GEOLOGICAL SURVEY OF CANADA
G. M. DAWSON, C.M.G., LL.D., F.R.S., DIRECTOR

REPORT

ON THE

SURFACE GEOLOGY

AND

AURIFEROUS DEPOSITS OF SOUTH-EASTERN QUEBEC

BY

R. CHALMERS

OTTAWA
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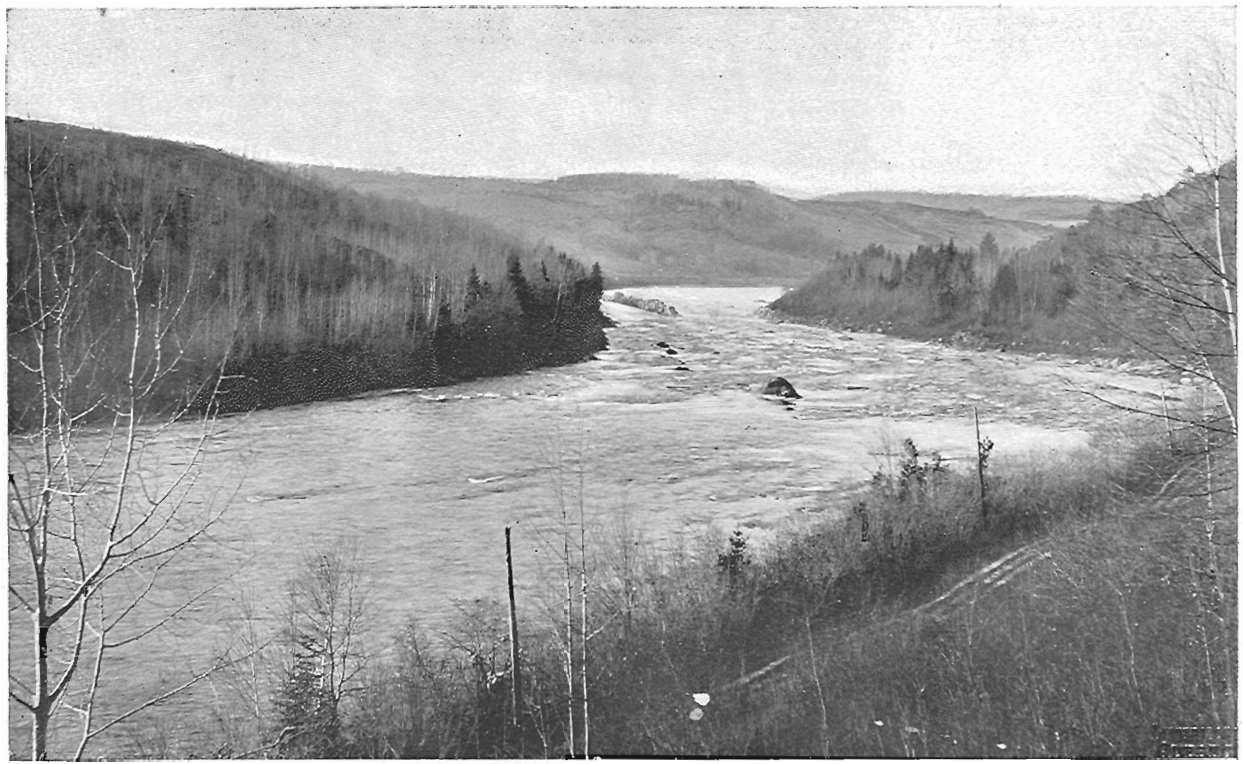

THE DEVILS RAPIDS, CHAUDIÈRE RIVER, BEAUCE CO., Q., LOOKING DOWN STREAM.

To GEORGE M. DAWSON, C.M.G., LL.D., F.R.S.,

Director of the Geological Survey of Canada.

SIR,—I beg to submit herewith a report on the surface geology and gold-bearing deposits of the "Eastern Townships" and adjacent portions of South-eastern Quebec.

I have the honour to be, Sir,

Your obedient servant,

R. CHALMERS.

GEOLOGICAL SURVEY OFFICE,

OTTAWA, May, 1898.

NOTE.—*The bearings in this report are all referred to the true meridian, and the elevations to mean sea-level.*

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Introduction.

The following report contains the results of observations made by me in South-eastern Quebec during the three seasons of 1895, 1896 and 1897. The district included in the report is that which extends from Lake Champlain and the Vermont boundary north-eastward to Montmagny county, and from the province line along the New Hampshire and Maine border, north-westward to the plain of the St. Lawrence valley. A general study of the superficial deposits of the region was made, with special reference to the auriferous alluviums of the "Eastern Townships."* To carry out this thoroughly it was necessary to examine the whole St. Lawrence valley in some detail. Accordingly, considerable time was spent in investigating the glaciation, and the distribution of the boulder-clay, and in tracing this and other superficial materials to the places of their origin. The pre-glacial decayed rock-materials, sedentary† and transported, lying beneath the Pleisto-

District examined.

Character of investigation.

*The name "Eastern Townships" is applied in a somewhat loose and general manner to that portion of South-eastern Quebec lying to the south-west of Beauce county and the seigniory of Lotbinière, and between the St. Lawrence River and the International boundary.

†The terms "sedentary" and "transported" are employed in a restricted sense in this report, in describing the pre-glacial beds of the region. Sedentary materials are those found *in situ*; Transported, are the same after having undergone modification by subaerial and fluviatile agencies, etc.

cene series, were likewise studied in the gold-bearing districts, as it is chiefly in these that the precious metal is found in workable quantities.

Changes of level.

The great changes of level which took place during the later Pleistocene, evidenced by the marine fossils and shore-lines on both sides of the great valley referred to, are most interesting questions for investigation. These show a differential upheaval, as the latest movement, the gradient of which increases in height above sea-level from the Gulf of St. Lawrence toward the Great Lakes, although apparently with some irregularity. Considerable attention was given to this question.

A large body of facts relating to the subjects above-mentioned has been collected; but only such as are closely connected with the various questions treated of in this report and mainly embraced within the region under discussion, will be presented in the following pages. The examination of the upper St. Lawrence and Ottawa valleys and region of the Great Lakes is still in progress.

Former observations.

Observations on the surface geology of the area specially included in this report were made early in the history of the survey,* by Sir J. Wm. Dawson,† and by Dr. R. W. Ells,‡ the latter treating of the glaciation, distribution of boulders, and the post-glacial deposits, in some detail.

Topographical and Physical Features, Altitudes, etc.

Topography and elevations.

Topographically, the region under examination may be described as an undulating plateau with an average height of from 1200 to 1500 feet above the sea; but, in its details, it nevertheless presents highly diversified features. Three parallel elevated ranges traverse it, which, although interrupted in places, are yet conspicuous throughout, trending in a north-east and south-west direction, and constituting the extension of the Green Mountains into Canada in two or three spurs known as the Notre Dame Mountains.§ Of the three ranges referred to, the highest and most extensive is that forming the boundary between Quebec, and Vermont, New Hampshire and Maine. The elevation of this range, at certain passes where railway lines cross it, is as follows: On the Grand Trunk railway, just south of Norton Mills station, 1361 feet; on the Maine Central railway, at Beechers Falls, 1214 feet; and on the Canadian Pacific railway, at Boundary station, 1825 feet. Where the old Kennebec road, leading from Rivière du Loup to the

Mountain ranges.

* Geology of Canada, 1863, pp. 886-930.

† Notes on the Post-pliocene of Canada, Can. Nat., 1872, The Can. Ice Age, 1893.

‡ Annual Report, Geol. Surv. Can., vol. II. (N.S.), 1886, pp. 44-51 J; *Ibid*, vol. III., 1887, pp. 98-101 K.

§ Annual Report, Geol. Surv. Can., vol. II. (N.S.), 1886, pp. 30-31 J.

State of Maine crosses it the height by aneroid is 1950 feet. Towards the head-waters of the St. John River this range is lower, and between the Chaudière and Daaquam rivers the region has no pronounced hill features, and does not exceed a height of from 1200 to 1500 feet.

Higher summits.

The higher summits along the International boundary, between Lake Champlain and Lake St. John, often reach an elevation of 2500 or 3000 feet, and are conspicuous features in the landscape, being observable from almost every part of the "Eastern Townships."

The next parallel range to the north-west is narrow and much broken, stretching from Memphremagog Lake to Lake St. Francis, bearing the general name of the Stoke Mountain range, but known locally by different names, *e. g.*, Massawippi Mountains, Stoke Mountains, Dudswell Mountains, and St. Francis Mountains. Usually, it does not exceed a height of 1200 or 1500 feet, but some peaks rise to 2,000 feet or more.

Third paralle range.

The third range extends from the International boundary near Sutton Mountain north-eastward to Montmagny county, crossing the Chaudière valley at Beauce Junction, Quebec Central railway and throughout its whole length faces the St. Lawrence plain to the north-west. Its general elevation is from 1000 to 1500 feet; but several summits rise from 2500 to 3000 feet above the sea. Within the region under review, it is a broken range, intersected by numerous passes and river-valleys, notably those of the Etchemin, Chaudière, St. Francis and other rivers. Longitudinal valleys also traverse it. The height is greatest where it leaves the State of Vermont and passes into Canada, lowering towards the valley of St. Francis. Thence it gradually rises north-eastward to the Chaudière River and the township of Cranbourne.

Heights of valleys.

Between the mountains described are parallel valleys, occupied for the most part by later rocks than those constituting the three ranges. In these valleys thick deposits of superficial materials lie. The widest of these, between the International boundary and the Stoke Mountains, forms an undulating plain with an elevation of from 900 to 1500 feet. Along the line of the Maine Central railway, the height of this plain varies from 800 feet, near Dudswell Mountain, to 1660 feet as the International boundary is approached. The levels of the Grand Trunk railway show it to have a height of about 750 feet on the north-west, rising to 1250 feet or more on the south-

east, while the elevation where the Canadian Pacific railway traverses it, is from 750 to 800 feet on the west, to 1700 feet at Springhill near Lake Megantic. Along the Tring and Megantic branch of the Quebec Central railway, the elevation of this plain is from 984 feet at Tring Junction, on the divide between the St. Francis and Chaudière waters, to 1676 feet near Little Megantic Mountain, descending thence to 1325 feet at Lake Megantic.

Crossing this valley in a south-easterly direction from Robertson station, Quebec Central railway, 1195 feet high, on the divide referred to between the St. Francis and Chaudière rivers, and proceeding towards the foot-hills along the International boundary, it is found to be nearly horizontal or rather to have only a slight ascent. But to the east of this, within the drainage basin of the Chaudière River, this interior valley has a north-west slope again, as in the St. Francis River basin, from the divide between the first-mentioned river and the St. John.

General remarks on the contours of the district.

The elevation and contours of this large interior valley, bounded as it is by mountains on both sides, are described, because, though it has doubtless suffered much deformation, it seems to have been a basin for the accumulation of sediments from a very early geological period. The rocks occupying it are slates, sandstones and limestones of Cambro-Silurian age, with granite mountains at intervals rising above the general level. Taking the ranges and included valley together, they indicate that the region must have been for a long time above the level of the sea previous to the Pleistocene period, and have formed an area of profound denudation. This subaerial denudation must have lowered the surface several hundred, perhaps several thousand feet, especially where the rocks were more yielding, and thus the crystalline ranges and mountains have been left standing above the general level. To this evolution of topographic forms must be added the changes of contour which were brought about by orogenic and general changes of level, as well as those due to igneous causes during the protracted geological ages which intervened from the time the region became dry land till the present. These will be referred to in the sequel.

General and Local Changes of Level in the Region.

Changes of level.

An examination of the geological maps of the region shows that it is mainly occupied by three systems of geological formations, extending in parallel bands of greater or less width in a nearly north-east and south-

west direction. The rocks composing these geological formations have been classified as follows commencing with the oldest: Pre-Cambrian (probably partly Huronian) consisting chiefly of schists, gneisses, etc.; Cambrian slates, sandstones, and quartzites, and Cambro-Silurian slates, limestones, etc. Intrusive rocks occur in these, most commonly in the Cambrian and pre-Cambrian. The rocks of these geological systems being different in character and hardness, they have, in their degradation, necessarily developed different topographical features, a result due probably to some extent also to differential vertical movements. A considerable body of facts has been obtained relating to these local or orogenic uplifts which will be referred to in the following pages. As will be shown from observations made in the country extending from the International boundary in the vicinity of Memphremagog Lake north-eastward to the Chaudière valley and Cranbourne, the areas occupied by pre-Cambrian and Cambrian rocks, appear to have been unequally uplifted relatively to the broad band of Cambro-Silurian to the south-east. This anticlinal movement seems to have commenced at a very early date in geological history, and was probably repeated at intervals since. Connected therewith, and apparently in some degree related to it, were eruptions of igneous rocks along the same belt. These eruptions have taken place at different geological periods. The fact that such mountains as Owls Head, Orford, Big and Little Ham mountains, Adstock, etc., which consist of igneous rocks, are the highest, or among the highest isolated summits in the "Eastern Townships" renders it probable that they owe their greater elevation, compared with the adjacent range, to their more recent origin, and to their having undergone less denudation. In corroboration of the conclusion that these mountains are of late origin, another fact may be added namely that dislocations of some of the river-valleys, notably the Chaudière at the Devils Rapids, the Famine River at the falls, caused evidently by these eruptive masses, appear to be of such recent geological date that the rivers have not succeeded since in cutting their channels down to the base-level of erosion.

Geological formations.

Orogenic movements.

Late origin of mountains of igneous rocks.

In regard to orogenic movements along the watershed at the International boundary, it is difficult to say whether this axis has been elevated differentially in a similar manner to the mountains near the St. Lawrence River during the pre-glacial existence of the ancient rivers referred to, although it seems probable that it has likewise undergone repeated uplifts from time to time. But which of the three mountain ranges in the "Eastern Townships" is really the oldest may be, after all, doubtful. A number of facts would seem, however, to favour the

Orogenic movements along the International boundary.

conclusion that the watershed along the International boundary was the original watershed. It seems to have been the axis of a wide range of collateral and subsidiary mountains for long ages, and the watershed of a number of very old rivers, and these facts, together with other circumstances, lend support to this view. The Cambro-Silurian plain, dissected by transverse river-valleys, rises towards this axis from the north-west, although its present contours may be quite different from those which existed when the valleys were being eroded. If, however, the rivers whose ancient courses traversed this interior valley flowed northwardly in their early stages, and there is no evidence to the contrary, then it is clear that the attitude which this valley now presents must have been assumed in early Palæozoic time, and it may, indeed, have had a greater slope then than at present, the direct courses and depth of some of these valleys strengthening this inference.

Disturbance of the rocks in the interior valley.

The interior valley referred to, as well as the mountain ranges on either side, bears evidence, however, of great disturbance and change of attitude. The rocks are tilted and faulted in a remarkable manner. As showing the stresses to which they have been subjected even in Post-Tertiary times, reference may be made to the dislocations and slips observed in them, in the areas occupied by Cambro-Silurian and Cambrian slates, in a number of places, since their surfaces were striated by Pleistocene ice. A few examples of these dislocations may be given.

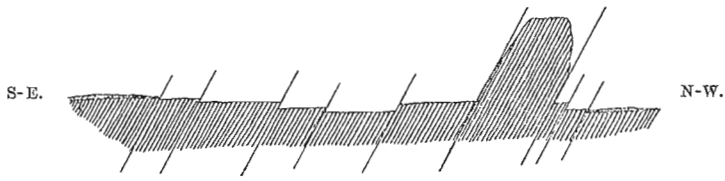
Dislocations of the strata since the glacial period.

In the southern part of the seigniory of Aubert Gallion, a band of slates about five feet in thickness, with a high dip to the south-east had been forced up about six feet higher than the rocks on either side. The displaced mass extends north-east and south-west for several hundred yards, though somewhat irregular as to height and thickness. On each side narrower bands or portions of the strata have also been displaced a few inches.

At St. Evariste de Forsyth.

At St. Evariste de Forsyth, Beauce county, a ridge of slate dipping about S. 30° E. < 60° showed displacements since the glacial period, as represented in Fig. I., a band of these four feet in thickness having also been thrust up five feet and a half above the general level of the rock surface.

Fig. 1.



DISLOCATIONS IN GLACIATED SLATES AT ST. EVARISTE DE FORSYTH, BEAUCE CO., QUE.

SCALE :—10 feet to 1 inch.

Succession of movements.

The main dislocated band shown in Fig. 1, was traced about 600 feet, although broken down in places. The pressure or shove which forced up this mass of slates seems to have been from the south. After the first shove there appears to have been a settling down of all the slates except the four-foot band, followed by another, or perhaps several shoves, each apparently succeeded by a slackening in the pressure. The basset edges of all the slate bands are striated by ice which moved S. 56° E.

Other dislocations

East of Jersey Mills, dislocated slates with a downthrow of about three inches on the south-east occur.

In Ste. Marguerite settlement, to the east of Jersey Mills, a band ot glacially striated slates from six to eight feet thick is dislocated abouf four feet. The downthrow is on the north. Other minor dislocations of three or four inches also occur in these glaciated rocks.

At the International boundary, on the old Kennebec road, the striated Cambrian slates are dislocated in a number of places from three to six inches or more. Here also the downthrow was on the north side ; but the surfaces are a good deal weathered.

Near the mouth of Gilbert River, a dislocation of from twelve to fifteen inches was observed in striated slates; downthrow to the north.

At MacLeod crossing, Canadian Pacific railway, east of Scotstown, dislocations of three inches or more in glaciated surfaces were noted; downthrow to the north.

On the road leading from Sherbrooke to Stoke Centre, five or six miles from St. Francis River, dislocations from two to six inches also occur in the slates.

West of Richmond Junction, Grand Trunk railway, a dislocation of three inches was seen in slates, the basset edges of which are glaciated.

On the west side of Orford Mountain a dislocation of four or five inches in a glaciated rock occurs. The downthrow is on the side towards the mountain, that is, on the north.

These dislocations and many others of small amount tend to show the changes recently, and perhaps, still going on in the outer crust of the earth in a region where it is supposed to have attained a considerable degree of stability. The slips or displacements are quite numerous in districts occupied by the Cambro-Silurian slates.

Slips near mountains or resisting masses.

A noteworthy circumstance in regard to the local dislocations or slips is that they seem often to have occurred near some ridge or mountain, or mass of resisting rocks, the downthrow being usually on the side towards it, or rather the sliding up of the slates has taken place on the side farthest from it. Whether this has been caused by a pushing up of the beds against this resisting mass, or by a slight sinking of such mass from cooling and contraction, or whether it is due to both causes, remains to be determined. The facts serve to show the instability of the outer crust even in the latest geological period.

Pleistocene Marine Shore-lines of the St. Lawrence Valley.

Shore-lines.

Besides the local and orogenic changes of level described, other movements have taken place in the Pleistocene period affecting not only the whole North-east Appalachians, but also the St. Lawrence valley and the Laurentides, and indeed, the whole of Eastern Canada. These were of a more general character, although, perhaps in some places, differential or orogenic. Investigations regarding these general oscillations are still in progress; but enough is known to give us a fairly accurate idea of their range or extent in the St. Lawrence valley.

Height of region in the later Tertiary period.

The data at hand respecting the height of that portion of Canadian territory lying to the south of the St. Lawrence River relative to sea level during the later Tertiary, appear to demonstrate that it stood considerably higher at that time than at present.* Except in the Lake

*Annual Report, Geol. Surv. Can., vol. VII. (N.S.), pp. 22-25 M.

Champlain basin, however, no new facts have been obtained specially bearing on this question. Lake Champlain is 402 feet deep in the deepest part,* and a large part of it has an average depth of 200 feet. Its mean surface level is 98 feet above the sea.

Here, therefore, we have what was probably a river valley, or a valley of denudation in the Tertiary, the depth of which below sea-level (304 feet) may be taken as a measure of the height of the land in that period relative to its present altitude. S. Prentiss Baldwin infers that the Lake Champlain district was in pre-glacial times at least from 300 to 500 feet higher than at present.† Be that as it may, the facts are in accord with those observed around the seaboard in Eastern Quebec and New Brunswick regarding the height of the region in the Tertiary period. On the advent of the glacial period, the North-east Appalachians seem to have maintained approximately the height at which they stood in the later Tertiary until they became enveloped in ice. Succeeding this was a subsidence, at the maximum stage of which the land in some parts of the region stood from 800 to 1000 feet lower than at the present day relative to the sea. A great gulf or estuary then occupied the St. Lawrence valley, which formed shore-lines or beaches when at its extreme height, and also others during its recession as the land rose. A preliminary table of the elevations of these shore-lines on both sides of the valley is given in the Summary Report of the Geological Survey for 1897, pages 66-68, but the levellings have been made with aneroids only, based on those of the nearest railway stations. In the present report, a general statement of the altitudes merely will be offered until instrumental levellings have been made at a few, at least, of the principal points.

Height of the North-east Appalachians in the glacial period.

Heights of shore-lines.

In the investigations regarding these shore-lines, the St. Lawrence valley has been traversed on the south side, from Métis to Lake Ontario, and on the north from Cap Tourmente, or Ste. Anne de Beaupré, to Lake Nipissing. Longitudinally, this valley may be said to ascend from the estuary and Gulf of St. Lawrence, of which it forms a part, and in its westward extension the bottom or plain preserves approximately the same gradient throughout till it enters the Lake Ontario basin. The tributary valley of the Ottawa also exhibits the same contours westward to Chalk River or beyond. From this point upward, as far as Mattawa, the valley rises more rapidly. Here it bifurcates, in one valley flows the Ottawa River, in the other its tributary, the Mattawa, the latter continuous to the Nipissing Lake basin.

Slope of St. Lawrence valley longitudinally.

*Report of the U.S. Coast and Geodetic Survey for the year ending June, 1887, pp. 165-166, 172.

† American Geologist, vol. XIII. No. 3, March, 1894, pp. 170-184.

Slopes transversely.

Transversely, the St. Lawrence valley ascends also from the river northward and southward to well-defined limits, although to the eye apparently a level plain. The plain abuts against higher slopes, and its margins can be traced almost as clearly as those of the Gulf of St. Lawrence at the present day. These margins are not, however, always uniform in height; but appear to have suffered deformation in a number of places. Skirting the valley or plain on all sides are terraces, beaches and benches, composed for the most part of stratified gravel, sand and clay, although occasionally a terrace or bench cut into the boulder-clay is met with. These mark the shores of the sea which invaded this valley in the later Pleistocene. Generally speaking, they form a series of three or more, the lowest distinct and continuous, the highest often interrupted. Like the bottom of the St. Lawrence valley itself, these shore-lines have an ascending gradient westward, that is, up the valley. This gradient is rather greater than that of the bottom of the valley, or of the marine plain; but neither

Deformations.

is exactly uniform. Local deformations, or what may be termed a 'bulging up' of the surface, occur in places. Near the border of the plain these affect the shore-lines and probably the higher grounds also. Correlative local sags or reduced uplifts may likewise be noted. From Cap Tourmente on the north and Montmagny on the south, westward to Montreal Island, or to an imaginary line drawn across the valley from St. Jerome to Danville or Richmond, the shore-lines are practically the same height on both sides, evidencing thus far the comparative uniformity of the general uplift. Along the north side of the Ottawa, their gradient increases from St. Jerome as far westward as they have been traced, although apparently with more local deformation. On the south side of the St. Lawrence, the shore-lines seem to indicate a slightly descending gradient from Danville south-westward towards the International boundary; but, owing to most of the measurements having been made with aneroid only, they probably contain small errors.

Method of tracing shore-lines.

The method pursued in tracing the Pleistocene marine shore-lines of the St. Lawrence basin was to proceed from the known marine fossiliferous beds outwards towards the margin of the plain, and to follow those beaches which flank the slopes and face the open valley. Along the foot of the Notre Dame Mountains they are practically continuous from the gulf as far west as Richmond or Shefford; to the west of that they are more or less interrupted, or rather they are more difficult to trace.

All the measurements of heights were made with aneroids based on the levels of the nearest railway stations, except where otherwise noted, and are referred to mean sea-level. Localities where shore-lines were levelled.

	Feet.
1. At Gaspé Bay (Annual Report, vol. VII. (N.S.) pp. 22-25 M.); height, 225 to	230
2. Near Trois Pistoles, three shore-lines at 240 feet, at 345 feet, and at	375
3. South-east of Montmagny, or St. Thomas, three shore-lines at 250 feet, at 465 feet, and at	545
4. At St. Anselme Mountain, 15 miles south-east of the city of Quebec, shore-lines at 540 feet, and by sp. level at	559
5. West of Ste. Julie in Somerset, shore-lines occur at 626 feet, at 790 to 800 feet, and at	890
6. Near Danville, shore-lines at 675 feet, at 720 to 740 feet, at 830 to 860 feet, at 875 to	895
7. At Shefford Mountain, an isolated trap hill, shore-lines and benches at 650 feet, at 725 to 735 feet, at 815 to 820 feet, and terraces and ancient dunes and spits at 865 to	885
8. North and north-west of Abbott Corner, near Pinnacle Mountain, shore-lines and terraces at 790 feet, at 835 feet, and at	885

The last-noted locality is within a mile or two of the International boundary.

The high-level terraces and shore-lines have not been definitely traced beyond the boundary line into the Lake Champlain valley. Baron Gerard de Geer, when in America in 1891, levelled the height of one of these at St. Albans, Vermont, and found it to be 658 feet,* and there seems to be one, at least, at a lower level, and possibly another higher.

On the northern slope of the Adirondacks terraces and mounds of fine sand with gravel in places, underlain with stratified clay, the whole resting on boulder clay, were observed in the vicinity of Chateauguay station and Malone Junction, (Ogdensburg and Lake Champlain railway). The sands apparently formed ancient spits and dunes along the margin of the Pleistocene waters during the period of submergence, although now at an elevation of 1000 or 1100 feet. The slope where these deposits occur faces the open St. Lawrence valley, and descends with a comparatively even surface to the bank of the St. Lawrence River. The present streams flowing down the mountain side have cut deep, narrow, trench-like channels into these beds, thus showing that they are comparatively new, and indicating Dunes and spits along northern Adirondacks.

* Proc. Boston Soc. of Natural History, vol. XXV., 1892, p. 469.

that the region has been uplifted at a recent date, geologically speaking. Much more detailed examination is necessary to trace out the shore-lines here, however, than the time at my disposal would allow.

Character of deposits on lower levels of St. Lawrence valley.

On the lower levels of the St. Lawrence valley, south-west of the International boundary and of Cornwall, it was found that the deposits on both sides of the river, as far as the Lake Ontario basin, are of the same character as those to the north-east. Northward and southward the surface of these gradually ascends to limits which have not yet been definitely traced, but are probably coincident with the lowest of the series of shore-lines which border the great valley. The eastern portion of the Iroquois beach, where it has been levelled, seems to form one of the limits referred to. These beds evidence submergence with deposition of sediments and subsequent uplift.

Iroquois beach.

High-level shore-lines on northern slope of Adirondacks.

Although the high-level shore-lines have not yet been fixed and levelled along the northern slope of the Adirondacks to the east of Fine or Watertown, State of New York, there seems little reason to doubt that they are continuous or practically continuous with those to the north-east of the International boundary, and the inference, tentatively held, is that they all belong to the same system of shore-lines, the northern part of the Adirondacks having undergone a greater differential uplift than the region to the north-east and probably also greater than that to the south-west. A similar local uplift above the normal gradient, although much less in vertical range, occurs in the shore-lines between Ste. Julie and Richmond, Quebec.

Shore-lines on north side of St. Lawrence and Ottawa rivers.

On the north side of the St. Lawrence and Ottawa rivers the shore-lines, as already stated, were traced from Cap Tourmente or Ste. Anne de Beaupré, along the ascending grade as far as Algoma or Lake Nipissing. The upper border of the marine sediments of Pleistocene age can, in many places, be followed more closely and to better advantage on the north side of the valley than on the south side; but in other places it runs in among the Laurentian hills forming a very irregular line. Generally speaking, however, the border of the Pleistocene area is coterminous with that of the lake area of the Laurentide plateau, the marine sediments having apparently filled in all the smaller lake basins to the limit of submergence. Commencing at the above-mentioned places, the heights of some of the shore-lines at a few of the principal points, as measured by aneroid, are as follows :—

Localities where observed.

	Feet.
1. At Ste. Anne de Beaupré, terraces or shore-lines at 350 to 355 feet, and at	540
2. North-west of Quebec city, near Charlesbourg, shore-lines at 450 feet, and at.....	560

Feet.

3. Near St. Raymond, on the Quebec and Lake St. John railway, terraces and shore-lines at 635 feet, and at..... 660
   Pleistocene marine shells were found in this vicinity at a height of 515 feet *above high tide level*, by Mr. A. P. Low, of this Survey.*
4. At St. Jerome, on the west side of Rivière du Nord, shore-lines at 620 to 625 feet, at 730 feet, at 765 feet, and at 895 to 900
5. North of Lachute, shore-lines at 600 to 625 feet, at 740 to 745 feet, at 845 feet, at 885 to 900 feet, and at..... 975
6. At Kingsmere Mountain, north of the city of Ottawa, terraces and shore-lines occur at different levels, viz. : at 480 feet, 705 feet (de Geer), at 800 feet, 925 feet, and a doubtful one, not properly levelled, at..... 965

Probable irregularity of upheaval north of the Ottawa.

Between forty-five and fifty miles of the Ottawa River, namely, from Allumette Rapids to Rapides des Joachim is lake-like and in places reported to be 200 feet deep, or more. If the depth stated is correct, the bottom of the channel there lies as low or lower than at the Chaudière Falls immediately above Ottawa City, 138 miles further down. This fact with the general features of the valley as far up as Rapides des Joachim, indicates that there may have been a local sag or reduced uplift here. Between Rapides des Joachim and Lake Nipissing, however, the Pleistocene upheaval seems to have been greater than to the eastward. On the north side of the Ottawa within this distance, terraces and other evidences of submergence are rare; but on the south we find heavy beds of fine stratified sand, with stratified clay beneath, the whole resting on boulder clay, which occasionally rises to the surface through the overlying series. Deposits of this kind are abundant at various places from Madawaska River westward to Klocks Mills or beyond, and are often deeply denuded on the higher grounds; but on the lower contain marine shells of Pleistocene age. They are especially noteworthy on the Ottawa, Arnprior and Parry Sound railway between Douglas and Barrys Bay stations, the latter 942 feet high. The summits of the sand-hills rise 100 to 150 feet above the railway track, and face the Ottawa valley at an elevation of 1000 feet or more. The same series of beds is extensively developed at Deux Rivières where they rise to about the same elevation.† They appear to be a great development of Saxicava sands marking the upper limit of the Pleistocene submergence in this part of the country.

Saxicava sands.

High-level beaches at North Bay, Ont.

High-level beaches, 1100 to 1200 feet occur north of North Bay, first observed by Mr. F. B. Taylor.‡ Whether these beaches are

* Annual Report, Geol. Surv. Can., vol. V., N.S., p. 55 L.

† Am. Geologist, vol. XVIII., p. 114. Paper by F. B. Taylor.

‡ Bull. Geol. So. Am., vol. V., 1893. Am. Geologist, vols. XIV. and XVIII.

marine, as first supposed by him, or due to the interruption of drainage by glacier-dams, has not yet been determined. Extensive deposits of sands and silts, implying submergence are spread over this part of the country up to a height even greater than that of the beaches referred to, which have been described in early reports of this Survey as Algoma sands. These await detailed investigation and study.

Beaches north of the Great Lakes.

In that part of the province of Ontario lying between the Ottawa and Mattawa rivers and the Great Lakes to the south, the evidences of submergence have been only cursorily examined by me. Elevated sand, gravel and clay beds resting on boulder-clay occur in numerous places, and beaches regarded as lacustrine by some and marine by others, have been traced by Spencer, Lawson, Taylor and other geologists along the north and north-east sides of the great lakes, Ontario, Erie, Huron and Superior. The question of the origin of some, if not all of these, is still under discussion; but on any hypothesis we must postulate a considerable upheaval of the region, although, so far as observations have extended, one which can be closely correlated with that of the Great St. Lawrence valley to the east of the Thousand Islands and Rapides des Joachim in the Ottawa valley.

Conclusions respecting uplift raising the beaches.

The conclusions which may be tentatively drawn from the foregoing facts, with reference to the Pleistocene uplift, are that the general elevation of the St. Lawrence basin, in the later Pleistocene, was unequal or differential throughout, increasing to the westward as far as the watershed to the north and north-east of the Great Lakes; but that some portions of the country were raised higher than others, the uplift being unequal locally as well as generally. And the hypothesis held by Spencer and Taylor, that the upheaval which raised the marine plain of the St. Lawrence valley and the shore-lines bordering it, was the same as that which elevated the beaches around the Great Lakes, seems to be supported by the evidence at hand. In the latter region, the uplifting force has probably acted along several axes not always parallel to each other, but conforming perhaps more or less to the longitudinal direction of the basins of these bodies of water. The period of these crustal movements appears to have been that of the deposition of the Saxicava sands, or rather that of its closing stage. Much faulting and displacement occurred, and there were doubtless upward and downward complementary oscillations of greater or less amount and complexity, the upheaval of so considerable a portion of the region near the Great Lakes presumably implying a corresponding downward movement in the basins occupied by these It is not at all improbable, therefore, that it was at this stage of the

Pleistocene that the lake basins attained in part their present form and dimensions, and sank so far below the level of the surrounding country.

Other changes of level in "Eastern Townships."

In the "Eastern Townships" of Quebec, and along both slopes of the St. Lawrence valley, evidences of changes of level of another and more local kind came under observation. These are best shown in the dislocations of river-valleys, and in the changes produced in river-courses, causing waterfalls and rapids, and in some cases a total diversion of a river from its old channel. Crustal movements of this kind may have been partially effected in the Pleistocene period; but there are reasons for believing that they are also of much older date, extending as far back as Mesozoic, and probably Palæozoic times.

A description of the changes which have taken place in the contours of the region, as evidenced by the erosion and base-levelling of rivers, necessarily involves a discussion of the origin of river-valleys and lake-basins. Those of the district specially under review will now be briefly referred to.

Rivers and Lakes of South-eastern Quebec.

Changes of level evidenced by drainage.

Abundant evidence has been obtained to show that the rivers and lakes of the region are of great age, geologically speaking, some of them having registered the changes of level, orogenic or destructive to which it has been subjected ever since Palæozoic times. The Chaudière and St. Francis, the two largest rivers, flow transversely to the general trend of the mountain ranges and intervening valleys, and have cut channels through the range nearest the St. Lawrence River down nearly to the base-level of erosion. That the courses and valleys of some of the rivers, notably the St. Francis, have been affected by orogenic movements is certain. Lake St. Francis occupies part of the valley of an ancient river which trenched the Cambro-Silurian and Cambrian rocks. It seems also possible that Lake Megantic lies in another part of the same ancient valley. This river-valley has been dislocated by orogenic movements which occurred in the crystalline range nearest the St. Lawrence and possibly also in that along the International boundary. Whether Trout Lake, Williams and St. Joseph lakes likewise occupy dislocated portions of the old river-valley mentioned has not been determined for lack of time to make a complete examination, but it seems probable.

St. Francis River.

The drainage of the area around Lake St. Francis now finds outlet by the St. Francis River, the upper part of which trends at right angles to the course of the ancient river, and to the lower part of the

present river,—a change produced by the dislocation of the ancient valley due to the differential uplift of the belt of Cambrian and pre-Cambrian rocks to the north-west, as stated. Different portions of the St. Francis River valley appear to be of different ages. The Coaticooke and Massawippi rivers seem to have been originally the chief upper portions of the present St. Francis River, although that portion between Sherbrooke and its source in St. Francis Lake is doubtless also of a very ancient date.

Massawippi River.

The old valley now occupied by Massawippi River and lake appears likewise to have suffered dislocation, although extending parallel to the trend of the geological formations instead of transversely, as St. Francis Lake does. Massawippi Lake has been thus produced. Little Magog Lake, lying parallel thereto along the western border of the Cambrian belt, occupies a dislocated portion of another ancient river-valley, the extent of which cannot now very well be traced, though apparently effected also by the vertical movements of the pre-Cambrian and Cambrian rocks to the south-east.

Memphremagog Lake.

In the basin of Lake Memphremagog, however, we find important evidence of the differential or orogenic movements which have taken place in the region. This lake also occupies a portion of an ancient river-valley, extending from the rivershed to the south of the International boundary, in the State of Vermont, northward by way of Fraser and Brampton lakes; thence by Salmon River to the St. Francis valley. This old valley is traceable at the present day across the valley of the St. Francis between Windsor Mills and Richmond Junction, passing to the north of Shipton Pinnacle, and reaching the great St. Lawrence plain at Danville. It can thus be followed for upwards of 85 miles, and is probably older, geologically speaking, than the valley of St. Francis River, which has intersected it transversely at a wide angle, apparently at a later date. Silurian limestones occupy a portion of the Lake Memphremagog basin, showing its pre-Silurian age.

The dislocation of this ancient Memphremagog valley has also been caused by a differential uplift, or series of uplifts, of the pre-Cambrian and Cambrian belt which crosses it. The first of these movements probably took place in early Palæozoic time; but there were doubtless others at later periods. The very latest is probably related to the igneous eruptions of the region, and may have been partly produced by them. That there have been more than one of these eruptive periods is assumed by Ells,* and seems probable as far as regards the diorites and

* Annual Report, Geol. Surv. Can., vol. VII. (N.S.), p. 77 J. *Ibid.*, vol. II. (N.S.), p. 41 I.

diabases. Correlatively with the uplifts there seem to have been dislocations and subsidences, as evidenced by the ancient lake-basins referred to.

Chaudière valley.

The Chaudière valley is, apparently, an exception to the rule, but a detailed examination shows that it also has sustained a dislocation and differential uplift in one part, with a corresponding sag or subsidence in the part of its course crossed by the Cambro-Silurian rocks above the Devils Rapids. The axis of the uplift, apparent even at the present day, occurs in a district of intrusive rocks. At the Devils Rapids, where these eruptives have produced the dislocation referred to, the waters now flow over bed-rock, and there is no appearance of an old filled-in passage of the river on either side. Above that point, as far as the mouth of Rivière du Loup, the bed-rock in the bottom of the Chaudière valley seems to lie lower than it does at the rapids referred to. Mr. W. P. Lockwood informs me that in a flat just above the last-mentioned point, on the east side of the Chaudière River, he sank a shaft 70 feet deep without reaching bed-rock. Opposite Jersey Mills, on the west side of the Chaudière River, a shaft, the mouth of which is about twenty feet higher than the level of the river at the nearest point, was sunk a few years ago to a depth of 77½ feet wholly in boulder-clay without reaching the bottom of this deposit. The difference in level between the Chaudière River at the Devils Rapids and at the point nearest the shaft mentioned, is, approximately, forty feet by aneroid, so that it appears this shaft has penetrated the boulder-clay to a depth nearly twenty feet lower than the present level of the river at the Devils Rapids without reaching the bed-rock.

Shafts sunk in Chaudière valley.

Mr. Lockwood also informs me that another shaft was sunk near the mouth of the Gilbert River, on the east side of the Chaudière, to a depth of sixty feet, but rock was not reached. Sections of the deposits passed through in the two shafts referred to sunk under his direction, are given on a later page.

Synclinal basin in Chaudière valley.

From the evidence afforded by these three shafts, it would seem that a great basin, or a sag corresponding with that observed at Lake St. Francis and to the south-westward, also occurs here. That the part of the Chaudière valley from the Devils Rapids as far up as Big Falls is not now occupied with a lake corresponding to St. Francis, Massawippi and Memphremagog lakes, is most likely because a much larger volume of water seeks outlet by this river, and consequently the barrier at the Devils Rapids has been worn down, though not as yet to the base-level of erosion. But it is pretty certain that a lake once existed here in pre-glacial time, and another in

the Pleistocene period. The great quantities of sand and clay beneath the boulder-clay evidence a long period of slack drainage in this part of the Chaudière valley before the advent of the ice age, while terraces and benches of stratified materials overlying the boulder-clay would seem to favour the conclusion that a post-glacial lake also was held in here by a barrier at the Devils Rapids, which was subsequently drained out to the present level by the partial erosion of this barrier.

Depth of material in the basin.

The depth of boulder-clay and of other overlying stratified beds in the valley of the Chaudière between the Devils Rapids and the mouth of the Rivière du Loup shows the amount of material which has been thrown into this basin by glacial action and by that of the drainage-waters of the country, fluviatile and lacustrine. It is probable also that the sea invaded this portion of the Chaudière valley during the Pleistocene submergence of the St. Lawrence valley, and that the deposits may be partly estuarine.

Long north-and-south lakes.

The foregoing facts and inferences are offered with the view of explaining the origin of the long, narrow north-and-south lake basins of the region, and of the present rivers and lakes. The great age and persistency of these ancient drainage systems is a noteworthy feature.

Why their basins have not been filled up.

In regard to these long north-and-south lake-basins, the question arises why if they are pre-Pleistocene, have they not been filled in and obliterated during the glacial period and subsequently by sedimentation. There is no doubt that portions of the original valleys have thus been filled in and levelled off, so that it is difficult, if not impossible, now to locate their position continuously; but other parts have from certain causes not been filled up in this manner, and it is these which now hold the lakes referred to. The correlative subsidence or sag of the wide belt of country lying between the ranges traversing the "Eastern Townships" of Quebec during the orogenic movements already referred to, also aided in the formation of these lake basins. That their bottoms have been partially filled up during the Pleistocene period there seems no reason to doubt. The present condition of the Chaudière valley between the mouth of Rivière du Loup and the Devils Rapids proves this; but owing to the scooping or erosive action both of the northward and southward moving ice-masses, as well as to the fact that portions of them never seem to have been altogether filled with drift even during the glacial period, they exist as we now find them,—receptacles for the drainage waters of the surrounding country.

Denudation of the Region.

Since this region rose above the sea in Silurian or Devonian time, it has been the theatre of a vast amount of denudation and base-levelling from subaerial, fluviatile and lacustrine agencies, as well as from that due to glacial and marine action. This denudation is well exhibited in the interior valley lying between the range along the International boundary and Sutton Mountain and its prolongation north-eastward, and is especially noticeable in the great St. Lawrence valley. It is observable indeed, in every part of the region under review. The bottom of the St. Lawrence valley is an extensive, denuded or base-levelled plain, this and the Carboniferous area of New Brunswick being the largest of the plains which have been reduced nearly to a uniformly level surface in Eastern Canada. The former has doubtless undergone repeated oscillations of level and deformations, both regional and local, accompanied by more or less faulting and dislocation since its latest rocks were formed; nevertheless these have in most parts preserved their original position and horizontality in a remarkable degree. Into the history of the causes which produced the denudation and uniform levelling of the bottom of this valley, we do not propose here to enter, leaving this for a succeeding report, but will pass on to the consideration of the agencies which have produced the present condition of the surface on the south side of the valley, especially in their bearing on the distribution of the auriferous drift. Denudation of the region, how caused.

