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# MARGINAL NOTES

## INTRODUCTION

These maps are part of a multi-year program to upgrade the Precambrian geology maps of the central Uchi Subprovince.

Approximately 1500 km² were mapped in the Lake St. Joseph area focusing on bedrock exposures along the lakeshores. Inland from the lakes, the bedrock exposure is poor. This has been a major impediment to gold exploration. Extensive overburden in the area between Soules Bay and the Benmeen Lake pluton and in the Pashkokogan Lake area, has imposed a constraint on the regional correlation of the stratigraphic assemblage.

This survey presents a revision of previously published maps. It provides a subdivision of the supracrustal rocks into four volcanic cycles in western Lake St. Joseph and shows that the fourth cycle can be traced along the full length of the lake. The northernmost extent of a major dextral shear zone along the southern margin of the belt has been defined. The granitic complex centred on Lake St. Joseph (formerly known as the Carling Granite) has been subdivided into several intrusive and supracrustal units. A summary is presented of the sequence of supracrustal and tectonic events.

## LOCATION AND ACCESS

The Lake St. Joseph area encompasses a large segment of greenstone belt from western Lake St. Joseph to Pashkokogan Lake east of Highway 599, and also includes most of the Lake St. Joseph granitoid complex which is surrounded by the major greenstone terrain in the central Uchi Subprovince. The area is bordered to the south by a fault separating the study area from the English River Subprovince, which consists of metasediments and anatectic granites. Access to the eastern part of Lake St. Joseph and to Pashkokogan Lake can be obtained from Highway 599. Other parts of the area can also be reached by float- or ski-equipped aircraft from Pickle Lake.

## PREVIOUS WORK

The most recent detailed mapping (1:31 680) was by Goodwin (1965) and Clifford (1969) in the eastern and western parts of the area, respectively. This was followed by a helicopter-supported reconnaissance survey in 1972 (Sage and Breaks 1982) covering the Cat Lake-Pickle Lake region and including the Lake St. Joseph area. Earlier geological reconnaissance along this very old Hudson's Bay Company trading route includes work by Bell (1887), Bruce (1923), and Dyer (1934).

## MINERAL EXPLORATION

Recorded mineral exploration is summarized by Goodwin (1965), Clifford (1969), Sage and Breaks (1982), and Kay and Stott (1985). Emphasis on exploration and development has focused in the past on large low-grade iron ore deposits in the vicinity of Soules Bay, Doran Lake, and Eagle Island. Reserves totalling some 1.2 million tons, averaging 19% to 35% Fe, were defined by Sanjo Iron Mines Limited (Soules Bay), Little Long Lac Gold Mines Limited (Doran Lake), and Lake St. Joseph Iron Incorporated (Eagle Island). These deposits are currently covered by patented claims. More recent exploration of the belt has been sporadic and principally directed towards massive sulphide deposits. A summary of this and the above-mentioned work is given in Table 1. As is evident from this table, relatively little assessment data has been filed.

## GENERAL GEOLOGY

Figure 1 summarizes the major stratigraphic units and intrusive bodies in the Lake St. Joseph area. The stratigraphy of the westernmost part of the Lake St. Joseph belt has been subdivided. Four volcanic cycles have been delineated, based on a revision of earlier work by Clifford (1969) and Berger (1981) in western Lake St. Joseph (Figure 2). Berger (1981) introduced formation names which have been adopted to apply to the first three volcanic cycles.

As shown in Figure 2, the three volcanic cycles forming the western Lake St. Joseph stratigraphy are folded about a major east-trending anticline that faces eastward, away from the Bamaji-Blackstone batholith. The thickest portions of each cycle, and the most intense carbonatization, occur in the vicinity of this fold hinge.

Each of the first three cycles comprises a bimodal suite of lower basaltic flows, and upper dacitic-rhyolitic pyroclastic deposits. The fourth cycle is also a bimodal assemblage, but with a voluminous pyroclastic sequence that typically progresses upward from dacitic to andesitic composition. The extent of the upper pyroclastic member of the fourth cycle (here termed the Brodribb cycle), as defined by this survey, is shown in Figure 1. There appears, overall, to be a progressive increase in the volume of total volcanic material from the first cycle to the fourth cycle.

The oldest cycle (the Blackstone cycle) forms the westernmost margin of the Lake St. Joseph Greenstone Belt adjacent to the Bamaji-Blackstone batholith. This cycle is divided into a lower basaltic assemblage and an upper dacitic to rhyolitic assemblage. Individual flows in the lower half of the basaltic suite show a progression from massive to pillowed phases, with only local evidence of carbonate alteration in the pillowed units. However, upwards through this basaltic stratigraphy along the major anticlinal hinge line, there is an increase in the presence of very fine iron carbonate amygdules. This has produced an intensely pitted, weathered surface which, along with locally abundant iron carbonate-quartz veins, characterizes the hinge zone of this anticline.

The upper rhyolitic-rhyodacitic member of the Blackstone cycle comprises several pyroclastic units. Deposits typical of a depositional environment proximal to a volcanic vent have been observed. They occur in the hinge zone of the anticline, and locally on its southern limb. Such deposits include clast-supported flow breccias, and pyroclastic flows with both coarse lithic clasts and rounded clasts of massive sulphide. Abundant, typically carbonatized basaltic dikes transect the stratigraphy in the anticlinal hinge zone. In this zone the pyroclastic rocks are also pervasively iron carbonatized.

The western Lake St. Joseph (WLSJ) cycle overlies the Blackstone cycle and is dominated by its felsic pyroclastic member. The underlying, comparatively thin (<0.5 km), basaltic member of the WLSJ cycle is intensely iron carbonatized. The corresponding pervasive white weathering of the basalts increases in intensity eastwards through the stratigraphy in the hinge zone of the anticline. In this vicinity there are also pods and veins of quartz and iron carbonate + quartz with stringers of pyrite in the carbonate. The quartz forms narrow "ladder" fracture fillings in the massive carbonate pods. The presence of basaltic dikes and local diatreme breccia dikes attest to the proximity of a volcanic vent in the same vicinity.

Further evidence of a vent facies assemblage is found in the overlying rhyolitic member of the WLSJ cycle. The base of the rhyolitic suite on the anticlinal hinge is marked by a massive quartz-feldspar phyric flow which progresses stratigraphically upward into a phreatic breccia of angular to subrounded clasts. Overlying this are a series of pyroclastic flow deposits. Clast sizes diminish along the limbs of the anticline. In Johnston Bay, the upper member of the WLSJ cycle is dominated by dacitic to andesitic tuff and associated volcaniclastic sediments.

These first two volcanic cycles, west of Eagle Island, may have had a common vent system. The vent and proximal facies deposits are concentrated in the hinge zone of the large anticline which marks the position of the common edifice for the two cycles. Substantial erosion of at least the top of the WLSJ cycle is inferred from the presence in Johnston Bay of dacitic to andesitic tuffaceous rocks on the flanks of this edifice. Andesitic tuff is dominant. Epiclastic sedimentary interlayers occur locally with hornblende-rich ironstone beds.

The overlying Carling cycle lies east and north of Eagle Island. Available younging directions indicate that this volcanic assemblage faces eastward and outlines the same large anticline that folds the first two cycles. The Carling cycle is dominated by massive to pillowed basaltic flows. The overlying rhyolitic to rhyodacitic pyroclastic rocks have been intruded by thick gabbroic sills. Coarse rhyolitic flow breccia underlying a thick tuffaceous sequence is found near the hinge of the anticline. Thinly bedded clastic metasediments overlie the pyroclastic member along the northern limb of the fold and appear to mark the top of the Carling cycle. As shown in Figure 2, a set of major transcurrent faults has offset the local stratigraphy along the northern limb of the anticline.

The Brodribb cycle is the fourth and most extensive volcanic cycle identified in this survey. Poor bedrock exposures inland between Doran Lake and western Lake St. Joseph prevent clear recognition of the base of this cycle. However, the upper pyroclastic member of the Brodribb cycle is traceable eastward from north of western Lake St. Joseph to Soules Bay in the eastern part of the lake. A possible further extension of this sequence along the eastern margin of Doghole Bay is being evaluated.

The pyroclastic sequence of the Brodribb cycle is typified by an upward progression towards the north from dacitic, lithic tuff breccia, to highly vesicular tuff breccia, to an increasingly mafic-rich dacitic to andesitic lapilli tuff. The coarsest pyroclastic deposits are to be found north and northeast of Soules Bay. Further west, the sequence is represented by a tuffaceous assemblage which displays characteristic progression northwards from dacitic tuff to andesitic tuff with locally abundant mafic lapilli clasts. This compositional change through the pyroclastic suite is consistent with a major eruption from a compositionally zoned magma chamber.

The Brodribb cycle is overlain by basaltic rocks exposed along the southern margin of the Lake St. Joseph granitoid complex. The basalt may be the base of a fifth volcanic cycle.

The interrelationships among the major stratigraphic components in the Pashkokogan Lake area and in the area south and west of Doran Lake have not yet been successfully resolved. The intermediate volcanics that outline a large fold on Pashkokogan Lake are similar to the dacitic to andesitic tuffs of the Brodribb volcanic cycle.

Major metasedimentary suites were originally mapped by Goodwin (1965) and Clifford (1969) and only modest revisions have been made to the original mapping of these units during this survey.

A major anticline plunging steeply to the east lies along the central axis of the Soules Bay metasedimentary suite. The metasediments thus stratigraphically underlie the uppermost part of the Brodribb volcanic cycle. This assemblage of sediments is composed of staurolite- and locally andalusite-bearing wacke interbedded with magnetite ironstone. Garnet is concentrated at the wacke-ironstone interface in most places, where iron was scavenged from the adjacent ironstone beds during prograde metamorphism. This sedimentary suite widens to the west and partially wraps around the post tectonic Doran Lake stock.

A synclinally folded suite of wacke and local sillimanite-bearing metapelites lies southeast of Doghole Bay. These rocks appear to overlie the westward facing pyroclastics and interbedded volcaniclastic sediments on the east side of Doghole Bay. They may be related to the large enclaves of metasediments found within and along the northern margins of the Osnaburgh pluton. These enclaves have been interpreted to correlate with the Billett Lake-Teevin Lake metasediments (Stott and Wallace 1984) which unconformably overlie the southward-facing volcanic cycles in the Meen Lake-Kasagiminnis Lake belt to the north.

