Excavations and metal-working at Llwyn Bryn-dinas hillfort, Llangedwyn, Clwyd

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The setting and general description of the hillfort (CRM)

Llwyn Bryn-dinas (SJ 172247; Clwyd Archaeological Record CAR 999) is the only hillfort of substance in this part of the Tanat Valley, lying almost midway between the major forts of Craig Rhiwarth and Llanymynech Hill (fig. 1). Craig Rhiwarth, enclosing an area of about 35 ha/86 acres, lies above Llangynog, about 12 km to the west, where the head of the valley cuts into the rugged uplands of southern Clwyd. The very large hillfort on Llanymynech Hill (56 ha/140 acres) lies about 9 km to the east, near the confluence of the Tanat and Vyrnwy, which feed into the Severn a little further downstream. Two smaller neighbouring sites of later prehistoric type are known from aerial photography - a small double-ditched enclosure known as Plas Uchaf, on a hillock at the very foot of Llwyn Bryn-dinas (SJ179245; CAR 1002), and a square double-ditched enclosure on the banks of the Tanat about 1.5 km to the south-west (SJ156245; CAR 1433); both enclose about 1 ha/2.5 acres. The site now lies within the community of Llangedwyn, Clwyd, but before Local Government re-organisation in 1974 it fell within Llanrhaeadr-ym-Mochnant, Denbighshire.

The dominant conical hill on which the hillfort is sited, rises steeply by about 160 m from the floor of the Tanat valley, to a height of 271 m (888 ft) OD, its peak commanding magnificant views in all directions, particularly to east and west down the Tanat valley. One of the few published plans and descriptions is that by Ellis Davies (Davies 1929, 300-301). The general site plan in this report is based on the 1912 revision of the O.S. 1:2500 and the 1980 revision of the 1:10000 map of the area, with the addition of minor details from field survey and vertical air photography.

The univallate defence encloses an area of 3.2 ha/8 acres. The interior is studded with linear outcrops of grey Silurian shale, forming spines of rock mostly running roughly east to west, and continuing down the deeply-indented eastern flanks of the hill. The northern half of the interior stands up to 10 m higher than the southern part, with a slightly lower saddle between the two, holding a small natural pond towards its western end. Although there is little flat ground within the fort, there are substantial areas of gently sloping land and terraces between rock outcrops which are likely to have been suitable for building construction.

The rampart generally follows the break of slope between the top of the hill and the steep falls to the valley below. This causes it to take a rather higher line around the northern side of the fort, and on the east gives rise to an imposing re-entrant round the deeper but more gently sloping of two substantial natural gullies which indent this flank of the hill, providing a readily defended entrance to the central saddle of the interior. The rampart around this re-entrant is represented by little more than a level terrace on the hillside, with no sign of an external ditch, and with a simple gap about 7 m wide at the head of the gully. The butt-end of the rampart on the northern side of the entrance is much disturbed by rabbits; on the southern side there are apparently quarried faces on a natural rock outcrop which may *possibly* indicate the presence of a recessed guard-chamber towards the back of the rampart. The top of the gully outside the entrance is marked by irregular humps and hollows, which may have resulted at least in part from earlier excavations (see below).

Around the southern and south-eastern circuit of the hillfort, where the ground falls very gently towards the back of the rampart, the bank stands no more than 50 cm above the interior. There are hints, suggested by rock-faces which appear to have been quarried, of an internal quarry-scoop about 8 m wide along the south-east side, in the lowest and most sheltered part of the hillfort. Deposits of soil up to about 10 ft/3 m deep were found by Stephen in one of his four trenches in this area in the 1950s. There is a slight 'offset' in the line of the rampart about half-way along the southern side which might perhaps represent a small subsidiary entrance, though there is no sign of a track leading away from it on the very steep slopes outside the fort.

There is no sign of an external ditch on the south, though it would not necessarily be expected in view of the very steep fall of the hillside to the valley below. To the south-east, however, relatively gentle external slopes provide weaker natural defences than round any other part of the circuit, and the apparent absence of a ditch is less easy to explain, unless it has become masked by erosion from a rampart made principally of soil rather than stone (a conjecture perhaps supported by Stephens' excavations *behind* the rampart in the 1950s, noted above).There may also have been some deliberate leveiling of the rampart in this area, within the small plantation which has slightly overlapped the interior of the fort at various times during about the past 50 years.

Along the western end of the hillfort the rampart increases in height and sharpness of profile. Around the higher and more rocky north-western side (where the interior often falls gently *away* from the rampart) it is up to 2 m high and 6 m wide, and is accompanied by a narrow outer ditch with a slight counterscarp bank which diminishes to a simple terrace at the south-west corner of the fort. Along the north-east side the ditch again reduces to a simple terrace, or appears as scarping through upstanding spines of bedrock; it becomes progressively less distinct as the rampart decreases in scale on its gentle fall towards the site of the 1983 excavations.

Well downslope from the rampart on the north-western side of the hill is an intermittent stretch of linear quarrying, of unknown antiquity.

The 1950s excavations (CRM)

Several short seasons of excavation were carried out on the hillfort in the years 1954-56 by Mr L. M. Stephen, a schoolteacher, with the help of pupils from his school at Wolverley, Worcestershire. It appears that he may also have returned to the site in 1958, after he had taken up a new appointment at Dover College, Kent. The results were never published, but the work was mentioned briefly in print by Dr H. N. Savory (Savory 1976, 260-1). Following the excavations by the Trust in 1983, Mrs Stephen kindly made available two notebooks, a series of photographs, correspondence, typescript notes, and a small box of finds from her late husband's effects. Dr Savory also helped by providing various notes and correspondence relating to the earlier work.

The precise location of Stephen's trenches can no longer be identified with certainty, but their approximate positions are shown from details in the notebooks (fig. 1, A-E). Trenches in the interior and outside the entrance on the east produced no clear evidence of occupation floors, structures or significant concentrations of charcoal or occupation debris. However, the two sections through the front of the bank and its accompanying ditch on the north-west were more informative, showing that the rampart here was up to about 1.5 m high above the underlying rock, with a stone outer facing still standing to about 50 cm. No more than half a metre in front of this facing (to judge from photographs and a sketch section), the ground fell away to a depth of about 3 m into a steep-sided rock-cut ditch, raggedly stepped on its outer face and perhaps 4-5 m wide (the width is not clear in the excavation records). Above a layer of about 50 cm of small stones in the base of the ditch, the fill consisted principally of large stones, beneath a thin cover of stony soil.

The only find from the rampart sections was a single sherd of coarse pottery of probable late Bronze Age date (no. 10), which came from the ditch filling. The only other finds from the 1950s excavations were two stone spindle-whorls (nos 19-20).

Siting, objectives and progress of the 1983 excavations (CRM)

The line chosen for the access track cut through the rampart at an angle of about 30° at a point where it had already been partially eroded by animals, just north of the entrance gully on the eastern side of the fort. The uneroded parts of the rampart here stood little more than 50 cm high above the interior, and even allowing for the accumulation of material behind the rampart it seemed unlikely that the total depth of core material would be more than about a metre. It was thought that a section about 3 m wide could be dug in about a fortnight with a small team seconded from work elsewhere, allowing the basic structural character of the rampart to be recorded, testing the underlying ground surface for the possibility of earlier (palisaded?) lines of defence, and seeking dating material from either the rampart core or the deposits behind or beneath it. The presence of the external ditch might also be tested, either in the excavation trench or in the subsequent bulldozing work for the access road.

In the event, the surface evidence proved to be entirely illusory, and the trench took over six weeks to complete. The rampart was found to traverse a deep natural gully at this point, giving a depth of over 3 m of stratified deposits from the surface of the underlying bedrock. The stratification behind the rampart was also deeper and more complex than expected, and included the metal-working evidence described in the main body of the report. The excavation trench, 3 m wide by about 14 m long, straddled the highest point of the rampart in the immediate area and extended a few metres into the interior, where occupation deposits might be expected. With the limited resources available it was not possible to extend the trench downhill to see whether there was an external ditch set well forward of the rampart.

After slow progress in the early part of the project it was decided to limit the width of excavation in the first instance to about 1.5 m, along the northern side of the trench. The lower parts of the rampart core and the underlying buried soil were therefore only seen in this relatively narrow trench. The eastern end of the trench, outside the front facing of the ramparts (Plate 16b), was excavated across its full width to the depth of the available deposits, except for a small area of ditch-filling exposed in the extreme south-east corner of the trench.

Behind the rampart, the narrower section was carried to the surface of the metal-working deposits, which were then excavated (with the underlying deposits) in the middle weeks of the project; the obvious importance of the metal-working material prompted the extension of the excavation in the interior to the full width of the trench, only small parts of the basal quarry-scoop at the extreme south-west remaining unexcavated here when digging was finally brought to a close by deteriorating weather.

The construction work for the road was later carried out with minimal further damage to the archaeological deposits, though the upper metre or so of the rampart along either side of the finished track has subsequently suffered a certain amount of natural erosion.

Bibliography

Davies, E. 1929. *Prehistoric and Roman remains of Denbighshire*. Cardiff.

Savory, H. N., 1976. Welsh hill-forts: a reappraisal of recent research. In D. W. Harding (ed.), *Hillforts: later prehistoric earthworks in Britain and Ireland*. London: Academic Press, 237-91.

Summary catalogue of metal-working debris from Llwyn Bryn-dinas (JPN, CJS)

See main report in printed text. The following sections give a full catalogue of metal-working debris from the site, together with descriptions and analyses of different categories of material.

