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OLD DROWNED WORK IN DERBYSHIRE.

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IN early Derbyshire lead-mining, the miners obtained the ore from comparatively near the surface, or followed a natural fissure in the face of an outcrop of rock. But when they began to sink deeper, water was generally struck. Sometimes, fortunately, they had warning signs such as a sticky ooze through a band of clay, and could take precautions, but all too often they would break through rock and an underground stream would rush on them—a "feeder" they called it. Old stories are still told of how men rushed out of mines, leaving their tools behind them. About eighty years ago in Mandale Deep Shaft, in the Lathkill Valley, there was a sudden flood. In this instance the men all got out, but there are mines where men's bodies have never been recovered; seven men still lie in Haysbrook Mine at Warslow just over the Staffordshire border.

As a rule the oldest mines are scattered on hilltops which are anything from 200-600 feet higher that the nearest stream-rising, so that shafts could often be sunk to a good depth without underground water flooding the workings. The Derbyshire mines must have been comparatively dry up to, and including, mediæval

times, and water was not the outstanding problem that it was through the late 17th, 18th and 19th centuries.

The permanent water-table of a district as a whole may be a few hundred feet below the hilltops, but flows of lavas from ancient volcanoes—which the miners term "toadstone"—or a band of clay which they call a "wayboard" are impervious to water, which would collect above them: when the miner broke into this his mine-workings were wet, although sometimes these acted as an umbrella, and the workings below were dry.

In early times when veins near the surface were worked, there does not seem to be any evidence of "hushing" or "hooching" which was done in Cornwall, where a stream of water would be used to wash down, or along, a hillside, and loose pieces of ore be washed out of gravel and soft beds, though it is not impossible the hushing may have been done in the county so long ago that all traces are lost, although the formation of limestone hills makes this unlikely. There is however an occasional mention of "flat ore," "float ore" or "potato ore," as the miners called it, being found in Derbyshire mines.

Only just over the border, in Staffordshire, on the shales going down into shaly limestone, are a great number of old lead mines. I have only examined the surface, and only gone a short way in one level, but the conditions are very different from those in the limestone, and here the trenches of the old hooshing can be seen on the hillsides.

In some parts of Europe draining adits were driven as early as Roman times, and revived by the Germans in the 13th century, but there is no actual evidence of Roman draining levels in Derbyshire. The Romans employed slaves for bailing their mines, but in spite of vague traditions, which range from Bradwell to Wirksworth, of "convicts" being used to work in Derbyshire mines, no proof of this remains.

There were several methods of early pumping used in mediæval times and the 16th century, and there is evidence that in this county these centuries-old methods lingered on, co-existent with the steam engine.

If the miner came upon an underground natural water-swallow—a "self-open" or underground pot-hole—which would take his water, he would divert it down the hole, and save himself the trouble of making a draining level. In the Blue-John mine, water was pumped up by men with hand-pumps, and directed down one of these swallow holes. In the early days of mining in Devonshire and in the Mendips, many mines had to close down in winter because of water, and this was also the case in some of the Derbyshire mines, just as many natural cave-systems are inaccessible in wet weather.

During the 14th century, and continuing for hundreds of years, water was laboriously bailed out in leather buckets wound up on a hand windlass, and thrown out by tilting the bucket into wooden troughs called trogues.

A Chain pump, or Chain-of-pots pump, was an improvement on this contrivance. This pump was a round barrel or cylinder with catches in it which grasped an endless chain. The chain descended outside the barrel and ascended inside, the buckets being attached to the chain, and the water being thrown out at the top into the troughs carrying it away. The barrel was generally made of wood, bound with iron hoops. This too was worked by men at a windlass.

A Rag pump, or Rag-and-chain pump, was sometimes also called a Chain Pump, the terms being used in confusing fashion. But the pumps themselves are quite distinct from the chain pump with buckets. A pump which is referred to as a "Rag Pump"—although the description is that of a Bucket Pump—was still working in 1865 near Alport-by-Youlgreave.

