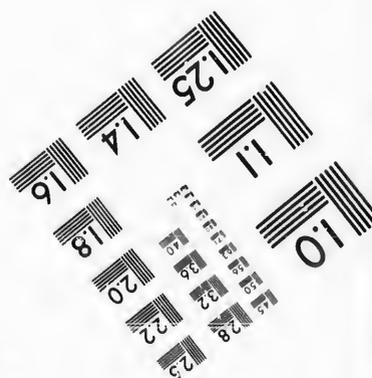
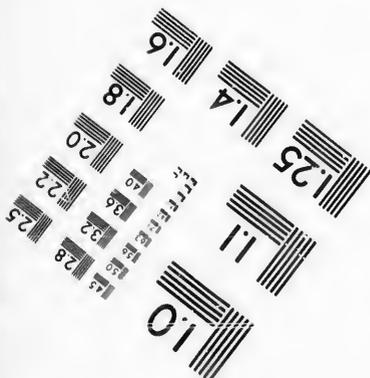
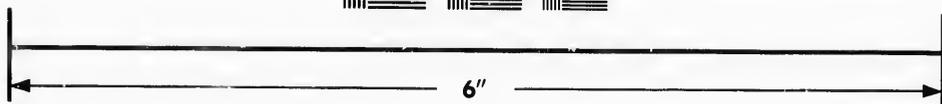
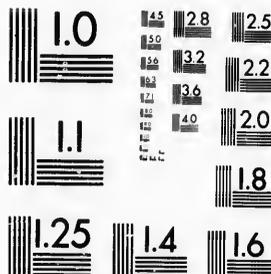


**IMAGE EVALUATION
TEST TARGET (MT-3)**



**Photographic
Sciences
Corporation**

23 WEST MAIN STREET
WEBSTER, N.Y. 14580
(716) 872-4503

**CIHM/ICMH
Microfiche
Series.**

**CIHM/ICMH
Collection de
microfiches.**



Canadian Institute for Historical Microreproductions / Institut canadien de microreproductions historiques

© 1987

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.

- | | |
|---|---|
| <input type="checkbox"/> Coloured covers/
Couverture de couleur | <input type="checkbox"/> Coloured pages/
Pages de couleur |
| <input type="checkbox"/> Covers damaged/
Couverture endommagée | <input type="checkbox"/> Pages damaged/
Pages endommagées |
| <input type="checkbox"/> Covers restored and/or laminated/
Couverture restaurée et/ou pelliculée | <input type="checkbox"/> Pages restored and/or laminated/
Pages restaurées et/ou pelliculées |
| <input type="checkbox"/> Cover title missing/
Le titre de couverture manque | <input checked="" type="checkbox"/> Pages discoloured, stained or foxed/
Pages décolorées, tachetées ou piquées |
| <input type="checkbox"/> Coloured maps/
Cartes géographiques en couleur | <input type="checkbox"/> Pages detached/
Pages détachées |
| <input type="checkbox"/> Coloured ink (i.e. other than blue or black)/
Encre de couleur (i.e. autre que bleue ou noire) | <input checked="" type="checkbox"/> Showthrough/
Transparence |
| <input type="checkbox"/> Coloured plates and/or illustrations/
Planches et/ou illustrations en couleur | <input type="checkbox"/> Quality of print varies/
Qualité inégale de l'impression |
| <input type="checkbox"/> Bound with other material/
Relié avec d'autres documents | <input type="checkbox"/> Includes supplementary material/
Comprend du matériel supplémentaire |
| <input type="checkbox"/> 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 | <input type="checkbox"/> Only edition available/
Seule édition disponible |
| <input type="checkbox"/> 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. | <input type="checkbox"/> Pages wholly or partially obscured by errata slips, tissues, etc., have been refilmed to ensure the best possible image/
Les pages totalement ou partiellement obscurcies par un feuillet d'errata, une pelure, etc., ont été filmées à nouveau de façon à obtenir la meilleure image possible. |
| <input type="checkbox"/> 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
						✓					

The copy filmed here has been reproduced thanks to the generosity of:

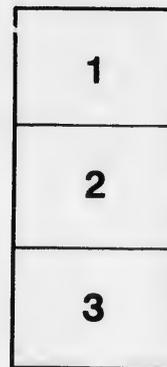
Library,
Geological Survey of Canada

The images appearing here are the best quality possible considering the condition and legibility of the original copy and in keeping with the filming contract specifications.

Original copies in printed paper covers are filmed beginning with the front cover and ending on the last page with a printed or illustrated impression, or the back cover when appropriate. All other original copies are filmed beginning on the first page with a printed or illustrated impression, and ending on the last page with a printed or illustrated impression.

The last recorded frame on each microfiche shall contain the symbol \rightarrow (meaning "CONTINUED"), or the symbol ∇ (meaning "END"), whichever applies.

Maps, plates, charts, etc., may be filmed at different reduction ratios. Those too large to be entirely included in one exposure are filmed beginning in the upper left hand corner, left to right and top to bottom, as many frames as required. The following diagrams illustrate the method:



L'exemplaire filmé fut reproduit grâce à la générosité de:

Bibliothèque,
Commission Géologique du Canada

Les images suivantes ont été reproduites avec le plus grand soin, compte tenu de la condition et de la netteté de l'exemplaire filmé, et en conformité avec les conditions du contrat de filmage.

Les exemplaires originaux dont la couverture en papier est imprimée sont filmés en commençant par le premier plat et en terminant soit par la dernière page qui comporte une empreinte d'impression ou d'illustration, soit par le second plat, selon le cas. Tous les autres exemplaires originaux sont filmés en commençant par la première page qui comporte une empreinte d'impression ou d'illustration, et en terminant par la dernière page qui comporte une telle empreinte.

Un des symboles suivants apparaîtra sur la dernière image de chaque microfiche, selon le cas: le symbole \rightarrow signifie "A SUIVRE", le symbole ∇ signifie "FIN".

Les cartes, planches, tableaux, etc., peuvent être filmés à des taux de réduction différents. Lorsque le document est trop grand pour être reproduit en un seul cliché, il est filmé à partir de l'angle supérieur gauche, de gauche à droite, et de haut en bas, en prenant le nombre d'images nécessaire. Les diagrammes suivants illustrent la méthode.

rrata
o

elure,
n à

GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA
ALFRED R. C. SELWYN, LL.D., F.R.S., DIRECTOR.

REPORT

ON

APATITE DEPOSITS,

OTTAWA COUNTY, QUEBEC.

BY

J. FRASER TORRANCE.



PUBLISHED BY AUTHORITY OF PARLIAMENT.

MONTREAL:
DAWSON BROTHERS.
1884.

I

S

t

a

t

a

V

n

DR. A. R. C. SELWYN, LL.D., F.R.S., &c.,
Director of the Geological and Natural History Survey of Canada.

SIR,

I have the honor to report that in accordance with your instructions received on the 17th May ult., I proceeded to Montreal to obtain any information and maps, procurable from Mr. Vennor or elsewhere, that might be of service to me in the geological explorations of the apatite-bearing region of Ottawa county. While there I engaged Mr. Wm. H. Howard, B.A.Sc. (McGill), and Mr. W. J. Torrance to assist me for the season.

My report of the season's work is herewith submitted.

I have honour to be,

Sir,

Your obedient servant,

J. FRASER TORRANCE.

28th March, 1884.

b
ac
d

C
u
R

g
co
in
an
re
l

pa
no
la
aw
w
se
co

REPORT
ON
APATITE DEPOSITS,
OTTAWA COUNTY, QUEBEC.

BY
FRASER TORRANCE.

We left Buc... together on the morning of the 7th June, and began our work... to the High Rock mines and the adjacent property in Portland West, upon the right bank of the Rivière du Lièvre, not far below the High Falls.

High Rock Mine.

The "High Rock" property is owned by the Phosphate of Lime Co. (Limited), London, England. The principal pits have been opened upon Lots 5, 6 and 7, Range VII., and Lots 1 and 2 and part of 7, Range VIII.

The openings are all on one broad belt of pyroxenitic rock, with a general north-west trend. Proceeding in the same direction we come upon the Dugway Pits, and then to the Star Hill mine, belonging to the Union Phosphate Mining and Lands Company of New York and New Jersey. In the reverse (S.E.) direction, this belt exhibits remarkably rich surface indications and pockets of phosphate on Lots 1 and 2 of Range VII., Portland West.

