THE MONTEREGIAN PETROGRAPHICAL PROVINCE

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CONTRIBUTIONS TO THE KNOWLEDGE OF THE MONTEREGIAN PETROGRAPHICAL PROVINCE.

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INTRODUCTION.

A study of the geology of a portion of the township of Outremont was made by the author, at the suggestion of Drs. Adams and Bancroft in the fall of I9I0 and continued in the fall of I9II. The laying of sewers during this period afforded certain exposures which were deemed worthy of record. A geological map has been made including that part of Outremont bounded by St. Catherines Rd and the C. P. R. Main Line, by Rockland Avenue and the small wood to the south-east of the golf-links. The area has a length of I300yards and a width of I240 yards. A survey was made using the transit-stadia method. True azimuth was obtained by means of sun observations. A plot of the survey has been made on the scale of 400 feet= Iin.

My best thanks are due to Mr.G.H.Gilchrist of McGill University for his practical assistance in the surveying, to Prof. McLeod of McGill University for the loan of a transit, and to the Director of the Geological Survey of Canada for the loan of a surveying-rod (Mr. Boyd's pattern)

PREVIOUS WORK.

The area under consideration is included in the sheet of Montreal and vicinity published by the Geological Survey of Canada to accompany the report of Adams and Leroy on The Artesian and other Deep Wells on the Island of Montreal (Ann. Rep. G.S.C. N.S. XIV. Pt. O. I90I.) A summary report of Leroy's work in connection with the areal geology of the same sheet appears in Ann. Rep. G.S.C N.S. XIII I900. p. I39A. Closely related breccias to those treated in this paper have been discussed by different writers. Mention is made of the St. helen's Island breccias in the 1863 report on The Geology of Canada, and again by Ells, Ann. Rep. G.S.C. N.S. VII p. 11J. They have also been discussed by Nolan and Dixon, Can. Rec. Sci. IX pp.53-66. 1903., and by Harvie, Trans. Roy. Soc. Canada, 3rd. Ser Vol. 4 Sect. 4 p. 249. 1909-1910. Other breccias in the vicinity of Montreal have been discussed by Harvie (loc. cit.) and by Buchan, Can. Rec. Sci. VII p. 524 1902. The most detailed treatment is that of Harvie, which deals with all the known occurrences of breccias in the vicinity of Montreal at the time at which the paper was written. An outline of the general characteristics of the Monteregian Petrographical Province has been given by Dr. F. D. Adams in the Journal of Geology, Vol. XI, No. 3, 1903, page 239.

TOPOGRAPHY.

The area constitutes a small patch having a slight elevation above its immediate surroundings, except toward the south-east in the direction of Mount Royal. It owes this to the fact that certain breccias and other igneous rocks exposed in the area are harder than the limestone of the district, ~~which~~ and have, owing to their greater resistance to weathering, retained a slight elevation above the normal limestone. The higher parts and all slight elevations are found to consist of the breccias or of igneous rock. Between the more elevated parts a softer contour is dependent on the limestone, which is the immediately underlying rock. In some parts a covering of glacial clay or sand produces a further softening of outline. One curious topographic feature calls for mention. In the golf-links, along the north face of the scarp on which the club-house is built is a series of small elevations and depressions, sometimes horse-shoe shaped, sometimes almost circular, about ten feet in diameter and four feet in depth. These afford an excellent set of bunkers, but the explanation is not obvious at first sight. The gravel beach which is exposed in the large pit to the west covers this area and was formerly worked for gravel, one layer being valuable and the rest valueless. The valuable layer was worked in the winter-time by tunnelling, the support of the roof being effected by the ice in the frozen gravel. In the spring the upper layers of pebbles and gravel collapsed giving rise to the hummocky appearance of the surface which has been noticed above.

The northern edge of the sheet is part of a flat plain covered with post-glacial sand which stretches away to the north.

GENERAL GEOLOGY.

PLEISTOCENE. Glacial clays and boulders, post-glacial sands, ~~clays~~ and gravels.

POST-LOWER DEVONIAN. Intrusive plutonic rocks, dikes breccias.

ORDOVICIAN. Trenton Limestone
Chazy Limestone.

CAMBRIAN. Petsdam? quartzite, included pebbles in breccias.

POTSDAM. This formation is possibly represented by inclusions of quartzite pebbles which occur in a matrix of igneous material at various points, which are indicated on the map. The quartzites were caught up by the magma in its passage through rocks at a lower level in the earth's crust. The general characters of the pebbles are those of the harder and better cemented members of the Potsdam Series underlying the district , but in the absence of fossil contents, reference to this horizon is purely tentative.

CHAZY Exposures in a trench along Van Horne Av. showed beds of a dark gray limestone, of which some layers are coarsely crystalline. Fossils were obtained from a narrow band above the coarsely crystalline members and just below the surface of the ground. Often, this band is almost completely made up of shells of Rhynchonella plena. No other form was recognised. This exposure of Chazy limestone is a continuation of that noticed by Leroy at the corner of Wiseman and Van Horne Avenues.* The dip of the limestone here is the same as that of the Trenton limestone of the area, viz. 5° to the south-east. The junction between the Chazy and Trenton limestones was nowhere observed. The contact along Van Horne Avenue is covered by beach deposit. The relations of the outcrops of the Chazy and Trenton make it probable that the junction is a faulted one, the fault following the line indicated on the map. Whether this movement was chiefly vertical, with relative raising of the beds to the north east of the fault-plane, or mainly horizontal, with displacement of these beds to the south-east, is a matter of conjecture.

TRENTON.

This series is the most important of the sedimentary rocks of the district, underlying nearly the whole of the area which is not occupied by igneous rocks. It consists of a bluish-black, thick-bedded limestone, occasionally slightly argillaceous and weathering to a light blue colour. In general, the beds have not been much disturbed and possess the usual dip of the Ordovician strata about Montreal, viz. 5° to the south-east. Certain beds contain numerous fossils, which serve to determine their age. The following forms have been obtained from the normal limestone exposed in the trench in Rockland Avenue:-

Brachiopoda. Orthis testudinaria. Dalman.

Orthis. sp.

Rhynchonella? fragment.

Trematis montrealensis. Billings.

Crinoidea. Joints of stems.

*Ann. Rep. G.S.C. N.S. XIII. p. 140 A. 1900.

Tabulata. Stenopora fibrosa. Goldfuss. (Bryozoa of Ulrich)
Bryozoa. Ptilodictya acuta. Hall.

When brecciated and intruded by the igneous material, (see below), the limestone is baked and takes on a white, or more rarely a pinkish colour, and is then brittle and possesses a china-like fracture. It represents a partial marmorosis, the heat having been insufficient to cause a recrystallisation of the limestone. A number of badly preserved fossils have been obtained from this altered limestone in the trench in Rockland Avenue, at a point immediately south-west of the exposure of Chazy limestone in Van Horne Avenue. These fossils are of Trenton age and form the basis of the assumption of a faulted junction of the Trenton and Chazy limestones. The fossils are:-

Trilobita. Ceraurus? sp. small part of cephalic shield.
Crinoidea. Parts of stems.
Brachiopoda. Orthis (Platystrophia) lynx. Eichwald.
Strophomena cf. filitexta. Hall.
Pteropoda. Conularia trentonensis. Hall.

The following Trenton fossils were found in the black, poorly fossiliferous limestone in pit 3:-

Trilobita. Ceruarus pleurexanthemus. Green. glabella.
Tabulata. Prasopora Selwyni. Nicholson.
Pteropoda. Conularia trentonensis. Hall.
Brachiopoda. Trematis montrealensis. Billings.
Strophomena filitexta. Hall.

From the cutting in Dunlop Avenue, close to the Golf Club-House the following forms were obtained:-

Tabulata. Stenopora fibrosa. Goldfuss.
Brachiopoda. Orthis testudinaria. Dalman. in abundance.

Orthis (Platystrophia) lynx. Eichwald.

Strophomena filitexta. Hall.

Lamellibranchia. Cyrtodonta. sp.

POST LOWER DEVONIAN IGNEOUS ROCKS.

A suite of intrusion-breccias, dikes, sheets and some rocks of a plutonic nature have been intruded into the limestone, and have characters which make them immediately referable to the same general act of igneous intrusion as Mount Royal itself. So that the age of these intrusives is assigned to some period later than the Lower Devonian, (Oriskany).*

The Plutonics. This group is not sharply marked off from that of the larger dikes and sheets, the latter class, on expansion, taking on a coarse grain and being classed as plutonic, whilst some of the types described under the head of plutonic rocks are very fine-grained.

