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GEOLOGY OF THE SOUTHWEST QUARTER OF BEAUCHASTEL TOWNSHIP, TEMISCAMINGUE COUNTY, QUEBEC

(1) Introduction

(2) Kekeko Hills and southern portion

By

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GEOLOGY OF THE SOUTHWEST QUARTER OF BEAUCHASTEL TOWNSHIP, TEMISCAMINGUE COUNTY, QUEBEC

INTRODUCTION

The town of Arntfield in the north central part of the map-area is 12 miles west of the city of Noranda and on the railroad and highway from Noranda to Kirkland Lake. Arntfield was formerly an important mining community and will likely be again when gold mining ceases to be a depressed industry. The Arntfield and Francoeur Gold Mines here produced about six millions in gold bullion prior to the closing of the Francoeur mine in March 1947. The Aldermac mine just north of the map-area produced 30,845 tons of copper, 10,675 ounces of gold, 389,100 ounces of silver and nearly 600,000 tons of pyrite between 1932 and 1943. At present the only industry in the area is agriculture carried on along the highway east of Arntfield and in a narrow strip fronting on highway 46 south of the Kekeko Hills. A number of summer cottages on Olier Lake are owned by residents of Rouyn-Noranda.

formation.

Geologically the sheet is composed of three entirely different units extending east-west across the full width of the sheet. 1. Area of Archean volcanic rocks and intrusives north of 2. an east trending belt of Proterozoic rocks (including the Olier Lake window of Archean sediments and porphyry) which in turn lies north of 3. an east-west belt of Archean sediments.

The topography coincides with the above three geological divisions: 1. rounded hills of volcanic and intrusive rocks projecting through the clay and, 2. the rugged hills of Proterozoic Cobalt series which reach a height of about 1600 feet making the maximum difference in elevation in the area over 600 feet and, 3. the flat area of Archean sediments south of the Kekeko Hills.

The area is all readily accessible by road. Repeated fires since the early thirties have burned all forest and made travel extremely easy throughout. The second growth poplar and birch have been repeatedly killed by grass fires during the springs and this dry refuse burned by grass fires on subsequent springs, so that with the exception of the area west of highway 46 in only a small part of the area is there second growth that interferes with travel or vision. The boundaries of the various "burns" are very evident. In areas of second growth that have escaped burning for fifteen to twenty years such as the area in range 1?, underlain by Pontiac rocks south and west of Donez Lake the moss again almost completely covers rock exposures.

NORTH PORTION OF AREA

BY C.H. STOCKWELL

GENERAL GEOLOGY

Pontiac Group

Recent studies by Wilson (1956) and Stockwell (1949 a and b) have shown, that the extensive mica schists, in the Noranda area, south of the greenstone belt and Cadillac fault zone are not Temiskaming, as concluded by H.C. Cooke (1923) and others, but a dominantly sedimentary group called Pontiac which is overlain unconformably by the Temiskaming. The writer has been able to make a fairly accurate calculation of thickness of the Pontiac in Bellecombe township and it exceeds 2½ miles. This group (Pontiac) includes impure quartzite, mica schist, interbedded lava flows, and large ultrabasic intrusives, commonly sills, whose emplacement may have been related to deformation closely following deposition of the Pontiac and it is felt these should be considered a part of the Pontiac group. The ultrabasic portion of the Pontiac is fairly extensive and remapping by the writer has shown that all rocks in the Opasatika sheet indicated by H.C. Cooke (1923) as basic lava, are not lava, but altered ultrabasic. The pillow selvedges described and used by Cooke (1923 p.) for top determinations in these rocks are actually alteration along joints which have a columnar appearing arrangement.

The Pontiac group underlies the southern third of the map-area and along its north extremity is overlain unconformably by the Cobalt series (Gowganda formation). Both bedding and cleavage in the Pontiac dip almost without exception to the north at about 45 degrees or less and a great many outcrops are composed of a series of ridges 10 feet or less in height, the north slope being the dip slope (cleavage and or bedding) and the south slope a joint or joints striking near west and dipping about 75 degrees south. On either side of highway 46 at the south limit of the map-area are outcrops of altered ultrabasic which are part of a large body that extends a considerable distance south of the map-sheet. This body is apparently a sill folded with the sediments. It is interesting to note that 1000 feet northeast of the assumed contact of the ultrabasic a few quartz stringers in the Pontiac contain asbestos fibres. This could be interpreteted as a substantiation of the hypothesis that this body is a sill and its contact is parallel to bedding of the sediments and that it consequently underlies these quartz stringers.

The ultrabasic rocks are quite variable in appearance and probably correspondingly so in mineralogy and composition. In a few places amphibole is visible but the more common rock is a sort of soapstone largely a chlorite, talc, carbonate rock. The large outcrop east of highway 46 has parallel plate structure described in similar rocks by Tremblay (1949, page). Considerable magnetite is present and it has caused the anomaly on Aeromagnetic Map 42G (Geological Survey of Canada, 1951).

The sedimentory portion of the Pontiac group is an impure quartzite and mica schist. It is definitely not a greywacke as a great many geologists have erroneously classified it. South of the map-area, where it has been more highly metamorphosed, the series of metamorphic minerals typical of an argillaceous rock are found staurolite, kyanite, and sillimanite. This series of minerals cannot form in greywacke because greywacke has not undergone sufficient weathering during deposition to increase the alumina content to a proportion at which these minerals can form. Too the Pontiac exhibits none of the other features of greywacke such as the occurence of angular rock fragments.

A few narrow green beds occur in the Pontiac which may be tuff. A short distance east of the township centre line in range 1 there are a few small outcrops of basic lava which are not indicated on map number 43-7A and although there are no outcrops this band of lava in the west half of the township it could well extend into this area. In the south half of lot 27 range 1, in the head of the large animal shaped outcrop are a few one-half inch thick nonmagnetic chert beds. Graphitic slates occur south of the large swamp in the north part of range 1. Scattered flakes of graphite up to 4 mm. in diameter are very noticeable in many of the argillaceous portions of the beds north of the garnet isograd.

It has a characteristic reddish brown colour, in part, due to the oxidation of widespread grains of pyrite. Rock entirely free from weathering effects occurs about a foot below surface where the colour as seen in rock cuts etc. is a dark grey to black.

Except where destroyed by movement each bed is remarkably uniform and of constant thickness. The thickness varies from about one and one-half to six inches although it is possible to find beds both thicker and thinner.

A common feature of surfaces not perpendicular to bedding in the more sandy Pontiac is a grid standing in relief of one-quarter of an inch or less above the general surface. This grid is formed by joints along which there has been introduction of material to render the rock more resistant to erosion for one-quarter inch or less on either side of the joints. The presence of quartz stringers and thin plates of quartz parallel to the cleavage is a common feature especially where considerable movement has taken place on the cleavage.

Grain gradation or graded bedding is very strongly developed. Where beds are well exposed and not deformed it is very easy to determine their tops. Usually each bed has a fine argillaceous top grading downward into an impure quartzitic lower part. There are areas where the beds are sandy throughout and tops difficult to obtain. However where deformation has not rendered individual junctions of beds indistinguishable and if several of these junctions can be recognized, the use of a jacknife or a small piece of steel the shape of a knife blade and tempered harder when scratched alternatively on either side of the junctions of beds the gritty feeling (bottoms of the beds) and soft (tops of the beds) are readily distinguishable.

West of highway 46 - 66 top determinations were made: 54 of these were on graded-bedding, 11 on cross-bedding, and 1 on channelling. East of highway 46 - 119 top determinations were made: 80 of these were on graded-bedding, 28 on cross-bedding, 9 on channelling, 1 on flow-casts, and 1 on soft-rock deformation (Shrock 1948 pps. 156-161 and 258-262). Where tops can be determined by one or more of the structures less common than graded-bedding the top can invariably be verified at the same locality by graded-bedding.

Cross-bedding with forsets 2 or 3 feet in length is rarely seen and occurrs in beds that are entirely impure quartzite or arkose quartzite. Not more than a half dozen top determinations were made on this type of bedding. Much more common or perhaps much more commonly preserved is a small scale type of cross-bedding with forsets less than an inch long and conspicuous due to formation of very dark biotite in occasional argillaceous partings of the forsets. This type of cross-bedding seems to have been resistant to destruction by movement. Two or three forsets often diverge from a common point (line) which is always the top of the bed.

The forsets all indicate current during deposition was from east or northeast to west or southwest. Unfortunately it was rarely possible to dig out and determine the attitude of the line of intersection of the forsets with the bedding and hence to determine the direction of current at 90 degrees to this intersection.

Minerals invariably present are biotite, feldspar, quartz and in some localities a mineral of the epidote group. The micas exhibit strong parallelism typical of schists.

Metamorphism. The most obvious change from north to south is an increase in grain size. There is also a colour change. The Pontiac rocks of lowest grade metamorphism (at the most northerly outcrops) are grey to buff southward they gradually become brown to reddish brown. This change is due to darkening of the biotite with increase in metamorphic grade. The first garnets to appear are very minute and pale pink and careful observation with a hand lens is necessary to detect them. The appearance of garnets seems to mark the south limit of widespread scattered flakes of graphite in argillaceous beds.

The staurolite and garnet isograds are shown on the accompanying map. Isograds are lines joining points of equal metamorphism, arrows on the isograds indicate the direction of increase in metamorphic grade. That is, the garnet isograd marks the line at which metamorphic conditions reached the level to form the mineral garnet in rocks of similar composition. That is anywhere south of the garnet isograd garnets will be found in the argillaceous parts of the beds. The argillaceous parts of the beds are used because with increasing grade of metamorphism a series of minerals ie: biotite, garnet, staurolite, kyanite, and sillimanite form and can be mapped as isograd (lines) indicative of this increase in grade of metamorphism. On the other hand no similar series of minerals forms in the sandy beds or parts of the beds. All Pontiac rocks north of the garnet isograd are in the biotite zone, similarly in all rocks of appropriate composition south of the garnet isograd (i.e. in the garnet zone) contain both garnet and biotite and south of the staurolite isograd (in the staurolite zone): biotite, garnet, and staurolite.

The garnet isograd is difficult to map for a number of reasons:
1. Garnet forms in the sandy beds before it forms in the argillaceou beds (i.e. north of the garnet isograd as shown) so that considerable judgement is required to determine the appearance of the first garnet in truly argillaceous beds or parts of the beds.
2. Another rock-type in which garnets can be found a considerable distance north of the garnet isograd are the thin very black argillaceous partings of forsets in cross-bedding. Since the garnets form first in sandy beds or in argillaceous beds immediately adjacent to sandy beds it appears permeability (greater in the sandy beds) was a factor in the formation of the garnet.
3. Variable local conditions such as quartz veins, emanations along joints, and intrusives have locally formed garnets north of the garnet isograd proper, in argillaceous rocks. These garnets north of the garnet isograd are especially noticeable adjacent to the type of joints depicted in Figure 2T and are especially noticeable in sections of the core at the Cran-Kor property where all drilling was north of the garnet isograd.

Despite the above uncertainties in mapping the garnet isograd its separation by north-south faults checked well with that on the large olivine diabase dyke lying a short distance south of the map-area at its east limit.

