

The Lumburn Leat - evidence for new pumping technology at Bere Ferrers in the 15th century

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Abstract

Faced with the increased cost/time penalties of driving deep drainage adits, at a time of increased real wages, the keeper of the Crown silver mines in Devon, at Bere Ferrers, sought other means of removing water from potentially rich workings. The method used was the water powered suction lift pump. This paper details the circumstances of its introduction and the surviving field evidence - a watercourse, 16 kilometres in length, from Millhill near Tavistock into the mines north of Lockridge Hill.

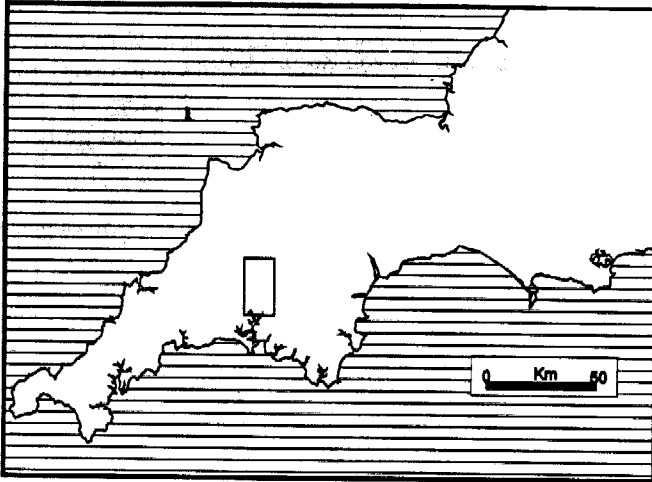


Fig. 1. The Lumburn Leat. Location.

INTRODUCTION

Mining of silver-bearing ores on the Bere Ferrers peninsula in south Devon, between the rivers Tamar and Tavy, was first documented in 1292. Under Crown control it developed as a capital intensive industry at the forefront of contemporary technology. However, high population levels in the late 13th and the first half of the 14th centuries, with an abundance of cheap labour, ensured that manual labour was an important element in that technology (Cloughton 1994).

This is evident from the drainage methods used. Manual haulage of water in leather buckets was the standard technique but that was quickly supplemented by the introduction of adits, allowing free drainage to surface. Construction of adits was in itself labour intensive but, in the shallow workings at the turn of the 13th century, benefits were quickly seen. The keeper of the Devon mines was to report to the Exchequer that:

Now we can do as much and extract as much in the winter as in the summer because the water will have its course out of the mine by aditods (drainage galleries) cut to the deepest point of the mine (Tanqueray 1916, 73).

It was later, as the workings were deepened, that the time/cost penalties of adit drainage became apparent. Manual haulage of water had increasingly to be resorted to in advance of an adit being driven up to the productive workings. The labour involved was a significant cost to the Crown who accepted that the miners themselves could not fund the work out of tribute payments.

By the mid 15th century working was at depths where free drainage, to the shallow valleys cutting the productive north

-south crosscourse, was no longer possible without long crosscutting adits. Nowhere was the problem greater than in the area north of Lockridge Hill, perceived as being a source of rich ores. A group of six shafts there had been reserved to the Crown whilst other sections of the crosscourse to the south had been sub-let to a small group of adventurers. Two short crosscut adits are known to have existed in that area but to have achieved any significant depth of drainage of around 40 metres below surface would have required a drive of some 350 metres from the valley to the west.

In an economic climate where population decline had resulted in a shortage of labour and low agricultural prices meant high real wages, there was little incentive to embark on such a labour intensive project as a long crosscut adit. On the other hand the historical alternative, manual water haulage, was in such a climate an equally expensive option.

It was against this background that, in the period 1471 - 80, mechanised drainage using water powered suction lift pumps was chosen. Even that choice involved a sizeable element of manual labour.

Lack of adequate methods of power transmission meant that the wheel had to be mounted directly over or in the shaft, as a contemporary document suggests: 'To William Clark for making one shaft under the wheel in the said mine (Bere Ferrers)' (PRO E101/ 266/25). This would be linked to the pump rods by a simple crank. As there is little surface water in the area north of Lockridge Hill bringing in an adequate supply for the wheel meant tapping a supply some distance away. Field evidence suggests that the source was two or more tributaries of the River Lumburn in the vicinity of Millhill, west of Tavistock. That required a leat of 16 kilometres following the steep west bank of the Rivers Lumburn and Tavy, and entailing significant engineering work, before crossing the saddle in the ridge near Higher Gawton to follow the line of the Tamar west then south to the mines.

