Hungry Chert Quarries Mouldside Arkengarthdale

A Discussion and Pictorial Record

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Mouldside in the autumn of 2013 looking towards Seal Houses. ©S. Eastmead 2013.

Back cover: Chert tramway ©S. Eastmead 2013.

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Introduction

The Yorkshire Dales is well known for its historic links with the lead mining industry particularly during the sixteenth to nineteenth centuries, but other metals like silver, zinc and copper have been extracted in smaller quantities. So too have some of the gangue minerals present like: baryte, witherite, calcite and fluorite and of course coal. Aggregates like limestone and sandstone are still being quarried. Chert was quarried in Swaledale and later in the adjacent Arkengarthdale from around 1900 to approximately1950 when the market for chert suddenly collapsed.

Chert quarrying in Arkengarthdale has been described by Tyson (1995), and in Swaledale and Arkengarthdale by Jackson (2010). Up to 1922 all the chert quarrying was at Fremington Edge situated above Reeth in Swaledale. To reduce transport costs as the chert had to be transported to the nearest railway station at Richmond, a suitable source of chert was sought nearer to Richmond. The deposits found near Richmond were of poor quality and the alternative scheme to extend the railway to Reeth never materialised. In 1922 chert quarrying started in Arkengarthdale on Mouldside not far from Langthwaite.

Whilst walking Mouldside for many years and having read these two published accounts, there appeared to be some aspects that did not quite fit or had not been described accurately.


Figure 1. Overlooking the top of Lily Jock's Hush below the old smithy building. ©S. Eastmead 2013.

I suspect these inaccuracies are largely due to them being present in the archival material being consulted. Unfortunately we can no longer ask the men who must have toiled long and arduous hours here, but I hope this short report will add an extra layer to what we already know, or at least stimulate further discussion.

In the autumn of 2013 Mike Walton and I used a ProMark 120 professional grade GPS to survey the chert tramway as it climbs up Mouldside from the loading bay beside the Langthwaite to Tan Hill road, up to three separate locations where at different periods the tramway terminated.

This publication is a discussion and a pictorial record of the Hungry Chert Quarries area. Its two primary objectives is to try to clarify how the chert tramway operated and to establish exactly where the chert opencasting operation was located.

This report started out as a simple survey and photographic record that was going to be deposited with the Yorkshire Dales National Park Authority's archives, however it gradually developed into this larger pictorial report.

The large number of images made it necessary to place the bulk of them (Figures 44–98) in Appendix 1. At the end of this discussion there are images of three minor lead adits nearby (Appendix 3) and the Jesse Shirley's Etruscan Bone & Flint Mill (Appendix 4).

Chert Geology

"Chert, perhaps originally chirt, is believed to be a local English term which was taken into geological use. It may be of onomatopoeic origin. The name *chert* appears to be of more recent origin than flint, as unlike flint it is not found in literary usage. Flint was well established in meaning by 1679 ..." Dana et al. (1962).

Chert is a fine grained microcrystalline, high silica content sedimentary rock, ranging in colour from white to black. It is formed when the siliceous skeletons of marine plankton[1] are dissolved during digenesis,[2] with silica being precipitated from the resulting solution, although some geologists believe it can be directly precipitated from the sea. Digenetic cherts can contain small fossils;[3] they are very hard rocks ranging between 6.5–7.5 Mohs. The Mohs scale is a comparative scale ranging from 1 (talc) to 10 (diamond) and is based on the ability of one mineral to scratch another. The mineral quartz which is hundred percent silicon dioxide (SiO_2) has a hardness of 7 Mohs. Minerals are pure and can always be represented by a chemical formula and have a crystalline structure, whereas rocks are a mixture of minerals or mineraloids (non-crystalline minerals like obsidian — an amorphous glass).

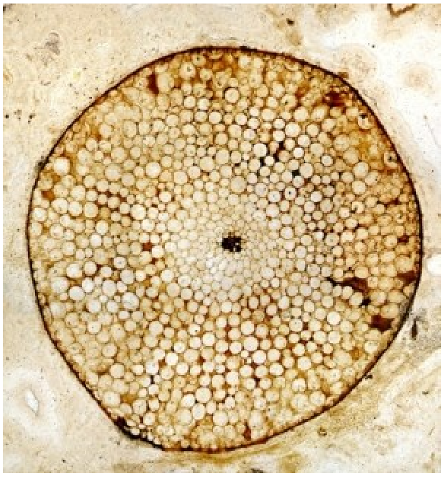

Figure 2. Rhynie chert showing a Rhynia stem cross-section.

Chert was formed when silica-rich water from volcanic springs rapidly flooded the terrestrial ecosystems, petrifying early forms of life on Earth. These organisms have been so well preserved that in some cherts fine cellular detail can still be seen (Figure 2). The carboniferous landscape of Swaledale and Arkengarthdale was formed mainly during the Visean period 331 to 347[4] Ma (Million years ago), and the Namurian period 316-331 Ma, when tectonic plate

[1] These include: diatoms, zooplankton, silicoflagellates and sponge skeletons that form the sea-floor ooze — the pelagic (deep open water) sediment found on many of the ocean floors. Wikipedia.

[2] Digenesis: (Wikipedia.org) defined as changes to sediment or sedimentary rocks during and after rock formation (lithification), at temperatures and pressures less than that required for the formation of metamorphic rocks or melting. In this context forming digenetic cherts. Wikipedia.

[3] A reference on the British Geological Survey website reports that the Richmond Black-bed cherts are fossil rich in zoophycos (a trace fossil). N.B. I have not found this to be the case at this location.

[4] Dates according to the British Geological Survey

drift (currently about 1–2 cm/year) was moving what is now the Yorkshire Dales from the warm shallow seas of the southern equatorial waters, northwards. During these geological periods there were many wide ranging fluctuations of temperature and sea level. Some of the formations we see today were created when the land was just above sea level in a low lying

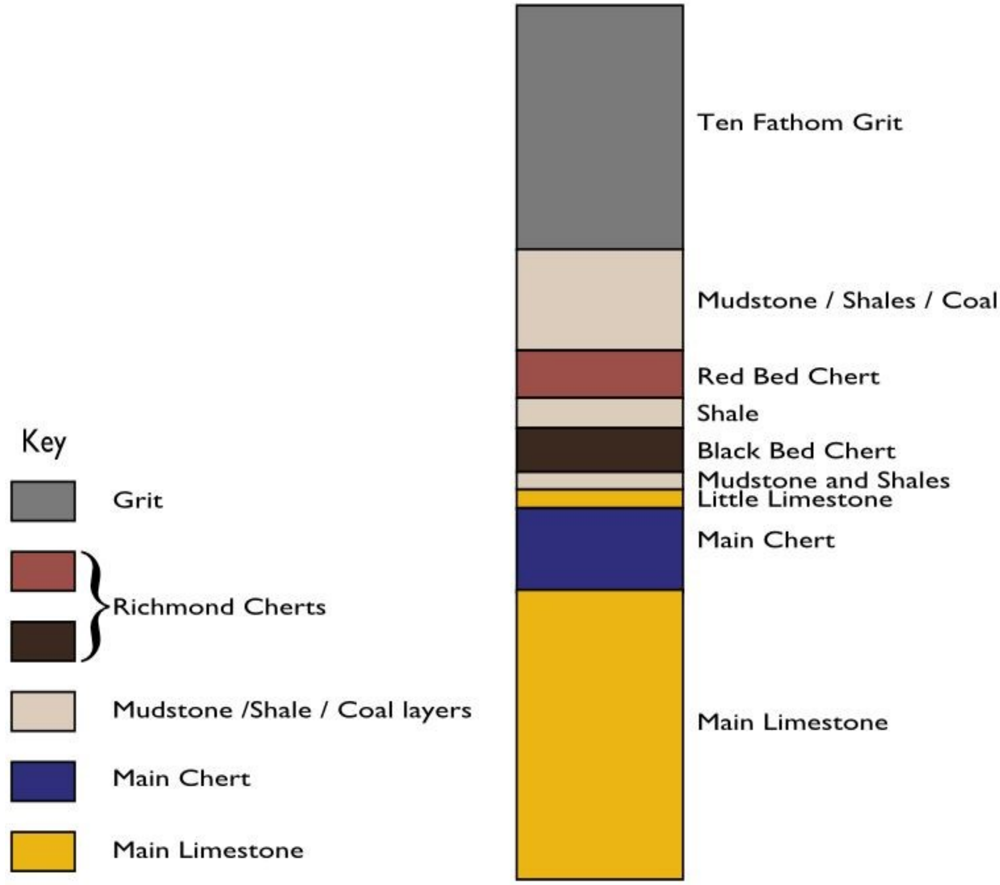

Figure 3. Typical Lower Namurian Yoredale Series for Arkengarthdale.

delta type landscape. Figure 3 shows the typical Lower Namurian strata in the Yoredale Series in Swaledale. The ratios of these strata can vary considerably in adjacent areas. The majority of chert quarried by Hungry Chert Quarries Company was from the Richmond Chert Black Beds, and is blue-black in colour (Figure 4), although to begin with chert was quarried from the Underset and later the Main Chert levels. The thickness of the Red Bed and Black Bed cherts varies throughout Arkengarthdale (Dunelm and Wilson page 56).

Chert is frequently confused with flint and to explain the difference further minerals need to be considered. There is a second mineral apart from quartz that is 100% SiO_2 called chalcedony. Chalcedony is a microcrystalline mixture of quartz and a polymorphic form of quartz called Moganite. The microcrystalline structure of chalcedony is so fine that it has a waxy lustre. There are a group of rocks that are effectively microcrystalline chalcedony with a small percentage of other minerals, when they become microcrystalline cherts. They include:

- Jasper — the common red form is due to iron (III) inclusions.
- Chert — which comes in a variety of colours depending on the inclusions.
- Flint — a form of chert that has a lustre, which from a usage point of view is superior to chert, as it has a finer crystalline structure and a slightly greater percentage of SiO_2. Geologically flint is found associated with formations of chalk and marly limestone, whereas chert is generally found associated with limestone.
- Many semi-precious gemstones and agates have high percentages of chalcedony.

In addition there are many different types of siliceous rocks. They are classified according to the amount of silica and detrital[5] minerals they contain. Cherts range from 75% silica up to over 98% silica for the best types of flint. The Hungry Hush cherts according to Jackson contain 95.69% silica.

Chert Usage

Figure 4. Hungry Hush Richmond Chert from the Black Beds. ©S. Eastmead 2013.

As you would expect chert usage reflects the physical and chemical properties for the various types of chert. Historically man has used chert and its archaeologically superior form: flint, for thousands of years. The high silica content and the fine microcrystalline structure allows flakes to be cleaved when it is hit with sufficient force by a hard object when it fractures in a partial Hertzian cone.[6] This results in conchoidal fractures (Figure 5), a characteristic of all minerals with no cleavage planes. By mastering this flint or chert knapping skill, stone tools of immense practical value were created, particularly tools with sharp edges like hand axes,

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[5] Detrital: Noun detritus; is particles of rock derived from pre-existing rock through processes of weathering and erosion. A fragment of detritus is called a clast. Detrital particles can consist of lithic fragments (particles of recognisable rock), or of monomineralic fragments (mineral grains). These particles are often transported through sedimentary processes into depositional systems such as riverbeds, lakes, deltas or the ocean forming sedimentary successions. Digenetic processes can transform these sediments into rock through cementation and lithification, forming the sedimentary rocks like those seen throughout the Yorkshire Dales. Wikipedia.

[6] A Hertzian cone is a cone of force that propagates through a brittle, amorphous or cryptocrystalline solid material from a point of impact. This force eventually removes a full or partial cone in the material (a flake). This is the physical principle that explains the form and characteristics of the flakes removed from a chert or flint core during the process of flint knapping (lithic reduction). Wikipedia.

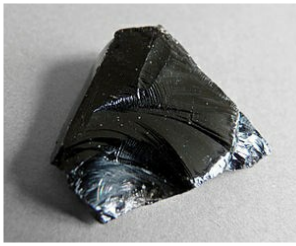

Figure 5. Conchoidal fractures in obsidian which is also a high silica non-crystalline mineral. Ji-Elle Wikipedia.org

scrapers, flint knives and arrowheads. Chert and flint knapping relies on its monocrystalline structure rather than its hardness. In Swaledale and Arkengarthdale sources of flint included beach pebbles from the North East and Western Coastlines and flint erratic nodules from glacial clays which were exploited during the Early Post Glacial and Mesolithic periods. Quarried flint from the chalk of the Yorkshire and Lincolnshire Wolds was the preferred source during the Neolithic and Early Bronze Age.

Tim Laurie has recorded many sites in Swaledale where chert and flint have been worked. He writes (Personal communication 2013):

> Artefacts of fine grained black Pennine chert are generally present on occupation sites throughout the catchments of the Ure, Swale and the Tees/Greta river systems, and at all periods from the Early Mesolithic (after 9500BP[7]) through the Later Mesolithic (after 8800BP) and Neolithic periods (after 6000BP), to the Middle Bronze Age around 3500BP.
>
> Wherever cores of chert are found; they are of water rolled cobbles indicating that the chert material used by early hunters and pastoralists was not quarried from an outcrop, but carefully selected water rolled glacial till or stream rolled gravel sources, where they are free of frost fractures. The chert cores are limited to the fine grained glassy black chert (weapon grade as I call it) which outcrops above the Underset Limestone. The frost fractured blue-grey chert which outcrops above the Main Limestone was never selected for small tools, microliths and arrowpoints, although natural flakes of this material may have been used as scoring tools.
>
> Examples of local chert tools include the tranchet or end-flaked stone axe of Early Mesolithic character found at a fine vantage point site on moorland above Calvert Houses in Upper Swaledale. This axe was found together with a fine assemblage of flint microliths, scrapers and arrowheads. These finds are of different periods indicating revisits to this site through time (Figures 6 and 7).
>
> An assemblage of lithic finds of Late Neolithic or Early Bronze Age character, now in the Swaledale Museum in Reeth, are from a site on Reeth Low Moor at Cringley Hill. It includes 28 chert scrapers and a small broken barb and tanged arrowpoint. For further details and the contexts of these finds, see Laurie, T.C. 2003.

