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## INAUGURAL ADDRESS.

THE WORK OF THE GEOLOGICAL SURVEY OF CANADA.

(R. W. ELLS, LL.D.)

*(Delivered December 17th, 1891.)*

Mr. Chairman, Ladies and Gentlemen,—In attempting to prepare the opening lecture of the course for the present season, I have been considerably exercised as to what subject would be of most interest to the members of the Club. It has, however, been suggested to me that to those of us who live in this city, where the Geological Survey has its location, as well as to many of our members abroad, some facts relative to the work of such a department, as annually carried out, might be of interest. Very often it has been asked: What is the work of the Geological Survey? What does its staff find to do year after year, and what great purpose does it serve in the country's progress and welfare? To discuss this subject fully would require a very long chapter, but I hope to be able to lay before you a few ideas regarding the general character of this work that may to some extent at least be an answer to the questions propounded.

In the opening paper which I had the honour of giving before this Club two years ago, I reviewed very briefly the subject of geological progress in Canada for the fifty years subsequent to the first recognized work done in this country in connection with that branch of science. In this, the work was divided into three periods, viz: 1st, that prior to the establishment of the Geological Survey; 2nd, that under the direction of the late Sir William Logan, and 3rd, that subsequent to his retirement; the latter of which could not, owing to lack of time, be then considered.

The confederation of the Lower Provinces with Ontario and Quebec in 1867 very greatly extended the field of the Survey's labours, and changed, very materially, the then existing arrangements of the staff and methods of operation. It brought into the work of the Department the study of the geology of New Brunswick and Nova Scotia; and this was speedily followed by the extension of this work into British Columbia and the great Northwest; thus furnishing a field for geological exploration of the most magnificent dimensions, comprising an area

second to that of no other colony or nation in the civilized world. This enormous and sudden increase in the work thrown upon the Survey necessitated an almost complete change not only in methods but a very considerable change in the personnel of the staff itself; an amount of work, in fact, which can scarcely be estimated by anyone without careful study and comparison with similar work done in this branch of science by other countries. For while the importance of a systematic geological survey has for many years been recognized by all nations and regarded as a very considerable factor in connection with the national progress and development, the areas embraced in the several countries in which such surveys have been carried on are, for the most part, of very limited extent as compared with the great stretch of country called Canada, and the entering upon the geological study of half a continent by so comparatively young a nation may well be regarded as one of the greatest and most important events in the history of the science.

Probably one of the most elaborately conducted surveys in recent times is that of the British Islands, in which we have an area embraced in the three divisions of England, Ireland and Scotland, scarcely two-thirds the extent of the Province of Quebec alone; densely populated and so arranged that the work of the geologist was facilitated to the utmost degree by the open character of the whole country and by the presence of the most carefully constructed large scale maps possible to be obtained; yet for more than half a century the combined skill of the geologists of England, Scotland and Ireland, aided by the most recent improvements in instruments and in appliances for conducting all necessary examinations, and by a financial backing sufficient to meet every requirement, has been devoted to the determination of their geological structure and mineral resources. Even the great Geological Survey of India, which, with the exception of the United States and Canada, is probably on the most extensive scale of any in the world, embraces in the whole Indian Empire an area of only one and a half million square miles, while the gigantic colony of Australia, even were the confederation there complete, would still in the whole island fail to approach the area embraced in the Survey's operations in Canada by half a million of square miles. In point of fact we here in Canada

have so acquired the habit of looking upon such immense areas as of every day occurrence, that an initial journey of three or four thousand miles to begin operations is regarded with no greater feeling of excitement or uneasiness than one of a tenth that distance in a much smaller country. In Australia, however, the work of the geological surveys has been comparatively local, and has never been applied to the enormous areas with which we are familiar in this country. The only survey, then which in point of extent can at all compare with that of Canada is that of our gigantic neighbour to the south, where the area of surface to be covered by its operations is not very different from our own, but where certain conditions exist which render a comparison of the work of the two surveys interesting from several standpoints. Thus, in the United States, owing to their more southerly position, field parties are enabled to spend a very much longer period in exploration than in Canada; in fact there is no reason why their field work cannot, in many portions, be carried on throughout the entire year. In Canada, on the other hand, owing to an early and often excessive snowfall, and to the extreme cold of winter, the period in which field operations can be carried on with profit in some years scarcely exceeds a third of the whole time. Then again, in many of the American states local or state geological surveys are, or have been, carried on, by which the structure and mineral resources of each have been investigated by the state authorities and at the state's expense, and thus the work of the general survey has been greatly facilitated. It is true, in the earlier days, before the confederation of our own provinces, local surveys were carried on, to a limited extent only, in Nova Scotia, New Brunswick and Prince Edward Island, but the amount of time and money expended in these was comparatively insignificant, although the work done by the local geologists was of very considerable value; while in the provinces of Ontario and Quebec, which have enjoyed legislative union for half a century, the work was done by the Geological Survey of Canada with a very limited staff indeed, for years scarcely exceeding in number more than half a dozen persons in all. Contrasting also the facilities for work of the British surveyors, and to a certain extent of the Americans as well, with the difficulties which the members of the Canadian staff have to encounter, the unfavourable position of the latter becomes most striking

