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Assessment of residues from Trellech (MH/AE/20)

Dr Tim Young
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Dr T.P. Young

Abstract

The submitted material comprised five bulk samples containing archaeometallurgical residues. Two of the deposits were apparently of burnt fine grained sediment, one dominantly of fine degraded charcoal and two were mainly formed by slag.

The metallurgical residues from each of the samples were almost entirely those from iron smelting in a slag-tapping bloomery furnace. In each sample there were some microresidues from smelting, but only in sample <2> from context (2003) did those exceed trace background levels.

The tapslags in contexts (1007), (3003) and (3006) were dominantly very dense slags, with fairly low vesicularity, mostly forming simple flows (with little disruption of inclusion of pre-existing tap slag clasts). Such slags are comparable with those from previous work in Trellech, and to a large extent with those of (probably) late 13th century date from recent work in Lydney (although the Trellech assemblage lacks the large flat-topped slag cakes found there).

In contrast those from context (2005) were paler, more vesicular and showed a greater prevalence of disruption and inclusion of pre-existing flow fragments. In part, these differences may be associated with a different post-depositional environment, but a different tapping regime may also be implicated. The incorporation of pre-existing tapslag fragments in various orientations is a feature of the tapslags of large later medieval furnaces, so this textural evidence might, speculatively, imply a slightly later date.

Alongside the tapslags, residues included prills, droplets and charcoal-rich slags that may have cooled inside the furnace. There were also several fragments of highly vitrified furnace lining.

Smithing microresidues were present in very small quantities alongside the smelting slags in all samples. Only in context (2003) was a significant quantity present, comprising both mostly very fine flake scale and some spheroidal hammerscale. The unusual heat-affected stone structure may possibly be the foundation for a chimney for a floor-level hearth.

Fragments of fine-grained goethite iron ore were recovered from the assemblages of contexts (1007), (3003) and (3006). These ores includes a few fragments of stalactitic ores (sometimes associated with ruddle), but most particles were of a dense, fine, grey ore with thin seams of botryoidal texture and a conchoidal fracture. All the fragments found were of a form and size (<25mm) likely to indicate they were accidental losses of furnace feedstock. Such ores are typical of the Bristol Channel Orefield, including the Forest of Dean.

A large (332g) block of silicified ore from context (2005) was an unusual lithology, rich in subhedral quartz crystals. It would appear likely that this is a deliberate discard of an iron-poor rock, associated with the ore, but not itself of suitable grade. Such lithologies are not known from the Forest of Dean but may be present in the Somerset and certainly in the Glamorgan sectors of the orefield. This block is potentially a significant piece of evidence for the movement of ores to Trellech from sources other than the Forest of Dean.

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Methods

The five submitted samples were initially wet sieved at 10mm. In the case of sample <2> the flot was removed from the fines and dried. The retents were further scrubbed clean for investigation. The fines were then wet sieved at 90μm. The retents at this mesh were dried and then separated with a magnet. The fines at this mesh were discarded.

All materials were examined visually, using a low-powered binocular microscope where required. As an assessment, the materials were not subjected to any high-magnification optical inspection, not to any form of instrumental analysis.

The identifications of materials in this report are therefore necessarily limited and must be regarded as provisional.

This assessment was conducted in January 2021 and was commissioned by Iestyn Jones.

Description of the assemblage

General

The submitted material comprised five samples from contexts containing archaeometallurgical residues.

The assemblages were united in being dominated by residues associated with the smelting of iron in slag-tapping bloomery furnaces. The microresidues included small amounts of hammerscale from smithing, but the macroscopic residues included no recognisable smithing slag.

Description of the samples

Sample <1> from context (1007)

This sample was of a fine texture sediment, with a reddish colour. The fines (90μm – 10mm) comprised a total of 586g (in this and subsequent descriptions this refers to a size fraction of the sediment, in each case dominantly a pinkish sand, the metallurgical component of the fines is described where appropriate), and discrete clasts just 104g.

Iron ore was represented by five sharp shards (1.83g) of fine-grained grey goethite ore with thin botryoidal seams, one ruddle fragment (0.03g). one piece of stalactitic ore with ruddle between the stalactites (0.25g), four fragments (1.37g) of browner (weathered?) stalactitic ore (3.47g in total).

The magnetic pickings (16g) from the fines include traces of both flake and spheroidal hammerscale, together with some small ore fragments and comminuted slag debris. The non-magnetic fines were dominated by gritty pink sand with some decayed sandstone particles, with some charcoal (570g).

