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THE TORONTO MAGNETIC OBSERVATORY. BY R. F. STUPART, DIRECTOR.

(Read January 14th, 1899.)

On the recommendation of the Royal Society and the British Association the British Government determined in 1840 to establish a fixed Magnetic Observatory in Canada, and it was decided that it should be placed under the general supervision of the Ordnance Department of the Army. Arrangements having been completed, Lieutenant Charles James Buchanan Riddell, R.A., was selected for duty in Canada. Leaving his detachment, consisting of four non-commissioned officers of the artillery to embark with the instruments on a vessel bound direct to Quebec, he proceeded himself to Canada by the more expeditious route of the United States. Having waited on the Governor-General at Montreal to present a letter of introduction with which he had been furnished by the Master-General of Ordnance, and having communicated with the commanding engineer, to whom he was the bearer of instructions and authority to build an Observatory, he proceeded to examine different localities which were suggested as convenient sites. The preference was finally given to Toronto, where a grant of two and a half acres of land belonging to the University of King's College was offered by the Council of the University. The first Observatory building was of logs, rough cast on the outside and plastered on the inside; it was completed during the summer of 1840, and the observations were begun in September. The operation of the Observatory as an Imperial establishment was brought to a close in the early part of the year 1853, and was resumed under the authority of the Provincial Government in July of the same year.

In the autumn of 1853 the present Observatory was commenced, to take the place of the old building. Very great care was taken during construction to insure freedom from magnetism in all the stone used, and all nails and fastenings were of either copper or zinc. For twenty-three years the position of the Observatory was, as far as known, faultless; observations were carried on systematically and carefully, and results were given to the scientific world which, with those obtained under the old military régime, have made the Toronto Observatory famous in the history of Terrestrial Magnetism.

In 1876, however, trouble began with the erection of buildings close to the Observatory, causing some very small changes in zero values. Then followed a few years later electric light circuits, which produced a change in the force instruments whenever the currents were turned on and off; this difficulty was in part overcome by the Light Company courteously agreeing to arrange their wires in the vicinity of the Observatory in such a manner that the currents would counteract each other. The next difficulty occurred when a large addition was made to the neighbouring buildings before mentioned, tons of iron were used in construction in all too

close proximity to the magnetic instruments, and much time and labor have been required to determine the precise effect of this "iron mine" on the various instruments. It was not, however, until the autumn of 1892, when the trolleys began to run, that we began to suspect that sooner or later the Magnetic Observatory would have to be removed to another site.

The magnetic instruments in the Observatory consisted of those brought out by Lieutenant Riddell in 1846, of which eye readings have been taken six times each day, and of another set of instruments, consisting of a bifilar for the measurement of the horizontal component, and a balance needle for the vertical force, and a declinometer, all of which record photographically.

Electric cars first ran in Toronto on August 17th, 1892. The line first put in operation was that on Church Street, which was followed on September 5th, by one on King Street, between George and Dufferin Streets. During the first few weeks, while a very small vibration of the needle was discernible on the V. F. curve, it was generally almost inappreciable, and it was not until September 20th that the movement increased to an extent sufficient to really impair the value of our magnetic curves. A marked increase of current must have been used on that day and afterwards. On October 10th the cars first ran on Yonge Street, and there was only a very small increase in the vibration, but a decrease of about .000070 of a dyne was observed when the current was on.

About 10 a.m., January 14th, there was a marked increase of vibration, and the vertical force increased about .000200 of one dyne. This disturbed period was only temporary, and shortly after 5 p.m. on the 17th there was a reversal to the smaller vibrations. This continued until May 15th, when larger vibrations began again, and continued with varying intensity during the summer, while the decrease of the vibration with the current ranged from about .000200 to .000500. This disturbance was very great between September 12th and October 17th, and at intervals during the following year; but there was no radical change in conditions until December 17th, 1894, when a decrease of V.F., while the current was on, was changed to an increase, this occurring when the cars first ran on McCaul St. Throughout 1895 the vibration and amount of permanent deflection was very nearly as it has been since; but on October 15th, the increase of V.F. with the current was again changed to a decrease, this occurring at the time that the railway company made certain changes in the feed wires. It is noticeable that, although several changes occurred in the V.F., it at times having been less with the current on and at other times greater, the horizontal force showed a decrease on all occasions with the turn on of the current. This decrease during the past two years was .000200 to .000500 of a dyne. No appreciable deflection of the declinometer magnet was noted, the only effect being a continuous vibration, which rendered the curves very ragged and difficult to read with accuracy.

A study of the traces during the times that the various electric lines were put in operation, showed that, with the currents ordinarily used, there was little effect at three-quarters of a mile, and a further survey with a portable instrument afforded further evidence in the same direction.

Before definitely recommending that the Magnetic Observatory should be removed from Toronto, the Director wrote to various well-known magneticians, present at the meeting of the British Association in August, 1897, requesting the favour of their presence at the Observatory to inspect the photographic magnetic curves there obtained with the view of expressing an opinion as to the advisability of continuing the records at the present site, or of removal to some point distant from electric tramways. Professor Rücker, F.R.S., Professor Carey Foster, F.R.S., Professor Fitzgerald, F.R.S., Dr. Van Rijkevorsel, and Professor Frank Bigelow, were the gentlemen who courteously accepted the invitation, and were pleased to sign a statement that, in their opinion, the value of the magnetic observations at Toronto had been seriously impaired by the trolley system, and advised removal to some other site.

It then having been decided to remove the Observatory, a point was chosen nine miles northeast of the former Magnetic Observatory, latitude $43^{\circ} 47' N.$, longitude $79^{\circ} 16' W.$, easily accessible by railway, and yet very unlikely to be invaded by the trolley system. At present there is no electric railway within seven miles, and little prospect of one within five miles for many years.

The new Observatory, which was commenced in June, and finished during the early days of September, consists of two parts—a circular stone cellar and an above ground structure. The cellar is nineteen feet in diameter, the walls two feet in thickness, the floor concrete, and the roof covered with felt and gravel. In which, on stone piers sunk in concrete to a depth of six feet below the floor, are placed the self-recording photographic instruments: namely, the declinometer for recording changes in the direction of the magnetic needle, and the bifilar and vertical force instruments for registering, respectively, changes in the horizontal and vertical components of the earth's magnetism. Above ground and connected with the Observatory by a flight of steps, is an erection which is divided into two portions, in the larger of which absolute magnetic determination will be made, piers being provided on which to place the necessary instruments, and an adjustable opening on the roof for transit work; the smaller portion is an office, which will be heated by a copper stove.

Observations were first made in the new Observatory on September 10th, and by Oct. 1st all the instruments had been adjusted in their new position, and everything was running smoothly. Results already obtained show that values will differ but slightly from those obtained at the old Observatory, and a very careful comparison was made before dismantling the old eye-reading instruments in Toronto.

Very great care was taken in selecting materials for the building. Every stone used was tested for magnetic effect, and none but copper and zinc nails and fastenings have been used.

There appears to be every prospect that the new Observatory will be admirably suited for the purpose for which it was designed, and there is strong reason to think that the series of observations at Agincourt will be practically a continuation of the old and valuable series of observations made in Toronto. All photographic records will be sent for development to the Toronto Observatory, which continues to be the central office of the Meteorological Service of Canada.

THE GREAT SUN-SPOT OF SEPTEMBER AND OCTOBER, 1898. BY ANDREW
ELVINS.

(Read February 18th, 1899.)

The present year has furnished us with one of the finest groups of sun-spots which I have ever observed; it has attracted the attention of observers throughout the world, and I have thought, that as I observed, and made drawings of it on each day when clouds did not render observation impossible, it might be of sufficient importance to bring it before the Institute.

The spot must have been on the eastern limb a day or more before I saw it. My first observation was on the 4th when it was inside the limb a day, or perhaps two days distance. I was struck by its large size, and the black umbra, and as I thought it would be an important spot I sketched it. On the 5th the umbra was seen to be composed of four parts; (*as some think*), formed by the photosphere throwing portions of itself across the dark umbra which is regarded lower than the photosphere; such divisions called "bridges" or "tongues" are seen in nearly all large spots. I think they are breaks or divisions in matter lying on, or above the photosphere; which permit the photosphere to be seen through the openings or breaks.

The spot had a small spot on the north preceding side very near the penumbra of the large spot, two or three on the north following side, also very near or joined to the penumbra of the large spot, and also two following between the spot and the limb.

On the 7th the umbra was greatly changed; I could only see three dark umbra divisions instead of four, the two small groups which followed on the 5th had become much larger and contained many black points in a penumbral shading which enclosed the whole.

On the 8th the three umbras had disappeared, and one large black mass existed in the large oval penumbra, the north preceding spot was more distant from the penumbra of the large one than on the 7th, and all the following spots in the train had become larger and more distinct; there were also fragments of penumbra, scattered through the intervals between the trains, larger spots, and a number of black points on the photosphere too small to show any details.

Being near the sun's central meridian I estimated its size in the following manner, roughly of course, but not far from the reality.

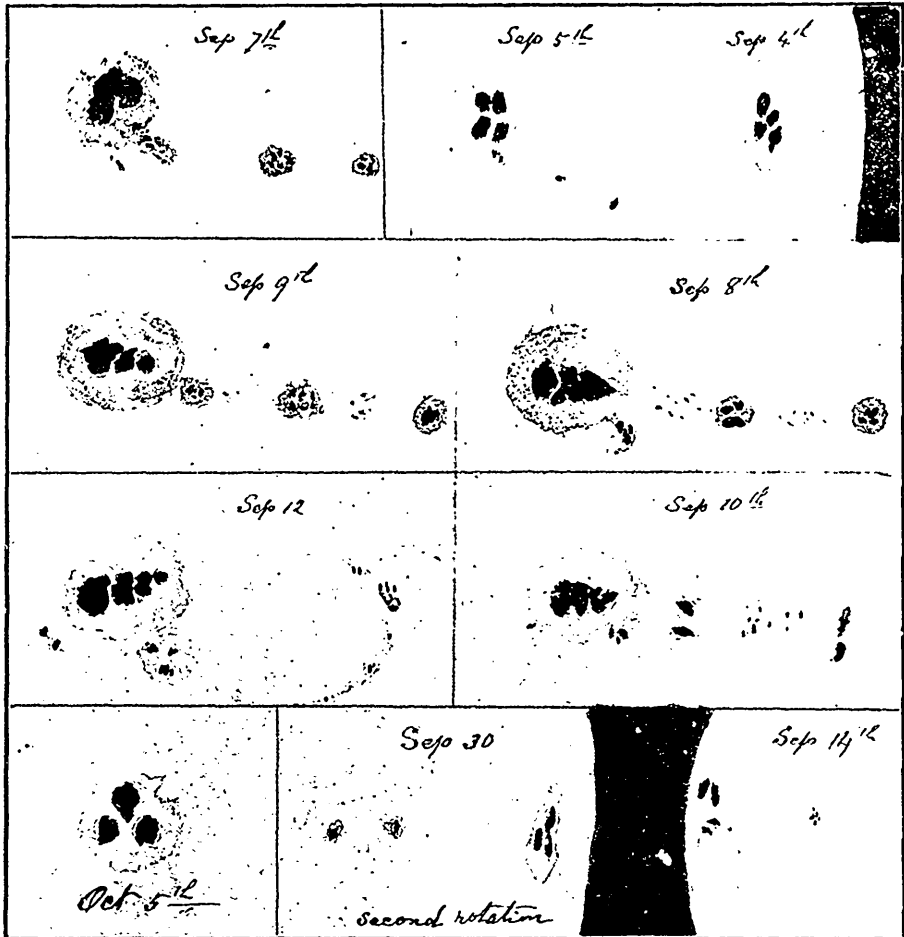
Sun's diameter 800,000 miles, length of group one-sixth ($\frac{1}{6}$) of sun's diameter, = 130,000 miles, large spot about one-third of the length of group, equal 43,000 miles.

An extract from a letter written September 9th by Prof. David E. Hadden will throw additional light just here.

.. When I first observed this spot, but a mere line of light separated it from the edge of the limb, no penumbra being visible except on the north and south edges of the long umbral line, (a bright aurora was seen the same evening.) On the following day penumbra was visible on all sides of the umbra, . . . the changes from day to day were quite marked. Owing to atmospheric conditions the spectroscope could not be used until the 6th, when but little or no disturbance could be noticed in the vicinity of the spot. On the 7th though, a sudden outburst occurred. When the spectroscope was adjusted at 11.40 a.m. central time, the entire region just preceding, and for some distance following, the spot was greatly agitated, the H α line being reversed and distorted, small black jets projecting from each side of the line were noted in several places, and on opening the slit slightly, the flame and spike-like figure of the disturbance could be clearly seen. At 12 noon, intensely brilliant flames were observed over the large spot extruding from the umbra to the umbra to the edge of the penumbra on the east side. This phenomenon was particularly striking—the intensely bright scarlet flame nearly in the centre of the dark absorption band of the spot spectrum being very interesting; the D β line was bright,

and D₁ and D₂ and many other lines widened. At 12.05 p.m. a small dark line attached to the H_α line extended obliquely toward the red end of the spectrum in the region just preceding the main spot. At 1.40 p.m., the entire disturbance had almost ceased."

September 9th.—The central spot in the train seems to be nearer the large spot than on the 8th, and the nuclei in all have kept changing; many fine black points are still visible along the line of the train.



September 10th.—The central spot in the train has moved onward and is now quite near the large spot. I think the spots must be situated at different depths in the solar atmosphere, and be moved by currents moving at different rates. Perhaps a cyclonic motion in a vertical plane nearly parallel with the sun's equator might best explain the motion.

I was not able to get a sketch on the 11th and I much regret it, for two sketches made on the 12th are very remarkable. The central group which was nearing the large spot on the 10th, has quite disappeared; has it ceased to exist?

or has it passed beneath the great spot and been eclipsed by it, or in some way mingled with it?

I hope photographs which have doubtless been taken will answer these questions.

On the 14th it was bad seeing but I made a rough sketch; the large spot was near the limb, one part of the penumbra was on it and only one spot could be seen following it; it probably passed over the limb on the 16th which was just fourteen days crossing the disc, and it came on on the 2nd.

The motion of the earth in its orbit adds about two days to the time which the sun's rotation alone would require to enable us to see a spot which is on either limb of the sun until it returns there again, about twenty-seven days together, and as this spot was on the east limb on the 2nd, it should be there again on the 29th. It appeared at the proper time but greatly decreased in size, and quite shorn of the fine train of spots seen when it was last visible.

Two spots, however, preceded it; the first must have been on the limb on the 27th. I saw it on the 28th and stated in a letter that the large spot had returned; I was mistaken in this, it was too early; the great spot was on the limb on the 29th and my first sketches were made on the 30th.

But the smaller spots which preceded it may have special interest. We noticed the fact that the spots in the train following the large one when it was last seen approached the large spot and seemed to coalesce with or pass beneath or above it, and it is possible that the spots which followed it, may precede it now; if the westward motion continued during the fourteen days when they were invisible to us they would have passed to where we see them now.

On October 1st the great spot was well in on the disc; it contained three pretty round black umbras and the penumbra was nearly circular, and two spots preceded it, the foremost one the largest.

From this time the size and activity of the spot gradually diminished, though occasionally very bright bridges, and bright points were seen. On the 6th the three umbras divided, and on the 8th four were plainly visible, the spaces between them being intensely white. I saw it last on October 10th, near the western limb; it was cloudy on the 11th and on the 12th it had disappeared.

I should note that the small spot preceding became more widely separated as time passed on.

I wish to state here as I have often stated before, that I see no evidence in this spot of spots being deep hollows in the photosphere; the drifting of the groups in the train in September toward the large spot, and the drifting of the spot preceding it in October, from the large spot render it far more probable that dark matter floating and drifting in the sun's atmosphere cuts off the light of the photosphere below, and is seen by us as a spot.

It is more than twenty years ago since I called the attention of this Institute to the influence exerted by sun-spots on the earth and its atmosphere. Prof. Loomis of Yale was working at that time on the subject, and had shown that *magnetic disturbances* and our *auroras* are more numerous when sun-spots are numerous than at other times; but whether they were directly influenced by solar disturbances, or are caused by cosmical conditions which affect both earth and sun was by no means certain. In the case of the present spot there has been a very marked magnetic disturbance just as the spot passed the central solar meridian, and at the same time, September 9th, brilliant auroras were seen in Europe, and also very generally through the Dominion of Canada.

Dr. Vedder and Mr. Shearman have noticed auroras and magnetic storms, when spots were near the eastern limb of the sun; European observers have noted such displays when the spots were on the sun's central meridian.

In the case of this spot, in Canada auroras were reported from thirteen stations on the 2nd of September, and from twenty-one on the 9th, and again on the 28th and 29th, when the spot had made one complete revolution and was again on the east limb, auroras were reported from many stations. So in this instance we have a plus of auroras when the spot was on the eastern limb and also when near the centre, whilst very few are reported at other dates. In this case both the American and European observers may be right as to the facts: and our theories of the cause of the coincidence will have to *include both*.