In western Lake St. Joseph, a folded sequence of magnetite ironstone and clastic metasediments infills a major basin along the southern margin of the volcanic belt. These sediments, best exposed on Eagle Island and a chain of islands to the west, were deposited unconformably within a basin that was carved out subsequent to both the deposition of the first three volcanic cycles described above, and an eastward tilting of the volcanic stratigraphy. The sediments form a basal suite of volcaniclastic material derived mainly from the felsic volcanics of the upper WLSJ cycle (Berger 1981). This was followed by a largely quiescent period during which much of the ironstone was deposited with intervening wacke beds. This stage was blanketed by the development of a major submarine fan deposit (Meyn and Palonen 1980) that prograded southward away from the volcanic pile. There is evidence that a major proportion of this epiclastic suite was derived from a felsic source, most likely from the felsic volcanic rocks that dominate the stratigraphy immediately north of these metasediments. The Lake St. Joseph Fault separates these rocks from higher grade biotite-bearing metawacke to the south, in the English River Subprovince.

Thick gabbroic sills and substratiform dikes have injected the upper part of the Carling volcanic cycle, parts of the Brodribb cycle and the Soules Bay metasediments. A large tabular gabbroic intrusion is interpreted to underlie part of central Lake St. Joseph. Numerous gabbroic islands northeast of Brodribb Bay outline this large intrusion. A modest degree of compositional zoning is observed locally on the largest gabbroic island north of Brodribb Bay.

A differentiated sill of peridotite to gabbro and local granophyre is intruded into the Carling volcanic cycle in western Lake St. Joseph. A large gabbroic intrusion and several sills occur in proximity to this differentiated sill and may constitute a concomitant suite.

Likewise, there are long tabular gabbroic sheets which have intruded the margin of the Soules Bay metasediments. One of these intrusions is mylonitized and trends along the southern shore of Doran Lake and into Thelma Lake.

On the peninsula north of Pedlarpath Bay in eastern Lake St. Joseph, three mafic intrusions have been mapped, two of which contain an outer peridotite margin exposed along the shoreline.

All gabbroic intrusions acquired a tectonic fabric that corresponds to the regional strain fabric in the supracrustal rocks. Two small exposures of a westward trending Proterozoic diabase dike were identified northeast of Brodribb Bay. One of these was previously mapped by Goodwin (1965).

The granitoid rocks in this area are dominated by late to post-tectonic plutons. No synvolcanic stocks were identified. All granitic intrusions within the supracrustal rocks contain primary unmetamorphosed fabrics, and some impose a very narrow contact strain aureole. These late plutons, including the Bamaji-Blackstone batholith, Benmeen Lake stock, and the stocks on Pashkokogan Lake, are typically composed of quartz-phyric granodiorite to monzogranite. The quartz phenocrysts define a very steep primary lineation which contrasts with the regional stretching lineation of the tectonic fabric in the surrounding greenstone belt. The Bamaji-Blackstone batholith is a large intrusion which imposed a 1.5 km wide contact strain aureole upon the Blackstone basalts along its eastern margin.

The Doran Lake stock is a post tectonic intrusion of potassic feldspar-megacrystic granite to syenite. It intruded into a pre-existing anticline, the hinge line of which trends through Soules Bay.

The Lake St. Joseph granitoid complex has been subdivided in this survey as shown in Figure 1. It is composed of an older tonalite to tonalitic gneiss terrain which was subsequently intruded by post tectonic granodiorite to monzogranite plutons. These younger bodies appear to have been injected along a pre-existing interface between an older tonalitic terrain and the surrounding greenstone belt. The result has produced large, sheet-like intrusions such as the crescent-shaped Carling pluton and the Osnaburgh pluton. Dominant portions of these late intrusions are potassic feldspar-megacrystic, and major granitic dikes have been injected from these bodies into the adjacent older tonalite. The Osnaburgh pluton imposed a 2 km wide contact strain aureole upon the greenstone belt to the north of the body.

The older tonalite terrain is subdivided into two parts. One is best exposed along Searson Bay and is referred to as the Searson tonalite. This fine-grained tonalite mass is partially bordered on the northwest by a large enclave of clastic metasediment. The margins are heavily intruded by granite dikes from the adjacent Osnaburgh pluton and Twiname pegmatite stock.

Of particular note is the Twiname Bay pegmatite stock in Eastern Lake St. Joseph. This body is approximately 8 to 12 km in diameter and is composed of coarse tourmaline-bearing muscovite granite pegmatite with garnetiferous aplitic granite dikes. The surrounding granitic rocks have been intruded by muscovite- and garnet-bearing pegmatite dikes from this body. There is also an abundance of muscovite pegmatite dikes in the supracrustal rocks to the east and south of the Twiname pegmatite stock. A smaller muscovite pegmatite stock occurs at the northern tip of the Caron Lake stock. In view of the presence of lithium-bearing pegmatite dikes at East Pashkokogan Lake, the recognition of this pegmatite field may warrant an evaluation of its rare-element potential.

The other tonalite terrain is the dome-shaped Pembina tonalite gneiss. This area is pervaded by abundant granitic dikes and foliation-parallel granitic interlayers. This gneissic terrain is partially separated from the more homogeneous Searson tonalite by a thin, discontinuous band of amphibolite. This amphibolite is only locally exposed near Pembina Bay; near Carling Island it forms abundant tabular inclusions in tonalite.

**TABLE 1. SUMMARY OF ASSESSMENT DATA (MAY 1985).**

| Area (by claim map and NTS) | Type of Work (see below for key) | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3a | 3b | 4 | 5 |
| Greenbush Lake (52J/16NE) | 4<br>400 ft | gf, py | 4 | - | Li<br>peg | GDIF 218 |
| Pashkokogan Lake (52J/16NW) | 20<br>4900 ft | py, cpy<br>po, gf, mag | 5 | 1 | - | GDIF 217 |
| Doran Lake (52J/15NE) | 7<br>2911 ft | py, po<br>cpy, mag | 2 | - | - | work concentrated on Fe formation |
| Dawson Lake (52J/15NW) | 4<br>1382 ft | py, po<br>gf | 1 | - | - | |
| Trist Lake (52J/14NE) | 56<br>20 700 ft | py, po<br>cpy, au | 5 | - | Au | Au showing reported by Noranda on island 17; work concentrated on Fe formation |
| Caron Lake (52O/01SE) | 11<br>2859 ft | py, po<br>cpy, gf | 5 | - | - | GDIF 214 |
| Riach Lake (52O/01SW) | 81<br>36 436 ft | - | 6 | - | - | GDIF 213<br>work concentrated on Fe formation |
| Carling Island (52O/02SE) | 30<br>11 295 ft | - | 4 | - | - | work concentrated on Fe formation |
| Pembina River (52O/02SW) | - | - | 1 | - | - | |
| Johnston Bay (52O/03SE) | 12<br>1624 ft | py, po<br>cpy | 3 | 1 | - | |

Key:
1. Diamond Drilling: number of holes/total footage
2. Mineralization encountered in drill holes (py-pyrite, cpy-chalcopyrite, gf-graphite, po-pyrrhotite, mag-magnetite, au-gold).
3. Geophysical surveys (number of surveys performed): (a) ground geophysics, (b) airborne geophysics.
4. Mineral occurrences (known).
5. General comments and availability of GDIF (Geological Data Inventory Folios compiled by Resident Geologist's Office in Sioux Lookout).

## STRUCTURAL GEOLOGY

Two major anticlines are clearly defined. The western Lake St. Joseph stratigraphy is folded by a large, eastward-facing anticline. Another anticline exposes the Soules Bay metasediments which underlie the Brodribb volcanic cycle.

Large folds of the stratigraphy in the Pashkokogan Lake area are evident from the map pattern, but reliable younging directions in that area have not been clearly established.

Along the length of the greenstone belt regional fold axes and lineations generally plunge steeply eastward or down dip of the foliation. Bedding and foliation generally dip steeply throughout the belt.

The regional deformation and metamorphism was followed by the emplacement of the late granitic plutons. Near the Bamaji-Blackstone batholith, the regional foliation and lineation in the supracrustal rocks are rotated to conform with the strain fabric within the contact strain aureole around the batholith.

This batholith appears to predate a regional deformation event that developed within the adjacent English River Subprovince and affected the southern margin of the greenstone belt. This event has resulted in subhorizontal shortening and dextral transcurrent shearing along a broad front in close proximity to the boundary between the Uchi and English River Subprovinces. Transcurrent shearing of rocks can be traced northward for 1.3 km into the greenstone belt from the Lake St. Joseph Fault that marks the subprovince boundary. Structural features show consistent evidence of dextral transcurrent shear. These include Z-folds, shear bands, sygmoidal asymmetry in the compositionally layered rocks, plus subhorizontal mineral lineations and associated steeply plunging crenulations. Local kink bands in these sheared metasediments are interpreted as a brittle product of this event.

This fault system has been observed from the sheared southern part of the Bamaji-Blackstone batholith eastward to the southern margin of Pashkokogan Lake. A fault splaying off the main fault trends along the southern margin of Doran Lake into Thelma Lake where a sill-like gabbroic intrusion is mylonitized.

Evidence in the western Lake St. Joseph area indicates that prior to the folding that resulted from a regional north-south compression, a stage of tectonic uplift occurred. The structural relationships in the vicinity of Eagle Island are critical to this interpretation. The available evidence of younging directions in the stratigraphy (Berger 1981; Meyn and Palonen 1980) demonstrates that the Eagle Island metasedimentary suite formed a synclinal basin. However this basin lies unconformably upon an eastward facing volcanic pile. Subsequently, the three volcanic cycles in the area, plus the Eagle Island metasediments, were deformed by a north-south compression. This accentuated the volcanic edifice into an eastward-facing anticline and tightened and refolded the synclinal sedimentary basin around the nose of this anticline.

The general setting of the western Lake St. Joseph area is comparable to the Geraldton area in that it contains folded ironstone units in a metasedimentary belt along the margins of a greenstone belt with a major transcurrent shear zone along the subprovince boundary. The major dextral transcurrent shear zone, defined along the southern part of the lake, affects the southern edge of Eagle Island and much of the interbedded and Z-folded ironstone and wacke deposits to the west of the island. The rocks in this shear zone have undergone two periods of deformation accordingly.

The overall tectonic history involves a general sequence of:

1. Regional tilting of the stratigraphy in western Lake St. Joseph.
2. Erosion of the volcanic pile to produce the Eagle Island ironstone-lined basin and submarine fan deposits. The relative age relationship has not been established between these sediments and the sediments of the English River Subprovince south of the Lake St. Joseph Fault.
3. Regional north-south compression that produced the major folds and the penetrative foliation. This event may be related to, or concomitant with, the emplacement of the tonalite of the Lake St. Joseph granitoid complex.
4. Emplacement of the granitoid plutons and stocks (Bamaji-Blackstone batholith, Carling pluton, etc.).
5. Regional oblique compression along a northwest-southeast axis to produce a major dextral transcurrent shear zone along the southern margin of the greenstone belt and into the English River Subprovince. The emplacement of some granite stocks may be concomitant with or may postdate this event.

