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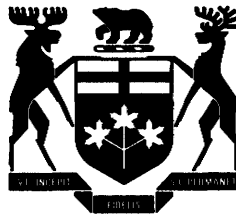
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Geology of the
Bell Lake-Sturgeon Lake Area
Districts of Kenora and Thunder Bay

By

N. F. Trowell

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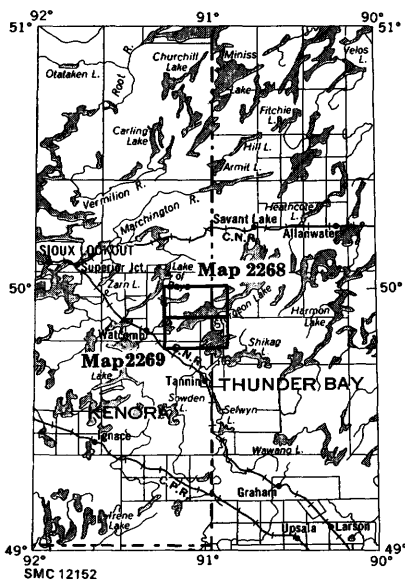
Geological Maps

(back pocket)

- Map 2268 (coloured)—Granite Bay, Kenora and Thunder Bay Districts. Scale 1 inch to ½ mile.
Map 2269 (coloured)—Bell Lake, Kenora and Thunder Bay Districts. Scale 1 inch to ½ mile.

ABSTRACT

This report describes the geology of the Bell Lake-Sturgeon Lake map-area; an area of about 200 square miles located in the Districts of Kenora and Thunder Bay.



**Figure 1—Key map showing location of Bell Lake-Sturgeon Lake Area.
Scale 1 inch to 50 miles.**

The bedrock is of Precambrian age but much of the area is covered by thick Pleistocene and Recent deposits. Volcanic rocks are the oldest rocks in the map-area. They consist of mafic to intermediate and felsic to intermediate lava flows, and pyroclastic rocks. Sedimentary rocks were deposited contemporaneously with, and may in part be derived from, the volcanic succession. The volcanic and sedimentary rocks have been intruded by gabbro, diorite, ultramafic rocks and granitic gneiss. They have been folded about east-west- to northeast-southeast-trending axes, and metamorphosed generally under greenschist but locally under lower almandine-amphibolite facies conditions. Subsequently these rocks were intruded by felsic to intermediate plutons composed of monzonite and granite, and a pluton or possible 'subvolcanic' intrusion composed of granodiorite, trondjemite, and quartz porphyry. A zone of contact metamorphism was locally observed in the country rocks at the margins of these plutons.

Sulphide (pyrite, minor pyrrhotite) mineralization is sparsely distributed in sheared and carbonatized zones in the metavolcanics. Chalcopyrite was noted in a brecciated metagabbro south of Mountain Island Bay and copper, molybdenum, and gold mineralization occur in the granodiorite-trondjemite-quartz porphyry 'subvolcanic' complex. The Mattagami Lake Mines Limited Zn-Cu-Ag-Pb ore body, in Block Number 7 of the Abitibi Power and Paper Company Limited, appears to be stratigraphically localized in a felsic flow and pyroclastic succession.

Geology
of the
Bell Lake-Sturgeon Lake Area
Districts of Kenora and Thunder Bay

by
N. F. Trowell¹

INTRODUCTION

The Bell Lake-Sturgeon Lake map-area is approximately bounded by Longitudes 90°54' and 91°11'W, and Latitudes 49°45' and 49°59'N, an area of about 200 square miles. The centre of this area lies about 42 miles southeast of Sioux Lookout. The map-area is in the Districts of Kenora and Thunder Bay, and in the Patricia and Kenora Mining Divisions.

MEANS OF ACCESS

Highway 599, from Ignace on Highway 17, passes through the western margin of the map-area. Secondary gravel roads, off Highway 599, provide access to Penassi Lake, Cobb Bay, Mountain Island Bay, and Granite Bay. An overgrown tractor trail, on the southern shore of Sturgeon Lake, can be traversed on foot. Sturgeon Lake provides access to a large part of the map-area; it is recommended, for reasons of safety, that only craft of suitable size be used on the lake. Portages provide access from Sturgeon Lake, through Darkwater Lake, to Bell Lake. Air service is available from Ignace and Sioux Lookout. The Thunder Bay-Sioux Lookout route of the Canadian National Railways passes about 3 miles south of the map-area.

PRESENT GEOLOGICAL SURVEY

The map-area was mapped during the summer of 1969 by the author and assistants. Wherever possible, pace-and-compass traverses were run perpendicular to

¹Geologist, Ontario Division of Mines, Toronto. Manuscript accepted for publication by the Chief Geologist, Geological Branch, 8 September 1970.

Bell Lake-Sturgeon Lake Area

the regional foliation, and were spaced 1,500 feet to 2,000 feet apart. The geological field data were plotted on the acetate sheets attached to air photographs (scale 1 inch to $\frac{1}{4}$ mile). These data were then transferred to a base map (scale 1 inch to $\frac{1}{4}$ mile) that had been prepared by the Cartography Section of the Ontario Division of Lands.

Four uncoloured preliminary geological maps, P.588, P.589, P.590, and P.591 at a scale of 1 inch to $\frac{1}{4}$ mile, were published in 1970.

The final coloured maps (Maps 2268 and 2269, back pocket) are at a scale of 1 inch to $\frac{1}{2}$ mile. Geological data provided by mining companies have been included in this report and map.

ACKNOWLEDGMENTS

Assistance in the field was provided by Wooil Moon, the late J. S. Hoad, T. D. McLellan, and William Waychison. Mr. Moon and Mr. Hoad, as senior assistants, were responsible for part of the geological mapping.

K. S. Watson and M. R. McKay of the Great Lakes Paper Company Limited permitted the field party to stay at GLP Camp 326 on Mountain Island Bay.

Chemical analyses and assays were done by the staff of the Mineral Research Branch, Ontario Division of Mines.

PREVIOUS GEOLOGICAL WORK

According to W. McInnes (1900, p.118-120), presumably the first geologist to describe the geology of Sturgeon Lake, gold was discovered on Sturgeon Lake in 1898. A. P. Coleman (1902, p.148), W. G. Miller (1903, p.83-86), W. H. Collins (1907), and E. T. Corkill (1909, p.81-82; 1910, p.79) gave brief accounts of the general geology, gold prospects, and mines in the Sturgeon Lake area. E. S. Moore (1911), T. L. Gledhill (1925, p.19-39), and A. R. Graham (1931, p.36-50) gave fairly detailed descriptions of the geology of Sturgeon Lake. H. C. Horwood (1937b, p.26-35), T. L. Tanton (1940), and D. P. Rodgers (1964) have given the most recent descriptions of the area.

PROSPECTING AND MINING ACTIVITY

W. McInnes (1900, p.118-120) reports that gold-bearing quartz veins were discovered on Sturgeon Lake, in the summer of 1898, by a prospector named Peter King and that a number of claims were staked. Intermittent exploration for gold was carried out during the next few years. The construction in 1909 of the Lake Superior Branch of the Grand Trunk Pacific Railway, and the establishment of steamer lines on Sturgeon Lake to facilitate transportation of materials for railway construction, resulted in increased though temporary exploration activity.

Darkwater Mines Limited was formed in October 1935 to develop certain gold-bearing quartz veins in a granodiorite-trondhjemite body south of Beidelman Bay. In 1936, a mining plant was installed and underground development began. Operations were suspended in 1937 because of low erratic gold values.

In 1966-1967, Steep Rock Iron Mines Limited carried out a program of geological, geochemical, magnetometer, electromagnetic, self-polarization, and induced polarization surveys, as well as trenching and diamond drilling to evaluate the copper-molybdenum mineralization located on the 20-claim group of their Beidelman Bay Property, southwestern Sturgeon Lake.

During the 1969 field season, the Exploration Division of Mattagami Lake Mines Limited began an extensive examination of the several claim groups they had staked in the spring and early summer. Their discovery of a base-metal sulphide deposit in October 1969, on Block No. 7 of the Abitibi Paper Company Limited, has resulted in increased exploration activity that is expected to produce a thorough analysis of the economic potential of the Sturgeon Lake area

NATURAL RESOURCES

The area is mainly covered by a mixed growth of jackpine, spruce, poplar, and birch with cedar prominent in much of the swamp areas. Parts of the area have been extensively cut-over so that very little red or white pine or tamarack is left. At present no lumbering is taking place.

Commercial fishing for pike, pickerel, whitefish, and lake trout is carried out on Sturgeon and Bell Lakes.

The area is easily accessible from Highway 599, and large numbers of tourists use the roads in the area. Pike and pickerel are plentiful in most of the lakes, with lake trout and whitefish present in Sturgeon and Bell Lakes. Perch and ling are also present in Bell Lake.

Spruce grouse, black bear, and moose were seen frequently in the area.

INHABITANTS

The Great Lakes Paper Company Limited maintains a camp on Mountain Island Bay. Tourist camps are located on Cobb and Mountain Island Bays and the southwestern end of Sturgeon Lake.

PHYSIOGRAPHY

The elevation of Sturgeon Lake is 1,342 feet above sea level, and the maximum local relief is never more than 200 feet above this elevation. The relief, though locally reflecting the distribution of the underlying bedrock units, mainly reflects the distribution of the Pleistocene and Recent deposits, i.e. esker-outwash-delta complexes and morainal areas.

Bell Lake-Sturgeon Lake Area

Higher elevations, reflecting bedrock topography, usually occur along the contact of two major rock units (e.g. Penassi Lake granite and intermediate metavolcanic rocks), or they are due to resistant massive rock units such as the granitic gneiss and migmatite assemblages which are exposed south and east of Bell Lake.

The present map-area lies in the drainage basins of the English River and its tributary, the Sturgeon River. The entire region has been glaciated, with the deeper lakes occurring in glacially deepened basins in the bedrock, and the shallower lakes in depressions in the glacial deposits themselves.

Outcrop distribution is variable. Numerous outcrops and good exposure are found to the east and south of Bell Lake where the granitic gneiss and migmatite groups outcrop. A thick cover of overburden covers bedrock between Sturgeon and Bell Lakes and to the east and west of Cobb Bay. In general the felsic intrusive rocks are better exposed than the metavolcanics and metasediments.

GENERAL GEOLOGY

The area is underlain by metavolcanics and metasediments of Precambrian age that are extensively overlain by sand and gravel of glacial origin and by recent accumulations of swamp and muskeg. Much of the southern part of the map-area is underlain by early granitic gneiss and migmatite which are assumed to represent the border facies of a large granitic batholith exposed to the south of the map-area. A folded series of felsic, intermediate, and mafic volcanic rocks, pyroclastics, and sedimentary rocks underlies the central and northern parts of the map-area. These have been metamorphosed under greenschist and locally almandine-amphibolite facies conditions and were intruded by peridotite, gabbro, diorite, and granodiorite gneiss. All these formations have been intruded by younger stocks or plutons of monzonite, granodiorite-trondhjemite, and granite.

None of the rocks have been radiometrically dated and time-rock units have not been used in this report; the terms Keewatin-type and Timiskaming-type can be used, however, to describe the volcanic and sedimentary rocks respectively. The Bell Lake monzonite complex is possibly a younger satellitic intrusion and probably middle or late Precambrian in age; it may be coeval and comagmatic with the Sturgeon Lake alkaline complex, exposed in Sturgeon Narrows.

Rodgers (1964, p.7) reports diabase dikes (Keewenawan-type) of probable late Precambrian age in the Metionga Lake area to the east of the present map-area.

PRECAMBRIAN

Archean

METAVOLCANICS

Volcanic rocks, including flows and pyroclastic units form approximately 90 percent of the metavolcanic-metasedimentary sequence exposed in the map-area. The

Table 1

**TABLE OF LITHOLOGIC UNITS FOR
BELL LAKE-STURGEON LAKE AREA**

CENOZOIC**PLEISTOCENE AND RECENT**

Swamp accumulations; till, clay, sand and gravel

*Unconformity***PRECAMBRIAN****ARCHEAN****LATE FELSIC AND INTERMEDIATE INTRUSIVE ROCKS****BELL LAKE MONZONITE COMPLEX**

Biotite-hornblende-augite monzonite; porphyritic biotite-hornblende-augite monzonite; porphyritic perthitic monzonite; quartz monzonite; biotite pyroxenite; gabbro; lamprophyre; aplite and syenite pegmatite.

BEIDELMAN BAY-BELL LAKE PLUTON

Granodiorite, trondhjemite, porphyritic granodiorite, sericitized and silicified granodiorite, myrmekitic trondhjemite, sodic granite; quartz porphyry, quartz-feldspar porphyry, quartz diorite; quartz-tourmaline, quartz-tourmaline-ankerite, and quartz veins; aplite, diorite.

LATE FELSIC PLUTONS

Sodic granite, trondhjemite, and quartz monzonite; hornblende syenite; quartz-feldspar and feldspar porphyry; pegmatite and aplite.

*Intrusive Contact***EARLY FELSIC INTRUSIVE ROCKS****EARLY GRANITIC ROCKS**

Biotite granodiorite, hornblende-biotite granodiorite, granite, trondhjemite; biotite-hornblende granodiorite; porphyritic biotite granodiorite; aplite and pegmatite.

*Transitional Contact***MIGMATITE ASSEMBLAGE**

Metagabbro, metadiorite, hornblende gneiss, biotite-hornblende gneiss, biotite-hornblende augen gneiss; migmatite; hybrid granitic gneiss.

*Intrusive Contact***EARLY MAFIC INTRUSIVE ROCKS**

Metagabbro, metadiorite; hornblende diorite; quartz-hornblende diorite; peridotite; amphibolite.

METASEDIMENTS

Arkose; greywacke, siltstone; slate; argillite; conglomerate; quartz-magnetite iron formation.

METAVOLCANICS**FELSIC METAVOLCANICS**

Rhyolite, rhyodacite; porphyritic lava; tuff, lapillistone; pyroclastic breccia; carbonate-sericite-quartz and chloritoid schists and phyllites; chert; quartz porphyry, quartz-feldspar porphyry.

MAFIC AND INTERMEDIATE METAVOLCANICS

Fine- to coarse-grained lava flows, chlorite schist; porphyritic lava flows; pillowed lava flows; gneissic volcanic rocks; tuff, lapillistone, pyroclastic breccia; flow-top breccia, flow breccia; chert; tuffaceous sedimentary rocks.

Bell Lake-Sturgeon Lake Area

close association between the pyroclastic and sedimentary rocks suggests a volcanoclastic origin for these sediments. Although mafic and intermediate volcanic rocks predominate, major sequences of felsic volcanic rocks were found; the felsic volcanic sequence exposed in the northern part of the map-area may be younger than the sequence exposed in the southern part of Sturgeon Lake.

Mafic and Intermediate Metavolcanics

Basaltic and andesitic to dacitic flows (Tables 2 and 3 analysis nos. 1 and 2) constitute the bulk of this group. They have been metamorphosed under greenschist facies conditions, and locally under lower almandine-amphibolite, albite-epidote hornfels and hornblende-hornfels facies conditions. Contact metamorphic facies were produced in these rocks by the intrusion of the Late Felsic and Intermediate plutons. Thick sections of mafic and intermediate volcanic rocks are exposed throughout the map-area; no thickness estimates could be made because the rocks appear to be tightly folded and in the southern part of the map-area they are in contact with granitic intrusive rocks over their entire length. These volcanic rocks weather pale green, brown, dark green, or black and on fresh surfaces are green, dark green, or black; the darker colours are commonly a reflection of higher metamorphic grade. The mineral assemblage of the greenschist and albite-epidote hornfels facies typically present in these metavolcanics is plagioclase (An₁₀ or less) + actinolite (locally hornblende) + quartz + epidote ± chlorite ± carbonate ± white mica. Primary calcic plagioclase is rare in rocks of the greenschist facies. Typically the mineral assemblage of the almandine-amphibolite and hornblende-hornfels facies is plagioclase (oligoclase-andesine) + hornblende ± quartz ± epidote ± carbonate ± clinopyroxene ± biotite ± garnet. Accessory minerals include iron-titanium oxide, sphene, pyrite, and pyrrhotite.

Flow contacts were locally observed; flow and flow-top breccia, chert, and inter-flow pyroclastic rocks were used to identify the upper surfaces of flows.

The volcanic rocks are generally foliated. Fine- to medium-grained flows are generally schistose, and gneissic structure is locally developed close to the younger felsic intrusions in the area.

Fine- to medium-grained and coarse-grained flows are equally common; locally the coarse-grained sections resemble gabbro and are considered to represent the coarse inner parts of thick flows. Chlorite schist may develop due to local shearing of fine- to medium-grained flows and pyroclastic units.

Both porphyritic flows and porphyritic zones within flows are locally present. Subhedral plagioclase phenocrysts (now saussurite or sericite pseudomorphs) of variable size are set in a fine-grained matrix of plagioclase, quartz, amphibole, chlorite, epidote, and iron-titanium oxide. Blue-green uralitic amphibole, after pyroxene, rarely exhibits a subophitic texture with plagioclase or replaces in part the plagioclase. The porphyritic flows are generally unfoliated except for a locally subparallel alignment of plagioclase phenocrysts.

