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A STUDY OF THE GERMAN 'GOTHIC' 15TH-CENTURY EQUESTRIAN ARMOUR (A21) IN THE WALLACE COLLECTION, LONDON

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ABSTRACT - RESUMEN

The most famous, indeed iconic, armour in the Wallace Collection, London, is the late 15th century German armour for man and horse (inventory number A21). Unfortunately for the historian of armour, it is also one of the most composite, having been assembled in its present form in the 19th century from elements of at least five armours. Archival research in the Wallace Collection has been combined with metallography in the Conservation Department to attempt to cast some further light upon its origins.

La armadura más famosa y emblemática de la Wallace Collection de Londres es un arnés para hombre y caballo de finales del siglo XV (inv. A.21). Desafortunadamente para la historia del arte de la armadura es también una de las más heterogéneas, compuesta en el siglo XIX con piezas procedentes de al menos otras cinco armaduras. La investigación archivística en la Wallace Collection se ha compaginado con el estudio metalográfico del Departamento de Conservación para intentar arrojar algo más de luz sobre sus orígenes.

KEY WORDS - PALABRAS CLAVE

Armour. Horse-armour. Landshut. Metallography. Thickness. Wallace Collection.
Armadura. Barda. Landshut. Metalografías. Wallace Collection.

The most striking single image that most general public take away with them from a visit to the Armoury of the Wallace Collection is undoubtedly that of the 15th-century Gothic knight astride his armoured horse (catalogue number A21). Its past history may be chequered, and its constituent parts composite, but it nonetheless remains an impressive and awe-inspiring reminder of the glory, and terror, of medieval warfare. Recent (and on-going) research in the Wallace Collection is currently shedding some new light on this famous set-piece display.

The armour probably once belonged to Hans von Freyberg (or possibly his son, Onuphrius). For nearly four centuries it was retained in the family armoury of the Counts von Freyberg of Castle Hohenaschau in the Bavarian Alps, close to the borders of the Tyrol. In the 17th century the castle and its contents passed by marriage to the Preysing family, but as far as we know the estate remained more or less intact, until in about 1861 the contents were sold off by auction, the property itself following some time after. Tragically, no catalogue of the armoury collection seems to have been produced, although inventories of the castle contents do survive from earlier times (one dated 1567, for example, was published by G. Schiedlausky

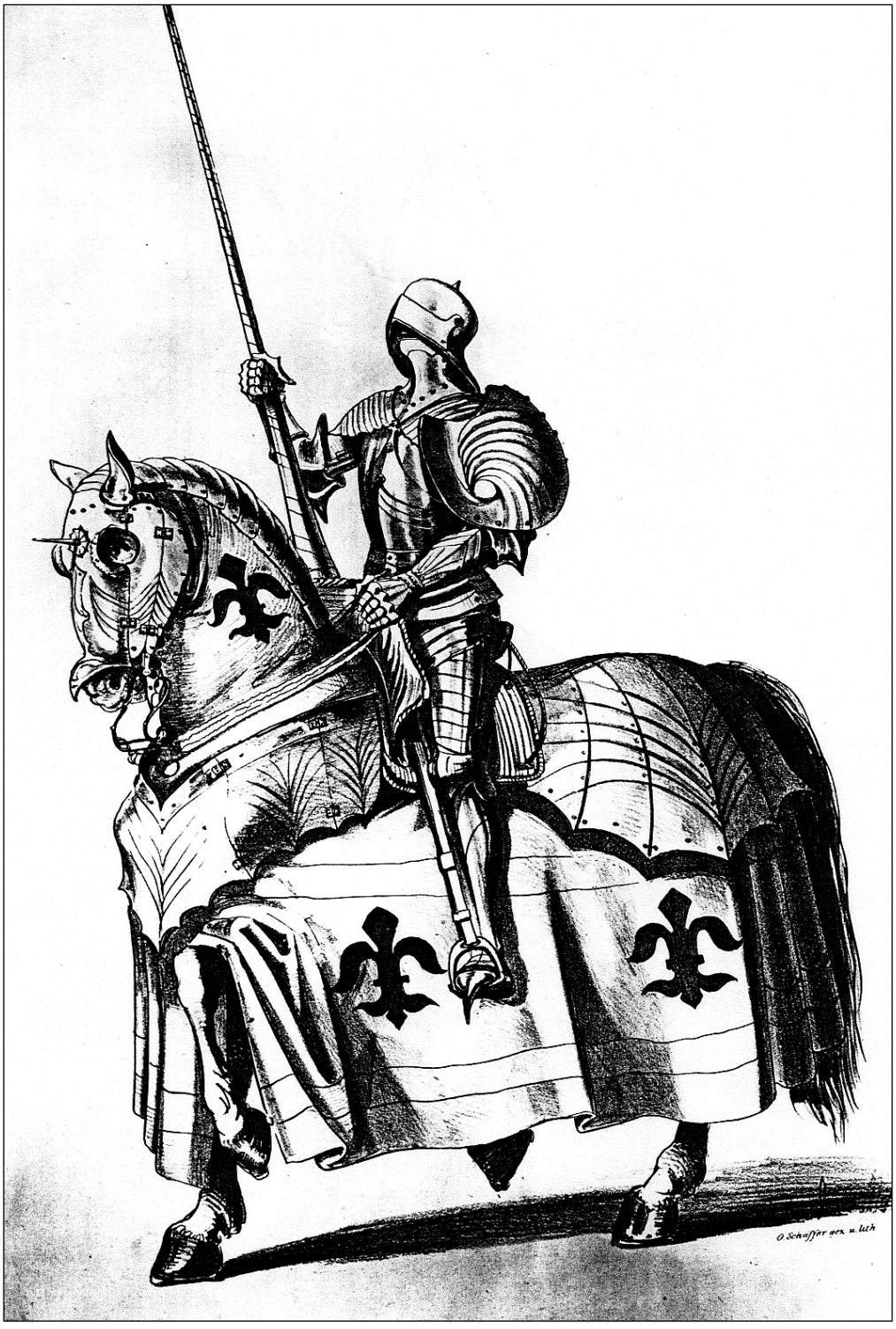

Fig. 1. Lithograph of the A21 armour dated 1868, by which time it was already in the collection of the comte de Nieuwerkerke, displayed in his private rooms at the Louvre in Paris.

in *Waffen und Kostümkunde*, 1962, pp. 25-34). An (as yet unpublished) list of the arms and armour in the castle, probably drawn up by an interested (but so far unidentified) visitor at some time just prior to the auction, makes reference to the presence of three mounted armours. One of these, a late-15th century 'Gothic' equestrian armour, may well be that now catalogued under number A21 in the Wallace Collection (*personal communication*, Stuart Pyhrr, curator of Arms and Armour at the Metropolitan Museum, New York, October 2001).