## METAMORPHISM

There is a pronounced change in metamorphic grade within the volcanic belt; from amphibolite facies in the Pashkokogan-Eastern Lake St. Joseph area, to greenschist facies in the western Lake St. Joseph area. Mafic metavolcanics in the east are typically composed of hornblende-plagioclase and garnet-hornblende-plagioclase. Metasediments in Soules Bay contain diverse assemblages including garnet-staurolite and staurolite-andalusite. These assemblages are typical of the low pressure Abukuma-type amphibolite facies metamorphism in the eastern half of the area.

In western Lake St. Joseph, mafic metavolcanics contain chlorite-actinolite-albite, and major parts of the volcanic pile are extensively carbonatized. North of the Lake St. Joseph Fault zone clastic metasediments typically contain chlorite-muscovite-biotite-quartz-albite, and south of the fault the assemblage garnet-staurolite-sillimanite occurs at least locally in metasediments.

While greenschist facies metamorphism is prevalent in western Lake St. Joseph, there is a notable upgrading of metamorphism to amphibolite facies near granitoid plutons. For example, near the Bamaji-Blackstone batholith and the large batholith south of the Lake St. Joseph Fault, within the English River Subprovince.

## ECONOMIC GEOLOGY

### GOLD

With the exception of iron ore deposits, relatively few mineral occurrences of economic interest have previously been defined in the Lake St. Joseph Greenstone Belt. During the current regional mapping program an attempt was therefore made to assess the potential for such mineralization with particular emphasis on gold. The eastern end of the belt was examined in reconnaissance fashion with the focus on the limited lakeshore exposures along Doghole Bay, Soules Bay, and Brodribb Bay. Bedrock is poorly exposed inland, making detailed evaluation of the mineralization potential difficult. The western end of the greenstone belt is marked by excellent lakeshore exposures and was studied in much greater detail. The nature, and presence or absence, of veining, alteration, and mineralization were documented throughout the belt and are discussed below.

### Veining

For our purposes, the eastern portion of the Lake St. Joseph Greenstone Belt is defined as extending from East Pashkokogan Lake to Brodribb Bay on Lake St. Joseph. This area is largely characterized by narrow (typically <15 cm), undeformed bull-quartz veins which are usually subparallel with, or at a low angle to, foliation. Locally, minor tourmaline, and less commonly, visible sulphides, were noted in these veins, but grab samples returned low Au values. (Unless otherwise stated, all assay samples discussed here were collected by field party personnel and analyzed by the Geoscience Laboratories, Ontario Geological Survey).

The relative abundance of quartz veining varies throughout this portion of the belt. The veins are very prominent within the metasediments in Soules Bay and the gabbroic intrusion northeast of Soules Bay.

Minor rusty-weathering, foliation-parallel, iron-carbonate stringers were seen locally in the mafic metavolcanics along the southern shore of Pedlarpath Bay. These are generally narrow (<5 cm) and contain no visible sulphides.

Veining throughout the western portion of the belt (i.e. west of Brodribb Bay) was noted in three distinct forms:

1. quartz ± tourmaline veins, subparallel with, or at a low angle to, foliation (Type 1),
2. massive iron-carbonate pods and veins, and narrower veinlets, generally parallel with foliation (Type 2), and
3. foliation-parallel, metamorphically differentiated quartz ± plagioclase veins (Type 3).

Each of these three vein types appears to occur in the absence of other vein types. They characterize the following areas:

*Type 1:* These quartz ± tourmaline veins were noted in the bay northwest of the Benmeen Lake area, south of Brodribb Bay and in the gabbroic intrusion north of Eagle Island. South of Brodribb Bay the veins occur in a well defined regional set obliquely crosscutting the foliation.

*Type 2:* Iron-carbonate ± quartz pods, veins, and veinlets characterize the mafic metavolcanics east of the Bamaji-Blackstone batholith. The carbonate contains local stringers of pyrite. The veins are notably abundant on the islands west of Eagle Island.

*Type 3:* Metamorphically differentiated foliation-parallel quartz ± plagioclase veins are restricted to the shear zone along the Uchi-English River Subprovince boundary. These veins are observed within the intensely deformed metasediments north and south of the Lake St. Joseph Fault.

Of the three vein types, the most notable are massive iron-carbonate pods and veins. These are most prominently developed in the basalts of the western Lake St. Joseph volcanic cycle near the hinge zone of the large anticline that folds the stratigraphy in the western part of the belt. These hydrothermal deposits occur within highly carbonatized pillowed basalts. They are generally subparallel to the regional east-trending foliation and occupy interpillow spaces. Some of the larger lensoid pods contain ladder quartz veins and fine-grained stringer pyrite.

Carbonate-quartz veins are not entirely restricted to the hinge zone of the anticline. They are also observed in places along the north and south limbs of this fold.

### Alteration

In general, there is a spatial association between the pervasive carbonatization of the metavolcanics in western Lake St. Joseph, which is interpreted to be a primary hydrothermal alteration, and the foliation-parallel carbonate veins. The latter are interpreted to be syntectonic hydrothermal deposits, perhaps a recirculation of material from the host rock. These two hydrothermal events—one primary, the other related to the regional deformation—are accompanied by a third event along the southern limb of the anticline. There, a further cycling of hydrothermal fluids occurred within a ductile shear zone. Within the metasediments, these resulting foliation-parallel veins are typically composed of quartz or quartz + feldspar with local tourmaline. There is little evidence of associated sulphides.

In other parts of the greenstone belt further east, there was little evidence of alteration of the metavolcanics.

### Mineralization

As previously mentioned, few mineral occurrences of economic interest have been recorded in the Lake St. Joseph Greenstone Belt. Noranda Incorporated reports a chemical-sediment-hosted gold showing east of Eagle Island. This, plus the ground covering a sulphide occurrence at the mouth of Johnston Bay, constitute the only active claim groups within the Lake St. Joseph area (*see* Figure 3).

The majority of the sulphide occurrences on the 1 inch to 4 mile compilation geology map (Sage and Breaks 1982) consist of numerous geophysical conductors that have been tested by drilling and are now documented in the assessment files (Table 1).

At the eastern end of the lake, few new mineral occurrences were noted during the course of the present survey. Two small, chert-hosted massive sulphide horizons were mapped, one on East Pashkokogan Lake and the other north of Pedlarpath Bay, on eastern Lake St. Joseph. These were sampled for Au assay and returned minimal values. The East Pashkokogan occurrence, although not recorded in the assessment files, had been trenched in two locations over distances of 7 m and 6 m, respectively. Mineralization encountered here consisted of massive pyrite and pyrrhotite in a black, possibly graphitic, chert matrix.

Despite the overall apparent lack of visible mineralization in those areas studied on eastern Lake St. Joseph, numerous grab samples were taken for gold assay. In general, these samples yielded <20 ppb Au with few exceptions.

The western Lake St. Joseph area appears slightly more promising for potential economic mineralization. The intensely carbonatized mafic metavolcanic horizon adjacent to the Bamaji-Blackstone batholith is the most likely candidate for gold mineralization. These rocks host rusty-weathering, iron-carbonate ± quartz ± pyrite ± magnetite pods in addition to foliation-parallel iron-carbonate stringers. Although we sampled these pods for gold assay, and they returned minimal values (Geoscience Laboratories, Ontario Geological Survey), the intensity of the alteration and the volume of rock affected make further sampling well warranted. In addition to this horizon, numerous sulphide showings have been recorded by this field crew and others in the area, including a gold and silver occurrence east of Eagle Island. These showings can be seen on Figure 4.

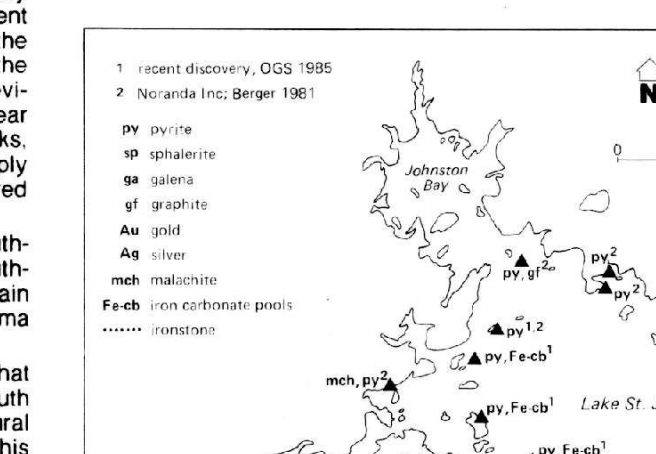


Figure 4. Mineral occurrences in the western Lake St. Joseph area.

The gold and silver occurrence east of Eagle Island was originally held by Noranda Incorporated in 1977. At that time, an assay was reported of 0.32 ounce per ton Au and 0.28 ounce per ton Ag from a grab sample containing pyrite, pyrrhotite, and arsenopyrite. The gold occurrence is currently staked by R.J. Rupert of Sault Ste. Marie, Ontario. It was mapped at a scale of 1:100 in order to determine the structural setting with respect to the subprovince boundary, and to document the nature of the host rock and mineralization. Results of this mapping are shown in Figure 5.

The outcrop consists of interbedded graphitic shale, sideritic chert breccia, and massive chert horizons. The chert bands, which are black-weathering and aphanitic, are continuous over the length of the outcrop. The bands range in width from 7 to 20 cm and are locally offset by east-trending transcurrent faults. The chert breccia beds constitute a major portion of the outcrop. They are up to 2 m wide and are laminated on a scale of 1 to 3 m. Chert breccia fragments are white-weathering, sugary-textured, tabular-shaped to subangular, and are commonly oriented subparallel to bedding. These fragments are set in a matrix of very fine grained, rusty brown weathered, sideritic argillite or siltstone.

The sulphide-bearing unit at this showing appears to be a graphitic shale. It dominates the western end of the outcrop, where it is tightly folded and appears to be rhythmically interlayered with black-weathering chert beds. The shale is rusty brown to black-weathering, and aphanitic. It contains sulphides both as fine-grained disseminated crystals, and as fine (1 mm) laminations. Pyrite and pyrrhotite were the only sulphides noted. Noranda Incorporated reported arsenopyrite, but none was identified during the course of mapping.

