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MINE TIMBERING IN SECTION 16 OF THE LAKE SUPERIOR MINING COMPANY, MICHIGAN.

(By C. G. CAMPBELL, S. Can. Soc. C. E.)

(Read before the Mining Section on 25th February, 1904.)

In the following paper it will be necessary to depart somewhat from the subject proper and give a brief description of the location of the mine, the method of mining the ore, the management, etc.

Section 16 is essentially a hard ore iron mine, situated three-quarters of a mile from Ishpeming, a town fifteen miles from Marquette, on the south shore of Lake Superior.

The mine is worked chiefly for hard ore, there being three large lenses, each of a different grade, according to the percentages of iron and phosphorus contained. There are also two " pockets " of soft ore, which is locally known as " Haematite," but after mining these " pockets " for some time, it was found that the ore was too high in phosphorus to compete with the soft ores of the surrounding mines. So, for the present, at least, the mining of it has ceased.

The hard ore is found with a foot wall of decomposed Diorite, resembling soapstone, and a hanging wall of quartzite or jasper. A great dyke of Diorite cuts across the deposit and makes the formation somewhat irregular. The three lenses dip at average of 70° with the horizontal. They have an east to west strike and vary very much in their dimensions ; ranging from 10′ to 700′ long.

The dimensions of the so-called "South vein" have not yet been determined, as it reaches below present operations.

The method of extracting this hard ore is as follows: At intervals of 60', levels are run out from the vertical or hoisting shaft until the ore is reached. A tunnel is cut along the length of the lens, clinging to either hanging or foot wall as the case may be. Raises are then made every fifty feet to the above level or nearly so, a back of fifteen feet being left to make tramming safe. Through this back a small hole is cut to let down timber, also for the purposes of ventilation, etc. When first cut, these raises are nine feet in diameter and are afterwards widened until the dividing pillar is as thin as is consistent with safety, say 15' in the average.

The next step is, in many ways, modified by the width of the lens, but it suffices to say that the stope is carried across the width of the vein, the shift boss using his own discretion as to the method employed. Finally, however, the stopes or raises are filled up with rock, leaving a timber tunnel for the passage of trams on the level below. Mills are also built and rock filled in around them, a process which will be described more fully later. The pillars are then mined out and the places where they were filled in with rock. In this way all the ore is secured.

The "Haematite," so-called, is mined by the "square set" system, which consists of taking out slice after slice of the ore, the length and breadth of the "pocket," and in its place putting timber in the form of skeleton cubes, the sides of which measure eight feet. These cubes or "square-sets," as they are called, are put in one at a time, just enough ore being taken out to allow the erection of a single square-set. The pocket is worked from bottom upward, thus securing the advantage of gravity for the removal of the ore. All the ore is sent down by means of improvised chutes made of lagging.

The mine is at present 850' deep and the shaft is still being sunk to tap the south vein. There are at present thirteen levels, twelve of which open on to the shaft. The 4th, 5th, 6th, 7th and 8th levels have all been mined out even to the pillars. On the lower levels, tunnelling and raising are being carried on, while on the first three levels, the "robbing of the pillars" is not yet completed.

There are two other shafts, besides the one above mentioned. These are used for ventilation and shooting down the rock used for filling. These shafts, one of which is inclined, reach only to the second level. From there on, the rock is sent to the lower levels by means of mills.

For the most part, the "Hard Ore" justifies its name and is hard and compact, but occasionally it is of a slaty structure or full of cracks and fissures. In such places it is necessary to use drift sets. Similar protection is also necessary when drifting through decomposed Diorite, locally known as "Soapstone."

The proposition which the timberman has to handle, now having been outlined, the respective applications of the different methods will be taken up in detail.

