Bulletin of the Peak District Mines Historical Society. Vol. 10, no.1, 1987.

A PERSONAL MEMOIR OF MILLCLOSE MINE IN 1939*

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INTRODUCTION

These notes primarily concern the underground conditions at Millclose Mine, apart from some brief notes concerning surface installations and a mill flowsheet showing the milling arrangements prior to the installation of the flotation plant. Most of the information was obtained from personal observation and questions put to members of the mine staff. The historical and geological sections were compiled with the help of information taken from maps and Memoirs of the Geological Survey and from sundry technical papers dealing with the area.

Millclose is at present* the largest and most productive lead mine in Europe and so far as has been recorded, has produced some 500,000 tons of lead ore concentrates, with many thousands of tons of zinc concentrates. These figures, however, almost certainly fall short of the actual total, since much of the early production probably remains unrecorded.

SITUATION

The mine is situated near Darley Dale in the valley of the river Derwent, and a few miles north-west of Matlock, in Derbyshire. The surface at the mine is 367 feet above sea level.

HISTORY OF THE MINE

a) Old Workings

The old workings at Millclose were situated to the south and south-west of the present mine and are chiefly in the valley of Cowley Brook.

The first recorded workings here date from the 17th century, though there were almost certainly earlier workings on a small scale.

In the year 1743, the Quakers Company (afterwards the London Lead Company, who worked extensively in the North Pennine lead-zinc mining field and other places) bought the mine. They then stated that they intended to work it "..to the benefit of the people of the Dales, who are poor and in great distress". However, the mine was closed down again some twelve years later as it was not a profitable proposition, and that ended the benevolence of the Quakers Company in these parts.

In those days the mine was worked entirely in the Cowley Brook and Knowle area. It was here that the Quakers Company "... not only erected a fire engine to draw water from the mine, but also erected coes." The pumping engine was at what is now known as Watt's shaft, about half a mile south-west of the present Warrencarr shaft. The building which housed the pumping engine is still partly standing and by its design, seems to have housed an engine of the Newcomen type.

Footnote - This memoir was written as a personal reference work 48 years ago after the author's work as a "student" from 1937-39, firstly as a miner in stopes on the 93, 103 and 112 fathom levels and later as Assistant Foreman. It is hoped that it will stimulate someone into bringing together all the scattered information on this, the largest lead mine in Britain, into a full account of its history. As the account was written before the mine closed, some minor editing has been done to cover later events.

After the closure, circa 1755, the mine apparently lay idle for over one hundred years, until 1859, when it was taken over and reopened by a local man, Mr. Wass. Since that date it has been in continuous work until the present day, apart from the two years 1875-77, when it was temporarily drowned. After the death of Mr. Wass in 1886, his trustees ran the mine until 1919, when the Bradford Vale Mining Company acquired it. This firm only held the mine until 1922, however, and it was then taken over by Millclose Mines Limited, later operated by New Consolidated Goldfields Limited.

Until 1933, all the galena concentrates were taken by road to the Lea Bridge smelter at Holloway, to the south of Matlock, but a new company smelter was erected at the mine and later formed the basis of Enthoven's works.

b) Modern Workings **Map 1**

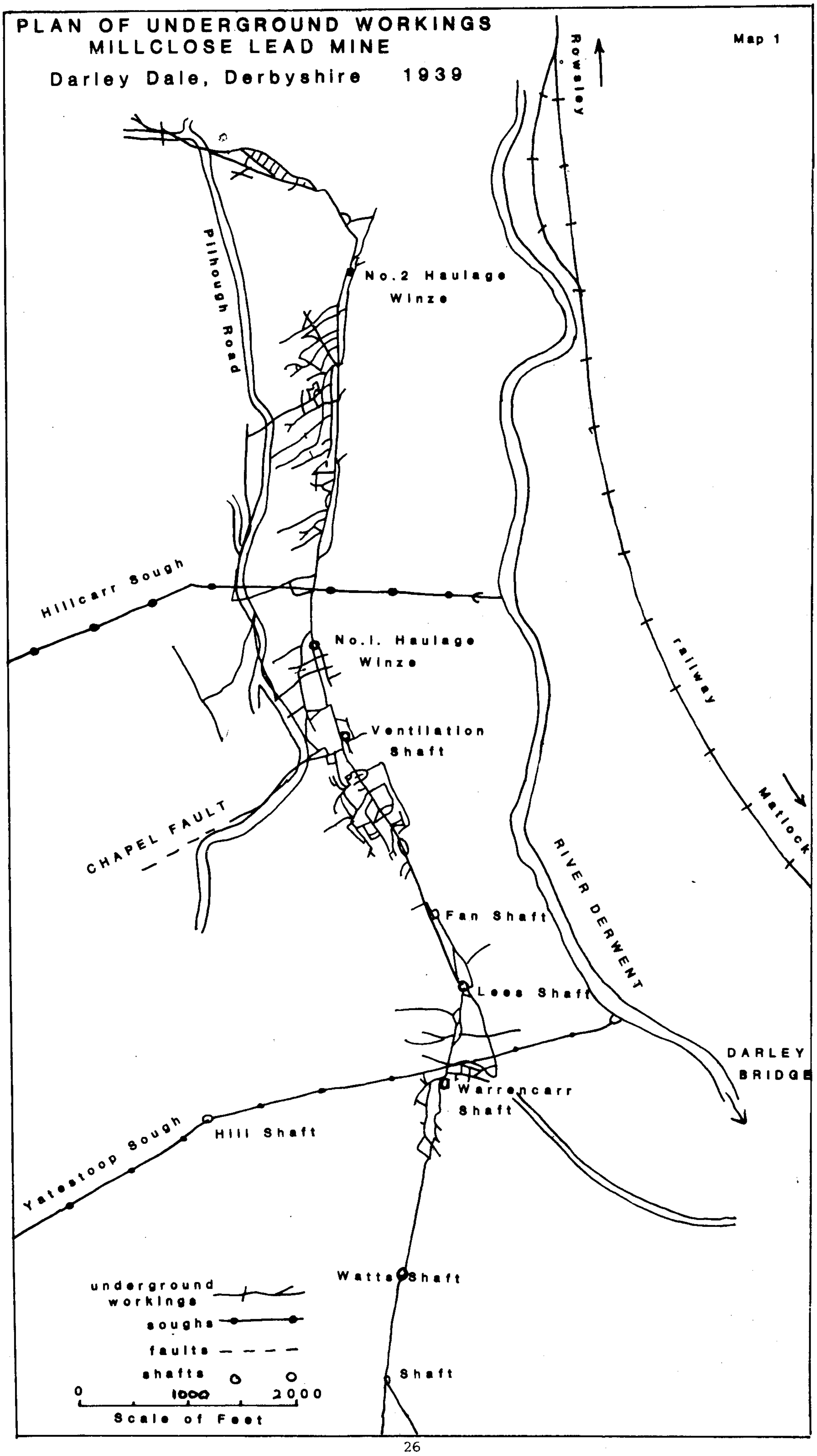
From 1919, the main part of the 73 fm. level was driven north-ward from Lee's shaft, then the main winding shaft linked to the dressing floors at Warrencarr by an inclined tramway. During this period the ore was got above between this level and the base of the Edale shales. The shales dipped gently northward until their base reached the 73 fm. level at about a mile north of Lee's shaft, and it was considered that the mine would be exhausted at this stage since it was then thought that the lower limit of ore deposition was the top of the Toadstone, which had been proved at Lee's shaft. This toadstone, an olivine basalt lava flow, lies some 100 feet below the shales, and local belief was then that no ore would be found below that horizon. Several trials were made, including the sinking of a winze through the toadstone, known as the "Munition" winze, since it was financed by the Ministry of Munitions during World War I. No ore was found in these trials.

Owing to the heavy influx of water at the 73 fm. level, increased by water from below the toadstone at the Munition winze, and the expected further increase in water with any further sinking, the company was reluctant to embark upon further trials in depth. Working would probably have ceased at that point and a new theory which postulated that further ore would be found below the toadstone at suitable points would have remained unproved but for the fact that New Consolidated Goldfields Ltd. then acquired an interest in the mine and enabled the necessary development work to prove ore in depth to be carried out. Thus the No. 1 Haulage Winze (also known as the "Boil-up" shaft) came to be sunk to the 103 fm. level. After some development work between the 73 fm. level and 103 fm. levels the results obtained more than justified the heavy outlay, despite the realization that further heavy feeders of water might be struck in this sinking.

The 81 fm. and 93 fm. levels were developed from this winze and proved to be enormously rich in limestone underlying the toadstone. At one time during this part of the Mine's history the dressed galena exceeded 800 tons per week for some time. The greater part of the output was obtained from workings centred around the 93 fm. level, but the whole of the ground between the 81 fm. and the 103 fm. levels was rich. (The depth of levels is measured below the collar of Lee's shaft, which lies at 367 feet above Ordnance Datum).

In this bonanza deposit, the ore consisted chiefly of massive galena in a gangue of calcite and with some barite and fluorite, the latter occurring mainly toward the fingering-out of the deposits: sphalerite also occurs here, but in subordinate amounts.