The staurolite isograd west of highway 46 has largely been determined on pseudomorphs after staurolite. A great deal of deformation followed the metamorphism and has tended to convert the metamorphic minerals especially staurolite, to lower grade minerals such as micas. Too if exact picture could be obtained the position of the isograds themselves have in all porbability a more complicated pattern than shown due to later folding and faulting.

Structure. The accompanying map presents the most structural data yet obtained for any comparative area of Pontiac. A narrow belt at the north limit of these rocks has now been mapped from Dasserat townships (Stockwell 1949) to the east limit of Rouyn township (M.E. Wilson 1943) a distance of 28 miles. More data were obtained during the mapping of the Pontiac in the southwest quarter of Beauchastel township because the exposures were much better, due to repeated burning, east of highway 46 than the exposures in the Rouyn-Beauchastel area when it was mapped by M.E. Wilson. West of highway 46 the exposures were in the same condition as in southern Dasserat township which was burned in 1922, but they are more numberous and a great deal of recent stripping by Cran-Kor Mines in a large section of this area produced many clean exposures for study.

In general due to the greater deformation tops are much more difficult to obtain in the southern part of the area. Wherever cleavage and bedding are parallel, movement has tended to obscure bedding and primary structures which give tops. Due to the complexity of the structure and widespread overturning bedding-cleavage relations were not investigated as a means of obtaining tops. Should bedding-cleavage relations prove a reliable indicator of tops - it would still be of limited value because bedding and cleavage are so commonly parallel.

Unfortunately the Pontiac is monotonously uniform and devoid of markers that can be mapped and traced, consequently there are probably many faults parallel the bedding and cleavage which were not recognized. In the area west of highway 46 the structure is so complicated it cannot be adequately shown on a scale as small as 1 inch to 1000 feet. Figure 2 depicts statistical plots of the various structures in the Pontiac - further information on the structure is given in the section devoted to this subject.

Temiskaming Series

These rocks, outcrop in the Lake Olier window and have been intersected in drill holes beneath the Cobalt series south of Lake Renaud, are cut by a porphyry and both are overlain unconformably by the Gowganda formation but contacts of the Temiskaming with the lavas to the north or the Pontiac series to the south are not exposed. However they can be fairly safely correlated with the Temiskaming series nearby on the basis of their distinctive lithology. M.E. Wilson (1956) has examined these rocks and he describes them as typical of the uppermost basal conglomerate of the Temiskaming.

In the Lake Olier window these rocks are entirely a monotonous conglomerate. The size of boulders varies from two feet to pebble size, the average being between two and three inches, all are greatly elongated and the plunge of their long axes is indicated on the map. The intermediate axes are at 90 degrees to the long axes and parallel the strong and ever present schistosity, while the minor axes are at right angles to schistosity.

In only two localities, was bedding in the chloritic greywacke matrix seen. Bedding indicated by lenses of sorted boulders is not common, and it seems to be parallel to schistosity in most cases, compare Figure 2E and 2F. Although every effort was made to determine tops not a single determination was made. Thin sections of the bedded greywacke, mentioned above, failed to reveal tops of the beds. The majority of the pebbles and boulders are a type of rock resembling the Pontiac, a few are diorite, porphyry, and acid intrusive rocks. Careful study has not been made but it appears a nondetrital biotite is present in the matrix of the conglomerate.

Figure 2E, 2F, 2G, and 2H is a plot of some of the structures in the Temiskaming conglomerate. From west to east the strike of both cleavage and bedding swings slightly southward and the dip flattens.

Feldspar Porphyry of the Lake Olier Window

This is a coarse-grained, massive, pink weathering rock with a low percentage of mafic minerals. The feldspar phenocrysts up to 1 inch long, have megascopically visible zoning. Between Lakes Olier and Renaud the inlier is practically all porphyry, east of the highway however the porphyry occurs in the form of large dykes. In areas of porphyry there are a number of inclusions of conglomerate. These are just as schistose as the conglomerate areas proper and have all structural elements parallel to those in the main conglomerate areas. On either side of the highway at the most southern exposures in the window are outcrops of a light coloured granitic rock. The two rock types were not found in contact so their relationship is unknown.

The large feldspar phenocrysts in this rock and its appearance in general are striking and it would seem worthy of investigation as a source of monumental or building stone.

Granite and Other Acid Intrusives

In addition to the three bodies in the western part of range 1, there are a number of small sills throughout the Pontiac which appear similar to the larger bodies and may be genetically related to them. The larger bodies are massive uniform granite low in quartz and containing about twice as much microclase as plagioclase feldspar a little biotite, epidote, and sphene. With the exception of the granite like rock along the south side of the Olier Lake window these rocks bear no physical resemblance to the porphyry of the Olier Lake window.

The sills although in most cases less than several feet thick are remarkably continuous. Some are porphyritic and although free quartz is rarely visible megascopically, considerable silicification has usually taken place in the sediments adjacent to them.

Younger Ultrabasic

The exact position of these rocks in the geological column is not known but they are probably post Temiskaming. There are at least two ages of ultrabasic ~~in the area~~ excluding the ultrabasic dyke near the west limit of the area. The ultrabasic along highway 46 at the south limit of the map-area belongs to the older group and is older than the granite gneiss in the southern part of the Opasatika sheet. This granite gneiss in Dufay township, on the property of the Carlson Copper Mines, is cut by an ultrabasic similar in appearance to the one at Donez Lake and like it is in a fault zone which seems to the mode of occurrence of these rocks. They are of very limited extent outcropping as a window south of Lake Donez. Although outcrops of the actual contact with the Cobalt rocks are not exposed no rocks of this type are known to cut the Cobalt elsewhere and it seems highly improbable they could be younger. East of the map-area along the Davidson Creek?fault other outcrops occur. The small outcrop shown as sediments west of the small bay of Kekeko Lake, that the large olivine-diabase dyke crosses, is not sediments as indicated on map 43-7A but ultrabasic as is the point forming the north side of this bay which is incorrectly shown as diabase. Drilling under Kekeko Lake cut a width of 2000 feet of this rock which caused the magnetic anomaly at this point (W.G. Robinson 1951).

These rocks are soft and have a particular punky feel when hit with a hammer. They do not contain hard rock types due to development of tremolite found in the older ultrabasics. The outcrops south of Donez Lake do not appear to contain much magnetite. Chief components are: chlorite, talc, carbonate, pyroxene pseudomorphs, with minor feldspar.

Basic Dykes

A 10-foot wide, pebble bearing biotite rich lamprophyre outcrops near the west tip of the most northerly outcrop of porphyry in Renaud Lake. This dyke cuts the porphyry and strikes about 15 degrees east of north. The pebbles in this dyke are porphyry similar to the rock it cuts but some are a fine grained aplite or rhyolite like rock.

In the extreme southeast part of the area a small outcrop of rusty biotite rich rock occurs which is somewhat similar to that in an outcrop 1500 feet west.

Ultrabasic Dyke

This distinctive rock forms a narrow dyke, striking about north-south and dipping vertically, near the west limit of the area. In the large outcrop in the north part of range 1 it can be seen terminating against a fracture at right-angles to its course and from this point north in the outcrop it is blind.

Its presence is suggested by angular float 1000 feet west of the township boundary and 320 feet north of range line 1-11. North of the swamp along the west side of the elongate Pontiac outcrop are a couple of small occurrences, the most northerly 400 feet south of an outcrop of Gowganda formation. The dyke appears to be older because it was not found cutting the Gowganda formation. Further the narrow, linear, and continuous valley in which the dyke occurs is evident as can be seen from the air photographs where the dyke is absent. There is no sign of this structure in the Cobalt series hence it could well be pre-Gowganda. From the south boundary of Beauchastel township this dyke has been traced south ~~for a distance of 14 miles~~ and maintains a remarkably uniform strike and width, its mode of occurrence being identical to that of diabase dykes.

An interesting speculation which the writer has already put forward (Johnston 1954 p. 10) can be made concerning this dyke and the diabase dyke(s) that occur some 9000 feet west at the Pontiac-Gowganda contact (Stockwell 1949b). Both the diabase & ultrabasic ~~of these~~ dykes have a constant strike and are very persistent having been traced south for over 14 miles by the writer. Both are probably pre-Gowganda and are cut by the large post-Cobalt olivine-diabase dyke that trends northeast across the Opasatika sheet. ~~This latter dyke has been shown as pre-Huronian by Cooke (1930) but it cuts the Gowganda formation north of Dufay Lake in Dufay~~

~~township.~~ North of the Cobalt rocks an ultrabasic dyke of identical appearance to that described south of the Cobalt rocks in Beauchastel occurs. Having the same strike and being of this same rather rare rock type adds weight to the hypothesis that it might be the same dyke. Furthermore some 10,000 feet west of it in the northeast-quarter of Dasserat township is a set of diabase dykes lithologically similar to those south of the Cobalt rocks (Johnston 1954). If these four dykes were originally part of two dykes one can postulate a fault beneath the Gowganda formation ~~(Stockwell (1949 a and b) found evidence for at least two faults)~~ which offset these dykes north side west the order of 10,000 feet. As these dykes are vertically dipping it seems this is a fair estimate of the horizontal component of the movement. This movement which may be the ~~resultant~~ movement on more than one fault is certainly not in contradiction with the movement of 8,500 feet calculated by Stockwell (1949b) for displacement of the Arntfield-Lake Wasa shear zone by the Horne Creek fault.

Gowganda Formation

This formation forms the Kekeko Hills lying in the central part of the area and standing over 500 feet above the surrounding country. This formation is separated into segments by the Olier Lake window and the Davidson Creek? fault. The Cobalt series in this part of Quebec is the lower member or Gowganda

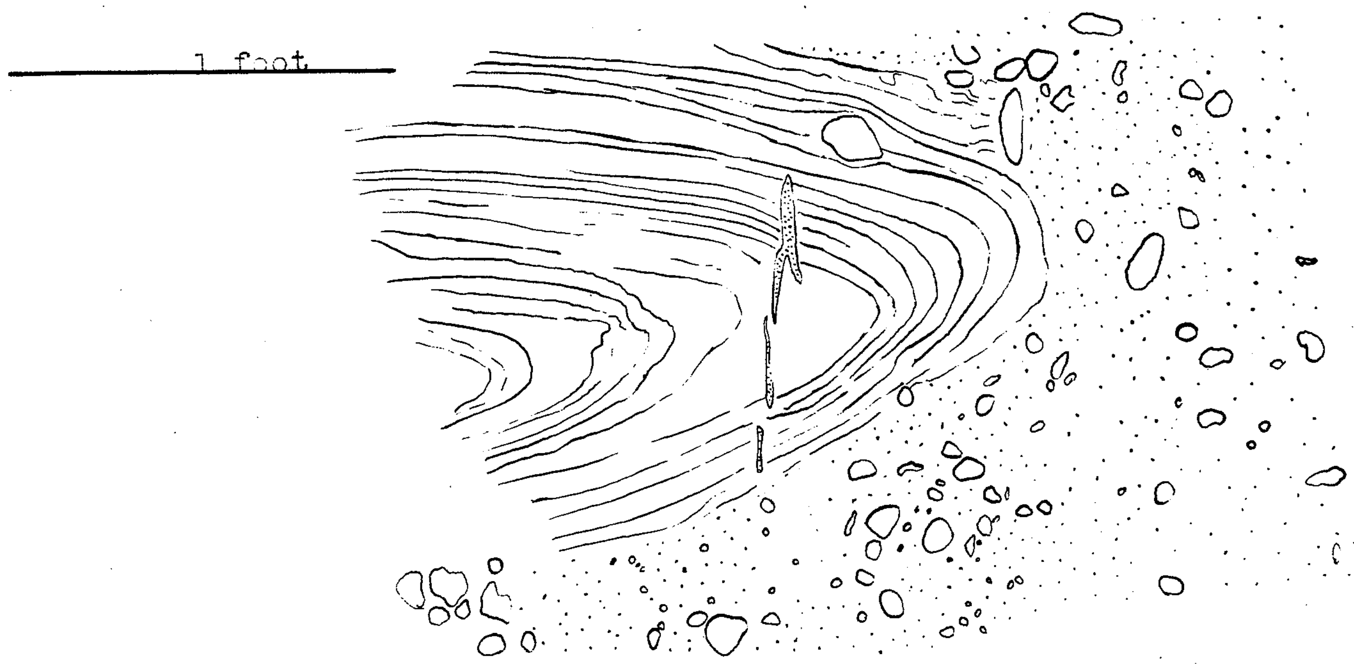

Figure 1. Penecontemporaneous fold in argillite in Gowganda conglomerate cut by a sand dyke, east of highway 46 at the southern extremity of Olier Lake.