THE SUCTION LIFT PUMP (Fig. 3)

Although forcing pumps were known to antiquity, suction lift pumps were an innovation of the 15th century. Their construction was simple. On its upward stroke a piston, pierced by a flap valve, reciprocating in the pump barrel drew in water by suction through a second flap valve at the base of the barrel. The second flap valve closed on the down stroke and the water below the piston passed through its flap valve into the pump barrel above the piston. On the next upward stroke the piston drew in more water whilst at the same time lifting the water above the piston. This sequence could continue indefinitely with the water above the piston rising

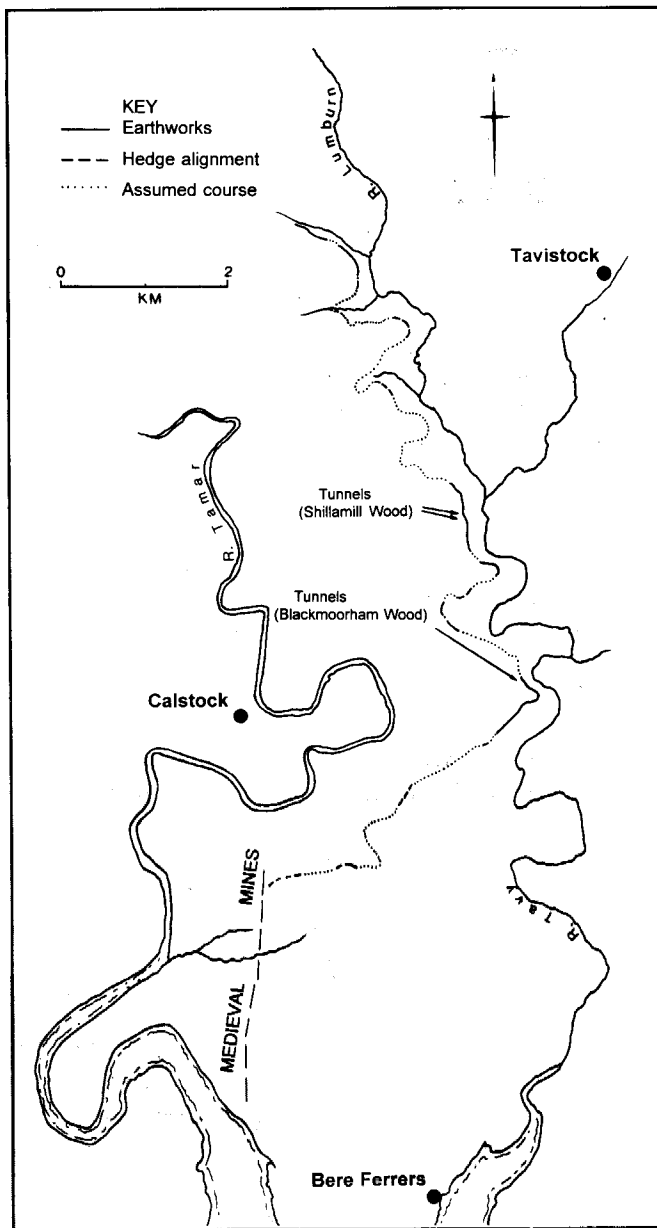


Fig. 2. Map showing the course of the Lumburn Leat.

until it reached the top of the pump barrel and poured out of a suitably fixed outlet pipe. The suction lift pump was essentially the bucket pump used as the sinking lift in most 18th and 19th century mines.

Whilst bucket lifts of up to 48 metres were common in the 19th century the 20 fathoms (36 metres) of pumps employed at Bere Ferrers in 1480 were unlikely to have been used as one lift. The height of each lift would have been limited by the ability of the materials used, primarily timber, to lift and support the weight of water above the piston. Those at Bere Ferrers were divided into at least nine sections but it is not clear if they were used singly or combined to form longer lifts. Available documents unfortunately provide no clues but, based on late 16th and early 17th century evidence, Hollister-Short (1994, 84) suggest lifts in the order of 9 to 10 metres.

DIFFUSION OF TECHNOLOGY

This is the first recorded application of this technology in England, fifty-five years after the first evidence for the concept of the suction lift pump¹ and only a few years after its application to mining in central Europe.