The ore horizon again dipped northward eventually going below the 103 fm. level almost one mile north of the No. 1 Haulage winze. Further beds of toadstone were also detected in depth, and the ore channel seemed to pass through these. At this point the No. 2 Haulage winze was sunk, from which were developed more large orebodies at the 112 fm., 129 fm. and the 144 fm. levels. Again, as these deposits were followed they dipped northward until they sank below the 144 fm. level. In this


PLAN OF UNDERGROUND WORKINGS
MILLCLOSE LEAD MINE
Darley Dale, Derbyshire 1939
Map 1
Rowsley
Pilhough Road
No.2 Haulage Winze
Hillcarr Sough
No.1. Haulage Winze
Ventilation Shaft
railway
Matlock
CHAPEL FAULT
RIVER DERWENT
Fan Shaft
Lees Shaft
DARLEY BRIDGE
Warrencarr Shaft
Hill Shaft
Yatestoop Sough
Watts Shaft
Shaft
underground workings
soughs
faults
shafts
0
1000
2000
Scale of Feet

part of the mine, however, it was found that both the quantity and quality of the deposits were falling off, and although extensive trials were made, both by raising above the 144 fm. level as far as the 76 fathoms horizon, and by sinking below the 144 fathoms as far as the 164 fm. level, and also by lateral trials, nothing of any real value was discovered. In fact the deposits seemed to tail right away in the further sinkings and in the northward extension of the main drifts. Further exploratory work at these levels was eventually precluded, as approximately 10,000,000 gallons of water per day were being pumped from the mine, at an average cost of about £40,000 per annum.

GEOLOGY

The mine lies on the eastern edge of the large dome of Lower Carboniferous rocks which outcrops most of the northern part of Derbyshire (Fig. 1). The Carboniferous limestone is partly overlain here by the Edale Shales. The limestone was entered in Lee's shaft after penetrating 240 feet of Edale Shales. The strata tend to dip gently but with some slight undulations, in a direction a little east of north. A slight anticline occurs in the Stanton Leys area as seen in the section.

Interbedded with the limestones are olivine-basalt lava flows of varying thickness and extent, indicating that volcanic activity was widespread locally. Seven such lava flows, or toadstones, have been met with in the mine workings, not counting a number of thin "wayboard" beds, resulting from falls of volcanic tuff. The lava has decomposed to a clayey material in many places, which varies from dark grey to a yellowish-green colour often with dark green speckles. On exposure to air it decomposes further and forms a very unsafe roof to the workings in which it occurs. The limestone below the lava flows is sometimes marmorised (= baked) to a depth of several feet. These lava flows, which occur over a large part of the North Derbyshire area are always known by the miners as "Toadstones", which name may have been applied originally by the German miners who at one time worked in the district. The name in this case may be a derivation from the German "todtstein", meaning literally "dead stone", thus indicating that it was then considered that no ore would be found in or below it; in fact a sort of "farewell rock" to the lead miners.

The original theory of ore deposition was that the lead and zinc ores had been derived at low temperatures from downward percolating or laterally migrating solutions which found their way into cavities in the limestone, became stagnant and deposited their metallic content when they became entrapped between the overlying Edale shales above and the underlying toadstones, both of which beds are relatively impervious. It was therefore assumed that all the ore deposits would be found in the uppermost limestones and would not be found below the toadstone. This theory was largely borne out by mining experience, where numerous veins were found to pinch-out on entering the toadstone and to be quite barren when followed through this bed and into the underlying limestone. It should be remembered however that most of these trials were made vertically below the older workings above the toadstone, where even in the light of more recent experience it is most unusual to find extensions of the ore deposits. In a few cases where ore was discovered below a toadstone the operators put it down to the fact that they were working on an especially powerful vein, which was therefore the exception to the general rule.

Even as late as 1919, when the Geological Survey published a Special Report on the deposits of this district, this theory was supported and the following statement occurs: "...the richest deposits have been got in the topmost layers of limestone, and repeated trials have shown that they do not extend below the toadstone".

A glance at the section of Millclose Mine will show why hese trials, made vertically below the old workings, almost always proved abortiv and why, even in Millclose the trials below the toadstone underlying the souther part of the 73 fm. level and those made to the south under the Elton road, failed to find any ore worth mentioning. The reason is that the deposits have been found in the more recent developments to have been "stepped-through" the various blanketing media at the points where the later trials were made.

The toadstones are to all intents and purposes impervious and would not allow aqueous solutions to pass through them, except where a strong fault passed right through and provided a passage for the solutions. This fact, together with other carefully collected data from a number of lead-zinc fields in the Carboniferous Limestone led to the formation of the theory that the ores were derived from some deep-seated source and ascended to the places where they have been deposited.

This theory holds that by following an ore-shoot down until it comes to a lower impervious bed, such as a toadstone, and then sinking on any powerful joint (further ore deposits should be found in the limestone below). The theory was tested at the Boil-up Shaft, with the result of finding of the largest lead-zinc deposit ever worked in the United Kingdom.

The ore-bearing solutions seem to have found their way from some unknown source, along a main joint system of the surrounding area.

Fig. 2 shows in plan how the solutions may have penetrated from a main channel into the many ramifications of open joints and solution cavities in the limestone. The arrows show a suggested course for this penetration.

Fig. 3 shows in a rough way the predominant minerals found in various parts of the ore-bearing ground throughout the mine.

Galena is the principal lead ore, while sphalerite is the only important zinc ore. Pyrite, fluorite, barite and calcite occur commonly, the barite and fluorite being chiefly confined to workings above the 129 fm. horizon. Cerussite, anglesite, hemimorphite are the commonest secondary oxidation minerals, and these have been seen to occur as low as the 103 fm. level. Greenockite, which is usually found as a yellow powdery deposit on sphalerite, has rendered the zinc concentrate more valuable than is usual as a source of cadmium. Small quantities of chalco-pyrite occur in the mine, more especially around the 93 fm. level.

The galena occurs in octahedral, as well as the more common cubic form. Barite is usually of a brownish colour and of poor quality, while fluorite normally shows poor crystal development and is generally of a purple hue at Millclose. Calcite is often well crystallised, especially when found lining cavities. Often the crystals are twinned and of very large size. Specimens up to 12 inches long are quite frequently found and some have been found even larger than this. The calcite is often quite clear and usually contains many small pyrite crystal inclusions within it, which renders it useless for optical purposes.

Fig. 4 illustrates the types of deposit which have been found and worked at Millclose:

(1) The Joint or rake type. The Main Joint, where productive, is like a normal fissure vein, but is of limited vertical extent, being controlled by the impervious beds above and below. The mineral contents of the Main Joint are usually banded.

(2) The Pipe deposit. This type is usually found where a vertical rake or joint has crossed a more or less horizontal open joint or bedding plane. The pipe in this case conforms to the local dip of the limestone and may extend for a considerable distance. It usually has a cavity in the centre, and this is often lined with beautifully developed crystals of calcite. There is normally a deposit of sticky red mud on the floor of the cavity, in which blocks of calcite and galena may be embedded. Flats may also be found leading off for some distance from the pipe and along the bedding planes in the limestone.

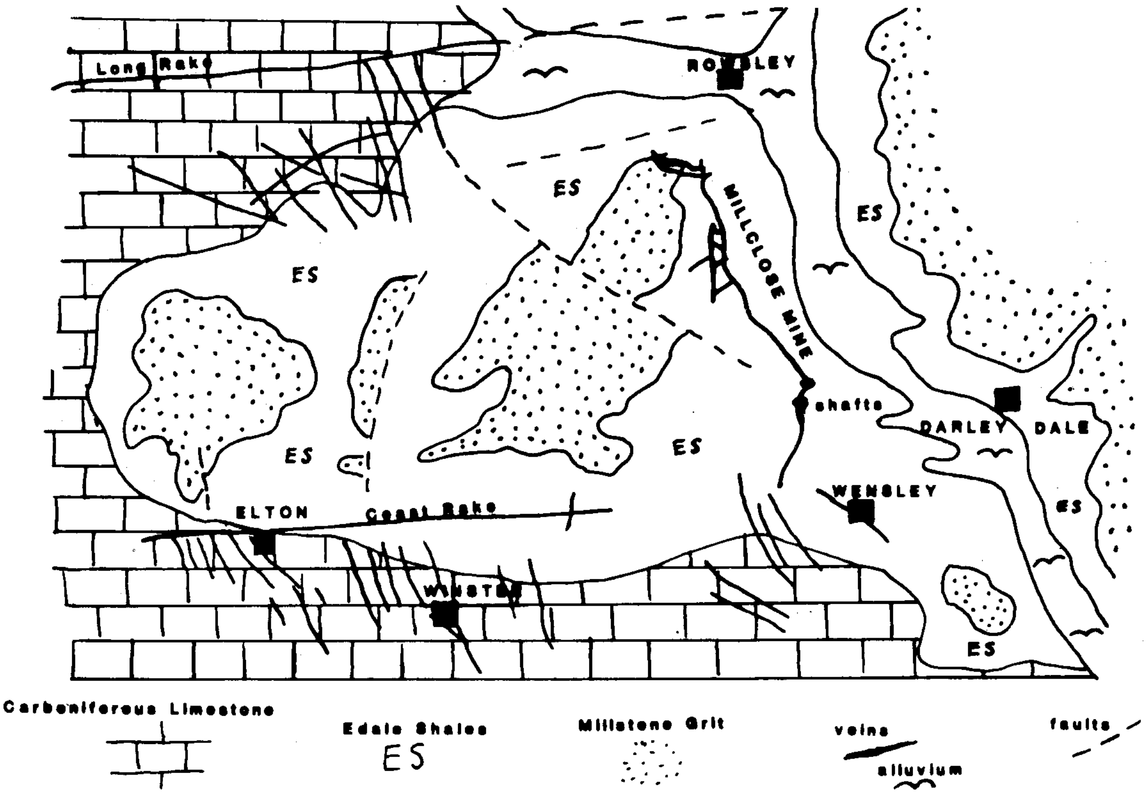


Fig. I. Geological sketch map of the area around Millclose Mine.

