

REPORTS

OF

MR. A. MICHEL AND DR. T. STERRY HUNT,

ON THE

GOLD REGION OF CANADA,

TRANSMITTED BY SIR W. E. LOGAN

TO THE

HONORABLE COMMISSIONER OF CROWN LANDS,

FEBRUARY, 1866.



Ottawa :

PRINTED BY HUNTER, ROSE & CO., SALLY STREET.

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MONTREAL, 14th February, 1866.

SIR,—In compliance with your request of the 5th January last, that I would communicate to the Crown Lands Department the results of any analyses of Canadian gold-bearing quartz veins, of which specimens had been obtained under the direction of the Geological Survey during the last year, I have now the honor of transmitting to you the Report of Mr. A. Michel and that of Dr. T. Sterry Hunt.

Mr. Michel, who formerly managed the practical working of gold mines in South America, has now for about three years devoted his attention to the auriferous region on the south-east side of the St. Lawrence in Eastern Canada, and was last season engaged by the Survey to examine such gold-bearing quartz veins on the Chaudière as had been opened by mining excavations, as well as to collect specimens of the same for analysis. He was instructed at the same time to study the facts relative to the distribution of gold in the gravels and clays, and to give such an account of the gold-mining operations of the last two or three years as his opportunities might enable him to furnish. Previous to visiting the Chaudière on behalf of the Survey Mr. Michel had been employed by Mr. R. W. Heneker, the Commissioner of the British American Land Company, to examine for gold various lots of land belonging to the Company in the Eastern Townships, and by the kind permission of Mr. Heneker Mr. Michel has included in his present Report the facts there ascertained.

The specimens of quartz collected by Mr. Michel have been assayed by Dr. Hunt, who, in addition to the results of his analyses, has embodied in his Report such remarks as have been suggested by the facts ascertained by Mr. Michel, together with information on some points connected with the assaying and working of gold that may be of use to miners.

I have the honor to be, Sir,

Your most obedient servant,

W. E. LOGAN.

To the Honorable A. CAMPBELL, M.P.P.,
Commissioner of Crown Lands,
Ottawa.

REPORTS

ON THE

GOLD REGION OF CANADA.

REPORT BY MR. A. MICHEL.

MONTREAL, 1st February, 1866.

SIR,—Since the publication of the General Report on the Geology of Canada in 1863, in which you have indicated the principal facts made known in previous Reports of progress, from 1848 up to that date, regarding the Geological distribution of gold in Lower Canada, farther discoveries have confirmed your observations, and have brought numbers of explorers to the Chaudière and St. Francis valleys. These later discoveries have been due to individual efforts, and to the perseverance of a few of the inhabitants of these districts. Their researches, rewarded in many places by unlooked-for success, have placed this region among those in which the systematic working of the alluvial deposits and of the gold-bearing quartz veins (when separated from false hopes and extravagances), may become a regular industry, having its chances of success and failure.

The acquisition by American companies of a great part of the auriferous lands along the borders of the Rivers Chaudière, Famine, Du Loup and their numerous tributaries, as well as the sale made by the Messrs. De Léry to another company of the mining rights in the seigniorship of Vaudreuil (Beauce), might have been expected to have given an impulse during the past year to the working for gold in this district, or if not, at least to proper explorations directed by skilful miners. Such, however, has not been the case; none of the companies, since their organization, have undertaken any important workings, nor even any serious exploration of their properties, while at the same time the country people have abandoned their search for alluvial gold, and the influx of strangers (who came there for the same purpose in great numbers in 1864) entirely ceased in 1865. It is not to the still unsettled difficulties which in many cases exist as to the mining rights, nor yet to the high prices demanded by proprietors for the privilege of working, that is to be attributed this abandonment of the alluvial gold deposits by the workers who were so numerous in 1864. If I am to believe reports, this discouragement may be in part attributed to the inactivity of the large organized companies, but in part also to the speedy exhaustion of the rich deposit of the Gilbert River, where the successful workings were confined to a very small area, trials both above and below which were unremunerative. After the extravagant illusions of some, and the exaggerations of other and interested parties, a reaction was inevitable, and great numbers of those who unwisely compared the alluvial deposits of the Chaudière to the richest valleys of California and Australia, seem to-day, with as little judgment, to despair altogether of the future prospect of the alluvial gold deposits of Lower Canada.

When we consider that the existence of alluvial gold has been demonstrated over a great extent of territory in Eastern Canada, and at the same time take into account the deposits, some of considerable richness which have been met with on the Rivers Chaudière, Guillaume or Des Plantes, Touffe des Pins or Gilbert, Famine and Du Loup, we may reasonably suppose, especially when we consider how limited have been the researches hitherto made, that there may exist in the alluvial deposits of the Chaudière basin other localities as rich in gold as any yet discovered, and perhaps even extended areas whose regular working may be made profitable. The question moreover arises whether these rich deposits are confined to the beds of the streams, their shores and flats. It is well known that in the Andes of equatorial America and in California alluvial gold has been wrought with success upon the flanks of the mountains, and on elevated table-lands, while in Australia the precious metal is as abundant in the dry valleys as in those of the present water-courses. A

vast field for exploration is now open in Lower Canada, where up to the present time the search for alluvial gold has only been made by the efforts of individuals, of small local associations, or of native companies who have employed but a limited capital. The result has been that these workers have been discouraged by the difficulties and obstacles which they met with, and have only sought for gold in places where it was possible to obtain it with little expense. Nevertheless the results of the trials made in 1851 and 1852 on the Rivière du Loup near its junction with the Chaudière, as well as those obtained by Dr. James Douglas on the Rivers Des Plantes and Gilbert are such as would authorise the trials upon a large scale. These would require, it is true, preparatory labors of considerable extent and cost, which would however permit the excavation and washing of a previously determined area of alluvion often of considerable extent. Up to the present time no single mining enterprise on an important scale has been undertaken in this region, nor has any one attempted to put in practice the economical and powerful modes of working by hydraulic processes, one of which has been so clearly described and so judiciously recommended in the Report of the Geological Survey for 1863, page 742.

In offering these general considerations as preliminary to the details which I have to place before you relative to the present condition of things in the auriferous region which you charged me to examine, I am animated by the same spirit of moderation which inspired certain articles published by me on this subject in 1864,* and I am desirous of warning the public, to a certain extent, against the fascination which the working of gold mines exercises upon many imaginations. But inasmuch as I owe to you a clear and precise statement of the impressions left upon my mind by the study of the region, the facts already established, and the results obtained, I do not hesitate to say that the various causes which have prevented the general exploration of the region by the searchers after alluvial gold are very much to be regretted. All the probabilities appear to me to be in favor of the existence and consequently of the ultimate discovery of other deposits as rich as those of the Gilbert, and I do not doubt that the distribution of gold in the alluvion of certain localities will eventually be found sufficiently abundant to authorise regular and methodical workings, which, if conducted with intelligence, activity and economy, will yield satisfactory results. This favorable judgment of the auriferous alluvions of the basin of the Chaudière will not seem strange to you, since some years since you concluded from the facts then established, that "*the quantity of gold in the valley of the Chaudière is such as would be remunerative to skilled labor, and should encourage the outlay of capital.*" (Report for 1863, page 742.)

The search after alluvial gold has been abandoned during the past year, while the discovery and the prospective working of veins of auriferous quartz now engage the attention of those interested in the Chaudière region. The greatest quantity of alluvial gold and the largest masses of the metal, both at the rich deposit on the Gilbert, and in the Chaudière at the point known as the Devil's Rapids, have been found below and not far removed from veins of quartz, which traverse the rivers in these places. On the other hand, above these quartz veins, that is to say in ascending the current of the rivers, but little gold has been met with, and that generally in small particles. This will appear from the result of my own examinations on the Gilbert, of which an account is given further on; and the information which I have received from the gold-seekers at the Devil's Rapids, where considerable quantities of the precious metal have been found within the last few years, leaves no doubt in my mind as to the correctness of this assertion. The facts would thus seem to favor the view that these alluvial deposits have been enriched by the quartz veins in their vicinity; but an examination of the gold from these localities leads to an opposite conclusion. This gold in fact, whether in large or small grains, is generally so smooth, so much rounded and worn by friction, that it appears to have come from some distance; and if some few masses of gold still imbedded in quartz, are met with in these alluvions, these are but rare exceptions. If the auriferous gravels owed their metallic impregnation to the destruction of the quartz veins on the spot, we should expect to find the gold angular, and with its gangue adhering. As it is, the condition of the gold shows it to have been, for the greater part at least, detached, rounded and ground by the erosive action of currents of water. We must therefore ascribe the origin of the gold at the Gilbert, not to the quartz veins of the vicinity, but to other sources farther removed.

*In *Le Canadien* at Quebec, and in *L'Echo du Cabinet de Lecture* at Montreal.

In indicating in your Report of Progress for 1863, (page 739,) among other veins, that in the Chaudière at St. Francis, you say that "*it is probable that this and similar quartz veins may be wrought with profit.*" The discovery of other veins, and the results of recent assays, increase this probability; but it is not the less true that all that relates to the veins of auriferous quartz in this region is still a subject for investigation, and that it is not possible to form any certain opinions, either from local circumstances, or by comparisons of these veins with those already known and wrought in other regions. I have therefore been surprised to hear in the Chaudière district, bold and confident opinions expressed relative to deposits of quartz which are as yet known only by their outcrops, or by very superficial openings, and whose attitude and extension below the surface, as well as their industrial value are as yet wholly unknown. The openings which have been made in many of the outcrops have sufficed to establish the existence of veins and their direction, and moreover to extract portions of gangue, in which the assays, sometimes mechanical and at other times chemical, have shown in some of the specimens assayed, the presence of appreciable quantities of gold. But the conditions of regularity or irregularity, of thickness, and of mean richness in gold; in a word, all the conditions which render the mining of a deposit of auriferous quartz profitable or unprofitable, must remain matters of uncertainty, until they can be settled by workings more extended and more serious than have hitherto been made. As to the mean richness of the quartz in gold, it would be unsafe to deduce a confident opinion from the results even of numerous assays, so long as the distribution of the gold in the quartz is irregular. Multiplied assays from the same vein have nevertheless their importance, since they establish the auriferous character of the quartz, prove its constancy, and consequently assure the possibility if not the probability of obtaining satisfactory results in working on the large scale. This in my opinion is all that can be determined by assays. The real value of the gold deposits of Lower Canada can never be known until a number of them are actively wrought. This involves, doubtless, a considerable risk for those who are the first to embark in the enterprise, for nothing is more uncertain than the working of auriferous quartz veins, especially in a region where there are no precedents to guide. Nevertheless it is much to be desired that serious working trials of the gold-bearing veins in Lower Canada should be made; the risks would diminish with experience, and besides it should be said that the facts already known as to the auriferous character of several quartz veins in this region are far from discouraging.

ALLUVIAL GOLD.

