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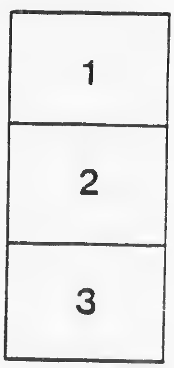
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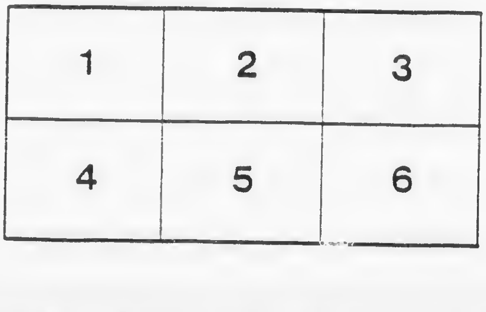
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NOTICE OF

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No. 1. THE HURONIAN OF THE MOOSE RIVER BASIN, BY W. A. PARKS.

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THE HURONIAN OF THE MOOSE RIVER BASIN

BY

WILLIAM ARTHUR PARKS, B.A

NOTICE OF

THE HURONIAN OF THE MOOSE RIVER BASIN

The Moose River, entering the south-west angle of James Bay, drains an immense triangular area of which the apex is at the river's mouth and the base stretches from above Lake Abitibi to a point west of Kabinakagami Lake. Each side of this triangle is approximately 250 miles, and, allowing for sinuosities in the boundary, its area cannot be less than 30,000 square miles.

Explorations in this extensive region have not yet put us in possession of the minute information desirable. In 1865 Dr. Robert Bell made certain explorations which are described in his report to the Geological Survey of Canada in 1875, and at a later date also he was employed for several years in this district. The results of his investigations may be found in the Report of the Geological Survey of Canada for 1880-2. Mr. E. B. Borron likewise made several journeys, particularly in 1881 and 1882, and reported on his explorations to the Ontario Government.[1] In 1896 Mr. Alexander Niven was commissioned to lay down the boundary line between Nipissing and Algoma, which he extended for one hundred and twenty miles; he was accompanied by Mr. E. Burwash, whose report on the geology of the region traversed appears in the Report of the Bureau of Mines of Ontario for 1896. This boundary line was continued to the Moose River in 1898, and a base line carried westward from the 120th post in 1899. The writer accompanied the two latter expeditions as geologist, and his reports appear in the Reports of the Bureau of Mines for these years.

With the exception of the above mentioned reports, there is very little available literature bearing on the region in question. The southern and major portion of its triangular area consists of Laurentian gneisses and granites crossed by several bands of Huronian rocks. The upper part presents limestones, dolomites and shales of Devonian and possibly also of Silurian age. The present paper deals with the Huronian alone, and more particularly with the petrography of the series as here exemplified. For information as to the general geology and topography, economic resources and other points, reference must be made to the reports above cited.

[1] *Report of E. B. Borron, Stipendiary Magistrate, on Part of the Basin of Hudson's Bay.* Toronto, 1883.

The term "Huronian" is applied in this paper to all the rocks above the Laurentian and beneath the lowest fossiliferous strata. In this sense the expression is made to include rocks of various age and different petrographical nature, such as Logan's original Huronian, Lawson's Keewatin and Couchiching series, the Animikie and Nepigon formations, the graywacké and associated rocks of the Sudbury region and the various schists, altered eruptives and crushed granites characteristic of wide areas in northern Ontario. In the region under discussion the Huronian is represented by a great variety of schists, presumably of clastic origin, and by others of altered eruptive nature, closely associated with both acid and basic eruptives in various stages of decomposition. No limestones or sandstones occur anywhere in the region examined by the writer, although Dr. Bell reports the former rock just so'th of the height of land near the Montreal River, and Mr. Burwash also refers to it.

It is in regard to the various schists that the great difficulty of determination arises. To establish a fixed nomenclature for these is almost impossible, as their varieties of colour, structure and texture are practically innumerable. In a distance of twenty feet no less than seven distinct varieties were counted on one occasion. On the other hand, to pass by these rocks with a mere description is altogether unsatisfactory, as megascopic descriptions by different observers might leave considerable doubt as to the identity of similar exposures. For example, the same rock is described as "dark quartzite," "dark gray siliceous schist," "quartzose schist," etc. To the trained scientist these terms, while not petrographically synonymous, are sufficiently suggestive to recall the rock in question. In publications, however, intended for the guidance of prospectors, this method causes great uncertainty. For economic purposes, it would suffice to establish the fact that, for a particular region, a certain variety of rock was ore-bearing, leaving the question of its origin to more scientific observers; but there are too many gradations to render such a classification of any real value. It is only on the basis of origin that a satisfactory arrangement can be effected.

The petrographical peculiarities of the rocks encountered will first be described, with little or no reference to geographical position, and afterwards the great Huronian areas will be outlined and the location of particular species indicated.

I

All rocks are either eruptive or sedimentary in origin, but such a primary division is useless in the present instance, where dynamic metamorphism has obliterated the dividing line and induced resemblances which force rocks of different origin into the same group on account of similarity of structure. Nevertheless it is to origin that we must look in deciding the more minute divisions.

We have therefore:—

I. Unaltered eruptives.

II. Much metamorphosed eruptives and clastics, generally schistose in structure, which may be embraced in the term *schist*.

Among unaltered eruptives are included all those rocks of primary igneous origin, in which the original structure and mineral constituents are unaltered or but slightly affected. They may be grouped and will be considered in the following order:—

(1) Acid or potash-feldspar rocks: *Granite, syenite, augite syenite, quartz porphyry.*

(2) Basic or plagioclase rock: *Diorite, diabase, olivine diabase, gabbro, basalt, amygdaloidal trap, pyroxenite, anorthosite.*

Granite.—This rock, in an unaltered condition, plays but a subordinate part in the geology of the district, as far as the Huronian is concerned. When present in this formation it is generally in the form of narrow dykes, conforming to the strike of the schists; the district described as the "second area" is more remarkable for these rocks. Muscovite, hornblende and biotite granites have been observed; in all cases they are typical and require no further notice. Large masses of granite, in some cases probably eruptive, in others representing the non-laminated portion of the Laurentian matrix, are common in many parts of the regions of that age. According to the theory of Dr. Lawson[1] the granitic portion of the matrix would be distant from, and the gneissoid portion near to the Huronian contact. On this assumption much of the granite observed must be eruptive, for a loss of lamination on approaching the contact is apparent in many places. Some of these masses are

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[1] *Report on the Geology of the Rainy Lake Region.* (Report Geol. Surv. Can., 1887, page 112.)

mapped as eruptive granite by Dr. Bell. It is not within the scope of this paper to discuss the point. (For localities see pages 22, 23, 25, 26, 27, 30, 31, 33 and 34.)

Syenite.—This rock also is not widespread, typical examples being very few. One mass occurs about fifteen miles up the Black River and shows altered hornblende and feldspar, the character of the latter being somewhat hard to determine in the specimen obtained; but as the general field appearance is decidedly syenitic, and the microscope reveals scarcely any trace of striation in the feldspar, it is concluded that the rock is syenite, although it probably contains some plagioclase. In addition to this exposure and some narrow bands associated with the schists, all the syenite is, like the granite, blended with gneiss and syenite gneiss and must be classed as Laurentian. (For localities see pages 23 and 30.)

Augite syenite.—The mass of eruptive which crosses the Abitibi River, forming the Lobstick and other rapids as well as the Great Canyon, is represented at its upper or southern margin by a rock of this nature, which continues with some variations for two or three miles. It is intersected by small dykes of fine black diabase, which present some beautiful examples of miniature faulting and branching. At the Lobstick Portage it is somewhat schistose in places and much altered, showing numerous red garnets, a little quartz, considerable orthoclase and some plagioclase with bright green augite. At the Oil Can Portage and above it, a section shows fairly large crystals of augite in a somewhat finer and mosaic-like mass of orthoclase with a little quartz and plagioclase. The augite is, in many places, almost entirely altered to fibrous hornblende, flakes of brown mica, garnet and magnetite. This rock presents a grayish-black, somewhat speckled appearance with evidence of flow structure or secondary lamination. In its more altered parts are seen sphene and mellilite. (For localities see page 33.)

Quartz porphyry.—This rock does not occur in a good state of preservation, but in an altered and schistose condition it is very common; in order to carry out the classification adopted, it cannot be included here but will receive consideration under the schists.

Diorite.—Typical diorite is composed of distinct anhedra of hornblende and plagioclase, forming a hard, massive and sonorous rock. In some cases the individual minerals reach a size of several inches, giving the rock a mottled appearance. From this coarse variety all gradations are seen down to that composed of individuals of microscopic size. The finer examples on fresh fracture still show the crystalline structure, but the mottled appearance is entirely lost, partly owing to the fineness of texture, but perhaps more in consequence of discoloration of the feldspar. This type is common and fairly fine examples are the rule, no very coarse diorites being seen in the region.

Diorite occurs in large dykes traversing the country rock in all directions, and also frequently in irregular masses forming the summits of hills; in some instances the intrusive mass has lifted the country schists to the summit of the hill, while the diorite appears on the flanks. By far the most general manner of occurrence is in bands of varying thickness, conformable with the strike and dip of the schists, which is generally at a high angle. These thin bands are invariably fine-grained and almost black in colour. Many of them towards their borders have entirely lost the crystalline structure and are homogeneous to the naked eye; the microscope, however, reveals some traces of crystallization in ill-formed hornblende and magnetite crystals, due, of course, to the more rapid cooling of the exterior of the mass. An important consideration now confronts us. Are these interbedded diorites contemporaneous with the schists, are they subsequent eruptions, or are the schists themselves derived from the diorites? It is probable that all these cases occur. The diorites can thus be divided into three classes, (1) massive eruptives, (2) contemporaneous diorites, (3) diorites passing into diorite schists.