Macroscopic slags included an 88g well-preserved dense fragment possibly from a runner, 12g of small fragments, including tapslags and rusted residues and 10g (18 fragments) or fired clay/furnace lining. Six stone fragments (sandstone) weighed 10g. There was a single tiny fragment of coal.

Sample <2> from context (2003)

This sample was dominated by dark carbonaceous material, representing rather poorly preserved charcoal. 160g of finely divided charcoal was extracted from the sample by flotation. The fines (90μm – 10mm) comprised a total of 94g, and discrete clasts just 68g.

The fines included 18g picked magnetically, that contained a significant quantity of hammerscale. This would not qualify as a major abundant sample of scale but was significantly more scale-rich than in the other samples. There was a moderate assemblage of mostly very fine flake hammerscale (FHS) and some spheroidal hammerscale (SHS). There was 76g of non-magnetic fines.

The discrete slag inclusions were mostly very small and fragmentary, totalling 46g of slag. All recognisable fragments were tapslag.

There was also 22g of small concretionary lumps. These appeared to have a ferruginous cement and mostly bound charcoal fragments. A few contained hammerscale and comminuted slag.

Sample <3> from context (2005)

This sample had a pale, charcoal-bearing matrix, of what appeared to be ashy origin, but as dominated by large inclusions. The inclusions frequently carried a pale, lime, coating, possibly indicative of post-depositional precipitation within void spaces. The fines (90μm – 10mm) comprised a total of 146g, and discrete archaeometallurgical clasts 3732g, with 46g of natural stone.

The dominant inclusion type was moderately dense tapslag, with moderate vesicularity, a pale internal colour and very commonly a complex form and/or inclusions of tapslag fragments (25 pieces, 3260g).

The sample produced some 140g of fine and/or unidentifiable slag fragments.

This collection includes a large block (332g) of silicified iron-rich rock, with coarse (up to approximately 800mm) subhedral quartz. The rock includes areas of less quartz rich goethite ore and one face of the block comprises a stalactitic facies, again strongly replaced by subhedral quartz. Parts of the surface of the block are coated by ruddle.

Of the fines, 16g were magnetic, mostly of indeterminate ferruginous material with comminuted slag, but also bearing a small quantity of hammerscale, both flake and spheroidal.

Sample from (3003)

This sample included the only substantial fragment of slag in the collection. The fines (90µm – 10mm) comprised a total of 146g, and discrete archaeometallurgical clasts 3288g, with 18g of natural stone.

The slags included a 2135g plano-convex block of tapslag (140mm long, 220mm wide). The rear face of this block showed some reddened lobes, with only a small area of fracture. This may indicate that the block formed a discrete tapped flow. The flow lobes were dull, large and of high convexity. The base comprised sheets of dimpled slag (suggesting cooling against a fuel or ash surface). A further nine fragments of dense tap slags of similar character (608g) were also present.

In addition to the tapslags, there were three fragments (380g) of charcoal-rich furnace slag and two substantial fragments of deeply vitrified furnace lining (164g). The was also 4g of very small slag fragments including 4 slag spheroids.

There were four pieces (1.02g) of grey goethite ore. This was very fine-grained with a conchoidal fracture and thin veins (<1mm thick) of botryoidal texture.

There was 130g of non-magnetic fines, and 16g of magnetic fines (including traces of both FHS and SHS).

Sample from (3006)

The fines (90µm – 10mm) comprised a total of 1014g, and discrete archaeometallurgical clasts 4330g, with 20g of natural stone.

This was a large sample, dominated by dense tapped bloomery slags (180 pieces, 2890g), with a significant quantity of fragments of vitrified furnace lining (13 pieces, 202g), but with a low proportion of lower-density tapslags (14 pieces, 278g). The residues possess a wide range of grain size from 100mm (a fragment of tapslag weighing 262g) down to sub-millimetre fragments. The sample produced some 936g of fine and/or unidentifiable slag fragments.

Although the majority of the smaller pieces were comminuted debris from tapslags, small individual particles, particularly slag spheroids, were also present.

The greater than 10mm fraction included 6 fragments of high-grade iron ore (weighing 10.9g, 2.5g, 5.4g, 1.9g, 1.2g, and 3.0g; total 23.7g).

