When the Yorkshire Dales National Park was designated in 1954 lead mining was still a living memory. The remains of the industry were considered by many to be an eyesore, something which disfigured the “natural beauty” of the area. Today we have a much greater understanding of how human activity has shaped every aspect of the Yorkshire Dales landscape, and the scars of the industry have been softened by another 60 years of ageing. The remains of the mining industry are now recognised as part of the special qualities of the National Park and are again playing an economic role as a resource visitors come to see, part of our cultural heritage.

The most obvious remains are those resulting from extraction and processing but the industry has had, and continues to have, a much wider impact. Much goes unseen – most mining activity took place underground and the mines are now inaccessible to all but a few intrepid enthusiasts who explore and sometimes reopen old workings. Vegetation changed as a result of the exploitation of woodland and cutting of peat for fuel for smelting lead ores and by alterations to natural drainage systems. Roads, tracks and paths which we use today were created or improved to access the lead mines or to transport lead to market. Miner’s cottages, if they survived neglect following the population crash of the late-nineteenth century, provide accommodation for residents and visitors alike. The high population density supported by the mining economy even had an impact on the density and pattern of farmsteads and field barns.

Most remains of the lead industry receive no special protection although some are Scheduled Monuments, others Listed Buildings and some are located within Sites of Special Scientific Interest. Since the early 1980s, the National Park Authority has been actively involved in conserving the remains of the industry, using funding from the European Community, Natural England, the Environment Agency and Historic England (formerly English Heritage) as well as its own resources.

The title of this exhibition is part of a description of Swaledale from William Camden’s Britannia, first published in 1695.

Robert White, Senior Historic Environment Officer
A Landscape of National Importance

Most of the images in this exhibition are of scheduled sites because this is where the Authority has concentrated its activities, working with Historic England (formerly known as English Heritage) to try and ensure the conservation of sites which had already been assessed as being of national importance. An exception is the Slei Gill area in Arkengarthdale.

Here recent work has been undertaken by the Authority and Historic England: a contract to assess how to define boundaries for large landscape-scale sites containing many undesignated but nationally important monuments in rural contexts. Slei Gill was one of the case studies chosen for this report.

Surprisingly, the Slei Gill area is neither protected by scheduling nor, unlike much of the moorland of Swaledale and Arkengarthdale, protected by SSSI designation. Collation of information as part of the contract clearly showed that the mining remains of the area are both archaeologically more interesting and in better condition than many designated sites, most of which are focussed around late-nineteenth-century smelt mills and dressing floors.

Slei Gill forms a parish and manorial boundary, and the visible mining remains differ on either side of the Gill. The most prominent features on the west side of the Gill are large hushes such as Tanner Rake Hush, shown here, Scatter Scar Hush and North Hush. These all contain smaller workings, both for extraction and processing and are surrounded by a series of shaft mounds of varying sizes as well as small levels. The extent of mining activity relates to the degree of mineralisation along the geological faults. On the east side of the Gill the extraction is concentrated along three veins and was also primarily by surface working. Here the workings are not named or labelled as hushes by the Ordnance Survey, possibly reflecting a different historical trajectory.

_Slei Gill, Arkengarthdale. NZ017030_
Beever Shaft and Wheel House are included as part of a pioneering lead mining trail at Grassington, created by the National Park Authority in 1981.

The Beever Engine Shaft was sunk for the Duke of Devonshire in 1837 and worked until the mines here closed in 1882. A wheel house for pumping and winding operations was built in 1837 and a dressing floor added in the 1840s. The wheel house, the building shown here, was enlarged in 1865.

After the Second World War, the remains of the wheel house were re-used and extended with concrete breeze blocks by Edwin Drake and William Taylor. They ran a successful business as a weekend hobby, reworking the nineteenth-century dressing wastes for barytes until the dumps were exhausted.

The mining remains at Beever now form part of the largest scheduled monument in the National Park. They have been entered into a Higher Level Environmental Stewardship agri-environment scheme. On behalf of the landowner, the National Park Authority organised consolidation works which were funded by Natural England. This was a difficult exercise at the wheel house, because the poor materials used in the earlier twentieth-century works were only intended as a temporary measure.

Suave Aerial Photographers’ unmanned aerial vehicle is here shown taking photographs of the site. The aerial photographs form part of the pre-consolidation survey of the complex and helped inform the preparation of the detailed specifications for the consolidation works.

*Beever Mine, Grassington, Wharfedale. SE02086568*
Conservation of lead-mining sites, as with other sites of historic interest, is a painstaking exercise that demands close attention to detail and the use of traditional materials and techniques. These skills can be learnt, but there is a scarcity of suitably skilled and experienced contractors who are willing to work in what are sometimes remote, challenging and uncomfortable conditions.

Here, at Coalgrovebeck on Grassington Moor, a contractor is repairing a bridge which had been partially undercut by stream erosion. The missing stones have been retrieved from where they had been washed downstream and are being carefully fitted back into position, a process akin to rebuilding a jigsaw with some of the pieces missing. The work was funded by the National Park Authority and Historic England.

Few of the users of the shooting track over the bridge would have been aware of the condition of the structure. Monitoring the condition of archaeological sites is an important part of conservation work. The Authority is assisted in this by the Dales Volunteers who carry out a Monuments at Risk Survey, a regular check on the condition of publicly accessible scheduled monuments in the National Park. The results help the Authority plan its conservation programme and bid for resources.

