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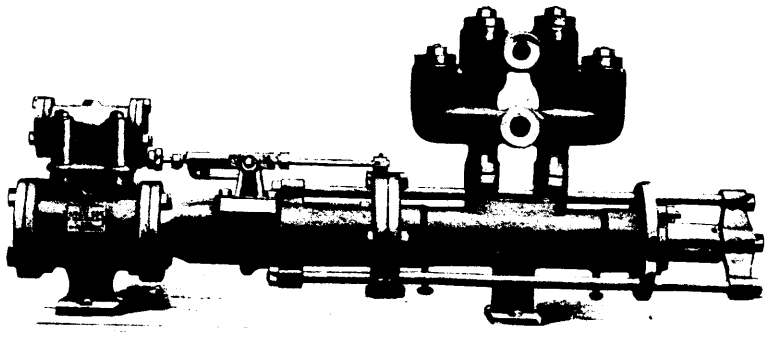

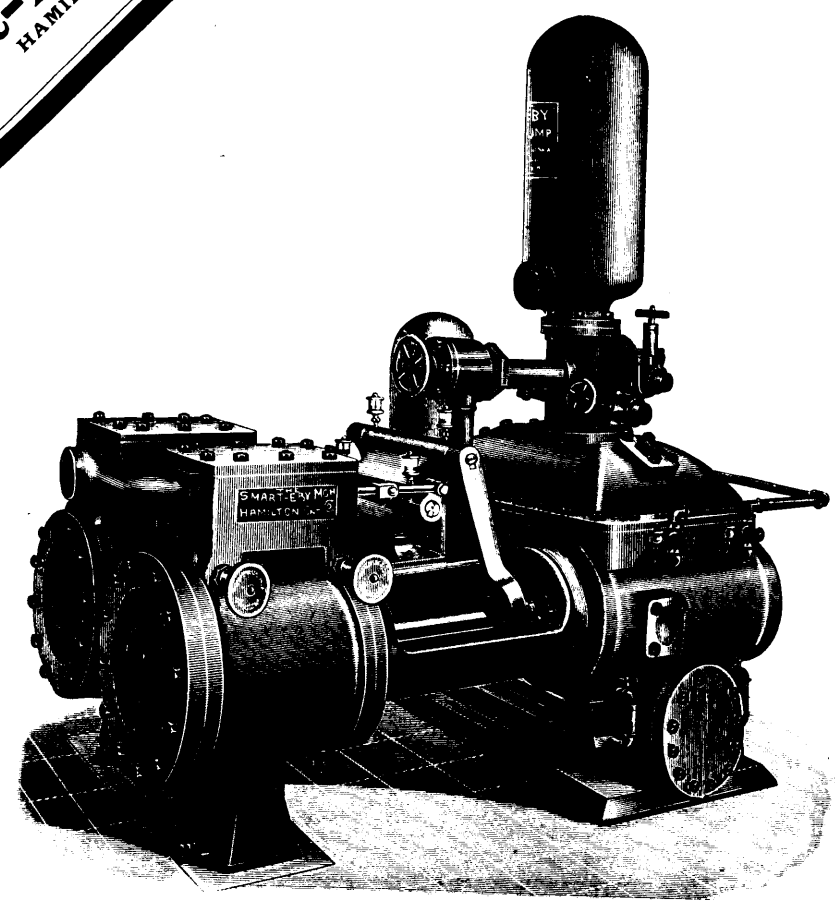

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The Fernie Explosion.

On May 22nd an explosion occurred in the Fernie mines of the Crow's Nest Pass Coal Co., by which 130 men lost their lives. An inquest on the bodies, which owing to the presence of expert witnesses sent by the Government, took the form of an investigation, lasting for twelve days, was concluded on the 21st instant, and a verdict unanimously arrived at of which the full text is given below. The purport is that the widespread explosion resulted from the presence of a large quantity of dry coal dust which had been allowed to accumulate in the mine until it became dangerous, and the jury added to their verdict recommendations to the Government to enforce the use of a better safety lamp, additional precautions as to blasting, a more thorough inspection of old workings, and an efficient system of watering.

This forms a strong indictment against the management, which, on the evidence adduced, was either ignorant of the true character of the danger existing in the mine, or of the precautions necessary to be taken for the protection of the miners, to say nothing of the property. The facts briefly are that the mine in question, No. 2, is situated on Coal creek, five miles from the town of Fernie, employing about 400 men and having an output of nearly 1,000 tons a day. It works three shifts, two for coal-getting and one for repairs. The morning shift had safely finished work on the 22nd May and the afternoon shift, commencing at 3 o'clock, had continued until 7.30, when a tremendous blast came from the tunnel mouth of No. 2 and No. 3 mines, which are only 100 feet apart, sending out clouds of dust and debris, flinging timbers and coal across the creek, smashing the sides and roof of the surface store-rooms and blowing the roof off the fan-house. In addition, a column of dust, like the spouting of a crater, rushed from the fan-house into the air to the height of 500 feet. There was no smoke and no flame. There were at this time in the two mines, which were connected, 152 men. The fan was saved by the blowing away of the roof, and, being unaffected, continued to revolve. Within a few minutes eager rescuers began to enter No. 3 tunnel and were able to assist 22 men, already in the last throes of a death struggle with after-damp, to escape. These are all who were saved, for almost immediately the whole of the workings to the mouth of each tunnel were filled with after-damp and it was certain that every man in the mine was dead. From the 22nd May to date rescue work was continued. Only three or four bodies are still missing, and they, it is almost certain, lie buried beneath falls of rock in some of the roads. There are 50 widows and 60 families bereft by this, one of the most extensive and fatal mine explosions with which we have had to deal in Canada. As the whole of the evidence will shortly be available we do not propose to discuss it at any length in this article, reserving a detailed examination for our next issue, but the magnitude of the disaster and the many important points raised during the investigation demand a passing comment, especially in view of the gravity of the verdict returned by the jury.

First of all, the fact is finally conceded by all parties that it was a coal-dust explosion. Every effort was made by the company to combat this theory, which was laid down a few days after the explosion by Mr. Wm. Blakemore, a former manager of the mine, in an expert report, but in the end the company's managers, the miners' committee and the Government experts confirmed the accuracy of his deductions, and the jury endorsed it in their findings. This is an important matter, because it establishes for the first time in Canada what has long been admitted in Great Britain, and raises the hope that such an admission will lead to the adoption of the most modern and scientific methods of dealing with what Professor Galloway, the greatest living authority on coal-dust, in his latest report on the Universal Colliery explosion in Glamorgan, says is "the *greatest* danger" in coal mines.

The Crow's Nest Pass Coal Co. have been slow and not apt scholars in respect to the safety of their mines. We wonder what they will say to the admission by their chief mining superintendent that he had had no previous experience in a "dry and dusty" mine before coming to Fernie; that he had never analysed or otherwise tested the dust in the Fernie mine to ascertain whether it was explosive or not; that he had neither removed nor watered the dust in the old workings because it was "impracticable"; that the only method of watering the dust was with "a car and a can," and that "the explosion may have resulted from his inability to remove or water the dust in the old workings," although he travelled them for purposes of inspection. The overman frankly admitted that the explosion may have resulted because of the ignorance of himself and the other officials as to the truly dangerons character of the dust, and this is the most charitable conclusion which can be drawn. But in all matters affecting the safety of human life, ignorance, which is the result of unacquaintance with what any official undertaking the direction of such matters should know, is culpable, if not criminal, negligence for which his employers are responsible.

The recommendations of the jury indicate with admirable perspicuity the other glaring omissions which have characterized this "management," and we have little doubt the Government will give effect to them without a moment's delay, as they are the practical working out of principles recognized in mining practice in Great Britain

more than ten years ago. One of the chief officials of the company stated during the progress of the enquiry that the explosion would cost them, directly and indirectly, $500,000, or the equivalent of two year's profits based upon the last annual report. We do not doubt it, but it is a small price to pay for the experience acquired compared with the heart-breaking sorrow represented by 130 mounds on a little hillock behind the town of Fernie.

VERDICT OF THE CORONER'S JURY.

The coroner's inquest upon the death of Steven Morgan, Joseph Sangalla, and Wm. Robinson, came to a close today, and the jury, after being out for seven hours, brought in the following verdict :—

"That the said Steven Morgan, Joseph Sangalla, and Wm. Robinson came to their death on Thursday, the 22nd day of May, 1902, at or about the hour of seven-thirty o'clock in the evening, in what is known as numbers two and three mines, situated on Coal creek, near the town of Fernie, in the province of British Columbia, the property of and worked by the Crow's Nest Pass Coal Co., Limited ; that we, the said jury, find the initial cause of the explosion, being at a point in the No. 2 mine aforesaid, not clearly defined, and that said initial cause extended from the said undefined point throughout the greater portion of No. 2 and 3 mines, by coal-dust being the conveying medium; and we find in consequence that the inadequate method of watering and removing of the dust left the mine in such a condition as to be dangerous, and thereby providing a medium whereby the initial cause was augmented and intensified ; that we, the said jury, recommend the Government to take such steps to enforce : 1st, the immediate installation of the most approved system of watering for allaying dust in coal mines ; 2nd, that a more thorough inspection be adopted at these mines, throughout the old workings and rooms contiguous to the air channel that are not being worked ; 3rd, that the safest explosives and most approved safety lamps be used.

(Signed) "A. H. CREE, *Foreman.*
"J. D. QUAIL,
"J. H. BRICKER,
"J. L. GATES,
"J. MILLS,
"J. L. McINTYRE."

Safety Lamps and Colliery Explosions.

By JAMES ASHWORTH, M.E., Mount Chaddesden, England.

The fearful explosions which are continually occurring in various parts of the world, notably that of the Universal Colliery in South Wales, the Fraterville coal-mine in Tennessee on the 19th of last May, and lastly the one at the Fernie No. 2 tunnel workings of the Crow's Nest coal field, on the 22nd of May, about 7.30 p.m., are sufficient in themselves to cause those who have the charge of mines which give out firedamp, as well as those who have money invested in them, to seriously consider in what way this risk may be lessened, if not almost totally prevented.

It is suggested by the newspaper reports on the Fernie disaster, that the explosion originated from blasting in the coal. Similarly it was also suggested that the explosion at the Universal Colliery, Senghenydd, was caused in a similar way, but in the latter case only one witness could be found to suggest that an explosive had originated the disaster, though many witnesses proved that it could not have thus originated, and that it was in all probability caused by a totally different cause, and in a totally different part of the mine. The other cause and in all probability the true one, was the failure of a safety lamp to prevent the flame inside the lamp igniting the firedamp outside.

Under the Mines Regulation Acts of Parliament which regulate the management of coal-mines in Great Britain, all the lamps in use must be bonneted, that is to say, the gauze part of the lamp must be protected by a shield, so that an explosive air current cannot impinge directly on the naked gauze and cause it to become so quickly overheated as to destroy its protective value. Experiments have proved most conclusively that gauze lamps of the Davy type, such as the old Scotch gauze lamp, cannot withstand an explosive current of the lowest velocity on account of their large cubic contents, because the ignition of a large volume of fire-firedamp exerts such a high velocity that the flame is forced through the mesh of the wire almost instantaneously, and without waiting to overheat the gauze. In like manner the naked Davy lamp which was in use by deputies, firemen, and shot firers for so many years throughout Great Britain, and was almost universally trusted by mine officials as the best lamp to use for the detection of fire-damp, and also as the safest lamp for a workman or miner to use, was frequently condemned by experimentors until the Royal Commission on Accidents in Mines made experiments, and finally condemned the lamp as unsafe and reported that where used it must be protected by a shield covering the whole gauze. So great a favourite has the Davy lamp been in the hands of mine officials, that it is still in use in some mines in its original form (Fig. II), and in others when protected by a metal and glass glass shield, the glass being moveable as shown in the section Fig. III. Where the Davy lamp has not been in use for detecting firedamp the Stevenson (Fig. IIa) and the Clanny (Fig. IV) lamps have been used, but as these are as unsafe as the naked Davy, they also have been put to one side, excepting the latter when bonneted as shown in Fig. V.

Tne safety value of the Davy and Clanny lamps, both naked and bonneted, is well known so far as their exposure to explosive currents

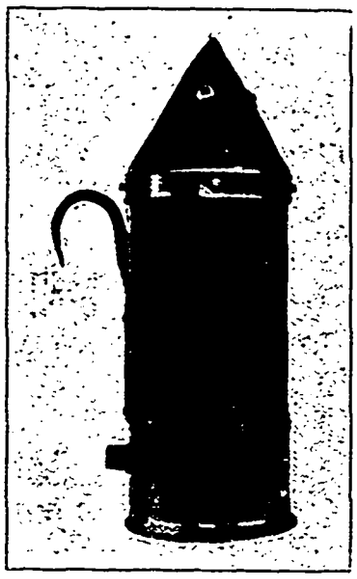


FIG. I.—Scotch Gauze Lamp.

of air and firedamp are concerned, but when we expose them to mixtures of air, firedamp, and coal-dust, the latter factor completely upsets the confidence which the official tests of safety lamps in mixtures of firedamp and air have heretofore inspired. Thus, in the North of England Institute of Mining and Mechanical Engineers' transactions, so long ago as 1880, a paper on Improved Safety Lamps of the Davy and Mueseler types will be found, in which it is shown by most careful experiments, which have been checked and verified, that if a mixture of air and firedamp contains only a normal per centage of coal dust, that is, just as much as the slow moving current of 370 feet per minute will lick up from the floor or carry along in suspension, 4½ per cent. of firedamp is sufficient to make the mixture so dangerous and highly explosive that a standard Davy lamp with a tin shield will pass the flame through the gauze in the short space of time of seven seconds. Without the presence of coal dust such a lamp would safely withstand a similar current, containing only 4½ per cent. of firedamp, for many hours without failure. Nothing carries convincement to the miner's mind so forcibly as a practical experiment, and

although the evidence of disasters resulting from the failures of safety lamps are not very voluminous, yet they are so definite and accurate in their details that they cannot be pooh-poohed, and treated as *Chateau d'Espagne*. Thus Mr. A. R. Sawyer, formerly an assistant inspector of mines in England, and now well known in the South African gold and coal fields, relates in one of his papers contributed to the North Staffordshire Institute of Mining and Mechanical Engineers, that on one occasion he took hold of a miner's Davy lamp, hanging at the face of a slightly dusty working, to examine it, and on giving it a slight tap with his hand, there was instantly a reddish flame of some magnitude outside the gauze, extending to a distance of about two inches. This fact makes it quite clear that if there had been any accumulation of firedamp in this dusty working, Mr. Sawyer would have lost his life, and we should not have had this valuable note out of his book of experiences. Since then many other failures have occurred. For instance, at Bryncoch, South Wales, in 1896, a Davy lamp failed in a very low velocity of current which had become fouled by a heavy fall of roof in another part of the mine. Many other explosions resulting from the failure of Davy lamps to withstand conditions which are frequently to be found in most coal mines, might be added, but need not be further referred to, as the Clanny type of lamp was the one in use at Fernie, and failures of this type will probably be of greater interest to Canadians.

At the Whitfield Colliery, North Staffordshire, in 1886, a Mueseler lamp (Fig. VI), which is a safer lamp than the Clanny, and is under ordinary circumstances automatically extinguished by an explosive current, failed entirely to resist what may be termed a very practical test. The lamp in question was hung on the side of a heading in the Cockshead mine (which is a thick coal having an inclination of about one in four), and the collier who was working by its light was moving dirt out of an old level into which he had thurled. Whilst doing so a

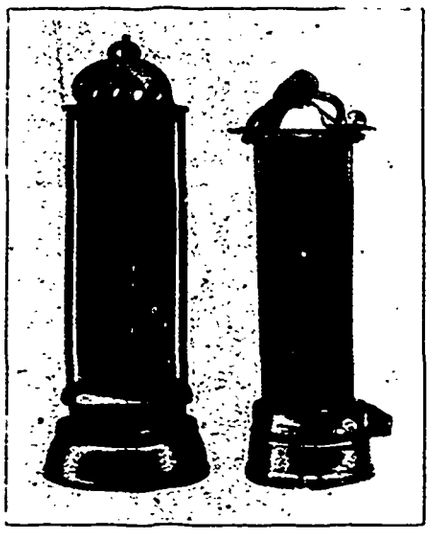


Fig. II.—(a) Davy Lamp. (b) Stephenson.

slight fall of roof took place in the old level, bringing down with it a small quantity of gas and dust, which, on coming in contact with the lamp, immediately exploded, and burned the man slightly. The lamp was carefully examined after the explosion, and was found to be quite correct, and to all appearances safe, but it was noticed that the lamp gauzes were perfectly clean, and as bright as a shilling, whilst another lamp hanging close against it was found to be very dirty from the dust.

To show that experimental results are often confirmed by practical demonstration may be shown by the failure of a double gauze Marsaut lamp The inventor of this type of lamp, in his book on safety lamps, states that he obtained one failure out of every nine tests with similar lamps when they were suddenly surrounded with an explosive mixture of firedamp and air. At the Wishaw colliery, Scotland, in 1895, an unbonneted Mueseler which was being used to test by a fireman for firedamp in a narrow heading partly ventilated by the exhaust from an engine worked by compressed air, suddenly passed the flame through both gauzes without the lapse of any appreciable interval, and immediately exploded the accumulated firedamp. Several miners who were present and saw what occurred were waiting to go into the heading to fetch out their tools, but no one was killed.

Passing on to the modern type of Clanny, viz., the one known as the bonneted Clanny, we find that at the Allerton Main colliery in Yorkshire in 1894, whilst several men were engaged in placing, and also replacing some air pipes which were used to ventilate a heading through a fault, an explosion was originated by the failure of a bonneted Clanny lamp to withstand a mixture of air, firedamp, and

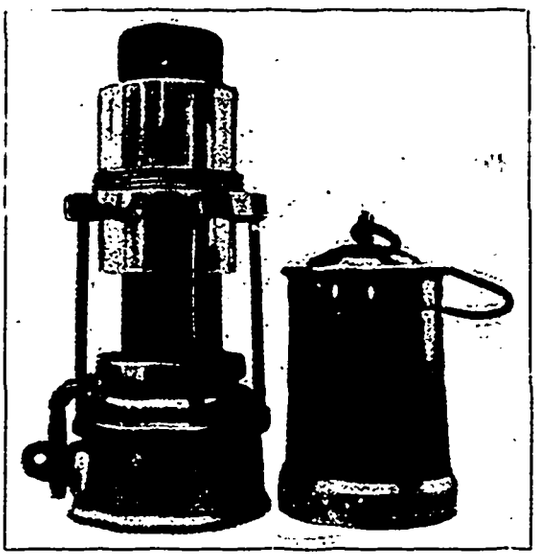


Fig. III.—Cambrian Davy Lamp for Firemen, showing glass part raised and the bonnet removed.

dust, moving at a low velocity. These lamps were afterwards submitted to Prof. Lupton, of Leeds, who tested them in high velocities of mixtures of firedamp and air, but without coal-dust, and failed to make them explode the outer atmosphere.

Another notable failure of a bonneted Clanny occurred at the Shakerley Colliery, Lancashire, in 1895, where a party of officials were engaged in trying to move an accumulation of gas by clearing an airway. All the lamps had been extinguished excepting one, and the man who was using it was practically in a quiescent atmosphere, but the heading being old and very dusty, undoubtedly dust, disturbed by the movements of the men, was a factor, along with the mixture of firedamp and air, in causing this one lamp to fail and explode the mixture. Every man present was instantly killed. The lamp which had failed was tested by Mr. Hilton, of Wigan, who had had considerable experience in the testing of safety lamps, but he could not explode it in any of the mixtures of fire-damp and air that he used. We may particularly note that in these experiments, as in those on the Allerton Main lamps, no coal dust was added to the explosive mixture.

In the year 1901 we have the suggested failure of either a bonneted Davy or of a bonneted Clanny at the Universal Colliery, South Wales, in a mine which was both fiery and dusty, and in which men were engaged in one part of the mine, as at Allerton Main, in adding air pipes to ventilate a heading through a fault. Later in the same year, viz., on December the sixth, a non-fatal explosion of gas occurred at the Shirebrook Colliery in Nottinghamshire, which was worked exclusively with locked (magnetic locks) double gauze bonneted lamps of the Wolf type, Fig. VII. And the following is the Inspector of Mines' report on the occurrence :—

"A night shift of workmen was sent to do some road repairs near the coal face, and near a fault. The place to be repaired was a breakdown of the roadway, leaving a high cavity in the roof. An official of the mine visited the place at about 11.15 p.m., and reported that he found no gas, and the men continued at work until "snap" time. They had just resumed work when the gas was ignited.

"The injured person had taken his lamp and placed it upon a bar about 8 feet 6 inches from the ground, whilst he stood upon a tub to fix some timber across the cavity above the bar. While doing this work an explosion of gas occurred and burned the man who was standing upon the tub. The other man was uninjured, but a number of men ran to the shaft in a panic. The explosion set fire to two brattice sheets and a wood pack, and so quickly did the fire extend that but for the energy of the officials and the use of hand grenades the fire would probably have soon been out of control, and have become exceedingly dangerous.

"After the extinction of the fire the firedamp again appeared, indicating that the fall of roof had liberated a small feeder from the fault. The lamp which was supposed to have fired the gas was carefully examined, but no serious defect was found."

This lamp was afterwards tested in an explosive mixture of gas and air without any failure. There was no appearance of overheating, and the gauzes were clean and free from dust.

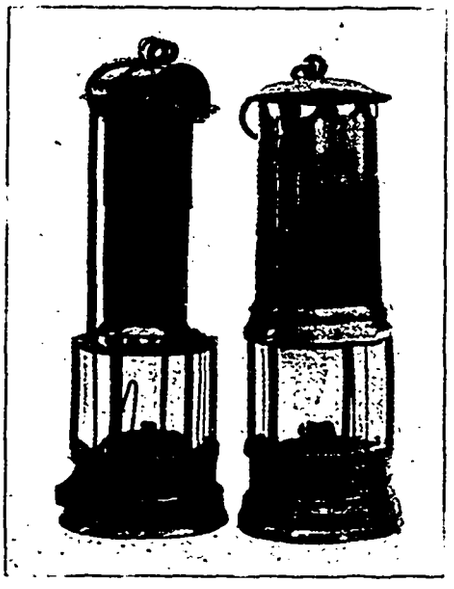


FIG. IV.—Clanny Lamps.

These instances might be greatly enlarged if problematical cases were added, but no event, as originating a colliery explosion, is so difficult to prove as the failure of a safety lamp, because the principal indication is not necessarily the evidence of an overheated gauze, but rather its great cleanliness as compared with other lamps in the immediate vicinity. This fact would, in the opinion of most people, be the most convincing proof that it had not failed. Experiments, as well as practical experience, has proved that the most dangerous condition to which a safety lamp may be subjected, is when the lamp is suddenly raised into an explosive atmosphere of firedamp, air, and dust, or when a ventilating current becomes suddenly charged with an access of fire-damp, or approaching the lamp from the top crushes down the wick flame. From this proving, mine officials will readily understand that any lamp which admits of a down current, and the crushing down of the wick flame, cannot be a safe lamp to put into the hands of officials who have to examine the mine for gas, or who have to make careful tests of the place, and also the adjoining places to that in which a shot or shots may have to be fired.

There are many sorts of lamps which are called deputies', firemen's, and shot firers' lamps, but very few of them are really safe to use under the conditions which surround the work of these officials. Yet there is one type of lamp which came out of the Royal Commission on Mine Accidents tests with distinguished honour, viz., the one known as the

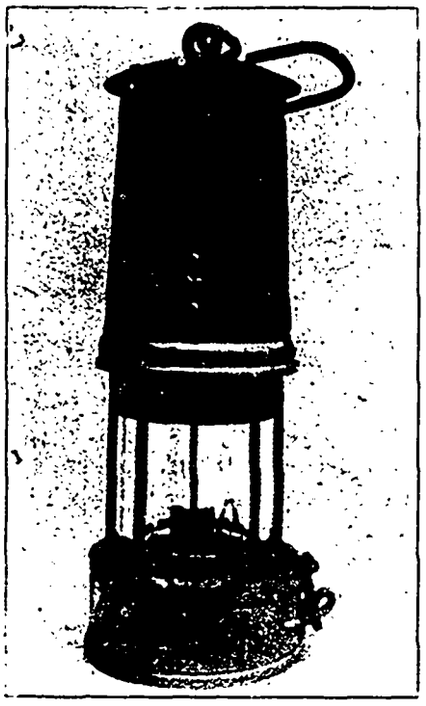


FIG. V.—Bonneted Clanny, Mueseler or Marsaut. Arrangement for gas-testing.

Gray. So impressed were the Commissioners by the suitability of this type of safety lamp for gas-testing, that one of the Commissioners. Prof. Clifton, tried to improve it. After the publication of the report an improved form was brought out by the writer, who has had a life-long experience in experimental work with safety lamps, and also in their practical use, and this lamp is well known throughout the English coal-fields and also in the colonies, as Ashworth's patent Hepplewhite Gray (Fig. VIII). The lamp, as thus improved, did not find the favor it might have been expected to have done in the fiery mines of South Wales, and so late as 1901 the original inventor, Mr. Gray, again took out a patent, which he calls No. 2, combining all the best points of the Gray and Ashworth lamps. Very long and careful

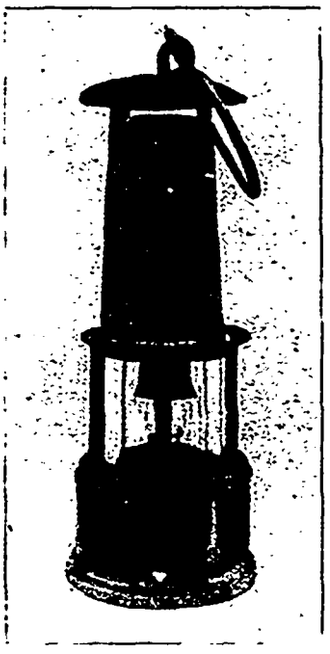


FIG. VI.—Mueseler Lamp.

practical experiments have been made with this lamp, and Mr. Gray may be congratulated on being able to provide his officials with such a valuable, simple, and useful safety lamp with which to ascertain the

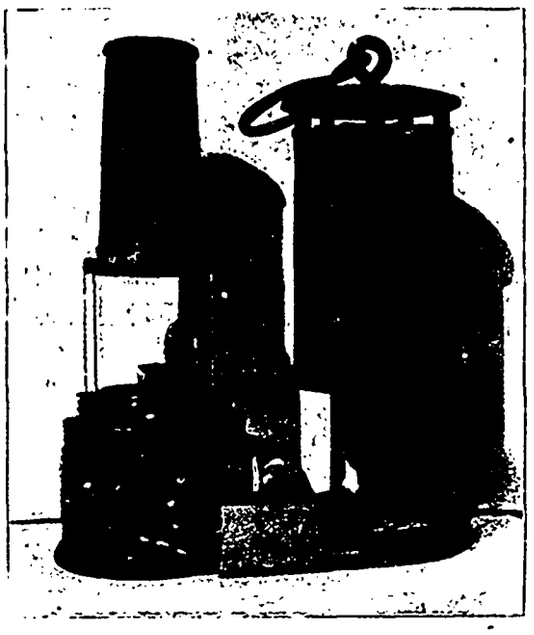


FIG. VII.—Wolf Lamp. Illuminant Benzolene. Showing arrangement for lighting without opening the lamp. Magnetic locking.

real state of a mine, and which produces such a good illumination that it is a pleasure to pass along the roadways of a mine where everything can be clearly seen, and the old idea of groping about a pit with the miserable light of a Davy lamp is no longer necessary. This type of lamp may be so constructed that it will be automatically extinguished when in a miner's hands if the air current becomes in any way fouled by a percentage of firedamp which would be indicated only faintly on the flame of a Davy lamp. It is also impossible to produce a down current, that is, to reverse the air current within the lamp, so well are the inlet and outlet air openings protected, and the lamp may be carried in any current of air without its being extinguished. Fig. IX shows

FIG. VIII.—Ashworth's patent Gray, Deputy or Fireman's Lamp. Showing mode of manipulation when testing for firedamp.

the lamp in sections, and on reference to this it will be seen that when the lamp is not being used for the purpose of gas detection all the air required for combustion, and to keep the lamp cool, enters directly above the cylindrical glass, and, passing down the four air tubes which replace the ordinary solid standards connecting the top part of the lamp with the bottom, goes through the ring gauze below the glass, and after supplying the wick flame, finds its escape with the products of combustion through the conical tin chimney, and then, as an extra protection through the slightly conical gauze which entirely covers and surrounds the chimney, and finally into the surrounding air through the double deflector openings in the top of the shield, as well as through a hole in the extreme top of the shield, which is perfectly protected from all down or angular currents by the baffle plate to which the handle is attached. As no mining laws in any part of the world make any stipulations with regard to the percentage of firedamp which a safety lamp shall be capable of detecting, it is only necessary to say that this lamp will detect more readily, and with greater certainty, the presence of the "blue cap" than any Davy lamp which was ever made. When the fire boss, fireman, deputy, or other official wishes to make a

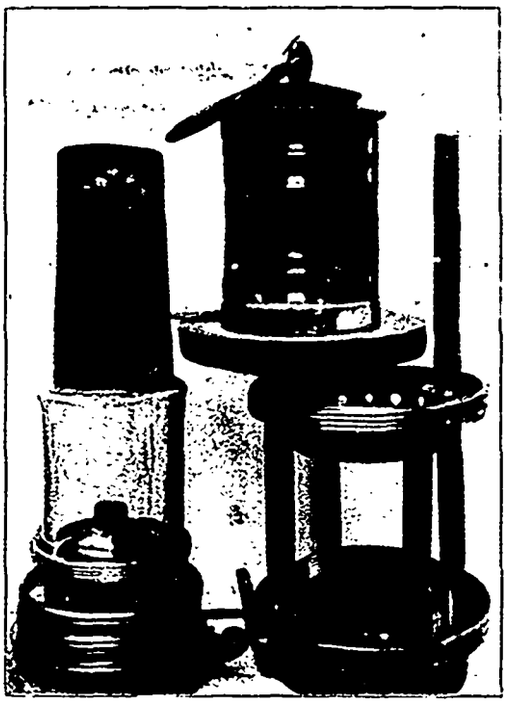


FIG. IX.—Gray's No. 2 Patent Safety Lamp for Deputies, Firemen or Miners. Showing gas-testing tube in position. Lead lock. Gives a particularly good light. Illuminant—paraffine or mineral colza.

test for fire-damp, he puts his hand in his pocket, and, taking out a short brass tube, places it on to one of the fixed air tubes, and is thus enabled to test the condition of the mine close up to the roof, without canting the lamp. If firedamp is present, it passes down this single tube, and is indicated on one side of the wick flame without extinguishing it, and no form of bonneted Davy, Clanny, Mueseler, or Marsaut can make such a close test either so quickly or so accurately.

If such a lamp as this had been in use at the Fernie mines, it would have been impossible, excepting with the grossest and most criminal negligence, to have allowed a shot to be fired when the mine was in an unfit state for shot-firing. Not only is a mine jeopardized by inaccurate examinations for firedamp, but by the class of workmen employed, as stated in the CANADIAN MINING REVIEW in the issue of February 28th, 1901. That this risk is not confined to the Fernie mines was amply demonstrated by a recent explosion in a pit near Wigan, England, where the contractor for the work, finding that the pit was dangerously fouled with firedamp, sent all the safety lamps

out of the pit, and left his men to continue their work by the aid of electric lamps coupled direct to acable from the pit top, but during the shift, a Pole, who could not read English, struck the main cable with his spade, causing a shortcircuit and an arc which originated an explosion of the accumulated firedamp, and which killed nearly every man in the pit, as well as the man on the top of the pit. Judging from the plan of Mine No. 2, printed in the CANADIAN MINING REVIEW, of the 31st of March, 1901, it would appear that an electric pump was at work in a place ventilated by return air, and in the immediate vicinity of a large area of gob, which, if unventilated, as shown, could not fail to be a source of very great danger, and would make the examinations of firedamp of even greater importance than in a mine where electricity was not in use.

A mine at such a high altitude above the sea must present points of great scientific interest. Thus, the barometrical pressure is very low compared with English fiery mines, showing a difference of at least six inches of mercury, and probably the air is very dry, therefore, if a low barometer indicates a danger, the dry state of the air compensates the danger to some extent. And moreover, as every cubic foot of air contains less oxygen than in an English deep mine, the proportions of air and firedamp required to form an explosive mixture must be altered also. It is therefore more than probable that the capacity of any lamp to detect firedamp will be lessened by a low barometer, and raised by a high barometer, because the heat of the testing flame will be reduced by the low barometer. Under like circumstances, the lighting power of safety lamps will be reduced, and if candles have to be abandoned an ordinary type of safety lamp like the Clanny will be a poor substitute.

