THE BARKER FAMILY AND THE EIGHTEENTH CENTURY LEAD BUSINESS

By Lynn Willies
(Hilderstone, Dale Road, Matlock Bath)

The mining and smelting business of the Barker and Wyatt families has previously been considered by the late Dr. Hopkinson in this Journal and elsewhere.[1] The present purpose is to examine in rather more detail the problems of organisation and management in the lead business, especially in the Barker lead business, in light of the additional information and research which has accumulated in the last decade or so. The debt to Dr. Hopkinson's work will be obvious, and occasional disagreements about fact and interpretation do not detract from the importance of his early study.

The Barkers are especially significant in that their business spanned a transition from small-scale to large-scale organisation, involving a considerable degree of horizontal and vertical integration. They are significant also as being the only 18th-century lead business whose records, to a considerable degree, are extant.

The lead business had within it three main functions: the mining and washing of ore; the buying, smelting or burning of ore; and the merchanting or disposal of the lead. Though it was not unknown for these functions to be partly or even wholly integrated before the 18th century, it is certain that generally they were separate. The key figures in the industry were usually the lead merchants and lead smelters who required large amounts of capital to purchase stock. Integration of these two functions was common, but not necessarily dominant, at the beginning of the 18th century.

Further integration, of all four functions, seems to have been fostered by technical developments: in mining, by deeper working with pumping engines and long soughs, and in smelting, by the introduction of the cupola furnace,*[2] both of which required much more capital than former methods. The cupola furnace may have been the main stimulus towards full integration, as it required both large and constant supplies of ore to reap the full benefits of scale economies. The first major company to exploit the cupola, the London Lead Company, though rather unsuccessful in Derbyshire, deliberately set out to exploit this advantage by large-scale mining.[3]

In the early part of the 18th century, most 'ore burners' seem to have been relatively small capitalists, and lists of them, either as non-attenders at the regular barmoots,* when they were amerced 1s. or as payers of cope* in the barmaster's books, or as sellers of lead in lead-dealers' books, at the mill, or at Bawtry, are fairly long. Thus the Brights' purchases of lead at Bawtry between 1708 and 1719 were from a total of 26 men.[4] John Baddeley, the Winster Barmaster, had 25 cope payers on his books in the years 1721–26, usually buying from many, often small, mines.[5] Some 15 ore burners were amerced at an Ashford Barmoot in 1735.[6] Only a few names recur, so that many more are likely to be found if all the books for a particular period could be consulted. Some of these men may well have been buying and selling on others' behalf, which could lessen the actual totals of smelters. On the other hand, it was possible for a smelter to hire a mill* for a limited period, paying for it by the shift, as at Lumsdale and Calver smelting mills,[7] so that it was possible to be a smelter on relatively small capital.

By the mid-century, there appear to be far fewer names of cope payers. At Winster between 1743 and 1750, only six names are so recorded, and the bulk of purchases were made by two, Twigg and Barker.[8] At Ashford the number of ore burners who were amerced was down to ten,[9] Barker and Twigg heading the list. Both Barker and Twigg were among the smelters who had first adopted the cupola process.[10]

(* reference): See 'Glossary', page 72.

In the early 19th century the bulk of ore buying was in the hands of the cupola owners, of whom Farey listed ten names (including family names as one entry) for the Derbyshire cupolas.[11] Some smelters controlled several sites: both the Hurts and Barkers controlled three. A list of cope payers in the Peak Forest Liberty for 1811 has a further eight names[12] not listed by Farey. As all these names also occur in the accounts of Lords' Cupola at a later date, smelting small quantities of ore and paying by the shift,[13] it can be presumed that they were 'relic' small capitalist smelters as referred to above. Some of these later bought or built their own cupolas, as did the Middletons, and possibly Royse at Bradwell, whilst Thomas Eyre later took over the Lords' Cupola at Stoney Middleton Dale.[14] As cupolas closed during the century, smelting became concentrated into fewer hands, so that in 1900 only two ore purchasers remained.

The smelters' activity also extended back into the mining of ore. Commonly shares were held in 1/24ths, or in fractions even smaller than this, and a smelter may have held shares in several or even many mining enterprises. At Winster, mining on a larger-than-usual scale began in the early part of the 18th century, in which four large companies participated.[15] With the exception of the London Lead Company, these mining companies were dominated by a few smelters, though shares were held by many of the local major and minor gentry. Thus at Yatestoop in 1766 there were 29 partners, including Lord Scarsdale, and at least a dozen smelters, but of the four who seemed to have executive control, three are known to have been substantial smelters.[16] For the two other major groups at Winster, the Portaway and the Plackett Proprietors, a similar situation can be demonstrated. The driving of soughs, a very expensive operation, in which a total expenditure of £30,000 was not uncommon, was also dominated by smelters—as at Meerbrook Sough, where three of the six directors were all of the smelting family of Hurt.[17]

In these activities, the Barkers were typical of the major concerns. In the sale of lead their methods again appear to be generally similar to other successful 18th-century concerns. In the early part of the century smelters usually seem to have sold their pig lead to lead dealers, who either purchased the lead at the mill or at one of the principal markets, especially Bawtry and Stockwith, or, in the case of Barkers especially, *via* an agent in London or Manchester or Hull. Much of the lead seems to have been exported, and there are very few references to its use in any form of manufactory with direct smelting connections. In the mid-1780s the imposition of an extra duty on raw lead exports led to an outcry from the smelters, ostensibly on behalf of the poor miners rather than of themselves) that it had caused a fall in price and in the quantity exported from Hull (down by 960 tons, about 25 per cent between the date of imposition, September 1784, and September 1785). The complaint is important in that the tax did not affect lead products, which the smelters resented, and in that the smelters correctly foresaw the competition to which they would soon be subjected from German and Spanish lead mines.[18] They were thus very conscious of the need to secure their position, and this was reflected in changes in organisation, prior to, and after, this date.

Barkers appear to have formed a partnership with Wilkinsons, who were lead dealers and red-lead manufacturers, after which practically all their lead was disposed of by the partnership. In 1755 ore worth £12,500 was smelted, so that the potential of a guaranteed outlet was considerable.[19] Milnes were active in mining and smelting in Derbyshire, but they seem to have concentrated on lead dealing,[20] and in the 1750s were in partnership with Wilkinsons.[21] In 1789 Sykes Milnes and Co. took over many of the interests of Twigg and Winchester when their smelting partnership collapsed,[22] including their Dore and Kelstedge cupolas. Sykes was the head of a Hull merchant house, and thus capable of providing capital and a guaranteed outlet. The Barker family (of Bakewell) also took action to maintain a market by acquiring a partnership, in the early 19th century, in the Sheffield White Lead Works. They were also considerable lead buyers from other cupolas[23] in the Middleton Dale area, a policy which was also followed by Barker and Wyatt, and then Wyatt, mainly after 1825 from Lords' Cupola.

The Barker Partnerships

A satisfactory account of the Barker family and their system of partnerships has yet to appear. In the 18th and early 19th centuries there were at least two main branches of the family, which, because of their predilection for the forenames George, Thomas and John, have been, and tend to be, confused. Dr. Hopkinson's account of the family and their mining and smelting business[24] appears to have errors and omissions due to this problem, and the following account must also be considered subject to correction if and when the Barker pedigree is completely determined.

The Barker Collection Catalogue[25] suggests that the family fortunes were founded in the 18th century, when Thomas Barker became Steward to the Duke of Rutland, and that his predecessors had been carpenters and wheelwrights.

This Smilesian type of origin seems unlikely, at least at this time, as the family had been living at Rowsley Hall for over half a century at that date, 1731.[26] Their fortunes were almost certainly tied up with their stewardships of both the Duke of Rutland, at Haddon and Belvoir, and the Duke of Devonshire, at Chatsworth. These posts, dealing, amongst other things, with the receipt of lot and cope payments to their respective employers, ensured that the Barker family had detailed knowledge of the production and prospects of almost every mine in the Peak District, and doubtless also gave them the opportunity to lease smelting mills, and the right to smelt duty ores on favourable terms. It is perhaps no coincidence that the Chatsworth Ore Accounts mainly date from the period when the Barkers took up their lead interests.[27]

The founding of their lead business appears to have been due to William Barker, Steward to the Duke of Devonshire, in 1729.[28] In 1731 a William Barker died,[29] and was probably succeeded by his son Alex. In 1735 or 1736 Alex Barker signed deeds of co-partnership with Thomas Barker, of Bakewell, Steward to the Duke of Rutland, as lead merchants.[30] Their interests were mainly in the mines near Monyash, smelting their portion of the lead at Shacklow.

