GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.

ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., DIRECTOR.

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REPORT

ON

MINES AND MINING

ON

LAKE SUPERIOR.

PART I.

A. HISTORY AND GENERAL CONDITIONS OF THE REGION.
B. SILVER MINING.

BY

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PUBLISHED BY AUTOHRITY OF PARLIAMENT.

MONTREAL:
DAWSON BROTHERS.
1888.

NOTE.

It was intended that this Report should have been published as Part H. of the Annual Report, Vol. II, 1886; but the illustrations not being ready, it was postponed and will now constitute part H. of the Annual Report, Vol. III, 1887. Additional developments on some of the mines to which it refers are noticed in Part S. same Vol.

Unless otherwise noted, the bearings throughout this Report are referred to the magnetic meridian.

To A. R. C. SELWYN, ESQ, C.M.G., LL.D., F.R.S.,

Director of the Geological and Natural History Survey of Canada.

SIR,—I send you herewith Part I of my report on Mines and Mining on Lake Superior, prepared in compliance with your instructions.

This part, whilst referring to the history of the whole region for the past forty years, and the economic and other conditions which have affected its development during that period, treats more particularly of the Silver Mining there, the subjects dealt with constituting the great bulk of the matter to be considered. In view of the fresh importance which the subject of Silver Mining in this region has assumed, owing to recent discoveries, it was deemed advisable to complete this part for publication at once rather than to delay it until the rest was ready.

Part II will treat of the mineral substances, other than Silver, found or mined in the region. These are receiving little or no attention at present, and, in comparison with what has been done in exploring and developing the Silver district, the history of the mining of these other substances constitutes a comparatively small part of the subject under consideration. This part is in an advanced state of preparation, but some important information is yet wanting to complete it, which I hope soon to be able to obtain when it will be at once put in shape for publication.

The field work of this investigation was only completed late in the fall of 1886, and the elaboration of the material thus obtained, together with the collection and preparation of the other information incorporated with it, has been, in the nature of the work, a very tedious and lengthy undertaking. The same applies also to the preparation of the illustrations, the data for which had often to be obtained from very various sources, and from people who had long since left the region; and all this, together with the natural difficulties encountered in compiling such data to form plans, etc., which should be as complete and reliable as possible, has caused the unavoidably slow progress of the work.

This work was further delayed owing to the fact that during the two winters following my appointment in July, 1885, to a position in connection with the work of the collection of Mineral Statistics, the greater part of my time was taken up in making, in conjunction with

Mr. Coste, the necessary preparatory arrangements for carrying out that undertaking; and in the compilation and writing of part of the report on that subject for 1887.

In conclusion, I beg to express my thanks to all those from whom I have received assistance during the progress of the field work, and to Messrs. S. J. Dawson, M. P., A. L. Russell, W. H. Furlonge, T. A. Keefer, P. McKellar, W. M. Courtis and H. K Wicksteed, who have supplied me by correspondence with much valuable information since leaving the district, and also to the many others who have kindly supplied information, maps, specimens, etc.

During the progress of this work I was assisted in the field by Messrs. A. W. Hopkins and J. H. Moore, in the summer of 1885, and by Messrs. H. P. Brumell and J. H. Moore, in the summer of 1886. In the preparation of the maps and illustrations for the report I was assisted in the office for a short time in the spring of 1886, and during part of the winter of 1886-7 by Mr. H. P. Brumell, and afterwards by Mr. J. White, who succeeded him in the spring of the latter year, and who did much towards the completion for publication of the accompanying map of the Silver Mountain district, and of the Sketch Map of the Thunder Bay mining region.

I have the honor to be,

Sir,

Your obedient servant,

7th July, 1888. ELFRIC DREW INGALL.

PREFACE.

The objects chiefly kept in view in the prosecution of this work have been: 1st. To make as complete a history as possible of the mining developments of the whole region. 2. To ascertain either personally or from the most reliable sources the results of such developments. 3. To examine as many examples as possible of the veins and mineral deposits with a view to the collection of information which might lead to their classification and a better understanding of their nature and relationships, and of the conditions under which they are found. Objects of investigation.

Regarding the attainment of the first two objects much difficulty has of course been encountered. The greater number of the mineral locations prospected have been worked upon by small gangs of men for periods varying from a few weeks to a few months, and that mostly years ago, so that those from whom detailed information might be obtained are now spread far and wide. Even where this is not so, those interested in the matter could hardly be expected to judge of results quite dispassionately, and again, where personal inspections of old mines were made, these being of course full of water, it was found necessary to supplement these observations, which were necessarily confined to the surface, by information obtained from others regarding the underground workings. In these cases however, a careful examination of the surface indications has resulted in useful and necessary additions to the information gleaned from such sources. Concerning the third object mentioned, I hope that the details and facts recorded in this Report may be considered desirable additions to our knowledge in this respect. Where advisable, I have also incorporated information gathered and published by other observers both amongst and outside of the officers of the Survey, with a view to making as complete a summary as possible of the evidence on the subject. Since the commencement of this investigation, after tedious enquiry, communication has been established with various people formerly connected officially with some of the important mining efforts of the past, and the information so obtained has been very valuable and will add materially to our stock of experience of the district.

Various questions naturally present themselves to capitalists, engi-

neers and others purposing to interest themselves in this region, such as the following:—

To what extent has this region been examined and prospected, and what have been the results of such search for minerals?

What is the state of the mining industry there at present, and what has been done in the past?

What have been the results of all these trials, and what experience has thus been gained of the nature and habits of the mineral deposits of the region?

How does the experience so gained apply to the recently discovered mining sections to which attention is at present directed?

In attempting to answer these questions, I have in the first part of the Report given the particulars of the work done, nature of the deposit and of its geological environment, etc., for each property which has been worked or prospected to any extent, and have thus summarised the evidence upon which are founded the general conclusions contained in the latter part.

Wherever it has been possible to secure the information for their compilation, plans, etc., illustrating the individual properties have been given, it being believed that a map or plan, even if somewhat diagrammatic, will produce a clearer idea in the mind of the reader than many pages of letter-press. A Sketch Map of the Thunder Bay region accompanies the Report which having been compiled from various sources does not pretend to represent the topography with absolute accuracy, but is as correct as the material at present available will permit, and is sufficiently so for the purposes for which it is intended, viz.: To show the various districts, their position, communications, etc., as well as the grouping and relationships of the veins as far as at present known. The rest of the illustrations being explained in their proper connection need no comment here.

Sketch map.

Every possible means has been taken to fill up gaps in our information on the subject in hand from reliable sources and doubtless a continuance of the effort would from time to time bring to light much that would serve to render this record still more complete, but the collection of such items being a very tedious process, it would be obviously unwise to further delay publication on that account. With the original matter then of this Report much extraneous and scattered information has been incorporated and rendered available, and it is hoped that in this way the Report here presented will be found to be as complete and systematic a record as it is now possible to obtain of Mines and Mining on the Canadian shores of Lake Superior, and the connected districts from the commencement of mining there in 1846 to the present day.

REPORT

ON

MINES AND MINING

ON

LAKE SUPERIOR.

PART I.

A. HISTORY AND GENERAL CONDITIONS OF THE REGION.

The area which may be said to naturally come under study in the consideration of the above subject is very great, extending as it does through a tract comprised within 10 degrees of longitude and 3 degrees of latitude. To those unacquainted with the region and unaccustomed to deal with the great distances of a new country, it may convey a better idea of the size of this tract when it is pointed out that its area nearly equals that of England. **Extent of area dealt with.**

I have placed this rather extended meaning on the term "Mining Region of Lake Superior" as I feel assured that in course of time, as the country back from the Lake shore gets opened up, new mining districts will be discovered which will naturally connect themselves with this region. I have also included a large section of country to the North of Lake Huron which geologically, geographically, historically and otherwise, seems to be naturally connected with the East end of Lake Superior, and in which the mining developments will be a guide for the future in the whole region. Thus considered then, the area dealt with may be described as a belt of country extending along the north shores of Lakes Huron and Superior to an indefinite distance back from them, commencing about at longitude 81 degrees on the east, and continuing west to where the International boundary is intersected by longitude 91 degrees, thus including the silver bearing area extending south-west from and tributary to the town of Port Arthur.

This great region, until a comparatively recent period, was a *terra incognita* to the great proportion of even the inhabitants of the Canadian Provinces themselves, and to the present date, large sections of the area spoken of are only known to the trapper, the Indian and the timber hunter, and have not even come under much notice from the mineral explorer.

Speaking generally of the whole region, it consists for the greater

part of a great rocky area covered with bush, which is mostly very dense, whilst extensive swampy areas are frequent. In places, considerable stretches are covered with useful timber such as maple and pine, but for the greater part the bush is useless, except for local demand such as would arise from mining operations. Districts of considerable extent of good farming land exist at places, but a large proportion of this region is little blessed with soil, and seems only fitted to be the happy hunting ground of the trapper and mineral explorer. For these it has many advantages, as it is a land of rocky hills and mountains, of numerous lakes and rivers where the large extent of rock exposed gives a chance to find valuable mineral deposits, and where the water stretches, whilst being seldom navigable for larger craft, yet furnish canoe routes whereby the interior of the country may be reached.

Surface features of region.

Geological features of region:

As might be expected in so extensive a tract of country, the geological features present considerable diversity, although, apart from the superficial deposits, the rocks are all referable to the Palæozoic and Archean. It may be said to consist of a large area of Laurentian gneissic and granitic rocks, etc., within which are found numerous and considerable areas of plutonic and volcanic rocks, and of metamorphic slates, etc., which are considered to be of Huronian age, whilst overlying these, chiefly round Thunder Bay and Lake Neepigon, occur the sedimentary and volcanic rocks of the Animikie, Neepigon and Keweenian groups, whose approximately horizontal position and low angles of dip contrast markedly with the steeply inclined or almost vertical older rocks. The lithological and other details concerning these different groups of rocks are best left for description in connection with the various mining districts dealt with hereafter, and full descriptions of these particulars will be found in the various publications of our Survey.

Mineral resources of region.

Within these rocks are found veins and deposits carrying ores of iron, chiefly as magnetite and hematite; of copper, which occurs both in the sulphuretted and native state; of silver, in the argentiferous galena and some of the copper ores and also native and as sulphide; of gold, both free and in the baser form contained in pyritous and arsenical ores. Besides these there have been found deposits of zinc-blende, veins carrying molybdenite and minerals of nickel, the latter found in connection with native copper ores, not to mention other useful but less generally important minerals which have been occasionally found. Amongst the other useful products of the region, other than ores proper, may be mentioned quartz-amethysts, and agates amongst the ornamental stones; various structural materials, especially a fine

variety of red sandstone; amongst the mineral pigments, barytes which has been obtained from the native silver veins constituting part of their gangue. Plumbago has also been found.

Thus we have the following useful elements represented in the mineral deposits of this region: gold, silver, copper, iron, lead, zinc, molybdenum, nickel, arsenic and sulphur. Reports were spread recently of the finding of ores of mercury, but these lack confirmation.

History of the Region.

Commencement of mining.

The history of the Canadian shores of Lakes Superior and Huron as a mining region may be said to have commenced about forty years ago, in 1846, when the first mineral locations were taken up. It is divisible into three periods separated by periods of inactivity, the first commencing as mentioned in 1846, the second in 1863, and the third in 1882, with the discovery of rich ore at Rabbit Mountain.

Attention first directed to search for copper.

Attention was first directed to this region by the discoveries which were being made and had been made for some years previously in the copper bearing rocks of the south shore of Lake Superior. Reference was made to this by Mr. Logan (afterwards Sir William) in his "Report of Progress of the Geological Survey for 1843," as follows:—

"It is at the summit of the rocks under description" (the inferior rocks) "in the peninsula lying between Lake Superior and Lake Michigan, in a great range of trap interposed between the transition series and a metamorphic group which rests on the granite, that Mr Douglas Houghton, the State geologist of Michigan, has made the discovery of an important collection of copper ore veins which are likely to become of considerable economic value, and it remains to be ascertained whether an analogous condition of circumstances may not extend to Canada."

Following this we have a Report addressed by Mr. Logan to the "Committee of the Honorable the Executive Council" dated the 24th March, 1846, in which, in answer to enquiries made by them respecting the mineral region of Lake Superior, he deals with "the data upon which it would be judicious to proceed in ascertaining the value of the mineral district in question; and the principles which should be taken into consideration in dividing it into lots for the purpose of mining locations."

Mr. Logan's exploration of the Canadian shore of Lake Superior in 1846.

The Government having decided to act upon these suggestions gave Mr. Logan instructions to investigate this region, which work he started in May, 1846, and spent the whole of that summer voyaging round the Canadian shores of Lake Superior.

In this voyage he was accompanied by a properly authorized land

surveyor who determined the position and limits of numerous tracts of mineral land which were required by sundry capitalists who had applied for them. These grants of land, to the number of 27, comprised about ten square miles each, having a width of about two miles, and running back from the coast about five, and were granted by the Government evidently upon the supposition that *bona fide* work on them was intended, and that the country would thus get the benefit of the tests there made of the value of the mineral deposits of the region.

First mineral locations granted.

Precautions suggested in granting mineral lands.

Mr. Logan, in his Report, urged that in order "to secure a *bona fide* intention of working the minerals and to avoid the encouragement of mere stock-jobbing speculation,—there should be some stipulation on the part of the Government, that a certain number of miners should be employed on each location" He further on points out that "In such sales of locations, it must be recollected, that all control over the working and proving of the mines would be relinquished by the Government, and the private interests of parties might in some cases carry them no farther than the establishment of a company for the purpose of traffic in shares; whilst in others, persons of a less sanguine temperament than their neighbours, might patiently wait to observe the success or failure of the more adventurous."

Effect of neglect of precautions.

It will thus be seen that even at this early date the Geological Survey had pointed out the precautionary policy necessary to be observed by the Government in order to ensure the proper development of the mineral resources of the country, and it is curious and instructive to observe that notwithstanding the clearness with which this time-honored experience of the development of mining districts was pointed out, the opposite policy of losing all control over the development of this most important part of the resources of the country has been followed ever since with the consequent effect of seriously retarding the opening up of the region.

Continuation of history.

But to proceed with its history. In this same year the *Bruce Mines* copper ore veins were discovered on the north shore of Lake Huron, east of Sault Ste. Marie, besides some other discoveries in that section of less importance of similar veins.

Discovery, &c., of copper ore veins of Lake Huron.

The development of the *Bruce Mines* veins was carried on by the *Montreal Mining Company* from this date until they were taken in hand by the *West Canada Mining Company* of London, England, which had commenced working similar veins in its immediate vicinity in 1855 under the name of the *Wellington Copper Mine Company.* From this time on, this Company continued to operate all this group of mines until about 1875, when work was discontinued, chiefly owing to the price of copper having for some years previously been so low as to

leave no margin of profit on the working of the mines. The operation of these mines has been the most extensive, and successful mining venture of the whole region here dealt with, continuing as they did over a period of more than thirty years, and for the greater part of that period yielding handsome profits. They employed directly and indirectly a large number of people, and were the cause of directing considerable attention to the district, and of forming quite a settlement around, and to this day a large proportion of the present inhabitants now engaged in farming, etc., are old *Bruce Mines* employees, or their descendants. So much then for the indirect benefits accruing to a district from the development of its mineral resources.

Period of stagnation in western district of L. Superior.

For sixteen years following Mr. Logan's visit to the region and the acquirement of the before mentioned mineral locations, little attention was paid to the mineral resources of the western end of the Lake, beyond a few spasmodic efforts at exploration and testing of some of the silver properties of the Thunder Bay district, for a year or two after their acquirement in 1845-6.

Spasmodic exploration of eastern district.

From time to time, however, the more easterly portion of the region received a little attention. The search for copper seems to have first occupied attention, and discoveries were made at intervals, of veins carrying sulphuretted copper ores, more especially in the Huronian rocks of the Lake Huron district, and a few in connection with Huronian and Laurentian rocks on Lake Superior. Amongst these were the *Wallace* and *Emerald Mines*, and some other places on Lake Huron and the discoveries at the *Begley*, *Palmer*, and *Point aux Mines* properties on Lake Superior, at which latter place work was carried on in 1856.

Exploration and testing of native copper formation.

The continued success attending the exploration of the native copper-bearing rocks of the south shore, now called Keweenian series, directed attention to similar areas on the north shore, and from time to time, during the period under consideration, slight efforts were made to discover the native copper deposits of this formation. The exploration of the St. Ignace Island properties in 1846 came first, but a great deal does not seem to have been done there. Following this, in 1853 came the commencement of work on the east end of Michipicoten Island by the *Quebec and Lake Superior Mining Association* on the native copper-bearing beds there, and later, a little testing work was done on similar beds on the north shore of the same Island at a place known as the *Bonner Mine*, where some interesting nickel and silver minerals were associated with the copper. At Mamainse Point also, about this time, some work was done on native copper-bearing fissure veins in this formation on a location known as the Meredith location belonging to the *Montreal Mining Company*. At none of these places, however, were the developments very extensive.

Second period of activity.

This brings us to the second period in the history of the region which began about 1863, when an era of much greater activity was inaugurated. This was more especially the case in the silver district of the western portion about Thunder Bay.

Further operations in the native copper formation from 1863 to the present.

The eastern end of the Lake did not benefit so much by this increase of interest in mining matters. Another effort was made in 1863, to place the *Quebec Mine* on Michipicoten Island on a working footing, and it was operated for about a year, after which this mine received no attention until 1881, when an English Co. acquired the property, and did considerable work, and with an interval of idleness during a change of ownership, this has been continued, and mining was still progressing at this spot in February, 1887. Another English company, the *Lake Superior Native Copper Co.*, in 1881 acquired the old McDonnell location at Mamainse from the *Quebec & Lake Superior Mining Association*, and expended some $400,000 in testing various veins which had been discovered there in 1880, and in erecting machinery, &c. The *Silver Islet Company* also about this time had a force at work, and did a considerable amount of exploring and testing, both on the old Meredith location, which is adjacent to the last mentioned, and had been worked as previously mentioned, and on the adjoining one to the south. Work was suspended, however, at all these places and, excepting at Michipicoten Island, nothing was being done in 1886.

Discoveries of iron ores.

Evidences of the possible future of the region in the direction of iron production first came to hand about 1863, in the discovery of hæmatite and magnetite deposits at various places along the shore of the Lake between Port Arthur and Sault Ste-Marie, but beyond an insignificant amount of testing work there is nothing to record, so that the possibilities of the region in this respect still remain an unsolved problem. This subject is, however, now beginning to occupy a good deal of attention, and fresh zest has been given to the search for ores of this metal in the Thunder Bay district by the great success attending the opening up of the deposits at Vermilion Lake in Minnesota, just across the International boundary in a W. S. W. direction from Port Arthur. It is argued, that as these are within a measurable distance of Canadian territory, and there is good reason to believe that the areas of similar rocks found a little way across the line in Canada are the continuation of the Vermilion Lake rocks, that there is therefore very good reason to predict the discovery of equally good and extensive iron ore deposits in our own territory. In fact, the veteran explorers of the district, the Messrs. McKellar Brothers have recently announced such a discovery in the Lake Shebandowan section.

The year 1870 saw the first discovery of gold-bearing ores at what is

now known as the *Huronian Mine* at Jacktish Lake, near Lake Shebandowan, about 70 miles in a direction a little N of W. from Port Arthur, where the precious metal occurs in the native state as well as combined in sylvanite and pyritous ores. From that day to the present, a few more gold-bearing veins have been discovered from time to time at various places both in the above mentioned district and on the shores of Lake Superior between Port Arthur and Sault Ste-Marie. The metal in all these is mostly carried by the sulphurets. The work done on these gold-bearing veins has not been great, considering the lapse of time since their discovery, and what has been accomplished in this way has been almost altogether on two of them, viz.: At the *Huronian Mine* which has been worked at intervals since its discovery with more or less vigour, but is now closed, and at the *Heron Bay Mine* which was discovered in 1872, and then worked for a short time, and also about two years later for a short period. Discovery and testing of gold veins.

In the Black Bay section of the Thunder Bay district, several lodes carrying galena were found in 1863 and 1865, which seems to have been the first time anybody turned their attention to this mineral. Amongst these are the *Cariboo* and *Enterprise* veins, at which latter place some test work was done in 1872, and in the same section similar work was in progress at the *Arctic Mine* in 1884. The only other localities of this mineral of any importance are at McKellar's Harbor on the north shore of Lake Superior near Middleton on the C. P. R., where an 80 feet shaft was sunk in 1878; and at the *Victoria* and *Cascade Mines* at Garden River near Sault Ste. Marie, at both of which latter places considerable underground work has been done and stamp mills have been erected. The work at the latter mine was prosecuted during the years 1880 to 1885, whilst the former worked during the greater part of this period, but had ceased operations in 1884. None of these galena veins were being worked at the end of 1886. Galena veins.

The history of the mineral development of the eastern end of the Lake would be incomplete without a reference to the *Zenith Mine*, about eight miles north of the mouth of Steel River on the north shore of Lake Superior about six miles east from Rossport on the C. P. R., where a deposit of zinc blende was found in 1884, and some test pits sunk on it. Zinc-blende discovered.

To complete this chronological review of the chief mining events of this region a few words must be said on the subject of the discovery of the silver veins proper of the Animikie rocks of the Thunder Bay division. History of discovery of silver veins.

Although a number of these veins had been located along the coast and islands S.W. from Fort William during the before-mentioned trip

First discoveries regarded rather as copper and lead veins.

of Mr. Logan in 1846, and although some pockets of rich silver ore were found in them, the only ones on which much test work was done, viz., those of *Spar Island* and the *Prince Mines*—seem to have been regarded more as copper than as silver veins, and it was not until 1866 that the first silver vein, or rather the first one properly recognized as such, was found. Veins had been located in 1863, in this formation at the *Wallbridge Mine* and at *Lot* 11 in Paipoongo township, and the former had had a shaft sunk upon it, but they also seem to have been looked upon as bearers of copper sulphurets and galena ores rather than as silver veins proper.

Subsequent discoveries of recognised silver veins.

Thus the discovery of the *Thunder Bay* vein in 1866 by Mr. Peter McKellar inaugurated the era of mining of the higher grade silver ores which has been continued with varying success up to the present. The next year, the *Shuniah* or *Duncan* vein was located, and in the summer of 1868 a Mr. Morgan, who was employed on the exploring party which, in charge of Mr. Thomas Macfarlane was examining the locations held by the *Montreal Mining Co.*, found rich silver ore in the now famous *Silver Islet* vein, which resulted in sixteen years of successful development of a mine which has been the great mining feature of this end of the Lake.

For the seven following years, exploration and development work was actively prosecuted in the district surrounding the *Thunder Bay Mine*, chiefly on the veins already mentioned, and at the *Beck* or *Silver Harbor*, 3 *A*, and *Cornish Mines*. Some discoveries were also made of veins along the W. coast of Thunder Bay, and on the Islands in that vicinity, and work done to test them, notably at *Pie*, *Jarvis'*, *Thompson's*, *McKellar's* and *Mink Islands*, and at *Stewart's Location* near Pigeon River, *Sturgeon Bay*, &c.

Intervening period of quiet in silver district,

By the year 1875, most of these enterprises had ceased working, and a period of quiet intervened, for though the *Shuniah Mine* did not finally cease operations until 1881, and the *Silver Islet* until the spring of 1884, the former had little success and the latter had passed the zenith of its prosperity.

Renewal of activity,

Following this period of quiescence came a renewal of activity which, commencing with the discovery of remarkably rich ores of silver at *Rabbit Mountain* in 1882, has been continued with increasing vigour until the present. Discoveries at numerous other places around this point have quickly followed, notably of the *Beaver*, *Porcupine*, *Silver Creek*, *Little Pig*, *Big Bear*, etc., veins, the first of which has of late become especially famous by reason of the recent find of large quantities of rich ore.

To this third period also belong the discoveries near Whitefish Lake,

to which district attention was first directed by the discovery of the *Silver Mountain* vein carrying rich silver ores. This discovery has been followed by the location of numerous veins in this formation both in its immediate vicinity and for some distance westward around Whitefish Lake.

Natural and Economic Conditions.

To fully judge of the results attained in this great region from the standpoint of the miner, attention must also be paid to the natural and economic conditions under which its development has taken place, and when it is remembered that the history of mining there dates back forty years or more, it must be admitted that when the matter is viewed superficially the results attained seem very small in view of the apparently numerous and widespread discoveries of minerals. A closer inspection however of the conditions existent during this period will go far to explain this seeming anamoly.

Lack of communications throughout region.

The communications of the region with the outer world have until recently been very poor. Until the opening of the Canadian Pacific Railway from Winnipeg to Port Arthur in 1883 and throughout in 1886, the only means of communication with other parts of the continent was by steamboat, and this necessarily during the summer only. Furthermore, it was only the two ends of the Lake that benefitted by this, Fort William and Port Arthur at one end, and Sault Ste. Marie at the other. A certain amount of communication was of course kept up between these points and isolated fishing stations around the coast by tug, but this only partially and occasionally met the requirements of prospectors. The coast line naturally formed the base of operations from which the exploration of the interior of the tract was undertaken, aud this stretch of some 400 to 500 miles had to be reached from the two previously mentioned centres by very imperfect means of transit, exploratory parties generally having to make long expeditions in sail boats carrying with them all their material, camps and provisions for the whole season's work. Even when the desired section was reached, other difficulties would have to be confronted, owing to the absence of any roads, so that the interior could only be reached by canoe routes or by starting through the bush on foot when every thing needful had to be carried on men's backs. The limited amount it is thus possible to transport, and the slowness of such means of travel over a rugged country covered with dense bush naturally forced the explorers, who could not of course have a large gang of men packing

Communications by water at first.

in material after them from the centre of supplies, to limit themselves to the examination of the country in the immediate vicinity of the shores of the Lake. Those who are not acquainted with new countries may perhaps better realise these conditions by supposing all England covered with dense bush and uninhabitated and its exploration undertaken with the coast line as a base of operations by comparatively a handful of explorers, who would have to start either from London or Newcastle in canoes or small boats.

Water travel unavailable during winter.

Even this means of travel was prohibited during the six months winter, for the end of November sees the stoppage of all water communication on the Lakes, and apart from this, the advent of snow, of course, puts an end to exploring.

Early difficulties and expenses due to isolation of region.

Incidents which occurred during the working of the *West Canada Mining Company* at the *Bruce Mines* on Lake Huron well illustrate some of the difficulties consequent upon this state of things. Owing to the state of siege existent in the region from the absence of winter communications, a stock of all necessary material for the whole winter had to be taken in every fall. One fall, the steamer bringing in the horse feed was wrecked, and the management had to resort to the expedient of substituting flour, of which they had a good stock, and having built a baker's oven, fed the horses on bread all the winter. At another time, the general supply steamer having broken her propeller shaft, a message was with some difficulty sent to the merchants supplying the goods, who duplicated the order for the winter's supply and chartered another steamer, only to find that it was too late, and that it could not get through on account of ice, so that the supplies had to be collected from all over the district, and teamed from long distances at great expense.

Before the opening of the ship canal at Sault Ste. Marie, Michigan, between Lakes Huron and Superior in the spring of 1855, things were even worse, for there was then no means of passing the falls at this place, and everything had to be trans-shipped and portaged overland for about two miles, and taken up Lake Superior in large canoes or sail boats. It is said that when the *Montreal Mining Co.* started work at *Point aux Mines*, that bricks which they took up for their smelting furnace cost 25 cents a piece at the mine, and everything else in proportion.

All this of course rendered access to the region both difficult and expensive, and largely deterred people from efforts to make or develope discoveries.

Another source of difficulty and expense, especially in the earlier part of its history, has been the difficulty of procuring supplies in the

region itself, for owing to the absence of agricultural settlers until a comparatively recent period, everything had to be brought in from distant places thus incurring heavy freight charges.

Deterrent effect of dense bush.

The effect of the dense bush also, covering as it does so large a proportion of the country, has been very potent in retarding discovery, as every one who has ever travelled through it realises how effectually it limits the vision, so that one may travel quite close to indications of a mineral deposit and never see them. This same retarding effect is felt in trying to work out the extent of deposits found, and the relationships of various exposures of either rock or vein, and when it is remembered how even when actual soil is absent and the rock is near the surface, it is yet concealed by moss, fallen trees and the general debris of defunct vegetation, the difficulties due to these causes may be better realised. Once the veins or deposits have been located, however, and traced up, this same covering of bush is found very useful in supplying material for building and fuel.

Comparison of conditions of development of region with those of other mineral countries.

Some points of difference between the development of this region and that of others on the continent is worthy of notice. In the case of the famous California and Rocky Mountain districts of the United States, the discovery of placer gold caused a tremendous rush of explorers to these districts in the first place, from the fact that this class of deposit enabled individuals, or small parties of individuals, without much capital to work claims in their own interests, with the chance, if lucky, of making large sums of money in a short time. This influx was largely assisted by the system adopted of staking out and recording the claims, whereby a discoverer or locator could acquire his property with the least possible delay, in the simplest manner and at the smallest expense. Thus these districts suddenly received a large mining community, which led to the opening up of the country in every way so that when the placer diggings began to get worked out, the explorers, being already on the ground, were naturally led to turn their attention to the discovery of veins and other mineral deposits, whilst all the necessary communications being already in working order, the conditions were very favorable to the opening up of mines at once, when found, and the eyes of capitalists being already turned in that direction by the original gold excitement, it was found easier to interest them in the proposed enterprises.

The Lake Superior region has, however, had none of these benefits. There has been no preliminary inrush of thousands of explorers and the opening up of the region has been consequently, as mentioned, very gradual, whilst the process by which discoverers can secure their claims has not been very satisfactory.

Retarding effects of mining laws.

The present system offers every facility to the man of means to acquire and to hold for an indefinite period, large tracts of land around discoveries, but retards and renders it difficult for the explorer himself to acquire his discovery. The process acts somewhat in the following manner. An explorer makes a discovery and possibly secures it but within a few months or even weeks, all the land for several miles around will have been surveyed and tied up by parties whose means allow them to hold for an indefinite period whilst they have not the funds or do not care to meet the much larger expenditures required to develop their properties. The interest of this class is to hold with a view to re-selling at much enhanced figures when the developments on the first good finds cause a demand for mining locations in the section. This does not always come about according to the expectation of the investors, so that at present large tracts of land in the mineral regions are tied up and held thus, the amount of taxes * on them being a comparative trifle to such as have spare funds enough to go into this kind of speculation whilst it is quite a considerable item to the prospector whose means, already slight, are all required to outfit him for the search.

Large areas tied up for speculative purposes.

The extent to which this state of things exists in one part of the region will be rendered plain by looking at the appended Sketch Map of Thunder Bay region, where the areas of patented land are shown, of which one may safely take four-fifths to three-quarters to represent mineral lands ties up. The worst effect of this system is that it disheartens the actual explorer and keeps him out of the district, for instead of a promising discovery causing as it should a rush of actual explorers to the section and a consequent multiplication of discoveries, the land around the very spot where other finds might be expected, is speedily bought up and discoveries made on property belonging to others are not very profitable.

This subject is of course a complicated one, but after studying the matter in the district and making enquiries amongst actual explorers, one cannot help coming to the conclusion that the effect of the mining laws is to encourage a wholesale speculative acquirement of mineral lands on the slightest provocation, rather than to ensure actual working and to foster discovery by rendering it as easy as possible for the explorer to get the full benefit of his toilsome and dangerous efforts.

Attention drawn to this in the past by Geological Survey.

Attention was drawn to this matter from time to time by the Geological Survey, for beside the already quoted suggestion of Sir William Logan in 1846 and other places, Mr. Macfarlane refers to it in his Re-

* A tax of 2 cents per acre on all patented lands in Algoma was imposed in 1868.

port on Lake Superior published in the Report of Progress of the Survey for 1866, page 147, where he says. "Although important results might reasonably be anticipated to flow from a search for rocks having the lithological character of the cupriferous beds or with the compass in the manner above indicated, probably the best method wonld be to make such arrangements as would induce the experienced miners and explorers of the south shore to undertake the search. So far as I can judge, numbers of them would be very willing to do so were they only certain that after having made a discovery they could reap the advantages. At present the impression prevails amongst them (how far it is justified I am unable to say) that in the event of their discovering valuable minerals and applying for the land containing them, it would, before it would be surveyed and secured, find its way into the hands of some more favored individual. In order to prevent this, it would be necessary, after ascertaining the limits of the copper bearing rocks or of the 'mineral range,' as it is called, on the south shore, to have those parts of it which are still unsold, surveyed, laid out in not too large lots; establishing a price for them such as that at present fixed, and making arrangements by which the public would at once know what lots were unsold, and by which any applicant for one of those could at once secure it."

Change of laws necessary to encourage exploration.

Were a system adopted based on the general principle of the discoverer or other person, holding his claim by doing a certain yearly amount of development work on it, coupled with arrangements whereby he would be allowed to make a preliminary definition of its position and area on the ground at the time of discovery, and were steps taken to make this widely known, it would undoubtedly greatly assist in inducing more explorers to make this region the scene of their operations. This is an end very necessary to attain, for although many efficient explorers have given attention to the region, still in proportion to its extent, their number has been ridiculously small, and it speaks well for the general prevalence of mineral that they have found so much as they have.

These proposed ameliorations of the conditions under which the prospector has to work are rendered the more necessary just now in view of the extensive new sections of country recently thrown open for exploration by the completion of the C. P. Ry. and its branches within the region in which the tying up of the land has not yet taken place.

Even when work has been commenced with a view to test deposits found, failure has often been courted, owing to the limited ideas held, of the extent of the expenditure and work necessary to convert an un-

Bad effects of erroneous ideas of mining requirements.

proved prospect into a proved mine, which misconception has caused premature abandonment of the effort, or a start to be made with insufficient capital, so that the end of the funds at disposal has been reached before the question is satisfactorily answered as to whether or not the mineral existed in paying quantities. Added to all this, a failure on the part of operators to realise to what extent a mine should be tested before erecting large stamp mills and making other surface expenditures not immediately called for, has often caused a waste of much capital, which used on actual underground work, might have seen the venture through barren stretches of vein to a successful demonstration of its value.

These failures, when from such causes, give the region an undeservedly bad name, and render it difficult to interest capitalists who living far distant from the section and unacquainted with the facts, must necessarily judge from superficial appearances.

Of the multitudinous erroneous ideas which find currency amongst explorers and others working in such a region, and of the large loss of energy, etc., in ill-directed effort consequent thereon, one need hardly say more, other than that when they have found common acceptance, they have materially affected the direction of the developmental energy in the district. One case, however, may be given as an illustration where an explorer acting on a belief widely accepted by the prospectors that "true fissures always run straight", had run a picket line of about a mile in length through the bush from a short outcropping of a vein, and then with perfect faith had sunk a shaft close to a creek bed and at a place where the thickness of the clay covering was evidently at least fifty feet, and probably much more, so that his chance of finding solid rock, even at a reasonable depth was small enough, not to mention the other absurdities of such a proceeding.

In pursuing the consideration of the subject of this Report viz.—Mines & Mining in the Lake Superior Region—the matter presented will be considered under the headings of the various mineral substances there found.

B. SILVER MINING.

Under this head will be considered the Silver mining proper, as distinguished from the operation of those veins carrying argentiferous lead or copper ores, and its history is practically that of the western end of the region, i.e., of the Thunder Bay mining district, for whilst veins and deposits have been there found and operated to a slight extent carrying other ores than the silver ores proper of the district, yet they have been so far comparatively few in proportion to the others, and will be considered under their proper heading in Part. II.

Extent of silver district.

This district, which is comprised within the area covered by the appended Sketch Map, has been more actively prospected than any other section of the region herein dealt with. Its history has already been given in a general way. The name of Mr. John McIntyre, the officer who was in charge of the Hudson's Bay Co.'s post during the earlier part of the history of the region, is prominently connected with the mining efforts of that time in association with the Messrs. McKellar Brothers whose active explorations extending over many years have done so much to prove the widespread existence of mineral deposits in the district.

Early conditions

The old Hudson's Bay Co's distributing and trading post of Fort William at the mouth of the Kaministiquia river naturally became the headquarters of the first mineral explorers, and remained so till the commencement of the operations for the construction of the Dawson route to the North-West. This road came out at a point on the shores of the Bay some three miles from the old Fort causing the village of Prince Arthur's Landing to grow up which has subsequently developed into the present town of Port Arthur, so that the two places with their wharves, &c., form the head of navigation of the great Lakes for the Dominion, and have become the headquarters of much mining activity at present.

Recent improvements in accessibility of district.

The means of communication of this district have been much improved of late, and are now very good. The completion of the C. P. Ry. affords connections with the rest of the continent, whilst still cheaper freight rates will be obtainable in summer from the numerous steamboat lines, by which the products of the mines can be shipped direct to other ports in Canada, or to American ports on the lakes. Starting from Port Arthur as a centre, the shore portions of the district can be easily reached by small craft or tug, whilst the C. P. Ry., Dawson road and numerous canoe routes over the lakes and rivers give means of communication with the inland portion.

Geological features.

The rocks of the district are comprised within several areas which are marked as Huronian, Laurentian and Lower Cambrian on the published maps of the Survey, and also include several granitic masses.

The veins carrying the ores of silver occur with one or two exceptions, which are pointed out later on, in the lower division of these lower Cambrian rocks which is known as the Animikie series, and whose distribution and extent are shown upon the appended Sketch Map. The chief area is that extending S. W. from Port Arthur which is roughly triangular in shape, with sides of about 40 miles extending along the west shore of Thunder Bay, 60 miles along the International boundary at Pigeon River, and 80 miles along the northern side, where the formation abuts against the Archæan rocks, which gives an area of approximately 1,200 sq. miles. Besides this, there are other areas of these rocks as shown on the map, on the N. E. side of Thunder Bay and extending down its eastern coast to Silver Islet. With the exception however, of this latter mine, all the discoveries of importance are confined to the first mentioned area, the general features of which it would be well to describe before going on to the detailed description of its mining phenomena.

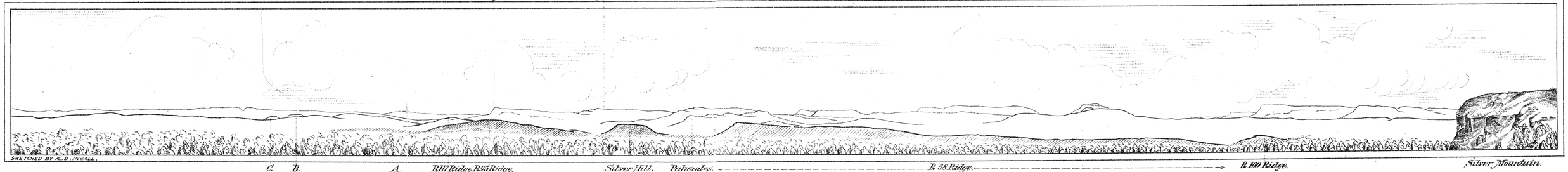
Extent and distribution of silver formation.

Surface characteristics of silver area.

The surface of the region presents a number of flat-topped hills and ridges, the former frequently roughly circular in shape, separated by valleys about two or three hundred feet deep. From the tops of the hills down, the rock is shown in cliffs varying in height from 30 to 150 feet, below which the debris fallen from above slopes off at an angle of about 45° for probably another 50 feet, when it merges into the gentler slope of the clay and soil filling the valleys. The peculiarities of the landscape due to these table-topped hills is shown on the accompanying panoramic Hill Sketch, which also shows the very different profile of the surface of the Archean rocks to the N. as contrasted with the Animikie hills to the S., the division between the two being about in the position of the letter " A ". The little flat-topped hills, " B. and C ", in the distance are most probably outliers of the Animikie formation lying on the Archean rocks. The mineral discoveries are so far mostly confined to a belt of country running along the northern fringe of the formation between Arrow lake and Port Arthur, and to the coast and islands of the N. and W. sides and in the mouth of Thunder Bay, the country in the interior of the triangle being comparatively little known. A few discoveries of similar veins have been made in the eastern areas of these Animikie rocks, but besides the notable one of Silver Islet, little or no work has been done upon them.