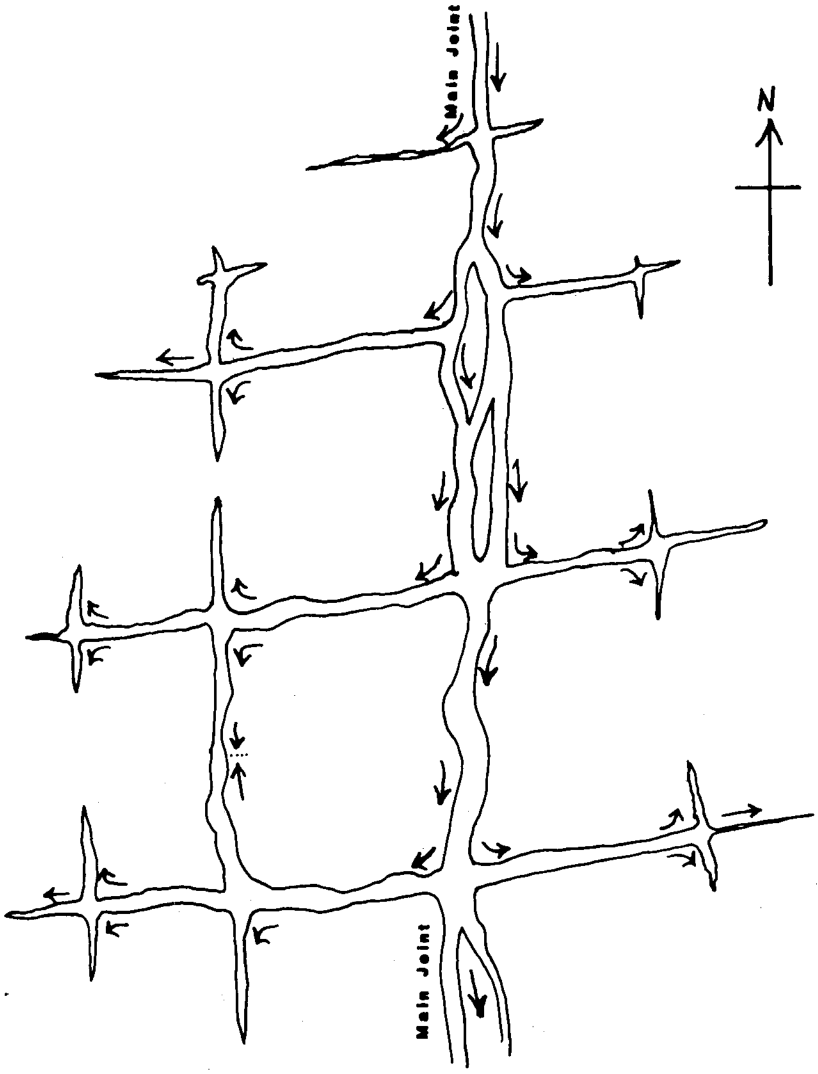


Fig.2. Sketch plan showing the suggested flow of ore bearing solutions in the Millclose Mine area.

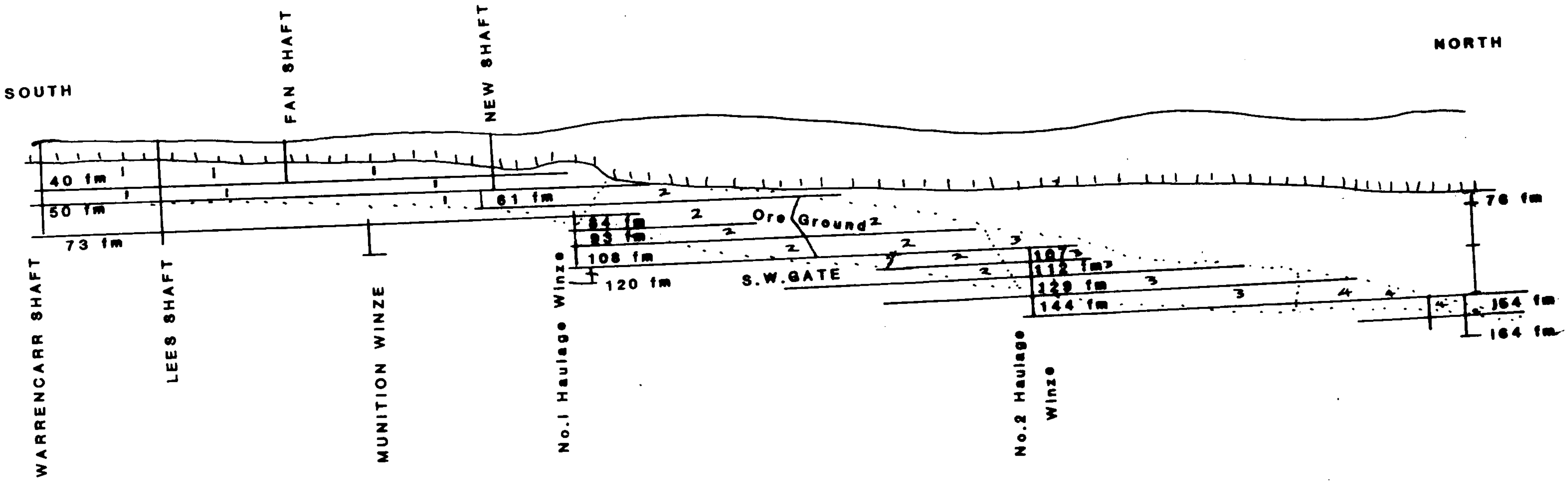
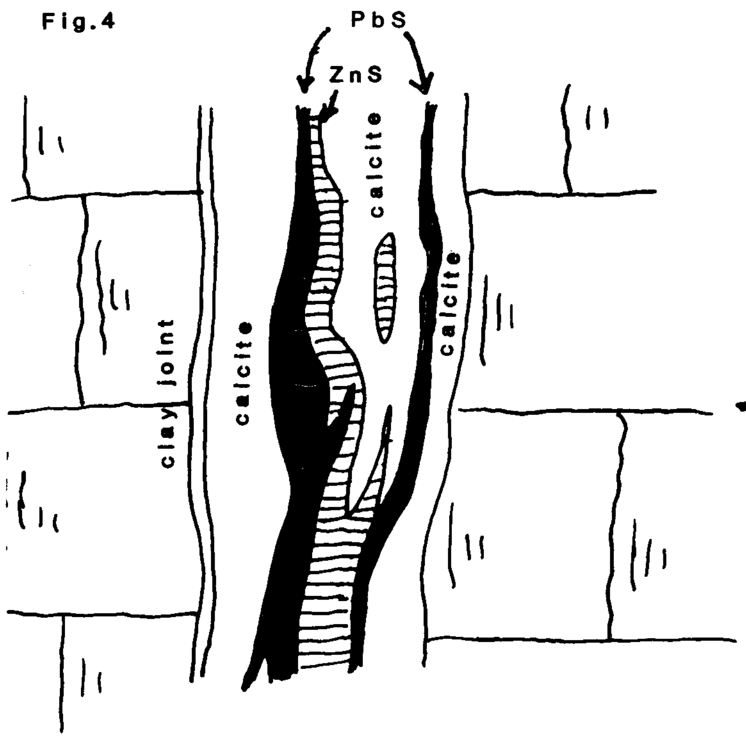


Fig. 3. Mineral distribution section of Millclose Mine.

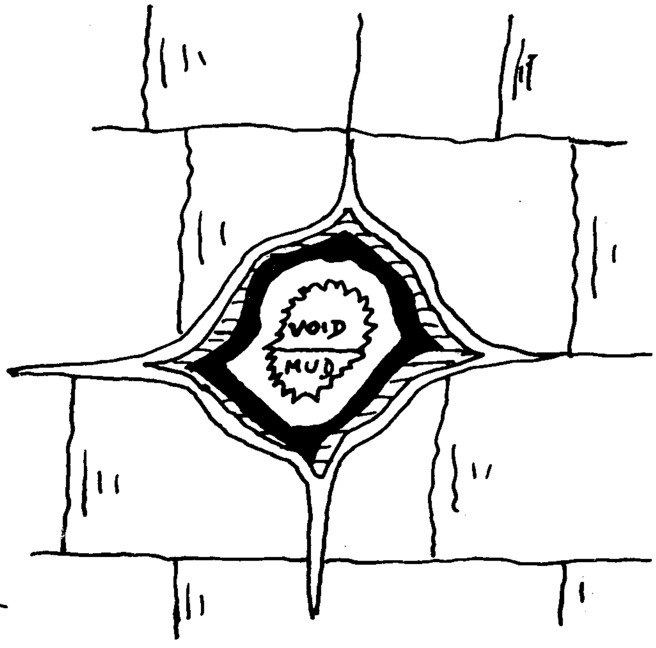
1 mostly galena, 2. massive galena with blende, 3 intimate galena and blende, 4 chiefly blende

Barite and fluorite occur in Zones 1, 2 & 3. Calcite in all Four zones.

