

## The Lead Industry in Britain and its Visible Remains

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The mining and smelting of lead in Britain is now almost non-existent, but it was an important industry over many centuries and during the nineteenth century was a major one, reaching an annual production (including silver which was an associated product) of the order of £2 million. In 1856 the total amount of lead produced was over 73,000 tons, and the silver production was over 600,000 ounces, or approximately 20 tons. Over half the lead came from the Pennines.

Although the lead industry itself is now almost extinct, its remains are numerous and visible. Lead ore occurred mainly in upland areas of desolate moorland, and therefore pressures of redevelopment have not caused the wholesale dismantling, demolition and removal of the buildings and works as would have happened if it had been an urban industry or even one carried out in agricultural areas. In the Pennines from Derbyshire to North Durham and South Northumberland, in Wales, in the Mendip Hills, in the Isle of Man, and elsewhere, one sees isolated chimney stacks on hills, often long stone-built channels leading up to them—sometimes a mile or two in length—and clusters of ruined buildings which were the engine

houses, offices and changing sheds of mines, or the remains of the smelt-mill and, in appropriate areas, of the peat-store. These are the remains of the 18th and 19th century boom in the industry. Earlier remains are very much rarer. On a wild day the moorland remains have an eeriness which tends to deter the would-be explorer; but on a fine day they have often a grandeur matching that of the wild scenery around them.

It is possible sometimes to find the entrances to underground workings, which may be by horizontal or vertical shafts, and although there is danger in exploring these for the inexperienced and unequipped, there are several societies (and individuals) which make a specialty of mine exploration, and it is to these societies that a great deal of knowledge of the mines is due. The lead industry has also fascinated many historical researchers, and there are numerous excellent books and papers on its history. In spite of this, however, it is still often remarkably difficult to find any information on a particular building or mine one has become interested in.

Lead occurred as lead sulphide (usually galena) and usually in quite thin veins. Its

occurrence was not widespread over Britain, but in the areas where it occurred it was not concentrated and so the remains of the industry are locally widely dispersed. The extraction of the ore necessitated excavating large masses of the adjoining rocks, and so there was need for a quite extensive ore-dressing process. Hand-selection, crushing, and separation of the heavy lead ore from the lighter other rocks by flotation methods in longitudinal or circular 'buddles', necessitated a large labour force for ore-preparation. Smelting was normally done in the mining areas.

Mines were opencast where possible. Ore near the surface was in earlier days (i.e. up to the 18th century) often removed by a hydraulic process known as 'hushing'. A small dam was built on a stream above the vein, and when a sufficient amount of water had collected, the dam was broken, the rushing torrent washed out the weathered rock, and the pieces of ore thus exposed were then collected by hand. The gullies produced by this process can still be recognized in many hillsides. Shaft and adit mining was necessary, however, in most 19th century mines, and miles of underground passages were built in many areas in the Pennines. Some of these were equipped with tramways for aiding the transport of the ore. Others were drainage tunnels (known as 'soughs' in Derbyshire). One huge tunnel under Alston Moor was 9 ft x 9 ft in section, contained a waterfall 210 ft high, and below this had a level stretch of over two-and-a-half miles with the water depth kept at 4 ft so that 30 ft barges could be used for carrying the ore out of the mine.

The history of the lead industry in Britain goes back far into the past. The Romans certainly mined and smelted lead in Britain, and extracted silver from it. The lead was largely used in their sanitary and water supply systems. The Danes are supposed to have been interested in it and to have given from their language many of the

A circular depression in the ground indicating the remains of a buddle. Underneath the grassy overgrowth lies a stone-lined shallow pit with a floor which slopes down gently from the centre to the circumference. Lead waste or ore ground up with plenty of water is fed by a channel or launder to a point above the centre; the lead-rich component, being heaviest, settles near the centre of the buddle and the rest of the material on the outside. This is one of a group of buddles at the Charterhouse Lead Works in the Mendip Hills, Somerset (grid reference ST 503 555). These buddles were in operation till 1885.



was a further reason for introducing long flues towards the end of the 18th century. In later years, special plant was sometimes installed in which the smelt exhaust was washed by water to condense the residual lead. In the Mendips and in Derbyshire, flue length was extended without the need for long distances over the ground by doubling the flue back on itself two or three times. An example at Charterhouse-in-Mendip has four tunnels side-by-side joined in series. At Alport in Derbyshire, the arrangement seems even more complicated.