But it is just here that we have found the record of the disturbance of the magnetic needle of great importance ; for the photographic tracing of the Toronto Observatory, which Mr. Stupart has placed at the service of Mr. Harvey and myself, shows a great disturbance just at the time when the spot crossed the central meridian of the sun. This shows, (or at present seems to show) that the solar energy passes *radially* from the sun to the earth, and that the outbreak of spots causes an *immediate* transmission of energy through the solar system.

I long ago called the attention of this Institute to the fact that HURRICANES have been far more numerous near the period of sun-spot maxima, than minima. This is so true that taking the four years near the maximum, we find more than double the number of occasions when the wind moves more than thirty miles per hour at Toronto than we get in the same number of years at sun-spot minimum.

The spot of September, 1898, broke out during the minimum period, and this enables us to trace the coincidences with a better chance of seeing and detecting *real connections* from chance coincidences than at a time of spot maximum.

In this connection it may be of some importance to notice the fact that a terrific hurricane swept the Windward Islands on September 10th, just the time when the spot was crossing or very near the central meridian, and we also had a most destructive tornado in the Niagara district when the spot was on the eastern limb or near it.

It has been found that as a rule spots at the commencement of a new cycle are far from the solar equator, and that they gradually approached the equator and were as a rule near it at maximum. The spot of September was, however, near the equator, though we must be near the minimum of the sun-spot period.

THE OCCURRENCE OF GOLD IN SOME ROCKS IN WESTERN ONTARIO. BY
 J. W. BAIN, ESQ.

(Read April 22nd, 1899).

Of many speculations on the origin of metalliferous lodes, perhaps none has attracted more attention than that which is known as the theory of lateral secretion, and the object of this note is to discuss in brief its possible application to some ore deposits of Western Ontario.

Delius in 1770 and Gerhardt in 1781 concluded that rain penetrated the earth, taking up any soluble material in its path, and, afterwards collecting in the fissures and cavities, gradually deposited the dissolved matter with the formation of a metalliferous lode. This is a fair description in general terms of the theory of lateral secretion, and for the next ninety years the idea lay fallow. In 1873, Sandberger in Germany commenced a series of investigations for the purpose of determining whether the theory were tenable, and the ores, veinstones, and country rocks of a number of veins, were subjected to careful analysis, particular pains being taken to detect and estimate small quantities of certain elements. The hornblende, augite, olivine and mica of the rocks were isolated, and in them could be detected appreciable quantities of almost all the elements commonly occurring in metalliferous veins. Space will not permit of any lengthened description of these interesting researches, which resulted in the author's adoption of the theory, but attention may be directed for a moment to the United States, where steps were being taken to collect evidence upon the subject. Geo. F. Becker was commissioned by the Geological Survey to examine the Comstock Lode, and during the work an investigation similar to Sandberger's, though on a much smaller scale, was carried on. The results which were published in 1882 led the geologist to the belief that lateral secretion would satisfactorily account for the origin of the lode.

J. S. Curtis, reporting on the Silver Lead deposits of Eureka, Nevada, concluded that the theory was capable of explaining the origin of these ore bodies also, and S. F. Emmons, in a monograph on the Geology and Mining Industry of Leadville, Col., describes some experiments which led to a similar view.

These opinions were witnessed by an array of analytical results, which dealt almost entirely with gold and silver, gold being determined only qualitatively. In view of these facts, it was decided to make some investigations upon Ontario ores. The methods were rendered as accurate as possible, and, although they differ somewhat from others which have been used, the changes were confined to details, with, it is believed, beneficial results.

The samples examined were country rocks, taken from 6 to 10 feet distant from the vein: the following are the results:

Foley mine—gold.....	6c. to 17c. per ton.
Mikado " "	12c. to 28c. "
Regina " "	3c. "
Sultana " "	none.
Granite, protogene, at least 500 feet from any vein—gold.....	none.

In endeavouring to estimate the value of these results, it must be remembered that more than one interpretation may be placed upon them. If we assume that the mineral-bearing solution can permeate the rock with a certain degree of freedom, and this premise is one which we can make with confidence, solutions from underground sources capable of depositing minerals would impregnate the country rock for some distance and produce a condition, close to the vein, resembling that which would result from lateral secretion. For this reason, a series of samples taken at points increasingly remote from the deposit, would yield results of much value, if it were possible to estimate with great precision the amount of gold

and silver in each. This, unfortunately, is a difficult task; the amount of silver present in the rocks and gold ores of Western Ontario is comparatively small, and the determinations are not sufficiently exact, in that case, to inspire confidence; while the amount of gold is often many times less than that which is commonly reported by assayers as a trace. In addition to this, the examination of the samples is tedious, and the limited time at my disposal was only sufficient for the attainment of the results above mentioned; it is almost superfluous to add that in such questions as this, the evidence can not be too abundant, and should as a minimum comprise many times the number of results which have been stated.

It is too soon yet to arrive at any definite conclusion, but we may state as a step towards the final result, that certain country rocks in our western mining district contain small but determinable quantities of gold.

COLONEL MAHLON BURWELL, LAND SURVEYOR. BY ARCHIBALD BLUE, DIRECTOR OF THE BUREAU OF MINES, TORONTO.

(Read April 22nd, 1899).

I have read all the letters and journals of Mahlon Burwell to be found on the shelves and in the vaults of the Surveys office of the Crown Lands Department, and if in the use of them I were to follow the example of Carlyle in his *Oliver Cromwell* I would make a large book. But Burwell has been dead only a little more than fifty years, and his journals and letters have not yet attained a richness of age, not even those of ninety years ago. The paper is but slightly yellowed, the ink is but faintly faded, and the penmanship is neat and flowing. I was going to say that they are as legible as if written yesterday, but that would be an odious comparison in view of the fact that in our time and in our own city good writing, like spelling and reading, has gone out of fashion, if it has not become a lost art. By the end of the twentieth century the old records of the Crown Lands Department will begin to have value, and if the Burwell papers are preserved until then some writer on Canada in the Nineteenth Century will find them out and make them live again in history. But will they be preserved? A few of the letters and more than one-half of the journals are already missing from their place, as a consequence, I have no doubt, of a lack of motive to keep the records of the office complete, and of the frequent movings of the seat of Government during the years of the Union of Upper and Lower Canada—to Kingston, to Montreal, to Toronto, to Quebec and to Ottawa.



MAHLON BURWELL.
(From an Oil Painting).

I am to write of Mahlon Burwell as a Land Surveyor, and therefore I shall say little upon other matters in which as a man active in affairs he took some part. The letters and journals indeed deal closely with the business he had in hand, and only at rare intervals is there a gleam of personal or human interest to lighten up the official soberness. I shall make two or three lengthy quotations from the official instructions and from the journals, to illustrate the methods of ninety years ago, and how difficulties were faced, and how work was done as the methods required. Those were days of military ideas in Canada, and men of the Civil Service, outside as well as inside, discharged their duties with the courage and precision begotten of military discipline. They were not all exemplary men in the highest ranks. Some took advantage of their opportunities, seeking especially to enrich themselves by securing valuable tracts of the public lands either as gifts from the Crown's representative whose favorites they were, or by paying for them at a nominal price; and the Crown's representative himself was not always a man above suspicion. But in the case of Mahlon Burwell I have not discovered the suggestion of an improper act. He appears throughout all the papers and letters as a modest, faithful servant, and as a dignified and high-minded man.

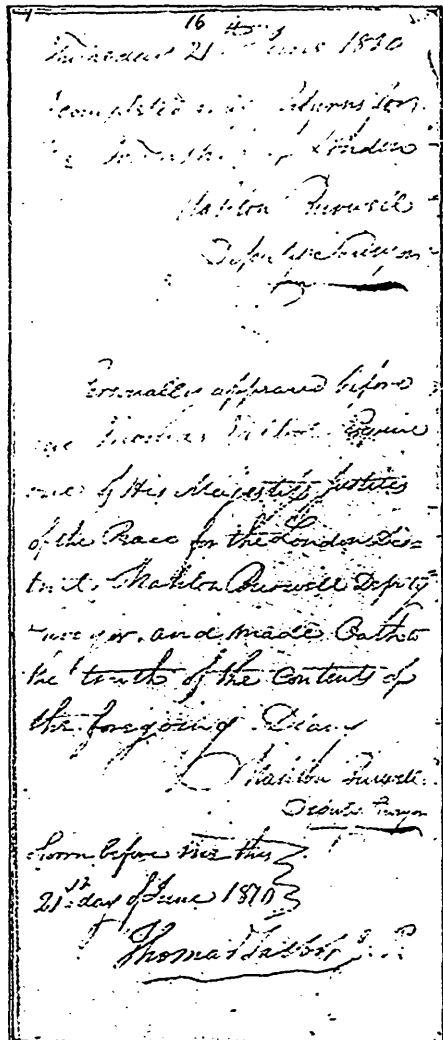
It has been said of Queen Victoria that she reigns but does not govern. This could not be said of the Governors of Canada in the days before responsible government, when George the Third was King. Francis Gore, who was Governor

of Upper Canada from 1808 to 1816, was every inch a Governor, and the administration of the country was in his hands down almost to the smallest detail. He kept a watchful eye upon the public domain, and, following the good example set by Simcoe, he sought diligently to promote its settlement.

In May, 1803, Col. Thomas Talbot commenced the settlement known by his name on the shores of lake Erie, in what is now Elgin county. Next year an expenditure of £250 currency was made under his direction in building a road through his lands. When Gore became Governor a memorial was addressed to him by Talbot, praying for a plan of settlement similar to the one adopted in the formation of Yonge street, which in Talbot's opinion would result in completing the road to the full extent of the first intention. The matter was referred to the Executive Council, who reported to the Governor that the district to be served by the proposed road was very thinly inhabited, that in no other part of the Province was the want of facility of intercourse more sensibly felt and experienced, and that the money already expended would be entirely lost to the public if the design of continuing the road was frustrated. Besides, it was felt that a highway extending through the country and occupied by a good class of settlers would add to the value of the large adjoining block of land which had been set apart in Southwold, Yarmouth and Houghton as the source of a fund for public schools. It was therefore advised that a grant of lots of 200 acres should be made to persons willing to become settlers on each side of the projected road, subject to these conditions, viz: (1) That within two years from the time each settler was permitted to occupy a lot he should build thereon a good and sufficient dwelling house of at least 15 by 20 feet in the clear, and occupy it in person or by a substantial tenant. (2) That within the same time he should clear and fence ten acres, and clear and open up one-half of the width of road in front of his lot, and cut down all trees within a hundred feet of the road. But as the lots proposed to be granted under this scheme were parts of the lands set apart for public schools, it was recommended that land of equal extent and value should be appropriated elsewhere for the same object.

The office of Surveyor General was vacant at this time, and was occupied by Messrs. Chewett and Ridout as acting Surveyors General.* They were commanded

* December 26th, 1809, Secretary William Halton was commanded by the Lieutenant Governor to inform Thomas Ridout, Esquire, Surveyor General, that he had been pleased to appoint William Chewett, Esquire, to be first clerk in the Surveyor General's office from the first of July last, in the room of Mr. Ridout himself, promoted to the office of Surveyor General from the same date. Mr. Ridout held the place about eighteen years, and again Mr. Chewett became acting Surveyor General, but he never attained the full rank.



A PAGE FROM THE LONDON TOWNSHIP JOURNAL.
 Reduced to $\frac{1}{4}$ size.

by the Lieutenant-Governor—his orders were always in the form of commands—to send a surveying party into the London District to survey and lay out the new road, and upon the recommendation of Col. Talbot the post of surveyor was offered to Mahlon Burwell, being his first commission from the Government. The instructions, under date of March 24th, 1809, were in the following terms :

“ In obedience to His Excellency, the Lieutenant-Governor’s commands to us, bearing date the 17th February, 1809, to send a surveyor and a sufficient party, as soon as the season will permit, to complete certain surveys in the London District recommended by the Executive Council and approved by His Excellency the Lieutenant Governor, upon a petition submitted to the Board from Thomas Talbot, Esq., of Port Talbot, who has recommended you to carry the said survey into execution.

“ You are hereby required and directed without loss of time, as soon as the season will permit, to survey and lay out a road to pass through the aforesaid townships upon the principle of Yonge street, by making the said road in breadth one Gunther’s chain, and laying out lots thereon of 20 chains in breadth on each side of the same, leaving a road on the side lines of each of the said townships, and a road between every five lots in each of the same, of one Gunther’s chain.

“ For this survey your pay will be 7 6 per day, with an allowance in lieu of rations of 1 3 Provincial currency per day.

“ Your party is to consist of eight men, that is to say, two chainbearers and six axe men only, considering the country through which you have to pass is lightly wooded, by having little or no underbrush.

“ The chainbearers will be allowed 2 – per man per day. The axemen will be allowed 1 6 per man per day, all Provincial currency, and you will be allowed for each ration furnished to your party 1 3 Provincial currency per man per day.

“ The ration to be of the following species, viz. $1\frac{1}{2}$ lb. flour, $\frac{3}{4}$ lb. of pork and $\frac{1}{2}$ pint of peas.

“ You are to understand that this allowance to you of 1 3 Provincial currency per man per day for each ration is to cover all expenses whatsoever, such as transport, batteau hire, camp kettles, axes, tommyhawks, tents, bags, snowshoes, etc.

“ The chainbearers must be sworn to the faithful discharge of their trust before they enter upon their operation. This you are authorized to do yourself, under an Act of the Province of Quebec, no law in the Province of Upper Canada having been made to the contrary ; but it will appear more solemn and have a better effect to have it performed by a magistrate.

“ The whole of your party, being eight in number, are actually to be employed in the field without any subterfuge, as you will be obliged to make oath to this fact. But should you not be able to engage the whole of your party—that is to say eight men, including axemen and chainbearers—you are to bear no more men on your pay list than those who are actually employed in the field.

“ Should you be under the necessity of discharging any of your party before the survey is completed, you must keep four open pay lists for that purpose, which the person so discharged must sign, whose signature must be witnessed by some person of respectability (if possible), and those who remain with you are also to be borne on the said pay list, a form of which is herewith enclosed for your guidance—so that the whole of the expense incurred on your survey shall not exceed the number of men your party is rated at, which must be sworn to according to the form given.

“ You must keep a field book of the whole of your operation, noting everything worthy of remark, but in particular the white and yellow pine, and the lots on which it is to be found, which must be so clear and distinct that the whole thereof may be traced on the plan, not only by a surveyor but by any person who can read writing, which must also be sworn to and returned with your pay lists and vouchers.

“ You must keep a diary or journal, clearly explicit, as how you have expended your time, in which you must enter everything worthy of remark, particularly the white and yellow pine fit or not fit for masting according to the best of your knowledge and belief, and such mines and minerals, etc., that you may pass in the course of your operation, noting the lot and concession whereon the

same may be found, as directed in your field book, and you must be particularly careful in your diary or journal to enter the time and names of the persons whom you engage and discharge, according to their respective dates, so that the same may correspond with your pay list, which also must be sworn to and returned with your vouchers.

“Your pay list and vouchers for your pay, ration and abstract must be in quadruplicate.

“The rough plans of Yarmouth, Southwold and Houghton, herewith sent to assist you in your operation, on which are laid down imaginary lines upon which the courses of the road are supposed to run, the situation of which must be determined by measuring on the side lines of the several townships from lake Erie, until you intersect the road you are to lay out, when it is completed, which must be returned with the fair plans of your operation, on which must be laid down in a clear and distinct manner the mountains, hills, rivers, marshes, meadows and swamps, or whatever else may occur that may be remarkable for its singularity or utility.

“The principle on which Yonge street is laid out is, that the lots are 20 chains in front by 100 chains in depth; therefore it is requisite to observe that whatever obliquity you may have occasion to make from the concession lines of those townships hereafter to be run, making Yarmouth as the centre township the governing one for the three townships, then you will have to calculate the obliquity of the same on the angle or difference deviating from the concession lines of the township of Yarmouth, which Mr. Chewett will explain, and show you the method of calculating should you be unacquainted the nature thereof. The plans of Southwold, Yarmouth and Houghton, sent with these instructions, will point out how far this can be carried into execution.

“You must always have in remembrance that you cannot approach nearer to lake Erie with the rear boundary forming the concession on the road to be laid out than the rear boundary of the 7th concession in Yarmouth, nor the rear boundary line of the 4th concession in Southwold from the river Thames, which have been so far conceded.

“You must not, however, set out to commence your operation until such time as you have reason to believe that the waters have sufficiently left the woods, that there may be no plea of delay by being obliged to hire your party and to commence your operation at an unseasonable time of the year.

“A reasonable time when you arrive at Port Talbot will be given to you for the hire of your party and purchasing your provision, which it is supposed may be done at one and the same time, and also for going to and coming from your place of residence to Port Talbot, and for making up your plans and vouchers, and no more, and every exertion that a surveyor is capable of in carrying the same into execution with accuracy and dispatch is expected from you.”