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[7] BP before present

When it was found that a spark was generated when flint or chert was struck against an iron-bearing surface probably in during the Iron-Age, another application was born, not just for lighting fires but later, explosively, in the firing mechanism of the flint-lock rifle or pistol.

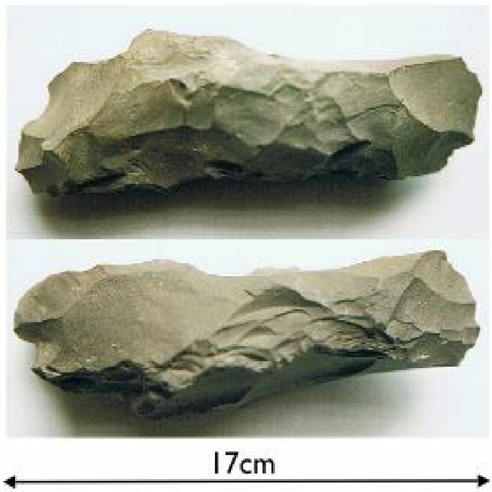


Figure 6. Chert tranchet or end-flaked stone axe of Early Mesolithic character found on moorland above Calvert Houses in Upper Swaledale. Found, detailed and photographed by Tim Laurie, first published: Laurie T.C. 2003. It can be seen in the Richmondshire Museum.

Figure 7. Swaledale: Chert tanged arrowpoints. Currently not on display. ©T. C. Laurie.

Chert has been used as a road-stone aggregate as it has the benefit of just compacting more when it gets wet and does not fragment turning itself into a mud. The same cannot be said about its use as an aggregate in concrete, as it is prone to be badly affected by surface weathering. In the more alkaline concretes chemical reactions lead to cracking and failure due to water penetration.

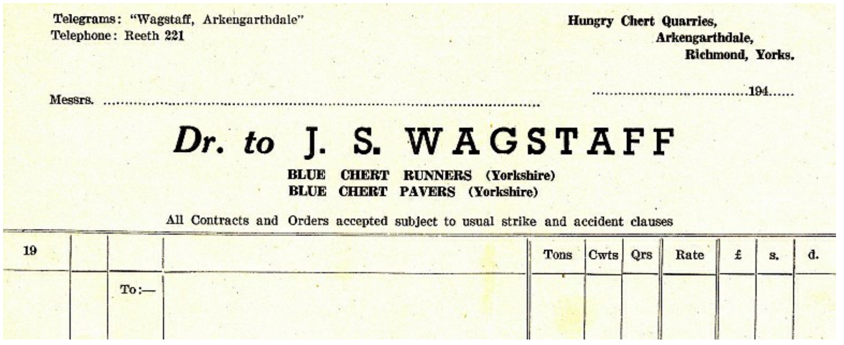
Chert has been used as road markers and in monuments and headstones, but its hardness and crystalline structure make it difficult to work. In areas where flint is common, flint nodules are still used as a wall building material.

In the first half of the twentieth century chert quarrying at Fremington near Reeth and later at Hungry Chert Quarries relied on the demand for chert by the pottery industry, where they required a high silica stone that was abrasive and sufficiently hard to be long lasting. The potteries also bought chert from Derbyshire and North Wales. These two sites had cheaper transport costs but in both cases their chert had a reduced silica content compared with Swaledale chert. They used the blocks of chert in round tubs to grind flint.[8] The inside of a tub was paved with chert blocks and rotating arms drove a second set of chert blocks in a circular motion on top of them. The tubs were then charged with flint and water and the rotation continued until the flint was ground sufficiently fine before being mixed with clay. With flint being a form of chert, the wearing of the chert blocks did not contaminate the final product. See Appendix 4 images. In the 1950s more efficient ball mills were introduced which quickly led to the demise of chert quarrying in Swaledale.

[8] Flint was used as an important constituent of ceramics because firing did not affect the coloured glazes.

Hungry Chert Quarries

The Hungry Chert Quarries Company was formed by J. S. Wagstaff in 1922 (Figure 8). He had briefly managed the Fremington Edge Quarries at Reeth before leaving that company to form his own in Arkengarthdale; taking a number of experienced quarrymen with him.



Telegrams: "Wagstaff, Arkengarthdale"
Telephone: Reeth 221

Hungry Chert Quarries,
Arkengarthdale,
Richmond, Yorks.

Messrs. ....

..............................194......

Dr. to J. S. WAGSTAFF

BLUE CHERT RUNNERS (Yorkshire)
BLUE CHERT PAVERS (Yorkshire)

All Contracts and Orders accepted subject to usual strike and accident clauses

19				Tons	Cwts	Qrs	Rate	£	s.	d.
		To:—								

Figure 8. Hungry Chert Quarries Company letterhead.
©Swaledale Museum Archive

According to Tyson and Jackson, Wagstaff quarried the Underset Chert from Moulds level from 1922 before commencing opencast chert quarrying at Stoddart's[9] and Hungry Hushes in 1932. Later three levels were driven above the Smithy Hut (Figure 1) to quarry chert from the Black Beds (Figure 4). These four areas are circled on the map of Mouldside (Figure 9).

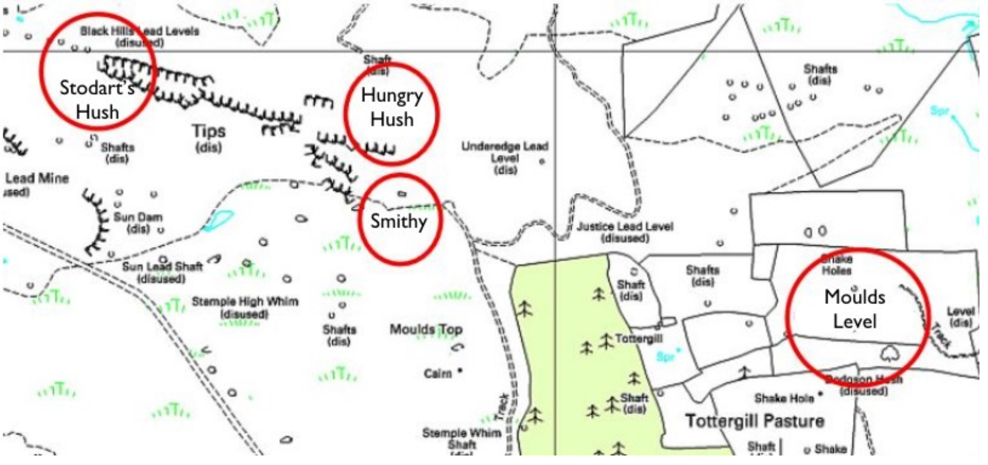


Figure 9. Mouldside map showing Stoddart's and Hungry Hush (this should be further to the south west), Moulds Level and the old Smithy hut and the area of the three chert levels. ©Crown copyright and database rights 2011 Ordnance Survey 1000237401, kindly supplied by the North Yorkshire Dales National Park Authority.

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[9] Stoddart is sometimes spelled Stodart see Figure 9.

The 1:10,000 OS map (Figure 9) does not show the position of the hushes very accurately, however Figure 10 shows the relationship of the hushes and the upper sections of the chert tramway Wagstaff constructed.

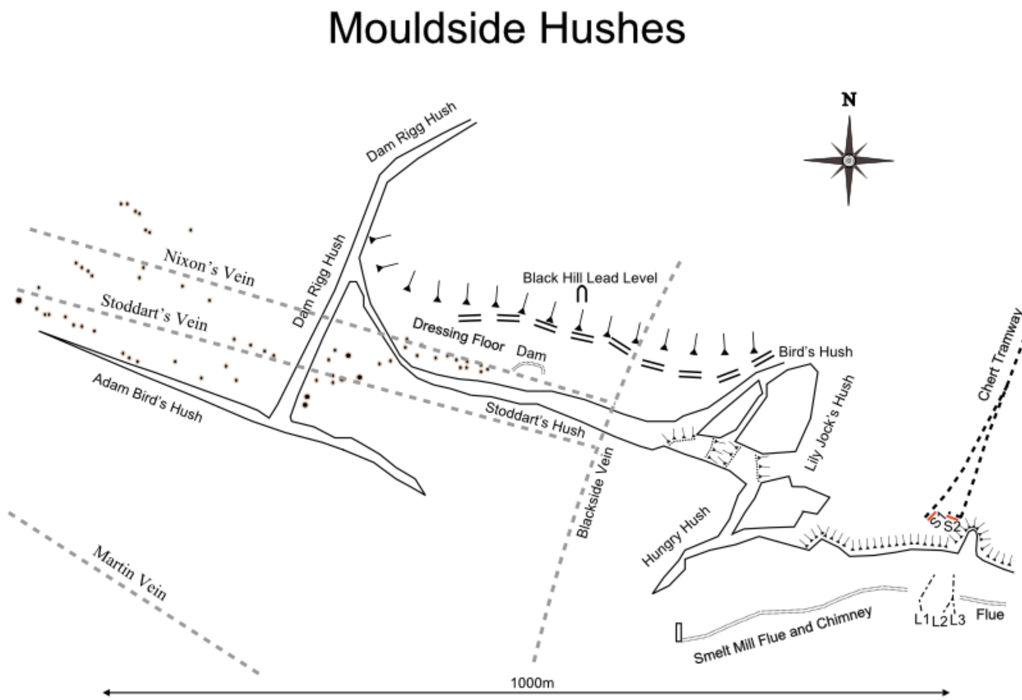

Figure 10. Mouldside Chert Workings. ©S. Eastmead 2013.

Mineralisation

On Mouldside chert is present in bands (Richmond Cherts, Main Chert and Underset Chert [Appendix 1: Figure 72]) at varying depths (Figure 3) in an area that has been extensively mined for lead ore. The mineralisation of this area and the consequent mining activity is responsible for the majority of the landscape features we see today when walking Mouldside. Only a small amount is due to chert quarrying.

Figure 10 also shows the main lead mine shafts around the Stoddart's and Nixon veins. There are a similar line of larger shafts following the Martin vein (not indicated). This shows that the mineralisation of the faults in this area does not appear to follow exactly the major surface faults. John Russell (Personal communication 2013-4) describes the mineralisation process below:

> Most geological faulting is linked directly to continental drift. As a general rule continents moving apart create *normal faults*, whereas colliding continents form *reverse faults* and continents or plates that slip past each other create *tear faults*.

Most of the Carboniferous period suffered from basement block[10] movement, which was accompanied by north-south compression almost until the end of the Carboniferous period. This caused reverse tear and normal faulting that is best seen locally in the Craven faults and at Hind Hole near Keld. At the end of the Carboniferous period the whole of the North of England was put under great tension.[11]

It is now thought that mineralisation occurred after the end of the Carboniferous period as the continents drifted apart creating a European sea which covered most of the North of England. Many normal faults were formed which became natural routes for sea water to permeate the crust, becoming warmed to around 200°C at depth, and dissolving many minerals. As these saline fluids passed through the faults and the jointed Carboniferous limestone, they gradually cooled, depositing the minerals and creating the mineral veins, which the Pennine miners have subsequently extracted for copper, lead, zinc and silver. This pulling apart gave rise to the huge European Permian Basin centred in the North Sea (Figure 11), which reactivated many of the Carboniferous faults especially the

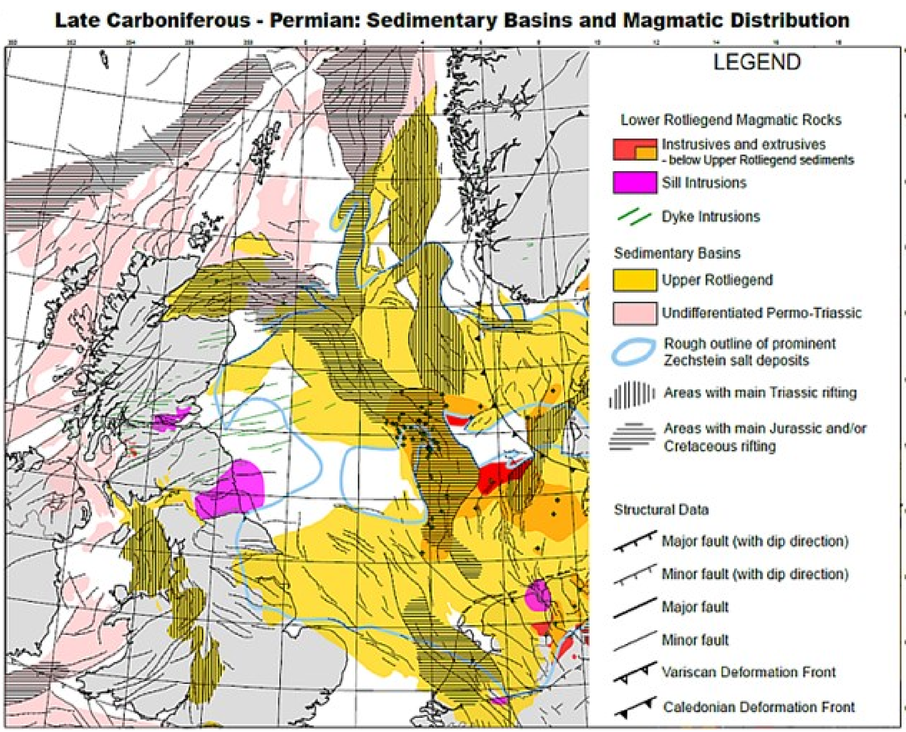

Figure 11. European Permian Basin showing the major faults across eastern Britain. Michel Heeremans, Jan I. Faleide and Bjørn T. Larsen (2004).