The timber is obtained, for the most part, from lumber camps, the furthest not being more than twenty miles from the mine. This timber is taken to the mine by rail and stocked near the main shaft. Second class logs are used, knots and slight crookedness not being objectionable. The logs, cut into either 5½′, 8′ 10′ or 16′ lengths, are lowered into the mine by means of chains attached to the bottom of the skip. The timber men land them at the level station below with the aid of a rope, ship them on to a tram and take them to a timber-dock, where they remain until required. Between the hours of twelve and one on the day shift the miners are on the surface for lunch, and advantage is taken of this fact to lower timber. In consequence the timbermen remain below and take out timber, thus postponing their lunch for one hour. Hemlock and white pine are used for the most part in the large timbering. Cedar is used for lagging. The captain is at present experimenting on hardwood. Squared timber is used only in the shaft and under certain special conditions elsewhere. In other places not only is timber used round, but also with the bark on. The life of a "stick" is very uncertain, depending upon the nature of the wood, the stress to which it is subjected and the temperature, hence the moisture. On the 7th and 8th levels, immediately above the pumps, which are on the 9th level, the timber lasts only five months, after which it is quite easy to force the point of a candlestick six inches into the wood with the hand. This is exceptional, however. The average life of timber in the mine is *said* to be ten years. The timber is often crushed, due to the settling of ground, but there is little danger to life in this owing to the slowness of settling.

SHAFT TIMBERING.

The method of sinking the hoisting shaft is somewhat similar to that of raising a square set. A rectangular hole is stoped down to a depth of 10′, having a width of 10′ and a length of 18′, and in this hole is set up a double square set, 8′ x 8′ x 16′. This square set is suspended from the ore above by means of bolts. It is then wedged into place and lagged between the timber and rock. The shaft is then sunk another 8′ and another double square set placed and bolted to the bottom of the former, and so the sinking and timbering proceeds. The timber in the square sets used is from

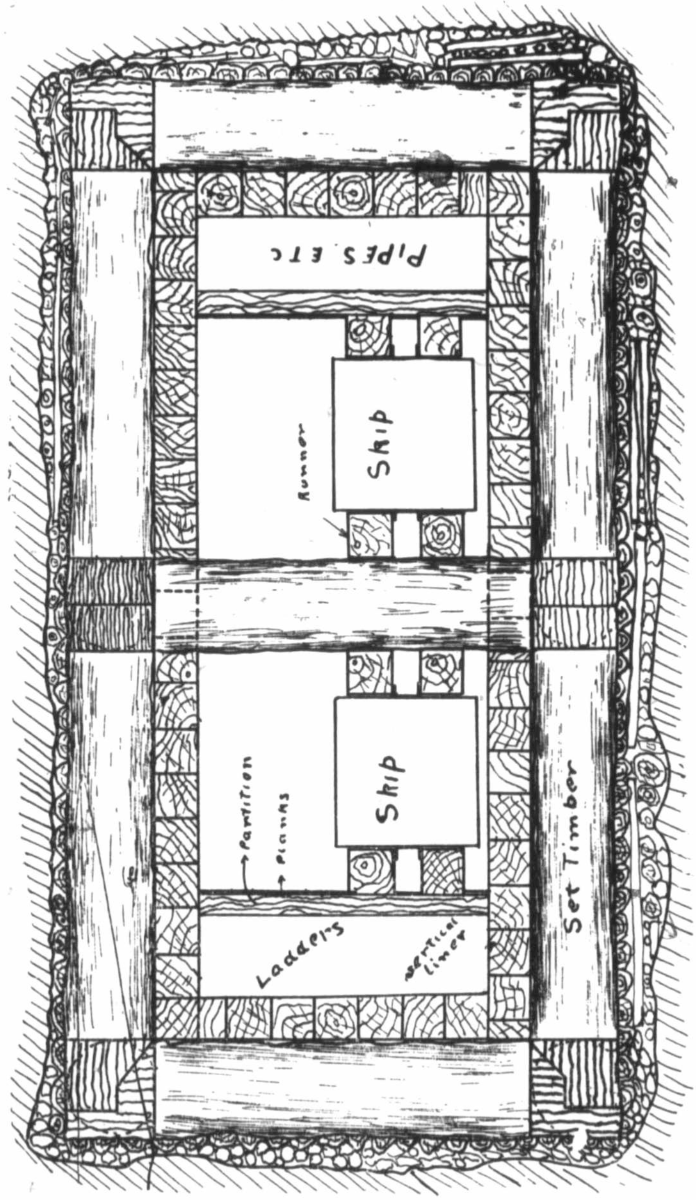


Fig 2.
Horizontal section through shaft.