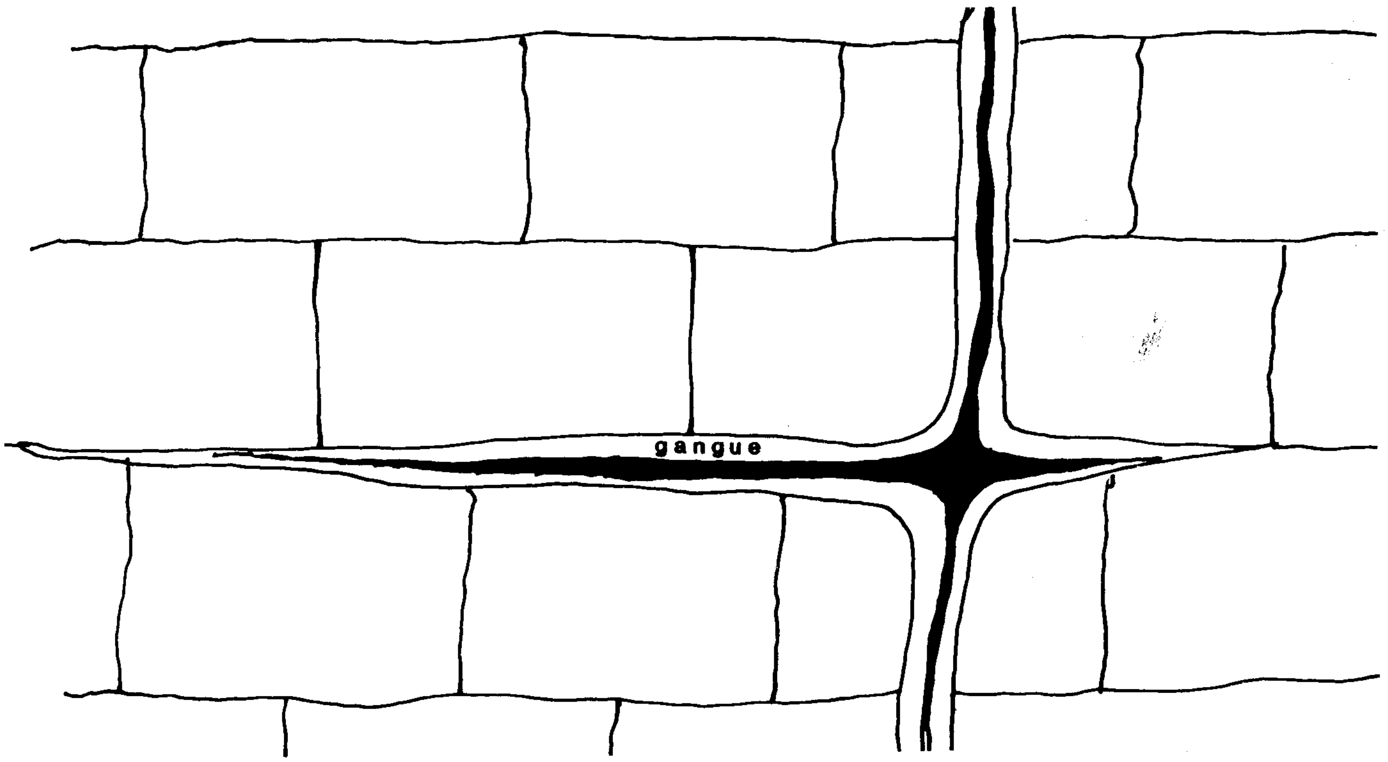
Fig.4



(1) typical rake or joint deposit



(2) typical horizontal pipe deposit



(3) typical flat deposit extending from a rake

Another variety of pipe sometimes found has its axis in a vertical rather than a horizontal plane, and this type may be found at the junction of two rakes or joints, the length of the pipe then being limited by the thickness of the limestone between upper and lower impervious beds.

(3) Flats. These deposits are up to 5 feet thick and normally lead off along a bedding plane from the side of a rake or joint and may extend for anything up to about 150 feet away from the parent joint or joints. They usually tend to tail-off as they are followed away from the joint.

(4) Wing deposits or "Wides". These are really cross veins linked to the main joint and have been named wing deposits from the shape which the pay sheet usually develops when viewed in section. Normally these deposits are only found on the western side of the Main joint, but occasionally they have been found to extend in both directions, though that on the west side is still the more extensive. They are often found quite extensive in themselves and may be followed for 300 feet or more from their parent joint or vein before becoming unproductive. Sometimes they have been found to have further "wings" leading from them and parallel to the main vein and in conformity with the joint system of the limestone, and in some cases they have also acted as feeders to small flats.

What has been termed the Main joint is not in fact all on one joint and might more correctly have been termed the Main Joint System. The plan of workings in the mine will clearly illustrate this. This system seems to have formed the principal channel up which the ore-bearing solutions have travelled and these solutions have sometimes branched out of one joint and into another of the same system, when it has offered an easier passage for them. The Main joint system itself is not always ore-bearing, even at points where productive wing deposits lead off from it, or where flats occur. In the south part of the mine, now called Old Mill Close, the Main Joint over the greater part of the workings was a fault with a small easterly throw, but in the present workings no associated faulting has been observed. The system trends roughly in a direction a little west of north, but tends to swing more westward both south of Warrencarr shaft and at the north end of the workings, to the north of No.2 Haulage winze. It has been proved for a distance of about three miles in all. It is usually made up of nearly vertical joints, with any observable dip in an easterly direction. These joints vary in width from a mere clay-filled crack to about fifty feet wide in some places. They are usually wider and more likely to carry ore where there are cross veins or joints. Most of these cross veins are richer in ore on the western side of the main joint system than those on the eastern side. This may be explained by the fact that the dip of the strata is toward the east and the easier passage for the ore-bearing solutions would have been upward on the west side. The walls of the veins are strong as a rule and the ground stands well, except where toadstone forms the roof of workings or the hanging wall. On the 129 fm. level, for instance, where a bed of toadstone forms the roof or hanging wall of the workings, a form of cut-and-fill stoping had to be adopted, with close support on "pigstyes" of timber. Even so there have sometimes been quite extensive falls of hanging wall material.

ZONAL ARRANGEMENT

Zonal arrangement of the ore minerals and gangue is not developed to any marked degree at Millclose. For the purpose of this report, however, the workings have been divided into four rough zones as follows:-

(1) In the old workings of the 40, 50, and 61 fm. levels the ore was chiefly clean block galena, sometimes well crystallised. The chief gangue mineral was calcite, though some barite and fluorite also occurred. There was not a great amount of sphalerite present in this part of the workings.

(2) In the workings at the 73, 84 and 93 fm. levels and southern part of the 103, 107 and 112 fm. levels the galena was of a massive nature, whilst sphalerite became more common lower down. Fluorspar and barite were less common, and neither seems to occur in great quantity below the 93 fm. level.

(3) In the northern part of the workings at the 107 and 112 fm. levels and in those at the 129 and the southern part of the 144 fm. levels, sphalerite becomes the dominant ore mineral and the galena content of the deposits decreases considerably.

(4) In the northern part of the 144 fm. level and in the lower workings and explorations to the north, at 154 and 164 fm. levels galena has become a very minor constituent of the deposit and the amount of sphalerite also drops off until almost the only mineral occurring in the veins is calcite. Below the 154 fm. level and in the developments at the far north end of the mine where exploration is now (March 1939) being carried out, there have only been small patches of sphalerite and calcite in the joints, which are in tight ground, and in fact the deposit seems to be tailing-out altogether northward.

MINING

a) Wings. In the wing deposits and in narrow joints, Fig. 5 illustrates the type of stoping adopted. It must be appreciated that all these deposits are relatively small and very uncertain in extent, so that there can be no question of blocking-out ore in advance of stoping. This being the case, deadwork was avoided as far as possible, hence the rather awkward method of stoping, which often entailed much double-handling of the broken ore. However, the method was found economic in this form of deposit.

In the first place, when a joint was discovered leading away from the Main leader, a level was driven out from A to B, where the joint becomes barren. Driving was then stopped and an inclined raise, usually at about 40 to 45° was put up to find the top of the deposit. This was normally a toadstone or shale bed and reached at C. The area D was then worked out, the broken ore being drawn off along the original drift from A to B. The remaining portion of the deposit above the drift E was then worked out in retreat back to the main joint. If there was any extension F below the main level, a winze was put down and worked out last.

b) Veins. In wide veins, such as the productive parts of the Main joint system, the main levels were driven and the ore was worked out in normal overhand stopes above them. Sometimes the ore was allowed to form a "sluther" down the slope of the stope and hand loaded at the foot of the slope, but sometimes boxholes were left above the drift and the ore loaded directly through them into the wagons below, as in normal shrinkage stoping. The boxhole pillars were worked out last.

c) Flats. In flats, shown on Fig. 6, the workings were usually very irregular in shape and the nearest system of mining in comparison was probably the bord and pillar method of coal mining.

d) Pipes. Pipes of the horizontal type were worked by clearing a road along the axis of the pipe and hand filling the broken ore directly into wagons as it was broken, the wagons being drawn up the slope of the pipe, if any, by compressed air winches.

Cavernous deposits, or large deposits of irregular shape and great bulk, as that at the 129 fm. level, were worked by a modified system of the cut-and-fill, overhand stoping method (Fig. 7). This particular method of fill work was used in the massive deposit between the 129 and 144 fm. levels, as the ground was weak and needed close support.

