CALCITE MINING IN THE PEAK DISTRICT

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Abstract: Calcite mining began in the Peak District in mid-Victorian times. Calc-spar was obtained by both open-pit and underground mining, mostly from the western parts of major rake veins. The principal uses were for stucco and terrazzo. A survey of incomplete production statistics suggests that over a million tons have been extracted from Derbyshire. An annotated list of known calc-spar mining sites is included.

INTRODUCTION

Calcite, calcium carbonate, ($CaCO_3$), is one of the most common minerals in the Earth's crust. It crystallizes in the hexagonal system with the most common form being the six-sided pyramid or scalenohedron, with strong rhombic cleavage. It is the principal constituent of all limestones, often as much as 99%, and is largely the fossilized remains of marine organisms such as corals, crinoids, brachiopods, molluscs and other shellfish. Limestones include both whole fossils and fragments held together by calcite cement between the grains.

Crystalline calcite is a significant component of most mineral veins of Mississippi Valley type, including the majority of the lead ore and fluorspar veins hosted in the Carboniferous Limestone of the Peak District. It is likely that at least some of the calcite was dissolved from the limestone and re-deposited in the veins. In some of these, calcite is only a minor component and is removed during processing and discarded as waste, but in other veins calcite is present almost to the exclusion of the other gangue minerals, and some of these calcite-dominant veins have had mines exploiting calcite in its own right (see Fig. 1).

Though there are many accounts of lead and fluorspar mining in the Peak District (e.g. Ford and Rieuwerts, 2000; Dunham, 1952), and outlines of zinc, copper and baryte mining, no review of calcite mining has been traced and the present contribution attempts to fill that gap. Calcite mining received only a few passing comments in the Geological Survey Memoirs (Stevenson and Gaunt, 1971; Frost and Smart, 1979; Aitkenhead *et al.* 1985).

Calcite is generally referred to as calc-spar or calspar in the Peak District though a few reports simply say spar, leading to potential confusion with fluorspar (Rieuwerts, 1998). Calc-spar is occasionally referred to as "Derbyshire Spar", a term sometimes used for Blue John in the late 18th century and also mistakenly applied to the alabaster from Chellaston and Tutbury used for small ornaments and sold in Peak District tourist shops during the early and mid 20th century.

USES OF CALCITE

Calcite in mineral veins occurs in two common forms - clear scalenohedral crystals (dog-tooth spar) and massive opaque white calc-spar. If clear enough, the former once had some value as Iceland Spar where its property of double-refraction was utilized as Nicol prisms in Victorian optical instruments such as petrological microscopes. Large clear dogtooth calcite crystals have long been known in some of the mines in Masson Hill, Matlock, and in the Lathkill Dale area but no record of specific working for Iceland Spar has been found. The invention of synthetic polaroid meant that this optical spar fell out of favour. Indeed it seems unlikely that Derbyshire calcite was ever used for optical instruments owing to the presence of pyritic inclusions in many of the large dog-tooth crystals. Clear cleavage rhombs of calcite were once sold to tourists as souvenirs of visits to caves such as the now-defunct Cumberland Cavern.

Several other varieties of crystalline calcite include rare rhombohedral crystals and combinations of rhombohedra and scalenohedra (yielding blunt dog-tooth crystals); these and nail-head spar (combinations of flat rhombohedra and hexagonal prisms) are scattered through the Peak District mineral veins (Ford *et al.*1993). Choice specimens were often put on one side for lucrative sale to mineral collectors but none has been mined commercially.

It is the opaque white calcite present in massive radiate layers in mineral veins and generally known as calc-spar, which has commercial value. The opacity is due to abundant ultra-microscopic fluid inclusions, usually too small for temperature determinations, though inclusions in less cloudy calcite indicate temperatures of crystallization below 80°C. Vein textures usually show calcite crystals growing inwards from opposing walls, sometimes with small amounts of other minerals interlayered; renewed fault movements along rakes sometimes led to patches of calcite breccia. Galena usually occurs on the walls, but patches may be present anywhere in the veins.

Calc-spar appears to have been produced in small quantities from the mid-19th century onwards. The earliest production record found so far in Derbyshire was at Long Rake in 1867. It was used for garden pathways but it is quite likely that calc-spar was recovered from lead mining waste for this purpose long before 1867. Indeed John Ruskin (the writer, social reformer and mineral collector, then only 10 years old) referred to white spar speckled with galena being used on paths in the grounds of the New Bath Hotel at Matlock in 1829. None of the late 18th or early 19th century county surveys mention calc-spar production.

The uses of white calc-spar depend on the size of the grains produced by mining and crushing and on their consistent whiteness. Initially coarse calc-spar with pieces around half an

Rear Cover: see for colour plates taken (by Paul Deakin) in Long Rake Mine:
Top left: Steel arches and bottom of decline.
Top right: View along main haulage level with loading chute with vein in roof.
Bottom left): Safety gates into the shaft.
Bottom right: Vein breaking-up at the west end of Long Rake.

inch across were in demand for garden pathways of country houses and, in more recent times, for horse arenas (Fig 2). Soon after the introduction of asphalt (tarmac), smaller calc-spar chippings were scattered over the black surface and rolled in to provide a speckled appearance. In addition, with the growth of large Victorian cemeteries, there was a demand for half to one inch chippings for ornamentation of graves, a use which persists to this day. Stucco, pebble-dash on the outside walls of houses, came into fashion in Victorian times and after World War I the demand for calc-spar expanded with the building boom of the 1920s and 1930s. This form of ornamentation of the exterior walls of houses comprised pebble-dash with chippings usually less than a quarter inch thrown on to a cement rendering whilst it was still wet. An alternative method was "wet-dash" where the chippings were mixed in with the cement and then dashed on to walls. Whilst other types of stone could be used, calcite was popular owing to its uniform white colour and the aesthetic appeal of the sparkling surface produced by reflections from cleavage planes. Though still used, stucco is less common on house walls today and its former use on public buildings has largely been replaced by polished stone cladding.