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[10] Basement block: any rocks below sedimentary rocks or sedimentary basins. Wikipedia.

[11] Tension (geology): a stress which stretches rocks in two opposite directions.

normal faults. The first idea on mineralisation of the Pennines, which is still quoted in some sources, is that hot granite was injected into the base of the Carboniferous rocks creating hot (hydrothermal) aqueous fluids under high pressure which dissolved the minerals. These hydrothermal fluids permeated the faults and limestone joints, where they subsequently cooled depositing their mineral load. This earlier explanation is accepted for the Cornish mineralisation but has been rejected as the main source of mineralisation in the Pennines.

The Hushes

Hushing is a mining method involved the sudden release of a dammed watercourse allowing rushing water to scour away the soil and small boulders exposing any veins of ore which then could be extracted as a surface opencast operation. This process would either create a valley or more usually just removed soil from an existing valley, the valley would then be referred to as hush. It is very likely that many valleys in mining areas were called hushes by miners even though no hushing took place. For example there is no evidence of any dam or water course entering the top of Turf Moor Hush. Water was an important commodity on Mouldside, but I believe little of it was used for hushing as the soils on Mouldside are very thin and the water was more usefully used in the ore dressing process. Surface ore was generally removed by opencasting, but the majority of ore was mined underground using either vertical shafts or near horizontal adits or levels driven into the hillside. The lines of shafts generally follow the direction of the vein whilst levels are usually driven initially to cut across the vein(s).

When you compare the six hushes listed below with Turf Moor Hush which is 1km to the south-east, their appearance is strikingly different. Turf Moor Hush has been extensively mined for lead for at least two centuries (and probably much longer) with the evidence under every footstep you take. But curiously with the exception of Lily's Jocks Hush there is minimal evidence of mining activity actually in the hushes.

To mine lead ore you have lots of waste (gangue) rock that needs to be disposed of. Many acres of Mouldside are covered with such heaps. The miners wanted to do this with minimum effort so they were usually dumped the rock close by the shaft or the level's entrance. Similarly when following a vein they kept the levels as narrow as possible to minimise the volume of gangue rock mined.

If lead was mined in Stoddart's Hush then where is all the gangue rock? There is insufficient room in the hush itself, and transportation along and out of the hush to an area that had a water supply and room to process the ore would have been difficult and very inefficient. There is no evidence they did this as it was far more efficient to access the veins from shafts adjacent to the hushes, where there was sufficient open ground around the shafts to dress the ore and dump the gangue rock, with the added bonus of a much easier route off Mouldside to the local smelt mills.

Two of the six hushes in this area that are named after eighteenth century miners Adam Bird and Joseph Stoddart (Figure 10), they are called:

- Adam Bird's Hush (NY 9816 0289 – NY 9787 0302)
- Bird's Hush (NY 9815 0289 – NY 9787 0302)
- Dam Rigg Hush (NY 9801 0296 – NY 9813 0325)
- Hungry Hush (NY 9863 0288 – NY 9854 0283)
- Lily Jock's Hush (NY 9868 0293)
- Stoddart's Hush (NY 9818 0303 – NY 9851 0294)

Lily Jock's Hush

This hush is not very well defined and does not appear on current Ordnance Survey maps, in fact the only reference I have seen of Lily Jock's Hush is in Tyson's book. Lily Jock's Hush is one of those areas on Mouldside which contains evidence of lead ore processing activity but with no obvious shafts or levels nearby. It is probable that surface veins were once visible around the entrance to Hungry Hushes, and Lily Jock's appearance is due to opencasting and dressing ore from that operation. There is some evidence above Lily Jock's Hush where surface lead veins have been followed.

The southern end of the hush appears to be defined by outcrops of Main Chert, and then as it extends northwards gradually petering out as it descends Mouldside. The other five hushes are all principally geological faults having an unmistakable valley profile. (Appendix 1: Figures 44, 57 & **98**).

Adam Bird's Hush

Walking into this hush from its eastern end you find dressing floor spoil that has slipped down from the northern side of the hush, and then some undefined drystone wall or remnants of a small building. Then approximately halfway to where the upper section of Dam Rigg Hush meets this hush, there is a substantial bank set across and damming the fault. To the east of the dam, the hush floor shows signs of once containing water. Beyond the dam there is no mining activity until you reach the western end of the hush when a series of shafts following the path of the Stoddart and Nixon's veins cut across the hush on their way south westwards towards the Martin vein. [Appendix 1: Figures 45–47 & **98**].

Dam Rigg Hush

This hush has two sections: upper and lower. The upper section is gently sloping northwards and the lower section starts just beyond where the upper section of Stoddart's Hush meets the upper section of Dam Rigg Hush. The lower section is very rugged and steep in places as it continues its northerly route down from Moulds Top. Walking down the lower section is not easy. It certainly is not a route down from Moulds Top for pack horses or carts, and as the name implies it appears to have been dammed at some stage [Appendix 1: Figures 48]. There are a couple of very small grassed over shafts in the mid-upper section of the hush.

They appear to be old in comparison with the eighteenth century and later shafts present above and on either side of the hush, and are possibly of late medieval origin. This line of shafts appears to be following the Stoddart and Nixon veins as it crosses Dam Rigg Hush (Figure 10 & **98**).

Stoddart's Hush

Like Dam Rigg Hush this fault has two sections: a narrow western section and a broadening and steeper eastern half which gradually develops into a very impressive gorge. The eastern section is extremely rocky with no clear track along its length. Either side of the fault both rock faces are relatively unstable with annual rock falls due to seasonal weathering. There is no significant evidence of mining or quarrying having taken place actually in the hush, although some fine gravel material has been tipped or slipped down the northern face from the dressing floors that surround the shafts above and to the north of the hush. There is one small depression that is grassed over that may have been a small possibly late medieval shaft. If you ever wanted to remove heavy ore or rock from Stoddart's Hush it is impractical to do so in an easterly direction towards to Siding 1 [Appendix 1: Figure 51]. Stoddart removed his lead ore from the dressing floor on the northern side of the hush down the diagonal trackway shown in Figure 24, just to the south of Black Hill Lead Level. There is no evidence of chert quarrying taking place as reported by Tyson and Jackson. This confusion may be due to inconsistent naming of these hushes in the archival documents. See images [Appendix 1: Figures 49–53 & **98**]. Dunham and Wilson shows on page 80, Figure 18(2) that the block between Stoddart's Hush and the Martin Vein has subsided relative to surrounding blocks to the tune of approximately 20–25m, this presumably was due to normal faulting. This accounts for why there is no surface extension of either the Main Chert to the west of the opencast area G in Figure 14, or of the Richmond chert outcropping to the west of point A in Figure 12. It also probably accounts or contributes to, the appearance of both Hungry and Dam Rigg Hushes being at right-angles to both Stoddart's Hush and Adam Bird's Hush.

Bird's Hush

Bird's hush is quite narrow, but is the easiest entrance into Stoddart's Hush. If mining or quarrying had taken place within the Stoddart's Hush then this is the obvious route out. It would have been passable for pack horses, but there is no evidence that it was ever used or widened for carts. See images [Appendix 1: Figures 54 & **98**].

Hungry Hush

This is a similarly rugged hush to Stoddart's Hush but not on the same scale. There is no obvious evidence of chert quarrying in the area, however there is a lot of poor grade chert spoil in and around the entrance at the top of Lily Jock's Hush to the north-east of Hungry Hush (G in Figure 14). It would have been a major task to take Black Bed chert blocks from Point A in Figure 12 down Hungry Hush to Siding 1. If this had been planned, then Siding 1 would have been located further west to make transportation easier. See images [Appendix 1: Figures 55, 56 & **98**].

Where was the chert?

In summary, Figure 12 shows the position of the Underset, Main and Black Bed cherts. Having walked Stoddart's and Hungry Hushes at low and high levels there are

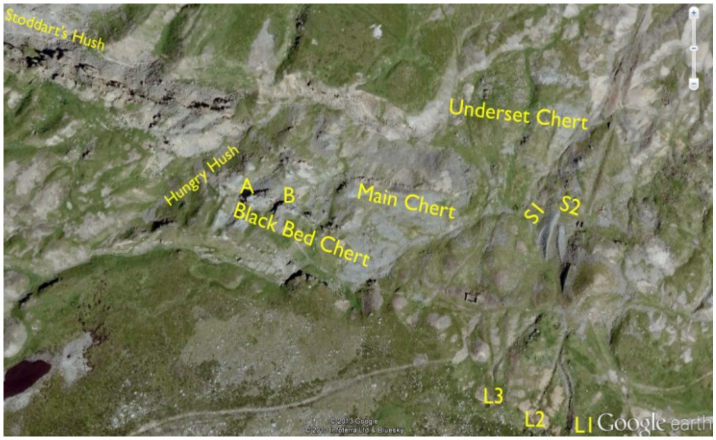

Figure 12. Chert locations.
Point A is the western-most Richmond chert outcrop. (Top of image is north).

no outcrops of chert present. Figure 13 shows an image of the outcrop of Black Bed chert at point B in Figure 12 looking towards the smithy building and the three chert levels beyond L1, L2 and L3. You can see in the image the chert dipping towards the south (right) but it is also dipping towards the east where it was being quarried inside the three levels. Dunham and Wilson (1985) indicates that Red Bed cherts should be present, but in this small area there is no surface evidence. They do however record that towards the north-west, a little further up Arkengarthdale, the Red Bed cherts thin out leaving only Black Bed chert.

Figure 13. Looking east. Black Bed chert outcrop (Figure 12 point B) with the smithy (SM) building just visible above it and the revetted bank (RB) on the left. The three chert levels are just beyond the smithy. The chert is dipping to the east. ©S. Eastmead 2013.

Chert Tramway

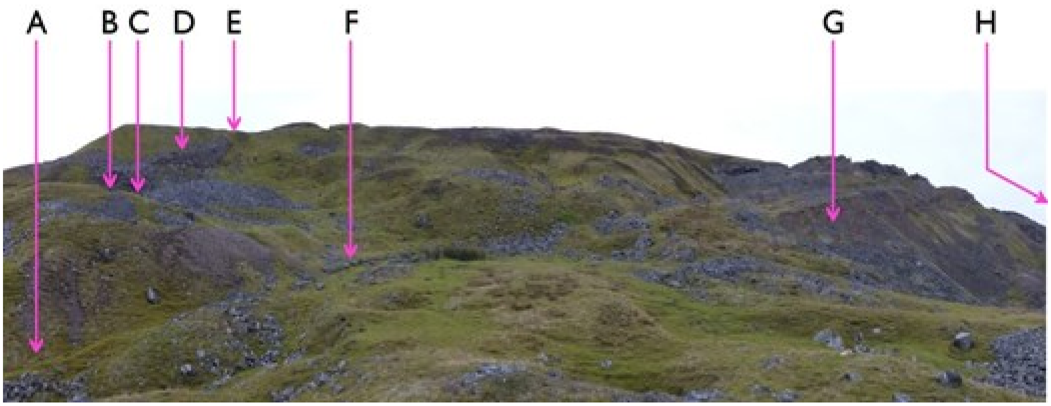

Figure 14. Chert levels, opencasting and tramway. ©S. Eastmead 2013.

A = Track-bed to Siding 1. **B = Lower Brake House Siding 2**
C = Siding 2 **D = Revetted Bank**
E = Upper Brake House at chert levels **F = Siding 1**
G = General area of open cast chert workings **H = Site of Hungry Hush.**
It was very unlikely Hungry Hush was worked for chert.
There are smaller areas of open cast chert workings lower down behind the camera.

According to Tyson and Jackson, Wagstaff worked Moulds level for chert from 1922 to 1932, but Tyson has a photograph of chert opencasting at the Hungry Hushes Quarries dated c1923. In the same photograph you can just make out what appears to be a section of single track. If so, then this is likely to be close to Siding 1 [Appendix 1: Figure 65], and indicates that the tramway may have been constructed earlier than 1932.[12]

The route to Siding 1 appears to have been the original route which could have been located much nearer to Hungry Hush if they either had been quarrying in that hush or transporting chert out via Hungry Hush [Appendix 1: Figures 58–61].

Siding 1 is nearest to the opencasting area at G in Figure 14 which presumably was in use until the upper chert levels became operational, when the tramway would have been rerouted to the three Chert Levels, and later to Siding 2. The route up Mouldside to Siding 1 is for the most part easily walked from the loading bay by the cattle grid beside the road to Tan Hill (Figures 26–27 & [Appendix 1: Figures 81]), up to approximately 150m from the top of the current track, where it branched off westwards up another valley to Siding 1. About half way up the valley to Siding 1 lie the remains of an old wagon [Appendix 1: Figures 64] which appears to be of similar construction to those used in the lead levels rather than the flat bed type seen in Figure 22. They were working the Main Chert just to the west of Siding 1. The western-most outcrops of the Richmond cherts at higher elevation; do not show any signs of being worked presumably because of the difficulty in getting the chert to the tramway.