It has been shown on a previous page that the rocks of the "Eastern Townships" extend in parallel bands in a north-east and south-west direction, and consist of three series, each of which is characterized by a different degree of hardness or capacity for resisting erosion, hence the old gneisses and schists now occupy the more elevated portions of the country, while the belts underlain by slates and limestones have suffered the most wear and denudation. In areas of Cambro-Silurian rocks, although the strata are everywhere tilted at a high angle, they are, nevertheless, worn down nearly to a uniform surface, which in some places is so level as to resemble a marine plain. This is especially the case on the divide between the Chaudière and St. Francis waters, also westward towards Lake Megantic, and about the source of Ditton River. Comparatively level tracts were also observed on both sides of Coaticook River, and in a number of other places. Crustal movements have doubtless taken place at repeated intervals here throughout the geological history of the region, producing deformations; but notwithstanding these the agencies of erosion have unceasingly continued their work of reducing it to a base-levelled Base-levelling.

surface. Taken as a whole it now presents, therefore, different physiographic features from what it did originally, or indeed, at any intermediate stage of its geological history.

Conditions affecting river-valleys.

The ancient river-valleys, dislocated portions of which now only remain, would, however, seem to show that the wide interior valley above referred to, occupied by Cambro-Silurian rocks, must have assumed nearly its present relations in early Palæozoic ages, as the rivers have followed a considerable gradient for a long time, geologically speaking, until their channels became interrupted by the orogenic uplifts shown on a previous page. The denudation and general lowering of the surface has been greatest in the drainage basins of the St. Francis and Chaudière rivers, these having sufficient erosive power to cut passages for themselves through the range of mountains nearest the St. Lawrence (the Sutton Mountains) and wear their channels down nearly to the base-level of erosion. The other rivers flowing in this interior basin, not having such power of erosion, had to seek outlets by the Chaudière and St. Francis, being unable to cut channels for themselves directly across the range referred to. Between the erosion of these latter rivers and the orogenic forces which raised the Sutton Mountain range there would seem to have been a long struggle for the mastery, hence we find the old channels of these still traceable across the uplifted belts or mountain ranges with more or less distinctness. But the orogenic forces seem ultimately to have gained the ascendancy and the dislocated portions of the ancient river-valleys in the synclinal basins became receptacles for the drainage waters, and thus formed the long narrow north-and-south lakes already described. The lakes seem to have stood at considerably higher levels at one time than they do now, before wearing down their present outlets. All the ancient rivers of the region have thus been forced to cut out new channels for themselves by the orogenic upheaval referred to, except the Chaudière and the lower part of the St. Francis.

How the long north-and-south lakes were formed.

Transportation of material.

The transportation of material by the Chaudière and St. Francis rivers from their upper drainage basins towards the St. Lawrence plain throughout their long existence must have been enormous. Notwithstanding the large amount of eroded material thus swept away, and the consequent reduction of the land surface within the drainage basins of these two large rivers to a lower level than in other parts of the interior valley occupied by Cambro-Silurian sediments, yet thick sheets of superficial deposits mantle and conceal the rocks from view everywhere within this valley. The hill and mountain ranges present their denuded summits, often of bare rock, above the valleys while

intrusive masses, such as Owls Head, Orford, Big and Little Ham mountains loom up above the whole surrounding country, imposing in their isolation.

Protective effect of deposits.

The deposits now occupying the surface of the region, being largely boulder-clay, have a preservative effect upon the rocks, and therefore, except on summits bared by ice-action, and along river-valleys, there must be less subaerial or atmospheric disintegration going on than in pre-glacial ages. The glacial period itself was, however, one of great denudation, and had a wonderful levelling effect, sweeping the material off the higher ground and filling the valleys. This agency and its effects upon the distribution of the deposits of the region may now be considered.

GLACIATION.

Glaciation of the region.

The glaciation of the St. Lawrence valley presents many remarkable and complex features. Three or more systems of land-ice and at least one system of floating ice are indicated by the facts collected in the field. First, there seems to have gathered upon the North-east Appalachians a glacier or system of glaciers in the early Pleistocene, independent of any other ice-sheet. This ice flowed outward from one or more central gathering-grounds in radial lines, northward, eastward and southward. The main *névé* appears to have been in northern New Hampshire and in the "Eastern Townships" of Quebec. This is the ice which produced the principal striation of the province of Quebec east of the Chaudière River and head of the St. John waters, also the striation of New Brunswick and the New England States. The striæ of the Appalachian glacier have been traced on the south slope of the St. Lawrence valley nearly from the International boundary down to the foot-hills and in some places to the bottom of the marine plain.

Appalachian glaciers.

Laurentide glacier.

Succeeding this was the invasion of ice from the north and north-west,—the Laurentide or Labradorian glacier of Dr. G. M. Dawson and Mr. A. P. Low,—the southern and south-eastern limits of which will be defined in the sequel. Below the city of Quebec no evidences of this ice having crossed the St. Lawrence River were found.

A second glacier or system of glaciers flowed off the Laurentian plateau in a south-westerly direction, the striation produced by it having been observed principally upon the southern slope of the plateau and in the bottom to the St. Lawrence valley. This striation is later than the south to south-east striation and is superposed on it.

Local glaciers. Towards the close of the glacial period, during the melting or retiring stage of the glacier systems referred to, a number of local glaciers crept down the slopes in various directions as they were influenced by the topographical features.

Floating ice. The lower slopes and the rock surfaces in the great marine plain of the St. Lawrence valley, have been striated by ice which appears to have been sea-borne and to have been carried westward, or up the valley. This implies a submergence of several hundred feet below the present level.

In the following list of striæ each of the three or four systems will be separately grouped in what seems to be their chronological order. The data upon which they have been separated are the courses of the striæ, with the stoss side noted wherever observed; the weathered condition of the rock surfaces glaciated by the earliest ice as compared with that of those striated by the latest ice; the superposition of one set of striæ upon another on the same exposures, the character of the boulder-clay produced by each, etc.

The striæ are all referred to the true meridian, and the elevations to mean sea-level.

Stoss side. To avoid repetition, the word "stoss side," though not used, is to be understood with a reverse bearing after each recorded observation of the courses of striæ. Where the "stoss side" is not known, or is uncertain, the fact will be stated.

Striæ produced by the Appalachian System of Glaciers.

Striæ of Appalachian ice.

No.

1. At Ste. Flavie, N.
2. Near Bic station, Intercolonial railway, N. 20° W. and N. 30° W.
3. At Trois Pistoles station, Intercolonial railway, N., N. 2° E., N. 5° E., N. 20° E., N. 24° E., N. 35° E., N. 40° E., N. 45° E., N. 50° E., N. 55° E., N. 58° E., N. 64° E., and N. 74° E.; also N. 4° W., N. 5° W., N. 10° W., N. 12° W., N. 14° W., N. 20° W., N. 26° W., N. 32° W., N. 34° W., N. 36° W., N. 40° W. The dominant course is N. 2° E.
4. In the second concession behind Trois Pistoles, N. 20° W. Height 435 feet.
5. In the third concession, N. 40° W., and N. 50° W.
6. At Rivière du Loup, in the second concession, N. 18° W., N. 25° E., etc.
7. On the Temiscouata road, near St. Honoré, N. 40° W.
8. Near Montmagny station, Intercolonial railway, N. 62° E., N. 67° E., and N. 72° E.
9. South-east of Montmagny station, N. 22° E., N. 52° E., N. 62° E., N. 72° E.; also N. 8° W., and N. 18° W. Height 465 feet.
10. Ten or twelve miles south-east of Montmagny station, N. 8° W., N. 32° E., and N. 42° E. Height 1,400 feet.
11. A mile or more south of St. Gervais village on the road to St. Lazare, N. 38° E., and N. 52° W.

Striæ of Appalachian ice—*Cont.*

12. Further south on the same road, N. 43° E.
13. Half way between St. Gervais and St. Lazare villages, on great bosses, N. 33° E.
14. At St. Lazare, N. 33° E., N. 43° E., and N. 7° W.
15. On the road from St. Lazare to St. Clare, N. 7° W. (See No. 328).
16. West of last observation, N. 2° W.
17. Two concessions west of St. Lazare, on St. Clare road, N. 61° W. (Later, S. 87° E.)
18. East side of St. Clare village, N. 7° W., N. 17° W.
19. West of St. Clare, on St. Anselme road, N. 22° W., and N. 25° W.
20. At northern base of St. Anselme mountain, 15 miles south-east of Lévis, N. 43° E. Height 555 feet.
21. On top of St. Anselme mountain, N. 47° E., and N. 62° E. Height 630 feet.
22. At Ste. Marguerite, N. 7° W. Height 1,120 feet.
23. In another place at Ste. Marguerite, N. 42° W.
24. On road from Bisson to Sts. Anges, N. 44° E. Height, 850 feet.
25. Three miles west of West Frampton, N. 27° E., and N. 61° E. Height, 1,460 feet.
26. To the south-west of West Frampton, N. 42° W.
27. Further to the south-west, on the same road on which No. 26 striæ were seen N 7° W.
28. Some rods further to the south-west, N. 1° E. Well defined.
29. On the southern brow of the same ridge, N. 17° W., and N. 3° E.
30. South-west of St. Odilon, N. 6° W., and N. 4° E.
31. Between Colway and Des Plantes rivers, N. 6° W., N. 4° E. etc.
32. On road on south side of Rivière des Plantes, N. 19° E., N. 24° E. Height, 775 feet.
33. Half a mile east of Ste. Rose church, N. 9° E. Height, 1,485 feet.
34. On road from Etchemin Lake to Culdaff P.O., N., 9° E.
35. On the same road nearer Culdaff P.O., N. 16° W.
36. South-east of Culdaff P.O., N. 16° W., and N. 1° W. Doubtful whether these are earliest or latest.
37. About two miles east of limits of Rigaud Vaudreuil seigniory, N. 16° W. Similar courses occur to the west within three miles of St. François village.
38. East of Jersey Mills P.O., N. 15° W., N. 20° W., N. 22° W., and N. 2° W. The last may belong to the latest glaciation.
39. On hill slope between St. François and Gilbert River, N. 17° W. Height, 800 feet.
40. South-east of St. Francis station, Quebec Central railway, N. 62° E.
41. In another place near above course, N. 4° E.
42. At Marlow, P.O., N. 26° W., N. 36° W., and N. 46° W.
43. On Lot 30, Linière, N. 46° W.
44. East of road between St. Henri and St. David concessions, Aubert Gallion, N. 5° W. Height, 920 feet.
45. West of Chaudière River at St. François, Beauce, N. 6° W.
46. Along second concession road W. of St. François, N. 14° E., N. 24° E. Height 1,120 feet.
47. On same road further north, N. 6° W.
48. South of Bras River, west of Chaudière, N. 4° E. Height about 860 feet.
49. On road going from Ste. Marie to St. Sylvester, near Rivière Beaurivage, N. 4° E.
50. East of St. Victor de Tring, N. 12° E. Height, 1,225 feet.
51. In another place nearer St. Victor de Tring, N. 10° E.
52. West of same place, N. 16° E., N. 20° E.
53. Further west of St. Ephrem de Tring, N. 14° E. (*See* No. 272.)
54. Near St. Ephrem on hill summit, N. 2° E.
55. North of St. Ephrem, on road to Broughton, N. 12° E., and N. 18° E. Height 1,250 feet.

Striæ of Appalachian ice—*Cont.*

56. Six or seven miles from Broughton, on same road, N. 2° E. with a S. 66° E. set superposed on it. Also N. 36° W. Height, 1,250 feet.
57. About five miles south of Broughton station, Quebec Central railway, N. 2° E. with S. 66° E., striæ also.
58. Near Broughton station, N. 6° W., N. 12° W., and N. 14° W.
59. On road from Broughton to Leeds and Inverness, N. 9° E.
60. Near Leeds on northern slope of range, N. 24° E. Height, 1,360 feet. This course occurs on several exposures here.
61. Between Leeds and Inverness, N. 12° E., N. 16° E.
62. Near brow of mountain before descending on marine plain of St. Lawrence Valley, N. 14° E. Height, 895 feet.
63. South of Ste. Julie, near Bate, N. 52° E., and N. 64° E. Height, 1,000 feet.
64. South-east of Wolfestown, N. 1° W. Height about 1,250 feet.
65. On same road, near Nicolet Lake, N. 2° W., crossed by a later S. E. course (No. 246.)
66. Still nearer Nicolet Lake, N. 16° W., N. 14° W. Height about 1,000 feet. Also crossed by a S. E. course.
67. North of South Ham, N. 20° E. Height, 960 feet.
68. At South Ham, N. 5° W., N. 15° W., and N. 25° W. Crossed by S. E. striæ, (No. 241.)
69. Between South Ham and Marbleton, N. 10° W., and N. 15° W. Numerous.
70. At limekilns, Marbleton, N. 25° W., and N. 30° W.
71. West of St. Romaine, N. 5° W., N. 10° W. Height about 1,400 feet.
72. Two miles east of Forsyth. (Also No. 275.)
73. Half way between Forsyth and St. Ephrem, N.
74. Three miles from East Angus, on road to Cookshire, N. 35° E.
75. About a mile from Cookshire, on same road, N. 25° E., and N. 30° E.
76. Two or three miles south-east of Scotstown, near Canadian Pacific railway, N. 35° W., N. 45° W., and N. 63° W. Height about 1,200 feet.
77. Near MacLeod crossing, N. 56° W., in several places.
78. North of Nadeau crossing, Canadian Pacific railway, and east of Lake Megantic, N. 46° W., and N. 66° W., besides (No. 189).
79. On Stoke Centre road, north of St. Francis River, N. 55° E. Height, 680 feet.
80. On the same road, five miles from St. Francis River, due W.
81. Further to north-east, N. 45° W. Height, 865 feet.
82. At slate quarry near Danville, N. 18° W.
83. West of Danville, N. W. Height, 750 feet.
84. At Stoke Lake, N. 55° W. Height, 800 feet.
85. South of Stoke Lake, N. 55° W. Numerous.
86. Seven or eight miles east of Windsor Mills, N. 85° W. Height, 850 feet.
87. About two miles east of Windsor Mills, S. 85° W. Height, 600 feet.
88. One mile east of Windsor Mills, N. 75° W., N. 83° W., and S. 85° W. Height, 600 feet.
89. West side of St. Francis River, opposite Windsor Mills, N. 85° W. At Kingsbury, N. 85° W. Height, 590 feet.
90. On the east side of Shefford Mountain, N. 45° W.
91. On road from Knowlton to Sweetsburg, N. 20° W. In another place further north, N. 5° E.
92. Three or four miles from Sweetsburg, on same road, N. 83° W., crossed by a southerly trending set, (No. 150.)
93. Another exposure shows N. 83° W., crossed by a later set S. 57° W.
94. Two miles from Sweetsburg, N. 87° W., varying to S. 57° W., crossed by a later set, (No. 150.)

95. South-west of "Pinnacle," Sutton Mountain on road from Abbott corner to Richford, Vermont. N. 62° W., and S. 88° W. Numerous. In other places in this locality N. 42° W., N. 52° W., etc. (See No. 138.) Striæ of Appalachian ice—*Cont.*
96. South of Phillipsburg, Missisquoi Bay, N. 38° W. Imperfect.

Striation produced by the earlier Laurentide Glacier.

97. At St. Eustache, north of Portneuf, Canadian Pacific railway, S. 12° E., S. 45° E. Height, 375 feet. Striæ of earlier Laurentide glacier.
98. Near Belair station, Canadian Pacific railway, S. 84° E. (This ice moved down the valley of Rivière du Cap Rouge.)
99. At Grand' Mère, St. Maurice River, S. 25° E. Height, 675 feet.
100. South of Maskinonge Lake, S. 28° E., and S. 33° E. Height, 675 feet.
101. In another place near Canadian Pacific railway track, S. 18° E. Height, 650 feet.
102. Further south, S. 13° E. and S. 9° E. Height, 640 feet.
103. At St. Jerome, S. 32° E., S. 30° E., S. 8° E., S. 3° E., S. 3° W., and S. 16° W. Height, 320 feet.
104. On a boss on bank of North River, at St. Jerome, S. 12° E. and S. 50° E.
105. At iron mines, west of St. Jerome, S. 5° W.
106. North of St. Jerome, S. 22° E. and S. 40° E. Height, 735 feet.
107. At Ste. Camille, S. 12° E.
108. On the road from Lachute to Dunany, S. 12° E. Height, 475 feet.
109. North of Lachute, S. 12° E. and S. 32° E.
110. North-east of Calumet, S. 18° W. and S. 28° W. Height, 530 feet.
111. On the road going north from Calumet station, Canadian Pacific railway, S. 2° E. and S. 12° E. Height, 635 feet.
112. Along Rouge River valley, one mile north of the Canadian Pacific railway station, at Calumet, S. 2° E. Height, 400 feet. Further up river, S. 17° E., in two places. Height also 400 feet.
113. North of Papineauville, S. 9° W.
114. North of Buckingham, near Mayo, two courses, S. 31° E. and S. 9° W. to S. 14° W. On weathered exposures.
115. Near last mentioned locality, viz., at Emerald mine, S. 11° E.
116. West of Buckingham, glaciated bosses with two stoss sides occur, one to the north, another to the east; but no distinct striæ were detected.
117. Near Old Chelsea, in Gatineau Valley, S. 10° E. to S. 20° E.
118. In Chichester, opposite Pembroke, S. 29° E. Heavy. Height, 625 feet.
119. At Chippewa Creek, two or three miles north of North Bay, S. 14° W.
120. On ledges north of North Bay, S. 4° W. and S. 9° W. Height, 660 to 670 feet.
121. At Klock's Mills both the southward and south-westward sets of striæ were observed.
122. At Madawaska station (Ottawa, Arnprior and Parry Sound railway), southward striation was observed.
123. Half a mile south of Perth, two or three courses of striæ occur, often in the same surface, the oldest being S. 28° E. Height, 435 feet.
124. About two miles south of Perth, older striæ, S. 28° E. and S. 33° E. These are nearly effaced by a later south-west set. Height, 435 feet.
125. West of Bathurst, Canadian Pacific railway, striæ were observed with courses trending from north to south, and another set from north-east to south-west.
126. At Tweed station, Canadian Pacific railway, S. 14° E., S. 16° E., S. 46° E., and S. 1° W.
127. About three miles north of Smiths Falls, S. 1° W., in several places, also S. 3° W.

Striæ of earlier Laurentide glacier—*Cont.*

128. South of Smiths Falls, S. 4° E., S. 1° W., and S. 6° W.
129. On Wolfe Island, foot of Lake Ontario, S. 21° W., S. 31° W., S. 31° E., etc. Height, 250 feet.
130. At Clayton, N.Y., S. 21° E., S. 11° E., and S. 6° E.
131. At Morristown, N.Y., S. 25° E., and S. 40° E. On another exposure, S. 7° E. On the higher grounds south of Morristown, S. 8° W.
132. At Nevin's quarry, west of Ogdensburg, N.Y., S. 5° E., S. 18° E., S. 23° E. and S. 22° W. The S. 5° E. striæ are the heaviest. Superposed on these are south-west striæ which may be due to floating ice.
133. About four miles south of Ogdensburg, S. 10° E., in several places. Light.
134. At Prescott, Ont., S. 15° E, and S. 18° E. Another finer set (No. 351.) superposed on these.
134½. Near St. Albans, Vt., S. 12° E.
135. On the south-east side of a ridge behind St. Albans, Vt., S. 14° W. and S. 18° W.
136. South of Phillipsburg, Que., S.
137. On the ridge just west of St. Armand station, S. 38° W., and S. 33° W.
138. On the road from Abbott Corner to Richford, Vt., S. 52° E., and S. 42° E., crossing N.W. striæ.
139. At foot hills north-east of "Pinnacle," S. 42° E. and S. 27° E. Height, 960 feet.
140. South-east of "Pinnacle," Sutton Mountain, S. 32° E.
141. On the west side of Pigeon Hill, S. 22° E.
142. Two miles south. of St. Armand, at International boundary, S. 18° W.
143. A mile east of St. Armand, S. 46° E.
144. At Frelighsburg, S. 27° E. Height, 500 feet.
145. South-east of Dunham, west of Sweetsburg, S. 40° E.
146. On the road going south from East Dunham, S. 60° E. and S. 65° E; well marked.
147. In another place near by, S. 34° E.
148. On north-west slope of ridge, three miles west of Sweetsburg, S. 72° E. and S. 52° E.
149. In another place on same slope, facing St. Lawrence plain, S. 28° E.
150. On hill south of Sweetsburg, S. 54° E.; another common course here is S. 62° E.
151. At Knowlton village, S. 12° E.
152. On summit of Shefford Mountain, in a hollow, S. 55° E.
153. On south-west side of Shefford Mountain, S. 62° E.
154. East of West Shefford, S. 37° E.
155. Near Iron Hill, Brome Mountain, S. 52° E.
156. In Bolton, near Grass Pond, S. 32° E., S. 12° E.
157. Near Foster junction, and at South Stukely, Canadian Pacific railway, S. 12° E.
158. At Eastman station, Canadian Pacific railway, S. 32° E. and S. 12° E.
159. On slope of Orford Mountain, S. 53° E. Height, 1,400 to 1,500 feet.
160. On same slope of Orford Mountain, at elevation of 1,800 feet, glaciated surfaces were noted, but without distinct striæ or grooves. Above this to summit, 2,860 feet, no glaciation was observed.
161. Near the foot of Orford Mountain, S. 23° E., S. 33° E.
162. South of Orford Mountain, S. 63° E., or N. 63° W., stoss side indistinct.
163. Along the Canadian Pacific railway, north-west of Lake Memphremagog, S. 23° E. and S. 33° E.
164. Between Memphremagog and Magog lakes, in several places, S. 13° E., to S. 9° W.
165. North of Lake Memphremagog towards Cherry and Fraser lakes, in several places, S. 14° E. Height, 800 to 915 feet.
166. West of Lake Memphremagog towards Orford Lake, S. 2° W.
167. Two miles south of Georgeville, S. 28° W., S. 8° W. Height, 800 feet.

Striæ of earlier Laurentide glacier—*Cont.*

168. On west side of Lake Memphremagog, three miles from north end, S. 4° E. Height, about 1,000 feet.
169. On east side of this lake, near Oliver, P. O., S. 12° W. Height, 1,000 feet.
170. At cross roads, south end of Little Magog Lake, S. 9° E. Height, 715 feet.
171. Near cotton mill, Magog village, S. 8° W. Height, 700 feet.
172. Near same place on east side of Magog River, S. 14° W. and S. 26° W.
173. On east side of Lake Memphremagog, above Magog village, S. 24° W. and S. 10° W. Height about 820 feet.
174. On road from Magog to Katevale, S. 8° W. Height, 900 feet.
175. West of Katevale, S. 20° W. and S. 14° W. Height, 1,090 feet.
176. At Katevale, S. 10° W. Height, 845 feet.
177. South-east of Massawippi River, S. 35° E. Height, 520 feet.
178. At International boundary, Maine Central railway, S. 35° E., and S. 25° E. Height, 1,118 feet.
179. At St. Malo station, same railway, S. 45° E.
180. West of Sawyerville, S. 60° E. and S. 50 E.
181. About a mile south of Dixville station, Grand Trunk railway, S. 30° E. Height 1,130 feet.
182. On granite hills further south, S. 80° E. Height, 1,950 feet.
183. On road from Norton Mills to Barnston, not far from International boundary, S. 57° E. Height 1,650 feet.
184. Further west, nearer Barnston, S. 33° E. Height, 1,345 feet.
185. On road from Coaticook to Barnston, S. 30° E and S, 25° E. Height, 1,265 feet.
186. South of Chartierville, at foot-hills, S. 55° E. and S. 35° E. Height, 1,750 feet to 1,800 feet.
187. On road from Ditton to Scotstown, S. 80° E. and S. 60° E. And on another ledge nearer Scotstown, S. 60° E. and S. 50° E. Height about 1,350 feet.
188. On easternmost road leading from Megantic to Spider lake, S. 86° E., S. 76° E. and S. 62° E. Near Spider Lake, S. 76° E.
189. On second short road crossing Canadian Pacific railway, east of Megantic, S. 86° E.
190. East of Agnes P.O., or Megantic, on south side of Chaudière River, S. 86° E. (numerous), S. 66° E., etc.
191. In another locality, east of Megantic, to south of last, S. 82° E. and S. 66° E. Height, 1,540 feet.
192. At north end of Lake Megantic, S. 66° E. and S. 56° E.
193. Along the road from Megantic to Ste. Cécile, four or five miles from lake, S. 66° E. and S. 61° E.
194. Near Lowelltown, Me., along Canadian Pacific railway, S. 86° E., S. 80° E., S. 73° E, S. 69° E. and S. 65° E.
195. At Hampden Settlement, Que. S. 45° E. Height, 1,565 feet.
196. Further east on same road, near cross roads, S. 60° E., and S. 15° E. Height, 1,770 feet.
197. Near McLeod crossing, Canadian Pacific railway, S. 85° E. and S. 52° E. In another place near last, S. 45° E.
198. At Scotstown, several sets, the most distinct being S. 65° E.
199. On the Macnamee road, west of Scotstown, S. 60° E. and S. 55° E. Light. Height, about 1,330 feet.
200. Four miles west of Scotstown, S. 75° E.
201. At Compton village, S. 55° E. and S. 45° E.
202. At Cookshire, S. 58° E. and S. 48° E.
203. On second cross-road west of Sherbrooke, on north side of Magog River, S. 13° E. Height, 800 feet.
204. At Sherbrooke, S. 54° E., S. 52° E., and S. 48° E.

Striæ of earlier Laurentide glacier—*Cont.*

205. Three miles north of Sherbrooke along Grand Trunk railway, S. 35 E. Height 480 feet.
206. From one to two miles east of Sherbrooke, S. 15° E., S. 1° W., and S. 5° W. Height, about 600 feet.
207. Half a mile further east on north side of St. Francis River, S. 40° E., S. 35° E. and S. 30° E.
208. Near Ascot station, Quebec Central railway, S. 81° E. and S. 53° E. Height, 640 feet,
209. At junction of two roads leading from Sherbrooke to Ascot, S. 55° E. Height 990 feet.
210. From one to two miles west of Ascot, S. 56° E. Height, 850 to 875 feet.
211. East of St. Francis River, on east road leading to Stoke Centre, S. 44° E. and S. 30° E. Height, 550 feet.
212. At junction of two roads leading to Stoke Centre, S. 46° E. Height, 950 feet.
213. Near Brompton Falls, St. Francis River, S. 40° E, Height about 500 feet.
214. Further down river, at the same place, S. 36° E. and S. 20° E. Height, 470 feet.
215. About a mile east of Windsor Mills, S. 35° E. Height, 600 feet. (See No. 88.)
216. Two miles east of Windsor Mills, S. 55° E. Height about the same as last.
217. At Kingsbury, S. 47° E. Height 590 feet. (See No. 89.)
218. On road leading direct from Kingsbury to Richmond Junction, north of first bend, S. 55° E. Light.
219. At Melbourne, south-west of Richmond Junction, S. 50° E. Height, 685 feet.
220. Seven or eight miles from Windsor Mills, on road to Wattopekah Lake, S. 41° E. Height, 850 feet.
221. South of Stoke Centre, on west road leading to Sherbrooke, S. 76° E., S. 65° E., and S. 56° E.
222. On the same road, north side of large brook, S. 61° E. Height, 850 feet.
223. South of same brook, S. 56° E. and S. 46° E.
224. South-west of Richmond Junction, Grand Trunk railway, S. 50° E. Height, 700 feet.
225. On a northern slope further west, S. 46° W.
226. Further west, on Montreal road, S. 56° E. Height, 720 feet.
227. Near Lisgar station, Grand Trunk railway, west side, S. 56° E. and S. 46° E.
228. On a boss west of Danville, S. 51° E.
229. Half way between Shipton Hills and Danville, S. 46° E. Height, 740 feet.
230. East side of Shipton Hills, S. 22° E., S. 20° E.
231. At slate quarry, south of Danville, S. 74° W. and S. 44° W.
232. South of Danville village, S. 22° E. and S. 20° E. Height, 550 feet,
233. On hill slope south of Danville, S. 36° E. and S. 26° E. Height, 895 feet.
234. On hill facing the St. Lawrence valley at Warwick, Grand Trunk railway, S. 74° E., S. 64° E., etc. Height, 860 feet.
235. Two miles west of Arthabaskaville, on hill slope facing St. Lawrence, S. 46° E. Height about 870 feet.
236. At Arthabaskaville, on similar hill slope, S. 8° E.
237. Three miles south of Angus station, Quebec Central railway, S. 40° E. and S. 35° E.
238. On the road from Angus station to Cookshire, near latter place, S. 40° E.
239. On road from Dudswell station, Quebec Central railway, to Marbleton, east of lake, S. 32° E.
240. Near Marbleton, on road to South Ham, S. 66° E. and S. 56° E.
241. At South Ham, S. 62° E. and S. 46° E.
242. Within a mile or two of Nicolet Lake, on road to Wolfestown, S. 86° E.
243. North of Nicolet Lake, on same road, S. 56° E. and S. 36° E.
244. Two or three miles north of Nicolet Lake, S. 86° E., also N. 75° E. Light striæ.

Striæ of earlier Laurentide glacier—*Cont.*

245. Further to the north-east, S. 84° E. Light: numerous.
246. Still further to the north-east, S. 68° E. (See No. 65.)
247. Five or six miles south-west of Wolfestown, S. 70° E.
248. Between St. Pierre Baptiste and Ste. Julie, about a mile from brow of mountain, S. 71° E.
249. Near brow of mountain, on same road, S. 86° E. Height, 950 to 1,000 feet.
250. Two or three miles west of Ste. Julie, along foot-hills, S. 54° E. Stoss side indistinct. Height, 700 feet.
251. At base of mountains south of Ste. Julie, on road to St. Pierre Baptiste, S. 22° E. Height, 680 feet. The same course occurs in other places on this road.
253. South of Ste. Julie village, S. 54° E.
254. South-west of Ste. Julie, among foot-hills, S. 76° E. and S. 62° E.
255. On road from Ste. Julie to Inverness, at foot-hills, S. 56° E. Height, 750 feet.
256. On brow of slope, going south on same road, S. 56° E. Height, 895 feet.
257. Still further south on slope, S. 46° E., in several places.
258. Just east of cross roads between Inverness and Leeds, S. 26° E.
259. Further south on road to Leeds, S. 46° E. and S. 36° E.
260. North of Leeds, S. 56° E., S. 46° E., etc. (*See* No. 60.)
261. South of Leeds near Harvey Hill, on road to Broughton station, Quebec Central railway, S. 86° E. Height, 1,150 feet.
262. At Broughton station, Quebec Central railway, S. 82° E.
263. At Weedon station, Quebec Central railway, 52° E. Height, 1,170 feet.
264. At west end of Lake Aylmer, S. 76° E. Height, 1,075 feet.
265. Near Stratford P.O., S. 66° E. and S, 52° E. Height, 1,175 feet.
266. Between Stratford and Stornoway, S. 56° E.
267. East of Stornoway, in a valley, S. 60° E.
268. At St. Romain church, S. 86° E. and S. 66° E. Height, 1,400 feet.
269. On road from Broughton to St. Ephrem de Tring, six or seven miles from Broughton, S. 66° E. (See No. 56.)
270. On same road north of Bras River, S. 66° E.
271. East of St. Ephrem on road to St. Victor de Tring, S. 86° E. and S. 66° E.
272. Half a mile or more to the east of last, S. 34° E. (See No. 53.)
273. At St. Victor de Tring, S. 50° E. to S. 60° E.
274. Halfway between St. Ephrem de Tring and Forsyth, S. 56° E.
275. About two miles east of Forsyth, S. 66° E. (*See* No. 72.) Height about 1,300 feet.
276. At Forsyth (St. Evariste de Forsyth), S. 64° E. on several exposures.
277. Behind R.C. church where dislocated slates occur S. 56° E.
278. On the west side of River Tierney, S. 56° E. and S. 46° E.
279. About a mile east of Lambton, S. 56° E. Height, 1,300 to 1,400 feet.
280. At the south end of St. Francis Lake, S. 66° E. to S. 70° E.
281. Near St. Elzéar in two places, S. 56° E. and S. 26° E. Light.
282. Further south going up hill, S. 32° E. Fine striæ. Height, 1,050 feet.
283. At St. Elzéar, S. 36° E., or the reverse. Stoss side indistinct. Height, 915 feet.
284. On road from St. Elzear to Ste. Marie, S. 52° E.
285. North-west of Millstream, near St. François, Beauce county, at rear of first concession, S. 86° E., S. 66° E., and S. 56° E. Height, 850 to 900 feet.
286. On west side of Chaudière River, south-west of the Devils Rapids, in the second concession, S. 76° E. Height about 960 feet.
Other striæ in rear of first concession near here, S. 66° E.
287. At east end of road between St. Henri and St. David concessions, S. 47° E. Height, 920 feet.
288. In the southern part of Aubert Gallion, S. 53° E. Numerous.

Striæ of earlier Laurentide glacier—*Cont.*

289. About a mile above mouth of Rivière du Loup on east side of Chaudière River, S. 47° W.
290. At Jersey Mills, S. 70° E., S. 64° E., S. 56° E., and S. 48° E.
Same place at bank of Chaudière River, S. 52° E. and S. 40° E.
291. At Ste. Marguerite, east of Jersey Mills, S. 32° E. Height, 1,170.
292. One or two miles above Jersey Mills, on east side of Rivière du Loup, S. 62° E., S. 46° E. and S. 27° E.
293. About four miles from Jersey Mills, on old Kennebec road, S. 77° E. and S. 72° E.
294. Seven miles above Jersey Mills on same road, S. 67° E. Height, about 840 feet.
295. At St. Come, S. 68° E., S. 37° E., and S. 20° E. Height, 935 feet.
296. In second concession east of St. Come, S. 47° E. Height, 1,100 feet.
297. Near Langevin road, in several places, S. 47° E. and S. 37° E.
298. At Marlow, P.O., N. 88° E., S. 80° E. and S. 62° E. Height, about 960 feet.
299. Further south-west on Kennebec road at school house, S. 52° E., S. 42° E., and S. 36° E. Height, 1,050 feet.
300. On Lot 30, Linière, S. 46° E. and S. 32° E. Height, 1,530 feet.
On another exposure here, S. 27° E.
301. At Monument stream, S. 46° E., S. 42° E. and, S. 36° E. The S. 46° E. striæ may be N. 46° W. as there is no distinct stossing.
302. At International boundary, east of Line House, Kennebec road, S. 57° E. or N. 57° W., stoss side doubtful. Height, 1,950 feet.
303. Along Kennebec road south of boundary line, S. 57° E. or N. 57° W.
304. Two miles south of boundary, on same road, S. 82° E., S. 72° E., and S. 66° E.
About three miles south-west of boundary, same road, S. 72° E., S. 66° E., S. 62° E., S. 56° E., S. 52° E., and S. 46° E. Last two of these courses light.
305. Along Langevin road going from St. Come, and before reaching head-waters of Abenaquis River, S. 75° E. and S. 45° E. Height, 1,245 feet.
306. South of Abenaquis River, on same road, S. 67° E., S. 47° E., and S. 37° E. Height, 1,275 feet.
307. North of Abenaquis River on this road, S. 66° E., S. 56° E., and S. 46° E.
308. North of St. Francis station, Quebec Central railway, in the Chaudière valley, S. 42° E., S. 37° E.; also S. 17° E.
309. Still further north along Quebec Central railway track, S. 72° E., S. 66° E., S. 62° E., and S. 56° E.
310. On south side of Famine River, two miles from the Chaudière, S. 36° E. Height about 1,000 feet. In another place further east, S. 46° E.
311. On the road from St. Francis to Gilbert River gold mines, S. 62° E., and due E.
312. Between Famine River and Lake Etchemin, S. 76° E. Height, 900 feet.
313. South of Lake Etchemin, S. 76° E. and S. 82° E.
314. Between Gilbert and Famine Rivers, in Fief Cumberland, S. 67° E.
315. Two miles east of St. Francis, Beauce, S. 47° E.
316. Between this and Chaudière River, S. 75° E. and S. 50° E. Numerous.
317. Four or five miles west of St. Odilon, S. 87° E. Height, 1,250 feet.
318. At mouth of Colway River, S. 76° E. and S. 72° E.
319. On eastern slope of Chaudière, between St. Joseph and Colway River, S. 67° E. Height, 535 feet.
320. East of St. Joseph, two or three miles, S. 82° E.
321. On road from Bisson to Frampton, second concession, S. 76° E. Height, 1,020 feet.
322. At Ste. Marie, S. 50° E.
323. About a mile east of Ste. Marie, S. 45° E. Height, 890 feet.
324. Between Ste. Marie and Ste. Marguerite to east of first concession, S. 72° E. and S. 62° E. Height, 1,080 feet. In another place near by, S. 72° E. Height, 725 feet.

325. West of St. Marguerite, S. 88° E. Height, 925 feet.
326. On hill at Ste. Marguerite, facing St. Lawrence River, S. 80° E. In another place, S. 83° E. Height, 1,120 feet.
327. Two concessions west of St. Lazare, S. 88° E.
328. At St. Clare and on road towards St. Lazare, S. 78° E.

Striæ of earlier Laurentide glacier—*Cont.*

Striation produced by the Second or Later Laurentide Glacier flowing south-westward, or, perhaps, partly by Floating Ice.

Striæ of later Laurentide glacier.

In the list of striæ given in Mr. A. P. Low's report on the Geology and Economic Minerals of the district in the vicinity of Quebec,* a number of courses with a south-west trend are recorded from Bonhomme Mountain, Fossambault, Bourg Louis, Ste. Anne River, etc. Some of these were noted by the writer during the summer of 1897. Others further west were observed as in the following list :—

329. At St. Jerome, N. 73° W., N. 66° W., N. 87° W., S. 57° W., S. 63° W., S. 72° W., and S. 50° W. Height, 320 feet.
330. On a boss on the bank of North River, at St. Jerome, N. 82° W. and S. 72° W.
331. On the road from St. Jerome to Ste. Camille, N. 82° W. Height, 440 feet.
332. Along the road from Lachute to Dunany, N. 72° W. and N. 82° W. Height 475 feet.
333. North-east of Calumet, S. 33° W. Height 530 feet.
334. Two or three miles north of Calumet, S. 78° W. Height, 450 feet.
335. On the south-east brow of Mount Royal, Montreal, S. 57° W.
336. On the north-east brow, imperfect grooves and striæ, S. 32° W., S. 27° W., and S. 22° W.
337. South-west of Ste. Julie, on road to Lake Williams, on mountain slope facing St. Lawrence Valley, S. 45° W., S. 15° W., etc. Height, 765 feet. (See No. 240.)
338. Higher up on slope, S. 55° W. and S. 30° W. Height, 900 to 1,000 feet.
339. West of Warwick station, Grand Trunk railway, on brow of hill facing St. Lawrence Valley, S 74° W. and S. 64° W. Height, 860 feet.
340 On north-east side of Shipton Pinnacle, N. 85° W., S. 85° W., and S. 75° W. Height, 800 to 1,000 feet.
341. On direct road from Richmond Junction to Kingsbury, due W.
342. On the south-east side of Shefford Mountain, S. 60° W.
343. On the north-west slope of Shefford Mountain, N. 75° W. Height, 550 feet.
344. On the summit of the same mountain, near the western slope, S. 75° W.
345. On the east side of Brome Lake, S. 75° W. At Knowlton village, S. 75° W.
346. East of Pigeon Hill, Missisquoi county, S. 78° W.
347. At east end of Beauharnois canal, S. 38° W., S. 33° W. and S. 28° W. Extensive ledges striated. Height, from 50 to 75 feet above the level of the St. Lawrence near by. On the shore of the river interrupted striæ and grooves occur trending, N. 82° W. The ledges grooved in the direction of S. 38° W. have a N. 87° W. course superposed on them, and although no north-to-south striation was seen yet some of the bosses are stossed on the north side.
348. Between two and three miles west of Valleyfield, on the bank of the St. Lawrence, S. 45° W., S. 51° W., and S. 34° W. These striæ occur on three exposures and have several intermediate courses. Boulder-clay, three or four feet deep rests on the surface of the ledges. One of the bosses shows a stoss side to the north or north-west with older glaciation than the south-west set. The south-west striæ trend parallel to the St. Lawrence River.

* Annual Report, Geol. Surv. Can., vol. V. (N. S.), pp. 48-52 L.