This gold showing does not appear to be structurally related to the dextral shear zone that forms a broad deformation band near the subprovince boundary. Instead, dominant S-folding of the metasediments, and a steep, easterly plunging, mineral lineation identify the rock fabric as characteristic of the southern limb of the major east-trending anticline, the hinge line of which passes through Eagle Island.

On the northwestern side of Eagle Island, Algoma Steel Corporation Limited has intersected interesting gold values in drill core through the base of the ironstone, in association with pyrite (private company data, not on public file, D. Szekely, personal communication).

The remaining group of active claims is located on a sulphide occurrence near the mouth of Johnston Bay. These claims are currently held by Noranda Incorporated and are shown in Figure 3. The area covered consists primarily of intensely iron-carbonatized mafic metavolcanics. Massive, brick-red iron-carbonate pods up to 2 m across are a common feature in these metavolcanics. These pods are foliation-parallel and locally contain deformed, discontinuous quartz + chlorite pods but no sulphides.

An intensely silicified and pyritized contact between pillowed metavolcanics and a dacitic pyroclastic unit was also noted within these claims. This contact is located on a small island southwest of Johnston Bay. It is marked by a 2 m wide, massive, white to rusty weathering quartz vein. This vein parallels the contact between the two units and appears to have associated sulphide mineralization.

The remaining mineral occurrences shown on Figure 4 include those compiled from the assessment file data and new showings outlined by the present mapping program.

### Recommendations for Exploration

Numerous assay samples for gold and other elements were collected in this region, and the analyses by the Geoscience Laboratories, Ontario Geological Survey, show very low gold values. Assay results of up to 230 ppb Au were obtained locally in western Lake St. Joseph. Potentially the most attractive area for gold exploration is in the hinge zone of the large anticline of western Lake St. Joseph and within the later transcurrent shear zone along the southern margin of the belt.

The anticline has refolded a synclinal ironstone-rich sedimentary basin exposed on Eagle Island. Since the refolded ironstone is concentrated close to the base of this sedimentary basin, it may form a suitable structural trap for hydrothermal fluids that were derived from the underlying volcanic pile and focused along the hinge zone of the anticline.

The transcurrent shear zone forms a broad deformation band south of Eagle Island and appears to be superimposed upon the earlier regional fold. It has refolded the ironstone beds into large Z-shaped structures along the southern limb of the major anticline in western Lake St. Joseph. The shear zone has affected a wide range of rock types, including felsic to intermediate pyroclastics at the western end of Lake St. Joseph and on Pashkokogan Lake.

This general stratigraphic and tectonic setting exposed in western Lake St. Joseph is comparable to the Geraldton gold camp along the boundary between the Wabigoon and Quetico Subprovinces.

## PEGMATITES

Figure 6 shows the locations of pegmatite dikes examined and sampled by field party personnel for potential rare metals mineralization during the 1985 mapping program. With the exception of the known lithium-bearing pegmatite on East Pashkokogan Lake, these dikes are previously undocumented occurrences. Two main areas of dike concentration were noted:

(i) East Pashkokogan Lake, and
(ii) eastern Lake St. Joseph, in particular Doghole Bay and northeast of Soules Bay.

These areas are discussed separately below.

### East Pashkokogan Lake

The known Li-bearing pegmatite on East Pashkokogan Lake, shown on Figures 3 and 6, lies within the only active claim group in the eastern Lake St. Joseph Greenstone Belt. It is currently held by R.J. Fairservice of Kenora, Ontario. Placer Development Limited staked the pegmatite in 1980 and conducted a ground geophysical survey and detailed mapping program at that time. Results of this work were inconclusive as far as determining the boundaries of the dike and little attempt appears to have been made to find similar pegmatite occurrences in the area. Our mapping, however, has revealed two previously unrecorded pegmatite dikes immediately west of the Fairservice lithium occurrence, as well as a thin (2 m) dike exposed approximately 10 m due north of the main showing, trending subparallel to the main dike.

These additional dikes share the following features:

1. They are lensoidal, pinching and swelling along strike; widths range from 2 to 15 m, and exposed lengths range from 2 to 30 m.
2. They commonly occur as *en echelon* sets that trend east-west, subparallel to foliation.
3. They are pink-weathering and homogeneous.
4. They contain a common and consistent mineral assemblage (*see* Table 2) of coarse-grained, blocky potassic feldspar with interstitial glassy quartz and white-weathering plagioclase, medium-grained green muscovite, euhedral black tourmaline and fine-grained red garnets.
5. A pervasive tourmaline alteration halo is associated with the dikes; this manifests as tourmaline rims along dike margins and tourmaline ± quartz-rich veinlets that crosscut foliation in the surrounding wall rock.

The authors sampled dikes to determine rare metals concentrations and to assess the degree of fractionation. A summary of the sample results (analysis by Geoscience Laboratories, Ontario Geological Survey) is listed in Table 3 (samples 1016A and 1020A) and is discussed under the Li-pegmatite description.

The Li-bearing pegmatite differs from the above-mentioned dikes in that, like most pegmatites that contain economically interesting mineralization, it displays a crude mineralogical and textural zonation. The Fairservice showing, which was mapped in detail at a scale of 1:100, is shown in Figure 7. It consists of four asymmetrically distributed units consisting of:

1. medium-grained quartz and potassic feldspar;
2. medium- to coarse-grained spodumene + green muscovite + potassic feldspar + tourmaline;
3. aplitic to sugary-textured quartz + potassic feldspar + tourmaline + minor green muscovite; and
4. coarse-grained spodumene + feldspar + white muscovite + tourmaline ± Nb-Ta mineralization.

Fine-grained red garnets are disseminated throughout these units and individual blue-green apatite crystals occur locally.

The dike is currently exposed over a width of approximately 10 m and a strike length of 12 m. The exact boundaries of this pegmatite have still not been established, but they likely exceed these dimensions; the dike trends into the lake to the west and disappears under overburden to the northeast.

Chip samples taken by Goodwin (1965) returned values of 1.25% $LiO_2$ over the dike width. Grab sample results from the present survey summarized in Table 3, give comparable values ranging from 0.71% to 0.13% $LiO_2$ (7100 ppm and 1260 ppm). The highest lithium values were obtained from the aplitic to sugary-textured tourmaline-rich zone of the pegmatite.

The remaining rare metals concentrations reported in Table 3 are generally equal to or greater than background values (also listed in Table 3) given for felsic intrusions or pegmatites. The only exception is titanium, which occurs in uniformly low amounts (approximately 0.03% $TiO_2$). Tantalum and niobium occur in concentrations up to 4 times background levels, with Nb>Ta in all samples except 1016A. Cesium and beryllium concentrations, respectively, average 20 to 25, and 5 to 7 times background levels. Tin is also uniformly high, averaging 2 to 4 times background levels.

From the rare metals concentrations obtained, the East Pashkokogan pegmatite suite is clearly highly fractionated and therefore may characterize a zone of economic interest.

A potential parental granite for these pegmatites was not identified in the Pashkokogan or East Pashkokogan Lake areas. Neither of the two small granitoid stocks mapped nearby exhibits characteristics commonly found in parental granite bodies (Meintzer *et al.* 1984; Trueman and Cerny 1982). A possible source for the pegmatites may lie farther south in the English River Subprovince. Alternatively, the dikes may be part of a progressively fractionated suite derived from the Twiname pegmatite stock or the Caron Lake stock (Figure 1). This aspect is reviewed later.

### Eastern Lake St. Joseph

Pegmatite dikes observed in the eastern Lake St. Joseph area are largely concentrated on Doghole Bay and northeast of Soules Bay (Figure 6). These dikes, like those seen on East Pashkokogan Lake, trend approximately east-west, subparallel to foliation. Mineralogically, they are similar to the East Pashkokogan suite (*see* Table 2) with the notable exception that the potassic feldspar crystals commonly contain graphic quartz intergrowths. Typical mineral assemblages consist of potassic feldspar + quartz (both as graphic intergrowths and interstitial crystals) + plagioclase + muscovite (ranging in colour from grey to green) + tourmaline + garnet.

Tourmaline alteration haloes associated with the East Pashkokogan pegmatites are also observed along the margins of the Lake St. Joseph dikes. Individual tourmaline crystals are seen disseminated throughout the wall rock for widths of 1.5 m or more. Locally, tourmaline crystals are pervasively developed adjacent to ironstone beds within intruded sediments, and randomly distributed disseminated green muscovite booklets are noted replacing staurolite.

Texturally, the eastern Lake St. Joseph pegmatites differ from the East Pashkokogan dikes in that they contain the previously mentioned graphic quartz intergrowths in the potassic feldspar, and unusual radiating aggregates of finely interleaved quartz and muscovite. These quartz + muscovite intergrowths occur mainly in two forms:

1. as medium- to coarse-grained veins that crosscut the pegmatites as an apparently late alteration feature; and
2. as finer grained discrete "inclusions" up to 25 cm across.

The latter form intergrowths that are locally so finely interleaved that they resemble sillimanite. It is quite likely that these intergrowths represent a retrograde reaction after sillimanite and reflect the peraluminous chemistry of the pegmatites. These quartz + muscovite aggregates are best developed in the dikes in the Doghole Bay area, where they locally constitute up to 15% of the pegmatite.

With the exception of one dike northeast of Soules Bay, the pegmatites observed are largely homogeneous. Dike exposures, which range in size from 6 to 70 m in width and up to 70 m in strike length, show little variation in texture or mineralogy. The above-mentioned exception shows a textural zonation and varies from a sugary-textured, fine-grained, or aplitic unit to a coarser grained, blocky, pegmatitic unit. Muscovite is noteworthy in this dike because it is an unusual silvery green colour and locally occurs in pods up to 40 cm across. Both muscovite and potassic feldspar, in this pegmatite and the other eastern Lake St. Joseph occurrences, have been sampled to determine rare metals content and relative degree of fractionation. Only one sample result is available at the time of writing and this is included in Table 3 (sample 0075A). Rare metals concentrations in this sample, although slightly lower than those seen in the East Pashkokogan suite, still exceed background levels for Ta, Nb, Cs, and Bi, suggesting that these dikes are moderately well fractionated.

Two possible parental intrusions exist for the pegmatite dikes. These are the Caron Lake stock and the Twiname pegmatite stock, located southeast and southwest, respectively, of Doghole Bay. The Twiname pegmatite stock has been subdivided from the granitoid complex to the north by the present survey. These intrusions, shown on Figure 6, display characteristics common to rare metals-associated granites.