12″ to 18″ in diameter. Every time an advance of three sets (24 ft.) is made, the small shaft pump is lowered the same distance, so keeping within the 27′ practical pumping limit.

The shaft is then lined inside the square sets with 8″ x 8″ squared timbers, 18′ long, placed close to one another vertically, giving the shaft a box-like character. In each set and parallel to the ends of the shaft are placed cross-pieces to which planks are nailed, thus dividing the shaft into four compartments. The centre two are about twice the size of the end ones and are used for skip roads, while the end compartments are used for pipe, pumps and ladder ways. (See Fig. 2.)

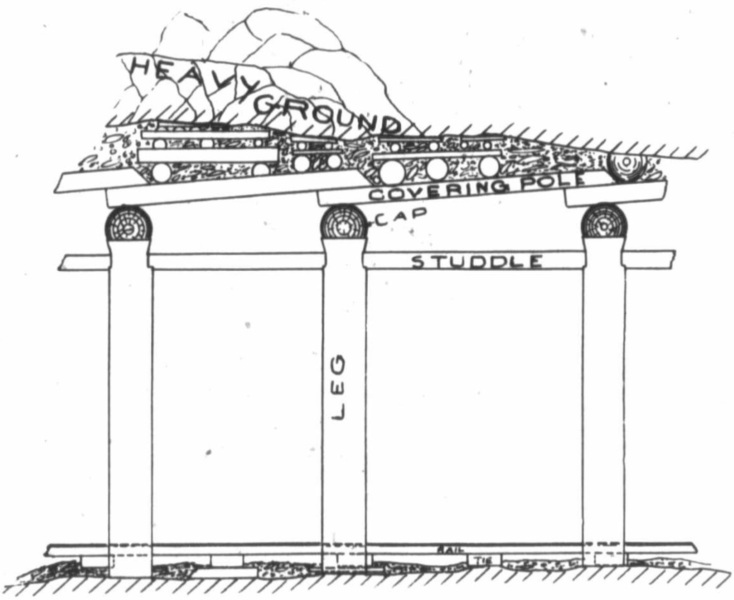
The skips, which are steel boxes 2′ 6″ square and 5′ high, slide in runners which consist of four 8″ x 8″ beams, two at each side of the skip. These are placed vertically 6″ apart.

Until lately much trouble has been experienced through water in the shaft. In view of stopping this water downpour, troughs or garlands have been arranged to carry the water into pumps at depths of 190′ and 680′. This has proved very effective.

The rock shafts are very much simpler in construction, being merely lined with rough unbarked logs built up like a crib. It is usual to hoist to the surface all rock from the stopes at the bottom of the mine and send it down again to the levels where the pillars are being robbed. Obviously this supply of rock would be insufficient. Hence carloads of loose rock are brought from the No. 1 Hard Ore Mine and dumped down one or other of the shafts as required.

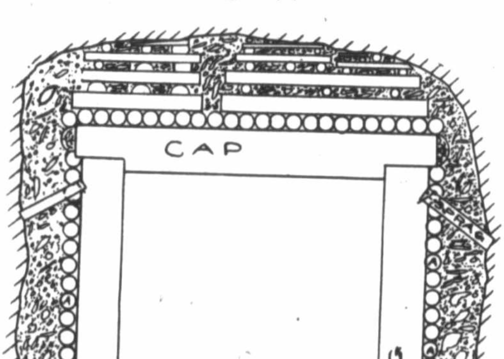
DRIFT SETS.

In running through Soapstone on the 2nd, 9th and lower levels, the back and sides of the tunnel are so weak that they have to be supported. This is done by means of "drift sets." Two trestles, five feet apart, each consisting of two legs and a cap, with a covering of poles resting on the caps, constitute for the main part what is known as the "drift set." The caps are chopped flat at the ends so as to sit firmly on the legs. The pairs of legs are kept apart by studdles, which are poles 4′ 6″ long and 4″ in diameter, set close under the caps and at right angles to them. See Fig 3 (a). The legs are firmly spragged against the wall and spaces between the legs lagged on the rock side. The lagging is nailed to the legs horizontally, one above the other, and the loose rock is piled in behind the partition so formed. The covering poles used are from 4″ to 5″ in diameter. These are laid lengthways, the ends of the poles in one direction of a set resting on a cap, and in the other direction resting on the ends of the poles of the preceding set. By means of small pieces of timber the back is caught up and wedged tightly.