The thickness of this member is variable the maximum being about 400 feet.

The above member is overlain by a well bedded uniform argillite containing a few scattered pebbles at some localities and also a few beds of arkose and greywacke. The final distinction between argillite and greywacke has been made chiefly on the basis of the feel of the rock when scratched with a knife, greywacke is gritty and argillite free of grit. Some soft-rock (penecontemporaneous) deformation in this member but unlike the member below the soft-rock deformation is local and confined to one or two beds and does not involve all bedding. In many of these rocks as well as other bedded numbers there is a sort of cleavage parallel to the bedding. The maximum thickness of this member is somewhat less than

200 feet.

Overlying the above argillite is the third conglomerate member which is the highest member of the series south of the Davidson Creek?fault. It is identical to the second conglomerate member described above. The thickness of this member is about 250 feet. It in turn is overlain by an argillite about 200 feet thick, overlying this argillite is about 250 feet thickness of greywacke and pebbly greywacke containing minor arkose, argillite, and conglomerate.

Structure of the Gowganda Formation

This formation is separated by a major unconformity from all underlying rocks. Along its south contact the structures of the Pontiac are mirrored in the Gowganda formation because the pre-Gowganda surface very closely paralleled cleavage and bedding in the Pontiac. This is evident from the strikes and dips of the contact indicated on the map and parallelism of Pontiac fold axes and attitude of the Pontiac-Gowganda contact. The dip of the contact is steeply north and in places vertical which corresponds with the south dip of the north contact. Along the north shore of Olier Lake a few fragments of Gowganda adhering to the porphyry indicate the same steep dip to the south. Non-Pontiac pebbles and boulders are often found at and adjacent to the Pontiac contact. As a rule Pontiac fragments are not found in the conglomerate more than several feet above the Pontiac basement, and the fragments are represented by all major rock-types that occur north of the Pontiac rocks and the Cadillac fault-zone. In the basal conglomerate west of highway 46 are a number of interesting exposures of conglomerate composed of granite fragments which resemble the granite east of highway 46 in range 1. In some places the angular granite fragments make up such a high proportion of the conglomerate that there are only occasional narrow seams of matrix. It is possible that the Gowganda formation at this point is underlain by this granite. Similar exposures occur west of the northeast-striking fault and about 1000 feet north of the Pontiac-Cobalt contact.

The Pontiac, Temiskaming, and porphyry on which the Cobalt lies is quite smooth and fresh and has no indication of a regolith. The limited surfaces that could be dug out for examination had no glacial striations, nor were any soled or facetted boulders seen. These, however, would be very difficult to find because the matrix of the conglomerate does not break free of the fragments.

An interesting structure was observed about 10 feet above the Pontiac contact in the large outcrop west of Nissaki Lake. Four completely concentric circular rows of small pebbles occur. The outer circle was slightly less than one foot in diameter. It is possible this structure is similar to pebble polygons found in Arctic regions.

There is considerable evidence the Gowganda formation was deposited in a basin symmetrical about an east-west axis, a remnant of this deposit now extends across the map-sheet: 1. The attitudes of bedding (Figure 2A) indicates a predominant west strike which is much less variable than the dip. 2. At a number of localities near the Pontiac basement, ripple marks are visible. These are parallel the actual contact of the basin as seen today and indicate the shoreline of the basin was parallel to the present contact and offshore direction was to the north. 3. Figure 2C a plot of soft-rock fold axes (lines joining points of sharpest flexure taken as fold axes) shows that the predominant trend of these axes is west, near horizontal, and likely due to movement (sliding of the beds in a north or south direction, at right angles to their axes) to conform to the shape of the basin. If these soft-rock folds were due to overiding by ice one would expect their axes to trend north because ice movement would in all probability be down and parallel to the axis of the valley or basin and hence toward the west. Ambrose and Ferguson (1945 p.13) have estimated the gradient of the pre-Cobalt valley as over 100 feet per mile falling to the west. A plunge of around 2 or 3 degrees west has been determined for the Gowganda folds in the central part of this basin. Plunges up to 5 degrees west occur south of the Davidson Creek ? fault and immediately to the north which seem to be the result of post-Cobalt movement. These lower values for the plunge indicates a gradient of nearly 200 feet per mile to the west, if these plunges are entirely initial, a result of the contour of the pre-Cobalt valley. A west plunge is also indicated by Figure 2C in that a larger number of soft-rock folds, recorded, plunge west than east. 4. The Gowganda formation in the Kekeko Hills stands about 500 feet above the level of the surrounding country and extends to a depth in excess of 600 feet below this level. To the west in Dasserat township Stockwell (1949b) has estimated the base of the Gowganda formation as 1500 feet below the level of the surrounding country. Throughout the area there are no outliers of Gowganda formation any appreciable distance from the main outcrops which again indicates that no deposition of Cobalt took place near any of the Archean land surface as exposed today and that the Kekeko Hills were formed by the differential of erosion of some 500 feet between Gowganda formation and the Archean rocks forming the basin.

One of the interesting features of the Gowganda formation is the great thickness which has been encountered in attempting to drill through it to mineralized zones it obscures from prospecting. The thickness as estimated from the map gives a value of about 1700 feet. However diamond drill holes near Renaud Lake were stopped in Cobalt at a depth of over 600 feet below the lake surface which when added to the thickness of sediments above lake level indicates an unknown thickness in excess of 1900 feet. One would estimate the thickness as considerable judging from the dips of the contacts along the north and south sides of the basin and also around the Olier Lake window.

Drilling in the vicinity of the old road south of Arntfield and just north of the Kekeko Hills show that the north contact slopes southward at more than 34 degrees and less than 45 degrees to a vertical depth of 535 to 907 feet (Ambrose and Ferguson 1945). Not all the dips of the contacts are however as steep as the above indicate. North of the Olier Lake window in the area south of Renaud Lake Ambrose and

Ferguson (1945) have calculated the dip of the contact as in excess of 38 degrees north but they did not consider the large fault along the north side of the window which if taken into consideration would seemingly reduce this angle considerably. At the northeast extremity of the Olier Lake window two outcrops of Temiskaming conglomerate approximately at the same elevation and 300 feet apart have small patches of Cobalt conglomerate adhering to them indicating that the contact is almost flat in this area. However to the west the contact is exposed in a pit and dips nearly 30 degrees to the north.

Although the writer is in agreement with Ambrose and Ferguson's (1945) interpretation of the structure in the Cobalt rocks as due to deposition in a basin as additional evidence presented seems to substantiate, he is also in agreement with Stockwell (1949b) that there has, for a number of reasons been folding as well as faulting of the Gowganda formation: 1. The simple observation that the bedding near the basement of the formation has a much steeper dip than the angle of repose, and maximum permissible initial dip indicates there has been further tilting (folding) in the direction of the initial dip. Along the north shore of Olier Lake dips in the greywacke lenses which are free from soft-rock deformation are in excess of 50 degrees, at the Pontiac-Gowganda contact one dip of 65 degrees was found. 2. South of the Davidson Creek?fault a syncline in the Gowganda plunges 5 degrees west. In the north limb of the structure dips in excess of 40 degrees occur and indicate folding due to movement on the Davidson Creek?fault.

Diabase Dykes

Two north-striking diabase dykes with dips near 90 degrees occur in range 1. As they are not in contact with the Cobalt series their age relation to it is unknown. The easterly dyke is porphyritic and appears to contain olivine. The dyke near highway 46 is porphyritic in places and quite altered, neither quartz nor altered olivine could be identified in it. These dykes were not found in the mapping south of the outcrops shown on the accompanying map.

The post-Gowganda diabase dykes are all parts or offshoots of the Aldermac diabase. One offshoot traverses the entire sheet from Wasa Lake southwestward and has been traced beyond to the interprovincial boundary. Its course through Beauchastel township is along a well defined fracture which in strike at least parallels the Horne Creek fault. In the Archean rocks it appears to occupy a fracture along which there was considerable pre-diabase movement. Dips obtained as indicated on the map suggest the fracture the dyke occupies changed dip in fault blocks bounded by north-south faults in the vicinity of highway 46. The fact that the structures in the Temiskaming are parallel in these blocks seems to rule out the possibility of the differences in dip of the dyke being due to rotation of fault blocks.

This dyke is considerably altered containing a lot of epidote at numerous localities. It has been classified as a quartz diabase or gabbro, by others.

North of the prominent hill in range 111 at the east limit of the area are a few outcrops of a dyke similar in appearance to the Aldermac diabase and the dyke described above. This dyke is also in all probability part or an offshoot of the Aldermac dyke. There has been considerable movement or deformation along this fracture both before and after intrusion of the diabase, its continuation northwest is a linear valley with evidence of deformation along its walls and have been indicated as a fault on the accompanying map. To the south in lot 41, range 1, Beauchastel township Wilson (1943) found what is probably the continuation of this same dyke (Aldermac?) cutting the large olivine diabase that trends northeast across the Opasatika sheet. This dyke (Aldermac) has been traced by the writer to the south limit of the Opasatika sheet. The large olivine diabase referred to above cuts the north-south diabase dykes west of Opasatika Lake and also the ultrabasic dyke in Montbeillard township. Two of these dykes are definetly post-Cobalt. The large olivine diabase dyke that trends northeast from Dufay Lake in Dufay township, where the writer found it, cut the Gowganda formation and is post not pre-Cobalt as stated by H.C. Cooke (1923). Hence there are at least three entirely separate ages of diabase dykes belonging to three entirely different epochs of diabase intrusion in the Opasatika sheet. If the ultrabasic dyke near the west limit of Beauchastel township is included in the diabase group to which its mode of occurrence is identical there are four periods of intrusion of rocks of this type. The fact that there are at least two different ages of north-striking diabase in the Noranda area is of considerable consequence as there is an association probably not accidental of the sulphides with diabase dykes of this attitude at the Horne, Quemont, and Normetal Mines. At the Aldermac the ore was near but not adjacent to the dyke. Wilson has weighed the evidence and although he emphasizes that it is conflicting he feels that it favours the ore at Noranda as being post diabase (1941). Wilson (1956, Figure 4) indicates the diabase he considers the Noranda dyke cuts the large olivine diabase, therefore if the ore at Noranda is later than the Noranda diabase dyke it must be post-Cobalt.