Epidote-feldspar-quartz aggregates are abundant in both the coarse-grained and porphyritic flows; the aggregates have a nodular form. These minerals probably crystallized along joint planes in the volcanic rocks as a result of hydrothermal action

Table 2

**CHEMICAL ANALYSES OF ROCKS FROM BELL
LAKE-STURGEON LAKE AREA**

Analysis No. Sample No.	1 6-2B	2 17-39	3 35-1	4 49-31	5 114-7	6 114-4	7 27-28	8 47-10	9 66-21	10 102-2	11 83-3	12 71-35	13 89-1
SiO ₂	50.6	56.2	73.0	72.8	74.2	67.6	49.9	39.2	57.8	57.7	59.6	58.1	53.7
Al ₂ O ₃	15.5	18.9	13.1	10.3	11.9	11.7	14.1	3.62	17.2	15.8	16.0	17.0	13.1
Fe ₂ O ₃	5.59	4.05	0.76	0.52	2.31	2.03	2.39	8.83	3.10	2.86	2.74	3.01	3.54
FeO	6.66	2.33	2.00	0.93	3.60	3.80	6.99	6.19	2.06	2.73	2.26	2.40	5.00
MgO	5.65	1.24	0.93	0.60	1.10	1.53	9.10	27.4	3.00	4.55	2.48	3.18	5.38
CaO	6.31	13.9	1.57	5.40	0.75	3.78	10.7	4.66	4.66	6.22	3.69	5.22	7.35
Na ₂ O	3.91	1.36	3.45	4.05	0.23	1.67	1.72	0.13	4.93	5.06	5.06	5.06	3.72
K ₂ O	0.16	0.12	1.83	0.86	0.86	1.21	0.31	0.07	4.27	3.28	5.24	3.73	3.73
H ₂ O ⁺	2.01	0.23	0.91	0.05	1.89	1.26	1.63	7.25	0.46	0.07	0.26	0.28	0.99
H ₂ O ⁻	0.22	0.12	0.21	0.12	0.21	0.13	0.22	0.45	0.11	0.17	0.16	0.22	0.23
CO ₂	0.81	0.71	0.81	4.66	0.68	4.96	0.33	0.08	0.15	0.34	0.10	0.11	0.31
TiO ₂	1.00	0.40	0.37	0.15	0.32	0.62	0.61	0.17	0.53	0.56	0.54	0.62	0.88
P ₂ O ₅	0.07	0.05	0.06	0.01	0.03	0.57	0.05	0.01	0.33	0.41	0.50	0.34	0.60
S	0.02	0.05	0.01	0.07	0.07	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01
MnO	0.20	0.22	0.05	0.06	0.14	0.17	0.18	0.24	0.10	0.11	0.09	0.10	0.17
TOTAL	98.7	99.9	99.1	100.7	98.3	101.0	98.2	98.3	98.7	99.2	98.9	99.4	98.7
Specific Gravity	2.82	2.82	2.70	2.66	2.63	2.78	2.88	2.82	2.73	2.75	2.66	2.73	2.95
Traces (ppm)													
Ag	1						1	1	2500	2500	2000	3000	3000
Ba	150	150	300	500	80	1000	200		20	20	10	10	30
Co	40	30	4	4	4	10	40	110	200	250	100	150	200
Cr	400	250	15	30	10	10	1500	500	20	10	30	70	80
Cu	90	30	6	50	8	6	20	7	20	30	30	30	30
Ga	30	20	20	20	20	20	20	5					20
Li													
Mo		15							80	90	50	60	90
Ni	110	120	20	20	20	30	240	810	30	30	30	20	15
Pb	30	30	20	20	20	10	50	10		30	30	30	30
Sc	30	30			30	30	30	20	3000	3000	3000	3000	3000
Sr	150	150	50	150	50	300	500		150	100	100	100	100
V	250	150	30			100	150	30	20	20	20	20	150
Y	30	20	30	40	100	30			80	90	80	80	20
Zn	100	200	60	30	140	90	100	60	20	100	20	20	20
Zr	100	100	200	200	1000	300	20	20					

DESCRIPTION AND LOCATION OF ROCKS

Analysis Number	Sample Number	Description (Field)	Location	
			Latitude (degrees)	Longitude (degrees)
1	6-2B	Mafic metavolcanic	49.982	91.066
2	17-39	Epidotized intermediate to mafic metavolcanic	49.908	91.138
3	35-1	Sheared (sodic) rhyolite	49.967	91.094
4	49-31	Sodic rhyolite	49.962	91.044
5	114-7	Quartz-chloritoid phyllite (felsic pyroclastic?)	49.870	91.039
6	114-4	Rhyolite	49.863	91.051
7	27-28	Metagabbro	49.894	91.118
8	47-10	Serpentinized peridotite	49.894	91.088
9	66-21	Monzonite	49.810	90.923
10	102-2	Monzonite	49.814	91.014
11	83-3	Monzonite	49.812	91.039
12	71-35	Monzonite	49.794	90.964
13	89-1	Monzonite	49.807	90.998

Bell Lake-Sturgeon Lake Area

Table 3

MOLECULAR NORMS OF ROCKS FROM BELL

Analysis No. Sample No.	1 6-2B		2 17-39		3 35-1		4 49-31		5 114-7		6 114-4	
	*		*		*		*		*		*	
Quartz	12.61	12.97	51.77	52.11	67.75	72.37	68.24	71.06	74.62	83.70	66.39	73.8
Orthoclase	0.50	0.65	0.36	0.38	3.73	4.20	1.65	2.09	1.24	1.42	1.96	2.6
Albite	18.53	24.25	6.15	6.48	10.68	12.04	11.83	14.95	0.50	0.58	4.10	5.6
Anorthite	12.81	16.77	22.60	23.79	0.76	2.86	0.00	3.04	0.00	0.99	0.00	5.6
Enstatite	19.82	22.40			2.21	2.50	0.46	0.00	1.66	2.13	0.00	3.9
Fe-Pyroxene	6.59	8.62			1.76	1.99	0.47	0.00	2.07	2.38	0.89	3.3
Mn-Pyroxene	0.41	0.54			0.07	0.08	0.08	0.00	0.13	0.15	0.18	0.2
Wollastonite			4.80	7.44				5.56				
Diopside	0.77	4.54	4.31	4.54				1.70				
Fe-Augite			0.18	0.19				0.59				
Mn-Augite			0.44	0.46				0.10				
Forsterite												
Ilmenite	1.84	2.44	0.70	0.74	0.44	0.50	0.17	0.22	0.27	0.31	0.59	0.8
Magnetite	5.14	6.73	3.56	3.74	0.46	0.52	0.30	0.38	0.98	1.13	0.97	1.3
Calcite	2.70	0.00	2.26	0.00	1.77	0.00	8.70	0.00	0.86	0.00	4.11	0.0
Mg-Calcite							0.90	0.00	0.19	0.00	2.89	0.0
Fe-Calcite											1.58	0.0
Apatite	0.05	0.06	0.03	0.04	0.03	0.03	0.00	0.01	0.01	0.01	0.20	0.2
Pyrite	0.05	0.06	0.11	0.12	0.02	0.02	0.24	0.30	0.07	0.09	0.01	0.0
Corundum					4.34	2.90	2.40	0.00	7.04	7.12	5.71	2.1
Unused H ₂ O	18.18	0.05	2.72	0.00	5.96	0.00	4.57	0.00	10.35	0.00	10.43	0.0
Normative Plagioclase Composition	An ₄₁	An ₃₉	An ₇₉	An ₇₉	An ₇	An ₂₀	An ₀	An ₁₇	An ₀	An ₇₂	An ₀	An ₄

* Molecular Norms — H₂O and CO₂ are deleted and other components are recalculated 100 percent.

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13	89-1	Monzonite	49.807	90.998

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7		8		9		10		11		12		13	
27-28		47-10		66-21		102-2		83-3		71-35		89-1	
*	*	*	*	*	*	*	*	*	*	*	*	*	*
7.92	8.26	0.00	0.00	2.73	3.69	0.00	0.00	3.69	5.89	3.75	5.18	0.00	0.00
1.00	1.22	0.14	0.24	13.25	21.85	11.42	17.05	15.34	26.79	12.13	18.62	11.55	19.11
8.44	10.28	0.40	0.68	23.25	38.34	26.78	39.97	22.52	39.32	25.01	38.39	17.51	28.96
6.31	19.87	3.12	5.31	6.40	10.56	6.31	9.42	2.71	4.73	6.97	10.70	4.21	6.94
2.95	26.56	24.18	40.23	6.77	10.34	6.30	3.83	4.05	6.53	6.40	9.24	3.31	0.37
1.34	13.81	2.79	4.74	0.36	0.60	2.12	3.11	1.02	1.78	1.02	1.56	5.29	8.75
0.37	0.47	0.19	0.32	0.21	0.34	0.25	0.38	0.18	0.31	0.22	0.33	0.35	0.58
1.39	15.27	4.62	8.16	4.11	7.60	9.03	15.37	4.43	8.28	5.68	9.31	11.83	21.26
		18.08	31.05			1.56	4.22					2.17	5.29
1.16	1.42	0.13	0.22	0.97	1.60	1.15	1.72	0.93	1.63	1.19	1.83	1.61	2.66
2.28	2.77	5.29	8.90	2.84	4.68	2.94	4.38	2.37	4.13	2.89	4.43	3.23	5.35
1.14	0.00	0.17	0.00	0.50	0.00	1.27	0.00	0.31	0.00	0.38	0.00	1.03	0.00
0.04	0.04	0.00	0.01	0.23	0.37	0.32	0.47	0.32	0.57	0.26	0.38	0.41	0.68
0.02	0.03	0.03	0.05	0.02	0.04	0.03	0.04	0.02	0.04	0.02	0.04	0.02	0.04
5.63	0.00	40.85	0.00	38.37	0.00	30.49	0.00	42.11	0.00	34.09	0.00	37.49	0.00
n ₈₈	An ₈₈	An ₈₉	An ₈₉	An ₂₂	An ₂₂	An ₁₉	An ₁₉	An ₁₁	An ₁₈	An ₂₂	An ₂₂	An ₂₀	An ₂₀

Bell Lake-Sturgeon Lake Area

involving secondary silicification and epidotization (Mountain Island Bay and Granite Bay granites might possibly be the source of these hydrothermal fluids); deuteritic alteration might also be partly responsible for the formation of these mineral aggregates.

Intermediate to mafic pyroclastic rocks were found both as thin interflow units and as major units within the predominantly mafic flow sequence. They are generally tuff and lapillistone. Very little pyroclastic breccia was found. An intermediate lapillistone unit, exposed between Mountain Island and Granite Bay, has a colour-banded appearance due to accentuation of an original layering (bedding) by metamorphic differentiation. Few felsic to intermediate clasts are present in the chloritic to amphibolitic matrix of this lapillistone unit. Embayed quartz and feldspar phenocrysts are present and some phenocrysts have been cataclastically deformed. This unit is highly epidotized and is cut by irregular masses of quartzofeldspathic material (not shown on Map 2268, back pocket), and by granitic dikes.

A zone of highly sheared mafic tuff and lapillistone is exposed along the shores of the southwestern arm of Sturgeon Lake. These rocks consist of lenticular fragments of pink, crystalline, felsic rock set in a matrix of dark green chloritic schist. In thin section the matrix of the tuff and lapillistone consists of crushed plagioclase and quartz phenocrysts in a chlorite-epidote-rich groundmass; carbonate and pyrite (euhedral disseminated cubes) are abundant.

An assemblage of mafic flows and pyroclastic rocks, exposed north of Bell Lake, has been metamorphosed under hornblende-hornfels facies conditions. The pyroclastic units were distinguished by the presence of rare felsic fragments and on the assumption that the compositional banding represents original layering (bedding). Metamorphic differentiation is believed to have accentuated original layering; dark green hornblende-rich layers alternate with pale green plagioclase layers. Light coloured plagioclase layers contain quartz, muscovite, and biotite, whereas the dark green layers contain hornblende, clinopyroxene, \pm biotite; accessory minerals include iron-titanium oxide, leucoxene, sphene, and epidote.

An unusual pyroclastic unit shown on the map as the 'Mafic Pumice Pyroclastic Unit' is located north of Darkwater Lake. This unit is lenticular and contains lapilli to lapillistone size fragments of what may be preserved pumice. The unit weathers dark black to green and has a nodular surface due to the differential weathering of matrix and fragments. Locally this unit is poorly bedded and contains what could be preconsolidation slump structures. The fragments are subangular to subrounded in shape. Ash tuff beds are locally present. In thin section the matrix of this 'Mafic Pumice Pyroclastic Unit' contains corroded, subangular, and fractured plagioclase (oligoclase) phenocrysts set in a matrix of fine-grained quartz, biotite, chlorite, carbonate, titaniferous magnetite, and iron oxide. The pumice fragments contain quartz and feldspar filled vesicles. It has also been suggested (L. D. Ayres, personal communication) that these could be fragments of a unit that originally crystallized with a granophyric texture. Since pumice fragments are rarely preserved due to the effects of compaction and metamorphism it seems that the vesicular spaces would have to be filled almost immediately after deposition, possibly by siliceous solutions percolating through the volcanic pile.

Flow-top breccia and flow breccia were locally found within the mafic and intermediate volcanic rocks; where poorly exposed, these breccias were distinguished with difficulty from pyroclastic breccia. The breccia fragments are angular (Photo 1) to subrounded (Photo 2) and vary in size from less than 1 inch to more than 10



Photo 1—Intermediate to mafic flow breccia or flow-top breccia zone of subangular to angular fragments (light) in fine-grained matrix (dark) of approximately the same composition; on Highway 599, approximately ¾ mile south of turnoff to GLP326.

ODM 8871

Photo 2—Intermediate to mafic flow breccia or flow-top breccia zone of subrounded fragments (light) in fine-grained matrix (dark) of approximately the same composition; just west of Highway 599, approximately ⅙ mile south of turnoff to GLP326.



ODM 8872

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ODM 8873

Photo 3—Bun-shaped vesicular pillow surrounded by 2 inch fine-grained selvage; on Highway 599 at turnoff to GLP326.

inches; they weather white, pale grey and pale green and are set in a darker coloured matrix of approximately the same composition as the fragments.

Pillowed flows are locally abundant within the mafic and intermediate volcanic sequence; they are exposed in a number of places including west of Mountain Island Bay, on Mountain Island, and south of Cobb Lake. Thin, pillowed flows are commonly separated by fine- to medium-grained flows. Pillows are generally bun- to balloon-shaped (Photo 3) and are approximately 2 to 4 feet long by 1 foot to 2 feet wide; where they are deformed their length to width ratio appreciably increases but rupture of the pillows does not occur. Commonly they have a 1- to 2-inch wide fine-grained selvage and both vesicular and non-vesicular pillows were noted.

Amygdaloidal flows and amygdaloidal zones within flows are uncommon in the mafic and intermediate volcanic sequence. Generally the amygdules are ellipsoidal in shape and vary in size from 1 mm to 10 mm; commonly they are filled with quartz \pm carbonate \pm epidote.

North of the eastern edge of Darkwater Lake pillowed and amygdaloidal intermediate volcanic rocks grade eastward into pillow breccia in which small isolated pillows are set in a fragmental matrix.

The pillows (tops to the north) are roughly bun-shaped and have a 1-inch thick chloritic selvage. Where the pillows are distorted (folded) they have been drawn out and possess dimensions of up to 8 feet by 1 foot. Some of the pillows have a compact central core with an outer amygdaloidal zone. In the amygdaloidal lava the vesicles are filled with quartz, carbonate, quartz + carbonate, or quartz + carbonate + chlorite. The amygdules vary from $\frac{1}{10}$ to $\frac{1}{2}$ inch in diameter. The amygdaloidal

rocks are cut by quartz pods, and quartz and quartz-epidote veins. Chloritic and locally epidotic alteration is marked. Locally secondary blue quartz eyes are present. Intermediate (andesitic) sills (not shown on Maps 2268 and 2269, back pocket) are locally present and appear to be comagmatic with the enclosing pillowed and amygdaloidal flows.

Local interflow chert bands occur (only one band shown on Map 2268, back pocket) within this volcanic sequence. A chert band and lean iron formation is exposed on Highway 599, approximately $\frac{3}{4}$ mile north of the turnoff to GLP 326; this unit varies in width from 4 feet to more than 30 feet.

Migmatite has developed in the mafic and intermediate volcanic assemblage along the contact with Early Granitic Rocks. Granitic material intruded the volcanic rocks to produce a contact zone, 500 to 1,000 feet wide, of migmatitic volcanic rocks which grade into granitic migmatite.

Tuffaceous sedimentary rocks were found on islands in the northeastern part of Sturgeon Lake. They locally show a transitional contact to greywacke-type sedimentary rocks.

Felsic Metavolcanics

Felsic metavolcanics have been metamorphosed under greenschist and locally under lower almandine-amphibolite facies conditions, and were derived from pyroclastic deposits and flows of rhyodacite to rhyolite composition (Tables 2 and 3, analysis nos. 3, 4, 5, and 6). On fresh surfaces these rocks are white, pale green, brown, or black; they weather white, pale yellow, green, grey, or brown.

