Lead bale sites in Nidderdale

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ABSTRACT: Five lead smelting sites have been located in Nidderdale, Yorkshire and residues from them examined. In addition, several other possible sites have been identified from place names. Nidderdale is unusual in that early mining was controlled by monasteries and the records of one, Fountains Abbey, contain considerable information on the medieval lead industry. The sites are located near woodland and on routes which are determined by the positions of river crossings and monastic granges which would have served as staging posts or administrative centres. There are references in the Fountains records of the use of a furnace for smelting lead and it is possible that this took place at a smelting site at Dacre Banks. The relative paucity of smelting residues at the Nidderdale sites has been attributed to the mineralogical composition of the ores which led to minimal incorporation of silica into the slags, the instability of roasted calcite slags with regard to weathering and the fertility of the soil which would have promoted rapid regeneration. Many of the place name sites are on private land where access is relatively difficult.

Introduction

A considerable amount of work has been published on the identification of lead-smelting bales sites in North Yorkshire, with over 50 sites reported. Although there is very little historical documentary matter available on these sites, surveys and slag studies have been carried out and an improved understanding of the smelting process is gradually being made (Smith 2005; 2006; Smith and Murphy 2007). In contrast, much less is known of the communities which were engaged in mining and smelting or of the socio-economic structure of the medieval mining industry. Virtually all of the published work on bales in North Yorkshire concerns Swaledale (Murphy and Baldwin 2001; Smith and Murphy 2003) and, to a much lesser extent, Wensleydale. Apart from a few place names, little is known of bale-smelting sites in neighbouring areas such as Wharfedale or Nidderdale. Despite this, there are more extensive documentary records available for Nidderdale, many from monastic sources. It seems appropriate, therefore, that these areas should receive more attention with the aim of utilising technical, archaeological and historical approaches.

The authors have carried out many field-walking searches for sites in Wharfedale and Nidderdale. Grassington and Coniston Moors have been explored but with no positive results. Field walking has discovered several sites in Nidderdale; some have been found from place names, others have been passed on from colleagues, others by searching in what were thought to be suitable locations.

Historical background

The main background to the history of Nidderdale is taken from Jennings (1967). The earliest indications of lead mining and smelting are the two lead pigs discovered in a hole in the ground on Heyshaw Bank in 1735 having the inscription: IMP. CAES. DOMITIANO AVG. COS. VII (Imperatore Caesare Domitiano Augusto Consule Septimum—Emperor Domitian's seventh term as consul, *ie* 81AD). The word BRIG. is also cast on the side of each pig. One of the pigs was kept at Ripley Castle and the other at the British Museum (Kirkshaw 1735; Raistrick 1930). A third pig was found near Nussey Knott and had an inscription indicating the name of the emperor Trajan *ie* 91–117AD (Lucas 1885). This pig has since been lost (Raistrick and Jennings 1965).

The Domesday survey of 1086 shows that most of Nidderdale was held by the Anglo-Saxon lord Gospatric (who held lands at the time of Edward the Confessor), the Archbishop of York and the Crown but all of the estates in the upper dale were described as waste as a result of William I's punitive 'harrying of the north' after the uprising of 1069.

By 1110 the northern parts of the upper dale, previously held by Gospatric, had passed to the Norman Mowbray family who held the Honour of Kirkby Malzeard. They turned large parts into a private forest, the Chase of Nidderdale. Most of the SW area became the royal Forest of Knaresborough, while lands in the eastern part of the upper dale remained under the control of the Archbishop of York. The conversion of most of the upper dale into hunting chase effectively froze recovery from the harrying of the north and ensured that when this did take place, the influence of the monasteries and the archbishopric on the economy of the area became dominant.

In 1132, the Archbishop of York gave land in Skelldale to a group of disaffected Benedictine monks of St Mary's Abbey, York, where they founded the Cistercian monastery of Fountains Abbey. A few years later, the Mowbrays founded Byland Abbey, near Thirsk. Gradually over the next fifty years the Mowbrays granted lands in the northern part of the upper dale to Byland, while various sub-tenants of theirs granted lands to Fountains.