Grassington Moor, Wharfedale. SE02466635
Plants that can tolerate high levels of heavy metals are known as metallophytes. They were probably used by early miners as a prospecting aid. In the Pennine orefields the strong association between one metallophyte, spring sandwort *Minuartia verna*, and vein outcrops, lead-mine wastes and other heavy-metal-enriched soils gives rise to its local name ‘leadwort’.

Mountain pansy, *Viola lutea*, is a pseudometallophyte – a plant that can tolerate a relatively high concentration of heavy metal in the soil but also thrives under other conditions. It is more typical of enclosed turf than bare polluted ground. Mountain pansies vary in colour, but the yellow varieties are characteristic of smelt mills as here at New Mill.

Some mining sites are of particular botanical importance because of the complex mosaics of heavy metal-tolerant plant communities which have established since extraction stopped. Calaminarian grassland, species-rich plant communities on mining and alluvial deposits, has a very restricted occurrence throughout Europe and is a UK Biodiversity Action Plan priority habitat. Lead-mining remains also support highly specialised lichen communities.

*New Mill, Arkengarthdale. NY99620347*
New Mill in Arkengarthdale was sold for building materials at the end of the Second World War. This free-standing wall is now the most prominent above-ground part of the smelt mill complex.

It is sited on Open Access land close to the former Reeth – Tan Hill turnpike road. Through the doorway can be seen part of CB Yard, a group of cottages originally developed in connection with the lead industry, some of which are now used as holiday accommodation. From the roadside this wall looked relatively sound, but unwary visitors might not have seen that the inner skin of the wall above the door had largely collapsed and that further stones could fall at any time.

Conservation work at New Mill, which included detailed survey, was funded as part of the Yorkshire Dales Industrial Monument Management Scheme, a partnership between the National Park Authority and Historic England. Normally, the approach followed on historic sites is to “consolidate as found”, but here the very unstable nature of the wall demanded a slightly different approach. Additional stonework, salvaged from some of the disturbed loose rubble on site, was used to partially rebuild the robbed sides of the doorway and to create a new inner skin for the wall above. The collapsed profile, caused by the loss of the wall’s inner lintel and breakage of the stone lintel, was retained and the wall above the opening strengthened with hidden core reinforcement, thus keeping the character and appearance of the ruined structure.

New Mill, which started smelting in 1824, forms part of a much larger scheduled monument. This includes the remains of the Octagon Smelt Mill, built just two decades before the New Mill on the opposite side of the road; an extensive flue system originally built for the Octagon Mill but which was subsequently used by the New Mill; some of the largest hushes in the country; and a chert quarry linked to the road by a long inclined plane.

*New Mill, Arkengarthdale. NY99630344*
Some consolidation work requires very little in the way of materials, just a combination of time, patience, enthusiasm and skill. Here a collapsed wall which had been undermined by rabbits is being carefully rebuilt. The wall supported an extension to the multi-level dressing floor at Beldi Plate Holes Level Mine.

Rabbits can be a particular problem for mining sites. They find loose uncompacted spoil relatively easy to burrow in and seem to be tolerant of high levels of heavy metals. The problem is exacerbated on some mining sites on grouse moors where their natural predators are controlled. Rabbits do however keep some vegetation under control. This is a benefit at Beldi, which is sited in the Kisdon Force Woods SSSI between an area of semi-natural ancient woodland and a meadow, which is now largely ungrazed by sheep. Unwanted woody vegetation was one of the factors placing this site on English Heritage’s At Risk register. Following negotiation with Natural England and the landowner, the Dales Volunteers have removed sycamore saplings from the site, but the need for ongoing maintenance will continue.

The dressing floor, which was built some time after 1829/30 and abandoned in 1882, was carefully planned to maximise the use of gravity in the dressing process, with each stage taking place at a different level. The mine entrance is just behind the spoil heap, visible near the top of the picture.

The poor-quality rubble walling of the extension to the complex contrasts with the well-dressed walling stones of the main dressing floor, suggesting it was a later addition.

*Keld, Swaledale. NY90310072*
Most mine shops were single-storey buildings. The mine shop at Dolly Level is unusual for one built at the entrance to a mine in that it was originally two storeys, although today only the south wall of the building survives to show it once had two floors.

The mine entrance, a standard-sized horse level, is inside the building below what was presumably an office, as there are the remains of a fireplace and chimney at first-floor level in the south wall. On early maps the northern part of the building was labelled as a smithy, but there is now no obvious evidence of a blacksmith’s hearth.

Forming part of the Gunnerside Gill Lead Mines and Ore Works scheduled monument, the mine shop is shown here in the first stage of consolidation in 2014. The work was funded through the Yorkshire Dales Industrial Monuments Management Scheme.

The very difficult access to this site – there is now no access for wheeled vehicles – had meant that there had been very little robbing of stone for other purposes, the fate of many more accessible mining sites. Unfortunately it also meant that bringing building materials and scaffolding to the site was an expensive, labour-intensive process which increased the cost of conservation works.

_Gunnerside Gill, Swaledale. NY93750088_
Bunton or Bunting Mine

Lead mining was a speculative venture. Some miners and mine owners made their fortunes; others worked long hours for very little return or lost fortunes investing in unprofitable mines. There was not always gold at the end of the rainbow.

