AML Report 2761

Revised version

Examination of metallurgical material from the Roman site at Brancaster, Norfolk.

(Lab. Nos 773[illegible] Series)

This was a random selection of iron work. The examination of the material, unlike that of Poundbury, did not concentrate on edge tools which in this case seemed to be in the minority.

The usual techniques were employed which included sectioning with a jeweller's hack-saw or, were appropriate, with a water-cooled abrasive cut-off disc. The sections were mounted and polished and etched in Nital.

Results.

773338. A triangular piece of sheet metal. A segment was cut from one edge; the sheet had been made by piling metal varying in composition from low carbon ferrite (HV = 143) to medium carbon (ferrite and pearlite) equivalent to about 0.3% C (HV=220). The welds were clearly shown by their ferrite content and it would seem that the As content is relatively high. The pearlite was fully spheroidised showing that it had been held in the range 600 - 700°C, probably during working.

? Could have been fashioned for a knife (tip), but not edged

773306. Another triangular piece of sheet metal - perhaps a small hoe blade, A segment was removed from one of the long edges. This was also piled with low As content. There were two distinct layers, one with low carbon (ferrite + grain boundary carbide, HV=224) and the other with much higher carbon giving a hardness of 330 HV. This seemed to consist of coarse granular carbide in a ferritic matrix, i.e. it was granular sorbite. The two pieces had a large elongated slag cavity along the join.

773559. An offcut; a stubby piece of sheet metal with very variable carbon content and grain size. It has slag stringers and as much as 0.4% C with a widmanstätten structure in places. The hardness of the ferrite is 119 HV, showing that it is low in phosphorus.

773492. The blade of a sickle. Made of two layers; one, a 0.4% C steel which projected so as to be the cutting edge. This consisted of ferrite and pearlite with spheroidised carbides and had a hardness of 230 HV. The rest, the major part, was ferrite and slag with a hardness in the range 143-166 HV.

773931 Another small triangular piece. A segment was removed from one of the larger edges. This was a low carbon steel consisting of ferrite with a varying amount of coarse granular pearlite. The carbon content varied slightly from the outer edge where it was about 0.2% and gave a hardness of 201 HV, through 185 HV in the middle to 162 HV at the thick section corresponding to about 0.2% C.

773302. A long tapered object; it could be a blank for a knife. Two distinct layers. One was ferrite with a hardness of 173 HV. The other was steel, ferrite and pearlite corresponding to a carbon content of about 0.4%. This layer had a weld down the middle showing that it had been "doubled" before welding to the iron. The hardness was 230 HV.

773725. A rectangular sectioned punch or wedge. A piece was removed from the sharp end and found to be steel varying from 0.1% C on one surface, to 0.7% C in the middle. Made by piling, with decarburized zones between. The steel had not been hardened as it consisted predominantly of ferrite and pearlite. The hardness of the low carbon areas was 224, and of the high, 305 HV.

773951. A dagger blade. A segment was removed from one edge. It was entirely ferritic with variable grain size. It contained some very large lightly worked slag inclusions and some slag stringers. There was some carbide film (cementite) in some of the grain boundaries. The carbon content would be about 0.05% C which agrees with the hardness of 119 HV. Clearly, a fairly pure iron.

773529. A square sectioned, flat-edged chisel with an expanded cutting edge. A segment was removed about 2.5 cm from the cutting edge. Made of piled pieces of variable grain size and carbon content

773529 cont. the latter varying from 0 to 0.6% C. The hardness varies from 178 HV (all ferrite) to 224 HV (ferrite and pearlite). The pearlite is lamellar indicating slow cooling through 700°C.

773642. A square headed spearhead with a fluted tang. A segment was removed from one corner of the square head 4 cm from the tip. This was all ferrite with a little carbide in the grain boundaries. There was one continuous slag inclusion across the section indicating folding to thicken the weapon. The hardness was 140 HV suggesting a medium to low phosphorus content.

773685. A small square sectioned spearhead with a round tang. Medium grain-size ferrite to 0.2% C steel. The pearlite is lamellar and there is some carbide in the grain boundaries of the pure ferrite regions. The hardness of the 0.1% C regions is 156 HV suggesting a low phosphorus content.

773715. A cleaver with a broad blade. Heavily laminated but mostly ferrite with variable grain size. It is very slaggy and there is no grain boundary carbide but the hardness is 270 HV which indicates a very high phosphorus content.

Conclusions.

This series is in marked contrast with the Saxon and later material in the previous series from Poundbury. While quite a large amount of steel has been used, no attempt has been made to quench-harden it. One wonders whether these tools were ever finished. The hardness of the cleaver stems from its high phosphorus content and this could well have come from local Norfolk, ores. Many of the objects clearly have too low a phosphorus content to have been made locally. It is noteworthy that the punch-end has a relatively high hardness which suggests that it was intentionally and correctly carburized; most of the edge would have responded to heat-treatment and given results comparable with the chisel-drift found at Chesterholm and examined by Pearson and Smythe[1] where the edge had been hardened to give martensite with a hardness of 464 to 579 HV.

On the other hand the steel axe from Silchester was unhardened,[2] and shears were no more than ferrite[3]. It is certain therefore that the average technical level in the Roman period was far lower than that of Saxon and later periods. This point has been made in the Foundsbury report, but has not so far been generally emphasised.

13 December 1978.

R.F. Tylecote.

References:

1. C.E. Pearson & J.A.Smythe. Proc. Univ. Durham Phil. Soc. 1938, 9 (3), 141-145.

2. H.H. Coghlan. Prehistoric and Early Iron in the Old World. Pitt Rivers Museum, Oxford, 1956, p. 189.

3. R.F. Tylecote. Metallurgy in Archaeology. London 1962. p. 245.

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Re Brancaster Report.

773642 Described as "Iron spearhead" on the outside of the box. It could be a spoon bit but if so has a very short (?broken) cutting edge.

773685 Described on outside of box as "Iron spearhead". It could be an awl.

773725 This is of soft steel and would not make a good chisel. So I prefer wedge for this; but it could be an unhardened punch or chisel although I think this is unlikely on grounds of shape.

RFT. 29/1/79.

Table

Summary of results of examination of ironwork from Lancaster.

No.	Object	Phases	% C	HV1	Comments.
773338	Triangular Sheet frag.	F to (F+P)	0.05	(Max) 220	
306	"	F + Fe_3C	0.05-0.5	224-330	
559	" (possibly for knife?)	F to (F+P)	---	Low(119)	Low Phosphorus.
492	Sickle	F	0.05	143 - 166	Sandwich
		F + P	0.4	230	
931	Sheet as above	F + P	0.1 - 0.2	162 - 201	
302	Bar	F	0	178	Sandwich
		F + P	0.4	230	
725	Punch	F + P	0.1 - 0.7	224 - 306	Edge
951	Dagger	F	0.05	119	Low Phos.
529	Chisel	F + P	0 - 0.6	178-224	--
642	Spearhead	F+Fe_3C	0.1	140	--
685	"	F + P	0 - 0.2	156 (0.1% C)	Low Phos.
715	Cleaver	F	0	270	High Phos.

F = Ferrite; P = Pearlite; Fe_3C = Carbide.