TABLE 2: SUMMARY CATALOGUE OF METALWORK AND METALLURGICAL DEBRIS

	Weight	Quantity	Length	Width	Thickness	Reference No.	No.
Context 03: occupation deposit behind Rampart Z							
fired clay	2.10	2	-	-	-	-	-
Context 04: core of Rampart Z							
dense slag type 4	174.00	1	99.0	50.0	28.5	LB-OX-82	55
Context 05: grey soil above/behind Rampart Y							
lining material frag	4.00	1	-	-	-	LB-OX-12	-
lining material frag	7.00	2	-	-	-	LB-OX-36	-
dense slag frag	8.00	4	20.5	14.7	8.8	LB-OX-58	-
dense slag type 4	50.50	1	48.4	38.5	15.8	LB-OX-81	56
dense slag frag	3.00	1	-	-	-	LB-OX-13	-
Context 06A: turf-line above Rampart Y							
crucible frags?	1.95	2	-	-	-	LB-OX-121	34
lining material frag	10.00	1	-	-	-	LB-OX-20	-
Context 07: grey soil between Ramparts Y and Z							
lining material frag	21.00	8	-	-	-	LB-OX-21	-
fuel ash slag/LRP	1.00	2	-	-	-	LB-OX-67	-
dense slag frag	5.20	1	20.6	20.3	10.0	LB-OX-66	-
Context 08: cleaning onto charcoal layer 09							
crucible frag	6.00	1	-	-	-	LB-OX-125	32
crucible frags	121.00	11	-	-	-	-	31
lining material	5.50	1	-	-	-	LB-OX-25	-
lining material	134.50	26	-	-	-	LB-OX-37	-
dense slag type 3/4	37.00	1	60.0	33.2	20.7	LB-OX-83	57
Context 09: charcoal layer on metal-working floor							
clay (yellow)	2.80	3	-	-	-	LB-OX-61	-
clay	6.50	1	-	-	-	LB-OX-26	-
clay	5.50	1	-	-	-	LB-OX-78	-
copper alloy prill?	0.10	5	-	-	-	LB-OX-130	-
copper alloy	-	1	-	-	-	LBD 3	44

Table 2 continued on next page

TABLE 2: PAGE 2	Weight	Quantity	Length	Width	Thickness	Reference No.	No.
copper alloy	-	1	-	-	-	LBD 2	45
crucible frag	3.10	1	-	-	-	LB-OX-115	37
crucible frags	16.00	15	-	-	-	LB-OX-118	38
crucible frag	4.10	3	-	-	-	LB-OX-120	39
crucible frag	2.20	1	-	-	-	LB-OX-123	33
crucible frag	2.15	1	-	-	-	LB-OX-124	36
crucible frags	0.25	5	-	-	-	LB-OX-126	35
crucible frag	7.80	1	-	-	-	-	26
crucible frags	7.10	3	-	-	-	-	27
lining mat/crucible	31.50	11	-	-	-	LB-OX-57	-
lining material	23.00	1	-	-	-	LB-OX-1	-
lining material	49.00	5	-	-	-	LB-OX-3	-
lining material	28.00	3	-	-	-	LB-OX-6	-
lining material	40.00	24	-	-	-	LB-OX-7	-
lining material	5.00	1	-	-	-	LB-OX-8	-
lining material	80.00	25	-	-	-	LB-OX-9	-
lining material	18.00	5	-	-	-	LB-OX-51	52
lining material	3.00	2	-	-	-	LB-OX-108	-
lining material frags	12.00	6	-	-	-	LB-OX-16	-
lining material frags	7.00	9	-	-	-	LB-OX-14	-
lining material frags	13.00	6	-	-	-	LB-OX-18	-
lining material frags	24.50	1	-	-	-	LB-OX-19	-
lining material frags	161.00	27	-	-	-	LB-OX-22	-
lining material/LRP	4.70	10	-	-	-	LB-OX-127	-
lining reaction product	22.00	6	-	-	-	LB-OX-52	-
lining mat/crucible	1.60	1	-	-	-	LB-OX-53	-
lining mat/fuel ash slag	8.00	8	-	-	-	LB-OX-68	53
fuel ash slag	0.60	1	-	-	-	LB-OX-54	-
fuel ash slag	2.00	1	-	-	-	LB-OX-15	-
dense slag drip	1.00	2	-	-	-	LB-OX-11, LBD 10	48
dense slag frags	19.00	3	-	-	-	LB-OX-17	-
dense slag drip/flow	9.00	1	31.6	15.1	13.9	LB-OX-23	-
dense slag drip/flow	1.00	1	15.6	11.8	8.8	LB-OX-24	-
dense slag drip/flow	5.50	1	28.7	16.2	11.8	LB-OX-55	-
dense slag type 4	121.00	1	69.2	68.1	19.3	LB-OX-75	58
dense slag type 2	21.50	1	44.0	32.9	20.3	LB-OX-76	-
dense slag drip/flow	8.00	1	23.7	20.4	12.0	LB-OX-77	-
dense slag type 4	173.50	1	85.4	71.5	22.5	LB-OX-99	59
dense slag	6.80	1	21.0	22.2	11.3	LB-OX-111	-
hammer scale	0.35	15	-	-	-	LB-OX-128	-
hammer scale + iron?	9.50	4	-	-	-	LB-OX-10	-
HS + other MM	386.30	5000+	-	-	-	LB-OX-143	-
HS + other MM	448.90	6000+	-	-	-	LB-OX-144.0	-
HS + other MM	11.65	10	-	-	-	LB-OX-144.1	-
hammer scale + SS	43.50	20	-	-	-	LB-OX-135	-
slag spheres	0.05	4	-	-	-	LB-OX-129	-
iron frag?	11.00	1	24.0	23.2	15.6	LB-OX-104	-

Table 2 continued on next page

TABLE 2: PAGE 3	Weight	Quantity	Length	Width	Thickness	Reference No.	No.
iron	9.00	1	-	-	-	LB-OX-5	-
iron frag	2.20	1	18.5	11.2	9.0	LB-OX-112	-
iron object?	2.05	1	18.3	11.3	8.4	LB-OX-113	-
iron (slagged)	12.80	1	30.0	21.5	18.3	LB-OX-110	-
unknown	3.00	1	19.8	19.4	9.7	LB-OX-105	-
rock slag aggregate	2.80	1	-	-	-	LB-OX-109	-
bronze pin	*c.* 1	1	32	7	1.9	LBD 8	25
Context 11: bowl-hearth							
copper prill	0.60	1	8.0	7.3	6.8	LB-OX-44a, LBD 9	46
copper alloy?	1.40	1	-	-	-	LB-OX-71	-
copper alloy?	0.05	1	-	-	-	LB-OX-72	-
crucible frag	3.60	2	-	-	-	LB-OX-117	41
crucible frags	23.50	3	-	-	-	LB-OX-119	40
lining material	5.20	2	-	-	-	LB-OX-45	-
lining reaction product	1.00	1	17.4	9.5	10.2	LB-OX-74	-
fuel ash slag	8.50	1	34.4	32.6	15.7	LB-OX-27	-
fuel ash slag	8.00	1	42.5	35.1	14.1	LB-OX-28	-
fuel ash slag	11.50	1	52.5	30.2	17.2	LB-OX-29	-
fuel ash slag frags	10.00	24	-	-	-	LB-OX-34, LBD 11	49
fuel ash slag	5.00	5	-	-	-	LB-OX-43	-
fuel ash slag/fused soil	20.50	8	-	-	-	LB-OX-70	-
hammer scale	0.15	8	-	-	-	LB-OX-35	-
over-heated iron frag?	4.50	1	23.4	16.0	8.9	LB-OX-73, LBD 12	24
Context 12: hearth and adjacent gully							
clay	5.00	3	-	-	-	LB-OX-42	-
crucible frag	1.00	1	-	-	-	LB-OX-116	42
Context 13: patch of charcoal							
clay (yellow)	47.00	15	-	-	-	LB-OX-63	-
fuel ash/LRP + MM	3.25	1	-	-	-	LB-OX-133	-
hammer scale	1.70	2	-	-	-	LB-OX-134	-
Context 14: bowl-hearth							
iron pin	1	1	13	3	3	-	21
iron punch/awl?	4	1	70	5	4	LB-0X-131	22
iron bar	3	1	66	5	3	-	23
Context 16: bowl-hearth							
clay (yellow)	27.00	5	-	-	-	LB-OX-62	-
copper alloy	0.15	1	-	-	-	LBD 7	47
crucible (complete)	113.00	1	-	-	-	LBD 1	28
crucible	30.80	5	-	-	-	-	29
slag (crucible)	2.30	5	-	-	-	-	29
lining material	14.00	1	-	-	-	LB-OX-30	-

Table 2 continued on next page

TABLE 2: PAGE 4	Weight	Quantity	Length	Width	Thickness	Reference No.	No.
dense slag fragment	4.50	1	18.5	14.4	11.6	LB-OX-31	-
dense slag fragment	6.50	1	15.7	13.9	12.0	LB-OX-69	-
slag spheres	0.05	4	-	-	-	LB-OX-137	-
copper-stained slag frags	0.05	5	-	-	-	LB-OX-138	-
slag frags + hammer scale	2.30	13	-	-	-	LB-OX-139	-
hammer scale	1.05	20	-	-	-	LB-OX-136	-
iron fragment	1.10	1	23.4	18.3	3.3	LB-OX-106	-
iron fragment	2.25	1	23.0	16.1	5.6	LB-OX-107	-
Context 19: possible forge/anvil site							
clay	9.50	7	-	-	-	LB-OX-60	-
lining material	9.30	4	-	-	-	LB-OX-100	-
lining reaction product	4.50	1	-	-	-	LB-OX-122	-
dense slag frag (4?)	26.50	1	28.2	27.5	17.3	LB-OX-101	-
dense slag frag (4?)	17.30	1	22.0	19.0	21.6	LB-OX-102	-
dense slag fragment	7.50	1	21.3	15.4	13.3	LB-OX-103	60
hammer scale	0.70	1	18.3	9.2	4.3	LB-OX-65	-
hammer scale/other MM	48.50	1100+	-	-	-	LB-OX-142	-
slag sphere	0.05	1	2.9	3.0	2.7	LB-OX-56	-
Context 20: stakeholes							
lining material frags	7.5 0	5	-	-	-	LB-OX-32	-
dense slag prills	0.80	2	12.1	9.1	6.0	LB-OX-33	-
Context 22: refill of quarry scoop behind Rampart X (presumably intrusive)							
crucible	26.30	1	-	-	-	-	30
dense slag type 4	194.50	1	113.0	73.0	24.1	LB-OX-80	61
Context 25: grey soil on 'bench' to E of metal-working floor							
fuel ash slag	4.50	1	-	-	-	LB-OX-85	-
dense slag type 3/4	52.00	1	52.6	41.6	18.2	LB-OX-84	62
Context 26: charcoal patch on sloping 'bench' to E of metal-working floor							
lining material	46.00	7	-	-	-	LB-OX-2	-
lining material	1.00	1	-	-	-	LB-OX-4	-
lining reaction prod/ FAS	0.40	1	-	-	-	LB-OX-141	-
Context 27: possible anvil/forge site							
crucible frags	4.75	3	-	-	-	LB-OX-114	43
lining reaction product	8.00	1	25.0	28.0	12.6	LB-OX-94	-
fuel ash slag frags	8.30	15	0.0	0.0	0.0	LB-OX-46	54
dense slag	23.00	9	23.3	17.1	13.5	LB-OX-38	-
dense slag	0.30	1	6.1	6.1	4.9	LB-OX-39	63
dense slag	0.35	1	9.0	7.7	5.6	LB-OX-40	64
dense slag	2.50	1	20.0	15.5	8.9	LB-OX-41	65
dense slag drip	1.00	1	12.3	10.6	8.2	LB-OX-47	-
dense slag drip	0.20	1	9.6	8.6	5.2	LB-OX-48	-