Thus, instead of a thickly settled country, opened up in all directions, and easy of access by railways or by ordinary roads, millions of square miles of our Dominion are at the present time inaccessible, except by means of canoes or boats and by the help of the hardy voyageur or hunter; and not only must the means of transport be provided for, but the means of obtaining subsistence, either from the woods or waters, by hunting and fishing, must also be taken into the account; and, in point of fact, with the exception of the more thickly settled portions of the older provinces, this mode of exploration must of necessity be constantly employed. To most people unacquainted with our country, and to many even in our midst, it will perhaps be news that even here in the Ottawa district, in the exploration of the area to the north of the rivers Ottawa and St. Lawrence, beyond a distance of twenty to twenty-five miles, where occasional settlement roads penetrate, the only means of carrying on the work to day is by the aid of the canoe and the Indian guide, by traversing the several rivers and the many lakes which lie so thickly scattered over the surface of the mountainous Laurentian country, communication between which is made by numerous and often exceedingly difficult portages, over which canoes and supplies must be carried upon men's backs wherever the route of the survey may lead; and all this in the very heart of the oldest province of our Dominion.

If now we compare the personnel and the financial outlay of the world's two greatest surveys in point of extent of area to be surveyed, we can see more clearly under what additional disadvantages the Canadian brethren of the hammer labour. Thus the expenditure for the year 1887-88 of the American Geological Survey, exclusive of publication, was about half a million dollars; that of the Canadian Survey for the same year about one-fifth of that amount, including publication and all expenses of management. A portion of this sum, amounting to about \$20,000 only, was divided among sixteen parties, whose operations extended from eastern Nova Scotia to Alaska, and included surveys in all the provinces, with special examination of the country east of Alaska and the Mackenzie River Basin, Hudson and James Bays and Lake Winnipeg and vicinity. In numbers the staff of exploration comprised in all, including assistants, thirty-five persons. In addition, work was carried on in the branches of Paleontology, Botany, Chemistry and

Natural History, the results of that year being comprised in twelve scientific reports, besides that of the Director, which were published in two volumes of 1364 pages, in addition to the bulletins on Paleontology and Botany. The American Survey during the same year employed in the Geographical branch alone eighty-five assistants, in addition to the chiefs of the several divisions, of whom there were fifteen in connection with the outside or geological work proper, and twelve for the associated branches, among whom are many of the leading professors in the different universities, men most distinguished in their special lines of work. With such a command of men and money magnificent results may be confidently looked for, yet in the published volume for the year mentioned there are only four scientific reports, besides that of the Director, with twenty-four administrative reports, corresponding with the summary reports of the Canadian Survey, and describing only the season's operations as carried on by the different parties, but not giving the scientific results, the whole being comprised in a magnificently printed and illustrated volume of 710 pages. In addition to this, as in the Canadian Survey, bulletins containing special reports on the work of the various associated subjects were also published. Comparing results, then, in so far as these can be ascertained, it is evident that the Canadian Survey has continued to maintain the high standard of work which it has ever enjoyed from its commencement and is giving at least full value for the amount of money expended thereon.

But many persons have asked the question: Of what does the work of the Geological Survey consist? and what is the object of sending out these parties of exploration all over the Dominion? what practical benefit does the country receive from such explorations? Some even appear to consider the fitting out of the field parties each spring as something preparatory, on the part of the staff, to going on some grand pic-nic, in which all that the persons engaged have to do is to enjoy themselves in the most perfectly epicurean manner. Now, while to the scientific explorer who enters upon the work in hand with the proper amount of interest there must ever be a certain amount of enjoyment, and that often of a very high order, in the unravelling of the complicated problems which are presented in the study of the wrinkled face of old mother earth, there is very little of the pic-nic character ob-