The following relationships to sulphides in the area were noticed, which have of course little bearing on the problem of the relations of sulphides to base metal deposits in the region:

1. In a pit within the older diabase dyke (Matachewan?) on the point between Lamy Bay and the main part of Opasatika Lake a very narrow quartz vein striking 20 degrees north of east and dipping 80 degrees south, contains carbonate, chlorite, and a little chalcopyrite.

2. The branch of the Aldermac diabase that trends southwest across the map-area is adjacent to chalcopyrite exposed in pits at Olier Creek about half a mile west of the Beauchastel-Dasserat boundary. At this locality it appeared to the writer the dyke cuts the chalcopyrite.

To the west in Ontario, where the Cobalt series is more abundant and can be used to determine the relative age of these dykes, a set of olivine diabase dykes, striking northwest, is in most areas considered the youngest set and resembles the olivine diabase in Quebec, as does a set striking northeast in the east Porcupine area. In the Gowganda area E.S. Moore (1955) has separated the diabase into four different age groups, although he believes two are related, it would seem to the writer there is a possibility of four separate ages of diabase in the Gowganda area. This all points to the obvious conclusion that there are more ages of diabase than commonly supposed and there is no good criterion from which to determine their age, lacking crosscutting relations. The strike of a particular diabase dyke or its composition does not necessarily mean it is a certain age, although dykes of the same age tend to have the same strike and composition, dykes of widely different ages will have identical strikes because a fracture pattern once developed tended to re-open to provide structures for dykes of different ages. In the Noranda area three probable ages occupy the north-south direction the ultrabasic, Matachewan? diabase, and a post-Cobalt diabase.

One of the difficulties in establishing the age and relative ages of these dykes is the fact they have often been the locus of movement, especially the older dykes, which has been both post and pre-diabase on the fracture they occupy. The post-diabase movement has jointed the diabase and consequently they are plucked out and do not outcrop. The writer has found that careful search of the walls of valleys suspected of being along diabase dykes often reveals fragments of diabase adhering to the walls, failing this a few dip needle readings will often suggest or confirm the presence of a dyke that does not outcrop.

Considering the great length, uniform width averaging 400 feet, of the large olivine diabase dyke in the Opasatika sheet and its depth of cover at the time of intrusion which as far as known was at some points, the thickness of the Cobalt series or a probablt maximum of about 3000 feet it is hard to reconcile how this structure could exist and form without having been a feeder for lava flows which have since been removed by erosion.

Pleistocene - Recent

Figure 3 is an attempt to show some of the features of glaciation which could not be shown on the geological map without over complicating it. In mapping the bed rock geology on a scale of 1 inch to 500 feet the country was gone over quite carefully and it seemed adviseable to note, in passing, any features of the Pleistocene geology, as it is not likely the area will be mapped as carefully again for some time. Too if a study of the Pleistocene geology is made at some future date Figure 3 might be of some help, as this work may be done under much less favourable conditions than existed when the present survey was amde. The area was almost devoid of second growth or growth of any type which obscures many features. Also as large quantities of gravel are used nearby for road building and mine back-fill, the location of the esker systems in the eastern part of the area which contain large quantities of good gravel is of considerable economic importance as is the location of areas underlain by clay which are the only ones suitable for cultivation. It should be emphasized that the moraines are till (loam, sand, gravel, and boulders, etc.) that could probably be utilized for road fill but are not a source of good sorted gravel for such purposes as road surfacing, which can be obtained from the eskers. Although a special effort was made to locate every outcrop the same effort was not made to locate every minor glacial feature such as washboard moraines.

As a special study was not made of the features of glaciation and in cases where it could not be determined whether ridges were washboard moraines or eskers or some other feature they were shown by a separate circle symbol. Authorities are not agreed on the origin of washboard moraines and it is possible those in this area are of more than one origin. They are one of the older glacial features although superimposed on irregular till hills they underly the lacustrine clays and have in some cases been partially destroyed by wave action in glacial Lake Barlow-Ojibway. Where this has occurred rows of large boulders are left behind. This feature is noticeable in the series of moraines in range 111 at the east limit of the map-area and also in the moraine in range 1 on the large outcrop at the east boundary of the area in range 1. In what appears to be their unmodified state the moraines are about 10 feet high, quite sharp crested the steeper side facing south more often than north and have a maximum exposed length of less than 2000 feet. There are not a sufficient number of well developed or preserved moraines to accurately determine the distance between them. The average of this distance is slightly over 400 feet which according to some is the yearly rate of retreat of the ice. Locally on the north side of the moraine the country is often several feet higher than on the south side. Where curved they tend to be convex southward and in some instances it is noticeable that at small outcrops along the moraine, that section of the moraine, has a sharp flexure to the south suggesting that their formation has something to do with ice movement which was easier over a rock outcrop. The moraines are composed of till and occur in areas underlain by till and are never found on large bare outcrops. There are unfortunately no cross-sections of them exposed. It is worthy of note that there may be some connection between the origin of the washboard moraines in this area and the prominent range of east-west Cobalt Hills. In the Opasatika sheet washboard moraines were not found north of these hills (this could well be due to the much more limited areas of till in which washboard moraines occur) and although they occur at least to the south boundary of the sheet south of this monadnock, they were not noticed south of the eastern limit of it which lies well within the sheet. If the origin of the washboard moraines is due to these hills which stand in an east-west ridge 500 to 600 feet above the surrounding country, it could have been due to their action as a divide and buttress between the main ice mass and a local area of ice south of these hills. This smaller area of ice south of the Kekeko Hills would be independent of the main ice sheet north of the hills at one stage in the retreat of the ice. In this local area of ice the opportune conditions for the formation and or preservation of moraines existed while to the north in the main ice sheet they did not. Their formation was dependent on movement of the ice.

They are approximately at right angle to the glacial striae. They are compsed of till and there is no evidence of sorting or transport by water.

The highest abandoned beach noted in the area occurred at elevation 1225 (estimated from a topographic map recently prepared by the Topographic Survey). Striations are not preserved in the Pontiac rocks exposed and are found only in dykes and veins and west of highway 46 in the extensive strippings exposing outcrops that have not been subject to all surface weathering agents. The striations indicate a fairly constant direction of ice movement at about 10 degrees east of south. At one locality west of highway 46 older fainter striations at south 20 degrees west were definetly cut by younger striations at south 12 degrees east.

STRUCTURAL GEOLOGY

As an aid to study of the structural geology 22 equal area statistical diagrams of primary and secondary structures in the area have been prepared. As yet this approach to structural geology is seldom used, in this country, but as it is believed it will in time become more widely accepted and as the report is written for the future as well as the present this Figure (2) which embodies an enormous amount of factual information has been included. The explanation + preparation of these diagrams is beyond the scope of this report and the reader is referred to some of the more recent editions of texts on structural geology. An effort has been made to write the report in such a way that it will be intelligible without reference to this Figure (2) and although this is not necessary, for an understanding of the contex even where reference is made to it, these diagrams depict more than any amount of explanation can hope to even inadequately convey. When a great many structures have been recorded and are available for study by this method as is the case here one is confronted with the problem of what areas or divisions to prepare diagrams for, or in other words how many diagrams will adequately depict the structures and at the same time indicate any major variations in them from one part of the map-area to another. One of the most obvious divisions is for rocks of different ages and types and by making this division and proceeding by constructing diagrams for smaller areas and combining these when they appeared similar the writer has reduced the number of diagrams to 22. A division in the Pontiac rocks is made at highway 46 because the character of the outcrops is very much different on either side of this road and the method of mapping employed was different and there are also some differences in the structures.

The structure of the Cobalt rocks has already been discussed and the following section is devoted mainly to structures in the Archean rocks.

<u>Folds</u>. The majority of attitudes of bedding determined in the Temiskaming series (Figure 2E) indicate a west-strike and north dip. This is identical to the structure in the Pontiac where the beds strike near west and invariably dip north (Figure 2I and 2M). Adequate structural data is available to show the Pontiac has been isoclinally folded and all fold axes overturned southward. As for the plunge of the Pontiac folds the writer has not yet had the opportunity to compile and study available data south of the map-area which would be of considerable help in this problem. Drag folds are not common but as can be seen from the map those for which complete information

could be obtained, appear congruous. Of the 14 whose axes could be determined (Figure 2Q) the plunge of the majority was at about 30 degrees in a direction near northeast. If these drag folds are congruous the major fold axes would be expected to have the same plunge however this does not seem to check with the attitudes available in the very limited exposures at the noses of folds which indicate the plunges steeper than 30 degrees and in some instances nearly vertical.

There are two sets of crenulations in both the Temiskaming and Pontiac. Those in the Temiskaming are in the schist lamellae of the highly schistose conglomerate matrix and in the Pontiac they are in the highly micaceous beds and micaceous parts of the beds and a set plunging northward is much more common than in the Temiskaming. In the Pontiac the two sets often occur together and are about at right angles as can be seen from the map. An attempt has been made to separate these Figure 2R and 2S; where they occur alone, it is difficult to determine to which set they belong and they have been more or less arbitrarily separated in Figure 2R and 2S. About the only criteria for distinction between sets being the direction of plunge and the more open folding and larger amplitude of the north plunging set. The height of the individual crenulations seldom exceeds ¼ inch in either set and is usually much less.

Cleavage and Schistosity. The cleavage in the Pontiac is parallel from bed to bed and where beds are transected cleavage cuts through them indiscriminately regardless of differences in character. This cleavage is largely parallel to bedding (compare Figure 2I and 2J; 2M and 2N). In the area west of highway 46 both bedding and cleavage are much steeper in range 11 than range 1. There are localities in the south part of the map-area where two cleavages can be distinguished, a cleavage apparently the older is exactly parallel bedding and occurs in sandy beds and is cut by a later and much more common cleavage, the one illustrated in Figure 2J and 2N.

In the Temiskaming, bedding and schistosity appear parallel (Figure 2E and 2F) the schistosity corresponds to the cleavage of the Pontiac, also striking west and dipping north and would seem to the writer to have originated at the same time.

Joints and Other Fractures. In order of numbers recorded as depicted in Figure 2D, 2L, and 2P the joints in Archean rocks can be arranged in sets as follows:

SET 1 Striking slightly east of north and dipping near vertical.

SET 2 Striking about west and dipping about 50 degrees south.

SET 3 Striking about 20 degrees west of north and dipping steeply west.