Throughout the stoping operations in the mine, hand-held jackhammers of the Holman SL-9 type, or Hardy hammers, were used for all drilling. All drilling in the

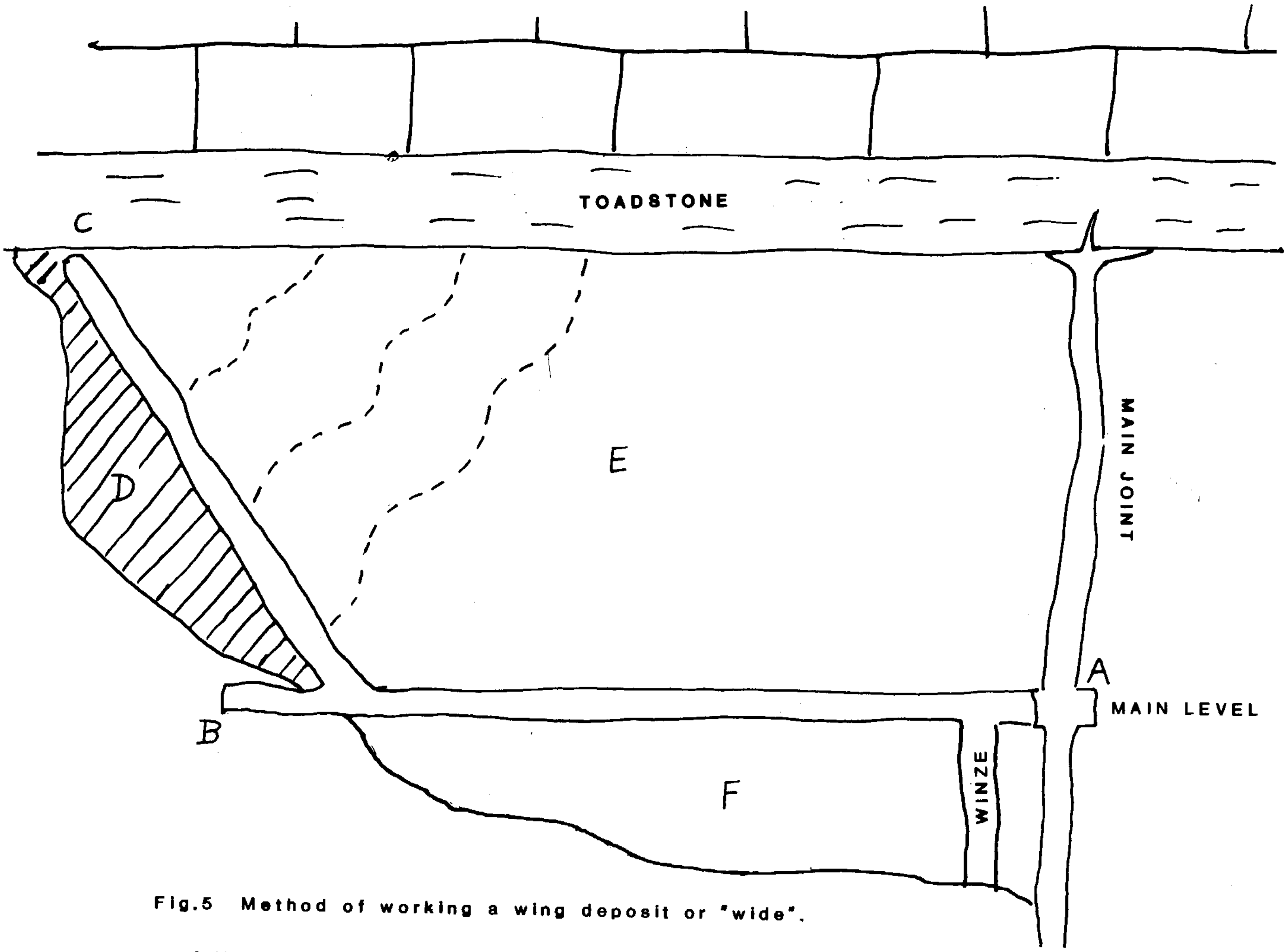


Fig.5 Method of working a wing deposit or "wide".

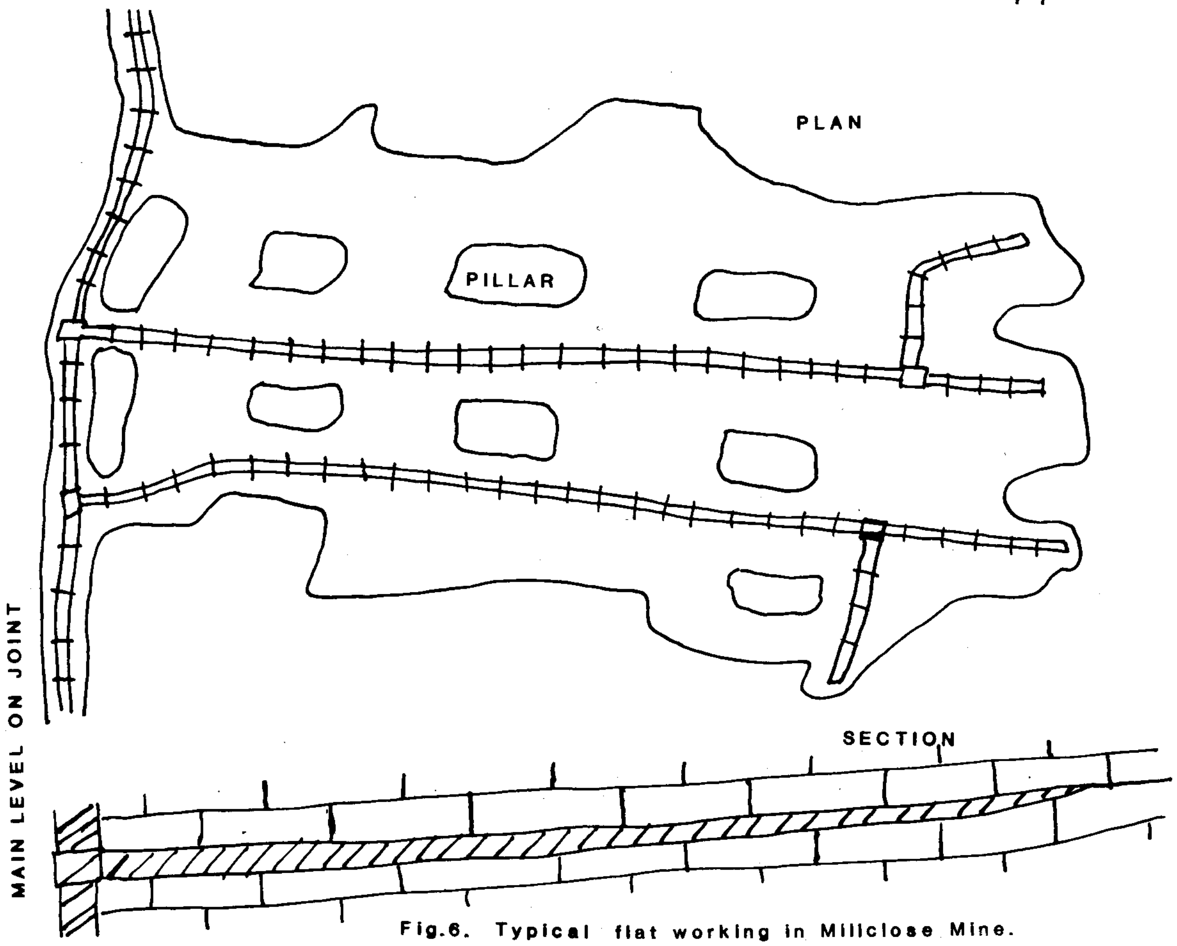


Fig.6. Typical flat working in Millclose Mine.

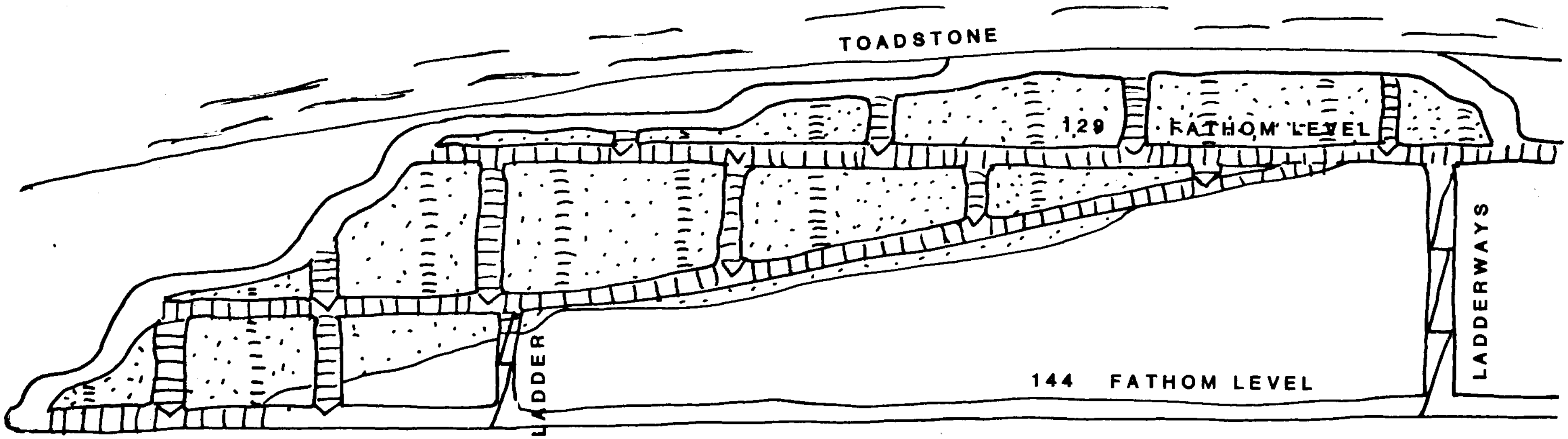


Fig.7. Method of stoping between 129 & 144 fathom levels.

