

ANALYSIS OF LATE BRONZE AGE MATERIAL FROM FRESHWATER WEST, DYFED

28 objects were submitted by Carmarthen Museum of which 27 were sampled. Five bronze artefacts were sampled by drilling with a 1mm diameter bit in a hand-held modelmaker's electric drill while samples were cut from the copper ingots with a jeweller's piercing saw with 32 teeth/cm.

The samples were hot-mounted in a copper-filled acrylic resin, ground and polished. Analysis was by electron probe microanalysis with wavelength dispersive spectrometry using the CAMEBAX automated instrument in the Department of Materials, University of Oxford. Operating conditions were an accelerating voltage of 25kV, absorbed electron current at the sample of 20nA and an X-ray take-off angle of 40°C. Thirteen elements were analysed as detailed in the tables below; detection limits for most elements were 100-200ppm, with the exception of 300ppm for gold and approximately 0.10% for arsenic. This last is the result of the compromises necessary to avoid the coincidence of the strongest lines in the arsenic and lead spectra, the arsenic K α and lead K β lines. With the instrument configured with only two spectrometers the most efficient way of analysing all elements in a single pass allowed the use of the relatively strong lead M α line but necessitated the use of the relatively weak arsenic K β line, hence the degradation in performance. A more sensitive analysis for arsenic can be made at a later date using the K α line on the copper or bronze matrix where lead can be assumed to be insoluble. In this case a detection limit of 250ppm can be achieved.

Three analyses were made on each sample, each over an area of 50 μ m; the mean compositions are given in the tables. All concentrations are in weight %.

Bronze objects

1. **Body of socketed axe:** broken, mouth missing; heavily corroded and battered; broad rectangular cross-section; three slightly convergent ribs on each face; cutting-edge curved, expanded, asymmetrically worn; present length 84mm; blade width 43mm; max. thickness 24mm; wall thickness 1.5-5mm; weight (as found) 211g; there is a concretion of purple red-sand (perhaps coloured by copper oxide) and small rounded pebbles in the socket.

The axe is a typical South Welsh socketed axe, one of a small number found in the area of Pembrokeshire.

2. **Blade fragment of socketed axe:** broken; most of body missing; heavily corroded and battered; broad rectangular cross-section; asymmetrically worn, curved cutting-edge; dark blue-grey-green patina; present length 40mm; blade width 41mm; thickness 14mm; weight 85g; concretion of dark grey sand and small rounded pebbles in socket.

The fragment is almost certainly from a socketed axe of South Welsh type.

3. **Body of socketed axe:** broken, mouth and part of body missing; heavily corroded and battered; sub-square section with slightly bowed faces and edges; dark blue-grey-green patina; present length 66mm; blade width 32mm; thickness 20mm; weight 87g; concretion of reddish sand and gravel in socket

The axe is of a small plain type not dissimilar to those found with other South Welsh axe hoards, e.g. Myddfai, Llantwit Major.

4. **Sword fragment:** broken tip of sword blade; heavily corroded and battered; two convergent grooves flank tapering mid-rib; possible groove or bevel at blade edge; dark blue-grey-green patina; present length 83mm; max. width 23mm; thickness 8mm; weight 35g.

This fragment is almost certainly the tip of a Carp's Tongue sword, the first to be found in Wales. Only three more or less intact Carp's Tongue swords are known from the British Isles;

they are generally present as fragments in scrap hoards of the Ewart park period in southern and eastern England.

5. Ewart Park sword fragment: broken; battered and corroded with some recent damage; lenticular cross-section does not reach original edge of blade; brown-green patina differs from rest of above; present length 135mm; width 32mm; thickness 6mm; weight 81g.