The Rag Pump was a vertical barrel or pipe about 20 feet high, with an endless chain having great blobs of

leather turning round a spiked wheel two to three feet in diameter: or knobs of rag, or a combination of leather and rag, were fixed at intervals on the chain, and it was worked by a windlass. The chain and the blobs fitted closely inside the pipe, and could lift quite a lot of water. It would however only lift in a series of twenty feet, was extremely exhausting to work by hand-winding, and very bad for the health of the men. One can well imagine the terribly wet conditions and the arduousness of the physical labour. In the late 18th century in Cornwall, the men working these pumps were paid £2 to £2. 10s. a month. One pump took about twenty men to keep it going, five or six of them winding at a time.

In Cornwall one of these pumps was found in a mine; the wheel was fastened with wooden pins, the pump-barrel being made of one piece of timber sawn in two lengthwise and scooped out like a prehistoric boat, forming a tube only seven inches in diameter. If extensive draining of present flooded levels in very old Derbyshire mines ever takes place and anything of such interest comes to light, one can only hope for its preservation.

By the 16th century hand-pumps were also used extensively, with the barrel made of hollowed logs and the bucket a wood-and-leather disc, with the rod attached to a cross-head which a man pushed up and down.

Horse-wims, or winding engines worked by a horse or horses walking round in a circle, came into use in the 17th century in Cornwall, and these were adapted for pumping. No date for their introduction into Derbyshire seems to be known. Barrels made of wood bound with iron were used, and as there were sixty barrels to a whim, the largest holding 120 gallons each, it seems as though this was on the endless chain principle. There was one of these pumping wims at Good-Luck Mine above the Via Gellia. Here, a horse-gin was fitted with a cog-wheel with spur-gearing, cranks, and pinions, but it is not stated what kind of a pump was worked from it.

One has to remember that everything was termed an "engine" in Derbyshire in early days, water-wheels and horse-gins, as well as the more limited meaning of steam-engine.

From horse-gins we pass to water-wheels, to which there are many references. The enemy, water, was to be harnessed to do its own pumping, and Rag or Bucket pumps, instead of being worked manually, were attached to an over-shot water-wheel, generally about twelve to fifteen feet in diameter, the chain being turned round a spiked wheel. Large wheels of 30-40 feet diameter came into use in later years.

To what extent wind-power was used for pumping in Derbyshire there seems to be little evidence, but there is mention in the 1880's of a windmill used for this purpose near Monyash.

An interesting early reference to draining occurs in the autobiography of Leonard Wheatcroft of Ashover. He had a share in lead mines which had "some waterworks which were then at Youlgreave," and in 1679 the engineer Wass went there to "drain the waterworks, but his engine would not do it," and Wheatcroft adds with annoyance that he and "many more were damnified by it, and he likewise to the value of £300." In August of the same year Wheatcroft again went to Youlgreave to "pay his grove charges," and in the next year the engineer went there again: Wheatcroft says that the engineer "did begin with wheels and trickes that summer but all did worke to no effect that I saw," so that Wheatcroft had to pay further charges.

In large mines there might be several wheels underground, and the Dove-Gang Mine, south of Cromford, is one of the best known examples. To work an underground wheel water had often to be brought into the mine from a neighbouring surface stream, but in Gang Mine the wheel was fixed in Cromford Sough, using the water on this level to work the wheel to raise water from a lower level.

In contrast to the underground wheels, some were outside the mine. There was a very large one at Side Mine, beneath the High Tor in Matlock Dale. This wheel was fixed in an engine house on the edge of the Derwent outside the mine: it was not erected until after 1788, but had ceased working by 1843. The making and fixing of it was said to have cost £900. It was estimated to be of 80 h.p., the wheel being described as "gigantic," and was said to raise 1,000 gallons per minute. An iron rod about 900 feet long connected the wheel to the pump rods. This distance away, at the entrance, one could hear the stroke of the pumps, and the rushing of the water and the play of the rods in the pulley grew more shattering in sound as one advanced into the mine.