Gold alluvions. *Chaudière Valley.*—The auriferous alluvions of Lower Canada cover an extended region, and we find that in 1852, the Geological Commission had already shown their extension over more than 10,000 square miles. (Report of 1852, page 71.) The gravels, through which the gold is very irregularly distributed, are generally covered by a layer of vegetable earth, and often by a bed of clay. They repose, as you have indicated in your Reports, in part upon metamorphic Lower Silurian rocks, consisting of schists, generally talcose, micaceous or chloritic, associated with diorites and serpentines. But to the southward, these Lower Silurian strata are unconformably overlaid by others of Upper Silurian age, which are also covered by gold-bearing alluvions. These upper rocks consist of argillaceous schists, with sandstones and limestones, all more or less altered. The rocks of these two formations, but especially of the Upper Silurian, are traversed by numerous veins of quartz running in the direction of the stratification, or between N.E. and E.

Many of the gold seekers in this region, imagine an analogy between the auriferous alluvions of Lower Canada and those of California and Australia, countries which I have never visited. If I were to compare the gold deposits of Lower Canada which I have examined, with those of any other country, it would be with Siberia. There, in the Ural and Altai Mountains, the auriferous sands are rarely found reposing on granitic or syenitic rocks, as in South America, but almost always on schistose rocks in the vicinity of diorites and serpentines, which has led the Russian mining engineers to consider the gold as having "its principal source in the ferruginous quartz of the metamorphic schists, and in the vicinity of the serpentines and diorites."

In the instructions with which you favored me, I was directed to determine the facts relative to the distribution of gold in the gravels and clay, to study the quartz veins, and

also to give an account of the gold mining operations of the last two or three years. But at the time (the 1st October last,) the favorable season for explorations was already far advanced, so that while occupying myself more or less with the whole district,

Vaudreuil. I was compelled to restrict my special examinations to the seigniori of Vaudreuil (Beauce), where up to the present time, the greatest activity in the search for alluvial gold has prevailed, and where the largest quantities of the precious metal have been found. In this seigniori also, the quartz veins already opened offered greater facilities for study than elsewhere in the region.

Chaudière. Alluvial gold has been profitably sought for in the Chaudière River

itself, at its junction with several rapid tributary streams. But it is at the Devil's Rapids. place called the Devil's Rapids, where the Chaudière makes a sharp turn and runs west-south-west, that gold has been most abundantly found in the cavities, fissures and cracks of the clay-slates, which often form the bed, both of this river and its tributaries, and are here seen running in the direction just mentioned, forming parallel ridges which are uncovered in low water; at which times the country people are enabled to break up and search these slaty rocks to the depth of several feet. The fissures of these rocks are filled with a clayey gravel, in which the gold is met with, and I have seen the metal to the value of several dollars extracted from between the layers of the slate. In one of these bands of slate, which the country people call veins, the gold is tarnished by a black earthy coating of oxyd of manganese. This deposit of alluvial gold occupies a distance of about a mile of

the river's bed, and is situated below the gold-bearing quartz vein which you Gold vein. have described in your Report for 1853-56, page 370, and which is more known in the locality as the O'Farrell vein; it has now been broken away down to the level of the slates. I was assured that the alluvial gold is found in greater abundance and in larger pieces in its vicinity.

I observed at the Devil's Rapids an excavation on the right bank, and about twenty feet distant from and below the Kennebec road. Here on lot 53 of range 1, north-east, a gallery was opened, having the slate rock for its floor, and continued for about 200 feet in a hard alluvial conglomerate cemented by clay. According to the information given me, the whole amount of gold obtained in this working was only about \$150.

Gold has also been found in many places in the bed of the Chaudière at low water, and I do not doubt that companies willing to incur the necessary expenses might work with profit certain portions of this river between the rapids just named and its junction with the Du Loup.

Rivière Guillaume or Des Plantes.—The river known by these two Guillaume River. names is bounded from the upper to the lower fall by high banks, and from its junction with the Chaudière to the greater fall, more than a mile from the high road, its course is successively over serpentine, diorite and chrystalline schists. The bed of this rapid stream, which is filled with boulders and pebbles of various dimensions, has been advantageously wrought for gold by the country people, and Dr. James Douglas also undertook some years since a regular working above and near the little fall. This was however abandoned after having yielded from \$2,500 to \$3,000 in gold. More than two years since, in the month of October, 1863, I spent several days in the examination of this stream. The washing of pans of gravel from its bed generally yielded grains of gold, with the black sand which ordinarily accompanies it in this region. I know that a company of five *habitants*, by laboring for twenty days during the months of July and August last, at a point on this stream a little above the former working of Dr. Douglas, obtained between eight and nine ounces of gold from the gravel accumulated in the re-entering angles and cracks of the diorite. At the same time another company working somewhat higher up on the stream got little or nothing. At this latter place, it is true, the auriferous gravel was found resting not on the bed-rock but on the bluish clay, and so far as has been observed in Lower Canada the alluvions overlying the clay are generally poor. The gravels between the lower fall and the Chaudière, have not been examined on account of a mill to which the working would be prejudicial.

Touffes-des-Pins or Gilbert River.—Up to the present time this river has Gilbert River. been the scene of the most important workings, and has yielded the largest amount of gold; I therefore made it the subject of a special examination. In ascending the course of this stream, which is a torrent at certain seasons, but easily

examined during the dry weather of summer, we find upon lot 75 of range 1 north-east, the remains of workings undertaken sixteen years since by Dr. James Douglas, which then furnished considerable quantities of gold, and would not, I am assured, have been abandoned but for the want of skilful management. A company of miners took up this old working last summer, but their explorations, conducted without energy, were not long continued, notwithstanding certain satisfactory results, among which may be mentioned a nugget of gold of six ounces weight. In following the course of the stream across the concession St. Charles, I observed on both banks and in the bed of the stream the traces of numerous explorations.

In entering the concession De Léry, we approach the rich deposit of alluvial gold which has been recently wrought. As it was important to determine the limits of this deposit, I commenced my explorations on lot 14 of this concession. I here made an opening on the right side of the stream, at a distance of about six yards from low water, and on a bank about two yards above its level. The excavation was rectangular in form, eight by twelve feet, and was carried to the bed-rock, a depth of seven feet. Three distinct layers were met with in this opening; first a foot of sandy vegetable soil, second a yellowish sand with pebbles, and third a clayey gravel containing gold, the latter layers having each a thickness of three feet. The washing, by means of a rocker, of one hundred cubic feet of this gravel, gave only seventeen grains weight of gold, the greater part of which was extracted from the fissures of the sandstone which formed the bed. On the same lot, about forty fathoms further up the stream, the company which has purchased the mining rights for the seignior of Vaudreuil, undertook, in July and August last, certain explorations, partly in the bed of the stream and partly on the right bank. The expenses of these explorations, which employed six workmen, were \$300 and but two ounces of gold were obtained. I have these details from the agent of this company, who assured me that he saw a company of four miners extract three ounces of gold in a week, from an excavation not twenty-five feet to the right of the spot where he had wrought with so little success.

Both sides of the stream on lot fifteen are full of excavations, and I was assured that several among them had given profitable results. The two branches of the Gilbert meet upon lot 16, which, like the preceding, is marked all over its surface by pits and excavations from which the auriferous gravel has been extracted. The distribution of gold was found to be very irregular, and the gravel generally poor. I saw upon this lot an excavation then in progress by the Reciprocity Company. It was a rectangular pit, twenty-five feet by twelve, opposite the junction of the two branches of the stream, and on the right bank. The sides of the excavation offered the following section in descending order:— 1. Three feet of sandy vegetable soil; 2. Three feet of sandy gravel; 3. Two feet of yellowish clay without boulders; 4. Two or three feet of yellowish clay with boulders; 5. A bluish clay. This excavation was, I believe, abandoned a few days after my visit.

Before following the Gilbert across the lots rich in gold, I resolved to examine the branch coming from the north-east. It crosses the two concessions, De Léry and Chaussegros, upon the lots 16, and has been wrought with success on the first-named concession, as I was assured, and as seems to be attested by the numerous workings which I observed alike in the bed of the river and on the two sides. These workings diminished in number and in importance in approaching the concession Chaussegros, where none of them are seen. The case is similar on lot 17 of the concession of St. Gustave, where exploring pits are found only here and there. The beds observed in many of the excavations in this vicinity are similar to those which I shall have to describe farther on in giving an account of my explorations on the other branch of the Gilbert above the rich lots; but I may here notice the existence of a very thin layer of sandy gravel resting upon the blue clay, and covered by another stratum of clay. I was informed that this thin layer contained gold enough to pay the expenses of the excavations, and had been followed as far as possible.

The rich alluvions of the Gilbert, which were wrought in 1853 and 1864 with considerable success (although the results were exaggerated by the spirit of speculation), are now considered to be exhausted. They were found on the lots 16, 17, 18, 19, and 20, of the concession De Léry. To form a notion of this area, we may regard the deposit as enclosed in a rectangle, having for its length the breadth of the four lots just mentioned, and for its breadth a measure of 180 feet, including the width of the river and a distance of eighty feet on either side. Let us farther imagine this area divided like a chess-board into

squares, each of which is occupied by a working. Many of these squares have been wrought with profit, and some have given results of exceptional richness, while the yield in the adjacent squares has been much less, many not having paid the expenses of excavation. We thus obtain, at the same time, a notion both of the irregularity of the working and the irregular distribution of the gold over the area.

When in October 1863 I visited the Gilbert River for the first time, I found upon the lots 18, 19, and 20, from 100 to 120 gold miners, divided into companies of from four to ten. Their workings consisted of a series of open excavations ten or fifteen feet deep, and of dimensions varying according to the number of workers. These open pits were sunk side by side, without method or regularity. While it is certain that large quantities of gold were extracted from these excavations, it is equally certain that a great quantity has been lost and left behind. The walls, often of considerable thickness, which separated the different pits, constitute in themselves a considerable volume of alluvion as yet untouched; and if we add to this the gold which was certainly lost by imperfect washings, it is safe to suppose, that a regular and methodic re-working of the deposit, including both the portions of undisturbed gravel and the refuse of the previous washings, would be profitable to whoever would undertake the operation. The Reciprocity Company in fact planned a work of this kind, and made costly preparations. At a second visit to this place, which I made in May 1865, the construction by them of a wooden flume, 1,800 feet long, four feet wide, and three deep, was already far advanced. It was supported on trestles of great strength, at distances of three feet, with a surrounding frame-work. The object of this construction was to carry away from a higher point the waters of the stream, thus leaving its channel dry, and, at the same time to afford water for washing the alluvions. Although of a sufficient strength and capacity for the ordinary volume of water, this structure appeared to me, when I examined it, to be unfit to resist the floods which occasionally bring rocks and uprooted trees down the channels of these ordinarily quiet streams. I remarked this to my fellow-traveller at the time, and the event soon justified my fears,—for in the month of July last the dam across the river and a portion of the canal itself were carried away by a flood following a violent storm. Having repaired this damage, and expended for the canal and for some buildings a sum estimated at from \$12,000 to \$15,000, the Reciprocity Company, I am informed, made an open cutting in the dried-up bed of the stream from lot 16 to lot 18, and extracted thence about \$2,500 in gold.