SET 4 Striking northeast and dipping steeply east.

The joints of SET 2 in the Pontiac west of highway 46 appear less numerous than to the east (compare Figure 2P and 2L). This is apparently not due to any actual differences in the number and importance of these joints but due to the moss cover which has obscured these rather low dipping joints west of highway 46 while east of it they are readily exposed and recorded.

One often encounters the statement that the fracture pattern in homogeneous igneous rocks is more uniform than in less homogeneous rocks such as sediments. The plots of joints for the area in question do not bear this out, there is very little difference in the joints in Archean igneous or sedimentory rocks.

Linear Structures. In addition to the folds and crenulations other types of lineations are abundant. In the Temiskaming conglomerate the pebbles and boulders are elongated throughout and plunge north (Figure 2G). In the Pontiac long axes of micas and quartz on the cleavage give a strong lineation plunging slightly east of north.

Igneous Structures. The two granite bodies in range 1 could well be part of the same body which is unroofed at these points. Similar bodies occur to the west on strike in Dasserat township. It appears that these bodies as well as the smaller sills were intruded parallel to the bedding cleavage plane.

Lake Donez adjacent to it is quite schistose. The schistosity strikes about 10 degrees north of east and dips 80 degrees south. Strong slickensides plunge 4 degrees west and indicate the north side moved east. Also present are later fractures striking 25 degrees north of east and dipping vertical, cutting the above schistosity and containing the majority of the quartz stringers present. Stockwell (1949 b) has shown that the separation on vertical diabase dykes at this fault was in excess of 500 feet south side west. In the map-area the post-Cobalt movement seems to have had a vertical component for the following reasons: 1 To produce the syncline that lies along the south side of the fault, which was in all probability a result of movement along it, the south side must have moved downward. 2 Although exposures are for the most part lacking immediately north of the fault they indicate this area is underlain by the lower part of the Gowganda formation. The outcrops of conglomerate along the north side of Nissaki Lake are characteristic of those near the base of the Gowganda formation. About 1000 feet west of Lake Donez is an outcrop of the basal type conglomerate which contains Pontiac boulders indicating it is very near the Pontiac and there is a possibility that the drift covered area in the vicinity is actually underlain by Pontiac. Although the above factors indicate a post-Cobalt movement of south side downward a noticeable increase in the grade of metamorphism of the

Pontiac on the south side of this fault at Kekeko Lake suggest the pre-Cobalt displacement was the opposite, south side upward.

A fault somewhat similar to the above fault along which there has in all probability been both pre- and post-Gowganda movement is the fault along the north side of the Lake Olier window. In the prominent valley at the north side of the Lake Olier window, east from Lake Renaud, the porphyry and Temiskaming conglomerate are more schistose than usual and this schistosity is much steeper than the regional schistosity of the Temiskaming conglomerate. This feature is noticeable all along the fault, although east of the north-striking fault that offsets the large porphyry dyke its course is less certain. Another feature that makes this fault a structural necessity is the position of the rocks on either side of it. If the Gowganda rocks on the north side of the fault at the lowest point of outcrop are projected south up dip they would intersect the high outcrops of porphyry and Temiskaming on the south side of the valley. Too these Gowganda rocks north of the fault are the upper part of the formation and if all members of the formation were ~~post-Cobalt~~ present at this point the vertical component of the movement was considerable.

<u>Northeast Striking Faults</u>. South of Lake Olier there is a prominent linear valley that has this trend and along which there

is a horizontal separation of the ultrabasic dyke and the Pontiac-Gowganda contact. Assuming: 1 that the ultrabasic dyke is vertical and 2 that all movement on this fault was post-Gowganda 3 that the dip of the Gowganda-Pontiac contact is 65 degrees north one can estimate the displacement on this fault as horizontal movement south side 600 feet northeast and the vertical component in excess of 2000 feet upward. This does not check with the movement suggested under economic geology on number 1 and 2 veins at the Cran-Kor property which may mean some of the above assumptions are incorrect.

North of Lake Renaud are a group of faults with a somewhat similar separation which could well be the extension of this fault.

Faults Striking North. There are probably a great many faults of this attitude with small displacement. The only evidence for these faults is closely spaced north-striking joints and occasional displacement of east-west contacts such as dykes and fold axes. Some of these faults are along prominent valleys such as those south of Nissaki Lake. As a rule the separation is east side north and slickensides indicate the movement was nearly horizontal.

Origin of the Structures. The structures of both the Archean and Proterozoic rocks in this area owe their origin to movement along and deformation caused by Larder Lake-Cadillac fault zone and associated structures underlying the Gowganda rocks. The structures in the Proterozoic Cobalt rocks are the direct result of deposition in a great valley formed in the weaker schistose rocks along this fault zone and to later post-Gowganda movement on this and or associated faults. The most plausible explanation for the structures of the Temiskaming rocks of the Lake Olier window, and the Pontiac rocks to the south, would seem to the writer, due to thrusting of the rocks along the north side of the Larder Lake-Cadillac fault zone southward and over these rocks. That such took place and that the structures in both the Temiskaming and Pontiac rocks are a result of movement (a south and upward direction of tectonic transport) is indicated by the following considerations:

1 In the Temiskaming and Pontiac rocks, bedding, and cleavage dip north Figure 2E, 2F, 2I, 2J, 2M, and 2N. The axial planes of the isoclinal folds in the Pontiac rocks dip north having been overturned to the south which is probably also the case in the Temiskaming and would be apparent if more data were available.

2 The linear elements (a) long axes of pebbles and boulders in Temiskaming conglomerate, (b) long axes of mineral grains in the Pontiac all plunge northward (Figure 2G, 2K, and 2O) and are a right angles to crenulations Figure 2H and 2R and fold axes Figure 2E, 2I, and 2M. The most logical

explanation for this pattern of structures is movement parallel the linear elements and at right angles to the fold axes.

3 The crenulations, particularly, in the west-striking and north-dipping schist lamellae of the Temiskaming conglomerate matrix have gently dipping, down dip limbs, and steeply dipping to over-turned, up dip limbs, indicating both by drag and feel of the surface that the movement was north side upward and south.

4 The crenulations in the Temiskaming conglomerate (in 3 above) adjacent to some greatly elongated pebbles form a fish bone pattern; as the parallel crenulations approach certain pebbles the strike on both sides of pebble change and they curve north-ward and down the dip of the schistosity instead of remaining strike lines in the plane of schistosity. Thus they have somewhat the appearance of a fish spine (head north and down dip) with the pebble forming the spine and the crenulations the ribs. Whether these crenulations formed in the above pattern or formed at right angles to the axes of elongation of the pebble and migrated to their present position, strongly suggests the pebbles offered resistance to movement which was easier some distance away from them in the matrix of the conglomerate and that this movement was north side upward and to the south.

5 The spacial relationships of certain fractures are in accordance with the above interpretation of the structures:

(a) A set of prominent joints, (SET 2) that usually form the south side of outcrops in the Pontiac and Temiskaming, strike west and dip about 65 degrees south and are at right angles to the prominent cleavage (and or schistosity of both the Temiskaming and Pontiac rocks). The lines of intersection of these joints and the cleavage is horizontal and parallel to axes of one set of crenulations. Hence these joints could be explained as due to "tension" by a movement of north side upward and southward. Joints of SET 2 are parallel to the lineation that plunges north that is long axes of mineral grains and pebbles, and would appear to also be "tension" joints which tended to open at right angles to movement. Tension joints parallel to movement seem to be of common occurrence and have been described for numberous areas. Further indications that these joints are of tension origin are found in the fact certain dykes occupy them and also Figure 2T indicates more of these joints than any other set must at one time been open to allow mineralizers passage along them to form ridges where these mineralizers reacted with the rock and formed resistant sheets along the joints that now stand up as ridges.

6 All schistosity, cleavage, and other surfaces which strike west and dip north along which there was appreciable movement have an arrangement of irregularities such that the feel of the surface indicates movement was upper side south and upward

parallel to the long axes of mineral grains and pebbles.

7 A consideration of the structures on a regional basis points to the Larder Lake-Cadillac Fault zone lying to the north has had a profound influence on the structures: (a) The Temiskaming conglomerate becomes more schistose northward and is much more schistose along the north side of the Lake Olier window and throughout is much more deformed than any of the Pontiac exposed. Lineations such as elongation of minerals (pebbles) and schistosity are much better and more strongly developed in the Temiksaming than the Pontiac. (b) South of the map-area there is a marked change in the structure of the Pontiac from overturned isoclinal folds to more open folds the axes of which do not all trend west; in fact the isoclinal folding in the map-area appears to be superimposed on earlier structures in the Pontiac.

Age of the Structures. As pointed out above the structures produced in the Pontiac, associated with movement on the Larder Lake-Cadillac fault zone appear to be superimposed on earlier structures. Another fact seems to point to this same conclusion-in the Pontiac rocks for a distance of a mile or more south of the Cobalt-Pontiac contact almost all garnet and staurolite have retrogressed to micas due to a later deformation. These minerals especially staurolite are rare in this zone and metamorphic isograds have been located on the basis of pseudomorphs or rare occurrences of these minerals which serves to identify the pseudomorphs. The metamorphism of the Pontiac rocks has been caused by the large granite gneiss bodies in the south part of the sheet (the evidence is beyond the scope of this report) hence these granite gneisses must be older than some of the movement on the Larder Lake-Cadillac fault zone. Another factor which also suggests all acid intrusive rocks in the area are older than some of the movement on the Horne Creek and or the Larder Lake-Cadillac fault zone is the separation of the older north-south diabase dykes as explained under the ultra-basic dyke. If these older north-south dykes are the so called Matachewan diabase, as far as is known, they are younger than all acid intrusives in this part of the Canadian Shield and hence if faulted this faulting took place after emplacement of of all acid igneous rocks in the area.

The feldspar porphyry in the Lake Olier window is much less schistose than the Temiskaming conglomerate which considering the foregoing, suggests it may be younger than the granite gneiss in the southern part of the Opasatika sheet and may belong to an entirely different period of granitic emplacement.

As emphasized, structures in the Temiskaming and Pontiac are so nearly parallel they are likely the result of the same deformation although an unconformity separates these rocks (Wilson 1943). The slight differences in attitudes are perhaps best explained by the fact they are not for identical areas or could be due to slight movement or rotation due to movement on faults since their formation. There are however a few structures in the Pontiac that were not found in the Temiskaming conglomerate such as drag folds and crenulations that plunge northestward in the quadrant between north and east, these could well be pre-Temiskaming structures.

It is interesting to note that once the fractures or joints form in an area subsequent deformation tends to produce joints of the same attitude. As already pointed out the granite in the area tended to follow cleavage and bedding of the Pontiac and yet the joints in it are parallel to those in the Pontiac some of which already existed when the granite was emplaced, if the explanation for their origin as presented is correct. This same condition is true for the Cobalt series, north-striking joints along which there has been introduction of material (Figure 2T) are pre-Gowganda as was the introduction of mineralizers as they are overlain by the Gowganda. Similarly the north-striking ultrabasic dyke near the west limit of the area appears to also be pre-Gowganda. Yet the north-striking fractures of identical attitude to those described above formed later in the Cobalt as can be seen from Figure 2B. These north-striking fractures offset the post-Cobalt diabase in the Lake Olier window. In the rock cut at the last outcrop of Temiskaming conglomerate on the east and right hand side of highway 46 there is an excellent exposure where slips and other fractures associated with the north striking faults striking about 10 degrees east of north and dipping 75 degrees west cut through the older west striking and north dipping schistosity.