The richest pit on the High Rock property, now abandoned and partially filled with water, was called the Bonanza Pit. It is on the north-east corner of Lot 7 in Range VII. In shape it is very irregular, both in its horizontal and its vertical sections. At the surface it averages about forty feet wide by sixty-three feet in length. At the water level its section is 60 feet \times 66 feet, and its sump is said to be seventy feet deep; but this is probably an exaggeration. Its depth could not be ascertained with a line, as the pit was sunk on an incline

beneath its south-eastern side. Its enlargement in sinking has been caused by undermining the southern and eastern sides in "winning" flat stringers of apatite from two inches to one foot in thickness. In the centre of the pit there rises a kind of island of comparatively barren pyroxenite to a height of some twelve feet above the water level. It also has been much undermined on its western side in following a flat stringer of apatite about six inches thick.

A cutting has been driven from the edge of the hill to drain this pit, but it was not driven at a sufficiently low level to afford any permanent relief. It failed to disclose any workable deposit of apatite. But this is not surprising, as the cut does not average over six feet in depth and about thirty feet in length.

The country rock is a crypto-crystalline green pyroxenite with finely disseminated apatite and occasional patches of coarsely crystalline white orthoclase. The walls and floor of the pit are everywhere dotted with crystals or scales of dark muscovite. The massive apatite occurs here in irregular masses of all sizes and attitudes. This pit is said to have yielded 700 tons of choice apatite.

I was much impressed with the admirable position of this pit for testing the question of the depth at which such deposits are likely to be worked to any great advantage. It stands on the brink of a hill, pitching sharply to the south-west, and the flat, locally known as the Beaver Meadow, lies about 400 feet below the pit. If a cutting were driven into the hill at any sufficient depth, at right angles to its general trend, it would in all probability disclose fresh deposits of apatite of sufficient extent to yield a very handsome profit upon the enterprise.

In such an undertaking it would be advisable to use a *pair* of steam drills to remove this large body of rock as cheaply as possible. It is to be regretted that the few companies at present employing such machinery in our phosphate mines are running single drills. While they thus save the capital required for the purchase of a second drill, and do not require quite so large or expensive a boiler, they employ almost as much labour for one drill as would suffice to work two. A fireman and a skilled mechanic, with an assistant, are requisite to work one drill. By the substitution of a slightly larger boiler and the employment of an additional assistant, two drills could be worked instead of one. The necessary repairs would cost less, and the work would be done twice as fast. When one drill is being run and it needs any repairs, the men are all idle until these are effected. But with two drills there is very little chance of both getting out of adjustment at the same time.

The next opening to the Bonanza is about 25 ft. to the south-east of

it, and is on an extension of the same deposit. It is 84 feet long, running S. 60° E. mag., and it averages about 10 feet wide. Its general features do not materially differ from those of the Bonanza pit itself.

"Captain pit," also abandoned and full of water, lies to the north-west of the Bonanza. Its length is 150 feet and strike N. 65° W (mag). ^{Openings on the High Rock property.} Its greatest width is 41 ft. and the least is 6 ft., averaging 18 ft. The country rock here also is pyroxenite, irregularly impregnated with apatite. Immediately on the north-east side of this deposit the country rock is a reddish gneiss, with a vertical dip apparently striking N. 70° W. (mag.)

Pit No. 4 is 59 ft. long \times 10 ft. wide, \times 12 ft. deep. It is now abandoned, but is said to have yielded about 300 tons of prime apatite.

Pit No. 5 is about 32 ft. long \times 15 ft. wide, with a smaller pit (21 feet long) at the north end of it, separated from it by 12 feet of comparatively barren rock. It is now abandoned, but is reported to have yielded about 250 tons of choice apatite. At the southern end of the opening, the pit is said to extend forty feet farther underground. But it was too full of water for us to see anything of this subterranean extension. The country rock here is chiefly pyroxenite with some white fine-grained felsite, reticulated with green pyroxene.

Pit No. 6 is about 41 ft. long by 25 ft. wide; now abandoned. The country rock is a massive dark pyroxenite, irregularly veined and impregnated with apatite.

Pit No. 7 is the nearest one to the company's office, on the northern side of the road from the wharf. Its length is 76 ft., on a strike N. 57° E. But its width varies greatly. At the E.N.E. end it is 50 ft. wide, in the middle only 16 ft. and at the other end 23 ft. The average depth in the western half was about 18 ft. (It is probably a good deal deeper now—February, 1884.) But the eastern end was full of water. The cross-cutting at this latter end follows the apparent strike of the country rock, which is here N. 60° W. astron., with a dip apparently S. 30° W. $<$ 45-60°. But this observation was not entirely reliable. More pyrite was noticed in this pit than in those above described. In the northern side of the western end, the apatite was arranged in narrow vertical bands, and had every appearance of being a vertical vein. And there was a very rich show of apatite covering the bottom of that end of the pit, apparently lying almost horizontal. These two masses merge into one another.

This affords a good illustration of the difficulty of classifying these ^{Classification of deposits as veins or beds.} deposits of apatite. During the past season I often noticed in the same pit patches of apatite that might easily be taken for the contents of a fissure vein, if there were any casing rock on either side of it to separate it from the country rock, and patches of flat-lying apatite that

might easily be called bedded if they were of any great extent or approximately uniform thickness and if the country rock showed any planes of bedding parallel to the longest axes of such patches. Or else it might easily be assumed that the country rock had been more or less tilted and overturned since the deposit of the apatite, and that the vertical patches were interbedded and the more horizontal ones were veins, if their relations to the country rock were such as veins and beds respectively are wont to maintain. But, unfortunately, I failed to perceive these concurrent conditions.

The season's work has left upon my mind a strong conviction that these deposits in Portland and Buckingham are irregular segregations from the country rock; and are confined to one or more zones of rock that approximately follow the course of the Rivière du Lièvre in a general N.N.W. direction, and are more or less heavily impregnated with apatite. Very possibly there is but one such zone, with the Rivière du Lièvre occupying a synclinal near the summit of the series.

These phosphate-bearing rocks are characterized by the predominance of pyroxene in their composition and the frequent presence of irregular patches of coarsely crystalline lilac or violet-coloured felspar.

Mr. Vennor's
opinion.

Mr. H. G. Vennor considered a band of rusty-coloured gneiss to be a guide to the richest deposits. I saw no such band associated with apatite; although such bands very commonly accompany the graphite. On the contrary, there is a singular scarcity of such gneisses in the High Rock belt of pyroxenite and associated rocks, considering that there is always more or less iron pyrite present in these phosphate deposits.

Pit No. 8 is a small shallow opening in pyroxenite. A good show of apatite on the surface pinched out on sinking a few feet. There is a patch of coarsely crystalline felspar at the end of this pit; which is now abandoned.

Pit No. 9 was almost 18 ft. square \times 12 ft. deep last June. The country rock is a massive, fine-grained pyroxenite with apatite in irregular flat-lying patches. About 60 tons is said to have been mined here at the above mentioned date.

Pit No. 10 is only 27 feet from No. 9, and the surface has been stripped from one to the other. But the character of the two deposits is very different. In No. 9 the apatite lies flat, or nearly so; whereas in No. 10 it occurs in small vertical veins in the pyroxenite. It is now abandoned and full of water. Supposed to be 24 feet deep. It is said to have yielded about 120 tons of apatite.

Pit No. 11 is said to have yielded from 350 to 400 tons. It is 95 ft. long \times 21 ft. wide, striking due East and West (mag.), with a small lateral pit on its south side.

It is now abandoned, and most of the bottom is under water. But at the west end it is quite shallow, with some show of massive apatite in the bottom and end. The country rock here is pyroxenite, with much felspar and coarsely crystalline mica. Here and elsewhere the mica and apatite are distributed quite independently of one another, occurring sometimes together, but just as often by themselves.

Openings on
High Rock
property
continued.

Pit No. 12 is rectangular and of tolerably uniform section, viz., about 26 ft. \times 18 ft. In June it was 44 ft. deep, and had a floor of solid apatite. At about 12 ft. from the surface the apatite is said to have pinched almost completely out, but it soon "came in" again quite as richly as before. The country rock is massive pyroxenite. On the dump we picked up specimens of compact, pale, greenish-yellow apatite. One large specimen, apparently of massive epidote, gave no reactions for phosphoric acid and calcium.

Pit No. 13 is 23 ft. long \times 16 ft. wide \times 12 ft. deep. The country rock is terribly mixed up. It is principally pyroxenite with patches of white and flesh-coloured felspar. The weathered surfaces about this pit are chiefly pinkish felsite with some white quartzites. The general strike of the beds is N. 50° W. The dip is uncertain, but seems to be N. 40° E. $<$ 82-90°.

Nature of
country rock.

The remaining openings examined on this property were more in the nature of open cuts than pits; being long, shallow trenches, rather low down on the slope of the hill, and not far from the Beaver Meadow.

Open cut No. 1 is 29 ft. wide where the line crosses it. It cuts about 50 feet along the west side of the hill, which is partly undermined, and ends in a cavern about 40 ft. long and 15 ft. wide, parallel to the survey line. The country rock is pyroxenite, rather rich in pyrites.