One example of this class suggests by the shape of its intrusion an intrusive sheet the tip of which extends as a tongue partway across the golf-links. At the tip of the tongue the rock is a coarse pyroxenite, carrying a small amount of olivine and a fair amount of hornblende. A few feet to the south-west the rock is a little richer in olivine but still belongs in the pyroxenite class. Still further to the south-west the rock passes into an essexite.

In the small pit 2, and just round about it is exposed a dark-coloured, fine-grained nepheline-syenite which is cut by many small veins of nepheline-aplite. To the south of this is a small exposure of essexite and in the wood to the south-west of the golf-links different types of nepheline-

*H.S.Williams. Trans. Roy. Soc. Canada. SER. 3, Vol. 3, SECT.4, I909-I9IO. p. 205.

syenite are exposed. On the northern face of the small hill in this wood a drk-coloured fine-grained type occurs as included blocks of a breccia, the cement of which is a fine-grained, light-gray pulaskite. On the west face of the same hill a more normal type of nepheline-syenite occurs. These rocks are cut by members of the "larger dike"class, one of which contains many pebbles of quartzite.
Certain inclusions occurring in a dike in the cutting just south-east of pit 3 belong here and are of the essexite typ
Some of the larger dikes are closely similar in composition and texture to some of the plutonic types so called and are separated from them because the dike nature of the intrusion to which they belong is more clearly shown.

Brecciation. Breaking up of the rocks through which the molten magma was intruded, and transport of this broken material is a very common feature of the development of igneous activity at Mount Royal. This has been strongly brought out by Harvie, (loc. cit.). Since that time [1909] a number of other breccias have been noticed. In the tinguaite sheet at Cote la Visitation fragments are found, which have the appearance, in hand-specimen, of a nepheline-syenite, closely related to that of Mount Royal, but poorer in ferro-magnesian constituents. In the Corporation Quarry at Outremont there was exposed in the fall of 1911 a large mass of rock showing blocks of the typical essexite of the Mountain brecciated by nepheline-syenite and the whole brecciated a second time by a dark, fine-grained rock similar to the camptonite of the "Outremont breccias". The two stages of brecciation are clearly shown, proving that there were three distinct periods of intrusion.

In the area under consideration similar "intrusion breccias" are exposed and will be discussed in detail.

The Breccias. The chief type, to which the name "Outremont Breccias" is here given, is that in which the paste is camp-tonitic in character. This constitutes the major part of the exposures of breccia. The rock is composed of angular blocks of limestone embedded in a larger or smaller amount of camptonitic cementing material. The limestone is white (vide supra), and the camptonite almost black, so that the resulting rock has a very striking appearance. See Plates I and 2, fig.2. The limestone usually composes more than 50 or even 75% of the mass, gradations being found with the paste decreasing to zero. The limestone blocks occur in all orientations, with bedding planes tilted in every direction. Some of the blocks have the bedding thrown into prominence by reason of the unequal susceptibilities to weathering of the different bands. The camptonite cement occurs filling up the interspaces between the limestone blocks, though in some cases this filling is not quite complete. In such a case the camptonite usually shows a "ropy" surface (Plate3 fig.I). The breccias of this type are usually connected with a large dike, (class I below), which represents the channel of intrusion of the magma which consolidated as the "cement". The intrusion of the dike is normal up to a certain point. The magma was highly fluid, at a comparatively high temperature and highly charged with gases. On reaching a point in the earth's crust at which the pressure of the gases became equal to, or slightly exceeded that of the super-incumbent strata, the water of the magma flashed suddenly into steam with explosive violence, shattering the limestone of the immediate neighbourhood. This shattering would be most easily communicated laterally, along a bed or series of beds, when once started. The broken blocks were thrown from their original into some inclined position and the molten magma rushed in to fill up the spaces between the limestone blocks,, impelled by the strong forces just called into play. This liquid being remarkably fluid filled practically every small opening that was left, and doubtless in some cases swirled the pieces of limestone in its eddies before finally coming to rest. In some few places the contact between camptonite and limestone is not quite close, allowing for the development of what the author considers to be "true flow structure. This flow structure is indicated by the "ropy" surface mentioned above. That it is not a cast of a fractured surface of limestone is shown by an occurrence of such a "ropy" surface within the igneous cement itself, a thin layer (¼ in.) being interposed between the "ropy" surface and the limestone. The excessive fluidity of the magma accounts for the fact that only rarely is a fluxional arrangement of the hornblende crystals seen under the microscope. The shattered limestone being now pervaded by the hot magma, gases and water vapour, underwent the baking or marmoresis which has been noticed above.

The "Outremont Breccias", then, represent a preservation of the record of explosive intrusion closely comparable to an explosive extrusion of lava, the only important difference being that in this case the explosive forces spent their violence before the surface of the earth's crust had been reached.

<u>Nepheline-syenite breccias</u>. See Plate 3 fig. 2.
This type has only a small development, but is important as illustrating the general feature of brecciation in the district, and because it emphasises the order of intrusion found to hold on Mount Royal, viz. an earlier basic followed by a later more acid phase. It is found at the point indicated on the map and covers only a few square feet of exposure. An approach to the same condition is seen in the small pit no. 2, where a rock very similar in macroscopic appearance to the basic part of the breccia just mentioned is cut by many small veins of a nepheline-

~~syenite~~ aplite, which is very poor in ferromagnesian constituents. In the cutting immediately south-east of pit 3 is exposed a dike four feet wide, of ~~camptonite~~ nepheline-syenite and carrying rounded masses up to the size of a hen's egg of a rock which is more basic than the ones just considered. Essexite. It is included here for convenience of treatment.

<u>Pets dam breccias.</u> In the cutting last mentioned occurs a narrow dike, three inches in thickness, of bostonitic material, now much weathered. On the floor of the cutting it appears to spread out in the form of a sheet and encloses rounded pebbles of quartzite of the size of a hen's egg. This dike is the youngest of those exposed in the cutting and can be seen to cut several of the other dikes. The quartzite pebbles were derived from some lower level ,from strata through which the magma was intruded. The rock most resembling the quartzite and known to underlie the district is the Potsdam Sandstone. These quartzite pebbles are therfore tentatively referred to the Potsdam Series, in the absence of fossil contents.

Another example of the quartzite breccias occurs at the point marked P on the map. Here the igneous rock enclosing the pebbles is camptonitic, and part of the paste of the "Outremont Breccias". At first sight it appears as if several dikes cut at the point at which the quartzite pebbles occur, but closer examination shows that all are of one age and that several cracks having different directions were filled at the same time by the camptonite, which carried up with it from below quartzite pebbles derived from a lower horizon than the Trenton, which is the country rock at this point.

Included quartzite pebbles are also seen in a dike of the more acid series at the point marked R on the map.

The Dikes.and sheets. These are treated under three heads:

I. The larger dikes and sheets.

2. The smaller camptonite dikes and sheets.

3. The smaller dikes of the bostonite family.

I. The larger dikes and sheets. A number of intrusives is included here some of which are seen to be dikes and can be traced to their expansion in sheet form, as, for example the essexite dike at the corner of Rockland and Van Horne Avenues, some of which are clearly sheets whose feeders are not exposed, as that in pit 3 and immediately west of it, whilst some do not show clearly whether they are dikes or sheets, e.g. the exposure at the extreme western corner of the map, and and the one east of the Golf Club-House. The dikes may run up to 75 feet in width and are regarded as the feeders of sheets which pass laterally into breccias of the Outremont type,or they are feeders of those breccias, without the development of the sheet. The widths exposed of these sheets runs up to I50 feet. Each outcrop of breccia is closely connected with one of these larger dikes or sheets, a section of the whole intrusion of which can be compared to a mushroom, the stalk being represented by the dike feeder and the top by the "Outremont Breccias" with in some cases the development of a sheet in addition.

One of the dikes, exposed at the corner of Rockland and Van Horne Avenues, is amygdaloidal. The amygdales are not numerous and reach a size of 4 inches in largest diameter, and ½ inch in thickness. The filling has been recognised as prehnite, which is developed in characteristic sheaves of needles. Associated with the prehnite is a small amount of pyrites and calcite.

In the area south-west of the golf-links a number of larger dikes are exposed. The most important of these is an altered basic nephelin-syenite dike, containing epidote in druses. Another of them is a bostonite with many quartzite inclusio Immediately south of the most southerly exposure of breccia in Rockland Avenue is a nephelin-syenite dike which is included here. It is characterised by many porphyritic crysta of hornblende and is a very striking rock. In hand-specimen it is very similar to the nehpeline-syenite found on the western face of the hill in the wood to the west of the golf-links. [Pt.T.]