Pyroclastic deposits comprise tuff, which has a grain size less than 2 mm; lapillistone which has fragments between 2 mm and 64 mm, and pyroclastic breccia which contains fragments larger than 64 mm (Fisher 1961).

Some of the tuff units are well bedded, but in general, pyroclastic deposits appear to be poorly sorted and thick bedded. The flows are locally flow banded. Most exposures have a weak foliation defined by the subparallel alignment of mineral grains; locally they possess a schistosity or gneissic structure.

Felsic metavolcanics were distinguished in the field by their colour index; locally some thin, concordant, intermediate to felsic rock units are grouped with the felsic volcanic rocks.

A predominantly felsic to intermediate volcanic formation is exposed between Darkwater Lake and the southern shore of Sturgeon Lake. Pyroclastic material predominates in this formation but flows are locally present on the northern side. This formation may also contain minor flows and tuffaceous sediments. The pyroclastic rocks consist of pyroclastic breccia, tuff-breccia, lapillistone, and tuff (ash and lapilli). Quartz, quartz feldspar, and feldspar porphyry are also probably of pyroclastic origin (crystal and crystal lithic tuff), but possibly also locally of intrusive origin.

The local presence of welded(?) units, eutaxitic texture, and pumiceous fragments indicates that these pyroclastic rocks might be wholly or, in part, of 'ash-flow' origin. Eutaxitic texture was described by Ross and Smith (1961, p.4):

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Eutaxite, eutaxitic.—Fritsh and Reiss (1868, p.414) proposed the name eutaxite for a volcanic rock composed of ejected fragments of different colours, and texture as follows: 'The different fractions in general lie beside one another as streaks, bands, and lenses in seemingly well ordered distribution'.

Alteration and metamorphism have destroyed most of the microscopic textures of these rocks and thus it will be very difficult to come to any specific conclusions about their origin. The close association of these rocks with mafic pillow lavas indicates that these rocks were possibly deposited in a subaqueous environment.

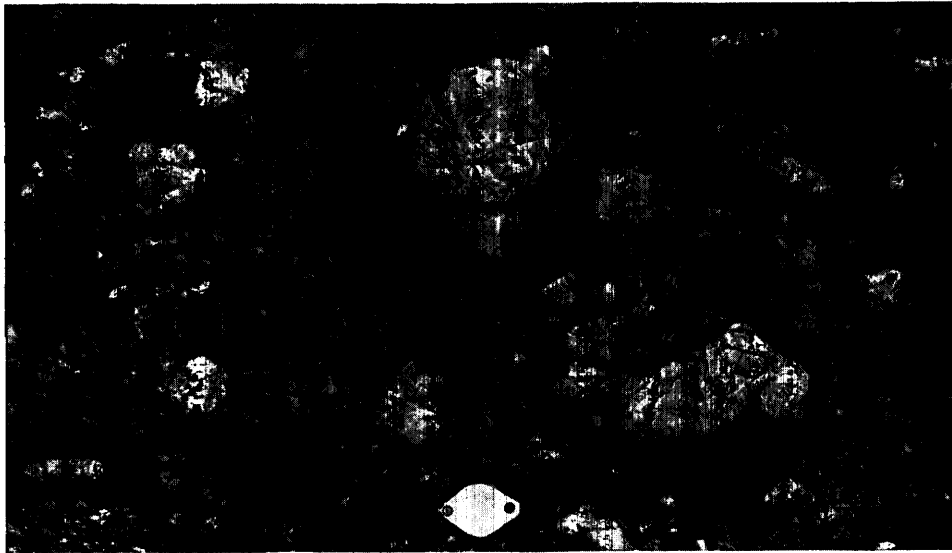
These felsic to intermediate metavolcanics have the following mineralogical composition: quartz + plagioclase (albite-oligoclase) + sericite (muscovite) \pm chlorite \pm biotite \pm chloritoid \pm clinozoisite \pm garnet \pm carbonate (calcite, siderite, ankerite, or dolomite). Accessory minerals include titaniferous magnetite, ilmenite, hematite, pyrite, pyrrhotite, chalcopyrite, rutile, zircon, and tourmaline. Kyanite and possibly andalusite were found locally. The felsic rocks are characterized by quartz phenocrysts and minor chlorite \pm biotite. The intermediate rocks contain quartz and feldspar phenocrysts and a greater amount of chlorite \pm biotite compared to the felsic rocks.

The felsic rocks are generally granoblastic-polygonal (Spry 1969, p.186) to porphyritic with a superimposed schistosity or foliation. The quartz and plagioclase phenocrysts are generally subhedral, rounded to subangular, corroded, and occasionally fractured. The plagioclase phenocrysts are sericitized and locally zoned. Sericite (muscovite) is generally fine grained and occurs interstitially or in aggregates. Chloritoid occurs as subhedral to euhedral lath-shaped phenocrysts and as rosette or sheaf-like aggregates. The chloritoid porphyroblasts (poikiloblasts) are randomly oriented and cut across the foliation. The foliation is marked by the parallel alignment of sericite flakes. The poikiloblasts contain a variety of inclusions, some identifiable as carbonate, quartz, magnetite, or iron oxide. They have very corroded borders and are locally mantled by chlorite; occasionally they are cut by carbonate. The sulphide minerals occur as disseminated grains, blobs, veinlets, and stringers. Titaniferous magnetite and ilmenite occur interstitially but hematite occurs as a dusting on the other mineral grains or in crosscutting wisps. Carbonate occurs interstitially as blobs and as crosscutting veinlets and stringers.

As mentioned above chloritoid metacrysts were locally found in these felsic pyroclastic rocks. Chloritoid is both a group name used for hydrous iron aluminum silicates having the general composition $\text{FeO} \cdot \text{Al}_2\text{O}_3 \cdot \text{SiO}_2 \cdot \text{H}_2\text{O}$ in which Fe^{2+} can be replaced by Mg^{2+} and (or) Mn^{2+} , Al^{3+} by Fe^{3+} , and OH^- by F^- , and a mineral name referring to the ferrous end-member of the group and having the composition $\text{FeO} \cdot (\text{Al,Fe})\text{O}_3 \cdot \text{SiO}_2 \cdot \text{H}_2\text{O}$. It is a polymorphic mineral occurring in both the monoclinic and triclinic systems. It is pleochroic (X=green, Y=blue, Z=colourless to yellow); typically polysynthetically twinned; and commonly zoned. Its stability is controlled by temperature, total pressure, pH_2O and pO_2 .

Halferdahl (1961, p.110) ascribes the formation of chloritoid to a process called 'stratic metamorphism', that is, it is formed in rock units having a composition that fits the following parameters (Halferdahl 1961, p.110, 111): (1) the percentage of SiO_2 varies widely; (2) the ratio of Al_2O_3 to $\text{Fe}_2\text{O}_3 + \text{FeO} + \text{MnO} + \text{MgO}$ generally lies between 1 and 3; (3) the sum of Al_2O_3 and $\text{Fe}_2\text{O}_3 + \text{FeO} + \text{MgO} + \text{MnO}$ is greater than the sum of $\text{K}_2\text{O} + \text{Na}_2\text{O} + \text{CaO}$; and (4) the sum of $\text{FeO} + \text{MnO}$ is greater than both MgO and Fe_2O_3 .

The local presence of up to 1 percent fine-grained, euhedral, inclusion-riddled tourmaline is not unusual but may be of significance in relating the felsic volcanic



ODM 8874

Photo 4—Angular white (cherty) felsic fragments of lapillistone to pyroclastic breccia size set in a fine-grained felsic to slightly intermediate tuffaceous matrix; east side of Highway 599, just south of junction of Highway 599 and Elva Creek.

rocks to the possible epizonal 'subvolcanic' Beidelman Bay-Bell Lake intrusive complex that is characterized by the development of quartz-tourmaline-(pyrite) veins.

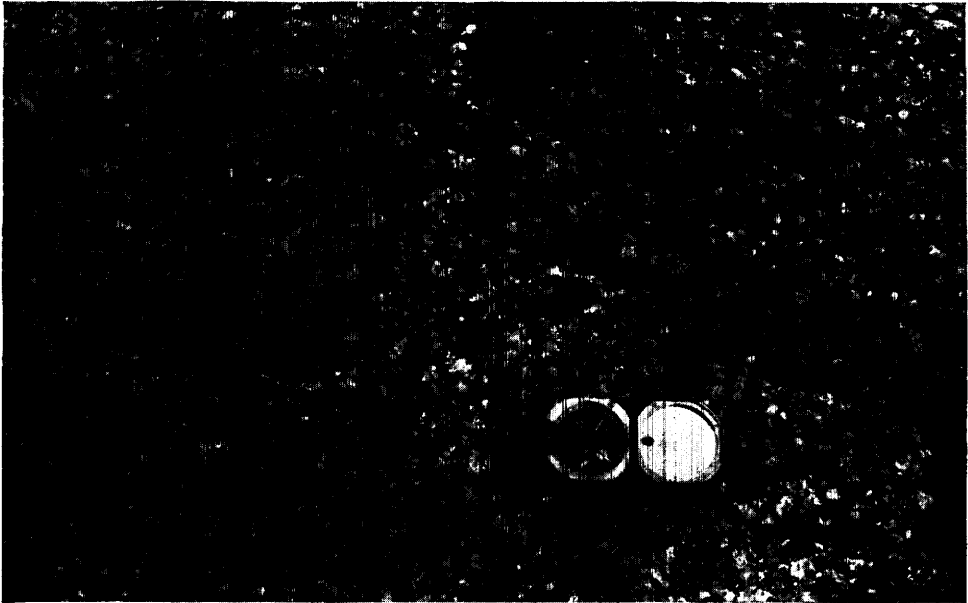
It is difficult to determine the order of formation of the various alteration and metamorphic minerals. It appears that the rocks were first sericitized and possibly carbonatized. Chloritoid may have formed later (post-kinematic). Carbonatization might have occurred once or several times.

The fragments in these pyroclastic rocks are variable in size but generally lie within the size range encompassed by lapilli-tuff to lapillistone although ash-tuff and tuff-breccia to pyroclastic breccia (agglomerate) are locally abundant.

A unit consisting of intercalated pyroclastic breccia and lapillistone is exposed along the northern shore of Darkwater Lake. Rectangular blocks (150 mm by 65 mm), fusiform bombs (65 mm in diameter), and subrounded to subangular lapillistone-sized fragments occur in a tuffaceous matrix. The fragments are fine grained, grey-green in colour, and appear to be of felsic to intermediate composition. The fragments have very fine-grained margins due either to chilling or to post-depositional hydrothermal action. In zoned fragments, the central core has been easily weathered leaving the marginal zone in relief. The abundance of fragments in these pyroclastic rocks varies greatly. They are identified with difficulty in thin section due to extensive secondary alteration.

A mixed unit of pyroclastic breccia and lapillistone is exposed south of the junction of the creek that flows into Elva Lake, and Highway 599 (Photo 4). The

Bell Lake-Sturgeon Lake Area



ODM 8875

Photo 5—Felsic lapillistone tuff unit with large scale salt and pepper texture; east side of Highway 599, just south of junction of Highway 599 and Elva Creek.



ODM 8876

Photo 6—Chilled contact between intermediate flow (right) and felsic pyroclastic breccia (left). Note apophysis of flow extending into pyroclastic breccia. Orientation of flow possibly defines primary bedding; shore of Elva Lake south of mouth of Elva Creek.

pyroclastic breccia zone contains fragments that are subangular to subrounded in shape, and which vary in size from 35 mm to 3 m; 25 to 35 percent of this unit consists of fragments greater in size than 64 mm, and fragments less than 64 mm comprise 10 percent. The fragments are predominantly felsic in composition and at least three varieties could be distinguished: (1) fine-grained, blue-grey, irregularly fractured chert; (2) white (feldspar-) quartz porphyry; (3) sausage-shaped mafic volcanic clasts. This unit might in fact be more accurately described as a volcanic conglomerate due to the variety of included fragments. Lapillistone-size fragments in this pyroclastic unit increase in relative abundance to the south (Photo 5). Pink felsic fragments in this lapillistone unit are enclosed in a green to black matrix. In thin section, these fragments are distinguished by the presence of hematite dust on their outer surfaces. The fragments have the following mineral assemblage: albite + quartz + white mica \pm epidote \pm chlorite \pm leucoxene. The matrix is slightly more chloritic. This unit is strongly jointed but not foliated. A thin intermediate flow (Photo 6) is present within this mixed pyroclastic unit. The strike length of this flow possibly defines the bedding of the unsorted pyroclastic rocks.

Lapillistone units, located on the islands just north of the southern shore of Sturgeon Lake, east of Beidelman Bay, are characterized by elliptical fragments of porphyritic rock in a crystal tuff groundmass. These phenocrysts in the groundmass are generally corroded or embayed, subangular to subrounded, and have been locally fractured.

The felsic flows exposed between the southern shore of Sturgeon Lake and Dark-water Lake are characterized by the same colours of fresh and weathered surfaces as are the pyroclastic deposits. Shearing and carbonatization has transformed most of these flows to carbonate-sericite(muscovite)-quartz schists (phyllites).

Porphyritic (quartz phenocrysts) felsic lava, and cherty zones (not shown on Maps 2268 and 2269, back pocket) are common within this zone of felsic flows. Rock fragments, recognized in some thin sections of rocks identified in the field as felsic flows, indicate that this northern part of the felsic volcanic unit may consist of flows interlayered with possible ash-flow deposits. Local quartz \pm carbonate \pm pyrite veins cut these felsic flows and pyroclastics; the source of this vein material might be the Beidelman Bay-Bell Lake granodiorite-trondhjemite body exposed to the south.

A felsic metavolcanic sequence exposed in the northwestern and north-central parts of the map-area consists of flows, pyroclastic deposits, metasediments, and some porphyritic rocks that in part may be of intrusive origin.

Isolated lenses of interbedded quartz-eye arkose and argillite are exposed throughout this sequence (Photos 7, 9). The author believes that these units were originally formed as a result of rapid erosion of pyroclastic materials with concomitant deposition in shallow restricted basins, or depressions.

A mixed unit of tuff, lapillistone, and pyroclastic breccia that is exposed on the southern shore of Cobb Lake has a eutaxitic texture possibly indicative of a deformation welded tuff. This texture was observed in several outcrops.

The fragments have been deformed by shearing parallel to the original layering (bedding); in one zone within this unit the clasts have been deformed to the extent that the rock now has the appearance of a flow-banded rhyolite. In thin section this banding appears to reflect differences in grain size rather than compositional variation. In the less deformed rocks within this unit, fragments and matrix can be distinguished in thin section by textural and compositional differences, and by the occasional rimming of the fragments by iron oxide.

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ODM 8877

Photo 7—Dark argillaceous and light laminated cherty units interlayered between mafic to intermediate volcanic flows (dark massive unit at bottom of photo is part of one flow). The sedimentary units are cut by several faults (fault plane orientation: N10°E/90°); on west shore of western bay of Cobb Bay.



Photo 8—Intermediate pyroclastic breccia consisting of angular fragments of intermediate composition in felsic tuffaceous matrix; on Highway 599, approximately 2,000 feet south of turnoff to Cobb Bay.

ODM 8878



ODM 8879

Photo 9—Interbedded greywacke and laminated argillite. Massive thick-bedded siltstone unit (under compass) separates thin-bedded laminated units. Graded bedding indicates tops to the north (top of photo); island in Sturgeon Lake, 2¼ miles east-northeast of northern tip of Big Island.

This unit can be traced west to McLeod Lake and east to Cobb Bay; similar rocks exposed on the western side of McKee Lake might represent a continuation of this unit. Quartz porphyry and quartz-feldspar porphyry material within this unit might be pyroclastic or intrusive in origin.

Scattered exposures of pyroclastic rocks occur throughout both the northern felsic and the mafic to intermediate volcanic sequences (Photo 8). Rounded fragments (agglomerate) in the pyroclastic breccia units indicate that these units are probably of ash-fall origin. Felsic flows are present locally; flow-banding is poorly developed or absent.

Both intrusive and extrusive quartz, quartz-feldspar and feldspar porphyry appear to be present within this northern sequence. The extrusive and intrusive types cannot be distinguished except where crosscutting relationships are exposed. This intrusive porphyritic material may be associated with a postulated high-level intrusion, which partially underlies the northern part of the map-area, or it may be associated with the felsic to intermediate volcanic rocks exposed in this area. This high-level intrusion is more fully discussed in the section on Late Felsic Intrusive Rocks.

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The extrusive porphyritic material occurs both as flows and pyroclastic rocks. The rock weathers white, pink, pale yellow, and pale green. Blue opalescent quartz eyes are abundant and feldspar phenocrysts are usually present. The phenocrysts are generally angular or shard-like and are set in a fine-grained crystalline matrix. The amount of rock fragments in these rocks is highly variable. The rocks in which they are present could be classified as lithic crystal tuff.