At some time between 1143 and 1166 Roger de Mowbray passed on to Byland a tenth of his lead-mining royalties or output and later gave lead mining and smelting rights to both abbeys (BL Egerton 2823 fol. 51, 76). This clearly indicates that secular lead mining was established, to some extent, in the upper dale before this time and led the way for a monastic lead industry in Nidderdale. The land grants increased after 1172 when Roger de Mowbray made more in exchange for various payments to raise money for the crusades. When Roger died in 1188, the two abbeys held lands in most of the upper dale, except those of the Archbishop, although the Mowbrays retained the hunting rights and placed appropriate restrictions on the monks' activities within the area of the Chase. From this time, several disputes arose with the Mowbrays who tried unsuccessfully to regain some of their lands from the monks.

Throughout the 13th century there are records of disputes between Fountains and Byland regarding mining rights and in the 14th century between Fountains and the officers of the Honour of Kirkby Malzeard.

The area was regarded as being inhospitable and conditions difficult. This is exemplified in an exchequer account of 1365 for the hire of two waggons for transporting 24 fothers of lead from 'Coldstones in Nidderdale by high and rocky mountains and by muddy roads to Boroughbridge' (TNA: PRO E101/598/9). Another example occurred in a dispute over tithes raised by the people of Bewerley and Pateley Bridge, which were being sent to the parish church at Kirkby Malzeard, nine miles away. The residents were said to be 'farre distant from anie parish church, to the which for the swellings of waters and other tempests greatlie in winter season some men cannot passe without greate difficultie and corporal danger'. Today, the mining areas are bleak, virtually unpopulated heather moorland; the valley of the Nidd, in contrast, is made up of villages, enclosed pastures and woodland.

At the extreme west end of the area, Bolton Priory (situated in Wharfedale) had acquired the manor of Appletreewick in 1300 and was carrying out lead mining there. At the same time in the west, Fountains Abbey was engaged in a protracted dispute concerning the ownership of lead mines near their boundary with the Forest of Knaresborough (TNA: PRO DL42/19/31, f39v and f72v). In 1480, the tenants of the Forest complained about the opening of a lead mine by Bolton Priory at Mungo Gill, near Craven Keld. In 1529 Thomas Pulleyn of Blubberhouses and William Deaconson of Brame, near Fewston, took out a lease from the Crown of this ground to test the lease. They were forcibly ejected by the prior's men and the dispute continued on and off, after the deaths of the two protagonists and well after the Dissolution in 1539, when it was taken up by the new landowners. (TNA: PRO DL42/ f74v; DL1 Vol 22, App. 6; DL1 Vol 7 D3)

By the end of the bale-smelting period around 1580, lead mining in Nidderdale, Greenhow and Appletreewick was well established and covered most of the areas exploited up until the late 19th century.

Place names

Searches for possible bale sites were made during 2001–05, looking at possible sites near mining areas, place names, and places where bales were thought to have existed. These are summarised in Table 1 and are shown in Figure 1. The name 'bale' is said to be derived from the Norse '*baal*' (fire) but care should be taken with place names, as the term has been given to the sites