Study of Figure 2B reveals that there are two sets of joints in the Gowganda formation that do not occur in the Pontiac and hence might be considered the result of Proterozoic deformation.

1. A set striking north 70 degrees east.
2. A set striking northwest.

It is appropriate to point out here that two ages of post-Gowganda diabase dykes strike north 70 degrees east: the offshoot from the Aldermac diabase that crosses the map-area and the large olivine diabase dyke that trends across almost the entire Opasatika sheet from Lake Dufay to a point beyond Kekeko Lake. Airborne magnetic data indicate this dyke is at leat two hundred miles long (personal communication A.W. Derby).

Of these two post-Cobalt dykes the Aldermac diabase is separated south side 400 feet west by the Horne Creek fault while it is not offset by the Larder Lake-Cadillac fault zone. This 400 foot separation in apparent opposite direction to the combined separation by the Larder Lake-Cadillac fault and the Horne Creek fault on the older north-south diabase and ultra-basic dyke (north side 10,000 feet west) which if nothing else suggests movement on these faults was limited since intrusion of the youngest diabase in the area.

Conspicuous by their absence in the Gowganda formation are joints of SET 2 in the Archean rocks which strike west and dip south. The fact that these fractures are absent in the Gowganda formation would seem to substantiate the origin potsulated for them as tension cracks related to movement on the cleavage which took place prior to deposition of the Gowganda formation. They are however present in the granite which seems to have been emplaced after the cleavage formed in the Pontiac but the majority of these joints were determined for small granite bodies which could well have jointed parallel the older joints in the enclosing Pontiac.

ECONOMIC GEOLOGY

From knowledge gained to date it would appear copper prospects are the most likely mineral discoveries to be made in the area. Some low gold assays have been obtained from the Olier Lake window but 15 well mineralized samples throughout the area of Pontiac rocks and intrusives cutting them assayed nil in gold with the exception of one that ran a trace. Molybdenite occurs in a number of granite dykes and quartz veins but none of these occurrences are significant. At the south limit of the map-area in Montbeillard township are large areas of altered ultrabasic rock which are possible sources of talc and soapstone. No asbestos was noticed in these rocks.

On the property of Cran-Kor Mines narrow veins of galena and sphalerite occur all discovered to date are less than one foot wide. These lead and zinc occurrences have been indicated on the map.

Occasional flakes of graphite occur throughout the Pontiac rocks but none were noted in sufficient quantity or size of flakes to appear a likely source of graphite. The highly graphitic slates in the Pontiac contain an amorphous type of graphite which is at present of no commercial value. At widely separated points in the area of Pontiac rocks there are occurrences of plates ilmenite up to one-half inch in diameter which are probably only of mineralogical interest. These occurrences are in small quartz stringers. The sediments

Table Number 1

The following table gives the locations of samples assayed and brief notes regarding their character. Blanks in the value column indicates sample not assayed for that metal.

Lot	Range	Locality	Description	Au	Cu	Ni	Zn
13	1	Pit north edge large granite outcrop.	3-foot wide vein strike N. 75°E. dip 55°S. with coarse pyrite.	Nil	—	—	—
10	1	N.E. extremity of large outcrop of both Pontiac and granite.	Granite well mineralized with quartz, pyrite and carbonate; galena, and native bismuth also present.	Nil	—	—	—
N/2 19	1	900 feet south of west end of swamp indicated on map.	Sulphide bearing graphitic slate.	—	.01	—	Nil
S/2 26	1	1200 feet north of the outcrop with the diabase dyke.	Quartz and pyrite in small acid sill.	Tr.	—	—	—
S/2 28	1	Pit on S.W. projection of large outcrop.	Pyrite and molybdenite in an acid sill.	Nil	—	—	—
N/2 24	1	Pit at south extremity of large outcrop.	Coarse pyrite and molybdenite.	Nil	—	—	—
N/2 31	1	900 feet north of range line 1-11.	Small quartz veins parallel cleavage, carbonate and pyrite.	Nil	—	—	—
N/2 21	11	T-shaped outcrop north of Lake Donez.	Quartz carbonate veins.	Nil	—	—	—
N/2 20	11	Large pit near south shore of Lake Donez.	Talc chlorite schist with quartz carbonate stringers sparcely mineralized with pyrite.	Nil	—	—	—
N/2 20	11	100 feet east of the above locality.	Similar to above.	Nil	—	—	—
S/2 34	1	2000 feet east and slightly north of the centre point of the township.	Fine grained green rock probably lava with considerable sulphides.	Nil	.02	Nil	Nil
4	11	Pit just east of surveyed lot line.	Chalcopyrite, pyrite, and quartz in an east-west fracture.	Nil	—	—	—
4	11	Pit just north of the range line.	Tourmaline bearing quartz and pyrite in silicified Pontiac no chalcopyrite.	Nil	—	—	—

Table Number 2

Molybdenite Occurrences other than those listed in Table Number 1

Lot	Range	Locality	Description
10 and 11	1	East of highway 46 in the north part of the range acid intrusive.	Molybdenite in a quartz vein associated with and in the acid intrusive.
4	1	Pit at west extremity of large outcrop.	Molybdenite occurs in the wall-rock at the contact of a quartz vein striking east and dipping 50° north.
4	11	South of lot line 4-5, test pit on fault and the test pit to west.	Igneous looking alteration zone striking east chalcopyrite, pyrite, quartz, and molybdenite.

adjacent to these stringers are silicified and the ilmenite occurs in the quartz or in vugs within the stringers which also contain carbonate and coarse green mica.

There are a large number of barren quartz veins and stringers parallel to the cleavage in the Pontiac, especially where there has been more than normal movement. Poles to 260 of these veins (Figure 2U) indicate that the majority strike west and dip 40 degrees north, a few strike near west and dip south and a still smaller group strike north and dip steeply east or west. From these attitudes or a comparison of Figure 2J, 2N, 2L, 2P, with 2U, it can be seen the quartz veins are predominantly parallel to the well developed common fractures especially the cleavage-bedding plane and to a lesser extent west-striking and south-dipping joints and steeply dipping joints striking north.

Cran-Kor Mines* This property lies immediately west of highway 46 in ranges 1 and 11. The main showing or number 1 vein lies 800 feet west of highway 46 just south of range line 1-11. It and the number 2 vein which is about 1200 feet west

*The writer is indebted to Mr. Th. Koulomzine consulting engineer for Cran-Kor Mines who placed some of his reports information on the property at the writer's disposal. All assays and dimensions and grades quoted are taken from Mr. Koulomzine's reports. The location of the diamond drill hole east of the swamp near highway 46 has been taken from the survey of Koulomzine and Geoffroy & Company as the sand pipe could not be located. The remainder of holes however were located and the attitudes determined by the writer's party.

of number 1 vein have been known for many years. Considerable test pitting was done throughout the property and some drilling but as the veins contain practically no precious metals they did not, until the increase in price of copper attract attention. In the middle of July, 1951 the present owners commenced development of the property. From July to November, 1951 the following work was done:

1. 3,900 linear feet of bulldozed trenches from which 5,900 cubic yards of earth were removed.

2. 2,580 linear feet of hand-dug tranches from which 480 cubic yards of earth were removed.

3. 23 short diamond drill holes totalling 4,472 feet, all except one were on number 1 vein.

From August 4 to December 12, 1952 the following work was done:

1. 2,000 linear feet of bulldozed trenches.

2. 2,400 linear feet of hand-trenching.

3. Between August 4 and September 15, 1952, 2,822 feet of diamond drilling was carried out on number 2 vein and in exploring the area west of number 1 vein. In 1953 and early 1954 the following buildings were constructed: hoist room, compressor shed, and combination office dry and core house at number 1 vein. Other work done on parts of the property consisted of a spontaneous polarization, electrical survey, and a magnetometer survey.

The portion of the property which received most attention is near the north limit of outcrops of the Pontiac series in a fault block between northeasterly and northerly striking faults. Probably due to movement on the northeasterly striking fault south of Lake Olier the structures in the Pontiac in this fault bloak are exceedingly complex, and in contrast to the apparent lack of mineralization in the rest of the map-area in these rocks mineralization is widespread as can be seen from the number and locations of test pits indicated on the map. Number 1 and 2 veins as well as a great many of the other veins on the property strike east of north (Figure 2V). This figure a plot of 106 poles to fractures containing galena and sphalerite and or chalcopyrite, on the Cran-Kor property indicates the largest number of these fractures (whose attitude was determined) strike 25 degrees east of north and dip 78 degrees east. Except for a few veins all strike northeasterly and dip in excess of 60 degrees either northwest or southeast. A small group strike 20 degrees south of east and dip 55 degrees north. Fractures with the same attitudes as the fractures and veins containing sulphides on the Cran-Kor property do not occur or are not common in the Gowganda formation (compare Figure 2V and 2B) and are much more common in the Pontiac west of highway 46 than east of it (compare Figure 2L and 2P with 2V). Fractures with this attitude are also present in the acid igneous rocks cutting the Pontiac (compare Figure 2V with 2D).

Number 1 vein strikes north 8 degrees east, at the south limit of exposure (just north of the most southerly buildings shown on the map) the dip is about 75 degrees west, diamond drilling indicates it is about 70 degrees west. As the vein is traced north it swings to the east and at the point of sharpest curvature the dip is still to the west but nearly 90 degrees, northeast of this flexure the vein has been traced for nearly 400 feet but the chalcopyrite content is very much lower than in the southern portion. It averages over 5 feet in width and contains parallel quartz veins and stringers of two or three different generations of quartz some of which is vuggy. Tourmaline was the only gangue mineral seen other than quartz. With the exception of a very small amount of pyrite, chalcopyrite is the only sulphide, bornite and chalcocite form secondary near surface stains on chalcopyrite. The wall-rock due to silicification is quite massive, and where bedding is not masked by silicification it is not disturbed. Although the vein has a very regular strike the stringers of chalcopyrite, in places quite massive vary in attitude considerably within the vein. Chalcopyrite is entirely confined to the vein and the best mineralization is associated with highly silicified fragments of wall-rock within the vein quartz which chalcopyrite has replaced inpreference to quartz. In this vein as at many other chalcopyrite occurrences on the property chalcopyrite has replaced one wall of its fracture.

One side of a sulphide stringer will be extremely sharp and unreplaced while the other will be just the opposite due to irregular replacement, extending outward in one direction for distances of 4 or 5 inches. This vein has been extensively trenched and the best 140 foot section contains an average of 3.5 percent copper over an average width of 5.6 feet. Seventeen shallow diamond drill holes gave an average value of 4.4 percent copper over a width of 2.5 feet and a length of 230 feet which is a greater length of mineralization than exposed on surface. Averaging these results 62 tons per vertical foot of material running 3.9 percent copper are indicated.