Distribution of mineral discoveries.

The valley bottoms in this area have usually a considerable depth of soil, consisting often of a compact white or yellow clay with varying



HILL SKETCH LOOKING EASTWARDS FROM CROWN POINT MINE

SILVER MOUNTAIN

thicknesses of alluvium on top. The bush which covers the whole district consists mostly of poplar and birch, in the lower lands with some intermixed pine, etc., whilst balsam, spruce and tamarac preponderate in the swampy parts. The trappean capping of the tops of the hills is usually scantily covered with soil, and generally supports a growth of jack pine, the dark foliage of which causes them to stand out prominently against the lighter shades of bush in the valleys. These valleys, forming as they do a considerable proportion of the area of the country and containing good soil, for the most part, render this section important from an agricultural as well as from a mineral standpoint.

Character of bush.

Agricultural possibilities.

In connection with the subject of the surface it will be interesting to note the frequent occurrence of smooth surfaces of rock which have been polished and grooved by ice, these show chiefly on the shores of Lake Superior and the inland lakes and rivers.

Glaciation.

It may be well here to give a short description of the general features of the Animikie rocks, leaving the details for consideration later on in connection with the description of the Silver Mountain and Coast groups where they were most carefully studied. Their relationships to the other formations of the district are to be seen on reference to the Sketch Map on which the boundary lines of each are given. These lines were put on from information gleaned from various sources, those west of Port Arthur being located from work done by myself, and from information kindly given by Dr. A. C. Lawson, whilst east of the same point, their position has been defined by the investigations of Dr. R. Bell and from data supplied by Mr. Peter McKellar of Fort William.

Geological character and relationships of Animikie series

The formation lies nearly horizontal, and rests in this position on the denudation surfaces of the older rocks which shew to the north whilst in their southerly and easterly extension near Black Bay, and in Thunder Cape peninsula, they are covered up by the rocks of the Neepigon formation, and S. of this, at the island in the mouth of Grand Portage Bay, are seen to pass under the Keweenian series, which consists of interstratified beds of conglomerate, sandstone and various trappean rocks. The rocks comprising this silver bearing formation consist of basic traps, black and grey argillites, cherts and jaspers, with some ferruginous dolomites, the mineralogical composition and structure of all of which will be understood by reference to the Appendix which contains the notes of Mr. W. S. Bayley of Johns Hopkins University, Baltimore, on his microscopic examination of typical specimens of these rocks collected by myself.

This Animikie formation is divisible into an upper and lower portion which while being quite distinct are not separated from each other

Sub-divisions of the Animikie.

by any very definable line, the rocks of each division at places taking on somewhat of the nature of those belonging to the other. Thus the chief character of the lower division consists in the almost entire preponderance of siliceous rocks, such as chert and jasper, which are often accompanied by ferruginous dolomites, and themselves all contain more or less iron in the oxidised state, at some places carrying so much magnetite as to constitute almost an iron ore. An analysis of such a piece, by Mr. Hoffmann, gave 53 per cent of iron, titanic acid being absent.* Occasional developments of the black argillites are found interstratified with the silicious beds but they are only local and do not seem to be ever of any extent.

Lower division.

Upper division.

In contrast with these, the upper division is formed for the most part of the black, soft, carbonaceous argillites. These are occasionally dolomitic, and at some places are quite ferruginous, whilst at others they hold such a large percentage of silica as to approach very nearly in character to the rocks of the lower division.

Distribution of lower division beds.

The cherty and jaspery rocks coming in at the bottom of the formation show chiefly in a strip forming its northern fringe where it abuts on the Archean. They constitute all the lower lying land north of the range of hills which extends along the southern boundary of the valleys of the Whitefish and lower part of the Kaministiquia rivers, commencing at McKay's Mountain on the east, and passing through Rabbit and Silver Mountains, and westward from this. These cherty rocks would seem also to constitute the greater part of the extension of the main area east from Port Arthur, and of the fringe of this formation along the North shore of Thunder Bay as far as the Mackenzie river, this section containing most of the Port Arthur group of veins.

Outliers of lower division beds.

Outliers of these rocks are to be seen as detached flat-topped hills out on the Archean area, some distance removed from the northern edge of the Animikie. The Outpost Hills shown on the Sketch Map constitute a group of these† which, when visited, were found to consist of high bosses of granitic and gneissic rocks, on the top of which rest thin sheets measuring from 20 to 30 feet thick of the typical cherty rocks of the lower division, with a capping of about 100 feet of the usual dark, vertically columnar basic trap. The opposite view entitled, owing to a printer's error, "Outline instead of Outliers of the Animikie on the Archean" shows the distinctive shape of these hills, their peculiar contour enabling one to recognise several other evidently similar outliers which show to the east of those shewn.

In passing south across the strike of the formation, one comes to the

* Report of Geol. Surv. 1886. Part I, Analysis of Iron Ores No. 4. Idem, 1887, Analysis No 10.

† By mistake the Archean ruled tinting on the Sketch Map has been run right over these outliers, which should, of course, have been left blank.

E. D. INGALL, PHOTO., 1886. IVES-PROCESS; G. E. DESBARATS & SON, MONTREAL.

OUTLINE OF THE ANIMIKIE SERIES, NORTH OF WHITEFISH RIVER, ONTARIO.

E. D. INGALL, PHOTO., 1886. IVES-PROCESS; G. E. DESBARATS & SON, MONTREAL.

TRAP FLOW ON ARGILLITES, ANIMIKIE SERIES. SILVER MOUNTAIN DISTRICT.

beds of the upper argillaceous division in the higher levels and forming the range of hills just mentioned, where they show in the cliffs which usually form their boundaries, and are seen to underlie the trap-sheet usually constituting the capping or top of these hills and ridges about which it is noticeable that they very frequently have a distinct southerly dip, their north facing aspect usually constituting steep bluffs and cliffs. These upper division beds would seem to form the surface rocks in all the area lying south of this fringe of hills, as far as can be judged from the reports of persons who have traversed it, and from the study of the cross section of the formation presented by the coast line from Port Arthur to Pigeon River.

Position and distribution of upper division beds.

The traps are not only visible as mentioned as vertically columnar beds capping the hills, but also exist at various lower levels. Whilst some of the highest might possibly be portions of a crowning overflow separated from each other by denudation and brought to different levels by faulting, the evidence seems to leave no doubt of the existence also of numerous other sheets at very various horizons in the formation, and the intrusive nature of some of these appears from a close study of them on the ground to be quite assured. The observed instances of this are mentioned later on in this Report in describing the different districts in which they occur. In view of all the evidence, it would seem then that the trap-sheets are not confined either to the lower or the upper division of the formation, although they seem to occur more frequently in the latter.

Trap sheets.

As has been already mentioned, the formation lies nearly flat, and it is very difficult to decide whether it really has any general dip or not. The dip measurements obtained both in the examination of the new silver districts west of Port Arthur and along the coast section south of that place, whilst ranging usually from 5° to 10°, were so conflicting in direction, and were evidently so often rendered unreliable by the proximity of disturbing influences such as dykes, veins, intrusions of trap, etc., as to leave it in doubt whether the rocks have any general dip, and if so, what its amount and direction is, or whether they are bent into a series of flat anticlinal and synclinal ridges, troughs and basins such as were commonly seen to exist along the coast section. This question will have to stand in abeyance for satisfactory settlement until the whole district comes to be thoroughly worked out, but meanwhile it would seem that the balance of evidence is in favor of the existence of a general flat southerly and south-easterly dip of the whole formation, probably averaging from 5 to 8 degrees.

Dip of formation.

If we assume the average dip to be 5° in a S.S.E. direction, and measure the width of the outcrop of the formation from Grand Portage

Probable thickness of Animikie formation.

Island, where it passes under the overlying Keweenian rocks, N.N.W. to near Woodside's vein, in the Silver Mountain area, where the Archean appears from below them, which we find to be some 25 miles, we get a thickness for these rocks of over 12,000 feet.

Contents of veins

The silver ore of the district consists of the native metal and sulphide or argentite generally associated with blende, galena pyrites, etc., in a gangue of calcite, barite, quartz and fluorite in a series of fissure veins the details of whose characteristics are dealt with later.

Vein groupings.

Such, then, are the general features of the Animikie or silver-bearing formation of Lake Superior. In considering the details of the various mining discoveries and experiments the veins historically, and naturally fall into the following groups, and will be hereafter considered in that way, viz.:—

1. The Coast Group.
2. The Port Arthur Group.
3. The Rabbit Mountain Group.
4. The Silver Mountain Group.
5. The Whitefish Lake Group.

The Coast Group.

Distribution.

This group comprises a series of veins located on the coast of Lake Superior between Port Arthur and the International boundary at Pigeon River, and on the group of islands in the mouth of Thunder Bay.

"Country rocks."

The greater number of these intersect what was formerly known in the district as the "Macfarlane Band," a belt of trap dykes and associated intrusive sheets, with argillaceous beds filling out their interspaces, constituting the string of islands between Silver Islet and McKellar's Point and considered to be the continuation of the Silver Islet dyke. The chief mine of this group is *Silver Islet*, and the great success attending the opening up of this vein caused great excitement in the district and directed the attention of explorers to the series of veins already mentioned, upon the supposition that whereas the Silver Islet vein had only been productive where it intersected the dyke, that therefore the presence of silver was due to its influence, and that all other similar veins intersecting its supposed extension would be found equally rich. The rocks enclosing the veins along the coast line consist of argillaceous beds which, in places, are so siliceous as to constitute argillaceous sandstones and flagstones, whilst they often merge on the other hand into dolomitic argillites. With these are associated also numerous trap-sheets which are seen to occur both capping the bluffs overlooking the shore, and also at lower horizons in the formation. Trap dykes are also very numerous, constituting, as they do, nearly all the capes and points of the coast. They nearly all strike N. E. & S.W., or at right

Trap sheets.

Trap dykes.

angles to the system of vein fissures. Further details regarding these rocks are given later on.

The gangue of this group of veins consists mostly of quartz, fluorite, calcite and barite, and they carry native silver, and silver glance associated with much zinc blende and galena and sometimes some copper sulphurets. **Vein contents.**

Apart from the work which was going on at *Jarvis Island* and *McKellar's Island* (the latter for barite) none of the mines of this group were working at the end of 1886.

Silver Islet Mine.

This having been the most extensive and most successful venture of the region, I have gone into its history and nature somewhat at length. It is situate on a vein crossing a small rocky islet about a mile out in the lake off Thunder Cape.

The vein strikes N. 35 W. and dips to the S. E. at an angle of about 70° to 80°, whilst in thickness it would average about 8 to 10 feet. In some places, however, it has shown from 20 to 30 feet of solid veinstuff. At the time of my visit the mine had been closed for some time, and was full of water, so that beyond making an examination of the surface I have had to depend for further information on various published accounts of the mine, chiefly by Messrs. Thomas Macfarlane W. M. Courtis, and F. A. Lowe, all of whom were connected officially with the mine at various times. From these sources and from information supplied by Mr. Richard Trethewey, the manager, who was in charge of the underground department since December, 1871, and took charge of the whole work from 1876 to its close, as well as from my own observations, I have been able to compose the following history and description of the mine. **Vein characteristics.**

The gangue of the vein consists of calcite, quartz and dolomite, the latter varying in color from cream to pink, according to the varying amounts of manganese it carries. Mr. Courtis also mentions having found rhodochrosite in the ore shipped to the Wyandotte smelting works. The metallic minerals are native silver, argentite, galena, blende, copper and iron pyrites with marcasite. Mr. Macfarlane also mentions tetrahedrite, domeykite and niccolite and cobalt bloom, the two latter, probably, oxidation products of a peculiar mineral called Macfarlanite, containing arsenic, cobalt, nickel and silver. Two new minerals are also said to have been found in the ore, by Dr. Wurtz, called by him Huntelite and Animikite. The three latter, according to Mr. Lowe, " are now" (October, 1881) "the principal producing silver ores of the mine " (E). Besides the above, Mr. Courtis found in the **Vein contents.** **Metallic minerals.**

ore shipped to the Wyandotte smelting works, annabergite, antimonial silver and cerargyrite, the latter "where the rock has been decomposed" (L). Graphite also occurs in considerable quantity and seems to be connected in some way with the occurrence of the silver. On enquiring of Mr. R. Trethewey as to what connection he had noticed between the existence of this graphite and the occurrence of the silver, with a view to ascertain its value as an indication, he told me that although they never had silver without graphite, they sometimes had graphite without silver. "The native silver is generally disseminated through the ore in more or less dendritic masses, the points of native silver forming nuclei for the deposit of niccolite and sulphurets" (A). In a specimen of the ore collected by myself are to be seen pieces of trap and graphite enclosed in pink spar, whilst from the graphite start out dendrites of silver. "Particles of silver were also found in some of the small feeders which intersect the country rock (or perhaps *horse*) lying between the two veins" (C). The vein splits in crossing the islet going south but according to Mr. Lowe, comes together again both in length and in depth at the fourth level, after which they continue both in length and depth as one vein, with an average width of 8 feet. "The southern part of the latter" (the western) "branch carried the richest ore, the eastern branch being less rich, and the whole of the vein to the northward being almost entirely barren and consisting of a huge mass of calc-spar with quartz and occasional cubes of galena which carry only a minute quantity of silver" (C). Mr. Hoffmann recently examined some large crystals of galena given me by Mr. R. Trethewey which the latter said came from a vug at the 560 feet level, and found only a trace of silver. "The blende, galena and pyrites are generally very poor in silver, seldom exceeding 2 oz., per ton when taken from the barren parts of the vein, but in and about the rich silver deposits, they become highly enriched both chemically and mechanically.... by particles of and streaks of native silver" (E). "The relative quantity of calcareous and siliceous matter varies, however, in different parts of the vein, and in some places, streaks of quartz have preponderated to such an extent as to make some of the ore highly siliceous." (C). A curious feature of the vein is the combustible gas which has been met with in large quantities in the workings. This gas, according to Mr. Lowe, is accompanied by water containing calcium chloride in solution. He says: "Two gallons of this water furnished, roughly measured, nearly a pint of very acrid and deliquescent salt, chloride of calcium." (D.) He further states "the gas and water are principally confined in large vugs or cavities in the vein under great pressure.....it" (the gas) "is met with in the deepest

Graphite.

Native silver.

Gas and mineral water.

workings.....above the 8th level all water infiltrating into the mine is pure lake water, whilst below that level is a zone of highly mineralised water.....the gas is unequally distributed through the lower workings, occupying independent cracks, fissures and vugs....the water annoyed the men very much; on touching their skin it would almost blister it.....it" (the gas) "was also previously met with in the 3rd and 6th levels." (D.) Mr. Macfarlane also mentions the occurrence of this gas on the 8th level in a vug.

Mr. G. C. Hoffmann, chemist to the Survey, having analysed a sample of this water which was collected by Mr. Richard Trethewey at the instance of Dr. Selwyn in the summer of 1882, reports as follows. * After giving the details of the analysis, he says: "Total dissolved solid matter by direct experiment dried at 180 C. 35·9566" in 1,000 parts by weight. "The foregoing acids and bases are most probably combined in the water as follows (Carbonates calculated as mono-carbonates, and all the salts estimated as anhydrous.) Analysis of mine water.

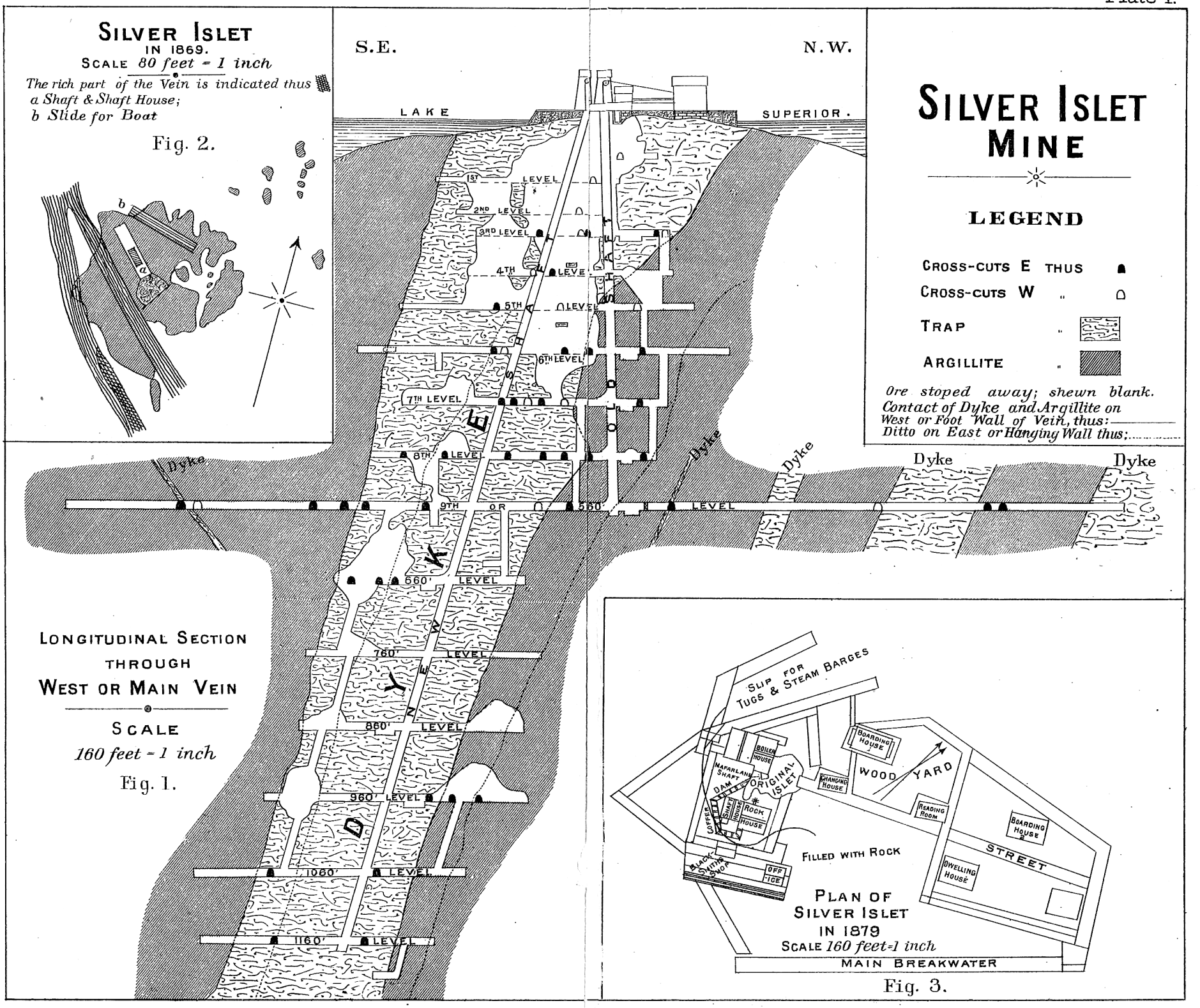
Chloride of Potassium	.4582
" Sodium	16.8098
" Calcium	17.0867
" Magnesium	1.2937
Sulphate of Lime	.0672
Carbonate of Lime	.2936
Silica	.0540

"The rock on the Islet intersected by the silver vein is a chloritic diorite, evidently forming a dike.† It differs somewhat from the rocks of the other dikes of this location among which may be mentioned corsyte and anorthite porphyry.....gray flags fill out all the "Country rocks."

* Geological and Natural History Survey of Canada. Report of progress. 1885, sec. M, page 17.

† Prof. Roland D. Irving describes these rocks as follows:

"Between Thunder Cape and Silver Islet a large number of dikes are seen cutting the slates. Only one of these dike rocks, which appear for the most part to be the same as those which form the numerous dikes of the South West shore of Thunder Bay, already described, was examined. This is the rock which forms the dike at Silver Islet. It is a nearly black, rather fine grained rock, distinctly composed of a greenish black and a white mineral, the latter being of course felspar. According to Macfarlane its specific gravity is 2.7 and its silica content 53.34 per cent. It contains 5.02 per cent of water, an amount indicating a considerable alteration; and this indication is fully borne out by a microscopic study of the thin section. This shows tabular plagioclases with some orthoclases as predominating ingredients. These felspars are all much dulled by alteration and are often penetrated by secondary quartz. In many places the larger felspars have between them a mass of smaller, much crushed and always highly altered felspars. The augitic ingredient is only partly fresh, being commonly much altered to ochre, and uralite with which alteration is connected the formation of some magnetite, Rather abundant titanic iron for the most part altered to its characteristic gray decomposition product and sparse apatite complete the resemblance between this rock and the finer orthoclase-gabbros of the Keweenawan." See monographs of the United States Geological Survey, Vol. V. "The Copper Bearing Rocks of Lake Superior" by Roland D. Irving, p. 378.



Figs. 2 & 3 are reproductions of drawings accompanying a paper on Silver Islet, by Mr. THOMAS MACFARLANE, in the Trans. American Institute of Mining Engineers for 1879-80. The Longitudinal Section is from tracings supplied by Mr. C. A. TROWBRIDGE.

spaces between the various dikes." (C). The vein "has been exposed at several points where it crosses the sedimentary beds, but there it is split up into numerous thin veins of quartz, and shows nothing of the great width which it carries on Silver Islet, nor have any of the rich silver minerals of that locality yet been found upon the mainland or upon Burnt Island" (C). This diorite dyke dips S. E. at an angle of from 60° to 75° from the horizontal, and is faulted some 80 feet by the vein. "The workings have never been productive outside of it, indeed there are large areas of the vein enclosed by diorite walls on both sides which have yielded no ore." (C). "The long" (diamond drill) "holes E. and W. on the 1st level proved that the dyke was saturated with graphite which is also noticed in its outcroppings known as Pyritic and Ship islands, one and five miles from the mine. Out of the whole series of twenty-one dykes cut by the vein,.....the Silver Islet dyke is the only one impregnated strongly with graphite and pyrites" (D). "The influence of the country rock upon this vein is very apparent from the development on the 6th level N. and on the 9th both N. and S. In both levels on entering the schists" (? slates) "the vein gradually thinned out to mere stringers, but recovered its width on entering two other dykes N....and the vein in them was highly mineralised..... In drifting south, a small dyke of a few feet in width was met with" (D). Regarding the connection supposed to exist between the *floors* which cross the vein at intervals and the occurrence of the silver ore. Mr. R. Trethewey told me that they were not necessarily to be regarded as an indication, as has often been alleged, for although there seems to be some little connection in the upper and richer part of the mine, they had the same floors below that in the poorer part, but they were unaccompanied by silver. However, in a general way, if on coming on to a *floor* it was found to be covered with patches of argentite, it was mostly a sign that the rock down to the next *floor* would be rich, though sometimes the silver would not be found for some little depth below such a floor.

Dykes impregnated with graphite.

Influence of *floors* in vein.

History of mine

Discovery.

History of the Mine.—The *Silver Islet* vein was discovered in the summer of 1868, during the exploration of the lands of the *Montreal Mining Co.* by a party under the direction of Mr. T. Macfarlane which, on leaving in the fall, after the summer's exploration of this and other properties, the party brought away with them specimens valued at $1,200 taken from the outcrop of the *Silver Islet* lode. During the summer of 1869, Mr. Macfarlane continued his work of surveying and exploring Woods' location, of which the Islet forms a part, and notwithstanding a stormy summer, rendering work on the Islet difficult, some 9,455 lbs. of ore were produced and shipped to Mont-

real, valued by assay at $6,751.67. In August of 1869, the same party began to sink a shaft on the Islet on the east branch of the vein, intending to cross-cut to the western or richer branch, and a party of twelve men with a horse were left to continue this work during the winter of 1869-70. They were instructed to take advantage of the formation of ice around the Islet to continue the extraction of the ore from the outcrop of the western or main vein which was under water alongside the Islet. The winter was favorable, the ice having formed quietly and remained for two months, so that the efforts of the party were successful, and by the spring they had, by subaqueous blasting, and fishing up the product with tongs, etc., enough rock to yield by sorting 17,669 lbs. of ore, whose total value by assay was $18,291.39. This ore was shipped to Montreal in the spring of 1870. The shaft, however, had to be discontinued on account of water. "That ten men had been able to produce $16,000 worth of ore, and that the actual time employed by them in so doing had not exceeded fourteen days, was again insufficient to induce the *Montreal Mining Co.* to proceed to work the Silver Islet vein" (C). Work commenced.

After some negotiations, the whole of this Company's property passed into the hands of New York and Detroit capitalists in September, 1870, and on the 31st August, Captain Frue arrived and commenced work with a party of about 30 men and two horses accompanied by the necessary provisions, etc. "In spite of severe weather extensive breakwaters were built, part of the vein enclosed by a cofferdam, the area within the latter pumped dry, a considerable amount of mining done, and about 77 tons of ore shipped before the close of navigation. The time devoted to mining was about four weeks ..... About $80,000 were expended in the above operations, and in making provision for wintering" (C). The total value of the ore in this parcel was $92,153.23. The winter of 1870-1 was taken up by Mr. Frue and his party in enclosing the Islet with cribbing, so as to establish a permanent mine there. The difficulties experienced from the storminess of the season and trouble with ice were very great, both in placing the cribbing and in keeping it in place, and gales took away most of it, which had to be replaced. Change of ownership.

"By the 1st May, 1871, an excavation had been made on the rich part of the vein inclosed by the cofferdam having a length of 65 feet, depth of 32 feet and an average width of 8 feet. By the close of navigation in November, this working had attained a depth of 90 feet, and had produced from the same time in 1870 about 485 tons of ore" (C)., and had thus in the year, Nov. 1870 to Nov. 1871, produced ore carrying silver, worth by assay $642,932.01, and also one lot of five tons,

Continuation of history of mine

worth $5,200, which was lost in transit on the propeller Coburn.

"Mining was continued with varying success after the close of navigation in 1871. The vein was found to be subject to frequent and sudden changes, both as regards size and richness. In the fall of 1871, it narrowed down to 6 inches in width at some points, with scarcely any first quality ore in sight. During the winter, it gradually widened and became very productive. In Mr. Frue's reports many such alternations are recorded. He says that in the summer of 1872, 'the lode became broken up, being thoroughly mixed with diorite and wedges of plumbago, and in the fall, the mine assumed anything but a flattering appearance.' Mr. Frue further writes on this subject as follows: 'In the following winter it suddenly changed in character and produced, up to May 1st, 1873, 250 tons of rich packing ore worth about $1,500 to the ton. During May, and the early summer, the vein disappeared almost entirely, being broken up into strings and feeders. Later, however, there was a decided improvement which was again overshadowed by a passing cloud, and although in extending the drift north on the 40, a very promising show of silver had been opened, I had often seen the mine clothed in richer apparel than it appeared at the close of navigation.' (1873)." (C).

During the winter of 1873-4, severe storms did considerable damage to the cribwork protecting the Islet, amounting to over $11,000, besides carrying away the upper portion of the main breakwater and doing other damage. The unfavorable changes which occurred in the fall of 1873, continued up to the close of 1876." The new levels which had been opened up, the 8th and 9th, proved wholly unproductive, although no difficulty was experienced in following and working on the vein. A vast amount of exploratory work by means of the diamond drill, also failed to discover any deposits of rich ore. The consequence was of course great financial embarrassment and an almost entire cessation of work during the summer of 1877. In August of that year, work was resumed, and up to December, 23,850 oz. of silver obtained by stoping in the upper part of the mine. It was even proposed to remove the rich ground lying betwixt the mine and the lake, substituting for it an artificial arch, but fortunately, in the summer of last year" (1878), "a bunch of rich ore was struck beneath the 4th level S. of the shaft which in a few months yielded 721,632 oz. of silver, a quantity amply sufficient to rescue the mine from all its embarrassments and provide a reserve or working capital of $300,000" (C).

Mr. Lowe describes this period of the mine's existence as follows: Speaking of the first bonanza, he says it "extended for a distance of 100 feet on the hanging wall of the main vein, and for nearly a like distance

upon the same wall of the east vein. It varied from 6 inches to over 2 feet in width, finally disappearing below the 6th level. The silver did not crop out in the east vein, but was found in cross-cutting through the horse of diorite on the 1st level. It extended upward within 40 feet of the outcropping. It was completely worked out by 1874, yielding over $2,000,000 .....The shape of this bonanza was that of an irregular pear and throughout its extent in both veins it was accompanied with a strong impregnation of graphite which formed the selvage of both veins. The bulk of this bonanza was arborescent silver, more or less mixed with Macfarlanite, a rich ore of silver carrying 78 per cent. of that metal along with arsenic, cobalt and nickel. Its physical structure resembles niccolite....The years from 1874-8 were devoted entirely to exploring, and but little silver was mined." (D.) During this period the new inclined shaft was started from the 9th level, diagonally across the vein, and on the pitch of the same. "Previous to the sinking of this shaft, the diamond drill was extensively used in different parts of the mine....long holes were driven N. & S. on the 1st level. In one of them, silver was struck, but it proved to be only a small pocket. On this level, 400 feet holes were driven E. and W. for parallel veins; 40 feet west a small vein was struck," (D.) but subsequent testing by cross-cut and drifting showed no silver. "On the 3rd level, S., another series of holes was driven, and one of them, which was subsequently proved, skirted along within a few inches of the second bonanza.....The small pocket of silver struck on the 1st level, S., was followed later on by a considerable streak of argentiferous pyrites, running 2,000 oz. per ton; lead with 800 oz. per ton, and native silver. This streak was cut near the junction of the two veins on the hanging wall in a cross-cut and extended down as far as the 2nd level.....The writer has since learned that another small bunch was struck S. of this point on the same level." (D). He further says in reference to the before mentioned second bonanza. "In drifting south on the 3rd level in August, 1878, strong impregnations of graphite were met on the hanging wall which were soon followed by the second bonanza. This deposit of silver was remarkable for its great width, 5 feet solid across the breast, and the occurrence in great quantity of two hitherto unknown compounds of silver, namely, Animikite and Huntilite. The shape of this bonanza was that of an inverted cone with a base of about 50 feet on the 3rd level with the apex down as far as the 5th level. This deposit was phenomenal in its structure and a winze in the middle of the deposit to the 4th level, sixty feet, was sunk literally through native silver, the metal standing out boldly from the four walls of the winze. In the breast of the drift it stood out in great arborescent masses in the

First bonanza.

Period of adversity.

Second bonanza

shape of hooks and spikes, in gnarled, drawn out and twisted bunches, followed by arborescent silver with intercalated bands of Animikite and Huntilite. This deposit was struck near the junction of the two veins and the whole extent of the bonanza was strongly saturated with graphite carrying a selvage of the same in the hanging wall three inches thick. The hanging wall was as smooth and as polished as a mirror, with horizontal striæ.... The width of the vein was over 10 feet, and the entire deposit, including the stamp rock, yielded about 800,000 oz. of silver. An interesting fact connected with this deposit was noticed in the manner in which the arborescent silver was disseminated throughout the whole width of the vein, and in the concentrated parts and the manner in which it was impregnated through a series of horizontal floors in the vein. These floors did not break or separate the deposit. This deposit paid off the bonded indebtedness, leaving a surplus of $300,000, which, however, was expended, along with six assessments, in the construction of the new shaft to the surface, and sinking of the same 500 feet below the 9th level, in driving five levels N. and S. from the same, equipping it with new pumping machinery, developments in the upper parts of the mine and two years' work on Burnt Island and the mainland." (D.)

"Floors" in vein.

Yield of mine.

Mr. Macfarlane's description continues :—"I have not found it possible to ascertain the amount of the product year by year subsequent to 1875, but according to information received from C. A. Trowbridge, Esq., Secretary of the *Silver Islet Co.*, there have been extracted since the commencement of operations in September, 1870, and up to the close of navigation in 1878, 2,174,499 ½ozs. refined silver with a value of $2,921,727.24. If to this we add the value of the ore obtained immediately after the discovery by the *Montreal Mining Co.*, we have a total yield of $2,948,019.81" (C.) He further adds that he had since learned from Mr. Trowbridge that the precise yield (up to the end of 1879) was $3,039,557.49 and continues "when visiting the mine in July, 1877, the vein appeared perfectly well defined on the 9th level, but nothing in the shape of ore was to be seen. The vein was said to possess the same character in the inclined shaft sunk 100 feet deeper than the level, and to a point about 640 feet from the surface. This shaft was filled with water at the time of my visit. The vein below this point has been tested by a drill hole 296 feet deep, in which traces of silver ore were detected. Even if we suppose this trace is the clue to another *bonanza*, the fact still remains that from the 6th level to the deepest working, a distance of 300 feet, the vein has been found to be unworthy of excavation, and this too in spite of the presence of diorite on both walls, a condition which, when the mine was first opened was supposed to ensure a remunerative vein" (C).

Barren stretch of vein.

The foregoing gives the history of this mine up to the end of the year 1879, as recorded by Mr. Macfarlane and others. Mr. Low's paper, from which I have taken the following items, brings it up to December, 1882:—

"On the 9th level a small bunch of silver was struck accompanied with graphite.....From 1878 to the present date" (December, 1882), "the mine has been passing through its second period of adversity, although in that time silver has been struck in various parts of the mine below the 9th level. The only important deposit met with was on the 13th level south. This was also accompanied with a graphite impregnation, but from its irregular and detached condition it did not augur well for a large deposit. It yielded about $30,000.....Gas and water were struck in considerable volume. The new inclined shaft is now down nearly 1,200 feet, with a strong, highly mineralised vein in the bottom, the vein being 9 feet in width" (D).

Second period of adversity.

Mr. R. Trethewey states that the mine had attained a depth of 1,230 feet before the cessation of operations. I have it on his authority that at 80 feet north on the bottom level, they had a good bunch of ore. He also tells me that the total yield of the mine from its commencement to its close in 1884, was about $3,250,000.

Total yield of mine.

Exploratory work was done on other parts of the vein which was traced inland for about a mile from the shore, making the length of the vein thus known, counting from the Islet, about 9,000 feet. In traversing this distance, it intersects many trap dykes which, however, do not seem to favorably affect it. Three shafts have been sunk to test it at various points along this inland portion, attaining the respective depths of 40 ft., 100 ft., and 60 ft., and a great deal of surface trenching has been done. This work did not, however, result in any discoveries of importance, but Capt. R. Trethewey told me that they had got some galena running 19 oz. of silver to the ton at Morgan Junction shaft (the furthest inland). He tells me they got no plumbago at any of these places. At the latter point, where the shaft is sunk at the intersection of the vein with a dyke of compact trap, I noticed in the dump a quantity of iron pyrites accompanied by a little copper pyrites in a vein stone consisting of argillite cemented together by calcite. The series of dykes crossed by the vein on the mainland differ in appearance from that on the Islet consisting as they do of dark compact trap, whilst the latter is much coarser grained and carries much iron pyrites. Besides the beforementioned shafts one was sunk on the vein where it crosses the dyke forming Burnt Island. These dykes are faulted by the vein and are, therefore, older than it. Mr. Lowe says that the diamond drill was also used extensively on Shangoinah Island and on Burnt Island.

Work done on vein on mainland.

Work on vein on islands.

Expenditure and returns

Mr. Curtis writing in February, 1877, sums up the history of the mine as follows :—"A capital of $73,000 paid a dividend of $160,000 the first year, besides paying about $200,000 towards settlement with the *Montreal Mining Co.*, and expending also a large amount of money to establish the plant. In the report for this year" (1877,) "we find that the total amount of dividends have been $622,666.66, and the total production $2,237,479.84. This great outlay was needed at the mine to establish a town on a barren rocky shore, to maintain a foothold on a little rock not 80 ft. square against the mighty storms of Lake Superior, to furnish steam-tugs, engines, pumps, and build a mill capable of concentrating over 75 tons of rock per day" (B).

Mr. Lowe states that more than $1,200,000 were expended in securing the Islet, also that the volume of water made by the Silver Islet vein per minute was about 170* gallons, its principal source being above the 9th level, and further that throughout the mine nearly 5,000 feet of holes were bored by the diamond drill.

Diamond drill holes.

Statistics.

The below given tables show the yield of the mine year by year, and are compiled from Mr. Macfarlane's paper above quoted and the other sources mentioned.

	Weight in Lbs.	Value per Ton. $ c.	Total Value. $ c.
Under Montreal Mining Co.	27,073⅜	1,646.80	23,115.35
" New Proprietors, 1870	155,543	1,175.80	92,153.23
" do 1871 (Newark)	183,453	1,507.64	138,291.88
" do 1871 (Wyandotte)	778,468½	1,296.48	504,640.13
Lost on propeller "Coburn"	10,000	1,040.00	5,200.00
	1,154,537⅞	$1,322.44	$763,400.59

Season 1872	310,744.02 ozs.		
" 1873	289,763.77 "		
" 1874	250,021.75 "		
" 1875	145,902.50 "		
	996,432.04 "	=	$1,195,718.45
Carried forward			$1,959,119.04

* Mr. Richard Trethewey says 155 gallons per minute is the correct figure.

Brought forward		$1,959,119.04
Produced by stamp mill, Dec. 1875, to Nov., 1876 (concentrates)	136,529.00 ozs.	163,835.00
Produced by stoping in upper part of the mine, 1877	23,850.00 "	28,620.00
Produced from second *bonanza*, 1878	721,632.00 "	865,958.00
Produced from deposit at 960 ft. level, about 1882. (Mentioned in Mr. Lowe's paper.)		30,000.00
Total of amounts mentioned in various accounts of the mine as above		$3,047,532.04
Amount unaccounted for above		202,467.96
		3,250,000.00
Total value of silver produced from the commencement to the close of operations, according to Mr. Richard Trethewey		$3,250,000.00

This discrepancy of $202,467.96 is not necessarily due to an actual disagreement of the different authorities, but probably represents the results of the treatment of mill rock taken out from various parts of the mine which had been neglected during its palmier days, and to which attention was turned after the mill was built and the rich ore bodies were worked out.

The last authentic statement regarding the mine is found in the official report of Mr. Richard Trethewey, dated January 20, 1884, to the President of the Company, where he says "The work at the mine during the past year has been devoted to the sinking of the shaft to the 1,160 feet level, drifting the same north and south of the shaft, sinking two winzes below the 1,160 feet level, and back stoping at encouraging points in some of the upper levels.....These drifts" (from the 1,160 feet level) "have been extended southward 227 feet and northward 81 feet. The vein, though well defined and carrying quantities of minerals, has not produced the expected amount of silver. A deposit of silver was opened into during the summer, near the end of the north drift, but proved to be small in extent. At this point and in this run of ground a winze is being sunk towards the 1,260 feet level, hoping that in its course other bunches may be found. A winze has also been commenced towards the 1,260 feet level, near the end of the south drift in the same run of ground in which silver has been found above. In the levels where back stoping has been carried on, the vein, although of a very encouraging nature, yielding minerals which are always found accompanying silver, has not produced silver in paying quantity; still it will be remembered that heretofore we have worked for long

Latest developments.

periods in ground such as described and finally been rewarded by encountering rich deposits, and there is no reason why we should not expect similar results again." He continues thus: "Ere long we shall find ourselves placed in a serious dilemma owing to the non-arrival of our winter supply of coal last fall—a vessel with a cargo of nearly 1,000 tons having failed to reach here, being laid up while *en route*. The present supply of coal is sufficient to run with until about March 1st, after which we shall find it extremely difficult to carry on the work." Operations were accordingly suspended early in the spring of 1884.

Closing of mine

Description of illustrations.

Plate I shows the underground workings of the mine on the west or main vein. I have not been able to obtain a section showing the same for the eastern branch above its junction with the main vein at the fourth level, but Mr. John Trethewey tells me it was mostly stoped out from the fourth level to surface, being worked by cross-cuts from the main vein from which levels were driven on it. The tracing from which the illustration was taken was apparently not kept quite up to date, for some of the measurements given me by the manager do not quite coincide with those of the tracing; these differences, however, are trifling and do not affect the utility of the drawing as an illustration of the direction and extent of the underground development made upon this famous vein.