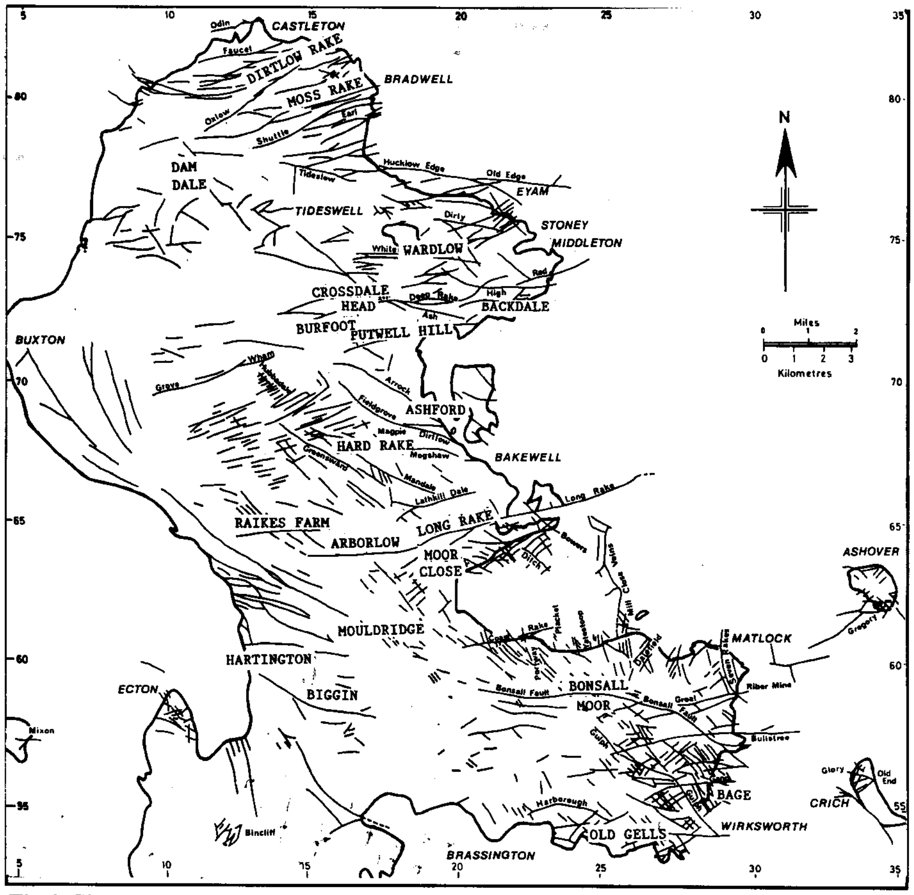


Fig.1. Sketch-map of the mineral veins of the Peak District (after Quirk) with calcite mining localities indicated.

Mosaic floors were made in Greek and Roman times with designs ranging from geometrical to figures of gods, men and animals. Most mosaics had backgrounds made of small square blocks of white marble with designs inserted by using other coloured marbles. Calcite was occasionally used for its lustre but its property of cleaving into rhombic fragments made it less attractive than cubes of marble. Labour costs meant that mosaics were largely confined to important public buildings and homes of the wealthy in both ancient and modern times.

A more economic equivalent to mosaic was terrazzo and so another demand for calcite came with its vastly increased use for flooring and panelling from late Victorian times onwards. Once described as artificial stone (Terry, 1909), terrazzo is a form of concrete made from small pieces of calcite set in a calcite-based cement matrix, with the final surface ground and polished to simulate marble. Terrazzo can be laid in situ with an appropriate mixture of calcite and cement poured where it is required. After it has set, electric grinders and polishers provide the final surface. Alternatively terrazzo can be cast in panels in a factory and mounted where required. The most common use is for flooring, staircases and the dividing partitions in toilet blocks, mostly in public buildings such as schools and hospitals. Such terrazzo surfaces have the advantages of being durable, cheaper than marble or granite, and easy to clean. Whether terrazzo is cast *in situ* or installed as panels, a critical aspect of the mixture is that it should not contain ordinary sand: quartz is much harder than calcite and single grains pulling out of the surface can cause unsightly scratches. Terrazzo is not as hard as polished granite flooring and there is a tendency to wear unevenly underfoot after years of use.

Most of the Derbyshire mineral veins have small proportions of baryte and occasional pieces of limestone scattered through the calcite and a small proportion of these adds a bit of colour to terrazzo. Larger pieces of calcite are occasionally used, again in a calcite-based cement, for artifical marble in fireplaces.

A by-product from screening calcite for terrazzo is fine calcite sand. With grains around a millimetre across it can be set in a special cement for use in the white line material on roads. The cleavage surfaces provide a reflective sparkle in headlight beams. Mica flakes or crushed bottle glass are sometimes used for the same purpose. A small proportion of calcite sand is used for non-stick dressings on roofing felt instead of the rather more expensive mica flakes. Another use for small quantities of calcite sand has been for chicken grit.

MINING AND PREPARATION

Both opencast and underground mining have been employed in

Fig.2. Modern use of crushed calcite.

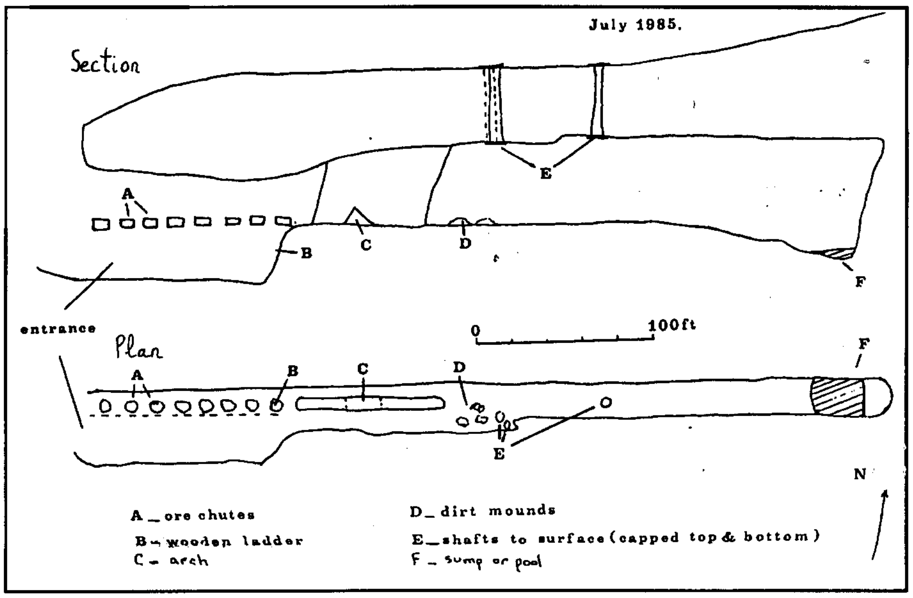


Fig. 3. Section and plan of the calcite mine in Horseshoe Dale, Chelmorton at SK 097 700 Drawing by K. Bentham from a sketch by D. Stables, July 1985. (After Bentham and Stables, 1985).

