GEOLOGICAL SURVEY OF THE STATE OF NEW YORK.

(GEOLOGICAL MAP.)

REPORT ON THE BOUNDARY BETWEEN THE POTSDAM AND PRE CAMBRIAN ROCKS NORTH OF THE ADIRONDACKS.

JAMES HALL,
State Geologist.

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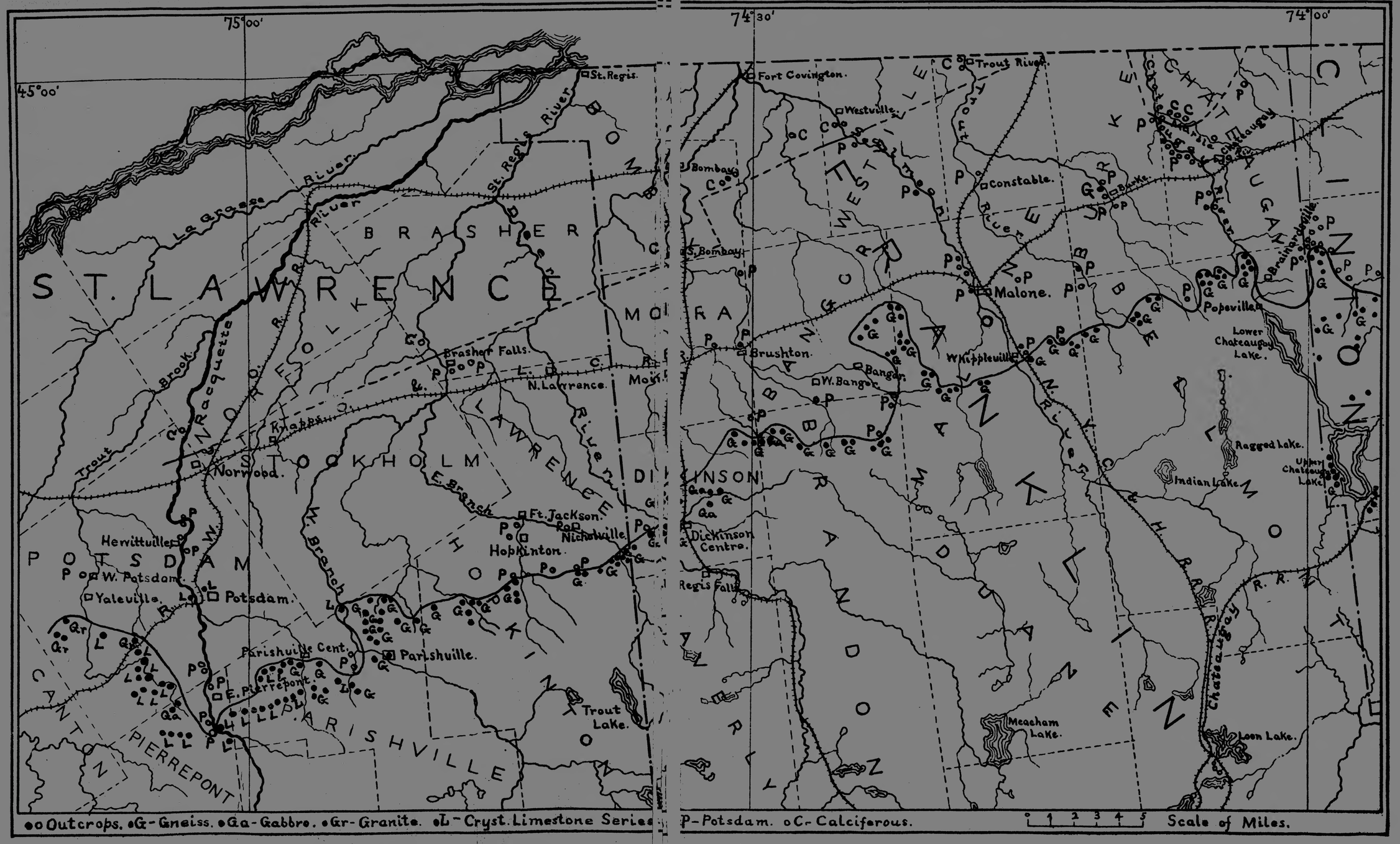
SIR:—The accompanying report is made in accordance with your instructions to map the northern boundary between the Potsdam sandstone and the Pre-cambrian crystallines across Franklin county and as far into St. Lawrence county as practicable; further, to determine what rocks younger than the Potsdam come in on the north and their limits, and, in addition, to make observations on the change in the character of the gneisses in going westward.

Respectfully yours,

H. P. CUSHING.

March, 1897.



Map of a portion of Franklin and St. Lawre[illegible] counties, showing the Pre-cambrian-Potsdam Boundary.

GEOLOGICAL SURVEY OF THE STATE OF NEW YORK.

(GEOLOGICAL MAP.)

REPORT ON THE BOUNDARY BETWEEN THE POTSDAM AND PRE-CAMBRIAN ROCKS NORTH OF THE ADIRONDACKS.

By H. P. Cushing.

Introduction.

The work of tracing this boundary was begun at the Clinton-Franklin line, connecting with the writer's work of the previous season. Thence the boundary was mapped across Franklin county and into St. Lawrence to a few miles west of Potsdam. It was not known to me until after my return from the field that part of the area traversed in the latter county had already been studied and reported upon by Professor Smyth. As the report has not, at this writing, been published, what follows must unfortunately be written without reference to it.

The country north of the Adirondacks is so heavily covered with drift that outcrops of the Palaeozoic rocks are very infrequent and boundary mapping is rendered hazardous on that account. Over much of the distance the best that could be done was to map the northerly limit of Pre-cambrian outcrops. In Franklin county and as far west as Parishville in St. Lawrence county, the mapping was a simple matter. The gneisses are so similar in

character and in resistance to erosion that the boundary is not especially tortuous, and though it is quite possible that isolated patches of the Potsdam may occur within the gneissic area, as has been found to be the case in Essex and Clinton counties, their discovery would require the mapping of a much larger area.

Westward from Parishville, the Pre-cambrian rocks at the boundary consist of an entirely different series of gneisses with belts of crystalline limestone. These rocks resist erosion very unequally, and as a whole are less resistant than those along the boundary to the eastward. The change in the topography, which is there strongly marked, is here much less serviceable. Furthermore these rocks were profoundly and unequally eroded in pre-Potsdam time. In the troughs thus formed the Potsdam sandstone was deposited and is yet found in them far within the area occupied by the older rocks.* To fix accurately the limits of the formations here will require areal mapping over an extended territory.