Open cut No. 3 is 181 ft. long on a N. W. and S. E. course, and from 12 to 30 ft. wide. At the S. E. end I observed a horizontal mass of apatite cutting into some vertically-banded pyroxenite and felsite. We obtained specimens of banded apatite and pyroxenite from near the same spot. One of these specimens weighs several hundred pounds, and exhibits a structure rudely resembling the *Eozoon Canadense*. At this end of the cutting we also found a mass of flesh-coloured felsite reticulated with green pyroxene, and containing more or less quartz: similar to that already described as occurring in pit No. 5. We found here some small, imperfect crystals of zircon, and crystals of ilmenite. Aggregations of the latter have been found weighing two pounds. A good crystal of pale-red zircon, about $1\frac{1}{2}$ inch in length, lying in the company's office, was said to come from this cut. We also saw there a very perfect crystal of scapolite, with small crystals of apatite embedded in it.

At Structure like
Eozoon.

Open cut No. 2 is situated between No. 1 and No. 3, but at a rather

lower level. It is 110 feet long, and parallel to No. 3. It varies from 25 ft. to 50 ft. in width, and is of various depths. Some of the apatite here is of reddish colour. A wooden tramway, 149 feet long, runs from this cutting to the roof of a large cobbing-house.

Wilsonite and
scapolite.

Besides the specimens already mentioned, we also found specimens of wilsonite and scapolite on the dumps of the Bonanza and Captain pits.

The Dugway Pits on Lot 7, in Range VIII., belong to this same company (The Phosphate of Lime Co., limited); although the greater part of the lot belongs to the U. P. M. & L. Co. of New York.

Pit No. 1 is 24 ft. south of its derrick. It is 80 feet long, east and west, and 30 feet wide at the widest part. The country rock is a massive, dark pyroxenite. Some large crystals of very dense, heavy apatite were blasted out of this pit. The manager, Mr. Wm. McIntosh, kindly presented me with some of them for our collections. One is now in the museum. This pit is abandoned and full of water.

Pit No. 2 is 60 ft. long upon the surface by 48 ft. wide at the surface. But the deeper end is only 33 ft. wide on the surface and contracts to 20 feet wide in the bottom. In June this pit was 28 feet deep with a splendid show of apatite in the bottom, carrying much fine pyrite. But work was abandoned here in the autumn. This pit runs E. and W. on line with pit No. 1, and close to it. At its east end there is a small cave, and on the surface there is a large pocket of decomposed apatite mixed with rotten pyrite. This rests upon the solid rock, and is overlaid by fine sand and boulders. The country rock here is chiefly massive dark pyroxenite, which in this pit seems to strike E. and W., with nearly vertical dip to the north.

Pit No. 3 is of very irregular shape. It lies on the opposite side of a shallow ravine from Pits 1 and 2. The pyroxenite here is interrupted by irregular patches and stringers of felsite. Much mica is mixed with the little apatite visible. This pit was never of great importance.

The dividing line between the two properties runs across the west end of pit No. 2. The Union Phosphate Mining and Land Co. employed a party of men for some time stripping and prospecting on their side of the line, but they found nothing worth opening.

Union Phos-
phate Mining
& Land Co. of
New York.

We next visited the works of The Union Phosphate Mining and Land Co. of New York and Orange, N.J. The chief workings are open cuttings on the western slope of Star Hill, which lies along the east side of St. Helen's Lake. The line of openings strikes N. 40° W. mag. Very rich croppings of phosphate are found extending for a considerable distance along this strike. These deposits are so rich that single blasts sometimes break out five or six tons of apatite. The country rock is usually a dark massive pyroxenite. The deposits of phosphate

are accompanied by an abundance of coarsely crystalline dark phlogopite. Pyrite is scarce.

The general strike of the country rock about there is N. 38° W. This is the trend of the ridge itself.

One of the richest "shows" of apatite here is contained in a crystalline biotite-orthoclase rock cut by a vertical trap dyke about four inches thick on a strike of W.N.W. The beds did not appear to be in any way affected by this intrusion. The apatite in contact with the trap did not differ in any perceptible way from that occurring elsewhere.

At the north end of St. Helen's Lake we found some yellowish-green garnets associated with ordinary red garnets in a white felsite, carrying spots of dark pyroxene. From a little distance this bed bore a striking resemblance to weather-beaten birch-bark. These pale garnets gave a yellowish-green colour to the borax bead.

This Co.'s "Red Show" pit was 31 ft. long \times 10 ft. wide, and quite shallow. It lies mid-way between the Star Hill and Dugway pits. The country rock is a coarsely-crystalline micaceous pyroxenite with some pinkish orthoclase.

Late in the autumn a steam drill was set to work on the breast of Star Hill with the intention of moving a great quantity of rock during the present winter.

The Emerald Mine.

During the season we paid several visits to the Emerald mine, which is one of the three largest apatite mines in Canada: "High Rock" and "Star Hill" being the other two. This mine is situated on Lot 18 of Range XII. in the township of Buckingham, on the left (eastern) bank of the R. du Lièvre and is about seven miles from the village of Buckingham. The chief openings are on the summit of a high hill popularly known as "The Fort." At the time of our first visit (in June 1883) mining operations were confined to one pit, whence a large quantity of choice sea-green phosphate has been extracted during the last three years. (The foreman estimated this quantity at five thousand tons.) There was a considerable admixture of pinkish calcite in this phosphate near the surface; and much of the apatite was obtained in large crystals penetrating in every possible direction these irregular masses of calcite. But there was not much of this mineral visible in the bottom of the pit. The apatite obtained thence contained but little admixture of anything save pyrite, chalcopyrite, and the pyroxenic country rock.

On the rise of the hill above this main pit and between it and the old Grant pit upon the adjacent property, there are several smaller

pits; all of them showing similar rich green apatite in this pyroxenitic rock and accompanying felsites.

Segregated
deposits from
country rock.

There are similar exposures on the north western flank of this hill. In fact, the whole hill is in all probability impregnated more or less richly with apatite. The workable deposits are merely segregations of greater or less extent from the surrounding country rock, which here presents no beds of marked and constant character to enable either the attitude or thickness of the formation to be determined.

This same difficulty was constantly met with throughout the summer. The lithological character of the rocks in this district was not found to be a safe guide for their identification at any distance from the point of original observation.

Occurrence of
galena.

Near the main pit of the Emerald mine is a dump of several hundred tons of "seconds," containing, probably, from 40 to 50 p.c. of apatite. Upon it we found some interesting specimens of rounded crystals of very dark glossy apatite; rounded lumps of red calcite, closely resembling blobs of sealing wax, in a crypto-crystalline mass; rounded crystals of dark-green apatite associated with chalcopyrite and pyrrhotite. We also found here some specimens of sphalerite, associated with these other minerals. But these latter specimens appeared to have been all extracted from a single small gasli vein from one to two inches thick. A diligent search failed to find any in the pit. One specimen contained a single speck of galena, identified by the blow-pipe reactions.

Old Grant pit.

In June the main pit was about 140 ft. long \times 40 ft. wide upon the surface, but narrowed and contracted very much in sinking. Its strike was about N. 60° E (true). Its depth was about 40 ft. The only means of draining it at that time was by heavy iron-bound tubs, hoisted by horses and two derricks on opposite sides of the pit. During the summer, however, a boiler was set up and a steam drill started with the intention of cutting through the slope of the hill into the pit, and thus freeing it of this very serious hindrance to mining. But the serious mistake was made of starting this cutting on a level but slightly lower than the bottom of the pit. As soon as this has been sunk a few feet deeper, recourse must be had once more to the former costly method of hoisting the rock and water.

The old Grant pit, on the adjacent lot, has been abandoned for several years, and is full of water. It was worked by a whim. On the dump here we found quite a number of fine specimens of the banded apatite and pyroxenite. The dump was mainly composed of pyroxenite, with a good deal of felsite. We found also crystals of scapolite.

It is perhaps worth while to note that this banded apatite and pyroxenite has never been found at any greater depth than a few feet

below the soil. Some of it was found in the eastern end of the main pit of the Emerald Mine, immediately below the soil. The specimens we obtained at High Rock were found close to the surface.

At the Emerald Mine we also obtained a large specimen of pink calcite banded with the pyroxenite in precisely the same way. But it was unfortunately left at Platt's house. Banded calcite
and pyroxenite.

The strike of the rock near the Grant pit was found to be N. 46° W (mag).

The Fowler and Bacon Properties.

These are adjacent to each other on the First Range of Portland East—Fowler's lot being the eastern half of Lot No. 2, and Bacon's being the western half of the same lot. Little work has been done here. The openings on both properties are close to the side line separating them, and not far from the south side of the range.