the Peak District. Open-pitting any vein where calcite is sufficiently abundant to be excavated by some form of mechanical shovel is obviously the most economical means of production, but it is liable to add some contamination from other minerals, wall-rock and near-surface soil or clay. Underground mining is more expensive and the only such mines are where almost the whole vein is composed of calcite and where the water-table is low enough for there to be no pumping costs. Underground mining requires drilling and blasting and mine lay-outs are developed in the same way as other vein mines with levels at successive depths. Peak District calcite mines either benched downwards with spar shovelled into tubs, or stoped either overhand or underhand. A Cornish mine manager on Long Rake introduced wooden chutes to reduce the need for shovelling. Floors about a metre thick were left between levels. Haulage to and up the shafts added to costs and reduced profits so where possible only the better quality material was extracted by underground mining.

Having raised the calcite to the surface, washing, crushing and screening are the only operations normally required. Hand-picking before crushing suffices to reduce the proportion of limestone, baryte and galena to acceptable amounts. Crushing between jaw crushers or rollers is the normal practice, followed by coarse screening to produce half to one inch lumps for graves etc. Further crushing and medium to fine screening yields smaller pieces, particularly 3/8 inch, 1/4 inch and 3/16 inch, cleaned by passing over trommels. These sizes are usually sold under metric equivalents today. Details of the crushing and screening process, together with a flow sheet, were given by Houston (1964). Screening is usually done wet and yields fine fractions of calcite sand and mud. The fines are put over a Holman Wilfley shaking table to separate lead ore, which usually amounts to a few tons per annum. As lead ore can be sold for £100 per ton in contrast to £20 or so for calc-spar, it can make a difference to the operation's profitability. Calcite sand and mud grades are further separated by washing. Some calcite sand is used in the cementitious component of terrazzo and slightly finer sand is set aside for white line material. The mud-sized particles are waste and are disposed of as slime. Water for processing is rainwater collected from roofs, taken from the mains or raised from the lowest levels of the mines. Since no additives are used, some water can be recycled from the settling ponds after waste slimes have settled out.

PRODUCTION

Records are very incomplete but they suggest that regular production started in the mid 19th century and the few statistics of yields are mostly limited to 19th century Inspector of Mines Reports (where calc-spar was not recorded until 1877 and which ceased in 1881) and the Annual Reports of the Secretary of Mines covering the years 1921 to 1940. In 1877 a total of 2353 tons was produced from nine Derbyshire mines. In 1878 ten mines yielded 3167 tons from Derbyshire. In 1879 1942 tons were raised from Derbyshire and 6 tons from Glamorgan. In 1880 the total was 2687 tons from Derbyshire, with 491 tons from Shropshire. Production continued in Shropshire until the 1950s with most coming from the vast waste heaps of Snailbeach and Roman Gravels Mines, after screening to remove as much quartz as possible. Use was mostly for stucco as the quartz spoilt terrazzo. Some Shropshire calcite was sent to Long Rake Mine for final treatment. The 20th century reports list national tonnage produced as

1922	6453	1923	9083	1924	9306
1925	14399	1926	12807	1927	14806
1928	17516	1929	16303	1930	15817
1931	15975	1932	17411	1933	15546
1934	18472	1935	22280	1936	26156
1937	27681	1938	28664	1939	26818

Most of this production came from Derbyshire until the early 1930s when the North Wales mines opened. An unconfirmed record said that in 1922 some 12000 tons were marketed from Derbyshire, twice the official national figure! In their summary of *Mineral Statistics* from 1845 to 1913, Burt *et al* (1981) did not include calc-spar production.

Individual Derbyshire mine records for 1877 were:

Backdale	400 tons	Bage	10 tons,
Brights Friendly	180 tons,	Horecliff (=Norcliff?) Rough	58 tons,
Long Rake	860 tons ,	Moorclose	57 tons,
Putty Hill	650 tons,	Rake Hard	
Wakebridge	40 tons.	(=Hard Rake?)	98 tons,

For 1878 the figures were

Backdale	400 tons,	Moorclose	100 tons,
Long Rake	587 tons,	Eyam	15 tons,
Putty Hill	826 tons,	Hard Rake	1030 tons,
Ball Eye	12 tons,	Norcliffe	15 tons,
Brights	40 tons,	Bage	41 tons.

The annual *Mineral Statistics* volumes compiled by the British Geological Survey from 1973 to 1998, but with back-dated records to 1963, give the whole UK production as varying between 13000 and 34000 tons, generally averaging 20000 tons. Figures are in tonnes from 1987. From the mid 1930s up to the early 1980s around half the British production came from Derbyshire and the other half from the only known competitors at Snailbeach, Shropshire, and from Lloyds Mine at Hendre and the Cilcain Mine on Halkyn Mountain in North Wales.The Hendre and Cilcain Mines worked veins up to 6 m wide before closure around 1984 (Appleton, 1989; Ebbs, 2000). Imports from Greece and Spain are said to have made the Halkyn Mines uneconomic and presumably affected the Derbyshire mines though production continues today and the last available U.K. figures were 13000 tons in 1997 and 15000 tons in 1998.

If one assumes an average output of around 10000 tons per annum from the Peak District in the 20th century with at least 30 years production at a lesser rate in the 19th century, it would amount to over a million tons in total. Estimates based on the volume of workings in the two principal mines on Long Rake and from the other mines listed below indicate that this figure is reasonable. Some calc-spar production was as a by-product of lead, baryte and fluorspar treatment plants, which were fed by tributers, so that exact localities for calc-spar extraction cannot always be identified.

Average prices are difficult to obtain and vary according to quality. In the late 1930s calc-spar sold for around 18 shillings (90p) per ton. In the early 1980s the top price was generally around £20, though one record of £27 per ton has been seen.