<u>2. Smaller Camptonite dikes and sheets.</u> The dikes of this class are exceedingly numerous in the district, whilst the sheets are developed only to a slight extent. Exposures are seen showing that the sheets are horizontal extensions of dikes. The dikes often form an intricate network cutting the limestone and "Outremont Breccias". Both dikes and sheets have a small width, being usually less than a foot in width, rarely reaching 2 feet, and in one case 4½ feet in width. They furnish an example of a "family" development of dikes so similar in characters that a description of one or two, only, is necessary to give an idea of the whole. Further descriptions would be mere repetitions with changes in detail only. They are dark bluish-gray, almost black in color, of a very fine grain and even texture. Chilled edges of finer grain are not often met with. Some few are very rich in iron pyrites. The dikes are usually very hard when fresh,

weathering brown with the development of limonite. The local name for these dikes is "Banc rouge", a descriptive name referring to the characteristic rusty weathering. Occasionally individual dikes are found completely weathered to a limonite-stained mass, which continues downward as far as the trench, i.e. 8 feet in depth. As a rule the dikes are very fresh. These dikes are closely related to the "Outremont Breccias", being most abundantly developed close to the outcrops of these breccias. They immediately succeeded the intrusion of the breccias, in time, and are often found cutting them. The dikes are very similar to the "cement" of the breccias in composition and microscopic characters. The dikes are always steeply dipping, nearly vertical, and occasionally they can be seen passing into sheets which are of the same order of magnitude as themselves. This can be seen in pit 3 and in the cutting immediately south-east of it. That all the dikes were not intruded at the very same time is natural and amongst the camptonites are found younger dikes which cut dikes of an exactly similar appearance. Thus the large dike 23 is cut by a small camptonite dike only a few inches wide., and other examples are to be seen in the cutting near pit 3. The most striking example is dikeI5. Here a younger camptonite dike, now badly altered has split down the centre an older camptonite dike. The older dike is found on each side of the younger as lens-shaped masses with a flat side next the dike in the centre and a convex surface which exhibits concentric weathering toward the limestone country rock. The central dike has jointing so developed as to give it the appearance of a series of bricks in a wall

Plate I fig. I. shows this. The central dike is very obvious but the older dike does not show up, except as a dark band on each side of the younger one. The older dike was only discovered on attempting to obtain a specimen of the central dike.

3. Smaller dikes of the bostonite family.

A number of dikes and veins have been included under this head which have the common characteristics of a light colour and paucity of ferromagnesian constituents, together with a younger age than the dikes and sheets of class 2. These dikes are much fewer in number than the camptonite dikes and include weathered bostonites, gieseckite-porphyries, nepheline-aplites and felspathic veins. They are seen to cut the basic intrusives wherever the two types are found in association. The dikes are for the most part very narrow varying from a few inches down to half an inch and rarely reaching six inches in width. What appears to be an expansion of one of these dikes into a sheet has been mentioned under the head of "Potsdam Breccias".

PLEISTOCENE.

The deposits of this age include erratics, glacial clay and post-glacial sand and pebble-beaches.

Erratic boulders of various sizes and of different types of Laurentian gneiss are common in this area. A block of tinguaite of exactly similar characters to that exposed at Cote la Visitation was found, ~~as mentioned above~~. As no rock of the same type was seen exposed in the area under consideration it is probable that this is also an erratic block.

A glacial clay usually containing small boulders, whose largest diameter is about 2 inches, fills in the depression between outcrops of rock and is responsible for the softening of topographic outlines. Whilst there is no direct evidence for the marine origin of this clay, it is of exactly the type which would be formed along a shore-line by transportation of mud and small pebbles frozen in floating blocks of ice, to be deposited on the stranding and melting of the ice. The clay is sometimes covered by a thin capping of post-glacial sand, especially toward the north of the sheet. At the extreme north of the sheet the flat plain which stretches away ~~the~~ to the north is covered by this post-glacial sand. This sand is correlated with the Saxicava Sand of the Ottawa and St. Lawrence valleys. In the wood at the extreme north corner of the sheet a small patch of sand covering breccia and dike material is composed of particles derived from the decay of igneous rocks close at hand.

Pebble-beach. A post-glacial pebble-beach covers the eastern portion of the sheet, hiding the contact of the Chazy and Trenton Limestones. A similar beach deposit covers a part of the centre of the sheet also, being exposed in an old gravel pit, (pit 4), and across the golf-links. The pebbles are fairly uniform in size, 2½ to 3 inches in largest diameter being an average size. The beach shows stratification of the pebble layers, with a slight dip away from what was the shore-line at the time of deposition. This dip is not greater than the normal angle of rest in pebble-banks under the action of the tide. A good exposure of the beach was made close to the Town Hall of Outremont in laying a sewer there in the fall of I9II. No fossils were found in the pebble-beds with the exception of a few shell fragments in the gravel pit. These fragments were so small as to be indeterminable.

The elevation above sea-level of the beaches of the area is between 250 and 280 feet, which is slightly higher than the water-works terrace on the other side of the Mountain (220')*.

*J.W.Dawson.The Canadian Ice Age. p. 62.

PETROGRAPHICAL DESCRIPTION OF ROCK TYPES.

PLUTONIC ROCKS.

PYROXENITE. See Plate 6. This rock-type is developed at the tip of the tongue-shaped intrusion stretching partly across the golf-links. Macroscopically the rock is black in colour, the only recognisable minerals being pyroxene and occasionally green grains of olivine, or brown limonite-stained pseudomorphs after olivine. Microscopically the rock is seen to consist of augite, brown hornblende, ilmenite, olivine, pyrites, calcite, chlorite, sphene and apatite in that order of importance.

The augite is by far the most important constituent of the rock, making up about 70 % of the whole, or in some sections even more. It is slightly violet in colour, is pleochroic and holds a number of small inclusions. Its maximum extinction angle is 54°. The scheme of pleochroism is c violet, of a bluish tint, = b violet, of a reddish tint, > a, light wine yellow. The inclusions are very small, and arranged in rows, usually straight, but often curved. They are brown in colour, and highly birefringent, and are probably rutile. Along its edges the augite shows, occasionally, incipient uralitisation. This is not important, as the rock is remarkably fresh.

The hornblende is deep brown and pleochroic:- c dark brown > b lighter brown > a very light brown. Its extinction angle is I9°. These characters show it to be common hornblende. At its edges it is sometimes green, a stage in its alteration into chlorite.

Olivine occurs in rounded grains. It is much cracked, with formation of serpentine along the cracks, sometimes with production of fine magnetite dust along the cracks. It has some small inclusions similar to those in the augite, and also dendritic schillers of iron oxide, such as are often found in olivine.

Ilmenite is present in considerable amount in large individuals not showing good crystal outlines. Some of it, at any rate, has crystallised later than olivine, but all before augite and hornblende.

Titanite is represented by a few grains or crystals with good wedge shape, and is a secondary product, probably formed at the expense of the ilmenite, or perhaps by alteration of the augite; for violet augites usually contain titanium. It is associated with calcite and chlorite in interstices, in one case with calcite pseudomorphic after augite.

Chlorite, green, pleochroic, (c=b light green, > a greenish-yellow.), is present in small amount. It is formed at the edges of hornblende, and is also found associated with secondary calcite after augite, in which case it may be fibrous.

Calcite is secondary after augite, and in part after hornblende.

Of pyrites there is only a small amount. It crystallised before the hornblende.

Apatite is almost absent in some sections and present in considerable amount in other sections. It occurs as long needles.

The order of crystallisation is apatite, olivine, ilmenite pyrite, augite, hornblende. The structure is allotriomorphic. Augite, olivine, ilmenite and pyrite show idiomorphic tendencies, whilst the hornblende is interstitial, filling up the spaces between the other minerals. The secondary minerals calcite and chlorite are found in interstices. Specimens collected a little further to the west show the introduction of plagioclase and a small amount of nepheline passing into the essexite type developed in the wood to the west. Zonary banding of the augites is another feature introduced.

ESSEXITE. (From point 2 on the map).