(1) The class of massive eruptives can be recognized by a distinct crystalline structure nearly always increasing in fineness towards the borders and *on both sides.* All the irregular masses that form hills, the large dykes crossing the country rock, and many of the interlaminated sheets show this peculiarity. As far as the last variety is concerned, the bilateral symmetry of the mass can be accounted for on no other assumption than that of subsequent injection. The accessory evidence of a sheet of diorite breaking across from one plane of stratification to another has not been observed here, although it is well known to occur.

(2) Contemporaneous diorites are generally less crystalline, more easily weathered and more inclined to show irregularities of colour and structure. If these rocks were originally overflows

they must have consolidated as diabases, because diorite is generally considered as essentially plutonic. On the assumption that the original magma was covered by clastic materials which eventually became metamorphosed into schists, we should expect to find a difference between the lower and the upper surfaces. This condition has been observed by no means constantly. A sufficient number, however, on examination gave convincing evidence of their contemporaneous nature, and it seems advisable to include in this class most of the narrow bands, perhaps all in which no bilateral arrangement can be detected.

(3) Rocks of the third class, *viz.*, diorites passing into diorite schists, consist of ordinary diorite towards the centre of the layer becoming more and more schistose outwards, and finally fading away into other schists without any distinct line of demarcation. This type of rock is doubtless the result of intense metamorphism, and, while easily recognized, affords very little information as to origin. While they seem to be best placed in a class by themselves, they are more probably derived from the second than from the first group on account of the difference in composition towards the borders. The outer parts show much more quartz than the inner. This could hardly result from metamorphism alone; therefore it is concluded that they were more or less mixed with acid clastics, which would point to a more contemporaneous origin.

Any of these diorites may present varieties, but more especially those of the first class. While typical diorite consists of hornblende and plagioclase, the former ingredient may be replaced wholly or in part by black biotite, giving a rock known as mica diorite, or quartz may occur, forming quartz diorite. Both these varieties are found in the region, as well as quartz mica diorite (tonalite). The latter generally has a pink feldspar and much resembles granite; a section to ascertain the nature of the feldspar is the only sure means of determination.

The passage of diorite into diorite schist and the so-called "greenschists" is a subject of much controversy. The metamorphism is accompanied by various phenomena of alteration, as changes in texture, softening, change of colour, alteration of hornblende to actinolite or chlorite, or even to hematite, magnetite, etc., alteration of feldspar to epidote and saussurite and in many places to calcite. These various changes have produced rocks which are in many instances almost impossible to recognize, and must be named more or less by analogy. They are included under the schists and a more detailed description will be given later. (For localities see pages 23, 25, 27, 28, 30, 31, 32, 33 and 34.)

Diabase.—This rock is by no means as common as diorite and its examples seem to belong to different periods of injection. Those of similar age to the diorites and schists are generally much altered; while a second series, of apparently later age, better retains the original nature. Rocks of the latter type occur in narrow dykes crossing the country rock in all directions; they are particularly noticeable in the eruptive region of the Abitibi Canyon. These belts are uniformly very fine-grained and black in colour; they commonly show a difference of texture at the periphery, which weathers smooth while the centre has a more punctated appearance. (See pages 22, 23, 24, 26, and 33.)

Olivine diabase.—Large boulders of this rock were found at the Sextant Portage in the Devonian area, and must have been derived from the neighbouring Huronian, although not seen *in situ*. A section shows the usual diabase structure with needles of apatite and irregular patches of olivine, which is much altered to magnetite.

Gabbro.—The most characteristic examples of gabbro occur on the northern part of the Abitibi Canyon, and even there it can scarcely be considered typical. The best exposures are seen at the deepest part of the gorge, where the cliffs are 100 feet high and of a dark massive appearance. Under the microscope the augite is seen in distinct crystals but little decomposed. The feldspar is represented by both varieties with the plagioclase in excess, whence it may be termed gabbro, although further south it passes into augite syenite. (See page 33.)

Basalt, amygdaloidal trap, pyroxenite and *anorthosite* are of such rare occurrence that sufficient reference to them will be found in the notes of distribution. (See pages 23 and 33.)

The whole series of Huronian rocks not included under the unaltered eruptives it is proposed to group together as schists, although they may not always present a schistose structure. The use of this term is at the best very uncertain, as is seen by the interpretation placed upon it by Professors Irving, Chamberlin and Van Hise. "Almost any non-fossiliferous rock presenting in some sort a stratiform structure, and more compact and indurated than is usual with post-archaean strata, has been spoken of as a crystalline schist. . . . The near approach of certain foliated fragmental derivatives to typical crystalline schists—indeed their gradation into undistinguishable, if not identical, forms, and the passage of massive eruptives into schistose phases — would render very difficult a sharply limited consideration of the typical crystalline schists." [1]

In this broad sense our region is for the most part made up of such derivatives, which may be divided into two main groups, (1) those whose origin was probably eruptive, (2) those whose origin was probably clastic. The difficulty in distinguishing these two classes is very great, as they pass imperceptibly into each other and as a mass of certain ultimate composition whether originally eruptive or deposited as a fragmental may give rise to the same rock. Professor Williams says, "Between undoubted massive rocks rendered schistose by pressure on the one hand, and fragmental tuffs which have been more or less completely solidified by the same agency on the other, there must therefore be rocks whose original form must always remain uncertain." [2]

In this connection see also Irving, Chamberlin and Van Hise, "The greenschists have been derived by the modification of original eruptives and present a degradational development which may be looked upon as offering a contrast to the constructive development of the crystallines built up from clastic originals." [3]

It will therefore be evident that any attempt to classify these rocks must prove in some manner unsatisfactory; various authors will adopt different methods, and some overlapping and uncertainty will always exist. The above mentioned authorities classify the Lake Superior schists thus:—

I. Eruptive derived (metamorphic) crystalline schists.

II. Tuff derived crystalline schists, which were developed from igneo-fragmental material.

III. Clastic derived crystalline schists, which were developed from fragmental rocks by secondary growths of the constituent crystalline fragments.

[1] Congrès Géologique International, *Études sur les Schistes Cristallins.* Londres, 1888, page 92.

[2] U. S. Geological Survey, *Bulletin 62*, 1890, page 133.

[3] Congrès Géologique International, *Études sur les Schistes Cristallins.* Londres, 1888, page 105.

IV. Clastic derived crystalline schists, which were developed from fragmental rocks by the conversion of the constituent silicate fragments into foliated minerals (metasomatic).

V. Chemico-clastic derived crystalline schists, in whose production chemical, organic and clastic agencies joined.[1]

Professor Dr. Albert Heim, after showing the difficulty of classification and summarizing the various effects of dynamic metamorphism, says, "Die Beschaffenheit der krystallinischen Schiefer in den Alpen ist vielfach durch den Gebirgsstauungsprozess verändert worden. Ursprüngliches und mechanisch später Gewordenes sind sehr oft noch gar nicht von einander zu unterscheiden." [2]

Dr. Andrew Lawson classifies the Keewatin series of the Lake of the Woods thus:—

I. Basic Volcanic:

Altered diabase and gabbro, massive and schistose with associated amphibolites or diorites and hornblende schists.

II. Acid Volcanic:

Altered quartz porphyries, felsite schists, sericite schists, porphyroids, etc.

III. Volcanic Clastic—pyroclastic:

Ash beds, many graywackés, tuffs, and agglomerates, both basic and acid.

IV. Detrital—epiclastic:

Conglomerates, quartzites, clay slates, micaceous slates; soft, gray, glossy hydromica schists; with chlorite schists, mica schists, and certain fine-grained gray gneisses, or rather feldspathic mica schists.

V. Gabbro, serpentine and granite.[3]

Many of the schists of our region are quite comparable to Lawson's series, but many of his members are almost or entirely lacking, notably the conglomerates, agglomerates, serpentines and graywackés.

It is not proposed here to deal with theoretical considerations as to the origin of the various representatives. Such points can only be determined by a detailed study of a more restricted area

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[1] *Ibid*, p. 104. [2] *Ibid*, p. 20.

[3] Congrès Géologique International, *Études sur les Schistes Cristallins.* Londres, 1888, page 71. *Report on the Geology of Rainy Lake Region.* (Report Geol. Surv. Canada 1887, Part F, page 57 *et seq.*)

than that now under discussion. The intention is rather to describe the various schists and to name and group them according to their present peculiarities, and, in view of the doubt attending their origin, to employ that evidence only when the rock seems to be analogous to some described by good authorities. From this point of view the following table will give an outline of the method adopted:—

I. Schists of eruptive origin:
 (*a*) The "greenschists" and diorite schists.
 (*b*) Altered porphyries and porphyrites.
 (*c*) Felsites and crushed granites.
 (*d*) Hornblende and biotite mica schists.

II. Schists of fragmental origin:
 (*a*) Pyroclastic schists and ash schists.
 (*b*) Quartzites.
 (*c*) Clay slates.

III. Schists of doubtful origin or belonging in part to both the above:
 (*a*) Quartzose schists.
 (*b*) Sericite and chlorite schists.

I. Schists of Eruptive Origin.

(*a*) *The "greenschists" and diorite schists.*—As indicated in the description of diorites, that type of rock passes gradually into diorite schist, retaining its mineral structure and merely becoming schistose by dynamic effects. These diorite schists are quite characteristic and need no comment; they are widely distributed and easily recognized, if not in the field, at least by the examination of a thin section. The "schists" are doubtless eruptives which have been subjected to more intense metamorphism and while generally occurring in narrow bands are sometimes massive and of considerable extent. They do not commonly present a schistose structure in the hand specimen, and very rarely can such a structure be made out under the microscope. In the field the weathered surface is a shade of dirty green; it generally shows a somewhat punctated appearance and frequently exhibits small whitish specks. (These must not be confused with the larger and more angular blotches seen on many altered porphyrites). The freshly broken surface is rather uneven, greenish to black in colour, and shows a somewhat silky surface, which under the hand glass is seen to be distinctly radial in structure. Microscopic sections are decidedly unsatisfactory, showing generally but an indistinct dirty mixture of kaolinized and saussurized feldspar, a very little quartz and light green hornblende and chlorite, with accessory pyite, hematite, magnetite, garnet, mica, etc. Some of these rocks very much resemble the darker varieties of quartzose schists to be subsequently described. In the field they may be distinguished from the latter rock by being more easily abraded by the hammer, and by the fact that they do not show the same tendency to break into rhomboidal blocks.