Stamp mill.

During the first few years whilst the very rich ore of the first deposit was being worked out which had only to be barrelled up and sent to the smelter, the poorer mill rock was neglected, and it was only when the period of adversity was experienced, that attention was paid to it, and a stamp mill erected on the mainland at a cost of about $100,000 to treat it. This work was carried out in the winter of 1873-4.

The machinery used consisted of 50 head of stamps, 24 Frue vanners (an improved form invented by Captain Frue of the old Brunton frame) and two No. 4 Blake crushers with the necessary hoisting gear, water tanks, etc., and a 250 horse-power engine to supply the necessary power. The ore as it came out of the mine was dumped by the self-dumping skip into cars and brought thence to the mainland on a scow towed by a tug. These were then hauled up an incline to the mill where the ore being dumped and fed into the Blake crushers, passed from them to the stamps. The battery slimes passed directly to the Frue vanners, which were arranged in two sets, one below the other, the upper or head tables and the lower or clean-up tables. The tailings from the former passed to the latter, and were there further concentrated, the heads or concentrates being barrelled up and sent to the smelter. The heads from the lower set were passed over to extra clean up tables to be further concentrated. The mill had a capacity of

about 60 tons per day, producing from 1 to 2 tons of wet concentrates, holding about 14 per cent. of moisture, at an average cost, according to Mr. Low, of $1.70 per ton. The concentrates varied in their value from $300 to about $10,000 per ton, but averaged between $500 and $1,500. Mr. Lowe states that the tailings averaged about $2 per ton, and that the mill saved 90½ per cent. of the silver in the ore. The rock put through ran from 6 to 37 oz. per ton.

Cost of milling.

To Mr. Richard Trethewey I am indebted for the following items regarding cost of production calculated per ton of rock milled :—*

Mining	$2.50 (to $3.00)
Sorting	50
Labour and tug expenses, transporting rock from mine to mill	50
Crushing, stamping and dressing	2.00
Total	$5.50

Smelting of ore, etc.

In the early period of the existence of the mine there seems to have been considerable difficulty in making satisfactory arrangements for the sale of the ore. The assays made of some of the first lots by different assayers varied greatly, and furthermore, the smelting charges were very high. "Both at Newark and Wyandotte, the smelters only guaranteed to return 95 per cent. of the silver contents and charged $100 per ton for smelting," says Mr. Macfarlane, and the smelters naturally refused to account for more silver than was shown by their own assay. These discrepancies no doubt arose from the natural difficulty of getting uniform samples from so very rich an ore, and one containing so much metallic silver.

Wyandotte smelting works

In consequence of this, the Company determined to erect smelting works of their own, and this was accordingly done and smelting was commenced at the Wyandotte works by July 1st, 1871. Of these works Mr. W. M. Courtis, in a paper read before the American Institute of Mining Engineers, Oct. 1873, says "The intention was to work Western ores with those from Lake Superior, since the latter contain but a small amount of lead. Hence the capacity of the works is much larger than is needed for the present yield of the mine. The planned process for treatment was, smelting with lead ores, desilverizing the lead by Balbach's process with zinc, cupelling the rich lead and refining the crude silver. Since the supply of Western ores was uncertain, and prices and freights were high, a sufficient supply could not be obtained; and hitherto the works have been in operation but a few months each year.

* For further details see Appendix B.

Yet they have produced a very large amount of silver—931,203 oz. in fine silver up to Sept. 1st, 1873. The process has been smelting for rich lead at once and cupelling and refining the bullion. In addition has come: treatment of the matte to save the nickel; refining the nickel matte; extracting the silver from the marketable nickel speiss, and treatment of the refuse too poor for smelting."

Other veins of Coast Group.

I have gone somewhat fully into the history of the Silver Islet mine, as it was the chief and typical mine of the district. In order to show how far the rest of the veins of the group under consideration have been tested as to their value, I have added below all the data obtainable, either from personal observation or otherwise, regarding the developments made on the other veins of this group and referring to their conditions of occurrence.

Angus Islands.

About ten years ago, a vertical shaft is said to have been sunk on one of the islands, and a drift run out from it to intersect the vein which could be seen outcropping under water near the shore. No success seems to have attended this effort.

McKellar's Island.

This vein was discovered in 1869 by the Messrs. McKellar Brothers, and some years afterwards the test work was done, shown in the accompanying drawing of the mine. (See Plate II, Figure 2).

Vein characteristics.

It is very large, consisting of coarsely crystallised, calcite and barite, occurring in separate ribs for the most part, although they are mixed in parts of the vein. With these preponderating minerals there is a smaller proportion of quartz, generally colourless. The metallic minerals consist of zinc-blende with a little galena and pyrites which are for the most part concentrated in dark coloured bands in the main vein, of which bands there are two on the north side and one on the south side of the island. A sample of one of these streaks assayed—gold, none; silver, about ¼ oz. whilst another from a different place in the same gave neither gold nor silver, showing that the dark coloration was not due to finely disseminated argentite or agentiferous blende. (See Report of Progress, Geological Survey of Canada, 1886, part T, assays 33 & 34.)

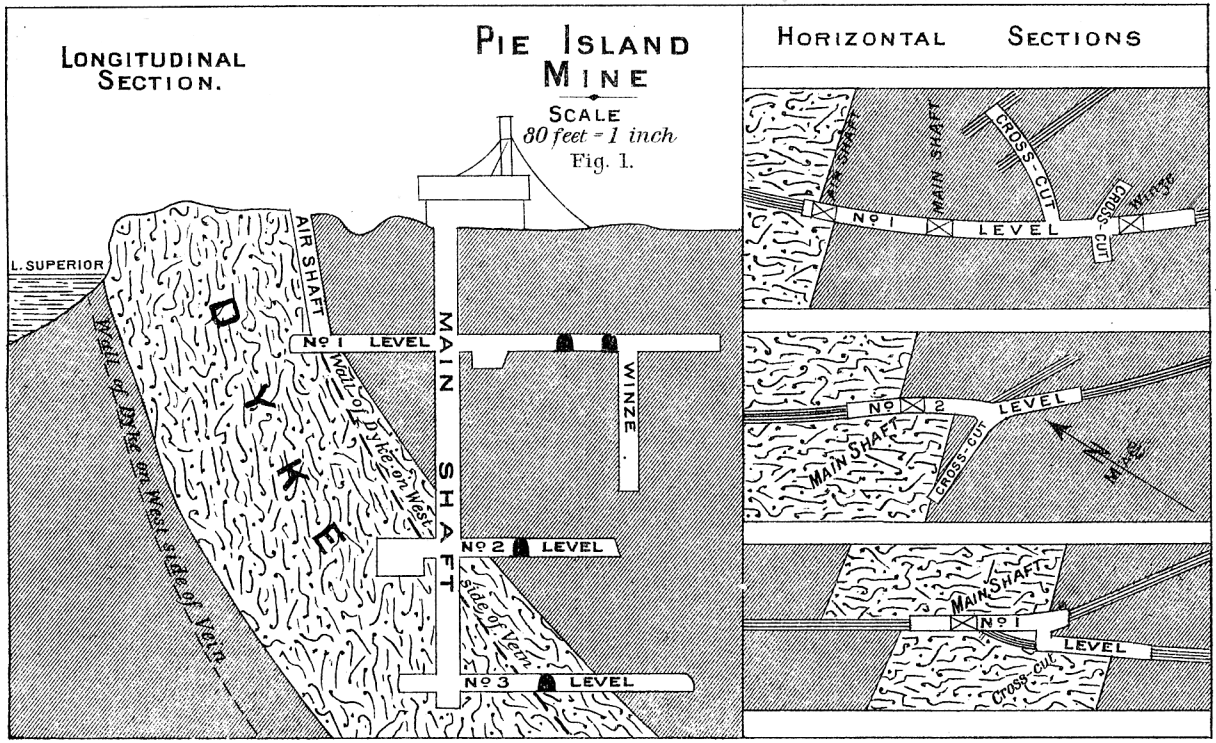
Assays.

Side branches.

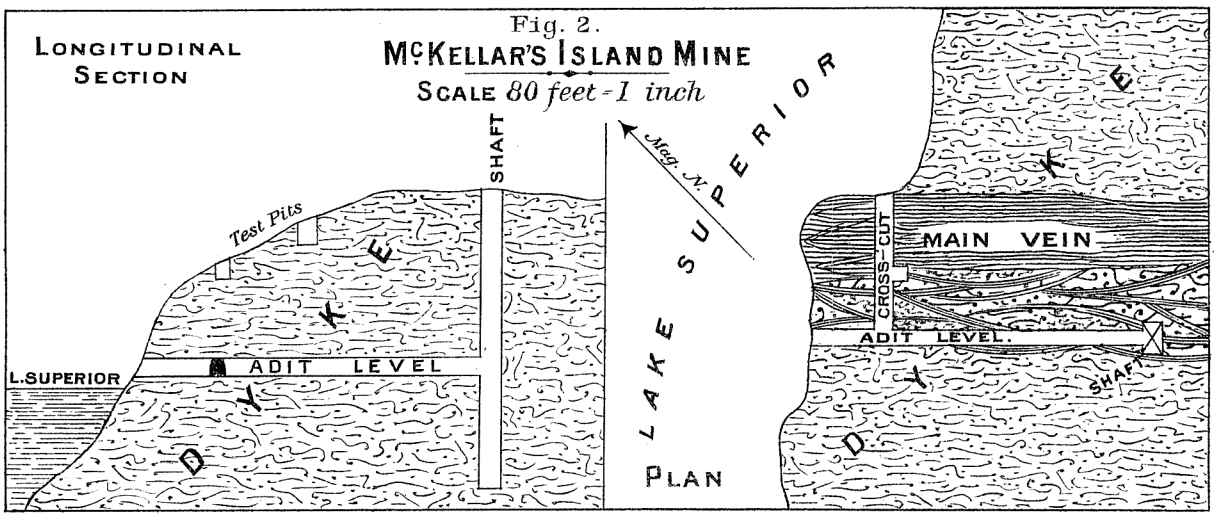
Besides this main vein which is composed of solid spar, and is about 60 feet wide on the south side of the island there are numerous side stringers intersecting the country rock of the west wall of the vein, and on these the developments have been mostly made as shown in the accompanying illustration.

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

Plate II.



From published Reports, Maps, and data supplied by Mr. P. McKellar.



From Sketch survey made by E. D. Ingall, M. E.

Desbarats, Lith.

EXPLANATION.

Trap. Argillite. Cross-cuts.

The enclosing rock is a dark green, coarse grained trap. This composes the whole island which is only some eight or nine chains in diameter, and is evidently part of the outcrop of a dyke which appears further west in Thompson's Island. A little altered argillite appears on the south side of the island still clinging to the dyke. Enclosing rocks.

According to Mr. P. McKellar, argentiferous blende was the chief silver bearing ore of the vein. The developments done so far have evidently not opened up any very large body of ore.

During the summer of 1886, the barite rib on the east side of the vein has been worked down from surface, some thirty men being employed at this work, and the product after handpicking to extract as much of the calcite and quartz as possible, was being shipped to the United States, the buying firm giving $5 per ton *over the rail* at the island for the best quality. Worked for barite.

Thompson's Island.

This island consists for the most part of trap in the form of dykes running lengthways through it with a small development of the argillites between the two forming the two points at its western extremity. The backbone of the island is constituted by the dyke which forms its eastern extremity, and which is evidently the same as that forming McKellar's island, which it resembles in appearance, being a dark green trappean rock of rather coarse texture. Enclosing rocks.

It was located in 1853 by Mr. T. Macfarlane for the Montreal Mining Co. A small amount of exploration was done in 1873 and in the winter of 1873-4, when some development work was done to test a vein crossing the island at its eastern extremity in a north-westerly direction. It consisted, as far as I was able to see, of an adit level run in on the vein, where it shows in the face of the cliff forming the north shore of the island, for a distance of about 25 feet, from the end of which a nine feet winze has been sunk on the vein, which here consists of an aggregate of stringers and branches of various sizes, covering a width of about four feet. The gangue consists mostly of barite with some calcite and white and amethystine quartz. It carries a small amount of the usual metallic minerals, viz., blende, galena and pyrites. Other veins occur, crossing the island in a north-westerly direction of a very similar nature to the last, and where seen, are all enclosed in trap. Work done. Vein characteristics.

Spar Island.

This island is part of the old Prince location, and was one of the first worked properties on the lake, operations having been carried on there in the years 1846 and 1849.

Rocks of island

It consists, like the others, of a group of trap dykes with argillites, between, which latter rocks attain their largest development at the east end of the island, where they are to be seen forming a cliff about 200 feet in height, and are capped with a thin sheet of columnar trap. They are cut at this place by several dykes running lengthways of the island. Passing along the south shore of the island the same geologic conditions are observable, except that for some distance the argillites are seen to be associated with intrusive sheets of trap. This is visible for some distance along the south shore at one place where in cliffs some 30 to 40 feet high are to be seen three such sheets. That they are intrusive sheets is shown by the fact that they are frequently lenticular and curve up the beds above them out of their plane of bedding, the under side of the trap sheet lying flat on the beds below it. At one place this was found to be the cause of a very sudden change of dip of the argillites from a flat angle to the eastwards to a dip of about 45° westwards. Again, where the covering argillite has been recently denuded away, the remarkably smooth upper surface of the trap sheet further attests to the correctness of this view, these surfaces in no way resembling those polished and grooved by ice which also occur in this region.

Intrusive trap sheets.

Enclosing rocks of vein.

A plan, etc., of the western point of the island where the developments have been made is given in Plate III. Here there are as shown two dykes of trap separated by argillaceous beds and accompanied by an intrusive sheet of trap, on which is left a slight thickness of the argillite originally covering it. The main dyke consists of a medium grained trap whose color is lightened by the presence of white feldspar occurring radiately crystallised, the interspaces being filled out with a dark green mineral, probably hornblende. The smaller dyke "B" is a dark green crystalline trap carrying a quantity of pyrites much more compact than the other, and weathering with a comparatively smooth reddish brown surface in contrast with the gray aspect of the weathered surfaces of the main dyke, which can be seen to be due to the kaolinisation of the felspar. The trap sheet in general appearance and fracture closely resembles dyke "B," and also carries pyrites.

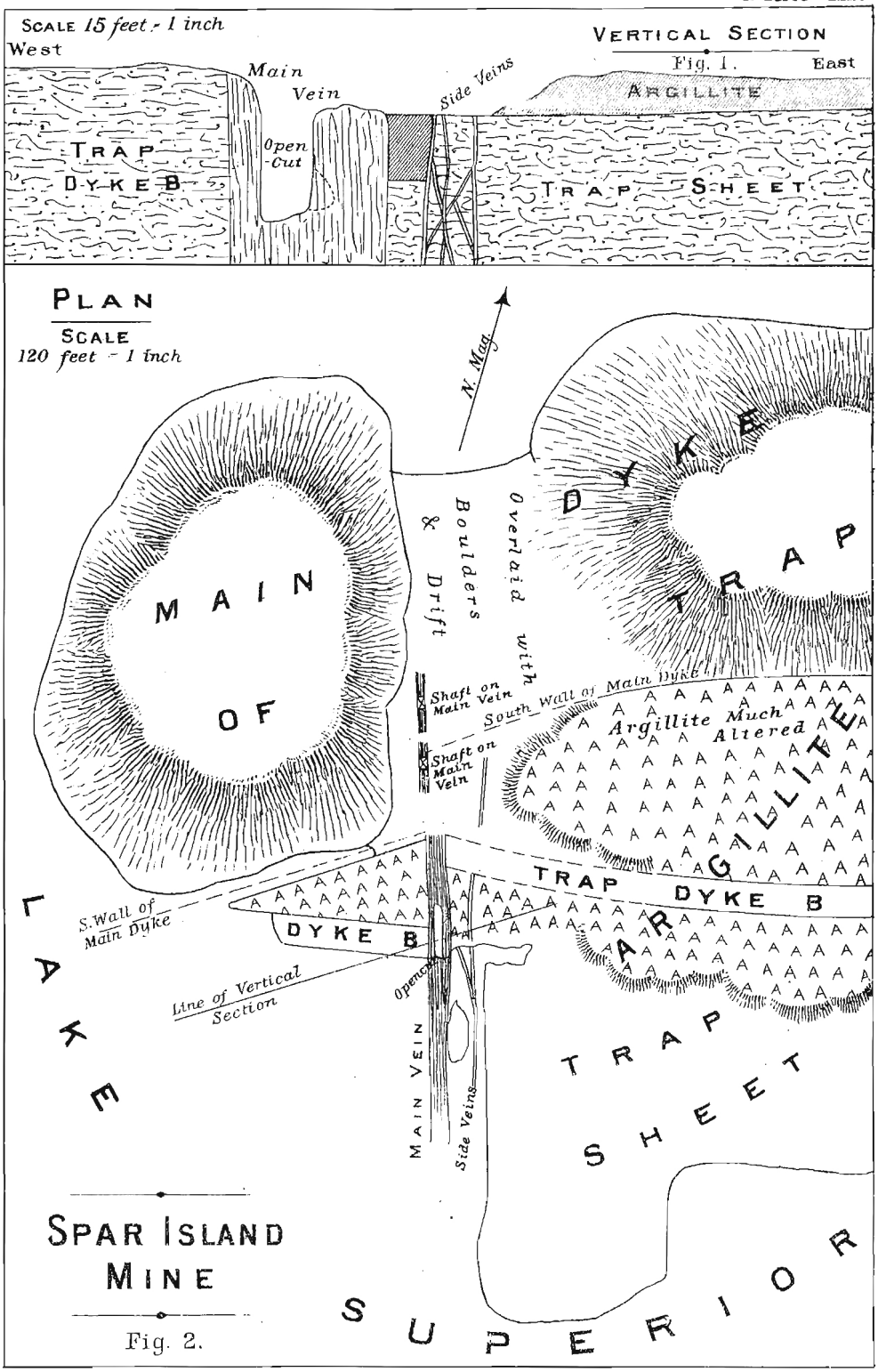
Trap dykes and sheets.

The argillites are of a dark gray color and lie nearly flat. They turn upwards as they approach the main dyke and are much altered. When within about twenty feet of it their bedding becomes obliterated and they take on a confused structure like false bedding, whilst on the fracture they resemble a fine-grained red trap. A similar altered argillite is described later as occurring at Jarvis Island.

Altered argillites.

Veins.

There are several veins visible on the shores of the island running across it in about a north-westerly direction. They show occasionally



From Sketch survey made by E. D. INGALL, M. E.

a little of the usual metallic minerals, blende and galena in a gangue of barite, calcite and quartz. The vein at the western end of the island shown in Plate III, is the only one on which any work has been done. The main vein with which are associated a few side branches is large and filled with a solid gangue of coarsely crystallised barite and calcite, the metallic minerals being represented by copper glance, copper pyrites, zinc blende and a little argentite, which occur for the most part disseminated through about six inches of gangue along either side of a six inch rib of pink barite occurring in the middle of the vein. This fissure has faulted the enclosing rocks about sixty-five feet horizontally. In the Geology of Canada, page 708, it is stated that the two shafts (shown on Plate III) are respectively 24 and 47 feet deep, so that the developments made have apparently not been extensive. It is said that besides the copper minerals found here some rich specimens of silver ore were obtained. Main vein.

Jarvis Island.

This vein was discovered in 1868. It runs across the island in a north-westerly direction and dips N. E. at 50° to 55°, contrasting thus with the nearly vertical dips of the veins of the other islands. In the summer of 1869 Mr. Macfarlane sunk a twelve feet shaft on the vein, "in accomplishing which work the following ore was produced:— History of developments.

79 lbs. first quality ore containing 3.45 per cent. of silver = 39.70 oz. at $1.25	$49.62
2,483 lbs. second quality ore containing 0.15 per cent. of silver=54.18 oz. at $1.25	67.72
Total.....	$117.34" (C).

In 1870 this shaft was sunk twenty feet deeper. In 1871 the *Ontario Mineral Lands Company* had a small party working on the lode during the months of June and July, when they sold it for $150,000 to an English company, under whose *regime* quite a considerable amount of work was prosecuted in the way of drifting, sinking winzes, &c. Three shafts were also sunk, of the respective depths of 160, 31 and 78 feet, and some stoping done. Besides this, the necessary surface work, erection of houses, etc., was accomplished, and considerable explorations made on the mainland portion of the property, which latter did not, however, lead to any results. These operations were conducted during the years 1871-2, and were suspended late in the latter year owing to unforeseen financial troubles. In the spring of 1886 the company which had prosecuted this work again commenced operations, and have been working ever since.

Their operations have been chiefly confined to sinking the main shaft and drifting from it. Mr. John Trethewey, who was in charge of the underground department at the time of my visit, was drifting south to get to the contact of the argillites and the dyke, as that was the position in which the ore had always been found at *Silver Islet*. I am now informed that, having been unsuccessful to the south, they are drifting north to get into the argillites upon the other side of the dyke, and that the superintendent, Mr. Arthur McEwan, says that the vein is looking well.

Enclosing rocks

The distribution of the enclosing rocks is shown in Plate IV. Here, as at Spar Island, the vein crosses two trap dykes with argillites in between, which lie nearly flat, but turn down and become much altered on approaching the more northerly dyke, as they do under similar conditions mentioned in speaking of Spar Island. A description of the microscopic characteristics of this rock is to be found in Appendix I., Specimen No. 127. Near the southern dyke the argillites are turned upwards, but there is little or no alteration. The most northerly dyke shows two varieties, the one a rather coarse grained rock, in which the hornblendic mineral, being mixed with white felspar, gives it a greenish-gray appearance; whilst the felspar of the other, being red, gives a redder color to the rock. A description of the microscopical characters of this rock will be found in Appendix I., Specimens Nos. 113 and 128. The vein on which this work has been done is somewhat similar to the two last described, the gangue being made up of the same minerals. It is from ten to fifteen feet thick, and the different minerals are arranged in bands more or less parallel with the strike of the vein. I notice the following succession at one point on the outcrop of the vein, in going from west to east across it:—

Vein characteristics.

1st. About four feet of largely crystallized calcite, with thin seamings of quartz throughout, occurring mostly between the crystals and along their cleavage planes.

2nd. A two foot band in which the calcite still preponderates, but with a large admixture of barite and a small per-centage of quartz seams as before.

3rd. About six feet consisting almost entirely of barite, with only a few inclusions of calcite.

The same banded structure is visible in the main shaft, where there is, however, a good deal of decomposed rock enclosed, and slickensided walls would indicate fissuring and movement subsequent to filling. Although silver ore has been found from time to time in the vein, the bodies have apparently been so far of limited extent.

The other metallic minerals, as elsewhere, occur concentrated in spots in the vein, and occasionally carry a little silver, as evidenced in the assay of a specimen which came from the lower drift whilst I was there. (See Report of Progress, 1887, Part T, Assay No. 34). It contained about 2 per cent. of blende and galena, with a little pyrrhotite, and gave: Gold, none; silver, 0·35 of an ounce to the ton of 2,000 lbs. An assay of some of the pyrites from this vein showed it to contain neither gold nor silver. (See Report of Progress, 1886, Part T, Assay No. 20). This vein is somewhat analogous to the Silver Islet vein in carrying carbonaceous matter, which shows as a black seam on the hanging wall. Assays.

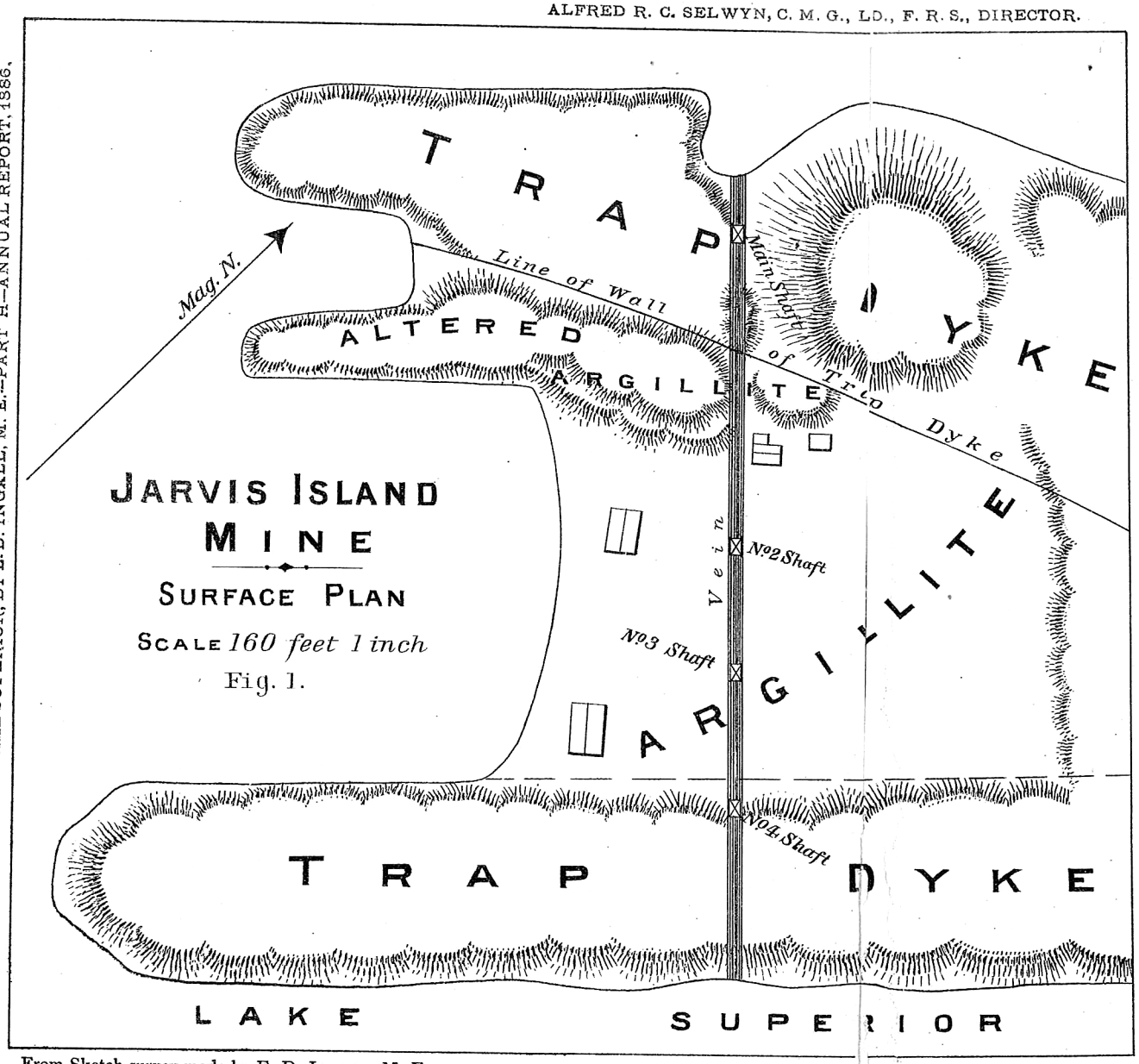
Victoria Island and McKellar's Point.

Passing westwards along the band of dykes forming the "Macfarlane Belt," we come to Victoria Island. This is similar to the rest, having several dykes of trap running through its length, with intermediate argillites, which latter however, here compose a much larger proportion of the island than is the case with those just mentioned. The developments made are situate at its western extremity, where a vein of the usual type, of barite and calcite, running in a north-westerly direction, has been tested by surface work and by two test pits to a depth of thirty feet. Some tunnelling was also done on another vein. It is said that about $5,000 were expended on this island. Geological structure. Veins.

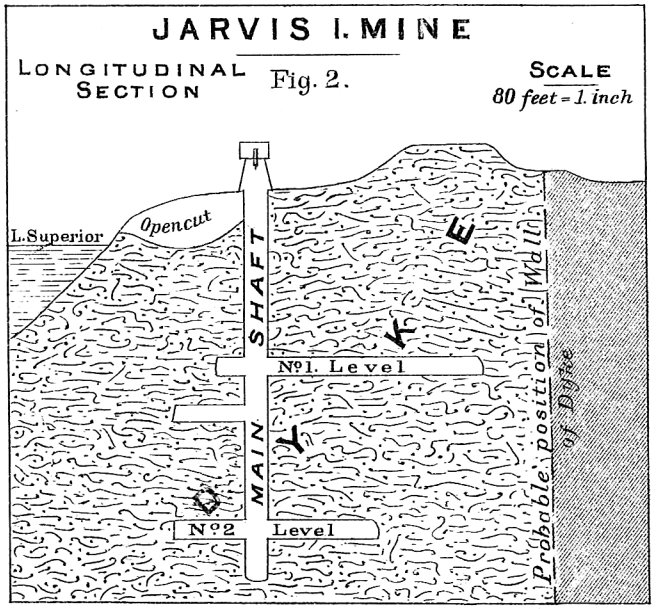
At this end of the island there is a large development of a red syenitic rock. Whether this is a product of the alteration of the argillites by the intrusive rocks of the dykes, or what is the precise nature of the causes which originated this rock, must be left in abeyance for closer study, both on the ground and with the aid of the microscope. Red syenitic rock.

On the further extension westward of this belt, at the extremity of McKellar's Point, very similar conditions are found. Here also there is a large development of the red syenitic rock in connection with trap dykes of the usual basic nature and dark appearance. The syenitic rock varies in different places from a highly crystallized, rather coarse-grained red rock, showing distinctly to the eye the red felspar associated with the green, apparently hornblendic, mineral, while in other places, whilst presenting the same general color and appearance as the typical syenite, it is much finer grained, and has more the appearance of a clastic rock which has been somewhat metamorphosed. Here also nothing can be definitely said of the origin of these rocks without further work being done.* This syenitic rock has a distinctly McKellar's Point.

* See Appendix, Specimen No. 85.



From Sketch survey made by E. D. INGALL, M. E.



From data supplied by Mr. J. TRETHEWEY, 15th Aug., 1886.

EXPLANATION.

TRAP.

ARGILLITE.

bedded appearance at this point, showing a dip to the east at about 15°. Another curious feature here presented, and which is noticeable also in the rock at the west end of Victoria Island, consists in the occurrence of inclusions, which have the appearance of bent and twisted pieces of argillite which have been metamorphosed.

These rocks only occur at the extremity of the point, the rest of which consists of a regular tangle of dykes of trap of the ordinary nature, with argillites included between them, the whole forming a prominent rocky ridge running back towards the mainland. Numerous veins of the usual nature cross the point in a more or less north-westerly direction. They carry a little of the ordinary metallic minerals of the district in a gangue of barite and calcite, with some colorless and amethystine quartz. A little work has been done on some of them, notably on one on the north side of the point, on which an 80 foot tunnel has been run in and a shaft about 30 feet deep sunk.

Veins on McKellar's Point.

Coast Section.

Red syenitic rock at Little Trout Bay.

The north shore of Little Trout Bay presents very similar phenomena to those just mentioned. Here we find quite a large development of this red rock, which at this point, however, has a much more distinctly syenitic composition and appearance, in marked contrast to the general appearance, structure and mineral nature of the other igneous rocks of this formation. It lies apparently in beds, interstratified with the usual sedimentary rocks. Several of these occur here, with varying thicknesses of argillite between, which latter in places thins out so as to leave two syenitic beds in direct contact, the plane of division between the two being, however, still quite distinct.

Examined by eye, this red rock seems to consist largely of red felspar, with which a green mineral is intermixed, probably hornblende or an alteration product of that mineral. It is for the most part moderately coarse-grained, and in places is porphyritic from the presence of large felspar crystals distributed throughout the rock and occurring occasionally in large nests or aggregates in a dark hornblendic base. Dykes of the ordinary dark-green basic traps cut these beds in places.

Intrusive trap sheets at Caldwell Pt,

On the eastern side of Caldwell Point occurs a little bay whose northern shores consist of cliffs about thirty feet high, coming down vertically into the water and which present a very good section, showing intrusive trap sheets in the flat lying argillities occurring similarly to those noticed at Spar Island. They show the same features, viz :—Flat under and arched upper surfaces closely conforming to the bedding planes of the enclosing argillities. Two distinct sheets are distinguishable,

the upper one at one place having protruded a tongue from its lower surface and lifted a part of the sedimentary rock on which it lies, which is now visible as a thin sheet of shale, projecting upwards into the mass of the trap and making an angle of about 19°, with a horizontal bedding of the rest of the beds. Passing eastwards along the section, the upper surface of this upper trap sheet is seen to curve downwards to the water level, and at its eastern end to be overlaid by the argillites resting on its remarkably flat, smooth upper surface, which here shows the end view of the columnar structure of the sheet. Another trap sheet is seen to overlie these argillaceous beds about fifty feet above this point. A vertical trap dyke about the middle of the section cuts the horizontal traps, &c., causing a displacement of a few feet, thus being evidently younger than them. Other displacements have also occurred causing a slight difference of level of different parts of the beds.

Different ages of trap dykes, sheets, etc.

At the extremity of the same point the surface of a similar trap sheet shows slightly above water, and is intersected by a small dyke of trap closely resembling it, but which, judging from its well defined walls, is evidently younger. Similar evidences of differences of age are occasionally observable with the dykes, notably at one point, on the shore about north of McKellar's Point where a larger dyke is cut by a smaller one, running on about the same course. The former consists of moderately fine grained greenish gray trap, showing distinctly the radiately arranged felspar crystals upon the weathered surface and decomposing into a loose granular mass, whilst the smaller and younger dyke has a much more compact structure, rendering the separate minerals indistinguishable, and weathers to a smooth, uniform, rusty-red surface.

Rocks of coast section N. from Caldwell Pt.

Passing northwards from this point the rocks are well exposed in a series of hills, with cliff faces, running parallel to and close to the coast. These vary from 200 to 400 ft. in height, and consist of the sedimentary beds of the series capped by coarse trap, giving them the table-topped appearance so characteristic of the district. The trap shows a thickness of from 50 to 100 ft, and has a very characteristic vertically columnar structure. This rock also appears in the shape of numerous dykes, cutting the sedimentary beds, and forming nearly all the points along the coast, owing to their superior power of resisting denudation agencies. These dykes consist for the most part of dark colored compact trap, and have often, a columnar structure at right angles to their walls. They are often left standing up like walls, and although they are frequently visible running up to the sheets of traps capping the hills, it could not be positively said in any instance whether they cut through them or not, and although in several cases they appeared

Traps.

to do so as viewed from the water, it was either found impossible to reach the spot at which this might have been proved, or when reached, the covering on the rocks prevented the necessary observations from being made. A good instance of this is observable on the north side of Turtle Point a little west of its extremity where a dyke of a very compact trap, and with a marked columnar structure, normal to its walls, rises out of the water as a perpendicular cliff, owing to the removal of all the argillite originally enclosing it on the lake side. This dyke is seen to extend as high as the top of the trap sheet capping the argillites on its inner side, and seems to retain its horizontal columnar structure to the top, even where in contact with the vertical columns of the horizontal trap.

Effects of trap dykes on sedimentary beds.

These dykes, curiously enough, have in nearly every case altered adjacent rocks very slightly or not at all, and in most instances the impress of the bedding of the argillities can be seen on the sides of the dyke where they have been stripped bare. Occasionally the argillite may be porcelanized for a distance of one or two inches away from the dyke, but this is the exception, and an instance was never encountered where a crystalline structure was induced in them. This contrasts strongly with the large amount of alteration observable near the Jarvis Island and Spar Island dykes already mentioned, and which was also observed near the dyke forming the western point at the entrance of Cloud Bay, where red felspar crystals were noticed to occur in the argillite, immediately adjacent to the dyke. This absence of alteration is also noticeable with regard to the contact of the horizontal sheets of trap where there is occasionally a slight amount of induration of the underlying sedimentary beds, a few inches below the junction, but generally there is no appreciable effect of this sort. The line of division between the two rocks, both in this district, and where studied elsewhere in the formation is generally quite distinct, and where the softer underlying shales, etc., have been removed by weathering, which is very frequently the case, the lower surface of the trap is presented as a smooth overhanging plane. Occasionally, where not assisted by this weathering effect, there is a little difficulty in locating the exact plane of the junction which is rendered more difficult sometimes by the frequently very fine grain of the trap close to the contact and its close resemblance to the colour and grain of the fracture of some of the underlying sedimentary beds. As a rule the thicker trap sheets found capping the hills get coarser in grain towards the top, but with the less extensive and thinner beds occurring at other horizons, no such effect is noticeable, and neither these latter nor the dykes show that coarser grain towards their centre which one would expect.

Effects of trap sheets on sedimentary beds.

Varying texture of traps

As a rule, the trap in both these last instances is a much finer grained, darker colored and more compact rock than the first-mentioned.

The sedimentary beds of the coast section consist of what may generally be termed argillites, although, from the preponderance of silica, they merge in some places into sandstone and in others take on more the nature of dolomites or limestone, from the large development of carbonates. They vary in color from a dark to a light bluish-grey, and in structure they vary also from flags to shales, according to the extent to which the bedded structure is present. Other noticeable features are the occasional presence of a little mica along the bedding planes and a confused ropy structure of the surface of some of the beds, resembling somewhat ripple-mark in some instances, whilst in others it gives one more the impression of the surface which would result from the flow of a viscous mass or thick mud beneath a surface skin. Sedimentary deposits.

Wherever developed, the jointing shows two sets of planes, one bearing between east-north-east and north east and dipping from 65° to 85° southwards; the other bearing about north-north-west and dipping from 80° to 85° westwards. It is noticeable that these two strike directions closely correspond with the two main systems of fissures in this vicinity—the north-easterly dyke and the north-westerly vein systems. Jointing of same.

These sedimentary beds all along the coast are found lying comparatively flat, and although locally they dip slightly, and these dips are at times in somewhat contradictory directions, yet they may possibly have a general dip in a southerly direction of a few degrees. The difficulty of determining the general dip of the whole formation is enhanced by the existence of numerous shallow synclinals and anticlinals and shallow basins in the beds, and by the local disturbances and contortions due to faults and dykes, although the latter only produce these effects occasionally. Dip of formation.

Several veins have been located along this Coast Section, and a little work done at the following places:—

Stewart's Location (Near Pigeon River).

This is one of the tracts of land originally taken up by the *Montreal Mining Company* in 1846, and is now owned by the *Ontario Mineral Lands Company*. In 1868 a small party of men explored there for about a month without result. Later on, the *Silver Islet Company* had a party working for about a year on several north and south veins carrying copper glance. Coast group of veins continued.

Pine Bay.

Coast group of veins continued.

A little has been done here on a N. N. W. vein carrying argentiferous galena, but the proportion of silver was not large.

Big Trout Bay.

Near the inner end of this bay some test work has been done on a vein running in a north-westerly direction, and dipping to the north-east at an angle of 70° to 75°. It is about twelve inches thick, and has definite walls where seen in the workings. It cuts a hill about 300 feet high of argillites, capped, as usual, with trap, and intersected by dykes of the same rock. The work done is near the top of the hill, and shows a vein which, in the usual gangue of coarsely crystallized calcite and barite with a little amethystine quartz, carries iron pyrites and shows indications of copper in the shape of occasional malachite stains. Around the workings the country rock is entirely trap, which carries a large percentage of pyrites adjacent to the vein. A piece of this was selected for assay to see whether the pyrites carried the precious metals, which proved not to be the case. (See Part T, Annual Report Geological Survey, 1886, Assay No. 17).

The work done consists of some stripping on the back of the vein, and two tunnels, each about 50 feet in length, one 30 feet below the other, run on the course of the vein. It was done in the years 1882-83, and some $1,500 were spent on these developments.

Cloud Lake.

Here argentite and native silver are said to occur in a vein with blende and galena in quartz. An adit 200 to 300 feet long was driven into the side of the hill to cross-cut the vein, but did not succeed in finding it, as it had apparently split up. The surface explorations traced the vein for about a quarter of a mile, in which a good show of silver is said to have been seen. The expenditure on this work probably amounted to about $25,000. This vein was supposed to be the continuation of the last-mentioned one, but as the distance between the two points is about five miles, this is rather a gratuitous assumption.