There were a small number of fragments showing 'rusty' concretionary overgrowths, mostly with botryoidal dark coatings (34 pieces, 146g). Rusted particles formed a higher proportion of the magnetic fraction of the fines.

Hammerscale was almost absent, with just a few tiny flakes of thin flake scale and small spheroids that were probably spheroidal scale and not slag droplets.

The tapslag showed upper surfaces with well - developed convex, often broad, flow lobes, with a dull grey-maroon surface. The bases of the flows showed a fine dimpling, suggesting flow over fuel/ash.

Despite the sample being labelled 'slag & gravel?' only 20g (5 pieces) of stone occurred in the >10mm fraction. The fines fraction was dominantly a slightly pinkish-coloured sand, rich in rusty fragments and comminuted slag debris. The fines totalled 1014g, from which 60g of magnetic residue were extracted (but only from half the total fines collection).

Interpretation

Iron smelting residues

The macroresidues from iron smelting were mostly dense tapped slags in small to medium-sized fragments. Only one block formed a substantial proportion of a flow (a 2135g block from context (3003). These materials were similar to those of 13th – 14th century age recorded from previous excavations in the NW of Trellech.

The slags in context (2005) were very slightly less dense, of a pale colour, of a slightly higher vesicularity and very commonly showing disruption or inclusion of pre-existing flow fragments. The preservation of this material was different from that of the slags from other contexts, but the morphology does appear to have genuine differences with the more conventional tapslags from other contexts. A high degree of disruption and inclusion is usually a feature of furnaces with a high slag output. Well-preserved 11th-13th tap slag assemblages tend not to show these features, whereas late medieval and earliest post-medieval assemblages from sites such as Mwyndy (pers. obs.). It is thus tempting, although far from certain, to interpret the material from (2005) as deriving from a larger, and potentially later, furnace than the assemblages from (3003 and (3006).

The preservation of the smelting slags was variable. Although all were fragmented (this slags tend to fragment easily after cooling), those in context (3006) were particularly comminuted, perhaps by treading.

Ores

It must be remembered that the Trellech area possesses no iron ores itself. The iron smelting centre appears to have been founded by the de Clare lords of Glamorgan to smelt iron ores from the Forest of Dean, just a few kilometres to the east across the river Wye. Fragments of fine-grained goethite iron ore were recovered from the assemblages of contexts (1007), (3003) and (3006). These ores includes a few fragments of stalactitic ores (sometimes associated with ruddle), but most particles were of a dense, fine, grey ore with thin seams (c. 0.5mm) of botryoidal

texture and a conchoidal fracture. Such ores are typical of the Bristol Channel Orefield (sensu Young & Thomas 1998, 1999, Young 2001), including the Forest of Dean. Detailed analysis would be required to prove which sector of the orefield produced these ores, but the most likely origin is Dean.

All these fragments found were of a form and size (all <25mm) likely to indicate they were accidental losses of furnace feedstock. Only one fragment appeared to have possibly been roasted; none of the others showed shrinkage cracking or reddening to suggest they had been roasted. This might suggest that either the ore was used unroasted or that it broken to size prior to roasting.

A large (332g) block of highly silicified ore from context (2005) was an unusual lithology, rich in subhedral quartz crystals. It would appear likely that this is a deliberate discard of an iron-poor rock, associated with the ore, but not itself of sufficient grade to be smelted. Such lithologies are not known from the Forest of Dean (Sibly 1919, did record minor quartz in an ore body in the Lower Dolomite at Red Hill Quarry Lydney, and chemical analyses of some ochres suggest the presence of very fine quartz) but are possibly present in the Mendips and are certainly to be found in the Glamorgan sector of the orefield. This block is potentially a significant piece of evidence for the movement of ores to Trellech from sources other than the Forest of Dean.

Iron smithing microresidues

Hammerscale appears as a minor element of all the fines assemblages and occurs above trace levels only in the assemblage from context (2003). This may imply that this charcoal deposit is waste from a smithy or from initial bloom compaction at the furnace, but the scale evidence is not conclusive.

The structure

The residues were associated with a stone-built structure or footing, of tapering form in plan and with intense heat alteration to the wider end. No precise analogue for this is known, but the form raises an interesting possibility that this might represent a low-level smithing hearth (particularly in view of the nearby charcoal deposit (2003) containing smithing microresidues).

