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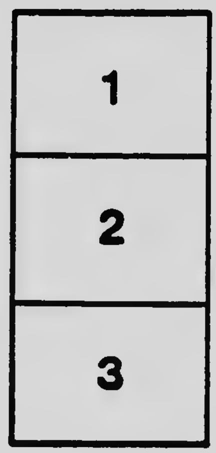

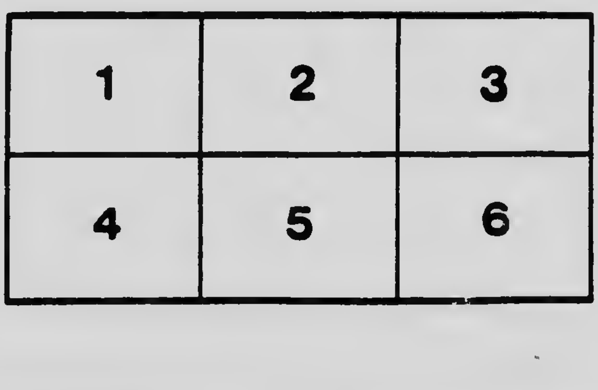

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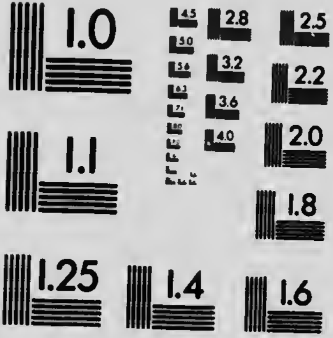

Phlogopite from the Lacey mine, township of Loughborough, Ont.

CANADA
DEPARTMENT OF MINES
MINES BRANCH
Hon. W. Templeman, Minister; A. P. Low, LL.D., Deputy Minister;
Eugene Haanel, Ph.D., Director.

MICA

ITS OCCURRENCE, EXPLOITATION, AND USES

SECOND EDITION

BY

Hugh S. de Schmid, M.E.

OTTAWA
GOVERNMENT PRINTING BUREAU
1912

No. 118

LETTER OF INSTRUCTIONS.

OTTAWA, June 10, 1910.

SIR,—

For the purpose of revising the previous report on mica, issued by this Department, you are instructed to proceed to the productive and prospective mica mines of the Dominion, and to collect all necessary data and information regarding the occurrence and mining of mica, and preparation of the mineral for the market.

The report is to cover the following subjects:—

Physical and chemical properties.
General topographic and geological features of the mica areas.
Mode of occurrence of the commercially useful deposits.
A concise description of all the mica mines and prospects of value.
Status of the Canadian mica industry: present condition, and future prospects.
Statistics of production and exports.
Commercial application.
Occurrence of the mineral in foreign countries—especially India.
APPENDIX—Abstract of the laws governing the acquisition of mining properties and the mining of mica in the different Provinces.

The text of the report must be accompanied by drawings showing sections through the deposits; together with other illustrations and photographs pertaining strictly to the occurrence, mining, and production of mica.

Special attention to be given to the commercial aspect of all the subjects above enumerated.

(Signed) **Eugene Haanel**,
Director of Mines.

HUGH S. de SCHMID, ESQ., M.E.,
Mines Branch,
Department of Mines,
Ottawa

LETTER OF TRANSMITTAL.

DR. EUGENE HAANEL,
Director of Mines,
Mines Branch,
Department of Mines,
Ottawa.

SIR,—In accordance with your instructions, I proceeded to the various mica-producing areas of the Dominion, and collected additional data and information regarding the occurrence, mining, and preparation of the mineral.

I beg to submit, herewith, my report upon the above.

I have the honour to be, Sir,
Your obedient servant,
(Signed) **Hugh S. de Schmid.**

OTTAWA,
September 11, 1911.

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MICA:

ITS OCCURRENCE, EXPLOITATION, AND USES,

BY

Hugh S. de Schmid, M.E.

INTRODUCTORY.

Since the publication of the previous monograph on mica, issued by the Mines Branch in 1905, the relations affecting both the mining and manufacture of the mineral in Canada have experienced some marked changes.

In the first place, the demand for mica has undergone considerable fluctuations; reaching a minimum 1907–8. In consequence of the market depression, many mines, both in Quebec and Ontario, closed down, and a large number of them still remain idle; the owners or lessees not considering the present market profitable enough to warrant a renewal of operations.

During the summer of 1910 the writer visited all the principal deposits in the Quebec and Ontario mica regions, and found over 80 per cent of the mines closed and under water.

Many of these so-called "mines" are mere surface pits, which were opened on small showings of mica, and were abandoned after a few months' work.

The true value of such deposits is naturally very uncertain. Many operators clean out the mica in sight at the surface and quit work as soon as the bunch or pocket of crystals is exhausted. It is, of course, not to be expected of miners that they should expend valuable capital in exploiting deposits in which they have little faith, yet it is unquestionable that many mica deposits, especially in the Quebec area, have as yet been only scratched.

The mining of mica is at present almost entirely of a superficial nature, and might, in most instances, more properly be termed quarrying. Where, however, deposits have been followed by means of shafts and drifts to depths of a hundred feet and over, results have shown that the mica is by no means confined to the surface.

The pockety nature of mica deposits must always prove a serious obstacle to their successful exploitation. There are few rules and indications, as in the case of ore bodies, by which miners may be guided, they having to depend, largely, on chance in following the mica leads.

Diamond drilling has proved of assistance in most cases where it has been employed; though even this method of determining the extent of the mica-bearing zone is liable to prove misleading. For instance, the impersistent nature of the deposits is in itself a serious obstacle, and may lead to very false conclusions, however carefully the drilling operations are carried out.

In the following monograph the writer has endeavoured to compile as much available information as possible concerning the chief Canadian mica deposits. The main portion of the report aims at giving a complete list of the principal deposits which have as yet been exploited, together with an account of the work done at the various mines; while Part II contains technical information relative to mica and its mineralogical and geological occurrence. Owing to a large number of the mines being idle and, for the most part, under water, a close examination of the workings was, in many cases, impossible.

PART I.

CHAPTER I.

ON THE EXPLOITATION OF CANADIAN MICA DEPOSITS.

The nature and general occurrence of mica and phosphate deposits present features so widely different from the conditions exhibited by those of any other minerals of economic importance, that their successful exploitation requires methods of mining in many respects dissimilar to those usually employed in the development of mineral bodies. There are practically no points of similarity between mica deposits and the generality of those of the metallic minerals. This being the case, methods of extraction have to be employed which possess few points of resemblance to those generally adopted in lode mining.

In the first place, the impersistency of the mica leads and zones is an important factor bearing directly upon the methods of extraction to be employed. Then again, the nature of the mineral is such that its quality, and not so much its quantity, is the principal point governing the value of deposits. That is to say: whereas in the case of ore bodies, mineral substance of definite chemical composition always possesses a certain value as such; although perhaps not occurring in sufficient amount to be profitably worked, yet, in the case of mica deposits, great quantities of the mineral may be present, but in such a crushed and twisted condition as to be almost totally valueless for the general purposes to which mica is applied. The character and condition of the mica existent in the various deposits are, therefore, the chief considerations in determining their value. It is the impossibility of correctly, or even approximately gauging the persistency of mica leads, and, what is still more important, the quality of the mineral they may carry, that has proved such an obstacle in the successful exploitation of the deposits. Veins carrying mica are often of such a pockety nature, widening and pinching out in a manner which it is impossible to foresee, that what seems one day an apparently promising deposit appears the next directly the reverse. This is, of course, a condition of affairs commonly to be met with in mineral occurrences; but the mica deposits exhibit this disconcerting peculiarity in such high degree as to render all the general rules applicable to mining methods entirely useless. Promising and paying mica leads may continue to persist in their course, and yet all at once commence to carry a quality of mica which is almost wholly valueless and of which only some 5 per cent is marketable.

On the other hand, narrow leads sometimes contain enough high-grade mineral to warrant a continuation of mining: in spite of the large amount of rock to be moved in order to extract a relatively small quantity of mica.

So many factors may adversely affect the quality of the mica: crushing—with not necessarily distortion, but a tendency to induce the laminæ to split up into ribbon mica; inclusion of foreign mineral substance between the sheets—with a consequent impairing of the splitting quality; size of the crystals; and last, but most important, the colour and general character of the mineral with regard to its suitability for the purposes to which it is to be put. A dark mica, generally speaking, is not as favourably regarded as a medium-coloured, and the same applies to the very light-coloured varieties, these being, as a rule, more brittle, less elastic, and poorer splitters than what are known as "silver-amber" micas. All these considerations have to be borne in mind when a mica-bearing rock has been located and trenching has disclosed the presence of, apparently, paying quantities of the mineral. Often enough, small pockets of excellent mica exist near the surface, and these, when followed to a depth of a few feet, abruptly peter out without disclosing any evidence of the deposit continuing in depth. The mica-bearing area is covered with small excavations, ranging from 2 to 10 feet in depth; all of which have been opened on small pockets of mica, the operators being either not sufficiently impressed with the appearance of the deposit, or else not possessed of sufficient capital to continue following the lead.

From the foregoing it will be seen that the exploitation of mica deposits is often attended by much uncertainty, and that their development, in the frequent absence of any indications to guide the operators, is still more often a matter of guesswork than even that of the general run of mineral deposits.

What has been said regarding the exploitation of mica bodies generally, applies equally to estimates of their extent and value. Any attempt to give an approximate valuation of a mica deposit is attended by such difficulties as to render any estimate exceedingly uncertain: even when diamond drilling is employed, the results may lead to totally false conclusions being formed. In the case of an ore body which crops out at the surface, and contains certain minerals, the obtaining of drill cores composed of similar mineral substance at a depth of, say, 500 feet, immediately below the outcrop, may lead to the reasonably safe assumption of the existence, between the surface and the spot reached by the drill, of a continuous body of ore.

In the case of a mica deposit, however, such an assumption would be entirely hazardous. The body of mica exposed at the surface might become exhausted at a depth of 50 or 100 feet, or, for that matter, of 10 feet, and sinking might proceed through many feet of barren rock, or rock carrying crushed and valueless mineral, before another deposit was struck. The tendency of mica bodies to occur in sporadic and pockety fashion must render any estimate of their extent a matter of pure guesswork, upon which no definite reliance can be placed; and the actual value of any deposit is only to be arrived at from results. The large deposits of mica which have been met with at the Lacey mine, belonging to the General Electric Company, were only struck after several attempts had been made by various parties to conduct profitable operations. The last of such operators ceased work when within a few feet of an almost solid mass of mica. Such illustrations of the uncertainty attending the development of mica bodies are numerous, and it is safe to assert that, in most cases, any attempt to arrive at even an approximate valuation of a deposit would be a matter of exceeding difficulty and any such estimate would be of purely problematic value.

This uncertainty regarding the true nature and extent of mica bodies has led to the widespread practice, among operators, of working deposits either under royalty or on option. In the first-named case a certain percentage on the sales of the mica raised is paid to the owner, with or without a sum of money for a lease of the property; while in the second instance the operator works the deposit under lease, in the ordinary way for a definite period, retaining the option of taking over the property at the end of the time on certain specified terms. Many modifications of both these systems exist and the terms of the agreements are often highly unsatisfactory, especially to the owner of the property. The latter has frequently to witness the cleaning out of rich surface shows upon which he receives a small royalty, being ultimately left with one or more openings upon his property, none of which exhibit much signs of mica. In such cases the operator seldom takes much regard for the future of the deposit, generally extracting all the mica in sight and often leaving the working in a highly dangerous condition. The fact that, in the majority of instances, the deposits are, in the beginning, exploited in a far from satisfactory manner by small owners, farmers, etc., is regrettable, in so far that what might prove to be extensive and valuable occurrences are often abandoned as soon as any signs of narrowing of the leads are perceived. Subsequent prospectors and operators are inclined to pass by occurrences which have the appearance of having been either worked out or unsuccessfully exploited, whereas, had such deposits in the first instance been developed with a regard to their future by competent operators, possessed of sufficient capital to thoroughly test their value and extent, there is little doubt but that a considerable percentage of them would be either to-day on the producing list or in a condition to be reopened should market conditions warrant it. The successful exploitation of any mine is largely dependent upon its economic and intelligent management and the nature of the methods adopted to extract mineral; not only with the least expense, but with the greatest foresight and provision for the future of the property. This should be especially true in the case of mica deposits, which present exceedingly difficult and unique problems and which require a higher degree of knowledge of their character and peculiarities than is essential for practically any other type of mineral deposits. In spite of this, and despite the important position held at the present time by the mineral, a position which, it may be safely assumed, will increase in importance with the increase in the manufacture of electrical appliances, the majority of the mica produced in Canada to-day is the output of some half dozen mines, chief among which is the General Electric Company's mine at Sydenham, Ont. With the exception of a few large mines, several of which have been entirely closed down for some years, and upon the remainder of which operations are now being conducted on a very limited scale, the mica properties of the above Company may be said to be the only deposits upon which important and extensive mining for mica has ever been carried out. As the General Electric Company consumes all the mica produced from its own mines, in addition to buying up the produce of other properties, the market at the present time is almost entirely supplied by the output of a few large producers. Many of the smaller properties hardly deserve the name of "mines," being merely small pits 12 to 15 feet deep, and sometimes even less, excavated on pockets of mica. These pits are worked in a desultory fashion, and their total yield during a year often does not exceed a couple of barrels of trimmed mica, hence they can hardly be regarded as constituting properties containing reserves of mica which may be drawn upon in case of a shortage of the mineral. It is true that when prices take an upward trend these small operators become active and carry out a few weeks' work upon their properties. This activity is, however, very spasmodic and is often interfered with by farming operations and the like. The product of such mines is generally disposed of to small dealers, or middlemen, who act as shippers to the English and American consumers. Often enough such operators are obsessed with very erroneous ideas as to the peculiarly high grade and quality of the mica they have raised, and hold their small stock for long periods in expectation of a mica famine and high prices. This hoarding of small quantities of mineral is very general throughout the mica region and is typical of the petty methods adopted by this class of operator.

Some of the larger owners also pursue a somewhat similar course. On one mine visited, a stock of mica—reported to consist of over 500 barrels—was seen.

When the writer made his tour of the mica districts, in 1909, 213 out of 250, or 85·2 per cent of a total number of mines and locations visited, were closed down, while 138, or 55·2 per cent, had been idle for over two years. The value of production of Canadian mica for the year 1910 is given as $143,409, over one-third of this sum representing the output of one mine.

General Mining Methods.

The greater number of the mica deposits being in the hands of small owners, their development is usually proceeded with, not only in the simplest manner, but also in the most economical; the chief purpose being to extract all the mica possible with the least expense. The owners neglect the fact that the methods employed may prove greatly detrimental to the eventual value of the property. Many of the owners have little knowledge of practical mining, and the successful development of a mica deposit calls, not only for such knowledge, but also for shrewd judgment.

The simplest, most obvious, and above all the cheapest method, is the open quarry, this naturally yielding the quickest returns and requiring little system. In some cases, where the mica occurs, not only in pockets, but also disseminated throughout the mass of the rock, this method is probably the most satisfactory. In many instances, however, the mica follows leads and pockets, and in such cases the system is exceedingly unpractical, since it often necessitates the removal of large masses of rock, occurring between the veins, and entails much extra and unnecessary labour. An outcrop of mica having been located, a pit is sunk at the spot, often without any preliminary trenching being undertaken to ascertain the nature of the deposit, its general direction, whether it is of the pocket and fissure, or the contact type, or if a more favourable position for sinking cannot be found. Such details are seldom of interest to the small operator, who puts down his pit in haphazard fashion and continues work as long as he sees paying quantities of mica, or until forced to quit by the infiltration of water into the pit.

Where an outcrop occurs on the side of a ridge, and the lead has a direction normal to the course of the latter, the open-cut method is usually adopted, the lead or pocket, as the case may be, being cut back into the hill. This system, if carried out with forethought, allows natural drainage; but often enough, the openings are made without regard to this and water difficulties again ensue, necessitating pumping or abandoning of the pit. A feature of pockety deposits is the natural drainage afforded, the water generally sinking away and causing little trouble. Such an occurrence is pleasing to miners, not only on the latter account, but also because it is regarded as a distinctly favourable indication of the existence of mica in depth. This is due to the fact that surface water dissolves the calcite filling of the pockets with the formation of natural drainage channels, these sometimes continuing to considerable depths. Frequently almost the entire calcite filling of surface pockets is found to have been thus dissolved, the cavities containing mud and surface soil, in which occur the mica crystals originally disseminated through the calcite.

In the case of definite leads of mica which crop out in a level country, on the summit of a hill, or that occur on the side of a ridge having a direction parallel with the course of the vein, open trenches are excavated. Sometimes several pits are sunk at intervals along the lead and these are then joined up by removing the rock between them. Again, sinking may proceed simultaneously from the surface along the lead, or a pit be opened to a depth of some 25 feet, from which the vein is followed in opposite directions. In some cases, stulls are inserted half way down, upon which lagging is erected, and work proceeds step-fashion, both above and below simultaneously. Such open trenches often attain a considerable length and are frequently carried to a depth of 80 to 100 feet. They are usually approximately vertical, but sometimes are excavated on a slight incline according to the dip of the vein. In the case of normal mica leads, the openings range from 8 to 15 feet in width, the average section of vein seldom exceeding the latter figure.

Not infrequently a number of parallel leads occur in close proximity to each other, and at one mine visited over a dozen such open trenches had been excavated on a strip of land less than 200 feet wide. In such an instance, underground mining by means of stopes with cross-courses between the lead would have many advantages over the open-work system.

When a deposit is of irregular form and has no enclosing walls, being composed of pockets of mica, sometimes joined by narrow fissures having no definite direction, pits are usually opened haphazard on surface shows, the mica bodies being followed by inclined or horizontal drifts along the most promising leads. This method often entails the removal of large quantities of barren rock and is necessarily costly, besides rendering such openings decidedly unsafe after a certain depth is reached. In fact, in some cases pits have to be abandoned on this account when a depth of some 35 to 50 feet has been attained. Openings of this type often possess a very irregular shape, twisting in various directions and "making in" under cappings of gneiss or barren pyroxenite. The pocket and fissure class of mica deposits is undoubtedly the most difficult kind to exploit successfully, after a certain depth has been reached, and it is unfortunately a fact that the greater number of mica occurrences are of this type. What is known as the contact class of deposits presents features more akin to those possessed by the well-defined leads. The main difference consists in the fact that they are generally of greater lateral extent than the leads, though this is by no means invariably the case. They would also seem to be characterized by the large bodies of calcite which they carry.

Such deposits possess well-defined walls and are usually exploited in a similar fashion to the leads, that is they are stoped out from the surface. All these open-work methods of development possess many disadvantages, chief among them being the removal of so much dead rock, while, in addition, no efficient mining can be carried on during the winter months. In spite of these drawbacks, the greater number of mines are operated open-work, even when operations have passed the exploratory stage. In some few instances, short adits have been driven into the sides of ridges showing outcrops of mica, but this plan is seldom adopted. In the few cases where underground mining has been pursued, the usual method is to sink a shaft, either vertically, or more often, on an incline, upon one wall of the deposit, if this is of the vein or contact type. This shaft is carried down some distance until what is considered a promising body of mica is encountered, and from this point, drifts are run along the line of the deposit, or in the case of an unusually wide vein, also in a lateral direction.

When the mica within sight has been extracted, another inclined or vertical shaft is put down from the point reached, and further drifts are carried along the deposit. This method gives the workings a step-like nature, and is the most practical manner of mining a deposit of this class, since it enables levels to be run through the mica zones, and winzes to be constructed if necessary. In a few cases, a vertical shaft has been put down on a rich mica body and levels run at various depths in both directions from the shaft. Very few of the pocket class of mica deposits have been exploited by means of underground working. The development of such occurrences is rendered exceedingly difficult and often impracticable by the irregular nature of the mica bodies. Where it has been attempted, the usual procedure is to put down an inclined shaft upon a body of mica, and to extract all the mineral in sight. The shaft is then continued and drifts are run in various directions in the hope of striking other deposits. This system is proceeded with until no more indications of mica are to be met with. This mode of working possesses the great disadvantage that it necessarily often leaves the mine in an exceedingly dangerous condition, and renders it incapable of redevelopment at a later date without a great expenditure of time and capital. From the foregoing, it will be perceived that the exploitation of pockety mica deposits is generally attended with considerable waste, and often results in their being abandoned as unprofitable after a depth of a few feet has been reached.

POWER AND HAND-DRILLING.

The peculiar nature of mica and the care which has to be exercised in its extraction do not permit of the rapid progress possible in other mining. Considerable attention has to be paid to the location of drill-holes, which are not placed solely with the intention of loosening as much rock as possible, but more especially with the object of doing the least damage to the crystals. To this end, comparatively few holes are made in the face, and these are, as a rule, shallow and lightly loaded, except where dead rock is being removed. In the larger mines, which are equipped with machinery, steam or air-drills are employed, but the percentage of such mines is relatively small. Hand drilling is the general rule, and the rock enclosing the mica is only loosened, being subsequently taken down with picks. This careful system leads to only slow progress being made, but is essential if the mica crystals are to be won in good condition. Hand-drilling is best performed in the double-handed manner, with two strikers and one turner to each drill. This method is adopted in all the larger mines, single-handed drilling being only employed in the smaller pits. Employing 1″ drills and six to seven pound hammers, three men should average, in hard pyroxene, about 15 feet a day of ten hours, at a cost of from 30 to 35 cents per foot. The depth of the holes seldom exceeds 4 feet. Where machine drilling by means of steam is employed, one drill should average 45 to 60 feet per day; with compressed air, the average is slightly higher. The cost per foot, which is somewhat dependent on the price of fuel in the district, ranges from 17 to 25 cents, exclusive of the wear and tear of machinery. In the majority of the smaller mines employing machine-drilling, steam is used. This is due to the fact that many operators find it necessary, in any case, to install small boilers to operate pumps in their pits, and so employ steam for drilling, without going to the expense of erecting a compressor.

The majority of the machine-drills used in the mines visited were of the Ingersoll-Rand type.

BLASTING.

Dynamite containing 35 to 40 per cent nitro-glycerine is the most commonly used explosive, and costs from 16 to 18 cents a pound. In a few of the mines, patent blasting powders are employed, but these are exceptions.

Firing is performed both by fuse and battery, both methods often being employed on the same mine, according to which system offers the greatest advantages in individual instances. Where it is required to move dead rock, battery firing is generally used, the purpose being to shatter the rock as much as possible, whereas when lightl; loaded holes have to be exploded in the vicinity of valuable mineral, fuse firing is the usually adopted method, since it permits of the different charges being exploded in succession. This tends to prevent fracturing and damage of the mica crystals—a very important consideration.

The cost of blasting with dynamite in hard pyroxenite and in large drifts is given as approximately from 5 to 7 cents per ton of rock broken. In open quarry work, the cost is less and should not exceed 4 cents per ton. Pyroxenite, although normally a relatively soft rock, being coarsely-crystalline and easily fractured, is yet subject to considerable variations of composition and character, and is, in some cases, exceedingly hard. This is especially the case where the dykes contain acid zones or "boulde ." These zones are often composed mainly of quartz and feldspar in varying proportions, while in some instances, quartz is so prevalent through the mass of the rock, as to render hand-drilling exceedingly slow work. These acid zones seldom carry mica and are only removed when absolutely necessary. On the other hand, the mica not infrequently occurs associated with considerable bodies of phosphate and progress is then materially accelerated.

REMOVAL OF DEBRIS.

The next operation, after blasting, is the removal of the broken rock from the pit to the dump, and simultaneously, the collection of the mica sheets and crystals.

In the case of an open quarry, whose floor is on a level with the surface of the dump, the debris is generally loaded on small dumping cars. These either run on a tramway, or, more usually, in the smaller mines, are of the nature of an ordinary wheelbarrow. They are filled with rock or mineral and are run to the dumps or cobbing-shed. In some mines, hand-barrows are used to collect the mica. These are nothing more than an ordinary box, to which are fastened two pieces of wood to form handles, after the manner of a stretcher. These carriers, of course, require two men to move them and are only employed where it is neither practicable to erect a derrick nor possible to build a tramway. Loose rock is generally brought down by means of hammers and wedges, and sometimes with picks. Ordinary shovels or forks are used to remove the smaller debris, and the mica is collected by hand as the work proceeds.

HOISTING APPLIANCES.

In the more usual cases, where shallow or deep pits have been sunk vertically upon a mica deposit, some means of hoisting the rock have to be adopted. These include hand-winches, boom-derricks operated by horse-whim or more often direct traction, steam-hoists operating boom-derricks, and cable-hoists. Only one instance of the latter type was seen, this being in use on a large open pit in the Quebec area. The most general method employed is the boom-derrick, worked either by horse-power or steam hoist, the former being the more usual. A boom-derrick possesses the merit of being simply and cheaply erected and can be readily moved from one spot to another. The smaller and cheaper types are usually constructed from rough lumber felled near the mine, while the larger and more elaborate derricks are composed of selected, heavy squared timber. The working radius of a boom-derrick seldom exceeds 50 feet and its operations are necessarily circumscribed by the supports of the mast. The buckets used in connexion with the derricks are usually of wood, being often formed from oil casks, and have a capacity of about half a ton. Wire cable having a diameter of from ½″ to 1″, is employed for hoisting. The whims used consist of wooden drums, 5 to 8 feet in diameter, and worked by horse-power. More often, direct traction is employed, the horse pulling in a straight line away from the pit. In the deeper pits, steam-hoists are used to operate the derricks, which are sometimes of a large and massive type. In a few of the larger mines direct haulage from a pulley-frame takes the place of derricks, the hoist raising small cars or buckets which run on an inclined skipway. Small rollers are inserted on the hanging-wall where necessary to carry the hoisting rope

Cable hoists are only employed on large mines where a great deal of material has to be handled. This type of hoist consists primarily of a cable stretched on an incline across the pit. The upper end of the rope is fastened to the summit of a solidly constructed mast, which consists of a tapering framework of either wood or steel. The lower end is fastened to stanchions, let into the rock on the opposite side of the opening. Along the cable runs a carrier controlled by a rope, which enables hoisting to be performed from any point vertically, or almost vertically, below the cable. These cables can be stretched several hundred feet and have a diameter of from 1½" to 2½", being made from cast steel. The hoist-ropes measure ½" to ¾" in diameter and are similar to those employed on boom derricks. The simplest form of such an inclined cableway is shown in Fig. 1. The carrier (d) runs on a cable (a) and has its lowest position determined by means of the stop-block

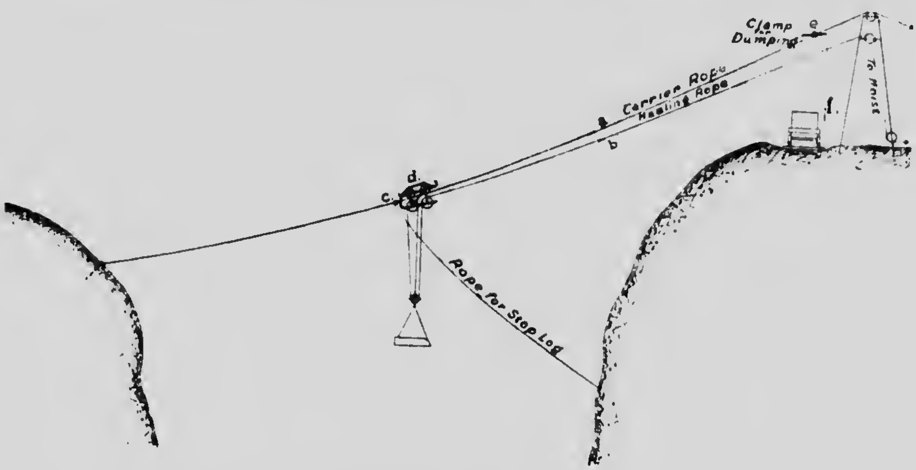


FIG. 1.—Inclined cable hoist.

(c), which is controlled by a separate rope (k). The hauling-rope (b) serves in some cases also to move the carrier up or down the cable, while in others, a separate rope is provided for this purpose. In order to provide sufficient resistance to cause the load to be lifted before the carrier commences to travel along the cable, it is necessary that the latter be sufficiently inclined, the loaded carriage then proceeding to a stop (e), situated above the dumping point. To ensure satisfactory working, the incline should not be less than 30°. On checking the carrier at any point on its journey along the cable, the load may be lowered and dumped, after which the carrier is released down the incline to the stop (c). It is generally necessary to provide a catch or link (e) pivoted to a wooden clamp on the cable above the dumping point. This link is raised by a cord (f), and dropped over the hook at the upper end of the carrier before dumping, being subsequently raised to allow its return down the cable.

When a third rope is provided for the raising and lowering of the carrier along the cable, the stops (c) and (e) may be dispensed with. This third rope, or fall-rope as it is called, is then wound in at the same speed as the hoist-rope, after the load has been lifted. Fig. 2 shows the ordinary type of carrier employed with cable-hoists.

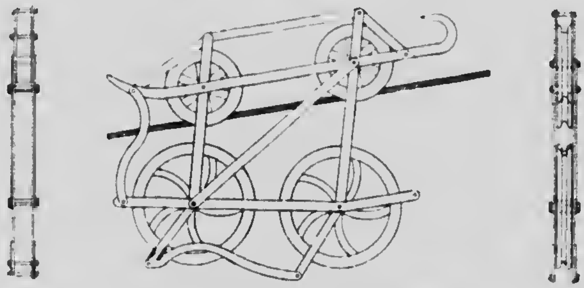


Fig. 2.—Carrier for cable hoisting.

Fig. 3.—Hoist tray.

In place of iron or wooden buckets, shallow iron or wooden trays are sometimes used for hoisting. These measure some 3′-0″ × 2′-6″, and are 1 foot high, having one end open, and the two sides rounded off so as to form a sort of scoop. Such trays are suspended on three chains, the two side supports being fixed, while the third, or front chain, can be unhitched for dumping purposes. Fig. 3 shows such a hoist tray.

The steam-hoists employed are of both one and two cylinder type, and are nearly always small, since no great depths are reached in the workings and it is seldom required to raise any great quantity of material. From the hoist buckets, the waste material is emptied into the dump cars, or in the case of boom-derricks, is swung directly on to the dumps.

The few mines which use tramways employ light, steel rails, running about 19 pounds to the yard, in their construction. The cobbing sheds are usually situated close to the pits and the mica is either tracked to them, or, more often, carried by hand, in boxes, etc.

COST OF MINING.

It is practically impossible to generalize upon this subject, as, owing to the variation in the character of deposits met with in mines even of the same locality, costs must necessarily show wide margins of difference. In one mine, expenses may be double those of its neighbour. Mr. Cirkel, however, quotes the following average expenditure upon a mine, which, at the time of writing in 1904, had been a steady producer for some years. The scale of wages remains much the same at the present time as then, and the figures quoted may be taken as a fair indication of the cost of mining an average mica deposit. As remarked above, however, numerous factors combine to render the expenditure upon a property subject to considerable fluctuations; in a wet mine, for instance, costs may be materially increased by pumping.

Apropos of the mine in question, which was apparently situated within the main mica area, that is, in an easily accessible part of the country, Mr. Cirkel observes:—

"This deposit constituted a vein-like accumulation of mica crystals, which, at times, were of such inferior quality as to render a very large percentage useless for the trade. However, the vein also produced very fine crystals, sometimes in large quantity, so that, taking it all round, the mine may be considered as working with fair success. The depth was from 150 to 190 feet and the deposit was opened up by large drifts, stoping and drifting being generally performed simultaneously. Drilling and hoisting were done by machinery. Two shifts were running; drilling was going on in both shifts, while hoisting was done only during the day shift. The average expenditure at this time per day for twelve consecutive months was as follows:—

2 Steam drillers	$ 3.50
2 Helpers	3.00
4 Muckers	5.20
2 Machinists	3.50
2 Drill boys	1.20
2 Bucket men	2.50
1 Blacksmith and helper	3.00
1 Man and horse	1.75
1 Foreman	2.50
Dynamite and blasting material	4.00
Fuel	5.50
Other material and supplies	2.00
Total expenses per diem	$37.65

"An average of sixty tons of rock was hoisted daily, while the output of thumb trimmed mica was 600 pounds, cutting from 1"×3" up. The daily wages paid for cobbing averaged $10, so that the total daily expenditure at the mine was $47.65, or $158.83 per ton, to which must be added general business expenses such as management, insurance, office, etc., amounting in the present case to approximately $150 per month, or, calculated on a monthly production of seven and a half tons, $20 per ton.

"One ton of thumb-trimmed mica of sizes from 1" to 7" upwards, was, therefore, produced at an average cost of less than $179. This sum, however, does not include prospecting and exploring work, which in nearly all cases is carried on simultaneously with the deep mining."

FACTORS REGULATING THE EXPLOITATION OF DEPOSITS.

The value of a mica deposit is thus dependent on several factors which must be taken into consideration when estimates are to be formed regarding the practicability of its successful exploitation. In some cases, large amounts of high-grade phosphate can be won simultaneously with the mica, and this naturally increases the value of the mine. At some mines, indeed, which produce only a low grade of mica, the phosphate won enables the mine to be kept working, and these should more properly be termed phosphate mines. As a rule, operators confine themselves to the production of either mica or phosphate, the less abundant mineral being saved as a by-product. In a few cases, however, equal attention is paid to both minerals, and when bodies of phosphate carrying little or no mica are encountered, these are followed and extracted. As already observed, the main factor determining the value of a mica occurrence is not so much the quantity of the mineral present, as its quality or grade. Many deposits have been abandoned owing to the crushed nature of the mica encountered. The value of mica sheets was formerly, and is yet to a large extent, proportional to their size. This is true both of amber mica and white mica, or muscovite, though in the case of the latter, when the mineral is to find employment in stoves, etc., size is an essential consideration. Inclusions of foreign mineral substance, imparting to the sheets a mottled and spotted appearance, often detract greatly from the market value of muscovite. In the case of phlogopite, or amber mica, the advent of mica-plate has rendered possible the utilization of large quantities of small and formerly discarded material. Mines which produce a large percentage of small crystals can to-day be profitably worked, whereas, in the early days of the industry, such deposits were often abandoned as worthless. This new use for the smaller grades of mica has resulted in the recovery from the dumps, both of old mica and phosphate mines, of large quantities of valuable mineral, and few such dumps now exist which have not been worked over at some time or another for the mica they contained. Some operators, indeed, have found it more profitable to secure and exploit old mine dumps, than to venture upon the development of new deposits. The value of "amber" mica depends somewhat upon its colour, this varying from almost black when the mineral approaches a biotite in composition, to light yellow. Both extremes are regarded with disfavour by the trade, preference being expressed for the medium coloured varieties, or what is known as "silver-amber" mica, this species commanding the highest prices. In spite of the advent of mica plate, in the building up of which mica of the smallest size can be employed, large sized sheets still remain the most valuable. Mica is sized or graded in sheets of the following dimensions:—

1" × 1"	2" × 4"
1" × 2"	3" × 5"
1" × 3"	4" × 6"
2" × 3"	5" × 8" and over.

Grading according to colour is also practised, and shipments of a uniform shade of mica are always more easily disposed of than mixed parcels, containing both dark and light varieties. Some mines produce two or more qualities of mica, and it is not infrequently found that the crystals from two pits, distant only a few feet from one another, vary widely in their colour and splitting qualities.

It is difficult to draw any average of the percentages of the different grades of mica produced by a mine, necessary to render it a paying proposition. Some deposits produce almost entirely small sheets, and others, an exceptional percentage of large; but the proportion is usually so variable as to render any attempt at tabulation of little value.

It may, however, be broadly stated that, taking an average of the various mines throughout the country, the main percentage yielded by the run of mines is of a 1" × 3" grade. Now that a demand for the 1" × 1" size has sprung up, this grade forms an important portion of the production of many mines, and it may be roughly estimated that of the total output of the generality of mines about 50 per cent is of 1" × 1" grade, 25 per cent of 1" × 2" and 3-5 per cent of 4" × 6" and over. The dimensions of the grades of mica given above refer to the cleaned and thumb-trimmed material, which is usually split into plates up to $\frac{1}{8}$" in thickness. The size of the crystals as taken from the mine often gives but a rough idea of the ultimate size of the cleaned and trimmed sheets. Some crystals yield clear cuts almost to their edges, and are but little troubled with inclusions, which impair their splitting quality. Others, on the contrary, may be of large size in the rough, but prove upon cleaning to yield only the smaller grades of mica.

A clean-splitting mica is naturally a source of considerable saving in wages, as far less time is required by the cullers to split and trim the sheets.

Apart from the quality and grade of the mica produced by a mine, the quantity of mineral present in the rock is naturally an important consideration governing successful working. Here, again, the percentage necessary to render the mine a profitable undertaking, is subject to the individual and local features of the deposit in question. Open quarries can be operated at considerably less expense than deep pits; but in both cases, the extraction of the mica involves the removal of relatively large quantities of rock. Obviously, also, in the case of a mine producing small-sized and low-priced mica, the quantity will have to be considerably in excess of that required in a mine yielding a high percentage of large sheets. Seeing that a grade of 1" × 2" only realizes about half the price obtained by 1" × 3" sheets, the quantity required in the former case would have to be double that of the latter, irrespective of the extra cost entailed in cleaning and trimming the larger quantity.

Generally speaking, in the case of a mine of the usual class, where no exceptional difficulties are encountered and no great depth is reached in the workings, an average production of 25 pounds of trimmed mica of a 1" × 2" grade per diem for each man employed in the mine, should enable operations to be profitably conducted. In the case of deep or exceptionally wet mines, the production is required to be rather higher.

The current market values of the various sizes of amber mica are as follows: the lower prices quoted representing the figures paid for the darker and inferior qualities, and the higher prices those obtained by the better-class sheets, or what is known as "silver-amber" mica :

1" × 1"	3½–5 cents per lb.	3" × 5"	75–85 cents per lb.
1" × 2"	7–10 " " "	4" × 6"	$1.00–$1.25
1" × 3"	11–20 " " "	5" × 8"	$1.50–$1.75
2" × 3"	40–45 " " "	over 5" × 8"	$2.00
2" × 4"	60–65 " " "		

Although generally regarded as not so suited to the uses to which phlogopite mica is put, muscovite yet possesses a market value little lower than that of amber mica. The quality of the sheets is more liable to be impaired by iron stains than is usual with phlogopite, but the higher grades of white mica, that is, the clear and colourless sheets, have, at the present time, a value approximately equal to that quoted above for the lower grades of amber mica.

The mining of muscovite deposits producing 1" × 3" sheets and under as their staple output is practically out of the question in Canada, owing to the high scale of wages, though such sizes can be profitably mined in India, and other Eastern countries where labour is cheap. The best qualities of muscovite may obtain still higher prices for use in the stove and similar industries, the values quoted representing the price paid by manufacturers of mica board, etc.

CHAPTER II.

STATUS OF THE MICA INDUSTRY.

The World's Supply and Production of Mica.

At the present time India, the United States, and Canada constitute the three principal mica-producing countries of the world, the two former supplying the muscovite, and the latter the phlogopite or amber-mica. The figures relating to the annual output of these countries, as well as to that of the various other producers, are usually available in values and not in tonnage. As the difference in value of muscovite and phlogopite per unit is considerable, and as, further, wide variations of value exist between the different grades and qualities of amber mica, the figures given in the various tables cannot be used to obtain correct estimates of the tonnage raised in the individual countries. As also, in the case of Canada, at least, no assistance is afforded by legislature to compel true and accurate returns of production from operators, shippers, etc., the figures supplied are necessarily open to criticism, and in many cases are only approximately correct. Thus, it may be remarked that the total annual exports are frequently considerably in excess of the total annual production. This, though in some measure due to the fact that a large percentage of the exported material has been manufactured into articles of commerce, mica-board, etc., is also caused by the fact that producers frequently accumulate large stocks of mica, which they hold for considerable periods. Returns of this mica may be either furnished in the year it is mined, or again in the year in which it is shipped from the mine, a considerable period sometimes elapsing between the two dates. In the meantime, the mine is closed down. It can be readily perceived that in the case of large stocks of mica, production returns of which are furnished during a period of mining activity and export returns at a time when the mines are to a large extent idle, apparent anomalies may easily appear.

A further source of confusion lies in the fact already mentioned, that all returns of mica production and export, no matter what the grade and respective value of the mineral, are lumped together under the comprehensive heading of "mica." Thus, the figures relating to the production of one mine may refer to cleaned and trimmed mica, while another producer may ship the mineral in a rough-cobbed state, any estimate of the value of the latter being naturally only nominal. Until some means are devised of obtaining fuller and more specific returns from both producers and shippers, of tonnage and value of the mica handled, the figures furnished can be regarded only as a partial index of the actual status of the mica industry.

Re-exportation may still further serve to create confusion. Thus, in the case of Canada, considerable quantities of mica are exported to the United States for re-shipment to Great Britain, and these exports not infrequently figure twice over in the returns of the countries concerned. The statistics also of the various official returns are seldom found to agree in detail when compared. For instance, the figures obtained from the Report of Trade and Navigation of the exports of Canadian mica to Great Britain for the year 1909 are found to be $21,316; while in the British Board of Trade returns, the imports of Canadian mica into Great Britain, for the same period, are given as $30,749, a discrepancy of $6,433. This may, however, be due to the fact that in the one case the figures relate to the fiscal year, and in the other to the calendar year. For the purposes of this report, the figures quoted are, as far as possible, compiled from statements issued by the producing country.

Up to the present time the output of the Canadian and American mines, coupled with a considerable amount of imported Indian mica, has been amply sufficient to supply the needs of the consumers in Canada and the United States, and at the present time large stocks of mica are held at various points by the different operators of mines.

English and Continental consumers are mostly supplied by the Indian mines, comparatively little amber mica being imported from across the Atlantic. The large number of mines at present idle in both Canada and the United States as the result of an over-supply of mica during the past few years, must lead to the disposal in the near future of the accumulated stocks, unless the owners of the same determine to hold for a price higher than that obtainable by imported Indian mica. The latter, being cheaper than the amber variety, and equally suitable for the manufacture of micanite, it seems probable that the product of the Indian mines is likely to gradually invade the Canadian and American markets, to the serious detriment of the amber-mining industry in the former country. The problem is a serious one, and whether the Canadian mineral can hope to compete with that produced in India and in other countries where cheap labour and natural conditions combine to reduce materially the cost of the marketable product is a point open to considerable doubt. If the Indian source of supply proves to be capable of supplying the world's markets, and if an organized attempt be made to establish an export trade to Canada and the United States, it seems probable that the Canadian amber-mica mining industry is fated to go the same way as the phosphate industry, which was practically destroyed by the competition of the Southern States some twenty years ago.

LONDON MARKET.

According to information furnished to the "Mineral Industry," the mica market in 1910 was fairly active. The year closed with limited stocks of block mica. Supplies were drawn almost entirely from the presidencies of

Calcutta and Madras, although Africa, Canada, South America, and Japan each contributed shipments of varying importance.

Shipments of block from Calcutta were somewhat limited and prices remained at a steady level. Owing to local complications, several important sources of supply at Madras were closed, resulting in a scarcity with considerably increased rates for all medium and large sizes.

Demand for splittings, especially the well-prepared grades, was satisfactory, and prices improved all round. Stocks in London at the close of the year were very low.

A few fresh supplies of African and Japanese amber mica constituted the chief feature for 1910: the former realized fairly satisfactory prices, but the quality of the latter was poor.

TABLE I.

[1] Value of Mica Raised in the Three Principal Producing Countries During the Seventeen Years 1894 to 1910.

Year.	Canada. £	Canada. $	Canada. Per cent	India. £	India. $	India. Per cent	United States. £	United States. $	United States. Per cent	Total £	Total $
1894	9,359	45,581	14·94	42,516	207,052	67·88	10,757	52,388	17·18	62,632	305,021
1895	13,347	65,000	13·86	71,481	348,112	74·23	11,464	55,831	11·91	96,292	468,943
1896	12,320	60,000	11·96	76,891	374,459	74·65	13,796	67,191	13·39	103,007	501,650
1897	15,605	76,000	14·67	71,238	346,929	66·95	19,553	95,226	18·38	106,396	518,155
1898	24,306	118,375	23·12	53,890	262,444	51·27	26,919	131,098	25·61	105,115	511,917
Total	74,937	364,956	....	316,016	1,538,996	....	82,489	401,734	....	473,442	2,305,686
Average	14,987	72,991	15·82	63,203	307,798	66·75	16,497	80,346	17·43	94,688	461,137
1899	33,470	163,000	25·39	73,372	357,321	55·68	24,941	121,465	18·93	131,783	641,786
1900	34,086	166,000	19·59	109,554	533,527	62·95	30,381	147,960	17·46	174,021	847,487
1901	32,854	160,000	25·82	70,034	341,065	55·04	24,348	118,578	19·14	127,236	619,643
1902	27,906	135,904	19·95	87,594	426,582	62·61	24,404	118,849	17·44	139,904	681,335
1903	36,520	177,857	23·99	86,297	420,266	56·70	29,389	143,128	19·31	152,206	741,251
Total	164,836	802,761	....	426,851	2,078,761	....	133,463	649,980	....	725,150	3,[illegible],502
Average	32,967	160,552	22·73	85,370	415,751	58·86	26,692	129,996	18·41	145,030	706,300
1904	33,013	160,777	21·21	97,932	476,928	62·92	24,705	120,316	15·87	155,650	758,021
1905	36,598	178,235	15·71	159,627	777,383	68·54	36,671	178,588	15·75	232,896	1,134,206
1906	62,405	303,913	16·69	254,999	1,241,845	68·21	56,466	274,990	15·10	373,870	1,820,748
1907	64,188	312,599	17·22	228,161	1,111,144	61·19	80,515	392,111	21·59	372,864	1,815,854
1908	28,720	139,871	13·64	126,834	617,681	60·23	55,015	267,925	26·13	210,569	1,025,477
Total	224,924	1,095,395	....	867,553	4,224,981	....	253,372	1,233,930	....	1,315,849	6,551,306
Average	44,984	219,879	16·71	173,511	844,998	64·46	50,674	216,786	18·83	269,169	1,310,861
1909	30,345	147,782	25·33	38,157	185,825	31·85	51,296	249,812	42·82	119,798	583,419
1910	29,447	143,409	19·23	54,427	265,059	35·55	69,219	337,097	45·22	153,093	745,565

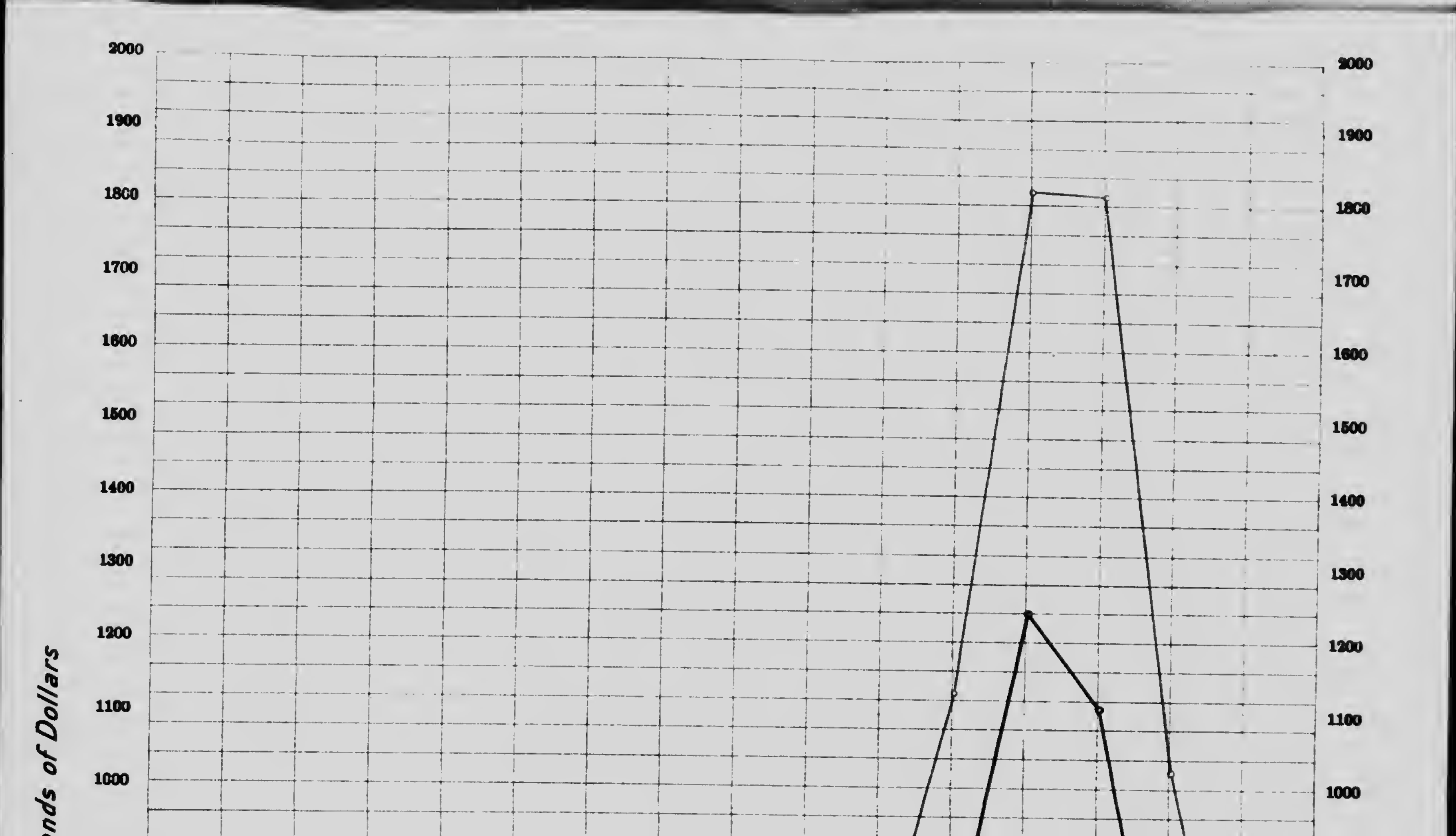
[1] Values calculated on the basis of £1=$4.87.

TABLE II.

World's Production of Mica for the Period 1894-1908.

(Summary of Table I.)

	Canada.		India.		United States.		Total.	
	£	$	£	$	£	$	£	$
1894-8........	74,937	364,956	316,016	1,538,996	82,489	401,734	473,442	2,305,686
1899-1903.....	164,836	802,761	426,851	2,078,761	133,463	649,980	725,150	3,531,502
1904-8........	224,924	1,095,395	867,553	4,224,981	253,372	1,233,930	1,345,849	6,554,396
Total........	464,697	2,263,112	1,610,420	7,842,738	469,324	2,285,614	2,544,441	12,391 194
Per cent of total..	18·26		63·29		18·45		100·00	



2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
nds of Dollars

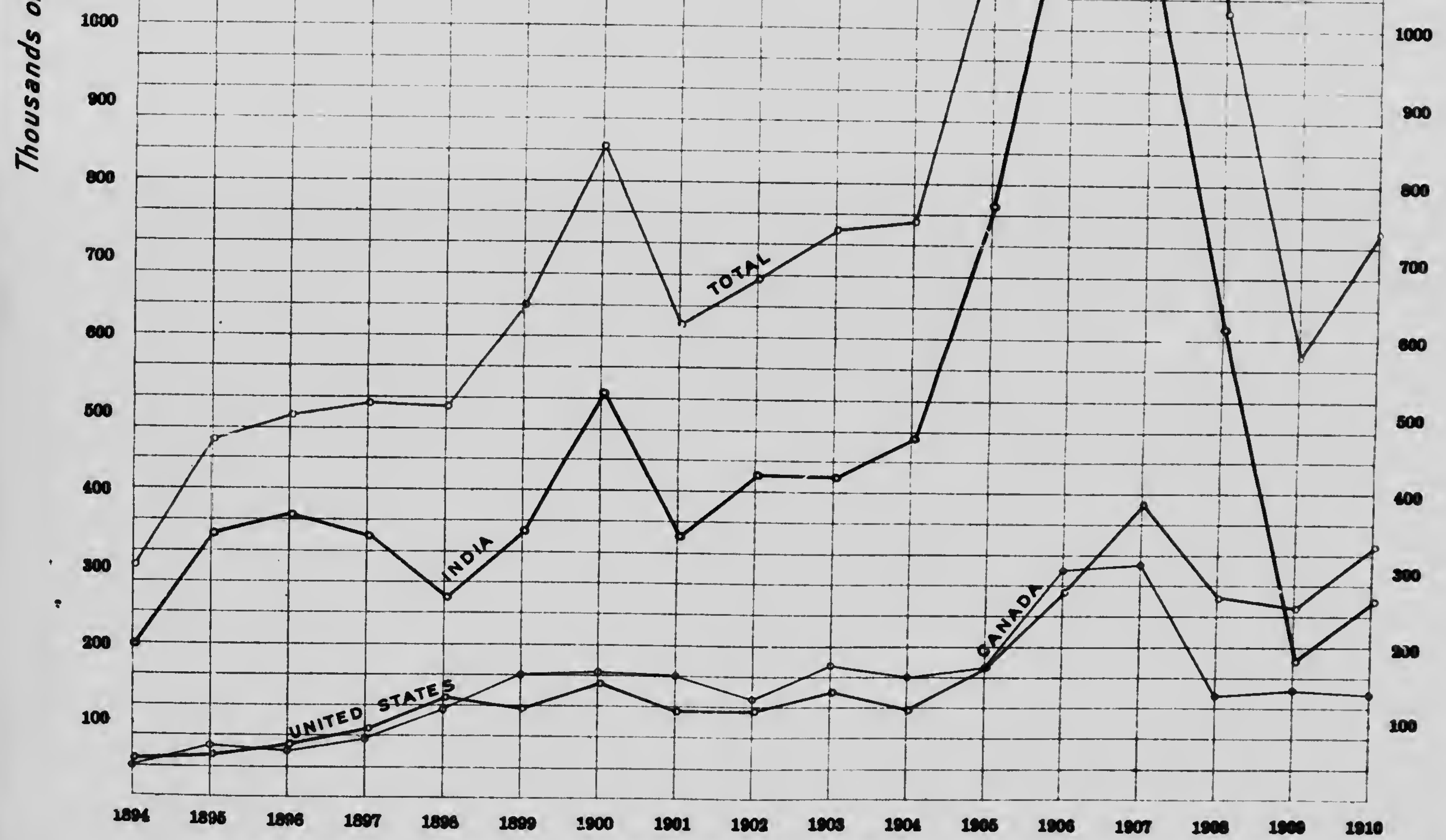


Fig. 4—DIAGRAM SHOWING THE ANNUAL PRODUCTION OF THE PRINCIPAL MICA-PRODUCING COUNTRIES FOR THE PERIOD 1894-1910

[illegible]

CANADA.

A glance at the diagram on page 22 will show that the values of the annual mica production of Canada and the United States during the past fifteen years have more or less kept pace with one another. The amount of mica raised in Canada has, in almost every case, been very considerably less than that raised across the border, but its value has for the greater part of the period in question exceeded that of the American mica. The latter consists almost entirely of muscovite or white mica, while the Canadian production is almost altogether amber mica. The world, indeed, has, until comparatively recently, depended entirely for its supply of amber mica upon the Canadian deposits, which were the only commercially valuable occurrences of the mineral known to exist. Increasing amounts of amber mica are, however, at the present time being derived from Ceylon, South Africa, and South America. The peculiar and uncertain nature of the phlogopite deposits renders it difficult to hazard an opinion upon the reserves of the mineral existing in the country at the present time. Few deposits have been exploited to a depth of over 200 feet, but in cases where this or a greater depth has been reached, indications of a continuance of the mica in depth have usually been found favourable.

In the deeper phosphate mines, such as the High Rock, North Star, Emerald, and other mines in the townships of Buckingham and Portland, in the Province of Quebec, large quantities of phosphate associated with mica are said to have been still in sight when the mines were closed down owing to the low price obtainable for the former mineral. In certain mica mines, work has been abandoned, owing to a narrowing of the deposits in depth, but as this is a feature just as frequently met with within a short distance of the surface, it cannot be said to prove a general tendency of the phosphate and mica to disappear in depth. It is characteristic of the occurrences, that pockety accumulations of both associated minerals peter out without warning, and just as suddenly reappear after many feet of barren rock have been passed through. Owing to this uncertainty always attendant upon the mining of mica, it can in no case be said to have been proved that the mineral is non-existent at greater depths. So many deposits have been exploited in a small way, then abandoned, and subsequently profitably re-developed, that it would be not only difficult, but even rash to assert, in any particular instance, that the deposit in question was exhausted. The demand for the mineral has always been subject to considerable fluctuations and it is this factor which has frequently proved the cause of the closing down of deposits of considerable value. The potential market value of mica plays an important role in this closing down and re-opening of the deposits. Owners, having an eye to ultimate, higher prices, frequently close down their mines for considerable periods, preferring to wait for more favourable market conditions before extracting their reserves, although mining might be carried on at a fair profit at current prices. Others continue operations, but store the mica produced, often for long periods, preferring to lose the interest on their outlay for mining, than to sell at a price which they consider lower than that which they may eventually obtain.

Such tactics tend to confuse and obscure the real status of the industry, especially as mine owners are seldom disposed to disclose their true reasons for closing down. Even the larger producers often conduct operations in a desultory manner, working and closing down their mines at intervals, according to the amount of mineral they have on hand. The extent of the distribution of the mica-bearing rocks throughout almost the entire region comprised between the Gatineau and Lièvre rivers in the Province of Quebec, and also in the Perth-Sydenham area in the Province of Ontario, is such as to well justify one in assuming the existence of as valuable, unexploited bodies of the mineral in these districts, as have already been disclosed in the mines. It is highly probable that many of the small pockets of mica, which have been worked by means of surface pits to a depth of a few feet and then abandoned, are portions of far larger deposits existing at inconsiderable depths, but separated from the surface pockets by bodies of barren rock. Many such pits are situated upon deposits which may always prove too low-grade to prove profitable, but it is equally probable that many of the surface pockets, which have been worked, are only the outcrops of large, deeper-seated deposits. Thus, the conclusion reached from an examination of practically the whole of the amber mica deposits, which have up to the present been exploited, is that Canada still contains very large reserves of the mineral, and that only a systematic development of the deposits by large operators is necessary to prove their extent and value.

In 1899, samples of amber mica from the Wallingford, Lake Girard, Vavasour, and Blackburn mines, all situated in the Quebec central mica region, were submitted for examination to Professor Dunstan, of the Imperial Institute, London, and were very favourab[illegible]mented on by him.[1]

The opinions of the English dealers and brokers, which were obtained at the same time regarding the prospects of an English market for Canadian mica, were that the mica would meet with a ready sale provided that shipments were kept up to the standard of the samples submitted, which were sheets of large size. The size of mica plates would seem to be an important consideration with English buyers, probably because consumers in England prefer to use the plates in their natural condition and not to build up small pieces into micanite, or mica board.

Production and Exports.

Subjoined are tables showing the production and exports of Canadian mica since the inception of the industry.

[1] See Ann. Rep. Geol. Surv., Can., XIII, 1900, pp. 8-10 A.

TABLE III.

Annual Production of Mica in Canada During the Period 1886 to 1910.

Year.	Value.	Year.	Value.	Year.	Value
	$		$		$
1886	29,008	1895	65,000	1904	160,777
1887	29,816	1896	60,000	1905	178,235
1888	30,207	1897	76,000	1906	303,913
1889	28,718	1898	118,375	1907	312,590
1890	68,074	1899	163,000	1908	139,871
1891	71,510	1900	166,000	1909	117,782
1892	104,745	1901	160,000	1910	113,109
1893	75,719	1902	135,904		
1894	45,581	1903	177,857		

The following table gives the exports of Canadian mica since 1887.

TABLE IV.

Exports of Canadian Mica During the Period 1887 to 1910.

Year.	Value.	Year.	Value.	Year.	Value.
	$		$		$
1887	3,480	1895	48,525	1903	196,020
1888	23,563	1896	47,756	1904	198,482
1889	30,597	1897	69,191	1905	179,049
1890	22,468	1898	110,507	1906	581,919
1891	37,590	1899	153,002	1907	422,172
1892	86,562	1900	146,750	1908	198,839
1893	70,081	1901	152,553	1909	256,834
1894	38,971	1902	391,812	1910	330,903

The apparent discrepancies exhibited by the figures in the above tables are caused by the fact that the mica exported is mainly composed of trimmed and high-grade mineral, and is, in part, also already manufactured into plate, etc.

The United States consumes the largest share of the mica exported, the bulk being shipped to the Westinghouse and General Electric Companies of Pittsburgh and Schenectady. A portion of the exports to the United States is, however, re-shipped to European consumers. Next in order comes Great Britain, and the remainder is taken mainly by Germany, France, and Belgium.

Table V shows the exports of Canadian mica by countries since 1906. The figures are compiled from the monthly statements of Trade and Navigation.

TABLE V.

Distribution of Canadian Mica Exported During the Quinquennial Period 1906 to 1910.

Year.	Great Britain. Quantity.		Value.		Val. per cwt.	United States. Quantity.		Value		Val per cwt	Other Countries. Quantity.		Value.		Val per cwt	Total. Quantity.	Value.
	cwt.	% of Total.	$	% of Total.	$	cwt.	% of Total.	$	% of Total.	$	cwt.	% of Total.	$	% of Total.	$	cwt.	$
1906.....	2,988	18·3	58,735	10·1	19	13,127	80·6	519,479	89·3	39	173	1·1	3,705	0·6	21	16,288	581,919
1907.....	1,432	14·4	43,913	10·4	31	8,358	83·8	372,798	88·3	44	183	1·8	5,461	1·3	30	9,973	422,172
1908.....	2,773	53·5	81,050	40·8	29	2,360	45·6	115,005	57·8	48	47	0·9	2,781	1·4	59	5,180	198,839
1909.....	549	8·6	24,319	9·5	44	5,795	90·5	229,689	89·4	39	58	0·9	2,829	1·1	49	6,402	256,834
1910.....	1,546	18·5	37,787	11·4	24	6,746	80·6	291,533	88·1	43	76	0·9	1,583	0·5	21	8,368	330,903

Although in the past, Canadian producers have, for the most part, been content to dispose of their mica to United States consumers, shipments are now also being made to the English market.

While appreciating the unquestioned superiority of Canadian amber mica for electrical purposes, English and Continental manufacturers nevertheless still procure the greater part of the mica which they require from India.

The Indian mica is, of course, considerably cheaper than the Canadian, but the true reason for the preference would seem to lie more with the shippers and the grade of mineral which they furnish, than with the price.

Indian mica is, as a rule, of standard quality, that is, it is not so apt to vary in colour, elasticity, brittleness, etc., as the amber variety. The latter possesses all the above attributes in greatly varying degree, its price varying accordingly.

Canadian shippers, being bound by no compulsory system of classification or grading, other than may be agreed upon between themselves and the buyers, may, in one instance, forward a consignment of more or less roughly trimmed mica of comparatively low unit value, while to another purchaser only high-grade sheets are sent. The difference in value of equal weight shipments would accordingly be very great, though both consignments would be similarly classed in Trade Returns as 'mica,' without distinction as to quality.

INDIA.

The muscovite or white mica deposits of India constitute, at the present day, the chief source of the world's supply of mica. Though not so suited to the uses to which the Canadian, or amber, mica is applied, the product of the Indian mines is, nevertheless, largely used, mixed in varying proportions with amber mica, in the manufacture of electrical appliances, while a large percentage is consumed in the stove or similar industries. A glance at the diagram showing the value of production of the three chief producing countries (see Fig. 4) will show that in no year during the period 1894–1908 did the value of output of the Indian mines fall below the combined values of output of Canada and the United States.

In 1909 the value of the production of the Indian mines decreased enormously, and fell to $185,825, the lowest figure reached since 1894. In the same year the United States output amounted to $249,812, so that the production of this country exceeded for the first time that of India, the lead being more than maintained in 1910.

The enormous decline of production of all three countries between 1907 and 1909 is remarkable, the total value of output in 1909 being only one-third that in 1907.

India is thus to-day no longer in the position of foremost mica producer of the world. Owing, however, both to her large reserves of the mineral and to the present unorganized condition of the Canadian mica industry, she is likely to soon regain her old position. Indeed, if, as seems probable, the further development of the Indian deposits is undertaken by companies, instead of remaining in the hands of small native operators, India is likely to considerably increase her output in the near future. With the advent of Rajputana to the list of producing states, a considerable extension of the hitherto producing area has been brought about. The production of this Province has risen from 804 hundredweights in 1904 to 6,234 hundredweights in 1908, a far greater increase than can be shown by either of the other producing Provinces of Bengal and Madras (see Table VI). By far the greater portion of the Indian output is exported to Great Britain, next coming the United States, and then Germany.

India[1], then, no longer ranks at the present day as the foremost mica producer of the world. During the quinquennial period, 1904 to 1908, the average proportion of Indian to the total mica production was 64·5 per cent. During this period the Indian mica industry expanded enormously, but the increase is not so apparent owing to abnormally large productions by both the United States and Canada in 1906 and 1907. The total and provincial production of mica in India during the five years 1904 to 1908 is shown in Table VI. From this it will be seen that the production has risen from 22,164 hundredweights in 1904 to 53,543 hundredweights in 1908, the average annual production during the five years being 41,219 hundredweights, or 2,061 tons, which is nearly double the average figure—1,140 tons—for the previous five years.

From this table it will also be seen that more than half the Indian production (57·3 per cent) is contributed by Bengal—the mica mines lying in the districts of Hazáribágh, Gáya, and Monghyr. Madras contributes 31·4 per cent, chiefly from the Nellore district, and a very small quantity has been mined in the Nilgiris (60 hundredweights in 1905). Ajmere and Merwára, in Rajputana, contribute the remaining 11·3 per cent. It is only during the present quinquennium that the mica-mining industry in Rajputana has assumed a position of importance.[2]

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[1] Compiled from Records of the Geological Survey of India, Vol. XXXIX, 1910, p. 168.

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[2] The production of mica in this State declined to 1,871 hundredweights, valued at £595 ($2,898), in 1909, and to 757 hundredweights, valued at £1,393 ($6,784), in 1910.

TABLE VI

Provincial Production of Mica for the Years 1904 to 1908.

Province	1904.	1905.	1906.	1907.	1908.	Average
	cwts.	cwts.	cwts.	cwts.	cwts.	cwts.
Bengal	16,520	14,601	22,360	28,579	36,060	23,624
Madras	4,840	8,280	24,420	15,865	11,249	12,931
Rajputana	804	2,760	5,763	7,759	6,234	4,664
Total	22,161	25,641	52,543	52,203	53,543	41,219

The quantity and value of the mica exported during the years 1903–4 to 1907–8 are shown in Table VII, the average quantity being 32,605 hundredweights, or 1,630 tons, of an average value of £5.07 ($24.70) per hundredweight.

The average quantity during the previous quinquennial period was 19,173 hundredweights, or 959 tons, worth an average of £4.05 ($19.70) per hundredweight.

Comparison of these figures with those for production shows that there was an average annual excess of production over exports of about 400 tons. It is probable that the reported figures of production are below the true ones, partly owing to understatement to escape royalty, and partly due to mica stealing. This figure—400 tons—may, however, be taken as giving a rough idea of the internal consumption of mica in India, for a considerable quantity of poorer grade mineral is used in the country for ornamental and decorative purposes, and a small quantity of the larger sheets for painting pictures on.

There was an increase from £4.05 ($19.70) to £5.07 ($24.70) per hundredweight in the value of the mica, and from £77,613 ($377,965) to £165,403 ($805,512) in the value of the average annual production of mica during the period 1904 to 1908, as compared with the period of the previous review, 1898 to 1903. Table VIII shows the exports arranged according to Province of export. The Bengal and Madras exports are of the mica produced within these Provinces, and the Bombay exports consist, probably, of mica mined in Rajputana. From these figures it will be seen that the Bengal mica has the highest average value £5.25 ($25.57) per hundredweight (£4.26, or $20.75, for the period 1898 to 1903). Madras mica stands second—£4.69 ($22.84) per hundredweight (£3.67, or $17.87, during the period of the previous review); and Bombay mica third—£3.80 ($18.51) per hundredweight (£3.30, or $16.07, for the period of the previous review.)

TABLE VII

Exports of Indian Mica During the Period 1903-4 to 1907-8.

Year.	Weight.	Value.		Value per cwt.	
	cwts.	£	$	£	$
1903-4	21,548	86,297	420,266	4.05	19.72
1904-5	19,575	97,932	466,929	5.00	24.35
1905-6	31,554	159,627	777,383	5.05	24.59
1906-7	51,426	254,999	1,241,845	4.95	24.11
1907-8	28,922	228,161	1,111,144	5.86	28.54
Average	32,605	165,403	803,513	5.07	24.26

TABLE VIII

Exports of Mica During the Period 1903–4 to 1907–8.

Year.	Bengal.					Bombay.					Madras.				
	Weight.	Value.		Value per cwt.		Weight.	Value.		Value per cwt.		Weight	Value.		Value per cwt.	
	cwts.	£	$	£	$	cwts.	£	$	£	$	cwts.	£	$	£	$
1903-4	18,001	67,802	330,196	3.76	18.31	217	374	1,820	1.72	8.37	3,330	18,121	88,188	5.44	26.47
1904-5	13,167	59,187	288,241	4.49	21.81	74	132	643	1.78	8.66	6,334	38,613	187,916	6.09	29.64
1905-6	21,568	107,904	525,492	5.00	24.35	198	1,221	5,942	6.16	29.98	9,788	50,502	245,776	5.16	25.11
1906-7	35,496	191,812	934,124	5.40	26.30	634	2,384	11,602	3.76	18.30	15,296	60,802	295,903	3.97	19.32
1907-8	25,374	169,810	826,975	6.69	32.58	710	2,862	13,928	4.03	19.61	12,833	55,476	269,983	4.32	21.02
Average	22,721	119,303	581,005	5.25	24.67	366	1,394	6,787	3.80	16.98	9,516	44,703	217,553	4.69	24.31

Table IX shows the average distribution of exported mica during the period under review. The United Kingdom took the largest share, amounting to 61·9 per cent of the average total value; but much of the mica sent to the United Kingdom is sold there for transmission to the Continent and America. The mica sent direct to America brought a higher price than that sent to other countries, because only the better qualities can stand the heavy import duty imposed by the Dingley tariff in 1897.

TABLE IX

Average Distribution of Indian Mica Exported During the Period 1903-4 to 1907-8.

Exported to	Average Quantity.		Average Value.		Value per Cwt.
	cwts.	Per cent of total.	£	Per cent of total.	£
United Kingdom	17,226	52·8	102,307	61·9	5.94
United States	4,781	14·7	29,497	17·8	6.17
Germany	7,391	22·7	21,337	12·9	2.89
Belgium	1,050	3·2	3,551	2·1	3.38
France	558	1·7	2,497	1·5	4.47
Other countries	1,599	4·9	6,214	3·8	3.89
Average Total	32,605	100.0	165,403	100.0	5.07

Table I, p. 21, shows the relative positions taken by the three principal mica-producing countries during the period 1894–1908. From this it will be seen that in the quinquennium 1894 to 1898, India contributed 66·75 per cent of the total; in the next quinquennium (1899 to 1903), owing to the increased output from Canada, the India production decreased to 58·86 per cent; while during the last period (1904 to 1908) the Indian mica industry expanded enormously, but the proportion increased only to 64·46 per cent, due to the great increase in the American production, and an abnormally large production by Canada in 1906. Thus it will be seen that, during the fifteen years under consideration, India has contributed, roughly, three-fifths of the total, and Canada and the United States, roughly, one-fifth each. The imposition of the Dingley Tariff in 1897 no doubt contributed to the falling off in exports of Indian mica to the United States, and occasioned a consequent stimulus in the mica-mining industry of the latter country.

Mining Methods.

The mining methods employed in the greater number of the Indian mica mines are of the same primitive character as those in use since the inception of the industry. No system of any kind is followed and the deposits are exploited in the simplest manner. No machinery worth mentioning is employed. Open-cuts along the outcrops of the veins alternate with cross-cuts at right angles throughout the mass of the dyke. These cuts have a depth of from 20 to 50 feet. The sides, on account of the decomposed nature of the veins near the surface, are often dangerous, little timbering being used. Despite this fact, accidents are comparatively seldom, the fatalities recorded averaging only 0·53 per thousand during the period 1904 to 1908. In exceptionally rich deposits, where the decomposition of the vein continues in depth, the work of exploitation differs somewhat from the above. The vein, in such a case, is followed to depths sometimes exceeding 200 feet, by means of inclines in a zig-zag form. At intervals along these inclines, native women are stationed who pass baskets filled with mica, or pitchers of water, from hand to hand. Two rows of women are usually employed from the water level to the surface, the full receptacles being passed up one line and the empties down the other. As many as seventy women are sometimes employed in this style of work alone. For ventilation purposes and for the raising of waste, circular shafts 2 feet in diameter are put down at frequent intervals along the course of the vein. Work is conducted only during the dry months, from November to May. Explosives are seldom used, but in cases where the rock is exceptionally hard, large fires are kindled against the face, upon which water is then thrown. This causes cracks to develop, into which iron wedges are driven, and in this way large masses of rock are detached. The method is precisely similar to that employed in the tin mines of Saxony during the middle ages and known as "Feuer-Setzen." The tools used in the mines are of a primitive nature and are usually fashioned from the magnetite not infrequently found in the vicinity of the mica deposits.

The mica crystals extracted in this way are raised to the surface and split into sheets of about $\frac{1}{8}''$ in thickness. The rough edges are trimmed off by means of an implement called "hasawah" and the sheets then sorted according to colour and size. The diameter of the plates sometimes runs as high as 24″ by 18″. Efforts have been made to induce the miners to adopt more scientific and up-to-date methods of mining the pegmatite dykes and over-hand stoping was at first advocated.[1] Mr. A. A. C. Dickson, however, who has made a study of the conditions in the Koderma area, has suggested a modification of this method. Mr. Dickson[2] does not consider that overhand stoping, on account of the danger incurred in the employment of a large number of untrained miners, can be universally followed in working out the mica-bearing pegmatites. He suggests and practises a system which is described as transverse stoping with filling. The pegmatite dyke is followed to a depth of about 100 feet and then, the dip being determined, a drift is run along the hanging-wall to fix the strike of the deposit. This enables the miners to construct a main haulage way for the removal of the mica and associated waste minerals during

[1] T. H. Holland, "The Mica Deposits of India" Mem. Geol. Survey, India, XXXIV, Part II, p. 78.

[2] Trans. Min. and Geol. Inst. of India, III, p. 87, 1908

the process of stoping out the material by a series of transverse cuts. Mr. Dickson has confirmed previous conclusions regarding the unnecessary cost of labour in carrying out the old system, whereby in a mine, only 75 feet deep, over 200 workers are often required to deal with the material raised by ten miners at work below; he has given some practical suggestions for the intro, duction of simple machinery to deal with the water and disposal of waste material. He agrees, therefore, that in the Koderma area, the day of the petty miner has passed, and the organization of systematic mining with the aid of machinery requires an expenditure of capital best obtainable by limited liability companies.

Labour Statistics.

Most of the mines are under the control of the Indian Mines Act of 1901, so that the labour statistics for the latter quinquennial period shown in Table X afford a fair index of the activity of the industry. The average number of persons employed during the quinquennium 1904 to 1908 was 15,667, so that, roughly speaking, the mica industry of India comes, with manganese, next to gold in the employment of labour. The risks attending mica mining seem to be somewhat less than those of coal mining in India.

TABLE X

Statistics of the Labour Employed in Mica Mines During the Period 1904 to 1908.

Province.	1904.	1905.	1906.	1907.	1908.	Average.
Number of persons employed.						
Bengal	6,927	6,122	7,716	10,683	10,287	8,347
Madras	6,585	9,199	8,007	7,154	4,661	7,121
Rajputana		260	261	146	329	199
Total	13,512	15,581	15,984	17,983	15,277	15,667
Number of deaths from accidents in mica mines.						
Bengal	10	2	8	12	3	7·0
Madras	2	2	2			1·2
Rajputana				1		0·2
Total	12	4	10	13	3	8·4
Death-rate per 1,000 of persons employed in mica mines.						
Bengal	1·44	0·32	1·04	1·12	0·29	0·84
Madras	0·30	0·21	0·25			0·15
Rajputana				6·84		1·37
Average	0·89	0·25	0·62	0·72	0·19	0·53

Note.—These figures relate only to mines under the Indian Mines Act.

Historical.

Mica mining in India dates from a very early period. The Hindus have been raising mica for centuries and the mines near Patna and Delhi are the oldest in the country. Dr. Breton visited these deposits in 1826, and found as many as 5,000 natives employed upon them. In 1849, Dr. McClelland records an output of 800,000 pounds. The first exports of mica were made from Bengal in 1863 and amounted to about 7,500 pounds. Much of the mica mined in the old days was used for ornamental purposes, painting etc., while some of it found use in the stove industry. It was not, however, until the adoption of mica for electrical purposes, that the mining industry assumed its present important position.

Distribution of the Deposits.

As remarked above, the productive areas of India are chiefly confined to the Gáya, Hazáribágh and Monghyr districts, in Bengal; Nellore and the Nílgiris in Madras; and Ajmere and Merwára in Rajputana. According to Mr. Mervyn Smith[1], the mines in Bengal are situated between 85° and 86° 30′ east longitude and 24° 25′ north latitude. They are distributed over a series of parallel ranges of low hills, some 400 feet above the surrounding country and 1,200 feet above sea-level. These hills form the boundary between the Hazáribágh district on the south and the Gáya and Monghyr districts on the north, and are part of the Bengal Presidency. The direction of these ridges is east and west. The most important mines lie in the districts of Hazáribágh and Gáya in Behar, and the mineral has also been found in certain parts of Manbhum and Singehum (Chota Nagpur), but little attempt has been made to exploit the latter deposits. In the Hazáribágh district, the greater part of the mines are situated in the Koderma area, both inside and outside the Government Reserve forests.

Pegmatites are known at many places where the older crystalline rocks are exposed. The dykes are, however, by no means always mica-bearing, at any rate from an economic standpoint. The valuable deposits are confined to the Peninsula, which represents a portion of the earth's crust which has suffered little dislocation from earth-movements. The extra-Peninsular portions of India are either covered with younger sedimentory deposits, or the crystalline rocks have been so thoroughly dislocated as to crush and render valueless the crystals of mica contained in them.

Briefly, the known mica-bearing areas are as follows:—

Bengal Presidency.—Gáya, Hazáribágh, Monghyr, Sikkim-Tibet.

Bombay Presidency.—Chhota Udepur, Nárukot.

Burma.

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[1] Trans. Inst. Mining and Metallurgy, 1898, Vol. VII, p. 168.

Central India.—Rewah.

Central Provinces.—Bálaghát, Bastar, Biláspur.

Coorg.

Madras Presidency.—Gánjám, Nellore, Nilgiris, Salem, Trichinopoli, Vizágapatám, Travancore.

Mysore.

Punjab.—Bhábeh, Gurgáon, Kángra.

Rajputana.—Ajmere-Merwára, Jaipur, Kishengarh, Sirohi, Tonk.

At the time of Mr. Holland's[1] examination of the producing districts, there were some 250 mines operated in Bengal turning out annually about 450 tons of marketable mica. Many of the mines were situated at some distance from railway communication and were consequently rather handicapped. A new line was under consideration, however, which was to run through the mica fields, and it was anticipated this would aid greatly in the development of the industry. The surface of the country in this area facilitates the detection of the pegmatites, being hilly and subject to considerable denudation during the rainy season. The mining methods adopted are exceedingly primitive, and there is a disposition to clear out surface shows without regard to deeper-seated deposits which may underlie them. The resources of the area are regarded as considerable. Small amounts of apatite occur in certain of the pegmatite veins, notably those worked at the Lakamandwa mine, near Koderma, and this mineral might possibly be won as a by-product at certain points. Accessory minerals of the dykes, which may be noted as of mineralogical interest, are triplite, uraninite, torbernite, leucopyrite, tourmaline, lepidolite, columbite, and beryl. Considerable quantities of high-grade feldspar are treated as waste, there being no demand for the mineral. Kaolin does not occur in any abundance.

The second great mica field is that of the Nellore district, in the Madras Presidency. As already remarked, the area differs considerably from the Bengal region, in that the surface of the land is flat and forms low-lying alluvial plains, a feature which is distinctly unfavourable to the detection of mica deposits, owing to the large amount of surface material spread over the older rocks. Mining also is more difficult and expensive in such a country than in a hilly district. The mica industry in Nellore is little more than twenty years old, and the total number of mines in operation at the time of Mr. Holland's examination did not exceed forty. The pegmatites here follow the foliation of the schists, and it has been remarked that their border zones are considerably more basic in character than their central portions. Dykes possessing graphic-granite structure are frequent, and such do not often carry good mica. By far the largest mica-crystals obtained in India have been discovered in this district. Sheets measuring 10 feet across were taken from the Juikurte mine, and plates 30″ × 24″

[1] T. H. Holland, "The Mica Deposits of India," Mem. Geol. Surv. Ind. Vol. XXXIV, Part II, 1902.

are of frequent occurrence. It is probable that large deposits of mica are hidden beneath the immense deposits of alluvium and sub-recent sandstones which cover great portions of the area; but even the mica-bodies exposed in the eroded districts are sufficient, it is deemed, to enable the present production to be maintained for many years.

The Nílgiris mica-area forms an important producing region, and large sheets of high grade ruby mineral have been obtained from Cherambádi.

Rajputana is coming more and more into prominence as a producing state, and the exports of the mines are increasing rapidly.[1] The other localities mentioned above do not contribute to any great extent to the total mica output of India, but promising deposits have been located at various points in the districts mentioned.

Geological Occurrence.

Large tracts of gneiss grading into mica-schist occur throughout the Bengal mica-bearing area. In immediate contact with the mica deposits, tourmaline schists, hornblende rocks and quartzites, with intrusive dykes of a fine grained diorite, are also found. The hornblende rocks resemble the diorite, and mica deposits are not infrequently found between these two rocks. The mica met with in the schists is of the muscovite variety, while black mica (biotite) and a red species (lepidolite) are also found. The gneisses are classed in Indian geology among the younger members of the Archæan formation and have an east and west strike with a dip of 75° to the north.

The pegmatites carrying valuable mica are not, as a rule, found traversing the gneisses or granite, the only occurrences of value being found in mica-schists, which are generally referred to the upper division of the Archæan crystalline series.

The mica of commerce occurs almost exclusively in pegmatite dykes conformably interposed in the schists and ranging in width from a few inches to 20 feet. The country rock is often faulted or thrown from its normal strike. The pegmatites have been subjected to the same faulting and frequently at the point of faulting so-called cross-courses of considerable width have been formed.

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[1] See footnote 2, p. 28.

The pegmatites consist of amorphous masses of quartz, large crystals of orthoclase feldspar, and crystals or "books" of muscovite. Generally speaking, their content of mica and the quality of the same depend to a large extent upon the nature of the country rock. The richest and best mica deposits are found in dykes cutting mica-schist (Fig. 5).

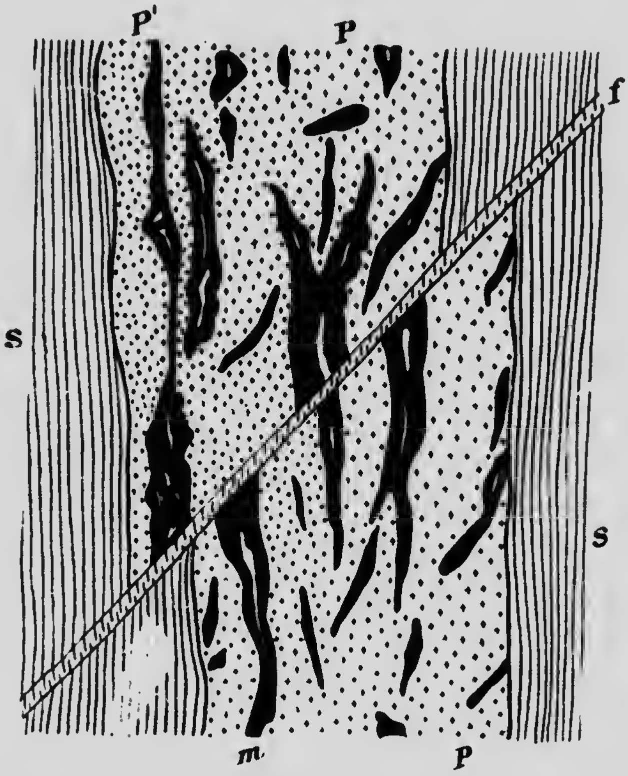


FIG. 5.—Section of faulted pegmatite dyke, Hazáribagh, Bengal.

P, normal pegmatite; P', quartzose zone; S mica schist; m, mica; f, fault.

Where the adjacent rock is highly feldspathic, feldspar crystals of a pink colour predominate in the vein, and the occurrence of mica is insignificant (Fig. 6).

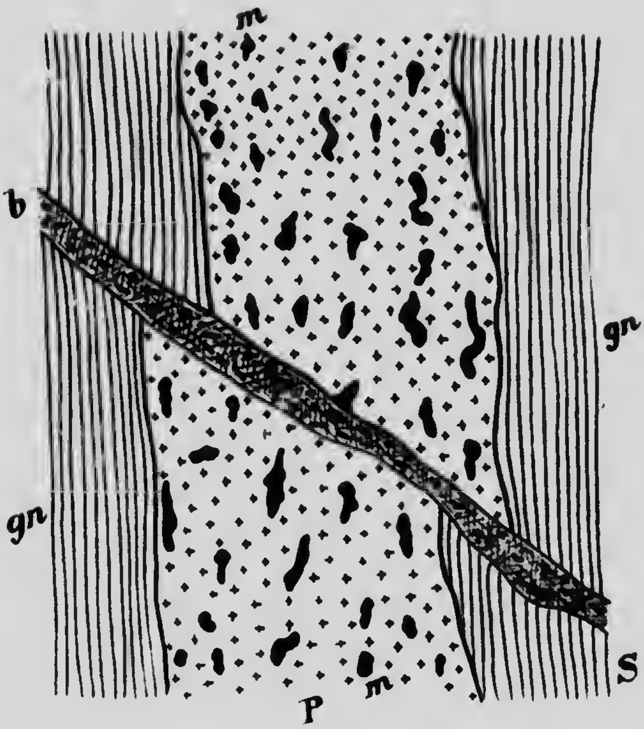


FIG. 6.—Section of faulted pegmatite dyke, Hazáribágh, Bengal.
gn, highly feldspathic gneiss; P, pegmatite with mica (m); b, breccia.

Many accessory minerals are met with in the dykes, such as tourmaline, garnet, columbite, etc. The tourmaline often occurs in large masses and is usually of a black colour (schörl). Tourmaline crystals not infrequently penetrate the mica crystals, rendering them unfit for use. In the Nellore district, Madras, the pegmatites are found in a low-lying plain mostly overlain by recent deposits and alluvium, and consequently their discovery and exploitation is greatly obstructed. The occurrence is in every way similar to that in the Bengal district. Pegmatite dykes cut mica-schist conformably and are often highly decomposed, the central part being formed of kaolin, while the outer portions are composed of pure feldspar or quartzose rock. The mica is found between this latter rock and the kaolin (Fig. 7). Mining in this low-lying area is generally more expensive than in the higher districts of Bengal. Mining land is leased from the Government at the rate of fifty rupees an acre, and with each application a deposit of 500 rupees, or a sum determined by the authorities is required.

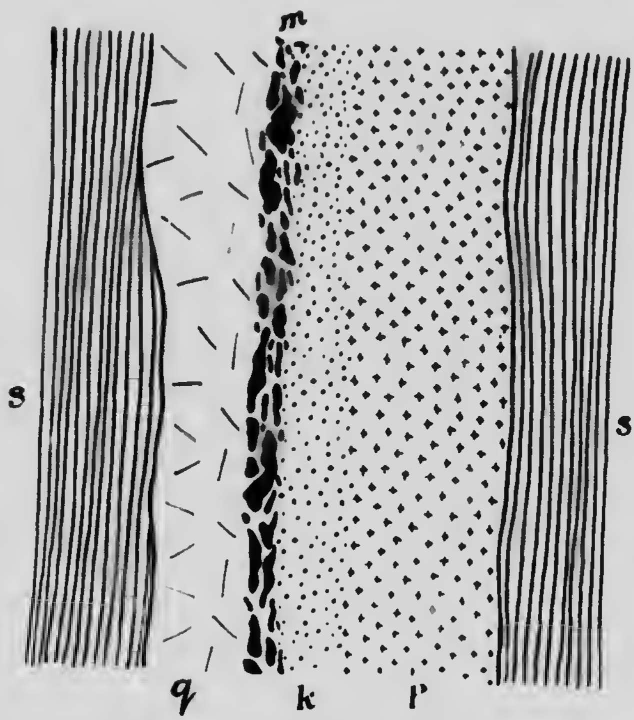


FIG. 7. Section of pegmatite dyke, Southeast Wainad, Nilgiris, Madras.
S, mica schist; P, normal pegmatite; k, decomposed feldspar or kaolin; m, mica; q, quartz.

Prices and Grades.[1]

Of the different grades produced in Indian mines, the trimmed mica sheets are sorted according to quality, four kinds being recognized by the dealers: (1) ruby mica, hard and rough; (2) white transparent mica; (3) discoloured and smoked; (4) black mica and flawed. If 8 represents the value of ruby mica, 4 would be paid for white, 2 for discoloured and 1 for

[1] Compiled from Mineral Industry, Vol. VII, p. 512.

black and flawed sheets of equal size. The sizing and approximate prices of best ruby per pound are:—

		s.	d.
No. 1.	Sheets measuring from 36 to 50 square inches	6	8
No. 2.	" " 24 to 36 "	4	0
No. 3.	" " 16 to 24 "	2	0
No. 4.	" " 10 to 16 "	1	0
No. 5.	" " 6 to 10 "	0	4
No. 6.	" " 1 to 6 "	0	2

These sheets are trimmed into the best shape that will clear them of flaws. Square, rectangular, or diamond shaped sheets fetch highest prices. The sheets are packed into boxes of 100 pounds and carted to the railway station for transport to the nearest port. The distance of the mines from the railway varies between 30 and 140 miles.

As to the quantity of mica available in India, there is no doubt that the pegmatite veins are numerous and, compared with those of other countries, large, while the quantity of mica in some places is abundant. But the method of working these mines is wasteful in the extreme and fully 90 per cent of the mica mined is injured and rendered unfit for use.

Wages are very low; women get threepence a day, while good natives work for fourpence. A first-class native foreman—and only such can be employed under the circumstances—receives from eightpence to tenpence a day. On account of the absence of any machinery, it is difficult to follow the deposits beyond 100 feet in depth, and many mines, still showing immensely rich mica deposits, have been abandoned. There cannot be the slightest doubt that, with the introduction of modern mining methods, the waste of mica will be much less, a better quality will be secured, and the life of the mine will be prolonged until the complete exhaustion of the deposits. At present only the decomposed or partially decomposed parts of a vein are mined, and it is evident that the mica must have simultaneously undergone a certain partial decomposition. Mining in depth in the hard vein material would yield hard, not decomposed mica, and in this way would increase the efficiency of the mine, both as to quality and quantity.

Some interesting mineralogical features are often observed in the Indian mica. The sheets are at times queerly marked. In places one-half of each sheet will be muscovite and the other half biotite, the line of division between the two colours being perfectly straight, while there is no other apparent change in the uniformity of the sheet. Other plates, again, are chequered in black lines, the lines being due to magnetite. In some cases dendritic inclusions of quartz between the laminae may be found. Of course defects have an influence upon the price. The most valued col ruby, amber, light green, and transparent white. There is als which the natives prize for ornamental inlaid work.

UNITED STATES.

Muscovite forms almost the entire mica production of the United States, though small quantities of biotite have also been raised from the same mines which yield the white mica. No phlogopite is mined commercially in the United States.

The mica possesses a similar occurrence to the Indian mica; that is, it is found associated with coarse pegmatite dykes. The greatest development of these dykes is found in North Carolina, Idaho, Maryland, New Mexico, New York, and South Carolina. The development of the deposits is conducted in a somewhat similar fashion to the methods followed in Canada, that is, the mines are, for the most part, in the hands of small operators, who mine in an intermittent manner. A few of the larger manufacturers of mica have their own mines, which they exploit on a larger scale with the aid of machinery, but the number of such is relatively small. The low cost of labour in India enables desultory and primitive mining to be carried on profitably; but it would seem that in order to establish both the American and Canadian mica industry on a sound commercial basis, it will ultimately be necessary to undertake the development of the deposits in a more systematic manner, in the hands of organized companies. Few of the American mines reach any great depth in their workings, the mica being usually extracted from surface pits.

The reserves of the mineral in this country would appear, from the information available, to be considerable, and the small variation shown by the figures of annual production during the past few years would seem to indicate that little serious attempt is being made by producers to increase their output.[1]

The appended table gives the production of mica in the United States for the last twenty-five years.[2]

[1] Author's Note.—When the above was written the figures of production for 1910 were not available. The United States at the present time heads the list of producing countries.

[2] Production of Mica in 1913. D. B. Sterrett. Published by the United States Geological Survey, 1914.

TABLE XI.

Production of Mica in the United States for the Twenty-Five Years, 1886-1910.

	Sheet Mica.		Scrap Mica.		
	Quantity.	Value.	Quantity.	Value.	Total Value.
	pounds	$	short tons.	$	$
1886	40,000	70,000			70,000
1887	70,000	142,250			142,250
1888	48,000	70,000			70,000
1889	49,500	50,000			50,000
1890	60,000	75,000			75,000
1891	75,000	100,000			100,000
1892	75,000	100,000			100,000
1893	51,111		156		88,929
1894	35,943		194		52,388
1895	44,325		148		55,831
1896	49,156	65,441	222	1,750	67,191
1897	82,676	80,774	740	14,452	95,226
1898	129,520	103,534	3,999	27,564	131,098
1899	108,570	70,587	1,505	50,878	121,465
1900	156,283	92,758	5,497	55,202	147,960
1901	360,060	98,859	2,171	49,719	148,578
1902	373,266	83,843	1,400	35,006	118,849
1903	619,600	118,088	1,659	25,040	143,128
1904	668,358	109,462	1,096	10,851	120,316
1905	924,875	160,732	1,126	17,856	178,588
1906	1,423,100	252,248	1,489	22,742	274,990
1907	1,060,182	349,311	3,025	42,800	392,111
1908	972,964	234,021	2,417	33,904	267,925
1909	1,809,582	234,482	4,090	46,047	280,529
1910	2,476,199	283,832	4,065	53,265	337,097

DISTRIBUTION OF THE DEPOSITS.

In Colorado the principal deposits hitherto exploited are found in Boulder and Freemont counties, where large clear sheets have been obtained. The Cañon Mica Mills and Mining Company obtained plans for a grinding mill at Cañon City in 1906, but further particulars as to development are not to hand.

A deposit of mica was opened and worked in the early nineties near Cripple Creek.

In Idaho, the Spokane Mica Company operated a deposit near Troy, Latah county, in 1906, the product being mostly shipped to the firm's grinding plant at Spokane, Wash. The majority of the mines are situated in the above county.

In South Dakota, the Westinghouse Electric Company worked two deposits in 1906, the New York and the White Star mines. Locations near Custer and Deadwood are numerous. Cassiterite is a frequent mineral in the pegmatite dykes of the Black hills.

In Virginia, promising outcrops have been located in Amelia county, but do not appear to have been mined to any extent.

In North Carolina, the principal deposits exist in the counties of Yancey, Jackson, Haywood, Macon, and Mitchell.

New Hampshire has possibly produced more mica than any other state in the Union, and at one time the output of the mines formed over 80 per cent of the total annual production of the United States. The Ruggles mine is said to have produced over $8,000,000 worth of mica since 1803. The principal deposits are in Groton, Grafton, Cheshire, Danbury, and Alstead counties. The occurrence of enormous crystals of beryl, associated with the mica, is a feature of many of the mines.

In Maine, mica-bearing pegmatites have been exploited in Oxford county, and the pegmatites of Mount Mica, near Paris, are famous for the beautiful tourmaline they carry.

In California, discoveries of extensive mica deposits were reported late in 1901, but their importance does not appear to have been very considerable. The deposits were located in the Piru district, Ventura county.

In Alabama, the principal deposits are in Randolph, Cleburne, and Clay counties.

Dakota, Wyoming, and New Mexico, Utah, Nevada, Washington, and Georgia have also yielded a small production of mica, but neither the quality nor the quantity of the mineral approaches that of the Eastern States.

A small production is also reported from New Jersey.

In Wisconsin, a new variety of mica was found a few years ago in a pegmatite dyke near Wausau. Only small crystals were met with, and the mineral was found to fuse readily and to contain large quantities of lithia, soda, and chlorine. The name irvingite has been given to this mineral.

Production.

The output during the year 1910 came principally from seven states-- North Carolina, South Dakota, New Hampshire, Colorado, South Carolina, New Mexico, and Massachusetts, named in the order of the value of their production. South Carolina and New Mexico returned to the list of mica-producing States in 1910, no production having been reported from these States in 1909. A small output was reported from Massachusetts, which had been a non-producer for several years. Virginia, Alabama, New York, Georgia, and Maine failed to report an output of mica in 1910, though all these States were producers in 1909.

The value of the production of mica in 1910 was greater by $56,568 than in 1909, and was greater than in any other year except 1907, when it amounted to $392,111. The production of sheet mica amounted to 2,476,190 pounds, valued at $283,832, an increase of 666,608 pounds and $49,350 over 1909.

The production of sheet mica reported from the different states each year is quite variable, and it is difficult to make a distinction between the small sheet mica for punched forms and scrap mica. The variation is also due in part to the fact that in some years producers complete the manufacture of more of their mica than in other years, thus reporting smaller quantities of sheet mica and more scrap mica than in years when less of the mica is trimmed into sheets.

Prices.

The average price of sheet mica in the United States during 1910 as deduced from the total production was 11·5 cents per pound, as compared with 12·9 cents per pound in 1909. The average price in the different states for sheet mica was: in North Carolina, 42·5 cents per pound; in New Hampshire 22·3 cents per pound; and in South Dakota 3·6 cents per pound.

For scrap mica in 1910, the average price was $13.10 per ton, as compared with $11.26 in 1909, and with $14.02 in 1908.

It is not possible to give absolute prices of manufactured sheet mica from dealers' lists, since discounts allowed vary with the nature of the purchases. The prices quoted are from a standard list for 1911. Discounts ranging from 70 to 10 per cent are allowed on stove mica and from 60 to 10 per cent on electrical mica.

Prices Per Pound Quoted for Stove and Electrical Mica for 1911.

Stove Mica.		Electrical Mica.	
Size.	Price.	Size.	Price.
1½" × 2"	$1.20	1 " × 3"	$1.75
2 " × 2"	2.00	1 " × 6"	5.50
2 " × 3"	3.50	1½" × 4"	2.75
3 " × 3"	5.75	2 " × 4"	3.50
3 " × 4"	7.00	2 " × 7"	7.25
4 " × 6"	9.50	3 " × 9"	11.00

Imports.

The imports of trimmed sheet mica into the United States during 1910, as reported by the Bureau of Statistics of the Department of Commerce and Labour, amounted to 1,961,523 pounds, valued at $724,525. Ground mica to the value of $1,298 was imported in 1910, as against no imports recorded in previous years.

The mica imports into the United States for the quinquennial period 1906-10 are given in the following table:—

TABLE XII.

Mica Imported into the United States During the Period, 1906-10.

Year.	Unmanufactured. Quantity.	Unmanufactured. Value.	Cut or Trimmed. Quantity.	Cut or Trimmed. Value.	Total. Quantity.	Total. Value.
	lbs.	$	lbs.	$	lbs.	$
1906	2,984,719	983,981	82,019	58,627	3,066,738	1,042,608
1907	2,226,460	848,098	112,230	77,161	2,338,690	925,259
1908	497,332	224,456	51,041	41,602	548,373	266,058
1909	1,678,482	533,218	168,169	85,595	1,846,651	618,813
1910	1,424,618	460,694	536,905	263,831	1,961,523	724,525

From the foregoing tables it will be seen that, in value the imports of mica for the year 1910 exceeded the total production for the same period by $387,428, that is, the value of production was considerably less than half that of the imports.

The introduction of the Dingley Tariff in 1897 resulted in the mica imports into the United States attaining a considerably higher grade than had previously been the case, and it is principally due to the effect of this tariff that the average price per ton of Canadian amber mica exported to the United States reaches such a high figure compared with that shipped to England (See Table V). The terms of the tariff provided for a distinction between unmanufactured and manufactured (cut or trimmed) mica, and the imposition of a duty of 6 cents per pound upon the former and 12 cents per pound on the latter, together with a 20 per cent ad valorem duty upon both grades. This tariff effectually prohibits the importation of low-grade mica, a fact which the Indian shippers also have been compelled to recognize.

GERMAN EAST AFRICA.

During the past five years the white mica content of certain pegmatite veins in German East Africa has been attracting some attention, and in 1909-10 the total quantity of mica produced in the colony amounted to some 104 tons of rough mineral, valued at 258,799 marks ($61,594). The figures shown in Table XIV give an idea of the growth of the industry during the period 1905-10, and it will be seen that the value of mica raised in 1909 exceeds the production in 1905 by some seven times. The following description of the occurrence of mica in German East Africa, together with the figures of production, were kindly furnished the Department by the German Colonial Office, and are the work of Dr. A. Klautzsch.

"The exploitation of commercially valuable mica deposits in German East Africa is chiefly confined to the districts of the Uluguru mountains and neighbouring ranges. The rock of this area is principally a biotite gneiss, which shows considerable variation of both structure and mineral composition. In the mica regions this gneiss is cut by numerous pegmatite dykes which dip at small angles from the vertical and range from 30 to 70 feet in thickness.

The mica found in these dykes is invariably muscovite, or white mica, and a number of examinations of material from the various districts have been conducted by the Geological Survey in order to determine the market value of the different samples. Numerous occurrences of mica are already known, and many of the deposits have yielded large sheets. In a number of instances, however, the mica was found to be too stained or too crushed, or else the deposits were not of sufficient extent to justify an expenditure of capital upon the exploitation of the dykes. Lack of transport facilities coupled with unfavourable labour conditions also add to the difficulties of development; with an improvement of the above, many of the deposits, which are at present unprofitable, will doubtless become valuable producers.

At the present time the two principal producing districts consist of the region bordering on the River Mbakana, a tributary of the Mgeta, which is operated by the German East African Mica and Mining Company (late William Schwarz), and the area owned by the Morogoro Mica Company (late A. Prüsse), which lies to the north of Morogoro.

On the Mbakana, the principal mines are the Bertha, Bornhardt, Gerlach, Borchers, and Hohe Wacht, which are scattered over the ridge sloping from the Lukwengale plateau to the valley below. A number of prospects also have been staked in the vicinity of the above mine and good shows of mica are said to be numerous. The mica occurs here principally in the pegmatitic salband of an almost pure quartz dyke, 12-20 feet wide, and having a strike of almost due north and south (170°). The zone in which the mica is found consists of a typical pegmatite containing large crystals of orthoclase and mica in a quartz matrix. This zone has a length of from 75 to 90 feet, and attains a maximum width of some 8 feet on the surface. At 16 feet, its width was found to be over 15 feet. The colour of the mica plates in thick sheets is dark brown to dark brownish green, but the mineral is very clear and plates 1 cm. thick are more than usually transparent.

Spots and blotches of magnetite, specularite, etc., between the laminæ, are somewhat frequent, but are said, from experiments which were made to test the conductivity of the mineral, not to greatly impair the insulating properties of the mica. The crystals are also relatively free from crushing and twisting, and the dykes are only weathered for a short distance from the surface.

In other dykes in the more or less neighbouring vicinity, the occurrence of the mica crystals is not confined to a single zone or stringer. Aggregates of large mica sheets are often found embedded in the mass of the dykes and a crystal measuring 35″ × 31″ across its plates has been found. Perfect sheets, free from cracks and injury caused in their extraction from the rock, have been obtained up to 13″ × 18″ in diameter.

The production, at the inception of the industry in 1902, amounted to an average of some 1·3 tons per month.

The following table shows the electrical character of the mica compared with that from other sources:

TABLE XIII

Dielectric Strength of Certain Micas.

Mica	Specific Resistance.	Thickness of Plates.	Breakdown Pressure.
	mill. megohms.	mm.	volts.
East African, Sample I	900	0·12	12,000
" " " II	980	0·17	10,000-12,000
" " " III	900	0·21	11,000
American, low-grade, spotted	380	0·25	11,000
Canadian amber, Sample I	900	0·25	12,400
" " " II	700-800	0·25	11,600
Best Indian Ruby	1,200	0·25	18,000

Of the areas owned by the Morogoro Mica Company, those at present being worked are the Kalte Platte, Hannoverland, Eimbeck, Richard Prüsse, Kronprinzessin, and Preussen. The remainder of the concessions taken up represent so far only spots where mica outcrops have been located. The occurrence of the mica here is similar to that in the Mbakana region, the crystals occurring in pegmatite dykes striking north and south and dipping steeply to the east. The country rock is similarly a biotite-gneiss and the principal development of the dykes is to be found on the right bank of the Morogoro creek, at an elevation of some 2500 feet. The production here in the first half year of 1908 corresponded to an average monthly output of 3·3 tons, and the average price obtained for the mica was 5·33 marks ($1.27) per pound for clear sheets, and 2·66 marks ($0.63) for spotted plates.

Further mica outcrops in the Uluguru range have been located at the following spots, but the extent and richness of many of the deposits have not as yet been determined:

Mindu hills near Morogoro—plates 4″ to 6″ across.

Kigambue, to the east of Morogoro.

Mssassa, Kibunduga district, in the Revu watershed, nests of crystals yielding plates 4″ to 16″ in diameter.

Kikoya kwa Komorra, on the left bank of the Mgeta creek.

Kong 'ho, north of Kikoya—plates up to 16″ across.

Kipfunge, on the south slope of Muhali mountain—plates 5″ to 10″ across and relatively free from flaws and inclusions.

Fichtnerwerk, west slope of Mount Lukwengule—clear plates measuring 4″ to 8″.

Other East African mica deposits are the following, though details of their economic importance are as yet wanting:—

The Suwi Creek district in the Pongue mountains. The Suwi flows into the Wami and traverses the Bagamoyo Hinterland. The mica is said to occur here in gneiss, and appears to be associated with an eruptive rock. This deposit is, perhaps, of contact metamorphic origin. The crystals are greatly crushed and bent and the samples so far submitted were not marketable.

West slope of Luganga mountain, Mpapua district.

Mkondumi in the Nguru Range, a northern spur of the Uluguru range—crushed and uneven plates.

Momboja, Mount Kissetui—large plates of ruby mica.

Tanjira, on the upper reaches of the Ulanga river, between the villages of Tutti and Nahungulla, west of the military station of Mahenge—crushed crystals 6″ across, but inclined to ribbon-structure.

Mount Fissage and the Upogoro Heights, Mahenge district.

Kigamba, Ktimiri mountains—clear sheets 4″ to 6″ across.

Mombo, Usambara (Roland and Hagen mines)—green and ruby coloured crystals yielding plates of 18·6 square inches and measuring 8″ × 20″.

Same, Usambara.

Woto Plateau, Langenburg district.

Mawe and Muero, situated in the gneiss region in the Lindi Hinterland—thick mica plates measuring 6″ by 10″, but rather opaque and crushed.

The occurrence of uraninite, or pitch-blende, with the mica of the Mbakana valley, Lugwengule mountain, in the Uluguru range, is interesting. The mineral is found embedded in the mica, and is often in the form of minute octohedral crystals. Masses have also been found, the weight of which exceeded 70 pounds. These masses are always found as isolated aggregates in the dykes. The mineral is superficially highly altered to a yellow substance which has been determined by Markwald as uranium carbonate (rutherfordite) and contains:—

U_3O_8	83·8%
CO_2	12·1%
PbO	1·0%
	96·9

The unaltered mineral, which is, similarly to the rutherfordite, strongly radio-active (about 20 per cent more so than the pitch-blende from Joachimsstal) possesses the following composition:—

U_3O_8	89·47
PbO	6·87
CaO	0·82
SiO_2	0·52
FeO	0·48
ThO_2	0·20
H_2O	2·03
	100·39

Its specific gravity is 8·63.

Another mineral containing uranium oxide, has also been found in pegmatites in the Morogoro district. An analysis of this mineral gave:—

Nb_2O_5	46·03
Ta_2O_5	1·20
UO_2	13·60
TiO_2	0·90
Y_2O_3	14·12
Fe_2O_3	5·72
Al_2O_3	0·17
PbO	7·55
CuO	1·21

MnO	0·28
CaO.	2·84
H_2O.	6·23
Total.	99·85

The specific gravity was found to be 4·80, which is much lower than the normal weight of fergusonite (5·8—5·9) for which it was at first taken. Further examination resulted in the recognition of a new mineral to which the name plumboniobite has been given by Dr. Hauser, its discoverer. The mineral is only very slightly radio-active.

The following table shows the development of the mica industry in the colony since 1905:—

TABLE XIV.

Production of Mica in German East Africa During the Period 1905-10.

Year.	Number of Mining Fields	Rough Mica.	Trimmed Mica.	Value.
		tons.	tons.	$
1905-6	21	63	20	8,823
1906-7.	30	73	....	16,345
1907-8.	35	103	33	16,190
1908-9.	....	85	....	50,211
1909-10.	....	104	....	61,594

The mica produced, as a result of lower market prices for the small and inferior qualities, is becoming steadily of higher grade. The proportion of rough mica, or ordinary run-of-mine, to trimmed and marketable mineral is about as 3:1

BRAZIL.

Pegmatite dykes yielding marketable sheets of white mica exist in the states of Goyaz, Bahia, and Minas Geraes, and have been worked to some extent. From the latest information, kindly supplied to the Department by Mr. O. A. Derby, of the Geological Survey of Brazil, it appears, however, that mica mining in this country is now practically at a standstill, the production of some years ago having almost completely ceased. There is no record of any recent shipments. There are, also, no official figures available relative to the production of the various mines, and the total output would appear to have been small.

The following notes on the occurrence of mica in Brazil are compiled from the report by Mr. H. K. Scott[1], and it appears that the general occur-

[1]Trans. Inst. Min. and Met., Vol. XII, 1902-3, p. 357 et seq.

rence in this country is similar in most respects to the usual types of muscovite deposits found elsewhere, the resemblance to the Indian deposits being striking.

No exact information is available with regard to the deposits of mica in Goyaz or Bahia, the quantity of mineral exported from these states having been small, though it should be stated that the mica from the state of Goyaz is of excellent quality.

The principal mica deposits are associated with pegmatite veins, lenses, or dykes, which occur in metamorphic schists near the city of Santa Luzia de Carangola, on the borders of the states of Minas Geraes and Espirito Santo; it is from these deposits that practically all the mica exported from Brazil has been obtained. The country varies in height between 2,500 feet and 4,000 feet above sea-level, and the pegmatite veins possess an almost due north and south direction along the side of the Cayama and Popogais Mountain ranges, which form the watershed between the rivers São João do Rio Preto and Carangola.

As a rule, the rocks of Brazil are decomposed to a great depth; this is particularly the case with the metamorphic schists in the regions where the pegmatite veins are found. Several parallel veins frequently occur close to one another and some of these continue for considerable distances. Owing to the country being thickly wooded, the outcrops are not easily discovered, but the presence of pegmatites is often indicated by projecting bosses of quartz.

The veins are from 20″ to 10 feet in width and generally consist of kaolin, resulting from the decomposition of the feldspar, in which 'books' of mica are irregularly disseminated. The dimensions of the mica 'books' vary considerably, ranging from 10″ × 20″ across and 6″ thick; but the average size is about 6″ × 6″ and 3″ thick. Much of the mica, also, is of the small spangle type.

Further, only a small proportion of the crystals contain marketable sheets, this being particularly the case with the mineral found near the surface, which is often partly weathered and hydrated.

About half a dozen mines have supplied mica for export, but only two have been worked at all regularly, viz. the Fonseca mine and the Coronel Seraphino mine.

Fonseca Mine.—The deposit was found on the summit and slope of a hill, where a large quantity of decomposed friable mica lay uncovered by the erosion of the pegmatite vein. The quality of the crystals improved greatly in depth and the quantity showed no signs of diminishing. The feldspar being completely kaolinized, little trouble was experienced in extracting the mica plates, mining being carried on by means of open pits and trenches. At a depth of some 30 feet, a large mass of quartz was met and mining had to be continued downwards on either side of the obstacle.

Fig. 8 shows a cut through the deposit, which possesses a width of about 7 feet at the surface. The mica crystals are not, as is often the case in pegmatite veins, confined to any particular zone in the dyke, but are scattered throughout the entire feldspathic portion. The output up to date is estimated at about 30 tons of marketable mica. Several other promising outcrops have been located on this property.

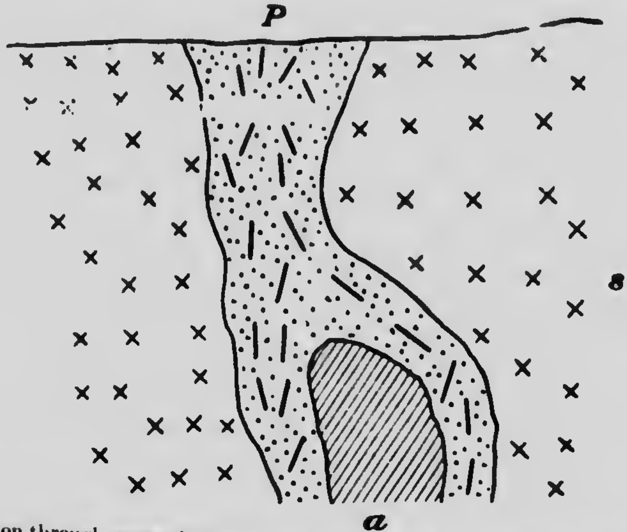


FIG. 8.—Section through pegmatite vein in the Fonseca mica mine, State of Minas Geraes, Brazil. (*After H. K. Scott.*)
P, pegmatite; s, metamorphic schist; a, quartz.

Coronel Seraphino Mine.—This mine lies about half a mile south of the Fonseca property, and is situated upon an extension of the same dyke as has been worked there. The occurrence of the mica at the two mines is identical, but the vein here is only about 3′–6″ wide and the mica crystals are somewhat smaller. The total production of the mine amounts to about 20 tons of trimmed mineral.

Further pegmatite dykes have been discovered in the immediate vicinity and others doubtless exist, but the country being very thickly wooded, it is extremely difficult to carry out prospecting work.

As already remarked, the quality of the mica sheets at the surface and for a little distance downwards is generally poor owing to hydration, but the sheets, as soon as the weathered zone is passed, are found to improve rapidly.

The greater part of the mica produced is utilized in the country for lamp chimneys, stoves, etc., the remainder being exported to London and the United States.

The mining methods are of a somewhat primitive nature, and as little care or pains need to be exercised in the extraction of the crystals from the soft kaolin matrix, unskilled labour is usually employed. The mica 'books' are roughly cleaned of decomposed mineral in the pits and are then passed on to women who trim off further valueless portions and split the sheets into plates $\frac{1}{8}$" to $\frac{1}{4}$" thick. These are finally trimmed on the guillotine machine and packed for shipment. The grade of mica is known as 'ruby' and about 50 per cent of the mineral shipped averages 6" across the plates. A considerable proportion (about 70 per cent) of the run-of-mine is useless owing to crushing or to the inclusion of foreign mineral substance, principally magnetite and limonite, between the laminæ.

Grading of the mica is not very carefully attended to, and the inclusion of flawed sheets in the shipments has both detracted from the value of the same on the London market, and has probably mitigated somewhat against an increasing demand for Brazilian mica amongst English consumers.

The mica sheets are packed into boxes of about 100 pounds, and conveyed by pack mules to the nearest station of Santa Luzia, some 10 – 15 miles distant.

The cost of marketing Brazilian mica is approximately as follows:—

	Per ton.
Cost of mining, trimming, and preparing for market, including transport to Santa Luzia station of the Leopoldina railway........	\$ 243.50
Freight charges to Rio de Janeiro.........................	7.80
State export tax..	29.22
Storage, transhipment, etc...............................	4.87
Freight to Europe or United States, with insurance, wharfage, etc..	24.35
	\$309.74

Considering the simple methods which can be employed in the mining of Brazilian mica and the low cost of labour, it is surprising that the industry has not progressed farther. As it is, the output of the Brazilian mines has steadily decreased and appears, at the present time, to be practically nil.

The united production of mica and talc from 1902-6 is given as follows:—

1902....................................	11 tons.
1903....................................	7 "
1904....................................	14 "
1905....................................	1 "
1906....................................	6 "

NORWAY.

An attempt to mine muscovite in this country was made in the nineties and pits up to 100 feet in depth were excavated. At the one, and apparently the only, point at which mining was essayed, namely the Godfjeld Mine[1]

[1]Colliery Guardian, Vol. LXXVIII, p. 32. Also Mineral Industry 1899, p. 428.

near Skutterud, on the southwest coast, a pegmatite dyke of considerable width was exploited. The mica crystals were, as a rule, small, though dimensions of 12" × 21" were occasionally met with. The mica-bearing zone forms a lens in the dyke and carries crystals of a green colour, which, however, near the surface, are much stained by iron, while a large proportion of even the fresh crystals are rendered useless by inclusions of garnet, tourmaline, and other minerals. A curious feature of the tourmaline penetrating the mica is that the long axes of the tourmaline prisms are often parallel with the vertical axes of the mica crystals, though the more usual vertical position is also met with. The most peculiar feature, however, is that the basal planes of the mica crystals are seldom parallel to one another, the results being that the sheets obtained are thicker at one end than at the other. It was found that after a depth of some 60 feet was reached, the mica became brittle and rotten, and was in part altered to steatite. The crystals are soft when extracted, but harden after a short time. No records of any large shipments are to hand, and it would appear that mining has now ceased.

CHINA.

Large deposits of white mica are reported to occur in China, the locality being supposed to be in the vicinity of Kiao-Chau bay. According to the latest information supplied by the Chinese Board of Agriculture, Labour, and Commerce, no important development of the deposits has ever taken place, a small amount of mica only having been mined for ornamental purposes and for painting upon. Deposits are also reported from Tschoutschong in Shantung, but lack of transport facilities would appear to prove an obstacle to their development.

ARGENTINE REPUBLIC.

Mica bearing pegmatites yielding large, clear sheets have been developed in a small way in the mountain districts of the province of Cordola. The output of the mines up to the present time is inconsiderable.

SOUTH AUSTRALIA.

Sheets of fine quality muscovite were obtained some years ago in the MacDonnell range, but transport difficulties alone resulted in an additional cost per ton of $125, and this seems to have effectually prevented the development of the deposits. All the mineral produced was shipped to London. Muscovite has also been discovered in Western Australia, but the exact locality is not specified.

SOUTH AFRICA.

According to recent reports,[1] extensive mica-bearing pegmatites exist in South Africa. The locality where the most promising dykes have been discovered is 25 miles east of Leydsdorp, near the Olifants river, in the Northern Transvaal. The veins run almost due east and west, and have been traced for a distance of some 60 miles. The mica is said to be unusually clear and perfect. Crystals measuring 16″ × 8″ across have been taken from the surface deposits. The region is known as the Maentsi mica-fields. The following notes on the above district are taken from the "Mineral Industry," 1910:—

The Leydsdorp Mica, Limited, is a new Company organized for mining mica in the Transvaal. The property consists of 600 base-metal claims, comprising an area of about 1¼ × ¾ miles of a ridge along the northern bank of the Olifants river. The property has been held up for nearly three years and during 1910 preparatory work was carried out in anticipation of the completion of the Selati railway, which will afford access to the district. About 200 natives are to be employed. Working costs have been estimated for present transport conditions, and have been found to be £75 to £95 per ton of rectangular cut mica (not less than 4″ in length) delivered in London.

In addition to the foregoing countries, mica has also been mined in small quantities in Russia, Saxony (chiefly lepidolite and zinnwaldite for their lithium content), Mexico, New Zealand, and Ceylon.

BUSINESS METHODS OF SHIPPERS.

Although the tests which have been carried out upon different varieties of mica obtained from various parts of the world, such as Ceylon, German East Africa, Brazil, India, Canada, [illegible] shown that first-class, clear muscovite possesses as high a [illegible] as amber mica or phlogopite, the latter variety is preferred [illegible] of electric machinery on account of its softness and [illegible]. Large-sized, perfect, and uniform sheets of amber mica always [illegible] price, and Canadian phlogopite is recognized in the trade as the [illegible] for use in electrical appliances. This being so, it is to be regretted that the majority of the Canadian producers do not endeavour to retain for the output of the mines the reputation which high-class amber mica most certainly enjoys among consumers of the mineral. It has to be admitted, regrettable though it is, that mica merchants in this country have for many years defeated, and still defeat, their own interests, by the tactics they pursue in the disposal of their mineral. It is not so much the fault of the larger operators as of the smaller dealers, though even the former indulge to some extent in similar practices. Several attempts have

[1] Mineral Industry, 1909.

been made to establish a market for Canadian phlogopite in Great Britain, but always without effect, and the blame for this would seem to rest entirely with Canadian shippers, who are, for the most part, satisfied to dispose of their stock on this side of the Atlantic. The failure to establish relations with English consumers is due almost entirely to the refusal or inability of shippers to furnish uniform and reliable consignments of mica to foreign consumers. This is a fact which is amply borne out by the statements of consignees and is in part admitted by the shippers themselves. The system of grading mica in vogue amongst Canadian merchants is hopelessly unsatisfactory and completely prohibitive of any well-established dealings being conducted with foreign buyers. This applies not so much to the large mine-owners who produce a more or less uniform grade of mica from one mine, or who use care to prevent the output of one mine from being mixed with that from another, but to the operators who confine themselves to working small pits scattered all over the mica areas, and who produce half a dozen grades of mica all possessing different colours, degrees of resilience, hardness, etc. Many of the former class of operators conduct considerable business with trans-Atlantic consumers, and the material furnished would appear to afford satisfaction. It is the latter class of dealers with whom the blame for gaining for consignments of Canadian amber mica the reputation of being unreliable and seldom up to standard chiefly rests. These small dealers often both mine, themselves, in a small way, and, in addition buy up small parcels of mica from farmers, etc., who work pits on their properties in a sporadic fashion, when they have nothing better to do. In this manner a quantity of mica (generally of relatively small size, up to 3″ × 5″) but averaging 2″ × 3″ and under, since any small mine producing large sheets would almost certainly be taken over and developed on a large scale by an experienced operator) is collected together, and since there is often insufficient of one grade and colour to make up an entire shipment, the various grades are mixed together and shipped in one consignment. Such a practice is naturally highly unsatisfactory to the consumer who desires as uniform a material as possible, and more often than not results in an absence of further orders, since by purchasing Indian mica he can depend upon securing uniform and reliable shipments.

This, however, is not all, and accounts only in part for the disfavour with which Canadian mica is regarded in the English market. Another, and an even more serious factor, is the practice prevalent among the smaller operators and dealers, and even to some extent among the larger producers, of including in their shipments a considerable amount of absolutely useless mica, rubbish in fact. Especially is this the case in consignments of the smaller grades, 1″ × 3″ and 2″ × 3″. English dealers complain that such shipments almost invariably contain a very large percentage of crumpled, crushed, and distorted sheets, which are utterly useless for electrical purposes and are only fit as scrap for grinding, etc. Compared with the methods followed by Indian shippers who take pains to include only perfect plates in their consignments, the procedure of Canadian dealers is crude in the extreme and has most certainly been the means of preventing an expansion of trade with Continental consumers.

It must, of course, be remembered that the peculiar nature of Canadian phlogopite deposits is to a large degree responsible for the inclusion of considerable quantities of inferior sheets in the output of the mines. Compared with white mica or muscovite, the percentage of amber mica sheets spoilt through distortion, creasing, or crushing while in the ground, is extremely high. Muscovite crystals, and also phlogopite crystals from foreign localities, would appear to have suffered a far smaller degree of natural distortion, and the sheets are seldom found to be crushed to anything like the same extent as plates of Canadian phlogopite. This disadvantage, added to the fact that the cost of labour necessary to mine amber mica is many times greater than that of the native miners employed in mining muscovite, has imbued Canadian producers with a somewhat erroneous idea of the value of their mineral, and has resulted in the adoption of the present parsimonious methods, whereby every scrap of mica is collected and sold. Small and crushed sheets are readily accepted by American and Canadian manufacturers, since they can be employed in the formation of mica-board, which has to a large extent supplanted the use of sheet-mica on this side of the Atlantic. English and Continental buyers, however, stipulate for perfect sheets, free from flaws, cracks, creases, etc., and which are cleanly trimmed; that is to say, are perfect to their edges and yield plates having a surface consistent with the dimensions agreed upon. Canadian dealers having to furnish a parcel of sheets measuring 2″ × 3″ regard themselves justified in supplying plates having maximum dimensions of 2″ and 3″, and often possessing ragged and irregular edges. The English consignees, on the other hand, maintain that a sheet of 2″× 3″ should yield a surface of approximately 2″ × 3″ to 6 square inches, and complain that the 2″ × 3″ grade supplied by Canadian dealers often yields a surface of only 2 or 3 square inches and even less. The following excerpts from a communication from Messrs. F. Wiggins & Sons, 102 Minories, London, one of the largest mica dealers in the world, show the disfavour with which the methods pursued by Canadian shippers are regarded: "Canadian mica miners have undoubtedly a reputation here for being unreliable, the goods being rarely up to sample in quality or grading, and usually a lot of absolute rubbish is included. Another thing to be remembered is that this is a free market, and Canadian mica has to compete with mica from all parts of the world, particularly with India, Ceylon, South America, and South Africa, the latter three districts all producing 'amber' mica of equal quality and *far better trimmed* than Canadian amber mica; some of the recent shipments from South Africa are the finest and softest amber mica we have ever handled. We enclose samples of South American, Ceylon, and South African amber mica to show the quality and trimming of the product of these countries. *Now compare these with the Canadian thumb-*

trimmed amber mica with its rough edges, its excessive amount of waste, and its buckled and useless pieces. . . . . while Africa and India send to this country mica in comparatively perfect plates, with every flaw and crack cut out and all useless stuff trimmed away. Can you wonder that the Canadian trade does not flourish in this country?"

Enough has been said to show that the failure to establish a trade in mica between Canada and Great Britain rests to a very large extent with the Canadian dealers themselves, and until a more satisfactory and rational method of grading is adopted it will be hopeless to expect a betterment of existing trade relations. Trans-Atlantic consumers are ready and willing to pay high prices for high-grade amber mica, for which a large demand exists, but are naturally reluctant to pay exorbitant sums for consignments which include large percentages of rubbish. If Canadian mine-owners, dealers, and middlemen, are satisfied to dispose of their material in the home and American markets, there is nothing further to be said. If, on the other hand, they are desirous of extending the Canadian mica trade with Great Britain, the solution of the problem lies entirely with themselves. Let them combine to establish a uniform and practical system of grading, adopt business methods which show some desire to study the wishes and requirements of the English market, and endeavour to establish a reputation for Canadian amber mica of reliability and quality. As long as present methods are pursued, the mica mining industry in this country cannot but deteriorate.

CHAPTER III.

PHLOGOPITE OR AMBER MICA.

General Occurrence in the Province of Quebec.

The amber mica deposits of the Province of Quebec, while not confined solely to the region bordering on and between the Lièvre and Gatineau rivers, and comprised within the county of Ottawa, have nevertheless been chiefly exploited in that district.