Caldwell Island.

This island is composed almost entirely of trap, intersected by numerous dykes of the same. A shaft was here sunk to the depth of 60 feet on a vein, without much result.

Mink Island.

A wide vein, carrying some indications of copper in a gangue of calcite and barite, crosses the dyke forming this island. In 1872-3 a slight amount of work was done here, and some little was accomplished on the mainland opposite, which showed a promising looking vein. The expenditure amounted to about $1,000. Coast group of veins continued.

Sturgeon Bay. (*K.* 13.)

Some capitalists of London, Ont., did some work here. Two large veins occurring in the argillites near a dyke were seen intersecting under water near the shore. A shaft was sunk close to the water's edge, on the north shore of the mouth of the bay, and a drift run out to cut the veins at their junction. A shaft was also sunk some 300 feet further inland.

K. 17 *Location.*

Some test work has been done on a brecciated vein consisting of the argillite country rock cemented together by quartz. It runs north 60° to 70° E. (mag), and dips to the south 80°. It is said a strong force of men worked here for nearly a year about 1878 or 1879, and that the expenditure at this time amounted to some $5,000.

Prince's Mine.

This is the oldest mine on the Canadian shores of the Lake, having been worked in 1846 or 1847, when it appears to have been regarded more in the light of a copper than of a silver-bearing vein. It strikes N. 30° to 40° W (mag)., and where it shows on the shore is split into two branches, with argillite between and trap forming the outer walls—that on the eastern side appearing to be a dyke cut transversely by the vein. Regarding the trap on the western wall, it is not very apparent whether it is a large dyke also traversed by the vein, but it shows as a forty-foot cliff rising out of the water, running south from the vein exposure mentioned for a distance of fifteen chains, whilst inland it shows as a similar wall running about parallel to the vein and dipping about 80° to the S.W., up against which almost horizontal argillites are seen to abut. About sixty yards in from the shore, at a point where the two before-mentioned branches would seem to come together, a 65 feet cross-cut tunnel has been run through the argillites in a westerly direction towards this cliff, the inner end of which tunnel intersects numerous branches for a distance of about twenty- Enclosing rocks.

Coast group of veins continued.

five feet. The vein next shows about 250 yards further inland, where it outcrops on a hill, at which place two shafts have been sunk on it and a tunnel has been driven in on it towards the shafts about fifty feet lower than the mouth of the higher shaft. The vein down to this level occurs in trap, but whether this is the bed which caps the argillites in the neighborhood, or whether it is the extension of one of the dykes that are seen on the coast further north, running in this direction, it would be impossible to ascertain without making a much closer examination than I found it possible to do with the time at my disposal. The drift being blocked up with debris, it was impossible to enter; but it is said that a winze was sunk some fifty to sixty feet below this, and whether the vein was thus followed down into the argillites, or what was the effect of this change of the "country" rock, it would be interesting to know, but it is now impossible to find out after this lapse of time. According to the Geology of Canada, 1863, this tunnel was driven for a distance of 163 feet, and one of the shafts was ninety feet deep, in sinking which a bunch of ore was obtained weighing several hundredweight and containing three per cent of silver, which in two assays yielded respectively one part of gold in 7,000 of silver, and eight parts to 1,000 of silver. This bunch contained "native silver disseminated in thin laminæ through the calcareous spar and blende.....Crystallised sulphuret of silver was also found in this vein, and the calcareous spar was stained with blue and green carbonates of copper and with red arseniate of cobalt."

Rich silver ore.

Between these workings and the shore exposure the vein must intersect several trap dykes which are to be seen along the coast to the north, striking in such a direction as to there run athwart it.

Vein characteristics.

The two branches on the shore are respectively five and six feet thick, whilst at the inland workings, where it exists as one vein, it is much thicker. It here shows a central rib of coarsely crystallised calcite with some barite, with a large proportion of largely crystallised, mostly amethystine, quartz on either side. Judging from the loose ore on the dump, blende seems to have been the most plentiful metallic mineral in the vein at this place.

On the shore exposure the vein presents very similar characteristics, except that the metallic minerals do not seem to have been so plentiful and that some of the branches consist almost entirely of quartz, whilst in others calcite and barite mixed constitute the greater part of the vein stone.

Assays.

Assays made of specimens selected on account of the metallic minerals present in them, proved these to carry neither gold nor silver. (See Report of Progress, 1886, Part T, Assays 21 and 22.)

Pie Island.

This island consists of the usual argillaceous series of sedimentary beds traversed in a north-easterly and south-westerly direction by dykes of trap, the same rock capping the argillites in the table-topped hills. Coast group of veins continued.

The developments shown in Fig. 1, Plate II, were made on one of the north-west series of veins which occurs on the western shore of this island. The underground developments have been made in the vein where it cuts a trap dyke, which intersects the argillites of the vicinity, or immediately adjacent to it. The width of the vein is from three to four feet and is filled with a breccia of fragments of the country rock cemented together by crystallised quartz, whch is mostly colourless but sometimes anethystine, and is accompanied by a little calcite, which occurs mostly crystallised in scalenohedra in the vugs. The great feature of this vein, as shown by an inspection of the dumps, consists in the large amount of metallic minerals it carries. These are blende, galena and iron pyrites, mentioned here in the order of their preponderance, and all occurring for the most part well crystallized, especially in the case of the galena, of which small but very perfect crystals of a combination of $\infty P \infty$ with O may be found. This latter also occurs sometimes as thin seams in the joints of the argillite, which, on account of their dark, lustreless appearance, might possibly be mistaken for argentite by the inexperienced, especially where the films are thin. An assay of such a piece showed it to carry neither gold nor silver. (See Report of Progress, 1885, Part T, Assay 28.) That these metallic minerals, although they are occasionally found to do so, as a rule carry either none of the precious metals or a very small proportion, is shown by the other assays given in the same place. Assay 25 of a specimen selected as carrying a good proportion of galena, free from other metallic minerals, gave: Gold, none; silver, 0.175 of an ounce to the ton. The other numbers: 26 carrying a good proportion of blende mixed with a little galena and 27 consisting nearly altogether of pyrites, gave neither gold nor silver. Developments. Vein characteristics. Assays.

The nature and extent of the developments made is shown sufficiently in the figure, and needs no further description. Operations were conducted here about the years 1875-7.

Some development work has also been done on a large vein on 13 B mining location, about a mile E. S. E. from the last mentioned. It strikes in from the shore with a course N. 75° W (mag.), and dips to the N. It is about twelve feet thick, is enclosed in the argillites of the district and intersects two trap dykes which cut through them. 13 B. Mining location.

13 *B* Vein.

A shaft has been sunk on it, the depth of which was not ascertainable, however, as it was full of water. In mineral contents it is very similar to the first mentioned, except that the quartz is accompanied by a good proportion of pink spar, probably dolomite.

Assays.

One assay made of some specimens selected as carrying some galena and a little blende, gave neither gold nor silver; whilst another sample, broken from an outcrop about half a mile from the latter point and about on the run of this vein, which carried some galena accompanied by a little pyrites, yielded on assay: Gold, none; silver, 0.467 of an ounce per 2,000 lb. ton. (See Report of Progress, 1886, Part T, Assays 29 and 30.) Little or no work has been done on the rest of this island.

The Port Arthur Group.

The Port Arthur group of veins.

The members of this group of silver veins may be considered in two sub-divisons:

Div. I.—In which the veins occur in the Animikie rocks.

Div. II.—Comprising those occurring in the Archean area to the north of the former.

Division I.

General conditions.

This comprises most of the veins of this group. They occur in the lower beds of the Animikie which consist for the most part of siliceous rocks, cherts, silicified argillites, etc., with a small development of the softer and carbonaceous argillites. The chief developments have been made on veins near the northern fringe of this formation, whose thickness must be here comparatively slight, owing to its practically horizontal position, and the way the old Pre-Cambrian surface dips under it. This was actually found to be the case at the Shuniah mine, where as hereafter mentioned, the vein was followed through it and into the underlying older rocks.

Thunder Bay Mine.

The discovery of this vein by Mr. Peter McKellar in the fall of 1866, may be said to have been the commencement of the second era of mining activity in the Thunder Bay region. As it was not found possible to visit this place, the following description has been compiled from various sources.

Vein characteristics.

This vein strikes N. 34 E. and dips at a high angle to the north-west and consists of a series of "closely reticulated veins of white granular quartz the largest being about one inch thick and the aggregate aver-

DEPARTMENT OF THE INTERIOR,

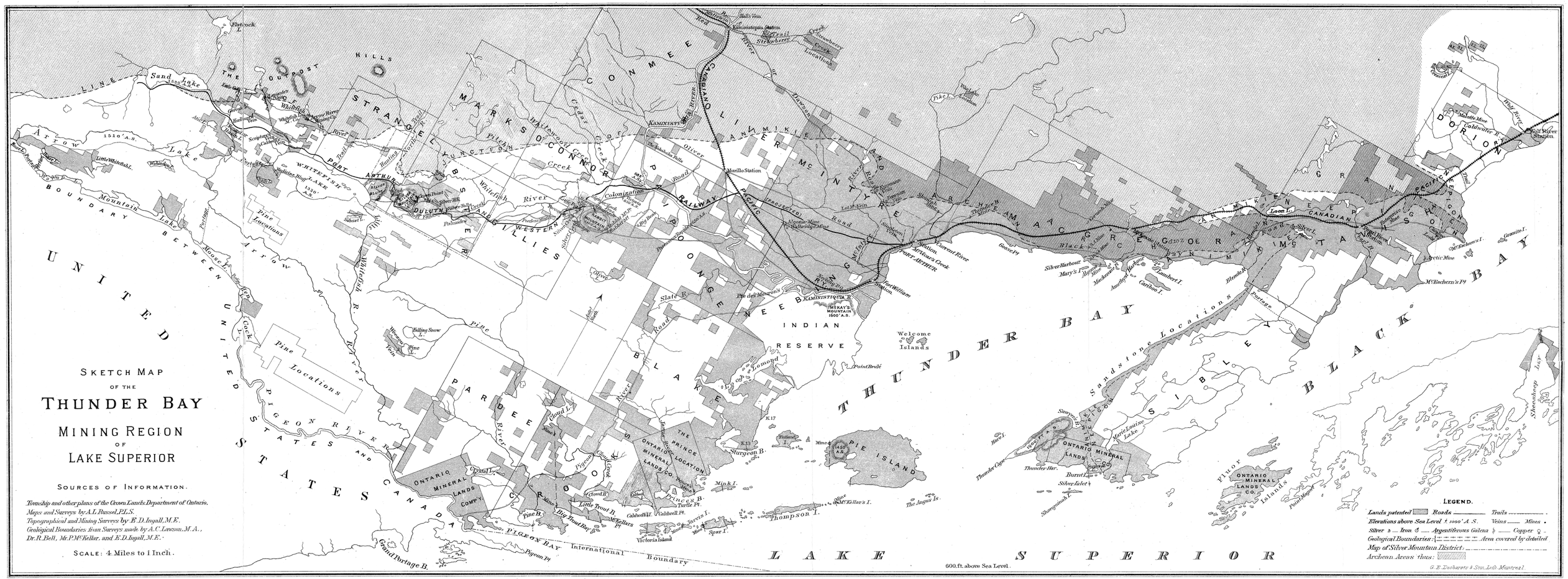
HONORABLE THOMAS WHITE, MINISTER.

Geological and Natural History Survey of Canada.

ALFRED R.C. SELWYN, C.M.G., LL.D., F.R.S., &c., DIRECTOR.

1887.

Mines and Mining on Lake Superior, by E. D. Ingall, M.E. Part II. Annual Report 1886.



aging perhaps ten feet. It carries native silver and argentite, accompanied by galena, blende and iron pyrites." According to Mr. McKellar "the ore occurs in bunches three to eighteen inches thick by six to forty feet in length, the silver being in strings, leaves, grains, etc., irregularly distributed through the vein-stone which constituted the greater part of the bunch. At the first opening there were two of the streaks, one next to the north or hanging wall, and one in the middle. It is not well defined, being generally in ribs with considerable slate between" (F). Mr. McKellar further states that the vein was strong and rich in the upper strata but below consisted of small stringers with galena, etc., but little silver. Port Arthur group of veins—continued.

Dr. Bell, in his description of the mine, points out that "silver often forms ten per cent. of the mass" (H). in the isolated bunches of ore occurring in the vein, and says further that the country rock consists of a thick bed of trap underlaid by from fifteen to twenty feet of "alternating beds of dark shale, impure dolomite, argillite and what appear to be diorite layers. These are followed in descending order by massive dark olive and drab-grey argillaceous slate, about fifty-five feet of which have been cut in the shafts." (H.) Enclosing rocks.

The work done consists of four shafts sunk on the vein, a cross-cut driven north-west at the ten fathom level, and some drifting, done between the two deepest shafts. No. 1 shaft is some seventy feet deep, No. 2 is the same depth and 300 feet north-east of it, whilst 150 feet further on is another shaft thirty-five feet deep, and again 150 feet to the north-east on the strike of the vein another shaft has been sunk to the depth of twenty-five feet. Ore was stoped out from the outcrop of the vein between the two extreme shafts over a distance of 600 feet. On surface the vein was traced upwards of half a mile, and besides the erection of necessary buildings, three miles of a good waggon road were constructed to the shore of Thunder Bay, where a stamp mill was erected as well as a dock 200 feet long, built of crib work filled with stone. Work was stopped in the spring of 1869. * Work done.

According to Mr. Robb (Report on the Mineral Statistics of Canada, Geo. Survey, 1871-2) the product of the mine was 3,294 lbs. of ore, worth $2,592. Expenditure and results.

The work was done by an English company having a capital of $400,000 divided into 80,000 shares of the value of $5 each, 60,000 of which were unassessable, thus leaving a working capital of $100,000.

The mine was again opened up in 1874, and Mr. Peter McKellar, in a letter to myself, recently received, says: "The *Thunder Bay Mine* was in operation on this occasion for six months or more....The mining was almost entirely done on the south spar vein with no success. The spar Mine re-opened.

* "The *Thunder Bay Silver Mine* ..... has not been worked since the winter of 1869-70." (I).

Port Arthur group of veins —continued.

vein is large, six to twelve feet wide, bearing E.N.E. & W.S.W. with a high angle of dip to the south, whilst the silver bearing vein, the one from which all the silver was taken, is a parallel vein about twenty feet to the north, one to three feet wide, principally quartz, and dipping at a high angle to the north. The south vein seems to be the main fissure occupying a line of fault, the other a dropper from it. The mining on the spar vein was carried on through a cross-cut at the ten fathom level from the foot of No. 2 or B shaft." He further states that some 200 tons of low grade ore from the first works of the mine had been hauled to the company's mill, but not treated, and that after the closing down of the mine the last time, the manager hauled it to his own mill (five head of stamps) at Port Arthur and milled it, of the results of which Mr. McKellar speaks as follows: "Having seen the work in operation I have no hesitation in stating that it yielded well, the concentrates, which were sold in the States, were unusually rich in fine native silver. The actual yield was not made known."

The Shuniah or Duncan Mine.

Vein characteristics.

The vein strikes nearly E. and W. and has a general dip to the south at a high angle from the horizontal. The total width on surface is twenty to thirty feet. According to Prof. Chapman who reported on the mine in August, 1868, "Several cross lodes intersect or run into the Champion vein. These are at present altogethe rundeveloped, but they show on the surface a gangue of quartz holding small quantities of galena, blende and pyrites.....These cross veins appear to have an average breadth of six or seven feet, and.....are well defined." Several of these were afterwards intersected in driving cross-cut "a." (See Plate V, fig. 2), and were found to dip northwards.

Mr. W. M. Courtis, who was manager of this mine for some time, gives the following description of it: "The vein consists of one main fissure, with many parallel fissures rising from the foot wall" (or south wall) "at different depths, and at some places striking into the main fissure afterwards continuing as separate fissures again. These small fissures seem to be the silver bearing part of the vein and the large fissure is silver bearing only in the neighborhood of these junctions.... The ore is in bunches with ground almost barren between.....The vein contains horses of the country rock.....The edges of the fissures are often brecciated carrying native silver or ore, as do also many of the black slate *horses* in the main vein, deposited on the surface of the slate" (B). "We find these *horses* from the size of a pin to masses weighing tons. The effect of the solution" (which filled the vein) "upon them was silicifying. The extremely fusible green slate, equally with

the black slate or felsite horses, retained its sharp edges. They all analysed much higher in silica than the adjoining country even though embedded in a mass of spar" (G). Port Arthur group of veins—continued.

"The principal gangue, almost all *the* gangue, is calc-spar. The lime sometimes is replaced by magnesia or manganese. At *Duncan*, there is no pink spar" (as at *Silver Islet*) "but it is coloured amethyst, and cavities near the surface are filled with black oxide of manganese..... Quartz is the second mineral in importance in the gangue" (B). He also says in a later publication that some of the vugs, as at *Silver Islet*, "contained hydrocarbon gas under great pressure" (G). Gas.

The accompanying cross-section (Plate VI, fig. 1) through No 3 shaft, shows the enclosing rocks of the vein at that point as worked out by Mr. Courtis from knowledge gained in the opening up of the mine, and from careful records kept by himself of the numerous diamond drill holes bored. The dislocation produced by the vein is very apparent. The trap sheet "A" shown overlies the rocks for an area of several square miles to the south. Owing to the trend of the vein bringing it nearer to the trap bluff in passing westward, and to the fact that the strata have a south-westerly dip—the trap forms the south wall of the vein almost down to the first level at No. 2 shaft, and to the half level at the west winze, being at these places opposed to the black slate of the north wall, the line of contact sloping upwards on the south side to the surface at No. 3 shaft as shown in the cross-section. Enclosing rocks

The rocks marked L, H & K in the figure may be said generally to belong to the Archean, as distinguished from the horizontal Animikie rocks lying on them, but whether they can be properly considered as the equivalent of the rocks which have been called Huronian in that district, and found to be gold-bearing, it is not possible to decide from an inspection of the eight specimens of drill cores kindly lent me by Mr. Courtis, for whilst one of the cores has all the appearance of coming from one of the green mottled dioritic beds which are very typical of the gold-bearing formation of the district, yet the rest of the cores seem to be more related to the gneissic rocks of the Laurentian. Mr. Sargent, who was in charge after Mr. Courtis, in writing to the latter gentleman seems to have noticed a great difference in these Archean rocks on either side of the vein, for in speaking of the drill cores got in boring north and south from the vein, he says, "The rocks on the south are unmistakeable diorite, whilst on the north they are felsite, hornblende and (syenite ?)"

The Animikie rocks in the section would seem to have all the characteristics of the lower beds of this series as exposed elsewhere in the district, viz., a great preponderance of dolomitic and cherty rocks with

Fig. 2.

HORIZONTAL PROJECTION

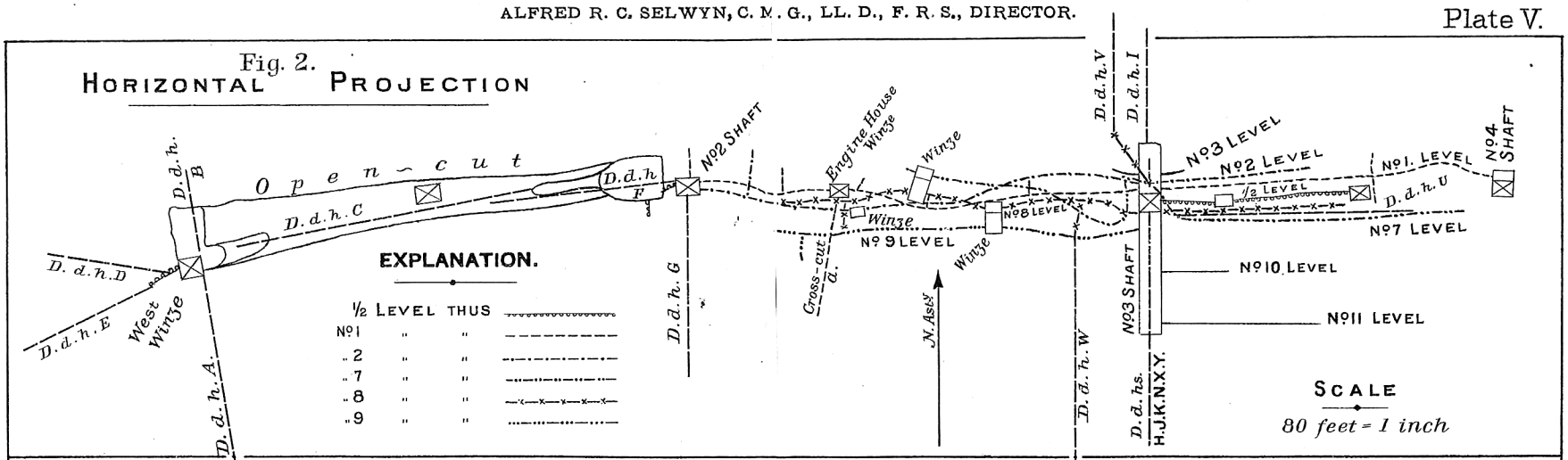


Fig. 1.

VERTICAL PROJECTION

SCALE
160 feet = 1 inch

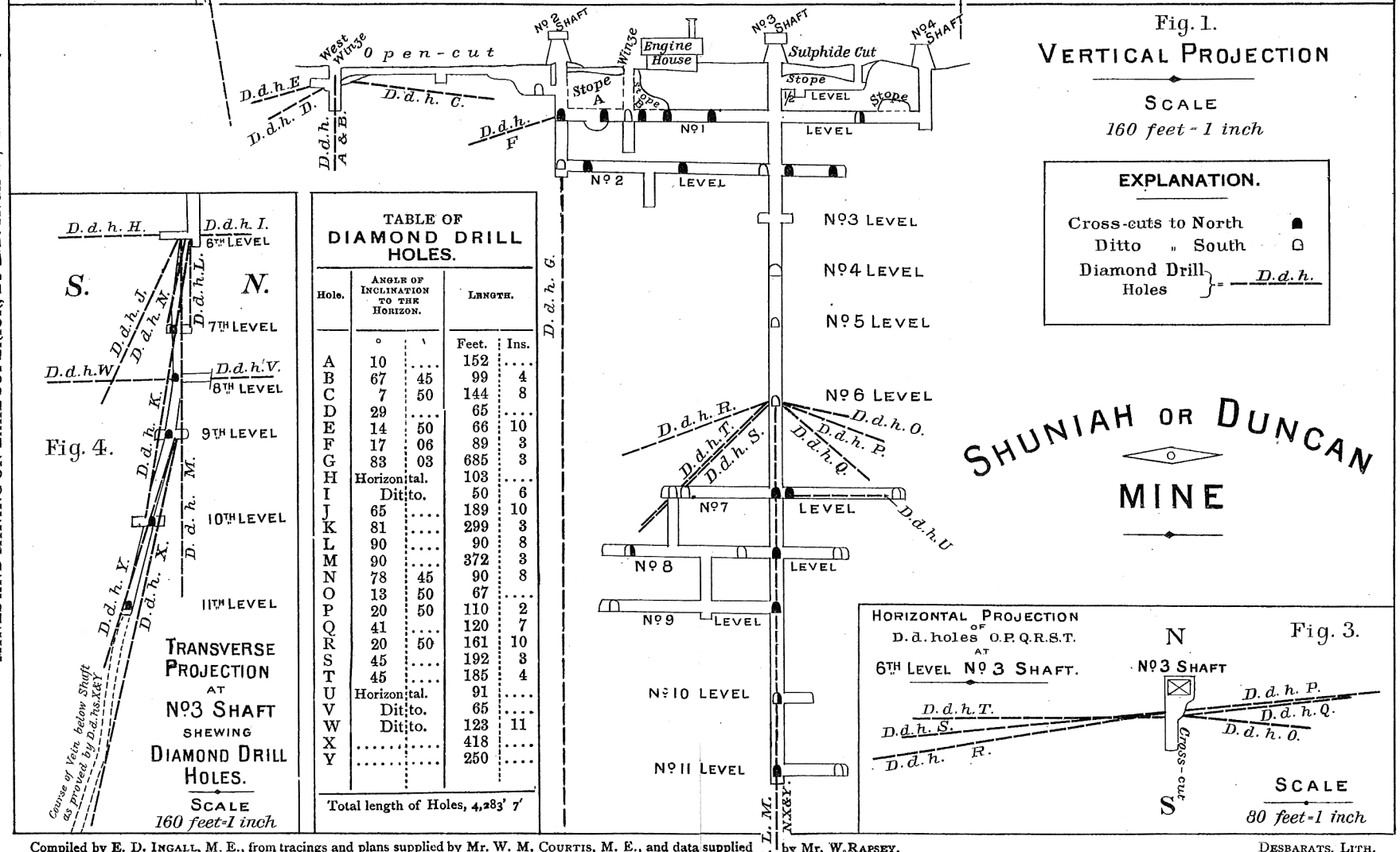


Fig. 4.

TABLE OF DIAMOND DRILL HOLES.

Hole.	Angle of Inclination to the Horizon.		Length.	
	°	′	Feet.	Ins.
A	10	....	152	....
B	67	45	99	4
C	7	50	144	8
D	29	....	65	....
E	14	50	66	10
F	17	06	89	3
G	83	03	685	3
H	Horizontal.		103	....
I	Ditto.		50	6
J	65	....	189	10
K	81	....	299	3
L	90	....	90	8
M	90	....	372	3
N	78	45	90	8
O	13	50	67	....
P	20	50	110	2
Q	41	....	120	7
R	20	50	161	10
S	45	....	192	3
T	45	....	185	4
U	Horizontal.		91	....
V	Ditto.		65	....
W	Ditto.		123	11
X	.....	....	418	....
Y	.....	....	250	....

Total length of Holes, 4,283′ 7′

Fig. 3.

Compiled by E. D. Ingall, M. E., from tracings and plans supplied by Mr. W. M. Courtis, M. E., and data supplied by Mr. W. Rapsey.

Desbarats, Lith.

Port Arthur group of veins —continued.

silicified argillite and small occasional developments of the soft carbonnaceous black argillites. Mr. Courtis says, "The silver seems to give out as soon as the leaders enter the dolomite." (B.)

As the cross-section given in Plate VI, fig. 1, would be incomplete without fuller descriptions of the rocks, I quote those given in Mr. Courtis' paper from which the illustration has been copied. (Transactions American Institute Mining Engineers. vol. XV, page 671).

"The microscopic determinations, made by Mr. John Caswell, of slides I had cut from some of the cores, are given below; but I should preface them with the remark that Mr. Caswell wrote me he had had very little time, and felt a great lack of confidence in describing these specimens, as the rocks were new to him. He added the names simply as suggestions, needing confirmation after more extended study."

Descriptions of the different rocks enclosing the vein are then given as follows:—

"A, on the section, is probably an olivine gabbro of Dr. Irving, but has been called diorite: sp. gr., 3.033; proportion insoluble in acid, 83.4 per cent.; silica, 54.2 per cent.; proportion attracted by magnet, 2.8 per cent.

"B, a black slate, containing less carbon than E: sp. gr., 2.640; proportion insoluble in acid, 91.5 per cent.; silica, 74 per cent.

"C, may be said to be a dolomite with chert, and G, a chert with dolomite and pyrite.

"D, is a dark-green slate, with masses of chert, red above and gray at the base of this formation. It very easily fuses to a black glass which is magnetic. Different specimens gave the following results:—

Sp. Gr.	Insol.	Silica.	
2.528	33.9 per cent.	31.5 per cent.	
2.776	61.2 "	48.3 "	
2.654	84.4 "	84.0 "	(chert).
3.225	19.0 "	17.7 "	18.9 per cent. loss on ignition.

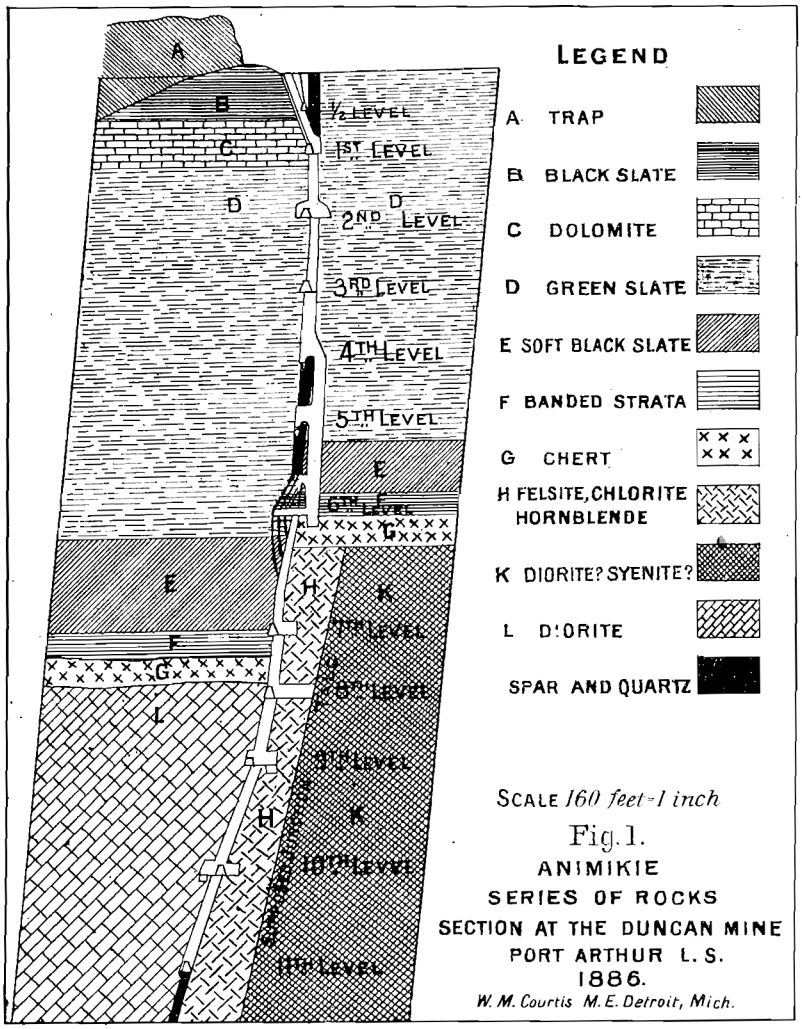
"E, is a soft, carbonaceous black slate, with shining particles, and apparently obliterated fossil stems. Sp. gr. 2.531; insoluble, 83.9 per cent.; silica, 54.2 per cent.

"F, was composed of three bands:

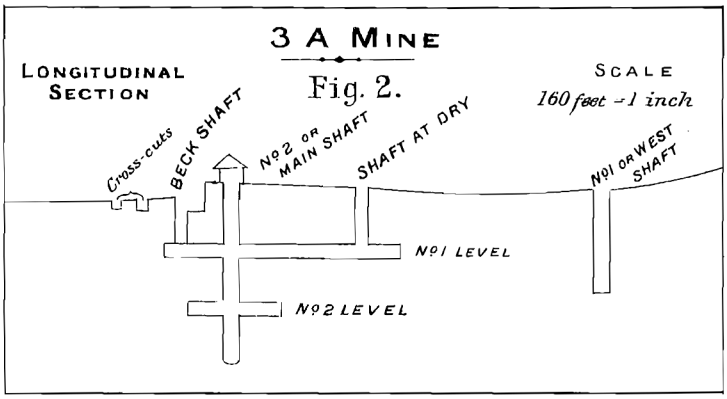
1. Calcareous band (green) containing much iron. Sp. gr., 2.765; insoluble, 43.4 per cent.; silica, 34.7 per cent.
2. Arenaceous band (green), in flinty black slate. Sp. gr., 2.488; insoluble, 78.8 per cent.; silica, 53.6 per cent.
3. Jasperized slate. Sp. gr., 2.627; insoluble, 92.6 per cent.; silica, 85.7 per cent.

"G is chert mostly, with some dolomite.

Plate VI.



From a paper by Mr. W. M. Courtis, vol. xv, Trans. American Inst., Mining Engineers.



From a drawing given in Mr. P. McKellar's Pamphlet on "Mining on the North Shore L. Superior," 1874.

"This band is so tough, that a party of excellent Cornish miners made, on contract, but five feet per month for two months in sinking an inclined shaft. On one seam, the diamond drill worked for eight hours, using up a bit, and took out but six inches of core, drilling about one foot in that time. Port Arthur group of veins—continued.

"Mr. Caswell describes a section of the quartz thus: 'Fine-grained, with some faint, skeleton-like crystals of augite scattered through it. Their character could not be determined exactly.'

"'Dolomite, dark-colored, effervescing in warm acid, with remains of fibrous diallage or hornblende, partly altered to serpentine mass. Quartz grains are scattered through it.'

"The vein seems to have been shattered at this point to thousands of stringers spreading through thirty to forty feet. Above, the vein was six to eight feet of solid gangue; below, as far as sunk on it, the foot-wall seemed perfect, to which these stringers were coming in from the south. These stringers carried in this belt much galena and zinc-blende, but not give above nine ounces in silver for highest assay.

Sp. gr.	Insol.	Silica.	
2.713	32.8	32.8	Olive-green dolomite.
3.023	69.8	69.8	
2.738	55.0	55.0	

"H. seems to be a belt of much broken-up rock, parts of it much altered, probably from the effect of the vein. Sometimes the drill would be in a solid red felsite, then in solid hornblende, then in talcose or chloritic seams, or the rock would take the form of a diorite for some feet, and then go back into solid hornblende.

Sp. gr.	Insol.	Silica.	
2.962 per cent.	32.8 per cent.	29.5 per cent.	Hornblende.
2.830 "	59.1 "	46.5 "	Mixed.
2.624 "	93.4 "	71.0 "	Felsite.

"As we entered the body of solid rock marked K, the drill-hole, being vertical, passed farther away from the vein, the rock became fine-grained, and increased in silica, mica replacing the hornblende to some extent. Sometimes there would be pretty large crystals of orthoclase. In certain parts, without any sign of vein-stringers, there would be amygdules of calcspar, various specimens of core giving up from 6 to 25.5 per cent. in acetic acid. The most calcareous had a specific gravity of 2.703; insol., 55.6 per cent.; silica, 42 per cent.; loss on ignition, 5.3 per cent.; in acetic acid, 25.5 per cent. Nothing was taken up with the magnet, but there was more or less pyrite in the mass.

Port Arthur group of veins —continued.

"K, is described from Mr. Caswell's sections, except the part carrying the most mica :—

Sp. gr.	Insol.	Silica.	Appearance.
2.737	89.1	64.0	Syenitic.
2.651	84.6	70.5	Syenitic, Granitic.
2.655	86.0	78.0	Porphyritic.
2.773	70.8	56.5	Dioritic.
2.980	83.2	44.9	Hornblendic.

"The core at 650 feet from the surface showed :—

1. Plagioclase, much altered and very dusty, but with banding still visible.
2. Quartz, in pellucid masses and grains, with some large and many small fluid inclusions with moving bubbles. The fluid cavities in the quartz are very pretty.
3. Hornblende, much altered, with greenish veins running through it; pale green color, and only slightly polarizing.
4. Apatite. The rock is much altered, and is probably of the same family as at 800 feet and 809 feet (diorite ?).

"Core at 800 feet from surface (diorite ? hornblende schist ?) :—

1. Hornblende, in green crystals, showing cleavage-lines of 124° and dichroism very distinctly. In some places altering slowly to brown biotite.
2. Orthoclase, cloudy and irregular in color, showing cleavage-lines. It may be plagioclase, a point which can only be decided by angle of absorption.
3. Quartz, pellucid grains, abundant between hornblende crystals.
4. Apatite, abundant in colorless crystals.
5. Plagioclase, faintly banded between crossed nicols.

"Core at 809 feet (diorite ?) : –

1. Plagioclase, much decomposed, but distinctly banded.
2. Orthoclase, some cloudy crystals.
3. Hornblende, the same as at 800 feet, but more altered.
4. Apatite, in colorless needles, and some large white crystals.

"L, wherever penetrated, seemed to be a typical diorite—was at least so called by every one seeing it, though it has not been yet determined microscopically. Specific gravity, 2.869; insol., 69.8 per cent.; silica, 5.7 per cent.

"I am indebted to Mr. Caswell for the determination of the slides, as a friendly matter for my private information.

"The rocks marked H and K crop out about 14 miles to the north of

the mine, and have been called metamorphic Huronian by geologists describing this section. They present the same appearance as the cores, a brecciated, wavy mixture of hornblendic, felsitic and granular patches." (G.)

Port Arthur group of veins—continued.

The silver in the vein was, as shown, all found above the first level, where the upper bed of black argillite formed one wall of the vein. And Mr. Courtis, writing me, says the best ore in the mine was obtained from near the engine-house winze, near the letter "A" in stope "A" (See Plate V., fig. 1). He says:—"In sinking this winze, which was at the junction of a spur going south-east from the main vein, we took out $3,500 in rich specimens, and supposed it denoted a large body, but the stope extended but a few feet each side and ran into poor ground, whereas we expected a block of rich ground from No. 2 shaft to the Sulphide Cut." He goes on to say that at this point there were stringers running parallel to the vein in the south wall, and that "the main vein was barren. The stringers carried more or less silver, which made in bunches of ore worth $1 a pound. From "A" (See Plate V., fig. 1) "we took out about $1,500 in one blast; two inches above it, trap made the walls and *horses* in the vein, and no more silver was found. The stringers pinched out both east and west."

Occurrence of ore bodies.

The history of this mine, as gleaned from Mr. Peter McKellar's statements, seems to have been somewhat as follows:—

History of mine and work done.

The vein was discovered in 1867. During the summer of that year and the following winter, trenching was done on the back of the lode at several places, and two shafts were sunk, one to a depth of thirty or forty feet and the other to a depth of sixty feet from the surface. From the bottom of the latter a cross-cut was driven across the lode. At first, silver was got in small bunches in the form of leaves and fine strings penetrating quartz, spar, blende and galena, in a streak of those minerals running along within two feet of the south wall. In sinking, it was lost at a depth of about eighteen feet, but found again in the middle of the vein in the cross-cut at the sixty feet level. Several barrels of ore were taken out, reported to have run from $200 to $300 per ton. The mine was then closed, owing to a disagreement between the owners and to want of funds, which led to a chancery suit, so that altogether, including expenditure thus incurred, some $25,000 to $35,000 were spent.

The mine was opened again in 1870, when it was bought for some $75,000. The main shaft was sunk to a depth of 135 feet, drifts were driven on the lode at the first and second levels, and cross-cuts at several places. One of these latter was driven south for 100 feet, in

Port Arthur group of veins —continued.

expectation of cutting another lode. A good many thousand dollars were spent in further tracing the vein on the surface, and they then began to follow up the silver in the drifts, and a few days after, orders were given to shut down, so the mine was again closed in the middle of the summer of 1873. The results of this work were that they failed to find any lode in the cross-cut south. They got silver at several points in the drift, and took out a barrel or two of very rich ore a few days before closing. The vein was found to continue large all the way down, the hanging wall only being seen in the cross-cuts.

In November, 1873, it was again started under the name of the *Duncan Mine*, having formerly been called the *Shuniah*. There were several reports of silver having been struck at various places, but Mr. Courtis says:—"All the reports that the *Duncan* had struck silver below seventy feet were false.....In January, 1877, however, plumbago was struck at a depth of 315 feet." (B.) He further says:—"The richest ore has assayed, in bulk, 2,020 ounces, the poorest concentrations seventy-three ounces, and as about sixty tons of rock are concentrated into one, the original stamp rock is often pretty poor. In some parts, especially near the surface, the stamp rock has assayed six to eight ounces, taking out the whole rock for six to twelve feet wide. These rich places also give some hundreds of pounds of very rich ore.....The very rich argentiferous zinc blende is found only at the surface. Although large quantities of zinc blende are found below seventy feet, it contains only a trace of silver." (B.)

Occurrence of ore.

Prof. Chapman, in speaking of this surface blende in the beforementioned report, says:—"The yellow blende holds in most samples a small amount of silver. Some fragments of this blende gave me also in one assay a trace of gold corresponding to about two pennyweights in the ton."