Side elevation of drift set.

Fig. 3 (a).



End view of drift set.

Fig 3 (b).

See Fig 3 (b). If the pressure is likely to be great, owing to caving in of the sides of the tunnel, the legs are set wider apart at the bottom to ensure greater stability. At each end of a line of drift sets, slanting props or "rakers' are propped against the legs to keep the whole steady when the blasts go off. See Fig 3 (c).

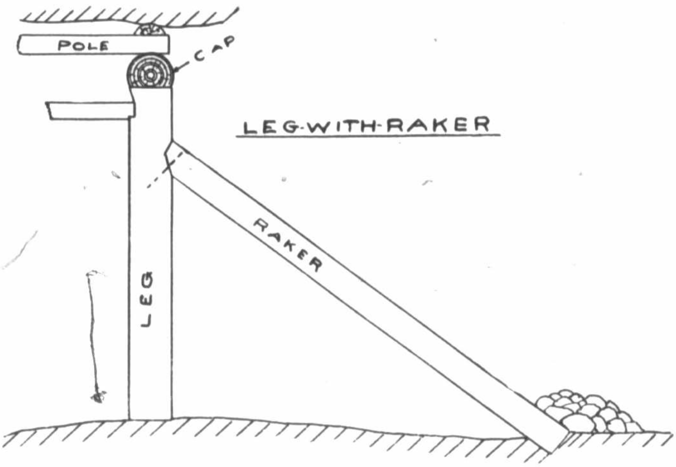


Fig 3 (c).

SQUARE SETS.

A single square set consists of four vertical legs arranged in an 8' square, each leg being 8' high. The legs of two opposite sides of this square set are held together by caps, which rest on the top of the former. The two other sides are held together, or better still, held apart, by studdles, in this case 8" to 10" in diameter. The studdles are nailed in place a little lower than the cap. The legs and caps have average diameters of 18" and 12" respectively. The top of each set is covered with 4" poles, in order to prevent ore from coming down on top of the miners. The whole set is spragged securely when first built and thus remains until surrounded with other sets. For the sake of strength and continuity, the same two sides of a square set always have the caps. If the stope is fairly wide and high, chutes are built in so that each one is fed by five columns of sets. Twice has an attempt been made to mine the hard ore by this system, but without success.

STULLS.

In raising up along the lens the hanging wall is often loose, great masses sometimes breaking off, and, in consequence, it is necessary to prop the loose ground up by means of stulls. See Fig. 4 (a). A stull is a single stick of timber varying in size according to the stress to which it is subjected. The distance is measured from

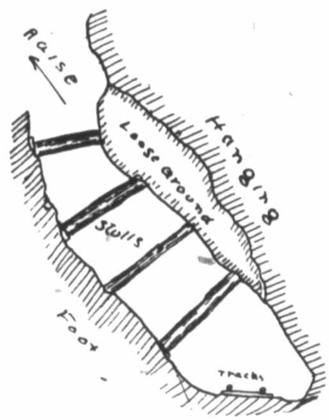


Fig. 4 (a).

foot to hanging wall and the stull cut a corresponding length. A socket is made for the end of the stull on the foot wall by scooping out a shallow hole. The stull is then driven into place and fixed tightly by means of wedges. For obvious reasons, every endeavour is made to have the greatest stress along the line of the prop, though in some cases this is not at all possible. See Fig. 4 (b).

In the raises on the 13th level, it is impossible to set up machines, owing to the narrowness of the lens and the steepness of the dip, except as follows: Two stulls are erected within 7′ of the breast on either side of the raise (8′ apart). On the top side, poles are laid halfway up to the hanging and then ore is pulled down behind these poles until a horizontal surface is obtained. On this surface, which is about 6′ wide by 9′ long, the machine is set up. See Fig. 4 (c) This is called a bench and is used for 16′ of advance stoping, after which another one is built above it in the same manner. It is found expedient to remove the lower ones as soon as the top ones are built, to give free passage for ore.