A party of surveyors usually consisted of ten men besides the chief, but as the woods in the west were supposed to be more open than elsewhere, Mr. Burwell concluded that he could effect the work with eight men, and so that number was placed in the instructions. He apprehended, however, that men could not be hired at the Government rate of wages, as they were accustomed to receive more from the farmers. Accordingly the Governor in approving the instructions agreed that “should it be impossible to procure men to assist the surveyor at the usual price, Col. Talbot must be requested to certify the lowest wages they are to be had for, which will be allowed upon this location.” The regular rate continued without alteration for a long period. In 1797 it was the same as in 1809, but in 1815, after the close of the war, rates were increased, owing to the higher cost of living. “The notice you have taken of the prices of Labor and Provisions having risen within the last three or four years is very cogent.” Mr. Burwell wrote to Mr. Ridout from Southwold, in November, 1815. “Provisions are dear here and Labor is high, which I expect is pretty generally the case throughout the Province. Farmers are giving from fifteen to eighteen dollars per month to laborers, which will make it difficult, if at all practicable in the present state of affairs, to execute the Surveys required at the former established rates. As to myself, I must confess that it is an arduous undertaking to be in the Wilderness exposed to the inclemencies of the Weather long at a time. It certainly impairs one’s health. An increase of pay is desirable—but

it would be indecorous for me to state my humble opinion of what it ought to be. The circumstances which lead you to mention it, are sufficiently known to yourself as Surveyor General, and I shall be content with such additional pay as the Lieutenant Governor in Council shall deem expedient to establish." The scale was made 10s currency per day for surveyors, 3s 9d for chainmen and 2s 6d for axemen, with the usual allowance for rations. In 1818 a new scheme was introduced. Surveys of townships were let under contract, and payment was made in a percentage of the lands. The common allowance was $4\frac{1}{2}$ per cent., but if the land of a township was shown to be marshy or the quality of it poor, the percentage might be drawn from lands elsewhere.

Economy was enjoined upon all surveyors, and the records show that it was rigidly exacted. "You will pay the strictest attention to the economy of your time." Surveyor General Smith advised Abraham Iredell in 1803, "as the most minute scrutiny will be made in respect of the same." There was an audit of the accounts in Toronto, and afterwards an audit in London before they were finally passed, and for this reason all accounts and vouchers were required to be made out in quadruplicate.

It will easily be understood that on the allowances for wages and rations a surveyor could not be generous. In most cases he went into the woods without even a tent, and when it rained the men peeled bark from the trees and made a rude shelter of it. But as the bark will not always peel, it would happen that the party had to lie down without any covering, and in the journals of Mr. Burwell there are frequent notes of this kind of experience. There was no allowance of tea or coffee with the rations of flour, pork and peas, and the early records do not give a hint of any other beverage. But twenty years after Burwell's earliest venture as a land surveyor, when Roswell Mount of Caradoc was provisioning a party to lay out a township on the St. Clair river—it was named St. Clair, but has since been divided into the townships of Sarnia and Moore—he began with the purchase of a barrel of pork, a barrel of flour and a barrel of whiskey.

We have travelled far since those early days, as witness some articles in the allowance of stationery supplied to the surveyor of ninety years ago, for which he gave to the Surveyor-General a detailed receipt. One item is 25 quills, for although steel pens were made before the close of last century, they did not come into general use until the middle of the present one. Another was a stick of sealing wax to seal letters, long before the days of the envelope. A third was a piece of monthglue, so completely gone out of use that a specimen of it would be a curiosity now. A fourth was "one Indian rubber," and a sample in my possession is as dry and hard and brown as a mummy of the days of old Rameses. There were also papers of ink-powder, black and red, but men under sixty may remember the use of ink powders. Some of us, whose faces have not lost the country bronze, who lived in the country school sections, twelve miles away from the nearest general store, may even recall memories of the fluid we helped to compound in an iron pot from the inner bark of the swamp maple, with green vitriol and sugar added—ink of just a slightly deeper shade of purple than Emperors were wont to use in writing their names, which shone like varnish on the paper and crackled like burning brush when the copy-book was opened, and was viscous enough to arrest a housefly. I think that I could identify that swamp-maple ink upon the written page after a lapse of ninety years; yet, in spite of the scrutiny and microscopic economy of the audit office, I am sure that Mr. Burwell was never forced down to the level of using it, at all events not in his official correspondence nor in his journals. But the records afford not a few illustrations of the infinitesimal mind that directed the audit office when Francis Gore was Lieutenant Governor. One is reminded of Elia's man, John Tipp, of the South Sea House, who thought an accountant the greatest character in the world, and himself the greatest accountant in it. Auditor is Accountant writ large.

The surveyors often were annoyed by delays in the passing of their accounts, although it happened sometimes that the Receiver General was more to blame than the Auditor—when there was no money in the Treasury. This, however, is slightly a diversion, and I come back again to the subject.

Mr. Burwell was enjoined to read his instructions carefully, and not to leave Toronto until satisfied that he understood them; and he was directed without loss

of time, as soon as the season might permit, to proceed with the work, but not until he had reason to believe that the waters had left the woods, so that there might be no fear of delay by commencing at an unseasonable time of the year, with himself and his men idle while under pay. "I have perused my instructions and looked over the plans," he wrote on April 1st, "as carefully and as much as I possibly could for the short time I have had them in my possession, and see nothing to prevent my putting the instructions into execution as soon as time will allow." On the same day he drew the allowance of stationery, and having gone to his home in Bertie township he began to fit out for the enterprise in hand about the middle of May. Four days were spent in making out voucher forms, a field book and plans of the townships, and then he was ready to begin the journey to Port Talbot. I quote a few pages of the journal.

"Sunday 21st May. Could not set out with a Boat on account of the Ice being wafted to the North side of the Lake.

"Monday 22^d May. Believing it would be difficult to hire men enough at Long Point or Port Talbot for my Party to consist of, and being ready to set out I engaged three, by name, Edward Kerr, John and Robert Burwell. Kerr for a Chain Bearer at 2 6 currency per day, and the Burwells at 1 6 per day each. Set out from Fort Erie and reached Point Industry. It rained all Night."

Point Industry is west of Point Abino and Sugar Loaf. It is lot 14 on the lake shore, the most southerly land in Wainfleet, and was patented to David Morgan in 1817. It seems likely, however, that Morgan was an old squatter here, as in the first edition of D.W. Smith's Topographical Description of Upper Canada (1799), Industry Point is also called Morgan's Point.

"Tuesday 23^d May. We set out early in the morning, had contrary Winds, and it rained all day, however, by being assiduous we reached Oustine's Creek.

"Wednesday 24th May. Set out early. Winds still contrary, but reached St. Gust at 11 o'clock a.m., and the Wind breezed up so strongly from the South that we had to put into the mouth of the River for Safety."

St. Gust is one of the several aliases for the most southerly point of Walpole. In Smith it is called St. Dusk or Sangas, and the same name is given to the stream which empties into the lake just east of it. On the U. S. Lake Survey chart the stream is called Sandusky river, and the point itself Peacock Point.

"Thursday 25th May. Reached Colonel Ryerse's in Woodhouse, with some difficulty, by rowing against the West Wind. I embraced the afternoon to enquire for men to engage, but found none.

"Friday 26th May. The Boat I went up in went no farther than Long Point. I went to Dover in quest of one, and of men to assist me, but all to no effect.

"Saturday 27th May. Was told that Stephen Bartow of Charlotteville had a Boat. I went to get it, but he wanted it himself. Made enquiry elsewhere, but could not hear of any in the vicinity of Long Point, and I found no men to engage yet. Mr. Mitchell the schoolmaster informed me that Col. Talbot had taken considerable of pork to his place, and he presumed part of it was intended for me, also that I could get a sufficiency of Flour there, and finding that I could not get a Boat, I concluded to set out on Foot. I could not engage any Men.

"Sunday 28th May. Rained severely the whole day, that I could not start.

"Monday 29th May. Rained until 2 o'clock P.M. I offered two Indians the wages allowed, but they said it was too little. We travelled to the house of Thomas Welch, Esq., tarried all night.

"Tuesday 30th May. Set out early. Mr. Welch sent his son to pilot us to Big Creek, there being no Road to that place. Found the creek very high in consequence of the great fall of rain. Travelled on to within four Miles of Big Otter Creek and encamped. Rained smartly in the night.

"Wednesday 31st May. Hindered some time crossing Big Otter Creek, had to fall a large Hemlock Tree across it, which would have failed us, had not the Creek been narrower below, that the Banks interfered as it swam down. We had to fall a tree across Cattfish Creek also and encamped on good land a mile to the Westward of the creek.

"Thursday 1st June. Travelled on to Kettle Creek and had to fall timber across it,—reached Port Talbot after Sunset and it rained in the Night."

At the mouth of Big Otter creek is now the village of Port Burwell, named

after surveyor Mahlon Burwell. At the mouth of the Catfish is Port Bruce. This stream was formerly called by its French name, Barbet river, and a line drawn due north from its mouth was the western boundary of Norfolk county. At the mouth of Kettle creek is Port Stanley, at first called Stirling. The name of this stream, like the one east of it, has also been anglicised, it having been known in the days of the French occupation as the Chaudiere river.

"Friday 24 June. Colonel Talbot engaged William Coyne to go with me at 2 per day it being the lowest he could be engaged for. Finding it impossible to get either Provisions, or men enough to constitute my Party at Port Talbot, I set out for Long Point in a Bark Canoe, that I might be at the return of the Boats from Fort Erie and engage one to take my Provisions to Port Talbot. The Weather somewhat unfavorable, that we only reached Catfish creek. After conversing with Colonel Talbot I found myself much at a loss how to act, his wishes differed so very much from the tenor of the Instructions I received from the Surveyor General's office."

This difference seems to have been owing to undue haste on Colonel Talbot's part, for the letters show that when he had perused the instructions he did not disapprove the plan.

"Saturday 3d June. Left Catfish Creek early but were soon interrupted by a head Wind, however we proceeded on to the Three Gun Battery and encamped."

The Three Gun Battery is not now known as a geographical term on the shore of lake Erie, and I have not found it mentioned elsewhere than in Burwell's journal. It is again referred to in connection with a traverse of the front of Houghton. "Proceeded from Big Otter creek down to the Three Gun Battery," the Journal of July 4th notes: "here are immense Sand hills above the regular high Banks, from the summit of which is a prospect of all the surrounding country." Most likely it was a name given to the sand dunes in Houghton, ten miles west of Big creek in Walsingham, eight miles east of Big Otter creek in Bayham, and near to the hamlet of Houghton. There are three hills, which extend for three-quarters of a mile along the lake, and apparently have been built up with the sand blown by winds from the beach. The largest, which is on lot 10 and lies between the other two, is 990 feet long, 300 feet wide, and rises to 195 feet above the water's level. The lake bank itself rises to 70 feet, which is about the average height from Port Dover west as far as the county of Kent. Mr. John Alton of Houghton, to whom I am indebted for this description, has forwarded a sample of the sand, and states that the material of the hills and of the beach is as nearly as possible the same. It is composed almost wholly of grains of silica, with small percentages of felspar, limestone and garnet, all finely rounded. "You may wonder from its appearance," Mr. Alton remarks, "why it does not blow away. But it has the peculiar trait of holding moisture well, and during a season of drought one can kick out moist sand at a depth of one or two inches from the surface." The effect is to keep the hills solid and compact, and there has been little change in their form within the memory of the oldest settlers. They command the best view of lake Erie to be obtained at any point along the coast, and a number of tourists visit them every summer.

"Sunday 4th June. Proceeded on the way, crossed the carrying place, and arrived at Col. Ryerse's at night."

The carrying place from the lake to the head of Long Point bay at the end of last century was a flat of sand about eight chains wide, according to Smith, which sometimes was sufficiently overflowed to be used as a passage for small boats. As late as 1832 there was little or no change in its condition, according to Bouchette, there being a passage for boats through a small brook when the waters were high, and when they were low boats were easily hauled across the slender isthmus. Now Long Point is separated from the mainland by a wide channel of shallow water.

"Monday 5th June. Went in Quest of a Boat and men to assist me, was at the General Training of the Militia and engaged Cornwall Ellis and his Boat to take my Provisions to Port Talbot.

"Tuesday 6th June. I went to Townsend to hire men to go with me, but did not meet with any.

"Wednesday 7th June. I was fortunate enough to procure three Men, by name John Bacon, John Rice and Jesse Millard. I agreed with Bacon for 2.6 per Day with Rice for 2/, and with Millard for 1.4 per Day.

“Thursday 8th June. I engaged Jeremiah Wolfen to go with me for 18 per Day and was all in readiness to set out for Port Talbot, but the Wind blew contrarily that I could not proceed, and then Wolfen refused to go at all, and I could not complete my party, but determined to proceed in the morning.

“Friday 9th June. Loaded the Boat early and rowed against the Wind to the carrying place, or Isthmus of Long Point. We took everything across to be ready in the morning.

“Saturday 10th June. Loaded the Boat early and rowed against the Wind to Big Otter Creek; the Wind blew hard and we lay by. About 6 o'clock P.M. it calmed and we rowed up to Catfish Creek by 10 o'clock P.M. there was a heavy swell and when entering the mouth of the Creek the Boat had like to have filled and my Trunk and my Papers got wet, by which some drawing Paper was considerably injured.

“Sunday 11th June. There was such a violent sea that it was impossible to proceed on the way.

“Monday 12th June. The Lake raged most tremendously all day that we could not move out of the mouth of the Creek. So I searched for the limit between the Townships of Yarmouth and Houghton, on both sides of the creek, but all to no effect.

“Tuesday 13th June. Early in the morning I set out with a pretty rough Lake and we rowed hard until 2 o'clock P.M., when we reached Port Talbot.

“Wednesday 14th June. It rained very hard all day that I could not proceed into the Woods. Colonel Talbot altered his opinion respecting the operation and did not wish to deviate from the intent of my instructions and I regretted that I had written the Acting Surveyor-General on the subject.”

These extracts from the journals show the difficulties and dangers which beset the early surveyors of our Province in parts of it which were the most easy of access by the best transportation of the time. To reach Port Talbot from Fort Erie with assistants and provisions, Mr. Burwell was occupied twenty-four days, and during much of that period himself and the men were exposed to the stress of weather, without shelter, and sometimes in peril of their lives; and journeying slowly on as best they could, on foot through a wilderness of brushwood and briars, or in open boat coasting a shore of high bluffs on the most treacherous of all the great lakes, which in the months of May and June is peculiarly liable to gales that sweep it for an unbroken length of more than a hundred miles from the south and west. Today a party can leave Toronto in the morning, take a run of 120 miles in a railway coach, drive fifteen miles across country along a finely graded road, and arrive at Port Talbot early in the afternoon of the same day. That fifteen miles embraces the first section of the Talbot road which Mr. Burwell was employed to survey. Some of the best farming land in Canada is to be seen there; and if on reaching the Southwold and Dunwich townline the traveller enquires, he may have pointed out to him the house where Col. Mahlon Burwell lived with his family for a third of a century, as well as the little building of red brick where he kept the register of titles for Middlesex county; and beyond these the quiet churchyard by the roadside where, under the shadow of great forest trees, is a grass-covered mound and a stone with this inscription:

SACRED
TO THE MEMORY
OF
MAHLON BURWELL
WHO DEPARTED THIS LIFE
THE 25TH DAY OF
JANUARY A. D. 1846
AGED 62 YEARS
11 MONTHS AND 7 DAYS.

HE WAS FOR SEVERAL PARLIAMENTS A MEMBER OF THE HOUSE OF ASSEMBLY FOR THE COUNTY OF MIDDLESEX, AND FOR ONE PARLIAMENT MEMBER FOR THE TOWN OF LONDON.