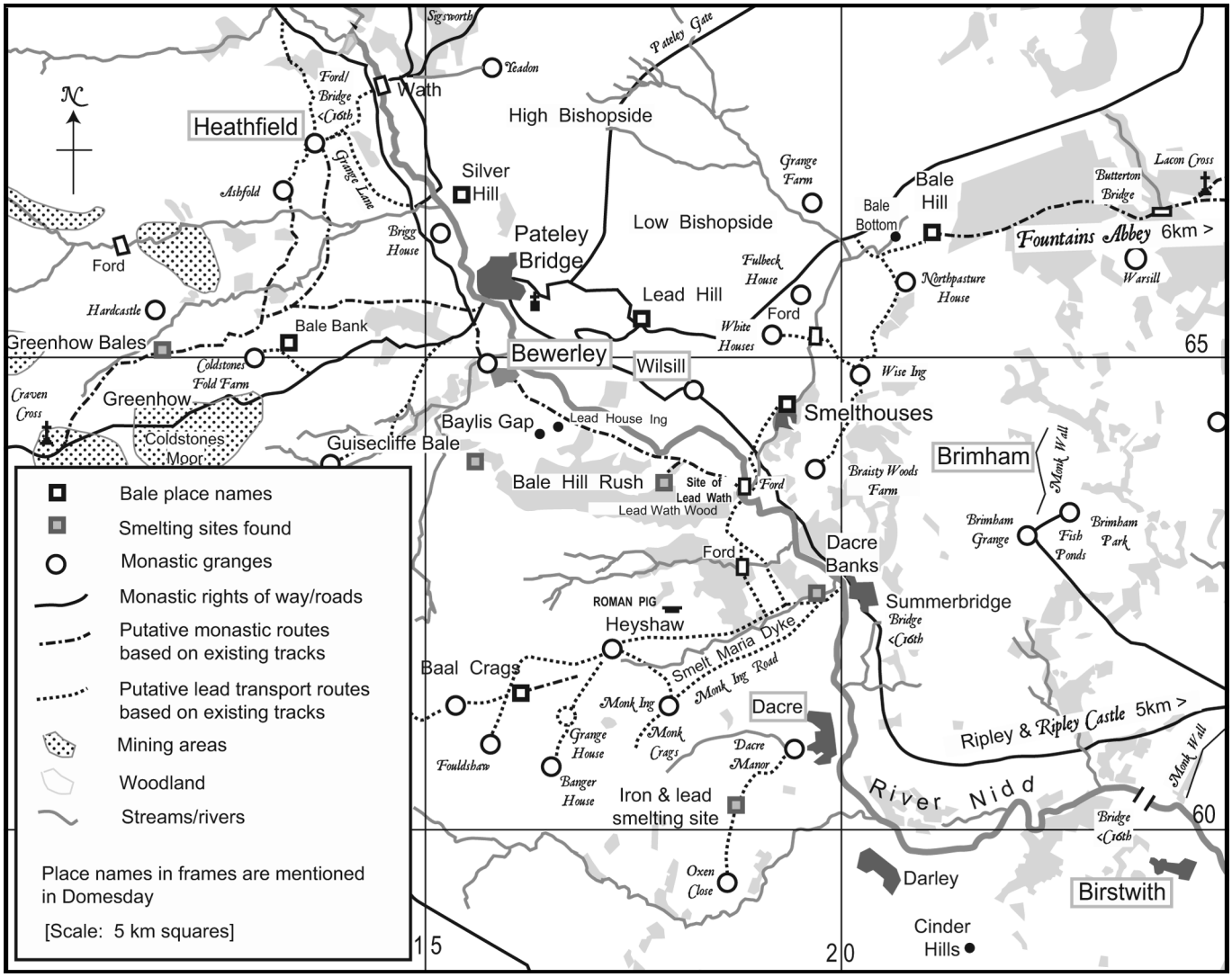

Figure 1: Map of the Nidderdale showing mining districts, bale smelting sites, place names, woodland, abbey granges and medieval roads.

of beacons used for signalling. This latter practice appears to be most prevalent in the West Pennines around Appleby, where Scottish incursions were relatively frequent. In upper Nidderdale, however, 'bale' place names appear to be associated with lead smelting.

Other place names such as Lead Hill and Silver Hill imply some sort of metallurgical connection and both are on the flanks of the Bishopside where records refer to lead being smelted (YAS, Fountains Lease Book, ff.94v, 95.). There are two Blazefields in the area but this name appears elsewhere in Yorkshire and may not refer to lead smelting. Brandstones ('burnt stones') Beck runs alongside Bale Bank and past two bale sites. Lead Wath is a crossing over the Nidd (the word 'wath' is a term used in Yorkshire for a ford) and Lead House Ing is an enclosed wood. Smelt Maria Dyke runs through several iron- and one lead-smelting site but appears to be a relatively new name, derived by sequential corruption of earlier names.

