Lead Mining in the Dales

The Dales have been shaped by lead mining and the scars can be seen in many places including many close to Laykin. Surrender Bridge, Old Gang Gill and Gunnerside Gill are all very interesting places to visit, and the Reeth Museum will enlighten you further. Reeth was once the capital of lead mining in Swaledale. In its heyday, in the mid-19th century, there were over 1000 miners living in Reeth.

Lead was used for so many everyday items and in so many ways, from guttering and plumbing to children's toys, ammunition and cannon balls and weights as well as in everyday substances like paint. Funnily enough, it was never used in pencils!

Yorkshire lead was used in the great castle and cathedral building age. It is said that lead from Yorkshire mines was used in Windsor Castle, St Peter's in Rome and even on church roofs in Jerusalem.

Early History of Lead Mining

The Yorkshire Dales are substantially formed from limestone and gritstone outcrops laid down in the Carboniferous Period some 320 million years ago. The lead ore occurs in veins which were deposited hydrothermally: hot pressurised liquids containing a range of minerals were forced through cracks in the native rock and deposited what they carried when the pressure and/or temperature dropped. The minerals are not conveniently deposited by type but mixed together. The veins are quite narrow – typically only a metre wide – but stretch deep underground.

When the Romans came to Yorkshire it is thought likely that there had been some small-scale lead mining from the Bronze Age onwards, although this remains to be proved. The Romans, therefore, probably took over existing mines and organised and expanded them, probably bringing with them experience gained from the mining of lead in Europe.

The Roman Empire used a lot of lead for, amongst other things, making into pipes and lead sheets, which were used for lining cisterns and baths. Lead mining declined when the Romans left Britain in the 5th century AD and the market disappeared. A number of ingots (or pigs) of Roman lead, some bearing inscriptions, have been found. For example, two pigs, dating from A.D.81, were found at Hayshaw Bank, near Pateley Bridge, in 1725. Two others, one found at Nussey Knott near Appletreewick and marked TRAJAN and the other from Hurst in Swaledale and marked HADRIAN, have since been lost, no doubt melted down and sold by their finders. Other than these finds of ingots there is no archaeological evidence to suggest where the Romans worked and the scale of their operations.
Medieval

Mining became important again in the 12th century when, for some 200 years, Yorkshire lead was used in the great castle and cathedral building age. It is said that lead from Yorkshire mines was used in Windsor Castle, St Peter's in Rome and even on church roofs in Jerusalem. During this time, much of the county's lead production was dominated by the monasteries, which were powerful landowners. They ran the mines, issued leases and charters, and collected royalty payments. Their records give the first documentary sources on lead mining. During the late 14th and early 15th centuries plagues, like the Black Death, devastated the country's economy by killing around a third of the population which in turn reduced the need for lead.

Trade gradually increased until, following the orders of King Henry VIII, all 650 monasteries in England and Wales were dissolved in the five years between 1536 and 1540. Lead, stripped from monastery roofs, flooded onto the market and depressed prices, causing many mines to close. Nevertheless, it was needed for the many large houses which were built when the monastic lands were sold by the crown. It was used for pipes, cisterns, guttering, and down-pipes. Work which we would term "plumbing", a word derived from the Latin for lead and, therefore, a plumber was literally a worker in lead. Historically, plumbers were not solely concerned with the supply and disposal of water as today; he was also skilled in the working of sheet lead used on the roofs of important buildings and in the making and repair of leaded windows. Lead was also used for making pigments. White and Red lead are both oxides of the metal and were used in paint manufacture until recently.

One consequence of the dissolution was a growth in speculative mining. The new landowners who had taken over the monastic land were keen to earn royalties and would issue leases on any obscure piece of land. These were often taken up by small partnerships of men who used mining to supplement their farming endeavours. Many of these enterprises were short lived and without profit, the veins so poor that they were soon abandoned. Occasionally rich pockets of ore were discovered which made the fortunes of the lucky entrepreneurs.

The Industrial Revolution

By the late 18th century wealthier companies began to lease larger areas of land. In Yorkshire, and elsewhere, the mines were transformed. They changed from
unplanned rabbit warrens, with small levels and shafts, to became systematically planned and worked, with secure shafts, lined with stone, and levels driven to explore and exploit the veins. This process, which was helped by the introduction of gunpowder blasting in the late 17th century, led to a large increase in output as the industrial revolution got underway.