The capacity of a safety lamp to detect small percentages of firedamp depends entirely on its heat and its non-luminosity, but principally on its heat, and these are the reasons why hydrogen gas and alcohol spirit were adapted by the writer to his Hepplewhite-Gray type for laboratory and main air current testing in coal mines.

In conclusion we should recommend Canadian colliery managers to carefully consider the subject of gas detection, and thus provide against the horrors of colliery explosions as well as against the great loss of capital which these disasters inevitably cause.

ASBESTOS MINING IN QUEBEC.

Mines which Employ over 3,000 Men, and that have Paid Handsome Dividends for many Years.

Supplementing the interesting article on Canadian asbestos, reproduced in this number of the REVIEW, and as contributory to the excellent series of photos which form our illustrated supplement, a few notes concerning the companies and operators who constitute this most successful and highly profitable Canadian mining industry may be of interest.

Although the areas of the Serpentine, in the townships of Thetford, Coleraine, Ireland, and Wolfstown are very extensive, the portions in which asbestos is found are comparatively rare, and the mining, though now prosecuted for nearly twenty years, is practically confined to two small sections a few miles apart. The first, and as yet the most important of these, is a small mound near the Thetford station on the Quebec Central railway, which rises about 80 to 90 feet above the track; the other, the bold ridge of brownish-looking rock to the south-east of Black Lake station, which assumes much greater prominence, and probably has an elevation of 650 to 700 feet above the railway at this point.

Bell's Asbestos Company.

As the visitor to the asbestos region drops off the train at Thetford Mines station, on the Quebec Central railway, the large quarries and imposing mill of the Bell's Asbestos Company, Limited, arrests attention. This is one of the oldest and one of the largest asbestos mining and manufacturing undertakings in the world. The company was registered in London on 4th May, 1888, to take over the business of John Bell and Sons, asbestos manufacturers, and the freehold asbestos estates at Thetford, Hayden, and Belmina, in the townships of Thetford and Coleraine. For the mines, then only partially developed, the company paid: £8,394 for Belmina, £41,300 for Thetford, and £8,000 for Hayden. The mines are admirably equipped with a thoroughly up-to-date mining plant, comprising Norwalk 12-drill compressor, six Ingersoll and four Bacon hoisting engines, nine Ingersoll-Sergeant rock drills, nine cable and four boom derricks, Blake and Worthington pumps, rock breakers, etc. The large mill was enlarged and rebuilt to meet the greatly expanded production of the company last year, and is equipped with a first-class plant for mechanical separation of asbestos, including rolls, crushers, picking tables, screens, and cyclone mills. In 1895 the then existing shares of £5 were subdivided into five shares of £1, and the share capital is now £700,000, of which £170,000 has been issued and paid up in full. Large profits have been earned annually from the working of the company's mines, and the dividends paid have been as high as 22½ per cent.

Much of the success of this large undertaking has been due to the skill and untiring energy of Mr. George R. Smith, M.L.A., the company's manager. Mr. Smith has been prominently identified with active mining in Canada for nearly twenty years, and since he succeeded the late Tom Sheridan in the management of the Bell's Company's property many important improvements and economies have been effected by his mechanical ingenuity. For instance, the unique type of locomotive shown in our photo was evolved practically from the scrap heap, a dismantled hoisting engine being converted by Mr. Smith's ingenuity into a handy and serviceable locomotive, hauling rock from the quarries to the mill. From this model Mr. Smith has recently turned out the handsome little locomotive No. III, shown in our illustrations, and, indeed, the type has proved so well adapted to the work of these quarries that it has been introduced by the neighbouring companies, and its manufacture forms one of the special features of the large shops of the Jenckes Machine Co. at Sherbrooke.

Mr. Smith, as everybody in Quebec knows, represents the County of Megantic in the Quebec Legislature, having been elected as a supporter of the Government, in succession to the late Mr. James King. He is also a member of the Council of the Canadian Mining Institute, and is chairman of the Eastern Townships branch of that important organization.

Beaver Asbestos Company.

Adjacent to the Bell's property is the fine new mill and mine of the Beaver Asbestos Company. This was originally a syndicate of Eastern Townships people, but it is understood that the controlling interest in the property is vested in Mr. R. H. Martin, of New York, the well-known American operator in asbestos, and for many years one of the principals of the H. W. Johns Manufacturing Company. The mining property comprises about 200 acres, and, as at the other mines, the works are open-cast, boom and cable derricks being used for hoisting. An excellent working plant has been installed by Mr. Harry J. Williams, the manager, who has been associated with asbestos mining almost since its inception. This mine employs about 150 persons.

King Bros.

Thfs old-established Quebec firm of lumber merchants were among the early pioneers in asbestos mining in Quebec, and their

mines at Thetford and Black Lake have gained a world-wide reputation for the exceptionally fine quality of their various grades of asbestos fibres. The company own a large mineral property extending over something like 21,000 acres, in the Townships of Thetford and Ireland, but its principal operations are at Thetford Mines, where a complete mining and milling plant is operated under the administration of Mr B. Bennett.

Johnston's Company, Limited.

This company was the first, if our memory serves us, to engage in asbestos mining, the present company being incorporated sometime later, about the year 1885. It has an authorized capital of $250,000, in shares of $500, and very large profits have been distributed among the shareholders, almost from the first year of its existence. This company operates, in addition to its well equipped mines, two large mills at Thetford and Black Lake, and the various grades it puts upon the market realize very handsome prices. Mr. Andrew S. Johnson is the managing director, the other principals being entirely composed of Quebec people. Very large prices, extending into the millions of dollars, have been offered for the purchase of the Johnson and King mines, but the owners know when they have a good thing and the properties are not on the market.

Union Mines.

This mine is situated about a mile from Black Lake station, a short distance over the way from Thetford, and will be remembered as having for several years been worked by the Wertheims, under the management of Mr. L. A. Klien. The present owners are also Germans, the head office of the company being at Hamburg. The mine is situated on Lots 27 and 28, South Half, Range B, of Coleraine, being worked open-cast and by two tunnels in respectively 200 and 300 ft. The mining plant comprises a Rand 7-drill compressor and drills, 7 hoisting engines of various types, Northey, Blake, and Snow pumps, Blake breakers, etc., power being supplied by 4 boilers, two of 40 h.p., one 90 h.p., and one 25 h.p. The milling plant includes a 25 h.p. Corless engine, crushers, screens, elevators, picking tables, rotary dryer, etc., etc. Mr. T H. Crabtree is the local manager of this excellently managed mine.

Standard Asbestos Co.

Another well-known producer at Black Lake is the Standard company, organized in 1901, with a capital of $150,000 in shares of $100, to take over the mine, worked for several years, by the Anglo-Canadian Asbestos Co., Limited. The property extends over 325 acres, forming part of Block A in the Township of Coleraine. The mining plant is largely of the Rand Company's manufacture, and a finely equipped fibreizing mill has been put into commission equipped with all the latest mechanical devices for turning out the various grades of asbestos. Mr. R. T. Hopper, who was the directing spirit of the Anglo Canadian Company in Canada, and who may be said to be the pioneer of asbestos mining in Black Lake, is the managing director of the Standard, and his mine captain is Mr. W. A. Clerihue.

Canadian Asbestos Co.

This company operates the property and plant of the old Glasgow and Montreal Asbestos Company, Limited, at Black Lake. Since taking possession the mining and milling plant has been overhauled and new sources of asbestos, it is reported, have been uncovered. The company, which is largely composed of Montreal people, is managed by Mr. Wm. Sclater.

Manhattan Asbestos Co.

This company, organized in 1901, is working over the old ground of the United Asbestos Company, and is a combination of American and British capital. In addition to a very complete mining plant, a modern mill has been installed. The property upon which the mine is operated covers some 75 acres in Block A of Coleraine. The capital of the company is $120,000 in shares of $100.

The Kerr-Murphy Mine.

On Lot A 31 of Coleraine, owned by Mr. A. H. Murphy and associates, Mr. Kerr is doing some preliminary development, it is said with such satisfactory results that a mining and milling plant will very soon be placed in commission. This, up till recently, was practically a virgin lot upon which no work had been done for a great many years, and then only upon a very small scale.

Dr. Reed's Mine.

Dr. James Reed, of Reedsdale, Que., is the owner of some asbestos property at Black Lake, upon which some mining has been done and a small mill built.

East Broughton Asbestos Manufacturing Co.

About a mile distant from East Broughton station, on the Quebec Central railway, is the Williams mine, which was reopened last year by the East Broughton Asbestos Manufacturing Co., and a small mill put up.

Asbestos and Asbestic Co., Ltd.

The most westerly area in the eastern townships in which the mineral is mined is the old Jeffrey mine, four miles east of Danville village, on Lot 9, Range 3, Shipton, operated on an extensive scale by the Asbestos and Asbestic Co., Limited, an English syndicate having a capital of £500,000. This company was exceedingly unfortunate in losing its large mill by fire in March, 1900, and the mine was shut down for the greater part of that year in consequence. A new mill has since been installed and the company is again shipping large quantities of asbestos. It also makes a specialty of the manufacture of asbestic, or ground fibrous serpentine, a product admirably adapted for fire-proofing material. The controlling interest in the company was acquired in June, 1900, by Mr. James P. Cannon, of New York, who furnished the bulk of the capital for the re-equipment of the mine and mill after the fire. The mining plant is largely of the Rand pattern, and the milling machinery on much of the same principle as that in vogue at Thetford and Black Lake. Mr. James R. Pearson is the managing director of the company's affairs at Danville.

The asbestos here occurs in a rounded knoll, one of a series which extends from Melbourne through Cleveland into the south-east corner of Tingwick, and is the only one in which valuable veins have yet been found in this direction. This was first worked in 1884, and has yielded a large amount of asbestos of excellent quality.

Columbia and Ottawa Asbestos Co.

In connection with the Laurentian rocks of Ottawa County, the serpentinous limestones sometimes carry veins of a pale yellowish asbestos, generally of short fibre, but at times having a length of three-fourths to one inch. In some pieces of rock several of these, six, eight, or more are found, occupying a breadth of ten to twelve inches, the thickness of the veins ranging from one-fourth of an inch upward. Few attempts have been made to work these asbestos veins, the only production coming from a mine worked by some Ottawa people, in

the township of Low. This property was turned over to the Columbia and Ottawa Asbestos Company this year, and it is now, we understand, to be worked systematically.

GROWTH OF THE INDUSTRY.

In 1879	300 tons,	worth	$ 19,500
" 1880	380 "	"	24,700
" 1881	540 "	"	35,100
" 1882	810 "	"	52,650
" 1883	955 "	"	68,750
" 1884	1141 "	"	75,097
" 1885	2440 "	"	142,441
" 1886	3458 "	"	206,251
" 1887	4619 "	"	226,976

For the past five years Mr. Obalski gives the returns as reported to the Provincial Mining Bureau as follows:

1897	25,365 tons,	valued at	$ 380,000
1898	23,015 "	"	511,256
1899	23,266 "	"	598,736
1900	29,433 "	"	735,364
1901	40,397 "	"	1,284,429

About 3,000 men are employed and the invested capital will will aggregate at least about four millions of dollars.

Trade in Mining Machinery

The opening up and equipment of many new mines throughout the country continues to create an active demand for mining, milling and smelting machinery and all our Canadian shops are well supplied with orders, many of them working double time. The imports for the first four months of the year, however, are somewhat less than in 1901, as will be seen from the following table:—

Month.	1901			1902		
	Free	Dutiable	Total	Free	Dutiable	Total
January	111,134	4,196	115,330	92,984	2,549	95,533
February	162,030	9,689	171,719	43,123	2,380	45,503
March	62,185	806	62,991	55 255	1,720	56,975
April	52,921	517	53,438	61,227	5,579	66,806
Total	388,270	15,208	403 478	252,589	12,228	264,817

1901	From United States		From Great Britain		From Other Countries
	Free	Dutiable	Free	Dutiable	
January	111,129	4,196	5	....	....
February	162,031	9,689	....	....	....
March	58,980	806	....	....	3,205
April	51,971	517	950	....	....
Total	384,110	15,208	955	....	3,205

1902	From United States		From Great Britain		From Other Countries
	Free	Dutiable	Free	Dutiable	
January	65,236	2,549	26,328	....	420
February	42,486	2,380	....	....	....
March	54,980	1,720	275	....	....
April	55,648	4,997	....	....	....
Total	219 350	11,646	26,603	....	420

New Iron Mine at Richmond, Que.—Messrs. MacDougall, of Drummondville, have opened an iron mine under lease on the property of H. Hall, a mile and a half from the Grand Trunk railway station at Richmond, Que The ore is a beautiful hematite, occasionally carrying magnetite crystals, and apparently occurs in small lenses in a dolomite adjacent to a mass of volcanic trap. Somewhat similar occurrences of iron ore are known at several places throughout the Eastern townships, but this is the first to be thoroughly tested.

Forty-third Mining & Milling Co., Limited.—The following circular, under date of 17th instant, was issued to the shareholders:—"Holders of two-thirds of the value of the stock of this company having consented to the issue of bonds, negotiations were entered into for the purpose of having the bonds issued under a guarantee of payment in order to make them more attractive to the investing public. As a result, the Imperial Trustee Company, of New Jersey, has notified the Local Board that it has accepted the trusteeship of this company's bonds, and will guarantee payment of the principal in full. Mr. H. B. Swart, of 29 Broadway, New York, has examined the affairs of this Company and assures a ready sale of the bonds, which he will undertake. The mortgage deed is being prepared, and as soon as ready the Board of Trustees will pass a by-law putting it in force, and the bonds will be placed on sale. The net result to the company will be about $75.000.00. Of this amount $40,000.00 will be used to discharge floating liabilities, and the balance for operating the mine. Everything is being pushed forward as rapidly as possible, and it is hoped that for a portion of this season the mine may be worked. In any case a small party will be sent in to see that no damage to the stores or works results from the delay. Should the shareholders decide that a party ought to be sent into the mine at once, this can be done by their providing sufficient funds for the travelling and other expenses. No outlay for machinery or supplies is needed. Your opinion or suggestions as to this would be acceptable."

Le Roi—Cable from the manager: "Shipment of ores average this month 420 tons per diem, value $15.50. We have struck ore 1,050 west raise $:7 per ton. 900 winze down 64 ft., ore therefrom assays $14."

(Office note.—The raise from the 1,050 ft. level is that mentioned in the monthly report for April, as about to be started to meet the winze coming down from the 900 ft. level). In the report for April, the gold contents should have been given as 56 cents higher, and the copper contents as .10 per cent., not 10 per cent.

Duncan United.—Engineer cables: "No. 5 level, Poorman mine—Driven 22 ft. last week; average width of vein, 2 ft. 2 ins.; average value, $10 per ton."

Snowshoe Gold and Copper Mines.—The following circular has been issued to the shareholders:—"In view of the 5s. call now being made upon the partly paid shares, the directors feel that it would perhaps be of interest to the shareholders to have a brief statement as to the present position. Apart from the vendors' shares, 48,475 shares have been allotted, on which 10s. per share has been paid up, yielding the sum of £24,237 10s.

"Though this company was formed on June 20th, 1901, it, in accordance with the terms of the prospectus, took over the Snowshoe mine and group of properties as from the 1st March, 1901, and has been responsible for all expenditure since that date. Since the new company took over the property, some 2 000 feet of underground work has been done in drifting, cross-cutting, raising, and sinking, thus developing and opening up the large ore bodies already shown up. A large new working shaft is in course of construction, and will shortly be completed to a depth of about 300 ft. This shaft will be capable of handling 300 to 400 tons of ore per day. In addition to this underground work, much has been done upon the surface. A large area of ground has been cleared and stripped, the overlaying soil being removed, thus exposing the ore body near the surface, and making it possible to mine the same very economically. The principal piece of stripping is 360 ft. long by about 80 ft. wide upon an average. It is intended to further continue these operations during the present season.

"Toward the end of last year the directors authorised the erection of a new bunk house and boarding-house, and new office and residential buildings for the officials and men employed in connection with the mine. Prior to this, the building accommodation was very inadequate, and consisted mainly of the old log buildings used by the original owners of the property. A considerable amount of machinery has been purchased in order to provide the necessary power and plant to enable the operations of the mine to be successfully carried on. An ore bin with a capacity of 325 tons has been built. The Canadian Pacific Railway runs across the property, and last year a private spur was built to connect with the mine workings and ore bins. Another short spur has been built recently in connection with the installation of the new machinery.

"Test shipments of over 2,000 tons of ore from various parts of the mine have been shipped to the smelters with satisfactory results. Negotiations are now progressing with several smelter companies, who have made prsposals to purchase Snowshoe ore, and provided satisfactory arrangements can be made, it is hoped before long to be making extensive shipments. The directors are giving the most careful attention to the economical treatment of the large ore bodies in the Snowshoe mine, and they have every confidence in being able to deal with these ore bodies at a considerable profit."

Certain Conditions in Veins and Faults in Butte, Montana.

By Wm. Braden, M.E., New York.

In practically all of the great mining centres of the world, faults of more or less extent are found. They are by no means an unwelcome feature to the engineer, as they often form an indicatio. to the vein's relations to its surroundings, and may directly or indirectly indicate the genesis and life of the ore deposits. On the other hand, with certain of those indications lacking (ordinarily caused by metamorphism), which an engineer immediately looks for, much annoyance may be the result. However, faults may be well looked upon as one of the most important and interesting phenomena with which we have to deal, be their influence for good or bad, commercially speaking. And here I should say that the result of research in these channels has been largely prompted by commercial motives. By this it is not intended to belittle the very keen interest which is taken in the study of the problems for the technical interest which it affords, but more often than not the necessary data can not be obtained without heavy expenditures. In Butte, Montana, millions of dollars have been spent before facts have been found upon which a positive theory could be based; and with each succeeding year of underground development facts will be uncovered which will further elucidate the more deep-seated effects and causes, the existence of which in some instances can now only be approximated.

Apropos of the above, while the general geology of the Butte District has been so fully described by Dr. S. F. Emmons, W. H. Weed, and others of the U.S. Geological Survey, in the special Butte folios, in this paper the district will be outlined as briefly as possible.

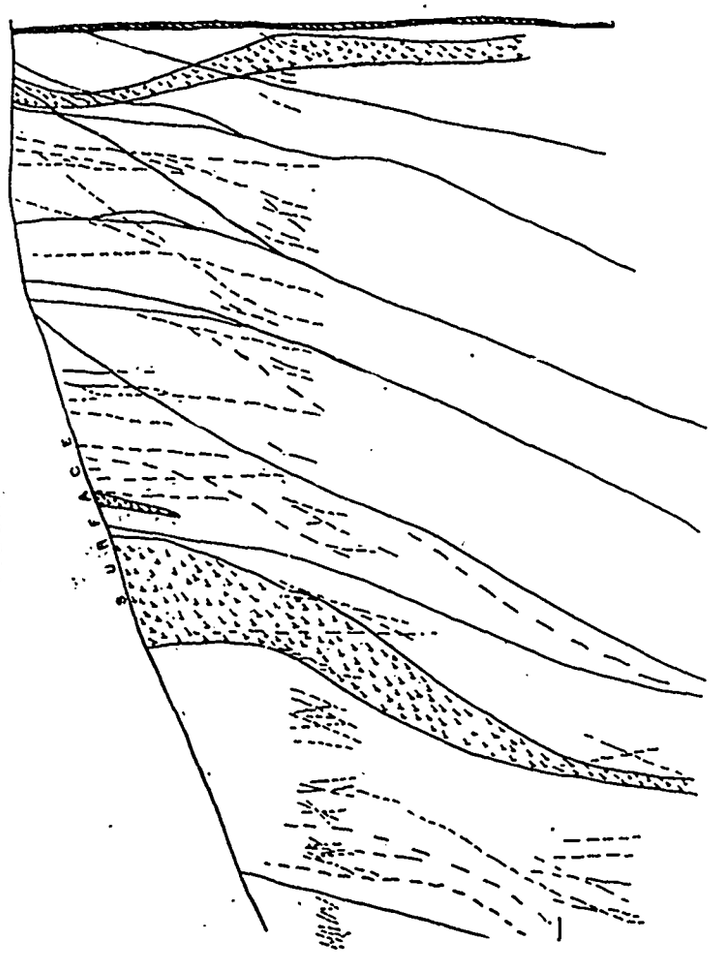


FIGURE 1

Then from the writer's personal observation some characteristic features will be noted, which occur in the midst of a region of great interest to the geologist, mineralogist, and mining engineer, and contain one of the most wonderful vein system or systems wherein mineral deposition has taken place.

The copper bearing veins cover an area of about one and a half miles east and west, along their general strike, by one mile in width. From the alluvium-covered Silver Bow valley to the south and east from the mines, the ground rises some 500 or 600 feet, and with the headworks, dumps, and railroad grades skirting the hill-sides, the appearance is not unlike that of an extensive fortification. On the north and west copper-bearing veins give place to veins whose principal commercial value is silver, with little or no copper; and a short distance from this termination on the west, "The Butte" (from which the district takes its name) rises sharply to a height of several hundred feet. This "Butte," representing as it does the latest volcanic activity in the region, consists mainly of a rhyolytic breccia, which is not penetrated by any of the copper veins; in fact, no mineralized veins being found therein. This rhyolytic intrusion was probably an important factor in some of the post-mineral movements which occurred.

The country rock in the copper mining section of Butte is a basic, much altered and decomposed granite, together with east and west intrusive dykes of quartz porphyry, ten to seventy-five feet in width. These dykes have branches and apophyses, and are practically vertical upon sinuous lines. This country rock is widely fissured and fractured.

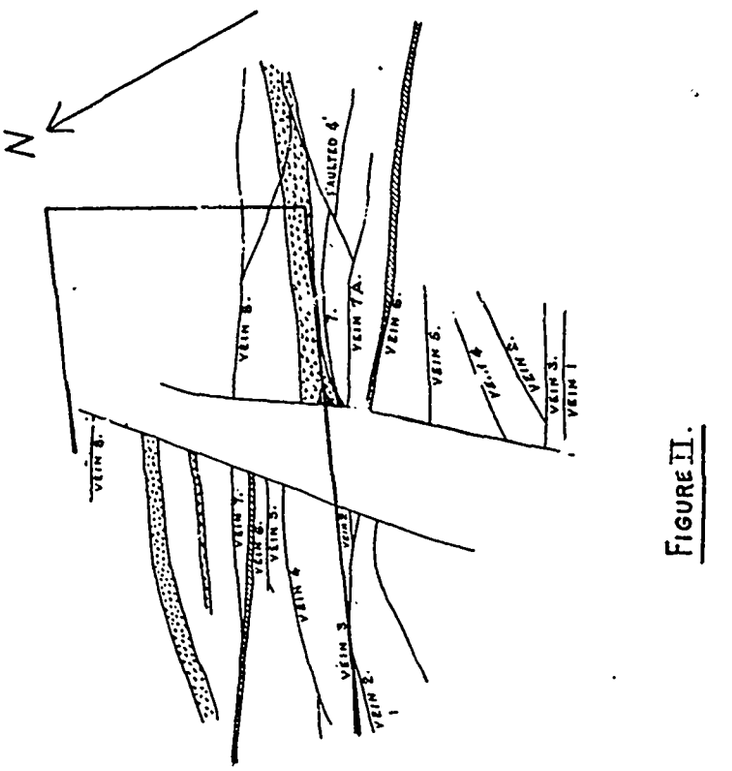
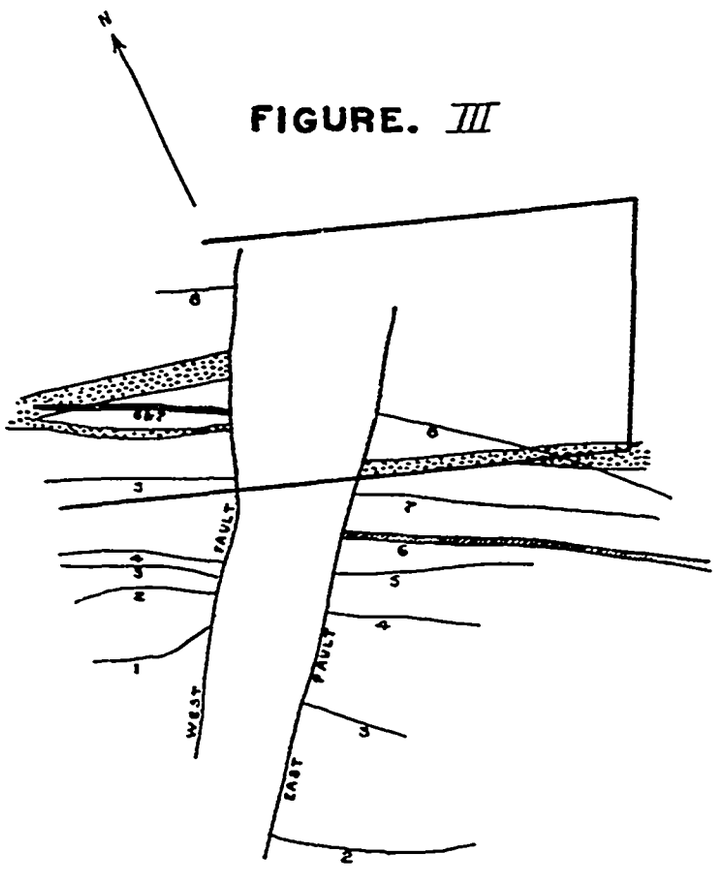


FIGURE II.

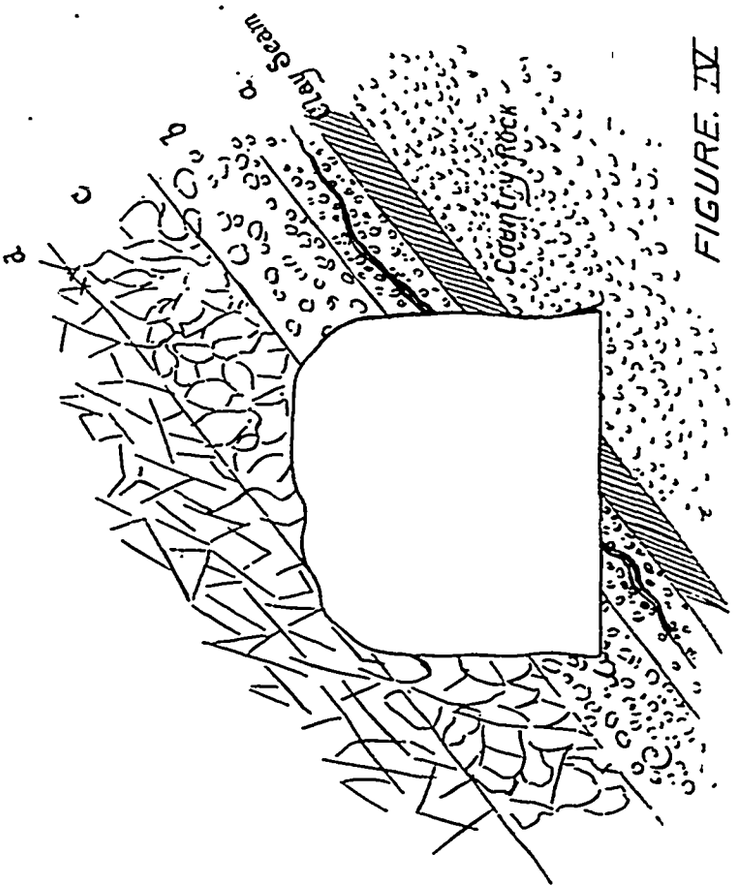
The vein fissures have a general east and west strike, oriented within an angle of forty-five degrees. Their dip is usually south, but varies from a slightly north dip to forty-five degrees south. They are mineralized with sulphide ores of copper, accompanied in more or less quantities by quartz and pyrite, sometimes the one predominating and sometimes the other. The mineral solutions have found their way into lesser fractures and jointings, and impregnated the country very considerably. While ore deposition has taken place within well defined limits of the fissures, in what are spoken of as "spaces of discission" by Professor Posepney, the bulk of the deposition has been metasomatic. The veins cross each other and bifurcate both on strike and dip. In some cases these crossing veins fault the earlier veins, and a distinct mineralization is seen in each. For the most part the veins are oxidized for considerable depths from their apices. This oxidization, represented by the present water line, reaches three hundred feet or more from the present surface, but varies considerably in adjacent veins, and is undoubtedly influenced by the individual characteristics of the veins and local conditions of the enclosing rock.

In this connection another feature to this oxidization is the fact that often, in this zone, a very large vein may, to all appearances, show no greater size than a mere off-shoot or fracture in the country rock, the mineralization of which has also been oxidized. It is possible that this effect is produced by either the mere skeleton of the former vein having been crushed in by its unsupported walls; or, in cases where this is especially noticeable, by the fact of little or no mineralization in "spaces of discission" having taken place, but rather a meagre metasomatic action in the country rock, through which the small solution-carrying fissure or fissures passed. It may be conceived that upon oxidization and saturation by the surface waters, the altered and widely-fissured granite and quartz-porphyry would take on much the same appearance as what might be termed the "vein granite." This latter theory is more acceptable to the writer. It is doubtful that secondary enrichment, due to this leaching out of copper and its re-deposition, has taken place, at least from the present oxidized area. If it has, its influences have penetrated to more considerable depths than have usually been spoken of. The writer's observations have been that such enrichment products as found in the Ducktown deposits in Tenessee are either entirely wanting or are quite superficial in the copper-bearing veins at Butte. As recently propounded by Dr. Emmons in his paper upon this subject, it is possible that the present water line is two or three thousand feet higher than formerly, owing to the great fault from what is known as "East Ridge," which, about two miles



eastwardly across Silver Bow valley, rises to an elevation of some two thousand feet, practically in bluff.

Having in mind the general mass of the country as being granite, and the east and west porphyry dykes, and a system consisting of a great number of veins quartering one with the other, so to speak, both on strike and dip a cross fault was encountered in one of the richest sections of the district. The fault was pronounced by the eminent geologist, the late Clarence King, to be a "double normal fault." At the surface, over the course of some hundreds of feet, are two fault planes, from ten to thirty feet apart, practically parallel, though with a tendency to converge at the ends, and with a strike approximately north thirty degrees east. They diverge to the deep so far as developed, the east fault dipping about fifty-four degrees and the west fault about forty-five degrees, both westerly. The extent of the oxidized zone between these two fault planes corresponds with the veins to the east and west of the faults. Between the fault planes, six or seven hundred feet in depth, much crushing, grinding, and kaolinization is found of the included pieces of veins, as well as the porphyry and granite. As the distance increases to some three hundred feet further in depth, some evidence of regularity is seen; nevertheless the subfaulting and crushing is still pronounced. With this condition and a bewildering geography of underground workings to study, it became



the privilege of the writer, together with a distinguished corps of engineers and geologists, to study the problem of establishing the apices of veins, so that the ownership might be demonstrated under that most enigmatical of United States laws known as the "extralateral rights clause." As an exhibit of the large number of veins and streaks, with their bifurcations and intersections, it is interesting to refer to Fig. I, showing a cross-section of an area undisturbed by the fault movement; and Figs. II and III, showing the 450 and 750 foot levels in plan. Veins not actually shown by workings on these particular levels have been projected either from above or below with tolerable accuracy. Referring to the veins from No. 1 to No. 8 east of the east fault, and veins No. 1 to No. 8 west of the west fault, it is seen that there is evidently no matching or correlation of these, though faulted porphyry is found on both sides of the faults, and between, and would seem to be some definite indication of the heave. But by bringing faces of the porphyry dyke into juxtaposition on the same horizon, we still found nearly as hopeless a condition as before, so far as the veins were concerned. This prophyry was a fairly reliable indicator to the heave, however, as it matched up reasonably well, being practically vertical, but in view of apophyses and bifurcations it gave undoubted evidence of a vertical throw, and the nature and extent of this it became necessary to establish. As the country rock was entirely granite of a more or less uniform appearance (no stratified formation being present), the effort was to study the situation from a standpoint of

different combinations. To be sure there were certain striations, but there were such abundant evidences of subfaulting and crushing, which might prove misleading, and as the granite was quite soft, there were no hardened faces to act as reliable guides in this direction. It was noted that there was considerably less grinding, trituration, and fault rubble upon the western than the eastern fault plane. Figure IV gives a typical illustration of the latter. At the plane there

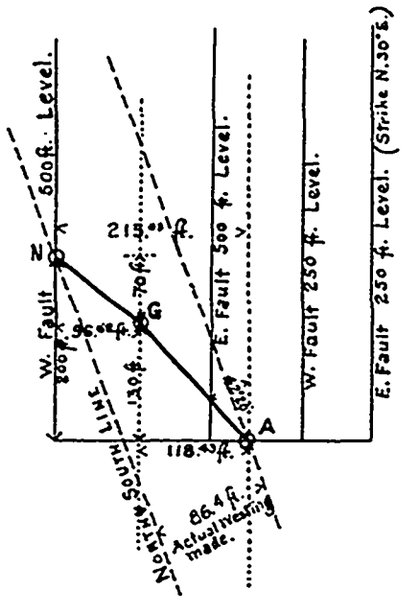


FIGURE V.

appeared a clay selvage, from an inch or two to twelve inches in width. Underneath this the country rock, while somewhat more kaolinized than at some distance east of the fault, was comparatively undisturbed. On top of the selvage appeared :—

(a) Comminuted vein matter, granite and porphyry, with pebbles up to the size of a small nut and sub-selvages; this for a width of one or two feet;

(b) For another two feet rounded fragments as much as two or three inches in diameter;

(c) Boulders sub-angular for two to five feet;

(d) And finally the angular much broken country rock, porphyry or vein, as the case might be, all very much kaolinized.