servable, taking that word in its ordinary acceptation. The work of the Geological Survey is of various kinds. In its inception it was held to include more particularly the study of the rock crust of the earth, and the determination of its mineral resources, since the relations between these two subjects are exceedingly close. Gradually attention was directed to the study of plants and insects, collections of these being occasionally made by some assistant attached to one of the regular exploring parties. Chemistry, which embraced not only the analysis or the assay of important ores, but of rocks as well, together with the analysis of mineral waters, and other kindred subjects also received a large amount of attention. But the rapid development and extension of the country and its various interests have in time necessitated a corresponding change in the operations of the Survey, so that it has gradually come to embrace not only Geology, Paleontology, Chemistry and Topography, but the Natural History of the country as well, including the subjects of Botany, Ornithology, Entomology, Zoology, Ethnology, Mining Statistics, and other kindred subjects—the proper carrying out of which is, however, at the present time very seriously interfered with, not only by great lack of space for displaying collections when made, but by a lack also of workers in the several fields.

In the American Survey the different lines of work are carried on in much the same way as the Canadian department, though on a much more elaborate scale. Thus the work of the interior department is arranged under certain divisions, of which the principal are those of Topography or Geography, Geology, Paleontology, Mining Statistics and Technology, Chemistry and Physics, Illustrations, Library and Documents, &c. Of these the topographical division has charge of the surveys proper, and the preparation of the maps connected therewith, with the care of the instruments, &c., and for the year 1887-88 their field parties were distributed over twenty states, extending from the Atlantic to the Pacific. The geological work is also arranged in divisions, of which there are thirteen, named principally on grounds of location, as the Atlantic Coast division, the Mountain division, &c., but also in some cases from the character of the work, such as the division of *Archæan geology*.

In paleontology also the work is specialized, and instead of pla-

cing upon the shoulders of one man the work of half a dozen, the American Survey has this subject so arranged that to one person is entrusted the division of the vertebrates as distinct from the invertebrates, the latter also being divided into the Paleozoic or ancient and Cenozoic or recent divisions, while in the case of fossil plants, fishes and insects, these are for the most part assigned to specialists in each of these branches, and in this way the very highest results are attained in each subject.

The division of geography or topographic work is one of the most important of the whole. Finding, as in Canada, the exceeding difficulty of doing accurate geological work without a good ground plan or map on which the observations made can be systematically recorded this division has been organized to meet the required want. This work employs nearly one hundred persons alone in the scientific work relating to the making and arrangement of the surveys, including ten draughtsmen, but the very great utility derived from having good and reliable maps of the country ready to hand for the work of the geological staff proper is such that whatever extra expense is incurred in their construction is amply repaid. Of course, in the comparison of countries like the United States and Canada, the conditions of which are alike principally as regards area, while the one has already an enormous development of wealth and population and the other an immense territory and a scattered population, such comparison appears to place Canada in a very unfavourable aspect unless the diverse conditions are thoroughly comprehended.

Although the work of the Geological Survey of Canada has been going steadily forward for almost half a century, it is surprising how few persons really understand what is the legitimate scope of the labours undertaken by its staff or in what direction the field work should actually extend. Thus many persons apparently have the impression that one part at least of its duties should be the examination of every locality where minerals may be fancied to exist by any person who may indulge the often foolish notion that there should be unlimited wealth in the rocks which may constitute a large part of his real estate. Such persons entertain the idea that not only should surface indications be carefully explored for their own particular benefit, but that even excavations, shafts or bore-holes should be put down, and in fact that

the Survey should completely develop their particular mining areas and open up their properties at the government expense. The absurdity of this method or the fallacy of their logic never appears to be considered by these individuals, since two very important obstacles would be presented at the very outset, the first of which would probably be the protest made by every mining engineer against the encroachment on the part of the government, through its staff, upon the rights of the private individual and the consequent interference with his profession; and secondly, the fact that very few treasuries could be found which would stand the enormous drain put upon their resources if the government should attempt the development of every mining location, real or fancied, and at the instance of every proprietor or company, while the staff necessary to undertake so extensive a system of work would speedily assume such enormous dimensions as to be beyond control. There are, however, certain cases where the advice of the government geological expert may be sought, and that with propriety, although it frequently happens that when such advice has been asked and obtained, the person giving it receives very little credit for ability either as a mining expert or geologist. Very often this by no means flattering result arises from the fact that some mining quack has already visited the spot, and in the hope or expectation of finding a job, more or less permanent, in the development of the property, has, by means of a judicious employment of certain technical terms, concerning the meaning of which he is very often ignorant, done his best to persuade the owner that great stores of mineral wealth lie just beneath the surface, waiting only for the application of the skill which he may possess for their successful extraction. How often this story has been told concerning certain areas, when upon a careful examination not the slightest indication of mineral wealth has been revealed, but such is the credulity and the peculiar bias of the human mind that the opinion most in accord with its own desires, is accepted, no matter how great its improbability.

