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

REPORT

ON

THE GEOLOGY OF

HUNTERS ISLAND

AND ADJACENT COUNTRY

BY

W. H. C. SMITH, C.E.

OTTAWA
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To A. R. C. Selwyn, C.M.G., LL.D., F.R.S.,
Director and Deputy Head of the
Geological Survey of Canada.

Sir,—I herewith submit to you my report upon the physical and geological features and economic resources of Hunters Island and adjacent country, lying principally in the Rainy River district of the province of Ontario, but extending eastward five miles and a half across the eastern boundary of this district into Thunder Bay district; also a geological map of the same on a scale of four miles to the inch. The sheet, No. 7, Ontario, embraces an area of eighty-seven and a half by forty-eight miles. The usual size of the sheets of this series is seventy-two by forty-eight miles, but fifteen and a half miles are added to this sheet to the west, in order to show on the one sheet that small portion of Canadian territory lying south of the eastern part of the area embraced in the Rainy River sheet, already published, and thus avoid the publication of a second seventy-two by forty-eight mile sheet, only a very small proportion in the north-east corner of which would be Canadian territory. Only about one-third of the area depicted on this map is in Canada, the boundary line between Canada and the United States extending in a sinuous line completely across the sheet.

All the topography north of this line is from our own surveys, checked and in some cases supplemented by township surveys, mining location surveys, timber limit surveys, and the survey of the boundary line between the districts of Rainy River and Thunder Bay by the Provincial Crown Lands Department.

All the topography on the American side is compiled from the best American maps extant.

The examination of the area was originally under the direction of Dr. A. C. Lawson, who, however, resigned before the work was completed. As his assistant, my work was for the most part topographical. The geological notes, taken in conjunction with those for the topography, were only intended to be supplementary, and in many places where surveys were not required, the writer took no geological notes. With a few unimportant and isolated exceptions, the main geological boundaries were, however, laid down by Dr. Lawson on the map, prior to his departure. These boundaries he determined partly from his own observations and partly from those of the writer, but he

had not indicated on the map the subdivisions of the Keewatin series, therefore the report is brief and incomplete.

The area of Canadian territory on this sheet being small comparatively, and the publication of the map having been already much delayed, it is deemed advisable to publish it at once, rather than to wait another year in order to acquire information for the minuter subdivision of the rocks of the Keewatin series.

I have the honour to be, sir,

Your obedient servant,

W. H. C. SMITH.

OTTAWA, 3rd May, 1892.

NOTE.—All bearings have reference to the true meridian.

REPORT

ON

THE GEOLOGY OF

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INTRODUCTION.

This report, with its accompanying map, is a continuation of the work commenced by Dr. A. C. Lawson in 1883, in the Lake of the Woods region. Since then his reports on the Lake of the Woods, Rainy River and Rainy Lake together with three sheets of the map have been published.

Position of shee

This sheet, lying to the south and east of the Rainy Lake sheet, is the fourth of the series published, although it is numbered "7," in accordance with a systematic numeration of the sheets of this series, which it is intended to publish.

Period of field investigation.

The present report and map embody surveys and geological investigations made in the latter part of the summer of 1887, during the summer of 1888 and part of the summer of 1889, during which time I was acting as topographer and assistant to Dr. Lawson.

Work of season 1887.

In the summer of 1887, I was assisted by Mr. William Lawson. The early part of the summer was occupied in finishing the topography required for the Rainy Lake sheet. We left Fort Frances on the 5th of August and commenced work on the area covered by this sheet on the 9th of August. Micrometer and compass surveys were made of all the lakes and streams north of the international boundary shown on this map west of Lac la Croix, with the exception of Little Vermilion and Loon lakes and the intervening stream; thence from the eastern boundary of Indian Reserve "D," we surveyed the Maligne River, carried a micrometer and compass line along the south side of Sturgeon Lake, and continued this line through Russell and Chatterton lakes to

Keat's Lake, which we surveyed, with the river stretches and lacustrine expansions to Kahnipiminanikok Lake, through which we carried the line; thence up the Kahnipiminanikok River to Saganagons Lake, where the system of surveys was connected with the mining locations which approach within a few chains of the south-west arm of this lake, and which had already been connected with the American township surveys.

Boundaries of Hunters Island.

The lakes and rivers above enumerated form the north-western, north-eastern and eastern boundaries of that area to which the name of Hunters Island has been given. The south-eastern boundary is formed by the northerly shores of Saganaga and Swamp lakes, by the Swamp Portage, by the north-western shores of Cypress, Big Knife, Carp and Birch lakes, with their connecting streams. Basswood Lake forms the southern boundary, while Crooked Lake, with the stream which pours into it the waters of Basswood Lake, and that which carries the waters of both into Lac la Croix, form the south-western boundary.

The work on the northern boundary of Hunters Island was finished on the 30th of September, and the season's work brought to a close at Silver Mountain on the 7th of October.

Work of season 1888.

In the summer of 1888 Mr. Wm. Lawson again assisted me, and from the 29th of June to the 24th of August, we were continuously engaged in surveying, by means of the compass and Massey patent boat log, the lakes bordering Hunters Island to the north-east, and those in the interior of the island east of, and including, the lakes and streams forming the route from Shelley Lake through Keefer to Kashapiwigamak Lake. In addition to these, Ross, Beaver and McKenzie lakes were surveyed during this period.

From the 24th of August to the 12th of September, we were engaged on work in the area included in the sheet north of this, the Seine River sheet (No. 6 of the series.)

Between the 15th and the 19th of September we surveyed Wink and Pooh-Bah lakes, with the creek and portage connections between these and Sturgeon Lake and River. The next week was spent in the Seine River sheet, but the remainder of the season, from the 27th of August till the 18th of October, was spent in the south-western and northern Laurentian areas of Hunters Island, during which time nearly all the lakes shown in these portions were surveyed wholly or in part.

Work of season 1889.

In the summer of 1889 I was again assisted by Mr. Wm. Lawson. Work was commenced at Savanne on the 6th of June, and continued until the 12th of August, on surveys in connection with the Seine River sheet. From the 14th till the 25th of August, while Mr. Lawson continued working in this sheet, I was employed in Hunters

Island, completing some unfinished surveys arnund Wicksteed, Brent, William, Conmee, McIntyre and Sarah lakes, and in investigating more closely some geological questions there, and on the south-east arm of Sturgeon Lake. The remainder of the season was spent on the Seine River sheet, with the exception of a week in October devoted to topographical work in the neighbourhood of Port Arthur and Fort William.

Much of the area embraced in the Hunters Island sheet had been surveyed for various purposes, with a considerable degree of accuracy, and for this reason it was deemed expedient to use, for the most part, the more rapid method of surveying with the prismatic compass, for determination of bearings, and the Massey patent boat log, for the measurement of distances. This log, carefully used, gives very satisfactory results and permits great rapidity of work, but it does not allow close continuous examination of the lake shores for rock exposures, as it is necessary to hold a straight course with the canoe from point to point.

Instruments used in surveys.

The southern shores of the lakes and rivers along the international boundary line were accurately defined by the Minnesota township surveys, which afforded an excellent base line for our work. The whole of Hunters Island had been traversed with the transit and micrometer for timber limit purposes, and this survey fixed with much accuracy many prominent points on all sides. The boundary line survey, between the districts of Thunder Bay and Rainy River, the Indian Reserve surveys, and the mining location surveys, all contributed considerably to the topographical detail, and to the accuracy of delineation of the geography of the field. Some of the outlines of the northerly shores of the lakes and rivers along the international boundary were taken from Mr. David Thompson's survey under the Boundary Commission. This work, when corrected by the American township surveys, has been found to be sufficiently accurate between points thus fixed. Little Vermilion and Loon lakes, the eastern part of Lac la Croix, Crooked and Basswood lakes are the principal places where this survey was made use of.

Older surveys made use of.

Minnesota township surveys.

Canadian surveys.

Boundary Commission survey.

That Man's and This Man's lakes were surveyed by Mr. McDougall of Port Arthur, and a map of them kindly given me by him. The position of The Other Man's Lake was fixed by Mr. McDougall with reference to those above mentioned, and the traverse of the shore line and island was made by Dr. Lawson.

Mr. McDougall's surveys.

With the above exceptions, all the topographical work of this sheet on the Canadian side of the boundary was performed by the writer and Mr. Wm. Lawson.

Original surveys.

I may take this opportunity of expressing my appreciation, not only of the cheerful manner in which this gentleman has endured the hardships and undertaken all the tasks incidental to our explorations, but also to the readiness and ability with which he mastered the requirements of the work and to the rapidity, care and accuracy which invariably characterized his performance of it. He not only assisted me throughout the seasons during which I was engaged in the topography of this sheet, but has been working under my direction for the last two seasons, five summers in all, during three of which he has, for the most part, been engaged in making independent surveys.

Acknowledgments.

I may here also take the opportunity of acknowledging my indebtedness to all the members of the engineering firm of Russell, McDougall & Russell, of Port Arthur, for maps, sketches and information; to the Messrs. McKellar, Mr. McIntyre and Mr. John McLaurin, of Fort William, for information, and for assisting me to secure suitable men; to Mr. Geo. McLaurin, of Savanne, and to Mr. Alex. Matheson, of Rat Portage, for similar favours. To Messrs. Thos. Marks & Co. of Port Arthur, I am especially indebted for courtesies and favours extending over several years.

Bibliography.

The geological literature of this field is very cursory. Half a century ago the two main routes from Lake Superior to the north-west, were the Pigeon River route and the route by Lac des Mille Lacs. The former which now forms the boundary line between British America and the United States, from Lake Superior to the Lake of the Woods, is represented on this sheet between Saganaga and Namakan lakes; the latter route joins this one at Lac la Croix. On these two routes only, therefore, do we find some brief references to the geology of the country in the earliest scientific records of the West.

Bigsby.

The earliest reference that I can find, is in Dr. J. J. Bigsby's delightful book of travels, entitled "The Shoe and Canoe," published in 1850.

In the Quarterly Journal of Geological Science, for 1851, the same author, in a paper entitled the "Erratics of Canada," has a brief reference, on p. 218, to the lakes in the sheet.

Owen.

In the report of the Geological Survey of Wisconsin, Iowa and Minnesota, by Dr. Dale Owen, 1852, are references to the rocks of Little Vermilion, Sand Point and Namakan Lakes, on pages 317 and 318.

Hector.

In Captain Palliser's report of an exploration of part of British North America, Dr. James Hector under date 1857, gives a few geological notes, and a sketch map and section geologically coloured, of part of this region.

evine.

On a map, by Mr. Devine, of the north-west part of Canada, published by the Crown Lands Department of Upper Canada, in 1857, the

part of the area shown on this sheet south-east of Sturgeon Lake and Maligne River is geologically coloured as belonging to the Silurian system.

Prof. H. Y. Hind in his report on the Assiniboine and Saskatchewan district, 1859, has a reference, on page 165, to the glacial groovings on the gneissoid rocks of Sturgeon Lake. Hind.

In the Quarterly Journal of Geological Science, vol. XVII., 1861, page 438, Hector refers to the rocks of Sturgeon, Saganaga and intermediate lakes. Hector.

Dr. Bell, in his report on the country between Lake Superior and Lake Winnipeg, published in the report of this department for 1872–73, and also in his report published in the succeeding volume, 1873–74, on the country between the Red River and the Saskatchewan, with notes on the geology between Lake Superior and Red River, briefly records some of the geological features of the eastern part of this region. Bell.

Prof. N. H. Winchell, in the 15th, 16th and 17th Annual Reports of the Geological and Natural History Survey of Minnesota, makes occasional references to the geology of all the lakes on the American northern boundary. Winchell.

Brief references to the geology of this region have been made in the annual summary reports of this department for the years 1887, 1888 and 1889.

N. H. and H.V. Winchell, in their joint report on the Iron Ores of Minnesota, 1890, refer to the rocks of Saganaga Lake. N. H. and H. V. Winchell.

Mr. H.V. Winchell, in the "American Journal of Science," for May, 1891, publishes an article on the same rocks. H. V. Winchell.

In the same journal, for April, 1892, Dr. A. R. C. Selwyn publishes an article on the "Geological Age of the Saganaga Syenites." Dr. Selwyn.

Physical Features.

The whole of the area, comprised in this sheet, is of the "*rocky lake*" character described by Dr. Lawson* and presents, particularly in the schistose areas, the same intimate dependence of lake and river shore lines upon the direction of the strike, cleavage or lamination of the rocks.

The surface features of the country present a rough hummocky succession of low-rounded hills, with irregular depressions occupied by lakes and their connecting streams. Surface features. A few well marked continuous ridges, roughly parallel to each other, occur in the eastern part of Hunters Ridges.

*Geological Survey of Canada, Annual Report, vol. III., 1887-88, Part I., p. 11 F.

Island, the most important and regular of which is that running north-west of Knife and Cypress lakes and which consists largely of greenstones, with which are associated the jaspilyte and iron ores. These ridges run in a general north north-east direction. They follow closely the strike of the rocks, and continue with occasional depressions for from ten to twenty miles These hills are particularly high and precipitous in the schistose area, rising to a height of about 300 feet above the level of the neighbouring lakes. The shores of Emerald and Big Rock lakes are especially high and rugged, the ridge between them probably marking the line of greatest elevation in the area comprised in this sheet.

Arctic and Atlantic divide Branch watershed.

The watershed between the Arctic and Atlantic slopes passes between North Lake and South Lake, sixteen miles east of this sheet, in a west south-west direction, and a branch of this divide crosses the Swamp Portage, and thence in a sinuous line, but general westerly direction, across Hunters Island, separating the waters that flow around the north-east and north-west sides of the island from those that flow around the south-east and south-west sides to meet again in Lac la Croix ; whence they flow down the Namakan River through Namakan Lake to Rainy Lake. With the exception of the narrow neck of land crossed by Swamp Portage, the area known as Hunters Island is completely surrounded by water. The whole area comprised in this sheet lies on the southern margin of the Arctic basin.

Drainage of Hunters Island region.

Elevations.

Probably the highest lakes in the region are the small lakes north of Jasper Lake and Louisa Lake, neither of which can be much below the level of North and South Lakes at the main divide.

Assuming the level of Rainy Lake, as estimated by Dr. Lawson,* to be 1,182 feet above the sea, the elevation of Cypress Lake would be somewhere in the neighbourhood of 1,400 feet. The elevation of Lac des Mille Lacs, as determined by the Canadian Pacific Railway levels, is 1,500 feet above the sea, which is probably higher than any lake in this area. All the estimates of the earlier explorers, of the elevation of the lakes at the height of land, seem to have been considerably too low, while Prof. N. H. Winchell's† estimate of the elevation of Saganaga Lake (1,518 feet) would seem to be a little too high, the highest land, however, in the area, can hardly be less than 1,800 feet, attained not only by the ridge north of Knife Lake, but also in all probability by that skirting the south-east shores of Louisa, Glacier and McEwen lakes.

Previous estimated elevation.

*Geological Survey of Canada, Annual Report, vol. III., 1887-88, Part I., p. 14 F.

†Geological and Natural History Survey of Minnesota, 1872-1882.

The greatest depth found, *280 feet, was in Agnes Lake, two miles from its southern extremity. Depth of water in lake

The following short list of soundings will convey a good general idea of the maximum depth of water usually found in these lakes, which would seem to bear about the same proportion to the height of the hills surrounding them, that the area of lake surface bears to that of the land.

SOUNDINGS OF LAKES IN THE HUNTERS ISLAND REGION. List of soundings.

	Feet.
Namakan Lake, western part	48
Namakan River, expansion, south-west of Captain Tom Lake	34
Sand Point Lake, bay on east side near southern end	70
do southern expansion	43
Pooh-Bah Lake, north side	50
do south-west bay	50
Chatterton Lake, central part	27
McDougall Lake, northern part	30
Keefer Lake, centre	72
Lake north of Keefer Lake	70
do do north-western part	50
Kashapiwigamak Lake, two miles from southern extremity	130
Hulburt Lake, one mile from southern extremity	33
Lake south of Hulburt Lake, western part	25
Williams Lake, northern arm	33
do middle of south-west part	75
Kahnipiminanikok Lake, two miles from northern end	80
do three do	62
do four and one-half miles from northern end	108
Murdoch Lake, southern part	14
Western outlet of Agnes Lake	13
Agnes Lake, eastern arm	94
do four miles from southern end	35
do three do	102
do two do	*280
Robin Lake, southern part	18

The whole country is, as a rule, very thickly clothed with forest. Most of the trees are, however, evergreens, and no hardwood trees, with the exception of a very few elms *(Ulmus Americana)*, soft maple *(Acer rubrum)* and, very rarely, small ironwoods *(Ostrya Virginica)* were anywhere seen. In parts of the country that have not been more or less recently swept by fire, the principal trees are white pine *(Pinus strobus)*, red or Norway pine *(Pinus resinosa)*, jack pine, called by some pitch pine *(Pinus Banksiana)*, and spruce, probably of the two varieties, white and black *(Picea alba* and *P. nigra)*; these are, as a rule, somewhat small in size. Canoe birch *(Betula papyrifera)* is also a very common tree, but, usually, it does not in this part of the Forests. Variety of trees found.

country grow to a sufficient size to furnish good bark for canoes. Very rarely the silver or yellow birch *(Betula lutea)* is seen of small size. The aspen poplar *(Populus tremuloides)* is very abundant, growing to large size in unburnt forests, and forming the sturdiest and quickest second-growth in portions that have been swept by fire. White cedar *(Thuya occidentalis)* is sometimes seen where the soil is deeper than usual, generally in somewhat marshy places and lining the banks of streams; it rarely attains to any very large size and, although widely, is sparsely, distributed. Tamarack *(Larix Americana)*, sometimes of considerable size, is generally found in the more extensive marshes. The balsam or fir *(Abies balsamea)* is a very common tree, but is usually smaller and less abundant than the spruce. Basswood Lake is supposed to have been named after the tree of that name, but I have seen no basswood in this part of the country, and Dr. Bell* reports that there is none, and that the name was probably taken from the whitewood or balm of Gilead *(Populus balsamifera)* which is abundant on the shores of the lake. Basswood is erroneously called whitewood by some. The Indian name of the lake is Bassmenani Sakahagun, and the first French name for it is Lac des Bois Blancs. From this it may be conjectured how the present name has been evolved.

Basswood.

Comparatively a great part of the country embraced in the area mapped has been ravaged by fire within the last half century. These devastating fires, which do so much to mar the beauty of the scenery and destroy the timber, are too often caused by the carelessness of explorers, prospectors and hunters; the Indians are very careful to extinguish their fires during the dry season; but it is to be regretted that the fatal carelessness of others cannot be checked; the amount of valuable timber thus destroyed is mutely but strongly attested by the gigantic half-burned dead pines which, towering in the air, add so much to the wildness and desolation of the scene. Where sufficient time has elapsed a dense second-growth has sprung up, consisting, in places, almost entirely of jack pine, thickly clustered, sometimes of more thinly scattered, birches and poplars, but generally of all three with the addition of spruce. Frequent clumps of Norway pine often break the monotony of the burnt country. These trees remain unscathed, and where they are thickly clustered have often arrested the progress of the fires in that direction.

Forest fires.

From the character of the woods noted on the lake shores, a general idea of the extent of these fires can be gathered.

Extent of forest fires.

*Geol. Sur. of Can., Rep. of Progress, 1872-73, pp. 87-111.

Below is a list of the lake shores which, in 1888, were observed to have been at different periods swept by forest fires which have destroyed the best timber :—

List of localities where traces of fires were observed in 1888.