In March 1743 George Barker, of Baslow, and Thomas Barker, of Bakewell, signed deeds as partners in the lead business, with George as manager of the business.[31] George and Thomas took over the smelting side of the business, apparently leasing the Shacklow Mill from Alex Barker.[32] Alex and Thomas Barker also stayed in business, probably dealing with the sale of smelted lead.[33] Hopkinson, however, wrote that the Alex and Thomas Partnership was taken over by George and John Barker, though he cited no reference.[34]

At this stage the two partnerships, Alex and Thomas Barker, and George Barker and Company seemed to operate separately. The activities of the former in buying and selling lead did not inhibit George Barker from conducting his own lead sales, either at the mill, or at Bawtry, etc., and the partnership accounts suggest that George was involved in mining and smelting and sales, much as the older partnership had been. The major feature of the George and Thomas Partnership is the expansion of smelting activity, so that the smelting mills at Rowsley and Beeley were soon taken over and put into good repair,[35] whilst smelting also took place at Calver Mill, possibly on a hire basis, in 1747, then under their own management in 1748.[36] In 1746 George Barker leased and smelted at Olda (Totley) Cupola and in 1748 took over the lease.[37] Soon after this the partnership between George and Thomas was dissolved, in November 1749, and the business then became the sole concern of George Barker until his death in January 1752. Why Thomas withdrew from the partnership is not known, though as he too died in 1752 it may have been ill health, or alternatively it could have been to concentrate on smelting on his own account, possibly at Rowsley and Beeley.

After the death of George, the business was taken over by Alex Barker, first as his brother's executor, then either on his own account or on a joint account with George's children. The functions of the two partnerships would thus be combined. At the same time he continued a close association with Milnes and Wilkinson, the latter taking nearly

all the lead produced for manufacture of red lead at their Brampton (part of East) Moor Mill. In or about 1759 a partnership was formed between Alex Barker and John and Isaac Wilkinson,[38] and from then until 1807 the firm was known as Barker and Wilkinson. In the late 1760s the Barker share passed to George Barker, perhaps when he became of age. In 1816 John Barker formed a partnership with Benjamin Wyatt, into whose hands the whole business accrued in 1829.[39]

The return of Alex Barker to the business marks the start of another phase of expansion. Harewood Cupola, built on East Moor not far from Wilkinson's Mill, was opened in November 1752.[40] In 1758 Washgreen Cupola was taken, and run by Barkers until 1774,[41] and Hopkinson suggests a brief holding of Lumsdale Cupola at the same time,[42] though it appears unlikely to have been used by them. In the 1760s they also smelted at two other mills in addition to Shacklow and Calver, at Barbrook and Stoke.[43] Rowsley and Beeley were probably given up in 1748, as the Rowsley stock does not appear in the 1749 accounts.[44] Barbrook, Calver and Stoke were closed between 1769 and 1773,[45] though Shacklow remained open until 1781.[46] Stone Edge was leased from Twiggs, certainly by 1774.[47] In 1803, George Barker purchased Middleton Dale (Upper) Cupola from John Storrs, son of the recently deceased Joseph Storrs,[48] after closing Olda Cupola the previous year.[49] In 1807, soon after George Barker's death and Isaac Wilkinson's retirement, the Stonedge Cupola was given up, so that John Barker's operations were concentrated at Harewood and Middleton Dale. In 1814 Harewood too was given up,[50] so that the business of Barker, later Barker and Wyatt, then of Wyatt alone, was concerned only with Middleton Dale.[51]

After Alex Barker had taken over the business, much of the ore-buying was done by a John Barker. Thus from 9th August to 12th September 1755 John Barker was paid £1,065 to settle 'sundries'.[52] Despite this importance in the affairs of the business, he does not seem to have become a member of the partnership. It seems likely that this John Barker was the son and heir of Thomas, of the joint partnership of Thomas and George Barker.[53] If so, then his involvement in mining and smelting is explained. John Barker, like his father, became Steward to the Duke of Rutland, during which time he opened his own cupola, on land belonging to the Duke of Rutland at Barbrook, Baslow.[54] The earliest positive indication of his smelting activity is contained in a list of subscribers, including a Mr. Barker, as well as Barker and Wilkinson, to pay the expenses of a petition to Parliament protesting about increased taxes on lead exports in 1775, though he may have smelted prior to this at Rowsley or elsewhere.[55] He is mentioned frequently as John Barker in subsequent ore accounts.[56] John Barker was succeeded by his two sons, Thomas and John, after his death in 1795.[57] After the death of John, in 1841, the business was run by his son Thomas Rawson Barker, as T. R. Barker and Rose, at Barbrook, Lords' Cupola, and finally Alport Cupola, until 1874.[58] Very few records of their business are extant.

The management of the Barker business can be divided into three operations: the maintenance and pricing of the ore supply; the acquisition and profitable running of the smelting works and the profitable disposal of the lead produced. Unless otherwise stated, the following account refers to the main Barker Company, not the Barkers of Baslow or, later, Bakewell.

The ore supply

The Barkers used three expedients to secure their ore supply. The most secure, and eventually possibly the largest ore supply, came direct from mines which they controlled, or had shares in. In the 1730s the Barker holdings in mines were still slender, and mostly in the Monyash area. Thus at Whafe Mine the family held only three twenty-fourths shares, but may have controlled a further twelfth, as 'Steward Barker for Mr. Sheldon'. As several other smelters also held shares, the total output was probably divided proportionately between them.[59] As the business expanded, so did the mining interests become more important. In the 1740s they took part in the rich Elton discoveries at

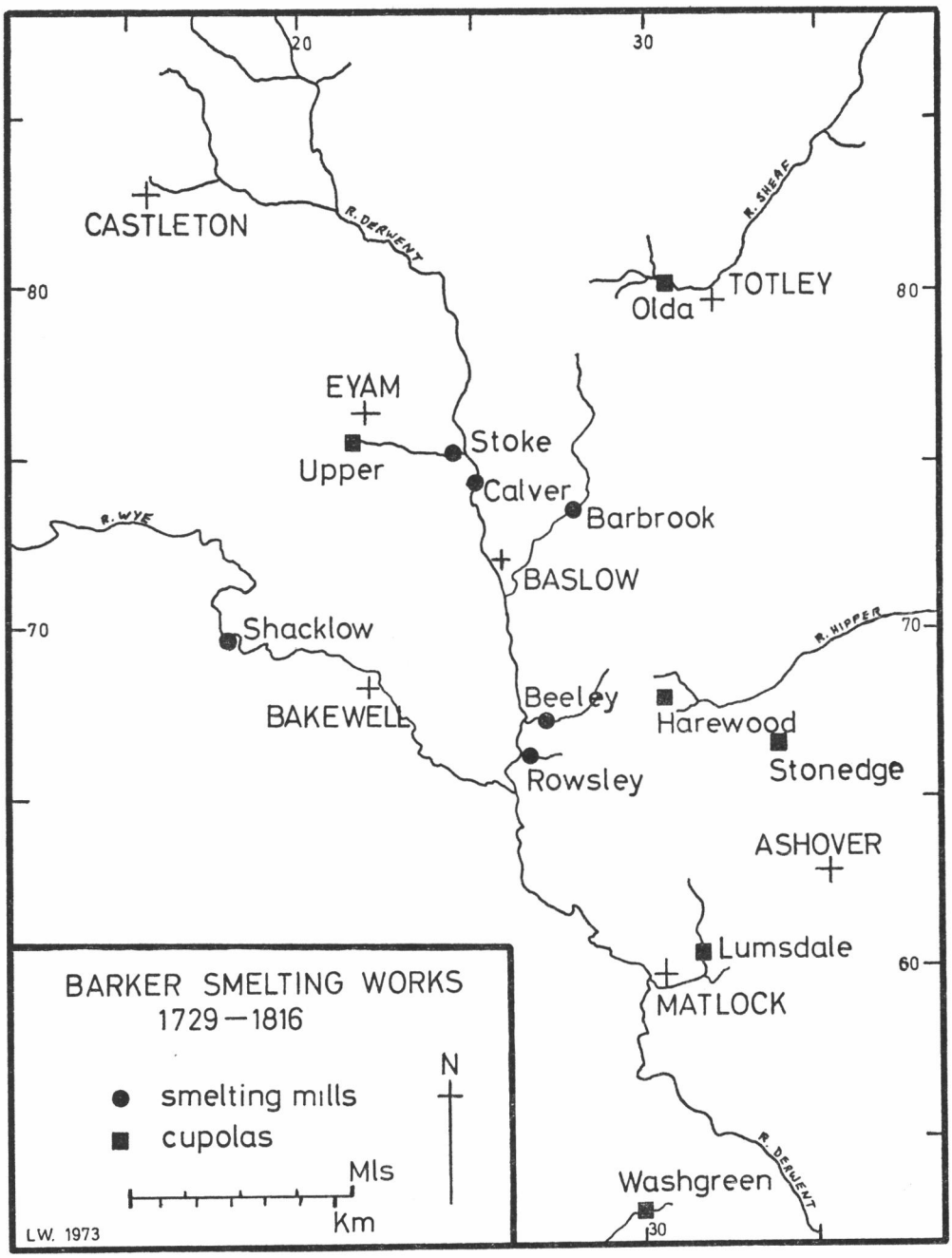

Fig. 1 Barker Smelting Works, 1729–1816.

