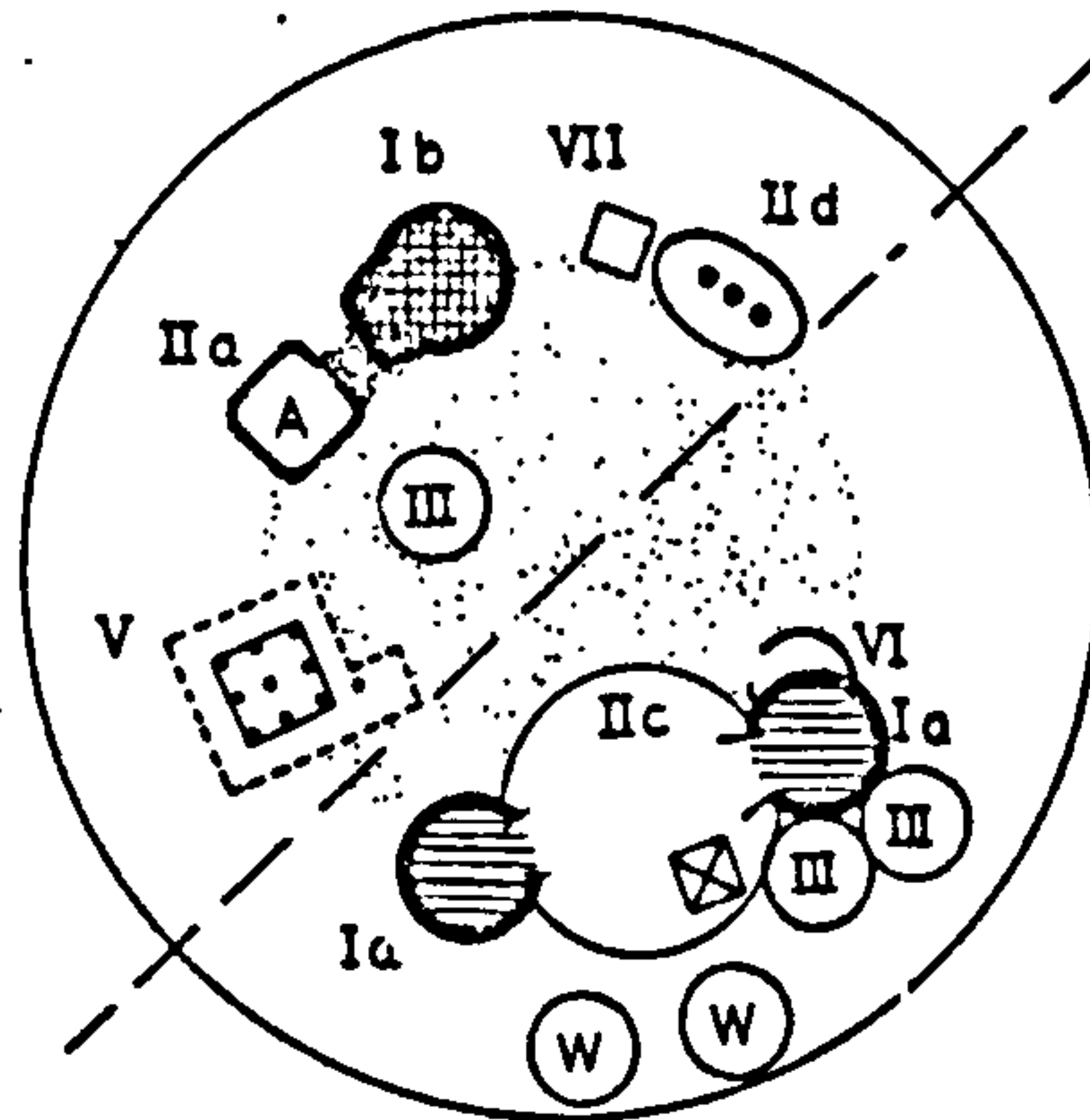
III.12 GLASTONBURY, SOMERSET
(ST 493409; corpus no 53)

The Lake Village at Glastonbury is located on the swampy peatlands of the Somerset Levels, and was totally excavated by Arthur Bulleid (latterly joined by H St G Gray) during the period 1892 to 1907. The settlement (c 1.4ha) was enclosed within a wooden pallisade and consisted of 89 mounds, each containing a series of superimposed clay floors set on brushwood and timber footings. The mounds were interpreted by the excavators as dwelling houses, or workshops, and this interpretation remains unchallenged.

Bulleid and Gray made no attempt to suggest a chronology of settlement for the whole Glastonbury site, though numerous local sequences were proposed (Bulleid and Gray, 1911). From a reappraisal of the evidence, however, Tratman (1970) suggested four distinct phases of occupation involving the entire site. A more thorough reassessment of the Glastonbury data enabled Clarke likewise to distinguish four phases, but in this case, each phase represented an increase in the area occupied by four, and eventually seven families (Clarke, 1972, 839). He proposed that mound groupings represented modular units, each occupied by an extended family. These units were said to comprise major houses (male), minor houses (female), courtyards, workshops and facilities for animal shelters (fig III.12.1). Neither a range in social status nor craft specialisation by individual families was indicated by the finds from each mound group. If Clarke's conclusions, described as "best guess interpretations of the combined output of all the analyses ... schematic and tentative" (Clarke, 1972, 831), are accepted, it would seem that at least four extended families, each virtually self-sufficient in food and equipment, were resident at Glastonbury at any one time.

Clarke, like Tratman, did not present the analyses that lay behind his interpretation, and neither of their proposed sequences is fully supported by the published evidence. For example, Clarke notes that shale artefacts are found predominantly in the northern part of the

PROVISIONAL MODEL OF AN IRON AGE SOCIETY



The modular unit – the social and architectural building block of which the settlement is a multiple. The analyses of vertical and horizontal spatial relationships, structural attributes and artefact distributions convergently define a distinct range of structures (I–VII) repeatedly reproduced on the site. Each replication of the unit appears to be a particular transformation of an otherwise standardized set of relationships between each structural category and every other category. The basic division between the pair of major houses (Ia) and their satellites, and the minor house (Ib) and its ancillaries may be tentatively identified with a division between a major familial, multi-role and activity area on one hand and a minor, largely female and domestic area on the other.

Below: the iconic symbols used to identify the structures in the schematic site models

- | | | | |
|---|---------------------|---|------------------------------|
|  | – Ia Major house |  | – IIe Annexe hut |
|  | – Ib Minor house |  | – III Workfloor |
|  | – IIa Ancillary hut |  | – IV Clay patch |
|  | – IIb Workshop hut |  | – V Granaries or Storehouses |
|  | – IIc Courtyard |  | – VI Stables |
|  | – IId Baking hut |  | – VII Sties or Kennels |
|  | – IIe Guard hut |  | – Waggon stance |
| <p>..... – Palisade or fence</p> | | | |

Fig III.12.1 Glastonbury modular unit (after Clarke, 1972)

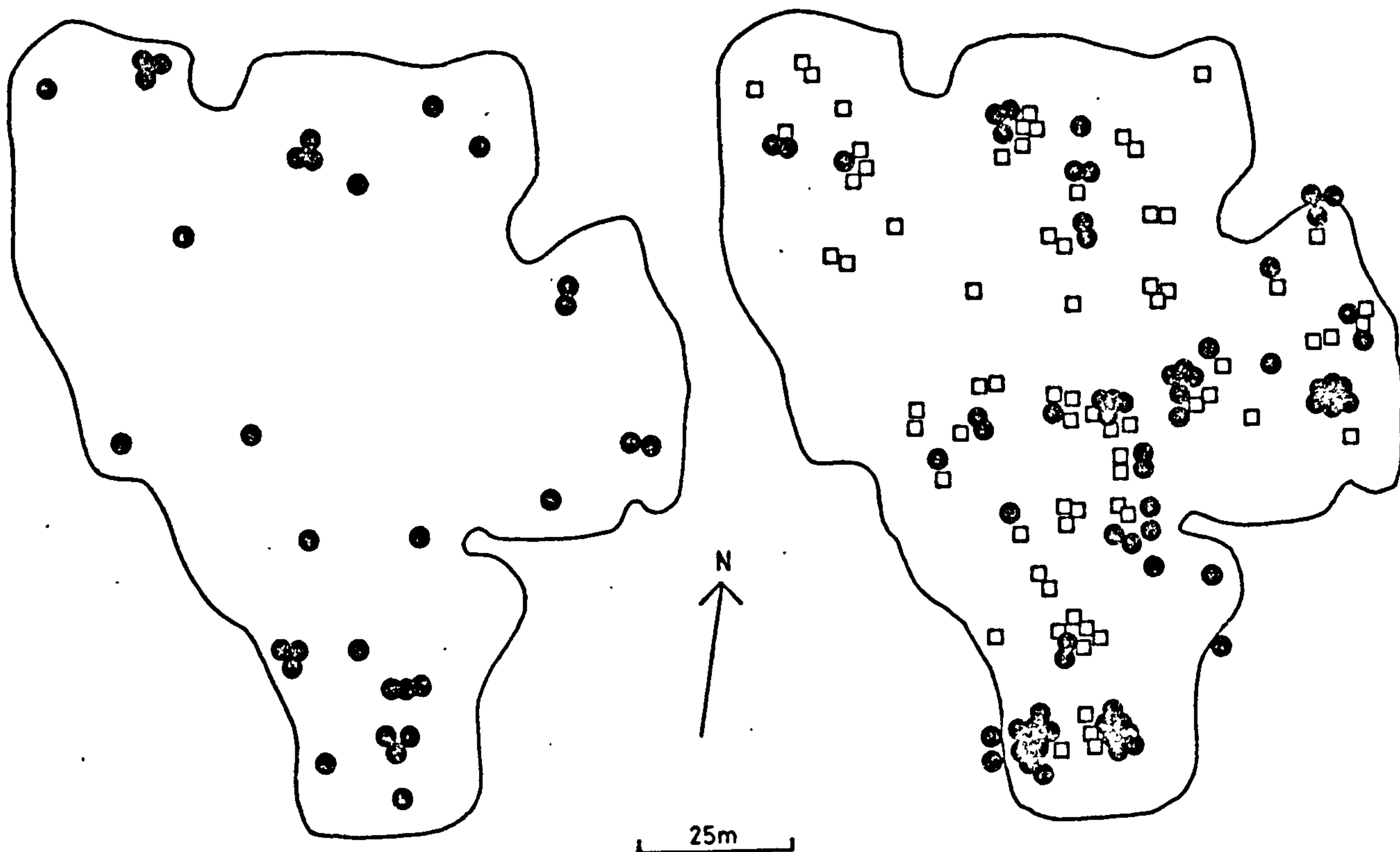


Fig III.12.2 (left) Distribution of shale artefacts, Glastonbury
(data from Bulleid and Gray, 1911 and 1917)

Fig III.12.3 (right) Distribution of Lias (●) and other sandstone
whorls (□), (data from Bulleid and Gray 1911 and 1917)

village (1972, 841). In fact, shale artefacts occur randomly over the entire settlement area (fig III.12.2). Crucibles, according to Clarke, are not found in "minor houses" (1972, 819), but minor house XLIV produced both triangular crucible sherds and a fragment of bronze dross. A further claim of Clarke's, that sandstone spindle whorls occur mostly in the north of the village (1972, 841), does, however, withstand inspection. Clarke saw this restricted distribution as a reflection of different trading contacts in that part of the site. If all the stone whorls are considered, a clear trend emerges, from predominantly Lias in the south to sandstone in the north (fig III.12.3). This may imply a change in supply of spindle whorls coterminous with a linear expansion of the site. Relative quantities of artefacts and frequency of refloorings suggest (albeit not conclusively) that this expansion took place from south to north, as Clarke proposed. The entire

period of settlement at Glastonbury is dated on ceramic grounds from c 200 BC to the Roman conquest.

III.12.1 The metalworking evidence

Sherds believed to represent 37 bronze melting crucibles were found during the excavations at Glastonbury Lake Village (Bulleid and Gray, 1911, 300-09; Pl LXIX). These included several reconstructable and virtually complete examples. Twenty four of the published crucibles are of triangular form, and fourteen unnumbered sherds stored in the Tribunal at Glastonbury would seem to be derived from similarly shaped vessels. Only fifteen of the 24 published triangular crucibles were located (Table III.12.1) and these display considerable variation in form and capacity (figs III.12.4-5).

The remaining thirteen vessels described as crucibles are globular or quadrangular in form. Although there is no evidence that any of these vessels "made of a quite different clay, which is not gritty but rather soft and unctuous" (Bulleid and Gray, 1911, 302) were connected with metalworking, the excavators were unable to suggest any other function. They therefore found it convenient to include them in the crucible report.

Tuyères were discovered in Mounds V and LXII (fig III.12.7) and the remains of possible furnaces were found in the same two mounds. Sherd D50 from Mound LXXII is almost certainly a sprue cup (fig III.12.6). Thirteen pieces identified as casting waste were recognised at Glastonbury, the majority from Mounds LXXI to LXXVI (fig III.12.8). No clay mould fragments were recognised, but a possible stone mould fragment (now untraceable) was found 8' NE of the central picket of Mound XLIV (Bulleid and Gray, 1917, 624, Pl XC).

III.12.2 Analytical results (see Table III.12.1)

The triangular crucible sherds from Glastonbury were examined by Clement Reid, who reported "All the fragments look as if they might be made of fire-clay and gannister-beds of the Bristol coal-field, and I do not think the material is local ... I do not think that the Somerset lias or oolites, or the alluvium would be at all suitable; but the 'under-clays' or fireclays beneath the coal seams are very good, and the

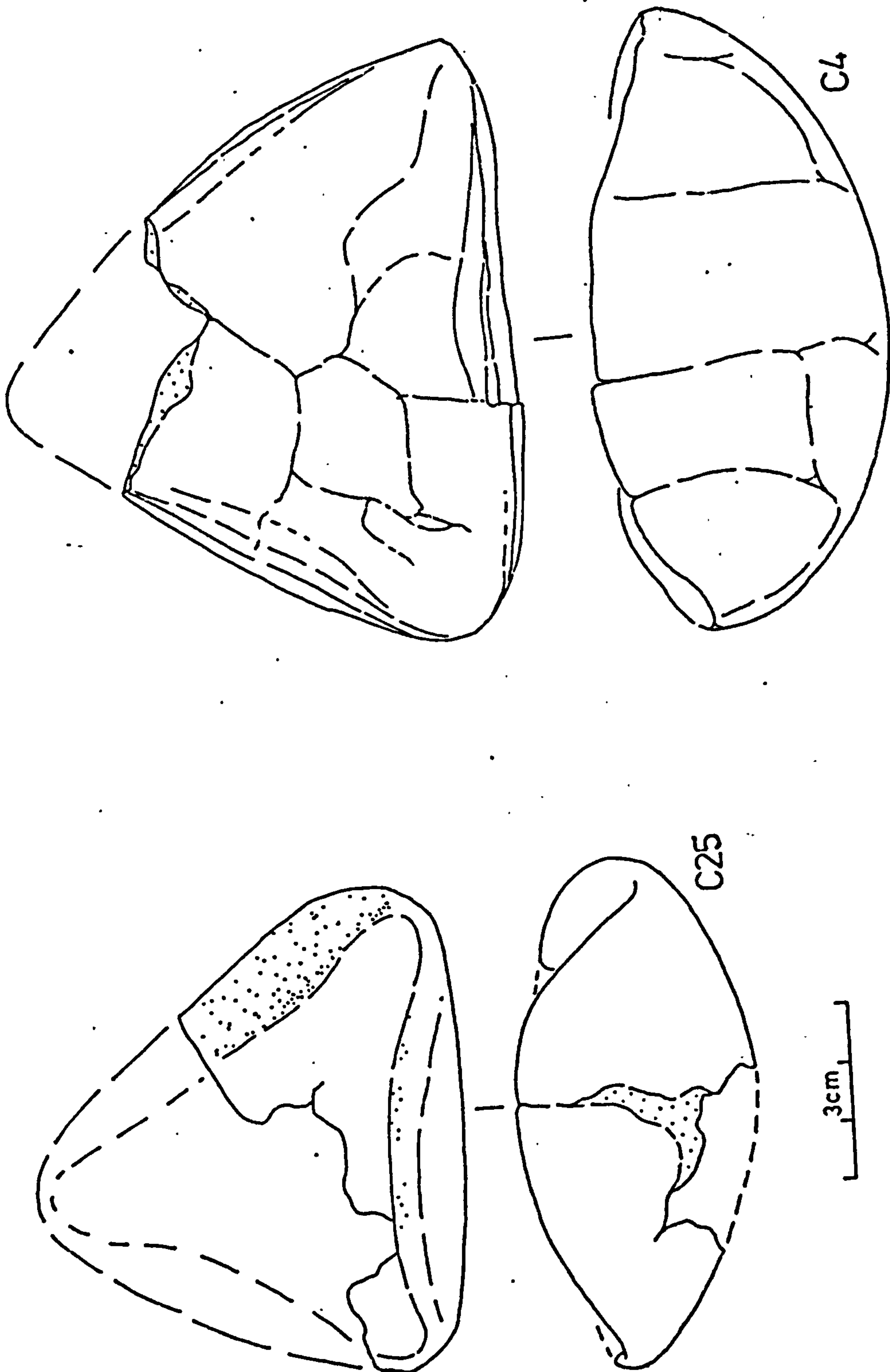


Fig III.12.4 Glastonbury crucibles

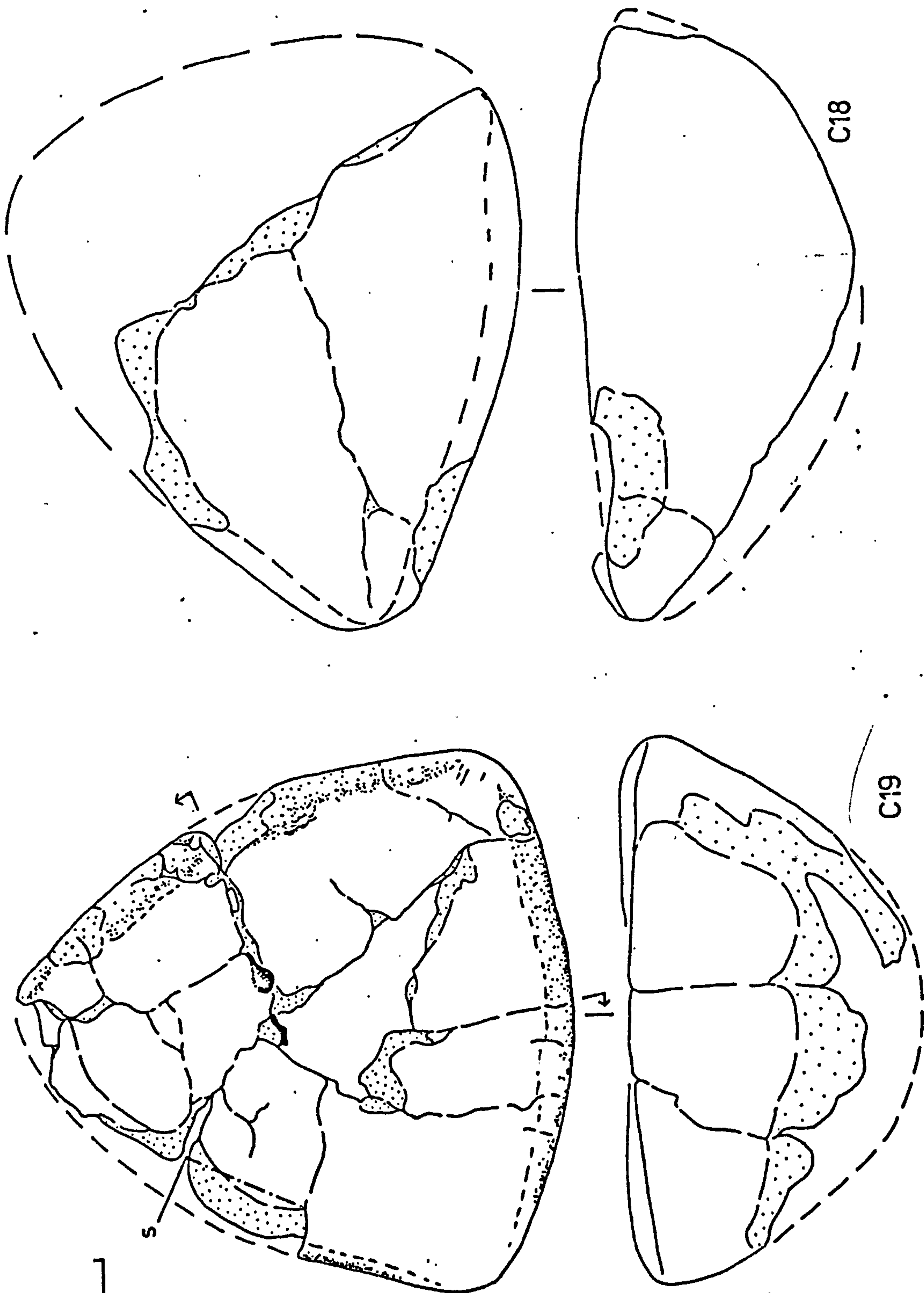


Fig III.12.5 Glastonbury crucibles. Note slag extruding from ancient break in base of C19. Bulleid illustrated the part between the arrows. The remainder, of uncatalogued sherds, is in the Glastonbury Tribunal. S = thin section line.

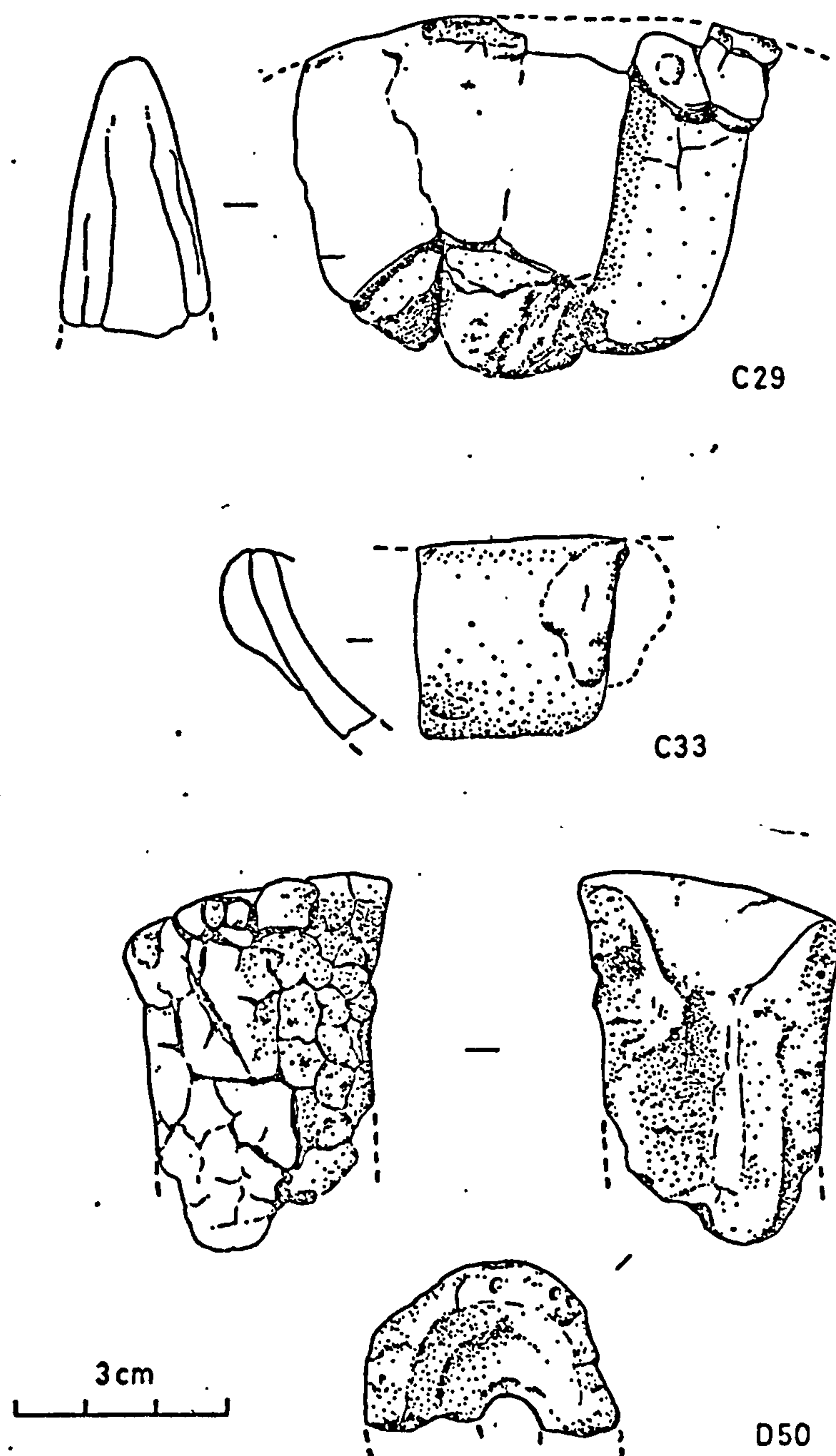


Fig III.12.6 Glastonbury: crucible rime showing unusual laminar structure (C29) and a possible 'handle' (C33), and a highly vitrified sprue-cup fragment (D50).

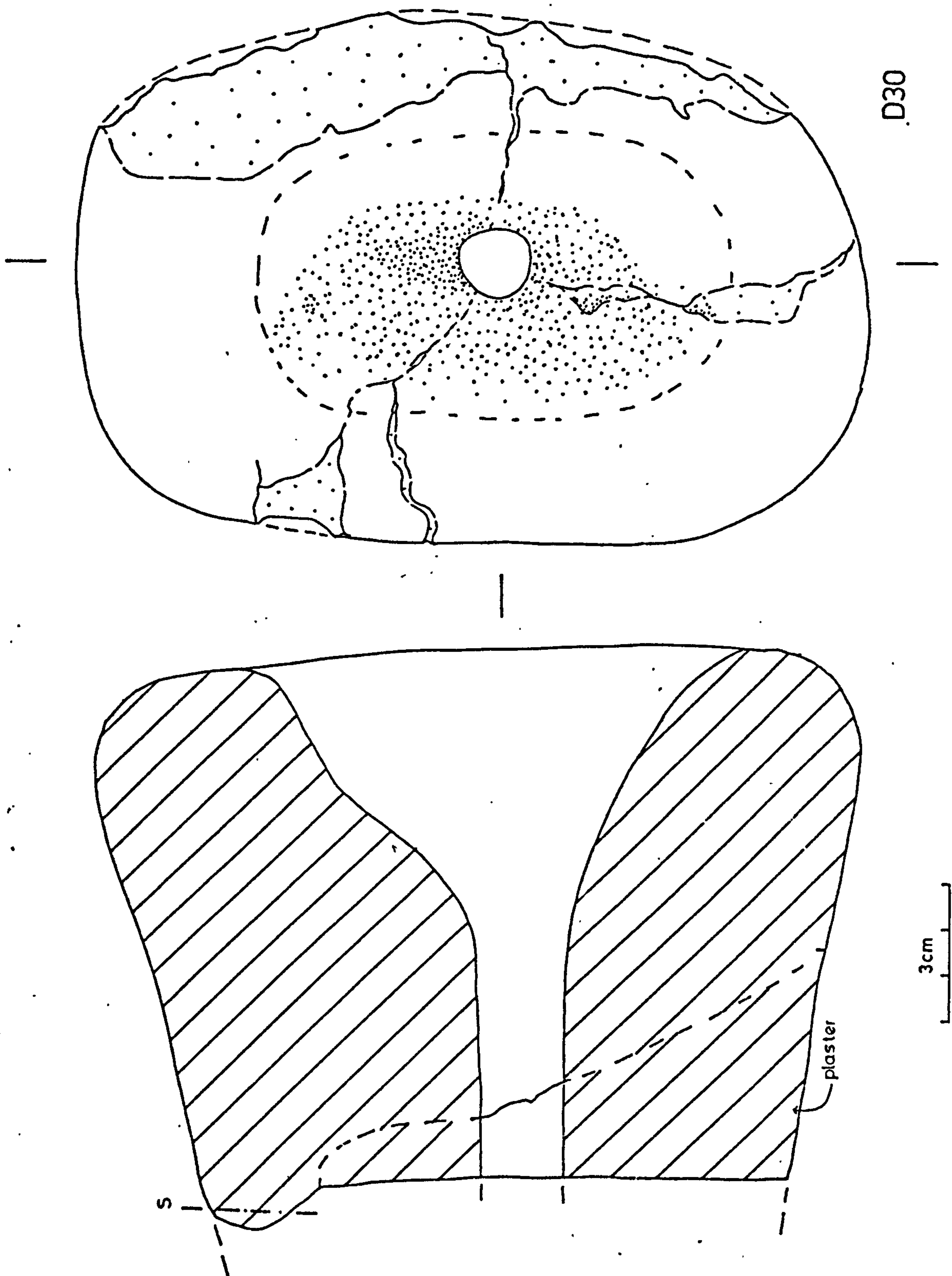


Fig III.12.7 Tuyere mouth from Mound LXII, Glastonbury.
S = line of thin section.

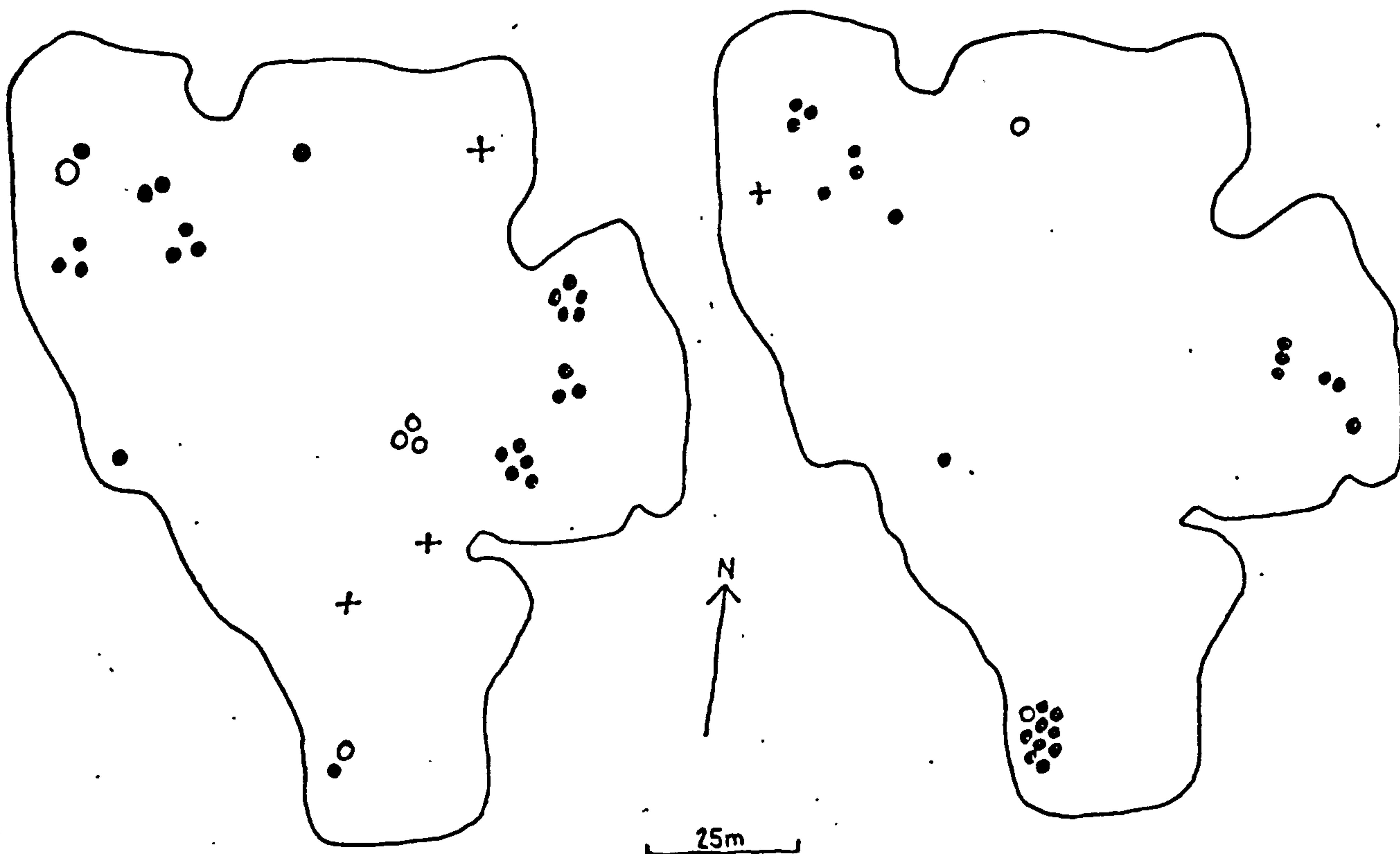


Fig III.12.8 Glastonbury: distribution of smithing debris. right: crucibles (● - one spot represents one "C" number, often more than one sherd), tuyère (○) and sprue-cup (+); left: "dross, lumps of bronze etc" (●), "lump of lead ore" (○) and "lump of tin" (+)

gritty gannister-beds are also much used. You seem to have crucibles made of each of these materials" (Reid, quoted in Bulleid and Gray, 1911, 301). These conclusions were based on purely visual inspection of the refractory sherds and on Mr Reid's knowledge of local geology.

All crucibles and purported crucible sherds stored in the Somerset County Museum and the Glastonbury Tribunal were examined by the writer in hand specimen. Tuyères, the sprue-cup and anomalous refractory fragments not included in the published report were also examined, and a total of eighteen pieces was selected for microscopic analysis.

The Glastonbury crucibles are invariably reduction fired with surface colours ranging from pale grey to brownish black. Light grey faced sherds are commonly black cores. A few of the finer examples are patchily oxidised on their outer faces to pale pinkish brown (7.5YR 7/4). All crucibles from the site are extremely hard-fired and most appear to be partially vitrified. Three broad fabric groups were recognised in hand specimen, and samples representing these groups were selected for thin section analysis. Six sherds which could not be assigned to any of the groups were also analysed, as was a fragment of the large tuyere mouth D30, and a representative sample of the globular and rectangular vessels described as crucibles in the site report.

Fabric 1: fine sand and carbon (C19, 20, unmc; assigned but not sectioned: C1, 27)

This fabric appears inclusionless in hand specimen save for minute flecks of carbon visible in fresh fracture, and rarely on the well-smoothed outer face. In thin section Fabric 1 is seen to consist of fine, dense angular and subangular quartz sand set in a sparse isotropic clay matrix. Grain size rarely exceeds 0.05mm, although incipient liquid state sintering renders individual grain boundaries difficult to determine. Tabular and oddly shaped fragments of carbonised organic material (to 0.8mm) occur erratically throughout all Fabric 1 samples. The well defined cellular structure of many of these fragments suggests that they are in fact fossilised plants typical of the Coal Measures Series of the Carboniferous System.

Fabric 2: fine sand (C18, 34, unmB, D50; assigned but not sectioned: C4, 7, 25)

Fabric 2 vessels (and the sprue cup, D50) are all well made and carefully smoothed on their sometimes oxidised outer faces. No inclusions are visible in hand specimen. In thin section, Fabric 2 sherds closely resemble those representing Fabric 1. However, save for two unusually shaped, tiny, cellular fragments seen in C34, no carbon is present. Rare small patches of iron oxide indicate the use of ferruginous sand, or perhaps, binding clay. A source closely related to that exploited for Fabric 1 production is suggested for these crucibles.

Fabric 3: coarse sand and sandstone (C15b, 29, 33, unmA, unmE; assigned but not sectioned: C21)

Although Fabric 3 sherds are invariably^a hard-fired, grains of the sand from which they are essentially composed often become detached during handling. This is indicative of a low proportion of binding clay. The fabric feels rough, and rounded clear and opaque grains of quartz and ? sandstone are clearly visible across the surface and in fracture. Under the microscope, some variation in quartz grain size range, matrix density and frequency of sandstone inclusions is observed among the Fabric 3 samples. C15b and unmA contain a higher proportion of binding material than do C33 and unmE. Sandstone fragments are rare in all samples, but are slightly more frequent in sample C33. C15b contains a larger proportion of small grains than do the remaining members of this group. The results of textural analysis of Fabric 3 sections are set out in fig III.12.10.

Sherds not assigned to fabric groups (C15a, 26, 28; D30)

Although in some ways resembling the major Glastonbury crucible fabrics, none of these sherds was sufficiently similar under the microscope to be included in a specific fabric group. The composition of the individual fabrics is variable. Grain size and matrix density measurements were made on samples C15a and 26 (C28 was too vitrified for measurement) and the results are included in the overall analysis of the Glastonbury site (fig III.12.10).

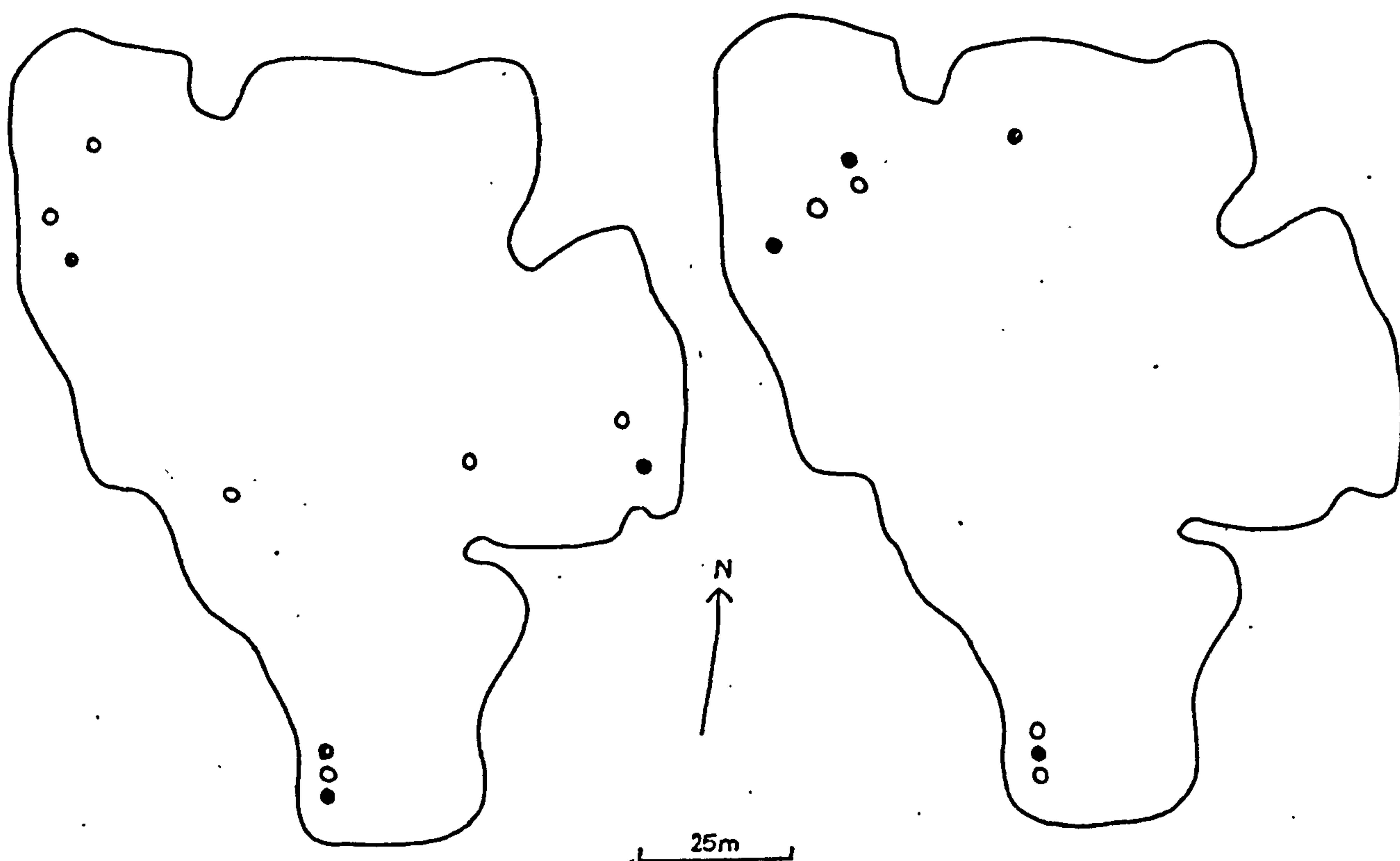


Fig III.12.9 Glastonbury: distribution of refractory fabrics. Left: Fabrics 1 (●) and 2 (○); right: Fabric 3 (○) and unclassified fabrics (●)

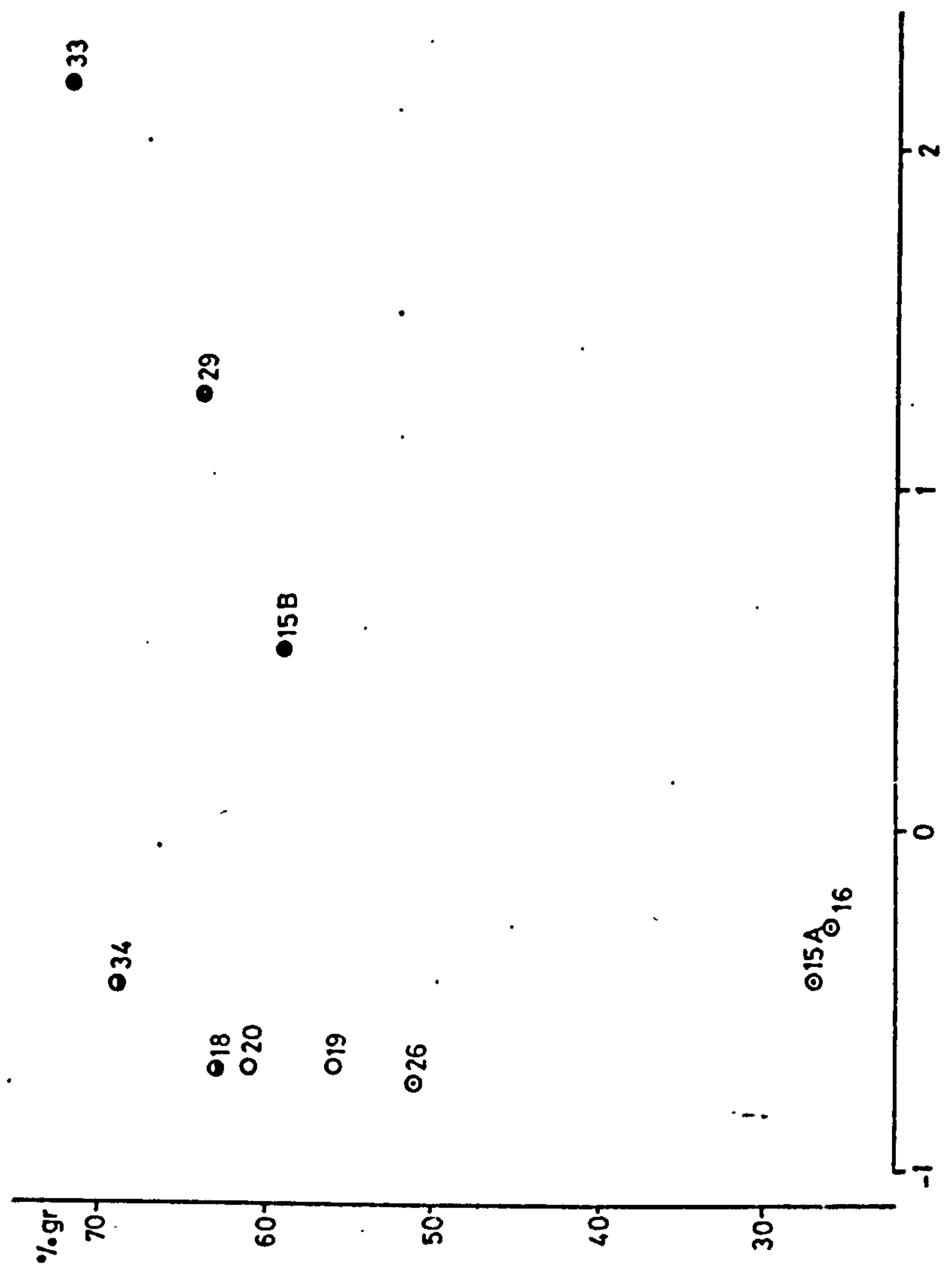


Fig III.12.10 Glastonbury: sherds plotted against grain size (expressed by scores on the first principal component extracted from the $\emptyset$ counts) and proportion of grains:matrix. Fabrics 1 (○), 2 (◐) and 3 (●) are crucibles; sherds 15a and 16, though so described by Bulleid and Gray, are not refractory.

A sample removed from the tuyère mouth (fig III.12.7, D30) differs both in hand specimen and thin section from all the crucible groups. The surface of the tuyère block is oxidised to light red (2.5YR 6/6), the inner core portion is reduced, and the areas around the apertures designed to take the bellows pipe is lightly vitrified. The fabric feels moderately rough and sandy. In thin section, the sample is seen to contain a scatter of poorly-sorted, subangular and rounded grains of quartz and sandstone with siliceous cement, set in a porous, partially isotropic clay matrix. The tuyère fabric is distinguished, however, by the presence of angular fragments of brownish cryptocrystalline silica (to 0.1mm), probably chert, throughout the matrix.

Sherd representing globular and rectangular vessels (C 16;
(assigned but not sectioned: C2, 9, 12, 13, 14;
D49, 63).

The fabric of all globular and rectangular vessels from Glastonbury, classed by Bulleid and Gray as possible crucibles, is soft and feels soapy to the touch. These vessels, which vary considerably in size, are almost always oxidised and pale pinkish brown (5YR 7/3 - 7.5YR 7/4) in colour. Variable wall thickness and poor surface finish suggest that minimal care was taken in preparation. Most globular and rectangular vessels appear inclusionless in hand specimen, but effervesce strongly with dilute HCl, indicating the use of a calcareous clay.

Under the microscope, the anisotropic clay matrix of vessel C16 is seen to contain a sparse scatter of fine, angular quartz (to 0.06mm) occasional ragged fragments of fine-grained sandstone with siliceous cement (One grain is metamorphosed) and rare threads of mica. Inclusions are unevenly distributed. The fabric is non-refractory, and, whatever their function, these vessels cannot be identified as crucibles.

III.12.33 Resource ecology and raw material analysis

Commenting on Clement Reid's conclusions concerning the origin of the Glastonbury crucibles, Bulleid writes: "With reference to the fire-clay and gannister beds of the Bristol coal-fields, the blue-grey clay or marl hearths found in the Village were probably made of the above

materials, and I am of the opinion that they were procured from the coal-beds that crop out in the Nettlebridge Valley a mile north of Oakhill and near and under Blackers Hill Camp" (Bulleid and Gray, 1911, 301, n 3). As to the suitability of locally available raw materials for refractory production, Bulleid further notes: "The lias clay used at Glastonbury and in the neighbourhood for brick-making is easily melted, and is fused at a comparatively low temperature" (Bulleid and Gray, 1911, 301, n 4).

To test these opinions, and to attempt to locate the sources of refractory materials exploited by the Glastonbury metalworkers (or their suppliers), samples representing the coalfield deposits were taken from the Nettlebridge and Blackers Hill areas (fig III.12.11, Table III.12.2; ST 647487 and ST 641498). Unfortunately, none of the "blue-grey clay or marl hearth" material described by Bulleid was retained to allow comparison. Samples from clay deposits located closer to the Glastonbury site were also collected and analysed (fig III.12.12, Table III.12.2: SOM 1-20). The majority of these local samples, representing the Lower and Middle Lias, Rhaetic and Keuper Marl formations contain variable amounts of microcrystalline or shelly limestone. Despite careful drying, pounding, soaking and wedging, many of these samples exhibited extensive cracking and distortion during the firing and cooling processes (Plate 3). To render the majority of these clays suitable for any form of ceramic production, additional preparation such as sieving or levigation would be necessary. To render them suitable for refractory production, sand, carbon or a mixture of the two would have to be added to the cleaned clays.

Abundant quartz sand, sandstone with siliceous cement and fossil plant material filled with silica all occur in the Glastonbury crucibles, and all point towards the fire-clay seams of the Bristol Coalfields as the most likely source of raw materials. The total area covered by the Coal Measures, recorded at the end of the 19th century, was 152,780 acres, mainly to the north of the Glastonbury area (Woodward, 1876, 49). Fire-clays generally occur beneath coal seams, which themselves are often overlain by thick deposits of Millstone or Pennant Grit. Few Coal Measures fire-clays are thus likely to have been accessible during the iron age. However, in the Nettlebridge Valley, "the seams are often

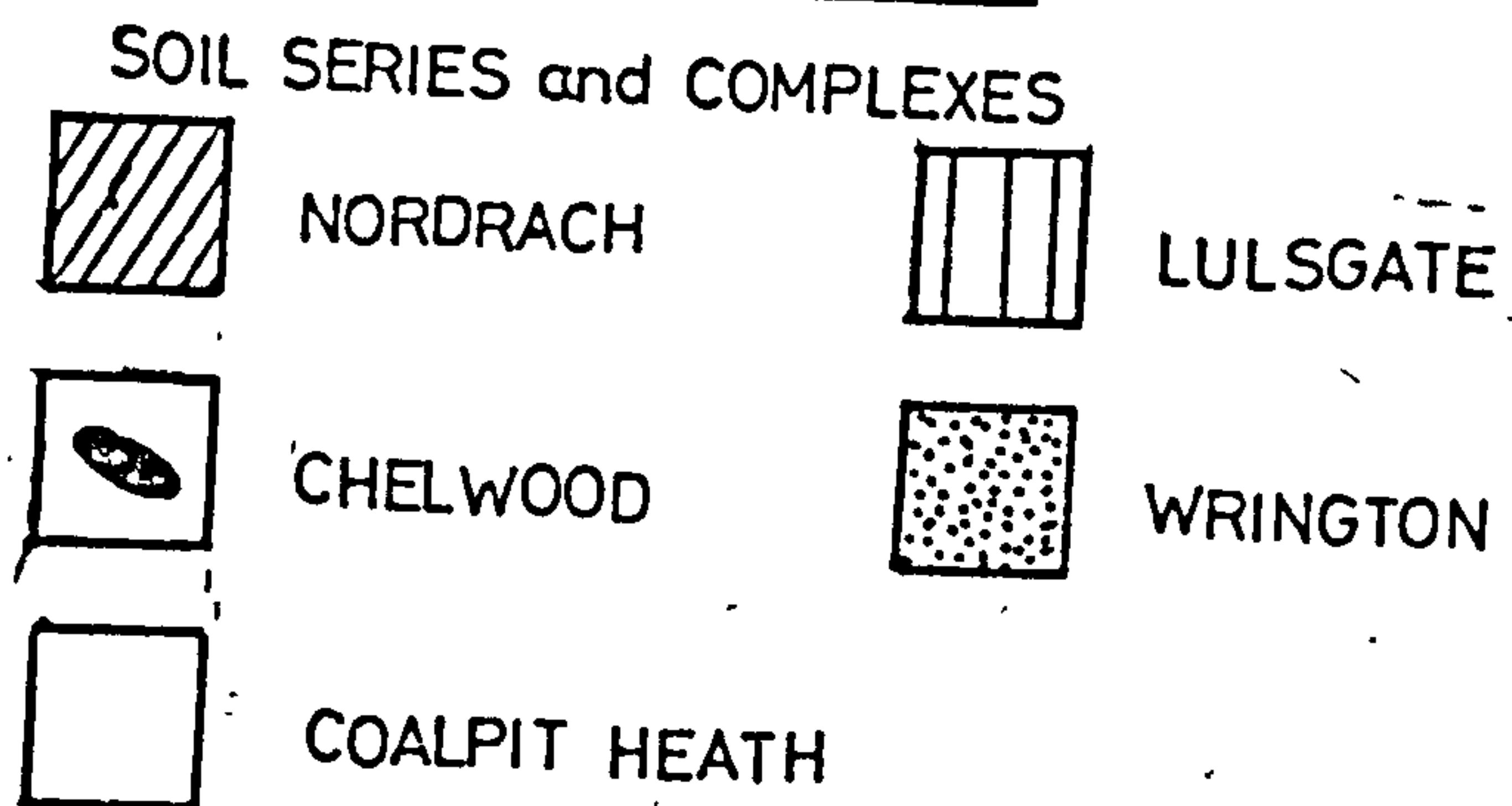
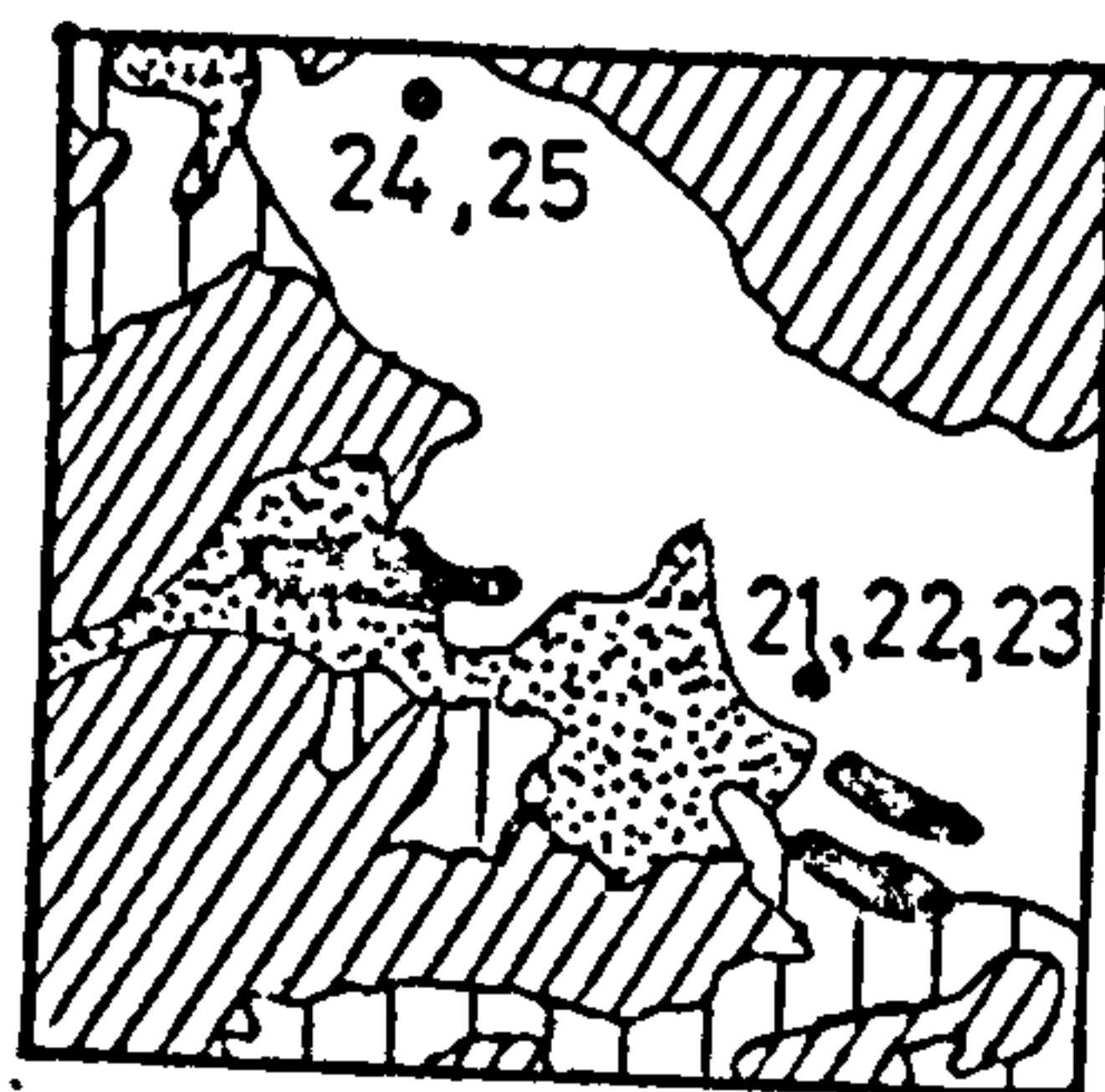
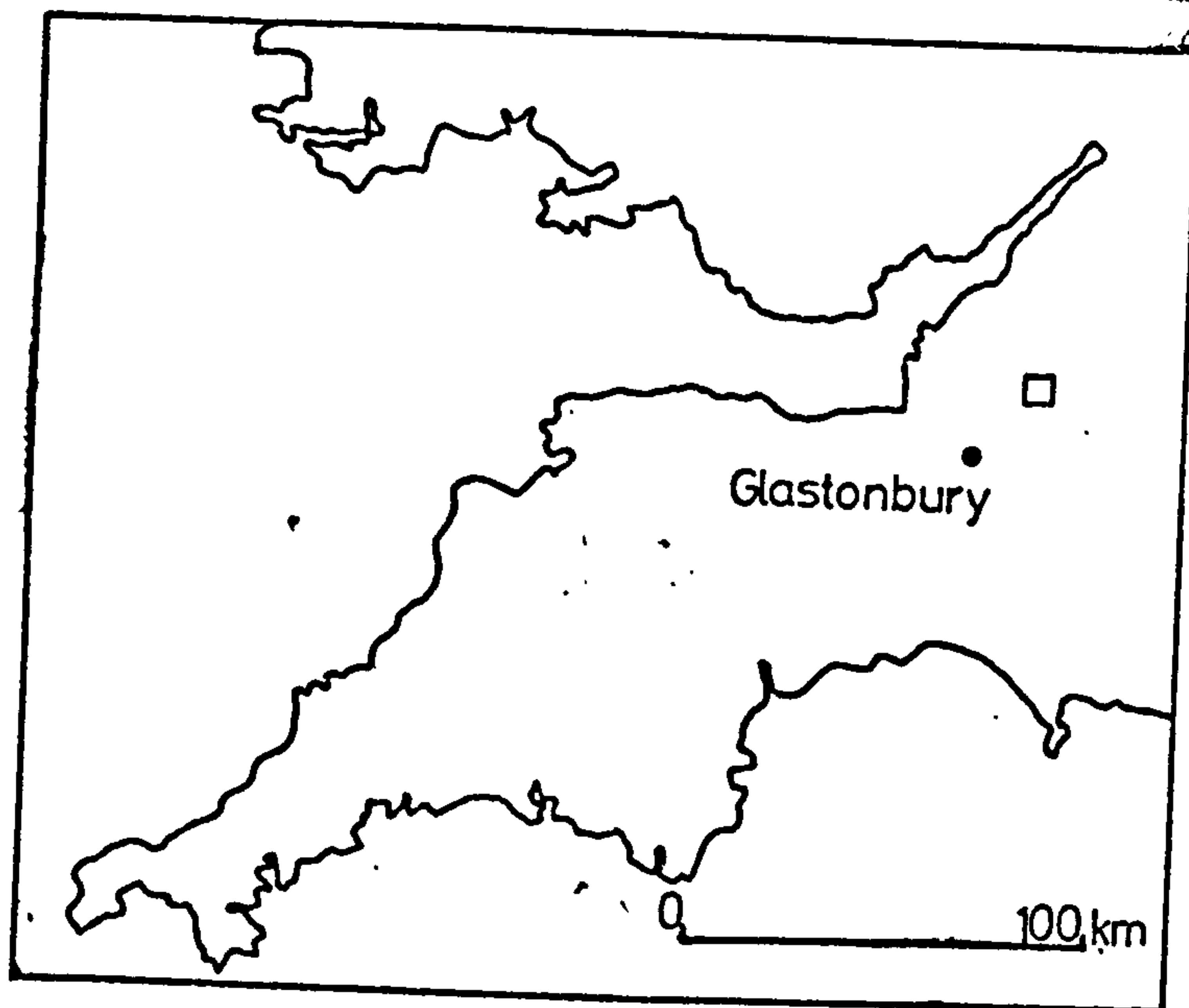


Fig III.12.11 Glastonbury: location of raw material samples SOM 21-25.