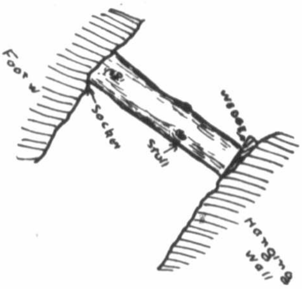


Fig. 4 (b).

Great difficulty is experienced in getting timber up into the raises. Owing to oversight, all the tackles are too short, so the logs have to be carried up the slope by the timbermen, who hold the log under one arm and use the other to pull themselves up. It is quite customary to do this for 30′ before the tackle comes into play.

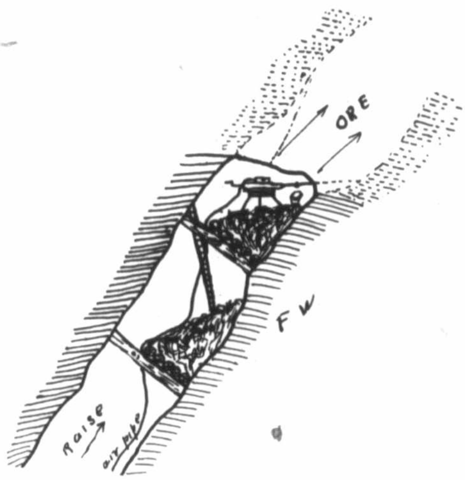


Fig. 4 (c).

"TIMBER PILLARS," OR CRIBS.

The duty of a timber-pillar is to "hold up ground." It serves the same purpose as a vertical stull, only on a much larger scale. The pillar is made of rough unbarked logs, 8′ in length and anything from 6″ to 2′ in diameter, according to the weight the pillar is to bear.

A pair of such logs, 7′ apart parallel to each other, are laid directly under the "bad ground" and on top of these are laid two more at right angles to the first two, the same distance apart and parallel to each other. Again on top of these are laid two more in the same way. The pillar is thus gradually built up to the back and eventually wedged down tightly by lagging and small pieces of wood. Considerable experience is required to make a tight fit, owing to the unevenness of the ground and the tendency for the whole to shift. All the pillars are inspected every day by the timber boss to guard against any such failure. In laying one cross-piece on top of another there is great tendency to roll, in consequence notches or "joggles," as they are called, are cut in the lower log, into which the upper one fits. It is not usual to cut them more than 3″ deep.

Wooden pillars are used nearly altogether in the robbing of the ore pillars in between the stopes. These ore pillars are about 25′ through from stope to stope. A space is cut out of the pillar,—about 9′ through and the width of the lens, if the same be narrow—and 8′ high. As many pillars as can be are built in this space, three feet always being left between them for walking roads. Sometimes, instead of making two pillars of the foregoing dimensions, one long pillar is made 16′ x 8′. The inside of the timber pillar is now filled with loose rock. This rock steadies the pillar and takes the bulk of the weight when the back settles. The long pieces are called "edgers" and the shorter ones "cross-pieces." When these pillars are securely wedged against the back, the machines are set to work again and a space similar to the first is mined out and treated with pillars. This process is carried on the width of the vein and breadth of the ore pillar until all the ore in the latter rests on timber. The stopes on either side are now filled with loose rock to the level of the top of the timber pillars, likewise the spaces in between the pillars, and the process of mining out and timbering proceeds as before, the timber pillars having as their floor the tops of pillars of the slice below. The level of the rock in the stopes is kept up to the bottom of the timber pillars.

"DOCKS."

The purpose of a "dock" is to hold back rock. It is used where loose rock is pouring down upon the track and so stopping the trams; likewise in filling the stopes, as before mentioned.