Table 2 continued on next page

TABLE 2: PAGE 5	Weight	Quantity	Length	Width	Thickness	Reference No.	No.
dense slag drip	0.70	1	9.2	6.5	5.4	LB-OX-49	66
dense slag drip	1.80	1	20.4	14.3	9.0	LB-OX-98	-
dense slag frag	23.50	1	31.0	28.0	28.3	LB-OX-88	-
dense slag frag	5.50	1	31.0	20.6	8.8	LB-OX-90	-
dense slag frag (1)	2.50	1	19.6	9.4	8.7	LB-OX-91	-
dense slag frag	17.00	1	30.6	26.6	15.6	LB-OX-95	-
dense slag frags	44.00	23	-	-	-	LB-OX-97	-
dense slag type 2	15.00	1	34.8	23.9	10.4	LB-OX-89	-
dense slag type 3	64.00	1	48.5	44.1	16.1	LB-OX-87	69
dense slag type 3/4	35.00	1	34.0	29.8	16.3	LB-OX-92	70
dense slag type 4 frag	31.00	1	36.6	29.7	20.2	LB-OX-93	-
dense slag type 4	240.00	1	114.2	70.6	28.0	LB-OX-79	67
dense slag type 4	227.00	1	89.5	73.3	26.6	LB-OX-86	68
dense slag type 4	145.00	1	73.8	52.0	20.6	LB-OX-96	71
hammer scale	0.05	1	5.3	5.8	0.1	LB-OX-50	50
hammer scale	0.70	26	-	-	-	LB-OX-59	-
hammer scale	0.60	5	18.5	14.0	2.2	LB-OX-64	51
hammer scale + other MM	0.05	10	-	-	- 1	LB-OX-40	-

Weights are given in grammes and dimensions in millimetres in the above table. Numbers in right-hand column are those given in the descriptive catalogues in the printed text and in Tables 3-9. Abbreviations are as follows: MM = magnetic material; SS = slag spheres; LRP = lining reaction product; HS = hammer scale; FAS = fuel ash slag. The weight and quantity of hammer scale from context 09 (ref. LB-OX-143, 144.0) and context 19 (ref. LBD-OX-142) are estimates made from sub-samples of the material collected.

ANALYSES OF METAL ARTEFACTS (JPN)

See also descriptive text in printed report. The additonal notes which follow are of analysed items only.

21. Examination during conservation (conservation report on Lab. No. 3543 by Kate Hunter dated 8 March 1988, a copy of which is lodged with site archive) had suggested that the pin had been manufactured by fixing a flat, rimless iron disc several millimetres from one end of the shaft, pushing the decorative head onto the shaft as far as the iron disc and then slightly flattening the end of the shaft in order to secure the decorative head. Microscopic examination of the decorative head showed that it had no clearly defined internal structure, and that extensive decay had caused some lamination, particularly near the upper surfaces. Initial spot tests with the reagents cacothalene and potassium iodide gave negative results for tin but a good positive result for lead, and although these tests are not wholly reliable they suggested that the decorative head was of corroded lead-based enamel or glass. Spectrographic analysis, of which the results are given in the following table, shows that the decorative disc head is made of tin.

TABLE 3: ANALYSIS OF DECORATIVE HEAD OF IRON PIN (weight fraction results)

No. 21: decorative head of iron pin (context 09)

Point	Si	W	P	S	Mo	Sn	Mn	Co	Ni	Cu	Zn	Ge	As	*remainder	oxygen
1	3.504	0.051	1.984	0.036	0.001	24.462	0.013	0.002	0.027	0.165	0.028	0.016	0.767	*	pin-head
2	0.000	0.000	2.234	0.000	0.000	35.916	0.006	0.001	0.075	0.838	0.076	0.000	1.812	*	pin-head

24. See description in printed report.

TABLE 4: ANALYSIS OF OVER-HEATED IRON FRAGMENT

No. 24: over-heated iron fragment (context 11; ref. LBD12; LB-OX-73)

Point	Sn	As	Sb	Pb	Co	Ni	Fe	Ag	Au	Zn	Bi	Cu	
1	-	0.33	0.11	0.14	0.01	0.02	6.64	-	-	1.39	-	14.64	(silica omitted)
2	-	0.23	0.10	0.09	0.02	0.06	15.93	-	-	2.46	0.04	4.12	(silica omitted)
3	-	0.28	0.11	0.09	0.04	0.08	17.50	0.02	-	2.24	-	9.20	(silica omitted)

25. The pin is formed out of forged wire (not cast); shaft has been smoothed to a round section while ring is still faceted, the facets showing transverse grinding marks; end of wire in ring cut square, probably with a chisel. Dark green/brown patina. There are traces of replaced wood on the shaft and charred wood near the base.

Metallography: a thick layer of corrosion products along each side of section retains some sulphide inclusions; extensive corrosion network following grain boundaries and original interdendritic network of $\alpha\delta$ eutectoid; some large sulphide stringers; fully recrystallised equiaxed grain structure with annealing twins; grain diameter 30-40μ; no subsequent deformation; no coring. The elongation of the sulphide stringers suggests that the wire for the pin was forged down from a rod perhaps three times its diameter, ie. 6 mm. The microstructure shows a typical cold-worked and annealed bronze, left in the fully annealed state.

Composition: a sample, cut from end of shaft showed the following composition (average; see also Table 5, LBD 8): 6.73% Sn; 1.58% As; 0.04% Sb; 0.28% Pb; 0.11% Co; 0.48% Ni; 2.04% Fe; 0.11% Ag; 0.45% Zn; balance Cu; some S present; Au, Bi not detected (see Table 5). The presence of a modest amount of the $\alpha\delta$ eutectoid in the microstructure indicates that the analysis, made by electron microprobe on areas of sound metal, is rather too low; the true tin content is probably a little over 8%. The impurity pattern (discussed in more detail in the discussion of the metal-working evidence from the site in the printed report) has the characteristics of the zinc-containing metal associated with Llanymynech on the Powys/Shropshire border (Musson and Northover 1989). Only a relatively small number of Welsh Iron Age copper-alloy artefacts, particularly ones of the early Iron Age, have been analysed, to some extent reflecting the small amount of material recovered. Nevertheless, the composition of the pin appears to be fairly typical of the period, as indeed for much of the Iron Age in Britain as a whole. Wales seems to produce a higher proportion of leaded bronze than the rest of Britain, however, but there are problems with the chronology of some of the finds concerned, namely rings from the Breiddin (Northover 1991), pins from Dinorben (Savory 1971, 65), and waste from Merthyr Mawr (Northover unpublished).

TABLE 5: ANALYSIS OF RING-HEADED PIN

No. 25: ring-headed pin (context 14; ref. LBD 8)

Point	Sn	As	Sb	Pb	Co	Ni	Fe	Ag	Au	Zn	Bi	Cu	
1	5.92	1.07	0.04	0.63	0.08	0.46	1.63	0.08	-	0.42	-		α phase
2	6.64	1.98	0.05	0.03	0.12	0.50	2.29	0.09	-	0.48	-		α phase
3	7.62	1.66	0.04	0.17	0.13	0.49	2.19	0.16	-	0.46	-		α phase

DESCRIPTIONS OF UNILLUSTRATED CRUCIBLE FRAGMENTS (JPN)

The numbering continues that given in the descriptions of illustrated crucibles and crucible fragments (fig. 4) in the printed text. See also full catalogue of metallurgical debris in Table 2.

32. Crucible body fragment, almost certainly from crucible no. 31 (6.00 g), showing relining; 25 x 22 x 20 mm. Context 08. Ref. LB-OX-125.

33. 1 body fragment from crucible no. 31 (2.2 g); thin vitrification only, outer layers perhaps having spalled off; 22 x 14 x 9 mm. Context 09. Ref. LB-OX-123.

34. 2 crucible body fragments with black vitrified outer surface (1.95 g); 4-5 mm thickness suggest location near rim. Context 06A. Ref. LB-OX-121.

35. 2 fragments and 3 chips spalled from the surface of a crucible (0.25 g); some vitrification but no slag. Context 09. Ref. LB-OX-126.

36. 1 piece miscellaneous fired clay, perhaps from crucible body (2.15 g); 25 x 10 x 8 mm. Context 09. Ref. LB-OX-124.

37. Crucible body fragment (3.1 g); white line of vitrfication, stained slightly pink in cross-section; 25 x 22 x 10 mm. Context 09. Ref. LB-OX-115.

38. 15 crucible fragments from body of crucible (16.00 g); black, rather vitrified; thin layer of ?metallic residues on some; highly curved inner surface from either base of vessel or small crucible. Context 09. Refs. LB-OX-118, LBD 5.

39. Three joining fragments of over-fired crucible (4.10 g), possibly from pointed base of crucible; 30 x 25 x 23 mm. Context 09. Ref. LB-OX-120.

