Archaeological Evaluation on land at Upper Belgrave Road Normacot Stoke-on-Trent Staffordshire NGR SJ 9197 4234

Planning Application No: SOT/48875

Site Code: UBR 09

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Produced for

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Non-technical summary.

Prior to the residential development of the site, Stoke-on-Trent Archaeology undertook the archaeological evaluation of a parcel of land off Upper Belgrave Road, Normacot, Stoke-on-Trent, Staffordshire (NGR SJ 9197 4234). The site was the former location of Normacot Vicarage, a 19th-century building allegedly converted from a 17th-century inn, and lay adjacent to the former Meir Heath ironworks, which was probably in operation from the late 16th to mid 18th century.

The evaluation was carried out between the 26th and 29th May 2009. It involved the excavation of three trenches, two of which were targeted on the remains of the vicarage and the third sited to investigate any evidence of the former ironworks within the south of the site. Very little structural and no artefactual evidence of the former vicarage or its occupants was found during the course of the evaluation, as it appeared that the demolition of the building had been extremely thorough. Although no structures pertaining to the Meir Heath ironworks were encountered on the site, evidence for metalworking activity in the form of blast furnace slag was found in abundance. The recovery and analysis of this material indicated that the furnace relied on charcoal as its fuel source and used a limestone flux, both typical factors of 17th- or 18th-century blast furnace slag. No evidence of coke being used as a fuel was identified, implying that the furnace was never converted from charcoal firing.

1.0 Introduction

1.1 The development area (DA) on Upper Belgrave Road is in the residential suburb of Normacot, located at the south-east end of Longton, the most southerly of the six towns that comprise the modern city of Stoke-on-Trent (Fig. 1). The DA was formerly occupied by a vicarage that was converted in the 19th century from an inn. Immediately adjacent to the DA is the historically important site of a post-medieval ironworks.

2.0 The development area

2.1 *Planning background*

2.1.1 An application for planning permission by Frank Haslam Milan (West Midlands) Ltd. on behalf of Staffordshire Housing Association to redevelop the DA with sheltered residential accommodation was registered with the Local Planning Authority (LPA), Stoke-on-Trent City Council, on 12th September 2008 (ref. SOT/48875). Consent was granted on 29th April 2009 with an attached condition from the LPA's Planning Archaeologist (Boothroyd 2009) recommending an archaeological evaluation of the site in advance of development.

2.1.2 The condition was applied in accordance with the Local Development Framework, which protects archaeological remains within the Saved Staffordshire and Stoke-on-Trent Strategic Plan Policies *NC14: Sites of Archaeological Importance* and *NC15: Sites of National Archaeological Importance.* It also conformed to national guidelines established in *PPG 16 (Archaeology and Planning, 1990)* (now superseded by *PPS5*).

2.1.3 An archaeological evaluation, as defined by the Institute for Archaeologists (IfA), aims to establish the extent, preservation and character of any archaeological features or deposits on the site. Stoke-on-Trent Archaeology (SOTARCH) was commissioned by Frank Haslam Milan to undertake the project.

2.2 *Site location*

2.2.1 Normacot nestles in a triangle of land approximately 2.0km south east of Longton town centre, bounded by Uttoxeter Road (the A50 trunk) to the east, Lightwood Road to the west and Upper Belgrave/Meir Roads in the south (Figs. 1 & 2). Upper Belgrave is a secondary road that extends on a south west – north east axis between the suburbs of Dresden and Meir.

2.2.2 The DA is centred on Ordnance Survey (OS) National Grid Reference (NGR) SJ 9197 4234 and is situated on the south side of Upper Belgrave Road, prominently located on the corner with Watery Lane. Opposite the DA to the south west is Longton Cottage Hospital while south east of the site are private residences on Watery Lane. Adjoining the north-east side is the graveyard and Grade II Listed parish church of the Holy Evangelists.

2.3 ***Site character and topography***

2.3.1 The DA is an overgrown brownfield site extending to a gross area of approximately 0.54 hectares (1.33 acres). It is a rectilinear area, aligned NW-SE, generally flat and lying at an elevation of approximately 168.0m aOD.

2.3.2 The area is bound by a sandstone retaining wall to the north west and south west, which continues as a brick wall in the south, while the perimeter with residential properties in the south east and east is defined by wooden panel and chain link fencing. The demarcation with the churchyard to the north east is open, except for a line of small trees. The boundary to the north west and south west is also characterised by a belt of mature trees.

2.4 ***Geology and ground conditions***

2.4.1 Surfacing at the site comprises a brown, gravelly sandy clay topsoil extending in depth to between 0.40m and 2.00m below modern ground level and overlying a layer of made ground consisting of a mix of sandy, gravelly clay that varies between 0.55m and 2.00m in thickness, with inclusions of brick, concrete, slag and ash (Edge 2009). Underlying the made ground is undisturbed natural represented by a drift of glacial silt, sand and gravel till deposited in the Devensian ice age (*c.*70-11000 years BP).

3.0 Archaeological and historical background

3.1 ***Early history***

3.1.1 There is no reference in the Stoke-on-Trent Sites and Monuments Record (SMR) of archaeological finds or deposits within the DA. Approximately 800m north, however, is Uttoxeter road, which follows the course of the Roman route (Rykneld Way) from Derby to Chester and an significant AD 3rd-century coin hoard (SMR Primary Record

Number 01222) discovered on Lightwood Road is indicative of Romano-British activity in the area.

3.1.2 There is also no record of Anglo-Saxon/medieval remains in the vicinity, although the first documented reference to Normacot is in 1086, when the Domesday survey recorded it in the possession of Richard the Forester (Williams & Martin 2002, 685). In 1223 Normacot was gifted to the Cistercian monks of Hulton Abbey who established sheep farming on the heaths (SRO, D593/B/1/23/2/6). It is likely therefore that during the medieval period the DA lay within an unenclosed pastoral landscape which formed part of Longton manor.

3.2 ***The blast furnace***

3.2.1 The history of the post-medieval manor and the furnace at Normacot (often cited as the Meir Heath works) are inextricably linked. The estate was acquired in the 16th century by the Leveson family of Trentham, who in *c.*1580 leased out a plot of land north east of the Longton-Stone and Meir-Blurton road junction, now represented by Lightwood Road and Upper Belgrave/Meir Roads respectively. The lessee, John Oldcotte, established a blast furnace for iron smelting on this land (PRN 04386).

3.2.2 By 1591 Longton manor was held by John Hunt and on his death in 1600 he was succeeded by his son, Thomas, who was described as an 'ironmonger' when he was declared bankrupt in 1649 (Young & Jenkins 1963, 230). Title deeds dated to 1647 reveal that the Normacot furnace was already known as *Baggaley's Smithies* and that the works incorporated the Whitewall, Ludwall and Munkeswall springs and the woods at Lightwood (SRO D593/B/1/20/4).

3.2.3 The manor was acquired in 1651 by Richard Foley, an entrepreneurial Birmingham ironmaster, whose family operated several iron furnaces and forges in Staffordshire, Shropshire and Cheshire (Young & Jenkins 1963, 230). In the decade 1690-1700 the Normacot furnace was producing 300 tons of pig iron per annum, rising to 600 tons per annum by 1717. This has been calculated as 2.5% of the total national output and together the various Foley enterprises were responsible for 6.4% of the total national production in 1717 (Hawke-Smith 1987, 100).

3.2.4 In 1702 the Foleys leased the manor and its furnace to the Lane family, who specialized in the casting of forge hammers and anvils (Young & Jenkins 1963, 244). Smelting and forging, however, had probably been discontinued at Normacot by the 1760s (Ward 1843, 558) and certainly by 1773 when the manor, which had descended with the Foleys, was sold to the Lane family (Young & Jenkins 1963, 230). By 1820 the ironworks site was occupied by *Furnace Mill* which probably utilised many of the original buildings for grinding flint for the pottery industry before becoming a corn mill, which was still operational in 1872 (Young & Jenkins 1963, 245).

3.3 *The vicarage*

3.3.1 The DA itself has reputedly been occupied from *c.*1620 by the *Furnace Inn*, a coaching inn that catered for travellers using Meer Lane (later Uttoxeter Road). It was apparently notorious for cock-fighting, bear baiting and dog fights and the village stocks stood just outside the inn, with the keys held by the landlord (Freeman 1999, 12).

3.3.2 In 1853 the inn, described in contemporary deeds as 'a public house at Furnace', was converted into a vicarage (SRO D593/B/3/3/13/2). The church of the Holy Evangelists had been built in 1847 as a chapel of ease to Blurton parish church, financed by the duke of Sutherland. Initially a perpetual curacy, an ecclesiastical parish was created in 1852 from the parishes of Stone and Trentham and the living subsequently became a titular vicarage in 1868 (Young & Jenkins 1963, 235).

3.3.3 A photograph of the vicarage in the 1920s (Fig. 8) shows the west and south facing elevations of a rambling, triple-gabled brick building with conspicuous two-flue chimney stacks and tall windows, probably with stone lintels and mullions. The 1911 census reveals that it had twelve rooms, not counting the kitchen, bathroom and ancillary offices.