Namakan Lake, isolated small areas.
Lac la Croix, west shore of western part.
Tanner's Lake, all the north shore.
Sturgeon Lake, nearly all the north shore.
McDougall Lake, eastern half.
Chatterton Lake, eastern part.
Keat's Lake, all the shores.
Shelley Lake do
Kahnipiminanikok Lake, western side of northern part at intervals for seven miles along the channel to Williams Lake.
Long narrow lake, north of Agnes Lake, western outlet.
Agnes Lake, northern part.
do western shore for nine miles to within one mile of southern extremity.
do north-west shore of bay to north-east, and on eastern shore of main lake for one mile and a half north of the mouth of this bay.
Sunday Lake, northern shore.
Burk Lake, all except one mile of southern shore.
Basswood Lake, north-eastern half of north-eastern part.
Shade Lake and lake north-west of it, and small lake south of it, all shores.
Noon Lake.
Lake Silence, southern three-quarters.
McNiece Lake, eastern shore.
Kashapiwigamak Lake, both shores for four miles from southern extremities.
Wicksteed Lake, western shore.
Lake south of above, all the shores.
William Lake, eastern part.
Conmee Lake, west shore and south-eastern bay.
Pooh-Bah Lake, all except north-western arm and north shore.
Brent Lake, north shore of eastern part and both shores for one and a half miles from eastern extremity.
McIntyre Lake, all except northern bay.
Sarah Lake, all shores.
Small lake south of Sarah Lake.
McKenzie Lake, southern part, and northern shore of arm of Kahnipiminanikok Lake for two miles west of it.
Kahnipiminanikok Lake, south-east shore of arm, for two and one-half miles from mouth of Kahwawiagamak River.
Bird Lake, and southern part of bay of Kahnipiminanikok Lake east of it.
Robin Lake, and small lake tributary to Agnes Lake south of it.
McEwen Lake, eastern side, and portions of western side.
Wet Lake, all shores.
Glacier Lake do
Louisa Lake, all shores except at southern extremity.
Cross Lake, all shores.

Saganagons Lake, Deadman Point and shore south of it to eastern extremity of lake, and north shore for three miles west of this extremity.
Ross Lake, all shores.
Beaver Lake, all shores.

Probable extent of these fires.

Without exploration, the distance to which these fires have penetrated into the interior from the lake shores, is a matter of conjecture; in many cases it is known not to be far, and probably owing to the increasing dampness of the woods in the more sheltered interiors, as the lake shores are receded from, the fires could not spread to any great distance except by repeated burnings in successive seasons; on the other hand, from the close contiguity of some of the lake shores which betray the evidence of forest fires, and from the contemporaneity of these fires on different lakes, as indicated by the second-growth timber, it is to be feared that in many cases the fires have swept over the whole intervening country from lake to lake.

A proportional estimate of the country which has thus suffered is somewhat difficult to arrive at, but in the field I concluded that not less than one-sixth of the whole area of this region had been ravaged by fire.

Periods of fires.

The second-growth timber would seem to indicate three main periods of conflagration. The first period would seem to have been about the year 1870, and the second about the year 1879 or 1880. Professor Macoun states that no extensive fires had occurred in the vicinity of Port Arthur and along the line of the Dawson route prior to 1869, and that, in 1870, fires were very general and destructive owing to the carelessness of the troops who passed over the Dawson route in that year. It is certain, however, that fires were prevalent along the line of the Pigeon River route (international boundary) long before this date, as Dr. Bigsby, in his "Shoe and Canoe," quoted above, refers to the bare hills of Saganaga Lake, and in one of his scenic sketches of Lac la Croix, the country is represented very much as it is now in that respect.

The last period of fires seems to have been quite recent, and to have affected for the most part those districts already burnt.

Pine.

There is much good pine timber in the unburnt areas, but the largest trees do not grow on the lake shores. The distribution of white pine is very general, although it bears but a small proportion to the forest timber. The finest pines were seen on Trout and Darkey lakes, the western part of Brent Lake, the south-east part of Sturgeon Lake, at several places on Kahnipiminanikok Lake, and in the northern part of Silence Lake. Isolated groves of medium-sized white pine are seen on the western side of McEwen Lake and on the north-

western shore of Russell Lake. Some fine trees were seen on Williams and Hulburt lakes, and around the south part of Brent Lake.

Regarding the character of the canoe routes traversing the district, a few words may be said for the guidance of future travellers. All the portages known are indicated on the map, the length being usually given in chains. The word "portage" is printed, where space is available on the map, on that side of the watercourse on which the path is to be found. Canoe route.

Those routes, which on the map are seen to be the shortest and to have the fewest portages, are not always the best, and are sometimes impracticable, from the number of rapids and shallows.

Of the two main routes from Lake Superior to the North-west, above referred to, *viâ* Rainy Lake, the one by Lac des Mille Lacs and the Dawson route through Sturgeon Lake to Lac la Croix, is, in the opinion of the writer, decidedly the easiest to travel, though much the less interesting to the geologist or explorer. Dawson route to the North-west.

The Pigeon River, or Grand Portage, or International boundary route, traverses the whole of this sheet. Between Saganaga Lake and Lac la Croix, the watercourse around the northern side of Hunters Island affords an alternative route. The distance between these two lakes by either route is about the same. There are fewer portages on the southern or boundary route, and there are no lengthy rapid streams which are dangerous to descend and difficult to ascend. By this route also the portages are better cut out and more easily found, but the lakes are larger and more intricate, and it is difficult for a stranger to detect at once the shortest way through them. Pigeon River route.

The old Dawson route led by one portage, four miles long, from Lac la Croix to Sand Point Lake; this portage is now overgrown with thick bushes and is impassable, and the traveller has the alternative of going round by the boundary line (the original route) which is undoubtedly the best, or of taking the Namakan River from Lac la Croix to Namakan Lake. This river is very rapid and turbulent: it is unsafe for the traveller without a guide who is thoroughly conversant with its many treacherous rapids and falls, and it is extremely laborious to force a canoe against its strong current. With small canoes and when the water is high a much better passage is afforded by the watercourse shown south of this river and north of David and Thompson lakes. Nequaquin Portage. Namakan River.

A route exists between Lac des Mille Lacs and Kahnipiminanikok Lake, by Kashabowie and Shebandowan lakes, and Kawawiagamak Lake and River. I am told there are twelve portages on this route, Kawawaigamak River route.

some of which are about a mile long, but that otherwise the route is a good one.

Means of access to Keewatin belt of rocks.

From Port Arthur the readiest access is obtained to the Keewatin belt of rocks in the south-eastern part of Hunters Island, by the railway to Whitefish Lake, thence by Whitefish and Arrow Lakes to the Pigeon River or boundary line route. From Cypress Lake, the upper series of these rocks is reached by Jasper Lake to Saganagons Lake, northward, and by Big Rock and Emerald lakes to Carp Lake southwestward. The portages are short and well cut out, having been prepared for the passage of testing machinery to the iron ore locations on Jasper Lake.

Routes between Sturgeon and Basswood Lakes. Agnes Lake route.

The best route between Sturgeon and Basswood lakes is that by Russell, Chatterton, Kahnipiminanikok, Agnes and Sunday lakes. An alternative, doubtfully preferable, is offered between Agnes and Basswood lakes, by Silence, Sultry, Noon and Shade lakes. This was the old route of the Hudson Bay Company.

From Sunday Lake to Basswood Lake the traveller may pass directly by the North Portage, or by Burk Lake and three short portages, as best serves the object of his journey. Agnes Lake has two outlets into Kahnipiminanikok Lake, of which the eastern one, by Bird and Robin lakes, affords much the best route.

Kashapiwigamak Lake route.

A shorter route between Sturgeon and Basswood lakes, is afforded by Keefer, Kashapiwigamak and Yum Yum lakes, but the portages between Kashapiwigamak and Basswood lakes more than counterbalance this advantage. The alternative route between Shelly and Kashapiwigamak lakes, by Kahnipiminanikok, Williams and Hulburt lakes is in no respect to be preferred.

Darkey Lake route.

The best of the more direct routes between the western part of Sturgeon Lake and Basswood Lake, is afforded by Tanner's, Darkey, Trout and Crooked lakes. Three of the portages are rather long, but the footing on them is good, and with lightly laden canoes time could probably be saved by going this way rather than by making the long detour by Lac la Croix ; in any case it requires less time and labour to traverse the western than the eastern side of Hunters Island.

Winter route.

The most direct route through Hunters Island crosses from the southwest end of Sturgeon Lake, at the Maligne dam, across Pooh Bah, Conmee, Brent, McIntyre and Sarah lakes to Basswood Lake. On account of its directness, and the absence of steep hills on the portages, this is a favourite route with the Indians and the traders in the winter with dogs and toboggans, but it is never travelled during the summer ; of the twenty-two miles, from the Maligne Dam to Basswood Lake, nearly six are taken up by portages.

From Sarah Lake to Basswood Lake there is a route by a chain of lakes, indicated in dotted outlines on the map; of the five lakes on the route, two are reported by my Indian guide to be comparatively large, and of the seven portages, the one into Basswood Lake is said to be a long one. Between Brent and Sarah lakes there is a chain of lakes, indicated in dotted outlines on the map, which affords an alternative route over four portages, only two of which are said to be of any great length. Lakes not surveyed.

These constitute all the canoe routes in this area, which the explorer is likely to have occasion to travel.

ARCHÆAN ROCKS.

The rocks to which this report refers are divisible into the same groups as those established and described by Dr. Lawson* in the Lake of the Woods and the Rainy Lake districts. They are: A, Laurentian; B, Huronian; b-1, Coutchiching; b-2, Keewatin. The upper series consists of micaceous and hornblendic schistose rocks, for the most part fine-grained. The field evidence fails to determine satisfactorily whether any of these rocks are of sedimentary origin, but they exhibit abundant evidence of having been subjected to great thermo-mechanical metamorphism. Upper group of Archæan rocks.

This series is divisible into two minor series, named by Dr. Lawson the Coutchiching and Keewatin, the former of which is essentially micaceous and felspathic in its character, and possibly derived from original bedded gneisses. The upper division is more varied in character and includes hornblende schists, micaceous hornblende schists, hydromica schists, quartz porphyries, grauwackes, felsitic schists, conglomerates and agglomerates, with which are associated more or less altered volcanic rocks, and volcanic ashes. Of these minuter subdivisions, I am unable in all cases to delineate the distribution from my notes, as this work was to be done by Dr. Lawson; and no uniformity of sequence appears to be discoverable in them, so that they are all included in the one colour, the localities where I am familiar with them being indicated by letters in red, referring to notes on the margin of the map. Coutchiching and Keewatin series. Rocks of Keewatin series.

The lower division of rocks, of the granitic and syenitic type of mineral composition, is in this field, for the most part, granitoid in character, and present many phenomena suggestive of the igneous irruptive origin of their present attitude with regard to the schistose series. Laurentian rocks.

* Geol. Survey of Canada, Annual Rep. vol. I., 1885, 29 C. C., and vol. III., 1887-88, p. 21 F.

Subdivision of Laurentian rocks.

It might be possible to map the distribution of the different lithological phases of the Laurentian, but my notes are unfortunately too incomplete to do this satisfactorily. From minuter observations made elsewhere since this work was performed, I think that this subdivision is more important than it has hitherto been considered, and that we may have in the hornblendic and in the micaceous phases of these granites, rocks of different ages, the relative age of which is determinable, and the discovery of which may throw much light, not only on the genesis of the Laurentian, but on its relations to the overlying Coutchiching and Keewatin groups.

A. Laurentian.

Designation of areas.

For convenience of description and for future reference, a name will be given to each geographically separated important area of Laurentian rocks. While a broad general similarity of character and of mode of occurrence obtains between the rocks of these distinct areas, each possesses individual characteristics which demand attention, and they are all separated by intervening belts of upper Archæan Huronian rocks.

Kawagansikok area.

I. The granitic rocks on Sturgeon Lake and the lakes to the east as far as Shelley Lake, belong to a very large Laurentian area, the western part of which is closely defined. Its general outline forms an elongated oval, with a rounded excrescence on the south side. It is known to be over twenty-two miles wide, north of the western part of Sturgeon Lake, to the east of which the extension south of Russell Lake adds eleven miles. The longest axis has a general direction of 10° N. of E. and S. of W., and cannot be much less than one hundred miles in length. The largest portion of the area, that north of the limit of this sheet, is characterized by the great abundance and persistence of bands of mica schist.

This area will be referred to as the "Kawagansikok Area" from the largest and best known lake in its central portion.

Pooh-Bah area.

II. The rocks surrounding Pooh-Bah Lake are lithologically distinct from those of all the other areas, and from this fact and from a certain doubt entertained as to their relative age, they require a separate designation, and the area will be referred to as the "Pooh-Bah Area."

Hunters Island area.

III. The broad belt of granitic rocks which extends all across the area embraced in this sheet, also for more than sixty miles to the west of its western boundary, and for about forty-five miles E. N. E. of its north-east corner, will be referred to as "Hunters Island Area." The rocks of this area are, in lithological character, typical generally of all the Laurentian rocks of north-western Ontario and northern

Minnesota, so far as these are known; but the shape of the area in its irregularity of outline and great length (over two hundred miles) compared with its breadth (nowhere over twenty-five miles and rapidly tapering from the centre each way to extend in long narrow tongues) presents a marked contrast to the usual oval or egg-shaped areas of the granite gneisses in this country.

Saganaga area.

IV. A portion of a granitic area is exposed around Saganaga Lake which, so far as its outlines have been determined, would seem to be of comparatively regular ovoid form; about sixteen miles in extreme width; and about sixty miles long, in a direction N. 60° E. of which forty-five miles will be mapped on the sheet east of this. This area will be called the "Saganaga Area," from the name of the best known and most important lake within it.

Lithological peculiarities of each area.

The rocks of this area present some lithological peculiarities, and differences of opinion prevail as to their age, which will be briefly alluded to in a later part of this report.

I. KAWAGANSIKOK AREA.

Limits of area.

The limits of this area have been already defined as far as they encroach upon the district under consideration. This portion of the area so far from presenting the feature of containing bands of mica schist, so characteristic of the area to the north, appears to be unusually free from them, even in close proximity to the occurrence of these rocks to the south. A few localities in which these bands occur have, however, been already noted.

Sturgeon Lake portion.

Description of rocks.

The rocks north of Sturgeon Lake are of typical pink-gray granite gneiss, usually distinctly foliated on the islands and on the more southerly points of the north-west shore, but appearing less distinctly so, as the distance from the line of contact increases. A hard, red, fine-grained granite, almost devoid of mica, hornblende or any of their decomposition products, occurs on the north side of the narrows at the east end of the western portion of Sturgeon Lake. Here a feature, very common, particularly in these felsitic granites of the Laurentian, is seen, viz., a parallel system of jointing planes a few inches apart. The constituent minerals of the rock do not show any parallelism of arrangement.

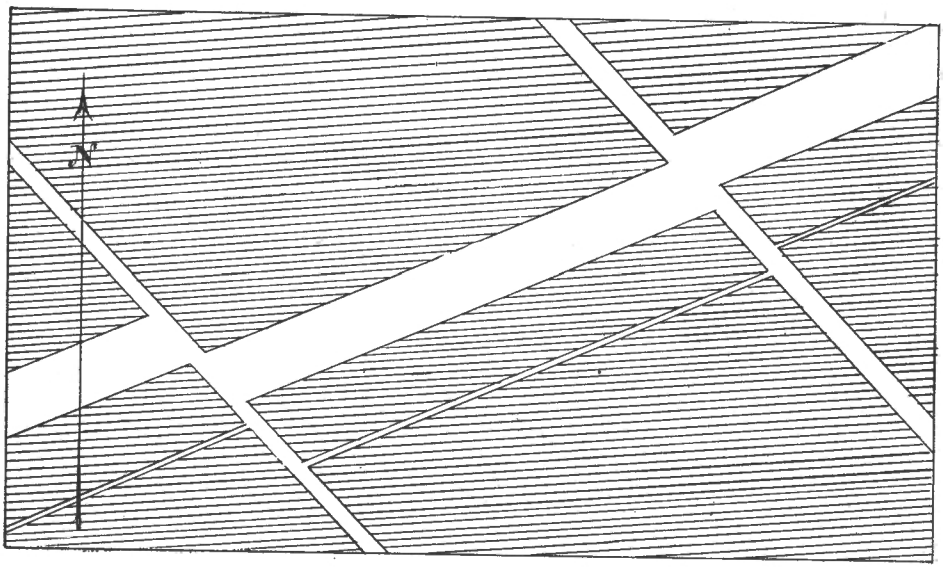
Jointing planes.

Pegmatite.

On the north-west shore of Sturgeon Lake, the rocks are also characterized by the presence of small irregular areas of very coarsely crystalline rock, or pegmatite; sometimes these areas are irregularly circular in form and sometimes gradually merge, by diminution in the size of the crystals, into the ordinary medium-grained granite, but as a rule there is a more or less sharp line of demarcation. Very frequently

the pegmatite occurs in distinct and uniform veins. A most excellent example of such veins is figured below, from an occurrence on the point between the two bays close together. and running north from the centre of this part of the lake.

Fig 1



The unshaded portions represent the veins of coarsely crystalline quartz, orthoclase and bleached mica. The figure is correctly drawn to a scale of eight feet to an inch, and the veins are as regular and straight as represented. As a rule however the veins are not so straight and uniform. The shading lines represent the direction of the foliation planes of the inclosing gneiss. From the "faulted" occurrence

Faulted veins.

of the veins, it would seem that they have been filled in, probably by infiltration from the inclosing rocks, after the gneisses had been cracked and faulted, as the age of the veins running in both direc-

Muscovite.

tions is evidently the same. The rocks of that portion of this area, in which are Russell, Chatterton, and the smaller lakes to the south, are characterized for the most part by the presence of muscovite, sometimes associated with, sometimes replacing, the biotite constituent of the granites. The presence of muscovite does not appear to have any

Garnets

especial significance, but it is observed that the presence of garnets in the granite gneiss, which in this part of the area is a notable feature, appears to be, in a measure, a function of the presence of muscovite.

Muscovite granites are particularly noted on the western part of Russell Lake and a little muscovite occurs in all the red granites around the shores of the south-eastern extension of Sturgeon Lake and of the lakes to the east tributary to this, and on the west side of Chatterton Lake where the granites are a dull whitish colour. Muscovite is the only micaceous mineral in the rocks of the south-east bay of McDougall Lake. Muscovite as well as biotite occurs in the rocks of the east side of Chatterton Lake. Localities of muscovite granite.

Garnetiferous granite gneisses are characteristic of the shores of the eastern or rather central expansion of Sturgeon Lake (a large expansion north of the northernmost point of Hunters Island is locally called this), particularly on the southern shores, and on the south side of the channel to the north-eastern part of the lake above referred to. Garnetiferous rocks of Sturgeon Lake.

Pegmatitic granite is of such frequent occurrence around this portion of the lake as to form a large proportion of the rock exposures. It occurs principally in irregular patches, often 100 feet or more across; sometimes a gradual differentiation of the pegmatite into the medium-grained granite is observed, but as a rule a more or less distinct line of demarcation is noticeable. Occurrence of pegmatite.

South-east of this, in the extreme south-eastern expansion of the lake, some straight uniform veins of pegmatite, only two or three inches wide were observed, cutting the red granite, which is here devoid of structure and contains a very little muscovite mica. The veins have weathered more than the inclosing granites, and form shallow channels or troughs in the surface of the rock.

It has been observed that, speaking generally, this aggregation of coarse crystals in veins and irregular areas, usually consists of orthoclase quartz and mica in the granitic rocks, and as a rule, almost wholly of white orthoclase with a small proportion of quartz, but with little or no mica in the Coutchiching and Keewatin rocks; and that in these latter the orthoclase crystals do not attain to so large a size. A much more frequent exception to this rule is found in the felspar rock, as distinct from pegmatite, associated with the granites, than in pegmatite associated with the newer rocks. Distribution of pegmatite and felspar rock.

At the north-east end of the main body of Sturgeon Lake, a bedded structure is apparent in the rocks. This, however, is probably a series of jointing planes simulating this structure. Bedded structure.

II. THE POOH-BAH AREA.

Limits of Area, Character of Contact and Lithological Characters.

The rocks of this area may be generally described as very coarsely crystalline aggregations of hornblende and felspar, generally ortho- Description of rocks.

clase. The felspar crystals are often twined, but they seldom exhibit the fine striation due to multiple twining, characteristic of plagioclase. While individual felspars attain to sizes larger than neighbouring crystals, the rock is not a true porphyry. On an island one-third of a mile south of the prominent point on the west side, felspar crystals were measured three inches in length; here the rock is intersected by jointing planes, but with no uniformity of direction. In places, particularly on the west side of the lake, a rough parallelism of arrangement among the constituent minerals is barely discernible on the surface, and sometimes the rock shows an inclination to cleave in parallel directions under the hammer, but it cannot be described as being foliated.