The mica-bearing dykes, or pyroxenites, find probably their greatest distribution throughout the region immediately to the north of the city of Ottawa, the typical green rock being met with on most of the exposed eminences in the townships of Templeton, Wakefield, Hull, Portland, etc. These dykes are known to extend westwards into Pontiac county as far as the townships of Bryson and Waltham, while eastwards mica outcrops associated with similar rocks have been located in Argenteuil county, Wentworth and Harrington townships, and even as far east as Montmorency and Wolfe counties in the neighbourhood of Quebec. These deposits, though as yet but little developed, owing partly to small ownership, and partly to present insufficient means of communication and transportation, are yet valuable as showing the extent of country traversed by the mica-bearing rocks and as indications of the probable existence of reserves of the mineral outside the area at present exploited.

Northwards, the limits of the mica-bearing zone are practically unknown. Mica has been profitably mined in the townships of Cameron and Egan, and promising outcrops are reported to have been located even farther north than this, in the townships of Aumond and Lytton. Hence, though the mica deposits which have up to the present been actively exploited are those lying within easy reach of railway communication or of other good means of transport, there is every reason to presuppose the existence of equally valuable deposits beyond the limits of the area mentioned.

MICA MINES AND LOCATIONS.

The Lièvre River District.

OTTAWA COUNTY.

Township of Buckingham

Range IV, Lot 25 N. ½.—This is the only locality in the above township where mica has been mined to any extent. In 1899 some work was done by Mr. Tetreau, and again in 1900 by Mr. D. Richard. The workings consist of surface pits, and a couple of tons of small mica were taken out. The deposit has not been worked since the last-named ceased operations.

Township of East Portland.

Range I, Lot 1 E ½.—Known as the Poupore mine, and belongs to Mr. E. Wallingford, of Perkins Mills. The mine was idle when visited, work having been suspended some three years before.

The workings are situated on a small knoll close to the main road from Buckingham to Glen Almond, and consist of one pit down some 50 feet, and about half a dozen shallower openings.

There are two horse derricks and several small buildings on the property.

The deposit appears to be of the pocket type, and the mica occurs in fair sized crystals of medium amber colour in a dark compact pyroxenite, accompanied by small quantities of pink calcite.

The property was originally prospected in 1893 by Mr. J. W. Poupore, who took off it several tons of mica, and resumed operations in 1900 for a few months.

Lot 1, 2 E. ½.—This property is situated on a steep ridge to the west of and adjoining the Poupore mine. Originally a phosphate mine, it was exploited some ten years ago, with a dozen men, by the Glen Almond Mica and Mining Company, who carried out trenching operations and drove a small adit into the hill.

No work has been done here since 1902.

The formation is a medium-coloured pyroxenite traversed by numerous fissures and filled with pockety cavities lined with pyroxene crystals and containing much pink calcite and green apatite.

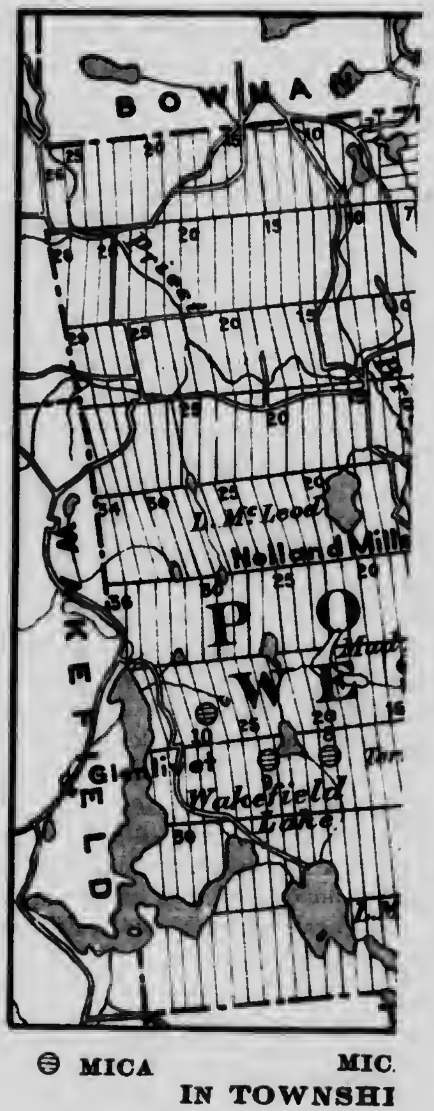
A considerable amount of small grade mica is reported to have been taken from the workings, and some larger sheets were found as drift in the surface soil.

The deposit is a good type of the pocket class, pits on the slope of the hills disclosing funnel-shaped chimneys in the rock which narrow down to small crevices and contain closely-packed masses of small mica crystals.

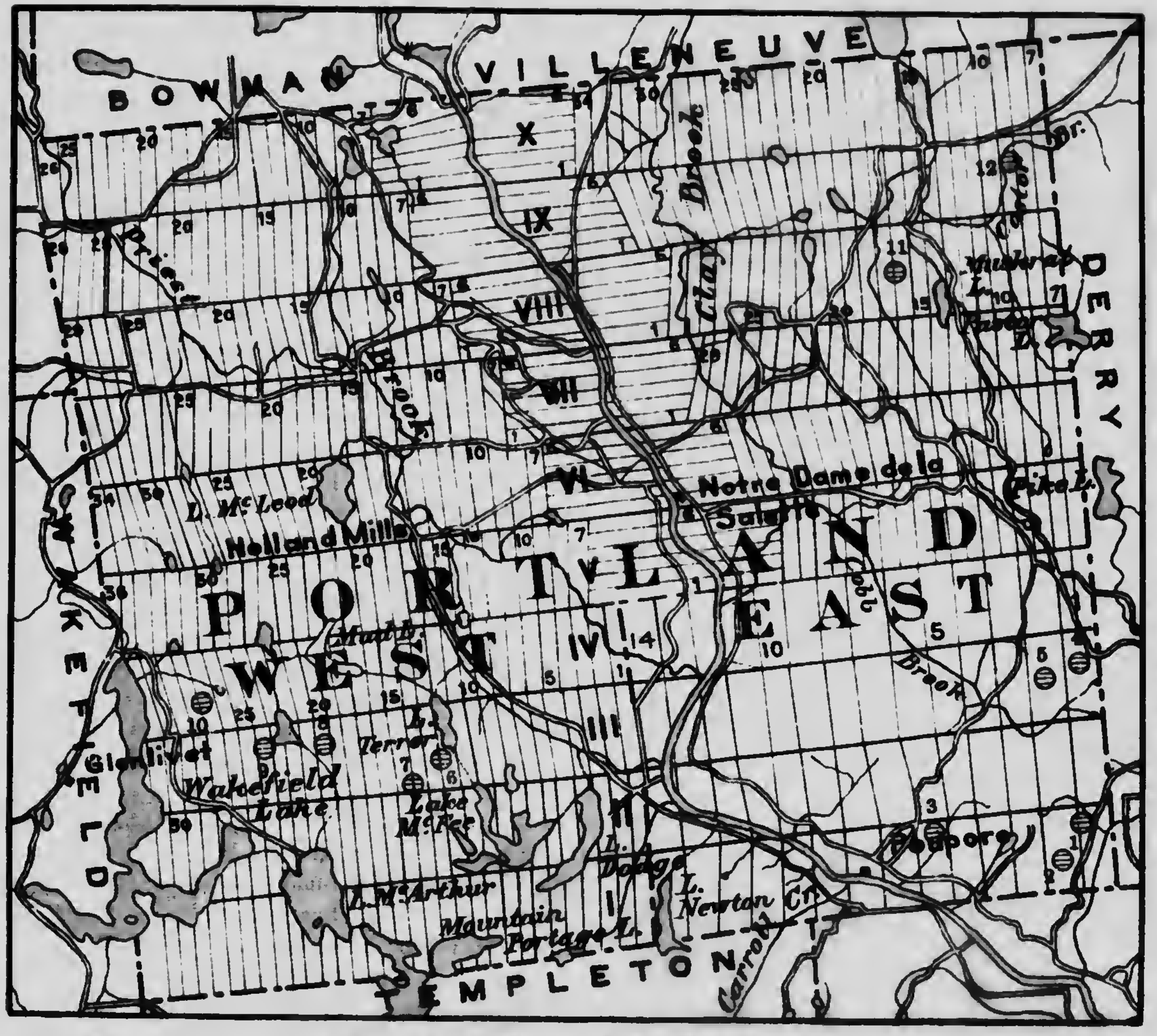
Lot 6.—Formerly an important phosphate producer, and known as the Little Rapids mine. The property is at present owned by Mr. W. A. Allan,[1] of Ottawa, who carried out considerable surface work by means of pits and drifts in 1892, and secured several tons of fair mica.

The deposit is of the fissure and pocket class and is of considerable extent, being especially valuable for the amount of phosphate it yielded. The mica is a dark amber, of good size, but a large proportion of the crystals is crushed and twisted. The mica occurs chiefly embedded in the apatite which is largely of the "sugar-phosphate" variety, often including good-sized and well-formed apatite crystals of the usual hexagonal prismatic type and green

[1] Mr. Allan sold out in 1911 to Messrs. O'Brien and Fowler, who are erecting machinery and re-opening the old workings.



⊖ MICA MIC.
IN TOWNSHI



No.	Name of Mine
1	Poupore
2	Poupore
3	Little Rapids
4	O'Brien & Fowler
5	O'Brien & Fowler
6	Lake Terror
7	Chabot
8	Prospect (White Mica)
9	Lila
10	Allan & Fleming
11	Tamo Lake
12	O'Brien & Fowler

⊜ MICA

MICA MINES AND OCCURRENCES
IN TOWNSHIPS OF EAST AND WEST PORTLAND, QUE

Scale 2 miles to one inch

1 ½ 0 1 2 3 4 5 Miles

in colour. Both the pyroxenite and the country rock (the latter a dark gneiss) are much shattered and traversed by numerous joints and fissures along which considerable crushed mica occurs. The pyroxene crystals weather readily, becoming brown and powdery as a result of exposure.

Range III, Lots 1, 2.—Worked some 25 years ago by the France Mining Company for phosphate. No extensive work was carried out, operations being for the most part confined to the surface.

The property now belongs to Messrs. O'Brien and Fowler, of Ottawa, who have had eight men employed in trenching and drifting during the past year. On lot 2, the principal opening is a trench about 15 feet deep driven at right angles to the strike of the pyroxenite dyke. This opening disclosed good showings of green apatite and mica crystals of fair size and of good amber colour. The dyke is here not of the usual pyroxenitic type; indeed little normal pyroxenite is to be seen in any of the exposures. The rock is, for the most part, a light-coloured aggregate of grey augite and whitish plagioclase with accessory pyrite. In many instances the plagioclase has been altered to scapolite or its variety wilsonite, several examples of the latter pink mineral being observed (Plate II).

This augite-scapolite rock seldom contains any mica, but pockets of apatite frequently occur in it. Small aggregates of medium sized black tourmaline crystals were observed at one spot, and an interesting occurrence in a bed of sugar-phosphate on lot 1 was a drusy mass of small purple and green fluorite crystals of octahedral habit intimately associated with small dark phlogopite crystals and faujasite.

It has not been ascertained whether the mica-bearing dyke forms one broad belt over both lots, or whether there is a series of parallel bands cutting the country gneiss at short distances from one another. Mica has been found at many spots on the property and generally occurs in small pockets with pink calcite. Well-formed apatite crystals, up to 12″ in length, are found in certain of the cavities, sometimes lying in calcite and sometimes in sugar-phosphate.

The principal work is at present being carried out on lot 1. Here several pits and drifts have been excavated on the side of a small hill adjacent to numerous old workings of the France Mining Company. Large quantities of phosphate have been found and also considerable mica in medium-sized crystals of excellent colour and quality.

An adit has been driven some 50 feet into the hill on an inclined fissure carrying good mica, and a drift sunk at the base of an escarpment to the west of the adit has also struck a promising deposit on what is probably a part of the same fissure (See Plate III). A crystal measuring 24″ × 18″ across has been taken from this drift.

The general trend of the mica-bearing rock is north and south and the mica occurs both on its eastern contact with the country and on irregular fissures in its mass having no definite direction.

No machinery is used on the mine—ordinary boom-derricks worked by horse-power, being employed, and the drilling done by hand.

Work was suspended on this and all other mica properties belonging to O'Brien and Fowler in the autumn of 1910, but operations are to be resumed in the spring.

Range VIII, Lots 16, 17.—Known as the Tamo Lake mine, and owned by O'Brien and Fowler of Ottawa. This and the succeeding property were formerly mined for phosphate, and have been surface worked by the present owners during the past year for mica, about two tons of rough mineral having been produced.

Range IX, Lot 9.—Also owned by O'Brien and Fowler, and has been worked by means of surface pits and trenches during the past year.

Some three tons of rough mica were taken out. Both this and the preceding property are of the usual pockety type in a normal pyroxenite.

Township of Derry.

Range I, Lot 4.—Worked by Mr. Davis, of Glen Almond, for six months in 1909.

The property is situated upon the same ridge, and is part of the same deposit, as that formerly worked by the Glen Almond Mica and Mining Company.

The mica is small and occurs in pockets with green phosphate and much pink calcite.

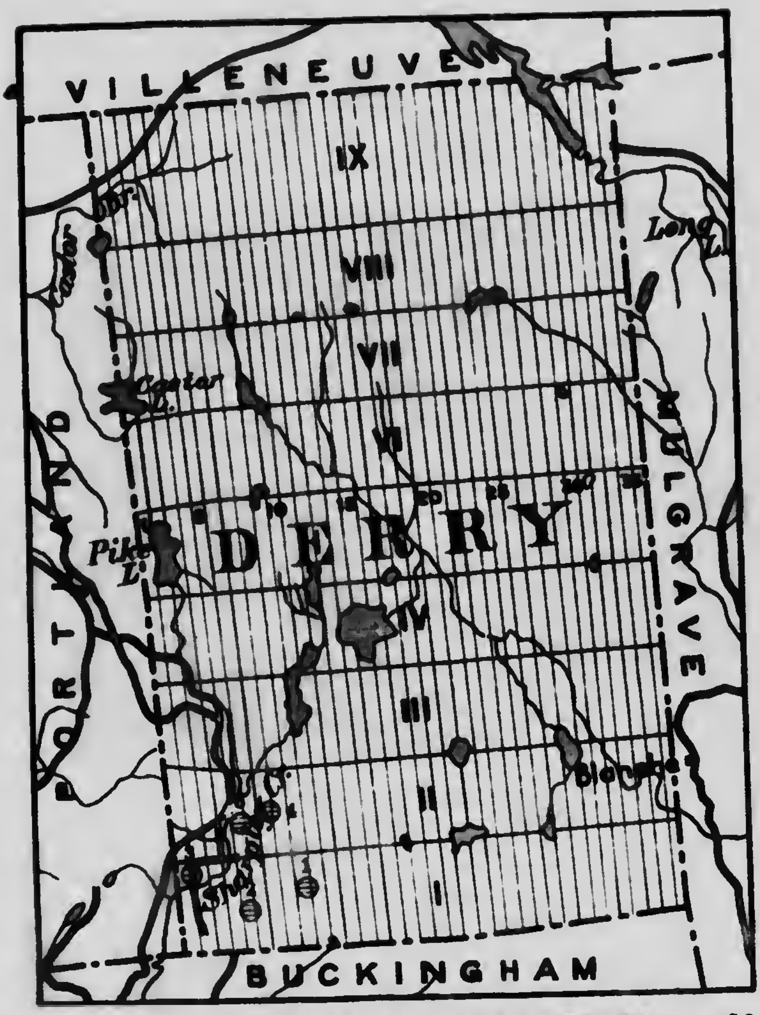
The workings consist of a few small pits, and were full of water when visited.

Lot 5, Cameron Mine.—Belongs to Dr. Sicard and Mr. J. S. Taylor, of Buckingham. The workings, which consist of a trench 30 feet long, 70 feet deep, and 6 feet wide, with a drift at the bottom of the pit, lie at the foot of the ridge upon which the Daisy mine is situated. The last work done here was carried out in January 1907, by the owners.

The mica is small and occurs in pockets and on narrow leads in a coarse-grained pyroxenite. The deposit is probably a continuation of the Daisy mine contact. The rock is very similar at both places, but there is far less iron pyrites to be seen at the Cameron mine, while the mica is rather darker in colour. No machinery was ever used on the mine. An examination of the hillside above the mine disclosed traces of mica at several points, and prospecting over the ground between the two mines might prove of value.

About ten tons of thumb-trimmed mica have been taken off the property.

Lot 9.—Known as the Daisy mine. This property formerly belonged to Mr. W. A. Allan, of Ottawa, who carried out considerable work around the year 1900, with seven men, reaching a depth of some 80 feet in the south workings.



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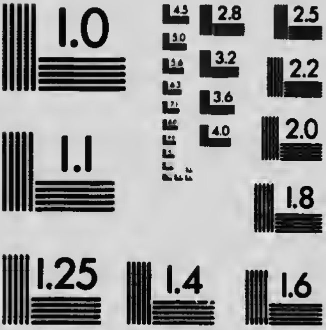
⊖ MICAMICA MINES AND OCCURRENCES
IN TOWNSHIP OF DERRY, QUEBEC

Scale 2 miles to one inch

No.	Name of Mine
1	Daisy
2	Cameron
3	Davis
4	Allan
5	Glen Almond

MICROCOPY RESOLUTION TEST CHART

(ANSI and ISO TEST CHART No. 2)



APPLIED IMAGE Inc

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Rochester, New York 14609 USA
(716) 482 - 0300 - Phone
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PLATE II

Inclined mica lead, showing adit, lot 1, range III, township of East Portland, Que.

PLATE III.

Boulder of pyroxene scapolite rock—exposed in surface workings, lot 2, range III, township of East Portland, Que.

In 1908, the mine was sold to Rogers, McCracken, and Lewis, of Ottawa, who only worked for six months. Since the last named ceased work, the mine has lain idle and the pits are full of water.

The workings are situated on the top of a high ridge and close to the shore of a small lake. In consequence of its proximity to the water, the mine is a wet one, and operations were much hindered by the infiltration of lake water.

There are about a dozen pits on the property, ranging from 10 to 80 feet deep and excavated on the contact of a pyroxenite dyke with the country gneiss. The pyroxenite is a loose green rock containing cavities and fissures lined with large and well-formed crystals of pyroxene. There is much iron pyrites present in the rock and the mica is consequently rather brittle and generally of a reddish-amber colour. Some phosphate occurs and a little white coarsely crystalline calcite. In addition, the occurrence of pink and green fluorite, of the zeolite faujasite, and of datolite (botryolite), is of interest.

Quartz also occurs in well-formed crystals frequently lining the walls of druses and cavities in the pyroxenite.

At the north end of the workings a massive quartz dyke containing a few scattered crystals of pink orthoclase forms the foot-wall of the pyroxenite dyke. This quartz dyke is from 8 to 10 feet across and is sharply defined, having been apparently formed subsequent to the pyroxenite and along the contact of the latter with the gneiss.

The mica is, as above remarked, rather brittle and inclined to split up into ribbon mica. The pyroxenite dyke strikes almost due north and south, and the mica occurs on its contact with the country and also on joints and fissures in the pyroxenite itself adjacent to the contact Exposures of mica can be traced along the latter for over half a mile.

The mine is equipped with the usual buildings, including boarding-house, culling-sheds, smithy, etc.

The property lies about 14 miles north of Buckingham.

Lot 23.—Prospected in 1897 by Mr. McTiernan with several men.

About three tons of rough mica were taken out. No work has been done since the above date.

Range II, Lot 7.—Belongs to Mr. W. A. Allan, of Ottawa. This property, upon which there are several shallow pits and drifts, lies in a swampy flat at the foot of the hills on which the Daisy mine is situated. Several small knolls of pyroxenite rise out of the swampy ground and carry considerable quantities of good quality mica crystals. The deposit is of the pocket type and much pink calcite occurs with the mica. The property was last worked five years ago with half a dozen men by the present owner, who continued operations for about eighteen months.

Water is understood to have caused considerable trouble in the pits.

The appearance of the deposits is promising, and the property should repay more extensive development.

Lot 23.—An old phosphate property, prospected and worked for mica in 1899 by the Glen Almond Mica and Mining Company. Several tons of rough mica were obtained. No further work has been done on the property.

Range III, Lots 3, 4, 6.—Some prospecting was carried out by the above Company in 1900, but results did not lead to any active mining being undertaken.

Township of Villeneuve.

Range II, Lot 2.—Belongs to Mr. J. B. Gautier, of Buckingham. This mine is situated 3 miles south of Val des Bois and close to the Lièvre river. The mica is shipped away by boats in summer and transferred to carts at a point some half mile up the river, whence it is transported by road to High Falls and shipped to Buckingham.

The property was not being worked when visited, but operations have since been resumed. The workings consist of a number of pits, the deepest of which is down some 45 feet, sunk on a line of pockets in a pyroxenite dyke.

These pockets, which in places extend to form well-defined leads and contain medium-sized crystals of a fair quality mica accompanied by some white calcite, occur along the western contact of the pyroxenite dyke with the grey country gneiss.

The dyke has a strike of almost due north and south, and conforms to the strike and dip of the country rock.

The dyke mass consists of a very light-coloured, grey, and somewhat soft, pyroxenite.

The mica occurs sometimes as individual crystals in the rock, but more often in the pockets, the walls of which are frequently lined with well-developed pyroxene crystals.

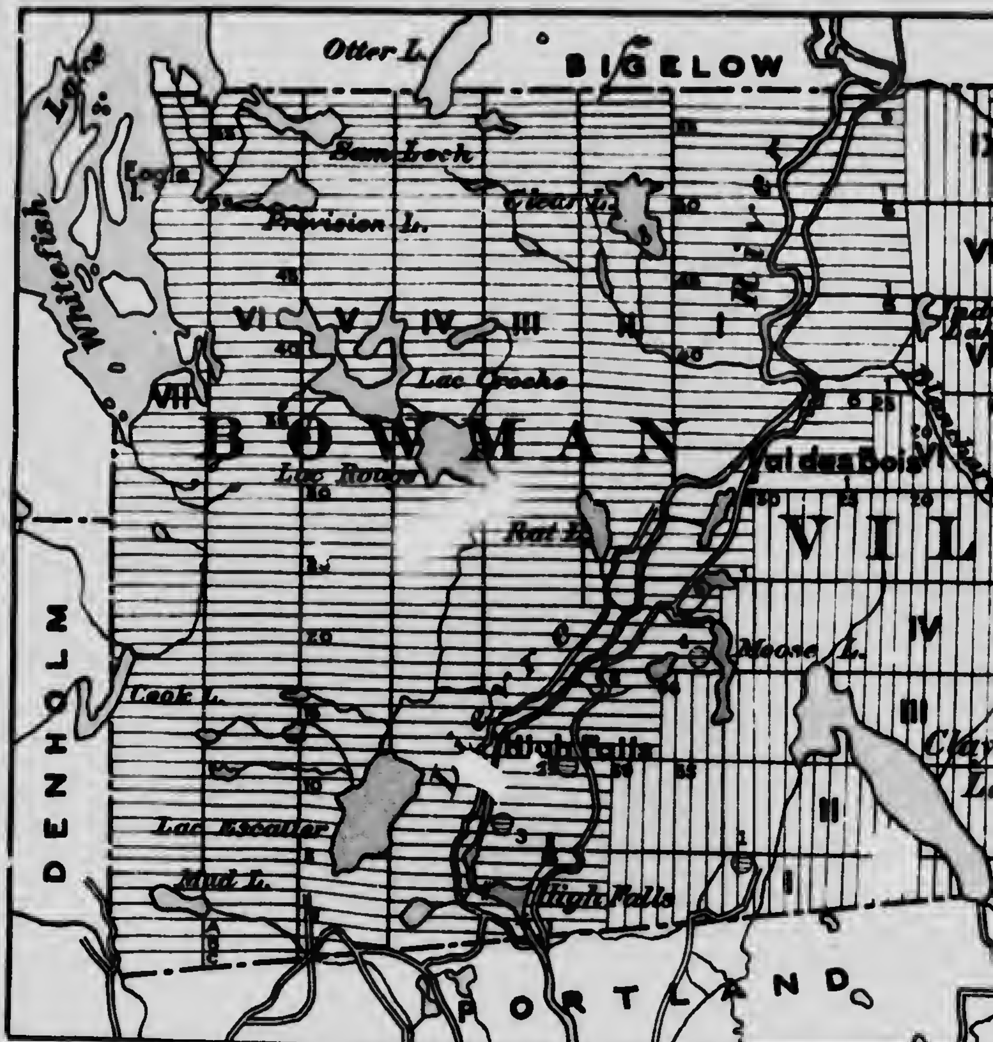
There is no machinery on the mine, and only a small number of men, usually four or five, have been employed. Work was stopped owing to the low price of mica.

Lot 6.—Owned by Mr. P. Pichette. Some prospecting work was carried out by the owner two years ago, and a small quantity of good quality mica is reported to have been taken out.

The deposit is of the fissure and pocket type in normal pyroxenite, the dyke striking north and south in grey biotite gneiss.

Range IV, Lot 1.—Moose Lake mine. This property was first exploited in a small way in 1908, and was taken over by O'Brien and Fowler in November, 1909. The mine is situated about half a mile west of the road leading from Notre Dame de la Salette to Val des Bois, and is connected with the main road by a good bush track.

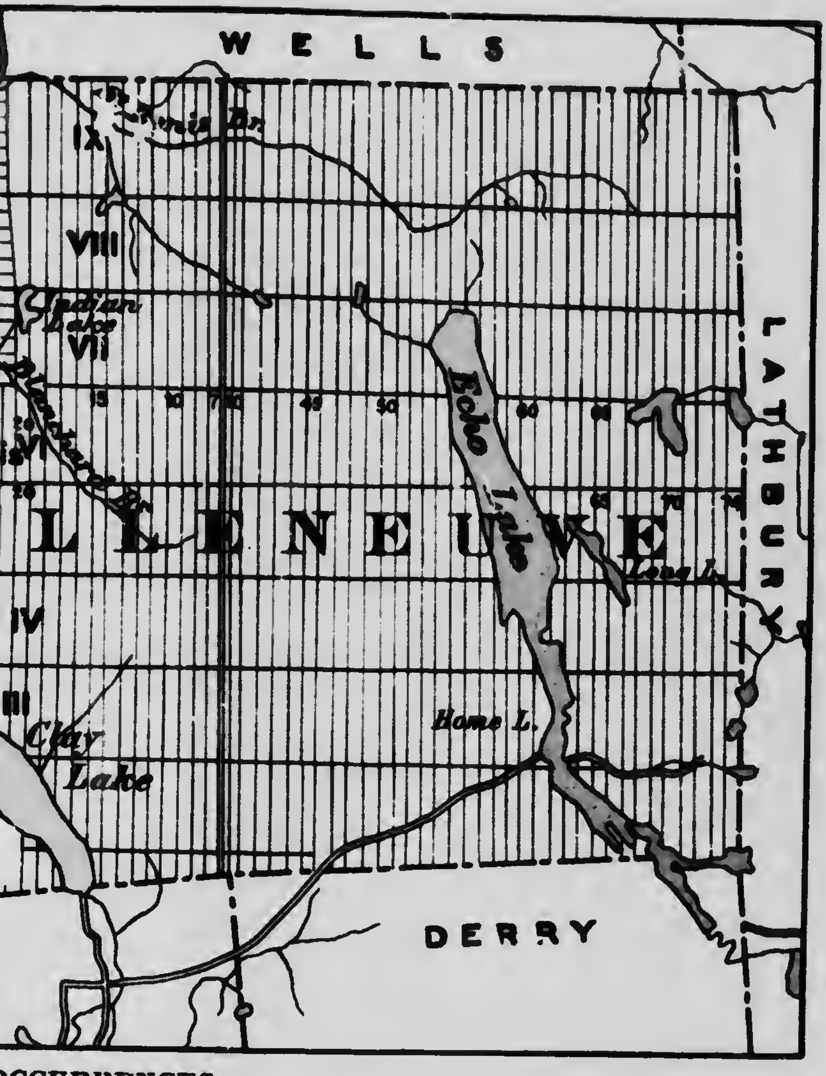
Work has been carried on steadily by the present owners since 1909 up to the present time, and some 82,000 pounds of thumb-trimmed mica ranging from 1″ × 1″, to 3″ × 5″ have been produced. Ten men are employed on



MICA

MICA MINES AND OCCURR
IN TOWNSHIP OF VILLENE

Scale 2 miles to one inch



No.	Name of Mine
1	Villeneuve
2	Prospect
3	Gautier
4	Moose Lake

OCCURRENCES

LLENEUVE, QUEBEC

one inch

3 4 5 Miles

PLATE IV.

Mica vein at Moose Lake mine, lot 1, range IV, township of Villeneuve, Que.

the mine which is provided with boarding-house and the usual buildings. No machinery is in use at present, two boom-derricks worked by horse-power being employed for hoisting.

The workings are entirely superficial and consist of a number of surface pits and drifts sunk on the west side of a hill about a hundred feet high. The west slope of this hill consists of pyroxenite which forms a dyke striking almost due north and south and in contact with grey biotite gneiss on the east, and crystalline limestone on the west (Fig. 9). The limestone has

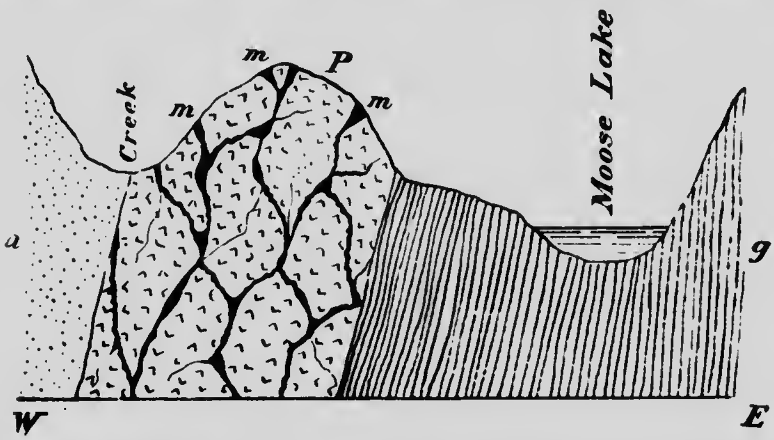


Fig. 9.—Section at Moose Lake mine, lot 1, range IV, township of Villeneuve, Que. a, crystalline limestone; P, pyroxenite with pockets and irregular leads of mica, m; g, gneiss.

been much eaten out by the action of water, and good-sized caverns exist at the base of the hill. The pyroxenite is a normal and softish rock much traversed by fissures and containing numerous pockets in which the mica, a good quality amber, occurs, accompanied by pink and white calcite, some green phosphate, and considerable pyrrhotite. The dyke has been traced for a width of over 300 yards and mica exists over practically the whole area. The pyroxenite appears to have been considerably shattered and mica occurs on the joints and fracture planes as well as on fissure-veins. This mode of occurrence sometimes gives to the deposit the appearance of large boulders of pyroxenite cemented by calcite containing mica and phosphate.

Plate IV shows a good example of mica occurring on a true vein. Many good crystals of mica have been found in the surface soil and underlying decomposed rock and a fine example of a crystal sheared by glacial action was observed.

The deposit is of the pocket and fissure class. The mica crystals are inclined to the small side, the largest sheets obtained seldom exceeding 3″ × 5″.

Phosphate occurs only in small quantities and is not saved. The deepest pit on the property does not exceed 30 feet. The mica is sent to the Villeneuve mine, some 3 miles distant, to be trimmed.

Township of Wells.

Range I, Lot 16.—Belongs to Mr. St. Louis, of Notre Dame du Laus. Some prospecting work has been done here and a little amber mica found.

Range III, Lot 11.—Known as the Oriole mine.

This property belongs to Mr. G. McCabe, of Notre Dame du Laus, and was originally opened up for phosphate. Eighteen years ago operations were started by Franchot, Haycock, and Watters, of Ottawa, for mica, and over $18,000 worth of good quality sheets are reported to have been taken out.

The mine has not been worked since the above-named ceased operations, and all the buildings were burnt down in a bush fire ten years ago. The present owner is erecting new buildings and intends starting work again for mica in the near future.

The mica occurs in pockets in a pyroxenite dyke striking north and south and cutting biotite gneiss. The workings consist of surface pits and drifts which have been excavated for 100 feet along the mica lead.

Township of Bigelow.

Range V, Lot 52.—Belongs to Mr. W. Parker, of Buckingham. This property, which is situated to the west of the Lièvre river, and some 3 miles from Notre Dame du Laus, was first opened up some years ago by the present owner in conjunction with Mr. W. Cameron, of Buckingham.

Operations have only been conducted for some three months in each year. When visited, the mine had been working since the preceding May, three men and a foreman being employed.

The workings consist of one main pit, down about 50 feet, following an irregular and pockety mica vein, and numerous shallow pits and trenches opened up on pockets and joints in the pyroxenite. No machinery is employed on the mine.

The mica is a dark amber, of an olive green shade when viewed in thin plates, and is not a very good splitter. The crystals are of medium size, averaging about 6″ across, and occur with white or yellowish calcite in pockets and on joints in a pyroxenite dyke of medium colour and grain: the deposit is of the pocket and fissure type.

The dyke borders on crystalline limestone and the contact zone, on the northwest, contains considerable quantities of black hornblende. Some mica also occurs in the dark hornblende rock, but in this case the crystals are usually small, and more often of the 'spangle' variety.

Little or no phosphate accompanies the mica. Close to the main pit a small excavation disclosed a kind of pocket in the pyroxenite. This pocket is more or less filled out with a grey mineral possessing good cleavage and vitreous lustre, and often well crystallized. Near the surface the crystals are

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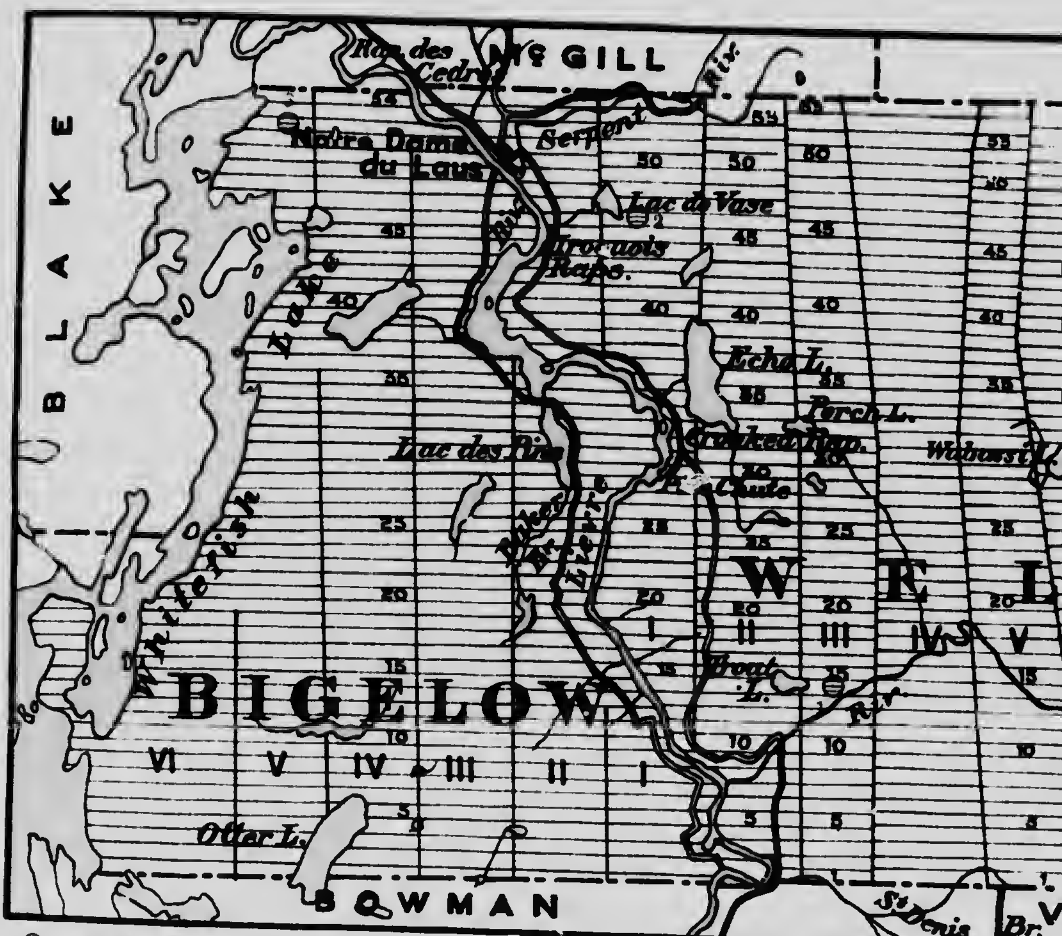
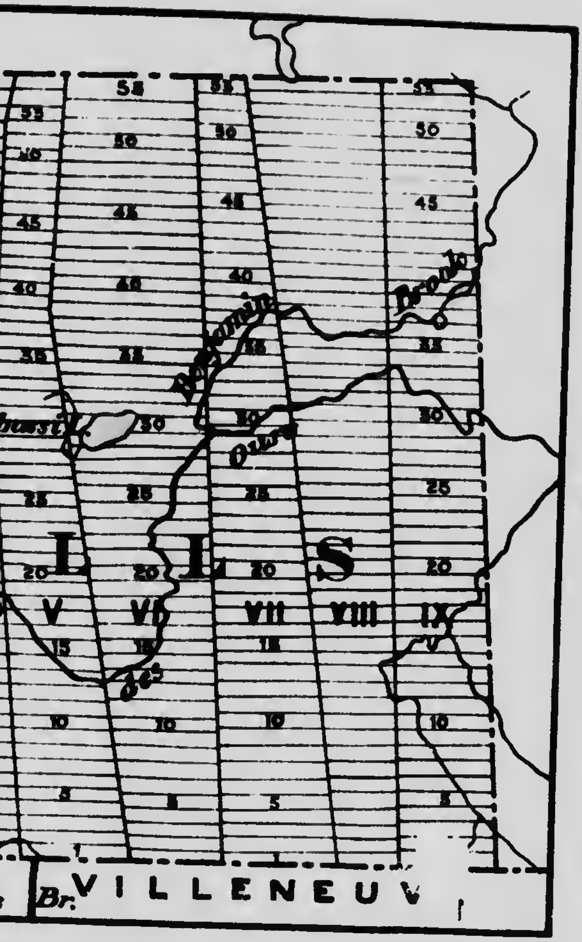


⊜ MICA

MICA MINES AND OCCURRENCES
IN TOWNSHIPS OF BIGELOW AND WELLS, Q

Scale 2 miles to one inch



No.	Name of Mine
1	Oriole
2	Prospect
3	Parker

ES
ELLS, QUEBEC

5 Miles

No.	Name of Mine
1	McVeity
2	Prospect
3	Prospect
4	Brady
5	Prospect
6	Prospect
7	Prospect
8	McElroy
9	Prospect
10	Phosphate King
11	Wallingford
12	[illegible] Rainville
13	Barbutte
14	Sophia
15	Prospect
16	Labelle & Bourke
17	Laurentide Co.
18	Goldring
19	Prospect
20	Gilmour
21	Prospect
22	~~Port~~ Post
23	Jackson [illegible]

MICA MINES AND OCCURRENCES
IN TOWNSHIP OF TEMPLETON, QUEBEC
Scale 2 miles to one inch

123

Prospect
20 Gilmour
21 Prospect
22 ~~Port~~ Post
23 Jackson Rae
24 Murphy
25 Smith or Jubilee
26 Victoria
27 ~~Gorur~~ Cornu
28 Prospect
29 Blackburn
30 Blackburn
31 O'Brien & Fowler
32 Prospect
33 Prospect
34 Prospect
35 Prospect
36 Prospect
37 Battle Lake
38 Progressive Mining Co.
39 Prospect
40 Rheaume Lake
41 Kent Bros.
42 King Edward
43 Blackburn
44 Briggs
45 ~~Marceline~~ Marsolais
46 Murphy

brown and friable through oxidization. The mineral is probably olivine and appears to have been deposited as a result of a later igneous intrusion into the pyroxenite. Especially interesting is the presence, both in the olivine itself and also in a whitish calcite which occurs scattered throughout its mass, of black spinel crystals. These are for the most part well formed individuals of octahedral habit, though combinations of octahedron, dodecahedron, and trapezohedron also occur. Twinning on the octahedral face is also common. The size of the crystals ranges from ¾" down.

Surface indications point to considerable quantities of mica on this property and also on adjoining lots, and the deposit deserves more extensive development. Up to the present no mica has been sold.

The rough mica is drawn from the mine to Notre Dame du Laus, where it is thumb-trimmed, packed into barrels, and stored.

Central Mica Region Comprising Templeton, Wakefield, East Hull, and West Portland Townships.

OTTAWA COUNTY.

Township of Templeton.

Range IV, Lot 22.—Known as the McVeity mine, and opened many years ago for phosphate. Messrs. Taylor and McVeity mined for mica in 1898, and took out a few hundred pounds of good mineral. The workings consist of a main pit 60 feet deep and 20 × 20 feet, from which a narrow trench 25 feet long and 15 feet deep has been carried along a narrow lead of medium quality mica and phosphate. The rock is a greyish pyroxenite and the deposit is of the fissure type.

Range VI, Lot 15.—Belongs to Mr. James Brady, of Perkins Mills, and was first worked by owner in 1900-1 for a few months with five men. Some good quality and large-sized mica was extracted, but no further work has been undertaken.

Several tons of phosphate were produced at the same time. The workings are situated 3 miles southwest of Perkins Mills, and consist of several small open-cuts or trenches, the deepest down 30 feet, sunk on fissures in a grey pyroxenite, and carrying mica, a little pink calcite, and brown phosphate. An unusual feature is the presence in the phosphate of druses lined with amethyst crystals. The quality of the mica is good, but the deposit does not appear to be of sufficient extent to warrant any extensive work being undertaken.

Lot 18 S.½.—Belongs to Mr. J. Cobey, of Perkins Mills, and was first worked by owner in 1905, with three men, for a couple of months; no further work has been done. About eighteen barrels of medium-sized light amber mica were taken from the workings, which comprise several small surface pits, the deepest being down 15 feet.

Lot 18 N.½.—Was worked by Mr. Perkins in 1904 with three men, and a small quantity of mica produced. No other mining has been undertaken.

Lot 22 N. ½.—Belongs to Mr. McElroy, of Gatineau Point, who commenced to work the property in 1906 and has continued operations intermittently up to the present time. The mine lies 5 miles southwest of Perkins Mills, and produces a reddish amber mica, which is somewhat brittle and inclined to ribbon structure. Some very large crystals have been taken from the workings which consist of an inclined main pit 45 feet long, 15 feet wide, and 130 feet deep, opened on a fissure deposit in a dark green pyroxenite and having a general direction of north and south.

The whole formation is thoroughly impregnated with iron pyrites which has caused a deep red coloration of the oxidized zone, and doubtless is the cause of the brittleness of the mica.

Some dark red phosphate occurs, but little calcite could be seen.

Massive bands of pegmatite cut across the deposit which is greatly shattered, and these later intrusions have been attended by the formation of blue hornblende-asbestos on slides in the pyroxenite.

Range VIII, lot 10.—Known as the Barbutte mine, and owned by Mr. Tanguay, of Weedon, Que.

This property was first worked some years ago by Messrs. Wallingford and Belcourt, and a pit 100 feet long, 40 feet wide, and 30 feet deep, has been opened in a fissure and pocket deposit of light silver-amber mica.

A considerable quantity of mica was taken out by the above operators, who were the last to work the property.

Lot 13 S.½.—Worked by Mr. J. Dwyer, of Perkins Mills, in 1907, and about 1,200 pounds of small mica taken out. No further work done.

Lot 15 E.½.—Known as the Rainville mine. This property lies 1½ miles southwest of Perkins Mills and 10 miles from East Templeton, on the southeast slope of the same hill upon which the Phosphate King and Wallingford mines are situated.

An alternative name is the Dugas mine. Originally worked for phosphate, in 1875, by Mr. W. Miller, of Montreal, and later by the Templeton and North Ottawa Phosphate Co., the property was acquired in 1891 by the Honourable C. A. Dugas, who turned over the dumps, and also carried out some surface work for a few months, the production of mica amounting to about 17 tons.

Some very large crystals were obtained, yielding sheets of 40″ × 45″.

Simultaneously, operations were carried out for asbestos which occurs in some quantity on the northern part of the property.

Later, in 1896-7, Messrs. Baumgarten and Manchester worked under lease and erected a camp, installed machinery, and took out considerable quantities of mica.

In 1897, Webster & Co. had twenty men employed on the mine, which, later, in 1906, became the property of Wallingford Bros. Ltd. The latter worked at intervals until the autumn of 1909, since when the mine has been idle.

It is estimated that over $200,000 worth of mica and 2,000 tons of phosphate have been taken off the property.

Each operator in turn equipped the mine with the necessary machinery, including steam pumps, drills, hoists, etc., and a depth of 70 feet was reached in the main pit.

There are several openings, consisting of long narrow trenches excavated on parallel leads of phosphate and mica, which have been deposited on fissures in a pyroxenite dyke.

The general direction of the leads is N. W. and S. E., there being a slight dip to the southwest.

The largest pit is 100 feet long, 20 feet wide, and 70 feet deep, and there are, in addition, numerous small prospect pits.

The pyroxenite varies considerably, ranging from a coarsely crystalline normal rock of a dark green colour, to a finely-crystalline and almost black mica pyroxenite. The vein matter is largely pink calcite and apatite of a deep sea-green colour, mica crystals lining the contact between calcite and pyroxenite wall, as well as occurring disseminated through the vein.

Considerable quantities of pyrites are present, and large masses of milky white quartz were noticed on the dumps.

The mica is an excellent brownish amber.

Lot 15 W.½.—Phosphate King mine. This mine lies about one-fourth of a mile from the Rainville, or Dugas workings, and on the western side of the same hill.

Formerly owned by Mr. A. W. Stevenson, the property passed in 1893 to the Lake Girard Mica System. This Company erected a camp, installed considerable machinery, and constructed good roads, working for two years and extracting both mica and phosphate.

In 1896–7, Webster & Co. had thirty men at work on the mine and obtained a large amount of mica. Then, in 1897 the Mica Mining and Manufacturing Co., of London, acquired the property and continued to mine until 1899, employing as many as fifty men. In 1906, Mr. T. J. Watters worked on lease for a few months with a small gang: this is the last work done on the property.

The general geological conditions correspond to those at the Rainville mine—in fact the deposits are continuous, the Rainville mine being situated at the southeastern, and the Phosphate King at the western outcrop of the dyke.

The mica and phosphate occur on pockety leads, having a strike of E. 20° S. and a dip of 60° S. An inclined drift 50 feet high has been carried 100 feet into the hill to the east, on the main lead. From here a shaft was sunk 70 feet and a further drift run 280 feet. The deposit has been worked without any regard to future mining, the mineral in sight being extracted, and the workings consequently abandoned in an extremely unsafe condition.

There are, in addition, numerous other minor openings, the largest being 50 feet deep, and a short distance to the east of the main pit.

The mica is of good colour, but a large percentage is crushed and inclined to ribbon mica.

About 8,000 tons of high-grade phosphate are said to have been taken from the mine.

Lot 16 W.½.—Wallingford mine. Adjoins the Phosphate King mine, about one-fourth of a mile to the northwest. Originally opened for phosphate in 1882 by Mr. G. H. Beacon, and worked by him for a couple of years, the property was then sold to the Pacific Guano and Phosphate Company, of Boston, who continued operations at intervals until 1891, with a force of ten to twenty men.

Mr. E. Wallingford subsequently acquired the mine, and holds it at the present time.

A large plant has been installed, including a large 80 H.P. boiler, six steam-drills, four steam hoists, three pumps, and six boom derricks, besides the usual mine buildings. All this plant is at the present time on the mine, which is said to still contain large reserves of excellent mica, while great quantities of small but valuable mineral exist in the dumps.

It is estimated that over 3,600 tons of trimmed mica have been produced by this mine since its inception.

One crystal is reported to have yielded $33,000 worth of mica. The production of phosphate is put at 4,000 tons.

The mica is a first-class grade of light amber, and has secured the First Prize at the Paris, St. Louis, and Liège Exhibitions.

Samples submitted to Professor Dunstan of the Imperial Institute were pronounced by him to be the most suitable mica for electrical purposes which had ever been tested by him, being characterized by perfect cleavage, great flexibility, and highest non-conductivity.

The workings consist of numerous minor openings, prospect pits, etc., and one main excavation, 170 feet long, 30 feet wide and 200 feet deep.

The deposit is of the fissure and pocket type, and carries large quantities of pink calcite, in which occur finely-formed mica crystals and large bodies of green phosphate. The last work carried out upon the property was in 1908. No detailed examination of the workings was practicable when the mine was visited, and the following description is taken from Mr. Cirkel's report of 1905, as is also the surface plan shown in Fig. 10.

"The main deposits where mining is going on are contact deposits between the older formation, a greyish and red gneiss, and the younger rock, pyroxene. These deposits are of considerable extent, one of them having been partially explored for a length of over 370 feet; the main openings have a length of 120 and 170 feet respectively, with depths of 125 and 200 feet. The mica forms vein-like accumulations near the solid wall of the older formation in thicknesses from 12" to 12 feet. Apatite and calcite are frequent companions in this mine, the former at times occurring in such large compact

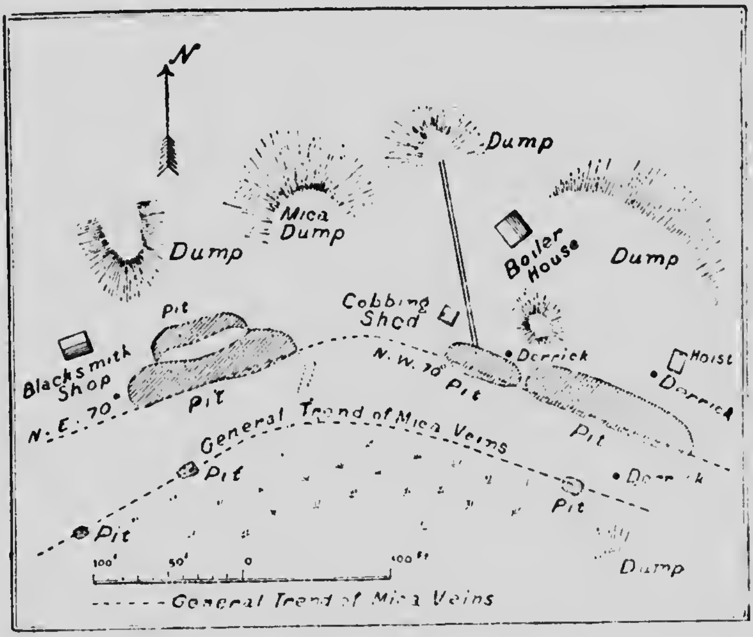


FIG. 10.—Surface plan of Wallingford mine.

masses and of such high-grade (yielding over 85 per cent phosphate of lime) that its mining, in spite of the prevailing low prices ($9 a ton), is well repaid. The underground work on this property consists of drifts along the mica vein and cross-cuts from the bottom of the 125 ft. shaft, to other parallel deposits, the outcrops of which appear on the southern side of this shaft. Generally, the veins on this property continue in great regularity and although, at times, dead ground interrupts the regular course of the mica accumulations, experience has shown that these interruptions are of no account and do not influence the regular and steady supply of mica."

Range IX, Lot 4a.—Known as the Sophia mine, and opened in 1892 by Lee Bros. of Montreal, with eight men. Subsequently the Lake Girard Mica System obtained possession but did not carry out much work. The present owner is Hon. P. MacLaren, of Perth, who bought the property about eight years ago and erected a camp, installed machinery, and continued work for a year. Since then the mine has lain idle.

The location is 4 miles east of Perkins Mills and three-fourths of a mile from Plumbago lake. The workings are situated on the southwest slope of a ridge, lying about a mile north of the main road from Perkins Mills and consist of several pits sunk on fissure veins in a grey pyroxenite, and carrying a little calcite and phosphate and light amber mica.

The main veins strike north and south, and the mica is found both on these and on joints and minor fissures in the pyroxenite adjacent to them.

Large quantities of pyrites and pyrrhotite occur throughout the deposit, and the mica is, in consequence, somewhat brittle. The main pit is a shaft-like opening 15 × 15 feet, and 100 feet deep, on the south side of the hill; the other workings lying higher up the ridge, and a few hundred feet to the north-west.

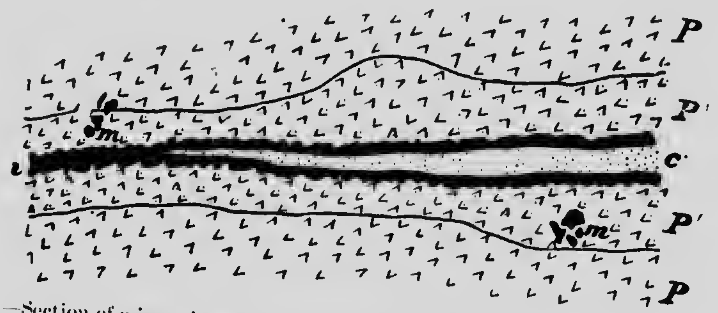


FIG. 11.—Section of mica vein at Sophia mine, lot 4a, range IX, township of Templeton, Que.

P, normal pyroxenite. P', altered pyroxenite. m, mica; c, white calcite (secondary).

In this pit · e exposed several small veins or stringers of white calcite traversing the pyroxenite and evidently of later origin than the pink calcite and mica. The pyroxene bordering on these veins, as also small fragments of pyroxenite included in them, is altered to a soft blue hornblende-like mineral.

Lot 11 S.½.—Belongs to Mr. J. Prudhomme, of Ottawa, who acquired the property and carried out a few weeks' work in 1907, employing five men, and taking out about two tons of mica.

A single open-cut has been driven into the west side of a ridge 200 feet high, lying about a mile southeast of Perkins Mills. A small deposit of light-coloured, silver-amber mica accompanied by pink calcite, and occurring on the contact of a normal pyroxenite dyke with dark gneiss, has been exploited by means of a cut 25 feet long, 10 feet wide and 30 feet deep at its inner end. The strike of the dyke and mica deposit is almost due east and west, and the whole is cut by narrow veins of felsite, inclined slightly to the direction of the pyroxenite and dipping 45° to the south.

A little phosphate accompanies the mica, and considerable deposits of this mineral are reported to occur on other parts of the property.

Lot 14, S.½.—Opened for phosphate some twenty years ago by Mr. A. Perkins, and worked later, in 1894, by Mr. Pullan for mica.

Subsequently, Webster & Co. carried out considerable work, and took out about twenty tons of mineral. In 1898 Mr. Perkins commenced prospecting, and found promising indications at various points. The following year Jurkowski & Co. worked for six months, and since then various parties have done a little mining at intervals, including the Laurentide Mica Co., who leased the property in 1905, and installed a boiler, steam hoist, drills, etc.; all machinery was removed from the mine some years ago.

The last work was carried out by Messrs. Loyer Bros. of West Templeton, during the early part of 1909, about 50 tons of phosphate and a little mica being mined. The workings consist of five pits, the largest of which is 60 feet deep, 20 feet wide, and 80 feet long. All the openings are open-cuts carried into the south and east slopes of a hill some 200 feet high, situated a mile from Perkins Mills.

The mica and phosphate occur on fissures in a normal pyroxenite, and have a general direction of east and west, dipping at varying degrees to the south. The walls of these fissures are often covered with a compact mass of small mica crystals.

The leads are very irregular and vary much in width: in a distance of 20 feet one vein narrowed from 15 feet to 3 feet. The property would seem to be of more value as a phosphate producer than for the mica it carries.

Lot 15.—Belongs to the Laurentide Mica Company, who started to work in 1905 with a force of 50 men. Machinery was transported from the neighbouring mine on lot 14, and work was continued for six months. A few pits were opened in a contact zone between pyroxenite and gneiss, the mica occurring on parallel fissures in the pyroxenite.

Results do not appear to have proved very encouraging, for, with the exception of a little prospecting in 1909, no work has been done since 1905, and all machinery, etc., has been removed from the mine.

The mica is a fair grade of darkish amber. The veins have a general trend of east and west and dip slightly to the south, while the pyroxenite dyke strikes northwest and southeast conforming to the strike of the country gneiss. The dip of the latter is 80° N.E.

Pegmatite veins cut both gneiss and pyroxenite, one such stringer being well shown in the main pit, and having a width of 18″ and a direction normal to the walls of the vein.

Lots 17 and 18 N.½.—Known as the Goldring mine, and an old phosphate property opened in 1876 by Mr. John McLaurin.

The Papineauville Lumber Company acquired the property, together with lots 17 and 18 of range X, some six years ago, but never worked until 1910, when half a dozen men were set to work on lot 17, range IX.

Sinking and drifting have been carried out to a depth of 70 feet in an old phosphate pit, and 700 pounds thumb-trimmed mica extracted, besides 120 tons of high-grade phosphate.

The mica is a good quality light silver amber, but does not occur in sufficient quantity to render mining for this mineral alone profitable, while a large percentage of the crystals are so crushed as to be commercially valueless. Large bodies of pink calcite have been formed on irregular fissures in a light-coloured pyroxenite, mica crystals and pockets of phosphate occurring disseminated through the calcite.

The fissures have a more or less general direction of east and west and dip at varying angles to the south.

Considerable pyrites occur on the leads, and an unusual feature is the presence in the phosphate of numerous druses lined with crystals of calcite and smoky quartz.

The mine is more valuable as a phosphate producer than as a mica property.

Lot 20.—Belongs to Mr. James O'Hagan, of Gatineau Point, who was the first to work the property about 12 years ago.

In 1906 Mr. Rainville, of Perkins Mills, carried out a few months' work with four men, a few barrels of mica being produced.

Range X, Lot 2.—Belongs to Mr. Gilmour, of Ottawa, and was worked in 1907 for a short period by a lessee. Results do not appear to have been very satisfactory and operations were soon suspended.

The openings consist of three small pits, the largest of which is 15 × 15 feet and 50 feet deep, sunk in a hard, dark pyroxenite, carrying veins of pink calcite and a little phosphate and mica. The latter is a light silver-amber of small size, and inclined to be rather crushed.

The pyroxenite has been intruded by a later dyke of serpentine, having a strike of northeast and southwest, and dipping 80° N.W. This serpentine is a greenish-yellow rock, and carries stringers of golden chrysotile-asbestos.

The intrusion has been attended by some curious results. The calcite accompanying the mica has been, to a great extent, resorbed by the serpentine, which has filled the space originally occupied by the calcite, so that crystals of mica are now found embedded in serpentine. Such crystals are usually crushed and traversed by minute cracks filled with serpentine matter. Vice versa, pockets also of calcite are found to contain small rounded fragments of serpentine. The latter has probably ascended along pre-existent fissures and joints in the pyroxenite, and partially resorbed the calcite and mica in its course. Apophyses from the main serpentine dyke are to be seen in all the pits. The deposit exists near the contact of gneiss with crystalline limestone.

Several veins of serpentine cutting crystalline limestone are exposed on the road leading to the mine, and some prospecting is reported to have been recently carried out for asbestos.

Lot 7.—Worked for a few weeks in 1908 by Mr. Greer, of Montreal, with two men. Only surface work was done, and not much mica was found.

Lot 8.—Known as the Marsolais mine, and an old phosphate property. It was formerly owned by the Templeton and North Ottawa Mining Company, of Montreal, and was acquired a few years ago by Mr. M. J. O'Brien, who has, however, carried out no work as yet.

There are two main pits on the property, 90 and 70 feet deep, respectively, both now filled with water. A few barrels of mica were taken from the dumps in 1897 by Messrs. Charette and Julien, and in 1900 Messrs. Powell and Haycock had ten men engaged in similar work, but no serious mining has ever been undertaken for mica.

The formation is similar to that at the neighbouring mines, namely a fissure deposit of mica and phosphate in normal pyroxenite.

No buildings nor plant exist at present on the property.

Lot 9 E. ½.—Known as the Post mine, and an old phosphate property. It was worked years ago on a large scale by the Canadian Industrial Company, who took out large quantities of high-grade apatite and erected machinery and a large number of buildings.

The mine was idle for many years until Mr. M. J. O'Brien secured possession in 1907, and started to work for mica and phosphate, with half a dozen men. The property was newly equipped with a 25 H.P. horiz[illegible] boiler, steam-hoist, boom derricks, two steam-drills, and two steam-pum[illegible], and considerable work was carried out during 1907-8. Some new pits were sunk, but work was also continued in the old phosphate pit which is an opening 125 feet deep, and about 100 × 100 feet, and a considerable quantity of fair mica was extracted. The last work done was in 1909.

The mica occurs on veins in a grey-green pyroxenite, cutting dark biotite gneiss, which is in places highly garnetiferous, and is traversed by a system of granite dykes.

The basic rock varies from a normal compact variety to a mica-pyroxenite, often mixed with considerable apatite.

Some of the veins carry large bodies of pink calcite, while on others this mineral is almost totally absent. The same applies to both pyrites and magnetic-pyrites (pyrrhotite) which is met with chiefly in the openings on the ridge above the main pit.

The phosphate is present both in the form of massive sugar-phosphate and isolated crystals embedded in calcite. Openings exist over almost the whole of the property which lies 2½ miles northeast of Perkins Mills, and produces a darkish speckled amber mica of fair quality.

Most of the machinery has recently been removed from the mine, and the owner does not propose to carry out any further work.

Lot 9 W. ½.—Jackson Rae mine. This mine formerly produced lagre quantities of phosphate, several thousand tons of the mineral having been extracted prior to 1890.

When the demand for mica sprang up in the early nineties, the dumps were worked over and large quantities of excellent mica were recovered. The mine is now owned by Mr. M. J. O'Brien, who commenced work in 1908, and continued until the latter part of 1910.

Some half a dozen men were employed, the mine was equipped with machinery including a small boiler and dynamo for electric lighting purposes, and adequate mine buildings were erected.

Most of this plant has since been removed, and only the boarding-house, stables, trimming-sheds, etc., remain.

Work was commenced in one of the old phosphate pits, which was pumped out and a shaft sunk about 90 feet, on a shattered zone carrying mica and phosphate, the former being rather crushed.

Later, a new pit was started to the south of this opening and carried down 35 feet, but the mica proved to be too crushed to repay further work.

Old dumps were also reworked, and about 35 tons of rough mica were recovered.

When visited, stripping operations were being conducted a short distance from the old workings, and some fair mica has been taken from the surface.

In colour, the mica is an excellent light silver amber, but the district seems to have been subjected to considerable dislocation and consequent pressure, with the result that a very large percentage of the mi a crystals is so crushed and distorted as to be commercially valueless. The mica occurs intimately associated with phosphate, both of the sugar and compact massive varieties, and this crushing of mica crystals when occurrent with large bodies of phosphate is a typical feature of the deposits.

The deposit is of the fissure and pocket class, irregular leads of mica and phosphate occurring throughout a somewhat dislocated and crushed grey pyroxenite.

Subsequent intrusions of acid dykes into the formation have been attended by the formation of considerable black tourmaline, which was seen in groups of radiating columns and needles, associated with secondary actinolite, brown titanite, calcite, and mica. A body of such acid rock was met in the main pit and cut off the mica lead at a depth of some 70 feet.

The old phosphate workings are situated about half a mile nearer Perkins Mills, and consist of a very large open-cut opened for a distance of several hundred feet on what is probably a contact deposit of phosphate and mica between pyroxenite and gneiss. The dump material exhibited many varieties of rock, varying from a normal dark pyroxenite to a mixture of blue-grey anorthite and brown titanite, the latter often in crystals 2″ and 3″ long.

Lot 10 N.½.—Known as the Jubilee or Smith mine, and now owned by the Routhier Mica Mining Company, of Angers, Que. Originally an old phosphate property, it was later worked for mica by Messrs. McLaurin and

PLATE V.

Stripping operations at the Jackson Rae mine, showing decomposed pyroxenite in which occur the mica crystals, lot 9, range X, township of Templeton Que.

McLaren, who installed machinery and erected a small camp. An average of ten men were employed, and some forty-five tons of rough mica were produced.

The present owners acquired the property in 1907 and a little mining for both phosphate and mica was carried out in the autumn of 1909 by Mr. Edward Smith, of Perkins Mills, under royalty.

The mica is a first-class light silver amber, and the percentage of large sheets is high. There is, at present, no machinery on the mine, but the mine buildings are in good condition, and the mine is in good shape for re-development at any moment.

There are various openings on the property, which is situated on a belt, or series of dykes, of pyroxenite cutting a dark and often garnetiferous gneiss. This pyroxenite system carries extensive deposits of mica and phosphate which have been exploited by numerous mines, the bulk of which are old phosphate producers and are situated on ranges X and XI of Templeton township.

Lot 10 S.½.—Murphy mine. Another old phosphate mine, and subsequently worked for mica by the Lake Girard Mica System in 1892. The owner, Mr. A. Murphy, carried out a little work in 1899, and later leased the property to the Sills-Eddy Co., who only worked a few months.

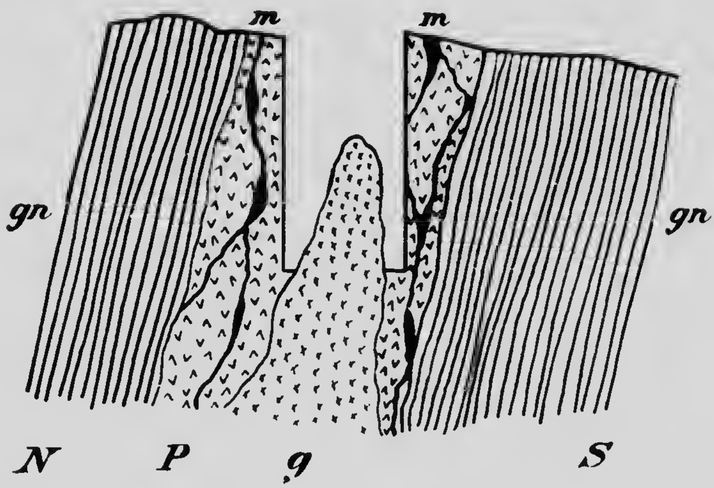


FIG. 12.—Section through mica deposit at Murphy mine, lot 10 S. ½, range X, township of Templeton, Que.
gn, gneiss; P, pyroxenite; g, granite dyke; m, mica leads.

The mica is a light silver amber of medium size and occurs in a pyroxenite cutting gneiss. The pyroxenite dyke has been intruded along its strike and midway across its width by a light grey pegmatite, having a direction of east and west, and fissures carrying mica have been worked by means of open-cuts on each side of this acid dyke, the workings reaching a depth of 65 feet.

Lot 16 N.½.—The property of the Canada Industrial Company, and was formerly worked for phosphate. No operations for mica have been undertaken though it is understood that promising indications have been located.

Lots 15 W.½, 16 N.½.—Victoria mine. Opened in 1899 by Messrs. McLaurin and McLaren, and has yielded a large quantity of fair mica. The property lies 2½ miles northwest of Perkins Mills and a mile off the road from this place to McGregor lake.

The present owner is Mr. T. G. McLaurin, of Ottawa, who installed the present extensive plant, including boiler-house, two large boom derricks operated by steam hoists, steam pumps and drills, and a tramway to dump. The mine was worked by the present owner from 1907 to 1910 for mica and phosphate, and 250 tons of trimmed mineral are reported to have been taken out during this period.

The workings consisted of a number of pits, the largest being 130 feet long, 45 feet wide, and 187 feet deep. This opening has been made on a contact deposit of phosphate and mica between pyroxenite and gneiss, having a strike of W. 35° N., and dipping 75° S.W. From the bottom of the pit a drift has been carried 60 feet to the southwest, following leads of phosphate and mica accompanied by large quantities of pink calcite.

The north side of the pit exhibits a well-defined vein-wall.

The mica is a good quality light amber, and is found disseminated through the contact body of calcite and phosphate.

The pyroxenite is a light grey-green rock and contains numerous pockets which are often lined with large and well-formed pyroxene crystals, and carry both sugar, and compact crystalline, phosphate.

The mica is often much crushed and exhibits good examples of fracture along the gliding-planes (See Fig. 58, page 227).

Unusually dark apatite is sometimes met with, well-formed crystals almost black in colour being noticed in one of the smaller openings.

Three well-defined leads of high-grade phosphate are reported to occur on the property, and have been little worked up to the present.

Mr. McLaurin has recently erected a new boiler-house and smithy, and it is understood that the property is about to change hands.

Range XI, Lots 9, 10.—Blackburn mine. This is the largest mica and phosphate mine in the township of Templeton and lies 13 miles north of the station of East Templeton and 4 miles from Perkins Mills. It is owned by Messrs. Blackburn Bros. of Ottawa. Originally opened for phosphate in the eighties by Messrs. Blackburn and McLaren, who operated under the name of the East Templeton District Phosphate Mining Syndicate, Limited, the mine has become one of the largest mica producers in the district.

PLATE VI.

Main pit at Blackburn mine, lot 9, range XI, township of Templeton, Que.

With the exception of a short period about fifteen years ago, when the mine was closed down for three years, operations have been continued without intermission since 1888.

A large force of men has been constantly employed, the number reaching a maximum of 120 some years ago.

When visited, market conditions were making their effect felt, and the mine was in process of closing down, only some half dozen men being employed, the intention of the management being to take out the pumps, etc., from the pit, and allow the workings to fill with water, mining to be resumed when the present large stock of mica on hand is disposed of. Actual mining ceased in December 1909, but the mine was kept unwatered until the following August.

The total area of the property comprises about 900 acres, but mining is confined to lots 9 and 10 of range XI.

Numerous openings exist on lot 9, the whole property having been extensively prospected for phosphate and mica.

The principal excavation is an open pit over 300 feet long, 180 feet wide at its southeast end, and 120 feet deep.

From the southeast end further underground workings have been carried in an easterly direction. These consist of three galleries, 300 to 500 feet long, on the 180, 240, and 280 ft. levels respectively, and communicating by means of a shaft 160 feet deep. These galleries have been stoped out by means of staging erected on the levels, and reach in places a height of over 25 feet. Drifts have been carried from them to the north and south, following pockety accumulations of mica and phosphate of irregular direction in a matrix of soft green pyroxene. The workings were electrically lit.

The mica is a first class light amber, and the crystals usually occur as individuals or in small aggregates embedded in the phosphate. Calcite is relatively absent.

The proportion of commercially valuable mica to the total amount mined is high, about 50 per cent being marketable sheets.

Phosphate is extracted simultaneously with the mica, and some 500 tons were stored on the mine when the writer paid his visit. Most of the phosphate producers accumulate their production during the summer and autumn, increased haulage facilities being afforded in the winter months, detours of many miles being often saved by transport across the lakes.

The mica is roughly cobbed on the mine, and thence shipped to the trimming shops at Ottawa, where it is prepared for market.

The output of the mine formerly kept forty persons employed in the trimming works.

The deposit is associated with a pyroxenite dyke of unascertained width and extent, having a strike of northwest and southeast, and cutting dark biotite gneiss. The whole is extensively cut by pegmatite veins which seem to have usually followed the mica leads as lines of least resistance.

This appears to be the case in many similar deposits, and frequently gives rise to the idea that the mica and phosphate are in some way connected with these later intrusions, whereas there is, in reality, no connexion whatever, the deposition of these minerals having always anteceded the injection of the acid rock.

Throughout the mass of the pyroxenite, but principally on the eastern side of the main opening, numerous fissures have formed. These fissures, which swell out into pockets and chimneys and have no definite direction, are filled with accumulations of phosphate and mica, the whole having a honeycombed appearance.

No limit has as yet been found for the deposit in depth, considerable reserves of both minerals being still present in the lower workings.

The mine is equipped with a large and adequate plant including a boiler-house with one 40 H.P. and one 50 H.P. boiler, an Ingersoll-Sargent compressor, with a capacity of 110 cubic feet free air per minute and a 1 K.W. dynamo used for generating current for lighting purposes.

There are two steam hoists capable of being operated either by steam or air, and a small reciprocating pump lifting 200 feet, with a capacity of 100 gallons per minute, is installed in the pit. The mine is supplied with power from a power house situated 2½ miles away, near the outlet of Dam lake.

This plant is equipped with a turbine operating a 115 K.W. dynamo generating (A.C.) at 2400 volts, transmission being by three-phase line to the mine. This power is used to work first a 75 H.P. motor at 2,200 volts, belted to an Allis-Chalmers compressor (110 cubic feet free air per minute), supplying air for drilling and also for pumping and hoisting if necessary.

In addition, the current is run to a 10 H.P. motor operating a hoist. Transformed to 550 volts, the current is used to work a 7½ H.P. pump in the pit and at 110 volts it is used for lighting, for driving small motors attached to saws, etc., and for running a small centrifugal pump circulating cooling water from a cement tank below the floor of the compressor-house through the compressor.

From the receiver of the latter, a 3″ pipe line is run half a mile to another pit to supply two air-drills, only 5 pounds pressure being lost in transmission.

A cobbing shed accommodates ten sorters, five being employed in cleaning mica, and five in cobbing phosphate. Rock is handled by means of a tramway on which run large wooden tipping cars with a capacity of 6 tons, and drawn by horse-power.

Hoisting is done by means of iron buckets supported from carriers running along 2″ cables suspended from two wooden towers 60 feet high, and situated one at each end of the pit, the cables being inclined across the pit and fastened to iron stanchions let into the rock.

In the old phosphate-mining days, large quantities of mica were thrown on the dumps as useless, and when the demand for this mineral arose, a force

PLATE VII.

Cable hoist, Blackburn mine, lot 9, range XI, township of Templeton, Que.

of some twenty to thirty men was employed for a year in turning over the large heaps of rock.

The present camp consists of a large boarding-house accommodating over a hundred men, a stable for fifteen teams of horses, store-house, weigh-house, and manager's quarters, offices, etc.

The mine has during the past few years been under the superintendence of Mr. H. L. Forbes.

Lot 10.—About half a mile northeast of the main workings a small inclined shaft has been sunk on a well-defined contact deposit between pyroxenite and gneiss, having an average thickness of 6 feet. The shaft is down 150 feet and is 8 × 6 feet square, timbered for a distance of 50 feet from the surface.

A shaft house has been erected and the pit is equipped with an inclined skip-way. A 30 horse-power horizontal boiler is used for running a steam-hoist, and steam is piped from the neighbouring mine to work drills and a small reciprocating-pump.

The mine is lit by electricity and is a model example of how a mica deposit of this class should be developed.

The mica is a light silver amber and occurs with apatite disseminated through a large body of pink calcite. This mine also is idle at the present time.

Lot 12.—A little work was done here during the summer of 1910 by Mr. John Stewart, who took out a small quantity of mica and phosphate. The former mineral occurs in small, dark, cloudy crystals embedded in sugar phosphate and is rather crushed, only a small percentage being [illegible]ble mica.

[illegible]y one opening has been made and is down about 25 feet on a small pockety deposit in normal pyroxenite.

Lot 14.—Owned by Dr. F. Cornu, of Ottawa. The property was originally worked for a few months in 1887 with five men by Lee Bros., of Montreal, who le[illegible]ed from the Templeton and North Ottawa Mining Company, and took out ten tons of rough mica.

In 1902 Dr. Ronthier worked for three months and secured a few tons of rough mineral. No further work has been undertaken.

T[illegible] mine lies on a point jutting into McGregor lake from the west. [illegible]y surface work has been carried out, a few shallow pits having been sunk on a fissure deposit of light silver-amber mica, in a dark, compact pyroxenite. There is an almost total absence of calcite and phosphate on the fissure, which strikes northeast and southwest, dips 75° S. and can be traced for a distance of 300 feet.

The mica is rather crushed and is found both on the fissure itself, and as individual crystals in the mass of the pyroxenite.

A white pegmatite dyke cuts across the deposit and is well exposed in the westerly opening.

Large isolated crystals of brown titanite were observed in the pyroxenite.

Range XII, Lot 4.—Belongs to O'Brien and Fowler, who purchased the property from Mr. E. Watts, of Perth, in 1909. The latter carried out some minor prospecting a few years ago, but the property was never worked until the summer of 1910 when the present owners set a few men to work, and stripping operations were commenced. Outcrops of mica have been found at several points, the most promising of which is on the north slope of a ridge overlooking Battle lake, and a few hundred yards from the south shore of the lake.

The exposure showed good-sized crystals of a darkish mottled mica occurring on irregular leads and fissures in a compact grey pyroxenite and having a general trend of northeast and southwest. Crystals sometimes also occur as isolated individuals in the rock mass, and small pockets are occasionally met with.

Little calcite is present and only a few small patches of phosphate have been found.

The country rock is a grey gneiss traversed by later acid veins and dykes.

A good example of variation in colour and quality of mica at points only a short distance apart is furnished by this deposit the crystals taken from one outcrop being a light silver amber possessing excellent cleavage, while a few feet away the sheets are dark and brittle.

Lot 5.—Belongs to Mr. H. Aylen, of Ottawa. A little work was done under lease from the above by Mr. P. Hamilton, in 1908, and some large but rather crushed crystals were obtained.

Lot 11.—Recently acquired by the Progressive Mining Company, of Ottawa, who report mica outcrops.

Lot 12.—Messrs. Cox and Emo worked a few months in 1907, and took out a few barrels of brownish amber mica. Two pits have been opened on the side of a small eminence a few hundred yards from McGregor lake, and the openings show some crushed mica accompanied by a little pink calcite on small leads in a greyish pyroxenite.

Lot 13.—Was first opened for phosphate over thirty years ago by the Templeton and North Ottawa Mining Company, and was subsequently worked in 1900 by the Star Mining Company, under lease, about five tons of rough mica being produced.

Later, Mr. Seybold continued operations for a few months with a force of twenty men and extracted a small quantity of mica and phosphate.

A little stripping was done in 1910 by Mr. L. Marcelais under lease from the present owner, Mr. J. Bruno, of North Templeton. The mica is a medium-sized fair grade of speckled amber, and occurs with pink calcite and phosphate in a dark green pyroxenite, the walls of which are lined with well-formed pyroxene and scapolite crystals.

A number of small pits exist on the property which lies about 100 feet above the road, and a few hundred feet from the north shore of McGregor lake.

The largest opening is 40 feet deep and 12 × 12 feet square.

Much of the mica exhibits zonal structure (See Plate XXIV).

Lot 20.—Some surface work has been carried out here at different times by various operators and a little mica and phosphate produced.

Lot 21.—Worked over thirty years ago for phosphate by the Templeton and North Ottawa Mining Company, and subsequently leased to Dr. Routhier, of Ottawa, who employed four men for a few months and took out a small quantity of mica.

Range XII, Lots 4, 5.—Battle Lake mine. This property belongs to the Wallingford Mica Company, and was opened up for mica in 1900, since when work has been continued intermittently up to the present time, an average of fifteen men being employed.

Extensive operations have been carried out and the mine is equipped with machinery including one 30 H.P. horizontal boiler, steam-drills, hoist, and pump. A tramway conveys the waste to the dump.

The workings are situated about 100 yards from the north shore of Battle lake, and consist of a large open pit, or quarry, some 200 feet across, and 70 feet deep, from the bottom of which drifts have been run in on the mica leads.

The rock is light grey pyroxenite, and the mica occurs on veins and fissures having no definite direction.

Only a little calcite accompanies the mica, which is a first-class light silver amber, often in crystals of large size, and an excellent splitter.

In the old phosphate days, this property is said to have produced large quantities of high-grade apatite, which were shipped to the Lièvre river, 2½ miles away.

The following account of the workings from Mr. Cirkel's report is of interest:—

"The mica deposits of productive value occur on the north shore of Battle lake in a dyke of pyroxene, cutting the gneiss strata in a northeast southwesterly direction. They occupy fissures in this rock which are almost parallel to each other at intervals of 5, 10, or more feet. These fissures are connected with each other by smaller veins of mica or cavities filled with mica crystals, thus giving the whole a cobwebby appearance. The deposits commence with the contact line between the gneiss and pyroxene, near the lake shore, and end with a chain of mica deposits at the crest of the hill farther north. A little farther north on the hill a pit has been sunk on a mica vein parallel to those worked in the quarry. This pit is 25 feet deep, and 10 feet by 12 feet square. The mica crystals are embedded in a soft pyroxene matrix, while the different branches of the mica vein are separated from each other by hard pyroxene and granitic boulders.

A careful estimate places the quantity of rock shifted from the principal excavation on Battle lake and from two small neighbouring pits at 2,800 tons; the thumb-trimmed mica extracted was approximately twenty-five tons or 0·9 per cent of the total rock hoisted. This percentage is far above the average and must be pronounced for open quarry work a very favourable result. Since the commencement of operations, seventeen per cent of the total output of sheets cut 4″ × 6″ and over. One crystal, weighing 200 pounds, cut 14″ by 19″, while another gave commercially useful sheets measuring 19½″ by 27″. The mine is furnished with the requisite machinery, consisting of a 30 H.P. boiler, one Ledgerwood hoist, two 3″ Ingersoll drills, three derricks, and all accessories. A spacious boarding-house provides accommodation for thirty miners."

Lot 14.—Owned by the Progressive Mining Company, of Ottawa. A few small pits were opened in 1906 by Mr. Marcelais, who took out about a ton of rough mica. The crystals are small and of a light amber colour, occurring in small pockets in normal pyroxenite, and associated with a little pink calcite.

Lot 15.—Belongs to Mr. A. Debruyne, of Aylmer, and was first worked in 1901 by Mr. Lachapelle for a few months. The present owner acquired the property some three years ago and leased in the early part of 1910 to Mr. R. Snowball, who had four men at work for a few months.

There is a single shallow pit on the property opened in a soft and very light-coloured, almost white, pyroxenite, cut by a pink felsite dyke, which has apparently metamorphosed the pyroxenite to its present condition.

The mica is a light silver-amber, but very crushed, about 70 per cent of the crystals mined being commercially useless. A little green phosphate and some pink calcite accompany the mica, which occurs in scattered crystals throughout the mass of the rock.

Gore, Lot 3.—Rheaume Lake mine. This mine is the property of the Wallingford Mica Mining Company, and is situated about 300 yards from the north shore of Rheaume lake on the side of a steep ridge overlooking the lake. The workings consist of two pits 25 feet deep, opened on several small leads of dark silver amber mica accompanied by large quantities of high-grade phosphate.

The leads have a general trend of east and west and occur in a normal, rather fine grained, grey pyroxenite containing considerable pyrites, which cuts a grey biotite gneiss.

The district is traversed by coarse pegmatite (graphic-granite) dykes having a strike of north and south and often of considerable width. One such dyke seen in the south pit has a width of over 20 feet and contains numerous druses, the walls of which are often lined with small crystals of albite. Drifts have been run in a northerly direction from the bottoms of the pits for a distance of 50 feet.

There is no machinery in use on the mine, which is provided with two horse-derricks and culling sheds.

The deposit appears to be of the contact class, a fissured zone in the pyroxenite adjacent to its contact with the gneiss containing mica crystals on the joints and cracks. The mine being full of water when visited, it was impossible to examine the workings, but the following description of the formation is taken from Mr. Cirkel's previous monograph.—

"In one pit, 25 feet deep, a cavity has been followed along the solid wall of the country rock, branching off in spurs filled with mica crystals and separated by a garnetiferous pyroxene granite. Small boulders of a very hard pyroxene are frequently met with, interrupting the course of these branches, and drilling in these boulders is very difficult. Apatite of a high grade is also found in most of the open pits and, judging from the many indications, it seems probable that both mica and apatite can here be worked together advantageously. All drilling on this newly opened property is at present done by hand."

The "garnetiferous granite" alluded to is probably either part of a later granitic intrusion or an acid differentiated portion of the original dyke mass.

The mine was first opened in 1901 by the present owners, and work has been continued at intervals up to the present time.

Gore, Lot 6.—Worked by Messrs. Watts and Noble, of Perth, for phosphate, in 1904, and since acquired by Kent Bros., who had a few men employed on the property in 1910, with what result is not known.

Gore, Lot 8.—Known as the King Edward mine, and owned by Messrs. Wallingford, Cornu, and Belcourt. The workings are situated about a fourth of a mile east of the Rheaume Lake pits, on the same ridge, and about 300 yards from the lake shore. The deposit is very similar to the Rheaume Lake mine occurrence, the mica being found on more or less well-defined leads having a strike of northeast and southwest and also in pockets and chimneys.

There is much pink calcite present, in which occur large and finely formed crystals of green apatite, some of which show decided evidence of subsequent resorption (See Plate XXVII, page 282.)

Large mica crystals were seen exposed in the bottom of one pit, about 20 feet down, but the quality of the crystals is often impaired by crushing and the presence between the laminæ of films of calcite and phosphate.

There are several openings on the property, consisting of small open pits and trenches, none of which exceed 25 feet in depth.

No machinery was ever used on the mine, which is equipped with two horse-derricks, boarding-house, culling-sheds, etc.

Gore, Lot 18.—Belongs to Blackburn Bros., who commenced to mine in 1908, and carried out about nine months' work in this and the succeeding year. Five men were employed, and seven tons of thumb-trimmed mica produced.

The occurrence is a fissure deposit, carrying mica and a little pink calcite, but no phosphate. Only one pit has been opened, and is down 20 feet.

Gore, Lot 38.—This property was worked in 1897 by Mr. A. Murphy, of Montreal, who had a dozen men engaged in mining mica and phosphate for a few months. No further work has been done.

The workings are situated a few hundred yards to the north of the Briggs mine, on the opposite side of the hill, and are approached by a bush-road of 2 miles from Grand lake.

Mining has been carried out by means of an open-cut 30 feet deep, 15 feet wide, and 50 feet long. This opening has been made on a fissure in grey-green pyroxenite, having a strike of east and west, and dipping 75° to the north, being part of the same deposit as opened up to the northwest. The mica is, however, not as dark as that on the adjoining property, and occurs both in the lead itself, with green phosphate, and also in the mass of the pyroxenite. Little or no calcite is present.

A pink felsite dyke, 6 feet in thickness, striking north and south, and dipping 50° W., cuts through the deposit and is exposed in the main pit.

Gore, Lot 39.—Known as the Briggs mine. An old phosphate property, and worked first in the eighties, by Mr. Stewart, of Ottawa.

No further work was done until 1907, when Kent Bros. had a dozen men employed on the mine for a few months. The mica proved, however, too crushed to be of much value, and operations were suspended and have not since been resumed.

The mine is situated 2 miles northeast of Wakefield and connects with the Wakefield road by a good bush track. The workings, which comprise half a dozen surface pits, have been opened on the northwest side of a hill 500 feet high, in a dark green pyroxenite.

The largest opening is an open-cut, following a fissure lead of phosphate and mica with a strike of northwest and southeast, dipping to northeast, and having a width of 12 feet. The cut has been carried 60 feet into the hill, is 15 feet wide, and 80 feet deep at its inner end.

The mica is a hard, brittle, and dark variety, being generally much crushed, and is of little value, the deposit being of more importance for the phosphate it contains. There is an interesting occurrence of wilsonite, which is found in large crystalline masses embedded in massive phosphate (See page 300).

No machinery has been employed on the mine.

The following properties in the township of Templeton were not visited, the locations and information being taken from Mr. Obalski's and Mr. Cirkel's reports. No additional information regarding them could be obtained during the writer's tour of the district and apparently no further exploitation of the various deposits has taken place.

Range IV, Lot 21.—Mica outcrops reported on Mr. McTiernan's property.

Range V, Lot 18.—Was worked in 1896 by Mr. Smith, of Gatineau Point, for a few months, and about fifteen barrels of mica extracted. No further work has been done.

Lot 20.—Slight indications of mica are reported on this lot by the owner, Mr. W. Smith.

Range VI, Lot 17 A.—Formerly the property of the Canadian Industrial Company, but never worked for mica. Good indications of both mica and phosphate are said to have been found, and the old phosphate dumps contain considerable quantities of mica.

Lot 21 B.—The same remarks apply as to lot 17 A.

Range VII, Lot 10.— Known as the Stevenson mine, and has been worked by various parties. The last work was carried out in 1900 by Mr. J. E. Asquith, of Ottawa, who employed a force of twenty men and installed a steam pump. A fair quantity of good mica was produced from a large surface pit.

Lot 11.—Was prospected by the American Mica Company, of Boston, in 1893-4. Results not known.

Range VIII, Lot 17, S.½.—Belongs to Wallingford Bros. and good indications have been found.

Lot 19.—Prospected in 1899 by Jarkowski & Co.

Range IX, Lot 13.—Indications of mica reported.

Lot 16.—Owned by the Canada Industrial Company, and is reported to show promising indications of mica.

Lot 21.—Prospected in 1898 by Jarkowski & Co.

Range X, Lot 15 W.½.—Worked in 1893, and several tons of mica are reported to have been produced.

Lots 17, 18.—Prospected in 1894 and indications of mica reported.

Lot 28.—Was worked in the eighties on a large scale for phosphate by the Canada Industrial Co. and a quantity of mica was also produced. No further work has been undertaken.

Range XI, Lot 20 N.½.—Prospected in 1898 and indications of mica reported.

Range XII, Lot 14.—Indications of mica located by Messrs. Clemow and Powell, in 1894.

Lot 24.—Mica outcrops reported by Mr. F. Haycock, in 1899.

Lot 27.—Mica reported by Mr. Hayes in 1889.

Range XIII, Lot 3.—East of the Battle Lake mine and reported to show mica outcrops.

Lot 13.—Mica reported to occur.

Township of Wakefield.

Range I, Lot 6 N.½.—Known as the McBride mine, and owned by Mr. J. Grimes, of Ottawa.

The property was worked about ten years ago, by Mr. Watts, of Perth, for phosphate, and the owner has taken out a little mica during the last two years.

In 1910, Mr. H. Flynn had a few men employed for six months, and secured a small quantity of mica.

Lot 12. Haldane mine. Owned by Mr. C. Hughes, of Montreal, and first worked thirty years ago for phosphate by Mr. Haldane

The last operations were carried out in 1892 by the present owner, Mr. Robitaille, who mined for both mica and phosphate.

There is a good mine road connecting the workings with the main road from Wilson Corners to Maxwell Ferry.

The mica is a light amber and is often rather stained by iron which occurs plentifully in the form of pyrites throughout the deposit.

The occurrence of the mica is mostly on small fissures and pockets in a greyish pyroxenite dyke cutting red orthoclase gneiss.

There are several pits on the property, one of which has been opened along the contact of pyroxenite and gneiss, the mica occurring on fissures adjacent to the junction of the two rocks.

The dumps were worked over in 1909 by Mr. Brown, of Cantley, and several tons of rough mica and phosphate were recovered.

Lot 15 S.½.—Known as the Comet mine, and one of the earliest phosphate mines in Canada.

The first miners were Messrs. Chitty and Loken, of Chelsea, who worked for phosphate about forty years ago, subsequent operators being Messrs. Wilson and Chubbock and the Comet Mica Co., who worked in 1898-9. The last work was carried out by Mr. J. K. Paisley, of Ottawa, who mined for phosphate during the early part of 1910.

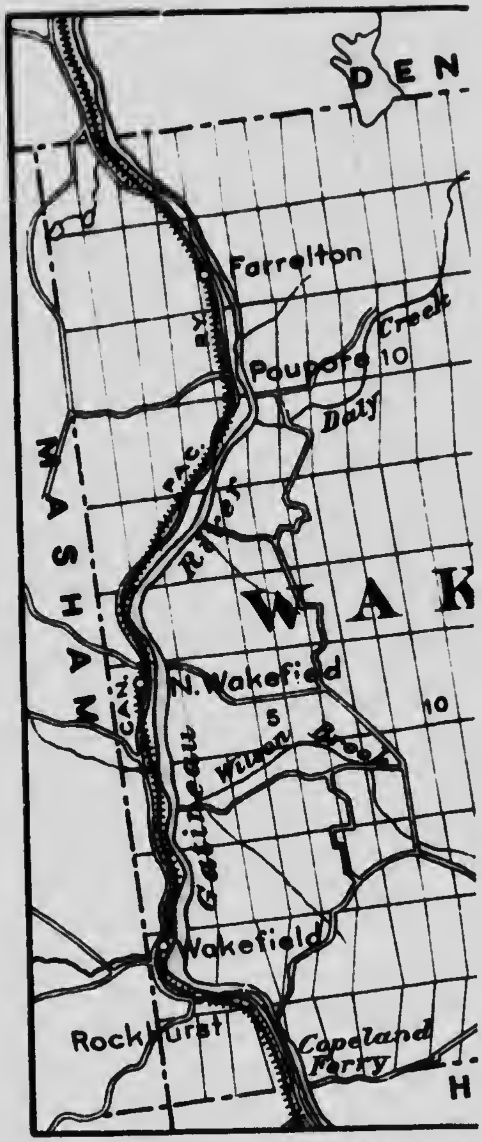
There are several openings on the property, mostly open-cuts and drifts, run into the side of a small ridge of dark gneiss cut by a series of pyroxenite dykes. The mica, a light silver amber of good quality, occurs with large bodies of sugar-phosphate and some calcite on fissures of irregular shape and indefinite direction in a grey pyroxenite showing considerable evidence of differentiation throughout its mass.

The leads of mica are in some instances almost horizontal and have been mined by means of flat drifts. The property has recently been acquired by the Canada Mica Manufacturing Company, of Ottawa.

Lot 16.—A little mica was taken off this property some three years ago by Mr. H. Flynn.

The mica is a fair quality amber of medium size, and occurs, with a little phosphate, on a contact between gneiss and pyroxenite. A pit 15 feet deep and 30 feet long has been sunk along the junction.

Range II, Lot 16.—Kodak mine. This mine was first opened up as a phosphate property in the eighties by Mr. Wilson, and has subsequently passed through various hands, including Webster and Co., and Wilson and



MICA

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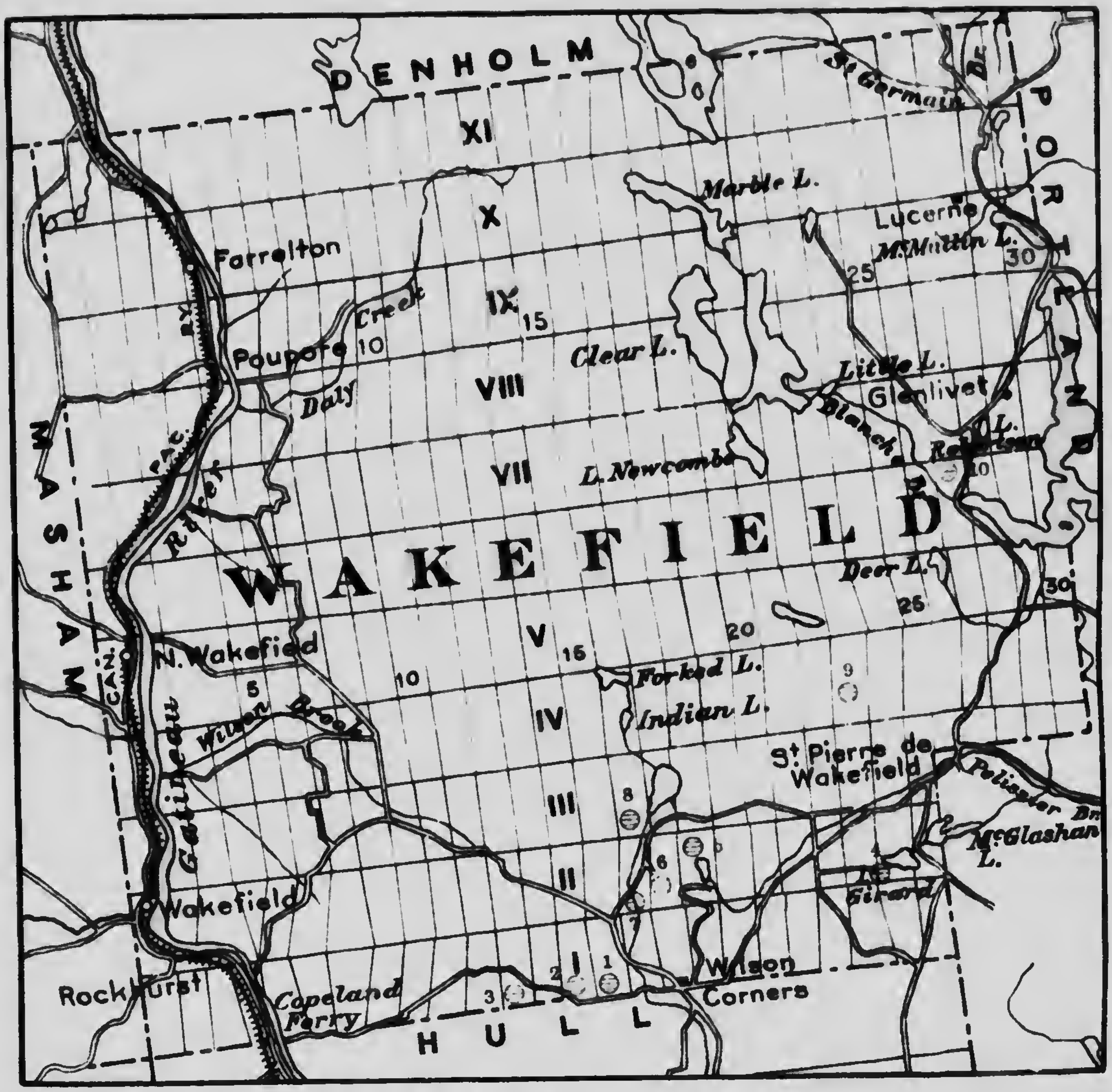


No.	Name of Mine
1	Comet
2	Allan
3	Haldane
4	Lake Girard
5	Seybold
6	Kitty Lynch
7	Kodak
8	Thompson
9	Prospect
10	McGlashan

MICA

MICA MINES AND OCCURRENCES IN TOWNSHIP OF WAKEFIELD, QUEBEC 124

Scale 2 miles to one inch

Chubbock, being now owned by the M. and H. Mining and Development Company, of Ottawa.

The last work was done two years ago by Mr. J. S. King, of Toronto, who took out a little mica.

The property lies about half a mile northeast of the Comet mine and produces an excellent silver amber mica. The following description of the workings, etc., is taken from Mr. Cirkel's report:—

"The main workings consist of a shaft sunk on the hanging-wall of a well-defined vein or lead having a strike of 4° east of north and a dip of 65°. The country rock is gneiss and the deposit in which this shaft has been sunk is a splendid example of a contact vein. The foot-wall is a light green pyroxene slightly intermixed with apatite; the latter is not, however, in sufficient quantities to be of commercial value. The depth of the shaft from the adit is 100 feet. The main constituents of the vein are calcite and mica, occasionally intermixed with pyroxene and apatite. The calcite, which is pink coloured, is generally found near the hanging-wall in a width of from 1

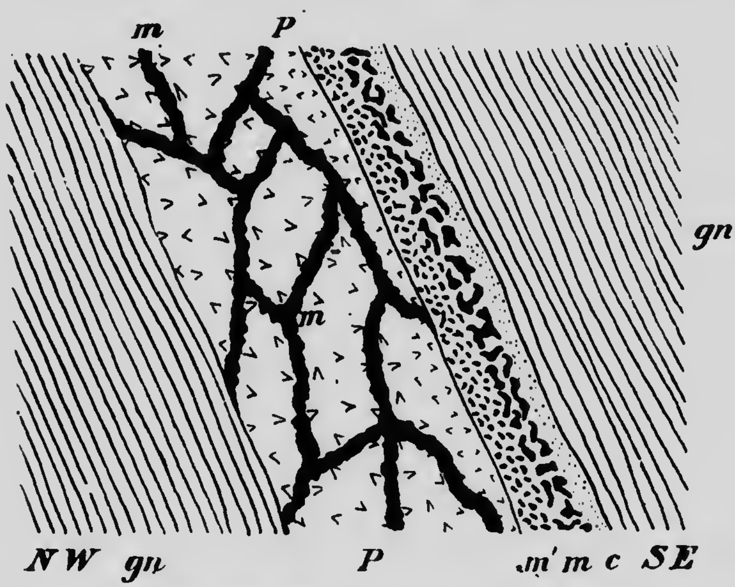


Fig. 13.—Section through mica deposit at Kodak mine, lot 16, range II, township of Wakefield, Que.

P, coarse grained pyroxenite; P', fine grained pyroxenite with mica on irregular leads; m, mica; m', small spangle mica; c, calcite; gn, gneiss.

to 3 feet. The mica crystals are either embedded in the same or form larger accumulations between the calcite and pyroxene. This shaft has yielded a large amount of a very fine quality of mica, and operations were interrupted only on account of legal difficulties regarding the ownership. The property has a good working plant, a well developed water power on the creek of 40 H.P. generating electricity for hoisting, drilling, and pumping purposes. The dynamo is worked by a turbine and power is transmitted by overhead wires to the mine one-fourth of a mile distant. There is a saw-mill on Blackburn creek with a capacity of about 10,000 feet of lumber per day, also an auxiliary plant, consisting of a 20 H.P. upright boiler and a 15 H.P. engine."

Thirty men were at one time employed on the property which is provided with a large boarding-house situated near the creek. It is reported that operations are shortly to be renewed by the present owners.

Lot 17 E.½.—Known as the Kitty Lynch mine, and belongs to Mr. Morris, of Wakefield.

The property adjoins the Kodak mine which is situated about 100 yards to the west. The owner worked for a year in 1892, and no further mining was done until 1907, when Mr. H. Flynn put in three months' work and took out about 25 tons of high-grade mica.

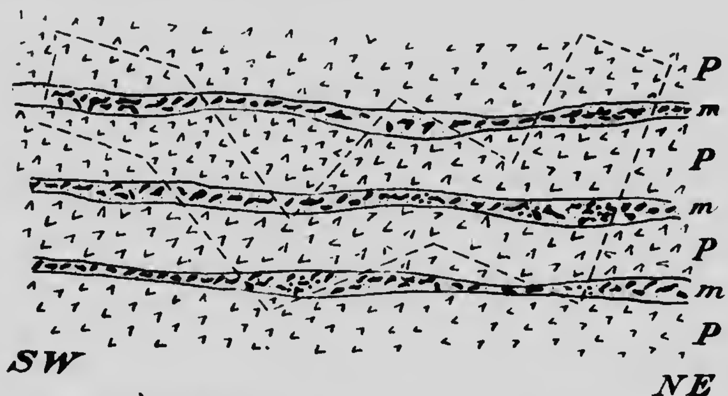


Fig. 14.—Plan of mica deposit at Kitty Lynch mine, lot 17, range II, township of Wakefield, Que.
P, pyroxenite; m, mica leads carrying calcite and apatite.
Outline of pit.

The mica is often of large size and occurs in a contact zone between pyroxenite and gneiss. Fissures have apparently formed in the pyroxenite parallel to the contact and these carry pink calcite and mica. The strike of the deposit is east and west and two pits have been sunk. The westerly opening is 100 feet long and 35 feet deep and follows the deposit in a zig-zag fashion.

Lot 18.—This property, which is known as the Seybold mine, and belongs to Mr. McLean, of Ottawa, was opened over twenty years ago by Mr. Seybold, for phosphate. Work was continued for a couple of years, and the mine was then idle until 1903, when the present owner worked one summer for mica.

In 1907 Messrs. Holland and Moore took a little mica off the property, which has since lain idle.

The workings consist of several surface openings and a narrow pit 50 feet long by 10 feet wide sunk on a contact deposit of dark and rather crushed mica and phosphate between pyroxenite and dark gneiss.

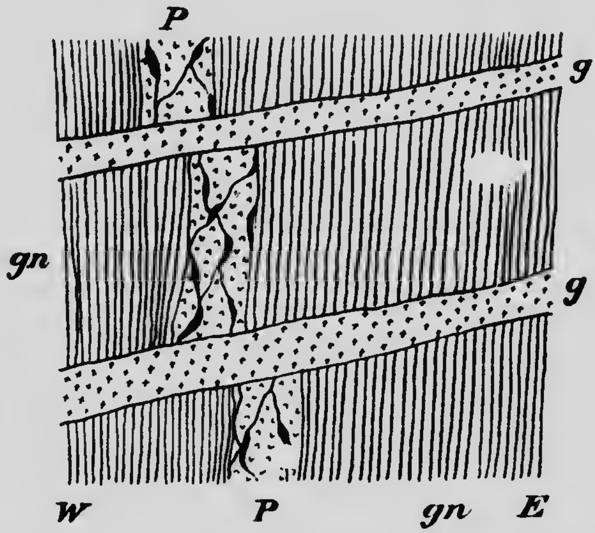


FIG. 15.—Plan of mica deposit at Seybold mine, range II, lot 18, township of Wakefield, Que., showing pyroxenite dyke P, with mica on pockets and leads, cut and faulted by later granite dykes, g; gn, gneiss.

The strike of the deposit is north and south and the dip 75° to the west. Several pegmatite dykes cut the pyroxenite at the exposure and one of these has faulted the deposit a short distance (See Fig. 15).

The other openings are concerned mainly with small pockety accumulations of mica and pink calcite on fissures in the pyroxenite.

Lot 24.—Lake Girard mine. Situated close to the south shore of Lake Girard, 3½ miles from Wilson Corners, and 21 miles from Ottawa. In the early nineties, this was one of the most important mica producers in the district. The property was first worked in 1890 by Messrs. Skeade, Paul, and McViety, who sold out, after a year's work, to the Lake Girard Mica System.

The latter worked steadily for five years, carrying out extensive operations and installing an adequate plant.

Results, however, seem not to have justified the expenditure of so much capital and the Company was forced to shut down the mine in 1895, owing apparently to the impersistence of the mica in depth. The dumps were subsequently worked over and a considerable amount of mica recovered from them.

The Mica Mining and Manufacturing Co. took over the property in 1896, unwatered the mine in 1900, and carried out intermittent work for some years.

The mine has been idle since 1904. When visited, all the mine buildings were in a state of dilapidation, and a considerable sum would be required to redevelop the mine.

All the exposures are now grown over and a detailed examination was impossible. The dumps, however, showed a light grey pyroxenite, considerable quantities of pink calcite, and a light silver amber mica.

The dyke seems to strike northwest and southeast, and a coarse pegmatite with similar direction is exposed above the main pit. The pyroxenite, probably owing to the influence of this pegmatite, has in some cases suffered extensive alteration, its colour having changed to a blue-green and the rock becoming soft and powdery. Large pyroxene crystals were observed which had suffered an outward alteration to a blue actinolite-like mineral (traversellite) the interior being soft and lustreless. Some black tourmaline also occurs penetrating white calcite.

The following description of the mine and section through the workings is taken from Mr. Cirkel's previous monograph on mica, issued in 1905:—

"The country rock is a grey and reddish gneiss, which is traversed in the vicinity of Lake Girard by a dyke-like mass of a light green pyroxene. The main shaft is sunk near the contact between the two rock masses to a depth of 165 feet at an incline of from 73° to 75°. From the 165 ft. level, at a distance of 25 feet, another incline shaft has been sunk to a depth of 45 feet, making a total depth of 210 feet. From the main shaft drifts have been run, following the course of the mica deposits, the longest of which was 140 feet to the east. The mica in this shaft occurs in large lenticular pockets of pink calcite, near the contact with the country rock, and delivers, on account of the absence of wrinkles and crevices, a very large percentage of fine commercial sheets. Most of the mica was of the larger sizes and anything below 2" by 3" was thrown into the dumps, but was subsequently gathered when the demand for the smaller sizes sprang up. All the mica was hauled to Ottawa, a distance of some 20 miles, where it was cut into sizes.

In 1893 when the writer made an examination of this property the average daily output for three months amounted to more than 4½ tons of roughly cleaned mica crystals. The average number of employes was forty-eight. For nine months the daily output was a little over three tons, with about the same number of men. About seventy persons were steadily employed in the Ottawa cutting establishment. From September, 1891, to July, 1893, the total output amounted to 113,000 pounds of mica cut to sizes, 109,545 pounds of trimmed mica of all sizes and 1,250 tons of rough mica, cutting 1" by 3". There are few mines in the district that can show a similar record. The mine was equipped with an adequate plant, consisting of a seven air drill compressor, two horizontal boilers of 120 H.P., two hoists, and two pumps. A large boarding-house and cook-house accommodated seventy-five men."

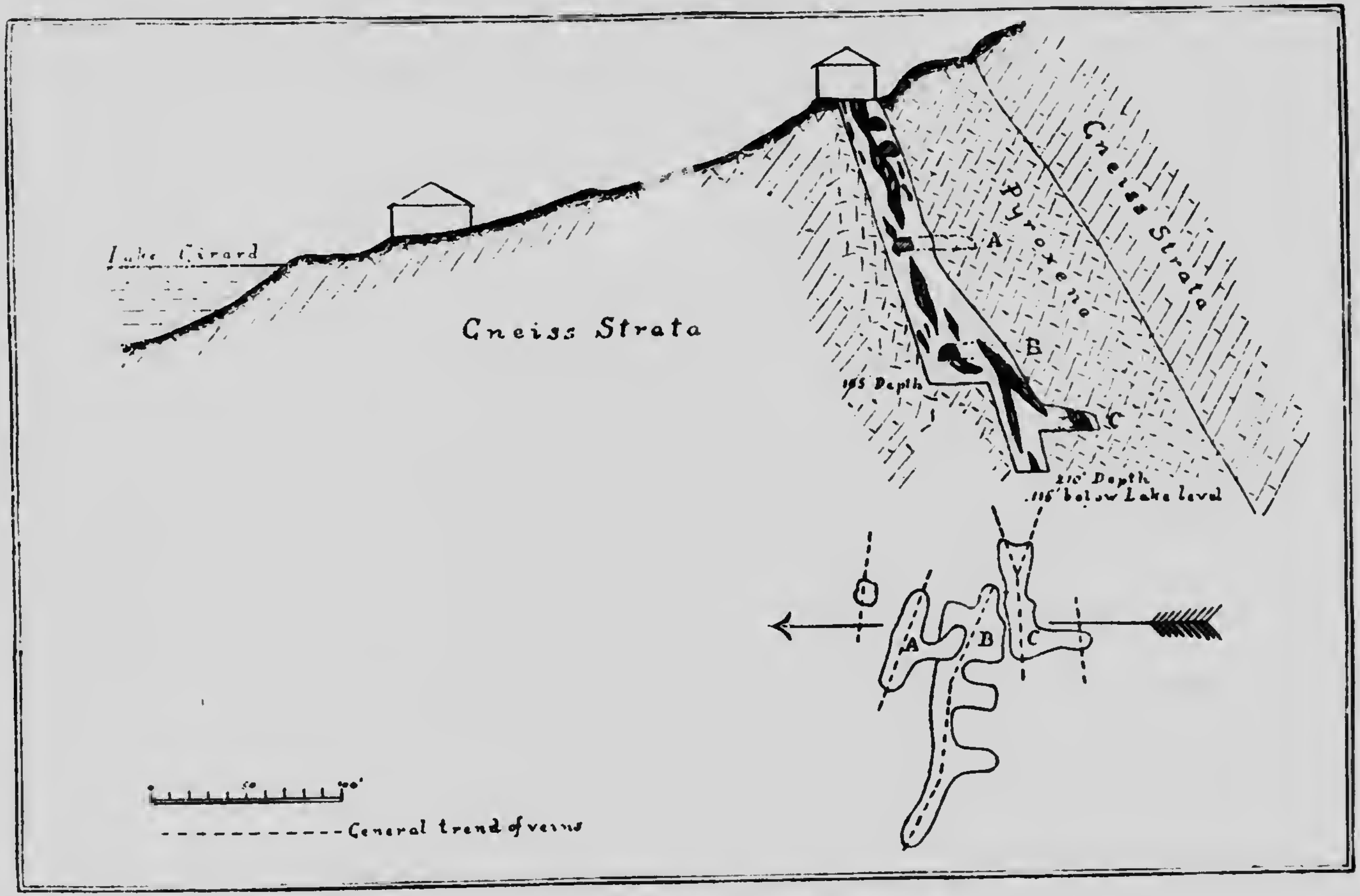


FIG. 16—Cut through workings of the Lake Girard mine.

The following notes upon the various operations of the Lake Girard Mica Mining System are taken from Mr. Obalski's report:—

"This Company has played a considerable role in the amber mica industry of the Ottawa region, and although it is now defunct and its properties passed into other hands, it is worth while to recall its history.

The promoter and soul of the enterprise was Mr. T. J. Watters, of Ottawa, who towards the end of 1891, forseeing the future of the mica industry, commenced to acquire the best-known properties and to develop the mines on a large scale, installing machinery and sinking deep shafts. He organized the Lake Girard Mica Mining System, with offices and mica-shops at 520 Besserer St., Ottawa, where about eighty hands were employed in splitting and trimming special shapes required in the electrical trade. The machines were driven by steam and the shops lit by electricity. An annex contained the stables of the Company, which did its own hauling.

The System owned or controlled at that time more than 3,000 acres of land in Quebec and Ontario, known to be rich in mica outcrops, and operated the important mines known as the Lake Girard, the Nellie and Blanche, Horseshoe, Phosphate King, and others.

The prosperity of the Company lasted until 1896, when it went into liquidation.

Several hundred persons were regularly employed in the mines and shops, and the production of rough mica amounted to about $4\frac{1}{2}$ tons per diem for several years, the total quantity sent to the trimming-sheds at Ottawa being estimated at not less than 3,000 tons of rough cobbed mineral."

Range III, Lot 16.—Belongs to Mr. Thompson, of Cantley. The property was worked some five years ago for mica by Kent Bros., of Kingston, and subsequently by Mr. R. Snowball, of Ottawa, with three men. The mine was last worked in the early part of 1910, by the last-named.

The mica is an excellent light silver amber and about ten tons of thumb-trimmed mineral have been taken out.

The occurrence is on an almost horizontal vein or lead in pyroxenite which carries mica, green phosphate, and pink calcite, and has been followed by means of a flat drift run 50 feet into the side of the ridge.

Range IV, Lot 23.—Was worked in 1907 by Mr. J. Rainville, of Templeton, who took out a few tons of rough mica. No further work has been done.

Range VI, Lot 26.—Belongs to Mr. R. J. McGlashan, of Wilson Corners. This mine is situated 3 miles north of Wakefield and near the west arm of Wakefield lake, on the crest of a hill rising 300 feet above the lake. Work was begun here by Mr. R. W. Eady, in 1905, and continued for two years. The present owner acquired the property in 1907, and has mined more or less steadily up to the present time.

The workings consist of a number of pits opened on the southeast side of the hill, from which drifts have been carried in a northerly direction. The main pit is 60 feet deep, 15 feet wide, and 75 feet long, opened on a pocket deposit of darkish amber mica, green compact and sugar phosphate, associated with pink calcite. The leads and pockets occur in a light grey-green rock, consisting of pyroxene, scapolite, feldspar, and dark quartz. The variety of scapolite known as wilsonite occurs in some quantity in certain of the pits.

The mica is often well crystallized, and a quantity of large-sized crystals have been raised. Large crystals of apatite also occur embedded in calcite and sugar-phosphate and the property is of value for this mineral, which is mined at present as a by-product.

In the pit, on the northeast of the property, a well-defined flat lead is exposed, the vein matter being pink calcite and massive phosphate, and the walls lined for some distance with well-formed apatite crystals.

Brown titanite in crystals measuring an inch in length is an accessory mineral in the dyke rock. The mica is roughly cobbed on the mine and hauled to the trimming shops at Wilson Corners, 6 miles away.

The following are less important locations in the township of Wakefield from which mica has been reported in the past, but which have not been further exploited.

Range I, Lots 11, 13, 18.—Prospected and mica outcrops located.

Range III, Lots 13, 17.—Indications of mica reported to occur.

Range IV, Lots 14, 15, 18, 19.—Indications of mica reported to occur.

Lot 25.—Prospected in 1899 by Fortin & Co., with a few men. Three pits were sunk to a depth of 20 feet in a grey pyroxenite carrying pockets of mica and pink calcite, the whole traversed by felsite dykes.

Range VI, Lots 12, 21, 22, 27.—Mica outcrops.

Range VIII, Lots 20, 27, 28.—Mica outcrops.

Range IX, Lot 19.—Mica outcrops.

Township of East Hull.

Range X, Lot 7.—Known as the Foley, or "Big Crystal" mine. This property was opened in 1892 by Messrs. Powell and Brennan, and a dozen men were employed; but owing to disputes as to ownership, work was only carried on intermittently, the Lake Girard Mica System claiming the mine. No work has been done here since 1898.

The workings consist of two pits 30 × 30 feet, and 20 feet deep, opened in a grey pyroxenite carrying a rather crushed dark amber mica on joints and fissures and cutting a crystalline limestone country. Very little calcite accompanies the mica and no phosphate was observed.

The pits are situated on the edge of a swamp, and water is said to have caused considerable trouble in the workings.

A large vein of barytes occurs on the same property and is owned by the Canada Paint Co., of Montreal.

Range XI, Lots 5, 6 S.½.—Known as the Kearney mine, and owned by Messrs. McRae and Allan, of Ottawa, who worked in 1892 with a dozen men, under the name of the Electric Mining Company. About fifteen tons of mica were extracted and diamond drilling was carried out, but apparently with unfavourable results, as no further work was undertaken.

The property was originally opened up for phosphate by Messrs. J. and P. Kearney, some thirty years ago.

Lot 5b.—Owned by Mr. C. Cashman, of Cantley. Messrs. Powell and Clemow were the first to work for mica, in 1891, and subsequently Webster and Co., Messrs. Fortin and Gravelle, and Mr. R. Snowball, did a little mining. Operations were never continued for any length of time however, the last-named only working for three weeks in 1909, since when no further work has been done.

The openings consist of a series of shallow pits sunk on a lead of rather crushed light silver amber mica in dark grey pyroxenite. The deposit occurs on a fissure carrying only very little pink calcite and no phosphate, near the contact of a pyroxenite dyke with dark biotite gneiss, the whole being cut by numerous narrow veins of pegmatite.

The mica lead strikes N.E. and S.W. and is of varying widths, but does not appear to be of sufficient size to justify any extensive sinking operations.

Lot 6.—Some work was done here in 1893 by Mr. J. W. Perkins, who employed half a dozen men and took out about eight tons of mica. No further work has been undertaken since. The present owner is Mr. James Burke, of Cantley.

Lot 10.—Known as the Nellie and Blanche mine, and situated about a mile south of the Vavasour mine. Like most of the other mica mines in this locality, the property was originally opened for phosphate.

It was worked over thirty years ago by Mr. J. T. Haycock, of Ottawa, who subsequently mined for mica. In 1892 the mine passed into the hands of the Lake Girard Mica System, and this Company set to work to develop the property on a large scale. Machinery was installed, including steam drills and hoists, a camp was erected and good roads built, and for a year 40 to 50 men were employed. Work ceased in 1897, and no further operations have been conducted since.

Several large openings were made, a depth of 50 feet being reached in the main pit near the engine house.

The mica, which is a dark amber and often gave large cuts of 14″ × 10″, occurs in a kind of chimney or lenticular pocket in a dark green pyroxenite containing considerable quantities of scapolitized feldspar. The rock shows abundant evidence of differentiation throughout its mass, large masses of grey, more or less altered, feldspar being met with in the workings.

A production of 40 tons of mica per month was reached at the time the mine was in full working order, the mineral being hauled to the Company's trimming-sheds at Ottawa.

Range XII, Lot 1 S.½.—Burke mine. Opened over thirty years ago for phosphate and subsequently worked by Mr. J. W. Perkins, with seven men, for one summer, about ten tons of rough mica being taken out; a large proportion of the sheets was of more than average size, cuts of 10″ × 12″ being not uncommon.

The dumps have been worked over during the last ten years, first by Messrs. McAllister and Hamilton, and later by Messrs. Holland and Moore, but no further mining has been done since 1894.

The openings consist of two pits, one a circular shaft 8 × 8 feet and 25 feet deep, and a second drift or inclined trench a short distance from the first, and about 20 feet deep, from the bottom of which a further drift has been carried to the N.W., the total depth being about 50 feet.

The rock is a vuggy green pyroxenite, carrying much pink calcite and silver-amber mica on fissures and pockets, the walls of which are lined with well-formed pyroxene crystals. The mica crystals are rather contorted and inclined to split up into ribbon-mica.

A large amount of iron pyrites is present throughout the deposit, the rock being in places stained a deep red.

The bottom of the main pit showed a large mass of pink calcite following a more or less horizontal lead, and carrying mica and brown apatite crystals disseminated through it.

Some of the massive pyroxene is of a very dark green colour, yielding perfect cleavage fragments in three directions.

Lot 4.—Indications of mica are reported by the owner, Mr. James Burke, of Cantley.

Lot 10.—This mine is variously known as the Gemmill, Nellis, or Vavasour mine, and was originally opened for phosphate over thirty years ago by Mr. Donald Gow, of Cantley, who worked continuously for six years and took out a great quantity of high grade apatite.

Subsequently, Messrs. Nellis and Gemmill took over the property and operated a few years for both phosphate and mica, under the name of "The Vavasour Mining Association."

The mine is now owned by Mr. E. J. Nellis, of Ottawa, who has kept an average staff of ten men more or less continuously employed during the last few years. The property lies about half a mile southwest of Cantley and 10 miles north of Ottawa, and connects with the Cantley-Ottawa road by a good field track.

The workings are situated on a small hill or knoll measuring about a third of a mile across and composed principally of a grey-green pyroxenite cutting normal biotite gneiss. The pyroxenite is much fissured in a northeasterly and southwesterly direction, the fissures being of varying widths, but seldom exceeding 15 feet, while the length of the principal lead has been estimated at 1,200 feet. The total distance of the fissures exceeds 2,100 feet,

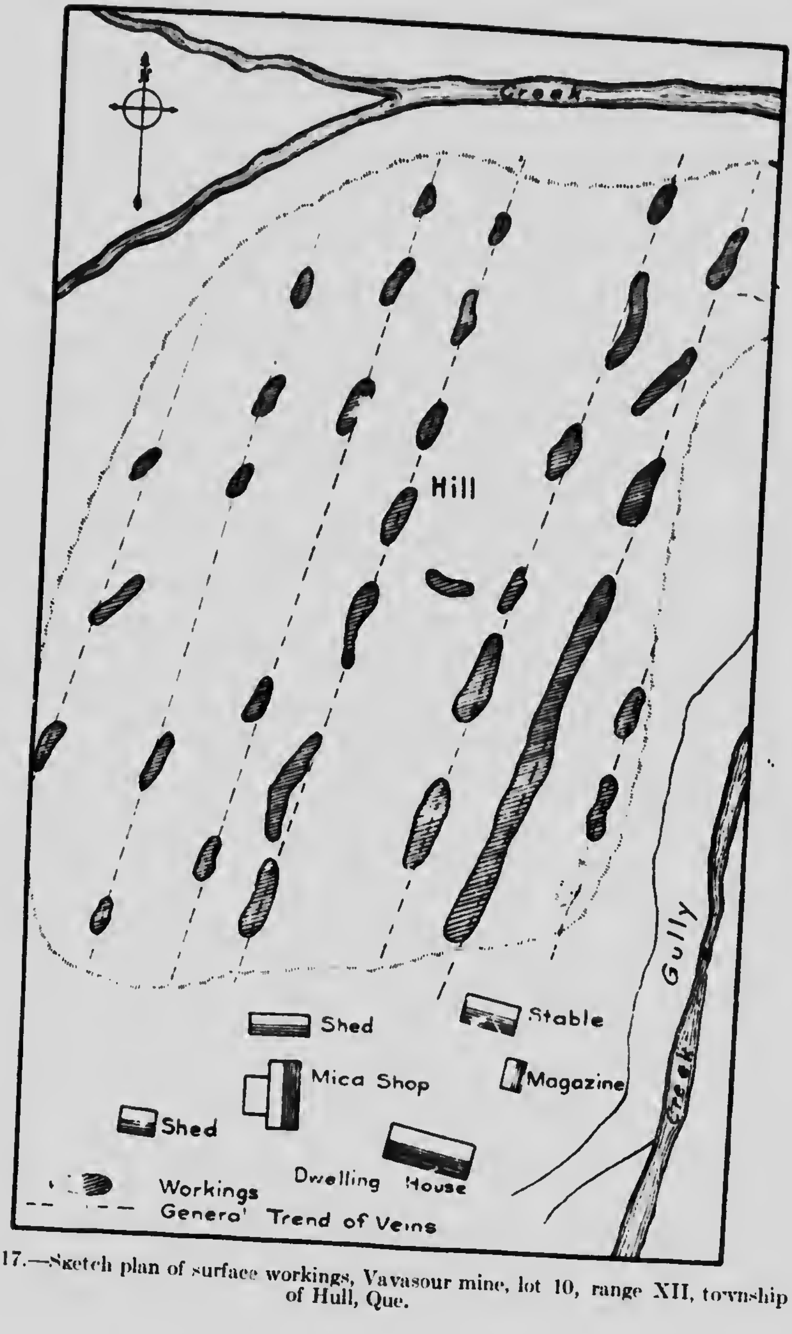


FIG. 17.—Sketch plan of surface workings, Vavasour mine, lot 10, range XII, township of Hull, Que.

and practically this entire length has been worked, though the openings are chiefly confined to five principal and parallel leads.

The principal filling of these fissures consists of pink calcite containing well-formed crystals and compact aggregates of green apatite, with mica crystals, often of large size, scattered through the mass. The mica is a first-class silver-amber, yielding a large percentage of 5" × 8" sheets, and over 300 tons of marketable mineral are said to have been produced from the mine.

Culling and trimming are carried out on the mine in large sheds, and a large quantity, estimated at over 500 barrels, of mica prepared for market, is stored upon the property.

Phosphate is won simultaneously with the mica, and several hundred tons of high grade mineral have been shipped as a by-product.

No machinery is, or has been, employed on the mine with the exception of small steam-pumps in the deeper workings. Hoisting is done by means of horse-derricks and hand-winches operating boom derricks.

The workings consist of numerous pits, trenches, and drifts following the line of the leads, the greatest depth reached being about 180 feet. The fissures are not as a rule vertical, the general dip being some 60° to southeast.

The pyroxenite varies from a coarse-grained normal type to a finely crystallized mixture of pyroxene and spangle mica, and the whole system is cut by several narrow pegmatite veins. Some exploitation work has been carried out to the southwest of the main workings, but without much success.

Fig. 17 shows a general plan of the workings.

Lot 11 a.—Known as the Lucky Reserve mine, and owned by Brown Bros. of Cantley. The workings are situated a few hundred yards northwest of the Vavasour mine, and have yielded about thirty tons of rough mica of excellent quality and good size.

The quantity of phosphate met with is small, considering the proximity of the deposit to the large masses of apatite met with in the Vavasour pits.

The occurrence is generally very similar to that at the latter mine, the mica occurring on what is probably the northwest contact of the dyke, or series of dykes, of pyroxenite, with the country gneiss.

The only workings are one pit about 25 feet deep and 30 feet long, showing a quantity of pink calcite and good indications of still further mica in depth.

The first work was carried out by the owners in 1906 and has been continued at intervals up to the present time, four men being employed.

Lot 13.—Belongs to Mr. Hibbard, of Minneapolis, who has taken out a little mica.

Range XIII, Lot 3.—Another old phosphate mine and owned by Mr. John Thibert, of Cantley.

There are a number of small pits scattered over the property, the largest being about 40 feet deep. The rock is a dark pyroxenite carrying a dark and rather stained silver-amber mica on joints in the rock. Little calcite is present and the rock exhibits many variations of composition.

Lot [illegible] S.½. An old phosphate property belonging to Mr. Thomas McDermott of Cantley, and opened by Mr. J. Haycock, over twenty-five years ago. M[illegible] has been carried out by several parties under lease from the owner during the past fifteen years, the latest work having been done by Mr. C. Brown, who prospected in 1910.

About [illegible] tons of rough mica are said to have been taken off the property.

Lot [illegible]. [illegible] ongs to Dr. Graham, of Hull, who took out a few tons of good [illegible] large sized mica some fifteen years ago. No further work has bee[illegible] it is reported that Kent Bros. have recently secured a lease [illegible] property and propose developing it.