According to Trueman and Cerny (1982), granitic intrusions parental to rare metals pegmatites are generally small to moderate in size, averaging 5 to 150 km² surface area. Both the Caron Lake and the Twiname pegmatite stocks are within this size range, at approximately 65 km² and 145 km², respectively.

**TABLE 2. MINERAL ASSEMBLAGES OBSERVED IN EASTERN LAKE ST. JOSEPH AND EAST PASHKOKOGAN LAKE PEGMATITES.**

| Mineral | Pegmatite | | | | | |
|---|---|---|---|---|---|---|
| | East Pashkokogan Lake | | | Eastern Lake St. Joseph | | |
| | Fairservice (1018)* | 1016 | 1020 | 0096 | 1110 | 2166 |
| Quartz | X | X | X | X | X | X |
| Plagioclase | X | X | X | X | X | X |
| Orthoclase | X | X | X | X | X | X |
| Spodumene | X | | | | | |
| Muscovite | X | X | X | X | X | X |
| Tourmaline | X | X | X | X | X | X |
| Garnet | X | X | X | X | X | X |
| Apatite | X | | X | | | |
| Columbite-Tantalite ? | X | X | | | | |

* numbers indicate station location

**TABLE 3. RARE METAL CONCENTRATIONS IN PEGMATITE DIKES.**

| Sample | Li ppm | Ta ppm | Nb ppm | Cs ppm | Be ppm | Ti %$TiO_2$ | Bi ppm | Sn ppm |
|---|---|---|---|---|---|---|---|---|
| East Pashkokogan Lake | | | | | | | | |
| 1016A | 10 | 80 | 38 | 32 | 140 | 0.03 | <0.1 | 87.1 |
| 1018A | 7100 | 26 | 31 | 115 | 140 | 0.03 | 0.2 | 136 |
| 1018B | 1260 | 19 | 36 | 33 | 100 | 0.05 | 0.1 | 133 |
| 1018G | 90 | 16 | 49 | 110 | 110 | <0.01 | 0.1 | 126 |
| 1020A | 16 | 23 | 26 | 130 | 150 | 0.05 | <0.1 | 36.1 |
| Eastern Lake St. Joseph | | | | | | | | |
| 0075B | 5 | 23 | 36 | 50 | 15 | 0.05 | 2.7 | 4.6 |
| background in felsic intrusions*** | 40 | 20 | 10 | 2-6 | 20* | 0.25 | 0.1 | 16.3** |

* background concentration in pegmatites
** background concentration in Sn-bearing granites
*** from Handbook of Geochemistry, 1978

The two unmetamorphosed plutons are post-tectonically emplaced near the Lake St. Joseph greenstone-granitoid contact. This contact represents a major lithological boundary between the Lake St. Joseph granitoid complex to the north and the greenstone belt to the south. Granitic intrusions parental to pegmatites often intrude along such large-scale lithological boundaries between units of marked competency contrast (Trueman and Cerny 1982).

Parental intrusions are also generally leucocratic, peraluminous granites or granodiorites, which contain both biotite and muscovite and are pegmatitic to medium grained (Meintzer *et al.* 1984). Common mineral assemblages in these intrusions consist of graphic quartz + potassic feldspar and blocky potassic feldspar + plagioclase + muscovite + biotite + tourmaline + garnet. The Caron Lake pluton is a leucocratic, fine- to medium-grained, two-mica granodiorite that locally contains fine-grained garnets and tourmaline. The Twiname pegmatite stock is a pegmatitic intrusion characterized by abundant quartz + muscovite intergrowths and local development of fine-grained garnet and tourmaline.

Further sampling and mapping of the above-mentioned intrusions and the eastern Lake St. Joseph area are necessary in order to firmly establish the relationship between the plutons and the observed pegmatite dikes. Preliminary evaluation however, as discussed above, strongly suggests that either one or both of these intrusions may be a candidate as the parental body to a fractionated suite of pegmatite dikes.

A sampling program has been initiated by the present survey to determine if a regional zoning of progressive rare metals enrichment occurs at a distance from these plutons. To test for such zoning relationships the authors have sampled both the muscovite and potassic feldspar from several pegmatite dikes to establish Li, Rb, and Cs contents in each and to draw comparisons after Gordiyenko (1971). Analyses of K/Cs vs $Na_2O$ are also being evaluated for potassic feldspars from these dikes following the method proposed by Gordiyenko (1976).

### Recommendations for Future Exploration

The degree of fractionation of the eastern Lake St. Joseph and East Pashkokogan Lake pegmatite suites is favourable for potential economic rare metals mineralization, notably Ta and Cs. The possibility that the two suites may be related and reflect a mineralogical and textural zonation from a single parental intrusion, or several related stocks, greatly increases the area of economic potential. Further work, in the form of reconnaissance mapping and sampling, is warranted to establish rare metals and textural zoning patterns and to locate additional unmapped dikes in the region. More detailed examination should follow this to determine average rare metals concentrations within the pegmatite suites.

Pegmatite dikes of similar texture and mineralogy to those seen in the eastern Lake St. Joseph area have also been noted at the west end of the lake. These occur in close proximity to the subprovince boundary and intrude metasediments east of Root Bay. Unfortunately, due to a shortage of time, these were examined only briefly. Their strong resemblance to the dikes discussed above, however, suggests that they also warrant a reconnaissance evaluation of geochemical indicators (Gordiyenko 1971, 1976).

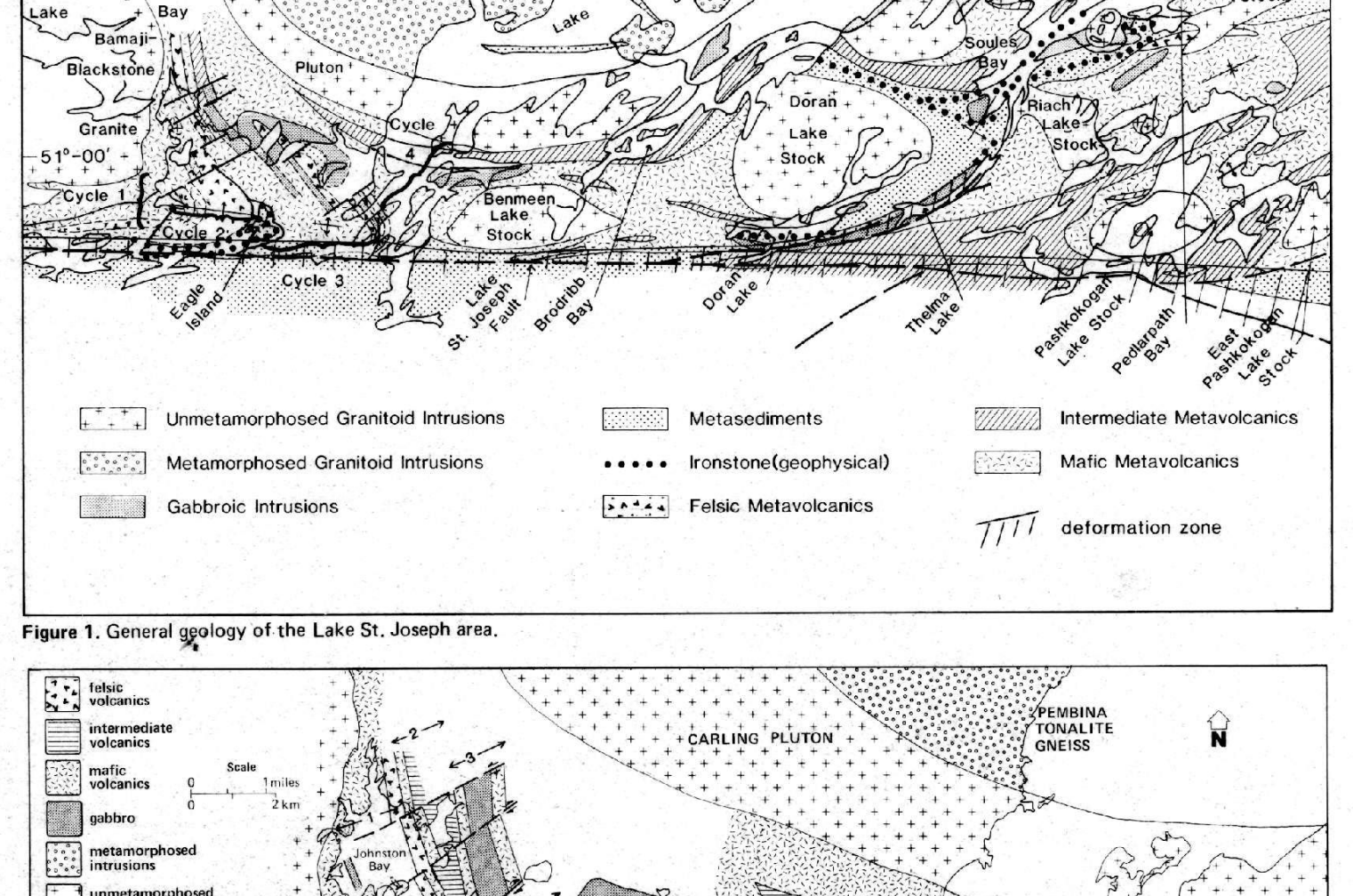


Figure 1. General geology of the Lake St. Joseph area.