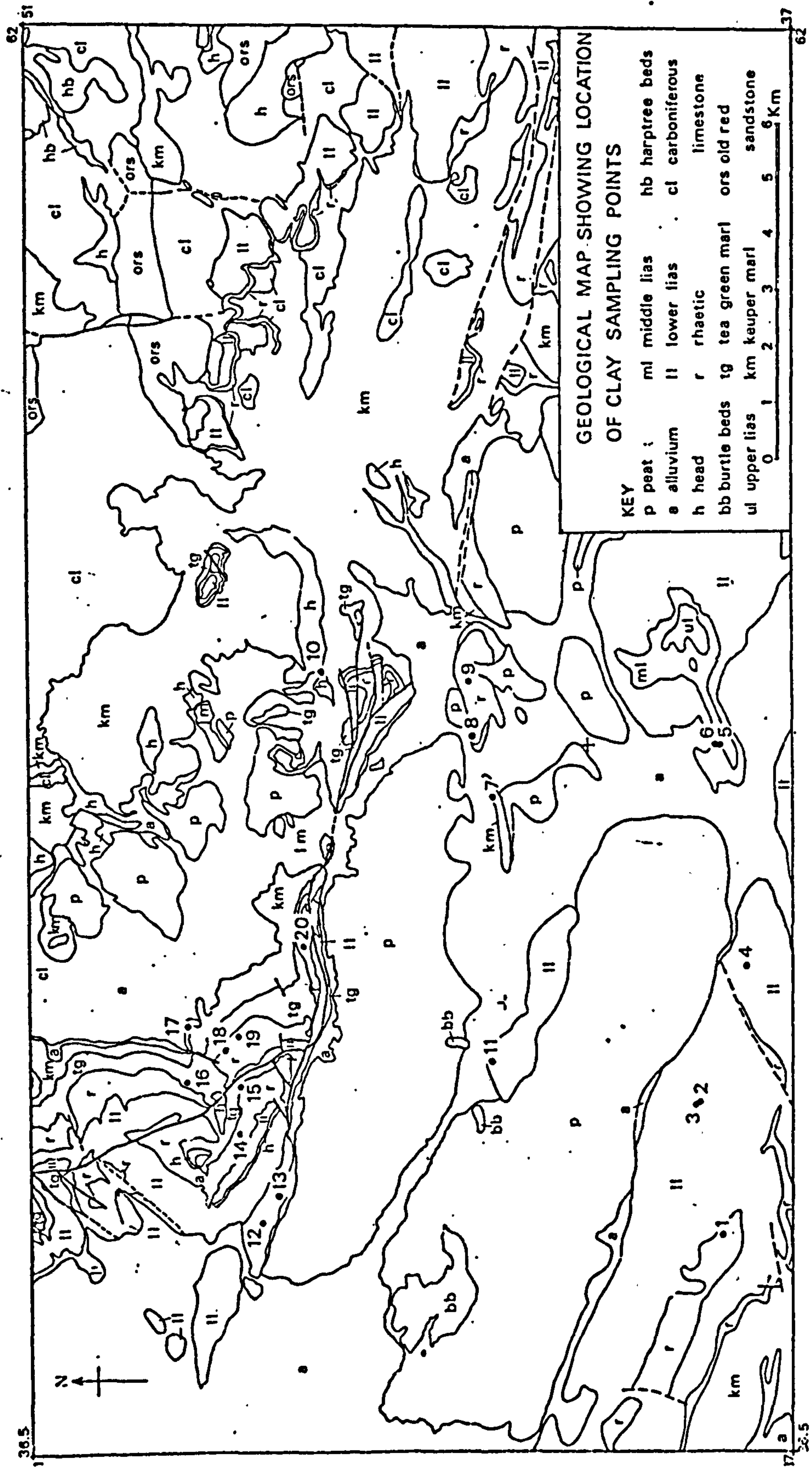


Fig III.12.12 Location of clay samples SOM 1-20 (after Bailey)

reversed, the fireclay forms the roof, to the great disadvantage of the miner (Woodward, 1876, 33). This phenomenon undoubtedly led Clement Reid to suggest that the Nettlebridge area was exploited by the Glastonbury metalworkers.

Five samples were taken from the Nettlebridge and Blackers Hill areas (fig III.12.11, SOM 21-25). Coal has not been worked in these areas for over a century, and exposures were difficult to find. All samples were taken from the Coalpit Heath and Wrington soil series, and when profiles were encountered they appeared similar to those described for the Clutton area to the north east of Nettlebridge (Findlay, 1965, 91). Samples SOM 21, 23 and 25 all contain varying amounts of ferruginous material, whilst SOM 22 and 24, like the Glastonbury crucibles, fire white. Sample SOM 24 retains a black core (to 2/3 depth of sherd) after slow firing to 850°C, indicating the presence of abundant carbon. In thin section, this carbon is seen to include numerous fossil plants showing cellular structure. The full range of fossil plants contained in the Coal Measures at Radstock has been recorded (Woodward, 1876, 36) but no such data are available for the Nettlebridge area.

None of the Somerset samples taken by the writer (SOM 21-25) contains a high percentage of quartz sand. Whilst raw material studies would seem to confirm that the Coal Measures clays were favoured by the Glastonbury refractory makers, no precise match was located. It is suggested that either a fire-clay source not sampled in the course of this study was exploited, or that the white-firing Nettlebridge clays were modified by the addition of sand and other silicates, perhaps from related sandstone seams.

III.12.4 Discussion

From a technological viewpoint, the majority of Glastonbury refractories are unusual in iron age contexts. At no other production site included in this study have crucibles been so frequently fired to vitrification temperatures. Poor selection and preparation of raw material may be suggested as a possible cause, but in the light of fabric analyses, raw material studies, and the fact that the crucibles appear to have been functionally successful, this suggestion can be

discounted. It is clear that the Glastonbury refractory makers were well aware of the technological requirements of crucible production, and actively sought highly refractory raw materials to meet these requirements. It has been shown that the most likely source of these raw materials lies in the exposed fire-clay seams of the Bristol Coalfield, more than 20km from the site. Crucible fabrics are quite distinctive and bear no resemblance to any of the fine or coarse pottery fabrics from Glastonbury. Many of the fine wares were imported to the site, perhaps from centralised workshops (Peacock, 1969), whilst all the coarse pottery could have been locally produced from a range of raw materials readily available within 13km of the Lake Village (Bailey, 1981).

Of the 37 "crucibles" and three additional sherds thought to be funnels or tuyères, nine have been rejected on the basis of fabric inspection, and fifteen could not be located (Table III.12.1). Any interpretation of metalworking at the 1½ha Glastonbury site must, perforce, be founded on a mere fifteen crucible sherds including one complete vessel, a sprue-cup and a unique tuyere mouth. Identified and probable refractory materials would seem to be concentrated in no less than four separate areas at the Lake Village (fig III.12.8). However, interpretation of these areas is complicated by the distribution of the various fabrics on the site (fig III.12.9). Whilst it is acknowledged that Fabrics 1 and 2 are closely related, and perhaps broadly contemporary, it would be unwise, on the basis of a single stratified Fabric 3 sample (C29, found on the fourth floor of Mound LXXIV) to suggest any chronological relationship between the groups. Unfortunately, no fabric data are available for the sherds found in the XLs mound group, as none of these sherds could be located. However, it would seem from the distribution of fine fabrics 1 and 1a, that the second floor of the LXXs mound group, the fifth floor of Mound V, and unknown levels in the XXs mound complex, represent distinct metalworking horizons (a model adopted by Childe: 1940, 237).

These 'horizons' are more appropriately interpreted as smiths' living quarters, than as areas of bronze casting activity. Industrial practices involving the use of intense heat (as demonstrated by the crucible evidence) are most unlikely to have taken place in a village

built almost entirely of wood and located in a swamp or lake. Instead, as has been suggested for Meare, the workshops are likely to have been sited at a safe distance from the village, on nearby dry land. Moulds, broken after each casting episode would have been abandoned in the workshop area, whilst reusable crucibles and tuyères would have been carefully curated by the smiths, perhaps from season to season. These theories are supported by the evidence. No clay mould fragments were recovered at the Lake Village (Bulleid and Gray were careful excavators and would surely have recognised distinctive mould pieces such as those found in Pit 209 at Gussage All Saints), and artefacts found in the mounds with the crucibles suggest domestic rather than industrial activity.

It is not possible to ascertain, from the available evidence, whether the four "metalworkers' mound" groups were all occupied at the same time, or whether changes in location of the smiths' living quarters relates to a chronological development of the site. Contemporaneity might imply specialisation by product, whilst sequential occupation may reflect changing location or organisation of activity involving the whole site. Unfortunately, the evidence does not permit more positive conclusions to be drawn.

TABLE III.12.1 GLASTONBURY: CONCORDANCE OF CONFIRMED AND PUTATIVE REFRACTORY SHERDS

Sample number	Mound number	Identification	Present location
C1	XXII	crucible	Glastonbury
C2	XXIII	not refractory	Glastonbury
C3	XLIV	probably crucible	?
C4	XXIV	crucible	Taunton
C5	XLV	probably crucible	?
C6	XLIV	probably crucible	?
C7	XXIV	crucible	Taunton
C8	LXII	probably not refractory	?
C9	LXII	not refractory	Glastonbury
C10	LXII	probably not refractory	?
C11	LXII	probably not refractory	British Museum
C12	LXII	not refractory	Glastonbury
C13	LXII	not refractory	Glastonbury
C14	LXIV	not refractory	Glastonbury
C15a *	V	? crucible	Glastonbury
C15b *	V	crucible ¹	Glastonbury
C16 *	IV	not refractory	Glastonbury
C17	V	probably crucible	?
C18 *	V	crucible	Taunton
C19 *	V	complete crucible	Glastonbury
C20 *	V	crucible	Glastonbury
C21	V	crucible	Taunton
C22	V	probably crucible	?
C23	V	probably crucible	?
C24	V	probably crucible	?
C25	-LXXI	crucible	?
C26 *	LXXVI	crucible	Glastonbury
C27	LXXVI	crucible	Glastonbury
C28 *	LXXIV	crucible	Glastonbury
C29 *	LXXIV	crucible	Glastonbury
C30	LXXV	probably crucible	?
C31		probably crucible	?
C32	LXXIII	crucible	?
C33 *	LXXIII	crucible	Glastonbury
C34 *	XXIX	crucible	Glastonbury
D49		not refractory	Glastonbury
D30 *	LXII	tuyere mouth	Glastonbury
D63	III	not refractory	Glastonbury
D57	V	probably not refractory	?
D50 *	LXXII	sprue-cup	Glastonbury
D78	V	probably tuyere	?
unmA *		crucible	Glastonbury
unmB *		crucible	Glastonbury
unmC *		crucible	Glastonbury
unmD *		crucible	Glastonbury
unmE *		crucible	Glastonbury

* = sectioned

1. crucible C15b is not mentioned in report

TABLE III.12.3 GLASTONBURY: GRAIN SIZE STATISTICS

[illegible]

III.13 GUSSAGE ALL SAINTS, DORSET
(ST 990140; corpus no 55)

This iron age enclosed settlement covers approximately 1.4ha and is located on a ridge some 30m above the modern village of Gussage All Saints in the Cranborne Chase area of Dorset. Total excavation of the site took place in 1972, when approximately 400 pits, several 'working hollows', various dwelling houses and four-post structures were identified (Wainwright and Spratling, 1973; Wainwright, 1979). The settlement is believed to have been founded some time after 500 BC and abandoned by the last quarter of the 1st century AD (Wainwright and Switsur, 1976; Wainwright, 1979, 186). Despite extensive plough damage (the occupation levels had been entirely removed, leaving sub-soil features as the only surviving evidence), three phases of settlement were discerned from ceramic and stratigraphic data (fig III.13.1). The excavator believes, however, that occupation was continuous throughout the duration of the site (Wainwright, 1979, 184).

A mixture of arable farming and animal husbandry was practised at Gussage. Sheep were reared for their wool, and items of spinning and weaving equipment were found in all occupation levels. Pottery would seem to have been locally produced during the earlier settlement period, whereas in later phases ceramic vessels appear to have been imported from the Wareham-Poole Harbour area of Dorset (Gale, 1979, 53). Saddle and rotary querns too, are believed to have been acquired through trade throughout the duration of the settlement (Buckley, 1979, 89). The excavator suggests that the querns, and later the pottery would have been exchanged for goods produced at Gussage such as wool, cloth, hides, cattle, dairy produce, honey, beeswax and metal objects. "The impression is that of a settlement prosperous in terms of its herds, crops and domestic crafts, which produced sufficient surplus to enable it to participate in contemporary trading patterns but which had little regard for items not directly related to the life of the settlement and its functioning" (Wainwright, 1979, 191).

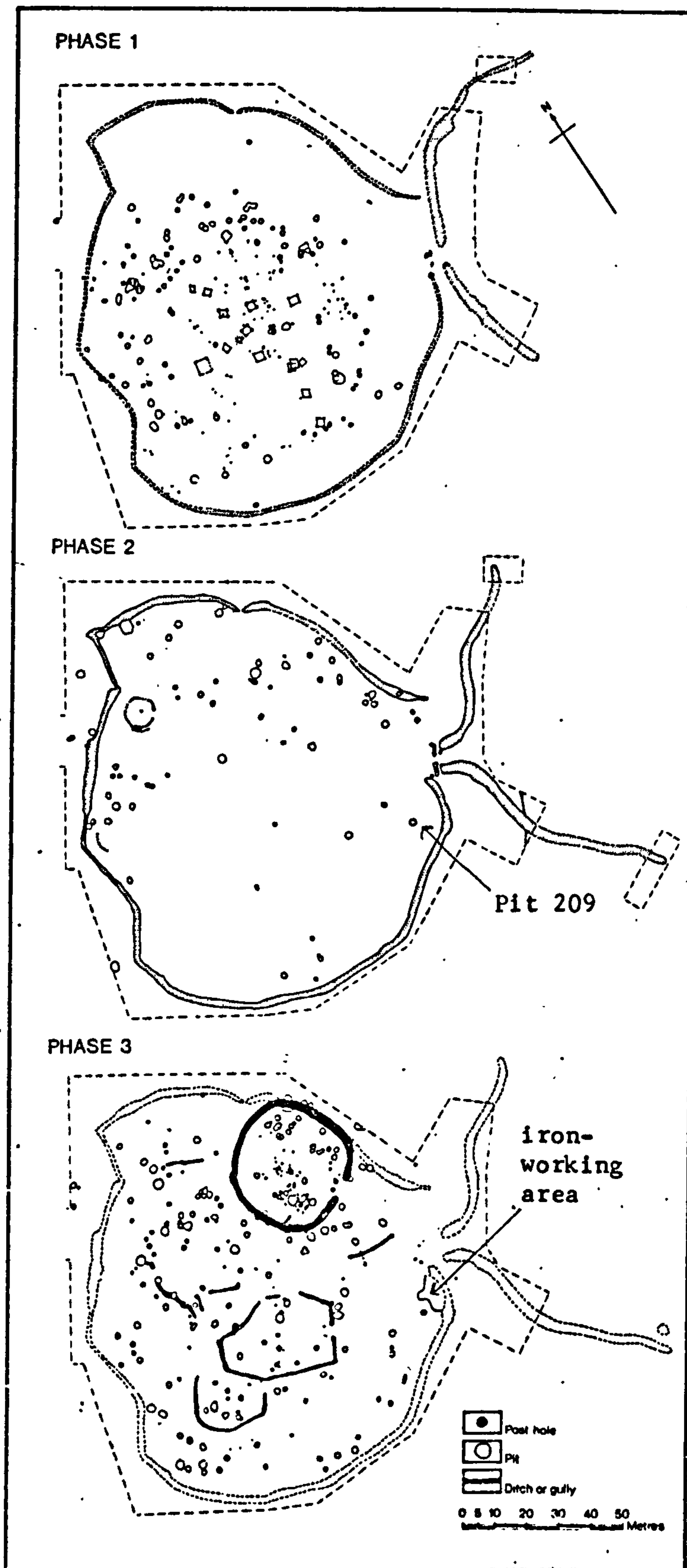


Fig III.13.1 Gussage phase plans (after Wainwright, 1979)

III.13.1 The metalworking evidence

Pit 209 at Gussage All Saints differed little in profile and character of upper fill from most other pits at the site. The lower fill, however, contained the largest and best preserved body of refractory debris from pre- and proto-historic Europe (figs III.13.2-4). Large samples of oak charcoal, intimately associated with the metalworking material, produced radiocarbon dates of 150 ± 65 bc (Q1207) and 70 ± 70 bc (Q1206). On metallurgical and ceramic grounds the lower pit fill has confidently been assigned to the 1st century BC and to the second phase of occupation at Gussage (fig III.13.1). Most minor finds of similar refractory debris from other features are believed to belong to the same phase, although there is some evidence that bronze casting activity continued during the third and final occupation period (Spratling, 1979, 125).

All but 84 of the 7318 identified mould fragments, and the vast majority of the 600 crucible sherds were recovered from the lower layers of Pit 209. The bulk of the deposit from layers 10-12 and A-Z (fig III.13.5) consisted of charcoal, wood ash and vitrified clay, intermixed with moulds, crucibles, tuyère fragments and hearth debris. Metallic finds included both bronze and iron working slag, and fragments of scrap bronze and iron. Four fine bone tools, identified as implements for wax-pattern modelling, were also recovered (Spratling, 1979, 127). Detailed post-excavation work on both crucibles and moulds resulted in the reconstruction of at least 35 crucibles (fig III.13.2) and the identification of eight categories of cire perdue investment mould (fig III.13.3-4). The mould assemblage is believed to represent approximately 50 sets of chariot fittings, and includes moulds for terrets, bridle-bits, linch pins, strap-unions and loop fasteners. A detailed description of all mould types and decorative variations has been published elsewhere (Foster, 1980).

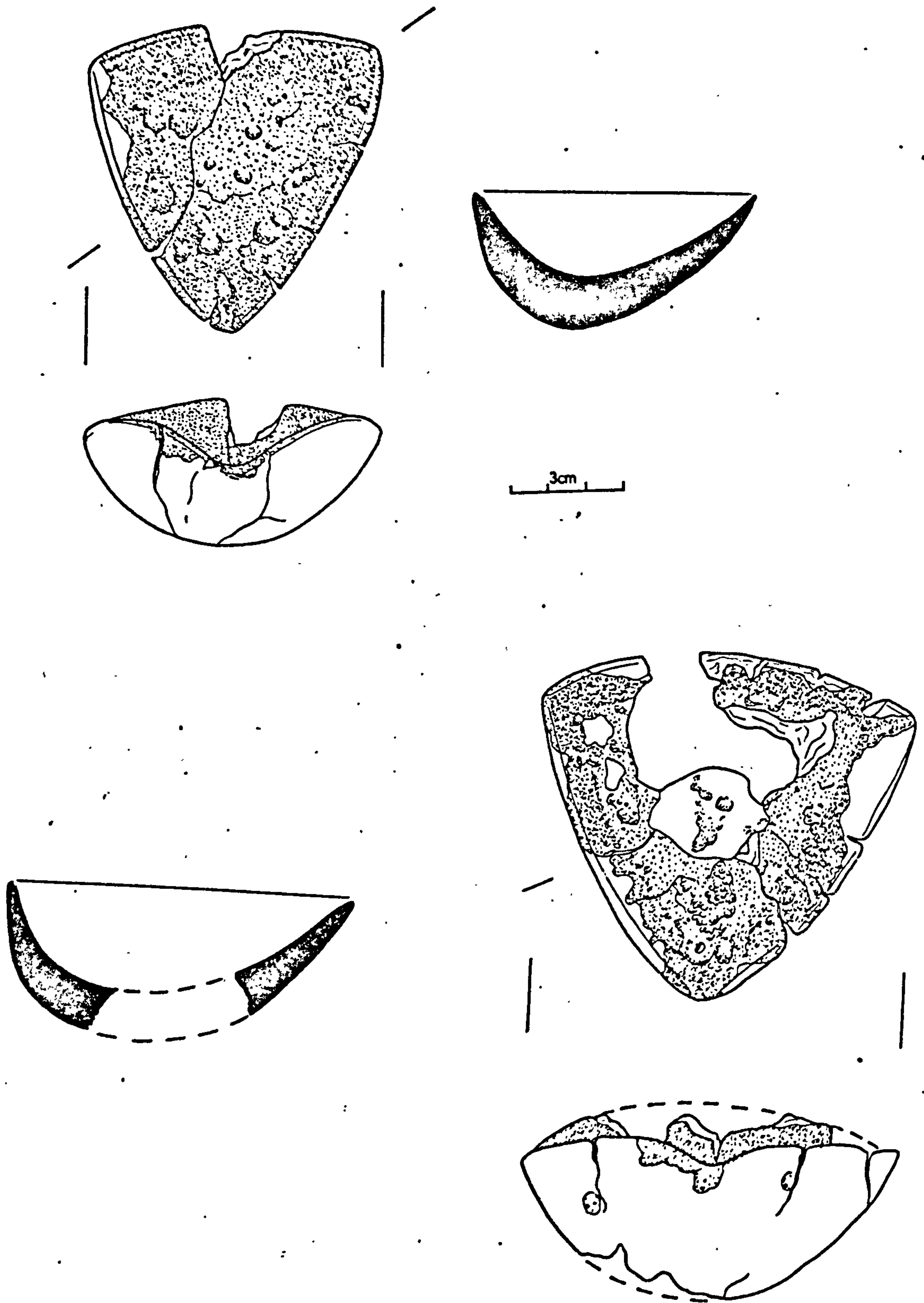
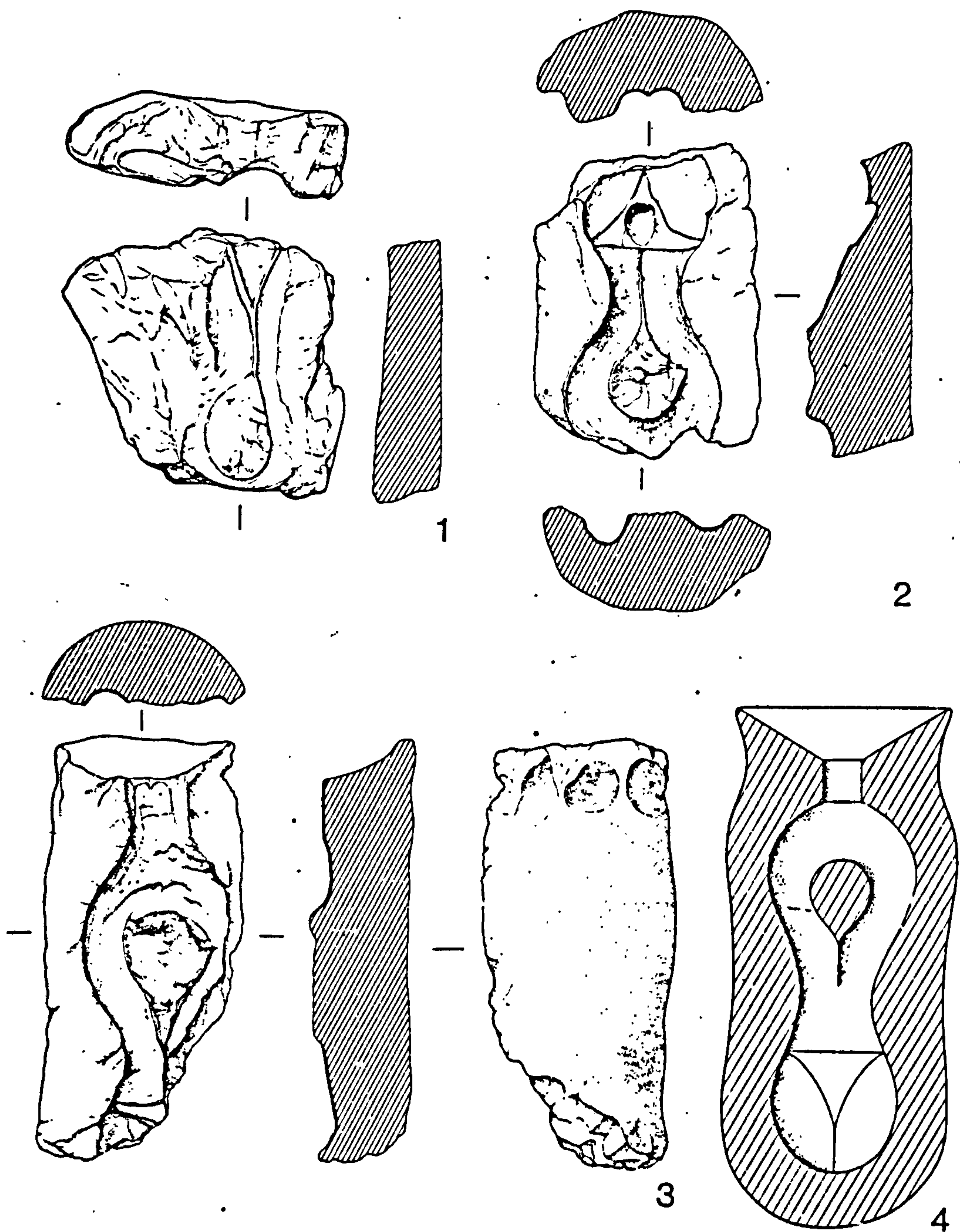
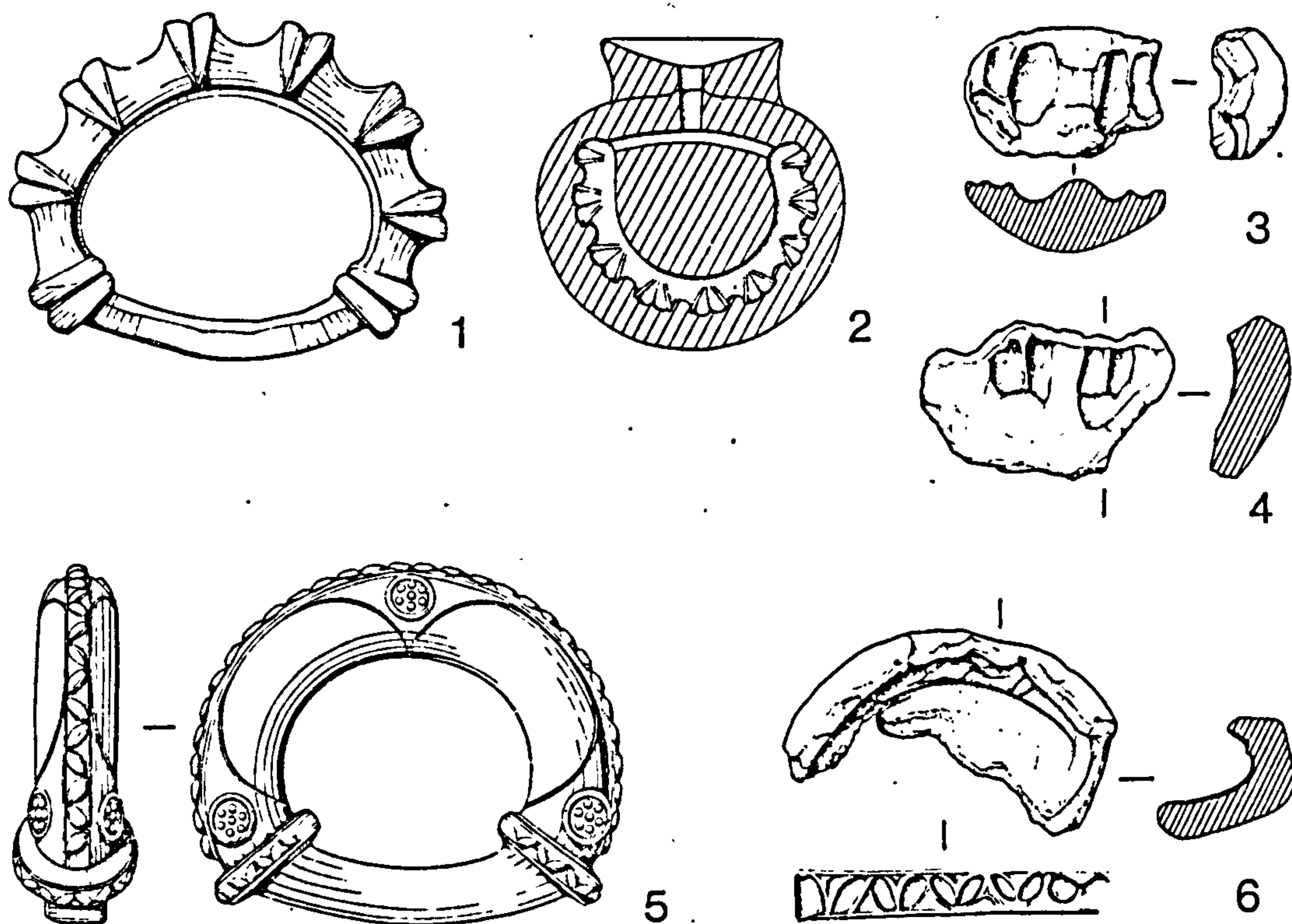


Fig III.13.2 Two crucibles from Pit 209, Gissage All Saints
(drawn by Jane Timby)



1: fragment of a mould for casting a side-link of a bridle-bit, (either onto an existing snaffle-ring or in one piece with the ring), from South Cadbury, Somerset; 2,3: fragments of moulds for casting the side-links of three-link bridle bits from Gussage All Saints; 4: schematic reconstruction of such a mould

Fig III.13.3 (after Wainwright, 1979)



1: terret of 'Arras' type from Hod Hill, Dorset; 2: schematic reconstruction of a mould for casting such a terret; 3,4: fragments of such moulds from Gussage All Saints; 5: terret of 'Mill Plain' type from ? Suffolk; 6: fragments of a mould for casting such a terret from Gussage All Saints

Fig III.13.4 (after Wainwright, 1979)

III.13.2 Analytical results (see Table III.13.1)

The crucibles

All crucible sherds from Gussage were examined by the writer in hand specimen, and samples representing the apparent fabric variation removed for thin section analysis. Crucible fragments all show evidence of high temperature firing with partial and often complete vitrification visible around the upper edges, particularly the pouring lip. White firing clay appears to have been exploited throughout for crucible production. Although most samples have been reduced to grey or black in use, refiring of six sherds to 1200°C in an oxidising atmosphere resulted in dull white or pale grey paste colour. Two distinct groups could be differentiated, mainly on the basis of fabric texture. Group 1 sherds are extremely crumbly and vesicular with abundant medium-coarse

sand interspersed with very little binding material. This fabric, without the slagging and surface vitrification, could easily be mistaken for a friable sandstone. Most group 1 sherds are black or purplish-black cored. Fabric 2 fragments are less friable, much finer, apparently less porous and have an altogether smoother texture. Black cores are rare, and most samples are consistently pale grey throughout their thickness. Fine quartz sand is abundant, and a scatter of tiny, rounded white grains (perhaps sandstones) is visible in some sherds.

Eighteen crucible sherds were selected for thin section examination to test the validity of the binary fabric division, and to investigate variation within each fabric group (Table III.13.1). No mineralogical differences are visible under the petrological microscope. All samples are seen to contain abundant subangular quartz sand of varying grades, set in a sparse isotropic clay matrix (Plate 8c). Virtually all the larger grains (0.25mm upwards) are extensively cracked as a result of stresses set up in the crystal structure during heating to $>1000^{\circ}\text{C}$ and subsequent rapid cooling during the bronze pouring process (Singer and Singer, 1963, 99). Incipient liquid phase sintering is visible in some group 1 sections, particularly those taken from close to the crucible rims. Occasional grains (to 0.35mm) of quartzite or metamorphosed siliceous sandstone occur in some sections representing both fabric groups, perhaps suggesting that variable technology rather than different raw material sources may account for the textural variation observed between the fabric groups.

Textural analysis was performed on all thin section of Gussage crucibles, and the results confirm the original fabric division. This division, however, is based exclusively on grain size (fig III.13.6-7). Fabric 1 ϕ curve is invariably bimodal, with peaks occurring c $\phi 2-2.5$ (0.25-0.19mm) and $\phi 4.5-5.5$ (0.04-0.01mm). The finer Fabric 2 contains few large inclusions, and is dominated by the finest measurable grain size ($\phi 5-5.5$: 0.02-0.01mm) (fig III.13.8). No significant differences in grain:matrix density are observed between the two fabric groups (fig III.13.6-7). The average proportion of grains in Fabric 1 was calculated to be c 77%, and Fabric 2 samples produced similar readings. These results show that two sands of different grain size range were selected for crucible manufacture, each containing a similar proportion

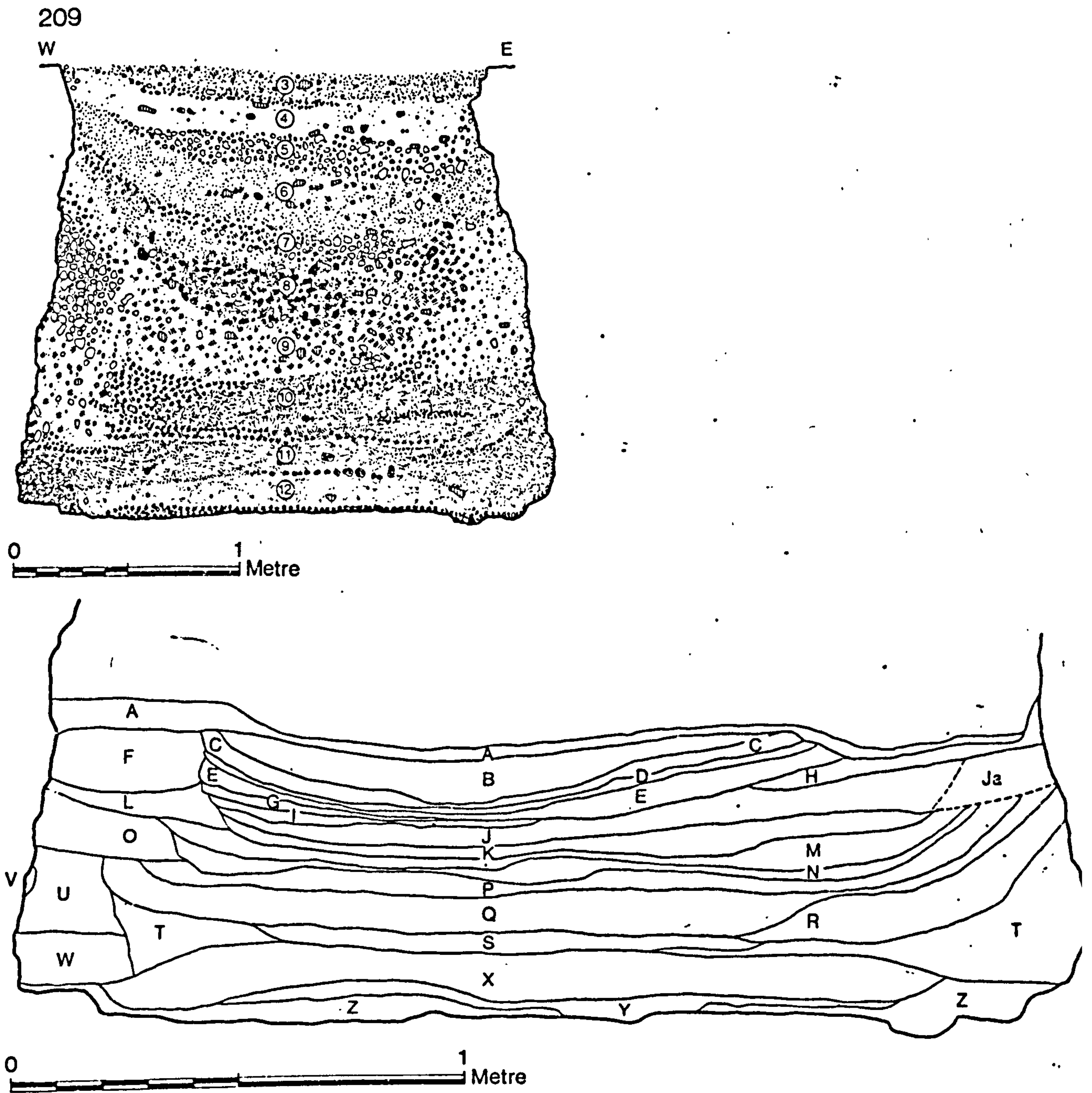


Fig III.13.5 Pit 209 (after Wainwright, 1979)

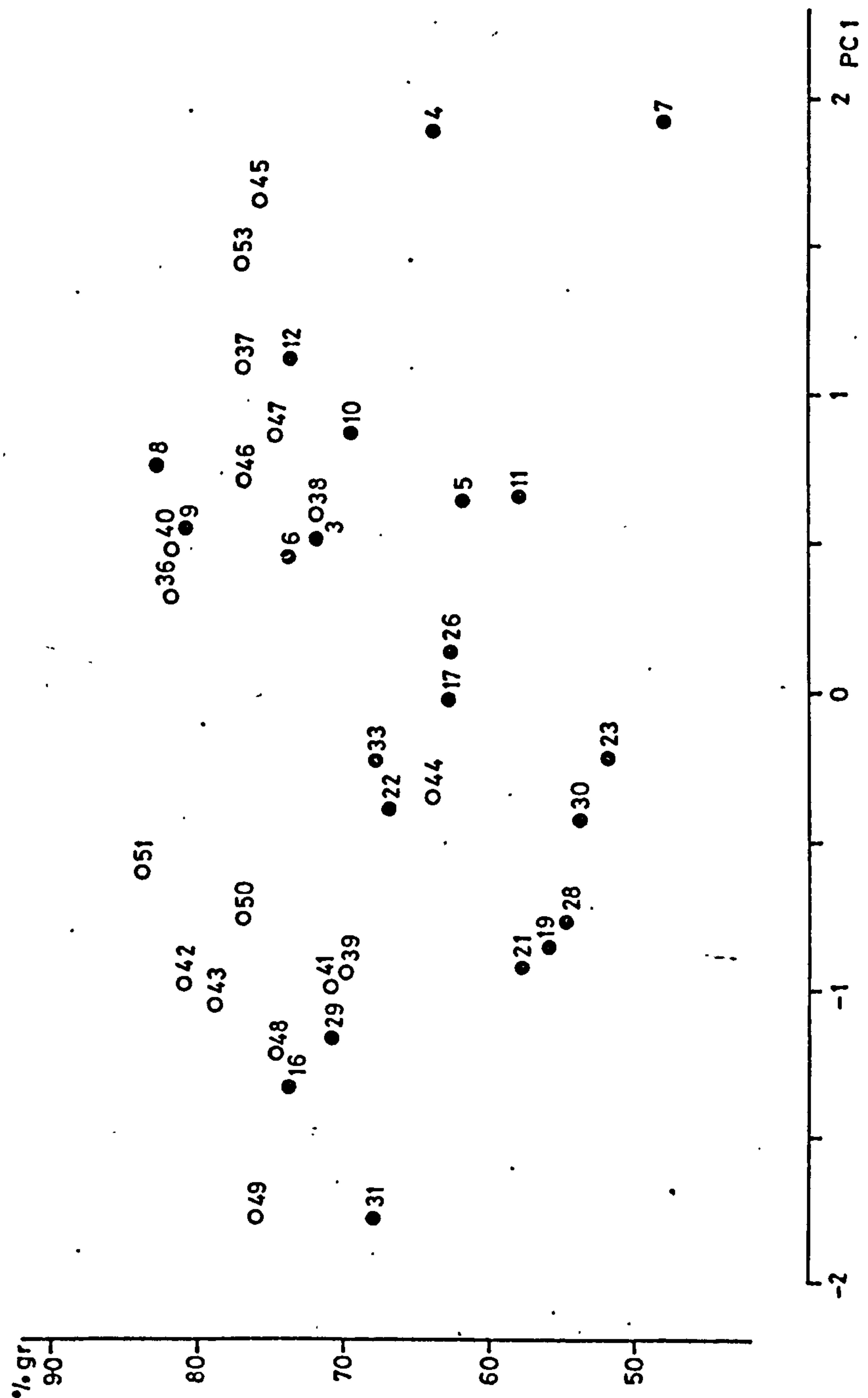


Fig III.13.6 Gussage All Saints: mould (●) and crucible (○) sherds plotted against grain size (expressed by scores on the first principal component extracted from the ϕ counts) and proportion of grains:matrix

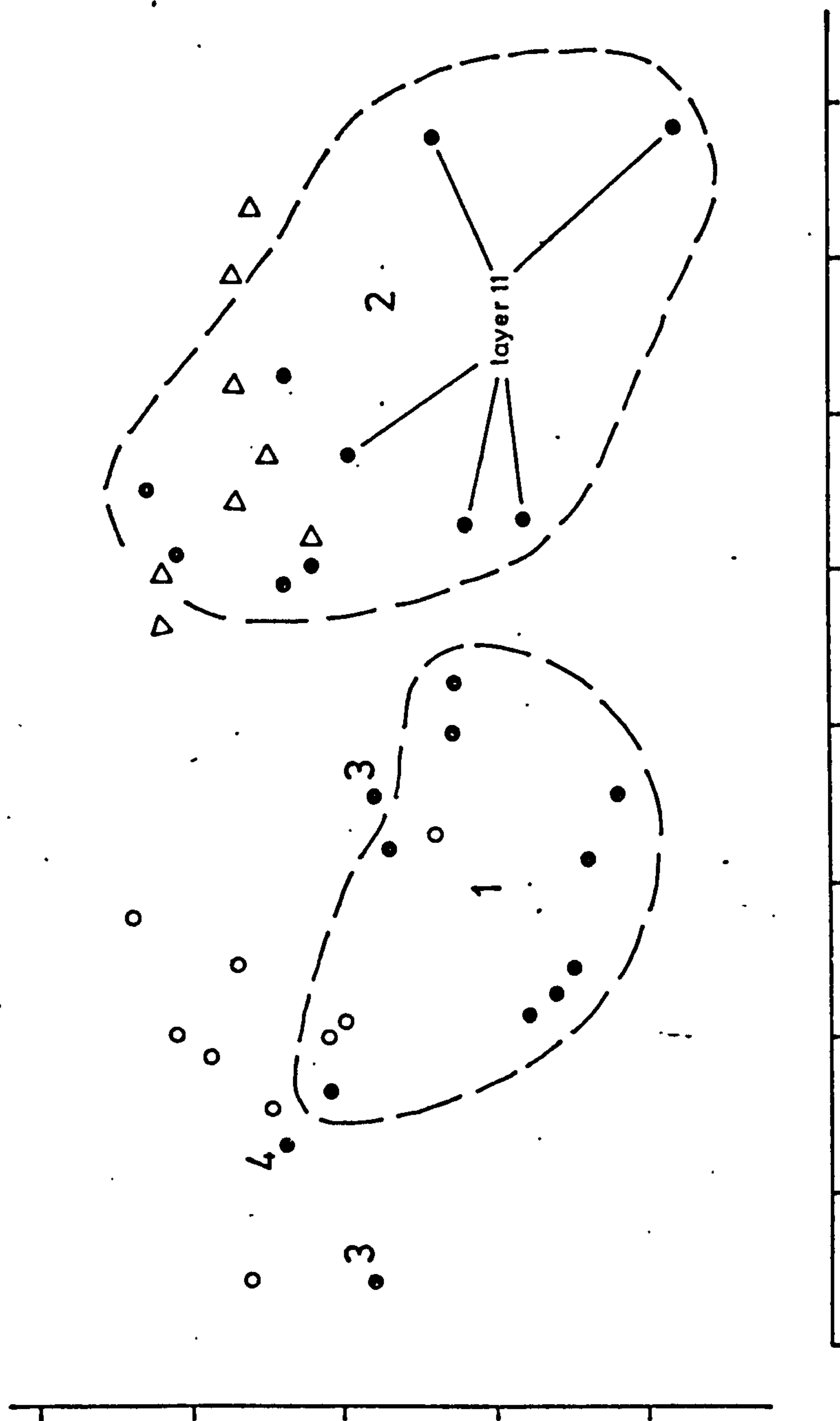


Fig III.13.7 Gussage All Saints: fabric classification of refractory sherds (compare fig III.13.6). The writer's crucible fabrics 1 (Δ) and 2 (O) are distinguished by symbols, while Foster's mould fabrics are numbered. Also indicated are the 5 mould sherds from layer 11 of Pit 209.

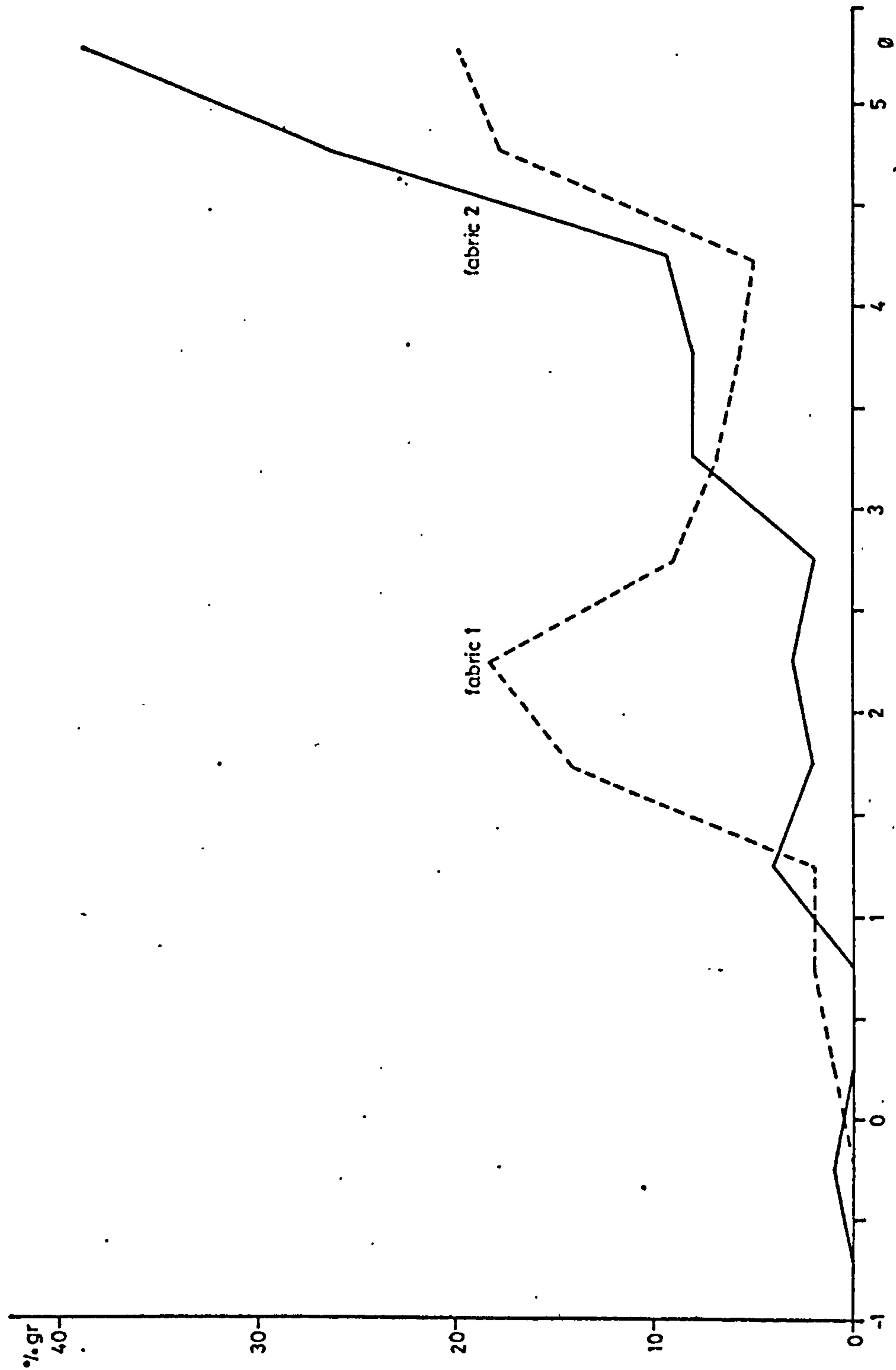


Fig III.13.8 Gussage All Saints: representative grain size curves for crucible Fabric 1 (sherd GAS 46) and Fabric 2 (GAS 43)

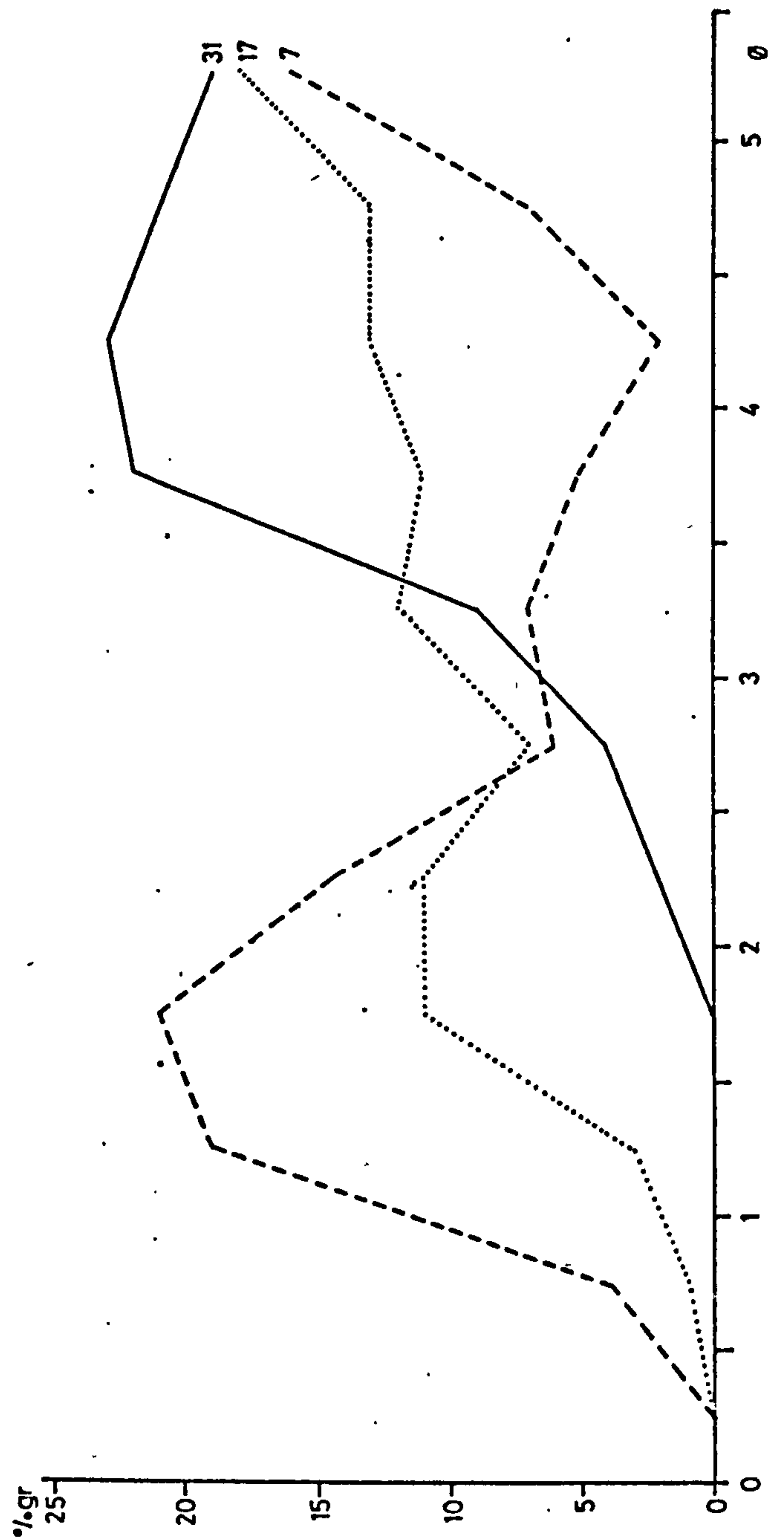


Fig III.13.9 Gussage All Saints: representative grain size curves for three mould sherds.

of natural or deliberately introduced binding clay.

Sufficient material from a single Fabric 1 sample was made available for heavy mineral analysis. This analysis was aimed at locating the origin of the sand. The residue was found to consist predominantly of tourmaline, with accessory amounts of zircon, rutile, kyanite, and a single grain of andalusite. A similar heavy mineral suite has been described for the Tertiary sands of the Wareham-Poole area (Williams, 1975). These sands occur within the Bagshot Beds, in close association with good quality white-firing pipe-clays. The Bagshot Beds, however, extend inland to Verwood, some 10km from Gussage (Reid, 1902,23) and it is possible that a source in this vicinity may have been preferred to the more distant Poole Harbour area.

The moulds

Gussage mould fabrics were classified by J Foster during typological reconstruction, and 32 formless sherds drawn from the four groups which seemed to be represented were submitted to the writer for petrological analysis. The fourteen hard-fired "Fabric 1" sherds are reduced to light to mid grey throughout their thickness. The paste is well compacted and contains abundant rounded quartz sand and occasional specks of iron ore. "Fabric 2" (twelve sherds) is coarser and more porous than "Fabric 1", is extremely crumbly and again contains a high density of quartz sand. Binding clay appears to be very sparse. The colour is more variable than that of "Fabric 1", with purplish-grey and black reduction zones occurring on many samples. Sherds of this colour range and texture tend to concentrate in the lower layers of Pit 209 (Foster, 1980). "Fabric 3" (four sherds) is similar in texture to "Fabric 1", but is bright red in colour (generally 2.5YR 5/6) and appears to contain slightly more sand. Few oxidised sherds were recovered, and most seem to represent bridle-bit mould (Foster, 1980). Only 30 sherds of "Fabric 4" were identified during cataloguing, and two were submitted for analysis. This distinctive fabric is invariably white or very light grey throughout, and appears inclusionless save for occasional dull black specks, comparable in hardness with the clay body.

Microscopic examination of the mould samples immediately revealed

a strong similarity between "Fabrics" 1, 2 and 3. All contain abundant quartz sand, and all but sherds GAS 7, 11, 17 and 23 contain occasional fragments of fine-grained sandstone with siliceous or ferruginous cement. Quartzite occurs rarely in GAS 10, 12, 17 and 31. Samples GAS 3, 5, 9, 17, 23, 25 and 31 also contain rare ragged clay pellets with inclusions of quartz sand similar in size and sphericity to the temper. Sparse iron ore and/or iron staining is visible in all samples.

Grain size and matrix analysis (fig III.13.6) reveals a continuum, with no indications of discrete fabric groups. Mean grain size varies from 0.07mm (GAS 19) to 0.22mm (GAS 4), and grain:matrix density from 48% (GAS 7) to 83% (GAS 8). Grain size curves are both smooth and bimodal (fig III.13.9). In defining "Fabrics" 1 and 2, Foster split this continuum into two parts. Textural analysis shows this division to be somewhat arbitrary. No generalisations can be made on the basis of the two "Fabric 3" sherds analysed.

"Fabric 4" is clearly distinctive. In addition to a high tenor of quartz silt (49% of the grains are $< 0.02\text{mm}$), small angular grog fragments are scattered throughout the sections. Quartz grain size and matrix analysis places "Fabric 4" at the fine, dense end of the spectrum (figs III.13.6-7). The grog fragments contain angular and subangular sand grains and may represent finely ground, used crucible and mould sherds.

Refiring experiments on crucible bodies representative of Fabrics 1 and 2 produced no significant colour changes at 1200°C . White fabrics remained white and grey reduction zones (other than those in immediate contact with slaggy residues) became white in an oxidising atmosphere. Mould sherds GAS 5, 23 and 15 were subjected to similar refiring experiments to see if the bright red colour of GAS 31, 32, 33 and 34 (classified as "Fabric 3") was indicative of the exploitation of different binding clay sources. After firing to 1200°C and cooling for 24 hours in the kiln, sample GAS 15 showed no appreciable colour change, whereas GAS 5 and 23 had assumed the bright red colour originally distinguishing "Fabric 3". These results show that sherds GAS 31-34 represent variations in firing techniques rather than different raw materials.

It may thus be suggested that the same, or very similar sand and

clay sources were exploited for most mould making ("Fabrics" 1, 2 and 3) throughout the period associated with Pit 209. On the basis of fired colour, inclusion range and texture, these sources would seem to be dissimilar to those preferred for crucible manufacture. Heavy mineral analyses of GAS 1 and 19 (originally assigned to "Fabrics" 1 and 2 respectively) produced similar detrital suites. Clear, somewhat rounded grains of zircon, and both foxy red and brown rutile are dominant. Minor amounts of staurolite, garnet, andalusite and tourmaline, and a single grain of ? apatite (GASc1) are also present. Similar heavy mineral residues have been obtained from London Clay and Reading Beds deposits, both of which lie within 6km of Gussage (eg Boswell, 1916; Davies, 1919, 78). Gussage Group 2 pottery (as defined by Gale, 1979, 55) yielded a comparable heavy mineral suite. These results confirm that different raw materials were selected for the production of individual categories of refractory artefacts.

The white-firing, grog tempered "Fabric 4" reflects a different technology and raw material source from the majority of Gussage moulds. This fabric basically resembles crucible Fabric 2 (fig III.13.7), and it is possible grog may have been added to this crucible paste for the production of certain moulds at the site. Unfortunately, no piece large enough for heavy mineral analysis was available, precluding investigation of this hypothesis.

Furnace lining

Macroscopically, furnace sample GAS 35 (from feature 70, outside Pit 209) appears to have been formed from a red-firing clay with little or no pre-moulding preparation taking place. The fabric is considerably pitted, probably the result of poor preparation and the burning out of organic material. In thin section, the paste is seen to consist of a low tenor of rounded and subangular quartz sand (to 0.4mm), frequent large clay pellets (mainly larger than 1mm) and abundant iron ore particles set in an anisotropic clay matrix. The inclusions are unevenly dispersed with a tendency towards banding, indicative of an ill-worked clay. Heavy mineral separation provided a sparse residue, mainly consisting of zircon (both clear and pitted) and brown rutile. Again the assemblage is consistent with a local source. This fragment is

lightly slagged, and appears to have had metalworking associations. However, the origin of the sample (from a feature close to Pit 209) suggests that it is as likely to be derived from an ironworking as a bronzeworking furnace (see fig III.13.1).

III.13.3 Resource ecology and raw material sampling

The settlement at Gussage was founded on Upper Chalk, but a patch of Clay-with-flints extends under the southernmost portion. Pockets of black or ochreous Clay-with-flints, many unmapped, are commonly featured on the Dorset chalkland, and are derived partly from the Chalk, and partly from Eocene outliers (Reid, 1902, 33; fig III.13.10). A single sample was collected from the Clay-with-flints near the Gussage site. This sample (DOR 1), taken from just below the modern land surface, was difficult to work and exhibited considerable cracking during drying and firing. Working properties, firing behaviour and mineral composition observed in thin section immediately excluded this local clay as potential refractory material. The Gussage metalworkers had, perforce, to travel further afield for their ceramic supplies. Petrological analysis and heavy mineral residues obtained from mould and crucible samples suggest that Reading Beds or London Clay, and Bagshot Sand deposits were exploited.

Nearest the Chalk, Reading Beds deposits are extremely variable with stiff, red-mottled clays and yellow loams changing laterally to coarse, glauconitic sand with splinters of flint (Reid, 1902, 8). London Clay appears on the map as a wide band roughly parallel to the Reading Beds outcrop. Buff and grey clay seams are often interspersed with bands of coarse flint gravels (Reid, 1902, 15). Bagshot Sands consist in the main of generally fine, white or buff sand intercalated with lenticular masses of whitish sandy pipe-clay. Both Reading Beds and London Clays in N Dorset have been exploited for the manufacture of bricks, tiles and coarse pottery. Bagshot Sands have been used in brickmaking, but the thin pipe-clay seams in this district have not been commercially exploited. By contrast, the prolific Poole area ball-clays have been dug for some three centuries, and used for the manufacture of pottery and tobacco pipes (Reid, 1898).

A raw material sampling strategy in the Gussage area was designed on the basic assumption that metalworkers would have travelled the minimum possible distance to acquire suitable clays and sands. Although pipe-clays do not occur in north Dorset in sufficient quantities to merit modern commercial exploitation, the small pockets which can be found within the Bagshot Sands on the Geological Survey's Sheet 314 may well have been adequate in amount and sufficiently pure for iron age refractory production. Minor occurrences of these clays in the vicinity of Gussage have not been described in the geological literature, and these were sampled for comparison with the archaeological material. Reading Beds and London Clay deposits were sampled at the nearest accessible points to the Gussage site.