DISTRIBUTION

As part of the gangue mineral zoning in Derbyshire's veins, calcite generally occurs in the western parts of the ore-field, fluorspar being dominant in the eastern parts of most veins and baryte in the middle zone. These zones reflect the temperature of crystallization, the warmest fluorspar zone in the east (90-140° C), a baryte zone in the middle (70-90° C) and the coolest calcite zone (generally less than 80° C) in the west. A subdivision of the calcite zone was proposed by Mueller (1954) who thought that opaque calcite was coolest, clear was slightly warmer, and clear with pyritic inclusions was warmest but no fluid inclusion data were offered in support. The zonal arrangement is an over-generalization as temperatures and fluids could change during the filling of a single vein; calcite was often the last mineral to crystallize and occurs lining vugs in fluorspar veins. Veins with fluorspar occur sporadically in the calcite zone and *vice versa.* The calcite zone forms a north-south strip several kilometres wide from Castleton to Wirksworth, wherein it is the rakes which have yielded most calcite. Scrins are too small to be economic, and flats and pipes both too irregular and rather small for sustained long-term production. Several rakes particularly rich in calcite were named White Rake in different parts of the ore-field. Examples were near Eldon Hole above Peak Forest, near Wardlow, in the Alport-by-Youlgreave, near Bleaklow on Bonsall Moor, and on Carsington Pasture. The Bonsal Moor and Wardlow examples have been worked for calcite. No real evidence has been found for the alternative, that they were named from their abundant cerussite (lead carbonate=white lead ore), though Wheatstone veins were so named according to Rieuwerts (1998).

MINES

Castleton: the middle section of Dirtlow Rake is currently being open-pitted for calc-spar eastwards from the large fluorspar open-pit formerly worked by Laporte Industries Ltd. (SK 143 814). The open-cut extends eastwards towards an older open-pit previously worked by J. Eidson for fluorspar and baryte. The Rake is in a fault showing both lateral movement (with horizontal slickensides) and a downthrow south. It is mostly about 3 m wide with a small proportion of galena. A little further east on Dirtlow Rake some calc-spar was produced at Howe Grove in the 1870s.

Dirtlow Rake has a high proportion of calcite where it descends into Pindale and the remains of waste heaps can be seen on the north side of the track (SK 157 822). Some calc-spar has been produced here but there seems to be too much admixed baryte, limestone and chert for regular working.

A small amount of calc-spar was obtained at Slitterton (presumably Slitherstones Mines, east of Eldon Quarry), Peak Forest in 1928 (Brown, 1966).

Bradwell: Moss Rake has been worked for the last 40 years or so from an open-pit some 100-400 m to the west of the Castleton-Tideswell road (SK 156 804). The vein is about 3-4 m wide, locally swelling to 15 m (50 feet) according to Terry (1909), and the walls showed much pickwork where galena had been worked long before. Moss Rake was also worked for calc-spar at Outlands Head (SK 163 806) (Outlane Head in Green and Strahan, 1887, who recorded that calcite was being worked for sale then). It was being processed for artificial stone (terrazzo) by Hodkin and Jones of Sheffield in 1909 (Terry, 1909). Later production took place in two periods, 1932-6 and 1945-50 (Brown, 1966). This site has been back-filled and is now a lorry park on the hill crest east of the Castleton-Tideswell road. The adjacent Outlands Quarry exposed a small section of the calcite-rich Moss Rake about 2 m wide on its northern wall.

Peak Forest: a small calcite mine was worked briefly in 1935 and was re-opened in the 1960s by George Fletcher in the Hay Dale continuation of Dam Dale (SK 121 771). It seems to have been a local development with up to 2 m wide calcite in an isolated lead vein. No records of its working life have been found and the entrance is partly collapsed. The southern end of the workings was flooded when last investigated.

Chelmorton: a calc-spar mine was developed by J. D. Bacon before World War I and was purchased by Buxton Lime firms around 1920. The mine is where Grove Rake crosses Horseshoe Dale (SK 097 706) at the head of Deepdale. Also known as Bull Hay Dale Mine, it is now usually called Chelmorton or Horseshoe Dale Mine (Bentham and Stables, 1986). An adit was driven in eastwards just above valley bottom for some 100 m in an east-west vein up to 6 m wide, which was then stoped upwards for up to 20 m leaving a single large stope with two shafts from the surface in the roof. There was a loading bay with chutes in the entrance. Some preliminary screening appears to have taken place outside. In more recent years the calcite was trucked to Arborlow Mine for treatment.

Deepdale: Thirst House Cave (SK 097 712) has a short adit in a calcite vein which suggests that it was tried for calc-spar in the early 20th century. A short pipe vein a few yards north was also tried and both seem to have been known as Chance Mine (Rieuwerts, 2002). No other details known.

Wardlow: White Rake extends eastwards from Wardlow village for about 2 km and the middle section from about SK 187 748 to 197 747 is rich in calcite. Most of it was open-pitted for calc-spar in the 1960s and 1970s, particularly at the Seedlow Mines east of the Housley-Longstone road. The spar was taken to Long Rake for treatment.

Monsal Dale: Putwell Hill mine (Putty Hill in Green and Strahan, 1887; also in Burt *et al*, 1981) (SK 179 718) was worked in much of the late 19[th] century solely for calc-spar according to Stokes (1878) but Burt *et al* (1981) recorded around 10 tons per annum of lead ore and a similar amount of baryte in the 1880s and 1890s. A Blake Crusher was used. Some 650 tons of calc-spar were sold in 1877 and 826 tons in 1878 at an average price of 11 shillings per ton. The mine had been working for the past 30 years according to Terry (1909). Production continued into the 1930s, and Brown (1966) recorded six men underground and five on the surface in 1926. Employment ceased in 1931 (Brown, 1966). The vein is generally 2-3 m wide and trends WSW across the hill-top where it was worked by shallow open pits for more than a kilometre. Underground mining took place close to the railway and an adit only a metre from the rails once opened into a stope. As the railway track is now part of the Monsal Trail, this entrance has been sealed with concrete for safety. According to Stephens (1942) an adit went into the hillside for 450 m (600 yards) though this was not found in the 1970s explorations and its exact position is not known. A newspaper report (Anon.1892) implied that the mine was worked on several levels with spar tipped through box-holes down to trucks in the adit whence it was trammed out to the surface, possibly on the same level as the adjacent limestone quarry floor. A connection to the surface 150 m (500 feet) above was mentioned by Stephens (1942), but this is an over-estimate as the hill top is less than 90 m (300 fee)t above. In its declining years calc-spar was trucked to Long Rake for final treatment.The mine was abandoned in the 1930s but some near surface parts of the workings are still accessible (Bird, 1972; Shaw, 1980). Two steam pumping engines were recovered by the Peak District Mines Historical Society (Thompson, 1971; Amner, 1974) and are now in the Peak District Mining Museum at Matlock Bath. As the lowest workings were well above river level it is thought that these pumps were used to raise mine drainage water to the treatment plant. The parallel Lees Vein at Burfoot on the hillside south of Litton Mill has also been open-pitted for calc-spar (SK160 727).