The diffusion path by which the technology arrived in England is still unclear. Sir John Fogge, the keeper of the Devon mines from 1471 to circa 1481, certainly had contacts

with continental Europe. He was treasurer to Edward IV's household from circa March 1461 (he was already in post at that date) until at least 30 September 1467 (still in post at that date), being succeeded by Sir John Howard. Whilst in that office, 17 March 1466, he was granted all issues and profits from the king's mines in Cornwall and Devon (PRO Cal. Pat. R., 1461-1467, p. 519) and was thus aware of the productive potential of the mines.

The letters patent for the grant of the mines themselves has not survived, but was dated 10 July, 11 Edward IV (1471), immediately after the king's exile in Burgundy. In referring to the original patent, a later document stated that 'it was agreed that the said John should bring water to the mines at his own expense' (PRO Cal Pat R., 1476-1485, p. 213) In 1474 he was active at the mines when he and John Fogge esq. (his son perhaps?) were granted the right to impress workers (Cal. Pat. R., 1467-1477, p. 420). By 1480 the work had been completed and water brought into the mine at Bere Ferrers.

Prior to taking the Devon mines he had some contact with possible sources of expertise on mining technology. In 1467 he visited Burgundy although prior to that he was probably fully committed to his office:

Treasurers of this reign seem, on the whole, to have given rather more personal attention to their household duties than did either chamberlain or stewards. During his tenure of office Sir John Fogge seems to have held no offices which need have taken him away from household for long, except for a visit to Burgundy in the last year of his treasurership... (Myers 1959, 282)

However his duties may have brought him into contact with others possessing knowledge of the technology, as in 1466 when the brother of the Queen of Bohemia visited England.

Later in the 1470s there was activity at Fletcheras and other mines in the northern Pennines where the adventurers had 'German' connections and Fogge may have had knowledge if not direct contact with those activities. His successor as treasurer to the royal household, Sir John Howard, had earlier been a member of a group who were granted the king's mines 'north of the Trent' which would have included the northern Pennine workings.

Fogge's grant of the Devon mines was possibly in lieu of all or part of his salary, Edward IV's indebtedness being considerable with debts of £168,000 in 1433 rising to £372,000 in 1449, and resorting to loans at interest rates of 25 to 33.3% (Myers 1959, 6).

THE FIELD EVIDENCE

Faced with the documentary evidence for the introduction of suction lift pumps at Bere Ferrers, probably at a mine between Lockridge Hill and Goldstreet, there appeared at first glance to be no suitable source for a leat serving the waterwheel. Having recalled Booker's reference (Booker 1967, 55) to 'a medieval leat' in Shillamill Wood a brief desktop survey was made suggesting that it could be part of an extensive leat feeding the mine². That was the position at the time of the 'Mining Before Powder' conference, at Ambleside (Claughton 1994.) Subsequent fieldwork has confirmed the route of the leat, identifying its source and destination.

The source of the leat is not the River Lumburn, as first thought, but its western tributaries. There is evidence for water management ponds fed from two of those tributaries. At Ogbear Farm the abstraction point at SX 44347510, on the

stream-bed north-north-west of the farmhouse, is visible although that stream-bed is currently dry. The substantial footbridge further downstream indicates a significant water flow was expected in times past. A short section of leat leaves the abstraction point, running south-west to a point at SX 444750, between the farmhouse and the stream, where the earthworks of a storage pond are visible. Continuation of the leat can then be seen as a slight earthwork ledge running across the field to the east, just above the 120 metre contour, before being lost in the road hedge at SX 4477485. Beyond the road, the present surface of which is well below leat level, it is not visible in the field corner but can be clearly identified in Ogbear Wood.

Within the wood, and clear of the boundary hedge, are the well defined earthworks of a leat 1.5 metres wide at its base, 2 metres wide at the rim and averaging around 0.5 metres deep. The well preserved nature of the earthworks and the remains of what appears to be a sluice gate on the bank about 180 metres into the wood, suggests that this section has been used for water storage in the relatively recent past. However, the leat is respected by an ancient hedgebank on the downslope side close to the sluice. The earthworks can be traced south following the 120 metre contour to an unidentified quarry west of Millhill³. Here the leat is cut by the quarry excavation and partially filled by an associated incline.

