Technical and Bibliographic Notes / Notes techniques et bibliographiques

The Institute has attempted to obtain the best original copy available for filming. Features of this copy which may be bibliographically unique, which may alter any of the images in the reproduction, or which may significantly change the usual method of filming, are checked below.

L'Institut a microfilmé le meilleur exemplaire qu'il lui a été possible de se procurer. Les détails de cet exemplaire qui sont peut-être uniques du point de vue bibliographique, qui peuvent modifier une image reproduite, ou qui peuvent exiger une modification dans la méthode normale de filmage sont indiqués ci-dessous.

- [x] Coloured covers/ Couverture de couleur
- [ ] Covers damaged/ Couverture endommagée
- [ ] Covers restored and/or laminated/ Couverture restaurée et/ou pelliculée
- [ ] Cover title missing/ Le titre de couverture manque
- [ ] Coloured maps/ Cartes géographiques en couleur
- [ ] Coloured ink (i.e. other than blue or black)/ Encre de couleur (i.e. autre que bleue ou noire)
- [ ] Coloured plates and/or illustrations/ Planches et/ou illustrations en couleur
- [ ] Bound with other material/ Relié avec d'autres documents
- [ ] Tight binding may cause shadows or distortion along interior margin/ La reliure serrée peut causer de l'ombre ou de la distorsion le long de la marge intérieure
- [ ] Blank leaves added during restoration may appear within the text. Whenever possible, these have been omitted from filming/ Il se peut que certaines pages blanches ajoutées lors d'une restauration apparaissent dans le texte, mais, lorsque cela était possible, ces pages n'ont pas été filmées.

- [ ] Coloured pages/ Pages de couleur
- [ ] Pages damaged/ Pages endommagées
- [ ] Pages restored and/or laminated/ Pages restaurées et/ou pelliculées
- [x] Pages discoloured, stained or foxed/ Pages décolorées, tachetées ou piquées
- [ ] Pages detached/ Pages détachées
- [x] Showthrough/ Transparence
- [x] Quality of print varies/ Qualité inégale de l'impression
- [x] Continuous pagination/ Pagination continue
- [x] Includes index(es)/ Comprend un (des) index

Title on header taken from:/ Le titre de l'en-tête provient:

- [ ] Title page of issue/ Page de titre de la livraison
- [ ] Caption of issue/ Titre de départ de la livraison
- [ ] Masthead/ Générique (périodiques) de la livraison

- [ ] Additional comments:/ Commentaires supplémentaires:

This item is filmed at the reduction ratio checked below/
Ce document est filmé au taux de réduction indiqué ci-dessous.

10X	12X	14X	16X	18X	20X	22X	24X	26X	28X	30X	32X
						✓					

ANNUAL MEETING—17th March, 4.15 p.m.

March 1891.

THE OTTAWA NATURALIST

VOLUME IV. No. 12.

The Transactions

Of the Ottawa Field-Naturalists' Club

(Organized March, 1879. Incorporated March, 1884.)

CONTENTS.

OTTAWA, CANADA:
J. D. Taylor, Printer, 48 & 50 Queen St.

Issued March 4th, 1891.

Published Monthly at $1.00 per annum.

Patron:

HIS EXCELLENCY THE LORD STANLEY OF PRESTON,

GOVERNOR GENERAL OF CANADA.

President: DR. R. W. ELLS.

Vice-Presidents:

1ST, R. B. WHYTE. | 2ND, J. BALLANTYNE.

Secretary: T. J. MACLAUGHLIN (Dept. Public Works).

Treasurer: JAMES FLETCHER (Experimental Farm).

Librarian: W. A. D. LEES (P. O. Box 258).

Committee: MISS E. BOLTON, MISS G. HARMER, MISS M. A. MILLS, H. M. AMI, W. H. HARRINGTON, A. G. KINGSTON.

Standing Committees of Council:

Publishing—JAMES FLETCHER, *Editor*; W. A. D. LEES, W. H. HARRINGTON, *Assistant Editors.*

Excursions—R. B. WHYTE, T. J. MACLAUGHLIN, H. M. AMI, MISS G. HARMER, MISS M. A. MILLS.

Soirées—JAMES FLETCHER, J. BALLANTYNE, A. G. KINGSTON, MISS E. BOLTON.

Leaders:

Geology—H. M. AMI, DR. R. BELL, A. P. LOW.

Botany—JAMES FLETCHER, R. B. WHYTE, WM. SCOTT.

Conchology—REV. G. W. TAYLOR, F. R. LATCHFORD.

Entomology—T. J. MACLAUGHLIN, J. FLETCHER, W. H. HARRINGTON.

Ornithology—W. A. D. LEES, PROF. J. MACOUN, A. G. KINGSTON.

Zoology—J. BALLANTYNE, H. B. SMALL, W. P. LETT.

The Librarian will furnish the Publications of the Club at the following rates:—

Transactions,—

Part 1, Not sold singly		$1.00 for Vol. I. To members, 50 cts.
" 2, 25 cts.; to members,	15 cts.	
" 3, 25 "	" 15 "	
" 4, 25 "	" 15 "	
" 5, 30 "	" 20 "	$1.00 for Vol. II. To members, 50 cts.
" 6, 40 "	" 25 "	
" 7, 30 "	" 20 "	

The Ottawa Naturalist, $1.00 per annum.

Monthly parts, 10 cents each; to members, 4 cents.

Quarterly parts, 25 cents each; to members, 10 cents.

NOTICE.—The Treasurer begs to call the attention of members to the advertisements.

ASBESTUS; ITS HISTORY, MODE OF OCCURRENCE AND USES.

(By R. W. Ells, LL.D., F.G.S.A.)

(Delivered January 15th, 1891.)

The asbestus mines of the province of Quebec are, at the present day, of special interest to the mining and industrial world, from the fact that in so far as now known they practically represent the only deposits where this mineral, of a quality adapted for spinning and for the finer purposes of manufacture, can be profitably obtained. So great are the advantages which these mines possess, particularly as regards their accessibility and the ease with which the asbestus is extracted, that unless fields as yet unknown and as easy of access can be discovered, this province will doubtless long enjoy the position of being the principal source of supply for this peculiar and important substance.