If anyone walking in the Derbyshire countryside wants to study the layout of a lead mine wheel on the surface, he cannot do better than go into the Lathkill Valley at Carter Mill, about a couple of miles upstream from Lathkill Lodge. Walking from the ruins of Carter Mill, in a tangle of trees and brambles and vicious nettles on the south side of the river, downstream from the dammed pool there is a leet along which the water is diverted, and it still flows for a little distance. This artificial water-channel ran along a very large embankment of earth and stones for three-quarters of a mile. It passes behind the ruined mine-buildings on this south bank, to where the embankment comes to what the Ordnance Survey 6″ map calls "Bridge, site of," but which is really the ruined piers which bore the acqueduct that carried the water over the Lathkill to an embankment on the north side. This finally goes into a short arched tunnel high up in the great hollow which once held a 52 feet diameter wheel at Mandale Deep Shaft.

The area is worth investigation if only to show the patience and efficiency of the old miner, and the good work he was prepared to put into anything he did.

Usually the underground wheels discharged their water

into lateral passages, adits, soughs or draining levels, and here in the soughs we come to what is perhaps the most striking example of the lead miner's endurance and perseverance.

In Derbyshire, so far as is known, there were sufficient veins of lead above the watertable for the first great soughs not to be driven until the 17th century. Careful search of the countryside will often reveal definite indications of minor draining levels, now with entrances fallen in and completely covered with soil, overgrown like many of the old working levels, but the draining levels are at stream height, and have signs of stone-walled channels.

It is stated that Cromford Sough was the first great sough to be made, and the Victoria County History says it was finished before 1688, and as proof quotes from an undated paper of Sir John Gell, who died in that year. It says that "Sir Cov. Perms made the first sough to unwater the Gang Mine, within the memory of man." It has always been assumed that this must have been Cromford Sough, but Longhead Sough was an earlier one made to unwater the Dove-Gang Mine. "Sir Cov. Perms" is a misreading for Sir Cornelius Vermuyden, the Dutch draining expert who drained the Bedford Level in the Fens. He was a partner in the Dove-Gang Mine, and made a sough to it which was probably finished before 1650. Complete working of the mine was delayed, possibly due to the Civil War and also to much quarrelling and law suits which went on all the latter part of the century concerning the ownership of Dove-Gang, and the lot and cope and office of Barmaster of the Wirksworth mines.

The mine-workings made up to then were drained by 1650, and completely worked out to the level of Longhead Sough by the 1680's, and the facts all point to this latter being Vermuyden's Sough. Personally I consider 1688 is too early a date for the *completion* of Cromford

Sough, or Long Sough—its older name—for this drains the mine to a depth of approximately 500 feet, and the mine was definitely only 300 feet deep in 1687. There is evidence that Cromford Sough was not begun before 1706.

There are well over sixty named soughs in the county: a number were already made by the early 18th century, and among these early ones are Cromford and Hannage soughs at Wirksworth, Magsclough and Brookhead in the Eyam area, Alport and Blyth soughs at Youlgreave, and a number of others which are probably old and which can still be traced, even though in many cases their names are forgotten.

Stoke Sough south of Grindleford, draining some Eyam mines, was driving in 1732 and is one of the most interesting of them all. Like many others, it was not made all at one time, and was not begun as a draining level. The first one and a quarter miles cost £35,000 and it was being still further driven at the beginning of the 19th century. On it is the Ladywash shaft, over 900 feet deep. It was a dangerous sough to drive, miners being killed by explosions of fire-damp, or marsh gas, coming out of the shales through which much of it was driven. In driving it, bitumen was found in hollow nodules, and the first miner finding one of these, discovering that it was a shell of stone with a soft inside, stuck his candle in the hole. When the candle burned down, the substance inside melted and burnt with a clear flame. Thinking that this seemed to be some sort of fat, the miners at first used it for greasing their boots, but found it shrivelled the leather. Rock-oil, which they called "fairies' butter" flowed out of this strata, and swam on the surface of the water to such an extent that it would take fire from a candle and burn for days, so that it was called "the burning spring."

The arched entrances of soughs have a sort of family likeness, but have their differences, and the entrance to

this particular sough, which is in the private grounds of Stoke Hall, is small, not much more than a couple of feet wide, and only about three feet above ground level. Below that it is silting up, and now the water is not flowing through it, but goes to an 18th-century bath-house and from thence to the river Derwent.