No rock of younger age than the Calciferous was found in the district examined, the Pleistocene deposits of course excepted. Outcrops occur so seldom that it is useless to attempt to show the limits of the formation except in the most general way.

On the map accompanying this report these boundaries are indicated, and the various outcrops seen are located. It must be borne in mind that the small scale of the map makes the outcrops appear much more numerous than is really the case.

TOPOGRAPHY.

In a broad sense the topography of the district under consideration is simple. The Pre-cambrian rocks come to the boundary in a succession of low ridges and knobs which ordinarily do not protrude very greatly above the general level, and which are separated by shallow, drift-filled depressions. Thence northward the country is heavily mantled with drift, has little relief, and slopes away to the north and north-west toward the St. Lawrence valley. Only rarely does the underlying rock project above the drift, the small streams do not cut through it, and in general the only outcrops to be seen are those exposed in the larger streams where they are out of their pre-glacial channels.

The minor features of relief which characterize districts of morainic drift (and much of it here is morainic) are here obliterated over much of the district, more especially along the stream valleys, by the deposits of sand laid down

* By way of illustration see Smyth's map of the vicinity of Gouverneur. Rep. N. Y. State Geol., 1893, Vol. I, p. 493.

upon it along the streams or the shores of the higher water levels which accompanied and followed after the withdrawal of the ice-sheet from northern New York.

The water-shed between the lake Champlain drainage and that direct to the St. Lawrence, passes from north to south through Clinton county close to the Franklin county line, till it veers to the south-westward into Franklin county just south of Upper Chateaugay lake. On this watershed the basal Potsdam reaches an altitude of about 1100′ A. T. Thence westward along the boundary it decreases steadily until south of Potsdam city it lies at an altitude of from 700′ to 800′ lower. This discrepancy must necessarily be due to differential uplifting since its deposition.

The largest streams, like the Racquette, St. Regis, Salmon and Chateaugay rivers flow in narrow valleys cut in the drift, and in still narrower rock gorges where they are out of their old channels. They are all actively engaged in deepening their channels and cutting back the rapids at the head of the gorges. The gorge of the Chateaugay is, in impressiveness, second only to the Ausable Chasm in the Adirondack region. The more westerly streams have less fall and are not cutting so actively.

THE GLACIAL DEPOSITS.

Only general attention could be given to the drift deposits, so that the hap-hazard observations made would not be commented on, were it not for the fact that the deposits are of great interest and are but little known.

Over a wide area north of the Adirondacks the drift proper is submerged beneath heavy sand deposits, the conditions being very similar to those prevailing in Clinton county near lake Champlain. The sands are of course mainly along the stream valleys but have considerable width on each side and become confluent when the streams are not far apart. Morainic knobs and ridges protrude through them here and there and cuts often show the underlying drift. The north and south roads in northern Franklin county and the adjacent part of St. Lawrence county are commonly near enough to some stream to make the roads excessively sandy, and driving over them is a most irksome task. The cross roads pass over the divides between the streams and are better.

These sands are found abundantly at certainly three, and probably four distinct levels and the descent from one level to another is sometimes quite abrupt, the sand plains rising in terraces, one above another. This is well shown just north of Malone, where the sand plain stretching north from the

city terminates like a huge embankment, dropping nearly 100′ to a similar sand plain below. The lower sands certainly represent delta deposits of the streams in bodies of standing water. Whether that is true of the uppermost is not so certain. What were apparently true beaches were noted at three or four points, but no attempt to trace them could be made. These sand-covered tracts are very level, and quite bare of vegetation, the sand often drifting to a considerable extent.

Outside of the sand-covered areas the surface drift is largely morainic in character. In many places heavy moraines lie in proximity to, or banked up against the out-lying gneiss ridges. Surface boulders are numerous over most of the district, and their extremely local character is worthy of remark and is most strikingly shown along the line of contact between the Potsdam sandstone and the Calciferous.

In passing north from the outermost outcrops of gneiss in Bangor, Brandon and Dickinson townships, Franklin county, one descends often into a slight depression, then rises on to a morainic ridge with boulders mainly of very large and sometimes of gigantic size, composed entirely of gneisses precisely similar to those in place to the south. Practically no Potsdam boulders are observable. The ridge is not entirely morainic, being composed in part of modified drift. It has a variable width, reaching sometimes half a mile. To the north of it, with an intervening depression is a much more massive moraine whose boulders are of smaller size, and are mainly of Potsdam sandstone, while the few gneissic boulders observable are of small size and, when compared with the blocks on the other moraine are more worn and give the impression of having traveled much further. The facts observed suggest that the smaller moraine may have been formed by a local ice movement outward from the Adirondack center after the withdrawal of the main ice sheet. While they are far from being conclusive they certainly suggest an interesting line of inquiry. Such a movement is perhaps *a priori* to be expected and Prof. C. H. Hitchcock has shown that a similar one took place from the White mountains center after the withdrawal of the Laurentide glacier.

SEQUENCE OF GEOLOGIC EVENTS IN THE ADIRONDACKS.*

1. The oldest rocks, and also the most widespread of the region, comprise a series of gneisses of somewhat variable character and questionable origin. Owing to profound metamorphism all trace of original structure is lost, their

*This summary of the geologic history of the region is intended merely to set forth the writer's present views concerning that history, and is of course merely tentative, as work is really but fairly begun. These views, it is thought, are in substantial accord with those held by Profs. Kemp and Smyth, and the history is closely paralleled by that of the Canadian area lying to the northward, as set forth by Prof. F. D. Adams.

present structure being predominantly cataclastic, though this structure is often masked by a greater or less amount of subsequent re-crystallization. They vary from well foliated rocks to those in which all trace of this structure has well nigh disappeared. In texture they vary from very finely granular rocks to very coarse varieties. They abound in quartz and pegmatite veins. According to their mineralogic composition they may be roughly classified in three groups.

(*a*) Quite acid gneisses, poorly foliated, commonly of red color, mostly poor in content of ferro-magnesian silicates, and with the mineralogy and composition of granites. They consist essentially of microperthitic orthoclase and quartz, with magnetite always present, and with an acid plagioclase, microcline, hornblende, biotite, apatite, zircon, and rarely garnet as accessory minerals. A strongly absorptive green-brown hornblende is the usual dark silicate and becomes a prominent constituent in portions of the gneiss. Biotite is an exceptional mineral in these gneisses and even when present is always subordinate to the hornblende, biotite gneisses being of extreme rarity in the rocks of this group in the northern Adirondacks at least.