The earliest illustrations of the Wallace Collection 'Gothic' armour known at the present time, however, all post-date the auction. Since they were made several years after the armour had already left Hohenaschau, we cannot be entirely sure in what state of completeness the armour had survived until the moment of its final sale and departure from the castle. A lithograph dated 1868 (Fig. 1) was given to the noted 19th-century armour collector and scholar Baron de Cosson by the Nuremberg antiques dealer, A. Pickert, who is thought to have been the first owner of the armour. This subsequently passed into the possession of Sir James Mann and was cited by him in his *Catalogue of European Arms and Armour in the Wallace Collection* (1962: A21, 9-15). An 1868 pencil drawing of the armour by Eugène Violett-le-Duc (Fig. 2) is now in the Detroit Institute of Arts (accession. no. 1993.105). This, dated, signed, and annotated, was presumably executed for Violett-le-Duc's famous *Dictionnaire de Mobilier*, although it does not seem to have been used; instead, only two images of A21 armour parts appear (V, plates 10 and 8, pages 340 and 460 respectively). In both cases, the horse upon which the armour is mounted is probably identical with that sold with it and subsequently removed from Hohenaschau castle, but it is quite clearly not the same animal that now bears its weight. As will be seen shortly, our present horse-figure in fact dates from 1908; the armour itself, though, is obviously the same throughout. The textile horse caparisons depicted in the two 1868 illustrations seem to be very different, however. Both were almost certainly not contemporary with the armour, but instead products of 19th-century refurbishment. That shown in the Detroit drawing has no sign of the *fleur de lis* so prominent in the Pickert lithograph, but seems instead to have the vertical stripes of the cloth caparison as it appears in pre-1908 photographs of the display as set up by Sir Richard Wallace in Hertford House. A note in the archives of the Wallace Collection tells us that these stripes were black and yellow. Since Wallace did not acquire the armour until 1871, it must therefore have been Nieuwerkerke who ordered the change-over from *fleur de lis* to colourful stripes.

It was probably the dealer Pickert who was initially responsible for 'improving' the armour that had been sold to him at Hohenaschau, and perhaps, therefore, it was he also who commissioned the undoubted restorations (Mann, 1962: A21, 9-15), including the regrettable addition of such features as the brass bands on certain of the pieces… nowadays viewed as a deplorable case of 'gilding the lily'. In 1962 it was Mann's opinion that the pierced tracery finial of the breast-plate, both pauldrons, both besagues, both gauntlets, the fauld plates, and both tassets were all 'restorations', as were three plates of the crinet. He also condemned as 'modern' the rider's solid-and-butted-link mail shirt (although actually it is likely that this may well date to the 1908 improvement work carried out on A21, of which more anon), and what he described as a butted-link mail hood worn (albeit invisibly) under the helmet. The authors of this article agree in principle with Mann's assessment of the plate armour; however, the hitherto unseen mail coif condemned by him is in fact made of fine-quality genuine late-15th or 16th-century riveted mail, but in segments pieced together with butted-mail joints. Although probably constructed in the 19th century out of original fragments it is nonetheless still of some interest, and has now been removed and will in due course be displayed separately, as a piece of armour in its own right. Mann also recognised that the saddle, although genuine, was of later date than the rest of the armour (certainly of German origin, but in the 'Maximilian' style of the 1520-30s), and that the armour for the knight was considerably more composite than that for the horse, with the arm harness, especially, being made up of several very different elements. The mis-matched two-piece left couter and poldermitton, in fact,

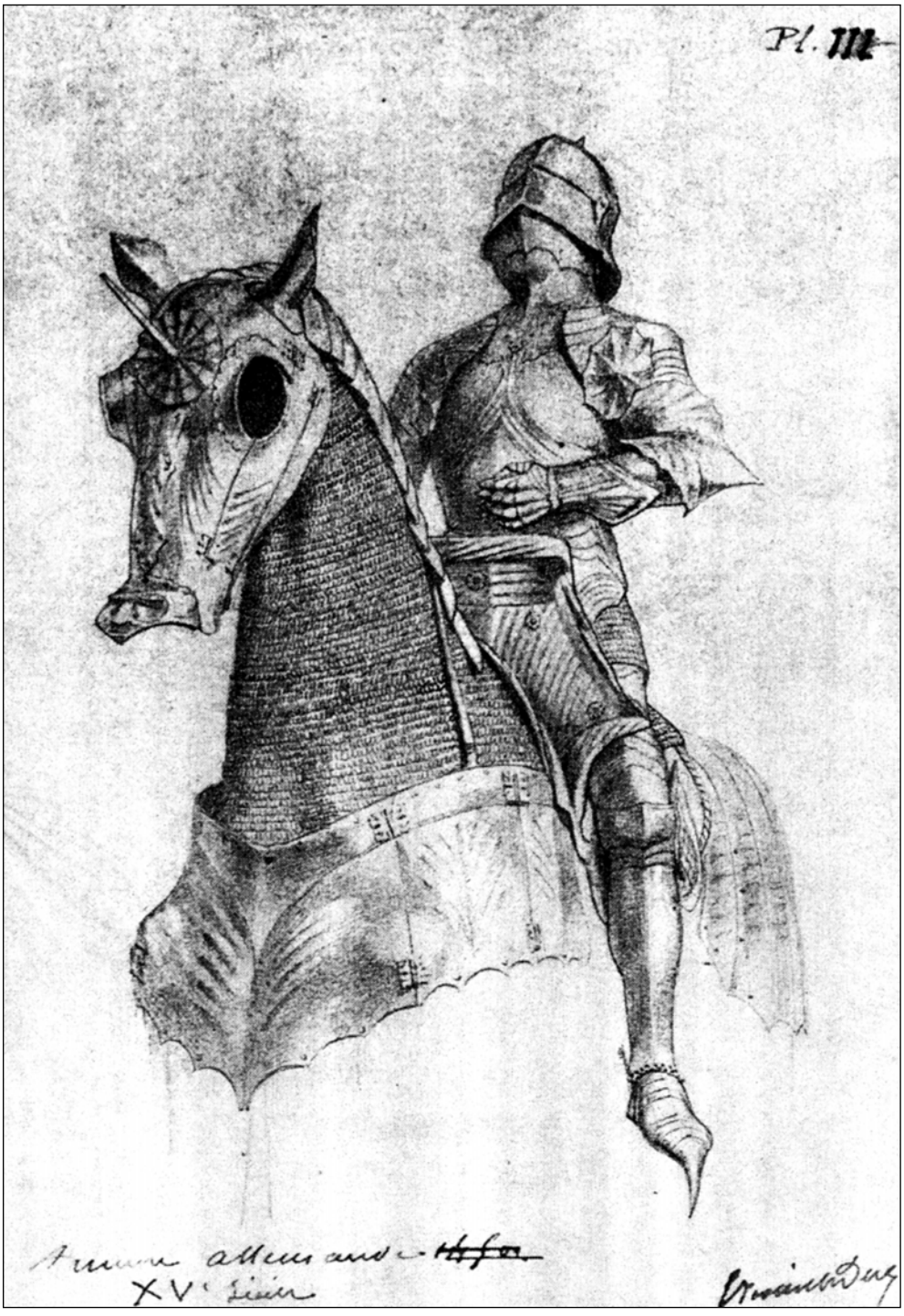

Fig. 2. A pencil drawing in the Detroit Institute of Arts (accession number 1993.105), dated and signed by Eugène Violett-le-Duc, showing the A21 equestrian armour as it appeared in 1868, presumably following Nieuwerkerke's replacement of the previous *fleur-de-lis*-decorated textile caparison with a black-and-yellow vertically-striped one.

Fig. 3. Photograph taken in the 1890s of the European Armoury room at Hertford House, as set up by Sir Richard Wallace. A21 can be seen at the far end of the gallery.