Soughs were simply made, but with admirable efficiency. Even to look at the arched entrances displays this, whilst to wade up one, knowing that a whole hillside is above one's head, in complete darkness except for the lights which are carried—and the men who made them had only tallow candles—is an unusual experience. Turning round, one can see, as straight as a ruler, the dark passage-way behind, with the entrance-speck of daylight growing smaller and smaller.

The entrance is often arched with a keystone in the centre, and where the facing of the arch is of gritstone, it may be as carefully worked as the quoins of a house. Inside, the tunnel-shaped passage is arched, the roof and walls being lined with limestone blocks, brick-like in shape for the walls, and wedge-shaped for the roof, and so constructed that pressure wedges them more tightly. It is all dry-stone building, no mortar used anywhere: the Derbyshire lead miner no more thought of mortar when underground than he did as a farmer when building the stone walls to his fields. The stone lining to the soughs continues for varying distances; so long as he was in shale, or soft treacherous ground, the sougher continued to line it, but if he drove into solid limestone then he left the natural rock for the lining.

One drainage level near Cromford is a particularly fine piece of work. For hundreds of feet it is picked in solid limestone, the walls perfectly smooth and straight, and the even semi-circular sweeps of the pick on the walls as fresh to-day as when they were done. In any old lead mine you learn to have a great respect for "the old man." He did not waste time doing unnecessary work, but

whatever job he did, he did soundly and solidly. After seeing a sough one can only imagine the blistering scorn with which the old-time lead miner would greet much that is shoddy in our pre-fabricated age.

Some soughs were first started as working levels: later mine drainage was diverted down them, and there are also worked-out rake veins known in places as the "sough vein."

When a built-up section of a mine is being re-opened or when a new level is being driven towards a part suspected of being water-logged, the same method is used to-day which has been used for centuries. The Cornish men called it "holing through to a house-of-water" and when a mine was drained of water he said the mine was "bled." The miner bores ahead with a long iron rod, so that if water begins to ooze he has warning and has a chance to get away before an inrush drowns him. The word "gunny" does not appear to have been used by Derbyshire miners, although it appears on Ecton Copper Mine plans. It was the Cornish expression for hollows full of water.

Once an old mine has been pumped dry again, a proportion of the levels will keep dry in normal weather, but below the water-table the miner has "got down to the house," and the pump must never stop or the water will rise again to that level. A vivid description of "holing through" to water in a Welsh mine in the mid-17th century exists in a letter written to Bushell, a Royalist expert on draining-adits.

After only four years of work, an adit 1,200 feet long penetrated the "chief shaft of the old drowned work," this shaft was 228 feet deep. "The foure workemen about one in the night (as their manner was) withdrew to take Tobacco within ten fathome of the Addits mouth, lest in the forefield it should damp the ayre, which was conveyed to them by your leaden pipe with bellows. Their smoake banquet was not yet at an end when they heard

a mighty and fearful noise, which some of them said was thunder. But old Bartholomew Clocker (a well experienced Miner) although he left the worke without any suspicion of so neere an approach, resolved suddenly, the work is holed, come let us away. No sooner had they gotten the free ayre, but out gusheth the torent of water with an incredible fury, such a breach it made in the solid Rock that it arose fully a yards height at the Addits mouth and drove away above 100 Tun of the rockie deads, affrighting the people of Tal-y-bont, who heard the noise and felt the water in their houses . . . about four houres after, the violence of the water being past, Fisher one other of the Miners went in with more curiosity than wit, to see what effect it had wrought there. And being some sixtie fathome in creeping very low, his candle enkindled a vapour, which came on him with three or four flashes, and he suddenly returning had his haire burnt off, and his cloathes scortched, in which conclusion it gave a crack like the report of a peece, and in the fierce gust of wind blew out the candles of three more Comming after him."

A hundred years before this occurred, there was a government order impressing twenty expert Derbyshire lead miners for work in the mines at Tal-y-bont: one wonders what hand they had in the making of the "chief shaft of the old drowned work."