Striæ of later Laurentide glacier—*Cont.*

349. At the Soulanges canal, S. 50° W., S. 40° W., and S. 30° W., with a great number of intermediate courses. From the character of the striation upon the rocks here it appears to have been produced by floating ice. The boulder-clay is in no respect different from that due to land ice.
350. From three to four miles north of Prescott, N. 70° W., and N. 80° W.
351. Just above Prescott, on the bank of the St. Lawrence, a fine set superposed on those of No. 134, S. 50° W., S. 22° W., and S. 10° W.
352. About a mile north of Smiths Falls, S. 46° W.
353. At and near Lansdowne station, Grand Trunk railway, S. 55° W., S. 52° W., S. 40° W., and S. 30° W.
354. About five miles west of Lansdowne, S. 50° W.
355. At Nevin's quarry, near Ogdensburg, N.Y., S. 80° W., N. 78° W., and on another exposure S. 76° W., and S. 62° W. These are superposed on No. 132 and are the latest. Some of them may be be due to floating ice.
356. At DeKalb Junction, New York Central railway, and between that and Philadelphia Junction to the west, the north-east to south-west striation is dominant. This course is also well exhibited on numerous ledges along the St. Lawrence River between Ogdensburg and Morristown, N.Y., and westward.
357. On the higher grounds south of Morristown, N.Y., fine striæ occur, S. 85° W.
358. At Clayton, N.Y., S. 53° W., S. 52° W. and S. 50° W. On another exposure S. 58° W., S. 45° W. and S. 25° W.; and on a third ledge, S. 55° W., and S. 45° W. Striation heavy, especially the S. 55° W. and S. 45° W. courses.
359. On Washington Island, at Clayton, S. 55° W., S. 45° W., and S. 35° W. The two first common and well defined. In many places these striæ cross the hollows in the rock surface, the ice apparently not having accommodated itself to the inequalities thereof, and their trend is closely parallel to the course of the St. Lawrence River.
360. Three or four miles east of Gananoque station, Grand Trunk railway, S. 36° W.
361. Five miles north of Gananoque, on the road to Seelys Bay, S. 41° W. in several places.
362. Between the last mentioned point and Seelys Bay, S. 45° W. and S. 42° W. A kame or gravel ridge occurs here parallel to the striation.
363. Between Gananoque village and the Grand Trunk railway station, S. 42° W. Common. Also S. 66° W.
364. On a boss near the Grand Trunk railway station, Gananoque, S. 56° W. and S. 42° W. The last, most common.
365. A mile or more to the north-east of Gananoque station, Grand Trunk railway, S. 76° W., S. 56° W., etc.
366. West of the last point, towards Willetsholme and Pitts Ferry, S. 56° W. and S. 42° W.
367. Nine or ten miles east of Kingston, along the road nearest the St. Lawrence, S. 37° W.; and at the junction of two roads about half-way between Kingston and Gananoque, S. 62° W. and S. 54° W. Nearer Kingston the courses have more westing.
368. On the west side of Wolfe Island, S. 52° W., S. 47° W., and S. 42° W. Superposed on these are striæ trending S. 76° W. and S. 62 W. Curving striæ also occur here S. 12° W. to S. 4° E. within the space of six feet square. These are clearly superposed on all the other striæ and may be due to recent lake ice. The straightness and parallelism of the deep grooves and striæ of the S. 52° W. set indicate rather the action of land than of floating ice.
369. In the suburbs of Kingston, S. 48° W., superposed on which is another set trending N. 82° W.
370. At Grove Inn quarry, Kingston, the same two sets occur. Here the N. 82° W. striæ are clearly seen to be the latest. In another place, near by, this latest course diverges slightly more to the north, being N. 73° W. and N. 68° W.

371. Half a mile south of Perth, superposed on older striation, S. 87° W. and S. 52° W. Striæ of later Laurentide glacier—*Cont.*
372. Four miles to the south or south-west of Perth, S. 42° W.
373. About two miles south of Perth, S. 47° W. (See No. 124.)
374. Near Beckwith Lake, south of Carleton Junction, south-west striæ were noted.
375. Between Maberly and Sharbot Lake stations, Canadian Pacific railway, the northern as well as the north-east and east sides of the bosses are stossed.
376. At Tweed station, Canadian Pacific railway, faint striæ, S. 54° W. and S. 47° W. Poorly preserved.
377. In the region around Peterborough there are boulder-clay ridges (drumlins or drumlike forms of drift) trending S. 60° W. to S. 45° W., apparently parallel to the striation, although no distinct striæ were observed.
378. Along the Canadian Pacific railway between Pembroke and Klock the north-east and east stossing was also noted.

On the south of the Ottawa River, near Mattawa, S. 62° W. and S. 52° W. In a third locality, near by, S. 42° W.

The older striation here is about south, especially as seen on the higher grounds. The south-west striæ are the latest. This is a common course to the north-east and north of the great lakes.

Striation produced by Glaciers of a still more Local Character at or near the close of the Glacial Period.

379. At Trois Pistoles, Intercolonial railway, N. 75° W., N. 60° W., N. 31° W., N. 25° W., N. 15° W., N. 11° W., N. 3° W., and N. 1° W. West of the railway station, N. 41° E., N. 39° E., N. 21° E., N. 17° E., and N. 13° E. Striæ of local glaciers.
380. South-east of Montmagny station, Intercolonial railway, seven or eight miles, S. 78° E. and S. 88° E. Height, 850 feet.
381. Ten or twelve miles south-west of same station, on road to St. Paul, N. 58° W., and still further south, S. 78° E.
382. Two or three miles south of Ste. Henedine, Quebec Central railway, on road to Ste. Marguerite, N. 72° E. and N. 62° E.
383. North of St. Lazare, on road to St. Gervais, N. 72° E. and N. 62° E. Height, 895 feet.
384. At St. Lazare, N. 86° E. and N. 62° E.
385. From one to two miles west of St, Lazare, S. 88° E.
386. West of St. Clare village, N. 72° E. (See Nos. 27 and 327.)
387. Further down Etchemin River, one or two miles below St. Clare, N. 72° E.
388. Half a mile south-east of Lake Etchemin, S. 48° W.
389. West of St. Odilon, four or five miles, N. 2° E., defacing south-east striæ in places.
390. In Watford on south-east side of Famine River, S. 8° E. and S. 2° W. Height, 1,050 feet.
391. In St. Thomas, between Des Plantes and Colway rivers, S. 38° E.
392. On road between St. Thomas and St. Jean, north of Colway River, N. 56° W.
393. At St. Odilon, N. 26° W. Height, 1,300 feet.
394. South-east of Culdaff P.O., N. 1° W. May be earliest striæ. Doubtful.
395. At Culdaff P.O., Cranbourne, N. 74° E.
396. On the road between the Townships of Ware and Watford, on the north side o Famine River, S. 12° W. and S. 7° W. Height, 1,600 feet.
97. Between Gilbert River gold mines and St. François, on hill slope, N. 27° W. and N. 10° W. Height, 800 feet.
398. North-west of Gilbert River gold mines, on east and west road, N. 27° W. and N. 17° W.

Striæ of local glaciers—*Con.*

399. East of Gilbert River, P.O., on hill slope facing Chaudière River, N. 17° W. and N. 12° W. Height, 800 feet.
400. Just south of Famine River, on road going east, S. 7° W.
401. Farther east, S. 8° E. and S. 5° E. Height about 1,500 feet.
402. Near St. Joseph, Beauce, N. 6° W.
403. Between St. Joseph and Colway River, in Chaudière valley, N. 16° W. and N. 2° W. These are superposed on the S. E. course.
404. At mouth of Colway River, N. 6° W. (*See* No. 318.)
405. On Kennebec road, four miles above Jersey Mills, N. 50° W. Height, 685 feet.
406. West side of Chaudière valley, above Devil Rapids, and at rear of first concession, N. 11° W.
407. On east side of Chaudière River, half a mile above Great Falls, N. 85° E. Imperfect.
408. On road between St. Henri and St. David concessions, Aubert Gallion, N. 3° E., or the reverse.
409. West of St. François, Beauce, N. 11° W., N. 6° W. and N. 1° W. Height, 800 or 900 feet.
410. East of Lambton, N. 14° E. Height, 1,400 feet.
411. East side of River Tierney, N. 6° W. Distinctly later than S.E. striation.
412. At south end of St. Francis Lake, N. 16° W.
413. At St. Romain church, N. 84° E.
414. North of Lake Weedon, nearly due W.
415. At Weedon village, N. 75° W. Height, 1,170 feet.
416. Near Broughton station, Quebec Central railway, N. 13° W., N. 2° E., and N. 11° E. Height, 1,110 feet.
417. In Ste. Marie, on road between St. Thomas and St. Jacques concessions, N. 32° E. Height, 1,220 feet.
418. On road from St. Sylvester to Ste. Marguerite, N. 47° E. Height, 1,300 feet.
419. At north end of Lake Williams, S. 76° W. and N. 84° W.
420. South-west of Ste. Julie, on road to Williams Lake, S. 63° E. Height, 950 to 1,000 feet. (*See* Nos. 63 and 64, also 248, 249 and 251.)
421. Still further south-west, N. 16° W. Light, numerous. Height, 1,100 feet.
422. From two to three miles west of St. Julie, along foothills, N. 21° W., N. 14° W., etc. Height, 700 feet.
423. On a large boss at the foot-hills, on road mentioned in No. 420, due N. to N. 25° W.
424. Five or six miles south-west of Wolfestown, N. 3° W. and due N. Height, 900 to 1,000 feet.
425. Another boss near the last shows the due N. course; also a S. 85° E. course.
426. Five or six miles south of South Ham, N. 70° E. and N. 65° E. Height about 925 feet.
427. North of Nicolet Lake, N. 75° E., S. 85° E. and N. 85° E.
428. Between South Ham and Marbleton, near the last place, N. 75° E. and S. 65° E. Numerous.
429. At Coaticook, on bank of river, N. 25° E.
430. Seven or eight miles east of Windsor Mills, on road to Wattopekah Lake, S. 15° W. and S. 5° W.
431. South-west of Shefford Mountain, two miles from West Shefford, S. 76° W.
432. East of St. Albans, Vermont, behind first ridge, S. 78° W. and S. 57° W.
433. Along Canadian Pacific railway, on second cross road east of Lake Megantic, N. 76° W.

Striæ supposed to have been caused by Floating or Sea-borne Ice at the close of the Glacial Period.

Striæ of floating, or sea-borne ice.

434. West of Bic, S. 50° W.
435. Near Trois Pistoles station, Intercolonial railway, S. 63° W. (short and apparently gouged out), S. 70° W., S. 84° W., N. 75° W., and E. to W., or the reverse. Height 100 to 110 feet.
436. Near Lévis, S. 65° W. Height (corrected) about 165 feet.
437. Near Mount Royal, Montreal, S. 68° W. and S. 60° W., etc., by Sir J. W. Dawson.
438. At St. Jerome, S. 32° W., S. 60° W., etc.
439. North of Lachute, E. and W. to N. 85° W.
440. At Soulanges canal, S. 50° W., and S. 40° W.
441. On shore of St. Lawrence at east end of Beauharnois canal, irregular curving or gouged striæ and grooves. E. to W., nearly.
442. On bank of St. Lawrence west of Valleyfield, S. 50° W. to S. 55° W.
443. Near Prescott, S. 50° W.
444. At Lansdowne, S. 55° W. and S. 52° W.
445. At Nevin's quarry, near Ogdensburg, N.Y., irregular light striæ, S. 76° W. and S. 65° W. These superposed on all the other striæ.
446. At Gananoque, S. 76° W., S. 56° W., etc.
447. West side of Wolfe Island, opposite Kingston, S. 76° W. and S. 60° W.
448. Near Perth, S. 87° W. to S. 52° W.

In addition to the above, numerous striæ, tentatively attributed to the agency of floating ice, have been observed in the bottom of the St. Lawrence valley between Métis and Lake Ontario. Usually their trend is closely parallel to that of the St. Lawrence River, although occasionally they diverge at a small angle from it. Whether all are due to ice of this kind alone has not yet been satisfactorily determined. Some of them may have been produced by land ice, *i.e.*, by the later Laurentide glacier.

Former lists of striæ.

A considerable number of striæ in the region under review are recorded in the Geology of Canada, 1863. In the Eastern Townships of Quebec, Dr. R. W. Ells made a large number of observations on striæ, lists of which are given in his reports on the geology of that region.*

The Appalachian Glacier, or System of Glaciers.

Observations respecting the Appalachian system of glaciers.

The oldest striation recorded in the foregoing list has been produced, as already stated, by ice which accumulated independently upon the North-east Appalachians in the early Pleistocene. As has been shown on a previous page the portion of Canadian territory lying to the south of the St. Lawrence River was at a higher level in the later Tertiary period than at present. At what height the Laurentian plateau then stood we have no data at hand to show. There are, however, some

* Annual Report, Geol. Surv. Can., vol. II. (N.S.), pp. 46-48 J. *Ibid.*, vol. III., 1887, p. 99 K.

considerations which tend to support the view that in the early Pleistocene this plateau was at least no higher than now, and may have been somewhat lower relative to the Appalachians. But whatever their elevation then was it seems pretty certain that the North-east Appalachians maintained approximately the same altitude in the early Pleistocene which they had in the later Tertiary. With this elevation the region was, therefore, very favourably situated, geographically and meteorologically, on the advent of glacial conditions, for the production of glaciers. The greater amount of precipitation there compared with that of the region to the north of the St. Lawrence, and its position with respect to the Atlantic Ocean, combined to render it as suitable a gathering-ground for ice as Greenland is at the present day. It is not unreasonable to assume, therefore, that ice began to form there independently, at an early stage of the Pleistocene period, probably before it gathered upon the Laurentian plateau. At all events the first Pleistocene ice does not appear to have advanced over Eastern Canada as a great flowing sheet from the north ; but doubtless formed originally at certain centres above the line of perpetual snow, and, spreading from these higher *névé* grounds was governed in its movements by the topographical features of the country. One of these centres was the North-east Appalachians, as already stated, and it would seem as if the ice had accumulated on these in sufficient thickness and extent to enable it to move down to the bottom of the St. Lawrence valley northward, eastward and southward, as well as in other directions, unchecked by ice from the Laurentides. Indeed, it is not at all unlikely, though the data are not yet at hand in full detail, that an interglacial period, *i.e.*, a period of ice-recession, supervened after the maximum extension of the Appalachian ice was reached and before the invasion of the Laurentide glacier took place, as evidenced by the weathering which the older striæ suffered before those of the Laurentide ice were superposed upon them, as well as by certain stratified interglacial deposits met with in a number of localities in the " Eastern Townships " of Quebec.

Difference in elevation.

But whether there was an interglacial period or not, if the relative altitudes of the North-east Appalachians and of the Laurentian plateau were even approximately the same as at the present day when glacial conditions came on in the early Pleistocene, ice would accumulate in a similar manner to that which has been supposed. Glaciers would gather first upon the Appalachians, accompanied or followed by a lesser and slower accumulation upon the southern and eastern Laurentides, and the ice of the latter would be long in attaining sufficient thickness to enable it to flow beyond the limits of the plateau.

Probable interglacial period.

The ice which generated on the North-east Appalachians had, as already stated, a radial flow from the central and higher portions of this mountain system northward, eastward and southward, and to all intermediate points of the compass. It was to this ice that the glaciation of that part of the province of Quebec lying to the east of the Etchemin River and the head-waters of the St. John is wholly due. The glaciation of New Brunswick and of the principal portion of New England at least, has also been largely effected by it, as was described in my last report.* It is to this ice-sheet or combination of ice-sheets that the writer gave the name of the *Appalachian glacier*, or *Appalachian system of glaciers.* † Movements of Appalachian ice.

In the "Eastern Townships" of Quebec, to the east of the Chaudière valley, the movements of the Appalachian ice are shown by heavy and distinct striation, especially on the south sides of ridges and bosses, the courses varying from north to east, though in a few places where it was influenced by the local topography the ice swung round and flowed to the west of north. On the watershed between the Chaudière and the head-waters of the St. Francis and Becancour rivers, the courses were, generally speaking, north to north twenty degrees east. In the district west of this watershed, however, the movements had a considerable westerly trend. The Appalachian ice in the valley of Wattopekah River flowed nearly westward, crossing the St. Francis River, and the striæ are traceable into Melbourne and beyond. Similar courses were observed in the vicinity of Scotstown and near Lake Megantic. Near the International boundary, to the south and south-west of this lake, the striæ produced by this ice seem to have been largely effaced by later ice, but the courses, generally, wherever observed, show a westerly trend. Further north, a westerly or north-westerly trend is especially noticeable at Shefford and Brome mountains, near Knowlton and Sweetsburg, and in other places on the north-west side of Sutton Mountain. On many of the exposures in the two ranges of mountains nearest the St. Lawrence, the (Sutton

* Annual Report, Geol. Surv. Can., vol. VII., (N.S.) part M.

† American Geologist, vol. VI., Nov. 1890, p. 324.

NOTE.—The latter name seems preferable, from the fact that the ice referred to cannot have formed one continuous sheet throughout Eastern Quebec, New Brunswick and the New England States. Although presumably originating in all these places at the same period, there were doubtless numerous local centres upon which it would first gather and from which it would spread until the maximum stage of accumulation was reached, much of the ice from these centres probably coalescing before then. Hence the name "Appalachian System of Glaciers" seems more applicable to the earlier Pleistocene ice of this region, when speaking of it as a whole.

and the Stoke Mountains,) evidences of the Appalachian ice having flowed across them and down upon the St. Lawrence plain were observed.

Probable thickness of Appalachian ice.

The striation produced by this system of glaciers in the "Eastern Townships" does not appear to have been as heavy, as a rule, as that produced by the ice which afterwards came from the Laurentian plateau. What its maximum thickness was on this slope we have no data at hand to show. On the south side of Cranbourne Mountain it must, however, have reached a thickness of from four to six hundred feet at least, to override the known glaciated portion of the summit. The apparent lightness of this striation is often the result of the weathering of the rock surface which took place since it was produced, and to its partial effacement by the later ice.

The Laurentide or Labradorian Ice.

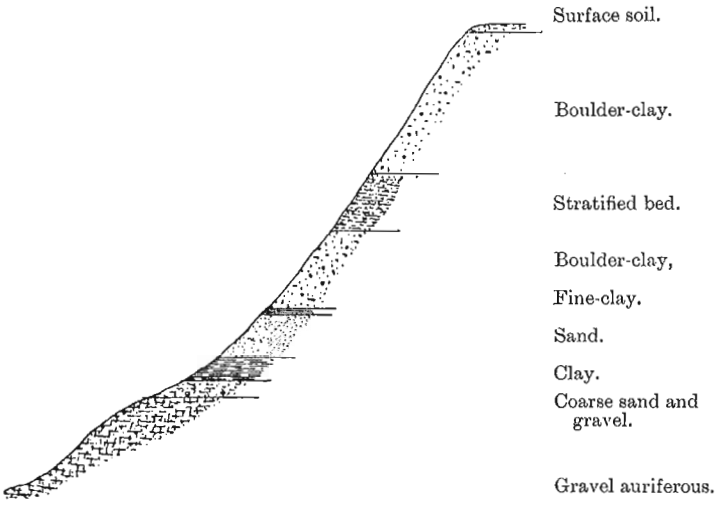
Laurentide ice, how originating and moving.

After the Appalachian ice had reached its maximum extension, and on the northern slope, had flowed down to the bottom of the St. Lawrence valley unchecked by contrary ice movements, a withdrawal or amelioration of glacial conditions seems to have supervened. What length of time elapsed then before the Laurentide ice advanced up the slope on the south-east side of the St. Lawrence River into the "Eastern Townships" region, or whether or not there was a coalescence of the two ice sheets, we are as yet unable definitely to decide. Although the St. Lawrence plain has been examined with some care from the lower end of the Island of Orleans to Lake Ontario, no glacial products containing interstratified beds have, so far, been found there. And from the fact that the Appalachian ice seems to have moved freely and without hindrance over the region striated by it, together with the fact that the Laurentide ice, when it subsequently advanced over the "Eastern Townships" region, moved southward and south-eastward, in a great number of places at least, as if it had received no check to its onward progress, it seems probable that the earlier ice had departed before the oncoming of that from the Laurentides. As already stated, the earlier or Appalachian striation is found in a number of places to have been weathered before that of the Laurentide ice was superposed on it. Further, the boulder-clay in a bipartite division occurs in certain localities in the "Eastern Townships" of Quebec. These facts seem to favour the view of an interglacial period between the two glaciations referred to. But the partial examination of the St. Lawrence valley and Laurentide slope carried out during the season of 1897, has not thrown any light on

the question, and further observations are required. The facts respecting the two-fold division of the boulder-clay are here presented:

Boulder-clay, with an intercalated bed, was observed in Riviére du Loup valley, a quarter of a mile above its junction with the Chaudière in Humphrey Pit, No. 2. Twofold division of boulder-clay.

Fig. 2.



SECTION NEAR MOUTH OF RIVIÈRE DU LOUP.

SCALE:—50 feet to 1 inch.

The series here shows, in descending order: (1) unstratified boulder-clay containing transported boulders, 37 to 38 feet; (2) an irregular stratified deposit, apparently lenticular, 15 feet, and (3) unstratified boulder-clay, more compact than the upper division, boulders not nearly so large, and as far as could be seen, chiefly from local sources, 20 feet.

At Le Rocher, in the Chaudière valley, the series seems to be as follows: (1) gray boulder-clay, unstratified: (2) a stratified band; (3) dark or bluish-gray boulder-clay of unknown thickness. Owing to the sliding down of the beds here exact measurements could not be made. Chaudière.

In a tunnel opened by Messrs. J. E. Hardman and Geo. Macduff, at St. George, Beauce county, the boulder-clay, which is here fifty or

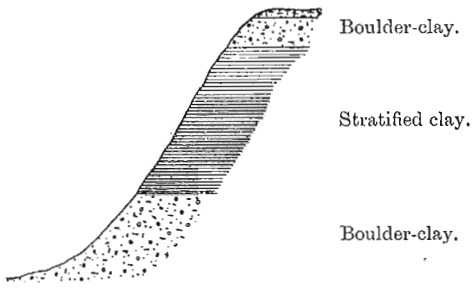
sixty feet in thickness, occurs also in a two-fold division, with an intercalated, stratified, band intervening. The precise thickness of the constituent parts was not ascertained here either.

St. Francis.

In the St. Francis River valley, three miles east of Angus station, Quebec Central railway, in a gravel cutting, a section of the boulder-clay likewise shows in descending series: (1) boulder-clay, unstratified, containing glaciated boulders, 12 to 15 feet; (2) stratified clay containing the same glaciated boulders as in the lower division, 3 to 5 feet, and (3) boulder-clay, unstratified, 20 feet or more exposed in the bank, but the bottom was not seen.

A quarter of a mile further east in another railway cutting, the following series occurs (descending order): (1) gravelly boulder-clay, containing glaciated boulders, 3 to 5 feet; (2) fine, unctuous, gray clay, distinctly stratified horizontally, 12 to 15 feet, and (3) boulder-clay, unstratified, thickness unknown.

Fig. 3.



SECTION SHOWING INTERSTRATIFIED CLAY IN BOULDER-CLAY, IN ST. FRANCIS RIVER VALLEY, 3 MILES EAST OF ANGUS STATION; QUEBEC CENTRAL RAILWAY.

SCALE :—20 feet 1 inch.

None but local boulders were observed in the boulder-clay and interstratified beds here. The Dudswell Mountains to the north-west seem to have shed off the Laurentide ice from this particular district, or checked the passage of Laurentian boulders into this valley.

Along the Clifton River, a branch of Eaton River, two or three miles south of Sawyerville, boulder-clay with a seam of stratified clay interbedded, was seen in two or three places.

The lower boulder-clay in the foregoing sections, so far as it has been possible to examine it, consists mainly of local materials, while the upper often contains Laurentian and other transported boulders from the north.

The Laurentide glacier having two extensions, an earlier and a later.

The Laurentide ice, the movements and striation of which have been traced in considerable detail in the provinces of Quebec and Ontario, seems to have consisted of two divisions or extensions, one earlier than the other. The first is named, provisionally, the *older Laurentide glacier*, the second the *later Laurentide glacier*. The older Laurentide glacier, the striæ of which have been observed throughout the St. Lawrence valley from the city of Quebec westward, and on the north side below that, had a general southward to south-eastward flow; the later Laurentide glacier flowed nearly at right angles to this or approximately south-westward. In many parts of the region, however, the older striæ have been much defaced, in some places entirely obliterated, by weathering and the action of the later ice, but wherever the two courses referred to are seen together, they can be distinguished.

Limits.

The eastern and south-eastern limits of the older Laurentide ice have been traced approximately and determined by the following criteria: (1) the striation and stossing on the north and north-west sides of the bosses, and (2) by the distribution of Laurentian boulders upon the region. Only in a few places does this ice seem to have crossed the International boundary. Near its eastern and south-eastern border it has had a tendency to spread out in places into separate tongues or lobes, extending in this way along valleys or upon the lower grounds. One of these lobes flowed along the valley of St. Charles River, north of the city of Quebec, partly following the depression between the Island of Orleans and the north bank of the St. Lawrence, overriding the eastern part of that island obliquely, the western and southern parts of which are unglaciated. Another tongue of this ice moved up the Chaudière valley and spread over and deployed upon the district to the east. Many of the peculiar easterly courses of striæ here, and to the east of the Etchemin River, are due to this swerving ice-flow. To the south of Cranbourne Mountain, a wide lobe or tongue of ice, apparently an extension of the Laurentide glacier, flowed across the divide between the Chaudière and St. John waters, 1200 or 1300 feet high, in an easterly direction for a considerable distance, but how far has not yet been definitely ascertained. From the fact that boulders, resembling Laurentian granite and gneiss, have been found in the St. John valley in northern Maine and north-western New Brunswick, however, it seems not improbable that the lobe referred to may have extended that far. Prof. C. H. Hitchcock records

striæ on the upper St. John, either following the valley, or caused by local glaciers flowing into it from either side, some of which probably, belong to the closing stage of the glacial period.* Other lobes or tongues of the early Laurentide glacier entered New England by the valleys and passes along the International boundary, especially at Norton Mills, Halls Stream, Lake Memphremagog and Lake Champlain. The striæ of the older Laurentide glacier are distinct on the latter basin, and as shown by the list of striæ on previous pages, were also observed in the vicinity of Ogdensburg and at other places in northern New York.

Movements of earlier Laurentide glacier.

The trend of movement of the early Laurentide ice is tolerably regular and direct from the mountains north of the St. Lawrence valley to the nearest range of mountains on the south-east side. Beyond this the movements were more or less affected by the topographical features, especially in the eastern portion of the "Eastern Townships" region. The range of mountains referred to, sometimes called the Sutton Mountain range presents a stoss side to the north-west almost continuously from the Chaudière valley, south-west to the Vermont boundary. In many places this Laurentide ice deployed on the slope, surged against the sides of the higher summits, and swung round sometimes to the north-east, and in other cases to the south-west, as it was affected by the contour of the surface. Some of the higher parts of the range have not been overridden by this ice, and on these we have a means of measuring its thickness or height above sea-level in this part of the region. Near Sts. Anges, or the north flank of the range to the east of the Chaudière valley, we have what appears to be the limit of the Laurentide ice in this direction at a height of 1025 feet. West of the Chaudière, on the north slope of this range, faint striæ due to this ice were observed at a height of 1050 to 1100 feet. Beyond this, towards St. Severin, they were not observed at 1325 feet.

Its thickness.

To the south-west, however, as stated, this Laurentide ice must have been thicker. Orford Mountain, at the north end of Lake Memphremagog, was found to be glaciated to a height of 1800 feet. The summit, 2,860 feet high, is bare rock, but no ice-action was observed upon it. Owls Head, on the west side of Lake Memphremagog, 2400 feet high, has not, according to Dr. Ells, been glaciated on the summit either. These and a number of other peaks in this range must have stood up above the surface of this ice-sheet as "nunataks" even during its maximum development.

*Agriculture and Geology of Maine, Second series, Sixth Annual Report, 1861 pp. 268-270.

Striæ with eastward trend.

Besides the easterly trend of the striæ of the early Laurentide ice observed near the city of Quebec and on the east side of the Chaudière valley, an easterly ice-flow is seen to be the prevailing one also on both sides of the International boundary as far west as the high grounds about the head-waters of Halls Stream and northern New Hampshire. These courses are especially noticeable about Lake Megantic and at Lowelltown, Maine, also to the north-east, where the old Kennebec road, which follows the south-east side of Rivière du Loup, crosses the International line. The source or centre from which this easterly-flowing ice received its momentum was probably in the elevated region between Lake Megantic and Norton Mills station, Grand Trunk railway. It may, indeed, have generated there independently.

A considerable area south-east of the Sutton Mountain axis on the watershed between the Chaudière and St. Francis waters, although glaciated by south-eastern flowing ice, the striæ of which are superposed on those of the Appalachian glacier, is without Laurentian boulders. This second striation may also have been caused by ice which gathered upon the axis referred to on the higher grounds of Wolfestown, Ireland, etc., during the period of invasion of the older Laurentide glacier.

Below the city of Quebec, or Lévis, the slopes on the south side of the St. Lawrence River present abrupt faces to the north, often with talus at the base. No Laurentian ice crossed this part of the valley.

Relations of Appalachian and Laurentian ice.

In studying the relations of the Appalachian and Laurentide glaciers, the question arises whether the altitudes of the mountains upon which they gathered changed during the time they were occupied with ice. It has been shown that the Appalachians stood from three to five hundred feet higher in the later Tertiary, and probably also in the early Pleistocene, than at present, while it was supposed that the Laurentides were approximately at their present level. After the Appalachian glaciers reached their maximum thickness and extent did a subsidence of the region occupied by them set in? This seems probable. The greater elevation of these mountains, compared with that of the Laurentidan plateau, may have been one reason why the ice of the latter did not reach its maximum stage as early as that of the north-east Appalachians. If a subsidence of the Appalachians began in the early Pleistocene, it was possibly accompanied by a correlative uplift of the ancient Laurentides. This subsidence would not only check the accumulation of ice upon the Appalachians, but would probably permit more moisture to reach the south-eastern and southern slopes

of the Laurentides. And this together with their supposed increasing altitude would be proximate causes for the increasing thickness of ice upon them, and for its spreading further southward and south-eastward than at the previous stage.

Probable thickness of early Laurentide glacier in the St. Lawrence valley.

If the early Laurentide glacier passed over those portions of the International boundary, which are upwards of 1800 or 2000 feet in height, this might be supposed to show that the divide was lower at that stage of the glacial period relative to the range nearest the St. Lawrence than at the present day. But no striæ strictly attributable to the Laurentide ice, nor any Laurentian boulders have yet been found at greater elevations near the boundary line than 1800 or 2000 feet. The occurrence of such a subsidence along the Appalachians followed by an uplift, would throw light on the origin of the high-level terraces and other stratified Pleistocene deposits occurring in the basins of St. Francis River and Lake Memphremagog.

From the foregoing facts and inferences it seems probable that the maximum stage of ice accumulation upon the Laurentides was later than that of the Appalachians, with perhaps as already inferred, an interglacial epoch intervening. But if this greater accumulation of ice upon the Laurentides was caused, either partially or wholly, by an increased recurrence of glacial conditions, following an interglacial epoch, such conditions would also affect the north-east Appalachians to some extent, and there would thus be another increase in the thickness of the ice upon the higher portions of these mountains at least. All that can be said at present is that this hypothesis is not incompatible with the facts as observed in the "Eastern Townships" and along the International boundary, but no positive evidence has been obtained on this point.

The Later Laurentide Glacier.

Movements of later Laurentide glacier.

Succeeding the older system of Laurentide ice-movements described, was the second or later Laurentide ice-flow, which has left the most distinct striation met with in this region, especially on the north side of the St. Lawrence River and of the Great Lakes. Whether this was wholly a system of land ice, or partly land ice and partly floating ice, is an open question. Within the limits of the St. Lawrence valley its trend was largely accordant with the direction of that valley, as will be seen from an examination of the list of striæ on a previous page. The striæ produced by it have been found superposed upon those of the earlier Laurentide glacier in a number of places, and are fresher and heavier. This would seem, in some instances, at least, to be the

result of weathering of the exposures after the first glaciation, and before the second was imposed on them. The later Laurentide striation has been found as far east as the hilly district to the west of the city of Quebec, and is traceable thence westward throughout the whole of the St. Lawrence valley into the Lake Ontario basin and beyond that. It has also been traced along the Ottawa valley to Mattawa, and seems from the observations of others to be common on the north-east side of Georgian Bay and Lake Huron. Evidences of this ice-flow are not, however, confined to the lower grounds, but have been observed on the more elevated tracts as well. From the fact therefore that it occurs over such a large area and with such a persistent trend, it would seem that it must have been produced by a separate body of ice from the older Laurentide glacier. Many of the bosses are stossed on both the north and east sides, and wherever this occurs the latter appears to have suffered most erosion. Other exposures exhibit light scratching, especially those met with in the lower parts of the St. Lawrence valley, as if effected by some body grating the more prominent parts of the surface only, and not by one moving slowly and accommodating itself to all the inequalities of the rock surface. Both land and floating ice seem, therefore, to have been concerned in the production of this system of striation.

Interglacial period.

In the study of the Laurentian glaciation two questions already referred to have arisen, namely: (1) whether there was a withdrawal of ice at the close of the earlier advance from the Laurentides into the St. Lawrence basin and an interglacial period between this and the advent of the later ice; and (2) whether a change of level occurred in the region during the interval between the maximum extension of the earlier and of the later Laurentide glaciers, and if so, how did it take place?

As regards the first of these questions we find that some of the bosses exhibit weathered surfaces after the earlier Laurentide glacier passed over them and before the second ice-flow occurred. No interglacial deposits have yet been discovered on the slope of the Laurentides, nor in the bottom of the St. Lawrence valley; but investigations are still in progress and final results have not been reached.

The second question may be answered in the affirmative. On a former page it has been stated that a correlative rise of the southern and south-eastern part of the Laurentian plateau possibly took place after the withdrawal of the Appalachian ice and simultaneously with the advance of the early Laurentide glacier. This movement, if it occurred, seems to have been general north-east

How changes of level occurred.

of the Great Lakes. For, in this region, wherever striæ produced by the older glacier have been observed, their trend is approximately the same, namely, southward. After this ice had advanced to its southern and south-eastern limits, there would appear to have been a withdrawal or amelioration of extreme glacial conditions, whether resulting in a complete departure of this ice from this region or not remains to be determined. A change of level, or tilting of the land, seems to have occurred about this time also, accompanied by a recrudescence of glacial conditions. The changed attitude of the region then brought about the south-west ice-flow so general in the St. Lawrence valley and to the north of the Great Lakes. Whether this tilting was due to a subsidence of the upper St. Lawrence basin only, or to a rise of the region towards the gulf, or to a correlative movement including both, cannot be fully determined. One thing seems to be certain, namely, that this subsidence attained regional dimensions towards the close of the glacial period, and continued until it reached that stage indicated by the highest shore-lines found on both sides of the St. Lawrence gulf and river, from Gaspé to the Great Lakes, as recorded on previous pages. Before the last withdrawal of ice from the region the whole St. Lawrence basin must have been at a low level relative to the sea; and whether the theory of land-ice or floating-ice, or both, be adopted to explain the phenomena, there appears to have been sufficient slope south-westward to cause a flow in that direction, as no flowage could take place with existing levels.

Extent of subsidence in St. Lawrence Valley.

The closing stages of the glacial period, therefore, found the St. Lawrence valley from the gulf to the Great Lakes, altogether below sea-level, to a depth of several hundred feet. A great south-westward driftage of floating ice appears to have marked the final episode of glacial conditions, during which the fossiliferous boulder-clay and the lower portion of the Leda clay were laid down. This is proved by the occurrence and character of marine fossils, and by the stoss side of ridges and hills, especially of the isolated trap hills in the St. Lawrence valley, *e. g.* Mount Royal, Montarville or Belœil Mountain, Mount St. Hilaire, Montagne de Rougemont, Yamaska, Johnson, Shefford and Brome mountains which are all abrupt on the north-east sides and slope gradually to the south-west, with terraces, ancient dunes and spits as high often as the limits of submergence, namely from 875 to 895 feet. The facts seem to point to strong currents flowing up the valley, doubtless heavily ice-laden during the winters, and impinging against these hills. The submergence continued until the Leda clay and Saxicava sands were deposited.

Towards the close of the deposition of the Saxicava sands, the grea differential upheaval was inaugurated, evidences of which are everywhere observable in the St. Lawrence basin and around the coasts of Eastern Canada. This rising of the land was apparently greatest towards the region of the Great Lakes; but was characterized by several inequalities or reductions in the uplift, these reduced uplifts being more pronounced in the districts where the greatest changes of level occurred, as has been shown on previous pages in discussing the evidence respecting the Pleistocene marine shore-lines, pp. 12-19.

Local Glaciers and Floating Ice.

Movements of local glaciers and floating ice.

The striæ supposed to have been produced by local glaciers and by floating or sea-borne ice in the St. Lawrence valley have been studied in some detail during the seasons of 1895–96–97, although much more has yet to be learned concerning them. The striation attributed to local glaciers is distinguished from that due to the Appalachian and Laurentide glaciers: (1) by its superposition on these, (2) by its more recent appearance, and (3) by its very irregular courses. As will be seen by an examination of the list of striæ, (pp. 26-39) they trend in all directions, the movements depending wholly upon the local topography. In a number of instances it is impossible to differentiate these from the irregular, veering striæ of the older sets, especially near their margins. In the "Eastern Townships" of Quebec the plateau-like character of the region, and the fact that the mountains and valleys lie transversely to the direction in which the Appalachian and early Laurentide glaciers flowed, show that these limited glaciers could only have a very local movement and would often be compelled to follow these valleys and pursue other erratic and apparently unaccountable courses.

Character of floating-ice striæ.

The striation attributable to floating ice has been traced from the lower St. Lawrence, at Bic, to Lake Ontario. It is usually confined to the valley proper, and is distinguishable from that produced by land ice by the manner in which the rock surfaces have been impressed by it. Where these are uneven, only the higher and more prominent portions have been scratched and worn, while the smaller hollows and inequalities have not been touched by the abrading agent. Bosses and short ridges extending parallel to the St. Lawrence River, of which there are many on the south side from Métis westward, have been much eroded and polished, and occasionally retain striæ produced by floating ice. The direction of movement was usually closely parallel to that of the valley. The striæ, although light, are in many places distinct, and are often found superposed on all other striæ, showing

Where noted.

them to be the latest. They have been noted at Bic, Trois Pistoles, Cacouna, Lévis, Ste. Julie, St. Jerome, Mount Royal, Soulanges canal, Valleyfield, Prescott, Gananoque, the Thousand Islands, Kingston, Perth, and other places.

There is no escape from the conclusion, therefore, that this latest striation is due to floating or sea-borne ice, and that the estuary or gulf which then occupied the valley must have found outlet somewhere to the south-west or west.

It is proper here to state that similar conclusions to these were long ago reached by Sir J. Wm. Dawson from his examination of the St. Lawrence valley.*

Summary of facts respecting glaciation.

Synoptic statement respecting glaciation of region.

Summing up the data in regard to the glacial geology of the St. Lawrence valley, we find that on the advent of the ice age in Eastern Canada the more favourable geographical and meteorological conditions for the development of glaciers in the Appalachian region compared with those which existed in the Laurentides, brought on a more rapid accumulation of ice upon the former. Contrary to the view held by many glacialists, the ice did not first gather upon the Laurentian plateau and then advance as a great wave-like sheet southward. It seems more reasonable to suppose that it would first accumulate upon certain centres above the line of perpetual snow as the climate became colder. The North-east Appalachians having been from three to five hundred feet higher in the early Pleistocene than at present, and receiving, evidently, a larger amount of precipitation than the Laurentides, would necessarily generate glaciers more rapidly than the latter. These flowed from the higher centre or centres in northern New England and south-eastern Quebec radially towards the periphery of the region lying to the south-east of the St. Lawrence river and gulf. On the northern slope this ice seems, in some places at least, to have reached the bottom of the St. Lawrence valley, apparently unchecked by ice coming from the Laurentides. Whether an interglacial warm period supervened at this stage is a question which cannot be answered. In the "Eastern Townships" of Quebec boulder-clay occurs in a two-fold division, denoting two separate ice movements. On a number of glaciated bosses here also, the striæ produced by the earlier or Appalachian ice have been weathered before those of the later Laurentide ice were superposed on them. Further observations are

* The Post-Pliocene Geology of Canada, Can. Nat., 1872.

required on the slope of the Laurentides and in the intervening valley, however, before this question can be settled.

Subsequent to the maximum stage of extension of the Appalachian ice, there would seem to have been changes of level in the Appalachian region, whether affecting the ancient Laurentides or not is problematical. The change was in the nature of a subsidence of the former, which possibly may have been accompanied by a correlative elevatory movement of the region to the north of the St. Lawrence River. Whether this last movement took place or not, the ice from the Laurentian plateau then advanced into the St. Lawrence valley west of Quebec, and up the slope on the south-east to, or nearly to the International boundary and crossing it in some places, *e.g.*, in the Lake Champlain valley, at Lake Memphremagog, Hall Stream, etc. The earlier Laurentide glacier was thicker here than to the north-east. At the Chaudière River, on the northern slope of the range nearest the St. Lawrence, evidence respecting its upper limit was found at a height of 1000 or 1050 feet above the sea, while on the slopes of Orford Mountain and Owls Head, at Lake Memphremagog, striation was observed up to an elevation of 1800 or 2000 feet. These and a number of other peaks in the range referred to, must have stood up as "nunataks," even at the maximum extension of this glacier. If, therefore, evidence can be found of this ice having overridden portions of the range along the International boundary, above 1800 to 2000 feet in height, the fact would tend to show that this range stood relatively lower during the invasion of the Laurentide glacier than at the present day. This view assists in explaining certain high-level terraces met with near the International boundary described on a later page, and also the deformation or rise of the gravel beds from north to south observed in the basins of Lake Memphremagog and along the Coaticook, Salmon, and other rivers.

Thickness of early Laurentide glacier.

After the early Laurentide glacier had partially or wholly retired from the region, and especially from the St. Lawrence valley, succeeding which there was probably an interglacial epoch, a re-advance of ice from the Laurentides again occurred. The changed attitude of the St. Lawrence basin, which had taken place meantime, however, caused the later ice to flow south-westward, instead of southward or south-eastward, following the general course of the valley towards the Great Lakes. The progressive differential subsidence of the region then begun appears to have continued until the ice had wholly disappeared from the region, and for some time afterwards, during the deposition of the Leda clay and Saxicava sands. The closing stage of the later

Later Laurentide glacier.

Floating ice.

Laurentide glacier was that which witnessed great numbers of local glaciers on both slopes of the St. Lawrence valley, and floating or sea-borne ice drifted south-westward. The deposition of the Saxicava sands brought the period of subsidence to a close, and the great Pleistocene upheaval followed.

Superficial Deposits of the St. Lawrence Valley, and especially of South-eastern Quebec.

Classification of superficial deposits.

The superficial deposits of the St. Lawrence valley may be closely paralleled with those of the Maritime Provinces, described in previous reports of the Geological Survey. The main divisions are Post-Tertiary and Tertiary (or Pre-glacial), the former being subdivided into the Recent and the Pleistocene. These are represented here both by marine and fresh-water beds. The Pleistocene is divisible into an earlier and later series of formations, to the latter of which belong the Saxicava sands and Leda clay and the deposits constituting the marine shore-lines and beaches of the St. Lawrence valley. This series also embraces the stratified sands, gravels and clays forming terraces in river-valleys, etc., and found overlying the boulder-clay. In south-eastern Quebec, in the auriferous districts these often contain gold. The earlier Pleistocene includes the boulder-clay or till, with moraines, eskers,* etc. It is slightly auriferous in some parts of the Chaudière valley.

Pre-glacial or Tertiary beds.

The Pre-glacial or Tertiary beds everywhere underlie the boulder-clay and other glacial products, and consist of (1) sedentary decayed rock-material, altogether in its original position, and (2) transported stratified deposits derived from this, in the form of coarse oxidized gravels, sands and clays which have been removed from their original position and worn by fluvial agencies. These are the true gold-bearing deposits of south-eastern Quebec.