Two of the Reading Beds samples collected (DOR 4 and 5) fired red, whilst the third (DOR 3) fired to a creamy white. All contain medium to abundant, well-sorted subangular quartz and a scatter of ferruginous concretions. Other inclusions are absent. All three samples were taken from cesspit and house foundation excavations at Uppington (SU 025063). The red-firing London Clay sample (DOR 6) again contains no inclusions save a moderate density of angular quartz of variable size. Five clay samples were collected from various locations in the Bagshot Beds. Aside from the Verwood area, clay is difficult to find in the northern extension of this deposit, and invariably occurs as small pockets within the sand, as described above. Two of the Bagshot samples (DOR 9 and DOR 12) fired white, whilst the remainder (DOR 7, 8 and 11) were red-firing. All contain generally well-sorted, abundant quartz sand, a little microcrystalline silica, and DOR 11 and 12 from Verwood additionally contain a sparse scatter of mica and detrital minerals including tourmaline. Microscopic inspection of these two extremely sandy Verwood samples, taken from approximately the same depth (c 1m) and located a mere 10m apart, indicates that considerable local variability of inclusion size and shape occurs.

It is clear from these raw material studies that both white and red-firing clays, containing variable amounts of sand, are available in the Gussage area. Additionally, free sand of varying grades occurs in profusion. Although no precise matches were made between the fired samples and the Gussage refractories, the range of variation suggested

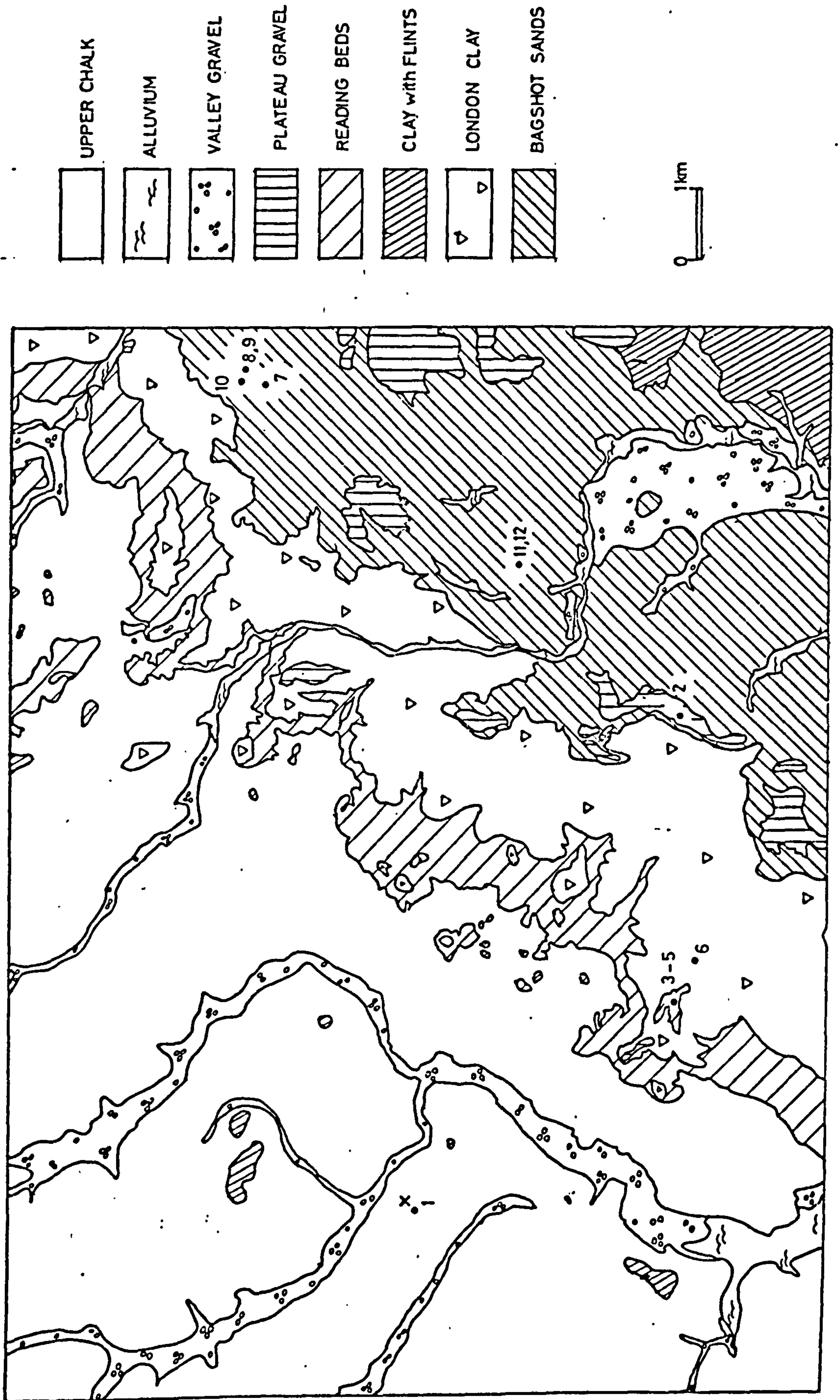


Fig III.13.10 Geology around Gussage and location of raw material samples

by the samples could easily include material combinations identical to those represented in the archaeological sherds.

III.13.4 Discussions

Analysis of the vertical distribution of refractory debris reveals four concentrations of material in Pit 209, each separated by lenses of chalk rubble (fig III.13.11). As this rubble is likely to have collapsed from the sides of the pit during the winter months (assuming the pit was not located within a structure), it is possible that the four groups of refractory material represent four seasonal casting episodes. The mould fabrics occurring within each of these concentrations were considered to test this hypothesis. If sequential seasonal production by a single smith (or smith group) had taken place, some paste variation may be expected, reflecting zonal variability in raw material deposits and/or subtle differences in preparation. Samples GAS 4, 5, 7, 10 and 11 (identified by Foster as "Fabric 2") all fall at the coarse end of the textural spectrum, and all derive from layer 11, the predicted casting phase II (figs III.13.7 and 11). Unfortunately, the majority of the remaining sherds submitted are from the first half of Pit 209 which was excavated in layers rather than spits. Stratigraphic information is thus inadequate for further detailed correlations to be made.

Examination of the vertical distribution of the crucible Fabrics 1 and 2 indicates that the coarser, Fabric 1 sherds tend to occur in the lower (mainly layer 12) depositional phases (fig III.13.11). Further samples would be necessary to test the significance of this tendency.

It is possible that Pit 209 could, in fact, reflect a period of activity of considerably longer duration than its contents imply. It has been noted that the nature of debris from other areas of the site attests the casting of bronze and working of iron throughout the duration of occupation at Gussage (Spratling, 1979, 125). The scarcity of evidence from periods other than the possible four seasons represented by Pit 209 is likely to reflect formation processes and factors of preservation, rather than variable intensity of activity. An unknown quantity of refractory debris may have been deposited in different contexts and then ploughed away with the occupation levels; Spratling

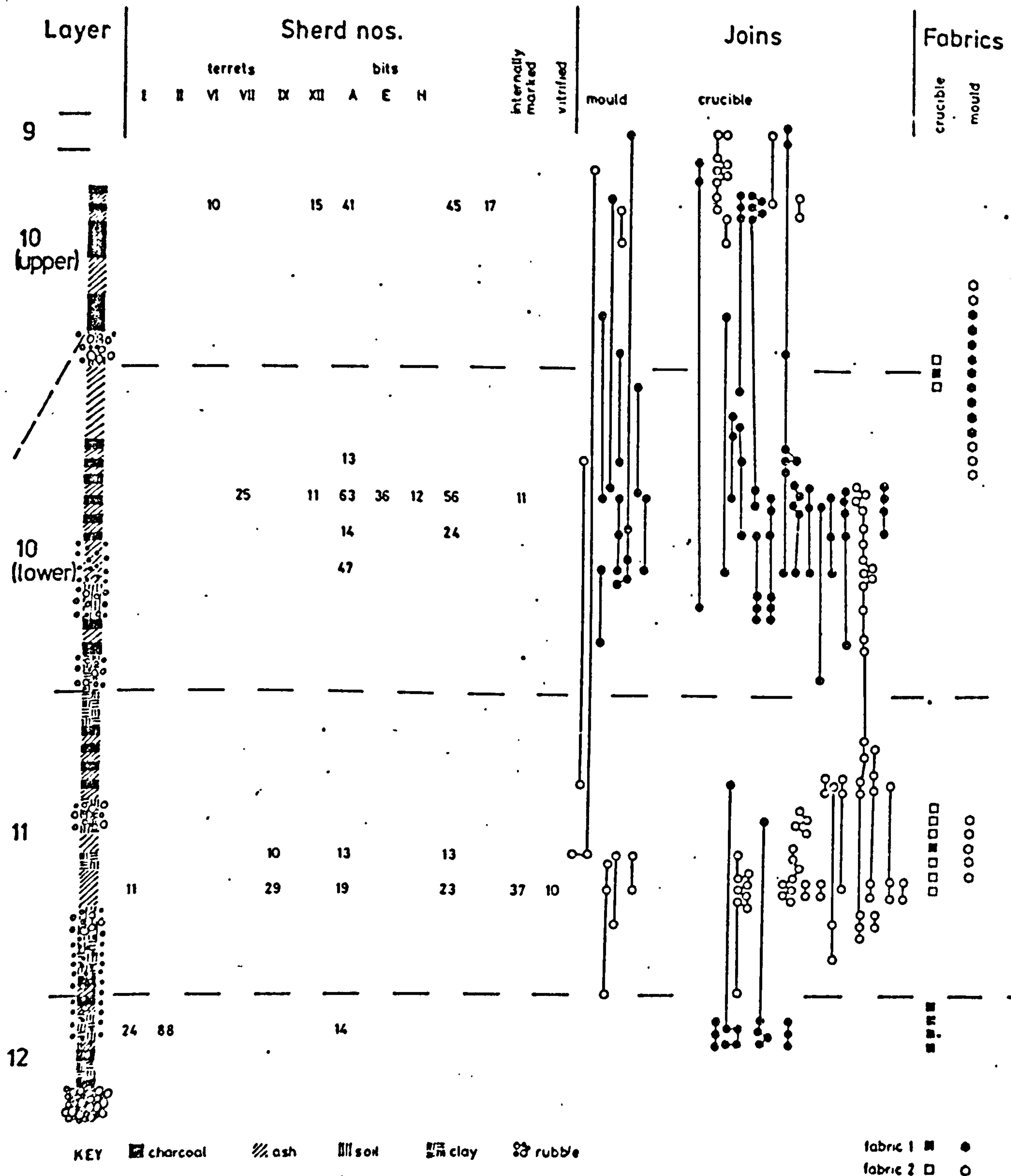


Fig III.13.11 Analysis of refractory debris in lower layers of Pit 209, Gussage. Schematised stratigraphy (left) is after Wainwright (1979, 127, fig 96 and Table XVI). Numbers of mould sherds (after Foster, 1980, Tables 1, 2, 3) are given for each stratigraphic unit if more than 9. Sherd joins are after Foster, 1980, figs 20-21 (note that the captions of these figs are reversed). Four casting episodes are suggested.

has drawn attention to the "trampling factor" when considering the survival potential of fragile refractory material (Spratling, 1979, 141); furthermore, casting activity and deposition of associated debris may have normally taken place outside the settlement area.

If, indeed, bronze casting was an integral feature of the Gussage economy throughout the duration of the settlement, it is still unclear just how this industry was organised. In an interim report, Spratling concluded that the metalwork represented by the debris in Pit 209 was produced by an itinerant smith (Wainwright and Spratling, 1973, 124). This view has later been revised, and the Gussage smiths are now believed to have been resident, manufacturing prestige goods intermittently over several centuries. In support of this interpretation, Spratling has drawn attention to the apparent duration of activity and to the quantity and complexity of equipment required to produce a mere 50 sets of harness fittings (Spratling, 1979, 141). It has further been suggested that Gussage may have been a specialist metalworking site, and have figured in a regional economic network in which different settlements supplied different products (Wainwright, 1979, 193).

Examination of refractory debris at Gussage sheds little light on the organisation of metalworking at this broad level. A locally itinerant specialist or a resident smith could have been equally familiar with suitable sand and clay sources in the vicinity of the site. The majority of moulds, especially from Pit 209, could well have been produced from locally available raw materials. Mould "Fabric 4", basically similar to crucible Fabric 2, is tempered with grog, and thus represents a radically different technology. Only 30 sherds in this fabric were recognised, but in the light of preservation problems, these sherds may be indicative of a separate smithing tradition, as important at Gussage as that represented by the predominant sand-tempered mould fabric.

It is equally difficult to draw conclusions from the two crucible fabrics identified at the site. The heavy mineral residue derived from Fabric 1 closely resembles that obtained from a high proportion of Gussage pottery. It has been suggested that this pottery, mainly recovered from later occupation contexts, reached Gussage from the

Poole-Wareham area via some form of exchange mechanism (Gale, 1979).

It is possible that at least some of the crucibles were produced in the same area. However, as has been shown by the results of raw material analyses, it is equally likely that the crucibles, like the moulds, were made by the metalworkers exploiting sources much closer to the site. Without further extensive sampling and analysis, definitive conclusions cannot be drawn.

In sum, the unique body of material in Pit 209 at Gussage, far from providing solutions to existing questions concerning metalworking organisation, serves instead to augment these questions, and reveals an industrial complexity hitherto unsuspected in prehistoric contexts

TABLE III.13.1 GUSSEGE ALL SAINTS: CONCORDANCE OF ANALYSED REFRACTORY SHERDS

Sample number	Excavation number	British Museum no	Identification
GAS 1 *	209/11.5-10	5558	mould
GAS 2 *	209/11.5-10	5558	"
GAS 3	209/2 10J	3595	"
GAS 4	209/2 11Q	5747	"
GAS 5	209/2 11R	5754	"
GAS 6	209/2 10B	4755	"
GAS 7	209/11.0-5	5513	"
GAS 8	209/2 10K	5284	"
GAS 9	209/2 10B	4760	"
GAS 10	209/2 11Q	5748	"
GAS 11	209/2 0-5	5512	"
GAS 12	209/2 10J	3596	"
GAS 13	209/2 10J	3603	"
GAS 14	-	-	not refractory
GAS 15	209/10	2868	mould
GAS 16	209/10	2869	"
GAS 17	209/10	6941	"
GAS 18	209/10	6942	"
GAS 19 *	209/10	6943	"
GAS 20	209/10	6944	"
GAS 21	209/10	6450	"
GAS 22	209/10	6541	"
GAS 23	209/10	6542	"
GAS 24	209/10	6543	"
GAS 25	209/10	6544	"
GAS 26	209/10	6545	"
GAS 27	209/10	6546	"
GAS 28	209/10	6547	"
GAS 29	209/10	6548	"
GAS 30	209/10	6549	"
GAS 31	209/9	4314	"
GAS 32	209/9	3473	"
GAS 33	209/10	2441	"
GAS 34	209/9	4313	"
GAS 35	Feature 70, L8	-	hearth/furnace
GAS CS	Pit 11	-	clay sample
GAS 36	209/12	267	crucible
GAS 37	437/3	629	"
GAS 38	209/2 (12) X	1326	"
GAS 39	209/2 11A	1342	"
GAS 40	209/11 10-15	260	"
GAS 41	209/2 10A	1349	"
GAS 42	209/2 11W	1237	"
GAS 43	209/11 B	1418	"
GAS 44	209/11 5-10	229	"
GAS 45	209/2 12X	1340	"
GAS 46	209/2 12X	513	"
GAS 47	209/10	1403	"
GAS 48	209/2 11T	466	"
GAS 49	209/2 11Q	412	"
GAS 50	209/10	98	"
GAS 51	C5B	-	"
GAS 52	209/10	154	"
GAS 53	-	5071	"

* = heavy mineral analysis others = thin section



TABLE III.13.2 RAW MATERIAL SAMPLES: DORSET

Sample no	Grid ref	Geological notes
DOR 1	ST 996101	Clay-with-flints
DOR 2 (S)	SU 905063	junction of Plateaus Gravel with Bagshot Beds
DOR 3	SU 025063	Reading Beds
DOR 4	SU 025063	Reading Beds
DOR 5	SU 025063	Reading Beds
DOR 6	SU 031060	London Clay; old clay pit
DOR 7	SU 112123	Bagshot Beds
DOR 8	SU 115127	Bagshot Beds; ferruginous clay seam
DOR 9	SU 115127	Bagshot Beds; white clay seam
DOR 10 (S)	SU 112127	Bagshot Beds; fine white sand
DOR 11	SU 087087	Bagshot Beds; grey clay in grey sand
DOR 12	SU 087087	Bagshot Beds; grey-black clay in sand

clays of various colours

10m between samples

S = sand others = clay

OBJECT	SLIDE	X	NO. OF	PHI	PHI	PHI	PHI	PHI	PHI	PHI	PHI	PHI	PHI	PHI	PHI	PHI	MEAN	STD
GR: GRAINS				-1 T	-0.5	0 TO	0.5 T	1 TO	1.5	2 TO	2.5	3 TO	3.5	4 TO	4.5	5 TO	GRAIN	DEV
MAT				0 -	0	0.5	0 1	1.5 TO	2	2.5 TO	3	3.5 TO	4	4.5 TO	5	5.5	SIZE	MM.
				5														
MOULD																		
	10	69	100	0	0	2	4	12	12	10	7	4	5	12	15	17	.1712	5.06
	11	58	81	0	0	0	6	15	6	5	14	13	14	7	9	11	.1727	4.59
	12	74	82	0	0	2	11	14	11	2	6	9	4	7	18	16	.2032	6.85
	16	76	81	0	0	0	0	0	0	0	5	2	10	13	21	49	.0396	.210
	17	63	89	0	0	0	1	3	11	11	7	12	11	13	13	18	.1161	2.10
	19	56	97	0	0	0	0	0	5	3	10	9	13	12	17	31	.0717	.806
	21	58	94	0	0	0	0	1	2	8	9	9	11	16	22	22	.0767	.895
	22	67	90	0	0	0	0	0	1	5	8	14	13	17	5	15	.0930	1.22
	23	52	84	0	0	0	0	0	5	12	13	12	12	4	18	24	.0917	1.18
	26	63	95	0	0	0	0	1	6	12	20	21	5	11	9	15	.1122	1.56
	28	55	105	0	0	0	1	2	5	5	8	13	18	11	18	19	.0921	1.42
	29	71	102	0	0	0	0	0	1	5	9	19	17	16	18	14	.0785	.744
	3	72	95	0	0	0	0	7	11	13	7	6	5	7	10	34	.1178	2.33
	30	54	84	0	0	0	0	0	0	3	23	24	12	7	13	13	.0953	1.00
	31	68	88	0	0	0	0	0	0	2	4	9	22	23	21	19	.0589	.397
	33	68	89	0	0	0	0	0	4	7	25	16	11	14	10	11	.1045	1.27
	4	64	94	0	0	0	4	22	20	11	11	5	7	4	9	7	.2196	5.93
	5	62	104	0	0	0	0	1	17	15	9	7	6	7	13	24	.1212	2.09
	6	74	91	0	0	0	1	3	11	12	17	7	5	10	12	22	.1217	2.23
	7	48	79	0	0	0	4	19	21	13	6	7	5	2	7	16	.2076	5.59
	8	83	110	0	0	3	2	10	13	5	9	4	8	8	11	26	.1580	4.76
	9	81	89	0	0	0	0	3	18	10	12	12	8	7	11	19	.1295	2.32
N SLIDES																		
N GRAINS																		
			22															
			2023															
CRUCIBLE																		
	36	82	222	0	1	0	2	8	9	11	11	8	11	10	11	18	.1459	3.96
	37	77	97	0	0	1	2	11	15	11	10	15	10	4	9	11	.1742	4.32
	38	72	78	0	0	0	1	3	14	15	13	4	6	3	23	18	.1273	2.43
	39	70	92	0	0	2	0	1	4	2	8	12	14	12	23	22	.0880	1.90
	40	82	95	1	0	0	1	3	11	11	11	9	5	6	14	28	.1262	3.71
	41	71	103	0	0	0	0	2	2	5	8	7	7	15	25	29	.0697	.871
	42	81	98	0	0	0	1	2	1	2	9	13	10	15	17	30	.0739	1.05
	43	79	103	0	1	0	0	4	2	3	2	8	8	5	24	39	.0755	2.01
	44	64	110	0	0	2	0	6	3	5	6	12	9	7	16	34	.1011	2.52
	45	76	105	0	0	5	4	5	12	19	12	8	1	4	12	18	.1689	6.12
	46	77	109	0	0	1	2	2	14	15	9	7	6	5	18	20	.1357	3.08
	47	75	100	0	0	0	1	6	10	21	11	9	8	7	10	17	.1413	2.78
	48	75	20	0	0	0	0	0	3	1	4	12	5	16	22	37	.0553	.502
	49	76	112	0	0	0	1	0	0	0	3	10	23	23	18	22	.0602	.588
	50	77	79	0	0	0	1	5	4	8	14	14	12	13	29	29	.0791	.984
	51	84	96	0	0	1	2	0	7	1	9	9	11	12	17	31	.0892	1.90
	53	77	92	0	0	0	1	20	16	12	4	3	2	4	8	30	.1732	4.49
N SLIDES																		
N GRAINS																		
			17															
			1777															
			39															
			3800															

Table III.13.3 Gussage All Saints: grain size statistics.

III.14 SOUTH CADBURY, SOMERSET (ST 620250; corpus no 74)

The fort at South Cadbury is located on a free standing hill which rises some 85m above the surrounding countryside on the Somerset-Dorset border. The site was initially investigated in 1913 by H St George Gray, and was intensively excavated between 1966 and 1970 under the direction of Professor Leslie Alcock. The results of these latter excavations (which have not been fully published) showed that the site had been occupied, albeit sporadically, from neolithic times until well into the Christian era. The most intensive settlement, however, took place during the iron age, when more than 7ha were enclosed by a series of ramparts. The main rampart was constructed in the 6th or 5th century BC and was remodelled at least three times prior to the Roman conquest. Evidence obtained from ramparts and gateways suggests a hiatus in occupation corresponding to the period between the "early" and "mature" phases of the iron age (Alcock, 1972, 30). Both rectangular and circular buildings of variable size were uncovered within the enclosure. Circular structures ranged between four and eleven m in diameter, whilst six-post rectangular buildings were generally small, rarely exceeding five by four m. One of these rectangular buildings has been identified as a shrine, with cella and entrance porch. A concentration of animal burials was found in front of this structure. Additional evidence of ritual activity took the form of a series of rock-cut pits containing carefully arranged cattle and horse skulls. Iron age activity at the site spans the excavator's phases Cadbury 5 to 9 (Alcock, 1980).

III.14.1 The metalworking evidence

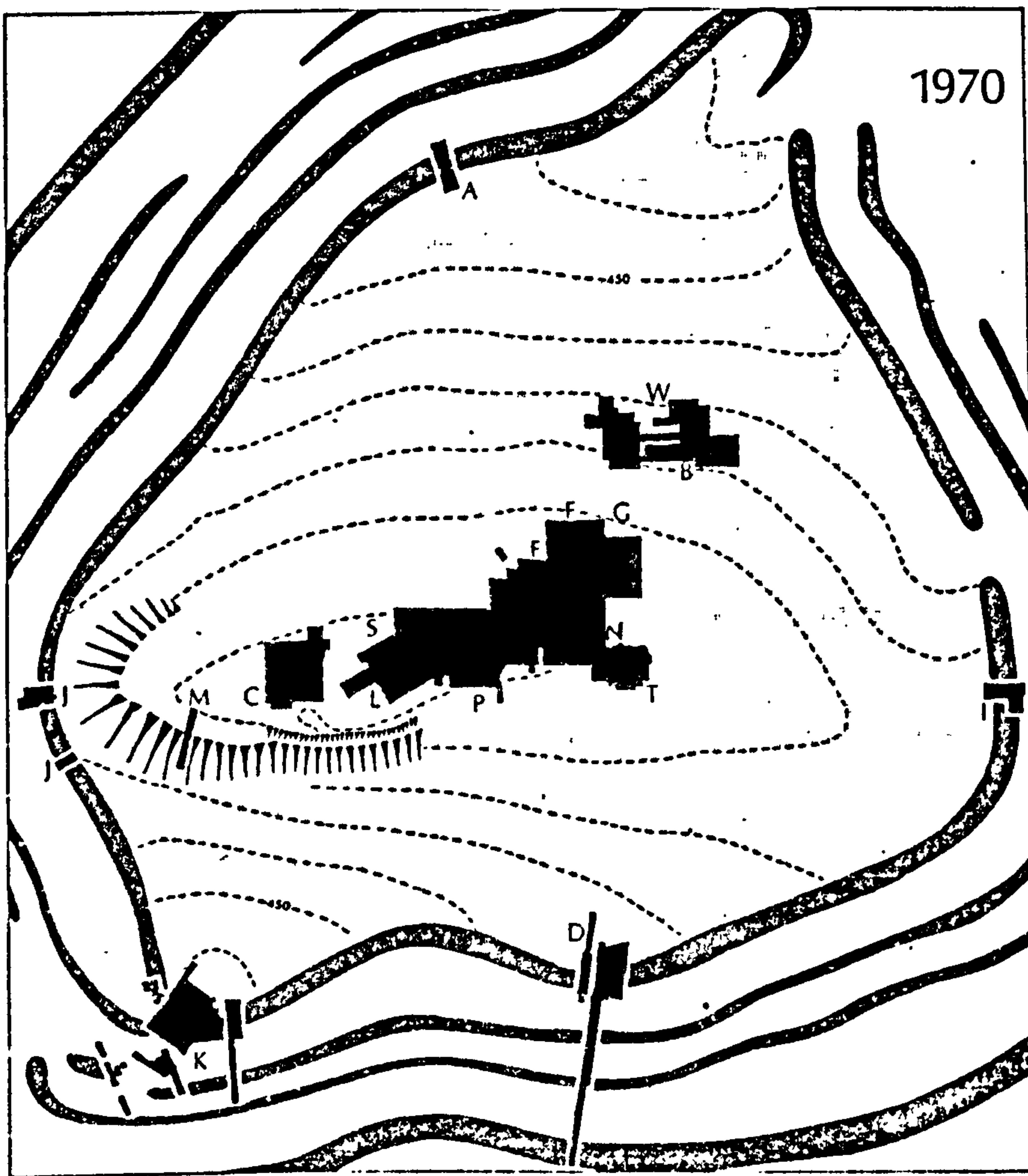
An unusually fine and varied collection of bronze and iron objects was recovered at Cadbury, many the products of highly skilled craftsmen. In area "N", immediately to the north of the axial ridge of the hill (fig III.14.1), a series of structures tentatively identified as ovens or furnaces was located, and various items of scrap bronze,

seemingly intended for the melting pot, lay close to the "furnace" area. Again in this area, the excavators found a collection of fine tools intended for the working and decoration of sheet bronze. These included a bronze tracer, two bronze punches, an iron scriber, a cold chisel and an iron hatchet stake. Evidence for bronze casting in addition to sheet metal working was also recovered. This consisted of numerous sherds derived from small triangular crucibles and a few fragments of cire perdue casting mould. These sherds were randomly distributed over the site (fig III.14.1 and Table III.14.1), and none was found in the area of the "furnace/ovens" (Alcock, pers comm). The majority occur in deposits of Cadbury phases 7 or 8, especially the latter (Table III.14.1). However, in the excavator's opinion, the concentration of refractory debris in contexts of phase 8 "merely reflects the fact that this was the great period of pit-digging and filling at Cadbury: pits are not distributed evenly across the six phases of the 1st millennium BC" (Alcock, pers comm).

III.14.2 Analytical results

The crucibles

None of the crucible sherds recovered at South Cadbury is sufficiently well-preserved for the profile to be reconstructed or the capacity to be assessed. Variety in form, however, is attested by considerable differences in rim shape and wall thickness (Table III.14.2). On initial inspection, fabrics seemed relatively homogeneous, but differences in texture and core colour suggested some variation in paste preparation techniques. Sixteen crucible sherds which appeared to represent the full range of fabrics represented were selected for analysis. These included two sherds tentatively identified as crucible during post-excavation work. Excluding the two possible crucible sherds, detailed examination in hand specimen and under the microscope permitted the division of the South Cadbury crucibles into two broad fabric groups.



The full extent of excavation (solid black) and geophysical survey (stippled) at the end of the 1970 season

Fig III.14.1 (after Alcock, 1972)

1. Fabric 1 (SC 11, 14, 17, 21, 26)

These hard-fired sherds are all reduced, although core colours vary from light grey to almost black. Inner faces are slagged, and slagging sometimes extends over the rim and covers the outer wall. The clay body in contact with these slagged zones is vitrified and some rim-areas (SC 26 for example) are vitrified throughout their thickness. All samples feel very sandy, and sand grains are just visible to the naked eye in samples SC 11, 14 and 26. No other inclusions can be seen although fine rounded or elongate (SC 17) voids are present throughout. In thin section, these samples contain a medium to high tenor of subangular quartz sand in an isotropic clay matrix. Size and packing density are

variable (fig III.14.2-3). Sections SC 14 and 26 both contain a little organic material, but its rarity suggests that it was residual in the clay rather than deliberately added as filler.

2. Fabric 1a (SC 19)

This sample is unusually fine, and contains in addition to very dense angular quartz sand, rare shreds of mica, and a scatter of rounded grains of iron oxide.

3. Fabric 2 (SC 10, 12, 15, 20, 22, 25)

These samples are again hard-fired, slagged and partially vitrified. All are reduced to mid to dark, purplish grey. Cut surfaces feel slightly sandy, but no sand grains can be seen in hand specimen. Rounded and elongate voids are abundant in most Fabric 2 samples, and a little finely divided carbonised material is visible in fresh fracture. Under the microscope, these samples are seen to contain a medium to high density of fine quartz and a scatter of carbon inclusions. These range from dust size particles to larger, ragged fragments. Density varies from section to section, but is always sufficient to suggest the deliberate incorporation of unevenly crushed charcoal into the siliceous paste.

4. Fabric 2a (SC 24)

The outer 1mm of this unusual pointed rim sherd is oxidised (5YR 6/8), and inner slagging is light. Although carbon inclusions are well represented in thin section, the fabric is generally finer than other Fabric 2 samples, and voids are virtually absent. SC 24 additionally contains finely divided mica.

*

*

*

Although body sherd SC 16 is heavily reduced and similar in overall appearance to the crucible fragments, a laminated structure and presence of abundant carbonate precluded its identification as an item of bronzeworking debris. The rim sherd SC 18, on the other hand, closely

resembles crucible SC 19 in thin section (Fabric 1a). The sherd is oxidised and the matrix anisotropic. This sample may well represent an unused crucible.

The moulds

Eleven small sherds were identified on typological grounds by Mansel Spratling (pers comm) as fragments of cire perdue casting mould. One of these (SC 1) is certainly part of a mould for casting rings, and in form and texture closely resembles pieces found at Beckford, Mucking and Gussage All Saints. The elongate fragment SC 6 may be a segment of a pin mould. All mould fragments are oxidised (7.5YR 4/6 - 7YR 6/6, with occasional red-firing, 2.5YR 6/6, flashes) on their outer faces. Inner surfaces are generally well-smoothed and reduced to medium to dark grey. Two fabrics were distinguished macroscopically, and this division was tested by thin section analysis. Two sherds, SC 3 and SC 7, were rejected as mould on the basis of the analytical results.

1. Fabric 3 (SC 1, 5, 6, 8, 9)

Samples are uniformly fine, slightly sandy and hard^d-fired. No inclusions are visible in hand specimen in this slightly micaceous, ferruginous clay other than distinct, medium-hard, iron-stained fragments, perhaps clay pellets. The sherds show no reaction with dilute HCl. In thin section, all Fabric 3 samples are seen to contain a medium high tenor (up to 64%) of fine angular and subangular quartz sand, well-distributed in a micaceous anisotropic or partially isotropic clay matrix. Sand grains are well-sorted, varying in size from 0.01mm to 0.12mm, with a tendency towards the smaller size range (figs III.14.2-3). All samples contain a scatter of subrounded inclusions of iron-rich argillaceous material containing sparse-medium quartz and mica. As Fabric 3 clays are extremely well mixed, these inclusions are more likely to represent deliberately added, crushed, lightly-fired ceramic than badly incorporated clay pellets.

2. Fabric 4 (SC 2, 4, 39)

This paste is distinctly coarser than Fabric 3. Fabric 4 samples

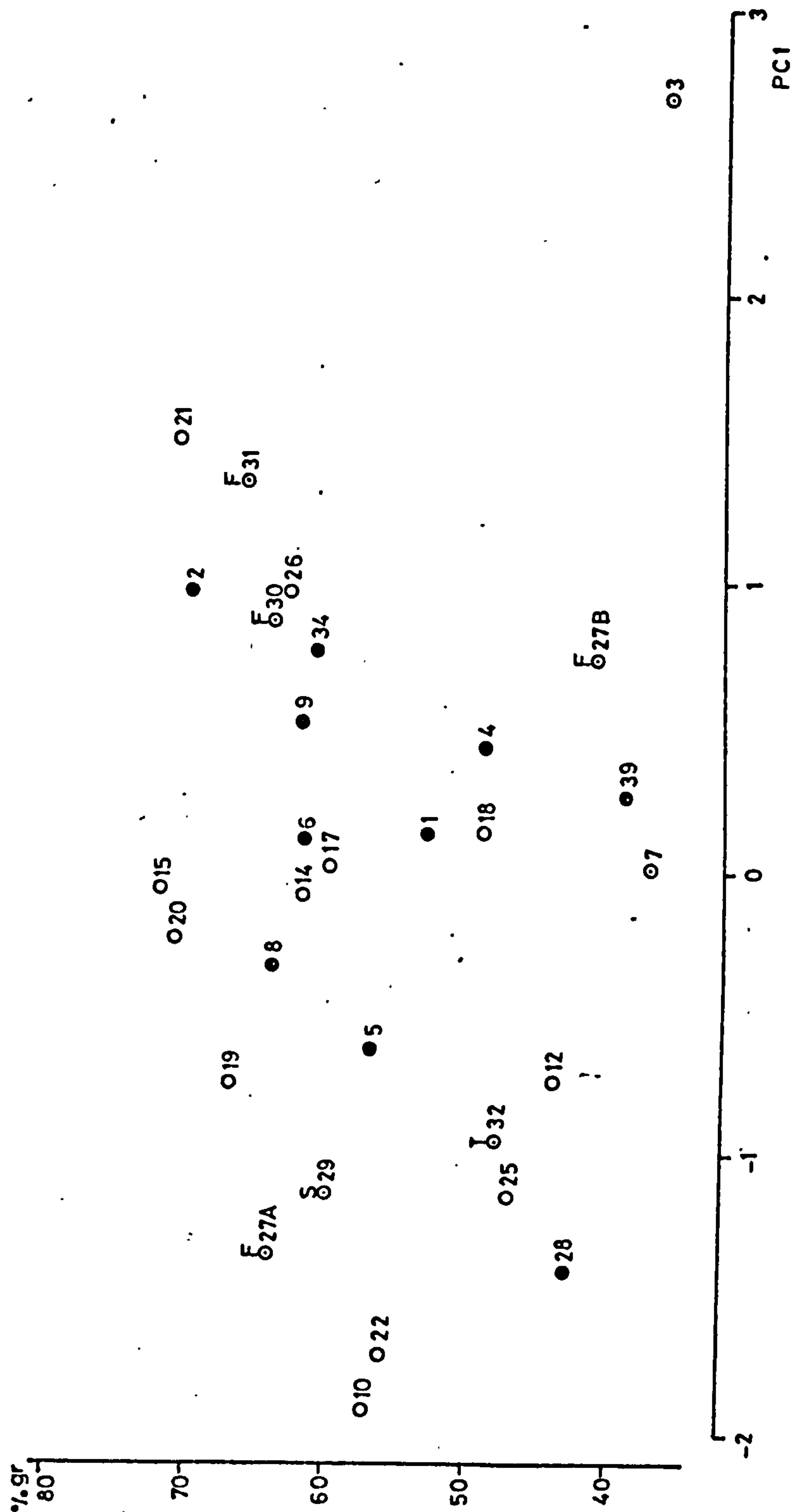


Fig III.14.2 South Cadbury: mould (●), crucible (○) and other refractory sherds (T = tuyère; F = furnace, S = sprue cup). Sherds are plotted against grain size (expressed by scores on the first principal component extracted from the ϕ counts) and proportion of grains:matrix

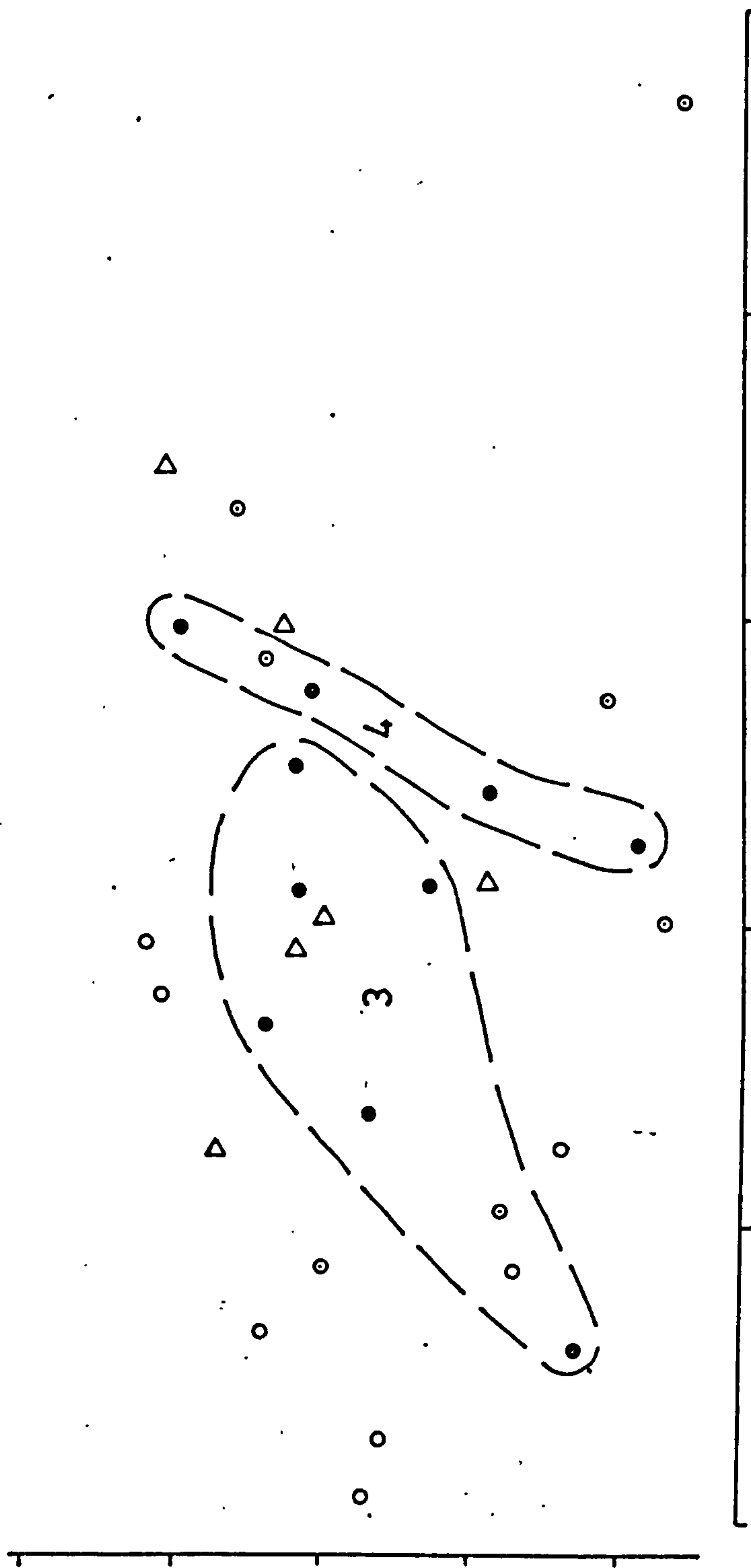


Fig III.14.3 South Cadbury: fabric classifications of mould and crucible sherds (cf fig III.14.2). Crucible Fabrics 1 ($\triangleright$) and 2 ($\circ$) are distinguished by symbols; mould Fabrics 3 and 4 by the dashed lines

are very sandy and feel harsh to the touch. Soft, whitish inclusions are visible on the surface and in fresh fracture. These inclusions and the surrounding clay matrix effervesce with dilute HCl. In thin section, all samples are seen to contain a variable tenor (up to 70%) of subangular quartz (average size 0.05mm) set in a slightly micaceous, anisotropic clay matrix. Rounded and ragged inclusions (to 0.5mm) of carbonate, probably recrystallised limestone, are scattered throughout. Fabric 4 appears less well prepared than Fabric 3, and the presence of carbonate would have lowered the refractory quality of the paste. All Fabric 4 sherds are formless, and perhaps represent the outer layers of cire perdue moulds. Inner, contact layers would have been formed around the wax pattern from the fine, non-calcareous Fabric 3.

? Furnace: Fabric 5 (SC 27, 30, 31)

Several fragments of fired clay have been tentatively identified as representing hearth or furnace lining. Three were selected for analysis. Samples SC 27 and 31 are oxidised, with surface colours varying from 7.5YR 5/6 to 2.5YR 5/6. SC 30 is black throughout its thickness. All three sherds react strongly with dilute HCl and dull white inclusions are clearly visible in SC 30 and 31. SC 27 is fine-textured whilst the remaining two sherds are coarse and very sandy. Surface mica is visible in all samples. Although some variation in inclusion size and packing density is observed in thin section (fig III.14.2), it is suggested that all "furnace" sherds be assigned to a single fabric group. The paste is less well prepared than those used for crucible and mould production, and all "furnace" samples contain frequent ragged fragments of microcrystalline limestone. Mica content resembles that of mould Fabric 3. The identification is by no means certain and comparisons should be made with all other ceramic fabrics at the site.

Tuyère: Fabric 6 (SC 32, 33)

Two heavily slagged and partially vitrified fragments, probably representing tuyères, were selected for analysis. One of these (SC 33) is vitrified through more than half of its 13mm thickness. Both contain a medium density of fine quartz grains (quartz is sparser than in most of the mould and crucible sherds) and a little residual carbon. Voids

visible in the tuyère fragments contain considerable yellowish, recrystallised limestone.

Sprue-cup (SC 29)

SC 29 has been identified on typological grounds as a sprue-cup, and as such is rare in iron age contexts. It would seem reasonable to suppose that this artefact, designed as a gate through which molten metal was introduced into the mould, would be formed from mould fabric. However, both macroscopically and in thin section, the sprue-cup fragment SC 29 is identical in all ways to crucible Fabric 2.

Clay lump (SC 34)

It was suggested that this large, formless lump of clay may represent material prepared in readiness for mould manufacture. The fabric is oxidised (7.5YR 6/6) and has been lightly fired, although this may have been accidental. The fine ferruginous clay is sandy, slightly micaceous, and contains a sparse scatter of dull white inclusions of carbonate. Specks of iron ore are also visible on a cut face. Under the microscope the fabric resembles mould Fabric 4, although it is less well mixed and contains a smaller proportion of carbonate. Heavy bands of iron-staining are visible across the thin section.

III.14.3 Discussion

Occupation at the South Cadbury hillfort was effectively and suddenly terminated in the 70s AD by a Roman military attack. Although the reasons for this attack are unclear, the fact that it took place at all means that at the time an individual or group, capable of organising resistance to Roman Imperial policy was resident at the site. Such resistance would seem to have been an unusual phenomenon (Alcock, 1972, 170-72). It was suggested that South Cadbury may have been the home of a warrior nobility during the 1st century BC. This suggestion was based partially on the discovery of large round-houses both in the centre and on the periphery of the hillfort. These could be interpreted as the dwellings of high status warriors. Further evidence for a warrior nobility was seen in the apparent presence of expert craftsmen and

armourers on the site. "In post-Roman Celtic society ... we know that such craftsmen worked at the courts of princes and chieftains, and if we can project back over six or seven centuries, the Cadbury armourers and bronzesmiths similarly imply the existence of noble patrons" (Alcock, 1972, 157).

In area N, a rectangular wall trench of unique plan has been interpreted as a shrine. A concentration of some twenty young animal burials was found at the approach to this shrine. North of these burials lay a substantial collection of ironwork including swords, daggers and fittings for dagger scabbards. The association of these objects with ritual burials or sacrifices suggests that some, at least, may have been deliberately deposited as votive offerings (Alcock, 1972, 84). From the same vicinity came fragments of bronze scrap, some of which display the finest elements of Celtic craftsmanship. A group of structures located in the same area as the shrine was identified as an armourer's workshop (Alcock, 1972 and Pl 55; Spratling, 1979, 190). The fine scrap bronze, apparently intended for the melting pot, abundant scrap iron, and a collection of sheet bronze working tools, were all found here.

Since the appearance of the main publication describing the site (Alcock, 1972), both the excavator and, apparently, Spratling have revised their interpretation of the "workshop" complex on site N. "It should be noted that Spratling has retracted his ... view that the tools and scrap found in the area of the shield fragments are part of an iron age smith's workshop" (Megaw, 1979, n 51). "I question whether we have in fact discovered any major metalworking area on the site. I believe this still remains to be found in an unexcavated area" Alcock, pers comm, November 1982).

Although some of the bronze casting debris was recovered in area N, crucible and mould sherds were not concentrated there, but occurred sporadically across the site (Alcock, pers comm). The refractory formulae defined through petrological analysis are those common throughout Britain during the iron age. No unique technology was observed, and as far as can be ascertained, the crucible sherds represent the usual triangular iron age forms. The few mould sherds from South

Cadbury are generally too abraded to allow recognition of the objects produced. The identified plain ring mould (SC 1) closely resembles, in form, one from Beckford and another from Mucking. The casting of special, prestige items is not attested by the mould evidence. Thin sections of material from rampart K have been described (Cornwall, 1980), and it would seem from these descriptions that raw materials for refractory production were available in the vicinity of the site (no clay sampling was attempted in the Cadbury area by the writer). The abundant fine quartz silt (0.01-0.06mm) observed in section K1 was derived from the local sandy limestone (Cornwall, 1980), and may have been used in the manufacture of crucible Fabrics 1 and 2.

In sum, the refractories recovered at South Cadbury show no attributes which might indicate bronze casters of unusually high status. Refractory distribution is random; sand and sand-carbon pastes were prepared to shape crucibles of common iron age form; no moulds for prestige artefacts were found; and all refractories could, conceivably, have been locally produced.

It is the writer's opinion that any consideration of metalworking at South Cadbury must take into account the possibility that different craftsmen, perhaps belonging to the same smithing group, specialised by activity in bronze casting and sheet metal working. These specialisations may have been carried out in separate areas. Casting facilities are likely to have been located outside the settlement for practical and, perhaps, social reasons (Part I, p 64). Fine sheet metal working, on the other hand, attested by the presence of the smiths' tools, requires no complex furnace facilities, and may have taken place within the hillfort. In the absence of any well contexted informative industrial debris, complex issues such as the relationship between different categories of metalworkers, their relative status, their work patterns or the nature and destination of their output, must remain within the realm of speculation.

TABLE III.14.1 SOUTH CADBURY: CONCORDANCE OF SECTIONED SHERDS

Sample number	Excavation number	Phase	Identification
SC 1	S 043A	7/8	mould: ring
SC 2	F 263	8/9	mould
SC 3	C 7A		unknown: rejected as mould
SC 4	F 306A	7/8	mould
SC 5	S 043	7/8	mould
SC 6	S 210	5/6	mould: ? pin
SC 7	A 648A		mould
SC 8	G 192	8	mould
SC 9	N 943	6/7/8	mould
SC 10	L 403C	11 or earlier	crucible
SC 11	C 558H	9	crucible
SC 12	L 601	topsoil	crucible
SC 13	S 207D	6/7	crucible
SC 14	C 403C	11 or earlier	crucible
SC 15	S 043	7/8	crucible
SC 16	C 403A		? crucible
SC 17	W 088	8	crucible
SC 18	N 996	6/7/8	? unused crucible
SC 19	B 322		crucible
SC 20	F 306	7/8	crucible
SC 21	P 822A	8	crucible
SC 22	S 052	8	crucible
SC 23	P 107B	7/8	crucible
SC 24	C 556		crucible
SC 25	L 792A	12 or earlier	crucible
SC 26	C 403C	8	crucible
SC 27a	T 317D	8	? furnace
SC 27b	T 317D	8	? furnace
SC 28	N 126	9	mould (originally thought to be furnace)
SC 29	P 218	8	sprue-cup
SC 30	G 192	8	? furnace
SC 31	T 317E	8	? furnace
SC 32	S 030B	7/8	tuyere
SC 33	D 715	9	tuyere
SC 34	L 601	topsoil	clay lump
SC 35	D 513D	8/9	pot
SC 36	F 658A	7/8	pot
SC 37	C 409F	7/8	pot
SC 38	C 403C	8	pot
SC 39	L 649	10 or earlier	mould

TABLE III.14.2 SOUTH CADBURY: DESCRIPTION OF CRUCIBLE SHERDS

Sample no	Portion of vessel	Maximum thickness
SC 10	base	13mm
SC 11	rim	12mm
SC 12	rim	13mm
SC 13	wall	10mm
SC 14	rim	10mm
SC 15	wall	8mm
SC 16 *	? wall	10mm
SC 17	wall	5mm
SC 18 *	rim	7mm
SC 19	wall	10mm
SC 20	rim	12mm
SC 21	rim	10mm
SC 22	wall	12mm
SC 23	wall or ?base	15mm
SC 24	rim	16mm
SC 25	wall	6mm
SC 26	rim	11mm

* = identification as crucible in doubt

OBJECT	SLIDE	2	NO. OF	PHI	PHI	PHI	PHI	PHI	PHI	PHI	PHI	PHI	PHI	PHI	PHI	PHI	PHI	MEAN	STD
			GR: GRAINS	-1 T	-0.5	0 TO	.5 T	1 TO	1.5	2 TO	2.5	3 TO	3.5	4 TO	4.5	5 TO	6 GRAIN	DEV	
			MAT	0 -	0 TO	.5	0 1	1.5 TO	2	2.5 TO	3	3.5 TO	4	4.5 TO	5	5.5	SIZE		
				5													MM.		
MOULD																			
	1	53	58	0	0	0	0	0	0	0	0	2	0	22	36	40	.0331	.105	
	2	70	60	0	0	0	0	0	0	0	0	12	11	17	30	30	.0457	.231	
	3	36	64	0	0	0	0	3	5	5	5	17	11	23	19	14	.0868	1.20	
	39	39	62	0	0	0	0	0	0	0	0	5	10	17	24	44	.0377	.158	
	4	49	51	0	0	0	0	0	0	0	0	2	12	16	35	35	.0378	.145	
	5	57	54	0	0	0	0	0	0	0	0	0	2	5	35	54	.0276	.069	
	6	62	56	0	0	0	0	0	0	0	0	2	9	18	26	45	.0351	.129	
	7	37	52	0	0	0	0	0	0	0	0	4	0	11	12	23	.0370	.178	
	8	64	58	0	0	0	0	0	0	0	0	2	8	9	29	52	.0318	.109	
	9	62	64	0	0	0	0	0	0	0	0	8	16	14	20	42	.0421	.203	
N SLIDES			10																
N GRAINS			579																
CRUCIBLE																			
	10	57	52	0	0	0	0	0	0	0	0	0	0	0	10	90	.0187	.024	
	11	999	55	0	0	0	0	0	0	0	0	0	11	5	20	64	.0287	.090	
	12	44	57	0	0	0	0	0	0	0	0	2	3	7	28	60	.0280	.083	
	14	62	60	0	0	0	0	0	0	0	0	2	3	2	13	33	.0340	.139	
	15	72	64	0	0	0	0	0	0	0	0	3	6	16	27	48	.0337	.122	
	17	60	52	0	0	0	0	0	0	0	0	4	0	11	12	23	.0370	.178	
	18	49	60	0	0	0	0	0	0	0	0	2	3	7	11	35	.0366	.158	
	19	67	57	0	0	0	0	0	0	0	0	0	0	0	14	25	.0264	.063	
	20	71	59	0	0	0	0	0	0	0	0	2	6	14	27	51	.0321	.109	
	21	71	66	0	0	0	0	0	0	0	0	0	6	14	27	51	.0321	.109	
	22	56	54	0	0	0	0	0	0	0	0	9	16	26	26	21	.0496	.249	
	25	47	57	0	0	0	0	0	0	0	0	2	0	4	5	89	.0210	.047	
	26	63	59	0	0	0	0	0	0	0	0	4	5	2	14	75	.0266	.090	
N SLIDES			13																
N GRAINS			752																
TUYERE																			
	32	48	59	0	0	0	0	0	0	0	0	2	2	5	25	66	.0262	.072	
N SLIDES			1																
N GRAINS			59																
FURNACE																			
	27A	64	56	0	0	0	0	0	0	0	0	0	4	3	16	77	.0232	.052	
	27B	41	64	0	0	0	0	0	0	0	0	5	6	14	14	22	.0451	.267	
	28	43	63	0	0	0	0	0	0	0	0	2	2	14	16	25	.0398	.182	
	30	64	56	0	0	0	0	0	0	0	0	11	14	16	25	34	.0453	.229	
	31	66	67	0	0	0	0	0	0	0	1	11	19	18	26	25	.0504	.274	
N SLIDES			5																
N GRAINS			306																
SPRJ CUP																			
	29	60	55	0	0	0	0	0	0	0	2	2	0	1	24	71	.0260	.091	
N SLIDES			1																
N GRAINS			55																
IN MOULD																			
	34	61	50	0	0	0	0	0	0	0	0	8	14	14	32	32	.0431	.203	
N SLIDES			1																
N GRAINS			50																
			31																
			1201																

Table III.14.3 South Cadbury: grain size statistics.

III.15 WEELSBY AVENUE, GRIMSBY, LINCOLNSHIRE
(TA 283085; corpus no 82)

The square enclosure at Weelsby Avenue is the smallest of the iron age metalworking sites discussed in detail here. A shallow perimeter ditch with a single entrance encloses two roundhouses and a scatter of pits or gullies (fig III.15.1). Excavation has taken place under the direction of John Sills and will continue for a further short season in 1983. The site has produced abundant pottery tempered with igneous rock and a large quantity of metalworking debris. This debris all occurred in the same layer of the final of three phases of the enclosure ditch, dated by decorated pottery to c 50BC - AD50. The ditch also contained two human skulls, one each side of the entrance cuaseway.

III.15.1 The metalworking evidence

Several kilos of cire perdue casting mould have been recovered at Weelsby Avenue, mainly from the perimeter ditch in three discrete dumps (a fourth dump, near the north east corner of the enclosure, consisted of "fired clay": fig III.15.1). Excavation of the western arm of the ditch terminated in 1981 at a point where a heavy concentration of clay mould could be seen in the section. Examination of this area will continue in 1983. Typological work and reconstruction of the Weelsby moulds has not yet commenced, but a few diagnostic pieces suggest that the large scale casting of horse gear was taking place at the site (J Foster, pers comm). Several thick-walled crucible sherds accompanied the moulds, and these too will be studied and analysed in detail in 1983.

III.15.2 Analytical results

An initial fabric inspection of a portion of the metalworking debris was permitted, and fifteen formless sherds were selected for analysis. These included thirteen mould fragments, one crucible sherd, and a single, thick, partially vitrified clay lump, perhaps representing

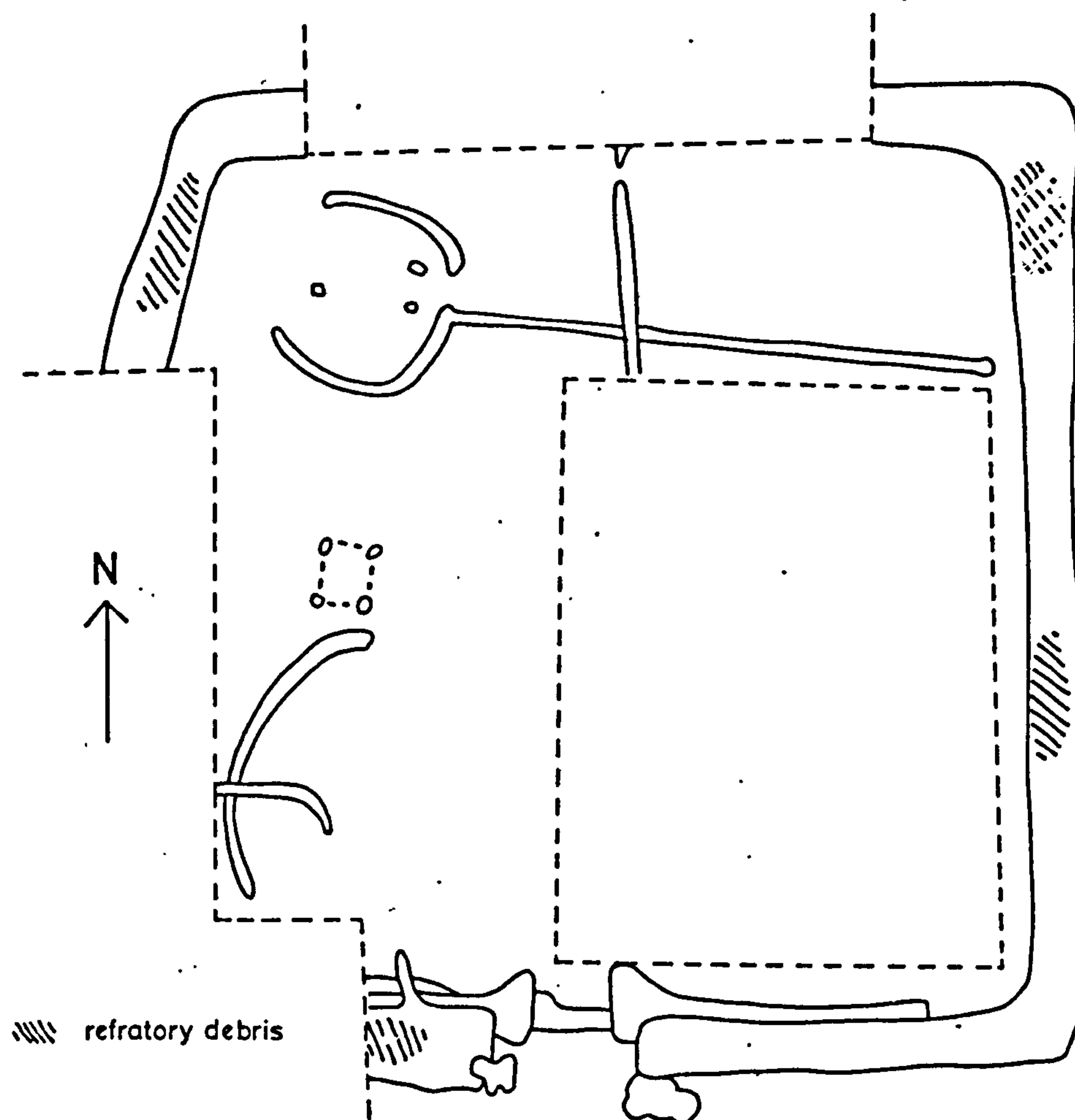


Fig III.15.1 Sketch plan of enclosure at Weelsby Avenue, Grimsby (after J Sills). The sides of the enclosure are about 40m long.

part of a furnace. All this material was found in feature 1, trench 14, layer 2. A small sherds of typical Weelsby pottery from the same context was also analysed for comparison with the refractory debris. None of the sherds was numbered; WBY numbers appearing in the following discussion were arbitrarily assigned by the writer for identification purposes.

The crucible: Fabric 1 (WBY 15)

A single body sherd was made available for analysis. This 10mm thick sherd is hard-fired and completely reduced to mid-grey. The paste feels extremely sandy, but no inclusions are visible in hand

specimen save a few flecks of carbon and rare grains of quartzite or fine-grained sandstone.