STOPES & FILL

"PIGSTYES"

TIMBERED

BOXHOLES

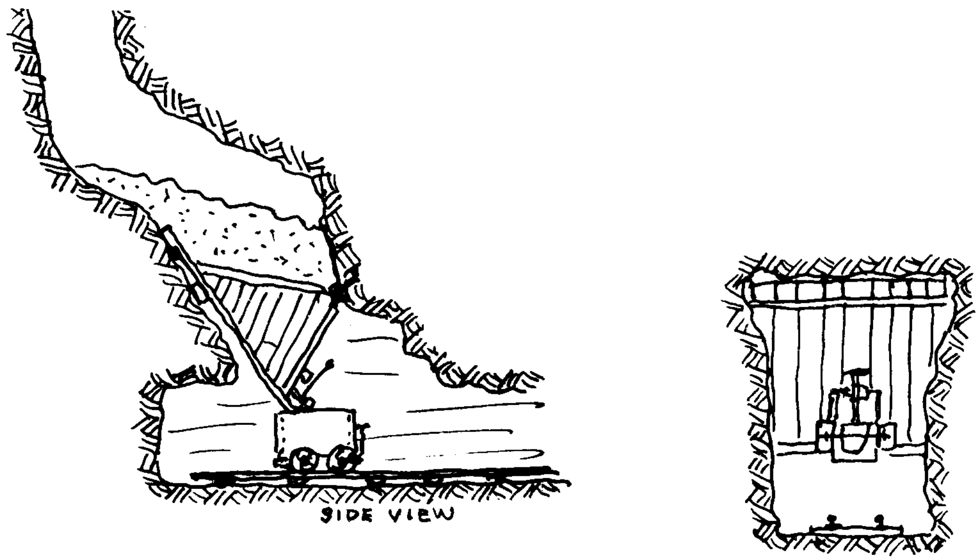


Fig.8. Type of ore chute or shuttle used

mine was dry, except in some development ends, where heavier machines were used, there being little if any quartz present to cause dust problems. Nevertheless dry drilling was not considered to be ideal in any mine and it was felt that wet drilling should have been introduced.

DEVELOPMENT WORK

The main drifts were usually made 7 feet high and 10 feet wide, but these dimensions were not constant through the mine. Subsidiary drifts were usually driven 7 feet high and 6 feet wide. A drainage grip was run along the side of the haulage road in the main levels 2-3 feet wide and 2 feet deep, according to the water flow expected along the drift. Hand held jackhammers of the heavier type were used in driving these levels. Drifters were used in driving the 103 fm. level, but their use was not continued for very long, as they were found unsuitable for the work required of them. Stopers were used for raising, where the use of normal jackhammers would be awkward.

Developments were in progress as follows in March 1939:-

112 fm. level -- Driving north on the Main joint.

144 fm. level -- Raising and sinking at the north end.

154 fm. level -- Sinking to the 164 fm. level.

The development at the north end of the 112-fm. level on the Main joint had not then discovered much ore.

At the north end of the 144 fm. level a raise was being put up through all the ground to the top of the limestone, about 400 feet, in order to prove whether the orebody might have an overlapping step above the tail-end of the present deposit, or whether a further deposit lay en echelon above it. The Main joint was also being driven further north at the 144 fm. level. Winzes were being sunk from the 144 and 154 fm. levels in order to test the ground in depth at the north end of the mine.

The West Back joint was a more or less barren joint which ran parallel to the Main joint system and some distance to the west. All the workings to the west of the Main joint system which reached it came to an end there and no ore was found to extend beyond it anywhere. Some trials were made in the neighbourhood of this joint in the "South-west" district, on the 103 fm. level, and a small amount of stoping was done on the joint. An extensive trial to and beyond this joint was also made at the 73 fm. level during the period 1916-18, with assistance from the Ministry of Munitions, and this was named the "Munition Gate", but very little ore was found in this trial. Large feeders of water were struck.

TRANSPORT METHODS

a) In the stopes. The gauge of mine rail track throughout the main haulages in the mine was 17 inches. Twelve inch gauge was used in narrow stopes. The mine cars were all of the end-tip variety, but the bodies could be swivelled and side-tipped if necessary. The mine cars were all made at the mine workshops and they held about one ton or ore when fully loaded.

In the stopes the ore was either shovelled down the slope of the ore pile onto flat sheets, from which it was hand loaded into the mine cars, or was drawn from the shrinkage pile through chutes and so into mine cars in the level below. In many of the irregular deposits worked the broken ore had to be trammed to intermediate chutes and trammed through intermediate levels before being delivered to the main haulage levels below. In the stopes and sublevels light section rails were nailed or dogged down to wooden sleepers, and rails were not fishplated, thus enabling the temporary tracks to be picked up and relaid as necessary.

b) In sublevels. Hand tramming was used in these levels, and in semi-main levels, such as the 93 fm. and 129 fm. levels, except where there was an incline, when small bar-mounted compressed air hoists were used, though some of the longer inclines used large compressed air hoists, mounted on wooden bases. A slightly heavier rail section was used in these levels than in the stopes, normally of 20 lbs/yd. section. In these levels the rails were fishplated and laid on steel sleepers. Steel flat sheets were used at all junctions and sharp turns in the levels under these conditions.

c) Main haulage levels. All the mine traffic was concentrated on to three levels in the mine; the 73 fm., 103 fm. and 144 fm. levels.

All the rails used were of 30 lbs/yd. section, fishplated and laid on steel sleepers. The tracks were all properly graded and well maintained for heavy traffic with locomotive haulage. Haulage was by Greenbat storage battery locomotives of 3 1/2 horsepower. They were capable of hauling 20-24 loaded mine cars, the grade being slightly in favour of the load. There were five of these locomotives in regular use, as follows: two on the 73 fm. level, two on the 103 fm. level and one on the 144 fm. level. The trains were made up at the respective shaft tops, full trains being preceded by the locomotive and empty trains being pushed by it, not considered to be good practice normally. There were pick-up sidings at various places along the levels where ore passed led up to the workings above. Midway along the 103 and 73 fm. levels there were passby loops, while on the 103 fm. level there was a branch line to the south-west district along which locomotives dropped or picked up mine cars as required, or when convenient to the main line service.

d) Condition of the main levels. The condition of the main drifts with regard to haulage was not good, though maintenance was kept up. The tracks were not really heavy enough for intensive locomotive haulage and in many places the drainage grips were not large enough to carry the necessarily heavy flow of water which flowed along them, with the result that much of the water washed along the haulage way and tended to undermine the track, which in turn caused derailments and delay. Also, in following the course of the Main joints closely with the drifts, the resulting haulage way had many sharp bends, which again slowed the traffic.

e) Chutes and ore passes. The type of loading chute in common use throughout the mine is shown in Fig. 8. This was a simple yet effective chute which, when connected with an ore-pass, made a convenient storage bin from which the ore was drawn off as required. The ore was generally of a coarsely broken nature and mostly dry, so it did not tend to hang up in ore passes unless unduly large lumps dropped in, against mine orders. Very little trouble was in fact encountered in this way.

f) Shafts. The condition of the main shafts was good, but their hauling capacity was somewhat limited and would not allow any large increase in output. However they were found quite adequate fo the conditions at Millclose.

Fig. 9 shows the layout at the different shafts in the mine, as follows: (i) At Warrencarr shaft, the main winding shaft for ore; (ii) Lee's shaft, used entirely for drawing men and materials and for mine waste; (iii) Nos. 1 and 2 haulage winzes, whose arrangements are the same; (iv) the winze from the 144 fm. to the 154 fm. level, and also that to the "Munition level" from the 73 fm. level. All the minor winzes in the mine were arranged in similar fashion.

The main winding shafts were all operated by electric hoists, but Lee's shaft was operated by a steam hoist of very old design, which was laid down at Millclose in 1872, and was rather slow. The engine itself was within a stone-built engine house, but the winding drums were outside. The engine was operated by hand working of the valves by the hoistman, a very skilled job. The engine itself was certainly of some historical interest and was apparently supplied by Thornwill and Warham.

The winzes at the 144 and 154 fm. levels were operated by Tickle Bros. single drum compressed air hoists, and the cage wound through single purchase pulley blocks.

The main electric hoist at Warrencarr shaft was by M.B. Wild and of modern design.

The haulage system, generally speaking, was unsuitable for any large increase in output. It was, of course, a very expensive and difficult haulage system, mostly as a result of the difficult nature of the mine itself and the way in which the deposits had to be developed. The chief reason became immediately obvious with a glance at the section of the workings, there being three different levels for main haulage, connected by shafts with limited winding capacity. A large amount of transferring traffic from level to shaft and back to level again was also costly and difficult at best. Other reasons have already been mentioned, namely the tortuousness of the main levels and the light construction of the track, also the very narrow gauge of the mine track and the consequent use of small mine cars added to the difficulties.

PUMPING AND THE WATER PROBLEM

Pumping was always a big problem at Millclose mine, since the further out the workings had been driven from the shaft, the heavier the influx of water became until it reached enormous proportions for the size of the mine. It is very likely that most of the water was surface water which had made its way down through the limestone by devious courses along joists and cavities and into the most convenient sump, Millclose Mine! This water probably travelled quite a long distance underground before making its way into the mine. Owing to the water finding its way into the workings in so many places and to the tabular and jointed structure of the surrounding strata, it would be quite impossible to seal it off in any of the known ways, so the whole quantity had to be pumped out of the mine, much of it not only lifted through almost 1,000 feet vertically, but also moved horizontally through a distance of over two miles. The quantity of water pumped amounted to about 7,000 gallons per minute, or some 10,080,000 gallons per twenty four hours. The average cost of pumping this water was about £40,000 per annum, with electric power costs at 0.45 pence per k.w.h.