Lot [illegible]2. [illegible] ngs to Mr. P. Flemming, of Cantley. Mr. H. Flynn worked for a sh[illegible] 908, an[illegible] the owner took out a little mica in 1910.

Lots [illegible] phosphate property, and was worked in the earl[illegible] by Webster & Co. No further work was carried out [illegible] of 1910, when Messrs. Winning, Church, & Co., of Ottawa, took ove[illegible] property, and have worked continuously up to date with some half a [illegible].

The mica is an excellent light silver-amber, possessing good cleavage and is often of large size, a large proportion of the sheets yielding cuts of 5″ × 8″.

The workings are about half a mile east of the Gatineau river, and on lot 13a, consist of a small surface pit, following a well-defined lead of mica and high-grade phosphate, striking N.E. and S.W., the vein being evidently part of a pocket and fissure deposit.

The exposure showed an extremely favourable formation, and stripping and trenching across the line of strike would probably disclose similar parallel leads.

On lot 12a, numerous small prospect pits have been opened. The main opening is a large stope or drift striking E. and W. and dipping 60° to S., following a fissured zone in pyroxenite carrying considerable quantities of mica. The pit is situated on the crest of a low ridge of dark green pyroxenite which has been intruded and shattered by apophyses and veins of a reddish fine-grained acid rock, consisting principally of feldspar with a little quartz and considerable quantities of well-formed brown titanite crystals scattered through it. The mica appears to occur on the contact of this felsite with the pyroxenite, but there may be only an apparent connexion between the mica and the acid intrusion.

The later acid rock has been probably injected into a pocket and fissure deposit of mica, and consolidating on narrow joints in the rock lends now to the formation the appearance of a mica deposit due to the contact of felsite and pyroxenite.

The injection of the later rock has exerted considerable influence upon the pyroxene. Along the contacts, the dark green pyroxene has been altered for varying distances, to a dark greenish-blue fibrous actinolite, and masses of the earlier rock which have been included in the felsite are completely metamorphosed.

Druses sometimes occur, the walls of which are lined with sharp well-defined monoclinic prisms of actinolite.

A little molybdenite occurs with the felsite, masses of half a pound weight having been found. Some very large mica crystals have been taken from this deposit, and the drift, which is now down about 60 feet, shows a strong lead of mica in depth. A little brown phosphate accompanies the mica and considerable pyrites is present throughout the rock.

No machinery is used on the mine which should repay more extensive development.

Range XIV, Lot 10 N. ½.—McClelland mine. An old phosphate producer and opened twenty-five years ago by Mr. Wilkinson, of Ottawa. The property has passed through many hands and is at present owned by Mr. R. McConnell who ceased work in 1908.

The mine is situated 2 miles from Cantley, and produces a dark mica, much of which is crushed and fractured and consequently useless.

The deposit is a good example of the contact class. A pyroxenite dyke having a strike of north and south cuts dark biotite gneiss, the whole formation being extensively traversed by later pegmatite veins.

On the west contact, a large body of pink calcite and phosphate, both

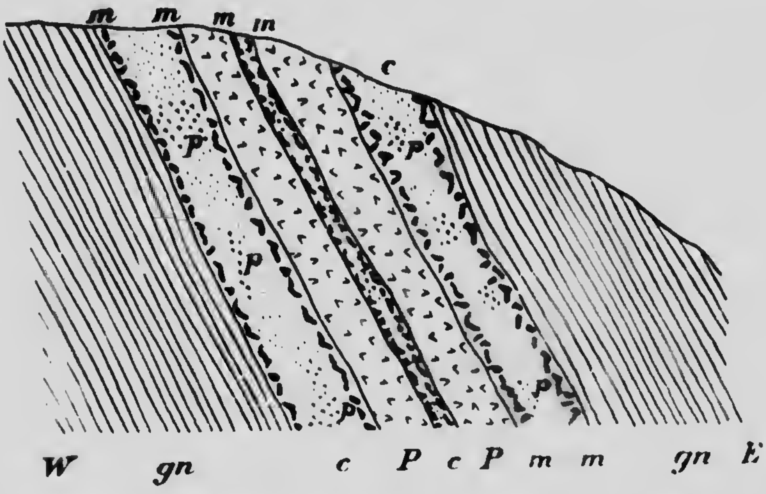


FIG. 18.—Section through mica deposits at McClelland mine, lot 10, range XIV, township of Hull, Que.

gn, gneiss; P, pyroxenite; c, calcite; p, apatite; m, mica almost entirely confined to the contacts.

brown massive and green sugar, has been formed, carrying considerable quantities of mica—the whole dipping 70° to the east. This contact-body, which averages 15 feet in width, has been followed on the incline to a depth of over 100 feet, and for a distance of 150 feet, stulls being inserted at intervals, and a cribbed haulage-way built in at the south end.

The mine is not of much value for its mica, being more important as a phosphate producer.

Lot 15.—Belongs to Messrs. D. and T. Ramsay, of Cascades.

The property was first worked in 1907 by the owner with seven men. Operations were only continued for a month, and seven barrels of thumb-trimmed mica of medium colour and size were taken out. Several surface pits were opened up, but the mica does not appear to be very persistent.

Range XV, Lot 12a.—Dacey mine.—This property belongs to the General Electric Company, and was first exploited over twenty years ago by Messrs. Chubbock and Rainsford, of Ottawa, who worked for a year. Webster & Co. then took over the mine and continued to work intermittently for five years, with about fifteen men, subsequently vending to the present owners; the latter have never worked, the mine being idle since 1904.

The workings consist of several deep and narrow pits sunk on a vein zone of mica and phosphate. The leads have a strike of northwest and southeast and carry large quantities of phosphate, mostly of the sugar variety, in which the mica, a light silver-amber, occurs embedded.

The deepest opening is 50 feet down and about 50 feet long and shows a lead of an average width of 4 feet. The distance from Ottawa is 18 miles.

Lot 12b.—This is one of a group of mines situated about 2 miles southwest of Wilson Corners on a ridge of altered gneiss cut by pyroxenite dykes, the whole extensively intruded by granite veins and apophyses.

The mine is the property of Mr. W. McAllister, of Ottawa, and is at present leased by Mr. R. J. McGlashan, of Wilson Corners, who began to work in the early part of 1910 with half a dozen men, and has taken out fifteen tons of rough mica.

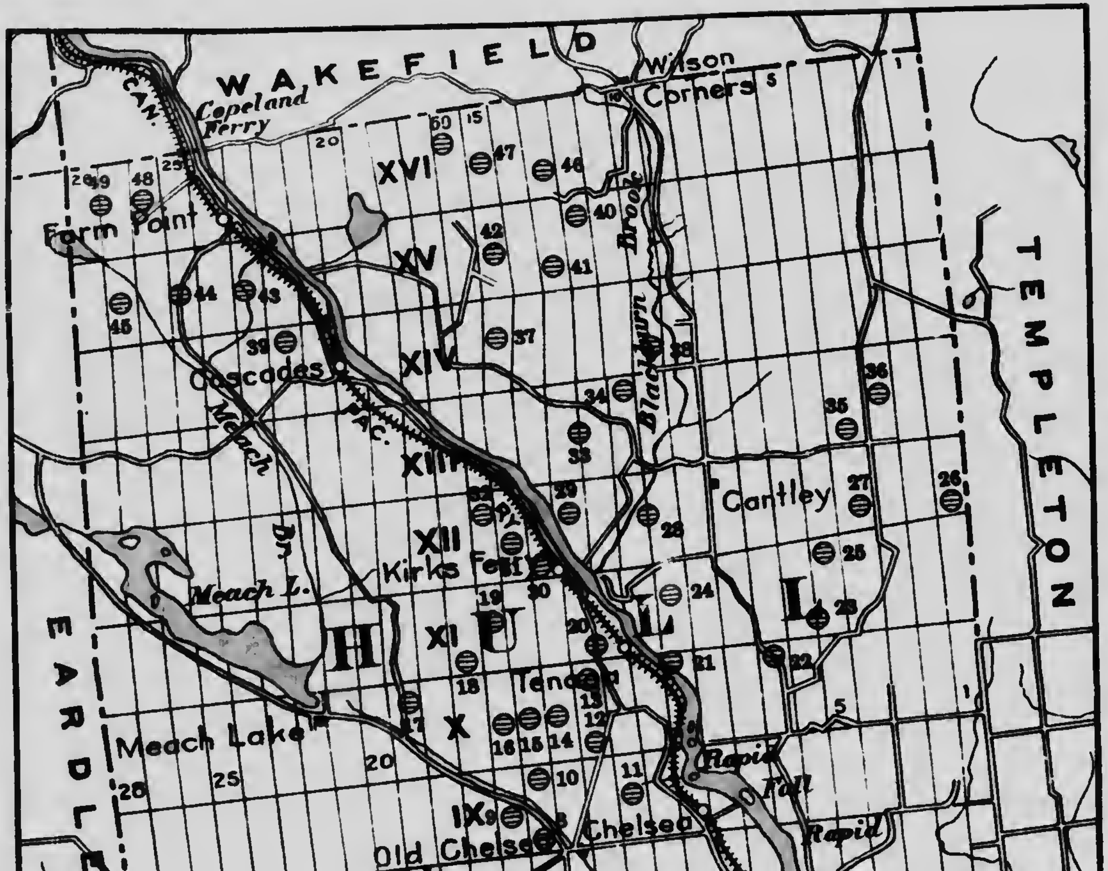
The property has been extensively worked in the past by various owners, and numerous openings exist. One pit is down 75 feet in a pockety deposit of sugar phosphate and mica crystals of medium size and light silver-amber colour.

All the openings show good indications of mica which, although not occurring in any great quantity, is of excellent quality, and seems likely to persist in sufficient amount to justify further sinking.

The phosphate, which is mostly of the sugar variety, is saved as a by-product.

The mica is drawn to Wilson Corners to the lessee's trimming-shop, whence it is shipped to consumers.

Lot 13.—Known as the Connor mine, and held on option by O'Brien and Fowler, of Ottawa, who worked the property in a small way in 1910. It has



No.	Name of Mine
1	Wallingford
2	Clift
3	For[illegible] & Gravelle
4	Laurentide Co.
5	Fleury
6	Brown Bros.
7	Prospect
8	Sweeny
9	O'Neill
10	Scott
11	Church
12	Prospect
13	Prospect
14	Prospect
15	Rainbow
16	Bradley
17	McConnell
18	Charleson
19	Connor
20	Prospect
21	Prospect
22	Foley
23	Eureka—Kearney
24	Nellie and Blanche
25	Cashman
26	Burke

MICA

MICA MINES AND OCCURRENCES
IN TOWNSHIP OF HULL, QUEBEC
Scale 2 miles to one inch

23 Eureka—Kearney
24 Nellie and Blanche
25 Cashman
26 Burke
27 Prospect
28 Vavasour
29 Prospect
30 Connor
31 Connor
32 Connor
33 Winning, Church & Co.
34 Prospect
35 McDermott
36 Thibert
37 Ramsay
38 McLelland
39 Bate
40 McGlashan—Dacey
41 Connor
42 Prospect
43 Flynn
44 Moore
45 Flynn
46 Wilson
47 Cassidy
48 Robertson
49 Carman
50 Horseshoe

been worked at various times by different operators, including Messrs. Chubbock and Rainsford, and Mr. Connor.

There are two large pits, the deepest of which is 60 feet down, besides numerous smaller openings. The mica, a light silver-amber, occurs on more or less well-defined leads having a strike of east and west and attaining a width of as much as 12 feet. The leads seem to follow contraction or dislocation fissures in the pyroxenite, the walls of which are sometimes lined with large and well-developed crystals of pyroxene (See Plate XXIX).

The work carried out during 1910 consisted chiefly of prospecting, and results do not appear to have been very satisfactory.

Range XVI, Lot 13.—Known as the Wilson mine and owned by Mr. Neil Stewart, of Ottawa. This mine is more properly a phosphate producer and was opened up as such some twenty years ago by Mr. J. A. Wilson, of Cantley, who at present has the mine on a lease and works each winter with half a dozen men: the mica is saved as a by-product.

Lots 15 N.½, 16 N.½, 17.—Known as the Horseshoe mine and adjoins the Haldane mine. The property was opened up twenty years ago for phosphate, and was subsequently taken over by the Lake Girard Mica Company, who carried out extensive work in 1891 and 1892. Kent Bros., of Kingston, worked a few months in 1909, and opened up a deposit of mica and phosphate accompanied by bunches of pink calcite for a distance of 80 feet, taking out $8,000 worth of mica. The opening is 35 feet deep and shows

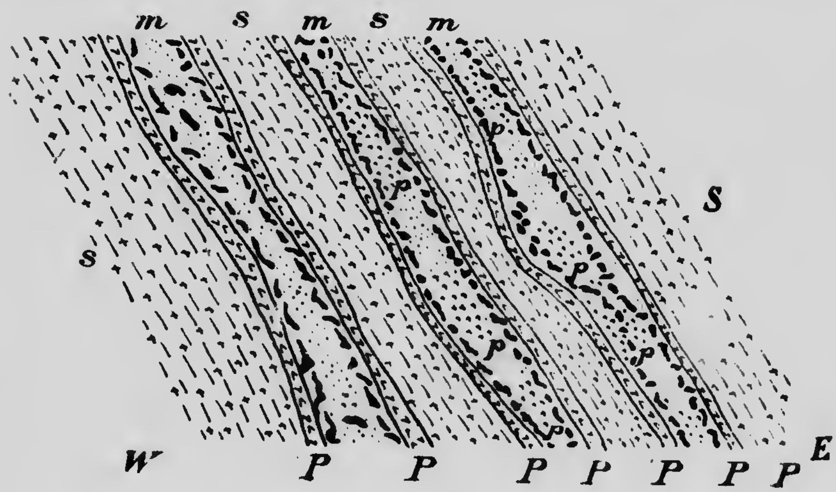


Fig. 19.—Section through mica deposits at Horseshoe mine, lot 16, range XVI, township of Hull, Que.
s, altered gneiss; P, pyroxenite; m, mica associated with calcite and bunches of apatite (p).

a number of narrow bands of dark green pyroxenite cutting dark gneiss, the mica and phosphate occurring along the contacts (See Fig. 19).

The leads strike north and south, and dip 60° to the east. The mica is a darkish amber and rather friable, but the crystals are often of large size.

A good deal of pyrites is present and considerable massive scapolite occurs at the north end of the workings.

The property is connected with the main road from Wilson Corners by two miles of bush track.

Appearances indicate that the deposit probably widens at depth, and drilling might be carried out with advantage.

Lots 15 S.½, 16 S.½.—Known as Cassidy's mine. This property is traversed by a wide belt of massive pyroxene, containing mica deposits along lines of fissures. These deposits form pockety accumulations or veins of mica, which can be traced for some distance. No contact with the country rock can be observed in any of the openings, and it appears that the principal mode of occurrence is in pockets of irregular shape. No calcite can be noticed, and apatite occurs only in small bunches. The mica crystals are generally of large size but they split up and deliver a great deal of small-sized ribbon-mica. Operations on this property were begun in 1893 by the Cascades Mining Company and were continued at intervals until 1901 by various parties, including a local syndicate, known as the Development Mica Mining Company. It is reported that the mine gave a very satisfactory percentage of fine, merchantable, mica sheets.

The present owners are Webster & Co. of Ottawa, who, however, have never done any work, the last operations being carried out in 1901 by Messrs. Wright and Jamieson.

The following locations in East Hull township, cited in Mr. Obalski's report, have not been further exploited during recent years:—

Range X, Lot 6.—Prospected in 1892 by Mr. G. Robertson, and indications of mica reported.

Range XIII, Lot 9.—Indications of mica reported.

Range XIV, Lot 16.—Prospected by Mr. Bishop in the nineties, and outcrops reported on the north end of the lot.

Lot 17.—Mica outcrops reported.

Range XV, Lot 15 E.½.—A quantity of excellent mica was taken off this property in the nineties by Mr. Jamieson.

Lot 16 S.½.—Has been worked at different times by Mr. Mortard and others.

Lot 16 N.½.—McFarlane mine. Worked in 1892, and has yielded several tons of mica, besides considerable phosphate.

Township of Portland West.

Range I, Lots 31, 32.—Owned by Mr. J. Prudhomme, of Ottawa. The property was prospected in 1910 by Mr. Charron and good outcrops are reported to have been found. It is proposed to start work during the coming summer.

Range III, Lots 12, 13.—Known as the Lake Terror mine and situated on the summit of a high hill 2½ miles west of the Lièvre river, which is reached by a bush road.

The property was prospected and worked for a short time in 1893-4 by Lewis Bros. & Co., of Montreal, who, however, ceased work after a few months.

No further mining has since been undertaken.

The mica is a light amber, rather crushed, and occurs on N. E. and S. W. fissures in a light grey pyroxenite. The leads are narrow and carry only traces of calcite and phosphate.

There are two small pits, the largest being 15 feet deep, and neither now shows much indication of mica.

Lots 14 S.½, 15.—Known as the Chabot mine and opened in 1899 by J. A. Chabot & Co., of Ottawa, who report a production of six tons of trimmed mica.

The workings are situated on the crest of a ridge 500 feet high and 4 miles west of the Lièvre river, which is reached by a bush road. The mine can also be approached by a steep track 1½ miles in length and communicating with the Wakefield road by way of Lake McArthur.

The workings are not very extensive, consisting of three or four small pits, the largest of which is 30 feet long, 12 feet wide, and 25 feet deep. The openings have been made on fissure leads in a light greyish pyroxenite, the strike of the leads being N.W. and S.E. The mica is a medium-sized light amber and is associated with small quantities of phosphate—calcite occurring but sparingly.

A high degree of differentiation is exhibited by the dyke mass—what are, apparently, segregated masses of coarsely crystalline white and brown feldspar occurring throughout the compact and fine-grained pyroxene rock.

Some well-crystallized scapolite also occurs on vugs associated with green phosphate.

This property was last worked some eight years ago, and has recently been acquired by the Progressive Mining Company, Ltd., of Ottawa, who propose to commence operations during the coming summer.

Lot 24 N. ½—Lila mine. This mine is situated on a hill 300 feet high, and 5 miles west of the Lièvre river. The workings are approached from Wakefield by a good road as far as McArthur lake, whence a bush track of 2½ miles leads to the mine. The distance from Ottawa is 30 miles.

Originally opened for phosphate in the seventies by Mr. John Doller, of McArthur lake, the property was acquired in 1898 by the Lila Mica Mining Company, who employed a gang of twenty-five men and erected a large camp.

Work was carried on at intervals for several years, and in 1907 a fresh attempt at mining was made, but after an open-cut had been run into the old workings for the purpose of carrying off the water, operations were suspended, and the mine has lain idle ever since.

There are five pits on the property, the deepest of which is down 60 feet. This is an open-cut or quarry excavated on the southeast side of the hill and from the bottom of which drifts have been carried 30 feet to the north on pockety leads of mica and phosphate in a greyish pyroxenite. The dyke-mass varies from a normal medium-grained rock to a fine-grained mica-pyroxenite, and is cut in the main pit by a pegmatite vein 9 feet wide and striking N.E. and S.W.

The mica is a medium quality wine-amber and is rather brittle. Large quantities of pyrites and pyrrhotite occur throughout the deposit.

Lot 24 S.½.—Was worked by the above Company in 1898–9, for a few months, and a pit 35 feet deep opened. Some very large crystals are reported to have been taken from the workings.

Range IV, Lot 27.—An old phosphate producer, opened in the eighties by Messrs. Fleming and Allan, of Ottawa, and has since produced large quantities of mica.

In 1891, Mr. H. McRae secured a lease of this property and the adjoining lots 26 and 28, and employed an average force of 35 men for two years, producing both mica and phosphate. Three large excavations were made, two upon lot 26 and one on lot 28, the latter being equipped with a steam hoist. Subsequently the mine was purchased by Mr. Farley, of Ottawa, who is the present owner.

In 1907, Messrs. Marcelais and Hamilton worked the dump and recovered some good mica.

Mr. T. G. McLaurin carried out a few months' work in 1908, under lease; no further work has been done since this date.

The two principal pits have been opened up for a distance of 75 feet, are 12 feet wide, and about 45 feet deep. They follow parallel fissure leads of phosphate and mica associated with large bodies of pink calcite, in a greyish pyroxenite dyke cutting dark gneiss.

Several dykes of grey felsite and granite traverse the property, quantities of black tourmaline having formed on their contacts with the country. Large masses of grey coarsely-crystalline feldspar were met with on the dumps, and carry small crystals of brown titanite scattered through them. This feldspar appears to be a segregation product from the dyke mass.

Lot 28.—Formed part of the Fleming and Allan phosphate property and is now owned by Mr. W. A. Allan, of Ottawa.

The dumps were turned in 1907 by Mr. Winning, who recovered a quantity of mica.

In addition to the foregoing, the following locations in Portland West are cited in the reports of Mr. Obalski and Mr. Cirkel; no further information regarding them was obtainable.

Range III, Lot 16.—Prospected in 1900 and indications of mica reported.

Range IV, Lots 16, 17, 18.—Mica outcrops reported to occur.

Range V, Lots 24, 25.—A little surface work was carried out by the Lake Girard Mica System.

Range IX, Lots 5, 6.—Old phosphate properties originally worked by the Canadian Phosphate Company. In 1892 Mr. W. McIntosh took out a few tons of mica. Mr. A. Cameron, of Buckingham, carried out a few months' work in 1899, and secured a quantity of large-sized mica, besides some phosphate.

Range X, Lots 1, 2.—Indications of mica reported.

Gatineau River And Western District.

OTTAWA COUNTY

Township of West Hull.

Range VI, Lot 19.—Owned by Messrs. Wallingford, who commenced mining about six years ago, employing twelve men for a year.

The workings are situated 2 miles from Kingsmere, on the southwest slope of the same ridge upon which lie the properties of the Laurentide Mica Mining Company, Messrs. Fortin and Gravelle, etc.

The country rock is a normal biotite gneiss, with a strike of northeast and southwest, and dipping 65° to the southeast. Dark, coarse-grained pyroxenite dykes cut the country conformably and carry a light silver-amber mica and a little phosphate and pink calcite, on pockets and fissures in the contact zones.

Later, fine-grained, granitic veins of a pink colour have intruded and shattered the older rocks. These granite intrusions have an east and west direction and have exerted considerable influence upon the pyroxenite, which, in proximity to the later rock, is highly altered to a bluish actinolite, while considerable quantities of blue-grey asbestos have been formed along the contacts. The fibres of this asbestos sometimes reach a length of 6". The workings consist of several open-cuts and drifts opened at intervals along the contact to a depth of 35 feet: most of the pits are now fallen in and grown over.

Lot 20.—Known as the Cliff mine, and owned by Brown Bros. of Cantley. The owners started work in 1898, and continued for ten months, a force of five men being employed.

No further mining has been carried out. About forty tons of rough first-class silver-amber mica were produced.

There are three pits, the largest being 30 feet deep, opened up on a pocket deposit in normal pyroxenite.

The main pit is said to still exhibit good showings of mica in depth.

Range VII, Lot 18 N.½.—Eva mine. Belongs to Brown Bros. of Cantley, who worked for two months in 1898 with five men and took out a little mica.

Lot 18 S.½.—Owned by Messrs. Fortin and Gravelle, of Hull, and adjoins the Laurentide Mica Company's mine.

Work was commenced by the owners in 1899, with a force of eight men, and continued at intervals until 1906.

The workings consist of two main pits sunk on a pockety deposit of mica having a general direction of northeast and southwest, and apparently occurring at or near the contacts of pyroxenite spurs with grey gneiss. Considerable quantities of pyrites are present in the pyroxenite, and the gneiss is highly impregnated with this mineral near the contacts. A large amount of big mica was produced from this mine.

One of the pits has been excavated to a depth of 90 feet, while the other is down some 20 feet, and is reported to still possess good showings of mica in depth.

The mica is hauled to Hull, where the trimming shops are situated.

All the mine buildings, consisting of boarding-house, stable, culling-sheds, etc., are now in a more or less tumble-down condition.

Lot 19.—This property, formerly owned by Messrs. Brown Bros., and worked by them in 1899, was transferred to the Laurentide Mica Company in 1904.

The latter had a force of 30 men at work on the mine until the autumn of 1908.

In May 1910, operations were resumed on a smaller scale, only five men being employed, and when visited, a similar number were engaged in sinking a shaft 9 × 7 feet, and drifting to the south upon what appears to be an irregular fissure carrying phosphate and mica.

There are over twenty pits scattered over the property, the greatest depth reached being about 80 feet.

In addition, extensive trenching has been carried out, and the property has been thoroughly surface prospected.

A diamond drill was brought on to the mine some time ago, but has never been put into operation.

A boarding-house accommodating forty men, boiler-house, trimming-sheds, stables, etc., have been erected on the mine, which is in a position to employ a large force of men at short notice.

At present, hoisting is being done by means of an ordinary horse-derrick, and drilling is done by hand.

The mica is a light-amber and a good splitter, the crystals being of medium size.

The occurrence seems to be a pocket and fissure deposit in a fractured zone adjoining the contact of a medium-coloured pyroxenite with dark gneiss, the whole being extensively cut by grey pegmatite veins having no definite direction.

This mine and the Fortin and Gravelle property adjoin; in fact the pit at present being sunk is only a few feet distant from the workings of the latter, and water from here is beginning to cause trouble.

Fig. 20 shows a sketch plan of the workings, etc.

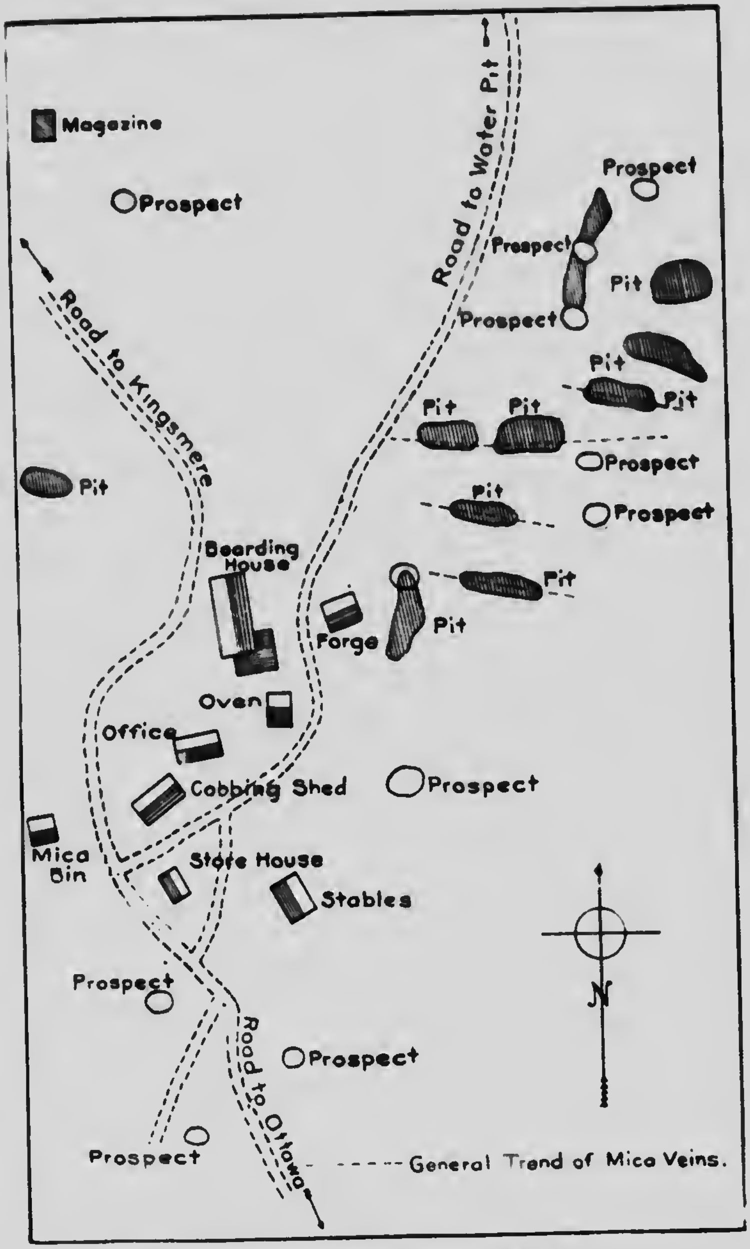


FIG. 20.—Sketch plan of surface workings, Laurentide Mica Company's mine, lot 19, range VII, township of Hull, Que.

Lot 20 S.½.—Fleury mine. Belongs to Messrs. Fleury Bros., of Kingsmere, and was first worked by Mr. C. Brown, of Cantley, in 1898, with two men. Later, operations were commenced by the owners, who had half a dozen men employed intermittently until 1908, since when the property has been idle. About 20 tons of thumb-trimmed mica have been taken from the workings, which consist of two pits 35 feet deep and several minor surface openings.

The deposit is of the pocket type, carrying a high-grade light silver-amber mica, pink calcite, and considerable quantities of phosphate. About 100 tons of the latter mineral have been produced.

Range VIII, Lot 17.—Belongs to Mr. James Padden, of Kingsmere. The property lies about half a mile south of the road from Kingsmere to Old Chelsea, and was worked for a few weeks in the early part of 1910, by Messrs. Winning and Church. Only two shallow openings were made, and a few hundred pounds of fair quality mica, and about 2 tons of phosphate, produced.

Lot 18.—Owned by Mr. Lawrence Dunn, of Kingsmere, who leased the property to Mr. H. Flynn in 1909. The latter only worked a short time and took out a quantity of mica from a small pocket. The mica is of good quality and often of fair size and is accompanied by phosphate and calcite.

Range IX, Lots 14 N.½, 15 N.½.—Scott mine. This is an old phosphate property, and was opened twenty years ago by Mr. Michael Scott, of Old Chelsea.

Some fifteen years ago, Mr. M. G. Robertson leased the mine and worked for a few months with a dozen men, taking out several tons of rough mica. No further work has been carried out since the last-named ceased work.

The deepest pit is only down 10 feet, and there are a number of small surface openings excavated on the east side of a small ridge of gneiss and crystalline limestone cut by narrow pyroxenite dykes, the whole traversed by later pegmatite veins.

The mica is a light silvery-amber, and is much crushed and fractured.

Considerable dark red phosphate occurs with the mica, but contains too much iron to be of much value.

The occurrence of red jasper on the property is interesting, several veins of this mineral being found on contacts between pegmatite dykes and crystalline limestone. The jasper is of a dark red colour and is associated with specularite and calcite—the vein being in one case over 3 feet wide.

Red ochre and soapstone are also reported to occur on the property, but have never been worked.

Lot 15 S.½.—This property belongs to Mr. John Sweeny, of Old Chelsea, and was opened up for phosphate over twenty-five years ago. The owner has worked at intervals since for mica. In June 1910, Messrs. Kent Bros., of Kingston, leased the property, and had half a dozen men engaged during the summer in prospecting and stripping operations. Numerous pits have been sunk on leads of mica, both in the pyroxenite and on its contact with the country gneiss, but the mica was in every case found to be of poor quality, not splitting readily and being much crushed. The deposit is of the usual pocket and fissure type and carries massive brown phosphate and pink calcite. Massive pegmatite dykes strike across the property, and it is probably to the intrusion of these later dykes and the subsequent dislocations caused by them, that the crushing of the mica is due. It is understood that Messrs. Kent Bros. have now ceased work on the property.

Lot 16.—Belongs to Mrs. J. O'Neill, of Old Chelsea. A little work has been carried out at intervals since 1903 by the owner, but not much mica has been produced. The deepest pit is 25 feet down, on a small pockety deposit of light silver-mica and phosphate in a coarsely crystalline pyroxenite.

A short drift has been carried along a few feet to the north and south, on a narrow lead of mica, but the indications do not point to the presence of any extensive deposit.

Range X, Lot 11.—Belongs to Mr. C. Church, of Old Chelsea. The first mining done was around 1897 by the owner, and in 1901, Messrs. Kent Bros. carried out a few weeks' work. In 1910, Messrs. Winning, Church, & Co. commenced operations, which however, were only continued a few weeks—the mica, a silver-amber of medium size, being rather crushed, and not occurring in sufficient quantities to render any extensive work profitable.

The deposit is of the pocket class, a little pink calcite and phosphate accompanying the mica. The pyroxenite, a light-coloured soft rock, has been much shattered by later intrusions of pink, fine-grained felsite which, however, has not here caused such extensive alteration of the pyroxenite as on range XIII, lot 12, across the river, where a similar granite [illegible] altered the pyroxene to blue actinolite (See page 293).

There is only one pit of any size on the property, this [illegible] feet deep, and showing a small irregular lead of mica cut by [illegible]

Lot 13 N.½.—Belongs to Mr. James Reynolds, of Kirk [illegible] worked, in 1898, by Mr. J. Swan, for a few weeks. Only a few barrels [illegible] were obtained, and no further work has been done.

There are several unimportant openings on the property, disclosing a little mica on joints and pockets in a normal pyroxenite cutting crystalline limestone.

Lot 13 S.½.—Some small and rather crushed mica has been taken off this property by the owner, Mr. May, of Ottawa; the openings are unimportant.

Lot 14.—Belongs to Mr. Thomas Macaulay, of Old Chelsea, and was surface prospected some ten years ago: when a little mica was found.

Lot 15.—Belongs to Mr. George Rainbow, of Aylmer. Mr. H. Flynn carried out six months' work, on lease, in 1906, and took out about one thousand pounds of rough mica. Not worked since.

Lot 16.—An old phosphate property, and owned by Mr. F. Bradley, of Old Chelsea.

Various operators have carried out work here during the last fifteen years, including Messrs. Clemow and Powell, the Lake Girard Mica System, and Messrs. Kent Bros. The mine has been idle since 1908. There are a number of small openings, trenches, etc., the deepest pit being down 25 feet.

The mica is a good quality light-amber.

Lot 19 N.½.—The property has recently been acquired by Mr. R. McConnell, of Ottawa, who has not yet commenced mining. Mr. Dunlop, of Old Chelsea, put in three months' work in 1906, and took out two tons of thumb-trimmed mica. A pit has been sunk 18 feet on a pocket deposit of light-coloured mica and brown phosphate, the openings having been carried along the contact of pyroxenite and a later granite dyke. The latter has a strike of W. 20° N., and dips 75° to the south, the foot-wall being thickly covered with medium-sized and much crushed mica crystals.

Crushing is a fault which affects most of the mica on this property, only about 25 per cent of the mineral mined being saleable.

The phosphate occurs in the form of well-developed crystals, embedded in pink calcite on small fissures and vugs in the pyroxenite.

Lot 23.—This property was worked for a few weeks in 1900 by the Mica Mining and Manufacturing Company, on a small scale; results are not known.

Range XI, Lots 12, 13 S.½.—A little mica was taken off this property some fifteen years ago by Mr. Haycock, of Ottawa, who had previously mined for phosphate.

Only a few shallow pits were opened, and these are now entirely overgrown.

Lot 16.—Some prospecting was carried out on this property about ten years ago, but nothing further was done until the latter part of 1907, when the Laurentide Mica Company commenced to work, under lease, and continued for a couple of months.

In June 1910, more definite operations were begun by the latter, and half a dozen men were set to work and a small camp erected.

The mine lies about 2 miles northeast of the road leading from Old Chelsea to Meach Lake, and connects with this by means of a good bush road.

The mica is a darkish, amber, of fair grade and medium size, and is found on joints and fissures in a light coloured pyroxenite, near its contact with grey gneiss, in which are intercalated crystalline limestone bands.

Well-formed crystals of green and brown apatite occur with the mica, and pink and grey calcite forms the filling of the fissures.

The district is extensively cut by later pegmatites and veins of coarse red felsite. Molybdenite, sometimes, is found near the contact of these acid dykes with the pyroxenite, never, however, in any quantity, the crystals being usually small and sporadic.

The workings are not extensive, consisting of several open pits some 20 feet deep, the largest being 45 feet long and 15 feet wide, sunk on a lead of mica striking northwest and southeast. A second opening, to the north of the preceding, is a shaft 10 × 10 feet, and 25 feet deep, showing good mica in depth.

Hoisting is done by means of a hand-windlass, and derricks are in course of erection; no machinery is in use at present.

Lot 16.—Belongs to Mr. J. H. Connor, of Ottawa, who worked for a few weeks about nine years ago. In 1903, Messrs. Fortin and Gravelle did a little mining, and in 1910, O'Brien and Fowler secured an option on the property, and conducted some prospecting operations.

The workings consist of a few small pits near the summit of the west Gatineau ridge, and about a mile from the river.

The main opening is an open-cut or trench 15 feet deep, 12 feet wide, and 160 feet long, having an east and west direction, and following a narrow pyroxenite dyke cutting dark gneiss. The mica occurs scattered through a mass of compact grey and green sugar phosphate, and is of good colour, but much crushed and twisted and often inclined to ribbon structure.

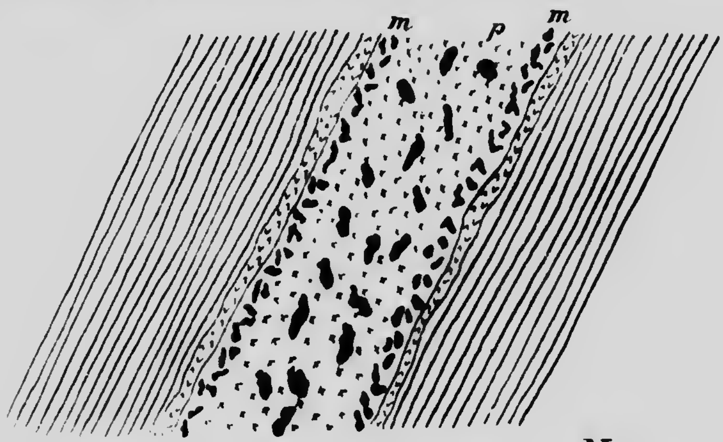


Fig. 21.—Section through mica deposits, lot 16, range XI, township of Hull, Que. gn, gneiss; P, pyroxenite; m, mica; p, apatite.

There is little or no calcite present, and the pyroxene rock on either side of the vein is only some 3″ wide. The deposit dips 60° to the south and is cut by several stringers of pinkish pegmatite having a direction of northwest and southeast. These seem to have exerted no influence whatever upon the mica or phosphate.

Lot 17.—Owned by Mr. W. Charleson, of Ottawa, and was first worked about fifteen years ago, by Mr. C. Brown, of Cantley.

Subsequently, Mr. J. Flynn carried out a few weeks' work with a couple of men, and took out a few hundred pounds of rough mica.

In 1907 and 1908, the present owner had a few men employed on the property for six weeks, since when no further work has been done.

The occurrence is a pocket deposit of mica, phosphate, and pink calcite, and only a few shallow openings have been made none of the pits being over 15 feet deep.

Range XII, Lots 14, 15, 16.—An old phosphate producer, and first worked thirty years ago by Mr. Irish, of Aylmer. Mr. Snow, of Ottawa, subsequently worked for mica, and took out a few barrels of rough material, in addition to sixty tons of high grade phosphate, from one pocket on the north of the property.

In 1908, Mr. H. Flynn secured an option, and mined three tons of rough mica, which was, however, rusty and of poor quality.

The owner, Mr. J. H. Connor, put in a few weeks' work in the following year, and in 1910, O'Brien and Fowler commenced prospecting with a view to taking over the property. The mica found was, however, of poor grade, and operations were soon abandoned.

There are numerous small openings scattered over these lots, the largest being the old phosphate pit near the railway. This pit is 35 feet deep, and has been formed by quarrying the north side of a small knoll of pyroxenite cut by a coarse pegmatite. The acid dyke has intruded a large pocket of mottled green and red phosphate, and has caused the formation in the phosphate of considerable quantities of black tourmaline which traverses the massive apatite in small veins and stringers.

There is very little mica present at this spot, and calcite is relatively scarce all over the deposit, which is associated with a dark green pyroxenite.

Range XIV, Lot 22.—Belongs to Mr. John Bate, of Cascades. Work was commenced by the owner in 1899, and continued for two months. In 1908, Mr. Wilson, of Cascades, took a lease of the property, and put in a few weeks' work, since when the mine has been idle.

The workings consist of two pits down about 15 feet in a pockety deposit of mica accompanied by much pink calcite.

The mica is dark and rather crushed, and occurs on joints and fissures in a greyish pyroxenite cutting a gneiss country, which latter has been extensively intruded by pink granite dykes. These granite intrusions have extensively altered the biotite gneiss, which seldom retains its original gneissose structure, having more the appearance of a gneiss-granite.

The district north of this mine and west of the Gatineau river presents a complex of many types of eruptive rocks. The country is a grey biotite gneiss, which has been successively intruded and shattered by dykes and upheavals of granite, diorite, serpentine, etc. These rocks may sometimes be found in intimate association over a very limited area.

Range XV, Lot 23.—Cascades mine. This property was first worked, some twenty years ago, by Mr. J. Flynn, subsequently by Mr. Jamieson, and in 1900 by Webster & Co. Work has been carried out on a contact deposit of dark-amber mica between pyroxenite and altered gneiss.

Some phosphate occurs with the mica, which is accompanied by large quantities of pink calcite, forming the contact filling between gneiss and pyroxenite.

In the early part of 1910, Mr. H. Flynn conducted a month's work on the property, and also overhauled the dumps, recovering a quantity of marketable mica.

This mine has produced a great quantity of fine mica, much of which was of unusual dimensions. Sheets 8" × 21", and 8" × 12" were not uncommon, and one large crystal, 5 × 7 feet, is reported to have yielded 6,300 pounds of rough-trimmed mica.

In addition to the main pit, there are a number of smaller openings varying from 10 to 20 feet deep.

An average force of 15 men was formerly employed; no machinery has been in use on the mine, which lies about a mile from Cascades station.

Lot 25.—Known as the Moore mine, and now owned by Webster & Co., of Ottawa. It was first worked about 1890, by Mr. W. Powell, who put in a few months' work with a small number of men. The property then passed into the hands of Messrs. Smith and Lacey, of Sydenham, who had ten men working for a couple of years. Messrs. Jamieson and Wright, of Ottawa, subsequently purchased the mine, and worked intermittently for five years, after which it passed into the present owners' hands: the latter have done little mining, and with the exception of some surface work and dump-turning carried out by Mr. W. Keller, under contract, in 1907-8, the mine has been practically idle for the last ten years.

The mine was one of the earliest to be opened up in the district, and extensive work has been done on the property. There are numerous pits, and the exposures indicate a deposit of the pocket type, carrying a medium-sized mica of good colour and quality.

The occurrence seems to be associated with a system of spurs diverging from a central pyroxenite mass, the whole being extensively cut by later granite veins: these latter have been the cause of dislocations which have contributed largely to the crushed nature of the mica crystals, which is a feature of the deposits in this district.

Lot 27. Owned by Mr. H. Flynn. The mine, which is situated about 2 miles from Farm Point, was first worked by the owner in 1905, and has been operated at intervals ever since.

The deposit is of a pockety nature, the mica, which is of dark colour and often of large size, occurring on irregular leads and in pockets in a grey pyroxenite cutting gneiss and granite.

The mica has been extracted by means of an open-cut driven into the northeast side of a high ridge for a distance of 120 feet, and 50 feet deep at its southwest or inner end. The main leads have a dip of about 30° to the southeast.

The last work done on the property was in May 1910, when the dumps were also worked over to recover waste mica.

Range XVI, Lot 26.—Belongs to Mr. H. Robertson, of Ottawa, who originally worked for phosphate thirty years ago. Some ten years ago, a little mica was mined by the owner, who, however, has done nothing since.

Range XVI, Lots 27, 28.—This property, which is owned by Mr. Osborne Carman, of Farm Point, is situated a few hundred yards from Mr. Flynn's workings on range XV.

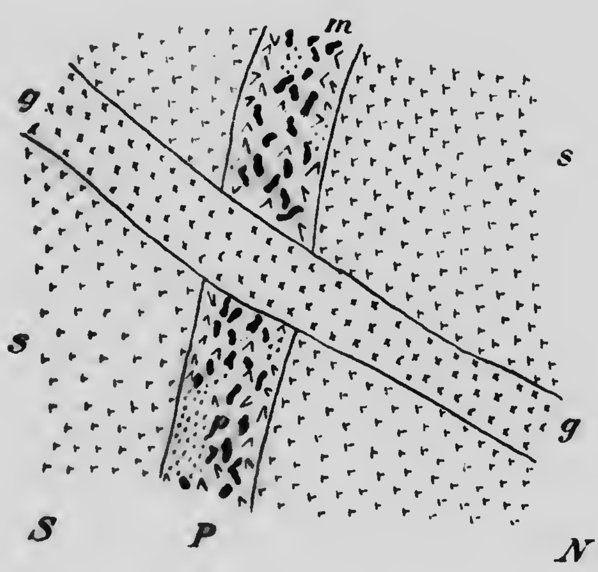


Fig. 22.—Section of mica vein cut by granite dyke, Lot 27, Range XVI, Township of Hull, Que.
s, coarse pinkish syenite; P, pyroxenite dyke carrying mica (m) and apatite (p); g, granite.

Operations for mica were first commenced by the owner, in the early part of 1910, and have been conducted fitfully since.

No extensive work has been done, the workings consisting of a few shallow pits sunk on small pockets of mica in a normal dark green pyroxenite.

The mica is of very dark colour, resembling typical biotite, and is much crushed and a poor splitter.

The exposures on this property exhibit very complicated geological features, granite, pyroxenite and serpentine dykes and veins cutting the country gneiss and each other in various directions.

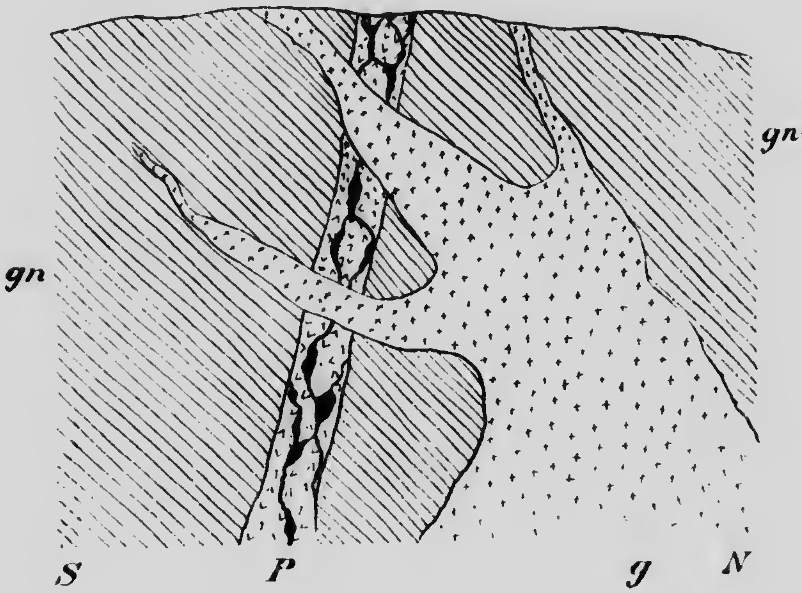


FIG. 23. Schematic section through mica deposit, lot 27, range XVI, township of Hull, Que.

gn, gneiss; P, pyroxenite dyke carrying mica on pockets and leads; g, granite intrusion.

Township of Masham.

Range III, Lot 17.—Belongs to Mr. F. Biron, of Masham. The property lies 3 miles west of Wakefield, and was first worked, under lease from owner, about twelve years ago. In 1907, Mr. H. Flynn had half a dozen men employed for a few months; no other work has ever been done.

The mica occurs on joints in what is, apparently, a shattered zone in pyroxenite near its contact with dark gneiss. The pyroxenite itself is of a light grey colour and shows definite evidence of differentiation, containing throughout its mass "schlieren" of acid rock, mainly a grey-brown

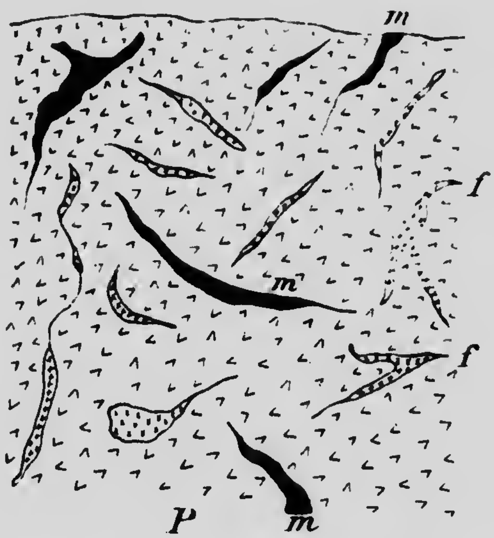
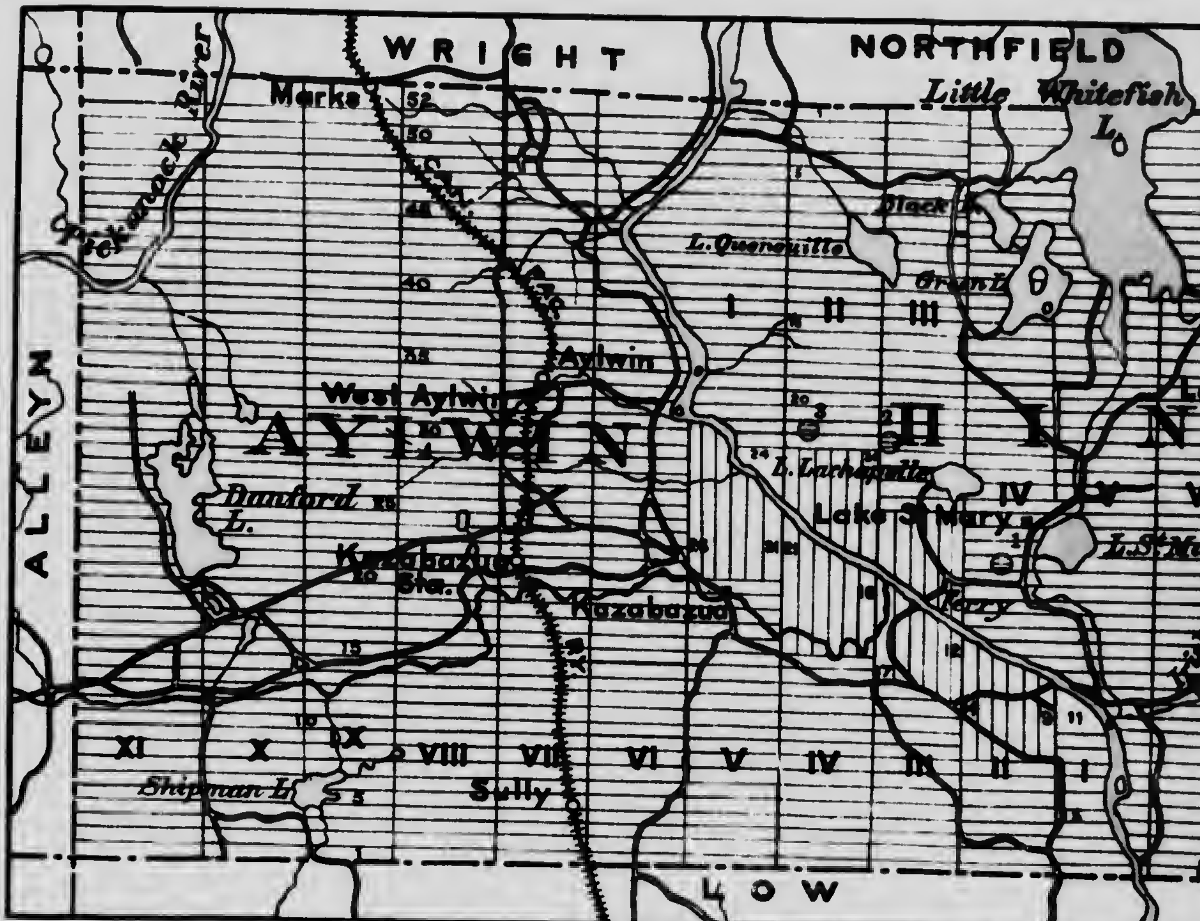


FIG. 24.—Section through mica deposit, lot 17, range III, township of Masham, Que. P, coarse grey pyroxenite; m, mica; f, differentiated masses of acid rock composed principally of greyish feldspar.

feldspar mixed with a little quartz and sometimes small crystals of titanite. No calcite or phosphate were to be observed, and the mica is a medium-quality speckled-amber. The pyroxenite seems to form a flat dyke, having a strike of northwest and southeast, and dipping 25° to the southwest, and the mica deposit occurs on the hanging contact.

There is only one pit, which is 50 feet long and 35 feet deep, and has been sunk from the bottom of an open-cut driven into the deposit from the northeast side.

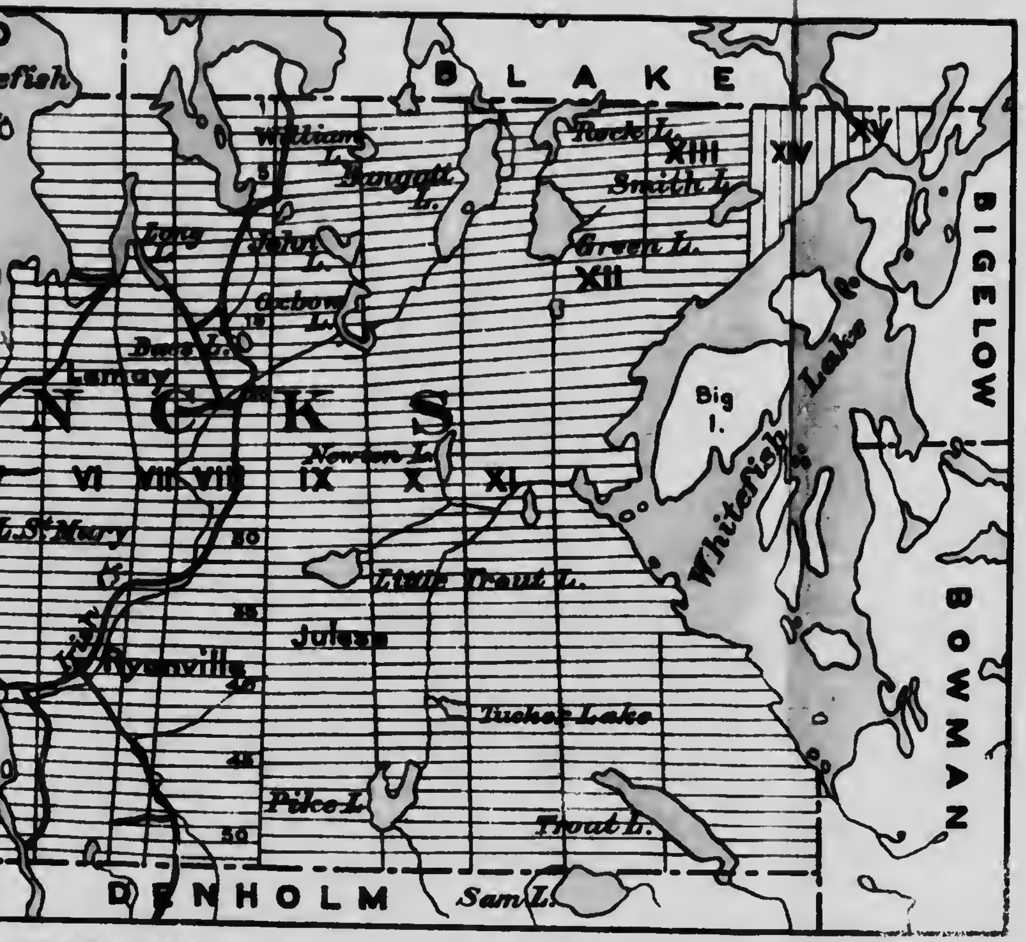
Fig. 24 shows a section through the deposit and mode of occurrence of the mica.



⊖ MICA

MICA MINES AND OCCURRE
IN TOWNSHIPS OF AYLWIN AND H

Scale 2 miles to one inch



No.	Name of Mine
1	Emond
2	Pritchard & Sparks
3	Hastey

CCURRENCES

AND HINCKS, QUEBEC

inch

3 4 5 Miles

Township of Denholm.

Range B, Lots 18, 19.—Belongs to Mr. T. G. McLaurin, of Ottawa, who worked for eight months during 1909, and secured a small quantity of mica from a surface pocket.

Township of Aylwin.

Range III, Lot 7.—Belongs to Mr. H. Flynn. The property was worked for three months in 1906, and again in 1910—only three men being employed.

The mica is a medium-coloured amber, and occurs in crystals of fair size; these are, however, often much crushed and twisted, and a large proportion of the mica mined is useless on this account.

The deposit, which is of the pocket and fissure class, has been mined by means of an open-cut carried some 20 feet into a small ridge, and 30 feet deep at its inner end.

Township of Hincks.

Range II, Lot 22.—This property was first worked by Messrs. Clemow and Powell, of Ottawa, in the early nineties, and in the space of some three months yielded nearly 200 tons of rough mica. The present owners are Messrs. W. and R. Hastey, of Wright, who started work in 1899, and continued operations for six months. The mine has been idle since 1900.

The mica, which is of dark colour, and often of large size—sheets measuring 4 feet across having been obtained—occurs on a contact between a very hard and compact pyroxenite and crystalline limestone.

The mica has been followed along the contact for a distance of 80 feet by means of a pit 10 feet wide and 50 feet deep.

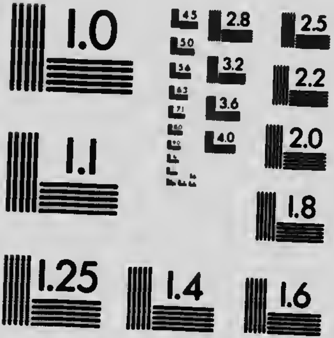
The deposit has a strike of northeast and southwest and lies east of the Gatineau river, about 3 miles from Aylwin P. O. No phosphate was noticed but large bodies of white calcite accompany the mica.

Range III, Lot 23.—Owned by Messrs. Pritchard and Sparks, of Kazabazua. The property is situated on the east of the Gatineau river, and about 7 miles from Kazabazua. The workings consist of a few shallow pits excavated on the northeast side of a small hill; the deepest pit is only some 15 feet down. The mica, which is of a very dark colour, and medium size, occurs on small fissures, veins, and joints in a dark pyroxenite, near its contact with crystalline limestone. Little phosphate accompanies the mica, but considerable calcite is present, both on the fissures and also throughout the mass of the pyroxenite itself. Large quantities of black hornblende have been formed along and adjacent to the contact, which has a strike of northwest and southeast. The mica is rather crushed and inclined to ribbon-mica.

The deposit was first exploited in 1901, by Mr. Emond, of Lake St. Mary, who, however, did little mining.

MICROCOPY RESOLUTION TEST CHART

(ANSI and ISO TEST CHART No. 2)



The present owners have not worked since the latter part of 1909.

Range IV, Lot 31.—This property lies some 8 miles from Kazabazua, and east of the Gatineau river. The owner is Mr. B. Emond, of Lake St. Mary, who carried out a few weeks' work in 1905. Only three men were employed, and a few barrels of mica were produced.

The mica is of a very light colour, being often almost white, but usually of a reddish-brown shade. The sheets are brittle and do not cleave readily; in addition, they are often traversed by minute fracture lines due to pressure, which further impair their quality.

There is only one pit, which has been opened along a contact between a light-coloured, almost white, pyroxenite and crystalline limestone. The

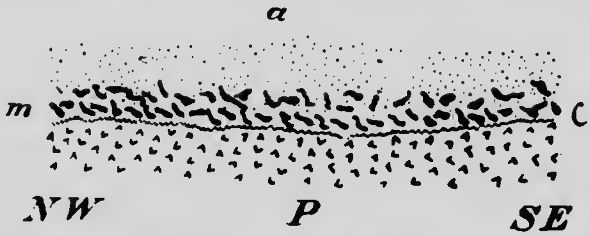


Fig. 25.—Plan of mica deposit, lot 31, range IV, township of Hincks, Que. P, pyroxenite; a, crystalline limestone; m, mica; c, contact.

junction is well-defined, and the pyroxenite hanging-wall is lined with small, well-formed crystals of pyroxene.

The strike of the deposit is northwest and southeast, and the contact can be traced for several hundred feet.

Township of Blake.

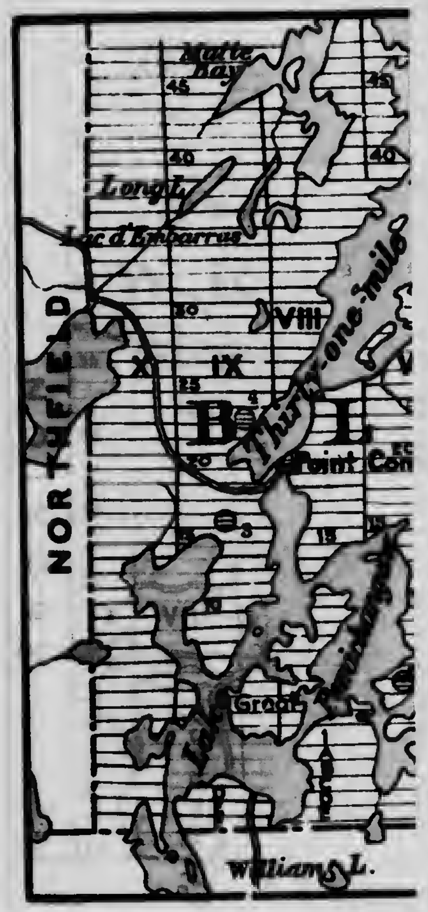
Range IV, Lot 43.—Belongs to Mr. C. Teeples, of Wright. The property lies about 5 miles from Point Comfort, and 1 mile from Thirty-one-mile lake.

Work was begun by the owner in December 1909, and continued with four men until May 1910, about a ton of thumb-trimmed mica of excellent quality, and fair size and colour being taken out. Two pits have been put down about 15 feet on the deposit, which is of the pocket and fissure type, the mica occurring with pink calcite.

Little or no phosphate is found.

Range V, Lot 1, and Range VII, Lots 4, 5.—This area has been prospected during the summer of 1910, by Mr. J. H. McGee, of Cobalt, and favourable indications are reported to have been found. Some two months' work was done, principally trenching.

Range VII, Lot 23.—Belongs to Mr. Antoine Serré, of Point Comfort. A little mica was taken off this property twelve years ago; no work has been done since.



⊖ MICA

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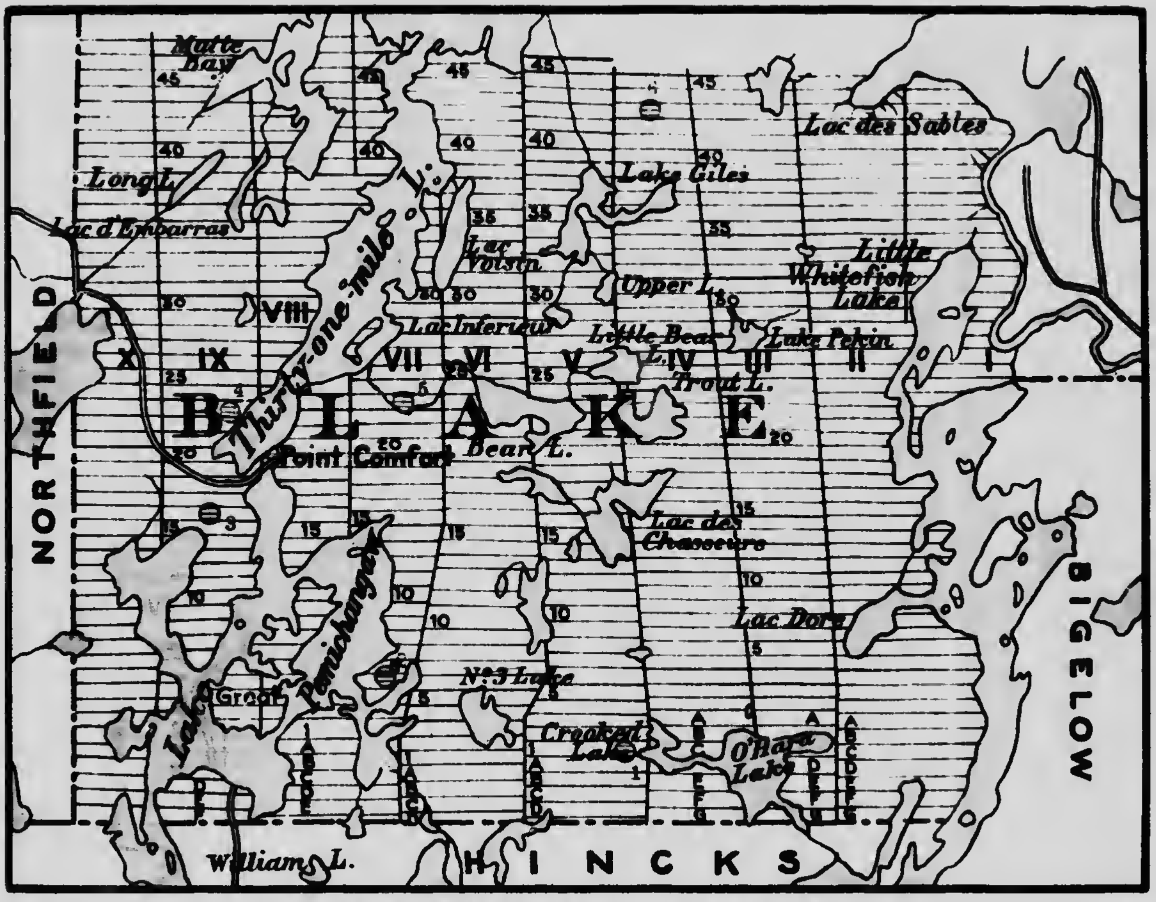

No.	Name of Mine
1	Prospect
2	Prospect
3	Flynn
4	O'Brien & Fowler
5	Prospect
6	Teeples

⊜ MICA

MICA MINES AND OCCURRENCES IN TOWNSHIP OF BLAKE, QUEBEC

Scale 2 miles to one inch

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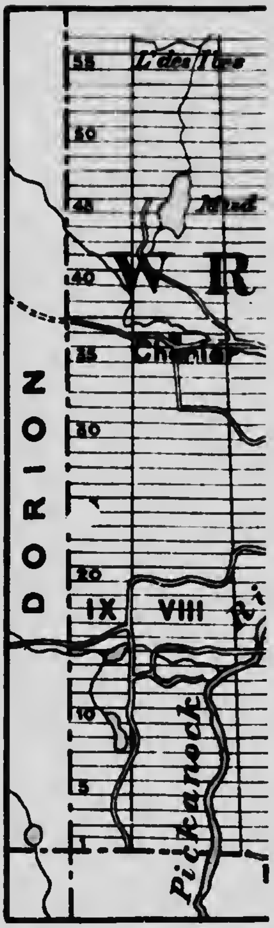

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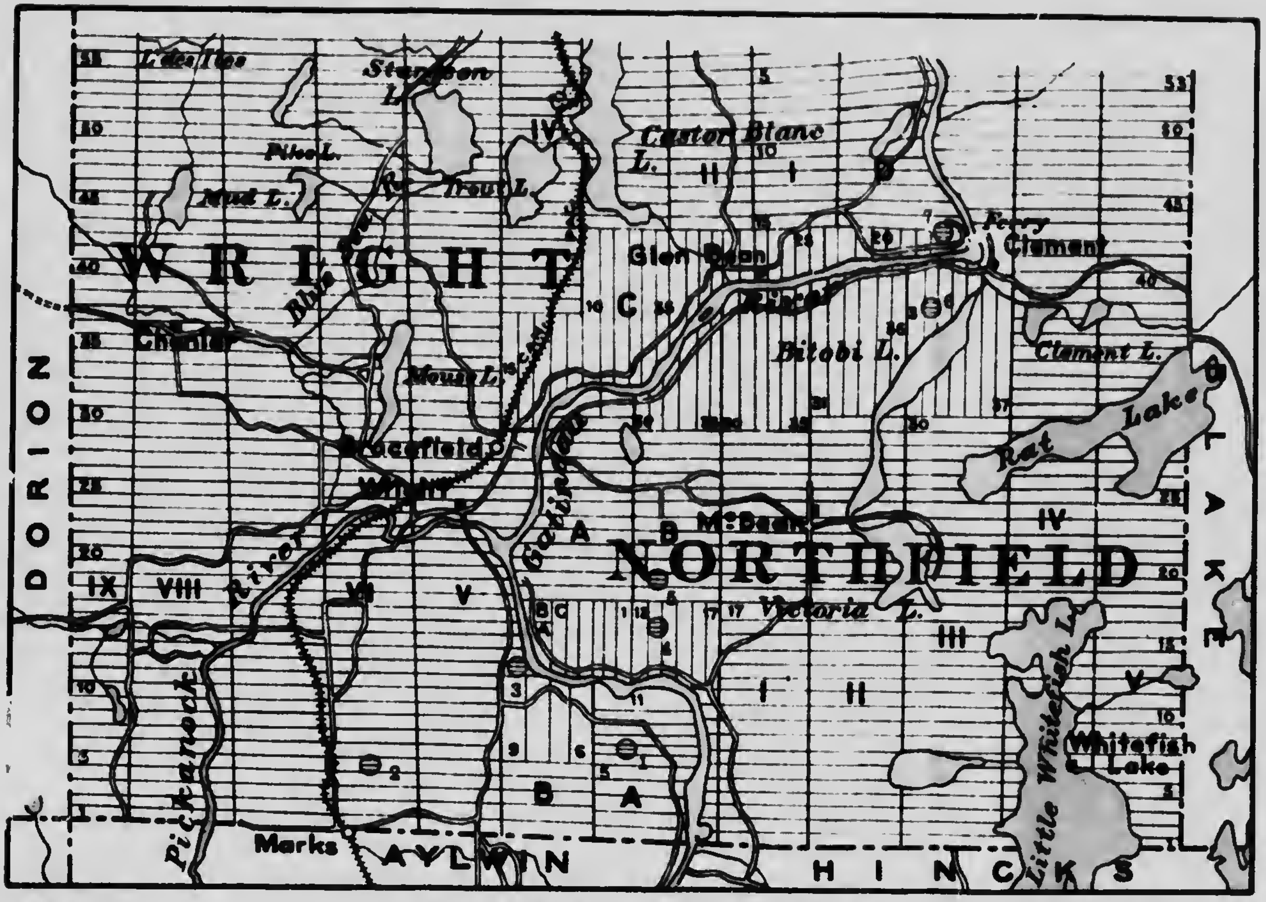


No.	Name of Mine
1	Chalbee
2	Thayer
3	Moore
4	Moore
5	Synek & Labelle
6	Prospect
7	Father Guay

⊜ MICA

MICA MINES AND OCCURRENCES
IN TOWNSHIPS OF WRIGHT AND NORTHFIELD, QUEBEC
Scale 2 miles to one inch

128

Range IX, Lot 16.—Now the property of Mr. H. Flynn, and formerly owned by Mr. C. Teeples, of Wright. The latter started to do a little prospecting work two years ago with a few men, and took out a few hundred pounds of mica.

The present owner had five men employed on the property for a few weeks in 1910, and about one ton of rough mica was secured.

There is little phosphate present, and the deposit is of the pocket class, the mica occurring with white calcite in a medium-coloured pyroxenite.

Range IX, Lot 22.—This property formerly belonged to Mr. Coron, of Point Comfort, and was prospected by him three years ago, being subsequently sold to O'Brien and Fowler, of Ottawa. The latter started work two years ago with ten men, and continued operations for six months. During the early part of 1910, some prospecting work was carried out by the owners over ground adjacent to the former workings, but with not very favourable results. The mine is situated on the crest of a high ridge overlooking Thirty-one-mile lake and is some 2 miles from Point Comfort.

The workings consist of a number of shallow trenches and a main pit 50 feet long, by 10 feet wide, and 90 feet deep, sunk on an inclined contact between a hard, compact pyroxenite, strongly impregnated with pyrites, and crystalline limestone.

The pyroxenite dyke strikes almost due east and west, and dips 80° to the north, contrary to the general strike of the pyroxenites in this district.

At the west end of the pit, the foot-wall is thickly lined with mica crystals of medium size, all so stained by iron as to be useless.

The hanging-wall is crystalline limestone, metamorphosed to coarse white calcite on the contact, and containing green apatite crystals, often of large size. Apatite crystals also often occur included in the mica.

The mica appears to be too stained by iron to be of much value, though below the oxidization zone it may improve in quality.

No machinery was ever employed on the mine, and the only buildings consist of small culling-sheds and a smithy.

Township of Northfield.

Range I, Lot 32.—Belongs to Mr. N. Clement, of Clement P.O. A few hundred pounds of fair-sized dark-amber mica were taken off this property in the early part of 1910.

Only four men were employed, and no work was being done when the district was visited.

Range I, Lot 6.—Belongs to Mr. H. Ellard, of Wright P.O. The property lies west of the Gatineau river, and some fourth of a mile distant from it.

There is only one small pit about 20 feet deep, sunk on a small pocket and fissure deposit of mica, accompanied by pink calcite, in a light-coloured pyroxenite.

Little phosphate is to be seen, and the mica occurs in small crystals of a darkish-amber colour. The pockets and leads are narrow, and the small quantity of mica won per ton of rock moved would preclude any extensive operations being undertaken.

Range B, Lots 12, 13, and Range A, Lot 1. This mine is situated on a high ridge about a mile east of the Gatineau river, and 3 miles south-east of Wright P.O. The ownership of the land came into dispute some years ago, with the result that a concession line was subsequently run dividing the workings into two parts. Lot 1 of range A was first worked some ten years ago, by a Toronto firm, who employed a dozen men for a few months. Mr. Chabot, of Ottawa, then took over the property, and continued operations for a year. No work has been done since 1908. The mine is now owned by Mr. Éthier, of Lake of Two Mountains, Que.

The eastern half, or lot 13, range B, was first worked by the present owner, Mr. Richard Moore, of Wright P.O., in 1908, for a couple of months, six men being employed. No further work has been done since 1908.

The mode of occurrence of the mica is rather obscure. As far as could be ascertained a pyroxenite dyke having a strike of east and west cuts across

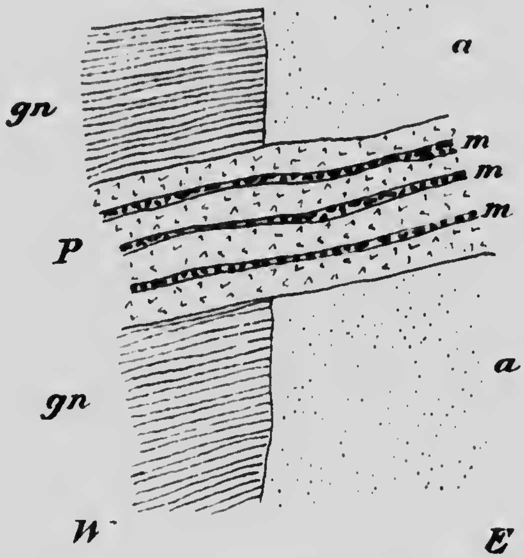


Fig. 26.—Plan of mica deposit, lot 13, range B, township of Northfield, Que. gn, gneiss; a, crystalline limestone; P, pyroxenite dyke; m, mica leads.

the junction of biotite gneiss and crystalline limestone, and almost at right angles to the line of contact (See Fig. 26).

Parallel fissures have developed in the pyroxenite, and on these, large bodies of white calcite have been deposited. Considerable quantities of phosphate occur with the calcite, and mica crystals, often of large size, line the walls of the fissures.

The mass of the calcite, on the contrary, contains little mica. The fissures, of which three have been worked, average some 12 feet in width, and are 15 to 20 feet apart.

The mica is rather brittle and inclined to split up into ribbon mica. Owing to the presence of considerable quantities of pyrites in the veins, the crystals are often much stained: in addition, they frequently contain inclusions of apatite and pyrites, which further impair their quality.

The veins have been stoped out from the surface, and the northernmost pit is the largest, being 80 feet deep, 12 [illegible]et wide, and over 80 feet long.

The walls of the veins dip 82° to the south, and are, in many places, coated with rusty mica crystals.

The fissures seem to carry the most mica where the pyroxenite dyke is in gneiss, little work having been done over the junction with the limesto[illegible] The two pits to the south are 40 feet long, 12 feet wide and about 25 [illegible] deep.

No machinery has been used on the mines, and there are no mine buildings. Hoisting w[illegible] done by means of a large boom derrick and horse-whim.

Range B, lot 19.—Owned by Dr. Synek, of Gracefield, and Mr. Labelle, of Hull.

This property, which produces a light-amber mica of medium size, was first worked in 1898, by the owners, who employed a dozen men on the mine. Operations were continued intermittently until 1905, since when the property has lain idle. Some 12 tons of mica were extracted during this period.

The deposit occurs on a contact between pyroxenite and crystalline limestone.

Township of Wright

Range A, Lot 6.—Known as the Cheibee m[illegible] and situated 3 miles southeast of Wright P.O.

This property was first operated in th[illegible] early nineties by the Lake Girard Mica Company, who carried out considerab[illegible] work. It was then bought by the Webster Company, of Ottawa, who did not do much mining, but sold again to the General Electric Company, of Schenectady, who started operations in 1902 and worked steadily for a year. The mine has been idle since 1903.

The workings consist of a main shaft 75 feet deep, at the bottom of which a drift has been run for a distance of 80 feet, along the contact of a pyroxenite dyke with the country gneiss. There are numerous other surface pits on the property, and considerable prospecting work was done by the last operators. Seven diamond drill holes were put down in the vicinity of the main shaft, ranging in depth from 40 to 140 feet, but no large bodies of mica were met with.

The deposit is of the contact type. A large body of pink calcite carrying a little phosphate and a dark-coloured mica has been deposited along the line of contact between the pyroxenite and gneiss, and fissures adjacent to the main contact, and both parallel and normal to it, have been similarly filled out. The country rock in the vicinity of the contact has both the structure and character of a pinkish granite-gneiss. The pyroxenite has a strike of almost due north and south, and is of a darkish colour and somewhat pockety, containing considerable calcite disseminated in small vugs lined with pyroxene crystals throughout its mass. Much grey feldspar is also present, and has been generally highly scapolitized.

The mine was formerly well-equipped with buildings, comprising engine-house, boarding-house, and mica-sheds, and boilers, hoisting machinery, drills, etc., were in use. All the machinery has been removed, and the buildings are now in a state of dilapidation.

Range D, Lot 15.—Known as the Father Guay mine, and situated 6 miles northeast of Gracefield, on the Maniwaki branch of the Canadian Pacific railway, and near Clement P. O.

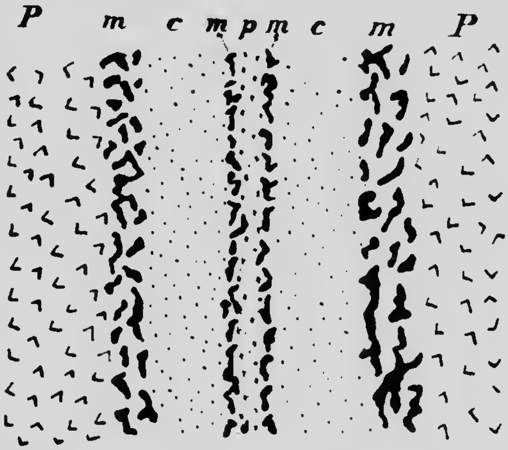


FIG. 27. Section of Mica Vein at the Father Guay mine, lot 15, range D, township of Wright, Que.

P, pyroxenite; m, mica; c, pink calcite; p, apatite.

This mine, which was first opened in 1896 by Father Guay, of Gracefield, was subsequently leased to an American syndicate who worked steadily for a year and a half and took out large quantities of mica. The mine was then idle for eight years, being leased in 1908 to Labelle and Boisvert, of Hull, who continued operations for some nine months. Since the last-named ceased work, the mine has been idle.

The workings are extensive, and comprise, besides the main pit, numerous smaller pits and trenches, excavated on parallel leads of mica. The largest excavation is an open pit some 200 feet long and 75 feet wide at its greatest breadth, narrowing towards its eastern or outer end to some 10 feet, a narrow trench having been cut at this point to carry off the water which collected in the workings. The pit has thus, in plan, somewhat of a bottle or flask shape; its walls are vertical, except for the last 15 feet down, where a slight incline has been run to the north.

The mine is equipped with several buildings, including engine-house, mica-sheds, etc. There are also several boom derricks and a short tramway for pitching waste on the dumps.

Drilling was done by steam, and hoisting by means of a small steam winch, operating a derrick; a 30 H.P. boiler, and all the machinery necessary for working the property are on the mine. The mica is a good quality amber and of medium size and colour.

Considerable quantities of high-grade phosphate and brownish calcite accompany the mica, which occurs both in, and adjacent to, a pyroxenite dyke striking northwest and southeast, and dipping slightly to the southwest in a country of grey biotite gneiss and crystalline limestone.

The mica occurs both in pockets and on fissures or stringers throughout the contact zone.

The pyroxenite is bordered, near its contact with the limestone, by large bodies of black hornblende, which is, in some instances, highly pyritiferous. Veins of pyrites, in some cases as much as 4" in width, are occasionally seen traversing the deposit. The width of the pyroxenite dyke could not be ascertained, but mica indications are to be found over a considerable area in the vicinity of the mine.

Lot 16.—This property adjoins the Father Guay mine, and belongs to Mr. L'Écuyer, of Clement P. O. The present owner first began operations for mica twelve years ago with two men, and the property has been worked at intervals by various persons under lease ever since.

The last work done was in the spring of 1910 by Mr. H. Flynn.

There are several small pits excavated on pockets in a medium-coloured pyroxenite, which forms a small knoll near the Gatineau river, and is part of the same dyke as that at the Father Guay mine.

The chief work has been done on the east side of the knoll, where the slope has been stripped for some 30 feet and cut back 25 feet. The face showed irregular stringers and pockets carrying considerable pink calcite and mica crystals of dark colour and medium size. A little green phosphate also occurs.

On the west side of the knoll the pyroxenite is in contact with crystalline limestone, and large crystals of pyroxene have been formed along the contact, associated with mica and pink calcite.

Range V, Lot 12.—Owned by Mr. Richard Moore, of Wright P. O., and situated 1½ miles from this place, and close to the main Gatineau road.

The workings consist of half a dozen surface pits, the deepest of which is 20 feet down, and lie on a small knoll of normal light-green and coarsely crystalline pyroxenite. This pyroxenite dyke has a strike of northwest and southeast and cuts a country of biotite gneiss which is extensively traversed by granite veins of varying width but seldom exceeding a couple of feet. The general strike of the vein is shown in Fig. 28.

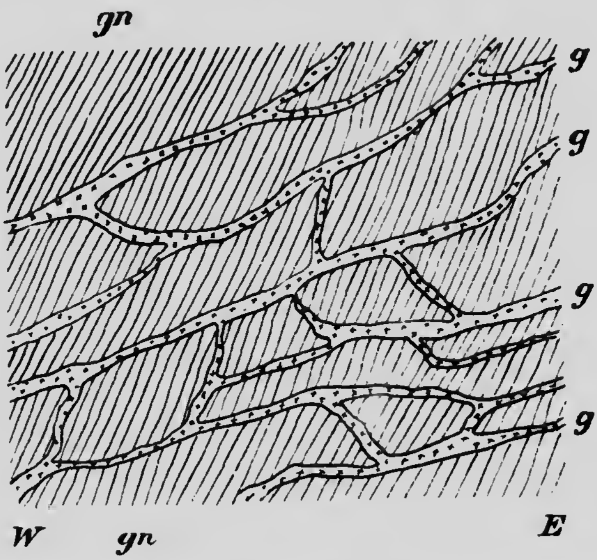


FIG. 28.—Plan showing cutting of gneiss by coarse aplite dykes, lot 12, range V, township of Wright, Que.
gn, gneiss; g, aplite.

There is much pink and white calcite, and also some phosphate, present in small pockets and fissures in the pyroxenite. The mica occurs on these fissures and is of small size and medium-amber colour, being often rather crushed.

The first work was done on the property by the present owner in 1890, and operations were continued at intervals until 1904, since which year the mine has lain idle.

No extensive work was ever carried out and the value of the mica produced does not exceed $5,000.

Range VI, Lot 5.—Belongs to Mr. Allan Thayer, of Wright P. O. The owner has worked the property intermittently since 1905—the last work being done in May of 1910. In 1907 the mine was leased to Messrs. Kent Bros., of Kingston, for five months, and in 1908 to Mr. Chabot, of Ottawa, for a short period. No extensive work has been done, there being two narrow pits on the property, down about 15 feet, and sunk on an irregular contact between pyroxenite and crystalline limestone. The strike of the deposit is northeast and southwest (See Fig. 29).

The limestone has been highly metamorphosed on the contact, and considerable quantities of calcite have been formed. The mica is of two colours, one a dark amber, and the other of a light reddish shade; the light-coloured occurs in and near the limestone, while the darker variety is found adjacent to the pyroxenite.

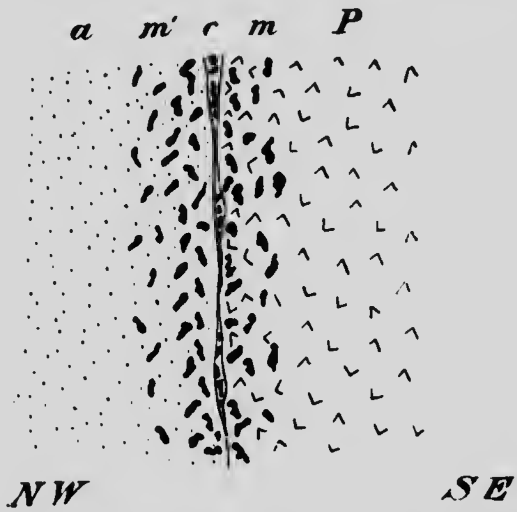


FIG. 29.—Plan of mica deposit, lot 5, range VI, township of Wright, Que. P, pyroxenite; a, crystalline limestone; c, contact; m, dark mica; m', light mica.

The lighter mica occurs in crystals of good size, but is often much fractured and "feathered," the result probably of pressure caused by the metamorphism of the limestone.

The pyroxenite is of a very dark colour and has a coarsely crystalline structure.

There is no phosphate present with the mica.

Township of Cameron.

Range II, Lot 10.—Belongs to Mr. W. Cleland, of Bouchette. The property lies 3 miles southeast of Bouchette, and close to Cameron lake. Work was commenced in June 1910, by the owner, with three men, and when visited in July, about a ton of rough mica had been taken out. The mica occurs on parallel narrow leads or veins having a strike of northwest and southeast and a dip of 80° to the southwest. These veins crop out at intervals along a low ridge, near the contact of a pyroxenite dyke with crystalline limestone.

The rock is highly impregnated with pyrites and the mica at the surface is consequently much stained and of poor quality, though in the fresh rock the crystals appear to be of higher grade.

The colour of the sheets is a light-amber, and the crystals are inclined to the small side.

Pockets of blue phosphate occur on the leads, and occasionally large masses of pyrites are met with.

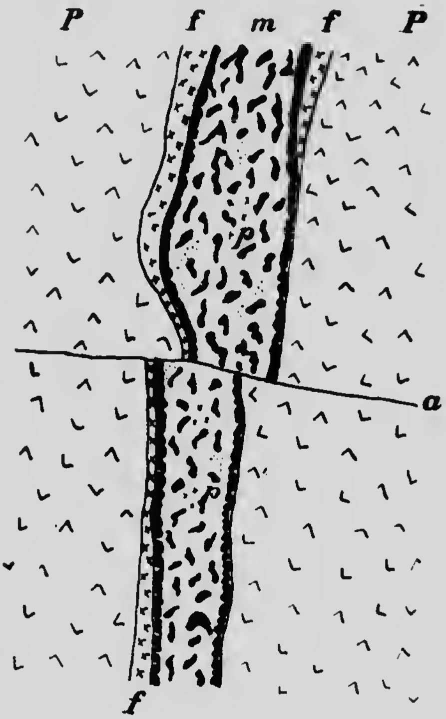


FIG. 30.—Section of mica vein, lot 10, range II, township of Cameron, Que. P, pyroxenite; f, feldspar; m, mica with calcite and apatite p; a, fault.

Only one of the mica veins has so far been worked. An open-cut, 10 feet wide, has been driven some 15 feet into the east side of the ridge and shows good mica. The property should repay more extensive development.

Lot 13.—Belongs to Mr. Lacroix, of Bouchette. The mine is situated about 2 miles from Bouchette, and east of the Gatineau river.

Work was commenced on this property late in 1909, and operations have been continued intermittently ever since. The mine was idle when visited. The principal workings consist of two pits sunk on the contact between a pyroxenite dyke and crystalline limestone. The limestone on the contact is very highly metamorphosed and contains good-sized crystals of fair quality amber mica. The main pit is about 20 feet deep.

No machinery has been employed on the mine, and work is hindered by water, which, in the absence of a pump, causes considerable trouble.

The deposit seems a promising one and should repay exploitation on a more extensive scale.

Lot 14.—Known as the Marguerite mine, and belongs to Mr. H. Flynn. Considerable work has been carried out here, and eight men were employed at the time the property was visited.

A large open pit has been quarried out to a depth of 70 feet on the east slope of a high ridge. The ridge is apparently the main body of a pyroxenite dyke having a strike of north and south, and the mica occurs on an irregular lead running approximately east and west.

A long pit was first excavated along the slope of the hill, and subsequently a drift about 12 feet wide was run in a westerly direction, or at right angles to the strike of the dyke.

The rock is a very hard and compact pyroxenite of a light grey colour, and contains few pockets or vugs. The mica, though following irregular leads, is more or less generally distributed through the mass of the rock, the crystals occurring embedded in pyroxenite: there is a little white calcite. The sheets are of fair size and of lightish colour.

Very little phosphate is present.

No machinery is used, drilling being done by hand, and hoisting by means of the ordinary type of boom derrick worked by horse-power.

Drilling is slow owing to the nature of the rock, and the proportion of mica to the amount of rock to be moved is small: consequently work is not very profitable, and the owner intends ceasing operations shortly.

The property was first exploited in 1908 by Mr. Cleland, of Bouchette, who worked for two months and took out a little mica. In 1908 the mine passed into the hands of the present owner who has worked steadily since.

Township of Egan.

Range II, Lot 28.—This property is owned by Mr. H. Joanis, of Maniwaki, and was first operated by him in 1907 for a few months with eight men.

Work was continued for three months in 1910, when the mica was considered exhausted, and it is not intended to resume operations.

The deposit has been worked by means of an open pit to a depth of about 40 feet along a contact of pyroxenite with grey gneiss. The mica is a lightish-amber, and good-sized sheets have been obtained. There is very little phosphate present.

The mine is situated 5 miles north of Maniwaki and close to the main road to Bois Franc.

PONTIAC COUNTY.

Township of Alleyn.

Range I, Lot 12.—Was worked for three months in 1895, and a small quantity of mica produced. Water difficulties finally put an end to operations. The mica is a medium quality dark amber.

Range II, lot 3.—Owned by Mr. S. Anderson, of Danford. The mine is situated on a small hill, half a mile from Danford Corner, and adjoins the Moore and Marks property. The occurrence is in every way similar to this last-named, being part of the same deposit.

The owner first began operations in 1907 with three men, and continued during part of 1908, taking out, in all, 700 pounds of thumb-trimmed mica.

There is only one pit on the property, 20 feet deep and 30 feet long.

The exposure showed good indications of mica on pockets and irregular leads in the pyroxenite, and this and the adjoining mine, though producing a dark mica, seem worthy of redevelopment.

Lot 4.—Belongs to Mr. R. Moore, of Wright P. O., and Mr. T. Marks, of Kazabazua.

The deposit was first exploited in 1898 by the owners, and work was continued steadily for three years with an average staff of eight men. The mine was leased in 1905 to the Laurentide Mica Mining Company, who worked for three months; since this time the property has been idle.

The mica is a rather dark amber, possessing good cleavage, and is chiefly remarkable for the size of the sheets obtained. One crystal taken out measured 34″ × 48″ across its plates and weighed over 3,000 pounds. A pyroxenite dyke of over 300 feet proved width cuts a country of dark biotite gneiss. The dyke conforms to the general strike and dip of the gneiss, which has a direction of northwest and southeast, and dips almost vertically.

Little phosphate occurs, and the mica follows joints and irregular leads in the pyroxenite. The deposit is, therefore, to be ranged in the pocket and fissure class.

From the dyke spurs run off into the neighbouring gneiss, and mica leads are sometimes found following these apophyses

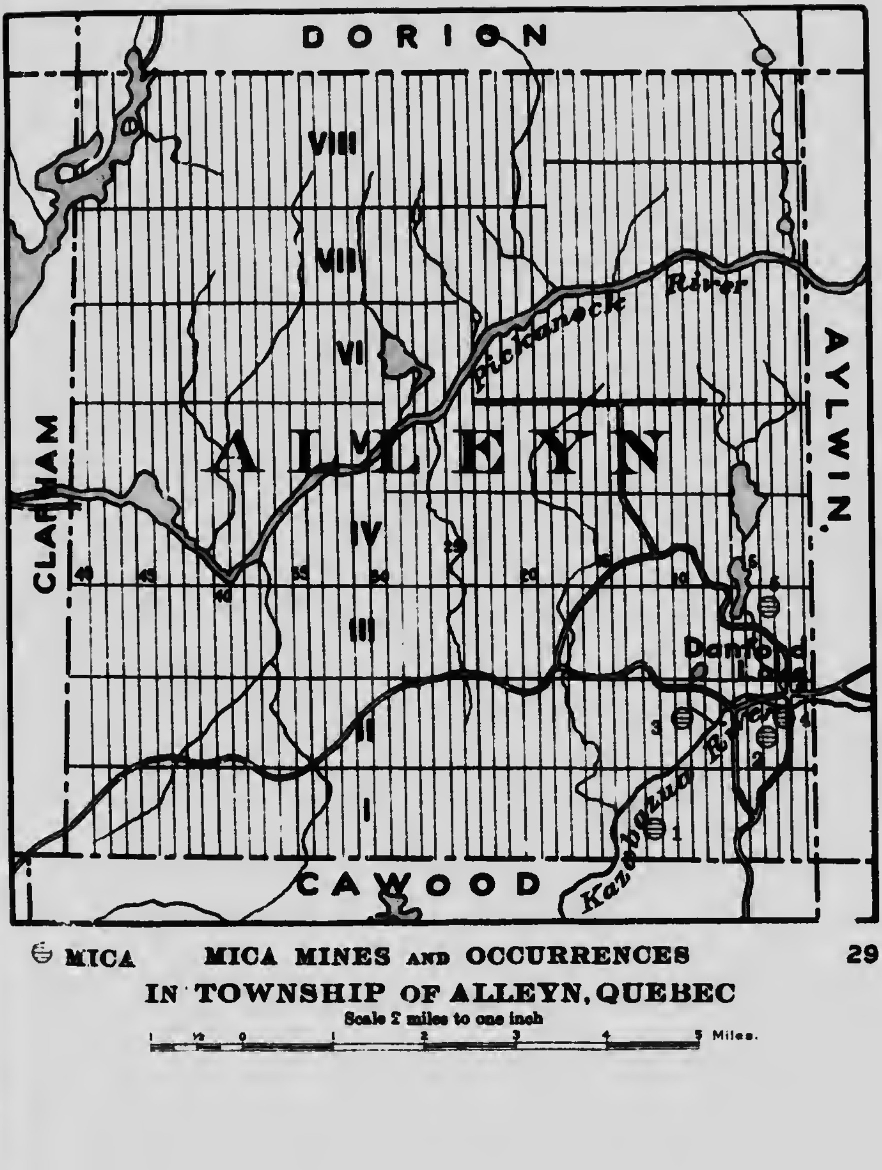
The workings are extensive, comprising numerous surface pits, and a large excavation on the west of the property reaches a depth of 93 feet. From the bottom of this pit a drift was continued 40 feet to the southeast, following a large lead of excellent mica.

The pits are said to still exhibit good showings of mica in depth, and work was only suspended on account of the low price of mica.

Lot 10.—This mine is situated about a mile from Danford Corner, and is owned by Mr. J. Ellard, of Wright.

The owner commenced work in 1898 with twenty men and continued operations each summer for four years. No work has been done since 1902. About 200 tons of rough mica have been produced and are stored on the mine, pending a betterment of market conditions.

The property has been thoroughly prospected by means of numerous surface pits and trenches. The chief workings consist of a large pit 80 feet deep, by 100 feet long, and 30 feet wide, excavated along the north face of a small ridge. The deposit, which is of uncertain type but appears to be of the pocket and fissure class, has a strike of east and west, or corresponding to the direction of the ridge, and dips 65° to the south into the hill.



No.	Name of Mine
1	Haycock
2	Moore & Marks
3	Ellard
4	Anderson
5	Jamieson

⊖ MICA

MICA MINES AND OCCURRENCES IN TOWNSHIP OF ALLEYN, QUEBEC 29

Scale 2 miles to one inch

1 ½ 0 1 2 3 4 5 Miles.

The mica occurs in a fractured zone in a dark green pyroxenite, which contains numerous small pockets and fissures carrying considerable pink calcite (See Fig. 31).

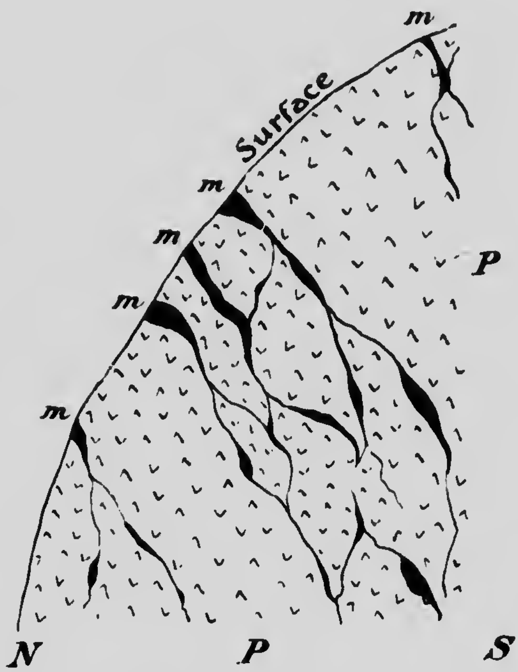


FIG. 31.—Section of mica deposits at Ellard mine, lot 10, range II, township of Alleyn, Que.
P, pyroxenite; m, irregular leads and pockets of mica.

Pyrites, in large and often well-developed crystals of both cubic and octahedral habit, occurs plentifully throughout the mica zone.

Large reserves of mica are reported to be still in sight at depth, and with a rise in the price of the mineral work will probably be resumed.

Range III, Lot 4.—Belongs to Mr. James Jamieson, of Danford. A small and rather dark mica occurs in pockets and on narrow leads, accompanied by white calcite, in a dark and compact pyroxenite cutting biotite gneiss.

The deposit is small and has been worked by quarrying back the west slope of a small bluff for a distance of some 40 feet and to a depth of 15 feet.

The property was leased from the owner by Mr. Kilt, of Ottawa, in 1907, and ten men were employed for a few weeks. The mica was, however, found to be of poor quality, being much crushed and twisted and inclined to ribbon structure. Operations were soon suspended, and have not since been resumed.

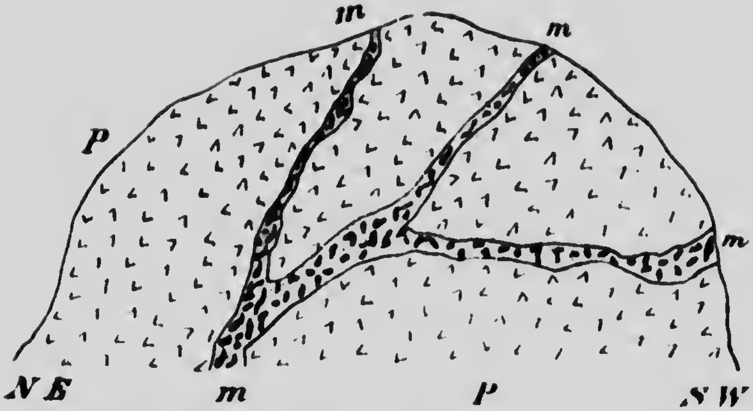


FIG. 32.—Section of mica deposit, lot 4, range III, township of Alleyn, Que. P, pyroxenite; m, mica leads carrying pink calcite and phosphate.

Township of Cawood.

Range VI, Lot 13.—Priestly mine. This property lies a short distance down the Kazabazua river from the Brock and Pritchard mine. Similar

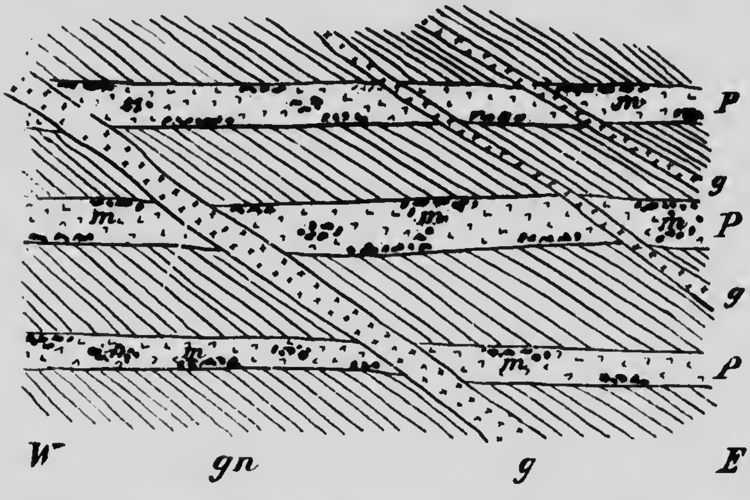
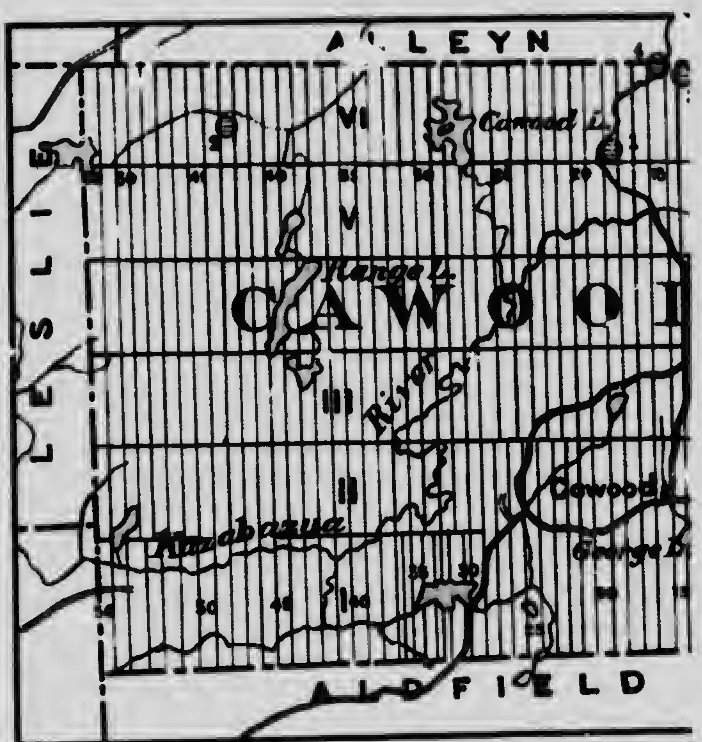


FIG. 33.—Plan of mica deposits at Priestly mine, lot 13, range VI, township of Cawood, Que.
gn, gneiss; P, pyroxenite dykes ing mica, m, and calcite in pockety accumulations; , granite dykes.

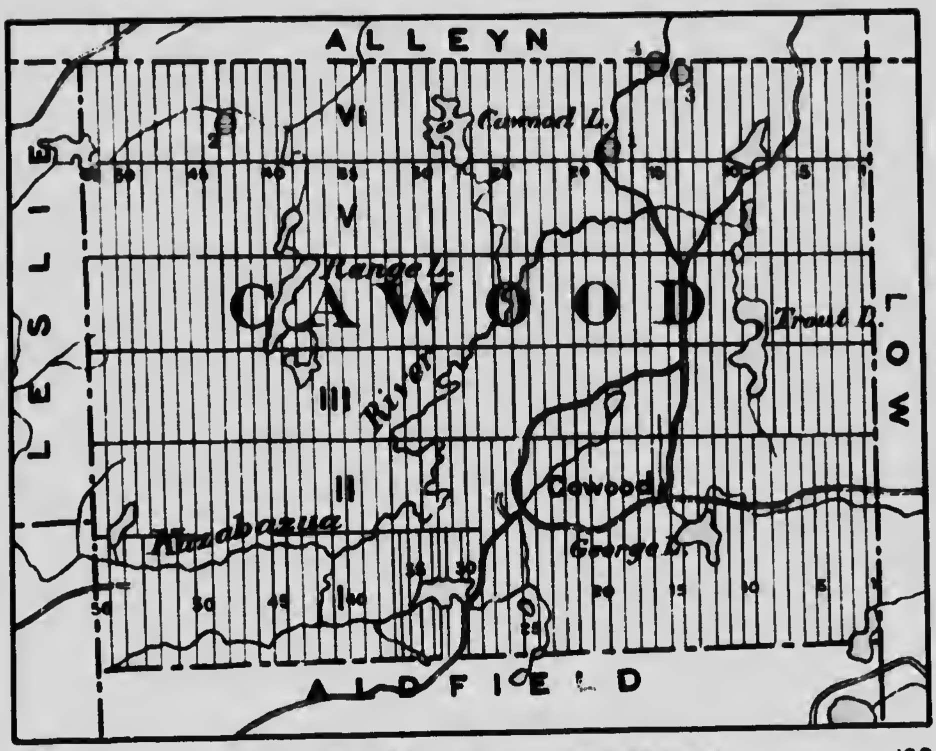


⊖ MICA

MICA MINES AND OCCURRENC

IN TOWNSHIP OF CAWOOD, QU

Scale 2 miles to one inch



No	Name of Mine
1	Brock & Pritchard
2	Stephens
3	Priestly
4	Heeney

⊜ MICA

130

MICA MINES AND OCCURRENCES
IN TOWNSHIP OF CAWOOD, QUEBEC

Scale 2 miles to one inch

geological conditions prevail at both spots. The mica is of much the same quality and colour, and occurs in a rather more pockety fashion; it is found also on joints in the pyroxenite, as well as lining the contact wall.

The deposit was first worked by Messrs. Pritchard and Brock, around 1900. Only a few weeks' work was done, and several shallow pits excavated, none of them exceeding 15 feet in depth.

No phosphate was observed, and some seven barrels of trimmed mica are said to have been the total production of the mine.

Lot 14.—Situated across the Kazabazua river from the Priestly mine, and belongs to Mr. Avesteen, of Ottawa, who has recently acquired the property from Mr. Heeney, of Danford lake.

The deposit was first worked in 1900 for a few weeks by Messrs. Powell and McVeity, of Ottawa, who employed four men.

The mica occurs in a similar manner as at the Priestly mine, and has been worked by means of one small surface pit 12 feet in depth.

The mine has not been worked since 1900.

Lot 18.—The property was first worked in 1898 by Messrs. Brock and Pritchard, who continued operations at intervals for three years, employing eight men. The last mining was carried out in 1906. The mine is situated 6 miles from Danford Corners and on the right bank of the Kazabazua river.

The country is a dark biotite gneiss traversed by numerous, narrow, pink granitic bands which have been intruded conformably to the strike of the gneiss. The latter strikes northwest and southeast, and dips vertically.

The pyroxenite dykes cut the gneiss at an approximate angle of 45°, their strike being almost due east and west.

The mica is of a dark colour and medium quality and occurs in a mass of pink calcite on the contact of pyroxenite and gneiss. The calcite body is some 12 feet wide and has been worked by means of an open-cut 35 feet deep at its inner end, and carried 25 feet into the northwest side of a small ridge.

There is no occurrence of phosphate, and the mica occurs both in pockety aggregates and as individual crystals embedded in the calcite.

The mine is difficult of approach and the mica has to be taken by road some 14 miles to Kazabazua.

Lot 43.—Belongs to Mr. T. Stephens, of Otter lake. The property has been worked by several parties during the last eight years, and the owner has carried out intermittent work with half a dozen men. Several surface pits exist, the deepest being 30 feet down, and the deposit has yielded several tons of medium-sized light yellowish-amber mica.

Township of Huddersfield.

Range IV, Lots 20, 22, and Range V, Lot 22.—These lots are the property of the Calumet Mica Company, of Bryson, and have been worked for a few months in 1906 and 1907, with an average force of eight men.

No machinery was ever employed on the mine. The workings comprise a number of small surface openings, the largest pit being about 20 feet deep.

These pits have been opened on a pocket and fissure deposit of mica in medium-grained grey-green pyroxenite, the leads having a general direction of N. 15° E.

The walls of the pockets and veins are lined with well-formed crystals of pyroxene, and large quantities of a coarsely crystalline brown calcite occur with the mica as vein-matter.

Phosphate is relatively absent. An unusual feature is the occurrence of purple fluorite, which is found in good-sized masses embedded in the calcite. Orthite is another unusual mineral which occurs here in the same manner, and the pyroxene crystals are remarkable for their freshness, being of a dark-green colour and possessing high lustre. Scapolite is also present in considerable quantity, the rock often having the composition of a scapolite-pyroxenite. The mine is situated 30 miles from Campbells Bay station, on the Waltham branch of the Canadian Pacific railway, whither the mica is hauled after being trimmed on the mine. A pyroxenite belt traverses reddish gneiss in this region, and mica indications are to be found for some distance along its course, adjoining owners having located considerable out-crops.

This pyroxenite dyke has a strike of N.E. and S.W. and forms a ridge 150 feet high, being traversed by fissures having an approximately similar direction, but which often branch off towards varying points of the compass.

The mica is well crystallized and often of large dimensions, but has a peculiar spotted or blotchy appearance, and is, in addition, a poor splitter, a large percentage of the crystals mined having to be discarded on this account.

The construction of a mine road to Fort Coulonge, 12 miles away, would materially shorten the present haulage distance, and is a proposal of the owners, should operations be resumed.

Range IV, Lot 25.—Belongs to Mr. A. G. Farrell, of Otter Lake, and was first worked five years ago for a few months with three men.

Only surface work was done, the deepest pit being down 10 feet, and no further mining has been undertaken.

The mica and mode of occurrence are in every way similar to those on the neighbouring Calumet Company's property.

Township of Litchfield.

Range IX, Lot 26.—Belongs to Messrs. Bowling Bros. of Thornby, who first worked the property in 1903 for a few weeks with four men. No further work has been undertaken.

The deposit can be traced by means of minor outcrops for over a mile, and several small openings have been made on small pockets and fissures.

The main pit is 25 feet deep. It has been opened on a pocket or chimney of small-sized dark and rather brittle mica, accompanied by small quantities of brown phosphate in a matrix of pink calcite.

The dyke strikes N.W. and S.E. and is traversed by fissures having a general direction of E. and W., along which small deposits of mica occur.

Later granite veins having a strike of N. E. and S.W. cut across the dyke, small pockets of molybdenite being found on the contacts.

Scapolite occurs in some quantity. The rock generally has the character of a coarse mica-pyroxenite. No machinery was ever used on the mine, which has produced about three tons of rough-cobbed mica to date.

Township of Thorne.

Range III, Lot 51.—Owned by Father Ferary, of Otter Lake, who first worked the property some ten years ago for one summer, employing an average of ten men. No further work has been carried out.

The workings consist of an open-cut carried 30 feet into the side of a high ridge and 25 feet deep at its inner end, while a small surface pit has been opened a few feet farther down the hill.

The rock is a dark grey-green pyroxenite, medium-grained and rather soft, often containing considerable quantities of scapolite both scattered through its mass and in the form of small crystals in small drusy cavities.

The dyke has a banded appearance and strikes N. 5° E., being capped above the main pit by a fine-grained brown granite.

The mica is a darkish amber, and occurs with a little red phosphate in small crystals on irregular veins ('schlieren'), the vein matter being coarse pink calcite.

The mica is frequently decomposed to a yellowish talc-like mineral which occurs plentifully on later fracture joints in the dyke mass.

A small camp exists on the property.

Township of North Onslow.

Range VII, Lot 17 N.½.—This property was worked intermittently ten years ago for a couple of years by an Aylmer syndicate, and subsequently by Mr. Chubbock, of Ottawa, for a few months in 1906.

A pit 85 feet long, 10 feet wide, and 30 feet deep has been opened on a contact between a dyke of medium-coloured pyroxenite and granite-gneiss country, the strike of the deposit being E. 25° N. and the dip 63° S.E. The contact-matter is pink or yellowish calcite in which a dark, greenish, and rather crushed mica occurs.

Small pockets lined with well-formed pyroxene crystals occur along the hanging-wall.

The mine is situated on the south slope of a granite-gneiss ridge bordering the clay flats to the north of Quyon station, on the Waltham branch of the Canadian Pacific railway, and about 6 miles from the railway.

In addition to the foregoing localities, the following list of deposits, taken from Mr. Obalski's report, is appended, as showing where mica outcrops have been discovered. The locations were not visited, and little work has been carried out upon them since the publication of the above report in 1901.

OTTAWA COUNTY

Township of Northfield.

Range A, Lot 1.—Opened in 1895 by Mr. F. Desjardins, of Ottawa, and subsequently worked in 1896 and 1898 by the Toronto Mica Manufacturing Company, who sank down 30 feet on three leads of phosphate and mica ranging from 4 to 5 feet in width. Several tons of good, but small mica were obtained.

The same Company carried out a little work on lot 2.

Lot 8.—Prospected in 1898 by Mr. W. E. Hamil, of Toronto, who took out a couple of tons of mica.

Range B, Lots 12, 13.—Prospected with fair results in 1891.

Lots 20, 21.—Indications of mica.

Range II, Lot 25.—Worked in 1895 by Mr. G. Reid, of Gracefield, for a few weeks, and a little mica secured.

Lots 32, 33.—Some large dark-coloured mica has been taken off these lots.

Range III, Lot 31.—Prospected in 1898 by the owner, Mr. J. Moriot, who obtained a small quantity of mica.

Township of Aylwin.

Range IV, Lot 7.—Ryan mine. Prospected in 1892, and has produced some large crystals of clear mica.

Range X, Lot 35.—Indications of mica.

Range XI, Lots 40, 43.—Mica outcrops located.

Township of Hincks

Range II, Lot 21.—Prospected in 1897 by Mr. Baumgarten, who reported mica outcrops.

Range III, Lot 25.—Good indications of mica reported.

Range IV, Lot 3.—Paquet mine. Opened in 1897 by the owner, who took out a couple of tons of mica, and worked in 1898 by Mr. Watters for a few weeks with five men.

Lot 6.—This property, which lies on a small hill between Black lake and Whitefish lake, shows leads of pink calcite containing large crystals of apatite and mica. In 1898, Messrs. Richer and Co., of Hull, carried out some prospecting for a couple of months, but the mica proved to be too small to be of much value. The mine is situated 6 miles from Aylwin station on the Maniwaki branch of the Canadian Pacific railway.

Lots 17, 18, 30, 36, 37, 38.—Prospected at various times and indications of mica and phosphate reported.

Range V, Lots 22, 23, 35, 36, 37.—Indications of mica and phosphate.

Range X, Lots 32, 33.—Prospected in 1898 by Mr. T. J. Watters, and mica outcrops located.

Range XI, Lots 10, 11.—Indications of mica.

Range XIII, Lots 48, 49.—Prospected in 1892 by Mr. A. Bowie, and indications of mica found.

The above-mentioned lots in the neighbourhood of Lake St. Mary were prospected in 1896 and 1897, and a little mica was found. A few hundred pounds were produced from various properties, but the indications did not appear sufficiently favourable to justify any important work being undertaken.

Township of Denholm.

Range I, Lot 1	Indications of mica reported to occur.
Range V, Lots 20, 21, 22	
Range VI, Lots 26, 27	
Range VIII, Lots 18, 19	

Township of Low.

Range XII, Lot 36.—Brock mine. Opened in 1892 and has produced some large crystals of clear mica.

Township of Masham.

Range I, Lot 34.—Prospected in 1898 by Mr. T. J. Watters.

Range III, Lots 10, 11.—Worked in 1892 and several tons of mica secured.

Range IV, Lot 1.—Indications of mica.

Township of Eardley.

Range IX, Lots 1, 2, 3.—Indications of mica.

Range X, Lot 2 N.½.—Owned by Mr. Charles Flynn. Has been prospected and good outcrops reported north of Lake Mousseau.

Range XI, Lot 3.—Indications of mica.

Lot 6 N.½.—Owned by the Grey Nuns of Ottawa, and exploited in 1899 with seven men. A quantity of mica was secured, some of the crystals being of large dimensions.

Range XII, Lot 6.—Indications of mica.

Range XIII, Lot 9.—Indications of mica.

Township of Aumond.

Range B, Lot 6.—Indications of mica.

Township of Lytton.

Range II, Lot 21.—Worked by the owner, Mr. Éthier, in 1898 and 1899, and in 1900 by Messrs. Moore and Webster, who extracted a fair quantity of mica.

Township of Ripon.

Range VIII, Lots 13, 14.—Opened in 1899 by J. Joubert & Co., who sank a few pits on a series of leads of pink calcite carrying mica and phosphate in a light-coloured pyroxenite. The mica is of good quality, but small.

PONTIAC COUNTY.

Township of Waltham.

Range A, Lot 7, 8.—Prospected in 1900 and a small quantity of mica taken out.

CHAPTER IV.

PHLOGOPITE OR AMBER MICA.

General Occurrence of Mica in the Province of Ontario.

The economic deposits of amber mica in the Province of Ontario are included in an area lying directly east of the Kingston and Pembroke railway, and on either side of a line drawn from Perth to Sydenham. The district measures roughly 30 miles north and south, and 25 miles east and west, comprising about 750 square miles, and is divided into two main areas, the Sydenham mica region and the Stanleyville, or as it is now named, Micaville mica region. These two mica zones are separated topographically by a chain of lakes, including the West Rideau, Sand, Upper and Big Rideau lakes.

Geologically, a tongue of Palæozoic rocks, composed chiefly of Potsdam sandstone and stretching to the west from the main body of sedimentary deposits in Carleton and Grenville counties, divides the two districts in the neighbourhood of Westport, while the high ridge of granite-gneiss forming what is known as the Mountain, directly north of Westport, may be regarded as a further natural division, though scattered deposits of mica occur also in this region. The chief mines in the Sydenham area are situated in the townships of Loughborough and Bedford, while in the Micaville, or as it is more often termed, the Perth district, the mines lie principally in the townships of North and South Burgess, and North Crosby.

TOPOGRAPHICAL AND GEOLOGICAL FEATURES OF THE MICA AREAS.

The character of the Ontario mica region is not as mountainous as that of the Quebec district. The whole area, and more especially the southern portion, is covered by a network of lakes and streams which, however, do not lie much below the general level of the surrounding country. Large stretches of more or less level farming land are separated by areas of low hills and ridges, sometimes sparsely covered with second-growth timber. These ridges are of all heights, and are usually rounded, forming what are known as "hogsbacks" (German—'Rücken'). Throughout the region swamps abound; large districts adjacent to the lakes having been drowned by the general rise of water caused by the construction of locks on the Rideau canal. The general direction of the ridges and low lines of hills is N.E. and S.W. and a glance at the map of the district will show that most of the lakes and streams throughout the area follow this direction. The district is well populated especially in its northern and southern portions, and is traversed by numerous good roads, transport facilities being as a general rule, excellent, while in most cases, mine roads are easy of construction.

Timber for mining purposes is not plentiful, but can be obtained at a cost of from four to five dollars a cord.

The greater portion of the country traversed by the pyroxenites, or mica-bearing dykes, is composed of a reddish or brown, fine-grained granite-gneiss. This rock is composed of layers of varying character—bands of normal biotite-gneiss alternating with zones of almost pure quartz, which sometimes contain a little scattered pink feldspar. These acid zones present, at first sight, the appearance of having been intruded along the planes of schistosity of the rock by some later granite eruption, forming what is known as "injection-gneiss," but they are perhaps part of the original rock-mass.

This granite-gneiss has probably been formed from normal granite by dynamic metamorphism, and it is in some cases somewhat contorted.

The general strike of the gneiss is N.E. and S.W., and its dip between 60° and 70° to N.W. In some places the rock is highly garnetiferous, this being especially noticeable in the vicinity of Gould lake, in the township of Loughborough.

Plate VIII shows an outcrop of gneiss in the neighbourhood of Perth Road.

Intercalated in this gneiss system are numerous bands of white crystalline limestone. These limestones are of medium grain, and sometimes contain large quantities of secondary minerals formed at the time of their metamorphism from sedimentary rocks. These minerals are generally lime-garnet, light-green diopside, feldspar, tremolite, and light-brown phlogopite, all of which occur in small crystals and aggregates throughout the rock-mass, being especially plentiful adjacent to the contacts with the gneiss and later intrusive rocks. This complex of gneiss and limestone is extensively traversed by bands of pyroxenite having a general direction of N.E. and S.W., or a similar strike to the country rock, though, in some instances, the dykes cut the country almost at right angles.

It is with these pyroxenites that the mica deposits enumerated in the following pages are associated; the occurrences being usually in every way similar to those in the Province of Quebec and already described.

It may be surmised that the last-named deposits are connected with those in the Ontario region, and this supposition is supported by the nature of the rock-formation.

The general strike of the gneiss and schists which go to form the earth's crust in the two mica areas is N.E. and S.W., and the greater number of the pyroxenite dykes have a similar direction. This fact would seem to indicate that these pyroxenite intrusions have, in many cases, followed the planes of schistosity of the country rock as lines of least resistance, and it may, therefore, reasonably be expected that similar dykes exist in the Laurentian formation which underlies the tract of later sedimentary deposits between Perth and the Ottawa river. In other words, the mica fields are associated with a series of more or less parallel pyroxenite dykes extending from the St. Law-

PLATE VIII.

Outcrop of gneiss, showing uptilt near Perth Road, township of Loughborough, Ont.

rence river, in the neighbourhood of Kingston, in a northeasterly direction to a point not yet determined, but situated at least 70 miles in a direct line north of the City of Ottawa, or over a distance of 175 miles in all.

In addition, deposits of dark phlogopite were worked in 1897 on concession XXII, lot 7, of the township of Cardiff, Haliburton county, and large crystals, as much as 2½ feet in diameter, are said to have been taken out. Similar occurrences were found on concession XIII, lots 30 and 31 of the same township, but none of these deposits have been worked for many years.

MICA MINES AND LOCATION.

FRONTENAC COUNTY.

Township of Loughborough.

Concession VII, Lot 11.—Known as the Lacey mine, and the largest producer of amber mica in Canada at the present time. Originally opened about 1880, by Messrs. I. Smith & Co., of Sydenham, the mine was worked for some twelve years, being acquired in 1894 by the present owners, the General Electric Co., of Schenectady, N. Y. This Company did not commence work immediately upon taking over the property, but leased it to Webster & Co., for five years, and later to Mr. J. W. Trousdale, of Sydenham. This mine affords a typical instance of the uncertainty attending the development of mica deposits, for the Webster Co. ceased work as unprofitable when within a few feet of the immense bodies of mica which have subsequently been uncovered by the present owners.

Upon the expiration of the lease obtained by Mr. Trousdale, the General Electric Co. commenced mining operations, under the name of the Loughborough Mining Co., and have continued without cessation to the present time.

The mine is situated 4 miles from Sydenham, near the east shore of Eel lake, and good roads connect the property with the main roads to the east and west.

The mica, which was formerly trimmed at the Company's shops in Sydenham, now undergoes a rough cobbing at the mine, and is then packed into barrels and shipped to the works at Ottawa, where it is trimmed and cleaned. When the Company commenced mining, there was a shaft 25 feet deep, exclusive of other minor openings. This shaft was subsequently carried down to 185 feet, drifting being simultaneously proceeded with along the vein, which has a strike of N.W. and S.E., and dips 80° to vertical to the N.E. In width this lead varies from a few inches to 25 feet, being, in some parts, almost a solid mass of enormous mica crystals. The largest crystal taken from the mine is said to have been over 9 feet in diameter.

An air shaft was also sunk 40 feet to the south of the main pit. This shaft is 8 × 10 feet, is timbered for 30 feet and provides a ladder-way. The main shaft is also timbered with a 30 ft. collar.

Six levels were carried along the vein from the main pit, the first being at a depth of 52 feet, and the others at distances of 22 feet. The fourth level runs farthest from the shaft, having been carried 150 feet to S.E., and 65 feet to N.W., making a total length of 215 feet.

A cross-cut was run from this level a distance of 66 feet to S.W., to pick up a parallel vein, which has been followed for a distance of 160 feet to S.E. From the second level, a cross-cut has been carried 55 feet to N.E., and a third parallel vein intercepted, and followed for 80 feet to S.E.

In 1906, it was decided to commence open-work mining, and a pit 60 × 70 feet square was started about 60 feet S.E., of the shaft house, sinking being carried out upon the main mica-lead and the parallel vein to N.E. This large pit is provided with a collar of inclined safety timbers, 10 feet below the surface, to prevent rock, etc., falling in (See Plate IX).

Sinking was continued on N.E. side of the pit until the cross-course from the second level was picked up. The pit is now 60 feet deep, and it is proposed to continue sinking, picking up the levels as work proceeds. Stoping is also being undertaken between the fourth and sixth levels, the mica being taken out and the room filled in with rubbish to save hoisting waste rock.

The hoist employed on the open pit is a 60 ft. boom derrick, operated by a steam winch, and the rock is raised in open, shallow, three-sided, wooden boxes, hung on three chains, and having a capacity of 15 hundredweight. From these it is tipped into small wooden cars, running on a tramway to the dump. A diamond-drill was employed on the property some years ago, and again in 1909; some good deposits of mica are reported to have been struck. The drilling was, in the first instance, carried out from the surface, and in 1909, from the fourth level.

There is a large boiler-house adjoining the shaft-house, containing two 70 H.P. boilers, used to operate the compressor and main-shaft hoist.

Drilling is done by steam and compressed air, Ingersoll-Rand drills being used.

A 30 H.P. boiler operates the steam winch used for hoisting from the open pit, and the drills are worked from a six-drill 60 H.P. compressor. One No. 9 Cameron pump is found sufficient to keep the mine un-watered.

The main shaft measures 8 × 16 feet, and has two compartments 8 × 8 feet, being provided with a single-drum hoist. The rock, etc., is raised in wooden buckets.

The present force employed consists of 35 men, but the number varies from 25 to 60; this latter being the number capable of being accommodated in the boarding-house.

The mine is under the superintendence of Mr. G. W. McNaughton, the foreman being Mr. R. H. Smith.

View of main pit, Lacey mine, lot 11, conc

...t 11, concession VII, township of Loughborough, Ont.

PLATE X.

General view of Lacey mine, lot 11, concession VII, township of Loughborough Ont.

The mica is a first-class mottled, wine-amber, and occurs on fissure-veins of irregular width in a greenish-grey pyroxenite of medium grain, which carries a good deal of pyrites disseminated through it. Bunches of massive phosphate of a dark green colour are occasionally met with on the leads, which carry white calcite as vein-matter. It is said, that, when this white calcite is met, the mica as a rule tends to disappear, occurring only in bunches of smaller crystals.

A large body of calcite occurs on the S.E. side of the main vein, and has not yet been pierced, though it is thought that mica exists on the far side of it.

No country-rock has been met with in the workings, so it is not known of what the walls of the dyke are composed. The surrounding country consists of gneiss, or mica schist, with intercalated limestone bands.

A white milky, amber mica is sometimes found associated with the clear variety, and in some cases the same crystal exhibits both clear and milky patches.

The old Lacey pits lie to the N.E. of the present workings and consist of several narrow openings on parallel leads of mica to those now being worked. The deepest of these pits is said to be down 180 feet.