3.3.4 The first vicarage was replaced in 1975 by a modest four-bedroom house located just to the south west of the original site, which was in turn demolished in 2008. A parish hall erected on the site of the earlier vicarage and a pre-fabricated scout hut located on the east side of the DA, both built on concrete bases in *c.*1972, were cleared in 2006 due to subsidence (Geograph 2008).

3.4 *Site development*

3.4.1 A *Map of the Royalty of Normacot* dated 1714 (SRO D593/H/3/921) (Fig. 3) shows land and property belonging to the Leveson-Gower family (later the dukes of Sutherland). It includes a two-acre plot called *Furness Croft*, occupied by a Joseph Bagguley, with the blast furnace depicted on the northern edge, on the south side of what is now Watery Lane. On its east side is the outline of a smaller building, possibly the casting house or forge.

3.4.2 To the north east of the furnace is a gabled dwelling-house with a centrally located chimney, which may be the ironmaster's house. Yates' Map of 1775 depicts a large L-shaped building which appears to be in the same locale as the house depicted in 1714 and is probably the edifice depicted on the 1838 tithe map (plot number 297) (Fig. 4). A later map of *c.*1845 (SRO D593/H/3/133) (Fig. 5) identifies this building as *The Miller's House.* The 1901 census records the same site as occupied by *Mill House Farm*, which is split into two separate properties, *Mill House East* and *Mill House West*.

3.4.3 The blast furnace itself is not shown on the 1775 map so had presumably been demolished by this date, although the brook and reservoirs are visible. By the time of the 1838 tithe map (Fig. 4), *Furnace Mill* occupied the site of the furnace (plot number 296) along with its former reservoirs (294 and 299). The mill appears again on the *c.*1845 map of the area (Fig. 5), but had been significantly reduced in size by 1878 (Fig. 6) and demolished by 1937 (Fig. 7). The site is now occupied by Foley Court.

3.4.4 The *Furnace Inn* is absent from both the 1714 and 1838 maps (Figs. 3 & 4), as the land it occupied presumably was not part of the Sutherland estate and was exonerated from the tithe assessment, perhaps because the land belonged to the church. It is not obviously depicted on the 1775 map which does, however, indicate a roadside building just to the north of the *Miller's House*, but does feature on the *c.*1845 plan (Fig. 5).

3.4.5 By the time of the 1878 OS map (Fig. 6) the property was a vicarage. The main body of the property had a footprint of *c.*170m² with a separate, north – south aligned range at the eastern end, presumably added after 1853 (see above, **3.3.2**). A stable block shown to the south of the inn on the *c.*1845 map is not indicated on the 1878 OS edition and the western boundary of the plot looks to have been realigned on Upper Belgrave

Road itself. Also apparent on the 1878 OS map is a new driveway on the north side of the building, built in 1853 at a cost of £7.0.0 as part of the renovation work, as was the sandstone boundary wall, erected at a cost of £2.10.6 (Freeman 1999, 21). Subsequent OS editions up to 1950 show no obvious change in the plan of the vicarage (Fig. 7).

4.0 Methodology

4.1 *Aims and objectives*

4.1.1 The primary aim of the evaluation was to determine the state of preservation of the original vicarage and locate evidence for the ironworks. The over-arching objectives of the project are described in full in the Planning Archaeologist's project brief (Boothroyd 2009) but are broadly summarised below:

- Confirm the presence or absence of buried remains of archaeological interest.
- Determine the date, nature, phasing and the state of preservation and relationships of any archaeological deposits and features.
- Preserve by record the archaeological evidence found.
- Attempt to provide information on the character of the site within a local, regional and national context.

4.1.2 The project brief required the opening of three 5.0m x 10.0m evaluation trenches, in accordance with the IfA *Standard and Guidance for field evaluation* (revised October 2008). The proposed locations for the trenches were determined by the historical map evidence and gave a combined excavation area of 150m², representing a 2.77% sample of the total DA. Due to on-site constraints the eventual trench areas that were excavated amounted to a total of 83.99m² (1.55%).

4.1.3 Fieldwork was undertaken between the 26th and 29th May 2009 and was conducted in compliance with the Planning Archaeologist's project brief (Boothroyd 2009) and a Written Scheme of Investigation (WSI) produced by SOTARCH (Goodwin 2009). The project was conducted in accordance with current best archaeological practice and conformed with relevant national codes of conduct, standards and guidance as advocated in the *By-laws of the Institute for Archaeologists* (revised October 2008).

4.1.4 The evaluation involved the archaeological supervision of a 180° backhoe excavator equipped with a 1.70m-wide toothless ditching bucket to remove overburden

down to the first discernible archaeological horizon. If no archaeological features or deposits were identified, excavation was continued either to a point where undisturbed natural subsoil could be confirmed or to a safe and practical working depth.

4.1.5 All archaeological horizons were cleaned by hand and the trench documented by means of a written record (site notes and individual *pro-forma* context sheets) and measured drawings (1:10 for sections and 1:20 for plans). A digital colour and 35mm monochrome print photographic record was maintained, showing specific stages of the fieldwork and the layout and relationship of any archaeological features. Finds were sampled where appropriate. The trenches were back-filled after recording with the permission of the Planning Archaeologist.

4.1.6 The site archive is stored at The Potteries Museum & Art Gallery, Bethesda Street, Hanley, Stoke-on-Trent, Staffordshire (site code **UBR 09,** Museum Accession Number **2009.LH.60**).

5.0 Results of the evaluation

5.1 ***Trench 1*** (7.90m NE-SW x 4.10m NW-SE) (Fig. 9, Plates 1 & 2)

5.1.1 Trench 1 was located toward the north-west corner of the DA. It was originally targeted on the centre of the vicarage, but a large spoil heap in the centre of the DA required that the trench be moved. After consulting with the Planning Archaeologist the trench was re-located to target the west wing of the building.

5.1.2 The removal of an overburden of mixed demolition material (100), 0.70m thick, revealed a 0.90m thick made-ground horizon of loose brown silty clay, brick rubble and gravel (101), which was present across most of the trenching area. In the south-western corner of the trench, however, (101) had been cut by a feature [109], *c*.0.70m in depth, possibly linear in nature and filled with orange sand (102). Beneath layer (101) were the remains of two brick structures.

5.1.3 In the south-west corner of the trench was a truncated stretch of mortared red brick wall (107), aligned north - south. The structure was approximately 1.80m long x 0.24m wide and its solid construction was indicative of a load-bearing wall.

5.1.4 To the north east of (107) were the remains of another structure, aligned east – west and totalling 4.65m in length. It essentially comprised two distinct components: a stub of lime mortared red brick wall (103) and a stretch of blue-brick flooring (104). Wall (103) was aligned roughly north – south and was approximately 1.73m in length, having been truncated at both ends. It was two courses (0.13m) deep and three rows (0.50m) wide, with the inner row laid as headers and the outer and inners skins as stretchers. Its solidity again suggested that this was a load-bearing wall. Abutting the west side of (103) was an area of blue brick pavers (104), approximately 4.12m in length and a maximum of 0.94m wide, but only one course (0.07m) deep. There was evidence of a single stretcher edging course along its south side, while at the east end was a slightly recessed slot that appeared to define a specific area, the remnant of which measured 0.86m east - west x 0.70m north - south and may have once extended further to the north.

5.1.5 Surface (104) was bedded on a *c*.0.02m thick layer of yellowish-brown silty sand (105), which in turn overlay a compacted reddish-yellow clayey sand that extended across the base of the trench (108). A sandy material (106) similar in nature to (105) was also observed in the south-east quarter of the trench above (108). Both walls (103) and (107) had been cut into (108), which probably represented the natural clay subsoil. The surface of (108) appeared to have been previously scoured by a toothed machine bucket, probably during the demolition of the vicarage.

5.2 ***Trench 2*** (10.0m NW-SE x 4.20m NE-SW) (Fig. 10, Plate 3)

5.2.1 Trench 2 was originally intended to target the vicarage's east service wing, which was assumed to be servants' quarters or domestic offices. The presence of a large spoil heap, however, required the trench's relocation *c.*4.0m to the north. In its new position this trench would catch the north-east corner of the front elevation and an open structure shown on the 1878 OS map that may have been a terrace (see Fig. 6).

5.2.2 This trench was found to comprise a layer of loose dark brown sandy silt and brick (200), which was a maximum 1.78m thick. Underlying this made ground at the west end of the trench was a deposit of loose orange sand (201), approximately 0.15m thick and containing occasional fragments of sandstone. Elsewhere, (200) lay above a layer of

orange sandy clay subsoil (202), recorded at the limit of excavation. No structural remains were encountered.