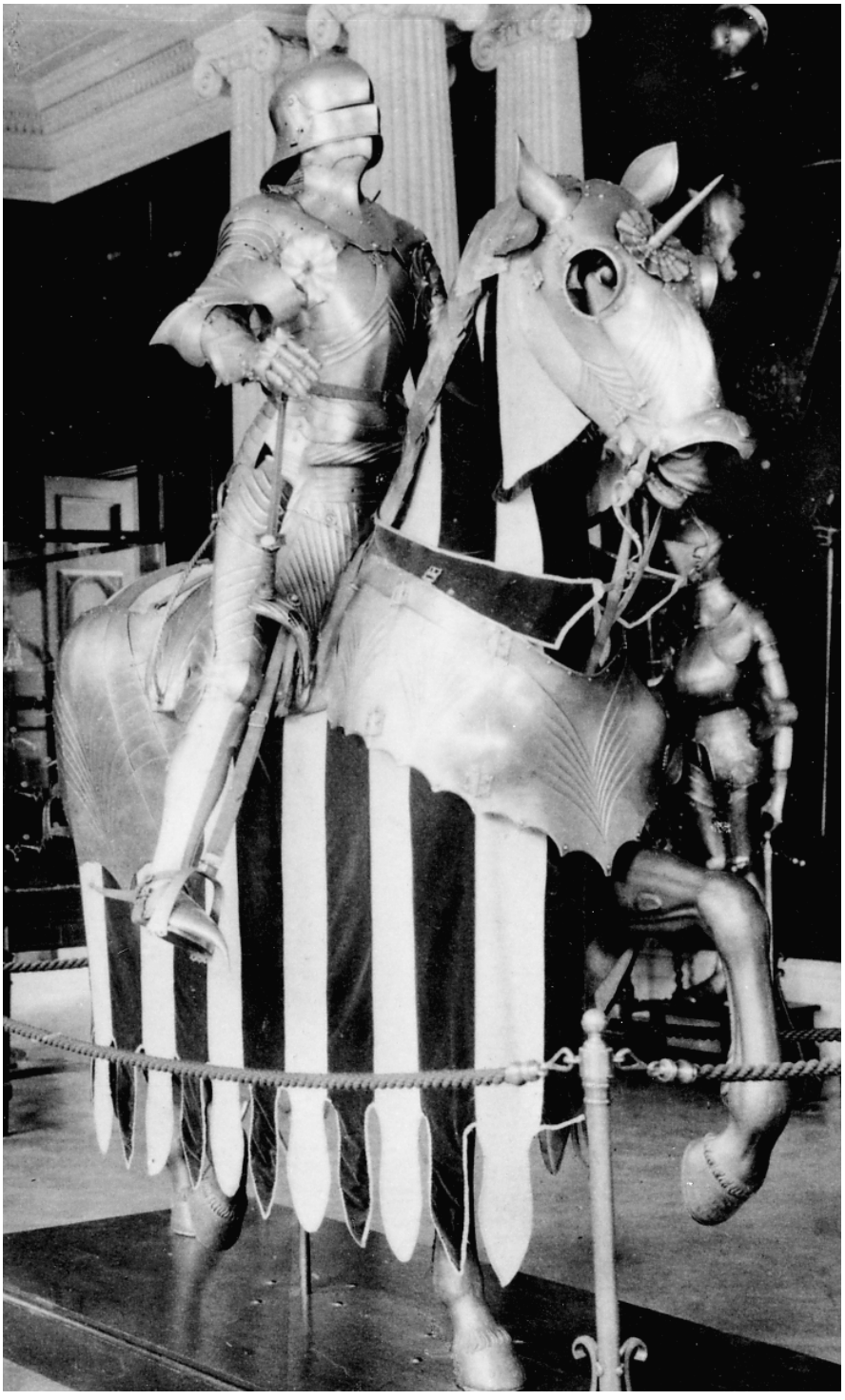

Fig. 4. The Armoury of the Wallace Collection as seen by the visiting public prior to 1908. The A21 horse still wears the boldly-striped cloth caparison commissioned for it by its former owner, the Comte de Nieuwerkerke, prior to the armour's acquisition by Richard Wallace.

was considered such a mess that it was entirely replaced in 1956 with a modern replica of the complete and original Gothic couter on the right arm. This very competent copy was made by Theodore Egli in the workshops of H. M. Tower of London. The two pieces it replaced were removed to store, where they remained for many years, but they are now on display again, as separate elements, in European Armour Gallery I.

In general, however, the reconstruction and restoration work carried out in the 19th century was in keeping with the age, style and appearance of the armour. Only the occasional hideous anachronism is to be found; the reader will note, for example, that in the 1868 lithograph (Fig. 1) the armoured knight is wearing a «tilting socket» on his left arm, as a shield … this should in fact be worn over the thigh! It is still in the Wallace Collection, cat. no. A301, displayed high on the south wall of European Armour Gallery I. Presumably it too must have come originally from Castle Hohenaschau, but although of the same date as the rest of the armour, metallurgically-speaking it is unlike any other piece, so probably does not belong to the barding at all.

The armoured figure as we see it today, of course, does not carry the lance depicted in the 1868 lithograph; if it originally entered the Collection still with a lance the single possible contender is A1022, now displayed with the only other lance in the collection (A1023), on the wall in European Armour Gallery I. Interestingly, there are traces of painted red and white spiral bands along its length, similar to the striped appearance of the lance in the 1868 lithograph. Frustratingly, however, Nieuwerkerke receipts exist for both lances now in the Wallace Collection, showing that they came from other sources. Since the Viollet-le-Duc drawing shows the armour without a lance, we can only presume that it had already been disposed of elsewhere, before Sir Richard Wallace came into possession of the horse armour, and that it is now therefore untraceable. This is a pity, particularly since Wallace on this occasion does not seem to have had much grasp of the historical chronology of arms. As displayed in his Armoury room at Hertford House in a photograph taken after his death in 1890 (one of a series probably commissioned shortly prior to or upon the death of his widow in 1897), our Gothic knight can be seen wildly anachronistically holding a 16th-century swept-hilt rapier (Fig. 3). The wooden horse is the same as that used until 1908, caparisoned in a striped black-and-yellow textile caparison which shows below the plates of the horse-armour, extending almost to the floor. This is the caparison installed by Nieuwerkerke to replace that shown in the 1868 lithograph; it is indicated by vertical pencil strokes in the Detroit pencil drawing (Fig. 2).

Despite the date on Baron de Cosson's lithograph, Pickert must have sold the armour prior to autumn 1867, because in September of that year its new owner, the Paris dealer and collector E. Juste, sold it to the Comte de Nieuwerkerke, *Surintendant des Beaux Arts* and Director of the Louvre under Napoleon III. The 15th-century armour for man-and-horse was set up as an impressive centrepiece in Nieuwerkerke's apartment in the Louvre, where it was seen and admired by many (including, presumably, Violett-le-Duc). By 1870, however, France was at war with Prussia, and by 1871 was tasting the bitterness of defeat; upon the collapse of the Second Empire, Nieuwerkerke decided to dispose of his entire collection of medieval and Renaissance decorative art, arms and armour, and accordingly sold it (at virtually cost-price, for £60,000) to Richard Wallace, who had only the year before inherited the vast personal fortune (and not inconsiderable art collection) of his father, the Fourth Marquess of Hertford. Thus it was that A21 entered the Wallace Collection. Wallace promptly moved his works of art, arms and armour out of Paris (ravaged at that time by the excesses of the Commune) to safety in London, eventually installing them in the Hertford family's elegant newly-renovated and refurbished 18th-century London town-house where the Collection still resides today. Wallace's Armoury rooms (one European, one Oriental) were situated

Fig. 5. The A21 display as set up in a much more dramatic pose by Felix Joubert in 1908. Both horse and caparison have now been entirely replaced in this new scheme.

amidst the cream of his art collection, on the first floor of the building; there the armour remained until after his death in 1890, the rooms essentially untouched until the death in turn of Lady Wallace in 1897. It was she who, in her husband's name, bequeathed his collection to the British nation.