(*b*) Gneisses whose main difference from those just described consists in the predominance of microcline among the feldspars. In the field they are often undistinguishable from the other gneisses. At other times owing to their fineness of grain and their peculiar lilac grey or lilac brown shade on fresh fracture, they appear quite distinct. They are so intimately associated with, and pass so gradually into the other type that the wisdom of attempting to distinguish them is by no means beyond question. They commonly occur in proximity to, and may belong with the Grenville series.

(*c*) Gneisses composed essentially of orthoclase, acid plagioclase and augite, with accessory titanite, hornblende, apatite, magnetite and ilmenite, quartz, garnet and biotite, in order of prominence. In composition they grade from augite-syenites into gabbroic rocks, or from hornblende-syenites into dioritic rocks according to the relative predominance of orthoclase or plagioclase. The more basic varieties, however, are more acid than the normal gabbros of the region, their feldspars belonging to the oligoclase-andesine series, seldom if ever becoming as basic as labradorite. The augites in these rocks are very variable in character, ranging from a light-green, non-pleochroic diopside to pleochroic varieties resembling aegerine-augite. The titanite is of a deep orange color and is so constant and characteristic as to almost attain the dignity of an essential constituent. Hornblende varies from complete absence to

an amount considerably in excess of that of the pyroxene. Much of the quartz present exists as inclusions in the feldspar and hornblende.

These gneisses are much more distinctly foliated than the other varieties, due to the concentration of their dark silicates along the planes of foliation. They pass into the others either by insensible gradation or by becoming finely interbanded with them. They also seem to grade into the basic gabbros of the region; at least these latter present phases practically not to be distinguished from them. The possible relationship between the two forms is one of the most pressing and puzzling problems here presented for solution.

The gneiss series is thought to be of igneous origin and in part, at least, of Archaean age, in the sense in which that term is used by the U. S. Geological Survey. There are, however, certain difficulties in the way of this view.

The magnetite deposits of the region are in this series, and, in large part at least, in the augite-gneisses, the deposits at Mineville, Essex county, according to Kemp, being in such rocks, as are also those of Lyon mountain and of Arnold and Palmer hills in Clinton county.

II. *The Grenville (Oswegatchie) Series.* The term "Oswegatchie series" was proposed by Smyth to include the coarsely crystalline limestones and associated rocks as exposed in St. Lawrence, Lewis and Jefferson counties.* In the writer's opinion these rocks are so similar to those of the typical Grenville series of Logan, and are separated from them by such a comparatively slight geographic distance that that term might with perfect propriety be utilized for the New York rocks.

This series is very heterogeneous in character. It comprises quartzose gneisses and schists, darker colored quartz-feldspar-biotite gneisses, dioritic and gabbroic gneisses, and occssional bands of coarsely crystalline limestone. Graphite is an abundant mineral. Pyrite is another, aiding by its decomposition in the production of the rusty, decomposed aspect which some of the beds present in outcrop. Sillimanite and tremolite are frequently present as is also garnet. The rocks are cut by later gabbros and granites, and are accompanied by belts of gneiss similar to the older gneiss, which seem at times to be interstratified with the other rocks, but concerning whose real relationships we are in doubt.

For the most part the gneisses of this series differ widely in appearance from the older gneisses, and may be distinguished from them in the field almost at a glance. A considerable portion seems to be unquestionably of

* C. H. Smyth, Jr., Rep. State Geologist, N. Y., 1893. Vol. I, p. 496.

sedimentary origin, yet has been so profoundly modified that practically all trace of clastic structure has disappeared. The larger part of the rocks have a very finely granulitic structure, having undergone nearly complete re-crystallization. The dynamic metamorphism to which they have been subjected has given them a foliation in common with the older gneisses, rendering the field relations of the two exceedingly obscure.

From Parishville westward to Potsdam and beyond, the Grenville series comes to the Potsdam boundary and may be seen to great advantage. Here, on the western side of the Adirondacks, it differs somewhat in character from the similar rocks to the eastward, being more widely distributed, less faulted, less completely metamorphosed, hence with its original sedimentary character less disguised. The distance from the great anorthosite intrusion, which has so profoundly affected these rocks on the east, is a probable cause for these differences.

That the eastern and western representatives are equivalent seems to be beyond question. It is, however, quite desirable that they should be connected by tracing them across Franklin county.

III. *The Anorthosite Intrusion.* At some time after the deposition of the rocks of the Grenville series, a great batholitic mass of the highly feldspathic variety of gabbro known as anorthosite was intruded into the existing rocks. The structure of the gabbro indicates that it solidified at considerable depth, hence the rocks with which it is now in contact must have been buried beneath other rocks, since wholly removed by erosion. The anorthosite has its largest development in Essex county. In Clinton county it is exposed around Keeseville and on Catamount mountain and Rand's hill. It occurs in the eastern part of Franklin county but its extent is not known. Further westward its presence is problematical.

IV. *Later Gabbros.* Dark colored rocks of the gabbro family, of greater basicity than the anorthosites, occur wide-spread in the Adirondack region, extending far beyond the limits of the anorthosites. They occur most frequently in the form of dikes or sheets of no very great width, though larger masses are not uncommon. In part they are certainly later than the anorthosites, for they cut them. They may in part represent apophysae from them, and basic peripheral portions of the intrusion, though this has not yet been demonstrated. The gabbro at Port Henry has been described in detail by Kemp,* and some occurrences from the western Adirondacks described by

* J. F. Kemp, Bull. G. S. A., Vol. V., pp. 213-224.

Smyth.* Similar gabbros have an extended distribution among the older rocks to the south and west.

The wide mineralogic variations commonly exhibited by these rocks find excellent illustration here, the typical gabbros grading into diorites on the one hand, and into norites on the other. All are more or less foliated, the hornblendic varieties most markedly so.

Along with these rocks may well be included the narrow, dike-like bands of hornblende-plagioclase gneiss found everywhere cutting the older gneisses of the region, and which apparently represent ancient diabase or diorite dikes.

V. *Granite.* Granitic rocks are frequent in the Adirondacks. In part they represent merely granitic phases of the basal gneisses, but in part they are of later date. The writer has frequently found in the northern Adirondacks, granites which cut across the gneisses, and Smyth has described an occurrence from St. Lawrence county with irruptive contact against Grenville limestone.† Evidence of the time relation between the granite and the gabbros is not at hand, though Smyth has described a contact where he believes the latter to be the younger.‡

The granite is commonly of red color, well jointed, unlike the gneisses, and composed essentially of quartz, orthoclase, microcline and oligoclase, ferromagnesian silicates being absent, or at best only sparingly present.