In thin section the sample is seen to consist in the main of subangular and rounded quartz set in an isotropic clay matrix. The majority of grains range from 0.09 to 0.25mm but reach 0.85mm. Also present are rare grains of quartzite, metaquartzite, and a single angular fragment (0.9mm) of grey-brown flint. Mica, and tiny (to 0.03mm) grains of colourless pyroxene and brown tourmaline are present though extremely rare. Scattered throughout the section are angular elongate fragments of carbonaceous material, many of which exhibit a fibrous structure. The frequency of these fragments suggests the deliberate addition, perhaps of locally available sea-coal (quantities of which were found on the Weelsby site), to the crucible paste. Although no metalliferous deposits appear on the surfaces of the sherd, slag penetration is clearly visible in section, confirming that the vessel had, in fact, been used for the melting of copper alloys.

The moulds: Fabric 2 (WBY 1-13)

All Weelsby mould fabrics examined are extremely fine, sandy, and apart from an occasional fleck of mica and very rare tiny grains of sandstone, appear inclusionless in hand specimen. Distinctive laminations visible through the thickness of the sherds indicate that the prepared clay was applied to the wax pattern in layers. The manner in which these layers have flaked suggests that the moulds were allowed to dry between applications. A maximum of three layers was noted through any one sherd, but the fragments examined are extremely abraded, and it is unclear whether the full original thickness is represented. Different clay layers are often distinguished by variation in fired colour (Table III.15.1).

Examination in thin section reveals little variety in inclusion suites among the thirteen mould fragments. All contain a high tenor (up to 79%) of rounded and subangular quartz sand set in a partially isotropic clay matrix. Quartzite and sandstones, including a slightly micaceous sandstone with ferruginous cement, are visible in most samples. Tiny grains of plagioclase feldspar, tourmaline, hornblende,

epidote and a colourless pyroxene appear in some section in varying combinations, but these minerals are rare and their presence/absence cannot be relied upon to discriminate between fabrics. Threads of white mica appear in all moulds examined, and although more plentiful than in the crucible section, are still infrequent. No variations can be observed between the separate layers of individual moulds, showing that the same clay was used for each application.

Microscopic inspection and the results of textural analysis (fig III.15.2) suggest a tendency for the moulds to fall into three groups. Samples WBY 2, 9 and 13 are fine-textured and contain densely packed quartz rarely exceeding 0.15mm. Samples WBY 7 and 10 are much coarser, less dense, and contain poorly sorted grains to 1.0mm. The remaining samples fall midway between these two extremes, containing 50-60% of moderately well sorted sand to c 0.5mm. It is possible that these three 'groups' represent three separate mould making episodes using related but slightly different recipes. More material should be analysed to test the validity of this preliminary division.

Furnace ? : Fabric 3 (WBY 14)

This formless clay lump, tentatively identified as furnace, differs in hardness, texture and fired colour from the crucible and mould sherds. The clay is poorly worked and banded. In fresh fracture colour variations from 2.5YR 4/4 (reddish brown) to 5YR 6/4 (light brown) may be observed. The fabric is sandy, friable and grains easily become detached during handling. In thin section, this sample is seen to contain a medium scatter of poorly sorted quartz sand set in a ferruginous anisotropic clay matrix. No slagging is visible, and the identification of this fabric as furnace must remain tentative pending the analysis of similar material.

Pottery:(WBY 16)

The pottery sherd from Weelsby is reduced to black throughout its thickness. The fabric is friable and 'platy' in structure. Numerous angular fragments of black slightly lustrous, igneous rock are clearly visible in hand specimen. Under the microscope, the pottery matrix is

anisotropic, free from white mica, and contains very sparse quartz. The fabric is tempered with large (to 1.5mm) angular fragments of quartz-rich hornblende-diorite. Tabular plates of green and greensih-brown hornblende, presumably derived from the igneous rock are also present together with a small amount of biotite. It is clear that a particular rock type, selected from among the coastal erratics, has been crushed and added to a fine textured clay.

III.15.3 Resource ecology and raw material sampling

The Weelsby Avenue site is located on the Lincolnshire coastal Boulder Clay. This clay contains a range of erratic rocks similar to those found further north along the coast from Dimlington to Flamborough Head (Ch III.3 above). Limitless clay and temper sources were thus locally available to the Weelsby metalworkers.

As the refractory material from Weelsby was not made available until the closing months of this study, it was not possible to conduct a clay and sand sampling programme in the area. A single sample of Boulder Clay from the site was kindly supplied by the excavator. The fired colour of this clay (2.5YR 5/8) is similar to that of some of the outer faces of the mould samples, but the texture is somewhat coarser. In thin section, the Boulder Clay sample is seen to contain a medium scatter of rounded quartz, quartzite and metaquartzite, several large grains of brownish chert or flint (some of which is fossiliferous), a single fragment of fossil shell, and extremely rare mica. Three large (in excess of 1mm) angular grains of micaceous sandstone with ferruginous cement are also present. Other than two small fragments of plagioclase feldspar, none of the detrital minerals (such as tourmaline and epidote) noted in the refractories is visible in the clay sample. Although the mineral suite present in the moulds and crucible implies an origin in the Boulder Clay, the high density of quartzite, abundance of chert/flint, and the presence of large, micaceous sandstone fragments in the clay sample supplied, suggest that the Weelsby refractory makers sought their raw materials somewhat further afield. A detailed programme of clay, sand and rock sampling in the Lincolnshire coastal area should be designed when more results are available from the Weelsby site.

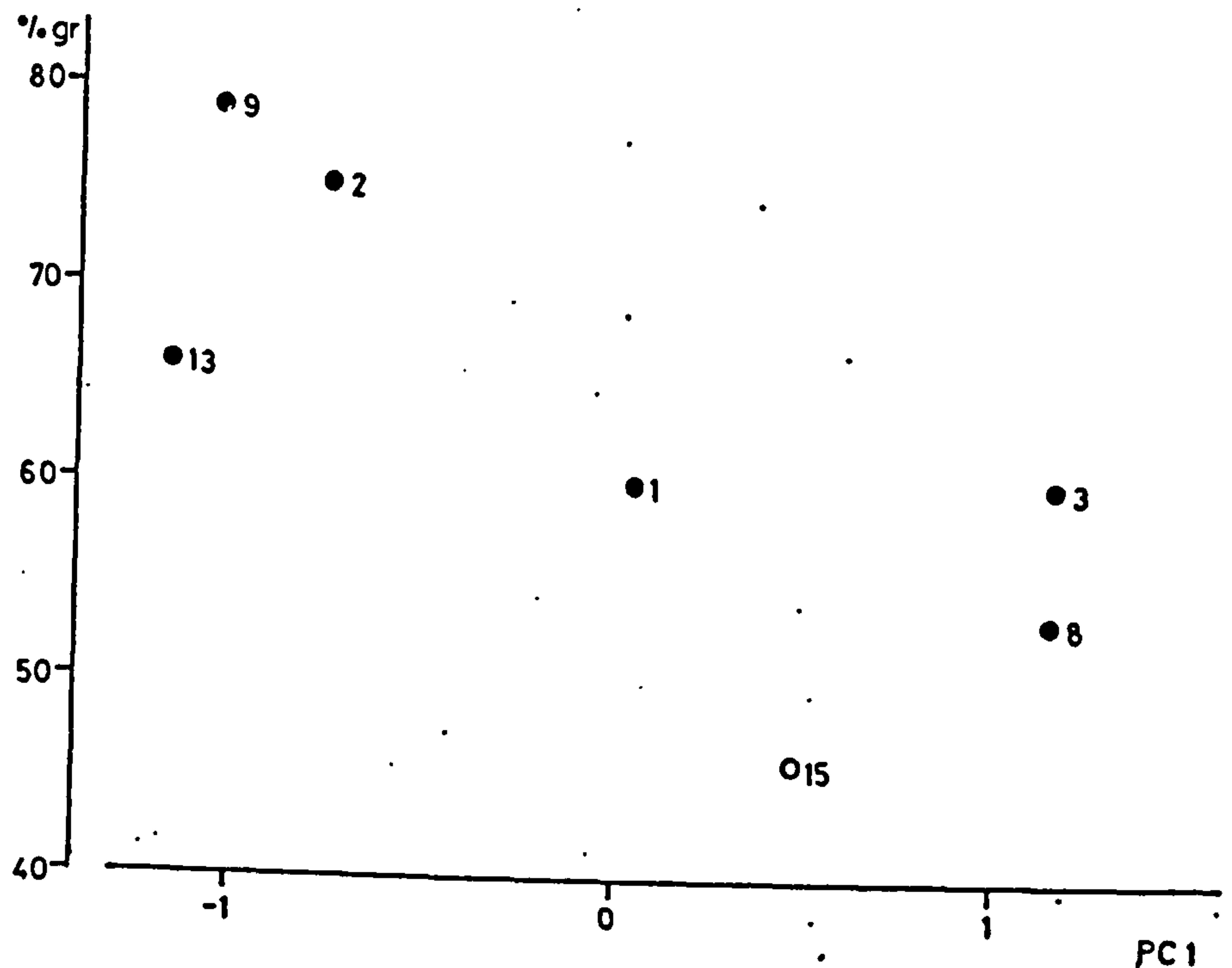


Fig III.15.2 Weelsby Avenue: mould (●) and crucible (○) sherds, plotted against grain size (expressed by scores on the first principal component extracted from the ϕ counts) and proportion of grains:matrix

III.15.4 Discussion

The Weelsby mould and crucible fragments analysed in the course of this study are generally similar in composition to iron age refractories from other areas of Britain. The moulds (tentatively divided into three groups, perhaps representing separate casting episodes) are formed from sand bound with clay and contain few impurities. That local raw materials were exploited is attested by the occurrence of quartzite and tiny detrital grains derived from erratic rocks in the local Boulder Clays. A different formula is represented by the single crucible analysed. Here, a mixture of quartz sand and carbon was bound

with Boulder Clay to produce a carbon-silica crucible paste. Only 46% quartz was recorded in this fabric, refractoriness being achieved by the incorporation of tabular carbon fragments, perhaps sea-coal. Similar carbon-silica crucibles have been recorded at Beckford, Mucking, South Cadbury and Meare. As at all bronze production sites examined in this study, refractories at Weelsby can easily be distinguished from other ceramic artefacts. The small pottery assemblage, like the single sherd analysed, appears to be exclusively igneous tempered (I Freestone, pers comm).

The refractory debris from Weelsby Avenue promises to be as prolific and informative as that from Gussage All Saints. These two sites which supported such intensive industrial activity, are, however, very different. Gussage is a large enclosed settlement with evidence of diverse subsistence and craft pursuits, whilst Weelsby, without the metalworking evidence, could easily be interpreted as a poor, isolated farmstead. Leaving aside the question of metal supply (a detailed investigation of this aspect of the industry is outside the scope of this study), Weelsby is ideally located for bronze casting on a grand scale. Limitless quantities of clays and tempers for moulds, furnaces and crucibles are locally available, and sea-coal which strewn the beach in this area would have provided a ready fuel supply. Sea-coal requires no processing, unlike wood, which must be converted to charcoal before it can be used effectively for metallurgical purposes. Lumps of sea-coal have been found during the excavations at Weelsby, strongly suggesting that this may well have been the fuel used.

Aside from these environmental factors, the social and economic reasons why large scale bronze casting should have taken place at Weelsby cannot, at present, be known. Few settlements of iron age date are known in the area south of the Humber, thus it is not possible to assess the site in a regional context. As has been suggested for Gussage, Weelsby may have constituted a key link in a regional economic chain; the smiths supplying a wide area with a single product type. However, even this possibility cannot be investigated until the moulds have been properly identified.

Were the Weelsby smiths self-supporting? Is the site in fact

a metalsmith's workshop located some distance from a (yet undiscovered) settlement, a situation observed in several ethnographic contexts? Could Weelsby be a workshop and temporary settlement, chosen on account of the raw material resources, and visited on a seasonal basis by a long-distant itinerant smith? Was this a ritual metalworking site (remember the skulls ...)? These questions must, for the present, remain unanswered.

TABLE III.15.1 WEELSBY AVENUE, GRIMSBY: MOULD COLOURS

Sample number	Layer 1	Layer 2	Layer 3
WBY 1	grey-black	10R 6/6	2.5YR 5/8
WBY 2	grey-black	dark grey	mid grey
WBY 3	black	7.5YR 6/6 - 2.5YR	-
WBY 4	10YR 6/4	dark grey	2.5YR 5/8
WBY 5	black	10R 5/8	-
WBY 6	5YR 6/4	5YR 6/4	5YR 6/4
WBY 7	light grey to 5YR 6/4 →		
WBY 8	grey-black	2.5YR 5/8	-
WBY 9	black	7.5YR 6/6	-
WBY 10	light grey to 5YR 6/4 →		
WBY 11	7.5YR 6/6	black	7.5YR 6/6
WBY 12	black	7½YR 6/6	-
WBY 13	black	2.5YR 5/8	-

This table describes the fired colours of the different layers of the Weelsby moulds. Layer 1 is the innermost layer preserved, Layer 3 is the outermost. When only two layers are preserved, Layer 2 is the outermost

TABLE III.15.2 WEELSBY AVENUE: GRAIN SIZE STATISTICS

[illegible]

III.16

BRONZE CASTING SITES AND BRONZE AGE MOULDS IN SOUTHERN BRITAIN:
A CATALOGUE

The following catalogue has been prepared (a) to illustrate the general nature of the archaeological evidence indicative of bronze casting activity; (b) to demonstrate the extent of the industry and the range of bronze age and iron age site types where casting took place; (c) to document the find places of various forms and materials of casting debris. The catalogue was compiled essentially from published literature. Unpublished, recently excavated material has also been included when known to the author.

The sites described in III.16.1 are arranged in alphabetical order (bronze age A-Z; iron age A-Z) with a continuous number sequence. Sites producing material of both bronze and iron age dates appear twice in the sequence (eg Mucking, Essex, is listed as no.15 and no.66). Sites recorded in detail in preceding chapters are noted in the catalogue, and the reader is referred to the full descriptions (III.2-15) above. Ceramic refractories from fourteen additional sites (four of bronze age and ten of iron age date), as well as a core from an uncontexted socketed axe, have been examined to extend understanding of ancilliary equipment production, and bronze casting organisation during the period under study. The results of these 'minor' analyses are included where appropriate in III.16.1 (and see also Table III.1.1 and fig III.1.1).

Kevin Leahy (University of Nottingham) is currently preparing a corpus of British stone and bronze moulds, as part of a doctoral thesis concerning prehistoric foundry practices. I am grateful to Mr. Leahy for providing information which has assisted me in compiling the mould catalogue presented here (III.16.2). Like the production sites, findspots of stone and bronze moulds are arranged alphabetically (stone A-Z; bronze A-Z).

III.16.1 Catalogue of bronze casting sites

The sites are arranged alphabetically within three groups: bronze age, iron age and late iron age coin minting sites. They are numbered in one continuous sequence. Site entries follow a standard format:

- a. site, county, national grid reference
- b. type of site, area (when known)
- c. date
- d. bronzeworking finds (with any comments)
- e. reference(s)
- f. [where appropriate] analytical results

*

*

*

- a. (1) Aldermaston Wharf, Berkshire. SU 605678
- b. unenclosed settlement; c 1350 sq m
- c. some time between 11th and 9th centuries (C14)
- d. several fragments of crucible and clay mould identified by M Spratling
- e. Bradley et al, 1980
- f. A number of pieces of fired ceramic were tentatively identified by M Spratling as refractory artefacts. These included four possible mould sherds, crucible fragments, and two formless pieces, perhaps derived from tuyeres or melting hearths. None of the mould fragments retains features which allow the identification of the artefacts being cast. All "casting debris" were found in secondary contexts, and no metal residues were recovered from any area of the settlement. Traces of copper oxide were, however, detected by Spratling on one of the crucible sherds, indicating that bronzeworking activities took place at the site (Spratling, pers comm). Unfortunately, neither the crucible sherds nor two of the putative mould fragments could be located for analysis. Seven "metallurgical" sherds were submitted to the writer for fabric examination.

Only two of the submitted sherds, ALD 167 and 14F (excavation nos) can be positively identified as refractory material. Both are double layered structures, and may be derived from bivalve casting moulds, but this cannot be confirmed. Inner faces are reduced to mid-grey and the

sandy, white mica, and a scatter of iron ore. Sample 14F additionally contains angular inclusions of flint to 0.8mm.

The remaining sandy sherds from Aldermaston cannot be identified. All consist of poorly mixed clay containing sparse quartz sand and flint. None appear to have had any connection with metallurgical activities. Until the crucible sherds are located, bronzeworking at the site can be discussed no further.

a. (2) Beeston Castle, Cheshire.

See Ch. III.5

a. (3) Bishops Cannings Down, Wilts. Su 058666

b. unenclosed settlement; 2-4ha

c. MBA-LBA (C14)

d. bronze casting jet with riser and bronze dross

e. Gingell, 1980

a. (4) The Breiddin, Powys.

See Ch III.9

a. (5) Bramber, West Sussex.

See Ch III.6

a. (6) Burderop Down, Wilts. SU 168764

b. unenclosed settlement

c. c 750 bc (pot and metalwork)

d. 3 pieces of single stone mould valve just outside settlement (mould catalogue no 5); 1 crucible sherd in centre of settlement area; droplets of bronze dross; 20-30 whetstones of Seend ironstone (fig III.16.1)

e. Gingell, 1980

f. A single fragment of a neatly-made, flat-rimmed crucible was found in the centre of the settlement area. The sherd is extremely ^dhard-fired and appears to have been formed from a sandy, white clay. X-ray fluorescence analysis of slaggy material from the inner surface indicated that the vessel had been used for melting a copper-lead alloy. In thin section, the isotropic matrix is seen to contain a high tenor of fine quartz

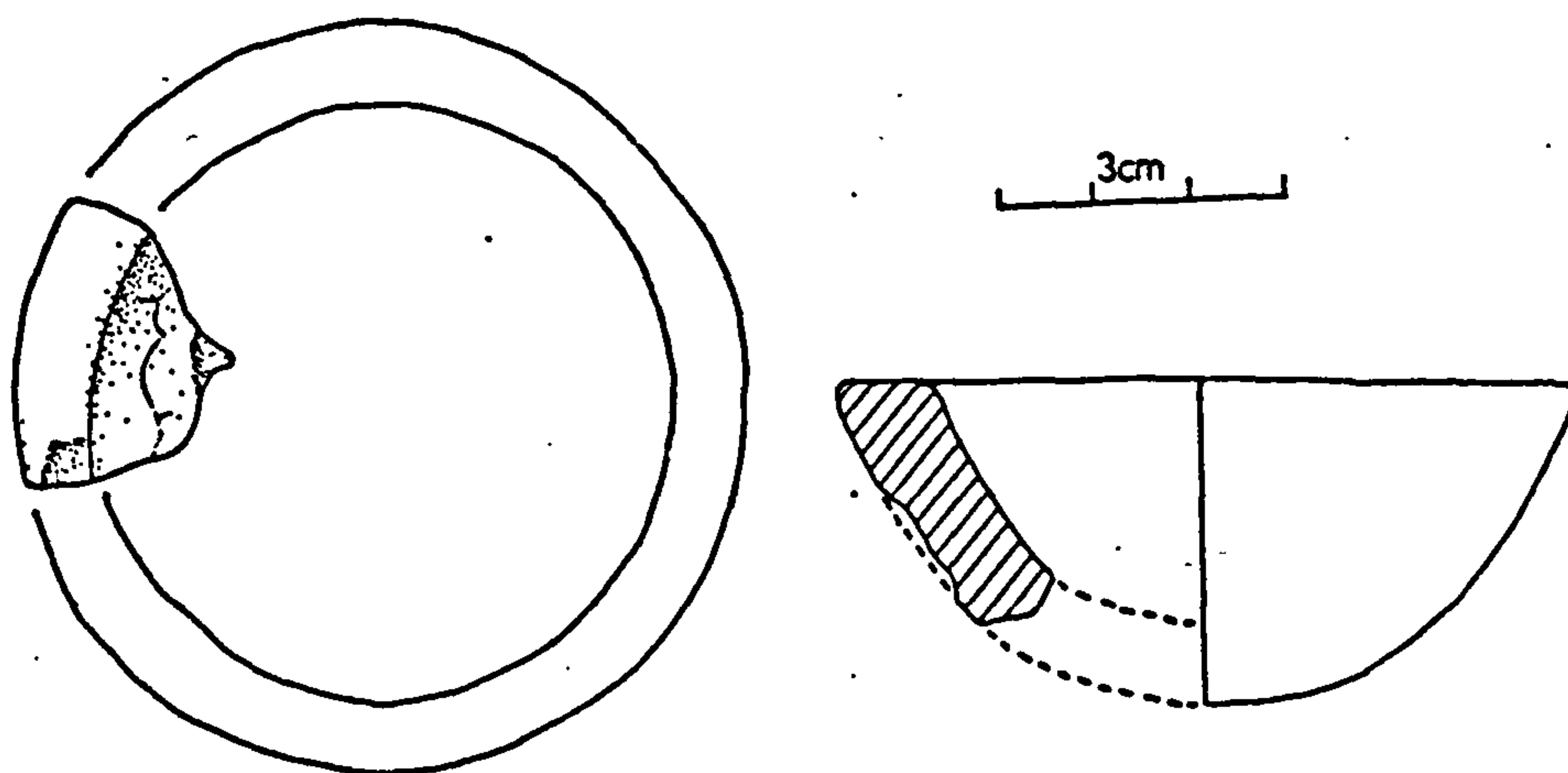


Fig III.16.1 Burderop Down crucible sherd

(0.01-0.04mm) and an even scatter of larger, subangular grains (to 0.4mm). No other inclusions are visible save for rare ragged grains of iron ore and a few threads of white mica.

The writer knows of no white-firing clays in north Wiltshire (Howard, 1981), and it is suggested that the vessel, or the materials from which it is composed, were brought to Burderop from some distance away. Parts of a stone mould valve for casting Stogursey axes were found on the edge of the settlement area. This mould was carved from trachyte, which outcrops in south Wales and the south west peninsular. Unfortunately, the crucible contains no inclusions diagnostic of a particular source. Although both mould and crucible would seem to have been imported to Burderop Down, there is insufficient petrological evidence to confirm a relationship between them.

a. (7) Dainton, Devon.

See Ch III.4

a. (8) Dean Moor, Devon. SX 678655

b. pound (huts and enclosures in rectangular enclosure); 1ha

c. LBA-EIA (post-Trevisker pot)

d. no crucibles or moulds, but pebble of cassiterite and small bead of slag from tin smelting. This could have been brought into hut by accident

on sole of shoe, but in any case indicates presence of smelting facilities nearby

e. Fox, 1957

a. (9) Fengate (Newark Rd), Norfolk. TG 1924

b. part of scattered settlement; ? 30x30m

c. late MBA/early LBA (bronze typology)

d. "small spill" of bronze, almost identical in composition to socketed spearhead tip found 104m to west

e. Pryor, 1980

a. (10) Fimber, Humberside.

See Ch III.3

a. (11) Grime's Graves, Norfolk.

See Ch III.2

a. (12) Gwithian, Cornwall. SW 585415

b. farmstead of 4 small huts with associated field system

c. late MBA-early LBA (bronze typology)

d. stone mould for Stogursey axe (mould catalogue no 6); 4 clay mould fragments, 3 believed to be for swords, 1 for a socketed axe

e. Megaw, Rowlands and Burgess, 1976; Rowlands, 1976

f. The three sherds believed to represent sword mould, and a single sherd of axe mould, were examined macroscopically and in thin section. Inner matrices only are preserved, although the axe and one of the presumed sword mould sherds retain a few flakes of outer wrap material. Faces which have contacted the molten metal are all reduced to medium grey. Outer faces of inner valves are oxidised to pinkish-red (10R 5/6), but the axe mould is reduced throughout. Farfics are all fine, and few inclusions are visible in hand specimen.

Microscopic examination reveals that different pastes were prepared for axe and sword mould production. The anisotropic axe mould matrix contains a medium-low density of inclusions of quartz, potash felspar, and quartzite. A little white mica and a few fragments of micaceous sandstone are observed in the section. The sword mould matrix, on the other hand, is partially isotropic and contains dense, fine, angular

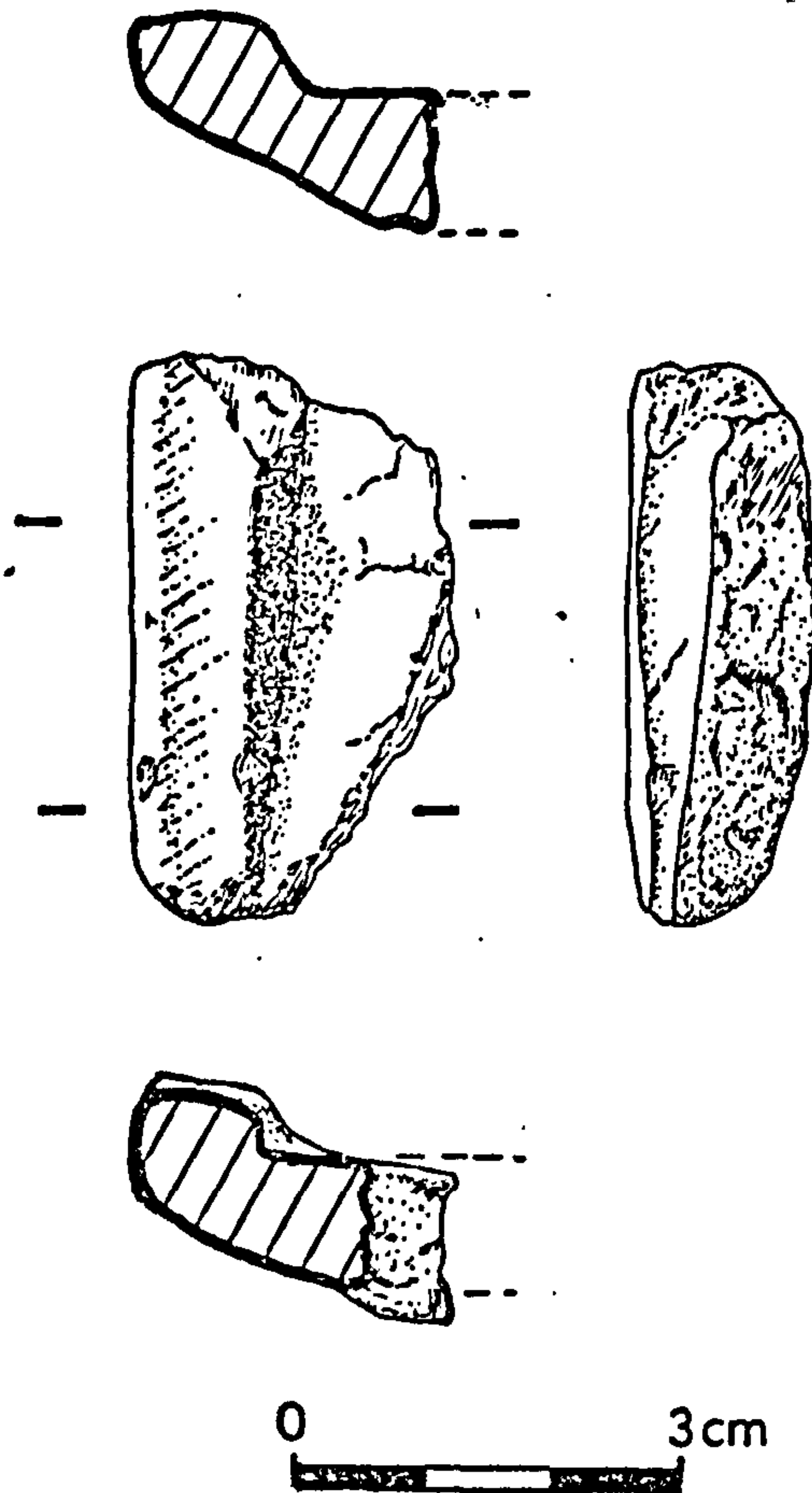


Fig III.16.2 Fragment of clay axe mould from Gwithian

quartz sand. White mica is scattered throughout, and a few grains of quartzite are present. Pale brown amphibole and rounded grains of iron ore are frequent within the matrix. A single, heavily stained, yellowish rock fragment (0.5mm) is tentatively identified as chlorite schist. Aside from this fragment, no inclusions exceed 0.2mm in size.

The fabrics are clearly differentiated by the relative abundance of inclusions. Although neither section contains minerals diagnostic of a particular geological formation, the presence of micaceous sandstone in the axe mould and possible chlorite schist in the sword mould suggests the possibility that different sources were exploited.

- a. (13) Highstead, Chislet, Kent. TR 2166
- b. large subrectangular ditched and banked enclosure
- c. LBA (pot)

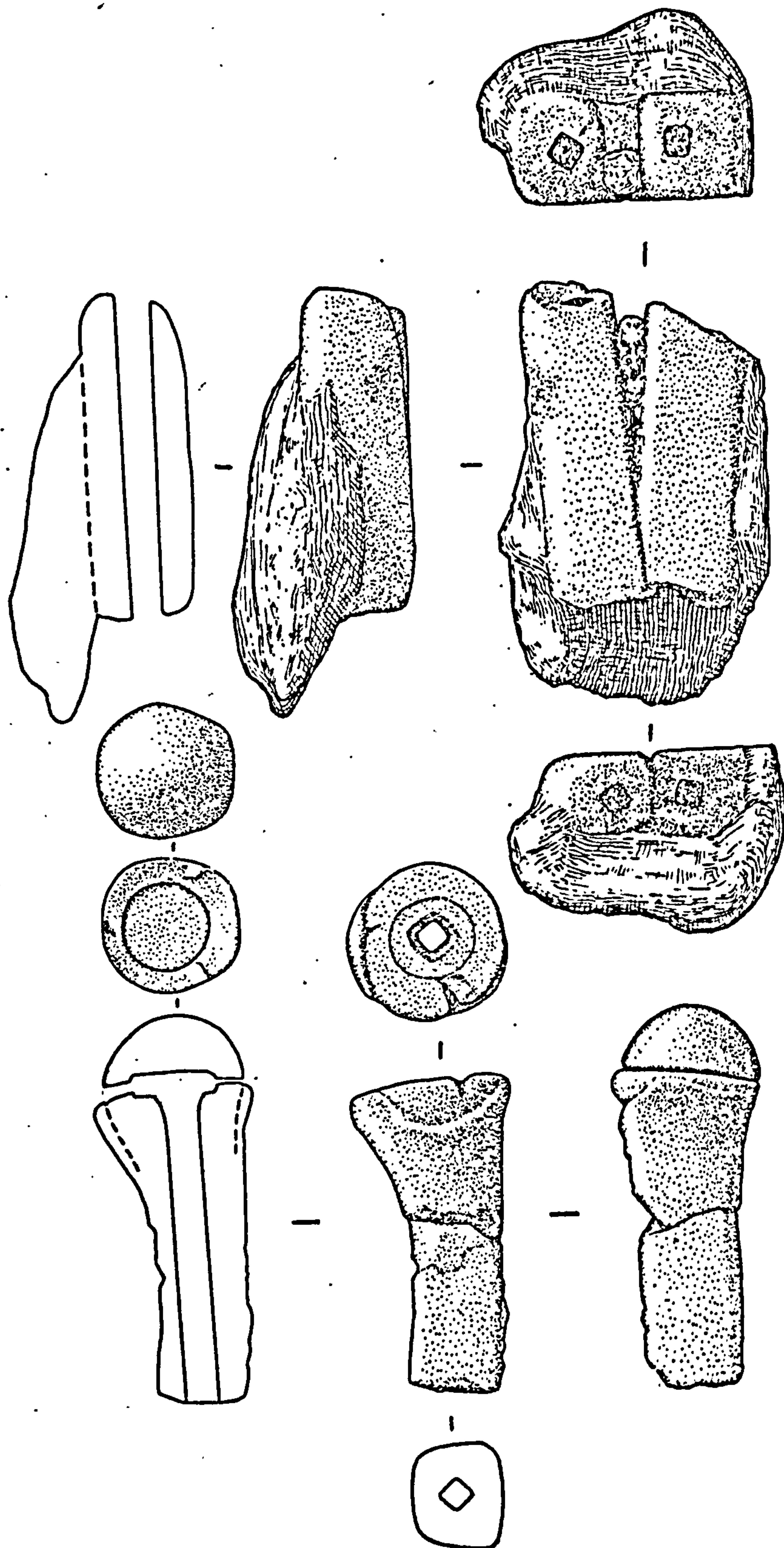


Fig III.16.3 Examples of pin moulds from Highstead
(drawings supplied by S Needham)

d. clay mould for casting pins (fig III.16.3)

e. Champion, 1980, 237 and fig 7

a. (14) Mill Hill, Deal, Kent. TR 3.62509

b. ring ditch with pit, hearth and depression (? hut circle); 50m diam

c. "towards the end of the bronze age" (metalwork typology)

d. piece of clay mould for casting small bronze rings; slag

e. Champion, 1980, 236-37 and figs 4-5

a. (15) Mucking, Essex.

See Ch III.8

a. (16) Potterne, Wilts. ST 996590

b. unenclosed settlement

c. 750-500 bc (pot)

d. vesicular slag from bronzeworking; 5 faceted whetstones

e. Gingell, pers comm

a. (17) Runnymede Bridge, Surrey.

See Ch III.7

a. (18) South Lodge Camp, Dorset. ST 954174

b. ditched settlement

c. EBA to Deverel-Rimbury, possibly 10th C

d. fragment of clay bivalve mould (outer wrap, probably spearhead socket);

fragment of twisted wire, perhaps scrap from ornament making

e. Barrett and Bradley, 1980b, 195; Ritchie, 1969

f. A single refractory sherd, believed to be part of a bivalve mould for

casting a socketed spearhead, was found during the 1977 trial

excavations. Outer wrap only is preserved. The sherd is oxidised

throughout (reddish-yellow: 5YR 6/6), and is composed of a fine,

slightly calcareous clay which appears inclusionless in hand specimen.

The inner, concave face is smooth, but no attempt has been made to

neaten the outer surface.

In thin section, the South Lodge mould is seen to contain a scatter of angular and subangular quartz grains and a little iron ore. Quartz grains are poorly distributed and tend to band, indicating minimal

preparation of the raw material. It is suggested that a local clay in 'as dug' condition was used for this particular outer wrap.

a. (19) Springfield, Chelmsford, Essex. TL 655065

b. settlement of unknown extent

c. LBA (metalwork typology)

d. many fragments of clay sword mould

e. Needham, pers comm

a. (20) Thwing, Humberside. TA 030707

b. circular earthwork; diameter c 100m

c. 950 $\pm$ 70 bc (HAR 1398)

d. bronze droplets and "clinker" (1980); crucible fragments (1982)

e. Manby, 1980; C.B.A. Newsletter and Calendar 6 (1982), 157.

a. (21) Weston Wood, Albury, Surrey. TQ 053485

b. unenclosed small farmstead

c. LBA (pot and loomweights); 510 $\pm$ 110 bc (Q 760)

d. "Very thick pottery which had been subjected to great heat (over 800°C) and might have been crucible, showed no sign of metal under x-ray, when tested by Dr R F Tylecote"; 2 pieces of copper ingot

e. Harding, 1964

a. (22) Woodcutts, Dorset. ST 963181

b. enclosure

c. MBA to 10th century (pot)

d. bronze droplet

e. Barrett and Bradley, 1980b, 196

a. (23) All Cannings Cross, Wilts. SU 080634

b. unenclosed settlement

c. LBA/EIA (pot and metalwork)

d. 2 crucible sherds

e. Cunnington, 1923

f. Two thick (15mm) crucible sherds were recovered at this late bronze age/early iron age site. Both sherds show signs of intense burning, and both are almost completely vitrified. The larger of the 2 sherds is considerably warped and twisted, perhaps as a result of overheating in

use. A small sample was removed for analysis from the least vitrified portion of the large sherd. In thin section, the crucible is seen to be composed of well-sorted (mainly 0.1-0.2mm), subangular quartz sand bound with a small quantity of ferruginous clay. No other inclusions are visible in the isotropic matrix.

Both sherds are derived from vessels of large capacity, and as such are typical of late bronze age crucibles designed to contain sufficient metal for substantial castings. The fabric, however, closely resembles that of many small crucibles of the iron age period. On the basis of the above single analysis, it may be tentatively suggested that (in Wiltshire at least) sand crucibles supplanted melting vessels of clay before the demise of large scale bronze casting. Further material of transitional date is required to test this hypothesis.

a. (24) Alstone, Somerset. ST 312467

b.

c. late IA (pot)

d. "Fragment of small, crude baked clay bowl. Perhaps intended as a crucible of the triangular form ... though no traces of vitreous material remain on it" [dubious]

e. Miles and Miles, 1969

a. (25) Ashville Trading Estate, Abingdon, Oxon. SU 483973

b. unenclosed settlement

c. throughout the iron age (pot and C14)

d. crucibles: 3 fragments, c 40mm thick, coated on outer surfaces with fused and vitrified slag; one piece has a fragment of bronze embedded; 1 piece dated to phase I (6th C), 2 to phase II (3rd C). Slag: 4 fragments of light, vesicular, bronze melting slag

e. Parrington, 1978

a. (26) Ballacagen Lough (A and B), Isle of Man. SC 259685

b. settlement

c. MIA (pot)

d. Site A: 60 fragments and crumbs of round-based crucibles, 20 pieces moulds of "soft clay", possibly used in glassworking (no metal residues). Site B: 3 fragments round-based crucibles, 1 fragment ? flat-based

crucible , 3 fragments of moulds of "hard clay" for ingots
e. Bersu, 1977

a. (27) Ballanais, Isle of Man. SC 255694

b. circular earthwork

c. MIA (pot)

d. "fragments of crucibles and moulds were found in every phase of the occupation layers", although "any such indication as hearths, ash etc of actual working within the houses was entirely lacking ... the fragments found within the houses are clearly displaced and may even have been picked up and brought in by children as playthings"; 1 ? flat-based crucible sherd, 12 fragments of "soft clay" moulds

e. Bersu, 1977

a. (28) Balksbury, Hants. SU 350445

b. univallate hillfort; c 20ha

c.

d. "small lump of copper or bronze slag"

e. Wainwright, 1969

a. (29) Beckford, Hereford and Worcs.

See Ch III.10

a. (30). The Berth, Shropshire. SJ 429237

b. hillfort; 3ha+

c. M/LIA (pot and metalwork)

d. 1 crucible sherd with possible lug

e. E Morris, pers comm

a. (31) Bredon Hill, Glos. SO 958400

b. hillfort; c 10ha

c. 1st C BC (pot)

d. bronze smelting floor behind rampart; quantities of brittle bronze slag obtained from surrounding ash and charcoal

e. Hencken, 1938

a. (32) Breedon-on-the-Hill, Leicestershire. SK 406234

b. MIA (pot)

c. MIA (pot)

d. half of small, three-cornered crucible; ware hard, light grey with white grits, mainly small but some larger, surface hard and sandy

e. Kenyon, 1950

a. (33) The Breiddin, Powys.

See Ch III.9

a. (34) The Caburn, East Sussex. TQ 444089

b. hillfort

c. 3rd-1st C BC (pot)

d. pit 97 (at edge of settlement) yielded much ironworking debris and

"several fragments of crucibles, some of which were stained green with copper"; other crucible fragments in pits 90, 108A and 109; round, flat disc of lead interpreted as ingot

e. Curwen and Curwen, 1927

a. (35) Caistor-by-Norwich, Norfolk. TG 230035

b. town

c. 1st C BC

d. lost wax clay mould for pins or awls, razor-type object, fibulae,

bracelets, spatula or toilet article; "In one or two of the fragments there were marks of pieces of straw-like material, but in the main the moulds had been made from fairly pure clay free from carbonaceous or gritty material". Crucibles: majority of Type 2, coarse, black, highly porous, coke-like ware, mostly typical hemispherical Roman forms; 2 sherds of Type 1, fine, thin, dark-grey ware of high density, 1 sherd of IA triangular shape. Drops of bronze and melting slag

e. Tylecote, 1969

a. (36) Camerton, Somerset. ST 692566 (area)

b. enclosed settlement

c. EIA

d. "constant occurrence of iron slag and bronze dross"; between

Peasedown St John and Shoscombe Vale, "several fragments of crucible were also recovered in which bronze had been melted ... The bronze dross still adhered to the crucible fragments"

e. Wedlake, 1958

a. (37) Candlestone Castle, Mid Glamorgan. SS 8676

b. ? hillfort (only surface finds from settlement complex that may include Merthyr Mawr Warren - catalogue no 65)

c. LIA

d. 1 almost complete crucible and crucible sherds

e. unpublished, National Museum of Wales

f. A single crucible sherd from this site was analysed, essentially

for comparison with those from nearby Merthyr Mawr Warren. The Candlestone crucible is reduced throughout, and partially vitrified on its inner face. The fabric feels extremely sandy, and dense fine quartz grains are clearly visible in hand specimen. A sand fabric was revealed in thin section. The isotropic matrix contains 70% fine quartz, with occasional fragments of quartzite (to 0.1mm) and very rare grains of feldspar. This crucible is in all ways similar to those from the neighbouring site, and the same, or closely related sources would seem to have been exploited.

a. (38) Carloggas, St Mawgan in Pyder, Cornwall. SW 874645

b. hillfort; c 120m diameter

c. LIA: earliest occupation in early 1st C AD (pot)

d. north-east of inturned rampart at north west entrance, Hut A contained lumps of partially reduced tin ore, droplets of bronze, pieces of crucible and, nearby, a small ingot of bronze and a folded piece of scrap bronze; also 2 shallow, charcoal-filled hollows. In other huts, tin slag and bronze droplets

e. Thriepland, 1957

f. Only 2 very small crucible sherds from this site could be located in the county museum, Truro. One of these (from a pit fill) was analysed together with 4 formless fragments of heavily slagged fired clay. The crucible sherd is derived from a thin-walled vessel (maximum thickness 5mm) and is lightly slagged on all faces. In fresh fracture, the sandy fabric is white in colour, and partially vitrified.

Under the microscope the crucible is seen to have been formed from fine sand bound with a small proportion of white-firing binding clay. Naturally bonded white moulding sands are known at several locations along the north coast of Cornwall (Reid and Scrivenor, 1906, 63, 86), and a sample of St Agnes sand was analysed for comparison with the crucible sherd. Binding material in the sand sample is more prolific than in the

archaeological sherd, and furthermore the St Agnes sand contains numerous detrital grains, none of which can be seen in the Carloggas crucible. A similar but less clay-rich deposit would seem to have been exploited by the iron age refractory makers.

The 4 oxidised, slagged sherds analysed may have had some connection with metalworking, but their purpose is unclear. The fabrics are refractory, consisting of abundant quartz sand and occasional fragments of slate and quartzite set in a ferruginous, slightly micaceous clay matrix. Clearly, different sources were exploited for the production of crucibles and these unidentified artefacts.

a. (39) Carn Euny, Cornwall. SW 402289

b. round and fogou

c. pre 400 BC - mid 1st C AD (pot)

d. cassiterite pebbles and iron slag

e. Christie, 1967

a. (40) Castle Ditches, Llancarfan, South Glamorgan. ST 059700

b. hillfort; c 4ha

c. 1st C BC

d. 1 small crucible rim with slag adhering, 1 casting runnel, 1 small lump of earthy slag

e. Hogg, 1977

a. (41) Castle Dore, Cornwall. SX 104547

b. hillfort; 75m diameter

c. 3rd C BC - 1st C AD (pot)

d. "fragments of crucibles were found in several places in the interior";

"partly smelted tin and slag" and "tin ore" [possibility of medieval origin for at least some of these finds]

e. Radford, 1951

a. (42) Chun Castle, Cornwall. SW 405339

b. walled settlement; c 55m diameter

c. 2nd - 3rd C BC

d. large oval cake of tin slag from floor of hut; behind hut, furnace of stone slabs thought to be originally c 50cm high, with 3 fire holes

connected to each other with a fourth flue, surrounded by much charcoal and a small quantity of slag

e. Leeds, 1927

a. (43) Castle Gotha, Cornwall. SX 027496

b. round; 0.6ha

c. 2nd C BC - 400 AD (pot; also LBA pot under bank)

d. hut G: "part of what is probably an ingot-mould" incorporated in stone floor paving. Ditch fill: half of bivalve mould ? material for bracelet which "would have been a simple one, penannular with knobbed terminals; a type which has iron age parallels". 2 hearths, each with large slab of slate with semi-circular notch, compared to slab in smith's hut at Carloggas (Threipland, 1957, 43). Pebble of stream tin inside one hut

e. Saunders, 1961; 1963

a. (44) Close ny Challyagh, Scarlett, Isle of Man. SC 245671

b. promontory fort; c 25 m diameter

c. 1st C BC - 1st C AD (metalwork)

d. 3 crucible fragments

e. Gelling, 1958

a. (45) Chysauster, Cornwall. SW 473350

b. unenclosed settlement; 150x150m

c. 50 BC - AD 50 (pot)

d. large pebble of rich tin ore in House 5, but such ore locally abundant, and thus not evidence of tin working; earlier 19th C find of metal in House 6 "though not sufficiently fused, had clearly passed through the fire. From this fact it may be inferred that ... smelting had been carried on"

e. Hencken, 1933

a. (46) Crickley Hill, Gloucestershire. SO 927161

b. hillfort; c 3.6ha

c. EIA

d. 2 crucibles with traces of copper alloy, found with Roman sherds; may not be connected with IA occupation

e. Dixon, 1972

- a. (47) Croft Ambrey, Hereford and Worcester. SO 445668
- b. hillfort; 2.2ha, enlarged to 3.6ha
- c. 550 bc - Roman conquest (C14)
- d. 3 possible crucible sherds: only the rim sherd from site I is slagged, the identification of the other 2 being in doubt
- e. Stanford, 1974

- a. (48) Danebury, Hampshire. SU 324376
- b. hillfort; 5ha
- c. 6th - end 2nd C BC
- d. crucibles, tuyère and iron slag
- e. Cunliffe, 1976b
- f. Only 8 possible refractory sherds have been identified at Danebury.

Of these, 7 were believed by the excavators to be bronzeworking crucibles, whilst the function of the eighth was doubtful. All sherds are sandy and show varying degrees of vitrification. All save DAN 7 contain tiny rounded voids which react with dilute HCl, indicating the leaching out of carbonate inclusions. Rare specks of soft chalky material are visible in some sherds.

In thin section, all crucible sherds are seen to contain a high tenor of quartz sand, occasional rounded grains of iron ore and extremely rare fragments of chalk set in an isotropic matrix. Textural analysis results suggest that the Danebury crucibles may be divided into 2 fabric groups (Table III.16.1). Fabric 1 (DAN 6, 7) is fine textured with more than 80% of grains measuring 0.04mm or less. This fabric contains c 75% quartz sand. Fabric 2 (DAN 3, 9) is coarser, and sand grains are less well sorted. Grain density in Fabric 2 varies from 65 to 87%.

The unidentified sherd (small find no 1715) is thick walled, curved and heavily slagged. Two samples were thin sectioned, one from close to the slagged outer face, and one from the friable oxidised inner area. The 'outer' sample DAN 1b is completely vitrified, and penetrated with reddish-black slag. The 'inner' sample DAN 1a contains 68% of ill sorted grains of quartz and chalk set in an anisotropic matrix. Iron ore is common. The form, the low temperature achieved at the inner face, the presence of considerable chalk and poor mixing of the constituent raw materials all suggest that this sherd be identified as tuyère. However,

whether this tuyère was used for bronzeworking or iron forging is uncertain.

Heavy mineral separations were performed on the tuyère (DAN 2) and a Fabric 2 crucible sherd (DAN 3a). Both samples yielded similar heavy mineral residues, being dominated by a high proportion (to 38% of the total residue) of subangular fragments of white and purplish ilmenite and its alteration product, leucosene. Zircon and rutile occur in about equal quantities (to 28% in each sample). Elongated and rounded grains of both foxy red and yellow-brown rutile are visible in DAN 2, but the yellow variety is absent from DAN 3a. Rare grains of andalusite (1 grain only visible in DAN 3a) garnet and barytes are also present. All these minerals have been found to occur in the Lower Eocene deposits of southern England, including the Reading Beds and the London Clay, both of which outcrop within 10km of Danebury (Boswell, 1916). A local source, therefore, may be postulated, although the high proportion of ilmenite and leucosene, diagnostic of certain localised deposits of titaniferous sands, indicate that a source further afield cannot be ruled out.

Insufficient Fabric 1 material was available for heavy mineral separations to be carried out on this group, so that the question of origin must remain, for the moment, in doubt. However, the obviously different paste preparation between the fabric types suggests that the group samples analysed were either made in separate localities, or were made by different manufacturers according to different technical traditions.

sample number	small find number	identification
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DAN 1a	} 1715	tuyère: inner surface
DAN 1b		tuyère: outer, glazed surface
DAN 2		tuyère: heavy mineral slide
DAN 3	} 1716	crucible(s) (2 fragments)
DAN 4		
DAN 3a		DAN 3a = heavy mineral slide, frag DAN 3
DAN 5	} 1717	crucible(s) (2 fragments)
DAN 6		
DAN 7	1718	crucible
DAN 8	1719	crucible
DAN 9	3105	crucible

- a. (49) Danes Camp, Conderton, Worcester. SO 971384
 - b. small hillfort
 - c. M/LIA (pot)
 - d. 1 thin and very fused crucible rime sherd in Birmingham Museum
 - e. E Morris, pers comm; Thomas, 1959
-
- a. (50) Dragonby, Lincolnshire. SE 905138
 - b. oppidum;
 - c. LIA
 - d. "traingular crucibles are well represented ... and there is some slag"
 - e. May, 1970
-
- a. (51) Eldon's Seat, Dorset. SY 939776
 - b. open settlement; c 5000 sq m
 - c. LBA - LIA (pot)
 - d. 1 crucible sherd identified by writer among LIA pottery; thin-walled, sandy, grey
 - e. Cunliffe, 1968
-
- a. (52) Fengate, Norfolk. TG 1924
 - b. open settlement
 - c. LBA/EIA (pot)
 - d. 2 fragments of bronze casting waste, pit D (early phase); mould runner, pit S; fragmentary bronze socketed axe
 - e. Hawkes and Fell, 1945
-
- a. (53) Glastonbury Lake Village, Somerset.
See Ch III.12
-
- a. (54) Goffs Park, Crawley, Surrey. TQ 258353
 - b. ? open settlement; c 8ha
 - c. MIA (pot)
 - d. "small clay crucibles"
 - e. Gibson-Hill, 1974
-
- a. (55) Gussage All Saints, Dorset.
See Ch III.13

a. (56) Ham Hill, Somerset. ST 478170

b. hillfort; 6ha

c. LIA (pot)

d. crucible C1, fragment with part of outer face "much glazed", and bronze slag, both in cutting X

e. Gray, 1924; 1925; 1926

a. (57) Hawk's Hill, Fetcham, Surrey. TQ 155554

b. open settlement

c. EIA - LIA (pot)

d. "fragments of a possible crucible from pit 11" (EIA)

e. Hastings, 1965

a. (58) Hembury, Devon. ST 112031

b. hillfort; c 5ha

c. IA

d. cutting XXXIV: tuyère and slag; 1 crucible sherd (uncontexted) found by writer during thorough search through pottery (fine grey ware, sandy, pointed rim)

e. Liddell, 1930; 1931; 1932; 1935

a. (59) Hengistbury Head, Dorset. SZ 170908

b. small settlement at first, major trading port in 1st C BC

c. 6th C BC to AD 43 (pottery and metalwork)

d. crucibles; copper cake and fragments of copper cake; droplets of metal waste, and casting ingate; "lumps" of coins may indicate presence of a mint

e. Bushe-Fox, 1915; Cunliffe, 1978b

a. (60) Hunsbury, Northants. SP 738583

b. hillfort; 1.7ha

c. 4th - 1st C BC (pot)

d. crucibles: 9 possible, 1 definite (complete)

e. Fell, 1936; George, 1917

a. (61) Llanmelin, Gwent. ST 460925

b. hillfort; 3ha

c. foundation c 200 BC (pot)

- d. part of triangular clay crucible, with traces of fused bronze
- e. Nash-Williams, 1933

- a. (62) Long Wittenham (Pearith's Farm), Berks. SU 540924
- b. ? farmstead (rubbish pit)
- c. EIA (pot)
- d. complete crucible; "its hard and rough walls are exceptionally thick"
- e. Savory, 1937

- a. (63) Maiden Castle, Dorset. SY 669884
- b. hillfort; 6 ha
- c. throughout IA
- d. 4 vessels believed to be crucibles illustrated by Wheeler; Atkinson found "a few globules of fused bronze" in a small hearth
- e. Atkinson, 1953; Wheeler, 1943
- f. All three "crucibles" illustrated by Wheeler in fig 119 (1943) were examined by the writer in hand specimen. No mould or other crucible sherds have been located, but time prohibited a thorough search through all ceramic artefacts from the site. Wheeler's "crucible 3" was rejected as a refractory on the basis of hand-specimen inspection. This poorly formed vessel was made from a fine, red-firing (5YR 6/6 - 2.5YR 4/8), smooth clay containing a little chalk. The form, the nature of the fabric, the lack of preparation and careless surface finish, all combine to suggest that this artefact be better identified as a non-refractory pot of unknown function.

Wheeler's crucibles 1 and 2, on the other hand, appear highly refractory, but are more appropriately seen as round-based, rather than flat-based vessels as illustrated (fig III.16.4). Both these large sherds are reduction fired throughout their 20mm thickness. Both exhibit a layered structure, but lack of slagging suggests that this reflects original forming processes rather than relining during use. Sand grains only are visible with a 10x lens. A small sample for analysis was cut through all the layers of crucible 1.

Individual layers cannot be discerned in thin section. Under the microscope, the Maiden Castle crucible is seen to contain 62% of well sorted subangular quartz sand) more than 50% of the grains measure

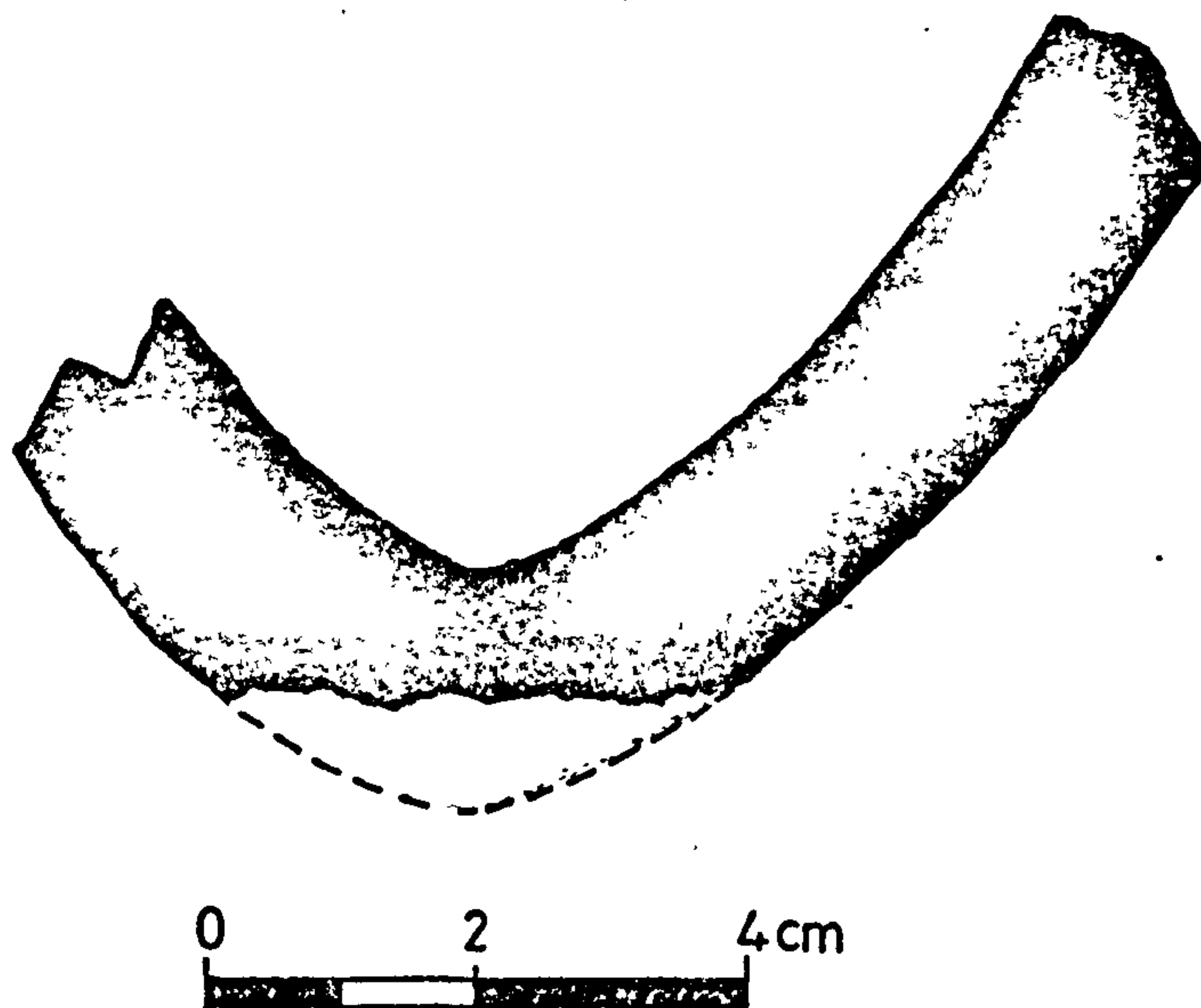


Fig III.16.4 Maiden Castle: section through crucible 1, showing rounded base.

0.14-0.35mm) set in a partially isotropic clay matrix. The yellow-brown colour of anisotropic zones suggests that a ferruginous clay was used, and that nearby Bagshot Beds refractory sands (naturally bonded with white-firing ball-clays: Reid, 1898) were not exploited for crucible making at Maiden Castle.

a. (64) Meare Lake Village, Somerset.

See Ch III.11

a. (65) Merthyr Mawr Warren, Glamorgan. SS 862768

b. settlement of unknown character

c. 4th - 1st C BC

d. "mound of the crucibles" produced 44 crucible fragments, and bronze drops and jets

e. Fox, 1927

f. Two crucible sherds were examined by the writer, together with two heavily slagged tuyère or furnace fragments, and a single potsherd. Crucibles are reduced, thin-walled (8mm maximum thickness) and compact. Dense, fine quartz sand is clearly visible in the slagged rim-sherd MMW 1. The furnace or tuyère fragments (MMW 2, 3) are oxidised (2.5YR 5/8) away from slagged, vitrified faces. These sherds are coarser than the crucibles and contain a scatter of larger inclusions.

Differences observed in hand specimen are confirmed through microscopic examination. Crucible sherds MMW 1 and 4 are seen to be composed of c 75% of fine quartz sand. Occasional small grains of quartzite and altered potash and plagioclase felspar are observed in both sections. Sand inclusions are sparser (48%) in MMW 3, which contains ragged clay pellets and a scatter of iron ore. No unvittrified material could be removed from MMW 2 for analysis. The potsherd MMW 5 contains a medium density of matrix quartz and is tempered with large (to 1.5mm), subangular grains of acid igneous rock composed of quartz, potash felspar and a little chlorite.

a. (66) Mucking, Essex.