The village of Smelthouses has been proposed (Jennings 1967; Raistrick and Jennings 1965) as the main centre for monastic lead smelting. There is no supporting evidence for this other than the place name. The village is ideally located on a route between the mining areas and Fountains Abbey. However, it may have been where the smelters lived or it may have been associated with iron working. The First Edition Ordnance Survey map shows the place as 'Smelthouse' with several coal pits at the N end of the village.

Bale sites and slag finds

Greenhow 204 and 205

Greenhow 204 and 205 were close together (Fig 2) and are immediately above Brandstones Beck. They are the only bales found so far in the vicinity of the mining areas. Further N, a part of the same hill side is known as Bale Bank. No smelting residues have been found for site

Table 1: Names and positions of bales and notes on lead-related residues

Site or place name	NGR	Position	Residues
Tag Bale	SE 054 667	Gritstone outcrop overlooking Gate Up Gill	None found
Baal Crags	SE 163 617	Gritstone outcrops	None found
Bale Bank	SE 138 652	N facing slope near Bale Bank Farm	
Bale Bottom	SE 208 665	Lower slopes of Bale Hill searched without traces; summit not examined	None found
Bale Hill	SE 210 662	Summit not examined	
Bale Hill Rush site 208	SE 178 63600	Summit of hill which has been quarried away	Traces of reddened stone with sparse Pb metal and cream Pb silicate on tumbled rocks on W slope
Bale Ing	SE	Not known but referred to by Jennings	
Baylis Gap	SE 164 641	Building	
Blazefield	SE 129 658	Building	
Blazefield	SE 180 653	Building	
Brandstones Beck	SE 119 651	Stream running through mining area at foot of Greenhow Hill.	
Greenhow site 204	SE 11653 64893	E side of small ridge by track to Gillfield Level	Heavy grass cover; charcoal in small pieces; site faces W
Greenhow site 205	SE 11642 64880	W side of small ridge by track to Gillfield Level, Greenhow Hill.	Reddened stones and black patch. Little sign of slags on surface but moderate amounts of fine Pb prills with sparse galena and one piece of black slag. Site faces W.
Guisecliffe site 207	SE 15620 63661	E side of road half way up Guisecliffe, flat part nr boulders	Bits of cement-like white slag which occludes galena
Silver Hill	SE 152 666	W facing hillside	
Lead Hill	SE 179 655	S facing hillside	
Lead House Ing	SE 165 643	Enclosed wood	
Lead Wath	SE 188 635	River crossing, now a weir	
Lead Wath Wood	SE 188 633	Wood near Lead Wath	
Smelt Maria Dyke, Dacre Banks	SE 197 623	Grassy field by N bank of stream	Slags
Smelthouses	SE 196 644	Village	

204 but there are copious charcoal residues exposed by breaking away of the side of a bank. This could be either a bale site or a charcoal heap. Site 205 is a black patch with reddened stone and minute lead prills. A tiny piece of vitreous black slag was found on the surface with some tiny pieces of galena. Because the residues were readily identifiable, no SEM/EDX studies were carried out.

Figure 2: Greenhow 204 and 205 bale sites.

Guisecliffe 207

There are few traces of metallurgical activity at this site, which is on one of the few roads over the high escarpment of Guisecliffe on the S side of the Nidd (Fig 3). The site is immediately above a wood named Lead House Ing and a feature shown as Baily or Baylis Gap. Metallurgical residues are very sparse and difficult to detect. There is a pro-

Figure 3: Guisecliffe 207 site.