Of course, it was found that the porphyry, pebbles, and boulders occurred only north of the porphyry east of the east fault, and on this extended only so far as the included porphyry between the faults.

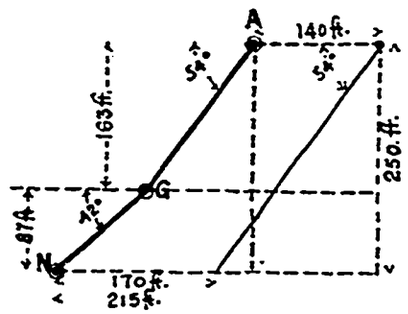


FIGURE VI.

In this connection, owing to metamorphosis, the outward appearance of the material going to make up the fault plane in the oxidized zone often bore a striking resemblance to the quartz-porphyry with its rounded grains of glassy quartz. Interesting samples were collected

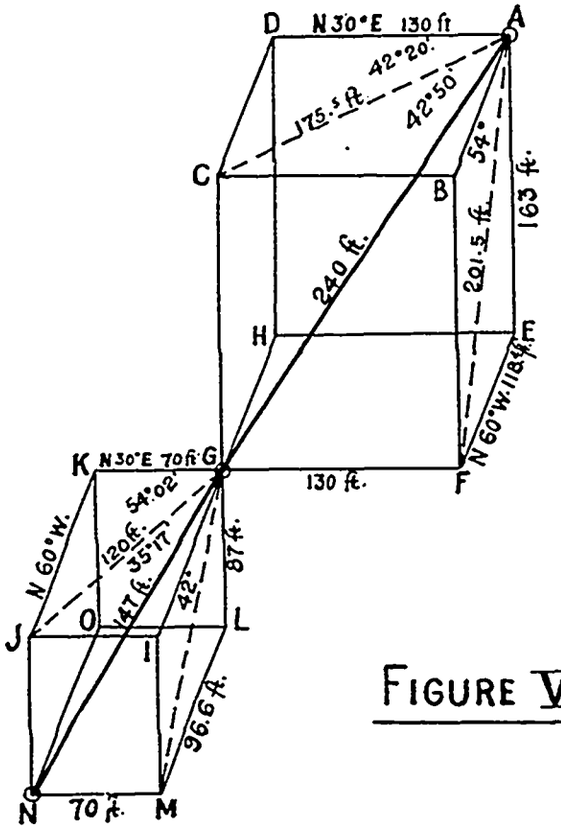
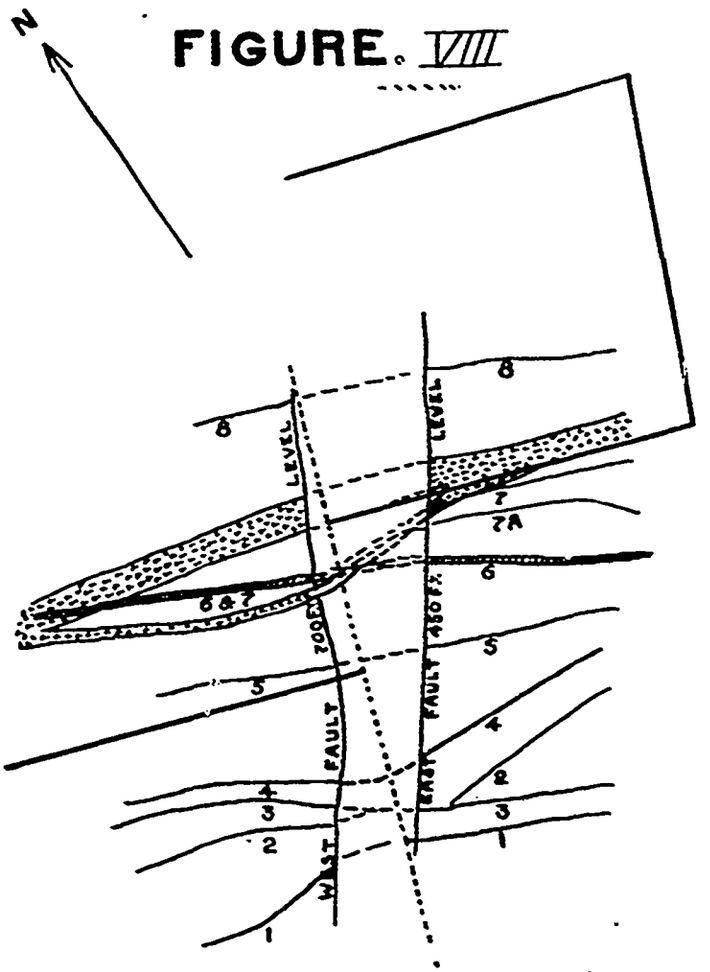


FIGURE VII.

of this material, surrounding included pebbles and boulders of the genuine quartz-porphyry.

Although between the faults were found local complications, it was found possible to gauge the course travelled by the country between the fault planes and west of the west fault plane. In Figures V, VI, and VII the horizontal, vertical, and diagonal courses of movement

FIGURE. VIII



are shown diagrammatically, the total vertical distance being some 250 feet; the horizontal distance 200 feet parallel to the fault about north 30 degrees east; the actual or diagonal distance being approximately 387 feet. It will be seen at a glance that the greater movement occurred upon the plane of the "east fault," hence the greater quantity of fault rubble is found therein.

From the very nature of fault occurrence the movement varies from nothing to the maximum. In this connection reference herein is made to an area subject to inspection during the period of the writer's examinations. Undoubtedly the conditions will be altered to the deep, and in extension of the fault at a distance from the immediate region treated of. However, taking any two levels to one thousand feet in depth, wherein the vertical distance of the workings west of the west fault plane were approximately two hundred and fifty feet below the workings of the level east of the east fault plane, it was found a perfect correlation of veins and porphyry dykes resulted by lifting the plan of vein occurrence on the former level up to the level of the latter, and then moving them two hundred feet southerly parallel to the fault. For example: Placing the 700 foot level west workings in juxta-position with the 450 foot level east workings, in accordance with the measurements shown in diagrams Figs. V, VI, and VII, such correlation is seen in Fig. VIII.

With the above data in hand, without going more exhaustively into the line of evidence, it was found possible to correlate the veins by bringing the country between and west of the faults back to what was assumed to be its original position. Vein bifurcations and intersections which, prior to the demonstration of this correlation, seemed obscure, became clear, and vein development could be carried on with practically positive assurance.

Asbestos and its Production in Canada.

By W. Mollmann, M.E., Black Lake, Que.

Amongst the minerals which have gained during the last decade a prominent position in Canadian mining, must be placed asbestos. Commercially, it occurs almost exclusively in serpentine, and possesses such valuable properties as to give it a commanding place in the arts and industries.

Asbestos is a fibrous mineral, in which the fibres are either parallel or divergent. It is often lustrous, and its color varies from white to gray, brown, and green. Amongst its valuable properties may be mentioned incombustibility, flexibility, and ductility, besides it is a non conductor of both heat and electricity. Its resistance to the action of acids is also worthy of note.

The particular prominence that asbestos at the present time has attained is through its resistance to fire. This property was known to the ancients more than 2000 years ago, and asbestos was utilized by them for the wicks of the lamps in the temples and for other purposes.

Now its use has become quite general, and its application for various purposes is continually increasing. Among the uses to which it is put may be mentioned: packing in various forms; covering for steam boilers and pipes; firemen's clothes; theatre curtains; boxes for money and valuable papers; covering for walls and roof; acid filters; powder bags; etc., etc.

As a matter of fact the demand for asbestos has been so great of late years that the opening of new mines has scarcely been able to keep up the required supply. Chemically, asbestos is a silicate of magnesia and lime—however with a fluctuating ratio of its constituent parts. Iron and aluminium are generally associated with it.

The asbestos of commerce contains about 14 per cent. of water, while a variety, which is, however, only of interest to the mineralogist, is almost wholly free from water, or only slightly hygroscopic.

The following table, taken from the admirable work "Asbestos and Asbestic" of R. H. Jones, of Montreal, gives the analyses of the principal kinds of commercial asbestos.

	Italian Fibre.	Canadian Fibre.	
		Thetford.	Broughton
Silica	40.30	39.05	40.87
Magnesia	43.37	40.07	41.50
Ferrous Oxide	.87	2.41	2.81
Alumina	2.27	3.67	0.90
Water	13.72	14.48	13.55
Totals	100.53	99.68	99.63

Mineralogically and genetically we distinguish two particular groups or forms of asbestos:

1. Hornblende asbestos.
2. Serpentine asbestos (of the mines).

The first form is so called because it forms one of the varieties of hornblende in the amphibole series. Among the latter may be mentioned actinolite (radiated) and tremolite, which are also known as amianthus or hypsolite when of fine fibrous structure. The color of amphibole asbestos varies greatly, but the more common is whitish-gray or green.

Especially during the period 1897-1900 has the great distribution of this mineral over the whole surface of the earth been established. In consequence of the high value of commercial asbestos it has been prospected all over the world. Although reports of finds have come from many quarters, yet very few have proved profitable for mining. When a find was reported it was generally found to be amphibole asbestos, which is materially inferior in quality to the serpentine variety. The difference between the two is that the former is less fine and less flexible, besides lacking that silky lustre.

The species of the second group is a variety of serpentine, the latter a mineral of great geological interest. This asbestos goes under various names: chrysotile, mineral flax; liquiformed asbestos; mountain leather; mountain cork; etc. With the exception of the first, the rest have all a yellowish-brownish appearance, and occur frequently in fissures or small seams (Canada, Norway, Germany). They are seldom available in industry.

Technically, chrysotile takes the first rank of the varieties of asbestos mentioned. Under the name chrysotile is designated that variety of serpentine asbestos, in which the fibrous structure is arranged in fine parallel threads of silky lustre. It is generally of a greenish color, although grey or yellow is found. The principal deposits are in Canada, in the Province of Quebec, where enormous deposits are found, which during the past twenty years have developed into an active mining industry.

Although many attempts have been made in many countries to supplant the Canadian article, yet up to the present they have not succeeded. The Italian, Russian, and American (U.S.) varieties cannot compete with the Canadian, as they lack fineness and toughness of the fibre. The greater length of the Italian fibre is not of much account when compared with the Canadian, as the latter, when only half an inch in length, can readily be spun. Furthermore, in the spun thread, the strength of the thread when composed of fibre over three inches in length, is no longer directly proportional to the length of the fibre.

Asbestos is found in the United States in Vermont, Pennsylvania, Georgia, and California. The latest discoveries in the Green mountains in Vermont look very promising, and it is expected that the veins will increase in size as the work progresses.

The total production in 1900 of asbestos was as follows:—

	TONS.
Canada	30,641
United States	1,054
Italy and Russia	1,500
Total	33,195

For 1901 we have—

Canada	38,500
United States	1,300
Italy and Russia	2,000
Total	41,800

Although the production of Canada has enormously increased, yet prices have been well maintained, and this serves as a guarantee for the steadily growing demand for asbestos.

The following table will be undoubtedly of general interest, showing the annual production in Canada and the United States of this mineral.

Year.	CANADA.		U. S.		Year.	CANADA.		U. S.	
	Quantity. Short Tons.	Value. $	Quantity Short Tons	Value $		Quantity. Short Tons.	Value. $	Quantity. Short Tons	Value $
1879	300	19500	....	....	1891	9279	999978	66	3960
1880	380	24700	150	4312	1892	6042	388462	104	6416
1881	540	35100	200	7000	1893	6473	313806	50	2500
1882	810	52650	1200	36000	1894	7630	420825	325	4463
1883	955	68750	1000	30000	1895	8756	368175	795	13525
1884	1141	75079	1000	30000	1896	12250	429856	504	6100
1885	2240	142441	300	9000	1897	30442	445368	580	6450
1886	3458	206251	200	6000	1898	23785	486227	605	10300
1887	4619	226976	150	4500	1899	25536	485649	681	11740
1888	4404	255007	100	3000	1900	30641	763431	1054	16310
1889	6113	426554	50	1800	1901	38500	962500	1300	20150
1890	9860	1262240	71	4560					

(From U.S. Geol. Survey: "Production of Asbestos in 1900," by J. Pratt.)

To give an idea of the important place asbestos takes in the mineral products of the Province of Quebec in the year 1900, the following table is given:—

KIND OF ORE.	Number of Workmen.	Quantities Produced, Shipped, or Utilised.	Gross Value of Ore Shipped or Utilised.
Magnetic Iron Ore (long tons)	10	1550	3875
Bog Iron Ore	120	17186	34372
Calcined Ochre.... (tons of 2000 lbs)	52	1182	9300
Chromic Iron ..... (long tons)	130	2068	53449
Low grade Copper .... (long tons)	270	33742	150152
Galena ..... (long tons)	24	286	57381
Asbestos .....(tons of 2000 lbs)	1040	21408	719416
Asbestic..... ditto	....	7935	15918
Graphite, prepared.. ditto	....	13	2500
Graphite, raw..... ditto	25	388	6964
Phosphate..... ditto	....	1370	8900
Mica, thumb-trimmed ditto	500	335	138600
Mica, not prepared.. ditto	.. .	150	25000
Feldspar..... ditto	....	147	441
Sulphate of baryta.. ditto	8	460	3220
Slate..... ditto	60	915	10131
Flagstone.....(square yards)	9	4000	3500
Cement .. .. (barrels)	40	22100	36570
Granite.....	170	.....	65000

(From Report Department of Colonization and Mines: "Mining Operations in the Province of Quebec," by J. Obalski, M.E.)

The principal localities in the Province of Quebec where asbestos is mined are Black Lake and Thetford, lying about midway between Quebec and Sherbrooke, on the Quebec Central Railway.

The asbestos is here found in narrow fissures, one to one and a half inches in width (maximum five inches) of the belt of serpentine; and the fibres are generally perpendicular to the walls of the seam. Although the veins seem to run in all directions, yet on closer examination a certain order is discernible. Foremost among the latter is the grouping of the fissures in long-drawn zones, which again may include narrower and richer ones. It does not always follow that by penetrating deeper the veins enlarge, in fact, the reverse is often the case.

As long as the genesis of asbestos is not thoroughly understood, we shall not be able to set up definite rules and methods, as obtains in the mining of ore and coal, to assist in the opening and development of asbestos mines. I surmise that the formation of asbestos from the serpentine magma was materially influenced by granitic eruptions.

The frequent occurrence of fissures, running in all directions, in the serpentine gives evidence that the area must have been subjected to intense disturbances after the cooling or solidification of the serpentine. The effect of these disturbances causes the greatest difficulties in the development of an asbestos area.

The mining of asbestos is carried on by quarrying. As the fissures or seams are small it naturally follows that a great deal of dead matter has to be moved. The serpentine carries on the average from three to four per cent of asbestos, and rarely does it reach as high as six per cent. Dynamite is used as the explosive, and is put into 10 to 12 feet deep drill holes. In out-of-the way places the hand drill is still used, otherwise steam or compressed air is utilized. The broken rock is reduced to smaller pieces by means of heavy sledges and steel wedges, and then smaller hammers are used for separating the asbestos from the gangue. The latter work is done either in the quarry, or under cover when a purer asbestos is desired. For this work boys from 14 to 16 years of age are employed. As magnetic iron ore is sometimes found in the asbestos, particular attention must be paid that the fibres are not unnecessarily damaged in separating the mineral. This treatment furnishes what is known as "crude" asbestos, which is then ready for shipment, in bags of 100 lbs. There are two grades—Crude No. 1 and Crude No. 2.

On account of the relatively small percentage of asbestos in the rock blasted, it is necessary to have special appliances for moving the latter. For the smaller mines the ordinary crane answers, but for the larger ones the crane is supplemented by cables. In the latter case the cable is put at an angle of not less than 30 degrees, so as to utilise gravity in returning the pit-boxes to work.

It is evident that by either of the above two methods the area that can be served is very limited, and this has led to the introduction of cable derricks with tail-rope. In applying the latter means a cable, one and a half inches in diameter, is stretched across two masts, from 30 to 60 feet high. One end of the cable is fastened to some high point in the quarry, while the other end is fastened on the other side of the mast, and distant as far as possible from the foot of the mast. By means of the endless cable the engineer is enabled to lower the pit-box quickly, and to hold it at any desired point. The hoisting cable (¾ inch) brings up the load. The pit-boxes are shallow wooden boxes lined with sheet iron, and carry from 1 to 1½ tons After being hoisted to the surface they are either loaded directly on to waggon frames or are dumped into larger dumping cars, and then moved by horse or steam power. For hoisting, twin steam engines of from 15 to 20 horse-power are used.

After having given a general description of the mining operation, a few words may be added about the treatment of the less valuable asbestos. This latter consists of waste (mostly serpentine) from the crude asbestos, and of larger pieces of serpentine traversed by small veins of asbestos, which, however, it would not pay to treat, as heretofore described, by hand.

The extraction of the fibre from this inferior material is done by machinery in asbestos mills. The broken material, or at least the smaller pieces, is first subjected to a drying process in rotating cylinders; it then passes through stone crushers and rollers, whereby it is reduced to a given fineness, when it passes into the "cyclones," where further reduction takes place, especially the disintegration or separation

of the individual fibres. This process (centrifugal) continues until the rock is ground to sand and the asbestos fibres are thrown on to the separating sieves. From the latter the fibers are drawn away by exhausts, and the sand is blown into bins. Nothing remains now to be done but to fill this asbestos, known as "paper stock," into bags of 100–150 pounds for shipment. According to quality it is designated as Nos. 1, 2, or 3.

It is probably scarcely necessary to state that the above description is but very brief, and the actual work is not at all so simple, but we cannot here enter into greater detail.

As already stated, asbestos commands a good price, and higher than ever, although the production has greatly increased.

"Crude" asbestos, No. 1 sells from $150 to $250, and No. 2 from $80 to $150 per ton; paperstock runs from $20 to $40 per ton. To explain the difference between the above prices it is necessary to state that in the different mines for a given class different prices obtain, depending upon the length of the fibre, and upon the per cent. of impurities.

Beside the mines of Black Lake and Thetford, those at Broughton and Danville deserve mention.

Although asbestos occurs near Ottawa, yet it is in too limited quantity, the veins being small in number, to be of any commercial importance. The fibre is very pretty, and of a light yellow-green color, the same as the serpentine.

So far as known there are no other localities in Canada where asbestos could be profitably mined. At the present time there are in Canada twelve asbestos mining companies, with a capital of four millions; the mines requiring at present about 3000 men. Difficulty is experienced, especially during the summer months, in obtaining sufficient labor, and efforts are made to obtain the requisite supply. The wages, for 10-hour shift, are from $1.25 to $1.50, which is considered fair pay, considering that the cost of living in the Province of Quebec is relatively low.

From the foregoing the importance to Canada of the industry of asbestos mining must be apparent. In this she rules the markets of the world, and to all appearances will continue to do so on account of the extensive area of her asbestos deposits and of their high quality.

We may safely say that, with the very good prices prevailing, and the rapidly increasing demand, asbestos mining in Canada has a decidedly bright future in store.

Notes on Oil Furnaces for Assaying and Melting.

By CHARLES BRENT, M.E., Rat Portage.

In view of the fact that the use of oil fuel in many departments of metallurgy has been greatly extended during the past two years, a few practical notes on the use of oil as applied to the furnaces necessary in the assay office and melting room may be found of interest to some of the members of the Institute.

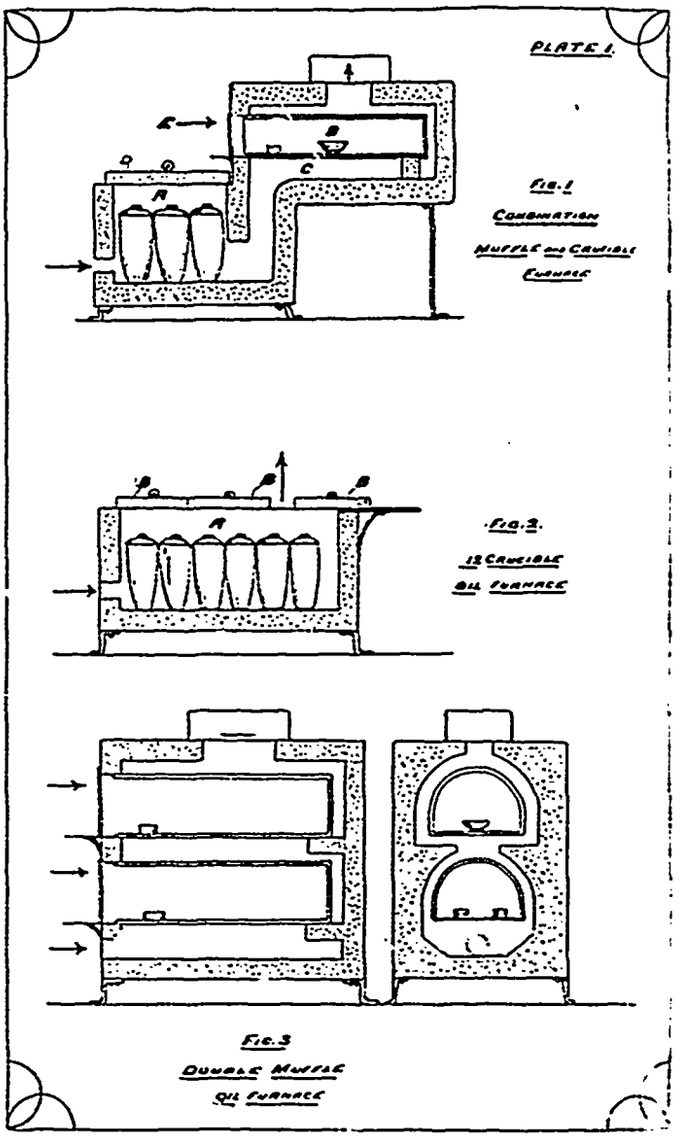
The furnaces described in this paper were designed by the writer mostly for use in my own laboratory and are the result of a good deal of practical experiment in the use of oil for fuel, carried on for the past twelve years. Petroleum, either as gasoline, refined oil or fuel oil, can be used in any of the furnaces and it will be found to possess many advantages over any other class of fuel wherever steam or compressed air can be obtained, or even the comparatively light pressures from an ordinary blower. It will be found in most cases more economical than either charcoal, coke, coal or gas, and wherever ordinary precaution is used the risk from fire or explosion will be reduced to the vanishing point.

The saving of time and labor in the use of oil fuel as compared with solid fuel must be known to be properly appreciated, and the ease of manipulation and the freedom from dust and ashes and outside heat will recommend this fuel very strongly to anyone who tries it.

The furnaces described and illustrated in this paper can be constructed by any ordinary mechanic, and will cost less than half the money ordinarily expended for furnaces of like capacity for solid fuel.

They occupy a quarter of the space usually taken up by furnaces of the old type, and can be placed in any convenient part of the laboratory to which air or steam and oil can be piped.

The construction of all the furnaces is the same in that they are all constructed of sheet steel, of suitable weight, according to the size of the furnace. The shells are lined with a plastic mass, composed of 4 parts of old assay crucibles ground to about 20 mesh and 1 part of good finely-ground fireclay. This mixture should be worked up with a



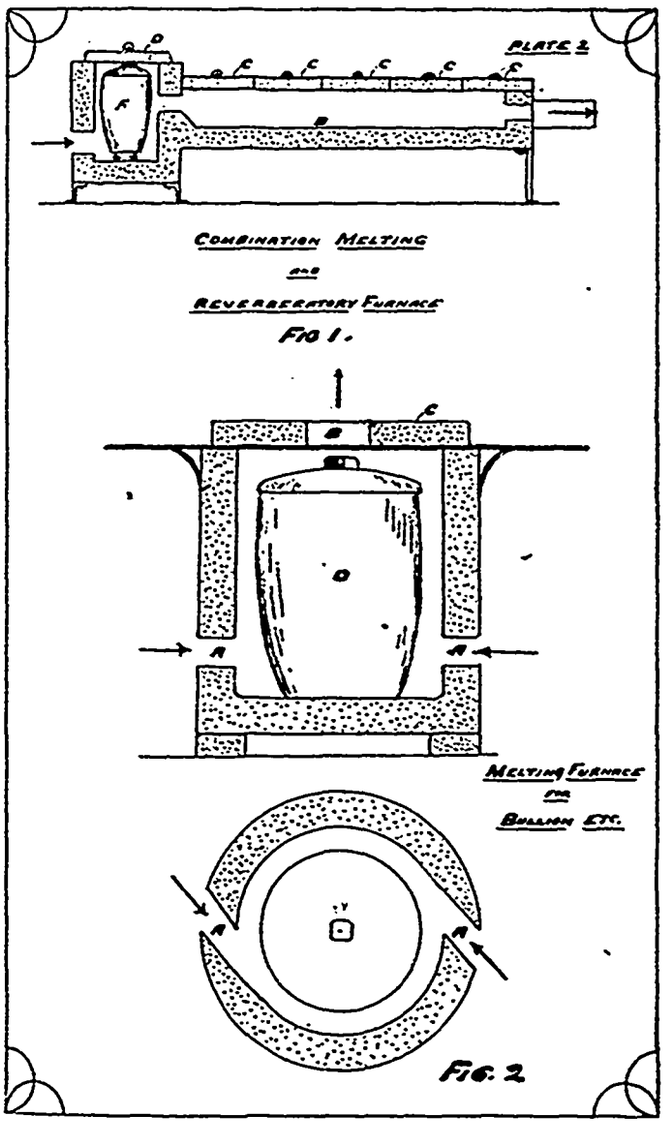
small quantity of water and put in as stiff as it can be handled. After a day or two drying, a light wood fire is put in the furnace until the lining is thoroughly hard.

A little caution must be used the first time oil fuel is applied, but if the furnace is thoroughly dried the heat may be pushed at once to the extreme limit required.

On cooling, the lining will be found pitted together by the small quantity of slag from the broken crucibles and will usually be free from cracks. Should any develop they should be filled with a thin mixture of the lining material. This lining burns as hard as porcelain, and as there are no ashes from solid fuel to slag the walls, it will be found practically indestructible. (The writer has a small furnace in his laboratory in which thousands of assays have been made, and the lining is today as good as the day it was first put in.)

The combination furnace shown in Fig. 1, Plate I, was designed to hold six Battersea crucibles, size E or F, and a size J or H Battersea muffle. In the diagram A is the crucible chamber with an opening below and in front to admit the jet of oil and steam or air. A convenient cover for the chamber is an ordinary soapstone foot-warmer, bored and fitted with an iron ring for convenience of handling Behind and above the crucible chamber is the muffle chamber, C, containing the muffle B. The walls of this chamber hug the muffle at the sides, the top and the end within ¾ of an inch and the opening for the escape of the products of combustion is placed in the middle of the muffle. A small door lined with a sheet of asbestos closes the opening to the muffle and a small shelf beneath this adds to the convenient working of the furnace.

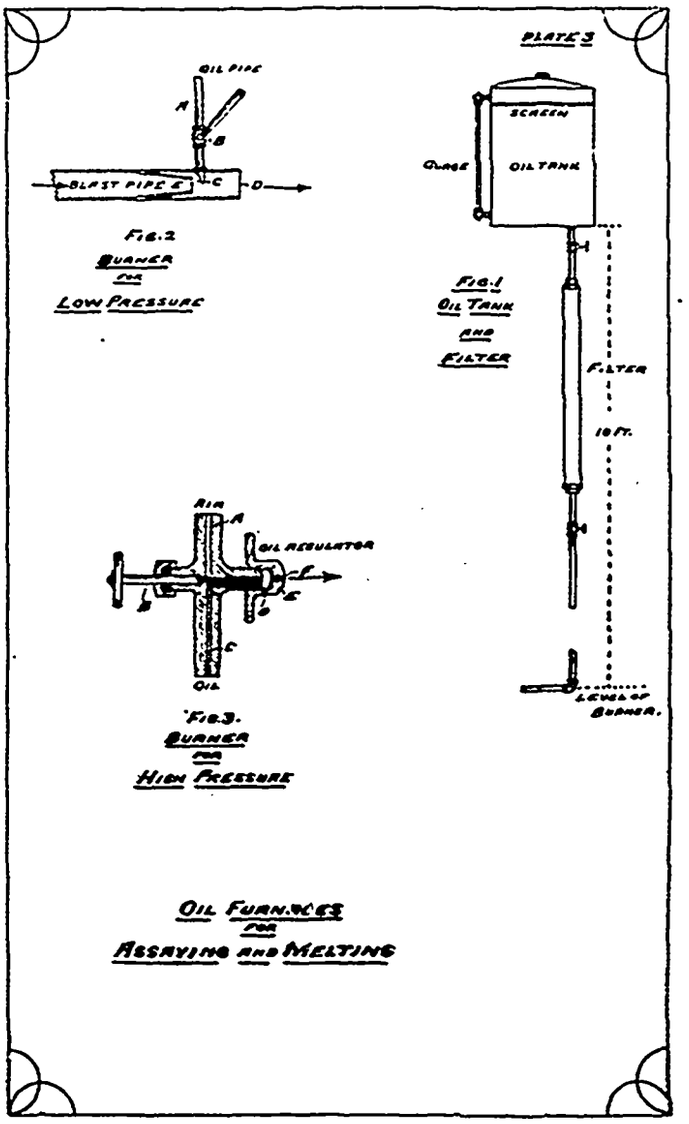
This furnace can, with the right quantity of oil and air at 80 lbs. pressure, be raised to the temperature for fusion for assays in less than ten minutes, and the muffle will be found at a suitable temperature for cupellation in fifteen minutes. Work can be carried on simultaneously in both crucible chamber and muffle, as the jet sweeps between the crucibles and strikes at once into the muffle chamber. This furnace will make a set of fusions in 20 minutes, and by the use of a second jet of compressed air, E, into the mouth of the muffle a set of cupellations



on 10 gramme buttons can be made in from 7 to 10 minutes. The fuel burned will be less than three-quarters of a gallon of oil, which, after the furnace has been burning a few minutes, can be cut down to burn with a practically invisible flame. The saving in crucibles and muffles in this furnace over a furnace of similar capacity for solid fuel, will be found a very strong point in its favor. (The writer has in use in his laboratory a muffle that has been heated at least five hundred times, and it is as good as new.)

The furnaces designated as Figs. 2 and 3 (Plate I) were designed to be worked together in an assay office handling ordinarily one hundred assays and upwards per day.

Fig. 2 is a crucible furnace designed to take in 12 size E or F crucibles in the chamber H, which is covered with three soapstone covers, B. The jet is admitted through an opening at the bottom and in front and the products of combustion escape through openings be-



tween the covers B, which are arranged to slide apart for this purpose. The regulation of the fusions is perfect. If it is desired to hasten up the melting of the back set of crucibles, an opening is left over them by sliding the covers apart.

A suitable sheet iron hood about 3 feet above the furnace is connected with the chimney and serves to carry off all fumes, without interfering with the work at the furnace. This furnace will burn a gallon of oil every hour and will turn out a batch of fusions every 25 minutes.