The Bunton or Bunting Mine forms part of a complex mining landscape. Here Gunnerside Gill cuts across four major lead veins. This exposed the veins on the valley sides, which made it easy for miners to exploit them through hushing and open-cast working and later from levels. The single-storey Bunton Mine shop was built near the entrance to Bunton Mine, partly on made-up ground formed from waste extracted in driving the level. To the south of the mine shop are a series of bouse teams, and a crushing plant and dressing floor powered by a waterwheel. The entrance to another level, Sir George Level is lost in the spoil heap near the valley floor. This had its own set of bouse teams, but these have been largely lost to stream erosion.

On a clear day, the remains of the Blakethwaite smelt mill can be seen from this viewpoint towards the head of the valley. The Old Gang Company however took its dressed lead ore from here and Sir Francis Mine back underground through Bunton Level to its mill in Old Gang Gill for smelting.

In the nineteenth century, Gunnerside Gill was one of the main mining areas in the Yorkshire Dales. Many of the tracks which served the mines were very well graded to make access easy for the miners and the pack horse trains, which carried materials to the site and took away the lead ores. Today they provide attractive and accessible routes for walkers and mountain-bike riders. They make an excellent and varied walk from the village of Gunnerside which takes in a variety of mining features. Walkers on the Coast-to-Coast walk have it less easy, as their route cuts across the steep-sided valley.

Gunnerside Gill, Swaledale. NY93970117
Bunton Water Wheel Case

With limited resources available a judgement has to be made as to whether the costs of conservation warrants the expenditure, particularly when, as here at Bunton in Gunnerside Gill, some of the structures are partly built on made (artificially formed) ground. This is gradually becoming unstable as the Gill changes its course.

Wooden features are a particular problem. Weathering of timbers produces an attractive patina of age and decay which it is impossible to replicate. It is probable that many of the larger section timbers used in the nineteenth century would have been imported, probably from the Baltic. Replacement timbers, even if close-grained timbers of a suitable size could be acquired, would drastically change the appearance of the site, while installing them would require engineering works and alterations which would further change the site. Short lengths of the well-graded track, which originally served the complex here, have been lost to erosion which would necessitate flying in scaffolding and other materials by helicopter.

Although helicopters were used to bring large quantities of sand and lime for consolidation of Blakethwaite smelt mill further up the Gill, the conservation approach to remote sites with particular access problems is normally a mixture of detailed recording and controlled decay with a recognition that some elements may not survive for much longer. A detailed survey record however will allow for future augmented reality visualisations. This is something which could only be done by hand drawing when the National Park started conservation work on the lead industry, but which now can be more easily achieved using computer-generated imagery. The mobile app which is being developed with support from Historic England is another form of interpretation which was unimaginable when the Authority first stated conserving the remains of the lead industry.

*Gunnerside Gill, Swaledale. NY93970117*
Rutters or Staple Shaft

Rutters Shaft, also known as Staple Shaft, is an open-mine shaft within the Gunnerside Gill Lead Mines and Ore Works scheduled monument. Although not directly adjacent to a public right of way, it lies within Access Land on a very steeply sloping hillside some ten metres below an eroded track serving the mining remains. Until recently, there was a risk of passers-by falling from the track into the open shaft.

Fencing around the shaft would have been both very difficult and obtrusive due to the steep slope and the fractured nature of the ground surface, so following discussion with mining and cave rescue specialists, a physical cap was installed. Because of the geology this cap, a walkway grill similar to those used on deep-sea oil rigs was set nearly two metres below the ground surface in order to be founded upon solid rock. This had the added benefit of not drawing attention to the shaft or being visually intrusive. The work was funded through the Yorkshire Dales Industrial Monuments Management Scheme.

The shaft, now nearly three metres in diameter at the surface, was originally sunk to help drainage below the Sir Francis Level. The 0.28m diameter cast-iron pipe supplied water to a hydraulic engine in the level capable of pumping 500 gallons of water a minute from a depth of 60 fathoms (110 metres) or lifting 24 tons of material an hour. However, the engine only worked for two years and remains underground, impressive but only accessible by wading through the long, now flooded, level.

The easily-accessible lengths of the pipe have been salvaged for scrap but, like the engine, the underground lengths are still in situ, a testimony to the engineering operation skills of the miners. It is not known where the pipes were cast or how they were brought to site, although it is likely that they were cast in Middlesbrough and hauled by horses from Richmond Station, 17 miles away.

_Gunnerside Gill, Swaledale. NY93830135_
A Founders Meer

Mineral rights are property rights to exploit an area for the minerals found within it. Since the Norman Conquest they have normally belonged to the lord of the manor, although rights could be sold or inherited separately. Grassington, and possibly many other mining areas, followed a system of customary mining law which provided a means of ruling the various relationships between the mineral right owner, merchants and miners. Disputes were settled at a mining court, called the Barmoot, by reference to the customary law.

In 1680 a system for allocating ground was adopted, whereby the first finder of a vein was granted two meers, with the next meer reserved to the Mineral Lord. The meer, a measurement of length, was increased to 30 yards. As customary law developed, some grants were traded so some holdings ended up considerably larger.