The smelt mills themselves were very varied in their architecture and arrangements, and often their ruins seem rather nondescript. Many, however, were notable pieces of building, with fine masonry work in the construction of arches. The Great Octagon Mill in Arkengarthdale in Yorkshire was particularly interesting. It was built about the year 1700. As its name implies it had eight sides, and internally had a maximum dimension of 107 ft and a width of 70 ft. In the centre was a water wheel of 36 ft diameter, with four groups of bellows around it to provide the blast for four furnaces. The flues from this mill ran as a double tunnel for about half-a-mile up the hillside to a chimney standing at an elevation of 1,320 ft, which was about 300 ft above the mill. A later mill, the New C.B. Mill, built in 1824, took over these flues when the Great Octagon Mill fell into disuse.

Associated with the mills were usually large fuel stores which also were stone-built and often had architectural merit. Peat was commonly used as fuel, being obtainable locally, and being satisfactory in ore-hearths; and as it is a bulky fuel, it necessitated large store-buildings. Coal had to be used in reverberatory furnaces, but quantities were not large, and could often be obtained from small local pits.

Remains of the waterwheels themselves are less common than those of the mill buildings, but a very spectacular one may be mentioned—the huge 72 ft waterwheel at Laxey in the Isle of Man, which is being restored to working order.

Although the silver content of most British ores was rather low compared with that of many European ores, it was never-

theless found worthwhile to extract the silver. This was a tedious process, involving in effect the removal of the lead from the silver—i.e. increasing the concentration of silver in the remaining lead. The earlier process was called cupellation and in it the lead was oxidised into litharge and blown away; the later process, introduced by Pattinson in 1833, was the crystallization process, in which lead crystals could be removed from the molten metal as it cooled. It was considered economic, in the early 19th century with silver worth about 5/- per ounce, to extract silver from lead containing as little as 3 oz per ton.

In many northern areas the miners and surface workers lived in the villages and hamlets in the dales and thus mixed socially with the farmers. Often miners were accommodated on farms. They thus learnt about farming and a widespread habit developed among miners of engaging in part-time farming, doubtless to the great benefit of their health. In some of the most northerly areas, however, the mines were far from any established villages, and the mining companies built special mining villages for their workers. An example was Nent Head, on the bleak moors to the east of Alston, where the London Lead Company in the early

19th century provided their workers with cottages with land attached—up to six acres in some cases—and also provided a market hall, wash and bath houses, school, chapel, and church.

Miners' wages were paid either on a time basis, or what we might now call a piecework basis. The 'pickmen', who dug out the ore, and the 'dead men', who dug the shafts and levels, usually formed small partnerships and worked on a kind of contract basis. They made 'bargains' with the Company to do or provide so much ore or excavation at such and such a price. This meant, particularly in the case of the pickmen, that weekly earnings varied greatly according to whether they struck a good vein or a poor one. In a given week, one pickman's wages could be more than ten times another's, although the average wage (around £1 per week in the 1870's) compared reasonably with other industrial wages. Miners usually worked only relatively short hours (36-40 hours a week). Women, girls and boys employed on the surface work had longer hours, perhaps 56 hours a week.

There was often hardship among miners, but some employers tried to help by advancing a minimum wage each week, selling grain to the miners at cost price or below,

The Great Octagon Mill, Arkengarthdale, built about 1700, was one of the finest buildings associated with the lead industry. As can be seen from the illustration, little now remains of its former grandeur. (Grid reference NY 996 037).