The new 'Wallace Collection' museum opened its doors to the public in 1900; the entire Armoury, meantime, had been re-located to the ground floor (Fig. 4), where it could be arranged in four spacious rooms rather than two. With commendable speed, a catalogue was produced by Sir Guy Francis Laking, an arms and armour scholar of note and a prolific writer/researcher, who besides holding the position of Keeper of the King's Armour at Windsor

Fig. 6. A detail of the Felix Joubert display, showing anachronisms such as the fringed leather reins (which were removed some time prior to 1958) and the leopard-skin trim around the edges of the horse barding, finally stripped off in the 1980s. Further work has been authorised this year to improve the authenticity of the display without compromising its dramatic appeal.

Castle had also been appointed Inspector of the Wallace Collection Armoury. Laking's first catalogue was further amended and up-dated in 1909, by which time he had already radically altered the way that the von Freyberg 'Gothic' armour was displayed. The previous year he had commissioned Felix Joubert to create entirely new horse and rider mannequins for the Gothic armour, arranged in a much more dramatic pose. Joubert was an experienced designer/restorer in this field, whom Laking also employed to refurbish the other equestrian armour in the Wallace Collection (that of Otto Heinrich, Count Palatine of the Rhine, cat. no. A29), without, however, altering or replacing its wooden horse. At Laking's command he also carried out much similar work at around the same time to 'improve' the displays of armour in the Royal collection at Windsor Castle and at the Tower of London. The Wallace Gothic equestrian armour, which already constituted an impressive centrepiece in one of the new public galleries, was at that time known by the catalogue number 620, which it retained until the Armoury collection was re-arranged yet again in 1945. At that time, during a major re-numbering exercise orchestrated by Sir James Mann, Laking's successor, 620 finally became A21, the catalogue number that the armour has retained to the present day. Incidentally, the sword (A500) that the knight holds aloft now originally had nothing whatever to do with the armour, and was almost certainly added to the display when it was completely rebuilt by Joubert in 1908. Only the blade is genuine; the hilt is a clumsy Victorian confection. The very fine Gothic mace (A978) carried by the figure of the knight throughout the 20th century, either in his hand or (as at present) suspended from the saddle-bow, similarly has nothing to do with Hohenaschau and the von Freyberg family. According to a surviving receipt, it was bought as an individual item by Nieuwerkerke from the Paris dealer Louis Carrand in August 1867, shortly before his purchase of the whole von Freyberg equestrian armour in September of the same year. One cannot help but wonder whether he thought in advance that the two would go nicely together.

The new horse constructed in 1908 (Fig. 5) was essentially a rather stylised papier-mâché sculpture built around a simple wooden frame, the appearance of the whole perhaps based upon the dramatic pose of one of the horse-and-rider figures in Uccello's painting «The Hunt in the Forest» in the Ashmolean, Oxford. The dummy figure of the rider was similarly constructed in wood and papier-mâché, but not to a fully-contoured «human» form apart from having an (unpainted) papier-mâché head. The now-redundant original wooden horse (which has so far eluded positive dating) was stored in the basement of the museum until 1938, at which point the Director, Sir James Mann, authorised its semi-permanent loan to the Fitzwilliam Museum in Cambridge, where it resides to this day, used for the display of a fine early-16th century 'Maximilian' equestrian armour in the centre of the principal armour gallery there.

By the 1980s the papier-mâché elements of the Wallace A21 display were in a very bad state, the horse in particular constantly shedding dust and fragments. A decision as to its future had to be made. There was no question of returning to the original 'staid' 19th-century pose, since the modern appearance of the display was so well-known and loved; accordingly, the figure of the horse was removed to the workshops of H & H Sculptors in London, moulded, and then completely 're-skinned' in fibre-glass using the new moulds. Funds were limited, however, and the rider was not altered or repaired at all other than by reinforcing his papier-mâché limbs with polyester resin and replacing his crumbling head with a modern-made fibre-glass one. The clumsy positioning and fixing of the sword (bolted to the flat of his hand, itself not a 'hand' at all but the stub-end of a steel bar), the awkward and unrealistic position of the left arm, and the incorrect alignment of the right leg (bent rather than straight as it should be), was not corrected at this time, and the rigid construction of the body and strained alignment of the head backwards (which made it difficult for the bevor to align correctly inside the lower edge of the sallet) remained incapable of adjustment. Faults with the horse figure (predominantly anatomical) could not be corrected either, even though

these were well-known and generally accepted following the critical article published by Loades (1995). These, in fact, are only now being rectified, following the successful raising of (albeit limited) sponsorship funds.

One of the biggest problems with the rider in the 1908 display is the way in which he is perceived to actually 'wear' the armour. The component elements should of course be attached to a padded and quilted textile arming doublet reinforced with mail, but instead they were held in place with an assortment of leather straps, string, and lengths of twisted wire, over a replica mail shirt. Even the shirt itself was not authentically-constructed, being made up of alternate rows of solid and butted links rather than riveted throughout, as arguably it should have been. The dummy's lack of a proper body shape, with arms no more than rigidly-fixed steel bars, meant that in any case the garment hung unattractively and was unconvincingly loose and baggy. During the last decades of the twentieth century some small-scale attempts were made to improve the armour's appearance, and its security, but nothing major could be attempted due to lack of funding. The inauthentic leopard-skin fringe applied around the edge of the main plates of the barding by Joubert in 1908 was by now filthy with grease; it was accordingly removed in 1985 (although the rivets once retaining it were left in place), and the armour was cleaned of its constantly-yellowing smeared coating of lubricating oil mixed with 'Vaseline' petroleum jelly, a protective treatment now replaced by regular applications of micro-crystalline wax. Those elements particularly prone to being handled by the curious public (the long, pointed sabatons for example) were varnished with a clear nitrocellulose lacquer to further protect them. Inauthentic leather thonging attaching elements of armour to the dummy was replaced by flat woven shoe-laces (regarded twenty years ago as being closest in appearance to the original flat woven-textile 'arming points' that almost certainly originally secured the individual elements of armour to the wearer's arming doublet). The dirt-encrusted and grease-laden leather straps of the armour were cleaned and, where structurally necessary, replaced with long-lasting 'buff' leather. Other elements of the leather, on the horse barding particularly, were repaired and patched together as well as they could be; where no longer structurally sound, the straps were augmented with steel wire. Virtually none of this strapping was original, but even 90-year-old leather can become dangerously weakened through time. The quilted leather side-panels of the early-16th century saddle were in a bad state of repair; they were removed and replaced by modern-made ones, the originals being retained in store.

Finally, to improve the overall security of the display, items potentially at risk from theft (such as the very fine Gothic mace A978, carried on the saddle-bow) were secured with stainless-steel strapping, and a sophisticated electronic alarm was fitted. In point of fact, only once during the past 100 years has anyone attempted to steal any part of the armour. During Sir James Mann's tenure as Director, after the Second World War, a thief snatched the elegant pair of spurs from the mounted knight and dashed with them towards the exit. He was floored in the front entrance hall with a flying rugby-tackle by one of the gallery attendants, in front of Sir James himself, who apparently did not partake personally in the fracas but bellowed instead from the doorway «Good man! Hold him down, hold him down!»