40. Three body sherds from crucible, one with part of handle attached (23.5 g); highly vitrified with glossy black vesicular surfaces; one sherd more vitrified than the rest probably represents semi-fused crucible dripping away from handle area; 35 x 22 x 15 mm; 45 x 30 mm; 20 x 20 mm. From top 10 cm of context 11. Refs. LB-

OX 119, LBD 6.

41. Two small fragments, one from pouring lip (3.6 g). From top 10 cm of context 11. Refs. LB-OX-117, LBD 4.

42. Small crucible rim sherd (1.0 g). Context 12. Refs. LB-OX-116, LBD 4.

43. Three joining fragments probably originally from the body of a crucible (4.75 g); now over-fired and very vesicular; 30 x 24 x 14 mm. Context 27. Ref. LB-OX-114.

COPPER ALLOY AND RAW COPPER WASTE: DESCRIPTIONS (JPN)

Analyses of the following items are given in microfiche Table 6, where details of sample and context numbers are also listed. See also full catalogue of metallurgical debris in Table 2.

44. Irregular flat piece of bronze, 13 x 12 mm; as cast medium tin bronze; corroded away; dendrite arm spacing = 30-40μ, suggesting a moderate cooling rate; interdendritic distribution of sulphide clusters, all basically Cu_2S, although some contain a few percent iron; massive surface corrosion with islands of α and δ; fragments of charcoal and small areas of typical melting slag adhering, some possibly having originally floated on the surface of a melt. It is reasonable to suppose that this piece could have been the residue left in a crucible after a pour and had set there and been knocked out later, with charcoal and dross still embedded in the metal. See also analysis of sulphide inclusions in microfiche Table 7.

45. Bronze drop, 5 mm dia., completely corroded cast dendritic structure; clusters of sulphide inclusions, both Cu_2S and mixed copper-zinc sulphides with some associated particles of silver; skeleton of δ phase of interdendritic αδ eutectoid with some isolated islands of α solid solution; large cavity at centre, and outer layers are porous; otherwise Cu_2O corrosion products are solid; surviving δ skeleton indicates a rather acicular morphology for the α dendrites with, in some areas, a lamellar morphology for the α in the eutectoid. Both these features are a function of a fairly rapid cooling rate, appropriate for a small drop split away from the fire; tin content is rather higher near the surface of the drop. See analysis of corroded bronze waste in Table 6 and sulphide inclusions in Table 7.

46. Oxidised bronze (0.6 g); low tin bronze in association with copper and dendrites of cuprite (Cu_2O), the latter largely replaced by corrosion; the copper areas are associated with cuprite and with laths of cassiterite, SnO_2 which extend into the areas of bronze; also attached are areas of fairly typical bronze melting slag (cf. Northover 1987). This piece is very typical of bronze which has become oxidised during melting, either in a crucible or by having dropped into the hearth.

47. Corroded 10-12% tin bronze with melting slag attached, notably rich in high-Sn prills with only a limited occurrence of cassiterite; slag probably largely composed of vitrified crucible. Bronze/slag fragment from soil within crucible 40 (0.15 g). Completely corroded cast dendritic structure; only fragments of the δ phase from the interdendritic αδ eutectoid remain, some associated with sulphide inclusions; there is an attached area of slag which appears to derive from completely vitrified crucible material with fine dendrites of iron oxides perhaps also related to iron in the bronze; this slag also contains prills of high-Sn phases (δ or ε); such prills are often typical of melting bronze under oxidising conditions but the slag fragments contain very little copper or tin oxides except, perhaps, for some in solution or very finely divided in the glassy matrix of the slag.

48. Small slag drip (1 g), sampled. Oval drop of corroded low-tin bronze; originally a cast dendritic structure similar to those of the other samples examined but here only α phase remains; this is partly the result of slightly different corrosion conditions but this is undoubtedly a lower tin bronze than some of the others and is perhaps comparable with no. 44. See also analysis of slag in microfiche Table 9.

49. 24 fuel ash slag fragments, some contained copper prills (10 g), sampled. Probable fragment of crucible with corroded raw copper adhering; two large areas of solid metal show mixed sulphide inclusions and small inclusions of silver; in one of the two areas free iron is also visible. Context 11. See analysis of copper prills in microfiche Table 6 and analyses of slag in microfiche Table 9. The analysis of the raw copper is compared with a sample from Llanymynech hillfort in Table 8.

TABLE 6: ANALYSIS OF NON-FERROUS METAL-WORKING WASTE

No. 28: bronze/slag from soil inside crucible (context 16; ref. LBD 1)

Point	Sn	As	Sb	Pb	Co	Ni	Fe	Ag	Au	Zn	Bi	Cu	
1	34.41	1.26	0.21	0.26	0.02	0.90	0.45	0.18	-	0.03	0.07		δ phase
2	36.93	0.82	0.24	0.21	0.02	0.89	0.61	0.25	-	-	-		δ phase
3	37.85	0.96	0.22	0.28	-	0.84	0.40	0.38	-	-	-		δ phase
4	0.38	0.38	0.13	-	-	0.04	0.22	0.14	-	-	-		copper prill
5	6.30	-	-	-	0.32	0.70	53.01	-	-	1.79	-	1.06	slag; iron oxides, tin oxides

No. 44: bronze waste (context 09; ref. LBD 3)

Point	Sn	As	Sb	Pb	Co	Ni	Fe	Ag	Au	Zn	Bi	Cu	
1	2.89	-	0.02	0.06	0.06	0.16	0.54	0.12	-	0.17	0.02		α phase
2	18.05	2.52	0.19	0.20	0.06	0.24	0.19	0.30	-	0.07	0.03		α+δ eutectoid
3	20.02	1.96	-	0.29	0.04	0.21	0.19	0.40	-	-	-		α+δ eutectoid
4	24.76	0.42	0.27	1.64	0.09	0.28	0.20	0.23	-	0.09	0.12		α+δ eutectoid
5	20.88	2.57	0.17	0.21	-	0.26	0.15	0.24	-	0.04	0.04		α+δ eutectoid
6	2.73	0.69	-	-	0.04	0.17	0.54	0.02	-	0.14	0.06		α phase

No. 45: corroded bronze waste (context 09; ref. LBD 2)

Point	Sn	As	Sb	Pb	Co	Ni	Fe	Ag	Au	Zn	Bi	Cu	
1	2.04	3.20	-	0.04	-	0.23	0.05	0.11	-	0.12	-		α phase
2	12.54	4.03	0.08	0.17	0.02	0.25	0.07	0.14	0.10	0.11	-		α phase
3	13.42	3.22	0.10	0.05	0.05	0.20	0.05	0.06	-	0.06	-		α phase
4	32.57	1.35	0.09	0.20	0.03	0.58	0.03	0.28	-	-	0.05		δ phase
5	32.29	1.22	0.10	0.37	0.04	0.63	0.08	0.21	-	-	0.02		δ phase
6	34.88	2.87	0.13	0.48	0.04	0.730,01		0.35	0.05	0.02	-		δ phase, corroded

No. 46: bronze waste (context 11; ref. LBD 9, LB-OX-44a)

Point	Sn	As	Sb	Pb	Co	Ni	Fe	Ag	Au	Zn	Bi	Cu	
1	4.72	0.58	0.06	0.25	0.05	0.18	0.36	0.05	0.05	0.32	-		α phase
2	6.22	0.87	0.07	-	0.03	0.16	0.67	0.11	-	0.53	-		α phase
3	3.90	0.72	0.09	0.02	0.03	0.16	0.11	0.16	0.04	0.14	-		α phase
4	2.72	0.52	0.09	0.30	0.01	0.08	-	0.15	-	-	-		α phase

No. 47: corroded bronze waste (context 16; ref. LBD 7)

Point	Sn	As	Sb	Pb	Co	Ni	Fe	Ag	Au	Zn	Bi	Cu	
1	(40.30	1.44	0.21	0.56	0.01	0.45	1.99	0.22	-	0.23	-	27.70)	δ phase, corroded
2	(37.48	2.02	0.19	0.66	0.01	0.40	1.99	0.13	-	0.15	-	30.50)	δ phase corroded
3	(34.23	0.44	0.05	0.33	0.02	0.66	2.23	0.01	0.08	0.16	-	55.08)	α+δ eutectoid, corroded
4	3.53	0.43	0.12	0.09	0.02	0.06	52.85	0.04	-	0.38	-	3.37	slag; iron oxides

No. 48: corroded bronze waste (context 09; ref. LBD 10, LB-OX-11)

Point	Sn	As	Sb	Pb	Co	Ni	Fe	Ag	Au	Zn	Bi	Cu	
1	(8.97	0.72	0.07	0.05	0.01	0.09	4.25	0.08	-	0.27	-	74.59)	raw copper
2	(12.56	1.44	0.10	0.15	0.01	0.12	5.79	0.04	-	0.26	-	65.75)	copper
3	(9.05	0.52	0.08	0.03	0.02	0.06	1.35	0.04	-	0.18	-	74.34)	oxide (silica omitted)

No. 49: raw copper (context 11; ref. LBD 11, LB-OX-34)

Point	Sn	As	Sb	Pb	Co	Ni	Fe	Ag	Au	Zn	Bi	Cu	
1	-	0.40	0.14	0.23	-	0.09	0.80	0.15	0.06	3.76	-		copper
2	-	0.38	0.07	0.06	-	0.11	0.79	0.11	-	3.37	0.01		copper
3	-	0.02	0.07	0.27	0.04	0.14	18.51	0.02	-	5.26	0.01	18.38	oxide (silica omitted)

note: figures in brackets indicate analysis of corroded metal

TABLE 7: SULPHIDE INCLUSIONS IN THE METAL WASTE

Values for tin will to some extent at least derive from the bronze matrix

No. 44: bronze waste (context 09; ref. LBD 3)

Point	Sn	As	Sb	Pb	Co	Ni	Fe	Ag	Au	Zn	Bi	Cu	S	
1	0.32	1.86	-	-	0.01	0.03	0.32	0.10	-	0.36	-	77.20	19.81	Cu_2S
2	0.75	0.76	-	-	-	0.01	6.29	-	0.10	0.45	-	69.89	21.70	$(Cu, Fe)_2S$
3	0.17	0.78	0.02	-	0.02	-	5.67	-	-	0.30	-	69.63	23.39	$(Cu, Fe)_2S$
4	1.02	0.30	-	-	-	0.05	0.07	0.10	-	0.05	-	77.87	20.49	Cu_2S