The mine has always been free from serious accidents, and, in this respect, holds a high place among the mines of the Province.

At one time the mine is reported to have yielded a daily output of between four and five tons of rough mica.

An analysis of the clear mica from this mine is given in the Journal of the Canadian Mining Institute, Vol. VII, p. 284, and is as follows:—

SiO_2	39·66
TiO_2	0·56
Al_2O_3	17·90
Fe_2O_3	2·76
FeO	2·00
MgO	26·49
BaO	0·62
Na_2O	0·60
K_2O	9·97
H_2O	2·99
F	2·24
Total	104·83

The axial angle of both the clear and milky varieties of phlogopite which occur here has been found to be identical, and the opaqueness of the latter mica is supposed to be due to secondary alteration, either of the mica itself, or of the minerals included in it. Whether this is the true cause is, however, still uncertain.

Lot 3 W.½.—Belongs to Freebern Bros., of Sydenham, and was first worked twenty years ago, by Mr. F. Foxton, under lease. Work was continued intermittently for fifteen years with an average of five men, and subsequently Mr. I. Hurley, of Rochester, N.Y., worked a year with a similar force.

In 1907, the Sydenham Mining Co. carried out a few weeks' work, and since then the mine has lain idle.

The workings consist of four pits, the largest being 61 feet deep, 30 feet long, and 20 feet wide, opened on three leads of mica in a dark-green pyroxenite of medium texture. The widest of these leads averages 2½ feet, and

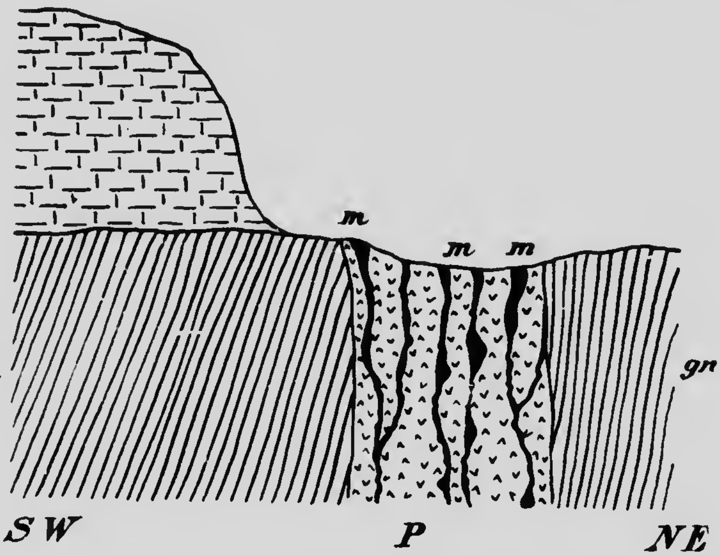


Fig. 54.—Section through mica deposits at Freebern mine, lot 3, concession VII, township of Loughborough, Ont.

P, pyroxenite dyke with mica leads m; gn, gneiss; c, Black River limestone (Palæozoic formation).

carries pink calcite as filling, with a small quantity of green and red phosphate. The veins are parallel, have a direction of W. 15° N., and are some 35 feet apart.

A considerable amount of pyrites is present in the rock.

The mica is a wine-amber of good quality and medium size, and samples from this mine have received the gold medal at the World's Fair, in Chicago, in 1893.

The mine was formerly equipped with an adequate plant, including steam-drills, and pump, hoist, etc., but this was all removed some years ago. Pumping has to be kept up continuously, the pits being situated on the edge of a swampy flat at the base of a high ridge of Palæozoic limestone, 2 miles north of Sydenham.

The total production of mica is valued at $25,000.

Concession VIII, Lot 6 E. ½.—The workings on this property are separated from the Scriven and White mine only by a fence, and consist of a few surface pits, the deepest of which is down 30 feet.

Operations were commenced in June 1910, with five men, and continued for three months, an attempt being made to pick up the mica lead which is being worked on the adjoining property. The attempt was, however, not successful, only a small stringer from the main vein being met with.

The occurrence resembles that on the west half of the lot, the rock being similarly decomposed, and the mica of a like, wine-amber colour. About a ton of rough mineral was mined by the operators—Messrs. Wood, Solliday, Freeman, and Reamer, of Sydenham.

Concession VIII, Lot 6 W.½.—Belong to Messrs. Scriven and White, of Sydenham who commenced to work the property in June 1909, and have continued operations steadily since. The mine is situated 3 miles north of Sydenham, and produces a medium-sized, wine-amber mica, which is often rather crushed. The workings consist of a number of minor prospect pits, and a main shaft 8 × 5 feet, which has been sunk to a depth of 120 feet, and is square-timbered for 65 feet from the surface, being a two-compartment shaft for this distance. One side is used for hoisting, while the other contains a ladder-way, pump, and drill pipes, etc.

The shaft has been sunk vertically for a distance of 80 feet, and from the 60 ft. level a drift has been carried 85 feet to the west, while from the 80 ft. level the shaft has been continued on an incline to the west for 40 feet. The general trend of the mica lead is N.E., and S.W., and its dip vertical to the 80 ft. level, where it assumes almost a horizontal position, continuing for about 25 feet to the west, and then becoming vertical again. The maximum width is attained 70 feet from the surface, being here over 13 feet.

The dyke-mass is a rather soft, dark-green, and fine-grained pyroxenite, being much decomposed for a considerable distance from the surface. Large quantities of pyrites are present in the rock, and it is to this that the reddish colour of the mica is due.

The vein-matter is coarsely-crystalline, white calcite, associated with which the mica and a little phosphate occur. So far only one vein has been located. The pyroxenite dyke cuts a country of normal gneiss, which, adjacent to the contact, is soft and friable in like manner to the dyke-rock.

The mine is equipped with an adequate camp and plant, including a 40 H.P. boiler, single drum steam hoist, steam pump, drills, etc. An average force of eight men has been employed in the pit, but when visited, the mine had been temporarily closed down, and only a few cullers were engaged in trimming the mica on hand.

The owners, however, propose installing a diamond-drill with a view to thoroughly testing the property. About twenty-five tons of thumb-trimmed mica have been produced since the present management commenced working.

and a small quantity was taken out by private operators, who, however, carried out no extensive work.

Lots 12, 13, 14.—This property was worked first in 1889, by Webster & Co., under lease from Mr. P. Freeman, of Sydenham, who subsequently worked intermittently for three or four years. Messrs. James Richardson and Sons, of Kingston, then bought the mine, and worked continuously for three years, after which it was acquired by the New York & Ontario Mining Co., who carried on one year's mining.

Mr. S. H. Orser, of Sydenham, worked a few weeks, under lease from the Company, in 1909, with five men, since when the mine has been idle.

The deepest pit is down 80 feet, on a vein of mica and coarsely-crystalline, white calcite, between gneiss walls, and with a capping of light-coloured pyroxenite. The leads are well-defined, and almost parallel, and have been followed by means of numerous surface openings for a distance of over 1000 feet.

The mica is a normal light-amber on the south part of the property;

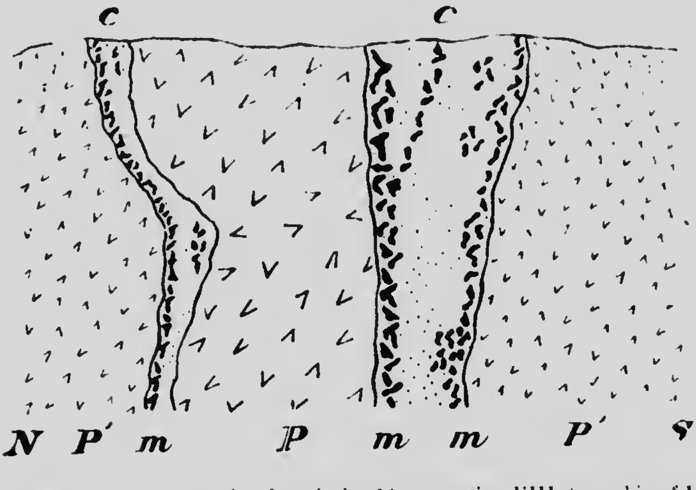


FIG. 35.—Section through mica deposit, lot 14, concession VIII, township of Loughborough, Ont.
P, hard pyroxenite; P′, soft pyroxenite; m, mica disseminated through calcite c.

to the north it becomes dark, and the leads change their direction from N.W. and S.E., to almost due N. and S. Some opaque, milky mica occurs in the south pits. The property is equipped with a camp, built by the present owners, who installed an 18 H.P. boiler, steam-hoist, duplex pump, and steam-drills, and employed an average gang of twelve men and a like number of girl-trimmers. About thirty tons of trimmed mica were shipped from the mine by the Company.

The property is situated 9 miles N.E., of Sydenham—lots 12 and 13 adjoining the Amey mine to the east, while the workings on lot 14 lie across a small lake, half a mile distant.

The occurrence on the first-named lots resembles that on the Amey property, dark mica being found with compact and fine-grained red calcite, which often contains small rounded crystals of green apatite disseminated through it. The whole has the appearance of an apatite-porphyry.

The main workings and camp are situated on lot 14, which produces a lighter mica, associated with white calcite and small amounts of phosphate. The mica crystals are generally small, but well-formed, and occur scattered through the calcite which forms the filling of the vein; the walls of the latter are often lined with a mass of small, dark mica crystals.

The country-rock is a reddish gneiss on the south part of the lot, with crystalline limestone on the north. The direction of the mica leads is W. 15° N. From the appearance of these latter, it is probable that they unite in depth.

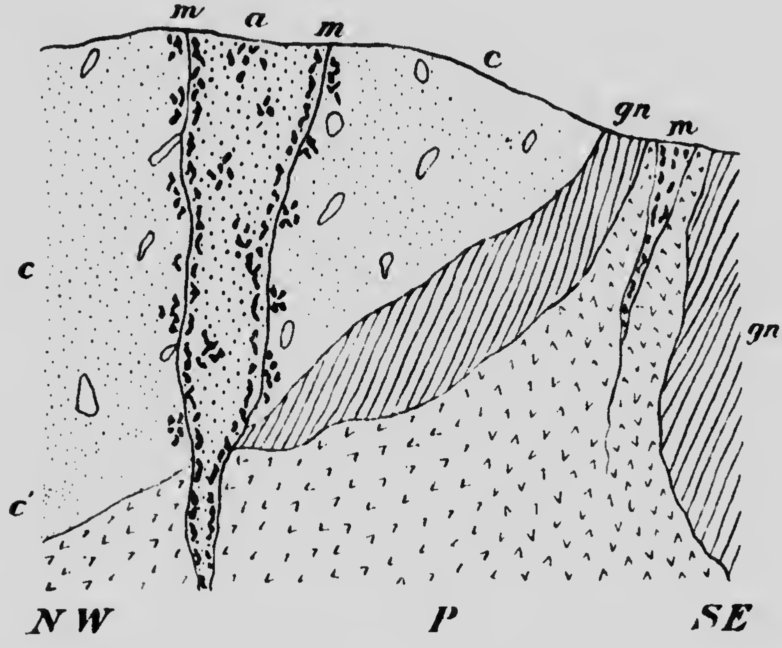


FIG. 36.—Schematic section through mica deposit, lot 14, concession VIII, township of Loughborough, Ont.

P, pyroxenite; c, crystaline limestone with inclusions of amphibolite; gn, gneiss; m, mica; a, coarsely crystalline white calcite.

A pit 25 feet deep has been opened near the lake, where the mica leads cut crystalline limestone, the direction here being W. 30° S., and the width of the vein about 8 feet. Mica crystals occur also in the country-rock adjacent to the vein. No pyroxenite is to be seen in this pit, the mi having apparently been deposited on, and adjacent to, fissures developed in the limestone by emanations from an underlying body of intrusive rock, which reaches the surface farther to the south.

Concession VIII, Lot 13 E.½.—Amey mine. Opened for phosphate in the seventies, by Mr. N. Amey, of Perth Road, and has subsequently been worked by various parties, including Webster & Co. In 1908, the Mica Product Co., of Toronto, acquired the property, but did not carry out much work, selling out after a few months to the Loughborough Mica Co., who still own the mine. Four months' mining, with ten men, was done by this Company, and the mine then lay idle until 1910, when Messrs. J. and P. Harris, of Cobalt, put in a few weeks' work under lease.

The mine lies 8 miles northeast of Sydenham. Numerous pits exist on the property, and range from 20 to 75 feet in depth. The main opening is 100 feet deep, and, like the other pits, has been sunk on a well-defined lead of mica and phosphate. Several such leads exist on the property, and have been exploited by means of long, narrow trenches averaging about 8 feet in width.

The veins strike N.W., and S.E. The mica is a dark-amber of medium size and quality, and is associated with considerable quantities of brown and green phosphate, and large bodies of pink calcite, as vein-matter. In fact, this mine shows more calcite, both on the dumps and in situ, than any other visited, with the exception, perhaps, of the McLelland mine in Hull township, Que. The two deposits possess many points of resemblance. The large amount of calcite present is shown in Plate XI, where the dump on the left is composed of little else than this mineral.

The series of parallel leads, of which latter there are seven, occurring at distances of from 12 to 20 feet apart, occur in a dark-green pyroxenite, cutting dark granite-gneiss with red feldspar aggregates. The leads seem to converge towards the southeast, and a cross-vein, with a strike of E. 20° N., cuts the series 150 feet southeast of the main shaft. Sufficient development work has not been done to prove the fact, but it is surmised that this cross-lead forms the principal deposit, the others being only stringers from it. The veins are narrow at the surface, and widen at depth, the largest lead having a width of 45 feet at the bottom of the shaft, and only 9″ at the surface. The deposit seems to be connected with an intrusion, which has shattered the country gneiss, and formed veins and apophyses, along which the mica occurs.

The main shaft has been sunk vertically for 80 feet, from which point a drift was run 12 feet to the N.W., further sinking being there carried out to 100 feet. A drift was carried along the vein at the bottom of the shaft, for a distance of 50 feet, and a cross-course run 45 feet to the S.W., in an attempt to pick up the foot-wall, but without success, the working being in pink calcite all the way.

⊖ MICA MICA MINI

IN TOWNSHIP OF

Sc

No.	Name of Mine
1	Lacey
2	Freeborn
3	New York & Ontario Mining Co.
4	Amey
5	New York & Ontario Mining Co.
6	Scriven & Whyte
7	Arcade Mining Co.
8	Roamer & Solliday
9	Birch Lake Mining Co.
10	Birch Lake Mining Co.
11	Prospect
12	Excelsior Mining Co.
13	McClatchey
14	Gould Lake
15	Baby
16	Redmond
17	Prospect
18	Bear Lake
19	Kent & Stoness
20	Birch Lake

⊜ MICA — MICA MINES AND OCCURRENCES — 131

IN TOWNSHIP OF LOUGHBOROUGH, ONTARIO

Scale 2 miles to one inch

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PLATE XI.

View of Amey mine, lot 13, concession VIII, township of Loughborough, Ont.

The mine is equipped with a 30 H.P. boiler, steam-hoist, and pump, two steam-drills, and a large boarding-house.

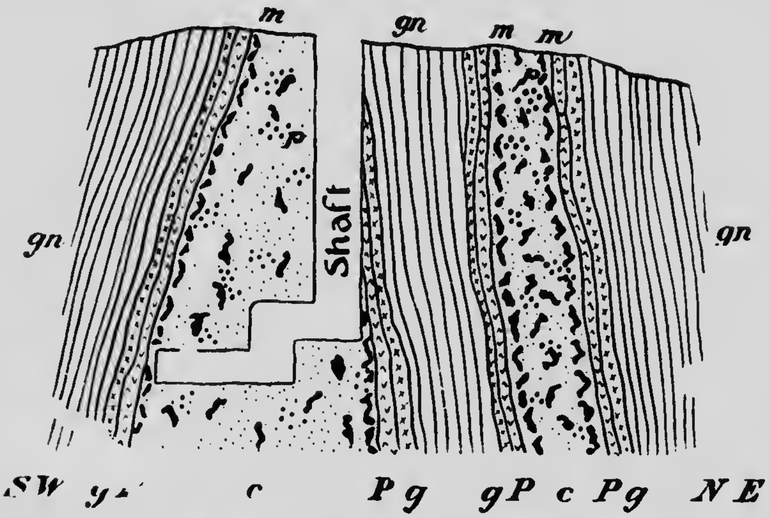

Fig. 37.—Section through mica deposit at Amey mine, lot 13, concession VIII, township of Loughborough, Ont.

gn, gneiss; P, pyroxenite; g, augite syenite; m, mica with apatite (p) distributed through large calcite bodies c.

Concession IX, Lot 1.—Owned by Mr. C. Martin, of Holleford. A small pit, 25 feet deep, was opened by the owners in 1909, and a small amount of mica secured. The occurrence is similar to that at the adjoining Baby mine, and is part of the same deposit—the mica lead cropping out through an overlying strata of conglomerate and coarse sandstone. Sufficient sinking has not been carried out to prove the extent of the deposit, but it is possible that a considerable body of mica underlies the sedimentary strata.

Lot 6.—An old phosphate property and worked many years ago by Messrs. Smith and Lacey, of Sydenham. Webster & Co. carried out some work here at the same time as they worked the adjoining Gould Lake property. No further mining has been done beyond a little prospecting in 1910 by the Birch Lake Mining Syndicate, who have a lease of the property. The country-rock in the vicinity is a pinkish granite-gneiss, often garnetiferous, and altered by dynamic metamorphism.

Lot 7.—Belonging to Mr. J. W. Trousdale, of Sydenham. No work has been done for the past fifteen years on the property, which was formerly mined for phosphate and the mica taken out used in the stove industry.

Lot 9 N.½.—This property was worked on a small scale in 1907 by Messrs. Snook and Freeman, of Verona, being subsequently acquired by Reamer and Solliday, of Sydenham, who are the present owners. The latter have carried out a year's steady work, employing an average of five men, and report a production of about twenty tons of rough mica. There are six pits on the property, the deepest of which is down 35 feet on a fissure deposit of brownish-amber mica, phosphate, and white calcite in a normal green pyroxenite.

The leads are well-defined and occur near the contact of the pyroxenite with a reddish granite-gneiss.

The mine lies 5 miles north of Sydenham.

Lot 12.—Owned by the Arcade Mining Co., of Arcade, N.Y., who worked the property for a few months in 1907, and again in 1909, with five men. The deepest pit is down 20 feet on a small lead of red phosphate, white calcite, and somewhat crushed medium-sized mica. There are several other parallel leads upon which small openings have been made, the direction of the fissures being N.E. and S.W. About 3,000 pounds of thumb-trimmed mica have been produced.

Concession X, Lot 1.—Known as the Baby mine, and owned by Messrs. Richardson and Ellerbeck, of Kingston and Hartington. The mine lies 6 miles northwest of Sydenham and produces a yellowish mica which appears almost colourless in thin plates. The crystals are of medium size, and are often stained red on the outside and for a short distance inwards. The mica-bearing rock is a brownish-grey, highly altered pyroxenite, ranging from a fine-grained rock to one composed of large pyroxene crystals, the latter possessing a high degree of cleavage and often attaining a length of a foot or more. This rock is capped by a few feet of brown Potsdam sandstone and conglomerate, and the latter rock is impregnated in the immediate vicinity of the mica lead with small crystals of mica. The mine is situated almost on the fringe of the Palaeozoic, sedimentary formation, the Laurentian gneiss and limestone being exposed a few hundred feet to the north of the workings. The direction of the mica lead is almost due north and south, and the dip vertical. In addition to being found upon a well-defined vein, the mica crystals also occur in the rock adjacent to the lead. The latter can be traced for a distance of over half-a-mile, and has been also opened up on the adjoining Martin property.

The mica has been extracted by means of a series of pits sunk at intervals of 15 to 20 feet along the lead, and from the bottoms of which drifts are carried in a southerly direction. The average width of the openings is 15 feet, and of the mica lead proper 4 feet. Considerable quantities of the mineral exist in the rock on either side of the fissure, and appear to have been deposited on minor cracks by emanations and pneumatolytic action.

The mica occurs for the most part in bunches of small crystals scattered through the rock, which is frequently altered from a hard, dark-grey or brown rock to a whitish friable mass. This latter crumbles easily into fragments having rhombohedral form.

The deposit carries a number of accessory minerals, including: quartz, actinolite, tremolite, chlorite, and brown tourmaline; pyrites occurs in considerable quantities.

PLATE XII.

General view of Baby mine, lot 1, concession X, township of Loughborough, Ont.

At 20 feet a red felsite band 10″ thick was met; at 35 feet a similar band 15″ thick; and at 45 feet another grey layer of 2 feet. These layers have the appearance of fine-grained quartzite and are termed "granite" by the miners; they contain no mica, the deposit becoming "lean" in their immediate neighbourhood.

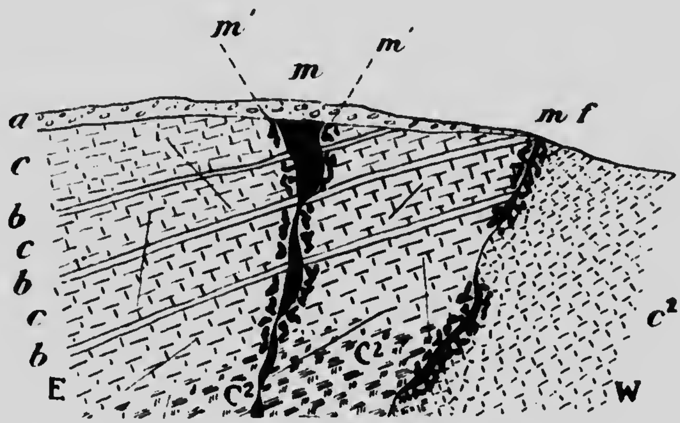

Fig. 38.—Schematic section through mica deposit in Baby mine, lot 1, concession X, Township of Loughborough, Ont.

a, Potsdam sandstone, c. ————; b, quartzite bands; c^1 faulted Archæan limestone; c^2, metamorphosed limestone; m, mica; m^1 small mica deposited adjacent to main lead. f, fault; s, surmised intrusive rock.

The deepest pit is down 70 feet, and the mica appears to peter out in depth, little more being found below the 70 ft. level.

Several pits have been opened on the north end of the property, where the ground falls away to the Laurentian formation. Here the surface is capped by 3½ feet of brown Potsdam conglomerate, and the whole formation is faulted for some distance along the slope as shown in Fig. 38.

Drilling is done by hand the rock being soft and easily worked. The mine is equipped with a small camp, 12 H.P. boiler, steam-hoist, pump, and a tramway to dumps.

The first work was begun twenty-five years ago, and the mine then lay idle until 1907, when Mr. J. Ellerbeck started operations. The present management have been working since the middle of 1909, and have produced about 150 barrels of thumb-trimmed mica.

An average force of ten men is employed. The mine is situated close to the main Sydenham-Bedford road. The mica is hauled rough-cobbed to the Kingston Feldspar Co.'s mine, 4 miles distant, where it is trimmed.

Lot 6 S.½.—Known as the Gould Lake mine, and first opened over thirty years ago for phosphate by Mr. T. Holland, of Sydenham. Subsequently Messrs. Smith and Lacey acquired the property and mined for both phosphate and mica, turning the dumps at the same time and recovering large quantities of high-grade mica, which at that time only found use in the stove industry. Later, about a year's work was carried out by Webster & Co., under lease, with an average gang of thirty men.

From this time until April 1910, the mine lay idle, and was then taken over by the Birch Lake Mining Syndicate, of Sydenham, who started to work the dumps and later pumped out the main pit. This opening is 115 feet deep, 12 feet wide, and 100 feet long, and has been sunk on a fissure vein of high-grade apatite and mica, with pink and white calcite as vein-matter. The mica is a golden-amber, and the crystals usually occur disseminated throughout the calcite. Good-sized sheets have been found, and the mica is of excellent quality. The vein has a N. and S. direction, and is almost vertical. The pit was not quite pumped out when the property was visited, but some good sized crystals were seen at the north end about 100 feet down.

A large boarding-house, culling-sheds, etc., exist on the mine, which is, however, not provided with any machinery—horse-derricks being employed for hoisting.

The vein has well-defined walls and not much timbering is required. A drift has been carried along the vein from the south end of the pit, and it is intended to stope upwards in a southerly direction, as the mica and phosphate are said not to persist in depth. The average width of the mica lead is 3 feet at the north, and 8 feet at the south end of the pit.

The dyke-rock is a light-coloured, grey, compact pyroxenite, and the borders of the vein are frequently formed of dark spangle mica and blue apatite, having a gneissose structure (See Plate XXXV, p. 330).

Apatite crystals of fair size occur in the calcite, which is very coarsely crystalline and cleaves into large-sized rhombohedrons; pyrites occurs in local enrichments.

Another pit has been sunk down 110 feet on a parallel lead to the above, and about 20 feet to the west, but the vein did not prove to carry much mica. There are also a number of small openings made on the main lead to the north of the big pit, but these do not seem to have produced much mica.

The mine is situated near the N.W. shore of the south arm of Gould lake, and is about 5 miles north of Sydenham. A good mine-road of 2 miles leads to the workings, and connects with the main north road out of Sydenham.

Lot 7 E.½.—An old phosphate property, and later worked by Webster & Co. for mica. In 1900, the General Electric Co. acquired the mine and started to work with half a dozen men. Operations were abandoned after a couple of years and have not been since resumed. There are numerous pits and shafts on the property, and a small camp, which is, however, now in a dilapidated condition. The workings adjoin the McClatchey mine.

Lot 8.—McClatchey mine. This mine was worked in the early phosphate days by Messrs. Freeman and Snyder, of Perth Road, who subsequently sold out to Messrs. McClatchey and Hayden, of Belleville, who commenced operations for mica.

In 1901, the property was acquired by Mr. J. W. Trousdale, of Sydenham, who has worked more or less steadily ever since, with an average of half a dozen men. The mine lies on a small hill about 200 yards away from the S.E. shore of Gould lake, and 5 miles from Sydenham. There are a number of old pits on the property, including a shaft 100 feet deep, but no work has been carried out in them of late years. Operations are now confined to small surface pits, the deepest of which is down 40 feet, and to turning the old dumps. The latter have yielded large quantities of excellent mica.

The mica occurs on north and south leads, which dip at varying angles to the east and west, and are found in a greenish-grey, compact pyroxenite cutting a dark gneiss, which is in some places highly garnetiferous.

The leads are not, as a rule, of any great width, and carry in addition to mica, white and pink, coarsely-crystalline calcite, a little phosphate, and considerable pyrites. The mica is of a lighter colour than that found in the neighbouring deposits, but is rather inclined to ribbon-structure. Some fine examples of "border mica" have been found, and a milky variety, similar to that found in the Lacey mine, occurs in one of the west pits. There is a small boarding-house, trimming-shed, stable, forge, etc., but no machinery is in use, hoisting being by means of horse-derricks and whims. Work in the main shaft was abandoned on account of water difficulties, infiltration from the lake taking place, and steam pumps being needed to keep the lower workings dry.

Lot 10.—This property was worked by Mr. Sloan, of Perth, about fifteen years ago, and subsequently by Mr. W. Mace, of Tamworth, in 1898.

In 1908, the Excelsior Mining Co., of Toronto, secured possession and worked for a year with ten men. Only surface work was done and the dumps turned, a small quantity of mica being recovered. The above Company propose resuming operations at an early date.

The workings are situated on a low ridge between Little Devil lake and Clear lake, and are rather difficult of access, there being no road to the mine. There are half a dozen pits, the largest being 40 feet deep and disclosing pockets of medium-sized brown mica associated with considerable quantities of red phosphate. The mica and phosphate occur on more or less parallel fissures in a red granite-gneiss underlain by pyroxenite, the fissures being normal to the direction of the ridge in which they occur. The pyroxenite seems only to reach the surface at certain points, but fissures occur in the gneiss, along which mica has been deposited.

Concession XI, Lot 18.—Bear Lake mine. This property belongs to Mr. J. H. Roberts, of Perth Road, and is situated 9 miles northeast of Sydenham, near the southwest shore of Bear lake. Formerly an old phosphate producer, and worked by Mr. W. Wallace, of Perth Road, the mine was acquired by the present owner in 1900, he having previously worked for mica under option for two years.

Work was carried on at intervals until 1906, only a few men being employed, but the softness of the rock and freedom of the working from water allowed quick progress to be made.

The main pit is 105 feet deep and has been sunk on an incline upon a deposit of medium-sized and good quality silver-amber mica, green phosphate, and pink calcite. The occurrence is on a contact of light-coloured pyroxenite with gneiss, the strike being N.E. and S.W., and the average width of the deposit being 12 feet. Good showings of mica are said to still exist in the bottom of the pit, and several parallel leads have been located to the N.W. of the principal vein and at distances varying from 15 to 50 feet apart. These deposits have been exploited in a small way, and some good mica taken out. The pyroxenite is soft, and all drilling was done by hand, no machinery of any sort being employed on the mine. Hoisting was done by means of a horse-derrick and buckets running on wooden skids. The mine has been closed down since 1906.

Over 200 tons of rough mica are stated to have been taken off the property. The main lead has been traced for a distance of 1,100 feet on the surface, but little work has been undertaken at any other point than the large pit. Bunches of phosphate occur at various spots, but only small quantities were met with in the workings. A large number of surface pits exist over the property, most of which are now caved in.

A systematic development of the area would probably result in the production of a large quantity of mica, most of the work so [illegible] carried out having obviously aimed at cleaning out all the numerous sur[illegible] shows.

Lot 20.—Belongs to Messrs. Kent Bros. and Stoness, [illegible] commenced work upon the property in 1903. Only a few surface pits were opened, none of which exceeded 20 feet in depth. Some phosphate was taken off the property many years ago, and the mine had been idle until the present owners acquired it. Only five men were employed for a few weeks in 1903, and no further work has been done. A small amount of excellent mica is reported to have been mined.

Concession XIV, Lot 14.—Birch Lake mine. This mine was worked in the early phosphate days by Mr. McKay, of Wisconsin and was acquired in the early nineties by [illegible]ebster & Co., who mined for mica for two years and sank down 75 feet on an incline of 80° to S.W. Work was stopped on account of bad ventilation, which put a stop to further operations.

The mine has lain idle until 1910, when the Birch Lake Mining Syndicate bought it, and propose to sink an air-shaft and deepen the main pit. The location is 11 miles north of Sydenham, and about 200 yards from the west shore of Birch lake. The mica is a good quality golden-amber, and is associated with small bunches of green phosphate on N.W. and S.E. fissure-leads in a light greyish pyroxenite. The occurrence appears to be a contact and fissure deposit. The mica is found in pockety accumulations in a vein-filling of white calcite, and is of very sporadic occurrence. The country-rock is a reddish granite-gneiss, and the pyroxenite shows a high degree of differentiation. A wagon-road of some 2 miles connects the mine with the Sydenham-Fermoy road.

In addition to the foregoing mines in the township of Loughborough, a deposit of mica was worked by Mr. F. Foxton, on concession VIII, lot 7, in the early nineties,[1] and Messrs. G. Foxton and Bros. exploited a deposit on lot 5 of the same concession, about the same time. No information is available regarding these mines at the present time, and no work has been done upon them for many years.

The same applies to the Godfrey mine, on concession I, lot 2, of the township of Hinchinbrooke, which was opened in 1890.

The Amy and Folger mine, worked by Messrs. Folger and Williams in 1892 with six men, is situated on concession VIII, lot 8, and has been idle for many years.

Township of Storrington.

Concession XV, Lot 1.—Belongs to Messrs. Kent Bros., and Stoness, who acquired the property about ten years ago and worked for a few months in 1901 and 1902. The workings, none of which exceed 25 feet in depth, are situated on a point of land projecting into Buck lake, the main lead running under the lake. A little phosphate accompanies the mica, which is a good light-amber and occurs on fissures in a normal pyroxenite.

Lot 15.—This mine was opened by Messrs. Smith and Lacey, for stove mica, about twenty-five years ago, and was worked intermittently for three years with half a dozen men. Subsequent operators carried out work on a small scale until the mine was acquired by the General Electric Co. in or around 1900. The present owners did no work until 1910, when some of the pits were cleaned out and a few men were engaged in prospecting for several weeks. Results were not very promising, however, and work had ceased when the writer visited the property in September.

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[1] Ann. Rep. Ont. Bur. Mines, I, 1891, p. 245.

The workings consist of a number of open-cuts and pits, excavated upon a low ridge of pyroxenite in which occur parallel veins of mica having a strike of N. 10° W., and averaging some 5 feet in width. These veins, of which there are more than a dozen, occur at intervals of some 20 to 50 feet, and have been worked by means of open-cuts on the east of the property; while farther to the west, pits and trenches have been opened on the crest of the ridge and carried to a depth of some 50 feet. Here the veins average about 7 feet in width and dip 80° E. All the leads carry a soft, decomposed filling of calcite, highly impregnated with pyrites, to the disintegration of which is due the nature of the vein-matter. The mica in the upper portions of the leads has also been attacked by the acid, is bleached and puffy, and can be rubbed in the hand [illegible] of small white scales. In the deeper workings, where the mica [illegible] unaltered, its colour is a light-amber and its quality good.

The pyroxenite [illegible] the veins is also, as a rule, decomposed and of a yellowish colour. No machinery was ever in use on the mine, which produces a small grade of mica, crystals of over 10" diameter being seldom met with.

Township of Hinchinbrooke.

Concession I, Lot 25.—A few small outcrops of a dark, almost black mica occur on this lot. The crystals occur in massive quartz and appear to be of the true biotite variety. No work has as yet been done on the property.

Concession II, lot 28.—This property was worked in 1898 for a few months, by Mr. B. Folger, of Kingston, who extracted three tons of rough mica. The deepest pit is down 20 feet. In 1908, Mr. J. Richardson, of Kingston, mined a few months for phosphate, and no further work has been done.

Township of Bedford.

Concession II, Lot 5.—Belongs to the Bedford Mining Co. of Kingston. The property was first worked in 1896, by Mr. F. Folger, who installed a small boiler, steam pump and hoist, and took out about seven tons of thumb-trimmed mica. In 1908, Mr. S. Orser, of Sydenham, commenced mining with six men, under lease, and continued for three months, resuming work in 1909 for a like period. Four tons of mica were produced. Mr. McDonald, of Toronto, carried out a couple of months' work in 1910, and secured a few barrels of trimmed mica.

The mine lies 3 miles from Bedford station on the Kingston and Pembroke railway, and close to the shore of Thirty Island lake. The workings are very wet, owing to the infiltration of lake water, and have to be kept continuously pumped out.

The source of the mica would appear to be a series of acid dykes composed of grey feldspar and quartz in varying proportions and having the character of a coarse aplite. These dykes have a strike of due E. and W., and dip at small inclinations from the vertical to N. and S., their width varying from a few inches to 5 feet. In the south pit, or main opening, the dyke exposed was 4 feet wide, and dipped 80° to S. The intrusions cut a country of white

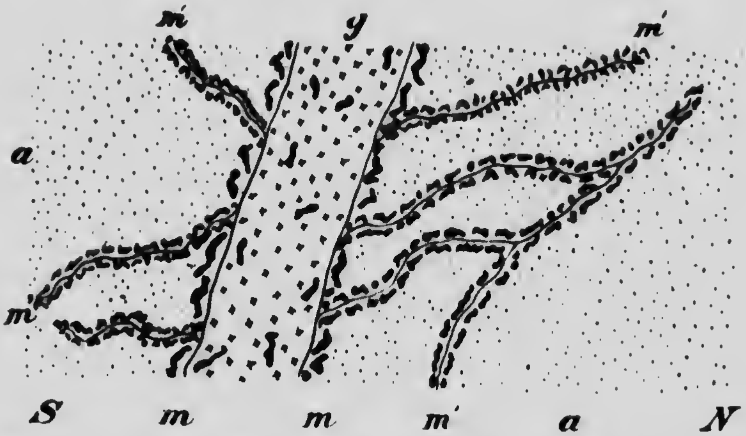


FIG. 39.—Section through mica deposit, lot 5, concession II, township of Bedford, Ont. a, crystalline limestone; g, acid dyke of aplitic character carrying some mica; m, mica deposited along contacts; m′, small mica on joints and fissures in limestone.

crystalline limestone, which is much decomposed and friable along the contacts. The mica occurs both on the contacts and on small stringers running off into the limestone, as well as to a small extent in the dykes themselves. (See Fig. 39).

The crystals are of medium size, of a whitish colour, and fairly clear, being slightly clouded towards the edges, and resembling those from the Richardson mine, lot 1, concession X, of the township of Loughborough. The intrusion has been attended by the formation of various secondary minerals, including gray actinolite, and tremolite, in massively fibrous and columnar aggregates, also dark-brown vesuvianite; while considerable quantities of brown tourmaline, crystallized and massive quartz, and pyrites have been injected into the adjacent limestone.

The mica is very hard and brittle and is of little value for electrical purposes, being used chiefly in stoves, etc. A notable peculiarity of the mineral is that the sheets, on being split, emit considerable quantities of sulphuretted hydrogen.

Concession IV, Lot 17.—Belongs to Messrs. Williams and Adams, of Toronto. The property was first worked about sixteen years ago, by Mr. E. Smith, of Prescott, and in 1898, by Mr. Ferguson, of Kingston, who mined intermittently for a couple of years. In 1905, the present owners purchased the property and conducted operations for five months. No further work has been undertaken.

The deposit is associated with a very narrow pyroxenite dyke of light grey-green colour, which forms a band between gneiss and crystalline limestone, the mica occurring in coarse calcite between pyroxenite and limestone

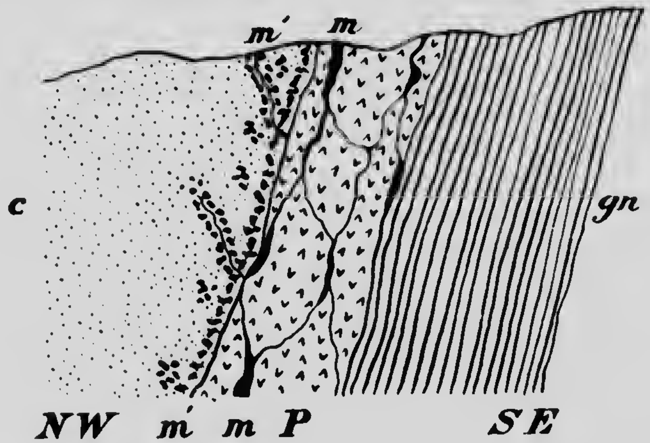


FIG. 11. Section through mica deposit, lot 17, concession IV, township of Bedford, Ont. gn, gneiss; c, crystalline limestone; P, pyroxenite dyke with pockets and leads of mica (m); m¹ mica deposited in limestone adjacent to contact.

and also, to a lesser exteat, in the limestone itself (See Fig. 10).

The mica is a light silver-amber, and is especially distinguished by its border-structure. By far the greater proportion of the crystals found exhibit this peculiarity, and often in very marked and beautiful degree. Plate XXIV (page 220) shows a specimen of mica from this mine.

No phosphate was noticed, but small quantities of magnetite occasionally occur in the limestone near the pyroxenite contact. The latter has a strike of N.E. and S.W. A number of pits have been opened, most of them small. The main opening is on the north end of the property, and is provided with a square timbered collar; the depth could not be ascertained, but is stated not to exceed 50 feet. A few mine-buildings exist on the property, which lies about 5 miles from Fermoy.

Concession V, Lot 15.—This property has been worked since 1898 by numerous operators, including the Frontenac Mining Co., Messrs. J. and J. Stoness, and the owners, Messrs. P. and W. Murphy, of Fermoy. The first-named have carried out the greater part of the work done, and ceased operations in 1909, since when the mine has been idle. A pyroxenite dyke carrying a lead of dark-amber mica associated with small quantities of green phosphate occurs conformably in the gneiss, which here has a strike of due

N.E. and S.W. and dips 38° S.E. The walls of the lead are formed of a crushed, light-green pyroxene mixed with dark green hornblende, quartz, and feldspar. Little or no calcite is to be seen at the surface, but the amount increases at depth. Pyrites in considerable amount is present in the vein, and a number of pink aplite dykes cut the formation normal to its strike. The mica crystals are of medium size and split readily, being rather crushed at the surface but improving in quality in depth.

The deposit has been followed to a depth of 60 feet by an inclined pit, from the bottom of which short drifts have been run. The width of the lead at the bottom of the pit is 4 feet. No machinery has been used on the mine, which has been developed without any regard to its future. The property lies 5 miles from Fermoy.

Concession VI, Lot 30.—Bobs Lake, or Taggart mine. This property was first worked by Mr. Taggart, of Westport, in 1897. Operations were conducted intermittently for three years, after which the mine lay idle until 1903, when it was acquired by Messrs. Kent Bros. and Stoness. The latter are the present owners and have mined for nine months in each year since obtaining possession. A total production of over two thousand barrels of rough-cobbed mica is reported. Work has been carried out upon a series of parallel leads of dark-amber mica, the crystals being often of large size. One individual weighed 2,250 pounds, the greater part of which was marketable mica.

The mica is associated with small quantities of green phosphate and pink calcite, and occurs on small fissures in a dark pyroxenite. These fissure-veins average about 2 feet in width, have a strike of N.W. and S.E., and dip 78° N.E. They occur at intervals of from 8 to 15 feet, and have their greatest width to the northwest, appearing to pinch out in a southwesterly direction.

The leads have been exploited by narrow individual trenches 6 to 8 feet wide, having a length of some 50 feet, and a maximum depth of 60 feet.

The workings are situated a few hundred feet from the shore of the Mud Bay arm of Bobs lake, the leads having a direction approximately parallel with the shore line. Two small ridges run down to the water, with a narrow depression about 60 feet deep between them. The workings are situated principally on the eastern ridge, though substantial outcrops have also been located to the west. Owing to their proximity to the lake, the pits make water rather fast in the spring and continual pumping is necessary.

The mine is equipped with an 18 H.P. boiler, steam hoist, and two Cameron pumps, besides the usual boom derricks. A camp including the usual mine-buildings, culling-sheds, and a boarding-house accommodating twenty men, has also been erected. The mica is rough-cobbed at the mine, and is transported across the lake, whence it is hauled 7 miles to Olden Station on the Kingston and Pembroke railway, and shipped to the trimming-shops in Kingston.

The vein-walls are sometimes lined with well-formed pyroxene crystals, and scapolite occurs in considerable quantities, being found mingled with the pyroxene, and also in crystal aggregates on vugs in the walls (See Plate XXX). Datolite in massive, powdery form is also met with in considerable amounts on one of the leads. A peculiar feature of the occurrence is that the mica, which down to a depth of 35 or 40 feet is found principally on the foot-wall, at this point goes to the hanging-wall. The veins seem to narrow in depth, and have been followed to about 50 feet and then abandoned. Pink aplite veins cut the pyroxenite and have a similar direction to the mica leads. The mine employs an average force of fifteen men. Mr. Stoness, who was formerly manager of the Stoness mine for a number of years, has charge of this property and has carried out all the work. The deposit is unique both for the great number of mica leads, and for their proximity to one another, and affords an example where underground development by means of cross-courses and stoping would be advantageous.

Lots 35, 36.—Owned by Mr. James Holley, of Crow Lake, and has been worked on a small scale by various parties during the past two years. A fair amount of mica is reported to have been produced.

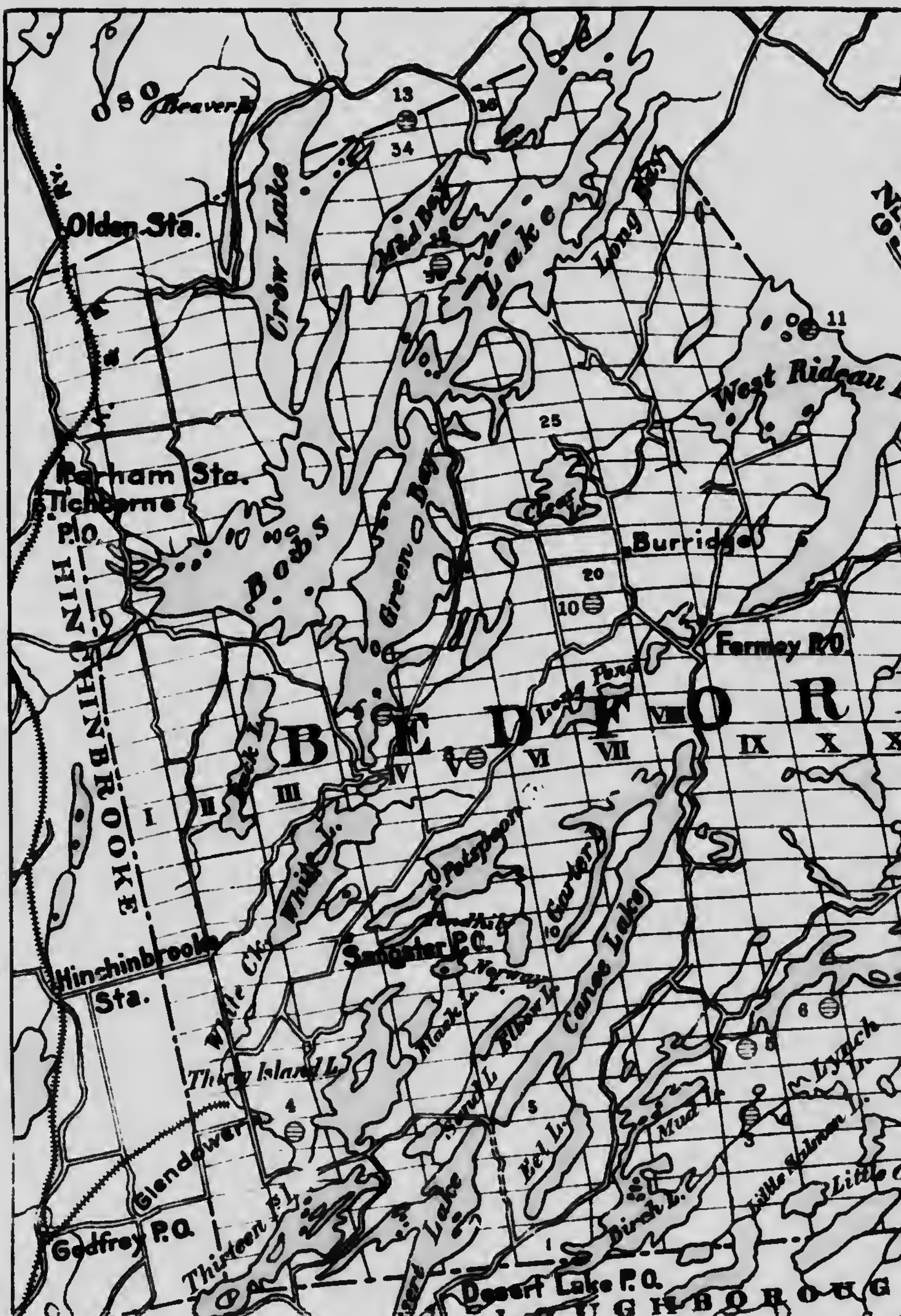
Concession VII, Lot 19.—Belongs to Messrs. W. and D. Robison, of Fermoy. This deposit was worked in 1908 by Messrs. McIntyre and McBelton, and in 1909 by Messrs. Adams and Stoness. A few small pits have been opened on a contact deposit of small-sized, dark-amber mica between dark pyroxenite and crystalline limestone. The lead is well defined and averages about 4 feet in width. It can be traced for a considerable distance on the surface, but has only been opened up at three or four points. The main pit is 15 feet deep and discloses a matrix of white, coarsely-crystalline calcite, in which occur the mica, small quantities of well-crystallized dark green apatite, and large bunches of pyrites, which latter mineral also occurs in small crystals disseminated throughout the deposit.

Pyrrhotite also occurs, and large and well-formed crystals of titanite are associated with the phosphate. Crystals of pyroxene, terminated at both ends, are occasionally seen embedded in the calcite. The contact has a direction of N.E. and S.W. and, as far as could be seen, dips slightly to N.W.

The mica decomposes rapidly upon weathering, owing to the amount of pyrites present in the deposit.

Concession VIII, Lot 4.—This property is owned by Messrs. Tett Bros., of Bedford Mills, who opened up a considerable deposit of mica in 1899. Work was continued for eighteen months with an average force of ten men, and has since been resumed at intervals; the mine finally closed down in 1908. The deepest pit is down 95 feet, at which depth the mica lead is said to have narrowed and become unprofitable, this being the reason the mine was abandoned. Several smaller pits were also opened on parallel leads, but little mica was found in them, the main deposit occurring on the easternmost vein.

The course of the veins is N. 30° W., and they dip slightly to the west, the main lead being inclined 78° W.



⊜ MICA

MICA MINES AND OCCUR
IN TOWNSHIP OF BEDFOR
Scale 2 miles to one inch

No.	Name of Mine
1	Stoness
2	Smythe
3	Tett
4	Bedford Mining Co.
5	Connors & Daly
6	Antoine
7	Poole
8	Frontenac Mining Co.
9	Williams & Adams
10	Robison
11	Prospect
12	Bobs Lake
13	Prospect

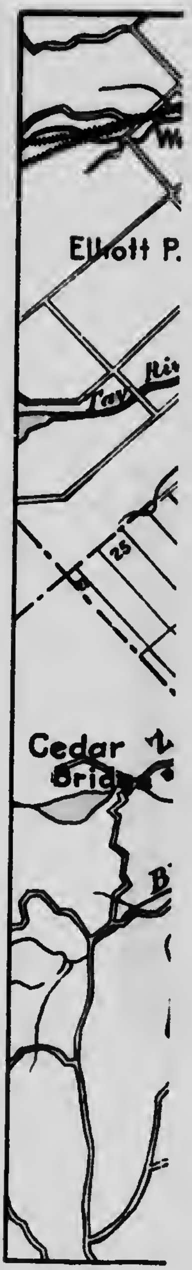
OCCURRENCES

EDFORD, ONTARIO

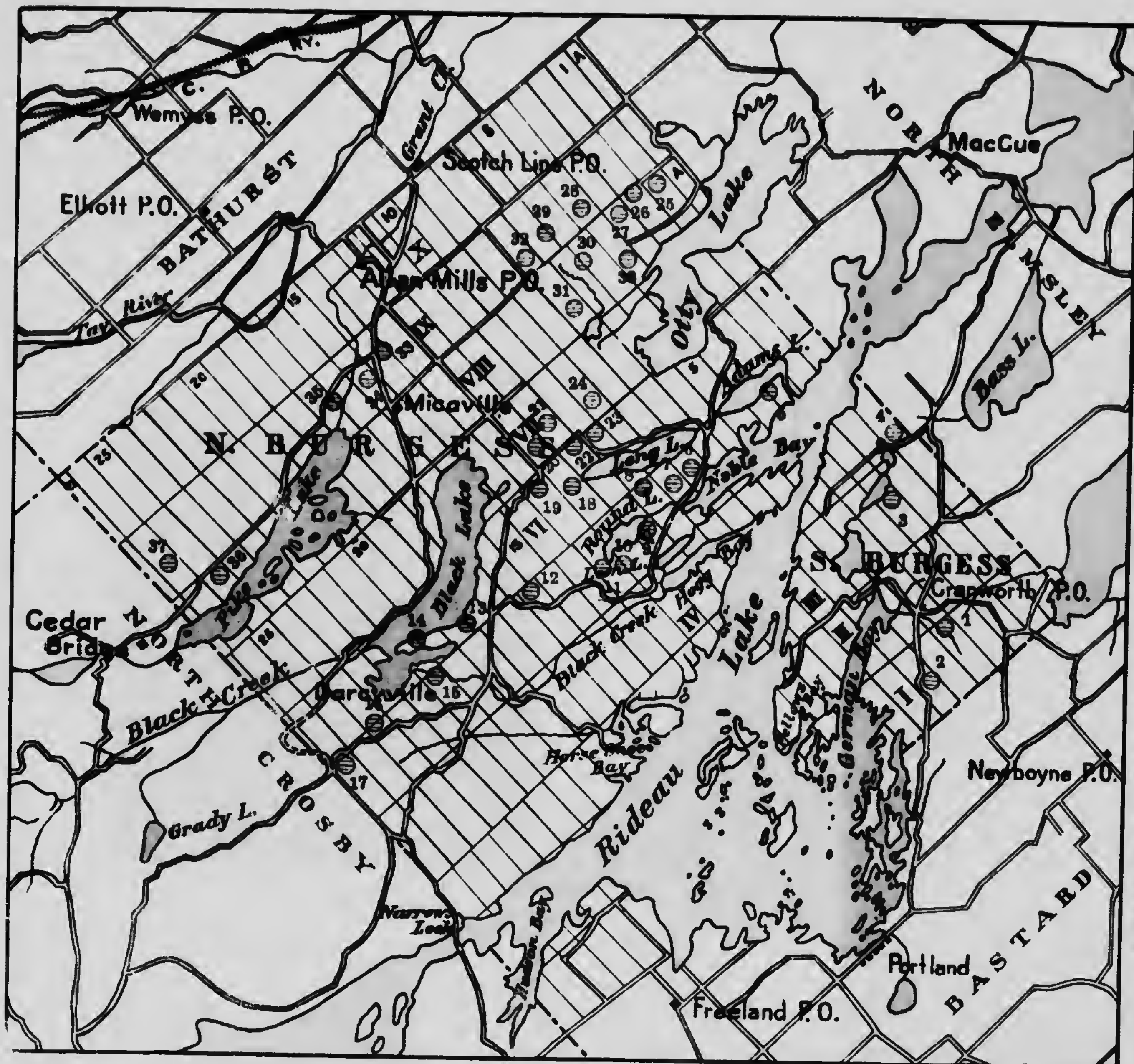
o one inch

3 4 5 Miles

132



MICA



No.	Name of Mine
1	Hyppan Heffron
2	Webster
3	Webster
4	Cantin
5	Smith—Rogers
6	Rogers
7	Smith
8	Mahon
9	Blackhall
10	Silver Queen
11	Baby
12	Donnelly
13	Prospect
14	Star Hill
15	McNally
16	Prospect
17	Prospect
18	Klondyke
19	Munslow—Martha
20	Byrnes
21	McLaren
22	Hanlon
23	Old Anthony
24	Smith
25	McConnell
26	Kent Bros.
27	Cordick
28	Atchison
29	Mendel
30	McLaren
31	Adams
32	Adams
33	Prospect
34	Prospect
35	Pike Lake
36	McParland
37	McParland
38	McLaren

⊜ MICA

MICA MINES AND OCCURRENCES
IN TOWNSHIPS OF NORTH AND SOUTH BURGESS, ONTARIO

Scale 2 miles to one inch

1 ½ 0 1 2 3 4 5 Miles

PLATE XIII.

View of pit at Bobs Lake mine, showing average width of veins. Lot 30, concession VI, township of Bedford, Ont.

The pits have all been opened in a narrow valley some 100 feet deep, the mine buildings, with the exception of the boiler-house which is beside the main pit, being situated on the ridge above. Drilling was done by hand, the boiler being used to drive a pump.

The mica is a medium-sized, reddish-amber and is associated with white calcite and small quantities of phosphate, pyrites, and pyrrhotite, on fissure veins in a dyke of grey-green pyroxenite cutting red gneiss. The latter has a strike of N. 60° E. with a dip to the N. W. The pyroxenite is coarsely-crystalline and drusy, the vugs being lined with pyroxene crystals and filled out with calcite. The mine lies about 8 miles southwest of Bedford Mills, and connects with the main road by a wagon-track some 4 miles in length.

Lot 6.—This property has been surface prospected by various persons in the past. In 1910, Mr. S. Orser, of Sydenham, obtained a lease from the owners—Messrs. Connors and Daley, of Bedford—and commenced mining with six men.

When visited, the property was being prospected, and several promising shows of mica had been uncovered. The mica is a dark, wine-amber of fair quality and medium size. It occurs in pockets and fissures along the contacts of pyroxenite dykes and spurs with red granite-gneiss. These pyroxenite belts vary from a few inches to 15 feet in width and are to be met with over almost the whole property. Calcite is relatively absent, the mica occurring associated with white and decomposed scapolite.

There are numerous surface pits scattered over the deposit, the deepest being down 10 feet. Judging from surface indications, the property would appear to be a promising one, though the mica is not of very high grade.

Concession IX, Lot 7 E.½.—Antoine mine. This mine lies a few hundred yards from the southeast shore of the westerly arm of Big Devil lake, and 25 miles from Sydenham. It is owned by Messrs. Kent Bros. and [illegible] and was first worked in 1895, by Mr. T. Taggart, for a few months with three men. Messrs. Webster and Jones subsequently mined inte[illegible] for a few years, after which Mr. Lewis carried out a few weeks [illegible] 1906 and 1907, Kent Bros. had half a dozen men employed on [illegible] and boarding-house, derricks, etc., were erected. Mr. W. Jones [illegible] done a little work, in 1909. A pit 65 feet deep has been opened, [illegible] feet long and 20 feet wide. The main portion of the opening is about [illegible] deep, and from this point a drift has been run from the southeast end and carried 25 feet to N.W. The mica is a light-coloured amber and occurs in crystals of small size scattered through white calcite as vein-matter in a fissure in normal pyroxenite. The lead has an average width of 1′ 6″, and strikes N.W. and S.E. with a dip of 75° to S.W. The mica was trimmed on the property and transported by boat across the lake, whence it was hauled to Westport.

Concession XI, Lot 10.—Belongs to Mr. W. Poole, of Freeland. Several parties have carried on work on the property during the past twenty years.

but always on a small scale. The last operator was Mr. S. Orser, of Perth Road, who has a lease of the mine, and mined intermittently during 1910.

The deposit is of an irregular fissure and pockety nature, and carries small crystals of a hard and brittle mica associated with white coarsely crystalline calcite, in which occur large quantities of pyrrhotite. The mica crystals are always of small size, seldom exceeding 5" across, are of a brownish colour, and are stained by iron. Small spots and films of either specularite or magnetite occur between the laminæ. No phosphate is present on the vein, which pursues an irregular course in an extremely hard and compact banded rock composed for the most part of pyroxene and quartz. The dyke has a grey to brown colour and cuts a country of crystalline limestone. The whole series is extensively intruded by later, grey, granite veins.

There is only one pit, which reaches a depth of 20 feet and discloses at the surface a narrow lead which dips rapidly and assumes an almost horizontal position in the bottom of the opening. The mica crystals are remarkable for their highly perfect cleavage and crystal outline, the sheets, although of small size, yielding cuts to their extreme borders. Border-structure is also not uncommon. No buildings or machinery exist on the property.

Lot 27.—Belongs to Mr. W. J. Webster, of Edmonton. The property was worked in 1900 by Mr. T. Taggart, and again, in 1903, by Mr. D. Ripley, of Westport. Only a few weeks' work was carried out, mostly of a prospecting nature, and it is understood that no mica was shipped, though several promising outcrops were located and followed to a depth of a few feet.

Concession XIII, Lot 4 E. ½.—Known as the Stoness mine, and belongs to Messrs. J. M. Stoness and Kent Bros., of Perth Road and Kingston. The property was first worked in the seventies by Mr. Stoness, who mined for phosphate. Fifteen years ago, the present owners commenced to extract mica, and continued steadily for seven years with a force of twenty-five men. The mine has lain idle for the past eight years, but there is some prospect of operations being resumed in the near future, should prices keep up. Work was carried out in an inclined shaft, 150 feet deep, and flattening from 42° at the surface to 20° at bottom, the average being about 30° north. This shaft, or stope, is 15 feet wide and 30 feet high, and follows a vein of mica associated with some phosphate and pinkish coarse-grained calcite, the average width being about 10 feet. The deposit is of the contact class, and occurs on the hanging-wall of a light greyish pyroxenite capped by red granitic gneiss, the direction being N.E. and S.W.

The mica is an excellent light silver-amber, the crystals, which are of medium size, occurring scattered through the calcite vein-matter. The bottom of the pit is said to still exhibit good showings of mica, which is, however, of rather a crushed nature. A production of about twenty barrels of rough-cobbed mica per week was averaged when the mine was in full working order.

The workings lie a few hundred yards from Buck lake, and about 19 miles northeast of Sydenham, a wagon-road of 2 miles connecting the mine with the Sydenham-Newboro road.

The workings were ventilated by sloping, air-tight pentices, 20 feet in length, in steps down the centre of the shaft, and along the top of which the man-way was placed, with the skip-road in the lower compartment. A large camp including boarding-house, mica-sheds, and hoist-house with boiler, exists on the property. The mica, rock, etc., were raised in small cars running on a skip-way to a wooden stage erected at the mouth of the pit. The rock was tipped onto the dump off the stage, and the cars containing mica were run back on a higher inclined line into the mica-sheds beside the hoist-house.

Lot 6.—Belongs to Mr. J. Smythe, of Kingston, who worked in 1899-1900 with eight men. Various lessees have carried out intermittent operations since, and Messrs. H. and C. Campbell, of Perth Road, are at present prospecting and working the old dumps. The property adjoins the Stoness mine to the north, and presents similar geological features. A large body of white calcite between pyroxenite walls carries mica in small crystals along the contact, and a few scattered crystals also occur in the mass of the calcite.

The mica is of poor quality, being much spoilt by inclusions of calcite in the crystals and between the laminæ, a large percentage being valueless on this account.

The veins strike N.W. and S.E., and are of irregular width. The lead exposed in the main pit, which is 25 feet deep, has a width of 15 feet at the S.E. end of the opening, and narrows to a few inches at the N.W. end.

A drift has been run from the bottom of the opening in a southeasterly direction, and a shaft sunk farther along the lead to pick up the drift. There are a number of minor surface pits, none of which, however, give indications of a very extensive deposit.

Township of Oso.

Concession V, Lot 2.—This mine was first worked by Messrs. Wilson and McMartin, of Perth, for phosphate, some twenty years ago. In 1905, the General Electric Co. purchased the property, and worked intermittently for a year. No further work has been done. The mica is a very dark variety and the crystals are much crushed and twisted, a large percentage being useless. Large bodies of red, compact phosphate accompany the mica and have been mined by means of open-cuts and drifts run into the side of a steep ridge of dark gneiss with intercalated limestone bands, the whole cut by a system of dark-coloured pyroxenite dykes. The adjoining lots along the same ridge have been worked by the various owners on a small scale for phosphate, and the general geological conditions are similar to the above.

Concession VII, Lots 2, 3.—Belongs to Dr. Tovel, of Sydenham, and was first worked a number of years ago by Mr. T. Cooke, of Harrowsmith, for mica and phosphate. The owner carried out a few weeks' work for mica in 1905, and no further mining has taken place. A fair amount of mica is reported to have been extracted from the workings, which consist only of small surface pits, and lie 1½ miles to the east of Crow Lake P. O.

Concession VIII, Lots 1, 2, 3.—This property belongs to Mr. James McEwen, of Bolingbroke, who reports good indications of mica on leads which have been worked on concession IV, lot 2 E ½ of the township of South Sherbrooke, and which also traverse the above area. The deposit has not been exploited up to the present.

Township of Portland.

Concession X, Lot 1 E. ½.—This property is owned by Mr. J. Redmond, of Holleford. A few surface pits were opened in 1909 by Messrs Reamer and Solliday, of Sydenham, but operations were soon abandoned.

The mica is similar to that on the Richardson property. A small deposit of amber mica occurs on the north end of the lot, and has been worked on a small scale. A dyke of red-pegmatite has also been opened up close to the road, and several tons of good quality feldspar extracted.

Lot 1 W. ½.—Mr. G. Smythe, of Kingston, carried out some work on this property thirty years ago and secured a quantity of mica which found use in the stove industry. In 1900, Messrs. Freeman Bros., of Hartington, opened up a few surface pits. No further work has been undertaken, but the General Electric Co. had a few men engaged in turning the dumps during the summer of 1910, and it is understood that a quantity of small, but good quality mica was recovered.

The largest pit is 45 feet deep and has been opened for a distance of 60 feet on a lead striking N.E. and S.W. with a dip of 85° S.E., the average width being 4 feet. The mica, which is a yellowish and brittle variety and rather inclined to ribbon-structure, occurs on a contact between grey pyroxenite and granite, with calcite and a little phosphate as vein-filling.

LANARK COUNTY.

Township of North Burgess.

Concession V, lot 3. An old phosphate property which was worked for mica in 1893 by Messrs. Levett and Davis with seven men, and subsequently by various parties for short periods. The Dominion Improvement and Development Co. acquired the mine in 1905, and had six men at work for a few weeks in the latter part of 1909, but results do not appear to have been very satisfactory. The mica is a dark-amber and much crushed, occurring with a little phosphate and calcite on parallel veins, having a direction of northwest and southeast, and situated about 100 yards from the shore of Big Rideau lake. The workings are not extensive, the largest pit being 50 feet deep.

Lot 1.—Another old phosphate property which has been exploited for mica. It was last worked in 1901 by Messrs. Watts and Noble, of Perth, under lease from Mr. J. Rogers, to whose estate the mine now belongs. The workings are situated about 60 feet from the north shore of Big Rideau lake, and consist of some half-dozen narrow pits excavated on parallel leads of very dark amber mica, having a direction of northwest and southeast, and some 10 to 15 feet apart.

The deepest of these pits is down 70 feet, the remainder being only shallow openings, and the average width not exceeding 5 feet.

Dark gneiss separates the veins which are apparently associated with narrow spurs of pyroxenite, the width of which is seldom more than 3 feet. To the north of these workings, a larger pit has been opened on a vein of pink calcite, phosphate, and dark brittle mica. This lead has a strike of east and west, dips 30° north, and has been worked for a length of 25 feet and to a similar depth.

No buildings exist on the property, and no machinery was ever employed.

Lot 8.—This property is owned by the Rogers estate, and was worked in 1907 by Mr. J. Rogers for four months. No more recent work has been carried out. A number of shallow pits have been opened on pockets and leads of silver-amber mica occurring with large bodies of pink calcite in a contact zone between pyroxenite and gneiss.

The deepest pit is 50 feet down, 5 feet wide, and has been excavated, open-work, for a distance of 70 feet along a north and south vein having a dip of 70° W. At the south end of the pit a timbered shaft 5 × 4 feet has been built in as a haulage-way. Stulls have been inserted some 25 feet down, upon which a staging has been erected, and the mica extracted by means of stoping along the vein. This lead has a direction of due north and south and carries a lighter-coloured mica than that occurring on the other veins.

Lot 9.—Owned by the Dominion Improvement and Development Co., represented by Mr. Edward Smith, of Prescott. The first work carried out for mica was commenced in 1898 by a syndicate represented by Mr. J. Rogers, of Perth, who mined intermittently for several years. In 1904, the above Company acquired the property and started operations in 1909, with half a dozen men. Work has been continued steadily ever since.

There are nine pits varying from 25 to 50 feet in depth, and opened on a series of parallel leads in a light greyish pyroxenite cutting rusty gneiss. These leads carry pockets and bunches of light, silver-amber mica crystals accompanied by pink calcite and a little green phosphate. They occur at intervals of 15 to 20 feet apart, have a strike of N.W. and S.E., and are apparently normal to the direction of the pyroxenite dyke, which follows the N.E. and S.W. trend of the gneiss, dipping some 80° S.E. In one of the easterly pits a large pocket of hematite was encountered, the ore having mica crystals scattered through it.

The mine is equipped with a 15 H.P. vertical boiler, steam-hoist, and drills, none of which were in operation when the property was visited, horse-derricks and double-handed hammer drilling being employed.

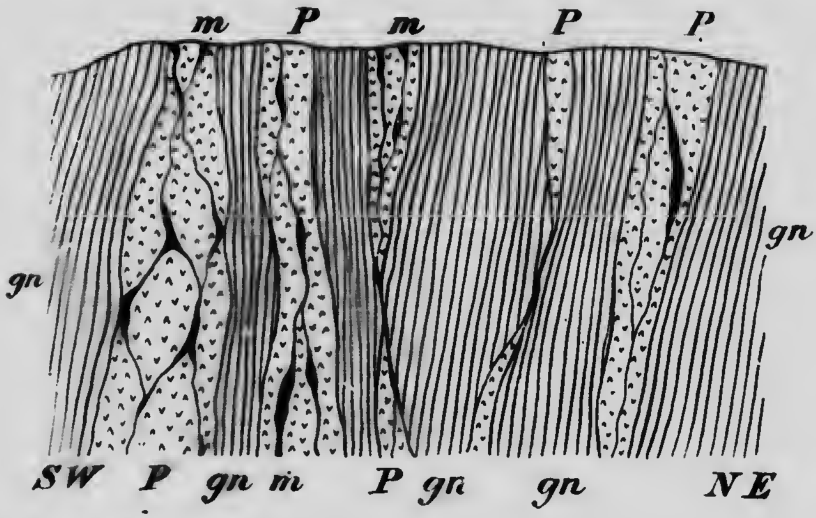


FIG. 41.—Section through mica deposit, lot 9, concession V, township of North Burgess, Ont., showing system of parallel pyroxenite dykes (P) with mica leads (m); gn, gneiss.

Lot 10.—This property belongs to Mr. J. Mahon, of Rideau Ferry, and lies about a fourth of a mile to the west of Mr. Smith's mine on lot 9. Formerly an old phosphate producer, the mine lay idle until 1908, when the present owner commenced work with three men, and has continued intermittently up to the present time. The present workings lie a few hundred feet southwest of the old phosphate pits, on a small gully which has been worn out by water along a line of pockets in a dark green pyroxenite. These pockets or chimneys connect horizontally by narrow fissures and are filled out with large bodies of pink calcite in which the mica crystals are disseminated. The latter are of fine quality, dark mottled-amber in colour, and of rather small size, the average being 2″ × 3″. A depth of some 30 feet has been reached in a small shaft sunk on the largest of the pockets, and several smaller openings have been made along the line of lead. The direction of the chain of pockets is W. 15° S., and indications tend to show the existence of similar cavities to a considerable depth. The fact that water never accumulates in the workings, but sinks away at once, is a very favourable sign. A little phosphate accompanies the mica. The present operator has taken out mica to the value of $4,000 in the space of a few months, and there is little doubt that the mine would repay more extensive development.

The mica is small, but the crystals are very firm and solid and yield good cuts to the edges, little waste occurring.

There is no machinery in use and no buildings exist, hoisting being done by means of a bucket and hand winch.

Lot 11.—Blackhall mine. This mine was first worked by Mr. John Blackhall, of Perth, in 1898, for a few months. In 1899, Mr. J. Stevenson, of Toronto, acquired the property, and worked for one summer with a force of eight men. Mr. Blackhall repurchased the mining rights later, and is the present owner. No further work has been undertaken, however, and the deposit is reported to have been worked out. There is only one pit of any size on the property. This is about 30 feet deep, and 20 × 20 feet across, and has yielded a small amount of dark mica and a little phosphate.

A few small pits also exist on the east end of the property. These were opened for phosphate, and disclose small leads carrying a light-coloured mica which does not, however, occur in sufficient quantity to warrant mining operations being undertaken.

Lot 12.—Belongs to Messrs. Wilson and Greene, of Montreal. Mr. Smith worked for a few weeks in 1902 under lease, and some excellent mica was secured from a pocket. No further work has been carried out.

Lot 13 E.½.—Silver Queen mine. The first exploitation of this property for mica took place in 1903, when Mr. R. McConnell, of Ottawa, carried out a few months' work with a small force of men. Two years later the mine passed into the hands of the Dominion Improvement & Development Co., who leased to Mr. C. Ellsner, the latter mining both mica and phosphate for a year under royalty. The Company then continued operations until a dispute as to ownership put an end to mining in 1909. The case was finally settled towards the latter part of 1910 in favour of the defendants, who propose to resume work at an early date.

The mine is essentially a phosphate producer, and has yielded large quantities of high-grade apatite both of the compact massive and sugar variety. The mica is a light silver-amber of excellent quality, and a high percentage consists of large-sized crystals. Several tons of both mica and phosphate have been tied on the mine during the last year owing to legal difficulties.

The deposit, which occurs along the contact of a pyroxenite dyke with gneiss and crystalline limestone and has a direction of N. 30° E. with a dip to N.W., has been mined by means of three pits, the chief of which lies on the side of a small ridge of gneiss rising some 50 feet above the neighbouring crystalline limestone zone. This pit has been sunk vertically for 35 feet, from which point an inclined stope has been carried a further 65 feet to N.W., drifts being run along the deposit in a northeasterly direction. The total length of the excavation is about 60 feet. At the north end a 4 × 5 ft. timbered collar has been built in, through which pass the pipes for drilling and pumping, and through which hoisting is carried out. When visited, the ground in the neighbourhood of this shaft was starting to sink, and was in a highly dangerous condition. Pillars of rock have been left at intervals on the stope and serve to support the roof. The mica and phosphate occur in large pockety masses along the contact, which extends a considerable distance and the occurrence somewhat resembles the Blackburn mine in Templeton township, Que., though on a smaller scale.

Much of the mica is crushed and twisted, as is often the case in shallow workings where large quantities of phosphate are present, but experience shows that with depth this crushing of the mica tends to disappear, the crystals becoming more firm and solid.

An interesting feature is the occurrence on crevices in the sugar-phosphate of sheets of white hornblende-asbestos or "mountain-leather." Long prismatic crystals of dark-green actinolite penetrating pink calcite were found on the dump, and small quantities of scapolite were noticed. The pyroxenite varies from a dark-green to a light-grey rock, the pyroxene often possessing highly-developed cleavage in three directions. The crystalline limestone adjacent to the contact with the pyroxenite dyke is remarkable both on account of its colour, which is a light blue, and for its property of liberating sulphuretted hydrogen in considerable quantities when crushed or struck with the hammer. The rock also contains a large amount of phlogopite in minute crystals, as well as pyrites, diopside, garnet, tremolite, and graphite.

The mine is equipped with a boarding-house for twenty men, boiler-house with 15 H.P. vertical boiler, steam-hoist, pump, and three drills. Wooden buckets are used for raising the rock, etc., and slide on a wooden skip-way inclined at varying angles at the different depths.

Lot 13 N. W. ½.—Known as the Baby mine, and owned by the Kingston Feldspar Mining Co. Formerly a phosphate producer, a lease of the property was secured in 1893 by the Lake Girard Mica System from the owner, Mr. W. A. Allan, of Ottawa. Considerable work was carried out and a pit was sunk to a depth of nearly 100 feet. In 1903, Mr. T J. Smith, of Micaville, secured an option on the property, eventually transferring to the present owners, who have worked intermittently during the last six years. At the present time only surface work is being done, several small pits having been opened on various parts of the property, without, however, discovering any extensive deposits of mica.

The colour of the mineral varies on the different leads from a first-class, light, silver-amber to a dark variety of inferior quality. The crystals are of medium size and are associated with bunches of both green and red phosphate occurring on fissures and pockets in a light-coloured pyroxenite dyke cutting normal gneiss.

The old workings, from which a very large amount of material was extracted (as is evidenced by the size of the dumps) are situated on the south-west part of the lot and on an inclined lead widening from 5 feet at the surface to over 20 feet at the bottom of the main pit. This pit has the form of a

PLATE XIV.

Silver Queen mine, lot 13, concession V, township of North Burgess, Ont. The white heap on the left of the photograph is phosphate.

narrow trench 50 feet long, with a wider shaft-like opening at the north end. Hoisting was done by means of an inclined cable-hoist and iron buckets running on wooden skids.

When visited, prospecting work was being conducted—with five men—on the northern part of the property, where pits were being sunk on small leads of mica and pink calcite in the side of a low ridge of gneiss cut by pyroxenite spurs. The deepest of these pits is 50 feet down and measures 8 × 8 feet. The bottom showed a small lead of rather crushed mica crystals and a little phosphate. Some small prospect pits have been opened a few hundred yards south of these workings on a well-defined lead of small-sized dark mica crystals disseminated through a large body of pink calcite and associated with white and yellow scapolite. This lead strikes E. and W. and is about 4 feet wide at the surface, being, however, pockety and narrowing in depth. Indications were not satisfactory at this point, and work was abandoned after a few weeks.

Lesser leads of mica may exist on the property, but it would seem that the main deposit has already been exploited in the original workings.

Concession V, lot 16.—Donnelly mine. This property, like the major number of present mica producers in the district, was opened about thirty-five years ago for phosphate. After being closed down for many years, the mine was leased in 1901, by Messrs. Gemmell and Thompson, of Perth, who commenced to work for mica with five men. Operations were continued for eight months, and about ten tons of rough mica mined. Subsequently mining was resumed by Messrs. McConnell, Gemmell, and Ewen, and in 1905 Messrs. Thompson and Noonan worked a few months. Since this time the mine has been idle.

The workings are located about 9 miles south of Perth.

The deposit is a typical contact between a dark compact pyroxenite on the N.E. and normal gneiss on the S.W., the direction being almost due N.W. and S.E. The vein-matter is principally pink calcite in which the mica crystals, associated with bunches of phosphate, occur embedded. The mica crystals are of more than usual size and of excellent quality and colour. The lead at the surface was only a few inches wide—but developed into a body over 8 feet across at the bottom of the main pit. The dip is about 80° N.E. Several pits have been opened along the vein, the deepest being 35 feet down, while the largest pit has a length of 35 feet and is 6 feet wide. Towards the south the lead appears to branch off into two portions. The total length of lead worked is about 150 feet. No machinery has been in use on the mine, hoisting being by derrick and horse-whim; the only building is a small mica-shed.

Lot 21 N. ½.—Known as the McNally mine, and owned by Mrs. McNally, of Westport. This deposit was first worked many years ago for mica to be used in stoves. In 1900-1, Messrs. McNally Bros. re-opened the mine and worked for some months, taking out a large amount of mica. No further mining has been undertaken.

Two pits have been sunk on a well-defined vein carrying mica, white calcite, and large quantities of pyrites and marcasite. These iron-minerals occur in such quantity as to have completely decomposed all dump-matter, the mica and rock being bleached and burnt by the acid formed by the weathering of the sulphides. These occur in large compact masses, often carrying gœthite in druses.

The vein at the surface has a width of 3½ feet, is associated with a narrow pyroxenite dyke, and has a direction of due north and south. The country rock is a normal dark gneiss with a strike of W. 30° N.

The main pit has a depth of 70 feet and is timbered for 20 feet with a 5×5 ft. collar. The only building is a small shed containing a portable boiler, used for pumping purposes, the pit being a wet one. Hoisting was done by means of horse-whim and buckets.

Lot 24.—Belongs to Mr. E. Byrnes, of Perth. A few months' mining was carried out under royalty, in 1907, by Messrs. Webb and Rombough, of Cardinal, a small amount of mica being secured. A few surface pits have been opened along a contact between pyroxenite and crystalline limestone, on which occur light-coloured mica crystals of small size. No phosphate was noticed and the occurrence is of only limited extent.

Lot 26.—This property, which is owned by Mr. F. Haughan, of Darcyville, was worked for a few months in 1908, under royalty, by Messrs. Webb and Rombough. Only surface work was done, none of the pits exceeding 15 feet in depth. The mica, a light-amber, occurs in crystals of medium size, associated with pink calcite and green phosphate, on a fissure deposit, in normal pyroxenite.

Concession VI, Lot 10.—An old phosphate property, and known as the Old Anthony mine. The dumps have been successively worked by various parties for mica, and in 1906, Messrs. Tully and Wilson, of Perth, secured a lease from the owners of the property, Messrs. Wilson and Greene, of Montreal, and conducted six months' work, employing an average gang of seven men. Most of the work was carried out in the east end of an old phosphate pit, and a fair quantity of small-sized, silver-amber mica was secured.

Some of the old workings reached a depth of over 100 feet, but the last operators sank no farther than 60 feet. No machinery was used, and no more mining has been undertaken since the last-named parties ceased work.

The mica occurs on the contact of a narrow dyke of dark-green pyroxenite having a strike of N. 35° E., with a red granite-gneiss. This dyke has a width at the west end of the main pit of 4 feet, while at the east end it narrows to a few inches. The pit is 70 feet long, and has been sunk on an incline of 75° to the southeast, following the dip of the deposit.

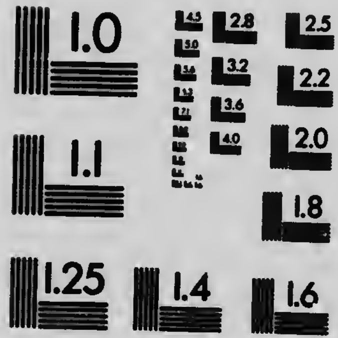
To the northwest of the main pit are a number of smaller openings sunk on similar narrow leads of mica and phosphate, occurring in similar country

PLATE XV.

General view of Hanlon mine lot 11, concession VI, township of North Burgess, Ont.

MICROCOPY RESOLUTION TEST CHART

(ANSI and ISO TEST CHART No. 2)



and having a like direction and dip. A curious featur. is the almost entire absence of calcite as vein-matter, not a trace of this mineral being noticed either in the vein or on the dumps. This is all the more remarkable, since at the Hanlon mine, only some few hundred yards away, very large bodies of calcite accompany the mica.

Concession VI, Lot 11.—Hanlon mine. This property, which was formerly one of the principal producers in the district, was opened in the late nineties by Webster & Co., of Ottawa. The Company carried out considerable underground work and took out large quantities of mica, selling out in 1901 to the General Electric Co., of Schenectady, N.Y., to whom the greater number of the Webster Co.'s properties have been transferred.

Work was continued almost without intermission by the new owners from 1901 until 1909, when the mine shut down and has not since been reopened. The deposit here is a typical contact, according to Dr. Ells,[1] and is distinguished from the adjoining Old Anthony mine by the lighter colour of the pyroxenite, the abundance of calcite present as vein-matter, and the green colour of the phosphate. The leads in the latter mine would seem to be associated with pyroxenite stringers from the main body exposed in the Hanlon mine.

The mica is similar in character at both places, being here also of a medium amber shade and much inclined to ribbon-structure. The calcite varies in colour from a white to cream, and finally to a blue shade, and is always very coarsely-crystalline, yielding large cleavage rhombohedrons. Small crystals of pyrites occur disseminated through it. The phosphate shows a great range of colour, the prevailing shade being a light greenish-blue. Most of the rock on the dumps proved to be a fine-grained pyroxenite of medium colour, and some masses of dark-grey feldspar-pyroxenite were also noticed. No access could be had to the workings, the pits being full of water to within a few feet of the surface.

The mine lies close to a large swamp, and the infiltration of water has always been a source of trouble, pumping having to be carried on continuously.

The deposit has a direction of northeast and southwest and has been exploited by means of open stopes which were subsequently timbered over, a shaft and haulage-way built, and drifts run along the deposit at various levels.

T'e depth reached in the workings was 175 feet, the lead having been stoped out for a distance of 200 feet at the bottom. The dip of the vein and stope is 75° S.E., and the greatest width about 20 feet. A shaft-house, open at the front, was built after the pit had been covered in, and a pumpway, two skid-roads, and one ladderway constructed. The buckets used

[1] Bulletin on Mica, R. W. Ells, 1904, issued by the Geological Survey of Canada.

for hoisting were lowered by means of a boom-derrick arm swinging into the front of the building.

A large camp and plant existed on the property, and included a large boiler-house, boarding-house, cobbing-sheds, store-rooms, magazine, and steam-hoist, drills, and pumps. Several tramway-lines run to the dumps and mica-shed. Most of the machinery has now been removed, though the buildings are still in fair condition.

At 50 feet north of the main pit, a shaft was sunk by Webster & Co. in 1899, to a depth of some 35 feet, and subsequently timbered. A large amount of good mica was taken from this opening, and outcrops exist in a direct line for an extensive distance, indicating that the deposit has a considerable extent.

A production of six barrels per diem of rough-cobbed mica was attained during the early exploitation by the General Electric Co., large quantities of phosphate being also extracted.

The average force of men employed numbered twenty-five.

The dumps still contain large quantities of valuable mica, which was discarded when only large sheets were marketable. A number of pits and trenches exist about a fourth of a mile southeast of the main workings. These were opened in 1901, and produced a small quantity of mica, but results did not lead to any active work being undertaken.

Lot 12.—Known as the Old Adams, or Klondyke mine. This property was originally exploited for phosphate, and lay idle for many years until the General Electric Co. took a lease of the mine in 1901. Work was continued with a force of half a dozen men for a few months, and the old pit was deepened to 35 feet with an 8 ft. drift to the north. In 1906, the mine was acquired by Messrs. Watts and McConnell, who worked for a year with eight men. This is the last work carried out upon the property.

No machinery has ever been in use, hoisting being done by buckets, derrick, and horse-whim. A large number of minor prospect pits and trenches exist, but no openings exceed about 40 feet in depth. The main pit is 60 feet long, and timbered over, having a 4 × 4 ft. collared opening in the south end.

The deposit is associated with spurs of pyroxenite cutting granite-gneiss. The main direction of the leads is north and south, and large bodies of pink calcite containing bunches of green phosphate occur in pockety fashion along the veins. The pyroxenite is of a light-grey colour, and the mica is a medium-amber in crystals of small size.

Concession VI, Lot 13 E.½.—Martha mine. This mine has produced large quantities of phosphate in the past. It was operated some twenty-five years ago for mica by an English syndicate, and in 1891 the Lake Girard Mica System took over the property and carried out extensive work for a couple of years. In 1893 the mine was purchased by the Mica Manufacturing Co., of London, who worked on and off until 1902. The Lake Girard System erected a

PLATE XVI.

Main pit at Martha mine, lot 13, concession VI, township of North Burgess, Ont.

large camp and installed machinery, including boilers, pumps, and a steam-hoist, all of which exist at the present time in a ruined condition. The Mica Manufacturing Co. employed the Lake Girard Company's machinery, and with an average force of a dozen men took out about 35 tons of rough-cobbed mica in 1901. This, however, was the last attempt of the Company to work the property, and in 1905, Messrs. Sewell and Smith secured a lease and worked for a year with a small gang. No further work has been undertaken. The mine is very wet and constant pumping has to be carried out, rendering operations both expensive and difficult. Besides the main pit which crosses this and the adjoining property, a number of smaller openings exist still farther to the east.

The geology and general mode of occurrence of the mica resembles that described at the Munslow mine.

Considerable scapolite was observed in one of the openings, and transitions of feldspar to scapolite were noted in several instances. Brown titanite crystals also occur disseminated through a feldspar-pyroxene rock exposed in the most southeasterly pit. This rock has the appearance of an augite-syenite and was of a brownish colour.

Small veins of grey granite cut the deposit at various points.

Lot 13 W. ½.—Known as the Munslow mine. This property adjoins the Martha mine, the pits of which are situated upon a continuation of the same vein as has been worked here. Both these mines were originally opened for phosphate. The Munslow mine was first exploited for mica in 1891, by Mr. .. J. Smith, of Micaville, under lease, with half a dozen men, and operations have been conducted intermittently by him ever since. When visited, a few men were engaged in turning the old dumps and some fine large mica was being recovered.

The mine is equipped with a plant comprising a 30 H.P. boiler, steam-hoist, drills, and two Worthington pumps, none of which have, however, been in operation for some years. The main pit is 200 feet long, 15 to 20 feet wide, and 130 feet deep. The dividing line between the two properties passes across this pit, the east half of which belongs to the Martha, and the west half to the Munslow mine. The mica deposit is associated with a series of narrow pyroxenite bands cutting gneiss, and occurs both on the contacts and on irregular fissures and pockets in the pyroxenite itself. The total width of the pyroxenite zone is over 100 feet, and mica exists over almost the whole of this strip. The general strike of the leads is N. 20° E., but no definite direction can be assigned, as many of the veins pursue an erratic course and are not infrequently cut off by horses of pyroxenite and gneiss. These horses, however, seldom persist and the leads are usually found to 'make in' and continue either to one side or the other. The mica found on the contact is said to be of a darker colour than that occurring on the fissures. The latter is large-sized and ranges from a dark-am to a lightish-brown, the former shade obtaining in the calcite and the latter in the phosphate.

Considerable quantities of the latter mineral occur, and pink, fine-grained calcite forms the bulk of the vein-filling. The mine was showing its greatest activity in 1907, when twenty men were employed. Considerable reserves of mica are reported to still exist in the bottom of the main pit. The owners of the mine are Messrs. Sewell and Smith, of Perth and Micaville respectively. The dumps were bought in 1910 by the Eugene Munsell Mica Co., who had a few men engaged in recovering waste mica during the summer of that year.

Lots 18, 19.—These lots adjoin the Star Hill property, and are owned by Mr. M. Killeen, of Stanleyville (18), and Mr. A. J. Mathieson, of Toronto, (19). A few surface openings have been made on mica outcrops and some good quality mica of light silver-amber colour is reported to have been extracted.

Promising mica outcrops are also reported on lots 14, 15, 16, and 17 of this range. Lot 15 is owned by the General Electric Co., and lot 14 by Mr. R. Cordick, Sr., of Perth.

Lots 20, 21.—Star Hill mine. This property is owned by Messrs. Wilson and Greene, of Montreal, and has been worked by a number of different parties, including Mr. P. C. McParland, of Westport, Messrs. Clemow and Powell,

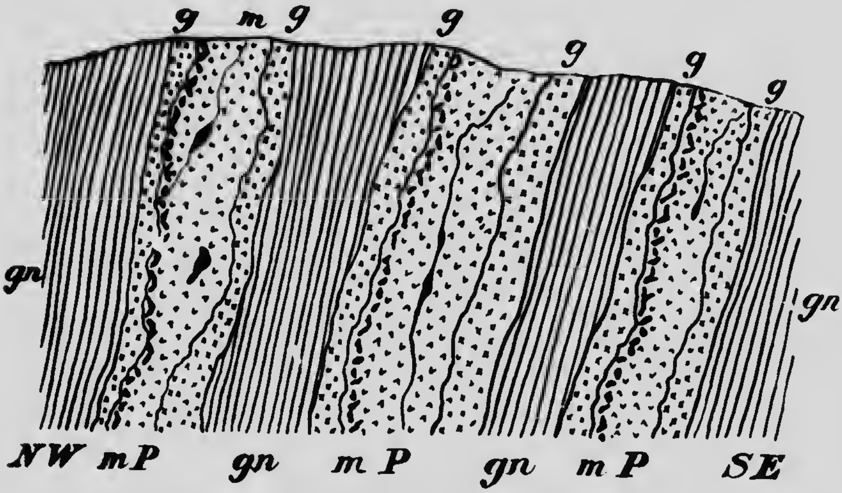


FIG. 42.—Section through mica deposit at Star Hill mine, lot 20, concession VI, township of North Burgess, Ont.

gn, gneiss; P, pyroxenite; m, mica; g, acid outer zones (Saalbänder) of pyroxenite dykes composed mainly of brown feldspar.

of Ottawa, and the present owners. In May 1910, Messrs. Thompson, Donnelly, and Gemmell, commenced operations, under lease, and had four men employed when the mine was visited in September. The property has been extensively prospected, openings existing over a large area. The mica occurs on fissure-leads in a dark pyroxenite, the veins having a direction of east and west, averaging 2½ feet at the surface, and narrowing in depth.

Massive green phosphate accompanies the mi... which is a rather crushed silver-amber. The old workings reach a depth of 50 feet, but the pits at present being worked do not exceed 25 feet. These latter are situated on lot 20 in close proximity to the old phosphate pits on lot 21. The pyroxenite here is of a much lighter colour and the mica is of a correspondingly lighter shade. Here, too, the deposit seems to be more of the pocket and fissure type, the general trend being N.E. and S.W. with a dip to N.W. The main opening is an open-cut 22 feet deep, and driven into the side of a small ridge jutting out into Black lake. This cut was opened on a lead of mica which widened out at 15 feet to over 3 feet, and then suddenly pinched out both at bottom and ends. Some of the leads carry pink calcite, while others show little sign of it. The mica occurs mostly on the hanging contact of pyroxenite with the country gneiss, which is locally garnetiferous.

The dyke-mass has undergone a considerable process of differentiation, mica crystals of large size being observed lying in a matrix of grey feldspar carrying scattered pyroxene crystals.

No machinery is employed on the mine and there are no mine-buildings, the mica being shipped to the Donnelly mine, where it is culled.

Concession VII, lot 9.—This is an old phosphate property and was first worked for mica in 1904 by Mr. Edward Smith, who employed ten men until the latter part of 1906, since when the mine has been idle.

The mica varies from a very light silver-amber to a brownish-amber, and is of fair quality, though somewhat crushed and impaired by calcite inclusions between the laminæ. The deposit is associated with a series of narrow pyroxenite dykes, light in colour, and cutting the granite-gneiss in a N.W. and S.E. direction at intervals of 15 to 30 feet.

The mica occurs with some phosphate and calcite on fissures in these dykes, which have a slight dip S.W.

The main pit is 90 feet deep, 65 feet long, and only 5 feet wide; while a ...ber of other openings have been carried down to depths of 40 and 50

No machinery has been in use on the mine, which is provided with a ...ding-house for twenty men, culling-sheds, and horse derricks and whims.

Lot 11.—Owned by Mr. McLaurin, of Perth. A number of small pits have been opened on this property at various times by different operators, but no mining has been carried out during the past eight years. The main pit is 45 feet long, varies from 4 to 12 feet in width, and is about 35 feet deep. It has been opened on a mica lead having a strike of N. 20° E., and a dip of 80° S.E., being apparently a contact deposit between pyroxenite on the northwest and dark gneiss to the southeast. The pyroxenite is a very light-coloured, fine-grained, and compact rock, and the lead carries only small quantities of calcite of a coarse white type, associated with bunches of brownish phosphate.

The mica is a dark-amber and does not appear to occur in any great quantity.

The main pit lies a few hundred yards distant from the Hanlon mine, from which it is divided by a road.

Lot 12—Byrnes mine. This property is situated about a fourth of a mile from the Hanlon mine, the average distance of the entire group of mines in this district from Perth being about 11 miles. Originally opened for phosphate, the mine was worked about twelve years ago by Mr. P. Byrne, of Micaville, for mica. In 1901 the General Electric Co. purchased the property, and in 1901 commenced prospecting operations, employing a diamond drill and opening several surface pits. Results were not very encouraging and work was abandoned after a year, no further attempts having been made to extract mica. A number of old phosphate pits exist on different parts of the property, the deepest of which is not over 60 feet. These openings have been made on narrow leads, carrying a very dark and crushed mica, massive red apatite, and hardly any calcite. The trend of the veins is N.W. and S.E. with a varying dip to N.E. They appear to form stringers or branches of the main deposit exposed in the Hanlon and Martha mines. Curiously enough these leads, although having great similarity with those at the Old Anthony mine, possess a direction almost normal to the latter. The width of the veins seldom exceeds 10 feet, and the mica occurs both on the contacts of the pyroxenite spurs with the gneiss and in fissures in the pyroxenite itself. The dyke rock is very dark in colour, and the dumps show great quantities of black, twisted, and crushed mica.

A pit to the south of the old workings, which was opened by the General Electric Co., exposes a lighter pyroxenite cutting gneiss, light-coloured mica and green phosphate occurring along the contact, associated with a body of pink calcite.

The strike of the contact is E. 20° N. with a slight dip to N.W., i.e., a direction normal to that of the leads exposed in the old phosphate pits.

Concession VIII, Lot 1.—This, in common with lots 2 and 3 of the same concession, is an old phosphate property, and was worked many years ago by the Anglo-Canadian Phosphate Co. In 1908, Mr. R. McConnell, of Ottawa, acquired the mine and worked during the winter of 1909-10, producing a considerable amount of mica. The mine has been idle since April 1910. The present owner employed as many as 35 men, and equipped the property with a large camp and plant, including a boiler-house with two boilers (one vertical and one horizontal), steam-hoist and pump, culling-sheds, boarding-houses, etc.

The mine is situated about 4 miles south of Perth, and a few hundred yards from the shore of Otty lake.

A swamp adjoins the workings, and it is understood that water difficulties contributed considerably to the closing down of the mine. The deposit appears to be of the contact class, a dark pyroxenite cutting dark biotite gneiss. Large bodies of pink calcite occur on the junction, and carry, besides mica, considerable apatite, often in well-formed crystals of large size.

Scapolite is common, and both pyrites and marcasite are met with. The mica is a medium silver-amber, but the crystals are much crushed, a large proportion being useless. Large quantities of brown feldspar occur in the dyke mass, the rock taking on in some places the appearance and character of an augite-syenite. The workings consist of three main pits, the largest being 100 feet long, 15 feet wide, and 40 feet deep, this being now filled to the surface with water. A boom-derrick is erected on either side of this opening, and three tramways run from it to the dumps.

Lot 2.—An old Anglo-Canadian phosphate mine, and acquired in 1907 by Kent Bros., of Kingston, who have worked each summer since for mica, employing a small gang of some half-dozen men. Openings exist on various parts of the property, the largest pit being on the northwest end of the lot near the shore of Andrew lake. This opening is 25 feet deep, 60 feet long, and 25 feet wide, and was the pit being worked at the time the mine was visited. The mica at this spot is a light silver-amber and occurs in pockety fashion on irregular leads in a light-grey pyroxenite, accompanied by whitish

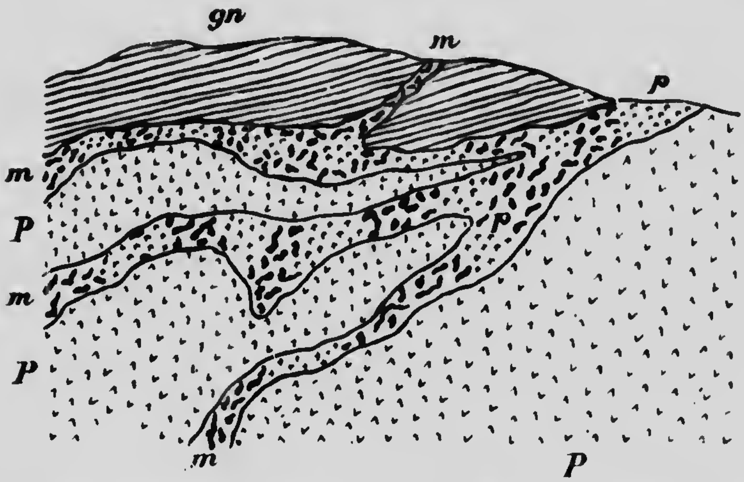


FIG. 43.—Section through mica deposit, lot 2, concession VIII, township of North Burgess, Ont.
gn, gneiss; P, pyroxenite; m, mica leads carrying apatite (p.)

calcite and small quantities of phosphate. The crystals are of medium to small size and are considerably lighter in colour than those found on the other end of the lot. The mica at the latter place occurs in small crystals on a flat, pockety lead averaging 3 feet wide, under a capping of dark gneiss. Several small openings exist on this lead, which has a general strike of northwest and southeast and carries large quantities of scapolite and wilsonite, the dyke-rock finally taking on the character of a scapolite-pyroxenite.

No machinery is in use on the mine, which is provided with a boarding-house capable of accommodating twenty-five men.

Lot 3.—This old Anglo-Canadian Phosphate Co.'s property was worked under option from the owner, Mr. R. Cordick, Sr., of Perth, for two months in 1908 by Kent Bros., of Kingston. Numerous old pits exist on the property, the newest openings having been excavated on small leads of medium-amber mica, associated with considerable bodies of both sugar and massive, compact apatite. These veins strike northwest and southeast, and seem to be branches of a larger deposit farther to the east. The leads average about 2 feet in width and have been exploited by means of shallow pits and trenches. Some large crystals of mica are said to have been taken from these workings,

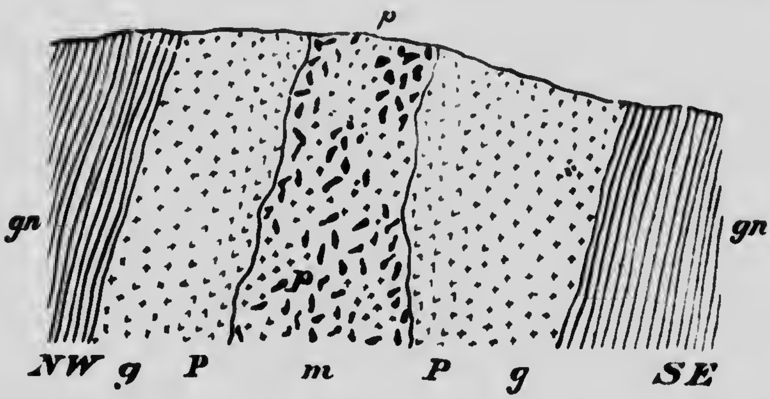


FIG. 41. Section through mica deposits, lot 3, concession VIII, township of North Burgess, Ont.
gn, gneiss; P, pyroxenite; g, acid rock composed mainly of brown feldspar and quartz; m, mica associated with bunches of apatite (p).

but the leads proved to be impersistent in depth. The rock adjacent to the leads is a coarsely-crystalline quartz-syenite, narrow bodies of pyroxenite separating the vein-filling from the country-rock. The workings are not more than a few hundred yards distant from the camp on the adjoining lot 2.

Lots 4, 5, and 6.—The property comprised on these lots is owned by Mr. W. L. MacLaren, of Perth. Lots 5 and 6 were originally worked for phosphate, in the eighties, by the Anglo-Canadian Phosphate Co., who erected an extensive plant and extracted large quantities of high-grade apatite, subsequently selling out to Hon. P. MacL[illegible]. Numerous pits exist on lot 6, but work is now chiefly confined to lot 5 and the part of lot 4 immediately adjoining. The mine is essentially a phosphate producer, though of late years more attention has been directed to the extraction of mica, which occurs in considerable quantities and is of high grade, phosphate being produced as a by-product.

The mine is equipped with a small plant, but no machinery is at present being used, the mine being dry and little pumping required. Hoisting is done with a bucket and horse-whim. The deepest of the pits are the old phosphate workings, some of which exceed 100 feet; they are mostly long, narrow trenches excavated on a series of more or less parallel fissure veins.

The pit in which work is at present being conducted is some 50 feet deep, and is sunk on a lead having a direction of northwest and southeast with a dip of 70° southwest. The principal vein-matter is phosphate, both massive, compact, and sugar, the mica crystals occurring embedded in this. Calcite is relatively scarce, and when met with is finely crystalline and of a pink colour.

The mica is a first-class, light silver-amber and of good size, crystals over 2 feet in diameter being not infrequent.

Some of the leads upon which openings have recently been made can be traced for a distance of over 200 feet. The mica is trimmed on the mine which is located 6 miles south of Perth.

Only a small force of men was employed at the time the mine was visited, but it was understood operations were shortly to be conducted on a larger scale.

Lot 7.—Belongs to Mr. W. H. Adams, of Micaville. This was one of the earliest mica mines to be opened in the district, and was operated in 1892 by Webster & Co., under lease from the owners. Various lessees have worked both prior and subsequent to this, but mining has always been conducted on a small scale and only small quantities of mica have been raised. The most recent work was carried out about three years ago. Numerous surface pits exist on the property, the greatest depth reached being 60 feet.

The mica, a light to medium amber, is associated with a little pink calcite and phosphate, and occurs on fissures and pockets in pyroxenite dykes having a direction of east and west on the northwest of the property and changing to northwest and southeast near the lake. C[illegible] preponderates on the latter veins, being relatively absent on those to the west. The mica is very crushed at some points and splits readily into ribbon-mica. The country is a normal gneiss on the west of the property, and a crystalline limestone on the east.

Lot 25, and Concession IX, Lot 26.—These lots belong to Mr. P. McParland, of Westport, who has worked in an intermittent fashion during the past five years. It is understood that some good mica has been extracted by means of surface pits, none of which exceed 25 feet in depth. Little or no phosphate occurs.

Concession IX, Lot 4.—Belongs to Mr. Allan Atchison, of Perth. The property is at present being worked by Messrs. Watts, Adams, and Noble, under option, and was originally a phosphate mine. Numerous old pits exist, some of which have been worked by the present lessees, who have, however, principally confined themselves to surface prospecting and turning the old dumps.

One of the pits, 15 feet long, 6 feet wide, and 30 feet deep, exhibits a lead of mica, green phosphate, and pinkish calcite between walls of normal pyroxenite, and having a direction of N.W. and S.E. The colour of the mica is medium to dark amber, but the crystals are frequently impaired by inclusions and the sheets often exhibit a blotchy appearance.

The mine has produced considerable quantities of phosphate in the past, and is of more value for this mineral than for the mica which occurs with it.

Lot 6 E.½.—An old phosphate property which was worked in 1906 for a few months by Messrs. Adams and Noble, of Perth.

Mr. J. H. Mendels, of Perth, had three men employed on the mine in 1910, and a little mica was extracted: work has since been suspended.

Numerous old pits exist on the property. These were opened on leads of phosphate and mica having a direction of E. 15° S. and carrying large quantities of high-grade phosphate.

The opening made by Mr. Mendels does not exceed 10 feet in depth and discloses a lead of the usual pocket and fissure type, carrying crystals of high-grade medium-amber mica. The mica, however, does not appear to occur in sufficient quantity to render mining profitable. No machinery has been employed in recent years.

Lot 7 E.½.—A small deposit of dark mica was worked on this lot in 1905 by Mr. W. H. Adams, of Micaville. Operations were conducted for four months on a small scale, and mica to a value of $12,000 is reported by Mr. Adams to have been extracted.

Only one pit some 20 feet deep was opened and this discloses a small pocket and fissure lead of mica, associated with a small amount of pink calcite, in an almost black pyroxene-hornblende dyke. The deposit is of irregular character, the vein appearing to suddenly turn at almost right angles to its main course. The mica found occurred principally in a small pocket, which has been cleaned out, and the deposit seems to be exhausted.

Lot 14.—Owned by Mr. J. Russell, of Micaville, and worked by the former owner, Mr. P. Murphy, about five years ago. A number of small pits have been opened on northwest and southeast leads having an average width of 2′–6″ and carrying a somewhat crushed, dark, wine-amber mica, accompanied by coarse, white calcite. No phosphate was observed. The mica occurs principally on the contacts of narrow pyroxenite spurs with a red, fine-grained, feldspathic rock. None of the openings exceed 15 feet in depth. A considerable amount of mica is said to have been taken from one of the smaller pits, which was sunk on a small pocket. Mica outcrops exist at many points on this and adjoining properties.

Lot 15 E.½.—Substantial outcrops of mica are reported to occur on this property, but no mining has ever been undertaken. The owner is Mr. A. Martin, of Micaville.

Lot 15 W.½.—Belongs to Mr. H. Burns, of Micaville. Both amber and white mica occur on this property, which was worked over forty years ago for mica to be used in stoves. No further work has ever been carried out, but the owner declared his intention of starting operations in the near future.

Only small prospect pits exist on this and the adjoining lot, which was worked for a few weeks in 1893.

The white mica leads are probably a part of the deposit which has been mined at the Pike Lake mine.

Lots 16, 17.—Pike Lake mine. This is one of the earliest mica mines to be opened in the Province, and was exploited as far back as 1860, the mica extracted being used in the stove industry. The present owner is Mr. W. A. Allan, of Ottawa.

The property has been worked by a large number of operators, including: the Lake Girard Mica System, who mined in 1892; Messrs. Watts and Noble, of Perth; and Messrs. Farry and McParland, who were the last to work, in 1902.

Extensive work has been carried out here in the past. Numerous pits were sunk, some to a depth of over 100 feet, and a large plant was installed, the only vestiges remaining of which are a few tumble-down sheds. The mica is a light yellowish, cloudy, and brittle variety, and is found in crystals of fair size, which, however, yield considerable waste, the sheets being seldom perfect to the edges. Sheets of over 2″ × 3″ are the exception, and as this size at least is required for stoves, and the mica is considered too hard and brittle for electrical purposes, the mine would seem to have seen its best days.

The leads of mica strike N.W. and S.E. and dip slightly to the southwest. They occur in a very soft and friable grey altered rock, the nature of which is difficult to determine, and are found at distances of from 10 to 25 feet from one another, being approximately parallel.

These veins occur on the northeast slope of a small ridge near the shore of Pike lake, and have been exploited by means of narrow pits having a length of some 50 feet, by 6 to 12 feet wide. The mica occurs not only on the leads themselves, but also in the mass of the rock adjacent to the fissures. This rock is sometimes found to consist of little else than masses of small, spangle-mica with intermixed crystals of larger dimensions.

Small quantities of pyrites occur disseminated through the rock, and masses of brown tourmaline were also noticed.

The country gneiss crops out about 100 feet to the south of the workings and has a strike of northeast and southwest.

It is recorded that large sheets of mica from this mine were shipped to Paris as far back as 1860, for use as windows in the French battle-ships, a price of $2 per pound being obtained.

Township of South Sherbrooke.

Concession II, Lot 7.—Belongs to Mr. W. Fowler, of Bolingbroke. Mr. Austin, of Toronto, carried out a little work three years ago, and in 1909 the same syndicate as that which worked the adjoining Ritchie property mined for a few months.

A pit 20 feet deep, 15 feet wide, and 30 feet long has been opened on a lead of mica striking E. 25° S. in a dark, coarse-grained pyroxenite cutting dark gneiss. The mica is a very dark variety and much crushed, being associated with a small amount of calcite and large quantities of pyrites.

Lot 9.—This property was first mined twelve years ago by Mr. T. Cook, of Harrowsmith, who, however, did not carry on much work. Later, in 1904, Messrs. Mills and Cunningham had half a dozen men employed for nearly a year, and some large openings were made. No work has been done since.

The main pit is an inclined shaft or stope 40 feet long, 80 feet deep, and 8 feet wide, sunk on a contact deposit of mica between a hanging-wall of pyroxenite and a foot-wall of dark gneiss. The lead has a strike of E. 12° N., dips 52° N., and has an average width of 2½ feet.

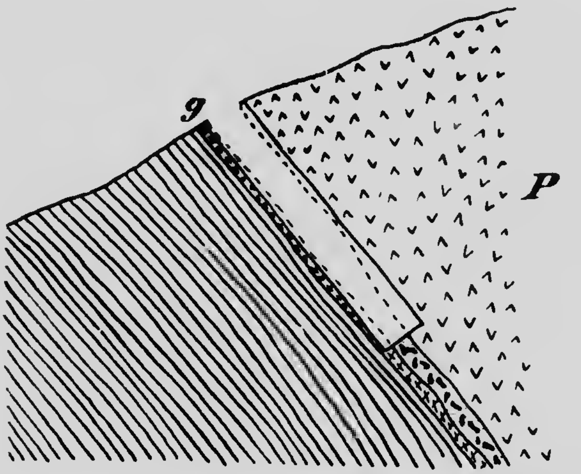


Fig. 45.—Section through mica deposit, lot 9, concession II, township of South Sherbrooke, Ont.

P, pyroxenite; gn, gneiss; g, body of massive quartz; m, mica lead.

The mica is associated with decomposed calcite and is dark in colour, the crystals being rather twisted and crushed. Large quantities of pyrites are present, and seem to have adversely affected the quality of the mica.

Considerable differentiation has taken place in the dyke mass, large masses of segregated feldspar being observed on the dumps.

Between the foot-wall proper and the lead is an acid zone averaging about a foot in width, composed of almost pure quartz, and resembling that at the Daisy mine in the township of Derry, Que.

The deposit is cut at the west end of the pit by an aplite dyke striking N.W. and S.E. with a dip to the S.W., and having a width at the surface of 4 feet. Hoisting was done by means of wooden buckets running on a wooden skidway built into the west end of the stope.

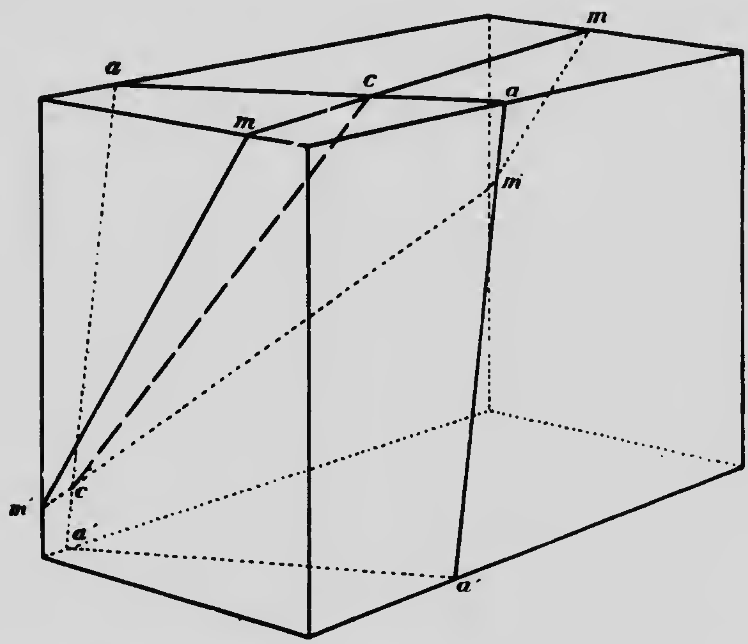


FIG. 46.—Diagram showing cutting of pyroxenite by an aplite dyke, lot 9, concession II, township of South Sherbrooke, Ont.
a a a' a', aplite; m m m' m', pyroxenite; c c, line of section.

The lead is reported to still carry considerable quantities of mica at bottom, but any examination was impossible owing to the water in the pit. Several smaller openings exist to the west of the large pit and these disclose small pockets and bunches of dark mica, a large proportion of which is so crushed as to be useless.

Concession III, Lot 4 N.½.—This property is owned by Messrs. Miller and Innes, of Battersea. It was first worked some ten years ago by Mr. McNally, of Westport, under lease, and subsequently by Messrs. Cunningham and Mills, of Kingston, being acquired by the present owners in 1908. The last work was done by the owners in 1909. Only surface mining has been carried out, and there are several small pits, the largest being 30 feet deep.

The average width of the leads is 2 feet, and the mica is a light-coloured amber, occurring with small quantities of pink calcite. There is little phosphate present.

Lot 4 S. ½.—Belongs to Mr. A. McEwen, of Bolingbroke, who reports good outcrops of mica. No mining has as yet been undertaken, but it is understood that operations will shortly be commenced, the owner having leased the property to a syndicate.

Lot 7.—Mr. John Ritchie, Sr., of Bolingbroke, is the owner of this property, which was worked in a small way in 1909 by a Battersea syndicate. Work was only continued for a few weeks, and a single pit was opened to a depth of 12 feet, the mica, which is a light-amber of fine quality, giving out at that depth.

The occurrence appears to be a small pocket in a hard rock consisting of a mixture of feldspar and pyroxene, the whole being impregnated with pyrites and carrying considerable tourmaline.

Galena occurs on the north of the lot on an east and west vein in crystalline limestone.

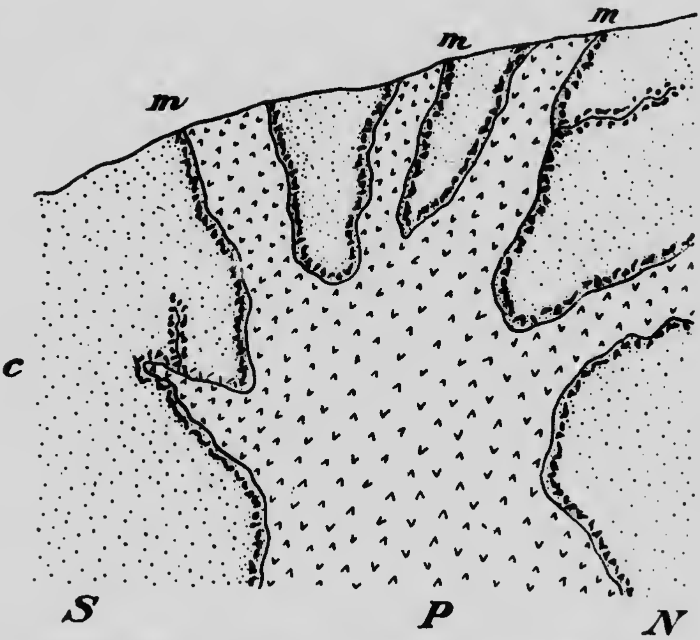


FIG. 47.—Schematic section through mica deposit, lot 2, concession IV, township of South Sherbrooke, Ont.
P, pyroxenite intrusion; c, crystalline limestone; m, mica deposited along contacts of pyroxenite with limestone.

Concession IV, Lot 2 E. ½.—Owned by Mr. J. McEwen, Sr., of Bolingbroke. The property has been worked by several parties on a small scale during the past three years, an average of 6 men being employed. The mica is reported to be an excellent light-amber, yielding perfect sheets and little waste.

Lot 2 W. ½.—Belongs to Mr. S. Dowdell, of Bolingbroke, and was first

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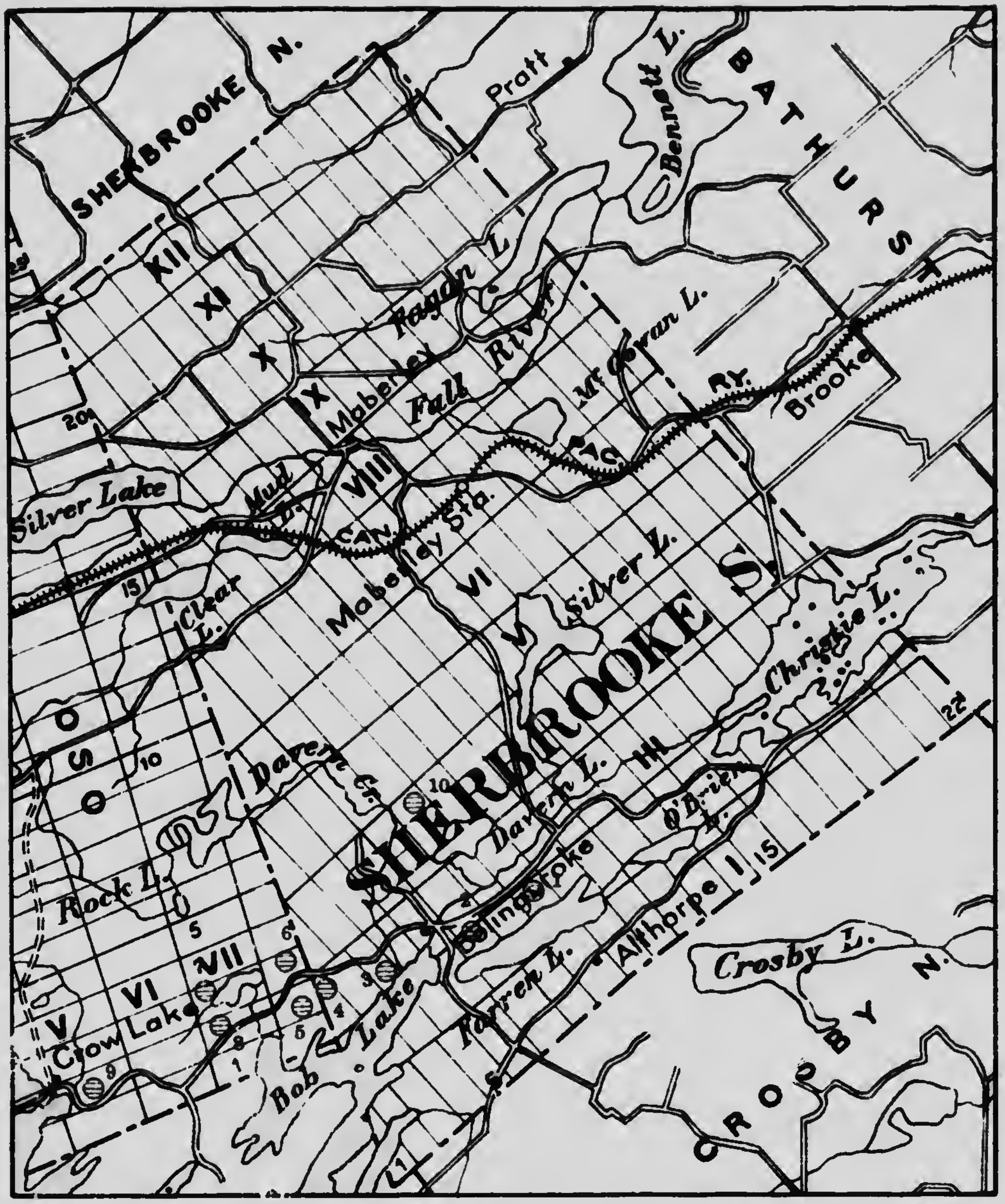

No.	Name of Mine
1	Mills & Cunningham
2	Prospect
3	Prospect
4	Dowdell
5	Prospect
6	Prospect
7	Tovel
8	Tovel
9	Loughborough Mining Co.
10	Loughborough Mining Co.

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IN TOWNSHIPS OF OSO AND SHERBROOKE SOUTH, ONT.

Scale 2 miles to one inch

1 ½ 0 1 2 3 4 5 Miles

worked in 1907, for a few weeks, by Mr. D. Anderson, of Perth, with 2 men. No further work has been undertaken.

Spurs of dark green pyroxenite cut a country of crystalline limestone and the mica occurs on the contact zones, associated with pink calcite.

Several small pits have been opened, the largest being 20 feet deep and disclosing a lead 3 feet wide carrying crystals of rather crushed lightish amber mica. The contacts have a general trend of E. 15° N., and the formation has been intruded by later granite dykes which carry considerable black tourmaline.

The workings lie close to the road from Crow Lake to Bolingbroke, and about one mile from the latter place.

Lot 8.—This mine was opened by the General Electric Co., in 1905, and was worked for about three months with half a dozen men. No further mining has been undertaken. There are several openings, the chief of which is 56 feet deep, excavated on a fissure-lead of mica associated with small bunches of pink calcite in a dark-green pyroxenite. The lead at the bottom of the main pit is 3½ feet wide and carries a light-amber mica in crystals of medium size. A short drift some 10 feet long has been run along the lead to the south from the bottom of the pit, and seems to be in a pockety deposit of small mica.

The strike of the leads is N. 20° W., and the dip at surface 80° E.

The mica is rather inclined to ribbon-structure, and is impaired by layers of calcite between the laminæ. The pyroxenite of the hanging-wall has a distinctly banded structure, the bands being normal to the mica-lead and dipping vertically. This would seem to indicate that the fissures in the pyroxenite have developed at right angles to the strike of the dyke.

No machinery was ever employed on the mine which is approached by a bush-road a mile long and joining the highway at Bolingbroke.

Township of Bathurst.

Concession II, Lots 21, 22.—Belongs to Mr. J. H. Mendels, of Perth, who commenced mining in 1907 with a force of ten men, and continued for five months. No further work has been done. The workings consist of two pits a few yards apart, the deepest being down 50 feet and 25 feet long by 8 feet wide.

These openings are situated 3½ miles west of Perth, and within a few feet of the right bank of the Tay river. The infiltration of river water was found to cause considerable difficulties and continual pumping was necessary to keep the water under.

The mica is a dark-amber and occurs on northwest and southeast fissure-leads in a soft, dark pyroxenite. Little calcite or phosphate accompany the mica which is usually of small size. The mine has produced $4,000 worth of mica to date. There are no buildings on the property, with the exception of a couple of small sheds containing a portable boiler used for operating a small steam-pump.

Township of North Elmsley.

Concession IX, Lot 25.—Known as the Gibson mine. Mica was discovered on this property in 1901, and a little work was carried out by Messrs. Gibson and Hayes, who subsequently transferred to Mr. L. Gemmell, of Perth. The latter worked for four months, and extracted a few tons of trimmed mica. The mica body is said to have gradually pinched out at depth and the crystals were not of very good quality, being dark in colour and crushed. Work was suspended in the latter part of 1901 and has not since been resumed.

LEEDS COUNTY.

Township of North Crosby.

Concession II, Lot 7.—Belongs to Mr. T. Kane, of Westport. The property has been prospected and small outcrops of mica located.

Lot 16.—Belongs to Mr. J. Egan, of Westport, who commenced work in 1904 and continued for a few months. In 1908, Mr. H. Adams, of Westport, worked a few weeks and secured a little mica. No further work has been done. Two small pits were opened to a depth of 15 feet upon a small fissure vein in dark pyroxenite, carrying small-sized and somewhat crushed crystals of a mottled-amber mica. Little calcite occurs on the lead and no phosphate was noticed. The pyroxenite dyke cuts crystalline limestone and both have been intruded by large veins of red granite which often include blocks and fragments of pyroxenite carrying crystals of mica.

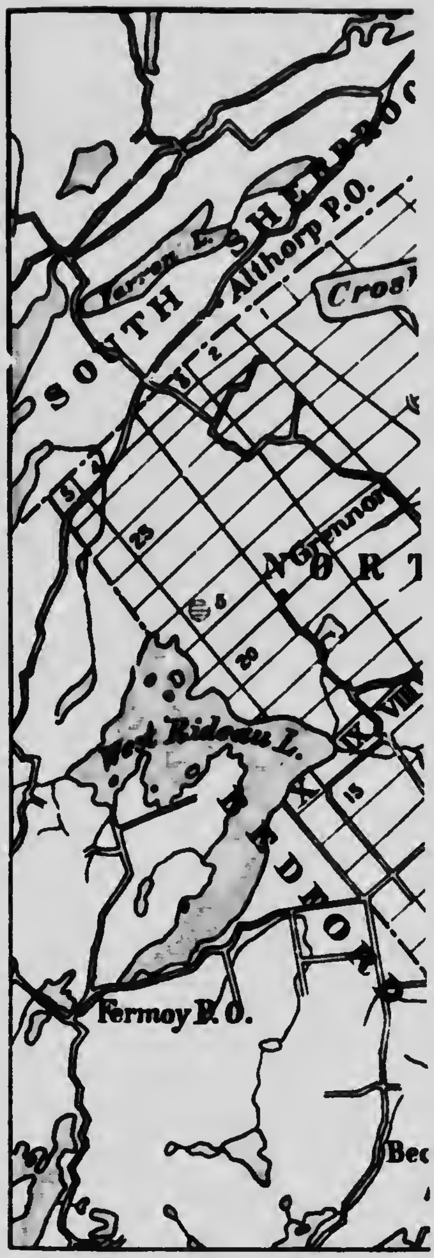
The deposit does not appear to extend any great distance.

Small outcrops of mica were also worked some six years ago upon lot 10, concession I, and lot 18, concession II, of this township, but results were not encour. ,ing and operations were soon abandoned and have not since been resumed.

Lot 21.- Belongs to Mr. J. Smith, of Cedar Bridge. A contact deposit between a narrow pyroxenite dyke and normal dark gneiss has been exploited by various parties, under lease. The deepest opening is down 25 feet and shows a narrow lead of medium-amber mica. No work has been done since 1900 and the occurrence is unimportant.

Concession III, Lot 8, and Concession IV, Lot 8.—A small amount of development work has been carried out on these lots during the past six years by various operators, under lease from the owner, Mr. C. Drysdale, of Westport. The most recent work was done in 1907, on concession IV. A small amount of mica was taken out, but the deposit does not appear to be of any great extent.