5.3 ***Trench 3*** (3.20m NW-SE x 3.00m NE-SW) (Fig. 11, Plate 4)

5.3.1 Trench 3 was speculatively sited in the south-east corner of the site to assess whether elements of the ironworks extended into the DA. The blast furnace would have been approximately 40.0m to the south east of the trench. On the historical 1878 OS map (Fig. 6) this area appears as a distinct structured garden space, possibly the kitchen garden. This area had not been disturbed and was heavily overgrown.

5.3.2 Underlying a 0.20m-0.40m thick layer of turf and top soil (300), was a light brown gritty clayey sand (301) approximately 0.08m thick. This overlay a narrow band of black sandy silt (302), 0.07m thick, beneath which was a very thin layer of light brown clayey sand (303), 0.08m thick, very similar in consistency to (301), but with occasional inclusions of pebbles. This overlay an extensive deposit of waste material (309) consisting of numerous fragments of glassy grey/green and black slag. In the north-east-facing trench section, an east-west sloping, 0.10m thick band of greenish-grey clay (308) was present within (309), although this was not observed in any of the other sections. Deposit (309) was excavated to a depth of approximately 3.50m below present ground level before encountering what may have been the natural brown sandy clay subsoil (310). Specimens of slag were retrieved from (309) for metallurgical analysis (see appendix 1).

5.3.3 In the east corner of the south-west-facing section context (301), (302), (303) and (309) had been vertically cut [304] to a depth of 0.98m by a north – south aligned drainage trench containing a 0.14m diameter ceramic waste pipe (306) buried in a sidefill of dark brown silty clay (305) containing frequent inclusions of rubble, including 19th-/20th-century brick, floor tile, roof tile and concrete fragments incorporating items of 19th-century kiln furniture.

5.3.4 Due to the depth of excavation and instability of the slag it was decided not to extend trench 3 to its originally intended dimensions. After being recorded it was immediately backfilled with the permission of the Planning Archaeologist.

6.0 Discussion

6.1 *The blast furnace*

6.1.1 The principal post-medieval technical innovation for the primary reduction of iron ore to wrought-iron (that is, iron that could be worked) was the blast furnace, which was introduced to south-east England by the early 16th century (Jones 2006, 28). The technology had arrived in Staffordshire by 1561 when the county's first ironworks was established on Cannock Chase (Harrison 1979, 24). By 1750 Normacot was one of only four blast furnaces in north Staffordshire (Thompson 1974, 41).

6.1.2 A blast furnace invariably comprised a vertical stack of brick or stone about 6.0m tall, flaring out to a hearth or melting zone in the lower part of the structure (Crossley 1990, 158). The ore was charged into the top of the stack from a barrow ramp, with alternating layers of charcoal fuel and, sometimes, a flux of limestone or cinders. Archaeometallurgical analysis of the slag recovered from context (309) confirmed that charcoal was used to fuel the Normacot furnace (see appendix 1 for full results). Coal was not used as a fuel as it contained sulphur which made the metal unworkable, while limestone was used to form molten slag, which floated on top of the molten iron and could be easily drawn off (Jones 2006, 98). The charge was heated to about 1400ºC using a pair of bellows at the base and contemporary accounts state that it took three days of intense heat for the ore to begin to run (Plot 1686, 162). After two weeks molten iron metal could be run out once every twelve hours and 'tapped' into sand-lined troughs for casting into finished items or to solidify as ingots known as 'pigs' (Plot 1686, 162).

6.1.3 Cast-iron is an impure alloy of carbon and iron useful for casting cannon balls or domestic artefacts such as cooking pots, kettles and fire-dogs, as well as equipment for the forge, such as anvils (Harrison 1979, 22). Though hard it is brittle due to its high carbon content and cannot be reworked. The majority of blast furnace output therefore was 'pig-iron' which was then despatched to the forge, which consisted of two parts, the 'finery' and the 'chafery'. In the former, the iron was placed on an open charcoal hearth and made malleable by being re-melted under further blasts of air. The carbon in the iron was oxidised and removed ('decarburized'), leaving a low-carbon bloom which could be forged again in the 'chafery'. Heavy tilt-hammers removed laminar slag and consolidated the bloom into commercially-pure wrought-iron bars ('bar-iron') suitable

for trading or 'putting out' to other foundries where it could be worked up into finished goods by smiths (Cranstone 2001, 190).

6.1.4 Both furnace and forge employed water-power for the bellows and hammers so were usually built apart, each supplied by a head of water from storage ponds (Harrison 1979, 22). Usually the furnace was near the head of the race while the forge, which required larger quantities of water, was lower down (Sherlock 1976, 94). At Normacot the Ludwall spring was dammed to create the necessary reservoirs; the resulting leat is still extant as Furnace Brook, while the significance of water-power is commemorated by the road name 'Watery Lane'.

6.1.5 The change-over from the simple medieval bloomery process to blast furnace brought about significant increases in output. Whereas a bloomery could only smelt 20-30 tons of iron in a year, the annual production of a blast furnace was 200 tons of pig, to be converted at the forge to between 130-150 tons of wrought-iron (Crossley 1966, 273). The furnace would have created an industrial landscape of ironstone extraction pits, charcoal burning and waste heaps. The large quantity of material found in trench 3 at Normacot suggests that sizeable amounts of slag were discarded in areas adjacent to the furnace. Ward (1843, 558) cites the large deposits of 'scoria' present in the brook, while the ground to the south of the DA is identified on the 1845 map as 'Cinder Hill' and bore much evidence of industrial waste when the Cottage Hospital was built in 1890 (Freeman 1999, 14).

6.2 *The vicarage*

6.2.1 It was anticipated that an investigation of the old vicarage would contribute to an understanding of 19th-century urban clerical life and provide evidence with which to compare and contrast a vicarage with working-class housing previously studied in Stoke-on-Trent (Boothroyd 2009, 2). The site of the vicarage, however, had been severely disturbed and only a few traces of the building remained in trench 1.

6.2.2 Trench 1 contained fragmentary features that can probably be ascribed to the vicarage. These comprised a surface of blue-brick pavers (104) which may represent a cellar floor. Comparison of the 1878 map evidence (Fig. 6) with the abutting linear stub of masonry (103) suggests that this wall was probably part of the internal partition

between the eastern and western elements of the main building. If this is correct then the position of wall (107) appears to correspond to the exterior west elevation of the building. The significance of the recessed brick course alongside (103) is uncertain, although it may represent the former position of a cold-slab for food storage.

7.0 Conclusions

7.1 Very little structural and no artefactual evidence of the former vicarage or its occupants was found during the course of the evaluation at Upper Belgrave Road. Demolition of the structure in the mid 1970s appears to have been extremely thorough and reduced the building to cellar level.

7.2 Although no structures pertaining to the Normacot/Meir Heath ironworks were encountered on the site, evidence for metalworking activity in the vicinity was strongly represented in trench 3. No new evidence relating to blast furnace technology was revealed, but archaeometallurgical analysis of the sampled debris (309) revealed that it stemmed from a charcoal fuelled furnace, which used a limestone flux. These factors, coupled with the high iron content of the slag, are consistent with material recovered from other early blast furnace sites, notably the 16th-century example at Cannock (Doonan & Pitman 2009, 5). No evidence of coke being used as a fuel was identified, implying that the furnace was never converted from charcoal firing.

7.3 It is not clear whether this waste is a primary deposit. Its proximity to the site of the furnace implies that this is not unreasonable, although it may simply have been deposited as levelling material at any point up to the mid 19th century. No evidence of slag was encountered in trenches 1 and 2 which suggests that the spread of material has a defined limit within the DA, perhaps not surprising given that occupation of the site is broadly contemporary with the furnace.

7.4 Nonetheless the volume of slag within such a small trench (approximately 28m^3) is indicative of the quantity of waste buried in the wider landscape and offers an estimate of the total weight of debris revealed in trench 3. The potential volume of slag in this trench multiplied by its density (usually 3-4.5 kg/m^3) gives a total mass of between 864kg and 1.297 metric tonnes (Bayley *et al* 2006, 8), of which 25.9 kg was sampled.

7.5 The importance of the early iron industry in north Staffordshire cannot be over-estimated, nor its significance for the development of Longton (Hawke-Smith 1987, 100). Blast furnaces in particular represent the beginnings of industrial mechanization and iron working was the first process to become an industry (Gale 1973, 149).

8.0 Acknowledgements

8.1 Fieldwork was undertaken by Richard Cramp AIfA (supervisor), Peter Stuart and Heather Anne Cope of SOTARCH. This report was written by Richard Cramp, with illustrations by Zoë Sutherland. Thanks are extended to Noel Boothroyd, Stoke-on-Trent City Council Planning Archaeologist; Dr Roger Doonan and Derek Pitman of the University of Sheffield for the metallurgical analysis; the client, Frank Haslam Milan (West Midlands) Ltd; and T.G. Barnett Plant Hire for their assistance and co-operation on the project.