The rocks with which the asbestus veins are associated in Quebec constitute a somewhat distinct series, which have, for the last thirty years, been known under the name of the "Quebec group." They comprise an extensive and important development of both sedimentary and eruptive rocks, which extend through at the eastern part of the province, from the Vermont boundary to the extremity of the Gaspé peninsula. They are not recognized in their entirety in any other part of Canada, though certain portions of the group are found in their extension southward into the United States. Crossing the Gulf of St. Lawrence they, however, form a very extensive belt in the island of Newfoundland, where, more particularly at certain points on the west coast, the same series of slates, sandstones, diorites and serpentines occur, the whole presenting features both from geological and mineralogical standpoints, very similar to what are seen in this portion of Canada. While these rocks in Newfoundland have, to a certain extent, been traced out, in so far at least as the entirely unsettled and unopened character of that section of the country permitted, no systematic search for asbestus has as yet been made, though, that the mineral occurs there at a number of points and in a variety of forms is clearly indicated by the specimens which have from time to time been obtained in the course of the general geological exploration of the

Island. Some of these specimens belong to the group of actinolitic minerals like the deposits found in Potton and Bolton, but among others observed from that country, were samples of vein asbestus, equalling in quality any obtained at Thetford, and having a fibre from two to three inches in length. Little attention has, however, been paid to these deposits by the people of the island, and their extent is entirely as yet, unknown. It cannot, however, be expected that this seeming indifference will long continue, in view of the rapidly increasing demand and consequent advance in prices. And it is probable that the time is not far distant when Quebec's greatest rival as a source of supply for asbestus will here be found.

While the mode of occurrence of asbestus, and, to a limited extent, its uses as well, have been known to a few, probably for the past twenty centuries, the discovery of its true economic value and of its great commercial importance are matters of quite recent date. Under the general term "asbestus," we find included several varieties of minerals, or of rock matter, some of which present startling and somewhat anomalous features. For instance, rocks as a rule, or the ingredients of mineral veins are generally regarded as possessing a weight or density several times greater than water, yet in one form, at least, of this mineral, we have a substance so light that it will float readily upon water, and has in consequence received the name of *mountain cork*. To most people, also, in speaking of rocks, minerals, or ores generally, the impression is conveyed that these are dense, heavy bodies, which can be crushed to powder with the proper application of sufficient force, yet here we have a mineral which can be pulled apart with comparative ease, teased out into fibre, and which thereupon presents the characteristic appearance of fine floss silk or cotton, so much so that in certain places this material is familiarly known by the name of cotton rock—or as the French call it, *pierre du coton*.

We have therefore here a substance which in some respects presents features belonging to both the mineral and vegetable kingdoms.

While, however, asbestus in all its forms must be styled a true mineral it possesses certain properties which distinguish it very clearly from many others. Among these presumably the most important is that of non-conductivity or its power of resisting the action of heat,

in which respect it possesses some of the properties of wood, which also is in one sense a slow conductor, though in much greater perfection; since wood under the action of sufficient friction rapidly becomes charred and even ignited, whereas friction apparently exercises very little influence upon asbestus, no matter how long it may be applied. This property of non-conductivity, or of resistance to fire or heat, is one of the principal reasons for its extensive application in certain lines at the present day.

The term *asbestus* is derived from the Greek and signifies literally *inextinguishable*, while the other term frequently applied to the same mineral, viz., *amianthus*, is also of Greek origin and signifies *undefiled*, from the property possessed by the mineral of being purified by the application of flame without injury to the substance i self. This was a property well recognized by the ancients, since we read in several of the earliest authors that the custom prevailed of wrapping the dead bodies of their important personages in an incombustible cloth by which the ashes resulting from their cremation were retained intact. The process of weaving this cloth from the fibres of amianthus shews that considerable scientific skill in the textile arts had been acquired by those people, judging from the difficulty which has been experienced, even in modern applications of the art, and it is supposed that the requisite degree of tenacity was imparted by the admixture of threads of flax or silk, which could afterwards, if necessary, be removed by burning. The wicks of the lamps in the early heathen temples, which were supposed never to be extinguished, were also held to have been made of this material.

The resistant action of the asbestus fibre, or of the cloth woven from this fibre, to heat, is one of its most wonderful properties. Temperatures of 2000° to 3000° are easily withstood, while with some varieties a temperature of 5000° Fahr. has apparently produced no visible effect. Its property also of successfully resisting the action of acids is one of great value, and these properties render this substance of great importance in certain chemical operations, so much so that its use in this direction is rapidly increasing.

In addition to the cloth used by the ancients in the process of cremation, napkins were also woven and specimens of these are preserved.

in the museums of several of the cities in Italy. The old story of the table cloth of Charlemagne is doubtless familiar to many of you, in which it is stated that he used to draw this cloth from the table, all soiled with the *debris* of his feasts, and in the presence of his guests throw it upon the blazing fire, from which it was soon taken, cleansed from all impurity. This peculiarity, however, probably applies to a cloth made from the true abestus and not from the chrysotile, the difference in which will be pointed out as we proceed, but which varies from the other somewhat in composition. To the former variety, also, probably belongs the garment described in the story so quaintly given in the book by Montpetit, concerning the French *habitant*, in which he relates that at a certain lumber camp in one of our great northern forests, one of the men, newly engaged, upon his return from his day's work in the soft melting snow, when the rest of the crew were gathered about the stove, coolly proceeded to remove his boots, and then his socks which he dashed into the open fire. He, however, speedily extricated his foot gear, now cleansed to immaculate whiteness, and proceeded to dress his feet as if nothing unusual had occurred, a proceeding which, it is needless to say, among a group of people unaccustomed to witness such marvels, resulted in something stronger even than amazement, and with a sudden accession of terror at the presence of a man who could thus perform such miracles with apparently flaming garments, they incontinently fled and left the uncanny stranger undisputed master of the situation, under the impression that he could be no other than the evil one himself. Explanation was of no avail, and the men refused to return to work until the foreman had discharged absolutely the unfortunate wearer of asbestus socks.

Somewhat analogous to this is the story related to me by one of the local managers of an asbestus mine in Coleraine township. This gentleman, also, was the fortunate possessor of a pair of asbestus mittens and under the impression that these were indestructible by fire, and desirous of astonishing the crowd which was gathered around the stove in a country store proceeded to throw one of them into the flames within. The success of the wished for miracle was not, however, equal to his expectation, since upon withdrawing his mitten from the flames, after a short interval, it was found

that the action of the fire had rendered the fibre so brittle that its tenacity was almost entirely destroyed, and the mitten was of no further use. In order to explain then the seeming inconsistency between the two cases, it may be stated that what is known as the Quebec asbestus of commerce, and the true asbestus, are two distinct substances, and belong to two distinct groups of minerals. Thus asbestus proper belongs to what is known as the pyroxene or hornblende group, while that obtained from the Quebec mines belongs to the talc or serpentine group. The former is classed among the igneous rocks proper, such as syenites, granites, syenites, porphyries, etc., and embraces among other varieties augite, diallage, hornblende, etc. Some asbestiform minerals are augitic, but the greater number belong to the hornblende family, and are known by several names, such as amianthus, asbestus, byssolite, tremolite, actinolite. In the variety known as pilolite, which is also a division of the hornblende group, several curious forms of asbestus occur, such as mountain paper and mountain leather, in which the fibres have become felted together in a somewhat uniform consistency, and are in the form of thin sheets; mountain or rock cork, which is a more massive form, and in which the specific gravity ranges from .68 to 1.34, and mountain wood, the name of which is derivable from its ligniform or woody aspect. The chemical composition of these several asbestiform minerals varies considerably, but for the most part they may be classed as silicates of alumina and magnesia, with varying proportions of lime and iron and occasionally a little water. The varieties known as mountain cork and leather contain a considerable proportion of water, amounting some times to 23 per cent.