Developments in lower part of mine and results.

Regarding the developments in the lower part of the mine, it would seem that after sinking into the Archæan, no silver was found to any extent, although the vein still carried the other metallic minerals, which, whilst nearly always free from silver, or very poor in it, occasionally assayed high. The vein was much smaller and less solid than at the surface, with numerous branches coming in on the hanging wall, whilst quartz replaced the spar gangue found above, the spar being only found in a few stringers and filling vugs. In boring the diamond drill hole "U," sludge assays were got, giving from $110 to $2,500; and Mr. Sargent, speaking of this point in writing to Mr. Courtis, says:—"A diamond drill hole was bored from the shaft east, ninety-one feet, and meeting with good sludge assays for quite a distance, and one small speck of native silver being found, a drift was

run in that direction, but was discontinued at ninety feet, as the vein had pinched to a thread, and only a few specks of silver had been found in a small seam in talcose slates on the south. Some little native silver was found in the shaft from twenty feet above the level to fifteen feet below; in every instance as a thin coating on the felsite breccia, and not in the quartz. The vein was pretty well filled with felsite horses." Port Arthur group of veins—continued.

The mine closed finally in the fall of 1881, having been worked almost continually since its discovery in 1867, although with very varying vigor, the force varying from two men to one hundred. Mine closed.

Besides other surface work a mill of ten head of stamps with four Frue vanners was built at the mine, and operated for a couple of months. Mill.

According to Mr. Courtis, the total product of the mine amounted to about $20,000 worth of ore, whilst the total outlay, including cost of property amounted to about $500,000. Expenditure and returns.

Besides those shown in the illustration, Plate V, I find there were other drill holes bored, viz.: Horizontally, N. and S. from the 11th level; one W. from the end of the 9th level, and one near No. 2 shaft, the latter to seek for silver in the lode between the 6th and 7th levels, amounting in all to about 600 feet, which added to those shown on Plate V, makes a total length of holes bored of about 4,884 feet. Diamond Drill Holes.

Dr. Selwyn in visiting the mine in August, 1872, found development work in progress on the vein on the adjacent property to the west of the west winze. This consisted of three test pits, respectively fifteen, thirty-four and twenty feet deep, placed equi-distant, and testing a length of vein of some 600 feet beyond the west winze.

The Beck, or Silver Harbour Mine.

This mine has been opened on a vein running E. N. E., and dipping at a high angle to the N. W. It has a brecciated character and is about five feet thick. The gangue consists mostly of white granular quartz, but barite, calcite, fluor and amethyst are also present with much iron pyrites, galena and blende. The silver occurs mostly as argentite, but also in the native state. The country rock is here much the same as at the *Thunder Bay Mine*, and consists of smoke colored cherts and dark argillaceous shales, running nearly horizontally under what appears to be a bed of coarsely crystalline trap. The junction of the Animikie and the Huronian lies about half a mile to the north of the mine. Vein Characteristics. Enclosing rocks.

This vein was discovered in the summer of 1870, and during the winter of 1870–1, a force of about fifteen men worked on it, who did History and results.

Port Arthur group of veins —continued.

some surface exploration, built three or four houses and sank a forty foot shaft. Work on the shaft was then suspended and developments made on the vein in the surface bed. In the winter of 1871–2, a new manager took charge who continued the workings in the surface bed. A number of good buildings were erected and a dock built, at which the largest steamers could lie. Work was stopped in the fall of 1872.

Ore obtained.

"The vein showed a considerable quantity of silver in the upper siliceous and dolomitic bed, but towards the bottom of the shaft in the argillaceous beds it was irregular and poor" (F). Mr. Courtis states that 125 barrels of ore were shipped, reported to be worth $300 per barrel, but proved only to assay $17 to the ton (B). Mr. McKellar who saw this ore in the barrels before it was shipped, accounts for its low yield thus: "No wonder by the way it was assorted.....the greater part of it was very poor, although some was good." (F.)

The company working this property paid $10,000 in cash for it and guaranteed to spend $100,000 in developments.

It has not been found possible to obtain any plans, etc., of the underground workings of this mine, and as it was found impossible to personally visit it, the above description has been necessarily compiled from the writings and statements of others, chiefly from those of Mr. Peter McKellar in his paper on Mining on the North Shore of Lake Superior.

Algoma Mine (Macgregor Township).

This must not be confounded with the mine of the same name in the township of Neebing.

According to Dr. Selwyn, who visited this place in August, 1872. this vein strikes about E. N. E. He makes the following remarks on the phenomena there observable. It is "half a mile east of Silver Harbour, and similarly situated at the base of a diorite bluff, fifty to sixty feet high. Here they have sunk through about thirty feet of soil or clay before striking the rock which is the usual cherty banded shale traversed by a brecciated vein of quartz, calc-spar and rock fragments, holding galena and pyrites in nests and small aggregations of crystals. The shaft is at present only twenty feet deep. Captain Talon stated that in another shaft sunk on the run of the vein to the eastward, they had driven towards the diorite bluff and struck it, cutting the flat shales like a wall, but that there was no indication of a vein at the junction. This would show that many of these diorite bluffs are dykes and not interposed beds."

Lambert Island.

This island consists of trap and on it some $500 were expended in 1884, in testing a vein of rose colored quartz with fluor spar. The vein strikes about N. W., and is from eighteen inches to three feet thick. A shaft was sunk on it, but did not penetrate the trap to the argillites supposed by the owners to underlie it. Port Arthur group of veins continued.

Cariboo Island.

Some surface exploration has been done on veins in the Animikie rocks here, but with little or no result.

Blende Lake.

Two or three test shafts have been sunk on a vein carrying argentiferous galena, said to run $14 to the ton in silver. It cuts the Animikie rocks of the vicinity.

Singleton Mine.

This is the name given to a small opening made on a vein of granular white quartz about one foot thick, from which some rich bunches of native silver were obtained. It is situated within the town limits of Port Arthur in the Animikie rocks of that locality.

Walbridge Mine.

This is in the north-west corner of the township of Neebing, and according to Mr. Peter McKellar's descriptions, it would seem that the vein worked here ran nearly E. and W. and dipped at a high angle to the south. It has a width of some twenty-four feet and is well defined. It carries galena, blende, copper and iron pyrites in bunches, stringers and disseminated in grains through a gangue of calcite and quartz. The *country* consists of the siliceous and argillaceous beds constituting the lower division of the Animikie rocks of the district. In 1863, the property was bought for $1,200 or $1,400 from the original owners, by Detroit capitalists, who kept a party of six to seven men at work on it during the summer and following winter. Some trenching was done on the back of the lode at various places, and a forty foot shaft was sunk on the copper-bearing part of the lode. The miners said there was a two to three inch streak of ore in the bottom of the shaft, and the vein increased in richness in depth. They also got some good shows of galena in some of the open cuts on surface and traced the vein for a considerable distance. The developments were made with a view to selling the mine, but not having been successful in this, no more work was done (F).

Port Arthur group of veins continued.

Dr. Bell, in his report on this district made in 1870, also describes the following veins as occurring in this vicinity:—

Algoma Mine.

This is on the adjacent lot to the last. "Three veins, one of them thirty-one feet in width, and holding galena, occur here." There is an outcrop of a highly ferruginous sandstone, giving on analysis about 37 per cent. of metallic iron.

Paresseux Rapids.

A ten to twenty-five feet vein shows here, crossing the river in an E. N. E. direction. In a gangue of barite, calcite, quartz and fluorite, it carries a little galena, blende, copper and iron pyrites.

Lots 4 and 5 Paipoonge.

On the north bank of the Kaministiquia river, a vein three to four feet thick occurs running north eastward. It contains a little copper pyrites, iron pyrites and galena in a gangue of barite, quartz, calcite and fluorite.

Mining Lot M. (McIntyre Township).

On this lot is a large barren vein, having a total width of forty feet, coursing N. 50° E. and dipping to the S. E. at 80° from the horizon. It has a coarsely brecciated character, much of it consisting of a network of small veins of quartz with a little calcite. It cuts the arenaceous beds, and dark slates all weathering to a dark iron black.

Mining Lot C. (McIntyre Township).

A vein carrying copper pyrites cuts the same ferruginous sandstones mentioned as occurring at the *Algoma Mine.*

DIVISION II.

Silver veins in Archean rocks.

The members of this group are still silver-bearing, but occur as said in the rocks of the Archean age, and from the data obtainable, apparently in that sub-division known as the Huronian system.

The three A. Mine.

Vein characteristics.

This vein strikes N. 75° E, and dips slightly away from the vertical. It has a thickness of from eighteen inches to two and a half feet. The gangue is mostly quartz with a little calcite, "through which are

irregularly distributed the ores of iron, copper, lead, zinc, nickel and silver, with some cobalt and gold as shown by the assays. The silver is found native and combined with sulphur and nickel, thickly penetrating the vein stone in small and large patches, in some of which it is very heavy" (F.) The ore is stated to have been as rich as much of that at Silver Islet. One sample of the ore is said to have assayed 1.4 per cent. of cobalt, and 25 per cent. of nickel. Port Arthur group of veins continued.

The enclosing Huronian rocks here consist of grey dolomitic schists, associated with dark green compact diorite, whilst dark greyish red, felsitic syenite occurs a short distance to the south. The dip of the strata is nearly vertical. Enclosing rocks.

The discovery of this vein was made in the winter of 1869 and 1870. A considerable amount of work was done on it. The accompanying sketch plan and section of the mine up to March, 1874, taken from Mr. McKellar's paper on Mining on the North Shore of Lake Superior shows the underground work. (See Plate VI, fig. 2). On surface the vein has been traced over half a mile. During the winter of 1871-2 two miners worked on the lode and took out twenty-two barrels of ore. Towards the fall of 1872, the sinking of the shaft was begun and the work of development carried on for some time. The silver seems to have lasted down but to have been pocketty. I have been unable to ascertain when operations were discontinued, but Mr. Courtis, writing in February, 1877, speaks of the mine as closed, He also says that the value of the ore obtained was probably about $2,000. Work done and results.

Near three A.

Mr. Courtis mentions the discovery of a two feet vein of milky quartz in the vicinity of the last mentioned mine, carrying native bismuth and yielding on assay a little silver. It was traced for some distance, and a few shallow pits were put down on it. (B.) Bismuth.

Cornish Mine.

Active operations were commenced on veins at this place in the spring of 1873, and continued for about a year, but apparently without any satisfactory result. The veins strike about east and west, and are said to be in the Huronian, and to carry much blende, galena and iron pyrites.

Emmons' Mine.

This mine is situated on Lot A in the township of McIntyre on the Dawson road, about five miles from Port Arthur. Dr. Selwyn, who visited it in 1872, describes it thus: "The 'mine' consists of one pit

The Port Arthur group of veins concluded.

twenty feet deep, full of water, sunk on a thick vein of white calc-spar mixed with quartz, often showing amethystine colours, and both traversed by thin strings and cubic crystals of galena, also spots of mispickel and iron sulphurets, and more rarely, copper pyrites. The rock is a hard, white-weathering silico-felspathic gneiss, sometimes epidotic and dioritic, probably Huronian.

Dawson Mine.

The same authority also mentions the occurrence of a vein at this point on a property known as R 2, about three and a half miles up the Dawson road from Port Arthur. It strikes about E. N. E. and, is in hard cherty silico-felspathic rocks, probably near the junction of the Huronian and Animikie rocks.

RABBIT MOUNTAIN GROUP.

The Rabbit Mountain group of veins.

Mr. Oliver Daunais, a trapper and explorer, besides his many other discoveries, located the first vein in this district at the spot where the *Rabbit Mountain Mine* now is, having had it pointed out to him by an old Indian. The great richness of the ore found there caused the revival of interest in the Silver Mining of Thunder Bay, and the commencement of the present era of activity, the inauguration of which has been largely due to the hopeful and energetic initiative of Mr. T. A. Keefer, of Port Arthur.

Conditions of occurrence.

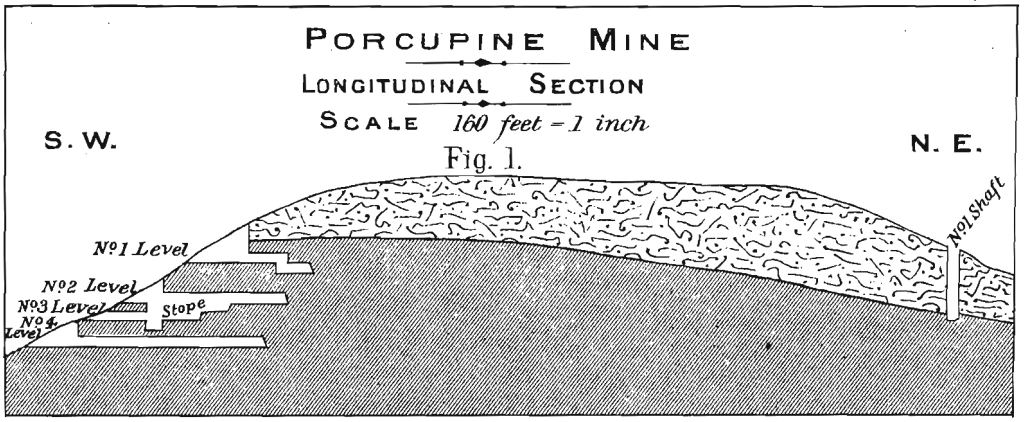
The conditions of occurrence of this group are somewhat different to these of the others situated on this line of discoveries in being further removed from the northern boundary of the formation, and from the outcrop of the lower siliceous division. They are all in the upper argillaceous division with its associated trap sheets, the argillites here being soft and black, and showing little or none of that silicification and mergence at places into the cherty rocks which characterises these beds at some other places. In a preliminary examination of the rocks of the vicinity, no developments of chert were found even in the lower levels. These rocks show, however, at the *Victoria Mine* at a point about three miles north-east from the *Beaver Mine*, alongside the road from that place to Murillo, at a level of about 350 feet below the adit of the latter mine so that the downward extension of the argillaceous beds in this district must be considerable.

Rabbit Mountain Mine.

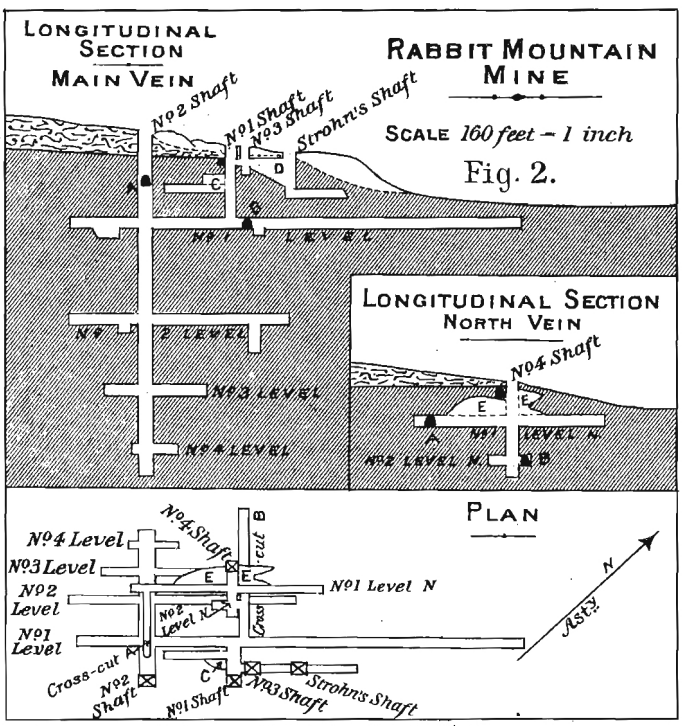
Vein characteristics.

This vein strikes N. 35°-45° E., and dips at an angle of about 65° to 70° to the N. W. The vein is a composite one, consisting of a number of branches and stringers interlaced, and is about four to six feet in thickness, although much wider in places. The ore

Plate VII.



From Sketch survey made by E. D. INGALL, M. E.



From plans and data supplied by Mr. W. C. McCOMBER.

EXPLANATION.

TRAP. ARGILLITE. CROSS-CUTS.

consists of native silver and argentite, accompanied in considerable quantity by blende with a little iron pyrites and galena, and occasionally copper pyrites in a gangue composed of quartz, calcite and green and purple fluorite. The accompanying plan and section will show the amount of work done to test the vein. (See Plate VII, fig. 2). A good show of rich ore was obtained on surface and caused great excitement in the district. On surface, the vein has been proved for a length of some 800 feet to the south-west, by two trenches and cross-cuts into the side of the ridge along which the vein runs. It is thus exposed at two places, one of which is 500 and the other 800 feet from the main shaft. At the first point the vein shows four feet thick, but the cut was not through the vein. No mineral was visible there. In the second cut a similar quartz vein showed, but it carries a little galena, calcite and green and amethystine fluorite. The vein was in the trap at this place.

The Rabbit Mountain group of veins continued.

As will be seen by a reference to the illustration, the lithological environment of the vein is similar to that of many of those already mentioned, and the developments have been made, as at those places, following the vein downwards through the trap sheet, which it intersects at the surface, into the dark colored, soft argillites below. On either side of the valley, in the bottom of which the vein has been worked, are high bluffs, showing horizontal argillites, capped again by the usual vertically columnar sheet of trap from 80 to 100 feet thick, whose contact with the supporting argillites is, on the south side of the valley, about 150 feet above the mouth of No. 2 shaft. Whether the lower trap sheet at the mine represents a portion of the upper one, brought down into its present position by faults, it is impossible to say without a much more detailed study of the ground than time allowed to be made, but it seems more likely that the trap at the mine is a separate sheet occurring lower in the formation.

Enclosing rocks.

South-west of the mine a small dyke of compact basic trap is seen to cut the argillites in the before mentioned cliff and runs up into the capping sheet of trap. It strikes about N. W., or in such a direction as to cross the vein a little to the east of No. 2 shaft, and Capt. McComber states that they crossed it in the underground workings. It is only a small dyke and can be seen cutting the lower trap sheet near the shaft, whilst above in the cliff it has apparently faulted the strata, the bottom of the capping trap being 13 feet lower on the west than on the east side of the dyke. This would seem to show that the dyke is younger than either of the sheets of trap, although it cannot be very plainly seen on the ground that it cuts the upper one whilst beyond the fact that the dyke rock may be a little more compact than

Trap Dyke.

Rabbit Mountain group of veins continued

the upper part of the capping sheet, no mineralogical or structural difference between the two is discernible by the eye, and they both appear to be compact basic traps. The argillite immediately below the upper capping trap appears to be somewhat indurated, and is paler in color than the argillites of the vicinity.

Parallel veins.

A parallel and similar vein to the last mentioned crops out about 100 feet north-west of the main vein, and dipping at a flat angle to the south-east would join the main vein a little below the No. 2 level. (See Plate VII, fig. 2, north vein.)

About 300 yards N. N. E. from No. 2 shaft and a little way beyond the mill, a vein is seen to outcrop in the base of the hill, forming the north side of the valley. It is similar in nature to the main vein, and about four feet thick, and appears to be parallel with it, both in strike and dip, and a blast put into the outcrop at this point whilst I was there showed some very good ore. The vein in this exposure has argillite for its southern or foot wall, which is opposed to the trap forming its hanging wall, which latter has either been faulted down by the vein from a higher position or is a dyke. In ascending the bluff rising to the north of this vein, the argillites are seen to occur above this again, whilst capping the whole, comes the columnar trap, which is apparently the equivalent of that on the other side of the valley.

Developments.

Figure 2, Plate VII, shows the underground work done upon the vein up to the end of May, 1887. As shown, most of the ore taken out up to that date had come from depths of 100 feet below surface and under, where shown *stoped* out at "C," "D," and "E" in the figure, but good ore has been struck in other parts of the mine below this from time to time, and I myself saw some rich ore in No. 2 shaft at No. 2 level.

Stamp mill.

A stamp mill with a capacity of fifteen tons per diem has been erected near the mine for the treatment of the low grade ore which is left after selecting out that which is rich enough to be barrelled up and sent direct to the smelters. Here the battery slimes are run over Frue vanners, and the concentrates thus taken out are sent to the smelters. Capt. McComber, who was the manager in 1886, claimed that these concentrates ran as high as $4,000 to the ton, and averaged $1,500. The slimes which pass over from the vanners are settled in tanks, and then amalgamated in pans. These slimes are said to average about 8 ounces of silver to the ton. The amalgam thus obtained is retorted in the usual manner to separate the mercury and the silver, and the latter is cast into bricks at the mine. Capt. McComber also stated that the milling ore was averaging $80 to the ton, whilst the tailings from the mill only show a content of about 1.5 oz. per

E. D. INGALL, PHOTO., 1886. IVES-PROCESS ; G. E. DESBARATS & SON, MONTREAL.

RABBIT MOUNTAIN SILVER MINE.

LOOKING EAST.

The bluffs on either side consist of columnar trap, (diabase) capping the argillites in which the intervening valley has been eroded.

ton. The mill, however, proved to have been placed in rather an unfortunate position, as it had frequently to be stopped on account of scarcity of water supply. Rabbit Mountain group of veins continued

Since its discovery in 1882, the work of testing this vein has been proceeded with in a very spasmodic manner, having changed hands several times and been worked with forces varying from two to sixty men. It stopped work recently on the 16th December, 1887. The accompanying view of this mine shows the bluffs spoken of and the position of the different buildings, etc. On the left hand side in the foreground is the shaft house over No. 2 shaft, with its dumps of ore and rock extending outwards from it, and the engine house showing just over the outer end of the nearest one. Over the top of the shaft house further away towards the north bluff is the mill building. All the rest are dwelling houses, etc. History of mine. View of mine.

Rabbit Mountain Mine, Jr.

This name has been given to the workings on a vein which crops out on the adjacent property to the last mentioned about 400 fteet N.W. from No. 2 shaft. It is about four to five feet thick, striking parallel with the *Rabbit Mountain* vein, and dipping towards it at an angle of about 75°. The vein-stone consists of calcite and white and amethystine quartz, with pale green fluorite, and carries blende, copper and iron pyrites. It outcrops in the same bed of trap which is seen at the *Rabbit Mountain Mine*, but owing to the ground rising about fifty feet from that point, the seventy-five feet shaft sunk on it had not at that time penetrated to the argillites below, which would probably account for the fact that the work done seems to have yielded little silver.

Porcupine Mine.

Here a fair amount of development work has been done on a vein which strikes about N. 65° E., dipping S.E about 75° to 80°, and has a thickness of from two to five feet. Its contents are similar to those usually found. The fluorite is coloured both green and amethystine, and the quartz often assumes the latter colour. A special mineralogical feature of this vein is the occurrence of the carbonate of barium or witherite, a specimen of which was analysed in the laboratory of the Survey by Mr. Hoffmann, who says "So far as I am aware this is the first time that this mineral has been met with in Canada" (See Report of Progress, 1885, page 29 M). The peculiar talcose material which occurs in some of these veins is also present here to a certain extent occurring in con- Vein characteristics. Witherite. Talcose material.

Rabbit Mountain group of veins continued

nection with the ore bodies. It consists of a white or pale green material impregnating the vein stuff, which is quite soft and greasy when first taken out, but afterwards dries and hardens. The bulk of the silver occurs in the form of sulphide in nugget and leaf form, which is accompanied by a small proportion of metallic silver in wire and mossy form.

Enclosing rocks.

The enclosing rocks of the vein are as usual black argillites, capped on top of the hill with a sheet of dark compact diabasic trap. The faulting of these rocks by the vein has not been so great here as in some cases, only amounting to some 16 feet downthrow on the east side as seen in No. 1 shaft, which at the time of my last visit was down 57 feet, the junction of the argillite and trap being met with at 35 feet on the foot wall, and 51 feet on the hanging wall side. As shown in plate VII, fig. 1, nearly all the development works have been made in the vein where it cuts the argillites.

History.

This work was commenced in the spring of 1884, and has since been continued spasmodically with long intervals of inactivity, owing to the intention of the owners having been to simply prove the value of the vein with a view to sale, and not to work it. Mr. T. A. Keefer, one of the owners, states that about $10,000 had been expended on this vein to date, which expenditure had been more than repaid out of the proceeds of the sale of the ore obtained.

Beaver Mine.

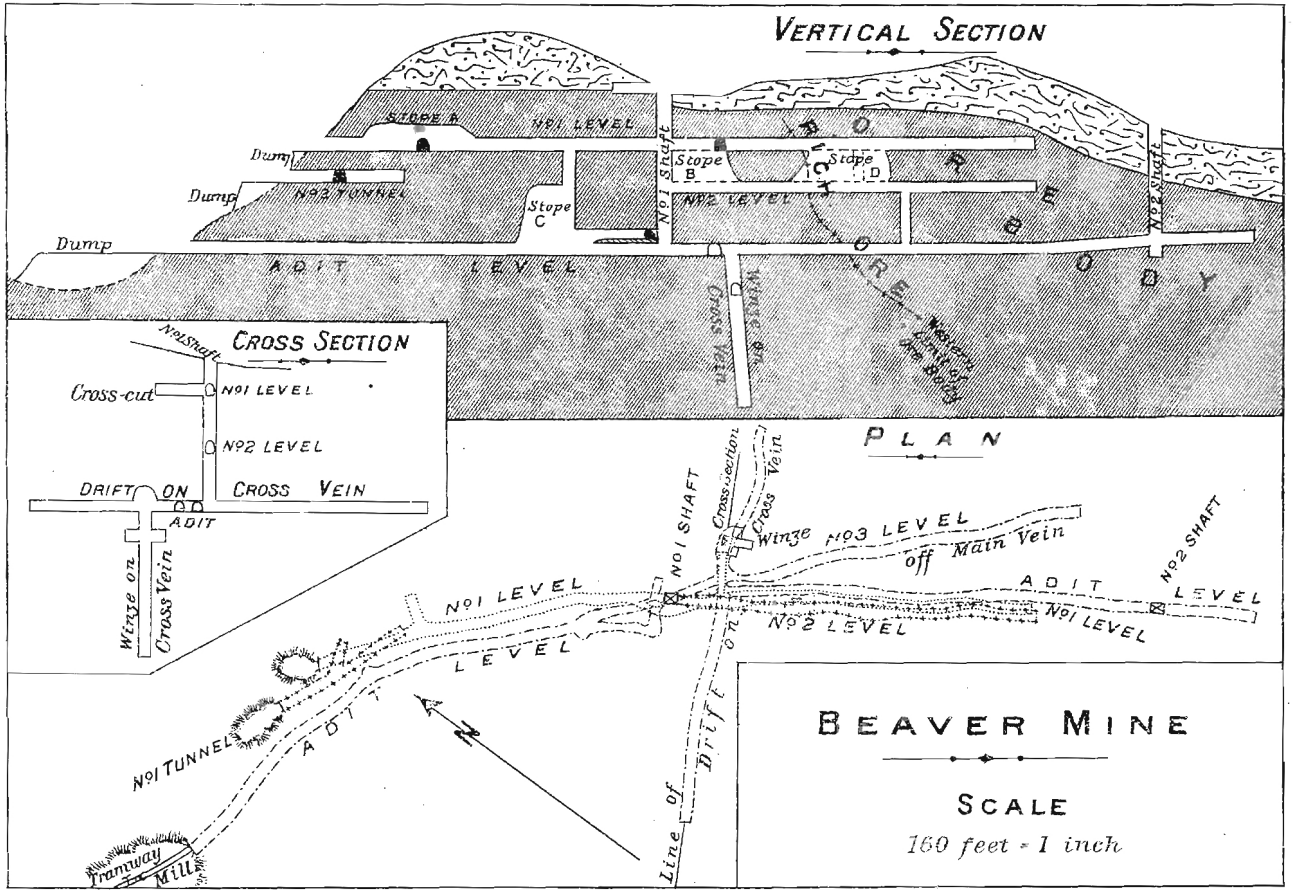
Vein characteristics.

Two veins have been worked on in this mine. The main vein cuts in a northwesterly direction across a ridge about 200 feet high having a steep bluff face to the N.W., whilst it is intersected about 300 feet in from the face of the ridge by a cross vein running in a northeasterly direction or parallel to that face. The cross fissure is very irregular and hard to follow, varying from a few inches in width to almost nothing. It was drifted on in No. 1 level for a short distance, and followed also on the adit level below for a distance of about 350 feet, but being very irregular, and only carrying a little mineral here and there, it was not considered profitable to follow it any further. The main vein has an average width of about four feet, although in parts of the mine it has pinched out to a mere thread. The contents are, as usual, yellow and dark coloured blende, with some iron pyrites and a little galena in a gangue consisting for the most part of calcite with some colourless and amethystine quartz, and a little fluorite which is generally green, but occasionally purple. The silver occurs in the ore bunches chiefly as argentite, in nugget, sheet and leaf form, with occasionally a little native silver. A marked peculiarity of this vein

Cross-vein.

Silver ore.

Plate VIII



From measurements made by E. D. INGALL, M. E., Plans supplied by Mr. E. COSTE, M. E., and Section published by the *Thunder Bay Sentinel*.

EXPLANATION.

TRAP.

ARGILLITE

CROSS-CUTS.

is the occurrence of the greasy talcose substance which is very abundant in the orey parts of the vein occurring in the fissures and cleavages of the gangue minerals, and surrounding pieces of argillite enclosed in the vein. It is very soft when first taken out, but hardens somewhat on exposure to the air. It occurs as white pearly films and incrustations, and also as pale green matter filling interstitial spaces. Some of this latter kind was examined qualitatively in the laboratory of the Survey, and Mr. Hoffmann says that the examination made showed it to be talcose in its nature, but that properly it was neither talc nor serpentine, as it was found to contain too much water for the latter. It is most likely closely allied to the mineral saponite, a hydrous magnesian silicate mentioned by Dana as occurring in the traps of this region. The ridge spoken of consists of black soft argillites from its base to within about fifty feet of the top from which point the rock is trap of the usual kind. The rocks have been faulted slightly by both veins.

Rabbit Mountain group of veins continued

Talcose material.

Enclosing rocks.

The work done in testing and opening up the vein is best appreciated by a reference to Plate VIII* which shows the developments to the spring of 1887.

Developments.

The history of this mine has been a very instructive example of what difficulties are to be met with in developing the veins of this district, and how they may be overcome by pluck and energy. The vein where first discovered on the brow of the hill, was solid and well defined, and where it passed down into the argillites below the trap, some good ore was obtained. In the drifts in the upper part of the mine it retained its definite characteristics, but in opening up upon it lower down in the adit level, considerable difficulty was experienced in following it, and it was found to be small and irregular, and for long distances was represented by a mere seam until the cross vein was reached and also for some distance on the other side of it. At the time of the last visit made drifts were being driven either way on the cross vein, with a view both to test it and also to cross-cut for the main vein to see if it had been by any chance left on either side in driving the adit level. This indefiniteness at this point seems to have resulted in the drifting of No. 3 level beyond the cross vein off the course of the main vein, as will be seen in the plan. Finding nothing but a small stringer in this direction, surveys were made, a course which should evidently have been adopted long before, and these having shewn what a very wrong direction the drift was taking to strike No. 2 shaft, where the vein showed definite and strong, a fresh start was made from the drift on the cross vein, and the adit level as well as Nos. 1 & 2 levels above, were driven forward to connect with No. 2 shaft, with the result that

History of mine.

* On this plate No. 1 Tunnel in Plan should be No. 2.

Rabbit Mountain group of veins continued

the vein was found to become strong and definite, and the body of very rich ore* was found which has made the prospects of the district look so much brighter. This vein was discovered shortly after that at Rabbit Mountain, and work was commenced on it by the owners to test it in the fall of 1884. This was continued with a small force of men until the sale of the mine to an American capitalist, who proceeded at once to equip it for work on a larger scale, and to open up the vein with most commendable vigour, with the results before mentioned.

Stamp mill.

A mill has been erected about half a mile from the mine, on Silver Creek, to treat the lower grade ore which occurs with the smelting grades. It has a capacity of about thirty tons per diem. The rock, after passing through the rock-breakers and two patent pulverizers,† is carried by the water over four Frue Vanners and a Golden Gate concentrator, whilst the slimes from these pass into settling tanks, the deposits from which pass to the amalgamating plant on the lower floor, which consists of two amalgamating pans and the accompanying settling pans.

Shipments of silver.

Some idea of the richness of the ore body mentioned may be gleaned from the following statements made by *The Algoma Miner and Weekly Herald* of August 27th, 1887, where it is stated that "the total value of the products of the Beaver mine for the past two and a half months in smelting ore and concentrates from the mill is $93,000. This may be relied upon as being authentic." There is every reason to believe this to be correct, as I am informed that the Customs export entries for Port Arthur showed that $190,000 of ore were exported during 1887, the greater part of which certainly came from this mine.

Silver Creek Mine.

Vein characteristics.

This is yet another vein in which silver has been found. It is from two to three feet thick, and strikes about N.E. in practically the same direction as the *Porcupine* vein, and for the slight depth to which it has been followed is about vertical. The preponderating mineral in the vein stuff seems to be calcite, which is accompanied by a little colorless quartz and some green fluorite. The unbroken part of the vein did not present much mineral to the eye, but the ore pile, which contained some eight tons, and had, I understand, come from the bottom of the shaft, where they get all their silver, contained the usual

* The value of the ore in sight in this body in the fall of 1887, has been variously estimated at from $1,500,000 to $3,000,000. The most reliable authorities, however, estimate it nearer the lower figure.

† I understand that since the date at which the mill was visited, stamps have been substituted for the patent pulverizers.

metallic minerals, viz., blende, both light and dark coloured, with some pyrites and a little galena, whilst the silver showed in the form of leaf and film argentite. Rabbit Mountain group of veins continued

The vein runs into a little ridge consisting of argillite capped with trap, which rocks have been faulted by the vein, the capping trap showing on the east side of the vein at the edge of the ridge, argillite being opposite to it on the other wall, the remainder of the trap sheet being most probably higher up on the other side, where the cover on top of the ridge prevents it from being seen. Enclosing rocks.

The test work done here has not been extensive, consisting of only a 75-foot tunnel driven into the base of the hill, on the course of the vein, at a depth of about fifteen feet below the bottom of the before mentioned trap, from the middle of which tunnel has been sunk a small test pit said to be 70 feet deep. This work was first prosecuted by the original owners, in the summer of 1885, who sold an interest shortly afterwards to the same American capitalist who owned the *Beaver Mine*. Under the new owners a little more work was done, with the result, as asserted by Mr. Crowe, under whose guidance it was done, that good ore was struck in the bottom of the shaft. The ore on the dump purporting to come from this point showed enough silver to class it as good mill rock. The energies and attention of the owners being required in the development of their other mine (the *Beaver*), work was discontinued on this vein until a more convenient season. Mr. T. A. Keefer, one of the owners, says that the total amount expended was about $3,000, and that the total value of the ores taken out, some of which was sold and some left in the dump, about covered this expenditure. Developments and results.

Little Pig Vein.

Through this property runs a high ridge, with a bluff facing north-west, a few chains from the base of which and parallel to it runs the Colonization road, connecting these mines with Port Arthur. A little way from its base and parallel to this bluff runs the vein which is known by this name, with a strike of N. 50° to 60° E. (mag.), and dipping about 70° to 80° to the S.E. It shows a thickness of six feet in some places, whilst in others it is split up so much as to leave the question of its thickness undeterminable. The vein-filling consists in places almost altogether of coarsely crystallized calcite, whilst at others a saccharine and crystallized white and amethystine quartz predominates, calcite playing a secondary part and being accompanied by a little purple fluorite, whilst the metallic minerals are represented by light coloured blende and galena. At places the vein is quite rusty from the decomposition of iron pyrites. Vein characteristics.

Rabbit Mountain group of veins continued

The bluff consists of the usual dark colored argillites for 125 feet above its base, on top of which rests about 20 to 30 feet of columnar compact blue-grey trap, which sometimes carries a little iron pyrites.

The work done to test this vein to the end of 1886 consisted of three small tunnels driven into the base of the bluff to cross-cut the vein at about 40 feet below its out-crop on the side of the ridge. These are about 200 feet apart, and from their ends a small amount of drifting has been done on the vein amounting in all to about 60 feet. This work was commenced in 1885, but most of it was done after September, 1886, at a cost, it is said, of about $1,500.

Elgin Vein.

About half a mile to the north of the *Beaver Mine* a vein has been located, named as above, which strikes about E.N.E. and dips at about 80° to the N.W. It consists of a number of parallel stringers distributed through a width of about ten feet of the enclosing argillite, which rock is capped by trap about thirty feet above the outcrop of the vein. The metallic minerals, which are very abundant and mostly crystallised, are represented by light and dark coloured blende, with galena and copper and iron pyrites in a gangue consisting mostly of white and amethystine quartz, with some dark purple, white, and light yellow-coloured fluorite and a little calcite. A 30 foot shaft represents the testing work done on the vein, which does not seem to have shown the presence of much rich ore, although the occurrence of silver in the other metallic minerals present, was demonstrated by an assay of some of that class of ore, which was made at the *Silver Mountain Mine* assay office, and gave $10 to the ton, as stated by the owner.

Other Veins.

Besides those already mentioned, many other similar veins have been located, upon which more or less test work has been done. The most important of these are known as follows: *R 48*, *Big Bear*, *Beaver Jr.*, *Badger*, *Rothwell*, *Peerless* and *Victoria*, all of which, with the exception of the first, are shown upon the Sketch Map.

R 48 is a vein cutting the east face of Rabbit Mountain about three-quarters of a mile north of the *Rabbit Mountain Mine*. On the *Big Bear* vein, which was located in 1886, a fair amount of development work has been done, and it is claimed that samples of ore obtained from the outcrop assayed from $8 to $124 per ton. The name of *Beaver Jr.*, has been given to a vein about one-quarter of a mile north of the

Beaver Mine. It is one of the south-easterly dipping series. The *Badger* is a south-easterly dipping vein on which test work is being done by American capitalists. On the *Peerless* vein, a small test shaft was sunk in the summer of 1886. The *Victoria* is the name given to a vein on which some little surface work has been done, which yielded vein stuff in which the metallic minerals were plentiful, but which at the points opened upon, does not seem to have yielded on assay more than a few dollars to the ton of ore. The veins at the two latter places are in a much lower horizon than the rest, being in the siliceous division underlying the black argillites.

Rabbit Mountain group of veins concluded

The Silver Mountain Group.

This group received greater attention and closer study than the others with regard to the lithological environment of its veins, the details of which are represented in the accompanying contoured map of that district, which whilst, of course, specially illustrating the conditions of occurrence of this group, yet apply also in many particulars to the rest of the silver districts.

Method adopted in contouring map.

The rocks lying so nearly flat, it was deemed advisable, in constructing a map shewing this lithological environment, to contour it so that the vertical relationships of the different beds might be apparent at a glance. In a rough country such as this, and with the difficulties and delay consequent upon this roughness, this object could not of course be accomplished in any reasonable time with very great accuracy, and a method had to be adopted which would give reasonable results with the necessary rapidity. This was accomplished by levelling along the Colonisation road with an ordinary Y level, and leaving B.Ms. where it crossed the location and township lines. The profiles of the country were obtained over the rest of the area by levelling over the location and township lines with a hand-level and target staff, and connecting these as often as possible with the road B.Ms. when in calculating the results any discrepancies (which were not found to be very great) were distributed over the whole series in such a way as to be very slight at any one spot. The positions of the intersection of the contour planes with each profile having been worked out and transferred to the map, the contour lines were joined up in between points with the help of the general knowledge of the surface shape of the ground gained in the examination of the district.

Vertical sections of map.