This rock is one of the most frequent occurrence and probably constitutes the bulk of the first or greater Huronian area, the limits of which will be indicated in the second part of this paper. The whole question of the metamorphism by which these rocks were produced would fill volumes. As here exemplified they are analogous to the so-called "green Huronian schists," and probably identical with the series described by Professor Williams in the "Greenstone schist area of Michigan," where he says:

"There seem to be only three different ways of explaining the facts as they are plainly and abundantly manifested in each of the several points examined on the Menominee River. We may suppose, as did Foster and Whitney, Whittlesey and Credner, that the schistose portions of the rocks exposed at these several points are more or less perfectly metamorphosed sedimentary material, while the more massive portions represent intercalated beds of eruptive origin. We may imagine on the other hand, as did Rominger and Brooks, that all of these rocks, including the most schistose and the most massive phases, are probably altered sedimentaries, supposing with Rominger that the more massive kinds are merely the same sedimentary material fused by the intensity of the metamorphosing action so as to lose all trace of the original stratification, or admitting with Brooks the possibility, though great improbability, that some of the more massive phases, like the gabbro of Sturgeon Falls, are of eruptive origin. Finally, we may imagine that all phases seen at these several places represent material of eruptive origin whose stratiform structure is due to secondary dynamic agencies. (Irving.)" [1]

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[1] U. S. Geological Survey, *Bulletin 62*, 1890, page 66.

Here Professor Williams undoubtedly includes other schists than the variety now under discussion, but from the descriptions this particular rock must form a large part of his series.

The theory that the massive diorites are intensely altered sediments is utterly untenable for this region; for proof of this the reader is referred to the remarks already made regarding the more massive diorites, to the bilateral arrangement of many of the bands, to the fact that in many instances they abut with a sharp line of distinction against entirely dissimilar rocks, and further that an enormous number of similar belts of diorite traverse the neighbouring Laurentian gneiss, notably on Hay Creek, Misanabie Lake, Little Misanabie Lake and River and the Laurentian area around the Pishkanogama and Makozenda or Trout Rivers. Granted then that the massive variety is eruptive, the frequent and beautiful gradation into rocks of this type so constantly seen is sufficient proof that they had a primary eruptive origin. (For localities see pages 22, 23, 25, 30, 31, 32 and 33.)

In this connection mention must be made of the altered diabases. Rocks of undoubted diabase origin are rare, but the possibility must be admitted that many of our greenschists are of that nature. The proof of this in many individual cases can never be obtained. However, greenschist, showing no trace of pyroxene but exhibiting undoubtedly the structure of diabase has been met with, notably on Kamiskotaia Lake. This rock is grayish green in colour, not extremely hard, and only by the microscope is its diabase origin revealed; the feldspar is almost entirely altered and the augite changed to almost colourless hornblende and chlorite, but the ophitic structure is well preserved.

(b) *Altered porphyries and porphyrites.*—As already mentioned, unaltered rocks of this type are absent, but a large series of altered representatives are met with. Schistose quartz porphyries present almost invariably a light gray or white surface and very frequently the quartz individuals stand out on the exposed surface by the weathering away of the more decomposable constituents. Concerning the origin of these rocks Professor Williams says: "They contain small porphyritic crystals of feldspar and quartz, and a considerable amount of sericite or hydromica. . . . . Rocks of this general type have a wide distribution and have arrested the particular attention of petrographical investigators. In some cases they have been conclusively proved to be the product of the metamorphism of fragmental rocks—either tuffs or true sediments—while in other cases they have resulted from the action of great dynamic forces upon massive rocks of a corresponding constitution, *i.e.*, quartz porphyries. When it is possible to trace with certainty the origin of these rocks to stratified deposits they are usually designated as porphyroids, while in case their mother rock can be shown to have been quartz porphyry they are usually called schistose porphyries. In their extreme development these two types are often petrographically indistinguishable, and they present an instructive instance of the production of identical results by the action of the same physical forces upon matter of the same average composition, though widely different in origin and structure."[1]

It is extremely probable that many of the rocks of this general appearance should, in accordance with the above view, be called porphyroids and as such be included in the clastic division. It is probable, however, that an eruptive origin, as true quartz porphyry, is the proper explanation of the presence of most of them. In many cases, by the loss of the porphyritic individuals, they pass into felsite schists, a section of which in some instances much resembles the ground mass or matrix of the altered porphyry. These rocks are associated with the diorites and greenschists as well as with the quartzose series; it may be that in the former case they are of eruptive origin and in the latter belong to the porphyroid type. A typical section from near the Montreal River shows a fine-grained ground mass mostly of quartz but rendered somewhat dirty and muddy, by decomposed feldspar and small flakes of sericite. In this are fairly large crystals of orthoclase, much altered but retaining their angular outline, together with somewhat smaller quartz individuals which, in nearly all cases, show a rounded outline. (For localities see pages 25, 26 and 33.)

Many of the so-called speckled and mottled schists as well as some more massive varieties are altered porphyrites. They may, in general, be described as gray, green and purplish rocks with blotches of white matter of an angular form. They are not as common in this region as in the Huronian around Lake Minnietakie to the westward, but exposures are found at the first falls on

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[1] U. S. Geological Survey, *Bulletin 62*, 1890, page 119.

the Frederick House River, on the line of portages between Matagami River and Porcupine Lake, and in some few other localities. A section shows a fine-grained matrix, largely of feldspar and secondary quartz with bright green chlorite, brown mica, etc. Implanted in this are large much altered plagioclase crystals.

Another peculiar schist which probably belongs here is seen on the same line of portages mentioned above. It is blackish green in colour, of a pronounced schistose character and excessively altered. A section shows plagioclase individuals surrounded by an exceedingly fine ground mass, in which the secondary minerals, largely magnetite and chlorite, are arranged in a distinctly spheroidal manner. (See page 25.)

In addition to these we find a series of very fine-grained schists of whitish or lightly tinted gray and red colour, readily weathering and presenting a soft and gray-white surface. They seem to contain little or no ferro-magnesian mineral and under the microscope show fine feldspar individuals and quartz which is largely allotriomorphic. This matrix is traversed by fine dark lines, probably representing the remains of mica or hornblende, and is dotted by relatively porphyritic crystals of plagioclase. This rock passes into coarser examples (still very fine however), in which the crystals of plagioclase can just be made out with the naked eye on fresh surfaces. The coarser of these rocks is undoubtedly a sheared porphyrite, and as it passes imperceptibly into the finer variety we are quite justified in assuming the same origin for the latter. These schists are very common and have been loosely described as "white weathering schists," "soft fine-grained schists" and possibly as "fine-grained ash rocks." (For localities see pages 25 and 31.)

(c) *Crushed granites and felsites.*—Rocks which may with safety be placed in this group are exceedingly wide-spread and present many stages of alteration. They are generally pink or light gray in colour with ill defined dark specks, and occur intercalated with various schists, particularly near the head of Lake Matagaming. Under the microscope the only well defined mineral is quartz, and sometimes orthoclase, but the latter mineral is generally much altered and presents a muddy appearance. The quartz uniformly shows undulatory extinction and frequently occurs in narrow bands of a somewhat coarser texture traversing the ground mass of the rock. The mica or hornblende, as the case may be, is always much changed and drawn out into indefinite patches in one direction so that it appears as oblong or oval spots with the long diagonals parallel. In these spots the microscope reveals actinolite threads, chlorite, magnetite, hematite, pyrite, etc. (For localities see pages 26, 27, 32 and 33.)

(*d*) *Hornblende and biotite mica schists.*—The first of these rocks is a dark gray or green mottled or homogeneous rock according to the dimensions of the constituents. It is composed of hornblende and quartz and frequently shows little or no schistose structure. Biotite mica schist is somewhat lighter in colour, with shades of brown, never green, its schistosity is more pronounced, and it is much more subject to weathering. Both rocks are more associated with the Laurentian than with the Huronian, and by the addition of feldspar frequently pass into gneiss. More or less angular fragments of these rocks are often seen imbedded in the gneiss, and they probably at one time played an important rôle.

In this connection Ch. Lory, in "Les Schists Cristallins des Alpes Occidentales," says—"Les micas schistes se chargent de feldspath et passent à des gneiss, avec lesquels ils alternent . . . . Du reste, la séparation entre les deux parties de la série des schistes cristallins est loin d'être absolue: de vrais micas schistes, avec des couches de calcaires cipolins, et même de vrais gneiss, se rencontrent jusque dans le groupe supérieur; ils alternent souvent, à diverses reprises, avec les schistes chloriteux ou amphiboliques . . . . Ainsi dans la série des pierres vertes, comme dans celle des vrais micas schistes et gneiss, les diverses structures schisteuse, gneissique ou granitoïde alternent entre elles, en concordance, sans qu'il y ait lieu de supposer que le passage de l'une à l' autre soit lié à l'intervention de roches éruptives."[1]

It will be observed that it is considered better to include here only typical examples of these rocks, and that many of the dark gray and green schists, containing, no doubt, hornblende and quartz, are classified under the quartzose schists. There are two reasons for this; first, because the amount of hornblende or mica is so small compared with the quartz and is generally so altered and indistinct that the megascopic appearance does not suggest a hornblende schist; second, because the associations of these rocks

[1] Congrès Géologique International, *Les Schistes Cristallins.* Londres, 1888 page 24.

point more to a clastic than to an igneous origin. It cannot be denied however that a sharp line is difficult to draw, and that the two classes pass one into the other.