"Fowler's big show" is a stripping on the side of a hill. It shows a breast of massive green apatite about 10 feet long, freely spotted with large but imperfect crystals of black phlogopite. This stripping runs north and south across this bed (?) of apatite. The country rock is pyroxenite and felsite irregularly mixed. There are a number of other smaller openings close to this, all showing some apatite. Country rock But I did not hear of any apatite being found elsewhere on this lot than in this one patch, close to the side line. No attempts have been made to mine this deposit. It has simply been stripped on speculation. Now (February, 1884,) I am told that it has been recently sold for a very considerable sum.

Higher up on the same gentle slope are the Bacon pits on the west half of this lot. Bacon pits. The main pit is 19 ft. × 13 ft. × 10 ft. deep, with fair shows of apatite in both ends. The country rock is massive pyroxenite. There is a small vein of pink felspar in the western side of the pit. Another small opening has been made about 60 ft. N. 60° E. of this pit. And a little trenching has been done in the immediate vicinity. About 20 tons are said to have been taken off this property and about 10 tons off Fowler's half.

On our way back to the Lièvre we observed the strike on two different exposures to be respectively N. 15° E., with dip S. 85° E. < 47°, and N. 38° E. with dip S. 52° E. < 75° (mag.)

La Compagnie Française des Phosphates du Canada.

This Company, organized in France, owns a large number of so-called phosphate lots, but their chief work seems to have been confined to Lots 1 and 2 of Range III. and No. 1 of Range IV., Portland East, and Lot 16 of Range VIII. in the same township.

Compagnie
Française des
Phosphates du
Canada.

Pit No. 1 on Lot 2, Range III., is 30 ft. long \times 10 ft. wide and 25 ft. deep. The strike of this opening is N. 56° E. In the S.W. end and bottom there is a 2-3 ft. seam of apatite dipping N.W. The country rock is a massive iron-grey crystalline rock, consisting chiefly of quartz, hornblende and mica. The apatite has a good deal of mica associated with it. There is some brilliant red calcite finely disseminated through portions of the country rock, and also in the apatite itself. This pit was being worked at the time of our visit.

Pit No. 2 was abandoned. Its length was 91 ft. on a strike N. 30° E. The N.E. end and centre were full of water. But at the S.W. end there was a little massive green apatite exposed, with coarse phlogopite imbedded in it. The country rock is similar to that about No. 1. Its strike is obscure, but appears to agree with the direction of the opening, and has a dip of N. 60° W $<$ 65°.

Pit No. 3 is 16 ft. wide by 32 ft. long. The country rock here is a granular massive pyroxenite with some white felsite upon the surface, with a strike N. 30° E. and dip N. 60° W $<$ 77-90°. Very little apatite was visible in the walls of this pit, and almost no mica or pyrite.

Pit No. 4 is 20 ft. long by 13 ft. wide and 6 ft. deep. It differs from No. 3 in having large patches of pink calcite in the country rock, holding crystals of green apatite and some mica. In the country rock there are also patches of pale lilac felsite carrying a little apatite.

Pit No. 5 is a stripping on the side of a hill to the N.W. of M. Folcher's house. It is 15 ft. \times 6 ft., and shows a little apatite and mica in pyroxenite. There are four or five other strippings on the side of this hill—west of No. 5. But none of them show any quantity of apatite.

Pit No. 6 is noteworthy for the scarcity of apatite in it. Its eastern end is sunk in gneiss, striking N. 30° E. with a vertical dip. But the western part is in pyroxenite showing a little apatite. A few tons are said to have been obtained from this pit.

Pit No. 7 is 45 ft. N.E. of No. 6, and is 34 ft. deep. Its section is about 15 ft. \times 10 ft. It runs on the strike of the country rock N. 32° E. and has a very regular foot-wall, dipping N. 58° W. $<$ about 80°. There were no ladders to get into it. We saw very little apatite in the walls. There seemed to be more in the bottom. But it was too dirty for a clear view. The country rock is pyroxenite with a little white felsite and some spots of pink calcite.

I noticed a little titanite in almost every stripping on this hill.

Pit No. 7 is 68 ft. due east of my station L. Its area is 20 ft. \times 10 ft. and is 4 ft. deep. Here we found a little green apatite and black mica in pyroxenite.

Pit No. 8 is 9 ft. wide \times 10 ft. deep. The country rock is pyroxenite, with a little titanite in white felsite.

Near my station M there are four pits.

Pit No. 9 is 17 ft. N. 20° W. from it and is 23 ft. deep. Its section is 16 ft. by 12 ft. The country rock is massive pyroxenite.

Pit No. 10 is 25 ft. N. 82° W. of No. 9. This is 15 ft. wide and 26 ft. long on the strike N. 08° E. Full of water. The country rock is a massive pyroxenite, containing some tourmaline. A little titanite and some small crystals of chabazite accompany the apatite, and also some black mica and pyrite. Some calcite here is very red.

Pit No. 11 is 16 ft. from M, bearing S. 20° E. from it. It is 10 ft. \times 10 ft. \times 7 ft. deep. The country rock here is chiefly felsite; Country rock. mostly lilac, but some red. A fair show of apatite in the bottom.

Pit No. 12 is 27 ft. from M, bearing S. 10° W. from it. It is cut into the side of the hill. It is 13 ft. \times 16 ft., and on its upper side is 23 ft. deep. The country rock is pyroxenite, with spots of dark red calcite in one corner. Some of the apatite is very deep red. On the dump we found specimens of a dark red micaceous mineral containing much water. Its foliae had lost all elasticity. Doubtless this is an altered mica. (rubellan?)

Pit No. 13 is full of water. Apparently deep. It is 25 ft. wide and about the same length. The country rock is pyroxenite.

Pit No. 14 is 25 ft. \times 10 ft. Country rock, pyroxenite.

Beside pit No. 15 there was an open cut about 40 ft. long, striking N. 26° E. and showing a deposit of apatite averaging 3 ft. in width, as far as it had been stripped.

East Half of Lot 7, Range I., Portland East.

The main pit upon this lot is 32 ft. \times 63 ft., on a strike N. 63° E., and is about 43 ft. deep. As this pit was full of water at the time of our visit, and was scooped into a deep cove at the NE. end, I had to take these dimensions from Mr. Platt, who assures me that over one thousand tons of phosphate were taken from this one pit. In its N.E. end black mica is much more abundant than apatite. This pit is richer in mica than any other yet visited. It occurs here chiefly in large im-
perfect crystals, whereas it generally occurs mostly in fine scales. We noticed also at this pit an unusual scarcity of sulphides of all kinds. While this pit was being worked, a great deal of the mica extracted here was used for road metal, for which purpose it is about equal in value to sawdust.

Pit No. 2 is cribbed up at its mouth for a windlass and is full of water. Platt says that it averages 10 ft. \times 6 ft., and is 14 ft. deep.

He reports that 22 tons of apatite were extracted. We found zircon on this dump. The country rock around 1 and 2 is pyroxenite.

Pit No. 3 is a dry hole of irregular shape. It averages about 9 ft. \times 7 ft. and is 13 ft. deep. The country rock is pyroxenite, with a good deal of pink felsite.

Pit No. 4 is a tunnel driven into the hill. It is 6 ft. high \times 8 ft. wide, and is 16 ft. long. The country rock is chiefly white (with some pink) felsite. Very little apatite is visible in the sides and end of this tunnel. About fifty tons of apatite are said to have been obtained here.

Tamo Lake Mines.

On Lot 14 of Range V. in Portland East there are three pits lying close together. They are small and shallow and offer no features worthy of note. The country rock is pyroxenite, showing but little red and green apatite in patches through it.

Found the strike of country rock near one of these pits to be N. 28° W. with dip S. 62° W. $<$ 83°. Another exposure a little to the east of this gave the dip as N. 60° E. $<$ 67°. It seems likely that these pits are on the summit of an anticlinal.

Major
Chapleau's
company.

Major Chapleau's Co. own Lots 16, 17 and 18 in Range VI. of Portland East. During last summer they worked almost exclusively on the N.W. corner of Lot 17. The long opening is 66 ft. long on a strike N. 10° E. At the south end it turns off abruptly to S. 40° E. for another 60 feet. The deepest sinking was done in this easterly extension. But it was nowhere over 9 ft. deep at end of September. The country rock is a massive pyroxenite. On the gentle slope just below this pit to the south, is a series of strippings, showing patches of red and green apatite in the pyroxenite. The apatite mined was green and massive, with no crystals. This pit is remarkably free from mica and pyrites.

The strike of rock near the boarding house was noted as N. 9° W.

On Lot 16 we saw a couple of small abandoned openings by the roadside.

The Haycock Mine.

