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Evaluation of archaeometallurgical residues from Llynfi Ironworks

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Evaluation of metallurgical residues from Llynfi Ironworks

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Abstract

Bulk samples from Llynfi Ironworks have been evaluated through the extraction and wet sieving of small sub-samples.

Only Sample #4 was potentially closely linked to direct metallurgical activity. It comprised spheroidal hammerscale, probably representing spatter from a steam-hammer or similar equipment.

Sample #1 was clinker from a coal-fired hearth, quite possibly a steam boiler. Samples #6, 7, 9, 11 were all dominated by fine-grained coal detritus. Some of these samples, and possibly all of them, were laminated and therefore possibly at least partially water-lain.

Samples #2 and #3 were somewhat similar in the nature of their brown clay matrix. Both were rich in coal detritus, but #3 also contained a great deal of varied gravel-grade debris from a variety of sources.

Samples #5 and #10 contained assemblages of rather coarser detritus, including slag fragments as well as fuel-related materials. These detrital materials were very varied, indicating that the material was not associated with any particular metallurgical process.

Sample #8 comprised a tough dark slabby material, containing a fibrous substance. This was not examined in detail because of the risk of this material being asbestos. The sample was likely to have been some form of pipe lagging.

No bags labelled #12, #13 or #14 were present. However two bags with no labels were present. The contents of these bags appeared similar (so were presumably either #12 or #13). The material comprised an ochreous collection of mixed coal detritus and varied slags. One sample contained soft material, possibly degraded leather or rubber.

Contents

Methods

As an evaluation the samples were tested to assess the likelihood of yielding significant information. Small sub-samples of each bulk samples were examined and wet sieved at 100μm. The residues were examined optically using a handlens or binocular microscope as appropriate.

Because this is an evaluation the identifications and interpretations offered are not intended to be definitive, and are limited by the optical approach employed.

Results

Sample1 (C138): ochre-coated contorted clinker bearing abundant fired shale fragments. The clinker is dominantly of a rather pale colour and much seems to have the form of twisted plates.

Sample 2 (C145, fill of 108): soft brown clay containing coal debris (dominant) and a little spheroidal hammerscale. The coal debris is mainly very fine grained. There is also a range of fragments of a khaki-coloured mudstone.

Sample 3 (C147, fill of 115): brown clay, containing coarser and more varied debris than sample 2, including slag fragments, spheroidal and flake hammerscale, brick, coal and fired coal shale.

Sample 4 (C148, fill of 102, 103, 113, 135 & 136): dense mass of spheroidal scale up to 2mm in diameter, bearing a few larger slag lumps, mainly dense slag fragments. Mostly uncemented material, although some lumps of material possibly cemented by secondary corrosion products are included.

Sample 5 (C144, fill of 122): mixed coarse debris, including blast furnace slag, limestone, coal, coal shale, clinker, mortar, and sandstone.

Sample 6 (C149): fine coal debris, mainly sand grade, rarely extending up to 10mm. Includes a very small proportion of coke fragments, but dominantly unburnt.

Sample 7 (*C250, fill of 217/249; 2 bags)*: soft black finely-layered sediment. Finest grades probably coal fines or soot, sieved residue dominated by sand grade coal particles. Has small enclaves of yellow-brown quartz sand, of uncertain significance. The material includes some coarse grains including rounded blistered masses which appear to be a low density fuel ash slag.

Sample 8 (C283): fine dark material, locally hard and concretionary, which was fractured to reveal that it was bound by fibrous, transparent brown hair-like material. This would appear to be lagging. This material may well contain asbestos, so is not being examined further at this stage.

Sample 9 (C370): dense cemented layer of dark material. Although indurated, this material otherwise resembles closely the material in Sample 7. It is dominated by small sand-grade coal particles, it contains soft quartzose sandstone grains a few mm in diameter, and harder pale sandstone fragments, sometimes with glazed and clinker coated surfaces.

Sample 10 (C376): up to several 10s of mm fragments of iron, limestone, coal, coal shale, fired coal shale and bottle glass, cemented probably by the corrosion of the iron inclusions. This is very heterogeneous debris.

Sample 11 (C305): soft black material apparently dominated by coal fines, but also bearing some small proportion of hammerscale.