Pre-glacial Decayed Rock-material, Sedentary and Transported.

Decay of rocks of the region.

The facts relating to the base-levelling and the denudation of the region have been given on previous pages of this report. The most potent cause of the general wearing down or reduction of the surface in pre-glacial ages was the subaerial decay of the rocks. Although it is not the purpose of the writer to enter into details regarding this in

*Eskers are long ridges of gravel and sand, sometimes with boulder-clay beneath. They are often called åsar, or osars, and formerly horse-backs, boar's backs or kames.

the present report, it may be stated that under the climatic conditions of this country the most important of the processes which bring about rock decay are: (1) the precipitation, and (2) the action of the carbonic acid of the atmosphere and of decaying vegetable matter. The changes of temperature which have such a wide range in these latitudes must also have exercised a direct influence in producing expansion and contraction of the rocks, producing joints, cracks, and crevices and opening them to the disintegrating agents referred to. The ever-recurring climatic oscillations of summer and winter have doubtless subjected the rock-surfaces to very great wear and waste. This erosion or decay resulted in the production of extensive sheets of decomposed rock in Eastern Canada in pre-glacial ages, and these and other waste products of rock decay must have accumulated to a great depth in the long time during which the surface was exposed to this process, so much so that they doubtless formed an almost universal mantle overspreading the country. Upon the elevations it would be more or less denuded even before the advent of the ice age. The removal of the decomposed materials from the higher grounds would tend to give the disintegrating forces renewed power from time to time to act directly upon the rocks, and consequently these higher grounds would suffer the most erosion and waste. Some of the products of rock decay in this region must be of an early date, geologically speaking. They have, however, been so shifted about, and have undergone so many changes, that they have probably altogether lost their original character. Those met with on the surface of the rocks, now beneath the boulder-clay, are most likely all of Tertiary age. No great quantities of sedentary material are found in any one place. In valleys and on declivities these materials have been acted upon by the usual atmospheric agencies before the glacial period, and in large part have undergone more or less transportation, and assortment and re-assortment, being laid down in stratified sand, gravel or clay beds, as the case may be, such as are now met with beneath the boulder-clay. The materials of the boulder-clay itself, and of the later stratified deposits overlying it, are derived from them.

Distribution of derived materials.

In the sections of the stratified, pre-glacial beds, given in the following pages, it will be observed that those in the bottom, whether lying upon the sedentary decomposed material or upon eroded rock-surfaces, are usually the coarsest. They consist of well water-worn gravels and sands which have probably undergone repeated removals and transportation by the rivers and streams, the finer earth and sand having apparently been carried further down stream from time to time. As might naturally be expected from this continual shifting in pre-glacial

Lower deposits containing gold.

time (and in certain local instances in the post-glacial period also), the materials now consist mainly of gravel and boulders, and in auriferous districts contain gold in the bottom. The loose alluvial gold of the Chaudière and Du Loup valleys, also of the Ditton and Dudswell districts of the "Eastern Townships" of Quebec, occurs in these gravels and sands. In the sedentary beds it is met with in a very scattered condition; but in the concentration which these underwent in the bottoms of river-valleys the loose nuggets and particles of gold have been brought together, and are now found on what formed reefs and shoals of these ancient river-courses. The gold generally lies on the rock-surface, or in the gravel next to it. Often it has worked its way down into the crevices, cracks and openings below that, especially in shaly or slaty strata with a high dip. The ancient, coarse, auriferous bottom gravels have either been laid down in portions of river-valleys which had a steep gradient, or else in comparatively shallow waters, or, perhaps, under both conditions—the finer material originally intermixed with them having been carried down to still lower levels.

Probable age of the pre-glacial beds.

The precise age of these pre-glacial auriferous deposits has not been determined, no fossils having yet been found in them; nevertheless, as stated, they appear to be largely Tertiary, and were possibly contemporaneous with the deposits found further west, on the north side of the Green Mountain range, at Brandon, Vermont, many years ago, which Lesquereux, on the evidence of fossil plants and leaves, referred to the Miocene.*

Changes of level.

Succeeding the deposition of the yellow, coarse, auriferous gravels above described, considerable changes of level seem to have taken place which affected the region in a remarkable degree, causing a change in the character of the beds subsequently deposited before the glacial period set in. The range of mountains known as the Sutton Mountain axis and its extension north-eastward, and also the parallel range of the Stoke mountains, seem to have sustained a greater differential uplift relative to other parts of the region, while the wide parallel basin between these and the range along the International line probably suffered a sag or correlative subsidence. In consequence of these movements the two westerly ranges (the Sutton and the Stoke mountains) must have again been vigorously attacked by denuding agencies, while the depression to the south-east became the receptacle of a large amount of sediment transported thither from the north-west, and also from the axial divide of the International boundary. Along with this transported material con-

* Geology of Canada, 1863, p. 929.

siderable quantities of alluvial gold were carried thither from the old pre-Cambrian ranges on either side, much of it in a very finely divided condition. From the varying character of the sediments deposited in some of the river-valleys at this stage, it is evident that the changes of level have been slow and of long duration. The beds graduate upwards from the gravels in the bottom to clay, then to sand, which is overlain by the boulder-clay. This seems to be the general succession of the pre-glacial beds throughout the region. The clay and sand deposits denote lacustrine conditions, or more probably quiet lake-like river expanses; but these have doubtless been merely local in certain parts of river-valleys. The materials of these gravels, clays and sands have been originally derived from the sedentary beds of decayed rock, or from portions of these which had undergone a previous assortment or shifting down stream. As regards the origin of these stratified, pre-glacial sediments, there seems to have been no general law, the character of the material as now observed depending upon the force of the currents, the volume of the rivers, etc. The coarse beds would probably be deposited in those portions of the river-channels where the currents were strongest, while in the deeper parts and where there were slack currents, the fine sand and clay would be laid down. From the fact that these fine sand and clay beds are well developed and widespread in the valleys of the Chaudière and Du Loup rivers, and occur at a nearly uniform level from the Devils Rapids in the former to the vicinity of St. Come, in the latter, it would appear that lacustrine conditions existed there for a considerable time in the later Tertiary, just previous to the advent of the ice age. Whether these conditions were due to a change in the climate caused by the approach of the glacial period is not known, but it seems probable. The gradual increase in thickness of the ice upon the North-east Appalachians would give a greater volume to the rivers during the summers while this ice was spreading from the higher grounds and before it reached the lower slopes and valleys. There would then be the waters from precipitation, plus those from the melting snow and ice of the mountain districts, throughout the summer months each season. For these reasons the rivers were probably larger than at present for a great part of the year. Hence the greater erosion and deposition of sediments, coarse and fine, during the later Tertiary or early Pleistocene, that is, if we draw the dividing line between those two periods at the stage when ice first began to gather upon the mountains, and before it descended into the valleys.

Character of sediments

How deposited.

Greater volume of rivers.

The causes of the great accumulation of beds of stratified gravel, clay and sand resting on the inferior auriferous deposits are, there-

Summary of conditions.

fore: (1) the differential movements which occurred in the region, producing lakes or lake-like expanses in the river-valleys in which the finer sediments were deposited; (2) the greater volume of the rivers from the approach of glacial conditions, and (3) the greater quantities of material at hand in the sedentary and stratified fluviatile beds of an earlier date.

Deposits of the glacial period.

Before giving a detailed description of the pre-glacial auriferous deposits and the mode of occurrence of the gold in them, it seems desirable to present the facts regarding the boulder-clay, and later formations, well developed in many of the river-valleys, after which the origin and distribution of the gold found in the alluviums can be more intelligently discussed.

Boulder-clay, Moraines, Boulders, etc.

Boulder-clay.

Generally speaking, it may be stated that the boulder-clay forms a mantle, of greater or less thickness, covering the rock surfaces and decayed rock-materials throughout the whole St. Lawrence valley, including the region here under description. Although, often irregular as to thickness, and thrown into mounds and short ridges, which may occasionally be classed as drumlins or drum-like hills,* it presents few structural peculiarities, and no true moraines or eskers have yet come under observation. The boulder-clay of the region was described many years ago by Logan and his officers †, and by Sir J. Wm. Dawson. ‡ For the most part it seems to have been the product of land-ice; but in the bottom of the St. Lawrence valley, especially at Rivière du Loup and below that, it has been found to contain arctic marine shells of Pleistocene age, and is apparently due to the action of floating, or sea-borne ice. Local glaciers both from the north and from the south have, however, debouched into the valley, to which portions of the boulder-clay found here are likewise to be attributed.

Drumlins.

Marine boulder-clay.

Except as regards the presence of marine shells in some of the deposits of boulder-clay met with in the St. Lawrence valley it exhibits no characters by which the marine can be distinguished from the land-ice product.

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*Drumlins are long oval-shaped ridges or mounds of boulder-clay, their longitudinal trend being usually parallel to the striation of the district in which they occur. They differ from moraines, inasmuch as they are not marginal formations; but are supposed to have accumulated beneath the ice.

† Geology of Canada, 1863, pp. 893-896. ‡ Notes on the Post-Pliocene Geology of Canada, pp. 6-16. The Ice Age in Canada, pp. 37-52.

Within this valley the boulder-clay has been subject to very great denudation by subaerial agencies, by the rivers, and by the sea during the submergence of the later Pleistocene.

Bi-partite division of boulder-clay.

As has been shown on previous pages the boulder-clay has a bi-partite division in the "Eastern Townships" of Quebec; but this has not been observed as yet in the bottom of the valley, nor on the Laurentide slope, although intercalated beds have been found in it at Toronto by Prof. A. P. Coleman.*

Very little gold has been met with in the boulder-clays of the auriferous districts of south-eastern Quebec. The reason of this seems to be that but little of the pre-glacial assorted gravels from the river-valleys have entered into their composition, the materials composing them having been gathered mainly from the higher grounds. It is, nevertheless, made up largely of decayed rock-material.

Although no moraines nor eskers have been found in the St. Lawrence plain; yet, on the slopes, short broken ridges composed of boulder-clay, or partly of boulder-clay and partly of coarse stratified and worn deposits, have been met with. Such of these as are distinguishable from drumlins and kames may be classed as moraines of recession.

Kames.

Kames or kame-like deposits† have been noted, some appearently of constructive origin, others due to denudational. The greater number belong to the Saxicava sand period, and are usually composed of stratified materials, although exhibiting hummocks, ridges, kettle-holes, etc.

Sources of boulders.

Dispersion.

The principal source of the boulders met with throughout the St. Lawrence valley has been the Laurentian plateau, but a number belong to the Appalachians and to the eruptive crystalline rocks of the region. The wide distribution of Laurentian boulders has been effected by several agencies, some of which are still in operation. The first dispersion of Laurentian boulders took place during the extension and southward movement of the early Laurentide glacier, the powerful action of which transported them across the St. Lawrence valley and to an elevation of 1800 or 2000 feet up the southern slope. Following this was the south-west ice-flow, or later Laurentide ice-movement, which likewise effected a great transportation of boulders towards the region of the Great Lakes, and across the International boundary.

*American Gelogist, vol. XIII., 1894, p. 85.

†Kames are short, irregular ridges or hummocks of gravel, sand, etc., the materials being much the same as those of eskers, or osars, Their mode of formation is, however, supposed to be different, but has not yet been clearly defined.

Agencies of dispersion.

And during the subsequent submergence of the St. Lawrence valley beneath the sea, floating ice played an important part in their distribution—a work which is still in progress in the estuary of the St. Lawrence and around the shores of Eastern Canada. Boulder pavements can be seen in the littoral similar to that illustrated by Sir J. Wm. Dawson, (frontispiece of *The Ice Age in Canada*). These are due to recent floating and coast ice. But the most unequivocal proofs of the carriage of boulders by floating ice were seen in certain non-glaciated areas, for example, on Orleans Island below the city of Quebec, where large angular boulders were found lying scattered about singly upon the surface of the Saxicava sands, evidently having been dropped there during the great submergence.

Transportation by rivers.

The agency of rivers, especially during floods, and also that of river-ice, in transporting and distributing boulders within the St. Lawrence basin, have likewise been very great. Remarkable examples of this can be seen along the tributaries flowing into the St. Lawrence from the Laurentian plateau. It is quite evident from the immense numbers of boulders derived from the Laurentides, which now cumber the valleys and strew the inner border of the plain, that other agencies besides that of Pleistocene land-ice have been influential in their production, and one of these seems to have been subaerial denudation, large quantities of decayed rock-material, including boulders, having been met with along the slopes and foot-hills of the Laurentian highlands. The Ottawa valley, for example, appears to have received an immense amount of this material, a portion of which, however, was doubtless accumulated during the invasion of the sea which followed the glacial period. Subsequently, as the region rose and emerged from beneath the gulf waters, denudation in the littoral and also in the river-valleys, attacked the deposits referred to, and great quantities of sand, gravel and clay must have been swept away and transported to lower levels, leaving the boulders exposed on the surface.

Boulders in the Ottawa valley.

Accumulation at Rigaud Mountain.

In large valleys, such as the Ottawa, Mattawa, etc., great accumulations of boulders occur at certain places. At Rigaud Mountain, on the south side of the Ottawa River, not far from its confluence with the St. Lawrence, we find remarkable boulder deposits. These were first described in the Geology of Canada (1863, page 896) where it is stated that "there is a series of plains destitute of vegetation and covered with boulders." One of these boulder plains on the north-west side of the mountain was examined. It is situated on a sloping terrace, about 300 yards long from south-west to north-east, which descends in overlapping or imbricated parts about 65 feet in that distance. Transversely it is nearly horizontal and about 140 yards wide.

The height above sea-level, at the upper part, is 550 feet. The terrace on which these boulders lie, extends along the base of a low escarpment to the south-east, and the boulders are entirely local, belonging to Rigaud Mountain. Not a single boulder from the Laurentian hills, directly opposite, was seen. The depth of the boulder-bed is not known, but holes from five to ten feet deep do not show the bottom. It is evidently deepest in the centre however, thinning out towards the margin where it becomes covered with a growth of bushes. Nearly all the boulders are less than a foot in diameter, only an occasional one reaching two or three feet. They are without any appearance of ice action, though well-rounded probably from attrition.

How produced.

These boulders are evidently the result of the subaerial wear and waste of Rigaud Mountain in pre-glacial times; but how they escaped the denudation of the Laurentian ice is an unsolved problem. During the marine invasion they must have been entirely submerged, and probably buried in superficial deposits. On the emergence of the land which followed, the finer and lighter materials seem to have been entirely swept away, leaving not a vestige of anything but the boulders. The imbricated or overlapping condition denotes powerful currents and perhaps the action of floating ice from the west. They had apparently reached their present stable situation just as this mountain was deserted by the later Pleistocene sea.

Boulder-beds at Hull.

At Hull, north of the city of Ottawa, another singular boulder-bed, or series of boulder-beds, came under observation. These occupy short ridges trending east and west, or to points between north-east and south-west. Some of the ridges are wide or flat-topped, and show two kinds of boulders on them, one series exhibiting a majority of Laurentian boulders and another of limestone slabs. The boulders in the first are probably secondary from moraines, as a number of them show signs of effaced glaciation. The ridges appear to have been formed at the meeting of the Gatineau and Ottawa waters. Those ridges containing most limestone boulders have probably been produced by the Ottawa River, and are partly due to accumulation and partly to subsequent denudation. A section of the deposits in one of these, in descending order exhibits the following:—(1) Sand and gravel, packed with boulders or limestone slabs, of all sizes, from five feet in diameter downwards. Most of these belong to the underlying Cambro-Silurian rocks, but some have been brought down the Ottawa apparently from outliers of these along the valley. Very few Laurentian boulders occur in these ridges. The limestone slabs lie mostly in an imbricated manner, as if acted upon by some powerful current or impact of floating

Section at Hull.

ice from the west. None of these slabs are glaciated. The thickness of this bed is from 5 to 10 feet. (2) Dark gray clay, (Leda clay), containing fragments of marine shells of Pleistocene age, resting on boulder-clay. Thickness from 12 to 15 inches. (3). Boulder-clay from 1 to 2 feet or more in thickness, lying apparently on the rock-surface.

Origin of the boulder ridges.

The ridges in which boulders of limestone predominate are on the south side, and those with the greater proportion of boulders of Laurentian origin lie on the north, or nearest the Gatineau River. But why there should be such a difference in the distribution of the boulders on ridges so near each other, for they are not more than from a hundred yards to a quarter of a mile apart, is not apparent. The rivers and river-ice may have been instrumental in this regard during the period of deundation or emergence of the valley from beneath the Pleistocene sea. The trend of the ridges is not in the direction of movement of the ice from the Laurentian highlands—in fact seems to be entirely independent of it. There is little doubt that many of the boulders in this locality have been brought thither by floating ice, both sea-borne and river ice, during the great submergence.

Boulder-bed at Mattawa.

But Rigaud Mountain and Hull are not the only places along the Ottawa valley where boulders occur in great abundance, indeed, they are common everywhere throughout its whole extent. Ascending the valley we find them plentiful at Deux Rivières, also at Klock, and thence to Mattawa, at the latter place the village being really built on a bed of boulders. A great accumulation of sand and gravel containing worn Laurentian boulders appears to have taken place at the junction of the Mattawa and Ottawa rivers, which has since been much denuded, leaving the boulders exposed on the surface. The succession of the Pleistocene deposits here, so far as observed, is as follows in descending order:—(1) Sand and gravel with great numbers of worn boulders, a few of which still show traces of glaciation; (2) a clay and silt bed, calcareous, fine-grained, stratified, bluish in colour, and without sand or gravel, 16 feet. The underlying deposit was not reached, but it is probably boulder-clay.

Between Mattawa and Lake Nipissing, the valley is plentifully strewn with boulders and occupied for the most part with water-laid deposits.

Conditions in Ottawa valley.

The boulders of the Ottawa valley seem, therefore, to have been brought to the surface by the denudation of the beds of which they formed a part, as the valley emerged from beneath the Pleistocene sea during the closing stage of the Saxicava sand period and these beds became subjected to erosion by the Ottawa River and its tributaries

The upper portion of the series now occupying this valley may, therefore, be partly marine and partly fluviatile. Whether or not the upper Great Lakes once found outlet by the Mattawa-Ottawa valley is a question which appears to the writer to require further detailed investigation.

Although glaciated boulders occur in the Leda clay and Saxicava sand, this must not be taken as necessarily evincing the action of glaciers at the time. Glaciated boulders are to be found in all the formations above the boulder-clay, even in the recent river alluviums and marine-beach sands. These have merely been transferred from one deposit to another by the existing agencies of transportation, and have all been derived originally from the boulder-clay.

Inland Gravel, Sand, Clay, River-beds and Lake-beds, stratified and often terraced.

High-level, stratified deposits.

The stratified deposits thus classified are those found on both slopes of the St. Lawrence valley above the level of the shore-lines described on former pages of this report. They consist of sand, gravel and clay, usually in the same succession as the known marine deposits, and rest upon the boulder-clay; but thus far no fossils have been detected in them. In the "Eastern Townships" of Quebec they are well developed in the wide interior valley between the north-east prolongation of the Sutton Mountain range and the International boundary. Commencing in the south-western part of this valley, we find, in the basin of Lake Memphremagog, thick deposits of stratified gravel, sand and clay. At the northern end these are terraced at an elevation of from 865 feet to 875 feet above the sea, or 180 feet above the lake surface. Near Georgeville, on the east side of the lake, ten miles from the north end, the height is from 915 to 920 feet. Further south, near Magoon Point, terraces and benches occur at about 950 feet above the sea-level. At Newport, Vermont, near the southern end of the lake, similar denuded terraces rise to an elevation of 990 feet, or about 295 feet above the lake surface. Whether these deposits rise in still higher terraces and banks along the Memphremagog basin to the south of Newport, has not been ascertained, but the facts, so far as observations have extended, show their gradual rise from north to south.

Lake Memphremagog.

Massawippi and Coaticook rivers.

In the valleys of the Massawippi River and its tributary the Coaticook, a similar rise from north to south, was observed in the terraces. At Sherbrooke and Lennoxville they occur at heights of 875 feet. Ascending the Coaticook River, terraces were noted at Coaticook station, Grand Trunk railway, on both sides of the valley at an eleva-

tion of 1235 feet. These are formed of stratified materials, underlain by boulder-clay. No barrier exists between these high-level terraces and the great St. Lawrence plain capable of holding in a body of water at that elevation. At Norton Mills, further up the Coaticook valley, terraces occur at about the same height as the railway station there, viz., 1361 feet; but as these are somewhat uneven, and are almost wholly surrounded by hills, they may be lacustrine or fluviatile.

St. Francis River.

Proceeding eastward from Sherbrooke and Lennoxville along the main valley of the St. Francis River, terraces were also found to ascend as far as the divide between these waters and those of the Chaudière River. In the vicinity of Sherbrooke they are, as stated above, about 875 feet high, while at Lake Aylmer they occur at an elevation of from 1050 to 1075 feet.

Chaudière River.

In the valley of the Chaudière River, terraces have been formed along both slopes of the valley, apparently under similar conditions to those of the terraces described above. The height of the upper terraces in the lower part of this valley, corresponds with that of the marine shore-lines observed on both sides of the mouth of the Chaudière River, namely, 750 or 760 feet. As we ascend the valley of this river and that of its principal tributary the Du Loup, the terraces also ascend and have been traced up to a height of 875 or 900 feet. But as the latter are in basins lying within the boundaries of the river-valleys, the conditions of their formation seem to have been such that they may be of either fluviatile, lacustrine or marine origin.

Sutton and Stoke mountains.

In the Sutton Mountain range and its extension north-eastward, also in the Stoke Mountains, valleys and depressions occur occupied with stratified gravel, sand and clay, usually terraced, at about the same elevation as the marine shore-lines on the north-west slope of the mountain. Examples of these can be seen in the Wattopekah valley, and between that and Danville, at Dudswell, etc.; and west of the St. Francis River in the direction of Kingsbury, and many other places.

General view of these deposits.

Taking a general view of the facts in connection with these stratified and terraced deposits it appears that those found in the mountains referred to and near the south-eastern side of the Stoke Mountains are practically at the same elevation as the marine shore-lines of the St. Lawrence valley at the nearest point. From the base of the Stoke Mountains and their continuation north-eastward, however, these stratified beds rise, in the drainage basin of the St. Francis River, towards the south, south-east, and east till they approach the base of the range along the International boundary. Were these beds laid down originally in a horizontal attitude, and subsequently eroded or

deformed? Are they fresh water or marine? No fossils have yet been found in them except near Little Magog Lake, lot 6, range 14 of Ascot, where Mr. A. Michel found "fragments of shells many years ago, too imperfect to be preserved, but from a drawing made on the spot" were supposed by Dr. T. Sterry Hunt, who records their occurrence, to be a species of Mya.* The height of the bed from which the shells were taken is about 690 feet.

Question of original attitudes.

As regards the question of the original attitude of these deposits the facts would seem to favour the view of a differential elevation, the axial divide of the International boundary having apparently undergone a greater uplift than the district nearer the St. Lawrence, as held by Prof. J. W. Spencer.† Whether this hypothesis has any foundation in fact, or not, it explains the deformed attitude of these stratified deposits. Moreover, it seems to receive support from the local conditions which affected the glaciation of the region, especially by the manner in which the early Laurentide glacier moved. This ice flowed apparently with tolerable regularity over what is now a surface with a considerable gradient, the slope being opposite to the direction of ice movement. It appears also, in a few instances at least, to have reached levels higher than its source, *i. e.*, allowing that the relative heights of the Laurentides and of the north-east Appalachians were even approximately the same in the glacial period as at present. Whether during this period the relative altitudes of the two principal mountain ranges, viz., the Sutton Mountain axis and its extension north-eastward, and the axial divide along the International boundary, were different from what they are at present, cannot be determined; but it seems possible the latter was lower for some time.

Mode of origin of these stratified deposits.

In reference to the origin of the deposits under discussion several hypotheses may be advanced.—(1) They may be marine; (2) they may have been deposited in so-called glacial lakes; (3) they may be of fluviatile and lacustrine origin; or (4) they may be partly due to subaerial base-levelling. Indeed, it is possible that two or more, perhaps, all these causes combined have contributed to bring about the present condition of things as regards these deposits. If existing levels obtained during the period of their deposition, the third hypothesis may be eliminated, except as regards terraces in river-valleys, as no barriers of sufficient height to hold in bodies of water at the level of the higher terraces lying outside of the river-valleys exist at the present day in the region between these and the St. Lawrence plain. But if the

*Report of Progress, Geol. Surv. Can., 1863–66, p. 87.

† Bull. Geol. Soc. Am., vol. VI., pp. 460-461.

region along the axis of the Nôtre Dame Mountains were lower relatively at that stage than at present, rivers and lakes may have been largely instrumental in their formation.

Hypothesis of glacially dammed waters.

The second hypothesis, namely, that of glacial dams and glacial lakes, does not seem capable of explaining the facts; indeed serious difficulties present themselves when an attempt is made to elucidate the phenomena by its aid, except as regards some local beds. Only a very brief statement concerning these objections can, however, be given here. In order that these terraced gravels, sands, etc., could be deposited in waters held in by an ice-dam, we must postulate the existence of a mass of ice occupying the bottom of the St. Lawrence valley, and covering the first range of hills to the south-east (the Sutton mountain range) at that stage of the Pleistocene, while the principal portion of the region to the south-east of the range, especially the wide valley in which the deposits referred to mainly lie, was free from it. It is at once evident that this hypothesis is not in accordance with the physical conditions governing the existence of glaciers. For is it not a matter of observation as well as of theory that glacier-ice first melts and disappears from the lower grounds and clings latest to the slopes and valleys among the hills and mountain ranges? It may be maintained, however, that ice would occupy the Sutton and Stoke mountain ranges after its disappearance from the St. Lawrence valley and from the interior valley between the ranges referred to. But even if this were the case, it does not seem probable that a barrier of ice on these mountains would hold in water for a sufficient length of time to allow the deposition of sediments in a supposed glacial lake or series of lakes, to a thickness or vertical range of two to four hundred feet. Such a barrier, if it ever existed could only have been of the most temporary character. The nature of the deposits, their similarity to the terraced beds on both sides of the Sutton Mountain range, and also to those in the central parts of that range, where an ice barrier on the theory of glacier-dams may be supposed to have existed, their comparatively uniform height from the marine shore-lines south-eastward through the mountains and into the portions of the interior valley nearest thereto, etc., preclude the theory of a continuous ice-dam occupying the Sutton and Stoke Mountain ranges and holding in a glacial lake to the south-east. Moreover, it appears doubtful whether deposits of the character met with here would be thrown down in hypothetical glacial lakes of the kind, in the sequence usually occurring in the terraces found in the region inside the Sutton Mountain range.

Probably of marine origin.

For these and other reasons which cannot be given in detail here, the marine hypothesis would seem to afford a more satisfactory expla-

nation than any other of all the stratified and terraced deposits met with up to a height equal to that of the marine shore-lines on the north and north-west side of the Sutton Mountain range, which varies from 750 feet near the mouth of the Chaudière River to 875 to 900 feet near the International boundary. And in regard to the stratified beds found at a higher level, the question of their origin will for the present be left open.

High-level stratified beds on north side of the St. Lawrence.

On the north side of the St. Lawrence River, similar beds occur in certain localities above the level of the marine shore-lines, but they are more uneven and detached than in the "Eastern Townships." They are generally found among the Laurentide hills, and are at different levels, and in many of the valleys they cannot be separated from those of fluviatile and lacustrine origin. The thick beds of stratified sand, in terraces, noted in many of these valleys necessarily suggest the question as to their source. The existing rocks of the region do not seem capable of furnishing such quantities of sand, and it would seem as if these beds must be due to Palæozoic strata of an arenaceous nature largely or wholly denuded.

Gold.

The deposits under discussion yield gold in the Chaudière and Rivière du Loup valleys, also at Dudswell, Ditton, etc. The gold is very fine, however, and very much scattered. Its occurrence in these gravels and sands is due to the assortment and re-assortment which the valley drift underwent since the glacial period. The rivers have cut down into the pre-glacial auriferous gravels and their superincumbent boulder-clay beds, transporting the whole to lower levels to form post-glacial terraces, etc. In this way the gold has been re-distributed in these post-glacial deposits. Some of these terraces and valley drifts have again been eroded, and undergone renewed transportation. Doubtless some of the fine gold found in the present river-beds is from these sources.

Leda Clay, Saxicava Sand and Marine Shore-lines of the St. Lawrence Valley.

Leda clay and Saxicava sands.

The Leda clay and Saxicava sands of the St. Lawrence valley were first described in a general way by Logan and his colleagues,* and the nomenclature now in use regarding them was then employed for the first time by Sir J. William Dawson. Since that early date the last-mentioned author has more fully worked out the Pleistocene geology

* Geology of Canada, 1863, pp. 915-928.

of the region, and published detailed results, with extensive lists of fossils, etc.* The extent and character of these deposits are now pretty well known, both on the north-west and south-east sides of the St. Lawrence valley, where they are delimited by the marine shore-lines described in former pages of this report; but to the south-west their limits have not been traced, and whether they reach as far inland as the valleys of the Great Lakes or not is a debatable question.

Character of materials.

The materials constituting the Leda clay and Saxicava sands are fully described in the publications referred to above. The former not infrequently consists of coarse clay with pebbles and some boulders in the bottom, graduating into a dark or blue clay near the summit, usually containing marine shells. The Saxicava sands are generally composed of fine, stratified—in some places blown—sands, of variable amount, sometimes reaching a thickness of one or two hundred feet. Occasionally they contain gravel towards the summit. In many places they are found resting directly upon the Leda clay, but elsewhere on boulder-clay or upon the rock surface. They are very seldom fossiliferous except at the base, or at their contact with the underlying Leda clay, and contain only shallow-water species.

Irregular surfaces.

The surface of the Saxicava sand beds is not always flat, being occasionally hummocky, or formed into kame-like ridges and mounds, with hollows intervening which may be called kettle-holes. The latter often contain ponds or lakelets. These topographical features appear to be the result of two causes, first, that which may be termed constructive—and which may have imposed certain forms upon them during the deposition of the materials; and secondly, destructive, that is, due to subsequent erosion. Examples of this kind of surface are more frequent near the borders of the marine area, but were also noted at lower levels.

Materials of shore-lines.

The materials of the Pleistocene marine shore-lines of the St. Lawrence valley seem to be chiefly Saxicava sands; but gravel, and occasionally bands of clay enter into their composition. Most of the shore-lines are formed of built terraces. In a few places, however, they have been produced by wave-cutting in boulder-clay. The stratified clay in these shore-lines appears to be the equivalent of the Leda clay, although hitherto no fossils have been found in it. Ancient beaches of gravel and sand, behind which a lagoon or shallow channel lay have also been met with. These do not at all places indicate high-water mark, however, being found at different levels.

*Notes on the Post-Pliocene Geology of Canada, 1872; The Ice Age of Canada, 1893.

The heights at which Pleistocene marine fossils have been found in the St. Lawrence valley may be here noted. The data are mainly compiled from the publications of Sir J. Wm. Dawson and from the reports of the Geological Survey. Elevations at which marine fossils occur.

Between Kenogami and Belle Rivière, near Saguenay, 400 feet. (Dawson.)

At Murray Bay and Les Eboulements, 600 feet. (Dawson.)

North of St. Ambroise station on the old line of the Quebec and Lake St. John railway, 575 feet, with terraces of Saxicava sand, 600 to 615 feet high. (Low).

At Mount Royal, Montreal, 560 feet, with distinct beach at 625 feet. (Dawson, Adams, de Geer).

At Magog Lake, 690 feet? (*supra*).

Near Smiths Falls, remains of a whale, 440 feet. (Dawson and others).

In Lake Champlain valley, 400 feet, with marine terraces up to 480 feet. (Baldwin).

At Fort Coulonge Lake, 365 feet.

Throughout the counties of Renfrew, Lanark, Carleton and Leeds, Ontario, 425 feet.

The above are the highest known fossiliferous beds; but lower beds are numerous throughout the St. Lawrence valley, and occur at various altitudes.

Formations of the Recent Period.

The peat beds and other formations belonging to this period are well developed in some parts of the St. Lawrence valley; but only those of fluviatile origin can be noted here. These consist of sand, gravels and clay along the river-valleys, the two first forming "bars," which in auriferous districts contain "colours" of gold. The gold found in the river bottom at the Devils Rapids, on the Chaudière and at Great Falls, also that met with in the present channel of Riviere du Loup near its mouth, appears to have been brought thither in the recent period. Beds of the recent period.

Extensive boulder-beds which belong to this period, occur in the littoral along the lower St. Lawrence below Quebec having been formed by river and coast ice. They have been described by Sir J. Wm. Dawson. *

*See frontispiece in The Ice Age in Canada.

THE GOLD-BEARING REGION OF SOUTH-EASTERN QUEBEC.

Gold-bearing region of south-eastern Quebec.

The gold-bearing region proper of south-eastern Quebec, as at present known, extends from Memphremagog Lake on the west, to the Etchemin River and Township of Ware on the north-east, and from the crystalline range of mountains nearest the St. Lawrence (the Sutton Mountain anticline) south-eastward to the International boundary. In an early report of the Geological Survey * the region was estimated to comprise from three to four thousand square miles; but in a considerable part of this area gold does not actually occur, while in several places within these limits it is in such an exceedingly fine state of division and is so sparsely discriminated as to be of little or no economic importance. The non-auriferous districts are principally in the Cambro-Silurian basins lying between the ranges of mountains above referred to.

Original source of the gold.

The topographical features of the region, as outlined on a preceding page, seem to have had an important influence on the distribution of the gold. The examinations here reported on show that the original source of the precious metal was in the oldest rocks of the "Eastern Townships," namely the pre-Cambrian or Huronian (?) of the three mountain ranges which traverse it. The Cambrian and Cambro-Silurian rocks are probably composed largely of materials derived from the pre-Cambrian in their disintegration and waste, and the gold they contain, as well as that met with in the alluviums derived from them probably owes its origin likewise to the same source. Concentrating processes have been in operation ever since. During the formation of the Cambrian and Cambro-Silurian rocks there may have been some mechanical concentration of the gold in these, as the sediments which were derived from the pre-Cambrian in Cambrian and Cambro-Silurian times would naturally contain it in a fine state of division. It is difficult except on this supposition to account for its presence in some areas and its scarcity or absence in others. But the chief concentration seems to have been in some of the quartz veins at a later stage in areas of eruptive diorites and other intrusive rocks, and still later in the alluviums of the river-valleys during the wear and waste of the land surface.

Literature pertaining to gold-mining in south-eastern Quebec.

In the following account of gold mining operations in the "Eastern Townships" and adjacent portions of the province of Quebec, free use has been made of all previous publications relating to the subject. The literature pertaining to it is somewhat voluminous and extends

* Report of Progress, Geol. Surv. Can., 1850-51, p. 6.

over a period of more than sixty years, but much of it is now out of print and inaccessible to the public, hence quotations and references are frequently given. Considerable new material, is however, added, for which I am indebted to a number of gentlemen whose names are given below. The reports and publications which have principally been made use of are as follows :—

Sir W. E. Logan and Dr. T. Sterry Hunt, 1851-52.—Report of Progress, Geol. Surv. Can.

F. T. Judah, Clerk of Crown Lands, 1863.—Report of the Quebec Government, on the Gold Mines of the Chaudière.

Sir W. E. Logan, Geology of Canada, 1863.

Report of the Select Committee appointed by the Quebec Government to ascertain the value of the Chaudière gold areas, 1865.

Sir W. E. Logan and Dr. T. Sterry Hunt, 1865-66,—Report of Progress, Geol. Surv. Can.

Mr. A. Michel, 1865-66.—Report on the Gold Region of Lower Canada, in Report of Progress, Geol. Surv. Can., 1865-66.

Dr. A. R. C. Selwyn, C.M.G., 1870-71.—Notes and Observations on the Gold Fields of Quebec and Nova Scotia ; Report of Progress, Geol. Surv. Can., 1870-71.

Mr. W. Chapman, 1881.—Gold Mines of Beauce.

Dr. A. R. C. Selwyn, C.M.G., (Mr. A. Webster) 1880-81-82.—Notes on the Geology of the South-eastern Portion of the Province of Quebec. Report of Progress, 1880-81-82.

Prof. E. J. Chapman, 1886.—Report on the property of the St. Onge Gold Mining Company.

Dr. R. W. Ells, 1887.—Report on the Geology of a Portion of the Eastern Townships. Annual Report, Geol. Surv. Can., 1886. Part I.

Dr. R. W. Ells, 1888.—Second Report on the Geology of a Portion of the Province of Quebec. Annual Report, Geol. Surv. Can., 1888. Part K.

Dr. R. W. Ells, 1888-90.—Report on the Mineral Resources of the province of Quebec. Annual Report, Geol. Surv. Can., Vol. VI., 1888-89. Part K.

Prof. H. Y. Hind.—Unpublished reports on the auriferous deposits, etc., of the Chaudière and Du Loup valleys.

Mr. J. Obalski, Inspector of Mines for the province of Quebec. Reports of the Commissioner of Crown Lands, and Reports of the Commissioner of Colonization and Mines for the province.

Besides the information derived from the above-mentioned sources, the writer begs to acknowledge his indebtedness to a number of miners

Other sources of information.

and others who have wrought in the gold mines referred to or been connected therewith. Mr. Wm. P. Lockwood of Montreal furnished Mr. E. D. Ingall of the Division of Mineral Statistics and Mines of this Survey and the writer with a large amount of valuable data, accumulated during his extended operations in the Gilbert River valley and freely placed his notes, maps and plans at our disposal. Tracings of the surveys of the Gilbert valley made by his son, Mr. Arthur Lockwood and of the elevation and gradient of the valley referred to as levelled by him have also been obtained. These data together with the position and depth of a number of shafts sunk by Mr. Lockwood, have enabled us to determine the site of the old pre-glacial river and ascertain its gradient in the auriferous district approximately at least.

The gentlemen named below have likewise kindly supplied me with valuable information respecting gold mining operations in the particular districts in which they have worked.

Mr. Samuel Byrne of the American Gold Mining Company has given me an account of the operations carried on in the Gilbert River valley by him. Mr. Louis Gendreau, whose extensive knowledge of gold mining matters in south-eastern Quebec has afforded me with a large number of facts collected during his lengthened experience in Beauce, Ditton, etc. To the following gentlemen I am also under obligations for assistance courteously given and for various acts of kindness :—J. E. Hardman, Capt. Geo. Macduff, Peter Brown of McArthur Bros. (Ltd.), P. Angers, Notary, St. François, Beauce, H. C. Donnell, Chas. Rodrigue and T. C. Osgood of the Rodrigue Mining Company, Dudswell; F. E. Harrison of Harrison Brook, John Blue, Eustis Copper Mines, E. B. Haycock, Ottawa, Dr. R. W. Heneker, Sherbrooke and others.

History of Gold Mining in South-eastern Quebec.

Gilbert River.

History of gold mining in the Gilbert River valley.

Gold is reported to have been first discovered about the year 1823 or 1824, by a woman near the mouth of the Touffe des Pins, or Gilbert River, an affluent of the Chaudière. This statement was presented in a paper read before the Literary and Historical Society of Quebec, in 1863, by the Rev. James Douglas, entitled, "On the Gold Fields of Canada," but little or no attention was paid to it. In 1834, a young girl named Clothilde Gilbert, who afterwards became the wife of Oliver Morin, of St. George, Beauce, "taking a horse to water near

the same spot, perceived as she supposed, a stone glittering in the bed of the river, and thinking it curious enough to preserve, took it home with her." This was the discovery reported by Gen. Baddeley in 1835.* The piece he described was said to weigh 10·63 grains; but he was unaware that this piece had been cut off a larger nugget, the weight of which was 1056 grains. Mr. Leger Gilbert, father of the girl who found the nugget, sold it for $40, a sum apparently much below its value. Encouraged by this discovery he made further search, and on several occasions found more gold, but not of any considerable amount. The DeLery family, owners of the seigniory of Rigaud-Vaudreuil, in consequence of these discoveries and of the indications of gold which the district afforded, applied for and obtained letters patent from the Crown, dated September 18th, 1846, giving them exclusive mining privileges for the precious metals *for ever*, within the limits of the seigniory in question, subject to certain conditions, among others the payment of a royalty of ten per cent on the gross produce after melting (smelting) of the ores in furnaces, which conditions it appears were never complied with. No royalty was paid to the Government, as no gold was produced in this way. The seigniory comprises an extent of three leagues (9 miles) along the Chaudière River, and a depth of two leagues (6 miles) on each side. Explorations were carried on by Mr. C. DeLery, and an examination and report on the value of the property made by J. P. Cunningham. In 1847, the Chaudière Mining Company was formed, to which Mr. DeLery leased all his rights in consideration of receiving an improved royalty, amounting for the first portion of the leasehold term to twenty-five per cent, and for the latter portion to thirty-three and a half per cent, but this arrangement not being found satisfactory, the improved royalty was bought up for a fixed sum. This company also acquired the right of working in the fief La Barbe, through which the Famine River flows.

Rigaud Vaudreuil seigniory.

The Chaudière Mining Company began operations on the Touffe des Pins, or Gilbert River, at a point about one mile from its mouth, where they worked for several years, but in such a reckless and unscientific way that expenses were not met. They also operated on the Des Plantes River in 1847, and several rich deposits were struck. At one of these, just above the first fall, from three to ten ounces of gold were obtained daily for several weeks. Dry digging from the gravel hills was also tried, but though gold was found in considerable quantity the appliances for washing and collecting were so poor that the attempt was abandoned.

Early operations.

Of the two reports written by Mr. Cunningham, the first, in 1847, was addressed to the proprietors of the seigniory of Rigaud-Vau-

Mr. Cunningham's reports.

*Am. Journ. Sci. (1st Ser.), vol. XXVIII., p. 112.

dreuil, Messrs. Charles and Alexander DeLery, and related chiefly to the character of the rocks as compared with that of the mining areas of Carolina and Virginia, U.S. He, however, refers to the finding of nuggets of gold weighing from thirty to fifty pennyweights, which had their angles rounded, but which he concluded had their source in close proximity to the spot in which they were found.

Chaudière Mining Company.

The second report was addressed to the Chaudière Mining Company, in 1850, in which the results of two experiments in working the gravels of the Gilbert are given. The first of these extended from the 24th of June to the 6th of August. The work consisted in digging several pits or trenches, the largest of which was 150 feet in length with an average width of twelve feet. In these, the gravel directly overlying the slates was found to be auriferous, while an overlying stratum, directly beneath the soil, was also found to carry gold in places. Much difficulty was experienced from the water, and the work was at last abandoned for another portion of the deposit. The amount of gold obtained from the first trial is said to have been one hundred pennyweights.