Boundary stone of the Stockton and Darlington Railway on the high moors above Stanhope beside the track of the railway line that began as the Stanhope and Tyne Railway in 1834 and was taken over by the S. and D. R. in the 1840's. The S. and D. R. was itself taken over by the North Eastern Railway in 1863, so this boundary stone is evidently over a century old. From this moorland line several long branches led to lead mines, as well as to iron mines and limestone quarries. (Grid reference NZ 003 433.)

and by trying to maintain employment in bad times. The London Lead Company seems to have been a good employer on the whole.

Miners in the lead industry tended to develop health troubles due to foul air in the mines, lead poisoning, and dust. Statistics show that in a particular northern area in the mid-19th century the average age of death of a lead miner was about 47 compared with about 61 for non-miners.

Transport was always a problem in the lead industry and it accounted for a sizeable proportion of the cost of the finished product. Throughout most of the history of lead, packhorses formed the main basis of transport, even well into the 19th century. Owing to the remote and hilly country in which lead ore was found, transport by waggon

was often impossible and usually uneconomic. Both in taking the ore from the mines to the smelt-mills, and in taking away the lead to the markets, trains of packhorses were used, and some regular routes became famous, as for example the 'Lead Road' over which trains of 12 to 30 packhorses, each carrying 2 to 3 cwt, carried lead from the mills of the London Lead Company on Alston Moor to Stella-on-Tyne. Turnpike roads, developed in the 18th century, played some part in lead transport, and occasionally in a suitable area, a canal could be used.

Even when railways developed with locomotive traction, they could be of only limited help to the lead industry. Their cost could be justified only where there was other traffic as well as lead. This applied to a greater extent in the Northern Pennines than elsewhere, as iron, limestone and coal also needed transport. The Stockton and Darlington Railway, opened in 1825, extended itself later into the lead-mining areas along and to the north of Weardale, where the Stanhope and Tyne Railway, built in 1834, was absorbed by it, and from which several mineral railway branches were built to lead mines at Rookhope, Ramshaw, Allenheds, etc. Many rope-worked inclined planes were involved in these railways, and the track formations, remains of engine houses, and bridges, can still be seen. Only a tiny remnant of this large railway network up on the high moors still remains in use.

In the Derbyshire Pennines another interesting and famous railway was built at least partly for the lead traffic. This was the Cromford and High Peak Railway, 33 miles long, built in 1831, and also involving rope-worked inclines.

Present-day activity in the lead industry

in Great Britain is very small. In most areas there is none. There was considerable but short-lived activity in Derbyshire in the 1930's, and some mining is still done in County Durham in old mines, but mainly for barites and fluorspar.

#### Reading List

*There is a vast literature on the subject. This is a short selection of some of the more important or accessible works. Hundreds of other references are cited in them.*

- A. Raistrick and B. Jennings, *A History of Lead Mining in the Pennines*, Longmans, London, 1965.  
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 T. D. Ford and J. H. Rienwerts, *Lead Mining in the Peak District*, Peak Park Planning Board, Bakewell, 1968.  
 W. J. Lewis, *Lead Mining in Wales*, University of Wales Press, Cardiff, 1967.  
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 R. Burt, 'Lead production in England and Wales, 1700-1770', *Econ. Hist. Rev.*, 22, August 1969, pp. 249-267.  
 R. A. Mott, 'Lead smelting in Derbyshire', *Bull. Historical Metallurgy Group*, No. 8, Jan. 1967, pp. 6-11.  
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 F. Brook, 'The Fallowfield Lead and Witherite Mines', *J. Industrial Archaeology*, 4, 1967, pp. 311-322.  
 J. D. Carlisle, *Lead Mining and Smelting in the Yorkshire Dales with Future Prospects*, Thesis, Dept. of Minerals Engineering, University of Birmingham, Feb. 1964.