The following partial list of the pumps operating at the mine is not complete as it was not possible to visit all the pumping stations.

SITUATION	g.p.m.	HEAD	TYPE
Winze from N.W. Incline	----	----	1 Rotopump
154 level pump station	(750	58	M.& P.
	500	125	M. & P.
144 level winze from NE X-cut	---	----	1 Rotopump
No. 5 District	(---	----	3 Rotopumps
	(---	----	2 Ram pumps

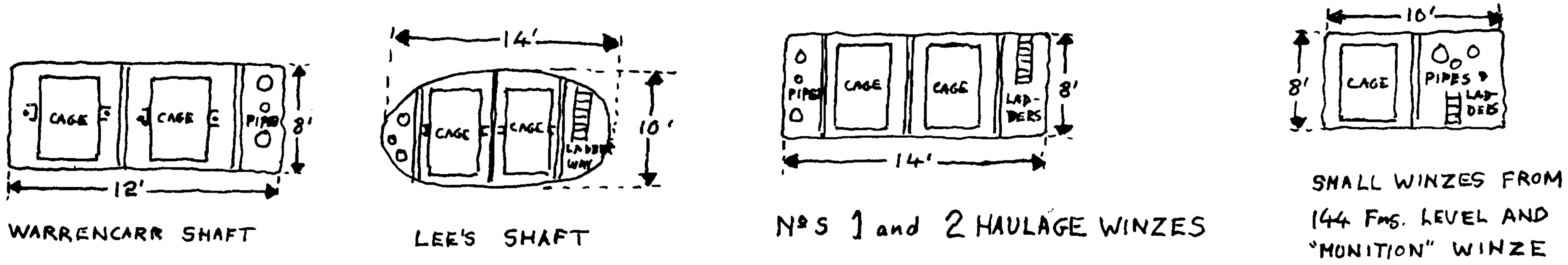


Fig.9. Sketches of shaft lay out at Millclose Mine.

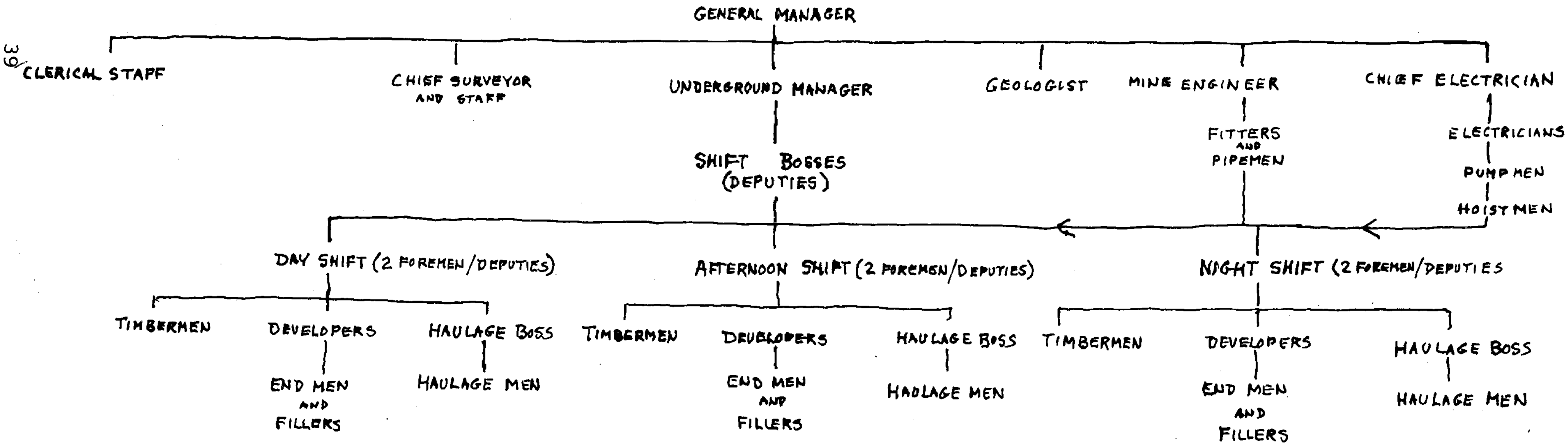


Fig. 10. Mine administration at Millclose Mine.

SITUATION	g.p.m.	HEAD	TYPE
144 level, shaft bottom	(3000	270	*Mather & Platt.*
	(1600	300	M. & P.
	(500	325	M. & P.
	(3000	270	M. & P.
103 level booster	3000	120	M. & P.
128 level station	500	----	M. & P.
112 level	(450	80	M. & P.
	(		3 Rotopumps
103 level Boil-up bottom	(1000	215	M. & P.
	(2000	215	M. & P.
	(750	215	M. & P.
	(800	205	M. & P.
	(1500	215	M. & P.
	(500	120	M. & P.
"Munition" bottom	(2260	175	M. & P.
	(2000	155	M. & P.
Munition" booster sta.	2000	80	M. & P.
73 level boosters	(3000	117	M. & P.
	(1600	95	M. & P.
Lee's shaft bottom	(750	500	M. & P.
	(1600	450	M. & P.
Stage in Lee's shaft	Three M. & P. pumps, details not seen.		
Warrencarr shaft bottom	2500	410	M. & P.

Until a few years ago the water was dealt with by three large Cornish pumping engines at the surface and one at No. 1 Haulage winze, which was electrically driven. These were all replaced by electric pumps underground.

ORGANISATION AND LABOUR

Fig. 10 shows the arrangement of the mine staff directly concerned with underground operations. The underground workmen were all paid on the day's wage system and the development men got a bonus when the nature of the work and progress warranted. The day's wage system was open to some criticism on the grounds that it made for a certain amount of laziness among the workforce who knew that they were guaranteed the same wages whether they worked hard or not. For the system to work satisfactorily close supervision was necessary. Under the day wage system of payment the supervision of work was not really comprehensive enough, since each of the two "Deputies", or Foremen on each shift was responsible for a very large area of workings and could not visit each working place for more than a very short time during each shift.

The times of shifts were: Day shift from 6.0 a.m. to 2.0 p.m., afternoon shift from 2.0 p.m. until 10.0 p.m. and night shift from 10.0 p.m. until 6.0 a.m. Half an hour was allowed for a meal break in the middle of the shift, taken at or near the working place.

Wages were not high, miners earning 11/- to 12/- per shift and miners' mates 9/- to 10/-, and with time and a quarter on Saturdays and time and a half for Sunday work.

Since there had long been a tradition of mining in this area, a cadre of older and fully trained miners was always available, and the local younger men took to the work at the mine very readily and quite soon became skilled workers.

Many of the older miners were highly skilled men who had a great knowledge of local mining conditions and were also deeply interested in the mines of the area and the nature of the ore deposits themselves. If they had any drawback it was probably that many of them tended to adopt an attitude of "what was good enough for my father is good enough for me and should also be good enough for you young fellows." Thus they sometimes did not take very kindly to new methods of working.

BRIEF NOTE ON THE SURFACE PLANT

The ore was wound up the Warrencarr shaft and tipped into one of two 500-ton ore bins at surface. There were two royalty areas in the mine, the Stanton and Haddon areas, and tallies on the mine cars indicated into which bin the ore should be tipped. Until 1933 when the new hoist and surface works at Warrencarr became operational, all ore was wound up Lee's shaft and sent by an inclined tramway to the dressing plant at Warrencarr.

Two of the replaced Cornish pumping engines stood idle in their engine houses at Warrencarr, but were out of use after the electric pumps were installed underground.

Electric power came to the mine via three different feeder lines. Since an electric power failure of any duration at the mine would be very serious, a diesel driven standby plant was installed and kept at immediate readiness.

Compressed air for the mine was provided by two 1,500 c.f.m. direct coupled Bellis and Morcom air compressors at Warrencarr, where there was also an assay office and engineering workshop. Drill sharpening was carried out close to the top of Lee's shaft.

The General Manager's and other mine offices were situated close to the road at Darley Dale, between Lee's and Warrencarr shafts.

After 1933 the mill was completely reorganised and the flowsheet attached to these notes shows the position at the beginning of 1937, but after that date the slime table department was replaced by a flotation plant, with a battery of 72 Denver Sub-A cells.

From the mill the lead ore concentrates were loaded into a narrow gauge (2 ft.) train and trammed by a diesel locomotive to the smelting plant, about a quarter of a mile from Warrencarr.

CONDITION OF THE WORKING PLACES AT THE END OF APRIL 1939

a) <u>The stopes and development ends</u>. **(Fig.II).**

On the 93 fm. level: still some good ore at this level, being stoped out, although it consisted chiefly of the leavings from previous working. Number 3 end showed some promise that it might lead to a good flatting below the old stopes, but other than this there seemed to be little prospect of finding a great deal more ore at this level.

On the 103 fm. level and in the South-west District several joints were still being worked for good ore, but again the quantity was strictly limited and there did not seem to remain any further known prospects at this level.