VI. *Dynamic Metamorphism of the Region.* After the time of these various igneous intrusions the region was subjected to intense dynamic metamorphism, whereby secondary structures were produced and the primary ones destroyed; the rocks were all rendered thoroughly crystalline and their original relationships masked. That the rocks now exposed at the surface were then deeply buried beneath other rocks, since removed by erosion, is shown by the manner in which the rocks adjusted themselves to the forces acting upon them, the adjustments being of the kind that can only occur under heavy load.

VII. *Pre-cambrian Dikes.* At some period subsequent to the metamorphism of the region, all the rocks so far described were fissured, and through the fissures thus formed fused rock made its way toward the surface. Along some of these fissures faulting took place. That earth movements produced results of this character leads to the belief that the rocks were under

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* C. H. Smyth, Jr., Bull. G. S. A., Vol. VI, pp. 268-274. Also, Am. Jour. Sci., Vol. XLVIII, pp. 54-65 and Vol. L, pp. 273-281.

† C. H. Smyth, Jr. Bull. G. S. A., Vol. VI, p. 266.

‡ C. H. Smyth, Jr. Bull. G. S. A., Vol. VI, p. 270.

less load than at the time of their great metamorphism, and thus a long intervening erosion period is suggested.

The erupted rock may or may not have reached the surface. So far as known it is found at the present day solely in dikes. These are exceedingly abundant in the eastern Adirondacks. Though presenting considerable variation they may all be classed as diabases, and mostly as olivine diabases.

Accompanying these dikes, and having, so far as observed, the same area distribution though far less abundant, are other dikes, ordinarily of red color, of a much more acid rock. The writer has heretofore classed these with the trachytes (bostonites), but they present constant differences when compared with the lake Champlain bostonites, and evidence is accumulating that they are distinct in age. They are quite numerous in Clinton county and in the eastern part of Franklin, and have not been seen cutting any but the Pre-cambrian rocks. While they may be nothing but representatives of the post-Utica trachytes the writer is disposed provisionally to regard them as distinct, and of Pre-cambrian age. They have the same general east and west trend as the diabases, and neither has as yet been observed cutting the other.

VIII. *Palaeozoic Rocks.* After this period of dike formation, erosion continued in progress for a considerable length of time. Then ensued a depression carrying all the peripheral portion of the Adirondack region below sea level, where it remained during the deposition of the Potsdam sandstone and the lower Silurian limestones, which were laid down on the deeply denuded but uneven floor of the older rocks.

The Potsdam sandstone north of the Adirondacks is of very considerable, though unknown thickness. It is at least as much as 500′ however, and probably considerably more. From the lack of fossils except in the upper portion it is an extremely difficult formation to subdivide. The extreme basal portion is a conglomerate, often very coarse, and also carries layers of coarse, feldspathic and hematitic, easily rotting sandstone. Otherwise it is a quite pure quartz sandstone, though occasionally some layers are dolomitic. The basal one-fourth is prevailingly of red color, while the remainder is white, yellow or brown. It grades into the Calciferous dolomites above through passage beds, 30′ to 50′ thick, of alternating layers of sandstone and grey dolomite. In its upper portion it carries an upper Cambrian fauna.

IX. *Post-Utica Uplift.* After the close of the lower Silurian the submerged district was raised anew above sea level and was then affected by the earth movements which caused the Green mountain uplift. But whereas the rocks of Vermont were folded, faulted and metamorphosed by their action, the

effect produced in New York was much less pronounced and mainly effective in the production of faults, the rocks being only slightly folded and not metamorphosed at all. The faults, however, are very numerous and often of considerable magnitude. The present topography is largely due to their presence and they have no doubt frequently served as lines of readjustment since they were originally formed.

X. *Post-Utica Dikes.* During or subsequent to the time of the dynamic movements just referred to, igneous rocks made their way toward the surface through fissures. They are now found mainly as dikes and, as shown by Kemp, are of two widely different types, both very basic rocks (camptonites, monchiquites, fourchites) and quite acid rocks (trachytes) occurring. The basicity of the one type and the acidity of the other seem somewhat more pronounced than in the case of the supposed Pre-cambrian basic and acid dikes. As far as New York state is concerned, these dikes seem confined to the vicinity of lake Champlain, not ranging westward as do the earlier dikes.

FAULTS.

The true boundary, if its minutiae could be mapped on a large scale, would necessarily be exceedingly irregular. The Potsdam was laid down on an uneven floor, especially so when the Grenville series formed that floor, and where it has been pared away by erosion down to its very base this irregularity of floor must make a highly tortuous contact line. These minor details are for the most part obscured by the drift covering. An interesting illustration is furnished by exposures two miles south of Nicholville, St. Lawrence county, which will be described in their appropriate place.*

While some of the contacts are clearly those of deposition others are unquestionably due to faulting. The much-faulted structure of the eastern Adirondacks has been emphasized in previous reports by Professor Kemp and the writer. In the district under consideration here, the evidence is less pronounced, but that faults are present, and that numerously, is clear. The well known outcrops of Potsdam sandstone along the Racquette river south of Potsdam lie along the west side of a fault. The outlier of gneiss at Burke village, Franklin county, seems brought up by a pair of faults. Two miles northeast of Whippleville, Malone township, are Potsdam exposures whose attitude is due to faulting.

*The areal results of the work are delineated, so far as may be, on the accompanying map. As outcrops of the Potsdam sandstone are very infrequent much of the boundary as there shown can only be regarded as a reasonable approximation, it being marked at the limits reached by the Pre-cambrian outcrops, with such aid as the topography furnishes. Westward from Parishville its true position is quite uncertain, the conditions being much more complicated than those prevailing to the eastward.

While the great scarcity of exposures of the Calciferous dolomites renders hazardous any attempt to delineate the Potsdam-Calciferous boundary and to generalize concerning structural relations, the prolongation of the north-easterly strike invariably shown in outcrop would not connect the different exposures, there is but little indication of folding, and a series of north-south faults throwing to the east would furnish a satisfactory explanation of the existing conditions.

Local Geology.

FRANKLIN COUNTY.

Belmont.