The second trial lasted from the 8th of August to the 20th of September. The course of the stream was changed for a short distance, and the gold was collected from the old bed, amounting in all to 940 pennyweights, which, it is stated, was the result of about two men's labour for that time. Further explorations of a similar character were made subsequently, and good results obtained, the examination of a quartz vein at this place, which was stripped for 150 feet, showing several fine pieces, one of which weighed twenty-five pennyweights. In the construction of a canal and dam for the purpose of working a second portion of the river-channel, one man is reported, in the six weeks in which the work continued, to have taken out, by panning, 380 pennyweights of gold. Fine pieces of gold are reported to have been taken at this place along the course of a fissure caused by the decomposition of a vein of quartz, while the loose gravel lying upon the slates yielded, upon several trials, more than three grains of gold per bushel of 100 lbs.

Dr. Douglas's operations.

In 1851 Messrs. DeLery leased, subject to a percentage, their mining rights over the whole seigniory to Dr. James Douglas and others of Quebec. Dr. Douglas eventually became solely interested in this lease, and under it mining operations were carried on by him and others, under sub-leases, at different times and at different places. Dr. Douglas's lease expired on September 1st, 1864, and was transferred, in consideration of the sum of $3,000, in July of that year to Messrs.

Hans Hagan & Company, who began mining operations on the Gilbert. This company likewise obtained from the Messrs. DeLery a further similar lease of fifteen years, for which they agreed to pay $8,000, $2,000 of which were given in cash. Both of these leases were given by the DeLerys expressly without any guarantee on their part.

Operations of Poulin Bros.

The success which attended gold mining operations on the Gilbert River at this time commenced in the autumn of 1863. It appears that one of three brothers named Poulin, who had been mining with more or less success for some time, discovered rich gravels on lots 19, 20, 21 and 22, DeLery concession, Gilbert River, and being joined by the brothers and others they commenced operations and a large amount of gold was taken out. The north branch of the Gilbert was therefore set apart as a mining district for a distance of a mile above the forks and a rush of miners set in for that locality. Two spots were selected for work—the upper, on land owned by a man named Viellieux, lot 20, DeLery concession, the other about half a mile further down on this branch on the southern half of lot 19, owned by Rodrigue. Upon these claims, but more especially on the upper, a considerable number of people wrought in 1863 and obtained in the aggregate, a large quantity of gold. The largest piece reported, and sold for $22, was said to have been found by a woman named Parie. Among other instances regarding the discovery of gold given by Dr. Douglas was that of a party of six, including two of the Poulins, who acknowledged to finding fifteen ounces in three days, and another party of the same number found six ounces and a half in two days. These miners were all working without licenses, and upon the facts being reported to Mr. DeLery, bailiffs were sent and the crowd of workers driven off. On Rodrigue's property, lot 19 De-Lery, according to affidavit given in Mr. Chapman's pamphlet, by the Poulin brothers before Mr. Belanger, N.P., of St. François, in 1880, three of them with Rodrigue washed in tin pans, from the alluviums in one day, seventy-two ounces of gold. This party is said to have admitted finding ten pounds of gold in eleven days' work with tin pans only. The largest piece found at this place during the season was sold for $200. The beds on Rodrigue's lot were as follows, descending order,—vegetable mould and earth, two or three feet; gravel and sand; and lastly a thickness of two or three feet of rock surface? (rotten rock) consisting of slate down to the bed-rock, which is found at about eight or ten feet from the surface. It was in the gravel and sand and embedded in the slate that the gold was found in small pieces and nuggets. After exhausting the bed of the stream they washed the gravel from the banks in a sluice, and are reported to have obtained

Rodrigue's property.

a pound of gold one day, and ten ounces another. Rodrigue, working with one man only, is said to have panned out in one day two ounces, two pennyweights and eight grains, valued at thirty-eight dollars. The earnings of this party for twenty days in each month for four months of the summer, averaged sixteen dollars a day per man. This success was not general, however, and many only cleared their expenses. The bed of the stream, at this place, is composed of a dark fissile slate, and the banks are made up of alternations of sand and gravel.

DeLery Gold Mining Company.

In 1864, the DeLery Gold Mining Company was formed to work the quartz veins as well as the alluviums in Rigaud-Vaudreuil, under a lease of thirty years from the DeLery family, who granted the new company all the rights originally possessed by the owners of the seigniory. This company erected extensive works, comprising a crusher, at the place known as the Devils Rapids on the Chaudière River, a short distance below the mouth of the Gilbert; and the claims and operations of the company prevented the explorations of private individuals over the seigniory or tract covered by their letters patent for some years. Quartz veins were found at the Devils Rapids, and in the Gilbert valley, some of which were reported to have yielded gold on assay. The crusher, however, proved to be an entire failure. In 1865 an American company called "The Reciprocity" organized by Col. Rankin leased from the DeLery Gold Mining Company the mining rights over several lots along the Gilbert. A wooden flume 1800 feet long with a dam at its head, was constructed to supply water for washing the gravels on the North Branch. This, although supposed to be well and strongly built, was not able to withstand the heavy freshets which occur in these streams, and the greater part of it was swept away before it was in use long, and consequently it became a total loss. This company, after the destruction of their flume, washed in a trench dug along the river bed from which the water had been diverted, and took out some $2,500 in gold, the whole expenses, including the dam and flume being from twelve to fifteen thousand dollars. The DeLery Gold Mining Company then granted permits to a few miners to work on the celebrated lots, 16, 17, 18, 19, 20, 21 and 22, DeLery concession, North Branch Gilbert River, and during the summer of 1866 Mr. Henry Powers, with several miners, drove a tunnel across lots 15, 16 and 17. A large amount of gold is reported to have been obtained along this tunnel, for the use of which each company that operated there paid to Mr. Powers two dollars per day. In the official documents of the time it is stated that gold to the value of $142,581 was realised, and that two nuggets, one found by

Mr. Kilgour on lot 17 weighed 52 ounces 11 dwts. 6 grains, and the other by Mr. Arch. McDonald, was worth $821.56. In the following summer Mr. John McRae on a claim of seventy-five square feet on lot 15, DeLery concession, is said to have realized the sum of $17,000. The Kilgour and other nuggets.

From 1863 to 1866, Mr. A. Michel, who had previously managed the practical working of gold mines in South America, was employed by Sir W. E. Logan, Director of the Geological Survey of Canada, to study the auriferous region in question, relative to the distribution of gold in the gravels and clays, to examine such gold-bearing quartz veins as had been opened up by mining excavations, to collect specimens of the same for analysis, and to give such an account of the gold mining operations of the preceding two or three years as his opportunities might enable him to furnish. Mr. Michel submitted his report in 1866. Examination and report of A. Michel.

As regards the alluvial gold, Mr. Michel prepared a detailed statement of the workings on Gilbert River, St. Francois, Beauce, where a small area of considerable richness was found, but at that time limited on all sides by much poorer alluviums. Numerous exploratory pits were sunk by him in the vicinity of these rich workings, with the view of determining their extent, and similar trials were made by him in the other more western districts, namely, at Lambton, near Lake St. Francis, at Ascot, Orford, etc. A fact of geological significance established by these various examinations, was that the rich auriferous gravels found reposing on the bed-rock, were covered in many places by a coarse clay corresponding to the unstratified boulder-clay of the St. Lawrence valley. This clay, as appeared from the testimony of the miners, and also from experiments made by washing considerable quantities of it in the three areas examined by Mr. Michel, is destitute of gold, but is in some parts overlain by a stratum of auriferous gravel, less rich, however, than that below. This boulder-clay was observed resting on auriferous gravel on the Gilbert, and likewise on lots 2 and 3, range 13 of Ascot. In many places, however, it reposes directly on the bed-rock with an intervening stratum of auriferous gravel, while in some places, as at Lambton, near Lake St. Francis, pits were sunk 30 feet in the boulder-clay without reaching its base. These facts were taken as showing that the original gold-bearing drift was of considerable antiquity, and that both it and the overlying boulder-clay had suffered local denudation which not improbably gave rise to the auriferous gravels found in some places overlying the latter. In one locality, lot 6, range 14, of Ascot, what was supposed to be the shell of a species of *Mya* was found in the boulder-clay. Conditions of gold occurrence. Age of auriferous drifts.

Mr. Michel further states: "Up to the present time the Gilbert River has been the scene of the most important workings, and has Gilbert River.

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.

Explorations of Mr. Michel in Gilbert valley.

"In entering the concession De Lery, 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 exploration 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 hundered 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 of the seigniory of Vaudreuil, [The De Lery Gold Mining Company], undertook in July and August last, [1865], certain explorations, partly in the bed of the stream, and partly on the right bank. The expenses of the 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 much success.

"Both sides of the stream on lot 15 are full of excavations, and I was assured that several among them had given profitable results. The two branches of the Gilbert meet on lot 16 [De Lery concession] 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 to three feet of a yellowish clay with boulders. 5. A bluish clay. This excavation was, I believe, abandoned a few days after my visit." Section of beds on lot 16.

"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 Lery and Chaussegros, upon lot 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 Chaussegross, where none of them are seen. The case is similar on lot 17 of the concession of St. Gustave where exploring pits were 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 1863 and 1864 with considerable success (although the results were exaggerated by the spirit of speculation), are now considered to be exhausted. [This is scarcely correct as it is known that between the drifts in the ancient channel of the Gilbert traversing some of these lots, partings exist which have not been wrought]. They were found on the lots 16, 17, 18, 19 and 20 of the concession De Lery. 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 Alluvions on lots 18, 19 and 20.

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.

First visit to Gilbert River.

"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.

Work of Reciprocity Company.

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, 1800 feet long, four feet wide and three deep, was already far advanced. It was supported on tressels 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 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 ordinary 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 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 over a pound. When I visited the Gilbert, in May last [1865], these subterranean workings were still going on, and I was able to examine them. The pits, fifteen in number, and all on lot 18 [DeLery], were opened on the left bank, at distances 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 clay-slates and sandstones, is sometimes broken up [decayed], to the depth of five or six feet, and it is in the joints and between its laminæ, 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." Operations in winter.

"The line of separation between lots 20 and 21 [DeLery], 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 of Chaussegross 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 Probable upper limits of rich alluvions.

alluvions, agreeably to your instructions, I made an excavation on
Lot 21, DeLery. lot 21 of the concession DeLery, in the bed of the river, in a place where an eddy might have been supposed to favour 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 [boulder-clay]. Twenty-five cubic feet of the gravel washed in a rocker yielded only three very small scales of gold.

Lot 23, DeLery. "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 [boulder-clay] 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.

Lot 24, DeLery. "I next examined lot 24 (DeLery), 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.

Lot 26, DeLery. "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 north-east to south-west. 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.

Trial on lots 27 and 28, Chaussegros. "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 [boulder-clay], which, from this cause and from its com

pactness, 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.

Lot 21, De-Lery, northern limit of rich deposit.

"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 Lery, 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.

Remarks on the source of the gold.

"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 more or less auriferous. The constant absence of gold from these clays which are associated with the aurifercus 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."

Commencement of Mr. Lockwood's operations.

In the year 1867, Wm. P. Lockwood obtained leases covering three sections or more in the Gilbert River valley from the DeLery Gold Mining Company, eventually acquiring nearly all the mining rights on the east of the Chaudière, sections 3, 4, 7 and 2, also sections 1 and 5. From this date until 1893 or 1894, he carried on extensive operations throughout the valley, leading to important developments, and the recovery of a large amount of gold. In 1866 he began a survey of the Gilbert from its junction with the Chaudière to the boundary of Fraser, S. E., which was continued until the bed of the stream was measured and levelled throughout. His plans of working were comprehensive, but were thwarted in several ways, so that he was never able to

Plans of work.

carry them fully into effect. They embraced (1) systematic exploration as to the position and depth of the auriferous gravel along the old river bed, and (2) the tunnelling of this bed in such a way as to afford natural drainage for the whole mining district, the slope of the valley being considered sufficient for this purpose. To carry out these schemes, Mr. Lockwood states that it was desirable to ascertain (1) the average yield of gold per acre; (2) whether the gold leads were continuous throughout the lots, and if so what the area and entire yield of the ground to be worked might be, and (3) whether the old river-bed was conformable in slope and direction with the present river-channel. Mr. Lockwood met with serious difficulties, not only at the inception of his work, but throughout the greater part of it from a number of small operators who held claims and were carrying on mining in the concessions DeLery and St. Charles. Nor did he succeed in carrying out his schemes to completion, although he proved the continuity of the pre-glacial river-channel through the concessions referred to and showed that it was in the bottom of this channel that the gold existed in greatest quantity. His first explorations were in the upper part of the DeLery concession, afterwards he undertook mining on lots 13 DeLery and in St. Charles concession. It was between these two points that the local miners which Mr. Lockwood attempted afterwards to prohibit were at work. He states that from 1862 to 1894 gold to the value of one million dollars was taken out of that part of the Gilbert valley between lots 15 and 21 DeLery by himself and others.

Amount of old obtained.

Gradient of present Gil-River.

In the surveys and explorations which Mr. Lockwood carried on, it was found that the present channel of the Gilbert had an average gradient through concessions De Lery and St. Charles of fifteen to eighteen inches per hundred feet. To ascertain, among other things, the gradient of the ancient or pre-glacial river channel, he commenced his system of exploratory shafts. These show a gradient, so far as could be ascertained, in the old river-bottom between lots 8 St. Charles and 21 De Lery, of twenty inches or more per hundred feet. This old channel is from thirty to eighty feet below that of the present Gilbert for a great part of that distance. If this slope obtained in pre-glacial times it must have given the river remarkable concentrating power as regards the gold derived from the rocks within its drainage basin.

Gradient of pre-glacial river.

Topographical features of Gilbert valley.

Before describing Mr. Lockwood's exploratory shafts it may be desirable to outline very briefly the main topographical and physical features of the Gilbert River district. In doing this the surveys, plans, and levels of Mr. Arthur Lockwood, already referred to, will be used.

The Gilbert River, which is but a small stream, enters the Chaudière through a wide alluvial flat, with a comparatively gentle flow. The

height of its mouth by aneroid measurements, based on that of the railway station at St. François, is 515 feet. This is the datum for Mr. Lockwood's levels along the Gilbert River.

Ascending this stream we find the eastern line of the first range, N. E., 8142 feet from the mouth of the river following its sinuosities, to be 126·5 feet above datum, or 641·5 feet above the sea. A constriction of the valley occurs at this point,—a dyke of instrusive rocks crossing it and apparently causing a waterfall. Very little gold mining has been carried on below this point. Proceeding up stream we pass from the first range, north-west, into lot 8, concession St. Charles. The Gilbert valley then expands, and at the mouth of Caron creek there are flats of considerable extent. A lake-like expanse seems to have existed here in pre-glacial times in which quicksands and other deposits were laid down.

Northern bank.

The northern bank of the Gilbert, above the lower line of St. Charles concession, maintains a tolerably regular contour as far up as the junction of the north-east branch at least, rising with a uniform grade from the river to an elevation of 250 or 300 feet above it. Opposite the mouth of the north-east branch, the slope or ascending surface on the north-west side begins to recede, and the valley of the Gilbert becomes considerably wider, and continues to widen northward to the concessions of Chaussegros and St. Gustave, according as the channel and flats on either side rise. The southern slope of the Gilbert valley is more irregular and broken and not so steep as the north slope. The base of this slope is also further from the river, flats of 50 feet to 100 and even 200 feet in width intervening. It is on this side and beneath these flats, etc., that the old pre-glacial channel, containing the auriferous gravel lies, between lots 8 St. Charles and 21 De Lery. The bottom of the present river-valley is, nevertheless, comparatively narrow, and the whole valley itself forms but an insignificant topographical feature.

Southern bank.

Bottom of valley.

Watershed of the Gilbert.

The watershed of the Gilbert comprises a rugged and hilly district, no part of which exceeds an elevation of 1200 to 1400 feet, the mean elevation not being more than from 900 to 1000 feet. The broken, uneven surface, appears to be largely due to the unequal disintegration which the rocks have undergone, these being of different character and different degrees of hardness. Much faulting and dislocation would seem also to have prevailed here; but the heavy capping of boulder-clay upon a large portion of the surface renders the study of the geological structure very difficult, and little has been done in working out the details.

Surface.

General succession of deposits.

The general succession of the deposits in the Gilbert River valley is much the same as in other places throughout the "Eastern Townships" district, being as follows, in descending order:—(1) Surface gravels and sand; (2) boulder-clay, sometimes irregularly stratified in the bottom; (3) yellow gravel, stratified; and (4) fissile slates, nearly vertical, usually oxidized in the upper part.

The gold is found in workable quantities only in the lower part of the inferior yellow gravels, and between the laminæ of the slates or in the crevices of other decaying rocks beneath.

Pipe-clay and quicksands.

In concession St. Charles, pipe-clay occasionally overlies the yellow gravels, coming in between these and the boulder-clay; and at the junction of Caron Creek and Gilbert River, where there appears to be a basin or depression of some depth, a considerable development of quicksands was noted by Mr. Lockwood in sinking a shaft.

The position of these quicksands is described below.

Mr. Lockwood's shafts and

In the following description of the shafts and pits opened in the Gilbert valley by Mr. Lockwood, or under his direction, we shall commence at the lower line of concession St. Charles and proceed up stream. The two concessions, St. Charles and DeLery, really comprise the gold area of Gilbert River.

Principal gold district.

On ascending the Gilbert River from the mouth across the first range N.E., into the adjoining concession of St. Charles, lot 8, we enter the principal gold district. Mr. Lockwood furnished Mr. Ingall and the writer with much of the data he had collected during the twenty-seven or twenty-eight years he worked in this gold field. He also gave us written notes relating to the shafts he sank, the materials passed through in sinking, the thickness of the auriferous gravels, quantity of gold extracted, etc. The facts in relation to these matters given in the following pages are compiled from his MS. notes as well as from my own observations. The letters and figures referring to the various openings are those of Mr. Lockwood's plans.

Shafts on north side of Gilbert, St. Charles concession.

Shafts A. and B. Lot 8, St. Charles.—Distance from the mouth of Gilbert 8144 and 8149 feet respectively; height of the top of the shafts above datum, 130·6 feet. These shafts were sunk "about 12 feet deep; the beds in each in descending order being (1), mixed alluvium, yellow clay and gravel with colours of gold; (2) blue clay (probably boulder-clay); (3) cemented ferruginous gravel, containing coarse gold and one nugget about two ounces, 1 foot; and (4) yellow slate-rock. A number of pits from two to twelve feet deep were sunk at this point, but the

results were unsatisfactory. Coarse gold was found on the bed-rock of some of these."

Shafts, Lot 8 St. Charles.—No. 1, 44 feet deep; No. 2, 54 feet deep, top 11 feet above river level; No. 3, 38 feet deep, top 6 feet above river level. Top of the deepest shaft (No. 2) was 150 feet above datum, the Gilbert opposite these three shafts being 139 feet. Mr. Lockwood states "these three shafts were sunk through about four feet of mixed clayey alluvium with gravel, to blue clay (boulder-clay) then timbered and puddled with 2 feet 6 inches of fine clay to make them watertight; then through fine clay in thin layers, perfectly dry, and remarkably hard (pipe clay), until the gravel (probably auriferous gravel) was struck, when the shafts filled with water, No. 2 so rapidly that some tools had to be left in the bottom. The water overflowed and continued to do so up till 1893. The results gave the information required and further work was suspended until a general plan of operations was decided upon."

Shaft Y.—This was a prospecting shaft, ten feet deep, in river gravel and boulders.

The shafts and pits, above described, are all on lot 8, concession St. Charles, and on the north side of the Gilbert River. Mr. Lockwood states that he is of the opinion that the old pre-glacial channel is accordingly on that side at this point, although on the south side of the present river further up.

Shafts on south side of Gilbert, St. Charles concession.

Shaft or Pit No. 4, Lot 8, St. Charles.—This shaft "was sunk on the south side of the Gilbert, through gravel and boulders till surface-water was reached."

Shaft No. 5, Lot 7, St. Charles.—This shaft was sunk to a depth of 35 feet. The beds passed through were, "8 inches of dry angular gravel; nearly 3 feet of alluvium; 32 feet of blue clay (boulder-clay) to gravel (probably auriferous gravel), when the shaft filled with water and overflowed until shaft X. was sunk 64 feet, which drained it."

Shaft X., Lot 7.—This shaft, which was sunk 64 feet to gravel, is just below the mouth of Caron Creek, on the south side of the Gilbert. The river at this point is 11,415 feet distant from the junction with the Chaudière, and 151·2 feet above datum. The deposits passed through were, "alluvium with silt, slates, clay, angular stones and gravel, 16 feet; then 48 feet of blue clay (boulder-clay) to gravel, when water rose to 61 feet in the shaft."

Shaft No. 6, Lot 7, St. Charles.—Just above the mouth of Caron Creek, on the south side of the Gilbert. This shaft was sunk to a depth

of 33 feet. "River gravel and sand, 4 feet; soft sandy gravel, angular stones and quartz (boulders?) to water, 29 feet. The ground was so bad that this shaft was filled with clay from shaft 6*a*. described below."

Caron Creek.—"Sluiced gravel from bed of creek and from pits on each side. Fair show and some nice round gold obtained for some distance up the stream. The materials were sandy loam, gravel, clay and stones."

Shaft on lot 7, St. Charles.

Shaft No. 6a, lot 7, St. Charles.—Depth, 100 feet, or about 95 feet below the level of the Gilbert, near by. Distance from mouth of Gilbert, 11,540 feet; height of river above datum, 156·5 feet. Auriferous gravel reached at 85 feet below the bed of the Gilbert. A section of the deposits passed through, is as follows: (1) "Loam and river gravel, 4 feet; (2) hard, blue clay with large boulders (boulder-clay), 36 feet; (3) dark gray sand (clay-slate and quartz), soft and wet, 23 feet; (4) firm gray sand with rough stones and large boulders, 10 feet; (5) gravel and gray sand, (one large boulder 3 feet in diameter, filling the entire shaft), 14 feet; (6) ferruginous sand and gravel, very sharp, hard and firm, with boulders, 3 feet. Struck bed-rock at 97 feet, dipping south three feet in the bottom of the shaft. It was a dark-blue rock, worn perfectly smooth."

"This was a very difficult and dangerous shaft to put down. We had to blast boulders in soft wet sand, and had only two light 4-inch pumps, procured for prospecting. We did not take up the bed-rock, and left gold in the crevices; but we took an ounce and a half of nice, coarse gold with the gravels. We had to use strong timbers for ten feet of the shaft, with extra thick puddling (2 feet 6 inches to 3 feet of clay) in order to keep out the surface water."

This shaft seems to be at the junction of the two 'leads'—one in the old Gilbert valley, the other in the Caron creek valley. The bottom of the shaft was reached on February 13th, 1871.

Above lot 9, St. Charles concession, Mr. Lockwood states the underground water-flow is not connected with local surface drainage, but percolates through the same bed of gravel lying on the bed-rock the whole distance from Fraser concession.

Shaft No. 6 B., near last, Lot 7, St. Charles. Depth, 83 feet. "This shaft was sunk with great difficulty into firm, hard gravel." Preparations for extensive operations were then made by Mr. Lockwood, when on the 13th of January, 1877, his buildings and plant, the latter recently brought from England, were wholly destroyed by fire at a loss of $35,000.

The shafts, above described, near the confluence of Caron Creek and the Gilbert, were on the south side of the latter.

Shafts on north side of Gilbert, St. Charles concession.

Shaft C., Lot 9, St. Charles.—This shaft was put down on the north side of the Gilbert in clay and gravel (fluviatile) to a depth of about 12 feet.

Shaft D., Lot 10, St. Charles.—Depth, 21 feet. Distance from mouth of Gilbert, 14,297 feet; height of river above datum, 181·2 feet. "Passed through, (1) drift; (2) blue clay (boulder-clay); (3) gravel and sand with large pieces of angular quartz."

Shaft No. 7, Lot 10 A., St. Charles.—Depth, 70 feet. Top of shaft, 8 feet above river level, shaft therefore 62 feet below the Gilbert. Sank near a bluff. Beds passed through, "alluviums and dark slaty sand with small stones and quartz and other large boulders,—all dry to bed rock; no auriferous gravel or gold. No flowing water."

The last three shafts were also put down on the north side of the Gilbert River.

Shaft on lot 11, St. Charles.

Shaft (A.L.), Lot 11, St. Charles.—Depth to bed-rock, 60 feet; depth to auriferous gravel, 56 feet. Distance from mouth of Gilbert, 16,346 feet; height of top of shaft above datum, 201·3 feet. Beds passed through:—"Mixed soil and stones, 15 feet; blue clay (boulder-clay) 37 feet; sand and gravel to bed-rock, 8 feet. Fine gold in bottom gravels. A drift run towards shaft No. 12 struck gold in small quantities."

Shafts on lot 12, St. Charles.

Shaft No. 8, Lot 12, St. Charles.—Depth 60 feet; depth below river level, 56 feet. Shaft on north side of Gilbert. Height of top of shaft above datum 212 feet; height of river above datum 208 feet. Beds disclosed in shaft:—"Clayey soil, 6 feet; clayey blue silt with small worn stones and quartz and occasional large boulders (probably boulder clay), 54 feet to bed-rock. No pump required. Drifted east and west 50 and 60 feet respectively; but found neither gravel nor gold. Rock surface rose rapidly in both directions."

Shaft No. 10, Lot 12, St. Charles.—Depth 25 feet. Below river level, 15 feet. "Gravelly soil, 4 feet; blue clay (boulder-clay) to bed-rock, 21 feet. Barren,—neither water, gravel nor gold." This shaft was on the south side of the Gilbert.

Shaft No. 11, Lot 12, St. Charles.—Depth 60 feet. Height of top of shaft above datum 250·7 feet; height of river opposite, 212·7 feet. "Mixed soil and stones, 15 feet; blue clay (boulder-clay) 37 feet, sand

and gravel to bed-rock, 8 feet. Fine gold in bottom gravels. A drift towards shaft No. 12 struck gold in small quantities."

This shaft is 80 feet from the river, on the south side.

Shaft No. 12, Lot 12, St. Charles.—Depth 64 feet. Height of top of shaft above datum 253 feet, height of Gilbert above same 212·7 feet. This shaft is on the south side of the river, and distant from it 100 feet. Deposits disclosed in shaft :—"(1) Mixed alluvium, 18 feet; (2) blue clay (boulder-clay), 40 feet; (3) sand and gravel to bed-rock, 6 feet. Drifted towards river in direction of shaft No. 11, also southward. The two exploring drifts gave two ounces of gold a day, and some nice nuggets, one weighing nearly five ounces. As soon as the continuity of the 'lead' and its average gold yield were thus established and traced from lots 14 and 15 De Lery, bed-rock was taken up and post holes for timbering made."

"Having secured these shafts and drifts they were left to be worked afterwards according to a continuous plan of operrations and drainage system from lot 7, St. Charles, to Miners' Claims on lot 15, DeLery concession."

Shaft No. 13, Lot 12, St. Charles.—Depth 40 feet. Distant from river on south side, 90 feet. "Soil, 3 feet; blue clay (boulder-clay) to gravel and water, showing position of the 'lead,' 36 feet."

Shaft on lot 13, St. Charles.

Shaft No. 14, Lot 13 A, St. Charles.—Situated on north side of the Gilbert. Height of top of shaft above datum 221 feet. The deposits were,—"Soil 4 feet, blue clay (boulder-clay) to bed-rock, 23 feet. Barren, stony, no gravels, no traces of gold 'lead'."

Shaft on lot 11, St. Charles.

Messrs. Sands, Oldson and Miller having acquired surface rights on lot 11, St. Charles, sank a shaft 38 feet deep in 1876, and although working without authority from Mr. Lockwood, took out a considerable quantity of gold, estimated at over 400 ounces. They testified to 205 oz. 18 dwt. 5 grs. taken out in five months.

The shaft they sank is nearly 70 feet from the Gilbert, on the south side. The top is 216·3 feet above datum, and the Gilbert at the nearest point is 203·3 feet.

Operations of the St. Onge Bros.

In 1876 the St. Onge Brothers and five other miners acquired a lease of a portion of lot 11 St. Charles, and were given Government licenses to mine for gold, notwithstanding the letters patent granted the De Lery family in 1846. Eighty or ninety feet south of the Gilbert they sank a shaft 37 feet to bed-rock, commencing work in September, 1876. The difficulty of keeping out the water was such, that a ditch 1800 feet in length had to be opened, and a water-wheel connected with pumps was driven by this contrivance. By these means

they were able to prosecute their operations. Gold mining was carried on here for several years, although under great difficulties. From this shaft the returns show, however, that the St. Onges took out $70,000 worth of gold. Nuggets worth from $125 to $740 each were obtained.

In the same year, the St. Onges also acquired a lease of four acres on lot 12, St. Charles, situate on the south side of the Gilbert, covering ground prospected by Mr. Lockwood. The St. Onges, Mr. Lockwood states, admit taking a regular average of $3.60 a day per man from July, 1876, to July, 1880, and recovering altogether out of this property $190,000 worth of gold. Owing however, to various difficulties with which they had to contend, they eventually sold out.

The great success of the St. Onges caused a rush of miners to the Gilbert, among whom were the following companies:—Payne and Chapman, Forgie, North Star, Victoria, Gendreau and others, when difficulties arose between the proprietors of the ground or surface and the proprietors of the mining rights. Mr. Lockwood, to defend his interest, applied to the Provincial Government, asking for protection. His demand was not, however, complied with; but he was advised to take his case into the civil courts and test the validity of his lease, and of course, that of the letters patent. This Mr. Lockwood refused to do, and soon after entered into partnership with Mr. J. N. Gordon and others under the name of The Canada Gold Company, England, with Mr. Gordon as manager. Mr. Gordon on assuming control at once impeached several of the miners working on the property leased by Mr. Lockwood, and took them before Mr. H. J. J. Duchesnay, Inspector of the Gold Mining Division of the Chaudière, which so exasperated the men that serious disturbances were on the point of breaking out when the Government interfered. The consequence was that the objectionable clauses of the mining law were repealed, a new law enacted, and the validity of the letters patent of 1846 to Messrs. DeLery finally established by the courts in 1883. But meantime, the three shafts which Mr. Lockwood had put down on lots 11 and 12, St. Charles, and which he said were in good order in 1877, were entered by the trespassers, who blocked the drifts and interfered in such a manner with his mines that his men had to leave them. The law against these trespassers could not be enforced until 1884, when on opening his preliminary works on these lots he took out $10,872 worth of gold with thirty-five men. Before the work was interfered with he had taken out in October, 1877, 169 oz. 2 dwt. and 10 grs.

Difficulties as to mining rights.

The Canada Gold Company.

Gold extracted by Mr. Lockwood.

The favourable impression produced by the new mining law, which came into force in 1884 gave a fresh impetus to gold mining in Beauce

New companies formed.

county, and especially in the Gilbert valley. Several new companies were formed, among them the Ainsworth Company of New York on lot 13, DeLery, and the Beauce Mining and Milling Company on lot 14 of the same concession, under the management of Walter I. Smart, of New York. A short distance below these the Canada Gold Company (Limited), already referred to, under Mr. Gordon, carried on mining operations with Mr. W. Moodie in charge. On the neighbouring lot the mine of McArthur Bros. (Limited), formerly the St. Onge property, managed by Mr. Wm. Smart of Martintown Ontario, was being operated.

On the north-east branch of the Gilbert, a small company called The East Branch Company, wrought on lot 16, DeLery, and met with some success. About this time also Mr. Morey, of New York, began work on the lot adjoining, which he had purchased from Mr. L. Gendreau; while on the North Branch Mr. Asher, of Montreal, also carried on some explorations. On lots 29 and 30, concession of Chaussegros, Mr. Wilder, of Boston had reached what was supposed to be the old channel and obtained gold. From the returns made to the inspector's office it appears that during the month of October, 1880, the three companies, the Ainsworth, the Canada and the Beauce, took out 581 oz. of gold.

Changed methods of mining.

The new companies established in Gilbert materially changed the methods of mining there. Formerly the mines could not wash the gravel more than one-third of the year owing to frost in winter and drought in summer. Mr. Moodie, however, constructed machines under sheds which washed the alluviums with water pumped from the shafts every day. Mr. Ainsworth, whose shafts were at a considerable distance from the river, constructed a tramway along which the gravel was dumped and afterwards washed by the hydraulic process, when the rains swelled the river. For this purpose a ditch over 3000 feet in length was dug to bring the water from a small tributary of the Gilbert. The Beauce Company also used this ditch.

Among other companies and individuals who obtained leases or began operations about this time were Messrs. Coupal, on the North Branch of the Gilbert; Mr. P. A. Dupuy, on lots 16 and 17, concession De Lery; Messrs. Côté, Doris and Clouthier, concession St. Charles; Messrs. Cadot, Bernard and Company; The Eureka Company, comprising Messrs. Powers, Tomlinson and McDonald, in the same concession; Messrs. Nicol and Osgoode, on first range N. E.; Messrs. Poulin and Bernard at the Devils Rapids, and Mr. Spaulding on the old mines of the Gilbert.

In 1878, Mr. Lockwood put down two shafts, each about 70 feet deep, at the "north-west end of the St. Onges' ground, lot 11, St. Charles, and took out considerable quantities of gold." In 1879, the Canada Gold Company (Limited), referred to, was formed, J. N. Gordon, manager. From 1st July, 1880 to 1894, a large amount of gold was taken out of these two lots (12 and 13*a*, St. Charles), as the returns to the gold mining inspector show. Mr. Lockwood calculated that this portion of the Gilbert valley alone yielded $50,000 worth of gold per acre. Mr. Gordon, is reported to be one of the few who, after making money by gold mining in the Gilbert valley, retired. Although he is said to have spent $80,000, yet he declared a dividend before closing operations.

Yield of gold per acre.

Mr. Gordon's profits.

Besides the mining rights on St. Charles concession, lots 7, 8, 9, 10, 11, 12, 13 B, 13 C and 14, held at one time by Mr. Lockwood, he also purchased those of lots 13, 14 and 15, DeLery concession. A reserve on each side of the Gilbert River, one hundred feet in width, was set aside, and those portions of lots 14 and 15 DeLery, on the east, were laid off in claims (Miners' Claims), and numbered 1 to 82.

Lots held by Mr. Lockwood.

Miners' Claims.

Two shafts were sunk on lot 13, DeLery, — No. 1, to a depth of 79 feet, reaching 57 feet below river level at the nearest point. Here the Gilbert is 224 feet above datum, and the distance from the mouth is 19,713 feet. The shaft is on the south side, and about 135 feet from the river. No section of the deposits passed through is given, but the thickness of the auriferous gravel appears to be two or three feet. Shaft No. 2, furthest up river, was sunk 40 feet, or 35·6 feet below river level. Elevation of top of shaft about the same as last, and the distance from the river about 150 feet. Thickness of auriferous gravels, 4 feet; no other materials described.

Shafts on lot 13, DeLery.

Two shafts at the southern point of Miners' Claims were sunk through similar ground to that in the shaft put down in rear of claim 16 (described below), the only difference being that there were more stones and boulders. These shafts were nearly 600 feet from the river. The bed-rock was reached at 87 feet, and was found to be very much decomposed, the clay-slates showing numerous adhering nuggets. The mud lying in the auriferous gravel thinned out and was replaced by sand and dark silt, and the southern boundary of the old river-channel was found well defined. Mr. Lockwood carried in a drift until the (auriferous) gravel was replaced by clay and sand, quite dry, with hard slate-rock rising rapidly.

Shafts on Miners' Claims.

"Several shafts were sunk near the 100-foot reserve, as well as on claims 20, 24 and 23; the rock rose rapidly towards the Gilbert, and crops out all along its north bank to the hill ranges in the distance."

Miners' Claims—*Cont.*

Shaft on Claim 16.—This shaft, which is about 375 feet east of the Gilbert, was sunk in very bad ground. The top of the shaft is 327 feet (?) above datum, and the height of the river at the nearest point is 274 feet. The depth of the shaft to bed-rock was 78 feet, and the depth below the river about 25 feet. The deposits passed through were, (1) "Mixed soil, 3 feet; (2) yellow clay, sand and stones, 2 feet; (3) blue clay with some boulders (boulder-clay), 30 feet; (4) fine blue sand, small stones and quartz (boulders), 20 feet; (5) fine to coarse gravel with yellow clay and boulders, 16 feet; (6) very fine sand or solidified mud, 3 feet; (7) coarse gravel resting on loose, soft yellow slates (oxidized) with yellow clay in the cleavages, and very round nuggety gold, 4 feet. Drifts were opened in every direction to discover the course and width of the gravel. The first day's sluicing gave one nugget of 5 oz. 6 dwt. and 2 grs., and coarse, round, gold, 7 oz. 1 dwt. 2 grs., total, 12 oz. 7 dwt. and 4 grs.

"South of claims 17 and 22, two shafts were sunk in similar ground to that in rear of claim 16, to a depth of 85 feet. The bed-rock near the shaft is clay-slate; to the south it was a belt of quartzite. About five feet above the bed-rock, in compact mud, numerous pieces of semi-fossilized wood (small trees) were found. There was a steady flow of water passing through the bottom gravel, showing a true, ancient river channel."

Shaft on Claim 12, Lot 15, DeLery.—In regard to this shaft Mr. Lockwood states, "the ground here rises abruptly 30 feet from the 100-foot reserve. The reserve was full of shafts and old workings for about 500 feet, when I began operations there. These had yielded rich, but irregular returns at depths of 20 to 30 feet." This shaft was 69 feet deep, and showed the following series of beds: (1) Mixed alluvium 4 feet; blue clay (boulder-clay) 40 feet; coarse blue sand with small stones and boulders, 12 feet; heavy gravel to bed-rock, 13 feet. About 18 inches of the bottom part of the gravel, and 18 inches of the open yellow slates gave a fine show of round worn gold." The height of the Gilbert near this shaft, which is situated about 150 feet to the east of the river, is 278·7 feet above datum, and the distance from its mouth 22,462 feet.

Claim 14 and half of claim 19 were leased to the Poulins. "They got $100 worth of gold; but had to abandon the mine, as water was let in by other shafts in the 100-foot reserve."

A shaft on claim 18 was sunk 78 feet to bed-rock. "The materials and bed-rock and the quantity of gold obtained were so nearly the same as in the shaft on claim 12 as to need no separate description.'

The prospect shaft on lot 15 DeLery, and also those sank by Nash, McNolty, Fenton and Smith and by Smith and Dale, were all barren and unproductive.

Mr. Lockwood states that in exploring and testing these Miners' Claims with the Poulins, he took out very nearly 2000 ounces of gold. Gold taken from Miners' Claims by Mr. Lockwood.

In 1891, Mr. Lockwood made arrangements to work the abandoned ground near the line of concession St. Charles, up to his old works on Miners' Claims. The first engine-shaft was sunk on lot 13 DeLery, going down 66 feet to bed-rock, and passing through "(1) 6 feet of clay soil and stones; (2) 16 feet of soft, moist quicksands; (3) 36 feet blue clay (boulder-clay); (4) 8 feet yellow clay, angular stones and gravel to bed-rock."

"The rock in this shaft at 66 feet was soft contorted clay-slate in irregular masses. We sank in it 16 feet, and then tunnelled in the rock northward about 60 feet, and struck an old drift filled with broken timbers and clay. Continued the drift 193 feet northward from the shaft, and finding no gold, ceased work in this direction. Then tunnelled and drifted southward 135 feet. Tested the gravel from these drifts by a number of side drifts, but found the ground too poor in gold to pay the cost of working."

Mr. Lockwood also tunnelled and sank another shaft on lot 13 De Lery. The tunnel was 200 feet long and over 45 feet deep, passing through blue clay (boulder-clay) to gravel and bed-rock. A tramway was constructed in this tunnel and horse-power used. At the shaft, which was 43 feet deep and near the river's bank, he passed through 3 feet of stony soil; 35 feet of blue clay (boulder-clay); 5 feet of gravel to slate-rock. "The yield of gold was in every way disappointing, though for a considerable distance above and below these workings the ground was very rich." Operations on lot 13, DeLery.

"The bed-rock (clay-slate) in all these workings was in broken ridges covered by a deposit of poor auriferous gravel, in most part mixed with yellow sandy clay. Overlying this bottom gravel were irregular deposits of yellow and blue clay, and to the south mostly barren brown sand and blue silt with small stones. The yield of gold was so poor, and the work so costly that I gave it up after making a continuous heavy loss."

Mr. Lockwood states that during his "30 years' experience in gold mining in the Gilbert valley, he failed to find any upper auriferous gravels, that is, any deposits lying above the level of the present Gilbert River that offered a fair inducement for the employment of No upper gold-bearing gravels along the slopes of the Gilbert.

modern machinery to work them with profitable results." He is convinced that no such deposits exist in the Chaudière district.

Total gold won from the Gilbert.

Mr. Lockwood "calculates that the whole ground worked on the Gilbert 'lead' has yielded two million dollars worth of gold." The ground he himself "worked on the 'lead', including that opened by the Canada Gold Company, gave forty-five thousand dollars per acre, or from one dollar to one dollar and a quarter per foot."

"From lots 16 to 21 DeLery, 5192 feet measuring along the river, the ground was first worked in the autumn of 1862, and steadily from 1863 to 1867, in a partial manner, and mostly in the river's bed and along its banks. Since 1867, work has been carried on irregularly at various times (lately by the American Gold Mining Company). The width of the 'lead' wrought is from 50 to 100 feet, except on lot 16 where it is much wider. At the junction of the east branch, the bed-rock was reached in places at two feet, and in others from two to twenty-four feet, the surface being very uneven." The shallow portions seem to have formed 'bars' on the lower side of which gold was dropped. From lots 15 to 17 the gold was very coarse, much of it in nuggets from $\frac{1}{4}$ to 1 oz., and some from 1 to 6 oz.; besides others 12, 15 and 20 oz.; the largest were two over 30 oz., one at 35 oz. and another 51$\frac{1}{2}$ oz." This was called the Kilgour nugget and was the largest found in the Gilbert valley.

Upper part of river.

Mr. Lockwood further states, that "on the upper part of the main Gilbert, I made several explorations and obtained coarse gold; near the forks and also near the low swampy ground about 41 and 42 Fraser, S. E. concession. The gold was coarse and thickly coated with iron."

Channel below Caron Creek.