I must here call attention to a fact which is not without importance for the future of gold mining in Lower Canada, namely, the subterranean working of the alluvions during the winter season. This was attempted in the winter of 1864-65 by about thirty miners divided into companies of from four to six. By the aid of pits and galleries they were able to carry on their search for gold throughout the winter, and to extract and wash a large quantity of gravel, in which the gold was so abundant as to richly repay their energy and perseverance. Among others was a mass of gold weighing a little over a pound. When I visited the Gilbert in May last, these subterranean workings were still going on, and I was able to examine them. The pits, fifteen in number, and all on lot 18, were opened on the left bank, at distances of from fifty to one hundred feet from the stream, and sunk to the bed-rock, a depth of from twenty to twenty-five feet. They were connected by galleries, one of which, draining the whole of the works, carried the waters into a pit, from whence they were raised by pumps and carried into the river. The auriferous materials were washed in rockers, generally at the bottom of each pit. Some gold was found in the gravel which covered the slates and sandstones, but the greater part was extracted from the fissures in these rocks. The same was true in most of the rich workings on this river, and particularly on lots 19 and 20, where, of two layers of gravel, separated by a stratum of bluish or yellowish clay, only the lower one was auriferous. The bed-rock, formed of interstratified clayslates and sandstones, is sometimes broken up to the depth of five or six feet, and it is in its joints and between its laminae, where the gravel has penetrated and often become indurated, that the gold has been found in the greatest abundance and in the largest masses. It is impossible to form an estimate, even approximative, of the quantities of gold extracted from the Gilbert and its banks during the last three years, the interests of opposite parties having led some to depreciate and others to exaggerate the amount.

The line of separation between lots 20 and 21, both of which are traversed by veins

of quartz, was indicated to me as the upper limit of the rich alluvions of the Gilbert. I followed the course of the stream upwards, examining both banks, as far as lot 34 in the concession of St. Gustave, and found in the concession Chaussegros numerous exploring pits, which became farther and farther apart. As no workings had resulted from these multiplied trials, I was naturally led to conclude that the alluvions along this portion of the river were poor in gold; but as I wished to assure myself of this by personal examination, and also to study some of the facts relative to the alluvions, agreeably to your instructions, I made an excavation on lot 21 of the concession De Léry, in the bed of the river, in a place where an eddy might have been supposed to favor the deposit of particles of gold. The pit was six feet by five, and was carried to the bed-rock, a depth of seven feet. Below two feet of sand, was a similar thickness of gravel, reposing on a bluish clay holding boulders. Twenty-five cubic feet of the gravel washed in a rocker, yielded only three very small scales of gold.

I sank another pit on lot 23 of the same concession, in the bed of the stream, and about twenty feet above a band of clay-slate which traverses the stream, giving rise to a fall of eight or ten feet, and is exposed at low water. This excavation was a rectangle eight feet by four, and was carried eight feet to the bed-rock. Here, beneath two feet of sand, followed by two feet of gravel, the blue clay with boulders was met with, as in the previous trial. The washing by the rocker of thirty cubic feet of this gravel, gave only five minute scales of gold.

I next examined lot 24, immediately below a saw-mill, under which I was assured gold had been found in the fissures of the slate ridges, which here cross the stream at three different levels just above the mill, giving rise to a fall of twenty-five feet, broken into several cascades. After having removed about two feet of sand in the excavation, the yellowish clayey gravel was found resting directly on the bed-rock, which was six feet from the surface. The washing of twenty cubic feet of this gravel yielded only two particles of gold.

Another excavation was made on lot 26 of the same concession, also in the bed of the stream, and very near an outcrop of quartz two or three feet wide, which crosses the stream from N.E. to S.W. After removing the sand, the gravel was met with, followed as before by blue clay resting on the bed-rock. Twenty cubic feet of this gravel washed by a rocker, did not yield a single particle of gold.

The last as well as the most important of the trials which I made on the Gilbert, was on the line between the lots 27 and 28 of the concession Chaussegros, on the right bank of the stream, and near an exploring pit which was said to have given encouraging results. I began the excavation sixteen feet square, but at a depth of five feet reduced it to ten feet square, thus leaving on each side benches of earth four feet wide to facilitate the further workings. Beneath a foot of vegetable soil was a layer of three feet of yellowish sand, and another of the same thickness of gravel. This rested on a bluish clay filled with boulders, which from this cause, and from its compactness, was very difficult to excavate. Towards the bed-rock however it became sandy, and more easily wrought. The thickness of this clay was eight feet, the whole depth of the pit to the rock being thus fifteen feet. Notwithstanding the proximity of the stream, no infiltration of water occurred till near the bottom, when two pumps were required to keep it dry. The washing by the rocker of thirty cubic feet of the gravel from this pit, did not yield a single particle of gold.

It seems then to be established that the rich deposit of the Gilbert River has for its upper or northern limit lot 21 of the concession De Léry, beyond which point, so far as examined, the alluvions, although generally more or less auriferous, are not workable. The irregularity in the distribution of gold in the gravel, is noticeable throughout the region, but appears more marked on the Gilbert than elsewhere.

Although the greater portion of the gold which has been found here is in small grains and scales, masses have, as is well known, been found from an ounce up to five ounces, and even to a pound in weight. It appears to me from the smooth, rounded and worn condition of its surface that the original source of this gold must be somewhat remote.

I have remarked that where the layer of gravel is found resting on the bluish clay with boulders, it is poor, but becomes richer when reposing directly upon the bed-rock; while in the case of two layers of gravel separated by a stratum of this clay, the upper layer is generally without gold, while the lower is sterile clay.

more or less auriferous. The constant absence of gold from these clays which are associated with the auriferous gravels, was certified by numerous miners, and confirmed by the washing of no less than one hundred cubic feet of the clays taken from my exploring pits at different levels, and even from the surface of the bed-rock itself. These clays however contain besides numerous pebbles and boulders, notable quantities of cubic pyrites, black ferruginous sand, and grains of garnet.

Alluvial gold has also been found in the greater part of the streams falling into the left bank of the Chaudière, and among other places in the Townships of Tring, Shenley and Dorset, as you have already stated. You have also noticed the auriferous character of the River Bras. This region has however as yet been but very superficially examined by the *habitants*, and careful explorations are needed to determine whether its valley contains workable alluvions.

Although the Gilbert has more especially attracted the attention of gold-seekers during the last few years, the district drained by the waters of the Famine and Du Loup, as far as the frontier of Maine, has been the subject of numerous explorations.

The richness of the alluvions of the Rivière du Loup was shown by the workings at its confluence with the Chaudière, in the years 1850-51-52, as described in your published Reports. All the tributaries of the Du Loup, as you have there mentioned, hold the precious metal in their sands; and it has also been found in many of the tributary streams of the Chaudière, in the townships of Jersey and Marlow. When I commenced my explorations, early in October last, I could not count upon more than three weeks of weather favorable to the examination of the alluvial deposits. It was therefore impossible for me to extend my explorations to these localities, which I much regretted. I was, however, able to assure myself that no important mining operation had as yet been undertaken in the townships of Linière and Metgermette, so that the thorough examination of the alluvions would have presented great difficulties. I have, therefore, but a very brief account to give you of the alluvions of the Famine and Du Loup, and their tributaries. Although I did not neglect the information which I received from various parties, or which was to be gleaned from publications on the subject, such as the Parliamentary Report "On the Canadian Gold Fields, and the means of their development," I could not make such information the basis of a report to be submitted to you. I may, however, state that in consequence of the encouraging results of a series of explorations, large tracts of land in this region have been purchased by various parties. What is now required is the investment of capital in regular workings upon the Rivers Famine, Du Loup, Metgermette and Oliva, as well as upon the other streams along the Kennebec road, from the forks of the Rivière du Loup to the frontier. If we take into consideration the results already obtained, and the facts established as to the distribution of gold in the Chaudière valley, we may, I think, entertain legitimate hopes for the success of such enterprises.

VALLEY OF THE ST. FRANCIS.

You have indicated in your Reports the existence of gold on the River Magog above Sherbrooke, and have also stated that it has been found along the St. Francis valley, from the vicinity of Melbourne to Sherbrooke, and in the townships of Westbury, Weedon and Dudswell, as well as on Lake St. Francis. Having been charged by R. W. St. Francis valley Heneker, Esquire, to examine during the months of July, August and September last, several lots of land belonging to the British American Land Company, in the Eastern Townships, I now, with his authorization, give you an account of the results of my investigations.

Orford.—The examination of lot 19, of range 5 of Orford, presented a special interest, owing to the discoveries reported to have been made on the neighboring lots, several of which had been sold at high prices, as containing workable auriferous alluvions. The explorations which I made upon the lot above mentioned were not very satisfactory, although gold was found in three out of five trial-pits, sunk pretty far apart in the beds or on the banks of two rapid streams, which run parallel to each other lengthwise through the lot and fall into the Magog River. Beneath a layer of vegetable earth the argillaceous gravel is found resting directly upon the slate. The gold is distributed irregularly and very sparingly throughout this layer of gravel, whose thickness

is extremely variable, and did not seem to be more abundant nor in larger grains on the bed-rock than elsewhere. One of the excavations however offered an exception to the conditions just described. It was sunk to a depth of twenty-nine feet, and after two or three feet of vegetable soil and a similar thickness of auriferous gravel, presented a mass of extremely compact bluish clay enclosing boulders, and continuing down to the bed-rock, which consisted of white quartz and black slate. Thirty cubic feet of the gravel washed by the rocker yielded a few small particles of gold, but not a trace of the precious metal was found in the residues from the washing of twenty-five cubic feet of the bluish clay extracted from various depths. It contained, however, small crystals of black ferruginous sand, besides numerous boulders and small rolled pebbles of divers colors.

Ascot.

Ascot.—Lot 6 of range 13 of Ascot, is traversed lengthwise by Grass Island Brook, a mile and a half higher up, on which an American Company, known as the Golconda Mining Company, has made explorations and planned an establishment which I have visited. Three excavations were opened by me on this lot, one in the bed of the stream, and the two others upon its banks. The bed-rock was met at an average depth of six feet. The sections resembled those in Orford, and the gold seemed irregularly distributed in the gravel, but more abundant. I doubt, however, if the auriferous zone having this stream for its axis, and extending about twenty-five feet on either side, could be wrought with profit.

On an adjacent lot, 6 of range 14, of Ascot, six excavations were made, in none of which was found a trace of gold. The stratum of auriferous gravel was entirely wanting, and the vegetable soil, sometimes sandy, rested directly on the bluish boulder-clay. None of the pits, one of which was sunk to the depth of sixteen feet, reached the bed-rock. The washing of a large quantity of the matters extracted from these excavations showed the presence of grains of pyrites and black ferruginous sand, but not a single particle of gold was met with. No outcrop of rock was observed either on this or the adjacent lots, although loose masses of quartz were seen in the bed of the brook.

