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Assessment of materials from Hebburn

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Abstract

The submitted materials comprise six fractured blocks of dark glassy blast furnace slag. These are most likely to have derived from smelting under a cold blast technology, though an early hot blast process cannot be excluded.

Potential local sources are discussed, but the ironworks at Walker on the opposite bank are likely.

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Methods

All materials were examined visually, using a low-powered binocular microscope where required. The material was all unstratified.

This assessment was conducted in February 2023 and was commissioned by Jon Welsh. The materials derive from investigations at Hebburn.

Results

Blast furnace slag

The submitted materials comprise six fractured blocks of glassy slag (weighing 2145g, 790g, 698g, .206g, 192g, and 68g).

The 2145g piece is a section 110mm thick through the lower portion of a slag flow. The slag is a very dark grey glass. The basal surface is smoothly undulating and impregnated with fragments of sandstone, mostly of less than 2mm, but with one fragment of 40m. Between the stone fragments the basal surface is finely dimpled, locally with multiple chilled surfaces. Above the basal surface is a zone of large vesicles with an elongation in the vertical direction approximately 30mm thick. This zone contains many corroded blebs of iron of up to 30mm. Above that is a zone 30mm-50mm thick with smaller vesicles (from approximately 4mm) at the base rising to 40mm at the top. An upper zone, up to 30mm thick, shows flattened large vesicles of up to 50mm, showing a strong deformation as a result of flow. The top of the flow is not preserved.

The 790g fragment has no original surfaces, although one corner grades into a finely vesicular material with sandstone grains and fine-grained pale grey clasts, so is probably close to the base. The slag is a mid-grey-green colour. The majority of the sample is a dense glass, with sparse, but large, vesicles of up to 20mm.

A fragment weighing 698g s of a very dark glassy slag, almost black in colour, probably about 80mm in thickness. It is divided into two zones. The presumably lower zone is a zone of 30-50mm in which the vesicularity decreases in size upwards but is abundant. This zone contains large (up to 50mm) inclusions of iron and sandstone. The upper zone, locally up to 50mm thick, is of a very dark glass with almost no vesicularity.

The fragment weighing 206g is a dark greenish grey slag, with almost no vesicularity, except for one surface which shows partially reserved vesicles of up to 20mm.

The two smallest fragments are very similar to one another and show a dark slag, slightly greenish. Both show a lower zone with low vesicularity passing upwards into a zone with vesicles increasing in size and abundance upwards, giving an almost frothy texture. This gradation occurs over an original height difference of approximately 70mm. The smaller of the two fragments preserves the top of a flow, with poorly - developed flow lobes (or perhaps simply raised upper surfaces over large vesicles.

Interpretation

The material is suggestive of residues produced in a blast furnace. Larger foundry cupolas can produce similar slags during the remelting of iron, but these tend to be less homogeneous and to contain clasts of fuel. The large size of the flows suggested by this material allows reasonably confident attribution of these materials to a blast furnace.

The dark colours of the glass are typical of slag produced by a coke-fuelled furnace operating under cold blast. Hot blast blast furnaces tend to produce a high proportion of slags that crystallise on cooling (to give a grey-, weathering cream-, coloured slag) rather than chilling to a glass.

The notably greenish colour of some of these examples might just support a composition closer to the hot blast slags, but this is far from certain. So, although a cold blast origin is likely, an origin under a low-temperature hot blast cannot be excluded.

The hot blast concept is generally attributed to Neilson (see discussion in Belford, 2012), whose patent is dated 1828. Working at Clyde Iron Works, the hot blast he developed allowed both the smelting of blackband ironstones there, but also the use of raw coal rather than coke.

The use of a heated blast expanded rapidly across Britain in the 1830s and most new furnaces in the 1840s would have employed one of the variants of the process.

The local context of iron smelting in this period was provided by Hoskison (1945), albeit primarily for Northumberland rather than Co. Durham. He stated that the Tyne Iron Company's works at Lemington, was for the early 19th century 'the only furnaces between the Firth of Forth and the West Riding'. There was thus no blast furnace close to the site during the heyday of cold blast coke-fuelled smelting.

The first works to be developed close to the present site were those of Losh, Wilson & Bell at Walker. The first furnace was built in 1842, largely to smelt the abundant forge waste already present on the site. A second furnace was built in 1844 (for smelting Cleveland Ironstone from Grosmont), with a third in 1852 that was demolished in around 1870 to make way for hot blast stoves. It is unclear whether the initial furnaces were operated under hot blast, but a watercolour of c.1853 shows two iron-clad furnaces of apparently modern design, but insufficient detail to indicate any presence of hot blast stoves.

The nearest ironworks to the site on the S bank of the Tyne was that at Palmers, Jarrow, which had blast furnaces from 1858-1933. These were certainly of up-to-date design and would this have been less likely to produce dominantly glassy, rather than crystalline slag. However, details of the precise recipe, as well as of the slag tapping regime, may alter the physical nature of the cooled slag and it is hard to rule out such a late origin with certainty.

Another indicator of an earlier rather than later origin, is that the slags appear to have been tapped onto a prepared sandy bed. Later 19th century usage, particularly on larger sites, would have been to tap the slag straight into wagons, for ease of transport to the waste dumps. Finally, the very high content of iron in the lower levels of some of these samples suggests a less advanced tapping regime than is common in the later 19th century (perhaps because these rather siliceous slags might have been more viscous than typical hot blast slags at tapping temperature).

Further work

Detailed laboratory investigation and elemental analysis would be capable of providing further clarification on the processes that generated these residues. However, since the materials were unstratified, further analysis would be unlikely to generate data of great archaeological significance.

No further investigation of the materials is recommended.

References

Belford, P. 2012. Hot blast iron smelting in the early 19th century: a re-appraisal. *Historical Metallurgy*, **46** (1), 32-44.

Hoskison, T.M. 1945. Northumberland Blast Furnace Plants in the 19th Century, *Transactions of the Newcomen Society*, **25**:1, 73-81. [DOI: 10.1179/tns.1945.008]

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