Hornblende granite.

In some localities the hornblende syenite merges into a finer-grained hornblende granite, by the addition of a little quartz, and on the western part of the large island, in the northern part of Pooh-Bah Lake, the rock becomes quite fine-grained. In some localities, associated with the hornblende syenite, is a finer-grained, decomposed, greenish-black felspathic hornblende rock, containing sometimes a pyroxenic constituent, and generally many disseminated scales of black mica.

Decomposed felspathic hornblende rock.

These are probably local phases, where the felspar has become subordinate and the hornblende partly changed to chlorite, with the biotite developed as an accessory mineral.

Localities where this rock occurs.

Occurrences of this rock were observed at the south-west end of Pooh-Bah Lake, near the portage; on the north-west shore, one mile north-east of the portage; and at several points along the south-east shore, to the eastern end; but none were observed in the more central portions of the area.

At the point on the south shore, near the east end of the lake, associated with this decomposed rock, is a hard black coarsely crystalline hornblende felspar rock, the felspar apparently one of the triclinic varieties (diorite).

Limits of Pooh-Bah area.

Wink Lake.

The Coutchiching rocks of Wink Lake are represented by fine-grained light gray evenly laminated biotite gneisses; on the south shore merging into felspathic mica schists, elsewhere, particularly on the northern end of the lake, sometimes containing siliceous nodules. The syenites are represented on this lake apparently only by a red medium-grained hornblende granite, containing some large crystals of felspar perhaps porphyritically developed. This rock is lithologically the same as the dark gray medium-grained rock found associated with the hornblende syenites of Pooh-Bah Lake, on an island near the south shore one mile and a quarter east by north of the portage from Wink Lake.

Hornblende granite is seen in various exposures for three-quarters of a mile on the north-east side of Wink Lake, where indicated, and on the adjacent islands. Its contact with the mica schist is concealed under the waters of the lake or under the boulders and marshy land of the shore.

North side Pooh-Bah Lake.

The outlet of Pooh-Bah Lake is eroded entirely out of the mica schists and on the west shore of this lake south of the outlet, the contact line can be very closely located by the proximity of adjacent exposures of each variety, although the actual junction is concealed. The whole of the north shore of Pooh-Bah Lake is occupied by mica schist, becoming in places, particularly near the syenites, very hard, compact and fine in texture, and hornblendic in composition.

On an island near the north shore, forty-five chains east of the portage to Hoffmann Lake, is an almost aphanitic, hard grayish-black rock, containing very much iron pyrites, very slightly schistose and resembling a fine diabase; it is, however, close to the line of junction and strictly parallel with it. A continuation of the band is seen on an island to the north-east and on the main shore, where it is more schistose and less fine-grained. In this band, where schistosity is visible on the last island mentioned, the planes of schistosity are much contorted, and the rock is cut by bands of granite and felspar rock.

The contact line can be traced with considerable accuracy through the islands and between them and the main shore, and although it cannot be seen exactly in the north-east bay, it can be located within the limits of accuracy definable on the scale of the map.

The whole of the eastern and southern shores of the lake, as far as can be judged from the comparatively few exposures they afford, is occupied by the hornblende syenites, with their local varieties.

Contact in south-west end of lake.

A single exposure of mica schist on the extreme south-west shore, with several exposures of very coarse-grained hornblende syenite a few chains east of it on the north shore, define the contact with the mica schists, which are exposed at intervals across the portage to Wink Lake.

Metamorphism of schists near contact.

It is here observed that the mica schists become less massive and compact as the distance from the syenites increases.

Contact south of Pooh-Bah Lake.

The contact can be again located with considerable accuracy on the first lake south of Pooh-Bah Lake, on the winter route to Conmee Lake, and the contact line from here to the last determined point is probably closely approximate as laid down.

Limits of area east of Pooh Bah Lake.

East of this the line of junction is conjectural, and is inferred to be approximately located as indicated on the map, from the convergence

of the strike of the mica schists in their most easterly exposures, to the north and to the south of Pooh-Bah Lake. It has been found that the line of contact is conformable with the strike of the rocks, and from the rapid convergence of these strikes it would seem evident that the syenites do not extend very far east. The ovoid termination given to the area is representative of the usual form assumed by these small areas, wherever they have been worked out accurately. The country between Pooh-Bah Lake and the eastern part of Sturgeon Lake is very rugged and affords no means of access by canoes, and very few exposures of rock certainly *in situ* are revealed.

Possible continuation of granites south-east of Sturgeon Lake.

It is possible that this area connects geographically with, and is a western extension of, the granite area south-east of Sturgeon Lake; but this is very unlikely, in consideration of the probable and revealed directions of structural planes already detailed, and from the great dissimilarity, in general characters, between the rocks of the two areas and from a well-founded doubt as to their being of one age.

General character of contact.

From the foregoing, it will be seen that the syenites and mica schists were nowhere observed in actual contact, but from the close proximity of adjacent exposures of the two classes of rock, from the absence of bands of mica schist in the syenites and of the syenites in the mica schists, the brecciated aspect of the contact so characteristic of the granites elsewhere, seems to be here entirely wanting.

Outcrops of felspathic hornblende rock.

Several outcrops of the greenish-black micaceous hornblende rock described as associated with the syenites are found in very small areas among the mica schists, particularly at the south-east end of Wink Lake.

Reasons for correlation of rocks of William Lake with those of Pooh-Bah Lake.

The small area of rocks mapped in the same colour as the Pooh-Bah area, extending from William Lake to form the tongue of land in the western part of Brent Lake, are assumed to be of the same origin and age as the Pooh-Bah syenites, from the strong similarity between them and the associated greenish-black felspathic hornblende rocks of the latter.

Character of hornblende rocks of William and Brent Lakes.

They may generally be described as coarsely crystalline, hornblende rocks, frequently containing a felspathic constituent and occasionally having some scales of black mica, probably secondary, associated with them. The felspar cannot be determined macroscopically, but appears to be orthoclase. The structure in the field has been very closely worked out, and the map exhibits their relations to the mica schists and granites with all the accuracy possible to the scale. These

Surrounded by mica schist.

rocks are observed to be nowhere in direct contact with the granites, but to be surrounded on all sides by mica schist strictly conformable in its strike to the outline of the hornblende rocks. The band of mica schists intervening between them and the granites to the east is only a few chains wide.

The aspect of the hornblende rock in its relations to the mica schist, is that of an eruptive boss. On the south-east side of William Lake, about thirty chains north-east of the portage into Brent Lake, and in the west bay of the latter, the mica schist is seen to be very much contorted and crumpled. In William Lake, associated with the crumpled mica schist, are bands of granitic rock very similar to the bands found usually in the contact zone between the Laurentian and the Coutchiching rocks, and these bands, quite conformable with the schist with which they are intercalated, have suffered the same contortions. They may be later segregations, but it is difficult in the field to avoid the conclusion that the structure is due to a later intrusion of the hornblende rocks through the contact zone between the Laurentian and Coutchiching rocks. In that case, as the date of folding of the Coutchiching and Keewatin rocks was in all probability the same, these hornblende rocks would be Keewatin or post-Keewatin in age. Eruptive character.

This may or may not involve the age of the Pooh-Bah syenites, as the correlation of the two is a doubtful one; but as the question involves broad and general issues, it will be discussed later under "Theoretical Considerations."

III. "THE HUNTERS ISLAND AREA."

As before stated, the rocks of this area are typical of the Laurentian series in this part of the country, and a general description of them applies also to the Kawagansikok area partially exposed in the area of this sheet. Typical rocks.

The rocks vary in colour from white through shades of gray and pink to dark gray and deep red. In texture, they vary from almost aphanitic, in the unmicaceous varieties, to such extreme coarseness of crystallization, as to characterize them as pegmatites, nor can any general law be as yet formulated which the rocks seem to follow in this particular. Description of rocks.

Sometimes large crystals of orthoclase developed porphyritically in a finer-grained ground-mass, are observed, but no deduction with regard to any stratigraphical significance of these occurrences could be drawn from such observations as were made in this connection. Porphyritic structure.

The foliation of the granites has been observed with some care, and while it may be stated as a general rule, that in the neighbourhood of upper Archæan areas the granites are more or less distinctly foliated, and that in the central portion of granitic areas the rocks show very faint traces, if any, of this foliation, still, the rule is by no means without exceptions to both statements. The localities where the rock exhibits very few or no traces of parallelism in the arrangement of its constituents, are indicated on the map by short red lines drawn Foliation.

in all directions, and can be considered as reliable only on the shores of the lakes; those localities where the rocks are more or less distinctly laminated are indicated by a parallelism and continuity in the direction of these red lines; again these give reliable information only on the lake shores, where they have been observed, and where corroborated by the strikes shown; however, it is probable that the structure thus indicated is the true one.

Composition. In composition, the rocks are usually biotite granites in which the orthoclase and quartz are very constantly present; but the biotite is often replaced by, or associated with, muscovite or hornblende, and in many places these bi-silicates are changed to chlorite. It is probable that a minute proportion of plagioclase is a more or less common constituent, but in the Kawagansikok and Hunters Island areas it can seldom be detected by the unaided eye.

Limits of area. The limits of the Hunters Island area, in so far as it occurs in Canadian territory on this sheet, have been already described in defining the limits of the Huronian, or upper Archæan, rocks.

Namakan Lake. The Laurentian rocks of Namakan Lake are massive reddish granite, for the most part not foliated, although in places faint structural lines are visible. This granite holds in places bands of mica schist, which would appear to be large included fragments broken off from the main series.

Sand Point Lake felsites. On the east side of Sand Point Lake at, and on the prominent point north of, the narrows in the southern part, the granite changes into a very fine-grained hard red rock, containing very little if any bi-silicate, and is more truly a felsite than a granite. No foliation of the constituent minerals is observable, but it is intersected by well marked sharp cleavage or jointing planes in three directions: One horizontal, the other two vertical and nearly at right angles to each other; these planes cut the rock into small rhomboidal blocks, often less than a foot in largest measurement, although in places the blocks are very large. This is a very common feature, particularly in the felsitic granites. The change from this phase of the granite to the more micaceous and coarser variety, appears to be somewhat gradual, and there is little doubt that the felsites are merely local phases.

Jointing planes.

Localities of felsites. This felsitic phase of the granite is not at all uncommon, and is seen in many places, among others:—

Kahnipiminanikok Lake. On Kahnipiminanikok Lake, on the west side of the two large islands extending from the second to the fifth mile from the northern end, and on the main shore opposite.

On the lake south of Hulburt Lake.

On the south part of Agnes Lake. Here a gradual transition from the felsites (by the introduction first of chlorite, then of biotite, accompanied by a gradually increasing coarseness of texture) into the ordinary biotite granites, is seen, not only in the direction of the structural planes, which are almost indiscernible in the felsites, but also across this direction. Agnes Lake.

Felsites are seen north-west of Louisa Lake, where in places they are quite aphanitic and become a felstone.

About the narrows between Sand Point and Vermilion Lakes the granites have a porphyritic structure. The rock is massive and granitoid. Sand Point Lake.

On the boundary route from Lac la Croix to Basswood Lake many varieties of typical Laurentian granite and granite gneiss are seen; but the rocks are generally faintly foliated, pink, biotite granite gneisses. Lac la Croix to Basswood Lake.

Dr. Bell* describes the rocks of Basswood Lake, east of the Hudson's Bay Company's post, as "rather fine-grained, bright, light gray and reddish-gray syenite, consisting of crystalline white or red felspar and black hornblende, with more or less quartz in some parts." Basswood Lake rocks.

In Wicksteed Lake the rock is very coarse-grained, in many localities pegmatized, particularly on the south shore; is usually light pink and not foliated, and is characteristically a muscovite granite. On the northern shores it becomes a medium-grained muscovite biotite granite gneiss, somewhat distinctly foliated. Wicksteed Lake.

On the lake south of this, and west of Darkey Lake, the muscovite granite is deeper in colour, finer in texture and contains a little biotite.

It has been thought advisable to indicate on the map the localities where muscovite occurs as a more or less prominent constituent of the granites, and this has been done by placing the letter *(a)* in red in such places. Similarly the occurrence of garnets is indicated by the letter *(b)* in red on the face of the map. Muscovite localities.

The eastern shore of the southern part of Darkey Lake is occupied by coarse-grained reddish biotite gneiss, associated with some subordinate bands of mica schist. On the west shore almost continuously, is exposed a dark reddish-gray micaceous gneiss, quite distinctly foliated in bands, with more massive phases intervening. Darkey Lake.

The rocks of Conmee Lake, and the western part of Brent Lake, have been already described. In the north-westerly bend of the latter, between the eastern and western parts, the granites on the west side Brent Lake.

*Rep. of Progress Geol. Survey of Canada, 1872-73. Report on the country between Lake Superior and Lake Winnipeg, p. 94.

present high precipitous cliffs, due to vertical jointing planes. In the eastern part the rocks are pink biotite muscovite granites, rather distinctly foliated. A very light gray gneiss is seen on the north side near the portage on the route to Pooh-Bah Lake, in which the alternate bands of white and dark gray rock are uniform, and the laminæ much distorted; the bands in which the biotite predominates are comparatively far apart and give the rock a streaked aspect.

McIntyre Lake.

On McIntyre Lake the granites are rather fine-grained, deep pink, and indistinctly foliated; the same rock is seen on Sarah Lake. On an island at the east end of the latter the granite is darker in colour, and affords macroscopically distinct evidence of having been sheared.

Graphic quartz.

A peculiar graphic granite is seen at an exposure at the north end of the small lake south of Sarah Lake, where a red felspar, in medium sized crystals, is associated with irregular grains of quartz; this is intersected by veins and stringers, less than half an inch in thickness, of pure quartz; these little veins as a rule are roughly parallel in a general north and south direction, but sometimes veins intersecting these at various angles are seen.

Keefer Lake route.

The rocks of the second lake north of Keefer Lake, south of Shelley Lake, are in places doubtfully biotite granite, the bi-silicate now existing as a chloritic mineral which may have been derived from hornblende. Comparatively large imbedded crystals of orthoclase give the rock a porphyritic aspect.

Most of the rocks of this route are reddish biotite granites somewhat obscurely foliated.

Chloritic granites.

Chloritic granites are associated with the biotite granites of the first lake north of Keefer Lake, and on the west side of Keefer Lake, about the middle; here the rocks show crushing and shearing phenomena, and it is probable that the chloritic mineral has been derived in this way from mica.

The shores of Kahshapiwigamak Lake are rather high and abrupt, and present continuous exposures of granite, reddish in colour, and fine-grained, containing, as a rule, but a small proportion of mica, and none at all in several places in the southern part. In the rocks of the north-eastern arm the bi-silicate is now a chlorite, and they contain some porphyritic twinned crystals of felspar. The rock is deep red in colour. On an island near the west shore, north of the centre of the lake, the granite contains a little muscovite, probably secondary, as the rock exhibits crushing and shearing phenomena. The chloritic phase of the granite is seen on the west side of the most easterly of the two bays at the south end. Pegmatite with muscovite is seen in the northern part of the lake.

The shores of Hulburt and Williams lakes, with those of the other lakes forming this route, are high, rugged and precipitous, presenting bold, sometimes perpendicular, cliffs, seen to be composed of granite, containing as a rule a small proportion of mica. The rocks are gray or reddish-gray in colour and coarse in texture. The lamination is very indistinct, often indescernible in the hand specimen, though foliation is often quite apparent in the field. Biotite pegmatite occurs about the middle of the lake south of Kahnipiminanikok Lake. Hulburt Lake route.

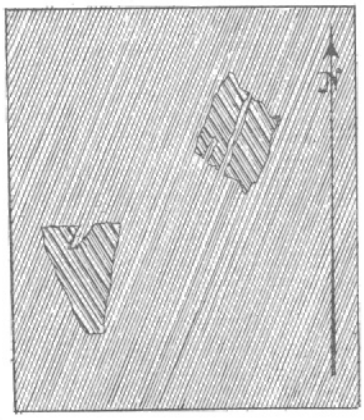
The granitic rocks of Kahnipiminanikok Lake may be generally described as light pinkish-gray, medium-grained biotite granites, usually somewhat distinctly foliated. Their character is comparatively uniform in all parts of the lake, and presents no novel features beyond those already referred to. In the bay on the north side of the lake one mile west of McKenzie Inlet, some of the largest crystals of orthoclase known in this country, occur, some of them measuring four inches in length. Iron pyrites occurs in the granites of the north end of the lake. Muscovite-biotite-pegmatite occurs on the north side near the mouth of McKenzie Inlet. Rocks of Kahnipiminanikok Lake.

The granites of the northern part of Agnes Lake, are on the whole a pinkish-white or light gray biotite-granite-gneiss generally quite distinctly foliated. Agnes Lake.

A curious example of patches of foreign rock included in the granite, is seen on the bare hill on the east side of the little bay forming the southward extension, behind the spur running north of the large bay running north-east from about the middle of the lake. Inclusions in granite.

The country rock is a pink foliated granite gneiss, dipping S. 70° E., angle 45°. There is a faint appearance of bedding in planes parallel to this. Imbedded in this are the fragments, figured here, which consist of a dark gray micaceous gneiss or mica schist, with a greenish tinge, probably due to a partial decomposition of the mica into chlorite.

Fig. 2



The lamination of the gneiss abuts sharply upon the outlines of the fragments, and continues into the little dikes which cut into the fragments, as shown. These dikes are parallel to the direction of the lamination.

The surfaces of the inclusions have a regular ribbed or fluted appearance, the ribs being two or three inches apart and standing nearly an inch above the trough-like depressions. These ribs are parallel to each other, and their direction in different inclusions are also roughly parallel; they also mark the direction of the planes of schistosity of the mica schist (which is not, however, very fissile), cross that of the lamination of the inclosing gneiss, at an angle of about 50°.

Synclinal axis.

It will be observed that a line drawn from this locality, north-east, parallel to the lines of strike shown on the map, would strike the schistose band of McEwen Lake, and the inference is strong that these inclusions mark a synclinal axis in the once overlying Coutchiching rocks, which, save only these fragments, have been entirely denuded.

The rocks on the south part of Agnes Lake, for the most part obscurely foliated red granites and felsites, have nearly all been incidentally described in previous pages.

Pegmatite.

A pegmatite, containing no mica, is seen on an island in the northern part of the lake, thirty chains south of the mouth of the narrows through which the eastern outlet passes. A little iron pyrites is here associated with it.

Agnes Lake to Basswood Lake.

The rocks exposed on the route from the middle of the west side of Agnes Lake, are for the most part reddish medium-grained biotite gneisses. Near Basswood Lake, they usually contain a little bi-silicate, which is now principally changed to chlorite. The foliation is generally apparent, but rarely distinct. In some places they are lighter in colour and are banded with dark gray varieties.

Remaining portion of area.

All the rocks east of this, comprising the Hunters Island area, may be generally described as pink gray, medium-grained biotite granite gneisses, usually foliated with more or less distinctness; they present no varieties which require special mention.

Hornblende Granites.

Stratigraphical relations.

As yet no specific mention has been made of the hornblendic variety of granites occurring in this area. The writer has not studied the relations of these to the mica granites sufficiently closely, or extensively to enable him to formulate any general observations thereon; while it is probable that they are but phases of Laurentian rocks, and that they possess no stratigraphical importance, it is on the other hand possible that some general law giving them a distinct significance may be deduced and that they may be shown to differ both in origin and age from the ordinary biotite

granites. For the present, only some of the localities where they are found in the Hunters Island area can be indicated.

A small area of hornblende granite or syenite is seen on the portage at the south-east end of Brent Lake. The same rock is exposed on the south portage at the west end of Conmee Lake. The area is here a small one and would seem to be an inclusion in the biotite granite. Similar rocks are seen on the west shore of the lake, south of the Coutchiching belt of rocks. Brent Lake. Conmee Lake.

Hornblendic granite is associated with the biotite granites of the lake north of Keefer Lake.