Although nowadays some might say that the original display (as Sir Richard Wallace knew it) should perhaps have been retained, in the end Laking's decision to remount the armour in a much more dramatic pose was vindicated; this armour, although actually neither so fine nor as homogenous as some other surviving equestrian armours of the Gothic period (such as the superb, albeit still composite, example in the Royal Armouries at Leeds, for instance), has nonetheless become an icon, known throughout the world, its image invariably chosen to illustrate countless books on medieval arms, armour and warfare (Edge-Paddock, 1988: 127). It was largely as a result of this fame that visitors to the museum began coming here specifically to see how a 'real' 15th-century knight's armour was constructed and worn,

Fig. 7. Front and rear standing views of the armoured A21 figure dismounted from its horse, prior to the limited restoration undertaken in 1956. The earlier clumsy arrangement of couter and poldermitton can be seen on the left arm, prior to its eventual replacement by a modern-made one-piece couter matching that on the right.

but then, due to the inauthenticity of its display, in many cases leaving with entirely the wrong impression. In the late 1990s, therefore, the present armoury staff, supported by the Director and Trustees and in consultation with the recently-formed Wallace Collection International Conservation Advisory Panel, embarked upon a concerted hunt for sponsorship funding to enable the display to be radically overhauled and improved. That this work *was* eventually undertaken is due in large part to the efforts of an Armoury volunteer, Logan Thompson, and the generosity of the Esmée Fairburn Charitable Trust. Work was postponed during the major upheavals of the museum's Lottery-funded Millennium Project (the conversion of the museum's long-neglected basement into reserve collection galleries and educational facilities), but was finally begun in the summer of 2001. The nature of these improvements will form the basis for a separate report to be published at a date in the near future.

In the late 1990s a systematic programme of research on the armour was initiated by the authors of this article. A primary aim was to ascertain through optical microscopy the nature of the metal used to make it, and therefore perhaps to shed some light on which elements may have originally belonged together. The interim results of this work were collated into a short exhibition, incorporating a series of gallery talks, created for National Science Week in March 1999; this was only made possible through the generous financial sponsorship of COPUS (Committee for the Public Understanding of Science). In the course of carrying out major improvements to the A21 display, it obviously made sense to undertake close examination of the armour, taking this opportunity to pursue some further research on its construction and the materials of which it was made. This work of analysis is on-going, and further results will be published in due course.

Initially, prior to metallographic analysis, a fresh study was made of the makers' marks that the armour bears. The rear plates of the cuisses and the poleyns are both stamped with the guild mark of Landshut and an armourer's mark of «two crossed flails» (Mann, 1962: 11). The shaffron bears the Landshut mark and also an armourer's mark of a Gothic «**r**». Norman (1986: 3) points out that this mark is also to be found on an upper vambrace and right spaudler in the Stibbert Museum, Florence (3792, 3910) which are discussed below. It was also suggested in the exhibition catalogue «Landshuter Plattnerkunst» (Spitzlberger, 1975: 15) that the Gothic «**r**» was the mark of the armourer Ulrich Rämbs.

Mann (1962: 14) said that the mark of the crossed flails is on part of a Gothic armour in Berlin. However, Norman (1986: 1) pointed out that the Berlin breastplate did not in fact bear this mark, however, the mark of the crossed flails is present on the legs of a Gothic armour in Berlin. However, the source of this confusion may be that the breastplate of the Gothic armour in the Deutsches Historisches Museum, Berlin (W.1052) bears the crossed sceptres mark which is also present on a bevor in the Wallace Collection displayed as part of the composite armour A20. Quaas (1992: 49), does not mention any mark on the legs. The Berlin armour (currently in store pending re-display of the collection) is described as Landshut, but apparently by association only. Its metallurgy does not resemble that of either the legs, or the horse armour, of A21.

THE METALLOGRAPHY OF ARMOUR

This consists of the examination of cross-sections of plates of armour, after suitable preparation, by a metallurgical (reflected-light) microscope. One of the authors (ARW) has published several papers in «Gladius» and elsewhere (see refs.) on the metallographic examination of medieval mail and plate armour.

Metallography (microscopic examination) provides information about the composition of the metal; that is, whether it is iron or steel, how homogeneous it is, whether it has been

hardened by heat-treatment or not, and whether it has been worked hot or cold. What it emphatically does not do, is to enable any direct dating or provenancing to take place. Comparison of the microstructures of items of arms and armour from known and dated sources with others of unknown provenance may well lead to conclusions about the likely date and place of manufacture of the latter, but such conclusions can only be inferred from comparisons with the former. A further consideration is that the heterogeneous nature of medieval iron and steel means that a large number of specimens must be examined before generalisations can be made about the significance of individual variations.

OTHER MEASUREMENTS

Surface hardness measurements were taken on most of the main parts of the A21 armour with a Krautkramer-Branson Sonodur electronic hardness tester, to investigate the overall consistency of the armour plates (average hardness readings are given on the Vickers Pyramid Hardness (VPH) scale):

Arms: upper vambraces;	left 160 VPH,	right 290 VPH
lower vambraces;	left 256 VPH,	right 327 VPH
Legs: main cuisse plates;	left 270 VPH,	right 380 VPH
rear plates of cuisses:	left 355 VPH,	right 335 VPH
front of greaves;	left 280 VPH,	right 385 VPH
rear of greaves;	left 232 VPH,	right 320 VPH.

Thickness measurements were also recorded for most of the plates (figures quoted for thickness are averages only, based upon measurements taken in several places and quoted in mm; where appropriate the range of measurements is also given):

Upper breastplate:	1.6 mm (1.2 - 2.2)	
Lower breastplate:	1.2 mm	
Backplate:	1.5 mm (1.1 - 2.3)	
Arms: upper vambraces;	left, 1.4 mm	
lower vambraces;	left, 1.5 mm	
Legs: main cuisse plates;	left 1.2 mm,	right 1.3 mm
front of greaves;	left 1.1 mm,	right 1.2 mm
rear of greaves;	left 1.2 mm,	right 1.3 mm.
Sallet: skull	2 mm (1.9 - 2.1)	
visor	2.5 mm (2.1 - 2.8)	
brow at front of skull	4.4 mm (4.1 - 4.6)	

Horse armour:			
peytral;	left 1.2 mm,	middle 1.1 mm.	right 1.0 mm
crinet;	left 0.4 mm,		right 0.6 mm
front plate of crupper;	left 1.1 mm,		right 1.9 mm
rear plate of crupper;	left 1.5 mm,		right 1.5 mm.

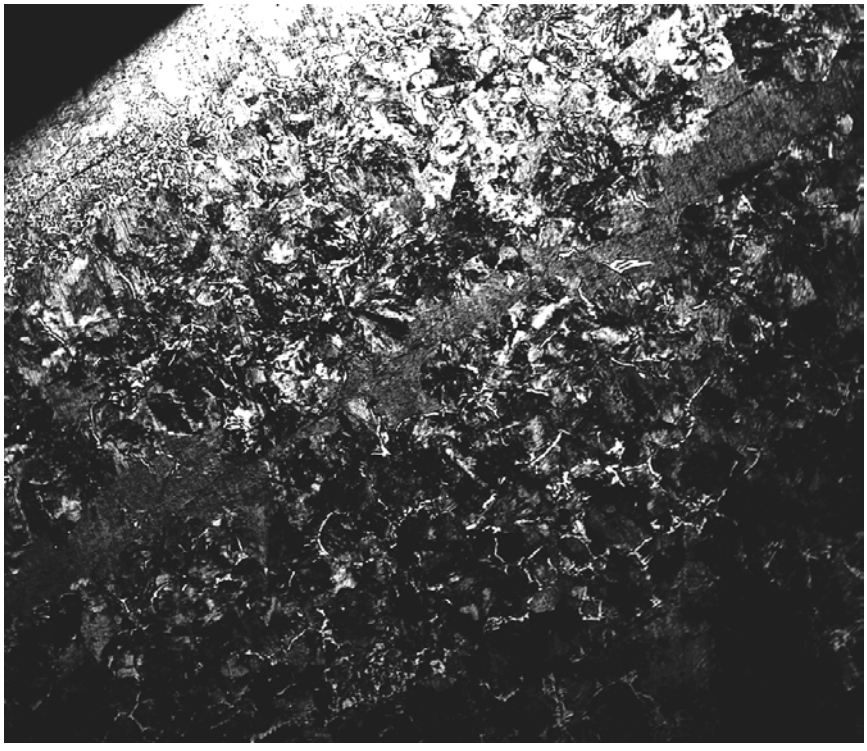

Fig. 8. Cross-section of the poldermitton, or elbow-reinforce, associated with A.21. The microstructure shows mostly fine pearlite with almost no ferrite or slag.