See Ch III.8

a. (67) Old Oswestry, Shropshire. SJ 2929

b. large hillfort

c. beings in EIA

d. crucible with lug (analysis of slag indicates use of zinc alloy)

e. Savory, 1980; Varley, 1950

a. (68) Pen Dinas, Llanaber, Gwynedd. SH 606208

b. hillfort

c. IA

d. 1 crucible fragment, found in 1980 amongst finds from Crawford's excavations

e. E Morris, pers comm

a. (69) Porthmeor, Cornwall. SW 438372

b. round, enclosing courtyard houses and hut circles; c 0.5ha

c. 50 BC - AD 50

d; several pieces of tin in courtyard house 2; one piece and ? slag in courtyard house 1

e. Hencken, 1933; Hirst, 1937

a. (70) Redmore, St Austell, Cornwall. SX 0152

b. ?

c. EIA

d. La Tène I fibula in Sir John Evans' collection had note attached which read: "Found at Redmore St Austell in Cornwall under 6' of peat and 20" of river gravel. Beneath the sand lay another deposit of peat 2½' in thickness which had been partially cut as fuel. Mixed with the cut blocks of this second peat deposit were the remains of a smelting hearth and pieces of tin slag"

e. Leeds, 1927, 236

a. (71) Ruckstalls Hill, Hants. SU 651515

b. open farming settlement; 80x120m

c. late MIA (period I) to Roman (period III)

d. copper or bronze slag in period I ditch; 2 unstratified concentrations of bronze/copper slag on surface

e. Oliver and Applin, 1979

a. (72) Runcton Holme, Norfolk. TF 619099

b. ? (gravel quarry)

c. E/MIA

d. "considerable quantity of pottery of iron age A2 and AB types, loom weights, firebars, crucibles etc"

e. Clarke, 1940, 93

a. (73) Salmonsbury, Gloucestershire. SP 173208

b. multivallate "hillfort" (on valley bottom); 21ha

c. 4th C BC - 1st C AD (pot)

d. 4 or 5 crucible sherds and ? furnace/tuyère

e. Dunning, 1976; O'Neil, 1977

f. Four certain and two possible crucible sherds and a "furnace" fragment were examined by the writer in hand specimen and thin section. Several fragments of daub, pottery and "fired clay" were also examined for comparison with the refractory debris. Crucible sherds vary in thickness from 6mm (SB 18) to 15mm (SB 19). All are reduction fired, and all, save the 2 uncertain sherds SB 20a and 20c, are slagged. Bright green copper oxides are seen to have penetrated the body of SB 18. Fabrics vary from sandy and very fine-textured (SB 18, 20b and the uncertain sherd 20a), to coarse and porous (SB 19, 21). Both coarse sherds contain a scatter of subangular, medium-hard, white inclusions which react strongly with dilute HCl. The formless sample SB 22 is oxidised and heavily slagged in

one area. This sherd may well represent furnace, or perhaps tuyère.

In thin section, three crucible fabrics are clearly distinguished. Fabric 1 (SB 18) contains only dense fine quartz sand; Fabric 2 (SB 20c, 21) contains 60% of slightly coarser sand and rare inclusions of limestone; Fabric 3 (SB 19) contains medium dense quartz sand with abundant grains of cryptocrystalline limestone. Scattered fragments of carbonaceous material also appear in this fabric, but uneven distribution suggests these may be residual in the clay.

The "furnace/tuyère" sherd SB 22 also contains a medium density of quartz, and is otherwise inclusionless. None of the remaining examined clay artefacts from the site resemble the refractory fabrics in composition. Daub fragments are either inclusionless save for occasional grains of limestone or contain variable amounts of quartz sand (density never approaches that present in the refractory sherds). the three potsherds examined are all tempered with abundant fossil shell.

sample number	excavation number	identification
SB 1	863.92	daub
SB 2	863.92	daub
SB 3	863.91	unidentified fired clay
SB 4	863.84	daub
SB 5	863.81	pottery
SB 6	863.69	daub
SB 7	863.62	unidentified fired clay
SB 8	863.59	pottery
SB 9	863.48	daub
SB 10	863.48	daub
SB 11	863.48	daub
SB 12	863.26	daub
SB 13	863.24	unidentified fired clay
SB 14	863.24	unidentified fired clay
SB 15	863.22	daub
SB 16	863.14	pottery
SB 17	855.4	unidentified fired clay
SB 18	855.9	crucible rim
SB 19	855.5	crucible base
SB 20a	855.4	unidentified, rejected as crucible
SB 20b		crucible wall sherd
SB 20c		probable crucible wall sherd (unslagged)
SB 21	855.1	crucible rim
SB 22	855.2	furnace/tuyère

a. (74) South Cadbury, Somerset.

See Ch III.14

a. (75) Studland Bay, Dorset. SZ 036826

b. open settlement

c. early 1st C AD (pot)

d. fragments of 3 crucibles

e. Field, 1965

a. (76) Sutton Walls, Hereford and Worcester. SO 522463

b. hillfort; 12ha

c. late IA/early Roman

d. complete crucible from Area I, Pit 2, Period IV: "the paste is light grey in colour, and well-levigated with a few micaceous specks. A skin of molten bronze adheres to one side". A second fragmentary crucible has recently been found amongst the pottery.

e. Kenyon, 1953; E Morris, pers comm

a. (77) Swallowcliffe Down, Wilts. ST 968254

b. settlement enclosed by ditch

c. E/MIA

d. bronze slag in Pits 33 and 46

e. Clay, 1925

a. (78) Trevelgue, Cornwall. SW 825632

b. promontory fort

c. LBA and M/LIA (pot)

d. clay crucibles and bronze slag

e. Dunning, 1949

a. (79) Trevisker, Cornwall. SW 888687

b. 2 circular house, ancilliary structures and ditches; 250 sq m

c. 1110 bc $\pm$ 95 (NPL 134)

d. bronze dross or waste metal from posthole a.83 in house A (several lumps); 2 cassiterite pebbles from posthole a.80 in same house

e. ApSimon and Greenfield, 1972

- a. (80) Uley Bury, Gloucestershire. ST 784989
- b. multivallate hillfort; 6ha
- c. LIA
- d. quantities of slagged fired clay and 1 ? crucible sherd
- e. Saville and Ellison, forthcoming
- f. Some 200gm of industrial waste believed to be derived from metalworking were recovered at Uley Bury. These debris included a considerable quantity of heavily slagged, formless fired clay, and 2 possible fragments of bronzeworking crucibles, P66 and P207. Eight samples were selected for analysis including the two putative crucible sherds and six samples of slagged clay. The "crucible" fragments only are described here. A full report by the writer on the Uley Bury refractories will appear in Saville and Ellison, forthcoming.

Sample P66 (UL7), possibly a rim sherd from a triangular crucible, is hard-fired and brownish-grey in colour. The fabric is markedly vesicular, and contains in addition to fine sand, a scatter of soft, deep brown, rounded inclusions, and occasional flecks of silvery mica. Tiny white, effervescent grains are present, though rare. Sample P207 (UL 8), tentatively identified by the excavator as a crucible body sherd, is exceptionally friable, pinkish brown in colour (10R 5/6), and is characterised by a scatter of rounded and elongate carbon inclusions. The fragment has a laminated structure and appears to have been formed from poorly mixed clay.

In thin section, UL7 bears a strong resemblance to the "furnace" samples from Uley Bury, and contains abundant well-sorted quartz grains, a little residual carbonated, rare mica, and a scatter of opaque iron ore. The presence of rounded, brown argillaceous pellets and large elongate voids differentiates UL7 from the furnace samples. No slag attack or slaggy minerals are visible in the section.

Sample UL8 is devoid of matrix quartz, and contains an uneven scatter of greyish oolitic limestone showing a concentrically banded structure, and elongate and platy fragments of fossil shell. Reddish-brown iron ore particles occur throughout.

Although similar in grain size and density to the furnace remains

(all adequately refractory for bronze casting), sample UL7 also contains pellets of argillaceous material and irregular voids, indicating a somewhat different technology. The uneven shape and distribution of these voids suggest poor clay preparation rather than the deliberate addition of organic filler, since burnt out. The form of this rim sherd (UL 7) and the refractory nature of the material suggest that this artefact may well have been intended as a bronze melting vessel, but inferior clay preparation combined with careless forming militate against its successful deployment in this capacity. Refractories which have failed because of poor raw material selection or preparation are not unknown in British contexts (see for example III.7 above), and it is suggested that UL 7 may represent such a failure.

The artefact represented by UL 8 is most unlikely to have had any connection with metalworking. This poorly worked clay is rich in carbonate and lacks silica, and would not have resisted high temperatures or thermal shock. The paste resembles Uley Bury pottery Fabric 2 (identified by E Morris, pers comm) and is of local origin. The function of this artefact is unknown. It is too friable for pottery and may, perhaps, represent burnt daub.

a. (81) Walesland Rath, Dyfed. SM 915173

b. fortified farm; 64x48m

c. Phase I: 210 ± 90 bc (NPL 245)

Phase II: 85 ± 90 bc (NPL 244)

d. Phase I: layer of charcoal against inner edge of bank near south east entrance contained fragments of 7 crucibles; beneath this layer, more crucible fragments.

Phase II: south ditch terminal contained thick layer of ash on primary silts, with crucible fragments and some slag.

e. Wainwright, 1971

f. More than 30 crucible sherds were recovered at Walesland Rath, including one reconstructable vessel. Heavily slagged, baked clay fragments, believed to represent tuyère, were also found. All material from the site was examined by the writer in hand specimen, and seven sherds were selected for more detailed inspection.

Crucible sherds WR 1, 4 and 5 are slagged and reduced throughout, and

display textural differences ranging from coarse (WR 1), through rough and platy (WR 5), to fine and compact (WR 4). These three sherds appear inclusionless in hand specimen, save for a single carbon fragment visible in WR 4. The 15mm thick rim sherd WR 7 is partially oxidised (7.5YR 7/4), and appears to have been refurbished with a layer of fine clay during its period of use. Large grains of quartz are clearly visible in WR 7. The formless "tuyère" fragment (WR 3) is completely oxidised (colour variable) and very friable.

Thin section analysis reveals that crucibles at Walesland Rath were formed from quartz sand with a small proportion of binding clay. No carbon appears in any of the crucible sections. Grain size is generally very fine, save in WR 7, which is composed of tightly packed, subrounded larger quartz sand (mean grain size in WR 1 and 5: 0.03mm; WR 7: 0.23mm). No other inclusions are present in any of the crucible fabrics. The "tuyère" (WR 3) again contains quartz, but the density is lower than in the crucibles, and argillaceous pellets indicate different preparation methods. Potsherd WR 6 is characterised by angular fragments of igneous rock temper, rich in feldspar and pyroxene.

sample number	excavation number	identification
WR 1	71.33H/36	crucible rim
WR 2	68I.ZA 173/023 (3)	pottery (not sectioned)
WR 3	71.33H/36	? tuyère
WR 4	68I.159/013 (45)	crucible lip
WR 5	71.33H/36	crucible wall sherd
WR 6	68I.PZ 146/029 (3)	pottery
WR 7	71.33H/36	crucible rim (relined)

a. (82) Weelsby Avenue, Grimsby, Lincolnshire.

See Ch III.15

a. (83) Winklebury, Hants. SU 613529

b. hillfort; 7.6ha

c. 3rd - 1st C BC (hollow 2779)

d. 1 fragment of crucible, reconstructed a triangular in shape, from "working hollow" 2779; "other much smaller fragments of crucible fabric

also occurred in some quantity". From the same context as the crucible, came a bronze ingot (14.2gm), with c 15% tin equivalent and negligible lead content

e. Smith, 1977

a. (84) Wookey Hole, Somerset. ST 532480

b. occupation in cave; c 30m long

c. 2nd C BC - 1st C AD (pot)

d. "a little crucible of clay, 1½ in. in diameter ... it appears ... to be unused". Ingot of tin (34%), lead (38.5%) and impurities (27.5%); 'another lump of alloy of the same metals, obviously the result of pouring from a crucible' (tin 16.5%, lead 70%, impurities 13.5%); also "a little ingot of tin with lead"

e. Balch, 1913; Balch and Troup, 1911

*

*

*

Late iron age sites with coin moulds and other minting evidence

no	site	grid ref	reference
85	Bagendon, Gloucs	SP 017062	Clifford, 1961
86	Braughing, Herts	TL 395240	Jones et al, 1976
87	Colchester, Essex	TL 987253	Hawkes and Hull, 1930
88	Gatesbury Wood, Herts	TL 3924	Partridge, 1981
89	Needham, Norfolk	TM 2281	Frere, 1941
90	Old Sleaford, Lincs	TF 0645	Jones et al, 1976; Tylecote, 1962
91	St Albans, Verulamium, Herts	TL 125065	Frere, 1957; 1958; 1980
92	Silchester, Hants	SU 639624	Boon, 1954
93	Thetford, Norfolk	TL 825899	Linton and Bayley, 1982

The crucibles from Thetford (catalogue no 93)

The crucibles vary considerably in size. The smallest class (55mm high, 47mm in diameter, wall thickness 8mm) would have held up to 22cc of molten bronze. Slightly larger crucibles are 70mm high, and 60mm in diameter, with walls 10mm thick. The brim-full capacity of this class would have been c 40cc. Insufficient remains of the largest Thetford crucibles to permit reconstruction, but the 16mm wall thickness indicates

a large capacity (Linton and Bayley, 1982). Hand specimen examination of several of the reduced, sandy crucible sherds suggested a correlation between coarseness of texture and crucible size. Sherds representing each of the three size classes were sectioned to test for textural variation.

In thin section, all three Thetford crucibles are seen to consist of a high tenor (average 68%) of subrounded quartz sand set in an isotropic clay matrix. Textural analysis was performed on THT 1 (small class) and THT 3 (medium class). A clear difference in sand grade is observed between the two sectioned crucibles, but more samples would be required to test for discrete groups. Quartz sand grains present in THT 2 (large class) appear much larger overall than in the two measured sections, but a less vitrified sample is needed for accurate determination of the size range. All Thetford crucibles contain a scatter of tabular carbon, and the even distribution of this material suggests deliberate addition. A single grain of flint is present in THT 2, and all samples contain rare detrital grains, indicating a glacial origin for the sand.

[illegible]

TABLE III.16.1 Grain size statistics

SITE	DA OBJECT	SLIDE	Z	NO. OF PHI																STD		
				GR: GRAINS																	DEV	
				MAT																		SIZE
				0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
SALMONSBJR IA CRUCIBLE																						
				21	60	93	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
				N SLIDES																		
				N GRAINS																		
						1																
						93																
THETFORD IA CRUCIBLE																						
				1	71	85	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
				3	65	108	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
				N SLIDES																		
				N GRAINS																		
						2																
						193																
ULEYBURY IA CRUCIBLE																						
				1	61	51	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
				2	999	67	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
				3	49	63	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
				4	63	62	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
				6	999	67	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
				7	48	76	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
				N SLIDES																		
				N GRAINS																		
						6																
						386																
WALES 2A14 IA CRUCIBLE																						
				1	77	71	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
				5	75	84	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
				7	77	77	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
				N SLIDES																		
				N GRAINS																		
						3																
						232																
				N																		
				N																		
						3																
						232																
				N SLIDES																		
				N GRAINS																		
						3																
						232																

TABLE III.16.1 (continued)

III.16.2 Catalogue of later bronze age stone and bronze moulds
from southern Britain

The moulds are arranged alphabetically by findspot (stone A-Z; bronze A-Z). Entries follow a standard format:

- a. findspot, county, national grid reference
- b. context
- c. object(s)
- d. matrix type (ie object(s) cast)
- e. material
- f. reference(s)
- g. comments

*

*

*

- a. (1) Abermâd, Llanychaiarn, Powys. SN 603761
- b. dredged from river bed
- c. one valve, very worn condition
- d. socketed chisel with simple collar
- e. "fine gritstone"
- f. Savory, 1980, 125; fig 40

- a. (2) Bulford (Nine Mile Water), Wiltshire. SU 1844
- b. uncontexted
- c. single block, 2 matrices
- d. socketed axes, Stogursey type
- e. "it proves to be trachytic in composition. That is, it comprises essentially sodic alkali feldspar with iron oxide as the principal accessory mineral. It is probably a member of the keratophyre suite" (A Wooley, quoted in Needham)
- f. Needham, 1981, 12-15)

- a. (3) Burderop Down, Wiltshire. SU 168764
- b. surface find, just outside limits of bronze age settlement area
- c. 3 joining fragments of single mould valve; 1 matrix
- d. socketed axe; Stogursey type
- e. syenite or coarse keratophyre
- f. Needham, 1981, 10-12

a. (4) Chidbury Hill, Nottinghamshire.

b. unknown

c. "3 moulds"

d. [apparently socketed] axes

e. casts in Dover Museum; originals of "granite"

f. Brent, 1879

a. (5) Everley Water Meadow, Dorset. ST 861115

b. excavated 1982, from pit also containing charcoal, slag, burnt flint, animal bone and pottery

c. 1 valve fragment

d. socketed axe; type unknown

e. ? trachyte (macroscopic identification)

f. unpublished; fig III.16.5

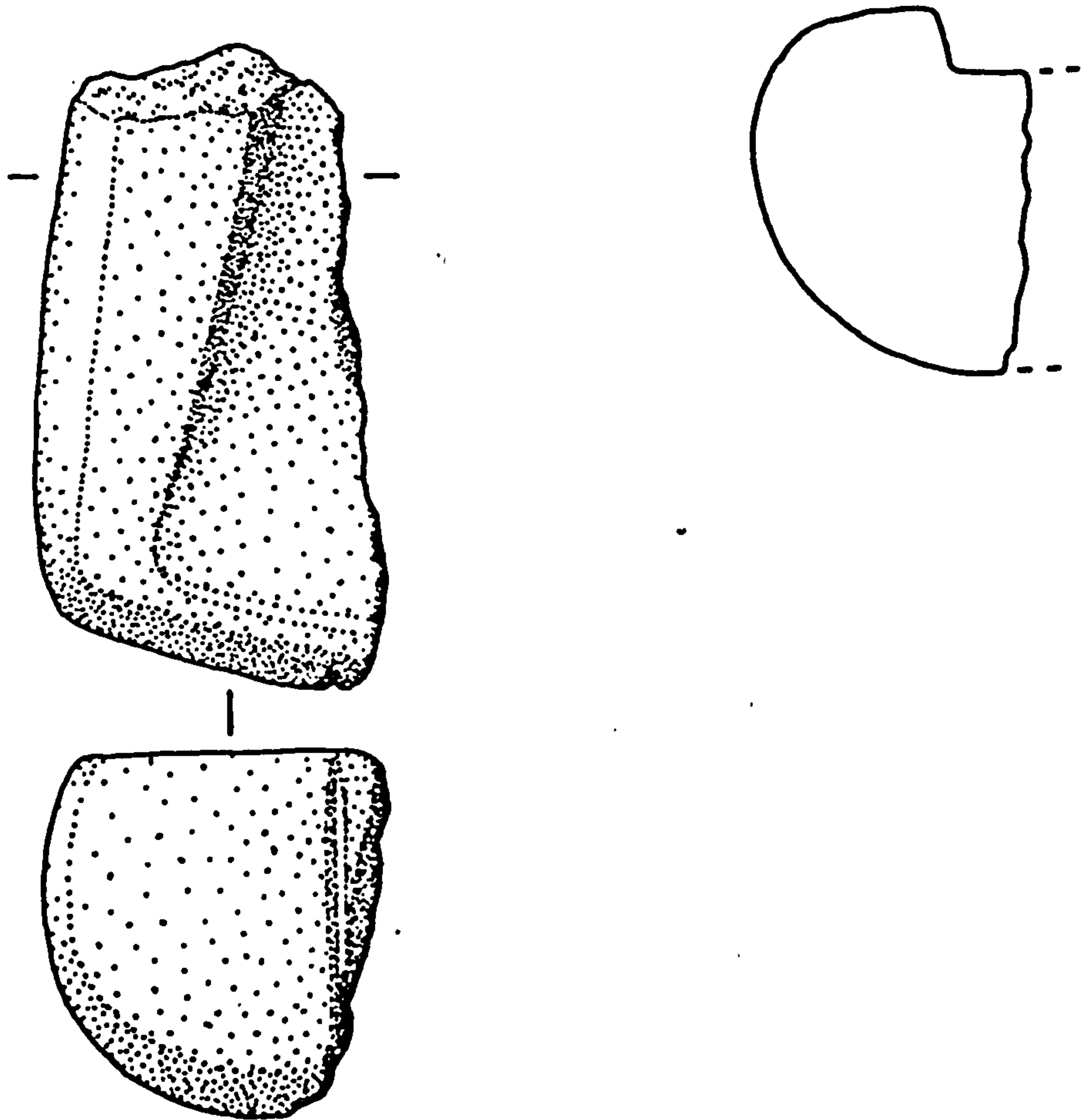


Fig III.16.5 mould fragment from Everley Water Meadow (x1)

- a. (6) Gwithian, Cornwall. SW 591423
- b. on settlement; 2 joining fragments found separately in 2 houses, Gwithian settlement layer 3
- c. 2 joining fragments of single mould with 2 matrices
- d. socketed axes; Stogursey type
- e. chlorite-talc schist (macroscopic identification by Camborne School of Mines)
- f. Needham, 1981, 15-17

- a. (7) Ham Hill, Somerset. ST 478170
- b. uncontexted (surface find within hillfort)
- c. fragments of 2 valves, not from same mould
- d. socketed axes; type unknown
- e. greisen (macroscopic identification, author)
- f. Hodges, 1960, Pl IIIc; figs III.16.6-7

- a. (8) Helsbury, Cornwall. SX 087790
- b. found during quarrying operations in 1934
- c. 7 stone blocks, 4 of which form 2 mould units; 2 are now lost
- d. unit 1 (Needham A + B): socketed axe; Stogursey type

unit 2 (Needham C + D):	"	"	
unit 3 (Needham E + F):	"	"	(lost)
block (Needham G):	"	"	
- e. unit 1 (Needham A): chlorite-schist

unit 2 (Needham C):	talc-chlorite-schist
block (Needham G):	similar to chlorite-schist moulds (macroscopic)
- f. Needham, 1981, 18-24

- a. (9) Linkinhorne, Cornwall. SX 3173
- b. unknown
- c. believed to be single valve
- d. socketed chisel
- e. "stone"
- f. Hodges, 1960, Table 2

- a. (10) Ansty, Milton Abbas, Dorset. ST 7603
- b. uncontexted
- c. 1 valve

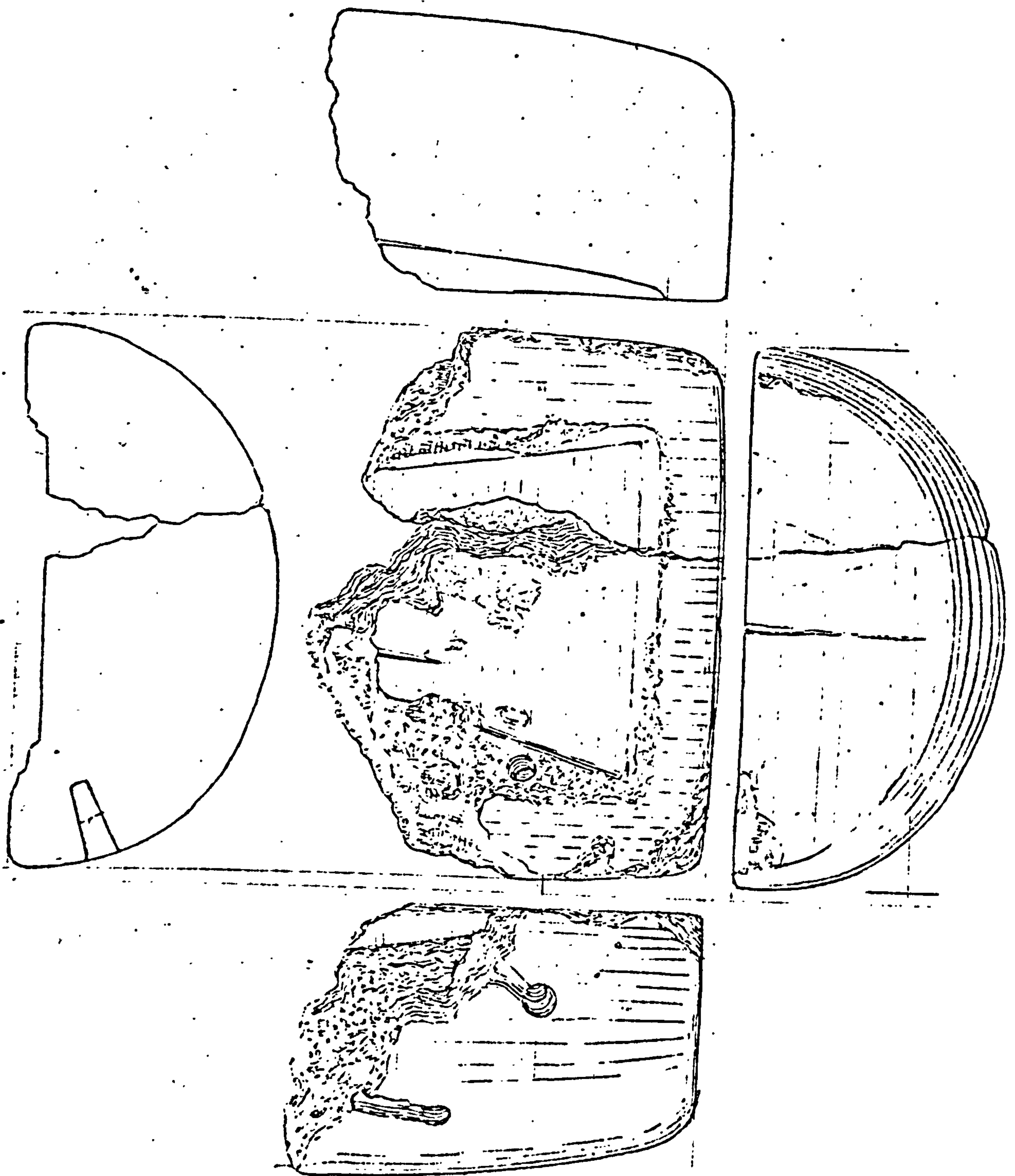


Fig III.16.6 Stone mould fragment from Ham Hill (drawn by P Dean)

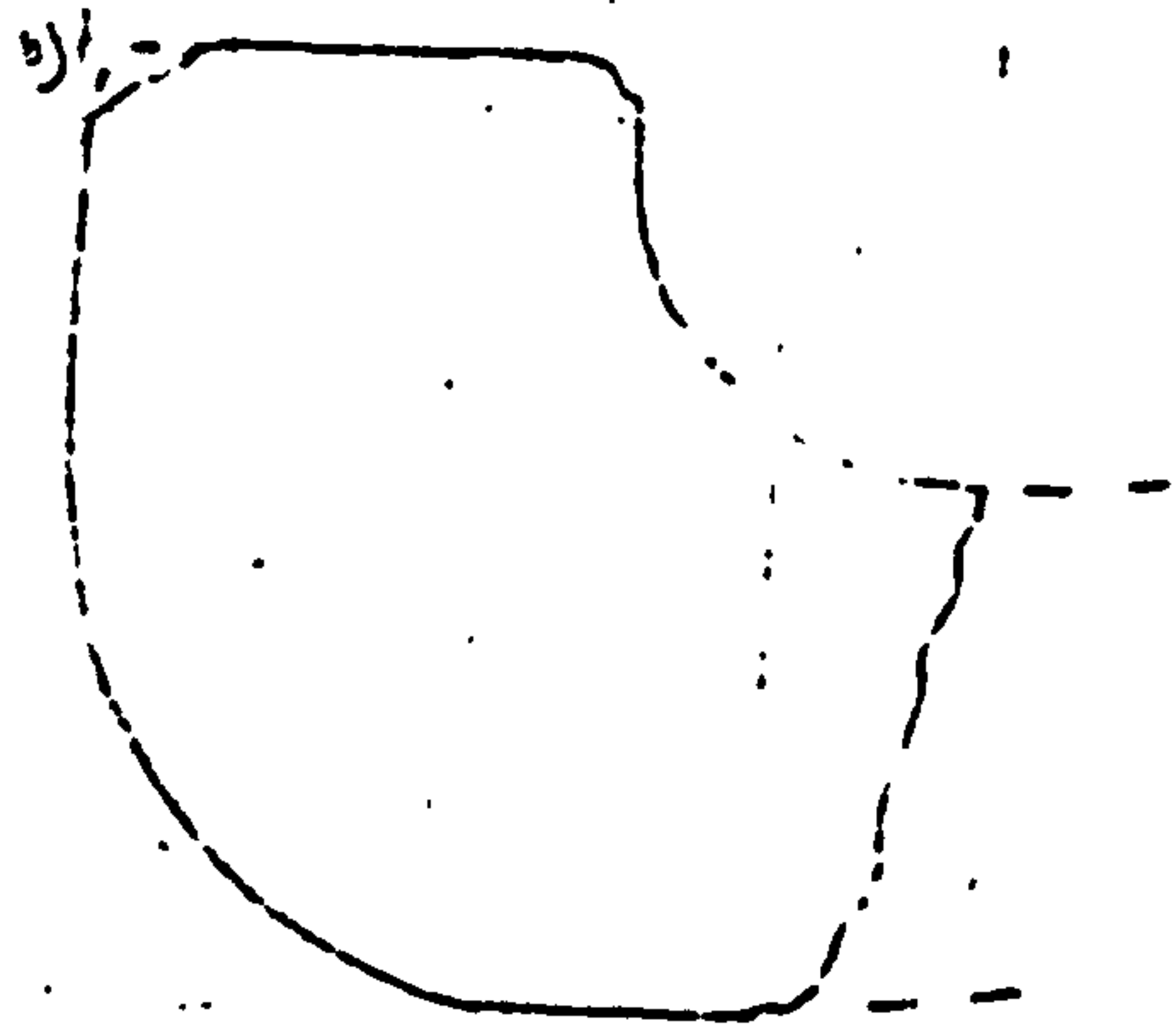
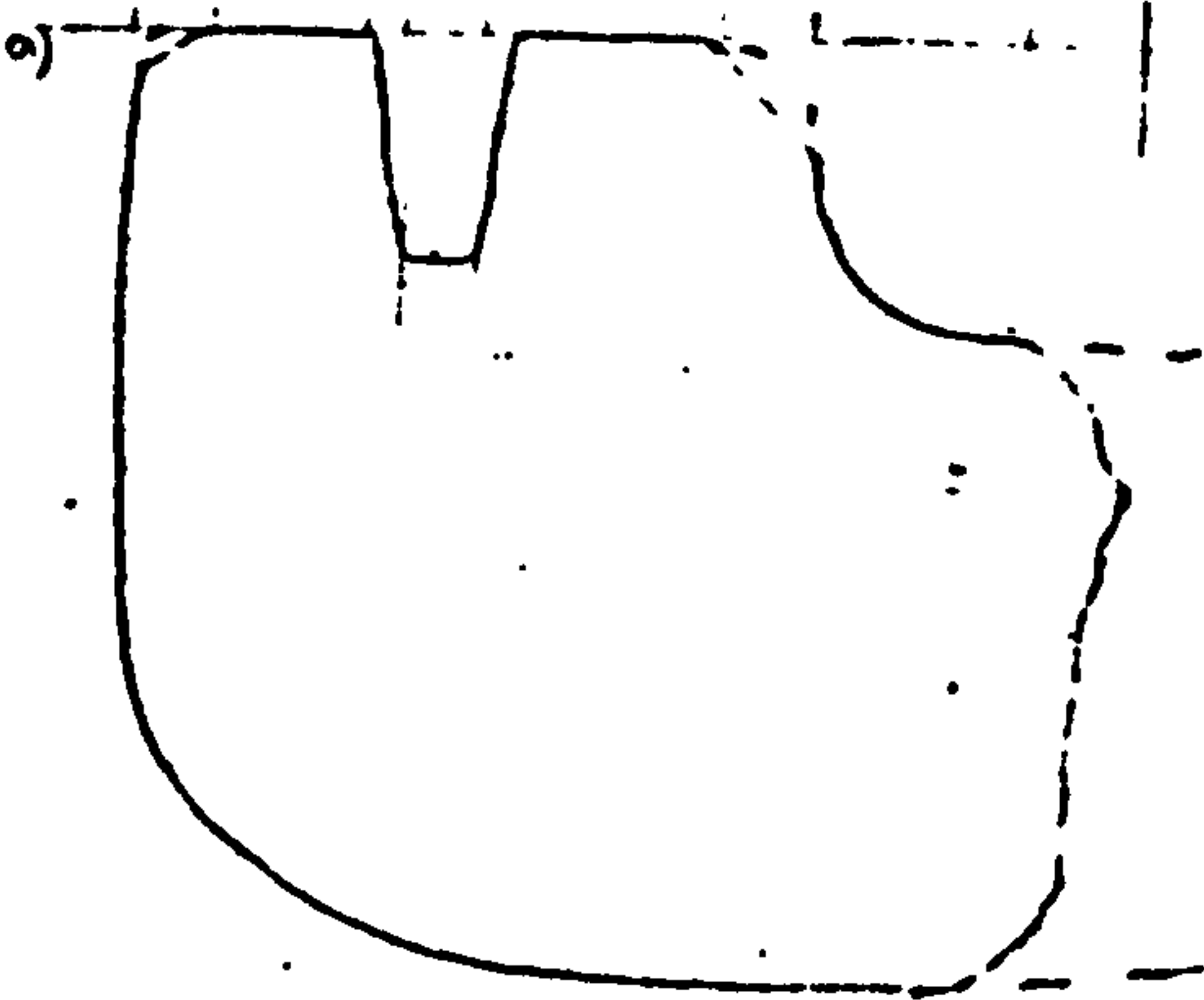
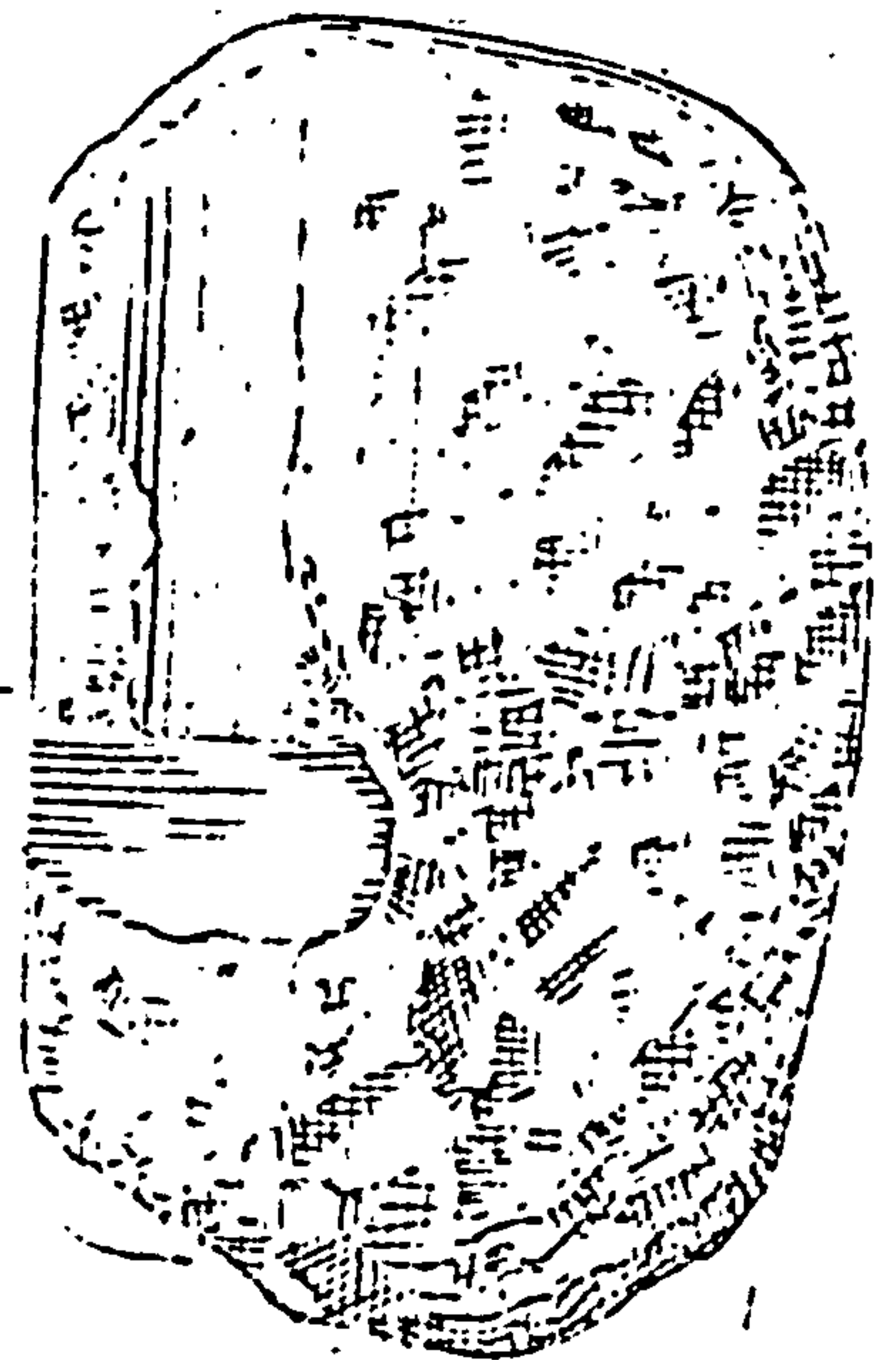
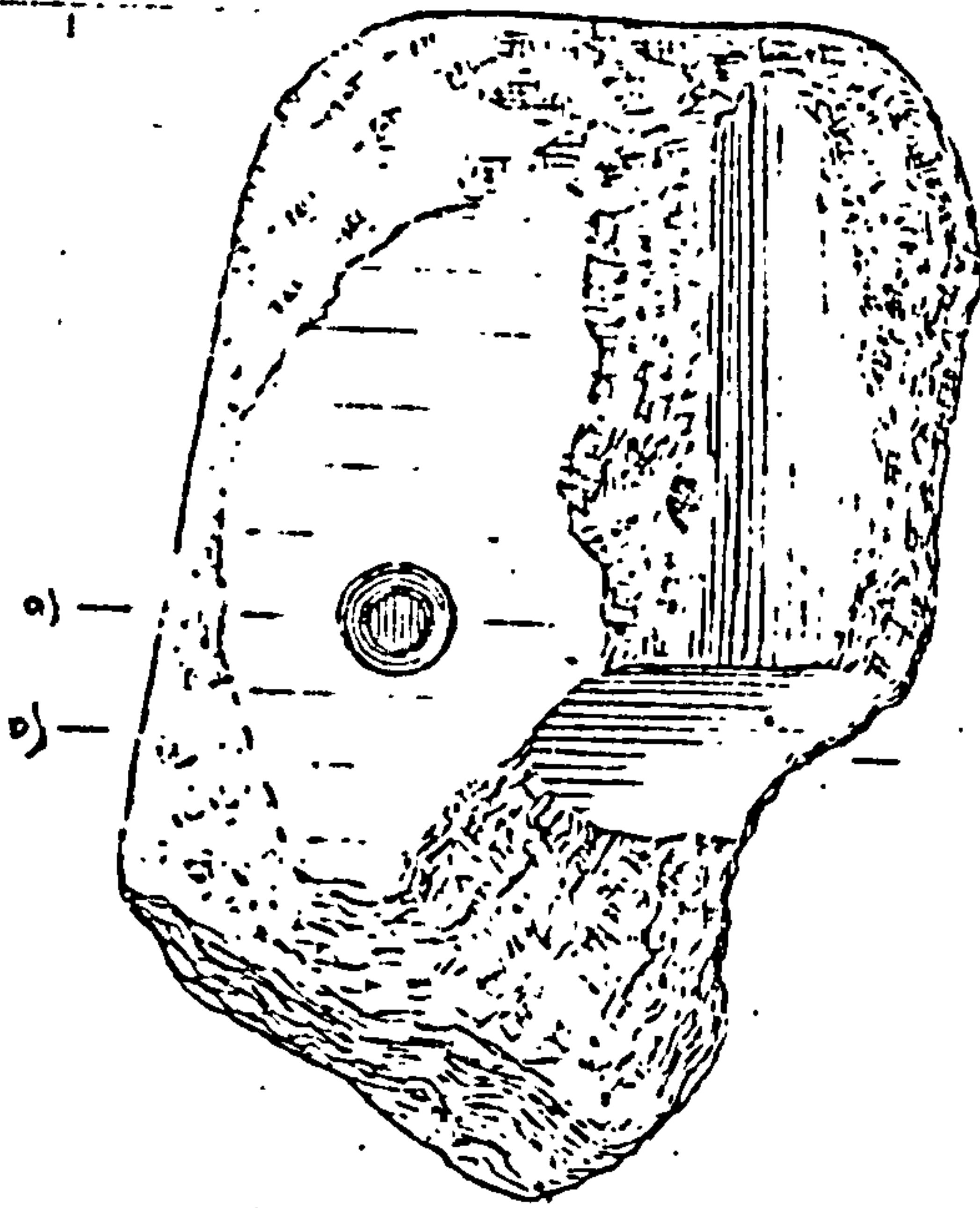
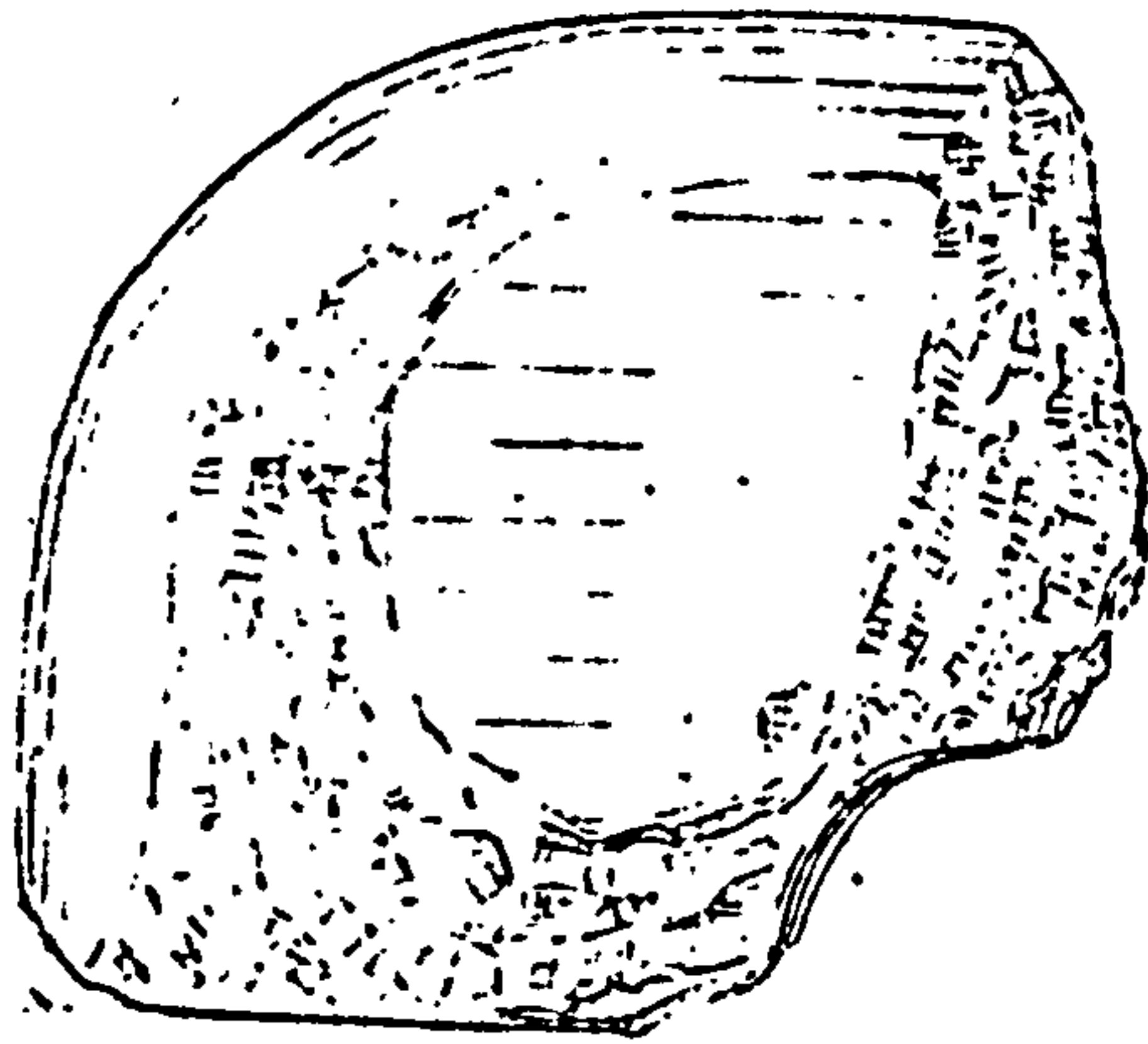


Fig III.16.7 Stone mould fragment from Ham Hill (drawn by P Dean)

d. faceted socketed axe

e. "stone"

f. Hodges, 1960, Pl IIIa; Needham, 1981, 32

a. (11) Petters' Sports Field, Egham, Surrey. TQ 016715

b. 3-4cm deep in layer 1 of pit in trench 3; settlement site

c. fragmentary block, single matrix

d. socketed axe; Stogursey type

e. "it proves to be a quartz-trachyte of the type known in the petrographic literature as keratophyre. The rock is much shattered, but it is not clear whether this is due to tectonic effects or possibly rapid heating" (A Wooley, quoted in Needham)

f. Johnson and Needham, 1974; Needham, 1981, 9-10

a. (12) Arkesden, Essex. TL4834

b. hoard, containing 50 objects, including socketed and winged axes, spears, a palstave and scrap metal; found in a hole surrounded with stones, associated with charcoal and ash

c. 1 valve

d. socketed axe e. bronze

f. Fox, 1923, 58, 60, 324

a. (13) Beacon Hill, Leicestershire.

b. uncontexted

c. single valve; contained a layer of lead

d. socketed axe

e. bronze

f. Hodges, 1960, Pl VIc; Tylecote, 1962, Table 48

a. (14) Beddington, Surrey. TQ 2964

b. hoard containing "many fragments", including broken socketed axes, spearheads, a gouge and ingot

c. 1 valve

d. socketed axe

e. bronze

f. Evans, 1881, 447; Hodges, 1960, Pl VIIa

- a. (15) Beeston Regis, Norfolk. TG 175427
 - b. hoard containing 21 objects, mainly complete or fragmentary socketed axes; also parts of socketed gouge and chisel, a rivet, a knife and a chape, 2 bronze cakes, a jet and a spearhead; all in a pot
 - c. single valve
 - d. socketed axe (of type not present in hoard)
 - e. bronze
 - f. Lawson, 1980b
-
- a. (16) Brough on Humber, Humberside. SE 9326
 - b. hoard containing "a bushel [of socketed axes] ... each enclosed in a brass mold, or case"
 - c. 1 complete and 1 broken valve illustrated
 - d. socketed axes
 - e. bronze
 - f. Lort, 1779
 - g. 1 axe illustrated "that perfectly fits mold"
-
- a. (17) Cambridge (New St) Cambs. TL 4458
 - b. hoard
 - c. both valves of single mould; both contain layer of lead
 - d. socketed axe
 - e. bronze
 - f. Fox, 1923; 58; Hodges, 1960, Pl VIb
-
- a. (18) Castle Rd, Worthing, West Sussex. TQ 126038
 - b. uncontexted, 45cm below surface; valves c 1m apart; "the site was examined for indications of occupation but there was no sign either of darkened soil, daub or pottery"
 - c. both valves of single mould; lead compound deposit in 1 valve
 - d. socketed axe
 - e. bronze
 - f. Green, 1973
 - g. axe from hoard c 1km away "almost an exact fit" for mould

- a. (19) Donhead St Mary, Wiltshire. ST 895232 (?)
 - b. hoard, containing complete and broken socketed axes, a gouge, a hammer, bronze wire, lumps of bronze (? ingot metal) and "whetstones"
 - c. both valves of single mould
 - d. socketed axe
 - e. bronze
 - f. Passmore, 1931
-
- a. (20) Heathery Burn, Stanhope, Durham. NY 9939
 - b. in cave, where numerous other objects were scattered, including the following (whole or fragmentary) bronze objects: 20 socketed axes, 18 rings, 10 pins, 8 spears, 4 armlets, 3 swords, 3 gouges, 2 knives, 1 each of chisel, tongs, button, razor and cauldron; and 1 piece of copper and a bronze jet
 - c. 1 valve
 - d. socketed axe
 - e. bronze
 - f. Hodges, 1960, Pl VIIc; Inventaria Archaeologia GB 55
-
- a. (21) Isleham, Cambs. TL 635728
 - b. large hoard, containing fragmentary weapons, tools, ornaments, sheet metal vessels, decorative mounts, casting waste and broken slabs and harness fittings
 - c. single valve
 - d. late palstave
 - e. bronze
 - f. Britton, 1960; Edwardson, nd
 - g. 1 palstave in hoard exactly fits mould
-
- a. (22) Isle of Harty, Kent. TR 610060
 - b. hoard, containing socketed axes, socketed hammers, gouges, razor fragments, tanged knife and whetstone
 - c. i: single valve; portion of lead adhering
 ii: both valves of single mould
 iii: " "
 iv: " "
 - d. i: socketed axe (3 castings from this mould in hoard)
 ii: socketed axe (1 casting from this mould in hoard)

iii: socketed axe (5 castings from this mould in hoard)

iv: socketed gouge

e. bronze

f. Evans, 1881, 441-45; Inventaria Archaeologia GB 18

a. (23) Quantock Hills, Somerset.

b. uncontexted

c. both valves of single mould

d. socketed axe

e. bronze

f. Evans, 1881, 447; Hodges, Pl VIIa

a. (24) Roseberry Topping, Cleveland/North Yorkshire. NZ 5712

b. hoard containing 2 complete and 1 fragmentary socketed axe, 2 chisels,
2 gouges and 1 knife

c. both valves of single mould

d. socketed axe

e. bronze

f. Hodges, 1960, Pl VIIIc; Howarth, 1899, 86-69 and Pl

a. (25) Southall, Middlesex. TQ 510800

b. hoard containing palstaves, ring and bronze cake (latter lost)

c. both valves of single mould

d. socketed axe

e. bronze

f. Inventaria Archaeologia GB 51

a. (26) Stoke, Hoo, Kent. TQ 8275

b. hoard, containing 19 pieces socketed axe, 5 fragments sword, gouges,
casting jet, 23 pieces bronze cake, scrap sheet bronze

c. 1 valve fragment

d. socketed axe

e. bronze

f. British Museum 1893.2-5.27 (unpublished)

a. (27) "South Wiltshire".

b. unknown

c. both valves of single mould

- d. socketed axe
 - e. bronze
 - f. Leahy, 1977, 44
 - g. given provenance of "Yorkshire" by Evans (1881, 447), but apparently from Wiltshire (Leahy, 1977, 4)
-
- a. (28) Unthank Rd, Norwich. TG 219079
 - b. hoard containing worn or fragmentary axes (5) and spearheads (5), and indeterminate scrap metal (4 fragments)
 - c. both valves of single mould
 - d. socketed axe.
 - e. bronze.
 - f. City of Norwich Museum, 1966, 29, fig 93; Evans, 1881, 468; Hodges, 1960, Pl VI d
-
- a. (29) Washingborough Fen, Lincolnshire. TF 0471
 - b. hoard containing 4 or 5 socketed axes
 - c. both valves of single mould
 - d. socketed axe
 - e. bronze
 - f. Davey, 1973, 98, fig 23 no 216
-
- a. (30) White Edge, Froggatt, Derbyshire. SK 2676
 - b. uncontexted
 - c. 1 valve
 - d. socketed axe
 - e. bronze
 - f. East Midlands Archaeological Bulletin 1980, 1; Leahy, 1977, 34, fig 19
-
- a. (31) Wickham Park, Croydon, Surrey. TQ 3266
 - b. hoard containing socketed axes, mainly broken and damaged, sword fragment, spear ferrule, gouge, casting jet, 3kg of copper cake
 - c. parts of 1 valve
 - d. socketed axe
 - e. bronze
 - f. Hodges, 1960, Pl VIId; Inventaria Archaeologia GB 39

- a. (32) Wilmington, East Sussex. TQ 5404
- b. hoard containing 12 palstaves, 11 socketed axes, 5 winged socketed axes, 1 sword (all fragmentary or worn) and bronze waste; in pot
- c. both valves of single mould
- d. socketed axe
- e. bronze
- f. Curwen, 1954, fig 59; 216-17; Hodges, 1960, Pl VIa

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An axe core from East Kennet, Wiltshire. SU 110668

The socketed axe found near Coleman's Barn, East Kennet (Devizes Museum catalogue 601/dm 1135) is of the type known as "Breton" or "Armorican", a profusion of similar implements having been found in that area of northern France. The distribution of Armorican axes in Britain was mapped by Dunning (1959), and more recent finds have been listed (O'Connor, 1980, 586). These axes are invariably looped, long and narrow-bladed (the East Kennet example is typical of the class, measuring 12.0cm in length and 3.5cm along the blade edge), and square-mouthed. They are poorly finished, often retaining casting flashes, and rarely show signs of use. The lack of post-casting treatment and frequent high lead content suggest that they were not designed as functional implements. Armorican axes are generally believed to have been imported across the Channel to Britain as ingot metal or, perhaps, a form of currency at the end of the late bronze age (Burgess, 1974, 213). This date is supported by the recovery of another example in Wiltshire, at the transitional late bronze age/early iron age settlement at All Cannings Cross (Cunnington, 1923).

The East Kennet axe, like several others of its class, still retains its casting core. Petrological analysis of the core material was undertaken with the co-operation of the Wiltshire Archaeological Society. The thin section shows that the core was composed essentially of sand, mixed with a very small proportion of ferruginous binding clay. The sand consists in the main of fine subangular grains of quartz, generally less than 0.1mm across their long axis. Also present are tiny tabular fragments of altered plagioclase feldspar, rare anhedral grains of

yellowish-green tourmaline, and a single large (1.5mm) grain of quartzite. Flecks of both brown and white mica (to 0.3mm long) are visible throughout the sample.

These results show that a fine-grained sand, probably of granitic origin, was selected for the preparation of this particular casting core. The sand may have been naturally bonded, or alternatively a little clay may have been added as binding material. Gases generated when molten metal was poured into the mould could easily be absorbed by this porous material, thus limiting the chance of a spoiled casting.

The mineral suite identified indicates an origin in the vicinity of a granite massif. Whilst it is clear that the axe was not locally produced (unless by an itinerant smith in the habit of carrying quantities of core sand considerable distances), it is not possible to ascertain whether manufacture took place in Britain or northern France. Both the Dartmoor granite and granite outcrops in Brittany contain the full suite of minerals identified, including the distinctive yellow-green tourmaline.

PART IV

REFRACTORY PRODUCTION
AND
THE ORGANISATION OF BRONZE CASTING
IN PREHISTORIC BRITAIN

IV.1 REFRACTORY PRODUCTION IN PREHISTORIC BRITAIN

IV.1.1 Introduction

The production of refractory equipment for use in the bronze casting process is controlled by rigid technological constraints. These constraints have been described in some detail in part II of this study (p 155ff, and see summary Table II.2). Variations in form, methods of preparation and materials selected within the framework of these constraints are governed by the smith's environment, his skill in exploiting this environment, and cultural factors relating to his social group. However, it is clear from the ethnographic and historical data presented in part II, that whilst compositional and typological variation can be described (etic data), the emic reasoning behind the particular choice of this or that form, mode of preparation, or building, and selection of raw materials cannot be defined without a comprehensive understanding of the socio-cultural environment of the smith. Few ethnographers have attempted to study artefact production within a complete social context, and for the historian, the context is generally unavailable. The same problem applies to the study of refractory manufacture in prehistory. Variations can be described, but explanations must be couched exclusively in etic terms. The emic elements, the cultural factors affecting choice within constraints, perforce, remain within the realm of speculation.

On the positive side, the analyses described in part III of this study have provided a considerable body of etic data concerning the production of crucibles, moulds, furnaces and tuyères in prehistoric Britain. These data have greatly increased knowledge of ancient refractory composition and changes in refractory technology. Materials used to produce the various artefact categories have been related to ceramic resource ecology, and it has been clearly demonstrated that smiths at all sites skillfully selected materials from those available to meet their particular technological/cultural requirements.

It is appropriate here to review the technology of refractory

production in prehistoric Britain as it is understood from the results obtained in the course of this study, and to discuss this technology in the light of the constraints and allowable variation described in part II above.

IV.1.2 Refractory production in the bronze age

Crucibles

Crucibles of bronze age date have been recovered from only seven southern British sites (Grime's Graves, Dainton, Beeston Castle, The Breiddin, Mucking North Ring, Runnymede Bridge and Burderop Down). Although the crucible sherds from Bramber were found in association with a bronze age hoard, these have not yet been examined, and a bronze age ascription remains to be verified. All authenticated bronze age crucibles are thick-walled, and although the absolute capacity is measurable only at Dainton, all would seem to be capable of holding a large quantity of molten bronze.

The best preserved crucibles come from Dainton, where at least two distinct vessel forms have been recognised (III.4, figs 5-7). One of these crucibles is supported on three legs, perhaps to allow access under the bowl, or perhaps to facilitate pouring (Needham, 1980a, 189). Each of the Dainton crucibles appears to have been provided with a single pouring lip. The solitary thick-walled crucible identified at the Breiddin is pear-shaped and the pouring lip is strongly accentuated (fig III.9.5, p 309). The bowl is similar in depth and diameter to Dainton vessel A, but there is nothing to suggest that leg support was provided. The single published crucible from Runnymede appears to have had an out-turned rim (Needham and Longley, 1980, fig 3.1). The Mucking North Ring crucible is the heaviest thus far retrieved (maximum thickness 33mm), and unlike all other extant examples, has a flat base. Insufficient remains of either the Grime's Graves or Beeston Castle crucibles to permit reconstruction. At three sites (Dainton, Beeston Castle and Runnymede) the crucibles show positive evidence of relining and/or wall heightening. Relining would prolong the life of the vessel, and an increase in wall height would enlarge the capacity of the bowl.

Crucible fabrics have been described in detail in the relevant site chapters, and a summarised description is provided in Table IV.1.1 to facilitate comparison. Grain:matrix density varies from 50% to 80%, although most samples contain between 50% and 60% inclusions. These proportions and the general uniformity of inclusion size, suggest that a measured quantity of sand or crushed rock was added to a carefully chosen clay for most bronze age crucible production.

Crucibles from six sites were thin sectioned (the Runnymede Bridge crucibles are not yet fully processed) and a wide range of recipes was identified. The constituent minerals differed from site to site, and it is clear that the metalworkers selected their refractory ingredients with care from among those available at or near each individual locality. Although raw material sampling in the vicinity of each site produced no conclusive results other than in the case of the Breiddin, possible origins were located for the Mucking, Dainton and Beeston Castle pastes. The Breiddin igneous tempered crucibles are believed to have been produced on the site from clay and dolerite rock available on the Breiddin Hill itself. A measured amount of well-sorted sand would seem to have been carefully worked into the locally available London Clay at Mucking. If the suggested sources of raw materials exploited by the crucible makers at Beeston Castle and Dainton are correct, this indicates that the metalworkers were prepared to travel somewhat further afield for clays and sands to meet their special requirements. It is interesting that crucibles from these two sites have been relined, indicating careful curation.

A single bronze age crucible fabric (Beeston Castle, Fabric 2) has been identified which contains a high proportion of carbon. Although it has been shown that this carbon could have occurred naturally in an organic rich clay (BC clay samples 1 and 2), and was not necessarily added as filler, the selection of a carbon fabric suggests that the Beeston metalworkers at least were aware of the refractory properties of this material. The use of carbon in refractory manufacture will be discussed more fully below, in connection with iron age crucible production.

