Lead Mining Technology in the Northern Pennines from early times to 1900

by Helen Wilkinson

Introduction

Northern Pennine Geology

The Pennine hills are known as 'the backbone of England' and can be separated geologically into three upstanding 'blocks' separated by lower lying areas 'troughs' between them. Mineralised fissures called veins cut all three of these blocks and all three have been mining districts for centuries.

The Durham Dales are part of the northernmost of these upland areas, known as the Alston Block. The area is composed of layers of alternating sedimentary rocks- sandstones, shales and limestones that were laid down in Carboniferous times when the area was in tropical latitudes south of the equator.
At this time, about 354-300 million years ago, this was the vicinity of a large river delta disgorging into a warm shallow sea.

These sediments were laid down on top of a weathered mass of granite. Granite is a rock with comparatively low density and therefore tends to form a buoyant part of the earths crust and this is the main reason why the Alston block remains an upland area today. Granite is also a good conductor of heat and the mineralisation in the veins was formed late in the Carboniferous by the circulation of hot saline mineralised fluids circulating through the granite and the overlying fissures.

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The small faults, which filled with minerals to become veins, tend to be wider in the hard beds of rock such as limestones and some sandstones but very thin or non-existent in the softer beds of mudstone and shale. This is because these softer rocks tend to deform and fall into the fissure thus impeding the flow of mineralising fluids.

This means that the veins are only well mineralised at certain horizons where they intersect the more competent beds of rock.

The minerals

The principle ore of lead is galena (Lead Sulphide) another common metallic ore in these veins is sphalerite (Zinc Sulphide) and along with these ore minerals in the veins are other minerals, termed 'gangue' by miners which include barite, witherite, calcite, fluorite, quartz and ankerite. Iron ore in the form of siderite and limonite was also common in parts of the orefield and was extensively mined as well as the lead. In later years the production of barium minerals and fluorite replaced lead in importance.

Today there are no longer any active mines producing industrial minerals though there is some very small-scale activity producing mineral specimens for sale to the mineral trade. I am involved in one of these ventures, which is what has inspired my own interest in the history of mining in this area.

Mines are excavations in rock and one of my principle interests has always been in the means used to actually break the rock and remove it from the mine. In my explorations of long abandoned workings I have come across some evidence of how parts of them have been driven, visits to the record office and reading around the subject have brought to light further information which in turn has given me more clues of what to look for underground. What follows is a presentation of some of the information I have discovered and the conclusions drawn.

Methods of Developing Mines

It is not, and probably never will be, definitively known when mining first began in this area, although the Romans were certainly present in the area and are known to have mined for lead in Derbyshire there is no direct evidence that they did so here. Earlier workings have been so extensively reworked by later enterprises that almost no trace of them survives.

As a matter of necessity the earliest workings would be where the vein outcropped to surface and was therefore discovered. The earliest workings were opencast scratchings on the veins at outcrop. One way of operating this kind of surface excavation was a by process known as hushing.

Hushing

This method was used both for prospecting and for mining and was in common use during the eighteenth century. Once an area of hillside was identified which was suspected to have potential, a dam and a series of water channels called leats were constructed. The leats collected water and channelled it into a reservoir behind the dam. The vegetation was then cleared from a strip of the hillside below the dam by hand and the stored water was then allowed to rush over the prepared section scouring away earth and loose rock. If a workable vein was found this method could be continued with where the outcrop of the vein ran down the valley side. The rock would first be loosened by hand and the strong flood of water would be allowed to wash the digging area, ore being sorted from broken rock at the foot of the hush.

This method of mining was not popular with downstream residents as it could cause floods at some distance from the working and by the beginning of the nineteenth century it had been superseded in this area.

There is plenty of evidence in the landscape for the practice of this technique by miners in the Pennines and many examples of both mining and prospecting hushes are still to be seen, some particularly obvious examples are Dowgang Hush Nenthead, Coldberry Gutter, Teesdale, and Cowhaust Hush near Killhope in Weardale all of which were production class.

There is a limit to how deep workings can go by this method when orebodies are of the vein type as found in this area, soon the amount of 'dead' rock which has to be moved in order to access the vein becomes too great to be economical. It then becomes necessary to turn to underground mining.