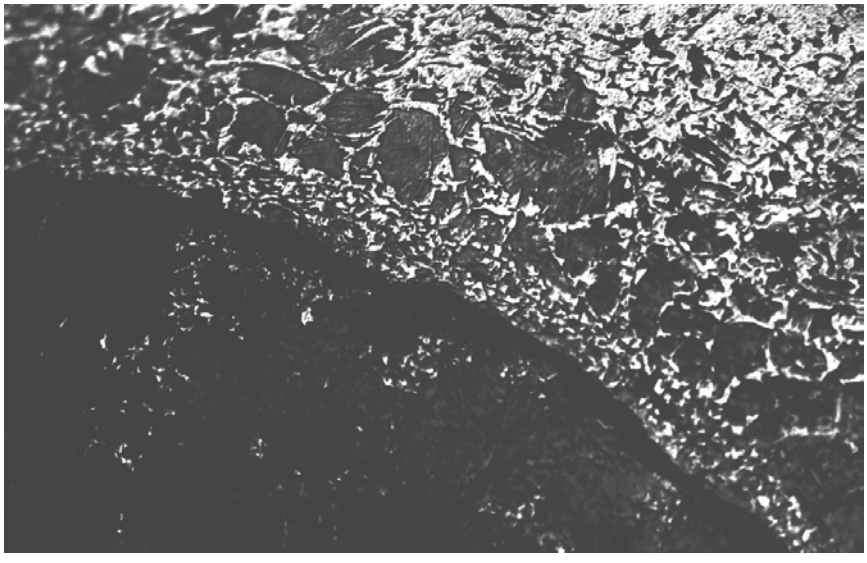

Fig. 9. Cross-section of the left lower vambrace, on the inside edge. Note the banded nature of the steel; there is a band consisting almost entirely of tempered martensite, and another (of lower carbon content) in which the tempered martensite is mixed with ferrite.

RESULTS OF METALLOGRAPHY CARRIED OUT ON ELEMENTS OF A21

KEY:

i. Ferrite F
ii. Pearlite P
iii. Slag S
iv. estimated carbon content (%)

products of heat-treatment (i.e. a final accelerated cooling to harden steel)

v. fine pearlite FP
vi. bainite B
vii. martensite M
viii. tempered martensite TM (or overtempered martensite OTM)
ix. hardness (VPH scale) units of kg/mm2

MICRO-CONSTITUENTS IN COLUMNS BELOW:

	METAL				HEAT-TREATMENT (IF ANY)				HARDNESS
COMPONENT	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.
shaffron (all 4 plates)	F	P	S	0.4%					
crinet	F	P	S	0.1%					166
besagew	F			0%					
tasset	F	P	S	0.2%					
gauntlet (right)	F			0%					
lower vambrace (left)	F		S	0.5				TM	
lower vambrace (right)	F		S	0.5%				TM	327
backplate	F		S	0%					
upper vambrace (left)	F	P	S	0.4%					
upper vambrace (right)	F	P	S	0.4%					
breastplate upper	F	P	S	0.4%					
breastplate lower	F	P	S	0.3%					229
bevor	F			0%					
peytral	F	P	S	0.3%					248
crupper (left)	F	P	S	0.5%					
crupper (right)	F	P	S	0.4%					
poldermitton			S	0.5%	FP				
left cowter	F	P	S	0.2%					
cowter (A.280)	F	P	S	0.4%					
right poleyn	F		S	0.4%				OTM	266
left cuisse	F		S	0.5%				TM	409
bevor A 193 (*not part of A21*)			S	0.5%				TM	360

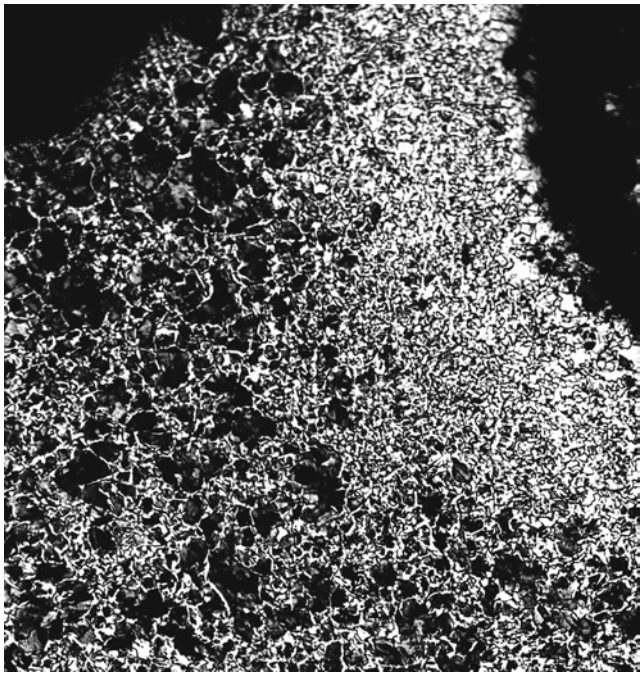

Fig. 10. Shaffron (cross-section) photomicrograph X 160. Pearlite and ferrite

Fig. 11. Cross-section of the left cowter. The microstructure consists of pearlite with a little ferrite.

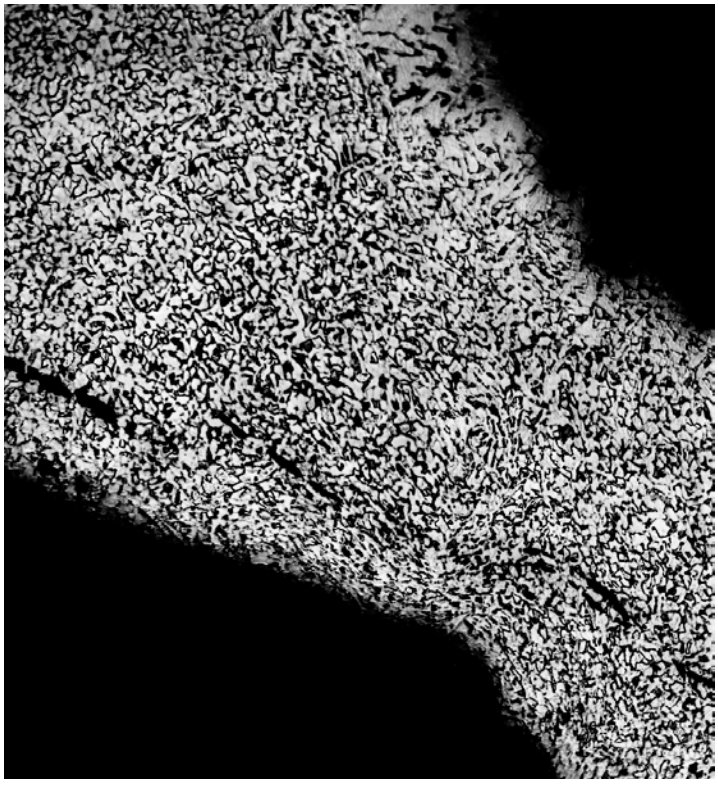

Fig. 12. Cross-section of a specimen from the peytral. The microstructure consists of pearlite mixed with ferrite.