In the extreme north-western portion of Ellenburgh township, Clinton county, is a low ridge of gneiss whose edge reaches further north than any other exposure of the New York Pre-cambrian rocks, the small outlier at Burke excepted. It is flanked on the north and west by most excellent exposures of basal Potsdam, consisting mainly of massive arkose conglomerates, which reach over the border into Franklin county. Thence westward the level drops sharply into the Chateaugay valley, which is heavily drift-filled on its eastern side, so that no rock shows, and the boundary here is uncertain. Like so many of the Adirondack valleys, the river here seems to occupy a fault line. On the west the river hugs the side of a ponderous ridge of gneiss which extends northward to the town line. Somewhat more than a mile further down stream commences the series of excellent Potsdam exposures which culminate in the "Chasm" at Chateaugay village. Still further down stream the overlying Calciferous shows near the mouth of Marble river. The section here has been measured and described by Mr. Walcott.* It shows the upper 250′ of the Potsdam, but gives no notion of the entire thickness of the section along this line.

Passing westward through Belmont the gneisses come up to the boundary in a series of low ridges separated by shallow depressions filled with drift. The gneisses consist here of the red, poorly foliated, microperthitic variety, alternating with dark grey plagioclase-pyroxene gneisses, in which the feldspar is oligoclase or andesine and the pyroxene the aegerine-augite variety. The former predominate toward the east and the latter to the west, but the two occur interbanded in every section. There are also the usual dike-like bands of gabbroic and dioritic gneiss. With the exception of the exposures in the Chateaugay river but one outcrop of Potsdam sandstone was seen in the township in the vicinity of the gneisses. The exposure occurs in a depression between two ridges of gneiss, and shows several layers of coarse, somewhat pebbly rock, which is very quartzose and of light-brown color. Numerous loose blocks occur wide-spread in the vicinity, some of which are of very

* Bull. U. S. G. S. No. 81, p. 343.

coarse conglomerate, though these also do not agree in color and composition with the basal Potsdam as it usually appears. These loose blocks are manifestly not far removed from their parent ledge.

Burke.

In Burke township is a small and interesting Pre-cambrian outlier, at a distance of over five miles from the main boundary. The rock is well exposed in the Trout river at Mackenzie's mill, half-a-mile north of Burke post-office, and thence may be traced westward for one-third of a mile, the outcrops covering a wedge-shaped area with the apex at the mill, and the base to the west. Both to the east and the west the rock passes beneath heavy drift, concealing its extent in those directions, but Potsdam sandstone crops out near at hand to the north and south. In the former direction and only 100 yards down stream is a twenty-foot cliff of hard, yellowish sandstone, here abruptly cut off. A half-mile to the south, at the village, similar sandstone appears in the stream, dipping in the other direction. The accompanying section shows the observed relations. The sandstone has the lithologic characters which mark the middle and upper portions of the formation, and the writer sees no way of accounting for the structural relations here exhibited except on the assumption that the gneiss is brought up by a pair of faults.

The exposures here show a red, well-jointed, acid granitic rock composed of quartz and microcline or microperthitic orthoclase and a little magnetite. At the mill two large dikes constitute half the exposure. The southerly one is of syenite porphyry and is 27′ wide with the south wall not showing. Thirteen yards north of it is a 15′ dike of a diabasic rock which differs somewhat from the normal diabases of the region and is very coarse grained. A few rods to the westward, in the woods, are two other dikes, both of normal diabase, one of which is noteworthy in that it contains numerous inclusions of the wall rock scattered through it, commonly of small size. Such inclusions are not a common feature in the Adirondack diabases.

FIGURE 1. Section north of Burke village

The occurrence of this Pre-cambrian outlier, probably brought up by faulting, suggests interesting possibilities in the way of other occurrences of like nature, now concealed beneath the drift.

Malone.

In this township the boundary pursues a west-south-west course nearly to the western line of the town, when it bears away to the north along the edge of Cornish hill, a massive ridge of gneiss which extends well up into Bangor. As in Belmont, low ridges and spurs of gneiss protrude through the drift along the boundary, separated from one another by shallow, drift-filled depressions.

The gneisses are of the same general character as in Belmont. The two extreme varieties are, on the one hand, red, acid gneisses, composed of quartz and microperthitic orthoclase with magnetite and varying amounts of dark green-brown hornblende, and on the other, grey, more basic gneisses, made up of plagioclase, orthoclase, aegerine-augite and titanite, with or without hornblende and quartz. Sometimes one or the other of these attains considerable thickness, but ordinarily the two are interbanded, the bands not exceeding a few inches in thickness, and the one rock grading into the other. The resulting rock is therefore well banded, but neither in structure nor composition does it give any hint of a sedimentary origin. The customary dike-like bands of hornblendic gneiss occur in all exposures of any extent.

An interesting garnetiferous gneiss was found in the township outcropping near the road one-half mile east of District School No. 6. It is a nearly black gneiss and occurs interbanded with a reddish pyroxene gneiss of intermediate composition. Garnets, which are so deeply colored as to be almost black, make up nearly half the rock. In thin section they become transparent in deep yellowish-brown tones. The resemblance to colophonite is strong. A careful qualitive test made by Prof. E. W. Morley shows the presence of titanium in small amount, and the color is probably due to it. In addition to the garnet the rock is mostly made up of microperthite, but holds also a little aegerine-augite, oligoclase and quartz.

But two localities were found in Malone where the Potsdam was exposed near the boundary. The first is along the Adirondack railroad about two miles south of Malone, where 15′ of red, thin-bedded, feldspathic sandstone are exposed at the south end of a cut within 100 yards of massive exposures of red, microperthitic gneiss banded with pyroxene gneiss. The dip is in the normal direction and is not high, 10° to N. 35° W.; the character of the rock indicates the basal portion of the formation and there is no sign of faulting.

The second locality is a mile and a half distant and one mile east of School No. 6. Here in a field south of the road, lying in an embayment between

two gneissic ridges and with gneiss within a quarter-mile on each side, is a knoll of hard, well indurated, red and white banded sandstone which has been somewhat quarried. The location of the exposure, the 25° dip and the fact that the horizon in the Potsdam is somewhat above that of the previous exposure, indicate that the presence of the sandstone here is owing to dislocation.