In the plan of this paper I have purposely entered into details of the beginnings of Col. Burwell's work as a land surveyor, to illustrate the value of his letters and journals as materials of history, but without a pretence to elaborate them into literary form—for history is not written hastily in broken hours at the end of a day's work. What remains to be done is the harder task of presenting within the limits of a few pages a clear idea of the extent and nature of Burwell's labors during the next twenty or more years of active career as a surveyor; or down to the time when, though still in middle life, his physical powers had decayed and he was no longer able to execute a commission from his chief. "Should His Majesty's Government require that this township (Dunwich) should be re-surveyed," he wrote to Acting Surveyor-General William Chewett on February 24th, 1832, "may I beg that you will not order me to perform the service, as my health would really not permit me to go into the woods at this time,"—and he suggested the name of another to whom the order might go instead. After that time it does not appear that Mr. Burwell attempted any work for the Government except to finish the surveys of one or two townships which he had commenced long before. A list of his undertakings from 1809 to 1835 includes surveys in whole or in part of the townships of Wainfleet, in Haldimand; Houghton, Middleton and Townsend in Norfolk; Bayham, Malahide, Southwold and North Yarmouth, in Elgin; Caradoc, Ekfrid, Lobo, London, Mosa and Westminster in Middlesex; Harwich, Howard, Orford, Raleigh, Romney, Tilbury East and Zone, in Kent; and Colchester, Gosfield, Maidstone, Mersea, Rochester, Sandwich and Tilbury West, in Essex. The list also includes surveys of the towns of London and Chatham (the latter being a re-survey): of Talbot Road East, from the west line of Southwold to the east line of Middleton; of Talbot Road North, from the west line of Southwold to the junction with the Longwoods Road in Westminster; of Talbot Road West, from Port Talbot to the town of Sandwich on the Detroit river; of the Middle Road, midway between lake Erie on the south and the river Thames and lake St. Clair on the north, from the east line of the township of Orford to a point of junction with the Talbot Road in the township of Sandwich; of the Brock Road in Wellington, from Guelph to the rear of Flamboro; of the north limit of lands purchased from the Chippewa Indians in 1827, from the northwest corner of Garafraxa to lake Huron; besides several Indian reserves in the counties of Middlesex and Lambton.

The survey of Talbot Road East, or Colonel Talbot's Road, as it was first called, occupied the whole of the season of 1809 and part of 1810; and the work was pushed on without cessation every day the party was in the woods, the only days of rest being the rainy days. The limits between Dunwich and Southwold, Southwold and Yarmouth, Yarmouth and Houghton, and Houghton and Walsingham were first traversed, the western boundary of Yarmouth being intended as a governing line, and the most eligible points of intersection for the road were found in this way. No difficulty was experienced in discovering a suitable location across Southwold and Yarmouth, and only two courses were necessary in the former, made to avoid a marsh in which Talbot creek had its source. The southern part of Yarmouth had been surveyed in 1799, where a grant of 5000 acres was made to Hon. James Baby and his brothers. In the instructions to Surveyor Jones Yarmouth was described as situated between Southwold and Houghton. The original intention was to run the road through the seventh concession, but Mr. Burwell's explorations showed that a more favorable route was one on the line between the eighth and ninth concessions. He reported it as "an extraordinary place for the Street to pass, there is but Four Chains of Swamp the whole way and that not bad." To the east of Yarmouth the country along the projected line was broken by gullies and swamps. "All the creeks of any account between Port Talbot and Long Point," Mr. Burwell observed in one of his letters, "come from the North East to within about eight miles of the Lake, and then run nearly a South course into it." This was the real cause of the difficulty of finding an easy route across Houghton—whose western boundary at that time was the east line of Yarmouth—for the direction of the road was nearly parallel to the main streams in their upper reaches, and it crossed many of their tributaries. But a fairly good route was obtained in the end, which for the last thirty miles eastward lay in a splendid forest of pines. The terminus of the road was at the eastern line of Middleton, where the village of Delhi now stands; but the name of Talbot Road has been applied to one extending eastward through Cayuga in Haldimand.

Mention has been made of the difficulty Mr. Burwell had in procuring supplies of provisions for his first campaign. He was destined to have more experience of the same sort before the end of the season. The quantity which he at first thought sufficient to complete the survey was entirely expended at the beginning of September. Everything was in such a situation that the whole party had to march out, as clothes and shoes were required as well as provisions. The first day they travelled twenty miles and encamped on Big creek. Going by way of Townsend, the settlement on the lake was reached on the third day. But all the flour there had been sent away, and the only thing to be done was to thresh wheat and get it ground. A team was hired to carry a barrel of pork from Col. Ryerse's to Townsend, and on the fifth day the men threshed seven bushels of wheat and took it to Sovereign's mills. But the miller was not at home, and as a last resort on the seventh day the grist was ground by one of Burwell's own men.

On Sunday, September 10th, Mr. Burwell records in his journal, "I took a Boy and Two Horses whom I had engaged to Pack the Flour and Pork to the Survey on the Old Road, had much trouble on account of Logs, Brush, Briers, &c., but Reached Big Creek." Next day the provisions were packed into Houghton, "and it took us faithfully all day to proceed Seventeen Miles." There a deposit was made, and taking a supply they proceeded to resume work at the point they had left twelve days before. Such is an instance from life in Norfolk county ninety years ago.

In 1810, besides finishing the survey of Talbot Road East Mr. Burwell surveyed the southern part of the township of London, which was believed to be suitable for the cultivation of flax. "I kept a Proof Line in the centre of the Township," he wrote to the Surveyor General's office, "that my Survey might be as correct as possible, on which I Proved every Concession Line that I run, by measuring on the said Proof line, and can say that the operation is very correct." This was the origin of the name of the road which leads out of the city of London to the north boundary of the township. He also received instructions to survey the vacant land between Houghton and Yarmouth, and to divide it, if sufficiently extensive, into two townships, under the names of Malahide and Bayham. The work was done accordingly, and under date of February 12th, 1811, the Lieutenant Governor commanded his secretary to acquaint the Surveyor General that "the townships of Malahide and Bayham are to be annexed to the county of Middlesex." In making this survey Mr. Burwell selected a block of land in Bayham at the mouth of Big Otter creek, a part of which was subsequently surveyed for a town plot and called Port Burwell. Writing of that region to the Surveyor General in June, 1815, he said: "Otter creek discharges more Water than all the small Rivers which disembogue themselves into the North side of lake Erie excepting the Grand River. When a few drifts are cleared out of it, Boats may descend from the Mills in Norwich to its mouth, at almost any Season of the year. There are beautiful Groves of White Pine Timber, on each side of the Creek, interspersed with Groves of other Timber, alternately; there is therefore no doubt, but what ere long considerable quantities of Lumber will be conveyed down that stream, from Norwich and other places to the Lake. It would appear as if Nature had intended the mouth of Big Otter Creek for a place of greater importance than any other in the District of London. In my mind it is highly probable that such will be the case before many years. I am about to lay out what Land I own on the East side of the mouth in a Town Plot." At the same time he encouraged the Government to lay out an adjacent lot held as a reserve for the same object; and "if it should meet with the approbation of His Excellency the Provisional Lieutenant Governor, it would much facilitate the future growth of that part of the Province, to have it laid out by the Government, for a Town at the mouth of Big Otter Creek." But these bright anticipations have not been realized, and although the town is beautiful for situation, it has been for many years a finished town. Like its neighbor town, Vienna, on the same stream, its glory departed when the last of the Big Otter pine was cut.

The north branch of Talbot Road was laid out in 1811, the object of it being to connect the main line of the Talbot Settlement with the road through Westminster. Its western end is at the Dunwich and Southwold line, where the village of Iona now is, and it extends eastward through Southwold parallel with the main

road, to a point where five roads converge, long known as Five Stakes, but now called Talbotville Royal. Thence the road runs north to join the Talbot Longwoods Road in Westminster at a place formerly known as the Junction, but now called Lambeth, six miles from the city of London.

An instruction was received the same year to survey under the direction of Col. Talbot a road from Port Talbot west near the shore of lake Erie to Amherstburg on the Detroit river, to be known as Talbot Road West. "In surveying the Road through Dunwich and Aldborough," Mr. Burwell wrote to the Surveyor General on October 24th, "Colonel Talbot directed that I should begin to number the Lots from his Mills and continue to the westward, which I have done, and also continued numbering them in succession as far as the Survey extends at present: without regard to the Townships through which they pass." Work was commenced on August 26th and was carried on until September 8th, when the survey reached lot 90, near the west side of Howard, and was then discontinued for the season.

It is likely that Mr. Burwell had before this time left his home in Bertie, as a deed dated February 25th, 1812, from Col. Talbot to him of a small piece of land in lot 24 of the 11th concession of Dunwich, describes him as of Port Talbot.* But the war between the United States and Great Britain, which had been threatening for several years, broke out in the summer of 1812, and until peace was again established surveying operations near the frontiers of this Province were suspended.

Only a few references to the war occur in Mr. Burwell's official letters, and no information is conveyed in them that he was engaged in military service. The report of the Loyal and Patriotic Society states, however, that he was active against the enemy on all occasions and became odious to them. The letters show that he was at the Niagara frontier in 1812 and 1813, when fighting was going on there, and that in the following year, when a small body of American soldiers ravaged the Port Talbot settlement, he was carried off as a prisoner of war and his maps and instruments destroyed. A map of Malden had been given by him to Proctor when that General was on his way to take command at Amherstburg in 1812, which was afterwards taken by the enemy and destroyed, with his papers. "The Plans of the other Townships I had deposited, with the Instruments and other appendages of my Surveying Establishment, at a person's House, where I thought they would not be likely to be suspected or discovered, but when the plundering party came through which swept the whole Settlement and captured me, all was taken and destroyed—and I have not been able to get properly equipped with Instruments yet." This was in explanation to the Surveyor General (November 4th, 1815) of the loss of plans of townships traversed by the projected Talbot Road West. One other reference to the war is worth quoting. It is found in Mr. Burwell's journal of the Talbot Road West survey under date of September 18th, 1816. "I passed the place in Front of Lot No. 177 (Tilbury East) where Major Holmes of the United States Army had encamped a Day or two, when on their intended expedition against Port Talbot in time of the late War. I find here, as well as upon every other occasion, when they have remained all night in our Woods, they have felled large Trees flat to the Ground all round their Encampment, to serve as a Breast Work in the event of an attack. Two Field Pieces and ammunition Waggons were left here by Major Holmes, which were destroyed by the Loyal Essex Rangers. The Carriages were burnt, and the Guns and ammunition were carried back and deposited in a Black Ash Swamp where they remained until the Treaty of Peace." The Major Holmes of this record is no doubt the same officer as the Colonel Holmes commanding at Amherstburg, mentioned in Sir Gordon Drummond's dispatch of May 27th, 1814.

The survey of Talbot Road West was resumed by Mr. Burwell in the summer of 1816, and under instructions the western terminus was fixed at Sandwich instead of Amherstburg. The final report upon it was not sent in until the end of 1824.

The first settlements in Kent county were formed upon the river Thames, and after the Talbot Road began to be opened up a scheme was proposed to the Government by Col. Talbot for a main road to follow as nearly as practicable the height of land between lake Erie and river Thames across the county. This was referred

Mr. Gill, the registrar of London, informs me that Mr. Burwell was appointed registrar of Middlesex in 1811, and that the first deed was registered by him May 28th of that year. The first registry office for the London and Western Districts was established February 20th, 1801, and the seat of the office was at Turkey Point, with Thomas Homer as registrar. The office was afterwards removed to Vittoria, and again to Princeton.

to Mr. Burwell, and reporting thereon to the Surveyor General in August, 1821, he expressed the opinion that the laying out of a Middle Road on the highest ground or dividing ridge would tend much to quicken and consolidate the settlements between those waters. The work was entrusted to himself, but as the road as finally laid out extended from a point of junction with the Talbot Road in the township of Sandwich eastward to the county line between Kent and the present county of Elgin, it was not completed until September, 1825. The last division of the survey is the most easterly, being in the township of Orford, and as the height of land there is very irregular it was found necessary to alter the direction of the road frequently. There are in all twenty-eight courses across the township, which has a width of 6½ miles, and only one lot has a straight front. A large tamarac swamp was met with on the way, and there is a tradition that Mr. Burwell was nearly defeated in the effort to find a pass through it. The situation was reported to Col. Talbot, who with his usual urbanity directed the surveyor to follow the ridge. "Follow the ridge, if it takes you to—Hades." But I need not say that Col. Talbot used another word.*

There are many matters of interest connected with surveys of the townships north of the Thames, and of Indian reserves there and on the St. Clair river and lake Huron in Lambton county; and there are also some interesting observations of natural history that deserve attention. But these must be left unnoticed in this paper, in order that its short remaining space may be devoted to the largest of Mr. Burwell's undertakings in his later years as a land surveyor.

The Government of the Province in 1825 made provisional terms with the Chippewa Indians of the London and Western Districts for the surrender of 2,200,000 acres lying to the north and west of former cessions, and about the same time it entered into an agreement with the Canada Company for a transfer of 1,000,000 acres of the same land, in a block which afterwards became famous as the Huron Tract. By order from the Surveyor General's office of July 6th, 1827, the survey of the northern boundary of the new purchase was undertaken by Mr. Burwell, and the work was carried on and completed during the months of September, October and November. Provisions for the expedition were purchased at Guelph, and were packed northward to the starting point of the line, at the northwest corner of Garafraxa. A journal entry of September 19th reads: "Met Mr. Galt near Guelph, who invited me to dine on Friday the 21st Instant at his House near Burlington Bay;" and under the latter date is this entry: "Went to Dine with Mr. Galt at his House—was civilly treated—an agricultural party—Mr. Galt proposed that I should be a member of the Agricultural Society of which he is the head. I declined. Did not know that it was an agricultural meeting until after the cloth was removed. Left Mr. Galt's about 10 o'clock P.M. and slept at Mr. Beasley's." This is the nearest approach to a supercilious tone that I have discovered in all of Mr. Burwell's official writings. But no one could have more heartily enjoyed the scorn of the land surveyor than John Galt himself.

The survey of the line was commenced on October 4th. Ten days were spent in running 18½ miles, as progress was much hindered by dense swamps of cedar, tamarac and spruce. Then the head waters of the Menesetung river (now called the Maitland) were reached, and a very fine country was entered. During the next ten days the line was run 29½ miles, and the river was crossed frequently. In four days more, during which the survey bore away northward from the river, lake Huron was reached at 59 miles 39 chains from the starting point. Storms of rain, hail and snow were frequent, and the actual running time was only nineteen days.

The return journey occupied six days, and was made disagreeable by storms of rain and snow, and by the swollen waters of the river, which had to be frequently forded. The stores of provisions which had been left at various points for the return trip were found to be destroyed by wild animals, and it was observed that bears, wolves, foxes, fishers and martens had followed the party along the line. A note of Natural History is entered in the journal of November 3rd, upon the authority of the Indians. "The Deer all appear to have left Lake Huron, some time ago, for the Shores of Lake Erie, where the Snow does not fall so deep, and

* I heard this story from the late John Sinclair, who moved from Aldborough into Orford in 1822, and took up a lot on the Middle Road. My father, the late John Blue, was the second settler on this road in Orford, having been located by Col. Talbot late in 1826 or early in 1827. His nearest neighbor was four miles away, and the woods were alive with turkeys, deer and wolves.

this the Chippewa Indians inform me is uniformly the case with them every Autumn, to avoid being taken by the Wolves during the deep snow of this neighborhood, which is frequently crusted over." This is doubtful, and I do not think it has been confirmed by observation elsewhere in our country.

The instances are exceedingly rare in which the land surveyor unbends himself in the letters and journals of Mr. Burwell, and one might suppose that the beauties of landscape and of woodland scenery were unappreciated by him. But over the Huron Tract he grew almost eloquent. "Notwithstanding the fatigues and privations attendant on such a tour," he reports to the Surveyor General. "I have had great pleasure in Surveying the purchase line—the country through which it passes is magnificently fine. The River Menesetunk is about half the size of the Thames. It is a fine River of pure clear water. Its banks afford numerous eligible situations for country seats to the right and left, sufficiently elevated and in variety to add beauty to their appearance, and in general they are easy of access, and the Flats extensive. When you are in possession of the Field Notes, Map, and report of the Survey of the purchase line, and the exploring expedition for the Canada Company in detail you cannot fail to feel a deep interest in this part of the country."* It would be a wonder indeed if a stream of so much picturesque beauty flowed on forever without a poet to write a verse in praise of it. The Menesetung has its singing lover, and although I think his genius has been nurtured overmuch on the metrical version of the Psalm of David, he sings out of the heart with a swelling note and a touch of Robert Burns.†

Unknown to fame thy waters run,
 Past groves of living green ;
 And all obscure they gently flow
 Thy leafy banks between :
 Thy beauties ne'er have found a voice,
 Thy charms are yet unsung ;
 Be mine to sing in humble strains
 Thy praise, Menesetung.

No tumbling torrent roaring down
 Its rocky bed art thou ;
 Thy peaceful waters murmuring low
 Kiss soft each nodding bough ;
 The sombre cedars bathe their limbs
 Thy crystal depths among ;
 And mirror'd hemlocks sigh to thee,
 Oh, fair Menesetung !

The dappled trout in many a pool
 Their speckled beauties hide,
 Or, startled from their shy retreat,
 Swift down thy current glide :

* Menesetunk, as the word was written by Burwell, is stated by him to signify in the Chippewa language a large, open harbor. In a private letter to Ridout he says: "The Canada Company have called it the Neston, after an estate of the Father of Lady Goderich in England, and they have called the mouth of the River (Goderich Harbor)." Mr. J. C. Bailey, the railway engineer, who is one of the best of our local authorities, writes in reply to an enquiry: "Goderich, or in that neighborhood, was called by the Indians Ma-nese-tung. So, if the Maitland river was called after the village—as the rivers generally are—it should have the word 'sebe' after it, which means a river, and should then read Ma-nese-tung-se-be. Menis means an island; Menis-ung, in, at or on an island; Me-ne-ting, an island in a river; Me-ne-te-goje-wun, an island in a rapid." At about 25 miles from the starting point of the purchase line survey it is described by Burwell as "a fine River with Islands, gentle banks, and Stoney bottom."