No. 45: bronze waste (context 09; ref. LBD 2) with Pb oxides/sulphides

Point	Sn	As	Sb	Pb	Co	Ni	Fe	Ag	Au	Zn	Bi	Cu	S	
1	1.72	-	-	-	0.01	0.09	0.37	1.72	-	0.13	-	74.91	20.96	Cu_2 + O
2	0.58	0.50	-	-	0.04	0.06	2.61	0.85	-	43.78	-	22.52	29.03	Zn_2CuS_3 + O
3	0.44	0.15	-	-	0.08	0.02	2.81	0.88	-	49.79	-	15.51	30.20	Zn_3CuS_4 + O
4	0.24	0.46	0.03	-	-	0.03	3.68	0.42	-	-	-	72.61	22.51	$(Cu, Fe)_2S$
5	1.34	1.07	-	-	-	0.06	0.63	8.09	0.08	0.02	-	68.92	19.81	Cu_2S + Ag
6	2.06	0.66	-	-	0.08	0.06	2.65	3.83	-	46.84	-	13.63	30.17	Zn_3CuS_4 + O

TABLE 8: COMPARATIVE ANALYSIS OF RAW COPPER FROM LLANYMYNECH HILLFORT

Compare with analysis of no. 49 from Llwyn Bryn-dinas in Table 6.

Raw copper from Llanymynech (re-analysis of material described in Musson and Northover 1989)

Point	Sn	As	Sb	Pb	Co	Ni	Fe	Ag	Au	Zn	Bi	Cu	
1	-	-	0.06	0.25	0.01	0.11	0.04	0.42	-	1.02	-		copper
2	-	0.88	0.09	1.04	-	0.08	0.05	0.97	-	1.41	-		copper
3	-	0.64	0.03	0.41	-	0.07	-	0.43	0.09	0.11	-		copper prill in slag
4	-	-	0.04	0.43	0.02	0.07	29.18	0.03	0.04	8.20	-	11.01	oxide (silica omitted)

HAMMER SCALE AND SLAG SPHERES: DESCRIPTIONS (CJS)

Analysis of the following items is given in microfiche Table 9, which also gives details of sample and context numbers. See also full catalogue of metallurgical debris in Table 2.

50. Hammer scale (0.05 g). Microstructure: impossible to stabilise, therefore only a small amount polished. Massive oxide (mainly magnetite) and a 'fayalitic glass' but containing Al and P as well as the elements expected of fayalite.

51. 5 flakes of hammer scale.

LINING MATERIAL, FUEL ASH SLAG AND LINING REACTION PRODUCT: DESCRIPTIONS (CJS)

See analyses of the following items in microfiche Table 9, where details of sample number and context are also given. See also full catalogue of metallurgical debris in Table 2.

52. 5 fragments of lining material (18 g).
53. 8 fragments; probably pieces of vitrified lining material with Cu stains (8 .00 g); possibly just over-fired crucible.
54. 15 fragments of fuel ash slag (8.3 g), some copper stained. Analysis indicates copper-working slag.

SLAGS: DESCRIPTIONS (CJS)

The following slags are described separately: see also full catalogue in microfiche Table 2. See analyses of each of the following items (with the exception of no. 69), including occasional metallic inclusions, in microfiche Table 9, where details of sample number and context are also given.

55. Moderate-sized plano-convex slag (type 4), with moderate porosity and few charcoal impressions (174 g). Microstructure: moderate-sized semi-dendritic iron-oxide FeO (40-60%) inhomogeneously distributed, in matrix of fayalite and fayalite plus iron oxide pseudo-eutectic. A little ternary glass+fayalite+iron oxide eutectic present. Some regions of pure fayalite; others with large laths of fayalite and iron oxides outlined by glass and iron oxide eutectic. A little metallic iron present.

56. Fragment of dense plano-convex slag (50.5 g). Patchily distributed iron oxide (FeO), locally massive (100%), and distorted. Dendrite arm size and spacing varies through fine-moderate-large arms. Matrix of fayalite and unresolved eutectic. A little metallic iron.

57. Piece of dense plano-convex slag (37 g). Moderate porosity. Metallic iron common in regions with less iron oxide. There are two regions: one with pools of massive semi-globular FeO with 90+% iron oxide (wustite), interspersed with regions with moderate or fine dendritic FeO in a matrix of unresolved material. Metallic iron contains several percent copper!

58. Plano-convex dense slag with smooth irregular upper surface (121 g). A lot of porosity. Variable but high iron oxide content, averaging 80% with semi- and non-dendritic forms predominating. The matrix consists of a mixture of 60% fayalite laths and 40% unresolved material. In some areas the eutectic just resolved. Some metallic iron present.

59. A small plano-convex cake of slag with charcoal inclusions (173.5 g). Smooth upper surface and coarse lower

surface. Slight lip and vitrification indicating tuyere direction.

60. Fragment of dense slag (7.5 g). Sample consisted of a fragment of badly corroded metallic iron rusted to a fragment of slag. Microstructure of slag consisted of an inhomogeneous distribution of iron oxides (wustite/magnetite) mainly with coarse irregular to semi-dendritic morphologies. On the side away from the metal there were areas of fayalite with dark and mid-grey matrix. The dark matrix may contain iron oxide eutectic. The structure fines towards the iron, to fine fayalite laths with unresolved eutectic. No metallic iron in slag. Metal: in the main only the ferrite part of a coarse widmanstätten structure retains any metal: however, a residual pearlite structure is visible between the ferrite laths, and in the SEM it could be seen that some metal was retained in the pearlitic regions.

61. Thin plano-convex slag, 113 mm by 73 mm with moderate porosity (194.5 g). Mainly massive iron oxide (90%), some globular dendritic. Small pools of pseudo-eutectic fayalite laths with glass and iron oxides. Some metallic iron.

62. Small thick plano-convex slag with moderate porosity (52 g). Microstructure with 40-50% fine to moderate dendritic wustite/magnetite in matrix of fayalite laths and glass. In some areas fayalite and glass form eutectic. No metallic iron present.

63. Dense slag fragment (0.3 g). Microstructure of large dendritic iron oxide (70-80% of cross-section) with overgrowth of fayalite and iron oxide and glass eutectic.

64. Fragment of dense slag (0.35 g). Microstructure: moderate-sized dendritic wustite (45%) in a matrix of fayalite laths (45%) and an eutectic of wustite and glass.

65. Fragment of dense slag (2.5 g). Microstructure: wustite (45-50% cross-section) in matrix of fayalite and an eutectic of black glass and wustite.

66. Fragments of dense slag (0.7 g). Microstructure: 80-90% moderate-sized wustite dendrites in matrix of 'fayalite' and glass eutectic. A little metallic iron.

67. Plano-convex slag 114 mm by 71 mm with very little porosity (240 g). Microstructure: about 70% iron oxide as long large dendrites tending to finer forms towards the upper and lower surfaces. The finest dendrites were seen on upper surface. On upper surface there was region of low FeO with magnetite (5-10%), fayalite (15-20%), dark spinel? (15%), plus a mid-grey phase and metallic copper.

68. Plano-convex slag 90 mm by 73 mm with moderate to low porosity (227 g). Microstructure: 50% moderate to moderate-fine semi-dendritic wustite in a matrix of 40% fayalite and 10-15% 'leucite' and wustite ledeburitic type pool eutectic. The microprobe shows streaks of even darker material.

69. Smaller plano-convex form of dense slag (64 g).

70. Fragment of small plano-convex slag (35 g). Microstructure: fine to moderate dendritic iron oxide (80-90% of cross-section), in matrix of fayalite (90% of remaining material) with a small amount of third phase. There is a clear dendritic arm spacing gradient across the sample, with two cycles across most of the specimen. Fine at top, coarsening to wustite boundary layer, then fine and coarsening again. There are some pools of matrix relatively free of FeO at this intermediate boundary. (Metallic iron rare or absent).

71. Plano-convex slag 74 x 52 mm (145 g).

TABLE 9: ANALYSIS OF SLAGS FROM LLWYN BRYN-DINAS

No. 48: dense slag drip (context 09; ref. LB-OX-11)

Point	Na	Mg	Al	Si	P	S	K	Ca	Ti	Cr	Mn	Fe	Cu	Zn	O	
1	0.00	0.18	0.21	0.21	0.00	0.00	0.00	0.00	0.03	0.00	0.03	73.08			26.26	iron oxide?
2	0.00	0.10	2.38	0.26	0.00	0.00	0.02	0.02	0.19	0.00	0.01	68.18			28.84	iron oxide
3	0.79	0.41	1.76	14.69	0.21	0.08	2.77	0.87	0.02	0.00	0.02	47.45			30.93	'glass' needle
4	1.55	0.47	2.27	19.58	0.34	0.15	4.68	1.99	0.01	0.00	0.03	31.53			37.39	'glass'

No. 49: copper-working/fuel ash slag (context 11; ref. LB-OX-34)

Point	Na	Mg	Al	Si	P	S	K	Ca	Ti	Cr	Mn	Fe	Cu	Zn	O	
1	0.74	3.92	4.24	18.97	1.03	0.00	3.56	11.05	0.24	0.03	0.29	8.38	5.01	2.65	39.90	'glass'
2	0.00	3.48	2.83	0.76	0.00	0.01	0.06	0.23	0.29	0.01	0.30	53.33	0.73	5.54	33.18	dendrite
3	0.05	1.53	1.50	0.07	0.01	0.01	0.03	0.17	0.18	0.02	0.18	56.86	0.29	8.31	30.82	dendrite
4	1.06	3.79	4.52	18.87	1.10	0.01	3.96	11.29	0.24	0.02	0.40	8.13	3.07	3.86	39.69	'glass'

No. 50: thick hammer scale (context 27; ref. LB-OX-50)