Concession V, Lot 9.—Owned by Mr. J. Foley, of Westport, and opened up in 1905 by Messrs. McBelton and Taggart. Only a few weeks' work was conducted, and the property has idle since. A surface pit has been



MICA

MIC.
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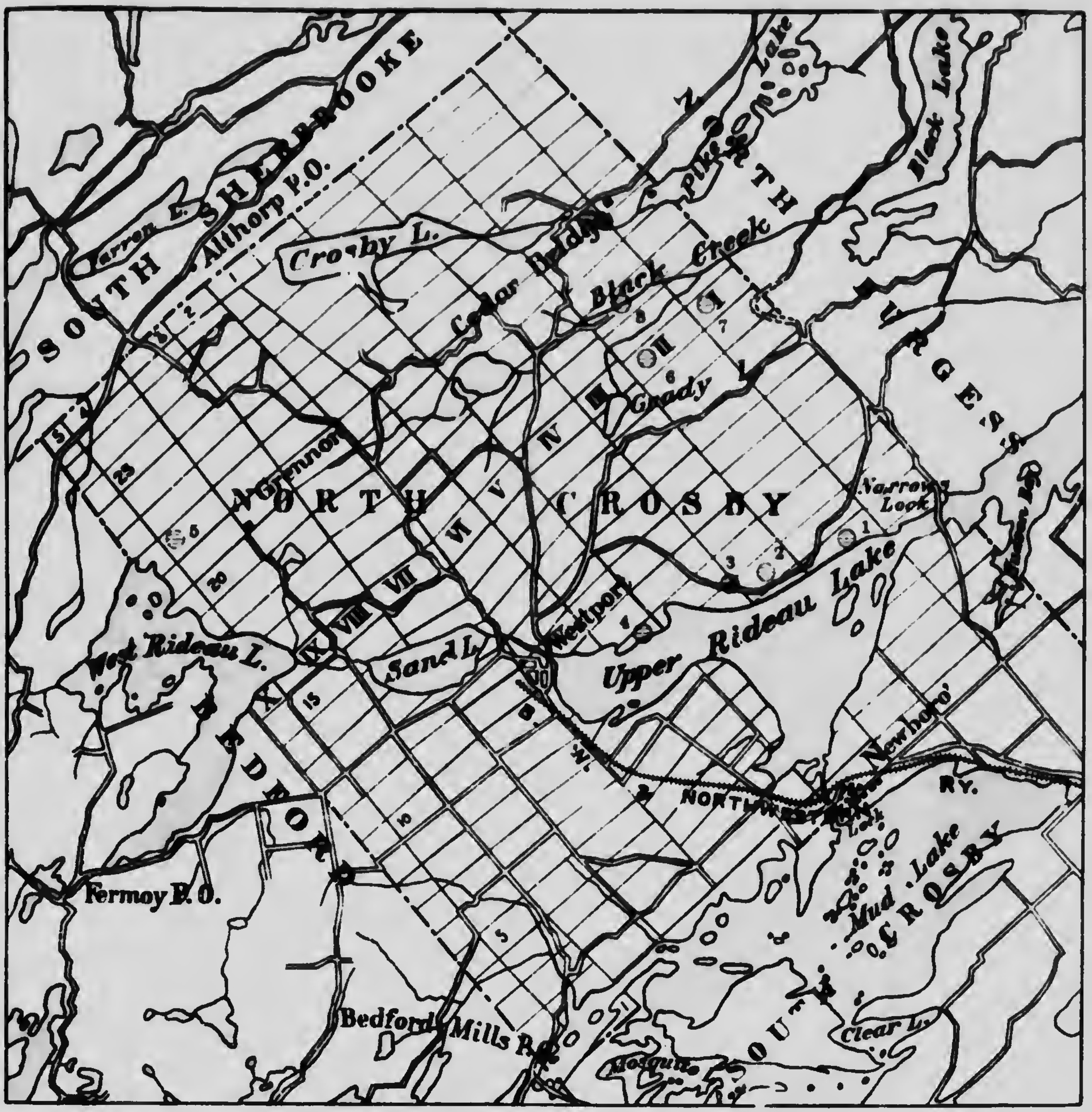


No	Name of Mi
1	Prospect
2	Prospect
3	Prospect
4	Foley
5	Webster
6	Prospect
7	Prospect
8	Prospect
9	Smith

⊜ MICA

MICA MINES AND OCCURRENCES IN TOWNSHIP OF NORTH CROSBY, ONTARIO

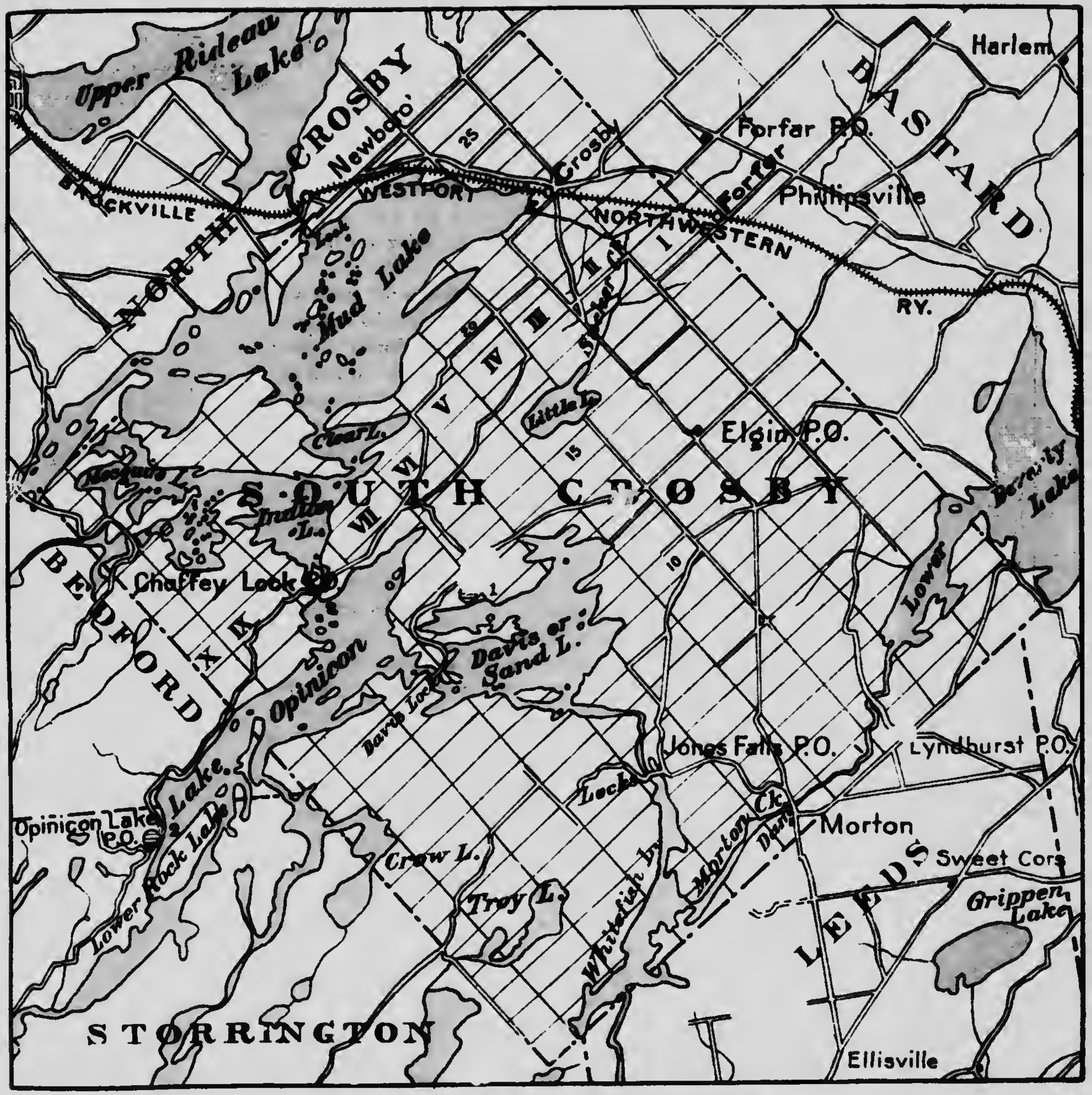
Scale 2 miles to one inch

1 ½ 0 1 2 3 4 5 Miles

Upper Rideau
BROCKVILLE
NORTH
Chaffey L
BEDFORD
Opinicon Lake
P.O.
Lake
Lower Rock Lake
STORR

⊜ MICA

In



No.	Name of Mine
1	Sand Lake
2	Loughborough Mining Co.

⊜ MICA

MICA MINES AND OCCURRENCES
IN TOWNSHIP OF SOUTH CROSBY, ONTARIO

Scale 2 miles to one inch

opened to a depth of 18 feet on a northwesterly and southeasterly lead in normal pyroxenite, carrying a rather crushed grade of medium-amber mica associated with considerable bunches of green apatite.

The mica crystals are often impaired by inclusions, these sometimes consisting of well-developed prisms of apatite of considerable size. In the latter part of 1910, Mr. Adams, of Westport, who has a lease of the mine, unwatered the pit and intended to start work, but abandoned the idea.

Concession IX, Lot 22.—Belongs to Mr. W. J. Webster, of Edmonton. A few surface pits were opened on the property in 1900 by Messrs. Taggart and Arnold, who employed half a dozen men for several months. The owner carried out a few weeks work about six years ago and no further mining has been conducted.

The workings are situated near the northeast shore of Wolf, or West Rideau lake and probably upon part of the same dyke as has been mined on lot 27, concession XI, of Bedford township. There is only one opening of any size on the property. This is a pit some 15 feet deep, sunk on a deposit of mica occurring on a lead with a strike of N.E. and S.W. and on joints and fissures in the immediate proximity of the vein. The mica is an excellent light silver-amber, though of small size.

Township of South Crosby.

Concession VII, Lot 14.—Known as the Sand Lake mine, and formerly one of the important mica producers of the district. Originally a phosphate property, it was acquired in 1900 by the Brockville Mining Co., who installed a large plant and worked for a year, subsequently resuming operations in 1905. Work was continued steadily until the latter part of 1907, since when the mine has lain idle. At the present time, Mr. D. Farry, of Ottawa, with a few men, is working the dumps for Messrs. Mendels and Smith, of Perth, and it is reported that a quantity of valuable mica is being recovered.

The chief opening is a circular pit about 75 feet deep and 25 feet across at the surface, excavated on what is apparently a chimney deposit of mica in a very dark-coloured pyroxenite highly impregnated with pyrites. This pyroxenite appears to have shattered a country of dark biotite gneiss in which small mica leads occur adjacent to the main pyroxenite body. One such lead exposed in the upper part of the shaft had a width of 1′-6″ and a strike of W. 18° S. The pyroxenite is a dark-green rock, often much crushed, and containing small bunches of brown and green apatite. Large, lenticular masses of black, coarse-grained amphibolite occur in the main body, which does not appear to have true dyke character, but rather has the appearance of a batholite which has shattered the gneiss and sent off apophyses and small veins into the country. This supposition is supported by the fact that the mica is said not to have occurred on regular leads, but to have been found on joints and fissures both in pyroxenite and gneiss, the formation having a cobwebby character. The gneiss is a very compact and fine-grained rock possessing little schistosity, and would thus seem to have offered more than the usual resistance to the intrusion of a batholite, with consequent high degree of shattering.

The mica is a dark wine-amber of fair quality and is associated with small bunches of coarse, pinkish-white calcite.

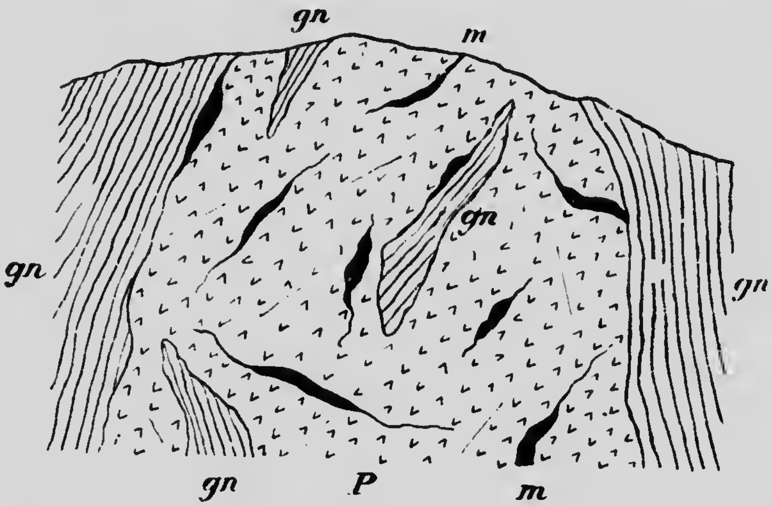


FIG. 48.—Section through mica deposit at Sand Lake mine, lot 15, concession XV, township of South Crosby, Ont., showing pockety distribution of the mica (m) in the pyroxenite (P); gn, gneiss.

A large camp exists on the mine and includes boarding-house, cullingsheds, and boiler house; while an adequate plant, comprising steam-drills, hoist, pumps, and tramway to dump, has been installed.

The mine lies 17 miles southeast of Westport, and 4 miles from Elgin.

Mica outcrops have also been located and worked on a small scale on the adjoining lots to the northeast.

Township of South Burgess.

Concession I, Lot 5.—Heffron mine. This property was first worked in the early eighties, by Mr. W. Plummer, of Boston, who extracted considerable quantities of mica to be used for stove purposes. Mining has been undertaken by several parties since the above-mentioned first worked, among the number being Webster & Co., and Mr. G. W. McNaughton. The latter employed a half dozen men for eighteen months during 1905-6, some drifting being carried out in the old pits and the dumps being re-worked. The latter are reported to have yielded very large quantities of high-grade mica, as, since only the largest cuts could be utilized in the stove industry, any sheets

PLATE XVII.

Main pit at Sand Lake mine, lot 14, concession VII, township of South Crosby, Ont.

under 2″ × 3″ were thrown aside as valueless. A number of long narrow pits have been opened on a series of parallel mica-leads having a direction of northwest and southeast, and occurring at intervals of some 25 feet. The largest opening is 60 feet deep, 50 feet long, and 6 feet wide. The vein-matter consists of pink calcite and green phosphate, and pyrites occur in considerable amount. Veins of the latter mineral were encountered traversing the dyke and attaining a width of from 3″ to 5″. The mica is a golden-amber, and a large percentage of the crystals, though of fair size, are somewhat crushed and split up into ribbon-mica. The leads are true fissures and occur in a medium-coloured compact pyroxenite near its contact with normal gneiss. The veins have been stoped out, stulls and lagging being inserted at intervals, and the fissures appear to narrow in depth. No machinery has been employed with the exception of a small pump. The distance from Perth is about 14 miles, and the mine is now owned by Mr. E. F. Jones, of Perth.

Lot 7.—Owned by Webster & Co., who have, however, never done any mining on the property. The deposit as originally exploited many years ago for stove-mica, and the mine has since passed through many hands. The last work was carried out some years ago by Messrs. Gemmell and McLaren.

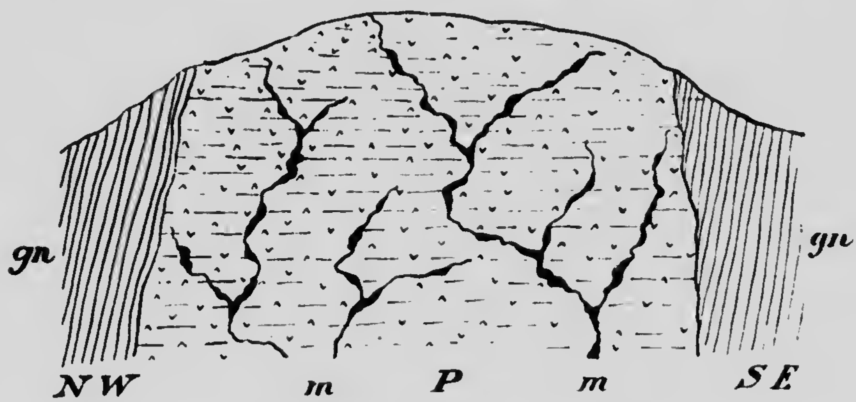


FIG. 49.—Section through mica deposit, lot 7, concession I, township of South Burgess, Ont. gn, gneiss; P, banded pyroxenite; m, mica leads.

The dumps were turned in 1910 by Mr. E. F. Jones, of Perth. The mica is a light golden-amber, and occurs on irregular fissures and joints in a very light-coloured pyroxenite. These fissures have been followed by means of an open-cut, with a direction of W. 20° N., carried some 60 feet into the side of a small ridge. This cut is 35 feet deep at its inner end, and has a width of 30 feet. The pyroxenite is hard, compact, and horizontally banded, the mica leads pursuing an irregular course through the rock, and having the appearance of 'schlieren.' Pyrites occur in large quantities and the dyke-rock becomes harder and darker in depth, retaining, however, its banded structure. Little phosphate occurs, and calcite is also relatively absent.

Lot 1.—O'Connor mine. This mine was worked in a small way in 1893 by Mr. O'Connor, with five men. The deposit did not repay expectations and operations were discontinued and have not since been resumed.

Concession III, Lot 3.—Belongs to Webster & Co. A little surface work was carried out here about 10 years ago and some small outcrops were located. Operations were abandoned after a few weeks and have not since been resumed.

Concession IV, Lot 1.—Cantin mine. An old phosphate property, and now owned by the General Electric Co. The mine was originally exploited for mica in 1893 by Webster & Co., with a force of thirty men, and work was continued at intervals for a number of years.

The present owners have carried out intermittent work on the property, and a small gang of men were employed during 1909 in turning the old dumps which were found to contain a quantity of excellent mica.

Numerous openings exist, the main pit being situated near the high-road. This has a length of 85 feet, is 110 feet deep, and varies from 12 to 25 feet in width. The direction of the deposit upon which this pit has been opened is E. 10° N., and the occurrence is on a contact between dark compact pyroxenite and granite-gneiss. The deposit is of considerable width, the contact-filling being pink calcite carrying bunches of green phosphate and crystals of medium-amber mica, the latter often of good dimensions. At 100 feet, the mica zone appeared to be cut off by a horse of reddish granite, and after fruitless attempts to discover the extent of this obstacle work was finally abandoned. Whether the cut-off was due to a fault or to a later intrusion of granite could not then be ascertained.[1]

Several other pits have been sunk along the contact at intervals of 30 to 50 feet, but these do not extend to any depth.

The calcite is coarse-grained and is remarkable for its range of colour, varying from a pinkish-white to grey-blue in one and the same mass. Considerable pyrites is present and the mica crystals are not infrequently black-stained by the action of the acid formed by the decomposition of the sulphide. The pits on the south of the property are mostly small and do not exceed 30 feet in depth. They are excavated on what is probably a branch of the main deposit. A camp exists, comprising boarding-house, sheds, boiler-house with large horizontal boiler; and a full complement of machinery was installed, including: steam pumps, drills, and hoists, the latter operating on a swinging boom-derrick. The greater part of this camp and machinery was erected and installed by Webster & Co.

It is reported that the property is to be prospected with a diamond-drill in the near future, and an effort made to pick up the continuation of the main contact in depth.

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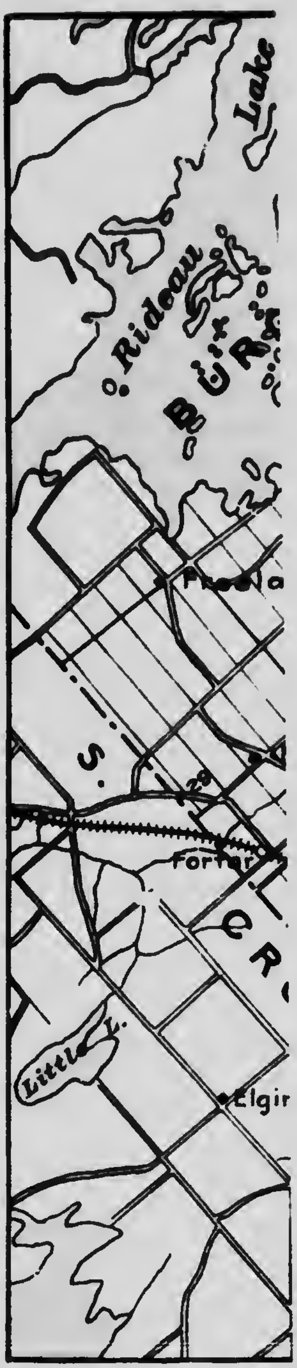
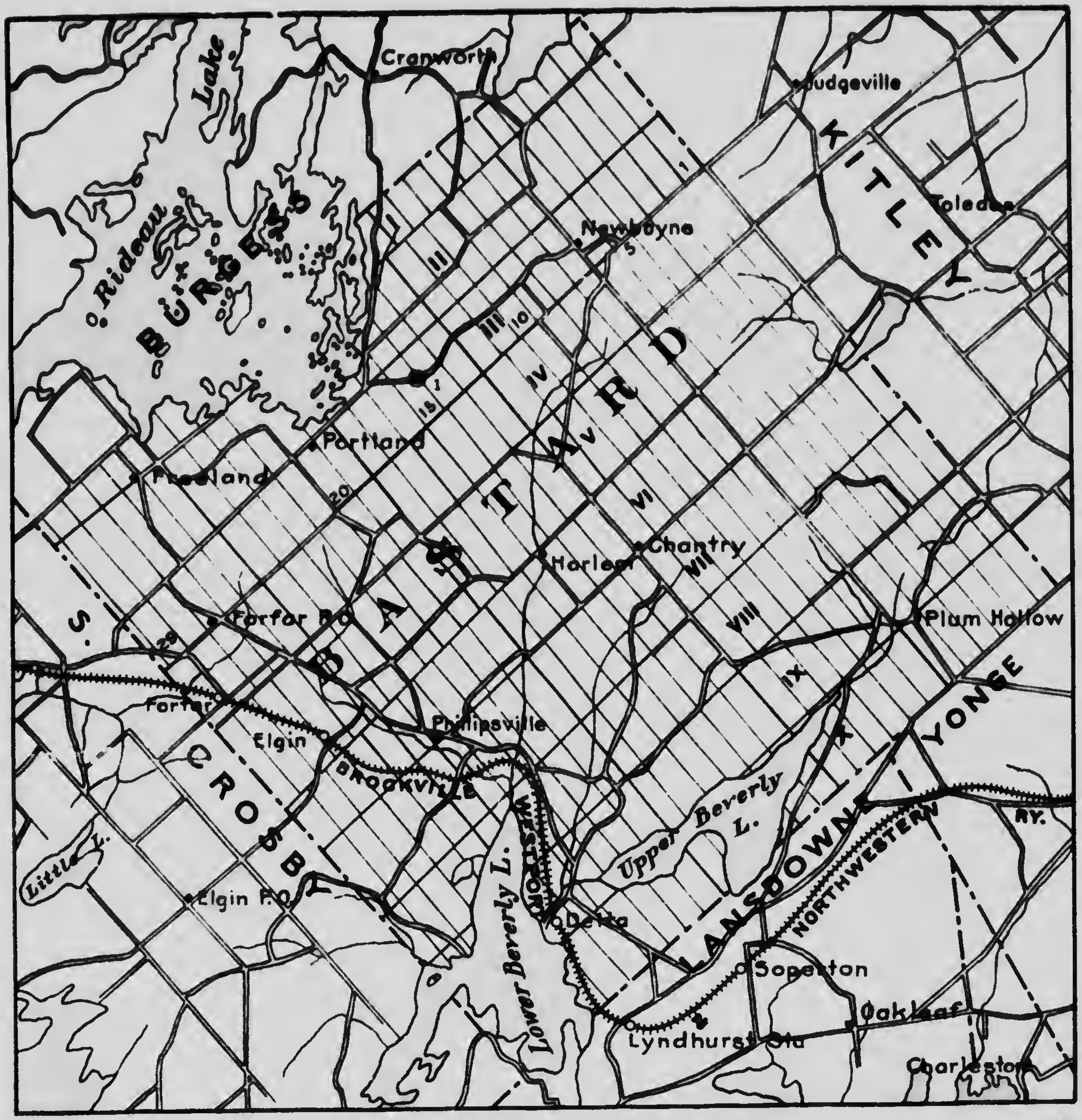
[1] R. W. Ells, Bulletin on Mica, p. 25, Geol. Surv., Can., 1904.



⊜ MICA



⊖ MICA

MICA MINES AND OCCURRENCES
IN TOWNSHIP OF BASTARD, ONTARIO
Scale 2 miles to one inch

No.	Name of Mine
1	Rogers

Township of Bastard.

Concession III, Lot 14.—Belongs to Mr. A. Rogers, of Portland. This property, which produces a hard, brittle mica of a yellowish colour, was first worked in 1906, for a month, with six men, by Messrs. J. and J. Stoness, of Perth Road. In 1908, Mr. H. Adams, of Westport, carried out a few weeks' mining, and the mine has since lain idle. There are two small pits, the deepest of which is down 20 feet, on east and west leads of mica and red and green phosphate.

These leads occur in a coarse, decomposed brown rock which is probably part of a basic (pyroxenite) dyke which, however, has not so far been met in the workings.

Large quantities of phosphate occur and about eighteen tons are said to have been excavated. The mica, which is rather cloudy, occurs in crystals of medium size—sheets 12" across being not uncommon. The crystals are, however, somewhat impaired by the presence between the laminæ of layers of calcite. The pits are situated close to a swamp and water causes difficulties and necessitates continuous pumping.

The mine lies 2 miles northeast of Portland.

Concession VI, Lot 7.[1]—In 1907, the Brockville Mining Company had fifteen men employed here, and installed a 40 H.P. boiler and a small plant. A pit 85 feet deep and measuring 60 × 60 feet was sunk on an inclined vein of dark-amber mica 4 feet wide and dipping 45°. Work does not seem to have been continued for very long and no mining has been carried out for several years. The mine is situated 3 miles from Elgin, and the mica was shipped to Perth to be cleaned.

(The writer could gather no information concerning the above mine when visiting the neighbourhood, and as the map shows that the district is overlain by sedimentary rocks it is possible that the description is intended for the Sand Lake mine, on concession VII, lot 14, of South Crosby township.)

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[1] Ont. Bur. Mines, Ann. Rep. XVI, p. 87.

CHAPTER V.

MUSCOVITE OR WHITE MICA IN CANADA.

Introduction.

Muscovite occupies only a minor position in the mica production of Canada, being found at relatively few points compared with the large deposits of phlogopite associated with the pyroxenite dykes.

The best deposits so far discovered are those of the Saguenay district, Que., situated on the lower St. Lawrence river, below Quebec.

Besides these, there are deposits to the north of Ottawa, at several places in Ontario, and in British Columbia.

Little activity has ever been displayed in the exploitation of muscovite deposits, the mineral having, until late years, usually commanded a somewhat lower price than the amber mica, owing to its greater hardness and to the fact that the sheets are frequently stained with iron or manganese, both of which are faults which impair its quality for electrical purposes. Then again, muscovite deposits are, as a rule, found associated with pegmatite dykes of small width, these seldom exceeding a dozen feet across their strike. The crystals occur disseminated somewhat sporadically throughout the mass of such dykes and it is relatively seldom that a deposit is met with which yields a steady and profitable yield, as is the case with amber mica occurrences. In most of the instances in Ontario and Quebec, such muscovite deposits have been worked in a small way to a depth of some 20 feet, and then abandoned as soon as mining difficulties, with a consequent increase in expense, set in.

First-class, i.e., clear and unstained, sheets measuring 3″ × 5″ and upwards are, at the present time, almost as much in demand and command as high a price from the dealers as similar-sized amber mica sheets.

Some prospecting has been carried on during recent years in the Yellowhead Pass district of British Columbia, and large-sized samples of clear white mica have been obtained. The latest advice from the British Columbia Bureau of Mines, however, seems to indicate that the mica industry in that region is still only in a preliminary stage of development, and there is, as yet, no recorded output from the mines.

Many of the following descriptions of muscovite occurrences, etc., are taken from the previous reports of Mr. Cirkel and Mr. Obalski, and from the Reports of the Canadian Geological Survey.

Geology.

The exploitation of muscovite deposits in Canada has been attended with many difficulties, and it is hardly to be wondered at that, save in a few instances, where deposits of unusual richness have been encountered, a speedy abandonment of the pits has resulted. The often isolated positions of the deposits, their sporadic and somewhat erratic occurrence, combined with the difficulties of transportation, are factors which heavily handicap the growth of the industry.

The occurrence of muscovite is confined, in Canada as in other parts of the world, to pegmatite dykes or veins. These pegmatites are, in effect, coarse granites, or as they have been termed "giant granites," and are to be found in all parts of the world, cutting the more ancient rocks—such as gneisses and mica-schists. In Canada, they occur in what is known as the Laurentian formation, a vast complex of gneisses and crystalline limestones, associated with other dyke-like rocks, such as amphibolites, pyroxenites, etc. Pegmatite dykes are of frequent, and indeed, almost universal occurrence throughout the area of Laurentian rocks, and cut the gneisses both conformably and at varying angles to their strikes. The larger dykes are more usually found having a dip and direction corresponding to that of the enclosing rock, the former ranging from 35° to vertical and the latter being approximately N. 30° E. The smaller dykes seldom carry mica crystals of any size and often cut across the gneiss, etc., at various angles.

Credner, Dana, de Saussure, and Sterry Hunt, among other notable geologists, held the view that an analogy could be drawn between pegmatites and true lodes, and that the mineral content of the former was the result of successive deposition from aqueous solution on fissures in the gneiss or schists in which they occur. The opinion generally held at the present day is that pegmatite dykes represent 'after-births' of a normal deep-seated granite, and are the result of pneumatolytic emanations from a still fluid granitic magma during its process of cooling. An alternative theory is that the dykes represent apophyses of a granitic intrusion, the variation from normal granitic structure being due to the different conditions of temperature and pressure prevailing within the confined space of a fissure and also to an excess of w[illegible] vapour in the residual magmatic mass. Holland is inclined to the vi[illegible] he schists traversed by the pegmatite dykes, while to some extent alt[illegible] the action of the intrusions, have, in return, exerted a correspondi[illegible] influence upon the composition of the dykes.

Though, as a rule, carrying only muscovite mica, pegmatite dykes not infrequently contain a considerable amount of biotite or black mica. This is the case with the dykes in the Saguenay district, Quebec, and the same feature has been met with in the Hastings area, Ontario. In Methuen township, the occurrence is recorded of muscovite crystals measuring 3″ × 4″ across in syenite-pegmatite dykes. These dykes have been worked for corundum, and at a depth of 15 feet biotite crystals containing corundum inclusions were [illegible]ntered. At 41 feet the vein ended in a mass of corundum, muscovite, and biotite. Much of the mica met with in corundum deposits is regarded as constituting an alteration product of the corundum.

Typical examples of pegmatite dykes containing mica deposits of economic value are depicted in Figs. 5, 6, and 7, pages 38, 39, and 40. Though not of such high mica content as the Indian pegmatites, the Canadian deposits yet resemble these in their general geologic features.

As a rule, muscovite sheets of commercially valuable size do not occur in dykes of less width than 5 to 10 feet. Occasionally good-sized crystals are met with in narrow dykes, but the occurence is usually sporadic and prohibits profitable mining. On the other hand, some of the largest dykes contain no muscovite at all, being composed mainly of quartz and feldspar. The size of muscovite sheets ranges from small scales, similar to those found in normal granites, to plates 3 and 4 feet across. For further notes on the geology of muscovite deposits, see under Brazil, India, and German East Africa.

Location of Muscovite Mica Occurrences.

PROVINCE OF QUEBEC.

Saguenay District.

On the east side of the Saguenay river, a number of coarse pegmatite veins occur cutting the dioritic gneiss. This region is not surveyed or thoroughly explored, but since 1891 and 1892 constant discoveries have been made, some of them of very large extent. The mica generally found here has a kind of dark rose colour when in thick sheets. The principal deposits have been found in the townships of Bergeronnes, Tadoussac, and Escoumains.

The *McGie mine* is situated in block G, Bergeronnes, 12 miles from Lac des Escoumains The vein, according to Mr. Obalski's examination, runs northeast for a length of a fourth of a mile, cutting the dioritic gneiss strata. The width is from 15 to 25 feet in the southern part, where the same has been worked for a length of 140 feet. On the northern part the vein measures over 75 feet and large crystals can be seen distributed all over the matrix. Two pits, 15 and 25 feet deep, have been sunk. Some of the mica crystals are of large size but break up in small sheets when freed from the rock. Very fine crystals of tourmaline, of garnet and beryl, the last sometimes 3″ in diameter, are met with; small quantities of apatite also are found in the vicinity of the mica crystals. The mica generally is of excellent quality, clear and free from spots and well adapted for ornamental purposes. Fifteen tons of rough mica crystals produced $2\frac{1}{4}$ tons of cut mica, 3″ × 4″; some larger sizes measured 7″ × 10″. The mine has been worked intermittently, and at present operations are suspended.

Adjoining this property is the Moreau mine belonging to Mr. L. A. Robitaile, of Quebec. The vein has a northeasterly direction and exhibits, where it has been explored, a large number of fine transparent mica crystals. Though there are many pegmatite dykes in the surrounding country, no work has been done on them.

The next property of importance is the Beaver Lake claim, known as the *Hall mines.* It is situated at the head of the little Bergeronnes river, near the lake, about 11 miles from the St. Lawrence river. The width of the vein, according to Mr. Obalski, is 100 feet, increasing sometimes to 200 and even to 300 feet, with a vertical dip and a northeasterly course. Several exposures of the vein show fine mica crystals irregularly distributed through the pegmatite. This property has yielded white transparent mica of exceptional value.

In addition to the above described occurrences there are a great number of prospects, some of them of very promising character. Several veins have been reported in the country north of the McGie mine, at the head of the rivers Beaulieu and Bas de Soie, but the remoteness of these locations is a great hindrance, at present, to their successful exploitation. Between Tadoussac and Bergeronnes, on the little Bergeronnes river, a dyke of pegmatite has been discovered holding large mica crystals on the contact with the gneiss. The vein has been opened up by Messrs. Dupuis and Latimer, of Quebec, and has given encouraging results.

Along the banks of the Canard river, near the St. Lawrence, a large number of pegmatite veins have been located, but the mica, with one exception, occurs only in small crystals.

In this exception, a large vein of quartz associated with another vein of pegmatite exhibits an appreciable amount of crystals of fair size. In the Lake St. John region many discoveries have been made, but the transport difficulties are so great that, up to the present, no serious exploitation has been attempted.

The chief mica outcrops have been located in Pontbriand township, near the headwaters of the Peribonka river, and 250 miles north of Lake St. John. The mica is reported to be of good size and very clear, occurring in a pegmatite dyke of large extent.

Large crystals are also recorded from near Notre Dame des Anges on the Batiscan river, Lake St. John district.

On the north shore of the Gulf of St. Lawrence, north of the island of Anticosti, numerous pegmatite dykes carrying some mica are to be found on the islands in the mouth of the River Watshishu. The dykes attain their greatest development on the east coast of the Bay of Quetachu, Manikuagan, and carry, besides mica, large quantities of valuable feldspar.

Mention of an occurrence of dark mica, in crystals 2 feet across, is made by J. Laflamme,[1] from the vicinity of l'Anse à Caron, on range III of Jonquière, Saguenay district. No exploitation of the deposit has apparently ever taken place.

[1] Rep. Prog., Geol. Surv., Can., 1882-84, p. 9 D.

An occurrence of muscovite associated with schörl is recorded from Yeo island, in the Upper St. Maurice river, Portneuf county, but the deposit does not appear to have been worked to any extent.

OTTAWA COUNTY.

Township of Villeneuve.

Range I, Lot 31.—Villeneuve mine. Situated 20 miles north of Buckingham and 3 miles east of the Lièvre river. This deposit was first mined in 1884, by Mr. W. A. Allan, of Ottawa, who later sold the mine to the Canadian Mica and Mining Company, Limited. This Company worked

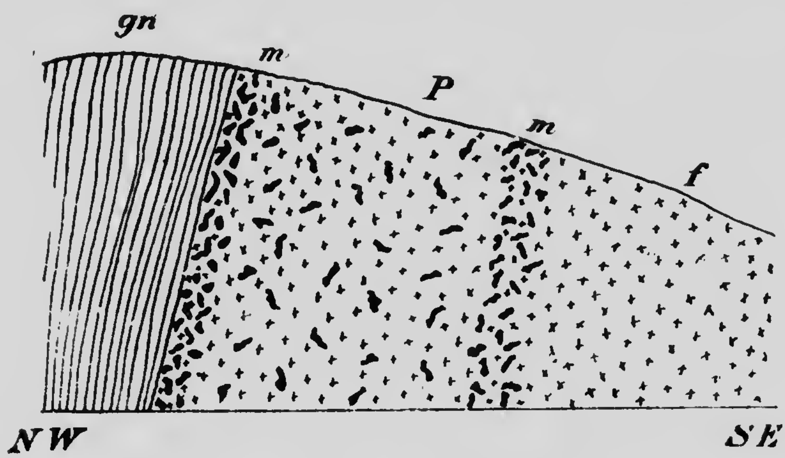

FIG. 50.—Section of hill at Villeneuve mine, lot 31, range I, township of Villeneuve, Que. gn, gneiss; P, pegmatite dyke; m, mica zones; f, massive feldspar (microcline and albite).

steadily from 1884 to 1888, and produced about 35,000 pounds of cut marketable sheets of excellent quality. The mine, which was well equipped with modern machinery and employed a staff of about twenty-five men, passed, in 1888, into the hands of Mr. S. P. Franchot, who worked intermittently from 1890 to 1898. In 1908, the property was purchased by O'Brien and Fowler, who continued to work until December, 1909, with an average of ten men. Since this date the mine has been idle.

The property was formerly equipped with an extensive plant, but the boiler-house containing compressor, etc., was destroyed by fire some seven years ago. The present buildings consist of a large culling-shed, a boarding-house, smithy, and waste sheds. The mica from the Moose Lake mine, belonging to the same owners, is brought here by road for culling, a staff of girls being employed for the purpose.

The Villeneuve mine is situated upon one of a parallel series of white pegmatite dykes which have been intruded along the bedding of a reddish-

PLATE XVIII.

General view of Villeneuve mine, lot 31, range I, township of Villeneuve, Que.

grey, fine-grained gneiss. The dykes strike northeast and southwest and dip some 80° to the northeast. They are of varying widths, the one in question being the widest and measuring about 150 feet across.

The country gneiss is highly garnetiferous and is tourmalinized adjacent to the contact, as a result of the granitic intrusion. The workings are situated on the southwest side of a low hill (See Plate XVIII) and consist of an open drift carried some 100 feet into the hill and having a height of 60 feet at its inner end. From the bottom of the open-cut, additional drifts have been cut into the hill, and a shaft 12 × 12 feet sunk to a depth of 50 feet. The mica occurs principally along and adjacent to the western contact, and it is here that the most extensive work has been carried out. The dyke mass consists of an intimate association of white feldspar (microcline and albite) and grey quartz, in which the muscovite crystals occur embedded.

Black tourmaline (schörl) is abundant throughout the rock-mass in large, well-formed needles, which often occur in radial aggregates and sometimes possess a length of several feet and a thickness of a couple of inches. Plate XXXIa shows such tourmaline crystals traversing a mass of feldspar.

The occurrence of spessartite, a member of the garnet family with manganese content, and of a reddish-brown colour, is of interest. The mineral occurs, generally in local aggregates, but sometimes also as scattered individuals, throughout the mass of the dyke. The crystals do not, as a rule, possess definite outlines, being usually distorted and with rounded faces. Exceptions to this mode of occurrence are, however, those garnets not infrequently found included in the muscovite crystals themselves. These, though sometimes rather flattened, are usually well developed examples of the usual dodecahedron type. Other minerals which, though not common, sometimes are found in the dyke, are: grey-green apatite, (usually massive); zircon, in medium-sized individuals; purple fluorite; beryl; and the rarer minerals monazite, pitch-blende, and the alteration product of the last-named, gummite. These minerals are to be considered more in the nature of curiosities than economic products, being rarely found in any quantity. The mica, which was formerly much in demand for stoves, etc., is a greenish muscovite and occurs often in large crystals. One crystal found weighed 281 pounds and measured 30″ by 22″, yielding $500 worth of merchantable mica.

The individuals seldom possess regular crystal outline, being usually of rather indefinite form, though distortion due to crushing is rare. The sheets are, as a rule, flat and split readily, but are not very resilient, having a hard, brittle feel, when bent. In addition, the quality of the sheets is often much impaired by the presence between the laminæ of numerous flattened garnet crystals, which are so thin as to be little more than stains. Dendritic films of specularite and göthite are also common and often render the sheets almost opaque (See Plates XXXVII and XXXVIII).

These inclusions render the sheets unsuitable for electrical purposes, since they improve the conductivity of the mica, while for stove and lamp purpose, they are equally unsuitable. Consequently it is difficult, at present, to find a market for the mica produced, and large quantities are at present lying at the mines.

The feldspar, which has been won as a by-product to the mining for mica, is of two varieties, microcline or potash-soda feldspar, and albite or soda-feldspar. Both are generally white, though the variety of microcline known as amazon-stone and greenish in colour, is sometimes met with. Peristerite, the name given to a variety of albite showing high iridescence, is not uncommon, and beautiful examples of this mineral, which rivals labradorite in its varieties of colour-play, have been found at the mine.

The feldspar has, on account of its purity, been recognized both in England and the United States as remarkably fit for the manufacture of fine chinaware. Mixed with kaolin in the proportion of 52 per cent, tests have given the best results. In 1889 about 400 tons were shipped to England and to the United States, and although the price paid ($7 to $9 a ton) is not very high, pure feldspar must be considered a commercial by-product in connexion with mica mining.

The following analysis of the feldspar has been made by the United States Geological Survey, and in order to demonstrate the remarkable purity of the mineral the theoretical composition is added:—

	Analysis.	Theoretical Composition.
Silica	63·96	64·61
Alumina	19·46	18·49
Potash	16·88	16·90
Iron	trace.	

A sample of uraninite, or pitch-blende, from this mine, has been analysed by the United States Geological Survey, and was found to contain:—

Oxide of uranium	37·70%
Oxide of yttrium	2·57%
Oxides of cerium and thorium	6·81%

A specimen of gummite obtained by the writer was found to slightly excite the scintilliscope, showing the presence of small quantities of radium.

Cerite is reported to occur, and a brown, compact mineral having a matt appearance and resembling monazite was found. The occurrence of such minerals containing rare earths is interesting, but, as remarked above, is so seldom that no possibility exists of their ever being economically exploited.

Some of the massive quartz from this mine is remarkably clear and free from flaws. When cut en cabochon, it displays a well-defined six-rayed star, and is then of value as a gem stone—so-called 'quartz asteria' or 'star-quartz.'

Plate XIX shows a narrow vein of pyroxene-quartz-porphyry, which traverses the pegmatite dyke near its southeast contact with the gneiss. The vein is only a few inches wide and consists of a black, compact, and very

PLATE XIX.

Vein of pyroxene quartz-porphyry cutting pegmatite, Villeneuve mine, lot 31, range I, township of Villeneuve, Que.

hard rock, and is striking as being the only evidence seen in the district of later intrusions than the pegmatites themselves.

A specimen of rose-coloured muscovite from this mine is mentioned by G. C. Hoffmann in 1887.[1]

The finding of a large mass of monazite is also mentioned on page 18 T of the publication quoted, and an analysis of a portion of this mineral will be found in the American Journal of Science, 3rd Ser., Vol. 38, 1889, page 203. A mass of uraninite of over 1 pound in weight, partly altered to gummite, is said to have been found in the mine in 1885.

Township of West Portland.

Range II, Lot 20.—Indications of muscovite are reported to occur on this lot. The sheets are, however, much stained by iron, and contain specularite and garnet inclusions.

Lot 21.—A little mining for muscovite mica was carried out here about fifteen years ago by Hon. C. A. Dugas, but the quality of the sheets was much impaired by iron-stains, and no further work has been undertaken.

Township of Hull.

Range XII, Lot 7.—Small deposits of muscovite occur on this lot, but have never been exploited. Pegmatite dykes are common throughout the district and possibly carry muscovite mica, but no occurrences of importance have as yet been discovered.

Township of Buckingham.

Range XII, Lots 12, 13.—Pearson mine. A coarse pegmatite occurs on this property and has been worked for feldspar. A considerable quantity of mica has been found, but is of little value on account of the stains and inclusions it contains.

Township of Wakefield.

Range VII, Lot 25, E.½.—Leduc mine. This property belongs to O'Brien and Fowler, and has been worked for feldspar and tourmaline. The deposit is of the usual pegmatite type, and carries green feldspar (amazonite), peristerite, and garnet, in addition to small plates of grey lepidolite and aggregates of green and red tourmaline. A quantity of the latter mineral was mined with the idea of employing the clearer and more perfect crystals as gem stones, but the proportion of valuable to cloudy and fractured specimens was so small that operations were abandoned.

The mica has little commercial value, being hard and brittle, and only of importance as an eventual source of the element lithium, of which it contains some 5 per cent.

The occurrence of small quantities of uraninite, gummite, and fluorite is also recorded from this mine.

[1] Ann. Rep. Geol. Surv., Can., Vol III, p. 58 T.

In 1884, about a ton of lepidolite was mined under the idea that it was muscovite and sheets up to 2 feet in diameter are said to have been obtained. An analysis[1] of this mica gave:—

SiO_2	47·89
Al_2O_3	21·16
Fe_2O_3	2·52
MnO	4·19
K_2O	10·73
Na_2O	1·34
Li_2O	5·14
MgO	0·36
F	7·41
H_2O	1·90
Total	102·94

ARGENTEUIL COUNTY.

Township of Grenville.

Range VI, Lot 9.—Mica crystals of large size were mined here as far back as 1853, and sheets were sent to the Paris Exhibition in 1855. No work has been done for many years.

Outcrops of mica are reported also from range V, lot 10, and range X, lot 1, of the same township.

BERTHIER COUNTY.

Township of Maisonneuve.

The *Maisonneuve mine*, the property of Theodore Doucet, of Montreal, is situated on the southeast border of Mica lake, range II, lots 1 and 2, of the township of Maisonneuve, county of Berthier, 40 miles from St. Emilie station on the Canadian Pacific railway. The rocks on this property belong to the Laurentian gneiss varieties and are cut obliquely by a massive vein of pegmatite varying from 36 to 52 feet in thickness, copiously charged with muscovite in large crystals, many of which yield sheets of merchantable size and quality. This vein has been exposed by an excavation of about 20 feet by 12 feet, averaging 10 feet in depth. The vein runs due east and west, while the strike of the gneiss is N. 52° W., thus showing that the vein cuts the rocks of the country at an angle of 38°, the dip being perpendicular. A solid, well-defined wall can be seen on the northwest side; on the eastern side the wall has not been laid bare. The vein has been exposed by stripping for a distance of 300 feet and shows the characteristics of a promising deposit. The rock on either side and in contact with it, and throughout the country

[1] Ann. Rep. Geol. Surv., Can., 1899, p. 12 R.

generally, is a comparatively fine-grained aggregate of quartz, feldspar, and hornblende, with scaly particles of mica arranged in parallel layers. The vein matrix, on the other hand, consists of large and coarsely crystalline masses of pure quartz and flesh coloured orthoclase feldspar, confusedly aggregated together, but perfectly distinct and frequently appearing to penetrate each other with straight radiating cleavage faces for a considerable length. The white muscovite mica occurs in this vein partly in isolated crystals, distributed irregularly over the whole width, and partly in accumulations near the contact with the adjacent formation. All crystals obtained from this mine furnish fine sheets, cutting from 2" × 3" up to 3" × 7", and some crystals in situ measured 18" square.

This pegmatite vein, like that of the Villeneuve mine, is distinguished by the occurrence of foreign minerals. In addition to tourmaline, beryl, and garnets, the rare mineral samarskite occurs somewhat abundantly in the excavations made in the vein. An analysis of the samarskite found on this property gives the following percentages of the rare earths it contains:—

Oxide of uranium	... 10·75%
Oxide of yttrium	.. 14·34%
Oxide of cerium and thorium ..	. 4·78%

Township of De Sales

Another property which has come into prominence on account of the mineral cleveite,[1] containing radium, is situated 17 miles northeast of the village of Malbaie (Charlevoix county), near Lake Pieds des Monts, in the township of De Sales. The pegmatite vein has a length of 300 feet and an average width of 20 feet. Some exploration work was done on this property in 1893-4, and a crystal weighing 700 pounds and measuring 32" × 25", yielding perfect sheets of 10" × 14", was extracted. Fifteen to twenty tons of rough mica crystals were mined and prepared for the market.

The mine was subsequently worked by the Canadian Mica Co. for a few months, but the Company went into liquidation, and the property has since lain idle. The occurrence of biotite associated with the muscovite is noteworthy, but the former mineral is too crushed to be of value.

PROVINCE OF ONTARIO.

In the Province of Ontario, several deposits of promise have been discovered, but so far none of them have been worked to any extent.

One of the first—if not the first—mica mines to be operated in the Province, was that worked in 1869 by the New York Mica Co., on concession IX, lot 16,

[1] See Journ. Can. Min. Inst. Vol. VII, p. 245.

of the township of North Burgess. A force of 22 men was employed, and about 2 tons of mica were produced, most of which was shipped to the United States and presumably found use in the stove industry.[1]

In Frontenac county, Clarendon township, a deposit of muscovite was worked irregularly on concessi n II, lot 24, but the mica was found to be rather iron-stained, and work was abandoned some ten years ago.

In the adjoining township of Palmerston, a muscovite deposit was worked in the early eighties on concession II, lot 24, by a Mr. Sheppard. Plates 14″ × 18″ are said to have been extracted, but work was soon discontinued, —for what reason is not stated.

In the township of Miller, concession XI, lots 4 and 5, muscovite has been mined at intervals for some years. The locality lies about 20 miles from the Kingston and Pembroke railway, and the mica is often spoilt by iron stains.

In the township of Calvin, about 10 miles west of Mattawa, and 1½ miles northeast of Eau Claire station on the Canadian Pacific railway, deposits of white mica have been located and worked to some extent. Mining was practically confined to concession IX, lot 19, where the mineral occurs in a large pegmatite dyke cutting gneiss. The crystals were found to be of small size, and work was soon abandoned. On concession I, lot 9, a deposit of greenish muscovite was worked in 1893 by Mr. J. McKay, who sank down 25 feet and then abandoned the pits.

On lot 16 of concessions I and II of the same township, Mr. F. B. Hayes, of Ottawa, started to work six parallel veins of mica-bearing pegmatite in 1893, but no records are to hand to show with what success.

Muscovite also occurs in considerable quantities in the neighbourhood of Allumette lake, near Pembroke, Renfew county, Ontario. Large muscovite crystals were reported to have been found by Mr. A. Murray many years ago, but the extent of the deposit is not ascertained.

On Yeo island, near the upper end of Tar island, one of the Thousand Island group in the St. Lawrence, small quantities of white mica have been found in a pegmatite dyke, but no mining has been carried out on the deposit.

Mica outcrops are also reported from the township of Cleland, 12 miles southeast of Sudbury, and from the township of Gladman, 20 miles north of Lake Nipissing.

In Hungerford township, Hastings county, small muscovite sheets averaging 6″ × 8″ were mined in the early nineties from a narrow pegmatite dyke having a strike of N.E. and S.W.

The occurrence of considerable quantities of muscovite along the Petawawa river is also recorded.

In Effingham township, Addington county, some small muscovite deposits were worked in 1890 by Messrs. Smith and Lacey, who subsequently opened the Lacey amber mica mine near Sydenham, Ont.

In the early nineties, a muscovite mine was being operated in Abinger township, near Mazinawe lake—with what success is not stated.

[1] Rep. Prog. Geol. Surv., Can., 1870-71, p. 316.

In Ferguson township, concession II, lot 18, 10 miles from Parry Sound, the Georgian Bay Mining Company, in 1894, had a few men employed extracting a rather mottled muscovite. The crystals are said to have been somewhat crushed, and the sheets did not exceed 8″ × 10″. The mine was named the Harris mine, and a depth of some 30 feet was reached in the workings.

The Oak Ridge mine, on concession XII, lot 8, of McDougall township, was opened in the same year as the above, and produced a small quantity of mottled white mica.

On concession X, lot 12, of the same township, the Valentine mine was operated for some months in 1894, and was equipped with a small boiler and hoist. The workings consisted of open-cuts and were not carried to any depth.

Promising outcrops of mica were at the same time reported from concession I, lot 2, of Ferguson, and also from the adjoining township of Burpee.

Near Edgington, in Chester township, the Virginia Mining Company, of Toronto, opened up a muscovite deposit in 1896, but do not appe[illegible] have been [illegible]ccessful. White mica mining in the Parry Sound district does not s[illegible] t[illegible] proved a very profitable undertaking. Numerous small surface si[illegible]e opened up in the nineties, and operations have been conducted on a small scale at various points during recent years. The openings made, however, seldom exceeded some 25 feet, and it would seem that the deposits are not rich enough to repay exploitation on a large scale.

A. C. Lawson[1] mentions a muscovite mica mine in operation, in 1885, on the south side of Falcon island, Lake of the Woods, but no recent work appears to have been carried out here. The mica occurs in a pegmatite dyke cutting gneiss, and the sheets are large but rather iron-stained. Deposits also occur on Sabaskong bay, and on Big island, as well as on Rainy lake, the first named locality being the only one so far worked.

In the Parry Sound district, in the township of Proudfoot, a coarse and fine-grained gneiss occurs, containing biotite and grey, muscovite mica. The gneiss is penetrated by various masses of fine-grained diorite and by a great number of pegmatite dykes that have attracted the attention of prospectors on account of the beautiful crystals they contain. These dykes vary greatly in size and composition, but even the narrow veins sometimes contain mica crystals of excellent quality. In one of the largest of these dykes the various minerals occur in crystals of gigantic size—microcline crystals attaining a length of 3 or 4 feet, and mica crystals frequently yielding plates of 8″ × 10″. Both biotite and muscovite are found here, but the muscovite, which is perfect in quality and cleavage, is alone suitable for commerce.

Outcrops of large-sized mica have also been located in the township of McConkey, concessions IV, V and VI, but the deposits proved to be mostly confined to the surface.

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[1] Ann. Rep. Geol. Surv., Can., 1885, Vol. I, p. 149 CC.

PROVINCE OF BRITISH COLUMBIA.

In British Columbia, some mica deposits have been exploited in the vicinity of Tête Jaune Cache, about 150 miles to the northwest of Donald, on the Canadian Pacific railway. According to Mr. McEvoy,[1] the mica occurs as a constituent of coarse pegmatite veins, which cut the country rock—consisting in that locality of garnetiferous mica schists and gneisses, the schists predominating. The pegmatite vein has a width of 15 feet, sometimes yielding crystals cutting sheets 18″ × 11″. These crystals are generally found on the hanging wall, while some are irregularly distributed through the vein. The mica is a transparent muscovite with a very light greenish tint, and appears to be of excellent quality.

The deposit was being worked by a force of twelve men at the time of Mr. McEvoy's visit, the mica being shipped out by pack-horses to the nearest railway.

There are a number of other deposits of this mica in the same locality, and it is possible that this region may produce an appreciable quantity of very fine, clear mica, which, on account of its high price, will be used for ornamental purposes only. A great drawback, however, to the proper exploitation of these deposits, is the lack of access and communication, all supplies requiring to be carried in by pack-trains over trails, which, for the greater part of the year, are in bad condition.

According to the latest advice from the British Columbia Bureau of Mines, the mica mines in this district are still only in the exploratory stage, and no production has up to the present been recorded.

The presence of mica—probably muscovite—is reported by Dr. G. Dawson, in veins in granitic rock in the vicinity of the northeast arm of Shuswap lake, and also from a point about 120 miles northeast of Clinton.

Muscovite crystals have further been collected from near the junction of the Canoe river with the Coldwater river.

NORTHERN LATITUDES.

Throughout the Archæan rocks of northeastern Canada, pegmatite dykes occur, containing large crystals of mica, but, owing to the bent and broken nature of the crystals, they are seldom of commercial value.

A. P. Low[2] mentions the occurrence of a brownish muscovite in crystals 4″ across in a pegmatite dyke on Lake Winokapau, on the Lower Hamilton river, Labrador, and a similar occurrence is also recorded from the Eastmain river, between Talking and Island falls.

Probably the first mica mine in operation in Canada was that on a tributary of the Eastmain river near James bay, called Isonglass river, in

[1] Rep. Prog., Geol. Surv., Can., VII, 1895, p. 224 L.

[2] Ann Rep. Geol. Surv., Can., Vol. XI, Part D, p. 39.

latitude 52° 35′. A deposit of muscovite is recorded[1] as having been worked here as far back as 1685, but operations do not appear to have been very successful.

Crystals and plates of muscovite were obtained in 1877, by Mr. Endlich, from Cumberland sound, on the east coast of Baffin island.

P. G. McConnell[2] mentions a muscovite deposit which was being operated in 1903 at Lake harbour, on the south shore of Baffin island, near Big island. Nine whites and a number of nati s were employed in the mine, and the output for the year in question is given as 13 tons of rough mica.

In 1885, the presence of mica was reported by Dr. R. Bell, along the shores of Hudson strait, but the definite locality was not ascertained. Specimens of very clear mica are also reported as coming from some part of the coast of Labrador, but no information as to the precise point is available.

R. Bell[3] records a mica mine in operation in 1881, on Chateau bay, Strait of Belle Isle. The mica is said to be dark in colour, and averages 3″ × 6″ diameter. About one ton was shipped in the above year, via St. John, to Boston.

R. Bell also obtained specimens of muscovite from the Eskimos, on the north shore of Hudson straits, in 1884. Indications of mica seem to be fairly abundant in the district, and it was reported that traders took considerable quantities away.

Besides the foregoing, an occurrence of muscovite in large crystals is mentioned by J. B. Tyrrell[4] in a pegmatite vein near Cross lake, Saskatchewan. The locality was difficult of access, and there is no record of any work having been done.

[1] Ann. Rep. Geol. Surv., Can., 1887, Vol. III, Pt. II, p. 10 J.

[2] Ann. Rep. Geol. Surv., Can., Vol. XVI, 1904, p. 141 A.

[3] Rep. Prog. Geol. Surv., Can., 1882-84, p. 10 DD.

[4] Ann. Rep. Geol. Surv., Can., Vol. XII, 1900, p. 26 F.

PART II.

CHAPTER I.

MINERALOGICAL AND PHYSICAL CHARACTERISTICS OF MICA.[1]

Under the generic name "mica," are embraced—in a mineralogical sense—three groups of species possessing more or less similar characteristics:—

(1). The Mica Group, which comprises the micas proper.

(2). The Clintonite Group, or brittle micas.

(3). The Chlorite Group.

All the above species have highly perfect basal cleavage, and split easily into thin elastic laminæ. They crystallize in the monoclinic system, the crystals being often of pseudo-hexagonal or pseudo-orthorhombic habit, and exhibiting, in many cases, twin structure.

Chemically, the micas are silicates of aluminium, with potassium and hydrogen—often also magnesium, ferrous iron, and in some cases ferric iron, sodium, and lithium: further, in rare instances, barium and chromium. Fluorine is often present, while lime is seldom in evidence.

All the species yield water upon ignition, the true micas from 4 to 5 per cent and the chlorites from 10 to 13 per cent.

The minerals included in Group 2 resemble the micas proper both optically and crystallographically, but are chemically of more basic character, and are, in addition, distinguished by the extreme brittleness of the laminæ. They may be regarded as forming a transition from the micas proper to the chlorites.

The Chlorite Group (3) includes a number of minerals characterized by their green colour, due to ferrous iron. The members of this group seldom occur in crystals of large size; they generally form scales and incrustations on the walls of druses in dolomites and mica schists; they are also associated with serpentine, and sometimes fill cavities and seams in basic igneous rocks. They are frequently alteration products of ferro-magnesian silicates, and as such are often massive or earthy.

The species are, in many respects, closely related to the micas, crystallizing in the monoclinic system and possessing prominent basal cleavage: the laminæ are, however, tough and comparatively inelastic.

Chemically the chlorites are silicates of aluminium with ferrous iron, magnesium, and chemically combined water. Calcium and alkalies—the latter present in all the true micas—are to be found only in small amount.

The members of Groups 2 and 3, though of no value commercially, are, on account of their extensive occurrence as rock-forming minerals, of con-

[1] Latin, "micare," to shine; French, "mica"; German, "glimmer."

siderable geological importance. Many of them are pseudomorphs, or alteration products of other minerals. Such are: margarite, a species belonging to the Clintonite Group commonly found with emery and corundum, and regarded as formed directly from these minerals; ottrelite, a secondary species characteristic of sedimentary rocks which have suffered dynamic metamorphism, with the formation of so-called ottrelite-schist.

A further group of allied micaceous minerals are the vermiculites, hydrated silicates related to the chlorites and regarded as alteration products of the true micas.

None of the species included in Groups 2 and 3 are of sufficient economic importance to require more than the abov. passing notice, and it is certain members of the group of the true micas which engage the attention of miners.

MICAS PROPER.

This section includes the following main species—among which are to be found the micas of commerce.

Muscovite (Potash Mica).—This variety, which derives its name from its having been first obtained from Russia or Muscovy, is the commonest mica, and is the species usually present in granites and mica schists. In colour it is, as a rule, light, and sometimes clear and colourless, having a pearly lustre on the cleavage surface. As one of the two chief micas of commerce, its occurrence, etc., are further described in Chapter I.

Paragonite (Soda Mica).—The name paragonite was originally given to a white schist found at Monte Campione, in Switzerland, and which contains beautiful blue prisms of cyanite or disthene, associated with reddish-brown staurolite.

The rock was formerly supposed to be a talc schist, and received its name in allusion to its mistaken composition.

Lepidolite (Lithia Mica).—This is a rose-coloured, lilac, white, and sometimes grey mineral, which is one of the rarest of the micas. It is seldom found in anything but scaly aggregates, as, for example, at Pala, San Diego county, California, where a lenticular deposit of beautiful, lilac-coloured lepidolite containing the well-known rubellite, or pink tourmaline, has been mined to a considerable extent. Other localities where the mineral is found are western Maine, and the Black hills of South Dakota. At the latter place t occurs in connexion with the tin and wolfram deposits. Formerly of importance on account of its lithia content, which averages 4 to 5 per cent, and mined both at Pala and in the Black hills for this purpose, lepidolite no longer is a mineral of economi value, the triphylite, spodumene, and amblygonite deposits of Dakota and North Carolina having taken its place as sources of lithia.[1]

The colour of lepidolite is probably due to manganese.

[1] F. L. Hess. Mineral Resources of the United States, Calendar Year, 1909. Washington, 1910.

Zinnwaldite (Lithia-iron Mica).—

This mica takes its name from Zinnwald, Erzgebirge, where it is found accompanying cassiterite and wolframite in the tin-lodes of that district.

Zinnwaldite and related lithia-iron micas are characteristic of pegmatitic veins in granites and gneisses, and especially of those in which cassiterite associated with fluorite occurs.

The lithia content of the Zinnwald mica averages 3·35 per cent and mining was formerly carried on in this district for the mica on account of the lithium it contained.

The colour of the mineral is usually a brown or grey and sometimes greenish. The so-called "rabenglimmer," from Altenberg, is a dark, blackish-green variety of zinnwaldite.

Biotite (Ferro-magnesian Mica).—

Usually of a dark colour, biotite is regarded as forming one extreme of the magnesia micas; it is, in fact, a ferriferous phlogopite, and as such, may, with decreasing iron content, become normal phlogopite

Biotite, in small scales, is a usual constitutent of granite and eruptive rocks. Owing to its iron content and colour, it is unsuitable for trade purposes, and although much dark, so-called phlogopite, or amber-mica, is mined, it is questionable whether a large proportion of this is not in reality biotite. This being the case, and since no sharp distinction between biotite and phlogopite exists, many of the deposits mentioned in the preceding pages, and classed under phlogopite, may possibly be more correctly termed biotite mica deposits.

Since it would be necessary, for an accurate determination of the species, to conduct in each case a detailed optical and chemical analysis of the mica, and since such an examination hardly comes within the scope of this report, it has been deemed sufficient to class all the so-called "amber micas" under the common head of phlogopite, indicating by the colour in each instance to which extreme the particular mica belongs.

Phlogopite (Magnesia Mica).—

As described above, under phlogopite are classed the lighter-coloured and relatively iron-free magnesia-micas. The colour is usually a brownish to yellow, and the sheets have generally a mottled appearance. In addition to occurring in economically valuable deposits associated with dykes of basic rock, generally pyroxenite, phlogopite is also found in many metamorphic limestones, especially in those belonging to the Archæan period. Such limestones, altered either by contact or dynamic metamorphism, frequently contain phlogopite in considerable amount. The crystals are, as a rule, small and well defined, though occasionally large individuals occur.

Lepidomelane (Iron Micas).—

Under this name are grouped a series of micas with high iron and low magnesia content. They are all black, and possess a high glassy lustre.

These micas occur as small plates in plutonic rocks (granites and gneisses), and are known from Germany, Ireland, Scotland, and Finland.

In addition to the preceding, the following less important minerals may be mentioned as belonging to the group of the true micas:—

Alurgite, a manganese mica, from Piedmont; roscoelite, a vanadium mica of doubtful formula from California; coellacherite, or barytes-mica, from the Tyrol.

Chemical Composition.

The theoretical chemical compositions of the various micas are given below. Owing to the fact, however, that most micas contain quantities of minute inclusions of foreign minerals which may affect the analyses, and also that, in most cases, the equivalent elements replace each other in some degree, the results obtained are seldom found to agree with the theoretical compositions.

In the case of biotite, for instance, the two percentages given represent the extremes of the mineral with the highest and lowest iron content, respectively, the usual composition being more or less midway between the two.

In other micas, fluorine often replaces hydroxyl to some extent.

Muscovite: $H_2KAl_3Si_3O_{12}$.

Silica. SiO_2	Alumina. Al_2O_3	Potash. K_2O	Water. H_2O	Total.
45·2	38·4	11·8	4·6	100·00

The above represents the normal composition of the clear muscovite of commerce. Fluorine and iron are often present in small amount, while lithium and titanium occur in certain varieties.

The iron content is appreciably higher in the brown and red-stained sheets.

Paragonite: $H_2NaAl_3Si_3O_{12}$.

Silica. SiO_2	Alumina. Al_2O_3	Soda. Na_2O	Water. H_2O	Total.
47·1	40·1	8·1	4·7	100·00

Potash usually replaces soda to some extent.

Lepidolite: $HLi_2K_2Al_4Si_6O_2$.

Silica. SiO_2	Alumina. Al_2O_3	Potash. K_2O	Lithia. Li_2O	Water. H_2O	Total.
48·6	27·1	18·9	4·0	1·4	100·00

Fluorine is generally present in varying amount; lepidolite from Juschkowa in the Ural mountains contains as high as 8·7 per cent, often replacing hydroxyl; while a lithia content of 5·9 was found in a lepidolite from Paris, Maine.

Zinnwaldite: $Li_2K_2\overset{II}{Fe_2}Al_4Si_7O_{24}$

Silica. SiO_2	Alumina. Al_2O_3	Potash. K_2O	Ferrous oxide. FeO	Lithia. Li_2O	Total.
47·1	22·9	10·5	16·1	3·4	100·00

Fluorine is nearly always present, some varieties containing as high as 8·0 per cent. Water is also often present in small quantity.

The zinnwaldite from Zinnwald has been found to contain traces of rubidium, cæsium, and thallium, and boron has been detected in some cases—as also in some lepidolites.

The variety of zinnwaldite known as cryophyllite, from the granite of Cape Ann, in Massachusetts, has the following composition:—

Silica SiO_2	Alumina Al_2O_3	Ferric oxide Fe_2O_3	Ferrous oxide. FeO	Potash K_2O	Lithia Li_2O	Fluorine F	Total
53·5	10·8	1·9	8·0	13·2	4·1	2·5	100·00

Polylithionite, an optically related mica from Kangerdluarsuk, in Greenland, contains:—

Silica SiO_2	Alumina Al_2O_3	Lithia Li_2O	Soda Na_2O	Potash K_2O	Ferrous oxide FeO	Fluorine F	Total
59·3	12·6	9·0	7·6	5·4	0·9	7·3	102·1

Biotite: $(H,K)_2\ (Mg,\overset{II}{Fe})_2\ (Al,\overset{III}{Fe})_2\ Si_3O_{12}$.

The above formula indicates the possible range in chemical composition of biotite.

The equivalent elements, univalent, bivalent, and trivalent respectively, contained in the three sets of brackets, are interchangeable, so that, theoretically, the composition may in one instance be represented by:—

$$K_2Mg_2.Al_2Si_3O_{12}.$$

corresponding to:—

Silica SiO_2	Alumina Al_2O_3	Potash K_2O	Magnesia MgO	Total
39·5	22·4	20·6	17·5	100·00

while the other extreme would be:—

$$H_2\overset{II}{Fe_2}\overset{III}{Fe_2}Si_3O_{12}\text{ ; or}$$

Silica SiO_2	Ferric oxide Fe_2O_3	Ferrous oxide FeO	Water H_2O	Total
35·9	31·9	28·6	3·6	100·00

These two theoretical extremes probably never occur in nature, the equivalents replacing one another in varying ratios. Water, for instance, is always present, replacing in part the potash, and fluorine is also generally a constituent.

According to Tschermak, biotite is a mixture of $H_2KAl_3Si_3O_{12}$ (muscovite) and Mg_2SiO_4 (olivine) in the normal ratio of 1:3.

Phlogopite: $K_2Mg_6.Al_2Si_5O_{20}.$

With increasing iron content, approaches biotite in composition, and usually contains, in addition, soda, fluorine, water, and traces of lithia. The red-brown varieties all contain fluorine, while the green phlogopites have the smallest fluorine content.

The theoretical chemical composition of normal phlogopite is:—

Silica SiO_2	Alumina Al_2O_3	Magnesia MgO	Potash K_2O	Total
40·8	13·9	2·6	12·7	100·00

Lepidomelane: $HK_2\overset{II}{Fe_3}\overset{III}{Fe_6}Al_3Si_9O_{36}.$

The calculated composition arrived at from the above formula would give:—

Silica SiO_2	Alumina Al_2O_3	Ferrous oxide FeO	Ferric oxide Fe_2O_3	Potash K_2O	Water H_2O	Total
36·1	10·3	14·4	32·1	6·3	0·8	100·00

In addition to the water of constitution contained in all micas, a varying amount of mechanically held water is usually present in the crystals, and is given off on heating to [illegible]0° C.

In what manner the fluorine enters into the composition of mica, how the hydrogen is combined, how the excess or deficiency of oxygen above or below the orthosilic[illegible] is to be accounted for, and of what silicic acids these minerals are [illegible] problems which require still further investigation.

Heated in the [illegible], all the micas yield water. Lepidolite and zinnwaldite colour the [illegible] characteristic red, and fuse readily to a grey and dark globule [illegible].

Muscovite and [illegible] are little affected by boiling sulphuric acid, biotite and phlogopite [illegible] posed: all four minerals are only slightly fusible.

With the exception [illegible], which may eventually prove of importance as a source of lithia, the [illegible] members of the above group which are valuable from a commercial s[illegible] are muscovite and phlogopite (biotite).

As a result of a number of analyses of the various members of the mica family, F. W. Clarke[1] expresses his opinion that "all the micas, vermiculites, chlorites, margarite, and the clintonite group, may be simply represented as isomorphous mixtures, every constituent being a substitution derivative of normal aluminium poly- or ortho-silicate."

Distribution.

The various members of the mica family are of world-wide occurrence, and are amongst the most widely distributed, and on account of their high lustre, most conspicuous and easily recognizable of minerals. In the form of small scales and plates they are essential constituents of many of the chief rocks which go to make up the earth's crust. Granite, gneiss, syenite, and many schists contain mica in large quantities; while many other rocks, such as diorites, diabases, andesites, minettes, quartz porphyries, basalts, etc., all contain the mineral in greater or lesser degree. The rock-forming micas are mostly muscovite and biotite.

Metamorphic rocks, especially slates and similar sedimentary deposits, which have been subjected to regional metamorphism, often contain large quantities of mica.

[1] Amer. Jour. Sci., Vol. XXXVIII, 1889, p. 384.

Even rocks which macroscopically show no signs of mica are often found, when examined under the microscope, to contain considerable quantities of minute mica plates and scales. Owing to the great resistance it offers to weathering agencies, being little affected by moisture, etc., it is one of the most stable of minerals and is to be found practically fresh and unaltered in many products of disintegration of rocks, such as sands, conglomerates, and shales. Even in the more ancient of such sediments, as for example, in certain Silurian conglomerates of the north of Ireland, the flakes and scales of muscovite which occur plentifully scattered throughout the mass of the rock and which primarily formed part of an older granite or gneiss, still exhibit all the freshness and lustre they originally possessed in the parent rock.

Economically considered, mica deposits are confined to some half dozen countries. Muscovite is produced in large quantities by British India and the United States, and in lesser degree by Canada, Brazil, and German East Africa, while practically the entire world's supply of phlogopite is derived from Canada.

NOTEWORTHY LOCALITIES

Muscovite. The largest and finest examples of muscovite are found in the granites, and particularly in the white, albitic pegmatites. Large specimens occur in the Ural mountains, notably at Alabaschka and Ekatherinburg, associated with orthoclase, albite, and smoky quartz. Very large sheets are also obtained from Solovetsk island (Archangel).

Muscovite is won in commercial quantities in India, in the Provinces of Bengal, Madras, and Rajputana, the principal mines lying in the districts of Hazáribágh, Gáya, and Monghyr, in Bengal; Nellore, in Madras; and Ajmere and Merwára, in Rajputana.

The Brazilian granites afford an increasing supply of high-grade muscovite, the chief sources of supply being the States of Goyaz and Bahia, while a considerable quantity comes from the neighbourhood of Santa Luzia de Carangola, in the State of Minas Geraes.

German East Africa produces considerable quantities of muscovite, the occurrences being in the Uluguru mountains and neighbouring ranges.

Fine crystals occur at St. Gotthard, and Binnenthal, in Switzerland; Falun, in Sweden; also in Finland, at Pargas and Kimito.

In the United States, the principal occurrences are situated in North Carolina: in Jackson, Mitchell, Ashe, and Macon counties; Idaho: Latah county; Maryland: Howard and Montgomery counties; New York: St. Lawrence county; South Carolina: in the Grenville region. Massachusetts, Connecticut, Pennsylvania, North Carolina, Georgia, and Alabama also contain muscovite deposits.

In Canada, the chief occurrences are in the Saguenay district; Villeneuve township, Ottawa county; Maisonneuve township, county of Berthier; and

De Sales township, Charlevoix county—all in the Province of Quebec. In Ontario: in the Parry Sound district, in the townships of Proudfoot and McConkey.

Paragonite.—The best known occurrence of paragonite is at Monte Campione, near Faido in Canton Tessin, Switzerland, where it forms the matrix of the well-known blue cyanite and brown staurolite crystals.

It is also found in the Zillerthal, Tyrol; at Krutoi Klutsch, in the Nischne Issetsk district, Ural; at Unionville, Delaware county, Pennsylvania, associated with tourmaline and corundum.

At all but the last named locality, paragonite occurs in the form of mica-schist, composed of small, grey and yellowish scales.

Lepidolite.—Lithia mica occurs almost always associated with granite or pegmatite. At Mount Hradisko, near Rozena, in Moravia, it is found in aggregates of small flakes of a peach-red colour, associated with tourmaline, topaz, etc. The zone of occurrence is at the junction of a pegmatitic vein-granite with granulitic gneiss, and the lepidolite runs as high as 5·88 per cent lithia. This locality has been extensively mined in the past for the mica, which was formerly the principal source of the lithium used for medicinal purposes.

Lepidolite also occurs in coarse pegmatite veins near Penig and Wolkenburg, in Saxony; at Schaitanka and Alabaschka, near Ekatherinburg, in the Urals, also associated with tourmaline and topaz; and in the granite of St. Michael's Mount, Cornwall.

At Pala, San Diego county, California, massive, lilac-coloured lepidolite occurs as a lenticular deposit, associated with the beautiful pink variety of tourmaline known as rubellite.

At Hebron, Paris, and Auburn, in Maine, lithia mica is found in some quantity.

The pegmatites of the Black hills, South Dakota, contain lepidolite accompanying spodumene and amblygonite.

In Canada, lepidolite occurs in Wakefield township, Que., in a coarse, white, pegmatitic, granite dyke. The mica is of a greyish colour, and crystals of fair size occur: here also, pink and green tourmaline are associated with the mica.

A few years ago, a mica with a high lithia and soda content was discovered near Mesores, France, and was given the name hallerite by its discoverer.[1]

Zinnwaldite.—Zinnwaldite, or lithia-iron mica, is found principally at Zinnwald and Altenberg, on the borders of Saxony and Bohemia. At these places, coarse, pegmatitic veins carrying considerable cassiterite traverse granite and quartz porphyry. These veins contain large quantities of grey to brown zinnwaldite, associated with fluorite, topaz (pyknite), scheelite, and other minerals characteristic of tin-lodes. The "rabenglimmer," found at

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[1] Comptes Rendus, June, 1908.

Altenberg, is a dark, greenish-black variety of zinnwaldite. Much of the mica which accompanies cassiterite and tourmaline (schörl) in the Cornish granite is probably zinnwaldite.

Zinnwaldite has also been recorded from the York region, Alaska, where it occurs in a similar manner with cassiterite and topaz.

Biotite.—Beautifully crystallized biotite occurs in the acid ejections of Monte Somma (Vesuvius), and also in the druses of the limestone blocks from the same locality.

Large dark-brown sheets of biotite are found in a coarse, granular limestone on the river Sljudjanka, near Lake Baikal, Siberia. This mica is the typical anomite of Tschermak. At Mount Monzoni, in the Fassathal, small dark crystals occur in a white, dolomitic limestone.

Phlogopite.—At Campolongo, St. Gotthard, Switzerland, well-crystallized phlogopite is found in scales and plates in white dolomite, associated with greenish tourmaline.

Similarly, in crystalline limestone at Pargas, Finland, with paragasite, graphite, etc.

At Oxbow, Jefferson county, New York, phlogopite occurs in white crystalline limestone, mixed with serpentine. The crystals are of a brown colour, and are usually tapering prismatic in form.

Many metamorphic, crystalline limestones contain small scales and plates of brown phlogopite. The most notable occurrences of phlogopite are in Canada, the principal regions being: in Quebec, north of Ottawa and the Ottawa river, and in Ontario, south of Perth.

Lepidomelane.—Occurs in small plates only, in certain granites and gneisses, notably at Persberg, in Wermland; Harzburg and Freiberg, in Germany; Leinster and Donegal, in Ireland; Sutherland, in Scotland; and in the Finnish Rapakiwi.

An occurrence of lepidomelane is recorded from the Bob Neil mine, concession X, lot 14, of the township of Marmora, Hastings county, Ont.

The mica occurred associated with arsenical pyrites, and gave on analysis[1]:—

SiO_2	37·79
Al_2O_3	14·34
Fe_2O_3	4·52
FeO	26·32
MnO	0·29
CaO	1·45
MgO	4·68
K_2O	7·24
Na_2O	2·00
TiO_2	0·92
H_2O	5·06
Total	104·21

[1] Rep. Prog. Geol. Survey, Can., 1892-3, p. 14 R.

Further occurrences of the mineral are recorded from lot 16, concession XI, of the above township, and also in sodalite, from lot 29, concession XIII, and lot 25, concession XIV, of the township of Dungannon; and with pyrrhotite, from lot 2, concession II, of Drury, Algoma district.

The variety kanite is found at Rockport, near Cape Anne, Massachusetts.

Roscoelite.—Roscoelite has been worked to some extent in California and Colorado for its vanadium content, which, according to Mr. Curran (see below), runs as high as 14 per cent metallic vanadium.

The following notes[1] on the occurrence of the mineral, kindly supplied to the author by Mr. Thos. F. Curran, President of the General Vanadium Company of America, are of interest:—

"Massive roscoelite occurs in the Lower San Miguel mining district, San Miguel county, Colorado. The vanadium seems to have been in solutions that impregnated the sandstone. Immediately overlying the flat roscoelite deposits is a blanket, from 8 to 15 feet thick, of yellowish, porous sandstone, and this, in turn, is capped by a blanket of 'black limestone' from 5 to 10 feet thick. These ore bodies seem to have a mean elevation of some 8,000 feet. The richness and vanadium content of the roscoelite are variable. Wherever the ore body comes very close to the limestone cap, and when it runs into a fault, there is a marked increase of the vanadium content, the ore being at times as rich as 14 per cent metallic vanadium.

"The original workings were by the Vanadium Alloys Co. of New York, along Leopard creek, near Placerville, Colorado. The ore here is very low-grade—from 1 to 2 per cent V^2O^5,—and averages less than 1 foot in thickness. These mines, as well as all other property of the Vanadium Alloys Co., were leased to Primos Chemical Co., which operates a large vanadium oxide plant at Newmire (or Vanadium), 8 miles from Placerville.

"At Fall creek, 3½ miles from Placerville, on the south side of the San Miguel river, there are numerous workings of the roscoelite sandstones. Here the ore is 'in place,' and more than a dozen tunnels have been driven through the horizontal ore strata, some of them over 150 feet long. The content of the ore averages 3 per cent V^2O^5, and the thickness varies from 14 to 21 inches. At some points the ore outcrop may be followed along the surface a distance of over 1,000 feet.

"Up Bear creek, near Newmire, are the important workings of the Primos Chemical Co. Here the ore is very massive and is very thick, the main body being over 6 feet thick. The vanadium content averages close to 3 per cent V^2O^5."

An analysis[2] of roscoelite from Placerville, California, made by W. F. Hillebrand, of the United States Geological Survey, is appended:—

[1] See also Eng. and Min. Journ., Vol. XCII, No. 27, Dec., 1911, p. 1287.

[2] U. S. Geol. Surv., Bull. 262, 1905, p. 20.

PLATE XX.

Types of phlogopite crystals.

SiO_2	45·17
TiO_2	0·78
V_2O_3	24·01
Al_2O_3	11·54
FeO	1·60
MgO	1·64
Na_2O	0·06
K_2O	10·37
H_2O	4·69
Total	99·86

From the various descriptions of the roscoelite[1] occurrences in Colorado and California, it would appear that the mineral possesses an earthy or powdery character rather than a micaceous one.

Crystallization.

All the members of the mica family crystallize in the monoclinic system, though, owing to the basal angles measuring approximately 120°, there is a close approach, in many of the species, to hexagonal or orthorhombic symmetry. Crystals which allow of accurate measurement are relatively scarce, and twinned forms are common.

The habit of the crystals is tabular, pseudo-hexagonal or pseudo-rhombic prismatic—the prisms more or less tapering, with irregular sides which are usually rough and pitted and striated horizontally (Plate XX).

All the micas may be referred to the same fundamental axial ratio, the angle of obliquity being little removed from 90°: they exhibit the same forms, and are isomorph with one another, which is evidenced by their frequent intergrowth in parallel position, as biotite with muscovite—a very commonly observed association under the microscope.

The size of the crystals varies greatly, from the enormous and often well-developed examples of muscovite and phlogopite from the pegmatite and pyroxenite dykes, respectively, of Canada, to the minute and perfectly-formed crystals measuring only a few millimetres, to be found in many metamorphic limestones.

Crystals of muscovite have been obtained in the Nellore district, India, measuring 10 feet across their basal planes; while phlogopite crystals of over 3,000 pounds weight and measuring some 5 feet across by 9 feet long, have been taken from Canadian deposits. Such crystals are naturally exception and the normal size does not exceed 6" to a foot in diameter.

Aggregates of very small, scaly plates forming stellate and plumose groups are common, while the mineral often occurs in scaly, or compact, mas-

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[1]See also: Dana, System of Mineralogy, 6th Ed., 1906, p. 635; U.S. Geol. Surv. Bull., 315, 1907, pp. 110-117; U. S. Geol. Surv. Bull., 340, 1908, pp. 257-262.

sive form. Agalmatolite is the name given to a compact, massive, yellow variety of muscovite found in China, and used in the carving of ornaments, etc.

Geometrically perfect crystals of any size, which allow of accurate measurement, are comparatively scarce, the individuals being generally more or less distorted, crushed, and twisted (See Plate XXI).

"Step-crystals" are common, and result from pressure acting across the crystals. The laminæ have slipped in layers of varying thickness, and form a series of steps, being generally recemented in their new position by thin films of calcite or other mineral.

Plate XXVIII shows an individual from the Cantin mine, South Burgess. In this case, a section of ¾" of the crystal has been rotated some 20° from its original position, and cemented, as shown, by a layer of calcite, which has penetrated between the movement planes.

Disturbance of the ideal crystalline form may be due to the intergrowth of individuals, variations of pressure in the still unconsolidated rock, subsequent movements in the rock mass after cooling, and also to the inclusions of foreign substances in the mica crystals themselves.

As a general rule, the mica crystals occurring in a hard, compact matrix exhibit less distortion than those from a coarsely crystalline and softer rock, though there are occasionally exceptions to this. It is noteworthy, however, that the laminæ of crystals from such a compact rock are nearly always more brittle and less elastic than those of crystals from a softer rock. In addition, the sheets are, in such instances, often iron-stained, and consequently less valuable. These remarks apply not only to muscovite, but also to phlogopite and other members of the mica family. In addition to undergoing physical distortion, mica crystals often seem to have been subjected to some kind of chemical action after their complete formation from the magma. This is evidenced by the frequent pitting and roughness to be observed on the crystal faces, and which may either be due to incipient resorption occasioned by a subsequent rise in temperature of the dyke magma, or to an attack and partial solution by subsequent ascending vapours or waters. It may be remarked that the crystals of apatite occurring in the calcite exhibit similar appearance of resorption, being rounded and glazed, and, in many instances, eaten out by some agency, subsequent to their formation.

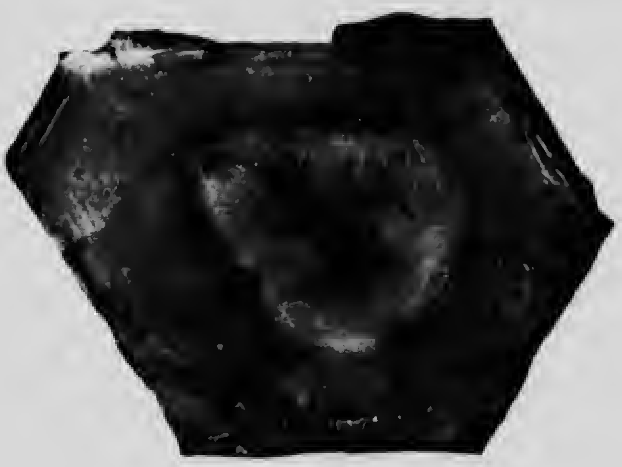
Crystals of a yellowish mica, occurring on lot 1, concession X, of the township of Loughborough, Ont., in a highly metamorphosed pyroxenite, exhibit hardly any signs of faces, being rounded and indented, and showing, in most cases, no sharp angles. The planes are rough, owing to attached, small, mica plates which have no definite orientation, but lie scattered upon the larger crystals in irregular aggregates.

Intergrowths of crystals and twinning are common. Such intergrowths are not always confined to similar micas. In some granites, for example, light-coloured muscovite encloses darker biotite in such a manner that the

PLATE XXI

Plates of distorted phlogopite crystals.

PLATE XXII.



Section of phlogopite crystal showing multiple crystallization.
(Negative printed direct from mica sheet)

PLATE XXIII.

Section of phlogopite crystal showing multiple crystallization.
(Negative printed direct from mica sheet).

PLATE XXIV.

Multiple crystallization of phlogopite—so called border mica

cleavage of the biotite continues into the muscovite. In such cases, the symmetry planes of the two varieties often lie turned at an angle of 60° to each other. Lepidolite and muscovite enclose each other in a similar manner, while zonal intergrowths of biotite and pennine (a member of the chlorite group) are known.

Apparently simple, well-formed crystals of mica are often found, on examination in polarized light, to be composed of two or more individuals, having an irregular junction line, with their optic-axial planes disposed at angles of about 60° to one another. Fine examples of this form of intergrowth have been obtained from near Kangayam, in the Coimbatore district,

Fig. 51.—Muscovite crystal formed by the intergrowth of two individuals having their axes disposed at angles of 60° to one another. From Kangayam, Madras. (*After Holland, Mica Deposits of India.*)

Madras (See Fig. 51). The frequent intergrowth of biotite and muscovite has suggested that the latter mineral is merely an alteration product of the former and this is a view held by many geologists.

The most prominently developed faces are oP (c), the basal plane; P (m) and −P (o), the positive and negative hemipyramids; and ∞P∞ (b), the clinopinacoid; while P∞ (r), the positive hemiorthodome; 3P3, the positive clinopyramid; and other less usual forms, also occur.

The twinning-plane for all the micas is a plane in the prismatic zone oP:∞P, parallel to the edge cm, and perpendicular to the basal plane c.

This twinning-plane may, in itself, form the intergrowth face, and should both individuals be in adjacent position, two cases would need to be distinguished, according as the second individual is in contact with the front *right* prism-edge (Fig. 52, 1), or with the front *left* prism-edge, of the first (Fig. 52, 1a).

Since, however, the growth of twin crystals seldom proceeds from the twin faces (i.e. in horizontal direction), but usually from the basal plane oP, both individuals appear, as a rule, superimposed, and in contact along a plane which lies almost parallel to oP. Fig. 52, 2 and 2a show this growth for the right and left twin respectively.

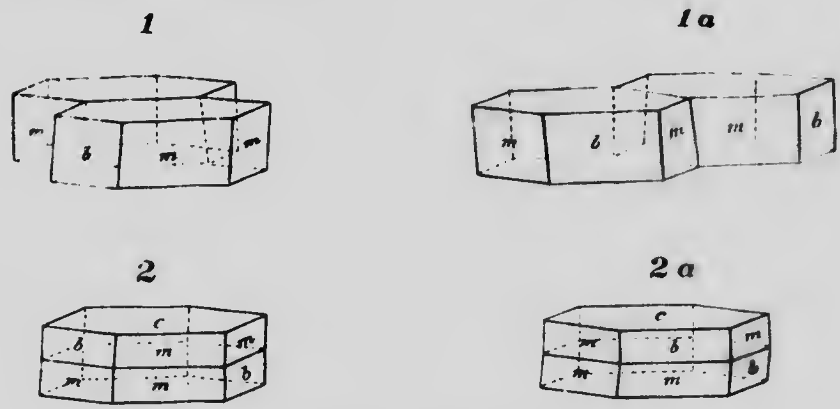


Fig. 52.—Examples of twinning of magnesia mica.
1. Individuals in juxtaposition on the front right prism face, and 1a on the front left prism face.
2. Superimposed individuals due to growth proceeding from the basal plane—right twin: 2a, left twin. Re-entrant angle m m 162° 49′, mb 171° 19′. (*After Naumann-Zirbal.*)

This method of twinning is of frequent occurrence, and is usually evidenced, especially in the case of zinnwaldite—by the matt appearance of the hemipyramid faces (m). The re-entrant angle m m 162° 49′, and m b = 171° 19′.

In large crystals, one or more thin, twinning lamellæ may often be observed.

Fig. 53.—Twinned phlogopite crystal with individuals in juxtaposition, showing series of parallel lines on base c.

The usual form of the mica crystals is tabular, through preponderance of the basal plane oP; sometimes with rounded edges; and seldom short columnar, in the direction of the vertical axis.

In addition to the complete twinning displayed by many crystals, a form of intergrowth may frequently be observed in which a number of small individuals of various shapes and sizes are symmetrically arranged to form one large crystal.

Such large crystals are sometimes hollow, the smaller individuals having probably formed around some mineral which has subsequently been removed.

Another interesting phenomenon exhibited by certain mica crystals is that known as multiple crystallization. Plate XXII shows this peculiar feature. As will be seen from the figure, a phlogopite crystal encloses a smaller crystal of lighter colour and somewhat different shape. The inner crystal conforms to the symmetry of the outer, though the lengths of the sides are in no manner proportional. In the centre of the smaller crystal appears a beautiful example of a natural pressure-figure, due to a minute inclusion of iron pyrites from which the rays diverge, and viewed by reflected light the entire composite crystal is seen to be traversed by three series of minute percussion lines perpendicular to the crystal faces.

Plate XXIII shows a similar occurrence: in this case, however, three crystals are to be seen, the inner (a) and outer (b) individuals being clear, while the third (c) appears cloudy. The laminæ of such crystals exhibit no imperfections, and no signs of joints or partings are apparent between the individuals, which are intimately intergrown.

The cause of this multiple crystallization is not very clear. It may possibly be due to changes of pressure and composition of the cooling magma, which have occasioned successive breaks in the process of crystallization, the crystals having subsequently developed in a new direction as soon as a normal condition was again established.

Plate XXIV is an illustration of so-called "border-mica," which is a further phase of the same composite crystallization, only, in this instance, the successive stages of deposition conform more approximately to the symmetry of the central individual, the growth of the crystal having proceeded equally in each direction.

Fine examples of this border-structure are exhibited by the mica from lot 17, concession IV, of the township of Bedford, Ont., and the same appearance may sometimes be observed in the mica from various localities in Quebec and Ontario.

Optical Properties.

The members of the mica group are sometimes divided into two classes according to the position of the plane of the optic axes.

The first class contains those kinds whose optic axial plane is perpendicular to the plane of symmetry $\infty P \infty$, or clinopinacoid, while to the second class belong the varieties whose optic axial plane is parallel to the symmetry plane.

In accordance with the monoclinic system of crystallization, the negative bisectrix is not quite normal to the basal cleavage plane, and in consequence, cleavage plates of all the varieties of mica display axial interference figures which, for the pseudo-rhombohedral kinds, are almost uniaxial. The optic axial angle varies greatly: of biotite it is very small; that of phlogopite likewise—usually 10° to 17°; while for muscovite, paragonite, and lepidolite, the angle is large—usually from 50° to 70°.

Curiously enough, the axial angle of phlogopite appears to increase with the amount of iron present in the mineral.

Asterism.

The name asterism has been given to the peculiar, star-like light-rays observed in certain directions in some minerals.

This property is not peculiar to mica alone, but is shared by various other minerals, notably sapphire (variety "star sapphire"), some species of quartz ("cat's eye," asteroid quartz), chrysotile, fibrous gypsum ("satin spar"), etc.

It is to be well seen, both by transmitted and reflected light, in the form of a six-rayed star, which appears when a flame is observed through a basal plate of a sapphire crystal, or when such a crystal, cut en cabochon normal to the main axis, is regarded by reflected light. In the case of sapphire, it is supposed that these light-rays are caused either by repeated lamellary twinning,[1] or by very minute interstices arranged parallel to the sides of the hexagonal prism.[2]

Cleavage plates of phlogopite mica often exhibit asterism, both by transmitted and reflected light, and this feature is especially characteristic of the mica from South Burgess, Ontario, though most phlogopite will be found to display a more or less well-defined, six-rayed star.

The asterism in the case of mica has been supposed to be caused by the inclusion between the laminæ of numerous minute crystals, whose axes are orientated at an angle of approximately 60° to one another, and which were formerly considered to be also mica,[3] but which have since been recognized as rutile.[4]

In some specimens, a double asterism may be distinguished, consisting of six brighter and six weaker rays, and this has been supposed to be due to a network of colourless, needle-shaped prisms of rutile, arranged parallel to the faces ∞P, $\infty P \infty$, $\infty P 3$, and $\infty P \infty$, of the mica crystals.

Other varieties of mica, notably muscovite, possibly owe their asterism to a regularly arranged pattern of hair-like tourmaline needles.

It will be seen from the above that the phenomenon of asterism has been attributed to the reflection of light from minute faces, which either belong, as in the case of mica, to included foreign and solid bodies, or, as with sapphire, quartz, etc., to the adjacent planes of twinning lamellæ; to interstices; or to the fibres which go to compose the mineral itself.

1 Volger., Sitzungsbericht d. Wien. Akad. Bd 19. 1856, p. 103.
2 Tschermak. Lehrbuch der Mineralogie, 2nd Ed. 1885, p. 146.
3 Rose., Monatsberichte d. Berliner Akad. 1862 p. 614, and 1869, p. 344.
4 Tschermak., Loc. cit.

Asterism does not appear to be in any way dependent upon the colour of an amber mica sheet, and it would appear doubtful whether it is really due to inclusions of foreign mineral substance. The most pronounced double-asterism observed by the writer was found in sheets of a clear and almost white mica (exact variety not determined) from a contact deposit on concession II, lot 5, of the township of Bedford, Ont. Sheets of mica from the same pits, and identical in colour and general appearance, sometimes display widely different degrees of asterism. In fact, it was sometimes found that mica sheets from one and the same mine show all gradations from the highest degree of double asterism to an almost entire absence of the rays.

It would seem, therefore, far more probable that the peculiar light effect is produced by exceedingly fine striations—due possibly to polysynthetic twinning; to minute fractures caused by some physical distortion of the crystals; or to inferior cohesion of the laminæ.

In the case of the primary asterism of mica, the light rays coincide with the direction of the pressure-figure, while in the secondary asterism, the arrangement is parallel to the lines of the percussion figure.

All the micas are more or less pleochroic, the strongest pleochroism being exhibited by biotite.

Some phlogopites also display this property in a marked degree. The amber mica from the Lacey mine, township of Loughborough, Ont., is beautifully trichroic: with the dichroscope **c** gives brownish-red, **b** brownish-green, and **a** yellow.

When viewed by ordinary light passing approximately normal to the basal plane (c) or parallel with the acute negative bisectrix **a**, the "face-colour" obtained is a reddish-brown, with **b** a deep brownish-red, and with **c** yellow. Muscovite and biotite possess the highest birefringence, and display, in consequence, the brightest interference colours.

Optically, the micas are negative-biaxial. In the case of biotite, however, the optic axial angle is frequently so small as to give the mineral a sensibly uniaxial character.

Percussion and Pressure Figures.[1]

In all varieties of mica it is possible, by adopting the following methods, to produce certain star-like effects, which have received respectively the names of percussion and pressure figures.

These figures are due entirely to the exertion of a physical force, and are quite distinct from the star effect produced by asterism.

If a sharp needle be held against a plate of mica and a rapid elastic blow be administered, a six-rayed star results (Fig. 51) which may, however, in

[1] German, "Schlag-und Druckfiguren."

some cases, be only imperfectly developed and appear as a three-rayed figure, owing to the radii extending from the centre in one direction only.

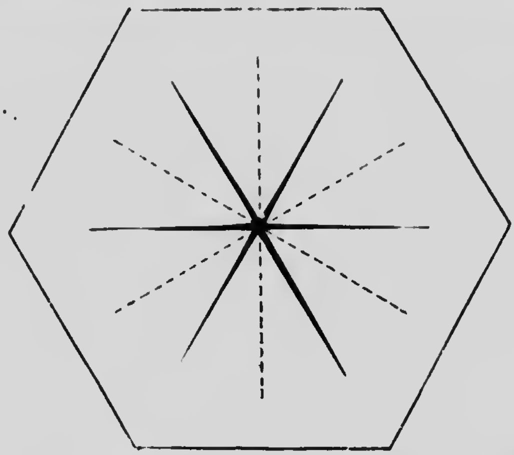


Fig. 54.—Diagram showing respective directions of percussion and pressure lines. The dark lines represent the percussion figure and the dotted lines the pressure figure.

One of these radii—the "Leitstrahl," or characteristic radius—is always approximately parallel to the two edges which correspond to ∞ P ∞, or the clinodiagonal, while the other two, which are not as sharply defined,

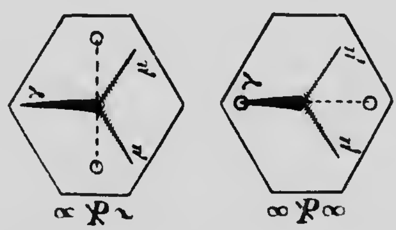


Fig. 55.—Ideal representation of percussion figures, showing position of characteristic radius (γ) for micas of the first and second classes. (*After Naumann-Zirkel.*)

but consist of steplike cracks (μ) are more or less parallel to the intersection edges of the prism (m) and the base (c) (Fig. 55.)

The percussion figures thus afford a simple method of determining the true orientation of a cleavage plate having no crystalline outline.

The angles of intersection of the rays measure approximately 60°.

κ, the angle opposite to ∞ P ∞ (b) (Fig. 56), has been found to be 53° to 56° for muscovite, 59° for lepidolite, 60° for biotite, and 61° to 63° for phlogopite.

Now, since the optic axial plane of most micas is parallel to the orthodiagonal, while, in the remaining cases, it is parallel to the clinodiagonal, the percussion figures afford a ready means of distinguishing between the two varieties.

In a mica of the first class, the plane of the optic axes will be normal to the characteristic radius of the percussion figure, while in a mica of the second class the radius will be parallel to the plane; in other words, the axial plane falls, in the case of the first-named, between two diagonals of the hexagonal percussion figure (Fig. 56A), and in the case of the second, it coincides with the characteristic diagonal, or Leitstrahl (Fig. 56B).

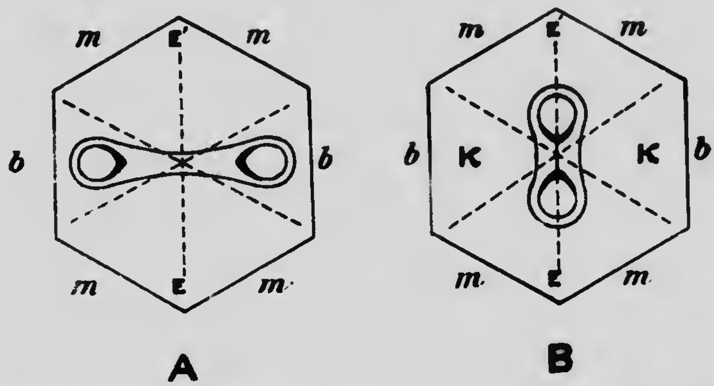


Fig. 56.—Disposition of lines of percussion figure and optic axial plane in A, micas of the first class (muscovite, etc.) B, micas of the second class (phlogopite, etc.), E E' characteristic ray.

The micas of the first class include muscovite, paragonite, lepidolite, and some rare varieties of biotite called anomite; while the second class embraces zinnwaldite, most biotite, phlogopite, and lepidomelane.

Connected with the "gliding planes" of the micas (see below), are the so-called "pressure figures," produced upon a crystal section by the exertion of sudden pressure from a suitable point. To obtain such figures the mica plate should be supported on a hard cushion (a blotting-pad answers the purpose), and a blow be struck with a light hammer upon a steel rod whose slightly rounded point is held against the surface of the plate.

As a result of such a blow, a more or less distinct six-rayed star is developed, the branches of which lie in a diagonal direction to those of the percussion-figure.

As a rule, the hard, brittle micas give sharper and better defined percussion and pressure figures than the softer and more elastic varieties.

In many instances, however, the figures are partially obscured by small cracks which spread from the branches of the star.

Fig. 57 shows a frequently obtained percussion figure result.

Crystals of mica, especially phlogopite and biotite, often exhibit pressure figures when taken from the mine.

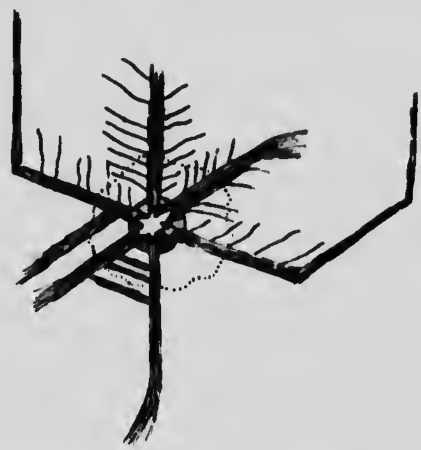


Fig. 57.—Highly magnified percussion figure. (*After M. Baure.*) Actual diameter 2-4 mm

In some cases, the pressure has been exerted by the crystallization of some foreign mineral contained within the mica crystals, in which case the pressure figures are generally confined to the laminæ directly above and directly beneath the inclusion. More often, however, mica crystals have been subjected to external pressure. All the cleavage plates of such a crystal (which need not necessarily have suffered distortion, provided the pressure has resulted equally from all sides) display on their surfaces a close network of intercrossing fine lines, which will be found to be parallel to the branches of an artificially constructed pressure figure. Such plates are said to be "ruled."

Provided the pressure has been sufficient, the laminæ of such a crystal will split up along such lines, forming numerous small fragments of irregular shape.

This splitting, due to pressure, is a fault which frequently affects mica, and reduces the value of a considerable proportion of the crystals mined. In many cases, the pressure lines have developed in only one direction, so that the cleavage plates split into narrow strips, termed in the trade "ribbon-mica."

This "ribbon-mica" was formerly regarded with disfavour by miners, and thrown aside; but with the advent of mica-plate, which is built up of small fragments and strips of very thinly divided mica, ribbon-mica has become of value.

Plate XXV shows a mica crystal in which the pressure lines have formed in two directions, giving rise to what is termed "feather-mica."

PLATE XXV

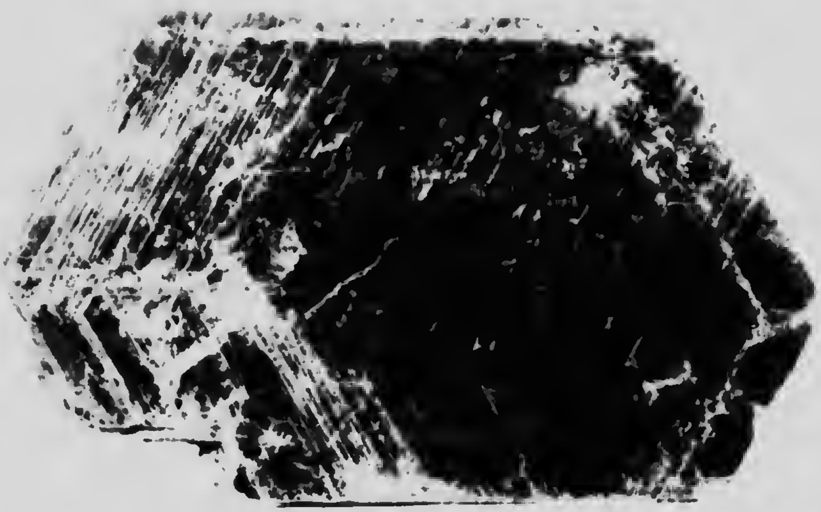


Plate of phlogopite, showing feather structure.

If pressure fragments of sufficient thickness (¼") be examined, they will be found to possess pseudo-crystalline faces, which are inclined some 67° to the basal cleavage plane (Fig. 58). Such faces are termed "gliding planes,"[1] and are due to the varying degrees of molecular cohesion of a crystal; they are directions parallel to which a slipping of the molecules may take place, under the application of mechanical force.

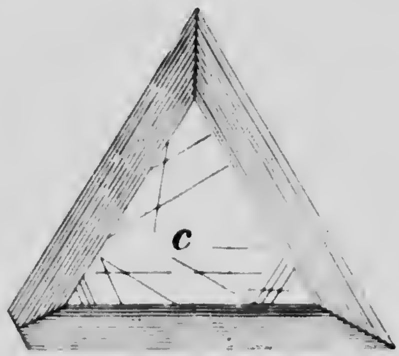


FIG. 58.—Biotite with pseudo crystal faces (gliding planes). (*After Tschermak*).

It is to be noted that the gliding-planes are quite distinct from cleavage-planes, and in no mineral do these two directions coincide.

The twinning planes of mica crystals are, however, coincident with the gliding planes.[2]

With regard to natural pressure and percussion figures, due to inclusions within mica crystals of foreign mineral substance, it has been found that the angles of intersection of the rays approximate to 30°, one of the rays occupying the correct position of the principal ray of the artificially produced percussion figure. The natural figure, unlike the artificial, is thus formed by the intersection of rays at 60°. This fact having been observed, by T. H. Holland[3], in certain specimens of Indian muscovite, the idea presented itself that muscovite, like some other minerals, might possess at a higher temperature a correspondingly higher degree of crystalline symmetry, and that its percussion figure, at the temperature at which the natural figures were produced, might possibly possess hexagonal instead of monoclinic symmetry. In order to test the theory, percussion figures were produced on samples of muscovite heated to about 300° C., and it was found that the angle κ opposite to the face of the clinopinacoid, was invariably larger than the corresponding angle obtained on the same mica at ordinary temperatures. The following results were obtained:—

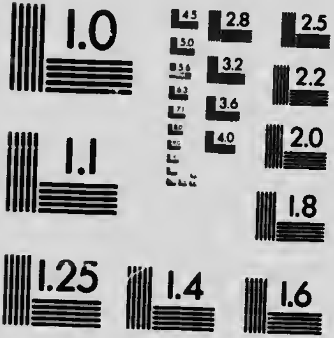
[1] German, "Gleitflächen."

[2] Naumann-Zirkel, Mineralogie, 14th Ed., 1901, p. 191.

[3] Mem. Geol. Surv. Ind. Vol. XXXIV, p. 21.

MICROCOPY RESOLUTION TEST CHART

(ANSI and ISO TEST CHART No. 2)



Locality.	Angle κ of percussion figure produced at	
	Ordinary Temperature.	300° C.
Saidápuram, Nellore	55°	57° 30′
Inikúrti, Nellore	54°	57°
Utukúr, Nellore	53° 30′	56°
Koderma, Hazáribágh.	53°	56°

At ordinary temperatures, the rays of the percussion figure do not invariably intersect at angles of 60°. A large number of mica specimens from various parts of the world have been examined by T. L. Walker, who found[1] that the size of the angle κ is distinctly variant in the different varieties of mica. A number of specimens from all parts of the world were examined, and the angle was found to range from 52° 53′ for muscovite from Murray Bay, Que., to 63° 28′ for phlogopite from Ceylon.

The results of the examination, by T. H. Holland, of numerous samples

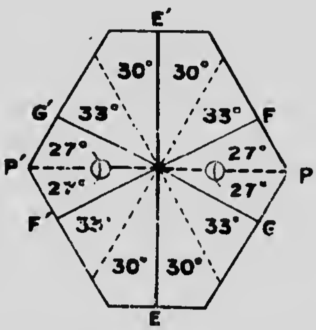


Fig. 59.—Diagram showing the average relations of the pressure figure, percussion figure, and optic axial plane in Indian muscovites. (*After Holland.*)

of Indian muscovite with regard to the relative position of the percussion and pressure figures, are shown below, and are illustrated in Fig. 59:—

(1.) The principal ray of the percussion figure EE′ lies in the plane of symmetry, and at right angles to the optic-axial plane.

(2.) The principal ray EE′ is cut at right angles by the ray PP′ of the pressure figure, which lies in the optic-axial plane.

(3.) The angle κ between the rays FF′ and GG′ of the percussion figure averages 53° 55′.

(4.) The remaining angles of the percussion figure are approximately each 63°.

(5.) The rays of the pressure figure intersect at angles of 60°.

[1]American Journal of Science, Vol. II, 1896, p. 5, and Vol. VII, 1899, p. 199.

(6.) The subordinate rays of the percussion figure meet the subordinate rays of the pressure-figure at angles of 93° and 33°.

(7.) The etch-figures produced by the action of hydrofluoric acid, or by fused potash, are bisected symmetrically by the ray EE'.

Inclusions.

In addition to imperfections caused by disturbed crystallization, pressure, etc., mica crystals are, in many cases, rendered useless for commercial purposes by the presence within them of impurities and foreign bodies, included during the process of consolidation from the magma.

These inclusions may be either microscopic or macroscopic. In the case of phlogopite, the former consist, as a rule, of prisms and needles of rutile, apatite, magnetite, etc., which can exist in such quantity as to sensibly affect the colour and conductivity of the mica sheets.

Phlogopite crystals often contain macroscopic inclusions of calcite, apatite, iron pyrites, quartz, etc. Such minerals may form crystallized groups or individuals within the mass of the mica crystals: they exist, however, more usually as films or layers of crystalline substance between the laminæ. Such films of foreign mineral materially affect the splitting quality of the mica, a large proportion of the crystals obtained from certain mines being totally unfit for use on this account.

Muscovite plates occasionally contain crystals of beryl, and needles of red, black, or green tourmaline; while red and brown garnet and zircon, feldspar, quartz, and apatite are not uncommon.

In addition to containing crystals of such minerals, sheets of muscovite are very frequently spotted and stained by flattened accumulations of foreign mineral substance (See Plates XXXVII and XXXVIII).

This consists, for the most part, of garnet, zircon, biotite, tourmaline, psilomelane, magnetite, and specularite. These minerals sometimes possess definite crystal outline, especially in the case of garnet and biotite, at the same time, however, showing evidence of resorption by their fretted edges. Iron and manganese stains, on the other hand, exist generally in dendritic form. Frequently, the symmetrical arrangement of such stains gives rise to a network of interlacing lines, which lines are found to possess definite orientation, being in all cases parallel to the branches of either the percussion or pressure figure.

The colour of the stains varies from black, through brown, to red, and often imparts to the laminæ a beautiful, mottled appearance. According to Rose, the black, brown, and red stains in muscovite are caused by specularite, the difference in colour being due to the varying thickness of the stains. Dana and Brush describe the black substance as magnetite, the red as specularite, and the yellow as hydrous iron oxide. Such stains render the mica in which they occur useless for economic purposes, both impairing the transparency, and increasing the conductivity for electrical purposes.

Gaseous inclusions in mica are rare, though some varieties (see page 155) emit, upon splitting, a strong smell of sulphuretted hydrogen, which would seem to indicate the presence of this gas enclosed between the laminæ. Such micas are always hard and brittle, and generally of a light shade.

Colour.

In addition to the variations due to chemical composition, the colour of mica, as may be inferred from the above remarks on inclusions, is greatly influenced by the nature of such inclusions. Even when free from them, the colour ranges through almost the whole scale. The lighter-coloured varieties are: paragonite or sodium mica, generally of a yellowish or grey-white shade; lepidolite, white to rosy-red; muscovite, colourless, grey, yellow, green, and even reddish, as in the case of some Bengal specimens; fuchsite, a variety of muscovite containing chromium, is of a beautiful, emerald green colour; zinnwaldite, grey, brown, and greenish. The magnesium and iron micas are usually of a dark colour. This is not, however, invariably the case. While biotite and lepidomelane are generally black, phlogopite passes from almost black, through brown and yellow, to almost colourless, while some specimens are of a green shade. The most prized colour for economic purposes is a yellowish-brown (so-called "amber"), and it is by this name, originally applied by Mr. Lacey, of Sydenham, Ont., to the mica from the Gould Lake mine, lot 6, concession X, of the township of Loughborough, that Canadian phlogopite is designated in trade circles. "Amber mica" is thus synonomous with phlogopite, the various shades being termed dark-amber, wine-amber, golden-amber, silver-amber, light-amber, etc.

The colour of the sheets is naturally, to a large extent, dependent on their thickness, even the darkest of micas appearing almost colourless when split into very fine laminæ. These variations in colour are due to the varying iron content of the different phlogopites, which form a transition series from the normal, almost iron-free, type of magnesium mica to normal biotite. These two minerals may, therefore, be regarded as extremes of such a series, though with what percentage of iron magnesium mica ceases to be phlogopite and becomes biotite is not with certainty established. It would be expected that, with the approach to biotite, the axial angle of the mineral would decrease; the reverse is, however, the case, the angle increasing with the amount of iron.[1]

Both the very dark and very light varieties of amber-mica, or phlogopite, find little favour in the trade, the preference being for medium-coloured sheets. "Silver-amber" is a much sought after kind, this being the term applied to a grey, mottled, amber-coloured mica having a somewhat cloudy appearance when viewed by transmitted light, the rays of which fall vertically to the basal

[1] See Dana, Text-Book of Mineralogy, 1898, p. 469.

cleavage plane. When held at an angle, however, to the light rays, the cloudiness disappears, the sheets becoming clear save for the inclusions present in the laminæ (See pleochroism).

A phlogopite having a milky or smoky appearance occurs at the Lacey mine, lot 11, concession VII, of Loughborough, Ont.; the cause of this milkiness is not known.

Mica crystals which have been subjected to pressure in the rock, and whose sheets are consequently cracked, display an alteration of colour along such fracture. Thus, for instance, a sheet of light-coloured, silver-amber mica will be traversed by irregular dark markings which occur adjacent to minute cracks extending inwards from the edges. Conversely, a dark mica sometimes appears to have suffered a bleaching along such fracture lines.

Macroscopic inclusions, also, often cause a similar darkening or bleaching of the mica around them. Especially is this the case with iron pyrites.

The influence of the rock matrix upon the colour of the mica it contains is a debatable point. It is the writer's general experience, gathered from a study of the various deposits, that no rule exists for any such dependence. Many dark pyroxenites carry light-coloured phlogopite, and vice versa. Granted, therefore, that the colour of the pyroxene is largely dependent upon the amount of iron it contains, no connexion would seem to exist between the shade of the mica and the iron content of the dyke-forming minerals, other than the influence due to the presence in the mica sheets of minute inclusions of dark-coloured iron or titanium minerals. The dark colour of an enclosing rock matrix need not, therefore, be considered prejudicial to the quality of the mica contained, in so far as this is governed by the iron content.

Small macroscopic inclusions often cause peculiar markings in sheets of phlogopite. These are sometimes aggregates of wavy lines of lighter colour than the mica itself, while occasionally a sheaf of such lines spreads in one direction from the inclusion. Amber-coloured muscovite is rare, having been found only in the Nellore district of the Madras presidency, India.

Alteration of Mica.

All micas, in spite of the natural resistance they offer to weathering, are yet subject to extensive alteration by hydration; recurrent changes in temperature, and the action of acids, also play an important role in the decomposition process.

Crystals which have lain on the mica dumps for any length of time are found to have become 'puffy'; the laminæ become separated from one another by alternating action of heat and cold; moisture, often charged with sulphuric and humic acids, has an opportunity of attacking the divided sheets, which gradually lose their lustre and become opaque and discoloured, eventually crumbling to a flaky powder.

Small flakes and scales of mica, as, for instance, those contained in mica-schists, granites, gneisses, etc., seem less prone to alteration, and even after extensive weathering present a relatively fresh appearance.

Pneumatolytic action, also, which, as in the case of the china-clays of Cornwall, has completely decomposed the feldspar of some granites, seems to have exerted little influence upon the mica.

Most of the micas give rise to a number of alteration or secondary products, and sub-varieties are numerous.

Varieties.

The following are the more important of such minerals:—

Rubellan and helvetan, red varieties of biotite; also bastonite, eukamptite, rastolite, voigtite, aspidolite, and manganophyil, further varieties of the same mica.

Siderophyllite is a species of biotite from the Pikes Peak district, Colorado.

Caswellite is an altered biotite from Franklin Furnace, New Jersey.

The members of the group of the vermiculites, which includes, amongst others, such minerals as jeffersite, hallite, and philadelphite, are regarded as altered phlogopite.

Haughtonite is a mineral related to lepidomelane, but containing more iron than the latter, and less magnesia than biotite.

Cryophyllite and polylithionite are varieties of zinnwaldite, the former having the highest silica content of all the micas. A further variety of zinnwaldite is the so-called "raben-glimmer," or "raven-mica," which occurs in dark-coloured flakes on the tin lodes of Altenberg, Erzgebirge, and which is characterized by the smallness of its optic axial angle, this measuring almost 0°.

Muscovite possesses a large series of varieties, chief among which are: damourite, a micro-crystalline form, of a yellowish colour, and, in many instances, an alteration product of cyanite or topaz, and also of corundum.

Sericite, a soft, greenish mineral, greasy to the touch, and often formed from feldspar. It is characteristic of many slates (so-called "sericite-slates"), and often occurs in mica-schists and phyllites.

Margarodite is, according to Tschermak, a mixture of muscovite and paragonite. It occurs in Switzerland, is of a grey colour, and possesses a compact to granular structure. Black tourmaline needles are sometimes found penetrating it.

Euphyllite is a variety of muscovite possessing a beautiful pearly lustre; it occurs as an alteration of corundum at Unionville, Pennsylvania.

The mineral known as gilbertite is found principally on tin lodes, both in Cornwall and Saxony. It occurs in aggregates of small, scaly plates of a greenish to yellow colour, having a greasy feel, and is usually found in druses, encrusting the quartz and arsenopyrite crystals.

The above-mentioned fuchsite is a beautiful green muscovite, containing around 4·0 per cent chromium-oxide, and is found at Schwarzenstein and Zillertal, in the Tyrol.

The occurrence of fuchsite in massive magnesite and dolomite from Bolton and Sutton townships, Brome county, Province of Quebec, is recorded by C. W. Willimott[1], and the mineral is stated to be locally so abundant as to form a species of chromiferous mica schist.

A further occurrence of the same mineral is mentioned[2] from Matawatchan township, Renfrew county, Ontario, and an analysis gave:—

SiO_2	43·72
Al_2O_3	35·51
Fe_2O_3	2·94
Cr_2O_3	1·26
MnO	0·26
CuO	4·46
MgO	1·36
K_2O	8·88
Na_2O	0·39
H_2O	3·68
Total	102·46

Pinite is the name given to a large number of alteration products which, in composition, resemble muscovite; in form they are massive to compact; in character amorphous, granular to cryptocrystalline, and rarely possess a submicaceous cleavage.

In hardness they range from 2·5 to 3·5, and the colour varies from grey to green, brown, and reddish.

The following are minerals which are classed as pinite: gieseckite and liebenerite, pseudomorphs after nephelite, from Greenland and Tyrol respectively; polyargite, a red mineral formed by the alteration of anorthite, from the syenite of Tunaberg, Sweden; wilsonite, grey to pink, and an altered scapolite, which is, in its turn, probably an alteration of plagioclase.

Killinite is from the granite of Killiney, Ireland, and is a grey or brown pseudomorph after spodumene.

Agalmatolite, a grey, yellow, or green mineral, with an even fracture, and having a hardness of 2-3, is found in China, and is there used extensively in the carving of ornaments, etc.

The occurrence of agalmatolite is recorded in Canada from St. Nicholas, St. Francis, and Lake Memphremagog, Province of Quebec, and analyses of

[1] Ann. Rep. Geol. Surv., Can., XVI, 1904, p. 229 A.
[2] Rep. Prog. Geol. Surv., Can., V, Part II, p. 21 R.

specimens from the above localities, by Dr. Sterry Hunt, are given in the Geology of Canada, 1863, page 484.

A very similar mineral, which is often confused with the above, is pyrophyllite, which, however, contains little or no potash.

Pagodite is another name for agalmatolite.

Cookëite is a micaceous mineral, resembling lepidolite, found at Hebron, Maine, associated with tourmaline, and regarded as an alteration product of rubellite.

An occurrence of cookëite is recorded from Waitabit creek on the Columbia river, near Donald, B.C.[1]

Many of the above varieties of muscovite were formerly held to be distinct minerals: such, for example, were gieseckite, liebenerite, pinite, gigantolite.

Secondary muscovite, forming distinct pseudomorphs of the normal mica habit, and to which no distinctive name has been given, often occurs replacing both garnet and tourmaline. Fine examples of such pseudomorphs occur at the Villeneuve mine, Que. (See Plate XXVI).

There are, in addition to the above, a large number of further hydrous silicates of aluminium and potassium, which, corresponding in their composition more or less closely to muscovite, belong properly under the heading of that mineral.

Paragonite, or sodium mica, has as varieties: pregallite, small, light green-coloured scales from Pragratten, Tyrol, and cossenite, a somewhat similar green mica with a smaller soda content than the former, also from Tyrol.

Margarite, or lime mica, sometimes termed "pearl-mica", is classed variously by different authors in the group of the true micas and with the brittle micas.

Its composition is $H_2CaAl_4Si_2O_{12}$, corresponding to:—

Silica.	Alumina.	Lime.	Water.	Total.
SiO_2	Al_2O_3	CaO	H_2O	
30·1	51·3	14·1	4·5	100·00

It occurs with emery in Asia Minor, and at Chester, Mass.; also with corundum in Pennsylvania and North Carolina.

The so-called "diphanite" is margarite from the emerald mines of the Ural mountains.

The preceding are the more important varieties and secondary minerals belonging to the group of the micas proper.

The term "talc" is often wrongly applied to the mineral mica, usually with especial reference to the sheets of muscovite used in stoves, lanterns, etc.

[1] Rep. Prog., Geol. Surv. Can., V, Part II, p. 67 R.

PLATE XXVI.

Pseudomorph of muscovite after tourmaline, from the Villeneuve mine, lot 31, range I, township of Villeneuve, Que.

Some species of mica, notably the compact varieties of muscovite, do possess a certain amount of resemblance to talc and the related acid and hydrous silicates of magnesium, having a similar greasy feel and lustre.

Hardness, Elasticity, etc.

All the micas possess a degree of hardness, according to Moh's scale, between 2 and 3; that is, they can be scratched by the finger nail.

Weathered sheets taken from the surface of deposits are naturally softer and more friable than plates split from fresh, solid crystals.

The specific gravity of all the micas ranges from 2·6 to 3·2.

The laminae of the different specie vary very considerably in their elasticity and toughness; the lighter coloured phlogopite (so-called "silver-amber" mica) is, as a rule, the most elastic and flexible, while the darker biotite, and most muscovite, is rather more brittle.

The chief consideration for economic purposes is naturally the degree of ease with which the sheets can be split into thin leaves, and it is exactly this property which varies so greatly in the micas from different deposits.

On what the eminence of the basal cleavage depends is not very clear. As a general rule it is the most perfect crystals, and those free from inclusions of foreign mineral substance which yield the cleanest and most uniform sheets.

On the other hand, however, many clean and apparently high-grade micas are poor splitters, the thin laminae tearing readily, and being separated with difficulty. This is especially the case with the very light and very dark-coloured varieties, the medium shades being usually the readiest splitting kinds.

Distortion of crystals, due to crushing, renders a large proportion of sheets useless, and this is the cause of the principal waste connected with the mining of mica.

Plate XXI shows examples of crushed and folded crystals of phlogopite.

Artificially Prepared Mica.

Small mica crystals h been artificially prepared in the chemical laboratory, notably by Ha uille and St. Gilles, von Chrustschoff, and Doelter, and Vogt instances their occurrence in some furnace slags.

Doelter[1], as long ago as 1888, succeeded in artificially preparing mica in the laboratory. By fusing a natural silicate, such as hornblende, garnet chlorite, andalusite, augite, or glaucophane, with an alkaline fluoride, at a dull red heat, small crystals of the mica which it was calculated would be found, were obtained. The varieties prepared were biotite, phlogopite,

[1] Comptes Rendus, Vol. CVII, 188 p. 42.

muscovite, and zinnwaldite. In the experiment which produced muscovite, scapolite was also formed in the fused product.

The occurrence of magnesia-mica in furnace slag at Marienhütte, near Zwickau, Saxony, is also recorded.[1]

It is, however, beyond dispute that the natural crystals required enormous periods of time to form; also, the conditions once existent in pegmatite and pyroxenite dykes are impossible of reproduction by human agency. While, therefore, it is of scientific interest that mica crystals have actually been artificially produced at the expense of other minerals, it is unlikely that it will ever be practicable to manufacture sheets of commercially useful size.

[1] Zeitschrift für Mineralogie, Vol. XVIII, 1891, p. 670.

CHAPTER II.

TOPOGRAPHY AND GEOLOGY OF THE MICA AREAS.

Quebec District.

The Quebec mica district is traversed by two large streams, the Lièvre and the Gatineau, and is dotted with numerous lakes. The rivers can be traversed by canoe for about 200 miles from their junction with the Ottawa; while by comparatively short portages, the great chains of lakes which cover this northern country are rendered easy of access.

On the Lièvre river, settlements extend beyond the junction of the Kiamika, nearly 100 miles north of the Ottawa, though roads do not exist for the entire distance. A west road has also been constructed north of Notre Dame du Laus, which connects with the main north Gatineau road a few miles east of Gracefield.

The nature of much of this upper country is much less hilly than that nearer the Ottawa, and while large portions are occupied by drift sands, certain areas valuable for purposes of settlement are already being occupied. Along the Gatineau, roads extend considerably above the Desert river, and the extension of the railway northwards will open up a large area of good agricultural land.

The value of the district for farming purposes is due to the fact that a broad belt of crystalline limestone extends northward in this direction for many miles, and, in consequence, the usually rugged aspect of the granite and gneiss country disappears to a large extent. The disintegration of the limestone also tends to produce valuable farming soil.

The construction of the projected railway, from Mount Laurier westward across the upper country to the Gatineau, will also open up a large tract of hitherto inaccessible country, which promises to be valuable for both farming and mining.