Beyond the quarry the leat is readily identified although disturbed by further quarrying and overlain with spoil from ancient (stone?) pits at about SX 45157449. Immediately south of this point the earthworks are lost where disturbed by allotment gardens associated with the cottages at Millhill. The line of the leat is marked by a distinct ledge in the top of the gardens visible south of the northern boundary and about 20 metres east of the western boundary. This ledge is joined by an old track to form the western boundary about 40 to 50 metres further south. Once this leaves the south-western corner of the gardens it is lost in the landscaping around the cottage at Artiscombe Leigh.

South of the lane from Three Oaks to Middle Lumburn Bridge and north-west of the house at Artiscombe Farm there is a section of hedge on the expected alignment of the leat. Here a ledge on the downslope side of the hedge bank appears to have carried the leat towards a small stream and slight earthwork evidence for a pond at SX 44787403. In relatively recent times the direction of flow in the leat had been reversed to feed a storage pond cut into the line of the leat but at a slightly lower level. A sluice from this later pond controlled water to a launder supplying a waterwheel (still *in situ*) in the farm buildings (OS 25" 1st edn., Devon CV:6/7, 1883).

Firm visible evidence of the leat between Artiscombe and Shillamill Wood has yet to be identified. There are, however, a number of indicators which require further investigation. On the prominent hillside west of Newton Wood the hedge bank, from SX 45577392 to SX 45807377, closely follows the 120 metre contour. Where that contour crosses the lane 170 metres west of Newton there is a clear discontinuity in both hedge banks and immediately south-east of Colcharton a hedgebank again closely follows the 120 metre contour for around 220 metres. This alignment of hedgebanks is a feature found at intervals along the whole 16 kilometres of the leat. Where it occurs the hedges are invariably running counter to the prevailing field boundary alignment in that area.

It is in the northern part of Shillamill Wood that the earthworks of the leat can again be clearly identified. The line of the leat immediately north of the wood is occupied by a

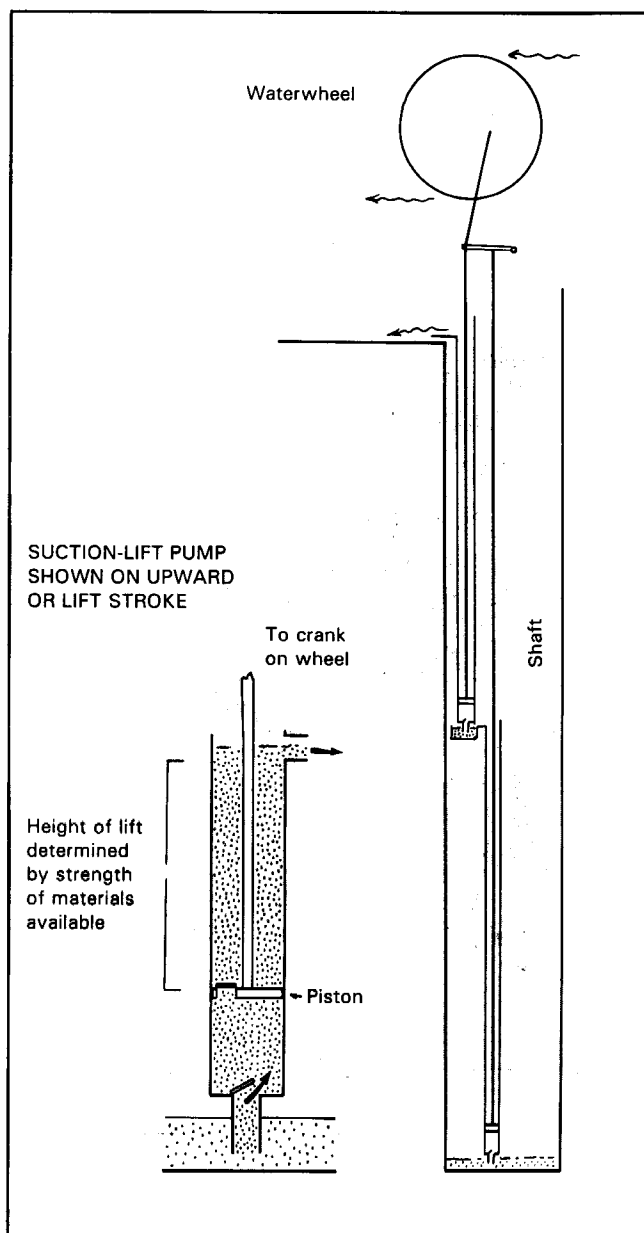


Fig. 3. Schematic diagram of the suction lift pump.

hedgebank. Once inside the wood, at SX 46237193, the well defined earthworks with a later stone built bank on the downslope side can be followed south to rock outcrops, immediately east of Stonage Rocks at about SX 46427151. Here a series of cuttings with three tunnels have been made in the rock face. All are hand cut without the aid of explosives, sweeping pick marks being clearly visible in the walls. The tunnels are up to 13 metres long, from 0.84 to 0.92 metres wide and 1.4 metres high.