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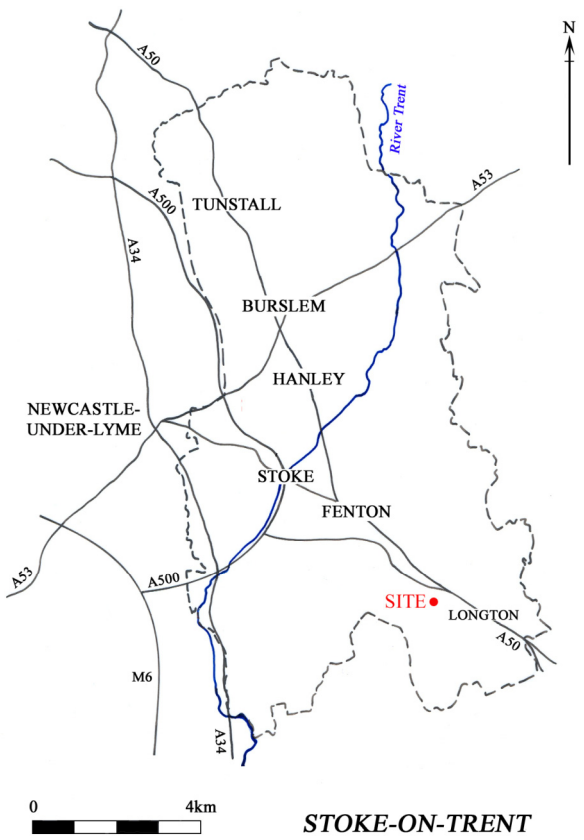

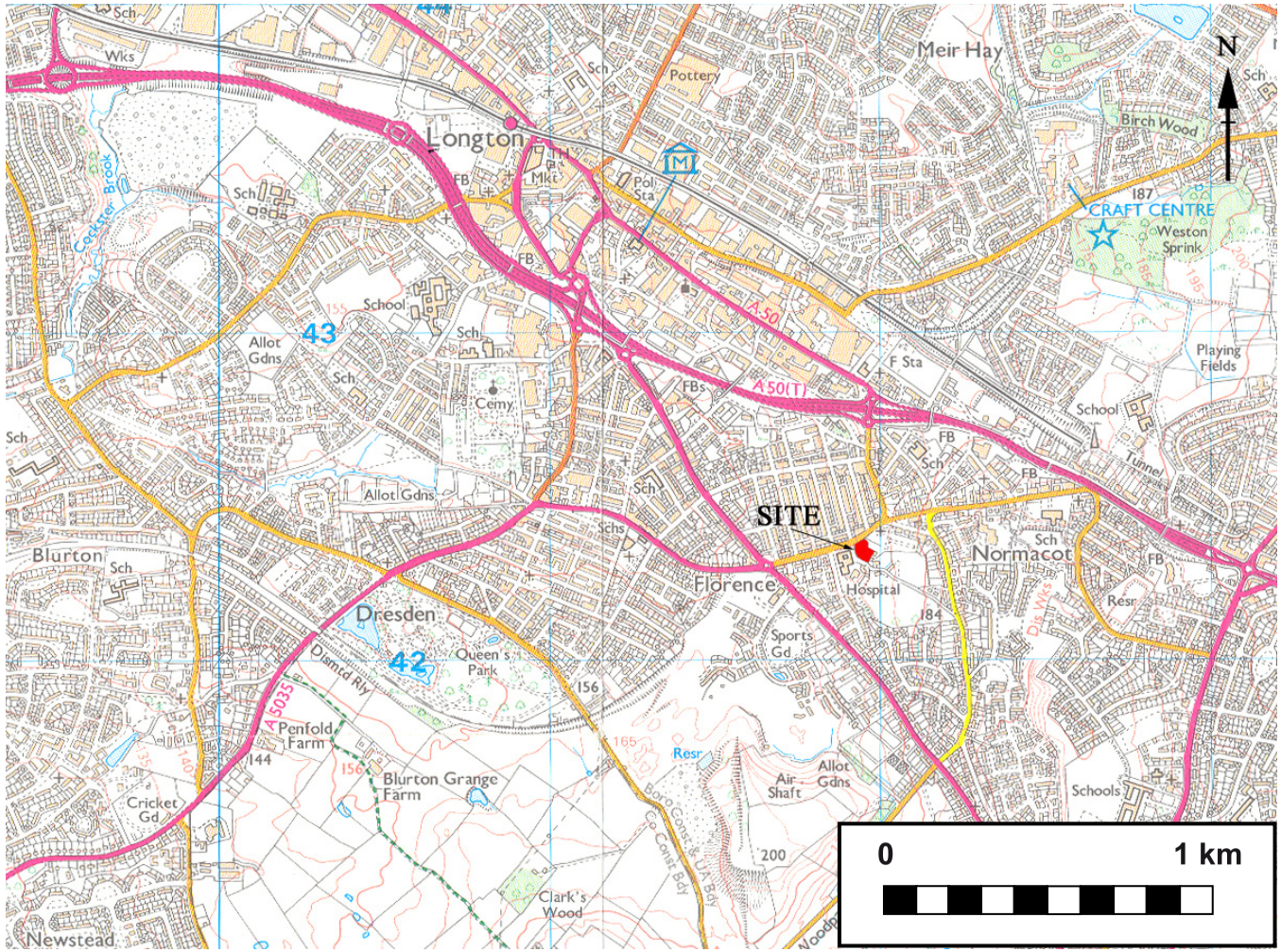

FIG. 1

Site location

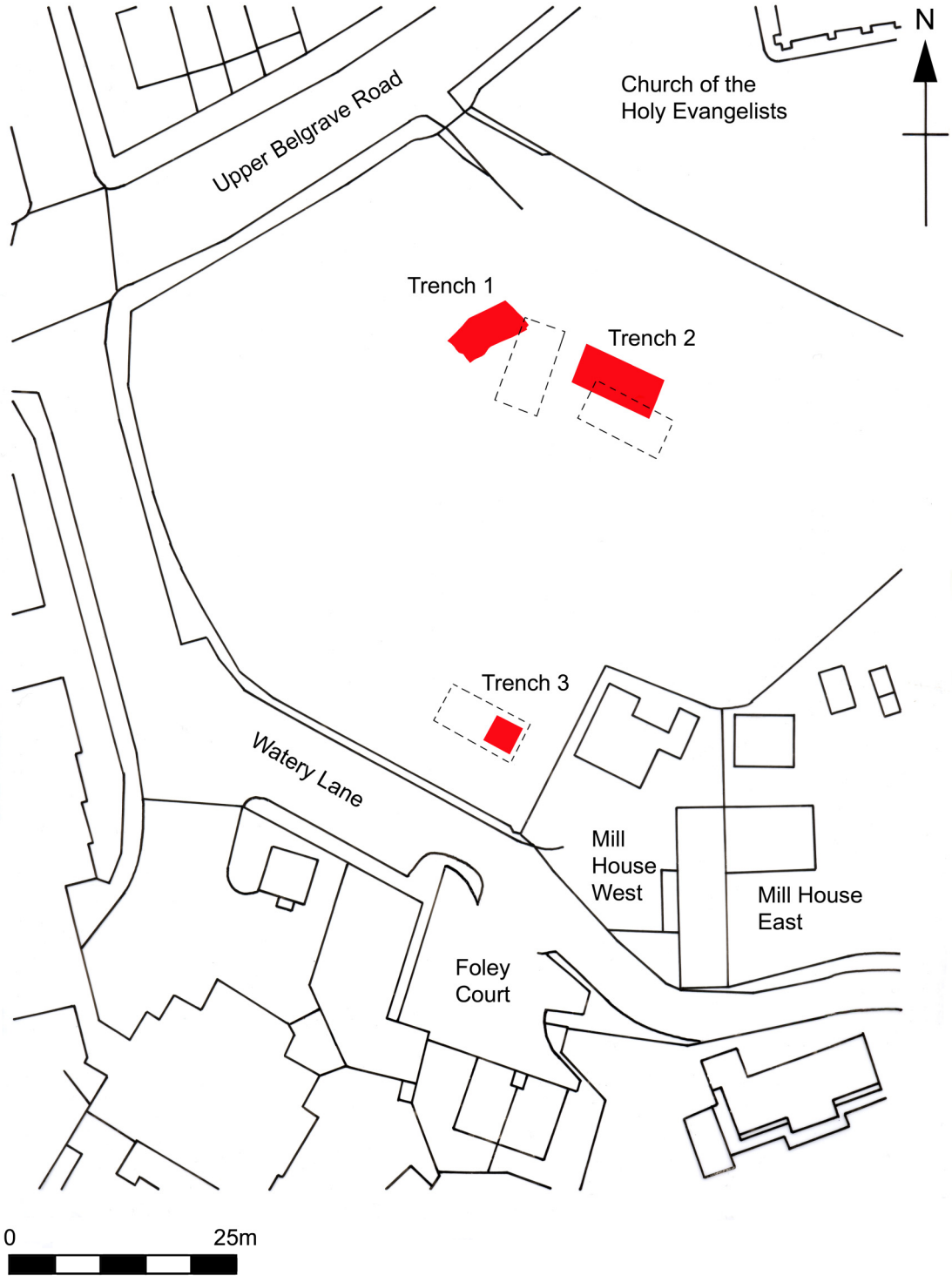

FIG. 2

Trench location plan.