This mine, on Tamo Lake, was worked in the early part of the summer by Messrs. Van Rensselaer, Falding & Co. of New York, under contract with the Dominion Phosphate Company of Montreal. The chief work done was the cutting of a deep, open drift, with a steam drill, from the western slope of the ridge of pyroxenite—along the course of which all the old pits had been sunk—into its heart. The direction of the cut was N. 80° E., and its length was 117 ft. It was carried in 18 ft. wide, and its greatest depth was 37 ft. The beginning of the

cut was through red and grey quartzites, striking N. 15° W., with a dip N. 75° E. < 80°. But almost the entire cut was through greyish pyroxenite.

Very little phosphate was found in this cut until the abandoned "Deep pit" was reached. In it they struck a very good floor of solid apatite, which they were just beginning to exploit at the time of my last visit. Haycock mine openings.

This cut and all the other openings in this property are on Lot 18 of R. VII, Portland East.

Pit No. 1 is 34 ft. × 70 ft. on a strike of N. 15° W. Its greatest depth is 12 ft., but it would not average more than 6 ft. Country rock is pyroxenite. We found here a fine specimen of crystalline tourmaline on pyroxenite.

There are twelve small pits to the north-west of the steam cut. They all occur in one bed of vertical, massive pyroxenite, striking N. 15° W. The greatest width of these pits apart, in an E. and W. direction, is 110 ft. The country rock in all of them is massive pyroxenite, with stringers of calcite. We found here crystals of white and yellow chabazite.

La Compagnie Française des Phosphates du Canada is working also on Lot 17 of Range VIII, in Portland East.

Pit No. 1 is 13 ft. × 45 ft. on a strike of N. 11° W. It was full of water and reported to be 25 ft. deep. From the north end of this pit the surface has been stripped on same strike for 115 ft., and shows patches of apatite with much mica and a little pink calcite, scattered through the pyroxenite.

Pit No. 2 is 9 ft. deep by 7 ft. in diameter.

Pit No. 3 is quite shallow. It shows very little apatite in the country rock, which is chiefly white felsite, enclosing patches of massive green pyroxenite.

Pit No. 4 is the only one now worked. It is of very irregular shape. It is 20 ft. long × 10 ft. wide, at its deepest end. The strike of this opening is N. 65° W., with a dip of S. 35° W. < about 75°. Its greatest depth was about 20 ft. Both pyrite and pyrrhotite occur in this pit—the former being in the larger quantity.

The Watt Mine.

This mine is situated on Lot C of Range I., Portland East.

Pit No. 1 is filled with water. It is sunk on an incline, and said to be 160 ft. deep. The section at surface is 15 ft. × 14 ft. At a depth of 15 ft. it decreases to 14 ft. × 8 ft. It was worked by a horse whim. The country rock is chiefly pyroxenite with disseminated spots of apatite. It contains very little mica. The rock in the vicinity of this

pit strikes N. 50° E. with a vertical dip. Other exposures on this property, gave strikes of N. 45° E., N. 50° E., N. 55° E., N. 45° and N. 50° E.

Watt mine
openings.

Pit No. 2 is said to be connected with No. 1 by a tunnel. The dimensions of this pit are 13 ft. \times 11½ ft. Platt says that it is 50 ft. deep. It has a log building over it. The country rock is similar to that of No. 1.

Pit No. 3 is 16½ ft. \times 7½ ft., and has a windlass over it. It was 16 ft. deep to surface of water—5 ft. deep. The country rock is pyroxenite, with a good deal of apatite disseminated in patches through it. There was a good deal of felsitic rock upon the dump, essentially composed of white felspar—with embedded particles of crystals of pyroxene. At a distance of 40 ft. from this pit, N. 15° W., there is a pit sunk in granite (?) showing also some quartzites. Very little mica in these rocks.

Pit No. 4 is 15 ft. \times 23 ft. Filled with water to within 11 ft. of the surface. Total depth about 18 ft. The country rock here is pyroxenite with a good deal of disseminated apatite, and also patches of it, and an abundance of mica. Specimens of crystalline titanite and calcite, crystals of hornblende and tourmaline, and lumps of white and grey felsitic rocks were collected here.

In the autumn Mr. William Allen of Ottawa took possession of this property, and has since been working steadily upon it.

Cameron's Property.

This name is often applied to Lot 27 in Range VIII. of Portland East.

Steam hoisting
engine.

Pit No. 1 is 62 ft. \times 24 ft., with strike N. 45° E. Its depth was 58 ft. to the floor of the pit, with an 8 ft. sump. This pit is a large, irregular cavern about 18 ft. high at the bottom of an inclined shaft 22 ft. \times 24 ft. in section. The apatite was chiefly red. The foreman reported that about 1,800 tons of apatite had been extracted from it. This shaft is the only one in the valley of the Lièvre with a steam-hoisting engine. The country rock is pyroxenite with some apatite and much calcite of great variety of colour. Some patches of lilac feldspathic rock. Very fine specimen of pink, green and white wilsonite and scapolite were obtained here. Strike of the rock near here is N. 20° W.

Pit No. 2 is 10 ft. \times 24 ft., and is 42 ft. deep. The apatite here was green. About 25 tons were extracted. The country rock is pyroxenite and a white and lilac feldspathic rock with pyrite, a little mica, some wilsonite, pyrrhotite, a little chalcopyrite and some calcite.

This property is owned by the Philadelphia & Canada Phosphate Mining Company.

McLaren's Mine.

This is the popular name of Lot 27 of Range VIII. in Portland East.

Pits 1, 2, 3 and 4 are all on a belt of rock running N. 50° E. The country rock of 1, 2 and 3 is pyroxenite with much disseminated apatite, a little mica and some felspathic rock.

Pit No. 3 has a good show of phosphate, mixed red and green. It yielded over 30 tons.

Pit No. 4 is 20 ft. × 6 ft. and about 20 ft. deep. It shows a vertical wall of mica (?) running N. 50° E.

Pit No. 5 is 16 ft. × 10 ft., with a depth of 25 ft. It has yielded 20 tons. The country rock is a dark, fine-grained pyroxenite with some felspathic rock. Other minerals are very scarce in this pit.

A number of fine specimens of stilbite were collected on this property, and also some very interesting specimens of apatite, in which the red and green colours were so mingled as to imitate woody fibre.

Croft's Mine.

This is on Lot 24 of Range VII. in Portland East. The Big pit is 60 ft. × 30 ft., and is 20 ft. deep to the surface of the water, which is about 15 ft. deep. The apatite here is both red and green. The country rock is pyroxenite with a little red calcite in patches through it. Crystals of pyroxene, hornblende and tourmaline are abundant. The two latter occur with the calcite. Apatite occurs in the walls of the pit in irregular veins and patches. A small piece of steatite was found upon the dump.

The other (small) pits showed some red and green apatite. The country rock is pyroxenite with very little calcite.

The Ross Property.

Lot 2 in Range VII. of Portland West has been already referred to in this report. The country rock is pyroxenite and a greyish felsitic rock. There are very good surface shows of green apatite with very little mica and pyrite. The general strike of these shows is N. 55° W. It is a pity that so little work has yet been done to test this property. It is situated on the same great belt of rock as the High Rock and Star Hill mines. I consider it to be decidedly one of the most promising lots for permanent work to great depth.

Kendall's Mine.

Is situated on Lot 26 in Range XI. of Buckingham. The apatite obtained there was extracted chiefly from a cut in the side of a hill. About 100 tons of hard compact apatite was mined from a vein about

18 ft. wide in massive pyroxenite. This phosphate is much coloured by ferric oxide, resulting from the decomposition of pyrite.

Plates of mica occur in the country rock, associated with the apatite.

Vennor's Lot.

This is the popular name of Lot 26 in Range XII. of Buckingham.

Pit A. is about 10 ft. \times 12 ft. and 22 ft. deep. The country rock is composed essentially of pyroxene and scales of mica. The apatite is whitish-green. The general colour of the rock is the same. Some specimens of apatite were almost white. But the paleness of the colour was largely due to the finely granular texture of the rock.

Pit B. is 9 ft. \times 6 ft. and 14 ft. deep. The rock is similar to A.

On Lot 24 in Range XII. of Buckingham, we obtained very fine specimens of pyrophyllite associated with noble serpentine in a white rock of unknown composition.

There are also two small shows of apatite on Lot 27 of Range XI. of Buckingham.

STATISTICS OF THE TRADE.

From Mr. John Lewis of the Montreal customs I obtained the following figures, for which I desire to express my thanks.

Shipments of phosphate from Montreal in the two years ending on 31st December, 1882, and 31st December, 1883, respectively—

	1882.	1883.
2nd Quarter	8,946 tons=\$177,741	6,619 tons=\$146,038
3rd "	5,657 " 112,275	9,729 " 210,582
4th "	1,982 " 42,003	3,118 " 65,342
Total....	16,585 tons=\$332,019	19,466 tons=\$421,962

The collector of customs at Quebec kindly informs me that during the year 1883 there were exported from that port 200½ tons of phosphate.