[12] This is very likely a typographical error with the 2 and 3 transposed.

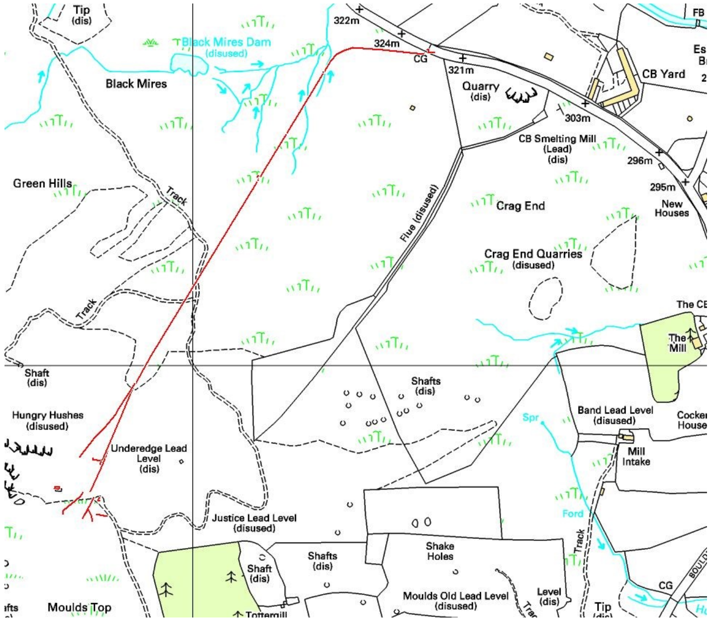

Figure 15. Chert Tramway on Mouldside. ©Crown copyright and database rights 2011 Ordnance Survey 1000237401, kindly supplied by the North Yorkshire Dales National Park Authority.

Figure 16. Chert Tramway. Photographed in 1946 by the late J. Myers.

There is no evidence that chert was extracted from Stoddart's Hush. This too would have been extremely difficult and would require a route down Bird's Hush and a separate route down Mouldside to the west of the tramway taking the same path as Stoddart used to transport the lead ore from the top of the northern side of Stoddart's Hush (Figure 24).

How did they get the chert blocks from the levels to the Tan Hill road?

Tyson and Jackson describe the tramway route that can be seen in the late J. Myers 1946 image (Figure 16), but this route stops about 60m before and 20m below the three chert levels. Tyson does mention the revetted bank inferring that it was in use at some stage but without any dates. The 1946 images show the piers and banks in a similar condition to how they appear today (2013). Compare Figures 16, 18 and [Appendix 1: Figure 75]. These structures are substantial evidence that the tramway was planned to climb to where the chert was being quarried, with the track being supported on a series of piers and the revetted bank. Unfortunately there are no images of the tramway above Siding 2. Was this ever completed and put in operation? If so for how long? The Swaledale Museum archive does have an image

Figure 17. This is thought to be the upper Brake House north of the entrance to Chert Levels 1 and 2. Photograph donated by the late Jean Hutchinson ©Swaledale Museum Archive.

that appears to show the upper pulley and braking mechanism (Figures 17 & 23). I believe it does although the background now looks different and all that is now present is a depression in the ground [Appendix 1: Figure 80]). Unfortunately these snow scene photographs are undated, and the image taken in 1946 shows the piers in poor condition as if they have been long out of use.

At some point I believe they found that the gradient of 1 in 2.7 up this section was just too steep when using flat-bed wagons without any sort of gradient compensation mechanism similar to that shown in Figure 20. This part of the incline certainly would have put an extra strain on the braking mechanism they had available. Figure 18 shows that the Siding 2 brake house must have been constructed after it was decided to abandon the use of the piers and

Figure 18. Piers: 1 (foreground left), 2 and 3, with the later brake house in-between piers 1 & 2. ©S. Eastmead 2013.

revetted bank, as it would have obstructed the track between the lower two piers when it had a roof.

Figure 19. Chert dressing floor by Siding 2 (top right). ©S. Eastmead 2013.

So an alternative method was required to get the chert down to the later position at Siding 2 (S2 on Figure 21). The clue appears to be in Figure 19 where there is a very neat and orderly avenue of chert dressings between Siding 2 and the upper chert levels. The quarried blocks were simply rolled down the bank to where they were dressed and subsequently loaded onto the flat-bed wagons. This could have had a quality control function too where flawed blocks did not survive the tumble down the bank. Full wagons were then pushed in front of the brake house onto the turntable, (Figure 22) and rotated through 90 degrees ready for sending down Mouldside to the loading bay beside the Tan Hill road. The upper section (Figure 21) where the three chert levels L1, L2 & L3 were driven, would have had its own small track system so laden wagons could be pushed from any of the three levels to where the chert was rolled down the bank. Comparing Figures 17 & 23, as expected it looks like the pulley/braking mechanism was transferred when the upper section of track was no longer in use.

Figure 20. Gradient compensation mechanism.
© David Sallery www.penmorfa.com/Slate

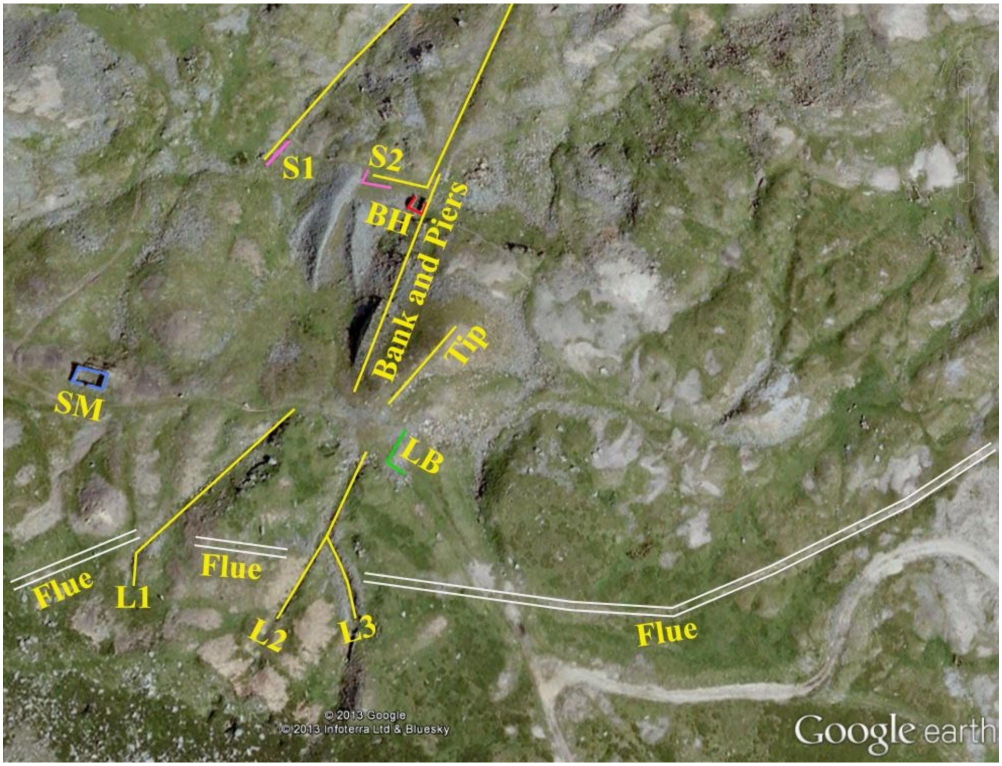

Figure 21. Key.

S1 = Siding 1	**S2 Siding 2**	
L1 = Level 1	**L2 = Level 2**	**L3 = Level 3**
SM = Smithy	**BH = Brake House and turntable**	**LB Loading Bay**

Flue = the flue that connected the New Lead Smelt Mill to the chimney on Moulds Top.

Figure 22. Chert tramway turntable. Photographed in 1946 by the late J. Myers.

Figure 23. Detail in Figure 22 revealed when the image is digitally enhanced twice to see the background.

How was the tramway powered and controlled?

According to Tyson the tramway was:

> *A double-acting incline using the weight of the descending bogies to haul the empties up on an endless rope, was built to carry the chert down the hill. A large embankment carried the first stage of the incline. At the top of the incline a large wooden drum with a long wooden brake lever slowed the descending bogies. The latter picked up quite a speed and runaways were not uncommon. Part way down, where the moor levels out, was a passing point. Here, the bogie was unhitched from the endless rope and hitched to a winch cable… …the winch then lowered the bogie to the bottom chert stand where it was unloaded and then brought back up to be hitched back onto the double-acting incline's cable.*

There are problems with this description:

- ❖ A double acting incline is not an endless rope system but in essence a single pulley system.
- ❖ Assuming Figure 17 is what was installed, this does not fit with the description of a large wooden drum, but it is consistent with a single pulley system with a braking mechanism that *could* be used on a double acting incline.
- ❖ The system describes the requirement of twin tracks where the up and down wagons pass each other.
- ❖ From where the wagons are unhitched and attached to a second cable to be lowered down to the roadside loading bay, the system would require an adequate gradient to power not only the laden wagon but also to overcome the friction and pull the dead weight of the cable.
- ❖ From the original site of the upper brake house the brake operator can see the engine shed but not the roadside loading bay. When the upper brake house was relocated adjacent to siding 2, the brake operator could only see about 20m of track before it disappeared over the crest of the incline. From the engine shed where a bogie was theoretically being transferred from one mechanism to the other, the operator again could not see the roadside loading bay. So how was it controlled?
- ❖ Was it a double-acting incline? If not how was it powered?

To try and make sense of the tramway system a GPS survey was conducted, the historic photographs examined and what can still be seen on the track-bed in 2013 reassessed.

What has the GPS, and photographic evidence established?

1. There is no evidence that chert was taken from Hungry Hush itself, but its eastern vicinity which perhaps is more correctly (according to Tyson's map) the upper part of Lily Jock's Hush. It would have been a difficult job transporting chert from Hungry Hush proper, and no doubt Wagstaff would have built Siding 1 further to the west if he had. Likewise there is no evidence that chert was present or any heavy material (chert or lead ore) was extracted from Stoddart's Hush. This too would have been extremely difficult and would require a route down Bird's Hush and a separate route down Mouldside to the west of the tramway, taking the same path as Stoddart

used to transport the lead ore from the top of the northern side of Stoddart's Hush. Figure 24.

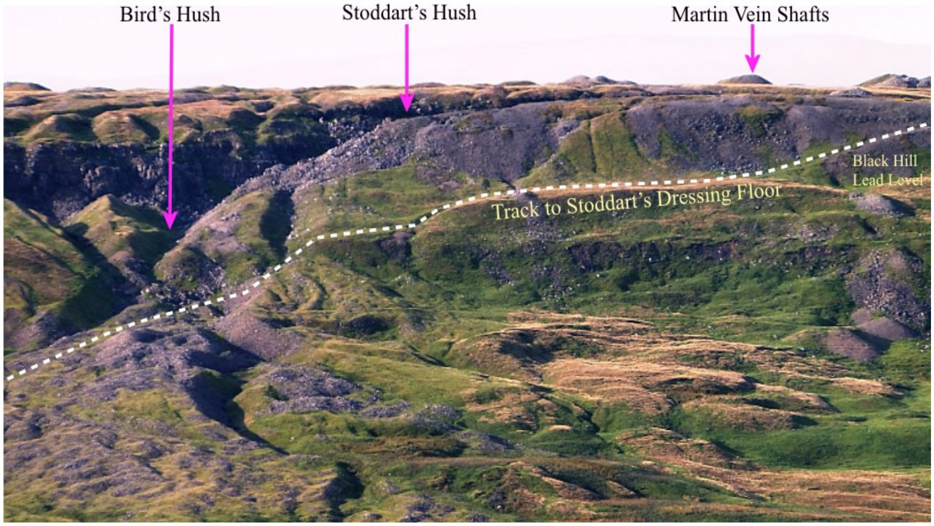

Figure 24. Track down from Stoddart's Dressing Floor. ©S. Eastmead 2013.

Figure 25. Chert Tramway Key. ©S. Eastmead 2013.

S1=Siding 1	**S2=Siding 2**	**CS=Chert Spoil**	**DF=Dressing Floor**
CR=Crane	**BH=Brake House**	**P=Piers**	**RB=Revetted Bank**
ES=Engine Shed	**A=Crest of slope**	**LB=Loading Bay**	**GR=Miner's Graffiti**
Red line= track to Siding 1			**©S. Eastmead 2013.**

Figure 26. Roadside loading bay pulley pit and hut foundation with track-bed leading off to the west. ©S. Eastmead 2013.

Figure 27. Roadside loading bay in autumn 2013. ©S. Eastmead 2013.

2. Adjacent to the small building that once stood beside the track at the lower roadside loading bay, is a square depression which appears to have been where the return pulley for the endless cable was positioned between the tracks (Figure 26).
3. The roadside loading bay (Figure 27) cannot be seen from any position on the track as it runs up Mouldside, or from the very top where the chert levels are located. This means that you probably had to have someone with a flag standing on top of the hill above the loading bay to signal when to stop the cable, or more likely, a device like the Smallman Haulage Clip (Figure 28) to disconnect the wagon from the cable whilst the cable was in motion.

Figure 28. Smallman Haulage Clip.
© North East Midland Photographic Record.