The making of the majority of the great soughs was not undertaken by the mine-owners themselves, but by companies of "Adventurers," shareholders in the sough, with men called soughers to do the actual work. The owners of the mines agreed to pay a certain amount of ore, called "composition," to those who made the sough. This payment, at Wirksworth, was one dish out of six from the ore obtained when the mines were drained. All too often the result was a loss to those who made them, for the soughs took longer to make, cost far more, and were not as successful as had been hoped; in many cases the ore became poorer as the mines became deeper.

The old mining laws said that a sough must be driven with the consent of the owners of the mines. If a few of them refused they must be given compensation but could not stop the sough. If during the making, the soughers broke into a vein already being worked, the owners had a claim on any lead obtained.

Ventilation of the long soughs was a serious problem. As an old book puts it, soughers were hindered by "not being able to carry the wind with them." They made square wooden pipes just above the water, called "the wind-gate," or pipes in the roof called "the air-trunk." They tried driving air in by means of bellows, or they made air shafts, and sometimes would hang braziers of fire on chains down the shaft.

In old cost books are entries "Liquor to the men on going through the sough," and up to quite recent times men were paid so much a year to go through some of the soughs and see that they were kept clear. They had long rakes and scraped the sole of the sough, working laboriously backwards to the entrance.

The 18th century was the great age of sough making, and a few more cannot go unmentioned. Possibly the best known is Hillcarr, or Hellcarr, over four miles long, from the Derwent south of Rowsley to unwater the mines of Youlgreave and the Alport area. This too had its tragic incidents, and soughers were killed by explosions. The water is deep and boats were used on it—not only by the old miners; I know one present-day miner who when he was a lad used to take a boat up it to tickle trout. It was begun about the middle of the 18th century, and took more than twenty years to drive. The length was originally intended to be two miles, but extensions and branches were driven from it. The cost was at least £50,000. In flood the water was so high that it was impossible to sit upright in the boats. The flow was measured in 1880 at 15,000 gallons per minute; in 1929 it was 7-8 million gallons per day. A great

portion of it was driven through shale, with arched roof, lined with undressed stone, and the floor paved with flags. It was 6-8 feet high and 5-8 feet wide. Fire damp came off the shale, and in one part there is said to be a roof of black shale for 120 feet, 25 feet across. Great fans had to be used for ventilation while it was being made, and when the limestone was reached, the rock was described as being of such hardness that "tools will scarcely touch it. Even the blasting by gunpowder was "impeded by the great quantity of water and moisture, that the powder must be enclosed in tin pipes." The usual form of fuse in those times in the lead mines was a straw filled with powder, and this fuse was still used in at least one place within living memory.

The Quakers of the London Lead Company had a good deal to do with Derbyshire lead mining, and among other things purchased about 1743 the Mill Close lead mine. They made a "sough or water-gate into Birchover Lordship, diverting a brook down this for the purpose of turning a water-wheel, which they had in their said mine." This was Cowley or Yatestoop Sough, which was driven to unwater Mill Close Vein, and Yatestoop Mine and Portway at Winster.

Yatestoop Mine and Sough might almost be said to contain the whole history of unwatering Derbyshire lead mines. Rag pumps were largely used in it, and it had the last one working in this county. When the sough was driven, water-wheels were used underground; it was also the only place in 1780 where an atmospheric engine worked underground, and its steam engine is said to have been the first of its kind in the lead mines. A lawsuit in 1753 had reference to the right to build an engine house, etc., on certain mine land called the Quarter Cord. In the course of the dispute it was stated that "fire engines were unknown in the county until within the last forty years." In all the other mines, engines had been erected with the consent of the owners, who had been "paid for this extraordinary privilege."

Finally, Yatestoop Sough comes into the latest history of Derbyshire lead mines, for it was used by the most successful and the most watered of them all, Mill Close. This mine has been flooded more than once during the last hundred years. Heavy feeders of water were struck towards the end of the last century, great caverns full of water were worked, and three Cornish pumps discharged into Yatestoop sough an average of 1,800 gallons of water per minute, winter and summer; by the 1930's 3,000 gallons per minute were discharged to the river at a pumping cost of £1,500 per month, but 800 tons of ore weekly were being obtained 600 feet below the water level. A great flood in 1938 threw three hundred men out of work, and new pumps were installed which were said to be capable of raising 30,000 gallons of water per minute.