The collectors of customs at Kingston and Brockville kindly inform me that no phosphate was shipped during the past year from their respective ports.

From Mr. Joseph Nimmo, jun., of the Bureau of Statistics at Washington, I received the following very interesting and valuable table of the imports of "Crude Phosphates, Kainit, Superphosphates, and Fertilizers," into the United States in the year ending 29th June, 1883.

STATEMENT SHOWING THE IMPORTS OF PHOSPHATES, CRUDE; KAINIT; SUPERPHOSPHATES AND FERTILIZERS, NOT ELSEWHERE SPECIFIED, INTO THE UNITED STATES, BY COUNTRIES, DURING THE YEAR ENDED JUNE 30TH, 1884.

COUNTRIES.	IMPORTS OF							
	PHOSPHATES, CRUDE.		KAINIT.		SUPERPHOSPHATES.		FERTILIZERS NOT ELSEWHERE SPECIFIED.	
	Tons.	Dollars.	Tons.	Dollars.	Tons.	Dollars.	Tons.	Dollars.
Danish West Indies.....	275	825						
France	102	682						
French Guiana.....	250	2,050						
Germany.....	44,033	307,970	39,119	246,231			50	1,866
England.....	1,262	24,081			7,666	120,576		
British North American Provinces	254	4,420					98	2,341
British West Indies	2,547	25,088						
Haiti	235	1,767						
Dutch West Indies	2	26						
Cuba.....	190	857						
Porto Rico.....	231	1,625						
Brazil.....							2	70
Total.....	4,381	429,391	39,119	246,231	7,666	120,576	150	4,277

TREASURY DEPARTMENT,
Bureau of Statistics,
February 12, 1884.

JOSEPH NIMMO, JR.,
Chief of Bureau.

Small imports
to United
States from
Canada.

From this statement I learn the extraordinary fact that only 254 tons of crude phosphate were imported from Canada in that year, although a very large amount of American capital is invested in our phosphate mines. One of the most productive mines for years past has been owned by an American company, viz., The Union Phosphate Mining and Lands Company, and another—viz., the Emerald Mine—has been recently purchased by American capitalists.

As far as I can learn the total output of these mines has always gone to Britain.

As 1,262 tons of crude phosphate and 7,666 tons of superphosphate were imported into the United States from Britain in that year, it is highly probable that a very considerable quantity of our Canadian apatite has been used in enriching American lands after a voyage across the Atlantic and back.

In regard to the destination of the 19,666 tons of phosphate exported from Canada in A. D. 1883, I obtained no figures. But Dr. T. Sterry Hunt, F. R. S., &c., in his admirable paper on the "Apatite Deposits of Canada," presented to the Am. Inst. of Mining Engineers, states that 1,576 tons were delivered in Hamburg and 650 tons in Stockholm, the rest going to British ports.

Prices.

Prices fluctuated very considerably during the year. Mr. Lomer, of Montreal, tells me that in the spring of 1883 he obtained 1s 6d per unit for the phosphate that he shipped to Hamburg and Stockholm. But in Oct., 1883, he was offered only 1s 2d per unit for 80 per cent. phosphate.

Messrs. Gillespie, Moffatt & Co., of Montreal, obtained 1s 1½d per unit for a consignment to Avonmouth of 75 per cent. phosphate, when similar apatite was worth only 1s 0d in London. This shows the difference in prices at different centres of consumption.

If the government had a mining bureau receiving quotations of prices from these various points at regular intervals, their prompt publication in our papers as an official bulletin or otherwise, would greatly benefit the trade.

Such an office might also materially help to develop a *direct* trade with the sea-board of the United States by *direct* shipments in barges from Buckingham to New York *via* the Champlain canal, instead of this indirect trade *via* England, with its numerous transshipments and many brokers.

Inspectors and
analysts.

The question of appointing official inspectors and analysts to certify to the quantity and grade of every shipment from Montreal has been often agitated. As far as I can learn, the shippers are at present compelled to accept the certificates of the analysts employed by the purchasers as the basis of settlement.

I hesitate to recommend any official action by the government in this matter.

The only suggestion that I could make is this, and it is of a very local character. The apatite mined in the valley of the Lièvre might be crushed in a suitable mill at the falls immediately below the steamb-boat landing at a fixed tariff and put up in barrels for shipment. Such a mill could have a mechanical ore-sampler attached to it in such a way that a certain definite percentage of the crushed product would be mechanically separated and delivered as a sample of the lot. This could be analysed by a chemist attached to the mill and his certificate delivered along with the consignment, or else the sample could be sealed and delivered to the owner for analysis by any other chemist.

Such a mill should be able to crush this apatite more cheaply than any English mill, because the apatite would require no extra handling. All of it has to be landed from the barges near that particular point and loaded on wagons to haul it to the railway station. It would not be difficult to arrange machinery to unload the barges and transport the apatite to the mill very cheaply with the aid of this water power.

The freight to Britain on this phosphate might be rather higher than when in bulk. But there would be no loss or deterioration in transshipment. Ballast could not get mixed with it or the Montreal wharves or in the vessel's hold, and the charges for loading and unloading, &c., would be lower. The greatest advantage, however, would be in the certainty of obtaining a fair and accurate sample of the entire shipment.

As long as phosphate is shipped in bulk no two samples can be taken from the same lot of *precisely* the same composition. If they are selected by some proper rule they should always approximate to one another more or less closely, but they can never agree.

This lack of correspondence has very frequently caused serious trouble between the Canadian shippers and English buyers. But the shippers have always been forced to give way and comfort themselves with some sorry theory about deteriorations and loss of weight in process of transshipment or discharging at the British port.

GENERAL REMARKS ON APATITE INDUSTRY.

I fail to agree entirely with Dr. Hunt's views upon the nature of these deposits. He divides them into only two classes,—viz.: bed and fissure veins. This is correct if we use the term bed in a sufficiently broad sense. But the majority of the deposits that I have yet seen are very irregular segregations from the phosphate-bearing country rock, which is generally a massive pyroxenite. As these deposits are found in a certain bed, which is more or less richly impregnated with phosphate and may sometimes be traced for a consider-

Dr. Hunt's
views on origin
of Canadian
apatite
deposits.

able distance, such deposits may be said to be merely a bed of phosphate of irregular richness. But I take exception to this kind of classification as being misleading. And it seems to imply the submarine origin of these deposits. Whereas the origin of these pyroxenic rocks may possibly be due to contemporaneous intrusion.

There has always been phosphoric acid in the earth's crust—long before any form of life existed upon our globe. Why should we conclude, without absolute and undeniable evidence, that this massive crystalline apatite was necessarily accumulated by organic action? In my opinion this is an open question.

But every scientific man, at all familiar with the past history and present aspects of our Canadian phosphate industries, must endorse his condemnation of the present methods of development, which he describes as follows:—

Condemnation
of existing
methods of
apatite
mining.

“The larger part of the productive workings are upon the bedded deposits. These, however, are for the most part opened only by shallow pits; a condition of things which is explained by the peculiar character and the frequency of the deposits, and also by the economic value of the apatite. This mineral, unlike most ordinary ores, is, in its crude state, a merchantable article of considerable value, and finds a ready sale at all times, even in small lots of five or ten tons. Like wheat, it can be converted into ready money, at a price which generally gives a large return for the labour expended in its extraction. Hence it is that farmers and other persons, often with little or no knowledge of mining, have, in a great number of places, opened pits and trenches for the purpose of extracting apatite, and at first with very satisfactory results. So soon, however, as the openings are carried to depths at which the process becomes somewhat difficult from the want of appliances for hoisting the materials mined, or from the inflow of surface waters, which in wet seasons fill the open cuts, the workings are abandoned for fresh ones, never far off. In this way a lot of 100 acres will sometimes show five, ten, or more pits, often on as many beds, from twelve to twenty feet deep; each of which may have yielded one or more hundred tons of apatite, and has been abandoned in turn, not from any failure in the supply, but because the mineral could be got with less trouble and cost at a new opening on the surface near by.”

“These conditions are scarcely changed when miners, without capital and unprovided with machinery for hoisting or for pumping, are engaged, as has often been the case, to extract the mineral at a fixed price per ton. These, having no interest in the future of the mine, will work where they can get the material with the least expenditure of time and labour, and often will quit one opening for another which

is more advantageous. The very abundance and the value of the mineral mined has thus led to its careless, wasteful and unskillful exploitation. It is the working of these causes, in the way just explained, which has thrown undeserved discredit on this mining industry, and, more even than the injudicious schemes of speculators and stock-jobbers, has retarded its legitimate growth."