Leadnams and Cowclose. After the mid-century they expanded their holdings very widely, especially in the Alport, Winster, Eyam, and Monyash areas.[60] The second method involved the purchase of all ore from a major shareholder, or the purchase of the right to all the duty ores of a liberty. Thus George Barker in 1748 and 1749 bought Bagshawe's and other's shares of Eyam Edge ores[61] and in the 1770s paid Rowland Eyre of Hassop £50 annually for the farm of Calver Liberty.[62] Thirdly, the Barkers employed agents to buy and bring in ore to be smelted, or sometimes bought ore 'at the mill' from miners or independent ore buyers. Thus Joseph Hamilton was paid £267 17s. 5¼d. for ore brought in to Totley Cupola during the two years ending Ladyday 1755, for 123 loads 2¼ dishes,* and jagging and salary.[63] John Barker's function at the same period was on a larger scale, probably dealing only with the large mines, and necessarily receiving payments more regularly. At a later date William Wyatt performed a similar service for George and John Barker at Upper Cupola, Middleton Dale, though he also dealt with lead sales and purchases.[64]

The pricing of ore was usually done on an empirical basis, and the assay of a small sample of ore did not become common until ticketing was introduced at Alport Mines and Eyam Mining Company in the mid-19th century.[65] Until the 1770s, the unit of ore measure used by the Barkers was the load and dish, and thus depended on volume. After this time, particularly for large quantities, they introduced the practice of weighing. Under the old method, ore was measured at the mine and packed into ore bags, probably one bag per dish of 60 to 70 lbs., then 'jagged' to the mill or cupola by packhorse. The ore was probably kept in the bags until smelting, so that accurate records of the yield of ore could be kept as a check on the quality. In the 1770s some Eyam ores at Totley were weighed[66] and by the 19th century this was the usual practice for ore from the larger mines. The change has a number of effects. The most important seems to be that the ore was carted rather than jagged, and bags were not used. To facilitate the payment of duty ore, based on volume as of old, a larger measure was sometimes used, called a bout of 24 dishes. In 1774, it was in use at Gang and Orchard Mines at Wirksworth[67] and in 1760 13½ bouts or 36 load of ore were sent to Washgreen.[68] This method obviously must have had economies at the mine, but meant it was no longer possible to keep the ore separate at the smelter, so that it had to be weighed in. The spread of the bout seems to correlate with areas of high production, where the disadvantages of the older method would most keenly have been felt. Later, *c.* 1800, ore was weighed—see Appendix II.

The quality of the ore was determined by a trial at the hearth* or cupola furnace. Sometimes it was done on a small quantity of the ore, and in the early part of the period might be defined as dishes of ore to the pig* of lead. At other times the whole of a quarter's ore from a single location was smelted, and if profits were satisfactory then the price paid for the ore would form the base for future transactions. Normally the single trial was not repeated until either profits or the ore quality got seriously out of line, and the price paid was based on the original price, the weight per dish, and the price of lead at Hull.

The trial involved much more than being an extension of the assay in that it also determined the profitability directly. By the time the Cupola was well established, a notional cost of smelting had been determined. In 1752 a comparison of smelting rates showed that these were computed by the fodder* of lead produced,[69] and this method was still in use in 1781.[70] However, by 1800 it was usual to charge by the shift rather than by the produce. Other expenses include the cost of cope, and of bagging, or, 'taking up', and the carriage of the ore to the mill or cupola. After smelting the lead had to be taken to market, usually Bawtry or Thorne, and an allowance was made for this. Commission sometimes had to be paid on sales, perhaps 1 per cent and interest on capital was also included, usually 5 per cent for three months (i.e. 1¼ per cent of total capital employed). On top of this 10 per cent of total outlay was commonly allowed for profit. The refinement to include fixed interest, commission and profit came rather late in the century, and at least up to the 1780s the smelter was content if he received a 'reasonable

profit' from the operation. In some cases the trial system was extended so that each quarter's ore was priced by its own 'extended trial', though this seems to have been done mainly for mines in which the Barkers had control, so that they, rather than free competition, set the price. Examples of two trials are shown in Appendix I. After 1810 the difficulties in the lead trade caused a reversion to the earlier practice of being satisfied with a reasonable profit, or, at times, any profit.[71]

In cases where an extended trial was not possible, and the ore buyer had to buy in competition with others, then the price to be paid or offered had to be based on the results of a previous trial, the quality of the ore, and the lead price. In 1769–75 the price of Oden ore (Odin Mine, Castleton) was decided by reference to a base price of £14 15s. 0d. for lead, so that a change in price of lead per fodder of £1 caused a corresponding change of 2s. in the price of a load of ore. Sometimes the quality of the ore improved, and Barkers then agreed to pay an extra shilling or so for each load of the next quarter's ore, and vice-versa.[72] The price paid thus depended on the price obtained for the lead, and its quality, during the last quarter. The risk involved, in the very volatile lead market, was thus lessened by the practice of making adjustments in the next quarter, so that both the miner and smelter, in the long run, benefited or suffered from changes in price. It was, of course, possible to hold onto lead awaiting a higher price, but this was more the function of the lead merchant rather than the ore buyer, and held its own risks.

As the techniques of weighing rather than measuring and of doing regular trials were introduced in the latter part of the 18th century, the Barkers introduced computing tables for pricing lead ore, based on the ore required to produce a fodder of lead and the price at Hull. These can be found in a number of notebooks and account books. Part of such a table is reproduced in Appendix II.

The smelting works

The location of smelting works depends on a variety of factors. Most such works appear to have been located to the east and south of the limestone/shale boundary,[73] that is, between the orefield and the markets. Ore was rarely transported more than ten miles from mine to smelter, and the trend, as the cupola process became more efficient in terms of fuel, was to locate the smelter as close to the orefield as possible. Cromford Cupola, for example, was sited almost astride Gang Vein. The ore-hearth smelting mill required water power and timber (white coal) for fuel—the valleys in the shale and millstone grit areas provided abundant supplies of both, though mills, as Shacklow, were to be found in the deeper limestone dales, such as the Wye and Lathkill. The cupola smelting works was independent of water power, but required coal. Some new locations were used to take advantage of this—Stonedge, Harewood, and Cromford Cupolas are excellent examples, though the owners of the first two of these later built slag mills* for resmelting cupola slag, utilising nearby water.[74] Other sites either developed on old smelting-mill sites, or had water power available anyway.

With the development of turnpikes and canals by 1800, then obviously those best sited would have an operating advantage—Barker and Wyatt's sole works after 1815 was excellently sited in this respect—on a turnpike with access to east and west *via* the Chesterfield and Cromford Canals, and the Peak Forest Canal respectively.

However, the problem of a lead smelter in selecting a particular site, and in deciding which process to follow is more involved, and is ultimately decided by his expectations of profit. His decision to take a site may be motivated also by the need to eliminate or buy out possible competition, and the usual long-term economies implied in locational analysis need not apply.

The decision of William Barker to take Shacklow Mill *c.* 1729 can be fairly easily explained in terms of its closeness to his sources of ore supply, the abundant wood supply (Shacklow Wood), and an adequate supply of power. It is not unlikely that the site had previously been used for smelting. Similarly, the acquisition of Rowsley and Beeley,

probably on a single lease, can be explained in these terms, with the proximity of Burnt Wood, and the high level of ore production at Elton. The selection of this actual site as against others in the area is probably a consequence of the employment of Thomas Barker as Steward to its owner the Duke of Rutland, and it is not unlikely that the ending of the Thomas and George Partnership in 1749 was responsible for the cessation of smelting there by George Barker.