Point	Na	Mg	Al	Si	P	S	K	Ca	Ti	Cr	Mn	Fe	Cu	Zn	O	
1	0.46	0.27	1.45	11.48	2.31	0.01	0.34	0.23	0.03	0.00	0.54	45.11			37.76	'olivine'
2	0.00	0.14	0.44	0.06	0.02	0.01	0.00	0.01	0.07	0.00	0.01	72.59			26.66	iron oxide
3	0.57	0.21	1.57	11.10	2.50	0.01	0.28	0.22	0.03	0.01	0.04	44.94			38.51	'olivine'
4	0.00	0.11	0.39	0.07	0.01	0.00	0.00	0.00	0.05	0.01	0.04	73.15			26.18	iron oxide

No. 51: hammer scale (context 27; ref. LB-OX-64)

Point	Na	Mg	Al	Si	P	S	K	Ca	Ti	Cr	Mn	Fe	Cu	Zn	O	
1	0.46	0.50	4.75	12.29	1.26	0.15	0.67	0.19	0.35	0.01	0.12	41.86			37.38	scale
2	0.41	0.48	5.88	15.12	0.12	0.27	1.16	0.18	0.36	0.00	0.02	38.13			37.87	scale

No. 52: lining material (context 09; ref. LB-OX-51)

Point	Na	Mg	Al	Si	P	S	K	Ca	Ti	Cr	Mn	Fe	Cu	Zn	O	
1	0.78	1.60	4.89	28.84	1.09	0.00	5.32	1.74	0.15	0.00	0.31	1.646			56.93	'glassy'
2	0.84	1.83	5.53	27.73	1.48	0.00	5.95	2.35	0.25	0.01	0.45	1.78			51.80	'glassy'

No. 53: crucible slag (context 09; ref. LB-OX-68)

Point	Na	Mg	Al	Si	P	S	K	Ca	Ti	Cr	Mn	Fe	Cu	Zn	O	
1	0.76	0.77	7.41	32.99	0.10	0.01	3.23	0.12	0.32	0.01	0.05	3.73	1.66	<0.1	48.85	crucible
2	1.02	1.42	7.25	20.34	0.26	0.01	4.02	2.95	0.42	0.01	0.08	13.60	4.56	4.08	39.98	crucible

No. 54: copper-working/fuel ash slag (context 27; ref. LB-OX-46)

Point	Na	Mg	Al	Si	P	S	K	Ca	Ti	Cr	Mn	Fe	Cu	Zn	O	
1	1.56	1.22	8.24	23.63	0.29	0.01	6.69	3.56	0.39	0.00	0.10	3.39	2.71	0.68	47.54	'glass'
2	0.10	4.12	3.49	1.24	0.02	0.00	0.43	0.22	1.47	0.02	0.36	48.30	1.41	5.84	32.98	iron oxide
3	1.42	1.11	9.07	25.30	0.16	0.00	6.54	2.83	0.50	0.00	0.06	3.11	2.73	0.54	46.64	'glass'
4	0.02	4.16	4.74	1.30	0.00	0.00	0.56	0.14	1.70	0.08	0.28	48.76	1.74	4.29	32.22	iron oxide

No. 55: dense slag type 4 (context 04; ref. LB-OX-82)

Point	Na	Mg	Al	Si	P	S	K	Ca	Ti	Cr	Mn	Fe	Cu	Zn	O	
1	0.00	0.16	0.04	13.99	0.03	0.00	0.01	0.20	0.02	0.00	0.00	52.11			33.45	fayalite?
2	0.00	0.00	0.11	0.14	0.00	0.00	0.00	0.02	0.02	0.02	0.00	74.11			25.59	iron oxide
3	0.00	0.17	0.06	13.88	0.03	0.00	0.00	0.17	0.00	0.00	0.00	53.12			32.58	fayalite?
4	1.49	0.01	5.46	22.36	0.70	0.37	9.28	4.28	0.01	0.00	0.00	17.56			38.48	'glass'

No. 56: dense slag type 4 (context 05; ref. LB-OX-81)

Point	Na	Mg	Al	Si	P	S	K	Ca	Ti	Cr	Mn	Fe	Cu	Zn	O	
1	0.00	0.12	0.47	0.20	0.00	0.00	0.02	0.07	0.14	0.00	0.00	72.57			26.40	iron oxide
2	0.01	1.79	0.05	14.79	0.03	0.00	0.03	1.27	0.00	0.00	0.10	49.21			32.73	fayalite?
3	1.06	0.19	6.12	16.72	1.01	0.05	4.18	8.51	0.06	0.00	0.06	24.73			37.33	'glass'
4	0.00	1.20	0.07	13.88	0.12	0.00	0.03	3.20	0.01	0.00	0.09	48.08			33.34	fayalite?
5	1.66	0.09	8.31	16.87	0.90	0.18	2.76	10.93	0.10	0.00	0.03	19.75			38.41	'glass'

Table 9 continued on next page

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No. 57: dense slag type 3/4 (context 08; ref. LB-OX-83)

Point	Na	Mg	Al	Si	P	S	K	Ca	Ti	Cr	Mn	Fe	Cu	Zn	O	
1	0.00	0.98	0.14	0.05	0.00	0.00	0.01	0.01	0.17	0.01	0.20	73.40			25.01	wustite
2	0.92	1.18	5.22	17.69	1.19	0.06	6.51	7.70	0.13	0.00	0.23	23.86			35.31	matrix
3	0.81	1.29	4.51	17.59	1.39	0.06	4.96	9.22	0.12	0.01	0.26	19.82			39.95	matrix
4	0.86	1.18	5.09	17.85	1.45	0.10	5.55	9.12	0.08	0.00	0.22	19.54			39.95	matrix
5	0.00	0.97	0.16	0.07	0.00	0.00	0.04	0.09	0.20	0.02	0.20	73.09			25.15	iron oxide

metallic inclusion analysis

Point	Si	W	P	S	Mo	Sn	Mn	Co	Ni	Cu	Zn	Ge	As	
1	0.000	0.000	0.007	0.008	0.229	0.008	0.006	0.272	4.444	1.051	0.000	0.009	2.722	inclusion
2	0.249	0.000	0.008	0.002	0.011	0.012	0.021	0.052	0.738	1.212	0.000	0.026	0.045	inclusion
3	0.247	0.009	0.013	0.005	0.020	0.028	0.012	0.039	0.269	1.439	0.005	0.007	0.048	inclusion
4	0.138	0.000	0.003	0.002	0.032	0.007	0.018	0.037	0.626	0.454	0.001	0.000	0.164	inclusion
Mean	0.140	0.002	0.007	0.003	0.071	0.014	0.011	0.089	1.362	0.955	0.001	0.013	0.715	
S Dev	0.098	0.004	0.003	0.003	0.081	0.008	0.008	0.092	1.550	0.367	0.002	0.010	1.024	

No. 58: dense slag type 4 (context 09; ref. LB-OX-75)

Point	Na	Mg	Al	Si	P	S	K	Ca	Ti	Cr	Mn	Fe	Cu	Zn	O	
1	0.00	0.30	0.21	0.09	0.02	0.00	0.01	0.03	0.07	0.01	0.02	74.2			25.05	wustite
2	0.04	1.78	0.17	14.77	0.10	0.01	0.17	4.24	0.01	0.01	0.12	45.19			33.38	olivine?
3	0.04	1.78	0.17	14.78	0.10	0.00	0.17	4.25	0.01	0.01	0.12	17.07			39.96	'glassy'

metallic inclusion analysis

Point	Si	W	P	S	Mo	Sn	Mn	Co	Ni	Cu	Zn	Ge	As	
1	nd	nd	nd	nd	0.019	nd	0.011	tr	0.034	0.020	tr	0.013	0.025	inclusion

No. 59: dense slag type 4 (context 09; ref. LB-OX-99)

Point	Na	Mg	Al	Si	P	S	K	Ca	Ti	Cr	Mn	Fe	Cu	Zn	O	
1	0.48	1.13	3.37	15.52	0.93	0.07	2.05	10.33	0.09	0.02	0.17	27.56			38.28	'glass' matrix
2	0.49	1.22	3.27	14.47	0.82	0.06	2.04	9.52	0.06	0.00	0.19	28.26			39.61	'glass' matrix
3	0.53	1.26	3.50	16.59	0.95	0.09	2.36	9.88	0.05	0.01	0.18	26.73			37.88	'glass' matrix
4	0.47	1.22	3.48	17.68	0.97	0.06	2.40	10.02	0.07	0.00	0.17	26.73			36.72	'glass' matrix
5	0.43	1.56	3.48	17.18	0.93	0.08	2.45	8.40	0.06	0.01	0.21	29.62			35.60	'glass' matrix

metallic inclusion analysis

Point	Si	W	P	S	Mo	Sn	Mn	Co	Ni	Cu	Zn	Ge	As
1	0.032	0.000	0.000	0.001	0.018	0.000	0.000	0.000	0.090	0.057	0.000	0.000	0.207
2	0.000	0.000	0.007	0.052	0.172	0.004	0.007	0.000	0.212	0.187	0.007	0.023	0.365
3	0.028	0.001	0.001	0.005	0.067	0.001	0.011	0.015	0.134	0.112	0.000	0.000	0.092
4	0.040	0.000	0.007	0.054	0.087	0.014	0.007	0.013	0.646	0.239	0.000	0.006	3.620
Mean	0.025	nd	0.004	0.028	0.086	tr	tr	0.007	0.271	0.149	nd	nd	1.071
S Dev	0.015		0.003	0.025	0.056			0.007	0.221	0.070		nd	1.475

No. 60: dense slag ?type 4 (context 19; ref. LB-OX-103)