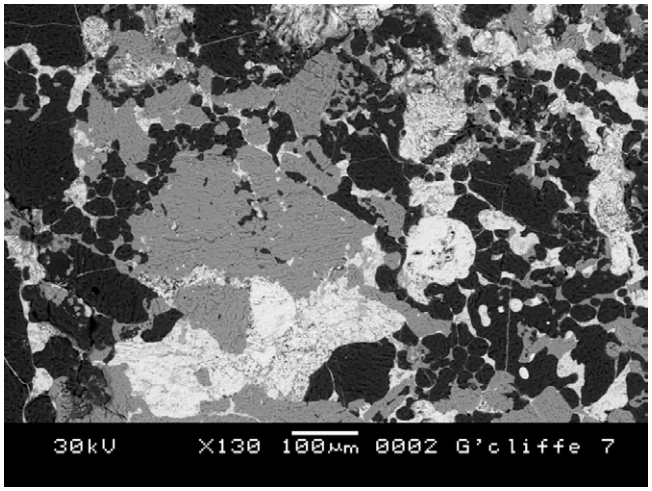

Figure 4: BSE micrograph of lead slag from Guisecliffe 207. The phase that appears white and light grey is lead carbonate with some galena, the mid-grey phase is barytes and the black phase is fluorite. The minerals show rounded edges, indicative of chemical reaction.

fusion of white gritty material which appears to be burnt limestone. Some of this had very small pieces (<1mm diameter) of what appeared to be galena. When examined by SEM/EDX, they were unmistakably lead-smelting slags consisting of lead carbonate, barytes, fluorite and galena. An example is shown in Figure 4. The phases were rounded in a way which suggests melting or chemical attack and one of the eight samples examined had inclusions of carbon.

Bale Hill Rush 208

Bale Hill Rush is a small hill with what is probably a potash kiln in a group of trees at its foot (Fig 5). This would have been constructed for the textile industry which has supported the dale for centuries. The kiln is ideally placed for access to large supplies of bracken and wood. Most of the top of the hill has been removed, apparently for stone, and traces of metallurgical activity destroyed. On the SW slope some reddened stones were

Figure 5: Bale Hill Rush 208 site.

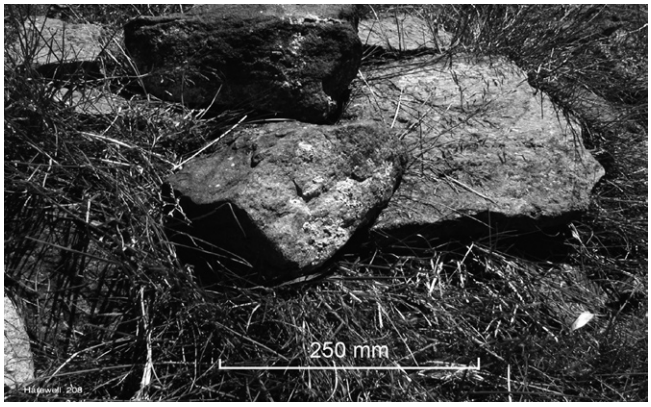

Figure 6: Lead and slag splatters on sandstone at Bale Hill Rush 208.

found which had slag and lead splatters on them (Fig 6). These were rare and obviously identifiable and it was decided that these should be left in place as further examination would add little.

Dacre Banks, Smelt Maria Dyke

Several iron-smelting sites and one lead-smelting site have been reported (Blacker *et al* 1996) throughout the course of a stream known as Smelt Maria Dyke. Although the name appears to indicate metallurgical activity and drew the authors there, it has since been proved from old maps to have been derived as a series of corruptions. Nevertheless, lead slags have been found in the N bank of the stream. The site has been the subject of a geophysical survey by Bradford University (Vernon *et al* 2002) reproduced in Figure 7. The main feature of