A peculiar bluish variety known as crocidolite, and found in South Africa, Norway, and at several other points, contains a very considerable proportion of iron protoxide, sometimes as much as 35 per cent., in addition to silica, magnesia, and soda, and contains also a small percentage of water. This mineral is more properly a silicate of iron, and has great tensile strength as compared with the ordinary form of asbestus, though deficient in fire-resisting properties.

These minerals occur for the most part in serpentinous rocks in the oldest formations. In Canada, the variety known as actinolite occurs

in large masses in the Laurentian rocks of Ontario, in the townships of Elzevir, Lake and Tweed.

It is also found in Norway and Sweden where rocks similar in age and character occur. The finer varieties of amianthus and asbestus occur most abundantly in the Alps of Savoy, near the boundary of Switzerland and Italy, and in the island of Corsica, at which places beautifully white silky fibre is found in considerable quantity along with much of the coarser varieties.

The variety known as tremolite is found in several countries, generally in the old Laurentian rocks, in connection with limestone. It consists of long prismatic crystals of white, grey and green colors, but has not the fine fibrous texture of amianthus or chrysolite, and it frequently graduates into actinolitic forms. It occurs in the Laurentians of Canada and New York where it has been mined for some years to a limited extent. Cork, leather, &c., are also found in rocks of the same horizon, and beautiful specimens of the former are obtained from the township of Buckingham, in Quebec. The preceding minerals belong to what is styled the group of the anhydrous silicates in which water is supposed, for the most part, to be wanting.

Of the other varieties, belonging to the talc and serpentine group we find water entering into their composition to a very appreciable extent, and they are therefore placed in the group of the hydrous silicates of magnesia. These include talc, soapstone, or stearite, potstone serpentine and a number of other kinds, somewhat similar but not economically important. The composition of all these may be generally stated to be silica, magnesia and water, with occasionally a little alumina and iron, the percentage of water, ranging from 2½ to 5, in talc, to 12½ and 15 in serpentine, so that the distinction between the two groups, the hydrous and the anhydrous, is, in this way, clearly marked. While the composition of talc, soapstone and serpentine is to a great extent the same, or with the ingredients in slightly varying proportions, the mineral which we call asbestus in Quebec, but whose true name is chrysolite, is confined almost entirely to the latter. The serpentine itself is frequently of varying colors, being green, grey, red, yellow and brown, having a hardness of about 3 to 3½, and a specific gravity of 2.5 to 2.7. It is generally massive, but some-

times presents a banded structure and is occasionally quite slaty, being frequently marked with spots, veinings and stripes of various colors. The coarser fibrous varieties are known as picrolite and baltimorite; the fibres themselves being devoid of the soft silky character and lustre which is a peculiarity of the better kinds of the variety known as chrysolite or the asbestus of commerce.

Asbestus is therefore seen to present a great variety of forms, and in some one or more of these it is found at various places over the greater part of the surface of the globe. Among these may be mentioned in Europe, small deposits in England, Scotland and Ireland; in France to a limited extent, except in the extreme southeast in Savoy, more abundantly in Italy and Portugal, and on the island of Corsica, where the beautifully silky variety, amianthus, is quite abundant. In Germany, Bavaria, the Pyernees, Russia, Norway and Sweden deposits of greater or less extent have been found.

In South Africa the peculiar bluish variety, crocidolite, has already been referred to, and recent reports state that extensive deposits of asbestus occur in the serpentine belts of Kimberley, in which the diamond diggings also are situated. Asbestus has also been found in South America, in Brazil, in Australia, and in Asia Minor. In several parts of Newfoundland, excellent fibre, more particularly of the variety known as chrysotile, is known to occur, and in the United States it is also found in connection with the serpentinous rock of the eastern mountain range in nearly every State from Maine to Georgia On the west coast also it is reported in considerable quantity from California and British Columbia, and as far north as Alaska, while its presence in the rocks of Ontario and Quebec has been recognized for many years. With such a widely extended distribution, therefore, it would seem natural that the supply of the material should be practically unlimited. Such, however, does not appear to be the case; since in many of these places the quantity is so small as not to be available for general use, and in others the quality is such as to be economically valuable only for the inferior purposes of manufacture; while in others again the difficulties of access preclude all possibility of successful mining, for years to come at least. Prior to 1880, the greater part of the fine fibre adapted for spinning came from the mines of Italy and

Corsica, and owing to the difficulty with which it was obtained and its exceptionally fine quality commanded a very high price in the market, reaching as much as $250 to $300 per ton; but the discovery of the chrysotile deposits in the province of Quebec, of a quality equally well adapted for spinning as that of Italy, taken in connection with the fact that these were situated directly along a line of railway within short haulage of a shipping port, almost immediately revolutionized the industry, and has lately nearly closed the Italian mines.

Much of the so-called asbestus of these mines, however, is not adapted for spinning, and is used for the manufacture of mill-board, cements, paints, etc., as is also the output from such mines in the United States as have been working more or less constantly for the last twenty years. The output of the Quebec mines has even alread had such an effect upon these that their present output is probably scarcely a tenth of what it reached ten years ago.

In Ontario, also, a large quantity of the variety known as actinolite is mined and ground at Bridgewater in Hastings county. This is used for cement roofing being mixed for that purpose with tar, the fibrous texture of the material being sufficient to allow of its felting sufficiently, but not for spinning.

The non-conducting substances available in the process of manufacture in addition to asbestus are not numerous. Among the most important probably may be mentioned *infusorial earth*, which is generally found as a white or grayish white earthy material occupying the beds of certain lakes, or under peat bogs and in deposits frequently of very large extent. In composition this earth is almost a pure silica and is composed of the siliceous shells or crusts of diatomaceous plants, spicules of sponges, &c. It is also known as tripolite and under the name of *Tripoli*, or polishing powder, is familiar to most housekeepers. The localities where infusorial earth occurs most abundantly in the States are in Virginia, where an immense bed, many feet thick, underlies the city of Richmond; and in California, where a deposit of fifty feet in depth occurs near Monterey. In Germany large deposits also are known under the name *kieselguhr*, and much of this material used in the United States comes from that country. Numerous lake bottoms filled with this substance occur in the provinces of Nova Scotia and New

Brunswick, generally of much greater purity than the American or German earth, and it is also found to some extent in the province of Quebec.