Fig. 3.—This is a double muffle furnace designed to hold two size K muffles, and the regulation of the heat in the two muffles is accomplished by the proper combination of the jet below and the draft above. Ordinarily the bottom muffle will become much hotter than the upper one, but on increasing the air in the jet below and opening the draft above, the two muffles can be regulated to the same temperature. The furnace will burn from ¾ of a gallon to 1 gallon per hour of oil, will be hot enough for cupellation in either muffle in 20 minutes and hot enough

for scorification in 25 minutes. An obvious saving in fuel is made in furnaces of this size as, in the oil furnace, the moment the work is done, the oil is turned off and there is no further consumption of fuel, while in a furnace for coal or coke, from half a bushel to a bushel of incandescent fuel is ordinarily left to burn to waste in the furnace after the work is done.

The furnace designated as Fig. 1, Plate II, was designed for drying and washing the gold precipitate from the chlorination process and melting the dried product.

The precipitate is dried and washed in a series of trays on the hearth B of the furnace, any part of which is accessible by sliding the covers, C. After drying and washing the product is transferred while hot to the plumbago pot, A, which has during the washing attained a full melting heat. Any fume or dust is retained in an enlarged section of the shaft pipe which can be opened and cleaned at suitable intervals.

Fig. 2, Plate II, shows a double jet furnace, designed for melting bullion.

The jets form a tangent to the surface of the melting pot and form a whirling flame between the pot and the furnace walls, the products of combustion escaping through a hole in the centre of the furnace cover. This furnace will be found extremely rapid and convenient to use, especially on bullion which requires a good deal of slagging and refining. Any melter who has stood over an ordinary coke furnace for an hour filled with incandescent fuel, will appreciate a melting furnace that at a touch can be so cooled off as to be worked over with no discomfort from either light or heat. The furnace can be placed anywhere in the melting room, requires no expensive smoke stack, and takes up but little room. The furnace itself is ordinarily only 4 inches more in diameter than the crucible it holds, and is only about 4 inches higher. The rapidity of melting must be also taken into consideration. The writer has melted a thousand ounces of retort sponge and slagged it thoroughly clean in less than an hour with the consumption of 1¼ gallons of fuel oil, and has repeatedly melted twenty pounds of brass in less than half an hour with less than half a gallon of fuel.

A great many modifications of these furnaces will suggest themselves to the members of the Institute; but anyone who once tries oil fuel in any of the various furnaces required about an assay office or melting room will afterwards "use no other."

Fig. 1, Plate III, shows an oil reservoir with screen near the top and gauge glass on the side and connected below to a filter, which is simply an enlarged section of the supply pipe filled with coarse clean sand. It will be found a very important matter to free the oil from every trace of suspended matter, especially when using the high pressure jets, as the openings are so minute that a very small particle of grit will stop the flow of the oil. It will be found convenient to locate the oil reservoir at least 10 feet above the jets to keep a proper head of oil on the burners.

Fig. 2, Plate III, roughly illustrates the form of burner used by the writer with an ordinary pressure blower giving a pressure of 6 to 10 inches. The oil comes to the blast pipe through pipe A, its flow being regulated by stop-cock B. The blast pipe is contracted to a nozzle E, and the end of the pipe C is flattened as shown in diagram.

Fig. 3, Plate III, shows the ordinary high pressure burner which can be bought now from a number of firms manufacturing oil-burning furnaces for steam-raising and forge work.

The air enters through a passage H, its blow being regulated by needle B. It issues through the central orifice F, and sprays the oil entering through a passage C. The flow of the oil is regulated by the cap E, which when screwed up completely closes the opening D of the passage C, without interfering with the passage of the air.

The Ore Deposits of the Boundary (Creek) District, B C.

By R. W. Brock, B.A., Ottawa.

The district treated of in this paper is that lying along the International Boundary line, in the neighborhood of and between the valleys of the north fork of the Kettle river and Boundary Creek, B.C. Following upon the construction of the Columbia and Western railway, a little over two years ago, and the installation of smelters at Greenwood and Grand Forks a year and a half ago, the district at once took a foremost place in British Columbia lode mining and it now ranks as one of the most important factors in the production of copper in Canada.

While the mountains are not rugged and the western and southern slopes are often open, prospecting has not been easy, on account of the covering of drift which conceals the rocks over a considerable portion of the surface and on account of the complex geological structure of the district.

* Eruptive rocks, including granites, greenstones, lavas (and associated tuffs) and various intrusive dykes have the widest distribution. More or less altered sedimentary rocks (limestones, argillites, quartzites) together with more highly altered metamorphosed rocks, including serpentine, are met with in all parts of the district, but do not, as a rule, have large dimensions in any one place, being usually nothing more than inclusions of older formations caught up in the intrusive rocks.

The oldest rocks recognized in the district are the sedimentary and crystalline rocks. In the south-eastern part of the district just west of Grand Forks, some crystalline mica and hornblende schists and crystalline limestone occur, which resemble lithologically the rocks of the Shuswap series (Archean), but they may possibly merely represent in a more highly metamorphosed form the argillites and limestones found elsewhere in the district.

The argillites are normally dark or red, occasionally highly carbonaceous, but are often altered to gray knotted schist, or hornfels, or they may be largely silicified. The limestones are usually white and crystalline, but occasionally show an original black color. In places the lime is replaced by silica, forming cherty or quartz-like jasperoid rocks. True quartzite is only sparingly found. Closely associated with these is a serpentine, probably derived from a basic eruptive rock. It is frequently altered to a siliceous dolomite or magnesite. These rocks form a series closely resembling, and probably of the same age as, the Cache creek series described by Dr. Dawson, and ascribed by him to the carboniferous formation.

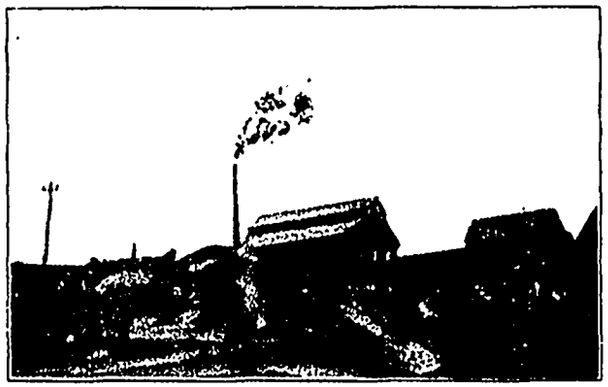
Somewhat younger than the sedimentary rocks is the greenstone, which has the greatest areal distribution of all the rocks of the district. Often it is altered, but where its structure is preserved it appears to be an augite-porphyrite, sometimes agglomeratic, similar to that rock found in many parts of West Kootenay, notably around Rossland. It cuts and holds inclusions of the older rocks. Indeed, in most of their occurrences, the latter appear simply as islands in the greenstone, varying in size from small fragments, closely packed and almost filling the greenstone matrix, to bands hundreds of meters long. Under pressure it becomes schistose and difficult to detect from some of the included argillites. Occurring with it are bands of tuff, filled with fragments of the older rocks, and interbanded with fine-grained ash-beds.

Younger than and cutting the greenstone is a gray hornblende-biotite granite which is exposed near Greenwood, in Wellington camp, and on Hardy mountain. Gray granite porphyry dykes from it cut the older formations a long way from the parent masses. The white altered porphyry on McCarren creek and at the City of Paris mine, may belong to this series of dykes. This granite will probably prove

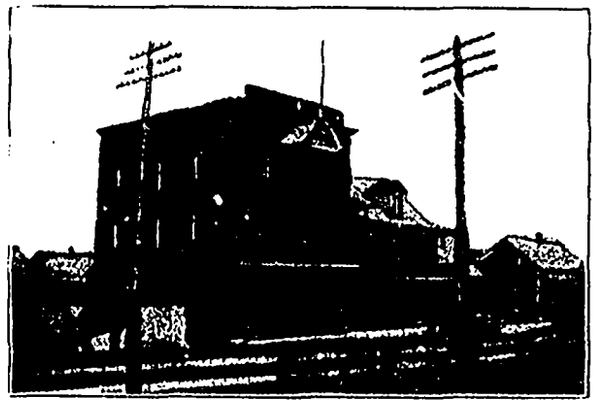
* The rocks have not been studied microscopically, and cannot therefore be named with strict scientific accuracy, but still closely enough for most practical purposes.

ASBESTOS MINING IN QUEBEC.

An interior view of the Main Pit of the Bell's Asbestos Co., Thetford Mines, Que.

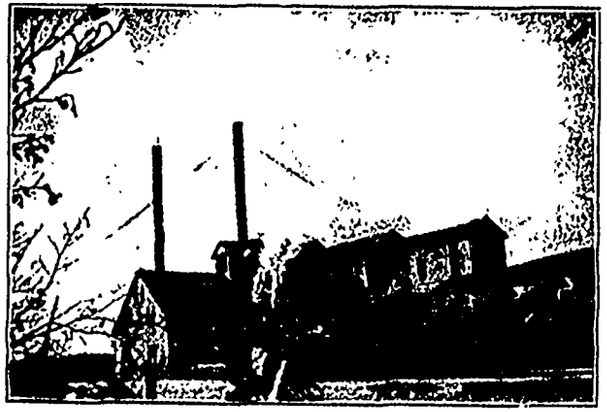


Johnson's Company, Thetford.

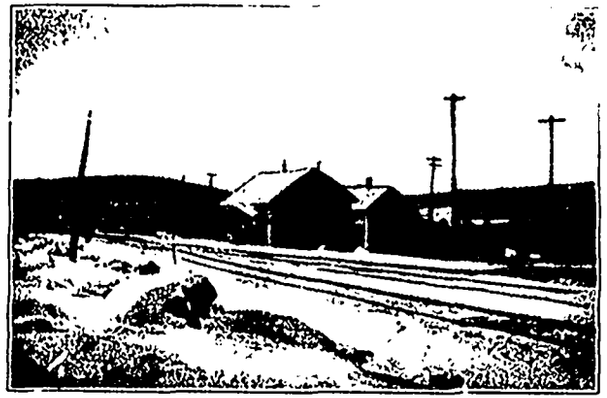


Commercial Hotel, Thetford.

Black Lake, Que.



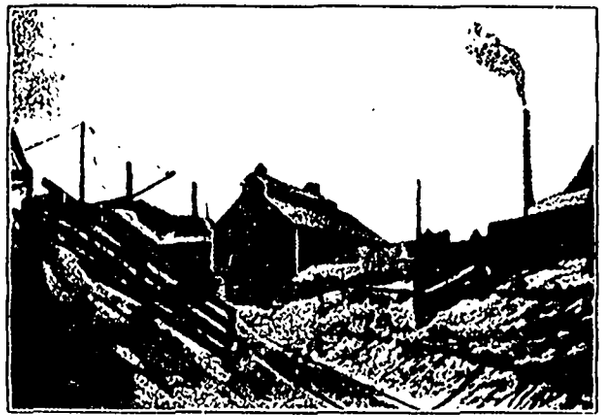
Asbestos Mills at Thetford, Que.



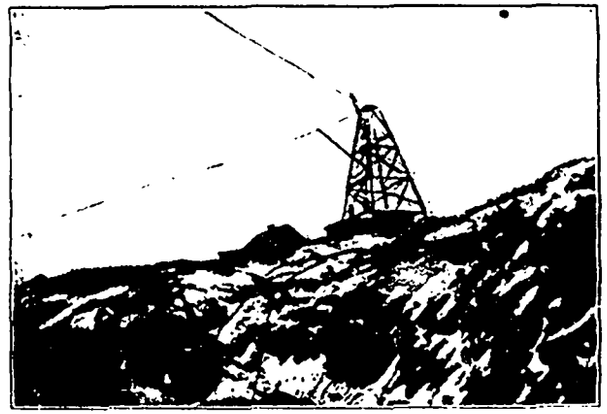
Black Lake Station, Q C.R.

Village of Black Lake, Que.

Main Street, Thetford Mines.

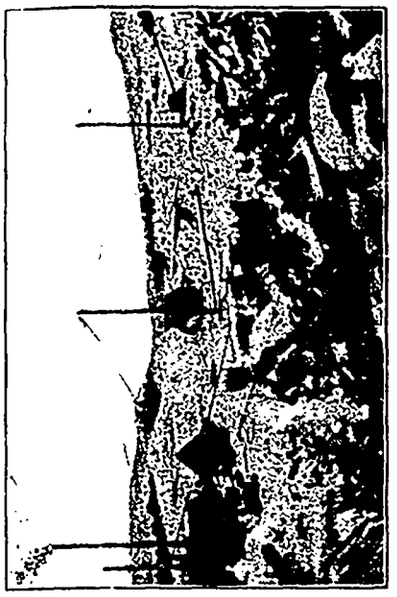


Bell's Asbestos Co., Thetford

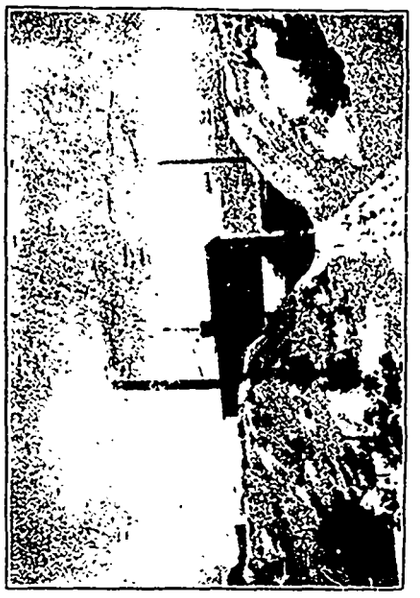


Manhattan Asbestos Co., Black Lake

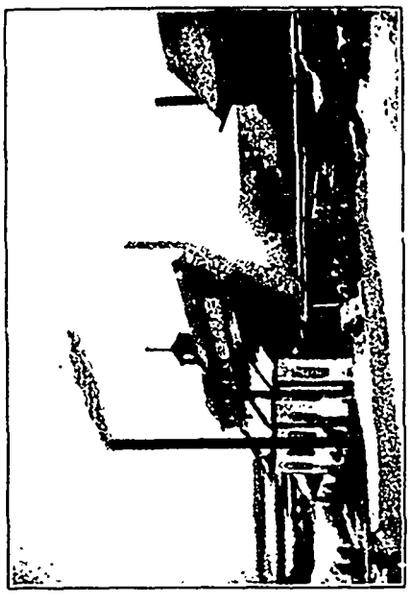
ASBESTOS MINING IN QUEBEC.



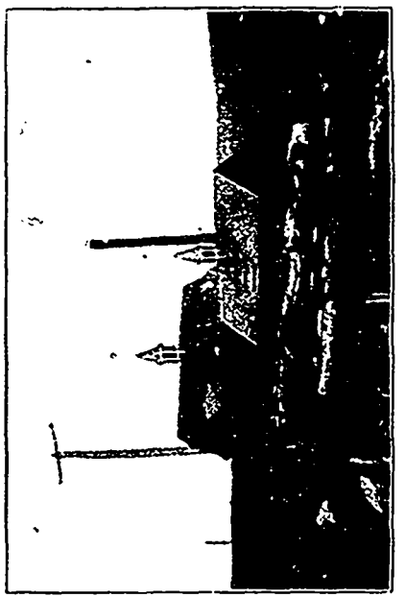
Johnson's Co., Black Lake.



Standard Asbestos Co., Black Lake.

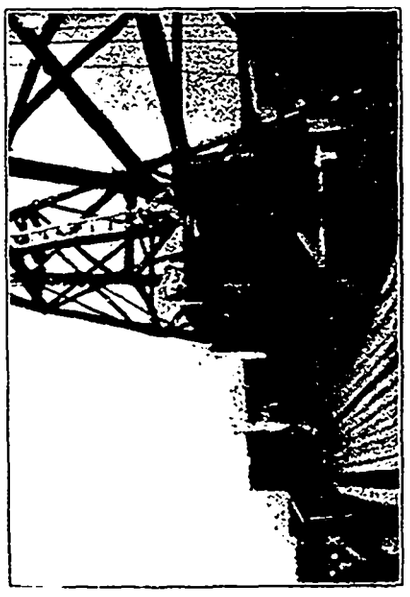


Black Lake, Que.

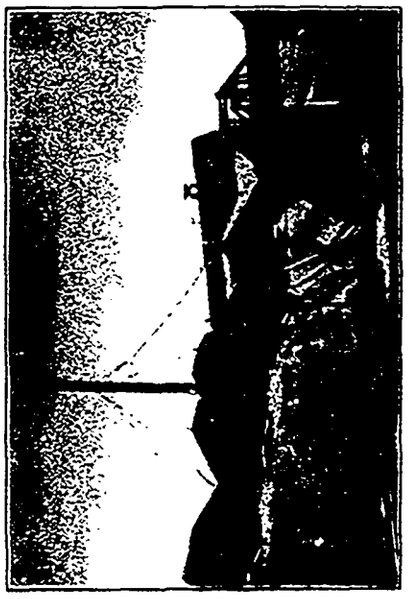


Johnson's Co., Black Lake.

Drilling for Asbestos.



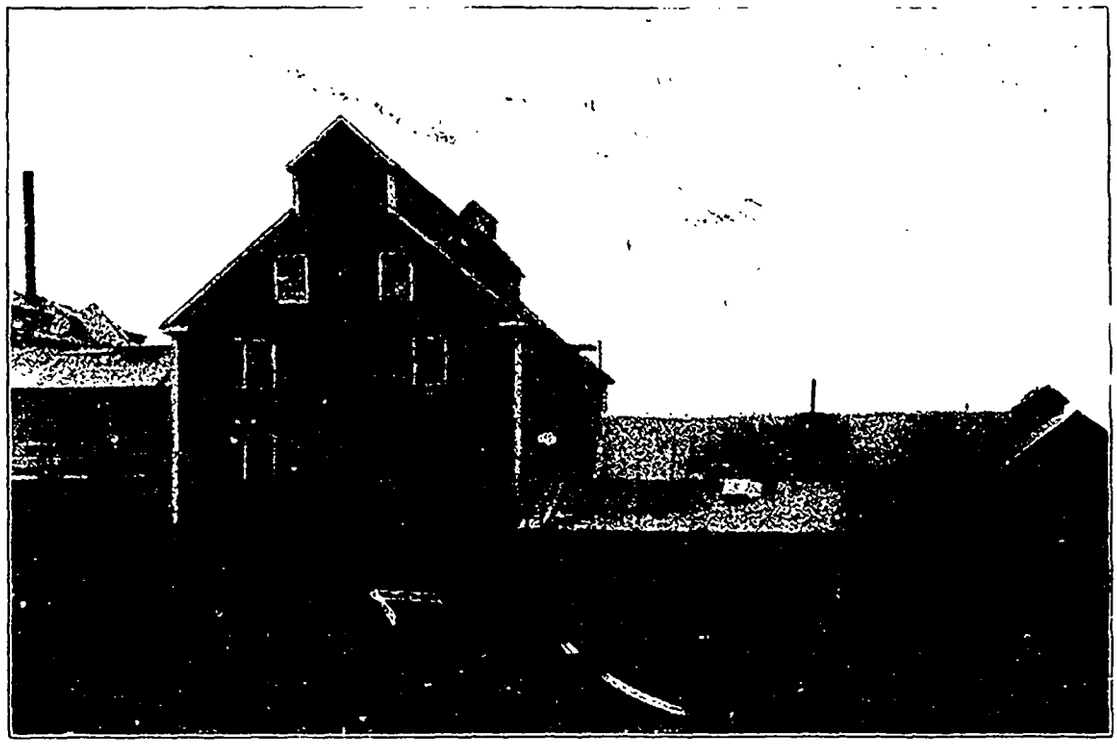
Union Asbestos Co., Black Lake



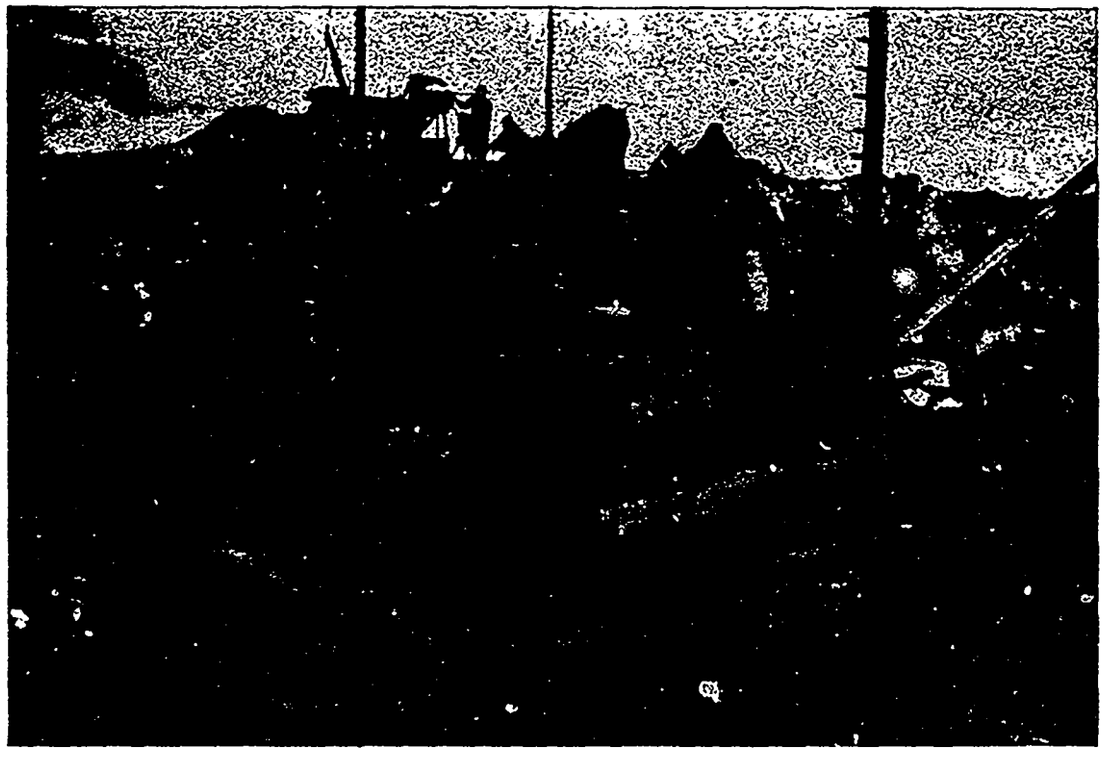
King Bros ' Mill at Thetford.

Hotel, Black Lake, Que.

ASBESTOS MINING IN QUEBEC.

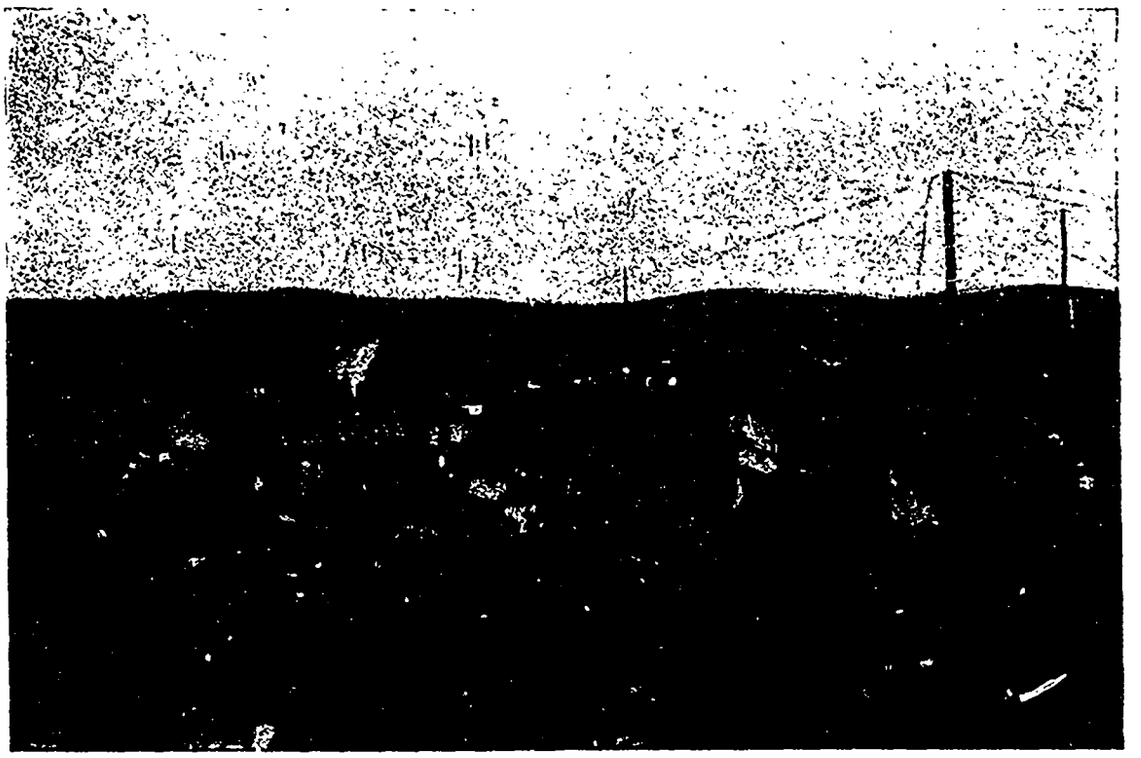


Asbestos Milling Plant of the Bell's Asbestos Co. at Thetford Mines, Que.

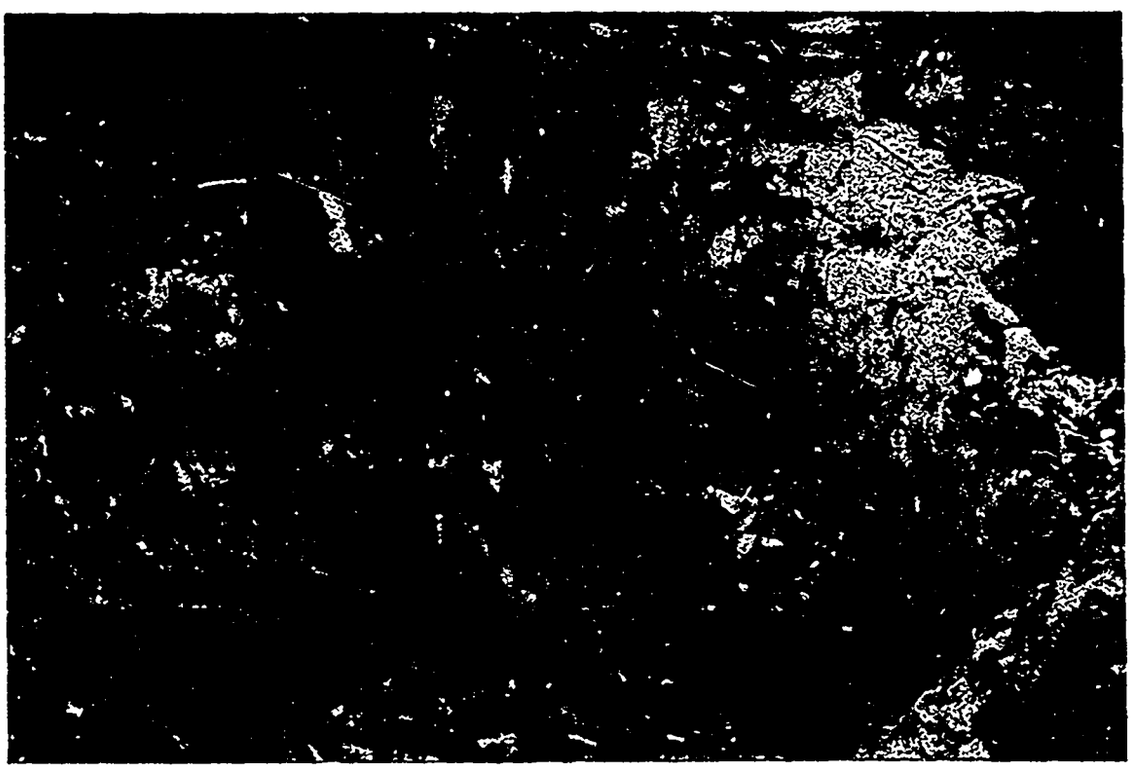


Interior of one of the great Asbestos Quarries worked by King Bros. at Thetford Mines, Que.

ASBESTOS MINING IN QUEBEC.

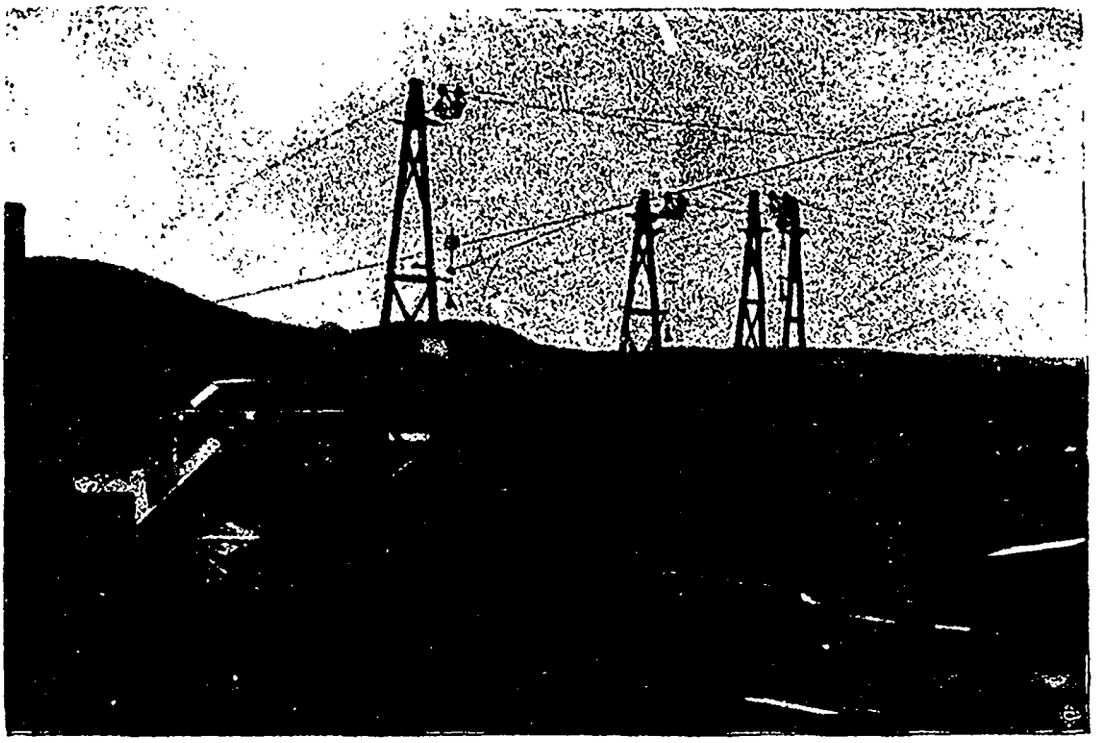


General View of Thetford Mines, Que.

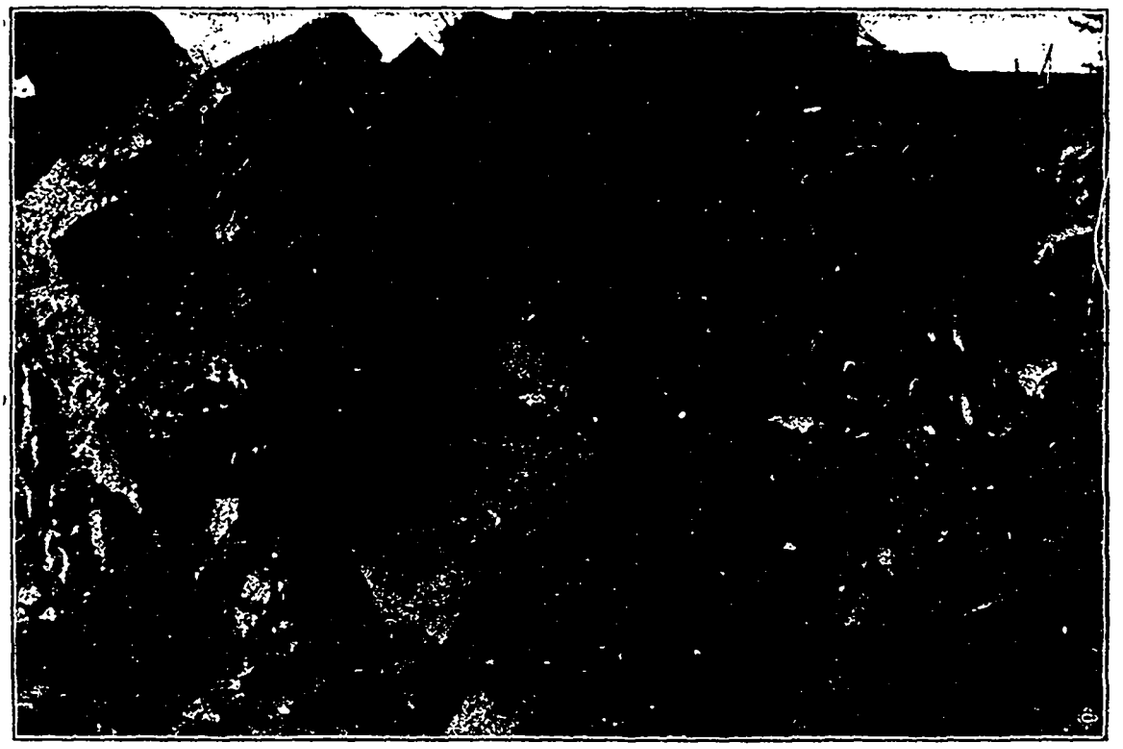


Interior of Big Pit—King Bros. Asbestos Mines, Thetford, Que.