In the Hay Dale tributary to Monsal Dale, a short length of the Watersaw Rake section of the Longstone Edge vein complex has been open-pitted for both fluorspar and calc-spar at Crossdale Head (SK 182 732), immediately west of the Wardlow to Ashford road, and a plant was established in the dale below (Rieuwerts, 2002)

Ashford-in-the-Water: The westward continuation of the Arrock Vein north of the A6 road about a kilometre west of Ashford (SK 183 699) was worked for calc-spar in the 1930s. The workings are immediately west of an old quarry. No details are available.

Hassop: Some 400 tons per annum of calc-spar were produced at Backdale (SK 233 734) in the 1870s, presumably obtained from the mines on Longstone Edge. In more recent times calc-spar was separated out as a by-product of fluorspar treatment at Backdale.

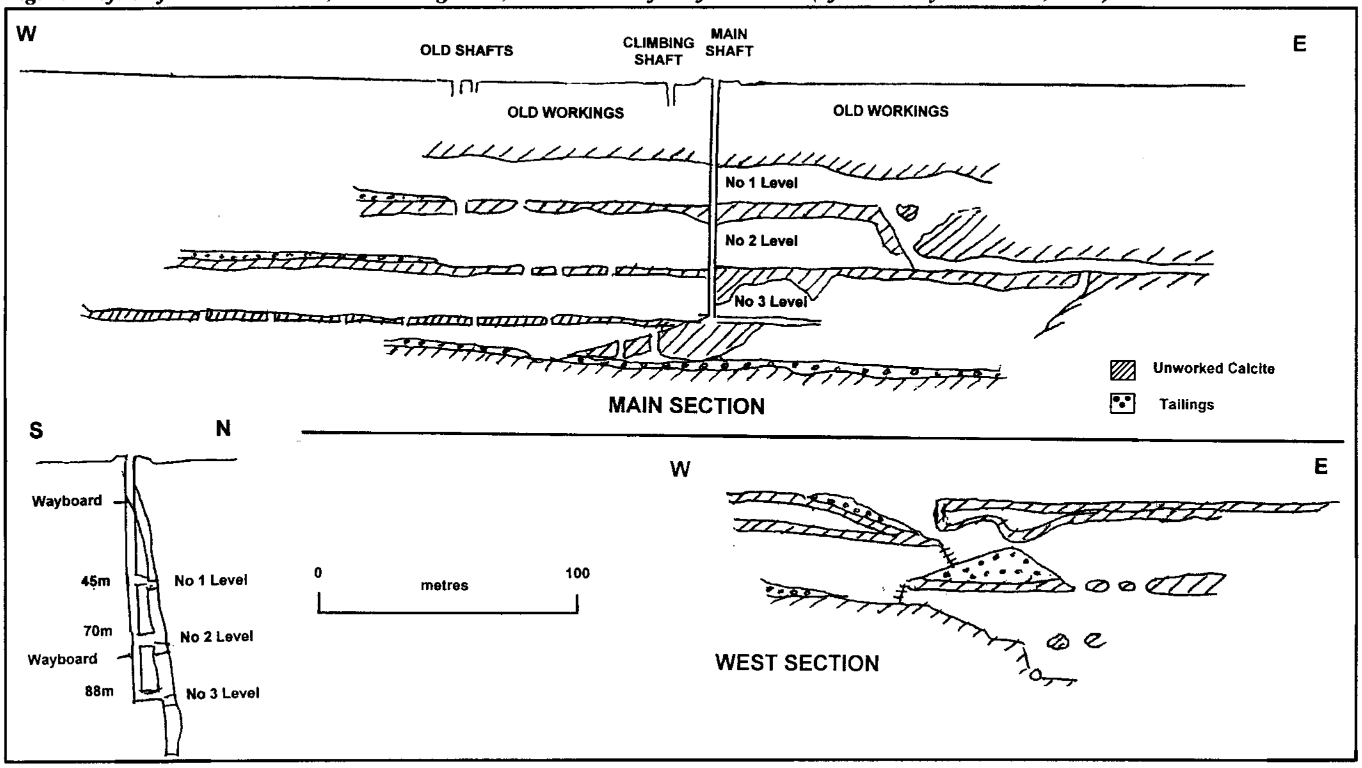
Calver: Calc-spar was produced at the Red Rake Mine (SK 238 740). George Blackwell Sons and Co installed a self-acting tramway (Terry, 1909). They operated the plant from 1907 to 1919 (Stephens, 1942).

Sheldon: Calc-spar was being produced from Hard Rake (SK 162 681) in 1877 and 1878, probably as a by-product of lead mining.

Monyash: A splay vein northwest of Long Rake was worked opencast in the 1960-70 period near Raikes Farm (Worley and Nash, 1978). Calc-spar was trucked to Arborlow Mine for treatment.

Hartington: A steeply inclined calcite vein forms the south wall of Hartington Station quarry (SK 151 612). About a metre thick, it is said to have been tried for calc-spar working but the presence of much earthy hematite discouraged operations.

Fig. 4. Profile of Arborlow Mine, near Youlgreave, with section of shaft and vein (after Worley and Nash, 1978).



Biggin: A small treatment plant adjacent to the High Peak trail (SK 160 594) was processing calc-spar from nearby open-pits until recently.