Markers known as meerstones were used to show the boundaries of a meer and thus identify who had the right to work the lead ore within. These varied in style; some were merely earthfast rocks, others upright stones set in the ground. Inscribed letters and numbers can identify the holder of the grant, although some meerstones are apparently devoid of markings. Over 140 meerstones have been recorded at Grassington, but many have been stolen and taken off the moor.

Those meerstones which mark the first meer granted on a vein are often inscribed with the word "founder".

This earthfast example, inscribed

J•CLAVION ESQ
& CO FOUNDER

probably marks the south-east corner of a grant held by J. Clayton & Co which is also shown on a survey map of 1781.

Grassington, Wharfedale. SE021657
Shaft Mounds

Shaft mounds are perhaps the most common archaeological feature found in the National Park. They vary considerably in size: from small areas of upcast around a relatively shallow shaft where everything was hauled up by hand; through slightly larger shafts where material would have been lifted with a hand operated windlass known as a jack roller; deeper shafts and larger mounds where material was lifted by horse engines or gin gangs; to the massive spoil heaps on Grassington Moor where lifting and winding operations were powered by a large centralised waterwheel which transferred power to the shafts by wire cable and reverberating rods.

Lines of regularly spaced shaft mounds at approximately 30-yard intervals can be an indication that a system of mining using meers was practised, because miners were expected to work or prove the vein along the length of the meer.

Shaft mounds where material was lifted by a jack roller are normally referred to as shallow shafts. Depth was limited to about 30 metres (100 feet), as longer, stronger and therefore heavier ropes added to the weight of the bucket of kibble and made jack rollers too difficult to use. However, greater depths could be worked by sinking shafts in steps within the mine. Horse whims could lift water ore and spoil from shafts more than 100 metres (330 feet deep). The wooden structures of the whims have long since rotted away, but their position is sometimes marked by a flat platform adjacent to a shaft, with a worn circular track where the horse or horses walked. These were sometimes protected by stone shelter walls.

When viewed from the A66 seven miles to the north, the row of eighteenth-century shaft mounds on Mould Side look like a row of Bronze Age round barrows, deliberately sited along a crest to mark a territorial boundary.

*Mould Side, Arkengarthdale. NY98140266*
Stemples

Underground workings represent a huge but often inaccessible part of the lead industry. Disused mines can present a raft of health-and-safety issues, and most access has been undertaken by mine enthusiasts and mine explorers.

This image is the view looking up from a level into a worked-out ‘stoping’. The vertical rock at the sides represents the edges of the worked-out mineral vein which has been entirely extracted, largely from the level beneath. The line of timbers, called ‘stemples’, are supporting a mass of ‘deads’ – unwanted non-ore-bearing stone that was extracted while accessing and mining the vein. It was often simpler, and more time and energy efficient, to store waste material within any available unused space inside the mine, rather than taking it outside.

The underground environment can be remarkably stable, with relatively constant temperatures and humidity. This can result in good preservation of wood and other organic materials. Sometimes, worked-out areas of mines were blocked during or after abandonment, meaning that there are areas which have survived as literal time capsules, complete with a wide range of tools, candles, personal items left by the miners and even clog prints in the mud. These artefacts are vulnerable to collection, and their movement and disappearance without documentation means that part of the story of lead mining is lost.

Other threats to the underground resource include alterations to drainage systems, rock falls, the failure of built structures and the risk of damage from unaware visitors. The clog prints left by nineteenth-century miners can very easily be obscured by the footprints of today’s mine explorers.

There has been little formal conservation work underground, although mining groups have undertaken some very important work. To supplement this and to enable visitors to appreciate the extent of the archaeology of lead mining, the Authority is planning to initiate a conservation project covering aspects of the underground heritage in 2016.

Raygill Mine, Wensleydale. SD901898
Spences Level

Spences Level is a typical horse level, some two metres high and 1.4 metres wide. It was driven underneath and to the side of Knotts Vein, which here had also been worked by a hush and by shallow shafts set into the bed of the hush. The entrance to the level was partly constructed as a cut-and-cover operation to give some protection against debris washing down from the hush.

The arched level originally projected further, but the stonework at the level entrance has been robbed, probably because it was constructed of well-dressed gritstone blocks and easily accessible from the metalled track in the foreground. The surviving arched section is relatively stable because of the depth of soil above it.

Levels were normally driven on a very slight incline which both facilitated drainage and ensured that ponies pulling loaded wagons out of the level had the benefit of gravity.

The water draining from Spences Level originally fed a small reservoir, now largely silted up, part of which is shown here by reeds. This was used as a power source for the dressing floor at Old Gang.

*Old Gang Gill, Swaledale. NY97220063*
Blakethwaite Dams

Water was essential to the lead industry, so managing water was a major consideration. Mines had to be kept free of water, but it was also useful as a power source: waterwheels were used for lifting material out of the mines, to drive pumps, to drive machines to crush ore-rich material to a uniform size so that it could be easily separated in water, and to power bellows in smelt mills. Separating the crushed material used the same principles as a gold digger’s pan. Flood control was also an issue as many dressing floors were close to watercourses.

While it was important to keep water away from working areas in the mine, sometimes it was also deliberately taken underground to help provide ventilation or to power machinery.