It would appear from the results of my examinations, as well as from the information received from the country people who have sought for gold in this vicinity, that although the alluvions of the Magog may be said to be auriferous, the precious metal in them is in too small quantity to warrant working. Exceptionally rich deposits, which are found in all alluvial gold regions, and of which that of the Gilbert is a striking example, may however be met with.

Remarkable results are said to have been recently obtained from what is called the Ascot Gold Mines, on lot 11 of range 11 of Ascot, belonging to an American company. A notice in the *Sherbrooke Gazette* of November 18, asserts that from October 20 to November 14, 1865, there were extracted from this mine by 553 hours of labor an amount of gold equal to \$996—corresponding to \$1.81 per hour for each laborer,—the largest masses of gold having been found on the bank of the Magog River, in that lot. As however the working had been abandoned at the time of my visit I had not the means of examining this deposit, nor the mode of working it. I therefore only chronicle the account of these extraordinary results, without vouching for them.

The reports which form a part of the prospectus published by another American company, known as the Golconda Mining Company, with a capital of \$5,000,000, ascribe a still more extraordinary richness to lots 2 and 3 of range 13 of Ascot, which are traversed by the Grass Island Brook. They speak, in fact, of \$14,000,000 of workable gold, of which \$3,000,000 are supposed to be in the alluvions; while the quartz and the slates found on the property are declared, according to published assays, to contain an average of \$153 in gold and \$7.53 in silver to the ton. When, for the first time, I visited this place in June last, several workmen were employed in washing the auriferous gravels, others in building a dam or in the erection of buildings intended for a mill for crushing quartz.

The quantity of gold which was then shown me as the result of the month's work, as well as the results of the washing before my eyes of numerous pans of the gravel, were such as to give me a favorable opinion of this alluvial deposit, which however my subsequent examination of Grass Island Brook has greatly modified. As to the quartz and the slate, which, if not auriferous, were abundant. I regretted not to find in the hands of the director of the workings, duplicates of the specimens mentioned in the prospectus, especially of a white quartz, which was said to yield \$3,326.10 of gold to the ton. If ever

an enterprise of this kind merited to be carried on with energy it might be supposed to be one supported by such reports and by multiplied assays so highly favorable, yet all working at the Golconda Mine has been abandoned since September last.

When I visited the spot at the end of August, I remarked in the stratified alluvion a succession different from that which I had observed in the lots that I had previously examined in the same township. Three layers are here distinguishable beneath the layer of vegetable soil,—the first a yellowish clayey gravel, containing grains of pyrites and a little fine gold; the second a stratum of large pebbles and masses of quartz and slate, cemented by a blackish clay, and without gold; while beneath this, resting on the slates, was a layer of iron-stained gravel, richer in gold than that above. The average thickness of the deposits here was about six feet. This condition of things is like that described on the Gilbert, where the sterile boulder-clay rests upon a rich auriferous gravel.

Lambton. *Lambton.*—In September last, I made an examination of lots 1, 2 and 3, in ranges A and B of Lambton. Particular regard was had to a stream which traverses lot 1 of range A, running northwards, for the reason that some ten or twelve years since explorations were there made, resulting in the discovery of considerable quantities of gold. At the commencement of my examinations, I found in the bed of the stream, in a place which had not been worked, and almost at the surface, a small mass of gold differing entirely in form and in size from that generally found in the region. A large and deep excavation at this place, and the working of a large amount of the materials extracted, gave no more gold like that first found, but only a few rare and fine particles.

The exceptional fact of the presence of this mass of gold at the surface, which I mention without comment, can have no bearing on the value of the alluvions which I have examined in this township. Although richer than those of the Magog River, I am persuaded that they cannot be wrought with profit. I found nevertheless an appreciable quantity of fine and scaly gold in the gravel from a large number of excavations on the lots already mentioned. The auriferous gravel here reposes upon a yellowish clay which holds boulders and great masses of rock, and is so thick, and at the same time so hard and difficult of excavation, that I did not think it worth while to carry the excavation to its base. I was informed that pits thirty feet deep had been sunk here without finding the

Lake St. Francis. bottom of the clay. In one case, however, in the vicinity of Lake St. Francis, on lot 3 of range A, I sank to the clay-slate bed-rock without finding a trace of gold, even in its crevices. The washing of about one hundred cubic feet of these clays, extracted from different excavations, did not furnish me a single particle of gold; so that these boulder-clays would seem to be *Sterile clays.* equally sterile with the similar clays of the Chaudière and the Magog. They however contain like these grains of pyrites and black sand, but I have remarked in all of these sterile clays the great fineness of the grains of the latter. I was assured that in a pit on lot 2 of range A, some particles of gold which seemed whitened with mercury were obtained. You have already noticed a similar fact in the Chaudière valley.

A water-course, which I may designate as the Lambton River, rises from a marsh to the south-east of the village, crosses the road from Shebrooke to Vaudreuil at about a mile from the church, passing through lots 13, 12, 11, 10, 9, 8 and 7, of range A, and lot 11 of range 3, before falling into Lake St. Francis. Having learned while at Lambton that gold has been found in several places, and in appreciable quantities, in this stream, I determined to examine it. Two excavations were therefore made on lot 8 of range A, of Lambton, about one hundred and fifty feet apart, and in the bed of the stream, and continued the one into the left and the other into the right bank. I here found gold disseminated throughout a layer of gravel resting upon a decomposing slate, which was so tender as to be readily removed with the shovel, to a depth of from one to two feet. The gold seemed to me to be more abundant on either side than in the bed of the stream, and its quantity was such that the gravel might be wrought with profit if the auriferous area were more extended. The superior limit appeared, however, to be the lot 9, which, like 8, was traversed by veins of quartz; explorations on the lots 10, 11 and 12 gave but insignificant quantities of gold. The precious metal in this vicinity is generally so rough and angular, and even dendritic in form, as to suggest that it has not been brought from a great distance.

GENERAL CONSIDERATIONS ON ALLUVIAL GOLD.

General considerations. The rule which appears to govern the distribution of alluvial gold in all other regions where it has been wrought holds good in Lower Canada. Here, as elsewhere, the layers of alluvion which contain the precious metal are not continuous, but occur in sheets or belts of greater or less extent and of variable thickness. The proportion of gold in these sheets or belts of alluvion is also far from uniform and regular, the richer portions being met with in patches more or less remote and isolated from each other. The auriferous gravels appear, from their composition and distribution, to result from a general alluvial action. In the crushed and pulverized veins of the neighboring hills, which make up the auriferous alluvions of the valleys, the gold is often so capriciously and irregularly distributed that in Australia and California the results of a week's working in some favored spot will amply compensate the miner for months of unprofitable toil in poorer ground. These general facts are illustrated by the rich deposits met with in several places of the Chaudière region, as at the Des Plantes, Gilbert and Du Loup, and it can hardly be supposed that in so vast a region these are exceptional cases. From these considerations it seems to me proper to encourage the search for alluvial gold in the hope of discovering other rich deposits, especially when such workings may favor the search for and the discovery of the veins which have furnished the precious metal.

In view of the wide distribution of auriferous alluvions—mines already prepared by nature, and requiring but a small capital for their working—the present tendency to neglect and depreciate them, while attention is turned to the search for mines of gold-bearing quartz, seems most unwise. I do not admit the opinion maintained by some writers, that the working of alluvial gold, as compared with that of veins, is the only really profitable gold mining; for although I know by experience that the worker of mines of gold-bearing quartz runs a great risk, I have seen many quartz veins in South America, when properly wrought, give not only satisfactory but richly remunerative results. The same is true for great numbers of mines in the western United States, Nova Scotia and Australia. Nevertheless, it is certain that the working of alluvial gold necessitates the employment of much less capital, that it is more easy and less uncertain than quartz mining, and consequently in all respects best adapted to the means of Canadian companies. It would, I think, be a subject of regret if the working of the mineral wealth of Canada were to be entirely abandoned by its people to foreign capital and foreign enterprise.

Conditions of alluvial working. In the working of an alluvial gold deposit its greater or less richness is not the only circumstance to be taken into account, for the situation of the deposit, the plans adopted for working, and the intelligence and practical skill of the director, must contribute in a very great degree to the success of the enterprise. Thus, for example, the working of dry alluvions upon table-lands or hill-sides will be easier and less costly than that of deposits on the shores or in the bed of a river, where the water is a source of embarrassment. On the other hand, the adoption of hydraulic methods for the breaking up or excavation of an alluvial gold deposit in situations which permit of their application may greatly expedite the working, and diminish very much its cost. I have never employed the hydraulic method which is made use of in California and described in the Report of the Geological Survey for 1863 (page 742), and which appears to offer incontestable advantages, but I have often, in working alluvial gold mines in South America, employed, for the removal of the sterile portions of earth, rapid currents of water, issuing from reservoirs constructed at higher levels, and so arranged that the flow of water could be regulated at pleasure. An open channel, as steep as possible, below the deposit to be wrought, serves to carry off the mud, sand and pebbles; the trees and large rocks having been cut down or broken and removed by hand. As soon as the auriferous stratum is laid bare the force of the current of water is reduced, but is still sufficient to break up and transport the auriferous material, washing it in a series of little channels or sluices arranged in different levels and in a broken line on a slope. The gold gathers at the head of each sluice, and if the operation has been well conducted the greater part of the precious metal will be found in the first one. Such is the method in general use in South America.

The hydraulic method applied to the breaking down of alluvial strata makes it possible to work deposits very poor in gold. This appears among other evidence from the report of

California. Mr. Simonin, a French engineer, who visited California in 1859. He says : " In the vicinity of Nevada, in California, they employ upon the placers the hydraulic method which I had already seen employed on a small scale on the banks of the Merced, and at Knight's Ferry. It is at Nevada that this method was invented, and there that its operation can best be studied. By means of a violent jet of water under a very high pressure, which the miner directs from a pipe like that of a fire-engine, great hills of alluvion are demolished; earth, gravel and boulders come tumbling down with a crash and the workmen have to take care lest they should be buried in the ruins. The materials thus disaggregated fall into a canal constructed like an enormous sluice and called a flume. By this means the poorest gravels, in which the presence of gold would hardly be suspected, are washed with profit." Similar statements are made by Mr. W. P. Blake, and cited in your report of 1863. According to him two men, by this hydraulic method, can do in a week the work which would occupy ten laborers for thirty-five days in the ordinary methods of working. I am of opinion that large areas of the auriferous region of Lower Canada are situated at levels which would allow of the advantageous application of hydraulic methods. It is therefore probable, as you have already said, " that before long the deposits of gold-bearing earth which are so widely spread over Lower Canada will be made economically available." (Report for 1863, page 745.)

QUARTZ VEINS.