The geological structure of the country, as worked out by the help of these levels, is shewn in the two sections given below the map, which speak for themselves. The upper one has been made nearly parallel to

Stratigraphical relations of rocks of district.

the direction of the greatest dip of the formation as far as it can be determined, and shows the Animikie rocks resting in a nearly horizontal attitude on the Archean rocks to the north. Passing through Silver Mountain it shows the upper argillaceous division resting on the lower cherty division and overlaid by the sheet of trap forming the top of this hill, whilst the measured displacement of all these rocks by the two chief veins intersecting the hill, is also apparent. The lower section is approximately parallel to the line of strike of the silver-bearing rocks, and shows the different levels of some of the principal trap sheets of the district. Assuming that there has been no faulting of the measures, other than those visible and measureable ones produced by most of the veins, this difference of level along a section practically parallel to the line of strike, must represent actual differences of geological position, and as in the study of the other parts of the Animikie area, such undoubted cases have been frequently found of trap sheets occurring at various geological horizons in these rocks, not to refer to the local evidences to be mentioned later on, it was not considered reasonable to assume the existence of a number of dislocations of considerable extent to account for these differences of level, of the existence of which dislocations no other evidences could be found.

Trap at different levels in formation.

Correlation of different trap exposures.

Whilst it is therefore apparent that many of these different exposures represent individual and separate sheets of trap at various geological horizons, the correlation of some of the trap areas with each other seems reasonably possible. Thus, Table Hill and Wedge Hill areas are probably simply outlying patches of the sheet that caps the argillites of Brulé Hill, this sheet lying above the Palisades sheet, and some hundred feet of the argillite being interposed between the two. Again, it seems more than probable that the trap sheets capping Silver Mountain, Silver Bluff and Boundary Hill are all portions of the same sheet. The Divide Ridge sheet would seem to dip under Silver Bluff, unless its south side has been let down by a fault passing through the valley between them, which might possibly be a fault of the existence of which there is some evidence at Contact Ridge, where the beds of the lower division are seen turned up into an almost vertical position against the Archæan rocks. In the case of the other areas, there is no reason to suppose but that they are sheets of trap of varying extent occurring at different places in the formation. From their irregular nature, the extent of those where only the top of the sheet is seen, the rest being covered up by surface deposits, can only be conjectured, the areas where this occurs are shown by the drift color on the map. There are fourteen areas of trap shown on the map, which I shall speak of as Brulé Hill, Wedge Hill, Table Hill, Outlook

Hill, Palisades, Silver Falls, Silver Hill, R 93, R 63, R 160, Silver Mountain, Boundary Hill, Silver Bluff and Divide Ridge traps. Two of these are undoubtedly intrusive, viz., Palisades and R 93. At the former place, the sheet can be distinctly seen in the cliff, as represented in the section, to divide into three tongues in passing eastwards, with argillites between. The lowest one thins out and stops in a short distance, whilst the upper and middle ones continue on, and form the upper and lower benches of the eastern end of the hill. Had these been separate flows, with deposition of sediments in hollows on their upper surfaces, there would be now some recognizable line of division, such as can be seen between the different trap flows of the Keeweenian rocks, even where they are separated by no sedimentary beds. But a careful study on the ground showed no such visible division. That there is no recognizable alteration of the argillites overlying the lower sheet, might be considered to disprove their intrusive nature; but when one sees that neither is this the case with those lying immediately below the same sheets, that such alteration is very seldom seen at any similar contacts over the whole region, and that where it does occur, it is slight, and extends over only two or three inches of thickness, and might therefore be easily overlooked, then it is plain that this negative evidence is of no account.

Description of trap exposures

Intrusive sheets.

The R 93 ridge consists of a sheet of the ordinary trap in the lower cherty rocks. It presents some peculiar features, which render its true relationship to the enclosing rocks very difficult to make out, on account of the absence of any sharp line of demarcation between the two, the cherts near the trap seeming to have taken on some of its nature. This will be seen on referring to the notes of the microscopic examination of the rocks, given in Appendix I. The sheet, which in the middle of the north face of the ridge is some fifty feet thick, showing the usual vertically columnar structure, seems to thin out going south, and in following it round the ridge both on the west and east sides. The specimens 317, 318 and 319, Appendix I., were got from the ridge near the south-east corner of location R 93, where there seemed to be three distinct layers of rock—317 representing the middle one, 318 the lowest, and 319 the uppermost. Specimen 320 came from some chert-resembling beds lying on top of the trap sheet at a point about a quarter of a mile north-west of the last-named, whilst 325 is from a similar position at a point about a quarter of a mile west again from the latter place. No. 325 seems to be the only typical chert amongst them, several of the others probably owing their peculiar mineral composition to an injection of trap material

R 93 ridge rocks.

amongst their particles at the time of the intrusion of the sheet. Specimen 323 is from the undoubtedly trappean part of the sheet. Typical beds of the lower division rocks appear both above and below this, all around. Judging from the irregular occurrence of this sheet, its wedge shape, and the alteration of the beds above it, it can be safely asserted that it is an intrusion.

Irregularities of contacts of trap and sedimentary beds.

Irregularities of the lines of contact of the trap with the underlying sedimentary beds are also seen at other places, one of which is shown in the illustration entitled "Trap Flow on Argillites, Animikie Series," where it will be seen that the contact of the trap and argillites is much lower on the left-hand side of the picture than on the other, and this without any signs at the place of any faulting. This might of course be explained by supposing the trap to have flowed out over an eroded surface of the argillites; but in view of the number of other evidences in this district of the intrusive nature of these sheets, it would seem more probable that this is due to the same cause, and that the intrusion has passed from one plane to another in seeking the path of the least resistance. A similar case to this was noticed on the southern edge of the Silver Mountain sheet, and also at the R 160 ridge; but owing to the exposures being nearly covered with detritus, they were not so plain as the one illustrated, which is on the north side of Brulé Hill.

The surface of this latter hill slopes away to the south, where at an estimated distance of about three miles, a high hill is seen to rise apparently composed of the argillaceous division beds, in which several trap sheets can be seen, all of which from their position would overlie the Brulé Hill trap.

Others trap exposures.

Of the other trap areas there is little to say. Outlook Hill appears to consist altogether of trap, but there is so much cover on top that it is hard to say whether some argillite may not be found capping it. The Silver Falls sheet only shows where the creek falls over it, and for a little distance around, with a smooth ice-grooved surface, being otherwise hidden by surface deposits, so that its extent must remain conjectural. It shows a thickness of 25 feet in the falls without the bottom showing. The R- 160 trap would seem to overlie the R. 63 sheet, with a slight development of the argillites in between, the latter sheet being traceable down to within a short distance of the former, and seeming to pass under it.

The levels of the lower surface of the Silver Mountain sheet were accurately ascertained at many points all around the hill, and when worked out, seemed to point to a very irregular under-surface. A curious thing bearing on this question is noticeable at Lizard Lake, at

the eastern end of which are visible a few feet of the argillites with the usual columnar trap on top, which would seem to point to considerable irregularity in the under-surface of the trap in this vicinity.

It is a curious fact that none of the dykes, which must certainly exist here, have yet been located, which contrasts forcibly with the coast section with its numerous examples, and it would appear that in the Silver Mountain area they must have weathered away more easily than the surrounding rocks, and so be covered up with the drift.

Microscopical characters of traps.

The nature and lithological affinities of these rocks will be seen by referring to Appendix I, where notes of their microscopical features will be found, (See specimens Nos.,259, 301, 323 and 338,) from which it would seem that they can all be classed as diabases. They vary from very compact dark-colored resinous rocks to medium coarse-grained greyer varieties, these differences showing in different parts of the same sheet, so that no distinction can be made between them in this way. About their field habit there is nothing peculiar, except that they are massive rocks nearly always showing a characteristic vertically columnar structure, sometimes accompanied by horizontal joint planes.

Sedimentary rocks.

Difficulty is also experienced in correlating the different exposures of the sedimentary rocks of the formation, owing to the fact that they seldom retain, for any considerable distance, characteristics by which detached portions of the same bed might be recognized, so that it is only by the general concensus of the evidences that an opinion can be formed of their relationships.

The separation of the rocks into an upper and lower division has been spoken of already earlier in the report, so that nothing remains but to describe the local characteristics of the various exposures of the different kinds of rock within the area under review. To begin then with the lower division, it consists in this district almost altogether of the siliceous rocks, which, whilst presenting great varieties of appearance, have all certain characteristics in common. In association with these are certain dolomitic and calcareous layers. On the map they are represented by the lightest shade of Payne's grey, the gradual mergence of this color into the darker tints, representing the upper division, being intended to show the absence of any sharp line of demarcation between the two divisions.

Lower division.

A study of these rocks in the field, coupled with the microscopic examination of a number of thin sections of different varieties, reveals the facts of their origin. They are seen to have been fragmentary rocks, consisting of rounded and sub-angular fragments which have been subsequently changed very much by the deposition of infiltration-products around their constituent particles, this action having gone so far

sometimes as to change the particles themselves and almost entirely obliterate them. A very good description of their microscopic characters is given in Appendix I. (See specimens Nos. 281 and 325.) In the field they are found to present very various appearances, the same bed to a superficial observer looking quite different at different points not far removed from each other, sometimes appearing quite granular and at others quite compact. They also assume very various colours—grey, light green, black, rusty, etc. Some of them on weathered surfaces are all pitted with little cavities which have hackly surfaces, from which atmospheric influences have removed some soluble mineral, leaving considerable hydrated iron oxide. All varieties contain more or less iron, either in the form of hydrated peroxide, giving them a general rusty appearance, or as magnetite, the percentage of the latter sometimes ranging so high as to give the rock a very high sp. gr., which together with the dark compact fracture so produced would cause the careless observer to mistake it for some of the compact varieties of the trap of the neighborhood. They sometimes also contain iron in the shape of pyrites.

Microscopic characters of cherts.

Ferruginous cherts.

The interstitial matter nearly always consists of silica, which on weathered surfaces, stands out as a fine reticulation from the removal of the more easily soluble particles. When, however, this interstitial matter consists of calcite, as it sometimes does, the reverse is found to be the case, and the particles are left projecting. In these granular varieties the particles seem to be very constant in size, varying from 0.02 to 0.06 of an inch in diameter. Imbedded with these more plainly fragmentary beds are sometimes rusty brown earthy layers, and also compact flinty layers of a black, brown, red, milk-white or green color. Microscopically, these latter can be seen to be due to the action of the infiltrating waters having gone so far as to completely or almost completely merge the particles into the general mass of the replacing silica. The various stages of this process can often be seen in the same specimen or thin section. In some cases ,traces of the original particles are left, as a white, red or brown mottling of the stone, whilst, when the mottling is red on a dark green ground, a very ornamental stone is the result. These varieties sometimes show a wavy, somewhat agate-like, structure, and occasionally crystals of calcite are distributed through them porphyritically.

Infiltrated silica.

Wavy bedding. A very constant and marked feature of the more granular beds is their wavy, irregular bedding, which, together with the general rusty appearance and the reticulation on the weathered surfaces already spoken of, constitute their most salient features. These beds are at places much broken up and fissured, the cracks being filled with crys-

tallized white secondary silica, super-imposed upon which, in one instance in a vug, were found rust-colored rhombohedra probably of altered ferruginous dolomite. An anthracite-resembling mineral is also found occasionally in these rocks in a similar relationship, and one specimen shows nodules consisting of concentrically arranged chalcedony surrounded by radiately crystallized vitreous quartz, with angular fragments of a similar nature imbedded in this anthracitic mineral.

Dolomitic and calcareous layers.

The calcareous and dolomitic portions are only developed to any extent locally, although the whole formation contains more or less of these minerals distributed through it. These beds where developed present a dark grey or cream coloured fracture, the weathered portions being generally very rusty, They often enclose fragments, nodules and sheets of jasper with hackly exterior surfaces, and present other curious features. One specimen, for instance, has the appearance of a conglomerate, and is made up of round pebble-shaped portions of a dark slate colour imbedded in a lighter coloured crystalline matrix, which on exposed surfaces is weathered away, leaving the pebbles standing out. They both effervesce with acid, the matrix, however, more freely than the other portion.* Another specimen is somewhat similar, but the dark imbedded portions are platy and angular, looking more like broken fragments of a thin bed, and though soft enough to scratch with the knife, and generally resembling the dark pebbles of the first mentioned, will not effervesce with cold acid.

From these and other appearances, it would seem that these dolomitic and calcareous layers are most likely due to a similar process of alteration and infiltration to that which has acted in the silicification of the rest of the beds and, that whenever this process of dolomitisation was going on in a bed whose composition and structure admitted of it, and which enclosed thin seams or portions not amenable to these changes, the crystallising power of the carbonates has broken these portions into fragments which have thus got distributed through the mass in such a manner as to form breccias, etc. The want of homogeneity of these dolomitic layers is well shown by the streaky structure brought out on exposed surfaces by weathering.

Dip of Formation.

With a few exceptions, which will be seen by reference to the map and are due to local causes, these lower division beds are found dipping at low angles. The most notable of these exceptions occurs towards the south end of Contact Ridge, where they show in the bed of a stream in an almost vertical position at the foot of a cliff of granitic gneiss.

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* Mr. G. C. Hoffmann, who recently made a chemical examination of such a specimen, found that whilst the nodules or pebbles were distinctly dolomitic, the matrix contained no magnesia.

They here consist of brownish red jasperry layers, interleaved with green chloritic slaty portions, which have a resinous lustre on the bedding plane.

Basal conglomerate.

Patches of a basal conglomerate are occasionally found lying in hollows in the old Archean sea-bottom near the northern fringe of the Animikie formation. The imbedding paste is dark, and whilst containing some carbonates, does not in general effervesce with acids, whilst the fragments which are mostly sub-angular, seem to consist in general of granitic material.

Upper division rocks.

The upper division rocks consist nearly altogether of soft, black argillaceous rocks, which, where the bedding planes are numerous, put on a very shaly appearance. The dark colour seems to be due to the presence of carbon in some form as on ignition they lose their blackness and assume a dark buff tint. The amount of contained carbon, and consequently their colour varies very much at different places even in the same bed, at some places being considerable, as at the *East End Mine* at Silver Mountain, whilst at others the lesser amount present causes the argillites to assume more of a grey-slate colour. A very common but a very unequally distributed constitutent is calcic carbonate, and layers of a purely calcitic and dolomitic nature are developed in these upper beds in a very similar way to those mentioned as occurring in the lower division, which is exemplified in the argillites underlying the trap of the R 160 ridge. The large *bombs* which have been mentioned by other writers as occurring in these beds are frequently found to effervesce with acid and are probably concretionary. This idea is borne out by the fact of the concentric arrangement of the pyrites which is found in them, and which generally shows when they are broken across arranged as a ring parallel to and near the exterior surface. Seen in place, the bedding planes of the enclosing argillites are found to bend up around the spherical ones, whilst in the more lenticular, apparently only partially grown examples, very similar effects are observable.

Bombs.

Silicified argillites.

At some places, whilst the argillites retain their general colour and appearance they are found to be hard from silicification, and sometimes in thin chips show dark rounded grains surrounded by transparent crystallised silica. Again, portions of beds which are at one place typical dark, soft argillites, at other places very nearly approach in appearance the lower cherty division rocks, as in the instance of the beds immediately underlying the trap of Silver Bluff which, in their composition and appearance, resemble much more closely the latter than the former,* whilst stratigraphically they appear to occupy the

* See Appendix Specimen No. 303.

position of the westward extension of the pure argillitic upper beds constituting Silver Mountain.

For this reason they have been colored on the map, an intermediate tint between those appropriated to the upper and lower divisions. The reason for thus correlating them with the Silver Mountain beds, is found in the fact, that they lie similarly between a trap sheet which is evidently part of that capping Silver Mountain and the top of the cherty division proper. In the Silver Mountain section at the north-west corner of location R 83, the top of these cherty beds is marked by the occurrence of some compact milk-white, red and black jaspery beds, which are also traceable east, through location R 64, whilst similar beds are found underlying these Silver Bluff upper division beds about the north-east corner of location R 65. A curious rock occurs at this place immediately under the trap sheet, whose microscopic characters are described in Appendix I. (See specimen No. 302). It seems to be due to a mingling of some of the trap material amongst the particles of the sedimentary beds immediately adjacent to it, either by original injection or subsequent deposition by waters infiltrating through the trap sheet above, and is somewhat akin to the rocks described from R 93 ridge. Sometimes the silicification has been confined to small portions of these upper beds when we get as shown in the Divide Hill section, the usual soft black argillites with seams and beds of red jasper through them. At the western end of this ridge, which, extending along the north shore of Whitefish Lake, forms the divide between the water-sheds of the Pigeon and Whitefish rivers, this is well shown, lenticules and more continuous bands of red and white chert occurring between the bedding planes of the more argillaceous parts, which bedding planes bend up over the lenticules, producing a general waviness of the bedding approaching that exhibited by the typical lower cherty rocks. I noticed in these jaspery and cherty seams the curious vertical tubular cavities which have been mentioned by previous observers. They have a curious hackly inner surface, and are filled with iron rust as are also numerous little fissures which run from side to side of these seams.

Partially silicified upper division beds.

In fact, the sedimentary beds of this formation, as they appear in the district under consideration, and also as far as observed along its northern fringe, both east and west of this, would seem to have been originally deposited as a series of sands and clays, the former largely predominating in the bottom, and probably near the edge of the basin of deposition, and becoming less prominent and extensive away from this edge, whilst above a certain ill-defined horizon, the clays would form the great bulk of the deposits, and preponderate more and more

Probable origin of sedimentary rocks.

as we pass away from the edge of the basin. As one would expect in the clay deposits proper, there would be occasional beds of sand, and in the sandy parts, beds of clay, whilst there would also be beds of sandy clay, and this intermixture would be more frequent as the fringe of the area of deposition was approached. Subsequent infiltration of chemical waters would then produce just such a state of things as already described. The clay beds being impervious would remain unaltered and be now represented by the soft black argillites. The sandy clays would become partially altered and produce the intermediate beds, whilst the sandy beds being quite permeable, would offer no resistance to complete alteration into the different varieties of cherts described, and when this alteration had gone so far as to quite obliterate the particles, we should get the jaspery beds.

These sands would seem, so far as a microscopic examination has gone, to be just such as would be produced by a disintegration of the older Archean rocks, especially of those of the Huronian division of them, and the varying composition of the sands produced from such a variety of rocks would, when decomposed by the infiltrating waters, account for all the various decomposition products observed in their miscroscopic sections and otherwise, such as silica, calcite, dolomite, various decomposition minerals of felspar and hornblende, etc., oxides of iron and so on, and would besides this also account for the varying extent of the alteration produced at different places, the mineral constituents of some of the particles being more readily alterable than others, and supplying by their decomposition a corresponding variety of material.

Archean rocks of district.

As shown, the Archean rocks project from the north into the area covered by the Silver Mountain map. Exposures are not very frequent over this area, which is largely drift covered, but where these rocks do show, they present the characteristics of the great division of rocks known as Laurentian. This mass may be said, in general terms, to consist of granitic and gneissic rocks. They have a general pink appearance, from the great preponderance of pink felspar. Occasionally they carry some hornblendic mineral, which, sometimes shows as locally developed bands of schist. Both the gneissic and the granitic variety are at places intersected by a reticulation of veins of a rock which is composed of quartz and pink felspar, the latter largely crystallised and predominant. These veins cut across the foliation of the rock in all directions, sometimes running with it for short distances, and then crossing to another foliation plane. Where they cut narrow and identifiable bands of gneiss they appear to have faulted, them. In one instance, the edges of a hornblendic schistose band, thus

apparently faulted, were turned towards each other on the different sides of the faulting vein. A description of the microscopic characters of a specimen from these rocks obtained near *Woodside's* vein is given in Appendix I. (See specimen No. 277). These Laurentian rocks having been so well and fully described at various times in the publications of this Survey, nothing more need be here said.

As before pointed out, the drift deposits cover all the lower lying country, the rock showing only occasionally. As far as such a thing is possible, the area covered to any extent by these drift deposits has been represented on the map, but it is hardly necessary to point out that in such a section of country this can be done, only with an approach to accuracy. Drift deposits.

They consist of stiff white clay, sands and gravels. The former seems to preponderate in the greater part of the area forming the basis on which rests the soil. The latter are well seen in the banks of Whitefish River, where exposures frequently fifty to one hundred feet in height are presented, consisting either altogether of gravel or more frequently of clay, sand and gravel interstratified, and containing boulders of granite, gneiss, trap and chert, with occasionally argillite, whilst at one place, veinstone was noticed to occur. These boulders are in most places very numerous.

The general surface of the drift deposits in the valleys would seem to be about 300 feet below the tops of the hills, below which level again the streams have cut deep valleys with steep sides, often 100 feet high, this surface being also further cut up by steep sided gullies forming water courses in the spring, but otherwise dry. The depth of the drift covering represented on the vertical sections appended to the map has been assumed from the data furnished by the sections afforded by these stream valleys.

In passing down the bed of the Whitefish river, and at some other places, several ice polished surfaces of rock were met with, on which the striæ were found to have the following directions at the different places observed:—N. 70° W., N. E., N. 80° E., N. 70° E., E. & W., N. 60° E. Glacial striæ.

Silver Mountain Vein.

This vein cuts through the middle of the hill of that name, with a general direction of a little north of east, whilst it dips to the northward at 80° to 85°. It has caused the formation of two indentations in the general contour of the hill, the one on the east side being comparatively slight, whilst on the west side about half a mile of valley has been denuded out adjacent to the outcropping of the vein. It is a Silver Mountain group of veins.

The Silver Mountain group of veins continued.

very strong and persistent fissure, showing at frequent intervals right across the hill for a distance of over a mile, appearing to split up at either end and become less strong, and also to change its direction, as shown in the map, where, at its eastern extremity, it is seen to strike about N.E. after leaving the brow of the hill, whilst at the western end it would seem to split up into two branches, both of which take a much more northerly direction than the general strike of the lode, throughout the greater part of its length. The change of strike which would result from the descent from a higher to a lower level, due to the dip of the vein, would not be nearly sufficient to account for this change of direction, which is possibly due to the dying out of the fissure at either end. A theory was at first held locally that there were two veins at the east end, and that the portion of the vein striking north-east was a branch of the main vein, joining it near "the cave," (see Plate IX., fig. 1), whilst it was believed that the main vein must continue on its original course down the valley. A careful examination, however, shows no grounds for such a supposition, and no reason for believing that two veins of different periods of origin exist, one being silver-bearing and the other barren.

Rocks faulted by vein.

The enclosing rock is argillite, surmounted, as usual, by a sheet of columnar basic trap, the faulting of which by the vein is clearly visible at the east end, and amounts there to eighty feet.

Vein characteristics.

Along its outcrop in the trap sheet, and for some little distance below it, the vein is large and solid, and from four to six feet thick, whilst in the argillites below, as one would expect, it does not retain its width so persistently, the fracturing force having in the looser rock become distributed over a wider area, so that at places the vein is only represented by a number of small indefinite stringers distributed through a wide area of the rock, whilst a few feet further on, these have been found to come together and form a large, solid vein. In these solid parts, large caves or vugs occur, several of which open up to the surface on the brow of the hill at the eastern end.

"Gangue" minerals

The vein stone consists of calcite, barite and quartz with fluorite, the different minerals preponderating at different places. The barite seems to be confined to those parts of the vein which are in contact with the trap or a little distance below it, whilst calcite and quartz form the preponderating minerals in the argillites below; the fluor-spar, although plentiful in places, generally playing a secondary part. These differences of gangue give a very different appearance to ore from different parts of the vein. Thus, around the rich ore at No. 4 pit, and in the other end of No. 2 level, the vein stuff was very beautiful, consisting of a crystalline mixture of translucent white and amethystine quartz,

with green fluorite and a little calcite, whilst in contrast to this, in the developments at the other end of the vein, the silver minerals have been found in a white saccharine gangue consisting mostly of white barite and calcite, with a little colorless quartz, and occasionally a little green fluorite. The vugs are generally lined with large cleavage masses and crystals of calcite, and in one there were found well-formed small crystals of that mineral showing the prism, terminated with faces of the rhombohedron, upon which were superimposed small crystals of iron pyrites. The metallic minerals are represented by blende, both light and dark-colored, galena and iron pyrites, with occasionally a little copper pyrites, the silver occurring both native and as sulphide or argentite. The latter is the most common, forming films, sheets and solid nuggets often several ounces in weight, whilst the former occurs in films, but more often in fern-like and wire forms.

The Silver Mountain group of veins continued.

Metallic minerals.

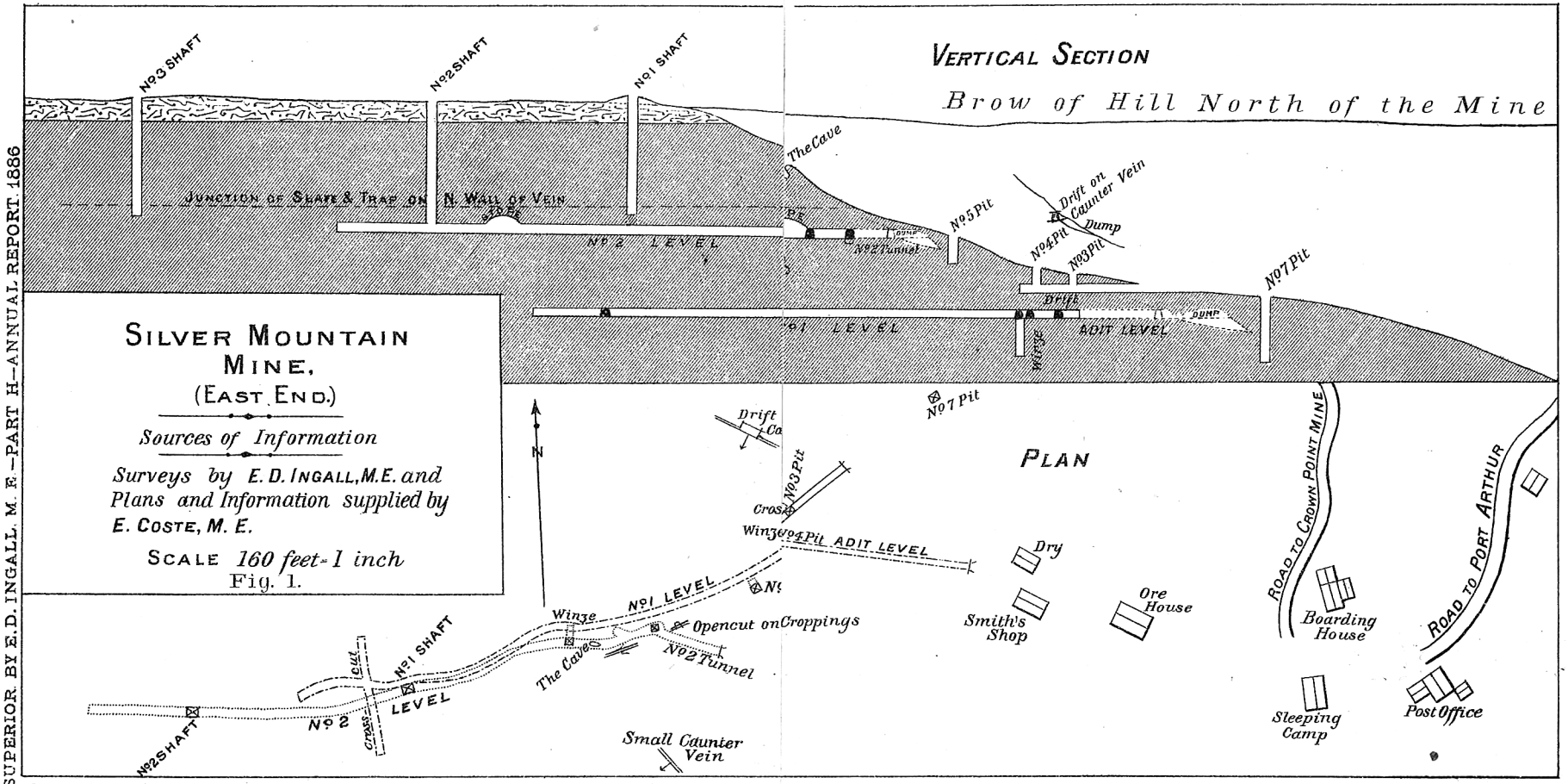
Silver.

The enclosing or country rock of this vein shows no very particular features which distinguish it from the other veins already mentioned, except that the argillite is probably somewhat more carbonaceous in places. This is notably the case around the developments made on the eastern face of the hill, and was especially noticeable in the driving of the adit, when the miners used to come out looking quite black, which characteristic, together with its softer nature, serves to distinguish the argillites in the neighborhood of this vein from that enclosing some other veins in the district. It shows a system of jointing in places, at one in two directions—one N. 15° E., dipping 85° E., and the other N. 85° E., dipping 85° S., the latter direction corresponding to one of the two prevalent in the rocks of the coast section. The capping trap presents no features of marked difference to that already described. The accompanying illustration (Plate IX., fig. 1, p- 72 H.) shows the position of the country rocks on the south or foot wall of the vein and also illustrates their displacement by it, the lower dotted line representing the under surface of the trap sheet on the opposite or hanging wall.

Enclosing rocks.

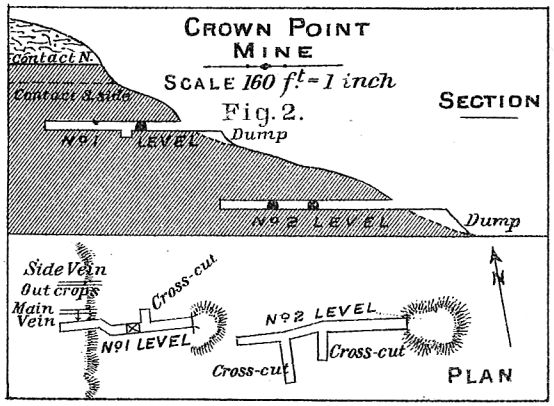
The work done on this vein is mostly represented in Fig. 1, Plate IX., which shews the developments made on its eastern end up to the end of July, 1887, but besides this, several test pits, etc., have been sunk on the outcroppings, for a distance of nearly 4,000 feet beyond No. 3 shaft, the positions and heights of which will be seen on reference to the accompanying contour map of the Silver Mountain mining district. These developments on the west end of the vein have been made chiefly at three points. The pit nearest to the east line of R. 56 location is only about 8 feet deep. Passing westwards, we come to a small cross-cut tunnel driven into the

Development work.



From the nature and incompleteness of the information obtainable, the above is necessarily diagramatic.

DESBARATS, LITH.



From Surveys made by E. D. INGALL, M. E.

EXPLANATION.

TRAP.

ARGILLITE.

CROSS-CUTS.

The Silver Mountain group of veins continued

side of the hill through the argillites for a distance of about 25 feet at which distance it cuts the vein at about 25 feet below its out-crop. From the end of this tunnel, a small shaft has been sunk to a depth of about 30 feet upon the vein. Further west again another similar cross-cut has been driven in through the argillites for a distance of about eighteen feet to the vein, and about twenty-seven feet beyond it. It cuts the vein at a depth of about twelve feet below its out-crop, which is here just underneath the lower surface of the sheet of trap capping the argillites. Below the floor of this tunnel a small pit, about fifteen feet deep, has been sunk on the vein.

The extent to which the vein has been tested at its eastern end is best understood by reference to Plate IX., fig. 1, which shows the developments up to the end of July, 1887, of which nothing further need be said beyond pointing out that in putting together the various data from which the illustration has been compiled that an error has crept in and No. 3 shaft should be shown at a distance of 820 feet west from No. 2 shaft, instead of as therein represented.

Erratum in illustration.

Occurrence of rich silver ore.

The first ore discovered here was remarkably rich. It was obtained from No. 4 pit (Plate IX., fig. 1) and carried a large percentage of native silver and argentite, accompanied chiefly by dark-colored blende. The native metal occured in the leaf and wire form, whilst the argentite occured in leaves, sheets, and as nuggets weighing often several ounces, which latter occurred quite plentifully in some spots. On my visit to the place shortly after its discovery, I saw a cigar box full of such nuggets which had been taken by the discoverer out of a few cubic feet of rock obtained in sinking the discovery pit (No. 4), and I feel sure that several tons of ore could have been obtained from this spot which would have averaged from $1,000 to $2,000 per ton. This was, of course, exceptionally rich and, although silver bearing rock has been found at several other spots in the vein, none of it has been so rich as this, nor, up to the present time, do the developments on the east end of the property seem to have resulted in the proving of any extensive bodies of ore. An encouraging fact is found, however, in the presence of good ore in the vein, running about $127 to the ton* at the west end, about a mile distant from the first mentioned, and it would seem strange if, between these extreme points, the vein were found barren of any bodies of payable yield and size. The developments, however, at the western end of the vein have not yet been extensive enough to throw any light on the extent of the body of ore there discovered.

"Caunter" veins.

Some good silver ore was also obtained in the two small caunter-veins shown on the plan on either side of the main vein. The one on the south shows in the trap, whilst the drift on that on the north is in the argillite just below the trap-bed.

*See Report of Geological Survey, 1886. Part T. Assays Nos. 48 and 49.

The history of this mine has been as follows:—It was discovered in the fall of 1884 by Mr. Oliver Daunais, before mentioned as the locator of the *Rabbit Mountain* vein and of the chief veins of that district. This gentleman, together with his associates, finding such rich ore as mentioned, took up locations including the vein for over a mile. The property was then dealt with in separate halves, known as the East and West ends respectively. The former was shortly afterwards leased to some American capitalists on a twelve months' option, and these gentlemen commenced operations in the spring of 1885, and continued with a considerable force until the end of the same year, when having, it is said, expended about $10.000 in work, their option having expired, and the results of their work not having come up to their expectation, they did not feel inclined to give the price asked, and the mine reverted to the original owners, who then interested with them the Messrs. Trethewey, who had formerly managed the *Silver Islet Mine.*

The Silver Mountain group of veins continued

History of mine

During the year 1886, no work was done, with the exception of a little occasionally undertaken by the owners, which, however, resulted in their striking some more silver bearing rock in the upper tunnel on extending it some little distance beyond the point at which the American company had left off and where the vein had been poor. In the fall of 1886 a company was organized in Liverpool, Eng., to purchase and work the mine with a share-capital of £100,000, under the name of the *Silver Mountain Mine Company (Limited)*, which has carried on operations ever since. According to the prospectus the capital was distributed as follows:—

Purchase of property and costs of floating Co. (paid by vendors)....	Cash, £30,000 Shares @ £1 25,000	£55,000
To be allotted to directors in lieu of remuneration for two years, and to other parties for services rendered in connection with the formation of the Co.—Shares @ £1 each.....		9,000
		£64,000
Leaving for Working Capital.....		36,000
Total.....		£100,000

The west end property was bonded also, but after a little work had been done with very encouraging results, the parties got into litigation as to who should have control, which of course put a stop to any further work, and it has remained in that state ever since. Operations were carried on at this point in the winter of 1885-6.

Crown Point Mine.

The Silver Mountain group of veins continued.

The vein here was discovered shortly after that at Silver Mountain. It is about three to four feet wide, although as in the case of the other veins of the district, sometimes split up and rather indefinite, and represented only by numerous branches through the *country* rocks. As far as developed up to the end of 1886, barite and calcite had been the preponderating minerals in the vein-stuff, which were accompanied by a little colourless quartz and some green and purple fluorite, in which gangue, in the orey parts, were to be found blende, galena and pyrites, the silver being in the form of argentite in leaf and nugget.

Enclosing rocks.

The enclosing *country* rock is very similar to that at the *Silver Mountain Mine*, the argillite being black and soft. The enclosing rocks are similarly faulted by the vein, but in the opposite direction, and to a much less extent than at that place, there being here a downthrow on the south side which only amounts to some sixteen feet. The capping trap has been described as a tolerably fine-grained, very much altered diabase by Mr. W. S. Bayley, who made a microscopic study of a specimen of this rock taken from near the vein. (See Appendix I., No. 259).

Developments.

The workings on the vein have all been prosecuted in the upper portion of the black argillites, and are comprised within a depth of 140 feet below the capping trap as shown in the illustration (Plate IX, fig, 2) which gives the developments made on the vein up to the end of 1886. These have all been made by the original owners, who have not had capital enough at command to open up the vein to a greater extent, although the results have certainly been encouraging.

Another vein.

About ten chains N.W. from this place occurs another very similar but smaller vein which was found cutting the capping trap, and a small amount of test work done to trace it down into the underlying black shales which was, however, stopped before anything very definite had been proved, owing to the parties who were prosecuting the work, finding that the vein was not on their own property.

Palisades Vein.

Vein characteristics.

Here a vein has been located and some little work done to test it. It contains the usual metallic minerals, which are plentiful in places, in a gangue of calcite with colourless white and pale amethyst quartz and a little fluorite occurring in scattered particles and mammillated layers, the surfaces of some of which have a tendency to assume an amethyst colour, the rest of the mass being emerald green. The vein,

where worked on, is entirely in the soft black argillites and shales below the lower tongue of the trap sheet which caps this hill. Of this trap, Mr. W. S. Bayley says "this is a medium-grained diabase with the typical diabase structure." (See Appendix, specimen No. 338). The Silver Mountain group of veins continued.

The developments to the end of 1887, consisted of a small cross-cut tunnel driven southwards into the base of the hill at a depth of about 40 feet below the outcrop of the vein and the base of the trap sheet, which, at a distance of fifty feet in from its mouth has intersected the vein, from which point a shaft has been sunk on it said to be fifty feet deep, and to have shown the enclosing rock to be argillite all the way down. At the end of the tunnel, the vein consists of numerous branches and stringers distributed through a thickness of about ten feet of the argillites. Developments.

Scripture's Vein.

This is a two to three feet vein showing in the capping trap bed of Silver Bluff, and the sedimentary beds below it. It is filled mostly with crystallised barite, giving the veinstone a confused interferent platy structure. The vein has a somewhat banded appearance at this place, owing to the presence of a two to four inch rib of green fluorite on each wall, and to a banded appearance of the barite filling near the walls. A little white quartz is also present. Very little metallic minerals were visible, but as only sixty feet of the vein was exposed in the cliff, the talus covering up all below, and as no development work had been done on it, very little is as yet known about it. No appreciable faulting of the rocks has been produced by the fissure. Vein characteristics.

The enclosing rocks of this vein consist of an upper bed of the usual trap of the district underlaid by a highly siliceous, wavily-bedded, flaggy rock with marked vertical jointing in two directions. These have already been described more fully, and their microscopic characters referred to. (See Appendix I., specimens, Nos. 301, 302 and 303). Enclosing rocks.

Silver Hill.

Two veins have been located at this place and worked upon to a small extent. The most southerly one presents the feature, at one opening, of two distinct ribs, one made up of barite crystallized in radiating platy forms, whose interstitial spaces are filled out with crystalline colourless quartz, whilst the rest of the vein at this spot consists for the most part of calcite, in coarsely crystallised masses, accompanied by a fair amount of, mostly colourless but sometimes amethystine, quartz, some barite and a little pale green fluorite. At another open- Vein characteristics.

The Silver Mountain group of veins continued.

ing again, the vein consists almost altogether of calcite, with quartz and green fluorite and very little barite. The work done on this vein to the end of 1886, consisted of a few shallow test pits, sunk at intervals apart, over a distance of 150 yards on the outcrop of the vein.

The other vein cuts the hill and is smaller and less definite than the last, averaging about one foot thick as far as exposed, and showing similar filling to the other, only that the barite is absent The work done to the end of 1886 was slight, consisting of three small open cuts driven in on the vein, one above the other, on the west side of the hill. The enclosing rocks of these veins consist of highly ferruginous cherty rocks, accompanied at places by compact jasper bands and ferruginous dolomite beds which, on the hill, are capped by a bed of trap. A little native silver and argentite has been found in the vein on the hill.

Silver Falls Vein.

Vein characteristics.

This is a large vein, and, as far as proved by the present developments, differs somewhat from the rest of the veins in the district. In the shaft, at the surface, it showed vein matter over a width of fifteen feet, but at the time of my visit, October, 1886, the work done had not been sufficient to demonstrate exactly its dimensions and nature. In a sample of about ten pounds, obtained by the owners from some distance down in the shaft, the vein stone consisted of an intimate mixture of compact quartz with some dark material, giving it a general dark greenish-grey appearance, which was relieved occasionally by the occurrence of quartz of a pale pink, amethyst, or more often white colour, with pale pink and cream-coloured dolomitic spar occasionally. The jointing surfaces were faced with a dark, probably plumbaginous coating. At other places, the pink spar constituted the bulk of the vein, and on the presence of this spar and its resemblance to similar vein-stone which had accompanied the silver of *Silver Islet*, the owners based hopes that similar rich ore might be found in their vein. In places a good proportion of finely disseminated iron pyrites was visible in the above described sample.

