A PETROGRAPHIC STUDY OF THE RELATIONSHIP OF THE TIMISKAMING TO GRENVILLE SUBPROVINCE

BY

WILLIAM GEORGE JOHNSTON

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ABSTRACT

A study of the granitic rock types along the Contact of the Timiskaming and Grenville subprovinces to the east of lake Timagami has been made. In the vicinity of the contact of the two subprovinces in the granites of the Grenville subprovince is a wide zone of faulting near which the rocks show wide spread cataclastic texture due to crushing. In this area the granite in the Grenville subprovince is very distinct from the Algoman granite of the Timiskaming subprovince and later than it. The granite in the Grenville subprovince is much fresher than the Algoman granite and unlike the Algoman is high in potash feldspar as determined by Rosiwal analyses. In the latter and other respects it strongly resembles the Killarney granite in Pardo and Dana townships and to the south along the north shore of lake Huron. In Sisk township it contains a rather rare amphibole hastingsite which is also found in the Creighton granite of Killarney age.

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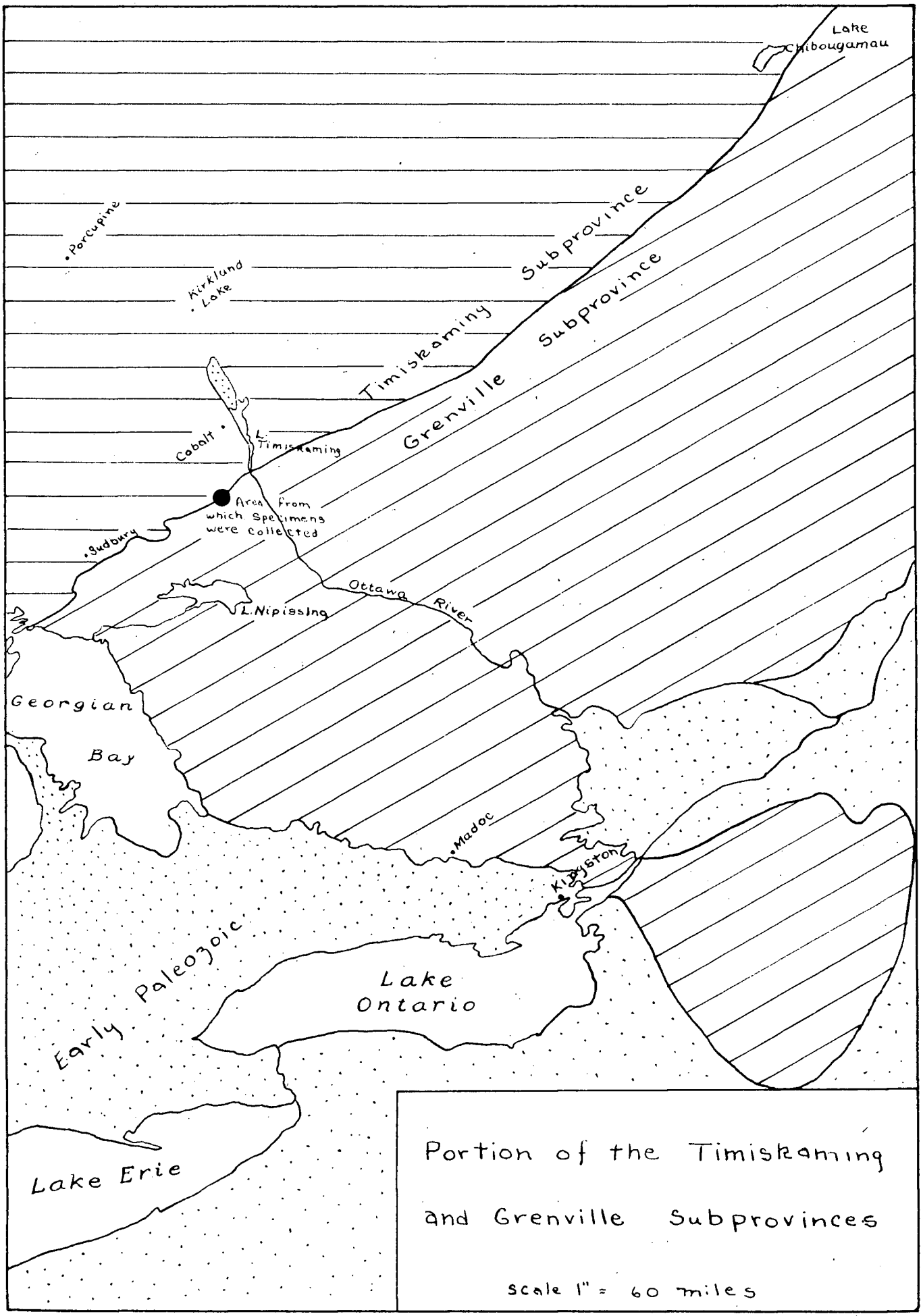
A PETROGRAPHIC STUDY OF THE RELATIONSHIP OF THE TIMISKAMING TO GRENVILLE SUBPROVINCE.

INTRODUCTION

The contact between the Timiskaming and Grenville geological subprovinces of the Canadian shield is a fairly straight line, trending north-east from Killarney on Georgian Bay to the foot of lake Timiskaming, and beyond as far as mapping has been carried out. (Figure, page 2.)

The northern portion of the Timiskaming subprovince is largely "granite" which contains in it bands of Keewatin and Timiskaming series closely folded along east west axes. In the Kirkland Lake area and to the east these series appear conformable; however at Porcupine there is a very definite unconformity, as also exists between rocks classed as Keewatin and Timiskaming in north-western Ontario. The Keewatin is predominantly composed of lava and pyroclastics interbedded with minor amounts of iron formation and clastic sediments. The Timiskaming series is made up of some conglomerate, clastic sediments and lavas. In the area to the north of lake Wanapetei and to the west of lake Timiskaming the above rocks are overlain by the Cobalt series composed of conglomerate, slate conglomerate, and slate overlain by quartzite. In the southern portion of the area the Stobie, Coniston and Hill groups may correspond to the Keewatin and Timiskaming. These rocks are thought to be pre-Huronian although this is not absolutely certain. The Stobie and Coniston groups to the south of the Sudbury basin are faulted


Lake Chibougamau
Porcupine
Kirkland Lake
Timiskaming Subprovince
Grenville Subprovince
Cobalt
L. Timiskaming
Area from which Specimens were collected
Sudbury
L. Nipissing
Ottawa River
Georgian Bay
Madoc
Kingston
Early Paleozoic
Lake Ontario
Lake Erie
Portion of the Timiskaming and Grenville Subprovinces
scale 1" = 60 miles

upward against the Bruce series the lowest member of the Huronian. The three members of the Huronian, the Bruce, Cobalt and Whitewater are separated by unconformities. Intrusive rocks are represented by the Nipissing diabase and the Sudbury nickel eruptive, both of which are cut by the Killarney granite. The latest igneous rock is an olivine diabase which is represented by small but wide-spread dykes.

TABLE OF FORMATIONS OF THE TIMISKAMING SUBPROVINCE

NORTHERN PORTION		SOUTHERN PORTION MODIFIED AFTER COOKE
	Keweenawan	Olivine diabase Trap (dykes) Killarney, Murray and Creighton granites Norite and Micropegmatite Whitewater series
	Period of erosion	
Olivine diabase	Upper Huronian	Olivine diabase Birch Lake Granite?
Nipissing diabase	(Animikie)	Nipissing diabase
	Intense folding possibly granite intrusion.	
Cobalt Series	Middle Huronian - Cobalt Series	
	Unconformity	
	Lower Huronian - Bruce Series.	
	Pre-Huronian	
Matachewan diabase		
Algoman granite Intense folding	Granite intrusion, probably folding	
Timiskaming Series		Stobie Group,
Local unconformities		Hill Group
Keewatin		Coniston Group.

A detailed account of the geology of the Grenville subprovince will not be attempted here. It will suffice to say the rocks of that series in the area under discussion are composed of biotite and hornblende gneisses which have in some places been intimately intruded in lit-par-lit fashion by granitic material. Gneissic, pink and grey granites occur at Martin river and especially along the contact between the two subprovinces.

The southern portion of this contact is of particular interest. To the east of it the Huronian sediments which continue 500 miles to the west and reach thicknesses of 23,000 feet suddenly disappear diagonally across their strike against a great area of granite gneiss separating the rocks of the Timiskaming subprovince from those of the Grenville and Hastings series, occuring in greatest profusion some 150 miles to the south-east. Attempts to correlate the rocks across this area have so far failed as the sedimentary remnants in this intervening granite are too highly metamorphosed. Since a correlation of the sediments is impossible the relative ages of the granite in each subprovince might shed some light on the relative ages of the other rocks. All previous work toward solving this problem has been done from Georgian Bay as far north as Sudbury. The work done by the writer is based on field work farther north-east along the boundary of the two subprovinces in the vicinity of the trans-Canada Highway and the Timiskaming and Northern Ontario Railroad.

SUMMARY OF THE LITERATURE

Many correlations between the Grenville and Timiskaming subprovinces have been proposed. In 1907 Miller* (1) page 49 and (3) page 221-223 states that he considered the Keewatin iron formation at Cobalt part of the Grenville series which was much better developed in southeastern Ontario and in the adjacent parts of Quebec. He considered the overlying Hastings series in south-eastern Ontario as being similar to the Huronian. Miller and Knight (3) page 281 and 1913 (4) set forth much the same correlation. They correlated a series of volcanics in the Madoc district with the Keewatin. They believed the Grenville series overlay the Keewatin and the two were separated by an erosional unconformity. Both had been intruded by the Laurentian granite and were overlain unconformably by the Hastings series later intruded by the Algoman granite. Geologists (5) for some years followed this classification. The granite which had intruded the sediments in lit-par-lit fashion was called Laurentian while that in larger dykes and stock like masses was called Algoman. Later work by Wilson (6) and Harding (7) has shown that the Grenville and Hastings are really a conformable group and that there is probably only one granite in the Grenville subprovince.