The first two-thirds of the 19th century was the golden age of British metal mining. Yorkshire’s lead mines played an important part, thanks to the development of long level networks, and between 1845 and 1870 produced an average ten percent of the nation’s output. At this time the UK was producing about one-half of the world’s lead, but the trade was at the mercy of the markets. Fluctuations in the price of lead caused a number of depressions, such as the one in 1830, when many miners left the Dales for more secure jobs, either in the coal mines and textile mills of neighbouring counties, or further afield in America or Australia.

The latter part of the century saw a combination of circumstances, which led to the demise of the industry. The price of lead fell as the market was flooded with cheaper, imported metal. Many of the mines were becoming increasingly poor with depth, whilst others were simply exhausted. The low prices meant that there was an unwillingness to commit capital to development work, which may have found new reserves.

The golden age was over, therefore, and the years between 1880 and 1900 saw the end of most large-scale lead mining in Britain. The market price of lead was reduced to a little over half of what it had been in the previous 30 years. This was not the end of the story, however, as attention was turned to the other minerals, such as barytes and fluorspar, in the early twentieth century. The minerals, which filled the veins alongside the lead ore, had been left as worthless by the Old Man, as earlier miners were known, became the new goal of the miners in the Yorkshire Dales.

Small-scale enterprises recovered minerals from the old lead mine hillocks from the 1920’s onwards. The mines in the Greenhow Hill area were the busiest, where considerable amount of fluorspar also remained underground. A number of mines were reopened, albeit on a small scale, and several new shafts, levels, and inclines were developed in the 1960’s on the Burhill veins. That decade was the most productive the dales had seen for many years.

Much of the fluorspar went to the steel industry, for use as a flux in iron making, but the chemical industry used the highest grade to make hydrofluoric acid. Barytes is used as a high-density drilling mud by the oil industry, as well as a filler in paper and paint making. A small amount of calcite was also mined and
sold for decorative pebble dashing. Washing plants were established at Cockhill and Dry Gill, both on Greenhow Hill, with others at Grassington Moor and in Swaledale.

The last underground mining was at Gillheads Mine near Appletreewick, in 1981, and the last plant for re-washing tip material, near the Old Gang smelt mills in Swaledale, closed in the early 1990s. As most of the mineral veins occur within the boundaries of the Yorkshire Dales National Park it is highly unlikely that planning permission will be granted for future mineral extraction, so a long history of mining has come to a close.

With grateful thanks to Martin Roe, for all the above information. More is available from his amazingly informative website.

http://www.martinroe.pwp.blueyonder.co.uk/sarc.htm

**Mining in the Dales**

**A life of extremely hard work**

Mining families worked hard and had a precarious existence as they were only paid by the amount of ore produced. If a vein ran out it was not uncommon for men to work for weeks with no profit. Boys were sent to work at an early age (usually around 10 years) to the 'washings' where they worked for about eightpence (approx. 3p) per day. They worked under often cruel conditions shovelling house from the crushing rollers. Some children also worked down the
mines. It is recorded that one father used to carry his son down 400 feet of ladder on his back at Duke Shaft, Grassington Moor.

By the age of 17 or 18 boys became part of the gang working for annual or half-yearly bargains. They would work with a skilled miner who expected them to do all the hard work. By the 19th Century men’s wages varied from 10-18 shillings per week (50-90 pence) with smelters earning the most.

Many women worked on the surface 'buckering the ore' or minding the 'hotching tubs' (the agitation tubes used to sieve out the ore from waste). In the 17th Century it is recorded that women earned as little at 1s 2d per week (approximately 6p) plus two flannel petticoats per year. Later in the 19th Century they earned a shilling a day (5p) for 10 hours of work and were provided with woollen skirts. One old lady was known to take her turn at the hotching tubs and knockstone at the age of 96!

Conditions underground were grim. It was always wet and cold but the biggest problems were 'bad air' and miner's dust which caused may lung problems (including fatal infections and TB). Mines used ventilation machines to freshen the air in the levels but the introduction of dynamite in the mid 19th Century added the new hazard of poisonous fumes. The average lifespan of a miner in 1860 was about 45 years.

Income levels were so poor and erratic that most families also maintained a smallholding with a few cattle and pigs and poultry providing food and extra income. Women would also make their own butter and cheese. Meat was cured with salt. Knitting was also a widespread method of making a little income as well as clothes. Men, women and children knitted at every opportunity – even walking to work across the fells was to the sound of clicking needles. Nothing was wasted – miners' tools were often made with recycled materials (look at the drill handle in the image), and old cloth was used to make mats to guard against the cold of the stone floors.