ASBESTOS MINING IN QUEBEC.

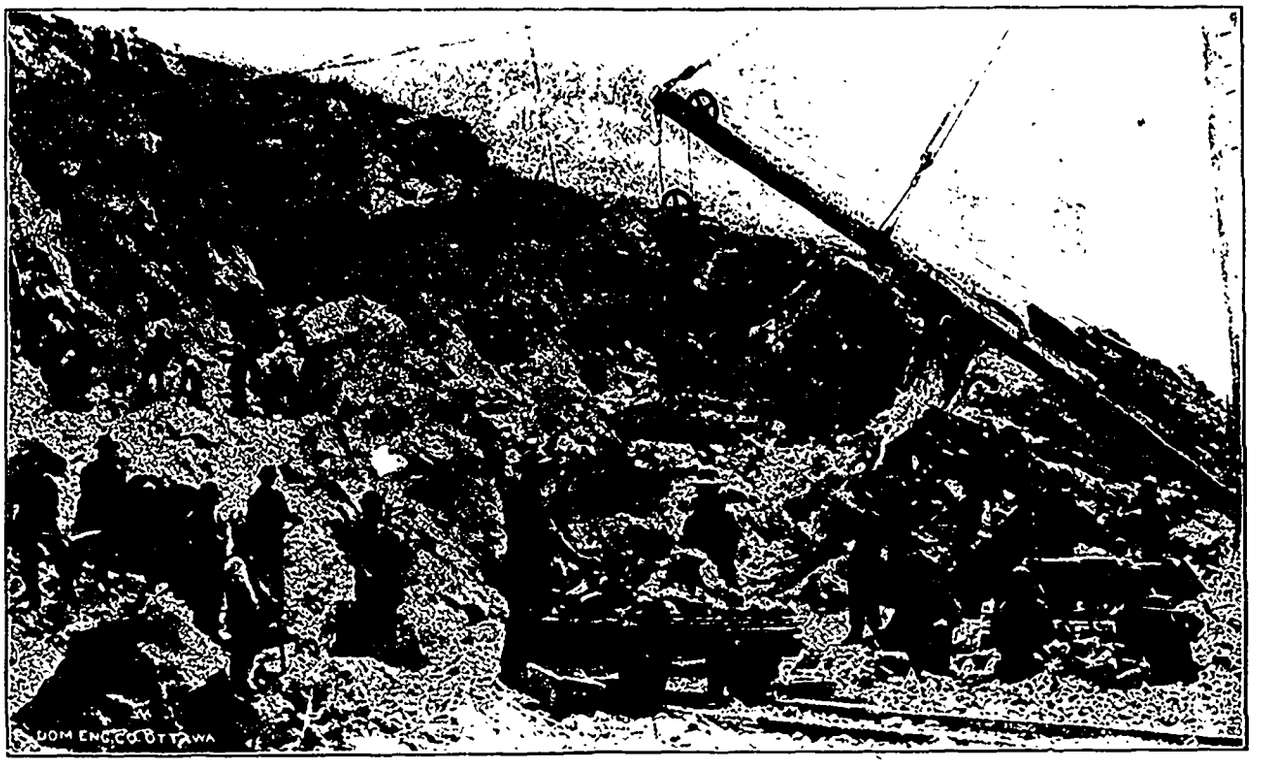


Cable Derricks and Surface Plant at Danville, Que., operated by the Asbestos and Asbestic Co. Ltd.



Interior of Pit, Danville, Que.

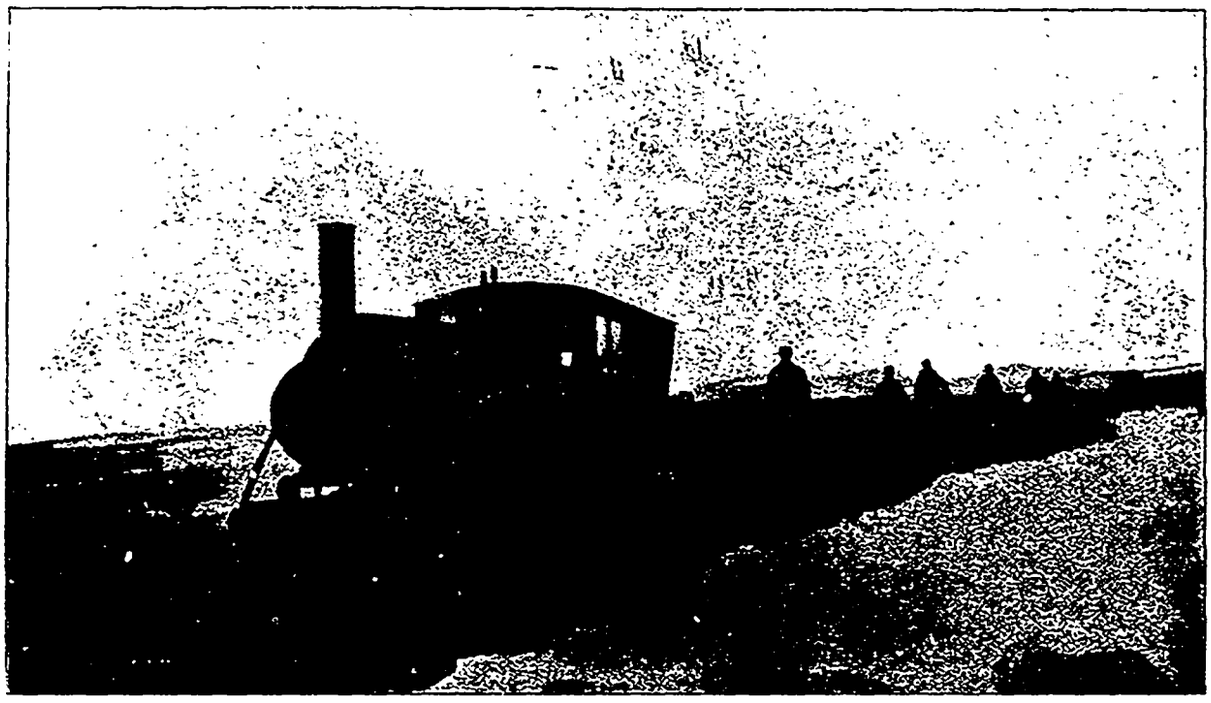
ASBESTOS MINING IN QUEBEC.



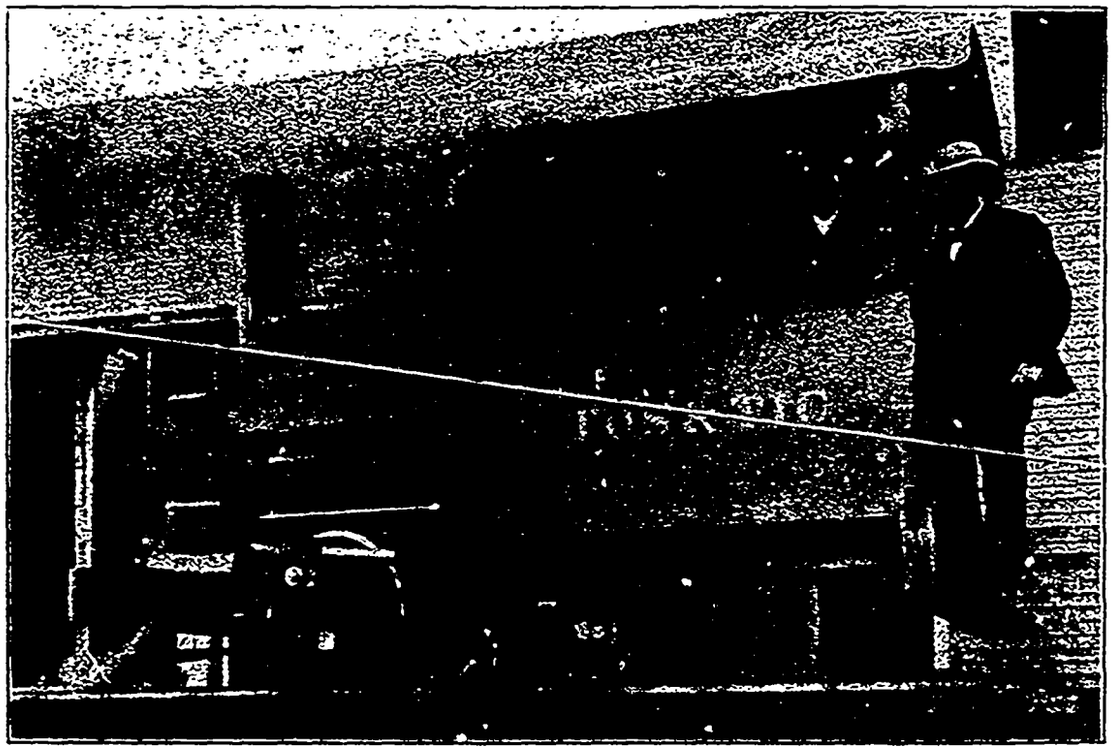
Asbestos Mining at Black Lake, Que.

Another view of the Quarry of the Asbestos and Asbestic Company at Danville, Que.

ASBESTOS MINING IN QUEBEC.



Unique type of Mine Locomotive in service at the Bell's Quarries, Thetford Mines, Que.



Locomotive "Tos and Tic" in service at the Pits of the Asbestos and Asbestic Co., Danville, Que.

ASBESTOS MINING IN QUEBEC.

B. BENNETT,
Manager, King Bros.,
Thetford.

T. H. CRABTREE
Manager, Union Asbestos Mines,
Black Lake.

HARRY J. WILLIAMS,
Manager, Beaver Asbestos Co.,
Thetford Mines.

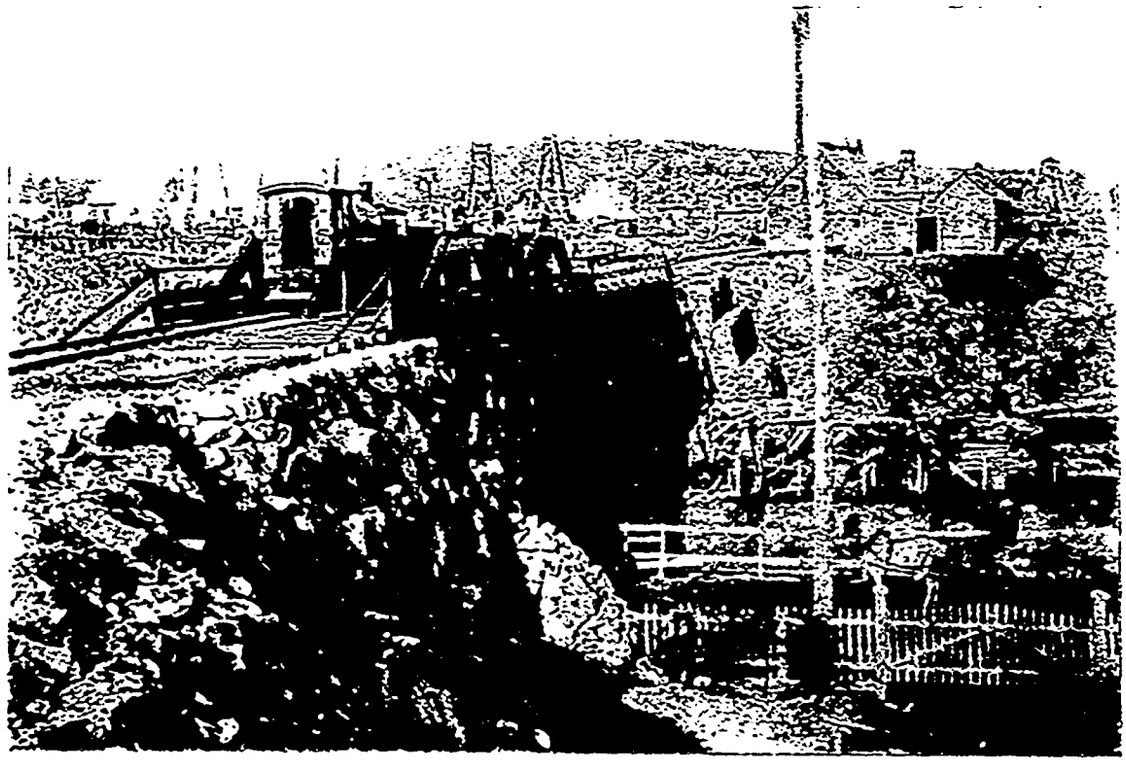
R. T. HOPPER,
Standard Asbestos Co.,
Black Lake.

GEORGE R. SMITH, M.L.A.,
General Manager, Bell's Asbestos Co.,
Thetford Mines.

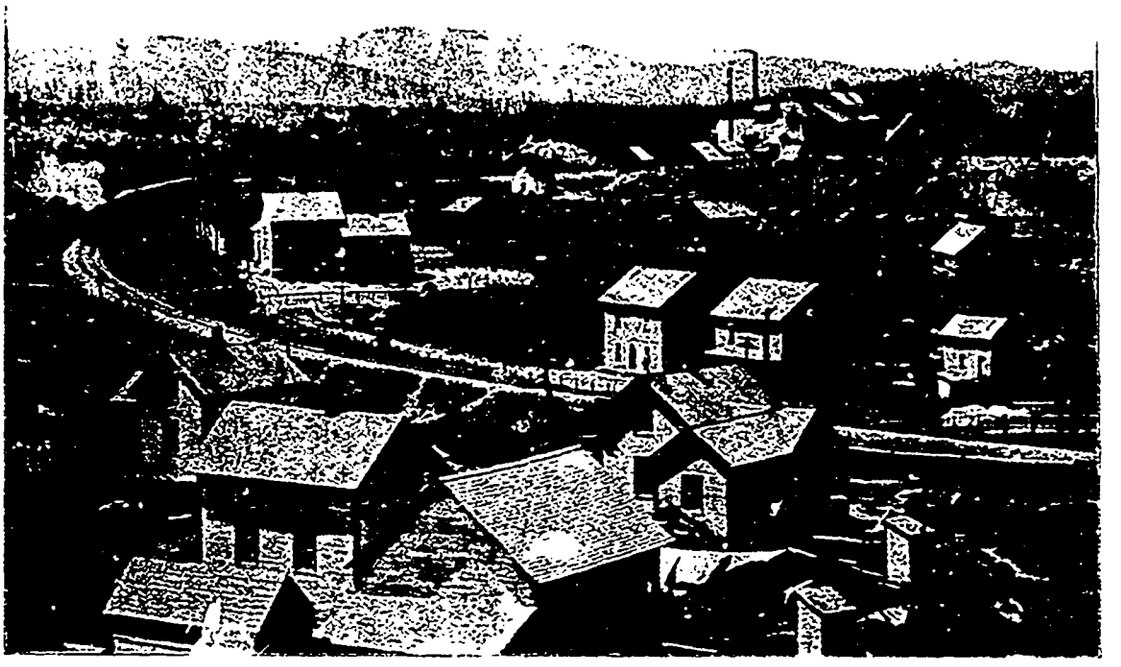
WM. SCLATER,
Canadian Asbestos Co.,
Black Lake.

ASBESTOS MINING IN QUEBEC.

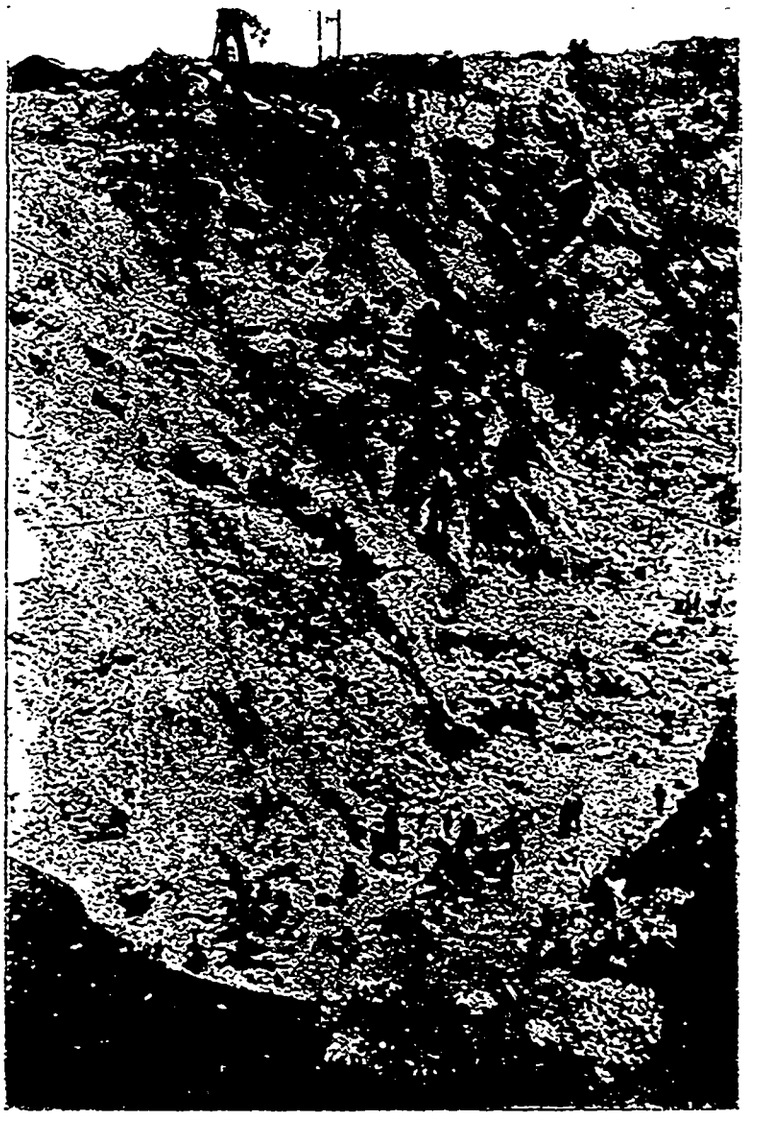
Asbestos Mining and Milling at Black Lake, Que.



Bell's Asbestos Co.—New Double Track Trestle over road and Q.C.R from dump.

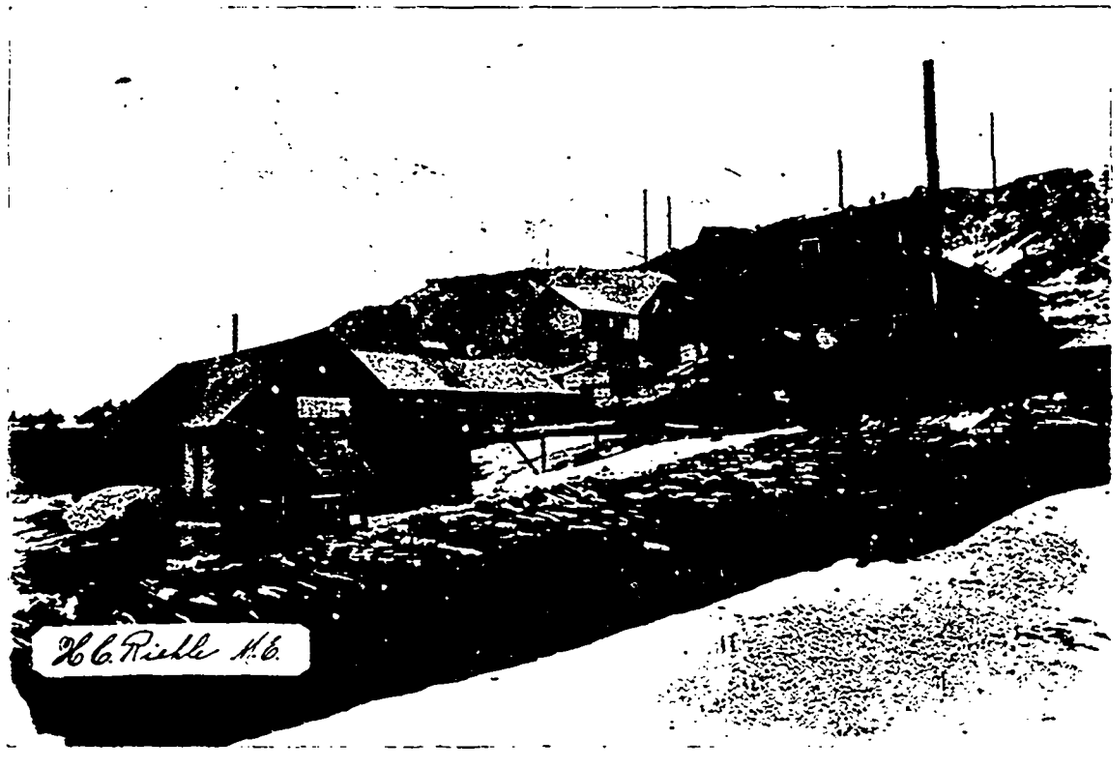


View taken on curve of the Quebec Central Railway at Thetford Mines, showing large new asbestos mill of the Beaver Co. in the background.

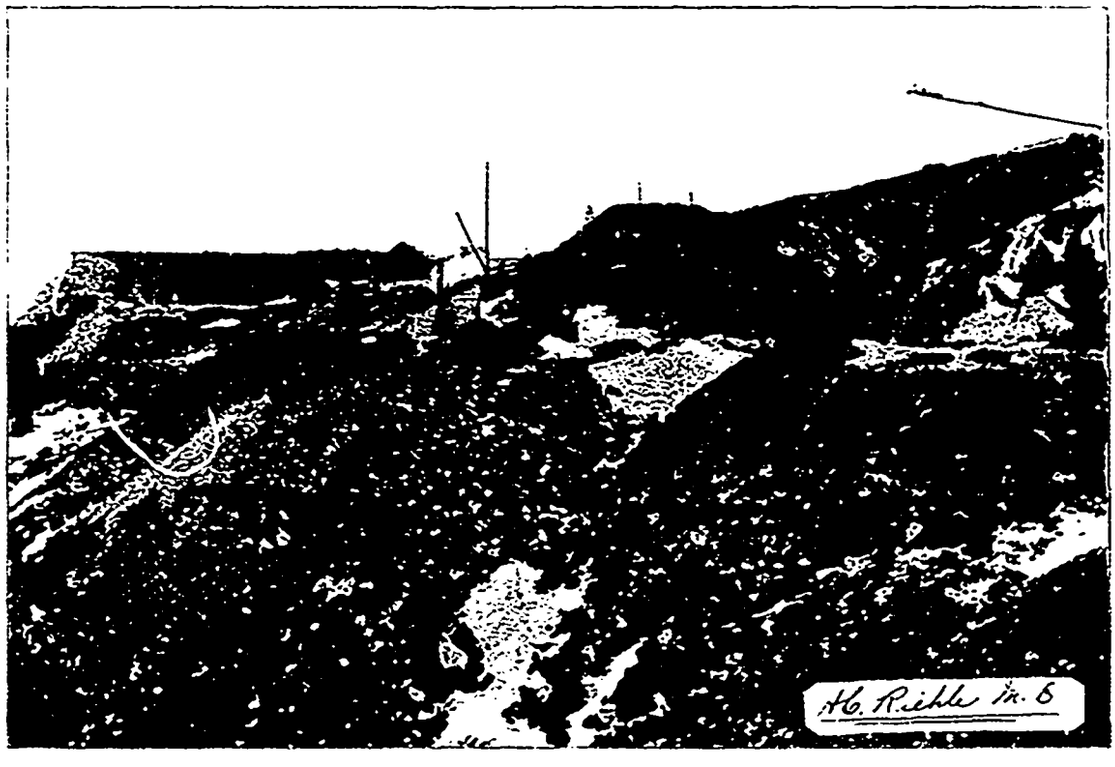


An interior view of the Main Pit of the Bell's Asbestos Co. at Thetford Mines, Que

ASBESTOS MINING IN QUEBEC.

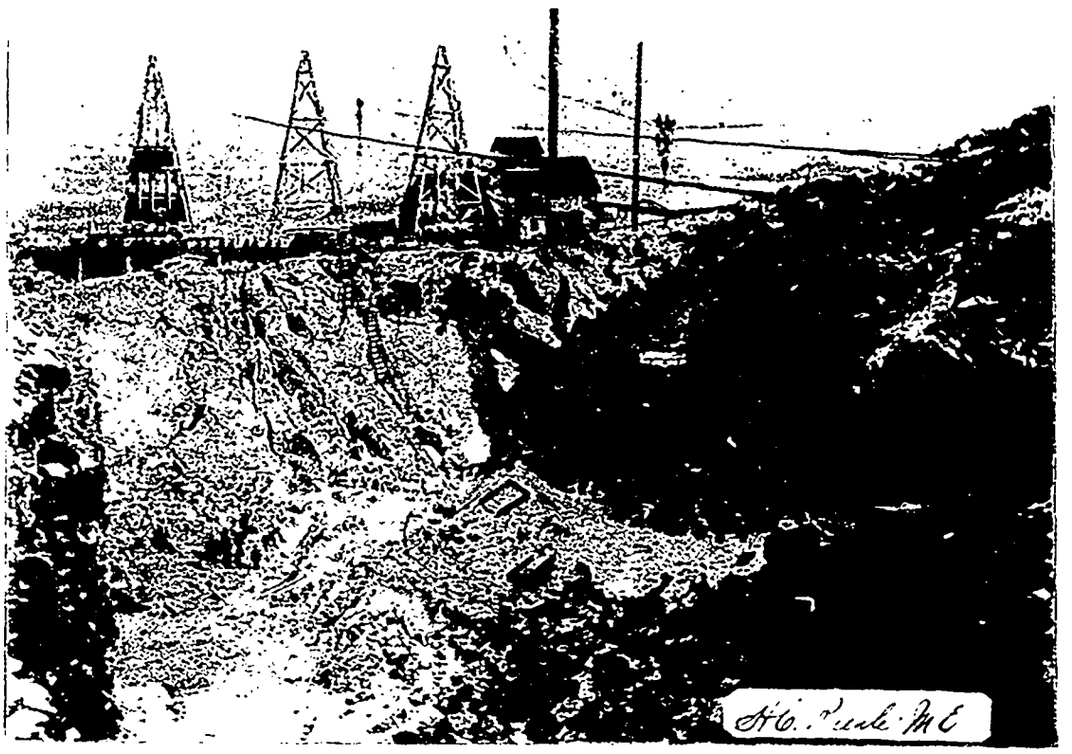


Asbestos Milling Plant at the Union Mine, Black Lake, Que.

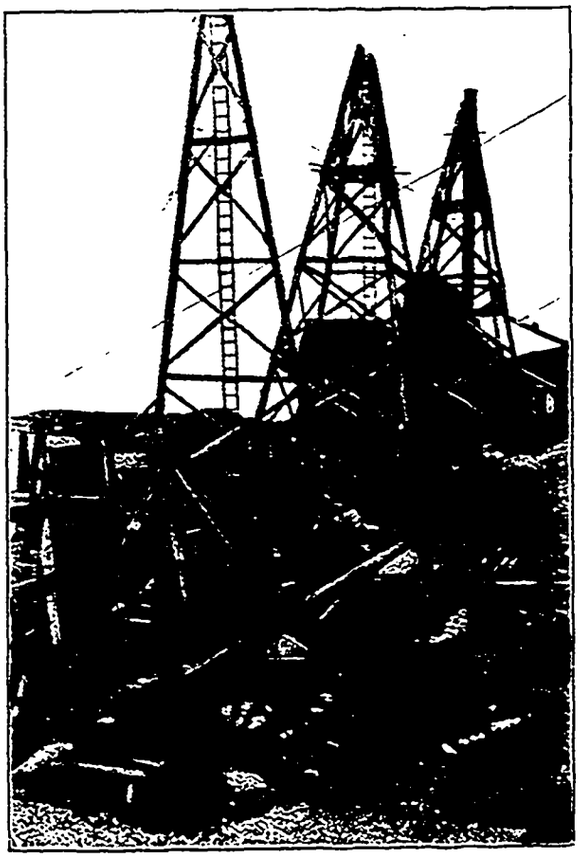


Another view of the Pits of the Union Asbestos Mine at Black Lake, Que.

ASBESTOS MINING IN QUEBEC.



Cable Derrick Plant at the Union Mines, Black Lake.

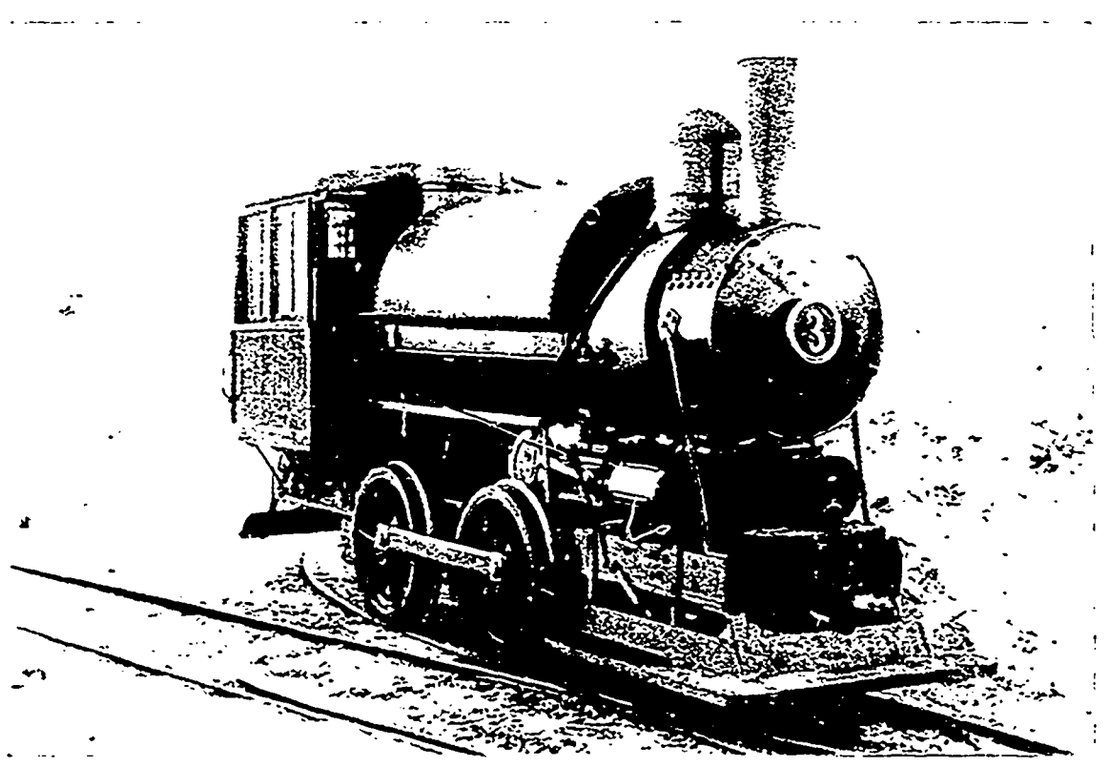


At Union Asbestos Pit, Black Lake, Que.

Union Asbestos Mill, Black Lake, Que.