It is extensively used for the manufacture of water-glass or soluble silica, and for the coverings of boilers and steam pipes for which purposes, owing to its great non-conductive properties, it is especially adapted. As a polishing powder it is also extensively employed, and for some years was an ingredient in the manufacture of dynamite, as an absorbent of the nitro-glycerine which enters into the manufacture of this explosive. For this purpose, however, wood-pulp has now to a large extent superseded it. In the lining of safes and for the protection of exposed portions of buildings, it is also largely used, but it can never compete with asbestus fibre in the peculiar processes to which that product is now applied.

Another non-conducting material which enters largely into competition, both with asbestus and infusorial earth, is the substance known as *mineral wool*. This is an entirely artificial preparation, and its discovery was doubtless due to the fact that a somewhat similar substance occurs in a state of nature in connection with certain volcanic eruptions, more especially in those of the Sandwich Islands, where the slaggy volcanic liquefied matter is acted upon by blasts of air and blown out into long silky fibres, which have received the name of "Pele's Hair." Mineral wool, or slag wool, is formed artificially in a somewhat similar way, viz., by subjecting a stream of molten slag from a blast furnace to a jet of steam or compressed air, by which means the slag is broken up into minute particles, generally with a small fibrous end or tail, which accumulate as they fall and resemble masses of roughly teased out cotton. The solid particles which form the head of each minute atom are subsequently detached and the finer fibres carried over into a separate chamber, when they are ready for use. This material possesses wonderful properties as a non-conductor of heat or sound, has great lightness, and is absolutely fireproof. It is extensively employed as a material for covering boilers, steam-pipes, and for lining buildings to render them fire, sound and vermin proof. While, therefore, it competes very successfully in many points with asbestus as a non-conducting substance, like infusorial earth it has not the property

of being spun, and has also several objectionable features besides which interfere somewhat seriously with its universal application.

Steatite or soapstone is an excellent resistant of heat, and as an ingredient in fire-proof paint is probably quite as valuable as asbestus, while as linings for stoves, furnaces, etc., it has long enjoyed a well deserved reputation. It also enters into competition with asbestus as a loader or filler of paper stock, and for several other purposes to which the lowest grades of the asbestus waste were formerly applied, but its special use at the present day would appear to be the manufacture of a non-corrosive and fire-proof paint.

As non-conductors of heat and sound several other preparations have been invented, among which may be mentioned *wood-pulp* and *terra-cotta lumber*, the latter being principally a mixture of clay and sawdust, made into bricks like ordinary clay. This mixture possesses great lightness, especially fitting it for interior work, such as dividing walls in buildings, being both fire and sound proof, but can scarcely be said to be a rival or competitor of asbestus in many respects.

Having thus briefly reviewed the several asbestiform and other non-conducting substances, we can now proceed to the consideration of the asbestus or chrysotile deposits as they occur in Canada, and more particularly in the province of Quebec, since it is in this province that the most important developments in this mineral have taken place.

The workable asbestus of Quebec is, in so far as at present known, confined to the serpentine areas of the mountainous belt which extends through the Eastern Townships from the boundary of Vermont to the extremity of Gaspé peninsula, with the exception of certain peculiar deposits which are found in connection with the serpentinous limestones of Templeton and the Gatineau valley in the Laurentian rocks north of the Ottawa. Concerning these latter deposits sufficient development work has not yet been done to determine definitely their economic value, but the quality of fibre obtained from some of the asbestus veins of this district is remarkable for its purity or freedom from foreign substances. The serpentines of the Townships form a series of disconnected masses, generally of small extent, surrounded by igneous rock, principally dioritic, but occasionally rising through great outcrops of slates or schists. At times these serpentinous masses assume such pro-

portions as to rank almost as mountain ridges, as can be seen in Wolfestown and Coleraine, and in Gaspé in certain parts of the Shickshock range. As pointed out last year in an excellent paper "on the serpentines of Canada," contributed by Mr. N. J. Giroux, of the Geological Survey to this club, these peculiar rocks are found in formations of different ages from the Laurentian to the Tertiary. To the latter period some of those found in British Columbia are supposed by Dr. G. M. Dawson to belong, while others are there associated with rocks of Carboniferous age. It is evident, therefore, that they have a very wide geological range; and this is seen, also, in the province of Quebec, where the serpentinous limestones north of the Ottawa are of Laurentian age, while the serpentine east of the St. Lawrence is associated with rocks of Huronian, Cambrian, and possibly even newer systems. Whether this difference in the age of the serpentine formations may have any influence on the question as to the presence or otherwise of asbestus in workable quantity is a question not yet fully ascertained, but there is some reason to suppose that the serpentines of a certain age are more productive of chrysotile in paying quantity, than that of more recent date in this country, in the same way that the quartz veins of the Cambrian rocks appear to be the seat of more productive gold mines than those found in newer formations.

The serpentinous rocks of New Brunswick have not as yet yielded asbestus except as mere thread like veinings. These are found to belong to the Laurentian system. In Nova Scotia it has not yet been recognized, but recent investigations in northern Ontario, according to the report of the Royal Mining Commission for that province lately published, indicate the presence of fibrous asbestus in the vicinity of Lake Temogami, according to the statement of Mr. E. Haycock, in veins of considerable length. This is in rock also supposed to be of Huronian age.

The serpentine areas of the Eastern Townships may be divided into three portions, viz.: 1st, a southern, embracing the masses in Potton, Sutton, Bolton, Orford, Melbourne and Shipton, which terminates not far from the Shipton Pinnacle, south of the village of Danville, though occasional detached outcrops appear above the surface for a few miles further north; 2nd, a central portion beginning with Big

Ham mountain and extending through the townships of Ham, Coleraine, Thetford, &c., to and beyond the Chaudiere River, in which the most conspicuous and important masses are in Thetford and Coleraine; and 3rd, an eastern area which is found in the Shickshock range of Gaspé and of which the most eastern outcrop is in Mount Serpentine, on the Dartmouth River, about ten miles from Gaspé Basin.

While all serpentine rocks present certain leading features which enable them to be readily recognized by anyone familiar with their general aspect; there are in the serpentine of these three areas several marked peculiarities which serve to distinguish them quite easily. Thus the rocks of the southern area are frequently, though not always, slaty, and occur sometimes with much soapstone, or potstone, and sometimes with dolomite, and have frequently a greasy smooth aspect on the slaty surface. About Brompton Lake they are associated with great hills of dioritic rock as well as with slate, and contain masses of white garnet. Mining has been attempted at several places in these rocks, more particularly for ores of copper, which has produced some very fine hand samples, but in so far as yet worked, not in quantity to be remunerative. Veins of asbestus are seen occasionally, but these are as a rule of short fibre, either soft and pasty, or harsh and stiff, while in extent they are mostly short and gashy, and do not possess the well defined vein character of those seen in Thetford and vicinity. Near Danville, however, in a peculiar knoll-like mound of serpentine the veins of asbestus are well developed, and fibre of very fine quality and of suitable length for spinning is found in abundance. The occurrence of this mass of serpentine, rich in asbestus, in a belt which is well developed a short distance to the south, but which is there, in so far as yet prospected, almost deficient in asbestus fibre of any length, is peculiar, and serves to indicate that, even in most unlikely places, exceptional development of conditions may give place to a favorable change in the rock which may lead to the establishment of a profitable mining area.