† The writer is my associate in the Bureau of Mines, Mr. Thomas W. Gibson, who was born in the village of Wroxteter, on the banks of the Maitland.

The wild canary builds her nest,
 And rears her timid young
 Upon thy calm sequestered banks,
 Oh, sweet Menesetung!

No lordly ships thy bosom bears,
 Slow-moving, one by one,
 Unknown, obscure, thou turnest still
 Thy bright face to the sun ;
 But while my heart within me beats
 Till life's last change is rung,
 I'll love thee still, and love thee well,
 Oh, dear Menesetung!

But if an idea that once possessed some leading men of the Canada Company had taken substantial shape, the "lordly ships" might have become a moving feature on the bosom of the Menesetung. Mr. Burwell was strongly impressed with the practicableness of the scheme; and in his report to the Surveyor General he ventured the opinion that the river might be the means of affording greater facilities for making a canal to pass between its banks and communicate between lake Huron and lake Ontario than any other that could be selected for the purpose. This river, he observed, passed through a very fertile tract of country, and discharged itself at a good position into lake Huron, so that a canal in its direction could not fail to produce very great advantages as well in a commercial as in a military point of view. "In producing the purchase line from its place of beginning, after crossing several rills trending in Northwesterly directions, I crossed the Menesetung in the 21st Mile at which place it is 80 links wide, and 18 inches deep, coming from the North East and affording I should think a sufficiency of Water for a canal. Between the 21st mile and the 45th mile, the line crosses the Menesetung, which constantly increases in size, seventeen times alternately, when it leaves the line and trends southerly to where it disembogues itself into lake Huron. Its general course is westerly, watering equally well the tract of country not yet conceded to His Majesty's Government with the late purchase. The rapidity of its current will compare with that of the River Thames, or Grand River, excepting that for several miles above the outlets of those rivers, their waters are apparently dead while the current of the Menesetung continues to within half a mile of its entrance into Lake Huron. The Grand River having its source nearly upon the summit level of the lands between Lake Ontario and Lake Huron, and being sufficiently large to afford feeders to a canal to both right and left, I conceive that the difficulty of connecting its waters with those of the Menesetung and the 12 Mile creek might be accomplished with more ease, and at less expense of excavation than might be at present anticipated. I should think that a position some ten, or fifteen miles above the Falls of the Grand River might be the best: from whence a connection could be made with the waters of the 12 Mile creek, along the side of which the canal could be taken to Lake Ontario. Should such a work be undertaken, and a position selected for crossing the Grand River at, or near the Falls, the feeder could be brought from a sufficient distance up the Grand River to avoid any increase in the expense of excavation save that of the feeder, and then if it was thought expedient, the Canal might be taken past the Town of Guelph, and connected with head waters of the 12 Mile creek in Flamboro' East, not far from the Road which has lately been surveyed from Guelph to the rear of the Flamboro's, or if no obstacle should prevent it, pass directly to the Canal at Burlington Bay." But nothing was attempted, and however feasible the project might have been when the whole country was in forest, and the streams were full and strong-flowing throughout the year, it is scarcely possible under present conditions that it can ever be revived.

There are a number of other interesting matters in the Burwell letters and journals that I would gladly have touched upon, but my paper is already much

toolong. In the preparation of it one of my aims has been to direct the attention of others who have more leisure than myself, and who possess historical tastes and gifts, to a treasure house of material which no one has yet ventured to explore or work over, and of which the Burwell letters and journals are a very little part. But whoever will undertake to exploit that treasure house with any degree of intelligence and thoroughness will soon become convinced that there is necessity for a new departure in the care of its contents, which ought to be treated as possessing great historical as well as official value. If we cannot have a Reference Library for the Province, with a Librarian possessing industry and genius in charge of it, established upon the scheme conceived and matured by the Canadian Institute, let us at least have a Provincial Archivist, whose office should be the collection and care of every paper, and letter, and record, and document that concerns the public and official business of the Province.

BIOGRAPHICAL NOTE. The Burwells are an old family, whose homes in England were in Bedford and Northampton. More than two and a half centuries ago some of them came to America, settling in Virginia. They were loyal to Charles I. throughout the Civil War, and some were loyal to George III. in the American War of Independence. In Sabine's *Loyalists* a sketch of one James Burwell of New Jersey shows that he served the King seven years, having enlisted in 1776, that he came to Upper Canada in 1796 where he received 200 acres for himself and each of his children, that he removed to the Talbot Settlement in 1810 and died there in 1853, aged 99 years five months. He was probably related to Adam Burwell, but that is uncertain. The latter was also a native of New Jersey, and came to Canada with his wife and family after the war. The records show that he settled in the township of Bertie, and that in 1797 he received a grant of 850 acres of land for military service; but the petition in which his claims were set out appears to be lost. There is a tradition in the family that he had large possessions in New Jersey, and that they were confiscated by the Government of the United States. Adam Burwell spent the later years of his life with his son, Col. Burwell. He died in 1828 at the age of 79, and was buried beside the walls of the English church in St. Thomas. His eldest son was the Mahlon Burwell of the foregoing paper, who was born in New Jersey February 18th, 1783, studied land surveying, and through the influence of Col. Talbot got professional employment from the Government. In 1811 Mahlon Burwell was appointed Registrar of land titles for the District of Middlesex, and in 1812 he was elected to represent the Districts of Middlesex and Oxford in the Legislative Assembly of Upper Canada. He held the rank of Lieutenant Colonel of militia at this time, and during the war of 1812-14 was active against the enemy on all occasions, and became odious to them, although there is no record of his being in any battle of the war. In 1814 a band of Americans raided the Talbot Settlement, and although Col. Burwell was in his bed, ill of fever and ague, he was carried off a prisoner and held for many weeks in Ohio or Kentucky. In a second raid his buildings were destroyed by fire and his family was driven off. In 1815 he was established in Southwold, where the Talbot Road crosses the townline between Dunwich and Southwold, afterwards known as Burwell Park. A new Registry building was erected there in which the office was kept until by authority of an Act of the Legislature it was removed to London in May, 1843. Col. Burwell was re-elected to represent Middlesex and Oxford in 1816 and again in 1820. A redistribution took place before the next general election in 1824, and John Matthews and Dr. John Rolph were chosen to represent Middlesex. They were successful again in 1828, and referring to this contest in a private letter to Hon. Thomas Ridout (Aug. 22nd, 1828) Col. Burwell wrote: "Our Election lasted 6 days—when the Poll closed the votes stood—for Rolph 340—Matthews 317—Burwell 305 & Hamilton 275, Matthews 12 over me, and many of my Friends not allowed time to vote, although returned to the poll two or three times for that purpose." In 1830 Burwell was successful in Middlesex, but was defeated in 1834, and in 1836 he became the first representative of London town. During the whole of this period he held the offices of Registrar and Postmaster, and was almost constantly

employed by the Government as a surveyor of Crown lands. But in those days the provisions of the Act for the Independence of Parliament were not as rigid as they are now. Col. Burwell had a family of seven sons, all but two of whom were named after great soldiers, viz., Alexander, Hercules, Isaac Brock, Leonidas, John Walpole, Hannibal and Edward. He had also two daughters, Louise and Mary. Of these only Edward and Mary are now living. All except Alexander and Louise are named in the will, which was executed eight days before Col. Burwell's death, and Alexander is no doubt referred to in a pathetic note to the Surveyor General (Dec. 20th, 1817) written to explain delay in reporting a survey in Westminster. "You would have received the report long since, had it not been for a most dreadful circumstance which occurred in my Family in October last, which deprived me of the use of my right hand for more than two months—A little son of mine two and a half years old was scalded to death, and in taking him out of the boiling water I scalded my Hands as related, but my right hand the worst." One ambition of Col. Burwell's life was to found a family, and with this object he memorialized the Governor in Council in 1829 for permission to extinguish his claim for 10,000 acres of land held in small isolated areas and receive in lieu thereof a block of 10,000 acres on lake Huron, adjoining the southern boundary of the Canada Company's territory, wherewith to make an entailed estate to his heirs forever. But no action appears to have been taken in the matter, and the records do not even show that the memorial was considered. But the idea possessed Col. Burwell's mind to the end, and by the terms of his will it was provided in the case of each of the sons that the lands bequeathed should be held to himself and his male heirs forever, and in the event of anyone of the sons dying without issue the lands should descend to the next son and his male heirs. "I have willed thus to fasten the before mentioned freehold estates upon my children and their heirs forever because my own experience, which has been extensive in this Province, and History have shewn me that children place less value on that which is given them than that which they acquire by their own care and industry; and because I have acquired the estates so willed and devised by a steady perseverance and laborious industry in my profession as a surveyor of lands, of which my heirs can never be sensible: I exercise this moral, legal and conservative right for their benefit: And when advanced in age my heirs in all time to come if they be sensible persons will know how to appreciate the soundness of my motives." Ermatinger, who has written unjustly and unkindly of Col. Burwell (Life of Col. Talbot), says he was tall in stature and dignified in appearance.

THE ILLECILLEWAET GLACIER IN THE SELKIRKS. BY ALBERT PENCK.

From The Journal of The German and Austrian Alpine Society.

(Translated by D. R. Keys, Toronto, Canada.)

(Read April 29th, 1899.)

The Cordilleras of Canada separate a well-watered coast from an arid interior. The moist winds, which blow from the northern Pacific into the interior, on meeting with the individual chains of the mighty mountain system, give up their moisture and then pass on, dried out like the Swiss Föhn, over the valleys beyond, until they have to ascend anew in order once more to lose their aqueous vapor. Each of the different chains, which, running north and south, form the Canadian Cordilleras, has, like the Cordilleras themselves, its weather side and its dry side. This is seen plainly in the course of the snow line. It lies lower on the west slope of the chain than on the east side. He who would view the Cordilleras as a snow-clad chain must observe them from the west: from the east they appear as a rocky chain, the "Rocky Mountains."

It is a bare, bald wall which rises above the great plain of North America. When first seen in lat. 51° N., not far from Calgary on the Canadian Pacific Railway, it resembles the Karwendel chain south of Munich, and although here reaching a height of nearly 3,000 meters, it is below the snow-line. It is the same in the National Park near Banff, so rich in beautiful landscapes. Not till we approach the watershed between the Atlantic and the Pacific streams, do we see snow-fields and glaciers. Near the height of land we can see from the railway the glittering ice upon the flanks of Mount Stephen. It is barely 200 meters higher than the highest mountains around Banff, and if capable, like its neighbors, of supplying ice streams, this is due less to its height than to its western position. Its situation brings it further into the snow limit which here must be sought considerably below 3,000 meters, (somewhere between 2,700 and 2,800 meters high).

The chief range of the Canadian Cordilleras, the Selkirk chain, lying in the bend of the Columbia river, likewise appears free from snow when seen from the east. These are broad-shouldered mountain masses, which rise to the west of the broad valley of the upper Columbia near Donald. The scenery here reminds one of the wide valley of the Inn with the Patscherkofel above Innsbruck, and the railway line which leads up along the Beaver Creek encloses landscapes like those of the Brenner railway. The top of the Roger pass (1314 m.) is, however, a narrower cut in the mountain than the Brenner; on both sides rocky peaks tower up to 2,800 or 2,900 meters. Then it descends into the valley of the Illecillewaet, the railway making the descent by a series of loops. At the same time a magnificent glacial landscape is unfolded and soon the train stops in sight of the splendid Illecillewaet glacier at the station called Glacier, (1256 m.) This station was the headquarters of William Spotswood Green* and Topham, Emil Hueber, † and Carl Sulzer, ‡ as well as H. P. Nichols§ and Charles E. Fay|| in their ascents of the mountains and glaciers of the Selkirks. The passenger trains of the C.P.R. make this their mid-day station. Those on board here enjoy a

*Explorations in the Glacier Regions of the Selkirk range, British Columbia. Proc. of the Royal Geographical Soc., London, 1880, p. 153. Among the Selkirk Glaciers, London, 1890. (This book I had not at my disposal). Climbing in the Selkirks and the adjacent Rocky Mountains, the Alpine Journal XVII., 1895, p. 289.

†Im Hochgebirg von British Columbia, Jahrb. Schweizer Alpen-Club, XXVI., 1890-91, p. 258.

‡Bergfahrten im Far West. Ibid., p. 290.

§Back Ranges of the Selkirks. Appalachia VII., 1893, p. 101.

||Up to the Crags of Sir Donald. Ibid., p. 157.

spectacle such as can be seen on no other artery of the world's travel. Scarcely 2½ kilometers from the station above the dark pine of the primeval forest shines a glacier in the perfection of purity. On the left Sir Donald (3250 m.) raises its proud summit of rock, from which a comb extends in whose cirques twinkle snow fields and tiny glaciers: the Eagle and Avalanche peaks stand out boldly. On turning around you see the beautifully formed pyramid of Mount Cheops, which although only 2,704 meters high conceals a couple of glaciers on its flanks. If the loop of the Brenner railway at Gossensass extended as far as Innerpferssch and the Feuerstein glacier came to meet it at Stein, then one would have a European parallel to the magnificent surroundings of Glacier House, which the C.P.R. has erected here, with every comfort in the immediate vicinity of its line.

I could not indeed quite fully enjoy this scenery when I reached Glacier Sept. 3rd, 1897. I came as a member of one of those exceedingly instructive excursions under excellent guidance, (our guide was the Director of the Geological Survey of Canada, Dr. Geo. M. Dawson), which were connected with the meeting of the B.A.A.S. in Toronto. Heavy clouds were collecting over the mountains and from time to time showers fell. The plan of some enterprising members of our party, to climb Mount Abbott (2,380 m.) behind the hotel immediately after the train arrived, proved impracticable and all our attention was concentrated on the Illecillewaet glacier, which was introduced to the travellers as "The Great Glacier of the Selkirks." The position of its tongue makes it certain that the snow line here lies very deep. In view of the small glacier on Mount Cheops and of small ones figured by Green on Mount Abbott, I should estimate it at from 2,200 to 2,300 meters at the highest, which, considering the dryness of the territory lying further west, appears remarkably low.

The way to the glacier leads through the primeval forest with its lofty trunks, under cedars, Douglas firs, Canadian pines, hemlock trees and balsams, which conceal it from view, until we leave the wood. There to the south of the road lies a great boulder which affords an excellent view of the ice tongue, (Point P5 of the diagram). It reminds one to some extent of the Rhone glacier: rising with a gentle slope it is traversed by only a few radial fissures. Above there is a precipitous ice cascade. Here the glacier is broken up into individual *seracs*. The higher glacial field, the neve does not become visible. It leads across to the Geikie glacier. A moraine, 70 to 150 m. broad, extends around the tongue and continues up the sides in two lateral moraines. The one on the right, near the foot of the wall over which the glacier descends, rises some 30 meters above it, the one on the left is considerably higher and steeper. This ground, which it is plain has only lately been free from ice, is surrounded by a space twice as broad, on which there is nothing but low underbrush. Then follows the forest with its giant trees in which lies our point of observation.

There can be no doubt that the glacier is retreating fast. The flat form of the tongue shows this, and still more the moraine in front of it. It can only recently have been free of ice, otherwise it would certainly have been occupied by the luxuriantly growing plants of the land. As a matter of fact one of Notman & Son's magnificent photographs taken in 1888 does not show the moraine. At that time the ice reached close up to the underbrush, and was surrounded by a low wall of boulders which now encircles the space free of ice with a terminal moraine perfectly well defined although only a few meters high. We have therefore indubitable evidence of the fact that the retreat of the ice only began after 1888. This is further confirmed by eye-witnesses. When the Rev. W. Spotswood Green explored the neighbourhood of Glacier House in 1888 it seemed to him that the ice tongue was advancing, for it had overturned some bushes at the northeastern extremity.

At the same time, however, the Rev. Mr. Green says that at the time of his visit all the glaciers in the Selkirks bore evidence of retrogression. He mentions the huge boulders which are met with on the road from the Glacier House to the glacier, and considers them moraines of an earlier glacier, made up of the Illecillewaet and Asulkan. The lofty tree trunks of the neighbouring forest would show the period of this giant glacier to be centuries ago, granting Green's explanation of the boulders to be correct. But there can be no doubt that the glacial high tide (Gletscherhochstand) of the end of the eighties has been preceded

by one of no long duration. This is shown by the brushwood that girdles the tongue. There must have been a state of affairs here not so long ago which hindered the growth of trees. The form of the land together with the numerous boulders, sometimes arranged like a wall, makes it certain that the glacier lay here at one time. Just how long ago can be estimated by the botanist who is familiar with the rapidity of the growth of plants in the Highlands of British Columbia. If it were in the Alps I should not hesitate to describe the brushwood-covered plain as the growth of some twenty years—it reminds one vividly of the bushes on the former site of the lower Grindelwald glacier. But the luxuriant growth of the primeval forest of British Columbia suggests the idea that everything grows more rapidly there than with us. Be that as it may, it cannot be so very long since that advance of the glacier took place to which the sharp boundary between brushwood and forest so plainly points and which is confirmed by the form and configuration of the land. It certainly belongs to our departing century. But it must have been the greatest advance for centuries, for it carried the ice forward to a wood with lofty trunks which, measuring at times two or three meters, must be centuries old. We have thus evidence in the distant Selkirks pointing to the same conclusion as in the Alps, viz., that the glacial advances in our century have been the most important for several hundred years.