The western extension of the intrusive tongue discussed above is not well exposed. Such exposures as are found show that the pyroxenite passes laterally into an essexite. Macroscopically this type contains large porphyritic hornblendes up to I½ inches in length and ¼ inch in width, set in a gray ground, containing smaller crystals of ferro-magnesian minerals. Under the microscope the ground is seen to be composed of plagioclase, augite, hornblende, biotite, nepheline, sphene, ilmenite, apatite, and pyrite in that order of importance. The hornblende porphyritic crystals and the smaller individuals of the ground have the same general characters. In colour it is brown and is strongly pleochroic; c dark brown, > b a little lighter brown > a very light brown. The large crystals finished their growth after the formation of plagioclase and the hornblende of the ground is also later than the plagioclase, being interstitial. The large hornblendes sometimes show twinning on IOO, and at the same time schiller inclusions which appear to be oxide of iron, parallel to the base. This combination gives rise to a herring-bone structure, such as is more often seen in augite. Augite is the most important ferro-magnesian mineral of the ground. It is violet-gray in colour and shows the same type of pleochroism noticed above. Its maximum extinction angle is 42°. It show idiomorphic tendencies. The biotite is deep brown in colour, and strongly pleochroic, $a=b$ dark brown > c light brown. It is interstitial, and often penetrated by plagioclase individuals. The plagioclase is usually idiomorphic, penetrating hornblende and biotite. It has twinning according to the albite and Carlsbad laws. On alteration it yields abundance of small mica flakes, - paragonite -, with occasionally a small amount of zoisite. This is shown most prominently in the weathered portion of the rock, sections from a few inches in from the surface showing the felspar to be fresh. Nepheline is present in small amount, occasionally as square sections. It is interstitial to the felspar and is detected by the absence of twinning, its uniaxial and negative characters. In the weathered parts of the rock it is represented by aggregates of mica (gieseckite). Ilmenite, as allotriomorphic individuals, is well represented, and crystallised after the augite. The sphene is a secondary product formed from the ilmenite, and often surrounding it. Apatite is present as stout needles and rounded grains. There is a little pyrite, sometimes enclosed by hornblende. The order of finishing crystallisation is apatite, augite ilmenite, felspar, pyrite, biotite, and hornblende. The larger hornblendes must have begun their crystallisation before some of the other minerals, but its final stages were later than the formation of felspar.

Essexite. Inclusions in dike R8.

This type occurs as roughly spherical inclusions, up to $1\frac{1}{2}$ inches in diameter, in a nepheline-syenite dike in the cutting near pit 3. It is a dark gray rock showing numerous black porphyritic crystals of augite, up to $\frac{1}{4}$ inch in length. In this section the following minerals are distinguished, arranged in their order of importance, augite and plagioclase in nearly equal amounts, ilmenite, pyrites, nepheline, apatite, biotite and titanite. The order of crystallisation is apatite, ilmenite, augite, biotite, plagioclase, nepheline, pyrites. The augite is greenish-gray and slightly pleochroic. Its extinction angle is 47°. It is much altered along its edges and cleavage cracks into ragged brown uralite. It has small inclusions of biotite in it. Plagioclase at times appears to be more important than augite. It is usually fresh, and shows both Carlsbad and albite twinning. A small amount of brown biotite is present ~~It is deep brown in~~ . It is strongly pleochroic, a=b>c, a and b deep brown, c light yellow. It occurs as small inclusions in augite or partially wrapped round ilmenite. A few sections of nepheline are distinguished by their uniaxial character. Gelatinous silica confirms the determination of this mineral. Apatite is abundant as large crystals or grains, and is enclosed by all the other minerals. Ilmenite, in considerable amount, has irregular shapes, and is sometimes enclosed by augite, itself enclosing apatite. It often has small pieces of biotite closely associated with it, though not as a complete celyphite border. In some cases the ilmenite has given rise to a little secondary sphene. Pyrites occurs erratically as ragged irregular patches, evidently formed at, or subsequent to the consolidation of the rock. A little chlorite is formed by alteration of uralite.

NEPHELINE-SYENITE. From pit 2.

In hand-specimen this rock is a dark-coloured, almost black fine-grained rock, cut by many small white veins, not often more than an inch in thickness, and carrying only small specks of black minerals. The dark part is a nepheline-syenite, and the white veins can best be designated neohel-ine-aplite.

The nepheline-syenite is a remarkably fresh rock and is composed of orthoclase, hornblende, nosean, nepheline, plagioclase, sphene, ilmenite and apatite.

The orthoclase is allotriomorphic, sometimes shows Carlsbad twinning and encloses many minute needles of apatite. The hornblende has idiomorphic outlines, is green in colour, and pleochroic. The colour scheme is :- c dark green b dark green a greenish-yellow. It has a maximum extinc-tion angle of 2I° and occasioally has the common hornblende twin developed (IOO).Nosean is irregular in shape, or hexagonal or arranged as a group of hexagons. It normally has inclusions of the other minerals with the exception of felspar and nepheline. It shows incipient alteration to small mica flakes (gieseckite). Nepheline is present in small quantity and is distinguished from orthoclase by its uniaxial character. It is interstitial and does not show good crystal outlines.

A few sections of plagioclase are present, showing abite twinning. Sphene is abundant, of a brownish-gray colour, is slightly pleochroic and shows good wedge shapes. Ilmenite is sparely represented by irregular grains. Apatite occurs as very many minute needles in hornblende, felspar, nosean, and occasionally in ilmenite and sphene.

The order of crystallisation in this rock is apatite, sphene, ilmenite, hornblende, felspar, nepheline, nosean.

NEPHELINE-APLITE. Also a remarkably fresh rock, found as small veins cutting the last-described type. It consists of plagioclase, orthoclase, nosean and nepheline, with very small amounts of hornblende, sphene and ilmenite. The struc -ture of the rock is allotriomorphic with greatest tendency to idiomorphism on the part of the plagioclase. The plagioclase is the most important constituent of the rock and shows twinning according to the Carlsbad and albite laws, and rarely to the pericline law. Nosean is interstitial and shows alteration to cancrinite. The nosean was proved in this, as in other cases by precipitation with $BaCl_2$. Nepheline is present only in small amount. The hornblende has the same characters as in the rock described last, but in this case is interstitial, filling in spaces between felspar individuals The ilmenite is not abundant and is sometimes idiomorphic and sometimes interstitial to felspar. A few grains of sphene occur and part of it at any rate is secondary after ilmenite, and is then in close association with ilmenite. The order of crystallisation is ilmenite in part, sphene in part, plagioclase, orthoclase, ilmenite, in part, hornblende, nepheline and nosean.

The contact between this rock type and the nepheline-syenite which it cuts is very sharply marked, (vide Plate 4 fig. 2) and there is no indication of reaction between the nepheline-aplite and the first formed nepheline-syenite.

COMPACT NEPHELINE-SYENITE.

This type occurs at the point marked S on the map, as the darker part of the nepheline-syenite breccia discussed above, and figured at Plate 3 fig. 2. The rock is dark-gray and fine-grained. Microscopically it is seen to consist of hornblende, orthoclase, augite, nepheline, plagioclase, nosean, sphene, ilmenite, and apatite. The hornblende as small porphyritic crystals has a brown core, with green edges, whilst the smaller crystals are wholly green. This distribution of colour suggests an enrichment of the magma in soda as crystallisation progressed, and the consequent formation of green hornblende, carrying a larger %age of soda than the brown variety. Its pleochroism is defined as follows:-c brownish-green > b brownish-green > a light yellow-ish-green, without the brownish tints in the green crystals. Twinning on 100 is occasional. The hornblende is idiomorphic. Augite is porphyritic, usually colourless, or occasionally with a slight greenish tint. It is distinctly subordinate in amount to the hornblende. The maximum extinction angle observed is 49°. The orthoclase and nepheline are interstitial, the nepheline often showing square sections. A small amount of interstitial isotropic mineral is nosean, demonstrated by precipitation with $BaCl_2$. Sphene occurs as numerous small wedges or rounded grains. The ilmenite is in small grains, often enclosed in hornblende. Apatite occurs as minute needles. The order of crystallisation is apatite, sphene, ilmenite, augite, hornblende, plagioclase, nepheline orthoclase and nosean.

PULASKITE.

The lighter part of the nepheline-syenite breccia is of the composition of a pulaskite. It encloses angular fragments of the compact type just described. It is light gray in colour, with needles of hornblende in a gray ground. It is composed of plagioclase, orthoclase, hornblende, nepheline sphene and ilmenite. The plagioclase occurs as elongated or lath-shaped crystals, with Carlsbad and albite twinning and is by far the most important constituent of the rock. It shows zonary banding. Orthoclase is present in considerable amount, but is distinctly subordinate to the plagioclase. The felspars are often clouded with kaolin dust and small mica flakes, products of decomposition. The hornblende has the same characters as in the rock type last described, the brown colour being more developed with occasionally slight green rims. The crystals are larger . Nepheline is present, but only in quite small amount. A considerable amount of sphene is present. It has the usual grayish tint and is very slightly pleochroic. Some of it is secondary. The order of crystallisation is ilmenite, sphene, hornblende, plagioclase, orthoclase, nepheline.