A local tradition about Meerbrook Sough, east of Cromford, which was made about 1772, with additions up to 1840, says that it was made by convict labour. At the beginning of the 20th century it was purchased by the Heanor and Ilkeston Water Board, and the average daily discharge is—or was until recently—fifteen million gallons, with a maximum of nineteen million gallons.

So far as I have been able to discover, Calver Sough entrance is unique, as it is in private grounds, and has been made into a delightful rock garden.

In this county separate shafts were generally used for pumping, for drawing the ore, and for climbing. But in lead mines in some parts of the country large shafts were made and divided vertically into three compartments. Some years ago I was one of a party which went down on rope ladders into a 200 feet deep disused lead mine shaft in Yorkshire. The machinery had of course all gone, but there was a ruined wooden partition dividing the shaft vertically. The wood was split and broken, and had a very dead sheep festooned on it in one place,

and in one corner of the shaft broken climbing ladders were still in place.

Pumping engines were generally placed on the surface. In the now ruined engine houses can still be seen the high arched window through which the engine-beam protruded, and with a chimney stack for the furnace. Sometimes these engines were fixed underground in a recess in the shaft, or at sough level, and drew water up to the sough.

These old engines working underground must have been very frightening to anyone unfamiliar with them. When the engine "went into fork," the escaping air bubbled through the water, making a shrieking noise. Underground water-wheels must have been alarming enough—imagine the great rushing of water above a vast turning thirty-foot level—but the clanking and rattling of the pump rods and the shattering noise of the engine must have been far worse. The darkness only lit by candles, and with perhaps two hundred or more feet above one to daylight, coupled with the weird shriek of the engine—no wonder that there are stories of raw young lead mining lads rushing about in terror.

The earliest mention of engines in a Derbyshire mine is in 1730. These must have been atmospheric engines, or "fire-engines" as they were called. But this is a fairly early date even for these in mines. Savery had one made for a coal pit in 1702, but this was unsuccessful: it was spoken of as "drawing water by fire." By 1714 there were said to be only three Newcomen engines at work in the country, although there may have been one or two more. In 1720 there were only two engines at work in Cornish mines, so that a passage mentioning that three pumping engines were working at Winster by 1730 is an important statement.

This passage occurs in the diary of the Rev. James Clegg, nonconformist minister and doctor, who lived near Chapel-en-le-Frith in the early 18th century.

In an entry for 1730 he says that at Winster he "saw 3 curious Engines at work there, which by ye force of fire heating water to vapour a prodigious weight of water was raised from a very great depth, and a vast quantity of lead ore laid dry. The hott vapour ascends from an iron pan, close covered, through a brass cylinder fixed to the top, and by its expanding force raises one end of the engine, which is brought down again by the sudden introduction of a dash of cold water into ye same cylinder which condenseth the vapour. Thus the hott vapour and cold water act by turns, and give ye clearest demonstration of ye mighty elastic force of air."

The earliest Newcomen engines had an open-topped cylinder fixed above the boiler. The early engines had a brass cylinder and a copper boiler. At first, condensation of the steam was obtained by cooling the outside of the cylinder, later by an injected jet of cold water. As early as these Winster engines were, they obtained condensation by injecting cold water into the cylinder.

There were a number of Newcomen engines erected in Derbyshire lead mines during the 18th century, particularly by an engineer named Francis Thompson. In 1782 one of his engines was installed on a sough over 500 feet below the surface, the stone blocks for the engine house and the parts of the engine being lowered down the shaft.

The Trevithick water-pressure engine followed, and Derbyshire possessed an interesting specimen of these. In 1801 the Hill Carr Sough proprietors held a meeting at which they discussed the proposed erection of an engine to unwater their mines at Alport. At their request Trevithick came up from Cornwall, but it was 18 months later of discussion and meetings, before he had given his decision on the respective merits of a wheel or a pressure-engine, and the latter was decided upon. 1803 has generally been given as the date for this engine, but Trevithick is speaking of the Derbyshire engine in

a letter dated September 23rd, 1804, when he says "the great pressure engine I expect will be at work before the middle of October."