II. Schists of Fragmental Origin.

(*a*) *Pyroclastic schists and ash rocks.*—These terms are practically synonymous, although a distinction is generally drawn, the former term being applied to examples showing round or angular fragments imbedded in a matrix, and the latter to fine-grained gray rocks.

The first type is but sparingly developed in this region, the best examples being seen at the head of the south arm of Lake Matagami. As here seen the rock is green in colour and very fine-grained; it presents a distinct flow structure around the included fragments, which vary from a foot in diameter to very small dimensions, and consist for the most part of light gray granite. The rock is therefore a conglomerate and perhaps graywacké conglomerate. Mr. Burwash reports conglomerate near Little Hawk Lake.[1]

The term "fine-grained ash rock" has been excessively employed to designate strata of a doubtful nature, but in many cases the expression is used without sufficient consideration. When the rock can be conclusively proved to have arisen from fine volcanic ejectamenta the term is as good as any other, but proof is not always available. This is possibly the origin of some of the rocks of our region, but it is preferable to class as quartzose schists and to ascribe to a doubtful or variable origin rocks which, by some observers, might be considered as ash derivatives. (See pages 21 and 22.)

(*b*) *Quartzites.*—In order to distinguish these rocks from those which have been called quartzose schists we must restrict the term to rocks in which no ferro-magnesian or micaceous ingredient occurs, and in which feldspar plays but a small part. The colour varies from white to light green or pink. By deepening of colour owing to increase in accessory minerals the rock passes into quartzose schist. Two varieties occur:—(1) Compact: a hard rock, almost pure silica in grains and broken crystals; (2) Saccharine: a loose friable variety resembling loaf sugar, typically pure white, but passing into brown and black examples by the occurrence of hematite and magnetite which are frequently seen in beautiful little crystals. (See pages 24, 25, 26, 28 and 31.)

[1] Report of the Bureau of Mines, Ontario, 1896, page 178.

(*c*) *Clay slates* and micaceous clay slates occur but sparingly and will be noted later: they are, in some cases, difficult to distinguish from true schists. (See page 26.)

III. Schists of Doubtful or Variable Origin.

(*a*) *Quartzose schists.*—This group includes a great number of rocks of varied appearance, with gradations of colour from almost white to dark green and gray. They are uniformly fine-grained and consist largely of quartz, with occasionally some fine feldspar, and a small amount of colouring matter, in many cases difficult or impossible to identify as a distinct mineral. Often, however, this matter can be resolved into mineral species, such as pearly white mica, asbestiform hornblende, hematite, magnetite and various ferro-magnesian minerals. Many of these schists show a pronounced rhomboidal cleavage and frequently films of secondary quartz occur on the planes of parting.

Under this head rocks are included which have been variously described as 'quartzites,' 'quartz schists,' 'mica and hornblende schists' and possibly the whole series loosely designated as 'fine-grained ash rocks.' The intense metamorphism to which rocks of this type have been subjected renders the question of their origin very difficult to answer. That they are altered eruptives is unlikely on account of their acid nature in contrast to the basic diorites with which they are so closely associated. Their relation to the altered quartz porphyries would nullify this conclusion, if it were not that the latter rock is of much less frequent occurrence. That they are formed of volcanic ejectamenta is also unlikely on account of their immense range and from the fact that no volcanic centres have yet been ascertained in the region. Again, the presence of so much diorite indicates a basic condition of plutonic activity and not an acid volcanic state with craters necessarily of some elevation in order to discharge the amount of ash required to form these schists. However, it is well to remember that some undoubted pyroclastics occur, and to the westward of our region are even common, and also that it has been conclusively proved by Williams and others that volcanic tuffs do pass into both diorites and acid schists. Any single example must receive the most minute examination to settle its origin; as this is impossible over the wide area in question it must suffice to name these rocks "quartzose schists," and leave the question of origin for future determination. Speaking generally the opinion of the present writer is that they are intensely altered sedimentary clastics analogous to quartzites. As might be expected many varieties occur, a few of which will be described.

A very pronounced variety, easy to recognize, and very widespread, is a hard white rock, weathering dull white, and frequently showing black veins. When broken across the planes of stratification it immediately suggests a very fine-grained quartzite. A fresh surface along the plane of stratification, however, presents small flakes of pearly white mica. This rock seems much like the novaculite described by Williams in the "Marquette Iron Region," concerning which he says,—"These are hard, compact, fine-grained but decidedly schistose beds, locally known as novaculite . . . The colour of these so-called novaculites is sometimes reddish, sometimes pale greenish or yellowish . . . Under the microscope they closely resemble the ground mass of the quartz porphyries. No porphyritic crystals, however, are ever observed, and the structure is too fine-grained to appear schistose in a thin section." (See U. S. Geological Survey, *Bulletin 62*, page 151 *et seq.*).

Another type is darker in colour, reddish or greenish, frequently exhibiting rapid changes in colour but always showing a decidedly quartz-like appearance on fresh fracture. This variety is seen to perfection at the third portage on the route between Matagami River and Kamiskotaia Lake. Examples from this region give from 69 to 78 per cent. of silica.

The third type is dark gray in colour, sometimes containing no more than 65 per cent. of silica, and is more readily weathered; it very frequently contains pyrite and it is the variety in which hornblende, mica and other ferro-magnesian constituents may be identified. This rock is more closely related to the diorites, which it somewhat resembles in rough mega-scopic characters, although its constitution is entirely different.

(*b*) *Sericite and chlorite schists.*—The sericite schists may be distinguished from any of the preceding rocks by a greater tendency to cleave; in fact they may be described as extremely fissile. Fresh fractured surfaces have a silvery appearance and sometimes are greasy to the touch. They are much more subject to sub-aerial decay; a talus of broken fragments almost always occurs at the foot of a cliff of this rock. It weathers rapidly and the surface is frequently rusty and spotted. Under the microscope the schistose structure is most pronounced. (See pages 22, 23, 25, 26, 28, 29, 30, 31 and 32.)

II

The types of rock which form the Huronian in this region having been briefly described, it remains now to outline the distribution and to point out some local peculiarities in the various schists and other rocks encountered. There may be said to be six distinct Huronian areas in the basin of the Moose River; two of these are of considerable extent and the others smaller. The first and greatest belt stretches in a north-west direction from Lake Abitibi to beyond the Misanabie River. It might well be designated the Abitibi-Misanabie area, but for brevity's sake will be hereafter referred to as the first area.

The southern boundary of this belt crosses the height of land near Muskegogama Lake, continues north and bending eastward across Minniesinaqua Lake just touches the south bay of Lake Matagami. Thence it extends a little east of north and crosses the Nipissing-Algoma line near the 96th post, to which it continues approximately parallel up to about the 115th mile (Burwash), when it bends off sharply to the west and crosses the Matagami River at the Wawiatan Portage after sending out a spur which crosses Lake Kenogamissee as a narrow band. From the portage it holds north and west to beyond the Pishkanogama River. There it bends northward and crosses the Trout River in a north-west direction which it holds to beyond the Misanabie River. The latter river is crossed by two belts which probably both belong to this great area, and are so figured by Dr. Bell. The northern boundary is not so well known. It has been determined on the Abitibi, Frederick House, Matagami and Misanabie Rivers and is shown on the map as a continuous line joining these points. In the description of the rocks of this region they will first be noted as they occur on the Nipissing-Algoma boundary, and afterwards on the various rivers and canoe-routes.

The Nipissing-Algoma boundary crosses the height of land and enters our region at the 76th mile north of Proudfoot's line near Little Hawk Lake. At this point, Mr. Burwash thus describes the series, "Reddish thick-bedded rocks cross the line and occupy the east shore of the lake . . . . They are succeeded on the north by a greenish gray conglomerate, and this is in turn followed by gray ash rocks, which in places give way to what appears to be an amygdaloid, the light coloured amygdules of which weather out at the surface." [1] Ash rocks appear to follow these outcrops to the north, and at the 83rd mile a small area of reddish crushed granite is met which is succeeded by a greenish conglomerate. At the 84th mile Burwash reports a "sericite dolomite schist," and at the 85th "schistose rocks stained with iron." At the 86th mile occurs a weathered diabase with cubes of pyrites, while to the eastward he encountered the reddish thick-bedded rocks met with on Little Hawk Lake. Following these occur weathered diabase, gray ash rocks and chlorite schist with pyrite. At the 97th mile the line enters a granite area and continues in it to the 104th mile. This is, no doubt, the corner of the Laurentian area which extends a mile and a half east of the line. Grayish sandstone occurs at the contact, and exposures of dioritic schist, reddish slaty rock and chloritic schists continue to the 111th mile, where the line again enters the Laurentian, finally leaving it at the 116th mile, and entering grayish slaty rocks. The rock from here northward is much obscured by the drift, and it is advisable to continue our section northward by following the water-course of Night Hawk and Frederick House Lakes and Frederick House River. Exposures on the south bay of Night Hawk Lake, and on Starvation Creek, which enters it, are not numerous and consist largely of altered diorites or greenschists. After the main body of the lake is entered the following series is found on the west shore:—Massive green diorite, altered dioritic schists and quartzose schists with pyrite, crushed granite (on an island off the mouth of the Redstone River), coarse hornblende and mica diorites (one and a half miles north of Redstone), fine-grained hornblende schist and a rather hard sericite schist (N. 30° E.). North of Porcupine River is a fine-grained massive diorite and typical chlorotoid schist.

No exposures occur on the river connecting Night Hawk and Frederick House Lakes, nor are any seen on the latter lake except towards the north and on the easterly side, where is presented a series of dark gray schists with streaks of pyrite exhibiting a banded spheroidal weathering and showing nuclei of a jasper-like variety surrounded by the darker schist. This rock has a decidedly volcanic appearance and is followed by a fine-grained porphyrite striking S. E. and dipping 30° from the vertical.