While the controversy over the age relations between

* References refer to the bibliography, page 40

the Timiskaming and Grenville subprovinces was taking place the fact that a post Huronian granite existed on the north shore of lake Huron was established. Murray (8)had described a post Huronian granite in 1849. Later geologists discredited his observations; and it was not until 1925 that Collins showed Murray's observations were the actual case.

The only real endeavour to solve the problem of the relationship between the two subprovinces was carried out by Quirke and Collins (9), who mapped a large area on the north shore of lake Huron from Killarney east and northward to lake Nipissing. Collins and Quirke conclude the Killarney granite extends eastward from Killarney at least to lake Nipissing. They consider there is some reason to believe that the granite of the Grenville subprovince may be Killarney in age. According to their observations the Killarney granite is in sharp intrusive contact with the Huronian sediments (eastern extremity of the Timiskaming subprovince). This contact has been the locus of a great fault with displacement east side up. The area to the south east of this fault constitutes one of the deepest horizontal sections anywhere exposed on the earth's crust. To the south-east of this contact line are found remnants of the Cobalt and Bruce series which can be unmistakenly correlated with the unmetamorphosed Cobalt and Bruce series to the west up to five miles from the granite sediment contact. Beyond this the highly metamorphosed character of the remnants makes definite correlation impossible. The profound metamorphism of these remnants is due to

the depth of burial and high temperatures. The contact aureoles around isolated masses of Killarney granite are very minor. The gneisses are composed of Huronian sediments transformed to granitic material by pressure, heat and chemical change operative at great depth. The evidence they give for this is: (a) The minerals are crowded with inclusions and there is (b) a very close similarity in the chemical composition between the "intruding" and intruded material, (c) the quartz grains of the igneous portion of the gneisses and of some granite have a detrital appearance.

They explain the unconformity produced by the northwest trend in the gneisses near lake Nipissing as being due to radiating folds from a centre near Burwash.

They show that age determinations on radioactive minerals from the Killarney intrusives and the Grenville subprovince appear to agree fairly closely. The suggestions put forth by Quirke and Collins that the sedimentary portion of the Grenville subprovince is Huronian has been questioned by some geologists. Wilson's(10) objections are as follows:

"1. The belt of banded gneisses that occurs on the shore of Georgian Bay between Killarney and Parry Sound continues north-easterly to the south end of Lake Timiskaming and beyond for many hundreds of miles, whereas the Killarney granite as shown by its intrusive relations to the Huronian Cobalt series terminates east of Lake Wanapitei, almost midway between Georgian Bay and Lake Timiskaming. If the Killarney granite terminates in a north easterly direction, is it not probable that it terminates in a south-easterly direction as well?

2. If the Killarney granite were intruded into a belt of banded gneisses it would almost certainly inject itself along their planes of foliation and banding so that its contact would be transitional just as Quirke and Collins have described.

3. The Grenville series, throughout most of the Grenville subprovince, except in local areas around the margins of some batholiths, consists of interstratified crystalline limestone, massive quartzite resembling vein quartz in appearance, and sillimanite garnet gneiss having the texture of granite but the chemical composition of pure shale. As one proceeds northward into the belt of banded gneisses that separates the Grenville from the Timiskaming subprovince the presence of Grenville sediments is indicated by areas of tremolitic limestone, bands of quartzite containing feldspar crystals along minute fractures and belts of garnet gneiss. The banded gneisses in the intervening areas as shown by chemical analysis have the composition, for the most part, of normal granite or in places of diorite and there is little in their chemical compositions to indicate that large amounts of Grenville series have been transformed directly into granite or granite gneiss in the manner that Collins and Quirke believe to have occurred in the case of the Huronian of the Killarney district.

4. If a large part of the granite of south-eastern Ontario or of the belt of banded gneisses of Killarney age and the Killarney granite was intruded during the Keweenawan then this region was mountain-built and denuded to a peneplain in the interval that elapsed between the Keweenawan and the early Palaezoic, when the sediments of this age that now rest on the surface of the Pre-Cambrian were deposited. It is doubtful whether all this could occur in so short an interval of time.

5. The Keweenawan, according to the report of the Committee of the United States Research Council on the measurement of geoligic time, ranges in age from 510 to 550 million years. The age of the granites, or pegmatites associated with granite, in south-eastern Ontario in 17 out of 20 analysis of uraninite as tabulated by Ellsworth range from 985 to 1,125 million years. Three analyses of uraninite in Henvey township, within the area mapped by Quirke as Killarney, gave ratios equivalent to 835, 792 and 792 million years respectively. Ellsworth states that the Henvey "material is not in the best stage of preservation, but nevertheless its ratio is so much lower than any of the other uraninites that it must be considered as probably really younger". ..... According to these determinations, therefore, the granites of south-eastern Ontario with the possible exception of those in Henvey township were probably intruded during the late Archean and are not of Killarney age".

In a recent publication Cooke (11) also seems to disfavor Quirke and Collins views although admitting the presence of a post Huronian granite. He says; (11) page 6,

"The writer has discovered two remnants of pre-Huronian formations, which he terms the Hill and Coniston groups. Their position in the stratigraphic column is otherwise unknown, but the discovery of the Coniston group may have an important bearing on the problem". Further he points out, (11) page 11, " .....They (chert bands in the Conistan Group) do seem to resemble the published descriptions of the so-called "iron formation" of the Grenville series in south-eastern Ontario.

He also says (11) pages 16, 17, and 18; "the discovery of these rocks and their relations has a direct bearing on the conclusions announced by Quirke and Collins in "The Disappearance of the Huronian". In that work these authors decide that certain remnants of sediments found in the granite here and there between Killarney village and Delamere township are remnants of Huronian formations. They base this conclusion, very soundly, on the fact that the petrographic character of these much metamorphosed remnants is such that they could have been formed from the different members of the Huronian system; and that where two or more members are found, their succession is the same as in the unmetamorphosed Huronian succession.

"It will be observed that the remnants they describe lie only about 24 miles south of the contact described in this report. The writer made a cross-section from the contact to Wanup Station, a distance of 6 miles, and within that distance all remnants of sediments belong indubitably to the Coniston group, and all dip to the south. Throughout that distance, again, there is continuous evidence of up-thrusts from the south."

"These two factors oppose one another, in considering what may have happened in the remaining 18 miles to the sedimentary remnants described by Quirke. If the southern dip is continued, it is quite possible that within that distance some stratigraphically overlying series may come in, and that series could well be of Huronian age. On the other hand, the continuing uplift on the south, due apparently to batholithic injection from below, by tilting the whole region upward from a hinge line on the Coniston-Mississagi contact would cause the Coniston group to continue much farther to the south than it normally would, and might even eliminate entirely the younger strata. Only a further study of this interesting section could discover what actually happened; in the meantime it would be best to regard Quirke's conclusions as tentative, and possibly subject to revision".

Pettijohn (12) has made a pertinent remark which has direct bearing on this problem. He says;

"One of the most striking features of the Archean is the singular scarcity of true quartzite and almost total lack of limestone. The Grenville, considered Archean by some, contains both limestones and quartzites .... If it be Archean, it represents a very different species of sedimentation than the Archean sediments" (of northern and northwestern Ontario).

In northern Quebec Gussow (13) has correlated a granitic mass well within the Timiskaming subprovince with the granite of the Grenville subprovince on the basis of chemical composition. This would indicate that careful study might bring more such granite masses to light which would be of great importance in the solution of the age relationships between the two subprovinces.

The only other description of an intrusive within the Timiskaming subprovince which might be suspected of belonging to a period of acid igneous activity other than the Algoman and Laurentian has been described by Miller (1) page 65 at Cobalt.

"Two thin rock-sections examined show it to be made up of feldspar, quartz and a colored constituent. The feldspar predominates and consists of microcline, and an acid plagioclase showing fine albite twinning lamellae. .... The colored constituent is not abundant. It was apparently a mica, but is now represented by chloritic material. This dyke is not unlike certain small dykes in the Montreal River area (James township etc.) known as apalites. The latter are, however, generally under eighteen inches in width, while that on the University property averages about fifty feet."

The foregoing is a brief summary of the broader phases of the problem chiefly from a point of view of the area from Killarney to Sudbury. The area under present consideration was first mapped in a rapid reconnassance manner by A.E. Barlow. He writes (14);

"The granite on both sides of lake Timiskaming appear to

grade gradationally into gneissic forms. The latter show many variations, and often pass abruptly from diorite-gneiss into granite-gneiss, the latter being by far the most prevalent type."

In this same work Barlow describes the large mass of Nipissing like diabase in Flett and Angus townships which he believed older than the surrounding gneiss.

Todd (15) in a much later work says;

"In the southern granite area (south east of Rabbit lake and the Matabitchuan river) ..... the three or more ages or generations of granite and granite gneiss and pegmatite present have been greatly brecciated and intermixed by fault movements."

Todd believes the Cobalt sediments overly all three ages of granite. Bruce (16) has mapped a granite in Pardo and Dana townships which he considers to be Killarney. Quartz biotite gneisses apparently similar to those in the townships of Olive, Milne, Flett and Sisk he assigned tentatively to the Sudbury series. Fairbairn (17) from work in the townships of Scadding, Davis, Street and Longhrin considers the rocks classified as Sudburian by Bruce are Cobalt sediments which have been granitized at great depth and are separated from the ungranitized sediments by a fault whose displacement is east side up.