Visitors to the Illecillewaet glacier are struck by the great purity of its upper surface, which is specially noted by Green. We have to do with one of those not uncommon glacial tongues which have no superficial moraines. This is no wonder, for the *névé* has no rocky masses behind, it fills a long valley up to a height of about 2,700 m. and has besides the Illecillewaet glacier to the north, an outflow to the west in the Geikie glacier. The same arrangement is repeated in a similar valley not far to the south, where the Deville snowfield supplies both the Deville and the Grand glaciers. These conditions bear witness to a peculiarly low snow limit on the rainy side of the mountains. This lack of upper moraines is by no means accompanied by a lack of ground moraines. On the contrary, the whole plain now free from ice is covered with them. Immense quantities of glaciated stones lie around; one sees the markings plainly on great boulders. This mass of material must have been brought along under the ice. Near to the edge of the glacier it seems as if it had been rolled with a broad roller. Broad, flat furrows are seen extending in the line of movement of the ice and separated by low-arched ridges. The two lateral moraines consist likewise of ground moraine material. So we have in the main the same conditions as those of the Sonnblick glacier which I described last year to the readers of this journal. We see again that the formation of the ground moraines is independent of that of the upper moraines. To those versed in the subject this is nothing new.

All the small glaciers that I saw about Glacier House are deeply sunk in their lateral moraines, and therefore seem to be retreating. The phenomena on the Illecillewaet glacier might therefore be generalized to a certain extent. Its special accessibility allows us to hope that it may often be observed in the future. It was therefore my intention to mark its position as observed on September 3rd, 1897.

But unfortunately there was no coloring matter or tar to be found either at the station or at the hotel. So I tried to sketch the position of the tongue in its relation to the surroundings as far as was possible by counting steps and the use of the compass. The result is the accompanying diagram on the scale of about 1:10,000.

I reckon the length of a step on the very uneven surface at 0.75 m. I determined the direction and the distance from the ice of three very marked erratic boulders, P₁ P₂ P₃ as well as of the Point (P₄) where the glacial creek leaves the space that is clear of ice. These are:

	For P ₁	P ₂	P ₃	P ₄
Magn. North	200 72 steps.	N. 220 26 steps.	N. 200 20 steps.	N. 110 225 steps.
True N.	226 54 m.	246 20 m.	226 15 m.	156 169 m.

I measured the heights with one of Naudet's large pocket aneroids. They are referred to the bridge over which the foot path leads to the glacier. Its height was 195 m. above the station Glacier. As the weather was uncertain this estimate, according to which the glacial tongue would be 1,461 m. high, can lay no claim to accuracy.

The tar marks made by Green I was unable to find. At P_7 however I saw a boulder with the mark COE. 1895, and at P_6 an arrow on a block. I could not find out who had made these marks. A railway labourer undertook to paint my marks ($P_1 P_2 P_3 P_4$).

The pictures on pp. 56 and 57 are prepared from photographs by Notman & Son in Montreal.* That on the left shows the glacier in 1888. The ice projects as far as the bushes and is still comparatively high in the arch. The one on the right, which I owe to the special kindness of Messrs. Notman & Son, was taken in October, 1897. The standpoint in both pictures is almost the same. Again one sees the high woods on the right and the girdle of lower brushwood, with the same inner border as in the other picture. But the ice has retreated. A wide strip of rubbish lies between it and the glacier. One can plainly recognize the great erratic boulders which are marked P_1 and P_3 . The tongue has not only receded, but is also very much shrunken. The lateral moraine on the left has at the same time increased in size. Above the rocky drift which separates the upper and lower glacial masses, the ice has also been retreating.

*These are not reproduced in this translation.

OBSERVATIONS MADE ON A TOUR IN CANADA. BY ALBERT PENCK.

A Paper Read on March 16th, 1898.

With 12 illustrations in the Text.*

*From the 38th Vol., No. 11, Society for the Extension of Natural Science, Vienna, 1898.**(Translated by D. R. Keys, Toronto, Canada).*

The British Association for the Advancement of Science met from August 18th to the 24th, 1897, for the second time on Canadian soil, at Toronto, on the north shore of Lake Ontario. The Government of the British Dominion of Canada and of the Province of Ontario, the Council and population of the city of Toronto, the great railway companies and all the scientific circles throughout the wide extent of British North America vied with one another in order to make the stay of their guests from the Mother country upon Canadian soil as pleasant and as instructive as possible, and in order to give them the most agreeable impression of the country. Connected with the meeting were extended excursions, partly in the neighbourhood of Toronto, partly under distinguished guidance across the continent as far as the island of Vancouver on the coast of British Columbia, the El Dorado of the present and near future.

A week before the meeting of the British Association for the Advancement of Science at Toronto, the American Society of the same name met from August 9th to the 14th, at Detroit, on the strait between Lakes Erie and Huron. It was a sign of the excellent relations between Britons and Americans that each society invited the other; first, the British were the guests of the American Association, which, realizing the pan-American idea, has members on both sides of the forty-ninth parallel, then the Americans attended the British Association, which represents the intellectual unity of the world-wide British Empire. Thus it was that within a short space of time an excellent opportunity was offered of meeting with American and British scientists in two places which, for that country, are not far removed from each other. While at Detroit a large number of American investigators had met with a considerable number of their British fellows, the meeting at Toronto offered such an assembly of British and American scholars as has probably never before taken place. One may say with confidence it was a meeting of the most eminent English-speaking scholars; one got not only the idea of a British world-empire, but still more of the actual existence of an English world-speech.

It was my privilege to be invited as an honorary guest to the British Association, and I also attended the American meeting in the same capacity. Never can I forget the days which I passed, first in Detroit and then more especially in Toronto, in a circle of illustrious men. The excursions connected with the British Association mark an extension of my geographical horizon such as I had never before experienced. But the recollection of all this scientific gain is rivalled by the memory of a truly magnificent hospitality which I enjoyed from my place of embarkation to the New World, that is, from Liverpool across the Atlantic and from its western edge across Canada to the Pacific.

The shortest, although not the quickest, way from Europe to Canada leads across the North Atlantic to the Straits of Belle Isle, which afford an entrance between Labrador and Newfoundland to the Gulf of St. Lawrence. By this summer route of the Canadian steamships from Liverpool to Montreal, one comes within 800 kilometers of Iceland and 500 kilometers of the south point of Greenland, and arrives at the most inhospitable part of the coast of America, that of Labrador. It is washed by the cold Labrador current, which bears the icebergs of Greenland away south to the Banks of Newfoundland. On the evening of August

* It is unfortunately impossible to reproduce the illustrations in this translation.

3rd, 1897, the *S. S. Laurentian* had reached this cold current. The temperature of the water, which is taken every two hours, fell suddenly, it became unpleasant on deck, and on the afternoon of the 4th the first icebergs came in sight. Three peaks arose from the waves like a mountain chain on the horizon. They shone with dazzling whiteness over the gloomy sea. Then a new one hove in sight further back. We came considerably closer to it and so it made a more imposing effect. Finally in the evening a magnificent white pyramid was sighted. The day after the cold current made itself felt by a thick fog, which lay heavy over the sea. The *Laurentian* had to stop frequently to avoid collisions with icebergs; several flocs drove past close by. By noon the observation showed us to be near Belle Isle, but no land in sight. The steamer stopped again and sounded the fog horn every twenty minutes. Finally in the evening, when the fog lifted a little, we saw the light of Belle Isle, after the cannon shots which we heard from time to time had made known to us already the nearness of this dreaded island. The captain, however, would not risk a night entrance into the cliff-bound straits, and we lay to again. The next day, fog again, the *Laurentian* advanced at "stand-by," in order to stop again presently. Then all at once a light streak became visible in the fog, and in a few minutes it was certain that the land was just in front of us. A dark mass of rock rose from the sea, the beach still spotted with snow, although it was only August 5th. Such is Belle Isle.

For a time we continued our way past ice-flocs and icebergs, gloomy land in the distance and an oppressive fog over it all. So the first impression of America at this point, where it is bathed by the waters from the Pole, was exceedingly unfriendly. Soon, however, upon entering warmer water, the weather cleared and the rest of the passage through the Gulf of St. Lawrence was very beautiful.

We seldom lost sight of land. In the north we saw the round humped mountains of Labrador, and of the northern part of the Province of Quebec. In the south the forms were quite different—long extended ranges with few divisions and high level plateaus on top. Such was the north coast of Newfoundland as we saw it during the rest of August 5th, and such too as seen on August 6th, were the mountains of St. Anne, 1200 meters high, on the peninsula of Gaspé, forming the southern shore of the long funnel shaped inlet which already at this point usually receives the name of the St. Lawrence river. On the northern shore rounded mountains about equal in height still prevail. We are here much impressed with the fact that we are travelling along one of the most important lines of disturbance in the geological formation of eastern North America. This is the St. Lawrence and Champlain line, which separates the primeval Laurentian land in the north, the protaxis of the American continent or the Laurentian shield, with its occasional covering of irregularly deposited paleozoic strata, from an old much-folded mountain chain composed of paleozoic rocks. By this contrast in form the journey up the St. Lawrence (whose waters are salt as far as Quebec) acquires a picturesque quality which is very attractive. The forest, which avoids the coasts of Labrador and Newfoundland, now comes down close to the sea in thick groves, only here and there destroyed by forest fires. Another feature of the landscape impresses itself at once on the attentive observer; parallel lines extend along the shore at varying distances from the water. Sometimes they appear as indentations in the declivity, sometimes as terraces in the openings of the little valleys of the precipitous Gaspé, as well as of the northern coast. These are the shore lines of an earlier sea, indented by the force of the waves, or heaped up by the rivers, after the great ice age when the land lay one or two hundred meters lower than to-day, and gradually but unsteadily rose with frequent interruptions. To every period of rest in its rise corresponds one of these terrace-like levels on which the Canadian French are so fond of building their little white houses.

Below Quebec at Grosse Isle is the real mouth of the River St. Lawrence, that is the place where the fresh water is severed from the salt. From here to Montreal the landscape is more monotonous, the mountains retreat on both sides and the shores become lower as we go further inland. The river itself often divides into numerous branches. Yet the journey is not uninteresting. Only we must not lose sight of the fact that we have travelled almost 300 kilometers up the river into the country on a great ocean steamer, and that the river has only by artificial means become the magnificent waterway that it is to-day. In various places canals have been made.

Our progress into the interior of the continent made itself apparent by an increase in warmth—August 8th brought great heat, all the more unendurable because a few days before we had been fairly frozen among the icebergs. In the winter, however, it becomes bitterly cold; every year the St. Lawrence freezes, and that so hard that they can carry the railway over it at Montreal. Still I could not discover any effect of the moving ice upon the form of the river bed, or upon the transport of boulders. The river bed has the same form as that of streams which have but little ice, and the accumulation of boulders on the shore is confined to places where the clay has been washed down. Near Lotbiniere only, it rushes along between heaps of boulders, and evidently it here traverses a mass heaped up in its bed during the ice age.

At midday on August 9th I landed in Montreal after a journey by steamship of 5146 kilometers. I was strongly tempted to stay in the neighbourhood of this city, where a boss of eruptive rock breaks through the superincumbent Silurian strata to form Mount Royal, which again bears glacial marine deposits almost to its summit. But, it seemed to me more important to go on at once to Detroit in order to meet the American investigators. Thither I hastened, merely making a short stop in the capital of Canada for the purpose of viewing the collections of the Geological Survey of Canada. I had then for the first time the pleasure of meeting with its director, Dr. Geo. M. Dawson, who afterwards guided the great excursion across the continent.

In Detroit the opportunity, for which I had been secretly longing, arrived, that is to make an excursion under approved guidance to the shores of the great North American lakes. These waters are of sea-like dimensions, on their shores the waves wash down cliffs as on the coasts of the oceans and cast up beaches, while the current along the coast forms spits and sandbars. All these phenomena have been excellently described by Gilbert, and it was a matter of great importance to me to see them as well as a number of other phenomena. Above the present shore line, for instance, there extend others belonging to an earlier period of higher water levels. The investigations of Gilbert, Spencer and Taylor have shown that they are not parallel with the present water line, but have a regular ascent towards the northeast. This fact is theoretically of great importance, for it leaves but one deduction possible, that of a general rise of the land which was stronger in the northeast than in the southwest. Therefore American scientists speak quite confidently of great elevations of the land, of a warping, a bending of the earth's crust, while Ed. Suess in Europe gave quite another significance to the phenomena on the Scandinavian coast, and being dubious as to any general rising of the land referred them to a movement of the surface of the sea.

To my great good fortune Grove Karl Gilbert himself met my wishes and conducted me around the phenomena which he discovered and described. After attending the meeting of the A. A. A. S. on August 10th to 12th, and visiting some sunken valleys near Detroit under Taylor's guidance, I found myself on the 13th in Buffalo, where I was to meet Gilbert. We first visited the counties on the south shore of Lake Ontario in New York State, where, like the fingers of a hand a number of long narrow lakes lie between pleasant shores, then we travelled to the western extremity of Lake Ontario in order to proceed along its northern bank to Toronto.

At the very start our journey afforded us an interesting phenomenon. A long sandbar entirely separates the western end of Lake Ontario from the lake itself, so that a wide bay stretches along beside the inland sea. On this is situated the flourishing city of Hamilton, built upon a terrace which evidently represents an old lake shore. From this terrace a broad dike, thirty-four meters high, and scarcely forty meters wide on top, extends like a railway embankment towards the north, separating marshland from the bay already mentioned. It has been cut through in the middle, and one can see that it consists of coarse gravel resting on fine sand, underneath which lies clay. It is a recent accumulation that we have here. The inhabitants of Hamilton have no doubt as to its origin. They regard the dike rightly as the sand bank of a Lake Ontario which stood thirty-four meters higher and which created also the present site of their city. Beside this older sandbank runs a recent one that converts the west end of the lake into a great bay. From here on we followed without interruption the old shore line—Gilbert's Iroquois

line. Everywhere it is easily recognized, here as a cliff, there as a high strand line (strandwall), then again it develops into a spit or a dike—an old sandbank—across the front of a little valley. We were thus convinced that we were following the same higher shore continually. After following it for forty-five kilometers we measured its height at Cooksville, finding it forty-five meters above the lake, and when I was visiting the interglacial deposits at Scarboro' Heights with Prof. Coleman a few days later, I met the Iroquois shore line sixty-nine meters above the lake. It rises, therefore, thirty-five meters within a distance of seventy-five kilometers as the bird flies, that is to say in round numbers 0.5 m. per kilometer in a northeasterly direction. The old surface of the lake as shown by the Iroquois shore line is inclined towards the present one at an angle of almost two minutes. It is out of the question that such an inclination of a water surface could exist, or that at the time of the formation of the Iroquois line the surface of the lake could differ to such an extent from that of to-day. We must therefore assume that since the origin of that shore line the district has been tilted up by a movement of the earth's crust. This is the same movement indicated by the beach lines in the Gulf of St. Lawrence. Canadian geologists have found that the marine formations here ascend in the direction toward southwest. Their greatest height (250 m.) is reached in the neighbourhood of Quebec. This is the middle point in a great arch-like upheaval, which has affected the whole St. Lawrence region along with the great lakes of North America since the ice age, and which, as Gilbert has lately shown, is still going on.

The excursion with Gilbert, several trips around Toronto under Prof. Coleman's guidance, finally an excursion which a number of members of the British Association took to Niagara Falls on August 22nd, all gave me an excellent opportunity to learn the character of the shore of Lake Ontario. It is gently rolling and cleared to such an extent that only a few patches of the original primeval forest remain. Everywhere stretch waving fields of grain, the well-to-do farmers' houses are often hidden in orchards, and indeed even the vine is successfully cultivated in Canada in the Niagara Falls district. The soil is almost everywhere fruitful. It is formed for the most part from the glacial deposits of the ice age, which are distributed over flat Silurian strata. On the northern shore of the lake these strata are of shale, on the south they are of limestone, giving a configuration to the country like that of the Swabo-Franconian Jura. This is the Niagara limestone formation at the foot of which Lake Ontario occupies a position similar to that of the Neckar district at the foot of the Rauher Alp. At the point where the Brock monument is built upon it, giving a wide lookout, this peculiar situation of the lake was very well shown on Aug. 22nd by Prof. Wm. Morris Davis, the distinguished American physical geographer. He expressed the opinion that the land surface around Lake Ontario, as indeed in all the region of the great lakes (except Lake Superior) has the features of a steppe-like landscape formed by subaerial denudation, and not much modified by glaciation, although the latter, as the dislosure at Scarboro' show, has been twice repeated. It has blocked up the old water-courses, as for example, a valley that coming from the west emptied into the lake near Hamilton. The rivers have thus been obliged to find new channels, and have not yet fully cut them out. The mighty Falls of Niagara bear witness to the youthfulness of its course. It has not yet cut through the Niagara limestone formation.