	Fe	Co	Ni	Cu	Zn	As	Sb	Sn	Ag	Bi	Pb	Au	S
<i>Mean compositions of bronze objects</i>													
1 S. Welsh socketed axe	0.03	0.01	0.13	85.82	.	0.10	0.14	10.23	0.08	0.04	3.30	tr	0.23
2 S. Welsh socketed axe	0.02	0.05	0.18	86.29	.	0.48	0.24	9.59	0.11	.	2.85	.	0.20
3 Plain socketed axe	0.03	0.02	0.10	89.49	.	0.12#	0.09	5.32	0.08	.	4.55	0.02	0.16
4 Carp's Tongue sword	0.06	0.02	0.07	83.58	.	0.60#	0.05	10.97	0.09	0.01	4.31	0.04	0.21
5 Ewart Park sword	0.04	.	0.01	82.98*	.	.	0.02	12.32*	0.03	.	4.12*	0.07	0.41

* = value for this element affected by corrosion

= element markedly inhomogeneously distributed

The range of bronze compositions is typical for a Ewart Park context; it might be expected that the lead contents of some pieces were higher overall but a metallographic check suggests that the compositions are approximately correct for the sampled areas.

21 analyses are presented from the ingot material (one sample could not be prepared adequately). The dimensions and sample numbers of the fragments are :-

6. 493g	58x46x28mm (FW6)	7. 272g	60x42x22mm (FW17)
8. 182g	45x45x22mm (FW11)	9. 139g	46x25x18mm (FW7)
10. 124g	32x26x24mm (FW10)	11. 135g	38x26x21mm (FW13)
12. 107g	36x24x22mm (FW8)	13. 88g	36x24x18mm (FW9)
14. 118g	46x28x18mm (FW12)	15. 91g	32x28x15mm (FW14)
16. 64g	38x21x18mm (FW15)	17. 33g	29x16x10mm (FW20)
18. 40g	40x12x12mm (FW16)	19. 17g	25x15x 6mm (FW19)
20. 32g	(FW18)	21. 22g	(FW21)
22. 15g	(FW23)	23. 20g	(FW22)
24. 11g	(FW24)	25. 10g	(FW25)
25. 5g	(FW26)	27. 6g	(FW27)

All the fragments are heavily corroded; they have a dark purple-grey patina. The majority have the typical shrinkage cavities and columnar growth of Late Bronze Age copper ingots; some of the smaller fragments may be from crucible or casting waste rather than ingots.

	Fe	Co	Ni	Cu	Zn	As	Sb	Sn	Ag	Bi	Pb	Au	S
<i>Compositions of ingot fragments</i>													
6 (FW6) 493g	0.01	0.01	.	99.02	.	.	0.01	0.02	0.01	.	.	tr	0.91
7 (FW17) 271g	0.01	.	0.01	96.02	.	0.77	0.09	0.04	0.03	0.01	1.57	0.03	1.42
8 (FW11) 182g	0.01	.	.	98.60	.	0.40	tr	0.01	.	0.01	.	0.03	0.93
9 (FW7) 139g	0.28	0.14	0.08	97.58	.	0.87	0.10	.	0.20	0.15	0.45	.	0.10
	0.02	0.03	.	95.25*	.	.	0.02	0.03	0.28	.	.	.	4.34
10 (FW10) 124g	0.16	0.06	0.06	94.02	.	0.67	0.10	0.03	0.40	0.60#	2.87	0.03	1.12
11 (FW13) 135g	0.01	.	0.06	98.64	0.01	0.14#	.	0.03	0.12	.	0.02	0.05	0.94
12 (FW8) 107g	0.98	0.81	0.17	90.37	0.02	2.23#	0.06#	0.04#	0.19	0.56#	0.88	0.06	3.66
13 (FW9) 88g	tr	0.01	0.06	98.94	.	0.10	0.01	0.02	0.01	tr	.	0.05	0.88
14 (FW12) 117g	tr	tr	0.02	93.86	0.02	4.75#	0.01	0.01	0.18#	.	.	0.03	1.12
15 (FW14) 91g	0.02	.	0.08	98.76	0.01	.	0.01	tr	0.02	.	.	tr	1.09
16 (FW15) 64g	.	0.01	0.01	97.97	.	0.11#	0.10	0.01	0.05	.	.	.	1.76
17 (FW20) 33g	tr	.	0.02	98.19	.	0.23	0.02	0.07#	0.03	0.09#	tr	tr	1.36
18 (FW16) 39g	0.01	0.01	0.01	98.08	.	0.48	0.23	0.04	0.05#	tr	0.09	.	1.02
19 (FW19) 17g	0.03	0.01	tr	87.07	0.02	.	tr	0.03	0.50	0.88	0.12	.	2.16#)