Methods of Developing Mines:

Shaft Mining

The earliest underground workings in the area are shafts, generally high on the fells where the soils are thin making it easier to find the veins at surface.

These workings (sometimes erroneously referred to as bell pits) consist of a series of shafts sunk at frequent intervals on the line of the vein with workings driven off for a short distance along the vein in the productive strata.

The distance that the workings were driven from the shaft would be limited by both ventilation and the difficulties of haulage, especially of 'dead' rock. The minimum amount of rock possible would be removed to access the ore which meant that mine tunnels were often narrow, low and twisting to follow every kink in the vein. Haulage in hand barrows or wheelbarrows in these circumstances was back breaking work and as much rock as possible would be left in the mine in areas that were 'worked out' however this could hamper later operations if they were left in the wrong place.

Once a shaft was finished it was quite likely to be used as a waste rock dump for the next working and so very few have survived, most being flooded, collapsed or backfilled. Shafts along Smittershill Gill Sun Vein on Rotherhope fell illustrate this form of working well with multiple closely spaced shafts and signs of small-scale shaft top dressing operations. A descent of one of these shafts revealed that it appears to have been used as a tip for waste from the ore dressing process of a later working, as it is much easier to barrow waste to a hole and tip it than to make a heap of it!

Methods of Developing Mines:

Drainage Levels

Preventing shaft workings from filling up with water was always a problem, occasionally sinking the workings into a well jointed limestone might allow accumulating water to run off naturally but usually workings had to be artificially drained. The simple method was to haul the water out by hand in buckets but this was inadequate if the 'make' of water was large or the workings very deep. Pumps, powered by man, animal or water, were developed but the best way to dewater a mine if possible, was to drive a 'level' in to the bottom of the working from the side of the hill and allow the water to run out. Given the topography of the Alston Block with relatively steep sided valleys and hills, this was often possible here where in flatter areas it might not be. Another advantage of putting in a drainage level was that in also helped greatly to improve the ventilation.

The main limitations on the extent of these early workings assuming the presence of a productive vein, would have been:

The depth to the productive ground.

The 'make' of water (amount of water flowing into the working from the surrounding strata).

The ability or not to put in a drainage adit.

The state of ventilation .

According to C J Hunt 'The Haugh Level, commenced in 1684, was one of the earliest examples of the long drainage adits, which later became a common feature of the mines in this area. Down this level ran the water, which was pumped out of deeper levels by a series of underground waterwheels beneath Allenheads village along with the water that powered the wheels themselves.'

Driving a drainage level could help not only by dewatering the workings but also by helping to create a through draft and thereby improving ventilation too.

Internal haulage would then become the most pressing problem. Early drainage adits were driven only just large enough to serve that purpose and were not large enough to use for access or hauling deads or ore.

Methods of Developing Mines:

The Introduction of Horse Levels

The opportunity drainage levels could present if they were driven large enough to be used as haulage ways allowing gravity to assist in hauling instead of having to raise everything up shafts to 'day' was appreciated and by 1765, there was a level at Coalcleugh containing a horse-drawn waggonway a mile in length.

Allenheads mine was developed by the driving of the Fawside level, commenced in 1776 by Westgarth Forster Snr, the then Principal Agent. This level was instrumental in the opening up of the workings of the East End of the mine.

In the same year the trustees of the Greenwich Hospital began the Nentforce Level. The intention was to dewater the extensive workings at the head of the Nent Valley and also to explore at depth the ground between there and the level mouth over four miles away in Alston.

An equally ambitious plan was the Blackett level, driven up the East Allen by Sopwith. Commenced in 1855 it reached a total length of nearly four-and-three-quarter miles and was intended to dewater Allenheads mine but stopped short of this goal in 1920 due to a collapse in the price of lead.

The introduction of these haulage levels in combination with wheeled mine wagons running on either wood or, later, iron rails and pulled by horses made the removal of ore and waste rock very much easier and quicker but the driving of these long levels in unproductive ground required a large capital investment that could only be supplied by well capitalised individuals or companies

By the nineteenth century the two major companies, whose records survive in any quantity, working in the area were the London Lead Company and W B Lead Company. They were both well capitalised and could afford to set about the opening of new workings in a systematic way. There were other companies some small and others with multiple mines under their control, but little information on their operations survives.