Quartz veins. The old rock formations upon which the gold-bearing alluvions of Lower Canada repose, contain numerous veins or bands of quartz, which run ordinarily in the direction of the stratification, north-east and south-west. Although these veins, with their encasing rocks, present numerous outcrops, they are concealed from view over large areas by a covering, variable in thickness, of vegetable soil or other superficial deposits, so that trenches or excavations become necessary if we would follow their course. As already observed, it is especially in the slates and sandstones of the Upper Silurian series that these veins have been observed in the greatest numbers. It is not yet certain whether the attitude of these masses of quartz is that of intercalated beds or whether they cut the surrounding strata. This question can only be satisfactorily determined after extensive workings, without which moreover it is impossible to arrive at any correct idea of the interior structure and composition of these veins. Their thickness and their aspect are very variable. The quartz however is generally white, although sometimes colored by oxyd of iron, apparently due to the decomposition of some foreign mineral, which has given to the mass a cavernous or carious structure. Some of these veins seem almost free from foreign minerals, while others as you have indicated, contain metallic sulphurets, such as cubic pyrites, arsenical pyrites, blende, argentiferous galena, and sometimes native gold. It appears also from the analysis published by the Geological Survey that the pyrites and blende are sometimes auriferous.

The Reports of the Survey have shown the presence of native gold both in the veins belonging to the crystalline schists of the Lower Silurian near Sherbrooke, in Leeds, and in St. Sylvester in the seigniory of St. Giles, and in those traversing the Upper Silurian rocks in the seigniory of Aubert Gallion (St. George),* and in that of Vaudreuil at the Devil's Rapids in the Chaudière. While thus establishing the presence of gold in the veins of both the upper and lower formations, both of which might have contributed to the auriferous alluvions, the Reports of the Survey express the opinion that the greater part at least of the alluvial gold of Canada is derived from the Lower Silurian rocks. I may mention in support of the facts just cited, several specimens containing visible grains of native gold in vitreous copper extracted from a quartz vein which crosses the two concessions known as "The Handkerchief," in the St. Giles. seigniory of St. Giles, one of the localities to which you have already referred. But inasmuch as visible gold has also been found in the veins of the Upper Silurian rocks, and as the largest specimens of gold in the gangue yet found in Canada are from the vein at the Devil's Rapids, I am led to believe that it is desirable to explore carefully all this part of the auriferous region in the hope of favorable discoveries.

* *Esquisse Géologique du Canada*, page 63.

Vaudreuil. The lots 48, 49 A, 50 A, 50 B, 51 A, 51 B, 52 A, 53, and 54, in the range 1, north-east of the seigniorship of Vaudreuil, were particularly examined. I there remarked numerous ridges of clay-slate and sandstone rising above the soil and traversed in various directions by small veins of quartz. Veins of the same mineral were also observed running in the general direction of N.E., and also in little cross-courses having a direction E.S.E. Superficial excavations on lots 49 A, 50 A, and 50 B, seem to indicate the existence of an extended mass of quartz intercalated in the form of a bed; but as already remarked, only extended explorations can show whether a similar character does not belong to many of the quartz masses of this region.

Although the veins which are now attracting most attention are those in the seigniorship of Vaudreuil, numbers of similar quartz veins are found all the way southward to the frontier; and many have been discovered in the seigniorships of Aubin-Delisle and Aubert Gallion, and in the townships of Jersey, Marlow, Linière and Metgermette. Several outcrops of quartz appear along the Kennebec road; and at low water many of them can be seen in the beds of the Famine, Du Loup and their tributary streams, such as the Oliva, the Metgermette, and others already mentioned in speaking of the alluvial gold. I may here notice especially the quartz veins which were, at the time of my visit, being examined in Linière, very near the frontier. The encasing rocks here, as elsewhere, were clay-slates, and sandstones more or less calcareous. These rocks and their veins are already described in your report for 1865, pages 436-437, and more in detail in the Report for 1859, pages 50-52.

The townships and seigniorships which are the subject of the preceding remarks, are on the right bank of the Chaudière, but the veins for the most part appear to cross the river,—for I observed many outcrops of them on the road from St. Joseph to St. George, as well as on the shores and in the bed of the Chaudière. Several of these have a nearly been followed, and uncovered on the left bank, especially in Vaudreuil and Aubert Gallion. Other outcrops of quartz are seen on the road from Vaudreuil to Lake St. Francis, in the townships of Tring, Forsyth, Aylmer and Lambton, where I observed several near the lake. I regret not to be able to give you a detailed description of the quartz veins in this latter region, the exploration of which was prevented by the early snows; but I shall now proceed to state the observations which I was able to make upon the veins of which I have sent you specimens.

Vaudreuil.—Upon lot 83 of range 1 north-east of this seigniorship is a vein of quartz running N.N.E., with a south-eastern dip. On this vein, at the time of my visit, a pit had been sunk, five feet by twelve, to a depth of sixteen feet, showing a distance between the clay-slate walls of twelve feet. The mass was not homogeneous, but composed of a network of small veins of quartz impregnated with oxyd of iron, and separated by what appeared to be portions of the wall-rock. I was afterwards informed that at a depth of twenty or twenty-five feet these veins united into a single small one. It is said that an assay of a portion of this quartz sent to Boston gave at the rate of \$37 of gold to the ton, while another assay on the spot, by a Mr. Colvin, gave \$106 to the ton. A mechanical assay, by crushing and washing twenty pounds of the quartz, of which I send you specimens gave me five very small particles of gold. (No. 1.)*

What appears to be a powerful vein of quartz runs north-east through lot 21 of the concession St. Charles, with a very slight dip to the south-east. An excavation seven feet by twenty, had here been sunk to a depth of eighteen feet, and the adjacent clay-slate was only visible on the south-east side of the vein, whose thickness here is at least seventeen or eighteen feet. It is divided by joints into irregular masses separated by ochreous and earthy matter, but seems more compact at the bottom. I remarked near the north side of the excavation, a vein of brown decayed material, having a thickness of from four to twelve inches, and running parallel with the quartz vein. It was said that a portion of this quartz, assayed at Toronto, gave \$136 of gold to the ton, and that another assay by Mr. Colvin gave \$54; the certified assay by Dr. A. A. Hayes of Boston, gave for the quartz of this vein \$77.56 in gold and \$2.55 of silver to the ton. After my visit in October, the pit was sunk to thirty feet; but on my return in January, the working was suspended, so that I could not examine the bottom. The specimens sent were taken in October. (No. 2.)

* This and the following numbers in parenthesis refer to the assays in the following Report by Dr. Hunt.

On lot 62 of range 1, north-east, there is an outcrop of a vein of quartz, from which a few cubic feet have been removed by a very superficial working. The breadth of this vein was from four to five feet, but as it was neither uncovered nor examined, it was impossible to determine its attitude. It is said that an assay of the quartz, made in New York, gave \$15 in gold and \$22 in silver to the ton of rock, but that by the assay of Mr. Colvin, it yielded not less than \$106 to the ton. I have sent you a specimen of this quartz. (No. 3.)

An opening two or three feet deep on lot 19 of the concession St. Charles, has exposed a vein of quartz in clay-slate, running N.E., with a south-east dip. The vein has a thickness of twenty-four feet at the outcrop, and an irregular jointed structure like that on lot 21. The assay by Dr. Hayes, of this quartz, a specimen of which I send you, gave \$70.95 of gold, and \$2.60 of silver to the ton. (No. 4.)

I have sent a specimen from an outcrop of quartz running N.E., on lot 39 of the range 1, north-east. Although my attention was called to this locality, the superficial workings which had been made were covered by snow, so that it was not possible to examine it. (No. 5.)

I also observed an outcrop of quartz in clay-slate, a little above the opening made by me on lot 26 of the concession De Léry. It has a breadth of three or four feet, and runs north-east, but its attitude could not be determined. The mechanical assay of twenty pounds of this quartz gave me no trace of gold, and it was not judged worthy of further trial.

In describing the alluvial deposits, I have already noticed a pit made by me on lot 14 of this concession, a little below the working undertaken by the agent of an American company. In both of these openings quartz and sandstone, apparently interstratified, and running north-east, were met with, and in one of the excavations were transversed by a vein of dark-coloured carious quartz, having an east and west course.

The vein of quartz which crosses the Gilbert on lot 20 of the concession De Léry, appears to be a continuation of that already met with on lot 19 of the concession St. Charles. It was examined on the right bank by an excavation, in which the vein showed a breadth of seven or eight feet between its two walls of clay-slate. Its course is N.E., with a dip to the S.E., and at the outcrop it is divided by matters derived from the wall-rock into two distinct veins, which evidently tend to unite below. The quartz of the vein is cavernous, and the other matters in the vein and adjacent to it are generally ochreous. On the left bank of the Gilbert the examination consisted in an adit opened in the side of the hill, where the vein was met with as before, divided into two parts, but much less impregnated with oxyd of iron. Some alluvial gold was found in the gravel from this adit. I submitted to a mechanical assay, by pulverizing and washing, twenty pounds of the quartz from the right bank, and found in the residue twenty-two particles of gold, very minute, but visible to the naked eye. I was assured that the assays of Dr. Hayes had given for this, of which I send you a specimen, from \$16 to \$18 to the ton. (No. 6.)

Two other outcrops of quartz, bearing in this case, E.N.E., were pointed out to me on lot 21, of the same concession. As the exploring pit which had here been sunk on the right bank of the Gilbert had partly caved in, and was filled, I could not examine the vein at this point. The other outcrop on the left bank had not yet been in any way examined. A specimen of quartz from the right bank is said to have given \$40 of gold to the ton.

I have mentioned the lot 53, on range 1, north-east in Vandreuil, as one of those on the bank of the Chaudière, at the Devil's Rapids, where there are numerous exposures of the rocky strata; among these is a strong band of sandstone, with a N.E. strike, the strata being traversed by numerous little veins of quartz running E.S.E., and among them a well-marked vein, a foot in width. A little to the east of this exposure of sandstone, is an outcrop of quartz, which a longitudinal cutting has exposed for a distance of thirty or forty feet. This mass of quartz, like some others already described, is divided by joints, which are filled with earthy matters. Other outcrops of a pure white quartz, seeming to belong to isolated masses, appear on the same lot. I made a mechanical assay of fifty pounds of the above quartz, without finding a visible trace of gold, while the assay of the same quantity of quartz selected from outcrops on lot 51 A, gave five small particles of gold. I have sent specimens from this lot, and also from lot 53. (No. 7.)

I observed at the northeast extremity of lot 2, of the concession St. Charles, the out-

crop of a vein of quartz running N.E., and having a breadth of about five feet. It had only been superficially explored. A mechanical assay of twenty pounds gave me no trace of gold.

In lot 16, of the concession Chaussegros, an opening has been made on the outcrop of a vein of quartz, running N.N.E. At the time of my visit it was too superficial to enable me to determine its attitude, and the cold weather soon after put an end to the working. I send you a specimen of this quartz, the mechanical assay of twenty pounds of which gave me five small particles of gold.