4. The engine shed (Figure 29) that powered some or all of the system is located 406m up from the roadside loading bay when following the track-bed. The total distance of the track-bed to the chert levels is 1030m and 970m to the existing brake house beside Siding 2.

5. Using the distances in paragraph 4. the four half-way marks can be calculated:
    a. From chert levels to the loading bay: 1030/2=515m — which places it 515-406=**109m** to the south of the engine shed.
    b. From the Siding 2 brake house to the Loading bay: 970/2=485m — which places it 485-406=**79m** to the south of the engine shed.
    c. From the chert levels to the engine shed: 1030-406/2=312m — which places it **312m** to the south of the engine shed.
    d. From the Siding 2 brake house to the engine shed: 970-406/2=282m — which places it **282m** to the south of the engine shed.

Figure 29. Engine Shed just before it was demolished in 1950/1. © Swaledale Museum.

6. Referring to the calculations in paragraph 5, and Figure 30:
    i. Icon B is the engine shed.
    ii. Icon C is where twin track would be required in a double-acting incline from Siding 2 to the roadside loading bay.
    iii. Icon D is where twin track would be required in a double-acting incline from the chert levels to the roadside loading bay.
    iv. Icon E is where twin track would be required in a double-acting incline from Siding 2 to the engine shed.
    v. Icon F is where twin track would be required in a double-acting incline from the chert levels to the engine shed.

Figure 30. Calculated halfway points along the track-bed, shown on Google Earth.

7. Looking at Figure 31 (J. Myer's 1946 image) and [Appendix 1: Figures 66–69] there is no evidence that the tramway has had twin lines to enable up and down wagons

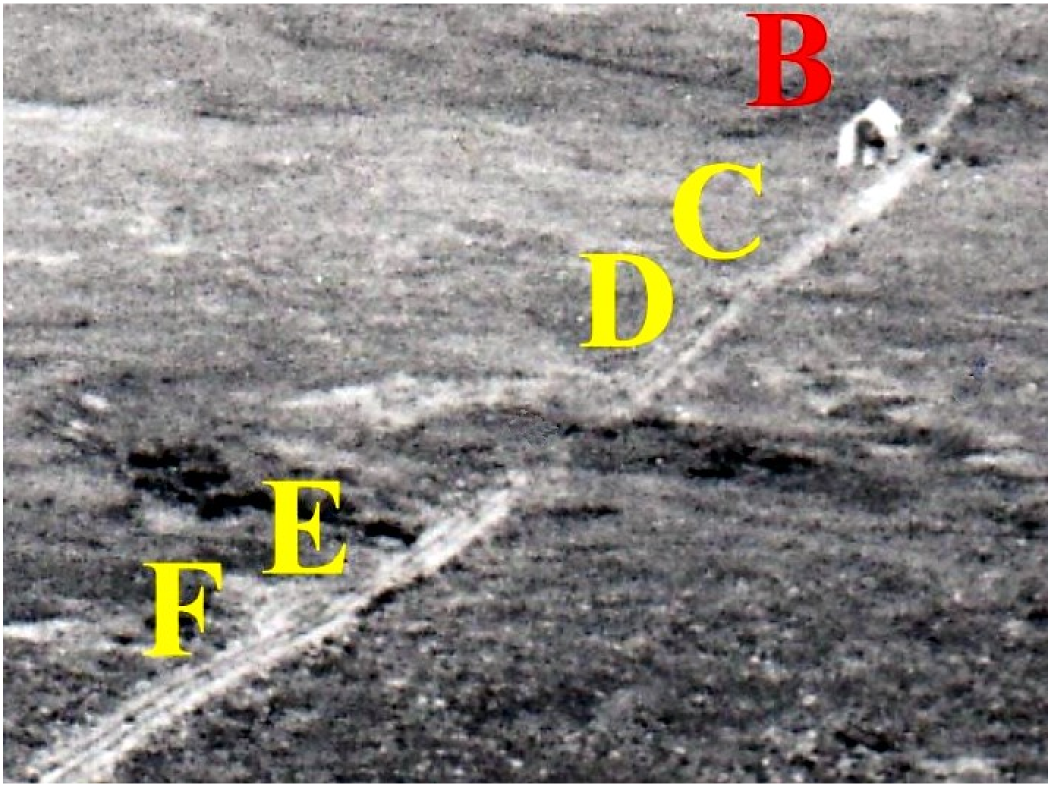

Figure 31. Halfway marks on the 1946 image showing an empty wagon reaching the top of the incline (Figure 14). There is no evidence that the line was twin track in the required areas. The pulleys guiding the cable can be seen between the tracks, and there is probably a second empty wagon waiting by the engine shed to be sent up to Siding 2.

to pass in a gravity powered double-acting incline. Only a short section near point F approaches being sufficiently wide, but the length of track-bed at that width is too short, and the 1946 Myer's photographs and remnants of sleepers present in 2013 indicate that it was not double-track.

The placement of the engine shed about 4/10ths along the track from the bottom appears to be a little odd, however it does fit in with Tyson's description that power was required at the lower section of the line. When you look at other mine or quarry tramways that are gravity powered, they all seem to be twin lines rather than having points and a short section of twin lines at the halfway point. In addition the point where up and down wagons would pass would not be consistent due to cable stretch and expansion, which would vary primarily due to ambient temperature, tram loading and cable age. So any section of dual track would have to be sufficiently long to cope with this. In addition when loaded wagons were dispatched from Siding 2 brake house, the person operating the braking system cannot see the tram after the first few metres so a second person would have to be on top of the crest advising him.

8. Figures 16 & 31 shows the absence of a fully laden tram on the original 1946 photograph that would be required if this was a gravity powered double acting incline as per Tyson's description, as it would be near points D or C on its way down

towards the engine shed. When you zoom into Figure 16 as shown in Figure 31, it gives the impression that someone is standing in front of the open doors of the engine shed watching the empty wagon cresting the rise.

9. Figure 32 shows the GPS survey height data from the roadside loading bay cable return pulley, up to the chert level in front of where the upper brake drum would have been sited. The gradient for a short stretch down from the top reaches a maximum of 1 in 2.7 and as the track progresses down Mouldside it reduces to about 1 in 9 around the engine shed and decreases to about 1 in 12 as it turns towards the road. From the Siding 2 brake house for the first 150m the gradient is around 1 in 4.

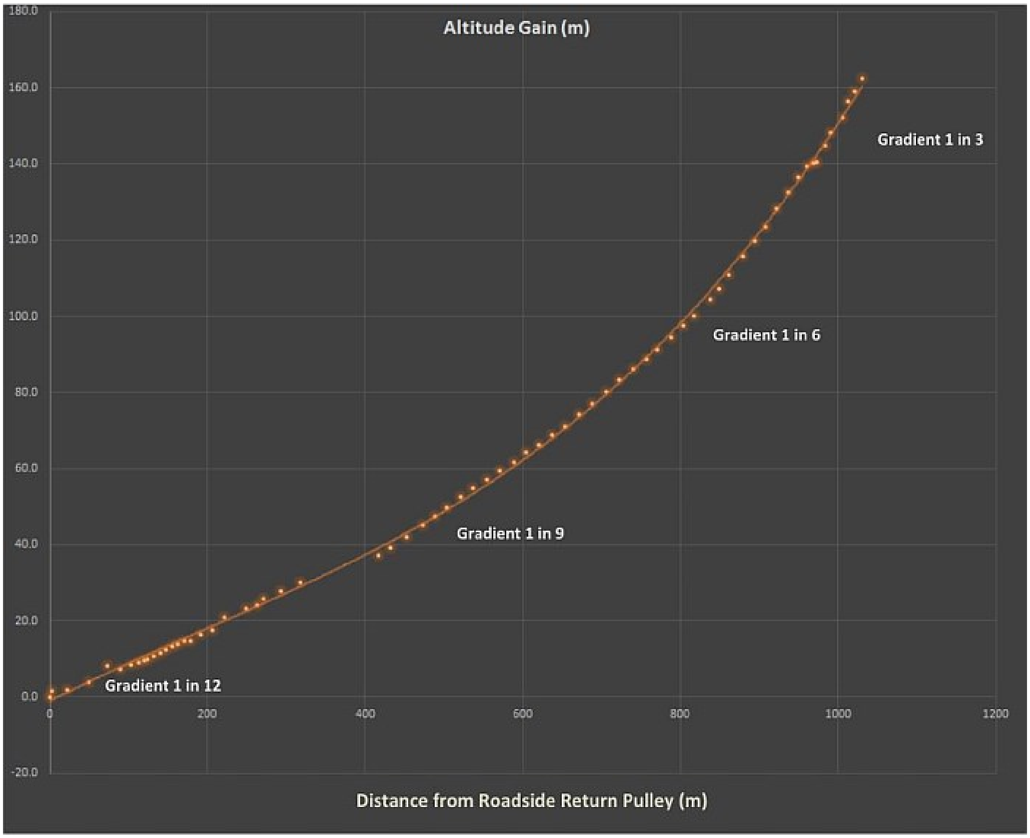

Figure 32. GPS Survey track-bed height (m) above the loading bay return pulley. ©S. Eastmead 2013.

10. Figure 31 shows the cable guiding rollers on the sleepers every 10m or so.

11. Figures 22 & 23 shows the cables by the turntable going around the upper pulley and braking mechanism.

12. Found in the Siding 2 brake house is a section of 7x6 regular lay[13] wire rope of approximately 11–12mm diameter. A modern version of this rope is suitable for loads up to around 10 tons. A splicing needle was found close by see Figures 33 and 34.

Figure 33. 7x6 regular lay wire rope. ©S. Eastmead 2013.

13. The engine shed foundation can still be made out, especially the western corners. So too can the engine's mounting position which is angled slightly within the building, which together with a small track leading northwards appears to indicate the path of the cables from the engine shed to the track (Figure 35).

Figure 34. Needle for splicing wire cables found at Siding 2 and now in the Swaledale Museum.

Figure 35. Engine shed (red dots) and its engine mounting blocks orientated to the north east (blue arrow) with the track-bed to the east of the shed (twin yellow lines). ©S. Eastmead 2013.

[13] 6 cores and the individual 7 wires per core twisted in opposite directions

So how did the tramway work?

The truth is we will probably never know for sure but the survey does show that it could not have worked as originally thought.

The evidence indicates that there were no passing places, which rules out the conventional double-acting incline, but it may not necessarily rule out being gravity powered to a degree. Certainly gravity would get a laden wagon down to the position of the engine house or thereabouts, but it is doubtful if the gradient is sufficient between the engine house and the roadside loading bay to do so. Empty wagons would also need to be powered to the top which indicates that the engine would need to power the whole length of the line. So how did they control the wagons when you cannot see either end of the track from any single position on the line? The available evidence appears to lead to the conclusion that the whole line was a continuous powered loop, with the orientation of the engine mounting suggesting the system shown in Figure 36.

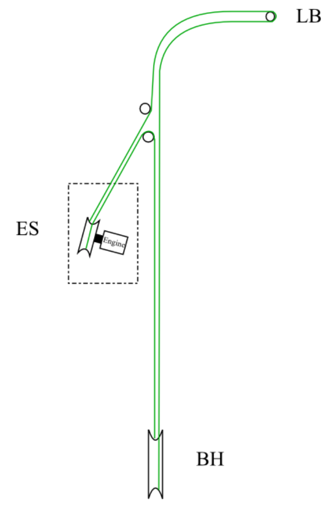

Figure 36.
Endless rope powered system.
LB=Loading Bay
ES=Engine Shed
BH=Brake House

If the line was powered like this then how could it have been operated? The small car engine used to power the system would have been geared appropriately and no doubt had some form of clutch mechanism again perhaps from a car. If so then power to the cable could be controlled. Once the cable was in motion then empty wagons at the loading bay (emptied perhaps the previous night) could have been coupled to the cable using a device like the Smallman Haulage Clip (Figure 28). The empty wagons one by one would then wend their way to the engine shed where they would be uncoupled from the cable and then pushed a metre or two up the track and reattached to the up cable. At the top of the incline the wagon would then be uncoupled again and pushed to Siding 2. A series of empties could be sent up the track in this manner, no doubt with the odd quarryman riding on them. Once the last empty was at the top, the system gearbox would then be put into neutral and the engine shut down.

At the end of the day with the system unpowered and gear box in neutral a full wagon could be attached at the top of the incline and then pushed over the crest to be gravity powered until there was insufficient energy to go any further. They could possibly have attached two or three wagons at intervals down Mouldside in this manner.

Perhaps on their way homeward they could then power up the system and send the laden wagons to the roadside where an operator would detach the wagon from the moving cable. The person operating the engine did not need to know where the wagon was, but just needed to give it sufficient time to get to the bottom.

There is one practical issue with this system — it needs a device to keep the cable taut. Cable tramways have used a variety of methods, both manual and automatic, to compensate for cable stretch and expansion. These are frequently sited near to the return pulley which would be near to the roadside loading bay. The earthworks there may indicate the position of

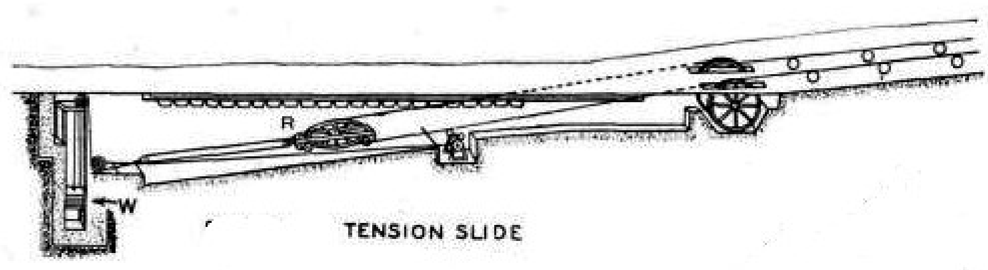

Figure 37. Cable Tension Mechanism

whatever mechanism they employed. Figure 37 is just one example but it could have been a simple system like you use to adjust the chain tension on a bicycle by manually sliding the pulley wheel to and fro. It could have been located at the engine shed too. There is evidence that the ground has been disturbed to the north of the shed, but without doing a formal archaeological excavation in that area you cannot tell.