In driving the cuttings and tunnels best use was made of faults in the rock. This is in evidence at the northern end of the tunnels where a fault forms the eastern wall. The weakness of the fault line appears to have been exploited by firesetting to commence the initial drive, leaving a characteristic concave face to the rock above the entrance. Pick marks on the wall rock suggest that working was completed, if not initiated, from both ends.

For the 150 metres between the tunnels and the Shillamill to Orestocks road, the line of the leat is a well defined earthwork ledge, up to 3 metres wide, in the steep wooded hillside. South-east of the road, and the disused railway tunnel entrance, the line can be traced as a ledge below the hedge bank. It is briefly lost in cultivated ground before being identified in Ramsham Wood where it has in part been

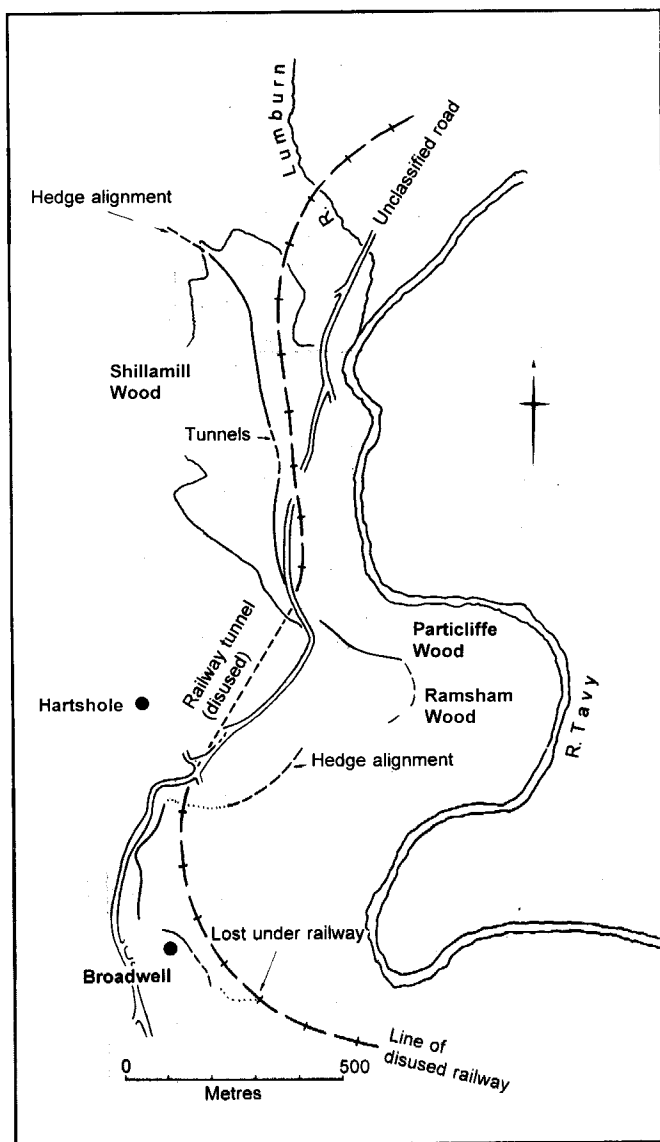


Fig. 4. Line of leat, Shillamill to Broadwell Wood.

obliterated by quarrying. Leaving the wood at SX 46717082 it is again lost in cultivated ground but appears as a hedge alignment 320 metres south-east of Hartshole Farm.

At SX 46167057, immediately west of the southern end of the old railway tunnel, the line of the leat can be identified as a distinct ledge in the field on the downslope side of the road, again following the contour southwards to the corner of the wood at SX 46097036, from where it forms the western boundary of the wood for 80 metres south before being lost in the old lane. On the north-east side of the farm buildings at Broadwell the leat appears as a shallow ditch running south-east and continues from SX 46197026 for 120 metres as a ledge on the downslope side of the hedgebank as far as the lane. There is no sign of it beyond the lane and it is then lost under the railway. However, in Broadwell Wood there is a track running east on the downslope side of the railway cutting which may be following the line of the leat.