Enclosing rocks.

The enclosing rock of this vein consists of the jaspery and cherty rocks of the lower division, which here, adjacent to the vein, present the unusual feature of being much contorted, which is in great contrast to the usually flat position of the rest of the Animikie formation of the vicinity. This disturbed condition will be apparent on referring to the map, from an examination of which it will be seen that the beds turn down sharply on the hanging wall of the vein, whilst they dip steeply the opposite way on the other side, and again reverse their

dip about seventy paces further down the creek, where they show in a little fall of about twenty feet. This is probably a local effect produced by the vein, which has probably faulted the rocks. These rocks here carry at places little interbedded lenticular patches of crystallised vein minerals, which enclose sometimes a little iron and copper pyrites, and all of which are probably due to infiltration into spaces formed by the folding of the rocks. The Silver Mountain group of veins continued.

To the end of 1886, the work done consisted of a fifty-feet shaft sunk on the vein, from which, at a depth of about forty-five feet, a cross-cut fifteen feet in length was driven across it. Besides this, some surface strippings were made, extending over a distance of about fifty yards of the outcrop of the vein. Work done.

R 64 Location.

Several large veins occur on this property, of thicknesses varying from three to eight feet, and showing all the characteristics of definite fissures. In their contents, the various forms of quartz preponderate, which are accompanied in places by varying proportions of green fluorite, calcite, and occasionally a little barite. At one exposure, the vein consists almost entirely of solid vitreous silica, and has a marked, banded or combed appearance from the "cone in cone structure" produced by the different coloured layers (amethyst, white, translucent, etc.,) of the quartz being arranged parallel to the faces of the terminal pyramid. The fluorite seems to have been mostly deposited between the irregular surfaces of these layers. The metallic minerals represented by blende, galena and pyrites occur occasionally, both disseminated, and the latter also as very thin films coating cleavage planes, jointing, etc. The enclosing rocks comprise the jaspery, magnetitic and rusty siliceous beds of the lower division. (See Appendix I., Spec. No. 281.) Vein characteristics.

The work done has been so far confined to the tracing of the veins and to the sinking of shallow test pits on their outcrops. Work done.

Other Veins.

Several other veins have been located in this district on which a little test work has been done, viz.: on Locations *R 79* and *R 111*, and on *Tchiatan's* vein on Location *R 115*. These are all in the siliceous rocks of the lower division. *R 79* vein is filled at one place with a gangue of saccharine quartz and spar, the latter mostly calcite, whilst at another opening it consists altogether of compact vitreous, iron-stained quartz resembling the gaugue of the gold veins of the Huronian areas of this region. It carries a little disseminated pyrites, galena and blende.

The Silver Mountain group of veins continued.

The *R 111* vein is very similar to most of those already described, carrying a little of the usual metallic minerals in a gangue of calcite, amethystine and colourless quartz and green fluorite. On this vein the prospecting work done to the end of 1886 had been inconsiderable, consisting of several test pits on the outcrop of the vein, tracing it for a distance of about two hundred feet, and a small thirty feet tunnel driven into the base of the ridge on which the vein outcrops and cross-cutting the same at a depth of about twenty feet below the surface.

Tchiatan's vein is large and compact, about three to four feet thick, on which, besides some surface work in the outcroppings of the vein, a shaft has been sunk said to be forty feet deep. Judging from the ore dump at this point, the vein has carried considerable quantities of blende, which, with a little galena, occurs in a gangue similar to those already described, but carrying occasionally a little flesh-coloured barite. The blende is light-coloured, and occurs largely crystallized in solid ribs and masses.* An examination of the rock broken shows that the beds encountered in sinking this shaft somewhat resemble those already described as occurring at the south end of Contact Ridge, viz., red jaspery beds separated by dark-green chloritic layers.

Woodside's Vein.

Vein in Archean rocks.

This example differs from the others within this area, in that it occurs in the Archean granitic and gneissic rocks underlying the Animikie, the northern fringe of which is most probably located in this immediate vicinity, being covered up by the drift which hides every, thing for some distance to the S. of the Whitefish river. The vein in its nature and contents is very similar to the rest, and carries blende-galena and pyrites distributed through the usual gangue in moderate profusion.† The pyrites occurs occasionally in peculiar ring-like or rather more hexagonal arrangements in the calcite, the centres of the rings etc., consisting also of the latter mineral. Purple fluorite also occurs in the joint fissures of the enclosing granitic and gneissic rocks. The work done up to the middle of October, 1886, consisted of some explorations and pits in the out-crop of the vein over a distance of about 100 yards, and of a twenty-five feet shaft, sunk on the hanging wall, which had just reached the vein at that depth.

Whitefish Lake Group.

The chief examples of the vein phenomena of this group which were visited are described below, together with the special conditions of their occurrence. They all occur in the district immediately sur-

*See Report of Geological Survey of Canada 1887, Part T, Assay No. 43.—Idem, 1886, Assay No. 45.
†Idem, Part T, Assay No. 44.

rounding this Lake. They are known as the *Sunset Lake*, *Medicine Bluff*, *Caldwell's*, *Scripture's*, *Hurlburt's*, *Geroux's*, *Laplante's*, *Arrow River Mining Co.'s* and *Whitefish Lake Mining Co.'s* veins, and all except the three first mentioned, which are in the upper black argillite division, occur in the lower siliceous rocks, and are located within a distance of about two miles from where these rocks abut on the Archean gneissic and granitic rocks to the north. Enclosing rocks.

The veins visited in this area were found to have much the same contents as those already described, viz., blende, galena and pyrites in a gangue composed of very varying percentages of calcite, and colourless, white or amethystine quartz with green fluorite, barite being only occasionally present. The metallic minerals are by no means present at all the places at which these veins have been exposed, being fairly plentiful at some of the places, whilst at others, the gangue minerals are almost or entirely free from them. General characteristics of veins of the I. group.

Up to the end of 1886, no extensive bodies of silver bearing ore had been found in any of them, and in fact at those places where good silver had been reported as found, it had been removed so completely as to render it difficult to find more than traces of the silver minerals here and there.

The rocks of this area show much the same features as those presented by the Silver Mountain district, viz.: a general division of the Animikie rocks into an upper argillaceous and a lower siliceous division. The latter form the northern fringe of the formation, and occupy all the lower lands to the north of the range of hills, forming the divide between Whitefish Lake and Whitefish River, their line of contact with the Archean rocks to the north, being roughly coincident with the course of that river. Passing southward from this, one comes in the higher levels of the south side of the river valley to the more argillaceous beds of the upper division, which shew, however, some tendency in character towards the lower siliceous division, whilst further south on the other side of the lake the lower beds are rarely if ever seen, and the upper argillaceous beds seem to be more largely developed and to closely resemble the typical black soft argillites of this formation. Geological features of the district.

These beds in the already mentioned range of hills north of, and in the others surrounding Whitefish Lake are all capped at about the same level by the usual columnar trap, whilst at lower levels on the north shore of the lake there are evidences of the existence of another and inferior sheet of the same. This inferior sheet shews at the water level along most of the north shore of this lake, and is noticeable in passing north along the trails leading from the lake to *Laplante's* vein near Little Traps.

Gull Lake, and to the *Arrow River Mining Co.'s* vein on Whitefish River.

Vertical section of the formation—Laplante's Trail.

The vertical dimensions of the sections obtained in passing over these trails were measured with the aneroid on several occasions, and gave the following mean results:—

Trail to Little Gull Lake:—

500 feet	.....Top of hill
400 to 500 feet	.....Upper trap sheet.
260 " 400 "	.....Exposures of argillaceous beds.
200 " 260 "	.....Covered.
0 " 200 "	.....Over lower trap sheet.

In descending the northern face of this hill, these same argillaceous beds were found to underlie the upper trap, but seem to have thinned out in this direction, and they measure here only about 50 feet, the lower siliceous beds occupying all below this until the Archean surface rises from beneath them to the north. To the west of this hill lies the one on whose northern and eastern slopes are located the workings on *Giroux's* and *Hurlburt's* veins and the lower surface of the trap sheet capping it having been measured in the same way, is found to occur at a height of about 450 feet above the lake with a thickness of about 100 feet, whilst further north, the lower surface of the trap capping one of the Outpost Hills immediately north of *Laplante's* vein, was found to be at an elevation of about 700 feet above Whitefish Lake, and its upper surface at nearly 800 feet.

Another vertical section of the formation.

In passing over the trail a mile or two west from the last mentioned one, from the lake to the *Arrow River Mining Co.'s* works, the following vertical section was obtained in a similar manner.

360 feet	.....Top of hill	
280 to 360 feet	.....Upper trap sheet	shewing in a hill a little to the east of trail.
180 " 280 "	.....Argillaceous beds	
140 " 180 "	.....Covered	
0 " 140 "	.....Over lower trap sheet.	

This hill is one of those forming the divide range between the Lake and Whitefish River, and in descending its northern face a diminishhment similar to the above-mentioned, is observed of the thickness of the upper division beds lying between the capping trap sheet and the lower siliceous division rocks, the latter constituting all the rock exposures along the trail from this point, on in a northerly direction till their contact with the Archean is reached.

In neither of these sections is the lower trap sheet met with in descending the northern face of the range, as the ground never comes

down to the level at which its upper surface shews on the Whitefish Lake side, so that the question as to whether it extends that distance, and therefore underlies the cherty rocks there exposed, or whether it thins out in going north, is still unsettled.

The composition of these various rocks has been described in the foregoing parts of this report, and the features presented by them at the various points visited, are dealt with later, so that nothing further need here be said.

Sunset Lake Vein.

This vein at the place where the chief development work has been done upon it is enclosed in siliceous beds, lying on a sheet of trap which shows in a little cliff to the south of the workings on the north shore of the little lake, known by the above name. About 100 yards to the north of this spot, beds of a higher horizon show in a bluff, consisting of black argillites capped with the usual columnar trap of the district. The vertical section of the beds here, is therefore, as follows, commencing from the level of Sunset Lake upwards. Whitefish L. group of veins.

Vertical section of the formation.

130 to 160 feet	An estimated thickness of columnar trap.
110 " 130 "	Black argillites and shale.
30 " 110 "	Covered.
20 " 30 "	Covered (at thirty feet workings on the vein in the siliceous beds).
0 " 20 "	Lower sheet of trap.

This brings us to the top of the ridge separating Sunset Lake from Whitefish Lake, from which point there is a fall of about 280 feet to the level of the latter lake, in the descent of which by the trail, however, the rocks below the upper trap are all found to be covered up.

Intrusive trap sheet.

The lower trap sheet shows considerable evidence of being an intrusion. It is darker and more compact than the upper one, especially towards its upper surface, where it has been in contact with the overlying rocks, which, by cooling this part more rapidly than the central portion, would have produced this compactness, whilst in descending the little cliff, we find the rock assuming a much coarser and more distinctly crystalline texture. The extremely smooth upper surface of this sheet would also seem to point to its being an intrusion amongst smoothly bedded rocks, as the absence of any grooving or polishing forbids the supposition that it is, like some of the similar smooth surfaces of this district, due to ice-planing.

The work done on the vein has been very little, consisting of a fifteen-feet test-pit and some surface work in the outcrop at various points.

Medicine Bluff.

Whitefish L. group of veins continued.

Two veins have been tested to a small extent in this vicinity, on mining locations R 208 and R 119 respectively. The work to the end of 1886, at the former place, consisted of a small cross-cut, driven about thirty feet through the argillite into the side of the bluff near the top to intersect the vein, which here dips at 80° to the north, from the end of which drift a little pit has been sunk. These developments have not been prosecuted far enough to prove much about the vein. Medicine Bluff itself consists of black, soft argillites and shales, capped by a columnar bed of trap. About half a mile to the east of the before-mentioned workings, the section presented in the bluff is as follows:—The contact of the argillites with the trap is found to be 400 feet by aneroid above the water of Whitefish Lake, the trap having an estimated thickness of from 100 to 150 feet above this point, whilst below it the argillaceous beds show at intervals for a distance, vertically, of about 150 feet, everything below this being covered up by detrital matter fallen from the cliff above. The name Medicine Bluff is derived from the occurrence in the face of the cliff of a mineral efflorescence, which is probably alum, stained with hydrated iron oxides derived from the re-action of the oxidation products of the pyrites on the shale in which it occurs. It is said that the Indians gather it for medicinal purposes, hence the name.

Location R 208.

Vertical section of the formation.

Location R 119.

The vein on R 119 location lies about half a mile to the west of the last-mentioned point, and skirts along the base of a bluff which rises out of a swamp, and consists of columnar trap for the greater part of its height of 300 feet, as measured by aneroid. Just at its base, argillites are seen to underlie it, only showing, however, a thickness of a few feet above the surface of the swamp. They appear to be mostly soft, but not so dark in color as the typical black argillite, whilst at other places there are portions whose coarser grain would relate them more to sandstones. The work done consists of a cross-cut driven in through the argillites of the hanging wall for a distance of about twenty feet, when it reached the vein. At this spot, the edges of the argillites lying in a horizontal position come abruptly up against the trap forming the cliff, and there is some appearance of this trap being a dyke running parallel with the vein, and cutting both the before-mentioned horizontal trap sheet and the underlying argillites; but further work is required to prove this. It is also difficult to decide, without working over a much larger area than was possible in visiting this spot, whether the capping trap here found at the level of the lake is part of that sheet which in the vicinity rests on the argillites at

a height of 400 feet above this level, and is faulted down into its present position, or whether it is a sheet occurring lower down in the formation. Whitefish L. group of veins—continued.

Caldwell's Vein.

This vein shows a little to the west of the trail going to Little Gull Lake from Whitefish Lake, cropping out on the side of the hill which rises to the north of the western end of Whitefish Lake, over which the trail passes. Where seen, it is enclosed in rather hard, dark argillites, which show a tendency in places to approach in their nature the more siliceous lower division beds. The vein shows here about four feet thick, dips steeply to the south, and passes a little above this spot upwards into the trap sheet which here caps the argillites and forms the top of the hill. The vein is here seen to have faulted the enclosing rocks several feet. Little or no work has been done on it. Rocks faulted by vein

Scripture's Vein.

A vein known by this name occurs some distance further up this trail, where it is seen to be enclosed in the typical jaspery and wavily bedded ferruginous cherty rocks of the lower siliceous division, which, in the neighbourhood of the vein, are plentifully penetrated in all directions by stringers filled with crystallised quartz, the vein itself being entirely made up of this mineral of the various colours prevalent in the district, and showing a tendency to a cone-like structure. The vein is solid, and four feet thick, dipping to the south. The work done consists of an open cut driven into the side of the hill which it intersects.

Hurlburt's Vein.

Passing westwards from *Scripture's*, we ascend the steep east-facing slope of a hill, showing about 150 feet of the wavily-bedded silico-ferruginous rocks capped by a sheet of trap about 100 feet in thickness. A little pit about six feet deep has been sunk in the vein where it outcrops about fifty feet below the trap. About half a mile further west, on the run of and presumably on the same vein, some little work has been done in its outcropping, and it is said that good ore, carrying native silver, has been obtained at both of these places. None, however, was to be seen at any of the accessible points, although an assay of some picked pieces from the first-mentioned developments gave nearly two ounces to the ton,* showing that the metallic minerals therein contained carried silver, as none of the silver minerals proper

* See Report of Geological Survey of Canada, 1887. Part T Assay No. 38.

Whitefish L. group of veins —continued.

could be detected in the rock, even with the lens. The latter, or most westerly workings, occur on the north slope of the same hill, and the enclosing rock of the vein is here a hard, dark silicified argillite, the edge of the capping trap sheet showing a short distance to the south at a little higher level than the workings.

Geroux's Vein.

The workings at this place are apparently upon the extension of *Hulburt's* vein, and are situated on the north face of the same hill, about half a mile west of the last-mentioned point. At *Geroux's* workings, the enclosing rocks belong to the typical cherty and dolomitic beds of the lower division, between which and the overlying trap sheet intervene some ten to fifteen feet of the black, soft argillites which show in a thirty-feet cliff about one-quarter of a mile south from the workings.

A curious feature here presented consists in the occurrence amongst the cherty rocks proper of a light green dolomitic rock, whose colour is found to be due to the plentiful distribution through it of a pale green aborescent or fibrous mineral, probably actinolite, which has most likely been developed in the dolomitic bed by subsequent metamorphism.

Below this point, the ground falls away rapidly to the north and west for a vertical distance of about 200 feet, over which area nothing but chert and jasper beds are to be seen, which a mile west of this are found to abut against the pale pink gneissic rocks of the Archean.

Laplante's Vein.

Contact of Animikie and Archean rocks.

About a mile and a half north-east from the last mentioned, on the line of junction between the Animikie and Archean rocks, test shafts have been sunk on two veins running parallel to each other on either side of a ridge of the latter, which is flanked on both sides by the Animikie jaspers and cherts. The shaft on the east vein is about thirty feet in depth and sunk on an indefinite vein or lot of branches and stringers distributed through a dark-green, *slickensided*, chloritic material, which may be possibly part of the vein, and having a general dip towards the north-west, whilst the strike is north-east. In the thirty-feet shaft on the opposite side of the ridge, a well-defined, solid four-feet vein is visible, going down about vertically as far as followed. It has evidently faulted the enclosing rocks, as the one wall consists of the gneiss, etc., of the above-mentioned ridge, whilst the ferruginous, jaspery and cherty beds form the opposite or W. wall. Just at the

top of the shaft, the original contact of these two systems of rocks is well shown, the gneiss being overlaid by a thin sheet of jasper in a horizontal position, which at places has been denuded off so as to be no thicker than one's hand.

Whitefish L. group of veins continued.

Arrow River and Whitefish Lake Mining Companies.

At the place shown upon the Sketch Map, the two above-mentioned companies have done a small amount of testing, both working on the same vein. It shows as a solid four-feet vein on the surface at one place, whilst at another there are eight to ten feet of solid vein stuff, but as is so common in these veins when followed down, it is at places all split up. Its dip would appear to be to the south, although the developments have not gone far enough to prove exactly. It outcrops in an area of the typical lower siliceous beds which show as the surface rocks for over half a mile south of the vein, being exposed along the trail leading to this place, and are again seen on the Whitefish River, about a quarter of a mile to the north of the same spot, where they come in contact with the Archæan. The enclosing rocks present no peculiar features, except in the occurrence towards the bottom of the shaft of a rock having more the color and texture of some of the argillites of the upper division, but which differs from them in being much silicified and hard. The bedding planes of the rock were found to be frequently coated with a black material that rubbed off and resembled graphite.

A peculiar feature is presented by some of the calcite in the gangue, which often has quite a pearly lustre and tendency to curvature of the cleavages, which variety is often stained dark by some material not determined, but that it is merely calcite is shown by its free effervescence with acids and by its cleavage angles. Other somewhat marked features are the occurrence of the quartz in veins intersecting the calcite and crystallized in the freer spots and cavities, and the presence of dark streaks through the gangue, which, judging from their dark-greenish-black, lustrous appearance, are probably some chloritic decomposition product. The work done consists in the main of two shafts sunk on the vein, each about thirty feet deep, at a distance apart of about 900 feet, with some little workings in the outcrop between them.

About half a mile to the south of this point, a couple of shallow pits have been sunk on a solid five feet vein which is enclosed in the siliceous rocks. As far as can be seen it dips to the north at 65° to 70°.

General Characteristics of the Silver Veins.

In order to complete the study of this subject, it will be here necessary to give a resumé of the characteristics of these veins, and to mention some of the general conclusions which may be based thereon.

Strike directions.

A study of the Sketch Map will show that as regards their strike-directions, they resolve themselves into three groups: A N.W. group, a N.E. group and an E. and W. group. The N.W. direction of strike is most characteristic of the Coast group, the famous *Silver Islet* vein being the most striking example of this, whilst all the rest of this group run parallel with it. The chief example outside of this is the *Beaver Mine.*

All the veins of the Rabbit Mountain group, with the already mentioned exception of the *Beaver*, may be classed as N.E., whilst the *Thunder Bay Mine* vein also belongs to this series.

The last series do not run in general due east and west, but a little N. of E. and S. of W. To this series belong nearly all the chief veins of the Port Arthur group, with the exception just mentioned, and nearly all the Silver Mountain group.

Dips of veins.

The dip of these veins is not sufficiently worked out to form any basis for classification as most of them have not been followed deep enough to be quite sure of what their real underlay is, and some of them have changed their direction of dip in depth as at the *Shuniah Mine.* In this connection, it may be useful to suggest that when too little of a vein is visible to decide its direction of dip, the study of the displacement of the rocks generally produced by these fissures will often aid in determining this point, as in nine cases out of ten, the lowering of the rocks has been on the hanging wall side, whilst the extent of the displacement may give a rough idea of the strength of the fracturing force producing the fissure, and therefore of the extent and definiteness of the vein.

Physical characteristics of veins.

The physical characteristics of these veins present some features of interest worthy of notice by those working on them. These, as one would expect, vary with the nature of the enclosing rocks; in the different varieties of which the fissuring force would have different effects. Thus, as a general rule, the veins in the trap beds are wide and solid, the proportion of the wall rock enclosed by the vein filling being comparatively slight, whilst in the argillites below, they are apt to be very irregular, and at times difficult to follow, being at one place large and solid, and at another all divided up, and represented by numerous small stringers and branches distributed through a great thickness of the argillites, these changes often occurring very suddenly in following

them. This is just what might be expected of the action of a force tending to produce a fracture in such rocks, for where the argillites were more compact, the force would act only over a small space, whilst in the more shaly parts there would be a tendency to give rather than to fracture, and the force would get distributed, and again, the trap being a more rigid and compact rock with jointings far apart in it, and those vertical, one would expect a wider fissure with definite walls. This would also apply, of course to the lower siliceous division where solid, whilst in the varieties with much bedding structure, the results would resemble more those produced in the argillites, and this is found to be so. This would probably account for the great width and solidity of most of the Coast group of veins which, in a general way, distinguish them from most of the rest of the veins under study; the former having been opened upon nearly altogether where they intersect trap dykes, or in their immediate vicinity, whilst the workings on the latter are almost altogether in the veins where they cut the argillites.

Irregularities in structure of the veins.

These irregularities in width have in some cases disheartened operators, and led them to believe that their vein had "pinched out," but in view of the explanations just tendered it may be usefully pointed out that such fears will generally prove to be unfounded, and that where the extent of the accompanying faulting of the enclosing rocks is considerable, and there is other evidence to believe that the fracturing force was such as to produce an extensive and persistent fissure, a little pluck and energy in following it up will generally take one through the disturbed parts to where the vein will again be found wide and solid, and this has been found to be the case already in several instances. The definiteness of the bounding walls of the veins, it need hardly be pointed out, also varies with the rock they are in, in a similar way. Some of them, as at Jarvis Island, show *slickensided* walls in the vein matter itself, and other evidences of movement since filling. *Slickensided* surfaces are, however, not very common in the district.

Slickensides.

Contents of the veins.

The vein-filling minerals consist in general of quartz, barite, calcite and fluorite constituting the basis of the gangue, in which occur the different metallic minerals, viz., blende, galena, pyrites of various species, and occasionally some sulphurets of copper, whilst the silver in the orey parts occurs as argentite and in the native state, the former being the most common. At places, the veins carry a dark green, probably chloritic material which on some surfaces has a bright, waxy lustre, whilst occasionally a soft, greasy, talcose material, probably Saponite, accompanies the ore, notably at the *Beaver Mine*, and to a lesser extent at one or two other places. Carbon in various forms has also been found here and there, whilst in some of the *vugs* in the veins, which

Chloritic and talcose materials.

Carbon.

have been found near the surface, stiff clay and ochreous material have sometimes been obtained, along with nuggets of argentite, the former, however, having evidently been washed in from the surface, and has thus imbedded the silver minerals already existing in the *vugs*.

Silver Islet vein exceptional.

These, then, are the mineral constituents of these veins but the *Silver Islet* vein forms somewhat of an exception, in that it carried, besides these, various arsenical and antimonial ores of silver with compounds of nickel and cobalt, and other metallic minerals which have, so far, not been found in the rest of the veins. Other salient features were the pink and cream-colored dolomitic spar which so frequently formed a characteristic and prominent constituent of the gangue of the rich ore, and the predominance of native silver in the rich parts, whereas in the rest of the veins, though this form of silver occurs in considerable quantity at places, yet argentite seems to be the form in which it is generally found.

Gas and mineral waters.

It is interesting to note that both the mineral waters and the inflammable gas that were met with in opening up the *Silver Islet Mine* have also been encountered at other points in the district.* At the *Rabbit Mountain Mine*, in one of the lower levels, I saw water running over the breast of the drift which gave off a faint odor of sulphuretted hydrogen, and was depositing a white flocculent material, whilst both at this place and at the *Beaver Mine* I was informed that small quantities of inflammable gas had been met with.

Variations in texture, etc., of gangue.

The general appearance of the filling differs very much at different places in the same vein, owing to the frequent variations in the proportions of the different minerals constituting it, and to the various colors some of them assume. The texture of the vein rock differs also very much, owing to the differences of crystalline aggregation of the minerals, varying thus from a compact, vitreous, crystalline or saccharine to a very coarsely crystalline gangue, whilst at other places, the vein-stones present more of a brecciated appearance, consisting of angular fragments of the enclosing rock, cemented together by the gangue minerals, and often with empty spaces between.

The coarser textured vein-stones are generally found, as might be expected, where the clear space to be filled up has been large, which, as pointed out, has generally been in the trap, so that the Coast Group of veins often present this character, as do the others also where they outcrop in the trap, and it is in these positions that the large crystal-lined cavities and *vugs* occur. The minerals which mostly affect this

* Inflamable gas also comes up at several points in and around Thunder Bay, causing considerable ebullition in the water and keeping it open all the winter. On one of these Mr. Murdoch, C.E., has placed a small tank connected with an inverted funnel anchored on the bottom and it affords sufficient gas to keep a good sized light burning.—A. R. C. SELWYN.

connection seem to be the barite and calcite, especially the former, the frequency of whose occurrence characterizes the gangues of the above-named group of veins, which thus contrast with the more commonly finer grained vein stones of the other groups, which consist more generally of varying amounts of calcite, quartz and fluorite. It need hardly be pointed out, however, that these distinctions are only based on the general prevalence of certain constituents and conditions of texture, etc., and not on any hard and fast lines.

Distribution of metallic minerals in the veins.

Through these different kinds of gangue are distributed the metallic minerals in a very irregular manner. Sometimes they are very plentiful, whilst long stretches of vein are frequent, which are quite free from them. When they are present, they occur mostly in bunches and more widely disseminated whilst more rarely they show as streaks parallel to the vein walls, a mode of occurrence more frequently affected by the Coast group than by the others.

Mode of occurrence of silver ore in the veins.

The distribution of the silver minerals in the veins is similarly very irregular, so that the rich ore generally occurs in detached bodies of very varying dimensions, surrounded by very poor or quite barren areas of the vein; the frequency with which they occur and their extent when found, constituting, of course, all the difference between success and failure of the mines.

Descriptions of the different minerals of the veins.

The details of the characteristics of the different minerals are as follows:—The quartz occurs massive, crystallized, and in granular crystalline form, transparent, white and amethystine in color, the latter being very characteristic of these veins. It sometimes fills the whole vein, and is occasionally seen crystallized in the wedge-shaped spaces between radiately arranged crystals of barite, and also similarly a jaspery form was seen to have filled out spaces between calcite crystals. It is also very frequently the case that thin films of colorless quartz are found in the cleavage planes and minute fissures in the calcite, which films do not show on the fresh fracture, owing to the similarity of appearance of the two minerals, but stand out on weathered surfaces as a regular reticulation from the removal of the surrounding calcite. The smaller vugs are generally lined with pyramidal crystals of this mineral. It is more common in the veins where they occur in the sedimentary beds than where they are in the trap. There is nothing particular to note about the barite except that it is generally white, but sometimes flesh-colored, and occurs sometimes crystalline, but more often largely crystallized in confusedly interferent platy combinations. The calcite occurs both crystalline, crystallized and in coarse cleavage masses. Where it occurs freely crystallized, as in vugs, it most commonly takes the shape of double-ended scalenohedra, but sometimes exhibits the prism terminated by faces of the rhombo-

Quartz.

Barite.

Calcite.

hedron. Mr. H. P. Brumell, who applied the alcohol flame test to a large number of specimens of this mineral from this district, reports finding strontium in nearly all.

Fluorite. The fluorite occurs granular, crystalline, crystallized and in mammillated forms, whose surfaces are often made up of faces of the cube. When crystallized, it occurs in well-formed cubic crystals or in groups of the same. Its color is most commonly light-green, but it shows amethyst tints nearly as often, whilst some of the layers of green fluorite show a tendency to this amethyst color on their mammillated surfaces. Occasionally, detached, well-formed crystals, occurring in *vugs*, are pale yellow or colorless.

Chloritic material, etc. The description of the saponite has been given in mentioning its occurrence at the *Beaver Mine*, and the presence of chloritic material has also already been alluded to. This latter, although not part of the veinstone proper, is yet of frequent occurrence, and its very dark-green or almost black, soft varieties have been occasionally mistaken by prospectors for plumbago, which is considered a favorable indication in the district.

Carbon. The association of this latter mineral, and the occurrence of other forms of carbon in connection with these veins, has already been mentioned at several places, and the favor with which it is regarded as an indication arises from its close association with the rich ore of *Silver Islet*. The anthracite-resembling form which is occasionally found in the veins, as well as in the enclosing rocks, would seem in composition to be almost pure carbon, showing, as it does, no volatile matter on being heated. It has been described as altered bitumen in the "Geology of Canada," 1863.

Water and gas. An analysis of one of the mineral waters has already been given in speaking of *Silver Islet*, so that no more need be here said regarding them, except, that if the managers of the mines could be induced to collect samples, further examinations might give interesting results. Of the gas we unfortunately know nothing, except that it is inflammable. I was never fortunate enough to be present when any was met with, but explained to some of the managers how it might be collected, thinking that a preliminary examination of such a sample might be of use, but my efforts to secure some have so far been in vain.

This completes the description of the non-metallic contents of the veins, the characters of the metallic minerals being given below,

Blende. dealing with them in the order of their prevalence. The blende comes first in importance, being the most plentiful. It occurs both crystallised and in cleavage masses, often of considerable extent. It is sometimes disseminated through the gangue, and often forms solid ribs, etc., traversing it. It frequently occurs thus along the walls of

the fissures, and as crystalline growths starting out from them into the veinstone. It shows both lighter and darker coloured varieties, the former more often as detached disseminated crystals, whilst its more massive occurrences are generally of a very dark brown colour or almost black.

The galena does not play such an important part, nor generally exist in such considerable masses, but is generally disseminated. It also shows sometimes as films, sheets and little patches in the jointings and cleavages of the veinstone, which, from having a dull, leaden surface and dark color, somewhat resemble similar occurrences of argentite, from which they can be readily distinguished, however, by cutting with the knife, when they break up into little grains showing the characteristic bright cleavage surfaces of galena. Both the blende and this mineral are often found in the *vugs* and open spaces in the veins, in beautifully perfect crystals, the latter showing most commonly in combinations of the cube and rhombic dodecahedron. Galena.

The pyrite is found to a lesser extent than the two last mentioned. It occurs often well crystallised in small cubes coating the crystals of quartz or calcite, which are found lining *vugs* and also disseminated in the gangue and to a less extent in films and dendritic markings in the jointings and cleavages of the gangue minerals. It is also found sometimes in the rocks of the district, especially in the trap, but sometimes in the argillites, cherts, etc., and occasionally in considerable quantity adjacent to some of the veins as at the *3 B* vein, on Big Trout Bay. Pyrite.

Besides these more important metallic minerals, others are found in connexion with them, viz., marcasite and pyrrhotite, which are, however, rather rare, whilst copper is represented, especially in the Coast Group, by chalcopyrite and copper-glance, the latter being often argentiferous. Other metallic minerals.

So much then for the metallic minerals which form the associates of the silver minerals proper: the mode of occurrence of the latter will be now described. In the ore bodies, the metallic minerals are generally present in large quantity, blende generally predominating largely, although galena sometimes plays a prominent part, and through these minerals are found distributed the argentite and native silver. Sometimes these silver minerals are distributed through the gangue minerals themselves, the others being hardly represented at all. The argentite which is the most common is found in nuggets of various sizes in the *vugs* bearing the impress of the quartz or calcite crystals which usually line them, and also in thin films coating the surfaces of such crystals, and in the joints and cleavages of the gangue Occurrence of the silver minerals. Argentite.

minerals, whilst it is also occasionally recognisable in the cleavages of the blende. Where filling in larger cracks, it, of course, occurs in thicker sheets, whilst at times, when very thinly distributed over cleavage planes, it assumes dendritic forms. Sometimes these films are found to merge at places into the native metal as if from a partial reduction of the sulphide. It is sometimes stated in the district that it occurs in the argillites themselves, but in these cases it is always found to be in thin joints and cracks in them. The native silver occurs in thin sheets, films and facings in a similar way to the last and also in wire and fern-like forms, the latter in *vugs* at times forming a very beautifully moss-like lining to them. In one or two instances these wires etc., were found seemingly penetrating small crystals of blende, or as if that mineral had crystallised around them. With the exception of *Silver Islet*, this form of silver seems to be more characteristic of the ore bodies near the surface and to be replaced by argentite in depth, which would seem to show that it is probably due to the reduction of that mineral to the metallic state by surface waters.

Native silver.

Dendrites.

Besides the dendritic occurrences of argentite, other dendritic films and stains are common in the cleavages and jointings of the veinstones. These have often been mistaken by prospectors for argentite, but to the experienced eye, whilst greatly resembling it, they have yet a distinguishable difference of colour and lustre. In composition they are probably oxides of iron or manganese.

Results of assays made.

Assays have been made in the laboratory of the Survey, to the number of about forty-nine, of specially selected specimens, with a view to get some further knowledge as to whether or no the other metallic minerals carry the precious metals. These specimens were selected on account of their holding as large a proportion as was obtainable of the metallic minerals, and where possible, which was seldom however, these different metallic minerals were obtained free from admixture with each other.* A careful record was kept of the mineral contents of each one submitted for assay and the study of these in connection with the results obtained point to the following conclusions, viz:—that the metallic minerals when free from visible silver compounds, carry none of that metal, or when they do so, its proportion is very small. The likelihood of their carrying any silver seems to be in the order in which they are here named, viz:—blende, galena and pyrite, only one instance being found in which the latter mineral did so, where being the only one visibly present in the specimen of veinstone treated, the assay yielded about half an ounce of silver to the ton.

* See Reports of Geological Survey for 1886 and 18 7. Part T.—In nearly all the instances of specimens submitted for assay they carried enough of the metallic minerals to constitute good milling ore, had these minerals proved to contain as much silver as was credited to them in the district.

All the specimens were also examined for gold at the same time, but only showed traces of it in a few instances, and in those nearly always in specimens where the blende preponderated, pyrite being absent except in one instance, although one might have expected gold in connection with the pyrite considering its frequent association with that metal in gold veins proper.

As has been mentioned in connection with *Silver Islet* and the older mines, these metallic minerals or rather the galena and blende get enriched with silver in the ore bodies, and it has often been asserted that the very dark-coloured blende which so frequently occurs in this connection is always rich in silver, but some of the assays made prove that this is not always so. Of two specimens of such blende each accompanied by a little gangue, one showed no silver and the other gave about 337 oz. to the ton. In the latter instance, the attached gangue carried a little visible argentite, but not enough to account for so high a yield.*

Assays.

In the study of these assay results, no connection was noticeable between the different kinds of gangue in which the minerals occurred and the presence of silver. Further details of these assays will be found on referring to the reports of Mr. Hoffmann of the work of the Chemical Branch of the Survey for 1886 and 1887, and other assay returns of specimens from these veins will also be found scattered through similar reports in the volumes of the Survey for some years previous to this.

Relationships of different vein.

Materials.

A much closer and more extensive study than the time at disposal has allowed of, would be required to determine the relationships of the various minerals to each other, and whether they all owe their presence to the continuous action of one set of forces, or whether they have been formed at different periods. So far as the study has gone, however, some suggestive points have been made out. For instance, the presence of the films of silica deposited in the cleavage planes and minute fissures traversing calcite would seem to prove that quartz must have been infiltrated after the calcite had been formed, whilst in other cases, these minerals are found so related to each other that they would seem to have been formed about the same time, which is probably due to the existence of quartz of two different ages, one deposited later than the other. There are some similar evidences of the presence of both primary and secondary calcite, the latter kind showing in the *vugs* as finely formed small transparent crystals, generally scalenohedra, but sometimes a combination of prism with rhombohedral terminations. These are there superimposed upon minerals which are otherwise

Primary and secondary quartz and calcite, etc.

* See Report of Geological Survey of Canada for 1887. Part T Assays 35 and 36.

generally found coating the other kinds of calcite whose coarse cleavage masses and opaque white appearance contrast strongly with the characters presented by the secondary forms.

Probable mode of deposition of silver minerals.

The mode of occurrence of the silver minerals, too, would seem to show that their presence was due to a later infiltration of silver-bearing waters subsequent to the deposition of the gangue minerals; occurring as they do, deposited in the fissures which traverse these, in the cleavage planes of the calcite and coating crystals of silica, etc., and as one would expect forming larger masses or nuggets in the wider spaces or *vugs* in the vein. This deposition seems to be confined to the permeable minerals and parts of the gangue as might be predicted, and I cannot recollect seeing the silver compounds actually in minerals such as quartz or barite which are evidently not adapted to this method of enrichment. It would also be in keeping with the facts noticed regarding the other minerals; the compact pyrites not being argentiferous, whilst the presence of cleavage planes in blende would allow of its enrichment in this manner at points where such deposition was going on. It is also noticeable that, so far, no instance has been observed of the secondary calcite carrying silver in this way. Mr. Courtis records a curious association of minerals which he observed at *Silver Islet*. He says:—"The breast of the stope showed a coating several inches thick of a spongy silver in which were imbedded, like plums in a pudding, double-ended quartz crystals."*

Possible sources of silver.

Many suggestions have been made by various observers as to the probable source whence these silver minerals have been derived. Some have thought them to be due to the same volcanic action to which are attributable the presence of the traps in the formation, and that the silver has been brought up by thermal waters accompanying these intrusions, but, as the fissures intersect and dislocate the trap sheets and dykes equally with the other rocks, the former must have been formed and solidified long before the fissures. The fact, however, remains that all the ore bodies found so far, occur near or within a reasonable distance of trap in some form, either in dykes, as in the case of the Coast group, or in sheets, as with the other groups. This suggests the idea that the silver may be derived from them by decomposition of some of their mineral constituents carrying minute quantities of silver, by waters infiltrating downwards through all their joints and pores, and that these waters passing onwards and soaking into the permeable parts and minerals in the gangue of the veins, have there deposited their silver contents, the various forms of carbon present in the sedimentary rocks having had some influence in effecting this precipitation. The presence

* See Transactions American Institute of Mining Engineers, Vol. XV, page 674.

of the soft talcose and of the various chloritic materials in this connection would seem to bear out this assumption, as they are just such decomposition products as would result from this kind of action. The most favourable conditions for the production of such results then would be :—1st. Such a combination of mineral and physical characters of the gangue as would render it easily permeable. 2nd. The presence of carbon in some form. 3rd. The presence in the adjacent trap of the silver-bearing constituent, and also of a jointiness and fissuring allowing of the infiltration of the decomposing waters. In this way we would expect more effect from the very jointy, columnar and more extensive sheets than from the more compact and less extensive ones. Thus, it would be only where all these conditions were combined, which would only be at spots, that the deposition of the silver minerals could be expected to take place, a view that goes far to account for the mode of occurrence of the rich ore in the veins in detached bunches varying much in size and frequency, and for the total absence of silver in the intermediate stretches of the veins, as well as for the curious fact that the metallic minerals carry no silver remote from the rich parts.