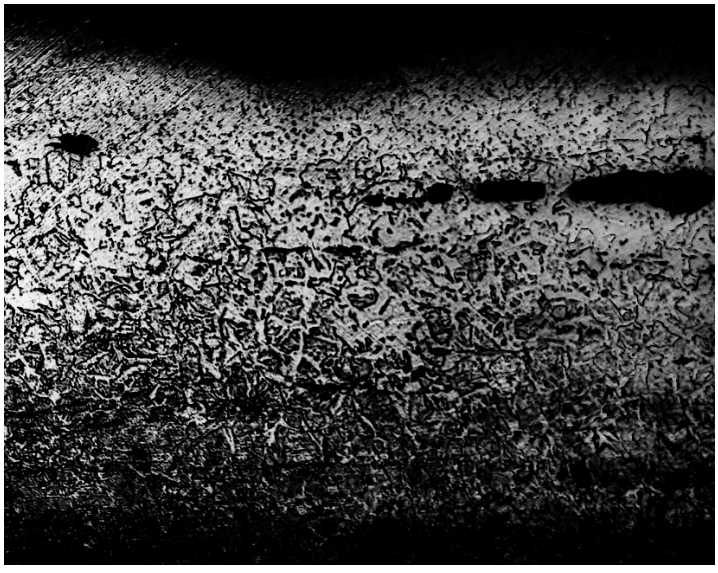

Fig. 13. Cross-section of the upper breastplate. The microstructure consists of ferrite with areas of pearlite along one side.

Related Items in Other Collections

City Museum,							
Vienna 126.710							
breastplate	F		S	0.4%	B	M	465
Berlin armour W.1052:							
breastplate	F	P	S	0.2%			189
left gauntlet	F		S	0%			
left knee							
(plate below kneecap)	F	P	S	0.1%			
left cuisse (side plate)	F	P	S	0.1%			
Stibbert 3910 (3570							
associated)							
upper vambrace	F	P	S	0.5%			258
Stibbert horse armour							
3612 peytral	F	P	S	0.7%			
3902 crupper							
(all 4 plates)	F	P	S	0.6%			

Stibbert Collection, Florence

Composite armour 3910 (some elements, e.g. the gauntlets, have inventory number 3570):

The breastplate is Italian in form and is a low-carbon steel. The backplate is German, its decoration perhaps that of Innsbruck; it is a pearlitic steel. The arms unfortunately do not belong to either of these pieces. There is a mark on the right upper vambrace, near to a repair, which resembles closely the mark ascribed to Ulrich Rämbs. The right lower vambrace is mostly pearlitic, with an average hardness 258 VPH.

EXPLANATORY APPENDIX

This study of samples of armour has been made largely by metallography; that is, by the microscopic examination of the crystalline structure of the iron or steel from which the armour was made.

Pure iron when viewed under the microscope will show white areas called FERRITE, with irregular grain boundaries. These areas are crystals containing iron atoms which are too small to be visible; since they are randomly orientated towards one another, the boundaries where the crystals meet are also random in outline.

Medieval iron («wrought iron») will show grains of ferrite and inclusions of SLAG, the latter elongated by forging. The absence of slag may be taken to indicate that the metal is modern, or dates from at least 1880 onwards, when iron was melted during extraction and entirely separated from its slag. Its hardness will be in the region of 80 - 100 VPH. Hardness measurements use the Vickers Pyramid Hardness scale, the units of which are kg.mm-2; they are carried out by lowering the point of a diamond under constant load (of 100g) onto the surface of the metal and measuring the size of the indentation.

If iron is heated in contact with carbon, then atoms of carbon are absorbed (over hours rather than minutes) to form steel. Steel is harder and stronger than iron, and can be made extremely hard by quenching (plunging red-hot into cold water). The increase in hardness and strength is because of the presence of iron carbide in the steel. Steel with only 0.3% carbon («mild steel») has a hardness of around 120 VPH and steel with 0.6% carbon (a «medium

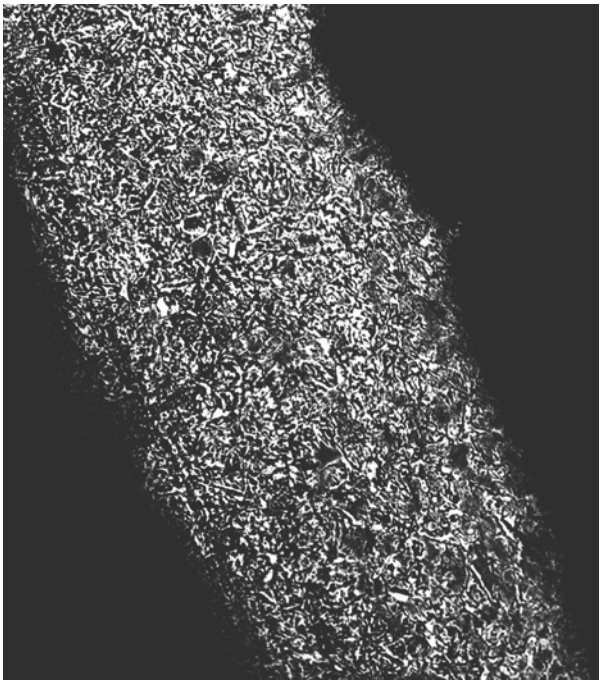

Fig. 14. Cross-section of the right crupper plate. The microstructure consists of pearlite mixed with ferrite.

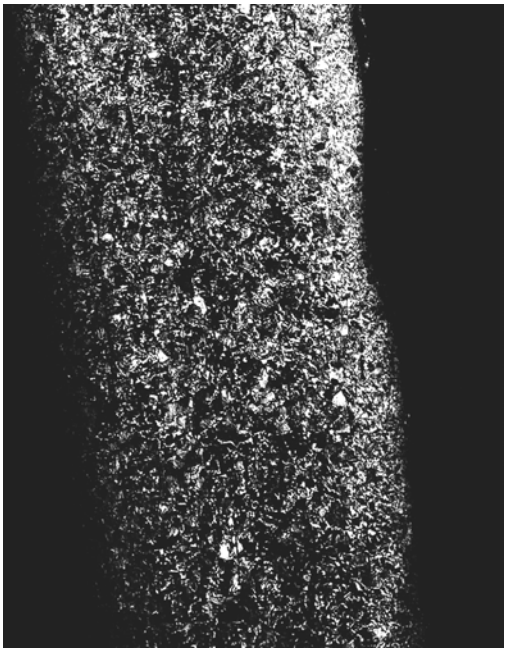

Fig. 15. Cross-section of the left upper vambrace. The microstructure consists of pearlite with a little ferrite.

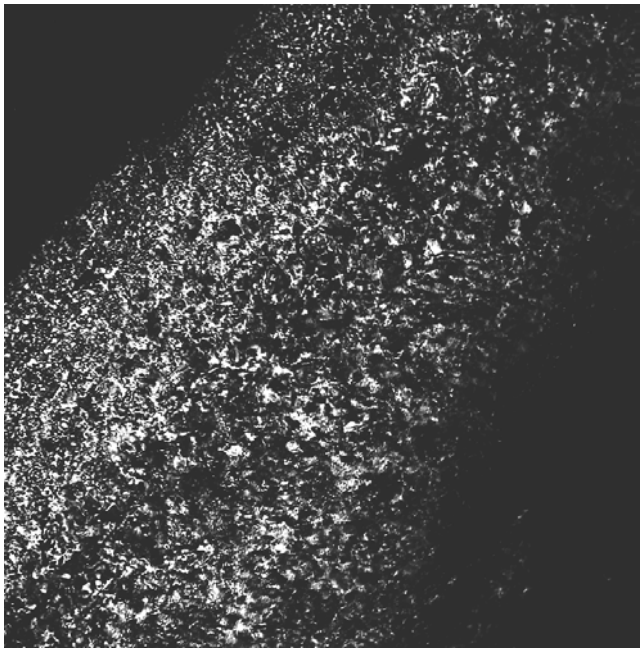

Fig. 16. Cross-section of the right upper vambrace. The microstructure consists of pearlite with a little ferrite.