It would appear desirable, also, that government advice should be given when requested in cases where large interests are involved, which are of more than a merely private importance; as, for instance, where the mineral resources of an entire district are in question, as in the case

of the great deposits of nickel at Sudbury, of asbestos in Quebec, of coal in Nova Scotia, or the North-West, or the mode of occurrence and geological horizon of apatite or any other mineral of great economic value, in which the welfare of large portions of the country is involved; or on the other hand the conducting of certain lines of assays where the fullest and most reliable tests should be made for the common good, such as the assays of gold bearing rocks or of silver bearing veins from certain areas not yet entirely passed out of the public domain. To those of you who have examined the great collections in the Geological Museum the wonderful variety of our mineral resources from every province of the Dominion must have been matter for astonishment, yet in very many cases these great stores of mineral wealth are even yet lying idle and undeveloped, owing to lack of capital or enterprise on the part of our investors.

Were the immense territorial extent of Canada which has been traversed in the collecting of the representatives of our economic mineral resources, often at large expense and with much labour, as easily accessible as the countries of Great Britain, France or Germany, the work of the geologist, botanist and naturalist would be a comparatively easy matter. I say comparatively easy, for while the intricate problems of structure would yet remain to be solved by the geologist, the facilities presented for their solution would be so great that much of the hardship and uncertainty which now prevail in the examination of a new and unsettled country would be done away with.

In the absence of such aids, however, to geological exploration, and in fact very often without any aids at all in the shape of maps, even over many portions of the older provinces, much of the time of the geologist in charge must now be devoted to deciphering his path through the tangled wilderness, and in getting together sufficient materials as regards topography as will enable him to place on paper and to render intelligible the scientific observations, geological or otherwise, which it is his peculiar province to obtain; for it can be readily understood by anyone, even but slightly conversant with the subject, that to attempt to delineate the geology or structure of any country on a projection, without the topographical features of river, lake or mountain, is almost a hopeless task. Thus it comes about that,

owing to the necessity of obtaining topographical data, which has been laid upon the staff of the Geological Survey, over very large portions of Canada, the ground work for many of our best maps has been derived from their labours, and great areas in all the provinces from the Atlantic to the Pacific have been mapped in detail, first of all by the officers of that staff, as can be seen in the large published maps of eastern Nova Scotia and in New Brunswick, in each of which many thousands of miles of roads, streams and coast lines were carefully measured and platted before the map necessary for the depicting of the geology of these countries could be laid down with any attempt at accuracy. In the newer and western sections, the well executed map of the Sudbury district, the Lake of the Woods, large portions of the Northwest plains, and great areas in the Rocky Mountains and British Columbia, testify to the labours of the Geological survey, in this capacity. In the province of Quebec even, the celebrated map of the Eastern Townships, which includes also a large portion of the province west of the St. Lawrence as well, has formed the foundation of all subsequent maps of that province since it was first carefully compiled in the Geological Survey office from materials drawn from Crown Land plans, supplemented and bound together with infinite pains and labour, by surveys made by the different officers of that department, a work the difficulty of which can only be properly understood by those who have attempted similar compilations.

Probably in no country under the sun do more complicated geological problems exist than in Canada, nor are such problems anywhere on a grander scale. A territory embracing three and a half millions of square miles, or very nearly the extent of the whole of Europe, and extending from the 49th parallel of latitude to far within the arctic circle, and embracing the extremes of heat and cold, in the northern part especially, where the fierce heat of the short summer is sufficient to ripen wheat almost to the 60th degree of latitude. Here we have the oldest known rocks of the globe, the solid backbone of the western hemisphere, extending from Labrador, in a great V shaped area, to near the mouth of the Mackenzie River, and including in its survey large portions of the provinces of Quebec and Ontario, and with great overlying areas of all the systems and formations of rock strata down to

the Cretaceous, with the finest opportunities for the study of the more recent geological phenomena, such as pertain to the glacial and post glacial times. Here we have the broad areas of the Silurian lying against the buttresses of the old Laurentian hills in as horizontal a position as when first deposited, and there we have the same series of rocks, folded and twisted, overturned and faulted, and metamorphosed to such an extent that all traces of their early and original character have apparently departed. Wonderful displays of the enormous foldings to which the earth's crust has been subjected are visible in the Rocky Mountain uplift on the west, and in the fractured and crumpled character of the rocks in the sections east of the St. Lawrence with their tangled complex of strata of widely separated horizons.