Youlgreave; Long Rake is the longest rake of the South Pennine Orefield. It stretches from Pickory Corner in the east some 8 km westwards until it breaks up into several lesser rakes north of Arborlow Stone Circle. Much of the rake was mined for lead ore centuries ago, but two large opencasts were worked for fluorspar either side of Lathkill Dale at Raper Pit (SK 217 652) and by Conksbury Lane (SK 210 650) in the 1960s and 1970s respectively, each producing around 500 000 tons of crude fluorspar ore. Both pits were limited in depth by the underlying Conksbury Bridge Lava but this dies out westwards and was not found in either of the calcite mines.

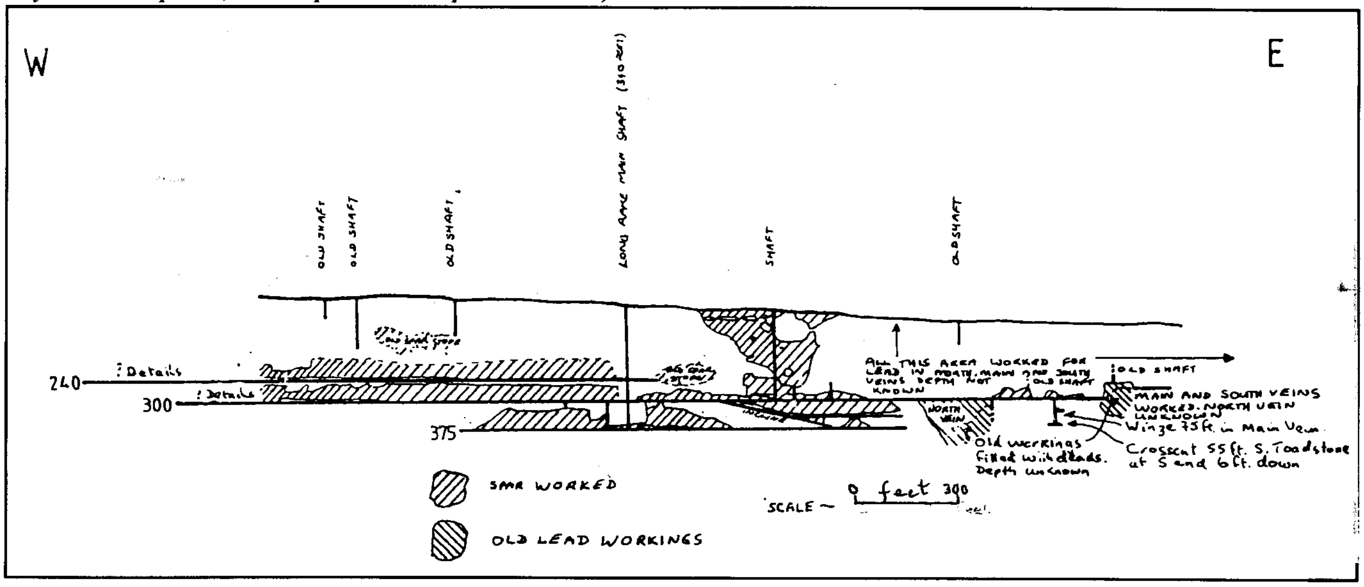
West of the Conksbury Lane fluorspar pit, the gangue changes to almost entirely calcite and two calc-spar mines have been operated there since the 1920s, namely Arborlow and Long Rake Mines. The two mines were operated by separate companies and were driven towards each other though they did not meet and at least 100 m of unworked ground lies between them.

Arborlow Mine (Stephens, 1942; Craven, 1959; Worley and Nash, 1978; Shaw, 1980 and see also this issue) (SK 172 640) was sunk to a depth of 88 m in a vein hading northwards at first but around 60 m the vein was vertical and below this the hade was to the south. Operated by Middleton Mining Co. the mine was opened in 1922 with a decline driven eastwards near its western end (SK 167 640). Some 250 m to the east the old Evans lead mine shaft was enlarged from 1926 and completed in 1932 when the treatment plant was moved to it. Up to 20 men were employed 1921-1950 (Brown, 1966). The mine closed in 1974 and Clyde Minerals occupied the site in the late 1970s during an unsuccessful attempt to enter the Derbyshire fluorspar mining business. They did not use the treatment plant but it was re-opened by Derbyshire Aggregates Ltd in 1987 (James and Foster, 2001). From the early 1970s waste slimes were dumped down the incline and later the shaft, followed by waste slimes from Long Rake Mine, so that most of Arborlow Mine is now inaccessible.

At Arborlow Mine the rake varied between 6 and 9 m wide narrowing to about 2 m at the bottom level. It divided and rejoined at several points and there were occasional patches of breccia with earthy hematite, particularly at the eastern end. Galena was mostly confined to the walls. At the western limits of the mine the rake narrows to 1 m near the lease boundary; beyond it splits into at least four veins as shown by the spread of old lead mine hillocks in the fields to the west. The east end also broke up into several scrins and patches of replacement calcite containing patches of ochre and hematite about 100 m from the western limits of Long Rake Mine. A length of about 450 m was worked from three levels at 45, 61 and 92 m below collar, and a sub-level went a further 20 m. The water-table was not far below this. In the last years of working, the floors between levels were "robbed" and stopes up to 28 m (90 feet) high were left.

Long Rake Mine (Stephens, 1942; Craven, 1959; Shaw, 1995; Sarjeant, 1995; James and Foster, 2001) (SK 187 642) has had a much longer history than Arborlow Mine. After centuries of shallow working for lead ore, calc-spar mining commenced in 1867 (James and Foster, 2001). It was in progress in 1877 (Shaw, 1995) and 860 tons were sold then (587 tons in 1878). The shaft was sunk to 90 m (300 feet) in the mid 1920s, later deepened to 115 m (375 feet). Most deep mining was carried out by Long Rake Spar Co., a company which has had several owners and directors over the years. Up to 50 men were employed in the 1921-1950 period though around 30 was more common (Brown, 1966). Underground mining ceased in 1981. Since 1985 the treatment plant has been operated by T. and T. Broadhurst. Historical details have been summarized by Shaw (1995) and by James and Foster (2001). The mine plan (20 feet long and too detailed for reproduction herein - copy in the P.D.M.H.S. collections) shows the main working levels but much of the upper workings is without any detail. It seems likely that these vein was here worked first for the galena coating the walls, and the central calcite mass was extracted later. There were several old shafts, one being maintained as escape route in later years. The old high level stopes had timber frames, stemples and ladderways (now all rather unstable), whilst the lower recent workings were ring-arched in several places.