Number 2 is similar to number 1 vein, occurring in a strong straight and regular fracture striking north 33 degrees east and dipping about 80 degrees west, and has been traced for nearly 2000 feet. The rocks on either side of it are not usually contorted or deformed for a distance of more than two or three feet nor is there much silicification or alteration. There has been some movement along the vein fracture because the walls do not match. The axes of three drags on the west side, adjacent to and apparently caused by movement on the vein fracture strike as follows: north 80, 70, and 52 degrees east, and plunge east at 32, 34, and 75 degrees respectively. One of the three drags suggests a direction of movement of east side southward and if this is the actual relative movement the east side must have moved southward and downward.

There is less quartz in this vein than number 1 vein however in other respects the mineralogy appears similar. Channel sampling of this vein indicated the following copper content in the four best noncontinuous sections:

PERCENT COPPER	WIDTH FEET	LENGTH FEET
1.7	3.2	35
1.7	3.5	25
2.0	4.1	100
1.5	2.3	15

Nine shallow drill holes cutting the vein below the best surface showings did not intersect mineralization of interest.

Other showings: A great deal of test pitting and systematic stripping have been done on the property and many small veins are well exposed and can be readily examined. These with the exception of a couple of occurrences along fractures that trend near west the veins and fractures containing chalcopyrite all have much the same attitude as number 1 and 2 veins, see Figure 2V. The best occurrences of chalcopyrite are in veins containing quartz. It also occurs alone or with very little quartz along narrow fractures in large well formed crystals. Galena and sphalerite are found in some of these fractures in quite massive form apparently as fillings of very narrow open fractures. All surface occurrences of these minerals are indicated on the map. Diamond drilling at both number 1 and 2 veins intersected a few narrow fractures carrying galena and sphalerite near but not in these veins and in a couple of surface occurrences they are in the same veins as the chalcopyrite but not with it, which considered together with their absence in number 1 and 2 veins and minor carbonate associated with them seems to indicate they belong to an entirely separate and different period of mineralization than the chalcopyrite. The galena is argentiferous as indicated by the following assays:

ZINC PERCENT	LEAD PERCENT	SILVER OUNCES PER TON
8.8	38.1	2.7
----	41.2	2.1

<u>Olier Lake Mines</u>. The shaft, the most important development on the property is a short distance east of the small lake between Lakes Olier and Renaud. A complete mining plant was installed on the property, long ago, and judging from the size of the dump the shaft must be 50 or more feet deep. Some diamond drilling was done on the property, the locations of two drill holes are in evidence west of the shaft and a great deal of test pitting and stripping was done.

The small amount of mineralization in the dump at the shaft, is chiefly chalcopyrite which replaced the syenite to a limited extent along fractures and a few small quartz stringers with a little carbonate and chlorite. A trench 2 to 3 feet deep and 100 feet long extends along the mineralized zone in a direction north 65 degrees east from the shaft. Considerable stripping was done in an effort to locate parallel zones without success. Mineralization throughout the porphyry in this area is in the form of quartz, specularite,

Table Number 3

Description of Pits in the Lake Olier window east of highway 46

Location of Pit	Structural Features	Mineralization	Remarks
250 feet east of highway 46 near north limit of Lake Olier window.	30 foot wide porphyry dyke strikes north 20 degrees east, quartz vein 2 feet wide parallel the regional schistosity.	Mineralization both in the porphyry and conglomerate quartz, calcite, rusty carbonate, and pyrite.	
350 feet northeast of the above.	Just south of a fault striking east strong schistosity striking northeast and dipping 75 degrees northwest in the porphyry.	Pyrite in the schistose porphyry and a few quartz veinlets some with carbonate and a few specs of chalcopyrite.	Very deep pit almost a shaft in part caved.
South side of old highway 46 over Kekeko Hills, east of the junction with new highway 46.	Strong shear zone along north side of the outcrop.	No mineralization apparent.	
350 feet southwest of above.		Quartz, carbonate, tourmaline, and pyrite.	
Along horizontal projection of the diamond drill hole just west of 46.	Flat quartz veins strike east and dip 20 degrees north.	Quartz, calcite, and a little chalcopyrite in vugs.	
300 feet east of above locality.	North contact of a body of porphyry strong schistosity.	Carbonate and a few specs of chalcopyrite.	
250 feet east of the above locality.	Pit crosses porphyry sediment contact.	Porphyry well fractured and mineralized with pyrite.	Very large pit over 50 feet long now largely caved.
350 feet east and south of above locality.	Light coloured porphyry or granite similar to the most southerly outcrop on the west side of highway 46.	Quartz, minor pyrite, and chalcopyrite,	
Most southerly pit indicated near the southeast extremity of the Lake Olier window.	Test pits largely in white porphyry similar to that at occurrences above, porphyry trends near north-south and fracturing trending north and dipping west.	Porphyry well fractured and mineralized minor pyrite and chalcopyrite.	
200 feet northeast of above.	Quartz vein several feet wide striking north.	Minor pyrite in chlorite seams in the quartz vein.	
450 feet northwest of above.	Quartz vein striking 20 degrees south of east and dipping 85 degrees south cutting coarse porphyry.	No mineralization apparent in the vein which is a weak pegmatite.	
At the contact of the Cobalt with Temiskaming near east end of Lake Olier window.	Schistosity in the Temiskaming conglomerate strikes 35 degrees south of east and dips 30 degrees north.	Small amount of pyrite in the Temiskaming conglomerate.	
150 feet southwest of the above locality.	Coarse porphyry cut by a finer aplitic type.	Sparce pyrite and carbonate.	A number of large pits over 10 feet deep.

and pyrite. West of the shaft on the south side of the small lake a pit exposes highly fractured porphyry mineralized with pyrite and a few veinlets of quartz. Also worthy of mention is the pit 250 feet northeast of the shaft on the south side of a strong shear zone mineralized with pyrite striking northeasterly along a prominent valley. A pit just west of highway 46 in the central part of the window is on quartz stringers containing calcite, chlorite, green tourmaline, and a little pyrite. The mineralization in other pits west of highway 46 appears less interesting than the above and is mainly quartz, specularite with minor carbonate.

Gold Showings in the Lake Olier Window East of Highway 46.

Quite extensive surface work in the form of test pitting and a limited amount of diamond drilling has been done in this area. Unfortunately assays from samples taken are not yet available. The pits in this area are described in Table 3 and have all been indicated on the accompanying map.

Summary and the Writer's Suggestions Regarding Exploration.

Very little mineralization was noted in the Pontiac rocks east of highway 46, narrow and very continuous acid sills have adjacent to them silicified Pontiac rocks with accompanying carbonate, tourmaline, pyrite, and in places molybdenite. The limited prospecting on these sills, as evidenced by pits, apparently did not meet with success and samples taken by the writer did not carry gold, however it is obvious that not all these mineralized sills have been prospected or sampled.

None of the molybdenite occurrences at present visible in the area appeared worth further work. The occurrences not listed in Table 1 are in Table 2.

In the eastern portion of the area it is possible north-south faults indicated might have mineralized zones in or associated with them similar to the north-south vein at the New Norzone property in Montbeillard township, lying about a mile south and slightly east of the map-area.

Another structure perhaps worthy of some consideration is the Davidson Creek ? fault. South of Lake Donez surface work was done many years ago on the window of ultrabasic adjacent to this fault. The ultrabasic here is a chlorite talc schist carrying up to 10 percent quartz stringers with some carbonate and a small amount of pyrite. Two samples taken by the writer assayed gold nil . However not all the limited amount of outcrop which is mineralized throughout at this locality was stripped or sampled. Regarding this fault it is interesting to note that in it or an associated structure is a zone mineralized with chalcopyrite, about half a mile east of the map-area near the mouth of Olier Creek indicated by pit symbols on G.S.C. map 49-25.

The structural control of the most significant mineralization discovered in the area to date, the number 1 vein at the Cran-Kor Mines property, can be explained by the change in attitude i.e. strike and or dip. For sake of simplicity consider these independently, although in all probability they both exerted control. Considering the change in strike a horizontal movement on the vein fracture of northwest side south would produce an opening and the best part of the vein south of the curve in it as is the case. Considering the change in dip which is near 90 degrees at the bend and 75 degrees at the south limit of the vein a movement of west side upward would tend to produce best opening and vein section south of the bend.

The majority of veins on the Cran-Kor property strike 25 degrees east of north i.e. about parallel to a major fault lying west of most of the mineralized localities. Some mineralization is adjacent to this fault hence there is a possibility veins throughout the property are related to this fault and as a prominent drift filled valley lies along the fault it would seem worth some prospecting by drilling. In regard mineralization on the Cran-Kor property certain points may be worthy of mention. The mineralization is in veins, replacement has been limited, the wall-rock carries no mineralization or even disseminated sulphides. The veins tend to be in the more sandy and brittle rocks which have been silicified along the vein fractures prior to or during vein formation. The actual vein openings were formed by virtue of movement at irregularities in the fractures.

As far as geophysical prospecting is concerned magnetic methods are of little use as no magnetite or pyrrhotite accompanies the chalcopyrite mineralization, the only type of importance yet discovered. Graphitic slates and occurrences of graphite throughout the Pontiac group limit the use of electrical methods, of these even the spontaneous polarization or self potential method proved unsatisfactory on the Cran-Kor property.

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Key and explanation for Figure 2 - Statistical diagrams of structures in the southwest quarter of Beauchastel township. Comprises key showing details of circular diagrams (this page), 1 page of caption notes (A-V) and 3 separate pages of diagrams (A-V).

A — 304 poles to bedding in the Cowganda formation. Contours 15-10-5-3-2-1%.

B — 756 poles to joints and fractures in the Cowganda formation. Contours 5-4-3-2-1%.

C — 102 axes of soft-rock (penecontemporaneous) folds in Gowganda formation. Contours 8-6-5-4-3-2-1%.

D — 167 poles to joints and fractures in acid igneous rocks cutting the Pontia[c]. Contours 5-4-3-2-1%.

E — 20 poles to bedding in the Temiskaming conglomerate Lake Olier window.

F — 70 poles to schistosity in the Temiskaming conglomerate Lake Olier window. Contours 20-10 5-3-2-1%.

G — 55 long axes of pebbles and boulders in the Temiskaming conglomerate Lake Olier window. Contours 20-15 5-3-2-1%.

H — 80 axes of crenulations in the matrix of the Temiskaming conglomerate Lake Olier window. Contours 20-15 10-5-2-1%.

I — 319 poles to bedding in the Pontiac east of highway 46. Contours 10-5 4-3-2-1%.

J — 548 poles to cleavage in the Pontiac east of highway 46. Contours 20-10 5-3-2-1%.

K — 157 long axes of mineral grains in the Pontiac east of highway 46. Contours 30-15 10-3-2-1%.

L — 845 poles to joints in the Pontiac east of highway 46. Contours 7-6-5-4-3-2-1%.

M — 154 poles to bedding in the Pontiac west of highway 46. Contours 10-5 3-2-1%.

N — 367 poles to cleavage in the Pontiac west of highway 46. Contours 10-5 3-2-1%.