To attempt to give even an outline of the work of the Survey during the past twenty years would require a far longer time than we have at our disposal this evening, and we can but point out some of the most prominent points in the policy of exploration which have been pursued. Prior to the admission of the North-West Territory into the Dominion we were practically destitute of any knowledge of that great country. What information we possessed was derived from the travels and explorations, principally, of the Palliser-Hector expedition of thirty-five years ago, from the Hind Saskatchewan expedition of the same date, as well as from the journals of Hudson Bay Factors and the story of search parties in the quest after Franklin. At best it was sufficiently meagre. Its great wealth of soil and minerals was almost entirely unknown, and the general consensus of opinion appeared to be that the greater part of the immense plain country, bounded by a sea of mountains on the west, and with its great inland seas and streams, navigable for many hundreds of miles, as fitted only for the support of the Indian, the buffalo and the fur bearing animals, and likely to be of but little prospective importance to the white settler. Directly following its incorporation into the Dominion, exploratory parties were fitted out by the Geological Survey which traversed the great plains, the passes of the Rockies, the country of the Peace River, and the Saskatchewan. Year after year has this policy been carried on till now these scientific explorations, geological and botanical, have explored a very large area indeed, reaching northward nearly to the mouth of the

Mackenzie River and traversing the hitherto unknown area between that river and the Pacific Ocean. As the result we know very accurately the botany, the natural history and to a large extent the general distribution of the several geological formations which there occur. We now have ascertained the welcome fact that in acquiring the North-West Territories we have become possessors of millions of acres of the choicest soil, adapted to the raising of the finest cereals, while its mineral wealth is widely distributed and practically inexhaustible, as we can witness in the great coal seams of the eastern Rocky Mountain slopes in which larger and even more important seams have recently been discovered, which will furnish a supply of the most excellent fuel, sufficient for the wants of the country for thousands of years. Consider also the wonderful extent of the great petroleum basin of the Athabasca River district where, for many miles the sands and gravel are cemented by thickened oil, and present a succession of black cliffs along the course of that stream, with indications which point to this area as probably, in the near future, likely to become one of the greatest oil producing districts in the world. Consider also the rich silver mines in the western section of the Rocky Mountain chain, along the McMillan, and more recently the great developments of the Kootenay district and vicinity which bid fair to rival the great Comstock deposits south of the boundary, with the great deposits of salt, the rich areas of placer gold, and the great masses of iron ore, concerning the existence and importance of all which but little was known prior to the labours of the Geological Survey fifteen years ago, and in some cases even at a much later date.

You will remember two years ago, in a lecture before this club by Dr. G. M. Dawson on "the unexplored areas of Canada," the fact was pointed out that there yet existed in our Dominion, at least one million of square miles of which it may be said we know practically nothing. While this is true, it may also be said of many other hundreds of thousands of square miles, that our information has been obtained only by traverses along river courses or lakes, and that the great resources of these portions must as yet of necessity be practically unknown. But such a lack of information about so much of our Dominion in spite of the fact that the labours of the Geological Survey

staff and of various explorers from the other departments have been carried on for nearly fifty years, as well as of hundreds of private parties, will cease to be matter for astonishment when we consider the enormous extent of our territory and the limited force available to carry on such work. Even in the older provinces of Quebec and Ontario, where these operations have been carried on most continuously, the great succession of mountain country to the north of the St. Lawrence and Ottawa, constituting the height of land between these rivers and those of Hudson and James Bays, is to a large extent comparatively unknown. True, sections have been made across this country here and there along the various water courses but these only afford us a knowledge of our mineral wealth over limited areas. Exploration under such conditions is necessarily slow and great areas must remain practically unknown until greater facilities of transport are presented, an instance of which is presented in the discovery of the mining district of Sudbury, within a short distance of Ottawa, a discovery due to the opening up of the country by the Canadian Pacific Railway, and in Quebec also in the discovery of the asbestos mines of the eastern townships, in a section opened up by the passage of the Quebec Central Railway, the localities in both cases being practically inaccessible prior to the building of these roads. It is not yet twenty years since the importance of the phosphate mines of the Buckingham district was ascertained. When such wonderful stores of mineral wealth at our very doors have so recently been brought to light, who can say what further enormous developments may be looked for in the extension of those mineral bearing rocks which have so enormous a development in our country, and which owing very often to present difficulty of access are entirely unknown. Thus if we contemplate the situation ever so briefly we find before us a problem pertaining to the development of our country and its mineral wealth which requires clear heads for its inception and brave hearts and strong hands for its successful accomplishment. In the elucidation of this problem it is needless to say the staff of the Geological Survey, in making known to the world at large the mineral and agricultural resources of our land, has performed and must continue to perform no unimportant part. With the utmost cheerfulness, in the simple discharge of their duty, the members of that

staff have never hesitated to penetrate into the most forbidding areas, fertile in resources to find or invent means by which unexpected difficulties may be overcome. In canoe, in cart, by boat, or on the trail they have gone forward year after year, "by dint of thought and hammering" they have collected great stores of information and have by their collections and researches made easily accessible to any who may choose to examine, the geology, the mineral resources, and the natural history of the northern half of this continent from ocean to ocean, and have displayed all this information in the most attractive and instructive form in the rooms of the Museum in this city.