From the foregoing it is seen there are various possibilities for the age of the granite of the Grenville subprovince in the area adjacent to the Timiskaming subprovince. These are:

1. Pre Keewatin
2. Laurentian (post Keewatin and pre Timiskaming)
3. Algoman
4. Killarney.

No granite has as yet been identified as pre-Keewatin in the Timiskaming subprovince. It seems improbable that such a large area of pre-Keewatin granite could exist without some evidence of its presence. However, a pre-Keewatin granite would explain the presence of granite pebbles in the Timiskaming conglomerates which are apparently conformable in some areas with the Keewatin better than a Laurentian granite for which there is little if any evidence. An Algoman granite would not entirely explain the disappearance of the Huronian. Even a great uplift along the eastern side of the contact of the two subprovinces would hardly account for removal by erosion of the Huronian sediments to the last remnant. Huronian sediments must have overlain a great portion of eastern Canada at one time. Rocks at Lake Mistassini and the Belcher Islands are probably Huronian. A series of sediments in Northern Quebec can be correlated with the Huronian of lake Superior with considerable certainty. Some of these rocks of Huronian age have been intruded by granite.

The absence of Huronian sediments to the east of this line between the Grenville and Timiskaming subprovinces can be explained by widespread intrusion of a Killarney granite and later uplift of the east side and erosion leaving only plutonicly metamorphosed sediments.

PRESENT WORK

The present work was carried out in an area that presents a number of advantages. Unlike the areas to the south there

is present here a granite (Algoman) which is pre-Cobalt. This allows a direct comparison between the granite of the Grenville series and a granite considered Algoman in the Timiskaming subprovince. If the granite in the Grenville subprovince is Algoman in age it should be possible to point out the similarity. Although the country is heavily wooded and outcrops scarce, fresh rock cuts along the trans-Canada highway provide excellent facilities for close examination.

The field work done was rather brief, being carried out in two weeks. It consisted of a fairly detailed examination of the geology and collections of specimens for laboratory study along the highway and the Timiskaming and Northern Ontario Railroad. A traverse of Olive, Opechee Bays and Opechee lakes was also made.

FIELD OBSERVATIONS

Timiskaming Subprovince.

The relationships between the two subprovinces have been complicated by the presence of faults of rather large displacement. There has been considerable post-Cobalt movement. The Cobalt series everywhere has steep dips and in some places has been intensely sheared. Otherwise it is fresh and shows no sign of being intruded by granite.

The granite on the Timiskaming side of the subprovince is at least of two ages or generations. A light grey granodiorite is cut by a pinkish syenite, (figure 1). Both are coarse grained, contain plagioclase and the mafic mineral appears to be hornblende. There is a very little mafic

mineral present in the pink type. Both types were later almost everywhere broken into blocks from ten to twenty feet to a side. Movement has taken place shifting the blocks about in a most complicated manner. Slickensides are present on the blocks but no mineralization or hydrothermal alteration has taken place along the fractures with the exception of some epidote noted at a couple of localities along a set of fractures striking N 60° W. A few trap dykes up to four inches wide occur in some fractures. The pink type of syenite becomes more plentiful to the south east until finally it completely replaces the grey granodiorite.

Contact Zone

The actual contact between the two subprovinces is a fault or usually a series of steep dipping faults. The faults usually consist of a hundred feet or more of highly sheared granite consisting of quartz eyes in a micaceous matrix. The displacement along these faults has been considerable judging from the deformation. Slickensides indicate an almost vertical movement with the east side moving up relative to the west. Another type of fault which may be considerably younger was observed at Pan Lake. It dipped about 40° E and consisted of about four feet of loose brecciated material similar to the granite gneiss of the hanging and foot walls. From the disposition of the fragments, movement along it seemed to be east side up.

Grenville Subprovince

When this fault zone is crossed at Pan lake, dark green biotite gneisses occur to the south-east. They consist of a

high proportion of biotite imparting a glistening to cleavage surfaces. Quartz seems to be the only other mineral present. In many places these gneisses have been intimately injected by granite stringers although granite in the form of dykes or other regular shaped bodies is non-existant. The granite occurs in bodies that pinch and swell. (figure 2). The biotite gneisses give way locally to minor bodies of feldspar gneiss up to 100 feet wide and elongated in the direction of strike of the biotite gneiss. (figures 3 and 4). A very marked feature of these gneisses is the presence of bedding or banding. The intricate crumpling of this structure would seem to indicate bedding rather than igneous banding.

In a feldspar gneiss along the highway 300 feet south of the Olive, Sisk township boundary is an inclusion which can be definitely identified as a metamorphosed slate cut by minute veinlets of epidote. This slate contains small flattened, lenticular unconnected masses of granite up to six inches long which are parallel to the schistosity of the enclosing rock. A considerable number of these inclusions were obtained by breaking the enclosing rock along the cleavage plains. In no case were they found to be connected. The nearest exposed granitic material is over 200 feet from this particular outcrop. This inclusion appears to have been a slate conglomerate similar to those of the Cobalt series. Unfortunately the granitic pebbles are too highly crushed to identify the original texture of the rock or its minerals in thin section.

These facts would seem to indicate these rocks are paragneisses which have undergone metamorphism at great depth. The general strike of these rocks is north-east although the ptygmatic folding present leads to considerable variation. The dips are even more variable than the strikes but are in general south-east.

The granite in the Grenville subprovince is a biotite granite with varying proportions of biotite, quartz and feldspar. The cleavage faces of the feldspar have a much brighter luster than those in the Algoman granite. Just south of Martin river on the highway there occurs a large granitic intrusive, the only one of any size seen in the Grenville area. It has a very marked primary gneissosity striking north-east. It appears to be a composite intrusive; the north-west margin is made up chiefly of biotite orthoclase and quartz. The central portion is biotite granite with orthoclase crystals up to two inches long. Associated with it are pegmatite dykes containing mica, quartz and orthoclase crystals up to three inches in diameter.

LABORATORY STUDY

Algoman Intrusives.

These are medium grained rocks composed largely of plagioclase, hornblende, quartz, and occasionally biotite, potash feldspar as microcline and orthoclase was observed in only one section. Accessory minerals are zircon, apatite, pyrite, and titanite. These rocks although considerably altered show no sign of deformation. The quartz grains in some slides show

strain shadows. The plagioclase is very uniformly altered as much as seventy percent (figures 5 and 6) to secondary minerals zoisite, sericite, epidote, and minor chlorite and carbonate. The hornblende is almost entirely altered to magnetite and frayed mats of chlorite. The biotite has also altered to chlorite, the asterism of the biotite remaining in the chlorite. The chief compositional variations in these rocks are in the proportion of quartz present. Those with a high proportion of quartz have a plagioclase of composition Ab95 An5 while those with a low quartz content have a higher proportion of hornblende and the plagioclase is near Ab60 An40. Hence they vary from granodiorites to quartz diorites.

INTRUSIVES IN THE GRENVILLE SUBPROVINCE

These rocks show much greater variation than the Algoman types although they have strong resemblances which indicate they are all very closely related. The most common minerals are quartz, potash feldspar and minor plagioclase. The potash feldspar occurs most commonly as microcline, (figure 7) The plagioclase is usually albite around Ab92 An8 varying to Ab85 An15. In many sections the plagioclase and orthoclase and rarely microcline contain inclusions of muscovite. Inclusions of biotite are sometimes present in the plagioclase. It is significant that a gneiss (figures 3 and 8) formed from the recrystallization of sediments has this same feature.

Biotite and muscovite are usually the only mafic minerals other essential present and rarely make up more than six percent of the rock. Pleochroic haloes are common in the biotite, occurring most

commonly in the biotite of the gneisses. They have diameters up to 0.08 mm. They almost always occur in partings following the cleavage of the biotite. In the granitic rocks they are most common where the rocks have suffered dynamic metamorphism. Here they reach diameters up to 0.06 mm. In one slide the nucleous was definitely identified as zircon. The normal biotite shows the characteristic pleochroism light yellow to dark brown. Some biotite has been bleached and is only slightly pleochroic but unlike the above shows high interference colors. Around Red Water lake the rocks have suffered considerable dynamic metamorphism, and the biotite has been to some extent altered to green biotite, epidote and chlorite. Moscovite is present in very small flakes usually with random orientation in the plagioclase. Closely associated with the biotite and muscovite is epidote which appears to have formed as a deuteric mineral.

The feldspars are extremely fresh. Where extensive deformation has occurred there is considerable alteration to sericite, chlorite, with some epidote and carbonate. This alteration has taken place along minute shear planes. The red coloration of the potash feldspar in hand specimen is due to hematite as some is visible in minute cracks and around the margins of the potash feldspar grains under the microscope.

The large granitic intrusive mass in Sisk township (figures 7, 9,) previously mentioned has a slightly different assemblage of minerals. The biotite present is dark green in color. The amphibole hastingsite is present. Titanite often

makes up to fifteen percent of the rock. A very minor amount of carbonate is present as a primary mineral. Other minerals identified are zircon, apatite, epidote, magnetite, pyrite and pyroxene. The few grains of plagioclase present are usually altered to chlorite, a yellow powder and sericite. The feldspar is over seventy five percent potash feldspar chiefly microcline. The pyroxene is altered to chlorite.

DIFFERENCES BETWEEN THE ALGOMAN AND THE GRANITE OF THE GRENVILLE SUBPROVINCE

The most striking petrographical difference between the two rock types is in the alteration (figures 5 and 6 show the characteristic alteration in the Algoman intrusives). The plagioclase feldspar of the Algoman intrusives is uniformly and quite highly altered. Comparison with any of the illustrations of the granite of the Grenville subprovince will illustrate this difference. The only extensive alterations in the feldspars of the Grenville subprovince intrusives is near zones of dislocation. The inclusions in the feldspar of these rocks are chiefly muscovite which have sharp contacts against the feldspar.