The proposed trench locations are marked by a dashed line

and the final locations are indicated in red.

FIG. 3

A *Map of the Royalty of Normacot* 1714, showing *Furness Croft* with the blast furnace to the north of the plot.

FIG. 4

The 1838 tithe map showing *Furnace Mill*.

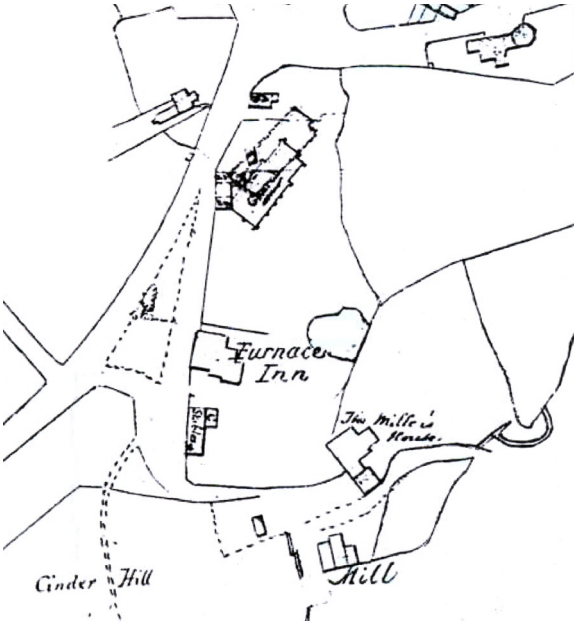

FIG. 5

Map of *c*.1845, showing the *Furnace Inn* and *The Miller's House*, with the mill building to the south.

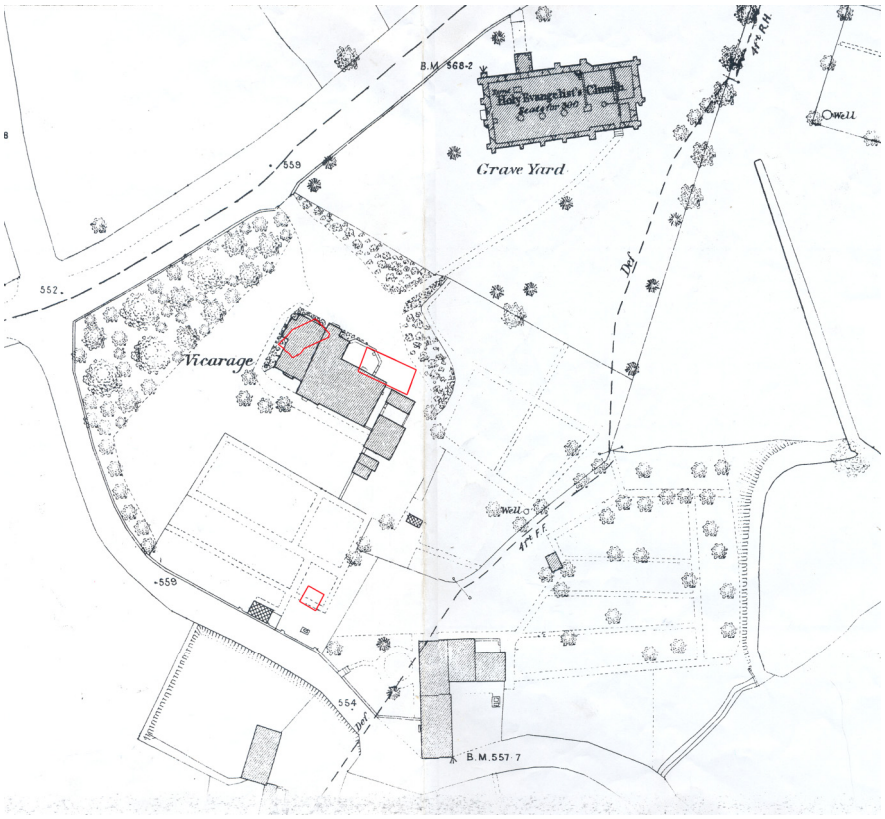

FIG. 6

Extract from the 1878 OS map, showing the vicarage. The property identified as *The Miller's House* in *c*.1845 is present, with the mill building just visible at the bottom of the map. The evaluation trench locations are indicated in red.

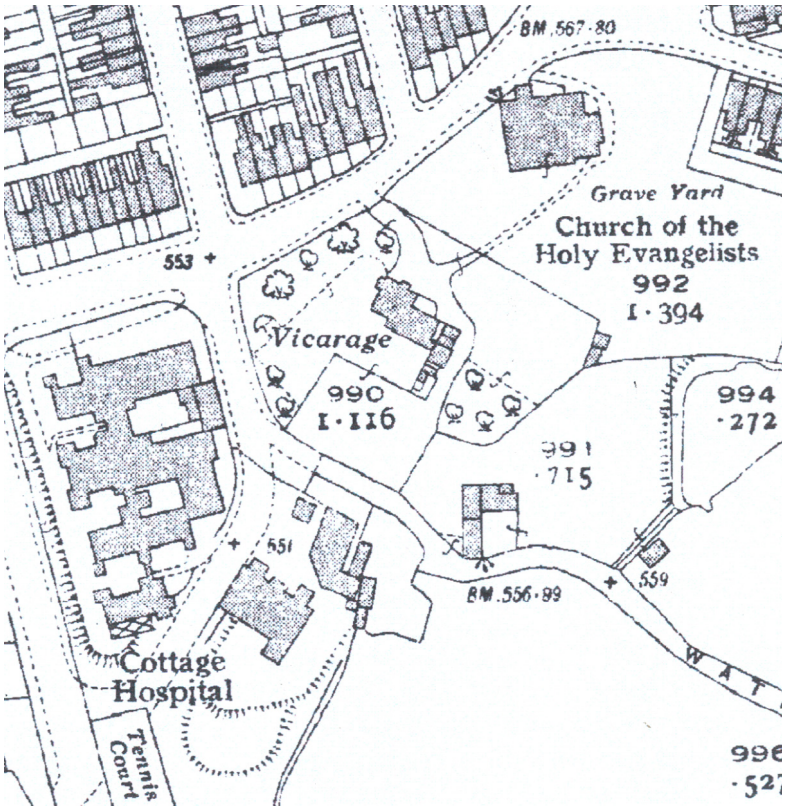

FIG. 7

Extract from the 1937 OS map, showing the vicarage. The property identified as *The Miller's House* in *c.*1845 is still present, although the mill building is not shown.

FIG. 8

The vicarage as it appeared in the 1920s, looking north east (courtesy of the Lovatt Collection).