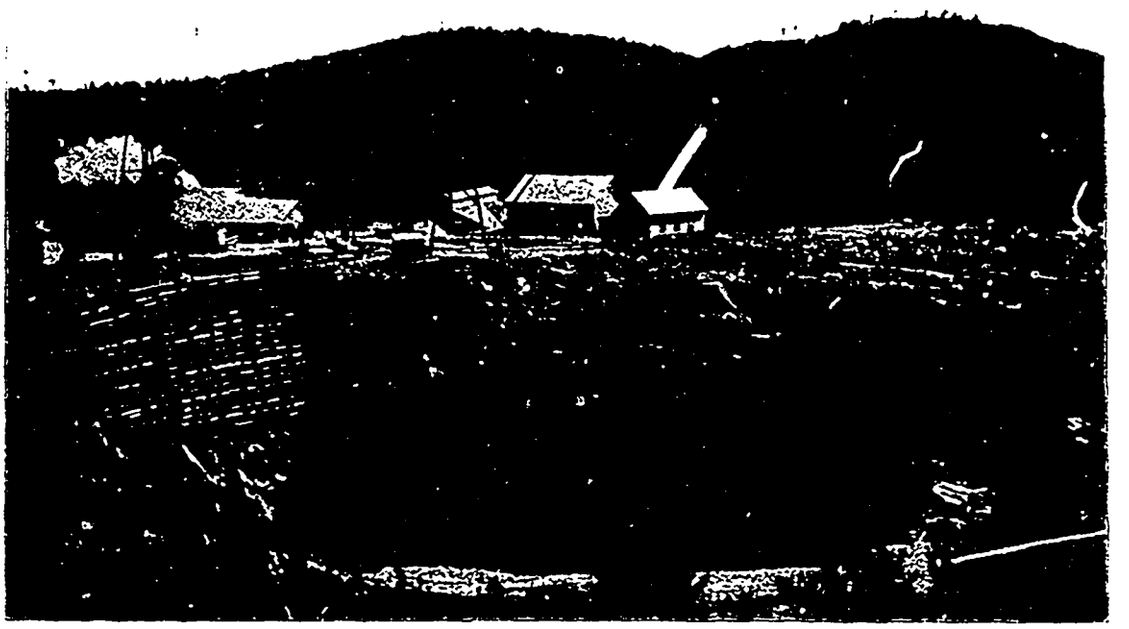
ASBESTOS MINING IN QUEBEC.

Milling Plant at Thetford Mines, Que., showing extensions added recently by the Bell's Asbestos Co.

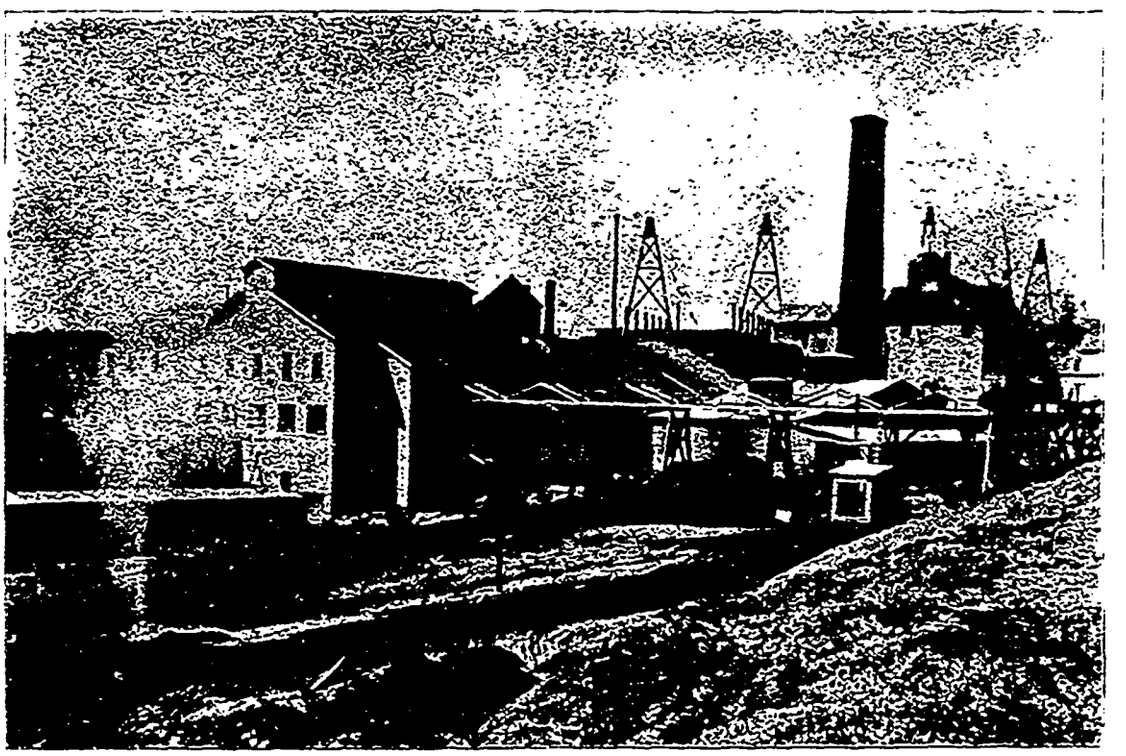


Locomotive No. 3 of the Bell's Asbestos Co.—This type of engine originally designed and constructed by Mr. George Smith, of the Bell's Company, is now generally adopted at the asbestos mines, its manufacture being one of the features of the shops of the Jenckes Machine Co. at Sherbrooke.

ASBESTOS MINING IN QUEBEC.

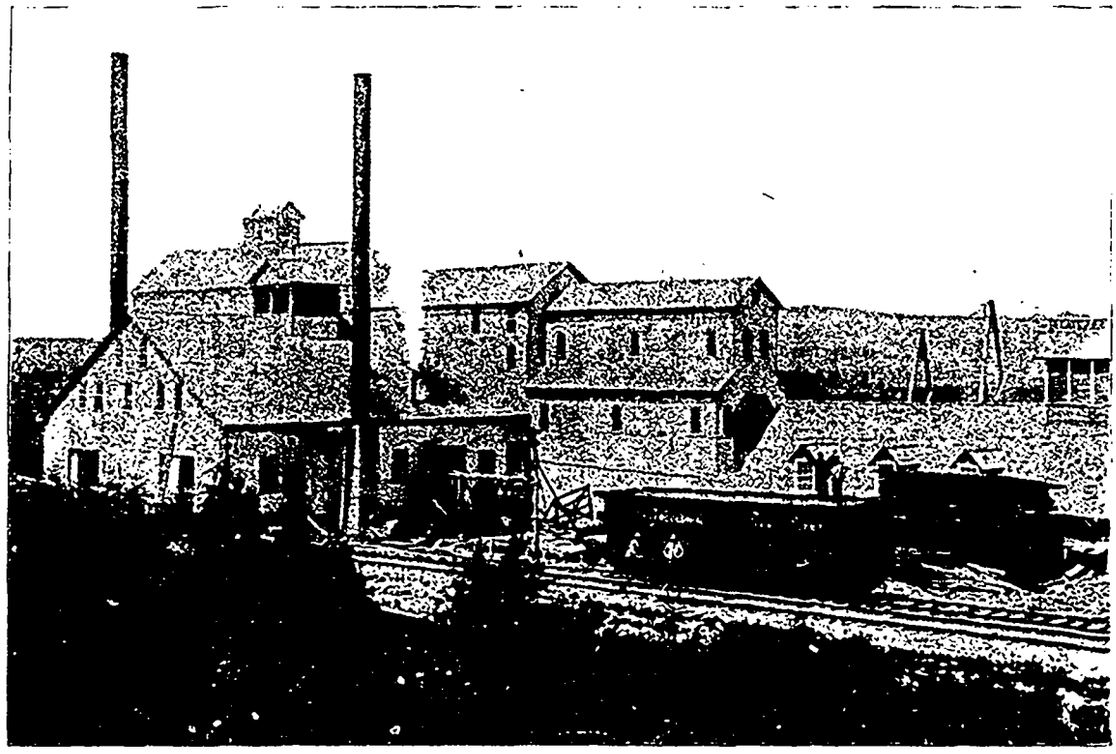


View of Main Open Cast Workings of the Asbestos and Asbestic Co Ltd., at Danville, Que.

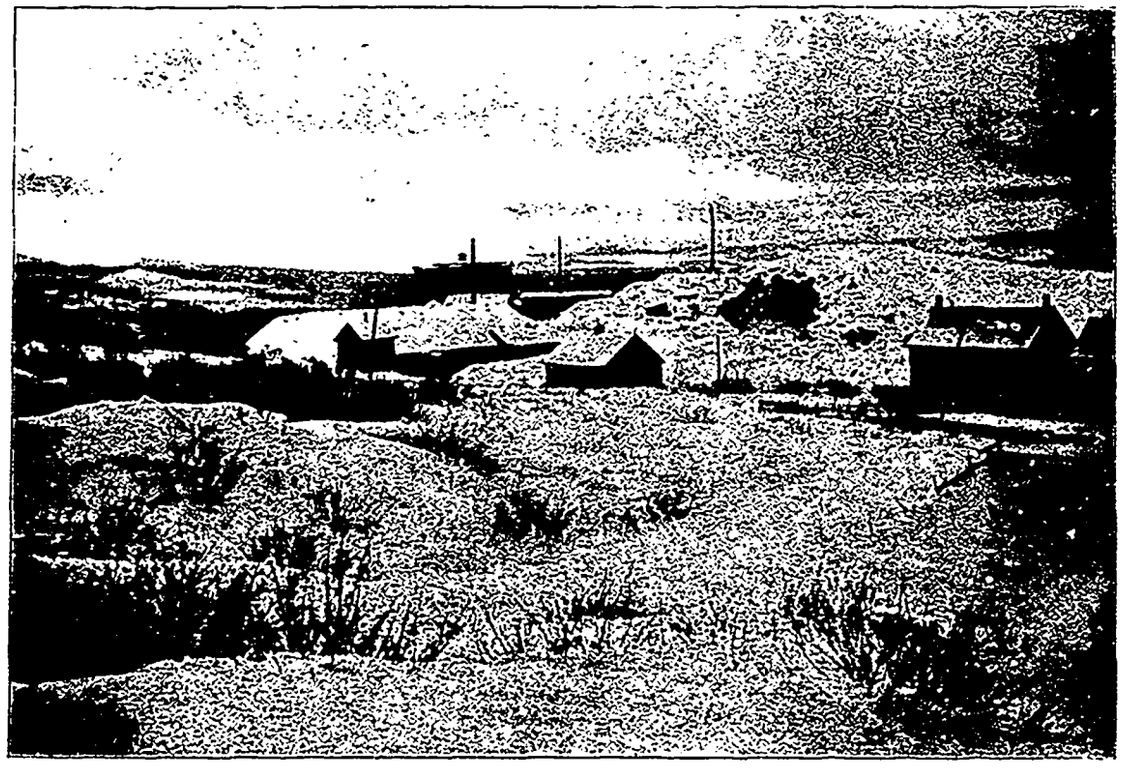


Milling Plant of the Asbestos and Asbestic Co. Ltd., at Danville, Que.

ASBESTOS MINING IN QUEBEC.



Large New Asbestos Mill erected by the Beaver Asbestos Co at Thetford Mines, Que.



Milling Plant of the Standard Asbestos Co. at Black Lake, Que.

to be the same rock as the Nelson granite, of West Kootenay, and about Jurassic in age.

Near Central Camp and northwest of it are bosses and dykes of a gray hiorite porphyrite, which microscopically closely resembles the Rossland monzonite, but until it has been carefully studied it is still uncertain that it is the same rock. Younger granites occur just outside the area described.

Beds of volcanic rocks are found at several points overlying the rocks already referred to. These are remnants of a sheet of volcanics which once covered the entire country but which, in this district, have been largely removed by erosion. The series consists of coarse and fine tuffs, ash-beds and shales (in which coal is sometimes found) with sheets of andesites, basalts, and other volcanic rocks. These latter are sometimes locally termed "bird's-eye porphyry." This series is probably of Tertiary age.

Dykes of a reddish or yellowish syenite-porphyry, having a fine-grained ground-mass, with conspicuous rosette-like phenocrysts of feldspar and some biotite, are common in the mineralized portions of the district, though wanting in the unmineralized. On the Carbonates claim, this reddish porphyry is seen as a contact facies of a coarse syenite-porphyry similar to those observed east of the North Fork and in the Rossland district, where such dykes are known to be from the Rossland granite. They would appear to have the same relationship here, but it is yet to be proved that they have no genetic connection with the volcanic flows as well. Dark lamprophyric dykes and some of a brownish basalt like rock also occur.

The ore-bodies may for convenience be roughly divided into three classes. (1) The large low-grade copper-bearing sulphide deposits; (2) the oxydized copper veins, and (3) the small gold and silver-bearing quartz veins.

Undoubtedly the most striking characteristic of the deposits of the first class is their enormous size. In the Mother Lode mine development work so far has exposed an ore-body, for a length of 1180 feet, and a width of 140 feet, which is continuous to the bottom of the workings, at present 500 feet. The Knob Hill–Ironsides lead is of as yet unknown dimensions. It extends through the greater part of the length of both claims and probably into the Gray Eagle. The lowest stopes are 700 feet below the highest point of the vein, but diamond drilling has proven the vein for another 100 feet. Its proved width is said to be 400 feet. On the second level three ore shoots are said to occur, one of 150 feet, one of 100 feet, and a third of 200 feet in width. These with the poorly mineralized rock between, would give a total width to the vein at this point of approximately 800 feet. One stope, 100 by 200 feet, is all in ore. While these figures are only approximate, they serve to illustrate the great size of the ore bodies and the extent of mineralization. These are of course the largest ore bodies yet disclosed, but some of the less developed properties have also very large deposits

In structure these deposits belong to composite-vein type, formed by mineralizing solutions traversing the country rock, principally along fissures or zones of fissures in which they deposit the economic minerals and from which they replace with their mineral contents, particle by particle, sometimes only partially, sometimes completely, the original material of the country rock. On the outskirts of an ore body this substitution may be seen in all stages of development, the individual constituents of the country rock being one by one replaced Sometimes, as on the Emma claim, the replacement of the country rock has gone on so evenly that a completely banded ore has resulted. A banded structure cannot here be taken as a proof of open filling.

According to the most prominent mineral content, this class of deposits may be subdivided into a pyritic type, in which pyrrhotite, chalcopyrite, with some pyrite, are the chief minerals, and a magnetitic type in which magnetite, chalcopyrite with some pyrite, are chief minerals. Excepting that the pyrrhotite of the one is represented by magnetite in the other, these two types appear to be identical. Both the magnetite and the pyrrhotite replace the constituents of the country rock in the same way, both seem to have been formed, on the whole, a little prior to the other vein minerals, holding them in little veins or as points scattered through, yet sometimes interbanded with them; they are both accompanied by the same accessory and gangue minerals and the country rocks show the same alterations in both cases. Rarely do both the pyrrhotite and magnetite occur in the same deposit. In the Mother Lode a very little pyrrhotite is however reported, and in one or two small veins, as on the O. P. and Wolverine claims. both are found. The B. C., Maple Leaf, Winnipeg, Lake and Morrison, may be mentioned as representatives of the pyritic type, while the Knob Hill–Ironsides, Mother Lode, Brooklyn, Snowshoe, Oro Denoro, Emma and R. Bell belong to the magnetitic type.

Besides the metallic minerals already mentioned some marcasite appears to occasionally be present, and sometimes arsenopyrite, galena, zinc-blende, and molybdenite, but these are in all cases subordinate in quantity. Tetrahedrite has been found on the City of Paris. Specular iron is found somewhat sparingly in the Knob Hill, Brooklyn, Stemwinder, Snowshoe, B.C., and other mines; and bismuthinite occurs on the Bluebell claim, Summit Camp.

Calcite is a common gangue mineral, sometimes well crystallized, forming large masses, and also in the form of little seams through the ore and country rock. Seldom is it found in large quantities in those parts of a vein in which magnetite is heavily concentrated. Quartz is also an abundant gangue-stone, occurring in the same way as the calcite, though I have not observed it well crystallized. Silicification of the country rock to a cherty or quartz-like (jasperoid) mass, is a common, though not invariable phenomenon in the neighborhood of a vein. Red and green garnet (probably grossularite and almandine) and epidote are very abundant in and near the veins, both well crystallized and massive, often interbanded with the ores and forming a very large percentage of the vein material. The progress of their formation may be observed at many points in all stages, not only when limestone, but also when greenstone and granite form the country rock. In the Mother Lode, where limestone seems to be the country rock, while these minerals are developed the chief mass of the altered rock is made up of a felt-like aggregate of short green fibres, apparently of actinolite. A beautiful white radial tremolite occurs in the limestone at the Morrison mine. Kaolin, chlorite, and serpentine are probably among the alteration products, but until the microscopic examination of the rocks has been made an accurate account of the secondary minerals and their relative importance cannot be given.

The ores occur in all rocks except the most recent, the latter being the youngest granites, the porphyry and basic dykes and the Tertiary volcanics. In age, then, these deposits are probably early Tertiary. So far as yet found mineralization is confined to districts which show evidences of recent disturbance, more particularly where the older rocks are cut by the recent intrusives. Limestone in such a district seems favorable for the deposition of ores. In some cases the ore occurs in the limestone itself, but more frequently it is found in a rock along its contact with limestone. Thus in a greenstone where it holds inclusions of limestone, the ore often occurs in the greenstone along its contact with the limestone, while the latter may show little or no mineralization. The lack of mineralization in the limestone in such cases may be due to the fact that the limestone often flows and forms compact lenticular masses, instead of fracturing, under pressure, and thus furnishes no channels for the mineralizing solutions. If attacked and replaced by them, it must have been along the contacts and this must have taken place comparatively evenly, leaving a clean-cut unmineralized wall. While this may have been the case in some of the larger deposits, in many of the smaller veins occurring along such contacts the mineralization shows a distinct preference for the greenstone, the

limestone remaining unmineralized. That the contacts between lime and other rocks should be favorable may have been due in part to the chemical influence of the lime in precipitating the mineral contents of the solutions, but it was also due to the lack of firm cementing between the limestone and the contact rock, which left free channels that the solutions used as highways and bases for their operations. But while such contacts are favorable, mineralization is by no means confined to them. In fact in the largest deposit yet found in the district (Knob Hill–Ironsides), with the exception of an insignificant island of it, found on the intermediate level, limestone is conspicuously absent, although it occurs at numerous unmineralized points in the vicinity. While most of the deposits are in greenstone, limestone or contacts between these, they also occur in the serpentine, argillites and gray granite.

Porphyry dykes are usually to be found in close proximity to the ores, sometimes as at the No. 7 mine the ore lies parallel to a dyke along its contact or in the immediate neighborhood. At the B. C., Mother Lode and other mines dykes lie almost horizontal, running through the ore-bodies at approximately right angles. The ore is continuous on borh sides of the dykes, little or not at all faulted or otherwise altered by them. The dykes, while containing traces of metallic minerals, show no signs of mineralization. In age they are about the same or a little younger than the ore deposits, showing the deposits to have been formed during or before the close of the cooling of the eruptive magmas.

While the deposition of the mineral contents of the veins is evidently largely hydrothermal, many of the minerals formed are characteristic of contact zones and there seems to be strong reasons for supposing the deposits to be connected with eruptive after-actions. The reasons for this belief cannot be discussed at length in the limits of a short paper. The magnetite appears to have been formed in the same way and under the same conditions as the pyrrhotite. It appears to be a primary constituent of the ore. Its formation seems to have depended upon a deficiency in sulphur, the available sulphur being siezed upon by the copper and going to form chalcopyrite. On account of the variety of rocks in which the ores are found it is evident that the source of the material of the veins cannot have been local. From the fact that the mineralized districts are much cut up by eruptive dykes, that areas of recent eruptions are close at hand and vents from which the volcanic series was ejected are probably near by, and that magnetite has so far seldom or never been found to have resulted from the deposition of ordinary mineral-bearing underground solutions, while common in contact metamorphism and as the result of solfataric action, it seems fair to conclude that the deposits have a connection with the recent eruptive rocks and that at least some of the material was derived from the magma of the eruptives brought up by the after-actions characteristic of vulcanism. This view is supported by the independence of the deposits with regard to the country rocks, the resemblance of some of their materials to that of nickel-pyrrhotite and other deposits considered to be the products of magmatic secretion and others to the products of volcanic after-action. At the same time it is not claimed that deep-seated underground circulating waters have had no share in the mineralization. Indeed the mingling of solutions from the two sources may have had a marked influence in the precipitation of their mineral contents.

Somewhat similar deposits, though on a much smaller scale, of magnetite and chalcopyrite occur at * Cherry Bluff, Kamloops lake, near what Dr. Dawson considered a volcanic vent. These have no doubt been formed by volcanic after-actions.

† In the Kristiana district, Norway, magnetite and specular iron, together with the sulphides of copper, zinc, lead, etc., occur within the metamorphosed zone of eruptions, especially granite, though as far as 2 kilometers from the actual contact. In association with them are contact minerals similar to many in the Boundary District. These deposits are explained by Vogt and others as the result of contact metamorphism and after-actions.

Similarly the Norwegian pyrite deposits have been shown by the same authority to be connected with contact metamorphism due to gabbro and granite.

‡ The pyrrhotitic deposits of Rossland, B.C., have many points of resemblance to the Boundary deposits, although differing somewhat in the accompanying minerals.

In ore-bodies formed by the replacement of the country rock along and from fissures, it is to be expected that mineralization should often be irregular and the ore-bodies should show correspondingly irregular forms. This is here the case. Often the deposits have no definite walls, the country rock in the neighborhood being mineralized to a greater or less distance from the main deposit, the line between the two bhing often merely a commercial wall. Unmineralized portions of the country rock are apt to be found as remnants in the vein and bunches or masses of ore may wander into the country rock. The ore is usually found in the veins in the form of shoots of various outlines. Sometimes several of these occur, often rudely parallel. In some places veins with similar filling intersect at various angles. Small stringers leading from the main veins are not uncommon. Most of the larger veins have a northerly strike with a high dip to the east. In the case of the Knob Hill–Ironsides the dip is as low as 45 or 50 degrees. Not enough development work has been done to generalize on the forms and pitches of the shoots. That of the Mother Lode pitches south. In the B. C. mine, a horizontal plating of the ore is quite pronounced.

There have been considerable movements since the ore was deposited; numerous slips, some with gouge or secondary filling, traverse the ore bodies. This broken nature of the ground, coupled with the original irregularity in the form of the ore body makes the exploitation of the smaller deposits sometimes difficult and precarious. The slips so far encountered have not been sufficiently large to have seriously affected the larger deposits. The serpentine is particularly full of slips, some prior but many subsequent to the formation of the ores, which make it probably the least satisfactory country rock in the district.

The values in the ores are principally in copper and gold, sometimes with accessory silver. Further study is required to formulate the laws governing the distribution of gold values. Generally magnetite and pyrrhotite when occurring alone are almost barren, yet this is not always the case. In the Knob Hill–Ironsides the massive magnetite is said to have a gold value. This is said to be the case on the Seattle claim, but in an assay of this magnetite made for the writer no gold was found, though the accompanying chalcopyrite was auriferous. In the Winnipeg mine pure pyrrhotite carries as high gold values as have been found in the mine, but at other points in the same mine barren pyrrhotite is found. Chalcopyrite occurring in magnetite and pyrrhotite is generally a gold carrier, but the gold value of an ore does not always increase with the copper percentage. Thus in the Mother Lode the best gold values are said to be found where the ore runs about 2 per cent. in copper. In the B. C. mine the gold is said to be confined to the chalcopyrite—pyrite and pyrrhotite being barren. On the other hand, in the Brooklyn, Stemwinder and Rawhide the best gold values are reported from the pyrite and ore-carrying specularite. So far as could be superficially observed, the local opinion that the intersection of veins or stringers with the main bodies does not cause an enrichment, seems to be supported by the facts. It may be noted that where dykes cross the ore bodies there appears in some cases to be an enrichment of the ore. Possibly there may prove to be a relationship between the

* Geological Survey of Canada, N.S., Vol. 7, 1894, p. 341B.

† Zeitsch. für Practl. Geology, 1894, pp. 177, 464; 1895, p. 154.

‡ Trans. Canadian Institute of Mining Engineers, Vol. 2, 1899, p. 72

quartz and the tenor of the ore. Though segregated in places, the chalcopyrite is on the whole remarkably evenly distributed through even the immense deposits. Away from the chief centres of mineralization while magnetite and pyrite are still sometimes found, the copper and gold are only sparingly present. The actual values of the ores per ton and the cost of mining and treatment have not been made public. The ores, as a rule, are certainly very low-grade, lower than was at first hoped. This has been partly counterbalanced by the size the bodies have shown on development and the remarkable adaptability of the ores to smelting. The magnetite, quartz and calcite are present in the required proportions so that no fluxing or roasting is necessary, so that the cost of smelting, as well as the cost of mining these ores, is exceptionally low. It is generally admitted that many of the properties can only be successfully operated by doing their own smelting; for this reason a union of the smaller mines or the building of a union smelter has been suggested.

A member of the Dominion Copper Company kindly furnished permission to publish the following figures regarding the contents of the ores of this company, which are more or less representative of the ores of Greenwood Camp.

GROSS RETURNS.

Si O	39.00 per cent.		
Ca O.	17.00 "		
Fe O.	14.00 "		
Cu.....	1.95 "	=39 lbs. Cu (at 10c. per lb.)	$3.90
AU....	.119 oz....		2.40
Ag....	... . 41 oz.		0.22

NET RETURNS.

Cu.....	$3.10
Au.	2.40
Ag.	.22
	$5.72

Values as high as $30 per ton are reported on car lots of ore from the Winnipeg mine, but such returns are exceptional, for the ores of the district as a whole.

The method of mining adopted in the large mines is to be presented in another paper and need not be referred to here.

A striking feature in the deposits is the lack of surface oxydation or alteration. At most, a few feet below the surface of the ground the ore exhibits the same characters as are found in depth. The soil overlaying a deposit is often quite unstained, offering no indication of the underlying ore, and consequently adding to the difficulties of prospecting, sometimes the surface of the ore even retaining the glacial polishing. The explanation of this feature is probably to be found in the heavy glaciation to which this region has been subjected. The old oxydized, and perhaps enriched, upper portions of the veins have been cut away by the Cordilleran glacier and since then the surface has been often more or less protected.

In Copper Camp oxydized copper-bearing veins occur, forming at first sight a totally different type of deposit. A short description of the King Solomon claim will illustrate this type. This deposit is found at a contact between a dyke of porphyry and crystalline limestone. Wedge shaped tongues of the porphyry extend from the main dyke into the limestone. Both the limestone and the dyke are much fractured and traversed by little slips. These fractures cut the limestone into small blocks. In the limestone, and to a less extent in the fractures in the porphyry, along the contact, are deposited various oxydation minerals of iron and copper, including native copper. These embrace red massive and earthy hematite and yellow limonite, crystallized and massive malachite and azurite, a black amorphous substance, a mixture containing copper oxide (melaconite, lampadite and chalcocite), cuprite, often in transparent crystals, native copper, chrysocolla and probably copper-pitchblende. The edges of the small limestone blocks have often been dissolved and the copper ores then occur as encrustations surrounding a core of lime. The main fissures are filled with the iron and copper minerals, the smaller principally with the copper. In the porphyry it is only the fractures near the contact which contain a thin film of copper ore, the rock itself remaining fresh and unaltered. About 650 feet from the main working on the King Solomon is a small vein. The rock is here not so badly shattered. On the suface carbonates and other copper minerals with iron oxides are found; a little below the surface the sulphates of these metals occur, and below these unoxydized pyrite and chalcopyrite begin to appear. What can be seen to be taking place here on a small scale is probably what occurred on the King Solomon ledge proper on a much larger scale, so that this type of deposit is probably an oxydized and secondarily enriched form of a sulphide deposit, similar to the first type of Boundary deposits and produced by the action of surface waters. The iron of the sulphides has been removed or redeposited as hematite and limonite; the copper has been more or less concentrated in the form of various oxydized minerals. At greater depth the unaltered iron and copper sulphides will presumably be found, although between the oxydized minerals and the unaltered sulphides it is quite possible that a zone of enriched sulphides will be found. That a zone of oxydation and enrichment should be found in the veins of Copper Camp and not elsewhere in the district may in part be explained by the local topography, and the broken nature of the country rock, but the chief factor, in all probability, has been the capping of volvanic rocks which covers the hill-tops all around and extends almost to the King Solomon and other of these deposits. In glacial times these rocks are likely to have extended a little farther, in which case they would have protected the deposits from the scouring effects of the ice-sheet. In addition, the contact between the volcanic and older rocks is likely to be a natural waterway.

The quartz veins, constituting the third type of deposit, are found in the neighborhood of the first type, but seem more abundant on the outskirts of the areas of chief mineralization They are sometimes parallel to the large sulphide bodies, but do not, as a rule, show the same regularity in their strike. In form they are more regular and they are usually enclosed between well-defined walls. Chalcopyrite, pyrite, arsenopyrite, galena and zinc-blende are the chief metallic minerals. Tetrahedrite and some rich silver minerals are said to have been found in some of these veins. The principal values are in silver and gold. High assays are reported to have been obtained from a number of these veins, but the only one at present being worked in the district embraced in this paper is the No. 7 mine. In age and mode of formation there have been little difference between these and the previous deposits, though in that case they would probably represent the closing stage of mineralization.

Some of the practical deductions from an examination of the ore deposits may be summarized as follows:—

Ores may be found in any of the older rocks where the other conditions for mineralization were favorable.

Districts which show evidences of late disturbances through vulcanism, manifested by intrusions of recent eruptives and heavy dyking, are promising fields for prospecting.

Limestone contacts in such areas should, in particular, be carefully prospected.

Since, with the exception of certain deposits in Copper Camp, there is no zone of oxydation and secondary enrichment in the main deposits, while the general conditions remain unchanged, no loss of values is to be expected in depth.

On account of the irregular form which the ore bodies may possess and the complex nature of the rock formations, a careful and detailed study of the surface of the ground in the neighborhood of the mines would be of great practical assistance in the exploitation of the ore bodies. For the same reason development work must always be kept well ahead of the actual mining. Cross-cutting must frequently be resorted to, to determine the actual limits of the deposit, and to prove

the existence or non-existence of parallel ore shoots. The limits of mineralization must be actually proved, and similarly only that ore can be with certainty reckoned on which has been actually blocked out.

In this connection diamond drilling can be used with advantage. Careful magnetic surveys would also be of great value in locating ore-bodies under the covering of drift, and also in testing for ore in the mines themselves. Especially good results should be obtainable by this method in the magnetitic type of deposit, but it should also prove successful in the pyrrhotitic deposits. It has proved successful in such deposits in Scandinavia, and I am informed that experiments made with it on the Sudbury pyrrhotite deposits, last summer, have yielded good results.

Where the ore occurs at a limestone contact the limestone wall may often be used for following the ore, it being kept in mind that the ore does not always follow strictly along the contact, and that the limestone may pinch out without causing the ore to likewise give out. The dykes in some cases may be used in the same way.

The pyrrhotite and magnetite should always be assayed, as barren-looking material may carry good pay values. The minerals in the ore and the conditions where pay values occur should be carefully studied with a view to ascertaining which carry the values, and what were the causes which produced the concentration of values. The porphyry dykes themselves, while not mineralized in the same way as the country rock, may in places prove auriferous. In a specimen from a similar porphyry dyke, from the Valkyr mountains, east of Lower Arrow lake, examined last winter, free gold was plainly visible, even with the naked eye.

In prospecting it is to be remembered that float may have been carried a considerable distance, even across valleys, by the former glacier. The general course of the latter was about S. 30 E., but it was influenced by the local topography.

In a promising deposit of the oxydized copper type, one would be warrented in testing the deposit to a sufficient depth to ascertain if a zone of enriched sulphides exists between the oxydized zone and that of the unaltered sulphides. As *Emmons and Weed have pointed out, the bonanzas of high-grade ore in Butte, in Arizona, and other points, are situated between the zones of oxydation and unaltered sulphides. Below the limits of alteration the deposit may or may not be rich enough to work.

On the Possible Occurrence of a Coal Area Beneath the Neo-Carboniferous or Peruvian Strata of Pictou County, Nova Scotia.

By Dr. H. M. Ami, Ottawa.

"The Pictou Coal Field is of a very complicated character," wrote Sir William Logan in 1869,† as he described a portion of the Pictou coal field, Nova Scotia. All previous and subsequent workings of coal seams in that field have corroborated the view there expressed by this eminent field geologist, as one may gather from the numerous writings of the Messrs. Poole, Hartley, Dawson, Gilpin, Fletcher, Rutherford, and others. "Undulations, important faults," or dislocations combine to make mining in this area rather difficult and intricate.

Millions of tons of bituminous coal have been obtained from the mines within the Pictou coal field. The Acadia and Intercolonial collieries together produced no less than 590,638 tons in the year 1900. The various workable seams have been described carefully, from the "main seam" to the smallest workable stratum of coal, and their respective character need not be entered into here.