Minor differences are the absence of pleochroic haloes in the biotite in the Algoman and their presence in the Grenville intrusives. Asterism is present in the biotite of the Algoman while absent in the Grenville intrusives. In contrast to the structureless Algoman the Grenville type intrusives usually have a primary gneissic character (figure 9). The frequent occurrence of cataclastic textures (figure 10) in the Grenv-

ille type and their absence in the Algoman has already been pointed out.

COMPOSITIONAL DIFFERENCES

If granites of more than one age are present in the area compositional differences should be apparent if they exist.

It is a well established fact that granite intrusives of the Algoman revolution are extremely low in potash. Rocks of similar types belonging to the Killarney revolution contain considerable potash. Moore and Armstrong (18) have also noted this:

"The Killarney granite shows in thin section that the feldspar is mainly orthoclase with a little albite. This is in contrast to the Algoman granite, which contains a much higher proportion of sodic plagioclase."

Quirke and Collins (9) page 102 point out,

"These gneisses and granite, which are termed Killarnean, are characterized throughout the map area by certain strong family resemblances which facilitate identification. They are notably low in iron oxides, lime, and magnesia, and high in alkalis, with soda and potash in a ratio of about 2 to 3. They contain a high proportion of potash feldspar to plagioclase and they are red in color, varying from pink to deep salmon. The Killarnean granites that are intrusive in the Huronian at various places farther west along the north shore of lake Huron also posses these characteristics."

The following tables (page 22) represent chemical analyses taken from the literature and recast to Rosiwal analyses for comparison with Rosiwal analyses (page 23) carried out on representative specimens collected in the field by the present writer.

It can be readily seen from a study of the analyses presented and diagram page 24 that the chemical compositions of the two granitic types under study are very similar.

to those of the Algoman and Killarney granites in other areas.

In addition to the outstanding difference in the composition of the feldspar and the lack of amphibole in the Grenville intrusives and its consistent occurrence in the Algoman it is worthy of note that the only amphibole in the Grenville specimens studied was in the number 41 specimens from Sisk township. This amphibole is hastingsite while the only amphibole in the Algoman is hornblende. Also the Grenville intrusives are very much lower in mafic minerals than the Algoman. A comparison of Rosiwall analysis made will make this evident.

MINERAL COMPOSITIONS (VOLUMETRIC) CALCULATED FROM CHEMICAL ANALYSES

	KILLARNEY					ALGOMAN	
	A	B	C	D	E	F	G
Orthoclase	41.6	28.4	32.3	30.01	30.1	15.9	3.90
Albite	17.1	27.9	23.4	26.1	27.2	30.5	32.2
Anorthite	1.9	8.53	7.1	6.8	1.52	17.6	5.56
Quartz	34.1	28.3	32.6	32.2	37.9	10.5	37.5
White Mica	1.4	.96					
Biotite	4.0	5.63	2.5	4.74	3.3		
Magnetite	0.5						
Titanite	0.1						11.8
Hornblende			2.0			25.2	
Sericite							8.07
Totals	100.7	99.8	99.9	99.9	100.0	99.7	99.1

A. Analyses II and IV Page 51 Memoir 160, Killarney granite from Killarney Bay, Ontario
B. Analyses III and VII Page 51, Memoir 160, Gneiss close to Killarney granite in character from Killarney, Ontario.
C. Analysis No. VI Page 90, Memoir 160, Creighton granite, Snider township.
D. Analysis No. V Page 20 Memoir 160, Birch lake granite, Hyman township.
F. Page 15 Ont. Dept of Mines, Vol. XXXIV Part III 1925, McDonald lake, South Lorrain township.
G. Page 11, Ont. Dept of Mines, Vol XXXV part III 1926, James lake, Best township

ROSIWAL ANALYSES - (volume per cent)

	KILLARNEY	KILLARNEY ?			ALGOMAN			
	KILLARNEY S107	41C	26	6A	5	6C	48B	8
Potash feldspar	49.2	72.2	55.5	65.0	2.8	--	5.30	--
Albite (feldspar)	9.24	5.17	5.52	10.4	34.7	42.0	46.6	65.9
Anorthite (feldspar)	.86	.49	.78	1.48	21.9	8.8	2.7	7.7
Quartz	35.1	13.6	21.4	21.7	28.6	7.44	24.8	4.3
Hornblende					12.0	31.0	20.0	21.1
Biotite	.86	6.84	14.2			9.7		
Muscovite	4.74							
Apatite						0.86		1.15
Titanite and Apatite		1.9						
Garnet and Apatite							1.25	
Garnet and Biotite				2.4				
Epidote			2.6					
Totals	100.0	100.2	100.0	100.0	100.1	99.8	100.7	100.2

S107 Lot 8 Con VI Dana township

41 C Martin lake Sisk township

26 Red Water lake Askin township

6 A Askin township

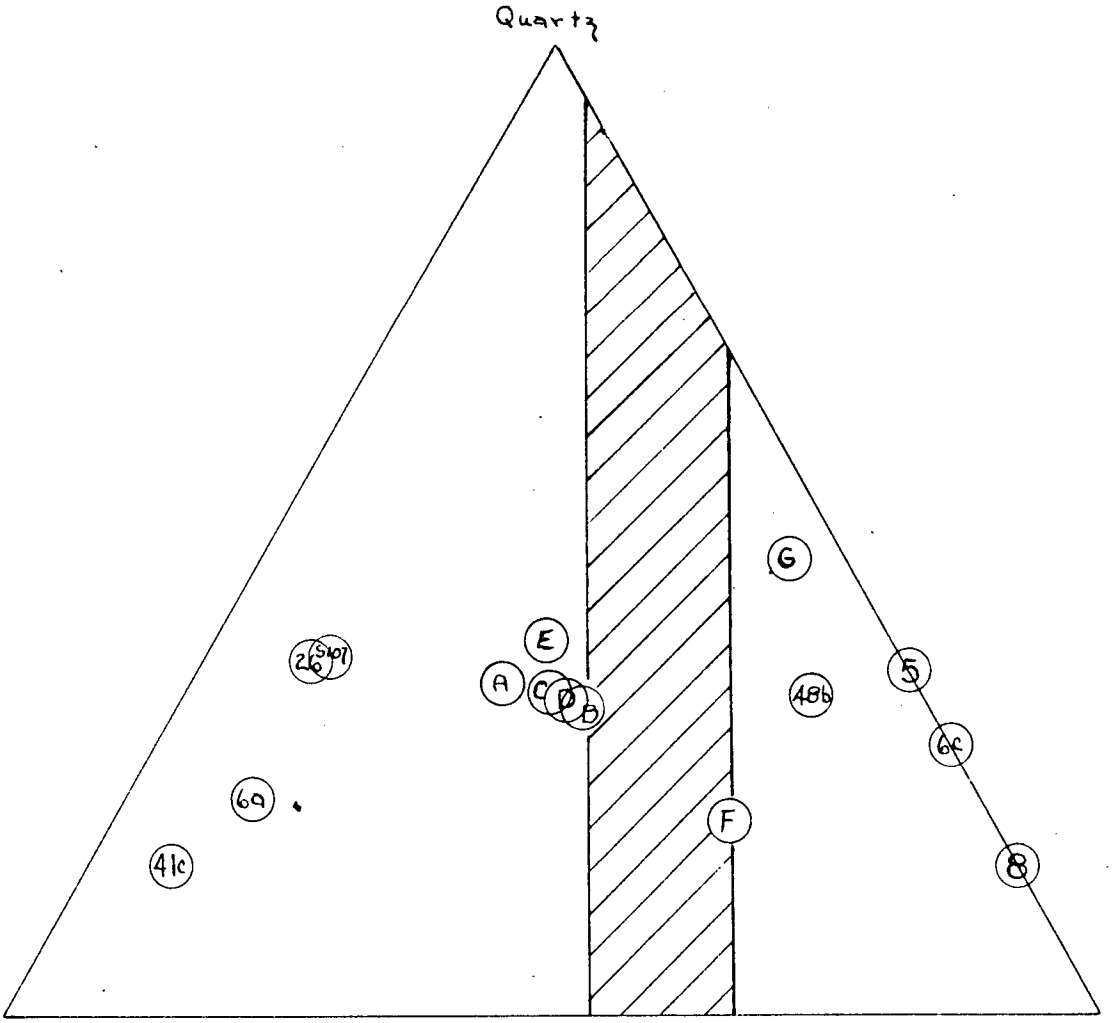
5 Askin township

6 C Askin township

486 Law township

8 Askin township

Plot of the foregoing analyses to show the difference in potash feldspar content in the Algoman and Killarney intrusives.



The Killarney fall into a group on the left and the Algoman one on the right, separated by a considerable compositional gap (crosshatched). B is 28·4 % potash feldspar and 36·4 % plagioclase feldspar. F is 16 % potash feldspar and 48 % plagioclase feldspar.

RELATIONSHIP BETWEEN THE ALGOMAN AND GRENVILLE INTRUSIVES

Microscopic study has shown that a syenite (page 13) originally believed to be a later generation of the Algoman (figure 1) corresponding to one described by Todd (15) to the north is really a part of the granite of the Grenville subprovince. The reason for this belief is that it corresponds to the Grenville type intrusives in petrographic character and composition (see analysis 6A page 23). This simplifies the relationship between the two subprovinces in that the faulting (page 14) mentioned is confined to the Grenville subprovince side of the contact leaving the granitic types of the Grenville in intrusive contact with the Algoman of the Timiskaming subprovince.