An outcrop of quartz having been indicated to me on lot 49 A, of range 1, north-east, I went to examine it, but the soil being covered with snow, and no exploration having been made, I could not do so; I, however, notice it, and have sent you a specimen of the quartz.

Another locality of quartz having been indicated on lot 59 A, of range 1, north-east, near Bolduc's Creek, I went to examine it. A superficial opening has here exposed for a breadth of thirteen feet an incoherent mineral mass, consisting of quartz, mixed with the encasing clay-slate and sandstone, but seeming nevertheless to form a vein running N.E. The surface being covered with snow, the examination of this deposit was difficult, and besides a deep excavation would have been necessary in order to determine the attitude of the vein. I send a portion of the quartz, of which a mechanical assay of twenty pounds gave me six very small scales of gold. (No. 8.)

On lot 9 of range 1, of the seigniorie of Aubin-Delisle, a pit six feet by eight has been sunk to a depth of twenty-five feet on an outcrop of quartz which runs east north-east, and dips south-south-east. The mineral mass, which is imbedded in clay-slate, is divided by an admixture of the wall-rock into several veins, one of which is four feet wide. Other outcrops appear here and there on the same lot, and lead me to suspect the presence of a considerable mineral mass in the attitude of a bed. I send a specimen of quartz. (No. 9.)

I here notice, in passing, a deposit of quartz, which I have not examined, situated on lot 30 of range 1 of Aubert-Gallion, and of which I send you a specimen. (No. 10.)

Another deposit of quartz which has been partially explored, is found on lot Linière-76 of range 1 of the township of Linière, but at the time of my visit in January last, the working was suspended and the pit filled with water and ice. The vein, which has a width of five feet, and runs north-north-east, is of white quartz imbedded in clay-slate. I was told that visible gold had been observed in another small vein, at the bottom of the pit, and that an assay of the quartz made at New York, gave \$54 of gold to the ton. I send you a specimen of the quartz. (No. 11.)

A shaft to the depth of twenty-five feet has been opened on lot 2 of range 1 of Linière, very near the frontier, on an outcrop of quartz running north-east, with a dip to the south-east. It is a large mass, consisting of several veins from four to six inches, and in one case a foot in width, with intervening portions of wall-rock. I send you specimens of the quartz. (No. 12.)

Another excavation on the same lot has exposed a network of small veins, more or less ochreous, and imbedded in the clay-slate. I know from reliable sources that other outcrops of quartz have been observed in this locality and in other places in the townships of Linière and Metgermette, but as the country at the time of my visit was covered by more than a foot of snow, I was not able to examine them personally.

While I was examining the lots of the British American Land Company, in the basin of the St. Francis, I made an examination of certain deposits of quartz, with the following results:—

The bed of the Magog River where it passes through lot 19 of range 5 of the township of Orford, presents numerous loose masses and several veins of quartz. I opened two trenches on the left bank at low water level; one of these made in the slate, in the supposed direction of one of the veins failed to meet it, while the other disclosed a mineral mass, irregular and of uncertain thickness, composed of a confused mixture of quartz with slate and a decomposed ochreous matter. One outcrop of quartz with a north-east direction and a thickness of about ten feet, had a cavernous structure and seemed likely to be auriferous. Having found a few scales of alluvial gold in the residue from washing about twenty cubic feet of the adjacent gravels, I suspected that the

precious metal might be derived from the quartz veins which I have just mentioned, but the results of assays made by Dr. Hayes of several specimens of the quartz from this vicinity, showed how uncertain are such indications, for not one of the specimens contained gold. These assays were the more interesting inasmuch as it appears to me that the band of talcose schists and quartz veins, which here crosses the lands of the British American Land Company, also traverses those of the Golconda Mining Company, which are the lots 2 and 3 of range 13 of Ascot. The results of numerous assays of the quartz and talcose slates from this locality, published by the Company, give, as I have before mentioned, a mean result of \$153 of gold to the ton. These rocks appear identical with those of Orford described above, from which they are only separated by a distance in a right line of about two miles.

The stream already spoken of (page 68) which falls into Lake St. Francis, after Lambton, having crossed several lots in range A of the township of Lambton, traverses several outcrops of quartz. These were particularly remarked on lots 8 and 9, where the bed of the stream is strewn with numerous masses of the mineral, portions of which were also found in the excavations made by me on lot 8, in the search for alluvial gold. At the time that I examined these lots I could not undertake the researches necessary to determine the attitude of these veins. I however remarked, that while appreciable quantities of alluvial gold were found on lot 8, scarcely a trace of the precious metal was seen either above or below it; while at the same time the angular aspect of the gold led me to suppose that its source was not far distant. I accordingly made a mechanical assay of twenty pounds of the quartz from lot 8, and obtained for as the result several very small particles of gold.

In accordance with the instructions which I received from you, I have limited my examination of the deposits of quartz in the Chaudière valley to those which were already attracting attention in the region. If I have given you but short and incomplete descriptions of these, it is because in most of them the walls of the veins cannot yet be determined, and because not one of them had at the time of my visit been sufficiently opened to allow of a correct opinion of its character or attitude. I have therefore preferred to pass over in silence certain points upon which information would be desirable, rather than give opinions which could only be conjectural. I read in the *Géologie Appliquée* of Burat, "that although the theory of metalliferous deposits, based as it is upon numerous facts which are the same in all parts of the world, may now be regarded as established, the practical conditions, that is to say those which regulate the character and richness of mines, are altogether local." The study of metalliferous deposits in a district where none of the same kind are actively worked, is thus surrounded with difficulties and uncertainty; so that in attempting the examination, with which you had charged me, of the Chaudière region, it was neither possible for me to judge by analogy, nor to establish comparisons. A knowledge of local conditions moreover facilitates the estimation of the economic value of metalliferous deposits, for in some districts veins slender and poor at the surface, may augment in size and become richer in descending, while in others wide and rich veins, in working, grow poor and narrow. We must therefore in a new country, work in the dark as it were, until experience shall have fixed certain rules for guidance. With these reservations, and relying on the facts established and made known in the Reports of the Geological Survey, on the results obtained by the gold miners in the region during the last three years, and finally upon my personal examinations as set forth in the preceding pages, I conclude with the following observations.

CONCLUSIONS.

1. The auriferous deposits which cover a great region in Lower Canada in all probability contain, particularly in the valley of the Chaudière, considerable areas whose regular and methodic working on a large scale by hydraulic processes may be made remunerative; in addition to which limited deposits of exceptional richness, such as have been already found, may be looked for.

2. Although the examination of the alluvial gold from the deposits hitherto worked does not permit us to attribute its source to veins of quartz in the immediate vicinity, it is nevertheless established that this alluvial gold is derived from the rocks of the region,

3. The existence of native gold having been established, alike in the veins of the altered Upper and Lower Silurian rocks of the district, the search for gold-bearing veins should not be confined to a few localities, but may be extended with probabilities of success to the whole area occupied by the altered rocks of these two divisions.

I have the honor to be,

Sir, very respectfully,

Your most obedient servant,

A. MICHEL.

REPORT BY MR. T. STERRY HUNT, LL.D., F.R.S.,

CHEMIST AND MINERALOGIST TO THE GEOLOGICAL SURVEY.

SIR,—I have now the honor to submit to you my report on the specimens of quartz collected by Mr. Michel from the gold region of Eastern Canada, and described in his report. To the results of my assays I have joined, as not without interest to those engaged in gold-working, some explanations as to the manner of assaying, the distribution of gold in nature, the nature and origin of the gold alluvions of Canada, and the mode of occurrence of alluvial gold in some other countries, as compared with Canada, together with a brief notice of the hydraulic process employed in California.

ASSAYS OF QUARTZ FOR GOLD.

Before giving the results of my assays of the quartz specimens selected by Mr. Michel, it may be well to explain briefly the mode in which gold occurs in ores, the processes adopted for its extraction, and the mode of assaying. While the gold most frequently occurs directly imbedded in quartz, (or in bitter-spar as in Leeds, or in calcareous spar,) it is sometimes contained in metallic sulphurets, as in iron pyrites, which is often auriferous; in vitreous copper ore, as in St. Giles; in blende, as at the Chaudière; or in arsenical pyrites, as in Nova Scotia. Sometimes the gold in these sulphuretted minerals is in particles visible to the eye, but often in a state of minute division, and although the notion has generally been questioned, perhaps in chemical union with sulphur and the other metals. In quartz or in spars, it is doubtless mechanically disseminated in Quartz-crushing particles of various sizes; but the operation of pulverizing the quartz tends to beat these into thin flakes, and thus reduce the metal to a still greater degree of division. The consequence is, that the simple crushing and washing of ores fails to separate the whole of the gold, partly because it is so finely divided as to be carried away by the water, and in case of metallic sulphurets, perhaps because it may be chemically combined. The new pulverizer of Messrs. Whelpley & Storer, of Boston, appears to overcome, to a great degree, the evil arising from the farther division of the gold in the ores. In this apparatus, which may be described as an air-mill, the mutual attrition of the particles rotating with great velocity in a current of air, rapidly reduces the ores and all brittle materials to dust, while grains of gold or any other malleable metal present, instead of being extended into scales, are beaten into pellets.

Amalgamation. The use of quicksilver in the process known as amalgamation, enables us to separate a much larger portion of gold than can be obtained by simple washing, and is the process most commonly resorted to with gold-bearing quartz; but in the case of ores containing sulphurets like pyrites, is much less efficient. In such cases the ores are first roasted to expel the sulphur, after which the gold is separated by amalgamation, or is dissolved out by a solution of chlorine,—a process now frequently employed in cases where the gold is in a greatly divided state.

It is found in practice, however, that the ordinary method of amalgamation under the most favorable conditions, fails to remove all the gold from pulverized quartz, and the mineral which has passed through the process, still yields to the assay a greater or less portion of gold. The loss of gold in this way is from twenty to forty, and even fifty per cent. of the whole amount present in the ore. This loss is due, in great part, to the fact that portions of the gold in an ore are not readily moistened by mercury, and thus escape amal-

gamation. The cause of this is not clear; but the difficulty is said to be overcome by an ingenious process recently invented and patented by Prof. Henry Wurtz, of New York, which consists in adding to the mercury a minute portion of sodium. This communicates to it a greatly increased amalgamating power, and so far as experiments have been tried, promises to be of much advantage in the working of gold ores. The method of Prof. Wurtz has also been introduced in England by Mr. William Crookes; and according to the statements lately published by Mr. Robert Hunt in the *Quarterly Journal of Science*, with excellent results.