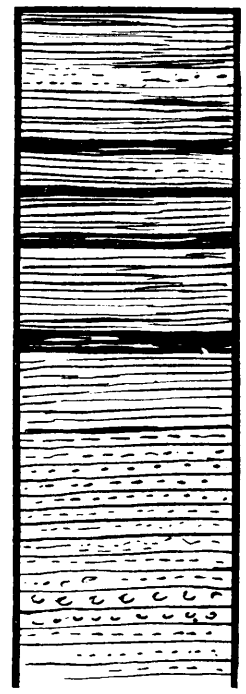
One of the most important faults of the district is that known as the "North Fault," to which is ascribed a vertical displacement or throw of several thousand feet. Alongside this fault, and in the vicinity of its line of outcrop, near Blackwood Brook, New Glasgow, the black bituminous and coal-bearing shales and strata of the Stellarton formation, which carries the productive coal measures of the Pictou coal area to the south of this fault, as recognised in the Vale, Acadia, Intercolonial, and other mines of the area, are seen to abut against the tilted sandstones and associated strata of the older and subjacent Westville formation, the latter constituting the so-called "millstone grit" formation of European geologists—subjacent to the coal-measures of England, etc., and very doubtfully the equivalent of the Westville formation of Canada.

There is but a narrow strip of the Westville formation visible in the Blackwood brook in New Glasgow (west side), between the outcrop of the New Glasgow conglomerates (which in their eastward extension constitute Fraser's mountain) and the "north fault," but larger areas of this formation occur both east and west of this point; east, over the area on which the telegraph road runs from New Glasgow to Weir's Mill and Sutherlands' Bridge, etc., as well as west of New Glasgow. At this point there occurs, therefore, a conspicuous unconformity, in which a series of newer conglomerates and sandstones capped by calcareous bands of sandstone, as well as some shales and freestones, cap unconformably the tilted measures of the Westville formation, otherwise designated as the "millstone grit."

That the tilted strata which are seen to underlie the New Glasgow conglomerates and their superjacent formations in Pictou County, north of Blackwood brook, are of "millstone grit," or Westville age, has been generally conceded by many geologists, in fact, by all who have described the geological or underground structure of that portion of Nova Scotia, and I have not seen any reason, as yet, why this view is not correct, and therefore accept it until such evidence is forthcoming to clearly disprove it.

It is well known that in the neighbourhood of the town of Westville and the areas south of the "north fault" generally in Pictou County, down to the south fault, and east of the west fault the Westville formation, in its normal development, is always capped by the Stellarton coal-bearing formation, and would present, if undisturbed, the following succession as represented in Diagram A.

FIG. A.



In Figure A the Stellarton formation, or productive coal measures

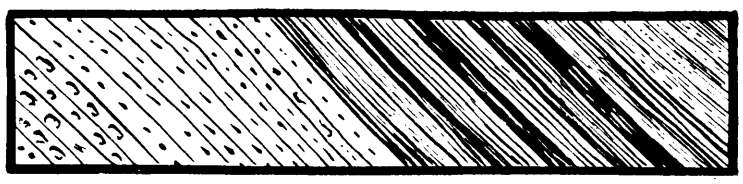
* Trans. American Institute of Mining Engineers, Vol. XXX.

† Report of Progress, Geol. Survey, Canada, 1866-69, p. 4. 1870, Montreal.

of Pictou county, rest directly over the Westville sandstones, grits and conglomerates, or "millstone grit" formation of most writers, so that wherever the productive coal measures of the Stellarton formation occur in their normal condition of deposition, undisturbed by faulting and tilting, the Westville sandstones and grits would be reached by traversing the Stellarton shales and coal seams.

Inasmuch as the original structure and condition of the strata since deposition have been considerably changed by later dynamic forces at work in the Pictou coal basin, and these have dislocated the strata, tilted them in many localities and let down into the depths of the earth between some of those deep faults which affect the carboniferous measures of this field, the productive and workable seams, so as to protect them from agencies of erosion which came subsequently, one of these changes may be best illustrated by means of a diagram—(See Figure B)—illustrating the case where the Westville and Stellarton formations are tilted at a high angle and their edges denuded.

FIG. B.



WESTVILLE
Formation or
"Millstone Grit."

STELLARTON
Formation or
"Coal Measures."

It will thus be seen that the Westville formation, with its sandstones, grits, and conglomerates, underlie unformably, and in its regular and normal position, the shales and productive coal seams and associated strata of the Stellarton formation. The block of Westville and Stellarton strata, thus represented in Figure B, though diagrammatical, nevertheless shows the relations which these two district geological formations bear to each other in various portions of the Pictou coal basin, south of the "north fault," and which may possibly obtain north of the same fault in the area in question and discussed in this brief paper.

Supposing, now, as is the case in the outcrop of the strata of the Westville (or millstone grit) formation at Blackwood brook, that its strata dip at an angle of 60 degrees towards the north, presenting the upper edges of the strata in an eroded condition, then, in the event of the succession of the carboniferous strata, these being normal and regularly without the intervention of a fault (of which there is no evidence whatever), it is reasonable to suspect—provided the unconformity prevails for a considerable distance north of the "north fault," in the direction of the mouth of the East river of Pictou or of Pictou town—that the newer and higher stratas constituting the Stellarton formation, or productive coal measures, will be found overlying the sandstones of the Westville formation exposed on Blackwood brook somewhere to the north, and the contact between these two formations would be somewhere between the latitude of Pictou town and that of Blackwood brook. The contact of the two formations—if it exist at all—is hidden by the overlying strata of the New Glasgow conglomerate formation, and the various geological horizons or formations which overlie the New Glasgow formation perfectly conformably, up to the measures of the overlying and newer Pictou and Cape John formations, which, by some geologists, are classed as Permian, by others as permo-carboniferous, and by others still as members of the carboniferous system.

Unfortunately there is but little of the Westville strata exposed in Blackwood brook, and also very little of the contact between the two unconformable series visible.

The bevelled appearance and condition of the Westville strata in Blackwood brook clearly indicate strong erosion by wave-action at the time of the deposition of the New Glasgow conglomerate, and subsequent formations, the tilting having taken place not very long after the deposition and hardening of the strata.*

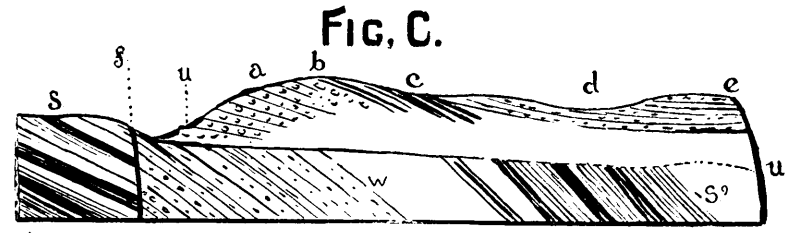
While the plane of marine erosion was being formed in the underlying tilted series of strata the wave action was accumulating the materials which now constitute and make up the New Glasgow formation of Fraser's mountain as well as the formations of impure limestone, sandstones, clays, sandy shales, bituminous shales, freestones, and conglomerates overlying the New Glasgow formation, and these materials, as may be gathered from the false bedding visible and the general character and structure of these materials deposited in these formations indicate rapid deposition or accumulation. Two or three small coal seams occur in these newer sediments also, whilst not a few of the layers of sandstone show innumerable grains of coaly matter—grains of coal, coal dust—accumulated or spread over the layers and throughout the strata themselves, along the divisional planes of stratification.

Taking for granted, then, as we did at the outset, that the New Glasgow conglomerate overlies the "millstone grit" or Westville sandstones at Blackwood brook, which latter dip to the north, why can we not expect to meet the productive coal measures on Stellarton coal-bearing shales and shaly strata by boring through the new overlying strata capping the tilted series of strata unconformably?

The very pressure of coal dust or finely broken coaly matter disseminated over the surfaces of the overlying strata predicates, in my mind, the fact that erosion in strata that were probably coal-bearing, though I must confess that the erosion of the shales would lead to the deposition of clays and mud-stones, which are, however, conspicuous by their almost total absence in the section from New Glasgow to Pictou or Cape John.

As to what portion of the Westville formation crops out along the line of contact and unconformability at Blackwood brook has not been ascertained precisely as yet, as far as I have been able to ascertain. Accordingly, at what distance north of the north fault and New Glasgow the top beds of the Westville formation occur and the beds of the

FIG, C.



f. North fault. *a*. New Glasgow conglomerate. *b*. Limestone. *c*. Gruelttroon shales. *d*. Pictou sandstones. *e*. Cape John red beds. *u*. Line of contact: unconformability. *s*. Stellarton coal-bearing shales. *s?*. Possible position of coal-bearing strata. *w*. "Westville" or "millstone grit" formation of authors dipping north.

Sketch section of geological formations between Stellarton coal field and Pictou town, showing position of the North fault and the relation of the newer overlying strata to the underlying series which may be a repetition o the north of the fault of the Pictou coal area now worked to the South.

Stellarton coal-bearing formation begin, depends entirely upon what portion—the lower, middle, or upper portion—of the Westville series crops out in the bed of Blackwood brook.

The newer or overlying series consist of more or less horizontal strata, and the precise thickness and extent of this formation has not been definitely ascertained as yet by boring. Should boring operations be carried on so as to give the locality a fair test to ascertain the probable occurrence of a coal field north of the great north fault, and in

* NOTE.—The faunas and floras discovered entombed in the overlying series of newer strata indicate an upper carboniferous facies with Permian affinities in the highest beds of the strata in Pictou County, near Cape John. It is difficult for me to be thoroughly persuaded that the tilted strata of Blackwood brook are of the Westville or "millstone grit" age.

the vicinity of and underneath Trenton or the country to the north, between the Straits and the fault, such boring operations will furnish the geologists with much data that are necessary and requisite in order to be able to state with precision to what thickness the overlying strata cap the tilted and supposed coal-bearing beds beneath.

That there should be a possible coal-field beneath the newer overlying series and in the inclined beds below is a question of much interest and worthy of more than cursory notice.

The prevalence of the coal basin depends upon the continuity of the unconformable contact between the two series of sediment, such as are exposed in Blackwood brook.

It may not be out of place here to state that far back an attempt was made to put down a bore hole with a view of obtaining coal, but inasmuch as the hole was not carried down to a great depth, neither was a careful log preserved of the strata traversed during boring operations, the results were negative rather than positive, and whilst at Blackwood brook the underlying, tilted series of beds are near the surface of the ground, and a few hundred yards north of the brook, probably only a few hundred feet from the surface of the ground, the precise thickness of the overlying strata can only be ascertained by boring or sinking a shaft.

It is to be hoped that before long the locality in question will receive a fair test—bore holes put down so as to traverse the newer overlying series—in order to ascertain the occurrence or non-occurrence of the coal-bearing shales and strata of the Stellarton formation in that portion of Pictou county north of the "north fault"

CORRESPONDENCE.

The Electrolytic Production of Metals, with Special Reference to Copper and Nickel.

SIR—In accordance with your request, I herewith send you a few notes with a view to correcting certain statements in Mr. Koehler's interesting article on "Electrolytic Production of Metals" in the April number of your excellent REVIEW.

In the first place, the statement made on page 97 of the article in question to this effect, that the two principal processes for the recovery of metals from their solution are those of Siemens and Halske and Hoepfner, certainly needs modification, as Mr. Koehler will readily admit that fully 90 per cent of all the copper recovered from its solution is obtained by neither of these processes, but from acid sulphate solutions by ordinary electro deposition with soluble copper anodes, which is essentially the old Elkington process, patented in 1865-70.

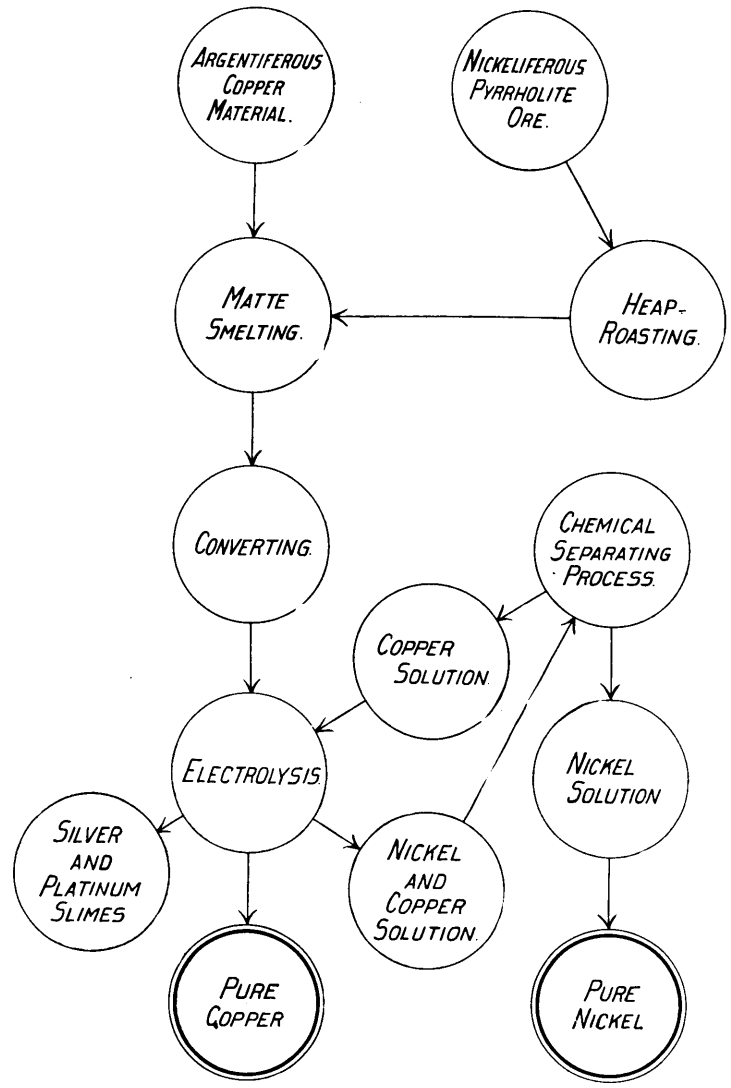
While it is true that the Hoepfner process, or rather a modification of this process, is being practically applied, both at Cleveland and Papenburg, in the production of a limited tonnage of electrolytic copper and nickel, it is likewise true that the solution and deposition of copper and nickel from chloride solutions is neither as rapid and simple in reaction as it is with sulphate solutions, nor as economical, all things considered, and the Hoepfner process was therefore abandoned by several companies after extensive trial.

Now to another matter. Mr. Koehler, on page 96 of his article, mentions and shows a diagrammatic sketch of the process I proposed years ago for treating Sudbury ore, giving me full credit, but adds that this is the process I now propose using at Sault Ste. Marie, which is wrong. As a matter of fact the process I advocate does not include separation smelting (the Bartlett-Thompson or Orford process), as Mr. Koehler states, as this is a patented process, both cumbersome and imperfect in effecting the separation desired, and is not at all necessary in my method of treatment.

My improved process, which is protected in Canada, the United States, and in Great Britain, embrace the following essential features and improvements:—

1. The difficulties hitherto experienced in attempting to bessemerize nickel-copper matte to a higher percentage than 80 per cent, involving losses of cobalt, etc., are entirely obviated, in my process, by the addition of sufficient copper bearing material in the matting furnace to reduce the percentage of nickel in the converter charge to 20 per cent. or less of the copper present. I am thus enabled to convert the matte up to 95 per cent. metal and above, instead of 80 per cent, and I also reduce the total percentage of metal going into the converter slag, and which, of course, requires retreatment, by largely protecting the slagging-off of the nickel by the copper.

2. The crude nickeliferous and argentiferous copper is cast into anode plates and hung in electrolytic tanks in an acid sulphate solu-



tion, just as in ordinary copper refining, and pure copper plated out on copper cathode sheets.

3. What I consider the most important feature of my process consists in the regular withdrawal of a small proportion (say 2 per cent.) of the total quantity of electrolyte in circulation in the copper depositing tanks, firstly, in order to keep down the increase of the nickel contents in the same, by replacing the withdrawn solution by one practically free from nickel, and secondly, in order to accomplish the regular recovery of the nickel, which is extracted from the withdrawn electrolyte by simple chemical means, followed by electrolysis.

4. Pure nickel is readily obtained, in my process, by electrolysis

of the slightly ammoniacal, heated, nickel sulphate solution with lead anodes, depositing the nickel on nickel cathode sheets, and remelting and casting of the cathodes into whatever shapes are desired. The subjoined plate shows a diagrammatic scheme of the essential steps of my smelting and refining process, as applied to nickel and copper material.

Trusting that the above contains the information you desire, and which you may publish as stated,

I am, very truly,

TITUS ULKE,
Supt., Copper Refining Dept.,
Lake Superior Power Co.

Sault. St. Marie, 27th May, 1902.

SIR—Your favor of the 30th to hand. In answer to Mr. Ulke's criticism (statement page 97), I would reply that I purposely did not enter upon the subject of refining, knowing very well that almost everybody is well aware of the fact that about 90 per cent. of copper used at present time is electrolytically produced through the refining of crude copper from an acid sulphate solution. This process is so old and so well known that giving details of same is more or less a waste of time.

There is a vast difference between refining using soluble anodes, when the deposition of metal upon the cathode depends upon the metal contents of the anode going into solution, and having simply a solution of a metal from which metal is being precipitated, without the solution's metallic contents being replenished.

In accordance with the last statement, the Siemens and Halske and the Hoepfner process are the only two recognized processes.

2nd. Page 96—Mr. Ulke's process.

I am not accountable for any changes, improvements, etc., etc., which Mr. Ulke has decided to adopt since his proposal of proceedure a few years ago.

All metallurgical processes are more or less subject to deviation.

In Mr. Ulke's description of his improved process, section 2, he cites: "Crude nickeliferous and argentiferous copper is cast into anode plates and hung in electrolytic tanks, in an acid sulphur solution, just as in ordinary copper refining, and pure copper plated out upon copper cathode sheets"; while in Europe (1895) scrap metal containing about 75 per cent. copper and 25 per cent. nickel, also mixtures of iron, copper, nickel, silver, and zinc, in other words, nickeliferous, or more generally speaking, metaliferous copper, was cast into anodes, hung in an electrolytic tank in an acid chloride solution just as in ordinary copper refining (except the substitution of an acid chloride solution for an acid sulphate solution), and pure copper plated out on copper cathode sheets.

I am pleased with Mr. Ulke's criticism, and would like to have you publish same in your valued paper, together with the above remarks.

Thanking you for past favors,

Very truly yours,

WM. KOEHLER.

Cleveland, 2nd June, 1902

SIR- Allow me to again call your attention to Mr. Ulke's criticism.

1st. Mr. Ulke evidently has not carefully looked over the paper re copper and nickel production.

On page 95 MINING REVIEW, 2nd paragraph (1st page of article), is stated the following:—

"Electro-metallurgy is divisible into two branches, first, the *electrolytic refining of crude metals*, and second, the direct production of metals from their solutions."

The Siemens and Halske and the Hoepfner processes are the two recognized methods of obtaining metals *direct from their solutions.* This statement needs no modification.

2nd. It is a well-known fact that about 90 per cent. of copper used in arts is obtained through refining of crude metal from an acid sulphate solution. This subject comes under *1st heading refining*, and was purposely only casually mentioned. The process is so old and so well known that in giving details of same is more or less a waste of time.

3rd. Regarding the advantages or disadvantages in obtaining metal from a sulphate against a chloride solution, it is my impression that the time will come when a chloride solution will more or less supersede a sulphate solution.

In the electrolysis of a sulphate solution no valuable by-product is obtained at the anode, while with chloride solutions you obtain (from a nickel chloride solution), for every 59 equivalents of nickel 71 equivalents of chlorine gas.

It is a well known fact that the electrolysis of a chloride solution will require a trifle more costly apparatus than will that of a sulphate solution. There will also be a slight difference in the power factor (viz., energy necessary for electrolysis), but when it comes down to dollars and cents I believe the chlorine gas obtained will more than overbalance the difference. The Canadian Copper Co. think they have their process down very nearly to perfection. This speaks well for chloride solutions.

4th. Mr. Ulkes' process has been cited according to his proposal of a few years ago.

I am not responsible for the Orford Copper Co. upholding their patented separation smelting process in Canada, neither am I accountable for any changes or improvements which Mr. Ulke may have made since he has begun practical operations.

All metallurgical processes are subject to deviations according as necessity demands.

5th. Mr. Ulke's improved process, section 1st:

The object of this paper has not been matting and converting mattes, etc., to the state of crude metal. This is a subject foreign to electrolysis.

6th. Section 2nd. Concerning crude nickeliferous and argentiferous copper cast into anode plates and refined. Mr. Uike certainly does not claim anything new for this.

While in Europe in 1895, scrap metal containing 75 per cent. copper and 25 per cent. nickel, also mixtures of copper, iron, nickel, silver, and zinc, in other words nickeliferous copper, or more generally speaking, metalliferous copper, was cast into anode plates suspended (identically as in copper refining in an acid sulphate solution), both in acid chloride and acid sulphate solutions, also in neutral and alkaline solutions and fine metal, obtained upon sheet copper cathodes.

7th. Section 4th. Concerning the winning of pure nickel by Mr, Ulke's process, through the electrolysis of a slightly heated ammoniacal nickel sulphate solution with lead anodes.

This method is the analytical method of determining nickel adapted to commercial use, which has been used in analytical laboratories for years, the substitution of a lead anode for the much more expensive platinum anode, and the use of an electrolytic bath of large dimensions, instead of beaker or a platinum dish, being the principal differences.

Very truly yours,

WM. KOEHLER.

Cleveland, June 4th, 1902.

SIR—In reply to Mr. Koehler's interesting comments upon my remarks, I beg to submit the following, and thank you for your kindness in allowing me space for this discussion, which, I trust, will be final, as practical work of very pressing importance is keeping me so busy, nowadays, that I have but little leisure, unfortunately, for digressions of this sort.

Allow me to take up Mr. Koehler's comments in their order:—

1st and 2nd. After carefully looking over Mr. Koehler's interesting article, I noticed the unscientific and illogical character of his classification of electrometallurgy into the two following branches, viz.: 1, the electrolytic refining of crude metal, and, 2, the direct production of metals from their solution. Every metallurgist should be aware that the second branch is covered by the first, and that *the direct production of metals from their solution* is the final step of *every* electrolytic refining process.

3rd. Regarding the advantage of obtaining metal from a sulphate as against a chloride solution, this fact certainly seems decisive, that those in charge of our large electrolytic refining works have never been prevailed upon to adopt the chloride solution method, instead of the method at present in almost universal use, for many reasons. *The chloride method is old*, has been tried under a great variety of conditions and with many modifications, *but has not yet attained commercially practical prominence.* Electrometallurgists are aware that the speed of reaction is too slow, and the apparatus and process too complicated for ordinary practical purposes. In a few cases it may be desirable to utilize the evolved chlorine, and the chloride method may then be be found suitable, but it is out of the question, at the present time, for large refiners to go to the expense of erecting a costly plant for liquifying chlorine gas or making bleaching powder when it is considered that the returns would be reduced to an unprofitably low figure as soon as such methods were generally adopted and the market flooded with chlorine obtained in this way.

The only electrolytic nickel and copper refinery running, I believe, in America at the present time, is the Canadian Copper Co.'s small plant near Cleveland. This company may or may not think that they have their process down to perfection, and they may soon have reason to revise their claims, just as they are beginning to see that their Sudbury mine equipment is not the best, nor that their method of handling ore to and from roast heaps is the cheapest.

4th, 5th, and 6th. Does not require any comment.

7th. Concerning obtaining pure nickel through the electrolysis of a slightly heated ammoniacal nickel sulphate solution, *with lead anodes*, I beg to note that Mr. Koehler is in error when he states that this is is the analytical laboratory method in use, for it certainly is not. I will add, in conclusion, that United States, Canadian, and British patents have been granted to me, covering the use of lead anodes in such solutions in electro-depositing nickel.

You would confer a favor by sending me a copy of this discussion, if it should appear in print. Thanking you for your kindness,

I am, very truly,

TITUS ULKE.

Sault Ste. Marie, Ont., 9th June.

British and American Capital in British Columbia.

SIR—Your correspondent, Mr. Best, in his paper on "The Minerals of Vancouver Island," printed in your issue of May 31, states "That at present most of the developed mines in the Province of British Columbia are in the possession of United States citizens, while England quietly slumbers, etc., etc." This assertion I regard as so misleading that it must not be allowed to pass without challenge. The facts are quite the other way. Englishmen have, during the last ten years, interested themselves largely in mining enterprises in this Province, and at the present moment they own and are operating something like one half of the principal mines in British Columbia, as, for example, the Le Roi mine and Northport smelter, Le Roi No. 2 group, Rossland Great Western, Kootenay Mines, Velvet, Portland, Ymir, Arlington, Snowshoe, Jewel, Ruth, Whitewater, Enterprise, Idaho, Bosun, Silver Cup, Highland, Lavinia group, Granite and Poorman, Queen Bess, Hall mines and Nelson smelter, not to speak of a very large number of less well-known claims and of heavy holdings in shares of innumerable local companies. If to the above-named list of properties controlled in the old country, we add the large number owned by Canadians, among which may be named the Centre Star, War Eagle, Payne, Molly Gibson, St. Eugene, Cariboo-McKinney, B.C., Brandon and Golden Crown, Winnipeg, Yellowstone, London Consolidated, Paradise Group, Crow's Nest Pass Coal Company, Mollie Gibson, White Bear, it would certainly seem as if British and Canadian enterprise has not been found wanting in this Province. Possibly Mr. Best's contention may be correct if limited to mining developments on the Island of Vancouver, but in seeking to apply it to the condition of affairs existing throughout the Province generally, he seems to me to have spoken at random and therefore incorrectly,

Yours faithfully,

F. W. ROLT.

Rossland, B.C., June 16, 1902.

MINING INSTITUTE.

Eastern Ontario and the Eastern Townships Organise District Branches.

In accordance with the policy of the Institute, inaugurated at the last annual general meetings, a successful start has been made with the organization of district branches of the Institute. These have been formed in Eastern Ontario with headquarters in the City of Kingston and in the Eastern Townships with Sherbrooke as a centre. Other branches will be formed later in British Columbia, at the Sault, at Rat Portage, in the Province of Nova Scotia, and at other points. The membership of the Institute which now includes close upon 400 active members and nearly a hundred student-members has been considerably augmented by the acquisition of the two new sections.

EASTERN ONTARIO BRANCH.

The meeting at Kingston on Monday evening, 2nd June, was well attended by local mining men, and considerable interest was taken in the proceedings which lasted until midnight. Dr W. L. Goodwin, director of the School of Mining, occupied the chair. Mr. Joseph Bawden, secretary *pro tem*, opened the proceedings by reading the minutes of a meeting held during the week previous at which it had been decided to organise a local branch. A motion to the effect that "The Eastern Ontario Section of the Institute be now formed" was then put to the meeting and adopted.

The following gentlemen handed in their names for nomination to membership subject to the approval of the Council: Dr. W. F. Coy, H. W. Richardson, Geo. Smith, John Donnolly, M.E., G. O. Grover, J. A. Madill, A. M. Chisholm, Fred. A. Folger, jr., Joseph Francklyn, R. E. Kent, all of Kingston; David Williams, C.E., Port Arthur; A. H Brown, Metallurgist, Canadian Gold Fields Ltd., Deloro; Fred. Foxton, Sydenham; Thos. Caldwell, Lanark.

The following committee of management was then elected:—

Dr. W. L. Goodwin, Kingston, Chairman.
P. Kirkegaard, M.E., Deloro.
Prof. Carr-Harris, C.E., Kingston.
Prof. S. F. Fitzpatrick, Kingston.
John Donnolly, M.E., Kingston, Secretary.

Dr. Goodwin then read a paper on the subject of "The Occurrence of Mica in Eastern Ontario" which, after some interesting discussion, it was decided to take up again at the next meeting of the Section.

The question of the establishment of the proposed new Department of Mines was also discussed and the local secretary was authorised to wire to Hon. the Minister of the Interior endorsing the proposal to establish such a Department and urging its organisation at the earliest possible opportunity.

At the meeting there was exhibited a very handsome series of phlogopite crystals from the Stoness-Kent mine, and some very fine samples of molybdenite from the Chisholm mine near Kingston.

The Section adjourned to meet again at the call of the chairman.

EASTERN TOWNSHIPS BRANCH.

A meeting of the Institute for the purpose of organising a local Section to the Eastern Townships was held in the Council Chambers, Sherbrooke, Que., on Tuesday evening, 10th June. Mr. George R. Smith, M.L.A., General Manager of the Bell's Asbestos Company, was called to the chair.

The Chairman, in opening the meeting referred to the influence and importance of the Institute which had done much to promote the interests of the mining profession in Canada. The mining industries of the Eastern Townships were not heard of very much in the papers, for they had no stock to sell, or schemes to unload, but he ventured to say that their asbestos, chrome and copper mines would take rank industrially with any other of the mining industries of Canada. While at the moment they were not threatened by taxation on the products of their mines, there had been some talk, and there were some people who openly advocated an export duty on asbestos, so that it was well to be prepared to meet any such emergency. Such emergencies could best be met by organisation. A local branch of the Institute would give facilities for local mining men to meet together, and would, doubtless, be made an excellent medium for advancing the great mineral wealth thay they knew existed in the Eastern Townships.

Mr B. T. A. Bell, secretary of the Institute, explained that the main idea the Council had in organising these branches was to give greater opportunities for local mining men to meet together than were afforded by the annual meetings of the Institute. By the formation of such a branch in Sherbrooke he thought much could be accomplished on behalf of the mines and mineral wealth of the district.

Mr S W. Jenckes, Sherbrooke, moved "That the Eastern Townships Branch of the Canadian Mining Institute be now formed." Mr. Jas. R. Pearson, Danville, seconded the motion. The chairman put the motion which was carried unanimously.

The following gentlemen handed in their names for election as members subject to the approval of Council: Jas. R. Pearson, Managing Director, Asbestos and Asbestic Co. Ltd., Danville; H. J. Williams, Manager, Beaver Asbestos Co.; J. A. Dresser, M.A., Richmond, Que., Jas. R. Woodward, Wm Farwell, James MacKinnon, W. S. Dresser, of Sherbrooke, and P. L. G. Mackenzie M.L.A., of Richmond.

The following committee of management was elected:—

George R. Smith, M.L.A., Bell's Asbestos Co., Chairman.
H. J. Williams, Beaver Asbestos Co., Thetford Mines.
S. L. Spafford, Nicholls Chemical Co., Capelton.
John Blue, C. & M.E., Eustis Mining Co., Eustis.
Jas. R. Pearson, Asbestos and Asbestic Co., Danville.
B. Bennett, King Bros., Thetford Mines.
James S. Mitchell, Sherbrooke, Que.
A. S. Johnson, Johnson's Co, Thetford Mines.
R. T. Hopper, Standard Asbestos Co., Montreal.
J. Dresser, M.A., Richmond.

Mr. Jas. R. Woodward, Sherbrooke, was elected secretary *pro tem.*

Mr. C. C. Hansen, Montreal, read a very interesting paper on the subject of "Power Drills" which we hope to reproduce in a future issue of the REVIEW.

Mr. F. Stacey Shirley read a paper on the Electric Drills, in which he described the new Gardner electric machine.

COPPER-BEARING ROCKS OF THE EASTERN TOWNSHIPS.

Mr. J. A. Dresser, M.A., Richmond, presented the following abstract of his paper read before the Montreal meetings of the Institute:—

"The copper-bearing rocks of the Eastern Townships of the Province of Quebec have long been known to comprise three principal belts which run approximately parallel to the northeasterly trend of the Green mountains in their extension into Canada. These belts are about twenty-five miles apart where crossed by the St. Francis river, and are themselves some two miles wide in each case along that river although elsewhere they are often considerably wider.

The most westerly of these, which is the first met in approaching the district from the St. Lawrence valley, is an extensive band of limestone which is sometimes associated with glossy black slates or graphitic shales. Small igneous intrusions are known to occur in the vicinity of most of the copper deposits of this belt, and in some cases the igneous rock itself carries copper. The best known deposits in this band are the once famous Acton Mine, the adjacent deposits at Upton, as well as the mines formerly worked at Roxton, Wickham and St. Flavien.