Along this intrusive contact the potash feldspars of the Grenville type intrusive replace the plagioclase feldspar of the Algoman (figure 11). During this replacement the microcline expels the alteration products of the plagioclase and is free of inclusions except for very minor ones, too minute to identify. In another instance of replacement observed microcline replaced the plagioclase along cleavage directions. The plagioclase not replaced during this process appears to undergo recrystallization, becoming fresh. It maintains its inclusions but they recrystallize. This is especially true of the sericite which recrystallizes into larger grains and exhibits sharp contacts with the host feldspar. The epidote and zoisite crystals seem to recrystal-

lize and diminish in size giving sharp crystal boundaries against the feldspar. It is worthy of note that southeast from the contact between the two subprovinces inclusions in the feldspar disappear.

CORRELATION OF THE GRANITE IN THE GRENVILLE WITH THE KILLARNEY GRANITE

The granite in the Grenville area studied has strong resemblance to the northern most rocks mapped as Killarney in Pardo and Dana townships. There seems to be sufficient evidence to correlate them. The composition, absence of amphibole, present of the same type of inclusions in the plagioclase, pleochroic haloes in the biotite, protoclastic and cataclastic textures are identical. A petrographic description of the Killarney granite from Pardo and Dana townships would merely be a repetition of the descriptions already given for the granite of the Grenville subprovince. (Compare figures 12 and 13 with the Grenville type intrusive).

It is also significant that the only amphibole present in all the sections examined was the rather rare hastingsite which occurs also in the Creighton granite which is Killarney in age. This granite shows the same mineral assemblage and and characteristics as specimens No. 41, from Sisk township.

THE pre-TIMISKAMING GRANITE

Although there appears to be sufficient evidence to indicate the granite of the Grenville subprovince is younger than the Algoman a hasty examination of pre-Timiskaming granitic types was made in order to see if there was any

similarity to the granite in the Grenville subprovince. Specimens of this granite were obtained from the nearest source, namely Archean (Timiskaming type) conglomerates near Haileybury.

These conglomerates dip about 70° north. They are made up of closely packed well-worn elliptical shaped pebbles up to six inches in length but averaging less than three, embedded in a fine grained argillaceous matrix. Well over fifty per cent of the pebbles are acid lavas and light weathering acid intrusive rocks. Green chert, iron formation, and basic lava pebbles are also found.

Twelve of the collected specimens were examined microscopically and were with one exception hypabyssal porphyries. Phenocrysts of quartz, hornblende, and zoned plagioclase are present in a fine grained groundmass of quartz and feldspar. The quartz phenocrysts are usually well rounded. The hornblende phenocrysts show excellent development of crystal faces. Alteration of the plagioclase has been chiefly to zoisite; the hornblende to chlorite and epidote.

The plutonic rock mentioned above is a coarse grained syenite made up of closely knit feldspar crystals up to one cm. in length. Filling minor intestices between the feldspar grains and in large grains is a green mafic mineral. Under the microscope the rock is made up chiefly of oligoclase and what appears to have been an amphibole now almost entirely altered to epidote and chlorite.

The pre Timiskaming granitic types are predominantly

porphyritic in habit and possess rather strong differences to the Grenville type intrusives (figure 14 and 15). Amphibole is usually present and all the feldspar appears to be plagioclase.

CONCLUSIONS

From this study it is clear that there are two very distinct granitic types in the area. Some evidence has been presented to show that one type lying to the south east of the contact between the Timiskaming and Grenville subprovinces is younger than the Algoman granite. These two granites can be readily differentiated both in field and laboratory work.

It would appear that the Algoman granite has had a long and complex history before the younger (Grenville) granite originated. Evidence for this is seen in the rather intense alteration of the feldspars to chlorite, sericite, epidote and zoisite as well as the alteration of the amphibole. This alteration is regional in character and has no relation to the intrusion of the younger granite. There is some reason to believe that the younger granite near the contact with the older is made up in part of a recrystallization of the older. The dissimilarity between pre Timiskaming granite and the younger granite has already been pointed out.

From a study of existing literature it is interesting to note this younger granite is similar to the granite throughout the Grenville subprovince (4) page 46, (5) pages 11 and 13, (19), (20).

Some evidence has been presented to show the younger granite resembles the Killarney granite in Pardo and Dana townships. Further, an uncommon occurrence of the amphibole hastingsite in a granitic mass in Sisk township is similar to an occurrence in the Creighton granite of Killarney age in Snider township.

It is evident a great deal of faulting has taken place in the younger granite both from field examination and widespread cataclastic textures present. Immediately to the north-west of the contact in the area under discussion, the Cobalt series is underlain by Algoman granite and not the Keewatin series. The non-igneous portion of rocks in the Grenville subprovince are paragneisses, not metamorphosed lavas. Since the granite of the Grenville subprovince is younger than the Algoman granite it seems most likely to explain the paragneisses of the Grenville subprovince as part of the Cobalt series which is present to the north-west of the contact.

There is at least some evidence in this area for the possible extention northward of Quirke and Collins (9) explanation for the disappearance of the Huronian. Some supporting evidence for this explanation has been given by Henderson (21). In the Ville-Marie and Guillet (Mud) Lake Map-Areas to the north-east of lake Timiskaming he describes two granitic rock types. One occupying what is probably the western extremity of the Grenville subprovince in that area is chiefly made up of microcline with biotite and minor amounts

of oligoclase. To the west of this is a granite with high plagioclase content possibly indicating that the difference in composition of the granitic intrusives of the two subprovinces is maintained northward. Also Norman (22) believes mountain building took place in late Precambrian times in the Chibougami district of Quebec (page 2). His reasons for believing this are: (1) east-west folding in the Keewatin series is truncated by later north-east folding and faulting at the contact of the Grenville and Timiskaming subprovinces. (2) This folding and faulting accompanied by mountain building is later than and hence affects late pre Cambrian sediments which he believes can be correlated with the Cobalt series. (3) The faults representing thrusts from the south-east, have considerable horizontal and vertical displacements and are healed by very fresh olivine diabase dykes which in other areas are the latest of pre Cambrian rocks. Norman also points out that if the strike of these dykes and faults be projected southward they intersect lake Huron near Killarney bay and hence are along the strike of faults described by Quirke and Collins separating the Timiskaming from the Grenville subprovince.

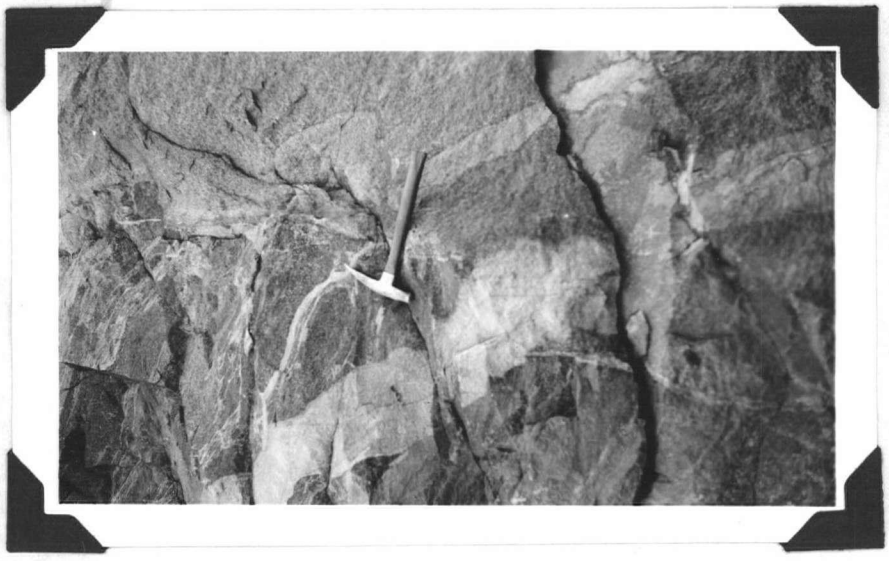


Fig. 1. Algoman granodiorite (grey) Askin township cut by a later syenite (light grey) thin section 6A. Hammer and handle thirteen inches long.

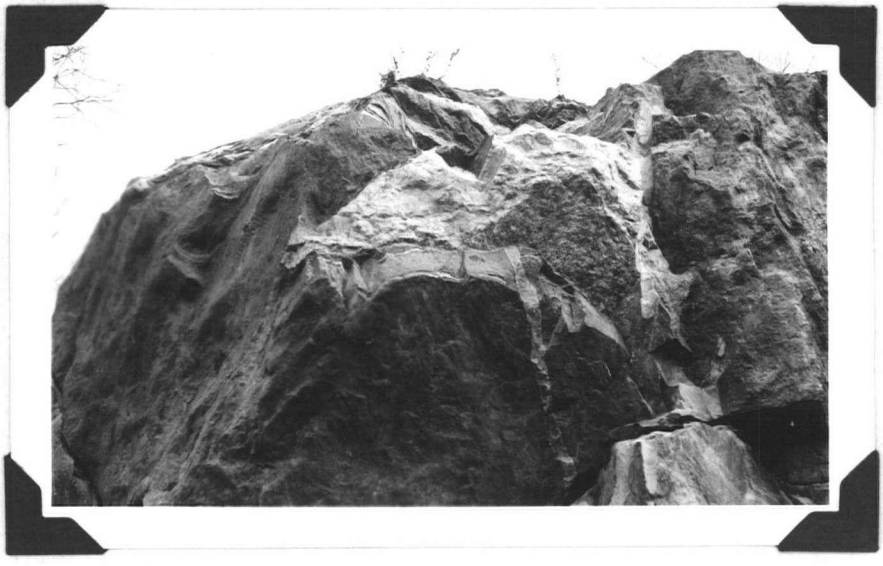


Fig. 2. Pinch and swell bodies of granite in the Grenville subprovince Olive township x 1/40