In so far, however, as experience has determined the conditions for profitable mining, the serpentine of this southern area does not yield indications favorable to successful development; and the same remark will apparently apply to much of the serpentine found in the adjoining

State of Vermont. It is possible that much of this serpentine may be the result of alteration from dolomitic rock, or from slates which contain dolomite; whereas it is clear that much of that found in Thetford and Coleraine is an alterative product of dioritic eruptive rock, rich in olivine or some allied mineral.

The rocks of the central or Coleraine area differ as a whole from those just described in being, as a rule, much more massive, and occurring in large areas. They have associated with them deposits of chromic iron and of magnetite, as well as of asbestus. Large areas of steatite or soapstone occur also about Ham Lake, and mining for nickel was carried on in this vicinity many years ago, the quantity of this mineral obtained being, however, but small. The country occupied by these rocks is generally rough and uninviting from the agricultural standpoint, and the whole area from Ham Mountain to the northern terminus of the main belt in Thetford or at the Bull Mountain in Adstock is of this description. In character of rock the serpentine presents several varieties. Portions are hard, reddish brown weathering and very siliceous, as seen in much of that in the townships of Wolfestown and Ireland, and even in the Coleraine ridge south of Black Lake and about Lakes Caribou and Little St. Francis. In this hard siliceous serpentine, asbestus very rarely occurs, and when present is mostly of imperfectly developed fibre in short and gashy veins. Occasionally, however, seamy partings are found which at first glance and at a distance present somewhat the aspect of asbestus veins, but on closer examination reveal the existence possibly of a small parting of fibre, or sometimes only of a seam of serpentine. In certain portions of the belt these seamy partings are quite numerous, and by some prospectors are supposed to indicate the presence of workable veins, on the general principle held by many practical miners, that a vein of mineral matter always becomes larger as it is followed downward, a principle of such peculiar application that its absurdity should be apparent to anyone who has ever thought a moment on the subject.

Passing beyond or to the north-east of the great masses of serpentine in Thetford and Coleraine, detached masses, knolls, and sometimes bands of this rock crop out at intervals. These are well seen near the Chaudiere River, both in the Bras de Sud Ouest and in the Des Plants

streams; but though these outcrops have been carefully prospected, nothing more than small gash veins have been found. Further to the north-east on the south side of the great dioritic mass called Moose Mountain in Cranbourne, a small outcrop of serpentine, on the bank of the Etchemin River, shows small veins of one quarter to possibly half an inch of fibre, and this is the most northerly outcrop of asbestus-bearing serpentine yet known in this belt.

The most easterly area, viz., that of the Shickshocks, is largely made up of serpentine, different in character from the rock of Thetford which we may take as our typical locality; the southwestern portion being very hard and siliceous, in contact with black hornblende schists on the north; while the eastern or Mount Albert serpentine, which is the principal area in this direction. is frequently banded with shades of reddish brown and green. In these rocks only small veins of imperfect fibre have yet been found, and the generally hard and siliceous character of much of the rock is against the presence of large deposits of the fibrous variety. In the most easterly exposure, on the Dartmouth, the serpentine is very much of the same nature as in the Shickshocks, associated with hornblende schists and containing small veins of one-quarter inch fibre of but little economic value.

It is easily seen, therefore, that the character of serpentine which is really asbestus-bearing to an extent which can be profitably worked, is confined to a comparatively limited area, and more particularly to contain portions of the townships of Thetford, Ireland, Coleraine and Wolfestown, in which localities successful mining operations have been carried on for some years. But even in these favored districts there are large portions of the serpentine belts which, in so far as yet proved, have disclosed no asbestus in quantity to be economically available. The rock carrying the merchantable asbestus is generally a greyish weathering serpentine of some shade of green on fresh fracture, generally a greyish green, in which are contained numerous small particles of iron, both magnetic and chromic, more generally the former. Serpentines that have a black, hard, chippy aspect do not apparently promise well, nor does the rock which weathers a dirty reddish brown. In the asbestus-bearing rock proper the veins of asbestus are seen without any special arrangement, intersecting the mass of the rock

generally in every direction, but for the most part at a considerable angle both to the perpendicular and horizontal. Certain peculiar arrangements of these veins are, however, noted in certain areas, as at the King Bros.' mine in Ireland, where the serpentine appears to be regularly stratified almost in the manner of sandstone or quartzite in layers dipping to the northwest, and the veins of asbestus apparently follow what, in sedimentary rocks, would be regarded as the bedding planes. In several other places the veins, few in number, cut the rock in an almost horizontal position, and when found in a knoll can be traced across from one side of the hill to the other nearly on the same plane, but as a rule the veins are irregularly placed. In size they range from mere threads up to a thickness of five or six inches, though the most of the workable veins in the principal mines do not, or but rarely, exceed two and a half inches in width or length of fibre, and such veins, where the asbestus is of good quality and unbroken by partings of iron, are regarded as extra No. 1 material. There are, however, generally more small veins of one inch or less than of the larger size. Serpentines associated with talc or with soapstone, where the latter is in quantity, rarely appear to carry veins of asbestus to any extent, and such steatitic rock is not usually considered good mining ground. The Broughton mine may possibly be cited as an exception to this principle, since at this place a vein of large size of very fine fibre was found lying between serpentine and soapstone walls. As the soapstone became more abundant, however, the size of the vein rapidly became less and finally split up into small strings and became useless, and it is a fact worthy of note that at the great and profitable mines in Thetford and at Black Lake soapstone is absent from the rock mass.

As for the origin of these veins in the serpentine several theories have been advanced. In composition the vein matter is, as already mentioned, apparently the same as the containing rock, and the chrysotile is simply a fibrous serpentine. Some have supposed the veins to be formed when the mass of the rock was in a pasty state and exposed to sundry strains or twistings which produced the fibrous nature of certain portions. That the rocks have been exposed to such violent action is very evident from their present faulted character.

Others have supposed the cracks to have been formed by the cooling and shrinking of the mass from a heated and pasty state by which cracks have been formed, which subsequently became filled with asbestiform matter from below. In whatever way the fissures were caused, and it is very probable that they have been formed by the great processes of metamorphism to which the rocks were exposed in the change from dioritic matter to serpentine, the vein asbestus appears more naturally to have been produced by a process of segregation of serpentinous matter from the sides of the fissure, very much as ordinary quartz in many mineral veins is known to have been produced, the segregated or infiltrated matter gradually filling the original fissure, and meeting at or near the centre, in proof of which the presence of a comb of particles of iron is very often found occupying the centre of the vein, and quite frequently these iron grains assume sufficient size as to form a regular parting of iron ore in the fibre. In this respect asbestus veins resemble very closely mineral veins with quartz or calcite which frequently contain alternate layers of ore on either side of a central comb of crystals. The arrangement also of the fibre at right angles to the sides of the containing fissure, except where the rock has been disturbed, is confirmatory evidence in the same direction.