The various trips on Lake Ontario were only a prelude to the great excursions which were arranged for the members and guests of the British Association after its close. There were four of them. They all had as their objective point the island of Vancouver on the west coast of the British Dominion of Canada, but to send all the numerous participants thither at the same time would not only have been mechanically impossible, but also from scientific reasons impracticable. For a scientific excursion to be instructive must be strictly limited in its numbers. Consequently the company was divided into groups, each of which had a specialist as guide. One left Toronto as early as the 26th, conducted by Dr. Wm. Saunders, director of the Experimental Farms of Canada. It was specially intended for botanists and geologists. The next day the geologists and geographers set out. Our guide was the distinguished geologist of Canada, Dr. G. M. Dawson, who presides over the Geological Survey with equal practical intelligence and scientific breadth of view. He had himself explored a great part of our route, and as the

geologist in America is generally obliged to take topographical observations; he was in every way a competent guide over wide regions whose geographical features had been recognized by him with great clearness. Moreover, his personal amiability and constant approachableness helped to make our long journey one in every way enjoyable. With him too was Dr. Coleman, Professor of Geology in Toronto, and State Geologist of the Province of Ontario, who likewise knows great stretches of our route by personal explorations. The C.P.R. assisted us by many favours and placed at our disposal a large sleeping car in which we lived the next nine days. There were twenty-seven of us. Among them I may name the former director of the Geological Survey of India, Dr. Blandford; Mr. Lamplough, of the Geological Survey in Great Britain; the mineralogist, Prof. Miers of Oxford; the Professor of Mining and Mining Inspector, Le Neve Foster; the explorer of Kafiristan, Sir George Robertson; and the explorer of the Amoor territory, Prince Kropotkin; further, the secretaries of the Geographical Societies of London and Edinburgh, Dr. Scott Keltie, and Colonel Bailey, the librarian of the London society; Dr. H.R. Mill, the Professor of Geography of Harvard University; Dr. W. M. Davis, the director of the Museum of Natural History in Manchester; Dr. Hoyle; Prof. Armstrong, the chemist; and the technicians, Prof. Beare and Dr. Harden of London; as well as the Breslau physiologist, Prof. Hurthle. Our two leaders and guides were assisted by the Canadian geologists who were working in the district. Mr. A. E. Barlow was awaiting us at Sudbury, and Mr. McInnes joined us on the road to Rat Portage. Finally in Banff we met with Prof. Macoun, the botanist of the Geological Survey. We had thus every opportunity of being shown a very great deal in a very short time. While our company was not of one profession, we were one in the eager desire for knowledge. The wives and daughters of some of the members accompanied us, and took a friendly interest in the magnificent landscapes and broad, scientific impressions which we enjoyed.

We first went north in order to reach the line of the C.P.R. The richly cultivated land on the north shore of Lake Ontario was soon left behind, and we entered the immense primeval forest which extends from the great lakes northward to Hudson's Bay. The boundary between the horizontal beds of the Silurian formation and their subjacent strata, the primeval Laurentian and Huronian rocks, has offered a barrier to the extensive progress of clearing, and will to all appearance continue to do so. The Laurentian land has been smoothed off by the glaciers of the ice age, stretches of bare rock appear in smooth, humped barrows, the hollows between filled with loose débris and boulders. This rock, however, does not produce a fruitful soil like the Silurian slates and limestones; it weathers very slowly, and since the ice age it has scarcely formed a humus. Besides the climate is very severe. The same conditions prevail as in Sweden and Finland, of which countries we are also reminded by the character of the extensive Laurentian forest. Rounded mountains of moderate height rise irregularly. Only here and there where they meet with specially hard rock do they take the form of ridges. Between stretch marshy plains or lakes full of islands, the only natural interruptions of the gigantic forest in which we travelled nearly 48 hours, almost 2000 kilometers.

A visit to a couple of mining districts on August 28th and 30th made a break in our long journey. At Sudbury, the point where the "Soo" line branches from the C.P.R. to Minneapolis, there is a rich deposit of iron pyrites on the boundary between the Huronian and Laurentian rocks. Along with the iron it contains copper and especially nickel, and is at present being worked with great energy. In the neighbourhood anthracite has lately been found in peculiar old slate deposits, upon which discovery the people of Sudbury are basing hopes that are probably too high. We were pressed by our amiable hosts to go there. An engine drew our sleeper some kilometers on, a stop was made on the line, and having taken to some rather rough wagons without springs, we continued our way to Vermilion Creek. Here we were divided up among a number of Indian canoes and heavy boats in order to row to Vermilion Lake. All the poetry of the Leatherstocking Tales at once came vividly back to mind as I was gliding forward upon the peaceful, mirror-like water between the trees of the primeval forest. Then our way led on by a narrow Indian path, a so-called trail into the lofty forest, now clambering over fallen tree trunks, now scrambling through them till we reached the spot in the middle of the woods where they were in the act of sinking a shaft. There

under noble trees stood a puffing engine and several men were working in the midst of that lonely forest at what seemed to me a hopeless undertaking. In the neighbourhood, however, some settlers had already taken up their abode on the good alluvial soil. The forest was burned over, only a few charred rampikes rose here and there; plain log houses were built in which, however, there was an air of comfort. We also came upon a school in the midst of the forest as we returned.

At Rat Portage also, on the boundary between Huronian and Laurentian rocks, gold appears. Consequently this little town at the northern end of the Lake of the Woods is growing rapidly and the lake is crossed by numerous steamboats. The principal deposit lies on a little island in the lake; this mine, the Sultana, was the object of an excursion for which we were as much indebted to the municipality of Rat Portage as we had been to that of Sudbury two days before for the trip to Vermilion Lake. A little steamer took us through the labyrinth of islands and narrow channels past Indian camps and burial grounds to the Sultana, where most of the labourers are Scandinavians. We had a jolly picnic, viewed the galleries and workings of the mine and then the active members of the party hurried to the highest point of the island which had already been cleared of wood. The view from above was wide and striking—the lake in the woods, the wooded islands in the lake, rising as smooth, polished, rocky humps like the point on which we stood, and a cloudless sky above it all. Toward evening we went to another little island where peculiar breccia appears in the Huronian slate, the so-called agglomerate; whilst next morning Prof. Coleman showed us Huronian conglomerate in the town of Rat Portage. They can be recognized as such at once on the surface of the rounded humps, but one cannot strike off fragments from them. They leave it certain that the material of the Huronian slate has here originated in the destruction of an old land. Undoubtedly we have in this case a clastic formation. However, the so-called Laurentian gneiss made the impression on me of a rocky mass, consolidated at a great depth, of a bedded granite somewhat like the Central gneiss of the Alps. The occurrence of the gold of the Sultana mine reminded me forcibly of that of the Hohen Tauern. There, too, the gold is found on the border between bedded granite and dark slate, the so-called Neuern, which is exactly like the Huronian of Canada. The exposures themselves did not seem to me, however, at all remarkable, only I was obliged to marvel how they could be discovered. This applies also to the nickel and anthracite of Sudbury. Only a very close investigation of the country could lead to their discovery. Such an investigation is in fact carried on by the "prospectors" who traverse North America in all directions even to the depths of the remotest forests in their search for iron and coal.

Between Sudbury and Rat Portage we came on the most beautiful landscapes of the Laurentian country which, with all its charms, is in general monotonous. In the night of August 28th-29th we crossed the watershed, some 400 or 500 meters high, between the Ottawa and Lake Superior, which latter we reached at noon the next day. The Laurentian country rises 200 or 300 meters above it and descends towards it with a bold fringe of precipitous rocks. Its valleys run under the water, the inlets of the lake extend far into the land. The railway winds along the shore for about 300 kilometers. Now it ascends the foot-hills from which a delightful prospect unfolds itself upon the sea-like lake which covers more space than Bohemia, Moravia and Silesia together; now it passes around charming bays in some of which are friendly havens.

A way had been prepared for it by the earlier shore line of the lake; the whole coast up to 120 meters above the level of the water is terraced in the plainest possible fashion by the old shore lines; gorges are to be seen in the foot hills, and piles of debris in the bays. It is the declivity of a mountain range along which we are travelling. But from the Nipigon Bay on the scenery changes. In front of the Laurentian heights with their irregular rise and fall, lie table mountains of a peaceful form. They consist of irregular beds of pre-Cambrian age, whose mighty tops are of trap. The boundary between this table mountain material and the Laurentian rocks is very remarkable. At the station, Mazokama, one can see how the latter is continued with its irregular upper surface under the former. One gets the impression that its typically characteristic irregularity dates from pre-Cambrian times. The same thing is seen in the northwest of Scotland, where the

irregular wavy surface of the old gneiss dips under the irregularly deposited cover of Torridonian sandstone. To this, too, the stratified rocks of the Nipigon Bay have the greatest resemblance. We have thus in two widely separated parts of the earth's surface indications of a pre-Cambrian land surface which was afterwards renewed.

Towards the west the rounded landscape of the Laurentians gradually disappears under younger formations. At the same time the forest growth recedes, it is confined more and more to the singly rising rounded hills and finally disappears altogether with these. The meadow land, which at first only appeared along the overflowed districts, begins to be the rule. Within about an hour's journey by rail, this transition from primeval forest to prairie is completed: Rat Portage is in the midst of the forest, Winnipeg, the capital of Manitoba, lies amid wide level meadows which take in the bottom of the former Lake Agassiz.

This is magnificent farming land, producing the very best wheat. Immense as was the forest before, the fields are now equally boundless, interrupted only along the rivers by wooded meadows. The land—an old lake bed—lies there as level as a table; the railway, no longer obliged, as in the Laurentian district, to wind in continual curves around the numerous rounded hills, now pursues its way as though it had been drawn with a ruler. Instead of stopping as in the forest once an hour at the little group of houses made up of station, hotel and shops, undeserving the name of village, the train now passes prosperous villages often inhabited by Scandinavians, and draws up every twenty minutes at a station beside which rises a huge granary or elevator. The harvest is just over. The fields are mowed in a week, the corn is already threshed and the elevators are filled. Meanwhile the news has arrived of a failure of the harvests in the old world. Joy reigns in Manitoba. They speak of millions that must pour into the land.

The journey continues about 100 kilometers over the almost level bottom of the old Lake Agassiz before the road, which at Winnipeg attained a height above the sea of 210 meters, rises as high as 250 meters. Then certainly a slope becomes apparent. We must ascend the plateau of the crataecous formation which extends through Western Manitoba. We soon reach a height of 500 to 600 meters, and for 500 kilometers this level is maintained with scarcely an appreciable rise or fall as we descend into the valleys of the rivers or ascend the water-sheds. The soil is still as fertile as before: alluvial clay prevails. It has just been turned by the plough. Here and there we meet settlements with good prospects such as Regina, the capital of the District of Assiniboia. Further west the land changes. Previously level or rolling it now becomes hilly. It consists of a number of closely crowded eminences separated by level marshes.

One perceives at the first glance that the Missouri coteau which we cross between Mortlach and Erfold is a true moraine landscape. But how different it appears here where it lies in a dry climate, from what it is in our richly watered land. Not a pond, not a pool, not a bog between the hills, nor any forest on them, not even a tree or bush; no little brook winding its way through the landscape; only a monotonous "up and down" covered by a comfortless steppe. For miles the dry vegetation is burnt away. The land is black with its charred remains; only the white erratic boulders gleam ghostlike from the black plain. Here and there where the water has been able to remain some time on the level, a little green appears, the white crusted plains beside it are the remains of a dried up salt marsh. A group of larger salt lakes, the Old Wives lakes, persists from year to year: the bottom of a freshwater lake now drained (Rushlake) serves as a farm. Not a house is to be seen for miles, perhaps once an hour the train stops at a wretched station. In other respects too the land is desolate, since the herds of buffalo which once inhabited it have been slain. At the station one sees great piles of their bones which have been collected on the steppe to be ground into bone meal. The very bare desolation of the land, however, aids us even in passing to get an idea of its structure. Several groups of moraine ramparts can be recognized, sometimes having a heap of debris lying in front of them. One is strongly reminded of the Alpine relationships; but the whole Missouri coteau seemed to me like a dried up Baltic lake plateau.

This great terminal moraine rampart, like its European equivalent, does not

indicate the end of the moraine formations. For not less than 500 km. to the west up to the foothills of the Rockies there is erratic material of Laurentian origin, such as boulder clay with polished stones. But the predominance of these glacial forms in the landscape is past. They become secondary features of the scene, the chief features of which receive their character from the irregularly laid cretaceous, and superimposed old tertiary (Laramie) strata. The latter form table rocks between the valleys, *e.g.*, the Cypress Hills, which bear the only forest in a wide circumference. A zone of moraines covered with loess is not present: the loess in America as in Europe does not reach above 300 to 400 meters. From the Missouri Coteau, which marks an ascent of over 100 meters, the C.P.R. keeps at a level of over 700 m.; only at Medicine Hat, where we cross the Saskatchewan, does it descend to 655 m. This is the great steppe country on the east of the Rockies—a land that offers the best prerequisites for cattle raising. The cattle here are replacing the buffalo, which is extinct. On the literally immeasurable plains one still sees tribes of Indians with wagons and some cattle wandering on their broad paths.

Yet even this is but an artificial accident in the natural scenery, which with all its uniformity makes a deep impression on the most rapid traveller. When the sun sinks and its parting beams suffuse the dry hills with a subdued glow and the shades of night creep into the hollows while the western sky is still gleaming with bright gold—it is then one feels the indescribable magnificence of this scenery and learns to comprehend that the dweller on the steppe loves his poverty-stricken land scarcely less than the sailor loves the sea. This landscape, indeed, is somewhat like the sea.

In the night of September 1st-2nd our sleeper was uncoupled at Calgary from the transcontinental train in order to be taken on to the Rockies after daybreak as a special train. Clear and sharp on the western horizon of the capital of Alberta was descried the broken rocky wall, forming in truth the Rocky Mountains.

If one could imagine the Karwendal chain advanced to the very border of the Upper Bavarian plateau, one might get such a view as we had during our subsequent ride, now from the windows of our sleeper, now from the windows of the caboose, and above all from the locomotive itself, in all parts of which our members had posted themselves in order to admire the magnificent mountains. Their vicinity was proclaimed by the geological formation of the land through which we were passing. Strata of the cretaceous system which had accompanied us so far in flat deposits appeared upright and in some places in a folded position. They form a few not very high ridges parallel to the mountain chain, the so-called foothills which take the place of a foreland to the mountains. After a journey of 80 km., during which we had only ascended at the Bow river 200 m. above Calgary (*i.e.*, 1,250 meters altogether), our train stopped on an open stretch at the foot of the Rocky Mountains. Before us rose its bare, bald walls to a height of 1,000 to 1,500 meters. They consist for the most part of palaeozoic limestones which have been shoved out over the cretaceous strata of the foothills. At the same time they have been pressed together confusedly whilst the former just at this point have been only slightly disturbed. On the border of the Rockies one sees old rocks turned upside down some kilometers away above the younger ones, and this fact lends a peculiar interest to the profile of the Kananaskis.