The general rugged character of the country seen from the Ottawa valley disappears to some extent to the northward, so that, though there is a general increase of elevation, a greater preponderance of level country is encountered in the more northerly districts. Much of this is occupied by deposits of sand, as in the case of the Kazabazua plains to the west of the Gatineau, but this sandy feature is also much in evidence over large areas in the neighbourhood of many of the streams throughout the district. Much of this drift is a normal siliceous sand, which often is found to overlie deposits of a stiff, blue clay, resembling in character the marine clays of the Ottawa basin. The greater portion of the district in which the mica deposits occur is, however, composed of crystalline rocks. These are continuous with those appearing to the south of the Ottawa, but are overlain by the broad area of Palæozoic formations of the lower Ottawa basin. These sediments consist mainly of bedded blue and grey limestones, shales, sandstones, and conglomerates, and are of Cambro-Silurian age. They form a series which, in ascending order, has the following sequence:—

Utica shale.
Trenton limestone.
Black River limestone.
Chazy limestone and shale.
Calciferous dolomite.
Potsdam sandstone.

These sediments are to be found concealing the continuity of the older crystalline rocks from Ottawa southward to the St. Lawrence river. A glance at the key-map accompanying this monograph will show the relative positions of the Quebec and Ontario mica areas. The general trend of the mica-bearing pyroxenites is N.E. and S.W. If now, a line be drawn from the main Quebec mica district (say the township of Templeton) to Sydenham, situated immediately south of the Ontario mica area, it will be found to cross a continuous area of sedimentary deposits for a distance of some 50 miles. It is practically certain that the crystalline rocks—gneisses, limestones, and pyroxenites—possess the same development beneath these sediments as in the eroded districts to the north and south, and it is, therefore, highly probable that extensive deposits of mica are concealed at varying depths by the sedimentary rocks in the neighbourhood of Ottawa.

Ontario District.

While not traversed by any large streams, as is the Quebec district, the Ontario mica area is even more extensively covered by large expanses of water than the former. Long chains of lakes, usually narrow and having a general parallel direction, extend over the townships of Bedford, Loughborough, and Burgess. The general elevation of the country is similar to that of the Quebec district, though its character is not nearly so rugged nor so well timbered as the latter. Large expanses of excellent farming land are scattered throughout the area, and the country is, on the whole, of a comparatively level character. What is known as "the Mountain," north of Westport, is a large mass of reddish granite-gneiss rising to a height of some 600 feet, and this is the highest eminence in the district.

From the western sedimentary deposits, tongues of sandstones and limestones extend eastward in the neighbourhood of Micaville and the Rideau lakes, while from the southern sediments bordering on the St. Lawrence, relatively few extensions run northward, the limit of the Palæozoic being represented by a line, which, though indented, has an approximately east and west direction.

The chains of lakes follow to a marked degree the trend of the gneiss, of which the greater part of the area is composed. The gneiss is found to have a general N.E. and S.W. direction throughout the district, while the dip varies both in degree and direction, many of the exposures evidently forming part of eroded anticlinal folds. Long bosses, or "hogs-backs," of red granite-gneiss, are characteristic of the country, while white crystalline limestone belts cover large areas. In general, it may be said that the gneiss presents a more foliated appearance than in the Quebec region, though local modifications show extremes of both foliated and normal granitic types. The lime-tone is, in every respect, similar in both districts, the rock containing inclusions of accessory silicates in greater or lesser degree, consequent upon its degree of metamorphism and distance from granitic contacts.

The mica-bearing rocks, or pyroxenites, present similar features in both areas, many modifications of the normal granular type being met with in each region.

General Remarks.

It is beyond the scope of this report to enter into a detailed discussion of the complicated geology of the districts in which the economic mica deposits occur. Since Sir William Logan, in the fifties, first attempted a classification of the various types of rocks to be found throughout the area in question, many eminent geologists have undertaken examinations of the district. Numerous opinions have been expressed, and many theories advanced, to explain the complicated features presented. While, in the earlier years, a considerable difference of opinion seems to have existed respecting the origin of the various rocks, and contradictory views were both held and expressed in a long series of papers and reports, our knowledge of the various processes which can take place in the earth's crust has, at the present time, reached a point where controversy is found to be not only futile, but even retrogressive. We can no longer assert, at this date, with any assurance or decision, that such and such processes have led to such and such results. On the contrary, although a vast deal is known regarding geochemical processes and the changes and results which such may produce, it has also been definitely shown that similar results are achieved in greatly varying manners, and it would be, in many cases, rash to make any definite statement regarding the genesis of certain rock types. The changes produced by both regional and dynamic metamorphism in various types of rocks often limit even the aid afforded by the microscope and chemical analyses in deciding in precisely what manner such rocks were formed. For example, it is to-day as far as ever from being established whether certain foliated crystalline rocks of a gneissose type were originally of sedimentary or igneous origin. That is, we do not know whether they were primarily laid down in water, or whether they have been intruded in a molten state into pre-existent rocks. Similarly, it is uncertain whether many basic rocks are a result of complete metamorphism in situ of pre-existent types, or whether they are true dykes of later origin than the rocks which enclose them, and which they have intruded while still in a plastic state. As such types, may be mentioned the gneisses and amphibolites of the Bancroft area, described by Adams and Barlow.[1]

Again, the white crystalline limestones which occur associated with the gneisses of the Laurentian formation have had widely different origins assigned to them. They have been regarded as eruptives, that is, as formed in their present condition from a molten state; as metasomatic products of the gneisses with which they occur associated; and finally as highly altered sediments. Correspondingly, they have been assigned to various geological horizons. In the first two instances, they might be considered as Laurentian, that is, as forming part of the same system chiefly represented by the gneisses and gneiss-granites, while in the third case, they might either be of earlier origin than the gneisses which have enclosed, intruded, and metamorphosed them to their present condition, or else contemporaneous with these, the whole series subsequently undergoing metamorphism concurrently. Still another theory was at one time advanced, namely, that the limestones were originally deposited from aqueous solutions, in the same way as gangue matter on mineral veins. The view generally held at the present day is that they are altered sedimentary rocks, though both the igneous and metasomatic theories are also held.

It may be added, that the theory adopted by Sir W. Logan, in 1863, regarding the Laurentian formation, was that the rocks comprising almost the entire Laurentian system consisted of a series of metamorphic, sedimentary strata—that is, that limestones, gneisses, pyroxenites, etc., were all merely altered sediments.

Bands of gneiss are, indeed, met with bedded in the limestones, and these are now regarded as of sedimentary origin. They are supposed to be siliceous portions of the original calcareous deposits, corresponding to the clay-stones or mud layers to be found in the more recent and unaltered sediments, and to have been changed to their present condition by the same processes which have metamorphosed the limestone to its present highly crystalline state. These gneisses are often indistinguishable, even under the microscope, from those which enclose the limestones. The foliation is supposed to be due to movements in the rock complex, which would, under an enormous mass of superincumbent strata, be in a sufficiently plastic state to assume schistose structure. According to the views formerly held, crystalline limestones occurred in several horizons in the gneiss, four distinct areas of limestones being recognized, and the whole series of gneiss and limestone was estimated to have a thickness of some 23,000 feet, of which the volume of the latter rocks comprised about 5,000 feet.

[1] Memoir No. 6, Geol. Surv., Can., pp. 25, 51, 157.

In describing the geology of the mica-area in detail, it was found impracticable to consider the Quebec and Ontario districts separately, so the following remarks may be taken as applying equally to the entire region over which the mica deposits occur.

THE GNEISSES.

About 80 per cent of the area over which the mica deposits occur is composed of rock of a gneissose type. The remainder is made up of limestones and basic rocks, chiefly pyroxenites. Although the gneiss may be, and has been, divided into two classes, namely the normal igneous rock which is regarded as enclosing the limestones and other rocks, and the sedimentary or so-called "rusty gneiss," together with certain acres of greyish and black varieties, little macroscopic distinctions other than colour can be drawn between the two types. A detailed examination of the area has led to the conclusion that the so-called "sedimentary gneisses" form relatively narrow bands enclosed in the limestones, and represent altered clay-stones originally deposited in the main body of sediments. The main body of gneisses is now regarded as composed of igneous rocks, which have suffered a high degree of alteration and possess by no means a universally constant character. Gradations of normal foliated gneiss to a crystalline rock resembling a granite are common, while local additions of pyroxene and hornblende in the neighbourhood of the limestones lead to the formation of rocks differing little from normal diorites, diabases, and gabbros.

The mention of such rocks in the description of mica deposits is common, and they are usually stated to cut or intrude the pyroxenites. The time at the writer's disposal was too limited to allow of an investigation into the true nature of such rocks, but it may be stated that in few cases only was seen a typical instance of such a rock forming a dyke across a pyroxenite. Owing to so many of the mines being idle and the pits full of water, few detailed examinations of the actual occurrences could be made. From an inspection of the accessible workings, however, as well as from a study of dump material, the impression was formed that much of such diorite and diabase is simply a result of local admixtures of hornblende or pyroxene to the more acid portions of the altered gneisses near their contact with the pyroxenites. Both fine and coarse-grained modifications of such rocks exist, the latter type preponderating.

It is not intended, here, to make any sharp distinction between the sedimentary and true igneous gneisses. To all appearances they are identical in character and composition, and it may yet have to be conceded that the theory of sedimentary origin is a mistaken one, such bands being only apophyses of the normal igneous gneisses which have intruded the limestones. The main reason for considering them as sediments, is that the limestones, which border upon them, have suffered little additional metamorphism along the contacts, as is the case when such are enclosed by undoubted igneous gneisses. The normal results of such an intrusion would be the production of a more coarsely crystalline limestone, together with the formation in the latter of a greater or lesser quantity of secondary silicates, according to the extent of the intrusion and the amount of mineralizers carried by it. A complete metamorphism of limestone to a rock of totally distinct character, namely pyroxenite or amphibolite, has been shown by Adams and Barlow to be not only possible, but characteristic of certain areas in the Haliburton and Bancroft districts of Ontario. There, zones of white limestones adjacent to granitic intrusions are surmised to have been completely altered to dark green amphibolite. Bands of such amphibolite are also found interposed in the granite gneiss of the area, and these are supposed to be smaller portions of limestone which have been engulfed in the batholithic upheaval, and altered in their entirety. The conclusions formed by Adams and Barlow regarding the rock types in the counties of Hastings, Renfrew, Haliburton, etc., may well be considered to apply, in part, also to the more eastern counties of Frontenac, Lanark, and Leeds. Although not containing so many modified rock types as the former, the area of the latter is mainly composed of similar gneisses and granite-gneiss, with belts of white crystalline limestone and pyroxenite. Many of the remarks, therefore, relating to the geology of the Haliburton area, may be regarded as equally applicable to the district here under consideration.

As regards the gneisses: these are considered as the outcome of vast, batholithic intrusions of granite, which have, as a result of movements while in a still plastic condition, largely assumed a foliated or schistose structure. This foliation is by no means universal, rocks with true gneissose structure grading into massive, granitoidal types in many places. The prevailing colour of the gneiss is reddish, and the rock is usually medium to fine in grain. Weathering produces a grey or pink coloration. Regarding the geological history of the area, the following extract from the report of Drs. Adams and Barlow may be quoted:—

"The district was in Pre-Cambrian times covered by a sea, in which there was deposited an immense series of sediments, aggregating many thousand feet in thickness. The thickness of the series shows that the period of deposition was a long one, and the prevailing calcareous character of the sediments shows that it was probably of marine origin. That there was land, however, in the vicinity, is shown by the fact that a certain amount of argillaceous and arenaceous sediment found its way into the sea. It was deposited at a time of violent volcanic activity, for there is reason to believe that a large part of the great volume of amphibolite interstratified with the normal sedimentary material represents volcanic ashes and other clastic material of volcanic origin, which was, from time to time, thrown into the sea, in which normal sedimentation was going forward.

Concerning the nature of the basement upon which this immense accumulation of sedimentary material was laid down, we have no certain knowledge, for no part of it can be recognized at the present time as the original floor.

This great series was then folded in a general direction of N. 30° E., and, probably contemporaneously with the folding, was invaded by an enormous body of granite. This granite slowly rose, in the form of great batholiths, into the overlying series, disintegrating it and becoming filled with countless fragments of the invaded rock. In the case of the limestones, this granite not only disrupted them, *but changed them into amphibolites*. The amphibolite produced in this way, as well as that referred to above as occurring interstratified with the limestones, and of different origin, was, in many places, dissolved by, or incorporated into, the substance of the granite, taking the form of basic streaks or 'schlieren' . . . . From what has been said, it will be seen that there are presented in this great area precisely the same phenomena as those seen elsewhere in North America, and the evidence available seems to indicate that this statement may be extended to all parts of the world. Where the oldest stratified or stratiform formations are exposed, these rest upon great bodies of granite, usually gneissic in structure, which penetrate them in great batholithic masses, the contact being an intrusive one."

The red gneiss is composed almost entirely of feldspar and quartz, the former generally preponderating. Little mica is present, but scales of muscovite and biotite exist in small amounts throughout the rock. Sometimes small quantities of hornblende are to be seen; and, as accessory minerals, may be mentioned apatite, magnetite, and zircon. Local impregnations with garnet are often to be found in proximity to the pyroxenites, a notable locality being at the McClatchey mica mine, near Gould lake, in the township of Loughborough. The feldspar present in the rock is of two types, oligoclase and orthoclase, the former as a rule preponderating. The rock might thus be classed as an oligoclase gneiss, rather than an orthoclase gneiss. The red colour of the feldspar can usually be destroyed by heating, showing that oxide of iron is not the cause of the coloration. This is also true of the reddish feldspar from the feldspar mines in Bedford township, which is shown by analysis to contain little iron, and which becomes white upon calcining. Little opportunity was found by the writer to differentiate between the grey and red gneisses, or the sedimentary and the igneous. Many modifications of the usual type were encountered, from the normal reddish rock poor in mica, to greyish varieties having, as a rule, a more granitoid character, and often possessing appreciable garnet content, together with a large amount of quartz, and finally to very dark and almost black types containing much biotite in small scales, in which the pink feldspar individuals lie embedded. Little quartz is microscopically visible in these darker varieties. Adjacent to the pyroxenite dykes,[1] mica is nearly always more plentiful in the gneiss, and is generally either biotite or phlogopite.

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[1] NOTE.—The term "pyroxenite dyke" has been employed throughout this Report to describe the belts of rock, consisting principally of salite and other members of the pyroxene family, with which the mica deposits occur associated. The name is not a happy one, and will be further considered under the description of these rocks. (See page 292).

Adams and Barlow[1] found that the grey gneisses of the Bancroft area differ in mineralogical composition from the red types, holding, in some cases, a greater proportion of iron-magnesia constituents, combined occasionally with a smaller quartz content. In other cases, a larger amount of plagioclase was found to be present. For the purpose of this report, which in no way claims to be a detailed, geological discussion of the various rock types, the use of an abundance of names, used to designate the minor varieties of rocks, has been purposely avoided. Many of these minor types differ in small degree from each other and, in fact, are often only local phases of one and the same family, all gradations from one to the other being traceable over limited areas. It is convenient, for the purpose of a detailed description, to draw up a list of names to which all the minor varieties of rocks may be referred, but in a superficial description it tends only to lead to confusion. For the purpose of sharp distinction between certain rocks it is necessary to not only conduct a microscopical examination by means of thin slides, but also, in many cases, to resort to chemical analyses of the rocks. Such examinations in the limited time at the writer's disposal were out of the question. In this report, however, recourse has been had to earlier examinations and descriptions of the districts in question, and also of those adjoining; certain main features being to a great extent common to the entire area. With these descriptions are incorporated the writer's own observations of the geological features of the mica region; and a short resumé of the main facts noted and the conclusions reached is added.

The greater portion of the red gneiss throughout the area may, then, be regarded as of undoubted igneous origin, and has resulted from an alteration of granitic material, which, originally intruded in massive form as batholiths, subsequently assumed a foliated or gneissic structure, owing to folding movements which took place while the rock was still in an unconsolidated state. The latter condition need not have been a necessity, since consolidated and cold rocks are known to have been, in many instances, rendered plastic by dynamic agency, and to have subsequently assumed a more or less schistose structure. However, in the district in question, it would seem probable that the folding of the granite occurred while the rock was still in a more or less molten condition. This view is strengthened by the universal occurrence throughout the gneiss area of pegmatite dykes and stringers which cut the rock in all directions.

Quartzite layers are sometimes met with intercalated in the gneisses. The bands are usually thin, but occasionally attain considerable width. Harrington[2] instances a gneiss with numerous quartzite layers on range X 11, lot 12, of the township of Templeton, Que., and also the occurrence of beds of considerable thickness in the hill behind Perkins Mill, in the same town-

[1] Loc. cit. p. 62.

[2] Rep. Prog., Geol. Surv., Can., 1877-78, Part G, p. 3.

ship. Many of the quartzose bands referred to as quartzites are, however, probably pegmatites, with an excess of silica.

THE PEGMATITES.

While possessing a general trend conforming to the folds of the gneiss, that is, N. 30° E., these pegmatites yet often cut across the foliation at all angles. Pegmatites, in the general application of the term, are generally held to be the final products of igneous activity attendant upon a granitic upheaval. They are, in other words, the dying effluxes of a deep-seated, granite magma which is in process of cooling, and are usually composed of the more acid, residual minerals segregated from the original magma by a process of differentiation. These acid outflows are supposed to have been accompanied by an excess of water vapour liberated from the cooling magma, and to the presence of this is attributed their coarsely-crystalline structure.

If, now, the folding of the granite took place before complete consolidation, but after the crust had partly solidified, we should expect to find the latter in a more or less shattered condition. The folding movements would then force the still liquid, and more acidic, deeper-seated rock into the cracks formed by shattering, and this rock would then solidify as a sort of cement in the fissures. This seems, in fact, to be what has actually occurred throughout the entire gneiss region, and these pegmatitic rocks are to be met with wherever the gneiss is exposed.

Though the usual form assumed by pegmatites is that of dykes of various widths—a few inches to several hundred feet—a common type is that of large, irregularly-shaped bodies, which have been termed "splashes."[1] These splashes are often of considerable extent, and it is not seldom found that a number of such acid zones exist in close proximity to one another, the appearance being such as to suggest that what was originally part of one and the same body has been separated by later movements of the enclosing rock into more or less elongated masses. Such pegmatitic zones consist sometimes of feldspar and quartz in varying proportions, and sometimes of almost pure quartz with a few scattered feldspar crystals scattered through it. Mica is usually absent, though local aggregations of both biotite and muscovite are met with. Large developments of such pegmatite bodies are to be found in the townships of Portland, Bedford, and Loughborough, and have been somewhat extensively worked for their feldspar. In the first-named township, the Border mine, on concession XII, lot 6, was opened up some years ago by the Pennsylvania Feldspar Company, who continued work for a short time. The same Company also operated the Freeman mine, situated on lots 1, concessions XII, of the townships of Portland and Loughborough, near Fourteen Island lake, and the Walker mine, on lot 2, concession X, of

[1] German: "Flammen."

Portland. The feldspar at all these places is a pinkish mineral, consisting principally of orthoclase with local admixtures of plagioclase and microcline. Quartz is present in stringers and occasional large masses; a little biotite also occurs. The dykes can be traced for considerable distances, and attain a width of some 50 feet. The Richardson mine, on lot 1, concession II, of Bedford, has been operated since 1900, and is situated on two bands of feldspar, one of which is 150 feet, and the other 60 feet, wide, the two separated by a narrow band of massive quartz. The length of the deposit is some 300 feet. The feldspar is of a light red colour, and is massive, with good cleavage. Two analyses[1] of the spar are given below, No. 1 having been made in Kingston, and No. 2 by Dr. H. Ries, of Cornell University. As will be seen, the red colour of the mineral is not caused by its iron content, but is a natural coloration.

	Silica SiO_2	Alumina[1] Al_2O_3	Ferric Oxide Fe_2O_3	Potash K_2O	Soda Na_2O	Lime CaO	Magnesia MgO	Loss on ignition	Total
No. 1	66·23	18·77	trace	12·09	3·11	0·31	nil	nil	100·51
No. 2	65·40	18·80	"	13·90	1·95	nil	nil	0·60	100·65

On lot 3, concession III, of Bedford, a further deposit of similar feldspar has been opened up in the Harris, or Jenkins mine, and a considerable amount of the mineral was extracted around 1902. All these pegmatites are enclosed by reddish gneiss, and the dykes have a direction parallel to the strike of the gneiss.

In the Quebec mica area, the most notable occurrence of pegmatite is at the Villeneuve mine, lot 31, range I, of the township of Villeneuve. In this locality, several parallel pegmatite dykes are found conformably interposed in the red gneiss, the largest—upon which is situated the Villeneuve mica mine—having a width of some 150 feet. The feldspar here is mainly albite and microcline in parallel intergrowth, and is very pure, and white in colour. A fuller description of this occurrence will be found in the notes on the Villeneuve mine on page 196. The feldspar is of superfine quality, and commands a high price (circa $20 per ton) for use in dental work. The gneiss bordering on the dykes is highly garnetiferous, and contains more mica than is usually present in the rock. Other similar pegmatite bodies exist in the vicinity of Blue Sea lake, but have not as yet been exploited. The rock here is more of the graphic-granite type, and contains an average of from 20 to 30 per cent of impurities—mainly quartz. Pegmatites also occur at various other points in the mica area, and some of them were formerly worked for the mica they contain.

[1] See Rep. Ont. Bur. Mines, 1900, p. 26.

In Bathurst township, Ontario, pegmatite veins exist on concession IX, lot 19, and are largely composed of the variety of albite known as peristerite. This mineral, commonly called moonstone, is of value as a gem stone, and has also been found at the Villeneuve mine, Quebec.

An analysis of the Bathurst peristerite, by Dr. Sterry Hunt, is appended:—

Silica SiO_2	Alumina Al_2O_3	Potash K_2O	Soda Na_2O	Lime CaO	Magnesia MgO	Ferric Oxide Fe_2O_3	Ignition	Total
66·80	21·80	0·58	7·00	2·52	0·20	0·30	0·60	99·80

Bands of perthite, of pegmatitic origin, occur on lot 4, concession VI, of North Burgess, and also in the vicinity of Perth, whence the mineral takes its name. Perthite consists of an intergrowth of orthoclase or microcline with albite, and is sometimes of value for polishing, for ornaments, etc.

Two analyses[1] of perthite, by Dr. Sterry Hunt, are given below:—

	Silica SiO_2	Alumina Al_2O_3	Ferric Oxide Fe_2O_3	Lime CaO	Magnesia MgO	Potash K_2O	Soda Na_2O	H_2O	Total
I.	66·44	18·35	1·00	0·67	0·24	6·37	5·56	0·40	99·03
II.	66·50	19·35		0·56	0·24	6·18	5·56	0·44	98·73

In addition to the above-mentioned notable occurrences of pegmatite, the entire gneiss area is intersected by small stringers and veins of more or less similar pegmatitic character. It is noteworthy that such veins are frequently found cutting across the pyroxenites and through the mica deposits. Examples of such intrusions are well exposed in the pits at the Seybold mine, lot 18, range II, of Wakefield, Que., where the pyroxenite is faulted by two narrow pegmatite veins, which cut across it at almost right angles to its strike, and to the strike of the gneiss. On lot 12a, range XIII, of Hull, a splendid example of pink felsite intruding pyroxenite is to be seen in the pits opened by Messrs. Winning, Church, and Company. The intrusive rock consists of a fine-grained, pink groundmass of orthoclase and microcline, in which occur crystals of dark-brown, opaque sphene porphyritically embedded. Small quartz grains occur sparingly, and occasionally a large feldspar individual is seen. The effect of the intrusion upon the pyroxenite is most pronounced. Bordering upon the felsite, the pyroxene has been almost entirely altered to a bluish-green hornblende, or actinolite, and scattered through the pink mass of the intrusive lie small, altered individuals of pyroxene. The

[1] Report Ont. Bur. Mines, 1900, p. 206.

various degrees of alteration to which these have been subjected are most marked. Side by side, are to be seen completely metamorphosed crystals of dark-blue colour, and green individuals of which only the outer portion has been altered. The former possibly represent pyroxenitic mineral which has suffered solution by the acid rock, and which has subsequently recrystallized out; while the latter consists of small fragments which have been caught up and only partially attacked. Both minerals possess irregular shape, and are not to be found with definite crystal outline. The sphene crystals are well formed, and sometimes attain a length of ¾".

A somewhat similar occurrence to the above is to be seen in the pits at the Wallingford mine, lot 19, range VI, of Hull. Here, a still greater formation of hornblende mineral has taken place, and where this has formed on joints in the rock, it has frequently been pressed into rough plates up to a foot across, from which fibres may be detached and rubbed to asbestos-like threads. Large masses of such hornblende-asbestos, having fibres nearly a foot in length, were observed on the dumps. The mineral is probably referable to the species byssolite, and is evidently the outcome of the action of the pegmatite upon the pyroxene. At both the above localities, molybdenite occurs in small bunches at the junction of felsite with pyroxenite. These intrusions, which are typical of similar occurrences to be met with in not a few of the mica mines in the neighbourhood of Chelsea and Kirk Ferry, on the Gatineau river, do not possess dyke form, and are thus distinct from the ordinary pegmatites. They seem, rather, to have been the result of a violent upheaval which has burst through the weaker portions of the earth's crust in the vicinity of pyroxenite belts, and has shattered the latter very considerably, tongues of the acid rock eating their way into the more basic material. No tourmaline was observed at any of the spots where rock of this type was met with, the brown titanite, or sphene, being, however, very characteristic of such occurrences. It may here be remarked that sphene is an almost constant accessory mineral in the vicinity of mica deposits. Where not actually present in the pyroxenite itself, it is generally to be found in the more acid portions of the dykes, being usually associated with grey, white, or brownish feldspar. The individuals sometimes attain a length of a couple of inches in the direction of the b axis, and generally possess the normal, wedge-shaped habit typical of the mineral. Clumps and masses of irregular shape are also common (See p. 298).

In an old phosphate pit, on range XII, lot 15, of Hull, a good example was seen of a pegmatite vein cutting a deposit of massive apatite. The latter is a dark-green and brown mottled mineral, and is cut by small pegmatite stringers, which are particularly noticeable for the amount of tourmaline they carry, the main portion of the veins often being composed of practically solid, black schörl. On lot 16, range XI, of Hull, a small pegmatite stringer, carrying molybdenite, was observed cutting through a mass of apatite, having a medium grain. At this spot, several narrow pegmatite veins cut across the pyroxenite at almost right angles, and are composed of pink orthoclase and white microcline. They appear to have exerted no influence whatever upon the apatite bordering on them, and were perhaps too narrow to cause any extensive alteration. The stringer referred to above had, in one place, cut through a crystal of phlogopite embedded in the apatite, and had carried portions of the mica with it. Numerous instances of pyroxenite dykes (with which are associated valuable mica deposits) cut by pegmatite veins were observed in the course of the examination of the deposits. These were generally in the form of narrow stringers, ranging, in width, from an inch to several feet. The impression was formed that many of the so-called diorite, diabase, and gabbro dykes, mentioned by former writers as cutting or intruding the pyroxenites, are not, in reality, dykes at all. On the dumps of almost all mica mines (which were carefully examined for specimens of the rock found in the workings—these being, for the most part, inaccessible) a quantity of brownish, feldspathic rock, carrying greater or lesser amounts of either pyroxene or hornblende, was met with. This rock ranges from fine to coarse-grained, and the amount of basic mineral present is very variable. The character of the feldspar is, however, constant throughout, and it seems highly probable that much of the so-called 'diorite' and 'diabase' is nothing more than acid portions of the pyroxenite, carrying admixtures of either pyroxene altered to hornblende, or normal pyroxene. Few instances could be seen of undoubted dykes of such rock cutting the deposits. In most cases where rocks of a dioritic or diabasic character could be observed in situ, the impression conveyed was that such zones were merely differentiated portions of the pyroxenite. Titanite was generally found to be present in this rock, and often in considerable amount. With few exceptions, therefore, the only definite and undoubted dykes which were observed cutting the mica deposits consisted of acid rocks, usually having the character of normal pegmatites.

Now, if—as surmised—the pegmatites represent a final intrusive phase of the granite gneiss which encloses the pyroxenites, it must follow that, since such pegmatite veins cut the pyroxenites, the latter were already formed and in existence before the final consolidation of the gneiss. If we adopt the theory that the pegmatites belong to two or more geological periods, the above assumption, of course, is unnecessary. The general uniform character of the pegmatites met with throughout the mica region, however, gives no reason to suppose that they belong to earlier and later periods. They would seem, on the contrary, to be the outcome of the great folding movements which have given to the original, batholithic, granite upheavals their present foliated character, and to have been expressed through the cracks and fissures caused in the already partly consolidated crust through the agency of such movements. If this be the true explanation of their origin, we must assume, as explained above, that the pyroxenites were already in existence before the final consolidation of what is now the granite-gneiss which encloses them, and are not, as has been supposed, dykes of basic, igneous rock which have been intruded into the gneiss at some period subsequent to the latter's alteration by folding from normal granite. This would suggest a similar mode of origin for the pyroxenites of the Quebec-Ontario mica districts as has been proposed by Adams and Barlow for the amphibolites and allied rocks of the Haliburton-Bancroft area, namely metamorphism from limestones, due to vast, batholithic, granite intrusions which have, in some instances, completely engulfed large bodies of sediment, altering them in their entirety to dark hornblende- or pyroxene-rock.

THE CRYSTALLINE LIMESTONES.

The correct place of these types in the series of older, crystalline rocks with which they occur associated has been the subject of much controversy ever since they were first studied by Mr. A. Murray and Sir William Logan, in the fifties. It was then thought that these rocks formed, with the gneisses, an alternating series of sedimentary deposits which have since undergone a high degree of metamorphism. That is, that what was then given the name of the Laurentian system consisted of many thousand feet of altered sedimentary rocks—four, and possibly five, distinct horizons of calcareous deposits being separated by thousands of feet of red orthoclase gneiss. All these later rocks were supposed to rest upon the original foundation of the earth's crust, to which the term fundamental gneiss was applied. The discovery, in 1853, in a crystalline limestone of North Burgess, of the far-famed Eozoon Canadense, which was long regarded by such eminent geologists as Lyell, Logan, and Dawson, as indisputably of organic origin, lent great weight to the theory of the sedimentary origin of the entire Laurentian series of gneisses and limestones. In 1866, Vennor introduced an arrangement of the older crystalline series by which they were arranged under three heads. In the first was placed a thickness of red syenitic and granitic gneiss, in part without foliation, which was held to be the base of the series. Above this came grey and pink gneiss, passing into mica schist, overlain by several hundred feet of crystalline limestone or dolomite. In this limestone what was regarded as Eozoon was found. In the second division came the amphibolites and pyroxenites, with various schists, and also magnetite deposits; while in the third were placed other crystalline, dolomitic limestones, mica slates, quartzites, and some conglomerates. Later, the above divisions were condensed, and the rocks placed in the first were classed as Laurentian, while the other two divisions were regarded as Huronian.

In 1877, Selwyn devised a classification by which only the lowest series of gneiss, granite, and syenite which showed no trace of sedimentation, were assigned to the Laurentian, while the sedimentary gneiss, limestone, quartzite, and schists, which made up the Grenville and Hastings series, were classed as Huronian.

In 1881, the original scheme of classification was again adopted, the Laurentian being divided into a lower, middle, and upper portion, succeeded by the overlying Huronian.

Again, a type of rock known as anorthosite, which had been previously regarded as an altered, sedimentary series forming the upper member of the Laurentian, was about this time recognized as an intrusive mass of later date than the Grenville rocks with which it occurred. The Laurentian, therefore, was subjected to a fresh arrangement by which it was divided into two portions, a lower series comprising the lower division of Vennor, and an upper series of gneiss and limestones with quartzites, which were embodied in the Grenville and Hastings formations. The terms Grenville and Hastings were applied to designate two series of what were regarded as sedimentary deposits in different stages of metamorphism and of different age. The view, however, gained ground, and is now generally held, that these two series, which were named from the counties in which they occur, are, in point of time, equivalents of one another, and represent only different degrees of alteration of one and the same set of contemporaneous deposits. The Hastings series, being less highly altered than the Grenville, has been at various times classed in the Huronian system, which succeeds the Laurentian; while the Grenville deposits, being chiefly highly metamorphosed limestones, were regarded as belonging to a lower horizon overlying the fundamental gneiss.

Sterry Hunt was inclined to the view that the Hastings series were of Huronian age, but that they were not the equivalent of the Grenville deposits, which he still regarded as Laurentian. The anorthosites were also classed by him as altered sediments, but were assigned the term Norian, being referred to a distinct formation separating Laurentian from Huronian.

The tracing of the crystalline limestones from their development as Hastings series in the county of that name, to the Grenville strata in the district of Grenville, met with much difficulty. The continuity of the belts was often affected by what were, apparently, large, intrusive masses of granite, which either cut off or deflected the course of the bands. The conclusion has, however, been reached that what has been termed the Hastings series is merely a less altered phase of the Grenville, since the petrographical difference between the two consists only in the degree of metamorphism. The only reason which might be given that the two series are unconformable is the presence of local beds of conglomerate. It is, however, as equally probable that these rocks are autoclastic conglomerates, formed by crushing, as that they are of sedimentary origin.

With respect to certain areas of the Grenville series in the Province of Quebec, in which the bodies of crystalline limestones are often small and very highly altered, the view was at one time held that these rocks were not, after all, of sedimentary origin. In most cases, all traces of stratification have been lost, and the beds simply assume the inclined position imparted by the tilted gneiss strata enclosing them. W. G. Miller[1] advances the possibility of some of the Ontario crystalline limestones representing alteration products of igneous rocks, the feldspar having broken up into unstable scapolite, from which have resulted the often dolomitic limestones. This is a view for which no supporting evidence whatever could be found from an examination of the limestones. If correct, it would imply the gradual passage of gneissic or granitic rocks into limestone, a feature nowhere observed by the writer, nor mentioned in any report on the district in question, which has come under notice. Though not occurring in the area specifically included in this report, the fact mentioned by Adams and Barlow,[2] that remnants of unaltered, blue, Archaean limestone were observed enclosed in great belts of white marble surrounding the granite batholiths of Methuen and Cavendish townships, is confirmatory evidence that such crystalline limestones are the result of contact metamorphism. Crystalline limestone may possibly, of course, result in various ways, yet the strong resemblance between the whole series of Grenville limestones would seem to indicate a similar mode of origin throughout.

When it is said that a strong resemblance exists between the limestones of various localities, this is intended to mean that such rocks exhibit marked, similar characteristics, and not that a similar character is universally possessed. While in almost all cases true limestones, these rocks are found to be locally dolomitic, and occasionally pass into true dolomites. This variation would seem, in some cases, to be connected with the occurrence in their neighbourhood of basic, pyroxenic rocks. The quantity, also, of scattered grains of various silicates is greatly variable, a dark colour being sometimes imparted to the limestone by the numerous small crystals of phlogopite, diopside, graphite, etc., present. In other cases, foreign silicates are entirely absent, the rock having the appearance of a pure marble. The grain, too, of the limestone is variable, ranging from that of a true marble to a coarsely crystalline aggregate, composed of individuals up to an inch across. The proportion of accessory minerals present in the rock seems to be directly dependent upon its distance from gneissic or basic types, the amount of silicates increasing as the contact is approached.

The presence of gneisses associated with the limestone has already been touched upon, and it has been shown that these are of two kinds—the true intrusives, which are portions of the batholiths which have penetrated the limestones and have later become foliated, and the sedimentary gneisses, representing altered sandy or clayey bands originally interstratified with the limestones. The latter often contain considerable quantities of graphite, and sometimes sillimanite, and it is with these gneisses that economic deposits of graphite are, as a rule, associated. The latter seem to owe their origin to a driving-off of the carbonaceous matter present in the limestones, this being

[1] Eighth Report, Ont. Bur. Mines, 1899, p. 225.
[2] Loc. cit. p. 23.

redeposited in the more argillaceous portion now represented by the gneisses. Another very pronounced type of rock sometimes found associated with the limestones is the amphibolites. These do not occur in the mica area to the same extent as in the region more to the west; they, apparently, being represented by certain of the pyroxenites so extensively developed in the former district. Though somewhat variable in character, the amphibolites commonly possess a dark colour and highly basic composition. They are composed, usually, of hornblende and feldspar, with subsidiary quartz; while biotite and pyroxene sometimes in part replace the hornblende—the rock then inclining to a pyroxenite. These rocks have been divided into two distinct varieties, the one termed "feather-amphibolite," while the other possesses a more granular character and has, in consequence, been termed "granular amphibolite." Adams and Barlow assign two distinct modes of origin for these rocks. The granular amphibolites are conjectured to represent altered igneous intrusives; while the feather amphibolites are surmised to be altered sediments, representing siliceous or dolomitic bands in the original limestone. Concerning these rocks, the above-mentioned writers give the following particulars:—

"All stages in the passage from on to the other (limestone to amphibolite) have been found. *It has also been proved that, elsewhere, amphibolites have been produced on a large scale from the alteration of the limestones by the metamorphic action of the granite batholiths.* It is found that, under intense metamorphism, a number of rock types very different in origin and character yield a convergent type of alteration products, which belong to the class of amphibolites, *and which resemble one another so closely as to be in many cases indistinguishable.*" Other amphibolites, mentioned as occurring with large gabbro and diorite layers, are concluded to be highly altered, basic, volcanic ashes and lava flows, connected with vents represented by the gabbro stocks. "Some of the varieties are well banded, others are streaked, or present an appearance strongly resembling a flow structure. The rocks are, however, so completely recrystallized that a microscopic examination does not yield any conclusive evidence concerning their original character." The "reddish, acid rocks" mentioned by these writers[1] would seem to be identical with the brownish or reddish types so often observed by the writer on the dumps of mica mines, and also in situ at such mines; they consist, principally, of brown feldspar and either pyroxene or hornblende, with accessory titanite. The relation of these amphibolites to the pyroxenites of the mica region will be further considered under their separate headings.

The Grenville series is computed to consist for rather more than one half its thickness of pure limestone, and it is taken to present by far the thickest development of Pre-Cambrian limestone in North America.

An unusual occurrence of crystalline limestone, having a blue colour, was noticed at the Silver Queen mica mine, lot 13, concession V, of North Burgess.

[1] Ibid., p. 26.

Ont. The exposure is about 100 feet distant from the mica deposit, at the base of the ridge upon which the pits are situated. The limestone, which is rather more coarsely-crystalline than usual, is of a distinct, blue colour, and is chiefly remarkable for the amount of sulphuretted hydrogen gas which it contains. Mere crumbling in the hand is sufficient to liberate appreciable quantities of this gas, while a blow from the hammer renders its presence still more perceptible. Small flakes of graphite and minute crystals of pyrites are also present in the rock. A small pit opened in the limestone, at a distance of perhaps 250 feet from the mica pits, disclosed a slightly less coarsely crystalline rock, of a greenish shade, containing considerable quantities of silicates, chiefly phlogopite, diopside, and wollastonite, and also pyrites, marcasite, pyrrhotite, and graphite.

Miller[1] gives a list of the various accessory minerals which have been found in the crystalline limestones, as do also Adams and Barlow, on page 198 of their report. The commonest of such minerals are the following: apatite, biotite, garnet, graphite, magnetite, phlogopite, pyrite, pyrrhotite, and scapolite, the total number of varieties found totalling 42, or four less than the total number recorded by Sterry Hunt for the limestones of the whole of North America. Detailed descriptions of these minerals, together with the localities where they were found, are given on pages 198–216 of the above report.

An interesting and somewhat puzzling feature in connexion with the limestones is the frequent presence in them of fragments and nodules of impure mineral. These generally consist of amphibolite or similar rock, and though sometimes angular, are more often rounded. When these are present in any amount, the limestone takes on the appearance of an ordinary conglomerate. It is conjectured that these nodules are portions of impure bands originally present in the rock, and which, by subsequent movements, have been torn apart, and even rounded, so as to be indistinguishable from water-worn fragments. It is the occurrence of such apparent conglomerates that formerly gave rise to the theory that the limestones of the Grenville and Hastings districts represented different horizons. An excellent photograph of such a limestone conglomerate appears facing page 24 of Part J, Annual Report, Geol. Surv., Can., Vol. XII, 1901. The various differences both in character and mode of occurrence of the crystalline limestones, due in part to the degree of alteration to which they have been subjected, also produced a theory that they had been deposited directly from solution, in a similar manner to the gangue matter in mineral veins. This idea has not many adherents at the present time, observations lending no manner of support to, and rather tending to disprove, the theory. A field examination of the various limestones gives little indication as to the amount of magnesia present, and in how far such are true limestones or dolomites. The rock presents little difference in appearance according as the magnesia

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[1] Loc. cit. p. 21.

content is high or low, the dolomite replacing the calcite without change of structure, the minerals being isomorphous. Analyses show, however, that the limestones do vary greatly in their true composition, and a few typical examples, taken from Mr. Miller's report, are given below:—

	1	2
Carbonate of lime	55·79	53·90
Carbonate of magnesia	37·11	45·90
Peroxide of iron	traces	.
Insoluble	7·10	...
Total	100·00	99·80

(1) White, coarsely-crystalline dolomite from lot 4, concession X, of Loughborough, Ont. Leaves, when dissolved, a residue of quartz and serpentine, and contains traces of oxide of iron and phosphate.

(2) Fine-grained, white marble from Mazinawe lake, Ont.

	1	2	3	4	5
Insoluble	2·92	.....	.....	.....	.....
Silica	......	3·24	1·50	5·40	1·18
Ferric oxide	0·56	1·14	0·41	0·72	0·41
Alumina	trace	0·82	0·53	0·68	0·62
Lime	50·12	44·52	49·68	25·02	48·51
Magnesia	3·66	8·00	1·27	23·49	5·27
Sulphur trioxide	......	0·29	0·06	.....	0·14
Carbon dioxide	42·92	40·62	43·38	45·14	43·14
Total	100·18	98·63	99·83	100·75	99·60

(1) White crystalline limestone from near Bedford station.

(2) From lime-kilns near Parham station.

(3) From Reynold's, south of Verona.

(4) From Goodbury's quarry, Verona.

(5) From two miles north of Goodbury's quarry, Verona.

In the Hastings area the following analyses are typical:—

	1	2	3	4
Insoluble	......	2·54	1·11	..
Silica	1·37	......	......	2·70
Ferric oxide	0·82	0·34	0·56	1·71
Alumina			trace	1·61
Lime	50·10	53·64	47·49	48·28
Magnesia	3·88	0·99	6·82	4·35
Sulphur trioxide	0·10	0·34	0·18	0·34
Carbon dioxide	43·32	42·92	43·91	42·60
Total	99·59	100·77	100·10	101·62

(1) From marble quarry near Madoc.

(2) From Ellis quarry, on Bay of Quinte railway, south of Actinolite.

(3) From Harrison's quarry, Actinolite.

(4) From Limekiln quarry, York river, near Foster rapids, Carlow township.

In Lanark county, large limestone areas exist, and the following are representative analyses:—

	1	2	3	4
Insoluble	1·32	1·12	3·06	1·20
Silica	......	......	......	......
Ferric oxide	0·49	0·38	0·46	0·49
Alumina				0·97
Lime	50·80	51·20	49·86	43·82
Magnesia	3·33	2·28	3·36	9·19
Carbon dioxide	43·51	44·50	42·69	44·00
Sulphur trioxide	0·06	0·32	0·28	0·46
Total	99·51	99·80	99·81	100·13

(1) From Cameron's kiln, Carleton Place.
(2) Dark limestone from Lanark village.
(3) Light limestone from the same place.
(4) From lot 2, concession IV, North Burgess.

In the vicinity of pegmatites, or granitic dykes, which are frequently found cutting the limestones, vesuvianite, or idocrase, is often a conspicuous mineral. On several of the islands in MacGregor lake, Templeton township, Que., this mineral occurs in large and well crystallized individuals in the partly decomposed limestone adjacent to granite intrusions. At a nearby spot, very coarsely crystalline, green calcite exists, in which occur large, light-green crystals of augite, which have evidently resulted in a similar manner to the vesuvianite.

A striking feature of the granitic intrusions into the limestones is that the former often contain inclusions, not of limestone, but of amphibolite—a further indication that the limestone fragments caught up in the intrusive rock have suffered an alteration to amphibolite.

THE PYROXENITES WITH THEIR ASSOCIATED DEPOSITS OF PHLOGOPITE AND APATITE.

If the correct origin of the gneisses and crystalline limestones in the Hastings, Grenville, and adjacent areas, has been the subject of much dispute since they were first studied, that of the so-called pyroxenites, or basic rocks, with which occur the economic mica deposits of Canada, has led to even more discussion.

The name 'pyroxenite' was first applied by Sterry Hunt to belts of basic, granular rocks, consisting, for the most part, of pyroxene and feldspar, which occurred throughout the system of the older crystalline series. The colour of these rocks ranges from a light grey, through grey-green, to dark green, and the character and texture vary greatly at different points. Practically all modifications exist, from a very hard, and compact, diabase-like rock to coarsely-crystalline, granular types, composed mainly of pyroxene individuals, often several inches in length. The amount of feldspar present is also greatly variable, and in many of the dykes this mineral is almost entirely absent.

As to the term "dyke." This expression is, strictly speaking, applied to a mass of igneous rock which has been intruded into pre-existent strata; that is to say, it is of later origin than the rocks enclosing it. Now, the genesis of the pyroxenite bodies being open to considerable doubt, it is questionable whether the term "dyke" can properly be applied to them; while the further probability that all rocks which come under the comprehensive heading of pyroxenite in this report do not possess the same origin, renders the term still more open to objection. Owing, however, to the difficulty which would be experienced in strictly differentiating between the various pyroxenites, and to the fact that the expression "dykes" has been used by the majority of writers in describing these basic belts, it has been decided to retain the term in the present report. The objection to its use is, however, fully recognized. The pyroxenites, as has already been mentioned, attain a considerable development amongst the gneisses, granite-gneisses, and crystalline limestones of the Laurentian system, which compose the earth's surface over the uncoloured area shown on the accompanying maps. They occur principally in the form of narrow belts, often interposed in the form of what may be termed pyroxenitic zones in the gneisses and limestones. That is, a number of more or less parallel belts are often observed at short distances from one another, separated by narrow bands of gneiss or limestone; while once such a zone is passed, a considerable extent of country may have to be traversed before other similar rocks are encountered. In width, the dykes range from narrow stringers, only a few inches across, to bodies many feet in thickness. It is often difficult to ascertain the true width of such a dyke, owing to the frequent presence of acid zones in its mass, as well as to the occurrence of narrow and often fractured bands of gneiss between belts of pyroxenitic rock. Often a considerable area may be traversed, in a direction normal to the general course of the dykes, and the major portion found to consist principally of pyroxenite—irregular occurrences of gneiss and pyroxene gneiss being met with at intervals. The determination of the true extent of a dyke is thus rendered extremely difficult, doubt often existing whether such bands are part of one and the same belt, or whether they were originally separate dykes, which have later become fractured by the folding movements to which the enclosing gneiss has been subjected. Broadly speaking, the character of the various dykes comprising a single pyroxenite zone is more or less similar, though a conspicuous feature of such dykes is the variety in the quality of the mica they may carry. Where one dyke in a zone is found to consist of a hard and compact pyroxenite, the probability is that the other dykes of the same zone will also be of similar nature; while the same applies where a dyke is granular and inclined to be pockety.

Although the pyroxenites frequently occur in such zones, isolated dykes are by no means an exception. The tendency, however, would seem to be for the pyroxenites to obtain pronounced local development, the various dykes being separated by narrow bands of gneiss, while the zones are often divided by many miles of strata. The narrow, gneiss bands have been adduced to support the theory of pyroxenites being altered limestones, such gneisses being supposed to represent argillaceous beds in the original sediments. It would require much detailed work to decide in each case the true nature of the gneiss, and whether a particular band should be classed as sedimentary or eruptive. Narrow gneiss spurs of the true batholithic granite-gneiss are known to have intruded the limestones at many spots, and the latter types are often indistinguishable in the field from what are regarded as the sedimentary gneisses. Even a chemical and microscopical examination cannot, at times, decide the point, the original rocks having been so greatly altered; while such an examination in every questionable instance would entail an enormous amount of work. The pyroxenites, then, may be stated to occur both in zones, and as isolated dykes, throughout the Laurentian system. A notable feature, and one which may, perhaps, have a direct bearing upon the true origin of the pyroxenite, is the frequent occurrence of the dykes in, or near, crystalline limestone. While, in the majority of cases, the dykes are found enclosed on both sides by gneiss, frequent instances are met with where the dyke is either bordered on one side by gneiss and on the other by crystalline limestone, or is entirely in limestone. An examination of the various sections of deposits contained in the notes on individual mines will show these various modes of occurrence.

Pyroxenites Enclosed in Gneiss.

As may be inferred from the above remarks on the similarity of the supposed sedimentary and the undoubtedly igneous gneisses, it is often a matter of considerable doubt, when a pyroxenite dyke is found bordered on both sides by gneiss, whether this gneiss represents the true enclosing rock, or whether it is merely a band of altered, argillaceous sediment, originally forming part of a limestone deposit of which the pyroxenite itself is a metasomatic product. This, of course, pre-supposes the metasomatic origin of pyroxenites, which will be considered later. Such a band of altered claystone, or sedimentary gneiss, might possibly possess considerable thickness, and to decide its nature, a close examination of the surface for some distance in a direction normal to the course of the dyke would be necessary, in order to confirm the positive or negative existence on its further side of further pyroxenite. *If such rock were found to be present, it might be taken to support the idea that the interposing gneiss were of sedimentary origin.* On the other hand, whatever the extent of this gneiss, it is always equally possible that it represents a narrow belt of true, igneous gneiss, the two types being often indistinguishable. It may be remarked that when the thickness of the gneiss and pyroxenite is spoken of, this measurement always refers to lateral distance, the dip of the rocks ranging, in most cases, from some 30° to vertical.

Thus, if a pyroxenite dyke be found enclosed by gneiss, a very necessary step in endeavouring to solve the mode of genesis of the former is to first of all decide, as far as practicable, the nature—whether altered sedimentary, or igneous—of the latter.

Before proceeding further, it may be well to set down the various theories which have been advanced for the origin of the pyroxenites. In the main, these may be said to fall under the following three head , and the pyroxenites have been conjectured to represent:—

(1). Altered sediments, principally argillaceous limestones, which owe their present character to metasomatic change induced by intrusions into them of the batholithic, Laurentian granite gneiss.

(2). Intrusions, or dykes, of basic, igneous rock of later origin than the gneisses and limestones which enclose them, and now existent in comparatively the same condition as when intruded.

(3.) Basic igneous intrusions, as above, which have, however, been subjected to a considerable degree of metamorphism, with possible refusion.

Each of the above views has found eminent geologists to support it, and, at the present time, the sedimentary theory, though considerably ridiculed in the past, has a number of advocates. It was soon realized from an examination of only a few of the dykes, that any attempt to solve the problem of their origin, and of that of the large deposits of mica which they often contain, would require far more time than was at the writer's disposal, and the more occurrences that were examined, the more complicated the problem was found to become. It will be doing as much as possible, then, under the circumstances, to set down some of the main features noted at the various mines visited, with a mention of the particular theory which would seem to receive support from the fact in point. A short consideration of the above alternative theories may, however, not be out of place. As will be at once seen, the adoption of No. 1, or the altered, sedimentary theory, must assume that the pyroxenites, together with their associated, supposed sedimentary gneisses, already existed, though in a different condition, previous to the intrusion of the main body of Laurentian gneiss which encloses them, and which has been the agent of alteration to their present state. If views 2 or 3—that the pyroxenites are eith. . ltered or unaltered igneous intrusions—be adopted, it must follow that these dykes are of a later origin than the gneisses and limestones, though of precisely what age it would be difficult to say. It is definitely established, however, that the pyroxenites, with their associated mica deposits, were already in existence before the deposition of the Cambro-Silurian rocks. These are in no case cut by the pyroxenites, and the occurrence of eroded crystals of phlogopite occasionally found embedded in limestone of Black River age (notably in the vicinity of Sydenham, Ont.) shows that the dykes were already existent at that time. Their formation would, then, have taken place some time between the final consolidation of the Laurentian gneiss and the beginning of the Palæozoic era.

The Sedimentary Theory.

From field observations and from numerous chemical analyses, Adams and Barlow claim to have arrived at the conclusion that the amphibolites and pyroxenites, in the Hastings area, at least, are indubitably altered limestones, and all transitions are said to have been encountered between normal crystalline limestone, through scapolite-pyroxene-limestone, and what is now normal pyroxenite. The products of alteration of the limestone through the agency of the granite-gneiss were divided into two classes:—

(1) Alteration of limestone into masses of granular, pyroxene rock, usually containing scapolite, or into bodies of a fine-grained aggregate of scales of a dark-brown mica.

(2) The intense alteration of the limestone, along the immediate contact, into a pyroxene gneiss, or an amphibolite. In this connexion, the following extracts, in support of the above views, may be quoted:—

"The alterations of the first class may be considered as due to the heated waters or vapours given off by the cooling magma, that is, to be of pneumatolytic origin; while the alteration products of the second class probably result from the more immediate action of the molten magma itself. The products of these two classes of alteration have a good deal in common, and naturally pass into one another. . . . . This pyroxene rock, resulting from the alteration of limestone, often varies considerably in texture from place to place, but is generally medium in grain and granular in character. . . Associated with this pyroxene, are found black mica, hornblende, scapolite, epidote, garnet, sphene, spinel, tourmaline, calcite, apatite, and even quartz and feldspar, as accessory constituents. In some cases, minute zircon crystals also occur. Certain metallic minerals, notably pyrite, molybdenite, and pyrrhotite, are common in these pyroxenites. . . . The mica occurring in these rocks has been mined at several points in the area, as, for instance, on lot 7, concession XXII, of the township of Cardiff, where mica crystals having cleavage surface 2′-0″ × 2′-6″ across have been obtained. The calcite, when present in the rock, is usually in the form of very coarsely crystalline aggregates, cementing the other constituents together and into which the other minerals grow in the form of perfect crystals with excellent terminations. This calcite represents portions of the original limestones, which have survived in an unaltered condition, except that they have become more coarsely crystalline." Among the more important occurrences of such pyroxenites in the area described, are given the following: lot 3, concession I, of Harcourt;

lots 5 and 6, concession II, of the same township; concession XIX, of Tudor; lots 22-25, concession VI, of Herschel; lots 8 to 14, concessions IX and X, of Monmouth; lot 22, concession XIII, of Stanhope. "These pyroxene rocks are identical in character with those which are so intimately associated with the apatite deposits of Ottawa county, Que., and of the Perth district, Ont. *Those from the former district . . . have been shown to result from pneumatolytic action connected with intrusions of certain basic, igneous rocks . . .* The other product of pneumatolytic action, emanating from the granitic intrusion which has been mentioned, is a rock composed of an aggregate of small leaves of a very deep-brown or black mica, and is less common. The rock. . . . . becomes gradually more and more calcareous, and finally passes into limestone. These mica rocks almost invariably contain more or less calcite disseminated through them, which, on exposure to the weather, is dissolved, the surface of the rock being thus resolved into a soft mass of small scales of black mica." Following the description of occurrences of a rock resembling anorthosite, is found the remark: "The question as to the origin of these curious rocks is one which, in the present condition of our knowledge, cannot be definitely settled. In Harcourt and Dudley, as stated above, their relations to the limestones, along the contact wit' the granites, are such as to render it almost certain that they are produced by the alteration of the former rock. In the case of the Burton occurrence, on the other hand, the rock occurs in the gneiss some miles from the nearest contact, but it is, nevertheless, quite possible that here also it represents a portion of a completely altered limestone band, which has sagged down into the batholith and been torn apart by the movements of the latter. . . . . It is a remarkable fact, that while limestone areas are clearly penetrated and shattered by the granite, and are traversed by great dykes of this rock, and that while, in the case of other rocks under similar conditions, the granite is frequently crowded with fragments of the invaded rock, it is very rarely, indeed, that fragments of limestone are found in the granite. . . . Between concessions IX and X, of Glamorgan, the granite is seen holding many inclusions of amphibolite, and a careful search led to the discovery among them of but a single fragment of coarsely crystalline limestone, on one side of which there was a mass of a light-coloured amphibolite, which had apparently been produced by its alteration. . . . . . Still farther east, when the amphibolite fragments were carefully examined, some of them were seen to contain crystalline limestone in little, interbanded layers and streaks, conformable to the foliation of the amphibolite, and partaking of the complicated twisting to which it has been subjected. . . . *The field evidence is scarcely susceptible of any interpretation other than that, under the influence of the granitic intrusions, the limestone has, in the zones of most intense action, been altered into an amphibolite.* The amphibolite, which is so intimately associated with the limestone, and which seems to have been derived from its alteration, when examined under the microscope, is seen to be a highly feldspathic variety. . . . Pyroxene, hornblende, sphene, and scapolite are also present, as well as a grain or two of magnetite and quartz. The amphibolite has a somewhat indistinct, banded character, some of the bands which are paler in colour being richer in pyroxene, while the darker bands are richer in hornblende. The scapolite occurs only in those bands which are rich in pyroxene, but contain no hornblende. . . . . The pyroxene is often filled with minute spots of hornblende, as it it were undergoing a change to the latter mineral. . . . . On lot 5, concession VI, of Glamorgan, the grey amphibolite consists of thin lighter and darker bands, breaking up into slab-like masses, and is often interstratified with narrow bands of impure limestone. The limestone bands fade away imperceptibly into the amphibolite, the latter being undoubtedly produced by the alteration of the limestone. . . . . The granite not only penetrates the amphibolite series, but floats off masses of it, which, in the form of bands, streaks, and isolated shreds, are seen thickly scattered through the granite in the vicinity of the contact, and which, while less abundant, are found throughout practically the whole mass of the batholith. The separate fragments of amphibolite, where completely surrounded by the granite, while clearly nothing more than masses of altered limestone, are rather harder and have a more granitized appearance than the rock which is still interstratified with the limestone. The fragments, moreover, sometimes have a somewhat flowing form, as if they had been subjected to a certain amount of movement when in a softened condition. . . . . Under the microscope, the rock, while possessing a more or less distinct foliation, has the pavement structure characteristic of rocks which have resulted from recrystallization brought about by metamorphic processes. It presents no evidence of crushing or of having been caused to move since its recrystallization took place. In this occurrence, therefore, the crystalline limestone can be seen, under the influence of the granite intrusion, to have changed into a typical hornblende-feldspar amphibolite, passing through the intervening stage of a pyroxene-scapolite-hornblende-feldspar amphibolite (pyroxene-scapolite gneiss)." Analyses of three specimens of amphibolite rock, chosen to show three stages in the progressive change from limestone to amphibolite, are appended:—

	No. 1		No. 2	No. 3
	a	b		
SiO_2	32·88	50·20	50·00	50·83
TiO_2	0·19	0·75	0·82	1·10
Al_2O_3	9·04	13·80	18·81	18·64
Fe_2O_3	0·77	1·18	2·57	2·81
FeO	3·88	5·31	5·51	5·97
MnO			0·08	0·10
CaO	30·90	17·71	10·65	7·50
MgO	1·18	6·38	4·63	4·90
K_2O	0·85	1·30	1·18	4·83
Na_2O	1·17	1·79	1·16	1·22
CO_2	15·20		0·10	0·11
Cl	undet.		0·10	0·03
S	undet.		0·03	0·01
H_2O	1·08	1·66	1·00	1·40
	100·01	100·08	99·97	99·48

No. 1 represents the first stage of alteration and the rock contained microscopic calcite, pyroxene, hornblende, scapolite feldspar, and sphene. The analysis No. 1 (a) represents the composition of the specimen as collected, while No. 1 (b) represents, except for the lime, the additions made to the limestone by the granite magma in this first stage of alteration.

No. 2 is the analysis of an amphibolite representing a second stage of alteration of the limestone, the specimen being practically free from calcite, and composed of hornblende, pyroxene, scapolite, feldspar, and sphene.

No. 3 is the analysis of a typical amphibolite, and represents the last stage of the change. All these specimens were derived from the same series of exposures, at greater or less distances from the intrusive contact.

"A comparison of the analyses shows that the granite at first transfuses into the limestones, silica alumina, oxides of iron, magnesia, alkalis, and titanic acid. As the alteration progresses, all these constituents continue to increase in amount. But in these later stages, the alumina, oxides of iron, and alkalis are added in relatively greater proportion than the other constituents, while no further addition of magnesia or lime takes place, the carbonic acid escaping and carrying the rest of the lime with it. This means that pyroxene and some scapolite were first developed in the limestone, and that, later, feldspathic constituents increased in amount, the calcite present being removed in solution. . . . It seems, also, that after the development of a certain percentage of silicates in the limestone, during which process the carbonic acid was expelled, and the lime combined with it used in the production of new minerals, no further lime was fixed. In the earlier stages, the waters given off by the granite, having accomplished the transference of material into the limestone, passed off with CO_2 in solution. In the later stages of the alteration, however, these waters, while continuing to deposit silicates in the limestone, made place for these latter by carrying off carbonate of lime in solution."

The above remarks, which are extracts from various portions of the report, will suffice to show that, in the opinion of the authors of the report in question, no doubt exists as to many of the amphibolites and pyroxenites of the Bancroft and Haliburton areas representing altered sedimentary limestones. It will be remarked, however, that due mention is made of the theory that the mica- and apatite-bearing pyroxenites of the Quebec and Ontario mica regions possess a different mode of origin to the rocks described, being basic, igneous intrusions, which owe their mica and apatite content to the action of later pneumatolytic emanations.

The fact, however, is recorded by them that deposits of mica and apatite do occur in the pyroxenites of the Haliburton area, and have, indeed, been to some extent exploited. The writer, however, not having visited the latter localities, can make no observation upon the positive or negative similarity of the two sets of rocks.

A. Osann,[1] who, in 1899, carried out a geological examination of a portion

[1] Geol. Surv., Can., Ann. Rep., Part O, Vol. XII, 1902.

of the Quebec mica region, more particularly of that area bordering on the Lièvre river, found that there were two types of gneisses present, one of which, from analyses, he was inclined to regard as sedimentary and the other as plutonic. The pyroxenites, he was inclined to consider as of two types: (1) intrusive rocks of plutonic origin, belonging to the family of the diorites and basic syenites, and (2), "altered gabbros and secondary vein fillings connected with the formation of the apatite." He is, therefore, disposed to consider the pyroxenites as of true, igneous origin, and the mica and apatite deposits associated with them as of secondary formation along crevices and fissures formed in the dyke rock. He remarks in this connexion: "All these peculiarities, and the similarity in mineral content of all the deposits of apatite in the Province of Quebec known to me, led to the belief that they are all of the same origin, and younger than the associated gneisses. They are, accordingly, true veins which have been formed in the same way as all other ore veins."

Sterry Hunt,[1] in mentioning the apatite deposits of the Laurentian rocks, refers to them as "irregular beds running with the stratification, and composed of nearly pure, crystalline phosphate of lime," and also as "parallel beds interstratified with the gneiss."

Later,[2] he regards the deposits as of two kinds, and remarks that they "are, in part, bedded or interstratified in the pyroxenic rock of the region, and, in part, true veins of posterior origin." The bedded deposits conformable with the strike and dip of the Laurentian rocks, he regarded as "true beds, deposited at the same time as the enclosing rocks. The veins, on the contrary, cut across all these strata, except in rare instances, when, what appear from their structure and composition to be veins, are found coinciding in dip and strike with the enclosing strata."

In 1885, the following further statement is made[3]: " . . . . . show that the crystalline phosphate of lime, or apatite, belongs to lodes of great size, which traverse the ancient gneiss of the region . . . All these lodes show a banded structure, not unlike that of the gneiss, to which they are evidently posterior and of which they often contain fragments."

H. G. Vennor,[4] in his account of the apatite mines, makes the somewhat sweeping statement that "there can be no manner of doubt that these deposits of apatite are of a comparatively superficial nature," and goes on to refer to them as "bedded deposits brought to the surface by undulations of the strata." This view is, of course, totally opposed to the real facts; since phosphate bodies of considerable size were still in sight when such mines as the High Rock, North Star, Emerald, etc., on the Lièvre river, were abandoned, the depths reached by some of the shafts exceeding 800 feet.

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[1] Geol. Surv., Can., Rep. Prog. 1863-6.
[2] Trans. Amer. Inst. Min. Engin. 1884.
[3] Trans. Amer. Inst. Min. Engin. 1885.
[4] Rep. Prog. Geol. Surv., Can., 1874-5, p. 108, et seq.

J. W. Dawson [1] is of similar opinion to Sterry Hunt, observing further that "it also appears that the principal beds are confined to certain horizons in the upper part of the lower Laurentian . . . though some less important deposits occur in lower positions." He was inclined to regard the apatite deposits "as a secondary formation, dependent on the original deposition of apatite in the series, which must belong to the time when the gneisses and limestones were laid down as sediments and organic accumulations."

Harrington [2] regarded the pyroxenites as altered strata originally containing phosphate of lime, and the apatite veins as of subsequent formation, deriving their mineral content from the pyroxenites.

J. F. Torrence [3] was of the opinion that the apatite deposits were irregular segregations from the country rock, which contains zonal impregnations of apatite.

W. B. Dawkins [4] considered the apatite to occur in veins in massive, bedded schists, the veins and schists having obtained their mineral content "from some common, deep-seated source of hydro-thermal action."

G. H. Kinahan [5] supported, in part, the theory of Adams and Barlow, and regards the apatites, and possibly the pyroxenites as originally limestones or allied rocks, which have been altered by paramorphosis.

G. M. Dawson [6] regarded the bedded apatite as organic in origin, and the gneisses, etc., which enclose them as altered sediments, the apatite veins having resulted from a segregation process. This idea was also expressed by J. F. Felding,[7] while R. Bell [8] is inclined to the view that the apatite has its source in the pyroxenite, which is possibly an igneous intrusion.

E. Coste [9] considered the apatite to be of eruptive origin and to be connected with igneous rocks, sometimes pyroxenite, and sometimes pegmatite, mica syenite, or pyroxene syenite, which cut the Archæan series. He also assigns a similar origin to many of the iron ore deposits of the same area, and concludes that "the iron ores and phosphate to be found in our Archæan rocks are the result of emanations which have accompanied or immediately followed the intrusions through these rocks of many varied kinds of igneous rocks, which are, no doubt, the equivalent of the volcanic rocks of to-day. These deposits, then, are of deep-seated origin, and consequently the fears, entertained principally by our phosphate miners, that these deposits are mere surface pockets, are not well-founded."

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[1] Quart. Journ. Geol. Soc. 32, 1876.
[2] Geol. Surv., Can., Rep. Prog. 1877-8.
[3] Geol. Surv., Can., Rep. Prog. 1882-4.
[4] Trans. Manchester Geol. Soc., 18, 1885.
[5] Trans. Manchester Geol. Soc., 18, 1885.
[6] Trans. Ottawa Field Club, 1884.
[7] Eng. and Min. Journal, 1886.
[8] Ibid.
[9] Ann. Rep. Geol. Surv., Can., Vol. III, 1887-8.

R. A. Penrose[1] regards the occasional, parallel bands in some pyroxenites as probable joint planes, and mentions the frequent absence of any sharp contact between gneiss and pyroxenite, the border zone being a gradual transition from one to the other with the formation of a pyroxene gneiss.

A. R. Selwyn[2] considers there is no evidence to support the organic origin of apatite or the sedimentary origin of the pyroxenites, which latter he regards as basic intrusions of Archaean age.

W. Davidson[3] believed that the phosphate deposits originated in beds in a Laurentian sea, and attained their present character through subsequent metamorphism, the enclosing gneiss having a similar origin.

R. W. Ells[4] came to the conclusion that the mica and apatite deposits were intimately connected with basic dykes of igneous origin, which have ascended along the bedding planes of the gneiss, though, sometimes, also cutting across this rock. The vapours carrying phosphoric acid, etc., would incline to follow the contacts of the dykes with the gneiss, and as a result of chemical action upon the calcareous portion of the latter, phosphate of lime was produced. This would seem to be intended to account for the class of occurrences known as 'contact deposits,' as opposed to 'pocket deposits.' He also emphasizes the cutting of the gneiss by the so-called dykes at various angles, and the frequent distortion of the foliation in their vicinity.[5]

With regard, more particularly, to the mica deposits associated with the pyroxenites, four distinct modes of occurrence were instanced[6]:—

(1) In pyroxene rock near the contact with the gneiss.

(2) On fissures in the mass of the pyroxene dyke.

(3) Along the contacts of later pegmatite or diabase dykes cutting the pyroxenite.

(4) In pyroxenite dykes cutting crystalline limestone and which have been intruded by later pegmatites or diabase dykes.

The views of F. Adams and A. Barlow[7] upon rocks of the area adjoining the Ontario mica-phosphate region to the west, and which may be regarded as allied types to the true pyroxenites, have already been given at some length. These writers consider the pyroxenites of the Haliburton-Bancroft area to represent altered limestones, and the apatite and mica which they contain to have been formed during the metamorphic process. The pyroxenites of the mica region were not examined in detail, but they are recognized as being identical in character with the rocks described in the Memoirs mentioned, and the tentative suggestion is advanced[8] that Osann's theory

[1] Bull. U. S. Geol. Surv. No. 46, 1888.
[2] Ann. Rep. Geol. Surv., Can., Vol. IV, 1888-9.
[3] Trans. Am. Inst. Min. Eng. 1892.
[4] Can. Min. Review, XII, 1893.
[5] Geol. Surv., Can., Ann. Rep. 1901, Vol. XII, Part J, p. 96.
[6] Geol. Surv., Can., Min. Res. Bull. Mica, 1904, p. 9.
[7] Geol. Surv., Can., Mem. 6, 1910.
[8] Ibid. p. 93.

of pneumatolytic action connected with the intrusion of basic igneous rocks may be the correct theory of their origin.

From the foregoing, it will be apparent that the origin of the pyroxenites, with their associated apatite and mica deposits, has for long been a vexed problem. Unfortunately, no great depths have as yet been reached in the exploitation of mica or apatite deposits, and the deepest workings which do exist are those of abandoned phosphate mines, which have been idle for many years and are now inaccessible. The exact depth reached in such mines is not known to the writer, but it probably does not exceed 1000 feet. These mines, when closed down, owing to the competition of the American phosphate producers, were said to still show considerable deposits of both apatite and mica in depth, so it must be conceded that we have as yet, no means of estimating, even approximately, the depth to which these mineral bodies may extend.

As will have been noted, not only the conclusions arrived at by the above-mentioned geologists as to the precise nature of the rocks examined and their mode of origin vary considerably, but even the actual field observations are found, in many cases, to show discrepancies. The writer made his examination of the various mica deposits before studying the views expressed by various authors as to their mode of origin, and so may be said to have approached the subject in a more or less unbiased frame of mind. Later, a due consideration of the various views held on the subject by the above-mentioned authors and others, led to what seemed to be a more or less rational explanation of several phenomena encountered in the field, and which, at the time, seemed to present unusual and unnatural features. Several of the features noted at certain points by previous observers were, however, either missed, or received a different interpretation. Such instances, while perhaps of little account in the individual cases, yet, when taken as bearing upon similar or analagous features presented by another deposit, assume a certain value.

A manifest difficulty presented, and one which often seems to offer direct, contradictory evidence, is the often marked dissimilarity shown by the various pyroxenites and the minerals they carry. If we are to regard the pyroxenite dykes as being primarily of igneous origin and to represent basic intrusions into the gneiss or limestone which encloses them, there are several features which we might expect to find common to the various occurrences.

From analogy with what are known to be true, igneous dykes, we would expect to find the following main characteristics:—

(1) Pronounced alteration of the enclosing country rock in the immediate vicinity of the contact, this generally taking the form of partial recrystallization.

(2) The presence in the adjacent rock of certain accessory or foreign minerals, principally silicates, induced by the action of mineralizers emanating from the intrusive. In the case of limestone forming the intruded rock,

partial or complete destruction of the calcium or magnesian carbonates, these compounds being either carried away in solution as such, or broken up, CO_2 being liberated, and the base used to form the replacing silicates. If the immediate contact were left, this destruction of the carbonates would become proportionately modified.

(3) More or less pronounced evidence of differentiation in the dyke magma, more especially along the contact with the country rock; and in dykes of large size (i.e., having a width of 50 feet and over), the formation of a distinct, contact-zonal facies of the more basic dyke minerals.

(4) The inclusion in the dyke proper of disrupted fragments of country rock.

(5) The existence of small stringers and spurs of intrusive rock, sometimes cutting across the line of strike of the gneiss, and also along joint planes or lines of least resistance.

(6) The junction in depth of adjacent dykes, which would converge and finally unite in a deep-seated pyroxenite body.

(7) An approach to pegmatitic character and structure by the dykes, owing to the quantity of water vapour carrying phosphoric acid, which would seem to have accompanied the intrusions.

(8) Certain points of similarity between the various dykes, principally in their mineral content, if, as would seem to follow, they had their origin in a common, deep-seated magma, and were intruded contemporaneously.

The foregoing would, in the main, represent the features we might expect to find more or less common to the various dykes, if we assume them to be of igneous origin.

If, on the other hand, we suppose the pyroxenites to represent altered sediments, and to have been originally limestones which have been metamorphosed by the batholithic granite-gneiss of the Laurentian system, we would expect to find the following main characteristics possessed by the various leads.

(1) Gradual transition from characteristic or normal pyroxenite, produced by intense metamorphic action at the igneous contact itself, to pyroxene-limestone, and finally to normal crystalline limestone.

(2) Considerable variation in the type of rock produced by such metamorphism owing to the primary difference in composition of the limestone, this possessing a locally widely-varying, magnesia content, besides being, at various spots, either more highly arenaceous or argillaceous, as the case may be.

(3) General, though not necessarily constant, conformability of the pyroxenite belts to the strike of the gneiss. (A fault, or a case where a mass of limestone may be supposed to have been floated off by the molten granite and given a false position, may lead to the occurrence of an unconformably placed, pyroxenite dyke.)

(4) Irregularity of form, width, and extent of the bands, due to the varying degrees of metamorphism and to the irregular shape of the limestone masses, which may, in certain cases, be assumed to have been torn from the main mass of sediments, and to have been partially engulfed in the batholithic magma. Such irregularity of form may further have been caused by the subsequent folding movements, which gave to the granite-gneiss its present foliated character, and which squeezed the plastic, pyroxenite bodies into a series of more or less lenticular deposits, often joined by a mere stringer of basic rock. Such movements would also explain the banded structure of some pyroxenites.

(5) Where limestones have been intruded by granite, the formation of true, contact, mineral bodies at the expense of the carbonates along the contact; this, however, being a feature to be expected in both cases, whether the pyroxenites *as pyroxenitic dykes* have brought about the formation of such bodies, or whether the pyroxenites themselves represent altered limestones.

It is the fact that many of the features to be observed in connexion with pyroxenite occurrences are capable of serving as illustrations of two totally dissimilar and opposed theories which renders the problem of origin

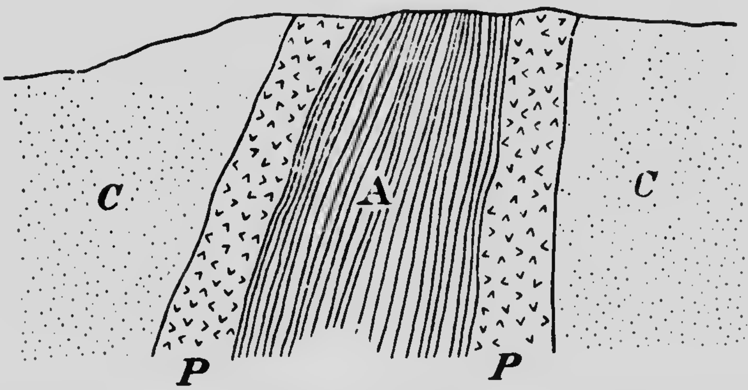


Fig. 60.—Typical section showing C limestone, P pyroxenite, A (1) intrusive granite altered to granite-gneiss, or (2) gneiss resulting from contact-metamorphism of argillaceous sediments originally present in the limestone C.

so puzzling. If a mass of granite (A) be injected into, or through, limestone (C), either as a batholith or in the form of a dyke, and the result of the intrusion is to produce a band of pyroxenite along one contact, it is fair to assume (granted that the limestone possessed similar character and composition) that a similar pyroxenite band would be also formed along the other contact.

The resulting appearance, after the folding movements which led to the foliation of the granite, would be as depicted in Fig. 60. Supposing, again, that the pyroxenite bands shown in the figure represent true intrusive dykes and that the portion between them be uptilted, argillaceous, sedimentary beds in the limestone, which have become altered through the influence of the pyroxenite intrusions to a gneissic rock, the final appearance will still be as shown in the figure. A microscopic and chemical examination of the rock A might or might not enable a decision to be come to regarding the sedimentary or eruptive origin. The probability is, that owing to its highly altered condition, such an examination would, in many cases, not betray the true genesis of the rock.

With regard to the observations recorded by the authors already quoted, some of these are in accord with the writer's own personal experiences, and others show wide divergencies from these. It may be remarked, with respect to Osann's views, that the general appearance of the apatite and mica "leads" gives no evidence whatever in support of the idea that they have been formed in the same manner as ore veins, namely from aqueous solution. The whole evidence is, on the contrary, opposed to such a theory. It is difficult to conceive, in any case, of mica being deposited from aqueous solution, and the constant association of mica with apatite would imply a similar mode of origin for both minerals. Besides, veins are more or less continuous mineral bodies, while mica and phosphate leads are by no means so; they have, in fact, practically no points of resemblance with true ore-veins.

Sterry Hunt's view that two distinct types of deposits existed, found no corroborative evidence; nor did his observation that fragments of gneiss frequently occur in the pyroxenites. In fact, no indisputable evidence of the presence of country rock in the dykes was noted. The idea of G. M. Dawson, Felding, Davidson, and J. W. Dawson, that the apatite in the pyroxenites is derived from organic remains originally present in the sedimentary gneisses may be said to find no support, and the same may be said for Harrington's somewhat similar views.

Dawkin's hydro-thermal theory seems to be more in accord with the features presented by the deposits, while Kinahan's suggestion that the pyroxenites are altered sediments and that the mica and apatite are the results of metasomatic processes, agrees, in the main, with Adams' and Barlow's conclusions.

Selwyn's and Bell's idea that the pyroxenites possibly represent igneous intrusions, which have brought the apatite, or at least the phosporic acid which enters into its composition, from below, has much to support it in the actual features to be observed; while the same may be said of Coste's pneumatolytic theory.

Penrose recognizes what seems to be actually the case in many deposits—namely, the gradual transition from pyroxenite to gneiss, and this type of the latter rock is probably the grey, sedimentary gneiss of Adams and Barlow and others.

The frequent references to what are variously termed "bedded" and "vein" deposits of apatite and mica seem to originate chiefly from the observed fact that deposits of these minerals have a direction either conformable or more or less inclined to the strike of the enclosing rock. It is the writer's opinion that, though such differences of direction do, in fact, occur, such variations need in no way be taken to support the supposition that two distinct types of deposits exist. It is a matter of common observation that what appear to be true fissure veins of mica and apatite and associated minerals frequently possess a strike practically normal to that of the pyroxenite in which they occur. This feature is, in fact, a frequent and often somewhat puzzling characteristic of the deposits; for, while the above is true at one spot, in the case of a neighbouring occurrence, what are to all appearances similar veins have a direction parallel to that of the pyroxenite dyke. It is seldom, however, that the pyroxenites themselves are found striking diagonally across the gneiss; in fact, it seems questionable if such is ever the case. Errors of observation are so easily made in the field, especially in instances where the district is much overgrown, as is frequently the case in the mica region, that what may appear to be the main pyroxenite body may often, on closer examination, be found to be merely a spur or offshoot from the main dyke. If, however, the view be correct that the pyroxenites are merely masses of altered limestones which have, in some cases, been floated off from the original body of such rock and been partially or entirely engulfed in the fluid granite, there is no reason to question the often apparently unconformable position of such rock bodies. If such a view be adopted, it is quite conceivable that such a strip of altered limestone (pyroxenite) might assume a position in which its long axis would be more or less normal to the strike of the enclosing gneiss, and might take on the appearance of an intrusive dyke cutting the gneiss at a greater or less angle. In the case, now, of an intruded or engulfed body of limestone, the subsequent movements of the entire complex, to which is due the present foliation of the gneiss, would cause fractures and even fissures to develop in such a body, having a direction approximately normal to the thrust and parallel to the foliation.

If, therefore, the intruded mass lay with its long axis normal to the thrust, fissures would probably develop parallel to this axis, or throughout the length of the mass; while in the case of the thrust actuating parallel to the long axis, the resulting fissures would assume a direction parallel to the short axis, or normal to the apparent strike of the dyke.

Instances of apatite and mica veins striking across the gneiss in a direction more or less normal to its strike, though remarked upon by previous observers, were not encountered in any of the deposits examined by the writer. What were probably meant by such transverse veins are those leads having a direction more or less normal to the pyroxenite dykes in which they occur, such direction being, however, still approximately parallel to that of the gneiss.

In the case of the deposits of the "schlieren" type, *i.e.*, those to which the denomination of true fissure-veins cannot correctly be applied, there are apparently no rules for direction of the leads, these pursuing a quite erratic course throughout the mass of the dyke, and pinching out and widening in a most irregular manner.

Types of Mica Deposits.

The various types of mica deposits may be classed under the following three heads:—

(1). True fissure deposits,
(2). Pocket and fissure deposits,
(3). Contact deposits,

the last-named being really a modification of the first.

The true fissure deposits are, as the name would imply, the simplest to exploit and the easiest to follow. They possess the usual features of fissure veins and are usually found in parallel systems at varying distances from one another. They are characterized, as a rule, by the large masses of calcite which they carry as vein-matter and which generally forms the bulk of the filling between the walls. The latter are well-defined and are frequently lined with well-formed and large crystals of pyroxene. In such deposits, the main mica-bodies are usually found near one or both of the walls, and these are often lined with a mass of intergrown mica crystals. Bunches of such crystals, as well as isolated individuals, also occur distributed throughout the mass of the calcite, which is, in most cases, of a pinkish or red colour. White calcite is characteristic of some deposits and the mineral is then, nearly always, of more coarsely-crystalline habit than the pink variety. The fissure-veins vary greatly in width, being sometimes over 25 feet across, while many are only some 5 to 8 feet wide. As a rule, they are approximately vertical, sometimes, however, dipping with the gneiss at varying angles. The contact deposits are regarded as formed along the contacts of pyroxenite dykes with gneiss or limestone, and are often of considerable width. They carry even more calcite associated with the mica than the ordinary fissure deposits. As already remarked, these two types of deposit are the most simple to exploit, since the miners have to do with a well-defined body of mineral which presents no difficulties in its following, though of varying degrees of richness—the mica often occurring in very bunchy fashion throughout the mass of the calcite vein-filling.

The most common type of deposit, however, and that which has been exploited in the greater number of mica mines, belongs to the class of the pocket and fissure deposits. These, as the name implies, are irregular mica bodies having no definite direction and of very varying width, which are found in many pyroxenite dykes. The mica is found, often disseminated through bodies of calcite, filling irregularly shaped pockets or vugs in the dyke mass. These pockets are of all sizes, from small vugs a few inches across, to large rooms measuring many feet. The walls are often, and in fact usually, lined with well-developed pyroxene crystals, in individuals varying from a few millimetres to enormous prisms such as are found on lot 13, range XV, of the township of Hull, Que., and which measure 2 feet and over in the direction of their vertical axis. These pockets are usually filled with masses of pink calcite carrying mica and apatite crystals distributed through it. Often, near the surface, the calcite has been dissolved out by surface water, and the mica and apatite crystals are then found loose in the earthy residue.

The pockets, which seem to persist even in the deeper portions of the dykes, are often connected by small fissures or channels of various widths; hence the designation "pocket and fissure" deposit.

Though often extremely rich in both mica and phosphate, deposits of this class present many difficulties to the miner. The erratic course and irregular distribution of the leads and pockets are a source of much confusion, and the sudden pinching out of an apparently extensive and promising pocket of mineral is a frequent occurrence and characteristic of such a deposit. The rock composing the dyke-mass of pyroxenites carrying deposits of the first and third types, is, in general, similar to that in which occur the pockety deposits, and the only evident difference consists in the mode of occurrence.

As already remarked, the dykes are formed principally of monoclinic pyroxene, salite for the most part, though occasionally orthorhombic varieties occur, such as hypersthene and diallage. In colour, the dykes range from dark green to light grey. In some instances, a large proportion of black hornblende is present, and the rock is then correspondingly darker in colour.

Where cut by large pegmatite dykes, an alteration of the pyroxene to a soft, greenish actinolite is frequently observed. At the Lake Girard mine, lot 24, range II, township of Wakefield, Que., large crystals of pyroxene, altered internally to a soft, powdery mineral, were observed, the outer portion being formed of lustrous, blue, actinolite fibres arranged with the long axes normal to the crystal faces of the pyroxene crystal. Irregular masses of grey-brown feldspar, principally orthoclase and microcline, occur throughout the dykes, and these have all the appearance and character of segregated products of an originally fluid magma. These feldspar aggregates are to be met with alike in almost every variety of pyroxenite dyke and present a remarkably similar appearance, specimens collected in the Quebec mica district being, to all appearances, identical with specimens found in the Ontario region, although the pyroxenites with which they occurred differed considerably in colour, grain, and general character. The generally constant occurrence of such feldspar masses in the pyroxenites is an important and noteworthy feature. In many cases, no doubt, this rock has been regarded as a portion of a granitic intrusion into the pyroxenite, a feature frequently remarked upon by writers in their description of mica deposits. There would seem to be no doubt, however, that granitic intrusions are by no means as frequent as would appear from such descriptions; and when actually occurrent, the injected rock possesses a character totally distinct from that of the feldspar rock described.

An almost constant accessory mineral to be found disseminated through such feldspar masses is titanite. This mineral, indeed, is seldom absent from pyroxenite dykes and is not infrequently to be found in the mass of the pyroxene itself. In colour, it is a dark brown or chocolate, and the crystals are often well formed, possessing the usual tabular shape and often attaining a length of some 2″.

It has already been remarked that all gradations exist, from normal pyroxenite, composed essentially of salite, to pyroxene-gneiss and augite-syenite, and the various transition stages are to be well seen at numerous points. The frequent association of hornblende, also, gives rise to yet other rock types, and the occasional presence of orthorhombic pyroxene still further extends the list. The five minerals, pyroxene (monoclinic or orthorhombic), hornblende, feldspar, and mica, in varying proportions, form rocks having much similarity with the following main types: gabbro, diorite, diabase, pyroxenite, amphibolite, augite-syenite, and pyroxene-gneiss, and these may be found in all stages of transition from one to the other. Often also, a rock composed entirely of small mica scales is met with, or a schistose type composed of apatite and mica (See Plate XXXV). The large variety of rock-types met with in the deposits necessarily complicates the question of their origin, and even a thorough chemical and microscopical examination of the various rocks would hardly suffice to decide the true nature of the pyroxenites.

The occurrence of minerals of the zeolite group in the dykes is of interest, the most frequent varieties being the lime-soda members chabazite and faujasite, while heulandite has also been found; datolite, also, is a not infrequent accessory mineral, its variety botryolite occurring somewhat plentifully at the Daisy mine, in the township of Derry, Que., while in powdery form it has been found in large masses at the Bobs Lake mine, in Bedford, Ont.

The apatite of the Canadian phosphate deposits is, as has been repeatedly shown by analyses of the mineral from widely separated localities, essentially a fluor-apatite. A number of analyses are given in the Report of Progress of the Canadian Geological Survey for 1877-78, Part H, and of the total number of specimens examined none possess a chlorine content of over 0·5 per cent, the percentage of fluorine ranging from 3·3 to 3·8. The fluorine content of the phlogopite is also often considerable, samples of the mica from the Lacey mine, Loughborough, Ont., having yielded as high as 2·24 per cent. The two most abundant of the accessory minerals found in the pyroxenite dykes having thus a considerable percentage of fluorine in their composition, it is a somewhat remarkable feature of the deposits that fluorite is a relatively scarce mineral, being, indeed, generally conspicuous by its absence. Small purple crystals occur at the Daisy mine, township of Derry, Que., and druses containing small, green octahedra associated with faujasite, have been found on lot 7, range III, of East Portland, Que. The occurrences at both these spots are, however, entirely minor, and the only mine in which fluorite, in large quantities, was observed by the writer is that of the Calumet Mica Co., range IV, lots 20 and 22, of the township of Huddersfield, Que. Here massive, plum-coloured fluorite occurs in large masses with a yellowish, coarsely-crystalline calcite forming the vein-matter of the leads which carry the mica. Apatite is almost completely absent at this spot, and it would seem as if the fluorite had been formed at the expense of the former mineral. When the enormous amount of carbonate of lime present in the pyroxenite dykes is considered, and the very considerable quantities of fluorine present in the apatite and mica is remembered, it is certainly striking that such small amounts of calcium fluoride are to be found associated with these minerals. The colour of the apatite ranges from deep red (when a considerable iron content may be surmised), through brown, to green, and sometimes blue. The colour of the mineral does not, except in the iron-stained varieties found usually near the surface, appear to be a result of difference of composition, all the various shades of apatite yielding relatively the same analysis.

Titanic acid is an important constituent of the dykes, both in the form of minute rutile needles included in the mica crystals, and combined with lime and silica as titanite, a mineral which may be regarded as typical of the pyroxenites.

Scapolite is another important mineral to be met with in the dykes and occurs in considerable quantities at many points. It has been often regarded as an alteration product of feldspar, and the writer observed several instances of feldspar crystals partially altered to a mineral strongly resembling scapolite. At the Horseshoe mine, range XVI, lot 16, of the township of Hull, Que., large masses of fresh scapolite possessing a high, vitreous lustre are met with, and small apatite crystals frequently occur embedded in these masses.

The presence of chlorine in the scapolite is interesting. A specimen analysed by F. D. Adams yielded 2.4 per cent of this element, and in fourteen other samples examined, the presence of chlorine was detected, though in some cases, the amount was small. The mineral wilsonite, regarded as an alteration product of scapolite and often possessing a pretty, pink colour, is of frequent occurrence, and crystals showing the transition from one mineral to the other are common. Of the metallic minerals met with in the pyroxenites, the most common are iron pyrites and pyrrhotite. Both these species are often present in considerable quantities, and, as a rule, where pyrites is abundant, pyrrhotite is relatively absent, and vice versa; while some dykes carry only pyrites, and others only pyrrhotite.

Curiously enough, although pockets lined with pyroxene crystals are characteristic of certain of the dykes, the occurrence of normal vugs containing crystals of such minerals as quartz, calcite, pyrites, etc., i.e., minerals typical of deposition from aqueous solution, is strikingly scarce in all pyroxenites. At only one mine, namely that on range IX, lot 17, of the township of Templeton, Que. do such druses occur at all plentifully. Here, well-crystallized smoky quartz, calcite, and small crystals of pyrites and zinc-blende occur lining vugs in the massive apatite and pink calcite. The best specimens seen were taken from a small pit some 30 feet deep, and similar examples were fairly plentiful on the dump. These druses are evidently the result of partial solution of the mineral matrix and subsequent deposition from ascending aqueous solution of the minerals mentioned. It is remarkable, considering the amount of more or less massive calcite present in the dykes (which mineral is often completely dissolved from the pockets, leaving eavy rooms), that the calcium carbonate removed in solution is so seldom redeposited at lower depths in the form of crystals, as is often the case in the sedimentary limestones.

The inclusions of foreign mineral substance in the mica crystals are many and various. Besides the almost constant presence of microscopic individuals of rutile, tourmaline, etc., the imprisonment of mineral matter derived from the main mass of dyke minerals is common. Amongst the most usual of such inclusions are apatite, calcite, and smaller individuals of phlogopite; while rarer instances are molybdenite, pyrites, albite, fluorite, actinolite, and pyroxene.

Mention may be made of the prevalence of rounded and apparently resorbed crystals of apatite in the dykes. This is such a common feature that it can hardly escape observation. The crystals, which are almost invariably of the combination $\infty P\,P$ the basal plane having never, as far as the writer is aware, been observed, frequently have their angles rounded and their faces glazed, as if subjected, subsequent to their formation, to some sort of resorbent action. Crystals are frequently found, also, which have their faces eaten out and pitted as shown in Plate XXVII; while cavities are often observed, on breaking a crystal, which appear to have been formed by some dissolving agent. These cavities are sometimes perfectly circular, and often enclose a nodule of calcite, the enclosed mineral then having a glazed and highly lustrous surface.

Sterry Hunt[1] mentions the occurrence of such resorbed apatite, in his report on the crystalline limestones of the Laurentian system, in the course of which he states his opinion that the pyroxenites are merely "beds of passage between the gneisses and the limestones."

The "calcareous veins," by which he means the pink calcite deposits occurring with the phosphate in the pyroxenites, he regarded as not due to intrusive agency, but as formed "by gradual deposition or accretion"; in sup-

[1] Rep. Prog., Geol. Surv., Can., 1863 66, p. 181.

port of which he cites the frequent banded arrangement of the minerals parallel to the walls, inclusion of apatite prisms in mica crystals and of mica crystals in massive apatite, and finally the rounding of the crystal angles of the apatite; while the pyroxene, feldspar, scapolite, sphene, etc., all possess sharp outlines. The rounding of the crystal edges he attributed to "the solvent action of heated, watery solutions from which the minerals were deposited, the crystals just formed being subsequently partially redissolved as a result of a change in temperature of chemical constitution of the solution." This implies that apatite was one of the first formed minerals in the veins, and also that the calcite was first introduced after the formation of the apatite, since the solutions which dissolved the latter would, according to the solubility ratio of minerals, first carry away the calcite.

Emmons considered the rounding of the apatite crystals due to a "partial fusion," and observed the same features on apatite crystals in the limestones of Rossie, New York.

Conclusion.

In the preceding pages, an attempt has been made to compile a broadly-outlined description of the main geological features presented by the mica areas of Ontario and Quebec. While comparatively little detailed geological work was conducted by the writer, the main conclusions arrived at by the previous observers have been noted, in order to show the wide variations of opinion held by the different observers who have studied the geology of the districts in question as to the origin of many of the rock-types encountered.

With no pretence at advancing any particular theory of the mode of origin of the mica deposits, it may, however, be stated that the writer's own observations accord most closely with the view that the pyroxenites represent altered sediments (limestones), which have been metamorphosed, as already described, by batholithic granite intrusions, and which have, upon cooling and contraction, been invaded along the shrinkage fissures by mineralizers from the yet partly unconsolidated, enclosing rock. The mica crystals embedded in the mass of the pyroxenite are probably contemporaneous with the rock itself, that is, are a direct product of metasomasis, while the large bodies of mineral found in 'pocket and fissure' deposits, owe their origin, perhaps, to the above-mentioned mineralizers, and are thus pneumatolytic products. The mica found on the true fissure veins would also appear to have been formed in the latter manner.

The absence of alteration shown by the enclosing gneiss along the pyroxenite contacts renders it difficult to suppose that the latter have invaded the gneiss as true igneous dykes.

The presence of such large bodies of calcite in the dykes is difficult to explain, the theory that they represent portions of the original sedimentary limestone in a crystalline condition being hardly tenable.

The Palæozoic Formation.

A description of the later sedimentary deposits bordering the mica areas does not come within the scope of this report, but the following few remarks may be of interest. Practically the whole o. the sedimentary series which conceals the continuation of the crystalline, or Laurentian, rocks outside the exposed district in which the mica deposits have been worked consists of strata of Cambro-Silurian age. Over scattered areas, more recent deposits of clay, sand, marl, and peat are to be found, and alluvial gravels are sometimes met with. These deposits are, however, of limited extent compared with the mass of older sediments. Both marl and peat have in some areas been worked in a small way, but the occurrences are of only minor importance. The Cambro-Silurian sediments are represented by blue and grey limestones, shales, conglomerates, and sandstones, and are divided into the following main groups in ascending order of age:—

Utica shale.
Trenton limestone.
Black River limestone.
Chazy limestone.
Chazy shale.
Calciferous.
Potsdam sandstone.

The lowest number of the series, the Potsdam sandstone, rests upon the eroded surface of the Laurentian, or Archæan, crystalline rocks, and forms the base of the Ordovician system. Its thickness rarely reaches 100 feet, though in the United States its development is considerably greater, and a thickness of several hundred feet is attained. The lower beds are formed of a coarse conglomerate, consisting of pebbles of the old, crystalline rocks embedded in a sandy or calcareous cement, according as it is underlain by gneiss or crystalline limestone. This conglomerate passes upward into more regular, sandy beds, which occasionally contain white, quartzite pebbles, and these sandy layers graduate finally into a dolomitic limestone, which constitutes the Calciferous formation. The transition beds between the Potsdam and Calciferous proper range from 5 to 10 feet and are often highly fossiliferous. The only place where the Potsdam sandstone was found in situ in the immediate vicinity of an exploited mica deposit was on lot 1, concession X, of Loughborough township, Ont., where a white mica deposit has been opened up by Messrs. Richardson and Ellerbeck. The mica-bearing rock is overlain by a layer of some 18″ of coarse sandstone, or conglomerate. Whether this rock actually covered the fissure upon which the mica occurs was not ascertained, but it may be seen at spots only a few feet distant from the workings. This mine is situated upon almost the fringe of the Palaeozoic sediments, the ground falling away immediately to the north of the pits to the underlying Laurentian gneiss.

The Calciferous beds usually consist of arenaceous, dolomitic limestones, and are frequently found to be locally entirely wanting in the succession of strata. This applies also to the Chazy shales and limestones, the Black River deposits being often found resting directly upon the Potsdam beds, and even these latter are sometimes absent.

The Chazy shales, when present, are generally found to range from grey to black in colour, and are sometimes even green or reddish. These pass upward into dolomitic limestones with interstratified shale bands. The Black River beds often attain a considerable thickness, and are extensively developed in the neighbourhood of Sydenham, Ont. They consist of blue or grey deposits, sometimes having a flaggy character and sometimes a modified, nodular structure. The base of these deposits is occasionally found to be formed of greenish-grey, marly beds, though whether these are strictly of Black River or Chazy age is not certain. The sedimentary rocks occurring in the Quebec western mica region are principally of Black River or Chazy age.

The Trenton limestone is an upward extension of the underlying Black River formation, the two divisions grading into each other without stratigraphical break. The thickness of the Trenton beds, however, far exceeds that of the Black River formation, the latter representing a thickness of probably not more than 100 feet, while the former reach a development of nearly 700 feet. The Trenton formation is more extensively developed in the district south of the Ottawa, and east of the mica district, though it also occurs around Ottawa, and west of Kingston. The large quarries operated by the Canadian Portland Cement Company, outside Hull, are opened in Trenton beds.

The Utica shale is represented by dark-coloured beds, which are strongly bituminous in their lower portion, the upper layers being more sandy in character and lighter in colour. They merge upward into the Lorraine shales and sandstones, and attain a development of close on 100 feet. Except for the presence of occasional small outliers, they do not occur in the district bordering the gneiss region, being found more to the east, in the neighbourhood of Caledonia Springs, south of the Ottawa.

Large crystals of mica eroded from the pyroxenites are sometimes found embedded in the later sedimentary rocks, such occurrences having been met with in the Black River beds in the Sydenham district.

Glacial Action.

Traces of glaciation are frequent throughout the area of the older crystalline rocks. Several fine examples of glaciated pyroxenite surfaces were met with near mica deposits, notably at the Freeborn mine, lot 3, concession VII, of Loughborough, and on lot 3, concession VIII, of North Burgess, Ont. At the Moose Lake mine, lot 4, range IV, of Villeneuve, Que., a fine example was seen of a mica crystal worn down by the action of ice. The crystal had lain on its side in the rock, and was ground down in the form of an arc for half its diameter. A similar, and even finer example of such an occurrence was seen at the Bowling mine, lot 26, range IX, of Litchfield, Que. Here, the crystal was extracted entire and presented a beautifully polished surface where its mass had been ground away by the passage of the ice at an angle to its basal cleavage.

Full descriptions of the sedimentary deposits in the area will be found in Parts J of Vols. XII and XIV of the Canadian Geological Survey Annual Reports; in Section IV, Volume IX, of the Transactions of the Royal Society of Canada, pp. 97-108; as well as in the Canadian Geological Survey Report for 1852-53. A valuable description, also, of both the Archæan and Palæozoic limestones of Ontario, by W. G. Miller, will be found in Part II of the 13th Report of the Ontario Bureau of Mines, 1904.

CHAPTER III.

MINERALS OF THE MICA DEPOSITS.

The following alphabetical list of minerals from the mica deposits includes the various species observed or collected by the writer during an examination of the various mines. In addition, several minerals are included, which, though not personally observed, are recorded as having been found in the mica or apatite mines. While many of the species enumerated occur directly on the mica and apatite leads and closely associated with these minerals, a number of them are found principally in the lean and barren portions of the dykes.

Albite.

Small crystals of albite were observed lining a cavity in a coarse-grained, felsitic zone in pyroxenite on lot 3, of the Gore of Templeton, Que. This variety of feldspar is by no means common in mica deposits and has been recorded from only a few localities.

Anthraxolite.

This mineral is a hydrocarbon compound of varying composition and is known from several localities in the Provinces of Ontario and Quebec.[1] It appears to be an alteration product of liquid bitumen or asphalt, and is found as vein-filling or as isolated inclusions in both sedimentary and igneous rocks. Specimens have been obtained from the chert beds of the Lake Superior copper region, where the mineral occurs on small fissures, and also from certain trap rocks. The specimens obtained by the writer from mica deposits consist of small rounded fragments or nodules, the largest of which does not exceed 2″ diameter. These specimens were secured at the Baby mine, lot 1, concession X, of the township of Loughborough, Ont., and occurred as isolated masses of approximately circular shape in the grey, altered, mica-bearing pyroxenite. The mineral is hard and brittle, possesses conchoidal fracture and somewhat resembles bituminous coal. Its streak is black; but the substance is too hard to mark paper.

Apatite.

This mineral is an almost constant associate of phlogopite in the pyroxenite dykes, and frequently, indeed, is present in considerably greater quantity than the mica. As will be already clear from the descriptions of the various mines, etc., many of what are now mica mines were originally opened up as phosphate producers, and both minerals are now won simul-

[1] Ann. Rep. Geol. Surv., Can., 1888-89, Vol. IV, Pt. T, p. 19.

taneously at several mines. Disregarding pyroxene, which forms the mass of the dykes, apatite, calcite, and phlogopite may be said to be the characteristic minerals of the pyroxenite deposits. It is occasionally found, it is true, that apatite is almost, if not entirely, absent from the mica leads, but such instances are comparatively rare.

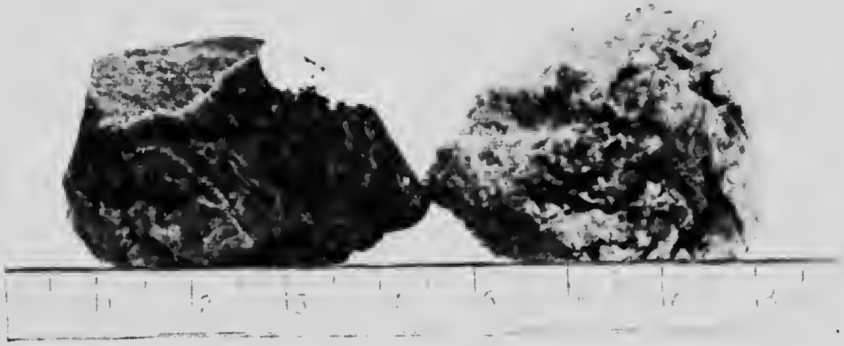
In character, the mineral ranges from massive, compact crystalline to what is known as "sugar-phosphate." The latter consists of a friable, powdery mass of small, rounded apatite grains, and is often found in large deposits, throughout which well-crystallized apatite individuals and mica crystals occur disseminated. When crystallized, the mineral invariably adopts the prismatic habit with pyramidal termination (∞ P.P). Occasionally the crystals are terminated at both ends, but this is unusual. In size, they range from minute individuals, which often occur scattered through the pink calcite of the dykes, to enormous forms several feet in length and a foot or more in diameter. Attention has already been drawn to the frequently rounded crystal edges, and to the often resorbed appearance exhibited by the individuals, a feature which is as common to the large as to the most minute crystals. The colour of the mineral varies greatly, even in one and the same deposit, and massive, compact apatite, also, is sometimes found to merge gradually into the sugar variety. The most usual colour is green, but brown, red, blue, grey, and even white, are also met with. The sugar phosphate is almost invariably of a greenish-white shade.

The best and most perfect crystals of apatite are usually found embedded in calcite. Well-formed individuals, also, often occur included in mica crystals, in which case the prisms almost always lie with their long axes approximately parallel to the basal plane of the mica crystal. Inclusions of other minerals, such as calcite, pyroxene, phlogopite, pyrite, fluorite, in the apatite crystals are not uncommon.

From numerous analyses which have at various times been made, it has been found that the apatite of the pyroxenites is always fluor-apatite, the fluorine content ranging as high as 3·8 per cent. A number of results of analyses of Canadian apatite are given in Part II of the Report of Progress of the Canadian Geological Survey for the year 1877–8. The samples for examination were taken from both Ontario and Quebec deposits, and included the "sugar" as well as the compact varieties of the mineral. A mean of eight analyses given in the above report, and conducted by C. Hoffmann, showing the chief constituents, is appended:—

Phosphoric acid	39·733
Fluorine	3·404
Chlorine	0·257
Carbonic acid	0·630
Lime	47·933
Calcium	3·823
Insoluble	1·658
	97·528

PLATE XXVII.



Apatite crystals, showing resorbed crystal faces, Rheaume Lake mine, lot 3, gore [illegible], township of Templeton, Que.

The mean specific gravity was found to be 3·17, and the analyses gave an average content of tri-basic phosphate of lime equal to 86·74.

Almost the entire production of apatite from the Ontario and Quebec mica mines is shipped to Buckingham, on the Ottawa river, below Ottawa, where the mineral is converted into superphosphates for fertilizing, and is also used in the manufacture of phosphorus.

Barytes.

This mineral was observed at one spot only, concession VIII, lot 2, of North Burgess, Ont. Masses of small, tabular crystals were found encrusting the walls of druses in white calcite, near the surface of the lead exposed in the S.E. pits, and associated with quantities of small calcite scalenohedrons.

Calcite.

Calcite may be said to be an invariable constituent of the pyroxenites, though it is true that the amount in which it is present is subject to considerable range. In certain dykes the mineral forms immense bodies, chiefly as the filling of 'rooms' or pockets in the rock, while in others it occurs in small quantities only throughout the mass of the dyke. It is frequently present in the form of layers or films between the laminæ of mica crystals, considerably impairing their splitting quality. In character, the calcite is usually more or less coarsely-crystalline, the individuals ranging from $\frac{1}{8}''$ to $\frac{1}{2}''$ across. Occasionally they are much larger, attaining a length of some 3" to 4". In such cases the colour of the min[illegible] is nearly always white or yellowish, in contradistinction to the prevai[illegible]sh or salmon-coloured tint of the more finely crystalline variety. The in[illegible]luals are always twinned polysynthetically along $-\frac{1}{2}$ R, and, save for the [illegible]ur, masses of the mineral much resemble an ordinary, coarse-grained crystalline limestone. The pockets, so frequent in the pyroxenites, are almost invariably filled out with calcite, mixed with which both mica and apatite occur. Where empty pockets are met with, the calcite has generally been removed by the circulation of surface waters. It is curious that druses in the calcite are of very infrequent occurrence; and the usual types of calcite crystals so commonly met with on mineral lodes or lining fissures in sedimentary limestones are exceedingly scarce. Only at some half dozen mines did the writer succeed in discovering any calcite crystals, and from inquiries made of the miners it is evident that such are rarities. Those observed were generally of scalenohedral habit and of small size. Crystals of this type occur near the surface of a mica lead on concession VII, lot 2, of North Burgess, Ont. At one spot—concession VIII, lot 13, of Loughborough, Ont.—a very compact, finely crystalline, dark-red calcite was observed, in which occurred porphyritic and rounded crystals of apatite. Small druses lined with white calcite scalenohedrons occurred plentifully in the mass of the red mineral. The red colour of the calcite does not appear to be due to the presence of any foreign mineral, but belongs to the carbonate, and cannot be destroyed by calcining.

Other colours possessed by the mineral are blue, white, cream, and greenish, and it is noteworthy that when such colours prevail either pyrite, or more commonly pyrrhotite, is to be found in considerable amount in the deposit. Small, circular lumps of calcite, resembling marbles, and possessing a highly glazed surface, are sometimes found enclosed in crystals of apatite.

Chabazite

Has been found on range XII, lot 21, of Templeton, Que., where it occurs in small, colourless crystals in scapolite and pyroxene. The crystals have rhombohedral habit, and penetration twins are common. Harrington considers the chabazite from the above locality, as well as the prehnite from mica deposits, to be of secondary origin, and possibly derived from the scapolite[1]. Another locality from which chabazite and other zeolites, including natrolite, have been obtained, is range XII, lot 21, of East Portland, Que. Small, clear, rhombohedral crystals of chabazite were seen coating large, decomposed scapolite crystals at the Rheaume Lake mine, lot 3, of the Gore of Templeton; and minute crystals of what appears to be chabazite were found associated with green fluorite on range III, lot 1, of East Portland.

Chalcopyrite.

Small grains or irregular fragments of chalcopyrite are sometimes seen embedded in the granular calcite of the dykes, associated with pyrites.

Chlorite.

Chlorite, having approximately the composition of ripidolite, has been found on range IX, lot 18, of Templeton township, Que., and at various other mines in the same district. The following[2] is an analysis of the above specimen:—

SiO_2	35·80
Al_2O_3	13·18
Fe_2O_3	4·28
FeO	10·18
MgO	22·80
H_2O	12·64
	98·88

[1] Rep. Prog. Geol. Surv., Can., 1877-8, p. 35 G.
[2] Rep. Prog. Geol. Surv., Can., 1877-8, p. 34 G.

Aggregates of small, green, chlorite-like scales were observed by the writer at the Baby mine, concession X, lot 1, of the township of Loughborough, Ont., usually upon joints and slide-planes in the altered rock.

Datolite

This mineral was observed at two localities, namely, range I, lot 9, of Derry, Que., where considerable quantities of white, compact, massive datolite, showing characteristic, Wedgewood-porcelainic fracture, occur in pyroxene and apatite, associated with dark, purple fluorite, and at the Bobs Lake mine, concession VI, lot 30, of Bedford, Ont. At the latter place, the mineral occurs in finely-divided, granular form, has a white colour, and can be rubbed to a fine powder between the fingers. The specimens seen by the writer formed part of a mass several pounds in weight, taken from the hanging-wall of one of a series of parallel mica leads. This lead also carries scapolite in aggregates of large and well-formed crystals. Datolite is recorded also from several other mica deposits, including the Lacey mine, concession VII, lot 11, of Loughborough, Ont.

Epidote.

This mineral is occasionally met with in pyroxenite dykes, and is recorded, amongst other localities, from range XIII, lot 23, and range X, lot 9, of the township of Templeton, Que. The mineral is, in both cases, of a yellowish-green colour, and occurs with dark pyroxene and pyrite. A further locality where epidote was found by the writer in considerable quantity is range I, lot 12, of Wakefield, Que.

Faujasite.

This mineral has been found in good-sized, white octahedrons, associated with green fluorite, at the Daisy mine, range I, lot 9, of Derry, Que. It is also reported to occur at various localities in the township of East Portland.

Fluorite.

This mineral is a somewhat scarce associate of the mica and apatite. Considering the high fluorine content of both these minerals (up to 2·5 and 3·8 respectively), it is remarkable that the fluoride of calcium should be so rarely encountered. When present, it is often associated with members of the zeolite family, and seems to be a result of the secondary alteration of apatite. Only small crystals (up to ½" in diameter) have been found, and these are usually of octahedral or cubic habit. Combinations of the two forms also sometimes occur. The mineral is generally of a green or purple colour.

An unusual amount of fluorite was observed at the mine owned by the Calumet Mica Company, range IV, lot 22, of the township of Huddersfield, Que. Here, large masses of fluorite of a purple-brown colour occur scattered through cream-coloured calcite, and small purple octahedrons were also observed lining cracks and fissures as well as forming inclusions in the mica crystals (see Orthite).

Galena.

Recorded from range XIII, lot 12, of Templeton, Que., in minute quantities, associated with smoky quartz, in cavities in pink calcite. Galena, sphalerite, and chalcopyrite, when present in mica deposits, are always obviously the result of deposition from later circulating waters. That is, they have been deposited in the same way as true lode minerals, and were probably not present as original constituents of the pyroxenites.

Garnet.

The occurrence of garnet, associated with apatite, is recorded by Harrington,[1] who mentions the varieties almandite and hessonite as having been found in Templeton and Wakefield townships, Que., respectively. No specimens of garnet were observed at any spot by the writer, associated with phlogopite, mica, or apatite. Both the above-mentioned varieties are frequent in the gneisses of the mica area and are also occasionally met with in crystalline limestone near intrusive contacts of pegmatite or similar rock.

Spessartite occurs plentifully, embedded in the feldspar and mica crystals of the large pegmatite dyke opened up at the Villeneuve mine, Que. What was surmised to be chrome-garnet has been found in the township of Wakefield, Que., associated with apatite, tourmaline, and pyroxene.

Goethite.

This hydrated iron oxide was observed in some quantity, lining the walls of small cavities in marcasite and pyrite, at the McNally mine, concession V, lot 21, of North Burgess, Ont. The mineral is of the variety known as przibramite, possessing dark-brown, velvety surface, and is associated with small quartz crystals.

Graphite.

Reported to occur at various localities in the mica area, associated with apatite, calcite, and pyroxene. The writer has observed it in the form of small flakes in the white crystalline limestone often found adjacent to the pyroxenites, and also in small quantities in the pyroxenite rock itself. In the latter case, the mineral usually occurs as a selvage filling upon joints and slips, and is often associated with crushed mica and pyroxene. Instances of this mode of occurrence are common at the Lacey mine, lot 11, concession VII, of the township of Loughborough, Ont.

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[1] Loc. cit., p. 26.

Hematite.

A large pocket of scaly hematite was encountered on concession V, lot 9, of North Burgess, Ont., while sinking on a mica lead. The iron-ore occurs in a sort of lenticular chimney, and contains fair-sized mica crystals scattered through it.

On concession IX, lot I, of Loughborough, Ont., pockets of massive, fine-grained specularite occur in close proximity to the mica lead.

Hornblende.

Primary hornblende, that is, non-pseudomorphous mineral resulting from the alteration of pyroxene, is of not uncommon occurrence along the borders of pyroxenite belts with crystalline limestones. Notable localities are the Parker mine, range V, lot 52, of the township of Bigelow; the Father Guay mine, range D, lot 15, of Wright, and range III, lot 23, of Hincks, all in the Province of Quebec. At the above spots large quantities of normal, black and lustrous hornblende have been formed along the contacts of the pyroxenites with crystalline limestone. The mineral forms compact masses, with individuals up to ⅓″ diameter, and is quite fresh and unaltered.

Actinolite in stout prisms of a greenish colour was observed at various points, notably at the Fortin and Gravelle mine, range VII, lot 18, of Hull, Que., and at the Silver Queen mine, concession V, lot 13, of North Burgess, Ont. At the latter place, sheets of the white, fibrous variety of hornblende known as "mountain leather" were also obtained. This mineral also occurs at the Lake Girard mine, and at several localities in the township of Derry, Que. The hornblende varieties of asbestos, known as amianthus and byssolite, were noticed at several points, notably on range VI, lot 19, of Hull, Que. Here, the former mineral occurs in masses with fibres up to nearly a foot in length, and is of a bluish colour. It is found on the contact of a pink felsite with pyroxenite, and is probably an alteration product of pyroxene, caused by pneumatolytic emanations accompanying the felsite intrusion.

What is probably edenite, a clear, reddish variety of hornblende, was observed associated with grey tremolite on concession X, lot 1, of Loughborough, Ont.

Molybdenite.

This mineral is frequently to be met with in the pyroxenite dykes, sometimes in large masses several pounds in weight, but more usually in the form of small flakes and scales disseminated through pyroxene. It is doubtful whether molybdenite is an original constituent of the pyroxenites, since, when present, it occurs, as far as the writer has observed, always in more or less immediate proximity to pegmatite or felsite dykes cutting the mica deposits. It seems probable, therefore, that the mineral has been brought in by the later intrusions, and is a result of impregnation of the pyroxenite by mineral-izers from the acid dykes.

Natrolite.

A white, fibrous mineral, resembling natrolite, was observed coating small calcite crystals in vugs at the Moore and Marks mine, range II, lot 1, of Alleyn, Que. The individuals were too small and altered to admit of accurate determination, and the mineral may possibly be stilbite or some other member of the zeolite family.

Olivine.

Olivine is by no means a usual mineral in mica deposits, and occurs only at one mine, namely, the Parker mine, range V, lot 52, of the township of Bigelow, Que. Here large and well-formed crystals are found associated with pyroxene, and frequently lining the walls of pockets, in a similar manner to the latter mineral. The crystals are of a greyish-green colour, usually tabular in form, and possess glassy lustre. The largest individuals observed possessed a length of some 4". On the east of the property, a small mica lead has been opened up, and the olivine at this spot contains numerous black spinel crystals. The latter also occur disseminated through the coarsely-crystalline, white calcite of the vein proper. At the surface, the olivine crystals are mostly decomposed and friable, possessing a brown or yellow colour, and often display a high degree of iridescence upon their faces (See p. 66 and Plate XXXI).

Orthite[1] or Allanite.

Tabular crystals, over 1" in diameter, and possessing the character and appearance of orthite, were observed disseminated through massive calcite on range IV, lot 22, of Huddersfield, Que. The mineral is black and possesses metallic lustre on its crystal faces, though often coated with the brown alteration substance characteristic of orthite. The fracture is conchoidal, the resulting surfaces possessing vitreous to resinous lustre. No analysis of this interesting mineral has been made, but it is noteworthy that the fluorite, which at this spot occurs in unusual quantity, often forming large masses embedded in the calcite, in close proximity to the dark crystals, invariably possesses a dark, violet colour. This violet shade gives way, with increasing distance from the orthite (?), to the normal lilac colour possessed by the mineral at this mine.

[1]Since the above was written, a communication has been received from Dr. Kolbeck, of the Koenigliche Bergakademie, Freiberg i.Sa, to whom a sample of this mineral was submitted for determination. Dr. Kolbeck kindly conducted an analysis of the sample and pronounced it to be orthite.

Orthoclase.

Orthoclase is a common constituent of many pyroxenites, and, associated with quartz and pyroxene in varying amounts, forms many rock-types throughout the dykes. The mineral is seldom met with in well-developed crystals, though occasionally scattered individuals are found associated with the crystals of pyroxene lining the walls of pockets or fissures. In colour it ranges from white, grey, or bluish, to brown, pink, and red, a greyish-blue or greyish-brown shade being the commonest. The usual mode of occurrence is in massive, coarsely-crystalline form, the individuals ranging from ¼" to 1" in length, and being frequently intermixed with quartz or titanite. The frequent, intimate association of one or more of the following minerals, in varying amount, with orthoclase, constitutes rock-types which are characteristic of the pyroxenite dykes:—

Orthoclase: ± titanite, ± pyroxene, ± apatite, ± phlogopite, ± quartz.

Pink orthoclase is, in addition, the chief constituent of the numerous pegmatite veins which are found cutting the mica and phosphate deposits.

Small, but well-formed, white, orthoclase crystals were seen lining a surface crevice in pyroxenite, on range X, lot 13, of Hull, Que.

Phlogopite.

The nature and occurrence of phlogopite, or 'amber mica', has already been fully described under the article "Mica", and elsewhere in this report.

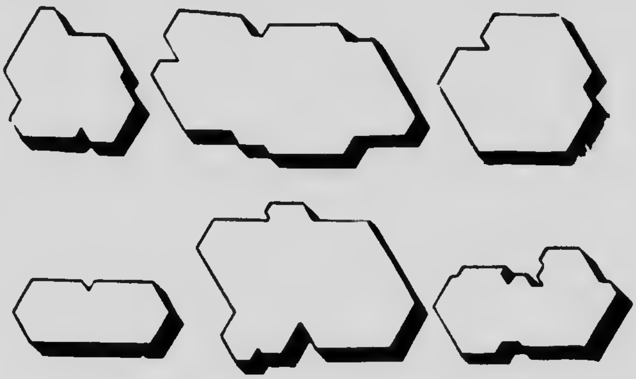


Fig. 61. —Types of compound phlogopite crystals.

It is unnecessary, therefore, to enter here upon a further discussion of the mineral. It may be remembered, in view of the opinion held by many authorities that muscovite is merely an altered form of phlogopite, that no instance is recorded of the occurrence of muscovite mica in a pyroxenite dyke; and that also, as far as the writer is aware, no example of an intergrowth of the two varieties has ever been noticed, save inasmuch as the extreme—

biotite is sometimes found in intergrowth with muscovite in certain pegmatite dykes, and also in some gneisses.

Common types of compound phlogopite crystals are shown herewith.

The optical phenomenon known as asterism, which is so characteristic of certain phlogopites, may be mentioned here as especially prominently displayed in sheets from the following localities.

LOCALITIES WHERE ASTERIATED MICA IS FOUND.

Province.	Township.	Concession.	Lot.	Degree of asterism.
Ontario	Bedford	[illegible]	6	A2
"	"	I	5	A2
"	Loughborough . .	[illegible]	13 E.½	A1A
"	"	[illegible]	11	A2 and A*
"	"	[illegible]	1	A1A
"	"	[illegible]	1	A2
"	North Burgess . .		13 W.½	A1A
"	"	[illegible]	8	A1
"	"	[illegible]	[illegible]	A1
"	"	[illegible]	[illegible]	A
"	"	[illegible]		A1
"	"	[illegible]	1	A1
"	"	[illegible]	1	A1A
"	"	VIII	2	A2
"	"	VIII	5, 7	A2
"	"	IX	6 E.½	A2
"	"	IX	17 E.½	A1A
"	South Crosby	V	9	A
		Range		
Quebec	Blake	IV	13	Single-rayed.
"	Hull .	VII	19	A
"	"	XII	10	A
"	"	XIII	13a	A2
"	West Portland .	III	24	A2
"	Templeton	IX	17	A1
"	"	X	10	A1

A =faint double; A1 =strong simple; A2 =strong double.
* The milky variety of mica from this mine possesses A2, the clear A.

Asterism has been attributed to the presence within the mica sheets of microscopic needles of rutile, tourmaline, or cyanite, arranged symmetrically in bands inclined at angles of approximately 60° to one another. That this is not the correct explanation of the phenomenon appears probable from the fact that sheets of mica split from the same crystal plate often exhibit widely varying degrees of asterism. The writer has split a plate, about 1½" thick, from a phlogopite crystal, and has then proceeded to divide this plate into layers, as nearly as possible of equal thickness, and thin enough to allow light to pass through them. In some cases, the sheets examined displayed no asterism at all, while others exhibited the highest degree of double asterism. It was found that cloudy (silver-amber) mica sheets, whose laminae were in somewhat loose contact with one another, usually displayed a higher degree of asterism than hard, clear, compact sheets. The most perfect asterism observed in any of the micas examined was shown by samples of a white,

PLATE XXVIII.

Crystal of phlogopite with upper portion rotated 20° and cemented into new position by calcite, from the Cantin mine, lot 1, concession IV, township of South Burgess, Ont.

brittle variety, occurring in limestone (probably as a result of contact metamorphic action due to igneous intrusions) on concession II, lot 5, of the township of Bedford, Ont. The exact composition and nature of this mica has not yet been determined. It would appear, then, that what is known as asterism is due sooner to minute interstices, cracks, or striations in the sheets of mica, caused by physical disturbance either during or subsequent to the formation of the crystals. The disturbance may have been caused by pressure, applied either externally, or exerted by the force of crystallization of included, foreign, mineral substance such as pyrite, calcite, apatite, etc., or may be due to polysynthetic twinning. As will be seen from the above list of localities, mica exhibiting asterism is not confined to the township of North Burgess, in Ontario, but is to be found at many widely-separated spots throughout the mica regions of both Ontario and Quebec.

Prehnite.

Harrington records the occurrence of this mineral from range XII, lot 16, and also from range XIII, lot 23, of Templeton, Que. No specimens came to the writer's notice while examining the deposits. The above-mentioned sample was translucent, of a yellowish-white colour with a greenish tinge. It seems to have occurred in a cavity, and showed rounded surfaces made up of an aggregation of crystals. The hardness was above 6, and specific gravity 2·891.

Pyrite.

Though not usually abundant in the pyroxenites, pyrite is nevertheless of frequent occurrence, and in certain deposits, indeed, proves a rather unwelcome accessory, from the miner's point of view, owing to its liability to decompose, the resulting acid attacking the mica and often rendering the crystals near the surface worthless. Large quantities of so-called "rusty" mica have, thus, often to be discarded when exploiting the upper portions of deposits, the sheets being stained by oxide of iron and useless for electrical purposes. Mica crystals, too, which are taken from deposits carrying much pyrite, are usually hard and brittle, and are characterized by what is known as 'wine-amber' colour, due apparently to the presence of the iron sulphide in the dyke matter. Though sometimes massive in character, and in this form occasionally to be found forming solid veins several inches across, pyrite is of more general occurrence in the form of isolated, irregularly-shaped fragments, having often a pitted surface, as if they had been attacked by some dissolving agency. Such fragments are usually embedded in calcite or apatite. Crystals are not uncommon, the usual forms being O, $\infty O \infty$, and $\frac{(\infty O 2)}{2}$, either simply or in combination. Large quantities of pyrite crystals, of octahedral habit, but with curved edges and faces, occur embedded in a sort of bluish selvage, on range II, lot 10, of Alleyn, Que. Unusually large quantities of pyrite also occur with the mica, on range IX, lot 23, of Blake, Que.; concession VIII, lot 6, of Loughborough; and concession V, lot 21, of North Burgess, Ont. At the latter place, marcasite occurs with the pyrite, which seems to form a considerable proportion of the vein-filling.

Small crystals of pyrite are not uncommonly included in phlogopite sheets, and then often give rise to very perfect, natural pressure figures.

Pyroxene.

The mica and apatite-bearing dykes are, as their name implies, chiefly made up of one member or another of the pyroxene group. The most common variety, according to Harrington,[1] appears to be an aluminous sahlite, or lime-magnesia-iron pyroxene, but other varieties of diopside, such as malacolite and diallage, are also common.

Orthorhombic varieties, such as hypersthene and enstatite, are sometimes met with, though not of frequent occurrence. The mode of occurrence of the pyroxene is most variable, and the dykes attain varying characteristics in consequence. Sometimes a dyke is formed of finely-crystalline, granular pyroxene, mixed with feldspar and quartz, forming a hard, compact rock, in which mica crystals, associated with small amounts of calcite, occur embedded. Again, a mass of pyroxene crystals, often of considerable size, may occur more or less loosely intergrown, with calcite filling the interstices between the partially developed crystals. It is in this type of dyke that pockets, often lined with beautifully crystallized pyroxene individuals, so often occur, the cavities being often connected by fissures of considerable size. This mode of occurrence has given to mica deposits associated with dykes of this type the designation, common among mica miners, of "pocket and fissure" deposits. A third type of dyke is that in which the pyroxene crystals form a relatively compact mass, with few pockets, but with well-defined and regular fissure-veins traversing the dyke. The walls of such fissure-veins are often lined with large and well-developed pyroxene crystals (See Plate XXIX).

The habit of the crystals is prismatic, and the more usual combinations are—$\infty \bar{P} \infty$, $P \infty$, $\infty \bar{P} \infty$, $\bar{P} \infty$, P. Other planes are, however, frequently present, and among them: 2P, 3P, and oP. The crystals are often striated longitudinally, and they are sometimes flattened in the direction of the orthodiagonal. Crystals terminated at both ends are not unknown, though scarce, and are usually found embedded in apatite or calcite. Good examples were observed on concession VII, lot 19, of the township of Bedford, Ont.

