AML Report 4663

METALLURGY RESEARCH (ARCHAEOMETALLURGY)

DEPARTMENT OF MECHANICAL ENGINEERING

ASTON UNIVERSITY

ASTON TRIANGLE BIRMINGHAM B47ET

COPPERGATE YORK METALLURGY REPORT NUMBER 10

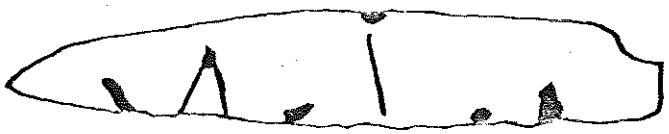
KNIVES 10434, 13374, 13820, AND 14153

KNIFE 10434

Knife 10434 was ascribed to Backform E2, the blade was complete but the tang was broken off. X-radiographs showed some penetration of corrosion, a crack running right across the knife at the centre of the blade, and no structural details, (Fig 1). In the unetched condition the section showed typicall vertically orientated slag inclusions, both single and double phased, but no evidence of banding. The exterior faces of the section had a continuous layer of corrosion products adhering to the surface. When etched, (Fig 2) there was a central white/yellow weld line, an overall appearance of banded structures, and an increasing carbon gradient towards the centre, although the degree of decarburisation on the outside varied from area to area. The cutting edge tip had been heat treated to produce a martensitic structure, which degraded to pearlite higher up the blade.

TABLE I KNIFE 10434 HARDNESS RESULTS

		VPN 5	uHV
Knife Back	Ferrite	161	157
	" plus Pearlite	216	240
Cutting Edge (tip)	Martensite	985	689



KNIFE 10434 (X1)
Fig 1

Fig 2

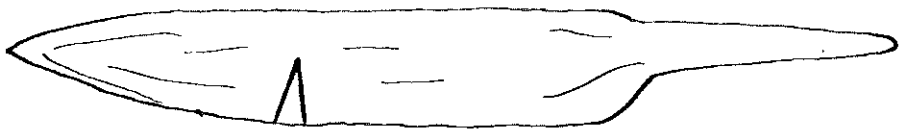


Fig 3 KNIFE 13374 (X1)

Fig 4

Knife 10434 did not conform to the usual manufacturing types, but was a variant on Type 1, ie. half a sandwich. There had been extensive carbon diffusion resulting in partial carburisation of the knife back.

KNIFE 13374

Knife 13374 was ascribed to Backform E1, and was complete. The X-radiographs showed evidence of horizontal slag line banding but no other structural details, (Fig 3). In the unetched condition a large number of vertically orientated slag inclusions were observed in a 'V-formation', the base of the 'V' towards the tip. When etched, (Fig 4), the structure was ferritic with minute spheroidal carbides and phosphoric ghost phases. The ferrire grain size was small, and became finer at the tip. The spheroidal carbides survived unaltered in the corrosion products at the edge where the ferrite matrix became completely replaced by oxide. The hardness results are shown in Table II.

TABLE II KNIFE 13374 HARDNESS RESULTS

		VPN 1	uHV
Cutting Edge (upper)	Ferrite plus Carbide	201	194
(tip)	" " "	276	206

It is difficult to determine the overall knife structure, but the 'V-shaped' banding suggests the cutting edge was an external sheath, ie Type 4. The nodular spheroidal indicate over-tempering.

KNIFE 13820 (X1)
Fig 5

Fig 6

KNIFE 13820

Knife 13820 was ascribed to Backform A. The shoulder was absent at the tang/blade interface on the knife back, and only very slight on the cutting edge. The X-radiography indicated the presence of two irons, (Fig 5); one was a thin strip forming the cutting edge which did not extend the whole length of the blade, distinguished on the radiographs by its cleaner appearance and greater corrosion resistance. The second iron formed the knife back and tang. The unetched specimen confirmed this overall structure. The knife back contained a large number of single and multi-phase slag inclusions, indicating transverse banding and the cutting edge contained fewer, single phase, inclusions. When etched (Fig 6), the weld line between the two irons was a serrated white/yellow weld line; the knife back was predominantly ferritic, but with some grain boundary carbides present. There had been extensive carbon diffusion at the weld line. The cutting edge was martensitic and of uniform composition. The hardness values are shown in Table III.

TABLE III KNIFE 13820 HARDNESS RESULTS

		VPN 5	uHV
Knife Back	Ferrite (mean value)	133	147
	" (Band 1)		135
	" (" 2)		162
	" (" 3)		118
	" (" 4)		142
	Weld Line		297
Cutting Edge	Martensite	927	550

Knife 13820 was a high quality knife. It is of interest to

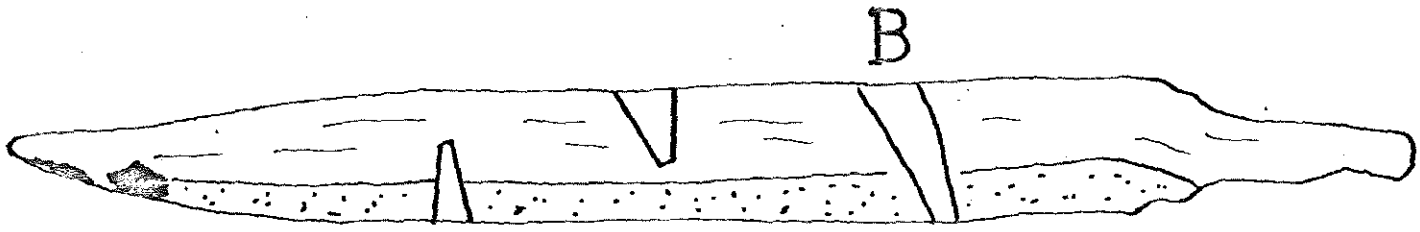


Fig 7 KNIFE 14153 (X1)

Fig 8

note the differential corrosion of the blade and the back. It is expected that the quenched and tempered cutting edge would corrode preferentially. The excessive corrosion of the back in this specimen was probably due to the large number of slag inclusions, which would provide corrosion pathways.

KNIFE 14153

Knife 14153 has an overall length of 18 centimeters, but with a tang of only 2 cemtimeters. It had been bent in antiquity through 30 degrees at about one third along its length from the tang, (Fig 7, 'B'). It was ascribed to Backform E1. X-radiography indicated the presence of two irons. One formed the cutting edge and was distinguished by small round corrosion pits(?). The second iron formed the knifeback and tang and contained fine horizontal bands of slag inclusions. Two half-sections were removed to obtain a complete cross-section. The sections confirmed the overall structure was of two types of iron welded together. The knifeback contained vertically orientated single and multi-phase slag inclusions which converged at the knife top, indicative of banding. The cutting edge contained predominantly single phase inclusions of random shape.The etched specimen(Fig 8), showed the knife back to be ferritic and the banding to be a variation in grain size (and hence phosphorus content). The cutting edge was a V-shaped steel sheath welded around the knife. It had a pearlitc structure. The corrosion products around the tip contained a few islands of nodular carbide as observed in 13374. The hardness values are shown in Table IV

TABLE IV KNIFE 14153 HARDNESS RESULTS

		VPN 1	uHV
Knife Back	Ferrite (mean values)	150	145
Cutting Edge	Pearlite	426	297

The knife was well manufactured but poorly heat-treated.