[1] Report of the Bureau of Mines, Ontario, 1896, page 178.

At the first falls, one and a half miles below the lake, occurs a ridge of much altered porphyrite weathering out in white spots. At the foot of the fall is a fine-grained gray quartzose schist accompanied by altered dioritic rocks, showing under the microscope feldspar crystals surrounded by radially arranged chlorite. Four miles below the falls, at the "Three Portages," a considerable mass of serpentine filled with magnetite is seen. This is followed by dioritic rocks resembling those at the falls, and a white-weathered fine-grained schist. Dark hornblende diorite is the only rock seen from this point to the Laurentian contact a few miles below. The contact appears to strike N. 60° W.

Somewhat to the east of this section another is afforded by the Black River and Abitibi River. A glance at the map will show the Black River entering the Abitibi at the great bend. About 20 miles south of this point, the former stream becomes small and rapid, and we find exposures of pyroclastics with three inch inclusions, also dark schists with diorite and splashes of quartz associated with a little sericite. Just below, the river drops 15 feet over mixed schists with a considerable amount of quartz, alternating with belts of diorite. Six miles below this point occurs a boss of syenite or possibly hornblende granite on the east side of the river; it rises to an elevation of 30 feet and is flanked at both sides by greenschists and some quartzose schists. On the opposite side of the river is an outcrop of a dark rock with round white spots of one-quarter of an inch diameter, exhibiting fluidal structure in the magma. It is probably an amygdaloid, but the specimen brought is too much altered for exact determination. Here also occurs a rock which is probably a much altered porphyry.

Below this exposure we find fine gray to black schists interstratified with diorites, the whole showing rhomboidal jointing. Just below, a small rapid is formed by a ridge of pronounced diorite schist striking N. 35° W. A mile further down a fall of 12 feet is occasioned by a belt of massive diorite striking N. W. From here to the mouth of the river, a distance of 13 miles, the only rocks seen are fine gray quartzose schist with pyrite and diorites of close texture. From the mouth of the Black River to Iroquois Falls (5 miles) only one exposure of dark schist is seen. At the falls the rock is a heavy dark gray weathered diabase. No Huronian exposures occur below this waterfall.

To the eastward of the mouth of the Black River, at the "Two Portages" a similar dark weathered diabase with pyrite is seen. Although the Huronian area extends further east and embraces most of Lake Abitibi a detailed description of it cannot be given here, the writer's explorations having ceased at the "Two Portages."

An excellent east and west section of the country between the Abitibi and Matagami regions is afforded by a canoe route passing from the mouth of the Black River westward to Frederick House Lake and from Night Hawk Lake by Porcupine River and a chain of portages to the Matagami. The first stretch of this route, *i.e.*, to Frederick House Lake, lies up a stream on which the only exposures are green quartzose schists. From the head of this stream several portages over high sandy soil bring us to Frederick House Lake; but no exposures are visible, so completely is the rock covered by sand. On the Porcupine River however the rocks are exposed at several places.

One and a half miles up there occurs a dark gray slate-like schist weathering white with bands of quartzite, strike N. 60° E., dip 30°. This exposure well shows the relation previously mentioned of the quartzose schists to the quartzites. The next outcrop above this is a fine quartzose schist with some sericite schist becoming ferruginous to the north. A mile higher up is a rock representing the connecting link between quartzites, as previously defined, and quartzose schist. It is almost pure silica and very fine-grained. One mile above this deposit is a much altered diabase with asbestiform hornblende and green hornblende schist. Rocks of similar nature crop out at intervals as far as Porcupine Lake, a distance of 30 miles. From Porcupine Lake to the mouth of the river is only above five miles in a straight line. On the north side of Porcupine Lake occurs an outcrop of a soft rock resembling soapstone, with crystals of magnetite and veinlets of chrysotile. Under the microscope the rock appears to be made up of indistinct fibres of this substance mixed with quartz. It is evidently a much altered example of the basic eruptive series. On the south side of the lake occurs altered diabase and gray quartzose schist with asbestiform partings and veinlets of quartz. On the creek entering from the south-west were found gray to white fine porphyrite schists, weathering quite white with streaks of quartz and pyrite. On the passage overland southward from this lake an interesting series of rocks is encountered as follows:—Soft mottled sericite schists very much altered, under the microscope showing irregular and strained quartz individuals, some feldspar presumably orthoclase, light indistinct sericite and considerable calcite; soft schists weathering with ferruginous stains, associated with bands of quartzite; interlaminated bands of quartz and quartzite, striking east and west, and so filled in places with hematite scales and crystals of magnetite as to become quite black.

At one and a half miles from the lake were seen diorite schists followed by soft and hard examples of the sericitic series.

Another exploration line passing S. E. from about the middle of the south shore shows the following:—Ridge of granite, east and west, flanked by soft calcareous sericite schist; hard gray quartzose schists; sericite schist; streaked quartz rock with pyrite (10 chains); sericite schist; 20 chains of granite; soft decomposed schists weathering out in brown spots.

On the first portage westward from Porcupine Lake occur gray quartzose schists and greenschists.

On the second portage are seen soft, rusty spotted schists with sericite showing on the cleavage planes. A fresh fracture across the planes shows very fine quartz. This is followed by diorite which is in turn succeeded by hard quartzose schists, and at the eastern end a rock very similar to that at the west, all striking about N. 75° E. and dipping vertically.

After crossing a small lake and a short portage, together about a mile, the route enters a lake about a mile and a half long in a north-easterly direction. On the east side of this lake are seen massive green diorite and diorite schist (pyritous), and on the westerly side fine gray quartzose schists, possibly altered porphyries, striking N. E. and S. W. Two portages, the first of 15 chains and the second of two miles, are required to reach the Matagami. On neither of these is any rock exposed.

A third north and south section of this area is afforded by the Matagami River and its approaches from the south. The Huronian is first encountered on the east shore of Muskegogama Lake, and is represented by diorite and dioritic schists, much contorted and mixed with gneiss and bands of quartz. Gneiss again crops out on the way down the lake, but a massive green diorite is characteristic at the first portage. At the next portage there is a mass of granite crossed by dykes of fine dark diabase. On the river below the portage various hard schists and belts of diorite are seen. On entering Minniesinaqua Lake by the portage connecting it with the river we first encounter a massive diorite which gives place westward to diorite schists, passing into a much mixed series of various quartzose schists, altered porphyries and possibly porphyrites, crushed granites and felsites, forming an extremely complicated mass and extending as far as the bend in the lake, *i.e.*, for about 15 miles. Here the formation swings eastward, and is encountered at the south end of Lake Matagami. On the east side of the bay at the extremity of the lake are seen high bluffs of a light greenish rock showing the structure of a crushed porphyrite under the microscope. This is followed by greenish Huronian schists with one inch to two foot inclusions of gray granite, evidently conglomerate. Somewhat farther north on the west side, sheared granite and some bands of diorite form high precipitous shores. About a mile farther north on the east side, gray and green spotted micaceous and sericitic schists mixed with bands of granite and felsite are seen. These strike W. 10° S. and are followed by mica and hornblende schists passing into gneiss. Dr. Bell describes the rock on the east side of the southern lagoon as "greenish gray quartzite, holding transparent grains." [1]

A portage from near Fort Matagami extends eastward to Lake Shattagami where the Huronian is again encountered and is thus described by Dr. Bell:—"On the west side of the narrow cove which forms both its inlet and its outlet, beds of greenish gray clay slate or shale, which are full of pyrite, are found, standing vertically, and striking S. 70° W. About a mile up the south-west side, a soft greenish gray rock occurs, which has a dioritic appearance, but is evidently of a magnesian character. It is rudely stratified, and beds, which are on edge, run east and west."

Following the Grassy River eastward we finally arrive at Little Hawk Lake. The rocks on the route, according to Dr. Bell, are "grayish quartzite (sometimes of a conglomerate nature) and greenish diorite." On Little Hawk Lake he describes a cliff of 200 feet of "grayish red fine-grained quartzite in thick beds, interstratified with others of greenish felsitic quartzite holding red

[1] Geol. Survey of Canada, *Report*, 1875-76, page 307.

grains." This is doubtless the thick-bedded red rock of Burwash already mentioned in this paper. "On the north side of Little Hawk Lake greenish gray clay slate is seen at two points. At the outlet there is a massive light-green felsitic volcanic ash, marked with specks of lighter and darker colours than the matrix."

From this exposure it is about forty miles northward through Matagami and Kenogamissee Lakes until the Huronian is again encountered. Here it consists of a narrow spur projecting westward from the main mass to the east. The rocks exposed show the following series from south to north:—Fine-grained diorites; hard gray granite and felsites; mica and hornblende schists; crushed granite; soft Huronian micaceous schists, striking E. 10° N., and dipping 30° to N. W.; dark crystalline diorite with white blebs. The latter rock might be described as a porphyritic diorite.

Some distance north of this series a belt of diorite crosses the lake near Moore's house.

The main body of the Huronian is encountered just north of Wawiatan Portage at the foot of Kenogamissee Lake. It is represented first by a belt of granite N. 20° W., followed by coarse green diorite and soft close-bedded white-weathering schist almost vertical and striking north-west. A microscopic examination of this rock shows a very fine-grained ground mass of quartz and feldspar with porphyritic crystals apparently of plagioclase, which would make the rock a porphyrite schist.

Below the rapids few exposures are seen until we reach Omeemee or Pigeon Rapids. On this stretch, however, quartzose schists and some clay slate striking N. 75° W. occur.

At the Pigeon Rapids greenish crystalline diorite is mixed with dark gray quartzose schists and contains bands of quartz carrying gold. Considerable intermixed calcite occurs here.