The dock is a simple cribwork like the timber pillar. Rock is dumped inside and then the running rock is allowed to bank up against it. The double length 16′ is more usual than the single in docks. To save timber and labour the inside edgers are sometimes

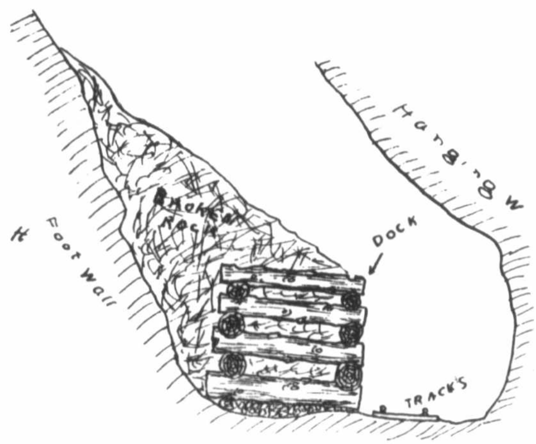


Fig. 5.

done away with, the ends of the cross-pieces resting on the outer edger and on the sloping pile of rock. As the work progresses, a couple of men shovel down rock and thus keep the level of the rock up to the required height for the cross-pieces to rest upon. See Fig. 5.

In filling the stope a tunnel must be left for the trams, hence on both sides of the track, docks are built to a height of 8′ and are filled with rock in and behind. A double layer of covering poles, 4″ in diameter, are laid across from one dock to the other and the whole is filled over with rock. It is considered advisable to leave ample space overhead in the tunnel, because the pillars sink sometimes three feet or more, owing to the settling of the rock filling. It is found that the hanging-wall side settles much faster than the foot-wall side.

The spaces between the logs are stopped up with "filling pieces," to prevent the rock from coming out into the tunnel.

MILLS.

Mills are used in robbing the pillars to convey to the level below, the ore which is mined. A mill might be called the converse of a timber pillar. It is cribwork built up like the other, but is not filled with rock. Instead, the mill is covered with cedar lagging on the outside and filled around with rock.

The mill is built in the same relative position to the tunnel as the dock. As the ore is taken out above, it is dumped into the

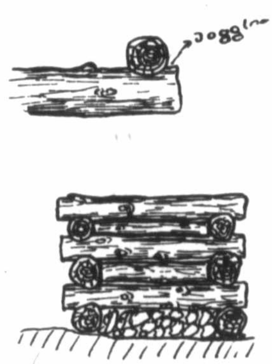


Fig. 6.

mill, coming out into a tram in the tunnel by means of a chute.

The mills are made either single or double, being 5′ 4″ x 5′ 4″, or 5′ 4″ x 10′. The latter is the more usual form, one compartment being used for a ladder road, the other to dump rock down.

Filling pieces are used in the partition of the double mill to prevent rock from coming into the ladder-road. (See Fig. 6). There is an enormous wear and tear on the mills due, to the falling ore, hence the soundest timber is used. Hemlock is preferred owing to its toughness.

The life of a mill is very uncertain. As an average, a mill lasts three months when it is worked night and day for six days each week. What happens is that the pieces of ore cut through the cribbing pieces, attacking all sides of the mill impartially. To repair a mill, it is lined with ¼″ 4′ x 6″ iron plates for 20′ down and then with 3″ planks. The wear and tear depends upon the height of the mill, the kind of timber and the nature of the ore. The diameter of the pieces of timber is from 10″ to 18″.

It is customary to give an inclination of 15° to the vertical, to the mill, in order to break the fall of the ore and so save the bottom boards of the chute, and, incidentally insure safety for trammers.

CHUTES.

The chutes that empty the mills are 2′ wide at the smaller end, widening out to 4′ and covering all the floor space of the mill. They have an inclination of 45°, the mouth is 4′ 6″ from the track and protrudes 1′ into the tunnel. All chutes are made of 3″ x 8″ planks. Spaces are cut out of the cribbing pieces of the mill to permit the chutes to be made. Chunks of ore, 8″ or less in diameter, can get through the chute, anything larger than this sticks in the chute and has to be "block-holed." This is to be avoided, because the blasting soon destroys both mill and chute. (See Photo II). In the case of the square set chute, the ore is never allowed to fall directly into the chute from any height over 8′, as will be seen, the inclined lagging in each set acting as a sort of chute.

The ore is kept back by means of boards fitting into slits in the sides of the chute. Sometimes it is hard to send these planks into place and so complications arise.

STAGING.

When it is necessary to take ore off the back of a high stope, the drilling-machine has to be raised within a few feet of the place to be mined. This is done by means of staging. A stage consists of three ladders, each at the apex of an equilateral triangle of 5′ side. The ladders are inclined outwards and are wedged against the back. Planks are then placed on the rungs of the ladders, so as to make a platform. The machine is then set up on this platform. At the best it is a very shaky affair and cannot be carried to any great height ; 15′ being considered a very good height for the platform of such a stage.