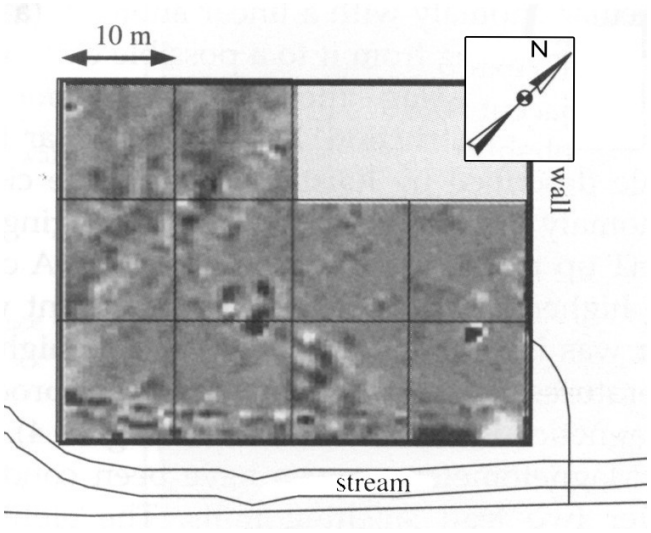

Figure 7: Geophysical survey of the Dacre Banks site. The diagonal line running N-S across the left hand corner correlates with a difference in levels of about 1.5 m with the higher ground on the top left. The line running SW-NE across the bottom is a path. The three black spots near the centre represent the anomaly believed to be a lead smelting site or furnace with the slag/metal running E towards the stream. The signal strength is 10nT (black) to -10nT (white); reproduced from Vernon et al *2002.*

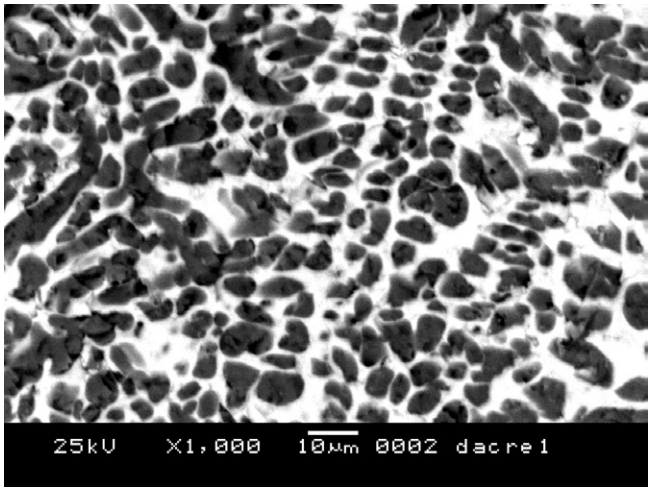

Figure 8: BSE micrograph of lead slags from Dacre Banks. The rounded particles are fluorite (black) in a matrix of mixed Ca/Ba/Pb silicate (white).

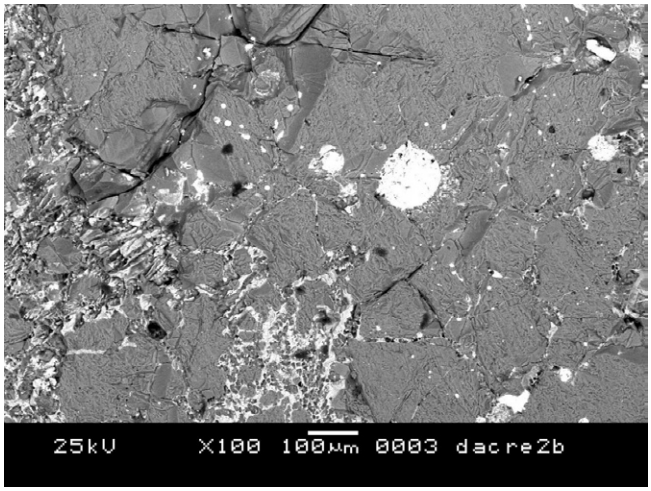

Figure 9: BSE micrograph of lead slags from Dacre Banks. The majority of the sample consists of unreacted fluorite (mid grey) held together by a matrix of mixed Ca/Ba/Pb silicate (white).

interest is the circular patch with a channel leading east from it, running to a tapping area near the stream. Vernon has passed on to us some of the slags which were found in this area and in the bank of the stream. Although the authors have visited the site, they have not found lead slags, either in the field or in the bank of the stream. The slags which have been examined are mixed silicates with considerable amounts of fluorite; lead has been found as metal, carbonate or sulphide (Figs 8 and 9).