Only a few exposures of siliceous schists are seen until the first of the Sandy Portages is reached (Kish-ki-qua-mo), where is seen a hard gray quartzose schist (gray siliceous and dark bluish gray clay-slate, according to Bell). Between this and the next portage occurs a green rock with white spots. A section shows the white to be entirely altered feldspar and the green mostly chlorite arranged around the feldspar. It is possibly a much altered porphyrite which contained a large amount of ferro-magnesian matter. It strikes about east and west. At the second portage the rock at the top is hard gray quartzose schist followed to the north by softer schists (nacreous, chlorotoid and talcoid schists, according to Bell), with streaks of quartz, strike N. 60° W. At the foot is a large dyke of green diorite. The rocks at the third portage are vari-coloured fine quartz schists with a considerable amount of fine decomposable magnesian matter, striking about north-east and south-west. Dr. Bell describes them as nacreous and talcoid schists, but it is doubtful if any talc occurs in them; they contain streaks of quartz and much pyrite. Four or five miles below these portages the Kamiskotaia Sagaigan River enters from the west. On ascending this stream slaty diorites are first encountered and then hard quartzose schists. At the third portage on the route to the lake a splendid development of the quartzose schists is seen. The country here is bare and rises into hills of considerable size which give a hummocked aspect to the whole region. The schists are of many colours, white, green, gray, purple, etc., and strike a little south of east with a nearly vertical dip. A section shows a pronounced schistose structure with fine quartz exhibiting undulatory extinction and sometimes arranged in lenticular patches. The other ingredient is of variable nature, brown mica being very common as well as chlorite and perhaps also sericite. These schists average 70 per cent. of silica. On the stream flowing out of Kamiskotaia is seen a fine-grained gray diorite followed by a coarser variety and on the lake itself is a typical quartz diorite of dark gray colour.

For a description of the river Matagami below the Kamiskotaia Dr. Bell's report is relied upon,[1] as the writer's investigations did not extend farther north.

The following is a brief summary of the rocks recorded:—On the east side, 30 chains below the branch is an ex[illegible] of "massive, gray, semi-crystalline steatitic rock, holding grains of specular iron, and cut by small veins of whitish bitter spar." This is followed for eleven miles by outcrops of greenish gray diorites, both massive and slaty. Then occur dykes of green crystalline diorite. Half a mile further is dark gray quartzite with iron pyrites and clear quartz grains, N. 80° W. At the end of another half-mile a massive, light greenish gray siliceous schist resembling diorite runs

[1] Geol. Survey of Canada, *Report*, 1875-76, page 312 *et seq.*

N. 75° W. (quartzose schist). At Sturgeon Portage, three and a half miles farther down we find hard greenish gray slaty diorite, N. 35° to 60° W., cut by a great dyke of greenish gray slate-like crystalline diorite running north and south. Six miles below the portage are seen "soft grayish green calcareous talcoid schists, N. 55° W." Eight miles more bring us to outcrops of "gray diorite or volcanic ash, holding sharp crystals of black hornblende, larger grains of white feldspar, and small crystals of iron pyrites." At Loon Portage, three miles down, the rock is "dark, greenish gray hornblendic schist," and at Davis' Rapid, a mile below, it consists of "chloritic and hornblendic schist." After this last portage we pass into the Laurentian gneiss.

On the Ground Hog River the southern boundary of this great area is considerably farther north than shown on Dr. Bell's map. This river was examined for ten miles below the point there represented and the contact was not found; the whole region around Wawayeskatching Lake and a considerable distance to the east is gneiss. The same observation holds true on the Pishkanogama River, the Huronian at the contact being represented by massive and schistose diorites.

This area is again met with on the Misanabie River, which it crosses in two belts separated by about eight miles of gneiss. The more northern of these belts is seven or eight miles wide, at right angles to the general strike, and the southern not more than six, at the point where the river crosses it. The rocks in both belts do not differ materially from those seen in other parts of the area. In the first belt the average strike is a little south of west, the rocks being the usual assemblage of quartzose schists and some mica schists crossed by belts of diorite. The second belt, towards the south, shows much quartzose schist and fine hornblende schist. There was no opportunity to examine these rocks west of the river; the limits as shown on the sketch are copied directly from Dr. Bell's map.

The second Huronian belt extends in a north-easterly direction for about eighty miles, crossing the Canadian Pacific Railway between Ridout and Woman River, and terminating near Aqnesqua Lake. The area embraces Sa-ge-tow-wash-ka, Matagaming and Ground Hog Lakes, and it was along this route that it was examined. On passing down the river from Rice Lake gneiss is encountered as far as the third portage, a distance of about three and a half miles. Here, however, gray hornblende schists crop out, followed by granite with inclusions of dark hornblende schist in such numbers as to indicate a sort of giant breccia. From this point to Lake Sa-ge-tow-wash-ka extends about a mile and a half of swamp showing only occasional exposures of gray granite and green diorite.

At the prominent point one and a half miles from the mouth of the river on the east side is a massive green diorite. North from here, on the west side of the lake, a typical hornblende granite extends for some miles along the shore. On the bay from which the river flows out are first seen very fine-grained white schists, almost pure quartz but probably containing some fine sericite, for they weather out a dull white. These rocks much resemble the variety described as novaculite. They are followed by green chlorite schists, mixed with greenish hornblende granite, to the foot of the bay. Between this lake and Lake Matagaming there is a fall of 150 feet; the country is very rough and the rocks varied and well exposed.

At the first portage, immediately on leaving the bay, are seen dark green chloritic and hornblende schists passing into lighter mottled schists to the north. At the next portage, one and a half miles down, green rocks like those above are seen splashed with quartz. Another mile and a half intervenes to the third portage, where are found a syenitic rock, green-schists with pyrite and a fine-grained sheared granite showing under the microscope a large percentage of fine quartz, a very little greenish mica and scattered, relatively large, crystals of orthoclase. A short distance north a series of vari-coloured schists cross the stream. These rocks are somewhat soft and sericitic in places and contain small seams of quartz. Very similar rocks, striking east and west, are seen on entering Matagaming Lake; they rise into considerable hills, having a banded appearance of white, green, reddish, purple, etc. Nearly half a mile of porphyritic hornblende granite follows, occurring in belts, interlaminated with gray quartzose schists and light green chloritic schists, striking north-east and dipping 40° to the north-west. Whitish schists are common about a mile beyond the wide granite belt. At the point where the lake begins to open out we encounter dioritic schists followed by hard gray and light green varieties. About a mile lower down, where the lake bends to the east, soft sericite schist is found, striking east and west and dipping 20° to the north. Opposite are seen hard quartzose schists. Very little more rock is seen on the lake or on the river below as far as Ground Hog Lake.

Half a mile north of Ground Hog Lake soft friable whitish schists run east and west, dipping at a high angle. Three miles below, the river is broken by the Kaskamene Rapids, where are seen soft micaceous slate-like rocks suitable for whetstones. Two miles below these rapids sericite schists crop out, striking east and west. Two and a half miles from this point a heavy rapid, Mekesewa-un, occurs. Here a dyke of heavy diorite crosses the river a few degrees north of east; above it are seen gray and green schists, and below five or six varieties of closely banded quartzose schists. On an island a mile and a half farther down we find hard gray quartz schists and diorite with pyrite. The Laurentian contact occurs just below, but a dyke of massive diorite N. 20° W. is found at the Ostandigististagan Fall a little farther down.

This area is also visible on the canoe route between Ground Hog and Pishkanogama Rivers. The trail leaves the former river a few miles below Ground Hog Lake. On the third portage gneiss is encountered, but towards the end of the trail it gives place to bright green fissile schists, probably chlorite. On the small lake succeeding, similar schists are observed striking east and west and mixed with sugary quartzite. Similar rocks are seen on the next portage, and the northern and eastern shores of the following lake are of gneissoid muscovite granite, while gray micaceous Huronian schists occur to the south and west. A creek connects this lake with a larger one on which are seen in order, fine gray gneiss, protovermiculite (?) schists, striking north-east and south-west, gray quartzose schists striking east and west and dipping 20° N., soft friable sericitic schists striking north-east and south-west and dipping vertically, soft brown highly ferruginous examples splashed with quartz; fresh specimens seem to indicate an extremely altered porphyrite infiltered with secondary silica.

Near this last exposure a small stream enters another lake on which are found green sericitic schists and sugary quartz, massive green and schistose diorites with pyrite, soft white schists, and hard white spotted varieties, probably altered porphyrites. Fresh specimens are much greener than the surface samples, and under the microscope show fine-grained feldspar decomposition products and indistinct light green chlorite with a little quartz. The second portage beyond this lake joins a stream flowing into the Pishkanogama; on it occur hard gray quartzose schists.

The Huronian area crosses the Pishkanogama River in three narrow belts. The most northerly has a width of about three miles and shows but few exposures of white, gray and green schists averaging north-west in strike and dipping to the south-west. Near the foot of Pishkanogama Lake the second belt crosses and shows green foliated schists apparently more quartzose than dioritic. The third belt is found as a narrow band about three miles up the lake, and consists of foliated green talcose schists, striking east and west, with a dip of 30° to the north.

From this description it will be observed that the basic eruptives are found towards both the north and south borders of the area, and that they are not at all common towards the centre. This is also true of the altered basic eruptives, diorite schist, greenschists, etc. The quartzose schists, crushed granites and more acid rocks generally are more characteristic of this belt than of the first, where altered basic eruptives probably constitute a large percentage of the area.

The third great Huronian area occurs on the south-west arm of Misanabie Lake, where it is exposed for about eight miles; it narrows to a point towards the north and crosses Long Lake as a spur. On approaching this region from the east we first encounter bands of diorite cutting the gneiss nearly north and south and dipping 20° E. Four miles west of Ferry Point we enter a region of mixed schists striking about north and south. Red, green and gray quartzose schists and crushed granites are interlaminated with diorite, diorite schists and much greenschist or altered diorite. These rocks form high bare hills the summits of which seem to be occupied by massive diorite while the various schists form the flank.