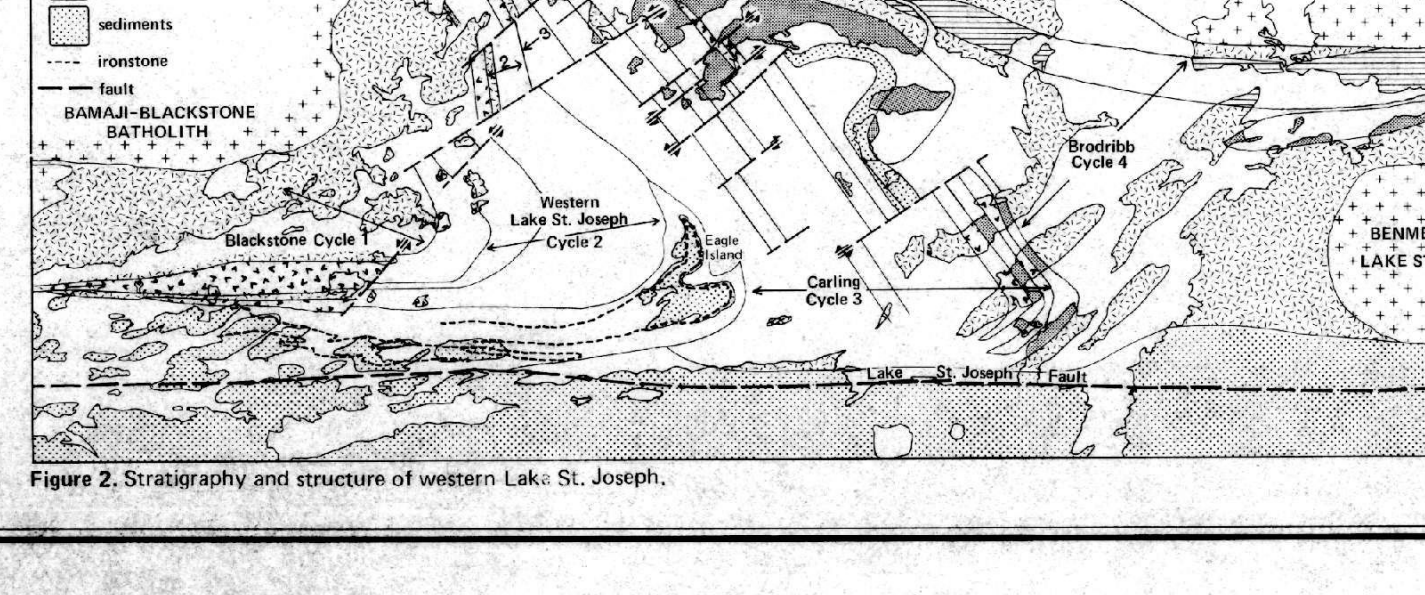


Figure 2. Stratigraphy and structure of western Lake St. Joseph.

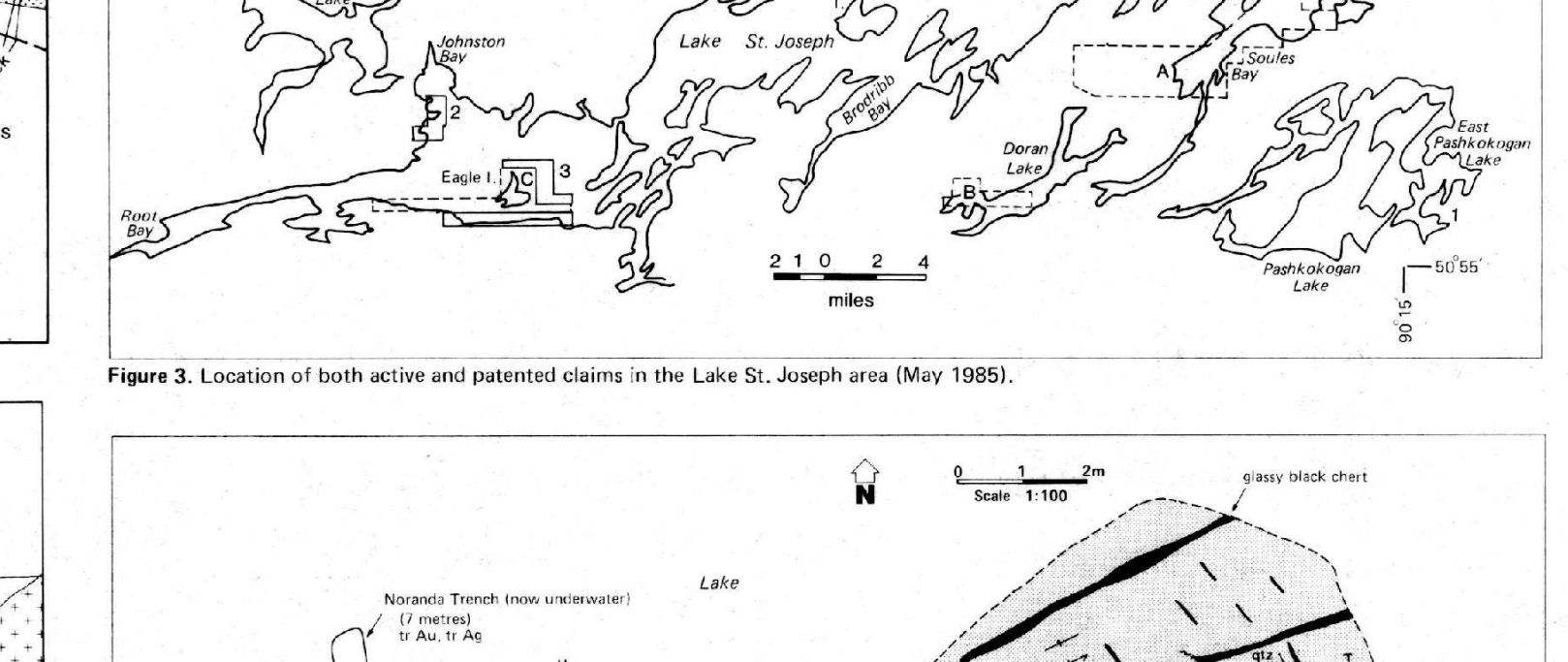


Figure 3. Location of both active and patented claims in the Lake St. Joseph area (May 1985).

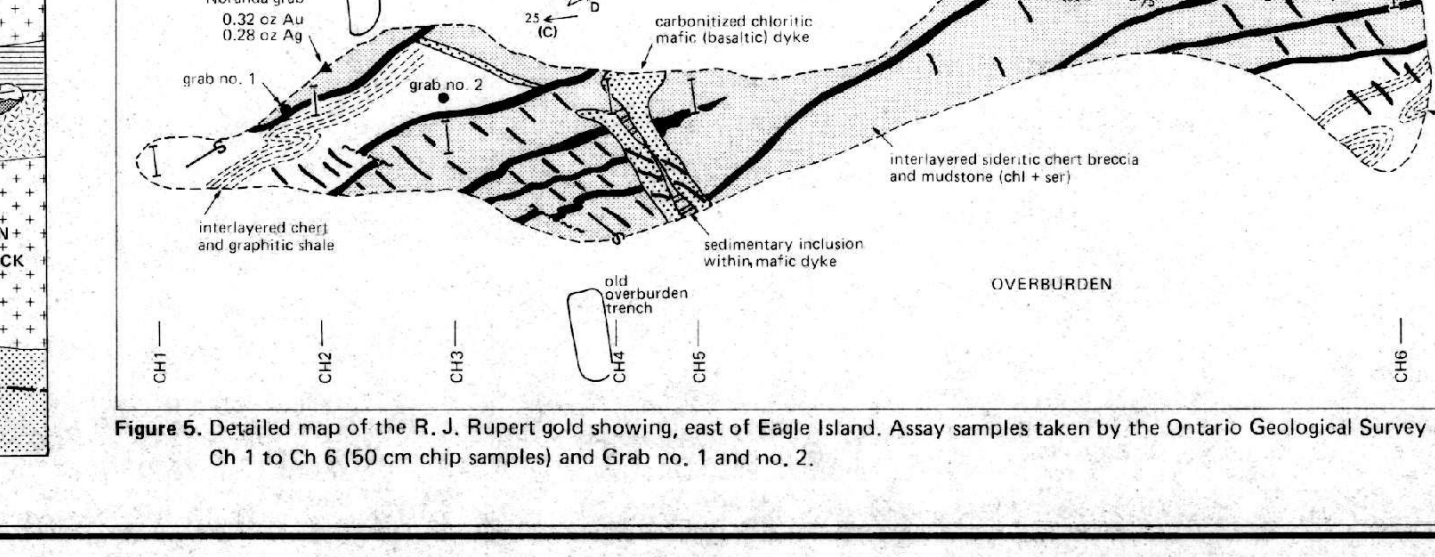
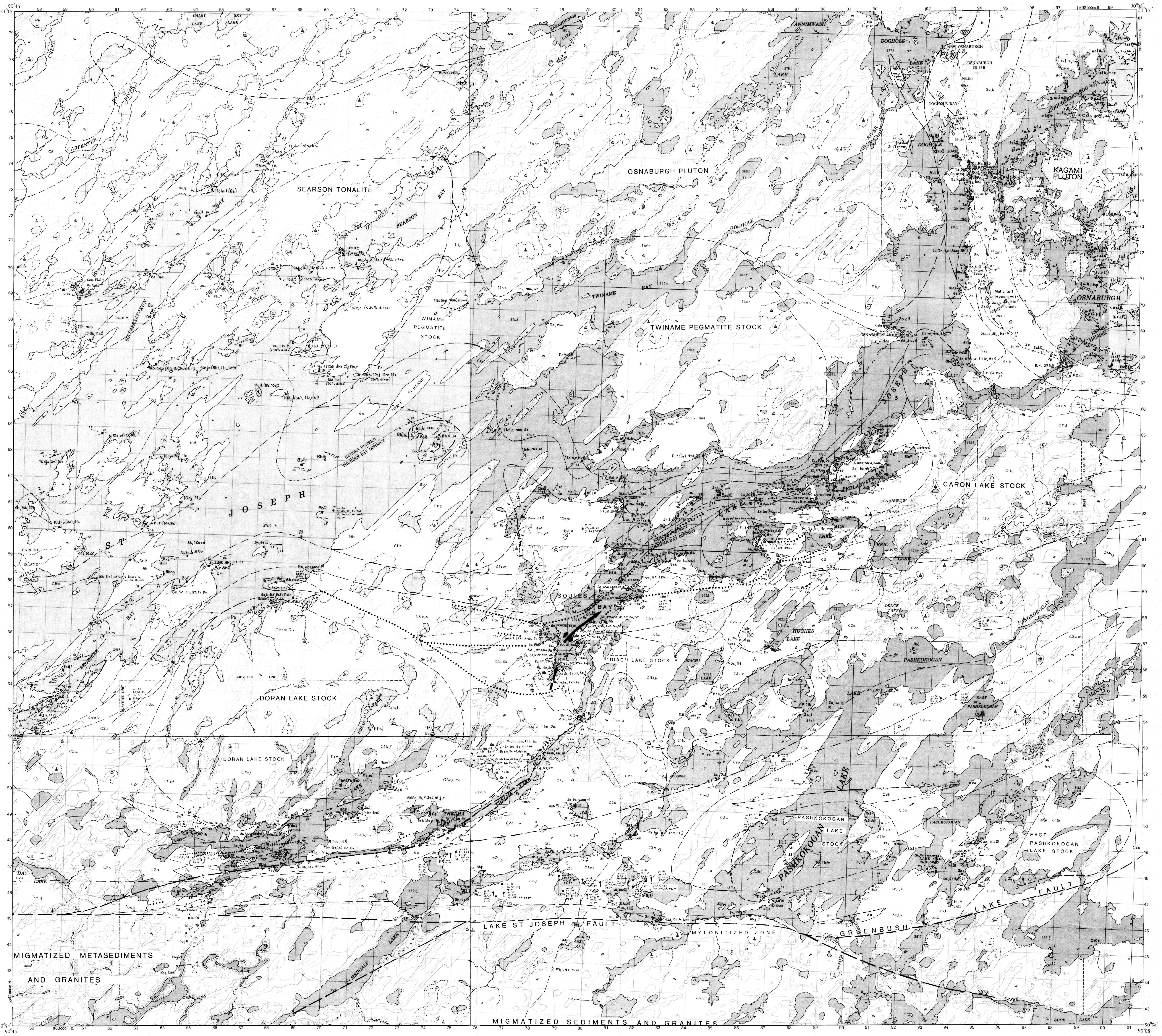