Not mentioned so far is a loading bay shown in Figure 21 just to the east of the 3 chert levels. It is not known if any chert was taken down Mouldside by lorry or if it was just for supplies like coal and timber coming up. In this same area the flue from CB New Smelt Mill crosses the entrances to the chert levels on its way to Moulds Top, the flue which is of a drystone wall construction using good building stone, is totally robbed out. They may have used the stone inside the chert levels and of course when building the piers, revetted bank and the upper brake house, or perhaps even exported some from Mouldside to be recycled by local building projects.

After the quarrying ceased, the three chert levels either collapsed or more likely had their entrances demolished for safety. Around this area there are good sized spoil heaps that clearly predated chert quarrying. Could it be that even at this height one or more lead levels pre-existed there being driven towards the Chip or Justice veins?

Lidar

Lidar images covering about 80% of the tramway were examined but they did not add to our knowledge. Because of copyright restrictions no image has been included, but they can be seen at:
http://www.swaag.org/DB_VIEW_Specific%20Record%20Number2.php?swaagrec=217

Conclusion

This is a fascinating area to walk. It is totally a man-made landscape. It has no doubt seen lead extraction since at least medieval times and perhaps even going back to the Roman period or indeed prehistory. Great riches have been made here by a few, but most have toiled long, cold and wet hours here for a near poverty existence or at best an unreliable living.

No doubt the landscape was once a more agricultural one, but the geology and in particular the mineralisation of the faults led to a number of extractive industries. The evidence for each can be seen walking Mouldside and Moulds Top, the predominant being the mining of lead and perhaps a little silver that was also present.

There were millstones being quarried on Moulds top (Figures 40–42), then the chert described here first from Moulds Level and later just below Moulds Top.

When the demand for chert ended, the lead spoil heaps were reworked for baryte and fluorspar (Figure 39) for twenty or so years.

Figure 38. Jean and Bill Henderson beside Moulds Level in 1950. This is where the J. S. Wagstaff chert quarrying started on Mouldside. Jean is Jack Wagstaff's daughter. Moulds Level looks totally different now see Appendix 1: Figure 72). Photograph donated by Bill Henderson 2014. ©Swaledale Museum Archive.

Not so far away to the west at Punchard, coal was mined. All of this can be seen by parking by the cattle grid near the chert loading bay and walking 1 km up the tramway and perhaps a little further up to Moulds Top.

Please look at the images and captions in Appendix 1: Additional Figures. They will provide a clearer view of the landscape that has been described.

Figure 39. Remains of a baryte/fluorspar jig probably used by Ernest Shevels in the 1950s–1970s. ©S. Eastmead 2013.

Figure 40. Mouldside graffiti where millstone grit was quarried ©S. Eastmead 2013.

Figure 41. Mouldside millstone grit abandoned before it was cleaved into two. ©S. Eastmead 2013.

Figure 42. Mouldside millstone grit quarrying. There are several millstones still in-situ that have been left after a previously unseen flaw has suddenly developed. ©S. Eastmead 2013.

Graffiti

The **1841** census records available on dalesgenealogy.com show this miner's family living at High Green Reeth opposite the CB Inn.

ALCOCK John/40/lead miner/N
ALCOCK Hannah/40/N
ALCOCK Margaret/12/Y

In **1851**:
ALCOCK John/Head/M/50/proprietor of houses/Durham/Barnard Castle
ALCOCK Hannah/wife/M/51/dressmaker/Durham/Step End
ALCOCK Margaret/dau/U/22/dressmaker/Yks/Arkengarthdale

In **1861**: Grocer's Shop
ALCOCK John/Head/M/60/lead miner & grocer/Durham/Barnard Castle
ALCOCK Hannah/wife/M/61/Yks/Holwick
ALCOCK Barnabas/visitor/U/50/coal miner/Yks/Arkengarthdale

In **1871**:
ALCOCK Hannah/Head/W/71/lead miner's widow/Durham/Holwick
HARKER Hannah/g-dau/12/scholar/Yks/Arkengarthdale

In **1881**:
ALCOCK/Hannah/Head/W/81/Retired Grocer's wife/Middleton Durham

Figure 43. A young miner's graffiti when aged 28y carved on millstone grit in 1828. In 1828: The Duke of Wellington becomes Prime Minister, London Zoo opens, Police force of Sir Robert Peel starts in London and the trial of the body snatchers William Burke and William Hare begins. ©S. Eastmead 2013.

Appendix 1: Additional Figures (44–98)

Figure 44. Looking down on the top of Lily Jock's Hush. ©S. Eastmead 2013.

Figure 45. Adam Bird's Hush East looking west with all mining activity above and to the north of the hush. ©S. Eastmead 2013.


Figure 46. Earth Dam across Adam Bird's Hush. ©S. Eastmead 2013.


Figure 47. Adam Bird's Hush West looking east with all mining activity above to the north of the hush. ©S. Eastmead 2013.

Figure 48. Dam Rigg Hush with remnant of a dam and no mining activity within the hush. ©S. Eastmead 2013.

Figure 49. Stoddart's Hush Showing mining activity to the north (left). ©S. Eastmead 2013.

Figure 50. Stoddart's Hush (left) looking WSW with the line of shafts following the vein crossing Stoddart's and later Upper Dam Rig Hush before continuing towards the Martin vein shafts on the horizon. ©S. Eastmead 2013.

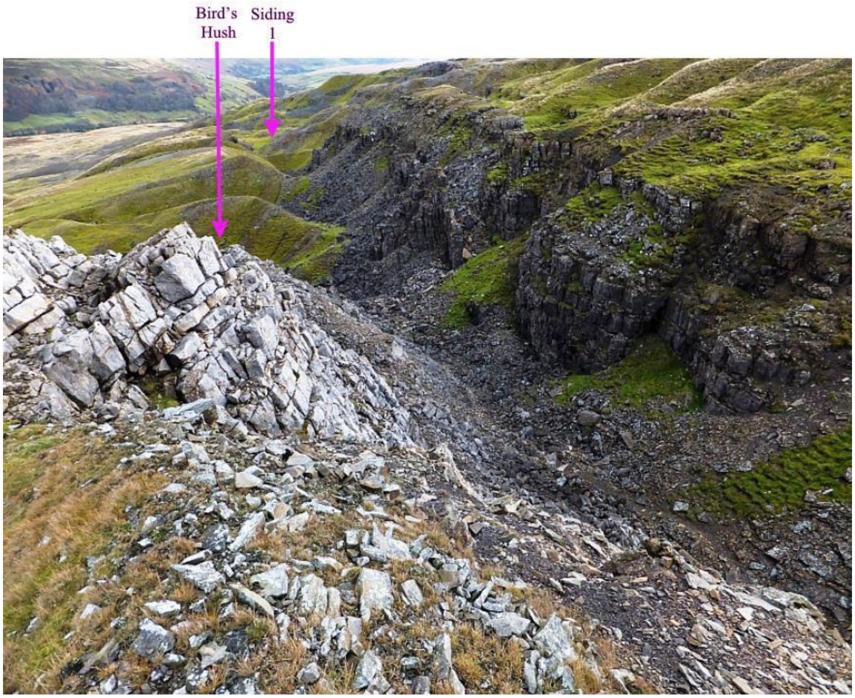

Figure 51. Stoddart's Hush East looking east indicating the direct path to Siding 1 and the necessity to use Bird's Hush if it was required to transport quarried stone out of Stoddart's Hush. ©S. Eastmead 2013.


Figure 52. Dam on Stoddart's Dressing Floor. ©S. Eastmead 2013.


Figure 53. Stoddart’s Dressing Floor on north side of the hush. ©S. Eastmead 2013.


Figure 54. Bird's Hush meeting Stoddart's Hush. ©S. Eastmead 2013.


Figure 55. Looking up Hungry Hush. ©S. Eastmead 2013.

Figure 56. Fine gravel bank at the bottom of Hungry Hush probably of glacial origin. ©S. Eastmead 2013.

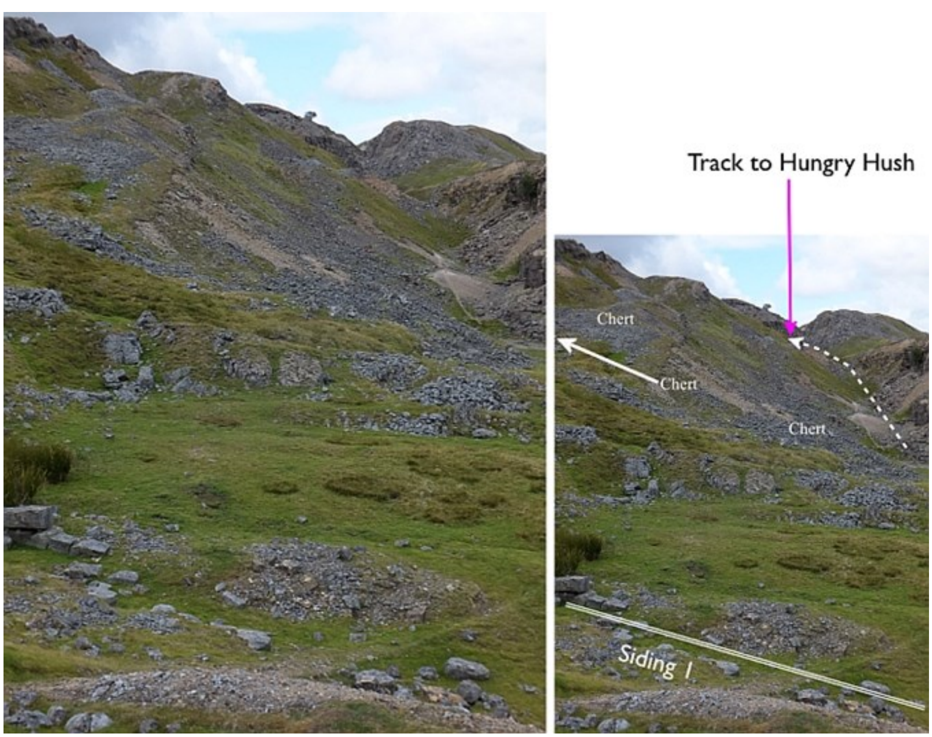

Figure 57. Siding 1 at the top of Lily Jock's Hush showing the position of Hungry Hush ©S. Eastmead 2013.

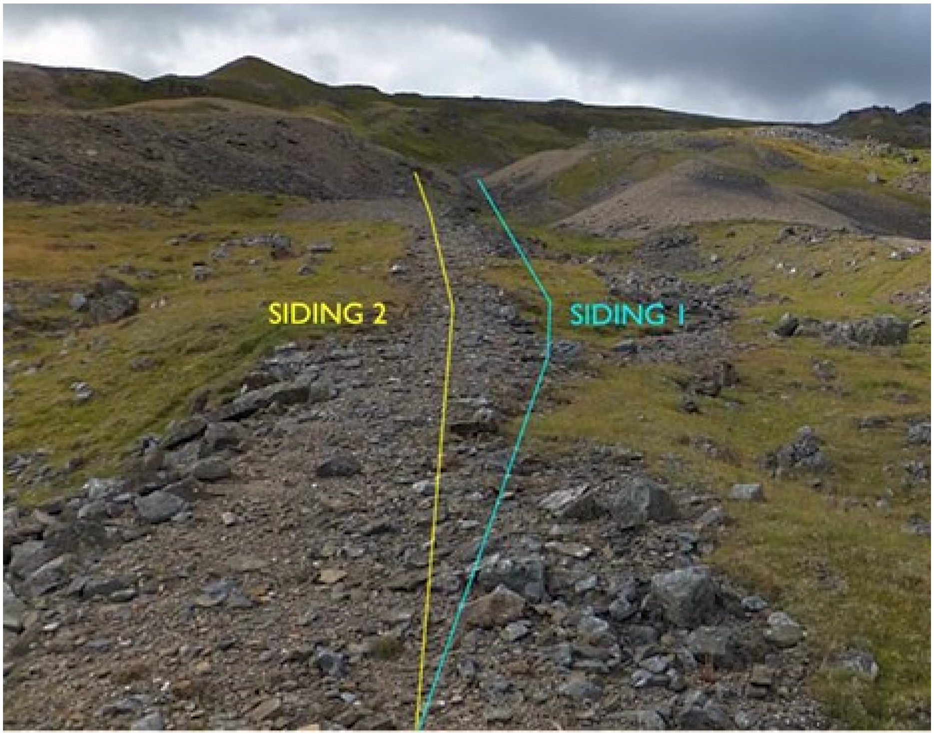

Figure 58. Route to Sidings 1 and 2 from north to south (part 1 of 4). ©S. Eastmead 2013.