The fourth Huronian area crosses the Abitibi River, extending from the Lobstick Portage to below the canyon, a distance of about seven miles. The average strike is a little north of west and the effect on the river is remarkable; a series of heavy rapids are formed followed by a distinct canyon two miles in length. This formation is decidedly eruptive in origin, little trace of schists of any kind being observed.

The first indication of the presence of this belt is seen on an island above the Lobstick Portage, where the gneiss passes into mica schist striking north-west and south-east with a dip of 20° to the north. On the east side the rock is diorite and at the south side it is augite syenite with some plagioclase, and with numerous garnets in the more weathered parts; it varies in structure from massive to quite schistose and towards the south-west corner is hornblendic and highly pyritous.

At the Lobstick Portage is seen first a highly hornblendic schist followed by streaks of dark gray schist with pyrite, which is succeeded by augite syenite and quartz porphyry, becoming more granitic in appearance down stream.

Augite syenite occurs about two miles down and is traversed by narrow bands of fine black diabase, running in all directions and showing beautiful examples of dislocation and miniature faulting. This rock seems to pass into diorite or rather alternates with diorites; a rock occurring above the Birch Portage presents a much altered appearance and may be a syenite or diorite with sphene and melilite. Above the Oil Can Portage a highly feldspathic augite syenite of coarse structure is seen; at the foot of the portage the rock is somewhat the same but contains rather more plagioclase, and is grayish black and speckled in appearance and shows evidence of flow structure running N. 30° W. Some small veins of fine crystalline calcite occur throughout this belt. At the head of the canyon the rock is practically the same as at the Oil Can Portage. Three quarters of a mile down a small amount of anorthosite occurs, and a little beyond a much decayed granite. One mile down the cliffs are nearly 200 feet high and are formed of dark gabbro mixed with irregular masses of granite and traversed by numerous calcite bands. A crushed granite or perhaps quartz porphyry succeeds to the north and continues, with a north and south strike, to the end of the rough water.

How far the belt may extend east and west is not known. Dr. Bell does not mention it on the Matagami, but describes numerous eruptive dykes, which may represent it. On the Misanabie, nearly in the required line of the strike, a Huronian belt crops out which is possibly continuous with this, but lacking proof of the continuity we must regard it as a separate area. On ascending the river it is encountered about a mile below the point where the river makes the great bend to the eastward and is represented by a heavy rock of trappean aspect; this is followed by various schists of dark colour, interlaminated bands of diorite and belts of granite and felsite. Unfortunately want of time prevented the obtaining of specimens, a microscopic examination of which would have established or disproved the identity of these rocks with those at the canyon of the Abitibi. The formation continues to the foot of the Long Portage, a distance of about five miles. (See Dr. Bell's *Report*, page 333).

Near St. Peter's Portage some narrow bands of Huronian rocks intersect the gneiss; these consist of both dioritic and quartzose schist, but it is doubtful if they are of sufficient extent to be classed as a Huronian area.

The only other Huronian belt is that lying to the westward of Trout Lake as determined by Dr. Bell. The writer had no opportunity of seeing this area and depends entirely on Dr. Bell's observations that the rocks here consist of "rather dark coloured hornblendic schists, with an east and west strike."

SUMMARY.

As a petrographical series most of the rocks of these various regions may be described as altered eruptives, both acid and basic, which have, for the most part, been subjected to intense metamorphism. Mixed with them are other schists of clastic origin consisting very largely of quartz. The whole complex shows evidence of much dynamic metamorphism and represents a more or less constant schistose structure, with the laminae dipping at high angles. While a great similarity exists between the different areas there are, in a general way, some peculiarities belonging to each. The first or great area is, on the whole, more basic than the second, the most important rock being diorite with its derivatives diorite schist and greenschist. These basic rocks seem to form the centre of the area and the more acid representatives, quartzose schists, altered porphyries, etc., appear to be distributed more towards the borders.

The second area is decidedly more acid with a preponderance of crushed granites, felsites, altered quartz porphyries and acid schists.

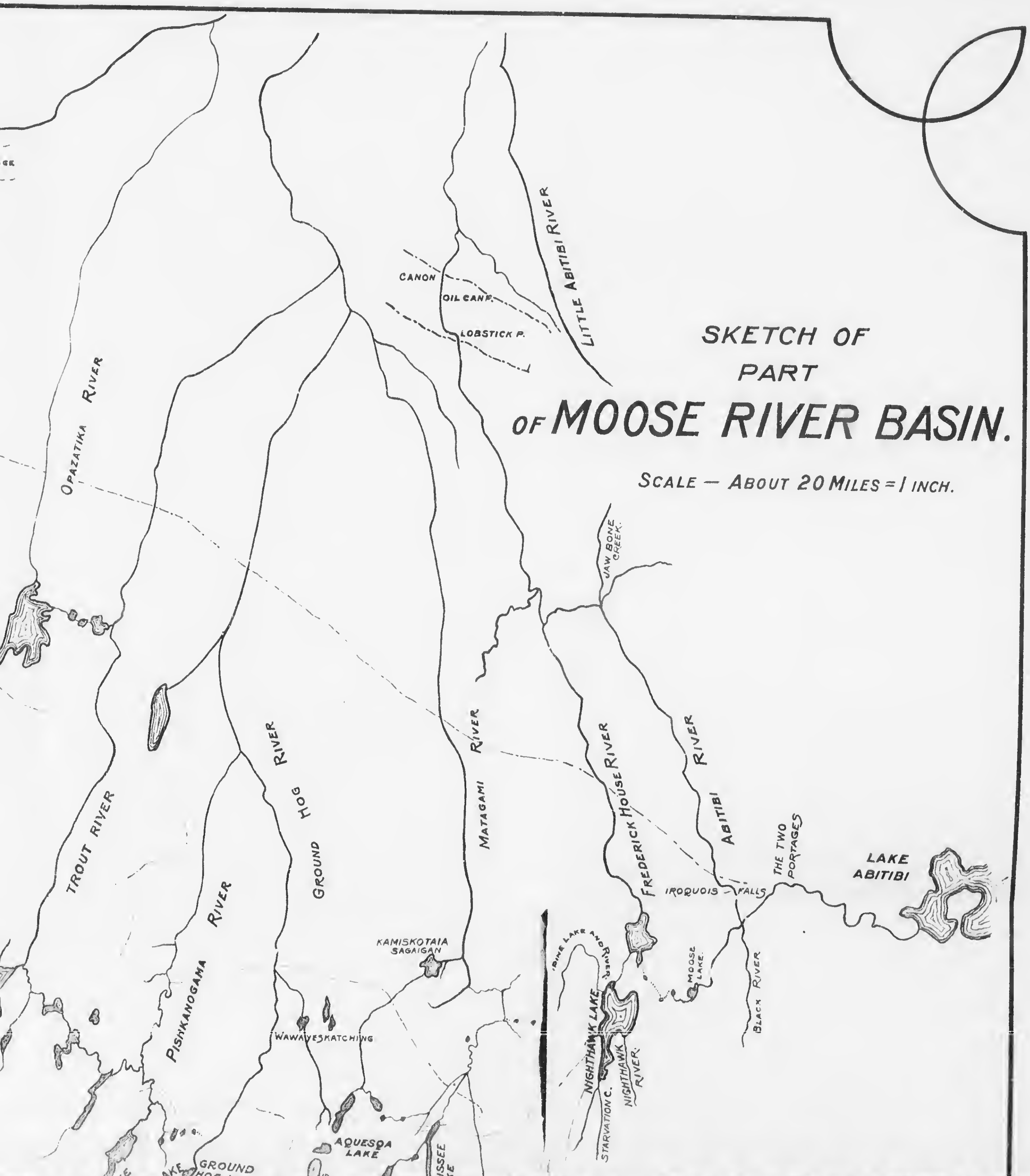
The third division shows considerable diorite of a somewhat massive nature, frequently forming hills, which are flanked by the same series of schists as in the other regions.

The Huronian area of the Abitibi canyon is quite different from any of these and must be regarded as a large eruptive dyke composed principally of augite syenite passing into gabbro.