Throughout the 18th and 19th Centuries lead production reached a peak and Britain became the main producer of lead in the world. During the 19th Century miners struck 'bargains' with landowners so that prospecting for ore was a mutual benefit. This effectively meant the miners became self employed and had a great incentive to find viable lead veins and exploit the deposits. Major advances in the harnessing of water technology in the form of water wheels meant that some degree of mechanisation was possible. However, mining in the Dales was always hard manual labour and in very remote areas relying on pick and shovel by men, women and children in dirty and often dangerous situations.

Miners rarely became wealthy. The precarious nature of prospecting meant that supplements to their income were needed and so most miners and their families also turned their hand to farming for food and even hand-knitting was used to generate extra income. The men often knitted on the long walks to and from the levels and smelting areas, so that time was not wasted.
Mining Methods - Bell Pits and Hushes

The earliest mining process was the digging of Bell Pits. These appear today as circular depressions in the ground occurring at intervals along straight lines, but can often be confused with the natural shake and swallow holes in limestone. Lead ore usually occurs as vertical veins. Miners identified these veins at the surface in flat areas and dug a hole to expose the ore. As they dug deeper they reached a limit when it became difficult to remove the waste by shovel and the walls of the pit became less stable. They dug vertically down into the rocks opening a small shaft and ultimately a bell shaped chamber underground, removing waste by use of a hand winch (a jack roller or windlass) with a bucket (known as a kibble). As they reached the limit of ore or the limits of practical working they would move along the surface following the vein of lead and start new bell pits. Spent Bell Pits were often sealed off with wood and then back filled to stop sheep falling in but this process has left a dangerous legacy as the wood has rotted.

Bell Pits were little use on steep hillsides and so the method of hushing was used and continued into the 19th Century. Hushes can be seen today as large scarred areas (usually gullies) on hillsides, with particularly prominent examples visible along the sides of Gunnerside Gill and Reeth Moor in Swaledale. The method involved building a dam near the top of the area to be cleared allowing water to collect from natural streams, rainwater and diverted water. When there was sufficient water the dam was broken, allowing the water to scour away the topsoil and small boulders exposing veins of lead which could then be exploited from the surface.

Mining Methods - Levels, Stopes, Deads and Spoil

As miners exhausted the hushes they dug into the hillsides producing Levels (horizontal tunnels) to gain access to the lead veins deeper in the hillside. Level entrances are still prominent in many valleys, appearing as arched tunnels – often lined with dressed stone.

Sometimes natural caves were used as an access point to lead veins and then Levels dug within the caves to gain deeper access to the ore – examples of such caves are at Devis Hole Mine near Grinton Smelt Mill in Swaledale and Dow Cave, near Kettlewell in Wharfedale.

Within the Levels miners usually dug upwards into the lead veins. This meant that gravity helped to bring the lead ore down to the level below where it could be taken to the surface. To achieve this, wooden platforms called Stopes were built ever higher into the worked out veins and accessed via wooden ladders. Ultimately miners could be working at great heights on these platforms. Waste rock and other materials called Deads had to be removed from the area but to many miners this was a waste of effort and so large quantities were left on the
Stopes, a real danger to people exploring the mines today as the wooden platforms become rotten.

Water was an ever present danger in the Levels and shafts. Heavy rain could turn Levels into underground rivers very quickly. Most Levels were dug slightly uphill to allow water to drain away, but the working conditions were always wet and potentially dangerous.

Levels often had metal track-ways laid for the use of wagons to carry spoil (waste products) and ore to the surface. These were often pushed by the miners, but in some mines ponies were used to haul the wagons. The uphill nature of levels helped with the removal of heavy wagons. Spoil was usually deposited at or near the mine entrance and picked over by children for ore that can be salvaged. Most mining areas are still covered by large spoil heaps which remain barren to plant growth because of the concentrations of lead. Wagons of ore would be pushed from the level to 'bouseteams', stone containers where ore was stored before being taken for processing.

**Mining Methods - Shafts**

It was not until the latter years that explosives started to be used to speed up the building of new levels which allowed speculative digs to be started rather than just following known veins. Over the years the levels and connecting shafts expanded under the hillsides. Many miles of such passages exist, connecting mines together underground with entrances as much as six to eight miles apart on the surface, and even in neighbouring dales.

**Shafts** also provided access in areas where the ground was not steep enough to dig levels and provided a convenient way to raise ore and waste to the surface. Hand winches were again used to lift materials to the surface but as shafts got deeper this became impractical as the weight of the rope combined with the material to be lifted was too great. In such case horse 'whims' were used, an ingenious method whereby a horse or a team of horses walked in a circle rotating a central post around which the rope would wind or unwind. None survive today but there are some of the stone bases where the winding post was planted in a central hole to be seen. To work at even greater depths water wheels were used to raise and lower the kibbles. Most shafts have now been filled in to avoid accidents to livestock and walkers.