At the northern end of Blackmoorham Wood, 120 metres south of the bridge carrying the lane from Orestocks over the railway, at about SX 47026965, the leat can be seen as a rock cutting emerging from the material forming the railway embankment. A few yards east of the embankment the leat enters a tunnel bringing it south through the spur called Raven's Rock. However, judging by the shelf, possibly cut into that rock it may have been originally intended to bring the line of the leat around the eastern end of the spur.

The leat tunnel is larger than those in Shillamill Wood, being up to 1.9 metres high and 1 metre wide. It takes a dog-leg course, first south-east then turning south before resuming a more south-easterly course to emerge south of the spur. The rocks are slates, softer than in Shillamill Wood and, where advantage has been taken of fault lines to aid in driving the tunnel, the rock on the footwall side of the fault has been taken away giving it an irregular cross-section.

There are further cuttings about 100 metres south of Raven's Rock. One, roughly cut, ends on the rock face with only a narrow ledge as its obvious continuation. To the west of this, on a parallel course, is a deeper cutting which connects with the leat's course south towards and through the Little Duke Mine site.

At Little Duke the western end of the openworking, on the lode above shallow adit, cuts into the leat and there is a shallow shaft immediately east of the leat, divided from it by a low boundary hedge. Beyond the mine the leat continues as a well defined earthwork following the 115 metre contour round to the south-west. It is lost under the railway embankment for much of the next half kilometre, reappears as a field boundary 150 metres south-east of Hocklake Farm, before being lost again as it crosses the shallow valley running down to the Tavy. Beyond, in the woods, the leat appears as a slighter earthwork, and upon leaving the wood at SX46616886 it has left no visible sign through the cultivated ground to the south-west, towards Higher Gawton.

The leat at this point is just below the 114.3 metre (375 foot) contour and is well placed to cross the saddle in the ridge to the Tamar side. Unfortunately the 19th century railway builders had the same idea and all traces of the leat are lost until it reappears as a hedgebank alignment north-east of Rumleigh Lodge. Cultivation has removed most of the evidence for the leat between here and the mines. Only in the area of Wheal Jenny are the leat earthworks to be seen. South-west of Philleigh Farm old hedgebanks which originally followed the line of the leat can be seen as frost marks on particularly cold mornings. (Mr Hugh Harrison, *pers comm*) A ledge, with a line of trees along its downslope side, in the uncultivated ground east and west of Wheal Jenny marks the line of the leat. It is cut into by the workings at SX450673. Continuation beyond the uncultivated ground is as a hedge alignment with a broad ledge on its downslope side. That continues for 50 metres beyond the Wheal Jenny bungalow and is then lost in cultivated ground.

A further length of hedge alignment commences 290 metres south-east of Bere Alston railway station running south of west for 300 metres to the road. The continuation of the hedge alignment has been removed but its route can still be seen in the field, between there and the road to Collin's Bridge, turning south towards Goldstreet. At this point the leat is at about 110 metres above river level with the mine site only 4 to 500 metres to the south on gently sloping ground. All visible trace of the final route into the mine has been lost under cultivation and the construction of the railway.

DATING THE FIELD EVIDENCE

Surveying and constructing a leat of these proportions was well within the capabilities of miners in the 15th century. The techniques had been known since at least Roman times although surviving examples in England and Wales are relatively rare. Those connected with the Dolaucothi gold workings are perhaps the best known, but there are others in mid Wales of later date. In this case what stands out is the

precision with which it was engineered.

With the exception of the documents cited above there is no known archival evidence for dating the construction of the leat. Booker (1967, 55) alludes to a document of 1460 in connection with the leat which, on the evidence available, would appear to predate its inception. Unfortunately he failed to quote the source and attempts to rediscover it have to date failed.

A map of the Broadwell area dated 1769 (DRO L1258M/E 7) shows that hedges aligned with the line of leat were already in place. In another area, Ogbear Wood, at least one ancient, but undated, hedge bank does respect the leat earthworks. Further work is required to positively date such features. Dating evidence is on the whole circumstantial. The leat is in the right place for the task and displays characteristics of construction before the advent of explosives. It passes through at least three mines which had their origins in the development of a new copper industry in the 1690s, William and Mary, Little Duke and Tavy Consols. Explosives were in use in the Devon mines at that date but it is known that earlier methods of breaking rock continued in use long after the introduction of the new technique. However the construction of a leat into those mines at such a height above river level could not be justified in the late 17th century. More effective sources were available from the River Tavy at a lower level. (DRO L1258M/SS/MC/17)

A CANDIDATE FOR PROTECTION?