The northern felsic volcanic sequence has invariably been sheared and carbonatized with the shearing generally concentrated in the pyroclastic units and along the contacts between the various units. Euhedral pyrite cubes are ubiquitous (1 to 2 percent). The typical mineral assemblage consists of albite (An_6 - An_{10}) + quartz \pm sericite \pm microcline \pm chlorite \pm carbonate \pm epidote; iron titanium oxide, hematite, and pyrite are usually present; biotite was noted locally. Albite, microcline, and quartz occur as phenocrysts that are subrounded to subangular in shape, generally corroded, and may be fractured or crushed.

Intermediate to felsic volcanic rocks also occur as interflow units within the predominantly mafic to intermediate volcanic sequence. A sequence of intermediate to felsic flows and tuffs is exposed on the northeastern part of Mountain Island. These units were mapped on the basis of their colour indices, and it is possible that some of them represent silicified and carbonatized intermediate to mafic volcanic rocks.

Felsic flows and pyroclastic rocks are exposed between Mountain Island and Granite Bays and on the islands to the east. In this locality difficulty was encountered in distinguishing the felsic pyroclastic rocks from the intermediate flow-top and flow breccias; worthy of note is the apparent close association of the felsic pyroclastic rocks and intermediate fragmental rocks with the sedimentary formation.

A narrow zone of felsic volcanic and sedimentary rocks exposed along the trace of the axial plane of the syncline west of Mountain Island Bay is characterized by an upper greenschist facies mineral assemblage; approximately 5 percent pale yellow garnet and 5 percent biotite are present in the felsic clasts of a lapillistone unit.

Metasediments

Metasediments form less than 10 percent of the exposed metavolcanic-metasedimentary succession within the map-area. These rocks range in metamorphic rank from lower to upper greenschist facies and are characterized by the general assemblage, quartz + albite \pm white mica \pm chlorite, \pm carbonate, \pm epidote, \pm microcline \pm biotite. Minor minerals include iron-titanium oxide, pyrite, and leucoxene. Rock clasts were seldom abundant.

Thin local lenticular units of sedimentary rocks are present in the volcanic sequence. In the northern part of the area, quartz-eye arkose, minor slate, and argillaceous units occur intermixed in the predominantly volcanic succession.

A thin lens of interbedded feldspathic greywacke and argillite is exposed along the trace of the axis of the syncline west of Mountain Island Bay. In thin section, the feldspathic greywacke consists of zoned, slightly rounded, plagioclase, perthitic microcline, and subangular quartz phenocrysts, in a fine-grained matrix of quartz, feldspar, white mica, biotite, pyrite, and magnetite.

A sedimentary formation of unknown thickness is exposed on the central islands of Sturgeon Lake. Although a disconformity was found separating the volcanic and sedimentary sequences on the large island east of Mountain Island, it appears in general that the contact between the volcanic and sedimentary rocks is gradational; also the sedimentary rocks appear to be mainly derived from the volcanic rocks.

In this sedimentary formation there appears to be rapid facies changes involving conglomerate, siltstone, greywacke, arkose, slate, laminated argillite, and iron formation. The change from laminated argillite to slate, however, reflects differing degrees of metamorphism rather than gross lithological differences.

Greywacke (feldspathic) and siltstone predominate within the sedimentary succession; they weather pale grey, pale green, and grey and on fresh surfaces are grey, and grey-green. Graded bedding was found locally; some of the thicker units contain pebble-conglomerate beds. With a decrease in detrital matrix the greywacke grades into arkose.

Laminated argillite is a field term used to describe the thinly bedded highly indurated claystone and siltstone beds; massive, thick, siltstone beds are locally present (Photo 9).

Local slate bands are present; these bands split into smooth sheets along a well developed cleavage approximately parallel to the bedding.

Pebble, cobble, and boulder polymictic conglomerate are exposed within the sedimentary succession. Cobble to boulder polymictic conglomerate was found on the island located $2\frac{1}{4}$ miles east-northeast of the northeastern tip of Mountain Island; clasts of felsic intrusive and extrusive rocks (quartz porphyry), but rarely of mafic extrusive rock, are enclosed in a greywacke matrix. Polymictic pebble and cobble conglomerate, composed of mafic extrusive, felsic intrusive and extrusive, and jasperoid clasts in a greywacke matrix, was found on a small island in Sturgeon Lake near the eastern margin of the map-area. Bedding in these conglomerate units is locally defined by siltstone and greywacke interbeds. The pebble conglomerate contains stretched pebbles which define a lineation in the foliation (approximately parallel to bedding) plane. The granitoid clasts were most likely derived by erosion of high-level intrusions associated with the felsic volcanism.

Highly contorted banded iron formation was found on an island in the eastern portion of Sturgeon Lake. It is interbedded with the sedimentary rocks. D. P. Rodgers (1964, p.16) described the general composition and texture of the iron formation:

The iron is in the form of very fine-grained magnetite. Minor sulphides, pyrite, and pyrrhotite, were noted in scattered localities. Hematite is not present. Garnet-rich bands are common. A thin section of magnetite-rich iron formation showed: bands rich in magnetite-quartz; quartz-magnetite bands containing minor amphibole; quartz-rich bands of a granular mosaic of quartz and minor magnetite, amphibole, and biotite; hornblende-rich bands containing minor magnetite and quartz.

Only minor amounts of feldspar and biotite, and occasional carbonate grains, were observed . . .

Aeromagnetic data (ODM-GSC Maps 1127G, 1117G) indicate that a major iron-formation extends approximately along the centre of Sturgeon Lake.

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EARLY MAFIC INTRUSIVE ROCKS

The mafic intrusive rocks in the map-area include metagabbro, metadiorite, hornblende diorite, and metamorphosed ultramafic rocks. The rocks of this group are present in small irregular masses, sills, and dikes which intrude the metavolcanic-metasedimentary sequence; they were probably associated with the mafic volcanism. An attempt to distinguish these mafic intrusive rocks from coarse-grained volcanic flows was based on differences in aeromagnetic expression, outcrop pattern, topographic expression, weathering characteristics, texture, and mineralogical composition. Differentiation of these two units, based on these parameters, was generally unsuccessful; in general unless intrusive contacts were observed these rocks were assumed to be mafic flows.

A body of metagabbro-metadiorite (Tables 2 and 3, analysis no.7) is exposed south of Mountain Island Bay, approximately $\frac{3}{4}$ mile east of Highway 599. This body was intruded into the mafic volcanic sequence and includes xenoliths of volcanic rock as large as 3 feet by 7 feet.

Thin sections reveal that these rocks consist of subhedral, sericitized, zoned plagioclase (andesine) phenocrysts, light green actinolite as phenocrysts and matrix material, red-brown biotite phenocrysts; iron-titanium oxide, and minor quartz. Talc, chlorite, epidote, and remnant clinopyroxene may or may not be present. The metadiorite is distinguished from the metagabbro by a lower colour index, the presence of minor alkali feldspar, and by a medium-grained, granular (sugary) texture. The metagabbro and metadiorite have been metamorphosed under greenschist facies conditions, as have the volcanic rocks which they intrude; remnant pyroxene and intermediate plagioclase still remain, however. In thin section, the plagioclase grains are kinked and fractured indicating that moderately strong cataclastic deformation has occurred.

A small body of porphyritic metagabbro-metadiorite is exposed on the eastern shore of Cobb Bay near the northern margin of the map-area. In this rock sub-rounded grey-green feldspar phenocrysts of variable size (4 to 40 mm) are set in a pale green chloritic matrix.

Metagabbro is exposed on Big Island and the smaller island to the west; it consists of subhedral plagioclase (An_{30}) phenocrysts, actinolite (uralitic), minor fine-grained interstitial quartz, epidote, minor chlorite, carbonate, spinel-twinned ilmenite-magnetite now altered to leucoxene, and locally pyrite (1 percent). The rock is massive and unfoliated.

A fine- to medium-grained mafic rock (amphibolite) of unknown age is exposed $1\frac{3}{8}$ miles east of the northern tip of Cluster Lake. No contact was seen between this rock and the granodiorite-trondhjemite which surrounds it.

A body of hornblende diorite is exposed on Highway 599, approximately $\frac{1}{2}$ mile north of the turnoff to GLP326. This body weathers light yellow, blue-grey, and brown, and on fresh surface is pale green. In thin section the minerals present include plagioclase (intermediate composition), altered to sericite and epidote and replaced by actinolite, as phenocrysts, actinolite phenocrysts and groundmass, minor quartz, chlorite, carbonate, and iron-titanium oxide. The rock is usually massive and quite strongly jointed.

Porphyritic hornblende diorite dikes cut the mafic and felsic (silicified mafic) volcanic rocks on Mountain Island; they are probably related to the mafic volcanism.

Metamorphosed medium-grained ultramafic rocks exposed on northeastern Mountain Island have an ophitic texture and characteristically weather white to brown; on fresh surfaces they are green to pink. A chemical analysis of one sample (Tables 2 and 3, analysis No. 8) indicates that these rocks are of peridotite composition. X-ray and thin section analysis indicates that the following mineral assemblage is present: olivine (30 percent) plus olivine pseudomorphically altered to pale green serpentine (antigorite) and fine-grained magnetite, clinopyroxene poikilitically enclosing the olivine and in turn also partly serpentinized, minor orthopyroxene, tremolite-actinolite mantling the pyroxene and occurring interstitially, magnetite, and chromite. The assemblage chlorite + tremolite-actinolite is perhaps indicative of greenschist facies metamorphism, and thus the serpentinized peridotites may be genetically related to, and metamorphosed along with, the mafic volcanic rocks. A high magnetic response is indicated for this area on ODM-GSC Map 1127G.

EARLY FELSIC INTRUSIVE ROCKS

The early felsic intrusive rocks have been subdivided into two groups, Early Granitic Rocks and Migmatite Assemblage. The Early Granitic Rock group contains only rare xenoliths of country rock (amphibolite), but rocks of the Migmatite Assemblage contain significant amounts of two components, one amphibolitic, the other granitic. This classification is only tentative because of wide traverse spacing (1,500 to 2,000 feet) and rapid gradation between rock types. The contacts between these two assemblages should be regarded as surfaces separating two lithologic facies. These facies together constitute the Early Felsic Intrusive Rocks. Faulting and folding have modified the distribution pattern of these two assemblages.

Migmatite Assemblage

The migmatite assemblage has been subdivided into three units: (1) a zone of contaminated gabbro and diorite believed to have been formed by reaction with and partial assimilation of mafic extrusive and intrusive rocks by a granitic magma; gabbro and diorite predominate but hornblende gneiss, biotite-hornblende gneiss and porphyritic (augen) gneiss also occur; (2) a migmatite unit of mafic intrusive and extrusive rocks (now amphibolite) set in a granitic gneiss matrix; breccia, raft, layered (lit-par-lit) and folded structures are present; (3) a hybrid granitic gneiss unit.

The term hybrid gneiss is used as defined by Shaw (1957, p.80, 81), "hybrid gneiss: any mixed gneiss consisting partly of older metamorphic rock and partly of igneous, anatectic or metasomatic material. The term may be applied either to granitic or non-granitic types, e.g., hybrid nepheline gneiss, hybrid granitic gneiss". Unit (1) is generally a discrete unit but there is complete gradation between units (2) and (3) both across and along strike.

A major zone of contaminated mafic extrusive and possibly intrusive rocks (unit 1), is located west of the northwestern tip of upper Bell Lake. The various rock types present within this zone are thought to have formed by contact metamorphism, metasomatic addition or removal of material, and deformation.

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The entire zone has been metamorphosed under hornblende-hornfels (almandine-amphibolite) facies conditions; metagabbro (coarse-grained amphibolite) was formed by metamorphism of mafic rocks and metadiorite by metamorphism of intermediate rocks. Hornblende-bearing gneiss was formed by metamorphic differentiation which possibly accentuated original layering. Biotite is considered to represent a reaction product of hornblende, or a metasomatic mineral resulting from the introduction of K_2O and H_2O . Augen texture in these rocks is the result of porphyroblastic growth of plagioclase feldspar probably related to the introduction of hydrothermal solutions along original joint planes and structural planes of the host rock. Shearing has produced local zones of chlorite schist. Volcanic structures are locally preserved.

In thin section the metagabbro consists of zoned calcic plagioclase phenocrysts that are corroded, altered to sericite and epidote, and contain abundant inclusions, blue-green hornblende, minor quartz, carbonate apatite, and iron-titanium oxide.

The second unit in this Migmatite Assemblage is migmatite. The term migmatite has been used as defined by Mehnert (1968, p.8):

A migmatite is a megascopically composite rock consisting of two or more petrographically different parts, one of which is the country rock generally in a more or less metamorphic stage, the other is of pegmatitic, aplitic, granitic or generally plutonic appearance.

In the map-area the country rock is amphibolite, the plutonic (plutonitic) rock of various granitic (gneiss) phases (see Early Granitic Rocks). The various structures produced by the intrusion of the granitic rocks into the amphibolite unit include: breccia or agmatitic structure in which the amphibolite has been broken apart or brecciated by the intrusion of the granitic phase; raft structure in which the breccia fragments have moved relative to one another; layered structure consisting of alternating bands of amphibolite and granitic rock; and folded structure in which both the amphibolite and intruded granitic material are mobilized and flowage occurs. Characteristic of this migmatite zone are lenticular, thin to moderately thick amphibolite interlayers lying subparallel to the foliation of the enclosing granitic rocks; the amphibolite is less resistant to weathering than the granitic layers and forms troughlike depressions. Feldspathic and pegmatitic material locally surround and intrude these bands and xenoliths of amphibolite.

The hybrid gneiss zone (unit 3) is characterized by schlieren structures in which the mafic fragments have been streaked out and extensively resorbed in the granitic matrix, and by nebulous structures in which the country rock and intruding rock can no longer be distinguished.

A thin section of amphibolite from the migmatite zone contains the following mineral assemblage; sericite pseudomorphs after plagioclase, fine-grained unaltered, interstitial calcic plagioclase (andesine) which replaces the hornblende, approximately 45 percent blue-green hornblende, and minor quartz, carbonate, epidote, leucoxene, and iron-titanium oxide. The author believes that the amphibolite present in the country rock part (paleosome) of the migmatite represents metamorphosed mafic volcanic rocks and possible mafic intrusive rocks. Where the granitic part (neosome) of the migmatite has extensively intruded the country rocks the metamorphism (hornblende-hornfels facies) of the country rocks has essentially been contact metamorphism. A few quartz-biotite schist xenoliths of possible sedimentary origin were found.

Early Granitic Rocks

The Early Granitic Rocks are predominantly biotite granodiorite and hornblende-biotite granodiorite, with subordinate amounts of biotite-hornblende granodiorite, porphyritic (augen) granodiorite, and minor granite and trondhjemite.

The biotite granodiorite and hornblende-biotite granodiorite weather grey, white, green-grey, and locally pink, and on fresh surfaces they are generally grey. Alignment of the biotite and hornblende grains gives the rock a well developed foliation. These rocks are laminated owing to the injection of leucocratic quartzofeldspathic material parallel to the foliation, and(or) possible segregation of the mafic and felsic components perpendicular to the foliation; differences in grain size further emphasize the banding. The biotite granodiorite consists of plagioclase (oligoclase), (perthitic) microcline, quartz, and biotite, accessory iron-titanium oxide, sphene, apatite, secondary carbonate, chlorite, and epidote. The plagioclase is invariably altered to sericite, the quartz shows mottled strain extinction and is locally granulated or fractured, and the microcline locally replaces the plagioclase. The hornblende-biotite granodiorite gneiss is characterized by blue-green hornblende, and by a slightly greater mafic content than the biotite granodiorite gneiss.

Biotite-hornblende granodiorite gneiss is locally present within the granitic gneiss assemblage. Since the hornblende-rich gneiss and biotite-rich gneiss grade into each other no major significance could be attached to the relative amounts of biotite and hornblende present in these gneisses. The rather common transformation of amphibole to biotite upon addition of $K_2O + H_2O$ indicates that 'metasomatic' solutions may have determined the local mafic mineral assemblage of these granodiorite gneisses.

Porphyritic (augen) granodiorite occurs at the granitic gneiss-Bell Lake monzonite contact; it would appear that porphyroblastic growth of feldspar has occurred in the contact rocks through the influx of alkali-rich metasomatic solutions.

Local occurrences of porphyritic (augen) granodiorite, trondhjemite, and granite in the granitic gneiss group may reflect original compositional heterogeneities in the original intrusive batholith. These heterogeneities may have been accentuated by metamorphism under hornblende-hornfels facies conditions.

The foliation trends and spatial distribution of the granitic gneiss and migmatite assemblages indicate that they have been folded, faulted, and intruded by younger felsic and intermediate intrusive rocks. Hematitized zones are locally developed in the granodiorite adjacent to faults.

Aplite and pegmatite dikes and irregular masses, and quartz and epidote veins (not shown on Map 2269, back pocket) intrude the granitic gneiss. Also local feldspathic and quartzofeldspathic mobilizates (Mehnert 1968, p.356) are present.

The transition from predominantly metavolcanic rocks through a migmatitic and granitic gneiss zone to an area underlain by homogeneous granitic rocks indicates that the migmatitic and granitic gneiss mapped in the southern part of the Bell Lake-Sturgeon Lake map-area may represent the border phases of a granitic batholith located south of the map-area. The migmatitic and granitic gneiss zone is characterized by long, closely spaced magnetic contours that are approximately parallel to the strike of both the metavolcanic rocks and the migmatitic and granitic gneiss zone; the more homogeneous granitic rocks exposed to the south of the map-area are characterized by long, arcuate, widely spaced magnetic contours.