#### Illustrations

The photographs illustrating this article, all taken by the author, are chosen to give a fairly broad survey of the surface remains of the lead industry from the Mendip Hills in the south to Northumberland in the north. They indicate, for example, the wide variety of the chimney stack architecture that is such an obvious feature of the remains, the often-long flues of arched stone, the engine houses, auxiliary buildings, smelting equipment, and ore-processing arrangements. Grid references have been included to make it easy for the interested reader to find these remains for himself.



**Somerset**

*Left:* A general view of the remains of St. Cuthbert's Lead Works in the Mendip Hills, Somerset (grid reference ST 545 505). It was established by Cornish mining engineers in 1857, and continued in operation, somewhat intermittently, until 1908. It is now so ruinous that it is hard to identify most of the remains. Old stone-lined tunnels abound, and the formation of the former tramway can still be seen and followed.

**Derbyshire**

*Right:* The ruins of the engine house at Nickalum lead mine in Derbyshire (grid reference SK 237 540), close to the village of Brassington. This mine was one of a large number on the area known as Carsington Pastures, but only one other (the Great Rakes mine, grid reference SK 240 536) had an engine. The mine was producing lead at least as late as 1895. The fact that it had an engine suggests that it was quite a deep mine, possible 200 ft. or so.



*Below:* Remains at the Snake lead mine in Derbyshire (grid reference SK 262 555). This was a comparatively small mine, active in the middle part of the 19th century, and worked sporadically since then, even up to the 1920's. The shaft was 250 ft. deep and now has a modern concrete cover.

*Below left:* A longitudinal buddle. This used the same basic principle as a circular buddle, i.e. the separation of the heavy lead ore from the other rock by flotation, but the fluid flow was from one end to the other. The white scale on the stone slab is 1 ft. long; it can thus be seen how small the buddle is.

*Below right:* A workmen's changing hut, or 'coe', about 8 ft x 12 ft, with a fireplace, and to the left of the fireplace a tunnel leading into the mine workings.



## Derbyshire

Stone Edge smelt-mill, Derbyshire (grid reference SK 334 670), is interesting, situated near the great Millstone Grit cliffs called Stone Edge. It is possible to trace many of the works as the smelter was evidently a small one and compactly laid out, although it is all in ruins except for the chimney. A mill-pond provided power. The maximum annual output was probably about 500 tons. The mill dates from before 1783, fell into disuse in the first part of the 19th century, but was rebuilt and re-used later, finally ceasing to be worked around 1850.

*On the right:* The chimney.

*Lower right:* A furnace arch.

The Magpie mine in Derbyshire (grid reference SK 172 682) is one of the most famous lead mines in Britain. It is an old mine, probably 300 years old, but certainly in operation around 1795. A Newcomen or atmospheric-type steam engine was installed for pumping in 1824 (over a century after the first Newcomen steam engine), but was replaced by a Cornish-type (high-pressure) engine about 1840. Other engines were also used at different times. The mine reached a depth of about 700 ft. It closed down in 1872, but has been operated sporadically since then, the last attempt to work it being as recent as 1958.

*Below:* General view of mine buildings from the south; on the left is the winding drum at the side of the small engine house which contained a horizontal steam engine, and in the centre background is the large engine house for the Cornish engine. The right-hand chimney stack is for the Cornish engine; the purpose of the left-hand chimney is uncertain.

*Below left:* Old tramway wagons from the mine piled up in a shed.





**Yorkshire**

*Above:* The chimney at Malham Moor mill (grid reference SD 883 661) near Malham Tarn, Yorkshire. The mill itself was by the stream about 30 yards below the chimney. There is a flagged stone flue joining the mill site to the chimney. The mill was erected in the early 18th century to deal with lead ore from nearby mines, but was converted to copper smelting about 1788.

The blowing of the ore-hearths in lead smelt-mills was generally effected by huge bellows driven by suitable linkages from a water-wheel. The latter was, in the Yorkshire mills at any rate, situated within the mill building, and the water was fed to it from the mill-dam (or pond) by a wooden channel called a launder. These pictures were taken at the site of the Old Gang Smelt-Mill above Swaledale (grid reference NY 974 006). The Old Gang Mill was built about 1790, on the site of an earlier mill. It was one of the most famous in Yorkshire, the mines associated with it being very extensive. It ceased operation in 1898. *Below left:* Old bellows; the size may be gauged by comparison with the 12-inch white ruler. *Below right:* Wooden launder, now somewhat displaced.