The expansion of Barker's interest to Eyam Edge Mines in the 1740s was presumably the key to the opening of their smelting activity in that area. George Barker's experiments at Olda Cupola quickly seem to have convinced him that the new process was viable at that location for smelting Eyam Edge ores, so that he soon decided to take the lease. At almost the same time, however, he took Calver Mill, probably also after carrying out trials. Using a similar method of calculation to that which Barker used at Olda, but making allowances for different efficiencies, costs, etc., Calver would not be economic. However, as Barker could have had but little experience of the characteristics of the cupola furnace at this time, particularly as regards the maintenance and building charges, his decision to take Calver Mill, where he might hope to reduce costs by good management, was probably wise, and had the additional advantages of providing extra capacity at low cost to replace Rowsley and Beeley, and to provide for further expansion, as well as reducing possible competition in that area.

The decision to build a new cupola at Harewood on Brampton Moor must have been made soon after Totley Cupola was taken over, as it came into operation by November 1752. Unfortunately, due to the death of George Barker just before building commenced, it is not known whether he made the decision before he died, or whether Alex Barker would have built it for operation by his own (Alex and Thomas Barker) Partnership, or even whether the decision was made very quickly after Alex had taken over George Barker and Company as executor. In any event it appears that the decision was very much shared between Barkers, and Milnes and Wilkinson, as the cupola was built very close to the latters' Cathole Red Lead Mill, which thereafter absorbed most of the lead produced at Harewood, and some from the other smelters also. The siting of Harewood had the value of isolation (lead fumes), proximity to its market, and availability of coal, much as had Olda. In addition it is fairly central to its main sources of ore—Winster and Elton, Wirksworth, and occasionally even Ecton and Warslow in Staffordshire.[76] How far Barkers took these factors into account to the extent of calculating costs is not known, but it is indicative that within a short time of starting production, complaints were made of the high cost of coal. Either the coal seam (Belper Lawn or Soft Bed) which outcrops nearby had not been found, or if found was unsuitable, as men were paid in January 1753 to search for coals on the Moor, and again in February, as far away as Clod Hall, almost four miles.[77]

The improvement in continental lead prices, almost certainly reflected in the home market,[78] was probably responsible for the increase in mining activity in the 1750s and 1760s, in which Barkers had a considerable share. In 1757 another Cupola furnace was built at Olda, and in 1758 the opening by Francis Hurt of his new Meerbrook Works probably gave them the opportunity to acquire Washgreen Cupola.[79] very close to their interests on Cromford Moor, which would lower transport costs and increase capacity considerably.[80] They also took over a further two smelting mills—Stoke and Barbrook as well as retaining Shacklow and Calver. In view of the apparent economies of the cupola, evident in the transfer to its use by other companies also, this by this time is rather more difficult to understand. Barkers may have considered the mills as a cheaper alternative to building or expanding their cupolas in what was possibly only a short-term rise in demand. The quarter rent for Olda Cupola at Totley had been £5 10s. 0d. in 1746, and it had cost £160 to build, whilst the annual rent for Calver Mill was only £6. If no attention was paid to the need for repairs to the buildings, etc., the actual running cost of the ore hearth, as at Olda in 1736,[81] was only about 6s. per fodder of lead produced so that a short-term profit could be made. Eventually the mill would require heavy expenditure if it was to continue in use, with the probable consequence

that it would close. Thus at Calver Mill at Christmas 1772, T. Parker, a working-smelter there, was paid for 'helping ye mason to support ye mill which was tumbling down', and in May 1773 it finally closed.[82] As Parker smelted at both Totley and at Calver, it is possible that Barkers took advantage of the main virtue of the ore hearth, the quick start-up and close-down without damaging the structure.

If the above is true for Calver, Stoke and Barbrook smelting mills, it was not so, except perhaps just before it closed, for Shacklow Mill, which stayed in operation until 1781. Unlike the other Barker smelting mills, Shacklow was a considerable distance from the cupolas, almost ten miles nearer to Sheldon Moor, from whence came most of its ore supply, than was Harewood, and to the extent to which lead was sent to Manchester, ten miles nearer to the market. Unfortunately, though accounts for Sheldon Moor ore smelting exist, at both Shacklow and Harewood near the time of the former's closure, the quantities and grades of ore are not uniform, so that it is impossible to assess accurately the actual advantage of smelting Sheldon ores at Harewood. A calculation showing the profit if the Harewood ore trial (see Appendix I) had been carried out at Shacklow suggests that instead of a profit of just over £68 on an outlay of £396 0s. 0d., i.e. about 17 per cent, Shacklow would have yielded only £15 10s. 0d. on an outlay of £387 10s. 0d., that is only about 4 per cent, neglecting any costs involved in selling. Actual comparison of the last six quarterly Sheldon Moor ore accounts for Shacklow, and the first six for Harewood (1779–82) show that Harewood had a 20 per cent return on outlay, and Shacklow only $1\frac{1}{2}$ per cent, though this latter figure rises to 6 per cent if an increment is added to allow for the value of the slag.[83] (The use of Bagshawe's 1736 estimate at this period is likely to be low, so that the 6 per cent return may be a slight underestimate.[84]) In the circumstances of 1780, when, it is probable, the total quantity of ore mined was falling,[85] it would no longer be feasible to keep Shacklow in operation, so that smelting was thereafter concentrated on the three Barker Cupolas remaining, at Harewood, Totley, and at Stonedge, which had replaced Washgreen and the smelting mills in the early 1770s.

Despite the fairly high prices at the turn of the century [86] the quantities of ore mined[87] and consequently the lead produced, declined steadily.[88] It was thus necessary to rationalise facilities, and Olda Cupola at Totley closed in 1802. However, the possibility of acquiring a cupola at the centre of the most productive area offered obvious economies, and in 1803 Barker bought Middleton Dale Upper Cupola. Stonedge, chosen possibly because it had rather poor slag-smelting facilities and was furthest from most orefields, was sold soon after, and Harewood closed with the fall of lead prices in late 1814,[89] leaving only Middleton Dale.

Unfortunately records showing details of operating problems and routine administration at any of the Barker Cupolas are sparse. Some information as to costs, wages, and minor repairs can be found in daybooks and journals, but this is usually inextricably bound up with payments and receipts from personal and other aspects of the business. All transactions seem to have been entered in the day books as they came in, in the form of a simple charge-discharge account. Balancing of accounts took place only at long intervals, often several years. The details of each transaction were drawn up on notes, or in notebooks, of which even less survive. From the day book, details were transferred to the particular account: the ore account, the lead account, the cupola account, etc.

George Barker's Cash Accounts for 1743–51, on behalf of the 'Joint Partnership' up to November 1749, and then himself, or in early 1752 his executor Alex Barker,[90] illustrate some of the details of management at the time of his adoption of the cupola process. Details which can be related to the smelting operations mainly concern the payment for fuel and smelting. At the smelting mills both wood (white coal) and cokes (for slag smelting) were purchased, the price paid apparently computed on the fodders produced. At Shacklow the charge for wood to produce a fodder of lead was 3s., at Rowsley, 4s. 6d., whilst drying cost a further 6d. Wages for smelting were about 5s.

and 2s. 6d. for the smelter and server per fodder, so that fuel and wage costs would normally be about 25 per cent and 50 per cent respectively of the customary charge for smelting of 16s. The balance would be made up of repairs, rent, and sundry small charges. At Rowsley and Beeley repairs seem to be often needed, and there are many entries for repairing and sludging the dams, slating the roof, etc., which may well, together with the higher cost of fuel, have influenced the decision to give them up. The rent at the smelting mills seems to have been higher than later, thus Calver Mill was £10 annually in 1750, but only £6 10s. a few years later. Sundries were very wide ranging, including for instance £5 for the Baslow and Edensor poor on the occasion of George Barker's funeral, and £1 14s. for 'spinning 32 yards of sack cloth, weaving and making it into orebags with the packthread'.

Close to the period of the take-over of Olda Cupola considerably more care and detail seems to have been taken with the account, probably so that a comparison could be drawn up. Generally, then as now, it would have been difficult to apply any form of cost analysis to the accounts.