The surviving features do not appear to be under any immediate threat. It is understood that planning consent for quarrying exists in respect of the northern part of Ogbear Wood but that area currently acts as a buffer zone for blasting activity in the main Millhill Quarry. Current forestry activity in Blackmoorham Wood would not appear to pose a threat unless there was a need to cut new access tracks. But in the long term some form of protection is required. No statutory protection is currently in place for any part of the leat and until November 1994 it was not even noted on the county Sites and Monuments register. It has now been put forward for inclusion in the English Heritage Monument Protection Programme in respect of the lead and silver industry. Given the criteria laid down for that programme, a 15th century leat of such complexity should

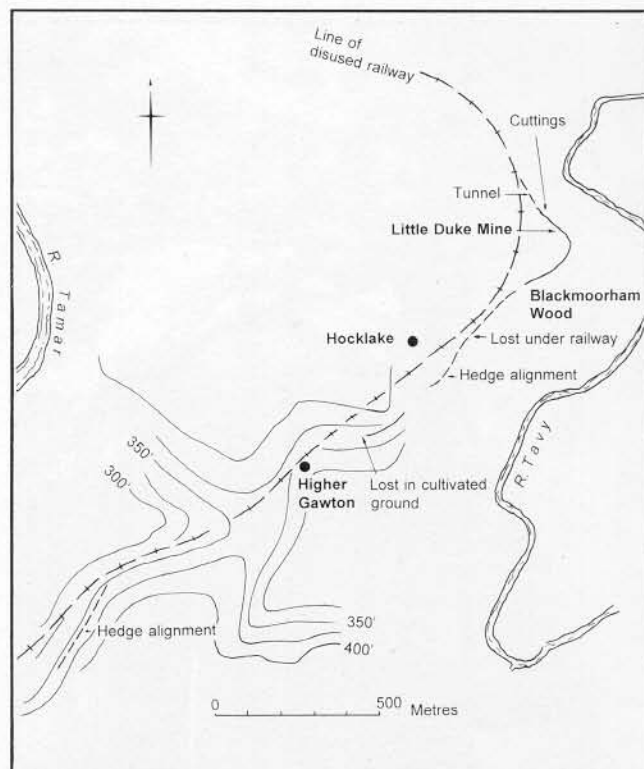


Fig. 5. Line of leat, Blackmoorham to Rumleigh Lodge.

warrant inclusion as a feature of national importance. The author is not aware of any similar features in England dating from before the late 16th century.

CONCLUSIONS

It is rare in this country to be able to link specific advances in medieval technology to such a clear survival of features in the field. Most have been lost beneath the debris of later activity, although it is not impossible that more will come to light in the future. One thinks particularly of the early crosscut drainage adits used in the Bere Ferrers mines of the 14th century.

Such discoveries provide a tangible link with what could otherwise be a theoretical connection between economic forces and the demands of mining. A welcome excuse to



Plate 1. Leat earthworks in southern part of Ogbear Wood (C Vulliamy).