Early smithing hearth are mainly simple cut features, often with a low clay wall separating the hearth from the bellows. By the late medieval period two major developments occurred in smithing – one was to raise the hearth to 'waist level' so the smith worked standing-up instead of crouched or kneeling on the floor. The second was the introduction of a hood and chimney above the hearth to draw the hot gasses away. This latter development was associated in part with changes to the design of buildings in general and the reduced use of a tall open hall and permeable thatch, in favour of storied buildings and tiled roofs.

In this case, the stone footing could be for the bellows for the hearth, but might perhaps better be interpreted as the footing for a wall (perhaps rather buttress-like) to carry a hood and chimney above the hearth, in what might otherwise have been a timber structure. Although such structures are best known in association with waist-level hearths, it could be argued that some illustrations (e.g. that illustrated in the 'Romance of Alexander' of 1338-1344; Figure 1) might depict isolated chimneys above floor level hearths – providing a potential analogue for the Trellech example.

The occurrence of some smelting residues adjacent to the structure may simply reflect their ubiquity in medieval deposits at Trellech.

Discussion

The interpretation of the siliceous ore block from context (2005) as almost certainly deriving from an origin outside the Forest of Dean is significant. The arguments for the origins of quartz-bearing iron ores have been presented by Young & Thomas (1998 and 1999) in the context of discussion of the origin of the cargo of the Magor Pill boat (a vessel built c.1240 that foundered near Magor with a cargo of iron ore; Nayling 1998). Young & Thomas suggested, on the balance of various lines of evidence, that the ore came from the orebodies in the southern limb of the South Wales syncline, somewhere between the Taff Valley area and Llanharry (contrary to the earlier suggestion that the ores came from Somerset; Allen 1996). They speculated that the ore might have been *en route* to Trellech, although medieval iron-making was undertaken elsewhere on the Severn Levels.

The present quartz-rich lithology, most likely a replacement of a dolomitised limestone, but possibly in part replacing an iron ore, can be closely paralleled by specimens in the GeoArch collections from Cefnyrhendy (from trial workings immediately west of the Bute Mine) and from deposits of waste from ore preparation at the Roman iron-making site at Caergwanaf, which is believed to have smelted ores from the area of the later Bute and Mwyndy mines.

The presence of quartz within, and associated with, the ores of Mwyndy was noted as early as the 1850s (Watson 1859; Vivian 1872, 1876, 1877, 1885), soon after the reopening of the mine. Very high silica ores are commonly recorded on the sites of early smelting of this ore (e.g. Caergwanaf, School Road and Rhiwsaeson) with silica contents of up to 40%. These were presumably spotted in the final stages of ore preparation and discarded. Despite this discard of very high silica ores, the furnace feed on the early sites close to Mwyndy was still very siliceous, leading to smelting slags with silica to alumina ratios averaging 48 at School Road.

It may be relevant that one block of ore from the Magor cargo (sample M107), interpreted as a fragment of dolomite wall-rock in the initial assessment of the cargo, returned an analysis with 76.5% SiO_2 and 15% Fe_2O_3 (and very little else), indicating that it was actually of a highly silicified lithology. No detailed lithological observations were, however, recorded for this piece, so it is not known how closely it matches the present example, but does at least demonstrate that some unsmeltable silicified material was shipped with the cargo (this piece should, however, be amongst the collection accessioned to NMW and thus available for restudy).

Young & Thomas (1998 and 1999) suggested that the cargo was produced, probably from the Mwyndy area, during the period between the initial absorption (or re-absorption) of the area into the de Clare lordship of Glamorgan, following the acquisition of Meisgyn and Glynrhondda in 1246. The Tewkesbury Annals record the discovery of iron by Gilbert de Clare, Earl of Gloucester, in 1228 and in 1282. It would seem

unlikely that a substantial iron industry (with its supporting charcoal production) could have been sustained in this contested area, hence the transport of the ore to Trellech (where the de Clares had already started facilitating the smelting of Forest of Dean ores (Redknap & Young 1998). The Trellech operation was operated on a very different basis but may have been seen as paralleling the operation of the royal arsenal at St Briavels, just across the Wye Valley, and only fractionally nearer to the Dean ore sources.

The slags that accompany the silicified 'ore' in context (2005) have been noted above as having subtle textural differences with those of the other contexts (and with material previously recorded from Trellech). It was suggested above that this might indicate a different slag management regime. Such a change might be necessitated by a change in furnace type or size, but also perhaps might occur because of a change in slag viscosity brought about by slightly different slag chemistry. Thus, the different slags in context (2005) might be the product of a different (later?) furnace design, but might, conceivably, be due to the use of a different ore. Could this, as suggested by the silicified 'ore', be a switch to the use of Glamorgan (high silica) ore, rather than usual low silica, dolomitic ore from Dean?