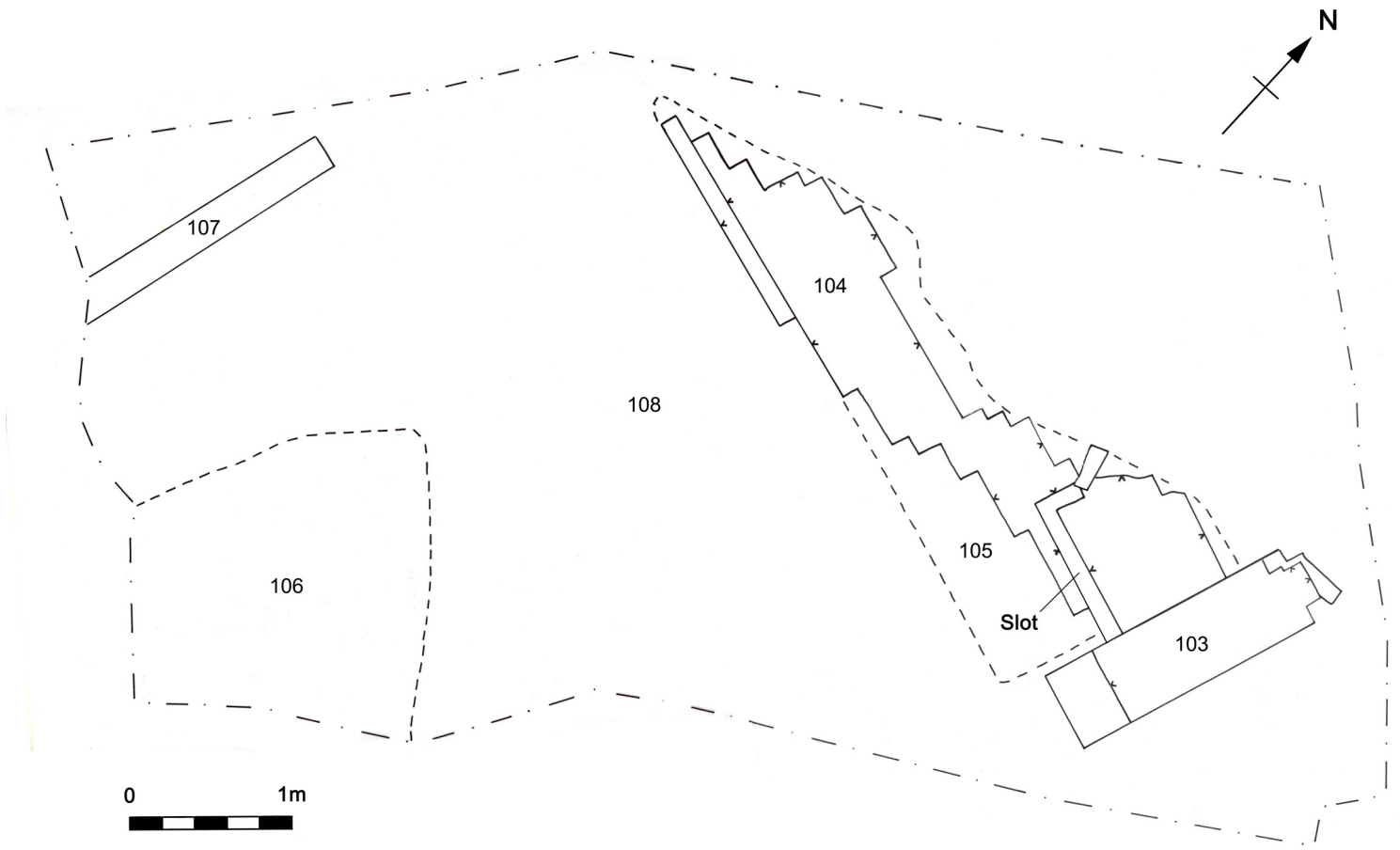

FIG. 9

Post-excavation plan of trench 1.

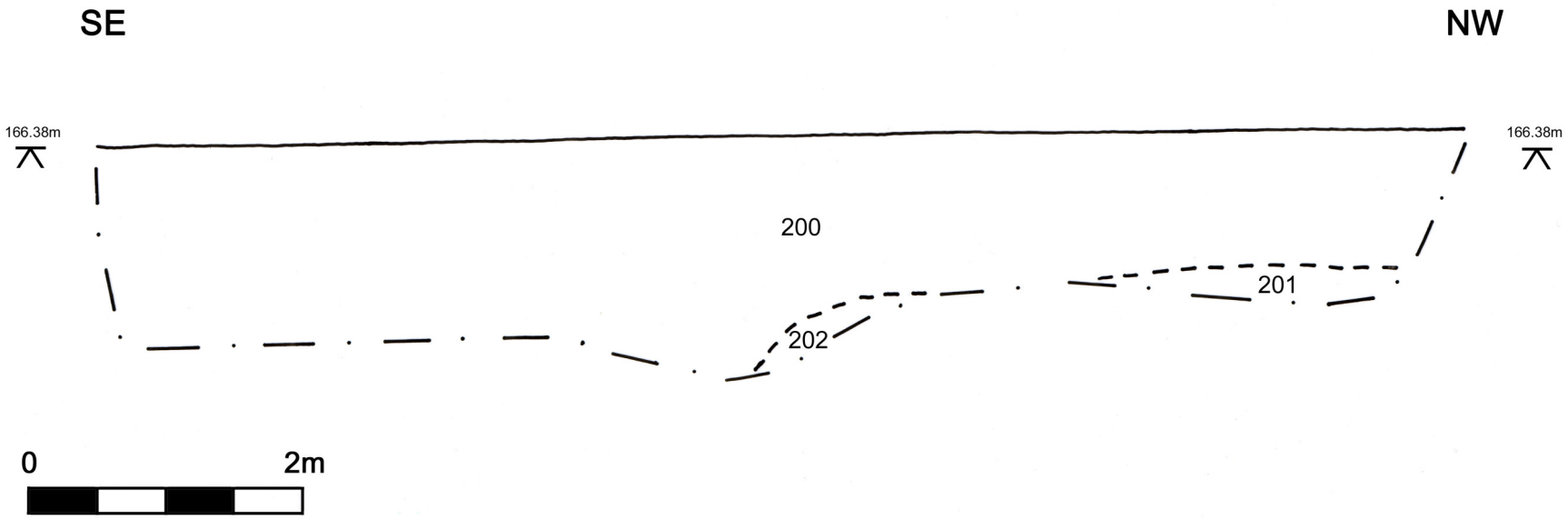

FIG. 10

North-east-facing section of trench 2.

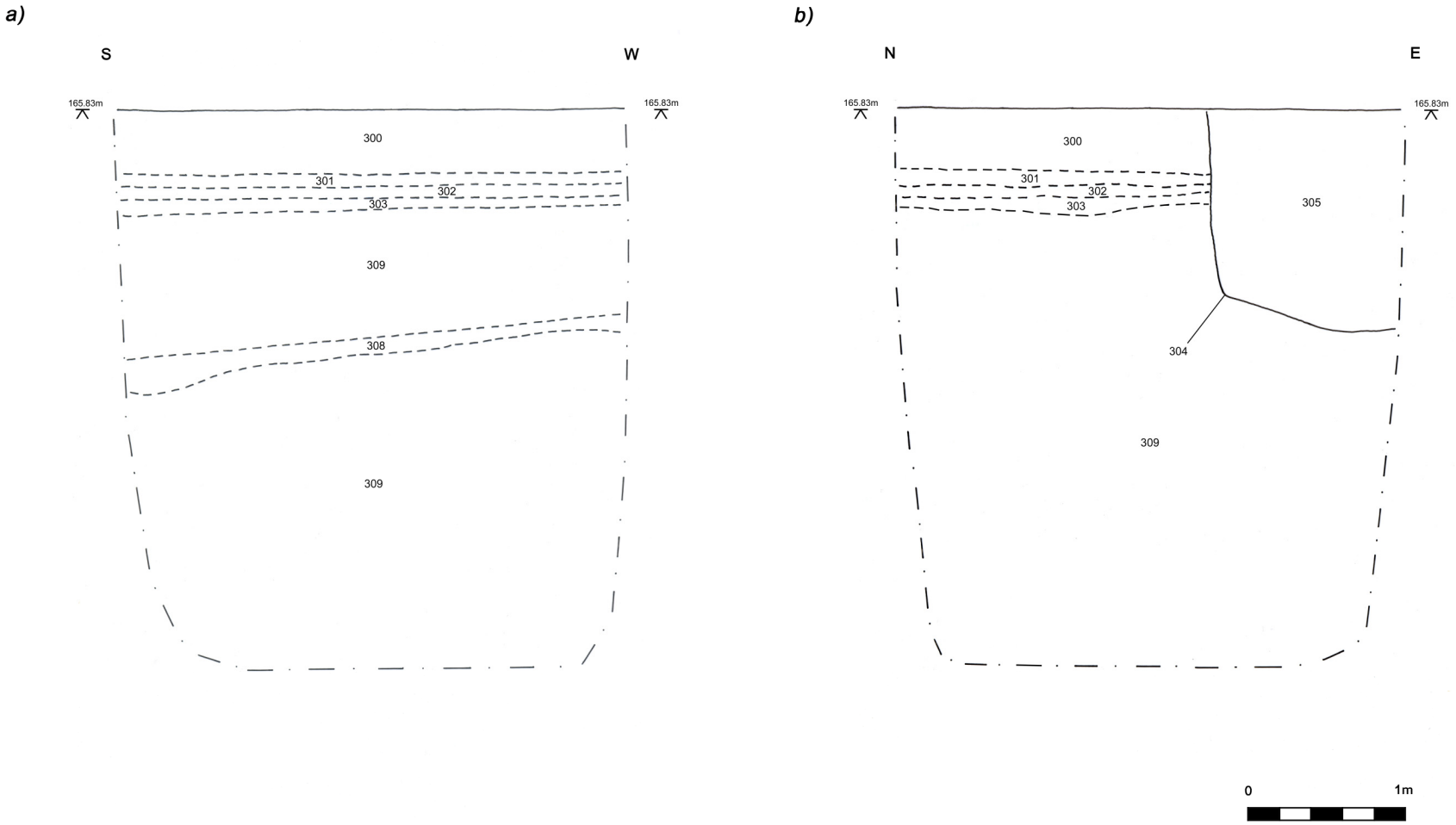

FIG. 11

a) North-east-facing section of trench 3 *b)* South-west-facing section of trench 3.

PLATE 1

General view of trench 1, looking north. Wall (107) is to the left and the cellar floor (104) and stub of wall (104) at centre top (scales: 1.0m & 2.0m).

PLATE 2

Detail of the cellar floor (103) in trench 1, looking north. Note the recessed brick course. On the right is wall (104) (scales: 1.0m).

PLATE 3

General view of trench 2, looking north west (scales: 1.0m & 2.0m).

PLATE 4

North-east-facing section of trench 3 (scale: 2.0m).

APPENDIX 1:

ANALYSIS OF METALLURGICAL DEBRIS FROM THE OLD VICARAGE, NORMACOT, STOKE-ON-TRENT.