The higher portion of the formation is well shown in the river at Malone and thence northward, it being quarried considerably about a mile north of the city. Beyond, occasional outcrops are found along the river for a distance of several miles before the Calciferous is reached near Westville. For about half of this distance the inter-stratification of grey dolomite with the white sandstone indicates the presence of the passage beds to the Calciferous, which apparently occupy the centre of a shallow synclinal trough, as the north-westerly dip beyond is replaced for some distance by one to the south-east. The wide extent of surface underlaid by the Potsdam here is thus explained. In the passage beds at this place are iron-grey sandy dolomites presenting a peculiar appearance, and such are found to characterize this horizon throughout northern New York. On the fresh fracture, glittering cleavage faces are shown a half inch or more in length and dotted in a psuedo-pœcilitic fashion by numerous rounded quartz grains, giving a peculiar satiny lustre. The thin section furnished the explanation. The rock is a fine mosaic of dolomite crystals in which are streaks numerously set with somewhat rounded grains of quartz. In the quartzose bands are frequent areas in which the cement enclosing the grains has the same extinction throughout. In these cases the matrix is found to be of calcite instead of dolomite. In the sandy streaks then, rather coarsely crystalline secondary calcite has been deposited around and including the quartz grains, its good cleavage manifesting itself when the rock is broken.

Bangor and Brandon.

The only Pre-cambrian rocks exposed in Bangor are the gneisses of Cornish hill which extend northward four miles beyond the average line of the boundary. Following the west side of the ridge the boundary passes into northern Brandon, then swerves to the westward and continues in that direction across the township into Dickinson.

The gneisses exposed are quite homogeneous and consist mainly of microperthitic gneiss in the eastern, and microcline gneiss in the western half of the township, the two having the same color and appearance and grading into one another. Hornblende is present in variable amount in all the exposures, and

the rock is well foliated. The more strongly acid gneisses are well jointed, the ordinary gneiss lacking this structure; the former may represent the later granites, decisive evidence on this point not having been found. The pyroxene gneisses, which are such a feature in Malone and Belmont, are mainly lacking here, though they are present to some extent. Considerable gabbro-diorite gneiss occurs together with the usual dikes of hornblende gneiss. Near the west line of the township are widespread exposures of acid granitoid gneisses, which alternate with masses of gabbro-diorite gneiss of considerable thickness. The two blend into each other along their contacts.

The Potsdam sandstone makes but meagre showing in these townships, the drift being very heavy. In the stream at South Bangor there are slight exposures of a buff, hard, coarse sandstone. There is an old quarry on the Bangor-Brandon line from which a slight amount of stone has been taken, the rock here being white and not well indurated. One mile to the south-west the red, hematitic arkose of the basal portion of the formation is poorly exposed by the roadside only a few yards away from the gneisses. This was the only outcrop lying close to the boundary observed in the township.

Dickinson.

In this township the boundary trends to the south-west. In the north-eastern corner the gneisses are well exposed at the end of a low ridge with Potsdam sandstone close at hand to the north. The entire western flank of the ridge is, however, so thoroughly drift-covered that no exposures are to be found until those opened by the Deer river are reached, so that the boundary here is uncertain though the topography indicates a position approximately as shown on the map. At Dickinson Centre and thence westward to the county line and beyond, outcrops of gneiss are plentiful with, in one case, the Potsdam in place only a few yards away.

The gneisses in the north-eastern part of the township are for the most part red, acid gneisses of microcline or microperthite and quartz, often coarse and full of quartz and pegmatite veins, as is usual in these gneisses. With these are narrow, sharply defined basic bands of hornblende gneiss which constitute but an insignificant proportion of the whole.

Around Dickinson Centre and for a mile and a half eastward, the rock is largely gabbro-diorite gneiss. This grades on the one hand into hornblende gneiss (diorite gneiss) and on the other into a red orthoclase gneiss which carries the same aegerine-augite and deep orange titanite which are found in the gabbro-diorite. This in turn gradually shades into the ordinary red

granitoid gneiss of the region. These relations are well shown one-half mile north-west, and again the same distance south of the Centre. At the latter locality a hornblende gneiss at the base of the section grades upward into gabbro-diorite and this in turn into red orthoclase-quartz gneiss. A considerable biotite content characterizes some of the gneisses here and is worthy of note as it is not an important mineral in most of the basal gneisses.

The gradual passage of one kind of gneiss into another in this region is not thought to possess the significance which would attach to it in an unmetamorphosed district. It is so general, and the rocks concerned are often so diverse that it would seem to have been produced during the metamorphism of the region and therefore to be secondary, instead of representing an original structure due to community of origin. North-west of Dickinson Centre quite massive gabbro-diorite is seen passing over into red orthoclase gneiss, not however by a gradual change but by the most minute kind of interbanding of the black and red gneisses, both of which here have a composition intermediate between that of the two extreme varieties.

One mile west from the Centre on Macomber's farm, is a ledge of Potsdam sandstone outcropping one-fourth mile south of the road. It is red in color and thin bedded, but hard and firm and has been quarried somewhat for local use. It has the usual moderate dip to the north-west. To the south it shows cut off edges, a marshy tract intervenes, then at a distance of 75 yards appears a massive wall of red, acid, microcline-quartz gneiss. This kind of topography prevails where the gneiss and the sand stone are found near together and may perhaps be accounted for by the easily erodable character of most of the basal Potsdam.

East and west of Dickinson Centre along the Deer river are heavy sand deposits which cover considerable territory. They are on nearly the same level as the upper sand at Malone, but probably represent deposits along stream made by the river during its flooded condition following the retreat of the ice sheet, while local glaciers may have still lingered in the Adirondacks.

ST. LAWRENCE COUNTY.

Hopkinton.

The boundary pursues a nearly east and west course across this township. It presents certain differences in character when compared with the boundary in Franklin county, owing to the fact that the gneisses here strike east and west so that the ridges run parallel to the boundary instead of coming up to it, while depressions are less frequent and cut across the strike. Out-

crops of Potsdam sandstone are more numerous close to the boundary in this township than in any other part of the district examined.

The gneisses along the boundary in Hopkinton are quite homogeneous and quite similar to those already described, their main distinction being the not infrequent occurrence of considerable biotite, this being especially true of those in the western half of the town.* In the eastern half they are mainly well foliated orthoclase or microcline gneisses with the usual variations in structure and texture and in the amount of quartz present, containing also varying amounts of plagioclase and hornblende and sometimes biotite. The usual bands of diorite gneiss occur plentifully. In an exposure on the Meacham farm, two miles south of Nicholville, is a dike-like band only 18 inches wide cutting the gneiss, and this furnishes the best and least metamorphosed specimens of the basic, ophitic gabbro which the writer has yet seen in the Adirondack region.