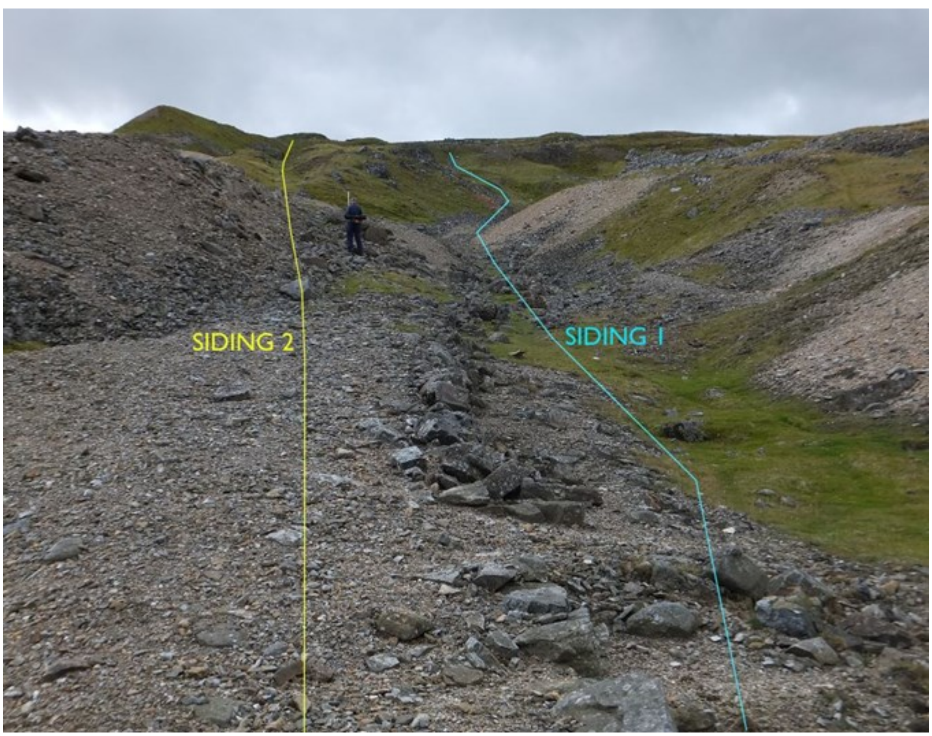

Figure 59. Route to Sidings 1 and 2 from north to south (part 2 of 4). ©S. Eastmead 2013.

Figure 60. Route to Sidings 1 and 2 from north to south (part 3 of 4). ©S. Eastmead 2013.

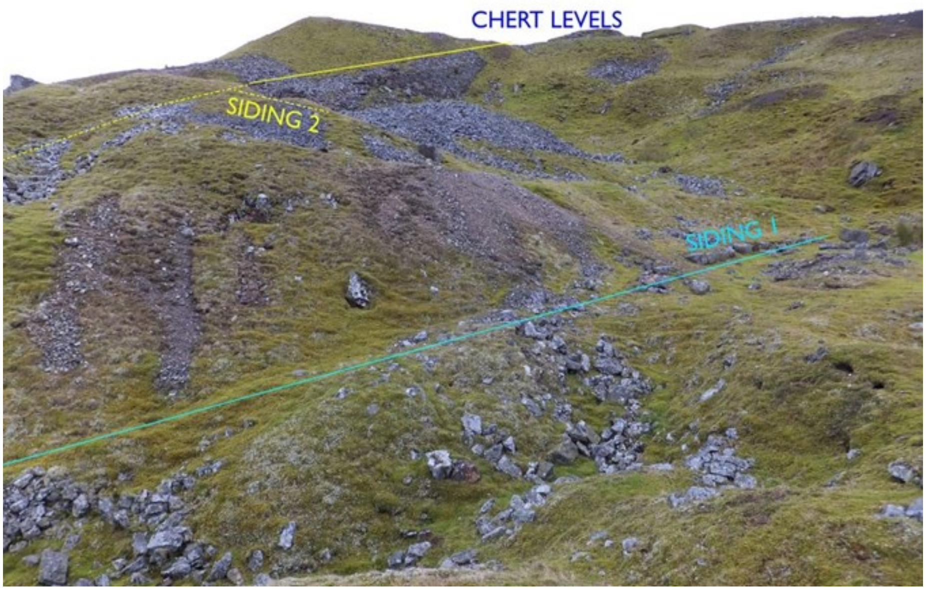

Figure 61. Route to Sidings 1 and 2 from north to south (part 4 of 4). ©S. Eastmead 2013.


Figure 62. Mike Walton and John Russell examining the Main Chert opencast area. ©S. Eastmead 2013.


Figure 63. Most westerly Black Bed chert outcrop at point A in Figure 12. ©S. Eastmead 2013.

Figure 64. Remnants of a wagon approximately 50m below Siding 1. It could be an earlier wagon found in a lead level that was superceded by the flatbed wagon. ©S. Eastmead 2013.

Figure 65. View down the track-bed route from Siding 1. ©S. Eastmead 2013.

Figure 66. Position C in Figure 28. ©S. Eastmead 2013.

Figure 67. Position D in Figure 28. ©S. Eastmead 2013.


Figure 68. Position E in Figure 28. ©S. Eastmead 2013.


Figure 69. Position F in Figure 28. ©S. Eastmead 2013.

Figure 70. Track-bed crossing the more northerly leat. See also Figure 81. ©S. Eastmead 2013.

Figure 71. Track-bed crossing the more southerly leat. See also Figure 81. ©S. Eastmead 2013.

Figure 72. Lower level Underset Chert outcrop of poor quality. ©S. Eastmead 2013.

Figure 73. Chert levels 1 and 2. ©S. Eastmead 2013.

Figure 74. Mike Walton surveying chert level 3. ©S. Eastmead 2013.

Figure 75. Revetted bank that once carried the track-bed up to the chert levels. ©S. Eastmead 2013.

Figure 76. Two rows of chert dressings with Siding 2 in the back right. ©S. Eastmead 2013.

Figure 77. Siding 2 Photographed in 1946 by the late J. Myers.

Figure 78. Siding 2 with the brake house to the left and the bases of 3 piers climbing up the slope. ©S. Eastmead 2013.

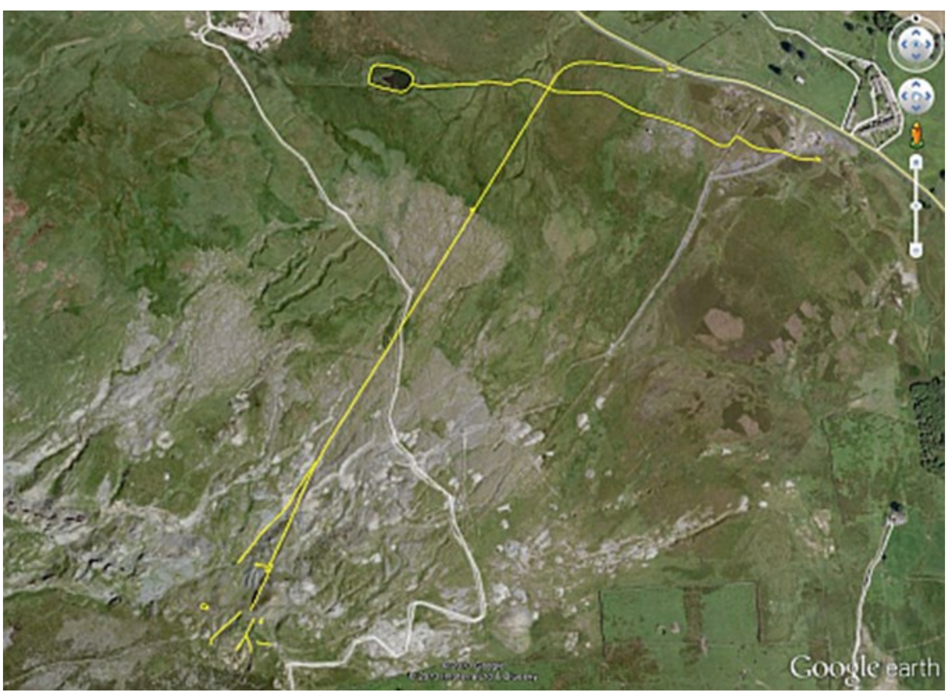

Figure 79. Google Earth image of the GPS survey data. At the top of the image the Black Mires Dam and the leat that had previously supplied water to the New Smelt Mill water wheel is also shown. ©S. Eastmead 2013.

Figure 80. A view down the tramway from behind where the chert level brake house (Figure 15) once stood. Black Mires Dam can just be seen to far left. ©S. Eastmead 2013.

Figure 81. Track-bed crossing the leats at the lower end of Mouldside and disappearing behind the hill. The leats are 18th or 19th century. ©S. Eastmead 2013.

Figure 82. Moulds Level 2013 compare with Figure 35. ©S. Eastmead 2010.

Figure 83. Inside Moulds Level.
A David Harper image courtesy of the ©Swaledale Museum.

Figure 84. Having a break by the roadside loading bay hut, (left to right): George Wilson, Sydney Hird, unknown, Willie Stubbs, Ramsey Hutchinson and Leo Hutchinson. ©Swaledale Museum Archive.

Figure 85. Working in one of the chert levels. Photographed in 1946 by the late J. Myers.

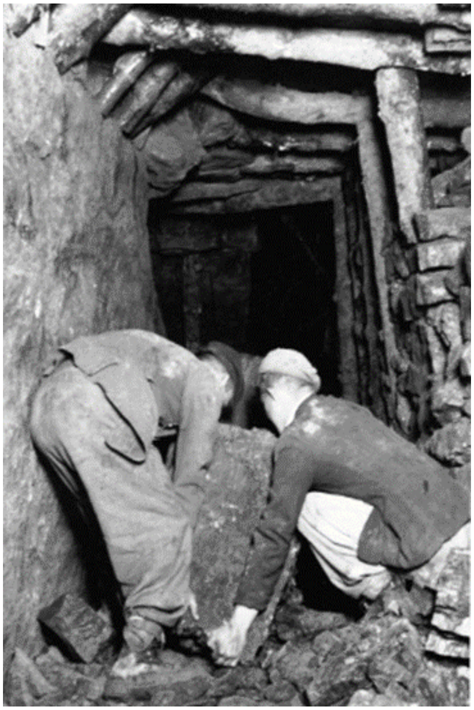

Figure 86. Working in one of the chert levels. Willie Stubbs and Ramsey Hutchinson. Photographed in 1946 by the late J. Myers.

Figure 87. Working in one of the chert levels. Photographed in 1946 by the late J. Myers.

Figure 88. Dressing a chert block at Siding 2. Photographed in 1946 by the late J. Myers.

Figure 89. Chert level pulley and braking mechanism. Photograph donated by the late Jean Hutchinson ©Swaledale Museum Archive.

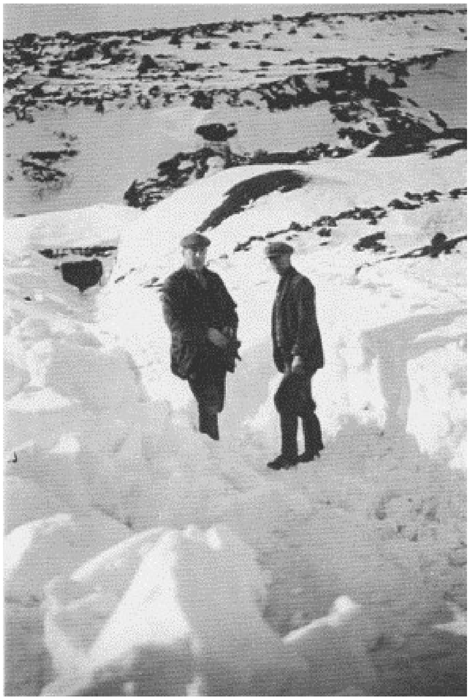

Figure 90. Digging out chert level 2. Photograph donated by the late Jean Hutchinson ©Swaledale Museum Archive.

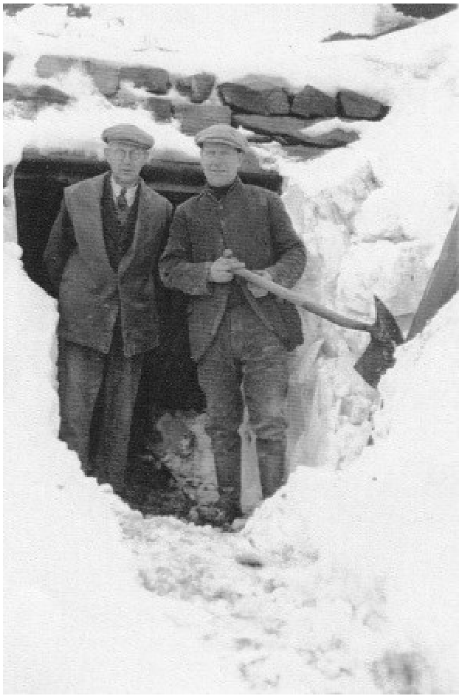

Figure 91. Digging out chert level 2. Photograph donated by the late Jean Hutchinson ©Swaledale Museum Archive.

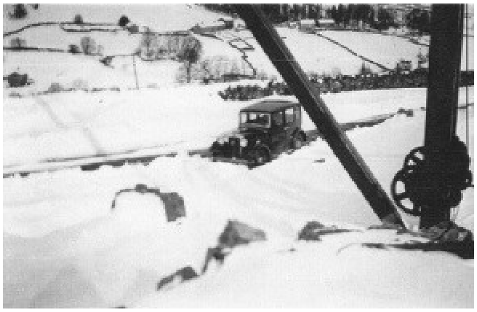

Figure 92. Roadside loading bay and crane with hut which was located by the return pulley. Photograph donated by the late Jean Hutchinson ©Swaledale Museum Archive.