A band of red coarse-grained hornblende granite, containing porphyritic crystals of felspar, perhaps triclinic, occurs on the east shore of the north-east arm of the lake south of Hulburt Lake, a quarter of a mile south of the portage into that lake; it is again seen half a mile S.S.W. on the south-east bay of the same lake. It has here a direction of S. 35° W., indicated by its foliation, which is in some places quite apparent. A probable southward extension of this band, is represented by a band of very similar rock occurring a mile S.S.W. of this, skirting the east side of the north-east arm of Kashapiwigamak Lake, near the portage between the two lakes. The strike is here S. 40° W., dip N.W., angle 75° A still further south-westerly extension may be represented by an occurrence of a similar rock, containing, however, a smaller proportion of hornblende, seen on the small island at the mouth of this arm; here the direction of the foliation planes is uncertain but appears to be about S. 10°W. A narrow band not over two chains wide, of a rock which answers to the same description, but which contains a mica constituent, is seen cutting the red indistinctly foliated biotite granite, starting from the west shore of the lake south of Hulburt Lake, due west of the first granite band referred to, on this lake, and is traced through the narrows, and, then with a more northerly trend it crosses in a north-westerly direction, the north-west arm of the lake. These two bands converging on the same point are suggestive of dikes emanating from a central mass, and may be altered post-Laurentian eruptives. Associated with both these diverging bands are narrow bands of fine-grained dark gray siliceous, micaceous, hornblende schist. Hulburt Lake. Diverging bands.

On the south-west bay of Agnes Lake, a considerable proportion of hornblende granite is associated with the foliated biotite granites. The whole of the southern part of the bay is occupied by these rocks, while a small area, probably a comparatively narrow band, is seen on the west side, just opposite the point dividing this bay from the main lake; here the rock is faintly laminated, and there appears Agnes Lake.

to be a sharp line of demarcation between it and the biotite granite, although some of the associated rocks contain both hornblende and mica. In some places the hornblende granite appears to be included in the biotite granite or felsite.

Fine-grained red hornblende granite, sheared and containing some biotite, is seen on an island near the east side of Agnes Lake, two miles and a half S.S.E. of the point above referred to, and south of this on the west shore similar rocks are occasionally seen.

Farquier Lake.

In the north-west bay of Farquier Lake, the granite is massive and very dark, and exhibits in the fresh fracture small inclosed masses of hornblende.

Murdoch Lake. Kahnipiminanikok Lake.

Gray medium-grained hornblende granite occurs on an island in the north end of Murdoch Lake, and in Kahnipiminanikok Lake, at the entrance to the bay north of Murdoch Lake.

McKenzie Inlet.

On the south side of the eastern end of McKenzie Inlet, the prominent points consist of large flat blocks of medium-grained hornblende granite; west of this on the north side of the narrows, a similar rock, but finer grained, occurs *in situ*, being apparently a band a few chains wide; the same rock is exposed at three or four localities due west of this, on the west shore. On the extremity of the prominent point on the south side of this inlet, a mile and three-quarters north north-east of the entrance, a local occurrence of coarse-grained sheared hornblende granite is seen, in which the hornblende has been largely changed to chlorite in the shearing planes.

Kahwawiagamak Inlet.

On the arm south-east of this, at the narrow part halfway between the main lake and the Indian reserve, a local occurrence of fine-grained hornblende granite is seen on an island in the centre; on the north shore opposite this a little biotite is associated with it.

South-east part of lake.

On the south-east part of this lake, on the north side, about the middle, is an irregular band of fine-grained hornblende granite, which, in the most westerly exposure examined, becomes a fine-grained, felspathic, dark gray hornblende schist, containing apparently a pyroxenic constituent.

Wet Lake.

At the outlet of Wet Lake, on the north side, the rock consists mainly of hornblende, considerable mica, a little flesh-red felspar and perhaps a little quartz; on the north side of the lake, about the middle, a narrow band having the aspect of a dike of hornblende syenite occurs.

McEwen Lake.

On the northern extremity of the island in the east bay of McEwen Lake, and opposite it on the north shore, a medium-grained dark red micaceous hornblende granite occurs; the same rock occurs on the

point at the extreme south end of the lake. These occurrences would seem to mark a continuous band or dike of these rocks. Continuous band of hornblende granite

At rare intervals a bedded structure in the granite is discernible. The beds are usually not much less than a foot thick, and seldom more than three feet thick, and are generally parallel to the foliation planes of the rock. From later observations made elsewhere, it may be stated as a general rule, that the hornblende granites exhibit this feature much more commonly, in proportion to their development, than the biotite granites do; but in hornblende granites the writer has nowhere seen a distinct lamination of the mineral constituents, associated with this structure. Bedded structures. Hornblende granite.

Some of the localities where this apparent bedded structure was observed may be briefly enumerated:— Localities of bedded structure.

On Kahnipiminanikok Lake, on the north side of the bay on the south side of McKenzie Inlet, beds from a few inches to a foot thick inclined to the south-west at angles varying from zero to 15° are seen. Kahnipiminanikok Lake.

On Agnes Lake, on the east side, near the north end, the planes dip to the north angle 10° to 15°, foliation planes which strike N. 30° E and are nearly vertical intersect these beds. Agnes Lake.

On the east side of Agnes Lake, near the entrance of the north-east bay, the beds dip N. 60° W., angle 30°. On the opposite side, near the north end of the bay, the beds are parallel with the lamination planes.

Two localities in the red granite of the east shore of the lake, about the middle of the southern part.

On the south-west end of Farquier Lake are rough irregular beds in red granite, inclined N. 70° W., angle 50°. Farquier Lake.

On Sunday Lake, south part, beds inclined S., angle 60°.

IV. SAGANAGA AREA.

The rocks of Saganaga Lake and vicinity were not examined by the writer who is, therefore, unable to make any definite statements regarding their character, or to do more than state the grounds on which they have been tentatively represented on the map as Laurentian. These reasons will be given later.

On the geological map of the Dominion of Canada, published in 1882, the granitic rocks of Saganaga Lake are represented as igneous granites breaking through Huronian strata. On the "Geological map of the Iron Regions of Minnesota," published by N. H. & H. V. Winchell in 1890, they are represented as Laurentian. The rocks are Previous correlations.

Winchell's description of rocks.

described by the above authors in the accompanying report as "receiving a distinctive character from the large grains of quartz. These grains are large, angular and numerous, and on weathered surfaces stand out prominently. The felspar exists in sub-angular patches, imbedded with the quartz in a ground-mass, which is mostly chloritic and in places develops chloritic spots, while in other places hornblende forms merge into visibility." Again they say: "The rock itself is not of course a characteristic syenite. All hornblende has disappeared; a felspathic matrix remains, with some green specks and spots, and the quartz is imbedded in it. Some of the broken surfaces of the rock have a sericitic lustre. The formation as a whole is roughly bedded." From this they would appear to be allied to the quartz porphyries.

H. V. Winchell's later description.

H. V. Winchell,* in a later paper on the subject, dated December 20th, 1890, says that "the rock is conglomeritic in places, and contains pebbles which are strikingly similar to each other in composition and appearance. A majority of the pebbles are composed of lamellar augite, with or without apparent small grains of felspar."

V. ISOLATED GRANITIC AREAS.

Breaking through the Coutchiching rocks of the region, are isolated areas of granite, which cannot certainly be said to be of Laurentian age, but it would seem that the balance of evidence favours that view.

Granite area north of Namakan Lake.

By the Soldiers' Portage route, above referred to, between Namakan and Rainy Lakes, there are two portages; on the south-easterly one felspathic mica schist is frequently exposed; on the slough and on the other portage (Soldiers' Portage) massive granite is exposed, as well as on several points of the southern extension of Hale Bay, and on the island in the angle of it. These exposures indicate the existence of what is probably an isolated local area, similar to those shown on Hale Bay and on the southern shore of the eastern arm of Rainy Lake, west of Kettle Falls (see Rainy Lake sheet). This granite is deep red in colour and not at all foliated; it would appear to be a distinct intrusive mass.

Thompson Lake granite.

The granite of Thompson Lake is an isolated area, being cut off from the main mass to the south by the band of mica schist indicated by the almost continuous exposures along the south shore of the lake. The exposures in the eastern and western extremities of the lake, and along the canoe route north, prove this area to be surrounded on all sides by mica schist. The contact is brecciated, and is typical in character of that of the large Hunters Island area to the south. On the north-west,

*Am. Jour. Sc., vol. XLI., No. 245, p. 386. 1891.

north and east sides, the schists, wherever observed, were found to dip away from the granite nucleus at angles varying from 40° to 60°, but there is no evidence of a synclinal structure between this and the granite apophysis to the south.

Wolseley Lake granite.

The granite boss on Wolseley Lake is inferred from a few exposures on the peninsula and adjacent islands. Its limits could not be exactly defined, nor its contact with the schists observed, owing to the drift covering by which it is concealed.

Small outcrops of granite in mica schist.

Small outcrops of granite in rocks of presumably earlier age, are seen in many localities, particularly in proximity to the large granitic areas, and as these areas are approached the increasing abundance of granitic bands marks the contact zone. Such small areas and isolated bands, more or less distant from this zone, and too insignificant to be shown on the scale of the map are found in the following localities :—

Captain Tom Lake.

Captain Tom Lake, about the middle of the north side.

South of Tanners Lake.

On the creek east of the portage south from Tanners Lake, reddish fine-grained evenly foliated biotite gneiss.

North-west of Darkey Lake.

On the outlet of Darkey Lake. Several small outcrops perhaps marking an anticlinal axis. Medium to coarse-grained and pegmatitic muscovite granite. Biotite is sometimes associated, and in one exposure, garnets are seen.

Near the mouth of the stream forming the outlet of Pooh-Bah and Wink lakes.

Conmee Lake.

On the portage north of Conmee Lake.

On the small lake, north of Conmee Lake, at the west end. This same band apparently occurs on the south side, near the north-east end ; but here it is very coarse-grained, the larger crystals of the felspar are twinned, and a little hornblende is perhaps present.

William Lake.

A small area of muscovite granite is seen associated with the mica schists of the west end of William Lake.

General Theoretical Considerations.

In the foregoing pages, doubts have been expressed as to the age of some of the so-called Laurentian areas, notably the Pooh-Bah syenites, the Saganaga granites, and the small areas of eruptive granitic rocks.

Any attempt to reconcile the various diverging theories regarding the Archæan rocks, is perhaps premature and can only be suggestive. The Laurentian rocks of the eastern part of the Dominion, as described by the older Canadian geologists, and corroborated by the observations of later workers, point to the conclusion that many at least of these granite gneisses are sedimentary in their origin.

Sedimentary gneisses of the eastern part of the Dominion.

Eruptive granites of the western portion.

In this western portion, the work of Dr. Lawson, in the Lake of the Woods and Rainy Lake regions, the observations recorded in this report, and the observations made by other workers in contiguous fields, indicate, with equal strength, that here the granites are eruptive in their attitude and relationship to the overlying rocks.*

Theory accounting for brecciated contact.

Objections to the theory.

It has been argued that while the Laurentian rocks as a whole may have been sedimentary in their origin, the brecciated character of the contact with overlying series may have been caused by later granitic eruptions along this line, which would be emphatically the line of weakness. This is a possible, though not probable, explanation of the facts; not probable, because no distinction can be drawn between the granites at the contact and those in the central portions of the great granitic areas, save that of a gradual change from a gneissoid character at the contact to a granitoid one in the centre, as a rule, and this is not the change that would be expected between a sedimentary nucleus however metamorphosed and a granitic periphery however foliated by flowing movements while in a liquid or viscid state. Again no line of demarcation between the supposed sedimentary rocks of the interior and the assumed newer granites of the periphery, which also cut the upper Archæan schists, has, within the writer's knowledge, ever been described. It must be acknowledged, however, that in such old and changed rocks, negative evidence is especially inconclusive.

Irruptive origin not certain.

The question of the irruptive origin of all the granites of this Lake Superior region cannot yet be answered with absolute certainty. It would be rash to state from the comparatively local examinations that have yet been made, that the contact is always of an irruptive character, although in many cases it must undoubtedly be so regarded. It would be equally rash to state that the nature of the contact is nowhere compatible with a sedimentary origin for the granite gneisses; minute and irregular interbanding is not an uncommon feature in the transition zone between contiguous formations of rock unquestionably sedimentary.

*Having personally examined both the eastern and the western Laurentian areas at intervals, from the Straits of Belle Isle to Ottawa, and thence to the Lake of the Woods and Lake Winnipeg, I am convinced that whatever theory of origin may be correct, it is equally applicable to the whole of the great Archæan area of Canada. The local greater or lesser development of some special lithological character, as limestone, quartzite, etc., or physical structure, as gneiss, granite, mica, schist, etc., has no more bearing on the question of age, than have the similar local peculiarities which are more or less characteristic of all the younger geological systems, as for instance, the Cretaceous of Britain and of Canada; the lower palæozoic of Canada, and of Southern Australia; and even within the limits of the Dominion, the upper palæozoic rocks are both lithologically and physically more unlike each other than are any of those of the great Archæan area from Labrador to Winnipeg, and thence to the mouth of the Mackenzie in the Arctic Ocean. A. R. C. SELWYN.

In the previous pages localities have been cited where an apparent bedded structure in the granite gneisses is more or less marked. This feature occurs at very rare intervals, and is extremely local in extent, wherever observed; the inclination of the bedding planes are generally, though not always, parallel to the lamination planes, where these are discernible; and the rock at the planes of parting does not present any of those changes in composition which so frequently mark the bedding planes of sedimentary rocks; from these facts it seems highly improbable that this apparent bedded structure indicates a sedimentary origin. It is probably caused by the accidental yielding of the rock in parallel planes under the various strains to which it has been subjected. Nor can the foliation and lamination discernible in these gneisses be regarded as indicative necessarily of sedimentary deposition. Bedded structure.

Between the Laurentians of the Ottawa Valley and of Western Ontario, there is one marked difference, the presence of a series of limestones in the former, and its comparative absence in the latter; but the absence of a lithological member of a series, as limestone or quartzite, does not militate against the correlation of the members occurring in different districts, and future investigation may prove the Coutchiching series to be the stratigraphical equivalent of the Upper Laurentian series of the east, to which as far as may be gathered from published descriptions of the latter the mica schists would seem to bear a marked resemblance in stratigraphical relationship. But whatever conclusion may be eventually arrived at regarding the origin of Laurentian rocks, or whatever subdivisions of, or rearrangement of certain members of this system future investigation may justify, the separate areas of granitic rocks referred to in this report present no individual characteristics sufficiently significant to justify the belief that any great difference exists between their respective ages, and the same theory of origin that applies to one applies to all. The smaller granitic areas of this region present no difference in lithological characters or in stratigraphical relations from those of the large areas which have been called Laurentian, such as to justify us in regarding them as of later date; and it seems most probable that they are subordinate developments of the same fused rocks, marking the crests of anticlinal domes or folds in the intensely and minutely folded crust. Laurentian limestones. Small granite areas.

H. V. Winchell regards the Saganaga Lake granitic rocks as of Keewatin age from their lithological character, from his discovery of a small band of chalcedonic silica in the syenites, and from their frequent alternation in bands with Keewatin schists. From the title to his photographs given by Dr. Lawson, he evidently regards these rocks as Laurentian. As before stated, the writer is not in a position Saganaga area.

to express any opinion on the subject, but he has mapped them as Laurentian in accordance with Dr. Lawson's opinion, and from the character of the contact as shown by his photographs and reproduced in plates I., II. and III., which seems to be typical of the contact of lower and upper Archæan rocks elsewhere in this region; and also because they seem to form an integral part of a granitic area, which, from what is known of its more eastern development, would seem to be more undoubtedly of Laurentian age. The portion of this area in this sheet is trifling in extent, and in working up the region embraced in the sheet east of this, the rocks will receive closer and more conclusive study. In the meantime it would seem safer to map them as Laurentian.

Pooh-Bah area.

The Pooh-Bah syenites differ in lithological character and in the nature of their contact, so far as can be determined, from the typical Laurentian biotite granites, but these differences are neither so marked nor so important as to offer any serious obstacle to the correlation of them with the Laurentian. In mineral composition they are typical of the quartzless hornblende syenites, which have always been regarded as a species, although a rare one, of Laurentian rocks; and they are not more coarsely crystalline than the pegmatitic phases of these rocks.

In comparison with the whole length of the periphery of the area, so little of it has been available for study, that it is hazardous to make any statement concerning the general nature of the contact, and though where the rocks are revealed sufficiently near the line of contact to allow its nature to be guessed at, it would seem to be unusually sharp and clear, this fact, in itself, has little significance. The mica schists appear to have suffered more than usual contact metamorphism; but on the other hand, the syenites reveal no differentiation from a coarse texture on the central portions to a fine one at the contact, indicating that they were intruded into cool consolidated rocks; and they would seem to have cooled very slowly and uniformly, such as deep seated subcrustal irruptions would be expected to cool.

The correlation of the hornblende rocks, between William and Brent lakes with these is at best a doubtful one, and while the field appearance of the former suggests that they were erupted at a later date, it by no means proves it.

In the absence of conclusive field evidence, we are again thrown back upon their lithological affinities with certain phases of Laurentian rocks to decide, for the present, the question of their age.

COUTCHICHING SERIES.

Limits of area and conditions of contact with lower rocks.

The Coutchiching series of rocks, which is so largely developed in the south-eastern part of the Rainy Lake sheet, extends into the north-west part of this sheet in a broad tapering area, whose outline will be now briefly defined.

Namakan Lake.

Passing up the channel above Kettle Falls (see Rainy Lake sheet) into Namakan Lake, where the channel bends sharply to the south, evidences of an approach to a granitic area is seen in the banded intrusions of granite into the mica schist; these intruded bands become more and more numerous and important as we proceed southwards, until when we reach the long narrow island, three-quarters of a mile south of the expansion of the channel into Namakan Lake, we find on the southern part of this island that the granitic rocks are decidedly the most abundant, while on the north part of the island the mica schists still seem to maintain their predominance, for this reason the line of contact is placed across that part of the island where the two rock species appear to be most equally developed. East of this island, along the north shore of the lake, the exposures are sufficiently numerous to admit of an approximate delineation of this line of equal development, as indicated on the map. The brecciated contact zone appears to become a little narrower. North of this conventional line the predominating rocks are medium grained felspathic mica schists, gray in colour; south of it massive pink granites, doubtfully if at all foliated, form the material of the widest and most numerous bands.

Soldiers' Portage route.

From the bay south of Hale Bay (see Rainy Lake sheet) to the middle of the north side of Namakan Lake, there once existed, probably but a short time since, a subordinate channel between these two sheets of water; it has become choked with boulders and drift and exists now as a narrow slough, between the north-western end of which and the bay south of Hale Bay the Soldiers' Portage is cut, while a shorter portage connects the south-east end of the slough with Namakan Lake.

American side.

Less than half a mile south south-west of this latter portage, the line of contact of the mica schists and granites can be fixed with great accuracy, from the close proximity of adjacent exposures of the two rock varieties and from the comparatively unbroken character of the two series each side of this line. From here the contact line sweeps to the south-east and passing through the centre of the lake crosses in an east south-east direction over to the American islands, and cuts across the

small peninsula to the south-west of the boundary line at the Narrows into Sand Point Lake, and appears again in Canadian territory on the south side of the bay north-west of David Lake.

Minnesota band of granite.

The contact thus far traced, marks the northern limit of the great development of granite gneisses shown on the geological maps of Minnesota.

Sand Point Lake.

David Lake.

In the bay of Sand Point Lake, north-west of David Lake, the junction can be seen on a narrow point forming a shallow bay of the south-east shore of this arm. The contact is next located in the south-west corner of David Lake; it cannot be placed here within a few chains. On the west shore of the lake the granites are frequently exposed, containing thin bands and irregular patches of mica schist. A single exposure of granitoid gneiss on the north-east shore of the lake, one-quarter of a mile north-east of the point about the middle of this part of the shore, probably marks the eastern limit of the granites. The point is occupied by a soft light gray evenly laminated gneiss, doubtless Coutchiching; the same rock is exposed near the outlet on the south shore; these exposures probably belong to a transition zone between the granitoid gneiss of the west shore, which, near the outlet, is distinctly foliated, and the mica schist exposed on the extreme eastern shore of the lake in one locality. The line of contact, therefore, would appear to strike from the north-west corner of the lake to touch the north-east shore, at the granite locality indicated above, then to turn sharply to the south and south-west under the waters of the lake and pass through the channel forming the outlet into Sand Point Lake, between the foliated granites, containing thin bands and patches of mica schist exposed on the north side of the channel, and the mica schist and fissile light gray gneiss frequently revealed on the south side. This location of the line of contact is supported by the strikes which are everywhere observed to be in conformity with such a line. The contact is seen on the point of the south shore, just west of the outlet of David Lake, and must pass very close to the north-west shore of the bay south of this point, as the rocks here consist of alternating bands of granites and mica schists, the former predominating, while there are several exposures of uninterrupted mica schist on the east side of the bay. The strike of the rocks on both sides of this bay are parallel to the shore line.