Point	Na	Mg	Al	Si	P	S	K	Ca	Ti	Cr	Mn	Fe	Cu	Zn	O	
1	0.00	0.17	0.38	0.17	0.01	0.01	0.00	0.01	0.09	0.00	0.04	73.06			26.05	wustite
2	0.03	0.85	0.43	14.51	0.09	0.00	0.42	1.56	0.01	0.01	0.15	47.31			34.64	fayalite
3	1.04	0.16	6.70	17.31	0.37	0.04	5.05	5.41	0.02	0.01	0.08	21.69			42.13	'glass'
4	0.01	1.24	0.30	14.37	0.11	0.00	0.19	1.01	0.02	0.02	0.14	47.92			34.66	fayalite
5	0.87	0.13	7.95	18.70	0.60	0.06	5.85	7.76	0.05	0.02	0.05	17.91			40.07	'glass'
6	0.53	0.52	4.14	16.73	0.29	0.03	3.26	2.50	0.04	0.02	0.12	34.84			36.99	matrix
7	0.00	0.29	0.29	0.12	0.00	0.01	0.01	0.02	0.09	0.00	0.05	72.54			26.57	iron oxide

Table 9 continued on next page

TABLE 9: PAGE 3

metallic inclusion analysis (No. 60, continued from previous page)

Point	Si	W	P	S	Mo	Sn	Mn	Co	Ni	Cu	Zn	Ge	As	
1	0.034	0.026	0.000	0.001	0.000	0.000	0.002	0.005	0.043	0.006	0.003	0.000	0.004	normal
2	0.010	0.000	0.009	0.004	0.000	0.000	0.001	0.000	0.016	0.003	0.001	0.000	0.017	widmanstätten
3	0.000	0.000	0.000	0.000	0.000	0.001	0.002	0.000	0.009	0.019	0.000	0.010	0.002	widmanstätten
4	0.025	0.000	0.000	0.000	0.002	0.000	0.006	0.000	0.024	0.012	0.002	0.021	0.043	normal
5	0.313	0.000	0.021	0.122	0.000	0.000	0.000	0.004	0.017	0.015	0.003	0.022	0.021	pearlite
Mean	0.076	0.005	0.006	0.025	0.000	0.000	0.002	0.002	0.022	0.011	0.002	0.011	0.017	
S Dev	0.119	0.010	0.008	0.048	0.001	0.000	0.002	0.002	0.012	0.006	0.001	0.010	0.015	

No. 61: dense slag type 4 (context 22; ref. LB-OX-80)

Point	Na	Mg	Al	Si	P	S	K	Ca	Ti	Cr	Mn	Fe	Cu	Zn	O	
1	0.01	0.95	0.04	14.15	0.05	0.00	0.03	1.81	0.01	0.00	0.16	49.26			33.53	fayalite?
2	3.00	0.01	8.44	20.77	0.92	0.48	7.63	3.49	0.13	0.00	0.00	11.46			43.67	'glass'
3	3.06	0.00	8.13	19.71	0.81	0.53	8.81	3.85	0.11	0.00	0.03	14.11			40.85	'glass' + iron oxide
4	0.00	0.11	0.12	0.09	0.02	0.01	0.06	0.04	0.15	0.00	0.04	75.33			24.03	wustite
5	0.03	1.17	0.04	14.03	0.01	0.00	0.04	1.93	0.00	0.02	0.14	48.13			34.45	fayalite?
6	2.69	0.05	14.68	20.91	0.15	0.01	15.38	0.75	0.00	0.00	0.00	5.68			39.71	'glass'

No. 62: dense slag type 3/4 (context 25; ref. LB-OX-84)

Point	Na	Mg	Al	Si	P	S	K	Ca	Ti	Cr	Mn	Fe	Cu	Zn	O	
1	0.78	0.02	11.89	15.92	1.49	0.04	5.79	0.04	0.01	0.00	0.00	73.33			25.68	wustite
2	0.00	0.15	0.44	0.13	0.00	0.00	0.03	0.03	0.17	0.02	0.02	50			34.06	olivine
3	0.00	0.56	0.15	14.23	0.06	0.00	0.01	0.80	0.04	0.01	0.09	19.36			38.77	'glass'
4	0.70	0.04	9.20	18.01	0.56	0.10	6.54	6.53	0.16	0.00	0.02	45.12			34.62	olivine
5	0.03	0.44	0.95	14.54	0.18	0.01	1.34	2.63	0.04	0.01	0.04	20.29			38.43	'glass'

No. 63: dense slag (context 27; ref. LB-OX-39)

Point	Na	Mg	Al	Si	P	S	K	Ca	Ti	Cr	Mn	Fe	Cu	Zn	O	
1	0.04	0.15	0.14	0.09	0.03	0.00	0.01	0.01	0.10	0.00	0.04	75.59			23.79	wustite
2	0.00	1.64	0.05	14.49	0.05	0.01	0.09	1.48	0.01	0.01	0.10	49.60			32.46	fayalite
3	1.11	0.04	11.59	22.25	0.07	0.01	10.36	0.03	0.03	0.01	0.01	22.26			32.23	'glass'
4	1.14	0.03	12.18	22.13	0.29	0.05	10.05	0.06	0.02	0.02	0.00	11.80			42.23	'glass'
5	0.14	1.36	0.41	14.41	0.19	0.05	0.29	2.52	0.00	0.02	0.12	46.17			34.34	fayalite

No. 64: dense slag (context 27; ref. LB-OX-40)

Point	Na	Mg	Al	Si	P	S	K	Ca	Ti	Cr	Mn	Fe	Cu	Zn	O	
1	0.00	0.20	0.09	0.14	0.00	0.00	0.02	0.05	0.18	0.00	0.06	74.26			25.00	wustite
2	0.04	3.15	0.14	13.63	0.15	0.00	0.10	1.29	0.02	0.00	0.20	47.43			33.84	fayalite
3	0.87	0.05	11.66	21.87	0.17	0.06	12.21	0.54	0.06	0.00	0.01	14.70			37.78	glass/eutectic
4	0.00	2.24	0.03	14.00	0.08	0.00	0.01	1.55	0.02	0.01	0.20	46.74			35.11	fayalite
5	2.68	0.08	11.83	16.32	1.92	0.09	5.81	2.31	0.01	0.01	0.01	10.17			48.76	'glass'
6	4.13	0.40	7.90	17.16	0.97	0.03	0.17	2.61	0.00	0.00	0.17	25.95			40.51	eutectic

No. 65: dense slag (context 27; ref. LB-OX-41)

Point	Na	Mg	Al	Si	P	S	K	Ca	Ti	Cr	Mn	Fe	Cu	Zn	O	
1	0.00	0.11	0.14	0.14	0.00	0.02	0.02	0.02	0.14	0.01	0.03	74.53			24.84	wustite
2	3.34	0.02	9.84	15.66	0.57	0.05	0.35	0.24	0.02	0.01	0.00	8.89			61.00	'glass'
3	0.01	1.18	0.07	13.81	0.03	0.00	0.00	0.77	0.00	0.00	0.16	50.04			33.93	fayalite
4	1.85	0.02	9.64	12.35	1.09	0.19	0.85	0.22	0.05	0.00	0.00	39.60			34.14	'glass'
5	0.00	0.86	0.01	14.58	0.07	0.00	0.00	3.33	0.03	0.02	0.17	47.58			33.34	fayalite

Table 9 continued on next page

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No. 66: dense slag drip (context 27; ref. LB-OX-49)

Point	Na	Mg	Al	Si	P	S	K	Ca	Ti	Cr	Mn	Fe	Cu	Zn	O	
1	0.03	0.64	3.38	12.99	0.11	0.00	0.27	0.40	0.06	0.00	0.07	49.58			32.47	ground mass
2	2.60	0.04	11.95	19.03	0.71	0.10	8.23	4.02	0.04	0.02	0.01	12.41			40.83	ground mass

No. 67: dense slag type 4 - possible copper-working (context 27; ref. LB-OX-79)

Point	Na	Mg	Al	Si	P	S	K	Ca	Ti	Cr	Mn	Fe	Cu	Zn	O	
1	0.00	0.15	0.28	0.13	0.00	0.00	0.02	0.03	0.08	0.01	0.04	73.87			25.38	wustite
2	0.01	1.23	0.04	14.21	0.04	0.02	0.07	1.11	0.02	0.01	0.06	49.64			33.53	fayalite
3	0.71	0.02	12.39	25.75	0.66	0.03	11.19	1.18	0.01	0.00	0.00	5.47			42.57	'glass' +eutectic
4	0.04	0.84	9.59	0.22	0.00	0.01	0.02	0.11	1.87	0.09	0.12	52.26		2.099	32.74	spinel?
5	0.00	8.24	0.11	15.34	0.07	0.00	0.22	1.11	0.04	0.01	0.37	39.11			35.37	fayalite
6	1.56	0.22	5.17	16.65	1.35	0.00	0.72	13.08	0.17	0.03	0.13	19.33			41.58	mid-grey phase
7	0.67	0.00	12.99	27.27	0.02	0.00	14.30	0.02	0.02	0.00	0.00	0.98			43.72	mid-grey phase
8	1.45	0.20	5.28	16.55	1.33	0.01	0.68	13.33	0.20	0.01	0.10	18.84			42.02	mid-grey phase
9	0.00	0.76	9.87	0.19	0.00	0.00	0.04	0.16	2.00	0.02	0.13	52.55		2.449	31.82	spinel?
10	0.66	0.00	12.53	26.48	0.01	0.01	16.64	0.00	0.01	0.01	0.01	0.94			42.70	mid-grey phase
11	0.03	6.63	0.06	14.95	0.04	0.00	0.04	1.54	0.01	0.00	0.38	40.39			35.93	olivine
12	0.01	3.51	0.04	13.78	0.05	0.00	0.01	0.43	0.01	0.00	0.16	46.27			35.73	olivine

metal inclusion analysis

Point	Si	W	P	S	Mo	Sn	Mn	Co	Fe	Ni	Cu	Zn	Ge	As	
13	-	nd	na	0.19	nd	0.28	nd	nd	3.28	0.42	94.55	0.04	nd	1.23	copper inclusion

No. 68: dense slag type 4 (context 27; ref. LB-OX-86)