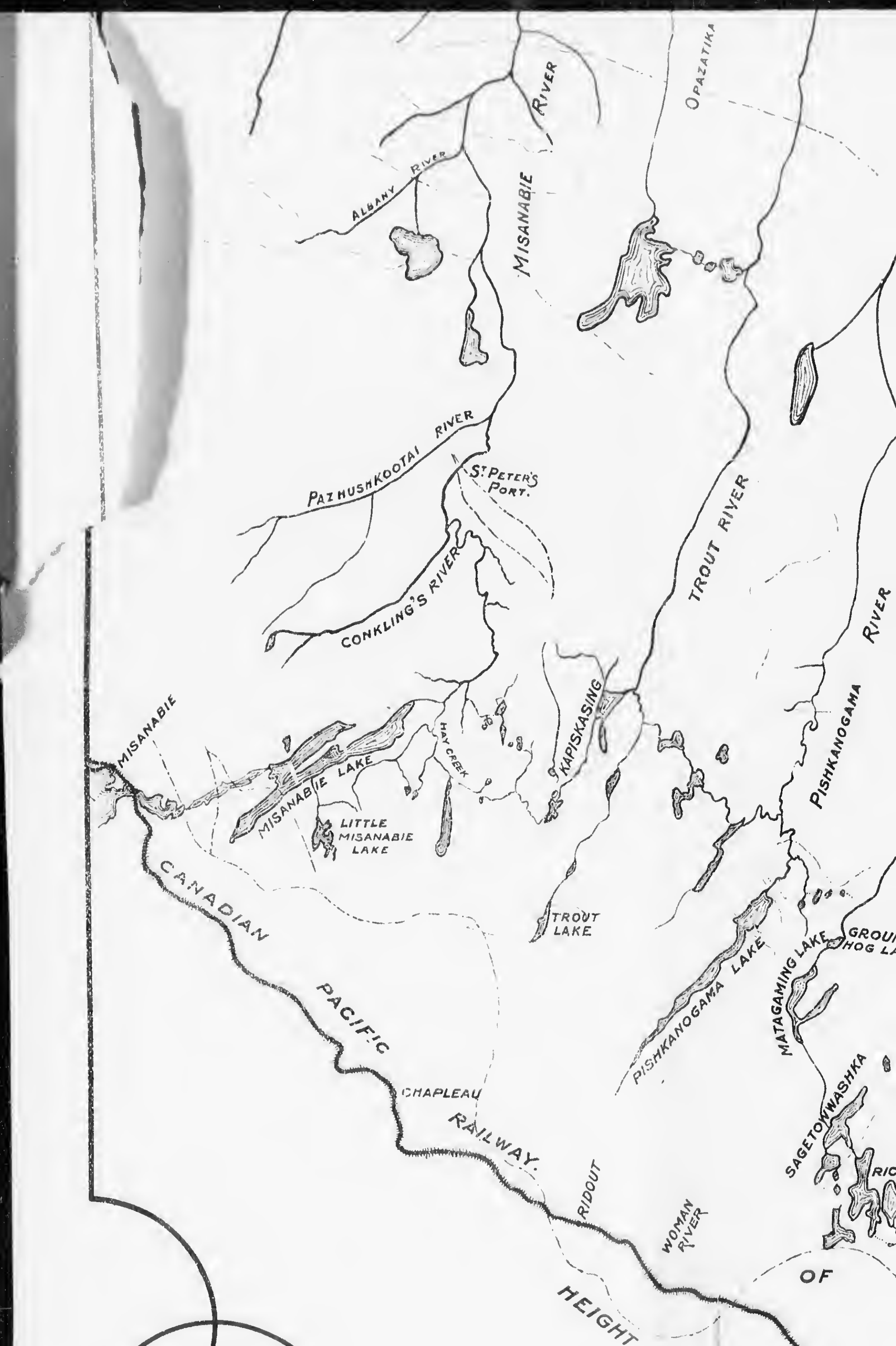
The schistose areas seem to be comparable to Lawson's Keewatin series, at least in part. They may also be compared to the greenstone schist area of Marquette. Their origin is probably similar to that of the regions mentioned and will not be discussed here; the reader is referred to Bulletins 62 (1890) and 86 (1892) of the U. S. Geological Survey, and to the Report of the Geological Survey of Canada, Part F, 1888.

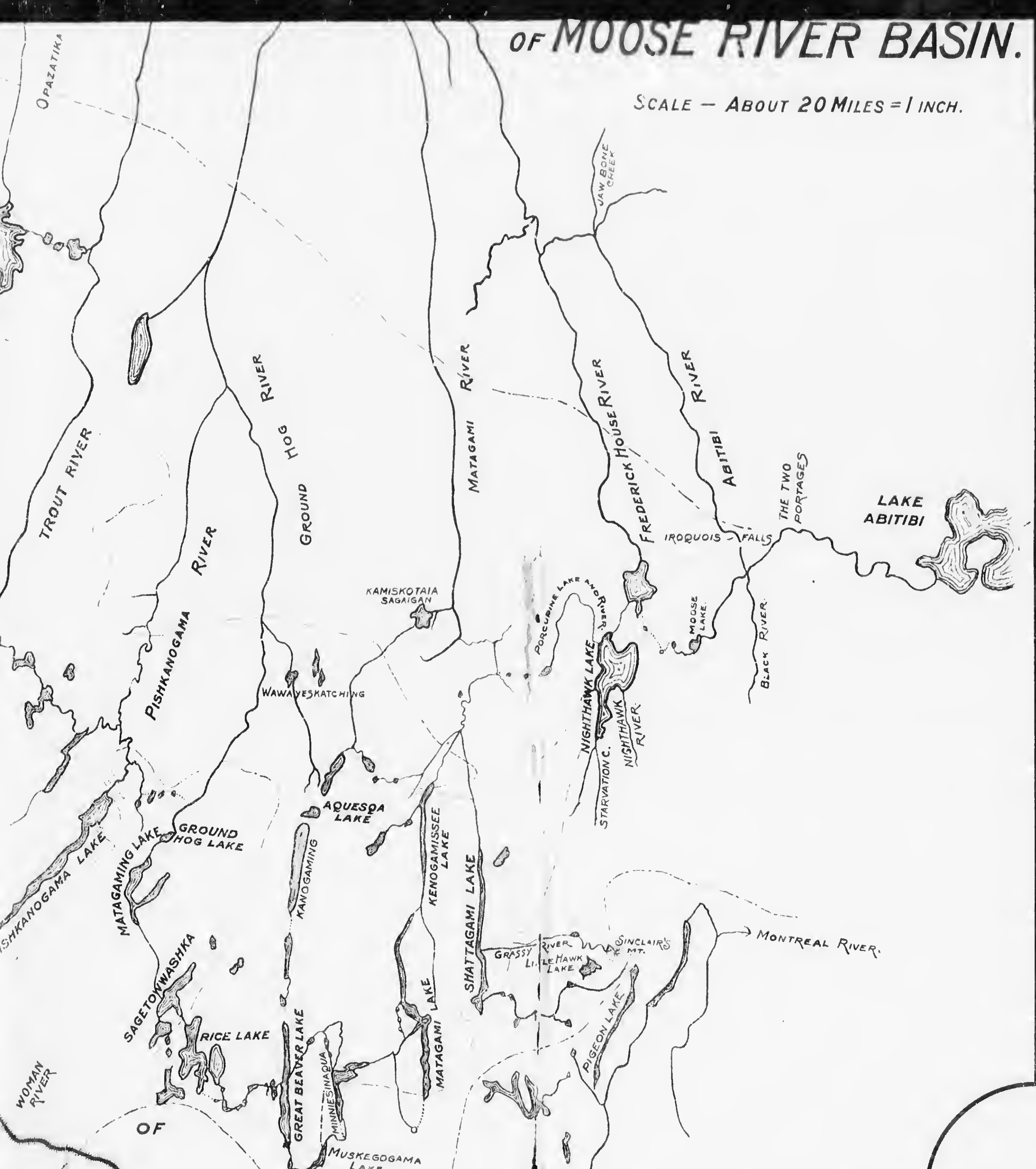
The sketch map accompanying this paper is compiled largely from Dr. Bell's map of the region, corrected in places by the more recent determinations on the base and meridian lines of Alexander Niven, O.L.S., as well as by the compass surveys conducted by the writer of this paper along most of the canoe routes. It cannot claim any great accuracy but will serve to indicate, in a general way, the distribution of the rocks in question. Owing to the small scale it was thought advisable to introduce but few names other than those mentioned in the text.


LONG PORTAGE
OPAZATIKA RIVER
MISANABIE RIVER
ALBANY RIVER
PAZHUSHKOOTAI RIVER
ST. PETER'S PORT.
CONKLING'S RIVER
TROUT RIVER
KAPISKASING
HAY CREEK
MISANABIE
MISANABIE LAKE
LITTLE MISANABIE LAKE
CANADIAN
TROUT LAKE
PISHKANOGAMA



SKETCH OF
PART
OF MOOSE RIVER BASIN.
SCALE — ABOUT 20 MILES = 1 INCH.
LITTLE ABITIBI RIVER
CANON
OIL CAMP.
LOBSTICK P.
OPAZATIKA RIVER
JAW BONE CREEK.
TROUT RIVER
GROUND HOG RIVER
MATAGAMI RIVER
FREDERICK HOUSE RIVER
ABITIBI RIVER
THE TWO PORTAGES
LAKE ABITIBI
IROQUOIS FALLS
PISHKANOGAMA RIVER
KAMISKOTAIA SAGAIGAN
MOOSE LAKE.
BLACK RIVER
NIGHTHAWK LAKE
NIGHTHAWK RIVER.
STARVATION C.
WAWAYESKATCHING
AQUESQA LAKE
GROUND HOG LAKE


OPAZATIKA
RIVER
MISANABIE
ALBANY RIVER
PAZHUSHKOOTAI RIVER
ST. PETER'S PORT.
CONKLING'S RIVER
TROUT RIVER
RIVER
PISHKANOGAMA
KAPISKASING
HAY CREEK
MISANABIE
MISANABIE LAKE
LITTLE MISANABIE LAKE
TROUT LAKE
PISHKANOGAMA LAKE
MATAGAMING LAKE
SAGETONWASHKA
CANADIAN PACIFIC RAILWAY.
CHAPLEAU
RIDOUT
WOMAN RIVER
HEIGHT
OF


OF MOOSE RIVER BASIN.
SCALE — ABOUT 20 MILES = 1 INCH.
HOG LAKE
OPAZATIKA
JAW BONE CREEK
TROUT RIVER
PISHKANOGAMA RIVER
GROUND HOG RIVER
MATAGAMI RIVER
FREDERICK HOUSE RIVER
ABITIBI RIVER
THE TWO PORTAGES
LAKE ABITIBI
IROQUOIS FALLS
KAMISKOTAIA SAGAIGAN
PORCUPINE LAKE AND RIVER
MOOSE LAKE
BLACK RIVER
WAWAYESKATCHING
NIGHTHAWK LAKE
NIGHTHAWK RIVER
STARVATION C.
AQUESOA LAKE
GROUND HOG LAKE
MATAGAMING LAKE
PISHKANOGAMA LAKE
KANOGAMING
KENOGAMISSEE LAKE
SHATTAGAMI LAKE
GRASSY RIVER
LITTLE HAWK LAKE
SINCLAIR'S MT.
MONTREAL RIVER
SAGETOKWASHKA
RICE LAKE
GREAT BEAVER LAKE
MINNIESINAQUA
MATAGAMI LAKE
PIGEON LAKE
WOMAN RIVER
OF
LAND
MUSKEGOGAMA LAKE.

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