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LATE (POST-TECTONIC) FELSIC AND INTERMEDIATE INTRUSIVE ROCKS

In the map-area five masses of presumably post-tectonic felsic and intermediate intrusive rocks were found: the Penassi Lake, Mountain Island Bay and Granite Bay granites; the Valora Lake-Jigger Lake quartz monzonite; and the Bell Lake monzonite complex. The author regards the Beidelman Bay-Bell Lake pluton as being a possible epizonal subvolcanic intrusion. This complex possesses many characteristics similar to those of porphyry copper intrusions. The author believes that a high-level intrusive body of granitic(?) composition possibly underlies the felsic and intermediate metavolcanics in the northern part of the map-area; much of the quartz porphyry, quartz-feldspar porphyry, and feldspar porphyry exposed in this northern area may represent felsic and felsic to intermediate differentiates of this inferred body. However the ratio of extrusive to intrusive porphyritic material could not be ascertained.

Valora Lake-Jigger Lake Quartz Monzonite

A quartz monzonite stock, which is semi-circular to elliptical in plan and has an approximate surface area of 9 square miles (3.5 miles east to west, 2.4 miles north to south), has intruded the volcanic, granitic gneiss and migmatite map-units. This stock has a characteristically high magnetic response, approximately 200 gammas above background, and shows up clearly on aeromagnetic maps of the area (ODM-GSC Map 1127G). The aeromagnetic data indicates that the stock is plunging vertically to steeply southwest. Two areas of low magnetic response within the anomaly indicate that the quartz monzonite is not completely homogeneous or that the stock is dislocated by faulting.

Contacts appear to be both discordant and concordant, but are not well exposed; they appear to be subvertical and relatively sharp. On the northwestern shore of Valora Lake, the stock has intruded mafic volcanic rocks producing a contaminated contact zone in which the volcanic rocks are bleached and contain porphyroblastic feldspar, and the quartz monzonite is less quartzose and more mafic. Monzonite dikes (not shown on map) intrude the volcanic rocks and plastic flow folding has occurred in the contaminated zone. On the southern shore of Jigger Lake, small, angular, mafic fragments are cemented by a quartz monzonite matrix (intrusion breccia zone). Quartz monzonite obliquely cuts the foliation of the migmatitic rocks located near the southern margin of this stock; the eastern contact of this body with the granitic gneiss and migmatite assemblages is not exposed. An outlier of quartz monzonite is present in the migmatite approximately $\frac{1}{2}$ mile south of the stock. The outlier is generally massive but shows poor foliation near the contact.

The stock consists of quartz monzonite with subordinate granodiorite. The rocks are commonly pink on fresh surfaces and pink, white, pale orange, or pale yellow on weathered surfaces. Grain size varies from 2 to 10 mm and the texture is equigranular with local porphyritic phases. The weathered surface is quite crumbly due possibly to alteration of the feldspars.

Intermediate (oligoclase) plagioclase is the predominant feldspar in these rocks which also contain perthitic microcline, quartz, minor biotite (5 to 7 percent) and

epidote, and accessory apatite, iron-titanium oxide, and sphene; myrmekite is locally developed.

The plagioclase appears to be slightly zoned, shows minor alteration to epidote and sericite and is partially replaced by microcline. The quartz grains are corroded and appear to have been fractured; the plagioclase is also slightly fractured, and shows kinked twin planes. The biotite is locally altered to chlorite.

The mafic content varies from 7 to 15 percent (average mafic content 6 percent) and is predominantly biotite although hornblende was noted locally. The eastern part of the stock is slightly more leucocratic than the other parts.

Intrusion of the stock appears to have been controlled by the metavolcanic-granitic gneiss contact but northeast-to north-northeast-trending faults (shown as lineaments on Map 2269, back pocket) may also have exercised some control over its emplacement.

Close spaced jointing (8 to 10 cm spacings) is common in the stock and three sets of joints were distinguished; a subhorizontal joint set which strikes northeast and dips both north and south, and two subvertical joint sets which trend N40E, dip vertical plus or minus 5 degrees, and N45E, dip vertical plus or minus 10 degrees.

This stock may be coeval with the Bell Lake monzonite.

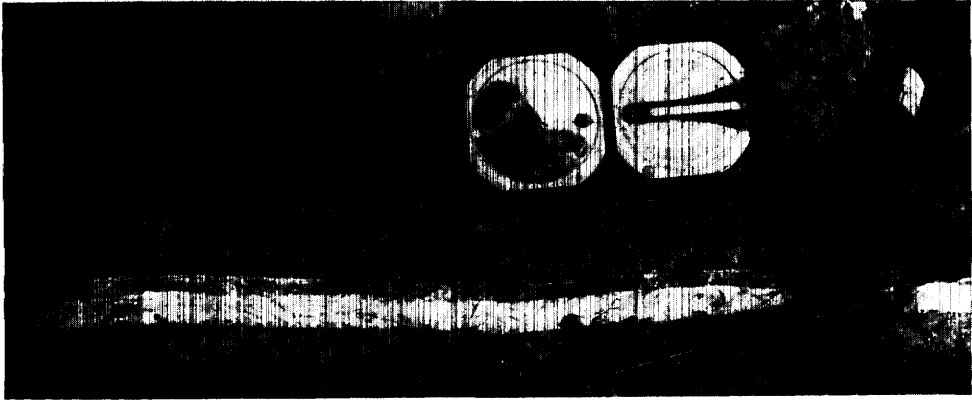
Mountain Island Bay-Granite Bay Granite

Two small stocks (diapirs) of granite have intruded the volcanic sequence at Mountain Island Bay and Granite Bay; these stocks are rectangular in form. The Mountain Island Bay Stock is 1 by 2.75 miles in size and the Granite Bay Stock is 2 by 1.75 miles. The centres of the intrusions are aligned along a northeasterly trend and they are separated by approximately $\frac{1}{2}$ mile of volcanic rocks. The centres of the intrusions coincide with magnetic lows, but although the general outline of each stock is apparent on aeromagnetic maps (ODM-GSC Map 1127G), their contacts cannot be determined from these maps. The difficulty is in part due to heterogeneous contact breccia zones formed by stoping of volcanic country rocks into the granite resulting in a variety of magnetic response in the contact zones.

Structurally, the Mountain Island Bay granite appears to have been intruded into an anticline in folded volcanic rocks; this mode of intrusion would account for the warping of both the foliation in the volcanic rocks and the synclinal axis around the Mountain Island Bay Stock (Map 2268, back pocket).

Contacts are not well exposed but do appear to be both concordant and discordant; discordant contacts are represented by an intrusion breccia or migmatite consisting of angular to subrounded mafic volcanic xenoliths set in a hybrid hornblende syenite matrix. The rocks are generally massive but locally show poor foliation.

These stocks consist of granite with subordinate trondhjemite and quartz monzonite. The rocks are commonly pink to grey on weathered surfaces and pink, white, and grey on fresh surfaces. Grain size varies from fine to coarse and the texture is equigranular to locally porphyritic. In thin section these rocks consist of medium-grained albite-oligoclase, microcline (locally perthitic), quartz, epidote \pm amphibole



ODM 8880

Photo 10—Porphyritic diabasic flow is cut by aplitoid dike near contact of mafic volcanics with Granite Bay granite; on side road from Highway 599 to Granite Bay.

(hornblende or actinolite) \pm chlorite \pm biotite \pm carbonate. Phenocrysts present include quartz, albite-oligoclase, microcline, biotite, and amphibole. Accessories include sphene, iron-titanium oxide, hematite, and leucosene. Myrmekite is locally developed. The hybrid hornblende syenite breccia matrix consists of brick-red plagioclase and microcline phenocrysts enclosed in an interlocking network of fibrous amphibole (tremolite-actinolite), 5 percent or less matrix quartz and approximately 5 percent interstitial carbonate. The plagioclase phenocrysts are corroded, strained and fractured, and exhibit oscillatory zoning.

Contact metamorphism has produced mineral assemblages characteristic of the hornblende-hornfels facies locally at the granite-volcanic contact and mineral assemblages characteristic of the albite-epidote hornfels in the volcanic rocks away from the contact. The colour banding observed in the intermediate pyroclastic rocks located between Mountain Island and Granite Bays may be due to accentuation of the original layering (bedding) of this unit by metamorphic differentiation; the silicification and epidotization observed in the mafic and intermediate volcanic rocks near these stocks was probably caused by siliceous fluids escaping from these stocks during the last stages of consolidation.

Dikes and irregular masses of pegmatite and aplitite, granitic and syenitic dikes, and biotite-quartz-feldspar (diorite) and biotite-feldspar (diorite) dikes locally cut the volcanic rocks (Photo 10).

Penassi Lake and Associated Felsic Intrusive Stocks

A body of granite has forcibly intruded the intermediate volcanic rocks in the vicinity of Penassi Lake; the shape and size of this body are not known as it was not mapped in its entirety. Neither the shape of this body nor its contact with the volcanic rocks is apparent on aeromagnetic maps (ODM-GSC Map 1127G).

Contacts are not well exposed but appear to be concordant. Within the volcanic sequence, forcible intrusion of this granite is suggested by the abrupt change of the foliation trend from approximately east-west to approximately north-south. In contrast to the other stocks the Penassi Lake Stock is generally foliated; the foliation swings from east-northeast to north-northeast as the contact with the volcanic rocks is approached.

This body consists of sodic granite with subordinate trondhjemite and quartz monzonite; a leucocratic granite phase is locally developed. These rocks weather pink, pale yellow, white, and grey and on fresh surfaces are pink or grey; grain size varies from fine- to medium-grained and the texture is equigranular. In thin section these rocks consist of zoned albite-oligoclase, microcline (partially replaced by albite), quartz, epidote, 5 to 10 percent biotite, and hornblende, white mica and sphene may or may not be present. Accessories include iron-titanium oxide, leucoxene, apatite, and hematite. Dikes and irregular masses of aplite and pegmatite are present locally within this body.

Two outcrops of granite are exposed approximately ½ mile east of Byline Lake in the north-central part of the map-area. Two varieties are present: (1) a pink leucogranitic rock, which varies in texture from equigranular to porphyritic and which is massive and unfoliated and (2) a coarse-grained biotite granitic rock which is slightly foliated. In thin section, variety (2) consists of albite-oligoclase, microcline, quartz, approximately 10 percent coarse-grained biotite, less than 4 percent hornblende, and minor epidote and apatite.

Beidelman Bay-Bell Lake Pluton

An elongate body of granodiorite-trondhjemite and associated porphyritic phases is exposed between Beidelman Bay and Bell Lake. This body, with an approximate surface area of 20 square miles, is 12 miles long from east to west, and 1 mile to 1.5 miles wide from north to south. The complex separates mafic and intermediate volcanic rocks on the south from felsic and intermediate volcanic rocks on the north. Although contacts are not well exposed this body appears grossly concordant but locally discordant to the enclosing volcanic rocks. This body is apparent on aeromagnetic maps (ODM-GSC Maps 1127G and 1117G) as a broad linear zone of high magnetic response surrounded by smaller zones of lower magnetic response; the actual contacts, however, are not defined by magnetic contours.

This body has been variously described in the literature. Graham (1931, p.43) described it as follows:

The granite salient south of Beidelman Bay is the most acidic of these later intrusions. It is a pink quartzose granite which in thin section is seen to consist largely of quartz with minor amounts of altered feldspar and small biotite shreds, some of which may be changed to chlorite. Along its north contact this granite becomes more basic and changes in colour from pink to light green.

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Horwood (1937b, p.27) described the granodiorite in the vicinity of the Dark-water Mine:

. . . The granodiorite is a grey or grey-pink, medium- to coarse-grained rock made up of quartz and highly altered feldspar and hornblende. The nature of the feldspar could not be determined in any of the sections examined, as it and the hornblende have been altered to sericite, carbonate, and chlorite. Close to the volcanic rocks, the granodiorite is dark in colour, whereas at some distance it is lighter and in places has opalescent quartz grains.

D. P. Rodgers (1964, p.26) referred to this body as being a quartz porphyry:

In the Metionga Lake area this 'granite' is in fact a quartz porphyry. Minor phases are coarse-grained and have a granitic texture. . . . In hand specimen milky to bluish quartz eyes are quite prominent. . .

The author considers that this body consists of two phases; an early granitoid phase and a later porphyritic phase. Contacts between these two phases are not well exposed but in general appear to be gradational. Compositionally the granitoid phase includes granodiorite, trondhjemite and granite, and the porphyritic phase includes quartz porphyry, quartz-feldspar porphyry and quartz-feldspar porphyry (granite). Pervasive silicification, minor carbonatization, and tourmalization and associated mineralization (copper, molybdenum, and gold) appear to be associated with the late stages of intrusion of the porphyritic phase. Two types of breccia could be recognized: (1) a breccia consisting of volcanic xenoliths and semicontinuous bands set in a granitoid matrix, and (2) an intrusive breccia consisting of subangular to rounded felsic intrusive xenoliths ($\frac{1}{4}$ inch to 10 feet in diameter) set in a fine-grained grey siliceous matrix.

The volcanic breccia was formed by intrusion of the granitoid phase into the volcanic country rock. Many of the volcanic rocks have been altered to chloritic and biotitic schists. The presence of semicontinuous bands of volcanic rock indicates that the granitoid phase was originally intruded along foliation planes.

The writer believes that the intrusive breccia was formed by brecciation of the first emplaced granitoid phase. The porphyritic phase exhibits an intrusive relationship to the breccia and therefore, although it could not be determined whether the breccia formed in situ or was mobilized and moved to its present position, it seems to have been formed before the intrusion of the porphyry phase.

As previously mentioned the contacts between the two phases are generally gradational; additional difficulty was encountered in distinguishing between these phases because of the porphyroblastic growth of opalescent blue quartz 'phenocrysts' in the granitoid phase as a result of pervasive silicification.

The rocks of the Beidelman Bay-Bell Lake complex are pink, white, grey, and pale grey on weathered surfaces and pink, white, pale grey, and pale green on fresh surfaces and texture varies from equigranular to porphyritic. Locally these rocks have a frothy, pitted, almost miarolitic looking weathered surface.

The various rock types present, in the body, were examined in thin section. The typical medium-grained, equigranular trondhjemite and granodiorite consist of zoned plagioclase (oligoclase), perthitic microcline, quartz, \pm chlorite \pm chloritic biotite \pm biotite, \pm actinolite, and minor epidote, white mica, carbonate, and iron-titanium oxide. Minor tourmaline and pyrite are also present locally. The plagioclase

is corroded, extensively sericitized, and replaced by quartz and the trondhjemite contains less than 3 to 5 percent microcline. Myrmekitic trondhjemite is considered by the author to have formed by metasomatic replacement during silicification of the original trondhjemite. Rock mapped as quartz diorite appears, in thin section, to be sheared and biotitized trondhjemite and granodiorite. Quartz diorite xenoliths were found in the 'intrusive' breccia indicating that the biotitization and deformation of the granitoid phase was in part a pre-porphyry phase; it is also possible, however, that the biotitization is a result of metasomatic alteration associated with the silicification (and mineralization) that affected this body, and thus post-dates both phases.

Hydrothermal alteration has accompanied the copper-molybdenum and gold (see Steep Rock Iron Mines Limited, Beidelman Bay Occurrence, and Darkwater Mine Occurrence) mineralization in this complex. On the present scale of mapping it was not possible to delimit the various zones of hydrothermal alteration in any but a general way. The terminology used in describing these alteration zones is taken from Meyer and Hemley (1967, p.166-235).

The pervasive nature of the alteration of biotite to chlorite indicates that it may be deuteric alteration, and the replacement of plagioclase, biotite, and amphibole by chlorite, in the mineralized rocks indicates hydrothermal alteration.

Sericitic alteration has developed over a broad area; sericite + quartz \pm pyrite, \pm tourmaline is the mineral assemblage characteristic of this alteration. Superimposed upon the sericitic alteration is a pervasive silicification, and minor carbonatization and tourmalization. Quartz porphyroblasts were developed in all rock types affected by silicification; the fracturing of these quartz grains indicates that deformation (shearing) either postdates, or is approximately contemporaneous with, the late-stage silicification and associated mineralization. E. S. Moore (1911, p.154) intimates that these blue opalescent quartz grains are the result of contact action, the blue colour being due to the presence of abundant inclusions in the quartz veins. The author observed that the intensity of the blue colour of these quartz grains seemed to reflect the intensity of shearing; the more highly the rocks are sheared, the more intense the blue of the quartz grains.

The copper-molybdenum mineralization is principally associated with the silicified and sericitized granitic areas; pyrite, chalcopyrite, magnetite, and minor bornite, pyrrhotite, and molybdenite are disseminated and structurally localized along shear fissures, within these silicified zones, and to a minor extent in the relatively unaltered rocks surrounding these silicified zones. Late(?) -stage quartz stringers also carry minor amounts of sulphide mineralization. Clusters of tourmaline needles are disseminated in these silicified zones and fine-grained tourmaline indicates that at one stage the hydrothermal solutions must have contained appreciable amounts of fluorine and boron.