The Potsdam, as exposed in the township, possesses considerable interest. Near the roadside at the Meacham farm and near the gabbro just discussed are the outcrops mentioned on a previous page, † a low knoll of very coarse, rotten, acid gneiss crossing the road, followed to the south at a distance of 15 yards by exposures of a coarse, feldspathic conglomerate which disintegrates with great readiness. The conglomerate is composed of debris from the gneiss and occupies a depression in its surface, as gneisses appear again in force a short distance further south.

One mile to the eastward, on a lane running south from the main road, is an old quarry opening in a single ledge which protrudes through the drift. The rock is a well laminated, coarse sandstone, in white and buff or brown colors, and has the abnormal dip of 18° to S. 20° E. It seems to represent an horizon well above the base of the formation and its attitude suggests dislocation. It lies, however, in a wide depression with no other outcrops near at hand.

One and one-half miles west of the Meacham farm exposures and less than two miles south of Hopkinton village, a ledge of red, feldspathic sandstone, containing also much magnetite sand, is well exposed by the roadside and for some distance to the westward, with the normal low dip to the north-west. Only ten yards south of it and parallel with it on the west, is a ridge of very coarse acid gneiss. There is no evidence of faulting between the two. One mile to the northward is Budd's quarry where a firm, red stone, often prettily banded

* As Professor Smyth is engaged in a detailed study of the Pre-cambrian rocks of St. Lawrence county, they will be but briefly referred to here.

† Page 14.

with white is opened and has a considerable local use. White sandstone is exposed by the river at Nicholville, and near Fort Jackson much quarrying is done in white and buff sandstone. Westward from this line of outcrops no Potsdam was seen in the township.

Parishville.

In this township the boundary at first bears to the north to enclose the massive but low ridge of gneiss lying to the northward of Parishville village. The exposures are excellent and show a well foliated gneiss of intermediate composition, for the most part with a considerable bi-silicate content which is usually hornblende. This is sometimes replaced by a pleochroic augite. Biotite is also a prominent ingredient and a little muscovite shows in some of the slides. The predominant feldspar is plagioclase, either oligoclase or andesine, but orthoclase, microcline and quartz are present in considerable amounts.

Just to the westward of Parishville village, the Grenville series comes to, and forms the boundary. Rocks which unquestionably belong to that series are separated by ridges of gneiss of uncertain relationship, but these excepted, the Grenville series remains at the boundary as far as the work was carried. The unequal resistance to erosion presented by the various members of this series, coupled with the fact that the general altitude of the country is much below that to the eastward so that erosion does not go forward so rapidly, combine to render the boundary very uncertain, both because of the exceedingly erratic distribution of the Potsdam and because it rarely shows in outcrop.

These rocks will be described by Professor Smyth. It may be said in general that the gneisses in this series differ from the older gneisses in being for the most part much more finely and evenly granular and in having, in many of the beds, abundant biotite as the only ferro-magnesian mineral.

The Potsdam was found exposed in but two localities in the township, both along the brook which empties into the river one mile west of Parishville. The best exposures are about a mile up the brook and consist of coarse sandstone of medium induration, striped in white and flesh color, or white and buff. The other outcrop is further north where the road from Parishville to Parishville Centre crosses the brook, and the exposure is but meagre. These rocks lie in a trough eroded in beds of very quartzose gneiss which oppose but feeble resistance to degradation. Sufficient data were not obtainable to admit of determining whether the Potsdam owes its present position to faulting or

to original deposition. It is quite possible that it reaches further south than is indicated on the map.

To the southward, in Colton, crystalline limestone outcrops in association with the gneisses which here appear. One mile south of the main Potsdam exposure, the brook shows an excellent section of the quartzose gneisses on each bank, along with some curious rocks of very uncertain origin, and in any event profoundly changed from their original condition. The exposure is mentioned here as it is of great interest, yet is an easy one to miss.

Pierrepont and Potsdam.

The boundary so far as traced in these towns is shown on the map accompanying this report. More detailed areal work would probably necessitate considerable changes as the relationships here are complicated, and the drift very heavy. The rocks of the Grenville series are well shown and possess great interest.

The Potsdam sandstone in the vicinity of Potsdam shows features of importance, and the accompanying map (Figure 2) has been prepared to show in detail the conditions along the river south of the city. Both east and west of the city the Grenville gneisses reach as far, or nearly as far, north as the city itself. They are even found in the city itself. But the river valley is so heavily encumbered with sand deposits and other drift that the limits reached by these rocks are completely hidden. Along the river, however, outcrops of Potsdam sandstone are found for a distance of six miles south of Potsdam, and probably extend still further in the same direction. The structure is sufficiently well shown to prove that it owes its position and attitude to faulting.

Northward from Potsdam, the upper beds of the sandstone are shown along the river, with the customary low north-westerly dips, followed by the passage beds, and, just below Norwood, by the Calciferous. These are all with the same dip, and manifestly in a continuous and undisturbed section. At Potsdam, as shown by N. H. Winchell, gneisses of the Grenville series outcrop in the river and in the city itself.* The heavy drift covering east and west prevents tracing this rock to any connection with Grenville exposures in those directions, but it seems most probable to the writer that it is brought up here by a fault. The absence of all the lower portion of the Potsdam formation in the exposures to the northward, and the high dips and disturbed character of

* Geol. Surv. Minn. 21st Am. Rep. pp. 103-104.

These outcrops were not seen by the writer, but a letter just received from Professor Winchell verifies the statements made in his report. The presence of this gneiss is the cause of the rapids in the river at Potsdam.

the exposures of the same formation to the southward harmonize with this view.

At Clarkson's quarry, three miles south of Potsdam, the rock is a firm red sandstone which is so cross-bedded and jointed that it is not easy to make out the true dip, which is, however, somewhat to the south of west.