TABLE IV.1.1.1 SUMMARY DESCRIPTIONS OF REFRACTORY FABRICS FROM BRONZE AGE SITES

Site	Crucible composition	Inclusions mean % size grains	Inner mould composition	Inclusions mean % size grains	Outer mould composition	Inclusions mean % size grain:
Grime's Graves	quartz sand, rare limestone and flint, very little mica, no detritals	.150 60	dense quartz sand, rare limestone, mica, detrital minerals	.105 61	as inner, but less well prepared; sprue-cup in this fabric	.152 43
Fimber	-	-	dense quartz sand, white mica	.052 75	sparse quartz sand, very little mica; tempered with large angular igneous rock fragments	.244 51
Dainton	3. quartz sand, potash felspar, quartzite, metamorphosed siliceous sandstone, rare biotite 3a. similar to 3, but also altered arkose sandstone	60-80 60-80	one fabric as crucible 3 1. fine quartz, micaceous sandstone, mica and quartzite 2. quartz, brown and white mica, potash felspar (including sanidine), microcline, plagioclase, phylite, quartzite, sandstone (sometimes feldspathic), accessory tourmaline, zircon, sphene, garnet	50-60 60	1. as inner, less well prepared 2. as inner, less well prepared	
Beeston Castle	1. quartz sand, a little iron ore 2. quartz sand, quartzite, sandstone, carbonised organic (2 relines 1 in one sherd)	.082 62 .081 50	Fine quartz sand, mica, detritals	.052 57	quartz sand, ferruginous sandstone, rare mica, iron oxide, ferruginous clay pellets, residual carbon; gate support in this fabric	.117 37
Runnymede Bridge	Fine grade, extremely sandy clay (macroscopic)	-	razor: alluvial, inclusionless clay 4 other fabrics determined macroscopically, including flinty gravel for axe mould	-	razor: as inner, but with residual carbon	-
Mucking	quartz sand, rare mica, detritals	.117 67	4. fine quartz sand, frequent mica and detritals	.044 73	5. as inner, but coarser grade quartz sand, mica and detritals rarer	.117 53

The Breiddin	1. quartz sand, rare plagioclase felspar; tempered with igneous rock fragments to 1mm	.151	67	5a. quartz sand, white mica, felspar, epidote, slate/ mudstone, occasional fragments of igneous rock	.034	47	as inner, but less well prepared; slate/mudstone and igneous rock fragments slightly more frequent	.044	47
Aldermaston Wharf	-	-	-	fine, quartz sand, white mica, iron ore; 1 sample contains flint	-	-	as inner	-	-
Burderop Down	abundant fine quartz, rare iron ore and white mica	.01- .04	-	-	-	-	-	-	-
Gwithian	-	-	-	axe: medium-low density of quartz, potash felspar, quartzite, mica, micaceous sandstone sword: dense fine quartz, white mica, quartzite, brown amphibole, and ? chlorite schist	-	-	-	-	-
South Lodge	-	-	-	-	-	-	scattered quartz and iron ore in calcareous matrix	-	-

Clay moulds

Almost twenty sites in later bronze age southern Britain have produced clay casting mould. Like crucibles, clay mould is invariably found with settlement associations. Moulds from eleven of these sites have been analysed in the course of this study (a brief description of the composition of mould sherds from Gwithian, Aldermaston and South Lodge is included in the production site catalogue, Part III, Ch 16 above). Two fragments from the Thames-side site at Pingewood, suspected to be mould during post-excavation work, have since been identified from fabric analysis as pottery. The identification of several small, featureless sherds from the bronze age settlement site at Poundbury, remains in doubt. These sherds are formed from an exceptionally sandy brickearth, and hence could be refractory. However, an identical paste was used for loomweight production at this site, and it is possible that the "mould" sherds in fact represent fragments of loomweight (Howard, in preparation). The Poundbury material is thus excluded from the analyses discussed here.

All bronze age clay moulds recovered to date are of the bivalve variety. The technological requirements for successful mould production are described above (II.2.2) and are summarised in Table II.2.2. It is clear from morphological examination and the results of fabric analysis that, with one dramatic exception, these requirements were clearly understood and met by the bronze age casters. The miscast razor from Runnymede Bridge clearly demonstrates the disasters which could occur when the smith failed to comply with the technological constraints on mould production. With this single exception, inner moulds at all sites are invariably fine-textured, refractory and well-worked and finished. On the other hand, attention has been concentrated on the permeability of outer mould pastes. At all sites almost all outer moulds are more porous than their inner counterparts, inclusions are generally sparser, and the clays less carefully prepared (figs IV.1.1-2).

Although mould composition varies substantially from site to site, at all locations save Fimber, similar raw materials appear to have been used for the production of outer wraps and inner matrices. In all cases, however, these materials have been prepared in a different manner to

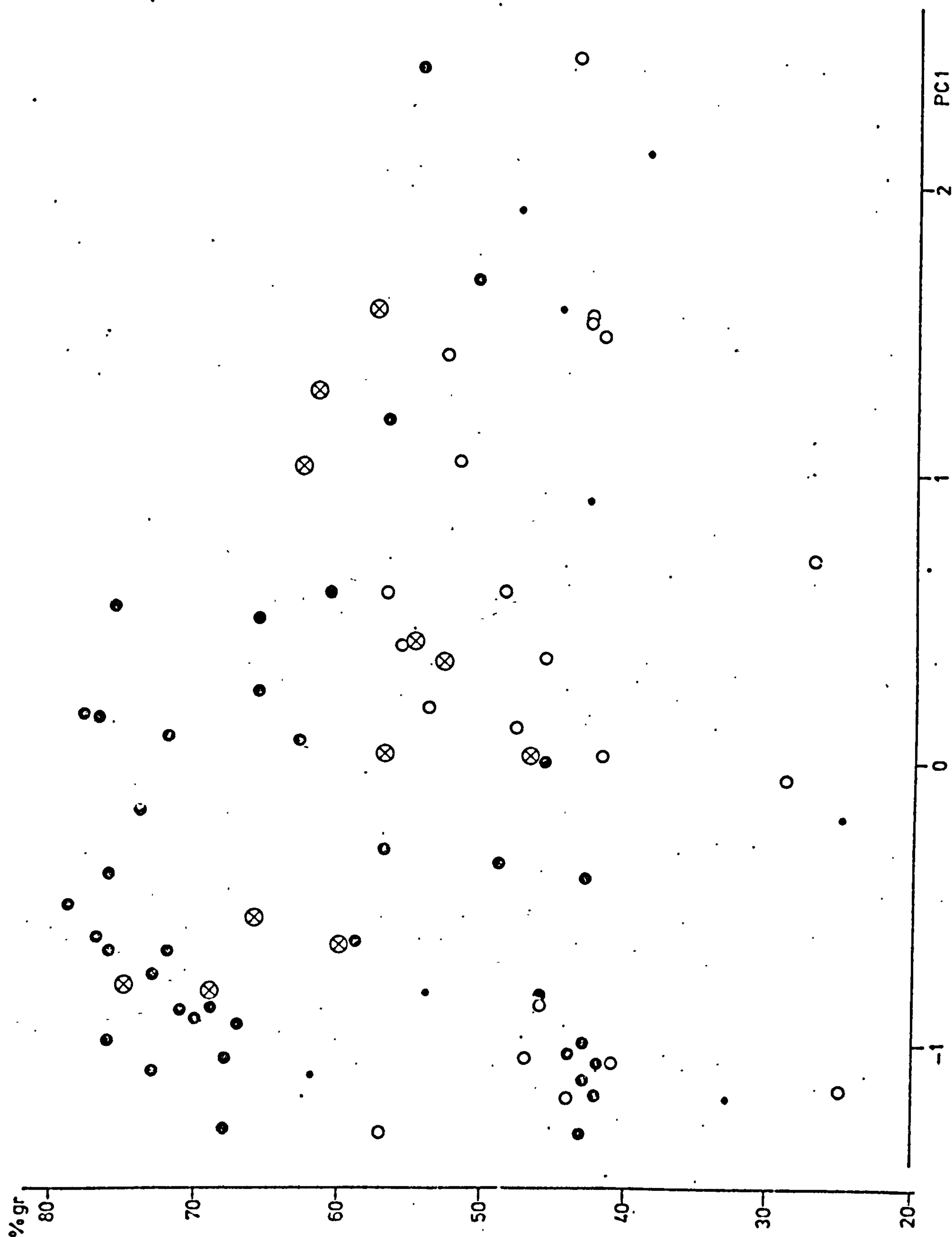


Fig IV.1.1 Bronze age refractory sherds from the five sites analysed. Inner mould (●), outer mould (○), crucible (⊗) and others (•) plotted according to grain size (expressed by scores on the 1st principal component extracted from the ϕ counts) and proportion of grains:matrix.

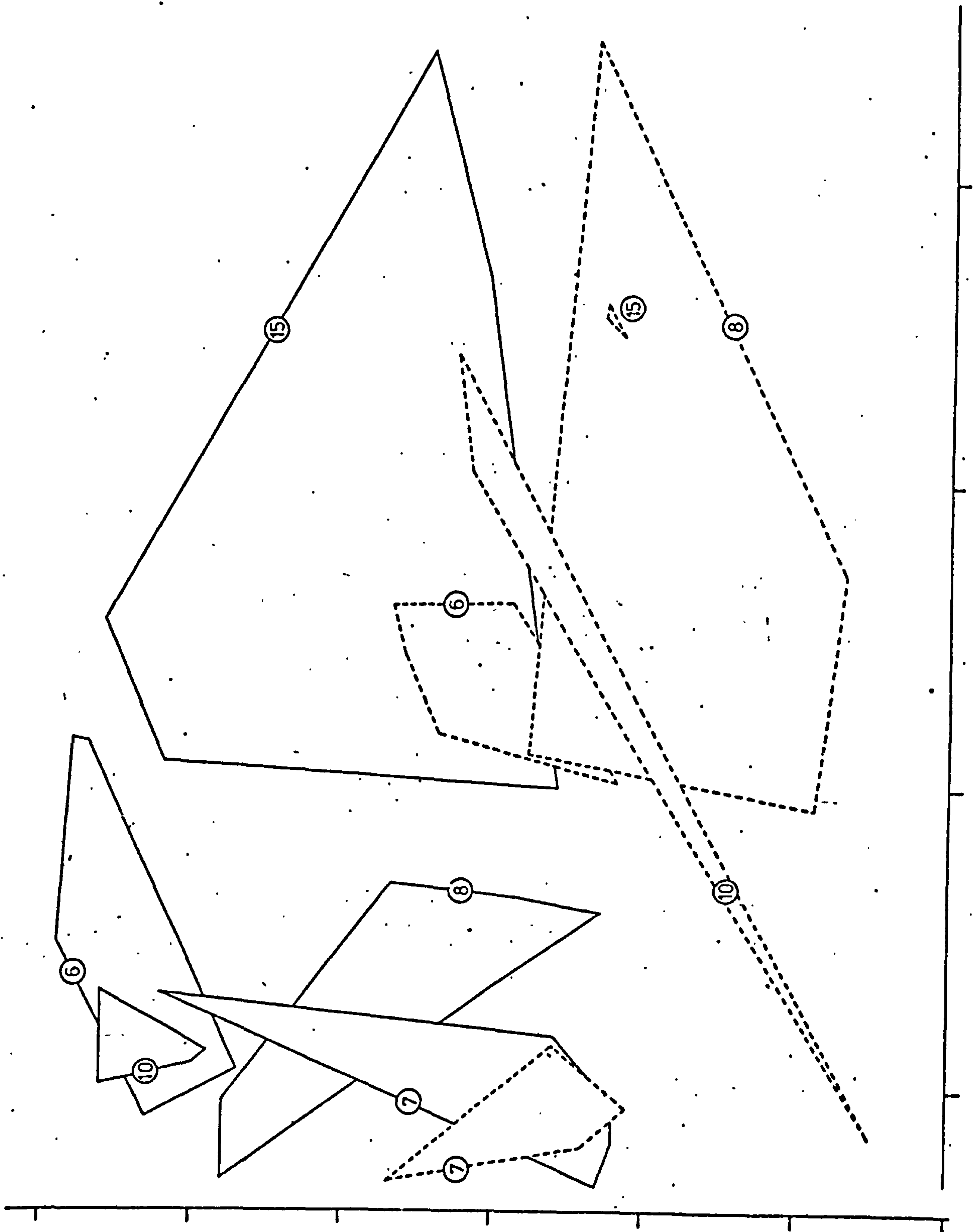


Fig IV.1.2 Polygons enclosing inner mould (—) and outer mould (---) sherds from the 5 bronze age sites (cf fig IV.1.1). Sites are numbered as in the computer file (see fig II.3.5): Fimber (6), Breiddin (7), Beeston Castle (8), Mucking (10) and Grime's Graves (15). Note distinction in grain size (horizontal axis) and packing density (vertical axis) between inner and outer fabrics both overall, and at individual sites. The specific characteristics of fabrics reflect differences between raw materials local to the sites.

conform to the requirements of the different mould components. At Dainton, for example, where two clearly defined weapon mould fabrics are represented, the evidence shows that these fabrics were never combined in mould production. Watcombe clays were carefully prepared for the inner matrices of fabric 1 weapon moulds, whilst the same clays, less well mixed, served to form the outer wraps. Similarly, the inner sheaths of fabric 2 moulds (made from clay derived from the metamorphic aureole surrounding the Dartmoor granite massif) are compact with evenly distributed inclusions. Outer wraps in the same clay are poorly worked and contain voids representing the burning out of residual carbon.

At the Breiddin, all identified inner mould would seem to be formed from local (perhaps levigated) doleritic clay. The same raw materials were used for outer mould production, but here the clay is not well cleaned, and contains slightly larger and more frequent dolerite fragments.

The Fimber smiths were versed in a completely different, and thus far, unique mould technology. Whilst inner matrices were fashioned from a fine, quartz-rich, micaceous clay (probably derived from the Wolds Pleistocene deposits), a different clay was used as the base for the outer wraps. This clay, which contains sparse quartz, was tempered with large angular fragments of igneous rock (identified as Whin Sill dolerite), selected from the coastal erratics some 30km from the site. There is no technological reason why igneous rock fragments should have been employed to increase porosity, and this phenomenon can only be explained in terms of 'cultural' choice.

Raw material analyses produced few specific matches with the mould fabrics. The results, however, suggest that materials located within easy reach of each site (with the notable exception of the Fimber outer moulds) were exploited for mould production. There is invariably a clear distinction between those local raw materials selected and prepared for crucible production, and those chosen for mould making.

Moulds of stone and bronze, and the problem of lead

Although, for the reasons stated above (II.1.2), ceramic refractories

were selected as the focal data for this study, it is apposite here to draw attention to moulds of material other than clay, which were produced to cast later bronze age implements. A number of moulds of bronze and stone have been recovered from all areas of Britain, and the majority have been found in hoards or as uncontexted finds (III.16.2). Settlement associations are rare. All are bivalve moulds, and although methods of fabrication are different from those employed to produce moulds of clay, methods of use would have been similar.

Rare finds of lead axes (one from Anwick, Lincolnshire and a second from Seamer, Yorkshire), the presence of solidified lead in some 30% of known bronze socketed axe moulds and high lead readings obtained from X-ray fluorescence analysis of the matrices and body of several stone moulds, have led certain writers to doubt that moulds of bronze and stone were used for the direct casting of bronze implements. Instead, it is suggested that these moulds (the manufacture of which would have involved a high energy expenditure) were designed to cast lead axes, either as ingots for later alloying with raw smelted copper, or scrap, or alternatively as patterns for use in a "lost lead" casting process (eg Clark, 1952, 196; Hodges, 1954, 73; Tylecote, 1962, 125-28).

A lost lead technique would involve the investment of a lead model with layers of clay in the manner described for cire perdue casting (II.2.2). The clay covered pattern would then be dried and fired, during which operation the lead would run out and leave a cavity into which molten bronze could be poured. The advantages of "lost lead" casting would be twofold. Firstly, the low melting temperature of lead would result in less wear and tear on a high energy input master mould, and secondly the pattern could be cleaned (pure lead can be pared with a knife) prior to investment, thus eliminating the necessity to remove the casting flashes inevitable in bivalve technology. There is, however, little evidence to support the use of "lost lead" casting in the bronze age.

If this process had been in vogue, we would expect to recover clay fragments typical of a single piece mould. All clay moulds recovered to date, however (including those few for the casting of axes), represent a bivalve technology. Furthermore, we would not expect to find implements with casting flashes. However, cast bronze items without casting flashes

or indications of casting flashes are extremely rare (personal observation and S Needham, pers comm), indicating that the great majority (at least) were cast in bivalve moulds. For example, eight or perhaps ten stone mould pieces for Stogursey axe production have been recovered, and all extant Stogursey axes retain casting flashes, suggesting that the stone moulds were used for direct casting (Needham, 1981, 30).

The argument for direct casting of bronze into bronze moulds is further supported by the relatively frequent occurrence of bronze axes which precisely fit the parent mould. The Isle of Harty hoard perhaps best exemplifies this phenomenon (III.16.2). If lead axes had been cast in bronze moulds, and these axes used in a "lost lead" casting process, double contraction would have taken place, and the final cast form would be much smaller than the original bronze mould (Leahy, 1977,5).

Experimental work has shown that bronze can be cast successfully in both stone and bronze moulds and that up to 50 castings can be produced without any damage being caused to the mould material (eg Allen et al, 1970; Coghlan, 1968; Drescher, 1957; Tylecote, 1973; Voce, 1951).

The occasional use of stone and bronze moulds for the production of lead ingots cannot be entirely disproved. It is significant, however, that no such ingots have been located in founders', or any other type of hoard in Britain. Furthermore, with one possible exception (New St, Cambridge; Fox, 1923) lead layers observed in several mould valves do not result from attempts at lead casting. Instead, lead appears to have been deliberately poured into redundant moulds, perhaps in preparation for alloying (bronze moulds having a lower than average lead content) and recycling.

In sum, it is clear that lead working in the British bronze age must remain a problem area, and it is assumed for purposes of the present study, that the primary role of stone and bronze moulds was the direct casting of bronze implements.

The objects cast

Three materials were thus in use during the bronze age to produce moulds for direct bronze casting: clay, stone and bronze. Aside perhaps from swords, which are long, complex castings requiring a high degree of skill on the parts of the smith and would be sensibly cast in clay moulds (Cowen and Maryon, 1935; Northover, nd), there is no a priori reason why any late bronze age artefacts could not be cast in a mould of any of the three materials. Thus, if choice is to be explained, it is necessary to consider organisational and cultural parameters. It is interesting that virtually all late bronze age stone and bronze moulds were intended for axe casting (fig IV.2.2), whilst only four clay axe mould sherds, all attesting a bivalve technology, have been recovered. The remaining clay moulds were designed to cast weapons and ornaments. Analysis of the Gwithian clay axe mould sherd, and macroscopic inspection of the fragments from Runnymede Bridge and Fimber have shown that in each case axe moulds were formed in a different paste from that used for other clay moulds at these sites. The implications of all these findings will be discussed more fully in the following chapter.

Furnaces

Although bronze age production sites can be identified by the presence of spent moulds and crucibles, the actual location of casting activities at these sites is generally unknown. With the single exception of the Breiddin, where a group of twelve furnace structures was recognised, in situ casting facilities have not been found. Small anomalous clay fragments, sometimes partially vitrified, appear among, or in the vicinity of the refractory debris at several sites. These fragments are often interpreted as possible furnace debris. However, as Bayley has cautioned, "furnace lining is not necessarily what the name implies, but could also be clay which has been strongly heated and similarly fluxed on one side ..." (Bayley, 1977, 80). Vitrified clay need not be connected with metalworking. A small number of "furnace" fragments have been examined and analysed (see above, especially at Grime's Graves and the Breiddin), but without positive evidence of a metallurgical connection such as may be obtained, for example, from X-ray fluorescence, their identification as furnace must remain in doubt. It is however, reasonable

to suppose that furnace structures, which demand large quantities of raw material, would be fabricated from local clays and sands. It is unfortunate that none of the lining material from the in situ Breiddin furnaces was available for analysis.

Tuyères

With the notable exception of the finds from Mucking, tuyère fragments, like furnaces, are elusive on bronze age sites. The large triangular tuyères from Mucking (III.8) are unparalleled in British prehistoric contexts. The fabric is highly refractory and the inclusion range resembles that of the single Mucking bronze age crucible (MU 2). It has been suggested that sand was added to the locally available, micaceous London Clay for crucible production during the bronze age at the site, and a similar formula (with minor textural differences) appears to have been prepared for tuyère manufacture.

Cores

Few bronze age casting cores have been found on settlement sites. Implements found in hoards, however, often retain core material. These implements are generally miscast and unused, presumably retained for their scrap value. Cores are most frequently found in a particular class of final bronze age socketed axe known as "Breton" or "Armorican", normally recovered in Britain as uncontexted finds. These implements are poorly finished and are generally believed to have been imported from northern France as currency or ingot metal rather than as finished tools (Dunning, 1959; O'Connor, 1980, 235). One Armorican core has been analysed (from East Kennet: Ch III.16) and found to consist essentially of granitic sand with a small proportion of binding clay.

A radically different technology is implied by the cores from the Breiddin and the Bramber hoard. The fabric of the Breiddin socketed knife or sickle core is finer than that of any other refractory artefact from the site. The micaceous clay matrix is inclusionless, save for a sparse scatter of quartz sand and a little organic material. The Bramber cores, too, are composed essentially of clay with minor amounts of carbonised and partially carbonised organic material. One sample contains a scatter

of crushed, fired ceramic to increase porosity. The axe core found at Everley Water Meadows (p 470) in summer, 1982, is probably derived from a workshop site with settlement associations (R Smith, pers comm). Macroscopic examination suggests that the primary constituent of this artefact is a fine, ferruginous clay, perhaps with a little residual or added carbon.

Raw material studies have not yet been undertaken in connection with the Bramber and Everley Water Meadows sites, and no match was found for the Breiddin core among the sampled clays. It is thus not possible to confirm, at this stage, that cores, like other refractory artefacts, were produced from locally available resources. Technologically, however, it is clear from the analyses presented here that casting cores were composed of clay with minor additions of carbon, and in one case grog, to increase porosity. The sand formula identified in the East Kennet analysis may indicate a chronological change in core technology, but as the axe is believed to be an import, this change could as easily be spatially defined.

IV.1.3 Iron age refractory production

Crucibles

The range of morphological variation observed among crucibles of bronze age date is not echoed in the iron age. All bronze melting vessels produced after iron had become the common material for tool and weapon production are round based and triangular in form with three possible pouring lips. Some variation in capacity is apparent and crucible size generally increases in direct proportion to wall thickness. Thick-walled, large crucibles are known, for example from Meare, Glastonbury and Maiden Castle (eg figs III.11.5, p 348 and III.12.5, p 371; and Wheeler, 1943, fig 119.1). The majority of crucibles found in iron age contexts, however, are thin-walled and small with an average capacity of c 30cc of molten bronze. This would have been adequate for a single terret ring or bridle-bit, or for continuous pouring of several small ornaments.

Minor morphological variations are manifest in rim form and in

depth. Rims can be rounded, flat or pointed, and both shallow boat-shaped, and deep conical crucibles have been recognised. The shallow forms are invariably of the large, thick-walled variety. Tylecote (1962, 136) has suggested several methods of holding and pouring iron age crucibles. A single sherd from Meare (MRE 3) seems to have been provided with a pinched handle, possibly to facilitate pouring.

Three basic crucible formulae appear to have been in use in southern Britain during the iron age, and these may, perhaps, have been chronologically defined (see summary Table IV.1.2 and Pl 8). Crucibles from Beckford and from various mounds at Meare consist essentially of carbon. It has been suggested that finely pulverised carbonaceous material, perhaps charcoal, was mixed with a small quantity of binding clay for the preparation of this crucible fabric. A second iron age formula combines quartz sand and carbon in approximately equal proportions. Sand-carbon crucibles are found at Mucking, Meare and South Cadbury. Crucible fabrics 1 and 2 at Glastonbury contain a scatter of carbon, and this has been identified as fossil plant material, an integral constituent of the Coal Measures fire-clays. At Weelsby Avenue, fragments believed to be of locally available sea-coal were incorporated into the crucible paste (Fabric 1). The final and most prolific iron age crucible fabric consists of carefully selected sand bound with a small proportion of clay. It has not been possible to ascertain whether sand and clay were derived from separate sources or whether natural moulding sands (containing a small quantity of colloidal material) were prepared for crucible making.

All iron age crucible matrices are isotropic, attesting firing temperatures in excess of 900°C , and incipient liquid state sintering visible in some samples indicates that much higher temperatures were achieved. The Glastonbury crucibles are the highest fired of all those examined. All vessels from this site are partially vitrified.

The appearance of a carbon crucible formula in iron age contexts merits especial comment. Although no experiments have been made, it is logical to assume that, from a refractory viewpoint, crucibles of carbon would have behaved in a similar manner to graphite melting pots. Graphite,

also known as plumbago, is a grey, greasy mineral species of the element carbon. Graphite was incorporated into crucibles in Germany during the 18th century, and the formula was soon adopted by British crucible makers. "The life of a clay crucible is short. When once taken out of the furnace and allowed to cool, it cracks and is of no further use ... Plumbago can resist very high temperatures, and heat flows through it easily. When withdrawn from the furnace, a plumbago crucible does not crack, but may be used many times" (Bennett, 1956, 18). An advertising leaflet issued by the Morgan Crucible Company in 1862 claimed "... [the graphite crucibles.] great superiority consists in their capability of melting on an average of forty pourings of the most difficult metals and a still greater number of those of an ordinary character, some of them having reached the extraordinary number of ninety six meltings" (quoted in Bennett, 1956, 26).

It is clear from the analyses presented above that carbon crucibles were, in fact, in use some 2000 years prior to the claimed date of their invention. At Meare the stratigraphy is poorly defined, therefore it is impossible to ascertain whether carbon crucibles pre-date, post-date or were contemporary with those of sand. At Beckford, however, carbon crucibles appear to be restricted to middle iron age contexts. Why this seemingly superior formula should have been abandoned during the late iron age in favour of the weaker sand recipe cannot be explained.

Moulds

With the single exception of the extremely large assemblage from Gussage All Saints, very little iron age mould material is available for study. All clay mould of this period thus far recognised is derived from late iron age (2nd and 1st centuries BC) contexts, and all represents the cire perdue casting method. At present, nothing is known of the demise of bivalve technology and the inception of the lost wax process. No moulds have been recovered from any site dated between c 700 and c 200 BC.

During the latter part of the first millennium, iron was worked at most sites and had completely replaced^d bronze for most functional items. Bronze was, at this time, reserved for the production of small

ornaments, art objects, and a wide range of horse and chariot fittings. Aside from a possible pin mould from South Cadbury, all moulds identified to date were designed to cast terrets, bridle-bits, linch-pins and associated horse-gear.

Iron age mould matrices vary from completely isotropic and reduced throughout their thicknesses (as at Gussage) to partially isotropic and oxidised through all but the contact faces (eg Weelsby Avenue and Beckford). Mould makers appear in general to have followed similar formulae to those used for sand crucible production, although grains overall are finer, and more binding clay seems to have been added (Table IV.1.2). At South Cadbury, two mould recipes were in use, and it has been suggested that the finer of these invested the wax model, whilst the coarser and more porous may have been applied as subsequent 'outer' layers. A similar layered structure is noted through the thickness of the Weelsby Avenue moulds, but here no differences in inclusion suites could be detected. Two iron age grog-tempered mould fabrics have been recognised. South Cadbury Fabric 3 contains a scatter of crushed, low-fired ceramic, whilst the rare Gussage Fabric 4 contains both dense quartz sand and angular grog fragments.

Furnace

An ironworkers' hearth in close proximity to Pit 209 was uncovered at Gussage, and bowl-shaped forging hearths have been identified at several other sites, but as yet no bronzeworking furnaces have been recognised. The location of casting activities at British iron age production sites and the design of the melting furnaces are unknown. As at various bronze age sites, fragments of vitrified clay which may possibly represent furnace debris have been recovered in association with crucible and occasional mould sherds. A selection of such fragments from Meare, South Cadbury, Weelsby Avenue and Gussage has been analysed. Only at Gussage, however, are these definite indications of metalworking association, although even here it is unclear whether the analysed sample was derived from ironworking or bronze melting facilities. It may be predicted that materials used in furnace building would have been procured at or close to the production site. The nature of the Gussage sherd confirms this prediction, and fabrics of other hypothetical furnace

TABLE IV.1.2 SUMMARY DESCRIPTION OF REFRACTORY FABRICS AT IRON AGE SITES

Site	Crucible composition	Inclusions mean size grains	Mould composition	Inclusions mean size grains
The Breiddin	2. sand with sandstone (1 relined)	.094 56	As crucible Fabric 3 (1 sherd)	.057 42
	3. silt, sand, rare sandstone	-		
	4. sand and carbon (carbon dominant)	.037 53		
Mucking	2. sand	.133 81	6. as crucible Fabric 2	.133 66
	3. sand and carbon	.037 63		
Beckford	1a. carbon (rare silt)	.020 -	3. quartz with carbon 4. sand	.047 34 .079 75
	1b. as 1a, but with more quartz	.027 36		
	1c. carbon, quartz as 1a, with some larger grains	-		
	1d. sand and carbon	.090 31		
	1e. tabular carbon with sand	.031 26		
	2a. sand	.040 64		
	2b. sand with some carbon	.043 58		
	2c. sand	.031 71		
	1a. as Beckford 1a	-	stone mould: greisen, probably from aureole surrounding granite	
	1b. sand and carbon	.041 45		
Meare	1c. as 1b, with larger sand	.178 50		
	1d. sand and carbon	.076 66		
	2a. sand with sandstone	.102 74		
	2b. sand	.040 72		
	2c. silt, sand, sandstone	-		
	2d. as 2c with better sorted grains	.066 66		
Glastonbury	1. sand and fossil carbon	.023 59	sprue cup: as crucible Fabric 2	-
	2. sand	.031 66		
	3. sand with sandstone	.115 65		

Gussage	1. sand	•152	77	1-3. sand with sandstone	•120	65
All Saints	2. sand	•087	75	4. quartz and angular grog	•040	76
South	1. sand	•039	64	3. sand and grog	•034	60
Cadbury	1a. sand	•032	58	4. sand with some carbonate	•040	53
	2. sand and carbon	•027	58	sprue-cup: as crucible Fabric 2	•026	60
	2a. sand and carbon	-	-			
Weelsby	1. sand (containing varied minerals) with some carbon	•139	46	2. sand (variable composition)	•115	66
Avenue						
All Cannings	sand	•112	59			
Cross						
Candlestone	sand	•046	70			
Castle						
Carloggas,	sand	-	-			
St Mawgan						
Danebury	1. sand	•053	74			
	2. sand	•149	76			
Maiden Castle	sand	•141	62			
Merthyr Mawr	sand	•057	74			
Warren						
Salmonsbury	sand	-	-			
	sand	•068	60			
	sand with limestone	-	-			
Thetford	sand with carbon	•087	68			
Walesland	sand	•103	76			
Rath						

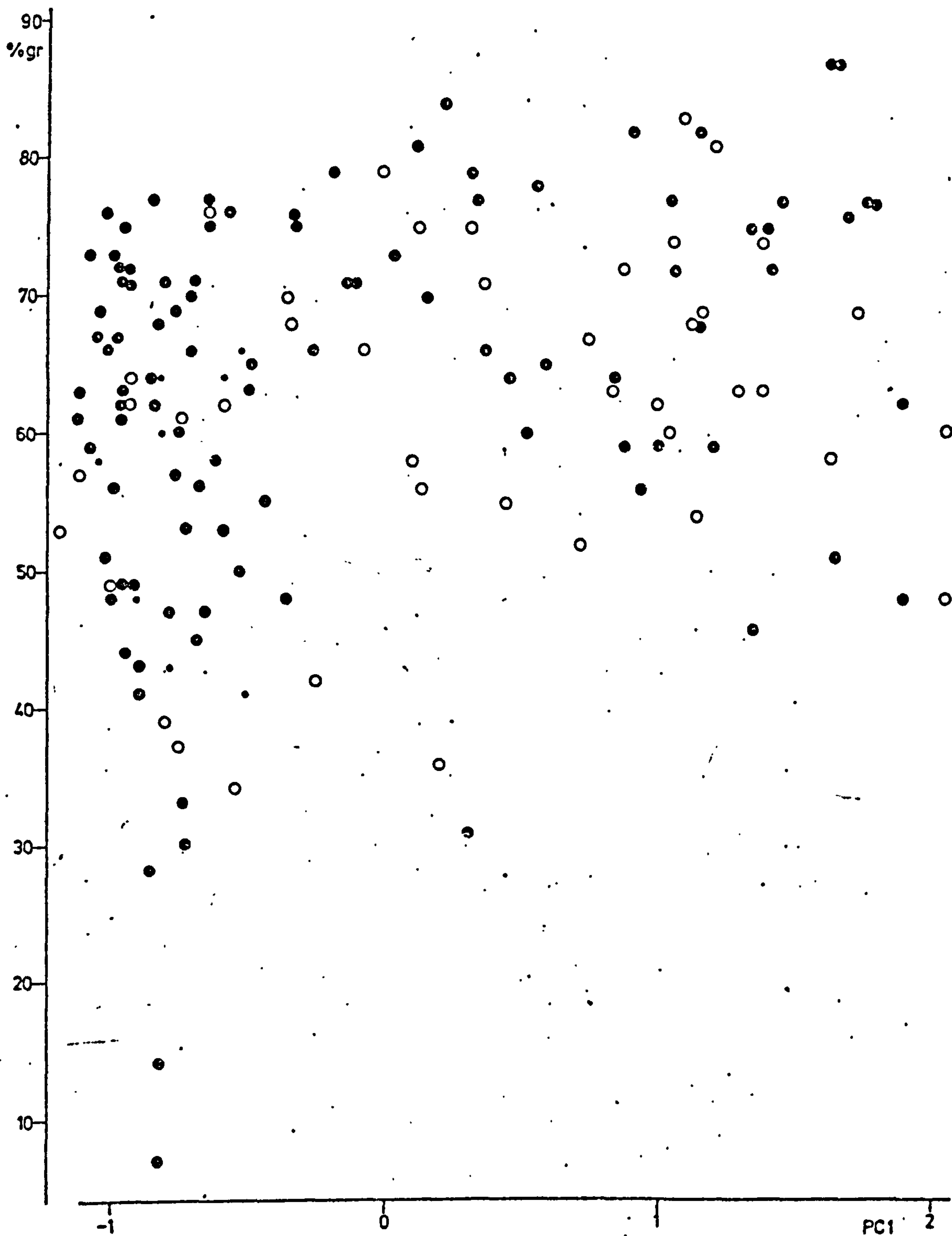


Fig IV.1.3 Iron age refractory sherds from the 17 sites analysed. Mould (O), crucible (●) and others (•) plotted according to grain size (expressed by scores on the 1st principal component extracted from the ϕ counts) and proportion of grains:matrix. The crucible sherds with relatively few inclusions (c 50% and below) contain proportionately greater amounts of carbon. cf Table IV.1.2

fragments would also appear to have a local derivation.

Tuyères

Whereas, aside from the distinctive artefacts from Mucking, no well-contexted late bronze age tuyères have been recovered, "tuyère" sherds have been found at several sites of iron age date. These range from the large subrectangular block from Glastonbury, to the narrow-bore pipe-shaped sherds recognised at, for example, Danebury, Hembury and Meare. The great disparity in form between these various artefacts suggests that, whereas until now all have been classed as tuyères (eg Tylecote, 1981), some terminological subdivision should be adopted.

It is proposed that the term tuyère be restricted to a self-contained artefact designed to receive the nozzle or tube of a bellows system. This tuyère could be inserted either into a specially constructed receptor embedded in or protruding from the furnace wall (fig IV.1.4a), or more simply, inserted directly into a hole in this wall (fig IV.1.4c). In the most complex situation, it follows that there could be three hollow ceramic constructs designed for the passage of air (receptor, tuyère and bellows nozzle). Unless unusually well preserved remains are uncovered, it could prove impossible to allocate a fragmentary ceramic object to one of these three categories. It may further be imagined that a tuyère, as here defined, could itself be dispensed with (fig IV.1.4b).

Viewed in the light of the above discussion, the object from Glastonbury (D 30) described by Bulleid and Gray as a tuyere may have been attached to a furnace (it is heavy, and the part nearest the fire is broken away) and thus can be described as a tuyère receptor. The Mucking bronze age specimens, however, appear to be discrete portable artefacts and therefore classifiable as tuyères. The total surviving evidence of forced-air furniture is, unfortunately, extremely sparse. A full understanding of both the items already discovered, and more generally the nature of furnace and bellows technology, await the recovery of further substantial remains.

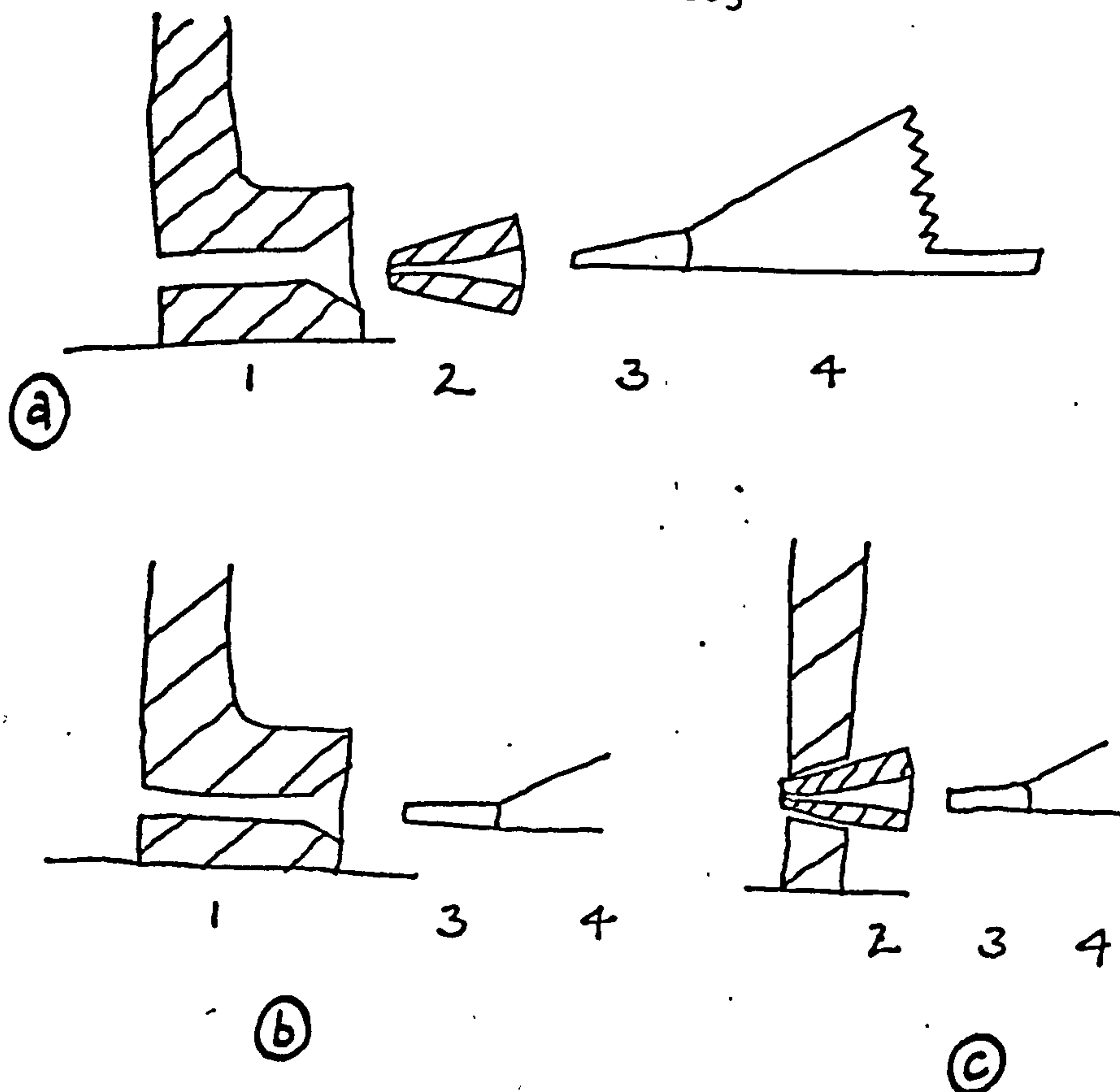


Fig IV.1.4 Provisional classification of forced air pipe furniture. 1 = receptor, 2 = tuyère, 3 = nozzle (4 = bellows).

Sprue-cups

These artefacts, designed to facilitate the entry of metal into the mould, have been positively identified at only two iron age sites (Glastonbury and South Cadbury). In each case, sprue-cups are made from material identical in thin section to a crucible fabric on the same site. At Glastonbury this fabric was sand tempered, at South Cadbury the sprue-cup was composed of sand and carbon. This contrasts with bronze age technology when sprue-cups (as, for example, at Fimber and Grime's Graves) were formed from mould pastes.

IV.1.4 Technological constraints and allowable variations exemplified in the archaeological record

It is clear from the data described in part III of this study and the discussion of these data presented in this chapter, that (1) the technological requirements of refractory production were clearly understood and met by prehistoric bronzeworkers, and (2) that a considerable degree of variation may be observed in the manner in which these requirements were fulfilled. Allowable variation in refractory form and/or materials (see Table II.2) has been noted and described at all sites studied in depth (part III chapters 2-15), and whilst many similarities may be observed between prehistoric, ethnographic and historical recipes and methods of manufacture, no attempt will be made here to search for precise parallels. Although intrinsically interesting, such an exercise would add little to current understanding of metalworking organisation in prehistoric Britain. As stated in parts I and II above, such evidence as exists concerning refractory production in historical and ethnographic contexts, was examined to gain an appreciation of the range of variation which might be expected in non-industrial bronzeworking.

It has already been stated that environmental and cultural factors govern the mode of allowable variation in refractory production. Whilst it is possible (through raw material survey and analysis) to acquire information relative to the environmental constraints on material variation, it is almost impossible to understand any of the cultural factors governing the choice of particular materials from within that environment. Non-technological factors controlling variety in form remain equally elusive.

It is unfortunate that other than the highly vitrified crucible sherd from All Cannings Cross and the conjectured bronze age/iron age transitional vessel from the Breiddin, no refractory evidence has been recovered from sites dated between 700 and 400 bc (this is the minimum possible date gap based on radiocarbon determinations). Aside from the earlier material from Beckford, all securely dated iron age production sites were occupied during the final two centuries BC. This lacuna in the data prohibits any investigation of the dramatic changes which took place

between the period of economic dependence on bronze, and the full iron age. Whilst the process of change cannot be documented, it is instructive to compare the different technologies of each period, and the implications this technological variability may have for the organisation of the metalworking industry as a whole. Of all refractories, tuyères have been subjected to the most extensive ethnographic study, thus it is exceptionally unfortunate that so few examples have been recovered in Britain. The selection of special clays for tuyère production and the symbolism vested in the manufacture, use and disposal of these artefacts (as described in parts I and II) must remain purely conjectural in prehistoric contexts. Furnaces too are well documented in the ethnographic literature. Furnace building is often a communal affair and an occasion for ceremony. Although furnaces consume large quantities of raw material (principally clay), their lifespan is often short. A short lifespan coupled with frequent rebuilding and perhaps resiting, may account to some extent for the lack of furnace remains on British sites.

Information concerning the technology of refractory production in both bronze and iron ages is perforce derived almost exclusively from two categories of artefact: crucibles and moulds. During that period conventionally known as the later bronze age, all metal tools, weapons and ornaments were cast in, or beaten from bronze. Crucibles were of large capacity to allow the casting of substantial implements. Moulds, all bivalve, were made from stone, bronze or clay. All bronze age crucible and mould recipes identified to date, differ from site to site and represent the skillful selection and preparation of materials local to the smith's work place. The bronze age smiths were clearly in command of sophisticated knowledge of the technological constraints on each functional artefact category, and were able (probably after considerable experimentation) to assemble compounds of local materials to conform to these constraints. Choice of ingredients from those available would be partly or completely governed by 'cultural' parameters, which at this stage cannot be fully understood. The selection of igneous rock temper for the outer moulds from Fimber (there is no valid technological rationale behind this choice) exemplifies this 'cultural' influence.

By the middle iron age period, bronze casting was restricted to

small ornaments, art objects and horse-gear. Bivalve moulds had completely disappeared and been replaced by cire perdue casting technology. Crucibles were regularly triangular, smaller than their bronze age predecessors, and perhaps most significantly, were produced according to three basic formulae: sand (the predominant fabric); sand and carbon; and carbon. Crucibles in these three fabrics occur throughout Britain, irrespective of local geology.

Similarly standard formulae were followed for cire perdue mould production. With rare exceptions, moulds at all sites were formed from sand with a slightly higher proportion of binding clay than is observable in the associated melting vessels (Table IV.1.2).

When, however, inter-site comparisons are made between average grain size and matrix densities of both crucibles and moulds, considerable overlap is observed. This suggests that although the same formulae were followed at each site, the smith was dependent upon the clays and sands in his own area for refractory production. The sporadic occurrence of quartzite, sandstone, chert and diverse detrital grains, together with variations in matrix mica content support this hypothesis. The results of limited heavy mineral analysis, and the positive identification of the Glastonbury crucibles fabrics with the fire-clays of the Bristol Coalfield, the Weelsby Avenue moulds with the coastal Boulder Clays, and certain Gussage refractories with the Bagshot Sands, provide further confirmation of the exploitation of local resources.

However, whereas the bronze age smith explored and exploited the local environment, eventually producing a paste to comply with well understood technological constraints, the iron age smith sought raw materials in his locale with a standardised formula in mind. Without denying that the iron age bronze caster understood refractory constraints, it is suggested that because of the availability of standard formulae, his knowledge of these constraints need not have been as sophisticated as that of his bronze age counterpart.

Furthermore, as the standard formulae stipulated specific ingredients it was not necessary for the iron age smith to possess such

an intimate knowledge of his environment. Iron age bronze casters could, conceivably, have moved from area to area producing crucibles and moulds from locally available sands and clays. Carbon recipes, whose major ingredient is manufactured, release the smith still further from local geological constraints.

IV.2 THE ORGANISATION OF BRONZE CASTING IN PREHISTORIC BRITAIN: INTRODUCTION

Constraints on the manufacture of bronze casting equipments and allowable variations within these constraints were considered in part II of this study. The production of refractory artefacts in prehistoric Britain was described in part III, and spatial and chronological variations in technology (relating in part to casting organisation) were discussed in IV.1 above. It is now time to leave aside those facets of production which are directly dependent on technology and consider the bronze casting industry in pre-Roman Britain at a broader level.

An attempt has been made to investigate metalworking organisation at individual settlements (III.2-15), but it is clear from the discussions following the site analyses that limited inferences can be drawn from the archaeological evidence alone. My study of the wider aspects of metalworking in ethnographic contexts (part I above), was undertaken with two main aims in view. It is appropriate to reiterate those aims here:

1. to appreciate the overall organisation of the metallurgical industries in varied settings, and to examine the relationship between the craftsmen and their parent societies;
2. to identify, within this overall picture, those aspects of production organisation which appear to have broad application, but which are not necessarily functions of technology (status of smith, hereditary nature of the craft, pattern of work etc).

From the analyses undertaken in pursuit of these aims, it was possible to draw a series of generalisations (I.7), which together provide a working framework within which to view bronze casting organisation in prehistoric Britain.

It was hoped, at the outset of this project, to consider the changing

organisation of the bronze casting industry during that period when man was relinquishing bronze and adopting iron as the primary material for tool and weapon production. However, the paucity of relevant archaeological data representing this period precluded any investigation of the process of change. Aside from a single crucible sherd from All Cannings Cross, well-contexted production evidence is rare on sites dated between c 700 and 400BC. It was during those three centuries or so that the change in metal dependence took place. Although the process of change cannot be documented, the archaeological record (viewed in the light of the generalisations drawn from ethnography) does, however, permit the formulation of organisational models for the later bronze and later iron age periods. Comparison of these models at least permits the effects of change to be assessed.

The term industry, as defined above (p 9), encompasses "a social setting, a production process and organisation, and a range of finished products". Certain aspects of industry thus defined have universal application. These are: specialisation; and a system of transactions involving both production in response to demand, and disposal of products. Although discussed in detail elsewhere in this study, it is pertinent to remind the reader of these concepts prior to proposing detailed models relating to bronze age and iron age metalworking.

Specialisation has been broadly defined as differential access to skills and raw materials (p 14). Comparisons have shown that the range of raw materials and diversity of sophisticated skills required to cast a single item in bronze far exceeded those necessary to produce most other categories of pre-industrial artefact. According to the above definition, the bronze caster, irrespective of time period, is essentially a specialist. The ensuing consideration of casting organisation in the bronze and iron ages is thus a consideration of a specialist craft. Refinements of specialisation pertaining specifically to metalworking (specialisation according to metal, activity or product) will be referred to where appropriate in the following pages.

The importance of demand has been stressed throughout this study. Production and distribution are both direct consequences of demand. Demand is an active response to functional need, either utilitarian,

symbolic or both. The nature of functional needs is determined by the social, ritual and economic organisation of the society in which they are embedded. The expression of demand which results in the production of a particular item, and the process by which that item enters the consumption network, have both been termed transactions. Transaction systems relating to the specialist craft of bronzeworking are determined by the total social contexts in which they operate, and will vary from society to society. Although transaction systems necessarily surrounded production at all bronzeworking sites included in this study, very little can be understood of the articulation of these systems. "Total social contexts" are at present unavailable to the archaeologist.

On the positive side, the examination of archaeological data in the light of generalisations drawn from an extensive survey of the metalworking industry in other contexts, has permitted the formulation of broad models relating to the operation of this industry in prehistory. Similar studies relating to other industries (even farming is poorly understood) would inevitably lead to a more comprehensive understanding of production systems, and on a broader level, the societies within which these systems operated.

IV.3 THE ORGANISATION OF BRONZE CASTING
IN PREHISTORIC BRITAIN:
THE LATER BRONZE AGE

"Man makes himself; but bronzes are not as versatile"

(Bradley, 1980, 58)

IV.3.1 The model

On the basis of all currently available production debris, and data derived from the ethnographic record, it is proposed here that three major forms of casting organisation were operative during the later bronze age in southern Britain.

Class 1: smiths producing weapons and ornaments were resident with a fixed workshop, were patronised, and used exclusively non-portable, non-reusable clay moulds.

The class 1 smith cast complex prestige artefacts, perhaps in considerable quantity, in response to the changing demands of his patron. He would therefore have required an adaptable mould technology, exploiting readily available refractory materials. Clay is the only material which allows complex casting, and clay is the obvious medium to meet a changing demand for artefact styles. Resident smiths would have needed a detailed knowledge of local resources, and to be in a position to obtain supplies whenever the need arose. Clay moulds would thus be produced from carefully selected refractory materials local to the workshop site. Crucibles too would have been locally produced, but here, because of more rigorous technological constraints, and because crucibles can be reused, the smith may have been prepared to travel a little further for his clays and fillers.

Class 2: smiths producing tools, principally axes, in bronze moulds were locally itinerant, operating within a limited area and perhaps affiliated to a particular socio-political unit. Crucibles and new bronze moulds were either made periodically at a good

refractory source, well-known to the smith: and located within his area of operation, or, alternatively, supplied by resident (class 1) smiths, perhaps in exchange for metal or axes

For the class 2 smith, bronze would have been the most suitable mould material. Bronze moulds are portable, non-breakable, reusable, and can be recycled at the end of their working life. As the itinerant axe smith was probably producing large quantities of basic functional implements, frequent stylistic change would not have been a crucial factor. Furthermore, the use of a bronze mould would have allowed the smith to operate in areas where his limited knowledge of, and perhaps access to suitable refractory resources, would have prevented him from producing moulds of clay.

Class 3: smiths, producing axes from moulds of specially selected stone, were long-distant itinerants, perhaps operating on an annual cycle

Late bronze age axe moulds were also produced in stone. Like bronze, stone moulds are portable, durable and can be used for repeated castings. Smiths using moulds of bronze or stone require no detailed knowledge of sand and clay resources. This is of crucial significance if a widespread itinerant circuit is envisaged. The selection of stone, rather than bronze for mould production is difficult to explain. The energy expenditure in seeking a suitable stone, in roughing out the block, and in chipping and carving the matrix, far exceeds that required for the production of a bronze mould. Furthermore, a stone mould cannot be recycled when broken or redundant. Other than the possibility of multiple castings (Needham, 1981), there would appear to be no practical reason for itinerants to prefer moulds of stone to moulds of bronze. It is suggested that these class 3 smiths were conforming to a rigidly defined 'cultural' tradition, and may have belonged to a specialist metalworking caste.

The definition of these three smithing classes involves specialisation by product (weapons vs tools), indirect specialisation by material (stone vs bronze for tool moulds; clay for weapon moulds), a range of work patterns (residency, local vs long-distant itinerancy) and the question of patronage. Prior to discussing these broad aspects of organisation, however, it is first necessary to set out the archaeological

evidence which supports the above, tripartite model.

IV.3.2 The archaeological evidence

The predicted contexts of deposition of the various categories of bronze casting equipment have been described in II.1.2 above. With very few exceptions, recovery contexts match these predictions (fig IV.2.1).

All clay moulds found in southern Britain have some settlement associations. No structural evidence has yet been located at Fimber, but the mould material (from two small pits) was accompanied by pottery and bone, suggesting some form of habitation. It is clear from the analytical evidence presented in part III and discussed in IV.1 above, that all ceramic moulds and crucibles were produced from materials available within the vicinity of each production site. The smiths possessed a sophisticated knowledge of local resources and were able to select appropriate materials from within this resource range to produce each different category of refractory artefact. Such detailed knowledge would only be available to a resident smith.

A small proportion of the extant bronze moulds are uncontexted, but the great majority occur in founders' hoards. No bronze moulds have been found on habitation sites. Whilst it is feasible, and indeed likely, that the mobile smith worked in the vicinity of settlements (proximity to customers), it is difficult to envision circumstances in which he would have abandoned his bronze moulds at his work place. When of no further use, these moulds would have been remelted or cached for recycling at a future date. The recovery pattern of these artefacts in caches away from settlements lends support to the theory of itinerancy.

Of the eleven later bronze age stone moulds (or mould groups) recovered to date, five are associated with settlement evidence, whilst the remainder are uncontexted (fig IV.2.1). Like the bronze mould users, itinerants casting from stone moulds would have set up workshops close to centres of custom. However, as stone moulds cannot be recycled when redundant, they would be abandoned at the final casting site. The association of stone mould finds with settlement evidence supports this

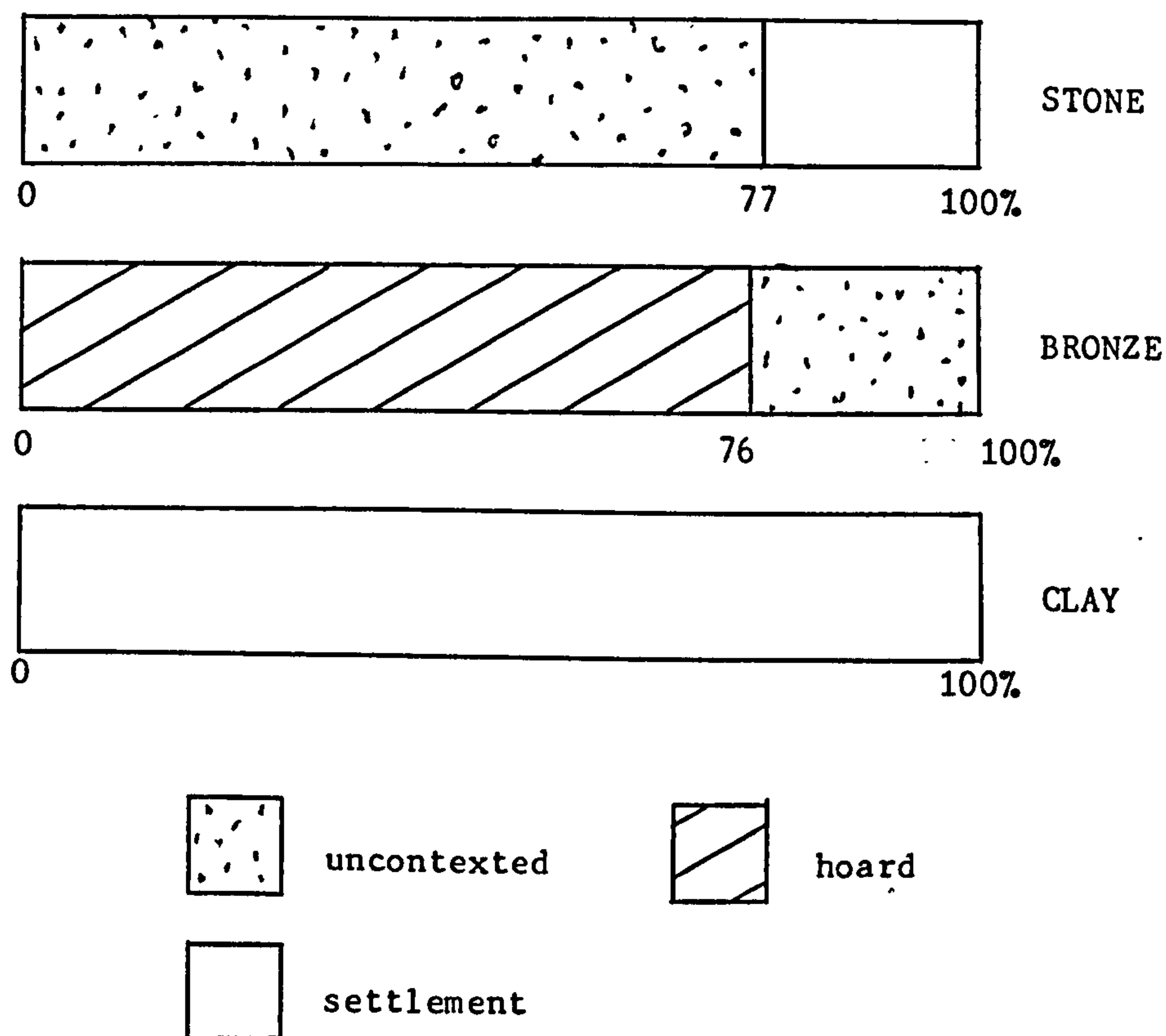


Fig IV.2.1 Later bronze age mould recovery contexts.

hypothesis. Although durable, stone moulds can be broken, and if damaged beyond repair in transit, would be abandoned where they lay. This may explain the occasional 'stray find', although the possibility of unlocated settlement associations cannot be discounted (Needham, 1981, 14, 53). The geographical occurrence of materials selected for stone axe mould production is restricted, and this, together with the high energy input required to manufacture a stone mould, would ensure careful curation.. One of two greisen mould fragments from Ham Hill (presumably the final casting site) had been repaired in antiquity (fig III.16.6).

The majority of late bronze age stone moulds recovered to date have been analysed petrologically. When the predicted rock sources are compared with the mould find spots, it is clear that considerable movement took place. This movement is most plausibly explained by the peregrinations of a mobile smith.

The most recent discovery (the stone axe mould fragment from Everley Water Meadow: III.16, p 370) was found with abundant charcoal, burnt flint, and an almost intact clay core, probably from a socketed axe. Everley Water Meadow could well have been the site of a workshop on an itinerant circuit. Although at the time of writing this piece has not been examined in thin section, macroscopically it resembles the mould fragments from Burderop Down for which a south Welsh or south western origin has been proposed.

As to the artefacts produced, the vast majority of the identifiable clay matrices are for weapons (fig IV.2.2). Ornament moulds and moulds for "art objects" are poorly represented, and only four fragments of clay axe mould have been recovered in southern Britain. With the exception of a single gouge mould, all bronze moulds recovered to date were designed to produce socketed axes of various forms. Five of the extant late bronze age stone moulds were intended for the production of a particular axe type, described as Stogursey axes (Needham, 1981).