... and its Visible Remains

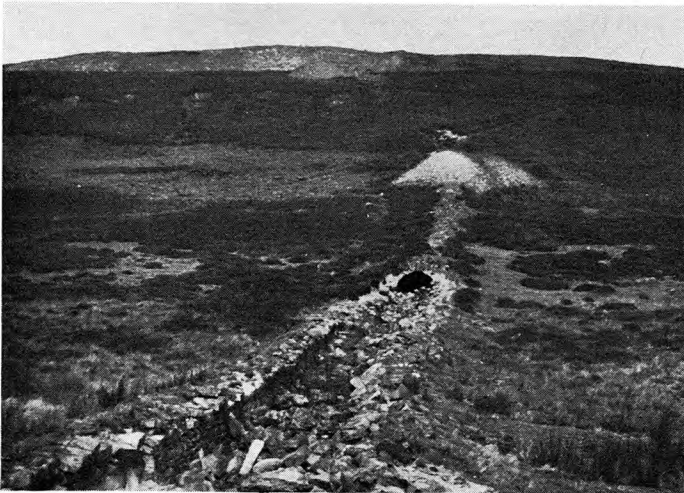
**Yorkshire**

The ruins of the Surrender lead smelting mill, above Swaledale, Yorkshire (grid reference SD 991 999) are shown in the lowest of the three illustrations. This mill was built about 1840 on the site of an earlier mill. It had inside it a waterwheel 22 ft. in diameter to drive the bellows for two ore-hearths. The peat store can be seen at the right-hand side of the illustration. It was a fine building of internal dimensions 188 ft. by 15 ft.

Work ceased at the Surrender mill in 1881. The three photographs were taken in 1936 and there has subsequently been further decay of the buildings, especially of the peat-store

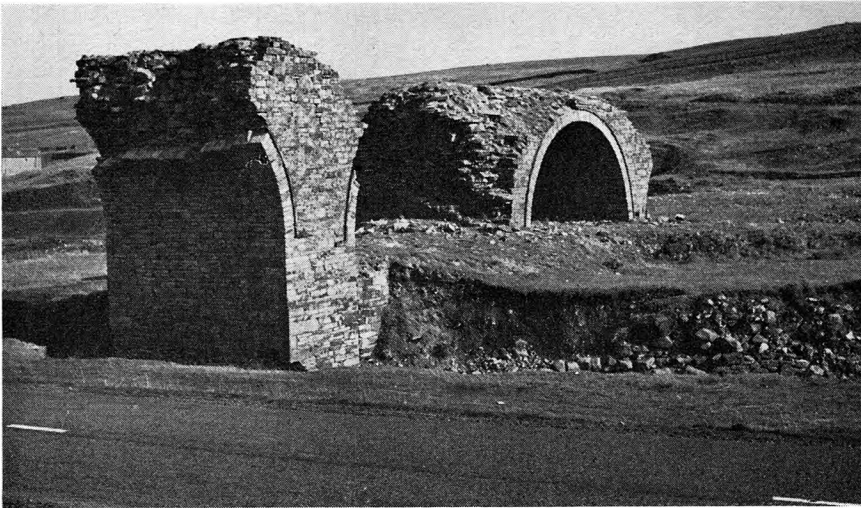


*Above:* The square chimney at the top of the flue from the Surrender mill (grid reference NY 988 003).



*Left:* Remains of the 500-yd-long flue at the Surrender mill; part of the tunnel was still intact in 1936 as can be seen in the illustration.