After the take-over of Olda, considerable repairs seem to have been necessary. Charles Wharton, who, a few years previously, had signed bonds of secrecy about the construction of cupola furnaces with the London Lead Company, for 20 years duration[91] was brought in to rebuild the Olda furnaces, and much ironwork seemed to need replacement.[92] Coal seems to have been purchased from a number of suppliers, probably from the Ringinglow seam close to the Barber Fields Cupola site, rather than from the closer Soft Bed seam (this is the same seam as outcrops close to Harewood, which also seems not to have been used), as one of the suppliers lived at Ringinglow, whilst another brought coal from 'Doer', or Dore, in which parish the seam outcrops.

It is not until the 1790s that any idea of total capacity can be gained from the accounts, which unfortunately is beyond the period of peak output.[93] Maximum output at all three cupolas at this period seems to have been about 5,000 pieces,* about 300 to 350 fodders annually, from 12,000 to 14,000 cwt. of ore. Average efficiency was about 66 per cent, though with considerable variations when examined in detail. Weekly output when working was about 100 to 110 pieces but with a maximum of 178 in one week at Stonedge in 1796, the busiest cited year for all three cupolas. Assuming a three-shift day (i.e. one shift per charge) and a seven-day week, this would be within the bounds of possibility of one cupola furnace. As Totley almost certainly had two furnaces,[94] and Stonedge had two chimneys, and stone and brick for two furnaces,[95] it is probable that Harewood was similarly equipped. If this was so then it would appear that only one furnace was in use at a time, so that the other could be in repair or on standby, or, if trade was very poor, in disrepair. During the period of high output, say the 1760s and 1770s, both furnaces would presumably be used to capacity, whilst in the slack periods of the 1790s neither furnace was used for quite long periods, presumably waiting whilst enough ore had built up to supply a reasonable campaign of a week or more, so as not to waste fuel, and cause unnecessary stresses by too frequent start-ups and shut-downs.

The calculation of the make up of the notional cost of smelting at the cupola is not clear from the accounts. Four men would be the required minimum to smelt at one cupola furnace over the 24 hours in two shifts and as far as can be determined this was the usual number employed. During this time they could expect to produce two fodders of lead. In 1771 Rowland Clarke received 5s. a fodder for smelting, probably to be shared between the two who had actually worked the shift.[96] The usual cost of smelting was about a pound a fodder, 20s. at Stonedge and at Harewood, but only 18s. at Totley. Labour costs were thus only about 25 per cent of the smelting charge.[97] The proportion due to fuel is unknown. At Middleton Dale, however, just before it was bought by George Barker, the smelting charge was 11s. 6d. a shift, probably the smelting shift of eight hours rather than 12,[98] so that the charge per fodder would be only about 16s. or 17s., and, unless wages were lower, the labour share would be correspondingly higher.[99] In a valuation of Stonedge and Middleton Dale Cupolas, *c.* 1806, Middleton

Dale was valued at over twice as much as Stonedge, so that it was probably larger, with perhaps four furnaces, and may thus have had economies of scale.[100]

The disposal of the lead

The paucity of extant accounts of the principal lead-merchanting families makes it difficult to assess how far Barkers were typical in their organisation of sales, and there is little that can as yet be added to Hopkinson's basic account.[101]

In the early 18th century the superficial inspection that is possible suggests that most of the more prominent merchants had some smelting capacity, though it is likely that the bulk of their lead came from independent operators. The distinction between lead merchant and lead smelter may in the 1730s and 1740s have still been common, and the change is perhaps apparent in the wording of the partnership agreements of Thomas and Alex Barker, who were lead merchants, and George and Thomas Barker, who were in the lead business. During the later part of the 18th century there is no doubt that most of the larger smelters looked on themselves as being 'in the lead business', and as did the Barkers, combined the mining, smelting and merchanting functions.

In the early years of the Barkers' lead-smelting business, most pig lead was disposed of conventionally to the local lead merchants, such as Bright, Milnes, Twigg, Storrs, and others, including a Mr. Battersby, either at the mill or at Bawtry. Prices paid for the pig lead were expressed as at Hull, Bawtry, or at the mill, and, in the 18th century, probably in terms of the fodder appertaining to each place, thus explaining the apparent anomaly in the accounts of prices at the mill being higher than those after transportation to Bawtry or Hull.[102] Some lead was sold *via* commission agents, such as Charlesworth and Edge at Hull, Thomas Battersbie at Manchester, and a Mr. Handley of London. This latter seems to have been considered something of an adventure, and Barker's letters have frequent notes of concern, such as when a whole shipment was carried in one vessel. There are several references to dealers in difficulty in London, causing further worry, not without reason, as in August 1748 Handley seems to have failed, and it was necessary to send a messenger to Stockwith to stop a shipment of lead. Happily, the debts were paid off later, though not by Handley.[103] Insurance seems not to have been used until late in the 18th century, when frequent payments began to be made to Urquhart and Hope of London.[104]

Some lead was disposed of to local manufacturers. In the mid-century lead was sold to red-lead mills belonging to a Mr. Lucas at Longside, to Nicholas Twigge at Oler, and to Milnes and Wilkinson at Brampton, all on East Moor.[105] It may in part have been the difficulties of the direct London trade that caused the partnership of Barkers and Wilkinson to be formed, following the very extensive business with Milnes and Wilkinson. The result was the formation of almost certainly the largest vertically integrated lead business of the century, with direct operations in mining, smelting, red lead and lead sales, both to London and to the continent.[106]

Complaints, in which the Barkers took a prominent part, about the imposition of an export tax on raw lead of £1 1s. per fodder in 1784, suggest that the smelters still saw themselves as raw lead producers dependent on the export market. They complained that the tax gave the red and white lead manufacturers an advantage over the miners (and presumably themselves), and would lead to the expansion of foreign lead producers in Germany, Spain and elsewhere.[107] Whether the tax was responsible for all the ills which were attributed to it is doubtful. However, an expansion in the home manufacture of lead products at the expense of the export of raw lead certainly did occur though it is likely that the trend was already strong. A considerable number of lead product manufacturers began operations at this period. Of these the most important was the firm of Walker Parker and Company, which began operations in 1778, and expanded greatly after 1785.[108] Many other firms, such as Cox and Poyser of Derby, and Yeats Brown and Scott of London, also became large buyers of lead. As a consequence of this, the direction of the Barker lead sales was increasingly direct to a few large manufacturers,

and almost completely so after the withdrawal from business of Isaac Wilkinson in 1807. Thus in 1808 Barker wrote to Joseph Walker and Company of Derby (an offshoot of Walker Parker and Company), that, as they no longer supplied Wilkinson's Red Lead Mill, they had no objection to making a contract with Walkers. Significantly, Barker quoted the value of lead in London rather than Hull as the determinant of the price—charging 30s. more per Hull fodder, but allowing 10s. per fodder for the difference of expenses.[109] Most of the lead produced subsequently by Barker and Wyatt, then by Wyatt, was sold to local manufacturers, notably to Walkers, and to Cox and Poysers of Derby, and to Rawson and Barker (Sheffield White Lead Company) of Sheffield, whilst considerable sales were made to London, Manchester and Birmingham, and to other towns with canal and, later, rail connections.[110]

The acquisition of Middleton Dale Cupola led to an expansion of the Barker merchanting activity. Storrs, the previous owners, have been mentioned previously as buyers of lead, including from the Barkers, and it seems that Barker continued this side of the business, probably under Wyatt's management. The accounts for lead bought[111] continue both before and after Barker's acquisition of the Cupola, though a duplicate account book[112] starts at the date of take-over, and notes that no lead was 'on hand from the old book'. The accounts show that lead was bought also from the other cupolas in the neighbourhood (Dale, Lord's, Bretton and occasionally Callow Bank), and suggest that all four Stoney Middleton and Eyam Cupolas smelted for the individual miners, who were responsible for the sale of the lead produced, probably paying smelting charges by the shift. The difference in organisation between Storrs and Barkers probably reflects the manner in which each integrated the smelting and merchanting activities—Storrs considering smelting an adjunct to merchanting, Barkers vice-versa. Barker, who probably left much of the management of Middleton Dale in Wyatt's hands, did not apparently change the former arrangements to any great extent, and the lead accounts continue to show that lead was purchased from individual miners until the 1850s, usually at about 15 per cent below selling prices in London, to cover costs and profit.[113]

Presumably this latter form of organisation had considerable advantages for the lead merchant, in that his fee for smelting was more or less assured, whilst the risk of being caught by a fall in prices was minimised by the rapid disposal of lead purchased—a stated part of Wyatt's policy.[114] The risk thus fell largely on the miner and enabled Barker to escape the nightmare risk as expressed in a letter to Robert Howe, his ore buyer at Castleton,[115] in 1808, when the London Houses would offer no more than the Hull equivalent of £36 a fodder 'as would bring impoverishment to us'. Barker had presumably bought in anticipation of a continuance of the unprecedentedly high prices.[116] After the closure of Harewood, the operation of Middleton Dale seems to have been divided between 'custom smelting' of miners' ores, and the usual Barker practice of smelting bought ore, a practice possibly made necessary to compete with the custom smelting at the nearby Lords' Cupola. It marks, however, a considerable departure from the almost wholly integrated operations of previous years.