Point	Na	Mg	Al	Si	P	S	K	Ca	Ti	Cr	Mn	Fe	Cu	Zn	O	
1	0.00	1.57	0.06	13.33	0.02	0.00	0.01	0.36	0.03	0.00	0.14	47.21			33.54	olivine
2	0.62	0.00	13.51	26.91	0.09	0.00	12.27	0.00	0.00	0.00	0.02	1.9			44.68	'leucite'
3	0.00	2.12	0.17	13.68	0.04	0.01	0.01	0.29	0.02	0.00	0.19	49.94			33.53	olivine
4	0.53	0.00	13.22	26.88	0.02	0.00	13.81	0.00	0.01	0.01	0.00	1.32			44.20	'leucite'
5	0.92	0.07	8.97	15.90	0.04	0.01	8.42	0.03	0.09	0.00	0.03	33.24			32.29	'leucite'/FeO
6	2.56	0.01	12.33	17.82	1.43	0.05	3.20	0.06	0.03	0.00	0.05	11.91			50.55	'leucite'
7	0.87	0.18	12.79	0.17	1.34	0.03	5.58	0.04	0.01	0.00	0.00	3.98			60.04	'leucite'

No. 70: dense slag type 3/4 (context 27; ref. LB-OX-92)

Point	Na	Mg	Al	Si	P	S	K	Ca	Ti	Cr	Mn	Fe	Cu	Zn	O	
1	0.42	0.00	13.28	27.61	0.01	0.00	10.50	0.01	0.01	0.00	0.00	1.4	0		46.76	K-rich phase
2	0.00	2.19	0.04	14.12	0.03	0.00	0.01	0.69	0.01	0.00	0.11	50.8			32.00	fayalite?
3	0.00	0.06	0.39	0.18	0.00	0.02	0.03	0.01	0.15	0.01	0.00	73.96			25.20	wustite
4	0.19	0.51	2.54	7.69	0.06	0.02	1.98	0.53	0.07	0.02	0.06	56.73			29.60	area
5	0.68	0.03	9.61	21.82	2.12	0.05	8.82	6.31	0.02	0.00	0.01	9.63			40.90	K-Ca phase
6	0.00	2.33	0.09	14.47	0.06	0.02	0.02	0.60	0.02	0.01	0.16	47.91			34.32	fayalite
7	0.03	1.59	0.10	11.56	0.05	0.01	0.03	1.57	0.03	0.01	0.13	53.47			31.44	fayalite
8	0.08	0.00	10.90	21.92	0.16	0.01	13.59	0.37	0.01	0.01	0.00	4.5			47.73	dark phase
9	0.04	1.58	0.10	13.55	0.06	0.00	0.05	1.63	0.02	0.00	0.13	49.01			33.82	fayalite
10	0.04	1.51	0.11	13.79	0.08	0.00	0.06	1.58	0.00	0.00	0.11	48.85			33.88	fayalite

No. 71: dense slag type 3/4 (context 27; ref. LB-OX-96)

Point	Na	Mg	Al	Si	P	S	K	Ca	Ti	Cr	Mn	Fe	Cu	Zn	O	
1	0.00	1.21	0.08	13.83	0.06	0.00	0.00	0.85	0.02	0.00	0.12	47.68			36.15	fayalite?
2	2.59	0.04	9.04	17.28	0.10	0.01	7.85	0.08	0.07	0.00	0.01	23.62			39.32	eutectic
3	1.42	0.00	12.33	24.41	0.03	0.00	10.70	0.01	0.04	0.02	0.04	5.17			45.84	eutectic
4	0.01	1.94	0.05	12.91	0.03	0.00	0.00	0.66	0.00	0.01	0.14	46.45			37.79	fayalite
5	0.53	0.01	12.33	25.07	0.13	0.01	14.86	0.44	0.02	0.01	0.04	2.97			43.58	eutectic

metallic inclusion analysis

Point	Si	W	P	S	Mo	Sn	Mn	Co	Ni	Cu	Zn	Ge	As
1	0.113	0.000	0.003	0.001	0.019	0.000	0.007	0.000	0.028	0.123	0.000	0.000	0.073

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Wood charcoals and other plant remains from Llwyn Bryn-dinas

by Jane Fitt[1]

This limited study was principally concerned with the identification of wood charcoal from the metal-working floor and bowl-hearths, in order to identify the timber species exploited for fuel in the metal-working process, although other charred plant remains present in the samples were also identified.

Samples from site had previously been treated to extract the charred material and separate the cereal and weed seed remains from the charcoal present.[2] A sample of plant remains taken from the sealed soil profile (38) beneath the rampart was also examined; it contained small-seeded legume species, cuscuta, grass rhizomes and fungal sclerotia and cleistothecia, which might be found in any soil.

Identification of a piece of wood charcoal requires its fracture in three planes (Leney and Casteel 1975). The fragments thus obtained were examined under an epi-illuminating microscope and identified by comparison with modern charred reference material and an atlas of wood anatomy (Schweingruber 1982). The minimum size of charcoal piece from which the three planes of fracture could be obtained was relatively large, so that many of the pieces in the samples were too small to be analysed. All samples contained at least twenty identifiable pieces, however, mainly of twig or branch wood.

The results are shown in microfiche Table 10, where an indication of the relative quantity of each species found is given. Oak and hazel were common to all contexts, but there is some variation in the other species present. The other plant remains identified are summarised in microfiche Table 11. The quantities are too small to be diagnostic, but may represent the waste products from crop cleaning.

The results from even a small study such as this can give information both about specific activities and the environments exploited. The range of timber species used in metal-working probably represent what was available locally as well as selection for particular qualities of combustion. Certainly oak, alder, birch and willow are noted for producing excellent wood charcoal and hazel provides reasonable fuel, but pine would seem less suitable since its wood burns hot and rapidly (Taylor 1981). Hazel, willow and oak could have been managed by coppicing and pollarding to produce a continuous supply of timber. The various species would also have produced human food, animal fodder, building materials and other useful products. Finally, the ecology of the individual tree species indicates the exploitation of different environments. Whereas oak and hazel tolerate a variety of conditions, birch requires plenty of light, alder and willow grow on soils with a higher moisture content and pine is found on poor acid soils.

Footnote references

1 1 Harvey Road, Guildford, Surrey, GU1 3SG

2 Sample preparation and initial sorting was carried out by Annie Milles, School of History and Archaeology, University of Wales College of Cardiff

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TABLE 10: WOOD CHARCOAL IDENTIFICATIONS

	CONTEXT					
	09a	09b	11a top 10 cm	11b middle	11c bottom	12
Quercus sp. (Oak)	*	*	*	*	*	*
Corylus sp. (Hazel)	*	*	*	*	*	*
Alnus sp. (Alder)			*	*	+	
Pinus sylvestris (Scot's Pine)	+	+		+	+	
Salix sp. (Willow)	+			+		
Betula (Birch)			*			

key: * = common + = occasional

TABLE 11: CARBONIZED CEREAL REMAINS AND WEED SEEDS

	CONTEXT				
	09b	11a top 10 cm	11b middle	11c bottom	12
grass rhizome	2	4	-	2	3
Corylus avellana shell fragment	1	-	-	-	-
Triticum dicoccum glume base	-	1	-	-	-
Triticum spelta glume base	-	2	2	-	-
Triticum spelta spikelet fork	-	-	-	1	-
Triticum dicoccum/spelta spikelet fork	-	-	-	2	1
Triticum sp. grain fragments	-	3	-	-	-
Hordeum sp. awn fragment	-	1	-	-	-
Cirsium/Carduus	-	1	-	-	-
Stellaria media	-	1	-	-	-
Carex spp.	-	2	-	-	-
Polygonum sp.	-	1	-	-	-
Deschampsia sp.	-	1	-	-	-
Festuca sp. caryopsis	-	1	-	-	-
Rumex conglomeratus	1	1	1	-	-
Nymphaea/Nuphar type	-	-	3	3	-
Nymphaea/Nuphar immature	-	-	-	-	3
Ranunculus acris	-	-	-	1	
Plantago lanceolata	-	-	-	1	-
Sinapis arvensis	-	-	-	1	-
Compositae sp.	-	-	-	1	-
Lapsana communis	-	-	-	-	1
Juncus sp. immature capsule	-	-	-	-	2

Radiocarbon dates from Llwyn Bryn-dinas

by P. Q. Dresser[1]

The following radiocarbon determinations were measured in the Radiocarbon Dating laboratory of the Department of Geology, University of Wales College of Cardiff. Calibrations are derived from the University of Washington, Quaternary Isotope Lab., Radiocarbon Calibration Program 1987, Rev. 2.O.

CAR-708
Context 09: charcoal layer on metal-working floor
Sample: charcoal (no further specific details available)
Date BP: 2160 ± 70. **Date bc**: 210 ± 70
Calibrated date range: 1 σ range 360-110 BC; 2 σ range 390-2 BC

CAR-798
Context 03: occupation soil behind Rampart Z
Sample: charcoal; range of lump size from mostly small with a few lumps up to 10 mm across. Mixed species present. Range of ring radii indicates inner (or twiggy) and outer wood present. Some large-pore timber (cf. oak) present. 6.9 g after pre-treatment
Date BP: 2100 ± 60. **Date bc:** 150 bc ± 60
Calibrated date range: 1 σ range 342-50 BC; 2 σ range 358 BC - AD 46

CAR-800
Context 06: core of Rampart Y (upper part)
Sample: charcoal; range of lump sizes up to 8 mm. Mixed species present. 14.2 g after pre-treatment of which 8 g were used for dating
Date BP: 2210 ± 70. **Date bc**: 260 ± 70
Calibrated date range: 1 σ range 398-173 BC; 2 σ range 400-74 BC

CAR-802
Context 34: stone dump sealed beneath Rampart X
Sample: charcoal; lump size up to 8 mm. Mixed species present. Range of ring radii show inner (or twiggy) and outer wood present. 4.3 g after pre-treatment
Date BP: 2710 ± 60. **Date bc**: 760 ± 60
Calibrated date range: 1 σ range 969-807 BC; 2 σ range 1010-790 BC

CAR-803
Context 38A: surface of buried soil profile beneath Rampart X
Sample: charcoal; small flakey lumps <5 mm across. Probably more than one species present. Very small sample at 1.6 g
Date BP: 2750 ± 70. **Date bc**: 800 ± 70
Calibrated date range: 1 σ range 1004-828 BC; 2 σ range 1188-800 BC

Footnote references

1 Radiocarbon Dating Laboratory, Department of Geology, University of Wales College of Cardiff