In colour, the mineral ranges from nearly black to almost white, the commonest shade being a greenish-grey. It is noteworthy that quite fresh,

[1] Rep. Prog. Geol. Surv., Can., 1877-8, Part G, p. 17.

unaltered pyroxene is relatively scarce, even in deep workings. In certain deposits, lustrous, fresh crystals are common, but, as a rule, the mineral is dull throughout its mass, and the crystal faces are usually matt and rough. When fresh and lustrous, pyroxene crystals are sometimes mistaken for apatite, especially when the prism faces are developed to the same extent as those of the pinacoid, giving a hexagonal appearance to the individuals.

Inclusions of mica, pyrite, calcite, and apatite in pyroxene crystals are often met with, the first two named being the commonest observed. Fractured and bent crystals, which have been re-cemented by calcite or apatite, are sometimes met with.

The perfect cleavage exhibited by the pyroxene crystals is a notable feature, the most prominent directions being $\infty P \infty$ and ∞P. Crystals twinned on $\infty P \infty$ are frequent, and prominent parting, or pseudo-cleavage, due to twinning, is often observed on large crystals.

The most interesting and conspicuous feature to be observed in connexion with the pyroxene, is its tendency to become altered into a kind of uralite. This mineral is essentially a pseudomorph of hornblende after pyroxene, which retains the crystal form of the latter mineral, while acquiring the composition and cleavage of the former. What were originally pyroxene crystals are frequently found altered to a greenish-blue mineral with fibrous structure, and which is probably referable to uralite or traversellite. This transformation of pyroxene to hornblende is especially to be remarked in cases where later pegmatite or felsite dykes cut pyroxenites. Localities which may be noted are range XIII, lot 12a, of the township of Hull; range VI, lot 19, of the same township, and range II, lot 24, of Wakefield, all in the Province of Quebec. At the latter place (the Lake Girard mine), large pyroxene crystals were noticed, which consisted of an inner core of soft, green, powdery mineral, having an outer covering, some ½″ thick, of blue, fibrous traversellite, the fibres being at right angles to the faces of the original crystal. The formation of blue hornblende along the contact of a felsite intrusion with pyroxenite is described in the notes on the mica mine situated on range XIII, lot 12a, of the township of Hull. Three analyses, by Harrington, are appended, the first of which represents the composition of the centre, or unaltered portion, of such a pyroxenite crystal: the second is that of the zone bordering upon the centre and partly altered to a lustreless mineral; and the third represents the most altered or exterior portion of the same crystal. The specific gravities of the samples were, in the first case, 3·181; in the second 3·205, and in the third only 3·003. Although mineralogically different in character, the two inner crystal zones have much the same chemical composition.

Analyses of Pyroxene Crystals.

A.

Internal, or unaltered, zone.

SiO_2	50·868
Al_2O_3	4·568
Fe_2O_3	0·970
FeO	1·963
MnO	0·148
CaO	24·438
MgO	15·372
K_2O	0·497
Na_2O	0·218
Loss on ignition	1·439
	100·481

B.

Intermediate, or partly altered, zone.

SiO_2	50·898
Al_2O_3	4·825
Fe_2O_3	1·741
FeO	1·358
MnO	0·152
CaO	24·392
MgO	15·268
K_2O	0·150
Na_2O	0·076
Loss on ignition	1·200
	100·060

C.

External, or completely altered, zone.

SiO_2	52·823
Al_2O_3	3·215
Fe_2O_3	2·067
FeO	2·709
MnO	0·276
CaO	15·389
MgO	19·042
K_2O	0·686
Na_2O	0·898
Loss on ignition	2·403
	99·508

PLATE XXIX.

Large crystals of pyroxene from lot 13, range XV, township of Hull, Que.

In the last case there is a loss of about 9 per cent of lime, and a gain of 4·5 per cent of magnesia; which loss and gain appear to determine the change from pyroxene to hornblende. The above analyses very fairly represent the average composition of pyroxene from the Archaean rocks of Ontario and Quebec.

Pyrrhotite.

Magnetic pyrites is an even more prevalent mineral in the deposits than the ordinary variety, and can usually be observed, if only in subordinate amount, in the majority of mica leads. As in the case of pyrite, the mineral is generally either massive, or in the form of irregularly-shaped fragments with pitted or indented surfaces, embedded in calcite or apatite. Mica crystals surrounded by massive pyrrhotite were observed at certain mines, and in such cases the laminæ are usually found to be of a reddish-brown shade and relatively hard and brittle. Small plates of pyrrhotite are common in the crystalline limestones which frequently border on pyroxenite dykes, and these plates sometimes possess obscured crystal outlines. More often, however, the mineral here also is in the form of irregular fragments. It is noteworthy that the calcite found in deposits in which pyrrhotite or pyrite occurs at all plentifully is almost invariably light in colour (usually white, cream, or yellow), in contra-distinction to the prevailing salmon tint of the normal mineral. This fact is especially noticeable at the Moose Lake mine, range IV, lot 1, of Villeneuve township, Que.; at the Cantin mine, concession IV, lot 1, of South Burgess, Ont. (calcite also of a blue shade); on concession XI, lot 10, of Bedford, Ont., and on concession VII, lot 19, of Bedford.

The surface of the pyrrhotite fragments at the first-named locality is peculiarly ribbed, resembling the face of a coarse file, the ridges often, however, pursuing a wavy course. The mineral seems to have been squeezed or pressed in amongst the calcite with which it occurs, and to have penetrated along the cleavage planes of the latter mineral, thus acquiring a ridged surface.

Quartz.

Although quartz has often been alluded to by various writers as a common mineral in the mica and apatite deposits, the writer's experience is that it is somewhat of a rarity. Massive, milky quartz is sometimes met with in the mass of the dykes, and the mineral is also present, associated with feldspar, as a rock-forming constituent, in the same manner as it is present in granite or similar rock-types. Crystals of quartz, however, were observed remarkably seldom, and then only as small individuals lining the walls of druses in calcite or apatite. It was never seen associated with pyroxene crystals upon the walls of pockets in pyroxenite. At the Goldring mine, range IX, lot 17, of Templeton township, Que., crystals of smoky quartz up to 1" in length were seen lining cavities in massive apatite, and on range VI, lot 15, of the same township, considerable quantities of pale amethyst crystals occur. Chalcedonic quartz, also, is recorded from the first-named locality. Much of what has been described as massive, vitreous quartz is probably fresh and unaltered scapolite, which sometimes occurs in considerable quantities in the pyroxenites.

Two very perfect, pseudomorphic crystals of a dark, earthy mineral after quartz were obtained from concession VII, lot 14, of South Crosby, Ont.

Rensselaerite.

This mineral is a pseudomorph of steatite after pyroxene, and is recorded from mica deposits, as is also the somewhat similar mineral pyrallolite.

Rutile.

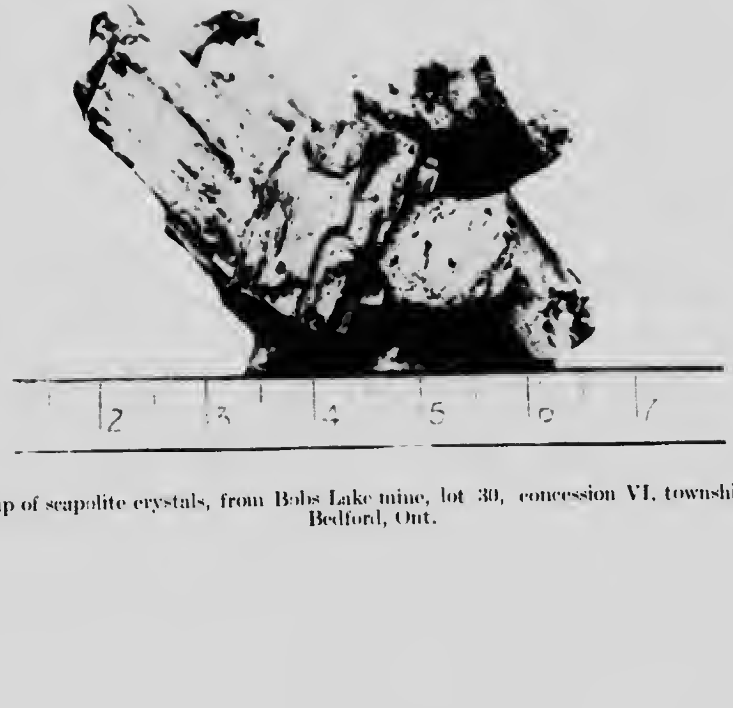
Rutile has been reported to occur in some mica deposits, one locality being range X, lot 10, of Templeton township, Que. No specimens were observed by the writer in any of the mines, but very large prisms occur in a barytes vein, associated with acicular, green actinolite, on range XIII, lot 13 N.½, of Templeton. The vein occurs on the contact of amphibolite with crystalline limestone.

Scapolite.

In many mica deposits scapolite occurs in considerable quantity, and often in the form of large crystals, either as isolated individuals or, more commonly, in crystal aggregates. If a careful examination of the rock matter from the various mines could be made, it would probably be found that scapolite is present in unsuspected amount in the majority of pyroxenites. While occasionally fresh and unaltered—and in that case possessing characteristic, vitreous lustre and splintery fracture—the scapolite most commonly encountered has undergone considerable alteration, and is opaque and often earthy, with a silky lustre. Fresh scapolite in massive form occurs somewhat plentifully at the Horseshoe mine, range XVI, lot 5, of the township of Hull, Que., and often encloses crystals of apatite and mica. Notable localities where altered scapolite occurs in quantity are, in Quebec: Chaibee mine, range A, lot 6, of Wright; Nellie and Blanche mine, range XI, lot 10, of Hull; range XII, lot 13, of Templeton (in well-formed square crystals); and in Ontario: Baby mine, concession V, lot 13 W.½, of North Burgess; concession VIII, lot 1, of the same township; Bobs Lake mine, concession VI, lot 30, of Bedford (See Plate XXX.)

The usual crystal forms exhibited are combinations of $\infty P \infty$, ∞P, P, $P\infty$, oP, while $\infty P2$, 3P, 3P3 sometimes occur. The cleavage parallel to $\infty P \infty$

PLATE XXX.



Group of scapolite crystals, from Bobs Lake mine, lot 30, concession VI, township of Bedford, Ont.

is prominent. In colour, the scapolite is usually of a grey, white, or yellow shade. A specimen of scapolite from a pyroxenite dyke in Ottawa county, Que., was analysed by F. D. Adams, and found to contain:—

SiO_2	51·68
Al_2O_3	22·15
Fe_2O_3	0·49
CaO	9·09
MgO	trace
K_2O	1·13
Na_2O	8·36
Cl	2·41
SO_3	0·79
H_2O	0·86
	100·41

The presence of chlorine is especially interesting, in view of the small amount of that element present in the apatite of the dykes (about 0·25 per cent). In order to ascertain whether chlorine is a usual constituent of the scapolite of the pyroxenites, fourteen other samples were examined by Adams, in all of which the presence of chlorine was detected, though mostly in small amount. A locality where scapolite occurs in more than usual amount is concession VIII, lot 6, of Bedford, Ont. Here large quantities of massive, highly altered, soft scapolite form practically the entire vein filling of the mica leads, calcite and apatite being noticeably absent.

Serpentine.

Dykes of asbestos-carrying, serpentine rock are of not infrequent occurrence among the Laurentian series of Ottawa and Pontiac counties, Que., and several instances of serpentine dykes cutting or intruding mica deposits were observed. Notable localities are range XVI, lot 27, of Hull, and range X, lot 2, of Templeton. At the former place, the rock was in the form of narrow dykes cutting the pyroxenite, but at the latter spot, a shattering of the pyroxenite seems to have taken place, with a squeezing of serpentine material into the fissures formed and a certain amount of resorption of the pyroxene and mica. Crystals of the latter mineral, of a silvery colour, and traversed by minute, irregular cracks filled with serpentine, which has also, in some cases, penetrated between the laminæ, are found embedded in a soft, yellow-green serpentine. Stringers of chrysotile, up to ½″ in width, occur here.

Specularite.

This mineral occurs with red and brown jasper along the contact of a pegmatite dyke with crystalline limestone, adjacent to a mica and apatite vein, on range IX, lot 16, of Hull, Que. The spessartite is both massive and in the form of small, tabular plates lining fissures in the jasper.

Sphalerite or Zinc Blende

This is recorded from range IX, lot 17, of Templeton, Que in small, yellow-brown crystals, associated with quartz and apatite. The mineral probably occurs somewhat more frequently than is supposed, but is liable to be overlooked owing to its occurrence in small, dark-coloured crystals.

Spinel.

Spinel is a mineral by no means common in mica deposits, and was only observed at one spot, namely, range V, lot 52, of the township of Bigelow, Que. Here, as already described in the account of the Parker mine, a kind of irregular pocket has been opened up in the mass of the pyroxenite, carrying a greyish olivine mixed with white calcite and dark mica. Scattered through the mass of this rock occur well-crystallized, black spinels, pleonaste, in individuals up to ¾″ across. The crystals are sometimes aggregated into small groups, and are usually combinations of O, ∞O, mOm, while twins are not uncommon. The occurrence would seem to be connected with an intrusion of peridotite of later age than the pyroxenite. Plate XXXI shows the mode of occurrence of the mineral.

Steatite or Talc.

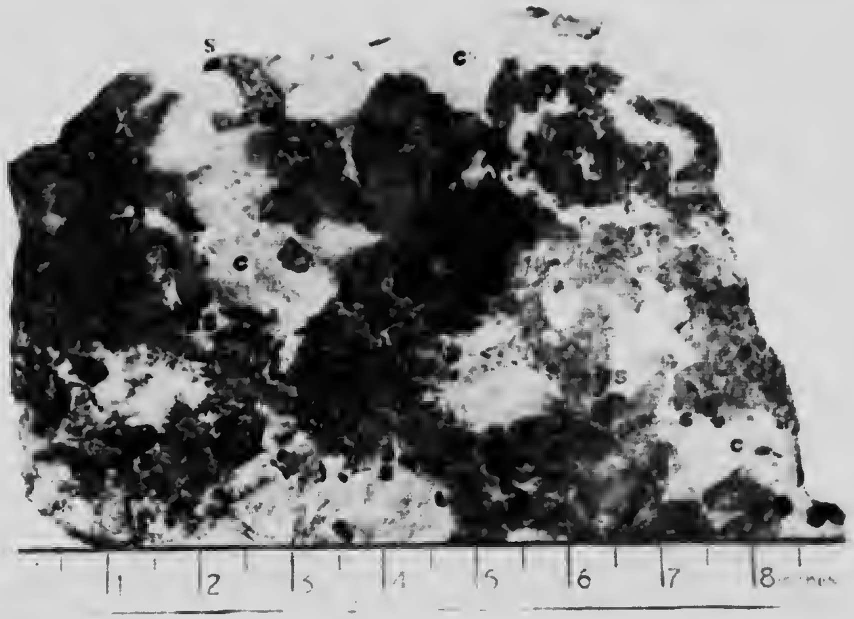
A soft, soapy mineral, of greenish-grey colour, and resembling talc, is frequently to be observed on joint planes in the dykes, and seems to be, in many cases, an alteration product of mica. True pseudomorphs of steatite after mica occur on range III, lot 51, of the township of Thorne, Que., and the latter mineral can often be observed passing into the former.

Titanite.

One of the accessory minerals most frequently to be observed in the pyroxenites. As a rule, titanite tends to occur most plentifully in the more acid portions of the dykes, associated with feldspar, and sometimes quartz. The almost universal occurrence in pyroxenite belts of acid zones consisting of a rock formed essentially of grey, blue, or brownish feldspar and titanite, was particularly observed by the writer. The crystals range from ¼″ to 1½″ in length, and are almost always of the typical, tabular, pyramidal habit assumed by this mineral. The colour is almost invariably a dark brown to black, and the crystals are usually more or less opaque.

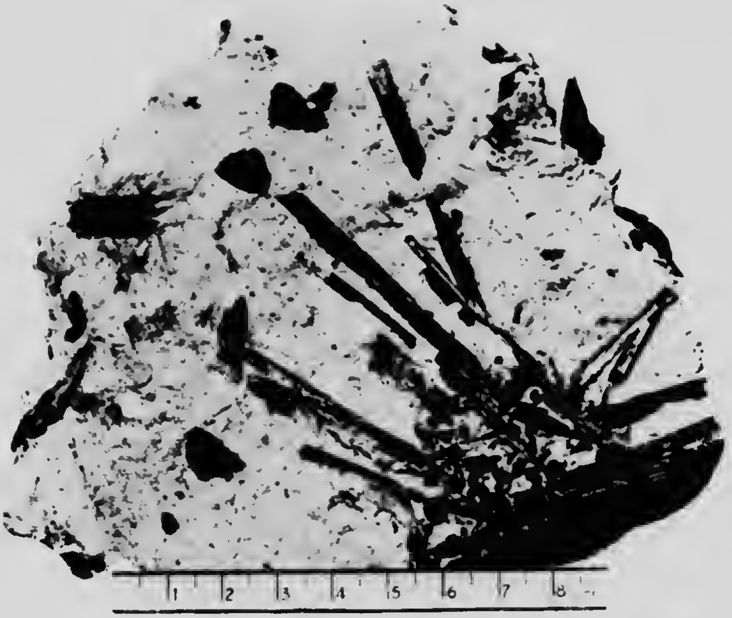
Titanite individuals are also sometimes found embedded in pyroxene, but this mode of occurrence is infrequent compared with the prevalent associ-

PLATE XXXI.



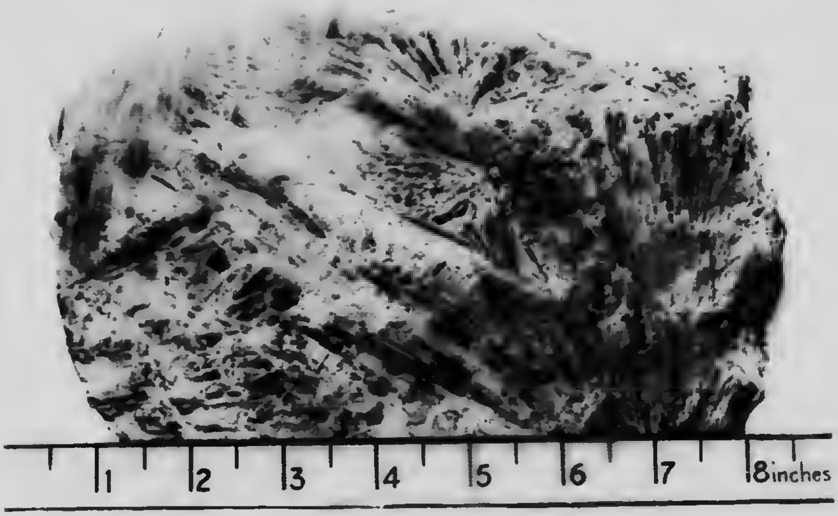
Spinel associated with calcite, olivine, and mica, from the Parker mine, lot 52, range V, township of Bigelow, Que. C, calcite; O, olivine; S, spinel; M, mica.

PLATE XXXII.



Tourmaline (schörl) penetrating albite and microcline, from the Villeneuve mine, lot 31, range I, township of Villeneuve, Que.

PLATE XXXIII.



Grey tremolite from lot 5, concession II, township of Bedford, Ont.

ation of the mineral with the more acid members of the dyke mass. Occasionally, also, titanite crystals are observed embedded in apatite or calcite. Rounded nodules of calcite, similar to those so often found in apatite, also occur enclosed in titanite. Large quantities of titanite crystals occur in a pink felsite cutting pyroxenite, on range XIII, lot 12a, of Hull, Que., and well-formed individuals possessing high lustre were observed on concession VII, lot 19, of Bedford, Ont.

Tourmaline.

Of frequent occurrence in pyroxenites, associated with apatite, pyroxene, pyrite, calcite, etc. The mineral is almost always referable to the variety schörl, or black tourmaline, and possesses either prismatic or rhombohedral habit. While sometimes apparently of primary origin and forming part of the pyroxenite proper, a quantity of the tourmaline found in the dykes is, no doubt, due to the acid intrusions which so frequently cut the pyroxenites. Schörl is an almost constant constituent of such acid dykes and has often been deposited in the adjoining pyroxenite, from pneumatolytic emanations. The pyroxenite has, in effect, been "tourmalinised." Large quantities of schörl, in prisms up to 18″ in length, occur in the pegmatite of the Villeneuve mine, Que. Green and pink tourmalines also occur at the Leduc mine, Wakefield township, in large quantities, associated with lepidolite, and have been mined as gem stones. Tourmaline occurs, also, somewhat plentifully on concession IV, lot 17, of Bedford, Ont., in the form of aggregates of small, flattened crystals of prismatic habit, also massive. Large masses of what is probably reddish-brown tourmaline occur associated with a yellowish mica on concession X, lot 1, of Loughborough, and on concession II, lot 5, of Bedford, Ont. The mineral is compact massive in form, with occasional small crystals developed throughout its mass, and fragments closely resemble vesuvianite in outward appearance.

Tremolite.

This variety of amphibole was occasionally observed as the result of an alteration of pyroxene. The most notable localities, however, and where the mineral occurs in large quantities, are on concession X, lot 1, of Loughborough, and concession II, lot 5, of Bedford, Ont. Here the contact-metamorphic action of an intrusive upon crystalline-limestone has resulted in the formation of large quantities of greyish-green tremolite, which occurs in aggregates of inter-penetrating, prismatic crystals adjacent to the intrusive contact. The prisms sometimes attain a length of 6″ or 8″. In addition, a quantity of brown, acicular tremolite occurs in compact masses in certain portions of the deposits. Plate XXXIII illustrates a mass of grey tremolite from concession II, lot 5, of Bedford. Greyish-white, fibrous tremolite occurs also on range II, lot 4, of Alleyn, Que., where it forms large masses in a normal pyroxenite dyke.

Vesuvianite.

Mentioned by Harrington as occurring with apatite in the township of Wakefield, Que. The occurrence seems doubtful, and is probably to be referred to the presence of considerable quantities of well-formed vesuvianite crystals, at various spots in the above township, in crystalline limestone, near intrusive dykes of pegmatite. The mineral at these spots is a contact-metamorphic product, due to the action of intrusive acid dykes upon the limestone.

Wilsonite.

This mineral was first observed by Dr. Wilson, of Perth, Ont., probably in a pyroxenite dyke. Its colour varies from white to a beautiful, peach-bloom pink, and, as far as the writer is aware, the mineral has only been met with in a more or less massive form, without definite crystal outlines. In character and appearance wilsonite resembles an altered scapolite, and it is very probable that it really is an alteration product of this mineral. Sterry Hunt, however, dissented from this view and considered it to be altered gieseckite. From the writer's own observations it appears that plagioclase frequently alters to scapolite, and that the latter mineral then undergoes a further change to wilsonite. No specimens showing all three stages were found, but the three minerals were on several occasions observed at one and the same mine. Wilsonite is mainly identifiable by means of its conspicuous pink colour, and the passage of scapolite to wilsonite is only to be remarked by the gradual change of shade of the mineral. No analysis of wilsonite is available, but it may be noted that Tschermak, Bauer, Naumann-Zirkel, Chapman, and others regard the mineral as an altered scapolite, whilst Dana considers it to be altered pinite. A notable locality for wilsonite is lot 39, of the Gore of Templeton, Que., where it occurs in large quantities, at the Briggs mine, generally in large, irregular masses surrounded by small, crushed, and very black mica, embedded in granular apatite. It was also observed on range III, lot 2, of East Portland; range VI, lot 26, of Wakefield, both in the Province of Quebec; and concession VIII, lot 2, of North Burgess, Ont.

Zircon.

The writer did not succeed in obtaining specimens of this mineral at any of the mines visited, but it is reported to occur in pyroxenites at various localities, amongst them being range XII, lots 12 and 21, range XIII, lots 21 and 23, of the township of Templeton, Que.

Harrington[1] records the occurrence of large crystals (up to 15" in length) from the above district. The habit is usually prismatic, a common combination being ∞ P.P. 3 P. 3P3, while the simple combination of prism

[1] Loc. cit. p. 29.

and pyramid z P.P. is also found. Distorted individuals are not infrequent. The colour ranges from hyacinth to cherry-red, brown, and greyish. The crystals are very brittle and full of flaws, and often contain inclusions of either apatite, calcite, or mica. They usually occur embedded in apatite, calcite, pyroxene, mica, or orthoclase, and in the first case the apatite is generally of the "sugar" variety.

CHAPTER IV.

COMMERCIAL USES, PREPARATION, AND PHYSICAL PROPERTIES OF MICA.

The natives of India and other countries where mica is found were accustomed to regard the mineral as endowed with the most extraordinary properties. Its dissimilarity to any other known mineral substance, and the peculiar mode of occurrence, have given rise to the most peculiar ideas concerning its origin. Hindu writers imagined the crystals to be the remains of lightning flashes, from which sparks had emanated and become preserved in the ground. Even now, the miners in the Indian mica districts regard the "books" as allied to a sort of fungus growth, a belief which is fostered by the discovery of surface crystals in ground eroded by the heavy rains. Quantities of the mineral have, from the earliest times, been employed for medicinal purposes, and even the most deadly diseases were supposed to yield to its healing powers.

A quantity of clear, large-sized sheets of muscovite, and some light-coloured phlogopite, is still consumed in the stove industry, it being used to form the fronts of oil and other stoves. Sheet mica is further used in spectacles, phonograph and gramophone diaphragms, fuse plugs, and electric light globes. Large sheets are also used, instead of glass, in workshops where glass would speedily be broken. The principal use of mica at the present day, however, is in the manufacture of dynamo-electric machinery. The enormous increase in the quantity of such machinery manufactured during recent years has led to the exploitation of mica deposits in all parts of the world. Many of the larger firms own and operate their own mines, besides buying up quantities of mica produced by private operators. All attempts to produce artificially a substance which will combine the insulating and incombustible properties of mica have so far failed, and the mineral seems likely to hold its place as an essential part of electrical machinery. The substance which has, up to the present, shown itself the most dangerous rival of mica for use in electrical machinery is a product obtained from separated milk, and known under various names, one of which is syrolit. A company has been formed to manufacture this substance on a commercial scale; but it yet remains to be proved that the artificial product can successfully supplant the natural mineral.

The ever-increasing output of electrical appliances calls for a proportionate increase in the supply of mica, and this has been partly met by the manufacture of micanite. This discovery enables large quantities of what was hitherto discarded as waste and valueless mica to be built up into an article which is found to perfectly answer the purpose which formerly demanded the utilization of large and expensive sheets, with the additional advantage over the natural mineral that it can be moulded and planed into any shape or form desired.

Great care is necessary in the mining of mica to avoid drilling through the crystals or shattering them by heavy charges of powder. The mineral thrown down by blasting undergoes a preliminary hand-sorting in situ. The selected material is then taken to the cobbing-shed, where the crystals are split and roughly cleaned of valueless mineral. Thence, the plates are sent to the trimming-shop, where they undergo a further cleaning and splitting, and from here only marketable and high grade sheets are allowed to emerge. Many mines possess their own trimming-shops, situated on the property, and ship only high-grade mineral. On the other hand, at a large number of mines, the mica is only roughly cobbed, and is shipped in that state to the trimming shops, which are often situated many miles away. Many operators do not possess trimming establishments of their own, but send the mineral in the rough to middlemen, who dress it for market. The sheets which proceed from the trimming-shops, or "culling-sheds" as they are also termed, are what are known as "thumb-trimmed," and represent the marketable product of the mines. The proportion of thumb-trimmed mineral to the run-of-mine brought to the cobbing-sheds ranges usually from 3 per cent to 10 per cent—the latter being exceedingly high; the average is around 5 per cent, and a mine yielding a higher percentage than this is an unusually rich producer.

Cobbing is carried out by means of a hammer and also sometimes of a stout knife. The rough crystals from the mine are dumped into large bins, whence they are taken as required and piled upon the cobbing benches. The latter are simply long tables, at which sit the cobbers, who clean away all the waste mineral and throw the cleaned sheets into boxes, which are then sent to the culling-sheds. The operators employed in the culling-sheds are usually girls, the work being comparatively light.

The sheets, which are sometimes several inches in thickness, are first broken, by means of a hammer, into plates some $\frac{1}{4}''$ thick. The edges of these plates are then hammered, in order to loosen the laminæ and soften the sides for the insertion of the splitting-knife. This is a double-edged implement with a V-point, and some 3″ long. The mica sheets are split into thicknesses of about $\frac{1}{16}''$, and their edges trimmed off, so that only clean plates, perfect to the edges, remain. All plates containing foreign mineral substance, such as calcite, apatite, etc., between their laminæ, are discarded, and only sheets which will split readily into fine layers are retained. The product from the culling-sheds is marketable mica, and can now be handled by the dealers, or shipped direct to the thin-splitting shops of the manufacturers of mica-board.

Thin-splitting, or the separation of laminæ having an approximate thinness of $\frac{1}{500}$ to $\frac{1}{1000}$ of an inch, is effected principally by hand. A number of devices and processes have been patented in recent years to supplant hand labour, these comprising methods by which a fluid is made to enter between the sheets, separation by superior adhesion, mechanical splitting by means of knives, and various other methods. A list and description of such devices will be found under the heading of patented processes for treating mica.

In spite of the efforts made to introduce mechanical splitting, hand separation is still practised in the majority of factories, and seems to be more satisfactory, a more uniform product being obtained than is possible by means of machines.

The thin-splitting shops represent the last destination of the mineral before it is made up into mica-board, and only the smaller sizes, measuring 1″×3″ and under, are sent here. The employés in these shops are almost entirely girls, and their work consists in splitting the product of the culling-sheds into fine layers of about 0·001″ to 0·002″ in thickness. This represents the extreme limit which can be practically attained by ordinary means, and is the thickness of the mica laminæ required by the makers of mica-board.

As remarked, only small-sized sheets are sent to the thin-splitting shops. The larger grades, that is, plates measuring over 1″×3″, are sent either to the manufacturers direct, or to middlemen, who trim and size the sheets into rectangular pieces of the dimensions specified by the consumers. These are then placed in packages of a certain number of sheets or of a certain weight, and can be employed without further preparation in the particular machinery for which they are intended. The various manufacturers require all sorts of sizes, and are particular that the shipments furnished them contain uniform grades, that is, that all the sheets in a package are of the same colour and quality.

A certain amount of large-sized mica is still consumed in the stove industry and for lamp chimneys, etc., but the variety usually employed for these purposes is the white mica, or muscovite, which has less tendency to burn or become 'puffy,' besides being more transparent. Most of the mica used for the above purposes is derived from India or the United States, the Canadian muscovite production being at the present time practically nil.

The tools required in the preparation of mica are of the simplest and most ordinary kind. A hammer, splitting-knives, scissors, and a guillotine-machine are about all the implements necessary to render the product of the mine marketable. Considerable care is, of course, required to ensure maximum-sized sheets being obtained, and the girls soon become skilled in extracting the largest amount of merchantable mica possible from the rough sheets. Many of the trimming shops employ a very large number of girls. The General Electric Company, in 1902, had as many as 300 hands at work in their shops at Ottawa, the greatest number of which were engaged in trimming the output of the various mines owned by the Company. The average production of thumb-trimmed mica per head per day of ten hours is about 40 to 45 pounds of medium-sized sheets. The average wage earned by trimming girls is from 65 to 75 cents per diem. The trimmed sheets are usually packed into barrels holding each some 250 to 300 pounds, and shipped to consumers.

A list of the more important trimming shops and factories will be found on pages 327-330.

For thin-splitting, the girls use a thin-bladed knife to split the sheets, which are first of all trimmed straight along one edge and then rubbed on a piece of sandpaper to loosen the laminæ and facilitate their separation, and a skilled worker can produce, on an average, about 5 pounds of 1″ × 2″ grade, or 10 pounds of 1″ × 3″ grade, per day of nine hours. The system adopted is usually piece-work, and the average price paid is about 15 cents per pound of split mica produced.

The invention of mica-board, or micanite as it is also termed, has rendered possible the utilization of great quantities of what was previously regarded as worthless mineral. Although the demand for the larger-sized sheets has suffered no diminution—the price obtained for this class of mica remaining as high as ever—a large amount of small-sized sheets is now handled by the trade. Formerly, anything under 2″ × 3″ was relegated to the dumps, and many persons have realized considerable sums by exploiting the waste heaps of old mica and phosphate properties. The tendency to avoid any unnecessary waste of the mineral is further exemplified in the treatment of scrap-mica in grinding mills, etc., and the utilization of the product for a large variety of purposes.

Grades of mica measuring 1″ × 3″ and 1″ × 2″ are now saleable, and a demand for even 1″ × 1″ sheets is springing up. The mica laminæ, split into thicknesses of a mil, or one-thousandth part of an inch, are cemented by means of shellac, and pressed into sheets as described in the following pages.

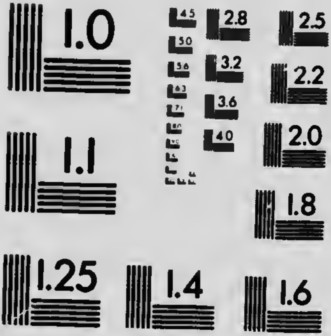
The mica factories, that is, the plants which are concerned with the preparation of the rough mineral as it comes from the mine, deal with two distinct classes of mica, viz., scrap mica and sheet mica. The factories themselves may be divided into two classes—those which deal solely with thumb-trimmed mica, and those which treat all grades of the mineral, including the rough waste from the culling of the sheets.

The latter class are usually owned and operated by the various mine-owners themselves, while the former generally belong to independent parties who buy up the trimmed mineral from the small mine-owners and manufacture it into various marketable articles, mica-board, etc. The most economical method is obviously for the mine-owner himself to operate his own factory and to manufacture products from the output of his own mine or mines, and this is the usual procedure with the larger operators.

The following notes on the preparation of mica in the factories of the United States are compiled from an article by Mr. R. F. Fitts, in the Mineral Industry for 1907, page 717, et seq:—

MICROCOPY RESOLUTION TEST CHART

(ANSI and ISO TEST CHART No. 2)



APPLIED IMAGE Inc
1653 East Main Street
Rochester, New York 14609 USA
(716) 482 - 0300 - Phone
(716) 288 - 5989 - Fax

"The mica enters the factory over a two-mesh screen, which removes all dirt and pieces too small to be handled. Screenings are sold for poultry grit and roofing material. Labour on the mica passing over this screen is performed by boys, girls, or women, and consists of separating the sheet from the scrap and removing any adhering rock from both. The scrap is run down a chute to a bin, ready for the grinder or pulverizer.

"*Sheet Mica.*—Sheet mica is separated into different classes, according to its various uses. The tools in this department consist of a thin-bladed knife (the blade of hardwood), an ordinary hammer, and a rasp fastened to the bench, on which the edge of the sheet is rubbed in order to spread the laminæ.

"Mica-washers and discs are made by a power punching press fitted with a compound die, cutting outside and centre hole at one operation. The washers and discs vary from $\frac{3}{8}''$ to 2″ diameter, and the centre holes in the washers from $\frac{1}{4}''$ to 1″. These are chiefly used in electric light sockets, sparking plugs, and for insulators on motors and switchboards. Sparking plugs for gasoline motors are made by pressing about 2″ of small washers tightly together and smoothing the edges by means of a lathe. Many washers are built up with a composition of shellac to any desired thickness, and then have the advantage of not being inclined to split readily. The best pieces of sheet mica are used for guards on rheostats and fuse boxes, and for stove and oven windows, automobile shields, etc.

"*Mica Plate or Micanite.*[1]—Thin pieces and irregular films are split to about 0·005″ in thickness and are then placed on a steam table and painted over with a preparation of shellac. Other layers are added and painted, until a plate is formed of the desired thickness, usually from $\frac{1}{16}''$ to $\frac{1}{2}''$. This plate is then submitted to hydraulic pressure varying from 100 to 200 tons. The press plates are heated by steam, to keep the mica plate warm throughout the operation. After being dry-baked in an oven or kiln, the plate is run through sand-paper rolls or millers. These rolls are adjustable, and grind the plates to a uniform thickness. The size of the mica plates ranges from 36″ square downwards. These large surfaces are then cut up into pieces of the desired dimensions by means of hand-saws, or if small, by dies or punching presses.

"The material is weighed before cutting, and charged to the consumer at so much per pound plus the labour charge for cutting. Commutator rings are another form of built-up mica. They are made in steam-heated moulds, pressure being applied by means of a threaded rod and burr. The sides of the ring are bevelled by the tapering of the mould.

"*Flexible Sheets.*—Mica cloth, mica paper, and flexible sheets are made by using a different adhesive, and are very pliable when warmed. Very thin

[1] The trade-name "micanite" was first applied to mica-board by its inventors and patentees, the Mica Insulator Company, of Schenectady, N.Y. The name, being patented, cannot properly be employed by other firms, though products identical in character are made by many manufacturers.

sheets of mica are laid on cloth or oiled paper, and treated the same as built up plates, only left much thinner. Rheostat, stove, and fuse-block mica is cut by hand on power-shears, and small sizes by a die on a power press.

"*Ground Mica.*—The pulverizing department of a factory often handles the waste material of many mines and trimming-shops. There are three practical ways of pulverizing mica, viz., (1) disintegration by heating, (2) abrasion with mill-stones or metal buhrs, and (3) baking at intense heat, followed by pulverizing by a blast of steam. The principle of the disintegrators used is broadly as follows, though many styles and modifications exist. A metal cylinder, lined with corrugated cast steel, contains a revolving shaft to which are attached metal beaters. This shaft rotates at a high rate of speed, generally from 2,000 to 3,000 revolutions per minute. The mica enters the cylinder either from the side or front, and is broken up and reduced to a powder, which either falls through a screen at the bottom or is drawn out by an exhaust blower running at a speed producing sufficient current to lift only such flakes as are of the desired mesh. These are deposited in a tank collector, which releases the air and retains the mica. Care must be taken in feeding these machines, as the pieces are very irregular in size and expand greatly after entering, often causing the cylinder to choke. Mill-stones are not much in use at the present time, inasmuch as they require water to wash out the material, making it difficult to dry. Baking and steam-blast pulverizing, being a new process, has not been tried extensively. The product treated by this process has a silvery hue, and is very much softer than that produced by the other methods. The mineral probably becomes hydrated to a certain extent during the operation.

"The mica leaves the pulverizer in a very mixed state, from 8-mesh to the finest powder, and it is necessary to separate this mixture into more uniform grades. The various grades are named from the size of the screen through which the mica passes, namely, 8, 10, 24, 40, 60, 80, 120, 160, and 200 mesh. To obtain these different grades, numerous screening and bolting processes are employed. The most practicable of these are the vibrating screens. Frames containing the different meshes are placed one above the other, with belt apron conveyers between, and set at an angle of from 15 to 30 degrees. The product is distributed over the top of the first screen by means of a spiral conveyer. That which passes over the first, or coarsest screen, returns to the pulverizer for further reduction, the throughs falling to the apron conveyer, which carries them to the next screen. The second screen separates all the finer grades and allows the first or coarsest grade to pass from the bottom into a hopper. The finer grades continue until the last screen is reached, each screen taking out the next coarser grade. The screens are vibrated by means of eccentrics and spring bumpers. A shaking box containing all the screens, one above the other, is another method of separation in use. The screens are made on frames, and laid in the box with blank frames between. The box is suspended horizontally by four spring rods at the corners. A short, projecting shaft, fitted into a socket on a horizontal, belt-driven eccentric, gives the box about a 3″ swing. Mica travels over the screen with the motion of the box, going down one side and back the other. About 4 ounces of locust seeds are used on each screen to keep the meshes clear, and to weight the mica as it travels back and forth. The mica passes through a coarse screen at the end, and the seeds continue round again. The end of the box is arranged with blank and open spaces, allowing the grades separated to pass into a spout, and the fines to fall on the next screen.

"Separation by means of air currents and of gravity has been tried, but does not appear to have met with success. The graded mica is packed in sacks or barrels."

The International Mica Company, of Gananoque, Ont., formerly produced considerable quantities of ground mica, but the works have been closed down for some years. The grinding process at the above factory is described as follows in Mr. Cirkel's report:—

"The mica is first roughly screened and then cleaned before entering the grinder, which is a sheet-iron cylinder 9 feet long by 30″ in diameter, punched in rows and set at an incline of $1\frac{1}{2}$″ in its length. As the machine slowly revolves, loose pieces of steel, enclosed in the cylinder, pulverize the mica until fine enough to drop through the holes which are $\frac{3}{16}$″ in diameter. It is then sized and graded in trommels, from flakes down to the finest powder, the finest screens being of silk. The plant is operated by water power on the Gananoque river."

Owing to the fact that mica possesses such perfect basal cleavage, and that the laminæ are smooth and tough, grinding is not such an easy matter as might be imagined from the softness of the mineral, and the process of disintegration is essentially one of tearing and battering rather than of mere crushing.

The greater number of plants engaged in the production of ground mica are situated in the United States, where large quantities of white-mica waste are produced annually at the mines and trimming shops, and utilized in the manufacture of mica-powder.

The following description of the grinding process employed at a large factory at Denver, Colorado, is taken from Bulletin 1, Vol. VII, 1909, of the Imperial Institute:—

"The mica comes to the factory in carloads just as it is taken from the mine. It is fed by boys into two machines which cut it into fragments about half-an-inch square. By a system of pneumatic tubes the mica so cut is delivered to the atomizing machines, which grind it into powder. Each machine consists of two steel shafts, 3 feet long, with a series of spirally arranged beaters of gun-metal, which revolve in a close case. These machines make from 5,000 to 7,000 revolutions per minute. The fingers on one shaft run between the fingers on the other, so that when the material is passed through the pneumatic tubes from the feeding machine to the atomizers at a velocity of 15,000 feet a minute, the work of atomizing is instantaneous.

"The mica, now reduced to minute particles, continues its course at the same velocity through another set of pneumatic tubes to the sizing bins. Here, the current is so retarded by a special mechanism that it causes the material to settle, according to its fineness, in the various compartments, of which there are six. Compartments containing the graded mica powder rest upon hoppers or bins immediately over the mixing pans. Into the latter the several grades of mica powder are drawn and, by means of mechanical mixers with which the pans are provided, treated with the proper percentage of oils and other ingredients.

"Directly over the hoppers are located the oil tanks, which supply the mixers by a pipe running down the outside of the hopper, at the end of which is a faucet.

"At one end of the bins is the 'dust arrester,' a cylindrical machine 4 feet in diameter and 10 feet high. Any of the material too light and fine to settle is driven into this machine by air currents, and is drawn off as needed. It is claimed for this concern that it can pulverize about 5 tons in a day of 10 hours, and that it turns out an excellent lubricant."

A somewhat different process is employed at a grinding mill in Mitchell county, North Carolina, the main features of which are as follow[1]:—

"Both steam and water power, or a combination of the two when the water supply is insufficient, are employed. The mica is first shaken thoroughly in rocker washing tubs, by which the dirt is removed. The grinding is accomplished by soft-wood beaters, through which large spikes are driven with the ends projecting on all sides. These beaters have an elliptical cross section, and are from 30″ to 36″ in diameter and from 6″ to 10″ thick. They revolve horizontally in large wooden tubs, and are so arranged that they can slip up and down vertically with their shaft when they become clogged in any position by an excess of mica. The tub is of suitable size for the beater to revolve in, and is from 30″ to 36″ high. The scrap mica is placed in the tub, with water, and the beater set in motion. As the latter revolves, the steel spikes beat and tear the mica. It requires about 12 hours to grind a charge, which often becomes steaming hot towards the end of the operation. Water is added as needed. From the grinding tubs the mica, now in the form of a mush, is washed into settling vats, where, after 8 to 12 hours, the water is decanted. The mica mush is then spread on cloth-covered drying tables, beneath the surface of which heat is supplied by steam pipes or in other ways. After 8 to 10 hours the mass has become dry, and is removed the tables on the cloth, in the form of cakes or lumps. The latter are crushed and beaten apart in disintegrators or pulverizers, and the ground material is sized off in hoppers or screens by bolting through silk sizing mesh.

[1] Mineral Resources of the United States, 1906; publication of the U.S. Geol. Survey.

A charge consists of from 100 to 500 pounds of scrap, according to the size of the grinder. From three-fourths to four-fifths of this is returned to the grinder from the sizing screens as over-size, and is ground with the next charge. The beaters are run at from 250 to 300 revolutions per minute. At one mill it was said that a larger percentage of 160 mesh ground mica was obtained than of any one of the other sizes separated—that is, 10, 60, 80, or 100 mesh, the sizes commonly separated at the mills. Different sizes, down to "bran mica", can be separated whenever ordered."

The prices quoted in the Bulletin mentioned are \$15 to \$75 per short ton for the ground product, according to quality, and \$10 to \$15 for scrap. The waste product of the trimming shops is preferred to the scrap obtained directly from the mines, being of greater purity than the latter.

In view of the enormous quantities of scrap mica produced by the Indian trimming shops, it is remarkable that little effort seems to have been made in that country to utilize this material for the manufacture of ground mica. Attention is drawn to this waste of scrap mica in India in the above Bulletin, and the reason assigned for it is partly ignorance on the part of the owners of the value of ground mica, and partly to the fact that methods of grinding are kept secret by the firms already engaged in the manufacture of pulverized mineral. If suitable machinery could be procured, there is small doubt that the Indian mine-owners would find the utilization of their scrap mica a source of considerable revenue.

Uses of Ground Mica.—Pulverized mica is used for a variety of purposes, one of the oldest and chiefest of which is to impart a lustre to wall-paper. Only the finer grades (160 to 200 mesh) are employed for this purpose, while the mica used as an adulterant of rubber, in paints, oils, and axle grease, is similarly very finely ground. The coarser grades are chiefly used for pipe-coverings, insulating compounds, and, mixed with certain non-flammable cement, such as agar-agar, for fireproof coverings. More recently, large quantities have been used on patent roofing materials, in order to prevent the surface sticking when rolled up, and as a protective covering. The coarsest grades are used for this purpose. Mica, being a non-conductor of electricity, is now used with hard rubber for telephone receivers and the like; while, mixed with shellac or similar substance it finds employment in insulators for wires carrying high-potential currents. As a lubricant, pulverized mica is much in demand. Being to a large extent frictionless, and even the finest grades having capillary attraction, the flakes hold the oil or grease to the bearings. In addition, the flakes adhere to both parts of the bearings and receive a large amount of the wear. Mixed with a heavy oil, mica will preserve the rubber packing of boiler manholes.

Experiments with powdered mica for use in fireproof paints are being made, and some very good paints have been produced. Mica flakes, sprinkled on the faces of ornamental tiles before firing, add a very bright finish. There are many minor uses for this material, but, at present, the producer looks to the above-mentioned for his chief market.

The ground product fetches from \$20 to \$30 per ton, according to fineness, while the scrap mica can be bought for about \$5 per ton. These figures are for amber-mica. White-mica fetches rather higher prices, ranging from \$36 to \$46 per ton, for 40 and 200 mesh respectively. Scrap white-mica costs about \$8 per ton. The above prices are for the product at the factory.

The use of ground mica for moulds was patented by G. H. Brabook, of Taunton, Mass., in 1901. In the construction of the moulds, one part of finely-ground mineral is mixed to a thin paste with water and added to three parts of plaster of Paris. When thoroughly incorporated, the mixture is cast on a pattern of the mould desired, and dried at a temperature of 250°-300° F., for from 10 to 12 hours. The temperature is then raised to 1,000° F. for from 2 to 3 hours, and the moulds are then slowly cooled. Such moulds are said to be particularly adapted for small, sharp castings, or for articles of large surface but little thickness. According to latest advice from Messrs. Reed and Barton, of Taunton, Mass., who experimented with ground mica in moulds some ten years ago, the advantages claimed were not borne out by results, and the idea of employing mica for such purpose has been abandoned.

The advantages of ground mica as an absorbent of nitro-glycerine in the manufacture of certain mica-powders has been recognized, the final product being to a certain extent elastic, and not so likely to explode from accidental concussion as dynamite, while possessing all the essential qualities of the latter. Powdered mica is also used to some extent in calico printing.

In Canada, the largest mica-grinding factory is that at Papineauville, Que., owned by Messrs. O'Brien and Fowler, and grinding is also carried on to a small extent by the Dominion Mica Works, of Ottawa, and by the Canada Mica Manufacturing Company, of Hull, Que.

Scrap Mica.

The use of scrap-mica for covering steam pipes, boilers, etc., was first introduced by Mr. H. C. Micheil, of Toronto, in 1894, and a company was formed, with the title of the Mica Boiler Covering Company, Ltd., to manufacture covering material having mica as its basis. The tests of the covering produced gave most satisfactory results, and an annually increasing output was recorded for some years. Later, the headquarters of the Company were removed to Montreal; but in spite of the admitted superiority of the material over other insulating mediums, the demand seems to have become gradually less, and the firm eventually closed their factory. The Canadian Pacific railway conducted tests of the material supplied by the above Company, in 1895, and the results appear to have been most satisfactory. Boiling water was introduced into an iron tank covered with a 1½" mica cover, and at the end of the seventh hour the temperature of the water was found to be 181°.

The method of manufacture of the covering was as follows: blocks and fragments of scrap mica were first passed through a series of corrugating rolls, which loosened the laminae; these were finally separated from each other by air currents, after which the sheets were again put through a process which corrugated them singly. They were then laid between light galvanized wire netting, made into wads of a suitable thickness, and stitched with wire on a special machine. The flexible web of mica was covered with canvas stiffened at the back with mill-board, and rounded into the desired shape. The covering, when finished, was fastened on the pipe by firmly lacing the edges together. An average of one ton scrap mica per diem was used, costing \$5 per ton at the mine or culling factory, or \$7.50 delivered in Toronto. Both amber- and white-mica were employed, but the former was preferred owing to its greater flexibility. The Company sold \$10,000 worth of covering in 1897, and used 110 tons of mica.[1]

The superior insulating properties of mica boiler-lagging are due not so much to the non-conductive properties possessed by the mica as to the presence of numerous air-spaces in the interstices of the lagging. It has been found that, supposing 100 to represent the loss by condensation in a bare steam pipe, the loss in the same pipe covered with a mica jacket equals only 12, that is, a saving of 88 per cent is effected.

Sheet Mica.

If mica is to be employed between the copper segments of dynamo-electric machinery, it is essential that a soft variety of the mineral be used, in order to ensure that the copper and mica wear down evenly. If hard, brittle kinds are used, the uneven wear of the two substances tends to impair the efficiency of the machine. As a general rule, high-grade, Indian white-mica is preferred for use in commutators, its softness causing even wear on both mica and copper, while its purity and uniformity of quality make it best to be relied upon. Amber-mica is also used extensively for the same purpose, especially in Canada, being softer even than the Indian product but inferior to it, by reason, not of its slight iron content (Ontario mica ranges around 0·5 per cent of iron oxides), but of the greater difficulty in the inspection for grosser impurities along the cleavage planes, and also of its lesser resistance to heat. Amber-mica, and electrical mica generally, should possess a degree of flexibility which will allow of a plate 0·01″ thick being bent to a curvature of about 3″ diameter without cracking. In addition, the mineral must be smooth, free from cracks, and must split readily. Dark, spotted mica, and that known as "smoky" mica, are not suitable for electrical purposes. Another important consideration is that the mineral shall withstand high temperatures without crumbling or burning.

The adaptability of mica as an insulating medium for use in dynamo-electric machinery, notably in the form of plates between the copper segments of commutators, is essentially dependent upon its dielectric strength, that is,

[1] See Ann. Rep. Ont. Bur. Mines, V, 1895.

its power to resist stress caused by induction across it, as measured by the difference of potential necessary to break through it [illegible] disruptive discharge. This resisting power is by no means constant and vari[illegible]atly in the different varieties of mica, and even in micas of the same type but from different localities. Softness and resilience are also two desired qualities in electrical mica, and samples of mineral which combine these two properties with high dielectric strength are naturally the most sought after by manufacturers. Tests of various samples of mica from the principal deposits of the world have been carried out by Messrs. E. and W. H. Wilson and T. Mitchell, and the results of their experiments have been published.[1] The following accounts of the investigations conducted are taken from the publication mentioned. The results of further tests upon mica, carried out by the German Geological Survey, will be found on pages 46 to 50.

THE DIELECTRIC STRENGTH OF CERTAIN SPECIMENS OF MICA.

By Ernest Wilson and W. H. Wilson.

"The method of test was to place each sheet between two circular bronze electrodes, each 1″ diameter and $\frac{1}{16}$″ thick, and to raise the difference of potential between them, by aid of an alternate-current transformer, until the specimen broke down. The frequency was 55, and the P. D. was raised by increasing the exciting current of the alternate-current generator. Each test was completed as rapidly as possible, but in the case of the micas having the higher dielectric strength (for example, some of the Bengal micas) there was slight local heating, due to the electric discharge at the edge of the discs consequent upon the increased density of the electric force produced there by the presence of the mica. In some cases, as many as eight or nine specimens of one kind of mica were broken down.

"The P. D. in volts per centimetre of the thickness was plotted in terms of the thickness, and a mean curve drawn through the points. From these curves the figures given in the accompanying table have been obtained. [illegible]es only have we figures obtained from sheets about 1 mm. thick, [illegible] to be of much larger size to render the tests possible. These [illegible]re Nos. 14, 15, and 3, placing them in the order of their dielectric [illegible], and, as these micas are most in use for electrical purposes, the curves are plotted in the accompanying diagram. The inference is that at about 1 mm. thickness the total dielectric strength of mica between 1″ discs becomes approximately proportional to its thickness. The ruby micas are largely used for condensers. The amber (Canadian) and green (Madras) micas are largely employed for insulation purposes generally.

"It is noteworthy that those micas which have the highest dielectric strength when thin are not necessarily the best when thicker layers are

[1] "The Electrician," Vol. LIV, p. 356.

No. of Specimen	Description and place where found	Maximum volts in 10^6, required to puncture.			
		Thickness in millimetres.			
		0·1	0·2	0·3	1
1	Madras, brown, spotted ..	1·6	1·2	0·9	.
2	" green, " A	1·3	1·1	0·9	.
3	" " " B	1·0	0·75	0·5	0·27
4	" " " C .	1·3	1·1	0·91	
5	" " stained ..	1·6	1·2	0·95	
6	" ruby, much stained	1·9	1·3	1·0	
7	" green, clear, B ...	1·7	1·2	0·95	
8	" " " C ..	1·7	1·2	0·90	
9	" " " D .	2·0	1·3	0·8	
10	Bengal, spotted	1·1	0·6	0·2	
11	" ruby, much stained	1·6	1·4	1·2	
12	" white ..	2·5	1·3	0·4	
13	" yellow ..	2·1	1·1	0·9	
14	" ruby, clear .	2·1	1·1	0·9	0·72
15	Canada, amber	1·5	1·1	0·8	0·5
16	South America, spotted ..	1·0	0·6	0·4	.
17	" " ruby, clear	2·1	1·4	0·9	

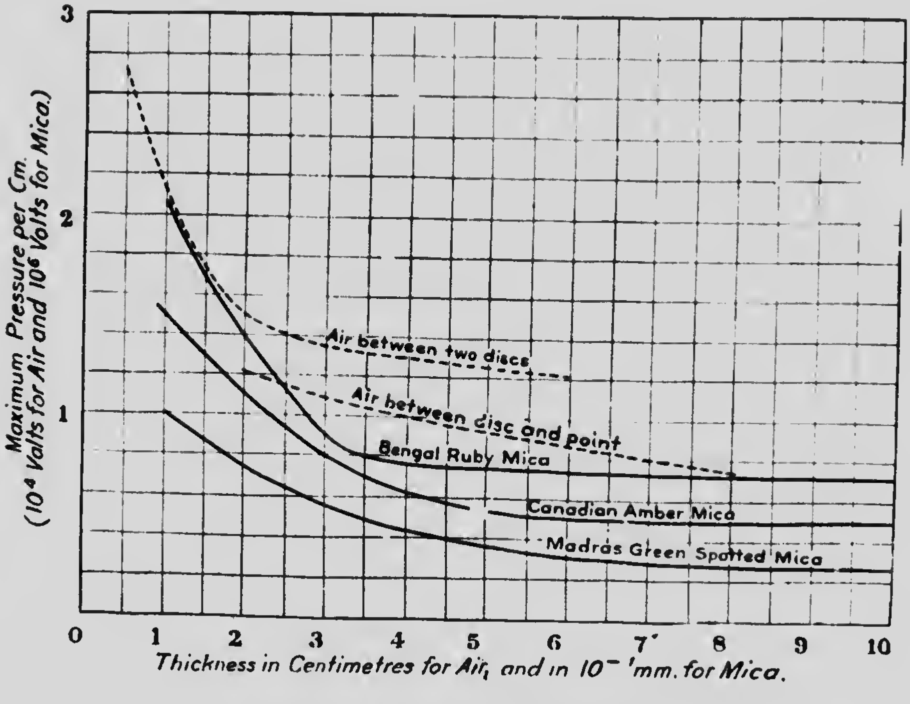


Fig. 62 —Diagram showing the dielectric strength of certain micas

compared. The time taken to break down most of the sheets varied from ½ minute to 1 minute, but in the case of the ruby mica, when 1 mm thick, its temperature would have been raised unfairly high, on account of excessive sparking, if we had broken it down with 1" discs. A blunt point, having an angle of 25 degrees on a rod ½" diameter, was used instead of one of the circular electrodes. In all other cases the circular electrodes were used, and in no case was the temperature more than one could bear by placing the hand on the specimen.

"In order to get a comparison between the dielectric strength of air and these micas, we show two dotted curves in the diagram. The upper one gives the strength of air between the discs which were used with the micas. The lower one gives the strength when one of the discs was replaced by the blunt point used for breaking down specimen No. 14 when it was 1 mm. thick. The difference between the strength of air of a given thickness in the two cases hardly justifies us in plotting the point obtained with specimen No. 14, when it was 1 mm. thick, on the same curve with those obtained when it was thin. The strength of this mica between the 1" discs would probably have been greater than $0 \cdot 72 \times 10^6$ volts per centimetre, but the sheet was not large enough to break down with sufficient rapidity to keep down its temperature. We chose discs for the tests, as they more nearly represent engineering practice; but, with flat mica sheets of moderate size, a difficulty is naturally encountered by the different conductivities for electric flow in the insulator and the surrounding air, producing electric discharge through the air.

"It must not be inferred, from the above experiments, that the *specific* dielectric strength of an insulator is a variable dependent upon its thickness. The P. D. required to puncture a given specimen, when surrounded by air, is a function of the shape, relative size, distance apart, and the nature of the electrodes. The following experiment is interesting in this connexion. Suppose two sheets of ruby mica (No. 14), each 0·07 mm. thick, be placed side by side between two circular disc electrodes, each 1" diameter. It will be found that the P. D. required to puncture these sheets in a given time is less than when two sheets of the same kind of mica, each 0·05 mm. thick, have placed between them a sheet of tinfoil of larger area than the electrodes, the total distance between the electrodes being the same as before. An examination of the brush discharge shows the greater area of the tinfoil accounts for this, [illegible]e it reduces the density of the electric force at the edge of the discs. This i[illegible]ased density at points along the edge of the discs suggests that the slots in which high-tension coils are embedded should be rounded off at the ends, or special shields used there to relieve it. In special cases an intermediate sheet might prove beneficial."

DIELECTRIC STRENGTH, CAPACITY, AND RESISTANCE OF CERTAIN SPECIMENS OF MICA.

Ernest Wilson and T. Mitchell.

"The dielectric strengths of certain specimens of mica have already been published, and Messrs. F. Wiggins and Sons have supplied one of us with another series of the same kinds of mica, of suitable area and thickness for the determination of the specific inductive capacities and specific resistances. The areas vary from 24" × 18" in the largest, to 9" × 9" in the smallest specimens, and the thicknesses are set forth in the table. The method of test for capacity was to clamp the specimen between the plates of a guard-ring condenser, and to compare the capacity so found with the capacity of the condenser in air. The frequency was due to the vibration of a weighted, Rhumkorff-coil hammer and was of the order 20 periods per second. There are slight indications that high dielectric strength might be associated with low specific inductive capacity.

"The specific resistances were obtained by gumming two sheets of tinfoil, each 81 mm. diameter, opposite one another on either side of the specimen, and measuring the resistance between them by the ordinary deflections method. There is some evidence to show that high dielectric strength may accompany high specific resistance.

No. of Specimen.	Description, and place where found.	Dielectric strength experiments. Maximum volts per cm. in 10^6				Capacity and resistance experiments at 9° C.		
	Thickness in mm.	0·1	0·2	0·3	1	Thickness in mm.	Spec. inductive capacity	Sp. resis. in 10^{12} ohms per cub. cm.
1	Madras, brown, spotted	1·6	1·2	0·9		2·77	2·5	22·0
	" brown, very slightly spotted					1·93	3·1	67·0
2	" green, spotted, A	1·3	1·1	0·9		2·1	1·8	16·0
3	" " " B	1·0	0·75	0·5	0·27	1·7	5·1	15·0
4	" " " C	1·3	1·1	0·91	...	1·13	3·9	91·0
5	" " stained	1·6	1·2	0·95		1·3	5·5	25·0
6	" ruby, much stained	1·9	1·3	1·0		2·4	1·1	55·0
7	" clear, green, B	1·7	1·2	0·95		1·73	1·1	133·0
8	" " " C	1·7	1·2	0·9	..	1·61	4·5	81·0
9	" " " D	2·0	1·3	0·8	..	1·8	3·9	125·0
10	Bengal, spotted	1·1	0·6	0·2	...	2·01	4·3	45·0
11	" ruby, much stained	1·6	1·1	1·2	...	2·5	4·7	20·0
12	" white	2·5	1·3	0·4	...	1·4	4·2	7·0
13	" yellow	2·1	1·4	0·9		1·1	2·8	80·0
14	" ruby, clear	2·[illegible]	[illegible]	0·9	0·72	1·9	4·2	118·0
15	Canadian, amber A	1·[illegible]	1	0·8	0·5	2·1	2·9	3·4
	" " B			....		5·0	3·0	0·41
	" " C	....		..		1·4	2·9	22·0
16	South American, spotted	1·0	0·6	0·4	....	1·22	5·9	39·0
17	" " ruby, clear	2·1	1·4	0·9	....	.....	.....	......

The following is a list of the various processes and methods of treating mica, for its use in electrical and other appliances, which have been patented between 1900 and 1910, in Canada, the United States, and Great Britain. Several of the devices enumerated have been patented in all three countries. In spite, however, of repeated efforts to introduce mechanical methods of splitting mica and otherwise treating the mineral in order to render it suitable for special purposes, the greater portion of the mica used in the trade is still prepared entirely by hand, as described in the preceding pages.

CANADIAN PATENTS.

Canadian Patent No. 71919, 1901.—Relates to a process devised by R. W. Heard and R. A. Snyder, of Pittsburgh, Pa., for the separation of the laminæ of mica crystals. The method is to heat the sheets in a furnace and then to immerse them in water. The heating, it is claimed, expands the laminæ, and the sudden cooling causes the liquid to permeate between them. The process, being repeated a number of times, results finally in a complete separation. An improvement is effected if the sheets, when still charged with the liquid, are passed between rollers so as to cause the liquid to spread. The rubbing action produced by rotating the rollers in opposite directions causes the laminæ to slip along each other, and effects a very fine subdivision.

Canadian Patent No. 71950, 1901.—A process devised by R. W. Heard and R. A. Snyder, of Pittsburgh, Pa., for the building up of mica-board. The method adopted is to apply a coating of shellac to a suitable surface (in this process, the periphery of a drum), mica sheets being then spread over this, and pressed on. The shellac is applied by means of rollers revolving against the drum, and the mica flakes are spread over the moistened surface by means of an air current. Each thickness of mica is transferred, as formed, to a second drum, whose surface bears yieldingly against the first and whose diameter is proportional to the size of the sheet to be formed. The adhesion of the mica sheet to the first drum may be destroyed by heat, or, better still, by providing a cloth or paper foundation on which to build up the plate. The resulting plate is removed from the drum by cutting through it along a line parallel to the long axis of the latter.

Canadian Patent No. 75968, 1902.—Relates to a similar process for separating the laminæ of mica crystals as described under Can. Patent 71919, 1901, namely, to heat the mica in a furnace and then to plunge it into water.

The patentee is W. C. Kent, of Kingston.

Canadian Patent No. 119,055, 1909.—A mica-splitting machine, devised by C. A. Guertin, of Ottawa, and having as its object the splitting of sheets from a crystal in a regular manner, the sheets to be all of equal thinness. The main principles of the invention are as follow: a wooden surface (a) has a circular opening cut in it of some 2 feet diameter. In this opening is set on a vertical axis (b) a revolving circular disc (c), slightly smaller than the opening. This disc is known as the knife disc, and is provided with spear-shaped knives (d) let into its surface. The points of the knives are set in the direction of

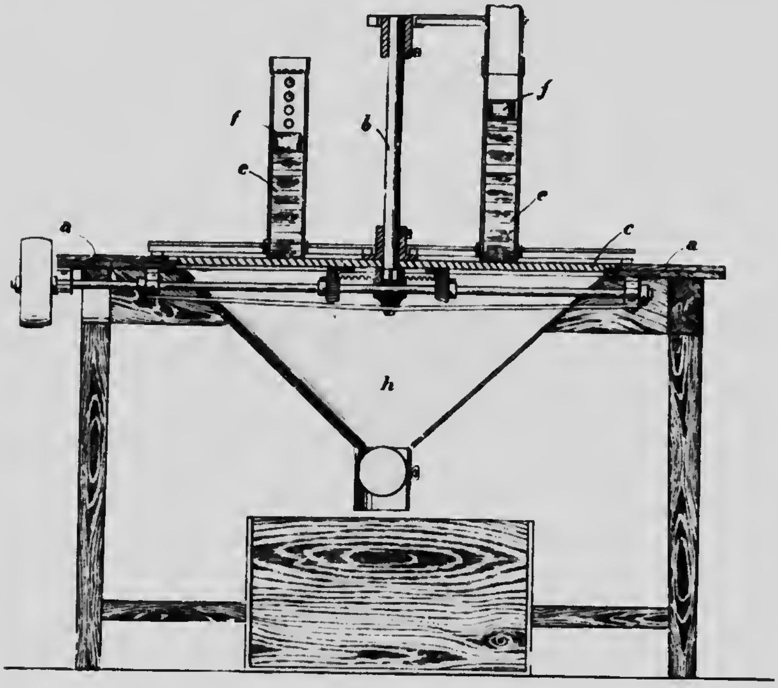


Fig. 1

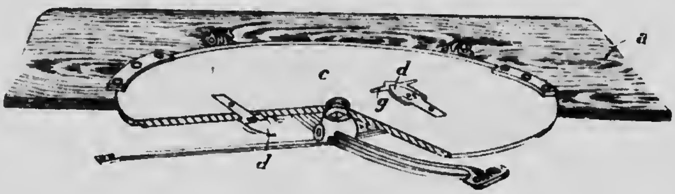


Fig. 3

Fig. 63.—Mica splitting machine—Guertin.

revolution, and can be raised or lowered, according to the thickness of the mica splittings required. Above the revolving surface, and on the circumference of a circle described by the knives in revolution, is situated the magazine (e) containing the roughly trimmed mica-sheets. This magazine is provided at the bottom with a slide, which can be closed or withdrawn at will, to open or interrupt the supply of mica to the knives. When filled, a weight (f) is placed upon the upper surface of the plates to ensure constant pressure. On the disc being set in motion, the point of the first knife impinges upon the lowest mica sheet, splitting off a film of the thickness determined by the elevation of the point above the surface of the disc. This film drops through a radial slit (g) beneath the knife into a hopper or similar receptacle (h), and the contact of the next knife point splits off another film from the plate. The number of knives is optional, and can be increased proportionately to the diameter of the disc. The side of the magazine farthest from the approach direction of the knife is in contact with the disc, in order to hold the lowest mica plate securely, and is recessed to allow the passage of the knife-point.

Canadian Patent No. 127,128, 1910.—Device for the thin-splitting of mica, invented by F. Lilienthal and G. Lauer, of Cologne, Germany. The principle of the invention consists in attaching bodies to the two faces of a sheet of mica, in such a manner that the cohesion between the faces and the said bodies is greater than that existing between the individual mica layers. Thus, by moving the bodies away from one another, the mica sheet is split apart. The attachment of the bodies to the mica faces is effected by adhesive material or by suction. The thickness of the resulting sheets can, it is claimed, be determined by nicking the sheet at the required place, prior to moving the bodies apart. When suction is employed to separate the laminæ, the principle adopted is to have a number of rolls in contact with one another, these being provided with circumferential suction places co-operating in pairs at their points of contact, and revolving in opposite directions. The plates split by the first pair of rolls pass to the second pair and proceed through the entire system, becoming thinner as they progress. Classification of the various thicknesses is effected by means of air currents or by bending tests. The latter act on the principle that, the thinner the sheets, the more easily they will bend, and, in a curved position, are variously affected by suction applied to their surfaces, the adhesive power of the suction being proportional to the radius of curvature.

UNITED STATES PATENTS.

United States Patent No. 677,775, 1901.—Mica-splitting machine, devised by I. de Kaiser and C. W. Hadfield. The principle of the machine is to hold the block of mica upon a rotating table (a) by means of suction actuating upon the lower surface of the block through perforations (b) in the table. Stationary knives (c) are placed upon supports (d) around the rotating table, and as the mica blocks pass the knives, a device cuts off the suction current and a thin flake is separated from the bottom of the block, which slides over the knife and is again made to adhere by suction to the table.

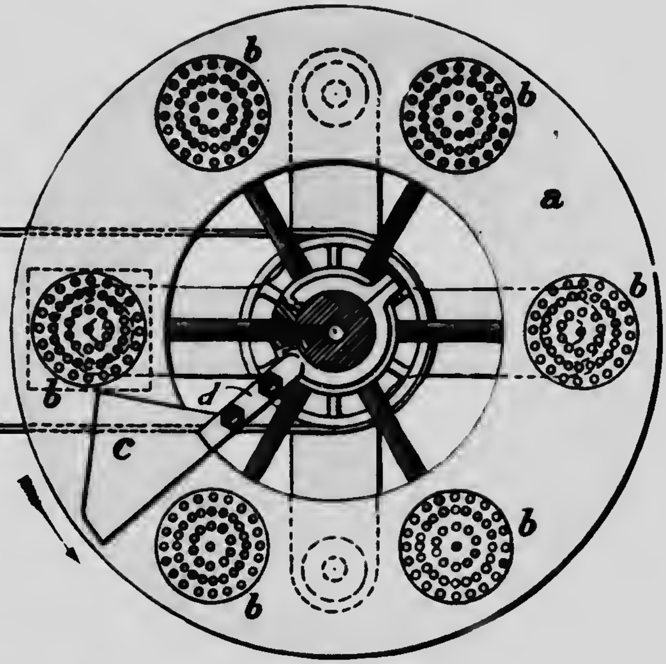


Fig. 1

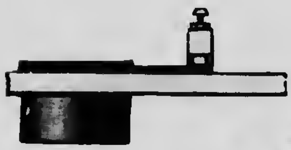


Fig. 3

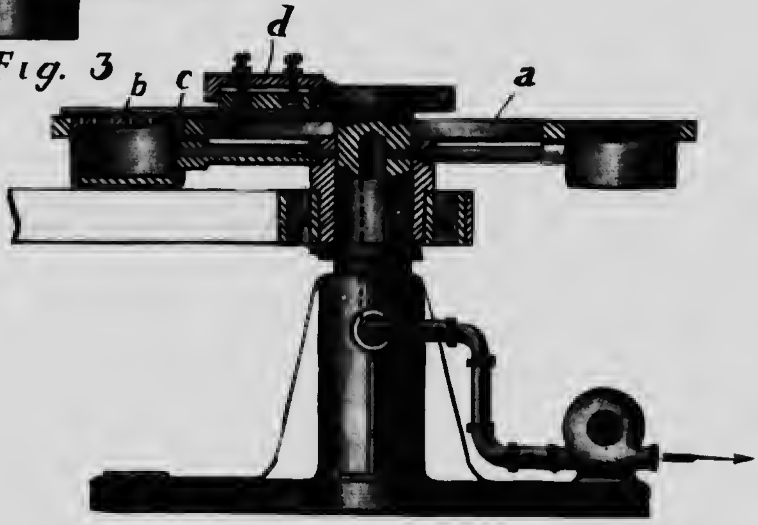


Fig. 2

Fig. 64.—Mica splitting machine.—Hadfield de Kaiser.

Modifications of the above process provide for a stationary table and revolving knife; or for a knife and table moving counter and parallel to one another; also for the removal of a film of mica from the upper surface of the block, instead of from the lower.

United States Patent No. 697,696, 1902.—Machine for making mica board, invented by H. F. Watson, of Valparaiso, Ind. The object of this somewhat involved machine is to supplant hand labour in the building up of mica-board. The mica is automatically fed to a conveyer, and is either sprayed with, or has applied to it by hand, an adhesive medium, such as shellac. The sheet is then passed between rollers and delivered to a table, where it is cut up into the desired sizes. The thin sheets are subsequently compressed into the desired thickness with the aid of steam heat.

United States Patents Nos. 764,810 and 764,811, 1904.—Method and means, devised by C. W. Jefferson, of Schenectady, N.Y., for treating mica flakes to render them tougher and in a condition to be united without the addition of any other material or substance. The above might be taken to indicate that mica flakes were to be made to adhere to one another by simple cohesion, without the addition of any adhesive medium. This, however, is not the case. The toughening substance itself forms the uniting medium. Briefly, the process consists in coating the surfaces of the mica flakes with shellac or similar adhesive material. The application of the shellac to the flakes can be made in one or two ways. In the first method described, the flakes are placed by an operator upon a conveyer, which passes beneath a bin, from which powdered shellac is allowed to pass. The flakes then pass over gas burners, which heat and melt the shellac upon the mica—thus providing it with an adhesive coating upon its upper surface. After passing from over the burner, the shellac coating cools and dries, and the flakes can then be handled by the sorters and removed from the conveyer.

The second method is to apply the adhesive in liquid form. In this case, the solvent for the adhesive medium is required to possess the property of evaporating with heat. The flakes pass, on a conveyer, beneath a jet which sprays them with shellac or similar substance. On passing over the gas burners, the solvent evaporates, and the flakes are then coated with a dry film of adhesive material. All that is necessary to unite the mica flakes into plate-form is, in the case of the mica prepared in the manner first described, to heat the flakes under pressure; and, in the second instance, to immerse them in a solvent for the cement, and subject them to pressure while wet, subsequently drying the resulting plate in an oven or kiln.

United States Patent No. 783,438, 1905.—Relates to a machine for cutting micanite, or mica-board, invented by E. G. Kastenhuber, of Schenectady, N.Y. The invention enables irregular shapes to be cut from large sheets of micanite.

United States Patent No. 832,494, 1906.—Relates to a process for 'flaking' mica (that is, for separating the laminæ of sheets and crystals of mica by mechanical means), invented by H. C. Michell, of London. The mica sheets are first thoroughly dried in a kiln and then elevated to a platform, from which they fall down an inclined chute and pass, by gravity, between a pair of rolls furnished with corrugated surfaces which fit loosely into one another. The mica plates, on passing through these rolls, are subjected to a bending action, whereby the edges of the laminæ become more or less loosened and separated from each other. Any number of sets of rolls required may be employed, according to the quality of the mica. The loosened plates are then again elevated and allowed to fall flatwise into the 'flaking chamber.' In this chamber, the plates are caught by a blast of air, which completes the separation of the laminæ. The air current is provided by a rotary blower, providing air at a pressure of about half a pound to the square inch. The air current carries the flaked mica into a chamber provided with bins. The heavier, and only partly separated, sheets fall into the bins nearest the flaking chamber, while the lighter flakes are carried to the bins farthest away from it.

United States Patent No. 833,401, 1906.—A process devised by B. G. Levis, Friedenau, Germany, for building composite mica plate. The chief feature of the invention consists of a carrier (a), upon which the thinly-split mica flakes (b) are placed in a heap. This carrier passes backwards and forwards beneath a suction-funnel (c) closed by a perforated plate (d) and connected with an aspirating apparatus (e). In the one terminal position of the carrier, in which the receptacle containing the mica flakes comes under the suction-funnel, a layer of mica flakes is aspirated against the perforated plate. As soon, however, as the receptacle has passed to its other terminal position and the funnel is shut off from the aspiration mechanism and connected with the outer air, the layer of mica falls upon a support placed upon the carrier. Over the layer is passed, either mechanically or by hand, a roller coated with cement. On the return of the carrier, a second layer of mica flakes is deposited upon the first, and the building-up process goes on until the requisite thickness is attained.

United States Patent No. 845,450, 1907.—A process invented by P. Dobler, of Munich, Germany, to reduce mica to a fine powder. The main point of the invention consists in heating the mica. The scrap mineral is placed in a drum, where it is kept at a white heat for several hours. This heating renders the mica opaque. After cooling, the mineral is cut into narrow strips and placed in a closed chamber into which steam is admitted. It is claimed that this heating and steaming render the mica soft and pliable and allow it to be more easily ground or crushed in the ordinary type of mill. As mica is a soft mineral in its natural state, it is difficult to appreciate the necessity of treating it in the above manner in order to reduce it to powder.

United States Patent No. 847,910, 1907.—This patent relates to a process for making mica-board, and has for its object the saving of labour in the operation. Thin-split mica is placed in a basket made of screen wire having

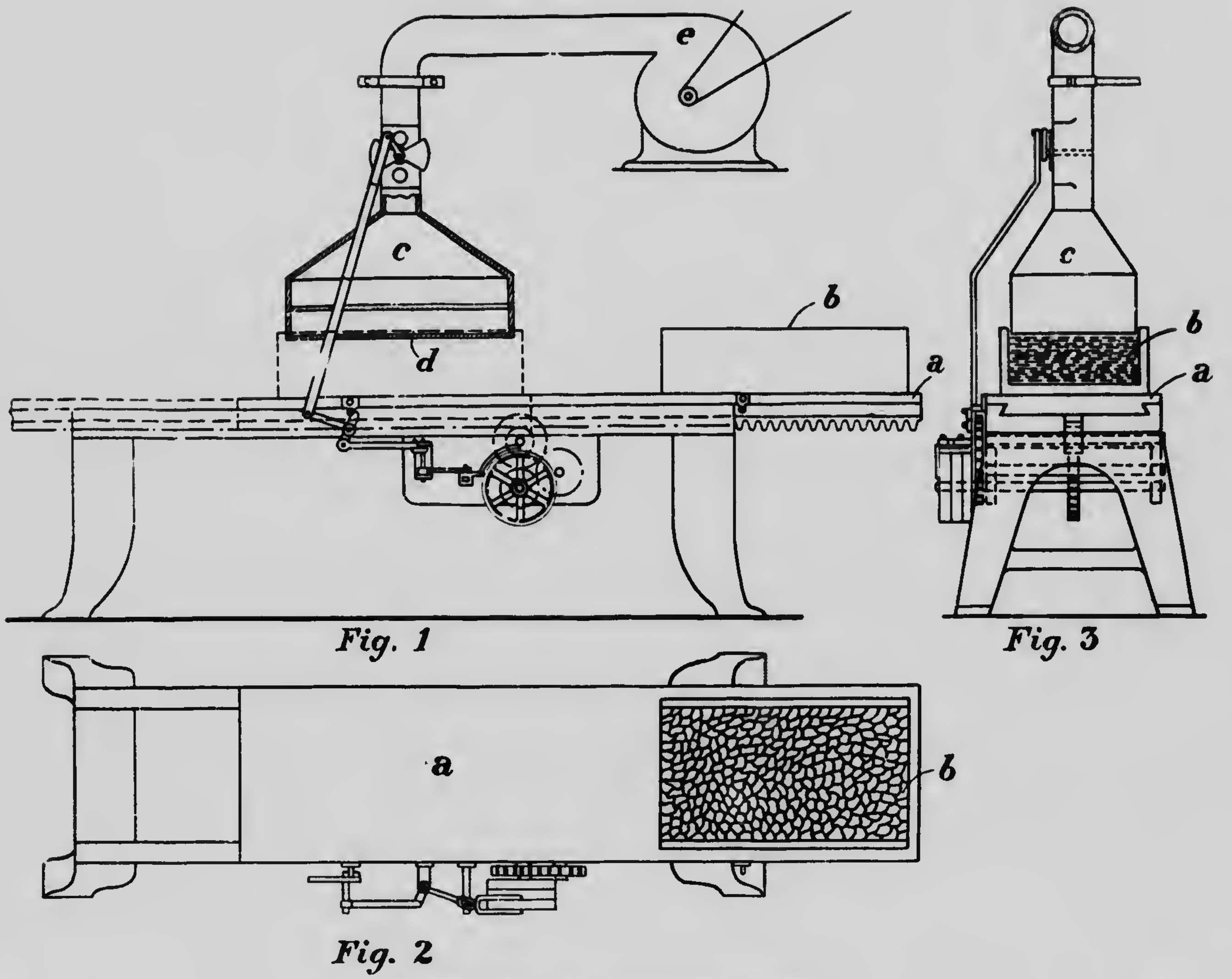


Fig. 65.—Mica plate building machine—Levis.

a mesh sufficiently open to permit the passage of a liquid cement, but fine enough to prevent the mica from dropping out. The basket containing the mica flakes is then immersed in a tank containing copal varnish or shellac, and the plates thoroughly coated with the cement. The basket is then removed from the tank and elevated, to allow surplus liquid to run off. The scales are then removed from the basket and arranged on a wire screen, without separating the individual flakes from one another. The next layer is placed over the spaces between the flakes of the first, and the screen is then tilted to permit light to shine through and reveal the weak places, which can thus be reinforced by the worker with additional flakes. The idea of using a basket obviates the use of a brush to wet each individual flake and allows several pieces to be used at once. The inventor claims a saving of labour of over 60 per cent by this process.

United States Patent No. 890,500, 1907.—Edward Cooper, of Newton, Mass., has devised a machine for folding sheets of mica for insulating covers, more especially for the cores of electric meters and for the linings of commutators. The various points of the machine are too involved to be described in detail, but the main feature of the invention consists of mechanism by which the blank is securely clamped to a holder from which the ends project on two opposite sides. This holder is then moved downward between two folding-blocks, which are engaged by the projecting portions of the blank on either side, thereby bending the oppositely projecting side of the blank along the side lines where intended to be folded. Means are also provided whereby the folding members are successively moved inward, to first fold over one side of the blank upon the former, and then to fold the other side of the blank down upon the first folded flap.

United States Patent No. 885, 934, 1908.—Relates to a method of making artificial mica, invented by I. J. Machaiske, of Niagara, N.Y. The inventor claims that the products obtained by his process have all the valuable properties of the natural micas, with the additional advantages of being free from iron-stained inclusions and other imperfections. The method adopted is to smelt a suitable charge in an electric furnace, avoiding reduction of the constituents by contact with carbon. The charge may be varied to obtain micas of different character and constitution. An electric furnace of the induction type is used, the secondary being formed of a metal which is not injurious to the product and, preferably, of a metal entering into its composition. Appropriate metals for the purpose are aluminium, magnesium, silicon, or, in the case of iron-mica, iron. Instead of an induction furnace, any type of electric furnace may be used having electrodes of a metal which is not injurious to the product, silicon for preference. For the charge, all materials entering into the composition of the product (with the exception of the caustic alkalies) are smelted together, and to the molten mass KOH or NaOH is added and dissolved. The mass is then discharged from the furnace and permitted to cool in an atmosphere charged with moisture. The water entering into the constitution of the product is derived from the alkali metal hydrate and from the water vapour contained in the atmosphere.

The charges employed by the patentee were as follows:—

Example 1. 45·5 parts *pure* (?) sea sand.
12·0 " bauxite.
30·5 " burned magnesia.

14 parts of 90 per cent caustic potash being added to the melted charge, which was cooled in an atmosphere containing water vapour. A mica having the following composition was produced:—

SiO_2	Al_2O_3	MgO	K_2O	H_2O	Total
44·2	10·8	29·4	9·9	5·7	100·0

The current employed was 1500 to 3000 amperes, at 30 to 60 volts.

Example 2. 46·5 parts *pure* (?) white sand.
40·0 " bauxite.

with the addition of 16·5 parts of 90 per cent caustic potash. The charge was melted in an electric furnace with silicon electrodes and cooled in a moist atmosphere. The mica obtained possessed the following composition:

SiO_2	Al_2O_3	K_2O	H_2O	Total
45·2	38·5	11·8	4·5	100·0

No mention is made of the size of the crystals obtained and the process hardly appears to be of commercial importance. It will be noted that both the above compositions are quite unlike that of any known natural mica.

United States Patent No. 888,197, 1908.—A machine devised by E. G. Shepherd, of Ottawa, for rapidly cutting or trimming the edges of pieces of mica, and automatically removing the waste. The object of this trimmer is to avoid, as much as possible, accidental contact with the knives, and an accumulation of waste. The main portion of the machine is enclosed in a fan-case (a), and the mica sheets are subjected to the action of the rotary knives (b) by being inserted through narrow slits (c) in the casing. Rapid trimming is also a feature of the device, which is operated by a belt or gearing.

These machines have to some extent supplanted the old-fashioned guillotine-knife, and a number are in use in the various trimming-shops in Ottawa. The following is a complete description of the machine:—

Upon a base plate A, are two standards x, preferably cast integrally therewith, the tops of which are formed into bearings x^1 having vertical bolting lugs x^2, cast solid therewith in one piece and afterwards slotted and held together by bolts x^3.

The front of the base plate is formed with a vertical plate A^1, also preferably cast integrally therewith and having its upper edge rabbeted on the inside to receive a knife blade B, held in position by screws or bolts B^1.

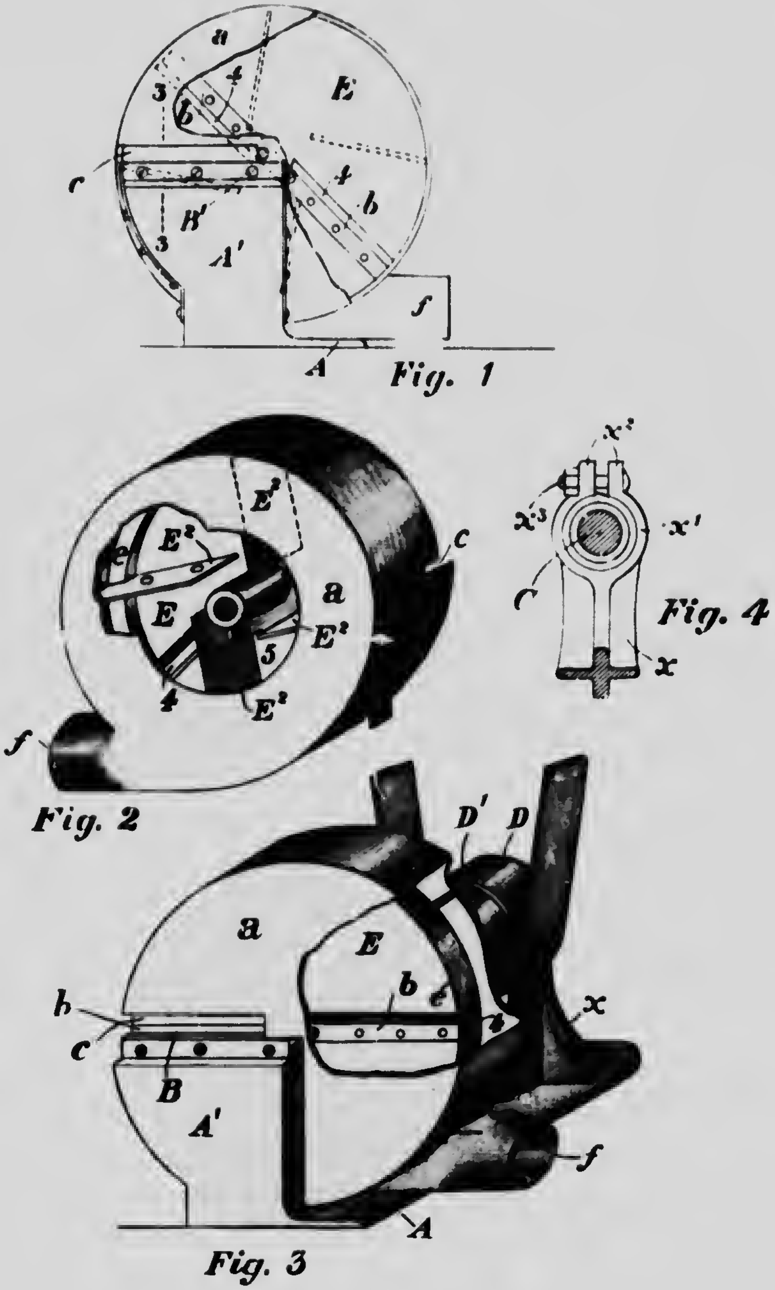


Fig. 66.—Mica trimming machine—Shepherd.

In the bearings is journaled a shaft C, carrying a fast and loose pully DD[1], between said bearings, and having mounted at the end a disc E. The disc E presents a flat face, and is formed with a rim e, to act as a fly-wheel. A wide and shallow groove 3 extends across its face, through the centre, to form a seat for a knife b, bolted into it slightly on the slant, so that the cutting edge projects a little. Coincident with the cutting edge is a slot 4 in the web of the disc, its lips bevelled so as to be flaring towards the interior, and allowing the waste cuttings to pass freely. The interior of the disc is fitted with vanes E^2, projecting beyond the rim in width and short towards the centre, to form a fan blower for ejecting the waste. The stationary knife B is set on the support A^1 with a slight bevel, so that the cutting edge projects towards the disc E about level with its centre.

The disc E is completely surrounded by a cover a, formed in the shape of a fan casing, with an intake 5 near the hub of the disc and a discharge chute f below; at t, at one end, a slit c being made in it opposite the cutting edge of the stationery knife, for the insertion of the mica plate. It is made wider than the thickness of the disc-rim e calls for, the vane E^2 extending into the wider part; the discharge f is formed in the latter part. It may be secured to the stationary knife support (which, as shown, acts as part of the cover) or o any other convenient stationary part.

The cover a, while forming a protection against accidental contact with the rotary knives, also forms part of a device for removing the waste, thus preventing accumulation within the machine and keeping the atmosphere of the room in a more healthy condition.

United States Patent No. 901,130, 1908.—A machine for splitting mica, invented by B. Walelmer, New York. The object of the invention is to split mica blocks into films of sufficient thinness to be used in the manufacture of mica-board. The machine consists of a horizontal table, to which reciprocating motion is imparted; a spiitting knife, located on the said table, and capable of being oscillated, and a clamp, or similar device, for holding the block of mica in line with the axis of the knife. An air-blast removes the sheets split off the block, which is released for the purpose. Any number of knives may be employed, according to the size of the table. The mica-blocks are first roughly trimmed, and then fixed in position with their basal planes parallel to the surface of the table. The backward and forward motion of the table brings the blocks constantly under the action of the splitting knife, above which is arranged a nozzle to supply the air blast for removal of the split-off film.

The drawback of this, and similar mechanical splitting machines, lies in the fact that the films of mica produced are seldom of sufficient thinness for the purposes for which they are required.

United States Patent No. 903,949, 1908.— A method of treating hard, brittle mica, in order to render it flexible, devised by L. P. Beckman, of Parnassus, Pa. This rather extraordinary process consists of immersing sheets of mica in molten metal, preferably aluminium, for a period of about an hour. It is claimed, as a result of this treatment, that mica sheets of $\frac{1}{32}''$ thickness can be folded flat without breaking. No comment is made upon the subsequent suitability of the mica for electrical and other purposes.

United States Patent No. 934,057, 1909.—A machine devised for making mica plates and the like, by E. L. Elwell, of Newton, Mass. The object of this device is to supplant hard labour in the cementing of thin-splittings to form mica-board. The main idea of the invention is to mechanically separate the laminæ from dust and other foreign substance, and to arrange them in layers upon an inclined bed. This bed is then vibrated, the motion causing the laminæ to slide on to a carrier, which deposits them upon a moving bed, where shellac cement is applied to them, a thick, firm sheet being obtained.

British Patent No. 10,919, 1905.—A process of calcining mica under pressure, devised by M. Meirowsky, of Cologne, Germany, in order to soften the mineral for use between commutator segments. The plates of mica are pressed between two suitable plates placed in a calcining furnace.

British Patent No. 12,570, 1908.—Relates to an improved process for producing ground mica from scrap. The inventor's plan is to grind the mineral, while saturated with a liquid of anti-lubricating character (preferably a solution of alum), in a mill of usual type. The alum solution is either removed by washing, or allowed to evaporate when the final product is dried, in order to further improve its non-flammable character.

In addition to the above devices, a patent was secured, in 1901, by Moses Judah, of Calcutta, for the employment of mica sheets in sun hats; also in the roofs of carriages, etc. A further use, to which the patent applied, was that of employing mica to build up cooling receptacles for food, drinks, etc.

MICA TRIMMING FACTORIES.

The principal mica-trimming factories are located in Ottawa and the adjoining town of Hull, which are centrally situated between the Quebec and Ontario mica fields and provide an adequate supply of labour. About 95 per cent of the employes in the factories are girls, the work being light, and the necessary skill readily acquired. The majority of the mica-shops are engaged in producing either thumb-trimmed mineral or thin-splittings, which are then shipped to the United States or Great Britain, to be used in the manufacture of electrical appliances, etc. A few of the larger factories work up the mineral into mica-board. In addition to the hands actually employed in the factories, a large number of girls are engaged in splitting mica in their own homes. The thumb-trimmed mineral is supplied to them by weight, and the girls receive so much per pound for the thin-split sheets, the price paid ranging from 14 to 20 cents. The amount of labour employed in the mica-trimming industry is subject to very wide variations. At certain periods, the factories are unable to obtain all the hands they require, while at others only a dozen or so girls will be kept on.

Ottawa.

Blackburn Bros., 202, Creighton Street. An average number of 30 girls are employed in thumb-trimming and thin-splitting. The shops are capable of accommodating about 150 hands. No machinery is in use. The mica consumed is derived principally from the firm's own mines in Templeton township, Que.

Canada Mica Works (Pritchard, Devlin, and Holland), 54 George Street. About 15 hands are employed solely in thumb-trimming.

Dominion Mica Works (R. Macdonald), 534 Wellington Street. An average staff of 35 girls are engaged in trimming and thin-splitting, building mica-board, preparing sheet mica for stove and lamp purposes, making flexible mica-cloth, etc. No machinery, other than mica-board presses, is used in the manufacture of the above. The scrap from the trimming tables, etc., is ground in a small knife-mill, grades of powder ranging from 60 to 200 mesh being produced.

Eugene Munsell Company, 400 Wellington Street. About 30 girls are employed in the shops of the above Company, and are engaged solely in trimming and thin-splitting. Shepherd trimming-machines (Canadian Patent No. 888,197) are in use, and also trimming-knives of the guillotine type, all these machines being power-driven. There are, in addition, several stamp-presses for punching out angle segments. The prepared mica is shipped to the Company's factories in the United States, where it is worked up into mica-board and fittings for electrical appliances.

Fillion, S. O., 345 Sparks Street. Has a few hands employed in trimming and splitting mica, but is chiefly engaged in handling the output of small mines, and also Indian mica, for re-shipment.

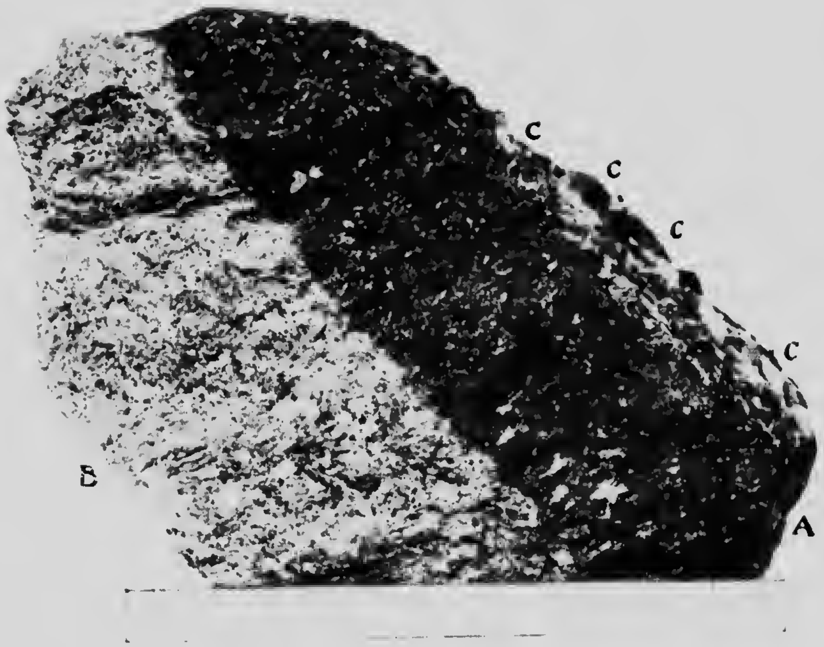
Foxton, F., Waller and Besserer Streets. A small number (7 or 8) of girls are employed in thumb-trimming.

Laurentide Mica Company (Westinghouse Company), Queen and Bridge Streets. The Company employs, on an average, 150 hands, chiefly girls, who are employed in thin-splitting and making mica-board. The output of the Company's mines in Hull township, Que., is trimmed in Hull, where some 20 hands are employed in the shops on Main Street, and is thence sent to the Ottawa factory to be worked up. Factories are, in addition, established at Aylmer, Que., and Rockland and Carleton Place, Ont., the two former being engaged in producing thin-splittings and mica-board, while the latter produces thin-splittings only. The manufactured product is mostly shipped to the Company's works at Pittsburgh, Pa.

Loughborough Mining Company (General Electric Company), Rochester and Albert Streets.

This Company operates a large factory, capable of employing some 300 hands. An average staff of 200 girls are engaged here in trimming and thin-splitting the product of the Company's mines, and further factories are located in Hawkesbury, Buckingham, and Masson. The latter employ an

PLATE XXXIV.



Contact of pyroxenite with syenite, showing wall of mica lead with crystals of phlogopite, from lot 13, concession VI, township of North Burgess, Ont.

PLATE XXXV.

Rock composed of small spangle phlogopite (dark) and blue apatite (light), Gould Lake mine, lot 6, concession X, township of Loughborough, Ont. The rock has a decidedly foliated structure.

PLATE XXXVI.

Typical mode of occurrence of phlogopite mica. The dark coloured mica crystals are plainly seen scattered through pink calcite and small spangle mica. Martha mine, lot 13, concession VI, township of North Burgess, Ont.

PLATE XXXVII.

Plate of muscovite showing inclusions of iron oxides arranged parallel to the lines of the percussion figure, Villeneuve mine, lot 31, range I, township of Villeneuve, Que. One-sixteenth natural size.

PLATE XXXVIII.

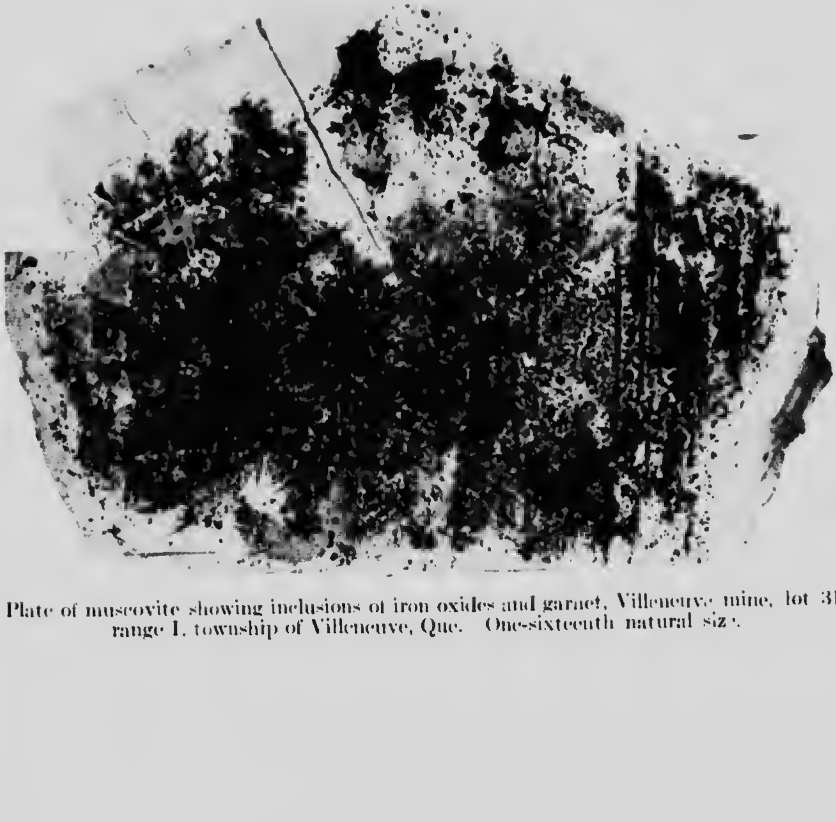


Plate of muscovite showing inclusions of iron oxides and garnet, Villeneuve mine, lot 31, range I, township of Villeneuve, Que. One-sixteenth natural size.

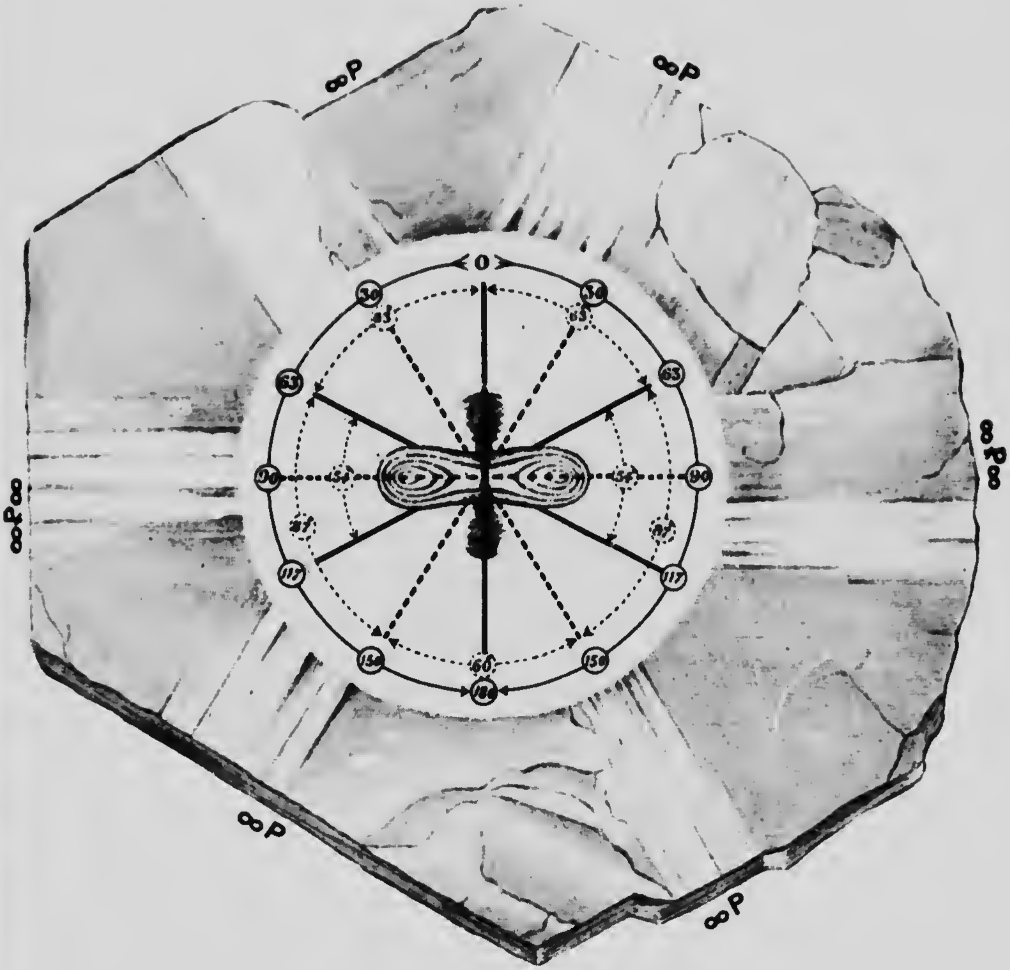


Fig. 67—Section of muscovite crystal showing the symmetrical disposition of the optic axial plane, percussion figure, and natural pressure figure.
(*After Holland, "Mica Deposits of India."*)
(Specimen from Turpunpandla, Nellore district—natural size.)

average total of about 125-150 hands. In the Ottawa works, to which the output of the Sydenham mine is shipped in the rough, the mica is cleaned, trimmed, and thin-split, being then shipped to Schenectady, U. S., to be manufactured into micanite, etc., and consumed in the various electrical apparatus manufactured by the General Electric Company. All splitting is done by hand, the only machines in use being Shepherd trimmers.

O'Brien and Fowler, Cummings Bridge.

About a dozen hands are employed in the manufacture of mica-board, washers, tubes, etc. The works are as yet only in a preparatory stage, and it is proposed to install larger and heavier machinery. The entire output of the firm's mines is thumb-trimmed either at the mines themselves or in their vicinity, and shipped as trimmed mineral to Ottawa.

A grinding plant is also operated by the above firm at Papineauville, Que. The mill was put into operation late in 1909, and has been working steadily ever since. Some 35 to 40 hands are employed, and the output averages about two tons of finished product per diem: 25 per cent of which is 200 mesh, and 75 per cent 60–160 mesh. Practically the entire production is shipped to the United States.

Webster & Co., 27½ Stewart Street.

An average staff of 50 girls are employed both in thumb-trimming and thin-splitting. The cleaned mineral is shipped to Boston, Mass., to be manufactured into mica-board, etc.

Hull.

Canada Mica Manufacturing Company, Ltd., 81 Brewery Street.

This concern is of recent formation, and has acquired the mines and business of several minor operators. The factory is not yet fully equipped and is mainly engaged, at present, in handling dump mica. An average of 100 hands are employed in trimming and thin-splitting, and a dry-grinding mill is in operation. This mill is of the ball-mill type, and consists of a steel cylinder, into which the mica is automatically fed. In place of balls, angular pieces of steel are employed to crush the mica, which falls, when finely-ground, through holes in the periphery of the cylinder. The powder is then elevated to a series of sieves, which grade it into various finenesses, ranging from 60 to 200 mesh. A wet-grinding mill also is in process of installation, and it is intended to equip the factory with the machinery necessary for the manufacture of mica-board and other mica products.

Flynn, H., 108 Brewery Street.

About 20 girls are employed in trimming the product of the mines operated by Mr. Flynn. No machinery is in use, and the mica is all shipped in the thumb-trimmed state.

In addition to the foregoing, *Messrs. Kent Bros., of Brock Street, Kingston, Ont.*, run a mica-trimming establishment, and employ an average number of 30 hands [illegible] chiefly engaged in culling, thumb-trimming, and thin-splitting [illegible] f the firm's mines. Washers, rings, segments, plugs, etc., are al[illegible] manufactured. The output of the factory is shipped principally to Great [illegible] l the United States.

A number of small trimming-shops exist at various spots throughout the mica districts of Ontario and Quebec, but are operated only intermittently, by small mine owners and dealers.

PART III.

A.

ABSTRACT FROM THE MINING LAWS OF THE PROVINCE OF QUEBEC.[1]

ACT OF 1892, 55-56 VICT., CP. 20 WITH AMENDMENTS.

Remarks Respecting Licenses and Mining Concessions.

Aliens as well as British subjects may enjoy the benefits of the present law (1422).[2]

The Minister of Mines grants prospecting and mining licenses, or simply sells the land and mining rights appertaining to the Crown.

With the exception of alienations under the authority of previous laws, these rights are distributed and situated as follows.

1st On lands conceded since the 24 July, 1880, in the townships and in the territories not yet conceded, all the mines belong to the Crown (1423).

2nd On lands conceded before the 24 July, 1880, in the townships, the gold and silver mines only remain the property of the Crown (1425 and 1426).

3rd In the seigniories all the mines belong to the Crown, with the exception of the seigniories where the mining rights have been conceded to the seigniors at the same time as the surface rights.

The seigniories in which the mining rights no longer belong to the government are the following, with certain reservations, however (royalty), for the first four: Beauport and Beaupré in the county of Quebec, Lauzon in the county of Levis; the Island of Orleans in the county of Montmorency; Verbois, le Parc, and Rivière du Loup, in the county of Témiscouata; Terrebonne, in the county of the same name; and la Petite Nation, in the county of Ottawa. These seigniories, with the exception of Terrebonne and La Petite Nation bordering respectively on the river Jésus and the river Ottawa, front on the river St. Lawrence.

On the Laprairie Common, the mining rights have been equally relinquished to the Jesuits by the act. 51-52 Vict., ch. 13.

In the Seigniory of Rigaud-Vaudreuil, gold and silver *and other precious metals* only, belong to the seigniors (concession title of 1846.)

Prospecting Licenses (1453 and following)—No prospecting licenses shall be granted to the same person for more than twenty-five square miles altogether in unsurveyed territories, or thirty lots of 100 acres in surveyed territories, within a radius of one hundred miles.

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[1] Containing the amendments of May 29, 1909.

[2] The bracketed figures refer to the articles of the law.

The fee for a prospecting license is $5.00 for each square mile of unsurveyed land; $5.00 for a lot of 100 acres if the surveyed land still belongs to the Crown, and $2.00 for a lot on private lands, every area less than 100 acres to count as 100 acres.

The prospecting license is valid for three months and may be renewed. At the expiration of the three months it lapses without further notice, and the holder has no claim in connection with the work he may have done. He shall make a report of his operations, stating mineral discoveries, or other results obtained (1455).

Whilst the prospecting license is in force, the holder has the exclusive right to purchase whatever mine he may discover, under the conditions established in articles 1436, 1443 and 1456. After exercising this right to the extent of the 400 acres, the license shall be void for the surplus territory therein designated (1456).

When another person makes an application to purchase the same territory or to take a mining license, the holder of the prospecting license must buy it or take the mining license himself, or give up his place at the expiration of the prospecting license.

Mining Licenses (1458 and following)—Mining is prohibited without a license. Such license may be obtained on private lands or on public lands (1460). It is granted for one year at a rental of $1.00 an acre and a fee of $10.00. It cannot be granted for an area exceeding 200 acres. It may be renewed at the end of the year (1461).

Applications for a prospecting and mining license must be accompanied by the price and fee above mentioned, and contain as accurate a description as possible of the land required; indicate the lots and ranges in the townships and seigniories, and a special description, illustrated with a sketch if necessary, in case of unsurveyed land.

Mining Concessions (1436 and following)—The application for mining concessions must also be accompanied by the price as indicated under repealed article 1444. As regards the description it should be accurate and be based on a plan of survey (1439, 1443 and 1456).

Superior and Inferior Metals.—See article 1421, note 11.

Transfers (1442)—The mining concessions, prospecting and mining licenses may be transferred by the holder to a third person, providing a copy of the deed of transfer is filed in the Department and the payment of the fee of $10.00.

Prospecting licenses so transferred are renewable wholly or in part, under ordinary conditions, in the name of the assignee, if he does not already hold a license covering an area of 25 square miles or 30 lots of 100 acres, according to article 1453.

Agents.—The government has no agent authorized to grant licenses or to concede any mining rights (recorders). All business is transacted directly with the Department of Colonization, Mines and Fisheries, Quebec.

Remittances.—If money is remitted by cheques, they must be payable at par at Quebec.

SECTION IX.

MINES.

DECLARATORY AND INTERPRETATIVE.

"**1421.** In this section which may be styled "the Quebec Mining Law," as well as in all orders in council or regulations promulgated in virtue thereof, the following expressions, unless the context or subject-matter otherwise requires, shall have the following meanings:—

1. The words "to mine" and "mining" mean any mode or method of working whatsoever, whereby the soil or earth, or any rock or stone may be disturbed, removed, carted, carried, washed, sifted, smelted, refined, crushed, or otherwise dealt with, for the purpose of obtaining any minerals;

2. The words "mines" and "minerals" mean and include all quarries of stone of whatever kind, and all stones or rocks, earth or soil, whether alluvial or not, in which are found gold, silver, copper, phosphate of lime, asbestos, or any mineral substance having an appreciable value;

3. The words "mining division" mean any tract of country erected into a "mining division" under this law;

4. The words "public lands" or "Crown Lands" mean all Crown Lands or Ordnance Lands transferred to the Province, Clergy lands or lands of the Jesuits' Estates, Crown Domain or Seigniory of Lauzon, which have not been alienated by the Crown;

5. The words "private lands" mean all lands conceded or otherwise alienated by the [illegible] other than mining concessions or lands conceded by the Crown as suc[illegible]h shall be hereafter conceded;

6. The words "[illegible]e person" mean any person who possessed a lot of land, as proprietor or usufructuary, upon which mines or minerals exist or are supposed to exist;

7. The words "mining license," mean a license granted to any person, firm or company to work a mine situated on a designated territory, on paying the rent fixed by law;

8. The words "miner's certificate," mean the authorization granted to any prospector to prospect for mines generally on all lands on which the mining rights belong to the Crown and to stake out claims;

9. The word "claim," means the land between the stakes surrounding a discovered mine;

10. The word "licensee," means any person, firm or company that has obtained a license under this section; and the words "holder of miner's certificate," mean the person that has obtained such certificate;

11. The words "party wall or *passage*," mean a bank of earth or rock left between two excavations;

12. The words "mill or machine license," mean a permit to use machinery for the purpose of extracting or preparing minerals;

13. The words "licensed mills or machines" mean the mills or machines so licensed for extracting gold or silver from stone or quartz; and the words "licensed mill or machine owner" the person to whom any such license has been granted;

14. The words "superior metals" or "superior minerals," mean all minerals, except products of little value, and building material, such as peat, bog ores, ochres, clay, marl, sand, gravel, mineral waters, and building stone such as limestone, sandstone or granite, which are called "inferior minerals;"

15. The words "mining concession" mean any tract of country sold for the purpose of mining;

16. The words "underground mining concession," mean any underground mining property sold for the purpose of mining under this section;

17. The word "Minister" or "Commissioner" when used alone, means the Minister of Colonization, Mines and Fisheries;

18. Measures or distances, made or computed in virtue of this section, shall be according to English measure."

§ 2.—*Privileges of Aliens and Reserve of Mining Rights.*

"1422. Aliens, as well as British subjects, may enjoy the benefit of this law, by complying with its provisions and submitting thereto. 43-44 V., c. 12, s. 2, and R. S. Q., 1422.

"1423. It has not been since the 24th July, 1880, and it shall not in future be necessary, in grants of land (not at the same time mining concessions) by the Crown by letters-patent or other title to the same effect, to mention the reserve of the mining rights, which reserve is always deemed to exist. 1 Ed. VII, ch. 13, s. 1.

§ 3.—*Exceptional Provisions.*

"1424. As respects the Crown the mining, rights so tacitly reserved constitute a property under the soil separate and independent from that of the soil that is above it." 1 Ed. VII, ch. 13, s. 1.

"1425. All mines belonging to the Crown under the law or titles of concession in the property under the soil, conceded before the 24th July, 1880, in the townships, with the exception of gold and silver mines, are abandoned by the Crown and belong exclusively to the owner of the surface, provided the latter has not divested himself of his right of preemption preserved by the former provisions ot the law.

When the owner of the surface has divested himself of his right of pre-emption, the person acquiring such right shall have the first and exclusive privilege of mining but only in the mines so abandoned, unless he declines so to do within a delay of six months on being duly put in default on behalf of the surface owner, after a discovery has been made of any ore whatsoever in workable quantities. "1 Ed. VII, ch. 13, s. 1.

If while one of the mines so abandoned is being worked, gold or silver is discovered in workable quantities, the proprietor working the same, may, within three months after being put in default so to do by the Department, obtain the grant thereof in preference to any other person, for the ordinary price of superior metal." 7 Ed. VII, ch. 18.

"1431. Every person, who has obtained or who may hereafter obtain, by letters-patent, for the purpose of mining for inferior metals, one or more lots forming part of the public lands of this Province, shall, if he or his legal representative, discovers and wishes to work, or cause to be worked, any mines of superior metals, pay to the Commissioner, over and above the price already paid for such mining land, a sufficient additional amount to make up the sum required by article 1414 for the purchase of mining lands containing superior metals; provided, always, that the sum already paid does not reach the latter amount. 43-44 V., c. 12, s. 10, and R. S. Q., 1431.

It shall, nevertheless, be lawful for the Minister to sell to another person the mines of superior metals that may be found in the same lots, if the proprietors of mines of inferior metals refuse to avail themselves of their right, after having been put in default to do so." 7 Ed. VII, ch. 18.

§ 4.—*Royalty.*

"1435. The Lieutenant-Governor in Council may, if he thinks proper, and in accordance with the conditions and formalities which he may deem advisable, claim, at any time, the royalty due to the Crown upon any land already sold, conceded or otherwise alienated by the Crown or which may be hereafter sold, but only five years after the date of such alienation.

Such royalty, unless otherwise determined by letter-patent or other title from the Crown, is fixed by the Lieutenant-Governor in Council, in accordance with the report of the mining inspector, and taking as a basis the value, at the mine, of the mineral extracted, after deducting the costs of the extracting, and it must not exceed three per cent of such value. 43-44 V., c. 12, s. 13, and R. S. Q., 1435.

§ 5.—*Mining concessions, their form and dimension.*

"1436. Mining concessions shall comprise, in addition to the ordinary allowance of five per cent for highways:

(1) In unsubdivided territory, a rectangular area of not more than two hundred nor less than forty acres in sections adjoining or separated from each other.

(2) In townships surveyed and subdivided, and in seigniories, an area one or two lots taken separately or forming a single parcel of land, as described in the plans of surveys, or the cadastral plans, as the case may be; each concession not to exceed two hundred acres nor to contain portions of lots; subject to the powers conferred upon the Lieutenant-Governor in Council by article 1443.

Small islands or islets, or beach, or deep water lots, and residues of lots parts of which have already been appropriated for mining purposes, shall be sold without warranty of their precise contents." 7 Ed. VII, ch. 18.

"**1437.** In unsurveyed territory, the principal outside lines of mining concessions may be drawn in a northerly and southerly and easterly and westerly direction."

"**1438.** When mining concessions, in unsurveyed territory, border upon lakes or rivers, they shall front on such lakes or rivers and be subject, in all cases, to the public rights in navigable and floatable waters.

Further, along such lakes or rivers, there is reserved a right of way, one half chain in breadth, which shall be comprised in the allowance of five per cent, specified in article 1436. 43-44 V., c. 12, s. 30, and R. S. Q., 1458.

"**1439.** All mining concessions, comprised in an unsurveyed territory, shall be surveyed by a provincial land surveyor, acting under the instructions of the Department of Colonization, Mines and Fisheries, and be connected with some known point in previous surveys, so as to be laid upon the office maps of such territory, of record in the Department.

Such surveys are made at the cost of applicants, who are required to furnish, with their application to purchase, the plan of surveyor establishing the position and dimension of the concessions they desire to purchase, with the field-notes and *procès-verbaux* of the operations; the whole in conformity with the present law and to the satisfaction of the Commissioner. 43-44 V., c. 12, s. 28, and R. S. Q., 1456.

§ 6.—*Acquisition of Mining Lands—Duties of proprietors who sell their rights.*

"**1440.** All lands, supposed to contain mines or ores, belonging to the Crown, may be acquired from the Commissioner of Colonization, Mines and Fisheries.

1. As a mining concession by purchase; or,

2. Be occupied and worked under a mining license. 43-44 V., c. 12, s. 21, and R. S. Q., 1439.

"**1441.** The mining rights belonging to the Crown in the lands of private individuals may also be acquired in the manner indicated in the foregoing article." 1 Ed. VII, ch. 13, s. 2.

"**1442.** Every proprietor of mining lands, as well as every holder of a mining license within the meaning of paragraph nine of this section, may sell, assign, convey, or alienate his rights as proprietor or license holder, by delivering an authentic copy or a duplicate of such sale, assignment, transfer or alienation to the Minister, who shall, upon payment of a fee of ten dollars, summarily register the same in a special register.

Every sale, concession or transfer not so registered, shall be null as regards the Crown.

The registration shall be effected within 30 days at the diligence of one of the parties interested. Any registration subsequent thereto shall be valid, but only as regards subsequent transactions." 7 Ed. VII, ch. 18.

§ 7.—*Price of Mining Concessions—Reserves of the right of cutting timber thereon.*

"**1443.** No sale of mining concessions forming more than two hundred acres, shall be made in the same year, to one person, within a radius of one hundred miles.

The Lieutenant-Governor in Council may, nevertheless, assign to such person, upon sufficient proof of his means and capital, a greater extent of land, not exceeding one thousand acres." 7 Ed. VII, ch. 18.

"**1444.** With applications to purchase a mining concession or concessions, and the production of the documents mentioned in this section, the applicant shall pay to the Department of Colonization, Mines and Fisheries, the price, in full, of the mining concessions he wishes to acquire, at the following rates: ten dollars per acre for superior metals more than twenty miles distant from a railway, and twenty dollars when less than twenty miles distant; and for inferior metals two dollars per acre, when more than twenty miles distant from a railway, and four dollars when less than twenty miles distant."

"**1445.** The Commissioner may, from time to time, and as often as circumstances require, offer and put up for sale such number of mining concessions as he may deem proper.

This sale is made by public auction, after notice duly given and published, during at least four weeks, in the Quebec Official Gazette, and at least in one French and one English newspaper, if there be any published in these two languages, in each of the cities of Montreal, Quebec, and Ottawa.

At each such sale, the upset price of first bid is fixed and determined by the Commissioner, but shall not, in any case, be less than total amount determined in the preceding article; and the entire price of adjudication is payable in cash, under penalty of the absolute nullity of the sale. 43-44 V., c. 12, s. 158, and R. S. Q., 1580.

"**1446.** Unless stipulated to the contrary in the letters-patent:

1. In concessions for the mining of superior metals, the sale of such concession shall give to the purchaser the right to mine for all metals which may be found therein;

2. In concessions for the mining of inferior metals, the sale of such concession shall give to the purchaser the right to mine for inferior metals only.

"**1447.** In townships duly erected, as well as in unsurveyed territory, no lands shall be sold under this law, unless there be some real indications of the presence of minerals; and the proof of such indications must be shown by the exhibition of specimens found upon or in such land, accompanied by affidavits of competent and credible persons, establishing that the specimens exhibited came therefrom. 43-44 V., c. 12, s. 31, and R. S. Q., 1459.

II.—RESERVE OF RIGHT OF CUTTING TIMBER ON MINING CONCESSIONS.

"**1448.** The holders of licenses to cut timber have, under such licenses, the privilege of cutting on all mining concessions granted within their limits, timber of all kinds according to law and the regulations governing woods and forests.

This privilege expires after three years from the date of the issue of the letters-patent for such mining concessions.

"**1449.** Timber of all kinds is reserved by law, in favor of the Crown, upon lands sold as mining lands in a territory which is not under license to cut timber.

Timber licenses may be granted according to the law governing woods and forests, for the timber so reserved in favor of the Crown, upon such mining lands.

The holder of timber license has a right to make and maintain across such mining lands all roads necessary for his operations.

The right to cut timber under a license, upon the mining lands mentioned in this article, expires after three years from the date of the first license to cut timber issued for such mining concessions." 4 Edward VII, ch. 16, s. 1.

"**1450.** The purchasers or proprietors of such mining concessions have in the case of the two preceding articles, the right to cut and take away, for their own use, such trees as they may require for the construction of the buildings and dependencies necessary for their operations. 43-44 V., c. 12, s. 33, and R. S. Q., 1461.

§ 8.—Cancelling of sales of Mining Lands.

"**1451.** Mining lands shall be sold on the express condition that the purchaser shall commence *bona fide* the mining of the minerals therein contained, within two years from the date of purchase, and that, during such delay, the purchaser shall, in such working, spend "for every section or lot of one hundred acres" a sum of not less than five hundred dollars, if for superior metals, and of not less than two hundred dollars, if for inferior metals. 7 Ed. VII, ch. 18.

The Commissioner may cancel the sale of such mining land in default of the performance of the conditions herein mentioned, according to the mode followed for the cancellation of sales of public lands.

Letters-patent shall be issued only on satisfactory proof that the foregoing conditions have been fulfilled. 13-14 V., c. 12, s. 31, and R. S. Q., 1462.

§ 9.—*Licenses*

I.—MINER'S CERTIFICATE.

"**1452.** The Minister of Colonization, Mines and Fisheries may deliver a miner's certificate to any person applying to the Department itself or to one of its agents. Such certificates shall be valid from the date of their issue until the first day of January next following.

"**1453.** The fee for such certificate shall be ten dollars, payable at the office of the Department or to one of its agents, on delivery. It shall be according to the Form F, and if accidentally lost or damaged, a duplicate may be given."

"**1454.** The bearer of a certificate shall exhibit it to any officer of the Department demanding the same.

"**1455.** Any person holding a miner's certificate may prospect on all public lands surveyed or not surveyed, or on the lands of private persons where mines are reserved by the Crown, but not any land that is the subject-matter of a claim, or that is under mining license or that is withdrawn from mining operations by competent authority.

Nevertheless, if the bearer of a miner's certificate desires to prospect on the land of private persons, he must give good and sufficient security to the satisfaction of the Minister, that he will answer for all injury or damage which he may cause to the surface owner while so prospecting.

1*a*.—STAKING ON UNSURVEYED TERRITORY.

"**1456.** Every holder of a miner's certificate may himself mark out on the ground, one or more rectangular claims, not exceeding five, with sides running northward and southward, and eastward and westward, each covering at least forty acres and not more than a total of two hundred acres in area, in the manner and to the effect following:

1. By planting a squared stake on a prominent point, indicating the discovery. Such stake shall bear, in very legible characters, the name of the discoverer, the number of his certificate and the date of the discovery;

2. By placing at the apex of each angle of the lot aforesaid, stakes numbered 1, 2, 3 and 4, the stake nearest the north-east point bearing the number 1, that nearest the south-east point bearing the number 2, and so on;

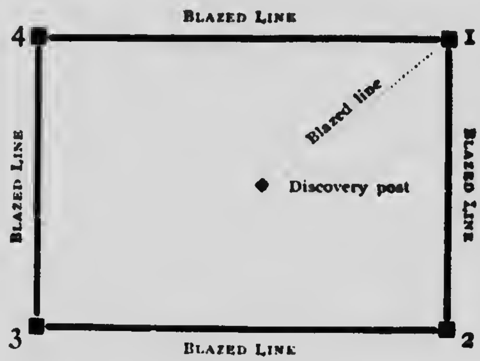
3. By putting on stake number 1 the inscriptions of the discovery stake and indicating the distance between those stakes;

4. The lines between those stakes, including that connecting the discovery stake with stake number 1, shall be visibly cut or indicated on the ground;

5. If it is impossible to plant a stake at one of the angles, owing to the configuration of the ground, such stake may be put at the nearest practicable point, by putting the following inscription on it: W. P. (witness post) or P. I. (*piquet indicateur*) and an indication of the distance in the direction of the true point;

6. The length of the stakes shall be about four feet above the soil and their diameter about four inches;

7. The following diagram gives the description of a claim marked out according to the above method.



1*b*.—STAKING IN SURVEYED TERRITORY.

"**1457.** In surveyed territory, the holder of a miner's certificate may stake out not more than one or two claims of one hundred acres or of one lot each, by planting one picket at the place of the discovery, in the manner mentioned in paragraph 1 of article 1456; the contours of the claim being sufficiently indicated by the boundaries of the lot itself.

Nevertheless, if the lot is in the forest, the indications mentioned in article 1456 must be made at the apex of each angle.

In the case of land no longer belonging to the Crown, the claim may nevertheless apply to a fraction of a lot only.

"**1457***a*. The bearer of a miner's certificate who makes a discovery, must proceed with diligence to stake it as required; otherwise he may forfeit his right if some other person stakes the claim before he does.