"Below Caron Creek, on lot 8 St. Charles," Mr. Lockwood says his "chief work was to discover the course of the 'lead' which is enormous in magnitude and extent. The ancient channel does not follow the present Gilbert; but is on the north side, crossing quartz veins and cutting into them very deeply down towards the valley of the Chaudière, where a rich deposit of gold will be found."

"A good deal of work was done on lots 74 and 75, first range north-east, nearly all on shallow ground, from six to twenty feet deep, and many nuggets from 1 to 12 oz. weight were found; but the ledge dips very sharply on the right (north) bank of the river, where deep sinking is required to reach bed-rock and pay gravel."

Course of preglacial channel.

The foregoing facts go to show, therefore, that as stated by Mr. Lockwood and referred to on a previous page, the preglacial channel of the Gilbert, from lot 8, St. Charles, at least, up to about lot 21, DeLery,

is deep, reaching 95 feet below the present bed of the Gilbert at the mouth of Caron Creek; but gradually decreasing in depth up stream to the junction of the north-east branch and beyond that. In this part of the valley he states, the ancient channel lies on the south-east side of the present one.

McArthur Bros. (Ltd.)

Mr. Lockwood ceased gold-mining operations in the Gilbert valley in 1893-94, and about this time the McArthur Bros. (Limited), acquired a lease of a large portion of the Rigaud-Vaudreuil gold fields, namely, sections 3, 4, 7 and 9, the latter being on the west side of the Chaudière and including the Mill River gold district. On the expiration of Mr. Lockwood's lease, McArthur Bros. renewed it, acquiring the above-mentioned sections for thirty years.

American Gold Mining Company.

About this time the American Gold Mining Company under Mr. F. Wadsworth of Boston, U.S., made arrangements with McArthur Bros. to work certain grounds in the Gilbert valley. Mr. Samuel Byrne who was the local manager, has furnished me with the following account of the operations of this company.

Operations of this Company in 1893.

"The American Gold Mining Company began active operations on lot 18, DeLery concession, Gilbert River, on June 1st, 1893. The point selected for a beginning, immediately below what is known as Rodrigue Falls, was chosen on account of the sharp curve or elbow in the river just above, offering a better chance than elsewhere to construct a cheap temporary dam to retain water for carrying on experimental work. By this means we hoped to ascertain the value of the ground per cubic yard, and if results proved favourable, would erect a large hydraulic plant there.

"The first piece of ground worked was as I have stated, immediately below the outcrop of slate forming the falls on the line between lots 18 and 19 DeLery. This bed-rock was broken up to a depth of 12 feet, and heavy gold, some pieces as much as two ounces in weight, was found in the crevices and between the slates. This heavy gold was, however, for the most part found resting on a hard, smooth rock-bottom, between which and the upper or overlying, nearly vertical slates there was a gritty, gray sediment, half an inch to an inch thick, which held it. I got $25 worth of gold from one pan of this gritty material, included in that amount, however, was one nugget valued at $22.

"In the work carried on in this locality, we sluiced only the decayed rock and about six inches of the gravel above it, because repeated trials had failed to reveal 'colours' in any other part of the material. The

piece of ground worked immediately below Roderigue Falls was found to contain about 1100 cubic yards, including the decaying bed-rock broken up as described. Out of this we took between $1,100 and $1,200 worth of gold, or about $1.00 per cubic yard.

"After cutting a drain through what remained of the falls, we worked in the old river-bed to the west, in that part adjoining lot 19. This piece of ground measured about 400 cubic yards, and we took out about $400 worth of gold from it, or $1.00 per cubic yard.

In 1894.

"In 1894 we constructed a flume of sufficient dimensions to carry the whole of the river water, even during floods, entirely clear of the works. With this we began ground-sluicing on the flushing system,—a system devised by myself. It consisted in damming the water above the flume to a certain level, then allowing it to rush through the flume which had a grade of four inches in every ten feet. The effect upon loosened gravel, boulder-clay, etc., was almost as great as that of a jet of water from the nozzle of a hydraulic monitor, and we were able to do very good work in this way. With an average number of fifteen men stripping bed-rock in this manner, we did as much work as with twenty-five wheelbarrows in the ordinary way.

"We never knew exactly how much gold the last-mentiond piece of ground yielded; but it was about $700 worth in 1894, and in 1895 probably about $500 worth, besides what was reported to have been carried off by midnight diggers. This, together with what was taken out of the same ground by the Leclerc Bros. in 1896, and in 1897 by Mr. Currie and myself, would bring the total production up to about 30 cents per cubic yard for the whole bank of 100x100x20 feet. It must be borne in mind, however, that this ground was previously worked,—some of it a number of times. Had we been permitted to take the gold from all the ground we stripped, it would, I think, just about have paid for labour, flume and other incidental expenses. But difficulties arising between lessee and lessor, we had to cease operations in 1896, and the company must have been several hundred dollars behind.

Total amount of gold obtained.

"Summing up the total amount of gold obtained, which was probably about $3,500, and the number of cubic yards wrought, 8500, we have an average yield of about 41 cents per cubic yard for the whole."

All this was obtained from open work, in the present bed of the Gilbert and on both sides of it.

Leclerc Bros.

The work of the Leclerc Bros. and others, on lot 18 DeLery, referred to by Mr. Byrne, was carried on for a few weeks only, after the

American Gold Mining Company had ceased operations in 1896. They ran two small drifts into the river's bank on the south side and were reported to have taken out $400 worth of gold. Two nuggets valued at $50 and $60, were, I was informed, obtained by these men. Their work was stopped by the owner of the land, or surface rights, so called, threatening them with an action for trespass.

Gilbert-Beauce Gold Mining Company.

In 1897, a company called The Gilbert-Beauce Gold Mining Company, whose promoter is Mr. Philippe Angers, Notary, of St. François, was formed to operate anew certain portions of the Gilbert valley. This company having acquired the right to work lots 15, 16, etc., DeLery, from the McArthur Bros. (Limited), proceeded to open a trench or open-cut to drain the ancient river-bed of the Gilbert above the McRae shaft on lot 15, by gravitation. These lots were wrought thirty years ago, or more, and proved to be the richest in gold in this district. Here the Kilgour and other large nuggets were found, and it is supposed that portions of the old river-gravels between the shafts and drifts still remain intact. It is to reach these that the present scheme was inaugurated. The great difficulty in deep mining in the Gilbert and other valleys in Beauce county is to get rid of the water, and it is believed this method is the most effective and economical hitherto devised for that purpose. By last accounts the bottom of the ancient river-bed had been reached near the McRae shaft in lot 15, and gold was being taken out.

An open drainage channel.

Mode of occurrence of the gold in Gilbert valley.

The foregoing facts regarding gold mining in the Gilbert River valley tend to show that the precious metal has not been equally distributed in the ancient bottom gravels, nor in the loose bed-rock beneath these. Only certain parts of these were found to be really workable at a profit. From the information obtained it would seem that gold occurs in greatest quantity at or immediately below the shoals and reefs of the old river-bottom referred to. The miners claim that the gold was originally laid down in 'leads,' and that when they find one of these they can follow it for a long distance. But these appear to be often interrupted and detached, and even when continuous the gold content is much less in some parts than in others.

Fineness of the gold.

The alluvial gold of the Gilbert River valley really occurs in paying quantities only in the bottom of the yellow gravel and in the partially decomposed slates beneath. It contains a certain percentage of silver. The assay of a specimen from this river gave Dr. Hunt 13·27 per cent of silver. The fineness of the gold is $20\frac{19}{24}$ carats.

Rivière du Loup.

Alluvial gold in Rivière du Loup.

The Du Loup attracted the attention of gold seekers at an early date, and considerable quantities of alluvial gold have, from time to time, been taken from the gravels along the lower part of this stream. In 1851-52 the Canada Mining Company, under Captain Richard Oatey, a Cornish miner, obtained the right to wash for gold on the flats of the Du Loup for about ten acres from its junction with the Chaudière, and some extensive operations were carried on. The

Mr. Oatey's work in 1851.

results of Mr. Oatey's work have been published in the reports of the Geological Survey of Canada.* Great difficulties were met with from the scattered condition of the gold and from an insufficient supply of water during the summer months, the method adopted being the same as that used in washing alluvial tin in Cornwall. The gravel from about three-eighths of an acre, with an average thickness of two feet, was washed during the summer of 1851, and yielded 2107 pennyweights of gold, of which 160 was in the form of fine dust, mingled with about a ton of black iron sand, the heavy residue of the washings. Several nuggets were found weighing over an ounce. The value of this gold was $1,826, and the whole expenditure connected with the working $1,643, leaving a profit of $182. In this account is, however, included $500 lost by a flood, which swept away an unfinished dam; so that the real difference between the amount of the wages and the value of the gold obtained should be stated as $682. The average price of the labour employed was sixty cents a day. From the above statement it would seem that these gold-bearing gravels could be profitably wrought, if they proved auriferous throughout.

The Canada Company's work in 1852.

Another attempt was made to work these gravels by the same company in 1852, when about five-eighths of an acre of ground was washed at the same place, the total amount of gold obtained being 2880 pennyweights, valued at $2,496. Of this 307 pennyweights were in the form of fine dust mixed with the iron sand. A portion was also found in nuggets or rounded masses of considerable size. Nine of these nuggets weighed together 468 pennyweights, the largest of which was 127 pennyweights, and the smallest 11. Native platinum and iridosmine were obtained in the washings, but the quantities were so small as to be of no economic importance. The season for washing the gold extended from the 24th of May to the 30th of October, and the total expenditure for labour was $1,888, leaving a profit of $608. As a certain amount was, however, expended in constructing wooden

* Report of Progress, Geol. Surv. Can., 1851-52; Geology of Canada, 1863; Annual Report, Geol. Surv. Can., vol. IV. (N.S.), 1888-89, part K.

conductors, supposed to be available for some years, for bringing water from a small stream, a distance of about 900 feet, properly chargeable to construction account, the actual profits for the year would be about $680. It thus appears that from an acre of the gravel, with an average thickness of two feet, $4,323 worth of gold was taken, while the expense of labour, etc., after deducting all that was not directly employed in extracting gold, was $2,957, leaving a net profit of $1,366. The result of a week's working at this place, under the inspection of a member of the Geological Survey, during the season mentioned, showed a yield of 143 pennyweights of gold, valued at $124, while the wages of the miners during that time were $60, showing a profit of $64. Assays of the black sands from the Rivière du Loup show that they contain a considerable amount of gold which was not taken into account in the above computation, so that the net profit might be thus increased. Mr. Oatey gives a list of nuggets obtained in this locality in 1852, with their weights: June 7, 126 dwt. 19 grs.; July 30, 83 dwt. 21 grs.; August 25, 10 dwt. 20 grs.; same date, 38 dwt. 21 grs.; September 7, 98 dwt. 21 grs.; September 24, 55 dwt. 2 grs.; September 30, 23 dwt. 20 grs.; October 2, 16 dwt. 22 grs.; October 9, 13 dwt. 2 grs.

The greater part of the gold was taken out of the gravel on the alluvial flats by the river side, but a portion was obtained by washing the material from the banks above.

Black sands with gold.

In regard to the fine black iron sand in the Rivière du Loup gravels, Sir W. E. Logan reports thus,* "resulting from the season's work [1851]....there was about a ton of fine black iron-sand in the Keeve or vat over which the copper bottom was used. The unseparated quantity of gold in this, after repeated trials, was ascertained to be 1·77 grains per pound avoirdupois; this would give $165\frac{2}{10}$ pennyweights to the ton, the gross value of which would be about £36 [$144]."

Work by Napanee company.

Owing to the gold becoming scarcer, and the licensees, (the Canada Mining Company,) having got into difficulties with the owner of the adjoining lot, they had to cease operations. Work was, however, resumed by a company from Napanee, which tried to sink a shaft through the slate near the mouth of Rivière du Loup, hoping to find auriferous gravel and sand beneath. This company worked for about three years and then also abandoned the property, it having been sold at the suit

* Report of Progress, Geol. Surv. Can., 1851-52, p. 26.

of Mr. Craig, and bought by Mr. Childs, notary, of Quebec, for him. The Napanee company never furnished any returns and were not very successful.

Search for quartz veins.

In June and July, 1867, a Mr. Maynard, of Boston, U.S., had a number of men employed in cutting a tunnel at Jersey Point, so as to traverse several of the quartz veins which here occur in the slates. This tunnel was about one hundred and fifty feet long, seven feet high and six feet wide and was timbered and secured. Portions of the quartz taken from some of these veins were assayed by Prof. Hayes of Boston, and were said to yield gold. Prof. H. Y. Hind examined this property in August, 1867, and prepared a report upon it.

Hydraulic operations in 1880.

Except some desultory work by the local miners, little mining seems to have been attempted on Rivière du Loup after this until 1879-80, when further explorations were resumed and the ancient bed of this river was reported to have been found. In 1880, Mr. A. A. Humphrey began systematic work here with the view of employing the hydraulic process in washing the extensive gravel banks along its lower course. A company of English and French capitalists called the Canada Gold Mining Association, was formed under his management in 1881, and a canal eleven miles in length opened along the west side of Rivière du Loup to obtain a sufficient supply of water for this purpose. This was completed in 1882, and gave a head of about 150 feet. The washing of a gravel bank on the east side of the river about a quarter of a mile from its mouth then commenced, and was continued until the autumn of 1883 when the work, owing apparently to imperfect facilities for saving the gold, having proved unsuccessful, was closed. No returns showing the actual amount of gold obtained by Mr. Humphrey are available, but it is known that the company lost heavily.

Section in hydraulic pit No. 2.

An examination of this pit (called Humphrey's hydraulic pit No. 2) was made by me in 1895-96 (see Fig. 2, p. 43). This pit affords a section showing the character and sequence of the pre-glacial and glacial deposits in the Chaudière district superior to any other met with. In descending order the following beds are exposed:—(1) Surface gravel and sand, 1 to 3 feet; (2) unstratified boulder-clay, containing glaciated boulders from five feet in diameter downward—some of them foreign to the locality, 37 to 38 feet; (3) irregularly stratified boulder-clay, or a deposit made up of coarse clay, apparently in lenticular beds, with glaciated boulders and pebbles, 15 feet; (4) unstratified boulder-clay, more compact than No. 2,—boulders not so large, and a greater number from local rocks, 20 feet; (5) dark-gray, unctuous, stratified clay with arenaceous layers, ochreous in places, 1 to 3 feet;

(6) gray, stratified, ochreous sand, ('quicksand' of the miners), containing a few pebbles, 12 to 14 feet; (7) compact, stratified clay, with variegated bands and an occasional layer of sand, the whole bed full of joints, breaking into rhomboidal shaped pieces, ('pipe-clay') 6 feet. Divisions 5, 6 and 7 maintain a strictly horizontal attitude as seen on the west side of the pit, but the bottom of No. 7 rests on the surface of a gravel-bed which slopes slightly to the north, *i. e.* away from the river, the slope being about two feet in forty; (8) gray stratified gravel, containing numerous pebbles and a few water-worn boulders. In the bottom there is a sand-bed eight or nine inches thick, with scarcely any boulders or pebbles. The materials are non-glaciated and local, and the strata dip northward as in the overlying bed. These gravels and sands are slightly auriferous; whole thickness, 5 feet. (9) Hard yellow oxidized gravel, stratified, strata dipping as in the two last divisions of the series, containing numerous worn boulders from two feet in diameter downward, non-glaciated, and all of local origin. The bottom of this member of the series was not seen, being covered by débris from the face of the bank and by tailings; but it apparently rests on ledges which crop out in the river-bed near by, and is probably as low as these. This gravel seems to be auriferous throughout, but especially so on the surface of the bed-rock; thickness, 28 to 30 feet. The material composing these pre-glacial beds appears to have been carried down stream in the direction of the flow of the present Rivière du Loup. (10) Non-glaciated rock-surfaces, broken and jagged, with gold in the crevices.

Noteworthy features in this section.

This section exhibits several noteworthy features, as, for example, (1) the bipartite division of the boulder-clay, (2) the great thickness of the pre-glacial deposits, about 45 feet, and (3) the change in the character of these from the bottom to the summit, denoting changes in the conditions of deposition and of drainage. The lower coarse beds have apparently been laid down in rapidly flowing and shallow waters at a time when the gradient of Rivière du Loup was considerably greater than at present, as referred to on a previous page, while the clay and sand beds in the upper part must have been deposited in quieter and deeper waters. The changed conditions of deposition are explicable only on the theory of differential changes of level in the region, as already outlined on a previous page, viz., an elevation of the hill ranges nearest the St. Lawrence (the Sutton Mountain anticline and the Stoke Mountains) and a corresponding subsidence in the large central belt occupied by Cambro-Silurian rocks.

Conditions of deposits.

Section in shaft sunk by Mr. Blue.

About three miles above the mouth of Rivière du Loup, on the east bank, Mr. John Blue, of the Eustis Copper Mines, sank a shaft fifteen

feet or more in depth during the autumn of 1895, disclosing the fol lowing series of beds, in descending order:—(1) River alluvium ; (2) dark-gray boulder-clay ; (3) gray stratified clay, hard and brittle, and (4) gravel and boulders, evidently pre-glacial. Colours of gold and particles of quicksilver were found in the gravel.

In a gravel terrace east of this shaft, on which the small Presbyterian church stands, gold occurs in fine particles. The materials of this terrace and their gold content appear, however, to be secondary, and due to post-glacial river action.

Humphrey's pit No. 1.

A short distance above this and near the mouth of Goldstream (shown on the Geological Survey maps as Grand Ruisseau) is the excavation known as Humphrey's pit No. 1. This is where Mr. A. A. Humphrey operated in 1880, before completing the canal. The washing was performed by the ordinary process of sluicing and it is reported that considerable quantities of gold were obtained from this pit.

Of these operations no authentic account is available as to the quantity of gold taken from the gravels, nor of the content per cubic yard; in some places, it is stated, one dollar's worth was taken, in others not more than ten cents worth.

Report by Prof. Hind.

During the operations of Mr. Humphrey on Rivière du Loup, Prof. H. Y. Hind made an examination of the alluviums of this valley and prepared a report on them. The report was not published. It deals exhaustively with the gravels, their origin, and the mode of occurrence of the gold in them; but what he took for the boulder-clay is, it seems to me, only the coarse fluviatile boulder-beds.

Work by Gendreau and Ha ycock, 1892.

About the year 1892, Messrs. Gendreau and Haycock commenced work in the lower part of Rivière du Loup. They first examined the gravels along the banks, and searched the bed of the river with some success, obtaining more or less alluvial gold. They afterwards built a dam across the Du Loup and erected a small three-stamp mill, about half a mile above Jersey Point, with the object of testing the numerous quartz veins occurring in this vicinity for gold. Their assays were favourably reported on by Mr. J. Obalski, Mining Inspector of the province of Quebec, in his report for 1894. Soon after this Mr. Haycock acquired the property himself, Mr. Gendreau retiring, and work was being carried on irregularly when I visited the locality for the first time in 1895. The Eustis Mining Company then acquired an option on the property, and during the whole season of 1895 the Messrs. Blue, of Eustis, Que., prospected it and tested the quartz veins. No work has followed the assaying or testing of these veins since that date,

Work by Messrs. Blue, 1895.

however, and it seems to be understood that the results were not encouraging.

Further work by Mr. Gendreau, 1896.

In 1896, Mr. Gendreau began the further exploitation of the gold bearing alluviums of Rivière du Loup along the lower five miles of its course, and formed a small company under the name of the Quebec Central Gold Fields Company. This company has sunk several shafts on the west bank of the Du Loup on lots 9 and 10 of the Kennebec road range, section A of Jersey, in an endeavour to locate the old river-bed and test the auriferous character of the gravels. The bed-rock was struck at depths of about 40 feet. Operations were carried on with six or seven men and the company was supplied with pumps had it been found necessary to use them. Mr. Gendreau informs me that fine gold, and also nuggets weighing about an ounce were found in the gravels at the bottom of a 60-foot shaft. Work was suspended in the autumn of 1897, until the pumps were put in place and other preparations made for deep mining.

Gold found above boulder-clay.

Along Rivière du Loup and its tributaries as far up as the International boundary, gold seems to have been found in the alluviums overlying the boulder-clay. In some instances it has also been met with in the recent alluviums, or in the flats along the streams which traverse the region. Good indications of gold occur in the Grand Ruisseau, (also called Millstream or Goldstream). Grand Condie River, near St. Come, has also furnished the precious metal. The Metgermette was prospected at the time Logan, Hunt and Michel examined the district, and it is said a good deal of gold was washed from the gravels of this river. Usually it occurred in the beds of the streams; but in the case of the Metgermette it was met with in the banks of stratified gravel at heights of fifty to one hundred and fifty feet above the river-channel.

Gold on tributaries of Du Loup.

The St. Lawrence Mining Company owned mining lands in the Townships of Jersey and Linière, on the Du Loup, Metgermette and Portage rivers, but is understood did very little work there. Gold was also found in the alluviums of Portage River, Oliva Stream, and indeed, colours could be found on every tributury of the Du Loup from its mouth to the International boundary. A number of mining claims formerly were taken up on the two branches of Metgermette River and some prospecting was done; but no gold mining has been attempted there for many years. The gravels are of considerable depth, and the gold very much scattered in them. The upper part of the Du Loup has not therefore offered such inducements to mining enterprise as its lower part and the Gilbert River.

The Famine River.

Famine River.

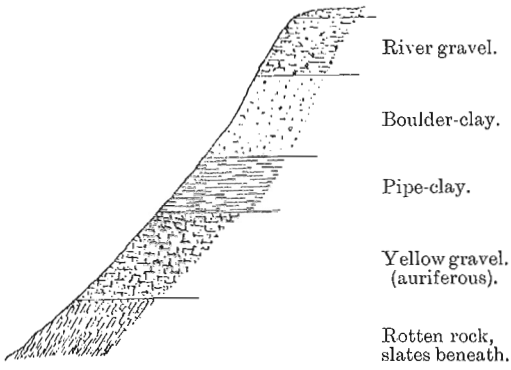
The Famine is the largest tributary of the Chaudière next to the Du Loup, and takes its rise close to the Maine boundary and at the head-waters of the St. John River. Alluvial mining has been carried on in the valley of this river from an early date, with frequent interruptions. The first record of work performed here was that by Dr. James Douglas, under the DeLery patent. When the Chaudière Mining Company acquired the right of working the Seigniory of Rigaud-Vaudreuil, in 1847, the mining rights of fief La Barbe, through which the Famine River flows, were also included. It does not seem, however, that any regular, systematic operations were begun in the valley of this river till the year 1864, or later. In that year leases were granted to Dr. James Reed and George Desbarats in concessions three and four, Township of Watford. During 1862 and 1863, Dr. Reed had explored this portion of the Famine and found "rich diggings" and some good-sized nuggets of gold. In consequence of this, twenty-two licenses for gold mining were issued by the Quebec Government in 1864 and 1865 on the Famine River, and mention is made in the report of the Select Committee on the Canadian Gold Fields (1865), printed by order of the Legislative Assembly, of the presence of gold in considerable quantities there. Capt. Richards and Mr. Beemer had carried on explorations for some years on the Cumberland, a branch of the Famine, joining it from the north-west, and gold was also found on the Abenaquis, a branch coming from the east. Capt. Richards sank shafts to the bed-rock along the Cumberland, and is reported to have found gold, but no returns showing the amount obtained are available.

Work from 1847 to 1865.

Work by St. Onge Bros., 1886.

About the year 1886, the St. Onge Bros. began operations on the Famine. They drove two tunnels into the north bank about two miles above the mouth, or three-quarters of a mile below the main falls of that river, and obtained gold. A section of the beds there exhibits the following series:—(1) Recent river-gravel containing many pebbles and boulders of all sizes up to two feet in diameter; (2) boulder-clay; (3) gray stratified clay ('pipe-clay' of the miners) from three to four feet; (4) yellow gravel, containing boulders and resting on the decayed rock-surface. This gravel is quite similar to that of the Rivière du Loup sections, and is auriferous. Its thickness is not more than five or six feet. The bed-rock (decayed) contains gold in the crevices.

Fig. 4.



SECTION IN BANK OF FAMINE RIVER, BEAUCE CO., 2 TO 3 MILES FROM ITS MOUTH. SCALE :—16 feet to 1 inch.

The St. Onge Bros. ran their tunnels in along the surface of the rock, which is very little above the level of the Famine River but it would appear that these tunnels were entered by the river water in time of floods. Whether the work proved a financial success or not, it demonstrated that the yellow, pre-glacial gravels and decayed rock-surface of this river also contained gold.

Deposits at upper falls.

Black, wrinkled, fissile, rusty slates, dipping S. 20° E. $<80°$, traversed by diorite dykes parallel to the cleavage, occur here.

At the upper falls of the Famine River, the deposits observed are (1) superficial earth or soil; (2) boulder-clay, and (3) yellow gravel. Beneath these, however, rotten rock was noted.

The upper falls are caused by a trap or diorite dyke crossing the river-valley in a north-east and south-west direction, the river not having worn down the channel to its base-level of erosion since the eruption took place. This dyke, like others observed in the district, also extends parallel to the cleavage of the slates, which dip S. E. $<75°$ to $80°$. Gold occurs in the yellow gravels here.

No recent work of importance.

Since the St. Onge Bros. wrought in the Famine River valley, no regular gold mining has been carried on. Some of the farmers occasionally wash or sluice for gold along the bed of the river, and not infrequently obtain as much as pays expenses and affords wages during the time spent in this work; but no deep or underground mining has been attempted since that above-mentioned, by the St. Onges.

Rivière des Plantes.

Rivière des Plantes.

This river is within the limits of the De Lery seigniory, and appears to have been first explored for gold in 1847 by Dr. James Douglas.

Michel's report on early work.

Mr. A. Michel, whose report has been already referred to, thus describes the Rivière des Plantes and its character as a gold-bearing district.* "The river 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 crystalline 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. 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 labouring 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."

Work resumed in 1879-80.

About the years 1879-80, gold mining was resumed on Rivière des Plantes, when the miners having learned of the deep pre-glacial channel of the Gilbert and other rivers, began a search for the ancient bed of the stream in question. In this they were reported to have been successful. Messrs. Mathieu, Bérubé, and Gendreau, discovered the old auriferous gravels, which gave promising indications of gold, and immediately began their exploration. Mr. A. Mackenzie, of Montreal, also commenced work here by the hydraulic process, about this time, a mile or more above the mouth of Des Plantes, in the river-bank, and is said to have met with success.

* Report of Progress, Geol. Surv. Can., 1863-66, p. 55.

In 1884-85, Messrs. H. Sewell, Bacon and others, from Montreal, began locating the old river-channel some distance below Mr. Mackenzie's works. A shaft was sunk in the east side of the river, about half a mile above its junction with the Chaudière. The bed-rock was reached at a depth of thirty feet, and consisted of sandstones, slates and diorites, with about four feet of well worn gravel, cemented with clay resting upon it. The rock-surface was followed for some distance by drifts and a rusty coarse gold in paying quantities found. Owing to the want of proper appliances for mining and sluicing and to other causes not known, this attempt at developing the mines on Rivière des Plantes was again abandoned. Operations in 1884-85.

When I examined the valley of Rivière des Plantes in 1895 and 1896, there was no gold mining going on. It was evident, however, from the abandoned workings, that most of the mining carried on here in former years had been in gravels of post-glacial, fluviatile origin in the narrow part of the valley situated from half a mile to a mile above the river's mouth. In the upper half mile of the auriferous portion of the valley, however, pre-glacial yellow gravels were observed to occur sparingly in the bottom of the beds. The old channel is apparently on the north side of the present stream. Mr. L. Gendreau, who formerly wrought here, states that the gold met with was usually coarse, and almost always rusty and dark-coloured from the presence of iron and other minerals in the bottom gravels. These gravels, although consisting of modified pre-glacial decayed rock material, do not seem to have suffered the same wear and transportation as those of other valleys in Beauce county. Gold chiefly wrought in post-glacial gravels.

At the distance of a mile, or a mile and a half above the mouth of Des Plantes, the river-valley widens and the ledges and bottom gravels disappear from view. Little or no gold mining has been attempted in this portion of the valley, although the upper gravels show 'colours' in most places.

The south-east branch of the Des Plantes, called Black River, seems to offer indications of being gold-bearing. At the junction of the main tributary 'colours' of gold were washed out of the recent alluviums from an opening in the bank, two or three feet deep. This stream rises in the elevated district of eruptive rocks and quartzites to the east of St. François and north of Gilbert River. The superficial deposits in its valley are very deep, and would require shafts, etc., to reach the auriferous gravels, if there are any in the bottom. No rock exposures were noted till approaching the source of the river. Black River.

Mill River.

Mill River. Work on Meule Creek, 1885.

Mill River is a small stream which flows into the Chaudière from the west, just above the village of St. François. A tributary called Meule Creek joins Mill River about half a mile from its mouth. It was known from an early date that gold occurred in these streams, but no mining was attempted until Messrs. McArthur, Coupal and Company began operations there about the year 1885. Prospecting for an old channel commenced some time afterwards, or in 1886, in the valley of Meule Creek. In September, 1888, Dr. R. W. Ells of this Survey visited the locality and reported that it had been tunnelled along the ancient channel, which is on the north side of the present stream-bed, a distance of over 600 feet, openings having been made for ventilation and the easier working of the mine. The old channel was found to be rich in gold, but the difficulties encountered in mining, owing to the quicksands and the unevenness of the rock surface beneath were very great. Dr. Ells states* that "at the time of my visit in September of that year the end of the tunnel at 400 feet was thirty feet lower than the present bed of the stream, which was about sixty yards to the east. The bottom of the old channel contained a good deposit of well-rounded, worn gravel, cemented with sand and clay, from which nuggets of gold from $10 to $153 in value had been reported. Difficulty in washing the gravel in order to save the fine gold was experienced, the system of sluicing not being properly arranged as regards fall and other appliances necessary for obtaining the best results." Work was eventually closed after taking out upwards of $4,000 worth of gold. It is reported that the company spent $18,000 in exploiting this mine.

Old channel.

Character of deposits.

The deposits disclosed in the tunnel were found to be, in descending order,—(1) Gravel and sand; (2) boulder-clay; (3) fine sand (quicksand); (4) gray silt and yellow gravel, about four feet thick; (5) rotten rock, three to four feet thick, in which most gold was found. The total thickness of the whole series of beds in Meule Creek valley is from 80 to 100 feet. In tunnelling along the rock-surface beneath these, the great difficulty was in keeping the openings free from water and quicksand.

Mr. Obalski's observations.

Mr. J. Obalski, Inspector of Mines for the Province of Quebec, who examined these mines as work was in progress, thus reports on them†:—"The auriferous layer, which appears to be the old bed of des Meules Creek, has been struck at a depth of 80 feet by a shaft which traverses

*Annual Report, Geol. Surv. Can., vol. III. (N.S.), 1887-88, p. 101 K.

†Mines and Minerals of the Province of Quebec, 1889-90, p. 63.

the slates and connects with it by a small drift. The draining of the mine is effected by means of a tunnel of 500 feet, extending to the Mill stream. The strata passed through in sinking the shaft to reach the gold-bearing gravel offered in this case much greater difficulty than at other mines. They appear to have been the following :—

Section of beds on Meule Creek.

	Feet.
Vegetable soil	.....
Clay and boulders	30
Fine white sand, mixed with boulders	20
Blue clay	10 to 15
Hard gravel	10 to 12
Fine quicksand and water, impossible to keep out	10 to 12
Auriferous gravel	.....
Slates (bed-rock)	.....

"The width of this basin is about 100 feet, and the paying or workable part 25 feet. The depth of gravel is very slight, the gold occurring nearly always in the fissures of the bed-rock, the stratification of which runs in about the same direction as the auriferous deposit. The same basin has been traced for a distance of a mile by means of three other shafts and the tunnel by which the mine is drained.

Gold obtained on Meule Creek.

"The company [McArthur, Coupal & Co.] owns the mining rights on 5000 acres, but has only worked with a few men for the last three years, a part of this time having been devoted to exploring and preparatory work. It has taken out 275 ounces of gold, worth $5,000, the largest nugget secured weighing a little over eight ounces and being valued at $153. On the occasion of my last visit, in September, 1889, only four men were at work in the mine, and they estimated that the amount of the precious metal found represented an average of more than four ounces, or about $100 per 80 square feet. The same company has secured a large tract of land in the valley of the Gilbert, and there is room to hope that other important workings will be shortly undertaken there."

Recent operations.

During 1896 and 1897, Mr. Coupal has been operating on a small scale in the valley of Mill River itself above its junction with Meule Creek, and I understand has met with gold in paying quantities there. No work except this has been going on for some years, and the shafts and tunnel on Meule Creek are now falling in.

Slate Creek or Ruisseau de l'Ardoise.

Slate Creek.

Slate Creek is a small stream flowing into the Chaudière on the north-east side of the village of St. George. While Mr. A. A. Humphrey was carrying on gold mining in the Rivière du Loup valley between 1880 and 1883, the St. Onge Brothers prospected this stream meeting with favourable indications. After operations were closed on the Du Loup in the autumn of 1883, Mr. Humphrey joined the St. Onge Brothers, entering into a partnership to carry on work along the valley of Slate Creek. Several shafts were sunk to test the ground, and finally one was selected and put down to a depth of 165 feet. Nearly a year was spent in sinking it, owing to the large quantities of quicksand met with. A layer of auriferous gravel was found at the above depth, resting on the bed-rock. Mr. Humphrey left the company in 1886, as the mine was not proving remunerative, and the St. Onges, after attempting to carry on the work themselves, at last abandoned the property, evidently from lack of capital to continue operations. The mine was subsequently sold for debt.

Work by Mr. Humphrey and St. Onge Bros., 1883-86.

Prof. Chapman's report.

In June, 1886, Dr. E. J. Chapman, of Toronto, examined and reported on the St. Onge gold mine on Slate Creek for Mr. William A. Allan, of Ottawa, Ont. Although speaking encouragingly regarding it, he stated: "During my stay of three days at the mine, $1\frac{1}{4}$ oz., $2\frac{1}{4}$ oz., and 1 oz. (in all $4\frac{1}{2}$ ounces) were taken out of three small portions of ground. It is not pretended, however, that the present yield is sufficient to cover the mining outlay. But it is assumed, and I think with good reason, that the drifts are at present in what is probably, if not necessarily, the poorest part of the mine."

Dr. Ells's observations.

Dr. R. W. Ells, of this Survey, who visited Slate Creek at the time Messrs. Humphrey and St. Onge were at work, thus reports on this mine*:—"By the kindness of Mr. A. A. Humphrey, Manager of the St. Onge Gold Mining Co., the following statement of strata passed through in the last shaft sunk on the old channel of Slate Creek, is here presented:—

*Annual Report, Geol. Surv. Can. vol. III (N.S.), 1886, pp. 49-50 J.

	Feet.
Boulder-clay, boulders, both native and foreign	40
Sand	2½
Boulder-clay	20
Stratified clay, without pebbles	60
Quicksand, small pebbles and fine gold	40
Sand and gravel, containing gold in quantity, often coarse	4
	166½

It is evident from the above table that these old channels had not only been excavated, but had been partly filled up, and the streams diverted to their present courses, long prior to the glacial action by which the boulder-clay was distributed. It would also appear from the lack of gold in the boulder-clay, and from its presence in the underlying and more ancient sands and gravels, that the causes which were principally instrumental in the formation and distribution of the alluvial drift, over the greater portion of the Cambro-Silurian area, were distinct from those which strewed the surface so thickly with granitic and other boulders, and that they preceded the latter by a very considerable interval of time."*

Since the St. Onge Brothers ceased operations here in 1896, no further explorations have been carried on at this place.

Operations by Hardman & Macduff, 1895-96.

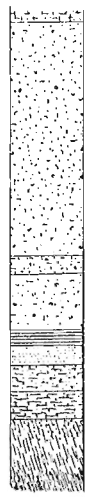
In 1895, Messrs. Hardman and Macduff began a new search for the ancient channel of Slate Creek. Starting from the bank of the Chaudière at St. George, they pushed boldly into the rising ground to the east, in almost a direct line towards the St. Onge shaft, about a mile distant. Great difficulties were experienced in keeping the tunnel open owing to quicksands and water. These quicksands and the overlying boulder-clay would occasionally rush into the works and fill in the upper end of the tunnel in such a way that it would take several days to clear it out again. After going in some 800 or 900 feet, it was discovered that the tunnel was too far north of the present stream and possibly of its old pre-glacial channel. Work was suspended in the autumn of 1896.

Section disclosed.

The succession of deposits disclosed in this tunnel is here given in descending order. The section is one of the most interesting met with in the Chaudière valley.

* There seems to be some doubt as to the correctness of some parts of the above section. Sixty feet of stratified clay without pebbles, is a deposit different from any other known to me in this region, unless in the marine area of the St. Lawrence valley, and I am, therefore, inclined to think there are other subdivisions included in this. The same remark applies to the bed of quicksand 40 feet thick.

Fig. 5.



SECTION OF DEPOSITS IN HARDMAN'S TUNNEL, ST. GEORGE, BEAUCE CO., QUE.

SCALE :—Approximately 10 feet to 1 inch.

(1) Surface soil; (2) boulder-clay with an intercalated band of stratified clay, or stratified boulder-clay; (3) stratified clay and sand ("pipe-clay and quicksand"); (4) coarse, stratified, gravel and pebbles and a few boulders one or two feet in diameter—colours of gold occur in this gravel; (5) a local bed of coarse slaty material, with thin, broken quartz bands running through it. This is apparently decomposed slate, originally thrown down as talus at the foot of a slope or of a boss, although now very compact; (6) fine, yellow sand with ochreous streaks through it, passing into rotten rock beneath, the strata being in the same position as in the solid rock; (7) non-glaciated slates, dipping south-east at a high angle.

"Saprolite."

The most remarkable member of the series is number (6), which is unlike any other bed met with in connection with the gold-bearing deposits of Beauce county. Material of this kind found in the gold fields of the Southern Appalachians, where it is quite abundant, has been named *saprolite* by Dr. G. F. Becker, of the United States Geological Survey.* The occurrence of this rotten rock mantled by other pre-glacial beds in the east bank of the Chaudière, in a position exposed to the full force of the Laurentide ice as it invaded the district and

*Sixteenth Annual Report U. S. Geological Survey, 1894-95, p. 289.

moved from north-west to south-east, evidences the slight erosive action of the Pleistocene glaciers in some portions of the "Eastern Townships" of Quebec.

The Bras, Pozer, Samson and Gosselin Streams.

Bras River. Gold was found in the alluviums of the Bras River at an early date, its occurrence there being noted in the Geology of Canada, 1863. It was traced along this stream for a distance of twelve miles from its mouth. Below the fall, which is about three miles from the mouth, a good deal of prospecting and washing has been done; but no regular systematic exploitation has yet been attempted.

Pozer River. In the valley of the Pozer River. some exploratory work by Mr. Humphrey led to the discovery of an old channel. A shaft about 40 feet deep was sunk near the line between the first and second concessions, passing through, in descending order:—stratified gravel, boulder-clay and yellow gravel. Whether the latter proved auriferous or not I could not learn. The bottom was not reached, as water came into the shaft so rapidly that the work had to be abandoned. Nothing seems to have been done there since, although gold has been panned from the gravel of the river-bed in several places.

Samson Stream. The Samson, a branch of the Chaudière, entering it about 20 miles east of Lake Megantic, has been prospected for gold, and is reported to have given promising indications. Actual mining had not been undertaken there, however, at the time of my examination of the region.

Gosselin Stream. The Gosselin Stream in St. Victor de Tring, was explored many years ago. Mr. Kennedy sunk a shaft 60 feet deep, and reached the ancient channel, but the results of this work were not ascertained. Gold was found in the gravels and sands of a number of the branches of the Bras River, in the Township of Tring, but beyond prospecting these nothing has been attempted.

Main Chaudière Valley.

Main Chaudière valley. Although it is generally held that the valley of the Chaudière River itself must be, in some parts at least, rich in gold, yet alluvial mining has been attempted only in a few of the shallower portions of its bed, namely, at the Devils Rapids, near St. François, and at the Big and Little Falls, three miles above the mouth of the Du Loup. At the former place, where the river is confined to a narrow, rocky channel, a con-

siderable amount of gold has been found from time to time in gravels and in crevices of the rocks beneath. Mr. Michel, in the report already referred to* thus speaks of the occurrence of gold here,—

Michel's observations at Devils Rapids.

"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 place called the Devils 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 the 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 (Sir W. E. Logan) have described in your Report for 1853-56, page 370, and which is 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 Devils 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."

Conditions at Chaudière Falls.

At the Chaudière Falls, already mentioned, gold has been washed from the gravel and sand, in the river-bed in considerable quantity from time to time. The conditions of its occurrence there are not unlike those met with at the Devils Rapids, the river flowing over

* Report of Progress, Geol. Surv. Can., 1863-66. pp. 54-55.

ledges and rocky beds, in the crevices of which the most gold is to be found. On the west bank of the river a great accumulation of yellow gravel occurs overlain by boulder-clay. A section of the beds here, from the surface downwards, is as follows :—(1) stratified gravel and loam; (2) boulder-clay; (3) the yellow stratified gravel referred to, containing numerous boulders of local rocks; (4) rock. The height of the bank is about 120 feet, and the thickness of the pre-glacial gravel from 40 to 50 feet. The latter was washed for gold, and found to be feebly auriferous. This gravel extends along the bank here for a quarter of a mile or more, lying upon a rocky floor about 50 feet above the level of the river.

Little known of deep-lying deposits.

In the deep-lying portions of the Chaudière valley, although some attempts have been made to find the auriferous beds by shafts, very little is yet known concerning them. It appears, however, that the ancient channel has suffered deformation in pre-glacial and also in post-glacial times, for, while the rock surface at the Devils Rapids is exposed in the channel and there is no evidence of an older or deeper course for the river on either side, yet above the rapids, the ancient valley, as it now stands, is considerably below that level. Indeed, it would seem that the river-bed at these rapids must have sustained a transverse local uplift, with perhaps a correlative subsidence of a belt of country crossing the Chaudière valley between that point and the mouth of the Du Loup. The ascent of the river from these rapids to the last-mentioned point, is from 45 to 50 feet (aneroid), and shafts have been sunk in three places in that distance as described below :—

Shafts sunk between Devils Rapids & Du Loup.

On the east side of the Chaudière River, on a flat just above the Devils Rapids, a shaft was put down under Mr. Lockwood's direction. The following series of deposits was passed through :—

		Feet.
1.	Surface soil mixed with sand and heavy river gravel, about	15
2.	River sand and gravel, finer than above, about	4
3.	Blue clay, with a few boulders of no great size (probably boulder-clay) about	30
4.	Clay and sand with small stones, about	21
		70

Water coming in rapidly, the shaft had to be abandoned. Neither yellow gravel nor bed-rock was reached, nor was any gold obtained.