Figure 93. Roadside loading bay and crane with hut which was located by the return pulley. Photograph donated by the late Jean Hutchinson ©Swaledale Museum Archive.

Figure 94. Loading chert to be transported to Richmond Station.
©Swaledale Museum Archive.

Figure 95. The end of an era — salvaging the track in the early 1950s.
Leo Hutchinson and George Wilson. ©Swaledale Museum Archive.


Figure 96. The end of an era — salvaging the track. ©Swaledale Museum Archive.


Figure 97. The end of an era — salvaging the track. ©Swaledale Museum Archive.

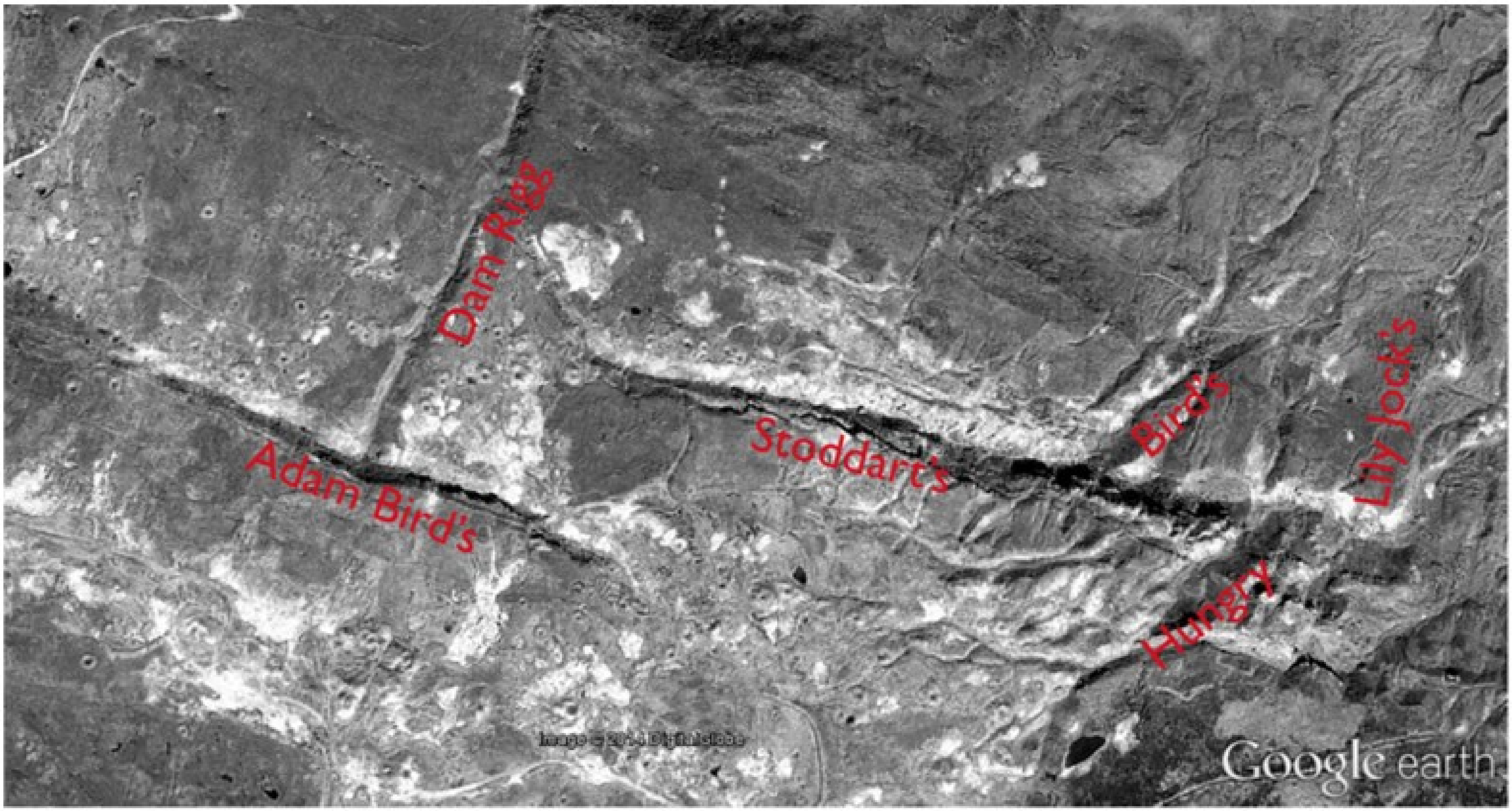

Figure 98. The six hushes in Google Earth January 2014.

Appendix 2: Tramway GPS Data

Easting	Northing	Altitude (m)	Horz[14] Conf (m)	Altitude[15] Conf (m)
399402.029	503540.569	323.181	0.15	0.13
399400.157	503540.562	324.914	0.17	0.15
399379.996	503542.798	325.068	0.15	0.13
399352.338	503545.350	327.080	0.15	0.13
399329.937	503547.101	331.330	0.24	0.26
399313.527	503549.470	330.684	0.07	0.07
399298.808	503550.556	331.773	0.07	0.06
399289.638	503551.341	332.373	0.07	0.06
399283.367	503551.396	332.834	0.07	0.06
399278.329	503551.106	333.239	0.07	0.06
399270.471	503549.560	333.954	0.07	0.06
399262.153	503546.847	334.924	0.07	0.06
399255.929	503544.133	335.697	0.07	0.06
399249.683	503539.824	336.465 0.07	0.06	
399244.146	503535.100	337.114	0.07	0.06
399239.083	503529.031	337.858	0.07	0.06
399234.308	503521.445	338.086	0.15	0.14
399228.189	503511.626	339.705	0.15	0.14
399220.380	503498.755	340.671	0.15	0.14
399211.591	503485.052	344.177	0.16	0.13
399197.704	503462.291	346.486	0.16	0.14
399190.870	503450.148	347.416	0.16	0.13
399185.968	503443.305	349.177	0.20	0.17
399174.892	503424.467	351.017	0.21	0.19
399162.280	503403.077	353.399	0.20	0.17
399111.193	503318.302	360.441	0.17	0.13
399102.901	503304.671	362.462	0.17	0.13
399092.304	503286.884	365.272	0.17	0.13
399081.621	503269.865	368.492	0.17	0.13
399073.697	503256.237	370.657	0.17	0.13
399066.315	503243.859	372.810	0.17	0.12
399057.009	503228.488	375.917	0.17	0.13
399049.075	503215.571	378.191	0.17	0.12
399039.881	503200.686	380.359	0.17	0.12
399030.798	503185.666	382.510	0.17	0.12
399022.017	503171.140	385.028	0.17	0.12
399013.390	503157.299	387.592	0.17	0.12

14 95% Horizontal Confidence in metres

15 95% Vertical Confidence in metres

Easting	Northing	Altitude (m)	Horz Conf (m)	Altitude Conf (m)
399005.673	503144.129	389.507	0.17	0.12
398996.714	503129.283	391.884	0.17	0.12
398988.482	503115.634	394.319	0.17	0.12
398979.161	503100.514	397.518	0.17	0.12
398970.231	503085.729	400.215	0.17	0.12
398960.894	503070.959	403.403	0.17	0.12
398951.924	503056.246	406.445	0.17	0.12
398942.775	503040.863	409.290	0.17	0.12
398934.405	503027.087	412.001	0.18	0.12
398927.069	503015.511	414.466	0.18	0.12
398918.090	503000.665	417.650	0.18	0.12
398910.354	502987.243	420.630	0.18	0.12
398904.044	502974.856	423.370	0.18	0.12
398894.298	502956.671	427.634	0.18	0.12
398889.895	502946.907	430.529	0.18	0.12
398884.846	502934.729	434.193	0.18	0.11
398878.411	502918.905	438.825	0.18	0.11
398873.106	502904.591	442.888	0.18	0.12
398867.701	502892.107	446.733	0.18	0.12
398862.377	502878.042	451.376	0.18	0.12
398856.679	502864.888	455.803	0.18	0.12
398851.562	502853.121	459.769	0.18	0.11
398847.612	502843.382	462.545	0.18	0.12
398843.576	502836.241	463.571	0.18	0.13
398842.254	502831.978	463.641	0.18	0.13
398840.978	502821.415	467.995	0.09	0.06
398838.185	502814.635	471.316	0.09	0.07
398831.975	502801.680	475.489	1.10	1.05
398828.834	502794.235	479.679	0.74	0.48
398826.295	502787.969	482.163	0.69	0.45
398821.521	502779.055	485.564	0.65	0.43

Appendix 3: Lead Mining

Whilst walking Mouldside there are three lead mine adits that do not feature to any degree in the literature. Below is a photographic record of them.

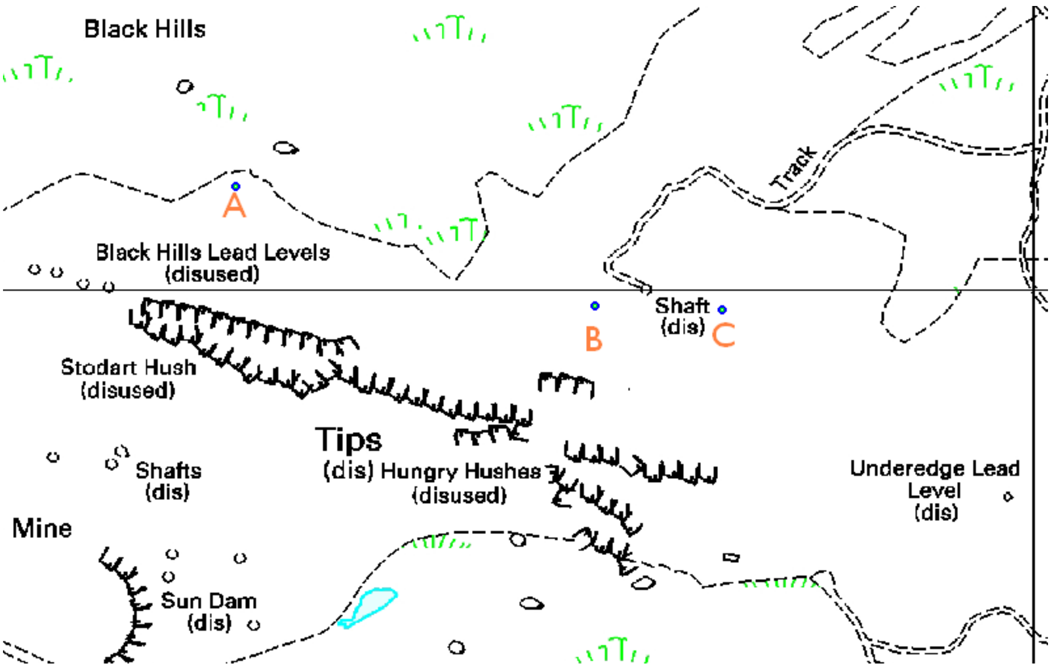

Figure 99. There lead adits below and to the north of Stoddart's Hush: A, B & C.
©Crown copyright and database rights 2011 Ordnance Survey 1000237401,
kindly supplied by the North Yorkshire Dales National Park Authority.

Adit A is the Black Hill Level mentioned in the text, however I cannot find any reference to adits B & C so they are nameless.. The co-ordinates are A: NY984308, B: NY986298 and C: NY988298. The entrance to Site B level does appear to be narrow so may have been a drainage adit.

Figure 100. A forged handle for a bucket/tub found on the Stoddart dressing floor. This has been lodged with the Swaledale Museum. Joseph Stoddart produced lead here worth £2500 over a ten year period from 1787. ©S. Eastmead 2013.

Figure 101. Site A in figure 98. Black Hill Level looking south ©S. Eastmead 2013.

Figure 102. Site A in figure 99. Black Hill Level looking north. ©S. Eastmead 2013.


Figure 103. Site B in figure 99. Looking north. ©S. Eastmead 2013.


Figure 104. Site B in figure 99. Looking north from end of tip. ©S. Eastmead 2013

Figure 105. Site C in figure 99. Looking south from the level to the tip with a dam to the west. ©S. Eastmead 2013.

Figure 106. Site C in figure 99. Looking west at the dam and a shaft beyond. ©S. Eastmead 2013.

Appendix 4: Jesse Shirley's Etruscan Bone & Flint Mill, Etruria, Stoke-on-Trent – a working museum.

During the first part of the 18th century the beneficial use of ground flint and bone was discovered. Flint (i.e. silica, up to 50% of the total) can be added to clay to produce earthenware products, it gives the ware strength, whiteness and prevents shrinkage during firing to make a hard cream product. The wet pan grinding method using chert blocks was developed to reduce harmful dust; this is illustrated at Jesse Shirley's Bone and Flint Mill (www.friendsofetruriamuseum.org.uk). Figures 107–111 ©Mike Walton.

Figure 107. Jesse Shirley's Etruscan Bone & Flint Mill, Etruria, Stoke-on-Trent. Wikipedia

Figure 108. Pan with partly laid chert paver blocks.

Figure 109. Pan with a chert runner in place.

Figure 110. Pan in operation.

Figure 111. Pan in operation.

Acknowledgements

I am grateful to Helen Bainbridge of the Swaledale Museum for access to the museum's Digital Archive and her advice, and to my colleagues in the Swaledale and Arkengarthdale Archaeology Group particularly Tim Laurie, Mike Walton, John Russell and Peter Denison-Edson.

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