But the geological aspect of the work of the Survey department, is at the present day only one of many. Here, stowed away in cases and high presses can be found one of the largest and finest collections of plants, illustrative of the botany of all parts of our Dominion possible to be obtained. Much of the work of this branch of the department is invisible to the ordinary visitor to the Museum, since, unlike rock specimens or masses of ore, dried plants are perishable things and cannot endure exposure to the light and open air. They must be carefully laid away and precautions taken to guard against the ravages of insects and other enemies of the botanist's handiwork. Yet here in the cases of the Museum are stored more than 100,000 specimens illustrating the distribution of our flora from the foggy shores of Anticosti to the green valleys of the Island of Vancouver. The flora of the Peace River district, of the great plains, and of the Rocky Mountain steeps on the west, of the shores and islands of the Atlantic on the east, as well as of the country about the great inland lakes and of distant Labrador, are here rendered available for study to any one interested in the botany of our country, and who may wish, for purposes of comparison or for any other cause, to examine the plant growth of any district whatever. The enormous value of such a collection can scarcely be overestimated, and its practical utility in determining the fitness of certain areas for the growth of wheat or other cereals, as determined by the flora of the district is an admitted fact, not now called in question by anyone at all familiar with this branch of science. To the botanists of the Survey, then, great credit and praise are due for the magnificent collections made and for the careful way in which this

branch of the Survey work has been executed, and the publications on this subject are regarded as of the greatest value by the learned societies, both of Europe and America. Equally inconspicuous with the botanical collection in the rooms of the Museum building are the magnificent collections, illustrative of the insect life of our country; and probably most of those who wander through the corridors of that building are unaware that such beautiful specimens are there stored. These have been brought together in various ways, since the resources of the Survey have not yet permitted the employment of a regular entomologist. The great importance of this branch of science is, however, acknowledged by the Government, and at the Central Experimental Farm the study of the insect life, of certain areas at least, is carried out and their benefit or injury to plant life carefully ascertained; but while these studies are of the greatest practical importance to the agriculturist they cannot, of course, fill the place which the science of entomology requires in a purely scientific department.

In the division of ethnology also much work has been done. Extensive collections, illustrative of the manners, customs and institutions of the various Indian tribes which now inhabit our country, have been made, as well as large quantities of remains and relics of former races. The ornithology and to a certain extent the zoology also of the Dominion are well illustrated by means of a good collection of the principal birds and mammals, the further expansion of which is sadly hindered by a lack of space for their display. The various species of land and marine shells are exhibited and though in but few of these are the collections by any means exhaustive, and though the Museum space at the disposal of such branches of the department's work is of necessity utterly inadequate, sufficient has been done to show that the comparatively newer branch of natural history has not only not been neglected, but that the results already obtained are large and important.

But while the main purpose of a geological department may be held to lie in the work of the geologist, very frequently that work is so clearly associated with the investigations of his confrere, the paleontologist, that the work of the one generally involves the assistance of the other. In this branch, and in mineralogy also, the Geological Survey of

Canada has always maintained a high place among similar institutions. Thirty-five years ago Billings set himself earnestly to the task of deciphering the history of our country as written in its fossil remains. How well he succeeded is evidenced by the fact that the work of E. Billings not only reflected the highest lustre on the Survey in his branch while he remained a member of its staff, but the determinations then made have never ceased to be regarded as authoritative. Since his day the opening of the North West has introduced a new feature into the study of Canadian paleontology by the accession of great collections of fossils from the Cretaceous and other closely associated formations of that area, and less attention has in consequence been directed to the study of the older paleozoic fossils; but this change in policy has only been in accordance with the rapidly growing importance of our western country. The result of the fifty years' collecting in this branch of the Survey work has been to gather together one of the finest and most comprehensive collections, illustrative of the life of past ages in the earth's history, that can anywhere be found; a collection of such value to the scientific world that if by chance it should be destroyed its loss would be regarded as a great calamity by everyone interested in science the world over.