This evidence clearly implies that tool and weapon production were each organised in a separate manner, and thus provides additional support for the tripartite smithing model proposed here. Typological and distributional studies of metalwork, particularly of middle bronze age date, have led other writers to predict a similar disparity between the organisation of utilitarian tool production and the manufacture of prestige items, principally weapons. From his exhaustive analysis of middle bronze age metalwork, Rowlands (1976) was able to demonstrate a range of tool styles, each with a narrow, regional distribution. No such localised groupings could be discerned for the distribution of spearhead and rapier forms. Similar weapon styles occur over much wider areas, and these areas cross-cut and overlap the "local tool zones" (Rowlands, 1976, 164). Rowlands proposed that "a separate category of weapon smiths may have existed ... operating in different economic

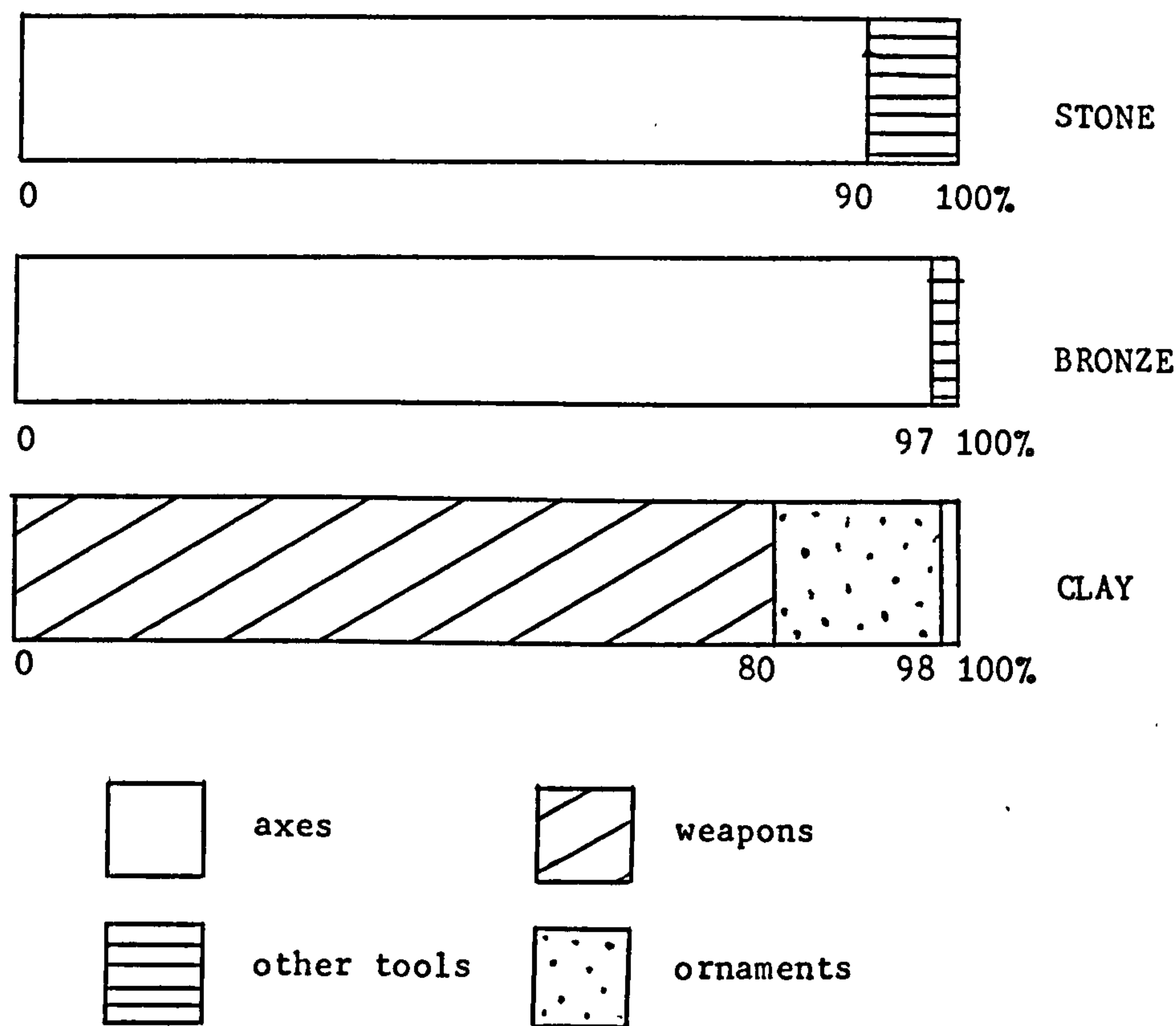


Fig IV.2.2 Later bronze age identified mould matrices
(numbers for clay moulds estimated)

economic conditions from the more locally based craftsmen" (Rowlands, 1976, 168). As an example, he suggested that such a category of smiths may have been active in East Anglia, where large basal-looped spearheads are widely distributed (Rowlands, 1976, 64). It is possible that the clay moulds from Grime's Graves (III.2), all designed to cast channel-bladed, basal-looped spearheads, represent a centralised weapon smiths' workshop.

The concept of different smithing organisations related to different product categories has been reiterated in a recent study of middle bronze age regional exchange (Ellison, 1980). Here, Ellison, drawing

heavily on Rowlands' earlier work, postulated different modes of production for three categories of metalwork (weapons, ornaments and tools), and three categories of ceramic vessels, functionally defined as "fine wares", "everyday wares" and "heavy-duty wares". She was able to resolve the six different levels of production into five modes of distribution, three of which involve metalwork. "Weapons involved the most complex methods of specialist manufacture and probably functioned as prestige items which were distributed through a complex system of ceremonial exchange networks between high-ranking individuals; ... ornaments ... were probably produced by part-time seasonal specialists working within territories of varying size; ... As in the case of ornaments, tools and fine wares were probably produced by part-time specialists, but the scale of production is more local ..." (Ellison, 1980, 137).

To date, no comprehensive corpora of late bronze age metalwork have been published, and explicit morphological studies of specific artefact types are exceedingly rare. Nonetheless, the limited published evidence suggests that with the possible exception of ornament making, middle bronze age production traditions continued into the later period.

Frequent attention has been drawn to regionalised distributions of individual socketed axe forms. Moore and Rowlands (1972), for example, describe a series of distinctive decorative variants of the plain "south-eastern axe". Pellet-ornamented axes occur mainly in Kent, Surrey and Essex; axes with both ribs and pellets are confined to Norfolk, and a distinctive semicircular decorative motif appears only on axes from Sussex. Bronze moulds for these Sussex axes have been found in the Wilmington hoard and at Worthing. "The very localised distribution of these decorative forms suggests that axe casting in south England was based on a number of fairly limited areas within the region" (Moore and Rowlands, 1972, 30). The Figheldean Down hoard (Wiltshire: SU 192493) contains only socketed axes of the "Sompting" type as defined by Colin Burgess (1969). Coombs (1979) distinguishes five broad decorative variants within this assemblage, representative of distinct regional groupings. In addition to the decorative groups defined by Moore and Rowlands, Coombs also recognised axes related to other regional styles. Axes with ribs joined by chevrons are limited to Lancashire, Nottinghamshire and Yorkshire,

and "box-patterned" axes appear only in the Thames valley (Coombs, 1979, 262-62). O'Connor (1980) similarly describes the localisation of axe styles (eg O'Connor, 1980, 161-68) and contrasts this pattern with contemporary weapon distribution. "The distributions of axe types are often confined to small areas, while the distributions of weapon types cover much larger areas ... [for example] socketed axes against Ewart Park swords during LBA3; the regional variations of ornament on Sompting axes of LBA4 against the distribution of Hallstatt bronze swords with all subdivisions widespread" (O'Connor, 1980, 303). According to O'Connor, this variation in distribution patterns "implies the existence of a warrior class, the production of whose weapons was more standardised and less localised than that of axes. These warriors must have exercised some dominance in society and should have been able to command the resources to obtain metal for their weapon-smiths and to distribute their products over a wider area than those of the tool-smiths" (O'Connor, 1980, 305). Coombs interprets late bronze age weapon hoards as reflections of an aristocracy with rights to the ownership of swords, horse-riding equipment, prestige non-military artefacts such as cauldrons, spearmen ... and a smith (Coombs, 1975, 77). Northover, considering the technology of production, has also suggested a two-tier hierarchy of late bronze age smithing organisation. He proposes that various modes of tool production may have been in operation, perhaps involving independent, itinerant smiths. Weapons on the other hand (because of the complexities involved in their manufacture) were more suited to semi-permanent centralised production controlled by an élite (Northover, 1982, and nd). Moore and Rowlands have also acknowledged that the casting of a sword in a mould of clay is more complex, and demands a greater range of skills, than does the casting of a simple axe in a pre-formed bronze mould. On this basis, and with considerable foresight, they suggest that "some form of social hierarchy grew up amongst bronze smiths during the late bronze age. "Axesmiths", because they used portable moulds, could easily have travelled round the countryside ... the position with "swordsmiths" using clay moulds was very different. Because the clay for each casting could only be used once ... "swordsmiths" were restricted to areas where suitable clay was available. They are likely to have been much more static, probably having their own workshop" (Moore and Rowlands, 1972, 33).

This interpretative model was based almost exclusively on metalwork typology and rare examples of bronze moulds. At the time of writing (c 1970) clay moulds were known only from Fimber, Jarlshof (Shetland), Traprain Law (Lothian) and occasional Irish sites. No bronze age crucibles were known. Yet, Moore and Rowlands' "axesmiths" and "swordsmiths" correspond on a broad level to the class 1 and class 2 smiths proposed in the present context.

In sum, it is clear from all the archaeological evidence presented here, and from the distribution of the various classes of metalwork discussed by other writers, that tool making and weapon production were subject to different organisational constraints. Localised groupings of axe styles, together with the bronze mould evidence strongly suggest that these functional implements were manufactured by a locally itinerant smith or smith group. Virtually all clay moulds were designed for weapon production, all are formed from locally available materials, and all are derived from settlement sites, suggesting the presence of a skillful, resident, weapon smith working under élite patronage. Although the distribution of late bronze age ornaments has not been considered in detail, it would seem from the mould evidence, that these too were produced by class 1 smiths rather than by the "intermediate" craftsmen envisaged by Ellison for the middle bronze age.

The identification of class 3 smiths is based on the results of a recent study of late bronze age stone moulds designed to produce Stogursey axes (Needham, 1981). These axes and their moulds (termed Bulford-Helsbury moulds after two findspots which represent regional groupings) are distinguished by both typology and technology of production, and although minor variations exist (such as variable length: width ratios), no subgroups can be clearly defined (Needham, 1981, 32). All moulds for Stogursey axes recovered to date are of stone, suggesting a distinctive production technology for this particular axe form. Dating evidence, based on associated material, indicates that this production technology began sometime during the 10th century BC and continued unchanged throughout the late bronze age (Needham, 1981, 34). The main concentration of Stogursey axes occurs in south east Wales (where, as yet, no moulds have been found), but similar products have been recovered throughout Britain south of the Wash. The distribution also extends into

northern France (Needham, 1981, 40).

The location of stone moulds designed to produce this axe type bears minimal relationship to the distribution of the products (fig IV.2.3). Petrological analysis and macroscopic examination has shown that two rock types were preferred for the manufacture of Bulford-Helsbury moulds. The three mould components from Helsbury in Cornwall (p 471) were made from chlorite-schist or talc-chlorite-schist. The Gwithian mould (p 471; examined macroscopically) also appears to have been carved from this material. Chlorite-schist outcrops in Cornwall and a relatively local source is suggested for these south western moulds. Bulford-Helsbury moulds from Surrey and Wiltshire, on the other hand, were all manufactured from rocks of the keratophyre suite. These rocks are plentiful in south Wales, but are also known as minor intrusions in the south west peninsular (Needham, 1981, 26).

Although caution must be exercised in formulating hypotheses on the basis of a comparatively small group of material, the manufacture of distinctive axes from moulds of clearly non-local rock would appear to argue for a specialist technology controlled by a group (or groups) of long-distant itinerant smiths.

The possibility of widespread itinerancy during the British later bronze age raises several questions and problems, many of which are impossible to discuss in depth on the basis of available evidence. One such problem concerns the relationship between peripatetic stone mould using smiths and their resident and locally itinerant counterparts. Needham, considering the situation in Surrey where good metalworking evidence is available, has argued for the presence of resident smiths at Runnymede Bridge (Needham and Longley, 1980; and see above, III.7). He further suggests, from the Bulford-Helsbury mould evidence (from Petters' Sports Field: p474) and the metalwork (which includes examples of Stogursey axes) that "a degree of tolerance was directed towards intrusive minority smith groups by the existing well-established Thames Valley industry" (Needham, 1981, 52). Unfortunately, evidence from other areas permits little further inference concerning inter-group relationships. How the long-distant itinerant smith obtained his moulds (did he make them himself? did he acquire them from a specialist stoneworker?) and his crucibles (did he obtain them from the resident smiths at settlements

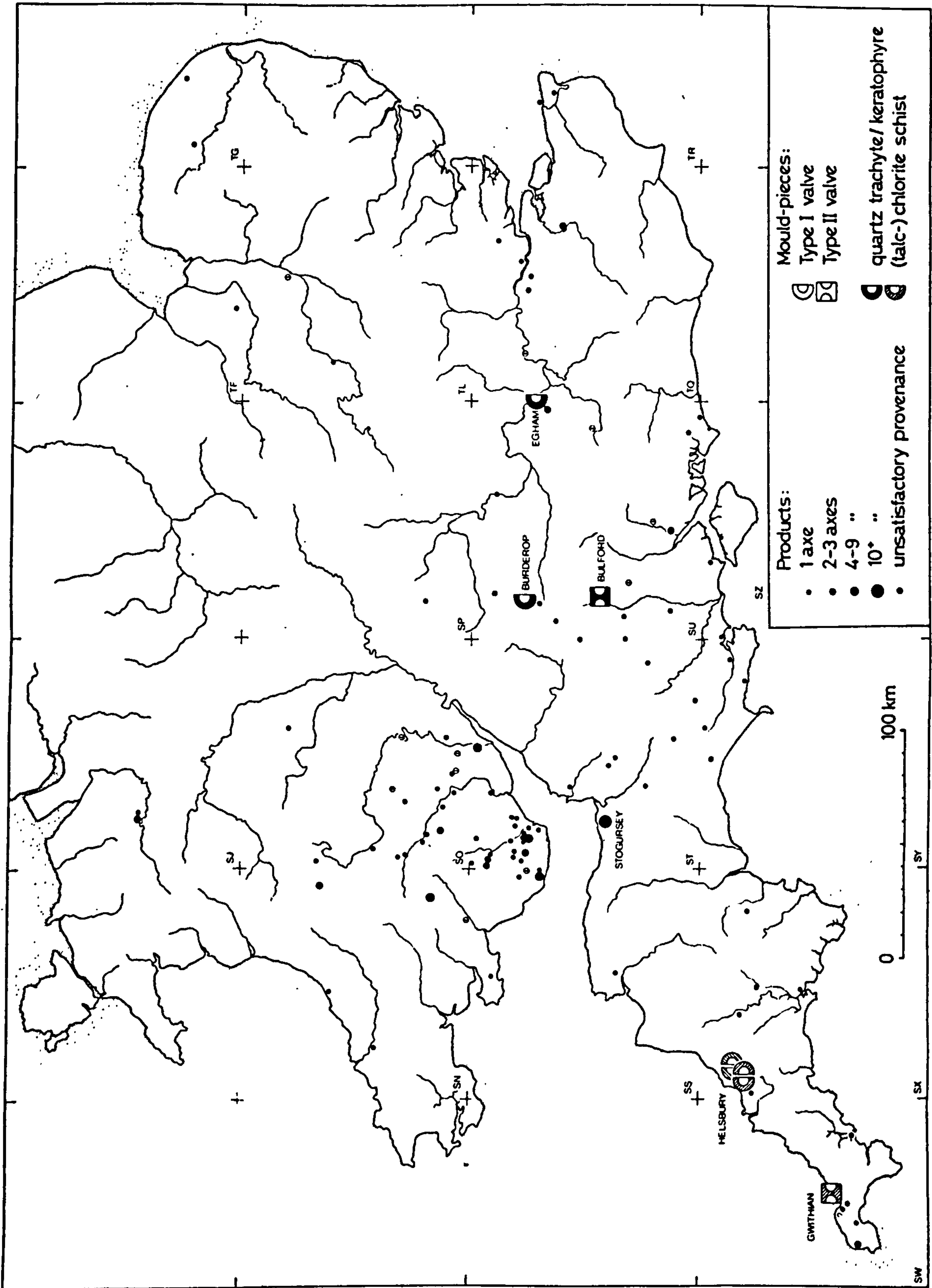


Fig IV.2.3 (after Needham, 1981)

The distribution of Bulford-Helsbury moulds and Stogursey socketed axes in Southern Britain.

where he operated? did he make thme at a known refractory source along his established route? did he carry along dry refractory materials to be reconstituted and formed into crucibles when necessary? - the Burderop Down crucible argues for vessel or material transportation: p 439) are further problems which cannot, at present be resolved.

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I have here proposed a tripartite model of bronze casting organisation in later bronze age Britain. I would not, however, venture to suggest that this model be regarded as absolute and definitive. Flexibility and spatial and chronological variation within the system must have undoubtedly existed, and the model is open to elaboration and refinement as more evidence comes to light. Four clay axe mould fragments (two from Fimber, and one each from Gwithian and Runnymede) already suggest a further degree of organisational complexity. These moulds, as far as can be ascertained (only the Gwithian mould has been petrologically analysed), were produced in fabrics different from the remaining clay moulds at each site. It is conceivable that these clay axe moulds may represent a fourth mode of smithing organisation, as yet not understood.

IV.3.3 Later bronze age casting organisation: the broader aspects

The concept of the itinerant smith was popularised by Childe in the 1930s and 1940s. Childe maintained that all smiths were full-time specialists (Childe, 1942, 77) and were supported by surplus production. Their livelihood depended upon their skills which they could exchange for food. This technological emancipation meant that smiths were free to detach themselves from their tribal unit and travel at will, seeking markets for their skills (Childe, 1940, 163; 1942, 78). Childe thus envisioned a separate, detribalised caste of metalworkers, moving freely over the countryside of Britain and Europe, producing tools and weapons on demand in exchnage for foodstuffs. A concomitant of this widespread itinerancy would have been the general diffusion of ideas, and Childe stressed the overall uniformity of early bronze products as an indication of such diffusion (Childe, 1958, 169-70).

Diffusionist ideas were extremely fashionable in the first half of this century, and those who embraced such ideas eagerly accepted Childe's concept of the itinerant smith. Henderson, for example, following Childe, interpreted "Continental" bronze types in Britain, "either as the work of itinerant British smiths who had travelled in Europe and returned to copy the bronzes they had seen there, or, alternatively, as the products of continental itinerants visiting Britain in search of raw materials (Henderson, 1938, 155). Clark too, seeing itinerant metalworkers participating in pan-European trade of rare and valuable goods (another theory proposed by Childe), states that "knowledge of metal-smithing was not diffused among the peasantries of Europe out of sheer zeal for improving the barbarians, but as an outgrowth of trade in such commodities as copper, tin and amber ... It was the travelling smith who was capable of teaching the neighbours how to copy imported bronzes" (Clark, 1952, 256-57).

"Invasions" and diffusionist ideas, and the concept of the detribalised itinerant smith retained popularity until the early 1960s, although the underlying ideas were never really examined or developed. Bersu, on the basis of very little evidence, applied Childe's theories, piecemeal, to iron age metalworking. "The scraps of slag are evidence that wandering smiths ... occasionally visited the settlement" (Bersu, 1940, 100). In Ireland, Raftery described special huts in forts and citadels which were reserved for the exclusive use of travelling smiths (Raftery, 1951, 30). Referring to elements of the Woodbury Culture, Hodson again espoused the ideas of Childe: "It is not impossible that schools of metalworkers formed a society of their own, unrelated to the basic settlement pattern" (Hodson, 1964, 107).

Alongside the death of "invasions" and the declining interest in diffusionism in the 1960s and early 1970s, came the demise of the itinerant smith. Rowlands, drawing on ethnographic data from a wide range of small-scale societies explored metalworking as a separate cultural institution, and isolated various aspects of this institution for detailed study. In doing so he examined and questioned many of the concepts upon which earlier archaeologists' theories of metalworking organisation were founded (Rowlands, 1971). In particular, he investigated the dependence (or otherwise) of the smith in the society in which he

works; seasonal (as opposed to full-time) production in relation to demand; itinerancy (and the concept of the detribalisation), the smith's status (Childe (1930, 4) believed all smiths to be privileged high status members of prehistoric society); clan or caste affiliations of the smith; specialisation (by product and by activity); and product distribution.

It is significant in the light of the model of bronze age casting organisation presented above, that Rowlands was able to find but one example of Childe's free-travelling itinerant smiths. Local itinerancy was attested, although the organisation and pattern of work were found to be variable. Since the publication of Rowlands' paper, the concept of the peripatetic metalworker has been gradually shunned by archaeologists. The possibility of local itinerancy is sometimes admitted (eg Burgess, 1980, 274; Lawson, 1980a, 281; Needham, 1980a, 214), but the free-ranging, perhaps detribalised metalworker is now a mere spectre in the halls of archaeological history.

Rowlands' ethnographic data were drawn mainly from ironworking societies, and although rare metal working was considered, little attempt was made to investigate differences in organisation related to groups specialising in specific metals. In the analyses of metalworking in ethnographic contexts undertaken in the course of the present study, maximum attention was focussed on rare metal working groups. This focus permitted the definition of organisational patterns which Rowlands had not examined in detail. In addition, since Rowlands' paper was published, a number of major studies of metalworking organisation have appeared, notably Neaher's (1976) study of the long-distant itinerant Awka smiths (bronze and iron), and Brown's (1980) comprehensive assessment of smithing in Kenya.

Although the study of material additional to that considered by Rowlands, served mainly to expand Rowlands' general conclusions and record even more complex organisational systems, a major contribution concerned the whole question of itinerancy. Itinerant smiths, with varying work patterns, are not in fact as rare as supposed. Furthermore, the long-distant itinerant, even "detribalised", can be seen in recent descriptions of practising smithing groups.

It now remains to use the various generalisations drawn from ethnographic research (I.1.7), to elaborate the tripartite model of smithing organisation proposed above. These generalisations, it will be recalled, concern the overall organisation of metalworking at a level that is always difficult, and often impossible to recognise in the archaeological record. The consideration of these generalisations, however, in conjunction with "material" data permit a more detailed interpretation of the "particular archaeological phenomenon under study" (Rowlands, 1971, 210), namely, bronze age metalworking. In the ensuing section, references will be made (eg "G7") to the generalisations set out in I.1.7 above.

The class 1 smith

Status The class 1 smith, producing prestige goods (weapons and ornaments) under élite patronage, would have been accorded high status (G14). Thus all resident bronze smiths versed in clay mould technology, recorded in this study, would be high ranking members of their social group.

Specialisation by product High ranking class 1 smiths specialise in the production of weapons and ornaments in accordance with the demands of their patrons. Complex social systems generate high demand, and thus complex product specialisation (G12). The homogeneity of the Grime's Graves mould assemblage (III.2) could indicate complex regional product specialisation. It may be speculated that an élite society controlling a wide area of East Anglia supported various smithing groups, each specialising in the production of a different category of prestige artefact. At Mucking (III.8), two smithing groups, each specialising by product (sickles at North Ring and spearheads and swords at South Rings), may have operated contemporaneously. This product specialisation is likely to have resulted from a high level of demand. Specialisation by product may again be predicted at the complex, high status site at Runnymede Bridge (III.7). Although only fourteen moulds have been positively identified thus far, a wide range of cast artefacts and five mould fabrics have been recognised. Analysis of weapon and ornament mould fabrics is required to test the hypothesis of complex product specialisation.

Pattern of work The ethnographic data have indicated that resident, patronised smiths work full-time at their craft, and do not participate in subsistence activities (G17-G21, G25). These data, as stressed above (passim) have, perforce, been drawn from societies using both bronze and iron. However, as little is known of the rate or context of demand in a society exclusively dependent on bronze, it is impossible to predict that a similar work pattern applied in the British later bronze age. It is feasible that demonstrably complex settlements such as Runnymede Bridge may have supported full-time smiths. However, at sites such as Dainton, the Breiddin and Beeston Castle (where virtually nothing is known of social organisation) although full-time weapons production may have taken place, it is equally possible that demand was sporadic, and the smiths, though patronised, may have participated in other activities.

Co-operative activity There are no solitary smiths. All smiths have at least one assistant, usually an apprentice (G31). This generalisation may be applied to all classes of smith proposed here. Thus at all sites where weapons and ornaments were produced, class 1 smith groups may be envisaged, although group size would, predictably, have varied in accordance with the diversity and magnitude of demand.

Location of activities Location of production is determined by product demand (G34). The patronised, class 1 smith will thus be resident in the area dominated by his patron (single site or wider region). High status, patronised smiths may work within settlement areas, but the casting place must always be isolated from other structures (G36). No bronze age production site included in this study has been completely excavated, thus very little information is available concerning the precise location of casting activities in the settlement area. At the Breiddin, however, a group of twelve furnaces was located near the supposed perimeter of the hillfort. It may be that during the bronze age metalworking period at the site, these furnaces and associated working hollows comprised an isolated metalworking area.

Metal supply It is likely that the class 1 smith received his raw materials for casting either directly from his patron, or through transactions with traders controlled by his patron (G31). The form

in which the smith obtained his metal is unknown, but may have been partially determined by cultural factors (G37). Although native metal sources are restricted to certain upland areas (Tylecote, 1962, 17, table 6, 63, 74), there are indications that copper, tin and lead were all available, if in limited quantities, throughout southern Britain during the later bronze age (Lawson, 1979, 178; Northover, 1982). Rare metal ingots may travel considerable distances (G38).

The relatively low lead content of certain weapons indicates that higher lead tools were not normally collected as scrap for recycling by the weapon smiths (Northover, 1982, 91). On the other hand, the (albeit limited) analyses of the cores in the Bramber hoard suggests the returning of spears by customers or a patron to their original maker for remelting. Scrap hoards dominated by weapons are a regular feature of the late bronze age in southern Britain (Burgess et al, 1972; Coombs, 1975; Moore and Rowlands, 1972, 26). This may indicate a system of scrap collection linked to the exchange network within which weapons and prestige objects circulated (see below: Transactions).

Additional supplies With the exception of charcoal, which is sometimes purchased and sometimes provided by the client, all smiths make their own peripheral equipment (G41-G43). It may thus be predicted that the class 1 smiths themselves always collected their own clays and fillers and prepared their own crucibles, moulds, tuyères and furnaces. In the bronze age, as shown above (III and IV.1), these were invariably produced from carefully selected locally available materials. Unless certain members of large resident smithing groups specialised ("by product") in crucible and/or mould-making, there is no suggestion in the archaeological or pre-industrial ethnographic record of specialist refractory manufacturers. In recent times in Spain, traditional potters supplied crucibles to a wide area, but this aspect of industrial organisation is poorly documented (Cortes, 1954, 156-57). On the basis of all the evidence presented here, it is unlikely that any refractories were produced by the potters at the various bronze casting sites.

Transactions The class 1 smith produces prestige goods (weapons and ornaments) in response to the demands of his patron. These products may be intended for personal use or display, or for entry into an élite

exchange network (G44). As similar weapon styles are found over extremely wide areas (pp 518, above) it is suggested that a high proportion of the output of the class 1 smith was intended for exchange or gift-giving. "The output of the patronised smith is not normally available outside élite circles, although it may be widely distributed (often inter-tribally) within these circles" (G47).

The class 2 smith

Status The class 2 smith, locally itinerant and producing tools from bronze moulds, may have been of high or low status (G14). He would, nevertheless have been set apart within the society or tribal area which he served (G1, G2).

Specialisation by product Class 2 smiths specialised in the production of utilitarian tools for community use. It is here suggested that during the bronze age the axe would have served as a multi-functional tool, and have been used extensively in varied agricultural and woodworking activities. Axes would have been available to ordinary community members (as opposed to weapons, which as proposed above, were restricted to the élite classes), and some prestige may have been attached to the ownership of an axe.

The general level of stoneworking technology during the later bronze age was of low standard, and few well-made flint tools have been recovered. Bronze tools would thus have been in great demand as the only items capable of taking a useable and lasting working edge (G16). The large number of axes found in hoards, together with the bronze mould evidence (all except one are designed for axe casting) indicates that certain smiths specialised in the production of these all purpose tools.

Pattern of work My reasons for suggesting that class 2 smiths followed a locally itinerant work pattern have been outline above (pp 512-13). Again exercising caution in applying generalisations drawn from multi-metal using societies to those exclusively dependent on bronze, it seems probable from the ethnographic data, that locally itinerant smiths produced mainly to individual order, and were unlikely to be

patronised (G26). It is likely that demand (and thus production) would have been seasonal, perhaps in accordance with the agricultural cycle, and that the smiths would have participated in subsistence activities at their home bases (G19). However, as the axe is believed to have been a multi-functional tool in the British bronze age, it is possible that the magnitude of demand (in certain areas at least) may have necessitated full-time production by the class 2 smith. In this case, local itinerants would have been producing exclusively for trade, or have received community support, and would have done no farmwork.

Pending the publication of comprehensive corpora of axe types and their distribution (eg M Ehrenberg's forthcoming corpus of socketed axes), it is difficult to predict the territorial range covered by individual smithing groups. No evidence is available concerning the patterning and organisation of itinerant routes. These may have varied in bronze age Britain in ways similar to those observed in ethnographic contexts (fig I.7.1). Patterns would have been influenced by demand for products, and/or availability of raw materials, and social considerations (G22, G23).

Co-operative activity "Itinerant smiths travel in groups with their apprentices, and carry their tools" (G32). In the case of local itinerants, group size, it may be suggested, would depend upon the number of casting operations undertaken during each circuit and the magnitude of these operations; the amount of metal (and perhaps finished products) transported between casting places, and the quantity and range of tools carried. All these factors depend on the rate of demand, the patterns of itinerant operations (fig I.7.1) and the range of territory covered.

Location of activities The numbers and location of casting sites on an itinerant route would, as already stated, depend on demand (G34). Casting is likely to have taken place within the vicinity of settlements (customer proximity), but on the basis of the ethnographic data, metalworking operations are most unlikely to have been conducted within settlement boundaries (G35). Archaeological evidence seems to confirm this prediction. Only at the Breiddin have casting facilities been recognised, and these were located on the periphery of the settlement.

Itinerants would have built their temporary furnaces outside the settlements they served, probably in areas with easy access to furnace materials (refractory properties are not crucial for temporary furnace structures) and an ample fuel supply.

Metal supply Hoards dominated by worn and broken socketed axes are common in late bronze age southern Britain. It has been suggested that in many cases these represent collections of scrap assembled and stored en route by itinerant "axesmiths" for retrieval on future visits (Moore and Rowlands, 1972, 33). Founders' hoards contain a variety of broken and miscast tools, casting jets and runners, and, rarely, ingots. There can be little doubt that such collections constituted the essential metal supply for at least some itinerant smiths. Broken objects would have been obtained from customers in return for new tools (G39, G48). It is possible that some small "personal hoards" (Evans, 1881, 459) in fact represent scrap accumulated by individuals anticipating the visit of a class 2 smith. Both smith and customer would have saved all recyclable bronze (G40). Few tools have been found on settlement sites, and it has been sensibly suggested that when broken or redundant, tools would have been returned to the smith as part payment for new implements (Needham, 1980b, 24).

Additional supplies (non-metal materials and bronze moulds) Like the class 1 smith, the local itinerant may have made his own charcoal, purchased it, or received charcoal as part payment for his customers (G42). Furnaces and perhaps tuyères would be built as required from locally available materials. The provision of crucibles and the casting of new bronze moulds, however, requires a sophisticated knowledge of ceramic refractories. Two possibilities may be suggested. Firstly, the class 2 smith may have made his own crucibles and cast new moulds at a familiar source of refractory materials located close to his home base, or, perhaps, at a point along his production circuit. Secondly, the local itinerant may have obtained his melting vessels and new bronze moulds from a resident smith better versed in clay-based refractory technology. Unfortunately, the only crucible examined in the course of this study which may have been the property of an itinerant smith (that from Burderop Down) yielded disappointingly inconclusive analytical results. The casting of a bronze mould is a complex procedure, and demands a high degree of skill

in manipulating ceramic materials (Hodges, 1960, 155-56). Payment for these services could well have taken the form of axes, which the patronised resident smith did not cast. However, obtained, the itinerant smiths would have carried their crucibles (which are considerably more robust than clay moulds) (G32), until broken or too heavily slagged for further use. Crucibles would then be abandoned en route, or at the final melting site. There are no crucibles in founders' hoards.

Transactions It is suggested that demand for the products of the locally itinerant smith originated in the needs of ordinary (that is, non-aristocratic) members of bronze age society (G44). It is likely that the class 2 smiths produced the majority of their axes in response to direct customer demands (explicit transactions, direct distribution: G45). However, if adequate labour and raw materials were available, some speculative production (ie stockpiling of finished products in anticipation of demand) may also have taken place (G46).

A common form of payment for axes made at each settlement visited, would have been raw material in the form of scrap metal. Smiths may additionally have been paid in charcoal, foodstuffs, other manufactured goods, and at their home base (assuming part-time itinerancy), farm labour (G48).

The Class 3 smith

Status Long-distant itinerant smiths, casting axes from stone moulds are likely to have been held in high esteem in the areas they served. Class 3 smiths may have been patronised, producing axes for the leaders of high status settlements, who also supported resident weapon smiths. Alternatively, class 3 smiths may have set up workshops on well travelled routes or in densely settled areas, and traded in axe types not normally available for local consumption (G24). The find places of the Bulford-Helsbury moulds in association with settlements (certainly the Runnymede - Petters' Sports Field complex and probably Gwithian were of high status), together with the rarity of Stogursey axes in areas where they are known to have been produced (Needham, 1981, 47) suggest that the former of these hypotheses be accepted. In the case of the

Bulford-Helsbury smiths, Childe's concept of a "detribalised^s caste" of specialist metalworkers cannot be entirely dismissed.

Specialisation All later bronze age stone moulds recovered to date in southern Britain were designed to cast axes. The majority of identified matrices were for Stogursey axes, and no bronze (or clay) moulds have been recovered corresponding to this axe type. The limited evidence suggests that a distinct class (perhaps caste) of smith specialised in the production of a single axe type, using a specialised technology (G12).

Pattern of work The pattern of movements of the long-distant bronze age itinerant is unknown. It is clear, however, that class 3 smiths, casting from keratophyre moulds, and working outside the areas where these materials occur, would periodically have returned to Wales or the south west peninsular to acquire replacement moulds. It is possible that these smiths may have had a "home-base" in the area(s) where the moulds were made, and like the Awka smiths in Nigeria (Neaher, 1976) have made an annual expedition to one or more locations where their products were in demand.

On the other hand, the class 3 smiths producing Stogursey axes from moulds of talc-chlorite schist, may have organised their work patterns somewhat differently. These moulds have, to date, been found only in the south west, the likely area of their origin. It is possible that the smiths, although producing special axes under patronage, operated within a more restricted range. "It is noteworthy that the keratophyre suite of rocks is harder than the chlorite schist group, and it would have required a greater expenditure of time and effort in the making of moulds, but would also have resulted in more durable equipment" (Needham, 1981, 27). Moulds of chlorite schist would have required more frequent replacement than those of keratophyre, and this may have influenced the extent of the itinerants' circuit (G23). All class 3 smiths would have worked full-time at their craft, and received subsistence from their patrons (G21, G24).

Co-operative activity It is logical to suppose that class 3 smiths would have travelled in groups with apprentices (G31). Heavy stone

moulds, crucibles (or the materials to make crucibles), hammers and other finishing tools, and perhaps bellows, would all have to be carried over considerable distances. Smith groups may have included specialist mould makers.

Location of activities The patronised, long-distant itinerant smith may have worked within settlement boundaries (G36). Until the recent (1982) discovery at Everley Water Meadow, no workshop evidence relating to stone mould technology had been recovered. Everley Water Meadow has been tentatively interpreted as a casting place and the presence of late bronze age domestic pottery suggests some form of settlement (R Smith, pers comm). Extensive excavations at this potentially informative site are planned for 1983.

Metal supply Like the class 1 resident smiths, patronised itinerants would have received their metal supplies from their patrons (G39). Needham suggests that "the siting of the Runnymede Bridge area of settlement was expressly concerned with the control of river-borne resources and commodities, in order to guarantee raw material supplies ..." (Needham, 1981, 53). Adequate supplies would thus be available to serve the needs of the resident weapon smiths and the visiting axe makers.

Additional supplies Moulds, it has already been suggested, may have been made by the smiths themselves (perhaps each smith group supported a specialist mould maker), or obtained from highly skilled stoneworkers in the area of origin. A combination of these modes of production would seem likely and conform to the hypothesis that all peripheral equipment would (for technical and cultural reasons) be made by the users (G41-G43). It has been suggested that appropriately shaped blocks of stone would have been roughed-out at the quarry (perhaps by a stonemason), but "the carving of the matrices in this semi-manufactured material may have been reserved for the smith group itself, whose members were best able ... to suit their own traditional requirements (Needham, 1981, 54).

Patrons may well have supplied charcoal along with the raw metal necessary for each casting episode (G42). Other supplies such as

clay for furnaces, cores and "mould jackets" (Needham, 1981, 28) would have been easily obtained in the areas where stone moulds have been found.

Transactions It has been suggested that the long-distant itinerant smith produced a specific axe type in response to patron demand. Patronised resident smiths (class 1), in general, cast only weapons and ornaments, most of which seem to have been intended for exchange between élite groups. If axes were required by the élite, these would have been acquired from smiths belonging to class 2 or class 3. Whereas local itinerants may well have supplied high status settlements with functional tools (for example, various forms of "south-eastern" socketed axes are prolific in the area around Runnymede Bridge), the ruling classes may well have demanded the rare Stogursey axes for personal display, or perhaps again, for exchange. The acquisition (albeit temporary) of a Bulford-Helsbury smith using a specialised mould technology, may itself have commanded prestige.

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Conclusion

It is stressed here that the expanded bronze age smithing model as described in the preceding pages is to be regarded as largely speculative. Many aspects of organisation considered here have no material correlates, and suggestions concerning, for example, patronage and the status of the smith all rely on inference from ethnographic research and limited archaeological evidence.

It is, however, believed that this model does describe the broad structure of smithing organisation, and as such, may be used as a framework for the interpretation of archaeological data. Nevertheless the model, in its elaborated form, is not designed as a rigid formula to account for the activities of every late bronze age smith operating in southern Britain. It is clear from individual site discussions (Chs III.1-7) that minor variations at the technological level, and probably at the organisational level did exist. Furthermore, there are certain phenomena (such as four clay axe mould fragments on settlement sites)

which cannot, at present, be explained.

IV.4 THE ORGANISATION OF BRONZE CASTING IN PREHISTORIC BRITAIN: THE IRON AGE

IV.4.1 Introduction

The iron age was a period of great change and increasing social complexity, which witnessed the evolution of urban society, the introduction of coinage, and culminated in the Roman occupation of Britain. Ironworking was introduced and gradually came into general use for all tools, weapons and some ornaments. The progressive adoption of iron broadly coincided with the cessation of hoard deposition during the 7th century BC, and iron implements have been found in some late bronze hoards (eg Llyn Fawr: Savory, 1980, 46-47, 53, fig 11; Sompting: Burgess, 1969 and Curwen, 1948; and Melksham: Gingell, 1979). It has been sensibly suggested that iron, already in use to a limited extent in late bronze age Europe, would have been generally adopted for edge-tool production when the pressure of demand prompted the exploitation of a more readily obtainable (and more easily worked) mineral (Champion, 1975, 142). The adoption of iron in Britain is currently being investigated in detail by Ann Turnbull (University of Edinburgh).

Although virtually no production debris has come to light at sites dated to the earlier iron age, it is clear from the metalwork recovered that bronzeworking continued to flourish throughout this period (eg Jope, 1961; Cunliffe, 1974, 280). However, the emphasis of the industry changed. As iron was gradually adopted for tools and weapons, so bronze became limited to the production of ornaments, art objects and horse-gear. The introduction of a new metal and a more restricted use of bronze naturally implies considerable changes in the organisation of metalworking.

Whereas, for the bronze age, the archaeological data permitted the construction of a basic organisational model, iron age production evidence is not so informative. Furthermore, as stressed above, the iron

age was a period of great change, and although social organisation is not well understood, it is clear from settlement, subsistence, and material evidence, that varied social patterns developed in different areas of Britain and changed in different ways and at different rates (Champion,,1979). This diversity would doubtless have been reflected in industrial organisation. Just as organisation varies in multi-metal using ethnographic societies (Part I above), so it would have differed spatially and chronologically during the southern British iron age. Mindful of this variability, it is nevertheless profitable to examine the evidence for iron age bronze casting in the light of the generalisations drawn from ethnographic research.

Both bronze and iron working were considered in detail in ethnographic contexts, firstly to seek universals applicable to all smiths, irrespective of metal, and secondly to compare and contrast organisational aspects of the individual (bronze and iron) industries. Although some allusion will be made to ironworking in the ensuing discussion, no attempt will be made to construct a model of iron age blacksmithing organisation. The examination of this industry in prehistory constitutes a study in its own right.

IV.4.2 The bronzeworker in iron age society: a general model

Status

"In an iron based economy, rare metal casters are almost invariably of high status" (G5). It would seem reasonable to assume, that at the southern British iron age sites examined in the course of this study, from the tiny enclosed settlement at Weelsby Avenue to the multivallate hillforts at South Cadbury and Maiden Castle, most bronze casters were held in high esteem.

Specialisation

By metal It is unlikely that blacksmithing and bronze casting would have been undertaken by the same metalworking group. As in ethnographic contexts, iron forging and rare metal working would have been distinct specialisations (G4). In societies where both blacksmiths

and bronze casters were patronised and of high rank (G7), it is suggested that some co-operative working may have taken place. Despite the rarity of ethnographic examples, this suggestion is supported by certain items of iron age metalwork (prestige items and horse-gear) which combine components of both bronze and iron (eg daggers and sheaths: Jope, 1961; horse-bits: Ward-Perkins, 1939).

By activity "Rare metal smelting and casting/beating are always distinct specialisations" (G10). In the iron age, as in ethnographic contexts this would have been partly conditioned by social factors and partly by the restricted occurrence of metal ores. Whether or not casting and sheet metalworking were each the province of a separate specialist group is difficult to ascertain. The association of sheet metal workers' tools with scrap art objects at South Cadbury (III.14) and fine tools with a small bronze anvil in the Santon hoard (Smith, 1909, 158), argue perhaps for specialist sheet metalworkers. Additionally, the exceptionally fine workmanship displayed by many late iron age art objects, suggests that these were likely to have been produced by skilled manipulators of sheet metal (Fox, 1958; Megaw, 1979; Spratling, 1972). It is possible, and indeed likely, that at many iron age workshops smithing groups incorporated individual specialist casters and sheet metal workers (mould and crucible fragments at South Cadbury testify to casting at this site in addition to sheet working: III.14).

By product The great range of iron age metalwork indicates complex specialisation, and the locations of various production centres have been predicted on the basis of similarities in metal typology (eg Spratling, 1972, 32-34; Hodson, 1964). Although the existence of these workshops has not been demonstrated, the refractory evidence examined in the course of this study supports the concept of product specialisation by iron age smiths. Bronzeworkers at Gussage, and almost certainly at Weelsby Avenue specialised in the manufacture of horse and chariot fittings. Horse-gear was also produced at Beckford, Mucking and South Cadbury, but the mould evidence from these sites is inadequate to confirm specialisation.

Pattern of work

The ethnographic evidence indicates that the rare metal worker in an iron-based economy tends to be patronised and work full-time at his craft. He may, however, be resident or itinerant (G25). Whilst it can be assumed that the manufacture^{rs} of prestige artefacts worked under patronage, the problem of residency or itinerancy is difficult to resolve. Analyses have shown that three basic recipes were followed by iron age refractory makers (IV.1.3). Although reasonably local refractory materials would seem to have been exploited at each site examined, the iron age smith required a far less detailed knowledge of available resources than did his bronze age predecessor. If itinerancy is suggested, information concerning the whereabouts of sands and binding clays (for sand crucibles and moulds) or binding clays alone (for carbon crucibles), may well have been obtained from the potters at each site visited. Although local potters themselves appear not to have used these materials, they would at least have been aware of their existence. The fact that the basic recipes (sand fabrics in particular) were followed throughout southern Britain, irrespective of local geology, suggests a considerable degree of communication between smithing groups; a further argument for itinerancy.

Spratling originally interpreted the refractory debris from Gussage as representing a single visit by a peripatetic smith (Wainwright and Spratling, 1973). This view has since been revised, and Spratling has concluded that "metalworking was very much a normal feature of life at the settlement ... carried on ... for several centuries" (Spratling, 1979, 141). This reinterpretation was based to some extent on stratigraphic evidence (bronze casting debris occurs in all three phases at Gussage), but mainly on the quantity and complexity of ^q equipment required to cast fifty sets of horse and chariot fittings. These are listed as: beeswax for patterns; clay for moulds, crucibles, tuyeres, hearth-lining etc; sand for tempering; oak for charcoal making; hawthorn for kindling; bone for making modelling tools; copper; tin; and iron to make the smith's tools (Spratling, 1979, 141). It is suggested here that bone and metalworking tools could easily have been carried by the itinerant, much as in the bronze age; metal would have been supplied by the client-patron in ingot or scrap form; kindling could have been

obtained with little effort in the vicinity of the site; and the procurement of sufficient sands and binding clays to produce all the refractories in Pit 209 would have necessitated very few trips to the nearest source areas (III.13.3, p 404). Beeswax for the manufacture of patterns and charcoal for the fire could, like metal, have been supplied by the patron. There is no a priori reason to suggest that the smiths operating at Gussage were full-time residents at the site (p 407). Similar problems arise at all sites examined in the course of this study, and on the basis of production evidence, patronised residency or itinerancy in the iron age of southern Britain must remain an open question.

It has been suggested by several writers, that in addition to smiths producing prestige goods under elite patronage (be they permanently attached to leaders or chieftains, or patronised itinerants), a second class of bronzeworker may have existed, manufacturing small ornaments and pins, perhaps for trade. Harding, for example, acknowledging that weapons and exotic ornaments would have been produced under the patronage of a wealthy tribal aristocracy, further suggests that "local agricultural communities would have required the services of a blacksmith for their basic tools and equipment, and would have acquired their relatively few luxury goods - small, personal bronzes and so forth - from pedlars distributing them from a professional centre" (Harding, 1974, 90). Fox, too, envisages a hierarchy of bronzesmiths, and provides the following (somewhat exuberant) embellishment of the model: "We are, however, not to suppose that all metalworkers served noble households, for brooches, pins and the like are spread widely through the commonality, of metalworkers themselves, of farmers, herdsmen, stablemen, chariot drivers, and household servants ..." (Fox, 1958, xxvii). Referring to the limited distribution of a distinctive form of fibula in Wessex, Cunliffe is tempted to think in terms of a "single bronzeworker settled somewhere in the area supplying local needs in the third or fourth centuries" (Cunliffe, 1974, 273). Cunliffe (implying full-time craftwork) suggests that such bronzeworkers would have received community support.

Although abundant small bronze ornaments have been found at the majority of sites included in this study, no moulds for their production have been recovered (the identification of a pin mould at South Cadbury

is dubious). Should a class of bronzesmith specialising in the production of pins and ornaments been operative during the iron age, there is, as yet, no primary evidence of production to shed light on the organisation of this industrial stratum. Until such evidence is located, theories concerning long-distant or local itinerancy, independent trading and community support must remain within the realms of speculation.

Co-operative activity

"There are no solitary smiths" (G31). As in the preceding era, smiths in the iron age, whether resident or itinerant, patronised or producing for trade, would have worked in groups. Itinerants and their apprentices would have carried their tools (G32), but as a result of universally applicable crucible and mould recipes, melting vessels need not have been carried, but could instead be made at the workplace from locally available materials. Highly specialised smith groups producing specific categories of prestige goods under patronage (eg the smiths at Gussage, and perhaps Weelsby), would probably have been composed of individuals specialising by activity. These specialisations may have included wax pattern makers, mould investors, crucible makers, master smiths performing the crucial tasks of melting and pouring, and finishers (probably apprentices) to remove casting jets and file rough cast pieces.

Location of work

"General production location is determined by product demand" (G34). Smiths producing prestige items under élite patronage would set up their workshops at or in the vicinity of the domicile of their patrons. Champion describes four categories of iron age settlement: hillforts; enclosures; unenclosed settlements; oppida. These categories are based on classifications used in earlier literature, and at a broad level take no account of site size or plan, either of which could justifiably form the basis of alternative classificatory schemes (Champion, 1979, 355-79 and n 25). These settlement types are not described in rank order, nor indeed is any element of differential status or ranking suggested.

Much has been written on the subject of hillforts and their pre-eminent role in iron age society (eg Cunliffe, 1974, 262-23; 1976, 140-41; Harding, 1976; papers in Hill and Jesson, 1971) but this debate is of little relevance here. For, it is clear, that although bronze artefacts were produced at or near such structures (eg Maiden Castle, Danebury, the Breiddin), patronised metalworking took place at all Champion's classes of iron age settlement. The best evidence of highly specialised bronze production has been recovered, in fact, not from hillforts, but from a large "banjo" enclosure (Gussage All Saints) and a tiny ditched area enclosing but two roundhouses (Weelsby Avenue). The implications of this evidence for correlations between site size and form, and iron age social ranking are, however, beyond the scope of this study.

If pins and small ornaments were, as has been suggested by other writers, produced for trade by a separate, specialist smithing class, workshops would be sited near large centres of population or on well travelled routes. It is also conceivable that such smiths could have been locally itinerant. However, as yet, no primary evidence for the production of small bronze items has been recovered.

Bronze melting facilities are rarely recognised on iron age sites. The identification of a furnace complex in the centre of the South Cadbury hillfort is now in doubt (Alcock, pers comm: III.14), and the only positive evidence for metalworking in the area of Pit 209 at Gussage is the presence of a bowl hearth used for iron working in the later phase III (III.13). Hut A at St Mawgan has been interpreted as a bronzesmith's workshop. The hollow centre of this hut contained two well-made hearths each accompanied by a shallow charcoal filled channel, perhaps a casting pit. The hut also contained droplets of casting waste, a small bronze ingot, bronze sheet scrap and crucible sherds. The crucibles have been analysed, and were found to be of the ubiquitous iron age "sand" variety (p.449). Hut A would appear to have been sited at the edge of the settlement, near the entrance, but stratigraphic relationships with other buildings are difficult to define. It is, however, possible that huts A and W together constituted a smithing area, hut W perhaps being used for mould preparation and associated activities. The location of bronzeworking facilities within the confines of a settlement suggests

the presence of a high status, patronised smith (G36). However, no mould evidence was recognised at St Mawgan, thus the nature of his products is unknown.

If the area around Pit 209 at Gussage is to be accepted as a metalworking quarter (some 30 sq m in the vicinity of the pit was not excavated), this, as at St Mawgan, was located on the periphery and close to the entrance to the settlement. Although ploughing had destroyed most structural evidence at Gussage, it can be conjectured that this hypothetical metalworking area was isolated from other buildings (G35, G36).

Finally, it is important to note that not all patronised, high status smiths in ethnographic contexts worked within settlement boundaries (Table I.3). It is suggested that more primary evidence of production might be recovered through excavation in the vicinity of settlements, rather than within the ramparts. The bronze casting site at Weelsby Avenue may yet prove an example of a specialist smith setting up his workshop close to, but not within, the domicile of his patron (III.15).

Metal supply

The supply of metal in scrap or ingot form to the iron age bronze smith, is a subject that has attracted scant attention. Both Cunliffe and Harding, in general discussions of the continuation of bronzeworking into the iron age, have suggested that copper ores continued to be exploited in Cornwall, north Wales, the Welsh borderland, Scotland and Ireland. Stream tinning continued in Cornwall (Cunliffe, 1974, 273; Harding, 1974, 91). However, just how these minerals, after smelting, entered the iron age "metal pool" has not been considered in detail. In the current state of knowledge, it is perhaps advisable to echo the wise words of Haselgrove: "In economies where exchange was not articulated through a monetary economy, it is easy to see how such complex cycles could lead to the development of a series of inter-locking trade networks, each dealing in different exchange commodities" (Haselgrove, 1976, 36).

At the more direct client-smith level, some generalisations can be

made from a consideration of both the archaeological data and generalisations drawn from ethnography. The results of metal analyses suggest iron age bronze smiths did not, in general, rely on residual late bronze age metalwork for their raw material supplies. Bronze in the late bronze age contains a high percentage of lead, whereas low lead and high tin readings have been obtained from analyses of bronze artefact produced in the iron age (eg Tylecote, 1962; Bayley, 1977; Bulleid and Gray, 1911, 178). Metal in ingot form has been recovered (eg at St Mawgan), supporting Cunliffe's and Harding's hypothesis that raw ores were, in fact, smelted during the iron age, and that the casters did not rely exclusively on scrap. Patronised rare metal workers in ethnographic contexts received their supplies from their patrons, and a similar situation may be supposed for the southern British iron age (G39). However, just how the overall supply system was controlled must again remain an open question.

Although the hoarding of scrap metal gradually ceased during the 7th century BC, occasional hoards of iron age bronzework have been found. The post 50 BC Ringstead hoard from Norfolk would seem to be a founder's hoard (Clarke, 1951). Its deposition has been imaginatively interpreted as "the hurried act of a wayfaring metalsmith beset by some sudden danger" (Clarke, 1951, 224). Nevertheless, this hoard may be suggestive of the manner in which independent smiths producing for trade, or full-time, community-supported smiths acquired their metal supplies. Such smiths may have made periodic local sorties to collect scrap for remelting. More analyses of different categories of iron age bronze objects are necessary to resolve this problem.

Additional supplies

Allusion has been made throughout IV.1 and the foregoing discussion of iron age bronzesmithing to the provision of peripheral equipment. In the light of ethnographic research, it can be assumed that the smith, or a specialist member of a smithing group prepared and fired all crucibles, moulds and tuyères (G41, G43). Although the heavy mineral suite identified from the analysis of a single Gussage crucible sherd was matched by that of much later pottery from the Site (III.13), it would seem unlikely, on the basis of the ethnographic evidence, that

pottery supplied the Gussage bronzeworkers with their refractory equipment. Further heavy mineral residues from varied Bagshot Beds sands and clays, and textural analyses of the Gussage pottery are required to test this theory. No similarities have been observed between pottery and refractory fabrics at any other iron age site examined in the course of this study (the Breiddin: Morris, pers comm; Mucking: Williams, nd; Beckford: Tomber, 1981a and 1981b; Meare and Glastonbury: Bailey, 1981; and Peacock, 1969; South Cadbury: author; Weelsby Avenue: Freestone, pers comm and III.15).

Transactions

Whilst it is possible that certain artefacts produced by the iron age bronzesmith were manufactured to meet the demands (perhaps anticipated) of ordinary group members, and whilst it is equally possible that certain items were produced for community exchange, the production evidence and the metal products themselves suggest that a significant portion of the iron age bronzeworkers' output was manufactured for individual patrons or elite groups (G44). The general lack of high status objects on settlement sites, and the wide distribution of such items in graves or as isolated finds (see for example, Fox, 1958; Megaw, 1979), indicate, that like the products of the class 1 bronze age smith, most fine metalwork of iron age date was designed for elite exchange.

It is notable that despite the recovery at Gussage of more than 7000 mould fragments for the production of horse and chariot fittings, not one single bronze item cast in these moulds was found at the site (III.13). Foster (1980), however, has identified artefact represented in the Gussage mould assemblage from the entire area of southern Britain, and whilst it is unlikely that bridle bits, terrets and strap-unions found as far away as Garton Slack in Yorkshire (Brewster, 1971) were actually cast at Gussage, the possibility cannot be entirely discounted. The extensive distribution of very similar prestige equipment has far reaching implications for the definition of elite exchange networks. However, how these networks were articulated, is at present unknown.

Spratling and Wainwright have suggested that Gussage may have

formed a link in a regional economic system in which smiths at different communities specialised in different classes of prestige product (Spratling, 1979, 144; Wainwright, 1979, 194). All the iron age sites which have produced primary production evidence in the form of casting mould, appear, like Gussage, to have been producing horse-gear (Mucking: III.8; Beckford: III.10; South Cadbury: III.14; Weelsby Avenue: III.15). Until more closely situated sites are fully excavated (for example, in the Cranborne Chase area), and more moulds are recovered, theories of site or regional specialisation cannot be tested.

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IV.4.3 Conclusion

It is clear from the above discussion that although generalisations drawn from ethnographic research are predictably more applicable to the southern British iron age (all economies were iron, not bronze based), the interpretation of the bronze casting industry during this period is far from simple. A basic problem stems from the dearth of well-contexted primary production evidence, especially moulds. A further (technical) problem concerns the homogeneity of such material when it is discovered. Sand is difficult, and charcoal impossible to characterise.

It has been possible to define a class of iron age smiths producing prestige goods under patronage, probably for élite exchange. However, whether these smiths were resident with fixed workshops and received continuous remuneration from their patrons, or whether they were full-time itinerants is unknown. Furthermore, if itinerancy was practised, no information is attainable concerning the organisation and extent of itinerant routes. Variations in prestige smithing organisation at the actual casting place have been discussed in the individual site chapters (III.8-15).

A second class of smiths producing small bronzes and ornaments for general consumption has been suggested by various writers, and this suggestion is supported by numerous finds of such items on settlement sites and in graves. However, no primary production evidence indicative

of such a smithing class has yet come to light, thus no inferences can be drawn concerning its organisation.

Questions of residency and itinerancy, production for trade, community support, product consumption and regional specialisation have all been left unresolved in the above broad model of iron age smithin organisation. It is hoped that this model may soon be amplified and refined by the recovery of more well contexted primary production evidence like that from Gussage All Saints.

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PLATES



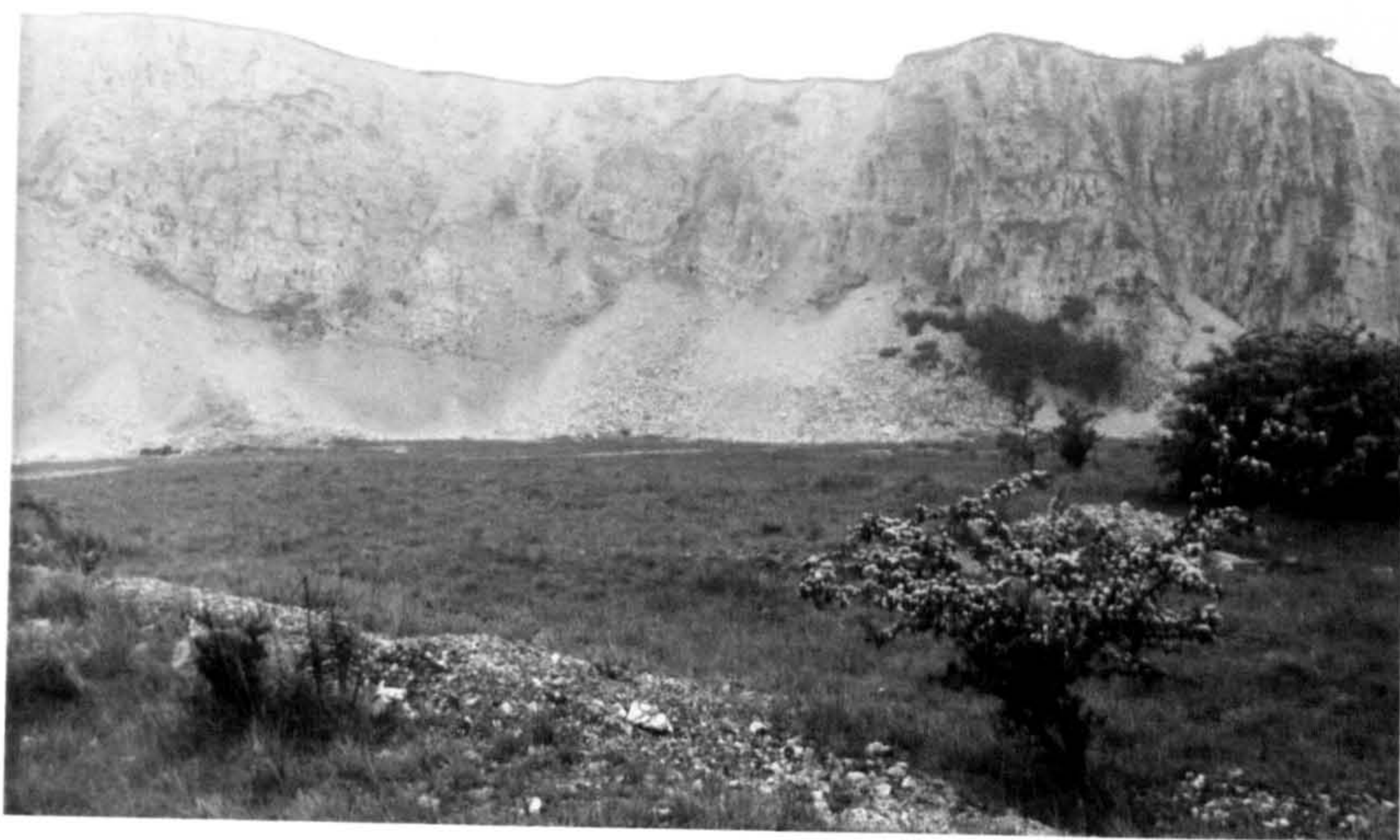
a



b

1a. The writer collecting samples of clay from a field drain trench at Bunbury, Cheshire. 4 samples were taken (BC 1-4) of clays that were all different in appearance. BC2 contained sparse/moderate amounts of quartz, and rare quartzite, ferruginous sandstone and very rare mica. In contrast, BC 3 displayed exceptionally densely packed quartz, very rare mica, and scattered grains of microcrystalline silica (perhaps chert). BC 1 and 2 both contained a considerable amount of rotted organic matter, and provided a possible match for a bronze age crucible fabric from Beeston Castle.