From the preceding observation it will be seen that none of the processes used for the treatment of gold ores (if we except that by chlorine) will enable us to determine the whole amount of gold present in an ore. To obtain such a result, the method almost universally adopted for the assay of gold-bearing quartz consists in fusing it, previously reduced to fine powder, with a mixture of carbonate of potash or soda, and oxyd of lead. In this process the quartz is completely dissolved, and if in such a solution a portion of metallic lead be present in a highly divided state, it unites with all the gold (and silver), and carries it to the bottom of the liquid mass. To effect this it is only necessary to add to the mixture, either before or after fusion, a little powdered charcoal, which reduces a portion of lead from the oxyd of this metal which was added. It is not necessary to reduce the whole, as the first portions of lead thus separated carry down with them the whole of the gold.

In practice, this operation is performed on small portions. Usually from 500 to 1,000 grains' weight of the quartz in fine powder is mixed with the same quantity of soda-ash or pearl-ash, and as much oxyd of lead (litharge). Using French weights, I take for an assay of the pulverized quartz, pearl-ash and litharge, each 100 grammes (1,543 grains), adding 4-10 grammes (6 grains) of charcoal. These are intimately mixed and heated in a covered clay crucible to bright redness for about half an hour, or until the whole is in a state of quiet fusion, when the contents of the crucible may be poured into a conical mould, and will form, on cooling, a greenish glass with a button of soft lead at the bottom weighing six or seven grammes (about 100 grains). When the ore contains sulphur or arsenic, this is first thoroughly expelled by roasting at a red heat, and the fusion then conducted as before, in some cases with the addition to the above mixture of 50 grammes of glass of borax.

The buttons of lead obtained by this operation are next subjected to cupellation—that is, are heated to a strong red heat in a muffle-furnace, in small cups of bone-ash, which absorbs the dross or oxyd of lead as it forms and melts, until at last there remains nothing behind, unless gold or silver be present,—these metals resisting the oxydizing process. In practice, it is generally found that the litharge employed contains a trace of silver, whose proportion may be determined if desired. If no gold were present in the assay, the little bead of silver left after cupelling the button of lead is at once dissolved by nitric acid, which does not attack gold. If there is much gold in the bead, this is melted before the blowpipe with so much silver that the gold shall form no more than one-fourth of the alloy, and this compound, when treated with nitric acid, leaves the gold in a pure state and ready to be weighed. Such is an outline of the method followed in the assays given below.

In the working of other metals, such as copper and lead, the ore is seen to be irregularly distributed through the rock or veinstone; and in the case of gold ores, though the metal is generally invisible, or in such rare and small particles as to be readily overlooked, the same irregular distribution is found to exist.

Quartz holding a troy ounce of gold to the ton is a profitable ore*; this quantity is equal only 1-32,666th part, or little more than a grain weight of gold to five pounds of the rock, and even this minute portion is not equally diffused, but, in part at least, is con-

*According to a published statement by Mr. Ashburner, the Mineralogist to the Geological Survey of California, an average yield of eight dollars of gold to the ton of quartz will there cover the expenses of mining, crushing, and amalgamating, provided the vein is wide, placed in favorable conditions for working, and near water-power for moving the machinery required. A vein yielding regularly ten dollars of gold to the ton, may thus be wrought with profit. Another estimate places the actual cost of working a gold-bearing quartz vein in the above conditions in California at not over seven dollars the ton.

Distribution of gold. concentrated into particles of some size; as is shown by mechanical assays like those described by Mr. Michel, where quartz specimens not greatly richer than that here supposed, yield by crushing and washing visible scales of gold. These considerations will serve to show how uncertain and how irregular must necessarily be the results of laboratory assays, which are rarely made on more than two or three ounces of the pulverized quartz, for the reason that the manipulation of much larger quantities by such a process becomes difficult.

In the following assays five or six pounds of quartz, taken at hazard from a larger quantity, after being heated to redness and quenched in water to make it more friable, were reduced to a powder, from which were taken portions for assay; these were more finely pulverized and sifted. Now it is obvious from what has been said about the irregular distribution of the gold in quartz that different portions of 100 grammes each of this powder may contain very variable amounts of the precious metal, and moreover that another mass of quartz from an adjacent portion of the vein may be much richer or much poorer than that selected for trial. Hence in an ore like gold-bearing quartz, in which the metal is generally invisible to ordinary inspection, the results of assays of selected portions have but a very subordinate value in determining the economic importance of a deposit; and it is only by several assay-trials of the powder resulting from the crushing of very large quantities of quartz from different parts of the vein, or by its working on a large scale, that the value of a gold-bearing vein can be determined. Instances of the variable results to be obtained from different portions of the same sample will be given below, but the following statements, from a late paper by Mr. Robert Hunt, Keeper of the Mining Records in Great Britain, giving an account of recent attempts to work auriferous quartz in the district of Dolgell, in Merionethshire, North Wales, where the precious metal occurs in veins formerly wrought for copper, are instructive. From two mines samples were assayed by Mr. Readwin, yielding from 200 to 400 ounces of gold to the ton of quartz, yet he at the same time expressed the opinion that the average yield would not exceed half an ounce of gold to the ton. We are farther informed that at one of the mines 200 tons of quartz had been stamped, yielding 15 dwts., and at the other 2500 tons giving an average of only 12 dwts; while another mine in the same district had treated over 4000 tons with an average produce of nearly 56 dwts to the ton. This lode was of quartz, with some carbonate of lime, yellow copper ore and telluric bismuth, a not unfrequent companion of gold in other regions.—(*Quar. Jour. Science*, Oct., 1865.)

Of the quartz from the twelve localities specially indicated in the Report of Mr. Michel as having been the subjects of some exploration, there were made in all thirty-one assays, each on portions of 100 grammes, and with the following results calculated for the ton of 2,240 lbs.; the value of the gold being estimated at \$20.67 the ounce troy of 480 grains. The silver was not determined in any of the assays, but it did not appear in any case to exceed the small proportion which is always alloyed with native gold, and which in that from the alluvions of the Chaudière, as appears from the mean of several analyses given in the *Geology of Canada*, to be about 12 per cent. It is well known, however, that both the copper and lead ores of the Eastern

Townships contain portions of silver, so that where these ores are associated with the gold, a larger alloy of silver may be looked for. Thus, in an assay of a pyritous copper ore from a quartz vein in the Lower Silurian rocks in Ascot, more than five parts of silver were found for one of gold. (*Geology of Canada*, p. 517.)

1. Vaudreuil, lot 83, 1st range north-east. Two assays gave no trace of gold.
2. Vaudreuil, lot 21, concession St. Charles. Five assays: of these four gave an average of only 6 dwts. 13 grs. of gold=\$6.76; while the fifth, in which a large scale of gold was seen in sifting, and was added to the assay, yielded at the rate of 4 ounces, 13 dwts.= \$161.29; the average of the five assays being \$25.66 per ton.

3. Vaudreuil, lot 62, 1st range north-east. Two assays gave me no trace of gold.

4. Vaudreuil, lot 19, concession St. Charles. Six assays; of these the mean of four gave 4 dwts. 21 grains of gold=\$5.03; and that of two others, in which, as in No. 2, a scale of gold was seen and was ground up with the powder, was 3 ounces 2 dwts.= \$64.07. The average of these assays is thus \$24.71 to the ton.

5. Vaudreuil, lot 39, 1st range north-east. Two assays yielded no trace of gold.

6. Vaudreuil, lot 20, concession De Lery. Two assays, the mean of which gave 14 dwts. 16 grains of gold=\$15.15 to the ton.
7. Vaudreuil, lot 53, 1st range north-east. Two assays gave no trace of gold.
8. Vaudreuil, lot 59 1st range north-east. Two assays gave no gold.
9. Aubin-Delisle, lot 9, range 1. Two assays gave no gold.
10. Aubert-Gallion, lot 30, range 1. Two assays gave no trace of gold.
11. Linière, lot 76, range 1. Two assays gave no gold.
12. Linière, lot 2, range 1. Two assays gave a mean of 6 dwts., 13 grains of gold=\$6.76 to the ton.

If we compare the results of these assays with those mentioned by Mr. Michel, we shall see farther proof of the irregularity with which gold is distributed in the gangue. The quartz from several of these veins has been examined by Comparison of assays. Dr. A. A. Hayes, of Boston, whose results, which are worthy of the highest confidence, are given by Mr. Michel, together with other assays by persons unknown to me, but probably reliable. The quartz of No. 1 had given in Boston \$37, and in another assay made on the spot, \$106 of gold to the ton; the mechanical assay also yielded a portion of gold to Mr. Michel; while two assays of another sample from the same vein gave me no trace of the precious metal. Again, in the case of No. 2, Dr. Hayes obtained \$77.56, and Mr. Colvin \$54.00, while one assay of the same vein yielded me not less than \$101.29; and four others, as seen above, a mean of only \$6.76. No. 3, in like manner, is said to have furnished gold, though none was found in the specimen just assayed. Nos. 4 and 6 have yielded gold both to Dr. Hayes and myself; while of No. 8, which gave traces of gold by Mr. Michel's mechanical assay, and of No. 11, which is said to have yielded gold to an assayer in New York, the specimens furnished me yielded no traces.

The specimens of quartz collected by Mr. Michel are all from the Upper Silurian strata, and, although generally running with the strike, appear to be from Nature of the veins. true veins. In many cases they enclose angular masses of the wall-rock, and evidently fill up fissures produced by fracture. These veins appear to differ in their greater extent and apparent continuity, from those which traverse the adjacent Lower Silurian rocks, and which are generally small and interrupted.

The quartz of the above veins is generally white and crystalline, often with drusy Calcareous spar. cavities lined with crystals. It frequently contains portions of a brownish cleavable spar, closely resembling ordinary bitter-spar or dolomite, which, as is well-known, often contains a portion of carbonate of iron and weathers brownish. On analyzing, however, a portion of the spar from 10, it was found to be a compound of carbonate of lime and carbonate of iron, with traces only of carbonate of magnesia, being identical in aspect and composition with a variety of calcareous spar from an unknown locality, analyzed by me and described in Dana's *Manual of Mineralogy*, 4th Edition, page 438. This sparry carbonate is slowly decomposed by the action of the air, giving rise to a very light pulverulent form of hydrous peroxyd of iron, which at the outcrop of some of these veins is seen still retaining the cleavage of the spar. The decomposition of Source of gozzan. this, or of a similar spar, is apparently the origin of the gozzan or ferruginous matter which forms, in some cases, the outer layer or selvage of the quartz veins in this region. In the case of No. 10, it forms a considerable portion of the vein towards the walls, and presents broad curved cleavage-planes. The accompanying quartz, which is generally white and crystalline, is sometimes stained green by chlorite, which forms small masses in the vein. Minute grains of galena are also present. The presence of the spar, or of the result of its decomposition, was also conspicuous in the veins 1, 2, 4, 6, and 12. In some cases, as in the vein at the Devil's Rapids, this spar contains a portion of carbonate of maganese, and then the result of its decomposition is black or brownish-black from the presence of oxyd of maganese. If gold were imbedded in this spar, as it certainly is in the bitter-spar of Leeds, it would be liberated during the decomposition of the spar, and appear near the outcrop of the veins. From such a source may be derived the angular and unworn gold which Mr. Michel found at the St. Francis, and of which occasional particles have been found elsewhere in the alluvions, offering a marked contrast to the ordinarily worn and rounded condition of the alluvial gold.