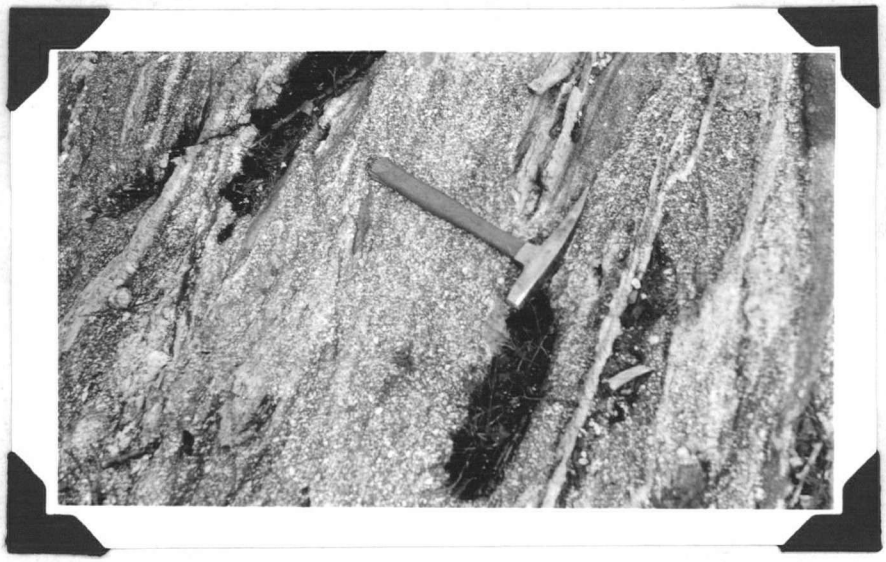


Fig. 3. Feldspar gneiss Olive township, thin section 33. Hammer and handle thirteen inches long.

Fig. 4. Paragneiss Olive township.

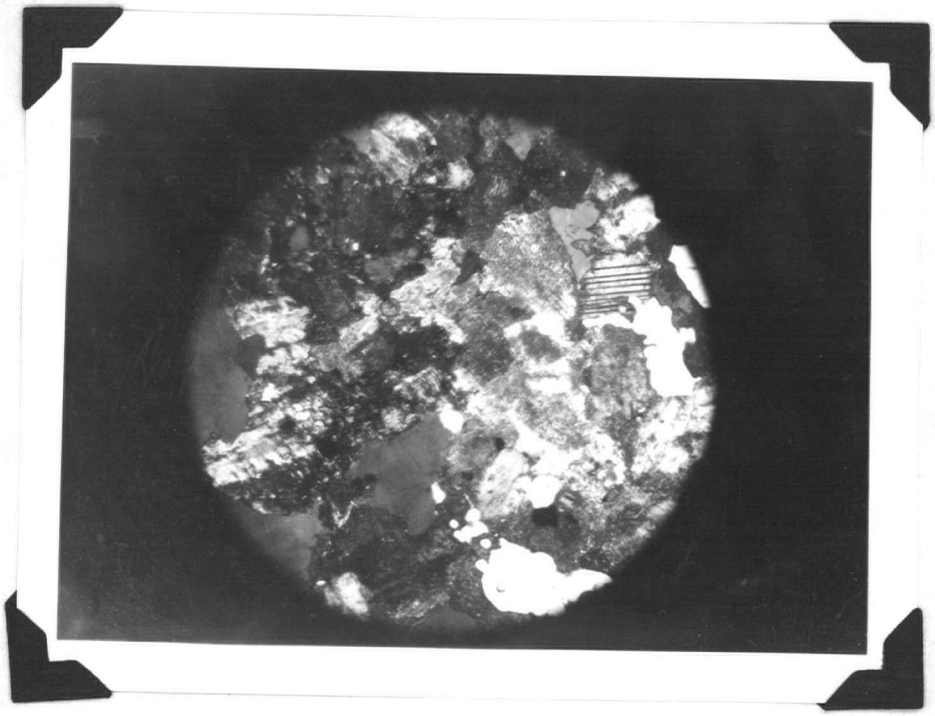


Figure 5

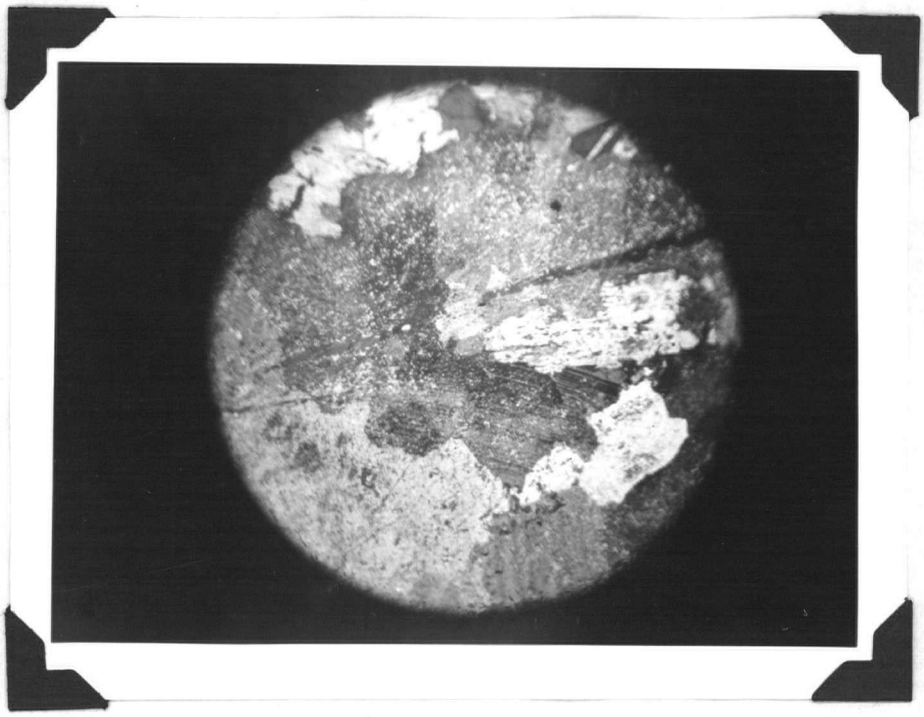


Figure 6

Fig. 5 and 6. Thin sections 5 and 8 Askin township, Algoman showing high proportion of plagioclase feldspar and its characteristic alteration. Crossed nicols x 12

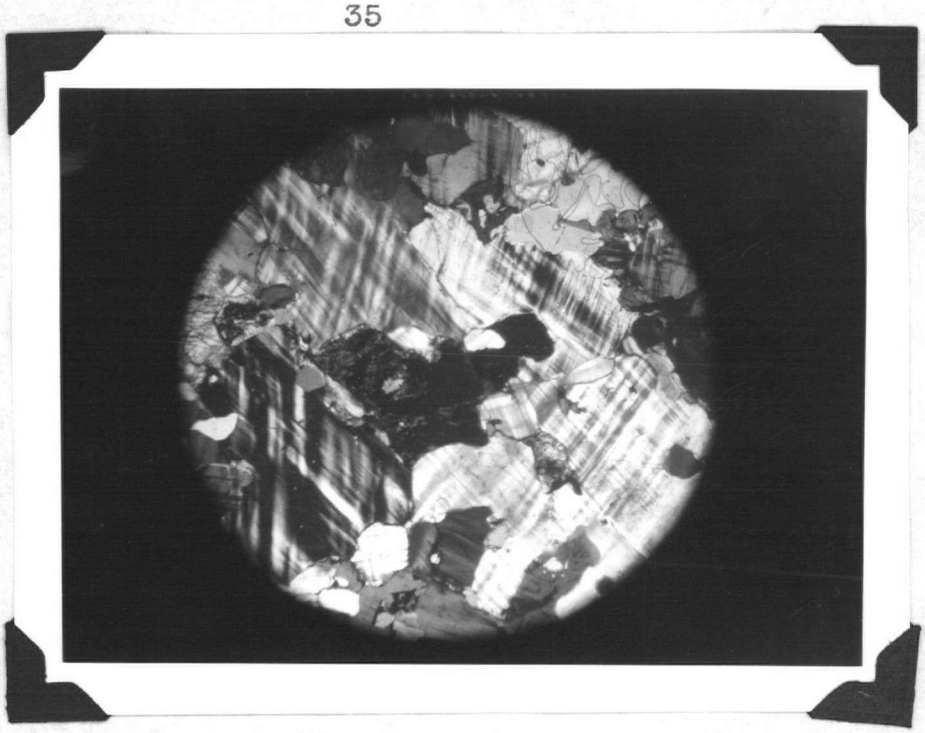


Fig. 7. Thin section 41C Killarney type granite, Sisk township showing high proportion of potash feldspar (microcline). Quartz, plagioclase altered to chlorite and titanite are the other minerals. Crossed nicols x12.