LADDERS AND SOLLARS.

In this mine the ladders all have an inclination. This inclination tends to make climbing much easier and safer. The poles of the ladders are made of 3″ x 5″ white oak scantling. The rungs or "staves" are either of white oak or iron, the former being 1½″

in diameter, the latter ¾″ in diameter. Under the corked boots of the miners they are soon worn through and are in many cases left too long for safety.

The shaft ladders are in sections of 20′. The sollars are 15′ apart, with a hole in each large enough for a man to get through with ease. The end of the ladder protrudes through the hole.

The ladders in other parts of the mine, in the other raises for instance, are much longer and are made by bolting together two or more 20′ lengths with scantling, on the outside. The ladders are always spragged securely to prevent shaking.

The sollars are a great means of safety and prevent many serious accidents, especially in the shaft, where it is now impossible to fall more than 20′, in the ladder road, that is to say.

MISCELLANEOUS.

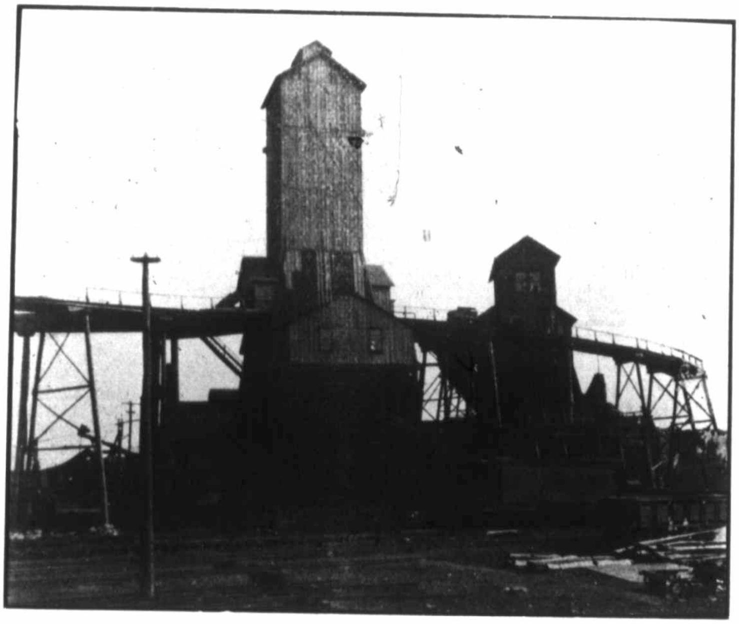
The timber-gang in full force is eleven strong, counting the boss. Below is a classification of the men in the mine.

Captain..	$4.50 per diem. (?)
Shift-bosses.. .. .. .. / Timber-bosses..	$2.50 " "
Barn boss..	$2.30 " "
Timbermen. ...$1.85 to	$2.00 " "
Miners..	$2.10 " "
Helpers to Miners..	$1.85 " "
Contract shaftmen..	(Paid per foot of shaft sunk,)
Ore trimmers.. .. .. / Rock "	$1.85 per diem.
Pumpmen.. .. .. / Track-layers.. .. .. / Skip tender.. .. .. .. / Track cleaner..	Unable to obtain amount of their wages.

The tools of the timber-gang are few. The following is a list of their whole outfit :—

Wax candles	..5 per day of 10 hours.
Two saws ..	..hand and cross-cut.
Axes..	..one per man (used also as hammers.)
Spikes	..various sizes. (1″-12″ long.)
Ropes.	" "
Chain.	..8′ long.
Timber truck.	
Log pike.	

The foregoing information was obtained by the writer at Section 16 Mine last summer. The figures given are, to the best of his knowledge, accurate. However, the character of the mine is such that rules of thumb are few and far between. When a problem presents itself, it is solved according to the ideas of the particular shift-boss in charge, subject to the approval of the captain who makes his rounds every morning. In conclusion, the writer wishes to acknowledge the kindnesses extended to his party and himself by the officials of the Lake Superior Mining Company during their stay in Ishpeming.



I.

Section 16 Shaft-house. Notice the steam shovel and the ore dumps.