Hopkinson has attributed some of the changes to the Wilkinson withdrawal from the partnership, and a consequent shortage of working capital. However, with falling supplies of ore and with the lower prices, and the comparative strength of the local users, and probably the growing competition in foreign markets from Spain and Germany,[187] this decision, which minimised transport and other costs, was the result of market requirements, and would have occurred regardless of the available capital.

Capital and profits

Again, due to the paucity of profit and loss accounts in the extant Barker accounts, and their failure to differentiate between capital and other expenditure, very few conclusions can be drawn about these aspects of their operations.

The Thomas and Alexander Partnership as lead merchants in 1735–36 was set up with a capital of £5,000, whilst that of Thomas and George was set up in 1743 with a working

capital of £1,500, and an eventual commitment of £3,000.[118] No evidence of the origin of these considerable amounts is available. Clearly, in a situation where the rent of a smelting mill amounted to no more than a few pounds a year, and wages not much more, the great bulk of the capital was required to buy ore and lead. Where the market was not unkind, they could thus expect any cash expended to return after about three months, with some measure of profit. In the 1740s a few figures for profits do emerge, probably on the £1,500 original capital:

Christmas 1744	profits for one year's trading	£268 19s. 2½d.
Christmas 1745	profits for one year's trading	£86 11s. 6½d.
Christmas 1746	profits for one year's trading	£261 0s. 0d.
Christmas 1747	profits for one year's trading	£337 1s. 3d.

These last profits were added to the original stock of £1,500, and in the following year:

Christmas 1748	profits for one year's trading	£339 6s. 11d.

but in addition £92 was due from Mr. Handley, the failed London Agent:

Christmas 1749	profits for the half year	£80 12s. 1¾d.

but this is after a loan of £250 plus interest of £10 had been repaid to a Mrs. Lillie (a relative by marriage). Further borrowing was done from a Mr. Seward—£500 probably in 1749–51 as required, and possibly again in 1751 from Mrs. Lillie—£100.[119]

This borrowing thus spans the break-up of the Thomas and George Partnership, and coincides with the expansion to Olda, which presumably absorbed all their liquid assets. No indication is given to the result of the withdrawal of Thomas, but presumably he withdrew his share of the capital, leaving perhaps £900, which was then reinforced by the borrowing. At Christmas 1750 a stocklist showed that George Barker had a stock of lead and ore, at mills, on the road, and in agents' hands, of about £1,265, so that his scale of operations was not very different than under the partnership. Assuming a turnover of stock every three months, this suggests an annual turnover of about £5,000. Profitability is not shown, though the figures above suggest about 20 per cent on capital, or about 5 per cent on turnover, to be good but not exceptional.

Later accounts are much less informative. There was a considerable increase in turnover, especially after the building of Harewood Cupola. In 1755 ore worth £12,500 was smelted at the two cupolas, and this seems to be a typical level in this decade.[120] Financing of this expansion was undoubtedly due to the co-operation of Milnes and Wilkinson, who seem to have advanced large sums against future output, especially in the first few months of Alexander Barker and Company.[121] Their close relationship continued until after the retirement of Isaac Wilkinson, and was formally acknowledged by the formation of the Barker and Wilkinson Partnership about 1759. Within the smelting side of the partnership, it is doubtful, however, whether this made much difference, except to guarantee ore supply and markets.

Harewood was the first smelting works, mill or cupola, which was actually owned by the Barkers, and even then it was built on leased land.[122] As with renting, the capital requirement spread over ten years, for example, was low in relation to the total capital required, so that a total of £250 would probably suffice as an initial cost of a cupola with two furnaces. A valuation of the Barker Cupolas, probably *c.* 1806, values Stonedge at £258, whilst tools, slag, etc., at both Stonedge and Harewood brought the total value of the two sites up to £729; with the addition of the cost of Middleton Dale, the total value of the three sites came to about £1,540.[123] As in 1796–97, Barkers had a turnover, computed on prevailing prices and output, of about £18,000, such a capital requirement was not high. In 1806, despite the very high prices, throughput at the Harewood and Stonedge Cupolas was down to half of the earlier level (but worth about the same in value), so that it was possible to dispose of the latter.[124]

Profits at this period are just as elusive, and the only figure available is a total of £11,000 for the two years 1806 and 1807.[125] On a turnover of, say, £18,000 a year at the

5 per cent rate suggested above, this is very high, but might be attributed to the prevailing abnormal price level.

The collapse of prices just before the end of, and after, the Napoleonic Wars to about £18 a ton caused a considerable contraction in the business, so that only Middleton Dale continued in operation. Hopkinson's postulated shortage of capital, due to the withdrawal of Wilkinson from the partnership, may have been the reason for the entry of Benjamin Wyatt into partnership with John Barker in 1816, subscribing £500 for a quarter share. In addition it may have been to ensure the continuation of Wyatt as manager of the business. The value of £2,000 placed on the business is not necessarily a reliable indicator of the actual value placed on it in these circumstances, but with the continued decline in both prices and ore mined, with profits rarely above a few hundred pounds a year, might still be considered over-valued in terms of historical profits. With the entry of Wyatt into the partnership, the business was largely out of the hands of the Barker family.

Conclusions

The survival of a family business for a century is unusual and itself indicates that any general conclusions may be atypical. Barkers had the considerable advantage of being stewards to the Dukes of Rutland and Devonshire, and additionally were very lucky, or skilful, in their choice of partners—with the Wilkinsons who provided the capital for the buoyant years in the mid-century, and with Wyatt who clearly introduced tighter financial control in the difficult war and post-war years of the early 19th century.

Others survived too. The Barkers of Bakewell, who broke away from the better-known branch, remained in the lead business for a further half century, with mining, smelting and the Sheffield White Lead Company. Similarly the Hurt, Nightingale, and Milnes families had long, if less well known, years in business.

Yet most others fell away. Hopkinson suggests the numbers declined as the derived wealth allowed them to leave trade and found their own landed families, such as Thornhill, Rotherham and Brights, whilst the increased capital required after the introduction of the cupola, and the more speculative conditions after the mid-century, prevented the entry of newcomers.[126]

The others do not always seem to have been as fortunate in their departure from the lead business as Hopkinson would have us believe. The Twigge business continued after John Twigge of Holme had left Derbyshire, to buy his £40,000 estate near Wrexham, and in 1785 become the High Sheriff of Denbighshire.[127] Yet by 1789 the business was in ruins, and the estate sold for £24,000. Not enough is known to attribute this entirely to the prevailing depression in the lead industry, but clearly his business technique was less successful than Barkers.[128] The Bagshawe operations at Olda Cupola in the 1740s were unsuccessful[129] and later they were to allow Barkers to buy their ores, and though they did retire to their existing estates, they were not spectacularly successful in the lead business.

Many more businesses seem to have ceased, unsurprisingly, with the death of the principal, to be taken over by either practising managers, or by other business-orientated families: Wyatt from the Barkers, and even earlier, as manager, from Storrs at Middleton Dale. Barkers at an earlier stage took over from Bagshawe and many lesser men—their system of buying ore rather than custom-smelted lead might have been designed to eliminate others, as much as for the direct financial gain. In the south of the area the Wass and Allsop concerns succeeded the Nightingales after the main line of the family failed, and at Kelstedge and Stonedge, the Milnes, who were involved in the lead industry for even longer than the Bakewell Barkers, took over from Twigges, then from Barkers when they were clearly in difficulties, and survived to succeed the Hurts at Meerbrook some 40 years later. Of the many others involved, few can have achieved the dignity of landed estates who did not already have them, and changes in organisation and scale cannot easily be accounted for in this way.