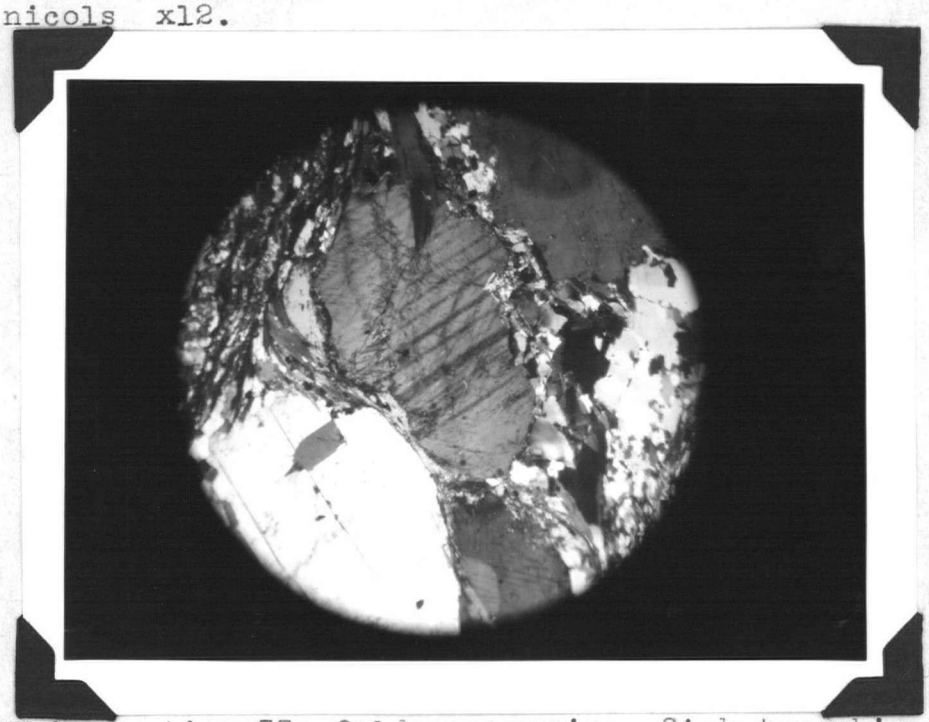


Fig. 8. Thin section 33, feldspar gneiss, Sisk township showing plagioclase grains with biotite inclusions. Crossed nicols x 12.

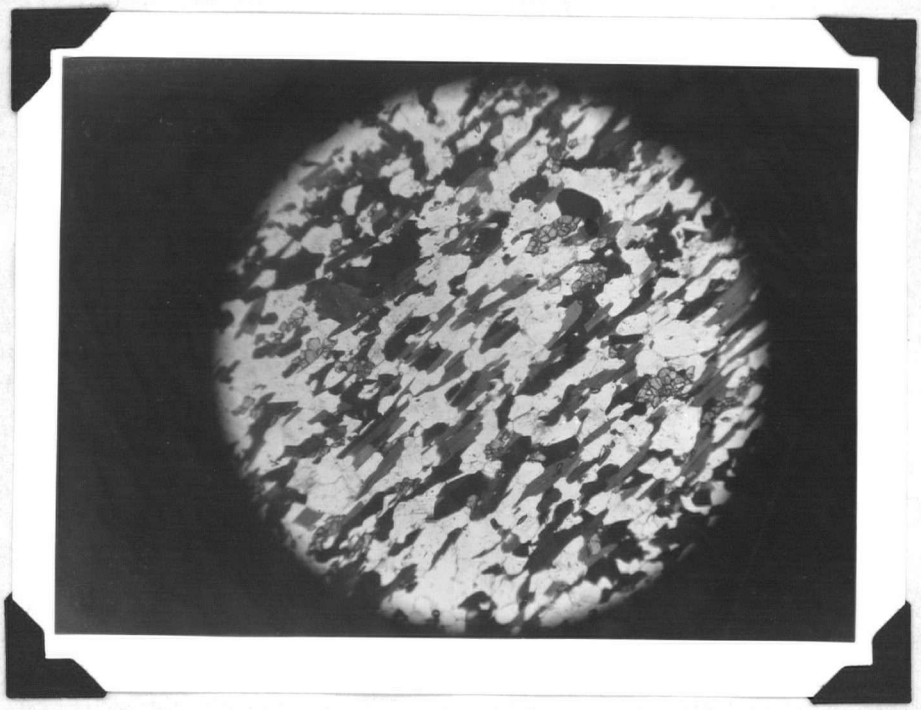


Fig. 9. Thin section 416 Sisk township showing primary gneissosity. Minerals present are hastingsite (opaque), biotite and titanite in a groundmass of quartz and orthoclase. Plain light x 12.

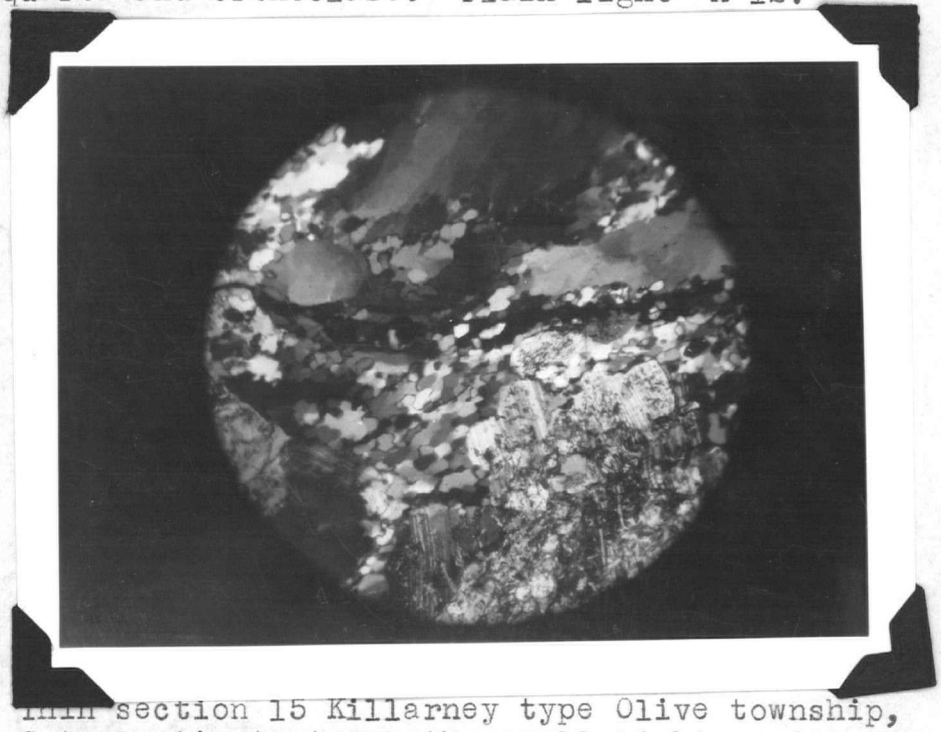


Fig. 10. Thin section 15 Killarney type Olive township, Cataclastic texture, the small light grains are granulated quartz and feldspar. Note the strain shadows in the quartz and mica inclusions in the feldspar. Crossed nicols x 35.

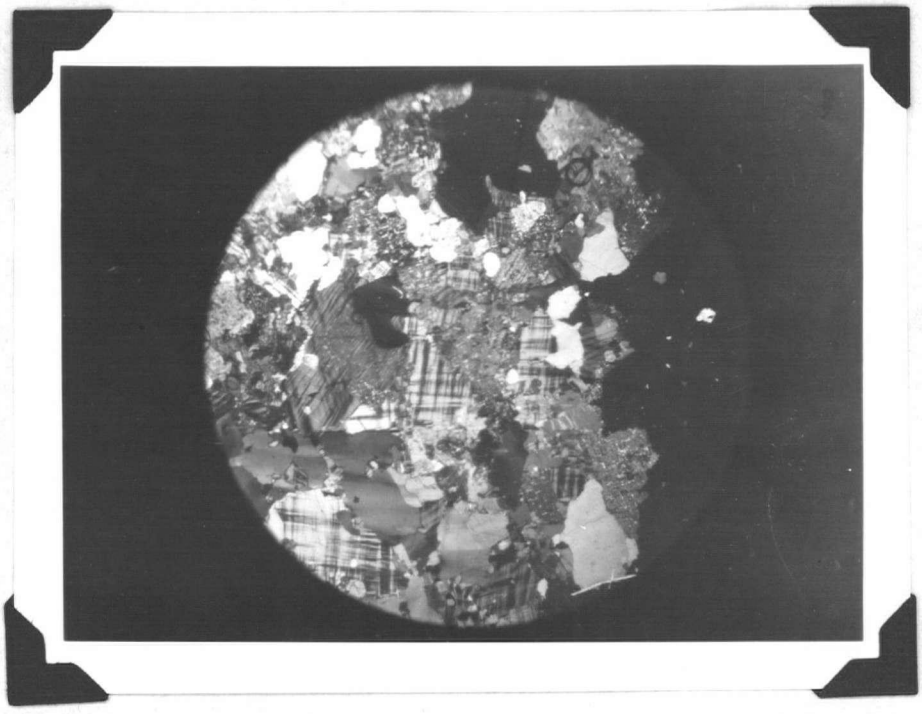


Fig. 11. Thin section 7a Olive township, plagioclase grains (algoman) under the cross hairs partly replaced by microcline of the Grenville intrusive. Tongues of microcline project into the plagioclase. Crossed nicols x 12.