N
0 1 2m
Scale 1:100
glassy black chert
Lake
Noranda Trench (now underwater)
(7 metres)
tr Au, tr Ag
Noranda grab
0.32 oz Au
0.28 oz Ag
grab no. 1
grab no. 2
carbonitized chloritic mafic (basaltic) dyke
qtz vein
folded chert and graphitic shale
interlayered sideritic chert breccia and mudstone (chl + ser)
interlayered chert and graphitic shale
sedimentary inclusion within mafic dyke
old overburden trench
OVERBURDEN
CH1
CH2
CH3
CH4
CH5
CH6

Figure 5. Detailed map of the R. J. Rupert gold showing, east of Eagle Island. Assay samples taken by the Ontario Geological Survey are shown as Ch 1 to Ch 6 (50 cm chip samples) and Grab no. 1 and no. 2.



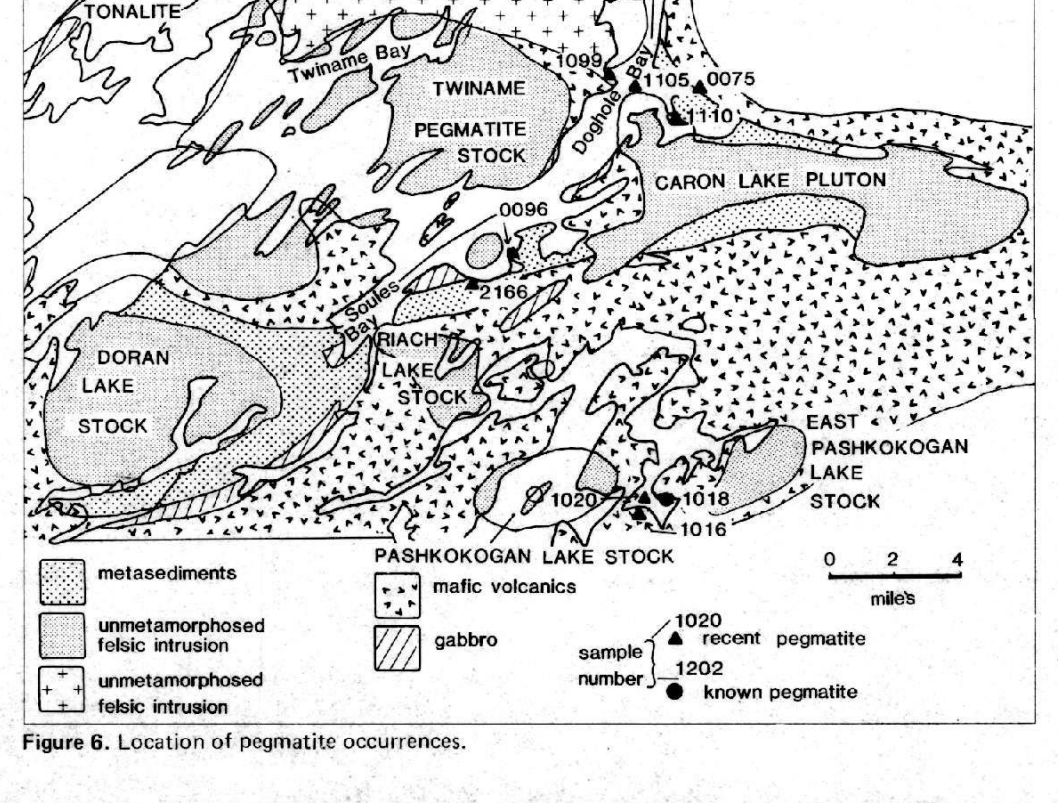


Figure 6. Location of pegmatite occurrences.

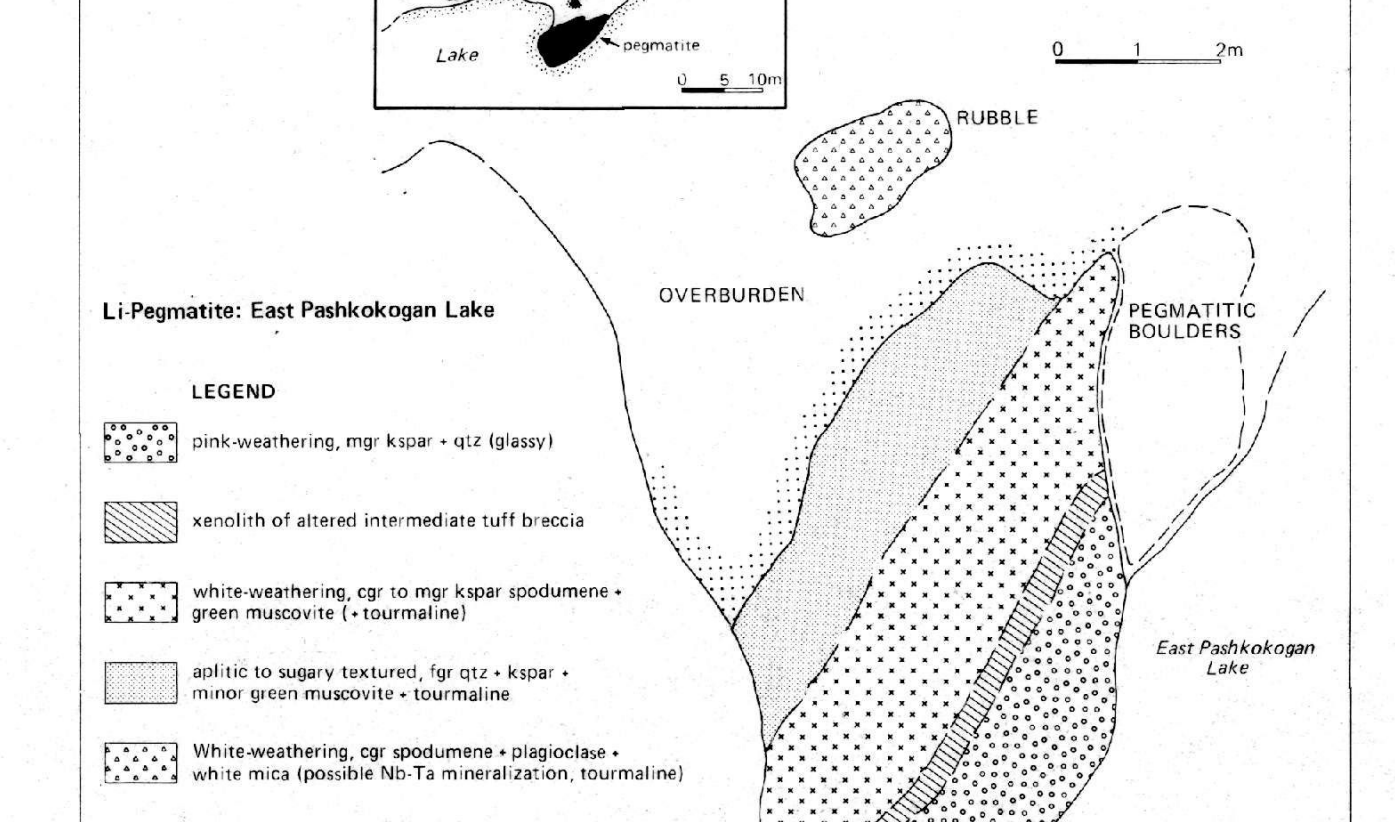

Pegmatite Extension
intermediate tuff breccia
Lake
pegmatite
0 5 10m
N
0 1 2m
RUBBLE
OVERBURDEN
PEGMATITIC BOULDERS
East Pashkokogan Lake
Li-Pegmatite: East Pashkokogan Lake
LEGEND
pink-weathering, mgr kspar + qtz (glassy)
xenolith of altered intermediate tuff breccia
white-weathering, cgr to mgr kspar spodumene + green muscovite (+ tourmaline)
aplitic to sugary textured, fgr qtz + kspar + minor green muscovite + tourmaline
White-weathering, cgr spodumene + plagioclase + white mica (possible Nb-Ta mineralization, tourmaline)

Figure 7. Detailed map of the Fairservice Li-pegmatite occurrence, East Pashkokogan Lake.

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Ministry of
Northern Development
and Mines
Ontario

Ontario Geological Survey
MAP P.3051
Geological Series-Preliminary Map

## PRECAMBRIAN GEOLOGY
# LAKE St. JOSEPH AREA
# East Half
### Districts of Thunder Bay and Kenora (Patricia Portion)

Scale 1:50 000
Mile 1 0 1 Mile
Metres 1000 0 1 Kilometre

NTS References: 52 J/14,15; 52 O/2,3
ODM-GSC Aeromagnetic Maps: 901G, 902G, 911G, 912G
ODM Geological Compilation Maps: 2218, 2442

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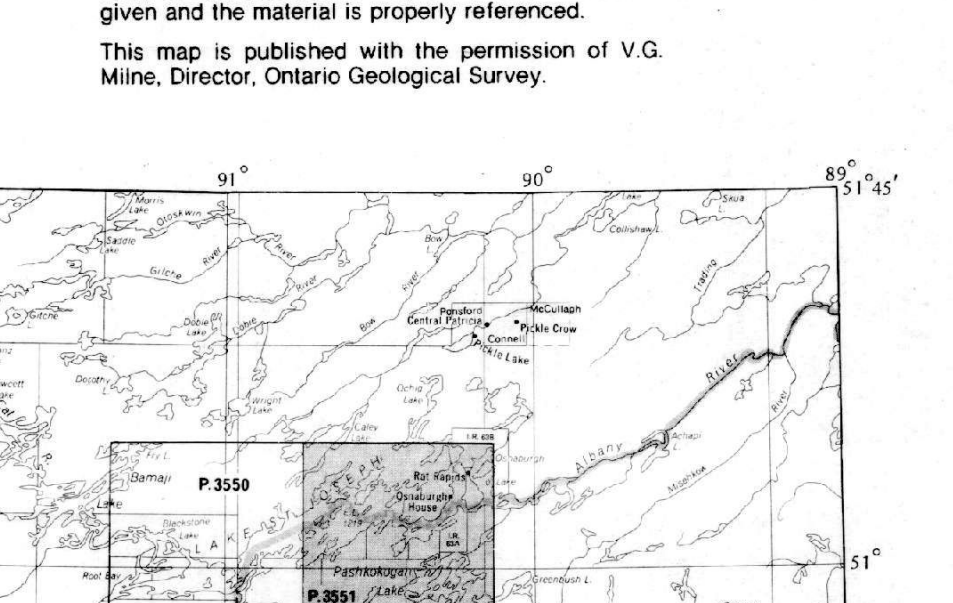