		Fe	Co	Ni	Cu	Zn	As	Sb	Sn	Ag	Bi	Pb	Au	S
20 (FW18)	33g	.	0.01	0.09	98.31	.	0.19	0.04	0.01	0.11	.	0.02	0.04	1.20
21 (FW21)	22g	0.01	tr	0.02	96.10	0.03	1.49	0.04	0.06#	0.03	.	0.07#	0.05	2.11#
22 (FW23)	14g	tr	tr	0.01	98.99	.	0.23#	0.01	.	0.01	.	.	.	0.75
23 (FW22)	20g	0.13#	tr	0.05#	95.64	0.01	0.57#	0.10	1.90	0.11	0.03	1.27	0.05	0.12
25 (FW25)	10g	0.01	0.01	0.03	98.77	tr	0.11#	0.03	0.01	0.04	.	0.06	0.08#	0.85
26 (FW26)	5g	.	.	0.14	94.27	0.01	0.36#	0.43#	0.02	0.06	.	4.70	tr	0.01
27 (FW27)	6g	.	0.01	0.14	97.00	.	0.36#	0.27	.	0.10	0.03	2.06	tr	0.02

= element markedly inhomogeneously distributed

(...) = analysis dominated by corrosion products

With one exception (No. 23) all these objects can be regarded as ingot copper: the table can be re-arranged to demonstrate the existence of several different groups:-

		Fe	Co	Ni	Cu	Zn	As	Sb	Sn	Ag	Bi	Pb	Au	S
<i>Compositions of ingot fragments</i>														
6 (FW6)	493g	0.01	0.01	.	99.02	.	.	0.01	0.02	0.01	.	.	tr	0.91
7 (FW17)	271g	0.01	.	0.01	96.02	.	0.77	0.09	0.04	0.03	0.01	1.57	0.03	1.42
8 (FW11)	182g	0.01	.	.	98.60	.	0.40	tr	0.01	.	0.01	.	0.03	0.93
11 (FW13)	135g	0.01	.	0.06	98.64	0.01	0.14#	.	0.03	0.12	.	0.02	0.05	0.94
13 (FW9)	88g	tr	0.01	0.06	98.94	.	0.10	0.01	0.02	0.01	tr	.	0.05	0.88
15 (FW14)	91g	0.02	.	0.08	98.76	0.01	.	0.01	tr	0.02	.	.	tr	1.09
16 (FW15)	64g	.	0.01	0.01	97.97	.	0.11#	0.10	0.01	0.05	.	.	.	1.76
17 (FW20)	33g	tr	.	0.02	98.19	.	0.23	0.02	0.07#	0.03	0.09#	tr	tr	1.36
20 (FW18)	33g	.	0.01	0.09	98.31	.	0.19	0.04	0.01	0.11	.	0.02	0.04	1.20
22 (FW23)	14g	tr	tr	0.01	98.99	.	0.23#	0.01	.	0.01	.	.	.	0.75
25 (FW25)	10g	0.01	0.01	0.03	98.77	tr	0.11#	0.03	0.01	0.04	.	0.06	0.08#	0.85
14 (FW12)	117g	tr	tr	0.02	93.86	0.02	4.75#	0.01	0.01	0.18#	.	.	0.03	1.12
21 (FW21)	22g	0.01	tr	0.02	96.10	0.03	1.49	0.04	0.06#	0.03	.	0.07#	0.05	2.11#
9 (FW7)	139g	0.28	0.14	0.08	97.58	.	0.87	0.10	.	0.20	0.15	0.45	.	0.10
		0.02	0.03	.	95.25#	.	.	0.02	0.03	0.28	.	.	.	4.34
10 (FW10)	124g	0.16	0.06	0.06	94.02	.	0.67	0.10	0.03	0.40	0.60#	2.87	0.03	1.12
12 (FW8)	107g	0.98	0.81	0.17	90.37	0.02	2.23#	0.06#	0.04#	0.19	0.56#	0.88	0.06	3.66
18 (FW16)	39g	0.01	0.01	0.01	98.08	.	0.48	0.23	0.04	0.05#	tr	0.09	.	1.02
26 (FW26)	5g	.	.	0.14	94.27	0.01	0.36#	0.43#	0.02	0.06	.	4.70	tr	0.01
27 (FW27)	6g	.	0.01	0.14	97.00	.	0.36#	0.27	.	0.10	0.03	2.06	tr	0.02
19 (FW19)	17g	<0.03	0.01	tr	87.07	0.02	.	tr	0.03	0.50	0.88	0.12	.	2.16#)
23 (FW22)	20g	0.13#	tr	0.05#	95.64	0.01	0.57#	0.10	1.90	0.11	0.03	1.27	0.05	0.12