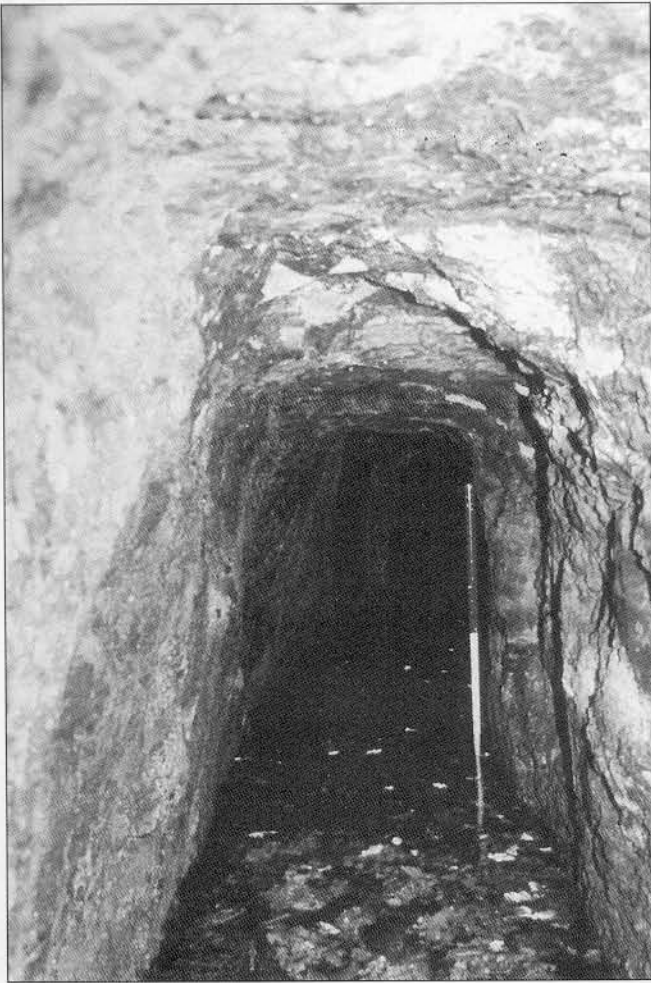


Plate 2. Inside southern tunnel, Shillamill Wood. (M. Munro)

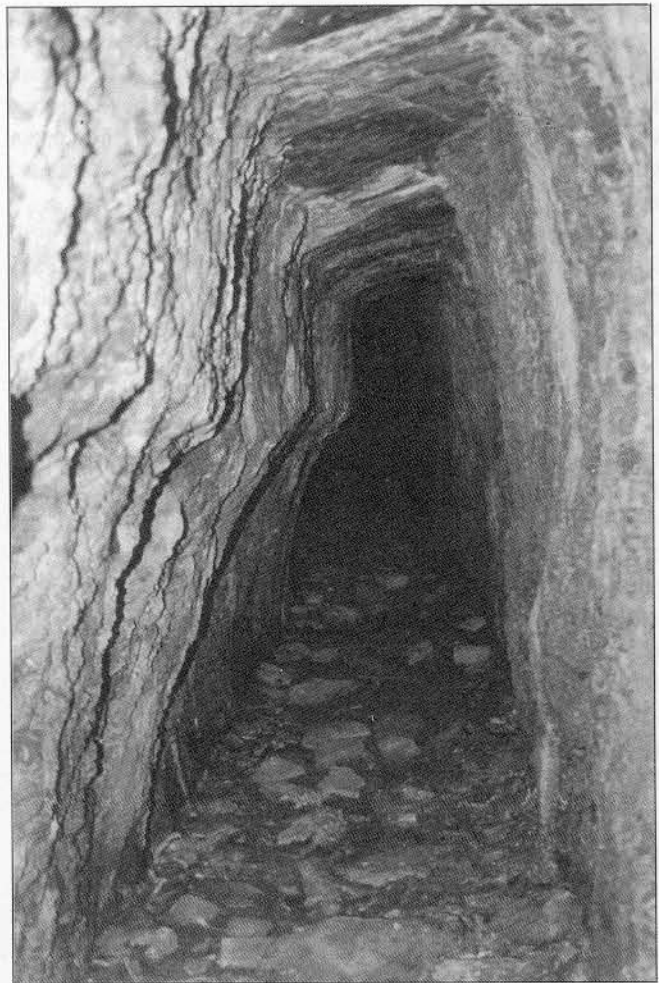


Plate 3. Inside leat tunnel, Broadmoorham Wood. (C. Vulliamy)

leave the archive material and make closer contact with the past.

The history and archaeology of medieval mining is, however, a relatively neglected subject area compared with the modern period. Archaeologists probably know more of mining in prehistory than in the late medieval period. Bere Ferrers and Combe Martin, the King's mines in Devon, represent only a fraction of a wide range of medieval activity in south-west Britain. It could be said that it was the backbone of the country's mineral wealth at that period. Dominated by tin, with significant contributions to silver, lead, iron, coal and possibly copper production. The history of the first two are being addressed but there remains much to be done, particularly in respect of mining archaeology outside of the tin industry.

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Peter F. Cloughton

NOTES

1. An illustration in Taccola's *De Ingeneis* has been dated to about 1425 (Hollister-Short 1993, 58).
2. Earlier writers had been aware of both the introduction of the suction lift pump and the existence of the leat in Shillamill Wood but do not appear to have connected the two (Hamilton Jenkin 1927, 84; Hoskins 1966, 19).
3. The quarry is not marked on the 1st or subsequent editions of the OS 25" maps.

Abbreviations

- DRO - Devon Record Office
- PRO - Public Record Office

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