In both of the rock types in this breccia mica-like decomposition products are present, but are not large enough to distinguish whether it be muscovite or cancrinite. More probably it is the latter.

NEPHELINE-SYENITE. From point marked T on the map and cover -ing a notable area on the south-west of the top of the hill, in the wood which covers the south-west part of the

sheet. It is a dark gray rock with long needles of hornblende and having lighter spots richer in felspar, in which, again, are pink spots. Microscopically plagioclase, hornblende, orthoclase, sphene, nepheline, ilmenite, augite apatite and pyrite are recognised, in that order of importance. The plagioclase is allotriomorphic and shows Carlsbad albite and pericline twinning. The orthoclase is subordinate in amount in the darker parts and more abundant in the lighter parts. Alteration of both varieties gives rise to a felted mass of mica flakes. The hornblende is brown and often shows decomposition along its edges with the production of magnetite grains. This is due to a slight amount of resorption. Its pleochroism is described as follows:-
c dark brown > b dark brown > a light yellow. The maximum extinction angle observed is 30°. There are occasionally small green pieces on its edges, which may be richer in soda, or places where chloritisation is beginning. Nepheline is present in considerable amount and becomes an important constituent in the dark gray parts. It is recognised by its uniaxial character. Occasional square sections are seen, but it is usually interstitial. On alteration it gives gieseckite. There is a large amount of sphene in the rock, as large and well-formed crystals of light grayish tint and only slightly pleochroic. It is often completely altered, sometimes to an opaque mass, sometimes to a mass of rutile needles and calcite with a small amount of iron oxide. The whole mass retains the original shape of the sphene crystal. The rutile needles are brown, slightly pleochroic and highly birefringent. Often they do not extinguish at all, but when extinction occurs it is straight. Ilmenite is the

chief iron ores and is idiomorphic toward hornblende, not toward apatite. There is a small amount of pyrite which is a late product of crystallisation. Occasional hexagonal clusters of mica flakes are pseudomorphs of gieseckite, after basal sections of nepheline. Long needles of apatite are seen penetrating other minerals, e.g. hornblende and ilmenite. There one or two sections of augite of violet tint, showing a faint pleochroism, violet to yellow as before. There is also a little secondary mica in the rock, as larger crystals than are usually formed as secondary products. The order of crystallisation is apatite, ilmenite, sphene, augite, hornblende, plagioclase, orthoclase, nepheline and pyrite.

<u>TINGUAITE.</u> This type was found as a loose block at the point marked V on the map. It is most conveniently described here. Probably it is a transported boulder, though in hand-specimen it is very similar to a dike found in the golf-links to the north, but which has not yet been examined in thin section. It is a dull gray, even-textured rock. Under the microscope it is seen to consist of orthoclase, nosean, aegirine-augite, nepheline, plagioclase, melanite garnet, augite and ilmenite, in that order of importance. The aegirine-augite occurs as very small needles, not making up a large part of the rock. It is markedly pleochroic, $a > b > c$, a dark green, b lighter green, c yellow-brown. It usually has a small extinction angle but some sections with angles up to 25° were noticed. Cross-sections are remarkably rare in the slice, though so many of the needles are present, but when they do occur they show the prism faces at the pyroxene angle, and so can not be confounded with

hornblende. Orthoclase makes up most of the rock and occurs as large allotriomorphic sections. Plagioclase is very subordinate in amount. Nosean is represented by interstitial masses, which sometimes show a hexagonal shape. It has the characteristic inclusions of nosean , which are often iron oxide, often secondary calcite. The nepheline is mostly altered to cancrinite, which forms interstitial patches, or small square sections . The latter are very common. Occasional larger sections are unaltered. The melanite is almost opaque in thin section and is always small in size. It has good crystal shapes. Augite is rare and has a greenish colour and is surrounded by a rim of aegirine-augite of deep green colour. The augite is slightly pleochroic and the rim is strongly pleochroic. The extinction angle of the augite runs up to 43°, but that of the aegirine-augite rim is much smaller. A few grains of ilmenite are enclosed by the augite.

THE LARGER DIKES; AND SHEETS.

ESSEXITE DIKE. This type occurs at the corner of Rockland and Van Horne Avenues. It contains a very few amygdales, not now exposed, which are filled with prehnite, calcite and pyrite. The rock is composed of the following minerals Augite, hornblende, plagioclase, pyrites, biotite, sphene, Ilmenite, apatite, and secondary, infiltered calcite. In hand-specimen it has a fairly coarse grain and is rich in pyrite. Under the microscope the augite possesses a violet colour with very faint pleochroim of the violet-yellow type It shows twinning on 100 and also zonary banding. It also is seen intergrown with hornblende, a core of the former being surrounded by a rim of the latter. It has an extinction angle of 48°. Alteration to dirty, ragged uralite is uncommon and only slight. Hornblende is subordinate in amount to augite. It is deep brown in colour and very pleochroic. c>b>a. c dark brown, b dark brown, a yellow. It shows the common hornblende twin, (on 100), and has an extinction angle of 22°. Biotite is less important in amount, deep brown in colour and strongly pleochroic. a=b>c. a&b deep brown, c yellow. It often occurs wrapping round augite. Plagioclase is allotiomorphic and makes up the larger part of the rest of the rock. It has Carlsbad and albite twinning and alters to paragonite flakes and kaolin dust. Orthoclase, ~~is~~ quite subordinate in amount, is associated with the plagioclase, and gives rise to small mica flakes on alteration. Nepheline is represented by gieseckite, in interstitial patches. There is also a fair amount of unaltered interstitial nepheline. Pyrites occurs as ragged, interstitial patches, is very abundant and evidently formed after the consolidation of the rest of the rock. Sphene is present in considerable quantity, is slightly gray in colour, with pleochroism to a darker gray. Many pseudomorphs after sphene occur. They are chiefly iron oxide, arranged along what were originally the cleavage planes of the sphene, being now of the nature of a grating. The spaces between the bars of iron oxide are variously filled in by calcite, pyrite and sometimes hornblende. One case shewed a combination of calcite and rutile filling, proving derivation from sphene. Many of the pseudomorphs have the lozenge shape of sphene.

ALTERED BASIC NEPHELINE-SYENITE DIKE.

This type is met with in the wood beyond the golf-links, at W. It is a dark gray fine-grained rock, with porphyritic crystals of augite and ~~amygdales~~ druses filled or partially filled with epidote. These are only a fraction of an inch in diameter, but are quite conspicuous on account of their green colour. The rock is composed of orthoclase, augite, hornblende, ilmenite, zeolites, plagioclase, pyrite, sphene, epidote, apatite and analcite in that order of importance. The augite is porphyritic, very slightly coloured and feebly pleochroic. It has twinning on 100 often, and lamellar twinning on 001 rarely. It shows zonary banding and has an extinction angle of 53°. There is a second generation of smaller augites of the same kind. Hornblende occurs as small laths of brown colour. Its pleochroism is $c > b > a$, c deep brown, b deep brown, a yellow. Twinning on 100 is common. Its extinction angle is 14°. Orthoclase fills in the spaces between the other minerals and alters to sericite and kaolin dust, tho' not to a large extent.Plagioclase is very subordinate in amount. Epidote occurs in ~~amygdales~~ druses with felspar. It is sometimes twinned on 100 and is markedly pleochroic:-c>b>a , c greenish-yellow, b light greenish-yellow, a colourless. A case of intergrowth of epidote and augite was noticed. Zeolites with sheaf-like arrangement or as felted masses indicate nepheline to have been small in amount before its alteration. There is a very small quantity of analcite. It occurs in cavities, has traces of cleavage and a low refractive index It is regarded as a secondary product. Ilmenite is important in amount and tends to take on crystal shape. Pyrites is subordinate, has ragged shapes and is found enclosed by augite and also associated with epidote, before which it was formed. Sphene is common as gray, slightly pleochroic wedges., and apatite as fine needles. Secondary calcite is quite important. The order of crystallisation is apatite, ilmenite, sphene, pyrite, augite, hornblende, felspar, nepheline and epidote.

NEPHELINE-BEARING CAMPTONITE.

This rock occurs as a sheet in pit 3. It is a bluish-gray fine-grained rock rich in pyrites. It consists of plagioclase, hornblende, pyrites, orthoclase, cancrinite, secondary calcite ~~and~~ sphene and apatite in that order of importance. The hornblende is very much resorped and lighter brown in colour than usual in these rocks. Twinned plagioclase makes up most of the rock and is slightly altered with the formation of paragonite flakes. Cancrinite after nepheline is present in fair tho' small quantity both as larger interstitial masses and also as small square sections.The order of crystallisation is apatite, sphene, ilmenite, pyrite, hornblende, plagioclase, orthoclase and nepheline.