In some of the mines fibre of exceptional length is observed. Sometimes there are veins caught along lines of fracture and drawn out of their natural position. At other times this long fibre is, to some extent at least, due to the friction of the rock walls by the displacement of a fault. In this way the long woody fibred material, known as hornblende to the miners, but which is rather a form of picrolite, is probably produced. In the same position also, and due probably to the same cause, are the long well fibred strips of asbestus seen in some of the mines, and which at first sight might almost be taken for vein matter of exceptional length. A very peculiar form of asbestus is found on an island in Lake Nicolet, where also the coarse picrolitic variety is well seen, which consists of small concretionary pellets of asbestus containing a nucleus of serpentine and enclosed in a steatitic rock. This peculiar development was first pointed out by Mr. C. W. Willmott, and has not been recognized at any of the other mines,

at least to a notice'le extent. But a still more peculiar form is that seen at the Megantic mine in Colerain·, where the serpentine wall for the distance of several feet is laced with minute veins of not more than a twentieth of an inch in thickness, and presents the appearance, on fresh surfaces, of a rock regularly and evenly striped with greyish white paint. The same mode of occurrence of small veins is seen at King Bros.' mine in Ireland, and at Bellmina, and occasionally some of these smaller veins there come together and form one of workable size. This peculiarity is also conspicuous in the serpentine asbestus deposits of Templeton and the Gatineau district, although the character and age of the containing rocks are entirely distinct from those of the eastern area. In this latter place the small veins of asbestus have a thickness generally of an eighth to a fourth of an inch, with partings of light greyish serpentine of about the same thickness. These occur throughout a space sometimes of a foot or even possibly more, and enclose roughly lenticular masses of limestone, which are often of large size. Sometimes several of these detached veins coalesce and produce a large vein having a thickness of two inches of wonderfully clear fibre, which continues for a short distance and then splits up again. The same peculiarity is seen in the lower part of the large vein at the Broughton mine in eastern Quebec, where the hanging wall is soapstone.

While, therefore, indications of asbestus or chrysotile may be found at most places where serpentine rocks occur, it is, I think, very clearly established by the work of prospectors, as well as by that of the staff of the Geological Survey, that very many areas do not contain, nor are likely ever to produce, asbestus in workable quantities; and while the greatly enhanced price of the mineral renders operative, areas which a few years ago could only be worked at a loss, it must be borne in mind that the great profit is made in the output of first-class material, rather than in third-rate asbestus. To any persons, therefore, contemplating investment in such mining areas, it is plain that the first thing to be attended to is a careful examination of the property by one not personally interested in the matter, and one, further, who has a good knowledge of the different kinds of serpentine, as well as of the conditions which should govern the occurrence of asbestus in sufficient quantity to repay the money invested. Unfortu-

nately prospectors as a class, not only of asbestus properties but of other minerals as well, are not sufficiently well informed as to such conditions. Many are led by what they have observed in connection with mines in certain other areas, such as for instance in the case of the Cornish miner, who measures everything in a Cornish half bushel. Whereas the truth is that the profitable or economical development of minerals very frequently depends upon the presence of local phenomena or conditions which have affected certain limited areas only of the earth's surface or crust. Just what the conditions have been in the past by which the serpentine areas of Thetford and Black Lake have become so impregnated with asbestus veins of great purity and large size, while the areas a short distance to the east or west should be almost devoid of asbestiform mineral, cannot yet be conclusively settled. It is possible that the presence of the large intrusive masses of granulite, which are of more recent date than the serpentine, may have had some effect in this direction, but in that case we should expect to find at Black Lake, where these granitic masses are the most abundant, the richest deposits of asbestus. On the contrary, however, it is found that the largest and most important veins are found at Thetford where the granitic masses are comparatively small and generally confined to narrow dykes; for while the serpentine of this area is, according to the best testimony on the subject, due to an alteration of igneous or dioritic rocks, we can scarcely suppose that the asbestus itself is of igneous origin. While, therefore, the reason why the Thetford areas are the most productive of fine asbestus fibre has not yet been satisfactorily ascertained, we have been able to learn some facts from the study of these Thetford mines, which are of value to guide the prospector or the scientific explorer in the search for other deposits.

Since the asbestus veins occur throughout the mass of the rock and come directly to the surface where exposed, as in the hill at Thetford mines and the great escarpment to the south east of Black Lake station, the mining of the mineral does not follow the methods which are usually employed in the working of other mines, viz., by underground slopes and levels connected with the surface by shafts. but is simply open quarry work, the entire rock being removed, broken up and the veins of asbestus separated by hand cobbing, in so far as the size of the

veins will warrant the expenditure of labor for this purpose. The bulk of the barren serpentine necessary to be removed in order to obtain a ton of fibre is consequently very great, and while no exact data are to hand by which the relative proportion of asbestus and serpentine can be determined, it has been estimated to range in the ratio of 25 to 1 in very prolific ground, to 50 to 1 in ordinary mining. Of course in such a great quantity of waste rock, under the present system of working, many small veins or portions of veins are not removed, owing to the expense and difficulty attending such operations by hand labor only—and the great heaps of waste material have accumulated till they now occupy large areas of valuable ground. As in the case of the drilling and hoisting, however, where hand labor has been obliged to give place to steam and compressed air, so, also, very shortly the breaking and cobbing must also be done by machinery, and with proper appliances, with a great saving of expense, as has resulted in the case of the drilling and other operations; since with a properly equipped mine the cost of production can be reduced from 50 to 75 per cent. from the expense due to the laborious system of hand labor.

The history of asbestus mining presents some points of interest in view of the rapid growth of the industry. Comparatively little importance was attached to the mineral, from the economic standpoint, in the early days of the Geological Survey's operations, and this combined with the fact that, although asbestus had been known before 1850 in the serpentines of the Eastern Townships, the quantity seen at the places where discovered was very limited, and led to the result that but little heed was paid to its occurrence. In 1877, owing to the burning off of the forest in Thetford and Coleraine townships, the hills of serpentine became laid bare and the weathering speedily produced the peculiar felting of the asbestus fibre on the surface wherever veins occurred. This was observed by a French Canadian named Fecteau, it is stated, and the importance of the new material was soon ascertained, which resulted in the establishment of mining operations on a small scale in the summer of the following year, by the Johnston Asbestus Mining Company, although the credit of the first attempt at working should probably be given to the Ward Brothers. The areas in the immediate vicinity were speedily secured and new mines located, since

which time the growth of the industry has been constant and rapid, the output increasing from 50 tons only in 1878 to probably not far from 8,000 tons in 1890, while the prices have also advanced within the last year or two at a like wonderful rate, till now No. 1 Quebec asbestus commands probably as good a price in the market as the best Italian, while No. 3 brings nearly as much as was obtained for No. 1 six years ago.