In 1864 the chief agent of the London Lead Company described the procedure that company followed to the commissioners reporting on the mines as follows:

''When we set on a level it is seldom for the purpose of covering only one object; we, generally speaking, know of the existence of a number of veins before us, and on our reaching the vein, if it be of sufficient magnitude and of a fair mineral character, then we rise to the surface, not only for ventilation, but for proving the character of the vein in all the strata between the level and the surface; we follow up the vein according to the course of the lode. Into . . . [the] level we put a horse and waggons always. Suppose we find, in the course of our rise, in the different strata through which we have passed, ore-yielding indications, then we put on, from the rise, drifts in the course of the vein; and between such drift and the horse level, and also the surface, frequent communications are made for ventilation and other pur-poses. As each vein is reached, a like procedure takes place.''

Today one of the outstanding features of the mines around Nenthead is the miles of excellent stone arching supporting the workings, CJ Hunt in 'The Lead Miners of the Northern Pennines' however quotes Jars, a visitor to the Rampgill and Coalcleugh Mines in 1765 as saying that

'although the rock required little support this little was rarely done at all properly. 'Il y a ... une negligence tres-grande cet egard: j'ai passe dans plusieurs de ces galeries ou les bois etoient pourris et casses, et menacoient d'une danger evident.''

Roughly translated; 'There is great negligence in this respect: I have passed through many of these tunnels where the walls were obviously dangerous.'

The sandstone arching that we now see supporting the horse levels and the shafts where they pass through incompetent beds or come to surface, and which is mainly responsible for the fact that many of the workings are still accessible, was largely constructed in the nineteenth century to protect the important haulage ways.

Larger scale working and mechanisation

The widespread use of horse levels greatly facilitated the removal of waste rock from the workings and made the development of workings far more systematic. These haulage ways became the arteries and veins of the mine. They were generally driven in the softer mudstone beds beneath the hard orebearing strata. They were linked to the production workings above by shafts some of which were ore passes and some manways. Another observation by Jars in 1765 was that he saw no ladders at all in the mines he visited in the area. The shafts were ascended and descended by means of 'stemples' these are pieces of timber wedged at both ends against the shaft or stope walls about 4 feet above one another.

Thomas Sopwith in his book 'Alston Moor' mentions having to climb 30 feet or so up a shaft in Hudgill Mine in order to gain access to a working 'an exertion of some difficulty, for these cross sticks were in places so far distant as to require all the active agility of youth to mount them'.

By the mid 1800's ladderways were gaining favour and gradually replaced stemples as the means of moving from one level to another. They were far easier and less inclined to sudden unexpected failure.

By this time access to most mines was by means of a level. With only the deeper mines below the valley bottom still using shafts as the main entries and at these some form of mechanical hoisting was common. By 1864 Gin Hill Shaft at Allenheads had two cages in the shaft each holding 3 men.

After the middle of the eighteenth century, power-driven pumps were in common use to drain the greater part of the mine systems below the main drainage levels. The water pressure engine was invented in 1765 by the mine agent at Coalcleugh, William Westgarth (probably with the knowledge that such engines had been in use on the continent).

Hydraulics were further developed by the well-known Tyneside industrialist W G Armstrong at his Elswick factory and were extensively employed especially by W B Lead Company. Paradoxically this extensive use of waterpower for pumping and powering ore dressing machinery meant that in very dry weather the water supply dried up and the mines could flood. To try to prevent this a very extensive network of leats and dams was constructed.

Steam power though extensively used elsewhere, was not popular for mining use in this area. It was tried at the Derwent mines where the workings were very deep and mostly below the valley floor and also in the Haydon bridge area where similar conditions apply. Steam was found to be very expensive to operate compared with hydraulic engines, which were almost as effective and much cheaper. By 1872 the last of the Derwent Steam engines had been replaced by a water pressure engine.

Methods of Breaking Rock:

Hand tools

Hammers, wedges, picks and shovels were basic mining tools from very early times and remained familiar to working miners right through the study period. In soft ground some progress could be made with a pick and shovel, but usually progress was hard won and a variety of differently shaped hammers and wedges for exploiting any small cracks and weaknesses in the rock were employed.