In the vicinity of the Darkwater Mine, fissure quartz veins contain gold, pyrite, and minor arsenopyrite. The mineralogy and gold distribution of these veins has been described by Horwood (1937b, p.32, 33):

The veins are of the fissure type and consist of fine- to medium-grained, white to grey, massive quartz, which, in many places, has been so fractured and sheared as to produce a banded structure. A small amount of very finely divided gold is believed to have been deposited with the quartz, as massive, unfractured material contains small amounts. Carbonate, principally ankerite, occurs in small amounts in surface exposures and on the 125-foot level, and in increasing amounts on the 250- and 375-foot levels. Very small amounts of pyrite and arsenopyrite are also

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present and are believed to have been deposited early in the mineralization sequence, probably immediately after the quartz and before the development of the banded structure.

Tourmaline was formed after the vein was fractured. It occurs along the fracture planes and to some extent as blebs of very finely crystalline material in the quartz. The latter type was poorly developed in surface showings but was predominant, almost to the exclusion of quartz on the lowest level. In the upper reaches, the vein is composed chiefly of quartz and tourmaline; on the 375-foot level, considerable carbonate is also present, and in most places there is little or no quartz.

Native gold was deposited after the tourmaline and occurs along fracture planes in the quartz. Some of this deposition was in the fractures containing tourmaline, some in very minor cross fractures.

A pink feldspathic material seen only on the 250- and 375-foot levels is believed to have been deposited after the tourmaline. In some places it occurs in dike-like form in the vein zone along the walls; in others, as patches replacing the quartz of the vein. Its presence may be indicative of higher temperatures on the lower levels at the time of deposition.

The pink feldspathic material mentioned by Horwood might be indicative of potassium silicate alteration (Meyer and Hemley 1967, p.178) or possibly be laumontite occurring along a fault plane.

The various types of alteration described above were also noted on the southern shore and islands of Darkwater Lake. Quartz-tourmaline veins and shear fissures filled with carbonate (ankerite) and quartz are localized along northeast-trending shear fractures and faults which cut the quartz-“eye” granite porphyry.

The host rocks were prepared for entry of hydrothermal solutions by extensive fracturing of both the granitoid and porphyritic phases of this intrusive body. Horwood (1937b, p.33, 34) described the relationship between the structural geology and mineralization in the general vicinity of the Darkwater Mine:

Primary fracturing is believed to have been produced by forces acting from two directions, N.15°W. and S.15°E. These forces, whether compressional, or torsional, produced two sets of fractures, one with a direction of from N.30°E. to N.50°E., the other from S.50°E. to S.70°E. The first set was better developed than the second, and more open spaces were produced. Consequently as the northeast fractures afforded the easier channels for the movement of hydrothermal solutions, the wider and more persistent veins were formed along this direction. A structural analysis indicates that the displacement along this direction was to the southwest on the north side and to the northeast on the south side. The horizontal displacement is believed to be in the neighbourhood of about 50 feet; the vertical displacement could not be ascertained.

Mill tests suggest that some very finely divided gold came in with the primary quartz, since massive, white unfractured quartz contains small amounts of gold. As much of this quartz was fine-grained it is probable that colloidal solutions produced some of this mineralization. Wall rock alteration is slight and is represented in a few places by a slight pink discoloration of the granodiorite immediately adjacent to the veins. Silicification was noticed in some of the rock cut in diamond-drill holes.

Deposition of small amounts of pyrite and arsenopyrite occurred at the same time as, or shortly after, the formation of the veins. These minerals make up less than one-quarter of one percent of the vein material and are not found concentrated along the fractures that were produced before the deposition of the late generation of gold, but as small blebs or disseminations in the quartz. Pyrite is much commoner than arsenopyrite.

The formation of the veins was followed by pronounced fracturing in the vein zone. This fracturing is best developed along and close to the sides of the vein where it is tightly frozen to the walls. Where the vein is not tightly frozen the fracturing produced a schisted wall rock. The later fracturing was caused in all probability by the same forces that produced the fracturing that preceded vein formation.

After vein fracturing, tourmaline was deposited as small crystals or in very fine-grained form both along the fractures and as small blebs in the vein.

The tourmaline mineralization was followed by very minor fracturing, some of which took place along the old fractures in the vein, some across the vein at high angles. This cross-fracturing

seldom produced a displacement of more than an inch in the vein and did not find any expression in the wall rocks.

Auriferous solutions came in after the minor fracturing and deposited gold both in the tourmaline-bearing fractures and in the cross-fractures in the vein. The gold was not evenly distributed in the vein but was deposited in places where the late fracturing was best developed. Consequently channel-sampling produced very erratic results.

After the gold mineralization there must have been a cessation of pressure and a reversal of movement, as faults, which were developed in the vein zone, moved the northwest block, to the northeast relative to the southeast block. In the northeast section of the vein this action is evidenced by a fault with a horizontal displacement of 20 feet. This movement could have been caused only by a lessening of the forces producing the fracturing, as later movement was along the same general direction as the original displacements.

The faulting produced by the reversal of movement was followed by an increase of stress and faulting in two directions, N.35°E. and S.65°E. Along the first direction, in which the northwest block was moved to the southwest relative to the southeast block, displacements were slight, generally only a few inches. In the other direction, in which the northeast block moved to the southeast relative to the southwest block, displacements were as much as 15 feet. This faulting caused the change in direction in the central part of the vein zone and the development of short discontinuous lenses.

A late barren stage of quartz mineralization followed the late stage of faulting. Small stringers of fine-grained, white massive quartz up to a few inches in width were formed in some of the northeast faults. On the 250- and 375-foot levels, fine-grained, pink feldspathic material came into the vein zone and in places appears to have replaced the vein quartz. This material, which closely resembles aplite, appears to have come in with the late quartz, as it is not cut by faults or fractures.

A partial structural analysis of the entire body by the author gave the following principal shear fracture trends (168 measurements): N35E plus or minus 5 degrees, N65E plus or minus 5 degrees, N55W plus or minus 5 degrees, N20W plus or minus 5 degrees; all dip approximately vertical plus or minus 10 degrees. Whether these orientation maxima represent two conjugate shear fracture systems (N35E, N55W, and N65E, N20W), or scatter in a single system (N35E-N65E and N55W-N20W) could not be ascertained. It was noted however, as mentioned by Horwood (see above), that the northeast-trending fractures contain most of the quartz and quartz-tourmaline veins. Closely spaced shear planes strike N55E plus or minus 5 degrees (140 measurements) and dip vertically plus or minus 10 degrees. Minor faulting has occurred along these shear fractures and shear or schistosity planes and it was also observed that these northeast-trending fractures were cut by the southeast-trending fractures. A major fault or fault zone was interpreted as trending approximately N40E.

Narrow aplite and diorite dikes are locally abundant but pegmatite phases were not observed. Contact effects in the surrounding volcanic rocks include the development of metasomatic quartz porphyroblasts, biotite, and chloritic biotite.

The nature of the mineralization, the close association of granitoid and porphyritic phases, the predominantly felsic composition and the hydrothermal alteration of this body or complex are all features which have been noted as being characteristic of porphyry copper-type intrusions.

Several features of this body which suggest that it is an epizonal subvolcanic intrusion are: porphyritic nature of the later formed phases; local development of possible miarolitic cavities; granophyric (myrmekitic) textures, lack of associated pegmatite dikes; aplite or rhyolite dikes; and abundant fracturing with the introduction of quartz and quartz-tourmaline veins. In addition, the matrix of the 'intrusive' breccia consists of ground-up and hydrothermally altered country rock and could

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have originated as described by Tabor and Crowder (1968, p.17) for their map-area in the Cascade Mountains:

The intrusive breccias clearly originated under low lithostatic pressure when clasts of country rock, and earlier solidified magma, were explosively broken and transported by magma and gas in a diatreme. . . .

This body is spatially related to the metavolcanic pile but whether it has a genetic relationship to the felsic metavolcanics is not known. Although there was no direct evidence, it is possible that the 'intrusive' breccias represent eroded feeders for the felsic pyroclastic rocks and flows exposed to the north of this complex.

This complex could possibly be a sill-like body as the apparent concentration of quartz porphyry towards the northern boundary (top?) of this complex suggests one might be seeing a side view of it. It is also possible that there is more than one centre of quartz porphyry intrusion.

To more conclusively demonstrate that this body was formed essentially contemporaneously with the volcanism would require either an age determination of both it and the volcanic rocks and(or) a study of the metamorphic history of this body to determine whether both this body and the volcanic rocks were simultaneously metamorphosed under the same facies conditions. Mention was made before of the alteration of biotite to chlorite in this body. It is possible that this alteration might indicate regional metamorphism under greenschist facies conditions instead of a deuteric alteration as suggested.

It is also possible that this body is akin to what Rutten refers to as Rheo-Ignimbritic Pseudo-Plutons, actually another type of subvolcanic intrusion. The characteristic feature of these plutons is that they have no accompanying dike cluster (Rutten 1967, p.545, 546):

There are, however, plutonic bodies which have no accompanying dike cluster . . .

It is postulated that this group of 'plutonic' rocks does not represent real plutons, but only pseudo-plutons. It is thought that they may be erosional remnants of former crater vents of ignimbritic eruptions. Upon the termination of the eruption the fluidized mass left in the crater vent would settle, de-gas and fuse, and then crystallize as a holocrystalline 'plutonic' rock. These pseudo-plutons consequently represent rheo-ignimbrites.

. . . Apart from the 'nakedness' of these types of plutons, their most important character is their situation in close relationship to abundant volcanics to which they show a genetic relation . . . granitic types predominate strongly. . . .

. . . the acid volcanism related to the 'naked' plutons has been predominantly ignimbritic, that is, deposited by ash flows. . . .

Bell Lake Monzonite Complex

An elliptical stock, which has an approximate surface area of 11 square miles (4.5 miles east to west, and 2.5 miles north to south) underlies the northern part of Bell Lake. This stock has forcibly intruded the granitic gneiss and migmatite assemblages and the intrusion appears to have been controlled by earlier folding, by the contact between the mafic volcanic rocks and the granitic gneiss and migmatite assemblages, and possibly by faulting. The stock has a noticeably high magnetic

response, approximately 600 gammas (maximum 830 gammas) above background (60,500 gammas), and shows up clearly on aeromagnetic maps of the area (ODM-GSC Maps 1127G and 1117G). The southerly shift of the magnetic expression of this body, with respect to its mapped geological contacts, and the presence of an elongate magnetic low located along the northeastern side of the stock possibly indicate that this body plunges steeply south-southwest. The low magnetic response over the west-central part of the stock probably reflects a decrease in the mafic content of the rocks towards the centre of this pluton. Contacts with the surrounding country rock are generally poorly exposed; fault and gradational contacts were locally observed. On the second, easternmost island in northern Bell Lake, mesotype monzonite is in contact with granitic migmatite; hematitized brick-red monzonite is separated from the migmatite by a narrow zone of fine-grained hematitized monzonite(?) which possibly represents the chilled margin of this intrusive stock. On the southeastern shore of northern Bell Lake melanocratic monzonite is in fault contact with biotite granodiorite gneiss. A thin section of the fault zone (mylonite gneiss) showed the following mineral assemblage: feldspar (major untwinned sodic plagioclase, and minor alkali feldspar), quartz, sericite, epidote, and sphene. The texture is cataclastic; the felsic minerals and the sericite are aligned parallel to the contact. On the western side of northern Bell Lake this monzonite pluton is in fault contact and gradational contact with the surrounding migmatite and granitic gneiss. A certain amount of hybridization has occurred on both sides of these contacts; mesotype monzonite and associated pyroxenite and gabbro phases have irregularly intruded the granitic gneiss and migmatite; blue quartz-feldspar veins and pegmatite (monzonitic) irregularly cut this hybridized rock. A gradational contact from mesotype monzonite through quartz monzonite to biotite granodiorite gneiss is exposed on the long narrow bay on the southeast side of Bell Lake. In thin section the quartz monzonite consists of major intermediate plagioclase and perthitic microcline, approximately 10 percent interstitial stain-mottled quartz, 5 percent chlorite, and minor hematite and magnetite. Patches of quartz monzonite are irregularly distributed along the border of this pluton; they possibly represent a hybridized or a differentiated silicic border phase.

In most places the monzonite is poorly foliated; locally lineation of the mafic minerals define a foliation. A banded appearance produced by the segregation of mafic and felsic minerals is only locally present, and is not a pervasive feature characteristic of the body. Minor shearing is locally in evidence. Jointing is well developed in the stock; analysis of 207 joint measurements indicated three major joint attitudes N65E plus or minus 5 degrees, dip vertical plus or minus 5 degrees; N65W plus or minus 5 degrees, dip 80 to 90 degrees east; and N15W plus or minus 5 degrees, dip vertical plus or minus 5 degrees. Locally these joints are filled by quartz veins and alteration or bleaching is evident in the rocks on both sides of these joint planes.

In the field, the various types of monzonite were distinguished by the mafic minerals present, percentage mafic content, percentage of quartz, qualitative estimate of the feldspar composition, texture, and structure. The distribution of 'percentage mafic content', as determined by hand specimen identification, over this pluton indicated that (1) in general, the mafic content decreases toward the approximate geometrical centre of the body, (2) that the mafic content of the border zone is extremely variable, and (3) that clinopyroxene and hornblende are invariably present but biotite is irregularly distributed. Based on the distribution of mafic content the

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monzonites were divided into two categories: (1) rocks containing greater than 15 to 20 percent total mafic minerals (mesotype monzonite) which makes up approximately 90 percent of the body; (2) a small zone ('central core') containing 10 percent or less total mafic minerals (leucocratic monzonite), exposed on the small islands 1 mile west of the southwestern tip of the largest island in Bell Lake.

The monzonites are essentially massive and mostly medium grained but grain size can vary from fine to coarse grain. Texture varies from equigranular to porphyritic. The colour of both fresh and weathered surfaces varies from purple through pink to grey; the pink colour is generally, though not necessarily, a reflection of low total mafic content. The rocks have pitted weathered surfaces due to weathering out of the feldspars.

These monzonitic rocks are composed of variable but approximately equal amounts of sodic to intermediate plagioclase (albite to oligoclase) and alkali feldspar (microcline, possibly minor orthoclase, perthite, and antiperthite), \pm augite, \pm hornblende, \pm biotite, rare quartz, chlorite and carbonate, and accessory apatite, iron-titanium oxide, zircon, sphene, and hematite.

Antiperthite appears to be characteristically developed in the mesotype monzonite, and sodic to intermediate plagioclase (possibly slightly cryptoperthitic) cores are surrounded by rims of antiperthite (plaid-twinned and string microcline antiperthite). An explanation of this textural zoning, as being the result of exsolution, is given by Upton (1960, p.59, 60):

The explanation may lie mainly in the concentration of volatiles in the fractionating intercrystal liquid inducing fuller unmixing in the later growth zones . . . in the case of 'normal-zoned' pure Na-K feldspar the marginal parts of the crystals should approach the minimal melting composition more closely than the inner zones and hence should reach the solvus curve at a higher temperature than the cores; (thus giving the margins a greater chance to exsolve than the cores) . . .

Locally, within the mesotype monzonite, discrete microcline grains occur interstitially to the antiperthite and the microcline component of the antiperthite appears to replace the plagioclase component. Rarely, perthite is developed by the exsolution of tiny blebs of plagioclase from these discrete microcline grains. In the leucocratic monzonite exposed on the small islands just east of the southwestern tip of the largest island in Bell Lake, perthite and rarely antiperthite are developed, and coarse-grained microcline is extensively replaced by sodic plagioclase. Within the mesotype monzonite the antiperthite and microcline grains are also locally fringed and extensively replaced by a late-stage sodic (albitic) plagioclase, thus forming replacement perthite and perthitic antiperthite. The development of the perthitic and antiperthitic intergrowths possibly reflects a history of crystallization under falling temperature conditions. Local heterogeneities in composition, variable amounts of volatiles present in the intercrystal liquid, and changing P_{H_2O} probably explain the textural and chemical variability of these feldspars. Upton (1960, p.57, 59) described a crystallization sequence, starting with the primary crystallization of a lime-bearing, soda-rich sanidine, which results in the formation of feldspars similar to those present in the Bell Lake body:

. . . on reaching the solvus, the disordered and monoclinic soda-sanidine unmixed into two components, namely a Na-rich sanidine and a K-rich sanidine. On further cooling the Na-rich sanidine inverted to anorthoclase. As Al-Si ordering proceeded with lowering temperature, the anorthoclase gave way to oligoclase and the K-rich sanidine converted to orthoclase, this resulting in the formation of an oligoclase-antiperthite. Continued ordering could yield an antiperthite containing microcline and oligoclase in a lower structural state.

Euhedral grains of clinopyroxene (augite), which are pale green, pale pink, and colourless, are interstitial to the feldspar. Usually the grains are highly altered to hornblende, but all gradations from fresh euhedral grains to complete hornblende pseudomorphs were observed. The variable colour of the clinopyroxene possibly reflects a change in composition.