Sample unlabelled: ochre-rich partially cemented material bearing clasts of vesicular low density and high density slags. The material is apparently dominated however, by cemented coal debris. Also contains a few rare grains of probable spheroidal hammerscale.

Sample unlabelled: description as previous unlabelled bag. Also includes small soft fragments of degraded leather or rubber?

Interpretation

Only sample #4 was close to being a deposit of primarily metallurgical character. It is almost entirely composed of small spheroidal bodies. Such spheroidal particles are most likely to be “spheroidal hammerscale”. These are slag droplets expelled forcefully from the work piece during hammering. Most examples in archaeometallurgy have been described from blacksmithing (Starley 1995), but it is clear that similar droplets are expelled during steam hammering, but on much greater scale (see http://www.youtube.com/watch?v=vRqLfiC7uCU for an early 20th century steam hammer in action).

The accumulation of the spheroids would not normally be permitted on the forge floor – so material such as sample #4 would be expected to accumulate in a secondary position. Somewhat similar material, although more indurated than the present sample was recorded in the initial evaluation of the site (Young 2005, context 305).

A group of samples (#6, 7, 9, 11) were all characterised by an abundance of coal fines. This ranges (in the sieved residue) up from sand-grade material to fragments several mm across. Several of these samples also contain slaggy material in the form of vesicular slag blebs and vitrified stone fragments. This material is frequently seen to have been laminated, but it remains unclear whether some or all were water-lain, or whether these were deposits from flues, with moving gas responsible for the particulate transport.

Sample #1 contained contorted pieces of clinker, comprising partially fused fragments of coal-shale. Such clinkers are not necessarily the waste from a metallurgical process (particularly given the lack of slag). It is more likely that these clinkers are derived from a coal fired hearth, such as a boiler.

Samples #2 and #3 were distinguished from all of the above group by a prominent brown clay matrix, rather than a black coal-dust rich matrix. Sample #2 contained only coal fines and pieces of a khaki-mudstone, whereas sample #3 contained a wider variety of clasts. These clasts appear to sample the whole range of particles likely to have been in the local environment including coal detritus, various stone, brick and mortar fragments, together with some slag.

Sample #8 has not been examined in detail, because cursory examination suggested it might be lagging material, and therefore very likely to contain asbestos.

Samples #5 and #10 contained assemblages of rather coarser detritus, including slag fragments as well as fuel-related materials. These detrital materials were very varied, indicating that the material was not associated with any particular metallurgical process. Sample #5 contained some blast furnace slag (separating this sample from the others). This might have been introduced as contemporary material from elsewhere on-site, but equally might have been derived from the underlying dump of blast furnace slag upon which the ironworks was built. Sample #10 contains a sherd of what appears to be bottle glass; again providing evidence for these coarse deposits as generalised waste accumulations.

No bags labelled #12, #13 or #14 were present. However two bags with no labels were present. The contents of these bags appeared similar (so were presumably either #12 or #13). The material comprised an ochreous collection of mixed coal detritus and varied slags. One sample contained soft material, possibly degraded leather or rubber. The high ochre context linked these samples with sample #1. The most likely source of the ochre is as a post-depositional precipitate resulting from the passage of iron-rich groundwater through the deposit. The source of the iron in such a situation is not limited to the

ironworks waste, but may also be generated from water from coal mines or coal waste.

Evaluation of potential

The samples have a rather limited potential to illuminate site activities and processes. Sample #4 is likely to represent residues from the operation of a steam hammer or similar equipment. Similar spheroids occur in several other samples (as well as in material from the site evaluation in 2004). This sample is the only one to show direct linkage to a particular metallurgical process. Its interest may lie in the apparent lack of documentary evidence for a steam hammer on the site, and if this is true, then documentation and analysis of the spheroids may prove useful. However, to the author's knowledge, no detailed description of steam hammer spatter has been published with which comparison could be made.

Material with high levels of coal fines may represent deposits from flues, but sediment texture may be more informative for depositional processes. Coal fines would likely to be widely distributed around the site.

Slag occurs in several of the samples, but it seems unlikely that there is a direct relationship (since the material in the samples is so mixed) between any of the slag-bearing samples and any particular metallurgical process.

The tentative identification of sample #8 as lagging material could be pursued if important to the interpretation, but for Health and Safety reasons (the potential of the sample to contain asbestos) this has not been undertaken in the evaluation.

References

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