Further work

The key outcome from assessment of the residues is the identification of a block of ore, a quartz-rich discard, that is likely to have originated in the Glamorgan sector of the Bristol Channel Orefield. Obtaining further evidence to support this observation would be important, for it may provide a 'smoking gun' in support of the hypothesis of the supply of ore from Glamorgan sources to Trellech suggested in the investigation of the Magor Pill boat some twenty years ago. The investigation of this piece could take the forrm of a full elemental analysis (major and trace elements) with petrographic investigation under the SEM.

As a rather loosely dated collection of smelting slags not associated directly with a furnace, the smelting residues would normally be considered as having low research potential, but the relationship of the slags to ore fragments and their provenancing evidence, raises the significance of the slags. Since the slags of context (2005) (which contained the probable Glamorgan ore fragment) are visually different to those of the other contexts, analysis of representative material would assist with the determination of whether ore source is detectable in these slags. It is suggested that analysis of a representative tapslag from each of contexts (2005) and (3006), and of a piece of iron ore from (3006) is also undertaken to compare with that of the siliceous iron ore from (2005)

The residues should be considered as being of high potential for inclusion in a deposited site archive.

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Table 1: summary catalogue of materials. Weights in g.

Context	Sample	Fines wt. (magnetic)	Fines notes	Macro-residue wt.	Macro-residue notes
1007	<1>	586g (16g)	Magnetic fraction includes traces of both FHS and SHS, together with some small ore fragments and comminuted slag debris. The non-magnetic fines were dominated by gritty pink sand with some decayed sandstone particles, with some charcoal. Iron ore was represented by five sharp shards (1.83g) of fine-grained grey goethite ore with thin botryoidal seams, one ruddle fragment (0.03g). one piece of stalactitic ore with ruddle between the stalactites (0.25g), four fragments (1.37g) of browner (weathered?) stalactitic ore (3.47g in total).	104g	88g well-preserved dense fragment possibly from a runner, 12g of small fragments, including tapslags and rusted residues and 10g (18 fragments) or fired clay/furnace lining
2003	<2>	94g (18g)	There was a moderate assemblage of mostly very fine flake hammerscale (FHS) and some spheroidal hammerscale (SHS). This sample was dominated by dark carbonaceous material, representing rather poorly preserved charcoal. 160g of finely divided charcoal was extracted from the sample by flotation (and is thus in addition to the weighed fines).	68g	Mostly very small and fragmentary; all recognisable fragments were tapslag. There was also 22g of small concretionary lumps.
2005	<3>	152g (16g)	Magnetic fraction includes traces of both flake and spheroidal hammerscale, but mostly comminuted slag and indeterminate ferruginous material.	3732g	Moderately dense tapslag, with moderate vesicularity, a pale internal colour and very commonly a complex form and/or inclusions of tapslag fragments (25 pieces, 3260g). 140g of indeterminate slag fragments. A large block (332g) of silicified iron-rich rock, with coarse (up to approximately 800mm) subhedral quartz.
3003		146g (16g)	Magnetic fraction includes mostly comminuted slag, but some flake and spheroidal hammerscale.	3292g	Dense tapslags (2743g, including a 2135g block), 380g of charcoal-rich slag, 4g of small slag fragments, 1g of iron ore.
3006		1014g (60g)	Magnetic fraction includes slag debris, including droplets, with traces of hammerscale.	4330g	Dense tapslags 2890g, 180 pieces and lower density tapslag 278g, 14 pieces, plus 936g unidentifiable slag fragments; 23.7g of goethite ore.

Figure 1. A floor-level smithing hearth, with smiths working at small anvils. From “The Romance of Alexander” in French verse, with miniatures illustrating legends of Alexander the Great and with marginal scenes of everyday life, by the Flemish illuminator Jehan de Grise and his workshop, 1338-44, Bodleian Library, MS. Bodl. 264, folio 84 recto.

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geoarchaeological, archaeometallurgical & geophysical investigations

Unit 6, Block C,
Western Industrial Estate,
Caerphilly,
CF83 1BQ

Office: 029 20881431
Mobile: 07802 413704

E-Mail: Tim.Young@GeoArch.co.uk
Web: www.GeoArch.co.uk