Contact curving to south-west.

Sand Point Lake.

From here the line of junction evidently strikes south-west, in conformity with the strike of the rocks, to the north-east shore of the southern expansion of Sand Point Lake. Although it can be here approximately located, the actual contact is concealed under the marshy shore. On the shore to the south and on the islands the mica schists

are frequently exposed, and from the curvature of their strike, and from the occurrence of granitoid gneiss on the American side of the channel, it is evident that the junction line sweeps to the south and then to the south-east, under the waters of the lake. Contact curves again to south-east.

The schists, in this part of the lake, dip away from the granite at unusually low angles, in one locality as low as 17°. From Sand Point Lake, the contact line has a still more easterly trend, and is located with considerable accuracy in the northern bay of Little Vermilion Lake. Low dips. Little Vermilion Lake.

From here it must strike generally east, then north-east to the south side of the bay of Lac la Croix, out of which the old Nequaquon portage leads. The mica schists of this bay are much invaded by granites, and the point on the south side of its narrow inlet is entirely occupied by the massive granite, indicating either a sharp twist in the line of contact, or an invasion of the granites across the strike of the schists, as the contact west of this point and east of it on the opposite side of the bay can be located with much precision. Lac la Croix.

The schists show considerable variation in their strike, but dip away from the granites at angles varying from 35° to 45°, in a northerly direction. In the northern extremity of this bay, is an exposure of massive granite which would appear to belong to the same mass as that exposed in the first portage going north from Lac la Croix to Thompson Lake, and on the long portage, further east, leading directly between these two lakes; and this granite appears to be an apophysis from the main mass of granite exposed on the adjacent islands and on the American shore. There is no evidence that the band of schists, above described, continues sufficiently far east to separate this tongue of granite from the main mass, although the granite on the islands to the south, includes narrow bands of schist. The dip of this band of schists is uniformly to the north at a fairly constant angle, viz., 45°, and there is no convergence of dip to indicate a possible synclinal structure in this band. Granitic apophysis.

From the north-west corner of the bay, in which on the map is shown the line of junction of the northern edge of the apophysis, the contact line appears to bend sharply to the south south-east, and then to strike a little south of east through the islands, and to skirt the American shore, until it is seen again in Canadian territory on the northern part of Roland Island; in this distance, the brecciated contact zone seems to be unusually broad, alternating bands of mica schist and granite being exposed on all the American islands, along the Minnesota shore. Roland Island

Through the south-eastern part of Lac la Croix, the topography was taken from the surveys of Mr. David Thompson, and the geological boundary was determined by Dr. Lawson.

Between here and Wicksteed Lake the contact was not actually traced, but it lies between the extreme north end of McAree Lake, and the southernmost outlet of Maligne River, and it is drawn in conformity with the strike of the rocks. On the north-eastern side of Wicksteed Lake, the contact is marked by a zone of alternating bands of granite and mica schist, which is here somewhat narrow, being about three or four chains in width.

Wicksteed Lake

Darkey Lake.

The numerous exposures on the shores and islands of Darkey Lake, enable the distribution of the rocks to be mapped with considerable precision. All along the northern shore, fine grained, brownish-gray mica schists are exposed, invaded by some bands of pink muscovite granite gneiss; going south down the east shore, there is a broad zone of alternating bands of mica schist and gneiss, and along the north shore of the outlet of Brent Lake, the granites preponderate, and on the south shore of this inlet they are almost entirely unbroken by schistose bands. These granites (fine-grained muscovite biotite) can be traced on the shore of Darkey Lake south. This would appear to be an apophysis of granite, as it is divided from the main mass by an unbroken band of dark gray felspathic mica schist exposed further south on the east side of the lake. The probable eastern extension of this band is exposed on the south-west shore of Brent Lake as a somewhat narrower band. This band has no extension westward, but on the portage into the small lake lying west of Darkey Lake, is an exposure of mica schist striking about N. 30° W., with a comparatively low north-easterly dip, which probably marks its western termination, as no considerable isolated band of mica schist occurs on the shores of Wicksteed Lake. The strike above given probably indicates a sharp horizontal fold in the mica schists lying between the main granitic mass to the south and the apophysis to the north.

Granite apophysis.

Band of mica schist.

Brent Lake.

The tongue of granite frequently exposed in the channel forming the outlet of Brent Lake, is not seen to extend further east than the west shore of Brent lake, where a single granite exposure is found a few chains south of the outlet. Along the south-west shore, for half a mile, the mica schists of the band described as terminating in Darkey Lake are exposed. They dip northerly at a low angle. The point forming south of it the small bay in the extreme southern part of this part of the lake, is composed of granite; this indicates the existence of another small granite apophysis, as the south and east shores of this bay afford numerous exposures of mica schist, somewhat hornblendic in character.

Granite apophysis.

On the portage, and in the little lake south of this bay, however, massive red granite, containing very little bi-silicate, is exposed. On the north-east shore of the bay the same mica schists are exposed, in-

vaded by narrow bands of granite; these occur all along the south shore of this south-western portion of Brent Lake. The little bay to the east affords one exposure of granite, on the south shore; which probably marks the northern limit of the large granitic area. The eastern end of the bay is marshy, but on the north shore and through the main channel to the north, massive gneiss, reddish in colour, and somewhat distinctly foliated, occurs.

Eastern extension of band of mica schist.

The band of mica schist to the south, therefore, is about ten chains wide where it is last seen on this lake; its continuation to connect with the band, probably about the same width, of brownish and dark gray siliceous felspathic mica schist, seen on the north side of McIntyre Lake, is conjectural, as also is the continuation of this band south-eastward; but whether continuous or not, the band shown on the map probably indicates the position of the axis of a synclinal fold, of which these exposures are the pinched in remnants.

McIntyre Lake.

The band on McIntyre Lake contains intermediate bands of granite, and dips N. by E., angle 40° to 45°, over the granites on the south and under them to the north. The granites are deep pink in colour, faintly foliated for the most part, and contain chlorite.

Brent Lake.

Returning to the south-western part of Brent Lake to trace the northern boundary of this band, we find exposures of mica schist at the two points at the entrance to the most easterly of the two bays running north, and again striking along the western shore of this bay, while the eastern shore is occupied by granites. Along the eastern shore the bare hillside slopes about 35° to the west; on the surface are seen many flat scaly inclusions of crumpled micaceous schist. This would seem to be a surface of contact between the underlying granites and overlying Coutchiching rocks, and the appearance is strongly suggestive of the irruptive character of the former. The line of contact appears, therefore, to sweep sharply to the north up this bay. The contact in the northern end of the bay is concealed by drift; but on the south side of William Lake, it can be closely located, and by the few exposures of schist on the north side of the east end of this lake, and the few granite exposures on the south side, is determined as lying under the waters of the east end of William Lake; thence it can be again somewhat closely located, on the west shore of Conmee Lake, by the exposures occasionally outcropping along the low marshy shore.

Surface of contact.

William Lake.

Conmee Lake.

Through Conmee Lake, the contact is determined as lying between the brownish-gray mica schist exposed all along the north shore, and the off-lying islands, which consist of medium-grained, dark gray granite, containing hornblende and biotite, and banded with subordinate bands of mica schist.

Bands of mica schist.

On the south side of the lake, is a series of narrow but persistent bands of mica schist, striking generally about S. 80° W. and dipping northerly at angles varying from 30° to 45.° On the bay running to the south, at the east end of the lake, is a band occupying the whole of the island, at the mouth of the expansion and traced on both shores; the band curves from S. 30° E., on the west, to S. 60° E. towards the east, with a north-easterly dip of 30° to 40.° This band appears to taper off to the south-east, but its extension to the north-west cannot be seen on the south-east shore of the main lake, and it would appear to be a comparatively large isolated lenticular band.

Possible unconformity.

The general strike of the foliated granitic rocks on the south-east side of the lake, gradually changes from S. 80° E. near the west end, to S. 20° E. near the east end; while the strike of the mica schists on the north side, varies between N. 65° E., and N. 85° E. This would appear to indicate a structural unconformity between the two series. One or two strikes obtained near the contact, indicate that the strike of the gneisses bends sharply round, in conformity with the structural planes of the schists, but as the line of contact is mainly concealed under the water, there is not sufficient evidence to establish whether there is here an unconformity or not. While the varying directions of the structural planes of the Laurentian and Coutchiching rocks may be explained by assuming the existence of a fault, there is no independent evidence at hand in support of this assumption.

The most easterly point where the contact is determined is on the south-eastern shore near the eastern end of Conmee Lake.

Distribution east of Conmee Lake.

The distribution of mica schists in the area between Conmee and Keefer lakes, owing to the inaccessibility of the country is conjectural, but is based on facts which will be given below.

Lake north of Keefer Lake.

A band of fine-grained, dark gray siliceous, hornblendic mica schist is seen on the lake north of Keefer Lake, on the bay running to the north-west. From the exposures on this bay, the band must be over half a mile wide, but its western boundary was not determined; it is interrupted by parallel granitic bands, of subordinate width. Presumably, the northern extension of the same band, is seen on the stream forming the outlet of these lakes, and is traced closely and accurately to the north end of Kahnipiminanikok Lake, where it is about half a mile wide. These schists contain so much hornblende, as to leave some doubt as to whether they are not Keewatin in age, but lithologically they are perhaps more closely allied to the Coutchiching hornblendic mica schists, than to the Keewatin micaceous hornblende schists. The presence of hornblende, even in predominant quantity, cannot be taken as conclusive evidence of age, in the face of opposing stratigraphical pro-

Kahnipiminanikok Lake. Hornblendic schist.

babilities, and for this reason I have mapped them as Coutchiching, considering the presence of hornblende to be a local and not significant facies.

Influences guiding the mapping.

The mapping of this band of rocks in continuation with the mica schists north of Conmee Lake, is inferred from the structure of the granites on the lakes surrounding this area. An examination of the strikes and dips of the foliated portions shown on the map, will show that with local variations the general strike of the rocks is rudely parallel with the general trend of the watercourse, from the small lake south of Keats Lake to the ultimate outlet of these lakes into Sturgeon Lake, viz., from south-west with a north-west dip south of Keats Lake, to north-west with a north-easterly dip on the south-east arm of Sturgeon Lake. On Brent, McIntyre and Sarah lakes, particularly the two latter, the rocks are granitoid and exhibit very little foliated structure, which, however, may be regarded as parallel to the general trend of the watercourse, which curves from E. by S. on Brent Lake, to S. by E. on McIntyre and Sarah lakes.

The general trend of Keefer and Kashapiwigamak lakes indicates roughly the direction of the structural planes of the surrounding rocks, which is S.S.W. or S.W. by S.

Triangular synclinal trough.

Such dips as are observable, are northerly, at a high angle, on the lakes south-east of Sturgeon Lake; north-easterly, at a comparatively low angle, on Brent, McIntyre and Sarah lakes, and westerly, at a comparatively low angle, in Keefer and Kashapiwigamak lakes, viz., if we regard the high inclination of the rocks on the north as representing overturned dips, all inward towards a triangular central area, which represents probably a triangular trough in the Laurentian rocks, in which would very likely lie the south-eastward extension of the rocks north of Conmee Lake, and the south-westerly extension of the micaceous schists seen on the lake north of Keefer Lake.

Southerly extension of the trough.

A southerly tapering extension of the trough would probably be involved by the folding above assumed which would extend roughly parallel to Kashapiwigamak Lake.

Attenuated anastomosing bands of upper Archæan rocks, surrounding nuclear areas of granite are so common a feature in these azoic rocks, that coupled with the suggestion offered by the structure of the surrounding granites, the general correctness of this mapping would seem highly probable.

South-western limit of central northern granite area.

The south-western boundary of the northern central area of granites, probably swings round from the north-western edge of the band of mica schists, revealed in the lake north of Keefer Lake, in general conformity with the trend of the watercourse of the lakes draining into the

south-eastern part of Sturgeon Lake; first westerly, then north-westerly, thence northerly and north-easterly, to the point where it is again accurately determined in the narrow channel between the eastern and south-eastern expansions of Sturgeon Lake, where the usual brecciated contact zone is seen between the fine grained gray muscovite biotite granite and the mica schist. The contact is placed where the included bands of mica schist become predominant in quantity. From here on the west shore to the mouth of the small creek half way to the point at the narrows between the eastern expansion and the main body of the lake south-west, the mica schists, though broken by bands of pegmatite and coarse grained granite, form the principal rock. This band of mica schist is nearly half a mile wide; the strike on the north side is N. 80° E. and in the south side N. 65° E. with a uniform southerly dip of about 70°. Opposite this on the eastern shore this converging band of mica schists appears to have almost entirely died out, and is represented only by two or three narrow bands only a few feet wide, which bend sharply to the N. N. E. with a lower southerly dip, and are flanked by massive red coarse grained muscovite granite, containing numerous small garnets. The above distribution is graphically represented on the map by the two long narrow tongues of Coutchiching rocks.

Contact on Sturgeon Lake.

South-western part of Sturgeon Lake.

The northern part of the peninsula forming the narrows at the north-east end of the main body of the lake, consists of pink muscovite granite, very coarse grained, pegmatitic in places, and often containing biotite as well as muscovite, and sometimes garnetiferous. The contact with the mica schists to the south is seen about half way down the western shore of the peninsula, south of this the mica schists are invaded by a few granitic bands. From here the contact must lie between the fine grained brownish-gray felspathic mica schist of the south-eastern shore of the lake and the pink, usually, distinctly foliated granite gneiss of the large off-lying islands. Neither the schists to the south nor the gneisses on the north contain bands of foreign rock, although some felspathic veins, probably segregated, occur in the former.

The contact line passes north of the islands, lying off the mouth of the deep bay of the south-eastern shore, as these islands are composed of mica schist, a narrow granitic band being seen on only one of them, and a single exposure of granitic rock is noted on the north shore of the bay.

Western shore of Sturgeon Lake.

The line of contact after passing under the waters of the lake, is again closely located on the west shore, as passing between adjacent exposures of the two varieties of rock. On the bay to the west, there are a few

exposures of felspathic mica schist, but on the north-western extremity two or three exposures of massive pink granite, taken in connection with the observed strikes, determine approximately the location of the line of contact. From here westward the line probably curves to the north-west to the contact of the Laurentian granite gneisses and Coutchiching mica schists, located on the Quetico route from Namakan River to Kawagansikok Lake.

General distribution of mica schist.

The limits of the area of Coutchiching rocks have thus been traced, and the data from which they are laid down, given. The very numerous exposures of mica schists on all the lakes and river shores shown in this area, leave no doubt as to their general distribution and render highly improbable the existence of any considerable area of older or newer rocks, except in the unexplored portion north of Wolsely Lake and Namakan River.

Character of the Rocks of the Coutchiching Area.

General characteristics.

The rocks in this area are singularly uniform in character. They vary in colour, from a light gray to a dark gray, sometimes with a tinge of brown, probably due to a bleaching of the biotite constituent, possibly in some instances due to the presence of iron-bearing minerals. They vary in texture from a medium-grained rock, in which the size of the mica scales is prominent, to a very fine-grained rock. Only occasionally in this area are they observed to be coarsely crystalline. They contain generally biotite, black, brown or bleached, or muscovite, with felspar (orthoclase) and quartz. The two latter are seldom or never absent, and sometimes these minerals are such important constituents, as to characterize the rock rather as a micaceous gneiss than a mica schist. These micaceous gneisses are always fine-grained, light gray, and finely and evenly laminated.

Hornblende is occasionally found as a more or less important constituent, and small garnets have been often observed.

Coarse grained schist in Namakan Lake.

In Namakan Lake, due north of the channel to Sand Point Lake, the schists are extremely coarse-grained, the mica, which appears to be a bleached biotite, or muscovite, occurring in large scales.

Sand Point Lake.

Hornblendic schist.

In some localities on the east shore of Sand Point Lake, particularly on the island at the mouth of the bay, leading to Nequaquon portage, the schist is coarse grained and black, from the abundance of hornblende contained in it in this locality characterizing it rather as a hornblende than a mica schist. The schists here dip away from the granite gneiss at unusually low angles, in one place as low as 17°.

Lac la Croix.

In Lac la Croix, on a small island north of Roland Island, is an exposure of rather coarse-grained hornblende schist, consisting almost entirely of hornblende in parallel crystals and needles; this may be a small outlier of hornblende schist, but it does not appear to be an eruptive rock. In the channel, south of the eastern line of the Indian Reserve, at the mouth of the Maligne River, the schist is hornblendic and fine-grained, and there are also some light green chloritic schists one-half mile E. N. E. of the Dam Island portage; these, in connection with the hornblende schist in Lac la Croix, above mentioned, may represent a band of basal Keewatin rocks, but if so, it is of insignificant development.

Possible pinched in-fold of Keewatin rocks.

Maligne River.

On the Dam Island portage, up the river as far as Tanner's Lake, and at some localities on this lake, the mica schists, or gray evenly laminated gneisses, contain siliceous portions which resist weathering, and give to the weathered surface of the rock a knobby appearance and on the fresh fracture present oval or lenticular areas of lighter colour than the more micaceous and felspathic surrounding material.

Siliceous lenses.

The occurrence of these siliceous lenses is also noted on a small lake one and a-half miles north-east of Darkey Lake. The fine-grained grey felspathic mica schists of Wink Lake also present this feature.

Wink Lake.

On the stream forming the outlet of Darkey Lake, the mica schists are dark grey in colour and fine-grained. They dip to the N. N.E. at very low angles from 10° to 25°.

Pegmatite.

Small irregular areas of coarsely crystalline pegmatite, of which the mica is white in colour, occur. These patches are possibly segregations from the surrounding mica schist. The mica schists are also intersected by thin stringers of quartz and felspar, which are at times curiously contorted. Thin stringers or veins of felspar rock are noted on Sturgeon and Namakan Lakes, and are of very common occurrence in mica schists. The vein material seems to consist almost entirely of orthoclase. Most generally the veins cross, more or less obliquely, the strike of the schists. Sometimes two or more veins, having different directions, will join together or intersect each other. They rarely exceed three or four feet in width, but are very irregular in their outline. They are most probably segregations.

Felspar rock.

All the rest of the rocks in this area fall under the general description given above.

Isolated Bands and Areas of Mica Schist.

Narrow isolated bands of mica schist, which may represent the remnants of pinched in folds, and, therefore, synclinal troughs of Coutchiching rocks, are noted in the granite areas more or less remote from the main Coutchiching area, in the following localities :—

North of the extreme north bays of the main western portion of Sturgeon Lake, several bands of mica schist were observed. Their direction is parallel to the line of contact and their inclination to the north at rather high angles. One is seen to be a lenticular band only 30 or 40 feet long, the others are bands about a chain or so in width. Sturgeon Lake.

On the south-east arm of Sturgeon Lake, near the mouth of the stream draining the lakes east of it, is a band of uncertain width of soft, friable, brownish weathering mica schist. It strikes N.E. by E. and dips about 60° N.W. This is probably the eastern representative of the bands seen in the granites, south of the small lake, one mile and a half west south-west of this, which strike N. 75° E. and dip N. $<$ 70°.

On the fourth lake from this south-east arm, and draining into it, is a band two chains wide, apparently underlying the gneiss on the north-west shore.

On Chatterton Lake, on the south side of the large island opposite the portage into McDougall Lake, is a band apparently interbedded with the granitoid gneiss. Dip N. 10° W. $<$ 15°. Chatterton Lake.

On the north-east shore, north-east of this island, is a band of brownish medium-grained mica schist, with a band of pegmatitic granite. Dip S. 75° E. $<$ 49°. Perhaps the same band as above.

On Kahnipiminanikok Lake, on the north side of the large island in the north end, a narrow band of brownish-gray medium-grained mica schist occurs. Kahnipiminanikok Lake.