The Blakethwaite dams near the head of Gunnerside Gill were constructed after 1836 to control the variable flow in the Gill, and to ensure a steady supply of water to an underground pumping engine and possibly dressing floors further down the valley. The water naturally draining into the Gill was supplemented by a leat over 2.5 kilometres long from the Moss Dam, which was in turn fed by another watercourse four kilometres long.

The upper dam was constructed of large faced and fitted stone blocks above a natural waterfall. It created a shallow 130 metre long reservoir, now almost completely silted up. Most of the sluice and its surrounding stonework have now collapsed, allowing the stream free access through the dam. The lower dam, which may have been built later, consists of two inner stone walls surrounded by soil and rubble and reinforced by stone-faced outer walls. It is some 4.6 metres high and 9.2 metres wide at the base. It is not known whether it was deliberately breached or failed during a flood.

Gunnerside Gill, Swaledale. NY935560295
Algal Bloom

The lack of animal life caused by the heavy-metal content of water draining from an abandoned level in Slei Gill, Arkengarthdale, allows this algal bloom to flourish.

Abandoned metal mines pollute seven percent of the rivers in England and Wales, despite most of the mines having closed over 100 years ago. Half of the total load of cadmium, lead and zinc discharged to rivers comes from abandoned mines, most of the rest is from industrial sources.

The Water Framework Directive seeks to improve the environmental quality of all Europe’s water resources. In England, the Environment Agency is charged with ensuring natural water bodies meet specific chemical and ecological water-quality criteria. Three of the four most polluted catchments in Yorkshire are in the Yorkshire Dales National Park: Hebden Beck, Gunnerside Gill and Barney Beck, the fourth is Ashfoldside Beck in Nidderdale.

The Authority is working with the Environment Agency to address the effects of diffuse pollution caused by historic lead mining within the National Park. The Environment Agency is carrying out more detailed monitoring and analysis of water quality, and the Authority is carrying out a field assessment of the mining remains in the three priority catchments. This involves mapping sites where there is a potential impact on water quality, identifying archaeological and other environmental constraints, and suggesting where action to reduce pollutant pathways and physical erosion might be mutually beneficial.

*Slei Gill, Arkengarthdale. NZ01930291*
Air Receiver, Sir Francis Level

Traditional mining techniques relied on brute force, the skill and strength of a miner to break rock by swinging a pick or hammer underground. Firesetting (heating the rock with fire, and then dousing it with cool water) could be used to weaken rock and make it easier to mine.

In the seventeenth century black powder (gunpowder) began to be used, followed two centuries later by dynamite, and these too depended on the miner’s skill in drilling a small hole, known as a shot-hole, in the rock in which to place the explosive charge.

Sir George Denys was a part-owner of the mineral rights in Swaledale, and he was actively involved in a number of mining companies. The Sir Francis Level in Gunnerside Gill is named after his son and was begun in 1864. Driving started using hand-bored shot-holes and black powder and achieved a rate of nearly seven feet a week, but as it reached harder rock progress dropped to less than half this. In 1869, to speed up work, Sir George suggested using compressed air drills. As the Old Gang Company was reluctant, he set himself up as a contractor to use this new technique, the first time in a Yorkshire lead mine. He described the set up as:

The motive power was water, brought to bear upon a wheel 28 feet in diameter and four feet wide, attached to one of Low’s improved double cylinder air compressors of high pressure with a wrought iron receiver and connections supplied by E R and W Turner of Ipswich which worked up to about 60 lbs pressure on the inch.

As an additional benefit, the waste air from the drills improved ventilation for the miners. Progress was still slow and Sir George died before the project was completed.

Little remains of the water wheel pit or the compressors, but the oval-ended 6.1m long and 1.08m diameter air receiver survives as a vivid reminder of this pioneering venture. Its size probably prevented it from being broken up and sold for scrap, the fate of much abandoned mining machinery.

Gunnerside Gill, Swaledale. NY93980001
Grassington Moor Flue

Lead smelting, the process of converting lead ore to metallic lead, produced noxious fumes which were harmful to the smelters and nearby livestock. Smelting was first carried out in bales, bonfire-like clamps, using wood as a fuel. The first smelt mills, introduced in the late sixteenth century, had short vertical chimneys. These developed into short ground-level flues linked to a separate chimney. During the nineteenth century many of these flues were extended and some systems ended up several miles long. The smelting fumes cooled inside the long flues and volatilised lead settled onto the flue sides. Hatches in some flues provided access for workers to scrape down the sides of the flue, and the collected fume, sometimes flushed down into settling ponds, was recovered for re-smelting.

The total length of the flues at the Grassington Cupola Smelt Mill is over 1.7 kilometres. The main stone-arched flue was partly dug into the ground and then covered over with soil and turf. This helped seal it and improve the draught.

The flue was not designed to be a walkway, but it now forms an obvious and relatively dry route for visitors between the smelt mill and the landmark chimney on Grassington Moor. Undermined by rabbits and with the protective turf covering eroded away by wind and feet, parts of the flue have collapsed.

Some sections of the flue have been partly rebuilt. Here a layer of soil laid over the top of the flue by Dales Volunteers and National Park staff is being covered by a soil blanket. This pre-seeded biodegradable mat protects the new soil from erosion by wind and rain wash, enhances soil moisture retention and provides a secure environment in which grass seed can germinate and thus to produce a new turf cover.

Other efforts to protect the flue include a flagged stone path laid beside the flue across one of the wetter areas of the moor, to provide an alternative walker-friendly route. Visitors are urged not to walk along the top of the flue.