According to the Ontario Commission's Report, actinolite mining in that province was commenced in 1881, since which time about 3,000 tons have been extracted. This material, however, does not command the price of the Thetford mineral, selling at about the same figure as the waste or No. 4 from that locality, it being used almost entirely for asbestus roofing, for which purpose it is mixed with tar, as already stated, and then applied in a coating of about half an inch in thickness. The waste from the mines of the Eastern Townships, and formerly the output graded No. 3, was at one time quite extensively used for the same purpose.

The asbestus of Templeton was probably first mined in 1883, but the industry has never proved very remunerative, owing to the limited nature of the deposit and the smallness of the veins, so that for some years mining was entirely abandoned. During the last season, however, operations have been started anew, and some very excellent fibre taken out, it is claimed at a profit. The conditions under which the asbestus occurs in this district are distinct from those which are found both at Kaladar in Ontario and in the serpentine areas of the Eastern Townships, the serpentine in which the asbestus veins occur being intimately associated with crystalline limestone, and in many places the latter is highly serpentinous. The fibre of the asbestus is distinguished from that of Thetford in having a marked pearly and wavy lustre, in being generally lighter colored, and by an entire absence of impurities in the form of iron grains. Sufficient study of these peculiar rocks has not yet been made to pronounce definitely upon their probable importance, but when the deposits are made more accessible considerable mining will be done, as these appear to be quite extensive.

As for the uses of asbestus, these have multiplied with exceeding rapidity. The early history has been briefly stated, in so much that

sufficient acquaintance with its peculiarities had been learned many centuries ago to enable it to be woven into cloths often of considerable size. At the present day the finer grades and longest fibres are still somewhat extensively used for weaving into cloths, from which drop curtains for theatres, suits of clothing for firemen, and various other articles, are made, among which are asbestus mail bags for railway transit. So important is the matter of fire protection in theatres now regarded in the leading cities of Europe and in the United States, that special legislation has decided that asbestus curtains of a size sufficient to completely shut off the stage from the body of the house must be a part of the stage furniture. As an instance of what can be woven from this material, it may be mentioned that the curtain of the Academy of Music, Philadelphia, by which the stage is separated from the body of the house in case of fire, is 54 feet wide and 53 feet high, and is made almost entirely of pure asbestus, only 3 per cent. cotton being employed, presumably to facilitate the weaving.

As a protection for firemen asbestus clothing has been proved to be of the greatest advantage. By its aid they have been able to enter burning buildings and approach so closely to the flames as to extinguish them in a much more speedy manner than by the old plan of fighting them at a distance. Of a somewhat similar character are the fire shields, also made of asbestus, which are placed between the burning building and those who are fighting the flames, thus protecting them largely both from the great heat and from the dense volumes of smoke as well. As for the great heat which can be endured when clad in these garments, the story of the extinguishing of the Coste gas well in western Ontario only last year is quite fresh in our memories. Here the huge jet of gas which issued from the stand-pipe of the well became ignited, and the screw-cap which closed the pipe having received some injury could not be adjusted so as to effectually close the orifice. Several expedients were resorted to in order to arrange the cap successfully, till at last, under promise of a heavy reward, some one, clad in an asbestus suit, boldly approached the flame itself, a thing absolutely impossible without the protection thus afforded, adjusted the cap properly, screwed it on and extinguished the ignited gas. But while the use of this material for the purpose of clothing has steadily increased within

the last ten years, so many other needs have arisen to which it appears especially adapted, that the manufacture of clothing is forced to take a comparatively unimportant place. Thus in chemical laboratories fine asbestus cloth, or even finely teased out asbestus fibre, is now used very extensively for filtering various solutions for which no other material yet discovered has been found so well adapted, especially for strong acids and alkalies which would quickly destroy the ordinary filtering paper. The advantages of the asbestus filter are also apparent in the fact it can be ignited without being consumed. It is also rapidly coming into use in sugar refineries for filtering the saccharine juices, and as a filter for water it has been found to possess very superior qualities over most of the substances in use, and will doubtless, before very long, become an important agent in the purification of our supply of water in large cities.

Its value as an ingredient in the manufacture of fire-proof paint has already been alluded to slightly, in which respect it ranks with steatite. Applied to woodwork it is capable of successfully withstanding a very considerable volume of flame and so confining the fire to a limited space. As a material for fire-escapes also, owing to its very considerable tensile strength, it is largely made into rope, the fibres of which are sometimes strengthened by the addition of brass or copper wires, from which ladders are then made, which are practically indestructible. More recently, also, its properties as a non-conductor of electricity have been discovered and a great demand has sprung up for it in the construction of dynamos, and other portions of electrical apparatus requiring insulation. Wall paper, also, printed in ornamental colored patterns, which when applied to the walls of a room reduce the risk of conflagration to the least possible degree, are manufactured even now in considerable quantity, and even writing and fine printing papers are made which have the property of resisting destruction by fire, and though becoming altered to some extent, even then preserve the writing or printing which has been made on them. A great difficulty, however, in the former case is to give the paper a sufficiently hard and smooth glossy surface over which the pen can glide freely; but this defect will doubtless be remedied in time, and with a fire proof ink the preservation of deeds and important papers can thus be readily effected.

To those affected with cold feet a stocking or insole of asbestus cloth, which is easily made, is a sure preventive of discomfort. This article has already been manufactured by an enterprising firm and a patent taken out theron, while a thin strip, used as a cork sole, will be found highly efficacious in keeping one's feet comfortable. While, however, the uses to which this peculiar mineral appears to be adapted are manifold, possibly the most important and valuable is that to which it is now so generally applied, viz., as packings for cylinder pistons in steam engines, and for joints in gas, steam and hot air pipes. In the manufacturing of steam packing good fibre is required capable of spinning. The mineral as it comes out of the rock in vein form is first pulled apart and the fibre teased out into a woolly or silky mass. Then, by specially prepared machinery, the gritty and iron particles are carefully eliminated, since their presence would be productive of injury to the rapidly moving polished piston rods, and the resulting product, a fine fluffy substance, is then carded and spun into yarn or woven into cloth. If the former, the yarn is treated after the manner of manilla and manufactured into ropes of various sizes and shapes, as required for the different varieties of packing into which it is to be made. In order to adapt the mineral to special uses the fibres of the asbestus are frequently intermixed with fine wires of copper or brass or associated with rubber. In some varieties also finely divided graphite enters into the composition, presumably to impart greater lubricity to the material. The great value of this packing arises from the fact that it is unacted upon by steam or heat, and consequently retains its elastic properties for a very long time in comparison with the old style of hemp or rubber packings; so that now, especially since the late improvements in engines of the marine type where enormous power is developed, such satisfactory results could not probably be obtained by any other known substance.