On the east side of the lake, at the mouth of the bay north-west of McKenzie Inlet, is a narrow band of black mica schist, dipping S. 80° E. $<$ 75°.

On McKenzie Inlet are exposures of dark gray hornblendic mica schist and brownish-gray felspathic mica schist in the localities indicated in the Coutchiching area on the map. On the small lake between this inlet and the Kawawiagamak Inlet, a gray siliceous mica schist occupies a considerable area, which reappears as a dark gray compact fine-grained siliceous mica schist, skirting the south shore of the bay into which this lake drains. Opposite this, granite gneisses are exposed. On Kawawiagamak Inlet, mica schists are seen in considerable development; on the shallow bay on the north side near the mouth there is a fine-grained felspathic mica schist, which passes into an evenly laminated biotite gneiss. These exposures, with the observed strike, render it highly probable that the area exists as mapped. A subordinate southern extension of the south fork of this area is indicated by narrow bands of mica schist on the channel to Agnes Lake. McKenzie Inlet. Kawawiagamak Inlet.

This area is probably a pinched infold of Coutchiching rocks invaded by an apophysis of granite. No synclinal structure is, however, shown by the dips.

South-east part of Kahnipiminanikok Lake.

At the narrows, near the south-east end of the lake, and on the bay north of McEwen Lake, are exposures of fine-grained hornblendic mica schists, which by their localities and the strike of the rocks indicate the presence of a crescent-shaped area, of probably Coutchiching rocks, as shown on the map.

Broad band of Coutchiching rocks.

On the south-east shore of the small lake, south-east of Kahnipiminanikok Lake, and on the stream flowing into it from the south-east, is a well-defined band of fine-grained felspathic mica schist striking E. N.E. and dipping north-westerly from 60° to 70°. This band is here about three-eighths of a mile wide, and is doubtless a north-eastern extension

McEwen Lake.

of the band, well defined in McEwen Lake, of very fine-grained evenly laminated gray biotite gneiss, merging into coarser-grained, darker and more fissile felspathic mica schists. Here the band curves a little more to the south and has a somewhat lower north-westerly declination.

The reasons for mapping the eastern extension of this band in continuation with the Keewatin rocks, will be given later.

Slate Lake.

On the south-west end of Slate Lake, the exposures of a mica schist, in which the mica is smoky-white in colour, apparently muscovite, but possibly a bleached biotite, indicate the existence of an area of Coutchiching rocks sufficiently extensive to be shown on the map. An

Saganagons Lake.

exposure of this rock at the bottom of the bay of Saganagons Lake, north-east, indicates a north-eastern extension of the band at least that far. Along the north-east shore of this bay the granites contain narrow bands of mica schist, which are, however, subordinate in quantity. The westward extension of this area is not determined, but is judged to be short on account of the rapid convergence in the direction of the strikes; on the north side of Slate Lake (S. 70° W.) and on the south side (N. 70° W.)

The lamination on the north side is vertical, and that on the south side dips to the south at a very high angle.

Agnes Lake band of mica schist.

On the north shore of Agnes Lake, between its two outlets, is a series of mica schists interbanded with the foliated granites in such abundance as to become a prominent constituent of the whole rock mass. The strikes vary from N. 50° E. on the east to N. 20° E.

Apparent sedimentary interbedding.

on the west. The manner of their occurrence is very suggestive of sedimentary interbedding. To the east the dip is S.W. $< 16°$ rapidly increasing in declination to 45°. On the most prominent point of this shore, the mica schists have a low easterly dip of 5°, and west of this

the dip is again reversed, dipping westerly at an angle of 35°. This would indicate an eastern synclinal and western anticlinal fold, but no indication of a syncline still further west is observed. The island south-west of the western outlet is composed of foliated granite, holding brecciated angular fragments of mica schist. Low dips. Areas of folding.

On the east side of Basswood Lake, east of the large island in the northern part, some small bands of mica schist occur, and further north-east is some fissile light gray micaceous gneiss, closely allied to the Coutchiching gneissic rocks. Basswood Lake.

On the point at the west end of Yum-Yum Lake, a local narrow band of siliceous hornblendic mica schist occurs. Yum-Yum Lake.

On this lake, as well as on McNiece Lake, and on the east side of Shade Lake, bands of this hornblendic micaceous schist are associated with the red foliated chloritic granites. McNiece Lake.

Thickness of Coutchiching series.

Any attempt to arrive at the probable thickness of the Coutchiching series is confronted with many difficulties, and the result must be accepted with hesitation, as being very uncertain, owing to the many possibilities involved in the structure, which cannot all be duly regarded. Difficulties of determination.

Dr. Lawson's estimate* of the thickness of the series in the Rainy Lake district is based on very evident and significant facts, and it will be interesting to see how far the facts of this field, similarly interpreted, corroborate his estimate. Lawson's estimate.

Dr. Lawson considers the whole volume of mica schists, south of the Keewatin area, to represent a threefold repetition of the series folded over a northern anticlinal and under a southern synclinal axis. The portion between the Keewatin schists and the anticline, he estimates to have a thickness of 4·50 miles. The portion between the axes he estimates at 4·588 miles, and the southern third at 5·44 miles thick, which, allowing for uncertainties of data, would indicate a much greater thickness for the series to the south than to the north.

The northern anticlinal axis, described as striking the shore of Rainy Lake between Rat River and Vague Point, crosses the Pipestone River about one mile and a quarter from its mouth, where diverging dips are seen ; thence its eastern extension marks the centre line of an ovoid area of Laurentian rocks, the southern edge of which is exposed on the north shore of Sturgeon Lake ; so that in the Hunters Island district only the southern synclinal basin is seen in its extension eastward from Rainy Lake. Granite area on line of anticline in Rainy Lake.

*Geol. Survey of Canada, Annual Report, vol. III., 1887-88, p. 100 F.

Eastern extension of Rainy Lake syncline.

The axis of this basin, along which the dips converge, can be traced from Kettle Falls, with a course east by south, north of Namakan Lake, south of Captain Tom Lake, touching the northern bend of Namakan River, whence it sweeps to the south of Wolseley Lake; from here it curves more to the east, encroaching, probably, on the north-east part of Indian Reserve "D," skirting to the north of Maligne River to cross it at the dam at the outlet of Sturgeon Lake, and passes between Sturgeon and Hoffmann lakes.

Thickness north of Sand Point Lake.

From the contact of the Coutchiching and Laurentian on Sand Point Lake, to the axis above described, the distance is about 5½ miles. The angle of dip varies between 25° and 70°, and for the first three-quarters of a mile north of the Sand Point Lake granite, may be taken to average 60°; for the next three-quarters of a mile, 30°; for the next mile and a half, 60°; for the next mile, 40°; for the next mile, 65°; and for the last half-mile, 80°. Making the corrections for these angles of declination, these measurements would give a thickness of 4·367 miles, considerably less than that found for this portion of the trough further west; but here the series might be expected to be thinner, and the calculation is based on a position of the synclinal axis determined from data obtained since Dr. Lawson's report was written.

Thickness of northern half of basin.

For a calculation of the northern half of this fold, there are no data sufficiently accurate to give satisfactory results. The distance between the synclinal and anticlinal axes on a line of section continuous with the above would be probably between five and a half and six miles, and if we assume the dips to be the same as for this part of the fold on Rainy Lake, viz., about 75°, the thickness would appear to be about 5,000 feet greater than that deduced by Dr. Lawson there. No reliance can, however, be placed on this calculation.

Thickness east of Thompson Lake.

From where the axis of convergence can be located as striking the Namakan River at the mouth of the Quetico River (the northern bend), south to the granites, can hardly be less than seven miles. The rocks have, however, a more uniform and a lower dip, averaging for the northern four miles about 60°, and for the southern three miles, 45°, which would give a thickness of 5·548 miles, greater than that calculated by Dr. Lawson. The series here, however, may have been thickened by the intrusion of the granites of Thompson Lake.

Thickness of northern fold.

North of the synclinal axis the contact with the mica schists and the granite area, seen in part on this sheet on the north side of Sturgeon Lake, cannot be accurately defined, owing to the very broad zone of alternate bands of granite and schist, but the granites first appear decidedly to predominate along a line rudely parallel with this axis and distant from it about 5½ miles. For a mile and a half north

of the axis the schists dip to the south, and north of this they dip constantly to the north under the northern granites. This indicates another anticlinal axis, probably due to an intermediate local disturbance, for such an axis is not seen on Rainy Lake. Ignoring this and assuming the average dip for the whole five miles and a half to be 65°, a thickness of 4·985 miles would be indicated.

Thickness north of Roland Island

The axis of convergence of dip can be only approximately laid down north of Lac la Croix, but it probably lies about four miles and a half north of the contact on Roland Island. For the first three miles north of the contact the dips are low, ranging from 30° to 45°, and averaging about 40°. The dips for the next mile would have an average of about 65°, and for the last half mile about 80°, giving a total thickness of 3·327 miles, which indicates a thinning of the series towards the east.

Thickness across Tanners Lake.

Neither the axis north of Tanner's Lake, nor the contact north of Wicksteed Lake, can be very accurately placed, but the distance between them would be about four miles. From the dips observed on the stream draining Darkey Lake, they would appear to be very low, averaging not over 25° for the southern mile and a half of this distance. The average for the next two miles, as revealed on Tanner's Lake, and on the portage south of it, would appear to be about 50°, and for the last half mile we may assume an average of 80°, giving a total thickness of 2·658 miles, indicating a still greater attenuation of the series.

Thickness across Pooh Bah Lake.

Still further east the series seems to have been split and wedged apart by the syenites of Pooh-Bah Lake. South of the syenites, the most reliable measurements would give a width of two miles to the schists, which have here an average dip of 45°, or a thickness of 1·389 miles, underlying the syenites. From the northern edge of the syenites to the axis of convergence of dip at the Maligne dam, the distance is 1·6 miles, the schists have an average dip of about 60°, which would give them a thickness of 1·386 miles, overlying the syenites. The total thickness would thus be 2·775 miles, somewhat greater than the last, but it is uncertain what effect the intrusion of the syenites would have upon the thickness of the series, at the present level of denudation, by the introduction of intermediate folds.

Thickness under the syenite.

Thickness over the syenite.

Thickness revealed in Sturgeon Lake.

The only place where satisfactory evidence of the thickness of the northern upward fold of the series is afforded, is on the west shore of Sturgeon Lake, where the horizontal distance across the fold is under two miles and the declination averages 75°, giving a thickness of 1·932 miles. A rapid thinning of the series would be expected so near the eastern end of the trough.

Allowing for local variations in the thickness of the series, and for inaccuracy and incompleteness of data, it is thus seen that in the Hunters Island region the enormous thickness revealed in Rainy Lake is maintained, and the calculations based on the same interpretation of the structure, give practically the same results.

Reasons for regarding the thickness as too great.

There are, however, weighty reasons for doubting the results of these calculations. In the report on the Rainy Lake region,* it is pointed out that the intervention of the mica schists between the granites and the rocks of the Keewatin series, has preserved the latter from the intense metamorphism which they exhibit when in direct contact with the former. It is, therefore, surprising to find that these mica schists, which would here seem to have been deposited in such enormous thickness, should exhibit comparatively little difference in degree of metamorphism, between its upper and lower members. Again, it is surprising to find here a development of a singularly uniform series, unparalleled by any other series of upper Archæan rocks, particularly in view of the fact that in no other part of the whole field between the Lake of the Woods and Lake Superior, is anything more than a comparatively subordinate development of mica schists observed.

Metamorphism.

Unusual development.

Period of folding of Coutchiching and Keewatin the same.

The contact between the Laurentian and the Coutchiching rocks, and between the former and the Keewatin presents the same characteristics; and no unconformity of structure between the two upper series has ever been observed. It is therefore highly probable that the two series were folded at the same time, and it is therefore most likely that the true original thickness of the Coutchiching rocks would be more nearly arrived at from measurements taken where these rocks are found in position between the Laurentian and Keewatin rocks, than in the main areas where the apparent thickness may have been manifolded by intense and minute plications. In the area comprised within this sheet, no such occurrence of the mica schists is seen, but one such instance is afforded on Rainy Lake, where the band of schists south of Pither's point, lying between the Keewatin belt on the south and the Laurentian area on the north, has been computed as 8,000 or 9,000 feet thick†. As pointed out in connection with this statement, the comparative thinness may be due to partial absorption of the mica schists into the magma from which the granites recrystallized, but this supposition is contradicted by the fact that the southern half of the southern synclinal basin, which would be subject to the same influence, is thicker (on the double synclinal interpretation of the structure) than any other part of the series.

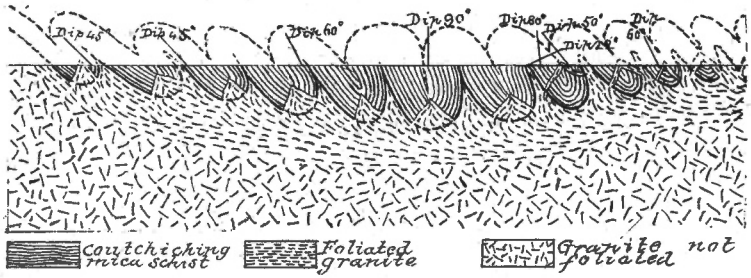
True thickness more nearly determined in intermediate bands.

*Geol. Survey of Canada, An. Rept., vol. III., 1887-88, Part I., p. 38 F.

† Geol. Survey of Canada, An. Rept. vol. III., 1887-88, Part I., p. 104 F.

A minute study of the section east of Thompson Lake reveals the following facts:—The schists at the contact on Roland Island have a northerly inclination of 45°, and this is the prevailing dip for three miles north; 60° being the average northerly dip for the remaining four miles to the axis of converging dips where the rocks are in vertical position. For one mile north of this axis the rocks have a prevailing dip to the south of 80°. One mile and a half north of the axis a dip of 22° S. was observed; at two miles north the declination is 80° to the north, lowering to 50° half a mile still further north; for the remaining three miles, to the line of predominance of the granites, the dip is uniformly to the north at angles differing little from, and averaging 55°. The section below represents what, in the writer's opinion, is the most probable structure of the rocks along this line. Section east of Thompson Lake.

Fig 3



Ideal Section across Coutchiching series East of Thompson Lake; suggesting probable manifolding of the series, the intrusive character of the gneissoid granite, and the probable cause of the brecciated contact zone.
Natural scale 4 miles = 1 inch

The alternating bands of foliated granite and mica schists, in the contact zone, may thus be accounted for not only by intrusive dikes of the granite, but by intrusions between the folds, and the shattering of the crumpled schists particularly at sharp synclinal turns and the intrusion of granites into these fissures. A comparatively thin series, thus manifolded would have a comparative uniformity of metamorphism throughout. Explanation afforded by diagrammatic section.

The low dips often observed in central portions of the basin might thus indicate proximity to the crest of an original anticline or to the trough of a syncline.

This interpretation of the structure nullifies all data from which a calculation of the original thickness can be made, and affords only a

reason for believing that the Coutchiching series is much thinner than it has previously been considered to be.

Keewatin Series.

Limits of area and conditions of contact with lower rocks.

Work done in Keewatin area.

It is unfortunate that, for reasons already given, I cannot describe these rocks with the thoroughness and minuteness that their scientific and economic importance deserves. A reference to the record of work, previously given, will show how little of the work in the area occupied by Keewatin rocks was performed by me. In 1888, I spent three days on Saganagons Lake, during which a hasty visit was paid to the most northerly of the mining locations, south-west of the lake. In July, 1888, I passed hurriedly from Basswood Lake through Birch, Carp, Emerald, Big Rock and Jasper lakes to Saganagons Lake, taking cursory notes on the way without any expectation of requiring them for future use. I surveyed the islands in Saganagons Lake. Mr. Russell had made an excellent traverse of the shores of the lake, a plat of which he kindly gave me, so that less attention was paid to the rocks of the shore than they would otherwise have received, but the notes and specimens collected at this time, form the only systematic geological work in this area that is at hand.

Contact in Basswood Lake.

The contact of the Laurentian and Keewatin rocks, shown in the north-east corner of the extreme eastern expansion of Basswood Lake, has been determined by Dr. Lawson. The contact of the granites of Meadows and Louisa lakes, with the Keewatin rocks of That Man's and This Man's lakes, must lie somewhere between them and in a line generally parallel to these chains of lakes, as the foliation of the rocks in both chains is coincident with the general trend of the shore lines. The next point north-east where Keewatin rocks were seen in contact with Laurentian, was on Glacier Lake, where a band of fine-grained black siliceous hornblende schist was found, the width of which could not be determined; it is exposed along the eastern shore for about a quarter of a mile, having a strike in the central part of this distance of N. 80° E. with a southerly dip of 45°, a single exposure opposite this on the west side of the lake has a north and south direction of strike. It is again exposed at the southern extremity of the lake, at the portage to Cross Lake; here the direction of structural planes is also north, with a low westerly dip of about 40°, the reversal of the dips and their low declination together with the sharp change in the strike indicate considerable disturbance. The contact with the distinctly laminated pink biotite gneiss of this lake was everywhere concealed by drift, the shores afford-

Glacier Lake.

ing only isolated exposures. The gneiss in the neighbourhood has a strike of N. 25° E. which would indicate probably the general direction of this band. The band is probably of insignificant width, from the fact that no certain continuance of it is seen to the north-east.

Parallel small band of hornblende schist. Louisa Lake.

South-west of this, on the portage between the two small lakes north-east of Louisa Lake, a band of precisely similar rocks to these, but so narrow in development as to be inappreciable on the scale of the map, is associated with the light gray distinctly foliated biotite gneiss, which here strikes N. 35° E., with a south-easterly dip of 80°. On the northernmost island, lying near the north-west shore of this lake, is a narrow band of similar hornblende schist, interbanded with a fine-grained red granite, in which the bi-silicate is changed to chlorite; here the hornblende schist strikes N. 45° E., and has a low north-westerly declination of only 10°. No occurrence of this band is seen between these two localities, but the rock exposures are comparatively infrequent, and the band is probably continuous. On the portage between Louisa and Agnes Lakes is another exposure of hornblende schists dipping S. 45° E., angle 80°. No intermediate occurrence of this band is seen, but where it would be expected the rocks on the shore of the lake are concealed by sand. These three exposures of hornblende schist are therefore nearly linear with each other in their localities and in the direction of their structural planes, and it would seem that they probably represent fragmentary portions of a pinched infold of Keewatin rocks, parallel to the main trough to the south-east. I have not mapped the rocks seen in Glacier Lake, although very similar in character, as continuous with this band, as the direction of the former in its most southerly occurrence seemed to suggest that it was rather an apophysis of the main mass than a greatly thickened development of the Louisa Lake band.

Band probably continuous.

Contact in Slate Lake.

The next place where the contact is seen is in Slate Lake, lying to the west of the south-west end of Saganagons Lake, on the southern bay of which massive quartzose hornblende schists are exposed. On the peninsula between the south and west bays is an important exposure of red, rather coarse-grained granite gneiss, in which the bi-silicate would seem to have been hornblende, now changed to chlorite. The actual contact, though not well exposed, presents the usual zone of interbanded granite and schist, here, however, narrow, with but few alternating bands. From the direction of the strike of the rocks here, together with the strikes observed by Dr. Lawson on The Other Man's Lake, there can be little doubt that the line of junction to the south-west is approximately as indicated on the map. The schists on the north shore of Slate Lake, north-west of the granites

above described, are mica schists, so characteristically Coutchiching as to leave little doubt as to their correlation with that series.

Contact in Saganagons Lake.

The bottom of the bay of Saganagons Lake, north-east of this, is occupied by granitoid gneiss, distinctly foliated and holding bands and lenticular inclusions of hornblende schist. On the long narrow point forming the south-western shore of this bay, the bands of hornblende schist or schistose trap become so frequent as to predominate over the foliated granites, and the contact is, therefore, placed north-west of this point. The islands at, and to the north-east of, the mouth of this bay present the same features of interbanded and foliated granites and black schistose rocks, indicative of the contact zone. The rocks here strike N. 35° E., and dip S.E., angle 80°. The large triangular island, three-quarters of a mile north-east of the above mentioned point is composed almost exclusively of hornblende schist.