Pale green to blue-green hornblende, which presumably formed due to an increase in water pressure as the temperature fell, replaced the already formed clinopyroxene and also crystallized interstitially as an independent mineral. In the more mafic monzonites, the hornblende has a deep blue-green colour, contains abundant inclusions, and is zoned.

Green, brown, and red-brown biotite (including chloritic biotite and possibly lepidomelane) is present in variable amounts. Locally it replaces hornblende and feldspar, mantles clinopyroxene, or occurs as phenocrysts (it evidently formed at a later stage in the crystallization sequence than did the clinopyroxene and feldspar and its variable colour perhaps reflecting a variable composition may be due both to increasing water pressure and to the local variability of the volatile content of the intercrystal liquid. Chlorite is locally developed as a further alteration of the biotite.

Accessory minerals include rare, interstitial quartz, iron-titanium oxide, calcite and apatite, zircon and sphene.

Chemical analyses and normative compositions of five samples of this monzonite are presented in Tables 2 and 3, analysis numbers 9, 10, 11, 12, and 13. Several thin sections of these monzonites were stained by the Mineral Research Branch of the Ontario Division of Mines. Staining emphasized the textural relationships of the feldspars but because of the very complex feldspar intergrowths modal analyses could not be done. Staining was done according to the method described by Laniz *et al* (1964, p.B152-153).

On the basis of field and thin section examination the two varieties of monzonite can be designated as mesotype to melanocratic antiperthitic monzonite, and leucocratic (porphyritic) perthitic monzonite.

The Peacock lime-index indicates that this monzonite falls in the calc-alkalic series. Although normative quartz is present in the majority of rocks, analysis number 11 (Table 2) is silica deficient possibly suggesting the existence of local under-saturated phases. The Na to K ratio varies appreciably for the chemical analyses given, possibly reflecting the local variation in the late stage volatile fraction and also the varying intensity of secondary (sodic) feldspathization that has affected the stock. A high barium and strontium content is characteristic of these rocks, lithium was only detected in the most mafic rock analyzed (see Table 2, analysis number 13).

A band or partial ring of biotite pyroxenite is exposed on the southwestern border of the Bell Lake Stock. This band varies in width from $\frac{1}{4}$ to $\frac{1}{8}$ mile and appears to be faulted off at both ends. In thin section the pyroxenite consists of

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ODM 8881

Photo 11—Donut-shaped pyroxenite xenolith (dark) set in mesotype monzonite (light grey). Configuration apparently due to plane of section; on western shore of north Bell Lake.

yellow-green to brown-green clinopyroxene (augite), actinolitic amphibole, which fringes the clinopyroxene, short stubby olive green biotite grains, secondary carbonate, and accessory apatite and magnetite. Rodgers (1964, p.33) reported the presence of minor orthopyroxene and chloritic biotite. The pyroxenite is dark green to black, is medium grained, and has a soft pebbly weathered surface. Contacts with the monzonite or the surrounding granitic gneiss and migmatite country rock are not well exposed; both sharp and gradational contacts from pyroxenite through gabbro to monzonite, were seen. Pyroxenite dikes, clots, and irregular masses are found throughout the monzonite body (Photo 11); xenoliths or inclusions of pyroxenite set in a monzonite matrix were mapped as inclusion breccia.

A lamprophyre pyroxenite dike cuts the migmatite and granitic gneiss assemblages on the south shore of southern Bell Lake. In thin section, this rock consists of subrounded augite grains fringed and extensively replaced by hornblende, and stubby fine-grained brown biotite grains set in a very fine-grained matrix of feldspar and quartz. The rock is cut by a thin veinlet of clinopyroxene (diopside) with minor carbonate. A plagioclase-rich lamprophyre dike cuts the melanocratic monzonite on one of the islands in northern Bell Lake; in thin section it consists of hornblende and minor clinopyroxene phenocrysts set in a matrix of diopside, carbonate, amphibole, plagioclase, and quartz. Other lamprophyre dikes were found locally.

A second type of intrusion breccia, composed of felsic and amphibolitic xenoliths set in a matrix of monzonite, (Photo 12) is believed by the author to have developed by stoping of the granitic gneiss and migmatite country rock during



ODM 8882

Photo 12—Intrusive breccia consisting of felsic (white, faulted) and mafic (dark; upper right corner) xenoliths in mesotype monzonite matrix; on island in north Bell Lake.

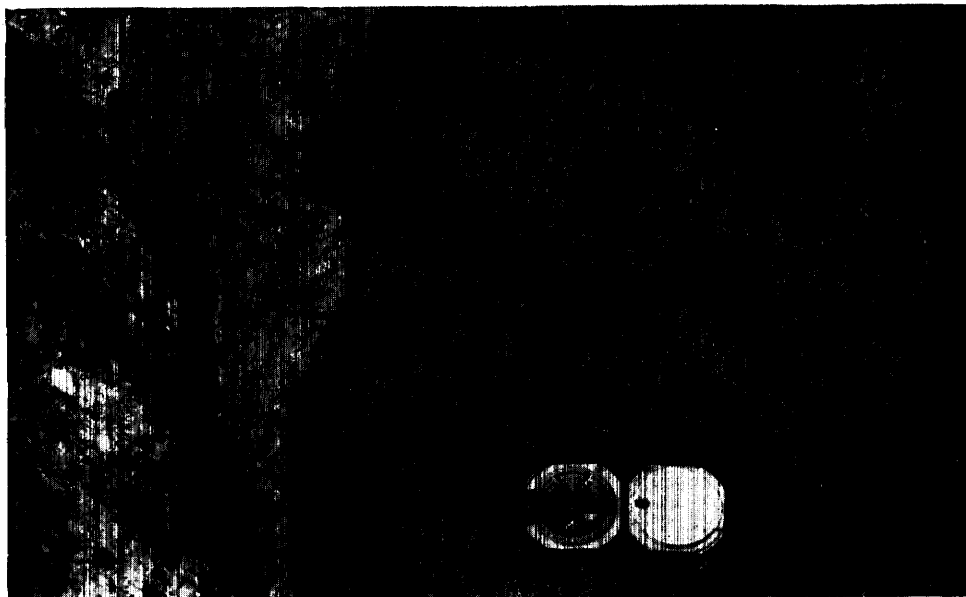
forcible intrusion of the monzonite pluton. The granitic rocks have reacted with the monzonite magma to produce a hybrid granitic rock whereas the amphibolite xenoliths are chemically unreactive and thus have maintained their essential shape and composition.

Gabbro(?) dikes cut the granitic gneiss on the west shore of northern Bell Lake. In thin section these rocks consist of calcic plagioclase (andesine-labradorite), light green clinopyroxene, blue-green hornblende which rims the pyroxene, red-brown biotite, secondary carbonate and epidote, and accessory magnetite, leucoxene, and apatite. Up to 5 percent blue opalescent quartz eyes are present locally.

Locally, aplitic or felsite dikes and pegmatite (Photo 13) cut the monzonitic rocks. The pegmatite appears to be restricted mainly to the north-central part of the pluton and generally consists of coarse-grained microcline and fibrous hornblende or biotite with minor zircon or sphene. Quartz-feldspar pegmatite dikes are also present locally.

Rodgers (1964, p.33) believed that the elongate negative anomaly over the northeastern part of this pluton is due to a change in lithology:

Along the northeast edge of the stock, four small exposures on the islands consist of a rock type of slightly different appearance. An elongate, negative magnetic anomaly appears to reflect this zone. In outcrop it is a medium-grained to porphyritic, purplish-coloured rock, containing varied amounts of streaky clots of biotite and hornblende, which are up to a few inches in length. In thin section it is composed of: acid plagioclase, 60 percent; microcline and perthite, 15 percent; fresh green hornblende and brown-green biotite, 5-10 percent; quartz, less than 5 percent; and accessory sphene, apatite, and garnet, about 1 percent.



ODM 8883

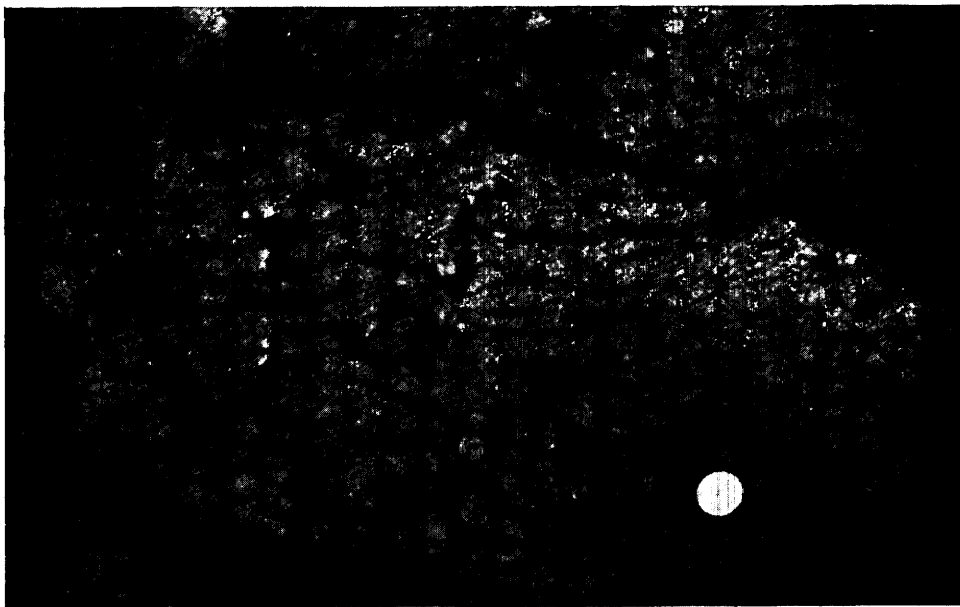
Photo 13—Monzonite pegmatite (light) cutting slightly foliated mesotype monzonite (grey). Note minor faulting of pegmatite and presence of small mafic xenoliths in monzonite; island in north Bell Lake.

The Bell Lake monzonite stock is possibly coeval and comagmatic with the Sturgeon Lake scapolite-augite alkalic syenite. A carbonatite occurrence associated with this syenite was reported to the Resident Geologist's office, Toronto, by W. G. Wahl Limited (March 1969). It has been suggested (W. G. Wahl, personal communication) that this carbonatite is localized in a rift structure, which occupies the northeastern arm of Sturgeon Lake, and possibly extends into the present map-area.

Quartz Porphyry, Quartz-Feldspar Porphyry, Feldspar Porphyry

Dikes and irregular masses of porphyritic material intrude the mafic, intermediate, and felsic volcanic rocks. Except in the northern part of the map-area, these dikes and irregular masses are sparsely distributed. In the northern part of the map-area porphyritic intrusive material appears to be relatively abundant, but, as previously noted (see Felsic Metavolcanics), extrusive and intrusive material can only be distinguished with difficulty.

The porphyritic rock weathers pale grey, pale green, pale yellow, white, and pink, and on fresh surfaces is pale grey, pale green, and white. It is massive to locally foliated; the foliation is due to secondary shearing. Two phases seem to be present: (1) a felsic quartz porphyry phase which is characterized by abundant subrounded and embayed quartz phenocrysts, and minor plagioclase (albite) phenocrysts set in a fine-grained matrix of quartz, plagioclase, sericite \pm chlorite \pm



ODM 8884

Photo 14—Ellipsoidal intermediate volcanic xenoliths set in matrix of intrusive quartz-feldspar porphyry. Xenoliths lie parallel to contact of volcanic rocks and quartz-feldspar porphyry dike; east of northern part of Cobb Bay, near margin of map-area.

epidote \pm carbonate \pm iron-titanium oxide, and apatite, and (2) an intermediate quartz-feldspar and feldspar porphyry phase, which is characterized by abundant subhedral plagioclase (albite-oligoclase) phenocrysts \pm quartz phenocrysts set in a fine-grained matrix of quartz, plagioclase, chlorite, \pm sericite, \pm epidote, \pm carbonate \pm biotite \pm iron-titanium oxide and apatite. Pyrite (1 to 2 percent) is extremely common. Carbonatization and minor silicification, which accompanied shearing, affects the extrusive and intrusive rocks alike.

Crosscutting relationships with the volcanic rocks were rarely seen; locally the intrusive material contains volcanic xenoliths (Photo 14).

Minor crenulations, and mineral assemblages characteristic of greenschist facies metamorphism suggest that a later period of deformation has superimposed dynamothermal metamorphic effects upon all the rocks including the intrusive rocks exposed in the northern part of the map-area.

CENOZOIC

Quaternary

PLEISTOCENE GEOLOGY

The Sturgeon Lake-Bell Lake area is extensively covered by glacial drift material of the following types: glacial moraine generally modified by lake action, outwash

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deposits of sand and gravel, and ice-contact stratified drift complexes generally modified by lake action.

The glacial drainage pattern in the area is illustrated by three major esker-delta-outwash complexes (glaciofluvial deposits) which generally trend southwest. The eskers are usually covered with vegetation and sections were rarely seen. They consist predominantly of sand and gravel with local accumulations of boulders. Small deltas occur along these esker complexes. The highest elevations in the area are along the esker complex extending south-southwest from Beidelman Bay through Valora Lake to the southern margin of the map-area and beyond. This complex probably follows a structural lineament in the bedrock. In the vicinity of and south of Valora Lake the esker complex has been modified by later lake action. The esker has a braided form and locally sections of the esker lie at right angles to the major trend of the esker complex. These traverse sections probably formed by stream flowage along a fracture parallel to the ice front. A partial explanation of eskers, which have a braided form and local transverse sections, has been given by Henderson (1959, p.32):

The belts of stagnant marginal ice, in which the braided esker ridges and the transverse eskers formed, may have been caused by a combination of topographic resistance to the movement of ice and thinning of marginal areas. Rock hills and ridges downstream from at least two of the braided areas suggest that as the ice approached them it was stranded by the blocking effect of the bedrock highs. The pronounced bend in the main eskers that takes place at some of the braided areas may be due to diversion of the meltwater streams by such local elevated areas.

A second complex trends southwest from north of Bell Lake, over the islands on Bell Lake, and southwest through Running Deer Lake. Potholes locally occur along the length of this esker. South of Bell Lake one section of the esker appears to be controlled by a southwest-trending fault.

A third complex extends south from Jackpot Lake to Cluster Lakes.

Morainal areas are not common within the map-area. A small area covered by sandy, boulder moraine modified in part by later lake action lies west of Bullseye Lake; a second morainal area lies between Jackpot and Darkwater Lake.

Outwash deposits comprising sand and gravel are prominent within the area. An east-west-trending mass of ice-contact stratified drift lies to the west of the southwestern tip of Mountain Island Bay. It is characterized by a lower 10-foot thick unit of sand and gravel covered by coarse boulder till. The bedding in this mass is defined by fine-grained thin clay units separating thicker massive sand and gravel units; on a finer scale the bedding is defined by the alternating of fine sand and fine sand and clay laminae. Faulting perpendicular to the bedding represents post-compaction deformation.

Glacial striae and fluting trend approximately northeast through the area; locally they appear to follow joint systems and structural lineaments in the bedrock. The glacial striae are most abundant in the areas underlain by metasedimentary and metavolcanic rocks. Drumlinoid ridges consisting of sandy boulder moraine locally parallel the glacial fluting.

Silt, sand, clay, and organic mud which are accumulating in the lakes, rivers, and swamps comprise the Recent deposits of the area. Swamp and muskeg cover a high proportion of the map-area; both open and treed (cedar swamp) varieties occur.

STRUCTURAL GEOLOGY

The volcanic and sedimentary formations in the map-area have been metamorphosed under greenschist to low almandine-amphibolite facies conditions, and appear to have undergone rather intense and complex folding. Top determinations are scarce, and marker horizons are absent. Top determinations were obtained from exposures of flow-top breccia, pillow structures, and from graded bedding in the sedimentary rocks.

Most of the formations in the map-area are foliated. Primary structures, such as those used for top determinations, are locally preserved.

The mafic volcanic rocks possess a foliation defined by the subparallel alignment of the mafic minerals (amphibole, biotite, and chlorite). Locally they are schistose (chlorite and actinolite schists); the fine-grained flows and pyroclastic units appear to be most susceptible to shearing. Hornblende-hornfels facies contact metamorphism has produced a gneissic structure in the mafic metavolcanic rocks by accentuating a preexisting banding or bedding. Deformation and local metasomatism has transformed the felsic volcanic rocks to sericite and chloritoid-bearing schists or phyllites. Primary flow-banding was only rarely observed.

Primary structures such as graded bedding are preserved in the metasediments which are locally foliated and schistose.

A gneissic structure is locally developed in the plutonic rocks, for example: compositional layering due to segregation of the felsic and mafic components is occasionally observed in the Bell Lake monzonite; semi-continuous bands of amphibolite define a gross foliation in the migmatite assemblage; and alteration of felsic- and mafic-rich bands define a gneissic structure in the early granitic rocks.

Fracture cleavage developed at high angles to primary planar features is only locally developed.

Lineations generally lie in the foliation plane and plunge subvertically.