Grassington Moor, Wharfedale. SE02716642
Moulds Level

Moulds Level is a rare example in the Yorkshire Dales of a horse level with an intact portal. The projecting key stone in the arch was probably intended to bear an inscription. This may have been the mining company’s name or possibly a date, 1801, the year this level is believed to have been started. Tithe accounts however show a Moulds Mine had been working in 1748. One of the enduring problems of mining history is that documents frequently give different names for the same site, especially if there was a gap in working, another is that miners were frequently imprecise about their exact location above ground; underground records were normally more accurate.

Moulds Level gives rise to probably the largest spoil heap in the National Park and, like Sir Francis Mine, was used by two mining companies. The first edition Ordnance Survey six-inch map of 1854 shows two grinding mills and two washings or dressing floors near the mouth of the level, but by 1893 work had concentrated on one site.

Strangely, but possibly because of its size, the complex falls just outside the boundary of the eponymous scheduled monument ‘Lead Mines and Smeltmills at Moulds Side West of Langthwaite’.

The mine is currently owned by Yorkshire Water. Although this level is dry, this is because the mining ground is drained by New Moulds Level dug in the 1870s. The outflow from the New Level used to provide the public water supply for Reeth and Arkengarthsdale.

Arkengarthsdale. NY99640255

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These rails originally linked Sun Hush Lead Level with a spoil heap of driving waste in Gunnerside Gill.

It is difficult to imagine the problems faced by miners when wheeled transport was not available. Moving every piece of rock by hand or in buckets was difficult so early miners minimised the quantities of rock moved, often by working in very confined spaces. Hand barrows and wheel barrows, sometimes with the path ‘smoothed’ with barrow boards, eased the problem. Optimistically, an underground canal was begun in 1796 in Hebden Gill so that boats could be used, but this never functioned as such and Dukes Level was completed as a horse level.

Rail transport began to be used in the eighteenth century, initially using wooden rails. These still occasionally turn up in old workings but, as the availability of iron increased, were generally superceded by more durable iron rails. Rail transport is associated with the development of mining using long horse levels. While the dimensions of the level had to be greater, which increased the excavation cost, the cost of transport along a horse level was much less than lifting material up to the surface in shaft working. Rail transport also had an added benefit of allowing the construction of centralised dressing floors, with the resultant economic advantages of large-scale working.

Hundreds of miles of railed workings were constructed underground. Rails were fixed on either stone sleepers or wooden sleepers. The rail section and chair designs varied with both age and manufacturer, but all had to be brought into the Dales. Rails were often removed when working was abandoned, either for reuse elsewhere in the mine or, as the industry declined, for scrap. Sometimes rails have been recycled for use as girders or fencing, but many miles still survive in situ underground, particularly in more remote locations.

Gunnerside Gill, Swaledale. NY93840129
Surrender Smelt Mill

The present Surrender Mill was built in 1838. A spread of stone which represents the ruins of an earlier mill can just be seen to the right of this image, whilst between the mill and the stream are the remains of a crushing plant. Today Surrender is probably the most visited of all the smelt mills in the Yorkshire Dales, the Coast-to-Coast walk running past the ruined mill and the peat store.

Lead smelting used vast quantities of peat as a fuel. This was cut on the surrounding hillsides and stored in separate buildings. These peat stores were generally open-sided buildings so that the wind would continue to dry the peat.

When Robert Clough, a young architect, visited the smelting mills in the 1940s, they were thought of by most either as industrial ruins or eyesores of little, if any, value, except as a source of building material. His pioneering survey was published in a series of articles in Cave Science and then, in 1962, he privately published his architectural drawings in an attractive book: The Lead Smelting Mills of the Yorkshire Dales. This seminal work tied in with a growing interest in industrial archaeology and dramatically raised interest in the industry.

In 1972 stone robbing from parts of Surrender Smelt Mill, shown here, and Grinton Smelt Mill led the then National Park Committee to serve Building Preservation Notices to prevent further demolition. This is believed to be the first time anywhere that this legislation was used to protect industrial ruins. Both mills were subsequently listed and later also scheduled as ancient monuments.

A management agreement between the National Park Authority, the shooting estate and the owners of the mineral rights has enabled the Authority to consolidate the mill and peat store buildings and install interpretation boards. These are located inside the central room of the main mill building.

Barney Beck, Swaledale. SD99059990
Old Gang Lead Smelt Mill

Old Gang is one of the largest smelt mill complexes in the Yorkshire Dales and one of the few mining sites where workers may also have lived on site – the small ruined building on the right hand side of the image appears to be domestic in scale and function. The building in the foreground is the latest mill at Old Gang. It housed four ore hearths in the main part of the building and a separate slag hearth to the right. The flues from the four ore hearths join together behind the mill to utilise the remains of an earlier mill, probably as a condenser, before running up the hillside in a cut-and-cover ground-level flue. This leads to a now ruined chimney on the plateau above, a distance of some 760 metres and a height gain of 175 metres. The flue from the slag hearth ran to the small squat chimney on the scar above the building complex, before joining the main flue.