"It is evident that the proper development of these deposits will require regular and scientific mining in place of the crude plan of open pits and trenches, which, from causes already explained, has hitherto, with few exceptions been followed. As a basis for calculation in mining, it becomes necessary to establish some data as to the production and the value of the apatite-layers which we have described. The specific gravity of the mineral, as deduced from many specimens of massive Canadian apatite is from 3.14 to 3.24. If we assume 3.20, this will give for the weight of a cubic foot of apatite almost exactly 200 pounds. A fathom of ground, carrying a bed or vein of apatite one foot in thickness, will thus contain thirty-six cubic feet, or 7,200 pounds of apatite; equal to a little over three and one-fifth tons of 2,240 pounds each. Allowing the fractional portion, equal to nearly seven per cent., for loss in mining (it will be noted that coarse and finely-broken apatite are equally merchantable), we shall have as the net product of a layer of apatite for a fathom of ground mined, three gross tons for each foot in thickness."

Dr. T. Sterry Hunt, in the same article, gives the following interesting facts about the cost of extraction and market value:—

"The market value of apatite, which, as is well known, is chiefly consumed for the production of soluble phosphate by the manufacturers of artificial fertilizers, varies greatly, other things being equal, with its purity. Thus, while at present the price in England is 1s 2d, the unit for apatite giving by analysis 75 per cent. of tri-calcic phosphate, there is paid an addition of one-fifth of a penny for each unit of phosphate above that percentage, so that a sample, yielding by analysis 80 per cent. is worth 1s. 3d. the unit. The price in the English market is subject to considerable fluctuations, having within the last four years been as high as 1s. 5½d., and as low as 11d. the unit for 80 per cent. phosphate. The present may be considered as an average price.

"The Canadian apatite shipped to England has yielded for various lots from 75 to 85 per cent., 80 per cent. being the average from the best conducted mines, though lots from mines where care has been used in the dressing and selection of the mineral for shipment have yielded 84 and 85 per cent. Many of the smaller miners to which we have alluded, selling their product to local buyers, take little pains in dressing, and hence their product is apt to be lower in grade. It will

Cost of
extraction and
market value.

be seen, from the rule adopted by foreign purchasers, that there is great profit in a careful selection and dressing of the mineral for market. The basis being 1s 2d the unit for 75 per cent., with a rise of one-fifth of a penny for each unit, it follows that while a ton of 75 per cent. apatite will bring only 87s 6d, a ton of 80 per cent. will command 100s. and one of 85 per cent. 113s. 4d."

"In the present state of the industry it is not easy to say what would be the cost of production. At the outcrop of the large masses of apatite, and in the open cuts and quarries already described, the cost of extraction and dressing is, of course, very variable, estimates in different deposits giving from \$2 to \$8 the ton. In Ottawa county, where within the last four years, deposits have been opened and mined on a better system than heretofore, the figures of production and cost are instructive. According to the report of the manager in July, 1882, the High-Rock mine, in Buckingham (*sic*) yielded, in 1880, 2,400 tons, and in 1881, 2,000 tons of apatite. An adjoining portion of land having been then acquired, the production of this company's mines in 1882 and 1883, is stated at 5,000 tons annually; from eighty to ninety men being employed. The cost of the mineral is here given at \$4 the ton, dressed, at the mine; in addition to which \$3 is paid for carriage to the railroad or the river, and about \$1 additional to Montreal, the port of shipment. The mines in the Ontario district are, for the most part, in or near to the waters of the Rideau canal, or some of the many lakes connected therewith, from which the freight to Montreal is \$1.50 the ton. I am informed by a merchant, who is a purchaser and shipper of apatite, and is always engaged in mining it both in Ontario and Quebec, that the average cost for freight from Montreal to England, with selling charges, is 20s. the ton; which, for apatite of 80 per cent., now worth 100s. the ton, would leave 80s. or \$19.36."

"Deducting from this the cost of production and of transportation to Montreal, there remains a large profit."

Statistics of
shipment.

Dr. Hunt follows this with a paragraph upon the statistics of shipments. When he speaks of 1883 and 1884, he evidently means the fiscal year ending upon the 30th June. He says:—"The amount of apatite shipped from Montreal has gradually increased, and, according to the published figures, attained in 1883, 17,840 tons, of which, it is to be remarked, that 1,576 tons were delivered in Hamburg, and 650 in Stockholm, the remainder going to Liverpool, London and other British ports. Of this about 15,000 tons were from Quebec, and the remainder from Ontario, &c."

Dr. Hunt's concluding remarks should obtain as wide a circulation as possible:—"The methods of mining hitherto generally pursued in the apatite deposits of Canada, allow of many improvements which would

materially reduce the average cost of production and give a permanency to the industry which the present modes of working can never attain. The regularity and persistence of the bedded deposits, and of some of the veins, warrants the introduction of systematic mining by sinking, driving, and stoping, with the aid of proper machinery for drilling, as well as for hoisting and pumping. The careful dressing and selection of the apatite for the market is also an element of much importance in the exploitation of these deposits. The cost of labour in the apatite-producing districts is comparatively low, and there are great numbers of beds now superficially opened, upon which regular mining operations, conducted with skill and a judicious expenditure of capital, should prove remunerative. It must be added, that the areas in question have as yet been very partially explored, and that much remains to be discovered within them, and also, there is reason to believe, in outlying districts; so that in the near future the mining of apatite in Canada will, it is believed, become a very important industry."

With most of these remarks of Dr. Hunt's, I fully agree. But some of them are open to discussion. In his statement of the cost of extraction of apatite from the High Rock mines, he evidently omits the very important factor of interest upon the Phosphate of Lime Co.'s capital. I cannot state the amount of this capital positively, but believe that it is £100,000 stg. As it is an English corporation I suppose that five per cent. would be a fair rate of interest for this calculation. For an annual output of 5,000 tons of phosphate this would be a charge of exactly £1 per ton. Thus, the phosphate shipped from High Rock costs about \$12 at the railroad depot in Buckingham, instead of \$7. Freight by rail to Montreal is \$1.25 per ton. Cartage in Montreal from cars is 25c. to 75c. per ton. Harbour and port warden's dues are 11 cents per ton.

If shipped by barge down the Ottawa from the mouth of the Lièvre River to Montreal the cost is \$1 to \$1.50, according to despatch. The barges can be laid alongside of the ship. Thus the charges for cartage are saved. But this is probably counterbalanced to some extent by the possibility of claiming for demurrage on the part of the ship or else of the barges, if they are kept waiting.

The margin for profit for companies of large capital in this phosphate business is thus shown to be altogether too small to permit of reckless or ignorant management. Great skill is required to conduct mining operations in such a way as to guarantee the stability of the enterprise while providing punctual dividends. Any fool can extract phosphate from the surface of a phosphate-bearing belt of pyroxenite. But it requires a very skilful engineer to do it in such a manner as to afford some reasonable hopes of the work being continued profitably

Margin of
profit.

Capital
invested.

for the next fifty years. It is hardly necessary to add that unless the mines are likely to maintain their dividends for that length of time, they should be now paying very large dividends to cover the ultimate extinction of the large capital invested.

I have already pointed out the folly of running a single drill on these mines. One boiler should not only run two steam drills, but the necessary pumps and hoisting engine also.

The heaviest tax on these phosphate mines is the cost of baling out the wide-mouthed pits with tubs hoisted by horses. As the work consists almost exclusively of sinking, with no attempts at drifting or stoping, a very small infiltration of water in the night prevents the men from commencing work next morning until an hour or two has been wasted in slowly baling it out with a horse. It is by no means uncommon for a whole morning to be wasted in this way. In any continuous spell of wet weather all the profits of mining may easily vanish. With small shafts and proper pumps the weather would have very slight influence upon the amount and cost of output.

Competition in
European
markets.

Our Canadian phosphates have always been exposed in the English markets to the keen competition of phosphates from Norway, Spain, Carolina and Germany in all their various grades of purity. The West Indian phosphates enter that market more largely every year. And now, I am assured, Russian phosphates are being offered freely upon that market.

Phosphate
deposits of
South Carolina.

In the recently published volume upon the Mineral Resources of the United States, by Mr. Albert Williams, jun., of the Geological Survey of the U.S., there is a very valuable article upon "The Phosphate Deposits of South Carolina," from the pen of Mr. Otto A. Moses. In this article he mentions that "although there are at least 500,000 acres of the lowlands and streams of South Carolina underlaid by the phosphate beds, there are not more than 20,000 acres which it will pay to mine at present prices." He says, "The price of phosphate rock changes but little, the demand being comparatively constant, as is the supply of labour. With the exception of a sudden rise to \$9 a ton a couple of years ago, there has been a uniform price of about \$6 for clean-washed phosphates. This, of course, varies with freights, most of the rock being exported. As the prices abroad fluctuate but little, there is a comparative regularity in the output, which gives great stability to the trade. There is a growing demand in all directions, caused by the impoverishment of land and the increase of knowledge; so that there is no present probability of an interruption to the further development of this industry."