Of the internal economy of the Survey we have as yet spoken but in general terms. Here much work of the highest importance must be carried out. The collecting of facts relative to structure and the making of surveys in the field would not possess one-tenth of their real value, were no provision made by which these surveys and facts could be presented in compact and visible shape to the general as well as the scientific public. Hence the necessity of a topographical corps, whereby not only can the work of the field staff be arranged in map form for publication, but connecting surveys can be made to render these more intelligible. Then there is the careful arrangement of the Museum by which everything deemed worthy of exhibit can be so placed as to show to the best possible advantage the relation between the rock structure and the contained fossils where such exist, and the minerals or ores also which may therein be contained; in order that anyone in quest of information can most readily obtain such to the fullest possible extent and with the least possible delay.

The library division also is one of importance, in which the working scientist can find the most recent helps to enable him the better to profit by the researches of his brethren in other, but similar, fields, and so become the better fitted to work out the problems he may himself encounter; and here it may be said that the library of the Geological Survey is probably by far the most complete in scientific literature of any of the libraries in the Dominion, and, in as far as practicable, is kept well abreast of the age as regards the current literature in the subjects concerned.

The financial management of such an institution is also a most important item in its general scheme of successful work and the proper disposition of the funds by which the necessities of the several widely scattered parties can be best met, calls for a wise discrimination of the needs of each, and the expense peculiar to each locality to be explored; the prime object being the most judicious expenditure of the funds at the disposal of the department consistent with the highest and most satisfactory results obtainable.

I trust in this very imperfect description of the work done by the Geological Survey department I have shown you that in the old building on Sussex Street many kinds of work of great importance to the nation are being carried on. The structure and contained wealth of the rock masses from the Laurentian or fundamental crust of the earth to the most recent formation of drift sand, gravel and peat are being systematically studied and their actual value, in so far as this is possible, ascertained. The importance of each system as a source of mineral supply is carefully weighed and the mode of occurrence and probable extent and value of each element of economic importance sought out where practicable, to some extent in the field and in more detail in the laboratory of the Museum. Not only are the analyses of the rocks and of the contained ores there conducted and their probable value, from many localities carefully proven, but the chemical composition of the mineral waters from various provinces of the Dominion is carefully ascertained and their probable beneficial effects noted. Many of these have proved already to be large and important sources of revenue to the localities in which they occur, as at St. Leon, Caledonia St. Catharines and other points. Much of this work though presented

annually in published volumes fails to reach the general public, being by some curious reasoning apparently regarded as of more importance to scientific bodies and institutions of learning abroad than to those who are most directly interested in the development and growth of our country's mineral wealth—a condition of things which doubtless to a large extent accounts for the oft repeated question: "What is the work of the Geological Survey?" In the present arrangement of publication, however, far greater facilities now exist for obtaining desired information on any particular area.

While it would be folly to assert that the work of the Canadian Survey or of any other similar institution has always been free from mistakes, since that would imply a degree of infallibility and accurate scientific knowledge, not yet enjoyed by mortals, it will, I think, be admitted by anyone conversant with its method of operations that the attainment of the truth, in regard to the geological questions presented, has ever been the chief aim of those associated in the work. That the Geological Survey has ever borne an excellent reputation both at home and abroad is due probably, first of all, to the excellent reputation of its founder, the late Sir William Logan, and secondly to the fact that the great majority of its staff have laboured to their utmost with hearts filled with a love for the profession and with the desire to achieve great results. While we may now be able to say that we have a fairly good general knowledge of the geology of our country, and can depict on the map the lines of the several systems, and in some cases even of the geological formations, yet as settlement and advancement increase, new fields will be constantly opened up which will call for further detailed examinations. The geological study of a country embracing three and a half millions of square miles may be truly said to be a great work. The field certainly is large and the labourers are lamentably few to accomplish it, and many more years must elapse before we can hope to see a complete geological and topographical map of this our great Dominion. The work which as members of the present staff we cannot hope to see successfully accomplished will we trust be handed down to our successors, who, imbued with the true scientific spirit and under more favorable conditions, as the development of this great country progresses, and with accommodations enlarged, and better

adapted to the necessity of the work and the preservation of the valuable records belonging to the department, will continue to do still nobler deeds in the cause of geological science.

—:o:—

SOME NEW MOSSES FROM THE PRIBYLOV ISLANDS,  
BEHRING SEA.

(Jas. M. Macoun.)

While with the British Behring Sea Commission last summer a number of plants were collected among which were several mosses new to America and a few new to science.

Dr. N. C. Kindberg has already described six new species and varieties which are given below. All were found on St. Paul Island, in about 57° N. Lat. and 170° W. Long.