Outremont Breccia.

The "cement" of the "Outremont Breccias" is a camptonite which is dark bluish-black, fine-grained and holo-crystalline. It is a very fresh rock. In thin section it is seen to be composed of hornblende, plagioclase, augite and pyrite with small grains of sphene which appear to be secondary, and in one section, one small crystal of zircon. The ratios of the two most important minerals, hornblende and felspar, vary, but the hornblende is usually the more abundant. The hornblende occurs as euhedral crystals of elongated lath-shape, of a brown colour. Twinning is a common feature, the twin plane being 100. The pleochroism is well-marked, c>b>a, c dark brown, b dark brown, a light brown. Extinction angles are mostly low, values between 20° and 25° are common, the maximum observed reaching 36°. Occasionally it shows green edges or tips which suggests the presence of soda excess in the magma in the final stages of consolidation. There are a few porphyritic crystals of augite of larger size than the crystals of hornblende. They have a faint violet or brownish tint and have the slight violet-yellow pleochroism so characteristic of the area. Its maximum observed extinction angle is 49°. Under the high power an intergrowth of hornblende and augite is seen, a kernel of the latter being surrounded by a rim of the former. The groundmass contains small crystals and grains of augite of the second generation and also some long fine needles of augite. There is a large amount of interstitial pyrites with ragged shapes, suggesting a deposition subsequent to the consolidation of the rock. There is also pyrites in the finer-grained part of the rock, where it occurs as good crystals and is a primary constituent.

The rest of the rock is composed of plagioclase felspar. Part of it occurs as lath-shaped crystals of the usual type showing albite twinning., but a large proportion of it has a radial arrangement highly suggestive of spherulitic or variolitic rock types. The radial arrangement is usually a good deal more perfect than in the ordinary type of variolite. A separation was made to confirm this radial felspar, and it could not be separated by means of differences of specific gravity from the lath-shaped felspars. By use of Shroeder van der Kolk's method and Wright's series of oils the felspar of the radial kind was determined to be a variety of andesine. The twinned felspar is also andesine.

A considerable amount of secondary, infiltered calcite is present in the rock. Resorption borders are found with both the augite and hornblende.

In some varieties brown biotite is present and ilmenite may be the chief iron ore to the almost complete exclusion of pyrites.

THE SMALLER DIKES.

CAMPTONITES. These dikes are the most common type of the district, fully 75% of the dikes falling in this class. ~~The most common type~~ Generally the rock is very fine-grained with sometimes a slightly coarser centre. ~~In general~~ It has a dark bluish-gray colour and is usually rich in iron pyrites, joint planes especially being faced with pyrite. More rarely a camptonite is porphyritic.

Microscopically the camptonites are very similar. The two important constituents are brown hornblende and plagioclase. Orthoclase is only rarely present, e.g, in the fine-grained edge of dike 2. Brown biotite is a common mineral tho' by no means universal. In one case, the fine-grained edge of dike 2 it becomes more important than the hornblende and the rock then approaches a kersantite in composition. Of accessory minerals pyrite is the most important and usually is later than the other constituents, sphene is very characteristic and ilmenite is sometimes present, whilst apatite always occurs in fine needles. Infiltered calcite is a constant feature and in some dikes, which are much altered because they have determined the flow of springs, the ground of the rock is so pervaded by calcite that it is impossible to recognise good sections of the felspar.

The hornblende is idiomorphic, except in one case, that of a small stringer cutting dike 22, in which case the plagioclase is idiomorphic and the hornblende is interstitial. The hornblende is deep brown in colour and markedly pleochroic:- $c > b > a$, c and b deep brown, a light yellow or yellowish-brown. In shape the crystals are elongate, often very much so; an extreme case is seen in dike 26. The hornblende is sometimes fresh, and sometimes shows strong development of resorption phenomena. In this case the crystals are bleached and there is formed an opacite rim of magnetite grains; sometimes the whole crystal being affected, in the case of smaller individuals; only the edges and cleavage cracks being affected in the larger crystals. Twinning on 100 is a constant feature of the hornblende in these dikes. There is no ~~marked~~ abrupt change in size of the hornblendes but all sizes are found from the largest to the most minute, and it is impossible to mark off definite generations of crystals. The biotite is deep brown and pleochroic:- a = b deep brown, > c light brown or yellow. It never shows crystal outlines and is always a later product of crystallisation than hornblende, round which mineral it partially wraps itself. The plagioclase may be subordinate in amount to the hornblende, as in dike R4, or it may be more important as in dike 23. Twinning on the albite law is distinct. Alteration yields small flakes of mica. Sphene is found as good wedges or as irregular grains. In spots in some dikes it is very important in amount, e,g, dike 26. Elongation of the wedges is often seen, the two adjacent faces being enlarged, producing a spear shape with non-paralellism of the opposite faces. This is figured at Plate4 fig.I. In one dike, no. II, some very fine needles were noticed in a felspar-rich patch.They are confined to this patch and are very numerous there. Most of them are straight, but some are curved. They have the high refractive index and birefringence of sphene. their extinction is not straight. They are provisionally identified as sphene. See Plate 4 fig. 3. The pyrites of the dikes is always indefinite in shape and was clearly deposited in its present position by the agency of circulating solutions at a period subsequent to the consolidation of the dikes. Ilmenite is not so constant, nor so important a constituent as in the rocks of coarser grain in this district.

PORPHYRITIC AUGITE-CAMPTONITE.

This type deserves separate description. Its best example is dike 23. The description will refer to this dike with occasional mention of dike 2.

The dike reaches a maximum width of 4½ feet, has a strike of II3° [Mag.] and dips at 6I° to the south-west. It is a dark gray rock with black, and more rarely green porphyritic crystals up to ½ inch in length. The black ones include augite and hornblende, whilst the green ones are augite. The dike has a fine-grained, chilled edge ½ inch in width. In thin section the black augite is grayish and slightly pleochroic. It has inclusions of ilmenite, hornblende and plagioclase. More rarely sphene is enclosed and one cavity contains secondary calcite and secondary green hornblende. Inclusions of felspar in the augite of dike 2 have curious schillers of magnetite, usually in two sets at right angles, more rarely at 60°. The maximum extinction angle of this augite is 5

The green augite is colourless and full of minute inclusion It has an extinction angle of 4I° and occurs as aggregates of crystals.

Other smaller porphyritic augites are now represented by carbonates. The augites show incipient uralitisation at the edges and along cleavage cracks, both brown and green uralite being seen. The hornblende porphyritic crystals have similar characters to those indicated above. They show resorption along the edges and cleavage cracks, with the production of magntite granules. Its extinction angle is 31°. Porphyritic crystals of plagioclase are rare and show zonary banding.

The ground is composed of hornbl ende, much resorped and plagioclase, with much pyrites in large masses of irregular shape, a small amount of sphene some of which is secondary, and apatite in fine needles. The plagioclase is an andesine. Much secondary, infiltered calcite occurs in the ground. A little epidote occurs in the hornbl ende, as a decomposition product and a colourless epidotic mineral with low birefringence, probably clinozoisite is associated with calcite, pyrites and green acicular hornblende in a vesicle.A little secondary quartz is also present in vesicles.

The fine-grained chilled edge of this dike is composed of plagioclase laths and much infiltered calcite with a few pyrite individuals, some very fine magnetite granules and some remnants of hornblende in the last stages of resorption. There are in addition one or two pseudomorphs after porphyritic elements some of which would appearto be felspar, but one was noticed now occupied radial aggregates of zeolites, suggesting the probable former existence of porphyritic crystals of nepheline in this chilled edge facies of the dike.

Smaller dikes of the bostonite family.

Gieseckite-porphyry. Two of the dikes of which thin sections have been examined fall here. They are I7 and R7. The former when fresh had a ground of bostonitic character, in which were embedded crystals of hornblende, now represented by partially resorped remnants changed over to green chlorite, and still containing granules of magnetite. It also had porphyritic crystals which are now represented by rectangular and square pseudomorphs of small mica flakes. From the general shape of these pseudomorphs it is probable that they represent original nepheline, though it is possible that the same kind of thing may be produced from original felspar. Infiltered calcite is constantly seen.
The latter dike is much more altered and the ground is almost all calcite. Some felspar remains and indications of the former existence of hornblende exist in remnants in the last stages of resorption, there being only grains of magnetite now in what was originally a hornblende crystal. The thin section of this dike examined had one square section composed of small mica flakes, and as in the last case may be considered as indicative of original nepheline, or possibly of felspar.

Bostonite.