Unlike the other sites, or the place-name sites, this is a most unlikely location for a bale. It is situated in a sheltered, flat location at the foot of a hill. A small ridge about 1.5m high runs across the field and the anomaly found by the geophysical survey is surprisingly at the foot of this ridge rather than at the crest. It is possible that this could be an early furnace, blown by bellows, in which case the small ridge would be of assistance with charging or working a footblast. This is one of the most interesting sites in Yorkshire and worthy of further investigation.

There is an account of lead metal being transported from Dacre to Warsill (Fowler 1918, 573 and 148–51). The memorandum book of Thomas Swynton of Fountains Abbey, 1446–58, refers to repairing ironwork at the smelting mill at a cost of 4d and to a blacksmith, William Hudson of Adfield, for making a *'sufflatorium pro le bales'*; which has been taken to be a tuyere or blast pipe for a bellows-blown furnace. Other references are to two smelters, one of whom is described as a *'baler'*. This account has other references to a smelt mill (Fowler 1918, 142–53 and 240–41). These records have been taken (Raistrick and Jennings 1965; Jennings 1967) as referring to a smelting works at Smelthouses but it is equally probable that they may refer to Dacre Banks.

Thomas Grainge (1863, 65) refers to 'a bale of more than ordinary size' at Dacre Banks, which 'was found to contain so much unfused ore that it was removed and smelted again with profit'.

Dacre

Since 2005 an important iron–smelting site has been discovered at Dacre, coincidentally on one of the monastic tracks between granges (Fig 1). On the edge of this is at least one lead-smelting site where significant spatters of lead have been found together with reddened stone and white slags, similar in appearance to those found at Guisecliffe. The lead-smelting site has not been excavated and is currently covered with turf. Several of the documentary references for Dacre Banks above could apply also to this site. (Brophy and Hovell 2010).

Location of the sites

Bale sites in Nidderdale do not follow quite the same pattern as in Swaledale or Wensleydale in that most are remote from the mines. This is a result of the scarcity of woodland in the upland mining areas. As there is a profusion of woodland along the course of the Nidd and its tributaries, the location of bale sites is therefore influenced very much by transport routes. Between the 11th and 14th centuries Fountains Abbey would have had a dominant influence on lead mining, and routes to the abbey would be expected to be very important, as indeed they are. The countryside was perceived to be hostile and dangerous and the abbey granges would have played an important part as staging posts along the way or as administrative centres nearer to the mines. Imposed on this pattern was the existence of few crossings over the Nidd (Fig 1).

The river has changed considerably as a result of the development of textile mills and the building of associated weirs and dams; these have made fording the river more difficult today than previously. Nevertheless, historical records do suggest that crossings were at some of today's established bridges or at definite fording points and that there were few of these. In the S, a bridge or crossing may have existed at Summerbridge very close to the Dacre Banks site on Smelt Maria Dyke. A few miles upstream, the ford at Lead Wath would have served the bale at Bale Hill Rush. A road or track is shown on Thomas Jeffery's map of 1770 connecting this with the village of Bewerley (Jennings 1967) which is now a farm road. Further upstream, the bridge at Pateley Bridge would have served the bale sites on Greenhow and at Bale Bank. Three other upstream crossings beyond these were known to have been used by the monks of Byland Abbey, whose main routes of access were through the N and NE parts of the dale (Fig 1).