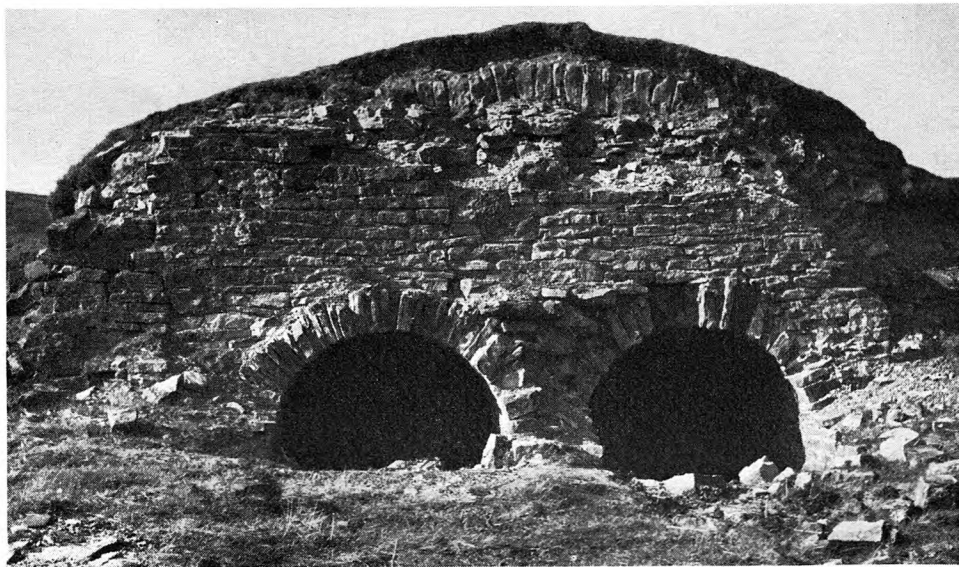




**Co. Durham**

The Lintzgarth smelt-mill (grid reference NY 925 430) near Rookhope, to the north of Weardale, was a huge affair, erected about 1750 on the site of an earlier mill, and extended in 1802. It remained at work until the 1920's. It was one of those mills in the North Pennines which had railway transport from about 1865, connecting with the Stockton and Darlington system.

*Left:* The remains of an arched bridge joining the mill by the stream to the opposite hillside, apparently for the purpose of carrying two large flues.



*Above:* This stone-lined structure must have been a condensing chamber in the flues at the hillside end of the bridge. The two flues entered by the openings shown, and a single flue left by a larger opening at the back.

*Right:* This ditch is the base of the flue which ran from the chamber shown above for one and a half miles straight up the moor to a chimney at the top. It was an arched flue built of stone, but the stones have evidently been removed for other purposes, leaving only this ditch as evidence.





### Northumberland

*Below:* The Fallowfield lead mines and smelt-mill are in Northumberland, north of the River Tyne and near Hexham. They are thus rather detached from the main lead mining areas in the Pennines. Mining and smelting have been carried out at Fallowfield for several centuries, but the main period of activity was the second half of the 18th century; operations finally stopped in 1913. From the 1840's the prosperity of the mines was greatly increased by the extraction of witherite, a fairly rare form of barium carbonate.

The illustration below shows the 'New Engine' house at Fallowfield (grid reference NY 931 673) used for pumping water out of the mines. The engine house is almost intact externally, and has been converted into a small house. It was probably built about 1786.



*Above:* The Langley smelt-mill in Northumberland, about 8 miles west of Hexham, was built in 1768 by the Greenwich Hospital Commissioners to smelt ore received as royalties from the London Lead Company who were their lessees in important lead-mining areas in the north, especially on Alston Moor. Much experimental work was carried out at Langley, and it was an advanced mill for its time. In particular, efforts were made to obviate the poisoning of the animal life and vegetation of the area, and eventually a flue, three-quarters of a mile long, was built to this rather unusual chimney high up on the moor at Stublick (grid reference NY 841 611).

*Right:* Remains of the Fallowfield smelt mill showing an arch above the presumed site of an ore-hearth. This mill (grid-reference NY 937 675) was built about 1770, but there had been earlier smelters nearby.