O — 27 long axes of mineral grains in the Pontiac west of highway 46.

P — 1157 poles to joints in the Pontiac west of highway 46. Contours 5-4-3-2-1%.

Q — 14 axes of drag folds in the Pontiac.

R — ~~55~~ 70 axes of east-west crenulations in highly micaceous beds of the Pontiac. Contours 15-10 5-3-2-1%.

S — ~~49~~ 36 axes of north striking crenulations in the highly micaceous beds of the Pontiac. Contours ~~15-5~~ ~~3-2-1%~~. 15-10-5-3%.

T — 242 poles to joints along which there was introduction of material resultin[g] in a resistant ri[dge]. Contours 15-10 5-3-2-1%.

U — 260 poles to quartz veins in the Pontiac south-west quarter of Beauchastel township Contours 10-5 3-2-1%.

V — 106 poles to fractures and veins containing lead and zinc and or copper sulphides in the Pontiac west of highway 46. Contours 15-10 5-3-2-1%.

Figure 2

Caption for Figure 2

No.	Structure	Area	Group or Formation	No. of Readings	Contours %
A	poles to bedding	Portion mapped	Gowganda	304	15-10-5-3-2-1
B	poles to joints and fra ctures	Portion mapped	Gowganda	756	5-4-3-2-1
C	axes soft-rock folds	Portion mapped	Gowganda	102	8-6-5-4-3-2-1
D	poles to joints	South of Gowganda formation	acid intrusive rocks	167	5-4-3-2-1
E	poles to bedding	Lake Olier window	Temiskaming conglomerate	20	- - - - - - -
F	poles to schistosity	Lake Olier window	Temiskaming conglomerate	70	20-10-5-3-2-1
G	long axes pebbles and boulders	Lake Olier window	Temiskaming conglomerate	55	20-15-5-3-2-1
H	axes of crenulations	Lake Olier window	Temiskaming conglomerate	80	20-15-10-5-2-1
I	poles to bedding	East of highway 46	Pontiac	319	10-5-4-3-2-1
J	poles to cleavage	East of highway 46	Pontiac	548	20-10-5-3-2-1
K	long axes mineral grains	East of highway 46	Pontiac	157	30-15-10-3-2-1
L	poles to joints	East of highway 46	Pontiac	845	7-6-5-4-3-2-1
M	poles to bedding	West of highway 46	Pontiac	154	10-5-3-2-1
N	poles to cleavage	West of highway 46	Pontiac	367	10-5-3-2-1
O	long axes mineral grains	West of highway 46	Pontiac	27	- - - - - - -
P	poles to joints	West of highway 46	Pontiac	1157	5-4-3-2-1
Q	axes of drag folds	Entire map-area	Pontiac	14	15-10-5-3-2-1
R	axes of west striking crenulations	Entire map-area	Pontiac	~~55~~ 10	15-10-5-3-2-1
S	axes of "north" striking crenulations	Entire map-area	Pontiac	~~49~~ 36	~~15-5-3-2-1~~ 15-10-5-3
T	poles to joints along which there was introduction of material resulting in a resistant ridge	Entire map-area	Pontiac	242	15-10-5-3-2-1
U	poles to quartz veins	Entire map-area	Pontiac	260	10-5-3-2-1
V	poles to veins and fractures	West of highway 46	Pontiac	[illegible]	[illegible]

Figure 2 (1)

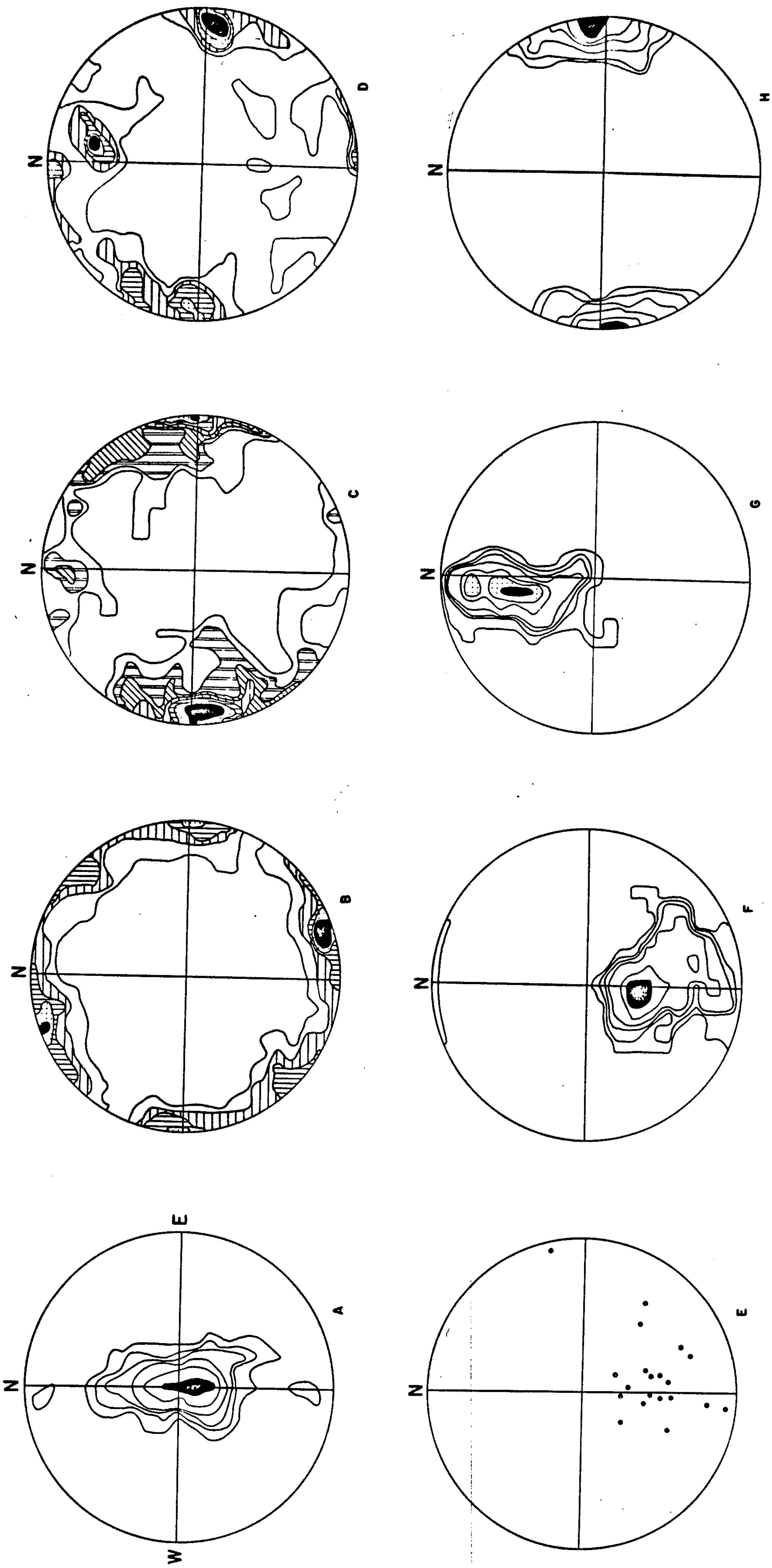

Figure 2 (ii)

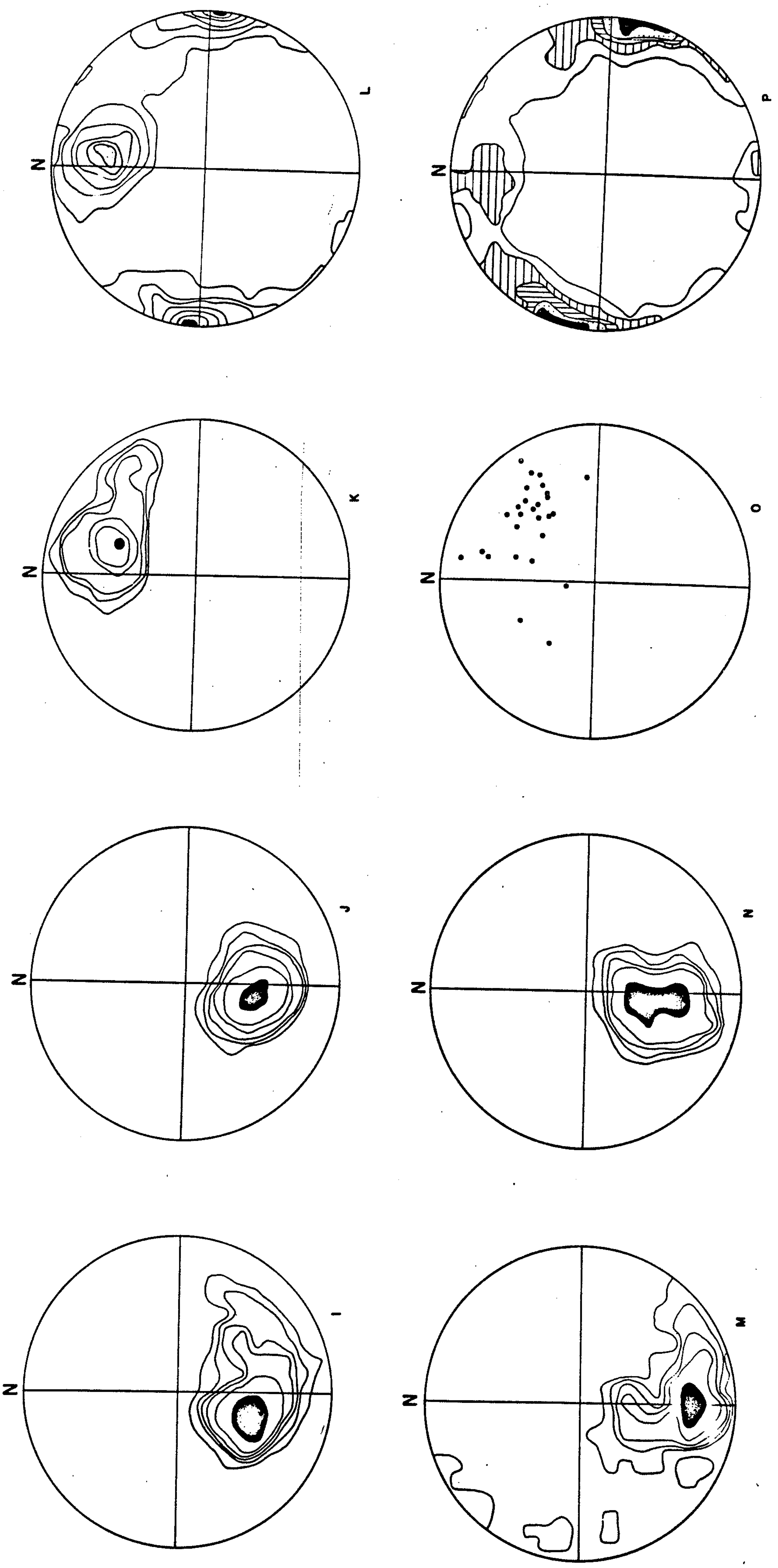

Figure 2 (iii)