Other buildings shown here include a smithy and two office buildings. That on the left is locally referred to as the Pay House, as it was where workers got paid. The other office building was partly lined with concrete in the 1950s to act as a reservoir for Swaledale Mines Limited. They used the new mill building for a time to reprocess material from old spoil heaps for barytes. Part of their wooden hopper and a shaking table survive inside the mill.

The Old Gang complex is also notable for a 120-metre long open-sided Peat Store, one of the longest buildings in the National Park, and a separate furnace building with a tall square chimney. This is locally known as the Silver House, although it is unlikely that there was any commercial silver production. Hard Level, which formerly provided an underground link to Bunton Level in Gunnerside Gill, is 350 metres upstream from the mills.

An earlier earth dam, part of the complex water system which powered the mills, appears as an area of grass amongst the heather moorland to the left of the flue. The bridleway in front of the mills is now used as part of the Coast-to-Coast walk.

*Old Gang Gill, Swaledale. NY97430052*
The unusual hexagonal shape of this early-nineteenth-century powder house – accentuated by the blind round-headed windows with projecting keystones, the triangular copings to the pyramidal main roof, the ball finial on the apex and the carved kneelers – was designed to stand out from the simple rectangular farm buildings found elsewhere in the Dales, so that it would be noticed by travelers along the nearby turnpike road. Its subliminal message was to suggest that it was part of a modern, successful industrial enterprise and thus to attract potential investors to Easterby Hall and Company’s mining business.

Its utilitarian function was to store black powder, the explosive used in the mining industry. Because of the danger of accidents, powder houses needed to be located away from any housing and ideally constructed so that the roof would blow off easily, thus directing any blast harmlessly into the air.

The building’s use as a powder house may have been short lived. Although described as a powder magazine on the first-edition Ordnance Survey six-inch map of 1854, it was used as a cottage in the later nineteenth century and has an internal fireplace. It was later used as agricultural storage, but is now disused.

The National Park Authority grant aided repairs to the building in the mid-1980s, but a recent survey has shown that while the exterior is sound, the plaster ceiling is beginning to collapse.

Arkengarthdale. NY99850342
Small Washing or Dressing Floor below Primrose Vein

Once mined, bouse, the mixture of ore, mineral and rock brought to the surface, needed to be processed before smelting to clean it and separate the lead ore from the unwanted “gangue” materials. This is normally called dressing. After any large pieces of lead ore had been broken off by hand, dressing usually involved crushing the bouse to a uniform size and then washing it in water. The earlier methods of dressing occurred near to the mine entrance and were done by hand using a specialised hammer called a bucker. A small area of unvegetated mining waste, often associated with larger rocks which could be used as an anvil or knockstone, characterises many early mining sites.

This image shows a slightly larger and more organised dressing floor, but one which still depended on manual labour – there is no water wheel nearby which could have provided a power source. It is not shown on early Ordnance Survey maps, so probably had been long out of use by the time this area was surveyed in 1854.

It did, however, require a water source to wash the ore. When bouse is introduced into a stream of water, the light waste is washed away leaving the heavier ore behind. Heavy ore could be separated from lighter waste in hotching tubs by plunging a basket containing bouse up and down in the tub of water. Any machinery used on this dressing floor would have been mainly made of wood, which rots leaving little trace. Detailed archaeological survey and careful examination of the wastes, however, can help to reconstruct the activities that happened on such sites.

_Slei Gill, Arkengarthdale, NZ02010265_
The Bouse Teams at Sir Francis Dressing Floor

As the lead industry developed in the nineteenth century, large centralised dressing floors were built. These mechanised dressing floors were equipped with water-powered ore crushers, and water-powered hotching tubs and buddies where fine particles of lead were recovered using carefully controlled flows of water.

The Sir Frances complex in Gunnerside Gill is unusual in that the Level was initially a partnership between two companies to access their mining grounds. Both companies constructed their own dressing floors which are on either side of the Gill. The complex on the east bank belonged to the Old Gang Lead Mining Company. It was connected to the Sir Frances Level by a tramway and bridge.

Ore-rich material was brought by the tramway to the rear of the eleven step-sided bouse teams. Here it was initially sorted by hand and large pieces of galena removed before the material was barrowed to a crushing mill, powered by the water wheel pit in the foreground. The cast-iron rollers of the mill broke the ore-rich material to a uniform pea size for further processing. The concentrated ore was then taken back up Gunnerside Gill to Bunton Level and then carried underground to the Company’s smelt mill in Old Gang Gill.

This set of eleven bouse teams is the best preserved of any of the bouse teams in the National Park. Its scale indicates the amount of ore-rich material that the company expected to produce. Little remains of the similar set of bouse teams on the more accessible AD Company’s dressing floor, which has been robbed for building stone, while much of the dressing floor itself has been lost to stream erosion.

*Gunnerside Gill, Swaledale. SD94199961*
Waste Heaps, Sir Francis Dressing Floor

These heaps of gravel-like material are part of the waste produced from the Old Gang Lead Mining Company’s dressing floor. The tail race from the crushing wheel pit was culverted underneath the site. The spoil still contains significant quantities of heavy metals, hence the lack of vegetation. Careful examination of the spoil gives clues as to the processes involved in dressing.

The unconsolidated spoil is easily burrowed into by rabbits and vulnerable to disturbance by people walking over the spoil heaps. After heavy rain, large quantities of this disturbed material can get washed into the beck, one of the reasons why Gunnerside Gill fails water-quality standards. The bracken slowly encroaching onto the site as grazing is reduced in the pastures above represents another threat to the site, both by providing cover for rabbits and through its rhizome roots which are a major threat to archaeological stratigraphy.