Another shaft was sunk by Mr. Lockwood's men on the east bank of the Chaudière and near the mouth of Gilbert River, disclosing the following beds in descending order :—(1) "Loose heavy gravel, about

10 feet; (2) blue clay, (possibly boulder-clay, thickness not given); (3) close (compact) hard clay, a few feet (apparently 'pipe-clay'); (4) clay, mixed with sand and fine gravel." At a depth of about 60 feet water came in so rapidly that the miners had to abandon the shaft. The bed-rock was not reached here either.

On the west side of the Chaudière, opposite Jersey Mills, a shaft 77½ feet deep was sunk in a terrace, the level of which is 18 or 19 feet above that of the river at the nearest point. The bottom of the boulder-clay was not reached in the shaft. Evidently an old pre-glacial channel of the Chaudière exists here, whether occupied by the auriferous Tertiary gravels or not, remains to be determined.

Great depth of old channel.

The above sections correspond roughly with those observed by me in other parts of the Chaudière valley, and show also the great depth of the ancient channel of the river in this part of its course compared with the present one. But the facts, while showing the depression or sag here, do not throw any light on the question as to the existence of gold in the river bottom. Mr. Lockwood informs me that, so far as he is aware, nothing is known as to the auriferous character of these deep-seated beds. The opinion prevails, nevertheless, that the deep-lying portion of the Chaudière valley between the Devils Rapids and Big Falls, must have been the receptacle for a large amount of gold, carried into it by the Gilbert, Famine, and Du Loup rivers from the east, also by the Pozer and other smaller streams from the west, but this has yet to be proved by boring or some other means. If auriferous gravels exist there, the fact that they lie wholly below the level of the rock-barrier at the Devils Rapids, renders the exploration of those in the old river bed in this part of its course one of very great difficulty, and only deposits of considerable richness would be likely to prove remunerative.

Difficulty of exploration.

Character of barrier at Devils Rapids.

In proof that the barrier at the Devils Rapids is merely a local one, and the result of a transverse uplift in this part of the valley of the Chaudière, it may be stated that at St. Francois village, below these rapids on the west bank, a shaft was sunk some years ago to a depth of 60 feet, or about 50 feet below the level of the river at the nearest point. Mr. Phillipe Angers, notary, of St. François, informed me that he obtained the facts in regard to this shaft at the time it was sunk, and that the bed-rock was not reached nor any gold discovered. The rock *in situ* is exposed on the east side of the Chaudière a short distance further down, and the pre-glacial valley of the river appears to be close to the foot of the bank or hillside on the west for two or three miles immediately below the Devils Rapids.

Mr. L. Blanchet, of the Registry Office, St. François, had a shaft sunk just at the foot of the rapids, on the west side of the river, reaching a depth of twenty feet or more without finding bed-rock. Water coming in very fast the work had to be stopped. Oxidized gravels were struck, but no gold.

The facts go to show that the pre-glacial valley of the Chaudière immediately below the Devils Rapids, is also very deep.

Occurrence of gold general above Beauce Junction.

Gold has not been found in the alluviums of the Chaudière valley below Bisson, two or three miles north of Beauce Junction; but it occurs everywhere above that, very nearly to the source of the river, and also in the valleys of the tributaries. The pay-gravels are, however, so far as known, embraced within a limited area, not more than eighteen miles long by five or six miles wide, and, indeed, may be comprised within even a still smaller space. Of the total gold production of the Chaudière or Beauce district, amounting to two million dollars or more, a million and a quarter, or perhaps a million and a half, have been taken from the alluviums of the Gilbert River valley alone. Although the district as a whole, cannot be compared with other well-known gold producing regions, its accessibility, and the reduced expense with which gold mining can be prosecuted, are considerations altogether in its favour. It is not supposed that the alluvial deposits are exhausted, though so much has been extracted during the last fifty years. Even in the Gilbert valley there must be many partings and walls between the old workings, still intact, that are as rich as those portions wrought in former years. The Gilbert Beauce Mining Company of St. François, recently organized, operating in the ancient alluviums of that valley, proposes to test these and has already done so with some success.

Post-glacial and pre-glacia deposits.

Reviewing the facts in regard to the occurrence of gold in the valleys of the Chaudière and its tributaries, it would seem that there are two kinds of auriferous gravels there—the post-glacial, feebly auriferous, as a rule; and the pre-glacial, usually oxidized and containing most gold, especially in the bottom. These are found throughout in the river-beds of the auriferous area.

Sedentary and assorted deposits.

The post-glacial gravels and sands containing fine gold in small quantities, overlying the boulder-clay, wherever found here, whether in terraces or alluvial flats, are mainly such as have been assorted and re-assorted from the pre-glacial, yellow, auriferous gravels of the river-valleys. The latter, as has been shown, are of Tertiary age or older, and consist of two kinds, sedentary or residuary beds, or rotten rock *in situ*, that is, decayed rock-materials which have not been removed from their original

situation; and modified, worn, assorted and re-assorted materials, often overlying the sedentary beds, which have been removed from their original situation by atmospheric agencies, rivers, etc., and in the course of transportation have had the materials worn and rounded. These are usually coarse and oxidized in the bottom, and finer towards the summit, changing into clay- and sand-beds. These modified deposits are, of course, stratified, in this showing their mode of origin, and the valleys of south-eastern Quebec appear to have been occupied to a greater or less depth with them at the close of the Tertiary period. The glacial period then ensued, when the boulder-clay was thrown down, often in thick beds, and mantling all the sands, clays and gravels described. At the close of the ice-age, when the glaciers retreated, the rivers began to clear out their ancient channels,—a process which is still going on, few, if any of them, having yet reached the base-level of erosion. In those portions of river-valleys where erosion has extended to the old auriferous beds beneath the boulder-clay, these have been attacked, and the materials have been transported further down the valleys either in terraces, or flats, or in the river-bottoms. In some portions of the valleys these deposits have been again eroded and have undergone a further reassortment. Thus has the gold now found along the present river-courses been distributed, the coarser in the bottom, the finer in the banks and terraces.

Gold at intersection of river channels.

It has been observed that where the latest channels intersect the ancient ones, these transporting and concentrating processes have had the greatest effect, and that just below these intersections the most gold occurs in the river-bottoms. It appears further that the same mode of distribution and concentration prevailed in pre-glacial ages, the greatest quantities of gold having been found, according to Mr. W. P. Lockwood and others, at and immediately below certain shoals or bars in the ancient valley of Gilbert River.

Dr. A. R. C. Selwyn writes in regard to these gold bearing gravels :* "The chief reason why the rich spots where it [alluvial gold] has hitherto been worked are so limited in extent is that they represent the places where the old channel or river-bed has been intersected by the existing one, and cut into down to the bed-rock, re-distributing its contents along the present river-course, and thus enriching, for a limited distance, the recent alluvions."

Orig in of the gold.

Of the origin of the gold in the Chaudière district very little is known, as none of the alluvial gold has yet been traced to its source, and no gold-bearing quartz veins with more than a trace of the precious metal have been discovered. Even in the richest gold producing district—

* Report of Progress, Geol. Surv. Can., 1870-71, p. 276.

the Gilbert River—although it is generally held that the gold there is entirely local, the precise locality or source whence it came has not hitherto revealed itself. Dr. Selwyn says, in the report already quoted: "The worn and comparatively heavy character of much of the gold which has hitherto been procured from the shallow washings in the Chaudière district, does not, I think, indicate that it has been derived from distant sources, so much as that it has been subjected to repeated and long continued abrasion in the drifts." These remarks are applicable to every part of the Chaudière district in which alluvial gold occurs in workable quantities. But, of course, this view can only be regarded as provisional, until gold has actually been found in the rocks in proximity to these alluviums in such quantity as will show that both they and the gold have been derived from the same source.

Little Ditton River.

Little Ditton River.

The alluvial gold mines of Ditton are situated on the Little Ditton, a branch of Ditton River, which is the west branch of Salmon River, an upper tributary of the St. Francis. The principal mines here are the Pope mines, called after the late Hon. J. H. Pope, and are located on lots 39 and 40, range 9, Ditton township. Mr. Pope carried on mining here for many years, and is reported to have extracted from the gravels of this stream, just above the bridge on the Chartierville road, seventy-five thousand dollars worth of gold. Here, as in the Chaudière area, the gold occurs in the lower part of coarse oxidized gravels, and in decayed rock, principally slates, beneath. The bed of the stream and the terraces and flats for the space of half a mile, were wrought by Mr. Pope, who sometimes employed from ten to fifteen men. A few large nuggets and a good deal of coarse gold were found. About the year 1884 or 1885 however, Mr. Pope ceased operations, but desultory mining has been carried on at intervals since. The mines were sold to the Ditton Gold Mining Company (Limited), of Toronto, in 1891, which began work a short distance above the bridge, on the ground from which Hon. J. H. Pope had obtained such quantities of gold. Not meeting with success, this company soon abandoned the property. This property, consisting of a large tract of timber lands as well as the mining rights, formed part of the estate of Mr. Pope, and is now in possession of one of his heirs, Mrs. W. B. Ives, of Sherbrooke, Quebec.

Operations by Hon. J. H. Pope and others.

Mr. Obalski, Inspector of Mines for Quebec, thus reports concerning work carried on at the Ditton Mines:—"In September, 1889, three parties of miners, numbering ten men, were digging on small claims, and on one of these I saw $30 worth of the precious metal, including a piece worth $15, collected in a single day.

Report by Mr. Obalski, 1889.

Each pan washed on this stream, as well as on the Ditton and Salmon rivers shows gold, and I was assured that the metal had also been found on several of their tributaries, among others on lots 5 and 6 of the VIIIth range of Ditton, and 4 and 5 of the IVth range of Chesham (Salmon River) where some small workings have been begun." Mr. Pope, during his life-time, and also the present owners of the mines, usually gave a few parties liberty to work on their own account in different parts of the valley, without exacting any royalty or rent from them, such work, however, being mostly in the nature of prospecting.

"On account of the slight depth of the alluviums covering the pay-gravel, these works are easily executed, open pits or cuttings being sufficient, and shafts being rarely needed."*

Report by Dr. Ells, 1886.

In reference to the Ditton gold mines, Dr. Ells thus reports:—"That attention has not been directed to this locality is in a large measure due to the fact that what is regarded as the most promising field for work, is entirely in private hands, and no royalty being in consequence paid to the Government, no official returns are available as to the amount of the precious metal obtained. Alluvial gold has, however, been found there and worked for many years. The place where operations have been more particularly carried on is on the Little Ditton stream, on lots 23 and 24, range IX., Ditton. Nuggets ranging in value from $50 to $150 are reported as having been found. Though a considerable amount of work has been done on this stream and a large quantity of gold obtained, no scientific mining has been attempted. The ground being generally low, the facilities for getting rid of the tailings are very poor, and in many of the trials the bed-rock does not appear to be reached. From the specimens already obtained, and the generally favourable results of the work already done under unfavourable circumstances and with ordinary appliances, it is evident that much rich ground must exist in this vicinity." †

Negat.ve results of quartz assays.

The writer made an examination of the Little Ditton valley and the upper portion of the Ditton River itself in 1895, and again in 1896. Specimens of quartz were collected at several points, especially from a shaft sunk in a quartz vein from two to three miles above the bridge on the Chartierville road. These were assayed for gold in the laboratory of the Geological Survey, but with negative results.

Sluicing in 1896.

Sluicing was carried on during both seasons for a short time. In 1896, two men from Scotstown, Messrs. McCritchie and McKay, were at work about a quarter of a mile above the bridge referred to, at the time of my visit. Here they washed the gravel for some weeks and obtained gold. One

*Mines and Minerals of the Province of Quebec, 1889-90, p. 64.

† Annual Report, Geol. Surv. Can., vol. II. (N.S.), 1886, p 56 J.

nugget, weighing an ounce, was found at the bottom of the gravel close to the bed-rock. The chief auriferous deposits occupy this position and are partly residuary and partly stratified. They are rusty and oxidized, as is also the upper portion of the rock beneath. These are all evidently pre-glacial, although the boulder-clay is rarely seen in contact with them in the Little Ditton valley. Overlying them are alternating gravel and sand beds, as shown by the following section exposed on the north side of the river about a quarter of a mile above the Chartierville bridge

Section.

1. Loam or river wash from 2 to 4 feet thick.

2. Gray gravel, packed full of pebbles well rounded, from 6 inches in diameter downward; thickness about 1 foot.

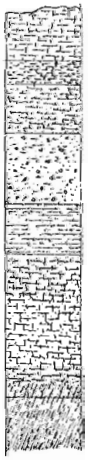
3. Sandy gravel with two layers of pebbles, the same size as in No. 2, the whole very dark or black from the presence of iron or manganese, thickness from 2 to 3 feet.

4. Gravel, rusty, oxidized, packed with boulders of all sizes up to 2 and 3 feet in diameter, from $2\frac{1}{2}$ to 3 feet thick.

5. Clayey gravel and sand with a few boulders from 6 inches to a foot in diameter, rusty in places; thickness from 1 to $1\frac{1}{2}$ feet.

6. Coarse gravel, ochreous, with round boulders from 6 to 9 inches in diameter in the upper part, but angular and embedded in material resembling rotten rock in the lower part. This rests on jagged, broken rotten slates, non-glaciated. The gold is found in the lower portion of No. 6, and on the rock-surfaces, as well as in the clefts beneath.

Fig. 6.



SECTION IN LITTLE DITTON RIVER VALLEY.
SCALE:—8 feet to 1 inch.

All the materials except the lower part of No. 6 are stratified.

The thickness of the several members of the series differs going up stream, some of them being absent in another pit immediately above the one in which the section was measured.

Absence of boulder-clay.

The absence of boulder-clay in the bottom of Little Ditton valley leads to the presumption that all the beds are of post-glacial origin except the inferior member of No. 6, which contains angular pebbles and stones and seems to be rotten rock resting on decayed and decaying rock-surfaces.

Source of the gold.

The rich deposit of auriferous gravel at the Pope mine, occurs just where the old pre-glacial channel is traversed by that of the present river; but the source of the gold in this part of the Ditton valley has not yet been traced. Has it been brought down stream from the pre-Cambrian at the International boundary five or six miles distant? Against this view there is the fact that a number of large nuggets,—one valued at $138—have been found at or near the Pope mine, which could hardly have been transported that distance by the river. If we suppose, on the contrary, that the gold is derived from the Cambrian rocks, the fact has to be borne in mind, that a number of specimens of quartz from veins in the part of the river yielding auriferous alluviums, failed, on assay in the laboratory of the Survey, to yield any traces of the precious metal.

The gold in fluviatile gravels.

The deposits occupying the valley of the Little Ditton appear to be all fluviatile, except the rotten rock in the bottom, and are due mainly to the erosion of the boulder-clay and other materials which occupied it at the close of the glacial period. Although the boulder-clay has been thus eroded in the river-channel it is still to be found on the slopes on either side of the somewhat deep valley. On the north it seems to cap deposits of the yellow stratified gravels.

The gold-bearing alluviums extend along Little Ditton valley from its confluence with the main Ditton up to its source near the International boundary in the vicinity of Prospect Hill, an intrusive mass of diorite.

Further occurrences of gold.

Alluvial gold has also been reported from two branch streams of the Salmon River flowing southward off Big Megantic Mountain. It has likewise been stated that it occurs in the valley of Spider River which flows north-westward from the International boundary through a granite district into Spider Lake.

Stratified deposits in upper valleys of Ditton and Little Ditton.

The district drained by the upper branches of Ditton River, is occupied by thick deposits of boulder-clay overlain by stratified

sediments. Sedentary beds of decayed rock-material lie beneath, but whether in continuous or detached sheets has not been ascertained. A wide undulating plain 1800 or 1850 feet in height above the sea, extending along the foot-hills and abutting against them, exists here. The sedimentary deposits of this plain appear as if they had been laid down in a lake or in the sea. No barrier exists at present to the north capable of holding in a body of water at this elevation. The upper portion of the valleys of both the Ditton and Little Ditton rivers are buried in these deep sediments as far up as the foot-hills. No Laurentian boulders were met with in this district, the superficial materials being mainly such as have accumulated in this particular locality from the decay of the underlying rocks, together with that transported northward from the mountains along the International boundary, which are here 2500 to 3000 feet high or more. The question arises, therefore, has the gold found here accumulated in the alluviums during the decay of the rocks and undergone transportation north-westward as the sediments were transported and deposited? Different relative local levels have existed and these may have effected a greater erosion of the beds in Tertiary and Post-tertiary times, and broughtabout such a reduction of the surface of the region and especially of the ancient barrier or barriers which held in lakes, if any ever existed, as to have obliterated them. By these changes whatever gold was in the rocks, and in the decayed materials which gathered on the surface, would gradually find its way into the river-valleys. But whatever changes occurred, the fact remains that we have here a remarkable accumulation of sediments along the foot-hills and in the old river-beds in the bottom of which gold occurs. The sediments when cut into and transported greater or less distances by the post-glacial rivers, have thus left, by concentration, considerable quantities of gold in the shallow portions of the beds of the several branches of the Salmon and other rivers in this part of the "Eastern Townships."

Materials local.

Mode of accumulation of deposit here.

Dudswell District.

The Dudswell district is one which has only recently come into prominence as regards gold mining. This district occupies the south-eastern and eastern slopes of that portion of the Stoke Mountain range lying between Dudswell Lake and Stoketon, or Ascot Corners. All the streams flowing down from this mountain (which is locally known as Dudswell Mountain), south-eastward, southward and south-westward, have been found to contain alluvial gold. These streams have local names which do not appear on the Geological Survey maps. The

Dudswell district.

First work 1891-92.

earliest work in this district was that begun by Messrs. Rodrigue and Mathieu on the Hall Stream, lot 11, range VI., Dudswell, in 1891-92. Two shafts from forty to fifty feet deep were sunk to bed-rock. These were not, it appears, put down in the deepest part of the old channel, and consequently when drifting was attempted great difficulties were experienced in keeping the works free from water. Although gold had been found in the stream-bed for some years, yet the gravels in the bottom of the shafts did not yield any satisfactory returns, and finally after spending a large amount of money and labour here the works were closed. It is said one nugget worth $90 was found in the gravels of this stream in 1893. Messrs. Rodrigue and Mathieu afterwards prospected other streams flowing off Dudswell Mountain, finding gold on almost every one of them. But as Kingsley Brook seemed to afford the best results, they continued operations there for some years.

Work on Kingsley Brook.

In 1895, on the occasion of my first visit to Kingsley Brook, I found these gentlemen at work with four or five men, and so far as could be learned they were meeting with fair success. Two nuggets worth about $90 had been found a short time previous. Gold had been found in several places along the stream-bed. Respecting operations here, Mr. Obalski thus reports:—*"Gold has also been found on the upper portion of the stream. Some prospects were also made on the neighbouring streams, especially Harrison Brook. The valleys of the streams running down from Stoke Mountains are rather narrow and shut in. It has not been proved that the auriferous alluvial area is extensive, but there is an important fact to be noted, and that is that several pieces of quartz weighing one or two pounds, containing gold visible to the eye, have been found in the streams . . . These pieces are generally yellowish in colour. Three years ago, on the Hall Brook, a large block of stone very little rolled was found, containing many visible specks of gold. This rock was a kind of quartz conglomerate with average grain, crossed by narrow strips of quartz."

Gold in quartz fragments.

Work since 1895.

No work has been going on at Hall Stream since 1895. In the four streams west of this, however, namely, Rowe, Kingsley, Maynard or Harrison, and Big Hollow, more or less alluvial mining has been in progress every summer, though with varied and uncertain results. On Kingsley Brook a good deal of work has been done, first by sluicing in the ordinary way, and latterly by hydraulic washing. Several thousand dollars worth of gold must have been obtained, though the exact amount cannot be ascertained. Messrs. Rodrigue, Mathieu, Coupal, Hayemal, Sotero and others operated on lot 3, range IV., Dudswell,

*Report of the Commissioner of Crown Lands, Quebec, 1895, p. 55.

until 1896, while Messrs. Osgood and Hall wrought on lot 4 of the same range. Several good spots were found, though the gold was somewhat irregularly distributed.

Deposits in Kingsley Brook.

In the valley of Kingsley Brook the deposits, glacial and pre-glacial, seem to have undergone similar denudation and assortment to those of Little Ditton River. Here, however, they seldom exceed a thickness of three or four feet. A section of the beds in descending order is as follows: (1.) One to three feet of mould or alluvial wash, becoming coarser in the bottom; (2.) gravel, brown and ochreous, with angular or slightly worn pebbles, and a few boulders, some of which are from five to ten feet in diameter. These stand up above the surface and are glaciated. The materials of the gravels seem to be local, or transported only short distances by the stream, and are auriferous; thickness, one to two feet. (3.) Compact, ochreous gravel, generally in thin detached masses; the materials as in number (2), but so hard and compact that a pick is required to remove them. This is probably the equivalent of the yellow gravels of other river-valleys,—the remnants which have escaped denudation. They contain gold; thickness from three inches to two feet. (4.) Gray schistose rock, slaty in places, non-glaciated. In the crevices of this, and below reefs and ledges, or in the lee of the large boulders, most gold is found in the gravels.

Maynard Brook.

In Maynard (Harrison) Brook the succession of the deposits and mode of occurrence of the gold are very much the same as in Kingsley Brook, except that the beds are rather deeper, and the valley wider. Great quantities of black sand were noted here. The amount of gold taken out of this stream was not nearly as great as that obtained in Kingsley Brook.

Rodrigue Mining Co., 1896.

Early in 1896, a company called the Rodrigue Mining Company was formed to operate the gold mines of Kingsley and adjacent brooks, and Mr. H. C. Donnell, of Boston, Mass., appointed manager. Having secured the mining rights of this stream, a dam was constructed near its source, and an 80 horse-power boiler and hydraulic pump were put in, principally to work the gravels. Mr. Donnell started on lot 3, range IV. first, extending his operations up the valley of Kingsley Brook. On the occasion of my visit, in the summer of 1896, he informed me that he was finding gold in paying quantities. Eight or ten men were then employed. Though sluicing the gravels from the lower part of the valley upwards, his ultimate object, he stated, was to discover the auriferous quartz or matrix, which he hoped to do as he uncovered the rock-surface in the progress of his work. The boiler was large enough

to furnish power to drive a 50 or 60-stamp mill, and could be utilized for that purpose when gold was discovered in the rock. Later it was found that the upper two or three feet of the schists and slates in the bottom of Kingsley Brook valley being decayed, and full of joints and crevices, contained quite an appreciable amount of gold. Mr. Donnell set about mining these, and sank his sluice boxes into the decayed rock some depth. The discovery of alluvial gold in these rock-fissures and openings implied, he claimed, an amount of work with profitable results which the gravels alone could not afford.

Operations in 1897.

In the summer of 1897, the Rodrigue Mining Company was still carrying on operations, but did not seem to be meeting with the success that was anticipated. The occurrence of the gold was found to be irregular; water became scarce in the midsummer months, and the large boulders met with in the valley were found to be a serious hindrance to hydraulic work. Attempts were made to obviate these difficulties, first by raising the dam, and second by blasting or removing the boulders by derricks. In the autumn of that year the Rodrigue Mining Company sold out to another Boston company.

Rowe Brook.

On Rowe Brook, from one to two miles north-east of Kingsley Brook, lot 8, range IV., Dudswell, alluvial gold mining was prosecuted during the season of 1896 by Messrs. Hayemal and Sotero for some months, who reported gold in paying quantities obtained by sluicing. A clean-up witnessed while visiting this stream seemed to prove this statement, about $3.00 worth of gold being obtained as the result of three-fourths of a day's work by one man. The gold was coarse and unworn. This stream is larger than Kingsley Brook, but the gradient of the valley is not so steep. The depth of the superficial deposits seems to be about 8 or 10 feet.

Big Hollow Brook.

During the summer of 1897, some prospecting was done in the valley of Big Hollow Brook, which lies to the south-west of Maynard, (Harrison) Brook, but the particulars were not ascertained.

Deposits of Dudswell chiefly post-glacial.

The deposits in the valleys of all the streams flowing off Dudswell, or Stoke Mountain seem to be closely similar to each other and to have the same origin, that is, they are mainly post-glacial. Boulder-clay was observed only on the slopes of the valleys, and the only material met with which may be pre-glacial is a dark rusty gravel, forming a hard-pan, in detached masses, lying immediately on the surface of the decayed rock and containing a little gold. This material, seen in several places in the bottom of Kingsley Brook, is often so compact that a pick is required to remove it. It varies in thickness from three inches to a foot or two.

All the other materials occupying the valleys of these streams are assorted and fluviatile, and contain boulders of various dimensions, foreign to the locality, some from five to ten feet in diameter. Gravels predominate, but occasionally clay and sand occur. It is in the bottom of these that the most gold is found.

Alluvial gold mining seems capable of being prosecuted at less expense at Dudswell than in the Chaudière district, as the beds are shallow and contain neither boulder-clay nor quicksands, except in the flats and terraces, where the streams escape from the mountains. But the gold-bearing area here is limited, and the precious metal is irregularly distributed in the gravels. The probability is, therefore, that unless gold in workable quantities is found in the matrix, mining will soon become unprofitable. Gold easily worked.

Lambton.

Gold was found in the township of Lambton many years ago, but only in small quantities. Mr. Michel visited this locality during his examination of the gold-fields of south-eastern Quebec, 1863-66, and reported on it thus :—"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 ago explorations were 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. Lambton. Michel's observations.

"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 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."....

Gold at Lambton.

"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 Sherbrooke 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 III., before falling into Lake St. Francis. Having learned while at Lambton that gold had been found at 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 lot 9, which like lot 8 was traversed by veins of quartz; explorations on 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."

No work has been performed in the Lambton district since Mr. Michel's examination. Several valleys and beds of streams in the ridge west of St. Francis Lake, which is a continuation of the Stoke mountains north-eastward from Dudswell, would be worth examining and prospecting; but the streams have cut deep courses among the hills, and it would be a very difficult task to reach the bottom of their old channels. Hence no systematic exploration of this part of the country has been attempted. Dr. Ells says:—"A belt of Cambrian slates, however, cut by granite, crosses Lake St. Francis about midway, where the conditions for gold should be more favourable. This area has, however, never been tested, and certain portions of the Cambrian slates, along with the serpentines and diorites of Thetford, Broughton and Adstock, and extending thence northward to the Chaudière at the Bras and the Colway, present many features in common with the rocks of the gold-bearing districts on these streams."*

*Annual Report, Geol. Surv. Can., vol. IV. (N.S.), 1888-89, p. 73 K.

Ascot, Magog, etc.

Gold at Ascot, Magog, etc.

During Mr. Michel's explorations in south-eastern Quebec, he examined the auriferous deposits of Ascot, Orford, Magog, etc. Two companies were at work here about that time, the Golconda Mining Company on Grass Island Brook, a mile and a half above lot 6, range XII. of Ascot, where they carried on some work and planned an establishment. On the lot above mentioned, Mr. Michel opened three excavations, 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, [described below,] 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."

The Golconda Mining Co.

Mr. Michel states that this company (The Golconda Mining Company) had a subscribed capital of $5,000,000, and in their prospectus ascribed extraordinary richness to lots 2 and 3 of range XII. of Ascot, traversed by 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 alluviums, while the quartz and the slates found on the property were declared, according to published assays, to contain an average of $153 in gold, and $7.53 in silver, 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 favourable, yet all working at the Golconda Mine was abandoned in September, 1865.

Character of deposits.

As regards the character of the deposits and mode of occurrence of the alluvial gold, Mr. Michel thus writes:—"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."

Ascot Gold Mining Co.

The other gold mine was that owned by another American company called the Ascot Gold Mining Company, on lot 11, of range IX. of

*Report of Progress, Geol. Surv. Can., 1863-66, p. 63. *Ibid.*, pp. 63 and 65.

Ascot. Remarkable results were also said to have been obtained from the workings in this mine. Mr. Michel states that, according to a report in the *Sherbrooke Gazette*, of November 18th, 1865, there was extracted from this mine by 553 hours labour, an amount of gold equal to $996, corresponding to $1.81 per hour for each labourer. As, however, the working had been abandoned at the time of Mr. Michel's visit, he had not the means of examining it.

Examinations at Orford.

An examination of lot 19, of range V., of Orford, was also made by Mr. Michel, as it presented a special interest owing to discoveries reported to have been made on neighbouring lots, several of which had been sold at high prices as containing workable auriferous alluviums. Mr. Michel says:—"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 sparsely 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 passing through two or three feet of vegetable soil and a similar thickness of auriferous gravel, presented a mass of extremely compact bluish clay inclosing 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 colours."....

"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."

Mr. Michel's observations and conclusions, it may be remarked, hold good to the present day.

Massawippi Lake.

Alluvial gold at Massawippi Lake.

Alluvial gold in small quantities has been known for many years to occur in the valley of a small stream flowing into the west side of Massawippi Lake, on lot 14, range VI., Hatley, Stanstead county. Mr. Charles Rodrigue prospected and wrought the gravels of this stream for gold, but was unsuccessful. In 1894 or 1895, Mr. Wm. Jamieson, of Magog, Que., who had acquired the mining rights of this property, did some sluicing and reported having extracted about $50 worth of gold. It was then purchased by an English company, represented by Mr. James Stark, of Liverpool. In May, 1896, when the writer visited this region he found Mr. Stark at work there with twenty two men. Some gold was found in the gravels, but not in sufficient quantities to pay for working them. Mr. Stark's object was, however, to find it in the matrix. Broken quartz seams, with sulphide minerals, traverse slaty and talcose rocks mapped as pre-Cambrian. Specimens brought to the office and assayed for gold in the laboratory of the Geological Survey failed to show it. Work was discontinued after a few months.

The stream along which the alluvial gold occurs, runs entirely across pre-Cambrian rocks, and the gold appears, therefore, to be derived from these. It is rough and apparently has not travelled far. The valley of the stream is not unlike that of Kingsley Brook, Dudswell, and the mode of occurrence of the alluvial gold is also much the same, except that the beds are of less thickness, nor did I observe the oxidized hard-pan in the bottom. This similarity of character and conditions can be observed throughout the Stoke Mountain Range, wherever gold has been found.

General Observations on the Gold-bearing Alluviums.

Remarks on the gold-bearing alluviums generally.

In the foregoing pages an attempt has been made to collect together and co-ordinate all the information possible to be obtained respecting the alluvial gold of South-eastern Quebec. As has been shown by a number of geologists and mining experts who have studied the alluvial deposits of this region, the original distribution of the gold in the pre-glacial river-beds here appears to be the same as in other countries. But the great changes of climate and the oscillations of level which took place in the latest geological periods, have subjected these deposits to greater denudation than elsewhere; and in the valleys and upon the lower grounds they are buried beneath immense accumulations of boulder-clay and other products of the ice age. In Australia, Cali-

fornia, Africa, South America, etc., where similar gold-bearing alluviums occur, they have not been eroded by grinding ice-sheets of Pleistocene age, nor overwhelmed by a thick covering of boulder-clay. Overlying the true auriferous gravels in a number of the larger river-valleys in the region in question, or occupying a position between these and the boulder-clay, occur beds of fine sand and clay which are called 'quicksands' and 'pipe-clay' by the gold miners. In the valleys of the Chaudière, Du Loup, Gilbert, Famine, Des Plantes and Mill rivers, and also in the upper part of the Little Ditton, these sands and clays are developed in great thickness, and, together with the overlying boulder-clays, form one of the greatest obstacles to alluvial mining in the deeper workings.

Degradation of the land.

The inquiry respecting the causes which produced the present condition of things takes us back to an early period in the geological history of the region,—soon after it first emerged from beneath the sea and became dry land. Subaerial denudation than began and has been in incessant operation ever since. The larger rivers then had their origin and began to carve out their valleys. Throughout the long ages which have intervened, these forces of nature, under varying conditions, have been actively engaged in wearing away and reducing the surface of the land. This reduction has been unequal, because of the unequal hardness of the rocks, and their power of resisting erosion. The degradation of the surface from these agencies must have been enormous, amounting to several hundreds, perhaps several thousands of feet, entirely changing the appearance of the country; the existing residual forms of relief being, in no small degree, the result of this denudation. Regional and orogenic movements have taken place during these ages, the effects of which are evidenced in the mountain ranges as well as in the folding and crushing of the strata, and the dislocations of the river-valleys. The records of the earliest of these are nearly all lost or so imperfectly recorded that it is not possible to reconstruct the original physical features of the country.

Probable condition of things in the Tertiary.

Coming down to the Tertiary period we can, perhaps, form some conception of the appearance of the region, though in an imperfect manner, if we suppose it stripped of all the boulder-clay and overlying deposits. Except as regards some of the more prominent hills and summits, the surface of the rocks would be mantled by a thick sheet of their own débris. On the slopes and in the river-valleys this material would be largely denuded, and portions of the decayed rock-material would form stratified beds, especially where it had undergone modification and transportation by fluviatile agencies. It is to

these modifying agencies that the concentration of the gold in the river-bottoms is due. The larger and deeper valleys of the "Eastern Townships" evidence thick accumulations of these deposits.

Gradient of rivers in Tertiary and Pleistocene.

In the Tertiary period there would seem to have been a steeper gradient for the old rivers of the "Eastern Townships" than at present. The dislocated portions of their valleys, referred to on a foregoing page, and the fact of the old channels having been more deeply eroded than the present ones, are evidence in support of this view, their erosive action apparently, having been, more powerful. If the gradient of the Chaudière River, for example, were the same now as at the period of the deposition of the yellow auriferous gravels, the river and its tributaries would probably have cut down through these to their ancient base-level during post-glacial time. But the differential or orogenic uplift of the whole Sutton Mountain axis, or rather of that belt of country occupied at present by eruptive rocks, extending from Lake Memphremagog to the Chaudière River and north-eastward to Cranbourne, took place apparently some time in the Tertiary, changing the drainage of the whole district to the south-east. This was probably only one of several oscillatory movements tending in this direction, but when it occurred, the uplift referred to was evidently sufficient to cause a ponding of the rivers in certain parts of their courses. In the valley of the Chaudière we have evidence of this ponding in that portion extending from the Devils Rapids to the junction of the Du Loup, as well as in the lower parts of the Gilbert, Famine, etc. Considerable quantities of fine stratified clay and sand were laid down at this stage (pipe-clay and quicksands) usually resting upon the old stratified auriferous gravel, locally known as the yellow gravel from its highly oxidized condition. These beds seem to have been deposited just before the advent of the glacial period.

The original pre-glacial gradient indicated by these dislocated valleys seems never to have been restored, although there is evidence of the North-east Appalachians having been from 300 to 500 feet higher than at present in the later Tertiary and early Pleistocene, as shown on a previous page.

Pre-Pleistocene clays and sands.

After a considerable deposit of these fine clays and sands had been laid down, glacial conditions supervened, and ice began to form upon the surface of the region and to move in the directions shown by the striæ already recorded. At the close of the glacial period the whole country was evidently at a much lower level than at the present day, as shown on page 50 J, and the sea not only invaded the St. Lawrence valley throughout its whole extent, but also the valleys of its principal

tributaries, such as the Chaudière and St. Francis, and thick deposits of material, constituting the Leda clay and Saxicava sands, were laid down upon the boulder-clay. On the rise of the land which followed, fluviatile beds have been superposed on the series in river-valleys, often to a considerable depth, especially in those of any size. As the materials of these fluviatile beds are partly derived from the boulder-clay and pre-existing formations, they usually contain gold in auriferous districts, although seldom in paying quantities.

Irregular distribution of gold in the alluviums.

From the observations of geologists and mining men in the auriferous area in question, it has been ascertained that the alluvial gold is not regularly distributed in the ancient river-bottoms, some portions being rich, while others do not yield the precious metal in remunerative quantities. This distribution does not seem to follow any rule or law, although probably there were reefs and shoals in the old river-channels, which proved to be resting places, and immediately below which the particles of gold would find shelter from the force of the currents. The richest gold-bearing spots are often isolated from each other, and consequently what is termed a "lead" is seldom continuous for any distance. Even when it is supposed to be continuous, interruptions are not infrequent, the "lead" being taken up or renewed on one side or the other and continued on again for a further distance. This irregularity causes the miners to infer that some river-bottoms have two or more "leads." But the fact merely serves to show how unequally the gold has been distributed in the alluviums, and proves that the distribution was governed by the strength of the currents and the form of the river-bottoms. Where the currents slackened, or where there were shoals or reefs, the particles of gold would be most likely to be dropped. The occurrence of gold in the crevices of the rocks under the river-beds, and especially between the folia of slates which are more or less tilted, is a somewhat difficult problem to solve, although one common to many gold-bearing districts. Only on the supposition that the particles of gold have been passing over these rock-surfaces for a very long time, can it be conceived how such a number could become lodged in these rock-crevices and openings. The movement of the gold particles must have occupied a prolonged stage of the river's history, or a series of successive stages which must have extended over a very long period, even geologically speaking. During this time there seems to have been a constant movement of the materials occupying the ancient river-bottoms—at one time deposition, at another erosion, the latter often reaching to bed-rock in places. By these processes the gold particles would find the lowest level and become lodged in the clefts of the

Causes of this.

rocks. Prolonged shifting of the gravels and their gold contents in this manner, assorting and re-assorting the materials and the sifting out of the least weighty, allowing the gold and other heavy particles to settle to the bottom,—were the processes which produced the present condition of things in the valleys containing the auriferous alluviums.

Very little gold except in river bottoms.

The question is often asked whether the auriferous alluviums of economic importance are all confined to the river-valleys, or whether or not they are also to be found on the slopes of these valleys and in other parts of the gold-bearing districts beyond these. Very little prospecting, so far as the writer is aware, has been done, except in the river-bottoms, but what has been attempted on the higher grounds has not tended to encourage the belief that there are workable deposits on the higher slopes. Of course it is quite an easy matter to find placer gold almost everywhere within the gold-bearing districts in minute quantities, on the higher as well as on the lower levels; but the difficulty is to get it in quantity sufficient to pay for working. As already pointed out, even in the valley bottoms where the gold has undergone the greatest amount of concentration, it is only in spots that pay gravels are found. On the upper slopes and in tracts outside of the river-valleys, no instance of its having been met with in remunerative quantities has come to my knowledge. On this point Mr. Wm. P. Lockwood states: "I have during the last thirty years endeavoured to find upper auriferous gravels of paying quality, I mean any considerable deposit above the level of the present rivers offering fair inducements for the employment of machinery and modern methods to handle with profitable results, and have failed. I am convinced no such deposits exist in the Chaudière district."

Hindrances to alluvial mining.

The superficial deposits of the "Eastern Townships" of Quebec containing gold are differently constituted from those of other known alluvial gold mining regions, except, it may be, in British Columbia the Yukon and Siberia. Below the boulder-clay and quicksands, the beds are practically the same as in most other countries, consisting of clay, sand and gravel, becoming coarser and more oxidized towards the bottom. The boulder-clay, quicksands, etc., usually mantle and conceal all the auriferous alluviums, and are apparently greater hindrances to alluvial mining than even the lava beds of Australia and California. Either in sinking shafts or in drifting, they constitute the great drawback to the exploitation of the deeper alluvial mining of Beauce county. This fact, together with the scattered distribution of the precious metal in the gravels beneath, already referred to, are con-

ditions which render gold mining here precarious and uncertain. In the ancient pre-glacial channels, the gold has, of course, been more or less concentrated; but when it is considered that these often lie below the present water-courses, and that tunnels or drifts at these levels are likely to receive a portion, at least of the drainage waters, the expense of exploration is great and only alluviums of considerable richness can prove remunerative.

Gold mining chiefly in the shallow beds.

Gold mining in the region in question has consisted largely in the exploration and washing of the gravels in the shallower beds, and but little has been attempted in the deeper portions, or where the auriferous deposits lie below the level of the present river-beds, except in the Gilbert valley, where alluvial mining was carried on at various depths from 30 to 80 feet below the channel of the present river, as shown on a previous page. The future exploration of these deep-lying deposits seems to be the direction in which mining efforts should lie, especially in the valley of the Chaudière and the lower parts of the main tributaries. Although great local difficulties present themselves in attempting to explore these valleys in the particular localities mentioned, they would appear, nevertheless, to offer an inviting and ample field for the mining engineer and practical miner. While the prevailing opinion in regard to these deposits is that they are rich in gold; their auriferous character should be sufficiently tested before development work is undertaken. If the gold-bearing gravels were known to be equally rich, or to have the same value throughout, they might be opened in the most accessible locations at the surface and worked thence downward; but these auriferous beds do not all seem to be equally rich, and, moreover, some portions at least, will likely be found not to contain gold in paying quantities. The necessity for exploring and testing them before commencing work is therefore evident. To effect this exploration adequately, it would seem that boring machines might be utilized to good advantage, especially in the Chaudière and Ditton districts. With appliances of this kind the position of the old river-channels, in which the alluvial gold is supposed to have been concentrated, could be located at less expense and in much less time than by shafts or tunnels, the thickness, and probably to some extent the paying character of the auriferous beds beneath made known, and the advantages or disadvantages with respect to drainage ascertained before commencing actual mining operations.

Boring machines.

Preliminary exploration of this kind therefore seems to be necessary to prove the gold contents and show, if possible, whether these

would warrant the expenditure necessary to work the deep-seated auriferous deposits. Some portions of the deposits, it is evident from the great expense attending their exploration, will require to be very rich in gold in order that they may be profitably mined, while in other places there does not seem, as already stated, to be sufficient gold to prove remunerative under the most favourable conditions for extracting it. A thorough study of these, and of the mode of occurrence of the gold in them, drawn from actual examination, are desirable, and in this investigation the experience of the old miners who have spent a large portion of their lives, and in some cases considerable sums of money, might be made use of to advantage. Knowledge and skill are, however absolutely necessary to success, and these if acquired from a study of the peculiar phenomena of the region itself, will prove to be the most serviceable.

Source of the Alluvial Gold.

Source of the alluvial gold.

Although the gold-bearing alluviums of South-eastern Quebec have been wrought and studied for more than half a century, by geologists, mining engineers and others, and a considerable mass of literature relating to their distribution and mode of occurrence published, yet very little is known concerning the true source of the gold found there. Logan and Hunt regarded its source as being in the oldest rocks of the region. In the Geology of Canada, 1863, it is stated :—

In Notre Dame Range.