Fig. 5. Profile of Long Rake Spar Mine, near Youlgreave (after Stephens, 1942; and Shaw, 1995). Note: a faded dyeline print taken from a tracing of the company mine plan (= profile, apparently dating from around 1980, is in the P.D.M.H.S. archives, but being 6 m long and very detailed in places, it is not practical to reproduce it here).



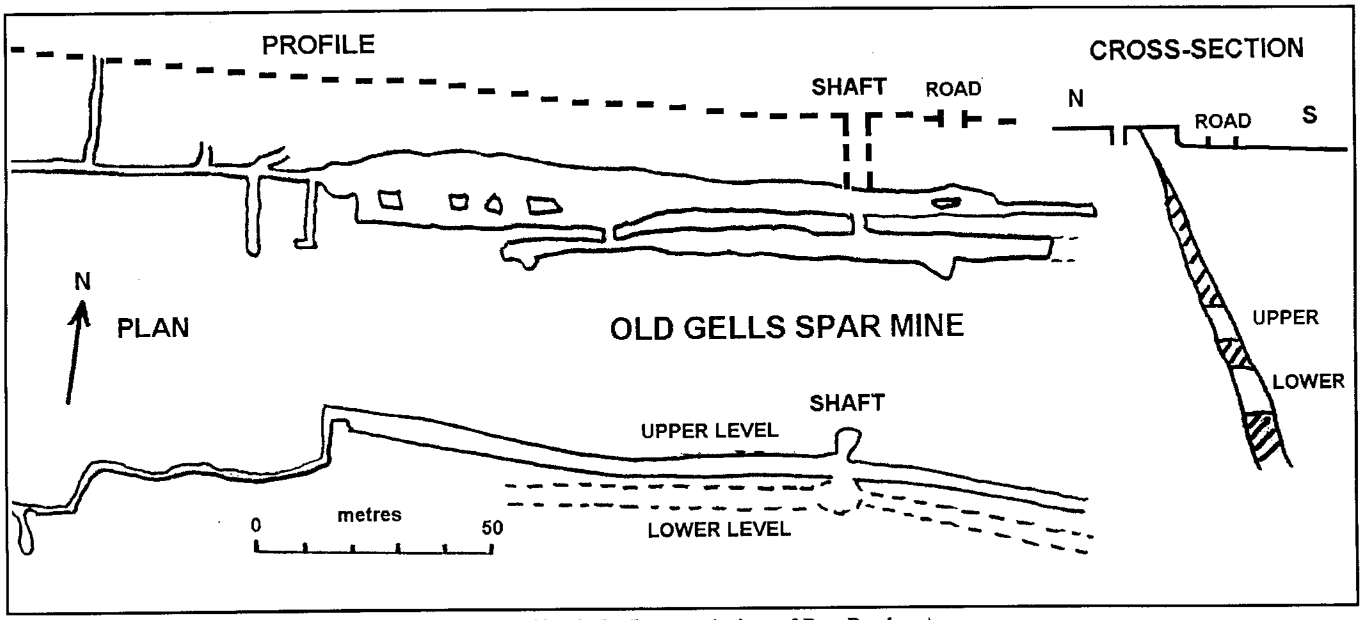


Fig. 6. Profile and plan of Old Gell's Spar Mine, Godfreyhole (by permission of Roy Paulson).

Long Rake Mine was worked for a length of some 2000 m with a final depth of 115 m (375 feet) where water became troublesome. Apart from surface open-cuts (some were open dangerously close to the road and are now protected or filled in) the main working levels were at 72, 90 and 115 m (240, 300 and 375 feet) below collar and both overhead and underhand stoping were normal with a metre or so of spar left as a floor between levels. Inclines connected the two deepest levels. Maximum production in the 1920s was claimed to be around 12000 tons per annum of calcite, though this was double the total official UK figure. In most years several tons of galena were separated as a by-product. The treatment plant is still operating on tributed spar, much of it from Moss Rake at Bradwell.

Though the rake had clear-cut, sometimes slickensided, walls for most of its length in both mines, the unworked length between them was marked by a break-up of the vein into a network of scrins and large irregular crystalline calcite patches known as The Maze at the western end of Long Rake Mine. These made systematic mining impractical. The shaft sections of both mines show curvature of the vein which haded in one direction near surface, changed to vertical at middle depth and haded the other way at depth. But the curvature was in opposite directions in the two mines.

There was some calc-spar production from the nearby Moor Close, Youlgreave (SK 20 64), in the 1870s.

Alport-by-Youlgreave: White Rake (SK 22 64) is a NW-SE vein in the Alport field particularly rich in calcite. It has been tried for calc-spar but the only record of systematic working is that two men were employed on White Rake in 1932.

Gratton Dale: Mouldridge Mine (SK 194 595) lies in a branch off the Long Dale extension of Gratton Dale, near the hamlet of Pike Hall. A series of scrins and pipes have long been worked for lead ore (Pearce et al. 1984). In the last attempts to extract lead ore in the 1950s and 1960s, a roller crusher and jig were installed in the first chamber and some lead ore was produced. The by-product was calc-spar and some was sold but the size of the stopes suggest that the quantities cannot have been large. The crusher etc were rescued and later taken to the lead-mining exhibit at the Crich Tramway Museum.

Winster: Limited production was obtained by open-pitting in Raithe Rake (part of Coast Rake, approximately at SK 2361) in 1922-26 (Brown, 1966).

Bonsall: Several WNW-ESE veins close together on the summit of Bonsall Moor (SK 25 59), including Beans and Bacon Mine, have been open-pitted for "spar". In some places the spar was mainly fluorspar whilst in others it was calc-spar. Lower on Bonsall Moor, Whitelow Rake (SK 25 58) was also tried. To the east of Bonsall village, Low Mine (SK 284 585) was primarily a lead mine, but both fluorspar and calc-spar were produced at times. In 1932 the ownership of 19 tons of calc-spar was disputed and the case went before the County Court.

Wirksworth: Wass and Son were recorded as producing 180 tons of calc-spar from Brights Friendly Mine in 1877. It was situated northeast of the town centre near to the Gulf Fault (SK 289 541). The output fell to 40 tons in 1878 but it is reputed to have continued production through the 1880s. Wass and Son also raised a few tons of calc-spar from Bage Mine on Bole Hill (SK 292 549). Northcliffe Mine (Norcliff, approx. SK 285 544) lay roughly beneath the recent Middle Peak quarry buildings and also produced calc-spar in the 1878-9 period, apparently either from the Gulf Fault or a vein closely parallel to it.
Some calc-spar production took place on Cromford Moor in 1923-4 with up to 7 men employed (Brown, 1966).