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The University Of Sheffield.

December 2009

Introduction

This report presents the analysis of metallurgical debris recovered from The Old Vicarage, Normacot, Stoke-on-Trent (site code UBR 09). The material analysed was retrieved from a single deposit of slag (context 309) and consisted of a total of 18 fragments weighing 25.9kg.

The assemblage

The samples were sorted into groups during hand examination based on physical criteria to facilitate further assessment. As many specimens were fragments and exhibited attributes for more than one group type, such specimens were grouped on the basis of their *dominant* visual characteristics. Larger specimens show a complete cross section of slag flow and therefore exhibit diverse slag textures. Smaller fragments tend to exhibit a more restricted or homogenous range of textures. The upper zone of the slag has a cinder-like appearance (Figure 1) which contrasts with the lower zones which are characterised by a highly porous, glassy texture. Most fragments were either green and/or black in colour. The larger more complete specimens indicate that black fragments of slag derive from the upper zone characterised as cinder-like, whilst green slags derive from the lower zones and underside of the slag. Much of the material is glassy in appearance with pores ranging from over two centimetres to under a millimetre. All of the fragments are opaque and the inter-zonal horizon between the black and green areas shows a high degree of interdigitation indicative of mixing prior to solidification. Visual analysis of fresh fractures reveals charcoal impressions which indicates the fuel used in the process (Figure 2).

GROUP	DESCRIPTION	TOTAL WEIGHT
1	Glassy, green with few visible pores. The larger samples show a gradual change from green to black with interdigitation at the interface. The largest sample (31cm By 24cm by 13cm) accounts for 11.4kg of this group.	17.1kg
2	Very porous, with pores up to 20mm in diameter. Mostly dark green to black with some green lamination.	4.7kg
3	Pieces retaining morphological detail, i.e. distinct edges. (See Figure 3).	4.1kg

Table 1, Description of fragments examined.

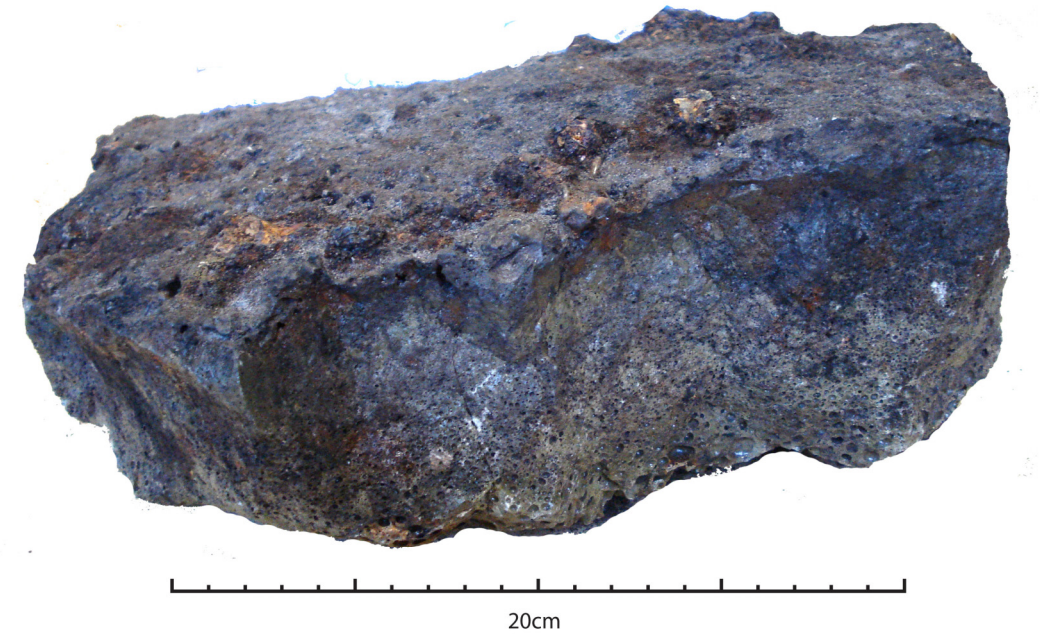

Figure 1, Large fragment showing presence of groups 1 and 2 in single specimen.

Figure 2, Charcoal impression in slag.

Figure 3, Slag with cylindrical impression

Microstructural analysis

A campaign of microstructural characterisation was undertaken to better characterise the material and to ascertain technical aspects of the process. Samples were selected from each group for microscopic examination using reflected light microscopy. The sample were sectioned and then polished to 1µm. Appendix 1 contains the photographic record of this work. Most of the samples were amorphous with no detectable microstructures other than metallic inclusions. Such inclusions were occasional large (c. 100µm) ferrous prills and frequent small (c. 10µm) ferrous prills. The microscopic examination revealed very little difference between the green and black slags. Only UBR 09-3 had a non-glassy texture, this sample featured a fine lath-like crystal structure and indicative of a slower cooling cycle.

Compositional analysis

In additional to microstructural analysis samples were also submitted for bulk compositional analysis. These samples were also analysed compositionally using x-ray fluoresce (XRF) and the results can be seen in Table 2. The results of analysis indicate that all slag samples displayed a high degree of compositional similarity. High concentrations of CaO (lime), Al_2O_3 and (Alumina), MgO (Magnesia) and SiO_2 (Silica) confirm, as suspected, that this is the product of blast furnace technology which was reliant on alkali fluxes to increase the efficiency of iron recovery. Whilst different slags exhibit different colours it appears that this is not due to variation in chemical composition.

Sample	SiO_2	Al_2O_3	CaO	MgO	MnO	FeO	TiO_2	K_2O	P_2O_5	S
UBR 09-1 BLACK	37.9	31.5	10.9	4.56	5.45	4.98	0.55	4.03	nd	0.07
UBR 09-1 GREEN	41.9	30.6	10.5	5.56	5.32	2.29	0.53	3.28	nd	0.06
UBR 09-2 BLACK	36.8	28.0	14.9	7.74	5.51	3.10	0.51	3.39	nd	0.10
UBR 09-2 GREEN	39.0	28.5	14.0	6.63	5.08	3.27	0.46	3.08	nd	0.08
UBR 09-3 BLACK1	38.6	31.2	12.5	4.06	4.72	3.83	0.51	4.35	nd	0.19
UBR 09-3 BLACK2	39.9	29.8	11.6	4.00	4.82	5.04	0.48	4.32	nd	0.12
UBR 09-4 BLACK	39.8	27.6	15.6	4.61	5.56	2.34	0.55	3.83	nd	0.12
UBR 09-4 GREEN	41.4	28.7	13.4	6.42	4.85	1.86	0.47	2.78	nd	0.13
UBR 09-5 BLACK	38.8	28.7	11.6	5.98	5.63	3.99	0.53	4.67	nd	0.17
UBR 09-5 GREEN	44.8	27.6	10.9	5.01	5.06	3.07	0.51	2.88	nd	0.13

Table 2, compositions of slag samples.

Discussion

Visual examination in conjunction with microscopic and compositional analysis strongly suggests this slag derives from iron production using a blast furnace. The diagnostic green colour and the glassy character of the slag coupled with the high concentration of lime and relatively low levels of Iron support this identification. The iron content is however, higher than would be expected in modern blast furnace slag, with is typically around 1%. This, coupled with the charcoal impressions in the slag and the levels of CaO and $Al_2O_3$is compelling evidence that this material was derived from an early example of the process rather than a more recent coke fuelled furnace (see table 2 for comparative analytical data). This is consistent with historical sources that suggest that the 'Mearheath' foundry in Normacot went out of use in the mid 18th century, before being converted to run on coke (Lead 1977). An early date for the material is also supported by the comparatively low lime content and the frequency of ferrous prills seen in the micrographs. In fact, the overall lime and iron content of the Normacot slag is most similar to the 16th century analysis from Cannock, shown in table 2.

Site	Fuel	CaO	SiO_2	Al_2O_3	MgO	FeO/ Fe_2O_3	MnO	S	P_2O_5	Total
Cannock 16th cent.[1]	Charcoal	11.90	47.90	23.20	7.20	4.40	3.30	0.10	0.10	98.10
Charlcot 18th cent.[1]	Charcoal	17.00	52.50	20.17	4.57	4.30	1.86	0.01	0.32	100.73
Tipton 19th cent.[1]	Coke	32.52	39.52	15.11	3.49	2.00	2.89	2.15	ND	97.68
South Staffs. 19th cent.[2]	Coke	32.50	39.50	15.14	3.49	2.02	2.89	0.90	ND	96.44
Lincoln. 20th cent.[2]	Coke	39.80	33.60	18.60	3.60	0.55	1.36	1.58	ND	99.09

Table 2, compositions of blast furnace slag ([1]Morton & Wingrove 1969, [2]Tylecote 1962).