Similar spoil deposits elsewhere in the National Park were until recently extensively used for track construction and maintenance. This not only damaged the archaeological integrity of mine sites but considerably increased the opportunities for polluting water courses, both by disturbing spoil heaps, which were slowly becoming colonised and stabilised by metallophytes, and by spreading large quantities of unconsolidated material over tracks where it was vulnerable to surface run-off.

*Gunnerside Gill, Swaledale. SD94219957*
Hartze Jig, Black Mires

There is a very long history in the lead industry of reworking spoil heaps. Technological advances and improved processing techniques meant that more metal could be extracted from the convenient heaps of ore-rich material abandoned by previous generations, who had already undertaken the hard job of extracting the material from the ground.

Nineteenth-century miners had few uses for the other minerals which had formed alongside galena and other lead ores and which were generally referred to as gangue. Twentieth-century industrialisation created a market for two of these gangue minerals: barytes and fluorspar. Barytes, the commercial name for a concentrate of the mineral baryte (chemically barium sulphate) has uses as an extender for paint, a filler in rubber and paper, as protection against X-rays, in fluxes and especially as a component in oil well drilling muds. Fluorspar, the commercial name for fluorite concentrates (chemically calcium fluoride), is used in the chemical, glass and metallurgical industries.

After the Second World War, a number of small companies such as Swaledale Mines Limited and the Dales Chemical Company were formed to rework some of the large nineteenth-century spoil heaps. Most of these were small scale, almost literally ‘one man and a dog’ operations, some only working at weekends.

Planning permission for erection of a temporary screening and jig plant at Black Mires was granted in 1962. This Hartze jig, surrounded by a mass of crushed spoil, is all that remains of this temporary plant. It originally had four watertight compartments in which pulses of water fluidized the crushed mineral particles. This started the separation process as, like lead, barytes has a high specific gravity and so would settle rapidly through a series of metal plates when the water flow ceased.

*Black Mires, Arkengarthdale. NY98790356*
The small, dispersed hamlet of Booze, one of the most inaccessible settlements in the National Park, originally developed on the fringes of common land. Its economy depended on a mixture of lead mining and farming. The collapse of the lead-mining industry in the 1880s led to severe depopulation. Several dwellings were abandoned, some of whose ruins can be seen today, whilst others have almost completely disappeared.

In 1851, some 1260 people were directly involved in the lead industry in Swaledale and Arkengarthdale as miners, smelters, ore dressers and washers, out of a total population of 6820. Many mining families practised a dual economy working both in the lead industry and on the land.

Booze still maintains two working farms, Town Farm and Fountains Farm, both of which have a mix of modern and traditional farm buildings, while the rest of the domestic buildings in the hamlet are now either in residential use or holiday homes. A series of well-worn tracks, some still followed by public rights of way, lead away from Booze into the surrounding walled fields and mining areas.
Coes and mine shops are a common feature of mining areas, even though most mining activity took place underground. A coe was a small shelter erected over a mine shaft which provided a secure access to the shaft, and also somewhere to store tools and lead ore. Larger mines with bigger workforces often had separate mine shops. These also provided a secure place to store tools and ore as well as an office to store mine plans and other records.

In the North Pennines and some other mining areas, mine shops also served as lodging houses for miners to stay overnight during the week, but in the Yorkshire Dales most miners walked to and from work each day from homes in nearby villages. Traditionally many spent the journey knitting.

Since the industry collapsed, some mine shops on grouse moors have found a new lease of life as shooting huts, somewhere for the guns and beaters to take lunch, but others have been left to decay or robbed for building materials.

When this building was recorded by the Northern Mines Research Society in the 1960s, it was still roofed and virtually complete. Dressed stone from around the main doorway, windows and fireplaces was robbed in 1997, weakening the building and hastening its decay. Mine shops provide a human scale to the mining remains and are a link to the people who worked in the industry: the management plan prepared for Grassington Moor for the National Park Authority and Historic England proposes consolidation work to this structure.

*Grassington Moor, Wharfedale. SE03456700*
CB Yard

CB Yard is one of only a handful of settlements in the National Park which owe their origins to the lead industry – here to the construction of Easterby Hall and Co’s Octagon Mill, which originally stood below the tree on the right hand edge of the image. Like its successor, the New Mill, the vestiges of which can be seen to the right of CB Yard on the west side of the Reeth – Tan Hill turnpike road, it was largely demolished for building material in the years following the Second World War. The Peat Store, now converted for agricultural and storage use, still survives.

CB Yard comprised a mixture of domestic dwellings, whose different sizes probably reflect the differing status of the workforce, a warehouse and a saw mill. The formal triangular layout of the buildings indicates that it was a planned settlement, but earthworks between the Yard and the Octagon Mill suggest there may have been plans for a larger development.

The horizontal lines running across the moorland above the Mills are leats. One of the leats also served a corn mill further down the valley. The remains of the New Mill and the Octagon Mill have both been surveyed as part of the Yorkshire Dales Industrial Monument Management Scheme. This survey included tracing the complicated and skilfully engineered water supply system for the mills.

CB Yard, Arkengarthdale. NY99730349