The line of junction passes through the islands, and crosses the narrow neck of land, cutting off the point north of the trail which forms a winter route to Saganagons Lake. This point and the small islands to the west of it, are composed of hornblende schists, while the shore of the shallow bay to the west presents numerous exposures of deep pink obscurely foliated granitoid gneiss. The bay north and east of this point, presents no exposures, but the extreme point, one-half mile to the north-east, offers an exposure of hornblende schist.

Chloritic schists.

A single exposure of granite, probably interbanded, is seen a few chains to the north-west. Here the rocks become chloritic in composition, the rocks on the point of the shore to the east being soft, fissile, dull green, quartzose chlorite schists. The contact is again determined

Deadman's Point.

in the bay north of Deadman's Portage, which crosses the narrow part of the long tongue of land which runs north-east to the eastern boundary of Rainy River district. This tongue is called Deadman's Point, doubtless from the fact that it has, for years, been a favourite cemetery of the Indians, several of their curious elevated coffins still remaining there. The portage crosses just east of the last point described. The tongue of land is occupied by hornblendic and chloritic schists. The south-western shore of the north-western part of the lake affords many exposures of reddish, coarse-grained biotite granite gneiss, having a strike of N. 50° E. The contact lies in a grassy bay in the extreme south corner. The junction can be traced as lying between adjacent exposures of hornblende schist and foliated pink granite, on the off-lying islands skirting the south-east shore of this part of the lake ; the usual strike being about N. 50° E., with local variations to N. 70° E., the rocks being nearly in a vertical position. The contact on the north shore of the lake, west of the narrow channel

to the eastern part, cannot be very closely located, owing to the stony character of the shores of the bay, but it must lie between the reddish biotite granite, indistinctly foliated, exposed on the point between the two deep bays to the north, and the chloritic hornblende schists revealed on both sides of the narrow channel between the north shore and the long narrow island to the south-west. The rocks on both sides of the contact line have a common direction of foliation of N. 70 E. The granites do not reveal the dip clearly, but the schists are in vertical attitude. The line of junction from here would seem to sweep from the north-east to the north, then to the north-west to form the south-western edge of the band of hornblende schists, indicated by the occurrence and strike of these rocks exposed on the shores of the lake west of Ross Lake, crossed by the boundary line between the districts of Rainy River and Thunder Bay. The rocks strike in a west-north-westerly direction from this lake, and in the east end of it they strike a little north of east, and due east near the centre of it; while several exposures in the west end of the lake show a uniform strike of W.N.W. The dip is uniformly to the south and south-west, at an angle of 45°. The width of this band is uncertain, but a westerly projection of the strikes noted would indicate a width of not less than three-quarters of a mile just west of the lakes, although it probably becomes attenuated in its westerly extension. This westward extension is a matter of conjecture; but, for the following reasons, I have mapped it as in continuance with the mica schist band of McEwen Lake, as being probably representative of the facts.

Lake west of Ross Lake.

This band is seen to strike west-north-west. The McEwen Lake band of mica schist, characteristically Coutchiching, is seen in its most easterly exposures, on the shores of the chain of lakes and connecting streams forming the outlet of Saganagons Lake, to strike east north-east. The projection of these two directions would intersect. For many reasons, which need not be detailed here, it may be assumed that the periods of folding of the Keewatin and Coutchiching rocks were identical. These bands represent synclinal folds of the Laurentian rocks, and whether the latter were in a viscid or in a hard condition at this period, it is simpler and more rational to conceive of a single curved trough than of two intersecting ones. Coutchiching and Keewatin rocks are frequently found occupying the same trough, the Coutchiching being always the inferior series, and generally seen to flank the Keewatin schists on both edges of the trough, while Coutchiching rocks may be found exclusively at one end of the trough and Keewatin rocks exclusively at the other end. The mapping, therefore, represents on a small scale conditions found to obtain elsewhere on a larger scale.

Reasons for mapping McEwen Lake band in continuation with branch of Keewatin rocks of Saganagons Lake.

While this represents, therefore, the most probable distribution, it is by no means certain that these bands do not terminate before reaching the point of intersection or of union, but bands of Coutchiching and Keewatin rocks, in granites, are usually found to extend for such great distances, in proportion to their width, that this supposition is unlikely.

Rocks on Ross Lake.

On the north side of the channel into Ross Lake, there are very few exposures, but such as there are indicate a continuous band of hornblende schists on the north side, striking east and dipping at a low angle to the south. On the south shore of the channel, near where it expands into Ross Lake, are some exposures which indicate the existence of a band of granitic rocks. The hornblende schists of the north side of the channel are again seen on the small island lying close to the south shore of Ross Lake, where they strike a little south of east and have a low southerly dip of 45° from the strike here, and on the west side of Beaver Lake it is probable that the band is continuous with the main mass to the south, and locally separated from it by a lenticular band of granite exposed on the south shore of Ross Lake. These exposures may indicate only small local intruded bands of granite, but in the absence of intermediate exposures of hornblende schists, it is mapped as representing a considerable band. This affords a graphic representation of a very frequent occurrence, though usually on a much smaller scale.

Intercalated granitic band.

Beaver Lake.

The north shore of Ross Lake and both shores of the channel to Beaver Lake afford a few isolated exposures of granitic rocks. There are few exposures in Beaver Lake, but such as there are, are of granite on the north side, and of dark green hornblende schist on the south side. On the south side the strike of the schists curves round from south of east, near the west end, to N. 75° E., at a point near the middle of the lake, the dip also becomes steeper, changing from 45° S. on Ross Lake to 52° S. at the west end of Beaver Lake and to 80° S. at the point near the middle of the lake. At the narrows, three-quarters of a mile east of Beaver Lake, the granite is fine-grained and red in colour, with a little biotite; it is cut by intersecting cleavage and jointing planes, one set of which, striking N. 65° E., would seem to represent the true structural planes of the rock. There are so few exposures on this route that the line of junction cannot be laid down with great precision, or described as to its character, but there is little doubt that it is defined on the map with as much accuracy as the scale will permit.

South-eastern boundary of Keewatin area.

As to the south-eastern boundary of the Keewatin belt, it was nowhere traced or examined by myself, but it has been closely defined by Dr. Lawson and laid down by him on the map.

The question of the age of the rocks of Saganaga Lake, in contact with the Keewatin, will be discussed later.

Cache Bay.

The line of junction is seen, on the Canadian side of the international boundary, only in and on the west and north shores of Cache Bay of Saganaga Lake, and along the north-west shore of the main lake in one locality. It skirts along this shore, the mainland being occupied, for the most part, by Keewatin rocks, while the off-lying islands are composed of granites.

Conglomerates.

An interesting series of specimens, collected by Dr. Lawson from Cache Bay, reveal the presence of a felsitic conglomerate in contact with a coarse-grained hornblende granite.

The conglomerate holds well water-worn pebbles of various sizes, usually as large as a hen's egg; these pebbles are of white and bluish quartz and coarse-grained hornblende granite; the matrix is a medium grained aggregation of quartz and felspar, with a little decomposed bi-silicate. The matrix has a granitic aspect and appears to be itself a finer conglomerate, made up of many partly-rounded grains of felspar and quartz cemented together. Beds of dolomite are associated with this conglomerate. Not having myself examined the localities where this conglomerate is exposed, I can say nothing of its relations in the field or of its stratigraphical significance.

Character of contact in Cache Bay.

On the north side of Cache Bay the contact between the hornblende schist and the granite gneiss is well exposed and is very characteristic of the contact between the Laurentian and upper Archæan or Huronian rocks of this district. Three photographs showing the nature of this contact at different localities were taken by Dr. Lawson, and are here reproduced. Plate I. represents what I shall so often have occasion to describe as the interbanded structure of the gneiss and schists. These lenticular bands of hornblende schist (dark coloured portions in the plate), included in the hornblende granite gneiss (light coloured portion), are not always so abruptly terminated, and often maintain a comparative uniformity for hundreds of yards. The appearance is frequently suggestive of an interbedding of the two series at the contact, and but for the brevity of these beds, and their sometimes rounded ends, such as shown in this plate, one would be apt to regard them as true interbedded depositions.

Lenticular bands of hornblende schist.

Angular fragments of schist in granite.

In plate II. is seen a common feature along the junction between the granites and the Coutchiching and Keewatin rocks, viz., the inclusion in the granites of scattered angular fragments of schistose rocks. These angular fragments usually have the appearance of having been broken and torn apart by longitudinal stretching. The longer axes of the fragments are nearly always parallel with the contact planes, and

sometimes would seem to have been moved but little from their original position as parts of the massive schistose series. Again, these scattered sharply angular fragments are often seen many yards from the contact, and isolated occurrences of them embedded in the granite have been noted a mile or more from any important development of similar rocks.

Granite dike.

Plate III. represents a bifurcated dike of hornblende granite (the lighter portion) striking from the main mass of these rocks into the hornblende schists across their planes of stratification.

Phenomena figured characteristic.

These plates afford very strong evidence of the intrusive character of these hornblende granites, and the phenomena here shown are of such frequent occurrence all along the line of contact of the Laurentian and the upper Archæan rocks, as to characterize the general nature of the junction and to strongly support the supposition that the Laurentian rocks of this region are as a whole irruptive in their relations to the overlying series.

Character of some of the rocks of the Keewatin belt.

Rocks in Birch Lake.

On Birch Lake the rocks exposed are coarsely crystalline hornblendic rocks, not very schistose. With these are associated very fine-grained fissile dark gray slates, apparently little altered clay slates. On Carp Portage, at the west end, these slates strike N. 58° E., and have a south-easterly declination of 84°. These schists or slates are almost continuously exposed on the south shore of Carp Lake, becoming more greenish in colour and softer, but less finely fissile, as we cross the series to the south, where they are exposed on the bare hills as soft chloritic schists.

Between Carp and Emerald Lakes, is a small lake surrounded by bold hills of massive "greenstone." These rocks are dull dark greenish-gray in colour, very hard, and they have as a rule very little schistose structure.

Emerald Lake.

The shores of Emerald Lake are very steep, presenting high, rugged cliffs of this same massive greenstone. At the east end of the lake, on the north shore, the rock is black in colour, compact and fine-grained, and appears to contain a small percentage of iron.

Big Rock Lake.

The rocks exposed in Big Rock Lake are fine grained, light greenish-gray altered trap or "greenstone." It is sometimes cut by jointing planes, but no true schistose structure is discernible. The rock is often

Iron staining

deeply stained with iron rust. This appearance of iron oxide staining is often closely simulated by an orange coloured lichen, which adheres very closely to the surface of the rocks, and at a distance is quite indistinguishable from the orange-brown stains caused by the deposition

of scales of iron oxide left on the surface by percolating waters. Prof. Macoun states that this lichen is the species *Placodium elegans*.

Cypress Lake seems to lie entirely in this greenstone horizon, these rocks being exposed almost continuously along the shores, which are high, rugged, perpendicular escarpments, rising abruptly from the water's edge for over one hundred feet. These scarped faces are very much stained with iron oxide. Cypress Lake.

On the portage between Cypress and Jasper lakes black crystalline hornblende schists are exposed, striking N. 56° E., and in vertical attitude.

On Jasper Lake, the massive greenstones appear associated with schistose traps and black crystalline hornblende schists. The structural planes of the schistose rocks strike in a direction between N. 55° E. and N. 60° E., and are, for the most part, vertical. Near the point at the south end of Jasper Lake, the rock is a fine-grained dark greenish-gray altered trap, which shows evidences of crushing and shearing. On a small island in the centre of this lake, is a fine grained dark gray siliceous rock, probably a variety of eruptive rock. In the bottom of the bay to the north-east, the rock is dark greenish-gray, compact and fine-grained, and would appear, macroscopically, to be an altered diabase. The shores of this lake are less rugged and precipitous. Jasper Lake.

On the portage going north out of Jasper Lake, massive greenish-gray hard greenstones are exposed. Associated with them, is here a band of ribanded jasper and hæmatite. The alternating bands of purplish hæmatite and cherry-red jasper have a comparatively uniform width of somewhat less than an inch; they are contorted and twisted in the most curious way, and present a beautiful appearance on the surface. This band is about forty or fifty feet wide, flanked on both sides by the greenstones above described. Banded jasper and hæmatite.

There are, no doubt, many other occurrences of this banded jasper and hæmatite associated with the greenstones to the south-west, the localities of which would be indicated by the mining locations shown along the route, the rocks of which I have briefly described.

This occurrence of jasper and iron ore associated with massive greenstones in this Keewatin belt, has great importance and significance, and is most encouraging to those interested in the iron industry of western Ontario. This belt of Keewatin rocks is shown on the "Geological Map of Iron Regions of Minnesota,"* as being in direct continuance with the belt of rocks, which the Messrs. Winchell also Importance of occurrence of jasper and hæmatite. Same belt as at Tower and Ely.

* Published in 1890 by N. H. & H. V. Winchell, State Geologists of Minnesota.

call Keewatin, in which are located the exceptionally rich mines of the neighbourhood of Tower and Ely.

Similar association of rocks at Tower and Ely.

There the ore bodies are found associated with greenstones and greenstone schists, and capped by formations of banded jasper and hæmatite, the removal of the silica and its replacement by iron oxide under favourable conditions giving rise to the solid ore bodies below. There is every reason to believe that beneath the jasper and ore capping in the region south-west of Saganagons Lake, the same agencies have produced the same result of concentrating the ores in workable bodies, that have operated to produce this result in the same belt less than sixty miles to the west-south-west. It is to be regretted that these Canadian localities have not been thoroughly tested, not only from an economic stand-point, but from the increased knowledge that systematic testing would give of the relation of the ore to the inclosing rocks.

Greenstone.

On the lake between Jasper Lake and the long south-west arm of Saganagons Lake, are light greenish-gray altered traps or greenstones, in some places quite schistose on the surface and fissile under the hammer, and in others quite massive.

On the portage between this lake and Saganagons Lake hornblende schist is exposed. It strikes N. 40° E. and dips at a very high angle to the north-west. There is seen also on this portage a very slightly schistose rock, probably related to the greenstones, which holds fragments of jasper.

South-west area of Saganagons Lake, Greenstones.

Passing up the westerly arm of Saganagons Lake the rocks exposed are massive, hard greenstones on both sides. These rocks continue up the north shore past the portage into Slate Lake, above mentioned.

The rocks near the line of contact with the Laurentian, along the north-west shore, have been described as far as Deadman's Portage.

Saganagons Lake rocks.

On the south shore from the trail, which is part of the winter route shown to Saganagons Lake, east to the mouth of the first bay running to the south, the rocks are light greenish-gray, fissile schists, apparently quartzose, chlorite schists, but possibly derivatives, by crushing and shearing, from the massive greenstones. These rocks on the fresh cleavage surface have a somewhat greasy feel. In the bay to the south a massive hard black eruptive rock is seen, which is probably of later age; whether it is diabase or diorite cannot be macroscopically determined with certainty owing to its fine texture. At the mouth of this bay on the eastern side, massive, hard greenstones are exposed, while on the small islands and on the large one opposite, the fissile, light greenish-gray rocks, above described, are seen.

Chlorite schists.

The large island to the east presents few exposures, but there is one of greenstone which is also exposed almost continuously on the main shore opposite.

On the small island between the east end of this island and the main south shore, the rock is schistose and weathers a dull light greenish-gray. While it closely resembles the chloritic schists to the west it does not break with the same smooth cleavage nor has the cleavage surface the same unctuous feel. It probably differs from it, however, only in degree of alteration.

Rocks in Saganagon Lake.

The rocks adhere in their strike very closely to the general trend of the shore line, striking N. 85° E., and dipping south < 80° On the shore to the south a local flexure in the strike is seen in conformity with the trend of the south shore of the little bay which strikes of S. 70° E.

Quartz porphyry.

On the east end of the large island no exposures are seen, but on the north shore a continuation of the schistose chloritic rocks exposed on the large island to the west is seen; the strike is here N. 85° E., dip S., angle 80°. On the shore of Deadman's Point, opposite the west end of this island, a rock is exposed which is very much sheared and crushed, it is rather coarse grained and contains felspar, quartz and chlorite, some of the felspar crystals appear to be porphyritic as well as some of the grains of quartz, and it would thus seem to be allied to the quartz porphyries; lying so near the granites, however, it may be genetically associated with them, and have received its present structure from accidental causes. To the west no occurrence of it is seen. An exposure of it is seen on a low hill a few chains to the north, but it does not occur along the north shore of Deadman's Point.

Rocks of Saganagons Lake.

It is exposed for a few chains along the south shore, to the east, where its southern contact with the green schists can be closely defined, although the actual line of junction is concealed under the sand. These exposures, therefore, probably represent a narrow lenticular subordinate band. It is in strict conformity with the associated green schists, which strike of N. 60° E., and are vertical, or dip at a very high angle to the south.

East of this at the southern extremity of Deadman's Point, the green schists are seen; here they are not very fissile.

Greenstones.

On the island nearly half a mile east north-east of this, the rock, while slightly schistose, assumes more the appearance of a greenstone. North-east of this the rock decidedly belongs to the greenstone series. The chain of small islands between here and the south-west point of the large island east of the extremity of Deadman's Point, are composed of schistose rocks, somewhat darker in colour and partaking more

Rocks of Saganagons Lake.

of the character of hornblendic schists ; these rocks are also exposed on the northern part of this island. On the south-west point of it, however, is an abrupt high rounded *roche moutonnée*, of massive rock, somewhat darker in colour than, but no doubt related to, the greenstones. Along the south shore of this island there are few exposures ; but near the middle and the east end, the greenstones are again seen, here containing irregular and crooked stringers of quartz. The small island lying off the main south shore opposite, also exhibits the same rock, containing similar stringers of white quartz. These quartz veins are comparatively a common feature, not only in the greenstones but in the more fissile chloritic schists.

None were seen of any considerable width, they are not more than two or three inches, and seem to be veins of infiltration, which, as a rule, cut across the structural planes of the rock.

Magnetite in greenstones.

The greenstones of Saganagons Lake do not generally affect the compass strongly ; but in this neighbourhood they contain sufficient magnetite to cause the needle to diverge considerably from the magnetic meridian.

On the main shore, opposite the east end of the large island last referred to, the rock is schistose but not fissile, it is light greenish-gray in colour and strikes N. 75° E. with a vertical dip. East of this the strike curves to the east in conformity with the shore and the rock becomes very fissile. Then for a mile along the south shore of this eastern part of the lake, there is no exposure. From here these light greenish-gray fissile schists are exposed all along the south shore to the eastern end of the lake. The strike changes from east to N. 75° E. in strict conformity with the general sweep of the shore line. The dips are south at angles never less than 75° and often vertical.

Saganagons Lake, east end.

Crossing the strike of the rocks along the eastern shore at the end of the lake, we find in adjacent exposures the rocks becoming darker in colour, coarser in texture and revealing distinct crystals of hornblende ; the rock is quite schistose, although harder and more compact than the chlorite schists.

Hornblende schist.

This hornblende schist is seen in the north-east corner of the lake, and all along the north shore of the large island south-west, and on the small islands between this and the north shore of the lake.

Hornblendic schists merging into ordinary black medium grained hornblendic schists are seen at several points along the north shore westward to the north-westward contact of the granites, and in the channel forming the outlet of Cross and Beaver Lakes. East of this channel the shore line adheres closely to the strike of the rocks.

There is considerable evidence in support of the belief that the light greenish-gray chlorite schists described as representing a large proportion of the rocks exposed about Saganagons Lake, and seeming to differ from the greenstones in external character, only in the varying degree of their schistosity, are derived by crushing, shearing and metasomatic change from these greenstones. Chloritic schist derived from greenstones.

Their macroscopic appearance is extremely suggestive of this, and the change in mineral composition involved is a simple one, frequently exemplified. I have not traced, in unbroken section, a passage from one into the other, but the scattered exposures afforded by the islands show a variation in degree of schistosity, hardness and texture, in such a way, and in such localities, as to render it highly probable that a Passage of this kind actually occurs. From the localities of greenstone already enumerated in Saganagons Lake, it will be seen that of the two south-western arms, the most westerly one is eroded out of these massive rocks. From the mouth of this arm the greenstones seem to strike in a north-east direction, under the waters of the lake and reappear on the south side skirting the channel between the south shore of the lake and the off-lying islands, occurring sometimes on the main shore, sometimes on the islands and sometimes on both, disappearing altogether in the open part of the lake east of Deadman's Point.