*CERATODON HETEROPHYLLUS*, Kindb. n. sp. Agrees with *Ceratodon purpureus* in the shape of the capsule and the stem leaves, the not excurrent costa and the revolvable annulus, but the capsule is often more curved and distinctly strumose; agrees with *Ceratodon conicus* (Hampe.) in the peristomial teeth having few articulations; differs from both in the blunt perichetial leaves, is also very peculiar in the short, concave, sub-oval leaves of the long shoots.

*DIDYMODON BADEN-POWELLI*, Kindb. n. sp. Differs from *Didymodon rubellus* in the dioecious inflorescence, the blunt, conic, very short lid, scarcely  $\frac{1}{3}$  of the capsule, and the distinctly dentate leaves (as in *Didymodon alpinus*, Vent.) The tufts are compact, about 2 cm. high, the leaves revolute nearly all around, short-acuminate, the lower pale brown, perichetial ones longer acuminate or subulate entire. The capsules are (unripe) more or less curved, the pedicel pale red. Named for Sir George Baden Powell, one of the commissioners.

*WEBERA CANALICULATA*, C. M. & Kindb., var. *MICROCARPA*, Kindb. n. var. Differs only in the much smaller capsule.

*BRYUM BRACHYNEURON*, Kindb., n. sp. Agrees with *Bryum pendulum* in the synœcious inflorescence, the peristomes orange, the

segments adhering to the teeth, the apiculate lid and the large spores (about 0.04 mm.); differs in the decurrent leaves, short-ovate, the costa broad, abbreviate, not excurrent, the sterile shoots bearing globose buds (gemmae), the very much broader peristomial teeth. Stem red, very short, the pedicel about 1 cm. long or shorter, often scarcely emerging above the tufts; costa of the lowest leaves red, percurrent only in the leaves of the shoots and the perichetial ones; capsule ventricose, short-necked constricted below the mouth. *Bryum fallax*, Milde., resembling it in habit, is dioecious; the segments are free, the spores smaller. *Bryum lacustre* differs in not having decurrent leaves, the capsule not being constricted below the mouth, the pedicel longer, the peristome pale, etc.

*BRVUM FROUDEI*, Kindb., n. sp. Habit of *Wiebera nutans*. Agrees with *Bryum inclinatum* in the synœcious inflorescence and the symmetric capsule, etc.; differs in the leaves being long-acuminate, cells long and narrow, the upper sublinear (nearly as in *Wiebera*), costa very long-excurrent, peristomial segments quite free from the teeth, spores smaller, scarcely 0.02 mm.; the cilia are wanting. Named for Mr. Ashley Froude, secretary to the commission.

*POLYTRICHUM (POGONATUM) ALPINUM*, Roehl., var. *MICRODON-TIUM*, Kindb., n. var. Differs in the leaves being nearly entire or indistinctly denticulate.

—————:O:—————



## SUMMARY

— OF —

# Canadian Mining Regulations.

## NOTICE.

THE following is a summary of the Regulations with respect to the manner of recording claims for *Mineral Lands*, other than *Coal Lands*, and the conditions governing the purchase of the same.

Any person may explore vacant Dominion Lands not appropriated or reserved by Government for other purposes, and may search therein, either by surface or subterranean prospecting, for mineral deposits, with a view to obtaining a mining location for the same, but no mining location shall be granted until actual discovery has been made of the vein, lode, or deposit of mineral or metal within the limits of the location of claim.

A location for mining, except for *Iron* or *Petroleum*, shall not be more than 1500 feet in length, nor more than 600 feet in breadth. A location for mining *Iron* or *Petroleum* shall not exceed 160 acres in area.

On discovering a mineral deposit any person may obtain a mining location, upon marking out his location on the ground, in accordance with the regulations in that behalf, and filing with the Agent of Dominion Lands for the district, within sixty days from discovery, an affidavit in form prescribed by Mining Regulations, and paying at the same time an office fee of five dollars, which will entitle the person so recording his claim to enter into possession of the location applied for.

At any time before the expiration of five years from the date of recording his claim, the claimant may, upon filing proof with the Local Agent that he has expended \$500.00 in actual mining operations on the claim, by paying to the Local Agent therefor \$5 per acre cash and a further sum of \$50 to cover the cost of survey, obtain a patent for said claim as provided in the said Mining Regulations.

*Copies of the Regulations may be obtained upon application to the Department of the Interior.*

**A. M. BURGESS,**

Deputy of the Minister of the Interior.

DEPARTMENT OF THE INTERIOR,  
Ottawa, Canada, December 19th, 1887. }

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