After a short stop we went on through the gate of the Bow river, "The Gap," into the mountains which here show a rare regularity in their geological structure. Every chain represents a block of Devonian-carboniferous strata which is raised in the east and declines in the west. In consequence the same succession of strata is repeated over and over again as is typical for the isoclinal structure. Between these palaeozoic stratifications extends a trough of cretaceous deposits which the Bow river follows for some distance to the neighborhood of Banff. The palaeozoic strata encroach upon it again from the west, as one can plainly discern from the profile of the three peaked mountain which bears the name of the Three Sisters, (2,957 m.) Not far away is the highest mountain of the region, Wind Mountain, 3,170 m. high. These lofty peaks exhibit the forms of great mountain chains. The intervening valleys are broad and level, having their sides bordered with moraines. The latter attach themselves to the slope of the mountains stretching away in a regularly curved talus. At the same time they support the beautiful

forest of that region whose farthest outposts extend to a height of 2,400 meters, *i.e.*, somewhat higher than in the central Alps which are 4° further south. Perpetual snowfields are confined to the very highest peaks. In this region is the Canadian National Park, its central point is the little town of Banff, where our excursion spent September 2nd. Soon after our arrival the more active hastened to Sulphur Mountain, (2,270 m.) It is a typical isoclinal mountain, with its peaks breaking off precipitously to the east and the surface of the strata, which might belong to the carboniferous (I found a productus on the top), sloping less steeply to the west. The summit is rounded as may be seen from a photograph taken by Prof. W. M. Davis. The glaciers of the ice age passed over it and left relics of the moraines. On the east at its feet lies the well wooded valley of the Spray, 900 meters deeper. Here bubbles up the warm spring which gives the mountain its name of Sulphur Mountain. It probably indicates the line of cleavage east of which the strata buckle up again into the Rundle mountain, (2,980 m.) To the west beyond the wooded Sundance valley, there rises another isoclinal rampart, the Bourgeau range (2,990 m.) Here cirques have been cut in the mountain ridges, between them the forest ascends much higher on the sides of the mountain than in the domain of their débris-filled floors. A portion of the valley of the Bow river running in a transverse direction cuts off the sulphur mountain and its neighbours to the north. In the broad, woody valley the river meanders along with many windings and in several places backs up so as to form a lake, while beyond rise new isoclinal mountains, among them the splendid rocky form of Cascade Mountain (2,986 m.) This transverse valley continues to the east, but on reaching the trough of cretaceous formations above mentioned the Bow River leaves it. Evidently it once followed this valley through the Devil's Gate out into the plain. The magnificent surface of Lake Minnewanka (Devil's Lake) some distance away indicates its deserted course.

For a long time we remained on the top of Sulphur Mountain lost in the contemplation of the magnificent beauty of the panorama. The almost geometrical regularity of the stratification, which showed only here and there by slight curves, as at Cascade Mountain, that it is due to a folding process, impelled one irresistibly to the consideration of the problem of mountain formation. But the geographer was enchained no less by the regularity of the internal form, the alternation of almost rectilinear valleys both longitudinal and lateral, and many peculiarities in the course of the valleys. Indeed the outermost advance post of Rundle Mountain is quite cut off by the Bow River as the Tunnel Mountain. The opinion was generally expressed that it is scarcely possible to imagine a finer field than the neighborhood of Banff for special study in stratigraphic geology, geotectonics and geomorphology. The basis has been already laid by the topographical and geological survey of Canada. The former prepared a special map of the National Park on the scale of 1 to 40,000, the latter had a transverse profile taken through the whole Canadian Rockies so as to cut through the region about Banff, by R. G. McConnell, and Dawson himself has explored the neighbouring cretaceous trough. At the same time the C.P.R. hotel offers headquarters comfortable enough to satisfy the claims of the most exacting.

From Banff the railway continues up the Bow river, then for a short distance in the transverse valley mentioned above, then again in a longitudinal valley running close by the watershed here formed by the Rockies. In the west one sees their proud snow covered heads which now regularly exceed 3,000 meters in height and bear considerable glacial areas on their shoulders. Mount Lefroy 3,353 meters is the highest. That the chain rises further north to 4,787 meters in Mount Hooker, and even to 4,880 meters in Mount Brown, as is given on our maps, is very much doubted by Sulzer and Hueber who during their journey among the Selkirks nowhere saw any such giants rising from the Rockies. The Hector Pass, a very narrow gateway 1,614 meters high, affords a passage from the Hudson Bay Territory to that of the Pacific. This height is easily attained from the east. We follow the Bow river to Laggan (1,503 m.) without having any real engineering difficulties to conquer, with an average ascent of only 2.8 per cent. Even then it is only a matter of ascending 111 meters in a distance of 11 kilometers, and we are in a saddle in which many cones of deposition display themselves. But then we must descend 348 meters in only thirteen kilometers. This is undoubtedly the

magnificent portion of the whole C.P.R., where the train in three quarters of an hour running time with a fall of 27 per cent. loses all the height it had gained from the foot of the Rocky Mountains. Slowly it glides down the steep slope, incessant is the grinding of the brakes. Only with difficulty has room been found for the road on the steep rocky walls which descend to the foaming and rushing Kicking Horse River. It pierces through them in tunnels and leaps from one side to the other on lofty bridges. The deeper it descends, the higher rise the mountains; at Field our next stop we have the beautifully formed pyramid of Mount Stephen (3,188 m.) rising almost 2,000 meters close above us.

The stratification of these highest portions of the Canadian Rockies is comparatively simple. Enormous Cambrian strata appear to lie almost as they were deposited. In consequence they recall to some extent the Ampezzaner Dolomites, the names often indicating their regular architectural structure; thus we have a Castle and a Cathedral mountain. They offer difficult problems to the climber; in the neighborhood of Laggan the first accidents of Canadian mountaineering have happened. Further west near the Columbia river the mountains become more irregular in their build. The fall of the strata becomes more precipitous and is almost exclusively eastern. At the same time Silurian deposits appear, hemmed in by the Cambrian ones. According to this the structure of the Rockies taken as a whole is about as follows: Younger palaeozoic strata, Devonian-carboniferous in the east and Silurian in the west, dip on both sides towards the middle of the mountains. There we find the oldest palaeozoic rocks prevailing in more or less irregularly disposed undulations. But this holds good only for the Rocky mountains in Canada. When I crossed them afterwards on the Great Northern Railway, south of the Canadian boundary, I found only strata inclining to the east. The whole zone of the chain as at Banff is lacking at the Maria Pass. In the valley of the Kicking Horse River we descend from Field at first rather rapidly, and from the many windings of the road we enjoy various splendid views of the proud glacier bearing peaks of the Rockies. Then we enter a narrow gorge whose walls rise threateningly several hundred meters above us. The road winds so that we can occasionally see the whole train from our car window. Nowhere any inhabited places, the stations are only watchmen's houses. Then all at once another picture. We come out of the narrow gorge into the valley of the Columbia river, lying only 770 meters above sea level. It is broad and wide, along its slopes stretch broad terraces like the Mittelgebirge in the valleys of the Inn and the Adige, a heavy forest covers its floor which the river traverses in many windings. One has the impression of having reached an important boundary line in the mountains. As a matter of fact one has on the east the Rockies formed exclusively of palaeozoic strata, and on the west rise the various chains which Dawson calls the Gold Ranges. They conceal the rich gold deposits of southern British Columbia, especially the Kootenay district, only recently opened up, in which the town of Rossland arose in the shortest time on record, as well as the older Cariboo district. Also the Klondyke of the north, which was opened up last summer and electrified all America, seems to belong to this zone. There appear in it, alongside very old sediments perhaps belonging to a pre-Cambrian age, also archaean rocks. Our line of demarcation may be followed morphologically for a long distance. From Donald, where we are first convinced of its significance, we can follow it on the map for 700 kilometers in a northwest direction, as a great longitudinal valley to which the Upper Fraser and the Peace River belong, and in a southeast direction to the Upper Kootenay and then into the valley of the Flat Head River for another 600 kilometers at least. This is a magnificent parallel to the great valley-gorge which separates the northern Alps from the Central Alps, and the resemblance holds good also as to scenery.

If the journey through the Rockies reminded me often of the Alps, now of the Alps in North Tyrol, now of the Kofel of the Dolomites, the rest of the journey through the first of the Gold Ranges, the Selkirks, reminded me often of the Brenner road. The railway passes through a narrow defile, such as seems to characterize the openings of the tributary valleys of the Columbia River, into the Beaver valley. Then it runs along the slope of the now widening valley, strikes into a neighbouring ravine and after an ascent of 540 meters, distributed over thirty-

two kilometers, we reach the Rogers Pass (height 1,310 meters), a deep saddle in the mountain, while the peaks rise steeply on both sides to a height of 2,700 and 2,800 meters. An outlet between the precipitous walls seems scarcely possible; then all at once the train rounds a corner and far below it appears the Illecillewaet River, to which it must now descend in great loops, passing frequently over high frail-looking trestles. As we do so quite a surprising mountain panorama is unfolded. Glaciers here recline against mountains only 2,700 meters high, and in the neighbourhood of the highest peak of the group, Mt. Sir Donald (3,250 meters), they cover considerable space. A turn of the road brings us quite close to the magnificent Illecillewaet glacier whose tongue only ten years ago reached immediately up to the lower shrubs, from which it has now retreated a distance of almost 170 meters. Not far from this glittering tongue, which is remarkably free from debris, rise the mighty giant trees of British Columbia. Evidently the snow line is here very low. Its height must be reckoned at 2,200 or 2,300 meters, that is lower than upon the summit of the Rockies, where it must be put at 2,700 to 2,800 meters, and far deeper than on the eastern edge of the chain, where peaks of 3,000 meters in height fall below it. The snow line sinks considerably from the interior of Canada to the Pacific. At the same time it is much lower on the west side of every chain than on the east side.

As at Banff in the National Park and at Field below the Hector Pass, so, too, at this supremely picturesque point, the C.P.R. has built an excellent hotel near the station Glacier, only a few kilometers from the end of the Illecillewaet glacier. This place is frequently made the headquarters for mountain tours in the Selkirks as well as being an excellent point to break the long continental journey. Our excursion also stopped here, but bad weather prevented us from making any use of September 4th. We were obliged to content ourselves with a visit to the tongue of the Illecillewaet glacier, of which I gave an extended account in the *Journal of the Alpen Verein* for 1898.

As at the Hector Pass, so, too, at the Rogers Pass the ascent from the east is easier than the descent to the west. The westward flowing river is in both cases the stronger; it works away with energy at the deepening of its upper channel and as at the Kicking Horse River, so, too, at the Illecillewaet the railway has difficulty in reaching the level of the valley. This is done by a fall of fifteen per cent. in a stretch fourteen kilometers in length. Then road and river descend together until the latter must enter a deep defile to reach the Columbia. It was here dammed up very high with driftwood. The track follows it with difficulty. At Revelstoke both have got down to the level of the great water-artery: it has circumvented the Selkirks in a great curve to the north and descended to a height of 450 meters in doing so. This is a level which we had passed away back on the prairies near Winnipeg, 1,200 kilometers from the eastern foot of the Rocky Mountains, and higher than this we scarcely get as we continue our journey westward. Even the chain west of Revelstoke, with its glaciers and peaks 2,700 meters high, which separates the waters of the Columbia from those of the Fraser river, is crossed in the Eagle Pass at a height of only 610 meters. Here we pass quite gigantic moraines with quite enormous erratic boulders.

The valleys within the Canadian Cordilleras lie considerably deeper than the prairie and steppe-land on their eastern borders. At the same time they are partly submerged, that is, they are occupied throughout their entire breadth by long and deep lakes, which not only follow the long valleys, especially in the region of the Columbia River, but also often assume very complicated shapes; the Shuswap Lake, which the Thompson River drains into the Fraser, reminds one, for instance, of Lake Lugano. Great deposits of sediment, as well as old deltas and shore lines, of which we counted not less than six at Revelstoke, reveal the fact that these lakes were once far more extensive. These deep valleys, rich in lakes, are really confined to the Canadian Cordilleras; farther south in the United States the space between the Rockies and the Sierra Nevada has not been broken up into valleys but appears as a uniform unbroken highland. This difference may probably be attributed to climatic causes. The Canadian Cordilleras are richly watered and supply mighty rivers. The regions to the south are dry and have no channels that reach the sea. But in consequence they have no way of being cut through, while such a power is working in the Canadian Cordilleras to a great extent and, as its

results, the valleys, prove, has been operative in the past also. This cutting up of the Canadian Cordilleras in comparison with the American is under such circumstances an indication that the general arrangement of the rainy districts on the west side of the Pacific has experienced no essential change for a considerable time but only oscillations.

It was already evening when we passed the Shuswap lake on the 4th of September, and that night we went past the Kamloops lake. Thus those of us who did not return by the C.P.R. lost the impression made by these great lake surfaces with their peculiar surroundings which form the rather dry plateau of the Canadian Cordilleras, lying enclosed between the Coast Chain and the Gold Range, an outpost of the great arid territory of the United States and like this latter distinguished by the outcrop of late volcanic rocks. On the morning of September 5th we found ourselves far down on the Fraser River which, for a while, follows a cretaceous trough on the eastern border of the Canadian Coast Range. These mountains rise not far from its banks to a height of 3,000 meters. But their proud heads were concealed in the clouds; our view was confined to the valley which indeed had enough to offer us. As a mighty stream the Fraser rushed along; we follow it upon a terrace of varying height. In several places, as for example at Hellgate, the valley narrows to a gorge, its walls rise over 1,000 meters from the river, which above such places seems to be dammed up, and has left plain highwater marks twenty meters above its September level. Laboriously and by astonishing feats of engineering skill the railway finds room. Here and there in the distance one sees Indian camps, inhabited by fishing parties and surrounded by platforms full of dried salmon. Besides these there are Chinese immigrants. They travel in bands along the railway line. The forest grows more and more luxuriant, the single trees rise like giants. Everything combines to make the journey through the Fraser canyon, as the magnificent valley is called, a most magnificent one, full of unique experiences.

The Fraser River gives the C.P.R. an outlet to the sea. It finds its way there south of the Canadian Coast Chain, where this range makes an obtuse angle with the North American Cascade Range. At this point it has descended to a level less than sixty meters above that of the sea and is bordered by broad alluvial plains. The projection of its great delta lies in the above-mentioned obtuse angle. Here rises beside it the volcano Mt. Baker, 3,256 meters high. A heavy rain shower as we were passing deprived us of this fine scenery; our view was confined to the delta, in whose great gravelly masses were embedded numerous tree-trunks which the river had brought down. A dense and lofty wood extended originally on all sides, but is now already cleared to a considerable extent. Here in an angle of the Straits of Georgia which the River Fraser has not yet filled up is the city of Vancouver, and here in a forest of gigantic trees still preserved in part, and within sight of the mountain is the terminus of the Canadian Pacific Railway. The line across the continent from Montreal to this point measures 4,677 kilometers; it is a journey of five days and six hours. Of this 946 kilometers and thirty hours' travel are taken up in traversing the Cordilleras. Certainly the longest mountain road in the world and everywhere uncommonly beautiful, more than three times as long as the longest of the Alpine railways—the Brenner line.

A large river steamer brought us from Vancouver through the Georgia strait in eight hours to Victoria, on the Island of Vancouver, the capital of British Columbia. It was an uncommonly instructive journey. The sky cleared, and the continental Coast Chain, 2,000 meters high, and the almost equally high mountains on the Island of Victoria became partially visible; between them we glided along over a surface smooth as a mirror, approaching a few small islands, which consist of evenly deposited cretaceous strata, and passing rapidly by the low alluvial land. All the banks are bordered with driftwood, brought down by the Fraser to the sea, which its muddy current troubles for a long distance from its mouth. By this one could realize vividly the geographical conditions under which originated the cretaceous strata that traverse the Canadian Cordilleras. They must have been deposited in narrow arms of the sea like the Strait of Georgia, in the neighbourhood of great river mouths which provided the wood for their coal deposits. Thus the present topography of the country still preserves features of times long gone by.

I got a very convincing assurance of this by a visit to the Nanaimo district and the Wellington coal mine, on an excursion participated in on September 7th by all the members of the various parties which had now re-united in Victoria. There at Nanaimo I saw conglomerates, which were evidently the product of the rolling action of the stream, old river pebbles, and I collected at the rubbish heaps by the coal-pits impressions of the leaves of trees. Nothing here indicates the nearness of the cretaceous sea, but south of Nanaimo in the same complex formation a rich marine fauna has been found.

The trip from Victoria to the above-mentioned coal district marks the end of my journey in Canada. Once more it led through a highly interesting landscape. The Island of Vancouver, which forms the fifth zone of the great Canadian Cordilleras, only partially rising above the waves, is covered in its deeper parts with a forest, the equal of which it would be hard to find. The Douglas firs, sometimes 100 meters high, form dense groves; with the prevailing dampness, forest fires, of which the Rocky Mountains afford many sad traces, can hardly arise. The train steams along under giants centuries old; only in a very few places have clearings been successful. They still rise in close proximity to Victoria, where the friendly and comfortable frame houses of the European settlers have a dwarflike appearance beneath them.

Here in Victoria where the excursionists enjoyed the friendly guidance of the inhabitants, there are still very striking traces of the glaciation of the ice-age, which, proceeding from the continent, covered the lower parts of Vancouver Island with ice. It crossed the fjord-like bay which forms the geographical reason for Victoria, at a right angle and therefore the bay cannot be considered the work of the ice. It is a submerged valley which shows that a sinking of the land has taken place. This sinking has now changed into a rising. The coast between Victoria and Nanaimo is accompanied by extended terraces. Thus we have on the Pacific coast the same phenomena as on the Atlantic shore of the great British Dominion in North America. As far as the traces of the ice-age extend the coasts are embayed, the outlets of the land valleys are under water and we find at the same time shore lines which betray the fact that a rise has taken place since the ice period. It has not been strong enough to obliterate the effect of the preceding sinking. The land that is in process of rising has the outlines of one that has been submerged.