It was fixed about 150 feet underground to raise water nearly fifty feet for its discharge into Hillcarr Sough, and it worked for nearly fifty years before it was sold, and it is recorded as having worked frequently for as long as four months "without missing a stroke or being stopped for any purpose" except once or twice a day to oil its bearings. Later its pumping depth was extended, and it was moved to another shaft close to its original position. The cylinder was 25″ diameter with a 10′ stroke, and was double acting, the water pressure being directed first on to the top of the piston and pushing it down, and then to the bottom of the piston. It worked a plunger-pole pump.

There was a lot of piracy. As Trevithick remarked rather bitterly in one letter, "You are not the first that has picked up my hints, and stuck fast in their execution, I make it a rule never to send a drawing until I have received my fee." He complained more than once that people had erected his engines without fee "but paid by accidents and defects."

Even more famous than the Trevithick engine, was the later water-pressure one called the "Guy Engine."

At the end of the 1830's a number of Bakewell lead miners decided to extend the mines at Alport and other places, and in 1841 they called in Darlington, from Minera in Wales. Some authorities speak of him as the maker of the Guy engine and two other engines at Alport. Another account ascribes the engine to John Taylor, and says that Darlington was the resident engineer who "fixed the engine in the shaft." The engine was made at Butterley Iron Works.

The Guy engine had a large cylinder of 50″, with a 10′ stroke of five strokes a minute, the piston rod being connected vertically to the pump rods. The plunger

pole of the pump had pitch pine rods, and is said to have weighed thirty tons, and to be still in the mine. Within living memory there was a terrific noise and a rumbling heard in Youlgreave. For a while it was thought to be an earthquake, and then it was discovered that it was Guy Shaft running-in. The engine was fixed 210 feet below the surface, and the water-pressure acted on the underside of the piston: the fall of the water down the shaft was 132 feet. This water was brought from the river Lathkill above Alport, was carried on a wooden acqueduct over the village into a drift high up on the south bank of the river, and taken nearly half a mile underground to Guy Shaft.

Normally the pumps delivered 3,600 gallons of water per minute into Hillcarr Sough, although in wet weather this was nearly doubled. The engine was still working in the 1890's, according to a contemporary writer who gives a detailed description, but a Science Museum pamphlet says it was removed to Talargoch in 1852. All other references however say that a *similar* engine was made for Talargoch.

Boulton and Watt engines, and Cornish beam engines followed, but these are described in detail in books on steam engines, and in an article as short as this, only brief mention can be made of many aspects of the draining of the lead mines.

All this draining and pumping and altering of the course of underground water which has been going on in the last few centuries has changed Derbyshire surface water as well. As an 18th century writer says of a former "pleasant and pure warm spring," in working for lead "they lost it." All over the limestone hills can be found stone troughs, now dry of the springs which fed them, and old books will mention streams in places which are now dry.

Underground water can behave in a queer and inexplicable manner. A friend and I were in Dale Lead Mine,

in the Manifold Valley, during the drought of the summer of 1949, when there had been little rain. We had been there many times from 1943 to 1949, at various seasons of the year. This day the whole level was wet underfoot, water oozed out of clay, and in one place rained on us steadily from a high roof—none of this ever having been seen previously. A week later the whole place was normal.

The underground is chancy, and full of mysteries which call for solution—that probably accounts for much of its fascination. Lead mines are in Derbyshire men's blood, and they have an extensive acquaintance with underground water. Within the last few years re-working was started on a lead mine with an exceptionally deep shaft, and great trouble was being experienced with water. As fast as it was pumped up and poured away in a channel, it found its way back into the mine. It was a quarryman who told me this, and he said that he had been standing watching near the shaft-mouth when the men who were pumping asked him, "Are you a miner? Ever been down here?" He answered, "No, I'm not a miner." They asked the same question of another man who was standing by, and he said, "No, I'm not a miner either. And it's not a miner you want, but a diver."

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GLOSSARY.

Float Ore = Pebble ore.

Forefield = Underground: the furthermost parts of the mine where the vein is cut or driven. Above ground: the end of the meer. (i.e. the end of the length of the measure of the vein).

Grove = The shaft. All the underground workings of the mine.