II.

This is a typical mill chute. Notice the extra cross-piece for the double-mill ; also the pike and tram-bar beside the track.

nd and 1

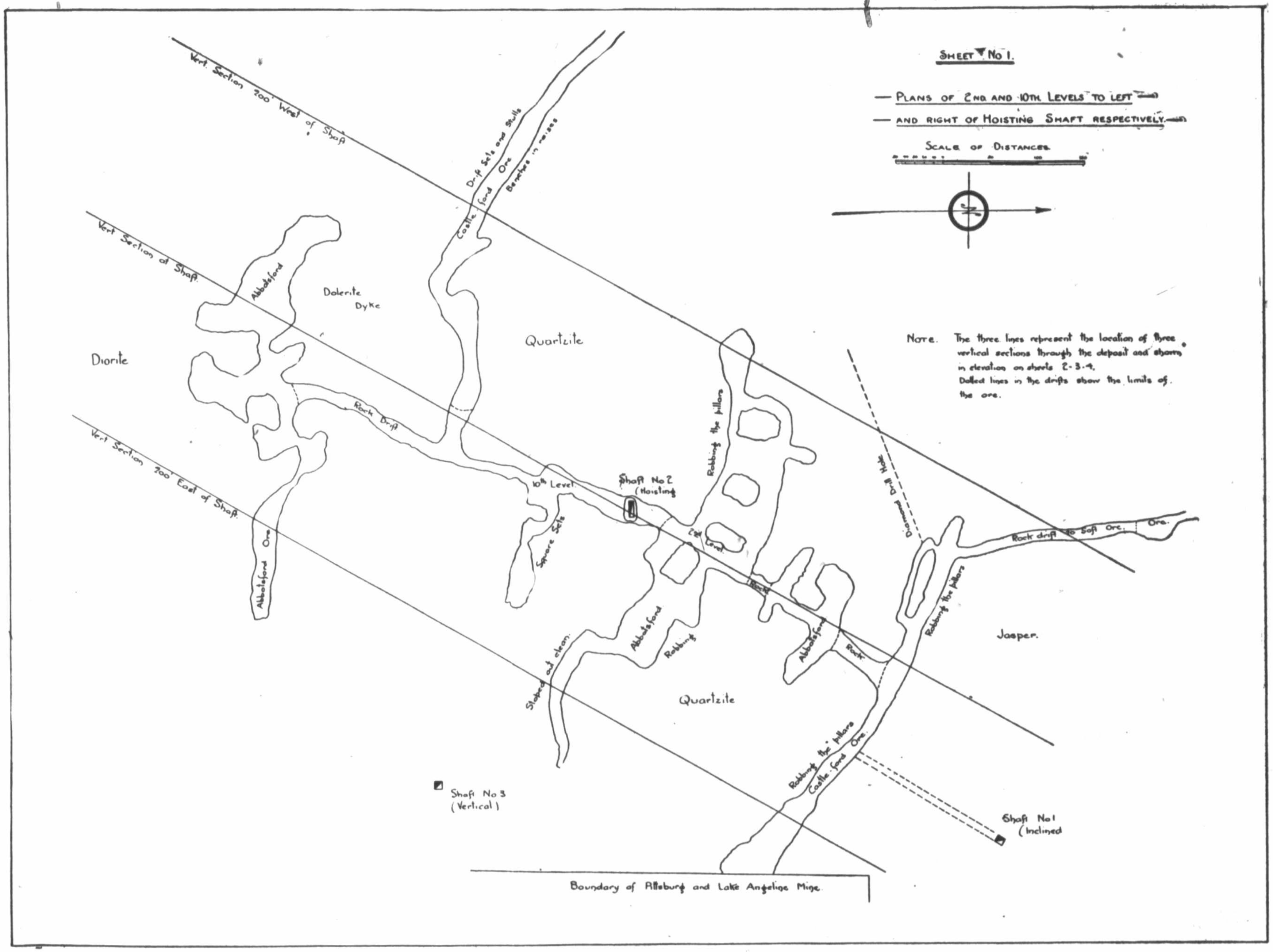


Fig. 1.
Projection of 2nd and 10th levels. These levels are 370′ apart.