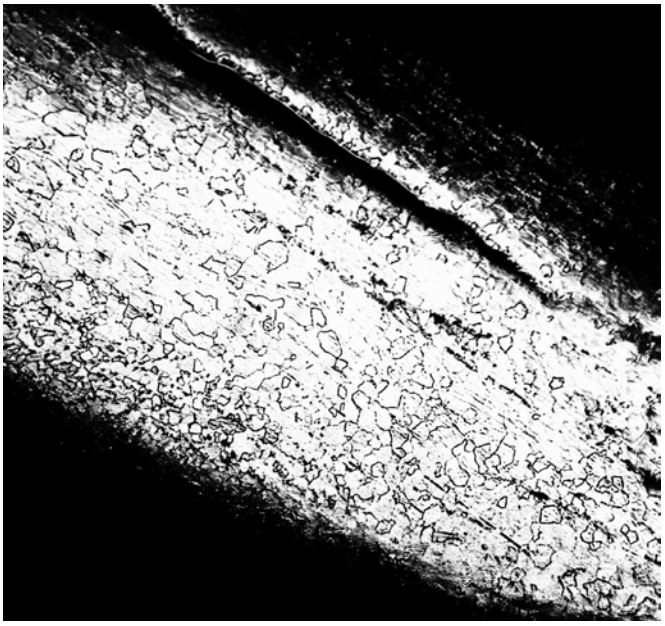

Fig. 17. Cross-section of the backplate. The microstructure consists of ferrite and a few slag inclusions only. A large corrosion crack is visible. c.f. the photomicrograph of the left cowter, which is a more complex shape and required more forging.

Fig. 18. Cross-section of the lower breastplate. The microstructure consists of ferrite with some areas of carbides.

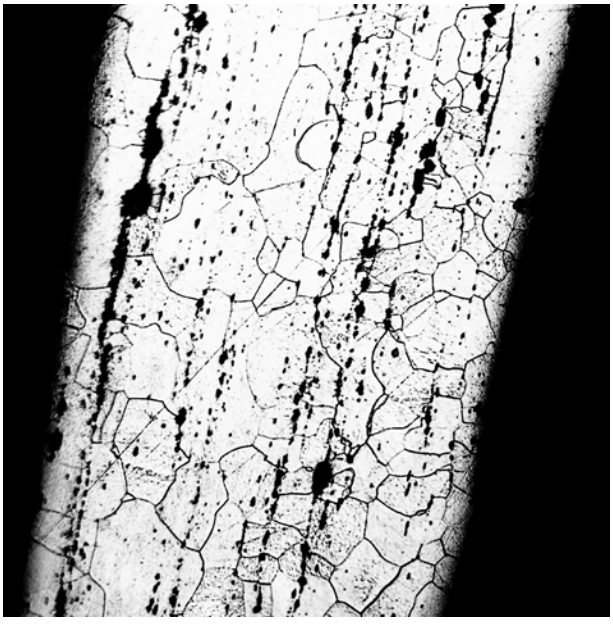

Fig. 19. Cross-section of a small finger-plate from the left gauntlet. The microstructure consists of ferrite and slag inclusions only. N.B.the regular spacing of the slag inclusions.

carbon» steel) has a hardness of around 200 VPH, but quenching might increase this to 800 VPH. If after forging, a steel is allowed to cool in air then the iron carbide forms as a material of lamellar appearance called PEARLITE.

If the rate of cooling is too fast for the separation of pearlite, then other crystalline products may form:

(1) FINE PEARLITE, almost irresolvable, (whose typical hardness might be 300 VPH).
(2) a material of acicular appearance harder than pearlite, called BAINITE (whose hardness might be 400 - 500 VPH).
(3) very rapid cooling may form MARTENSITE, a material of lath-like appearance and great hardness. Much depends on the carbon content and the dimensions of the object being treated, but quenching in water generally results in such rapid cooling that an all-martensite structure is obtained (this is called «full-quenching»). This is extremely hard, but brittle and prone to cracking. Quenching in oil, molten lead, or some other fluid which will lead to a less drastic rate of cooling than water, may produce a mixture of microconstituents - pearlite and bainite as well as martensite, which will be less hard and less brittle -as may an interrupted or delayed quench (such procedures are collectively called «slack-quenching» and are nowadays rarely used).

The customary modern procedure for hardening a plain carbon steel is to fully quench it, and then to reheat it carefully to «temper» it. Tempering causes the carbon dissolved in the martensite to come out of solution as minute particles of iron carbide (TEMPERED MARTENSITE). This reduces the hardness of martensite somewhat, but by removing most of the internal stresses, it reduces its brittleness and hence increases its impact strength. If tempering is continued for too long, and the iron carbide particles grow excessively in size to form carbide globules in a ferrite matrix, then an OVERTEMPERED MARTENSITE inferior in hardness and strength to a pearlitic structure will be obtained.

CONCLUSIONS

The components of the A21 armour for man and horse may be divided up into the work of at least four (or more) craftsmen, in decreasing order of metallurgical sophistication:

1. The forearms and the leg defences were made by a master craftsman probably of Landshut, who used steel and successfully hardened it by quenching and tempering. This is a sufficiently uncommon procedure in Germany at this time to suggest a common origin for these pieces. Matthias Deutsch was a contemporary Landshut craftsman who made the unassociated 'Gothic' bevor in the Collection (A193), which is also made of steel hardened by quenching and tempering. It is extremely tempting to suggest some family connection between the master of the crossed flails and Matthias Deutsch, but in the absence of any other evidence, such an attribution can only be speculative.

2. The poldermitton is made of a medium-carbon steel, and an attempt has been made to harden it, by an accelerated cooling. This was the work of a skilled craftsman, but one who did not employ the same procedures as no.1 or no.3. Stylistically, moreover, the poldermitton almost certainly does not belong with this field armour, but has been added to it (conceivably in the 19th century). Judging from its form, it could well have come from a joust armour («Stechzeug») of slightly later date than A21.

3. The different parts of the horse armour are mostly made out of steel, but not hardened. They are of a generally similar composition to one another, so it seems reasonable to con-

clude that these might all be the work of Ulrich Rämbs (assuming that he was master «**r**»), whose mark appears on one of the plates of the shaffron.

The upper arms were both made by a craftsman who did use steel but was unable (or chose not) to harden it; it seems at least possible therefore that these are also the work of master «**r**».

The arm-defence and parts of a horse armour in the Stibbert Collection, Florence, are also made out of medium-carbon steels, and since one component bears the mark of master «**r**», this confirms that he used steel regularly for his armours. It is not impossible that he made both horse armours.

4. The backplate is made of totally different and inferior metal. Despite the very high quality of the workmanship (the pointillé decoration upon the triangular plate at the back of the neck being particularly fine), it was made out of wrought iron, and is quite different to the rest of the armour.

Both parts of the sallet, the upper part of the breastplate and the left couter are made of low-carbon steels which metallurgically-speaking could have originated anywhere in medieval and early modern Europe. Stylistically, however, they are likely to have been produced somewhere within the German lands.

The work of the master of the crossed sceptres, if indeed he was also a Landshut armourer, bears little relationship to that of any of the masters 1-3.

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