1b. An active sand-pit at Beeston, Cheshire, the site of sand and erratic samples BC 5-8.



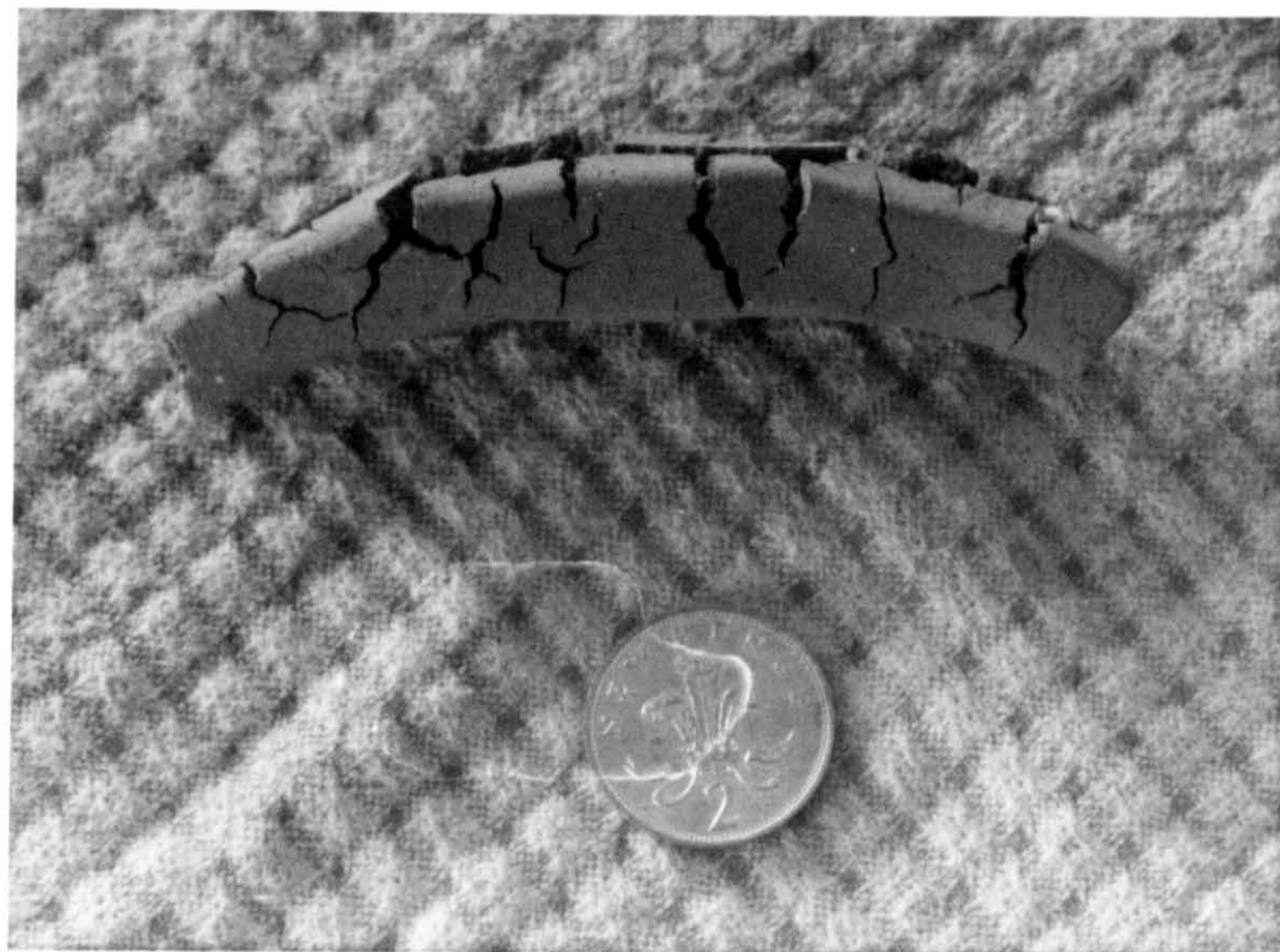
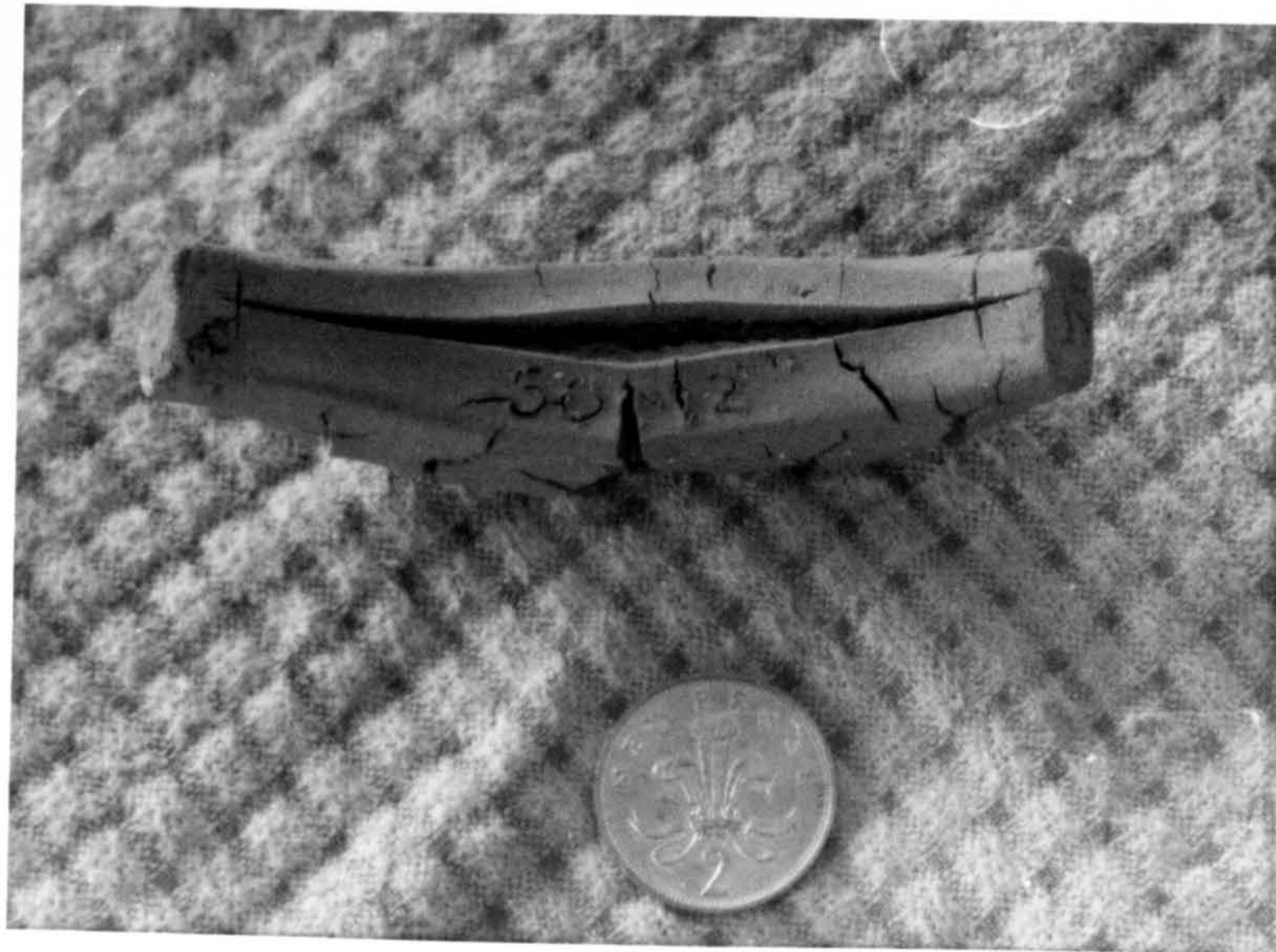
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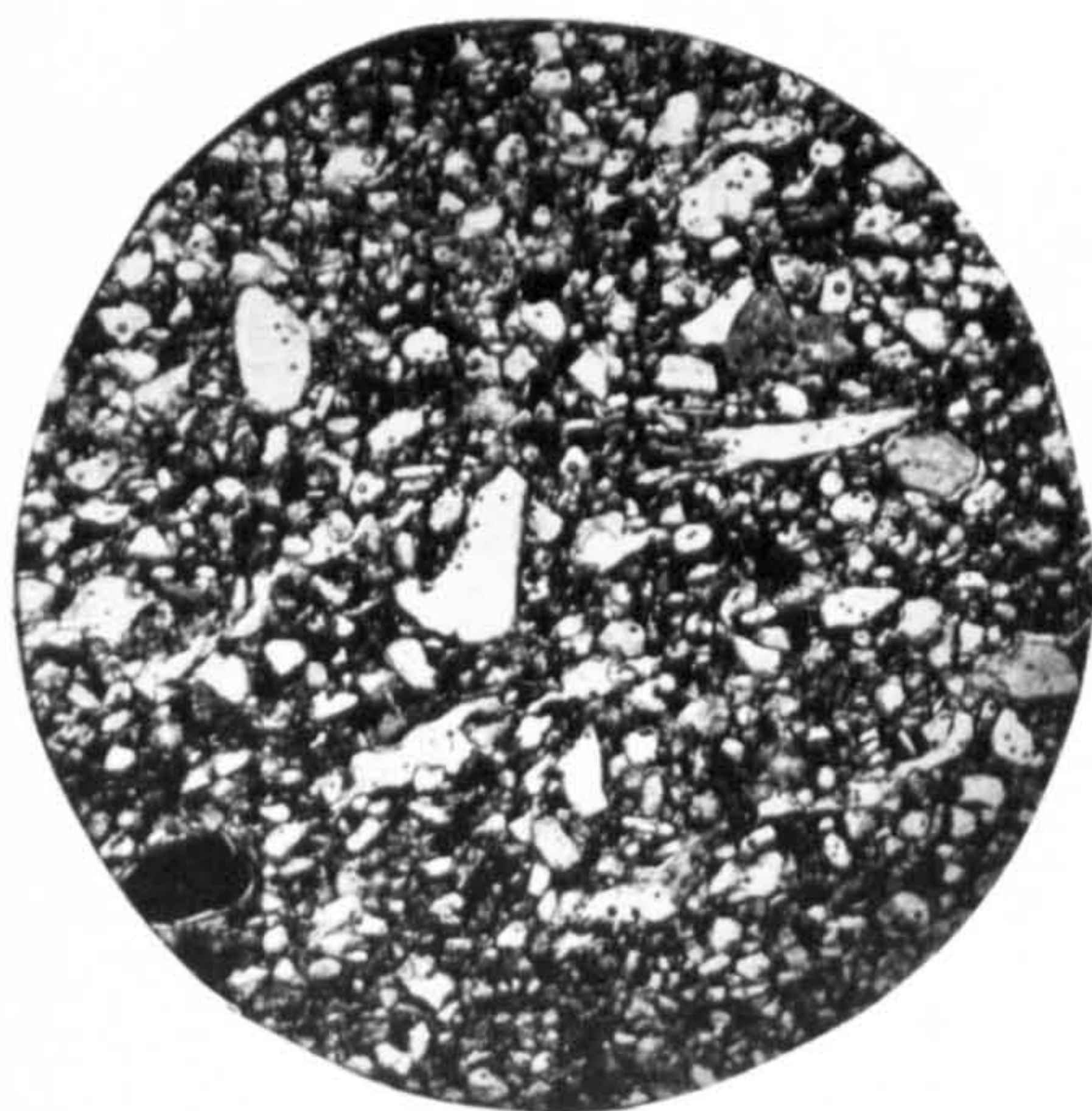
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2a. A disused chalk-pit at Burdale Warren, near Fimber, North Humberside. Samples of silty clay-with-flints were taken from fissures in the cliff face (YK 12-13).

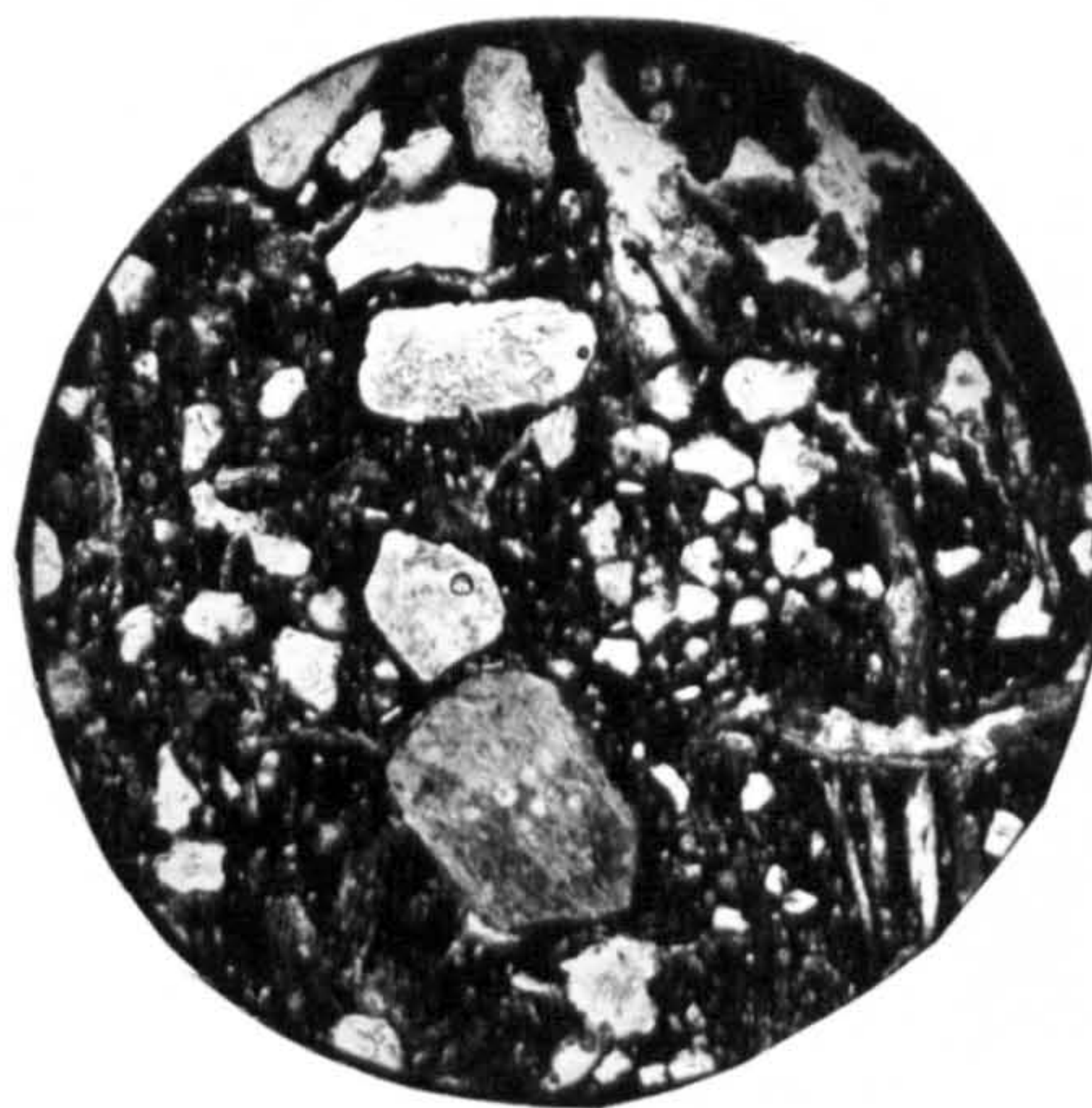
2b. A modern excavation for a house extension provided this exposure of clays and gravels in an overgrown gravel-pit at Fridaythorpe, North Humberside. The pit was observed when active by R Mortimer (1886). Clay samples YK 34 and 35 contained as inclusions only quartz and a little iron ore.



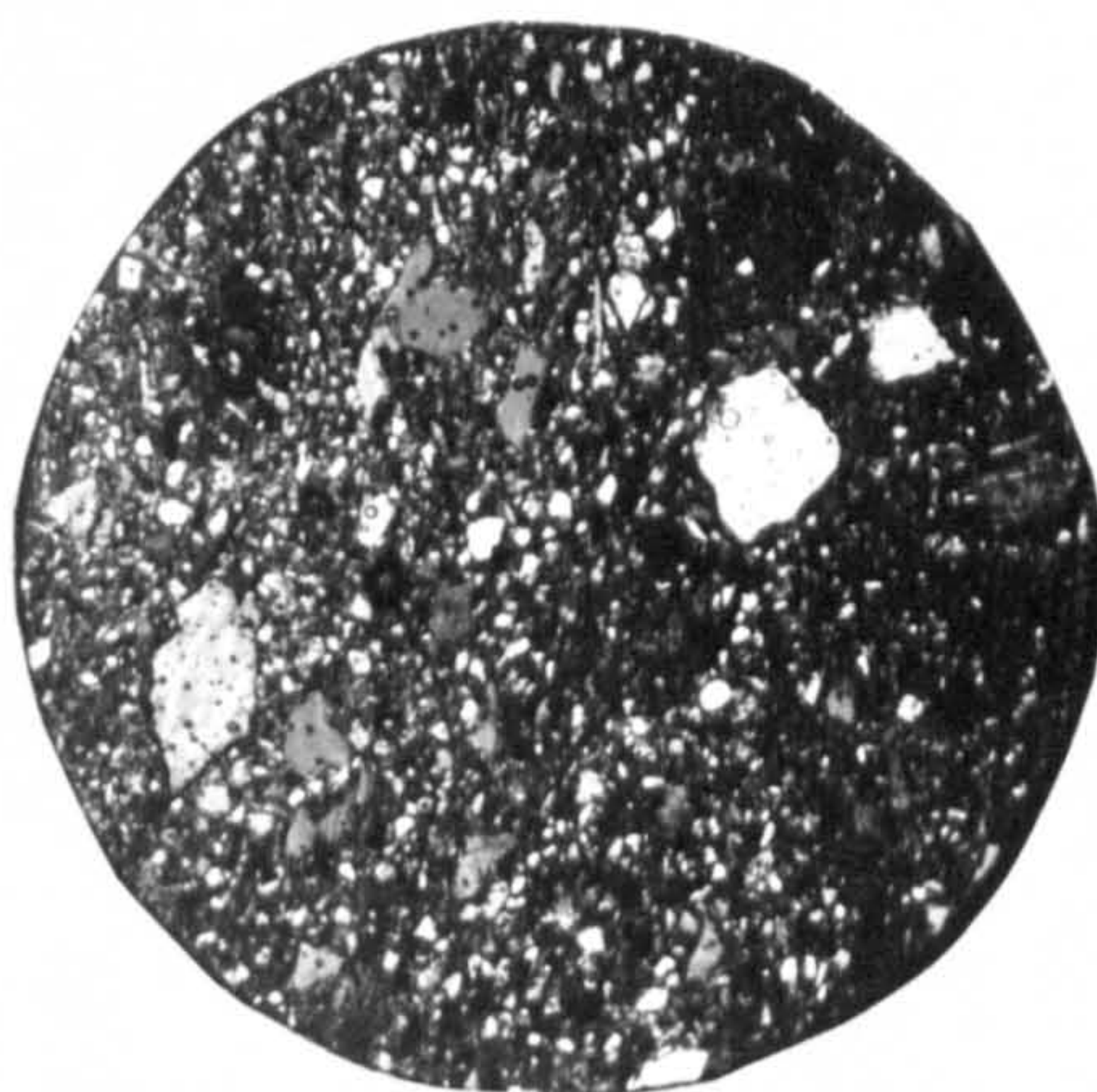
3. A fired clay sample from the Somerset Lower Lias. Distortions indicate the unsuitability of this material for ceramic production.



a



b



c

Moulds from bronze age sites where similar raw materials were used for inner matrices and outer wraps

4a. Inner mould from Grime's Graves for casting channel bladed spearheads. The fabric contains well-packed quartz in a calcareous matrix. Detrital grains are common.

4b. Grime's Graves outer moulds are coarser than inner valves. Pastes for both mould components are likely to be derived from the Norfolk Boulder Clays.

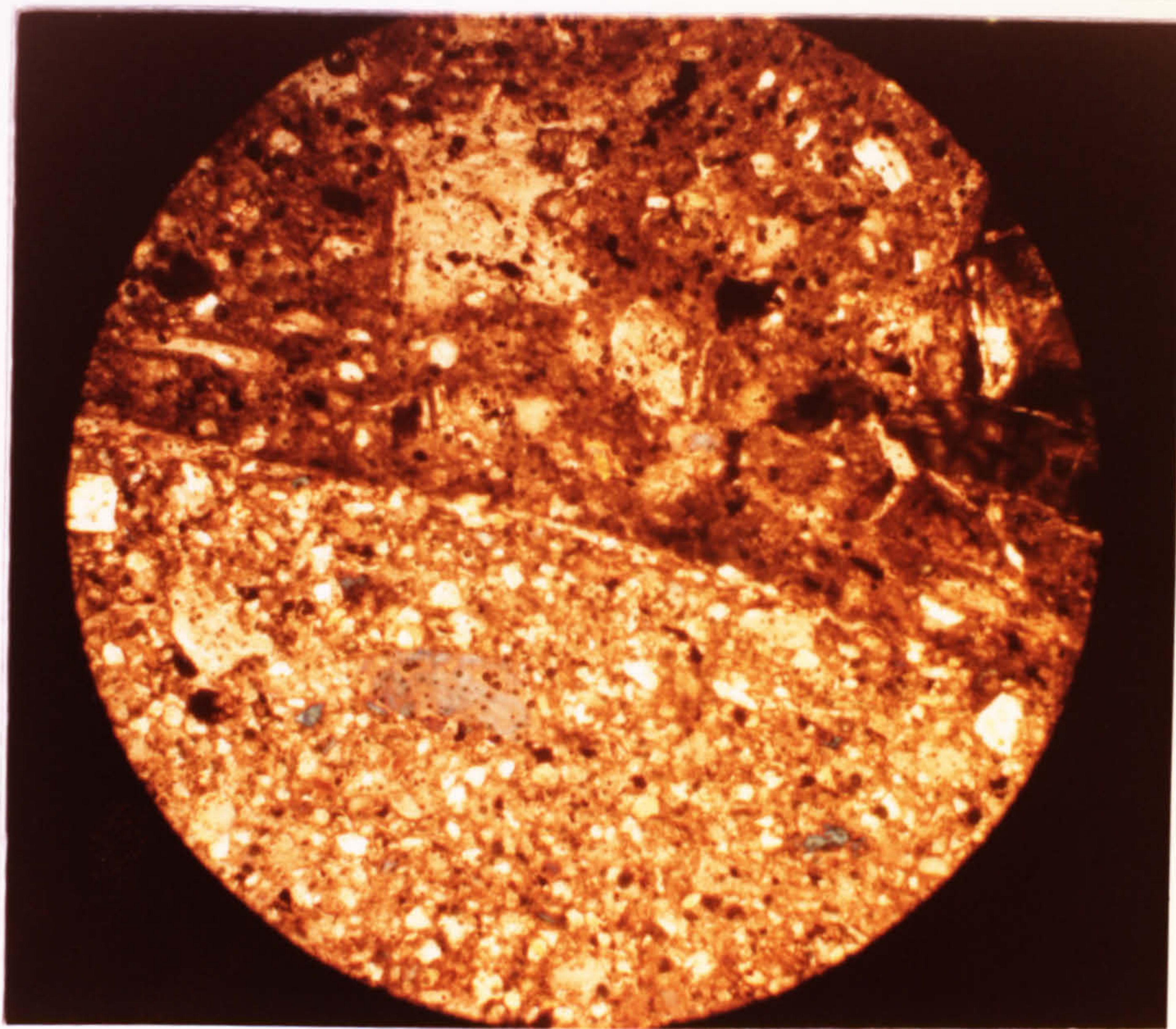
4c. Dainton mould Fabric 2 (inner and outer wrap) contains up to 60% quartz grains with biotite and white mica. Plagioclase and potash felspar, phyllite, quartzite and tourmaline are also present. This mineral suite is likely to be derived from the aureole surrounding the Dartmoor granite.



a



c

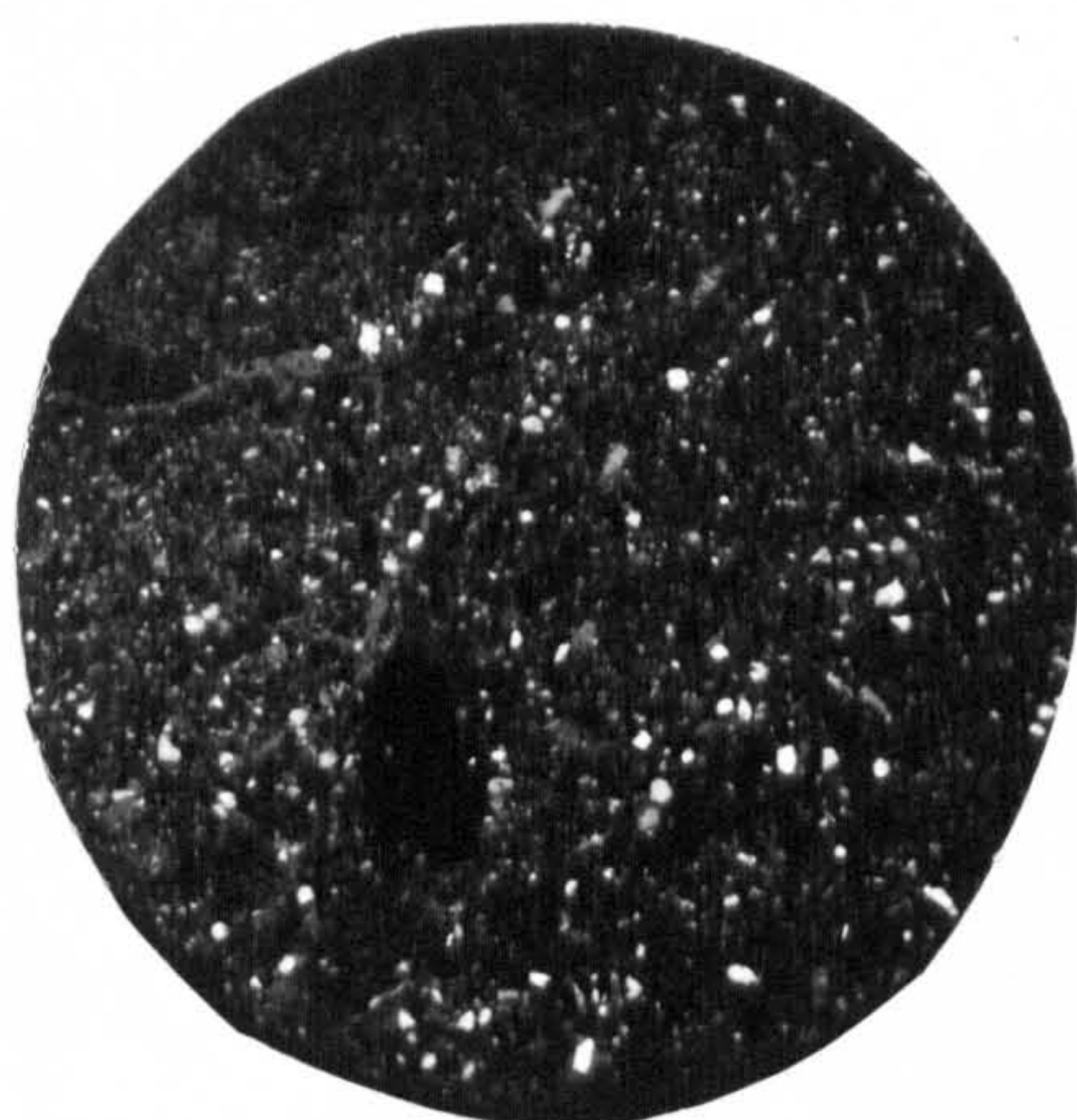


b

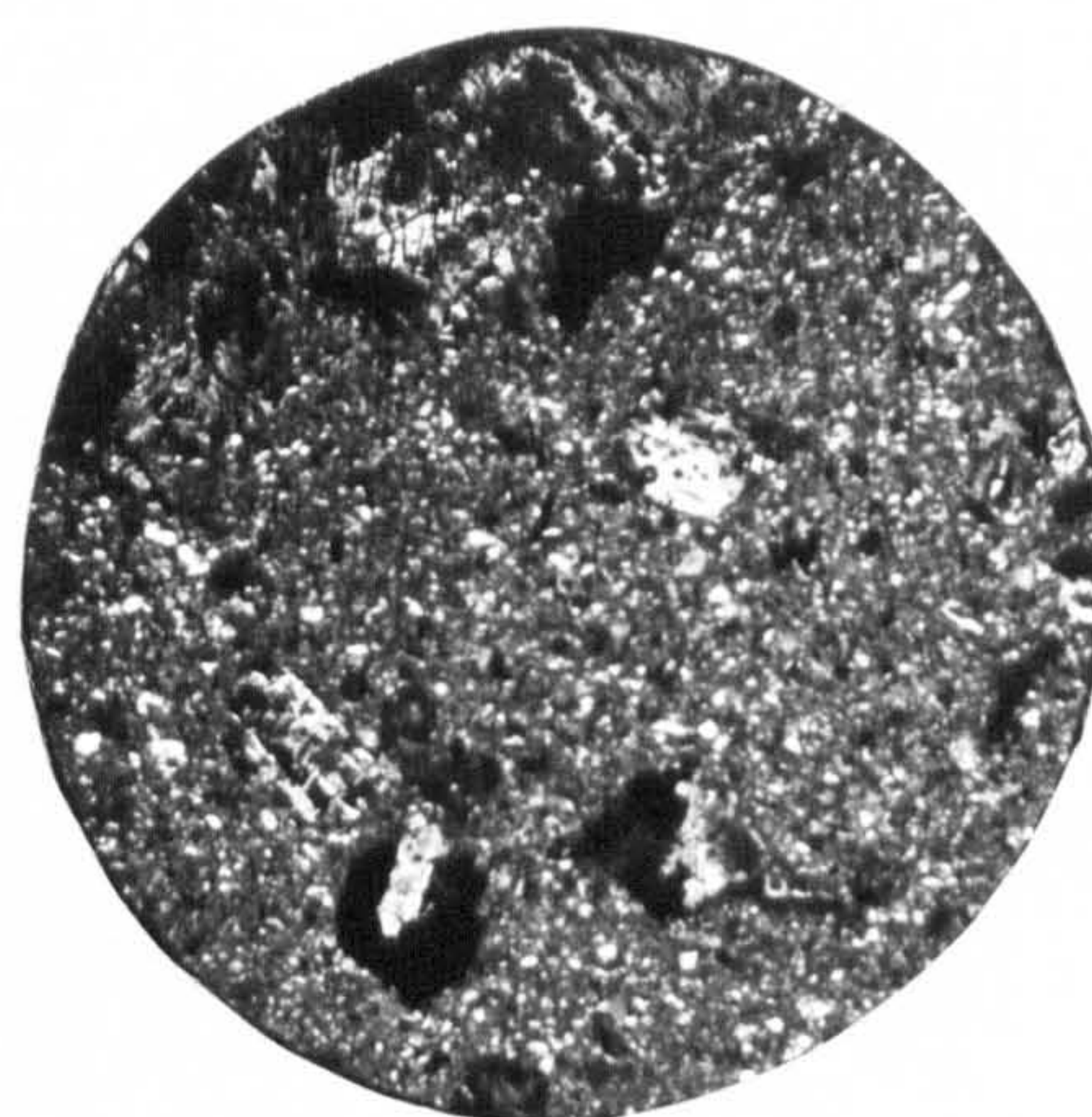
The use of different materials for inner valves and outer wraps of bronze age moulds

5a and b. Thin sections of typical Fimber moulds (a = FIM 14, b = FIM 12) showing the junction between the fine inner valve fabric and the dolerite-tempered outer wrap.

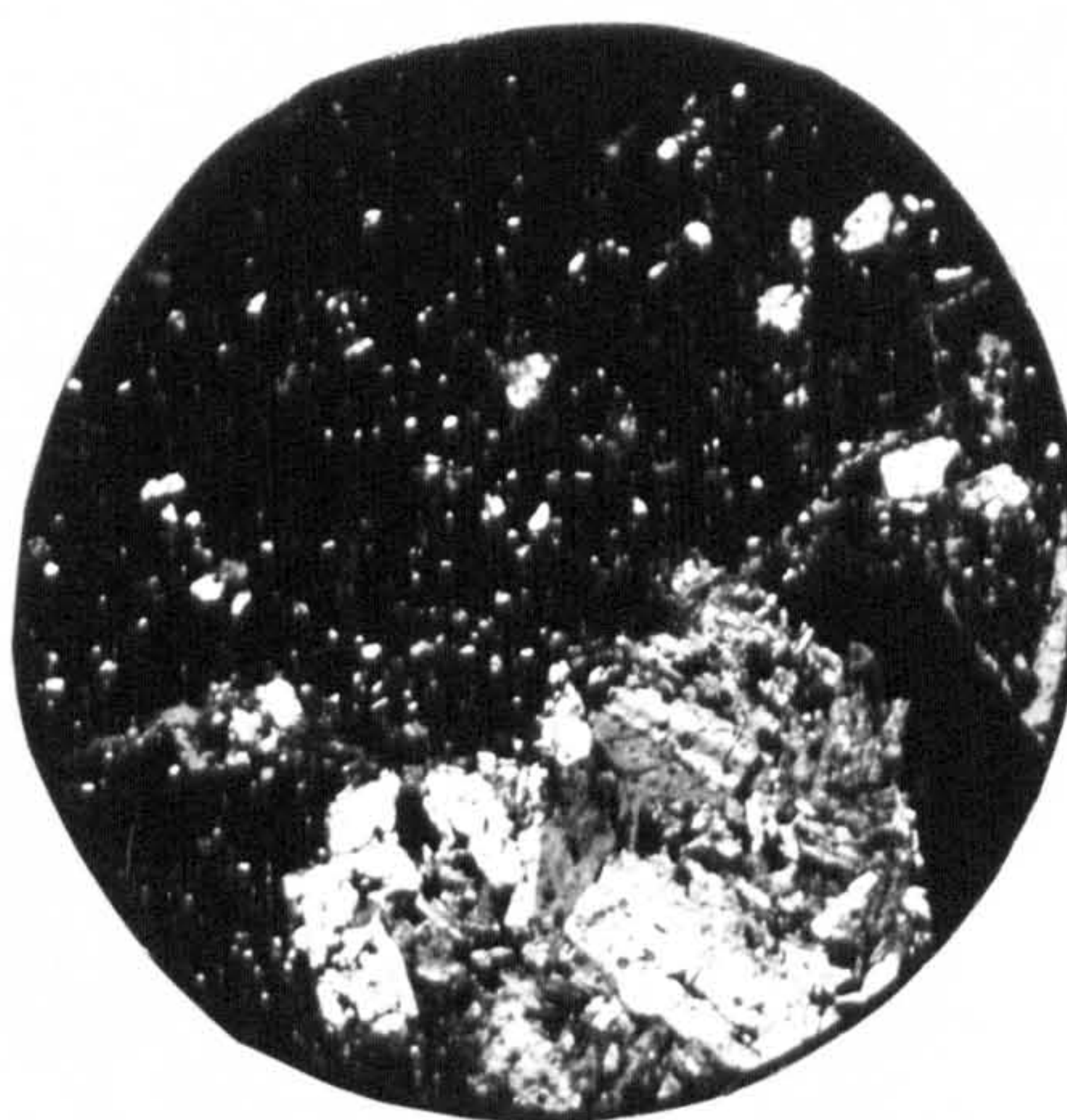
5c. Mould sherd from Mucking showing the junction between inner and outer pastes (MU 9)



a



b

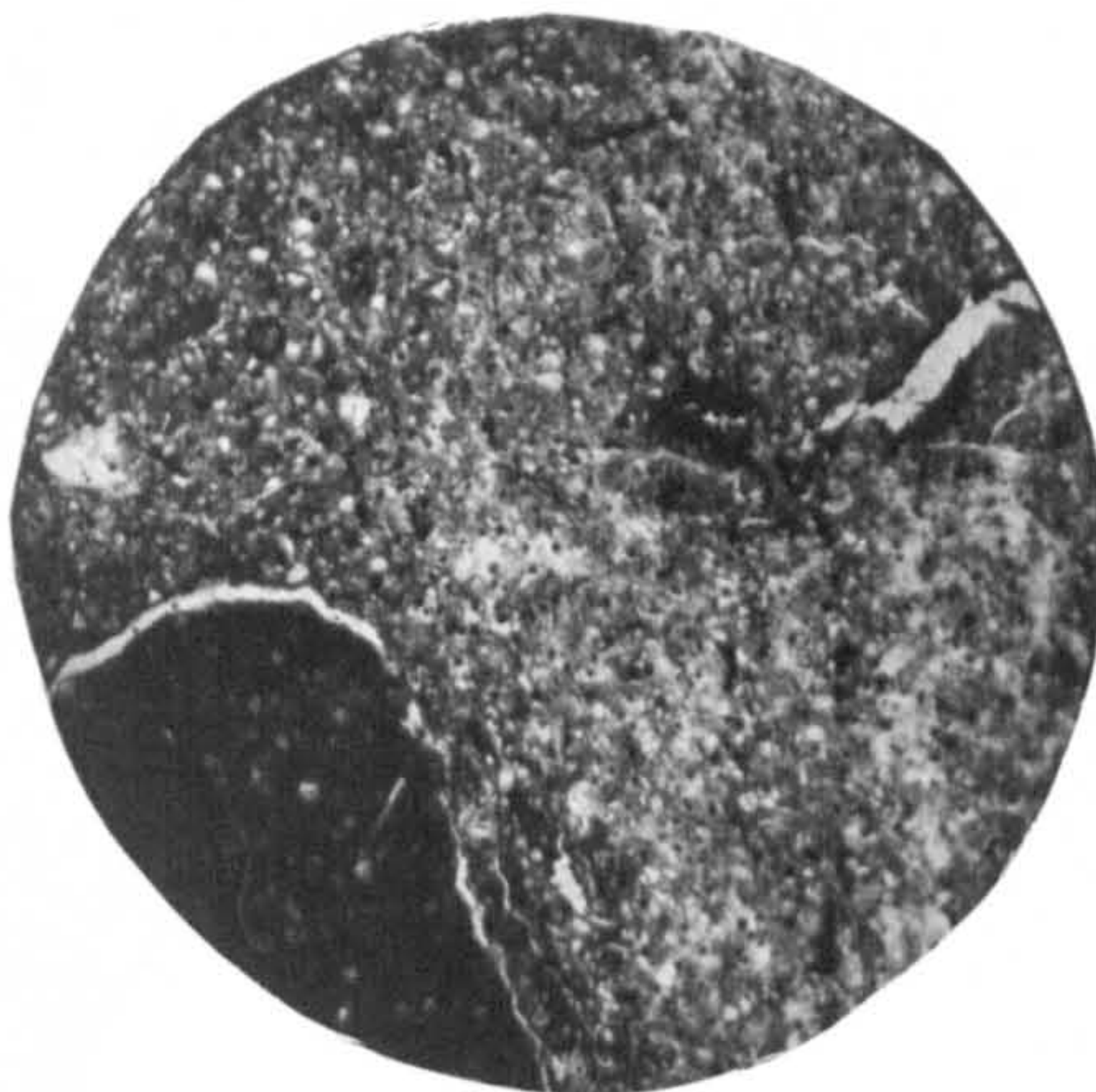


c

6. During the bronze age at the Breiddin, similar raw materials were prepared in different ways for various categories of ceramic artefacts.
- a. Fine textured inner mould Fabric (BR 2) contains quartz, rare shale and occasional tiny fragments of igneous rock.
 - b. Crucible pastes (BR 23) are tempered with medium sized, angular fragments of dolerite.
 - c. Pottery fabrics (BR 50) contain abundant large (to 3mm) angular dolerite fragments.



a



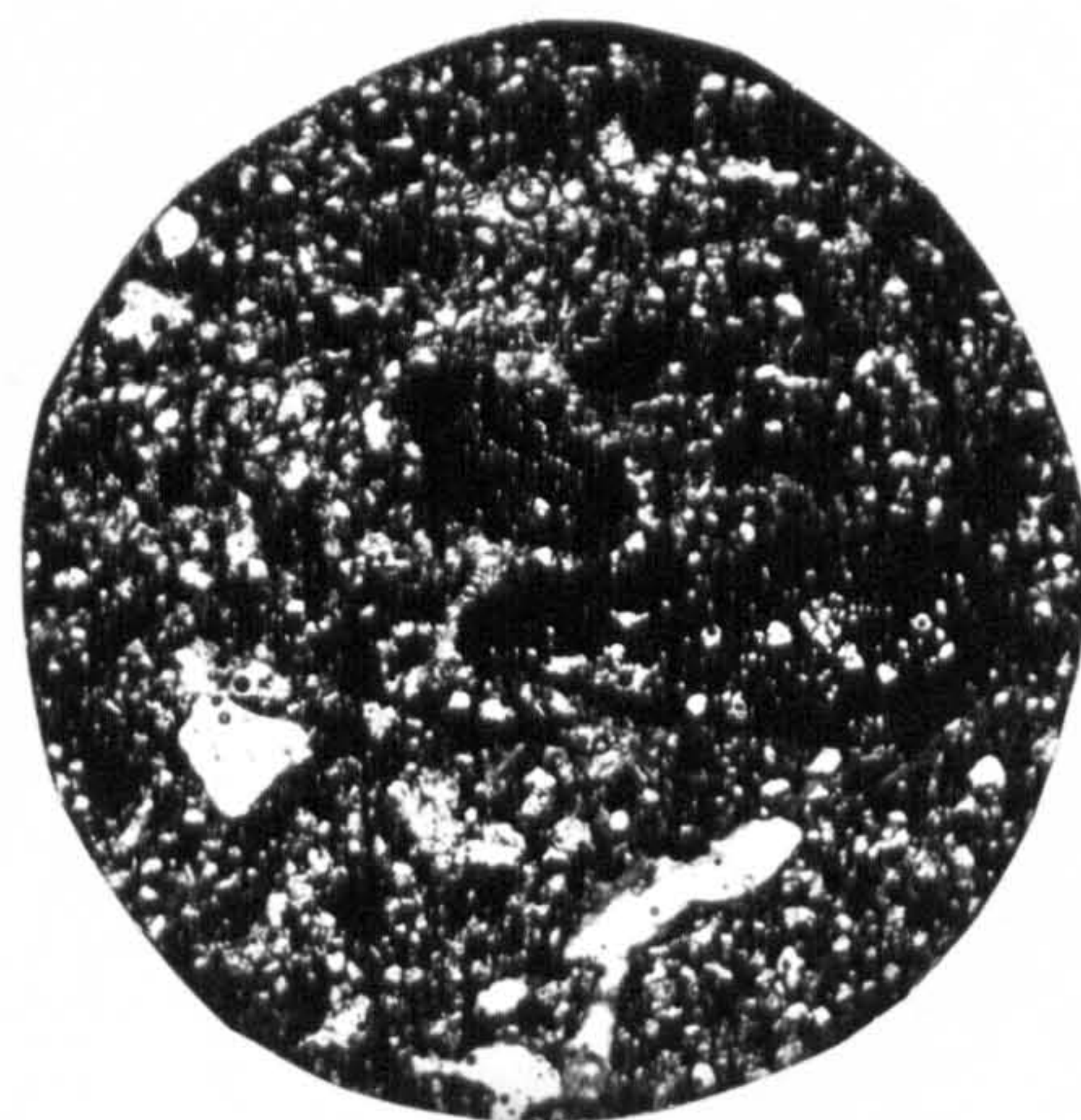
b

Bronze age cores

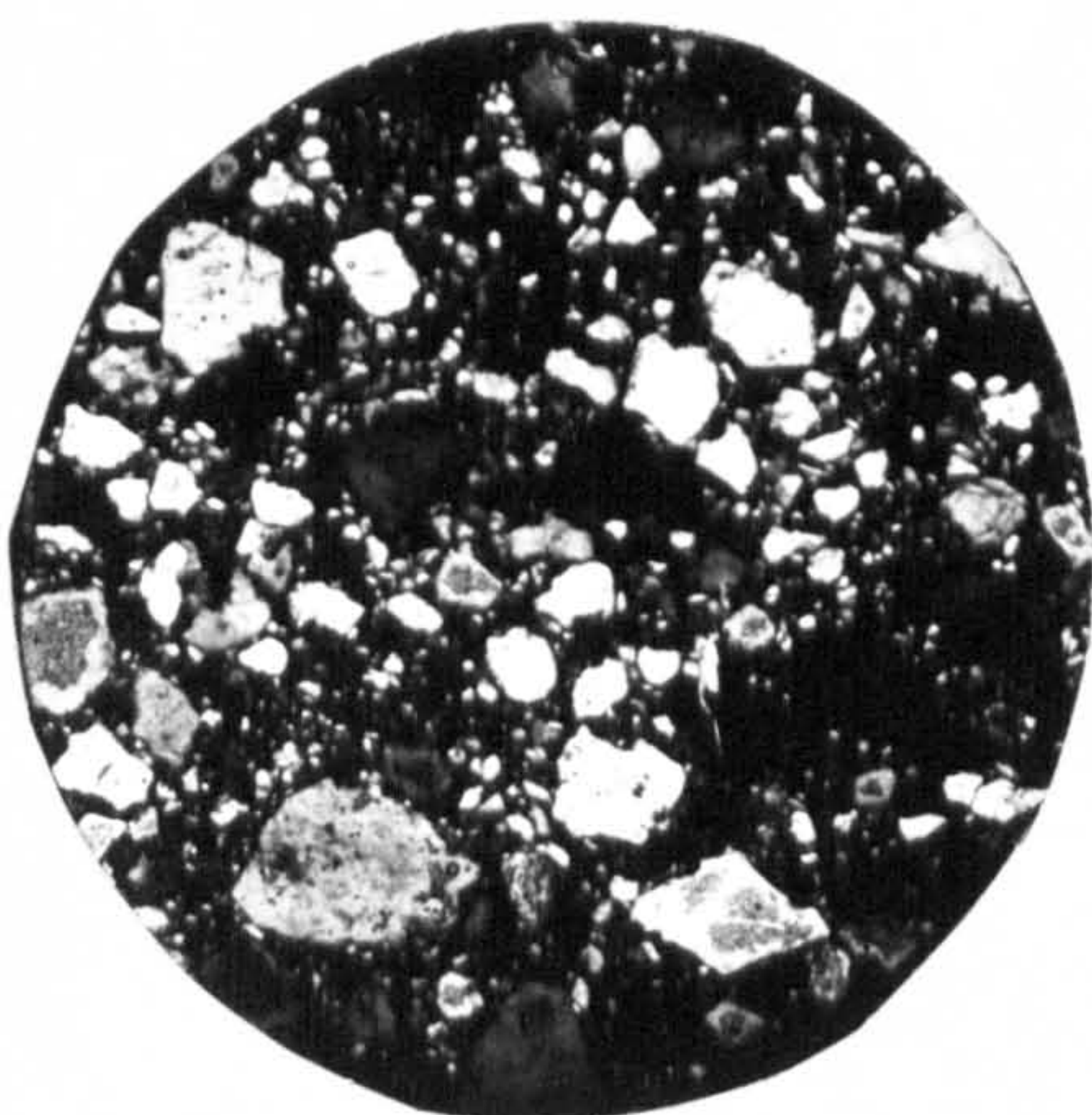
- 7a. socketed sickle or knife core from the Breiddin. The elongate inclusion in the centre of the photograph is a fragment of calcined bone (BR 97).
- 7b. core from a decorated socketed knife from Bramber. The large, dark inclusion at the edge of the photograph is fossiliferous chalk (BMB 3).



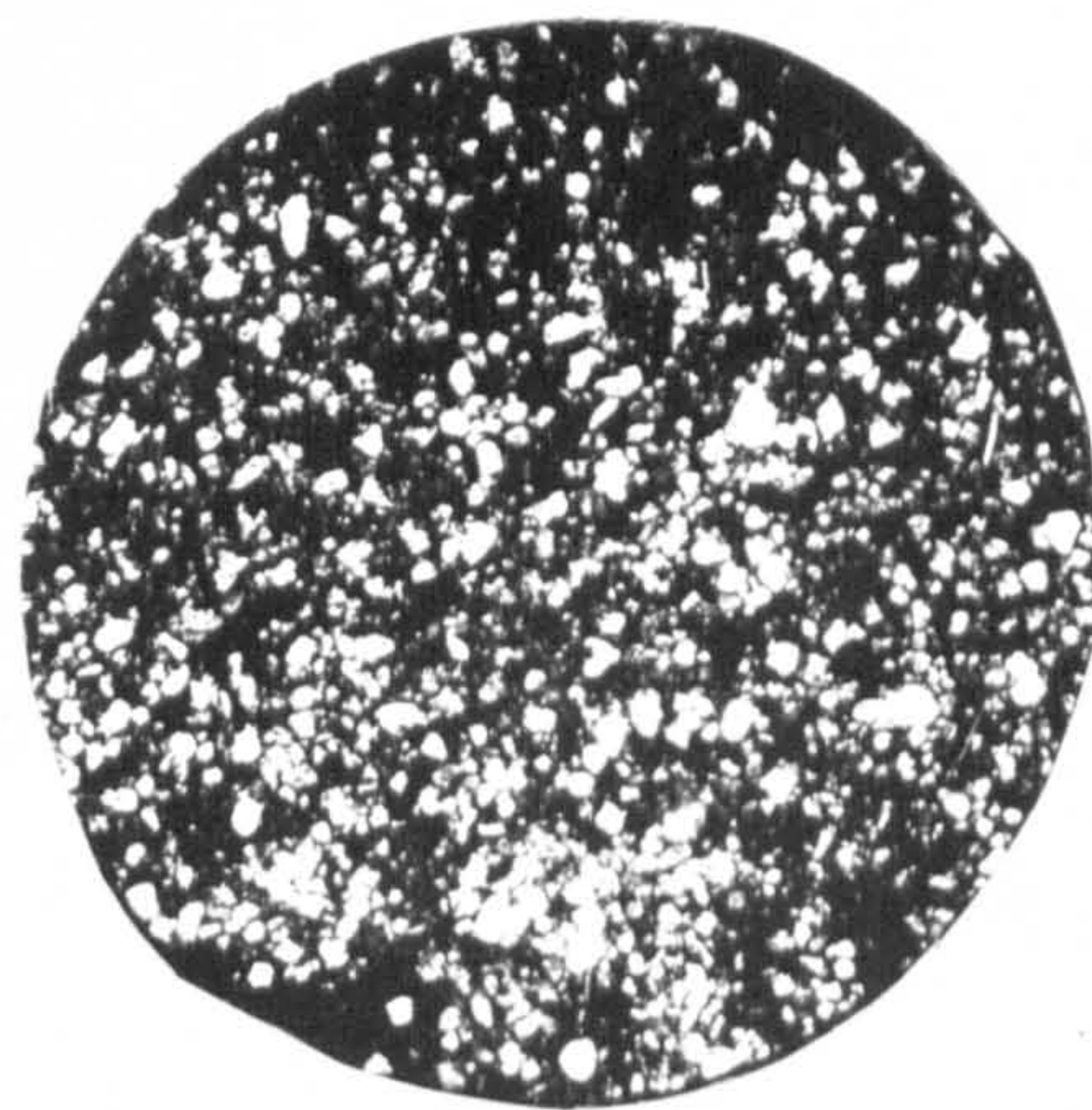
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c



d

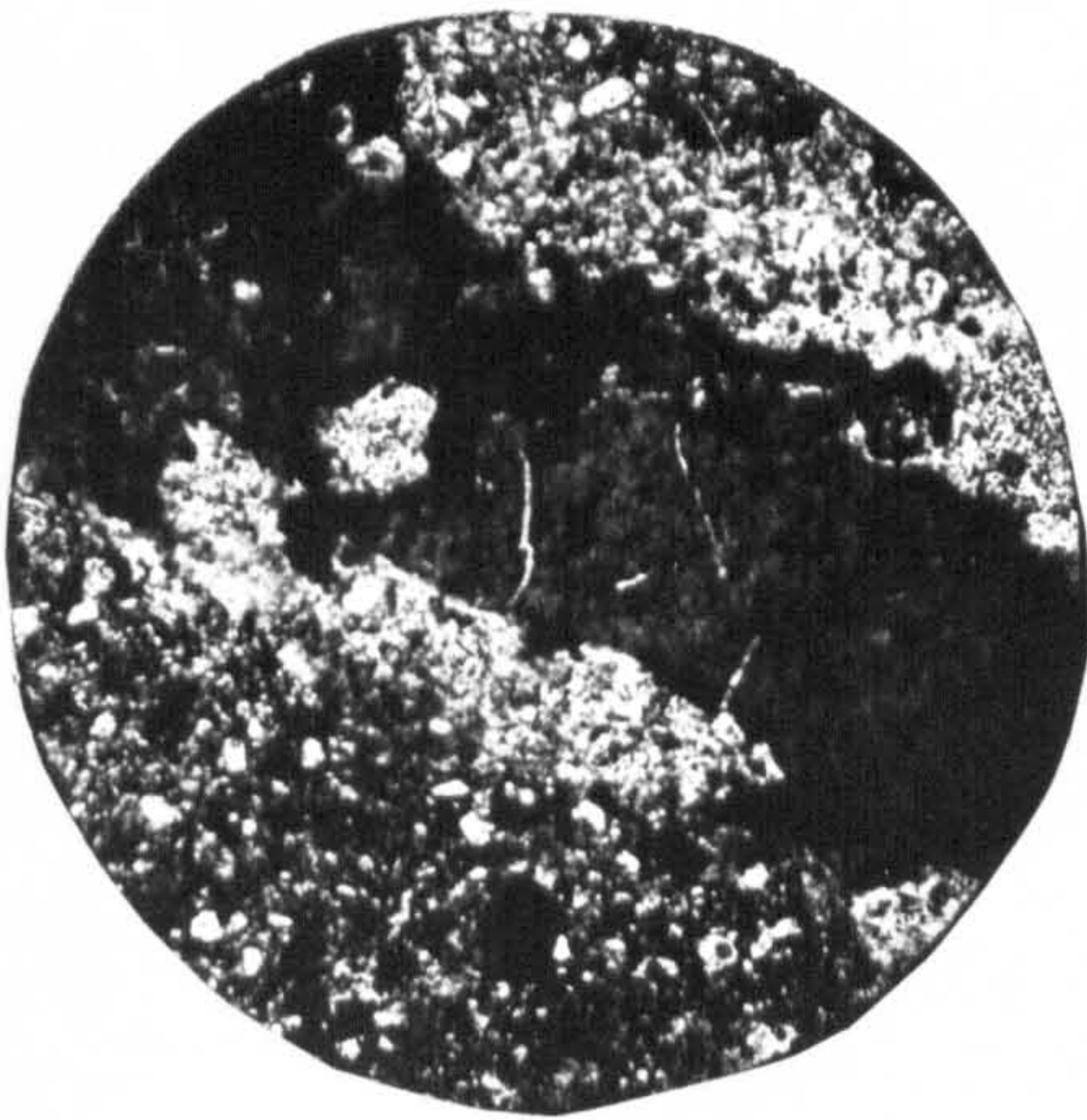
Representative examples of crucible fabrics in use during the iron age

8a. carbon crucible (Beckford: BK 5).

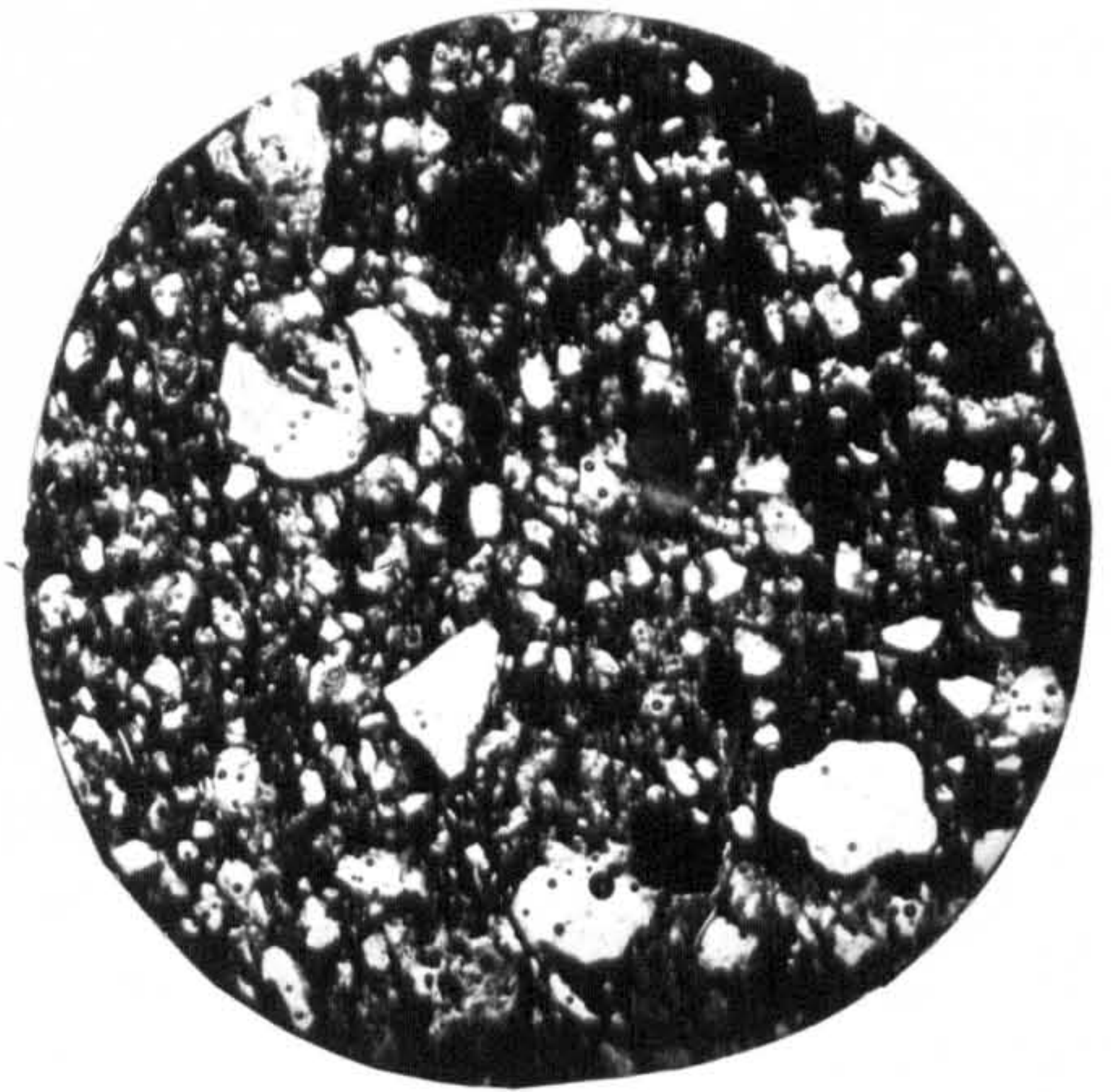
8b. sand and carbon crucible (Meare: MRE 37b).

8c. sand crucible (Gussage All Saints: GAS 35).

8d. fine sand crucible (Beckford: BK 14).



a



b



c

- 9a. A relined iron age crucible from the Breiddin, showing bands of slag between the sand-paste layers (BR 35).
- 9b. Late bronze age tuyère from Mucking (MU 15).
- 9c. A typical iron age mould fabric (Weelsby Avenue: WB 13).