LOCATION MAP
Scale 1:1 548 000 or 1 inch to 25 miles

## LEGEND[a,b]

PHANEROZOIC
CENOZOIC
QUATERNARY
RECENT
Stream, lake, and organic bog deposits
PLEISTOCENE
Eskers, drumlinoids, glacial till

*UNCONFORMITY*

PRECAMBRIAN[c,d]
PROTEROZOIC
MAFIC DIKES

12
- 12a Gabbroic dike
- 12b Ultramafic dike
- 12c Mafic phenocryst-bearing dike
- 12d Plagioclase feldspar-phyric dike

*INTRUSIVE CONTACT*

ARCHEAN
FELSIC INTRUSIVE ROCKS[c]
UNMETAMORPHOSED LATE TO POST-TECTONIC GRANITIC ROCKS

11
- 11a Syenogranite
- 11b Monzogranite
- 11c Granodiorite
- 11d Tonalite, trondhjemite
- 11e Monzonite
- 11f Syenite
- 11g Monzonite
- 11h Diorite
- 11j Granitic rock with amphibole>biotite
- 11k Granitic rock with biotite>amphibole
- 11l Granitic rock with biotite
- 11m Potassic feldspar-megacrystic granitic rock
- 11n Plagioclase feldspar-phyric granitic rock
- 11o Quartz-phyric granitic rock
- 11p Aplite dike or sill
- 11r Granite pegmatite dike or sill
- 11t Xenolith-bearing[d]

*INTRUSIVE CONTACT*

METAMORPHOSED PRE- TO SYNTECTONIC GRANITIC ROCKS

10
- 10a Syenogranite
- 10b Monzogranite
- 10c Granodiorite
- 10d Tonalite, trondhjemite
- 10e Monzonite
- 10f Diorite
- 10g Granitic rock with amphibole
- 10h Granitic rock with amphibole>biotite
- 10j Granitic rock with biotite
- 10k Potassic feldspar-megacrystic granitic rock
- 10l Plagioclase feldspar-phyric granitic rock
- 10m Aplite dike or sill
- 10n Granite pegmatite
- 10o Xenolith-bearing[d]

*INTRUSIVE CONTACT*

METAMORPHOSED FELSIC PORPHYRY INTRUSIVE ROCKS[e]

9
- 9a Quartz porphyry
- 9b Feldspar porphyry
- 9c Quartz-feldspar porphry
- 9d Felsite, fine grained
- 9e Xenolith-bearing[d]

*INTRUSIVE CONTACT*

MAFIC INTRUSIVE ROCKS[c]
METAMORPHOSED MAFIC INTRUSIVE ROCKS

8
- 8a Diorite
- 8b Gabbro
- 8c Leucocratic gabbro (Colour Index <35)
- 8d Melanocratic gabbro (Colour Index >65 and <90)
- 8e Peridotite, hornblendite, pyroxenite
- 8f Plagioclase-phyric mafic intrusive rock
- 8g Quartz-bearing mafic intrusive rock
- 8h Pegmatite
- 8j Xenolith-bearing[d]
- 8k Fine-grained sill, dike

*INTRUSIVE CONTACT*

METAMORPHOSED ULTRAMAFIC INTRUSIVE ROCKS

7
- 7a Peridotite
- 7b Hornblendite
- 7c Pyroxenite

*INTRUSIVE CONTACT*

METAVOLCANICS AND METASEDIMENTS
METASEDIMENTS
Clastic Metasediments

6
- 6a Quartzose arenite
- 6b Feldspathic arenite
- 6c Lithic arenite
- 6d Quartzose wacke
- 6e Feldspathic wacke
- 6f Lithic wacke
- 6g Mudstone (slate/argillite)
- 6h Polymictic conglomerate

Chemical Metasediments

5
- 5 Undifferentiated
- 5a Ironstone
- 5b Ferruginous chert
- 5c Chert, calcareous/dolomitic chert
- 5d Siderite
- 5e Amphibole-rich ironstone
- 5f Graphitic schist

METAVOLCANICS
Felsic Metavolcanics

4
- 4a Massive flow (may include fine-grained ash flow)
- 4b Flow top breccia, flow breccia
- 4c Quartz-feldspar porphyry[f]
- 4d Feldspar-phyric felsic metavolcanics
- 4e Quartz-phyric felsic metavolcanics
- 4f Tuff
- 4g Lapilli tuff
- 4h Lapillistone
- 4j Tuff breccia
- 4k Pyroclastic breccia
- 4l Volcaniclastic sediment (may include tuff and resedimented tuff)
- 4m Crystal tuff

Intermediate Metavolcanics

3
- 3a Massive flow (may include fine-grained ash flow)
- 3b Amygdaloidal intermediate metavolcanics
- 3c Spherulitic intermediate metavolcanics
- 3d Flow top breccia, flow breccia
- 3e Mafic phenocryst-bearing rock
- 3f Feldspar-phyric rock
- 3g Quartz-phyric rock
- 3h Tuff
- 3j Lapilli tuff
- 3k Lapillistone
- 3l Tuff breccia
- 3m Pyroclastic breccia
- 3n Volcaniclastic sediment (may include tuff and resedimented tuff)
- 3o Base surge of ash flow sequence
- 3p Crystal tuff
- 3r Lithic tuff
- 3s Pyroclastic rock with fragments more mafic than matrix
- 3t Pyroclastic rock with fragments more felsic than matrix

Mafic Metavolcanics

2
- 2a Massive flow
- 2b Pillowed flow
- 2c Pillow breccia
- 2d Amygdaloidal flow
- 2e Variolitic flow
- 2f Flow top breccia, flow breccia
- 2g Coarse-grained flow centre
- 2h Mafic phenocryst-bearing rock
- 2j Plagioclase feldspar-phyric rock
- 2k Quartz-phyric rock
- 2l Tuff
- 2m Lapilli tuff
- 2n Lapillistone
- 2o Tuff breccia
- 2p Pyroclastic breccia
- 2r Hyaloclastite
- 2s Pyroclastic rock with fragments more felsic than matrix
- 2t Rusty weathering gossan zone

Ultramafic Metavolcanics

1
- 1a Tuff

Notes:
a) This field legend is subject to changes pending results of subsequent laboratory investigation.
b) Age relationship of rocks coded 1 to 7 are varied.
c) Plutonic rock classification follows the IUGS Subcommission on the Systematics of Igneous Rocks (Streckeisen 1976).
d) Types of xenoliths are shown in ( ) in decreasing abundance where noted.
e) May be extrusive in part.
f) May be intrusive in part.

The letter "C" preceding a code refers to selected data compiled from previous maps of the Ontario Geological Survey in areas of poor outcrop exposure or areas not visited by the present mapping project.

The letter "G" preceding a code indicates that the interpretation is based on geophysical data.

Parentheses ), )), and ))) following a code refer to field estimates of intensity of rock deformation. A semi-quantitative scale of weak, moderate, strong, and intense deformation is used. Most greenstone belt outcrops show a "moderate" degree of deformation and are not labelled as such.

"Weakly-deformed" rocks are indicated by ")"
"Strongly-deformed" rocks are indicated by "))"
Intensely-deformed rocks (typically shear zones which include mylonitic rocks) are indicated by ")))"

The Symbol Legend applies to Lake St. Joseph Area, West Half, Map P. 3050, and Lake St. Joseph Area, East Half, Map P. 3051. Not all units may be present on both maps.

## SYMBOLS

- Esker
- Small bedrock outcrop
- Area of bedrock outcrop
- Bedding, top unknown; (inclined, vertical)
- Bedding, top (arrow) from grain gradation; (inclined, vertical, overturned)
- Lava flow; top (arrow) from pillows shape and packing
- Lava flow; top in direction of arrow
- Gneissosity; (horizontal, inclined, vertical)
- Foliation; (horizontal, inclined, vertical)
- Lineation with plunge
- Crenulation lineation
- Second lineation
- Anticline, syncline (showing strike of axial plane)
- Anticline, with plunge
- S-fold
- Geological boundary, position interpreted
- Fault
- Drillhole; (vertical, inclined with depth of overburden)
- Ironstone horizon
- Marsh; swamp (wooded)
- Spot elevation, precise: land, water
- Contours, Interval 10m
- Wooded area

## ABBREVIATIONS*

| | |
|---|---|
| Ag | silver |
| and | andalusite |
| asp | arsenopyrite |
| Au | gold |
| bio | biotite |
| carb | carbonatized |
| chl | chlorite |
| cp | chalcopyrite |
| ep | epidote |
| gt | garnet |
| hem | hematite |
| mus | muscovite |
| pent | pentlandite |
| po | pyrrhotite |
| py | pyrite |
| ser | sericite |
| serp | serpentine |
| sill | sillimanite |
| spd | spodumene |
| staur | staurolite |
| tour | tourmaline |
| trem | tremolite |

* Both capital (i.e.,"AND") and small (i.e., "and") letters are used for these:
- capital letters for outcrop mineral/metal occurrences
- small letters for drillhole mineral/metal occurrences

## SOURCES OF INFORMATION

Base maps derived from National Topographic Series Sheets 52 J/14, 52 J/15, 52 J/16, 52 O/1, 52 O/2, 52 O/3.

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Magnetic Declination is 0°47'W at Latitude 51°00'N, Longitude 90°30'W, 1985.

## CREDITS

Geology by G.M. Stott, S.V. Kay, and M.M. Sanborn, 1985.

Every possible effort has been made to ensure the accuracy of the information presented on this map; however, the Ontario Ministry of Northern Development and Mines does not assume any liability for errors that may occur. Users may wish to verify critical information. Sources include both the references listed here, and information on file at the Resident or Regional Geologist's Office and the Mining Recorder's Office nearest the map area.

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