De Re Metallica by Georgius Agricola, a German mining textbook unrivalled for 180 years was translated from the first Latin edition of 1556 by Herbert Clark Hoover and gives us an excellent idea of the state of mining technology at that time. It contains illustrations of many different hand tools and a wide variety of hydraulic machines for pumping and drawing ore. The more advanced technology, however, does not seem to have been widely known in the Northern Pennines at this early date. There is no doubt that German miners were brought to supervise work in the Lake District and it is suggested that some may have worked in the western part of the orefield on the basis of the name ‘Blaygill’, from the German ‘Blei gill’ or Lead gill.

Fire setting

The basis of this method was to light a fire against the rockface to be broken, the heat from the fire causing fractures in the rock. This could only be of use where the ventilation was good; otherwise the fumes from the fire could overcome the miners.

Wallace (1890) reports that remains of fired rocks had been discovered in parts of Briggleburn Veins near Nenthead.

The use of plugs and feathers

A hole was drilled into the rock to be removed and then the feathers were pushed into the hole; these were two wedges of metal with a circular profile the same diameter as the hole and they went in thicker end first. Between these two was then inserted another chisel like wedge and this was then hammered until the rock shattered. Sometime the workmen would be rather too ambitious in the amount of rock they tried to remove and rather than breaking rock the whole apparatus would become stuck in the hole. Wallace (1890) refers to having found examples still stuck in their holes. He refers to them as 'stook and feather'.

The introduction of gunpowder

The use of gunpowder (black powder) in mining was a major revolution in the art of moving rock. And probably first began to be used in this mining district from around 1680 or 1690 (Wallace suggests that the powder was at first confined by a metal plug with a groove cut in it to allow the introduction of a fuse or 'squib' he refers to having found both metal and similar plugs made from wood in old workings. The use of iron for this purpose was, of course, very dangerous since the metal is liable to produce a spark if roughly introduced into the hole and thereby cause a premature explosion) I have found, in old workings in Rampgill Mine cow horns which have had the ends removed and holes bored in the bases as if for a cord to carry it by looking very much like a funnel to assist in the loading of powder into the holes.

Later, clay tamping replaced the iron plug and tools for cleaning out the drill holes and introducing the fuse or stemming would be made of copper, which was safer than iron because it will not spark in the same way.

Methods of Breaking Rock:

Gun Cotton Powder

In the1850's entries in the diary of Thomas Sopwith, the chief agent for the W B Lead Company mines, describe various experiments being carried out in Allendale, both in the limestone foreheads at Holmes Linn Shaft on Blackett Level and also on surface in Thorngreen Quarry. These experiments were all related to the development of drilling and blasting rock.

One of these was in the use of Gun Cotton in place of powder. Sopwith was optimistic on these trials though the results were not conclusive since at the same time they were using an electric device to set off the charges simultaneously instead of fuses and they were also using an experimental drill steel that was drilling a hole with an enlarged area at the bottom. Gun cotton powder did come to be used commercially in the mines of the district and wrappers bearing the inscription 'Guncotton Powder Company London' are still to be found in some of the workings notably in Proud's Sump flat Smallcleugh Mine, by 1870 gun cotton had replaced powder in most of the WB Lead Co mines.

The other main experiment was in the use of a hydraulic powered rockdrill being developed by an engineer, Percy Westmacott, at W G Armstrong's works at Elswick in Newcastle. According to C J Hunt the Derwent Mining Company were also experimenting with a rockdrill. The version produced by the Elswick works was rather unwieldy and prone to breakages, it would have been limited in its application to those mines with a hydraulic accumulator and it never got past the experimental stage. The mines of the district had mostly failed by the time that a lighter more reliable compressed air rockdrill became available towards the turn of the twentieth century.

On 13th January 1873 Alfred Nobel, assisted by Mr. P. A. Liedbeck, who had supervised the building of the factory, made the first 1,500 lb batch of nitro-glycerine at his Ardeer factory near Glasgow. By this time the heyday of lead mining in the Northern Pennines was beginning to come to a close. New mining fields opening up, in the USA and in Spain for example, were causing a dramatic fall in the price of lead.

A few lead mines were still being worked into the twentieth century, but not many, and the mining of other minerals, either alongside or replacing galena in importance was key in keeping the mining industry going until the closure of the last fluorite and barite mines at the end of the twentieth century. There is currently no mining taking place in the Alston Block except for a small coal mine near Alston.

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