The central, or Sutton, belt contains amongst others the Harvey Hill mine at Leeds, the Halifax in the township of that name, the Viger in Chester, the St. Francis in Cleveland, the Belrath in Melbourne, and Sweet's mine in Sutton. The country rock of this belt has been generally described as chloritic, micaceous, talcose or nacreous slate and has been regarded as sedimentary in origin and the correlation of various deposits has been made on that assumption. Within the last two years, however, it has been found by the writer that these rocks in most cases at least are disguised volcanics of early geological age and much altered in character. Copper is found, not in true veins, as far as observed, but in lenticular masses conforming to the well-developed cleavage of the rock. The gangue is commonly calcite and quartz, and the character of the deposits such as to indicate their deposition contemporaneously with the gangue. The secondary derivation of the ore from the country rock is further evidenced by the fact that the latter commonly yields a small percentage of copper on assay.

Still more recently a similar discovery regarding the nature of the rock in the Ascot belt, the most easterly of the three bands, has been made by Mr, G. H. Pierce, C.E. This area includes, amongst many others, the widely known Albert and Eustis mines at Capelton, the Howard and others at Suffield, the Ascot and the Sherbrooke, nearer the City of Sherbrooke, the Moulton Hill, a few miles east of the St. Francis river, and the Garthby deposits, forty miles farther eastward. The country rock has not been usually described as differing essentially from that of the Sutton belt in general character, unless it be that the micaceous and nacreous slates have been to found predominate in the former while the chloritic prevail in the latter.

During the course of a recent visit to the Suffield mines, Mr. Pierce observed a massive appearance in the hanging wall of the Silver Star mine which suggested to his practised eye the probability of its igneous origin, although the sedimentary character of the rock, a supposed sandstone, had not been hitherto questioned, as far as can be learned, by the many previous observers of it during the past fifty years. A specimen which was handed the writer by Mr. Pierce proved, on microscopic examination, to be a quartz porphyry, the rapidly cooled equivalent of a granite.

As the rock was known to be one of considerable extent, specimens were subsequently taken by the writer at various points across the belt between Sherbrooke and Lennoxville and from several of the nearest mineral deposits. From these it is apparent that the Ascot belt, like that of Sutton, is a complex mass consisting chiefly of old and highly altered volcanic rocks.

The whole igneo metamorphic complex is occasionally cut by dykes which from their undisturbed position and fresh state of preservation are evidently of a very much later age than the main rock masses. The dykes were the latest rocks to form in the region, while the country rocks were the earliest, thus showing this belt to have been the scene of volcanic eruptions at very widely different times, at one or more of which the lavas ejected carried copper, silver and gold. From the fact that the ore bodies in many instances follow the cleavage of the rock, the form thus given the deposits causes them to easily simulate bedded veins which they have commonly been thought to be, owing to the cleavage having been generally mistaken for stratification. In view, however, of the igneous character of the country rock, the correlation of various deposits on assumed stratigraphical grounds becomes useless both in the case of the Ascot and of the Sutton belts, and opinions regarding the mode of occurrence of the ores also call for revision.

Concerning the deposits of the Ascot belt, Dr. Ells wrote in the Report of the Geological Survey, 1888-1889, (p. 56 K). "it may be very safely predicted that the real value of many of the mines which were opened twenty-five years ago and speedily closed, has never been ascertained, and that other masses of ore of equal importance to those so long worked, will, at some not distant date by careful prospecting be found. Much of the failure of twenty-five years ago was, doubtless, due to the speculative character of the work done. Mines were bought and sold on the flimsiest sort of evidence as to their value or worthlessness; often on samples which were obtained from an entirely different location from that represented. The growing importance of these ores as a source of supply for sulphuric acid is being fully realized by the men interested in this industry in the United

States and their superiority over most of the ore there found, for this purpose, being acknowledged. They are yet in this eastern belt many places thickly covered by forest growth, the prospecting of which is a difficult matter, but of the many mines already opened and abandoned it is highly probable, as in the case of those now worked, that deeper and more scientific testing would change the aspect of things greatly for the better."

Dr. FRANK W. ADAMS (Montreal) paid a tribute to the thoroughness with which Mr. Dresser had carried out his studies of these rocks. He thought his investigations had a most important bearing upon the future success of copper mining in the Townships.

Mr. B. T. A. BELL said it was a pity the Quebec Government made no appropriation to encourage original investigation of this character.

The CHAIRMAN said he believed something might be done towards extending the usefulness of the present Mining Bureau, if proper representations were made to the Government. He could promise them that he will cordially support anything calculated to promote the mining industries of the Province.

Mr J. R. WOODWARD stated that the copper deposits of the townships had been receiving his attention, and he was firmly convinced that many of the old mines, which had been abandoned years ago, could be reopened and worked at a profit. There was enough ore in sight to warrant the installation of a custom smelter having a capacity of at least 100 tons daily. He pointed out that not only Sherbrooke county, but Stanstead, Richmond and Wolfe, and Bagot counties were permeated with promising undeveloped copper properties. Work on these and other mines would be stimulated by the establishment of a smelter at Sherbrooke.

Mr. Wm. FARWELL concurred with the other speakers in the great resources of the Province in copper ores. The Federal Government had granted bonuses to the iron and steel, and the silver and lead industries, and he thought some encouragement might also be fairly asked for the production of copper.

Mr. OBALSKI, inspector of mines, said but few people really realized the great wealth of the Province in its resources of copper ore, and he would cheerfully render whatever assistance was in his power towards bringing the claims of his industry to the attention of the Provincial Government. He had just returned from Matane, where a very remarkable discovery had been made.

After some further discussion, the following committee was appointed to take action with respect to the copper question: Wm. Farwell, J. S. Mitchell, S. W. Jenckes, J. A Dresser, Hon. C. C. Colby, and A. N. Thompson (of Stanstead), John Bene, S. L. Spafford, A. N. Thompson, J. R. Woodward, and the Chairman, and report at a later meeting of the section.

The meeting adjourned at 11.30.

NOVA SCOTIA SECTION.

The meeting which was to have been held at Sydney on 13th instant was unavoidably postponed, the Secretary, who had gone as far as Levis on his way to the meeting, being recalled to Ottawa on an urgent personal matter. At a meeting of the Council of the Institute it was decided to hold this meeting later on in the year.

DOMINION COAL COMPANY.

The following is the report to the shareholders, submitted on the 17th instant :—

The sales of the Company during the past year have increased to the extent of over 600,000 tons, and it is expected that a satisfactory increase in output will be maintained during the coming year.

OUTPUT IN TONS.

YEARS ENDING FEBRUARY 28TH.

1895— 884,000	1897— 1,221,471	1899— 1,295,543	1901— 2,044,877
1896— 1,169,785	1898— 1,061,669	1900— 1,739,374	1902— 2,651,263

Owing to this increase in the business of the company, as shown by the above statement, it has been necessary to add largely to the mining plant and machinery; railway and equipment; shipping piers; houses for employees, etc; and during the past year nearly one million dollars have been spent on such extensions and improvements

Since the last annual meeting, arrangements for the supply of rolling stock, and for the erection of workmen's houses, have been completed with the Dominion Rolling Stock Company and the Cape Breton Real Estate Company, respectively, by which the company has acquired the necessary rolling stock and houses for its business, the expenditure upon these being provided for by terminable debentures, liquidated by equal monthly payments extending over a period of ten years, in which capital and interest at a reasonable rate are included. These payments are met by the earnings of these properties themselves, and at the end of the period they will become the absolute property of the Coal Company, free from encumbrance.

The company has succeeded during the past year in placing its coal in the European markets, where it is well thought of, and when Colliery Dominion No. 2 is completed, the company will have a market across the Atlantic for any surplus that it may not be able to place among its customers in Canada, Newfoundland, and the United States.

The company's properties at present comprise the following :—

COAL AREAS.

The coal areas of the company have an extent of 140 square miles, and the known seams over three feet in thickness are estimated to contain 1,500 million tons.

COLLIERIES.

There are six collieries at present in operation, known as Dominion No. 1, Dominion No. 2, Dominion No. 3, Caledonia, Reserve, and International. These collieries have been equipped with the most modern machinery for mining, hauling, and hoisting the coal. They are thoroughly ventilated. The bankheads, engine and boiler houses, and pit bottoms of the first four are electric lighted.

DOMINION NO 1.—This colliery has a capacity of 70,000 tons per month. The coal seam is known as the Phalen, and is eight feet thick. The coal shaft is 157 feet deep. The mining is done with puncher type coal cutting machines, driven by compressed air; endless wire ropes being used in haulage. The electric locomotive and haulage in the pit has a capacity of 50 tons per trip. A large duplex pump has been installed in the pit for pumping the mine water to the surface.

DOMINION NO. 2.—The work of opening this colliery was begun in 1899, and it is now nearing completion. The present capacity is 30,000 tons per month. It is expected that by the close of the year the capacity will be increased to 75,000 tons per month, and the ultimate capacity will be 150,000 tons per month. Two coal seams are worked, the Phalen, 7½ feet thick, and the Harbor, 5 feet 8 inches thick. The shaft is 408 feet deep to the Harbor seam, and 900 feet to the Phalen seam. The mining is done by puncher type coal cutting machines and hand picks. The mine tubs have a capacity of two tons each. The coal is weighed and tipped at pit bottom into a tank hoist of six ton capacity, which dumps automatically. It is the intention to install compressed air haulage in the pit bottom to handle the coal to the shaft. The steel bankhead, now being erected, will be 125 feet high.

DOMINION NO. 3.—The capacity of this colliery is 35,000 tons per month The coal seam worked is the Phalen, and is eight feet thick. The mining is done partly by hand and partly by puncher type coal cutting machines, driven by compressed air. The coal is handled by endless rope haulage.

CALEDONIA COLLIERY.—This colliery has a capacity of 70,000 tons per month. The coal seam is the Phalen, eight feet thick. It is mined partly by hand and partly by puncher type coal cutting machines. Endless wire ropes are used for haulage. The shaft is 182 feet deep.

RESERVE COLLIERY.—This mine has a capacity of 75,000 tons per month. The coal seam mined is the Phalen, eight feet thick. The work is done partly by hand and partly by puncher coal cutting machines, with endless wire rope haulage. There are basket elevators for handling slack coal.

INTERNATIONAL COLLIERY.—This colliery has a capacity of 17,000 tons per month. The Harbor seam, six feet thick, is mined by hand picks. Endless rope and tail rope haulage.

The company has also a complete coal washing plant, capable of washing about 2,000 tons per day; extensively equipped repair shops at Glace Bay; a foundry, car shops, etc.

The Sydney and Louisburg railway, which is owned by the company, extends from Sydney to Louisburg, making connections with all the mines—30 miles of main line and 57 miles of sidings. The railway is solidly constructed with 80lb. steel rails; the bridges are of steel with stone abutments, and the grades and curves are light.

The rolling stock consists of 19 locomotives, 1355 flat coal cars, and 12 passenger and service cars.

SHIPPING PIERS.

There are two piers at Sydney, having each a capacity of 10,000 tons in 24 hours. At the Louisburg terminus there are also two piers—one a high level, the other a low level pier. The high level pier is equipped with the Robins belt conveyor and slack pocket, with capacity of discharging 750 tons of coal per hour.

STEAMSHIPS.

The company owns five steamships, two tugs, and five barges. During the past winter the equipment has been thoroughly overhauled, and the "Bonavista," the company's passenger steamer, fitted up with electric light.

DWELLINGS.

The company has at present 1200 substantially built houses rented to workmen; and also has its own stores at Glace Bay and six subsidiary stores at different collieries.

EARNINGS.

During the past year the surplus earnings of the company amounted to $937,681.44, and there has also been deposited in addition $122,939.55 in the sinking fund for the redemption of the company's bonds. This latter amount, together with interest on $125,000 reserve sinking fund, is sufficient to retire $115,000 of these bonds, by which the bonded indebtedness will be reduced to $2,589,500.00.

Submitted on behalf of the Directors,

JAMES ROSS, *Vice-President.*

Montreal, 12th June, 1902.

NINTH ANNUAL REPORT of the DOMINION COAL COMPANY, LIMITED, For the year ending February 28th, 1902, as compared with year ending February 28th 1901.

	FOR YEAR ENDING FEB 28, 1901.		FOR YEAR ENDING FEB 28, 1902.	
Net Proceeds from Sale of Coal and Net Income from Steamships, Railroads, Stores, and Real Estate		$687,294.68		$1,551,880.99
Less—				
Interest on Bonds	$167,670 00		$162,240.00	
Dividend on Preferred Stock	213,333.33		240,000 00	
Miscellaneous Interest and Premiums on Bonds retired	47,348.16	428,351 49	91,727.85	493,967 85
Surplus of Net Income		258,943 39		1 057,913 14
Add—				
Preferred Stock Premiums		100,000.00		
Total		358,943.39		
Less Sinking Fund		95,743.30		120,231.70
		263,200.09		
Charged off		104,018.90		
Balance to General Surplus		159 181.19		917,681.44
BALANCES.				
ASSETS—				
Property Account as per last Report	20,249,721.99		21,333,163.86	
Less—				
Written off for Depreciation	51,930.06		122,371 77	
	20,197,791.93		21,21 0789.09	
Add Capital Expenditure during year	1,133,371.93	21,333,163.86	960,344.35	22,171.133 44
Cash in Banks and Offices		140 324.65		327,355.36
A. Accounts Receivable		71,345.86		632,344.29
B. Coal on hand		555,230 07		196,289.80
New Supplies in Stores and Warehouses		445,327.15		518,114.74
Insurance paid in Advance		4 498.73		25,451.41
Interest paid in Advance		11 511.34		2 308 05
Steamship Hire paid in Advance		7,595.21		14,072.79
Cash in New England Trust Co. for Sinking Fund		136,402.08		134,547.05
		22,705,718.95		24,021,616.93
LIABILITIES:				
Capital Stock, Common	15,000,000.00		15,000,000.00	
" " Preferred	3,000,000.00		3,000,000.00	
First Mortgage Bonds	2 801,500.00		2 704,500 00	
C. Hochelaga Mortgage			22,0 0.00	
D. Cape Breton Real Estate Debentures			289 391.75	
D. Dominion Rolling Stock Debentures		20,801,500 00	289,391.75	21,305,253.50
Accrued Dividend Jan'y-Feb'y	40,000.00		40,000 00	
Unpaid Royalty	87,616.62		37,589.50	
Accounts Payable	78,758.59		161,941.50	
Notes Payable	1,105,000.00	1,311,375.21	840,000.00	1,079,531.00
Special Reserve				106,277.25
SURPLUS—				
Balance from previous years	433,662 55		592,843.74	
For current year	159,181.19	592,843 74	937,681.44	1,530,525.18
		22,705,718.95		24,021,616.93

A. { For year ending Feb. 28th, 1901, "A" did not include Accounts Receivable at Agencies
B. { These were included in "B," as Coal on hand and balance due from Agents.
C. The Hochelaga mortgage dates since 1894, but was not entered on the books of the company until the present year.
D. This liability was incurred previous to year ending Feb 28th, 1901, and was for the purpose of providing for new miners' dwellings and additional rolling stock, as referred to in Directors' Report.

SINKING FUND, MAY 1, 1902.

$11,800 Unites States 4s, costing	$124,817.62	
Cash for retirement of Bonds	128,644.31	
Cash under Article IV	4,144.25	
Accrued interest on U.S. 4s	372.67	
		$257,978.85
For		
Reserve Sinking Fund	$125,000.00	
Retirement of Bonds, etc	132,978.85	
		$257,978.85
Balance Reserve Sinking Fund	$125,000.00	

CANADIAN MINING INSTITUTE.

BRITISH COLUMBIA SECTION.

A PUBLIC MEETING of Mine Owners, Mine Managers, Mining Engineers, Assayers, and all who may be interested in promoting the welfare of the profession and industry of mining in British Columbia, will be held in the **CITY OF NELSON**, on

Tuesday, 9th September, 1902

(AFTERNOON AND EVENING SESSIONS)

for the purpose of completing the British Columbia Section of the Institutel
A programme of papers of interest to mining men in the Province wil. be submitted for discussion.

B. T. A. BELL, *General Secretary.* CHARLES FERGIE, *President.* R. R. HEDLEY, *Chairman.*

IN PREPARATION

TWELFTH EDITION

The Canadian Mining Manual

FOR 1902

Up to date particulars of the Organisation, Equipment, Operations, Output, Balance Sheets and Dividends of all Canadian

Collieries Metal Mines Stamp Batteries
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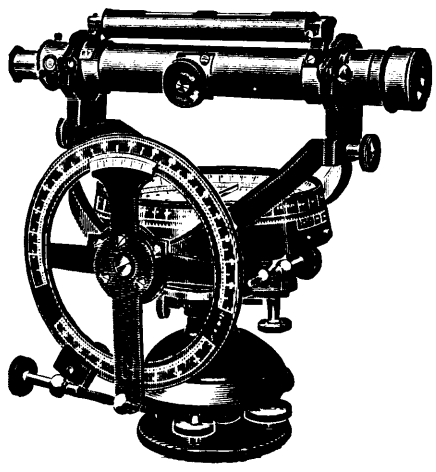
600 PP.—HANDSOMELY BOUND

The most complete and handily arranged work of reference to Canadian mining undertakings extant.

..PRICE FOUR DOLLARS..

THE CANADIAN MINING REVIEW

OTTAWA, CANADA.



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SCHOOL of MINING

Practical Science Faculty of Queen's University

Kingston, Ontario.

THE FOLLOWING COURSES ARE OFFERED

1. THREE YEARS' COURSE FOR A DIPLOMA IN
   - (*a*) Mining Engineering.
   - (*b*) Analytical Chemistry and Assaying.
2. FOUR YEARS' COURSE FOR A DEGREE B.SC. IN

   GROUP I.
   - (*a*) Mining Engineering.
   - (*b*) Chemistry and Mineralogy.
   - (*c*) Mineralogy and Geology.
   - (*d*) Chemical Engineering.

   GROUP II.
   - (*e*) Civil Engineering.
   - (*f*) Mechanical Engineering.
   - (*g*) Electrical Engineering.

   GROUP III.
   - (*h*) Biology and Public Health.
3. COURSES IN CHEMISTRY, MINERALOGY AND GEOLOGY for degrees of Bachelor of Arts (B.A.) and Master of Arts (M.A.

For further information see the Calendar of Queen's University.

4. POST-GRADUATE COURSE FOR THE DEGREE OF Doctor of Science (D.Sc.)

For further information see the Calendar of Queen's University.

Next Session begins October 1st, 1902.

MATRICULATION EXAMINATIONS HELD AT QUEEN'S UNIVERSITY, SEPTEMBER 16TH.

THE SCHOOL is provided with well equipped laboratories for the study of Chemical Analysis, Assaying, Blowpiping, Mineralogy, Petrography and Drawing. It has also a well equipped Mechanical Laboratory. The Engineering Building will be ready for occupation next session and the Geology and Physics Building the following session. The Mining Laboratory has been remodelled at a cost of some $12,000 and the operations of crushing, amalgamating, concentrating, chlorinating, cyaniding, etc., can be studied on a large scale.

For Calendar of the School and further information, apply to

The Secretary, School of Mining, Kingston, Ont.

PROVINCE OF NOVA SCOTIA.

Leases for Mines of Gold, Silver, Coal, Iron, Copper, Lead, Tin

—AND—

PRECIOUS STONES.

TITLES GIVEN DIRECT FROM THE CROWN, ROYALTIES AND RENTALS MODERATE.

GOLD AND SILVER.

Under the provisions of Chap. 1, Acts of 1892, of Mines and Minerals, Licenses are issued for prospecting Gold and Silver for a term of twelve months. Mines of Gold and Silver are laid off in areas of 150 by 250 feet, any number of which up to one hundred can be included in one License, provided that the length of the block does not exceed twice its width. The cost is 50 cents per area. Leases of any number of areas are granted for a term of 40 years at $2.00 per area. These leases are forfeitable if not worked, but advantage can be taken of a recent Act by which on payment of 50 cents anuually for each area contained in the lease it becomes non forfeitable if the labor be not performed.

Licenses are issued to owners of quartz crushing mills who are required to pay Royalty on all the Gold they extract at the rate of two per cent. on smelted Gold valued at $19 an ounce, and on smelted Gold valued at $18 an ounce.

Applications for Licenses or Leases are receivable at the office of the Commissioner of Public Works and Mines each week day from 10 a.m. to 4 p.m., except Saturday, when the hours are from 10 to 1. Licenses are issued in the order of application according to priority. If a person discovers Gold in any part of the Province, he may stake out the boundaries of the areas he desires to obtain, and this gives him one week and twenty-four hours for every 15 miles from Halifax in which to make application at the Department for his ground.

MINES OTHER THAN GOLD AND SILVER.

Licenses to search for eighteen months are issued, at a cost of thirty dollars, for minerals other than Gold and Silver, out of which areas can be selected for mining under lease. These leases are for four renewable terms of twenty years each. The cost for the first year is fifty dollars, and an annual rental of thirty dollars secures each lease from liability to forfeiture for non-working.

All rentals are refunded if afterwards the areas are worked and pay royalties. All titles, transfers, etc., of minerals are registered by the Mines Department for a nominal fee, and provision is made for lessees and licensees whereby they can acquired promptly either by arrangement with the owner or by arbitration all land required for their mining works.

The Government as a security for the payment of royalties, makes the royalties first lien on the plant and fixtures of the mine.

The unusually generous conditions under which the Government of Nova Scotia grants its minerals have introduced many outside capitalists, who have always stated that the Mining laws of the Province were the best they had had experience of.

The royalties on the remaining minerals are: Copper, four cents on every unit; Lead, two cents upon every unit; Iron, five cents on every ton; Tin and Precious Stones, five per cent.; Coal, 10 cents on every ton sold.

The Gold district of the Province extends along its entire Atlantic coast, and varies in width from 10 to 40 miles, and embraces an area of over three thousand miles, and is traversed by good roads and accessible at all points by water. Coal is known in the Counties of Cumberland, Colchester, Pictou and Antigonish, and at numerous points in the Island of Cape Breton. The ores of Iron, Copper, etc., are met at numerous points, and are being rapidly secured by miners and investors.

Copies of the Mining Law and any information can be had on application to

THE HON. C. E. CHURCH,

Commissioner Public Works and Mines,

HALIFAX, NOVA SCOTIA.

PROVINCE of QUEBEC

The attention of Miners and Capitalists in the United States and in Europe is invited to the

GREAT MINERAL TERRITORY

Open for investment in the Province of Quebec.

Gold, Silver, Copper, Iron, Asbestos, Mica, Plumbago, Phosphate, Chromic Iron, Galena, Etc.

ORNAMENTAL AND STRUCTURAL MATERIALS IN ABUNDANT VARIETY.

The Mining Law gives absolute security to Title, and has been specially framed for the encouragement of Mining.

Mining concessions are divided into three classes :—

1. In unsurveyed territory (*a*) the first class contains 400 acres, (*b*) the second, 200 acres, and (*c*) the third, 100 acres.

2. In surveyed townships the three classes respectively comprise one, two and four lots.

All lands supposed to contain mines or ores belonging to the Crown may be acquired from the Commissioner of Colonization and Mines (*a*) as a mining concession by purchase, or (*b*) be occupied and worked under a mining license.

No sale of mining concessions containing more than 400 acres in superficies can be made by the Commissioner to the same person. The Governor-in-Council may, however, grant a larger extent of territory up to 1,000 acres under special circumstances.

The rates charged and to be paid in full at the time of the purchase are $5 and $10 per acre for mining lands containing the superior metals* ; the first named price being for lands situated more than 12 miles aud the last named for lands situated less than 12 miles from the railway.

If containing the inferior metal, $2 and $4 according to distance from railway.

Unless stipulated to the contrary in the letters patent in concessions for the mining of superior metals, the purchaser has the right to mine for all metals found therein ; in concessions for the mlning of the inferior metals, those only may be mined for.

*The superior metals include the ores of gold, silver, lead, copper, nickel, graphite, asbestos, mica, and phosphate of lime. The words inferior metals include all other minerals and ores.

Mining lands are sold on the express condition that the purchaser shall commence *bona fide* to mine within two years from the date of purchase, and shall not spend less than $500 if mining for the superior metals ; and not less than $200 if for inferior metals. In default, cancellation of sale of mining lands.

(*b*) Licenses may be obtained from the Commissioner on the following terms :—Application for an exploration and prospecting license, if the mine is on private land, $2 for every 100 acres or fraction of 100 ; if the mine is on Crown lands (1) in unsurveyed territory, $5 for every 100 acres, and (2) in unsurveyed territory, $5 for each square mile, the license to be valid for three months and renewable. The holder of such license may afterwards purchase the mine, paying the prices mentioned.

Licenses for mining are of two kinds : Private lands licenses where the mining rights belong to the Crown, and public lands licenses. These licenses are granted on payment of a fee of $5 and an annual rental of $1 per acre. Each license is granted for 200 acres or less but not for more ; is valid for one year, and is renewable on the same terms as those on which it was originally granted. The Governor-in Council may at any time require the payment of the royalty in lieu of fees for a mining license and the annual rental – such royalties unless otherwise determined by letters patent or other title from the Crown, being fixed at a rate not to exceed three per cent. of the value at the mine of the mineral extracted after deducting the cost of mining it.

The fullest information will be cheerfully given on application to

THE MINISTER OF LANDS, MINES AND FISHERIES,

PARLIAMENT BUILDINGS, QUEBEC, P. Q.

DOMINION OF CANADA

SYNOPSIS OF REGULATIONS

For Disposal of Minerals on Dominion Lands in Manitoba, the North-West Territories, and the Yukon Territory.

COAL.

Coal lands may be purchased at $10.00 per acre for soft coal, and $20.00 for anthracite. Not more than 320 acres can be acquired by one individual or company. Royalty at such rate as may from time to time be specified by Order in Council shall be collected on the gross output.

QUARTZ.

Persons of eighteen years and over and joint stock companies holding Free Miner's Certificates may obtain entry for a mining location.

A Free Miner's Certificate is granted for one or more years, not exceeding five, upon payment in advance of $10.00 per annum for an individual, and from $50.00 to $100.00 per annum for a company, according to capital.

A Free Miner having discovered mineral in place may locate a claim 1500 x 1500 feet by marking out the same with two legal posts, bearing location notices, one at each end on the line of the lode or vein.

The claim shall be recorded within fifteen days if located within ten miles of a Mining Recorder's Office, one additional day allowed for every additional ten miles or fraction. The fee for recording a claim is $5.00.

At least $100.00 must be expended on the claim each year or paid to the Mining Recorder in lieu thereof. When $500.00 has been expended or paid the locator may, upon having a survey made and upon complying with other requirements, purchase the land at $1.00 an acre.

Permission may be granted by the Minister of the Interior to locate claims containing iron and mica, also copper in the Yukon Territory, of an area not exceeding 160 acres.

The patent for a mining location shall provide for the payment of royalty on the sales not exceeding five per cent.

PLACER MINING, MANITOBA AND THE N.W.T., EXCEPTING THE YUKON TERRITORY.

Placer mining claims generally are 100 feet square; entry fee $5.00 renewable yearly. On the North Saskatchewan River claims are either bar or bench, the former being 100 feet long and extending between high and low water mark. The latter includes bar diggings but extends back to the base of the hill or bank, but not exceeding 1,000 feet. Where steam power is used, claims 200 feet wide may be obtained.

DREDGING IN THE RIVERS OF MANITOBA AND THE N.W.T., EXCEPTING THE YUKON TERRITORY.

A Free Miner may obtain only two leases of five miles each for a term of twenty years, renewable in the discretion of the Minister of the Interior.

The lessee's right is confined to the submerged bed or bars of the river below low water mark, and subject to the rights of all persons who have, or who may receive entries for bar diggings or bench claims, except on the Saskatchewan River, where the lessee may dredge to high water mark on each alternate leasehold.

The lessee shall have a dredge in operation within one season from the date of the lease for each five miles, but where a person or company has obtained more than one lease one dredge for each fifteen miles or fraction is sufficient. Rental $10.00 per annum for each mile of river leased. Royalty at the rate of two and a half per cent., collected on the output after it exceeds $10,000.00.

DREDGING IN THE YUKON TERRITORY.

Six leases of five miles each may be granted to a free miner for a term of twenty years, also renewable.

The lessee's right is confined to the submerged bed in the river below low water mark, that boundary to be fixed by its position on the 1st day of August in the year of the date of the lease.

The lessee shall have one dredge in operation within two years from the date of the lease, and one dredge for each five miles within six years from such date. Rental, $100.00 per mile for first year, and $10.00 per mile for each subsequent year. Royalty ten per cent. on the output in excess of $15,000.00.

PLACER MINING IN THE YUKON TERRITORY.

Creek, Gulch, River and Hill Claims shall not exceed 250 feet in length, measured on the base line or general direction of the creek or gulch, the width being from 1,000 to 2,000 feet. All other Placer Claims shall be 250 feet square.

Claims are marked by two legal posts, one at each end bearing notices. Entry must be obtained within ten days if the claim is within ten miles of Mining Recorder's office. One extra day allowed for each additional ten miles or fraction.

The person or company staking a claim, and each person in his or its employment, except house servants, must hold a Free Miner's Certificate.

The discoverer of a new mine is entitled to a claim 1,000 feet in length, and if the party consists of two, 1,500 feet altogether, on the output of which no royalty shall be charged, the rest of the party ordinary claims only.

Entry fee $15.00. Royalty at the rate of five per cent charged on the gross output of the claim, with the exception of an annual exemption of $5,000 00.

No Free Miner shall receive a grant of more than one mining claim on each separate river, creek or gulch, but the same miner may hold any number of claims by purchase, and Free Miners, not exceeding ten in number, may work their claims in partnership, by filing notice and paying fee of $2.00. A claim may be abandoned and another obtained on the same creek, gulch or river, by giving notice and paying a fee.

Work must be done on a claim each year to the value of at least $200.00, or in lieu of work payment may be made to the Mining Recorder each year for the first three years of $200.00 and after that $400.00 for each year.

A certificate that work has been done or fee paid must be obtained each year; if not, the claim shall be deemed to be abandoned, and open to occupation and entry by a Free Miner.

The boundaries of a claim may be defined absolutely by having a survey made, and publishing notices in the *Yukon Official Gazette.*

HYDRAULIC MINING, YUKON TERRITORY.

Locations suitable for hydraulic mining, having a frontage of from one to five miles, and a depth of one mile or more, may be leased for twenty years, provided the ground has been prospected by the applicant or his agent; is found to be unsuitable for placer mining; and does not include within its boundaries any mining claims already granted. A rental of $150.00 for each mile of frontage, and a royalty of five per cent. on the gross output, less an annual exemption of $25,000.00 are charged. Operations must be commenced within one year from the date of the lease, and not less than $5,000 must be expended annually. The lease excludes all base metals, quartz and coal, and provides for the withdrawal of unoperated land for agricultural or building purposes.

PETROLEUM.

All unappropriated Dominion Lands shall, after the first of July, 1901, be open to prospecting for petroleum. Should the prospector discover oil in paying quantities he may acquire 640 acres of available land, including and surrounding his discovery at the rate of $1.00 an acre, subject to royalty at such rate as may be specified by Order in Council.

JAMES A. SMART,

Deputy of the Minister of the Interior.

OTTAWA, 9th Dec., 1901.

Ontario's Mining Lands..

THE Crown domain of the Province of Ontario contains an area of over 100,000,000 acres, a large part of which is comprised in geological formations known to carry valuable minerals and extending northward from the great lakes and westward from the Ottawa river to the Manitoba boundary.

Iron in large bodies of magnetite and hematite : copper in sulphide and native form ; gold, mostly in free milling quartz ; silver, native and sulphides ; zincblende, galena, pyrites, mica, graphite, talc, marl, brick clay, building stones of all kinds and other useful minerals have been found in many places, and are being worked at the present time.

In the famous Sudbury region Ontario possesses one of the two sources of the world's supply of nickel, and the known deposits of this metal are very large. Recent discoveries of corundum in Eastern Ontario are believed to be the most extensive in existence.

The output of iron, copper and nickel in 1900 was much beyond that of any previous year, and large developments in these industries are now going on.

In the older parts of the Province salt, petroleum and natural gas are important products.

The mining laws of Ontario are liberal, and the prices of mineral lands low. Title by freehold or lease, on working conditions for seven years. There are no royalties.

The climate is unsurpassed, wood and water are plentiful, and in the summer season the prospector can go almost anywhere in a canoe. The Canadian Pacific Railway runs through the entire mineral belt.

For reports of the Bureau of Mines, maps, mining laws, etc , apply to

HONORABLE E. J. DAVIS,
Commissioner of Crown Lands,

or

THOS. W. GIBSON,
Director Bureau of Mines,
Toronto, Ontario.

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Offices: CANADA LIFE BUILDING.

For Railroad, Electric Car, Street Railway and Lumber Truck Service, Etc.

THOMAS J. DRUMMOND, General Manager.

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