Conditions of
sales.

"The rock is generally sold on a simple guarantee that it shall contain not less than 55 per cent. of the bone phosphate of lime

(3 Ca. O., P.O.), and irrespective of carbonate of lime or moisture. This rather loose method causes a uniformity of product, but does not encourage the miner to select his rock with a view to obtaining the highest yield of soluble phosphates of lime with given quantities of solvents—an object to be considered in the manufacture of fertilizers." He further reports that—"Since the discovery of the value of the phosphate rock bed of South Carolina, in 1867, to the present time, about 2,250,000 tons have been mined by land and river companies in about equal proportions."

Mr. Moses gives a list of companies and individuals engaged in mining, and states that their aggregate capital is over \$2,000,000.

In regard to manufacturing, he says that the manufacture of phosphates in South Carolina has been developed on an enormous scale, ^{Manufacture of phosphates.} over \$3,500,000 of capital being invested by twenty-one companies, which have a capacity of 250,000 tons per annum. Ashley and Cooper Rivers, in the neighbourhood of Charleston, are lined with the finest and most extensive collection of fertilizer factories in the world. Others of equal importance are being erected in the Beaufort district. Most economically arranged, and located in the heart of the phosphate region, on deep water and on railroads, they have such natural advantages of position as will give them control of the phosphate trade of the South and Southwest, and perhaps, in time, of the whole country.

A total capital of \$3,350,000 is invested in this business. The shipments have steadily increased from 22,589 tons in 1872 to 130,000 in 1883 (up to 1st June).

This volume contains valuable reports upon Apatite, Marls and Gypsum, etc. From the article upon Apatite, written by Mr. F. A. Wilber, I must extract one brief paragraph—the concluding one:—

"Apatite is used in the arts as a source of phosphoric acid and phosphorus, and its value to the manufacturers of fertilizers depends upon the amount of phosphate of lime which it contains. Since the discovery of the deposits of phosphatic marls in South Carolina the demand for it has decreased, and these latter deposits now furnish the supply of phosphates in the market."

The output of the Norwegian mines affords a striking contrast to our ^{Norwegian phosphate.} frightfully improvident superficial Canadian methods (or, rather, lack of method) of exploitation. The comparison is all the more profitable from the fact that these Scandinavian deposits occur in rocks of very similar age and character to our own. That district extends about 50 kilometres along the coast, with a depth of about 5 kilometres. Mr. Frank Adams informs me that Gjögren (a Swedish geologist) reports that a single section of about one square mile in extent, viz.,

Oedegarden, in Bamla, yielded in 1882 about 15,000,000 kilogrammes (about 16,500 tons), valued at 1,750,000 marks—about \$437,500. This is only 85 tons short of the total output of all Canada for the same period.

I am at a loss to understand why no shipments of our Canadian apatite is made direct to New York via Lake Champlain by the American companies engaged in mining it here. My brother, Mr. Wm. F. Torrance, who is largely engaged in forwarding between Montreal and New York, writes me that a transportation company would contract to carry phosphate from the Buckingham wharf to New York City for \$3.50 per 2,000 lbs. during the summer months and \$4.00 during October. He adds that if no contracts were made in advance some might possibly be shipped as low as \$3.40 per 2,000 lbs., but that most of it would have to pay from \$4.00 to \$4.25.

Home markets
for superphos-
phates.

It seems to me that a greater effort should be made to develop a home market for these phosphates in the shape of superphosphates. The Ontario Agricultural College at Guelph has been doing good work in this direction. I believe that, in consequence, the demand for fertilizers in Ontario is steadily increasing. The only extensive factory in Canada is that owned by the Brockville Chemical & Superphosphate Co., Limited. Unfortunately, I have failed to obtain any statistics as to their annual output of superphosphate and other fertilizers and acids.

There is another superphosphate factory in Halifax, as I learn from the advertising columns of a local newspaper. But it is probably of small capacity and no national importance. It advertises itself as the Chemical Fertilizer Co., and sells its wares as "Ceres" superphosphates.

The report of Mr. Gordon Broome in 1870 contained some very startling figures as to the amount of phosphoric acid exported from Canada in 1869 in the shape of grain and flour. The figures for the past year would be still more striking.

Plumbago.

I cannot close this report without calling attention to the remarkable fact, that while the United States, in the years ending 30th June, 1882 and 1883, imported the following quantities and values of manufactured graphite, our Canadian mines were all idle:—

In 1882, 159,421 cwt., valued at \$363,835; and in 1883, 154,893 cwt., valued at \$361,949, being an average value of about \$2.30 per cwt.

Mr. Joseph Nimmo, Jr., the Chief of the Bureau of Statistics at Washington, sends me these figures and writes as follows:—

"No plumbago was imported from Canada during the year mentioned.

(viz., year ending 30th June, 1883), nor during the six months ended December 31st last. The imports of that article came mainly from Germany and the British East Indies."

One chief reason of the utter collapse of our very promising trade in that mineral was the *uncertain* quality of the article shipped. I am assured by an American expert who used a good deal of plumbago from the Buckingham mines, that his company "tried a great deal of the graphite some years ago, but were obliged to give it up *because it did not run uniform*. Some of the crucibles made from it were as good as any, but others would crack. They gave it a thorough test, and used a great many barrels of it." He thinks that "it contained sulphur and other impurities."

There is no excuse for dressed graphite containing sulphur, when the difference in the sp. gravity of plumbago (about 2.25 to 2.27), and pyrite (4.83 to 5.20) is taken into consideration.

In the very valuable report on Graphite, by Mr. Hoffman (Geological Survey Reports 1876.1878), a very simple and cheap method of destroying all other noxious impurities was pointed out and illustrated; viz: the digestion of the dressed graphites in a bath of hydrochloric acid. By this agent the carbonate of lime and oxide of iron are removed, besides alumina, magnesia, a little silica, and traces of manganese.

Until acid-chambers are erected in Ottawa county or at Montreal, the best plan of working our plumbago deposits would be to dress the plumbago as completely at the mines as mechanical skill can accomplish, and then ship it to Brockville in barrels for the further treatment with acid before its export.

As long as the price of dressed plumbago does not fall below \$40 per ton, many of our Canadian deposits could be profitably worked, always provided that they are managed by competent mining engineers. No mining company need hope to succeed in Canada or any other part of the world, unless its manager has had a careful technical training, or the ore is of phenomenal richness.

In the volume upon Mineral Resources, already so often quoted, there is an instructive article upon Graphite by Mr. John A. Walker. He says that:—"The only place in the United States where graphite is now mined successfully is at Ticonderoga, New York. The Dixon Company now mine a graphite schist 15 feet thick, carrying from 8 to 15 per cent. of graphite, practically an inexhaustible supply." In regard to ore dressing, he says:—"Several methods (both wet and dry) have been attempted. The process used by the Dixon Company at Ticonderoga owes its success to careful supervision. It is a wet process, in which the ordinary process is reversed, the 'tails' being the useful product, while the 'heads' are thrown away. All attempts at dry concentration have failed."

In 1882 the output of the Ticonderoga mine was 400,000 pounds. For 1883, the Dixon Company have arranged to produce 500,000 pounds. The average spot value may be stated at eight cents per pound.'

In regard to the different kinds of plumbago he gives some valuable information:—

German black lead.

"German black lead is a product of Bavaria. It is of the amorphous variety, and is dressed chiefly by washing. Its price depends on its percentage of graphite, and the nature of its impurities, varying from \$1 to \$10 per hundred weight in cargo lots. It is used in the manufacture of pencils, stove polish and foundry facings. Ceylon plumbago is mined at Travancore, Ceylon, and is shipped from Colombo to all parts of the world. It occurs in immense veins of great purity. Cobbing and sizing are the only preliminary operations it undergoes. It appears in the market graded according to size, as large lump, small lump, chip and dust. Its price varies from \$2 for dust to \$10 per hundred weight for prime lump, in cargo lots. It is used for all the purposes of the trade, except the manufacture of pencil leads."

Price of American phosphates.

"American graphite, from the nature of its occurrence, appears in the market only in the dressed condition. Its price ranges from \$2 to \$10 per hundredweight wholesale, according to purity and fineness. Fineness exercises considerable influence on the price of graphite, on account of the difficulty of pulverizing it. American graphite is used for all purposes of the trade, and *excels all kinds as a lubricant*. It is the same geologically, &c., as the Canadian."

CALL NUMBER

MCA 6. 168

AUTHOR (OR PERIODICAL)

Rept. on Pam.

Capital deposits

TITLE

Ottawa City Que.

Mr. Torrance