11 of the ingot fragments are very similar and some may well come from the same ingot. They have low levels of most impurities with the exception of arsenic, and all contain about 1% sulphur in the form of copper sulphide particles. The sulphide inclusions are mainly very small and finely dispersed with larger inclusions at the grain boundaries. This is a very typical microstructure for Late Bronze Age copper ingots in Wales. Two related analyses have abnormal segregation of arsenic but still could be from the same source.

Three ingot fragments have a significant cobalt impurity, with one has high as 0.81%, and having cobalt greater than or equal to nickel. This pattern, provided antimony is low, can be associated with both Bronze Age and Iron Age metalworking in south-west England and a source in that area should be considered at this stage. Two other groups have an antimony impurity,

two fragments with nickel and two without. The two with (Nos. 26-7) have an alloying addition of lead and look like two fragments of the same piece of waste rather than an ingot.

A final variation on composition is represented by a rather corroded fragment (No. 19) which has high bismuth and silver.

The main group of compositions is typical of the bulk of these copper ingots so far analysed from the British Isles, parallels can also be found for some of the others:-

	Fe	Co	Ni	Cu	Zn	As	Sb	Sn	Ag	Bi	Pb	Au	S
9 (FW7) 139g	0.28	0.14	0.08	97.58	.	0.87	0.10	.	0.20	0.15	0.45	.	0.10
12 (FW8) 107g	0.98	0.81	0.17	90.37	0.02	2.23#	0.06#	0.04#	0.19	0.56#	0.88	0.06	3.66
Vange 28	0.79	1.12	0.08	96.51	.	1.20	0.04	.	0.09	0.05	0.10	0.03	.
Vange 32	0.87	0.19	0.01	97.89	.	0.84	.	.	0.09	.	0.04	0.06	.
Wickham Bishops 11 3	1.52	1.66	0.22	93.89	.	2.41	0.01	.	0.23	0.03	0.02	.	.
Wickham Bishops 11 4	1.78	1.00	0.03	95.57	.	1.33	.	.	0.07	0.01	0.16	0.03	.
Wickham Bishops 11 10	0.91	0.20	0.01	97.63	0.01	0.52	0.04	.	0.08	0.08	0.53	.	.
18 (FW16) 39g	0.01	0.01	0.01	98.08	.	0.48	0.23	0.04	0.05#	tr	0.09	.	1.02
Rook Hall 25	.	.	0.05	98.43	.	0.64	0.67	0.01	0.08	0.02	.	0.08	.
Rook Hall 32	.	.	0.01	96.01	.	0.29	0.36	0.25	0.10	.	.	0.02	.
26 (FW26) 5g	.	.	0.14	94.27	0.01	0.36#	0.43#	0.02	0.06	.	4.70	tr	0.01
27 (FW27) 6g	.	0.01	0.14	97.00	.	0.36#	0.27	.	0.10	0.03	2.06	tr	0.02
Vange 19	.	.	0.11	76.76	.	0.11	0.12	0.08	0.07	.	22.75	.	.
Vange 80	.	.	0.14	97.06	.	0.04	0.20	0.12	0.33	0.02	2.10	.	.