As for new entrants, after the mid-18th century, substantial examples are rare—hardly surprising where the trend was to reduce many small to a few large. In the 19th century, when numbers of firms were more stable, Wyatt, Wass, Allsop, and later Fairburn and Moore were all new entrants who took their opportunity to become of equal or more importance than the older concerns.[130]

In landed families in this area lead for long remained a respectable form of income, but in few did it form the only source of wealth in the 18th century. The decline in the numbers of such participants in the industry seems much more likely to be satisfactorily explained by the normal problems of management in a period of very considerable changes in market forces and technological change, so that those less efficient either left by choice, or went bankrupt.

Acknowledgments

The writer is greatly indebted to the librarians and archivists at the offices cited, and to the Haddon Estate Office and Chatsworth Settlement Trustees for permission to see documents in their care. Individuals who have contributed advice and information include Mr. D. W. Crossley, Dr. J. N. Rhodes, and Mr. C. J. Williams. To them the writer is especially grateful.

APPENDIX I

Ore trials, for computing and checking on the value of ore bought.

(1) Sheldon Moor Ore, smelted by Harewood Cupola, for quarter ending Xmas 1781. (Source SCL.Bag.491)

Dr.	*Load*	*Dish*	*at*	£	s.	d.
To Mawry for Grove Ore	16	5	cost	33	14	10
To Crowshaw for Do	20	6¾	43s. 6d.	45	2	7½
To N. Hubberdale Do	6	2½	43s. 9d.	13	14	8
To Do Tail Belland		5¾	18s.		11	6
To Upper Do Hillock		4	30s.		13	4
To Jn. Roberts Bot Ore	123	¾	cost	216	11	8
To Cope .. .. on	167	6¾	6d.	3	10	0
To carr. 44 ton cwt. 1 of ore			11s. 6d.	25	8	9
To Duke of Devonshire ½ year lot	16	8¼	cost	31	19	10
To smelt 403 pcs lead			20s.	25	3	9
To Profit and Loss		Gained		68	3	2¾
				464	14	2¼

Weighed 884 cwt. 1 qtr. is 64 lb. per dish.

Cr.

By lead 403 pcs. 25 fodder 3 pc. £18 9s. 0d. 464 14 2¼

(The gain does not include costs of selling the lead).

(2) Watergrove ore smelted at Middleton Dale, 1806 (Source SCL.Bag. 587(87))

	£	s.	d.			
32 loads made 111 cwt. of lead at £35 Hull				185	18	6
Carriage to cupola, cope, and smelting W. W. (William Wyatt) value at 5s. for load	3	0	0			
Carriage to Hull 111 cwt. at 1s.	5	11	0			
1% commission selling	1	17	0			
5% for 3 months	2	6	6	17	14	6
Smelters Profit less 10% ..				168	4	0
				16	16	4
32 load worth				151	8	0

Price offered 94s. 6d. per load

The two trials show the very significant changes which took place in business techniques in the difficult years of the late eighteenth century, and in part the superior approach to costing adopted by William Wyatt as compared with Barkers, even at the same period. Thus the 1781 Harewood Trial was carried out merely as a check on empirical pricing. The Middleton Dale trial was carried out before the price was offered—probably on a sample of the ore, and included other costs than the notional cost of smelting—viz commission, interest and profit.

APPENDIX II

Part of a table drawn up by John Barker, 1806 as the basis of his bids for ore when buying. (Source SCL.Bag.477—Ore Account Book 1791—1809)

A table shewing the Value of one Ton of Lead Ore (112 lb. to the Cwt.) at Hartle, the price of a Fodder of Lead (19½ by 120 lb.) at Hull being known and the number of Cwts. of ore required to produce that Fodder determined.

Value per fodder suppose the Ore cost nothing ..		2.6.2.	2.7.10.	2.9.6.	2.11.2.
Addition in the price for every £ value per fodder exceeding the above		13	12/6	12/1½	11/9 etc.
Cwts. of ore required to make a fodder of lead ..		28	29	29	30
Price of a fodder of Lead	£13	6.18.9.	6.13.0.	6.7.6.	6.2.4.
	14	7.11.9.	7.5.6.	6.19.8.	6.14.1.
	15	8.4.9.	7.18.1.	7.11.10.	7.5.10.

A note below the table details that the cope paid (by the taker up of the ore) is to be deducted from the above values, viz. at Hartle 1s 3d. per load or 5s. per ton, at Youlgreave 4d. per load or 1s. 4d. per ton, and at Stanton 6d. per load or 2s. per ton. A further note defines Best ore as 31 cwt. Second as 35 cwt., and Hillock as 38 cwt.

The computation of the table is basically simple, though slight variations in some of the increments probably reflect practical corrections rather than strict reliance on theoretical calculations. The first row of values appears to refer to the cost of taking up, carriage of, and smelting (by the shift) of the ore, (not including cope) at the rate of 1s. 8d. a cwt., so that Best or 31 cwt. ore has an added cost of £2 11s. 2d. to the smelter after smelting. (This is a very similar to Wyatt's value at Middleton Dale). The second row shows the value added to each ton of ore for each extra pound on the price of lead. The third is obvious, but also suggests that an efficiency of 66% needed "Best ore", whilst the highest quality ore Barker thought worth listing could produce only a 75% yield. If the costs of making a fodder of lead are computed on the basis of the full table.

e.g. for 30 cwt. ore when lead sells at £13 per fodder

		£ s. d.
Added costs—smelting etc. ..		2 9 6
Cost of 30 cwt. ore ..	20 cwt.	6 7 6
Cost of 30 cwt. ore ..	10 cwt.	3 3 9
		£12 0 9

and for 40 cwt. ore when lead sells at £20 per fodder (not shown above)

Added costs	3 6 0
Cost of 40 cwt. ore ..	15 4 0
	£18 10 0

Then it is seen that although there are slight variations in the percentage of turnover available for post smelting costs and profit, the percentage is very close to 7½%. Compared with the margin allowed by William Wyatt, this is slender indeed, as after costs of freight etc., practically no profit could be made. Part of the explanation for this may be that the Barkers had major shareholdings in the mines of the Alport and Hartle area, whilst it is likely that the Barkers, of Barbrook Cupola, took the remaining share possibly in competition. This being so then they may have been content to take their profits at the mine from the sale of ore, and in fact several accounts of the 1790's show losses on reckonings of ore smelted from these mines. In addition economies in the cost of distribution may have resulted by the sale of lead locally rather than via Bawtry, Stockwith and Hull.

GLOSSARY

Smelting Works—the *smelting mill* utilised a *hearth* blown with water powered bellows, somewhat similar to a small blacksmith's hearth. It was in use from about 1580 to 1780 in Derbyshire. Its replacement was the *cupola furnace,* a coal fired reverberatory, for which water power is not required. The smelting works was subsequent to its introduction c.1735, often known as the *Cupola.* The *slag mill* was used to resmelt the slag produced by both types of furnaces. In later years it was often an old smelting mill hearth built up to form a small shaft furnace, blown by water powered bellows.

Weights and Measures—Lead ore was measured by the *dish,* a wooden box of about 15 pints capacity. The dish varied from liberty to liberty (see below), but held between 60 lb. to 70 lb. of ore. Nine dishes made a *load.*

Lead was measured by the *piece,* weighing as close to 176½ lb. as possible. Two pieces made one *pig,* and eight pigs made one *fodder* or fother. The local fodder, known as a 'mill fodder', thus weighed 2820 lb., but various fodders were used outside Derbyshire. (See note 102) Consignments were made by the piece, prices by the appropriate fodder quoted.

Administration of mining laws and customs—was controlled by the *Barmoot* Court and its officer, the Barmaster, in most mining areas (usually, but not invariably based on parish units) or mining *liberties.* Each and evvery miner and ore buyer owed suit to the court, and if they did not attend, as the smelters rarely did, then they were fined or amerced. Duties on mining included *lot, cope* and tythe. Lot and tythe were usually taken in kind, cope as a fixed payment of 4d. or 6d. a load, payable in the last case by the ore buyer. The duties and the duty owners or lessees are very diverse, but the barmaster was very commonly the collector, at the time of measuring, of the duties, and the representative of the owners.

REFERENCES

[1]G. G. Hopkinson "Five Generations of Derbyshire Lead Mining and Smelting" (Hopkinson I), *Derbyshire Archaeological Journal,* LXXVIII, 1958, 9—24. *The Development of Leadmining and of the Coal and Iron Industries in North Derbyshire and South Yorkshire 1700—1850* (Hopkinson II), Sheffield University, Ph.D. Thesis 996, 2 vols.