As a covering for steam pipes and boilers it has also come into very general use, the saving in fuel and power from its application far more than repaying the cost of the material, and is estimated to be not less than 30 per cent. of the energy developed.

But it would be practically impossible in a paper of this kind to enumerate the uses to which this wonderful material is now being ap-

plied, and concerning the adaptability of which fresh discoveries are being made almost daily. The great importance attached to the deposit in the province of Quebec is seen in the fact that several of the largest companies interested in the manufacture of asbestus products have found it to their interest to secure mines of their own in this district, among which may be mentioned the Bell Asbestus Co. and the United Asbestus Co., of London, Eng., and the great German firm of the Wertheims, of Frankfort, while American firms are also largely interested in several of the mines. In spite, therefore, of the wide geographical distribution of the mineral, it is evident that the asbestus of this country has, from its excellent qualities and from the ease with which it is obtained, risen to this prominent place, and in view of the fact that the sources of supply appear to be limited, it is doubly important that in all mining operations the minimum of waste should be permitted by the employment of the most improved machinery applicable to the purposes of mining and dressing, consistent with its economical and profitable output. This view of the case is now rapidly engaging the attention of those who possess the keenest insight into the great possibilities of this industry, and rapid strides have taken place in this direction during the last two years.

I trust that sufficient has been said in this paper to show that in asbestus we have a substance which is almost unique in the mineral kingdom —a substance of such ready adaptation to such a variety of uses that its neglect for so many years seems wonderful to those who have but superficially glanced at the subject. Doubtless, however, the great expense attendant upon its use prior to the discovery of the deposits of Thetford and Coleraine, in Quebec, is largely accountable for this state of things, and as in the case of many other substances when once they have come into general use, one wonders how the manufacturing and commercial world ever got along without them. It is possible that within the capacious bosom of mother earth there are stored up other treasures of the mineral kingdom, whose uses are also unknown at the present day, but which await the fortunate coming of some clever genius to show their great importance. A very striking case in point is seen in the enormous nickel deposits of Sudbury, and, to go a little further back, in the great petroleum wells and the reservoirs

of natural gas of Canada and the United States. In fact nature seems to delight in astonishing us at intervals with the production of some new material which almost revolutionizes the existing methods of work; yet it is equally certain that, just as soon as these substances are discovered, the inventive genius of man proceeds to find out some process by which they can be utilized. It will not do, however, to conclude absolutely that, because asbestus at the present day appears to fill a want which is apparently incapable of being filled by any other known material, this condition of things will continue forever or even for any very great length of time. Scientific investigation in the various branches of manufactures and arts is progressing at so wonderful a pace that one ceases almost to be astonished at each successive and brilliant discovery. It is gratifying to know, however, that all such discoveries, whether in the domain of medicine, electricity or in any of the branches of applied science tend to the increased welfare, comfort and advancement of the human race, and to those engaged in the solution of the problems which are constantly being presented in the different fields of scientific research, the thanks of all men are due as to to the world's greatest benefactors.

———:o:———

THE ANNUAL MEETING.

Members are reminded that the ANNUAL MEETING will be held on the afternoon of the third Tuesday in March (17th). It will be held in the Normal School lecture room at 4.15 p.m. The importance of every one attending the annual meeting is manifest, as matters of vital interest always turn up and the Council is most anxious that every member should consider that he has a voice in directing the management of the Club.

SUBSCRIPTIONS.

The Treasurer begs to request that all members who have not already done so will pay their subscriptions before the annual meeting.

INDEX.

SUMMARY

—OF—

Canadian Mining Regulations.

NOTICE.

THE following is a summary of the Regulations with respect to the manner of recording claims for *Mineral Lands*, other than Coal Lands, and the conditions governing the purchase of the same.

Any person may explore vacant Dominion Lands not appropriated or reserved by Government for other purposes, and may search therein, either by surface or subterranean prospecting, for mineral deposits, with a view to obtaining a mining location for the same, but no mining location shall be granted until actual discovery has been made of the vein, lode or deposit of mineral or metal within the limits of the location of claim.

A location for mining, except for *Iron* or *Petroleum*, shall not be more than 1500 feet in length, nor more than 600 feet in breadth. A location for mining *Iron* or *Petroleum* shall not exceed 160 acres in area.

On discovering a mineral deposit any person may obtain a mining location, upon marking out his location on the ground, in accordance with the regulations in that behalf, and filing with the Agent of Dominion Lands for the district, within sixty days from discovery, an affidavit in form prescribed by Mining Regulations, and paying at the same time an office fee of five dollars, which will entitle the person so recording his claim to enter into possession of the location applied for.

At any time before the expiration of five years from the date of recording his claim, the claimant may, upon filing proof with the Local Agent that he has expended $500.00 in actual mining operations on the claim, by paying to the Local Agent therefor $5 per acre cash and a further sum of $50 to cover the cost of survey, obtain a patent for said claim as provided in the said Mining Regulations.

Copies of the Regulations may be obtained upon application to the Department of the Interior.

A. M. BURGESS,
Deputy of the Minister of the Interior.

DEPARTMENT OF THE INTERIOR,
Ottawa, Canada, December 19th, 1887.

N1 3166
N1 3166

HENRY WATTERS,

Chemist and Druggist,

Corner of Sparks and Bank Streets,

OTTAWA.

ROBERTSON BROS.,

Booksellers and Stationers,

69 Rideau Street.

Natural History Works supplied to order.

C. P. WILLIMOTT & CO.

333 Wellington St., Ottawa.

Mineralogists & Lapidaries

Every variety of stone cut and polished. Large stock of cut stones to select from. Rock sections for microscope carefully prepared. Collections of named characteristic Canadian minerals from $1 upwards. Give us a call if you want something new. Send for catalogue.

J. D. TAYLOR,

Book and Job Printer,

48 & 50 Queen St.

OTTAWA.

J. G. BUTTERWORTH & CO.,

ALL-RAIL COAL,

86 Sparks Street.

WM. HOWE,

Importer of Artists Materials and Artistic Interior Decorations. Manufacturer of White Lead, Paints & Colors.

Howe's Block, - - OTTAWA.

M. M PYKE,

MEN'S OUTFITTER,

99 SPARKS ST.,

OTTAWA, - - - ONTARIO.

BOARDING and DAY SCHOOL

—FOR—

YOUNG LADIES.

(Established 1862.)

49 DALY AVENUE.

MISS A M. HARMON, - - PRINCIPAL

A. J. STEPHENS,

FINE SHOES,

39 SPARKS ST.

Boots and Shoes Made to Measure.

J. & R. CRAIG, Tailors, 105 Sparks St., Ottawa.