An agreement of September 1527 between the abbot of Fountains and Marmaduke Bayn, John Parkinson and William Lupton permitted them to carry away all the ore delivered to them on Greenhow Moor to 'the baill hills in the Bishopside' and to smelt it, making one fother of lead for every eight loads of ore (YAS Fountains Lease Book). High and Low Bishopside occupies virtually the whole of the N side of the dale in this part and more precision is needed to locate the sites themselves. Access to these areas has not been possible to date as they are on private enclosed ground. Silver Hill on High Bishopside would be away from the route to Fountains Abbey but on that known to be used by Byland and is immediately opposite a crossing point. Lead Hill is on the direct road between the mines and Fountains Abbey. It is fairly close to an Archbishopric grange at Wilsill. The lower parts of Bale Hill and the associated Bale Bottom have been searched without success; the upper reaches have not. This particular site is on a direct route between the crossing at Lead Wath and Fountains Abbey and is situated close to a grange of Fountains at North Pasture House. The country between the crossing and the grange is thickly wooded today and would be inappropriate for the siting of a bale. Bale Hill is the first exposed location on this route.

The sites at Greenhow 204 and 205 and the place name Bale Bank are near the mines on Coldstones, on an obvious route to the valley down Brandstones Beck and at a suitably exposed location with access to a supply of timber. Coldstone Fold Farm was a grange of Fountains Abbey and it is probable that it was also an administrative centre for the lead mines.

Smelting residues

None of the sites examined have displayed the profusion of smelting residues found in Swaledale or Wensleydale and there are a number of possible reasons for this. Nidderdale now consists of improved, enclosed pasture land with a thick soil cover, unlike the other dales where bales are generally found on uncultivated heather moorland. There has been considerably more activity which would destroy traces of sites and also more tendency for natural regeneration processes to do this. Many bale sites in Swaledale consist of splatters of lead silicate or lead on exposed stones at the surface of bare patches of ground. Such sites would become rapidly grassed over in Nidderdale or the stones removed to improve the land. It is not surprising therefore that signs of smelting activity are much more difficult to find.

The mineralogy of the ores may also be significant. The most profuse residues in Swaledale consist of mixed silicate slags or slags having a large proportion of barytes, often cemented by silicates. Although the main country rocks in the mining areas of Nidderdale are millstone grits, silicates may well have been relatively sparse within the mineral veins or the concentrates were very well dressed. Where the main vein material was calcite this would have been calcined to calcium oxide (quicklime) in the bale and natural weathering would have dissolved and dissipated this very rapidly. Eventually, the finely-divided residues would have been stabilised by reaction with carbon dioxide to form calcium carbonate. Any stable species such as silicates or fluorides would have been broken up by the disintegration of calcite in this way and although these residues would survive, they would be difficult to find. The residues at Guisecliffe are strongly suggestive of this. No slags have been found at Greenhow 204, 205 or at Bale Hill Rush. The slags at Dacre Banks consist mainly of gangue minerals held together by relatively small amounts of mixed silicates.

Conclusions

In this area place names have been good indicators of smelting activity and more work is to be done on this aspect with the aim of investigating these more closely. A good example is the high ground on Bishopside, which was known to be used for smelting and has not been examined in this work for the reasons given above. Without exception the sites examined, together with place name sites, have been in fairly close proximity to woodland and generally remote from the mines.

They have been on recognized old transport routes to either Fountains Abbey or its granges. The routes are particularly influenced by the presence of the few river crossings which existed during the period of monastic working of the mines.

The site at Dacre Banks is unusual in that it is situated in a sheltered lowland location, more suited to a furnace than a bale. A geophysical survey supports this view although it is not conclusive and excavation on this site is recommended.

The sites in Nidderdale which have been examined to date have sparse residues and this has been attributed to the low silica and barytes content of the ores; those examined have shown high amounts of fluorite. This is somewhat surprising as the soils on which the bales are situated are sandy or are clays. Improved agricultural land and thick soil cover has also tended to obscure or destroy traces of smelting activity and enclosures have made access more difficult when compared with the open moorland situations found in other dales.

Acknowledgements

Our thanks are due to Mike Gill and Richard Lamb for information on possible bale sites in the area, and to Rob Vernon for details of his geophysical survey at Dacre Banks and for permission to reproduce Figure 7.

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