While the results of numerous assays of quartz from the Upper Silurian rocks are certainly such as to encourage us to look for workable deposits in the rocks of that series, it should not be forgotten that specimens of native gold are also found in the veins of the Lower Silurian in Leeds and St. Giles. An assay of the quartz from the latter is said to have yielded Dr. Hayes 6½ dwts. of gold to the ton. Gold has also been found in similar geological conditions at the Halifax Copper Mine, in a veinstone, whose assay gave about the same quantity as the last. (*Notes on the Gold of Eastern Canada*, published by the Geological Survey, page 31.) It seems therefore quite as probable that workable gold veins may be found in the Lower as in the Upper Silurian rocks. Indeed, the opinion has already been expressed in the Reports of the Survey, that the chief source of the alluvial gold has been the disintegration of the crystalline rocks of the Lower Silurian series, which form the chain of hills to the north-west of the auriferous alluvions. It would seem, in fact, that the gold resting on the Upper Silurian rocks beyond these hills must be derived from a source somewhat remote; since it is difficult to conceive of a force which could break up the rock, separate the gold from its gangue, and give it a worn and rounded aspect, which should not be, at the same time, an energetic transporting agency. The derivation from the Lower Silurian rocks to the north, of a large portion of the materials making up the auriferous alluvions which rest on the Upper Silurian strata is evident; for intermixed with the dark-colored clay-slates of the latter are numerous worn pebbles of epidote, jasper, diorite, diallage, serpentine, and red argillite, which are derived from the Lower Silurian series; together with magnetic, titanite, and chromic iron ores,—all three of which, but especially the latter, appear to characterize the older rocks. It is further to be noticed that one of the richest alluvial deposits of gold yet observed in the Chaudière district is along the Rivière des Plantes, which runs entirely on the Lower Silurian rocks, and about a mile to the north of the boundary of the Upper Silurian area. As might be expected, Mr. Michel, who has carefully examined the alluvions of this stream, informs me that they differ from those of the Gilbert and other streams further southward, in which the ruins of the Upper Silurian strata are mingled with those of the Lower Silurian series.

With regard to the black sand in auriferous alluvions, and the erroneous notions which prevail with regard to it, it should be remarked that similar black sandy residues, consisting chiefly of various ores of iron (sometimes with oxyd of tin and other minerals), may be obtained from the washing of almost all sands and gravels derived from crystalline rocks, and that the occurrence of a black sand, therefore, in no way indicates the presence of gold. When however this metal is present in a gravel, it, from its great weight, remains behind with the black sand and dense matters in the residue after washing. As long ago described, the black sand of the auriferous alluvions in Canada consists chiefly of chromic, titanite, and magnetic iron ores.

The examinations of the auriferous alluvions above described, show the existence of a peculiar deposit of clay, bluish on the Gilbert River, but yellowish in Ascot, Orford and Lambton. It is very stiff and coherent, and encloses large quantities of boulders and rounded fragments of rock, but seems from the testimony of the miners and from the repeated trials made by Mr. Michel on the Gilbert and elsewhere, to be destitute of gold. It is worthy of record that on lot 6 range 14 of Ascot, he detected in it shells which were too imperfect to be preserved, but from a drawing made on the spot, appear to be a species of *Mya*. This clay, which seems to correspond to what has been called the boulder-clay of the St. Lawrence and Champlain valleys, is like it found distributed in an irregular manner, partly no doubt from the effects of subsequent denudation. While, on the borders of Lake St. Francis, which is 890 feet above the sea, the bottom of the boulder-clay was not reached at thirty feet, it was often found by Mr. Michel to be only two or three feet in thickness, and in many places was absent. Auriferous gravels are found resting on this boulder-clay, but the general testimony is that they are poorer than those found lying on the bed-rock; and the important fact is shown by numerous workings on lots 19 and 20 on the Gilbert, and also in Ascot, on lot 2 of range 13, that a rich layer of auriferous gravel lies below the boulder-clay, resting upon the clay-slates beneath.

The residue obtained by washing a portion of this barren clay from the Gilbert River was not without interest. Besides the rounded fragments, which were, with very few

exceptions, of Upper Silurian clay-slate, there were numerous worn and rounded masses of iron pyrites, which also made up one-third of the finer and heavier sand remaining after washing. This, after the separation of the pyrites, was found to consist of magnetic, chromic and titaniferous iron ores, resembling those of the auriferous gravels of the same vicinity, but in very much smaller grains. It is worthy of note that the grains, as well as the small rounded pebbles of iron pyrites from this boulder-clay, were bright, and free from any discoloration or tarnish, a fact which would seem to show that they had been carefully protected from the air by the clay ever since the time of their erosion. Such grains of pyrites, had they existed in a permeable gravel, would have been more or less completely destroyed by oxydation, which may explain the general absence of unoxided pyrites from the auriferous alluvions. The occurrence in this sterile clay of the chromic and titaniferous irons which elsewhere accompany the gold, is a fact which suggests further inquiry into the origin and history of the superficial deposits of this region.

In Australia the gold fields of Victoria have derived their precious metal, as in Canada, from quartz veins in Silurian rocks, but the breaking-down of these took place at a remote period, the great deposits of alluvial gold being in a series of sands, gravels and clays apparently of fresh-water origin, containing lignite, and of Miocene or Middle Tertiary age; which are covered in places by overflows of a volcanic rock, there called blue-stone. A partial disintegration of this ancient auriferous drift took place near the close of the Tertiary period, giving rise to the second gold alluvions, and the present action of rain and rivers on these two produces the third or recent alluvions. As a general rule, the portion richest in gold in all of these is found at their base, where they rest directly on the Silurian strata. In some cases these several deposits overlie one another, so that two or even three auriferous strata or *gold bottoms* are found at different depths. These details are from a paper by M. A. Selwyn, Geologist to the Colony of Victoria. (*Quar. Jour. Geol. Soc.*, 1858, p. 533.)

The notes furnished me by Mr. Michel, and the result of his observations during a residence of many years employed in gold mining in South America, show that the alluvial gold of New Granada and Bolivia occurs in conditions not unlike those met with in Victoria. The gold which there, as elsewhere, is derived from the disintegration of quartz veins in the neighbouring mountains, is found most abundantly in an ancient gravel, enclosing, besides many pebbles and boulders, the trunks of trees converted into lignite, and often cemented into a very firm mass, resting on the bed-rock. Above this are found successive strata of clays and gravels of various kinds, beneath which the auriferous layer is sometimes so deeply buried as only to be reached by subterranean mining. Although generally sterile, these overlying strata sometimes include a second bed of auriferous gravel, ordinarily however less rich than the lower one. This series of strata, which in some districts is not more than twelve or fifteen feet in thickness, attains in others more than seventy-five feet. Sections of them are exposed in the banks of the rivers which have cut through these clays and gravels down to the bed-rock. The materials excavated from the valleys and carried to lower levels, constitute the secondary alluvions, which are sometimes of great richness.

A similar condition of things exists in California, where however the gold-bearing quartz veins are in much more recent rocks than those of Australia and Canada, their age being chiefly newer secondary. The alluvial gold washings are divided into two classes, the older or *deep placers*, as they are called, and the *shallow placers*. The latter, which were superficial and local, and are now nearly exhausted, were derived from the washing down of the more ancient alluvions or stratified auriferous gravel; which rests upon the bed-rock, and attains a thickness of 250 feet where it has not been denuded. This ancient gravel, which like that of Australia, contains large quantities of lignite or fossil wood, forms in many parts the surface of the country; but in others is covered by a thick and hardened layer of volcanic ash, which caps the hills. It is where this auriferous gravel has been partially denuded, that it is now wrought by the hydraulic method. The upper part of the deposit is poorer than the lower, and the richest portions are near the bed-rock, where deposits of immense richness are sometimes found; but at the Forks of the Yuba River, where it presents an average thickness of about 120 feet, it yields, according to Prof. Silliman, who visited the region in 1864, from thirty to forty-five cents worth of gold to the cubic yard. This

applies to the gold actually saved by the hydraulic method there employed; besides which a large portion is washed away, and is partly recovered in subsequent washings by the Chinese labourers in the rivers below. The canal, with its reservoirs, for the purpose of working this region, has been constructed at a cost of \$600,000, and the amount of gold extracted from an area of about 200 square miles at the Forks of the Yuba, has averaged for several years past \$2,000,000 annually.

For a detailed account of the mode of working in this region, the reader is referred to a paper by Prof. Silliman in the *American Journal of Science* for July, 1865, from which these details are extracted. In the Report of the Geological Survey for 1863, some description of the hydraulic process is given; but a much more extended account of it, with its various improvements, will be found in the paper just cited. Prof. Silliman gives, from a report by Mr. George Black, a skilful English engineer long resident in California, many details, and among others the following estimate of the comparative cost of handling a cubic yard of gravel, estimating a miner's wages at four dollars a-day; with the pan, twenty dollars; with the rocker, five dollars; with the long-tom, one dollar; and with the hydraulic process, twenty cents; thus making the cost of washing gravel by this method one twenty-fifth of that by the rocker, commonly used by miners at the Chaudière.

The estimate as to the minimum quantity of gold which may be extracted with profit by this method, as stated by Mr. W. P. Blake, and copied in the Report of 1863, he has since informed me is subject to some revision, and the recent data above given will enable us to revise the calculation. We may assume that with labour at one dollar a day, the cost of washing gravel by this method in Canada would be one-fourth as much as in California, or five cents the cubic yard. Now, it was shown that the auriferous alluvion over an acre at the forks of the Du Loup and Chaudière yielded, during the workings in 1851-52, at the rate of one and thirty-eight hundredth grains of gold to the cubic foot, which is equal to thirty-seven grains to the cubic yard. At the ordinary fineness of the alluvial gold of this region, the value of this would be \$1.33 as the yield of a cubic yard of gravel. Now as has been already remarked in the Report for 1863, the alluvial gold of Canada is not confined to the gravel of river-channels, nor to alluvial flats, but is found in gravels high above the river beds, to which the hydraulic method might be applied with advantage even though the proportion of gold in them was only a tithe of that in the flats of the Du Loup.

A consideration not to be lost sight of, is the existence in Canada of an old auriferous gravel which lies beneath the barren boulder-clay, and of which the poorer gravel, overlying this last, is probably only a modified portion. The analogy which is evident between this state of things and the conditions met with in Victoria, Bolivia and California, is such as to lead us to expect that this ancient alluvion may, in some parts of the gold region of Lower Canada assume a greater thickness and importance than has hitherto been suspected.

I have the honor to be, Sir,

Your obedient servant,

T. STERRY HUNT.

OFFICE OF THE GEOLOGICAL SURVEY,
Montreal, Feb. 10, 1866.