A true bostonite is the paste of the Potsdam breccia in the cutting south-east of pit 3, A similar type occurs on the top of the hill in the wood west of the golf-links.
The paste of this breccia is far from fresh and has a brownish-yellow colour. It is fine in grain. It contains a large number of quartz and felspar grains derived from the same source as the quartzite pebbles. The matrix in which

these grains are embedded. is composed of calcite and minute mica flakes in the more weathered portions. The mica flakes (probably the paragonite variety), are the alteration products of the original felspars of the bostonite. In the fresher parts of the rock the original felspar laths can be seen and also a few resorbed remnants of hornblende, only recognisable as such after having been followed thro' all the stages of resorption in other slices. The greater part of the rock was composed of felspar and in addition to the lath-shaped felspars there were felspars with radial arrangement as in the paste of the Outremont breccias.

Potsdam? Quartzite.

The inclusions in the bostonite paste are composed of quartz and clear felspar grains, both orthoclase and plagioclase being present. The structure is typically quartzitic the grains being uniform in size, angular in shape and filling up the holes of the mosaic. Very occasionally there are some smaller grains than the average. There is also evidance of the intrusion of bostonitic material into the quartzite, especially round the periphery of the pebbles. This intruded bostonite of the pebbles is the frehest representative of that rock type. The intrusive action is thus seen to have been accompanied by an interchange between the intrusive and intruded. The other minerals to be noticed in the quartzite are zircon and rutile, which occur in small grains having the usual characters of these minerals. The rutile is dark brown in colour and pleochroic.

NOTE ON PREHNITE IN DIKE.

In the essexite dike occurring at the corner of Van Horne and Rockland Avenues were found a few amygdales, whose size reached 4 inches in largest diameter and ¼ inch to ½ inch in thickness. These amygdales were filled with prehnite, with which was associated a little calcite and pyrites. The prehnite has a light green colour with small patches of a yellowish tint. It is arranged in sheaves of fibres, with an attempt at radial structure. It fuses easily to a blebby enamel and is insoluble in HCl. It has a hardness of 6 and its specific gravity, determined by pycnometer is 2.97. A determination of its refractive index by Prof. Graham gave I.622, a value which falls between those of the highest and lowest refractive indices of prehnite. A full determination of refractive indices was not made because of inability to secure a suitable prism.

DESCRIPTION OF PLATES.

Plate I fig. I. Younger camptonite dike of more acid variety cutting older basic camptonite dike through the middle. The younger dike shows regularly spaced joints. Dike I5, exposed in trench in Rockland Avenue.

Plate I fig. 2. "Outremont Breccia", Rockland Avenue. Shows white baked limestone blocks embedded in almost black camptonite paste.

Plate 2 fig. I. Porphyritic augite camptonite. Dike 23, Rockland Avenue. x5/8.

Plate 2 fig. 2. "Outremont Breccia", showing angular limestone fragments in camptonite matrix. x 3/5.

Plate 3 fig. I. "Outremont Breccia". Camptonite paste showing "ropy" surface. x 5/8.

Plate 3 fig. 2. Nepheline-syenite breccia from point S, see map. The darker parts are compact nepheline-syenite, the lighter-coloured matrix is a pulaskite. x 2/3.

Plate 4. fig. I. Typical field of felspar-rich camptonite; U uralitised augite, H brown hornblende, B brown biotite, S spear shaped sphenes, iron ores are opaque. The relative amounts of felspar and ferromagnesian minerals in the more salic members of the family is well illustrated by this fig. x75.

Plate 4. fig. 2. Shows the very sharp contact of the nepheline-aplite and nepheline-syenite found in pit 2. S sphenes, the dark mineral is green hornblende, the solitary opaque mineral in the vein on right is iron ore. The colourless minerals are felspars. x 75.

Plate 4 fig. 3. Field of felspar in dike II, showing long needles with high refractive index and birefringence, probably sphenes. The opaque minerals are iron ore. The felspar-rich patch is an inclusion in a typical camptonite dike. x 350.

Plate 5. Thin section of pyroxenite, magnified 6½ diameters A augite, H hornblende, O olivine.

Plate I.

Fig 1.

Fig 2.

Plate II.

Fig 1. × $\frac{5}{8}$

Fig 2. × $\frac{3}{5}$.

Plate III.

Fig 1. $\times \frac{5}{8}$

Fig 2. $\times \frac{2}{3}$

Plate IV.