Godfreyhole: Old Gell's Mine (also known as Godfreyhole Mine) (SK 268 538) was worked for calc-spar by Thomas Hodson and Sons in the 1920s and around 1933 to 1936 by Old Gell Spar Mines Ltd (E. Glossop, proprietor). It was in the western range of Yokecliffe Rake which is in a fault both downthrowing and hading to the south. Much of the Rake had been worked intermittently for lead ore for many years. Old Gell's Mine, including the old lead mine workings at the western end, was about 2 km in length with a maximum depth of around 20 m where the Rake was about 3 m wide. Figures such as 275 tons of spar raised appear in the Chatsworth Barmaster's papers (Flindall, 1998) but it is not clear what period this tonnage covers. Hodsons are said to have sold finely crushed calc-spar for chicken grit. Both open-pit and underground mining were carried on according to Frost and Smart (1979) but there is not much to see of any open-pit today. Apart from the rake, there

Plate 1. Inclined open stope in Long Rake which had a full width of calcite, and with a rib remaining on the right-hand wall. (Photo - Paul Deakin).

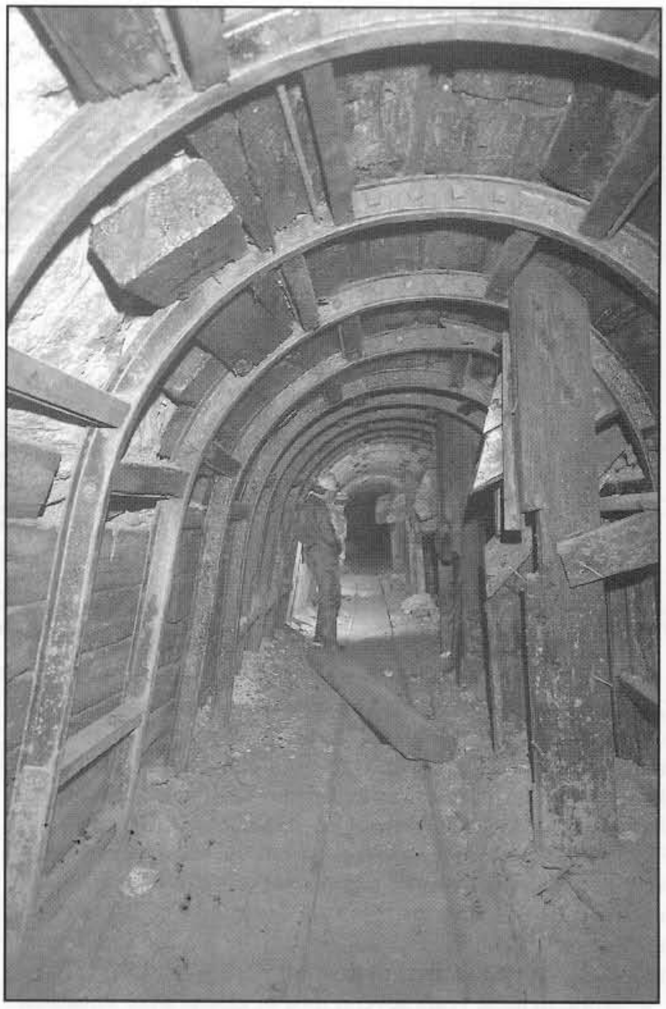


Plate 2. Steel-arched level in Long Rake with chute on right. (Photo - Paul Deakin).

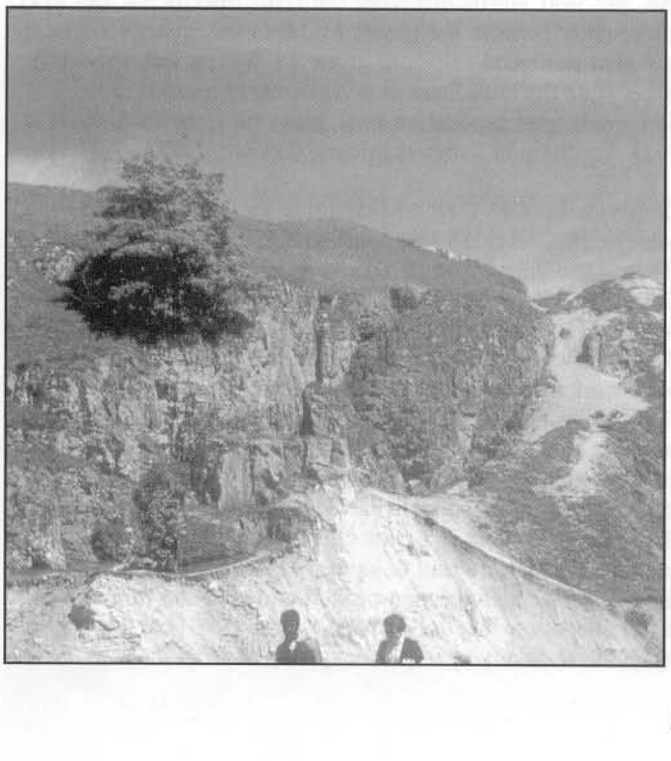


Plate 3 Calcite heaps on Dirtlow Rake in Pindale, near Castleton. (Photo - T.D. Ford).

Plate 4. Calcite breccia fill of Long Rake. (Photo - Richard Shaw).

were pipe veins and brecciated dolomite which interfered with production. From 1934-6 there was a dispute concerning extending the mine eastwards beneath the road into adjoining ground and into the Boulder Flats Mine further east on Yokecliffe Rake (SK 271 538) (Flindall, 1998). There was limited calc-spar production elsewhere on Yokecliffe Rake.

Apart from the above many other veins have been tried for calc-spar but none have led to regular production. Where it could be separated easily, calc-spar was a common by-product of lead, fluorspar and baryte mining. Many waste hillocks from lead-mining days have also been removed and processed for calc-spar. Increased proportions of baryte, galena and fluorspar necessitate preliminary jigging to separate them, so increasing costs.

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