[2]L. Willies, 'The Introduction of the Cupola "For smelting Down Lead" to Derbyshire' (Willies I), *Bulletin of the Peak District Mines Historical Society* (P.D.M.H.S.), Vol. 4, Pt. 5. 1971, 384—94.

[3]L. Willies, 'Winster and Eighteenth Century Lead Mining' (Willies II), *P.D.M.H.S.*, Vol.3, Pt.5, 1968, 271—9.

[4]John Rylands Library (RYL), Bag.12/1/5g.

[5]Derbyshire Record Office (D.R.O.), 504B/L12.

[6]D.R.O. 504B/L24/1.

[7]See RYLBag.12/1/59 and National Library of Wales (N.L.W.) Powis Castle No. 9216 respectively.

[8]D.R.O.504B/L213.

[9]D.R.O.504B/L24/3.

[10]Willies I 391—2.

[11]J. Farey, *A General View of the Agriculture and Minerals of Derbyshire,* 1811 Vol. 1, 0.385—6.

[12]D.R.O.504B/L255.

[13]D.R.O.504B/L64, L65.

[14]L. Willies, III '*Cupola Lead Smelting Sites in Derbyshire*', *P.D.M.H.S.* Vol. 4, Pt. 1. 1969, 97—115.

[15]Willies II 275—6.

[16]D.R.O.504B/L264/2.

[17]D.R.O.504B/L296.

[18]Sheffield City Library (S.C.L.) Bag.587(66)1—9.

[19]Hopkinson I 12—3.

[20]RYLBag.12/1/59.

[21]S.C.L.Bag.485, 486.

[22]D.R.O.195Z/T11—12 and S.C.L.W.H.C.4. Also see Willies III, 109.

[23]See S.C.L.Bag.66/1, 2, and Bag.562, 535, 662, 543.

[24]Hopkinson I, 10.

[25]S.C.L. Barker Collection.

[26]S.C.L.Bar.828.

[27]In Chatsworth House.

[28]Hopkinson I, 10.

[29]S.C.L.Bar.828.
[30]S.C.L.Bar.812.
[31]S.C.L.Bar.812.
[32]S.C.L.Bag.484—Mich. 1744.
[33]See entries in February 1744 and 1745 for example, in S.C.L.Bag.484.
[34]Hopkinson I, 10. The reference to John rather than Thomas seems due to the misreading of J for T in the Partnership Account (S.C.L.Bag.484), though that it does indeed refer to Thomas is clear enough later.
[35]S.C.L.Bag.484—October 1743.
[36]It was still possible to use the Calver Mill in 1752 on a hire basis at 14/8 per fodder of lead produced. N.L.W.Powis Castle No. 9216.
[37]RYLBag.8/3/11.
[38]Hopkinson I, 12—13. See also George Barker's will: S.C.L.Bag.635.
[39]Hopkinson I, 19.
[40]S.C.L.Bag.485.
[41]Willies III, 112.
[42]Hopkinson I, 12, but see Willies III, 105.
[43]S.C.L.Bag.488, 490.
[44]S.C.L.Bag.484. Beeley seems previously to have been accounted for with Rowsley.
[45]S.C.L.Bag.488.
[46]S.C.L.Bag.491.
[47]S.C.L.Bag.488.
[48]S.C.L.Bag.587(68):3429.
[49]S.C.L.Bag.482.
[50]Willies III, 109.
[51]Willies III, 103. Note that there are minor variations between Hopkinson and this account over dating.
[52]S.C.L.Bag.486.
[53]S.C.L.Bar.828. (Thomas Barker's will).
[54]Map in Haddon Estate Office.
[55]S.C.L.Bag.587(66).
[56]Especially in the Winster Accounts. (Chatsworth House).
[57]S.C.L.Bar.828.
[58]Willies III, 97—8, 107.
[59]S.C.L.Bag.490.
[60]Hopkinson I, esp. 13—15. It should be possible in the future to enlarge considerably on this aspect, especially for the period of the 1780s, as the relevant accounts have recently become available.
[61]S.C.L.Bag.484.
[62]S.C.L.Bag.488.
[63]S.C.L.Bag.486.
[64]See for example S.C.L.Bag.506, 661—1, 2.
[65]D.R.O.504B/L384/1 and S.C.L.Bag.585(45).
[66]S.C.L.Bag.491.
[67]S.C.L.Bag.546.
[68]S.C.L.Bag.487.
[69]N.L.W.Powis Castle Nos. 9214—9220.
[70]S.C.L.Bag.491.
[71]S.C.L.Bag.587(89).
[72]S.C.L.Bag.488.
[73]For cupola locations see Willies III, 115. Smelting mill sites are less well known, but a stream sediment survey suggests well over a hundred likely sites in these areas; Institute of Geological Sciences, Nichols *et al*, *Regional Geochemical Reconnaissance of the Derbyshire Area*, 1970. Most of the lead anomalies with over 150 ppm. of lead seem to be from smelting mill sources.
[74]Willies III, 103, 109.
[75]Willies I, 391.
[76]S.C.L.Bag.485.
[77]S.C.L.Bag.485.
[78]L. Willies, 'A Note on the Price of Lead, 1730—1900.' (Willies IV), *P.D.M.H.S.* Vol.4, Pt.2., 1969, 179—91.
[79]Willies, III, 108, 112.
[80]S.C.L.Bag.485, 486.
[81]Willies I, 388.

[82]S.C.L.Bag.484.
[83]S.C.L.Bag.491.
[84]Willies I, 388.
[85]See Watson, R. 1793 *Chemical Essays.* (6th Edit.), 231—2. His opinion is born out by examination of the relevant ore accounts at Chatsworth House.
[86]Hopkinson I, 15.
[87]Hopkinson I, 15.
[88]S.C.L.Bag.479, 480.
[89]S.C.L.Bag.543.
[90]S.C.L.Bag.584.
[91]S.C.L.MD.3707.
[92]He was also employed at Harewood during its construction. S.C.L.Bag.485.
[93]S.C.L.Bag.479, 480.
[94]S.C.L.OD.175.
[95]S.C.L.Bag.587/48. Though in 1790 it had four furnaces Woolley MS. B.M. Add MSS, 6679/78 et seq.
[96]S.C.L.Bag.490.
[97]S.C.L.Bag.491.
[98]D.R.O.504B/L65.
[99]S.C.L.Bag.548.
[100]S.C.L.Bag.587/48.
[101]Especially in Hopkinson (II) p.159 *et seq.*
[102]S.C.L.Bag.485. provides numerous examples. A mill fodder weighed some 2820 lb., a Bawtry fodder 2408 lb., a Hull fodder only 2340 lb. and the London even less at 2180 lb. Thus Thomas Battersbie bought lead at Shackloe Mill at £17 5s. on 8th October 1755, and £16 at Bawtry a day later.
[103]S.C.L.Bag.484.
[104]S.C.L.Bag.562.
[105]S.C.L.Bag.484.
[106]Hopkinson II, 163 *et seq.*
[107]S.C.L.Bag.587/66.
[108]A. H. John, *The Walker Family,* 1951.
[109]S.C.L.Bag.480.
[110]S.C.L.Bag.562.
[111]S.C.L.Bag.661—1.
[112]S.C.L.Bag.661—2.
[113]S.C.L.Bag.543.
[114]S.C.L.Bag.494.
[115]S.C.L.Bag.494.
[116]Up to £42—Hopkinson (I) p.17.
[117]Hopkinson I, 18, 24. Home market prices were not directly affected until duties of 36/— a ton were dropped to 10/— in July 1825.
[118]see S.C.L.Bar.810, 812.
[119]S.C.L.Bag.484.
[120]Hopkinson I, 12.
[121]S.C.L.Bag.485.
[122]D.R.O. Land Tax Assessments.
[123]S.C.L.Bag.587/48.
[124]S.C.L.Bag.477, 479.
[125]Hopkinson I, 16—17.
[126]Hopkinson II, 162.
[127]A. N. Palmer, *A History of the Town and Parish of Wrexham* Pt.5, 1903, 166—7.
[128]D.R.O.195Z/T11—12.
[129]Willies I, 390, 392.
[130]Willies III has a few details of these smelters at their various smelting cupolas. See especially entries for Middleton Dale, Lea, Stonedge, Meerbrook, and Brough.
B.M. . . . British Museum (Microfilm at County Library, Matlock).