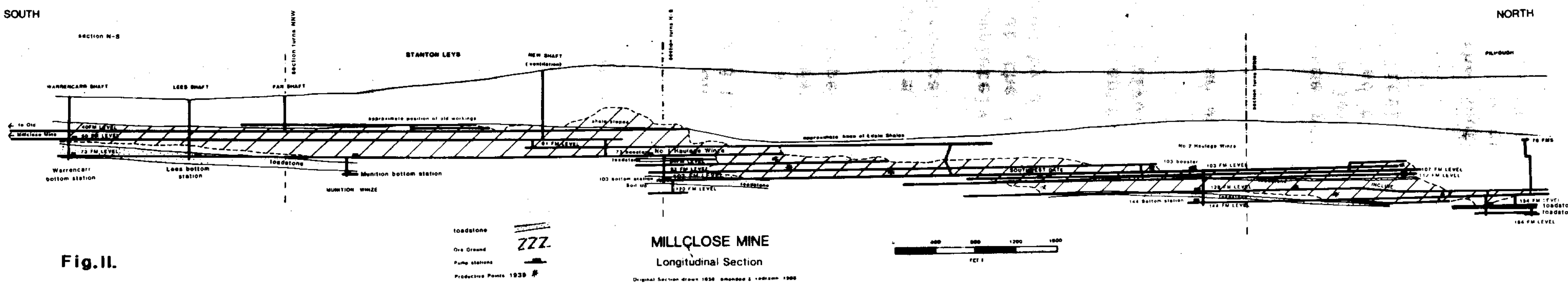
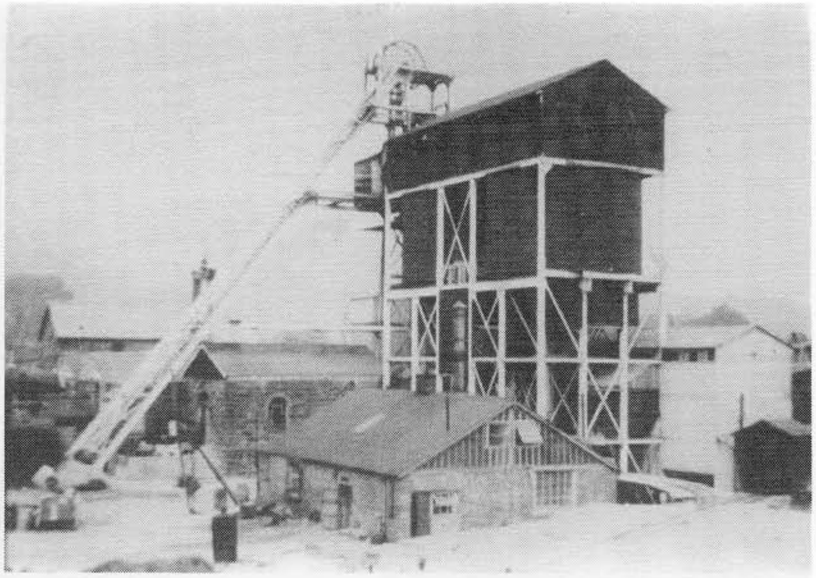
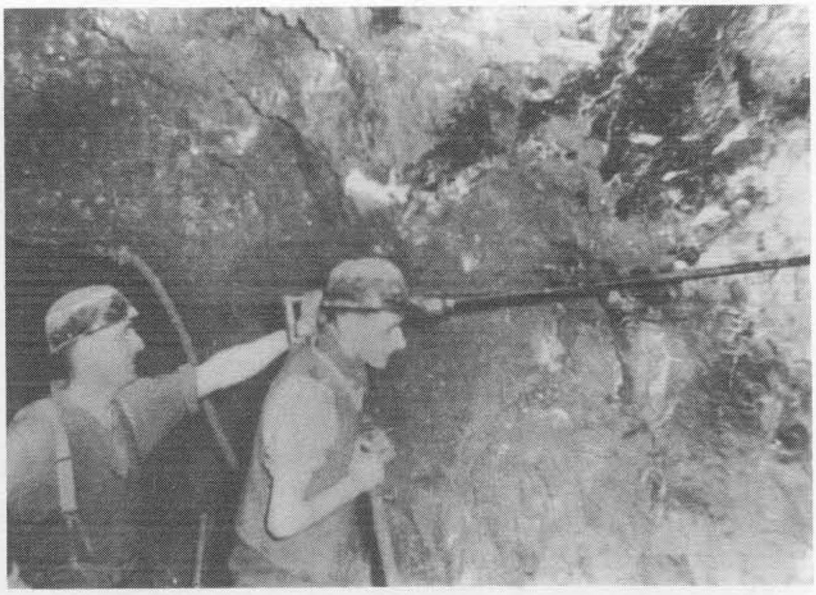

SOUTH
NORTH
section N-S
section turns NNW
STANTON LEYS
NEW SHAFT
(ventilation)
section turns N-S
WARRENCARR SHAFT
LEES SHAFT
FAR SHAFT
approximate position of old workings
shale stopes
to Old
Millclose Mine
40FM LEVEL
73 FM LEVEL
toadstone
Warrencarr
bottom station
Lees bottom
station
Munition bottom station
MUNITION WINZE
No 1 Haulage Winze
103 bottom station
120 FM LEVEL
approximate base of Edale Shales
No 2 Haulage Winze
103 booster
103 FM LEVEL
SOUTH WEST GATE
128 FM LEVEL
144 Bottom station
144 FM LEVEL
107 FM LEVEL
INCLINE
toadstone
toadstone
164 FM LEVEL
toadstone
Ore Ground
Pump stations
Productive Points 1939
MILLCLOSE MINE
Longitudinal Section
400
800
1200
1600

Fig.II.



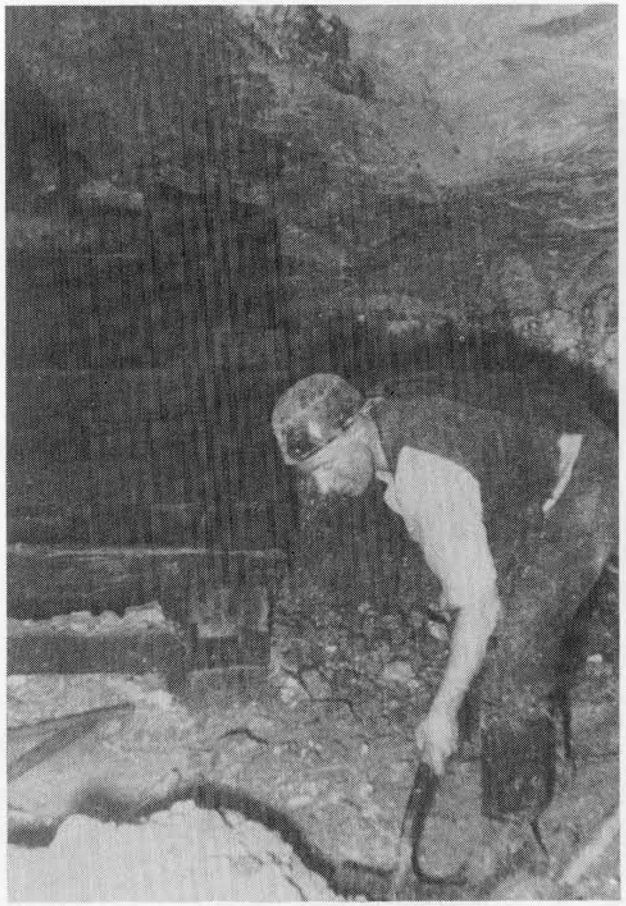
1. Warrencarr Shaft in 1939, showing headframe and ore-bins.



2. 93 ftm level: cleaning up last remnants of ore. Driller is Walter Boam.

3. 164 ftm level: exploration sinking at lowest level reached. A very wet place!

4. Lee's Shaft: mine office and coe at left, drill-sharpening and fitters" workshop at right.



5. 129 ftm level: shovelling ore into boxhole.

6. 93 ftm level: stowes at the top of a clean-up winze to the bottom of a wing deposit.

On the 107 and 112 fm. levels good ore was being worked in several places, but since all these places border old stopes, the prospects did not appear to be very good for future ore.

On the 129 fm. level there were only a few pillars left and these were being extracted.

On the 144 fm. level there appeared to be very little ore left in sight and cleaning-up was in progress. In any case the ore at this level was mostly zinc ore.

Such ore as there has been on the 154 fm. level appeared to be almost exhausted and was in any case of a low grade.

From the above it was evident that the mine was very nearly exhausted so far as the known ore deposits were concerned, and the future of the mine lay in the results which may be obtained from developments then in progress.

b). Developments. The new developments above the 112 fm. level included such ore as was found in the process being stoped out. This drift showed promise of finding good ore for some distance along the top of the 129 fm. level stopes, but could not extend very far in the known ore ground.

On the 144 fm. level there were three developments in progress. Firstly a raise was being put up at the far north-west of the mine to prospect the ground above the main ore channel. This raise reached the horizon of 76 fathoms from Lee's shaft datum, but discovered nothing new at all. In raising here feeders of water containing much hydrogen sulphide were encountered, so that it was known by the miners as "stinking water raise".

Secondly, a raise was being put up from the north drift, which branched east from the main joint at the end of the 144 fm. level. This raise only found a small leader containing half an inch of galena and some calcite. It also cut heavy feeders of water.

The winze from the N.E. crosscut, further back on the 144 fm level proved to be entirely barren, although it had been sunk more than seventy feet. The ground here was unmineralised, except by small patches of white calcite.

On the 154 fm. level the winze from the N.W. incline also proved to be entirely barren, and it passed the horizon of the 164 fm. level. The ground encountered had much the same appearance as that found in the last mentioned winze.

From the above it was evident that the ground exposed at the present time held very little of value and showed small prospect of finding anything more. On looking at the ore distribution map it appears that the run of ore ground tailed-out to the north and that so far as the known Main Joint system and its ramifications were concerned, the mine was almost exhausted. The Joint system had been tested in all directions and in every case it proved to be more or les barren as far as developed.

May 1939