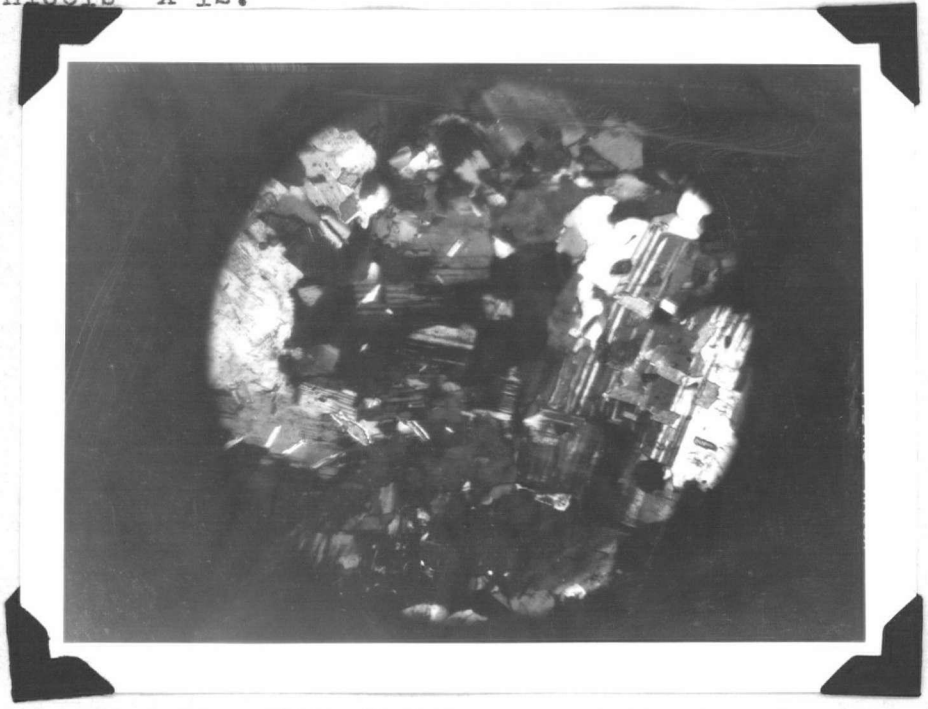


Fig. 12. Thin section S110 Killarney granite lot 6, Con. I Pardo township, note the mica inclusions in the plagioclase and the plagioclase grain broken and healed by mica. Crossed nicols x 35.

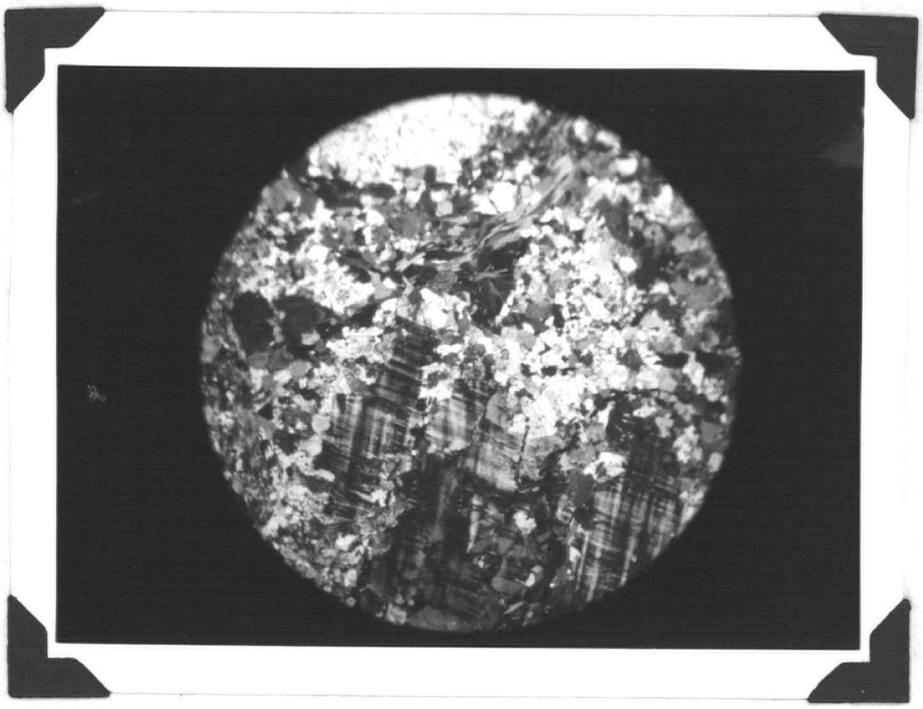


Fig. 13. Thin section S107 Killarney granite lot 8 Con VI Dana township, showing high proportion of potash feldspar (microcline) and cataclastic texture. Crossed nicols x 12.

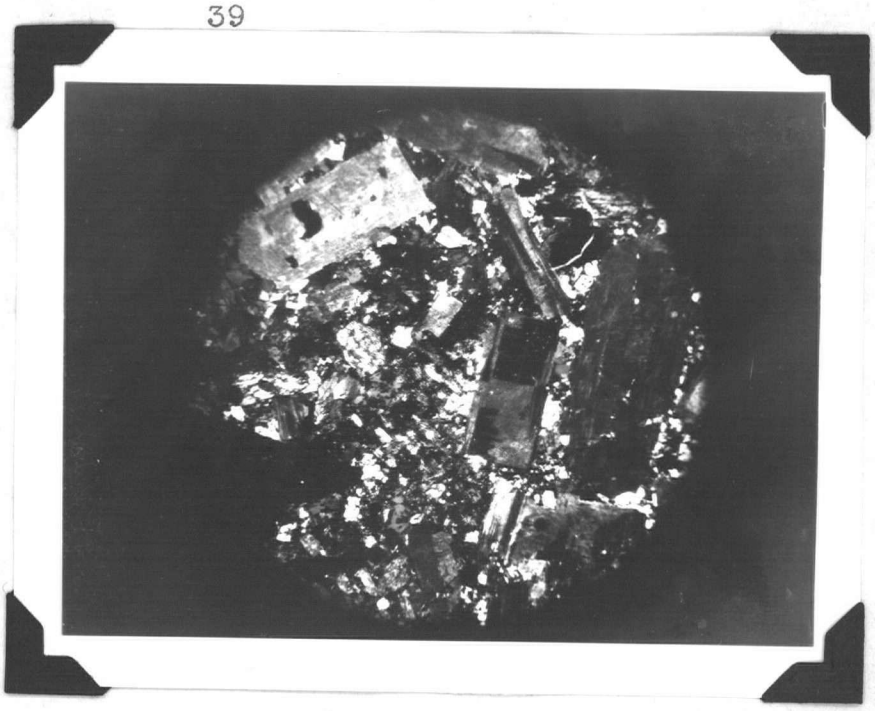


Figure 14

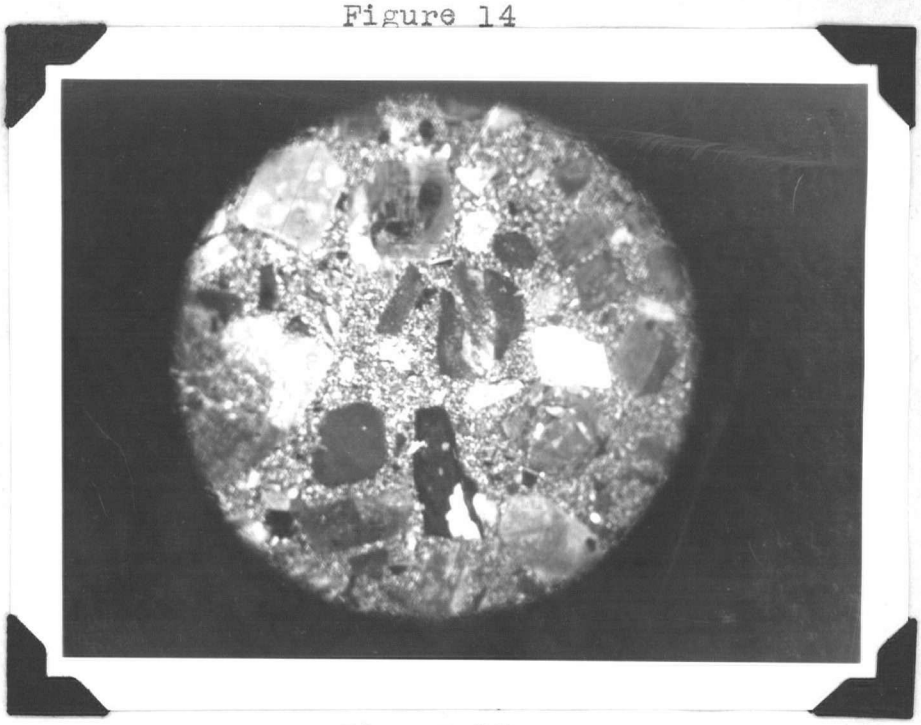


Figure 15

Figs. 14 and 15. Pre-Timiskaming porphyry showing phenocrysts of plagioclase hornblende and quartz. Crossed nicols x 12.

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GLOUSER M.C.

TUB M.C.

BIG THING M.C.

PONY CREEK

W°2 Post GLOUSER
N°1 Post BIG THING

12a -46°
11a -40°
10a -40°
9a -40°
8a -40°
7a -40°
6a -40°
5a -40°
4a -50°
3a -40°
2a -40°
1a -40°

TRENCH #1
TRENCH #2
TRENCH #3
TRENCH #4
TRENCH #5
TRENCH #7
TRENCH #8

℄ PROPOSED XCUT 685 FT.

FOOTWALL GRANODIORITE

CONTACT

APPROXIMATE

4100 4110 4120 4130 4140 4150 4160 4170 4180 4190 4200 4205 4210 4220 4230 4240 4250 4260 4270

GEOLOGY

- GRANODIORITE (QUARTZ DIORITE)
- PORPHYRY
- SCHISTS
- VEIN
- FAULT
- ASSUMED TRACE OF PORPHYRY IN DRILL HOLES

LEGEND

- CONTOUR
- DIAMOND D. HOLE
- TRENCH
- CLAIM BNDY.
- TUB M.C. / RUB M.L.

BIG THING M.C.
HUB M.C.

AMALEE M.C.

MAP OF

BROWN McDADE GROUP

WORKINGS & GEOLOGY

CARMACKS YUKON TY.

SCALE 1 IN. = 40 FT.

1946