"The source of the gold appears to be the crystalline schists of the Notre Dame Range; the materials derived from their disintegration, not only constitute the superficial material among the hills of this range, but are spread over a considerable area to the south of them. These same gold-bearing rocks may be traced south-westwardly, along the great Appalachian chain to the southern United States, and are supposed to belong, for the most part, to the Quebec group."*

At St. Francis.

At that time native gold had been found "in small grains with galena, blende and pyrites, in a well-defined quartz-vein, cutting slates which were supposed to be of Upper Silurian age, (since referred to the Cambrian), at the rapids of St. Francis, on the Chaudière.

Leeds.

In Leeds, at Nutbrown's shaft, masses of native gold of several pennyweights are found with copper-glance and specular iron-ore, in a vein of bitter-spar, and small grains of the metal have also been found imbedded in the white garnet-rock described on page 496." "The gold of Eastern Canada appears not, however, to be confined to the rocks of the Quebec group. Although it occurs in these with the copper ores of

* Geology of Canada, 1863, p. 519.

Ascot and Leeds, and in the garnet-rock of Vaudreuil, it is also found with mispickel and argentiferous galena in veins of quartz which traverse the upper slates."*

A considerable number of assays of supposed gold-bearing quartz have been made from time to time in the laboratory of the Geological Survey of Canada, and by reliable and competent assayers, which although affording merely traces of gold in many instances, yet serve to show that the rocks of the district really do contain the precious metal.

Gold in quartz veins of Rigaud-Vaudreuil.

When Mr. A. Michel made his examination of South-eastern Quebec, (1863 to 1866) he collected a number of specimens of quartz in the auriferous districts which were assayed by Dr. T. S. Hunt, of the Geological Survey. Brief descriptions of the quartz veins supposed to be auriferous, examined by him, and of the assays of specimens therefrom by Dr. Hunt are taken from their reports and here presented.†

In the seigniory of Rigaud-Vaudreuil, Mr. Michel found on lot 83, range I., north-east, a vein of quartz running north-northeast, with a south-easterly dip. The mass was not homogeneous, but composed of a net-work of small veins of quartz impregnated with oxide of iron. A portion of this quartz sent to Boston was reported to have yielded at the rate of $37 worth 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 specimens were furnished Dr. Hunt, gave five very small particles of gold. Dr. Hunt's two assays (No. 1) yielded no trace of gold.

In St. Charles

On lot 21, concession St. Charles, a large quartz vein was also seen following the strike of the rocks north-east. This vein the thickness of which was seventeen or eighteen feet, was divided by joints into irregular masses, separated by ochreous and earthy matters, though apparently compact at the bottom. On the north side a vein of brown decayed material was noted, having a thickness of from four to twelve inches, and running parallel with the quartz vein. A portion of this quartz assayed at Toronto, it was said, gave $136 worth of gold to the ton, and another assay by Mr. Colvin, $54 worth. The certified assay of Dr. A. A. Hayes, of Boston, yielded, for the quartz of this vein, $77.56 in gold and $2.55 of silver to the ton. Of five assays of this quartz by Dr. Hunt (No. 2), four gave an average of only six dwt. thirteen

* Geology of Canada, 1863, p. 519 and p. 745.

† Report of Progress, Geol. Surv. Can., 1863-66. The numbers in parentheses, 1 to 12, are the same as in Dr. Hunt's report on the result of the assays.

grains 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 four ounces eighteen dwt. = $101.29; the average of the five assays being $25.66 per ton.

In range 1, N. E.

On lot 62, of range 1, north-east, an outcrop of a quartz vein occurs, in which a superficial opening had been made. It was reported that an assay of the quartz, made in New York, gave $15 in gold and $22 in silver to the ton of rock; but by an assay of Mr. Colvin, it gave not less than $106 to the ton. Two assays by Dr. Hunt (No. 3) gave no trace of gold.

Lot 19, St. Charles.

A small opening on lot 19, of the concession St. Charles, exposed a vein of quartz in slate running north-east, dipping south-east. The vein has a thickness of twenty-four feet, and an irregular jointed structure similar to that on lot 21. An assay of this quartz by Dr. Hayes gave $70.95 of gold, and $2.00 of silver to the ton. Six assays of this (No. 4) were made by Dr. Hunt. Of these, the mean of four gave four dwt. twenty-one 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 three ounces two dwt. = $64.07. Average of six assays is thus $24.71 to the ton.

From lot 39, of range I., north-east, a speciman of an outcrop of quartz, was assayed by Dr. Hunt (No. 5). Two assays gave no trace of gold.

In concession DeLery.

An outcrop of quartz on lot 26, concession DeLery, has a breadth of three or four feet, and runs north-east. The mechanical assay of twenty pounds of this quartz gave Mr. Michel no trace of gold.

The vein of quartz crossing the Gilbert on lot 20, concession of DeLery, seems, according to Mr. Michel, to be an extension of that met with on lot 19, concession St. Charles. The course of this vein is also north-east, with a dip to the south-east, and at the outcrop, where it is seven or eight feet wide, it is divided by material derived from the wall-rock into two distinct veins, which evidently tend to unite below. The quartz is cavernous and the materials associated with it are generally ochreous. Mr. Michel submitted twenty pounds of the quartz from the right bank of the Gilbert to a mechanical assay, by pulverizing and washing it, and found in the residue twenty-two particles of gold, very minute, but visible to the naked eye. The assays of this quartz by Dr. Hayes gave from $16 to $18 to the ton.

Two assays of this quartz (No. 6) by Dr. Hunt, yielded a mean of fourteen dwt. sixteen grains of gold = $15.15 to the ton.

In range 1, N. E.

On lot 53, range I., north-east, Rigaud-Vaudreuil, already mentioned, comprising the bank of the Chaudière at the Devils Rapids, there are numerous exposures of the rocky strata. Among these is a strong band of sandstone (according to Mr. Michel) with a north-east strike, the strata being traversed by numerous little veins of quartz running east-south-east, and among them a well-marked vein a foot in width. To the east of this sandstone is an outcrop of quartz exposed for a distance of twenty or thirty feet, divided by joints filled with foreign material. A mechanical assay of this quartz by Mr. Michel failed to show a trace of gold, while the assay of the same quantity of quartz from outcrops on lot 51 A, gave five small particles of gold.

Dr. Hunt states in regard to this (No. 7) on lot 53, range I., north-east, that two assays gave no trace of gold.

Buldoc Creek.

Another quartz exposure having been observed on lot 59 A, range I., north-east, near Buldoc Creek, Mr. Michel examined it and states that it was an incoherent mineral mass, consisting of quartz mixed with the encasing clay-slate and sandstone, but apparently forming a vein running north-east. A mechanical assay of this material gave him six very small scales of gold.

Two assays of this (No. 8) from lot 59 A, range I., north-east, gave Dr. Hunt no gold.

Aubert-Delisle.

On lot 9, range I., of the seigniory of Aubert-Delisle, a vein of quartz extending east-north-east, and dipping south-south-east was found in the bottom of a pit twenty-five feet deep. It is imbedded in slate, and divided by an admixture of the wall-rock into several parts, one of which is four feet wide. A specimen of this sent to Dr. Hunt (No. 9), on two assays gave no gold.

Aubert-Gallion.

On lot 30, range I., Aubert-Gallion, a vein of quartz from which a specimen was obtained and sent to Dr. Hunt, failed on two assays, (No. 10) to yield a trace of gold.

Linière.

A vein of white quartz, partially explored, occurs on lot 76, range I., township of Linière. It has a width of five feet, and runs with the strike of the slates north-north-east. Mr. Michel 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 worth of gold to the ton. Specimen (No. 11) from this vein, sent to Dr. Hunt, gave, on two assays, no gold.

A shaft to the depth of twenty-five feet was opened on lot 2, range I., Linière, very near the International Boundary, on an outcrop of

quartz running with the strike of the slates. The quartz consists of several veins from four to six inches wide, and in one case a foot, with portions of slaty rock between each. Specimens from this mass of quartz (No. 12) gave Dr. Hunt on two assays a mean of 6 dwt. 13 grains of gold = $6.76 to the ton.

Dr. Hunt's remarks.

In regard to the foregoing, Dr. Hunt remarks:—"If we compare the results of these assays with those [the mechanical assays] mentioned by Mr. Michel, we shall see further proof of the irregularity with which gold is distributed in the gangue. The quartz from several of these veins has been examined by 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, 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."

Gold in rocks of Marlow.

Assays of specimens from Marlow, lot I., range VII., made by Prof. J. T. Donald, of Montreal, showed, in addition to silver and lead, small quantities of gold, in one case half an ounce to the ton. An assay of a sample from a vein in the same locality by Dr. Hoffmann in the laboratory of the Geological Survey, yielded traces of gold and forty-three ounces of silver to the ton. Specimens of quartz from the Bras du Sud Ouest, near the falls, having small quantities of felspathic rock associated therewith, and carrying some iron-pyrites, were likewise assayed by Dr. Hoffmann in the laboratory of the Survey, and gave ·117 of an ounce of gold to the ton. A mass of white garnetiferous rock occurring near this place has also been reported to contain gold.

O'Farrell vein.

The O'Farrell and other quartz veins at the Devils Rapids, Chaudière River, have yielded gold, and the occurrence of such veins led The DeLery Gold Mining Company to erect a crushing mill at this place in 1864, and attempt to work these and the quartz veins

of the Gilbert valley. Crushing for gold here, however, proved unsuccessful and was soon abandoned.

Dr. Selwyn's observations.

In 1870, Dr. Selwyn, as Director of the Geological Survey of Canada, examined and reported on the gold-fields in Quebec and Nova Scotia, and makes the following observations concerning the quartz veins of Beauce county. "The quartz veins of this district have already been examined and reported on, and their auriferous character has been established. I examined the outcrops of several of these from which samples were taken by Mr. Michel and carefully asssayed by Dr. Hunt. No efforts appear to have been made since the date of the reports above referred to, for their further development. The result of Dr. Hunt's assays was certainly not very encouraging, but when compared with other assays made by Dr. Hayes, of Boston, they only serve as he remarks, to prove the irregularity with which the gold is distributed in the gangue.

"Some of the veins are well situated for working, and so far as can be judged from the very limited extent to which any of them have yet been opened, there would be no difficulty in raising large quantities of quartz. Considering the heavy and often nuggety character of much of the alluvial gold of the Chaudière district, it is in the highest degree improbable that none of the veins from the abraded portions of which this gold has without doubt been derived, should be sufficiently rich to yield a fair profit to well directed enterprise applied to their exploitation, and it seems extraordinary that so little has hitherto been done in this direction."*

Gold in Handkerchief settlement.

Gold is reported from the Handkerchief settlement, seigniory of St. Giles de Beaurivage, also from the copper lodes of Harvey Hill. Traces of gold have been met with at Thetford, and Mr. Michel reports finding gold by a mechanical assay from lot 8, range A, of Lambton. Assays of specimens of quartz from lot 6, range XI., Whitton, gave traces of gold.

Along Rivière du Loup.

Mr. Obalski, Inspector of Mines for Quebec, reports that according to assays made by Mr. H. Nagant, of Quebec, of specimens collected by him, gold occurs in quartz from the following localities along the upper part of Rivière du Loup, viz., lot 79, Kennebec Road range, Township of Marlow; range VIII. or IX., near Portage Lake; near Portage River, range II., section C. Gold has also been found on lot 2, range XV., of Risborough, in quartz veins, and a specimen from a quartz vein near Lake Megantic, gave traces of gold to Dr. Hoffmann in the laboratory of the Geological Survey.

*Report of Progress, Geol. Surv. Can., 1870-71, pp. 276-77.

The gold obtained in Beauce county is alloyed with silver, a small mass from St. François, containing 13·27 per cent according to Dr. Hunt. Other specimens gave 13·60, 12·87, 12·23, 10·76 per cent of silver.* Alloy.

About half a mile from the mouth of Rivière du Loup, on the south bank, Messrs. E. B. Haycock and Louis Gendreau erected a small mill with three stamps (Fraser and Chalmers) in 1893, in order to test the numerous quartz veins in the lower part of the valley of that river. The results of their operations are given in the report of the Inspector of Mines for Quebec, Mr. J. Obalski.† Eventually the mill passed into Mr. Haycock's hands, but as work was closed there in the autumn of 1895, it is feared that the enterprise has not met with success, although according to the tests made gold was found in several of the veins. Respecting these Mr. Obalski remarks: "It is true that only small quantities of quartz have yet been milled by Mr. Haycock, and that the question of the productiveness of the quartz in Beauce cannot as yet be considered settled. In other countries gold has been found in paying quantities in quartz, where it was quite invisible, and it may be hoped that these first assays will encourage others which will have a definite result." In the summer of 1895, Mr. John Blue, of Eustis, Que., and his son, prospected the Du Loup for several miles above its mouth, and still further tested and assayed considerable portions of the quartz from the veins above referred to as well as from others in the vicinity; but the quantities of gold obtained from the latter were reported to be very small. No attempts have been made to work these quartz veins since. Mill tests by Messrs. Haycock and Gendreau.

At Dudswell, in the Stoke Mountain range, visible gold has been found in the matrix on lot 1, range VI., township of Dudswell. It was first discovered in a thin quartz vein, from one and a half to two inches in thickness, traversing a mass of altered arkose, which consists principally of quartz, felspar and talc. Iron-pyrites and other sulphides are found in this arkose, which appears to form a wide band in the pre-Cambrian schists, cropping out as a low ridge or boss. Whether the pyritous minerals occur throughout the whole mass of this rock has not been ascertained; but specimen from that part inclosing the thin quartz vein carrying visible gold, assayed in the laboratory of the Geological Survey, yielded ·35 of an ounce of gold to the ton = $6.40. Some exploratory work was performed here by Messrs. Harrison, on whose land the gold occurs, and by Mr. John Armstrong, of Marlow, who leased the property. Gold in matrix at Dudswell.

* Geology of Canada (1863), p. 520.

† Report of the Commissioner of Crown Lands for Quebec, 1894, pp. 88-89.

Mill test from Dudswell.

Subsequently, as this matter appeared to be one of considerable interest, the writer was instructed to again visit this place, and obtained several hundred pounds weight of rock, consisting largely of small quartz stringers, but including the arkose matrix and representing material that might be obtained in quantity. By the kindness of Professor J. B. Porter, of McGill University, this was submitted to a mill test, with the following results :—

Weight of rock tested 387 lbs.		
Free gold recovered, 321 millegrammes or at the rate of	$1.10	per ton.
Concentrates obtained from tailings by Frue vanner 1¼ p. c., value	8.30	"
Tailings from vanner 98¾ p.c., value	0.40	"
Total value of rock.	$1.62	"

Professor Porter also notes that, as assays of the rock gave from $4.00 to nothing to the ton, the gold must exist in particles of appreciable size scattered through it.

Previous to the discovery of gold in these rocks, pieces of quartz and conglomerate, generally yellowish in colour, and containing visible grains of gold, were found in the gravels of several of the small streams flowing off Dudswell Mountain. In 1892, a boulder of this rock, very little rolled, was found in Halls Stream. Numerous angular pebbles have recently been discovered containing specks of gold. Considering all the facts, it seems quite evident that the source of the alluvial gold obtained here is in the pre-Cambrian rocks of this mountain.

Near Sherbrooke.

In the Stoke Mountain range, near Sherbrooke, gold occurs in small quantities in association with the copper ores. Mr. John Blue, manager of the Eustis copper mine, informed me that traces of gold as well as silver were found on assay in the copper mines wrought by him, the value being about fifty or sixty cents to the ton of rock. In other places in these mountains, especially near Sherbrooke, and in the township of Ascot, gold has likewise been met with in the copper ores.

Massawippi Lake.

On the west side of Massawippi Lake, on lot 14, range VII., Hatley, gold is reported to have been found in the rocks in minute quantities, in the valley of a small stream in which alluvial gold occurs. The pre-Cambrian schists here carry a number of broken quartz seams, which in places, contain sulphide minerals, chiefly iron-pyrites. The quartz veins are irregularly interbedded in the talcose or chloritic schists and slates. It is quite evident that here also the pre-Cambrian rocks must be the source of the gold.

In the Ditton district, very little exploration for auriferous quartz veins has taken place. Mr. Obalski reports an assay of a specimen of quartz found there by Mr. Nagant, of Quebec, as showing an appreciable amount of gold. Ditton.

During the summer of 1895, the writer collected specimens of quartz from some of the veins crossing the Little Ditton valley, at different points above the Chartierville road bridge. These were assayed in the laboratory of the Geological Survey, and found to contain neither gold nor silver. Gold has, however, been reported to occur in a quartz vein near the source of the Little Ditton, but the writer was unable to verify this. Across the boundary line, in New Hampshire, it has been discovered at Plymouth and Bridgewater in rocks of pre-Cambrian age.

The foregoing facts serve to show that gold has been found in the gangue in a number of localities in the "Eastern Townships," and is not confined to rocks of one age, having been met with in the pre-Cambrian, Cambrian and the Cambro-Silurian, although in very minute quantities. Its occurrence in the districts mentioned, nevertheless, affords good grounds for supposing that the gold of the alluvial deposits has been derived from the rocks of the region, and is consequently of local origin. The comparative abundance of the precious metal in the alluviums of certain parts of the region where auriferous quartz veins occur, as, for example, in the Gilbert valley, at the Devils Rapids of the Chaudière River, and near the junction of the Du Loup with the last-mentioned river, would seem to indicate that it exists in some undiscovered portions of these rocks in greater quantities than have hitherto been met with, though whether in paying quantities is problematical. Observations on occurrence of gold in the rocks.

As stated on a previous page, the view held by Logan and Hunt regarding the primary source of the gold in South-eastern Quebec, was, that it occurred in the crystalline schists, or pre-Cambrian rocks of the Nôtre Dame range. Since that time the quantity of alluvial gold found principally in districts occupied by Cambrian or later rocks, has led to a change or extension of the views of geologists regarding its source. The Gilbert, Famine, Mill, DesPlantes and other rivers traversing rocks of Cambrian age, in the valleys of which so much gold has been found, prove that its source is near, and is in these and their associated rocks. From the quartz veins, found in considerable number in the places mentioned, specimens were collected by Mr. Michel, and assayed by Dr. Hunt, as shown on a former page, and since that time additional samples have been obtained from various portions of the

Cambrian and Cambro-Silurian districts, some of which have been assayed in the laboratory of the Geological Survey. But although yielding traces of gold, in no instance have the results been such as to encourage the expenditure of capital in working these ruins.

The source of the gold met with in the alluviums in Ditton, Emberton, Chesham, and along the International boundary north-eastward to Lake Megantic, and beyond, may also have been in the pre-Cambrian rocks which extend along the watershed. Near the boundary, however, gold has been met with only in very small quantities. And although a considerable amount has been extracted from the alluviums of the Little Ditton valley, none appears to have been discovered in the rocks there, except that noted by Mr. Obalski, as already mentioned.

Difficulties in accounting for origin of gold.

In endeavouring to ascertain the origin of the gold of the "Eastern Townships" of Quebec, a region in which practically no quartz mining has yet been carried on, great difficulties presented themselves, owing to the almost entire absence of information regarding its mode of occurrence in the rocks. Indeed, it was found that very little progress had been made in our knowledge of its derivation since the time of Logan and Hunt. While the assays given above are doubtless in the main correct, the results it will be seen are meagre. Quartz veins are numerous and occur in rocks of all ages here, but few of them are found to be auriferous. Their origin is a problem requiring a much larger body of data than is yet available for its determination. Owing to the fact that the rocks are everywhere covered with a thick mantle of boulder-clay, it is not surprising that our knowledge concerning these veins is so limited. It seems probable, however, from the differences in their appearance and character, that they belong to different geological ages. The great majority are interbedded or parallel to the schistose or slaty cleavage. Those found in the pre-Cambrian schists are often broken, interrupted, or lenticular. In the Cambrian rocks they are thicker and more persistent. The larger number of quartz veins are entirely barren, these predominating in the districts occupied by Cambro-Silurian slates. The sulphide quartz veins are to be found chiefly in Cambrian and pre-Cambrian rocks. The results of the investigations so far carried out indicate that the gold occurs only in these quartz veins or associated with them, though seldom met with in visible form.

In regard to the original source of the gold as defined by Logan and Hunt* it would seem that the ancient pre-Cambrian rocks, having fur-

* Geology of Canada (1863), pp. 519 and 739.

nished much of the material constituting the Palæozoic sediments, it seems possible that they may likewise have yielded gold to the latter in a fine state of division as they were washed down into the ancient sea bottom. The materials composing the Cambrian and Cambro-Silurian having been thus derived, were probably carried both from the north-west and from the south-east pre-Cambrian ranges, as denudation and waste proceeded. There is a possibility, also, that the gold of these early Palæozoic rocks, if any existed in them, may have been concentrated to some extent in much the same way as in the alluviums of later geological ages, and, if so, it would be somewhat unequally distributed in the sediments. This may be one cause of its occurrence more abundantly in some areas than in others.

Probable Relation of Gold-bearing Rocks and Diorites.

Occurrence of gold in diorite areas.

The rocks of the "Eastern Townships" have undergone a great amount of shearing, plication and faulting, and the slates everywhere dip at a high angle. Besides the lateral pressure to which they have been subjected, eruptive masses have been thrust up through them, producing, in some localities, marked changes in their character and physical relations. These eruptive flows are dominant in the belts of Cambrian rocks to the south-east of the Sutton Mountain anticline, though also noted in local areas in pre-Cambrian and Cambro-Silurian districts, and seem to have been repeated at intervals throughout the geological history of the region. Dr. R. W. Ells states that "it is probable that the diorites of the several localities have come to the surface at widely different periods, for, while some have evidently exercised a metamorphosing action on the Cambro-Silurian strata, at other places the lower beds of the Cambrian are largely made up of their débris."* Although it is held that gold is more likely to occur in those portions of auriferous districts in which intrusive rocks prevail, nevertheless for the reasons stated above, no new facts bearing on this question have been elicited by our investigation. It is true, nevertheless, that the two districts in Beauce county which have yielded the most gold are those traversed by numerous diorite or diabase dykes. Intrusives also occur commonly in those portions of the Stoke Mountain range in which gold has been found. The Gilbert and Mill River districts are much intersected by dykes of these rocks, and considerable faulting and fissuring appear to have accompanied the

* Annual Report, Geol. Surv. Can., vol. II. (N.S.), 1886, p. 41 J.

outflows of igneous materials there. The basin drained by the Famine River also contains numerous diorite or diabase rocks. Similar eruptives extend along the mountain ranges, especially the Stoke and the Sutton mountain anticline throughout the greater part of the "Eastern Townships." Dr. Ells has thus described them :—"Dioritic rocks are found at many points throughout the Townships, sometimes in masses of large extent, as in the Big and Little Ham mountains, and in the peaks along the western side of Lake Memphremagog; at others, as bosses and dykes..... The largest and most important areas are found in a belt which can be readily traced from the Vermont boundary, north-east for over one hundred miles, crossing the Chaudière River, and extending into the townships of Cranbourne and Ware.....

Dr. Ells's description of diorites.

"The course of the principal belt is generally north-east, following the prevailing trend of all the formations; but in Cleveland and Shipton it assumes a transverse twist which also affects the pre-Cambrian and other formations in the vicinity, and changes the strike for some miles in the townships of Wotton and Ham to an almost easterly course. The prolongation of the Melbourne and Shipton ridge, which apparently terminates at the Little Ham Mountain, after an interval of about five miles occupied by slates and sandstones, reappears in the Big Ham Mountain, which is on lot 2, range XI., Ham, and rises boldly from the somewhat flat country around its base, to a height of 1150 feet, forming a magnificent hill-feature in the landscape. Thence the diorites extend with a gradually curving outline to the north-east, crossing the road from South Ham to Garthby, and continuing through the latter township as well as the eastern part of Wolfestown, Coleraine and Thetford, where it is conspicuously marked by the large elevation of the Bull Mountain already noted..... As in the Brompton belt, diorites are more prominent at the extremities, while the central portion is characterized by the presence of serpentines, which in this direction have a great development, especially in Coleraine and Thetford, with some large areas in Wolfestown, now of great importance as the seat of the asbestus industry.....

"Smaller areas of dioritic rocks are numerous. Of these, probably the most important is seen in the township of Ascot, where it traverses the area of the copper-bearing schists, extending from lot 19, range V., of Ascot, south-westerly at intervals to lot 27, range IV., Hatley. This belt has a considerable development in the vicinity of some of the copper mines situated to the south of Sherbrooke. Diorites of

more limited extent occur also on the line between Westbury and Stoke, but these are of comparatively recent age, since they have altered the slates with which they are in contact.

"In the Megantic area in Clinton, Chesham and Emberton, dioritic masses are also seen. Two prominent hills are noted, the one on lots 10 and 11, ranges I. and II., Clinton, the other on lot 25, and adjacent range VII., Clinton. They are apparently part of the chloritic slate series, and may belong to an earlier date than many of those of the central and western area."* The probable age of the diorites has also been referred to on page 149 I.

Extent of diorite masses

The superficial or areal dimensions of these dioritic masses is variable, dykes from only a few feet or yards in width to great masses, of the extent of Moose Mountain in Cranbourne (see Geological Survey map) being met with. In the Chaudière valley from the Colway River and Bras du Sud Ouest to the junction of the Du Loup, they are quite commom. The Devils Rapids, just above St. Francis, are caused by one or more bands of these eruptive rocks crossing the Chaudière valley. East of Jersey Mills, in Ste. Marguerite settlement, diorite bosses were observed.

Further west, along the upper waters of the St. Francis and in the vicinity of Dudswell, as stated, diorites occur, and here gold has been met with in the alluviums and also in the rocks. The great band of eruptives continuous with the serpentines and diorites of Coleraine and Thetford, passes to the north, as has been shown by Dr. Ells.

Coincidence of gold-bearing rocks and eruptives.

Gold-bearing rocks are thus found in a number of places associated with the great band of eruptives described. It seems to be also in rocks traversed by these that silver, iron and copper ores, chromic-iron, asbestus, etc., are met with, irregularly distributed in a broad mineralized zone. So far as known, nearly all the precious metals and ores lie within this irregular belt, except such as occur near the New Hampshire and Maine boundary.

Gold in rocks near International boundary.

Along the International boundary in the townships of Emberton, Chesham, Woburn, Clinton, Ditchfield, and as far as Risborough, gold seems also to have been furnished to the alluviums by the erosion and waste of the Cambrian and pre-Cambrian rocks. Diorites or diabases have also come up through these ancient rocks. Gold is reported to have been found in a quartz vein at or near the source of Little Ditton

* Annual Report, Geol. Surv. Can., vol. II. (N.S.), 1886, pp. 39, 40, 41, J.

River, also in Risborough and Marlow in association with the silver or galena ores met with in these localities. The pre-Cambrian source of the gold, and the conditions of its origin, especially in relation to the presence of dioritic intrusives, appear to be similar here to those of the great belt to the north-west described above.

Source of Ditton gold.

In the Little Ditton valley, which is almost wholly within the area of Cambrian rocks, the source of the alluvial gold is problematical, unless it is derived from the pre-Cambrian of the International boundary. Specimens from four of the quartz veins traversing Cambrian slates in this valley, assayed in the laboratory of the Survey, gave no traces of gold. As, however, the alluvial gold occurs most plentifully just above the bridge on the road which leads from La Patrie to Chartierville, it would seem as if its source must be local, in the Cambrian rocks. The country is densely wooded on both sides of the river, and no explorations could be made beyond the valley. Towards the sources of the Ditton River, in Emberton, Chesham and Clinton, alluvial gold has, however, been found in the gravels south of the limits of the Cambrian area.

Co-ordinating all the known facts respecting the conditions of occurrence of the gold-bearing veins and the diorite group, it would seem that they have a very close relation to each other. At Dudswell the gold was found in an arkose, possibly conglomeritic. In every other instance where it is known to occur, its invariable associates seem to be quartz and sulphides, and diorite rocks are met with in the vicinity. The coincidence between the belts of these eruptives and the districts in which traces of gold have been met with is, to say the least, remarkable.

Primary source of gold of "Eastern Townships."

The primary source of the gold of the "Eastern Townships" seems therefore, to be the crystalline schists of pre-Cambrian or Huronian age, which were invaded by diorites and other intrusives and yielded material to the basal Cambrian conglomerates, and were also probably traversed by quartz veins. These schists having furnished by their denudation a considerable portion, perhaps the chief portion of the materials constituting the Cambrian and later rocks, if they contained gold, it would be transported along with other minerals, and disseminated in a very fine state of division in the sediments of Cambrian and Cambro-Silurian age. After the consolidation of the rocks, upheaval, crumpling, faulting and metamorphism would seem to have taken place, and the gold would probably be brought up in solutions in these and concentrated along with silica and the metallic sulphides in the faults and fissures, thus forming auriferous veins.

In the latest geological ages, subaerial action has oxidized and changed the rocks into soil (rotten rock) to considerable depths. The quartz veins and their contents would also suffer similar decay with the slates, sandstones, etc., and a great reduction of the surface undoubtedly followed wherever there was sufficient slope to allow the materials to be affected by drainage waters. In the removal and transportation of this sedentary material, whatever gold was in the quartz veins and in the products of rock decay would be concentrated in channels or river-bottoms in the gravels in which it is found at the present day.

In the auriferous districts of south-eastern Quebec, there has thus been a prolonged concentration of the gold throughout several geological ages, by mechanical, chemical and other agencies, bringing it more and more into an available economic form, the latest being in the alluviums of the present river-valleys. The gold-content of these alluviums as it now exists, therefore, is really in the form of a residuum of the processes of denudation and waste, a large part of the metal having, doubtless, been entirely lost in a very fine state of comminution.

APPENDIX I.

The following statistics have been compiled from information furnished to Mr. E. D. Ingall, of this Survey, by Mr. Wm. P. Lockwood, of Montreal.

"Gold extracted by Wm. P. Lockwood from the first property acquired by him on the Chaudière, 1867-68, as shown on Robinson's map, while working to prove the continuity of the auriferous gravel, its course, width, depth, and average yield per acre. The yield was easily calculated at any point. The drives were 8 feet wide, and each set of timbers 10 feet long. Every 10 feet could be tried separately. The usual yield was from four to five ounces of gold for every eighty feet, say one dollar to one dollar and fifty cents per foot, or fully $50,000 per acre on this lead. In many places it was much above and in others much below the average. Comparing the total length of the drifts run at any time, and the total amount of gold obtained, Mr. Lockwood was enabled to make reliable estimates, many drifts run in to known barren ground not being taken into consideration.

		oz.	dwt.	grs.
1868 to 1871.	Lockwood & Co. from prospecting shafts on Miners Claims	1904	17	15
1868 to 1876.	Lockwood & Co. from Lot 15 De Lery and Lot 8 St. Charles	250	0	
1871 to 1877.	Lockwood, from two 100-foot shafts with two sets of imported machinery, heavy pumps and extensive buildings for permanent works (destroyed by fire the 13th of January, 1877—a total loss of $35,000)	1	10	0
1876 to 1877.	Lockwood & Co. opened three shafts, and drives for 150 men, complete and in perfect order, making large returns, when they were driven from their work. Thirty-five men in the month of October, took out	109	0	0
1878.	Lockwood & Co. opened three shafts on Lot 12 De Lery, with full working plant for Canada Gold Company, and obtained	970	13	17
1891-92-93.	Lockwood & Co. from two shafts, one inclined tunnel and tramway, obtained	428	15	20
		3664	7	4

"Copy of sworn returns of gold extracted from the property of the Canada Gold Co., from the 1st of July, 1880.

			oz.	dwt.	grs.
St. Charles,		McArthur Bros.	458	16	0
"		La Santa Anna	29	10	
"	Lots 10 & 11.	Thos. Richards	1625	13	

				oz.	dwt.	grs.	
De Lery,	Lot	12.	Grenville Mg. Co. of Ontario..	41	7	10	
"	"	13.	Clarence Gold Mg. Co.....	1311	10	9	
St. Charles	"	12.	Geo. Therien & Co.....	60	7	14	
De Lery,	"	13.	Cameron, Gibson & King.	56	6	20	
"	"	"	McDonald, Powers & Potvin..	17	10	0	Tailings
"	"	14.	Chas. Lionais.....	27	6	20	
"	"	"	Beauce Mg. & Milling Co.....	324	1	2	
"	"	15.	John McRae..... ...	45	7	11	
"	"	16.	East Branch Co..... . .	12	16	12	
"	"	"	Béribe & Cie.....	3	19	15	
"	"	17.	Chaudière Mg. Co.....	0	17	10	
"	"	7 & 18.	Sands and Spaulding.....	4	4	23	
"	"	18.	Victoria Co.....	2	9	19	
"	"	20.	Jas. Reed	3	8	14	
St. Charles,	"	12.	Onésime Dion	3	16	0	Tailings
"	"	13.	Hugh M. Gillis..... .. .	4	11	10	
"	"	"	Jean Lefebre....	1	4	12	
"	"	"	A. Walker....	3	4	12	
"	"	12 & 13.	E. Fenton..	24	7	0	Tailings
Devil's Rapids,			L. Blanchet....	1	1	0	
St. Charles,	"	11.	Jas. Forgie.....	114	14	11	
"	"	"	Gilbert Tomlinson.....	118	0	5	
"	"	11 & 12.	St. Onge & Cie.....	1001	13	13	
"	"	"	Powers, Brack & Co	1	13	6	Tailings
De Lery,	"	13.	V. Coupal & Co.....	10	3	20	
"	"	18.	L. Gendreau.....	22	14	1	
1st Range,			John McNicholl.....	4	0	0	
Rivière des Plantes,			Billy Poulin & Co.....	8	0	6	
St. Charles, Lot		12.	Canada Gold Co.....	3306	14	21	
Gold dust and nuggets bought by Renault, Potvin and others from parties working within limits.....				284	5	0	

Certified 8th June, 1887,

(Signed) H. J. J. DUCHESNAY.

J. G. M. D.

(Copy.)

"Gold extracted ..... from the grounds of Wm. P. Lockwood & Co., from 1876 to July 1st, 1880, by the persons named as follows:—

		oz.	dwt.	grs.
1876 to 1877	Sands, Oldson & Miller, three of Mr. Lockwood's regular workmen, from lot 11, St. Charles, reported in the first five months	205	18	5
	Made no returns afterwards, but obtained at least...	200	0	0
	Total.....	405	18	5
	or			$7,290

1876 to 1877.	Gold obtained as above stated by Sands, Oldson and Miller, valued at.....	$ 7,290
1876 to July 1, 1880.	Jack St. Onge, one of Mr. Lockwood's foremen, who worked for him 8 years, joined his brother and six miners, and having made arrangements with farmers for land on Lot 11, St. Charles, obtained Government licenses and show a return of..	$ 75,000
1877 to July 1, 1880.	The St. Onges commenced working on Lot 12. They were holders of Government gold mining licenses, and stated that they won in gold	$190,000
	The ground worked was about four acres, which shows the average yield of gold, as reported by Mr. Lockwood, to be about $50,000 per acre for the main Gilbert lead.	
	The St. Onge Company stated that they took out, with forty men, about 8 ounces of gold per day, or an average of $3.60 per man.	
	In addition to the above the sworn Government returns from July 1st, 1880, to 1885, show a production of.....	$160,516
	Total...	$ 432,806

"Before July 1st, 1880, many of those working on Mr. Lockwood's grounds made large returns, but it was not possible to arrive at the facts. The Beauce Mining and Milling Co., and C. W. Kempton, M.E., in their pamphlets state that, previous to 1881, $400,000 worth of gold was taken from three-fourths of an acre on lot 14, DeLery.

"A number of other companies wrought between lot 11, St. Charles, and lot 15 DeLery, but it was not possible to obtain any account of the gold they obtained, until Flynn's Mining Act of 1880, came into force, or ..... until the courts in December, 1883, declared the DeLery title valid.

In addition to the foregoing statement of the gold production of the Gilbert, Mr. Lockwood shows a receipt from the U. S. assay office, New York, for gold bullion of the value of $1,194.96, deposited there in 1892.

APPEN

LEVELS OF GOLD WORKINGS, GILBERT

The datum of these levels is the junction of the Gilbert and the

Heights of shafts above river.	No. of shafts—Lots—Concessions.	Depth of shaft	Depth to pay gravel.	Depth to bed rock.	HEIGHTS	
					River opposite shaft.	Top of shaft.
ft.		ft.	ft.	ft.	ft.	ft.
	St. Charles.					
	A } Lot 8	12	11	12	206·5	130·6
	B }	12	11	12	.....	.....
	1 Lot 8	44	44	.....	.....	.....
11	2 "	54	54	.....	139·0	150·0
6	3 "	38	38	.....	.....	.....
5	4 "	.....	.....	.....	.....	.....
	St. Charles.					
	5 Lot 7	35	35	.....	.....	.....
	X "	64	64	.....	.....	.....
	6 "	33	.....	.....	.....	.....
5	6A "	100	83	97	156·5	161·5
	6B "	83	83	.....	.....	.....
	St. Charles.					
	C Lot 9	12	.....	.....	.....	.....
	D 10 A Lot 9	21	.....	.....	.....	.....
8	7 "	70	none.	70	.....	.....
	St. Charles.					
	Lot 11	63	56	63	201·5	239·5
	"	.....	.....	.....	.....	.....
St. Onge Sands & Co.	"	37	none.	37*	.....	.....
	"	38	.....	.....	201·5	216·3
4	8 Lot 12	60	none.	60	208·0*	212
6	9 "	9	.....	9	212·7*	218·7
10	10 "	25	none.	25	212·7	222·7
38	11 "	60	52	60	212·7	250·7
42	12 "	64	58	64	212·7	253·0
	13 "	40	.....	.....	.....	.....
		67·6	56	65·6	201·5	.....
		78·6	66·6	76·6	218·5	273·0
8	14 Lot 13 A }	27	none.	27	.....	.....
	" B }					
	"	.....	.....	.....	.....	.....
	"	.....	.....	.....	.....	.....
	"	.....	.....	.....	.....	.....
	DeLery.					
22	1 Lot 13	79	61	63	246	272
5	2 "	40	31·6	35·6	246	249
	Miners' Claims					
	Lot 12	69	56	69	278·7	322·7
	16	78	55	78	274·0	327·0
	18	78	.....	.....	.....	.....
	23	.....	.....	.....	.....	.....
	24	.....	.....	.....	.....	.....

*Approximate elevations.

DIX II.

RIVER, CHAUDIÈRE DISTRICT, QUE.

Chaudière rivers, approximately 515 feet above sea-level.

ABOVE DATUM.			
Top of pay gravel.	Bed rock.	River at nearest point levelled.	Remarks.
ft.	ft.	ft.	
117·6	118·6	.....	These shafts 4 to 5 ft. above river, on sma
.....	.....	.....	
.....	.....	.....	Not bottomed, struck water and filled.
96·0	.....	.....	do do do
.....	.....	.....	
.....	.....	.....	
.....	.....	.....	do do do
.....	.....	.....	do do do
.....	.....	.....	
88·5	64·5	.....	Overflowed.
.....	.....	.....	Not bottomed, works destroyed by fire.
.....	.....	.....	
.....	.....	.....	
.....	.....	.....	
183·5	176·5	.....	A. Lockwood & Co., No. 1.
.....	.....	.....	" " No. 2, about same as No. 1.
.....	.....	.....	Drifted from shaft into the hill to the lead.
.....	178·3	.....	Tunnelled into hillside above the ditch, about 15 ft. above river, and sank shaft to bed-rock.
none.	152	.....	
.....	209·7	.....	
none.	197·7	.....	
198·7	190·7	.....	
195·0	189·7	.....	
.....	.....	.....	4 ft. Test shaft.
.....	.....	.....	A. L. & Co. No. 3, near line of 11 & 12 about same as 1 & 2.
206·6	196·6	.....	W. P. L., near line of 12 & 13.
.....	.....	218·5	
.....	.....	.....	No particulars.
.....	.....	.....	
.....	.....	.....	
211·0	209	246	Depth of shafts from top of timbers 82 ft.
218·4	214·4	246	do do do 43 ft., chainage 202·37 to here.
266·7*	253 7*	.....	N. B. Line of 15 & 16.
272·0*	249·0*	.....	
.....	.....	.....	
.....	.....	.....	
.....	.....	.....	

The foregoing table is incomplete, the data for some of the shafts not having been furnished. There are also some discrepancies, noted by Mr. Ingall on the MS. in his possession. Taken along with Mr. Wm. P. Lockwood's report quoted in previous pages, however, it gives a number of valuable details regarding the old workings of the Gilbert valley, now all filled in and closed.

APPENDIX III.

Notes on the chainage and levels of the Gilbert River, St. Francois, Beauce county, Quebec, by Arthur Lockwood.

The datum is the junction of the Gilbert River and the Chaudière 515 feet above sea by aneroid, based on the height of St. Francois station, Quebec Central railway. From this point also the chainage was reckoned, following the sinuosities of the river.

Chainage and Levels from the mouth of Gilbert River to Lot 15, DeLery Concession :—

——	Chainage.	Levels.
	ft.	ft.
East line of 1st range, N.E.	8,142	130·6
Lot 7, St. Charles concession	11,415	151·2
Just below mouth of Caron Creek	11,540	156·5
Lot 10, St. Charles, concession	14,297	181·2
" 11, " "	16,346	201·3
" 13, DeLery "	19,713	224·0
" 15, " "	22,462	278·7

From Lot 15, DeLery Concession, to the Cranbourne line :—

——	Chainage.	Levels.
	ft.	ft.
Mouth of N.E. Branch, Lot 16, DeLery	22,669	281·0
Line of Lots 16 and 17, DeLery	23,067	
Foot of American Gold Mining Co.'s works, F. Wadsworth & Co., Lot 18	23,992	307·1
Line of Lots 18 and 19, DeLery	24,529	314·5
At line of Lots 20 and 21, DeLery, Foot of dam	25,819	349·5
At line of Lots 20 and 21, DeLery, Top " "	25,819	353·0
Line of Lots 21 and 22, DeLery	26,752	363·3
Foot of falls	27,091	366·5
Top of falls		372·1
Foot of falls and rapids at saw-mill, about line of Lots 22 and 23, DeLery	28,326	387·5
Top of falls and rapids above mentioned	28,400	399·2
Foot of small falls, Lot 25, DeLery	29,425	415·8
Lower side of bridge at road between Lots 25 and 26, DeLery	29,926	423·5
About line of Concession Chaussegros	32,121	445·9
" " " St. Gustave	37,586	534·2
Lower side of Lot 31, Fraser, S.E.	40,572	616·2
On hill at Atkinson's dam, Lot 43, Fraser, S.E.	46,911	709·9
Head of swamp at Cranbourne line		720·0