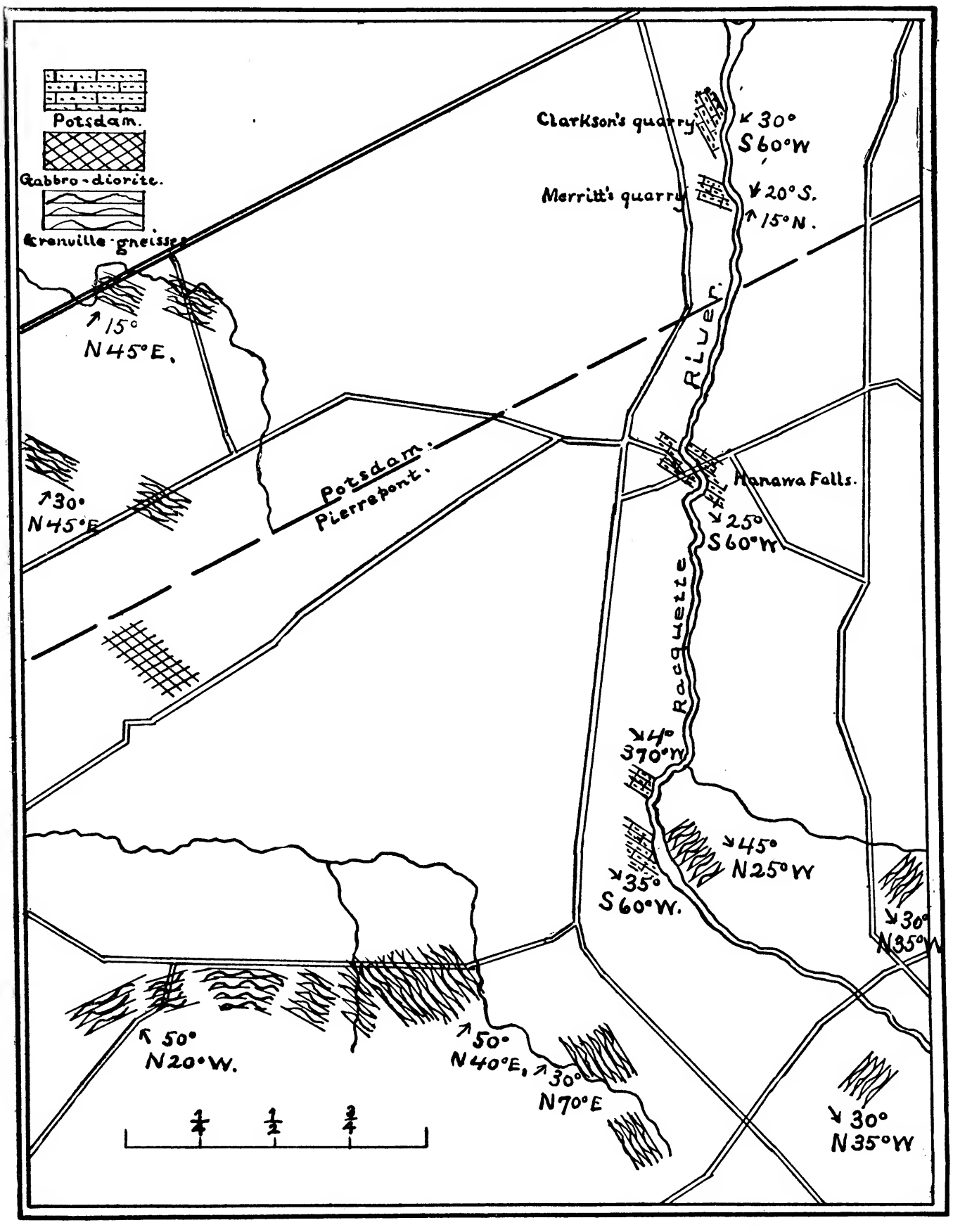

FIGURE 2. Map of a portion of Potsdam and Pierrepont Townships.

The lithologic character of the rock suggests an horizon low in the formation. A short distance further south, at Merritt and Tappan's quarry, the flesh-colored stone is banded with white and the structure is synclinal, as shown by N. H. Winchell.* Nearly a mile further south are excellent

* Loc. cit. p. 101.

exposures at Hanawa Falls, where the rock is prevailingly red and massive, the dip to the south-west has been resumed, and the horizon seems much the same as at Clarkson's.* Still another mile to the south is Elliott's quarry where the rock is light colored, being merely tinged with red. The dip is still to the south-west though here it is quite low.

One-fourth mile further south are most interesting exposures on both sides of the stream, at the site of an old mill. The west bank is formed of Potsdam sandstone, here of white color and with a south-west dip. It must lie higher than the rock at Elliott's quarry, and apparently is at a higher horizon than any other seen south of Potsdam. The east bank of the stream, which is here only a few rods wide, is composed of rotten pyritiferous, quartzose gneisses, much stained by hematite in their upper portion, which belong to the Grenville series. The river just here is clearly occupying a fault line, to the presence of which the disturbed character of the Potsdam is due. Drillings for hematite ore not far east of the river, show apparent Potsdam conglomerate overlying the Grenville rocks, so that the throw of the fault is probably not excessively great.

To the west of Potsdam is a great development of kame and drumlin-like drift hills. The boundary indicated on the map merely connects the most northerly Pre-cambrian outcrops seen, and in the absence of Potsdam outcrops to the northward, must be regarded with considerable suspicion. The only exposure seen was a meagre one at West Potsdam.

The Calciferous Formation.

No attempt to make a section of the Calciferous was undertaken. With one exception all the outcrops seen were in close proximity to the Potsdam and merely represent the basal portion of the formation. The rock exposed is a hard, iron-grey, often sandy dolomite, occasionally with nodules of coarsely crystalline calcite, and quite like the layers of dolomite in the passage beds.

In the Racquette river north of Norwood near the Norfolk-Potsdam line, the rock exposed differs somewhat from the foregoing, being a quite pure blue dolomite. One layer in particular is quite fossiliferous though the fossils are not easily obtained in good condition. Quite a variety of forms are present here, including species of *Asaphus*, *Orthoceras*, *Nautilus*, *Pleurotomaria* and a little *Murchisonia* which is identical with the species occurring in the *Ophileta* beds at Beekmantown, Clinton county The locality is at the

* Ibid. p. 104.

bridge over the river on the town line. It seems further south than the one mentioned by Winchell and from which his party obtained fossils.* The horizon can not be far above the base of the formation, if undisturbed.

Dikes.

In following the boundary across Franklin county, eleven dikes were noted cutting the Pre-cambrian rocks. These were all in the eastern half of the county. In St. Lawrence not a single one was seen in the belt examined, and Professor Smyth's work shows them to be rare in most of that county. In the eastern Adirondacks they are exceedingly abundant and the same is true further westward at the Thousand Islands as described by Smyth, who has demonstrated them to be there of Pre-cambrian age.†

Of the eleven dikes, ten were of diabase and one of syenite porphyry. Nearly all the diabases contain olivine. One of them is noteworthy in that it contains frequent large phenocrysts of a light green, almost non-pleochroic orthorhombic pyroxene, probably enstatite, a mineral not of common occurence in diabase.

A more detailed description of the dikes will be printed elsewhere.

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* Minn. Geol. Surv., 21st Ann. Rep., p. 109.

† Trans. N. Y. Acad. Sci., Vol. XV, p. 54.