South-west of Saganagons Lake, Jasper, Cypress, Big Rock and Emerald lakes are eroded, for the most part, out of the massive greenstones.

It is inconceivable that these hard rocks altered chemically to their most stable form, can have been the most susceptible to denuding agencies, and we are forced to the conclusion that this channel that we have traced for twenty-two miles from the west end of Emerald Lake to the east end of Saganagons Lake, must have been originally occupied by soft fissile schists, flanked for the most part by greenstones. The sinuous line of this channel, which sweeps across the main Keewatin trough from the north side to near the south-west side, renders it improbable that these soft schists were originally the upper portion of the series, folded within the underlying traps, and it would seem more probable that this assumed schistose belt marks the plane along which the traps yielded, within themselves, to the crushing and shearing forces induced by the sharp folding of the series. Fissile schist flanked by greenstones.

The breadth of the Keewatin series here revealed, does not afford any certain criterion by which to estimate its original thickness. The dips show an apparently simple synclinal structure of a series folded on itself. I have nowhere examined a complete section across the belt, Thickness of Keewatin series.

and cannot say whether the series affords any evidence of having been repeated by multiple folding or not. Again, from what is known of the distribution of the rocks on the American side of the international boundary, the hornblende granites of Saganaga Lake and Cache Bay, which from Swamp Lake sweep to the south around Gull Lake, would appear to be the south-westward ovoid termination of a large granitic area, dividing the main Keewatin trough into two branches, of which the northerly one is that seen on the Canadian side and above described, and the southerly one is seen only in a narrow tapering band of greenstones south of Gull Lake in township 65, ranges IV. and V., Minnesota, and no doubt represented, further east on the Canadian side, by the greenish-black schists of the north side of Gunflint Lake. This southern fork is largely concealed under sediments of a later age, and partly interrupted by the gabbro of the Mesabi range.

This belt branch of belt to south-west.

Thus the volume revealed between Saganagons and Saganaga lakes probably does not include the whole of the series, the upper members in all likelihood being wanting.

Width of belt.

The distance from the contact at the Deadman's portage, across the strike, to where the line of junction intersects the north-west shore of Saganaga Lake, is four miles. The rocks dip on the north at a high angle to the south, usually about 75°, and on the south side at about the same angle to the north and are vertical at the central synclinal axis; an average dip of 85° will not be far from correct, and this would give 1·992 miles as the average thickness of the series developed in this trough.

Thickness.

South-westward extension.

North-easterly extension of Keewatin belt.

As before stated, this belt has been traced in connection with that holding the iron ores of Tower and Ely to the south-west. This Keewatin belt, characteristically an iron-bearing series throughout its whole length, would appear to bend somewhat sharply to the north, east of Beaver Lake, then to sweep round more easterly, with its northern limit about three or four miles south of the south-east corner of Moss Township, thence to skirt south of Greenwater and Shebandawan lakes.

Iron ores.

Iron ores, of good quality, have been found at several points in this band, and on the line of the Canadian Pacific Railway, at several points west of Port Arthur, in a broader development of Keewatin rocks, no doubt magnified by the union of several broad bands.

Small isolated bands of hornblende schist.

Small isolated bands of hornblende schist, apparently included in, but quite conformable with the granitic rocks, are seen in several localities, sometimes at considerable distances from the Keewatin belt with which they would seem to be genetically identical.

Four miles and a half north-west of the Keewatin area, near Burk Lake, at a point between the north and north-east bays in the west end, occurs a band of hornblende schist, forty or fifty feet wide, in foliated pink-gray biotite granite gneiss. Large inclusions or lenticular bands of hornblende schist are seen in the pinkish-gray gneiss at the east end of Sunday Lake, two miles north-west of the main Keewatin trough. These bands would appear to indicate an original synclinal fold of the overlying Keewatin, yet the latter locality is in a direct line with the anticlinal, indicated by the diverging dips of the rocks, of Agnes Lake, two miles to the north-east, and which axis of divergence of foliation planes can be traced along the north-west shore of Louisa Lake to Farquier Lake.

Burk Lake. Sunday Lake. Agnes Lake. Farquier Lake.

On the second lake north-east of Farquier Lake, the red granite contains dark gray schistose hornblendic rock, with felspar, which more closely resembles a hornblende schist than a hornblende gneiss, but it may have been derived from the latter by crushing and shearing.

There is a band of coarse-grained hornblende schist, about three chains wide, on the west side of the large island in Agnes Lake, one mile south-east of the outlet of Lake Silence. It also occupies a small island close to the larger one. This is interbanded with thin bands of gneiss. The rock is more coarsely crystalline and also more schistose near the contact than in the central portion of the band. This may be a crushed and sheared hornblende eruptive rock.

Lake Silence.

Included in the granitic rocks are frequently found small areas of massive, coarsely crystalline, greenish black hornblendic rock, not at all schistose, sometimes measuring only a few feet in greatest length, which appear to be scattered angular fragments included in the granites. Several such areas are seen on Agnes Lake. They are here linear in their distribution, and are seen occasionally on the islands near the west shore, from the north end of the lake to the south-west bay, where they are seen on the west shore. Large irregular fragments or areas are seen on the portage south from Shade Lake included in micaceous gneiss, and they are here so frequent as to constitute the most abundant rock. From this locality, both north-east and south-west, the occurrences of this hornblende rock become less frequent, and the fragments are of smaller size, disappearing altogether about a mile each way.

Hornblende rock. Agnes Lake. Shade Lake.

Bands of hornblendic schist are also seen included in the red medium-grained granite of McNiece Lake. The granite here contains little bi-silicate, which now is mostly chlorite. On the point at the south end of Yum-Yum Lake, a local narrow band of micaceous siliceous hornblende schist is also seen.

McNiece Lake. Yum-Yum Lake.

Kahnipiminanikok Lake

A coarse grained sheared hornblende rock is associated with the mica schists of the south side of the inlet of Kahnipiminanikok Lake leading to McKenzie Lake, the most northerly one of the two deep inlets running north-east from the centre of the lake. As I shall have frequent occasion to refer to these two inlets, it will be convenient to call the north-westerly one McKenzie bay or inlet, and the one to the south-east of this Kahwawiagamak bay or inlet.

Brent Lake.

On the south side of Brent Lake, due south of the portage leading to Conmee Lake, is a narrow lenticular band of dark gray, decomposed felspathic hornblende rock, probably lithologically allied to those already described; most of it is concealed under the waters of the lake and only a few feet of its width is revealed.

Saganagons Lake.

At the north-western extremity of Saganagons Lake is a small area coloured Keewatin, but in which the rock is a hard, coarsely crystalline hornblende rock, with occasionally a few scales of biotite, and more rarely a little felspar. It is not at all schistose, and its general aspect and mode of occurrence is that of an eruptive rock, perhaps post Keewatin in age. The extension of the rocks composing it, east and west of the channel, is a matter of conjecture.

Keewatin volcanic vent.

Explanation of angular fragments in granite.

The small isolated areas described about Agnes and Shade lakes, on account of their diminutive size and proximity to each other, are probably highly metamorphosed fragments of Keewatin rocks, broken off from the troughs of synclinal axes, at the time that the Keewatin series was so sharply folded, and imbedded in the underlying rocks, and representing now all of the Keewatin series that denudation has spared in these localities.

Dikes.

Diabase dikes.

There were not observed in the Hunters Island region, many of those "Port Archæan Diabase Traps," described by Dr. Lawson[1] and by Dr. Lawson and Mr. F. Shutt, M.A.[2]. Indeed only two such dikes were observed by the writer, the one shown on McKenzie Inlet of Kahnipiminanikok Lake, and the other exposed on an island lying off the east shore of the bay running north, one mile west of the mouth of this inlet. This dike is not seen on the north side of this bay and the only indication of it, south of the island, is afforded by the strong magnetic attraction observed on the point at the mouth of this bay, on the east side.

Kahnipiminanikok Lake. Bay north of McKenzie Inlet.

1. Geol. Survey of Canada, Annual Rep., 1887-88, Vol. III., part I., pp. 147-163 F.
2. American Geologist, vol. VII., No. 3, March, 1891.

The island is less than one chain wide and two chains long. The whole of it is occupied by a fine-grained black crystalline diabase, which in one place, on the south-east extremity of the island, has become serpentinized. Detached hand specimens exhibit distinct polarity. As near as can be judged, the direction of the dike is a little west of south. On the west side of the island the rock becomes finer in texture which indicates the proximity of the wall. It is not seen on the south side of the lake across the channel.

McKenzie Inlet dike.

The dike indicated on the map in McKenzie Inlet can be much more closely studied, particularly on the south side of the inlet, where its contact with the inclosing mica schists is clearly seen.

The differentiation in texture between the wall and the centre, which is such a characteristic feature of these dikes was observed. The rock is a fine to coarse-grained, black, weathering pepper and salt gray, crystalline diabase. The width of the dike is sixty feet. Its course from the exposure on the south to that on the north side is due north, which is also the direction of the walls on the south side. It would not appear to extend very far south, as it is not seen in this direction, this, however, may be accounted for by the prevalence of drift in some of the localities where it might be expected to occur. It cuts the Laurentian rocks on the north side of the inlet, and the Coutchiching on the south, in such a way as to leave little doubt that it was intruded since the period of the last folding, which on the assumption that the Coutchiching and Keewatin rocks were folded at the same time, would establish their geological age as post-Keewatin.

Age of dikes.

Other dikes.

Other dike-like masses have been alluded to in previous pages, but they are not lithologically allied to these diabases, and their intrusive character is but conjectural.

Glacial Phenomena.

Lake of the Woods and Rainy Lake region.

The remarks made by Dr. Lawson in his report on the Lake of the Woods region, in the annual report of the Geological Survey for the year 1885, Part CC, and on the Rainy Lake region in the annual report for 1887, Part F, are generally applicable to this region also; the same features of glaciated surface, exhibiting generally rounded hill features and *roches moutonnées*, with the prevalence of drift, usually gravel, on the sides of elevations away from the direction from which the ice moved, are met with here. But while the broader features of glaciation are not less general or less marked in this region than in those reported on by Dr. Lawson, the minuter features of striations and groovings of the rocks are neither such conspicuous or universal

Roches moutonnées.

Glacial drift.

Glacial striæ less frequent.

features as in those districts; indeed in the area embraced in the western half of the accompanying sheet such indications are extremely rare, and only one observation is recorded. This is no doubt due to the prevalence of mica schists in this portion; the comparatively soft and friable nature of these rocks has no doubt yielded so readily to aerial influences, as to obliterate the striations in the period that has elapsed since glacial times; but the comparative evenness of this part of the country in minute superficial features as in great, attest that these rocks have yielded more profoundly, and have been planed to a greater uniformity of level by the passage of glacier ice, than have the harder granitic rocks of the Laurentian and eruptive and even schistose rocks of the Keewatin series.

Profound glaciation of Coutchiching rocks.

Preservation of striæ in different rocks

The only striation recorded in the western part of the sheet, occurs in the felsitic granites of Sand Point Lake; which is in accordance with the general rule that the granitic rocks preserve the striations for longer periods than the mica schists. In this region the Keewatin rocks have preserved the striations with still more clearness and persistency than the granitic rocks.

Nearly all the striæ observed are represented by a conventional sign which indicates their direction; and from these we can gather an approximate estimate of the general direction of ice movement.

Striæ in Sand Point Lake.

The single observation near Sand Point Lake indicates that there the direction of movement was S. 28° W.

Sturgeon Lake.

In the neighbourhood of the western part of Sturgeon Lake the directions of the striæ vary from S. 3° W. to S. 22° W.; and average direction of the greater number of the striæ is about S. 20° W.; south of this on Hoffmann and Pooh-Bah lakes, the same direction is indicated by striæ not recorded on the map.

Pooh Bah and Hoffmann Lakes.

In the neighbourhood of the middle part of Sturgeon Lake, the striæ vary in direction from S. 17° W. to S. 30° W.; and in the vicinity of the eastern part of this lake and of Russell Lake they vary from S. 2° W. to S. 32° W.; both extremes doubtless represent local deflections in ice movement due to local inequalities, and may be neglected in computing the general direction of movement, which would appear to be from S. 17° W. to S. 23° W.

Russell Lake.

Two observations in the shores of the McKenzie inlet of Kahnipiminanikok Lake give S. 27° W. and S. 29° W., and a third observation not recorded on the map indicates a direction of S. 17° W.

Lake Silence. McIntyre Lake.

Single observations on Lake Silence, and at the north end of McIntyre Lake, give directions of S. 19° W., and of S. 12° W., respectively.

The striæ observed on Knife, Emerald, and Carp lakes, and on The Other Man's Lake, vary between extremes of S. 10° W. and S. 38° W., and the general direction is S. 23° W. Knife, Emerald, Carp and Other Man's lakes.

On Cypress and Jasper Lakes, and on Cache Bay of Saganaga Lake, the striæ range between S. 10° W. and S. 28° W., and the most common direction is nearly the mean of these two, or S. 20° W. Cypress, Jasper and Saganaga lakes (Cache Bay).

In the vicinity of the western part of Saganagons Lake, the direction of ice movement has varied from S. 15° W. to S. 32° W.; and on the eastern part of the lake the movement has diverged very little from S. 20° W.; a local variation north of this is indicated on Beaver Lake, by striæ bearing S. 8° W. Saganagons Lake. Beaver Lake.

At a locality on the south shore of Saganagons Lake, near the middle, two sets of striæ were observed intersecting each other; but from the indistinctness of both sets it could not be determined with certainty which was the more recent. One set has a direction of S. 43° W. and the others bear S. 23° W. Two sets of striæ.

Mr. Robert Chalmers of this department in his paper on the "Glaciation of Eastern Canada,"* says: "The divergent courses of striæ, "often seen upon the same rock surface, are, however, sometimes "explicable on the theory of their having been produced by successive "portions of the diminishing glaciers, conforming in their motions more "closely to the surface features, during the period of melting." From the rarity of occurrence of this phenomena it would seem to be accounted for with more probability on this assumption, than by supposing these intersecting striæ to indicate the passage of two successive fields of ice at important intervals of time.

Roches moutonnées, well marked and prominent, form a conspicuous feature of shore surface in Kahnipiminanikok Lake and elsewhere, and prove the south-westerly flow of the ice. The direction of their axes (about S. 42° W.) appears to be rather a function of the structure of the rock, with whose strike it agrees, than of the direction of movement of the ice; which movement so far as observed in this region is never so westerly in its course. *Roches moutonnées* Kahnipiminanikok Lake.

It will be seen from the above records that over this whole area the direction of the ice flow has varied between extreme limits of S. 2° W. and S. 39° W.; and that the general direction is roughly S. 20° W. General direction of ice movement.

Dr. Lawson calculated the average direction of the ice flow in the Rainy Lake region† to be about S. 40° W. and in the Lake of the Woods region‡ to be about S. 45° W. These diverging directions are Rainy Lake region. Lake of the Woods region.

* Canadian Record of Science. April, 1889.

† Geol. Survey of Canada, Annual Rep., 1887-88, vol. III., part I., p. 164 F.

‡ " " " " 1885 " I., p. 138 CC.

doubtless a function of the direction of the general slope of these different portions of the country in glacial times, and would indicate that the glaciers have been shed from the higher northern slopes of the Archæan nucleus, in varying directions normal to the periphery of this nucleus, and determined by the general slope of each region, as suggested by Mr. Chalmers in the paper above quoted.

Erratic boulders.

Boulders transported by ice are not uncommon, but none were observed which by their composition indicated that they had necessarily been carried from any great distance.

South-east arm of Sturgeon Lake.

A curious boulder of granite, weighing many tons, and evidently transported by ice for some distance, rises ten or twelve feet out of the water in the middle of the first expansion, south of Sturgeon Lake, of the south-east arm. The under surface sloping out of the water is finely striated and the corners and edges well rounded.

Sometimes the surfaces of the rocks are seen to be indented by curious cracks in the shape of the arc of a circle and concentric with each other. These "chatter cracks" are doubtless caused by a large boulder being forced over the surface by an inclosing ice sheet, in which it is held very tightly, and in such a way that it cuts the surface of the rock for a short distance, then slips to catch the surface again a few inches further on. An instance of this kind occurring in Basswood Lake is figured in Plate IV.

Economic Geology.

Land suitable for farming.

No actual lumbering has been done in this part of the country. The forest trees have been already referred to. While the portion of Western Ontario depicted on the map which accompanies this report, offers practically no inducement to the agricultural settler, it is by no means devoid of areas covered by post glacial drift deposits, which would yield good crops for the sustenance of settlers led there by other interests, such as the miners, and for this purpose there is good land amply sufficient to fulfil all the possible requirements for many years.

Farming land in Indian reserves.

The largest drift areas, and those conspicuously the best, from an agricultural stand-point, have been granted to the Indians, and are for the most part included in the boundaries of Reserve D and Reserve 24C. The soil of the western part of the former is a sandy loam, but the eastern half is characterized as wild lands, and does not offer many agricultural facilities. The latter I have not visited in person, but I am informed that in the valley of the lower part of the Kawawiagamak River good farming land occurs.

Much good land in separate areas, sometimes of considerable extent, is seen in the whole valley of the Maligne River, including both shores of Tanners Lake, and extending in a broad belt along both sides of the river. Maligne River valley.

Very good land is also afforded by the alluvial drift near the mouth of the Namakan River, on the north side. North of Namakan Lake, in the western part, are also some areas of drift which would be worth cultivating if a market for the products were provided. Namakan River and Lake.

It is generally assumed that Laurentian and Coutchiching rocks do not contain metalliferous veins; narrow and subordinate veins of quartz do occur in the rocks of both these series, but they are as a rule not very persistent, and have not been found to contain any mineral, with the one exception of the molybdenite bearing quartz vein of the Bears passage of Rainy Lake, described by Dr. Lawson in his report, Vol. III., Part I.; 1887-88, p. 181 F. Granites in the neighbourhood of its contact with Keewatin rocks frequently contain valuable veins. Barrenness of the Laurentian and Coutchiching series with regard to metalliferous deposits.

Quartz veins are more abundant, larger and more important in rocks of the Coutchiching series, than in the underlying rocks; and some of them may yet be found to contain economic quantities of precious metals. The writer has since found low grade magnetic iron ores in rocks probably of Coutchiching age. In the rocks of these series however, one mineral may be hopefully looked for. The mica of the pegmatite patches, veins and dikes, is of excellent quality; while on the surface I have seen no sheets of considerable size, it is not unreasonable to hope that beneath the surface, below the level of aerial influences, sheets sufficiently large to be of commercial value will be found. Quartz veins. Mica.

The iron ores of the Keewatin belt of rocks, indicated on the south-eastern part of the sheet, have been already referred to at considerable length. These would appear to offer the brightest promise of future mining activity of any iron ores known between Lake Superior and the Lake of the Woods. The iron ores of the Atikokan River are very promising; but for these no other worked deposits, quite similar in occurrence, afford criteria by which their value can be more closely estimated, such as the mines of Tower and Ely afford for the estimation of the Hunters Island ores.

Additional prospecting, in the rocks of this Keewatin belt, will very likely be rewarded by the discovery of gold-bearing veins, as well as occurrences of other minerals.

In 1866 there was considerable excitement over the discovery of auriferous quartz in the Keewatin schists of Vermilion Lake in Minnesota. From twenty to thirty dollars of gold to the ton of quartz was

assayed from specimens brought in.* The gold-bearing quartz of the Lake of the Woods occurs generally in rocks of Keewatin age, but the veins of the "Sultana," "Ophir" and other mines of this district occur in granitic rocks, which the writer is inclined to regard as later post-Keewatin eruptives, but which may be of Laurentian age. The gold-bearing veins discovered north of the Atic-Okan and Seine Rivers, in the district north of that to which this report refers, occur in quartz-porphyries (often very similar macroscopically to the coarse grained granites of the Lake of the Woods in which the gold-bearing veins occur) and which are very probably post-Keewatin in age.

The development of the great mineral wealth of this counry is hampered by the entire lack of transportation facilities and is retarded by a spirit of petty speculation encouraged by laws which make clever speculation more immediately lucrative than active mining.

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* *Vide* 18th Annual Rep. of Minnesota, p. 19.