The existence of these parallels, all from hoards found in Essex, underlines the consistency of the ingot group suggested by the uniformity of the patination. As with the other analysed hoards it seems certain that this hoard, as with analysed hoards of copper ingots in south-eastern England, contains copper from more than one source. It is the first association of copper ingots and south Welsh socketed axes in Wales, and the first with a Carp's Tongue sword. This grouping can be paralleled in the Wick Park, Stogursey, Somerset hoard, now in Taunton Museum, and in the material from Kenidjack Castle, Cornwall. The Petters Sports Field, Egham, Surrey, find has copper ingots and a South Welsh socketed axe variant in close proximity. The expansion of the group with cobalt-rich compositions is of great interest given its association with south-west England. Perhaps for the first time we will be able to identify Late Bronze Age copper of British origin.

Thus, among Welsh Late Bronze Age metalwork the find is of the first importance.

FRESHWATER WEST, DYFED (SR 882 999). BRONZE AGE HOARD

Dyfed Archaeological Trust record number - 14393

A hoard of 28 bronzes was found on Freshwater West beach, Dyfed, in July 1991 by Mr Derek Roberts of Haverfordwest. The discovery was made using a metal detector. The find spot was some half to two-thirds the way down the beach in an area freshly scoured by the tide (National Grid Reference SR 882999). The spot was described as being at the junction of the yellow sand and black sand. All the objects were found within about 2m of each other. Some lay on the surface of the yellow sand, the rest were just below the surface. Subsequent searching of the find spot at a later date failed to reveal any further objects.

Of the 28 bronzes only five are recognisable implements. The remaining pieces are lumps of apparently solid metal of varying shapes and sizes.

Catalogue:

1. **Socketed Axe.** Broken, mouth end missing. Heavily corroded and battered. Dark blue-grey patina. Rectangular cross section. Three slightly converging ribs on the broad face. Wall thickness variable between 1.5mm and 5mm. Length 84mm, width 43mm, thickness 24mm. Weight 211g. A concretion of purple-red sand and small rounded stones is present in the socket.

2. **Socketed Axe.** Broken, mouth end missing. Heavily corroded and battered. Dark blue-grey-green patina. Rectangular cross section. Length 40mm, width 41mm, thickness 14mm. Weight 85g. Concretion of dark grey sand and small rounded stones in socket.

3. **Socketed Axe.** Broken, mouth end missing. Heavily corroded and battered. Dark blue-grey-green patina. Sub-square cross section with convex faces and edges. Length 66mm, width 32mm, thickness 20mm. Weight 87g. Concretion of reddish sand and gravel in the socket.

4. **Blade.** Broken. Heavily corroded and battered. Dark blue-grey patina. Two converging grooves on centre of body. Possible groove following outline of blade. Length 83mm, width 23mm, thickness 8mm. Weight 35g.

5. **Blade.** Broken and battered. Some recent damage on edges. Brown-green patina of different character from that on the above objects. Length 135mm, width 32mm, thickness 6mm. Weight 81g.

All the following lumps of metal are battered and heavily corroded. They have a dark purple-grey patina. The smallest lump weighing 2g. (object 28) may be part of the body wall of a socketed axe.

6. 493g. 58 x 46 x 28mm.

7. 272g. 60 x 42 x 22mm.

8. 182g. 45 x 45 x 22mm.

9. 139g. 46 x 25 x 18mm.

10. 124g. 32 x 26 x 24mm.

11. 135g. 38 x 26 x 21mm.

12. 107g. 36 x 24 x 22mm.

14. 118g. 46 x 28 x 18mm.

16. 64g. 38 x 21 x 18mm.

18. 40g. 40 x 12 x 12mm.

20. 32g. 25 x 15 x 10mm.

22. 15g.

24. 11g.

26. 5g.

28. 2g.

13. 88g. 36 x 24 x 18mm.

15. 91g. 32 x 28 x 15mm.

17. 33g. 29 x 16 x 10mm.

19. 17g. 25 x 15 x 6mm

21. 22g.

23. 20g.

25. 10g.

27. 6g.

Ken Murphy August 1991

Black and white Photo: Neg Nos: DAT 91-44 to 47.