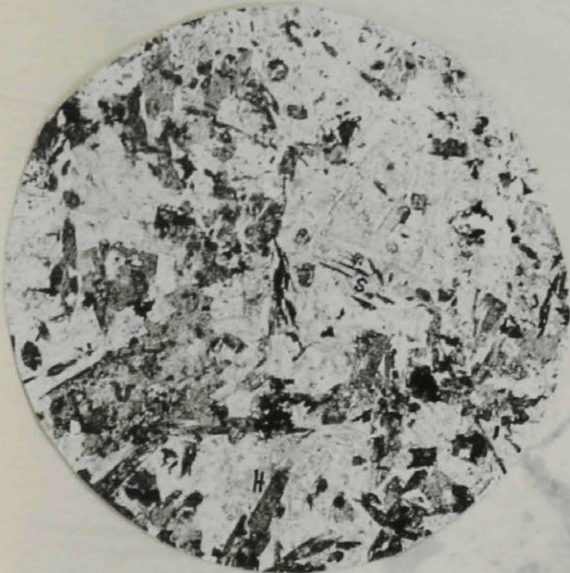


Fig 1. x 75

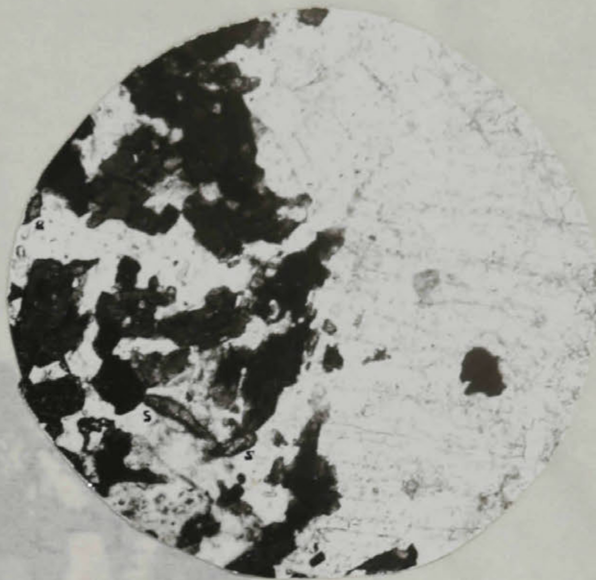


Fig 2. x 75

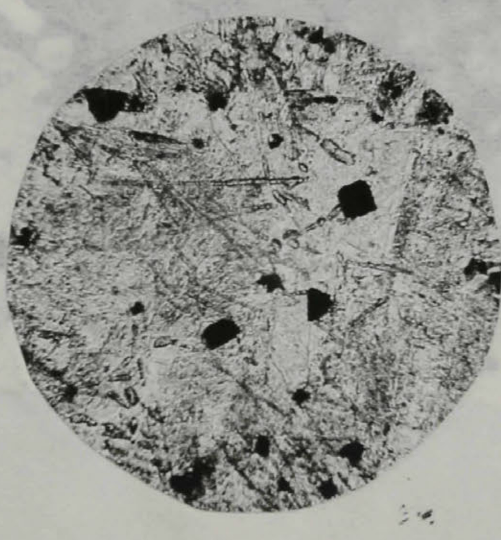
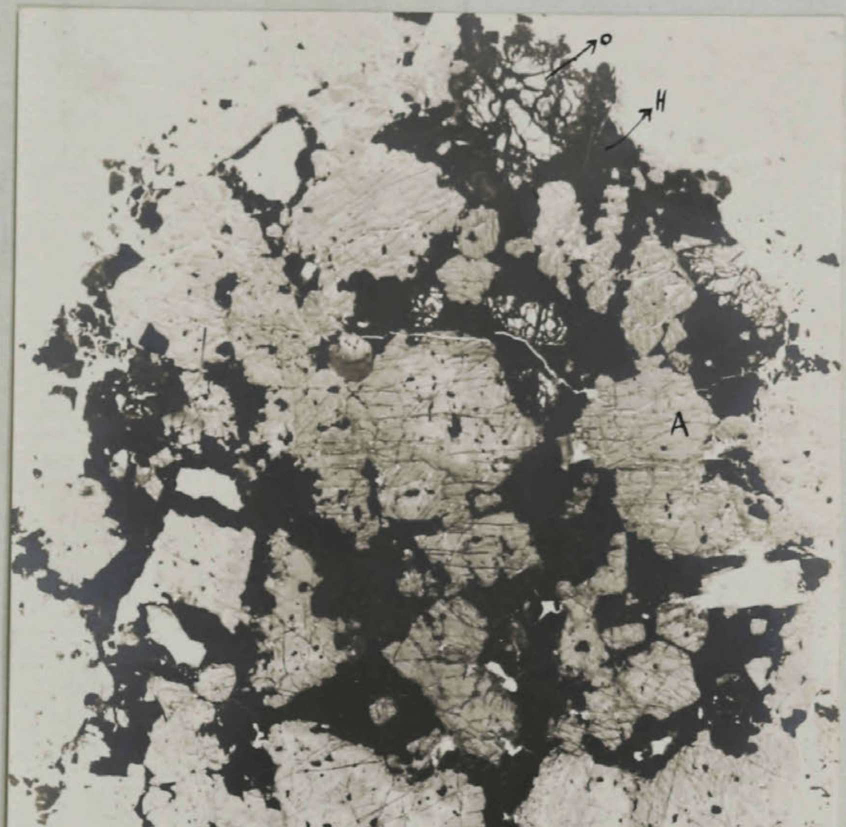
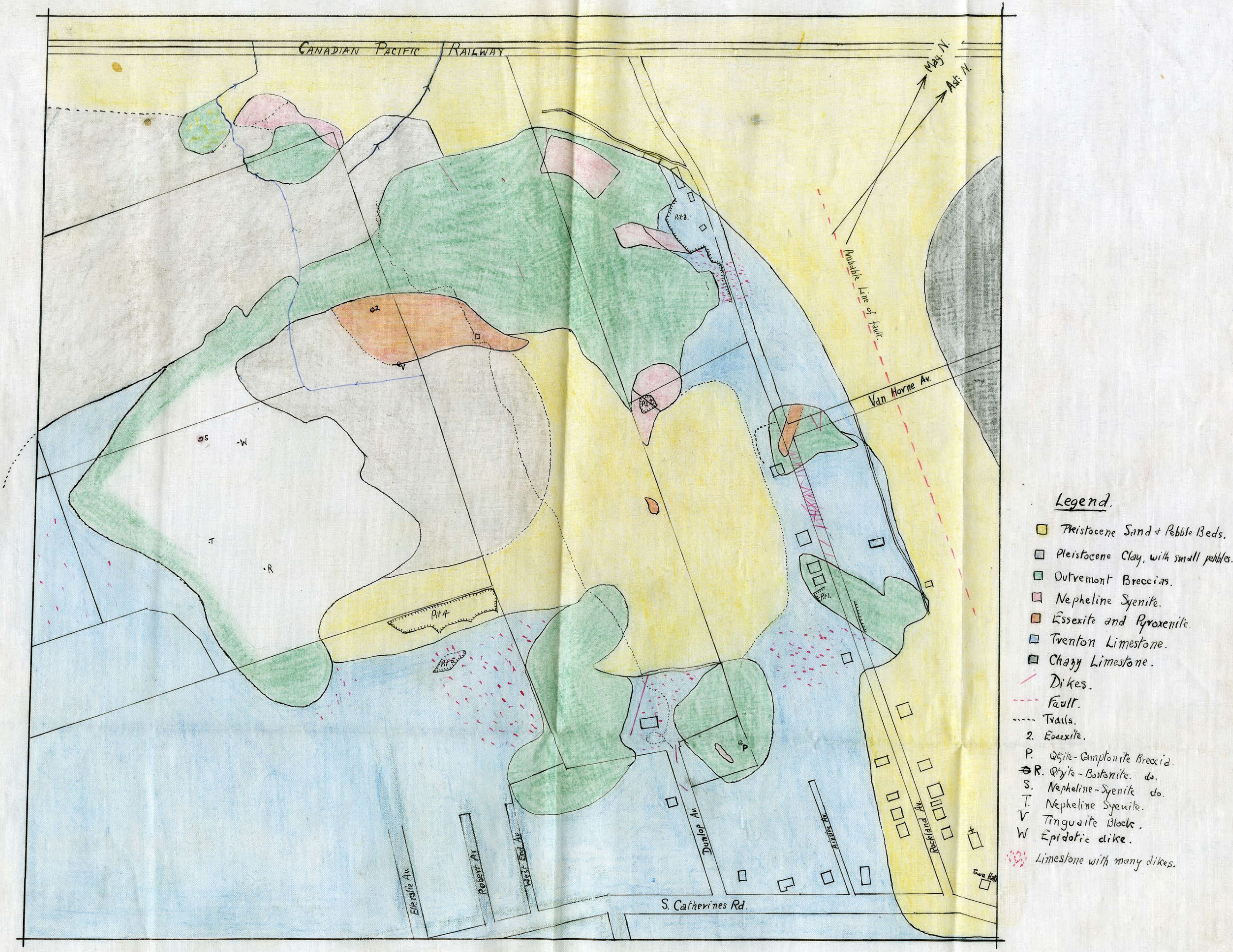


Fig 3. x 350

Plate V.



x 6½.



Scale. 400' = 1".

GEOLOGICAL MAP OF A PART OF OUTREMONT. QUE.

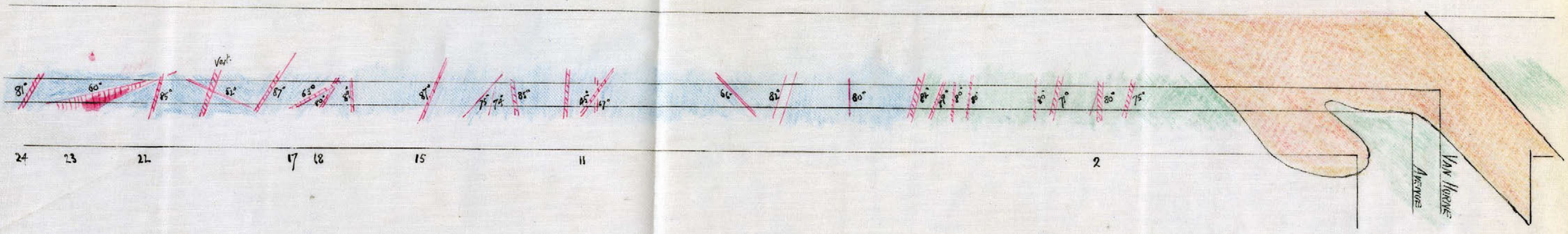
J. STANSFIELD

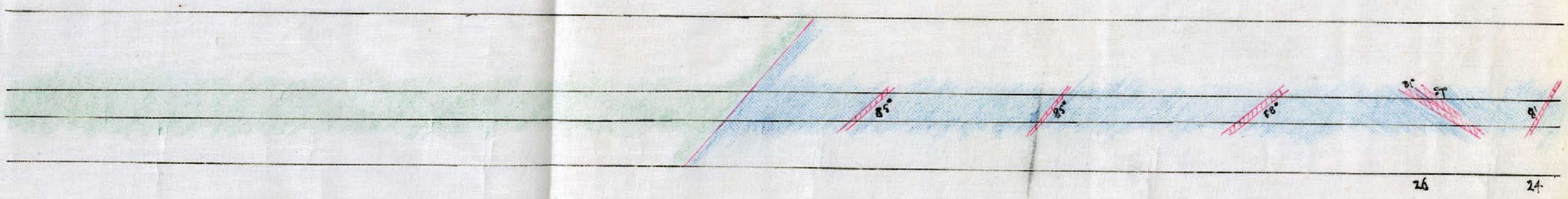
April 15 1912.

Dikes exposed in Rockland Avenue.

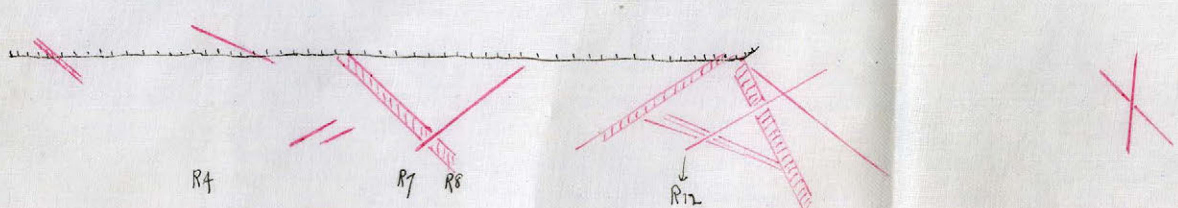
Legend as before.

Scale 40′ = 1″.





Cutting south-east of pit 3.



Rockland Avenue.