Conclusion

The analysis of the material from Normacot confirms visual suggestion that it is blast furnace slag derived from a furnace which relied on charcoal fuel. The blast furnace was first used in Britain in the 16th century and continues to be used today (Bayley et. al. 2008). There is however a great deal of difference between modern techniques and those used in the 16th century (Tylecote 1962). Early furnaces used charcoal as a fuel whereas later furnaces used coke. Historical records suggest that transition from charcoal to coke in north Staffordshire took place in the mid to late 18th century (Lead 1977). Whilst compositional analysis coupled with slag examination is indicative of an early date, such methods are not reliable for dating the material outright. The combination of historical data,

fuel type and analytical data does suggest an on early date for this deposit but this must be corroborated with other archaeological evidence

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Tylecote, R. F. (1962) *Metallurgy in Archaeology: A Prehistory of Metallurgy in the British Isles.* London: Edward Arnold (Publishers)

Appendix A

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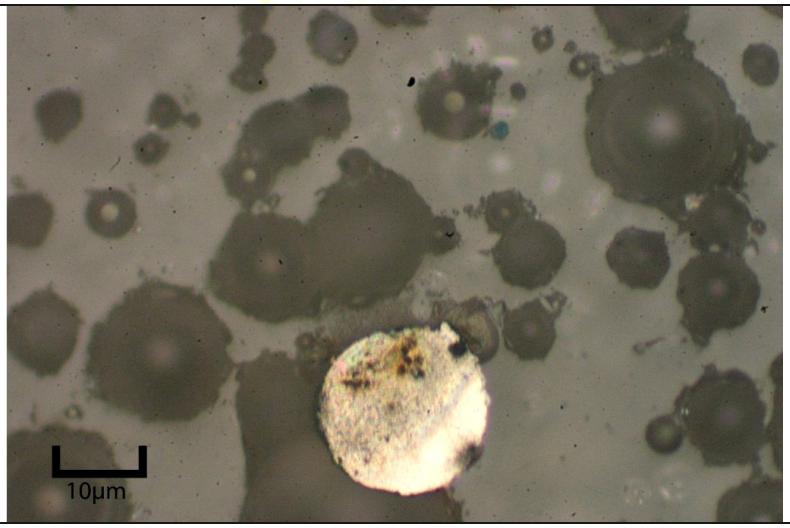
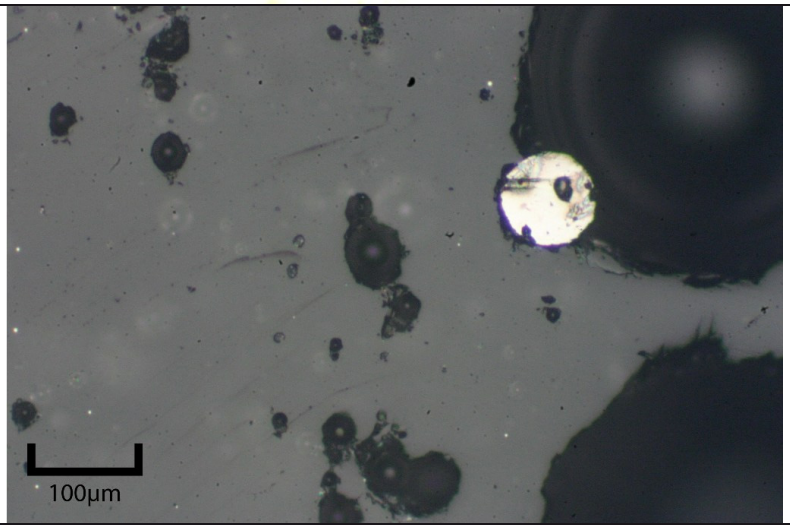
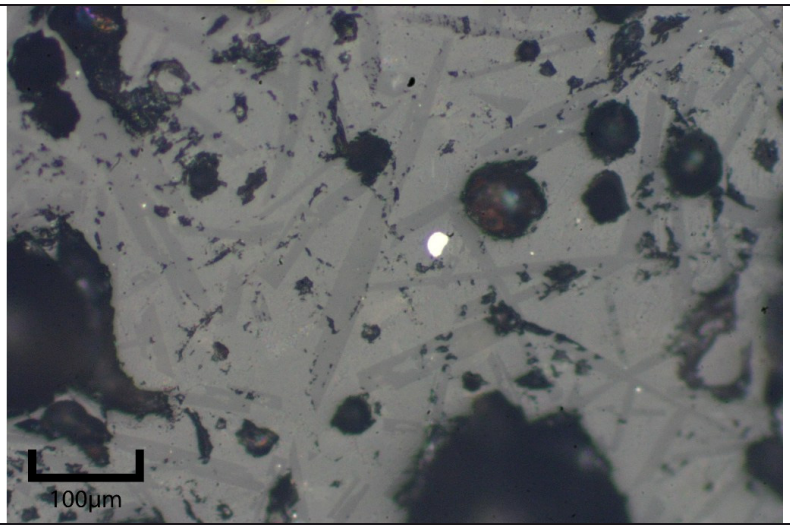
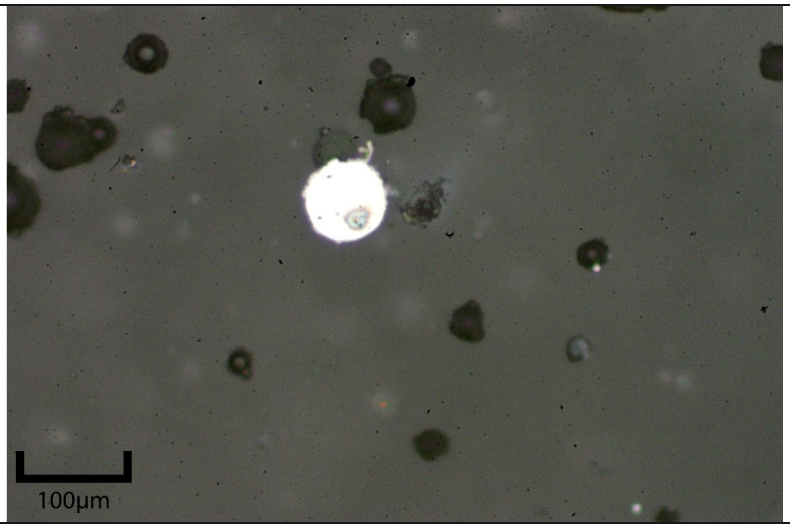
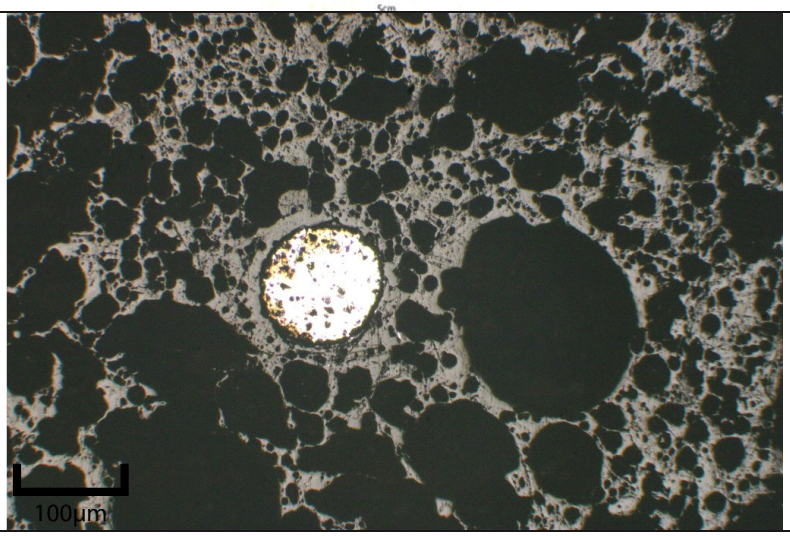
Sample UBR 09-1	
Macroscopic image	
Section	
Micrograph	
Description	This sample was derived from group 1; its microstructure is almost exclusively glassy in texture with very occasional large metallic inclusions and more frequent small inclusions. There is little textural difference between the green and black areas. However, more pours were visible microscopically than was noted visually.

Sample UBR 09-2	
Macroscopic image	
Section	
Micrograph	
Description	This sample has a curved edge and was assigned to group 3. As with sample 1 the texture of the matrix is glassy. This sample occasional large metallic inclusions, as well as frequent small inclusions.

Sample UBR 09-3	
Macroscopic image	
Section	
Micrograph	
Description	This sample was macroscopically sorted to group 2. Unlike the other samples this sample has a lath like texture to its matrix. It does however, still have numerous metallic inclusions.

Sample UBR 09-4	
Macroscopic image	
Section	
Micrograph	
Description	This sample belongs to group 3. The section was cut parallel to the cylindrical impression in the slag. However the microstructure displays very little porosity. This sample also contains occasional large metallic inclusions.

Sample UBR 09-5	
Macroscopic image	
Section	
Micrograph	
Description	This sample belongs to group 2. The sample contained occasional large (c.100µm) metallic inclusions. Although large pours were visible macroscopically the micrograph reveals a highly dominant pour structure.