Probable conditions of deposition of silver minerals

Movements subsequent to the formation of the veins (of which there is some evidence at places) would also tend to produce favourable conditions by fissuring and rendering the gangue minerals more permeable. These hypotheses might be held, by those who have the idea that the trap forms a single flow or sheet at a definite horizon in the formation, to necessitate the conclusion that the ores would be found only near the surface, but when we remember that this is not so, and that the trap sheets exist at various horizons all through these rocks, it will be seen that no basis for such an assumption exists, and that they are just as likely to be found in depth as at the surface. The above hypotheses must, of course, be only taken as suggestive, as there are yet many gaps in the evidence and points yet open for study, one in particular as to whether the traps do or do not contain any silver, a point that can, of course, only be settled by an extensive series of carefully made assays of these rocks, such as have been made in investigating similar phenomena at other places.

Conclusion.

In concluding this study of "Silver Mining on Lake Superior" from the standpoints enumerated in the preface, the results may be summarized as follows :—

Part of the area of the Animikie or silver-bearing rocks in Canada has been fairly prospected, although not nearly so thoroughly as it might, and probably would have been, but for certain adverse, economic

Extent of silver formation explored.

General results of explorations.

conditions previously mentioned. This search has led to the discovery of very many veins, some of which have been proved by development to contain extensive bodies of very rich silver ores. A great many of the other veins found have also yielded smaller quantities and specimens of similar ore, whilst in a great many none has been found so far. In the two latter cases, however, it generally appears on investigation, that the work done to test the veins has been so slight as to leave the question of their capabilities as ore-producers still unsettled, which also applies to many of the mines which were opened during the earlier periods of the history of the district and are now closed. In these, although much more was done than mere surface testing, and although shafts, etc., were sunk, still these underground developments were in most cases not sufficiently extensive to disprove the existence of ore bodies of sufficient extent and frequency to pay.

Results of prospecting and developement of silver veins.

Amongst the chief results of all this prospecting work have been: the proving of the widespread occurrence of rich silver ores throughout the formation, and the existence of very numerous veins, on very many of which, if properly handled, successful mines, besides those already in operation will be opened up. Of course, many of them may not thus reward the efforts made to develop them, but this is no more than occurs in every mining district in the world, and we cannot expect the one under study to prove an exception.

Lessons taught by past experiences in the district.

One of the most important lessons taught by past experience is, that owing to the mode of occurrence of silver in the veins, they require more extended underground developments to prove their value than most other lodes, and that unless this is borne in mind and acted upon in the future, and unless the developmental works and drifts are kept well ahead of the stoping out of the ore bodies already found, and the operating companies provide in the start a sufficient capital to do this, the failures of the past will be repeated in the future. Regarding the statistics of the yield of silver from this district further details will be found in the article on silver by myself in the Report of the Geological and Natural History Survey of Canada for 1886, Part S, pages 73-5.

APPENDIX I.

NOTES OF MICROSCOPICAL EXAMINATIONS OF ROCKS FROM THE THUNDER BAY SILVER DISTRICT.

By Mr. W. S. BAYLEY
of
THE JOHNS HOPKINS UNIVERSITY,
Baltimore, U.S.A.

Microscopical characters of rocks of silver formation.

No. 85.—McKellar's Point (*from near the end*). This rock is composed of felspar, quartz, green hornblende and magnetite. The felspar is in rudely outlined lath-shaped crystals, and in irregular grains between the other constituents. It is very much altered, and as a result of this alteration, is filled with inclusions of red iron compounds. These are scattered throughout the material of the crystals and grains, but are most abundant around their exterior portions. Kaolin and chlorite are the remaining products of its alteration. The quartz occurs in irregular areas and in club-shaped masses, intergrown with portions of the red felspar. The green hornblende is only sparingly present. It is found in little plates and shreds, and in allotriomorphic grains between the other components. It has undergone chloritization, resulting in the breaking up of the grains into small particles and fibres which are irregularly intermingled with the felspar and quartz. Magnetite is closely associated with the chlorite derived from the hornblende. It is also occasionally present in little grains in the felspar. In the latter case it is sometimes surrounded by rims of brown biotite. Apatite and sphene (?) also occur in small quantity.

From the examination of this single specimen it would seem necessary to regard the rock as closely allied to those of Irving's augite-syenites,* which are like the contact rocks on Pigeon Point,† at the junction of olivine-gabbro and an acid eruptive.

* Copper-Bearing Rocks, p. 112-125, Pt. XIV.
† Amer. Jour. Sci., Jan. 1889.

Microscopical characters of rocks of silver formation—continued.

No 113.—JARVIS ISLAND (*from North of Shaft*). In number 113 the original structure of the rock is still preserved. Very much altered lath-shaped crystals of plagioclase lie in a mass of red felspathic substance and secondary quartz. The quartz is either in little club-shaped masses filling the angular cavities between the large plagioclase crystals, or is in micropegmatitic intergrowths with the red felspathic substance. Wedge-shaped aggregates of chlorite, brown mica and green horn-blende, in the midst of which are often to be detected little areas of augite, leave no doubt that the latter mineral was once an important constituent. Apatite, magnetite, pyrite and a few plates of hematite are the remaining components.

The rock is evidently a much decomposed diabase. Its characteristics are very similar to those of diabases which have suffered alteration as a consequence of their penetration by solutions emanating from masses of acid eruptive rocks.

No. 128.—JARVIS ISLAND (*from North Side of Shaft*). Number 128 appears to be a rock whose characteristics are intermediate between those of No. 85 and No. 113. The outlines of the felspars can be detected only in rare cases. The quartz is present in those forms usually resulting from a secondary origin. Green hornblende is more abundant than in either one of the two rocks described above and is not infrequently possessed of its own crystallographic outlines. Only the minutest traces of augite can be discovered. Magnetite is more abundant than in the first two rocks, and is usually in rod like forms. A little apatite, leucoxene and secondary brown mica are also present.

The nature of the rock is probably the same as that of Nos. 85 and 113, i. e., it is was originally a diabase, which has been altered in the same way as has the gabbro in Pigeon Point, at its contact with an acid eruptive rock.

No. 127.—JARVIS ISLAND (*altered argillite*). This rock is quite different from either one of the others described. It is probably an altered slate or argillite. The least altered portion of the section examined consists of quartz, felspar and chlorite, with a few other subordinate substances. Its structure is that of a typical phyllite.

In the more altered portion, the felspar is bounded by traces of crystal outlines. It is red through the inclusion of little plates of hematite, and can occasionally be detected with twinning lamellæ. The green mineral corresponding to the chlorite in the least altered portions, is here grouped into little sheaves of fibres, which, between crossed nicols, give bright polarization colors. It has been changed into a micaceous substance with many of the properties of green biotite.

In its original state the rock was probably a slate, which under the

influence of some eruptive mass (probably of the composition of No. 85 or 113) has recrystallized, with the addition of felspathic substance derived from the eruptive which produced the recrystallization.

Microscopical characters of rocks of silver formation—continued.

OF THE FOLLOWING THIRTEEN SPECIMENS, THE SLIDES WERE RECEIVED FROM MR. E. D. INGALL.

You will notice the three traps (Nos. 259, 301 and 338) are, as you intimated in your note, very similar, and are probably parts of the me great flow. They differ merely in state of preservation.

The granite (No. 277) possesses peculiarities which distinguish it from ordinary intrusive granite. The pressure phenomena show that it has undergone considerable change since it was first produced. It would be supposed that as a consequence of this pressure, schistosity would have been induced. The specimen sent me is too small to distinguish this structure, if it does exist. The question whether the rock is metamorphic or intrusive will have to be left for you to decide. As a result of the microscopical examination, it would be most natural to suppose that the rock (whatever it may have been originally), was subjected to pressure after the present minerals had been formed, otherwise the structures observed would be impossible to explain. Whether the same causes first produced the rock and then by further action produced in it these pressure effects, is difficult to determine. While the question as to the origin of this rock is not positively decided, it would, I think, be safe to say that it is probably of metamorphic origin.

Nos. 259, 301 and 338 are all typical traps, e. i. are diabases, more or less altered. Of these, No. 338 is the least changed.

No. 338. PALISADES.—This is a medium-grained diabase, with the typical diabase structure. It consists of lath-shaped crystals of twinned plagioclase in a ground mass composed almost entirely of augite. The plagioclase is fresh in part, when it is almost glassy in appearance, and possesses very well defined twinning lamellæ. The angles of extinction measured against the line of union between contiguous lamellæ indicate that the predominating variety is labradorite.

Most of the plagioclase, however, has undergone alteration, and has thus given rise to secondary products, the most important of which are calcite and chlorite. The former occurs in very small quantity, and is found in little irregularly shaped grains near the periphery of the felspar crystals. The chlorite penetrates the plagioclase substance in little veins, and is also found around its edges.

Microscopical characters of rocks of silver formation—continued.

The augite is of a very light wine color. It fills in the interstices between the felspar. When fresh, its cleavage is very perfect, the section seemingly being made up of little square blocks of augite. In most cases, this mineral has undergone considerable change. Chlorite and a yellowish green aggregate of an earthy substance have taken its place.

In one or two instances, a yellowish substance, consisting of an aggregate of little fibres, looks very much like serpentine, which has been stained yellow by iron salts. It may be due to the alteration of an original olivine constituent. Magnetite in grains, apatite in long, slender needles, and a little leucoxene, occur as accessory minerals.

No. 301. SILVER BLUFF, R. 61 (*Trap from six inches above contact*), is not quite as fresh as 338, nor quite as much altered as 259.

Little cores of augite can be detected in the abundant chlorite which makes up the greater part of the slide. The magnetite, instead of existing in little irregular grains scattered among the other constituents, occurs in skeleton crystals, as is frequently the case in basalts.*

No. 259. CROWN POINT (*Trap from above tunnel*) is a tolerably fine-grained, much altered diabase, in which the original structure can still be very readily discerned.

The felspar occurs in lath-shaped crystals, with very ill-defined outlines. These crystals often contain so many inclusions of various kinds, and are frequently so much altered, that they are in some cases almost opaque. Chlorite, mica and calcite are the predominating products of alteration. Where it could be measured, the angle of extinction in this felspar was very small, thus indicating oligoclase, as the principal felspathic constituent.

The augite, which originally filled in the spaces between the felspar crystals has almost entirely disappeared, and in its place there is found a yellow mixture of chlorite and another mineral of a finely fibrous structure. The pleochroism of the chlorite is scarcely perceptible, and the polarization colors between crossed nicols are extremely weak. Rutile and leucoxene usually accompany these secondary products as inclusions, and a very small amount of secondary brown pleochroic biotite is not uncommon around the edges and in the interior of the aggregates.

Large crystals of very light green apatite and considerable magnetite are scattered throughout the rock, the latter being often surrounded by a rim of biotite. The similarity between these three slides is so great that they may well (as far as the microscopic examination goes) be considered as sections of rocks which originally formed part of the same "flow."

*Rosenbusch: Mikroskopische Physiographie I, 1885. Stuttgart. Taf. III., Fig. 2.

No. 277. WOODSIDE'S (*Granite*) at first sight appears to be a typical granitite, very much like the Huronian granite of the Wisconsin Survey. A closer examination, however, shows it to possess characteristics which serve to distinguish it from most of the granites heretofore described as existing in this neighborhood. Almost the only constituents are quartz, orthoclase, plagioclase and chlorite. Microscopical characters of rocks of silver formation—continued.

The quartz is clouded with inclusions of red and green earthy substances, little folia of chlorite and hematite, and is particularly rich in liquid inclusions containing movable bubbles.

The orthoclase is clouded in consequence of its alteration. The principal product of this alteration is kaolin, though frequently scales of chlorite are quite abundant. By far the greater proportion of the felspar is triclinic. This triclinic felspar seems to be of three distinct kinds:—1. Microcline, with its twinning lamellæ, crossing at angles of 90°. This is very fresh and glassy, and contains almost no inclusions. 2. A plagioclase, with tolerably broad twinning lamellæ. This has suffered alteration to a considerable extent. For reasons which will be mentioned hereafter, its extinction could not be measured. 3. Another plagioclase, with broad twinning lamellæ, the extinctions of which it was impossible to measure, in consequence of the great amount of change which it has undergone. The twin structure in many cases could only be detected after very careful search.

The chlorite is evidently the product of the alteration of biotite. It possesses all the characteristics of chlorite which has been thus developed. The original structure of the mica is preserved, and in not a few cases, traces of the biotite can still be detected.

The most interesting point in relation to this rock is its structure. All the constituents look as if they had been crushed. Their contours are not as regular as in the case of most granites. On the other hand, pieces of one mineral seem to have been shoved into the others. The chlorite occurs in very thin plates between the felspar and quartz, as if it had been squeezed by great pressure.

The most undoubted evidence of pressure, however, is the existence in the plagioclase of a very well marked cleavage, in most instances as well marked as in the case of calcite. In one piece of microcline, while the centre was to all appearances compact, the edges possessed very sharp cleavage lines, cutting each other at angles of 82°-83°. In addition to this, almost all the twinning lamellæ are bowed and twisted, just as in the case of the plagioclase in the gabbro of Penig.* For this reason, as mentioned above, exact determinations of the plagioclase were impossible. In addition to the original twinning, a secondary twinning was often observed, as a consequence of the action of pressure.

* Lehmann: Entstehung der altkrystallinischen Schiefergesteine, etc. Taf. C., Figs. 1 and 4.

Microscopic characters of rocks of silver formation—continued.

No. 281. R. 64. LOCATION (*Chert*).—This rock is composed in greater part of what were originally round and irregular pieces of felspar, in a ground mass of quartz. The felspar has for the most part been entirely replaced by its various decomposition products, viz., calcite, chlorite and hydrated iron oxides. That portion which has not undergone this alteration has been completely replaced by silica, so that round, cloudy areas of silica (principally in the form of chalcedony) now appear where originally felspar existed. These pseudomorphs are usually marked by a rim of green or red color, probably due to chlorite and iron oxide, which separated out either previous to or coincident with the silicification process. Immediately outside of these rims there is deposition of chalcedony, which forms a feathery periphery extending from all sides into the interstices between large quartz grains, which in turn form a mosaic in the centre of the spaces between the original grains of felspar.

Scattered through the slide, both in the larger grains and also in the interstices between these, are little cloudy, almost opaque, areas, which under crossed nicols, resolve themselves into calcite. The centres of these little areas are dark and structureless, while the outer portions are composed of the perfectly crystallized mineral. This calcite has every appearance of having been enlarged, after it had once been formed, by the addition of new material around the opaque portions in a manner analogous to the enlargements of quartz grains, so distinctly shown by Profs. Irving and Van Hise, of the United States Geological Survey.

The present condition of the rock seems to be due to a very thorough process of silicification.

No. 303. SILVER BLUFF, (R. 61)—(*About fifty feet below contact.*) Is of the same general nature as the above. In this, however, the calcite occurs with chlorite and other alteration products of felspar to form complete pseudomorphs of this mineral. Round and angular grains consist now of chlorite and crystallized calcite, mixed with magnetite (which is usually found around the edges of the grain), and a brown earthy substance. The outlines of the original grains are well preserved by the rim of magnetite, but their material has entirely disappeared. From the large amount of magnetite and other iron minerals present in the slide it may be doubted whether the original grains were not augite or some other iron-bearing mineral.

A few grains are composed entirely of silica, as in the case of section 281.

The interstitial silica in this slide differs from that in 281 in that it is present only inthe form of a mosaic of quartz grains.

No. 302. SILVER BLUFF, (R. 61)—(*Top of beds close under trap sheet.*)—This rock is very remarkable. If it was ever a chert, it has undergone such deep-seated alterations that every vestige of its original nature has entirely disappeared. Microscopic characters of rocks of silver formation—continued.

Under the microscope, it is seen to consist of a granular mass of a pale yellow mineral, highly refractive, weakly pleochroic and possessing between crossed nicols bright polarization colors. This mineral, probably epidote, is intermingled with long fibres of a very light colored hornblende, pleochroic in yellow and light green tints, which, together with a little chlorite and a few quartz grains, constitute the entire rock. It seems probable that the overlying trap may in some way have given rise to this very peculiar rock.

A chemical analysis would probably reveal interesting results.

No. 317. R. 93 RIDGE—(*Middle bed of ridge.*)—Like the last rock described, this appears to be a much altered chert. So very much altered is it that a description of its microscopical characteristics is almost impossible.

Little pebbles of various kinds are included in a ground-mass of quartz grains and a black earthy material, with some magnetite. Scattered through this ground mass are numerous needles of a greenish hornblende, which in some instances are so aggregated as to form little areas, which at first glance seem to have the form of a grain which they have replaced. Upon closer examination they are seen to be merely accumulations of fibres.

In some portions of the slide, little lath-shaped crystals of plagioclase and acicular crystals of hornblende occur in a ground-mass of hematite. In these portions the structure is very similar to that so common in diabases.

No. 318. R. 93 RIDGE—(*Bottom bed of ridge.*)—Of this rock very little can be learned from the section. It is so badly stained with ochreous material as to be for the most part opaque. Occasionally a little grain of a highly refractive mineral can be detected. This is usually fibrous, and sometimes possesses an extinction angle very near that of augite. Grains of epidote can also be detected.

No. 319. R. 93 RIDGE—(*Top bed of ridge.*)—This section also is so clouded with magnetite as to render its microscopical examination almost worthless. Bands of black earthy material, containing a large quantity of magnetite, alternate with bands of brightly polarising material in fibrous forms, which under a high power are resolved into grains of epidote and fibres of hornblende.

A little hematite and some chlorite complete the list of minerals which can be determined in the section.

Microscopic characters of rocks of silver formation—continued.

The several bands are arranged in such a manner as to suggest the flowage structure of felsites, rhyolites and obsidians.

No. 320. R. 93 RIDGE—(*Upper beds of ridge.*)—Is another very peculiar and interesting rock. It consists of alternate bands of small crystals of augite, perfectly fresh and unmixed with any other materials, and other bands containing considerable uralitized augite, mixed with plates and needles of a light green hornblende, with many of the characteristics of actinolite. Fine fissures extend into the rock in a direction approximately parallel to the bands. On both sides of these cracks the minerals are stained with a brownish-red ochreous material.

I know of no rock just like this described in any of the journals. It seems to me very much like an aggregation of augite crystals in diabase, similar to the well known "Olivin-Knollen" of basalts.

No. 323. R. 93 RIDGE—(*Trap sheet.*)—Is a well defined, fine-grained, altered diabase, very similar to many others described in Mr. Lawson's Report, and like No. 259 described for you some time ago. A great deal of the augite is still fresh and of a pale wine color. That which is no longer fresh is changed into a yellowish brown earthy substance. A little uralite and chlorite occur on the borders of some of the augite crystals, but in most cases both of these minerals are so colored by the ochreous material that their detection is not easy.

No. 325. R. 93 RIDGE—(*Overlying cherty beds.*)—Is not very different from 303, except in the alteration of the rounded grains. In many cases, these consist of a very dark reddish-brown micaceous substance, mingled with a green mineral (probably of the serpentine group) and reddish-brown iron hydroxide. In some of the lighter colored grains, the remains of a colorless augite can readily be detected.

In other cases, the entire substance of the original grain has given place to silica in the form of a fine mosaic of quartz. In these, the outline of the original grain has been rendered permanent by a line of little plates of brown mica.

As in 303, the interstitial substance is quartz. Around the edges of the separate grains, crystals of quartz extend out on all sides, like the lining of a vein. Where the space between the fragmental grains was small, the two rows of quartz crystals mutually interfere and completely fill the spaces; where the intervening space was large, that portion in its centre between the rows of crystals is filled by a mosaic of the same mineral. Cracks which extend through the rock contain iron oxides or hydroxides.

APPENDIX II.

LITERATURE.

The following list includes all those works dealing with the subject of silver mining on Lake Superior, or embracing references to it, of which I have become cognisant since the commencement of the investigation.

The reference letters appended to some of them are those which have been used throughout the report to indicate the source from which each quoted item of information was derived.

Trans. Am. Ins. of Mining Engineers,	Volume ii, p. 89—W. M. Courtis.	(A)
Idem.	" v, " 473— Idem.	(B)
Idem.	" viii, " 229—Thos. Macfarlane.	(C)
Idem.	" xv, " 671—W. M. Courtis.	(G)
Eng. and Min. Journal of New York,	" xxiii, —W. McDermott.	
Idem.	" xxvi, —W. M. Courtis.	
Idem.	" xxxii, " 251—F. A. Lowe.	(E)
Idem.	" xxxiv, " 321— Idem.	(D)
Pamphlet on "Mining on the North shore of Lake Superior," 1874.....	.....Peter McKellar.	(F)
Geol. and Nat. Hist. Survey of Canada, Report of Progress.....	1866-69, page 313—R. Bell.	(H)
Idem.	1872-73, " 108— Idem.	(I)
Idem.	Various assay returns included in yearly reports of Chemical Branch.	
Can. Naturalist, 2nd Series (Paper on "Geology and Silver Ore of Wood's Location, Lake Superior"=Silver Islet).....	Volume iv, p. 37—Thos. Macfarlane.	
Idem (Paper on Mineral Region of Superior).....	" vii, " 49—R. Bell.	
Quar. Journal London Geol. Society (Paper on "The Geology of the Thunder Bay and Shebandowan Mining Districts of the North Shore of Lake Superior").....	" xxix, " 16—H. A. Nicholson.	

Milling of Silver Ores at the Silver Islet Mine.

The following figures are based upon official data of the *Silver Islet Mining Co.*, regarding the working of their mill during a period extending from May 6th, 1875, to October 31st, 1876.

Tons of rock milled			24,446
Result	1·853 % "Concentrates"	453*	
	98·147 % "Tailings"	23,993	
	100·000 %		24,446

Average yield of bar Silver (999 fine) per ton of rock milled	8·33 ozs.
Average loss in "Tailings" per ton of rock milled	1·53 "
Original Silver contents of mill rock per ton	9.86 "
Average Silver contents of "Concentrates" per ton (200 lbs)	449·42 ozs.

Cost of working; calculated to the ton of rock milled:—	
Transport; Islet to Mill	$0.50
Stamping and Concentrating	1.97
Freight and Insurance on "Concentrates" to Wyandotte and expressage on bar Silver to New York	0.35
Smelting and Charges; Wyandotte	2.08
Total cost per ton of rock	$4.90

* "This was the 'dry weight;' although the Assay for moisture was so imperfectly done about 4 p. c. of the Silver was lost."

MINES AND MINING ON LAKE SUPERIOR.

PART H. ANNUAL REPORT, 1887.

By ELFRIC DREW INGALL, M.E.,

Associate of the Royal School of Mines, Mining Geologist to the Geological Survey of Canada.

SUPPLEMENTARY REPORT

TO

PART I.—B. SILVER MINING.

Since the completion of the report on Silver Mining, above mentioned, work has continued to be actively prosecuted in the Thunder Bay district. Information respecting this work has been received from time to time, and is given below. Details on the progress of development in this district up to the end of August, 1887, will be found in Part S, Annual Report for 1887.

Recent developments Thunder Bay Silver Mining District.

The chief points of activity S.W. from Port Arthur have been at the Beaver, Badger and Rabbit Mountain Mines, and further W. at the East and West End Mines of Silver Mountain, the former being also known as the Shuniah Weachu Mine.

Besides the mines mentioned, however, many others have been operated on a smaller scale, with the object of proving various veins. Prospecting for new viens has also been actively carried on, chiefly in the western districts around Whitefish Lake.

Rabbit Mountain Mine.

The working of this mine was continued with more or less vigour during the year 1887, but operations were suspended on the 16th of December in that year.

From information received from Mr. Michael Lynch, who was underground captain at the mine, it appears that the measurements of the workings at the time of cessation were as follows: No. 3 level E. from No. 2 shaft, 160 feet; No. 3 level W. from the same, 85 feet; No. 4 level E. from No. 2 shaft, 85 feet, and W. from the same, 30 feet.

Recent developments Thunder Bay Silver Mining District.

No. 2 shaft has been sunk to a depth of 355 feet from surface. The other workings had remained as shewn in the illustration (see plate VII., fig. 2.)

According to reports received from time to time, rich ore seems to have been obtained in sinking No. 2 shaft, for, besides that mentioned on p. 70 H. as having been observed at the 2nd level, it is asserted that for the last 100 feet of the shaft rich ore was continually met with. It has not been ascertained why work was suspended at this mine, which is still idle.

Porcupine Mine.

The necessary financial arrangements not having been made for the commencement of the work on a large scale at this mine, there is little to add to the description given in the body of the report, except to record the discovery of another vein in the vicinity of the original one, about 400 feet S. of and running parallel with it. Sufficient work has not been done on this vein to ascertain its dip, but it is considered by the owners to be to the N.W., as they find the trap to be lower on that side from the faulting effect of the fissure.

Beaver Mine.

Since the last visit made to this mine in the fall of 1886, during the prosecution of the field work for the main part of this report, a large body of rich ore was discovered, particulars of which are given in the Report on Mining and Mineral Statistics for 1887, Part S of the volume for that year and by many others, notably by Dr. Lawson of the staff of the survey who, in a letter addressed to the Director, describes it as follows :—

"I was in the mine last October, and was at that time not favorably impressed with the lead, and went last Saturday prepared to meet with the same experience, but this time I was very agreeably surprised. They are working the mine by adits run in from the face of a steep hill and by shafts from the top of the hill. The lead when observed by me last fall was very lean and unprofitable, and did not show any signs of becoming richer till some time in March, and the management of the mine were so discouraged that they were on the point of giving it up and abandoning the enterprise. They persevered, however, and in March or April the lead suddenly expanded from a mere stringer or series of stringers to a wide and exceedingly rich vein of magnificent ore. I was afforded a good opportunity for close inspection for over a whole day. There are many hundreds (I may safely say more than a thousand) tons in actual sight of rich ore which will yield 100, 200, 500 up to 800 and 1000 ounces to the ton.

"I am sure that the owners of the mine have struck a bonanza, and am very glad indeed, that their enterprise has been rewarded. What the limits of the body of rich ore are I am unable to say, as there is no engineer on the property to give data for an estimate, and no very recent survey of the mine showing the relation in space of the different parts of the drifts and shafts. If you desire it I could make a survey of the mine and give you more detailed information. At its best the vein runs from three or four to five or six feet in width. The gangue is soft, being mostly calcite with some fluor spar and colorless or amethystine quartz, and through it all there is a soft, greasy material, said to be a silicate of magnesia, and called saponite by the people of the mine. This saponite appears to be a later infiltration but is often rich in argentite. Besides argentite there are native silver, sphalerite and galena. I send you by this mail a few specimens of the high grade ore. The specimens are not exceptional ones. * * * *

"The mine may, on further exploitation of greater depths, prove even more valuable and become one of the remarkable finds in the history of mining. It will, I have no doubt, greatly encourage other mining enterprises in the district.

"(Signed) A. C. LAWSON.

"Port Arthur, June 6th, 1887."

Recent developments Thunder Bay Silver Mining District.

The management have kindly furnished details of the extent of the workings completed since the compilation of the plan of the mine given in the report (see Plate VIII.) which can be corrected to March 10th, 1889, by making the below given additions.

No. 2 shaft; total depth from surface 385 feet. No. 1 level, below the adit, extends E. and W. from No. 2 shaft at a depth of 220 feet from surface measures, 550 feet W. and 200 feet E. No. 2 level below adit, at a depth of 320 feet from surface, extends 380 feet W. and 150 feet E.

No. 1 winze is sunk below the adit at a point 185 feet W. of No. 2 shaft, and had attained a depth of 280 feet connecting thus with the lower drifts. No. 2 winze connects the two above mentioned lower levels at a point 100 feet W. of No. 1 winze. No. 3 winze started below the No. 1 level below the adit at a point a 175 feet E. from No. 2 shaft, and had attained a depth of 50 feet. No. 4 winze, sinking below the same level at a point 460 feet W. from No. 2 shaft, had reached a depth of 60 feet. This, together with three cross-cuts made at points along No. 1 level below the adit, viz., at 300 and 370 feet W., at 40 feet E. of No. 2 shaft, completes the description of the exploratory work done to that date.

Recent developments Thunder Bay Silver Mining District.

With regard to the ground stoped away, it would seem that, beginning at a point about 15 feet W. of No. 2 shaft to a point 300 feet W. of the same, the vein has been nearly completely removed above the adit level to within about 10 or 15 feet of the line of junction of the trap and argillite.

Badger Mine.

This mine was started since the completion of the report, and has attained considerable prominence, its development having been attended with very satisfactory results. A reference to the "sketch map" accompanying the report will shew the position of this mine and the strike or run of the vein which is said to dip S.E.

The work done to the 1st of January, 1889, is shewn on the accompanying section (plate X), which was kindly furnished by Mr. Chas. Brent, assayer at the mine. It also illustrates the relationships of the enclosing rocks, and shows that the geological conditions are similar to those of the other mines in the district, while the details regarding the nature of the vein, noticed by Mr. Coste (see vol. 1887, p. 94 s.), show it also to correspond with the other veins.

The official and other reports since received regarding the production of ore from this mine show a very large yield for the time it has been in operation.

Jarvis Island Mine.

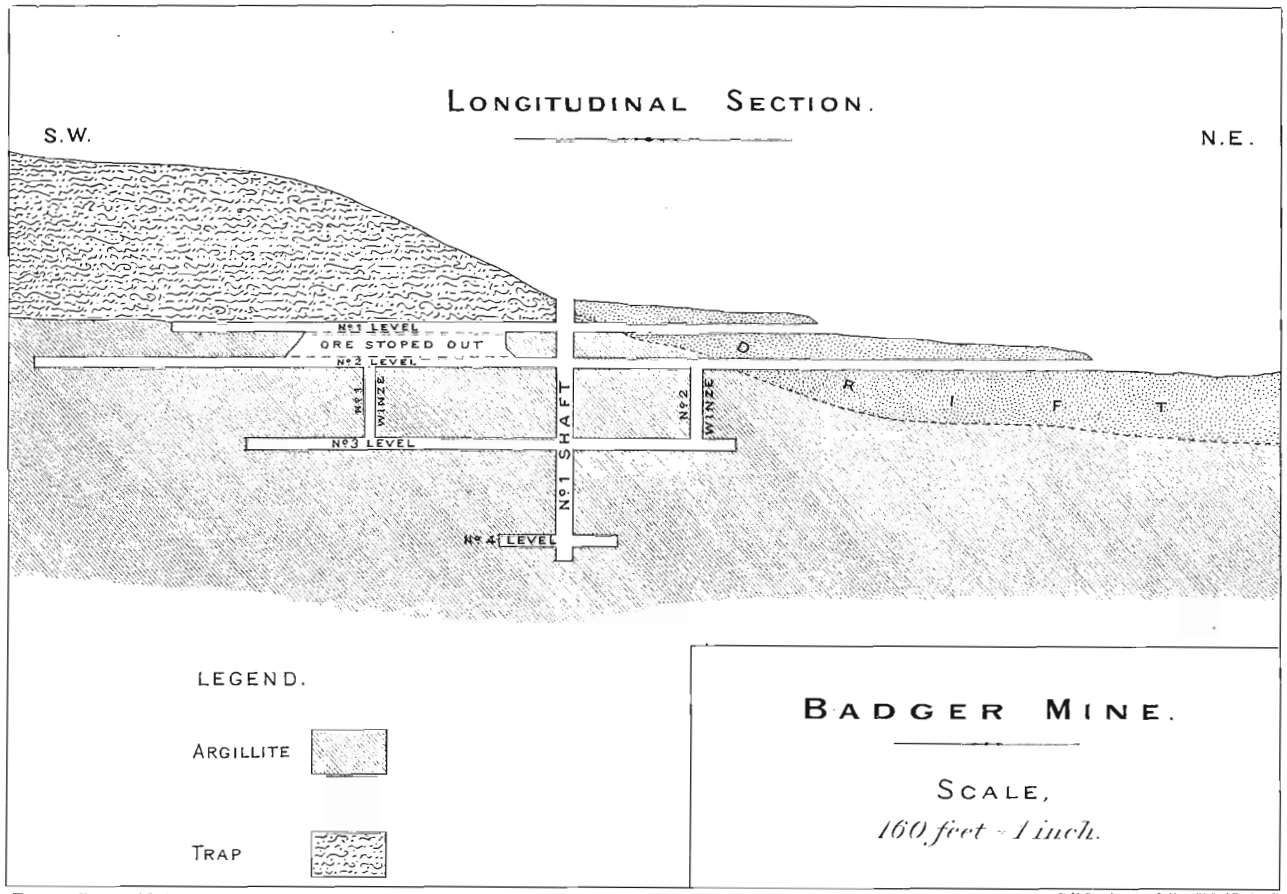
This mine is at present idle, operations having been suspended in October, 1888. The following dimensions of the workings at this time are taken from a section of the mine kindly furnished by Mr. Arthur McEwan, formerly the superintendent:

Main shaft, 270 feet from surface. No. 1, level driven S. 230 feet, ditto N. 20 feet, with a small amount of stoping done above the end. The intermediate level between Nos. 1 and 2 extends N. of the shaft 50 feet, with a small amount of ground stoped out at the end. No. 2 level measures 236 feet S. and 90 feet N. from the shaft, with a small amount of stoping done above the N. level. At a depth of 238 feet a drift (No. 3) has been run 130 feet N. and 30 feet S. At a point 50 feet S. of the shaft a winze has been sunk below No. 1 level to a depth of 35 feet.

A reference to plate IV., figure 2, will make these details plain, and by adding them, the figure will then represent all the work done at the time of closing, with the exception of a certain amount of cross cutting in various parts of the mine.

The drawing referred to also shows shafts Nos. 2 and 4, the former 50 feet and the latter 95 feet in depth, with a drift S. from the bottom,

Plate X.



Drawn by J. White.

G.E. Desbarats & Son, lith. Montreal.

50 feet long, and a cross cut at the end. Another noticeable point is that the drawing would seem to show that the S. wall of the northern dyke was met with in the drifts S. of the main shaft at a distance of about 240 feet from the shaft, which does not at all agree with the surface evidence, and is probably a mistake due to the very altered condition of the argillites near the dyke, causing the rock to be mistaken for trap.

Recent developments Thunder Bay Silver Mining District.

East Silver Mountain Mine.

Since the last visit made to this mine in 1886, work has been continuously prosecuted by the English company owning it, particulars of which to August, 1887, are to be found in Part S of the report of the survey for 1887, pp. 94-96. Of the work done since that date to December, 1888, particulars have been kindly furnished by Mr. Chas. M. Rolker, M.E., of New York, who then visited and examined the mine in the interests of the English shareholders. From the data thus obtained it would seem that the dimensions of the different workings were as follows, which will be understood by a reference to Plate IX., fig. 1:

No. 2 level, extended to 130 feet W. from No. 2 shaft. No. 1 level, extended to a point 590 feet W. from No. 2 shaft, which shaft has not been sunk any lower than No. 2 level, and does not therefore intersect No. 1 level. Above and below this level raises have been put up and winzes sunk at various point. Winze No. 1 (shewn in the section below "No. 4 pit"), sunk to a depth of 85 feet. Winze No. 3, at a point 320 feet W. from the last-mentioned, extends to a depth of 125 feet below this (No. 1) level. No. 4 winze connects No. 2 with No. 1 level at a point 100 feet west of No. 2 shaft. Measuring from this winze W. three "raises" have been put up from the back of No. 1 level, viz., at 100 feet W, a "raise" of 40 feet: at 300 feet W., a "raise" of 100 feet to the junction of the trap and argillite on the hanging wall of the vein, and finally, at a point 480 feet W., a "raise" of 25 feet. Besides this, Nos. 4 and 5 pits have been connected by a little drift, and ore stoped away around the latter pit to a depth of 45 feet from surface.

As mentioned in the report, No. 3 shaft is 820 feet W. from No. 2, and the dimensions of this part of the mine at the time mentioned were as follows: No. 3 shaft, 425 feet, but since sunk, it is said, to 465 feet from surface. No. 1 level, at a depth of 215 feet, driven W. from this shaft 230 feet, with a "raise" of 45 feet put up from the back of same at a point 75 feet in from the shaft.

No. 2 level, at a depth of 380 feet, extended to 125 feet east and 140 feet west, this end having, I understand, been since extended to 220 feet from the shaft.

Recent developments Thunder Bay Silver Mining District.

According to later information, received April 13th, 1889, work had been abandoned at this point, and another shaft (No. 4) had been started about 300 feet west from No. 3. This had been sunk ninety-five feet from the surface, and it is stated that from eighty feet to the bottom good ore had been encountered, consisting of argentiferous galena and blende, and said to assay from $80 to $150 per ton.

It would appear that small pockets of rich ore have been obtained at various places in prosecuting these workings, and it is said that a good bunch was encountered in No. 2 level, at a point about 120 feet west from No. 3 shaft, which is the more interesting in that the lower siliceous division rocks form the foot-wall of the vein at this point.

In the vicinity of a spot about 1000 feet north-east from the mouth of the lower tunnel (No. 1) a number of test-pits have been sunk to trace and prove two veins found there, which seem to be coming to a junction near this point. It is thought that one of them is the extension eastwards of the main vein from No. 7 pit (see plate IX.), whilst the other would seem to curve round to a more easterly and westerly course, and thus strike the bluff somewhere about 500 or 700 feet north of No. 1 shaft. These test-pits are on location R. 54, and are close to the lower limit of the upper division beds (see colored map accompanying the report), which are here, however, thrown slightly out of position by the faulting effect of the fissures. This junction-plane between the upper and lower division beds on the hanging wall of the vein has also been located in the main workings of the mine. At winze No. 1 it is met with at seventy-five feet below No. 1 level; at winze No. 3 at eighty-five feet, and at 135 feet below the same in No. 3 shaft, where it was also encountered on the hanging wall some fifty-five feet lower down, showing a very similar dip of the strata to the west, on the line of the vein, to that represented on the lower section, appended to the colored map accompanying the report.

According to Mr. Rolker's observations, with the fresh light thrown on matters by the recent developments, the lower surface of the trap rises slightly in going west, which, with the falling surface of the cherts, would show a slight thickening of the argillites in that direction, whilst the comparative horizontality of the surface of the ground would effect a thinning out of the trap sheet going west.

Recent work around this end of the mountain and the clearing in connection with it seem to have brought to light evidences of other faultings of the strata besides those found, and shown on the map, which is no more than one would expect, as doubtless all the vein fissures are accompanied by faulting to a greater or less degree, and it is not at all likely that they have been even yet all located, but rather that fresh discoveries of this kind will from time to time continue to reward searchers.

West End Silver Mountain Mine.

Recent developments Thunder Bay Silver Mining District.

Work has been prosecuted at this mine for some time past, and it is still in operation, but particulars of the developments made have not yet come to hand. From latest reports, two shafts are being sunk, one close to the eastern boundary line of location R. 56, in view of the success being attained in that direction by the East End Company.

Other Workings.

Besides the above-mentioned, which constitute the chief centres of activity, exploration has been continued with considerable energy, and testing operations have been carried on at many points, but chiefly in the Whitefish Lake district. The most prominent are the Peerless vein of the Rabbit Mountain group, and on the Crown Point and Palisades veins in the Silver Mountain district, whilst westwards, around Whitefish Lake, a fair amount of development has to be recorded on the claims known as the Silver Wolverine, Queen, Silver Fox and Silver Tip, as well as on location R. 119, at Medicine Bluff, and on several veinsin the vicinity of Atik Lake. Finds of silver ores have been reported from most of these from time to time, but no reliable data are to hand as to the extent of the ore found.

I am largely indebted to Mr. T. A. Keefer and others, who have collected and transmitted, from time to time, the foregoing information regarding the progress in the development of the Thunder Bay silver mines.

OTTAWA, June 1st, 1889.