The depth of a mine was largely restricted by the level of the water table, but during the 19th Century steam pumps were installed to pump out water from levels in some areas to allow miners to work at greater depths.

**Processing Ore - The Dressing Floor**

Processing the ore was a two stage process – **Dressing** and **Smelting**.

**Dressing** was the process of sorting out the raw materials (bouse) extracted from the mine. The miners brought the bouse to the surface. It was stored nearby
in stone built storage hoppers caller bouse teams from where it was ultimately taken to a 'dressing floor', the area where the sorting took place. Often one dressing floor was shared by more than one level or mine but it was important not to expend too much energy moving unprocessed bouse over great distances.

The bouse was sorted by hand by boys, often as young as 10 years old, women and older men. This involved sorting out the lumps of pure galena (ore) which was separated, and deads rock containing no ore, which was discarded on a nearby spoil heap. The remainder of the material contained some ore but needed to be cleaned up before smelting by knocking off lumps of with a spalling hammer.

Once a pile of pure galena was produced the lumps needed to be reduced in size to about the size of peas. Initially this was done by hand using a heavy flat hammer called a Bucker, but was later mechanised by the use of crushing wheels (essentially a giant mangle), powered by water.

Finally the small lumps of ore were sieved in water. This allowed the heavy particles to settle to the bottom and lighter waste particles to remain at the top to be scraped away and discarded. Later this was done more efficiently using Hotching Tubs – a large tub effectively sieving larger quantities of ore by jiggling the sieve up and down using a lever. Eventually Hotching Tubs were mechanised by the use of water wheels. The very fine grains or ore were not lost but gently washed in slow moving water to collect the 'slime' or fine ore while the lighter waste was washed away. Stepped designed ‘running biddles’ were used to make this a more efficient process. Being wooden not many have survived but there is more information about them in the link at the bottom of the page.

Once the pure ore was reduced to a suitable size it was transported to the nearest Smelt Mill which served a number of mines in the area.

**Processing Ore - The Smelt Mill**

The smelting process is essentially very simple. Pellets of Galena are heated until they reach melting point. Because lead has a low melting point any impurities are not melted and are left as waste. The molten lead can be allowed to drain from the fire hearth into a collecting pot and then poured into moulds to form blocks of pure lead metal.

In practice things are not quite so simple:

- To achieve the temperatures necessary (600-800ºC) to melt the lead from the Galena requires a source of fuel. This was originally found by coppicing local woodland but was eventually supplied by cutting and drying moorland peat which was in plentiful supply.
- A constant stream of air, to aid combustion, was also needed and was provided initially by the use of hand bellows, but as mechanisation increased the use of a water wheel to drive huge bellows became common. This of course meant that water was needed and so mills were
built in valleys to find a ready supply of water and then large scale earthworks produced a dam and reservoir to store and control the water.

- The heated Galena gives off poisonous fumes (particularly Sulfur Dioxide and also Vaporised Lead). In early small scale smelting these escaped into the atmosphere but in large scale mills the fumes needed to be removed efficiently. Large flues (horizontal chimneys) up to 1km in length were built up hillsides – usually topped with a vertical chimney. Periodically boys were sent into the flues to scrape condensed lead from the walls to return it for processing. You can see chimneys above Surrender Bridge and also at Old Gang Gill.

Where Miners lived

Most mining families had generations of mining history but many had family ties in other parts of the country from as far away as Scotland, Ireland and Cornwall. Consequently the mining communities were very mixed and like the gold rush of the wild west, attracted 'characters. Mining for most was a form of 'hunting and often a matter of chance when looking for veins of lead.

Most miners were self employed or worked together as private units. They struck bargains with landowners (later with mining companies) and were paid by the amount of ore they produced.

Due to the locations of the mines and smelt mills many miners lived in ‘mine shops’ during the week and returned home only at weekends. Many single miners lived permanently in these shops. The traditional miner's cottage was stone built, with a single storey and thatched roof. Sometimes the cottages had a second storey and were grouped into rows of two or more. In the later years second storeys were added with stone roofs to the old cottages. At weekends the small cottages could become very crowded with 10-12 people living in a small space and taking turns to sleep in the bed.

Lead mining has left a lasting mark on the landscape which visitors view with a romantic nostalgia as they stroll past ruined buildings, workings and spoil heaps on summer days. We should not forget the harsh realities of life for men, women and children who tramped across the fells in all weathers to work in damp, dark and extremely dangerous conditions.

Many thanks to the informative website below for all of the above information. http://www.mylearning.org/lead-mining-in-the-yorkshire-dales/p-344/