"**1457***b*. The holder of a miner's certificate who marks out a claim by proceeding as aforesaid, must give notice without delay to the Department of Colonization, Mines and Fisheries, or to the officer of the Department having an office in the place nearest to the discovery.

"**1457***c*. If the claim is admitted by the Department, or by the officer, mention thereof shall be made on the back of the miner's certificate and also in the books of the Department.

"**1457***d*. He must also, within four months from the date inserted on the stakes, obtain a mining license in accordance with articles 1460 and following, on pain of forfeiture of all rights and privileges.

The application to that effect must be accompanied:

1. By the amount of the fee and rent;

2. By a description of the lot marked out on the ground with a sketch or plan and also an indication of the nearest land-marks such as lakes, rivers, surveys or dwellings, if any;

3. By a solemn declaration attesting that such lot has not been previously marked out and is not under a mining license, and giving the names and the date of the inscription on the stake as well as the number of his certificate, the whole according to the Form G.

II.—MINING LICENSES.

1.—*Mining without license forbidden.*

"**1458.** Every person is prohibited, under pain of the fines and penalties mentioned in the article 1526, from mining in any mine, either upon public or private lands, when the mining rights belong to the Crown, without having previously purchased the same, in virtue of the present law, or without having obtained, to that effect, a mining license, and paid the fee and rent required by article 1461. 13-14 V., c. 12, s. 17, and R. S. Q., 1475.

2.—*Form of Mining Licenses.*

"**1460**. There are two descriptions of licenses for mining known as follows, to wit:

1. Private lands' license, where the mining rights belong to the Crown;

2. Public lands' license.

The first is made in the form of Schedule B. 13-14 V., c. 12, s. 50, and R. S. Q., 1478.

3.—*Granting and duration of licenses.*

"**1461**. Mining licenses are granted on payment of a fee of ten dollars, and of an annual rental of one dollar per acre.

2. Every such license is valid for one year from the date of its issue, and is transferable only with the consent of the Commissioner.

3. It cannot be granted for an extent of over two hundred acres in superficies, and in unsurveyed territory of less than one hundred acres.

4. The licensee may, before the expiry of his license, and not later than ten clear days thereafter, renew such license, on payment of a like fee of five dollars, or of any such other sum, as may be determined by law, at the time of its issue, and of an annual rental of one dollar per acre.

5. No such mining license can be renewed except upon payment of the said fee and of the said annual rental.

"1462. It shall be lawful for the Lieutenant-Governor in Council whenever he deems it expedient, to require the payment of the royalty, in lieu and stead of fees for a mining license and of an annual rental as aforesaid, except, however, in places in this Province in which the royalty due to the Crown under the letters-patent is paid by means of fees for mining licenses. 43-44 V., c. 12, s. 52; 47 V., c. 22, ss. 9 and 10, and R. S. Q., 1480.

"1463. Every inspector is bound to keep a book in which the licenses are registered, and he must further enter therein the names of the applicants for licenses, the description of the mining lands which they have marked, according to law, and all other information which the Minister of Colonization, Mines and Fisheries may deem useful.

"1464. Such book is to be open to the inspection of any one desiring to examine the same, upon payment of a fee of twenty cents to the inspector. 43-43 V., c. 12, s. 43, and R. S. Q., 1471.

1.—*Powers of Licensees on Private Lands.*

"1465. The holder of a mining license or the owner of mining rights on private lands is authorized to work the mines thereon, with the consent of the private person, or on his refusal, by compelling him thereto in the manner provided by the following articles. 1 Ed. VII, ch. 13, s. 4.

"1466. Every holder of a mining license or every owner of mining rights on private lands or their representatives who wish to mine on the land of such private person, must first cause to be served a notice in writing according to the form of Schedules C or *Ca* respectively of this law, stating:

1. That they intend to mine on the land of such private person;

2. That they are ready to pay the damages arising from such mining operations to be assessed by mutual agreement." 1 Ed. VII, c. 13, s. 4.

"1467. The notice shall give a delay of one month from the date of the service, to the said private person, to answer and make such agreement, if present, and if absent from the Province, double delay, and in the latter case, the notice shall be inserted in French and English, three times in a newspaper of an adjoining district. 43-44 V., c. 12, s. 56, and R. S. Q., 1484

"1468. Whenever a private person refuses to come to mutual understanding for mining on his land, the petitioner may then cause a plan of the land, absolutely necessary for his mining operation, to be made by a sworn land surveyor, who, for that purpose, is authorized to enter upon the said property with his employees, and cause to be served upon the said private person another notice, according to the form of schedule I of this law, containing:

1. A description of the land to be taken for mining purposes;

2. A copy of the land surveyor's plan;

3. A declaration that he is ready to pay a certain sum in money or rent, as the case may be, as a compensation for the said land or damages, and

4. The name of a person whom he appoints as his arbitrator, if his offer is not accepted, also a demand upon the said private person to appoint and declare the name of his arbitrator. 43-44 V., 3. 12, s. 58, and R. S. Q., 1486.

"**1471**. If the opposite party is absent from the Province, or is unknown, then, upon a petition addressed to the inspector of the mining division in which the land is situated, accompanied by a return of service, certifying that the said person is absent from the Province, and could not be found therein, the said inspector orders, under his signature, that the notice, drawn up according to the form of schedule D of this law, be inserted, three times in the French and English languages, during ten days, in a newspaper published in such district, if there is such newspaper, if not, then in a newspaper of a neighbouring district. 43-44 V., c. 12, s. 59, and R. S. Q., 1487.

"**1472**. The answer, to be given to the said notice, is made in terms of the form of schedule E of this law. 43-44 V., c. 12, s. 59, and R. S. Q., 1487.

"**1473**. If, during the ten days after the service of the notice, or the eight days following the last publication (as the case may be), the opposite party does not inform the petitioner that he accepts his offers, or does not give the name of the arbitrator appointed by him, then the inspector of the mining division, upon application of the said petitioner, appoints a competent person to be sole arbitrator, to determine the compensation which the opposite party has right to receive. 43-44 V., c. 12, s. 60; 47 V., c. 22, s. 17, and R. S. Q., 1488.

"**1474**. If the opposite party, during the above prescribed delay, notifies to the petitioner the name of the arbitrator whom he has chosen, the two arbitrators jointly name a third. 43-44 V., c. 12, s. 61, and R. S. Q., 1489.

"**1475**. Such arbitrators appointed by the parties must, within eight days after the opposite party has made known the name of his arbitrator, meet to agree upon the choice of a third. 43-44 V., c. 12, s. 61, and R. S. Q., 1489.

"**1476**. If the two arbitrators cannot agree upon the choice of a third, the inspector is bound, upon application of any of the parties, notice of at least two clear days having been previously given to the other, to appoint such third arbitrator himself. 43-44 V., c. 12, s. 61, and R. S. Q., 1489.

"**1477**. The arbitrators or two of them, or the sole arbitrator, after having taken oath before a justice of the peace of the district, or before the inspector of the mining division, in which such land is situated, to faithfully and impartially fulfil the duties of their office, immediately proceed to establish the compensation to be paid by the petitioner, as the majority may decide; and the award of the arbitrator or of the sole arbitrator, as the case may be, is final and without appeal. 43–44 V., c. 12, s. 62, and R. S. Q., 1490.

"1478. No proceedings can be commenced by the arbitrators before a sum of fifty dollars is deposited with the inspector of the mining division, to defray the costs of the arbitration, and a certificate of the inspector be delivered to them certifying such deposit.

The arbitrators may require the deposits of any other sum deemed necessary during the proceedings. 43–44 V., c. 12, s. 62, and R. S. Q., 1490.

"1479. No award can be given, and no official act done by the majority of the arbitrators, unless at a meeting of which the other arbitrator has received notice at least two clear days before, of the time and place at which such meeting is to be held.

The service of a notice on the parties is not necessary. 43-44 V., c. 12, s. 63, and R. S. Q., 1491.

"1480. In deciding upon the value of the compensation to be paid, the arbitrators are authorized and required to take into consideration the inconveniences, loss or damages arising from the fact that a third party takes possession or makes use of the land for the mining purposes. 43-44 V., c. 15, s. 64, and R. S. Q., 1443 and 1492.

"1481. If the arbitrators are not satisfied with the plan drawn by the land surveyor, as mentioned in article 1468, they may cause another to be made, at the cost of the petitioner, by another land surveyor, to whom they have a right to give the necessary instructions. 43-44 V., c. 12, s. 65, and R. S. Q., 1493.

"1482. The arbitrators, in proceeding with such arbitration, must allow only the land strictly requisite for mining purposes, which can, in no case, exceed fifteen acres in superficies, over and above the land deemed necessary, on the same property, for right of way with horses and vehicles to and from the nearest highway. 43-44 V., c. 12, s. 66, and R. S. Q., 1494.

"1483. The costs are paid by the petitioner, except, however, those of the arbitrator of the opposite party, which are paid by him, if the award does not allow him a higher compensation than that offered before the arbitration.

In all cases, the costs are taxed by the inspector of the mining division. 43-44 V., c. 12, s. 67, and R. S. Q., 1495.

"1484. The arbitrators may swear the parties and their witness, and, in their discretion, interrogate them under oath or solemn affirmation. 43-44 V., c. 12, s. 68, and R. S. Q., 1496.

"1485. In the case of a sole arbitration, if the latter dies before giving his award, or if he becomes ill, or refuses or neglects to act, within a reasonable delay, the inspector, upon satisfactory proof thereof, appoints another in his stead; but the latter arbitrator cannot recommence or repeat any of the previous proceedings. 43–44 V., c. 12, s. 69, and R. S. Q., 1497.

"1486. When the award of the arbitrators is given, the amount of the damages awarded and costs must be paid into the hands of the inspector of the mining division having jurisdiction. 43-44 V., c. 12, s. 70, and R. S. Q., 1498.

"1487. The inspector must give a receipt for the sums so paid; but no work shall be commenced, without the express permission of the inspector, or before the amount of the compensation has been paid or lawfully tendered to private person or the proprietor of the soil. 43-44 V., c. 12, s. 71; 47 V., c. 12, s. 18, and R. S. Q., 1499.

"1488. The amount of the compensation, and the costs so paid, are afterwards distributed, within the shortest possible delay, by the inspector, to the persons entitled thereto. 43-44 V., c. 12, s. 72, and R. S. Q., 1500.

"1489. Every petitioner, as aforesaid, may also, by following the procedure above set forth, obtain from neighboring proprietors and others, the right of way over their lands with horses and vehicles, and the right to make works necessary thereon for conveying the water required by him for the better working of his mining lands; provided, however, that he does not apply for anything which might have the effect of turning the course of any spring, river or stream, so as to deprive the inferior riparian proprietors of the use of such spring, river or stream. 43-44 V., c. 12, s. 73, and R. S. Q., 1501.

"1490. The preceding article is applicable to every person who works a mine of any kind in the Province. 43-44 V., c. 12, s. 77, and R. S. Q., 1504.

6.—Miscellaneous provisions respecting applicants for, and holders of licenses, and persons working mines.

"1497. Every person, holding a mining license, upon renewing the same, is bound, under penalty of the refusal of such renewal, to make to the inspector of the mining division, in addition to the annual statement which he is bound to furnish in virtue of the following article, a full and true statement, under oath, of the work performed, and of the minerals obtained by him, during the term of such license, which statement may be entered upon the expiring license. 43-44 V., c. 12, s. 86, and R. S. Q., 1513.

"1498. Every owner of mining rights, whether he mines himself or by others, and every person working mines must, during the first ten days of the month of January in each year, furnish a sworn statement of his operations for the past year, indicating the quantity of mineral extracted, its value at the mine, the quantity and value of the marketable product, and the number of workmen employed, as well as a list of the names of persons killed or injured in working the mines." 1 Ed. VII, ch. 13, s. 5.

"1499. No title to a mining concession or license shall, without the formal consent of the proprietor of the soil, give a right to mine, or to open pits or galleries or to erect machines or stores, in fields, yards or gardens, or upon lands close to dwelling houses, or boundary fences or dwellings,* nor

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*Within a distance of three hundred feet from such fences or dwellings.

even to enter such yards or habitations. 43-44 V., c. 12, s. 76, and R. S. Q., 1444 and 1503.

"1500. Every person who prospects or mines for minerals upon lands adjoining a mining division is subject to provisions of this law, as if he worked within the limits of such mining division. 43-44 V., c. 12, s. 98, and R. S. Q., 1525.

"1501. Every licensee, under this law, is bound, under the penalties mentioned in article 1538 whenever required so to do to exhibit his license to the inspector of the division, or to any constable or peace officer deputed by the said inspector, and to prove to the satisfaction of every such officer, making such demand, that the license which he holds is in force. 43-44 V., c. 12, s. 99, and R. S. Q., 1526.

"1502. Every licensee is bound, under the penalties mentioned in article 1539, to allow the inspector of the mining division, or any constable or peace officer, deputed by the said inspector, to enter upon the lands which he works, and to afford them all necessary facilities and assistance for that purpose. 43-44 V., c. 12, s. 100, and R. S. Q., 1527.

§ 10.—*Special provisions respecting mining.*

I.—PARTY WALLS OR *passages*.

"1506. A party wall or *passage*, at least three feet thick, shall be left between each holding worked as well on public as on private lands; which said party wall or *passage* is to be used in common by all parties as a mode of access to the stream, where one exists; and no one shall obstruct such party wall or *passage* by throwing soil, stones or material thereon, under penalties mentioned in article 1530. 43-44 V., c. 12, s. 93, and R. S. Q., 1520.

"1507. Any person interested may, at any time, remove a party wall or *passage* as aforesaid, if he thinks it necessary, but he shall, if required so to do, construct a new mode of access to the water, offering the same facilities as an approach at the party wall or *passage* so removed, under the penalties enacted in article 1531; but such removal cannot be effected without the written permission of the inspector of the mining division, who shall summarily decide, after hearing the adverse party, or, in his absence, if he has been duly notified. 43-43 V., c. 12, s. 94; 47 V., c. 22, s. 21, and R. S. Q., 1521.

II.—DAMAGES RESULTING FROM MINING OPERATIONS.

"1508. No person working mines shall cause any damage or injury to the occupant of any other mining land by throwing earth, clay, stones or other material upon such other land, or by causing or allowing any water which may be pumped or baled, or may flow from his land, to flow into or upon such other land, under the penalties mentioned in article 1532, over and above the damages caused. 43-44 V., c. 12, s. 95, and R. S. Q., 1522.

III.—WATER-COURSES AND EXCAVATIONS.

"**1509.** Every miner, who makes a pit, shaft or any excavation whatever, to a depth of four feet and over, is bound, under the penalties mentioned in article 1537, to enclose the same with a fence, at least four feet in height, if he discontinues working the same for a period of eight days. 43-44 V., c. 12, s. 97, and R. S. Q., 1523.

"**1510.** All owners of claims and mining locations, bounded by water-courses or rivers, upon public as well as upon private lands, may make use of such water-courses or rivers in working their respective claims or locations, but without hindering each other, subject in all cases to the provisions of article 1489, if they apply. 43-44 V., c. 12, s. 96, and R. S. Q., 1524.

"**1511.** Every dispute, arising between the parties on the subject, [illegible] settled and dec[illegible] by the inspector of the mining division; and whosoever disobeys the [illegible] the inspector is liable to the penalties mentioned in article 1533. [illegible] 12, s. 96, and R. S. Q., 1524.

§ 12.—*Penalties.*

"**1526.** Every person who works a mine in public or private lands, when the claim belongs to the Crown, without having first acquired the same under the present law, or without having first obtained a license and paid the fee and rental required by article 1461, is liable to a fine of two hundred dollars and costs for every contravention, and, in default of payment, to imprisonment for a period not exceeding three months. 43-44 V., c. 12, s. 102, and R. S. Q., 1529.

"**1528.** Every person who commences mining without having furnished to the inspector the name of the person, the full designation and description of his mining land and declared his place of residence, is liable to a fine not exceeding twenty-five dollars and costs, and, in default of payment, to imprisonment for the period not exceeding one month. 43-44 V., c. 12, s. 103, and R. S. Q., 1530.

"**1529.** Every person, who by himself or his agents, employs a woman or a girl, or who employs any male child in the working of such mine, contrary to the provisions of article 1548, is liable to a fine not exceeding twenty dollars for each offence and the costs, and in default of payment, of an imprisonment not exceeding one month.

"**1530.** Whosoever obstructs a party wall or *passage* upon land worked as mines under this law, by throwing thereon earth, stones or other material, is liable to a fine not exceeding five dollars and costs, and, in default of payment, to an imprisonment for a period not exceeding one month. 43-44 V., c. 12, s. 104, and R. S. Q., 1531.

"**1531.** Whosoever removes a party wall or *passage* and does not, if thereunto required, provide another mode of access to the water-course, is liable to the penalty mentioned in the following article. 43-44 V., c. 12, s. 105, and R. S. Q., 1532.

"1532. Whosoever, while engaged in mining causes damage or injury to the occupant of another mining land by throwing earth, clay, stones or other material in and upon such claim, or by causing or allowing any water which may be pumped or baled, or which may flow from his claim, to flow into or upon such land, is liable to a fine not exceeding five dollars, and costs, and, in default of payment, to imprisonment for a period not exceeding one month. 43-44 V., c. 12, s. 108, and R. S. Q., 1533.

"1533. Whosoever, in working a mine, does not comply with the decision of the inspector with respect to the use he is to make of a water-course, canal, drain, shoot, or other aqueduct, is liable to a fine not exceeding fifty dollars and costs, and, in default of payment, to imprisonment for a period not exceeding one month. 43-44 V., c. 12, s. 107; 47 V., c. 22, s. 22, and R. S. Q., 1534.

"1534. Any person convicted of intentionally removing or disturbing any stake, or post, planted in accordance with the provisions of this section, is liable to a fine not exceeding twenty-five dollars and costs, and to imprisonment for not more than one month in default of payment.

"1537. Every person who discontinues working in any pit, shaft or excavation whatsoever of four feet or more in depth, without fencing in the same to a height of at least four feet, is liable, for each offence, to a fine not exceeding fifty dollars and costs, and, in default of payment, to imprisonment for a period not exceeding one month. 43-44 V., c. 12, s. 111, and R. S. Q., 1538.

"1538. Every licensee, who, when required so to do, refuses to exhibit his license to the inspector of the mining division, or to any constable or peace officer deputed by such inspector, is liable to a fine not exceeding five dollars and costs, and, in default of payment, to imprisonment for a period not exceeding one month. 43-44 V., c. 12, s. 112, and R. S. Q., 1539.

"1539. Every person engaged in mining upon any land whatever, who refuses to allow the inspector of the division, or any constable or peace officer, authorized by such inspector, to enter, for the performance of their official duties, upon the lands on which he is so working, or who refuses, when thereunto required, to afford them the facilities and assistance necessary for such purpose, is liable to a fine not exceeding five dollars and costs, and, in default of payment, to imprisonment for a period not exceeding one month. 43-44 V., c. 12, s. 113, and R. S. Q., 1540.

APPENDIX.

SCHEDULE A.

Form of Private Lands' Mining License, where the mining right belongs to the Crown, under article 1460.

Province of Quebec. Mining Division of E. F. , having paid a fee of ten dollars and an annual rent of dollars per acre, is hereby authorized to mine for (*here indicate what mineral*) during twelve months from the day of the month of 19 , upon the lands of (*here give the name of the private owner and describe the land.*) in this division, subject to the conditions and restrictions set forth in the Quebec Mining Law and the regulations made in conformity therewith.

Dated , this day of 19

(*Signature*) A. B.
Commissioner of Colonization,
Mines and Fisheries.

43-44 V., c. 12, Schedule A, and R. S Q., 1487.

SCHEDULE B.

Form of Public Lands' Mining License, under article 1469.

Province of Quebec. Mining Division of E. F. , having paid a fee of ten dollars and a rent of dollars per acre, is hereby authorized to mine for (*here indicate what mineral.*) during twelve months from the day of the month of , 19 upon (*describe the lands*) in this division, subject to all the conditions and restrictions set forth in the Quebec Mining Law, and to the regulations made in conformity therewith.

Dated at , this day of 19

(*Signature*) A. B.
Commissioner of Colonization,
Mines and Fisheries.

43-44 V., e. 12, Schedule B, and R. S. Q., 1478.

SCHEDULE C.

Form of notice to work upon private lands under article 1466, under a license granted in accordance with article 1461.

Province of Quebec. Mining Division of

I (*or we, as the case may be*) residing in the county of in the district of (*or* having made election of domicile at) in the Mining Division hereby give you notice:

1. That I hold a mining license to mine for (*here indicate the mineral*) *on your land* (*description*) and that I intend to mine for the said mineral.

2. That I am ready to enter into any possible amicable arrangement with you to enable me so to mine.

Therefore, within one month from the service of this notice be good enough to come to an amicable understanding with me as aforesaid.

(*Signature*) C. D.,
Petitioner.

(*Countersigned*) A. B.
Inspector of Mining Division of
1 Ed. VII, ch. 13, s. 7.

"SCHEDULE Ca

Form of notice given by an owner of Mining Rights upon Private Lands to mine under article 1466

Province of Quebec. Mining Division of

I (*or* we, *as the case may be*) residing in the county of in the district of (*or* having made election of domicile at) in the Mining Division of hereby give you notice:

1. That I am the owner (*or* hold the rights of the owner) of the mining rights (*indicate the kind thereof*) on your land, (*description*) and that I intend to mine thereon for (*here indicate the mineral.*)

2. That I am ready to enter into any possible amicable arrangement with you to enable me so to mine.

Therefore, within one month from the service of this notice, be good enough to come to an amicable understanding with me as aforesaid.

(*Signature*) C. D.,
Petitioner.

(*Countersigned*) A. B.,
Inspector of the Mining Division of "
1 Ed. VII, c. 13, s. 7

SCHEDULE D.

Form of Notice, if the private person refuses to come to a mutual understanding, under articles 1468 and 1471

Province of Quebec. Mining Division of

Whereas it appears, by return of service made by , bailiff of the Superior Court, *or* by the certificate of service made by , constable for the Mining Division of (*as the case may be*), on the day of the month of one thousand nine hundred , that the proprietor of the lot situate and being in the range of (parish *or* township) in the county of , district of , which lot is bounded by , is absent from the Province *or* is unknown, *or* has refused to come to a mutual understanding with the petitioner.

Public notice is hereby given by the undersigned , of the parish of , county of district of (*or* having elected his domicile at), that:

1. He intends to mine for (*here indicate the minerals*) on the above described lot;

2. He is prepared to pay the sum or rent deemed necessary as compensation for such lot or damages assessed by arbitration according to law; and that

3. The name of his arbitrator is , of the parish of county of , in the district of :

Therefore the said (*name the proprietor of the lot if known*), proprietor, is called upon to appoint his arbitrator, within one month from the first insertion of the present notice in the newspapers according to law.

(*Signature*) C. D.,
Petitioner.

(*Countersigned*) A. P.

Inspector of Mining Divisions of 43-44 V., c. 12, Schedule H. and R. S. Q., 1487.

SCHEDULE E.

Form of answer by a private person to a notice requiring the right to mine on his lands, Articles 1467 and 1471.

Province of Quebec. Mining Division of

I (*or we, as the case may be*), in answer to your notice dated the day of the month of 19 declare that I desire to enter into an amicable arrangement with you respecting the mining operations which you wish to carry on upon my land (*or if the private person is bound to name an* *arbitrator)*, that I have appointed M. of the parish of in the county of district of to act as my arbitrator in the arbitration required by you.

Dated at this day of the month of 19

(Signature) E. F.
Owner.

(*Countersigned*) A. B.
Inspector of the Mining Division of
1 Ed. VII, c. 13, s. 8.

SCHEDULE F

Article 1453

Miner's Certificate

Department of Colonization, Mines and Fisheries

	These presents certify that A.B. of
—	on payment to us of the sum of $10.00, is authorized to prospect until the first day of January next,
Name	upon any surveyed or unsurveyed lands forming part of the public domain, or belonging to private persons, the mining
Address	rights upon which have not already been alienated nor made subject to a license of any kind or to a reserve. This
Signature.	certificate is not transferable.

Date . . . .

Minister of Colonization,
Mines and Fisheries.

Dated at
this day
of 19

(*Countersigned*) . . . .

SCHEDULE G

(*Article* 1457*d*)

To the Honourable Minister of Colonization,
Mines and Fisheries,
Quebec.

Sir,
I residing at
declare that being the bearer of a miner's certificate, bearing the n°
and dated the
I have discovered minerals, and that at the place of such discovery, I planted a stake bearing the date of my name and the number of my certificate. I also planted a stake as required at each of the angles of the grounds.

The distance from the discovery stake to the stake n° 1*..............
From No. 1 to No. 2. ....
From No. 2 to No. 3. ....
From No. 3 to No. 4. ....
From No. 4 to No. 1. ....

The ground consequently comprises an area of...........acres as to which I request the issue of a mining license, and for such purpose I enclose the sum of..
that is to say $10.00 for fees and $.................of rent.

For the purpose hereof I elect domicile at (*indicate the place and the post-office address*).

I have seen no previous discovery mark upon the ground, which, moreover, to my personal knowledge, is not under license of any kind; and I make this solemn declaration conscientiously believing it to be true, and knowing that it has the same force and effect as if made under oath, and by virtue of the Canada Evidence Act.

Declared before me
at
day of 19

Received at the
Mines Office, at
Quebec, the
day of 19
with the sum of"

* N.B.—In surveyed territory, only the discovery post need be mentioned.

B.

Abstract from the Mining Act of the Province of Ontario, 8 Ed. VII, cp. 21, 1908, with Amendments.

General Information for Prospectors.

Acquisition of mining claims in Ontario depends, in the first instance, upon the discovery of valuable mineral, followed up by staking out and recording the claim, performing and filing proof of work, applying for a patent and paying a small price per acre; all as set forth in the provisions of the Act. See sections 35, 67, 2 (*x*), 54-56, 59, 60, 78, 79, 106, 107.

No one is entitled to prospect or stake out or acquire unpatented mining lands or to acquire any unpatented right or interest in them without first taking out a miner's license, which can be obtained from the Bureau of Mines, or, except in the case of a company, from any Mining Recorder. See sections 22-23. The license is good throughout the Province, but must be renewed not later than 31st of March each year (sections 2 , 27). In order to prospect in a Forest Reserve, a prospecting permit also must be obtained, which will be issued at the Bureau of Mines, upon the Bureau being satisfied of the carefulness and integrity of the applicant. Crown lands in forest reserves may be leased, but not sold (sections 41-46).

Generally speaking, all Crown lands and lands of which the minerals are reserved to the Crown are open to prospecting and staking out if not already taken up; but there are a few exceptions. See sections 31-43. Specific information can be had and maps showing claims taken up and lands still open can be seen at the office of the Recorder.

All claims in unsurveyed territory must be laid out with boundaries running due north and south and east and west, and the boundaries of all claims go down vertically on all sides. An ordinary claim in unsurveyed territory is a square of 40 acres, being 20 chains, or 1,320 feet, on each side. Lands in surveyed townships and in old mining locations must be laid out as specified in the Act. Provision is also made for irregular pieces lying between other claims or lands not open to staking or bordering on water See sections 49-52. Claims in Special Mining Divisions must be only ha the size of ordinary claims, and in unsurveyed territory must be laid out 20 chains, or 1,320 feet, from north to south, and 10 chains, or 660 feet, from east to west (section 51). No more than three claims may be staked out or recorded in the name of one licensee in any one Mining Division during any license year (section 53).

Anyone who records a claim upon a fraudulent affidavit of discovery or who is guilty of any fraud in connexion with the acquisition of the claim, in addition to being liable to criminal prosecution and to forfeiture of his license, will not acquire a g d title to the property; and anyone who, except as authorized by the Act, stakes out any lands open to prospecting or puts any post or markings on such lands, or who stakes out a claim and fails to record it, is not entitled to again stake out any part of the same lands or to acquire any interest in them unless he first obtains a certificate from the Recorder, which can be granted only on proof of good faith and payment of a fee of $20. See sections 66, 176, 33, 57.

Upon the other hand, for the protection of purchasers and the security of title, it is provided that when a discovery has been allowed, and the time for appeal elapsed, the sufficiency of that discovery cannot afterwards be questioned in any proceeding or Court; and a certificate of record even without allowance of discovery is impeachable only when obtained by fraud or issued in mistake. See sections 92, 65.

To meet cases where a discovery of valuable mineral cannot readily be made upon the lands, the Act provides for the granting of what are called Working Permits, which give the licensee exclusive possession of an area of the size and form of a mining claim for six months, renewable for a further six months, that he may thoroughly prospect the property or sink upon it without interference from other prospectors. To obtain a working permit, the lands must be staked out and applied for as provided in the Act. The area remains open to other prospectors for 60 days after the staking out. Failure to carry out the required amount of work forfeits the permit. If the holder of a permit makes a discovery of valuable mineral he must stake out and record a mining claim in the usual way. If he fails to do so, his rights are at an end upon the expiration of the permit. See sections 94-103.

Where a prospector finds a vein or other indications of valuable mineral, not sufficient to stake a claim upon, but which he desires to follow up, he may while diligently pursuing his search thereon keep other prospectors off that particular place (not exceeding 150 by 50 feet) by planting prospecting pickets and marking a line, as provided in section 56.

The Act makes provision for speedy and inexpensive adjudication of disputes regarding unpatented mining lands. These are to be dealt with by the Mining Recorder of the division and by the Mining Commissioner, subject to appeal to the ordinary Court, the hearings being held in the local districts. See sections 123-156.

It is intended, as far as possible, to protect the honest prospector who complies substantially and to the best of his ability with the requirements of the Act from being defeated of any just claim by technicality, but a prospector should always endeavour, if he desires to avoid trouble and possibility of loss, to follow the provisions of the Act as carefully and accurately as possible.

Maps and blank forms and other general information can be obtained from the Bureau of Mines, Toronto, or from any Mining Recorder.

PART I.—PRELIMINARY.

INTERPRETATION.

2. In this Act — Interpretation.

(*a*) "Agent" where it occurs in Parts IX and X shall mean any person having, on behalf of the owner the care or direction of a mine, or of any part thereof. — "Agent."

(*b*) "Commissioner" shall mean the Mining Commissioner. — "Commissioner."

(*c*) "Crown lands" shall not include lands in the actual use or occupation of the Crown, or of any public Department of the Government of the Dominion of Canada or of Ontario, or of any officer or servant thereof, or under lease or license of occupation from the Crown or the Minister of Lands, Forests and Mines, or set apart or appropriated by any lawful authority for any public purpose or vested in the Temiskaming and Northern Ontario Railway Commission. — "Crown lands."

(*d*) "Department" shall mean the Department of Lands, Forests and Mines. — "Department."

(*e*) "Deputy Minister" shall mean the Deputy Minister of Mines. — "Deputy Minister."

(*f*) "In place" when used in reference to mineral shall mean in the place or position where originally formed in the solid rock, as distinguished from being in loose, fragmentary or broken rock, boulders, float, beds or deposits of gold-, or platinum-bearing sand, earth, clay, or gravel, or placer. — "In place."

(*g*) "Inspector" shall include an inspector appointed under this Act, for a Mining Division or any part thereof, or for the Province, and any officer having the powers of an inspector. — "Inspector."

(*h*) "Licensee" shall mean a person, mining partnership or company holding a miner's license issued under this Act or any renewal thereof. — "Licensee."

(*i*) "Machinery" shall include steam and other engines, boilers, furnaces, stamps and other crushing apparatus, winding and pumping gear, chains, trucks, tramways, tackle blocks, ropes and tools, and all appliances used in or about or in connection with a mine. — "Machinery."

(*j*) The noun "mine" shall include any opening or excavation in, or working of, the ground for the purpose of winning, — "Mine."

opening up or proving any mineral or mineral-bearing substance, and any ore body, mineral deposit, stratum, soil, rock, bed of earth, clay, gravel or cement, or place where mining is or may be carried on and all ways, works, machinery, plant, buildings and premises below or above ground, belonging to, or used in connection with the mine, and also for the purposes of Parts IX and X, any excavation or opening in the ground made for the purpose of searching for mineral, and any roast yard, smelting furnace, mill, work or place used for or in connection with crushing, reducing, smelting, refining or treating ore, mineral or mineral-bearing substance.

(*k*) The verb "mine" and the word "mining" shall include any mode or method of working whereby the soil or earth or any rock, stone or quartz may be disturbed, removed, washed, sifted, roasted, smelted, refined, crushed or dealt with for the purpose of obtaining any mineral therefrom, whether the same may have been previously disturbed or not, and also for the purposes of Parts IX and X of this Act all operations and workings mentioned in paragraph (*j*) of this section. 6 Edw. VII. c. 11, s. 2; 7 Edw. VII. c. 13, s. 2. "Mine." "Mining."

(*l*) "Mineral" or "Minerals" shall include coal, gas, oil and salt. "Mineral."

(*m*) "Mining lands" shall include lands and mining rights patented or leased under or by authority of any statute, regulation, or Order in Council, respecting mines, minerals or mining, and also lands or mining rights located, staked out, used or intended to be used for mining purposes. "Mining lands."

(*n*) "Mining rights" shall mean the ores, mines and minerals on or under any land where the same are or have been dealt with separately from the surface. "Mining rights."

(*o*) "Minister" shall mean the Minister or Acting Minister of Lands, Forests and Mines. "Minister."

(*p*) "Owner" when used in Parts IX and X of this Act shall include every person, mining partnership, and company being the immediate proprietor or lessee or occupier of a mine, or of any part thereof, or of any lands located, patented or leased as mining lands but shall not include a person, or a mining partnership or company receiving merely a royalty, rent or fine from a mine or mining lands, or being merely the proprietor of a mine or mining lands subject to a lease, grant or other authority for the working thereof, or the owner of the surface rights and not of the ore or minerals. "Owner."

(*r*) "Patent" shall mean a grant from the Crown in fee simple or for any less estate made under the Great Seal. "Patent."

(*s*) "Prescribed" shall mean prescribed by this Act or by Order in Council or by rule or regulation made under the authority of this Act. "Prescribed."

(*t*) "Recorder" shall mean the Mining Recorder of the Mining Division in which the lands in respect of which an act, matter or thing is to be done are situate. "Recorder."

(*u*) "Regulation" shall mean a regulation made by the Lieutenant-Governor in Council under the authority of this Act. "Regulation."

(*v*) "Shaft" shall include a pit. "Shaft."

(*w*) "Surface rights" shall mean lands granted, leased or located for agricultural or other purposes, the ores, minerals and mines whereof or under the surface whereof are reserved to the Crown. "Surface rights."

(*x*) "Valuable mineral in place," shall mean a vein, lode or deposit of mineral in place appearing at the time of discovery to be of such a nature and containing in the part thereof then exposed such kind and quantity of mineral or minerals in place, other than limestone, marble, clay, marl, peat or building stone, as to make it probable that the vein, lode or deposit is capable of being developed into a producing mine likely to be workable at a profit. 6 Edw. VII. c. 11, s. 2; 7 Edw. VII. c. 13, s. 3. "Valuable mineral."

LICENSES TO MINE AND LICENSE HOLDERS.

22.—(1) No person, mining partnership or company not the holder of a miner's license shall prospect for minerals upon Crown lands or lands of which mining rights are in the Crown, or stake out, record or acquire any unpatented mining claim, quarry claim, or area of land for a working permit or for a boring permit, or acquire any right or interest therein. 6 Edw. VII. c. 11, s. 84; 7 Edw. VII. c. 13, s. 27. License required.

26. A person who is not a licensee shall not prospect for minerals or stake out a mining claim, quarry claim, or area of mining land for the purpose of obtaining a working permit or boring permit on behalf of a mining partnership or a company. 7 Edw. VII. c. 13, s. 27. Unlicensed person not to act for partnership or company.

PART II.—MINING CLAIMS.—MINERAL IN PLACE.

WHAT LANDS OPEN.

34 Subject to the provisions herein contained, the holder of a miner's license may prospect for minerals and stake out a mining claim on any:— Where licensee may prospect for minerals.

(*a*) Crown lands surveyed or unsurveyed;

(*b*) Lands, the mines, minerals or mining rights whereof have been reserved by the Crown in the location, sale, patent or lease of such lands;

not at the time:—

(i) Under staking or record, as a mining claim which has not lapsed or been abandoned, cancelled or forfeited;

(ii) Under a subsisting working permit; or

(iii) Withdrawn, by an Act, Order-in-Council or other competent authority from prospecting, location or sale, or declared by any such authority to be not open to prospecting, staking out or sale as mining claims. 6 Edw. VII. c. 11, s. 131; 7 Edw. VII. c. 13, s. 34.

DISCOVERER MAY STAKE OUT A CLAIM.

35. A licensee who discovers valuable mineral in place on any lands open to prospecting, or a licensee upon whose behalf valuable mineral in place is discovered by another licensee upon any such lands, may stake out or have staked out for him a mining claim thereon, and, subject to the other provisions of this Act, may work the same and transfer his interest therein to another licensee; but where the surface rights in the lands have been granted, sold, leased, or located by the Crown, compensation must be made as provided in section 104. 7 Edw. VII. c. 13. s. 35. When claim may be staked.

37.—(1) Notwithstanding that the mines or minerals therein have been reserved to the Crown, no person, mining partnership or company shall prospect for minerals upon the part of any lot used as a garden, orchard, vineyard, nursery, plantation or pleasure ground, or upon which crops which may be damaged by such prospecting are growing, or on that part of any lot upon which is situated any spring, artificial reservoir, dam or waterworks, or any dwelling house, out-house, manufactory, public building, church or cemetery, except with the consent of the owner, lessee or locatee of the surface rights, or by order of the Recorder or the Commissioner, and upon such terms as to him may seem just. 6 Edw. VII., c. 11, s. 121. Lands used or occupied as gardens, etc.

(2) If any dispute arises between the intending prospector and the owner, lessee, or locatee as to land which is exempt from prospecting under subsection 1, the Recorder or the Commissioner shall determine the extent of the land which is so exempt. (*New.*)

Disputes as to lands exempt.

38. A water power, lying within the limits of a mining claim, which at low water mark, in its natural condition, is capable of producing 150 horse-power or upwards shall not be deemed to be part of the claim for the uses of the licensee, and a road allowance of one chain in width shall be reserved on both sides of the water together with such additional area of land as in the opinion of the Recorder or the Commissioner may be necessary for the development and utilization of such water power. 6 Edw. VII. c. 11, s. 155.

Valuable water powers not included in claim.

SIZE AND FORM OF MINING CLAIMS.

49. A mining claim in unsurveyed territory shall be laid out with boundary lines running north and south and east and west astronomically and the measurements thereof shall be horizontal, and in a township surveyed into lots or quarter sections or subdivisions of a section, a mining claim shall be such part of a lot or quarter section or subdivision of a section as is hereinafter defined, and the boundaries of all mining claims shall extend downwards vertically on all sides. 6 Edw. VII. c. 11, s. 108.

Lines how to be run.

Mining Claims not in a Special Mining Division.

50. Except in a Special Mining Division,

(*a*) A mining claim in unsurveyed territory shall be a square of 40 acres, being 20 chains (1,320 ft.) on each side;

Size and form of claim.

(*b*) Where mining locations the property of the Crown in unsurveyed territory have been surveyed in conformity with any Act into blocks of the following dimensions, namely, 20 chains in length by 20 chains in width, 40 chains in length by 20 chains in width, 40 chains square, or 80 chains in length by 40 chains in width, or thereabouts, and the plans and field notes of such locations are of record in the Department, a mining claim staked out thereon shall be 20 chains in length by 20 chains in width, and one claim shall comprise the whole of a loca-

Mining locations heretofore surveyed in unsurveyed territory.

tion 20 chains square. A location 40 chains in length by 20 chains in width may be divided into two mining claims by a line drawn through the centre thereof parallel to one of the shorter boundaries. In the case of a location 40 chains square a claim shall consist of one or other of the following subdivisions: the northeast quarter, the northwest quarter, the southeast quarter, or the southwest quarter. In a location 80 chains in length by 40 chains in width where the length of the location is north and south, a claim shall consist of the northeast quarter of the north half, the northwest quarter of the north half, the southeast quarter of the north half, the southwest quarter of the north half or any like subdivision of the south half; and where the length of a location is east and west a claim shall consist of the northeast quarter of the east half, the northwest quarter of the east half, the southeast quarter of the east half, or the southwest quarter of the east half, or any like subdivision of the west half. 6 Edw. VII. c. 11, s. 115.

(*c*) In a township surveyed into sections of 640 acres subdivided into quarter sections, or subdivisions containing 160 acres or thereabouts, a mining claim shall consist of the northeast quarter, the northwest quarter, the southeast quarter or the southwest quarter of a quarter section or subdivision, and shall contain 40 acres or thereabouts. 6 Edw. VII. c. 11, s. 111. In townships surveyed into sections of 640 acres.

(*d*) In a township surveyed into lots of 320 acres, a mining claim shall consist of the northwest quarter of the north half, the northeast quarter of the north half, the southwest quarter of the north half, the southeast quarter of the north half, or any like subdivision of the south half, and shall contain 40 acres or thereabouts. 6 Edw. VII. c. 11, s. 112. Townships surveyed into lots of 320 acres.

(*e*) In a township surveyed into lots of 200 acres a mining claim shall consist of the northeast quarter, the southwest quarter, the northwest quarter, or the southeast quarter of the lot, and shall contain 50 acres or thereabouts. 6 Edw. VII. c. 11, s. 113. Townships surveyed into lots of 200 acres.

(*f*) In a township surveyed into lots of 150 acres, a mining claim shall consist of the northeast quarter, the Townships surveyed into lots of 150 acres.

southeast quarter, the northwest quarter, or the southwest quarter of the lot, and shall contain 37½ acres or thereabouts. (*New*).

(*g*) In a township surveyed into lots of 100 acres, a mining claim shall consist of the north half, the south half, the east half, or the west half of the lot, and shall contain 50 acres, or thereabouts. 6 Edw. VII. c. 11, s. 114. In townships surveyed into lots of 100 acres.

Claims in a Special Mining Division.

51. In a Special Mining Division,

(*a*) A mining claim in unsurveyed territory shall be a rectangle of 20 acres, having a length from north to south of 20 chains (1,320 ft.) and a width from east to west of 10 chains (660 ft.). 6 Edw. VII. c. 11, s. 127. In unsurveyed territory

(*b*) Where mining locations the property of the Crown in unsurveyed territory have heretofore been surveyed in conformity with the provisions of any Act into blocks of the following dimensions, namely, 20 chains in length by 20 chains in width, 40 chains in length by 20 chains in width, 40 chains square, or 80 chains in length by 40 chains in width, or thereabouts, and the plans and field notes of such locations are of record in the Department, a mining claim staked out thereon shall consist of the east half or the west half of a location 20 chains square, or the northeast quarter, the southeast quarter, the northwest quarter, or the southwest quarter, of a location 40 chains in length by 20 chains in width; or the west half of the east half of any of the following subdivisions of a location 40 chains square, namely, the northeast quarter, the northwest quarter, the southeast quarter, or the southwest quarter; or the northeast quarter of the northeast quarter, the northwest quarter of the northeast quarter, the southeast quarter of the northeast quarter, or the southwest quarter of the northeast quarter, or any like subdivision of the southeast quarter, the southwest quarter, or the northwest quarter of a location 80 chains in length by 40 chains in width, or where the length of such location is east and west, of the east half or the west half of the northeast Special mining claims on mining locations heretofore surveyed in unsurveyed territory.

quarter of the east half, the east half or the west half of the southeast quarter of the east half, the east half or the west half of the northwest quarter of the east half, or the east half or the west half of the southwest quarter of the east half, or of a corresponding subdivision of the west half of the location, and every such mining claim shall contain 20 acres or thereabouts. 6 Edw. VII. c. 11, s. 128.

(c) In a township surveyed into sections of 640 acres, where the sections have been subdivided into quarter sections, or subdivisions, a mining claim shall consist of either the west half or the east half of the northeast quarter, the southeast quarter, the northwest quarter or the southwest quarter of a quarter section or subdivision, and shall contain 20 acres or thereabouts. 6 Edw. VII. c. 11, s. 123.

In townships surveyed into sections of 640 acres

(d) In a township surveyed into lots of 320 acres, a mining claim shall consist of the northeast quarter of the northeast quarter, the northwest quarter of the northeast quarter, the southeast quarter of the northeast quarter, or the southwest quarter of the northeast quarter, or any like subdivision of the southeast quarter, the southwest quarter, or the northwest quarter of the lot, and shall contain 20 acres or thereabouts. 6 Edw. VII. c. 11, s. 124.

In townships surveyed into lots of 320 acres.

(e) In a township surveyed into lots of 200 acres, a mining claim where the side lines of the lots run northerly and southerly, shall consist of the northeast quarter of the north half, the southeast quarter of the north half, the northwest quarter of the north half, the southwest quarter of the north half, or any like subdivision of the south half; and where the side lines of the lots run easterly and westerly, the mining claim shall consist of the northeast quarter of the east half, the northwest quarter of the east half, the southeast quarter of the east half, the southwest quarter of the east half, or any like subdivision of the west half, and every such mining claim shall contain 25 acres or thereabouts. 6 Edw. VII. c. 11, s. 125.

In townships surveyed into lots of 200 acres.

(f) In a township surveyed into lots of 150 acres a mining claim shall consist of the north half or the south half

In townships surveyed into lots of 150 acres of the northeast quarter, the northwest quarter, the southeast quarter or the southwest quarter of the lot, and shall contain 18¾ acres or thereabouts.

(*g*) In a township surveyed into lots of 100 acres, a mining claim shall consist of the northeast quarter, the southeast quarter, the northwest quarter, or the southwest quarter of a lot, and shall contain 25 acres or thereabouts. 6 Edw. VII. c. 11, s. 126. In townships surveyed into lots of 100 acres

IRREGULAR AREAS, ETC.

52.—(1) In unsurveyed territory an irregular portion of land lying between lands not open to be staked out, or bordering on water, may be staked out with boundaries coterminous thereto, but the claim shall be made to conform as nearly as practicable to the prescribed form and area and shall not exceed the prescribed area. Marking boundaries of irregular areas in unsurveyed territory.

(2) In a surveyed township where, by reason of land covered with water being excluded from the area of a lot, quarter-section or subdivision of a section, or by reason of the lot, quarter-section or subdivision being irregular in form, or from any other cause, it is impossible to stake out a mining claim of the prescribed area in accordance with the foregoing provisions of this Act, the mining claim where practicable shall be of the prescribed form and area and shall have such, if any, of its boundaries as can be so made coincident with boundary lines of the lot, quarter-section or subdivision of a section, and shall have as many as possible of its boundaries which are not so coincident parallel to boundaries of the lot, quarter-section or subdivision which are straight lines, and where necessary to procure the prescribed area the mining claim may extend into any part of the lot or quarter-section or subdivision of a section, but not into any other lot or quarter-section or subdivision of a section, and land lying between lands not open to be staked out or between such lands and a boundary or boundaries of the lot, quarter-section or subdivision of a section, may be staked out with boundaries coterminous thereto, but the claim shall be made to conform as nearly as practicable to the prescribed form and area and shall not exceed the prescribed area. In surveyed townships.

NUMBER OF CLAIMS WHICH MAY BE STAKED OUT.

53. Not more than three mining claims may be staked out, applied for, or recorded in the name of a licensee in any one mining division or in territory not comprised in a mining division during a license year. 7 Edw. VII. c. 13, s. 37. Number of claims which one licensee may record.

STAKING OUT CLAIMS.

54.—(1) A mining claim shall be staked out by:— Staking out and planting

(*a*) Planting or erecting upon an outcropping or showing of mineral in place at the point of discovery a discovery post upon which shall be written or placed the name of the licensee making the discovery, the letter and number of his license, and the date of his discovery, and if the discovery is made on behalf of another licensee for and in whose name the claim is to be staked out and recorded, also the name of such other licensee, and the letter and number of his license; Discovery posts.

(*b*) Planting or erecting a post at each of the four corners of the claim, marking that at the northeast corner "No. 1," that at the southeast corner "No. 2," that at the southwest corner "No. 3," and that at the northwest corner "No. 4," so that the number shall be on the side of the post toward the post next following it in the order named; Corner posts

(*c*) Writing or placing on No. 1 post all the particulars required to be upon the discovery post, and also plainly marking thereon the distance and direction therefrom of the discovery post, and if the claim is situated in a township surveyed into lots, quarter-sections or subdivisions of a section, the part thereof comprised in the claim, mentioning the lot and concession or the section by number. Particulars on No. 1 post.

(*d*) Writing or placing on No. 2, No. 3 and No. 4 posts the name of the licensee making the discovery, and if the discovery is made on behalf of another licensee for and in whose name the claim is being staked out, also the name of such other licensee; and Marking name of licensee, etc.

(*e*) Plainly blazing the trees on two sides only where there are standing trees, and cutting the underbrush along the boundary lines of the claim and plainly blazing a line from No. 1 post to the discovery post, or where there are no standing trees, clearly indicating the outlines of the claim, and marking a line from No. 1 post to the discovery post by planting durable pickets, not less than five feet in height thereon at intervals of not more than two chains (132 feet), or by erecting at Marking boundaries and blazing or picketing.

such intervals monuments of earth or rock not less than two feet in diameter at the base, and at least two feet high, so that the lines may be distinctly seen.

Witness post.

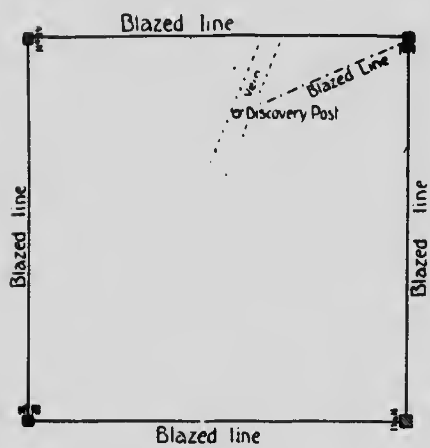
(2) Where at a corner of the claim the nature or conformation of the ground renders the planting or erecting of a post impracticable, such corner may be indicated by planting or erecting at the nearest practicable point a witness post which shall bear the same marking as that prescribed for the corner post at that corner, together with the letters "W. P." and an indication of the direction and distance of the site of the true corner from the witness post. 7 Edw. VII. c. 13, s. 36.

Mode of planting, squaring, etc. of posts.

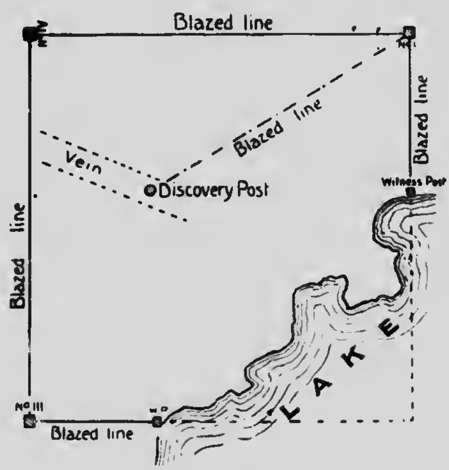
(3) Every post shall stand not less than four feet above the ground, and shall be squared or faced on four sides for at least one foot from the top, and each side shall measure at least four inches across where squared or faced, but a standing stump or tree may be used as a post if cut off and squared and faced to such height and size, and when the survey is made the centre of the tree or stump where it enters the ground shall be taken as the point to or from which the measurement shall be made.

Form of claim

(4) The following diagrams are intended to illustrate the method of staking out a claim as mentioned in subsections 1 and 2. (*New.*)



No. 1.



No. 2.

Staking promptly after discovery.

55. After a discovery of valuable mineral in place, the licensee, if he desires to stake out a claim thereon, shall at once plant or erect his discovery post and proceed as quickly as is reasonably possible to complete the staking out of the claim, and if he is in fact the first licensee to make a discovery of valuable mineral in place and plant a discovery post thereon no other licensee shall be entitled to stake out or interfere with the property while he is so completing the staking out, but if he fails to proceed with the staking out with such diligence and speed, he shall be liable to lose his rights in case another licensee makes a discovery of valuable mineral in place upon the property and completes the staking out before him. 7 Edw. VII. c. 13, s. 36.

Prospecting pickets.

56.—(1) Until a discovery post is planted or erected all licensees shall have equal rights upon lands open to prospecting, except that where a licensee has found what he believes to be a vein or deposit of mineral or to be an indication thereof, he may plant or erect not more than 150 feet apart two pickets, at least four feet in height, to be known as prospecting pickets, each marked with the letters "P.P." and his name and license number and letter, and may dig a trench not less than six feet long and six inches deep from each of such pickets along the line running towards the other picket, or where that is impracticable may erect a monument of rock or earth not less than two feet wide at the base and at least two feet high, extending six feet from each picket towards the other picket, and may also blaze the standing trees, if any, along the line between the pickets, and after he has so done, so long as he is diligently and continuously prospecting or following up indications on the block of land extending twenty-five feet on each side of a straight line between the pickets he shall be entitled to the exclusive right to prospect and to make a discovery thereon.

Not to prevent other licensee from staking out claim.

(2) Nothing in subsection 1 shall prevent any other licensee from prospecting anywhere outside the limits of such block of land, and the first licensee to discover valuable mineral in place and stake out a mining claim thereon shall, subject to the other provisions of this Act, be entitled to the claim, and if the claim includes such block of land the rights of such picketing licensee shall cease.

Licensee not to have more than one block picketed.

(3) A licensee shall not have more than one block of land picketed at one time, and if he has at any time more than one all his picketings shall be void. 7 Edw. VII. c. 13, s. 36.

Forfeiture of right to further staking.

57.—(1) A licensee or other person who for any purpose does any staking out or plants, erects or places any stake, post, or marking upon any lands open to prospecting except as authorized by this Act, or causes or procures the same to be done, or who stakes out or partially stakes out any such lands, or causes or procures the same to be done, and fails to record the staking out with the Recorder within the prescribed time, shall not thereafter be entitled to again stake out such lands or any part thereof, or to record a mining claim thereon, unless he notifies the Recorder in writing of such staking out, partial staking out, or planting, placing or marking and of his abandonment thereof and satisfies the Recorder by affidavit that he acted in good faith and for no improper purpose and pays to the Recorder a fee of $20 and procures from him a certificate stating that the Recorder is satisfied that he so acted. 7 Edw. VII. c. 13, s. 36.

(2) The Recorder shall enter every such certificate in his books with the date of its issue. Entry of certificate of forfeiture.

58. Substantial compliance as nearly as circumstances will reasonably permit with the requirements of this Act as to the staking out of mining claims shall be sufficient. 6 Edw. VII. c. 11, s. 137. Substantial compliance with Act sufficient.

RECORDING MINING CLAIMS.

59.—(1) A licensee who has staked out a mining claim or upon whose behalf a mining claim has been staked out shall, within fifteen days thereafter or within the further time allowed by subsection 4, furnish to the Recorder an outline sketch or plan of the mining claim, showing the discovery post and corner posts and the witness posts (if any) and their distance from each other in feet, together with an application (Form 4) setting forth the name of the licensee by whom the valuable mineral in place was discovered and of the licensee on whose behalf the application is made and the letters and numbers of their licenses, the name, if any, of the claim, and in the case of unsurveyed territory its locality indicated by some general description and such other information as will enable the Recorder to lay down the claim on his office map, or in the case of a surveyed township, designating the lot, quarter-section or subdivision of a section, and the portion thereof comprised in the claim, the length of the outlines, and if for any reason they are not regular the nature of such reason, the situation of the discovery post as indicated by the distance and direction from No. 1 post, the day and hour when the discovery of valuable mineral in place was made, when the claim was staked out and the date of the application, and with the application shall be paid the prescribed fee. Plan and application to be furnished to Recorder by licensee staking out claim.

(2) If a licensee claims to be entitled to a free grant of a mining claim, under section 108, he shall, in addition to the Application for free grant.

application to record the claim, make application (Form 5) for the free grant. 6 Edw. VII. c. 11, s. 156; 7 Edw. VII. c. 13, s. 43.

(3) The application and sketch or plan shall be accompanied by an affidavit (Form 6) made by the discovering licensee showing a discovery of valuable mineral in place upon the claim, with particulars of the kind of ore or mineral discovered, and, if possible, the kind of rock enclosing it, the date of the discovery and of the staking out, that the distances given in the application and sketch or plan are as accurate as they could reasonably be ascertained, and that all the other statements and particulars set forth and shown in the application and sketch or plan are true and correct, that at the tim of staking out there was nothing upon the lands to indicate that they were not open to be staked out as a mining claim, that the deponent verily believes they were so open and that the staking out is valid and should be recorded, and that there are upon the lands or the lot or part lot or section of which they form a part no buildings, clearing or improvements for farming or other purposes except as set forth in the affidavit; and an applicant for a free grant shall also file an affidavit (Form 7) showing his right thereto. (*See* 6 Edw. VII. c. 11, s. 157; 7 Edw. VII. c. 13, s. 44. Affidavit to accompany map, etc.

(4) Where the claim is situate more than ten miles in a straight line from the office of the Recorder for each additional ten miles or fraction thereof an additional day shall be allowed for recording. 6 Edw. VII. c. 11, s. 158. Additional time allowed in consideration of distance.

60. A licensee by or on whose behalf an application is made to record a mining claim shall at the time of the application produce the license of the licensee by whom the staking out was done and of the licensee by or on whose behalf the application is made to the Recorder, and the Recorder shall endorse and sign upon the back of the last mentioned license a note in writing of the record of the claim, and no such record shall be complete or effective until such endorsement is made unless upon application to or in any case coming before the Commissioner he deems it just that compliance with the requirements of this section should be excused. 6 Edw. VII. c. 11, s. 59; 7 Edw. VII. c. 13, s. 14. License to be marked as claims recorded.

61. If by error a licensee records a mining claim in a division other than that in which the claim is situate the error shall not affect his title to the claim, but he shall within fifteen days from the discovery of the error record the claim in the division Licensee recording in another division by error.

in which it is situate, and the new record shall bear the date of the former record, and a note shall be made thereon of the error and of the date of rectification. 6 Edw. VII. c. 11, s. 81.

62.—(1) The Recorder shall forthwith enter in the proper book in his office the particulars of every application to record a mining claim which he deems to be in accordance with the provisions of this Act, unless a prior application is already recorded for the same, or for any substantial portion of the same lands or mining rights, and he shall file the application, sketch or plan and affidavit with the records of his office; and every application proper to be recorded shall be deemed to be recorded when it is received in the Recorder's office, if all requirements for recording have been complied with, notwithstanding that the application may not have been immediately entered in the record book. What claim to be recorded.

(2) If an application is presented which the Recorder deems to be not in accordance with this Act, or which is for lands or mining rights which or any substantial portion of which are included in a subsisting recorded claim, he shall not record the application, but shall, if desired by the applicant, upon receiving the prescribed fee, receive and file the application, and the applicant may appeal to the Commissioner against the Recorder's refusal to record; but such filing shall not be deemed a dispute of the recorded claim, nor shall it be noted or dealt with as such, unless a dispute verified by affidavit is filed with the Recorder by the applicant or by another licensee on his behalf as in the next following section provided. 7 Edw. VII. c. 13, s. 13, *part*. Procedure when refused.

DISPUTING APPLICATIONS.

63.—(1) A dispute (Form 8) verified by affidavit (Form 9) may be filed with the Recorder by a licensee alleging that any recorded claim is illegal or invalid in whole or in part, and if the disputant or the licensee in whose behalf he is acting claims to be entitled to be recorded for or to be entitled to any right or interest in the lands or mining rights, or in any part thereof comprised in the disputed claim the dispute shall so state, giving particulars; and the Recorder shall, upon payment of the prescribed fee, receive and file such dispute, and shall enter a note thereof upon the record of the disputed claim. Dispute of recorded claim.

(2) A copy of the dispute and affidavit shall be left by the disputant with the Recorder who shall not later than the next day after the filing of the dispute transmit such copy by registered post to the recorded holder of the mining claim affected Not to be received after certificate issued.

thereby. If the copy is not left, the Recorder may refuse to file or note the dispute or may collect from the disputant ten cents per folio for making the copy.

(3) A dispute shall not be received unless it contains or has endorsed thereon an address for service at some place not more than five miles distant from the Recorder's office, and the provisions of subsections 4 and 5 of section 133 shall apply in respect to service upon the disputant. 7 Edw. VII. c. 13, s. 13, *part.*

(4) A dispute shall not be received or entered against any claim after a certificate of record thereof has been granted, nor except by leave of the Commissioner after the validity of the claim has been adjudicated upon by the Recorder or by the Commissioner, or after it has been on record for sixty days and has already had a dispute entered against it; but this amendment is not retroactive and shall not apply to any case where such validity has heretofore been adjudicated upon by the Recorder or by the Commissioner. (As amended in 1910, by 10 Edw. VII. c. 26, s. 35.)

CERTIFICATE OF RECORD

64. Where a mining claim not within a Complete Inspection Area has been recorded for sixty days and the alleged discovery has not been adversely reported upon by the inspecting officer, or where a mining claim within a Complete Inspection Area has been recorded for sixty days, and the discovery upon which it is based has been inspected and finally allowed, upon application of the holder of the claim, and if there is no dispute standing against the claim and the surface rights compensation, if any, has been paid or secured, the Recorder, unless by reason of an order pending proceeding or other special matter or thing it would be improper to do so, shall give to such holder a certificate of record (Form 10), or if a portion of the claim is unaffected by any of the matters aforesaid he may, if he deems proper, give a certificate of record as to such portion. 7 Edw. VII. c. 13, s. 13, *part.* Granting certificate of record

65. The certificate of record, in the absence of mistake or fraud, shall be final and conclusive evidence of the performance of all the requirements of this Act, except working conditions, in respect to the mining claim up to the date of the certificate; and thereafter the mining claim shall not in the absence of mistake or fraud be liable to impeachment or forfeiture except as expressly provided by this Act. 6 Edw. VII. c. 11, s. 71; 7 Edw. VII. c. 13, s. 22. Effect of issue and delivery of certificate of issue.

66. Where the certificate of record has been issued in mistake or has been obtained by fraud, the Commissioner shall have power to revoke and cancel it on the application of the Crown or an officer of the Bureau of Mines, or of any person interested. Cancelling certificate of record issued by mistake, etc.

EXTENT OF RIGHTS IN MINING CLAIMS.

67. Subject to the provisions of section 65, a licensee shall not acquire any right to or interest in a mining claim unless a discovery of valuable mineral in place has been made thereon by him or by another licensee on his behalf. 6 Edw. VII, c. 11, s. 117; 7 Edw. VII, c. 13, s. 31. Discovery of valuable mineral necessary to valid claim.

68. The staking out or the filing of an application for, or the recording of a mining claim, or all or any of such acts, shall not confer upon a licensee any right, title, interest or claim in or to the mining claim other than the right to proceed, as in this Act provided to obtain a certificate of record and a patent from the Crown; and prior to the issue of a certificate of record the licensee shall be merely a licensee of the Crown, and after the issue of the certificate and until he obtains a patent he shall be a tenant at will of the Crown in respect of the mining claim. 7 Edw. VII c. 13, s. 38. Rights in claim.

ADDRESS FOR SERVICE.

69.—(1) Every application for a mining claim or a working permit and every other application and every transfer or assignment of a mining claim or of any right or interest acquired under the provisions of this Act shall contain, or have endorsed thereon, the place of residence and post-office address of the applicant, transferee or assignee, and also, when he is not a resident in Ontario, the name, residence and post-office address of some person resident in Ontario upon whom service may be made. Address for service to be on application for claim, etc.

(2) No such application, transfer or assignment shall be filed or recorded unless it conforms with the provisions of the next preceding subsection. Application, etc., must contain address.

(3) Another person resident in Ontario may be substituted as the person upon whom service may be made by filing in the office in which any such application, transfer or assignment is filed or recorded, a memorandum setting forth the name, residence and post-office address of such other person and such substitution may be made from time to time as occasion may require. Substituting new agent for service.

(4) Service upon the person named as the person upon whom service may be made, unless another person has been substituted for him under the provisions of subsection 3, and in case of such substitution upon the person substituted, shall have the same effect as service upon the person whom he represents.

Service upon agent to be sufficient.

(5) The provisions of the next preceding subsection shall apply to every notice, demand or proceeding in any way relating to a mining claim or to mining rights or to any other right or interest which may be acquired under the provisions of this Act. (*New*).

General application of section.

TRUSTS, AGREEMENTS AND TRANSFERS.

70.—(1) Notice of a trust, express, implied or constructive, relating to any unpatented mining claim shall not be entered on the record or be received by a Recorder.

Mining Recorder not to record any claim "in trust."

(2) Describing the holder of the mining claim as a trustee, whether the beneficiary or object of the trust is mentioned or not, shall not impose upon any person dealing with such holder, the duty of making any inquiry as to his power to deal therewith, but the holder may deal with the claim as if such description had not been inserted.

Describing licensee as trustee, etc., effect of.

(3) Nothing in this section contained shall relieve the holder of the mining claim who is in fact a trustee thereof or of any part or share thereof or interest therein, from liability as between himself and any person, mining partnership or company for whom he is a trustee, but such liability shall continue as if this section had not been enacted, nor shall any provision in this Act relieve the holder from any personal liability or obligation. 6 Edw. VII. c. 11, s. 159; 7 Edw. VII. c. 13, s. 45.

Proviso.

71.—(1) No person shall be entitled to enforce any claim, right or interest, contracted for or acquired before the staking out, to or in or under any staking out or recording of a mining claim or of any mining lands or mining rights done in the name of another person unless the fact that such first-mentioned person is so entitled is made to appear by a writing signed by the holder of the claim or by the licensee by whom or in whose name the staking out or recording was done, or the evidence of such first-mentioned person is corroborated by some other material evidence, and where a right or interest is so made to appear the provisions of the Statute of Frauds shall not apply.

What rights enforceable only when writing signed.

(2) No person shall be entitled to enforce any contract, made after the staking out, for sale or transfer of a mining claim or any mining lands or mining rights, or any interest in or concerning the same, unless the agreement or some note or memorandum thereof is in writing signed by the person against whom it is sought to enforce the contract or by his agent thereunto by him lawfully authorized. (*See* B. C. 1898, c. 33, s. 15); 7 Edw. VII. c. 13, s. 45.

Transfer, form of

72. A transfer of an unpatented mining claim or of any interest therein may be in Form 11 and shall be signed by the transferor or by his agent authorized by instrument in writing. 6 Edw. VII. c. 11, s. 118; 7 Edw. VII. c. 13, s. 32.

RECORDING DOCUMENTS.

Prerequisites for recording instruments.

73. Except as in this Act otherwise expressly provided, no transfer or assignment of or agreement or other instrument affecting a mining claim or any recorded right or interest acquired under the provisions of this Act, shall be entered on the record or received by a Recorder unless the same purports to be signed by the recorded holder of the claim or right or interest affected, or by his agent authorized by recorded instrument in writing, nor shall any such instrument be recorded without an affidavit (Form 12) attached to or endorsed thereon, made by a subscribing witness to the instrument.

Recorded instruments to have priority.

74. After a mining claim or any other right or interest acquired under the provisions of this Act has been recorded every instrument other than a will affecting the claim or any interest therein shall be void as against a subsequent purchaser or transferee for valuable consideration without actual notice unless such instrument is recorded before the recording of the instrument under which the subsequent purchaser or transferee claims.

Recording to be notice.

75. The recording of an instrument under this Act shall constitute notice of the instrument to all persons claiming any interest in the claim subsequent to such recording, notwithstanding any defect in the proof for recording, but nevertheless it shall be the duty of the Recorder not to record an instrument except upon the proof required by this Act. *See* R.S.O. c. 136, s. 92.

Priority of recording to prevail.

76. Priority of recording shall prevail unless before the prior recording there has been actual notice of the prior instrument by the party claiming under the prior recording. *See* R.S.O. c. 136, s. 97.

77.—(1) The Recorder shall enter upon the record of any unpatented mining claim or other recorded right or interest a note of any order or decision made by him affecting the same, giving its date and effect and the date of the entry; and he shall upon receiving with the prescribed fee, an order of decision of the Commissioner, or an order, judgment or certificate in an appeal from him, or a certified or sworn copy thereof, file the same and enter a note thereof upon the record of the claim or right or interest affected thereby. Recording orders and judgments.

(2) In a proceeding calling in question any interest in an unpatented mining claim or other recorded right or interest the Commissioner or Recorder may issue a certificate (Form 13) and upon receipt thereof and payment of the prescribed fee the Recorder shall file and note it as herein above directed. Recording certificate of *lis pendens*.

(3) The filing of a certificate shall be actual notice to all persons of the proceeding. Filing certificate to be notice.

(4) The certificate, and the filing and noting thereof, shall be of no effect for any purpose whatever after the expiration of ten days from the date of filing unless within that time an order continuing the same is obtained from the Commissioner or the Recorder, and any person interested may at any time apply to the Commissioner for an order vacating the certificate. 7 Edw. VII. c. 13, s. 46. Duration of certificate of *lis pendens*.

WORKING CONDITIONS.

78.—(1) The recorded holder of a mining claim shall perform thereon work which shall consist of stripping or opening up of mines, sinking shafts or other actual mining operations as follows:— Working conditions on mining claims.

(*a*) During the three months immediately following the recording, to the extent of thirty days of not less than 8 hours per day;

(*b*) During each of the first and second years following the expiration of such three months, to the extent of 60 days of not less than 8 hours per day;

(*c*) During the third year following the expiration of such three months, to the extent of not less than 90 days of 8 hours per day.

(2) The work may be completed in a less period of time than herein specified. If more work is performed by or on behalf of the recorded holder than is herein required during the first three months or in any subsequent year, the excess Work may be done within earlier period

upon proof of the same having been performed shall be credited by the Recorder upon the work required to be done during any subsequent year. 6 Edw. VII. c. 11, s. 160.

Report of holder upon work.

(3) The recorded holder of a mining claim shall, not later than 10 days after each of the periods specified, make a report (Form 14) as to the work done by him during such period, verified by affidavit (Form 15), but a report shall not be required for any period in which in consequence of the work having been previously done and reported no work has been done. The report shall show in detail the names and residences of the men who performed the work and the dates upon which each man worked in its performance. 6 Edw. VII. c. 11, s. 161; 7 Edw. VII. c. 13, s. 47. (*As amended in* 1910, *by* 10 *Edw. VII. c.* 26, *s.* 45 (1)).

Certificate of performance.

(4) The Recorder if satisfied that the prescribed work has been duly performed may grant a certificate (Form 16), but he may first if he deems proper inspect or order the inspection of the work, or otherwise investigate the question of its sufficiency. Such certificate, in the absence of fraud or mistake, shall be final and conclusive evidence of the due performance of the work therein certified, but where it has been issued in mistake or obtained by fraud the Commissioner shall have power to revoke and cancel it upon the application of the Crown or an officer of the Bureau of Mines or any person interested. The question of the due performance of work shall not be appealable beyond the Commissioner. 6 Edw. VII. c. 11, ss. 162, 61; 7 Edw. VII. c. 13, ss. 48, 51. (*As amended in* 1910 *by* 10 *Edw. VII c.* 26, *s.* 45 (3)).

Performance of work on contiguous claims.

(5) A licensee who has given notice (Form 17) to the Recorder of his intention to perform all the work required to be performed in respect of not more than three contiguous mining claims upon one or two of them, may perform such work upon the claim or claims so specified and the report and affidavit as to work may be made accordingly. 6 Edw. VII. c. 11, s. 163; 7 Edw. VII. c. 13, s. 49.

Certain work not included as "actual mining operations."

(6) The construction of houses or roads or other like improvements shall not constitute "actual mining operations" within the meaning of this section.

Computation of Time—Extensions.

Periods excluded in computing time for performance of working conditions.

79. In computing the time within which work upon a mining claim is required to be performed, the following periods of time shall be excluded:—

(*a*) All time which by an Order in Council or regulation is excluded;

(*b*) In a Forest Reserve the time elapsing between the delivery by the holder of a mining claim to the Bureau of Mines of an application to work upon the same and the granting of such permission. 6 Edw. VII. c. 11, s. 161; 7 Edw. VII. c. 13, s. 50.

(*c*) In the case of lands under timber license the time during which working conditions are suspended under section 47;

(*d*) The time during which mining operations are prohibited by the Minister under section 48.

Extension of time for performance.

80.—(1) If by reason of pending proceedings or of the death or incapacity from illness of the holder of a mining claim the work is not performed within the prescribed time, the Recorder may from time to time extend the time for the performance of such work for such period as he may deem reasonable and he shall forthwith enter a note of every such extension on the record of the claim. 6 Edw. VII. c. 11, s. 72; 7 Edw. VII. c. 13, s. 51.

(2) Work performed within any such extended period shall be deemed to have been duly performed under section 78.

Proportionate contribution by co-owners.

81. Where two or more persons are the holders of an unpatented mining claim, each of them shall contribute proportionately to his interest, or as they may otherwise agree between themselves, to the work required to be done thereon. In case of default by any holder the Commissioner upon the application of any other holder and upon notice to and after hearing all persons interested or such of them as appear, may make an order vesting the interest of the defaulter in the other co-owners upon such terms and conditions and in such proportions as he may deem just.

This provision shall apply to all mining claims staked out or applied for on or after the 14th day of May, 1906, or before that day under regulations made under the authority of *The Mines Act*, being chapter 36 of the Revised Statutes of Ontario, 1897.

ABANDONMENT.

Licensee may abandon mining claim.

82.—(1) A licensee may, at any time, abandon a mining claim by giving notice in writing (Form 18) to the Recorder of his intention so to do.

Entry of note of abandonment.

(2) The Recorder shall enter a note of such abandonment upon the record of the claim, with the date of the receipt of the

notice and thereupon all interest of the licensee in such claim shall cease and determine, and the claim shall thereupon be forthwith open for prospecting and staking out. 6 Edw. VII. c. 11, s. 165; 7 Edw. VII. c. 13, s. 54.

83. Non-compliance by the licensee with any requirement of this Act as to the time or manner of the staking out and recording of a mining claim or with a direction of the Recorder in regard thereto, within the time limited therefor, shall be deemed to be an abandonment, and the claim shall, without any declaration, entry or act on the part of the Crown or by any officer, unless otherwise ordered by the Commissioner, be forthwith open to prospecting and staking out. 6 Edw. VII. c. 11, s. 166; 7 Edw. VII. c. 13, s. 54 (*as amended in* 1909 *by* 9 *Edward VII. c. 26, s. 31* (*1*)). Non-compliance with Act or direction of Mining Recorder to be deemed abandonment.

FORFEITURE.

84.—(1) Except as provided by section 85, all the interest of the holder of a mining claim before the patent thereof has issued shall cease and the claim shall without any declaration, entry or act on the part of the Crown or by any officer forthwith be open for prospecting and staking out:— Causes of forfeiture of mining claim

(*a*) If the license of the holder has expired, and has not been renewed.

(*b*) If without the consent in writing of the Recorder or Commissioner, or for any purpose of fraud or deception or other improper purpose, the holder removes or causes or procures to be removed any stake or post forming part of the staking out of such mining claim, or for any such purpose changes or effaces or causes to be changed or effaced any writing or marking upon any such stake or post.

(*c*) If the prescribed work is not duly performed.

(*d*) If any report under subsection 3 of section 78 is not made and deposited with the Recorder as therein required.

(*e*) If the application and payment for the patent required by sections 106 and 107 are not made within the prescribed time. 6 Edw. VII. c. 11, s. 168; 7 Edw. VII. c. 13, s. 52 (*as amended in* 1909, *by* 9 *Edw. VII, c. 26*, s. *31* (*2*)).

(2) No person other than the Minister or an officer of the Bureau of Mines or a licensee interested in the property affected shall be entitled to raise any question of forfeiture except by leave of the Commissioner.

86.—(1) Forfeiture or loss of rights under section 84 shall not take place for three months after default, if

Forfeiture postponed in certain cases

(*a*) In a case under paragraph (*a*) the holder of the claim obtains a special renewal license which shall be so marked and shall be issued only upon payment of three times the prescribed license fee;

(*b*) In a case under paragraph (*d*) the holder files a proper report and pays therewith a special fee of $25;

Relieving against forfeiture in other cases.

(2) Where compliance with any of the other requirements mentioned in section 84 has been prevented by pending proceedings or by any other special cause not reasonably within the control of the holder, the Commissioner within three months after default may upon such terms as to compensation for expenses incurred by any other licensee who has acquired any interest in the claim during such period and upon such other terms as he may deem just make an order relieving the person in default from the forfeiture or loss of rights and upon compliance with the terms if any so imposed the order may be filed with the Recorder and thereupon the interest or rights forfeited or lost shall re-vest in the person so relieved.

Entry of forfeiture by Recorder.

(3) The Recorder upon any forfeiture or abandonment of or loss of rights in a mining claim shall forthwith enter a note thereof with the date of the entry upon the record of the claim and mark the record of the claim "Cancelled," and shall forthwith post up in his office a notice of the cancellation. 7 Edw. VII. c. 13, s. 53.

Interest of joint holder on expiry of his license.

87. In the case of joint holders where the interest of a holder has ceased by reason of expiration of his license, such interest shall, if the Minister so directs, pass to and vest in the other holders in proportion to their interests in the claim.

Death of licensee before record or of holder before patent.

88. Where a licensee in whose name a mining claim has been staked out dies before the claim is recorded, and where the holder of a claim dies before issue of a patent for the claim no other person shall, without leave of the Commissioner, be entitled to stake out or record a mining claim upon any part of the same lands or to acquire any right, privilege or interest in respect thereof within twelve months after the death of such licensee or holder, and the Commissioner may within such twelve months make such order as may seem just for vesting the claim in the representatives of such holder notwithstanding any lapse, abandonment, cancellation, forfeiture or loss of rights under any provision of this Act. (*New.*)

94.—(1) A licensee may obtain a working permit giving him, for the purpose of prospecting for minerals, the exclusive possession of an area of land open to prospecting and staking out, such area being of the form and acreage prescribed for a mining claim, by proceeding in the following manner: Right to obtain working permit on staking out area.

(*a*) By staking the corners and marking the boundaries of such area and placing numbers and particulars upon the posts in the same manner as far as possible as is provided in section 54 in respect to mining claims, omitting only what is provided in respect of discovery and the discovery post, but the words "working permit applied for" shall be written or placed on No. 1 post and each post shall be notched with three rings of notches not less than ¼ inch deep and not less than 2 inches apart, beginning about 2 inches from the top of the post. 7 Edw. VII. c. 13, s. 39.

(*b*) By furnishing to the Recorder within 15 days after the staking out, an application in duplicate (Form 19), together with a map or plan, in duplicate, indicating generally and as definitely as possible the location of the area by reference to some ascertained boundary or locality, together with an affidavit (Form 20), stating the name of the licensee on whose behalf the application is made, and the letter and number of his license, the locality of the area as indicated by some general description and statement, and such other information as will enable the Recorder to lay down the area on his office map, and the time when the area was staked out, that at the time the area was staked out there was nothing on it to indicate that it was not open to be staked out for a working permit, that the deponent knows of no reason why the working permit should not be granted, and that he verily believes the applicant is entitled under the provisions of this Act to make the application. Where the area is situated more than ten miles in a straight line from the office of the Recorder, an additional day shall be allowed for furnishing the application for each additional ten miles or fraction thereof.

(*c*) By procuring from the Recorder a certificate of the application (Form 21) and securely affixing the same to No. 1 post within three days after the granting of the certificate, and where the area is more than ten miles in a straight line from the office of the Recorder an additional day shall be allowed for each additional ten miles or fraction thereof.

(*d*) By paying or securing to the owner of the surface rights in the case of lands the surface rights of which have been theretofore granted, sold, leased or located, compensation for the injury or damage arising from the prospecting of such lands, as prescribed by section 104.

(2) Upon compliance with the provisions of subsection 1 and payment of the prescribed fee, the applicant shall, after sixty days and within seventy days from the staking out of the area, procure from the Recorder a working permit (Form 22), which shall be for a period of six months from the date of its issue. Provided that in case the granting of a working permit is prevented by the recording of a mining claim after the property was staked out for the working permit or by any pending dispute or by failure of the applicant after reasonable diligence to arrange with the owner of any surface rights as to the compensation the Recorder or the Commissioner may, notwithstanding the lapse of the seventy days, order the granting of the working permit. 6 Edw. VII. c. 11, s. 141, *part*; 7 Edw. VII. c. 13, ss. 38, 39, 40.

When working permit may issue.

Proviso.

96. A licensee shall not apply for or hold in any license year more than three working permits in any one mining division or in territory not comprised in any mining division. 6 Edw. VII. c. 11, s. 153.

Number of permits which may be granted.

97. Until a working permit has been granted, and a notice thereof (Form 24) has been affixed to No. 1 post, the area included in the application shall be subject to prospecting and staking out as a mining claim by any licensee, but thereafter during the continuance of the working permit or the renewal thereof, if any, the holder thereof shall have the exclusive right to prospect and stake out on the said area. Provided that at any time after the expiration of 60 days from the staking out where it seems just the Commissioner or the Recorder may order that the area shall not be open to prospecting or staking out until the working permit application has been disposed of, and such order shall be effective as soon as a duplicate or certified copy thereof is affixed to the No. 1 post. 6 Edw. VII. c. 11, ss. 141 and 145; 7 Edw. VII. c. 13, s. 42.

Rights of other licensees.

98. Except as otherwise expressly provided, a licensee staking out an area of land for a working permit shall in all respects be subject to the same restrictions and conditions as to prospecting and staking out as are applicable to a licensee prospecting and staking out a mining claim, and without limiting the general application of this section, sections 34, 36 to 41, subsection 3 of section 42, sections 44 to 52, 57, 58, 60 to 63, 69 to 77, and 79 to 89, so far as they can be made applicable, and modified so far as may be necessary, shall apply to an application for a working permit and to a working permit when granted. 6 Edw. VII. c. 11, s. 143. Application of other provisions as to mining claims.

99. Commencing not later than the expiration of two weeks after the granting of a working permit, the holder shall perform upon the area described in the working permit, work consisting of searching for minerals by sinking shafts or pits, digging trenches making cross-cuts, boring by diamond or other drill, or other *bona fide* operations of a like kind to the extent of five days of eight hours per day in each week. Provided that he may perform such work during a lesser period than six months, but so that the amount of work performed shall not at any time be less than that herein prescribed. Working conditions of working permit.

100. A working permit may be transferred (Form 25), and upon the transfer being recorded the transferee shall be entitled to the unexpired term of the working permit and any right of renewal thereof. 6 Edw. VII. c. 11, s. 151. Right to transfer working permit.

101. The Recorder may grant to the holder of a working permit who has complied with the requirements of this Act one renewal thereof (Form 26), for a period of six months, but the renewal shall be subject to the same requirements as to work to be performed and otherwise as the original working permit. 6 Edw. VII. c. 11, s. 152. Right to renewal of working permit.

102. If the holder of a working permit makes a discovery of valuable mineral in place upon the area of land included therein he may stake out and record a mining claim thereon and the necessary variations may be made in the application for the recording of the claim and in the affidavit to be filed therewith. 7 Edw. VII. c. 13, s. 11, *part*. Staking out claim on working permit area.

103. The decision or order of the Commissioner in respect of a working permit or of an application therefor or as to any right or interest thereunder or affected thereby shall be final and shall not be subject to appeal. 7 Edw. VII. c. 13, s. 4, *part*. Decisions of Commissioner to be final.

PART IX.—OPERATION OF MINES.

REGULATIONS.

157. No boy under the age of fifteen years shall be employed or allowed for the purposes of employment to be below ground in any mine; and except in the case of mica trimming works no girl or woman shall be employed at mining work or allowed to be for the purpose of employment at mining work in or about any mine. 6 Edw. VII. c. 11, s. 192. Employment of women and children.

158.—(1) No boy under the age of seventeen years shall be employed or allowed to be below ground for the purpose of employment in any mine on Sunday or for more than eight hours in any one day. Hours of employment for boys.

(2) The time during which any such boy may be below ground for the purpose of employment shall be deemed to begin at the time of leaving and to end at the time of returning to the surface. 6 Edw. VII. c. 11, s. 193.

159. The owner or agent of every mine shall keep in an office at the mine, or in the principal office of the mine belonging to the same owner in the county or district in which the mine is situate, a register, in which he shall cause to be entered the name, age, residence, and date of the first employment of all boys under the age of seventeen years who are employed in the mine below ground, and shall produce such register to any Inspector at the mine at all reasonable times when required by him, and allow him to inspect and copy the same. The immediate employer other than the owner or agent of the mine of every boy under the age of seventeen years, before he causes him to be in any mine below ground, shall report to the owner or agent or some person appointed by him, that he is about to employ such boy in the mine. 6 Edw. VII. c. 11, s. 194. Register to be kept of lads employed.

160. Where there is a shaft, incline, plane or level in any mine, whether for the purpose of an entrance to the mine or of a communication from one part of it to another, and persons are taken up, down or along the shaft, incline, plane or level by means of any engine, windlass or gin, no person shall be allowed to have charge of such engine, windlass or gin, or of any part of the machinery, ropes, chains or tackle connected therewith, unless such person is a male of at least twenty years of age. Where the engine, windlass or gin is worked by an animal, the person under whose direction the driver of the animal acts shall Age and sex of persons in connection with engines.

MICROCOPY RESOLUTION TEST CHART

(ANSI and ISO TEST CHART No. 2)

1.0 2.8 2.5 3.2 2.2 3.6 2.0 4.0 4.5 5.0 5.6 6.3 7.1 8.0

1.1 1.8

1.25 1.4 1.6

for the purposes of this section be deemed to be the person in charge of the engine, windlass or gin, and no person shall be employed as such driver who is under the age of sixteen years. 6 Edw. VII, c. 11, s. 195.

Penalty for employment of persons contrary to Act.

161. Where any person contravenes any of the next preceding four sections, the owner and the agent of the mine shall also each be guilty of an offence against this Act., unless he proves that he had taken all reasonable means to prevent such contravention by publishing, and to the best of his power enforcing the provisions of this Act. 6 Edw. VII, c. 11, s. 196.

Fencing of abandoned or unworked mines.

162. Where a mine has been abandoned or the working thereof has been discontinued, the owner or lessee thereof, and every other person interested in the minerals of the mine shall cause the top of the shaft and all entrances from the surface, as well as all other pits and openings dangerous by reason of their depth, to be and to be kept securely fenced; and if any person fails to act in conformity with this section he shall be guilty of an offence against this Act, and any shaft, entrance, pit or other opening which is not so fenced shall be deemed to be a nuisance. 6 Edw. VII, c. 11, s. 203.

RULES FOR PROTECTION OF MINERS.

Care of Explosives.

Magazine for explosives.

3. No magazine for powder, dynamite or other explosive shall be erected or maintained at a nearer distance than four hundred feet from the mine and works, or any public highway, except with the written permission of the Inspector, and every such magazine shall be constructed of materials and in a manner to ensure safety against explosion from any cause, and shall be either so situated as to interpose a hill or rise of ground higher than the magazine between it and the mine and works, or else an artificial mound of earth as high as the magazine and situate not more than 30 feet from it shall be so interposed.

Where explosives are stored in mines.

4. No powder, dynamite or other explosive in excess of a supply for 24 hours shall be stored underground in a working mine. It shall be kept in securely covered and locked boxes, and, where thawed underground, it shall be kept in unused parts of the mine, never less than ten feet from lines of underground traffic nor less than one hundred and fifty feet from places where drilling and blasting are carried on, and shall at all times be in charge of a specified man fully qualified by his experience to take charge thereof.

8. No fuse, blasting caps, electric detonators, or articles containing iron or steel shall be stored in the same magazine with powder, dynamite or other explosive, nor at a less distance than fifty feet from such magazine, and they shall be stored in a covered box in a place of safety. Storage of fuse, blasting caps, etc.

9. In charging holes for blasting, no iron or steel tool or rod shall be used, and no iron or steel shall be used in any hole containing explosives, and no drilling shall be done in any hole that has been blasted, nor shall any metal tool be introduced into the bottom of any such hole. (As amended in 1909 by 9 Edw. VII. c. 17, s. 3). No iron or steel to be used in charging holes.

10. A charge which has missed fire shall not be withdrawn, but shall be blasted; and, in case the missed hole has not been blasted at the end of a shift, that fact shall be reported by the foreman or shift-boss to the mine captain or shift-boss in charge of the next relay of miners before work is commenced by them. Missed holes to be reported.

11. All drill holes, whether sunk by hand or machine drills, shall be of sufficient size to admit of the free insertion to the bottom of the hole of a stick or cartridge of powder, dynamite or other explosive, without ramming, pounding or pressure. Size of drill holes.

12. No powder, dynamite or other explosive shall be used to blast or break up ore, salamander or other material where by reason of the heated condition of the ore, salamander or other material there is any danger or risk of premature explosion of the charge. Blasting of roast heaps.

PART X.—OFFENCES, PENALTIES, AND PROSECUTIONS.

176.—(1) Every person who Description of offences.

(*a*) Prospects, occupies or works any Crown lands or mining rights for minerals otherwise than in accordance with the provisions of this Act, or 6 Edw. VII. c. 11, s. 103;

(*b*) Wilfully defaces, alters, removes or disturbs any post, stake, picket, boundary line, figure, writing or other mark lawfully placed, standing or made under this Act, or

(*c*) Wilfully pulls down, injures or defaces any rules, or notice posted up by the owner or agent of a mine, or (*d*) Wilfully obstructs the Commissioner or any officer appointed under this Act in the execution of his duty, or

(*e*) Being the owner or agent of a mine refuses or neglects to furnish to the Commissioner or to any person appointed by him or to any officer appointed under this Act the means necessary for making an entry, inspection, examination or inquiry in relation to any mine, under the provisions of this Act other than Part IX; or

(*f*) Unlawfully marks or stakes out in whole or in part a mining claim, a quarry claim, or a placer mining claim, or an area for a working permit or boring permit, or

(*g*) Wilfully acts in contravention of the provisions of this Act other than Part IX in any particular not hereinbefore set forth, or

(*h*) Wilfully contravenes any provision of this Act or any rule or regulation made thereunder for the contravention of which no other penalty is provided; or

(*i*) Attempts to do any of the acts mentioned in the foregoing clauses,

shall be guilty of an offence against this Act and shall incur a penalty not exceeding $20 for every day upon which such offence occurs or continues, and upon conviction thereof shall be liable to imprisonment for a period not exceeding three months unless the penalty and costs are sooner paid. 6 Edw. VII. c. 11, ss. 103, and 209. Penalty.

SCHEDULE.

THE MINING ACT OF ONTARIO.

Appendix of Forms.

(Coat of Arms.)

THE MINING ACT OF ONTARIO.

Form 1. (See sec. 23.)

Department of Lands, Forests and Mines.

No.

Fee $

(Name of place of issue and date of issue.)

191 .

Miner's License.

This License is issued to called the Licensee, of the of in consideration of the payment of a fee of dollars, under and subject to the provisions of *The Mining Act of Ontario*, to be in force until and including the 31st day of March next succeeding the date hereof, and is not transferable.

Mining Recorder of Mining Division.

Stub for Form 1.

Miner's License.

No. Fee $
Name of Mining Division.
Name of licensee.
Of
Date of issue

(Coat of Arms.)

THE MINING ACT OF ONTARIO.

Form 3. (See sec. 27.)

Department of Lands, Forests and Mines.

No. of License renewed
No. of Renewal

Fee $

(Place and date of issue of Renewal.)

191 .

Renewal of Miner's License.

This Renewal of Miner's License No. issued by the Mining Recorder of Mining Division, on the day of , 191 , to of called the licensee, is issued to the licensee in consideration of the payment of the fee of dollars, and under and subject to the provisions of *The Mining Act of Ontario*, renews the said license until and including the 31st day of March next succeeding the date hereof, and is not transferable.

Mining Recorder of Mining Division

Stub for Form 3.

Renewal of Miner's License.

No. of License renewed Fee $
No. of Renewal
Name of Licensee
Name of Mining Division
Date of issue of original License
Date of issue of Renewal

(Coat of Arms.)

THE MINING ACT OF ONTARIO.

Form 1. (See sec. 59 (1).)

Department of Lands, Forests and Mines.

Application to Record the Staking out of a Mining Claim.

To the Mining Recorder of Mining Division:

Application is hereby made under the provisions of *The Mining Act of Ontario* to record the staking out of a mining claim containing acres or thereabouts, composed of the area shown on the sketch or plan hereto attached and more particularly described as follows:—

The lengths of the outlines of the claim are as follows:—

The name of the claim is

The discovery post is situate feet from No. 1 post

The discovery of valuable mineral in place, upon which this claim is based, was made on the day of 191 , at o'clock .m., by holder of miner's license No.

The claim was staked out and the lines cut and blazed thereon on the day of , 191 .

The claim was staked out and is to be recorded in the name of , who resides at , whose post office address is , and who is holder of miner's license No. , dated the day of . 191 , issued by the Mining Recorder of Mining Division.

Dated at , this day of , 191 .

Name of applicant. License number.

Note.—If the applicant is not a resident of Ontario the name, residence and post-office address of some person resident in Ontario, upon whom service may be made, must be given as follows:—

Service may be made upon , who resides at , in Ontario, and whose post-office address is .

(Coat of Arms.)

THE MINING ACT OF ONTARIO.

Form 10. (See sec. 64.)

Department of Lands, Forests and Mines.

No. Fee $

Certificate of Record of Staking out of Mining Claim.

I hereby certify that I have this day granted to of the holder of Miner's License No. , dated day of 191 , (issued by the Mining Recorder of the Mining Division), a certificate of record of mining claim No. , known as , containing acres, more or less.

Dated at , this day of , 191 .

Mining Recorder of Mining Division.

(Coat of Arms.)

THE MINING ACT OF ONTARIO.

Form 18. (See sec. 82 (1).)

Department of Lands, Forests and Mines.

NOTICE OF ABANDONMENT OF A MINING CLAIM, ETC.

To the Mining Recorder of Mining Division:

The undersigned, holder of Miner's License No. issued by the Mining Recorder of Mining Division, and holder of Mining Claim No. hereby abandons all interest in said mining claim, and authorizes you to record such abandonment in the books of your office.

I reside at , and my post-office address is

Dated at this day of , 191 .

Name of Licensee.
P. O address of Licensee.

Note.—If quarry claim, working permit or boring permit, modify form accordingly.

(Coat of Arms.)

THE MINING ACT OF ONTARIO.

Form 22. (See sec. 94 (2).)

Department of Lands, Forests and Mines.

No. Fee $5.00.

WORKING PERMIT.

Pursuant to the provisions of *The Mining Act of Ontario*, and subject thereto, a Permit is hereby granted to of , the holder of License No. , dated this day of 191 , issued by the Mining Recorder of Mining Division to enter into exclusive possession, for the purpose of prospecting for minerals, of the area consisting of acres, more or less, defined in the sketch or plan attached hereto, and more particularly described as follows:
and to work thereon during the period of six months from the day of the date hereof, together with such renewal (if any) as is contained in the renewal hereof endorsed hereon.

Dated at , this day of , 191 .

Mining Recorder of Mining Division.

PART IV.

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HON W TEMPLEMAN, MINISTER,

EUGENE HAAN

CANADA

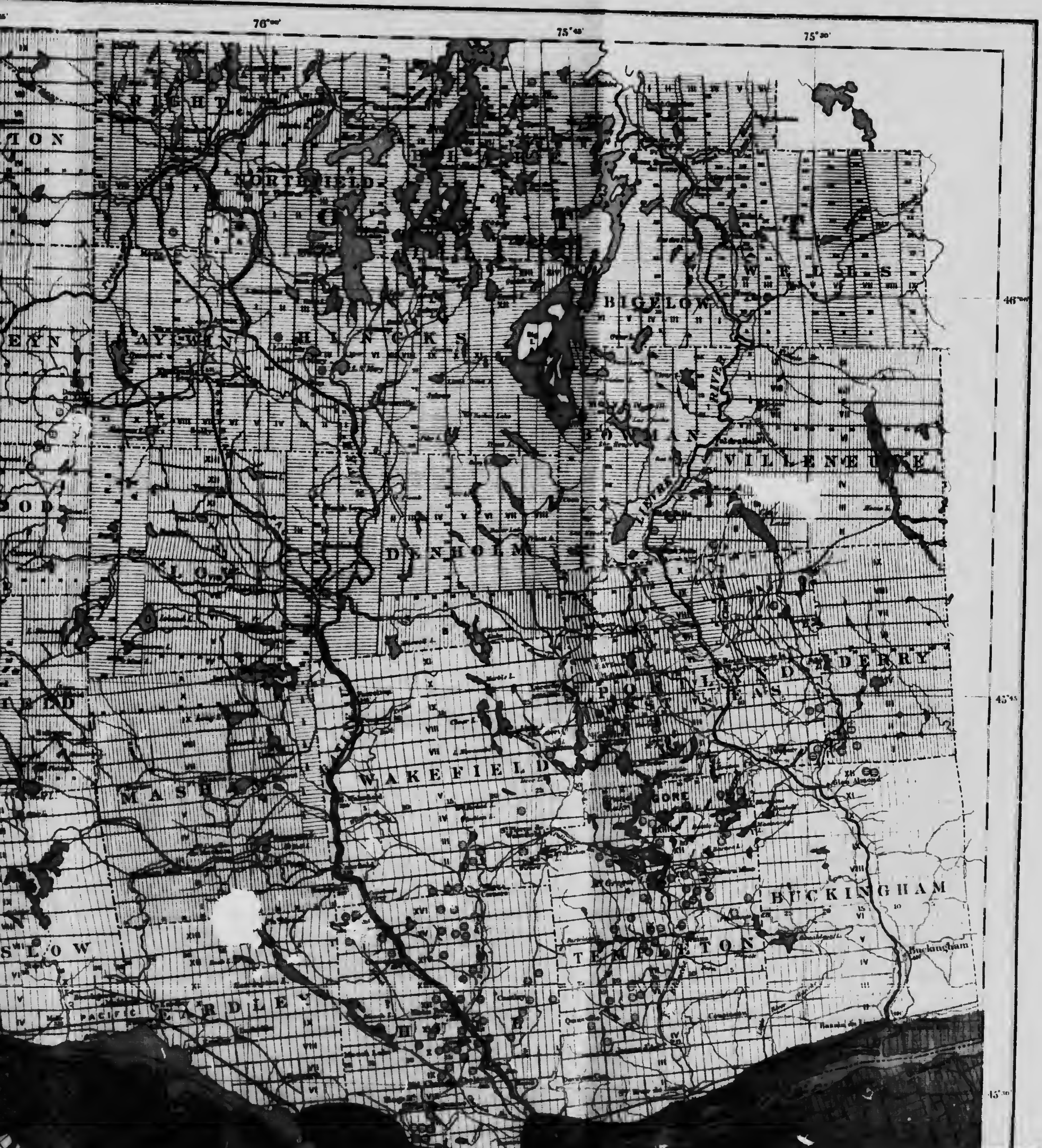
RTMENT OF MINES

MINES BRANCH

, MINISTER, A. P. LOW LL.D. DEPUTY MINISTER

GENE HAANEL PH.D DIRECTOR

1911



BASE MAP FROM OFFICE CHIEF GEOGRAPHER INTERIOR DEPARTMENT
H. E. BAINE, CHIEF DRAUGHTSMAN, MINES BRANCH

MICA

PALÆOZOIC ROCKS (CAMBRO-SILURIAN)

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MAP

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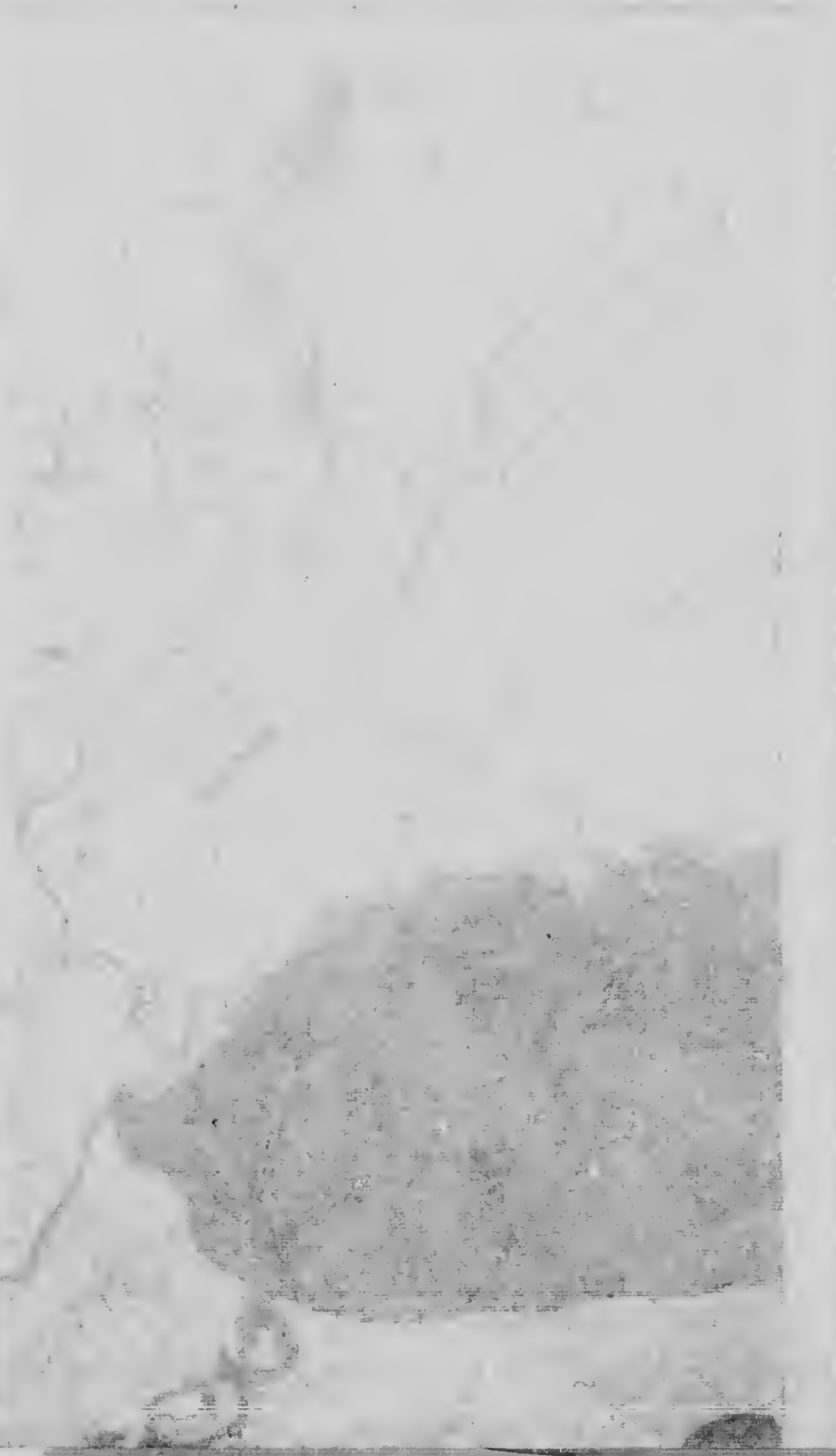
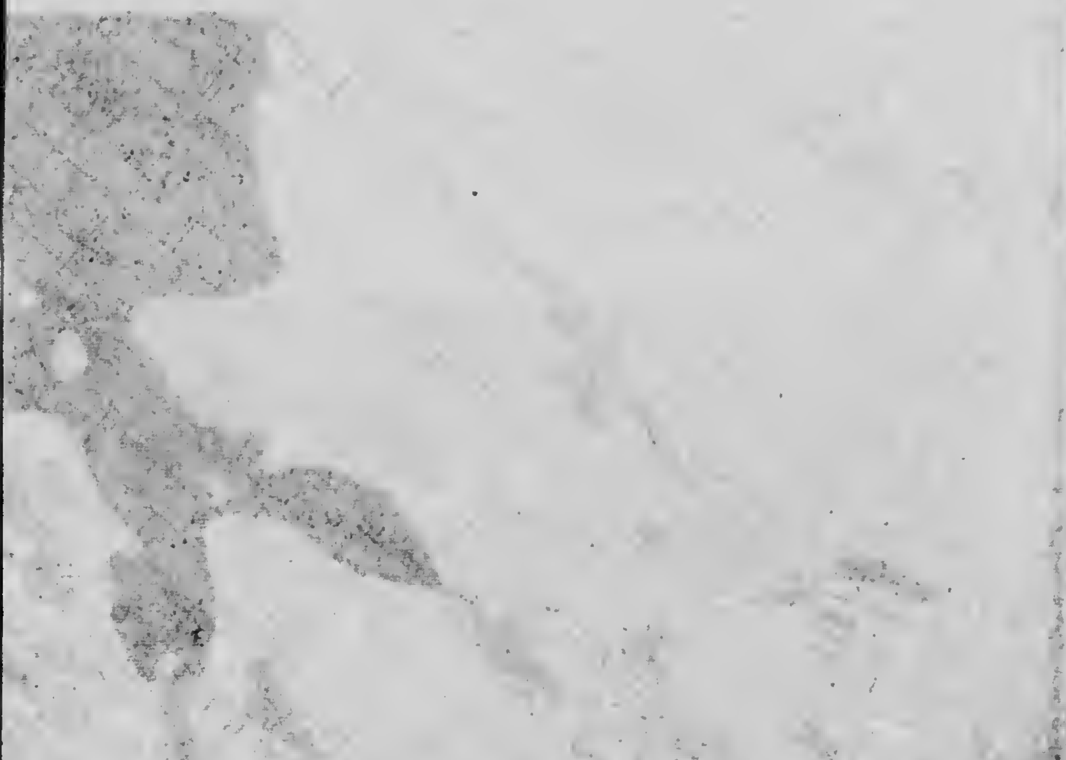
TO ACCOMPANY MONOGRAPH ON "MICA"
BY HUGH S. DE SCHMID, M.E., 1910

No. 138





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DEPARTMENT

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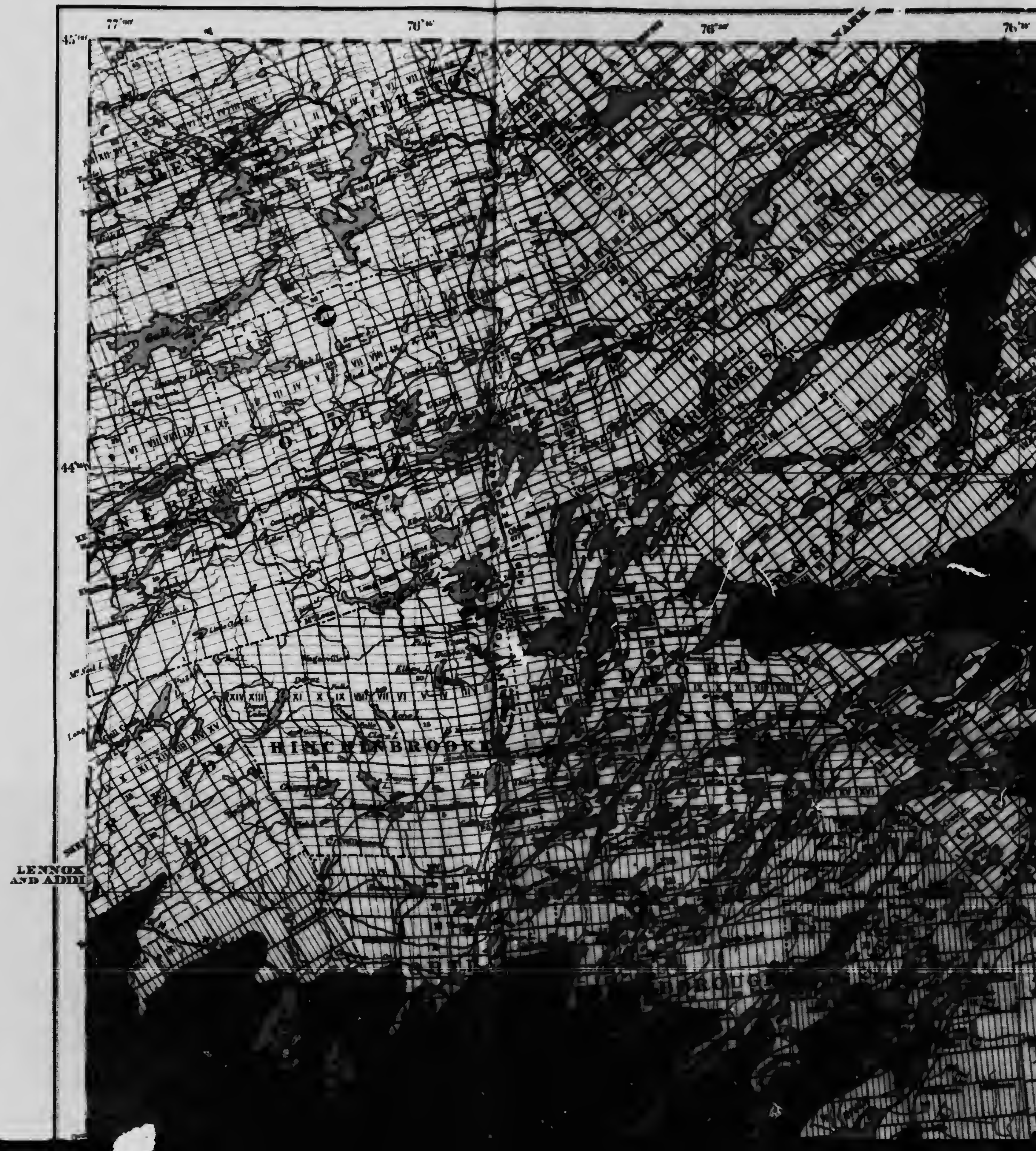
1911



CANADA

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STER, A P LOW LL D, DEPUTY MINISTER,

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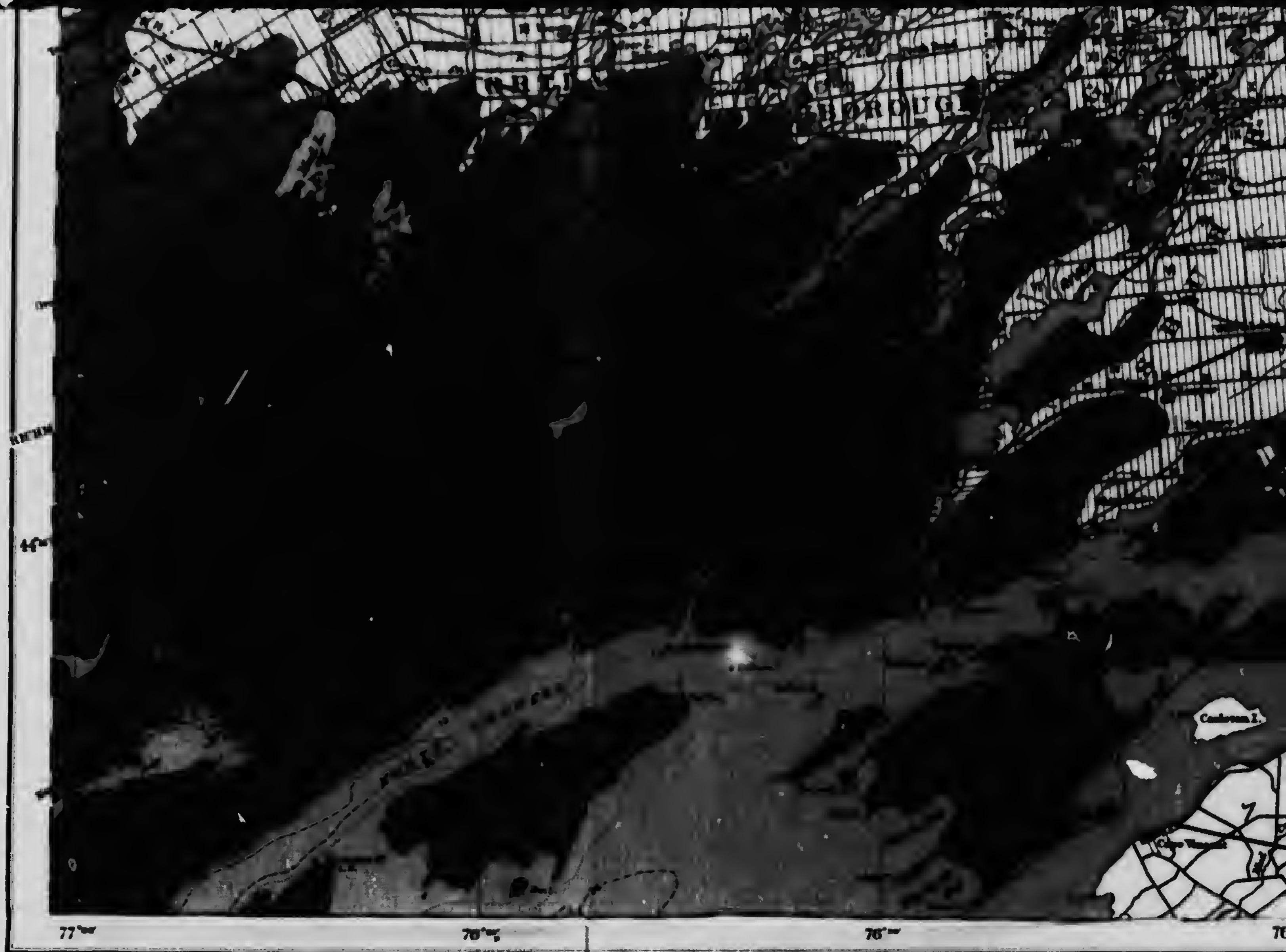
1911



BASE MAP FROM OFFICE CHIEF GEOGRAPHER INTERIOR DEPARTMENT.
H. E. BAINE. CHIEF DRAUGHTSMAN. MINES BRANCH

MICA

PALÆOZOIC ROCKS (CAMBRO-SILURIAN)

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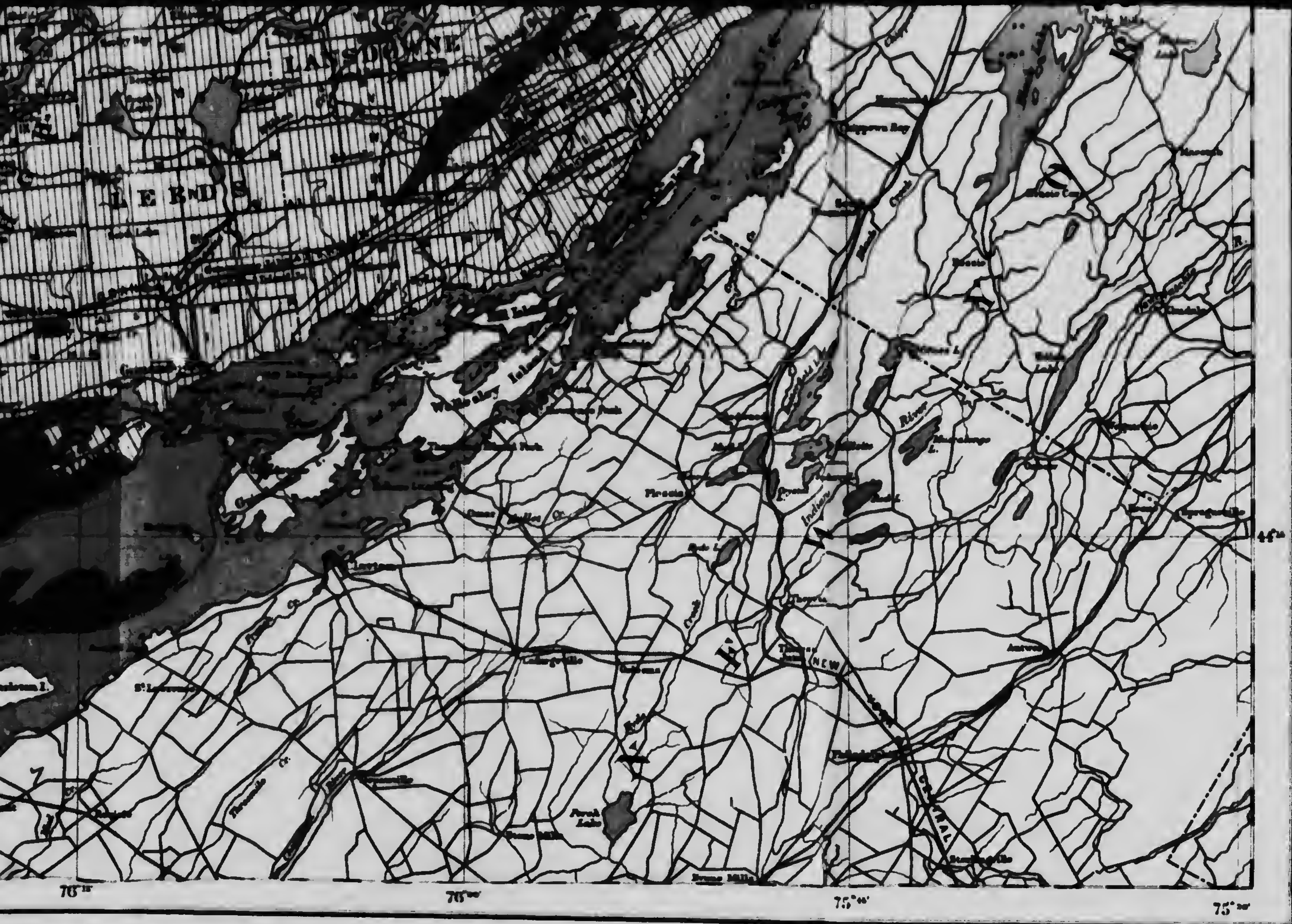

MAP

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or 3·95 miles to one inch

Miles

TO ACCOMPANY MONOGRAPH ON "MICA"
BY HUGH S. DE SCHMID M.E. 1910
GEOLOGY COMPILED BY HUGH S. DE
SCHMID FROM NOTES BY R. W. ELLS

No. 139

CANA

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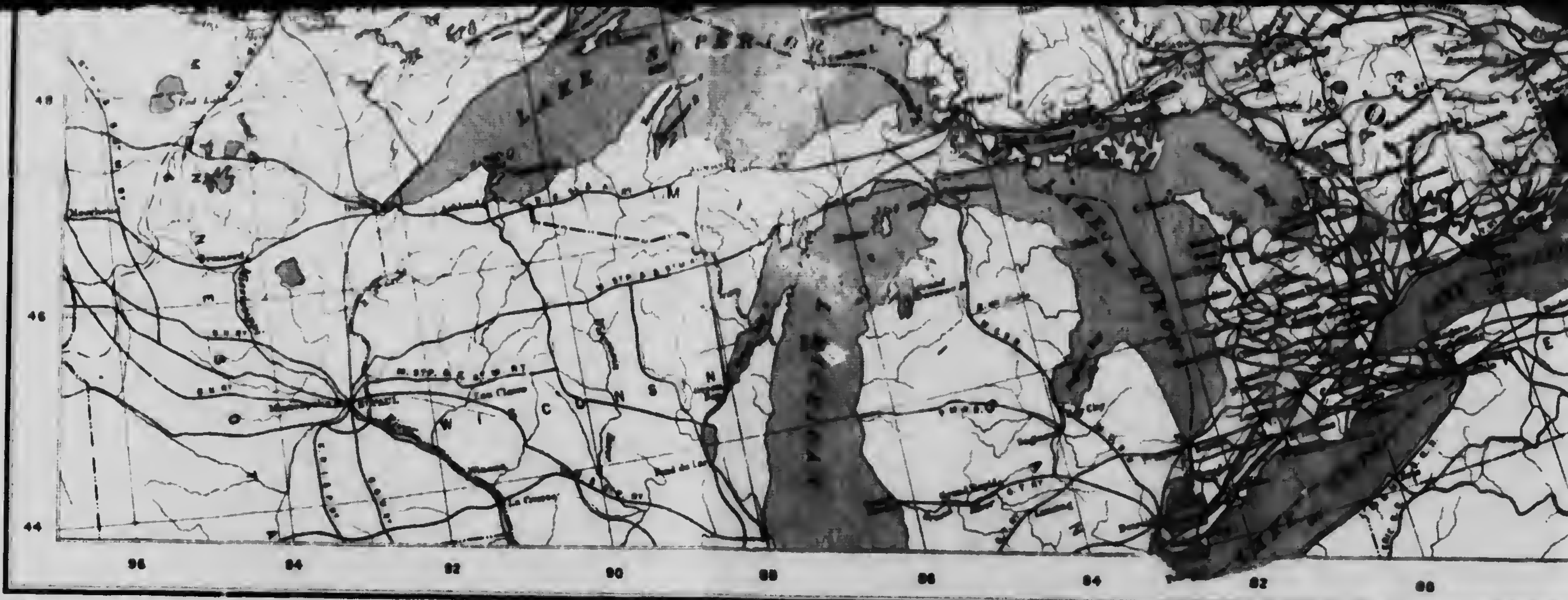


BASE MAP FROM OFFICE CHIEF GEOGRAPHER, INTERIOR DEPARTMENT
H. E. BAINE, CHIEF DRAUGHTSMAN, MINES BRANCH.

MAP

SHOWING DIST

OF TH

PRINCIPAL MICA

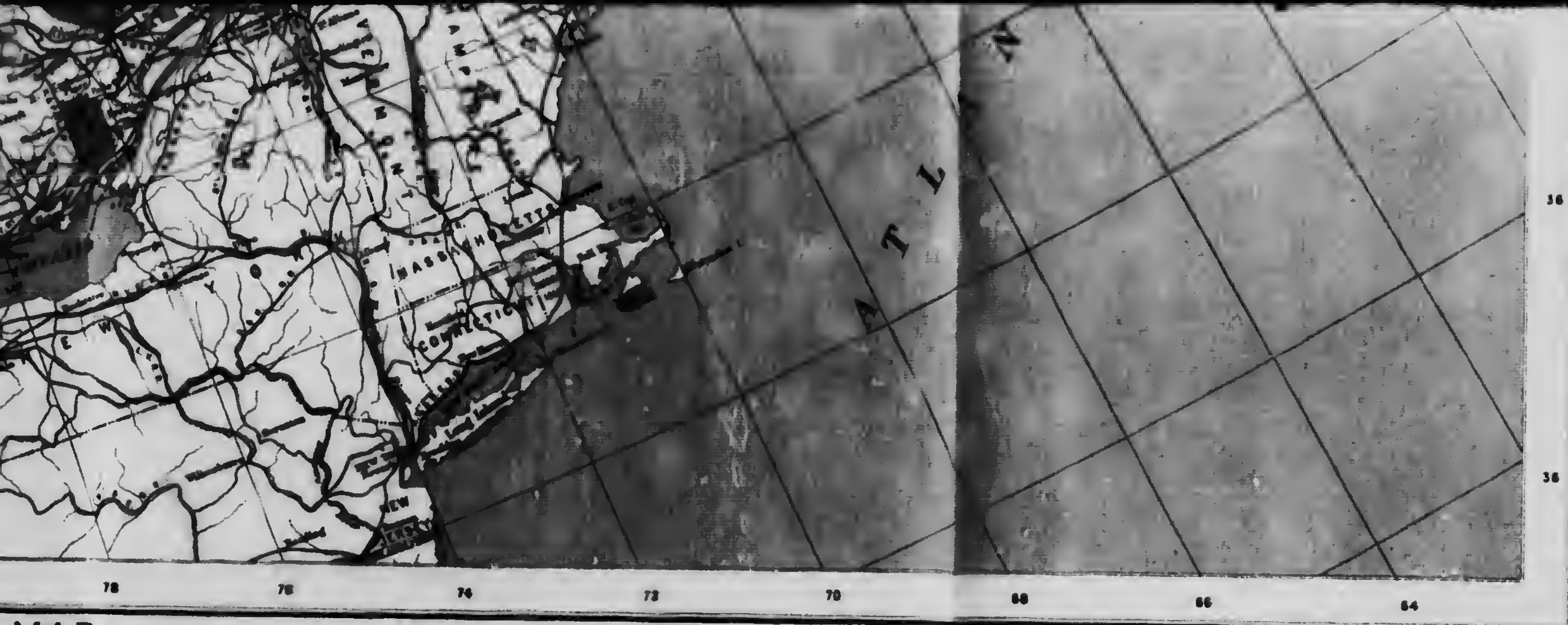
IN THE

DOMINION OF

MICA DISTRICTS

MICA OCCURRENCES (CHIEFLY MUSCOVITE)

Scale 100 miles to



MAP

G DISTRIBUTION

OF THE

ICA OCCURRENCES

IN THE

N OF CANADA

0 miles to one inch

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BY HUGH S. DE SCHMID, M.E., 1910.

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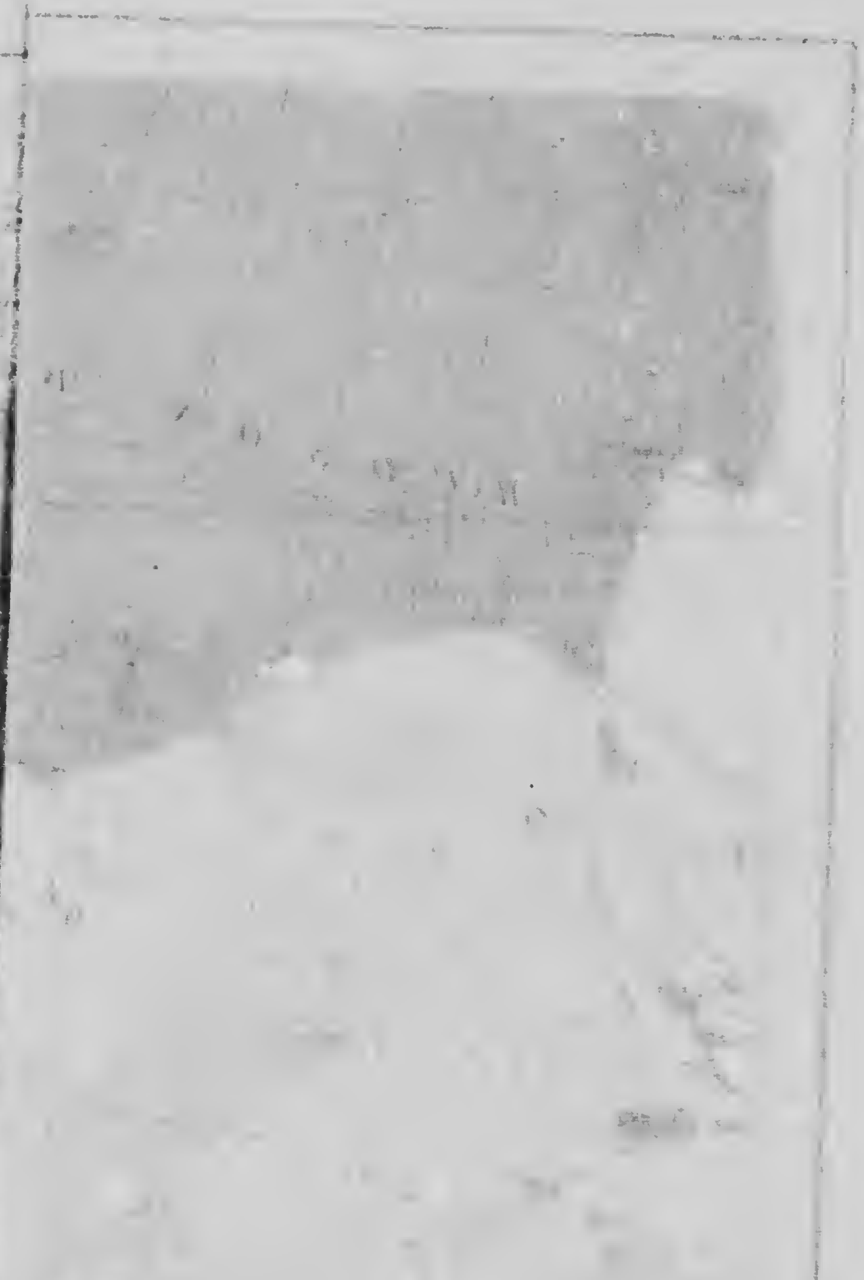

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