FOLDING

Approximately 1200 foliation and minor shear measurements from the meta-volcanic-metasedimentary sequence were analyzed. In the north half of the area two prominent foliation directions were noted: N35E plus or minus 5 degrees, dip vertical plus or minus 10 degrees; and N65E plus or minus 5 degrees, dip vertical plus or minus 10 degrees; the minor shearing also showed two prominent orientations: N40E plus or minus 10 degrees, dip vertical plus or minus 10 degrees, and N75E plus or minus 10 degrees, dip vertical plus or minus 10 degrees, approximately parallel to slightly east of the corresponding foliations. The primary foliation trend in this northern area is the N65E plus or minus 5 degrees, dip vertical plus or minus 10 degrees trend. The second prominent trend of N35E plus or minus 5 degrees, dip vertical plus or minus 10 degrees can be explained by warping of the foliation in volcanic and sedimentary rocks due to the diapiric intrusion of the younger intrusive rocks; minor cross-folding is also responsible for the variable foliation trends.

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In the southern half of the area the major rock sequences each possess slightly different foliation trends. The volcanic rocks trend east-west to east-northeast. A pervasive schistosity trending N55E plus or minus 5 degrees, dip vertical plus or minus 10 degrees cuts the granodiorite-trondhjemite-quartz porphyry complex south of Beidelman Bay. This schistosity also extends into the felsic volcanic rocks for a short distance from the contact with the Beidelman Bay complex. To the east of Beidelman Bay the foliation trend of this complex is approximately concordant with the trend of the volcanic rocks. The early felsic intrusive rocks in the southern part of the map-area trend east-west to slightly west-southwest. The concordant foliations of the volcanic country rock and the border gneiss and migmatite indicate that these early felsic intrusive rocks may have been syntectonically emplaced. Emplacement of the younger intrusive rocks appears to have been controlled by the fold pattern of the volcanic-sedimentary rocks, and by the contacts between these rocks and the early felsic intrusive rocks.

Folding is apparent locally in the sedimentary formation but in general structural information is rare and it could not be ascertained whether the sedimentary rocks are folded into a major synclinal fold or whether they are intercalated with the volcanic rocks. The volcanic derivation of much of the sedimentary rocks and the close association of the sedimentary rocks with felsic and intermediate pyroclastics and various breccia units indicate the latter. In the eastern section of this sedimentary formation the foliation is parallel to or at a small angle to the bedding; a lineation, defined by alignment of mafic minerals and preferentially oriented pebbles in the polyimictic conglomerate, lies in the foliation plane and plunges 70 degrees to the east.

The volcanic assemblage has been folded and further structurally modified by the diapiric intrusion of the younger granitic plutons.

The axis of an east-west-trending syncline is deflected to the north of Mountain Island Bay by the diapiric intrusion of a sodic granite pluton. This pluton appears to have been intruded into an anticline in the folded volcanic rocks. The axial trace of the anticline passes through Mountain Island Bay. Similarly the axial trace of an east-west-trending anticline has been deflected to the north of Granite Bay by intrusion of a sodic granite pluton which is coeval and comagmatic with the Mountain Island Bay pluton; presumably this pluton intruded along a synclinal structure in the volcanic rocks.

The northern unit of felsic flows and pyroclastic rocks intermediate flows, and intrusive porphyritic material is believed to be synclinally folded and modified by later cross-folding; the position of the fold axis could not be determined. South of Cobb Lake the welded(?) tuff horizon contains felsic fragments which are elongated east-west and plunge westwards at approximately 70 degrees. On the west this northern unit as a whole and the rock foliation in general swings northwards due to the intrusive effects of the Penassi Lake granite and the effects of associated faults.

The gross concordance of the Beidelman Bay-Bell Lake granodiorite-trondhjemite-quartz porphyry complex and the presence within it of semi-continuous bands of metavolcanic rocks indicates that this complex is subvolcanic as previously discussed and thus was deformed contemporaneously with the surrounding metavolcanics or that if it is a later intrusion, it was controlled by the earlier formed fold structure, and locally, by the layering and foliation of the volcanic host rocks.

Rapid reversals in dip of the sheared felsic flows and pyroclastic rocks in the southern felsic volcanic unit suggest that minor tight folds are present. In the few places where bedding was observed the strike of the schistosity and bedding diverge at a small angle. Kink folding, related to a later period of deformation is also present. The kink folds are rather small and have not disrupted the main foliation trend of these rocks to any great extent. These folds are characterized by the conjugate nature of their axial surface. One set of laminae is first folded into a dextrally folded form and then the same set may be folded into a sinistrally rotated form. The result is a conjugate fold set.

The foliation in the granitic gneiss and migmatite show semi-continuous to discontinuous fold patterns. These rocks are often folded and cross-folded into small pitching anticlinal and synclinal structures such as can be observed south of Bell Lake.

FAULTING

Although minor faults are locally indicated by outcrop evidence (Photo 7), the general lack of such evidence, the absence of marker units and the unknown effects of folding on the stratigraphy, severely hamper the recognition and determination of magnitude of faulting in the area. Despite this a number of major faults have been tentatively interpreted. These major faults have been interpreted on the basis of their topographic expression, which is usually a negative topographic lineament, breccia and mylonite zones, stratigraphic offsets, wall rock alteration, aeromagnetic expression, if any, and associated deformational features.

A major fault striking N40E is interpreted by the writer as passing through the Darkwater Mine shaft and as having an apparent right-hand strike separation of about 4,000 feet. The strike separation estimate is dubious, however, because of the long range extrapolation of geological contacts and contradictory evidence from the aeromagnetic map which indicates faulting, but with left-hand offset. The lineament which strikes north-northeast along the western side of Valora Lake may be the southward extension of this fault; the north-northeast-trending esker delta outwash complex also seems to have followed a structural(?) lineament in the bedrock. Minor faulting (cross-faulting) is interpreted in association with this major fault to explain the configuration of the contact between the metavolcanics and the granodiorite-trondhjemite-quartz porphyry complex and to explain minor displacements of a gold-bearing quartz-tourmaline \pm ankerite vein near the mine shaft. As mentioned previously Horwood (1937b) considers that repeated faulting has occurred with offsets in both directions. Associated with the deformation that gave rise to this faulting is a pervasive schistosity trending approximately N55E plus or minus 5 degrees, dip vertical plus or minus 10 degrees.

A second major fault is assumed to extend through the southwestern arm of Sturgeon Lake northeast to Mountain Island. The fault may extend still farther northeast to the St. Anthony Mine (W. G. Wahl 1969, personal communication) through the small islands located approximately 1 mile east of Granite Bay, because strong shear zones, locally carbonate-filled, were observed on these islands. South of Mountain Island, this fault presumably cuts off the southwestern extension of the iron formation which trends down the centre of Sturgeon Lake. Aeromagnetic Map

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1127G (ODM-GSC 1961a) provides additional evidence for the existence of this fault. The map indicates an area of low magnetic response over this assumed fault. Also minor faults on Mountain Island suggest the existence of a major (wrench) fault in the vicinity. Detailed geophysical information (W. G. Wahl 1970, personal communication) suggests that the fault may be located slightly to the west of its tentative position as shown on Maps 2268 and 2269 (back pocket).

In the area, south of Sturgeon Lake, between Highway 599, and Bell Lake, two predominant lineament directions were observed; one trends approximately north-northeast to northeast, the other east-northeast. Most of the lineaments belong to the more northerly trending set. Among these is a major lineament which extends from the northern tip of Running Deer Lake, under Wish Lake, and along the west shore of the western bay of northern Bell Lake and a northeast-trending fault which cuts the granodiorite-trondhjemite-quartz porphyry complex on southwestern Dark-water Lake and is indicated by the presence of carbonate-(ankerite) quartz-filled shear zones; no offsets were observed. Minor faulting is indicated in the volcanic rocks by minor offsets. An east-northeast-trending lineament crosses the Valora Lake-Jigger Lake quartz monzonite pluton.

As previously mentioned the Bell Lake monzonite complex is locally in fault contact with the granitic gneiss and migmatite assemblages, which it intrudes.

The northeast- and north-northeast-trending faults between north and south Bell Lake are indicated by marked negative topographic lineaments generally bounded on one side by a scarp; minor offsets of the formations were locally observed. These fault lineaments have been further emphasized by glacial scouring.

The three faults east of Penassi Lake have been interpreted from lineament study and from the fact that the foliation strike of the volcanic rocks in this area swings sharply from east-west to north-south, and is difficult to explain by folding alone.

The faulting on Mountain Island is indicated by cherty mylonite, breccia or crush, and carbonate-filled gouge zones, and by aeromagnetic data.

Two prominent linear features in the northern part of the map-area stand out; one is situated along the west shore of Granite Bay, the other trends east-west and is situated west of Mountain Island Bay. Their structural significance is not known.

Shearing is in general not pervasive but tends to be confined to zones of mechanical weakness such as flow contacts, breccia zones, and pyroclastic units.

Two major shear zones were mapped in the area. One shear zone striking north-east to east-northeast is located at the mouth of Cobb Bay in quartz (feldspar) porphyry which has been sheared to a quartz-sericite \pm carbonate schist. The second zone is indicated on Maps 2268 and 2269 (back pocket). It is located in the felsic metavolcanic rocks in the south-central part of the area. Felsic flows and pyroclastic rocks have been converted to quartz-muscovite-chloritoid and quartz-plagioclase-muscovite-chlorite-dolomite schist or phyllite due to the combined effects of shearing and metasomatism.

JOINTING

Joints are not shown on the accompanying maps (back pocket) because of lack of space; they are however present in all the rock types exposed.

Jointing in the younger intrusive bodies has been described in the section of the

Table 4 | SUBVERTICAL JOINT SETS IN ORDER OF DECREASING ABUNDANCE (METAVOLCANIC AND METASEDIMENTARY ROCKS).

North Half	Strike (± 5 degrees)	Dip (± 10 degrees)
	65	90
	135	90
	25	90
South Half	135	90
	65	90
	35	90

report dealing with these intrusions. Table 4 illustrates the joint sets, in order of decreasing abundance, in the metavolcanic and metasedimentary rocks. The early felsic intrusive rocks in the southern part of the area show a wide range of joint orientation, with only the set N35W plus or minus 10 degrees, dip vertical plus or minus 10 degrees occurring with any frequency.

Shear joints are relatively common in the metavolcanic rocks in the central part of the area; they are commonly filled or coated with quartz, quartz and epidote, or quartz, feldspar, and epidote.

CORRELATION OF GEOLOGY WITH AEROMAGNETIC DATA

The Sturgeon Lake-Bell Lake area was flown in 1961, and the map-sheets (scale 1 inch to 1 mile) for this area have been jointly released by the Geological Survey of Canada and the Ontario Department of Mines. These are: Bell Lake, Map No. 1117G, and Watcomb, Map No. 1127G.

The pronounced high magnetic response which trends approximately down the centre of Sturgeon Lake is probably due to iron formation. The sedimentary rocks which enclose this iron formation are characterized by linear magnetic highs.

As previously mentioned, both the Bell Lake monzonite complex and the Valora Lake-Jigger Lake quartz monzonite pluton have pronounced magnetic expressions which agree quite closely with their geological expression. The Beidelman Bay-Bell Lake granodiorite-trondhjemite-quartz porphyry complex has a broad poorly defined magnetic expression; faulting in the vicinity of the Darkwater Mine (north-east-trending) is indicated on the aeromagnetic map but the offset is opposite to that indicated by extrapolation of the geological contacts. The other younger intrusive plutons (Mountain Island Bay, Granite Bay, and Penassi Lake) have distinctive magnetic expressions but their contacts with the surrounding volcanic rocks cannot be distinguished due to hybridization at the contacts.

The ultramafic (serpentized peridotite) rocks on Mountain Island are probably responsible for the high magnetic response over the northeast part of Mountain Island; a northeast-trending fault on Mountain Island is perhaps indicated by dislocation of this magnetic high. The metagabbro body on the island in Elva Lake has a high magnetic response and two other high magnetic areas, perhaps indicative of

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metagabbro bodies covered by overburden, are located on the southwest shore of McLeod Lake and east of Granite Bay. The metagabbro-metadiorite body south of Mountain Island Bay correlates with an area of low magnetic response on the map.

Areas of volcanic rocks correlate on the aeromagnetic map with broad zones of mixed anomalies; the general trend appears to be indicated by a series of lows. No distinction could be made between the felsic and mafic to intermediate volcanic rocks on the basis of their respective magnetic responses.

The early granitic gneiss areas are characterized by broad widely contoured magnetic trends while the migmatite assemblage is characterized by long, arcuate, closely contoured magnetic trends which match the regional foliation of the early felsic intrusive rocks. Faulting is indicated on Mountain Island and south of Beidelman Bay, see above. A linear low on the aeromagnetic map extending through the southwest arm of Sturgeon Lake to Mountain Island is interpreted as a major fault (Maps 2268 and 2269, back pocket); this fault possibly extends northeast to the St. Anthony Mine on the northeast arm of Sturgeon Lake (G. W. Wahl 1969, personal communication).

ECONOMIC GEOLOGY

Until recently, exploration in the area was very limited but over the last two to three years, exploration activity has increased, and now, with the discovery by Mattagami Lake Mines Limited, Exploration Division, of a major base-metal sulphide deposit, the Bell Lake-Sturgeon Lake area and the surrounding territory have been extensively staked, and many companies are contemplating exploration programs to evaluate the potential of their respective claim blocks. A minor amount of assessment work, including geological and geophysical reports and diamond drill hole logs, has been submitted to the Ontario Division of Mines. Reports are on file at Toronto in the Assessment Files Research office, and reports and drill logs are filed with the Resident Geologist in Kenora.

DESCRIPTION OF MINERAL SHOWINGS

Cobb Bay Copper Occurrence (1)*

The Cobb Bay copper occurrence is located approximately $\frac{1}{2}$ mile north of the northeastern tip of Cobb Lake. Two trenches (6 feet by 4 feet), approximately 700 feet apart, have been dug on this occurrence. The northernmost trench is in a sheared and carbonatized intermediate metavolcanic outcrop, which has a red-brown weathering surface; only minor pyrite mineralization was observed. The southern trench is in an outcrop of a silicified, intrusive(?) porphyritic rock; it is highly sheared (northeast trend) and carbonatized and minor pyrite and chalcopyrite mineralization was observed.

* Number in brackets refers to property number shown on Geological Maps 2268 and 2269, back pocket.

Darkwater Mines Limited (2)

The history and development of the Darkwater 'Mine' has been summarized by Horwood (1937b, p.26):

Darkwater Mines, Limited, was formed in October, 1935, to develop certain auriferous quartz veins in a granodiorite formation in the vicinity of Beidelman bay, near the southwest end of Sturgeon lake, district of Kenora. The principal vein was opened up by stripping and trenching and explored by a series of diamond-drill holes. A mining plant was installed during the summer of 1936 and underground work commenced in November. After a considerable amount of work had been done on three levels the property was closed down late in the fall of 1937.

The first two claims of the property, K.333 and 405, were staked about 1909 by two prospectors, Le Moire and La Voie, who were prospecting in the country being opened up by the building of the Grand Trunk Pacific (now the Canadian National) railway. These claims were purchased by J. C. Beidelman in 1910, and three adjoining claims, K.355, 356, and 357, were staked to protect the showings along the strike. After exploring several veins, detailed development work was done on the most promising, and in 1912 the claims were surveyed and patented. Except for examination work by certain companies after 1912, nothing was done on the property until the summer of 1932, when Mr. Beidelman returned and resumed development work. In 1934 Robb-Montbray Mines Limited, examined the property and after doing some diamond-drilling formed Darkwater Mines Limited.

Horwood (1937b, p.29) goes on to say:

DEVELOPMENT WORK

Surface Work

Prospecting and surface work on the quartz-tourmaline veins indicated that the vein that strikes northeast across claims K.356 and 333 has greater continuity and width and greater values than any of the other veins and, therefore, warranted more intensive and detailed examination. Consequently, this vein, termed vein "A", was stripped, trenched, and explored in pits along a length of 945 feet [see Figure 2]. Work beyond this section along the strike to the northeast disclosed narrow and poorly mineralized stringers. After the surface examination was completed the zone was explored by diamond-drilling and by underground work on three levels at 125, 250, and 375 feet.

Surface work on the vein indicated that the 'break' could be conveniently divided into three sections. In the southwest section, the vein, which has a strike of N41°E. and a dip of about 75°S.E., appeared to be continuous for 400 feet. The vein ranges in width from 1 foot to 12 feet and averages 3.8 feet. In the last 50 feet, the direction of the vein changed from N41°E. to almost east and west. The second or middle section, which is 470 feet in length, contains no large lenses of quartz. For 220 feet the vein is broken up into small lenses, up to 2 feet wide and 40 feet long, by a series of small faults that strike approximately S65°E. For 120 feet the strike of the 'break' is east and west, with a dip of from vertical to 83°S., and then for 100 feet the strike is N.45°E., with a dip of from vertical to 83°S.E. In the remaining 250 feet of this section, which strike N.45°E., the vein fracture appears to be continuous but it is tight and unmineralized. The third or northeast section contains a well-defined section of the vein for a length of 95 feet. The vein has been faulted back on itself and has an average width of 5.6 feet and a dip of about 83°S.W.

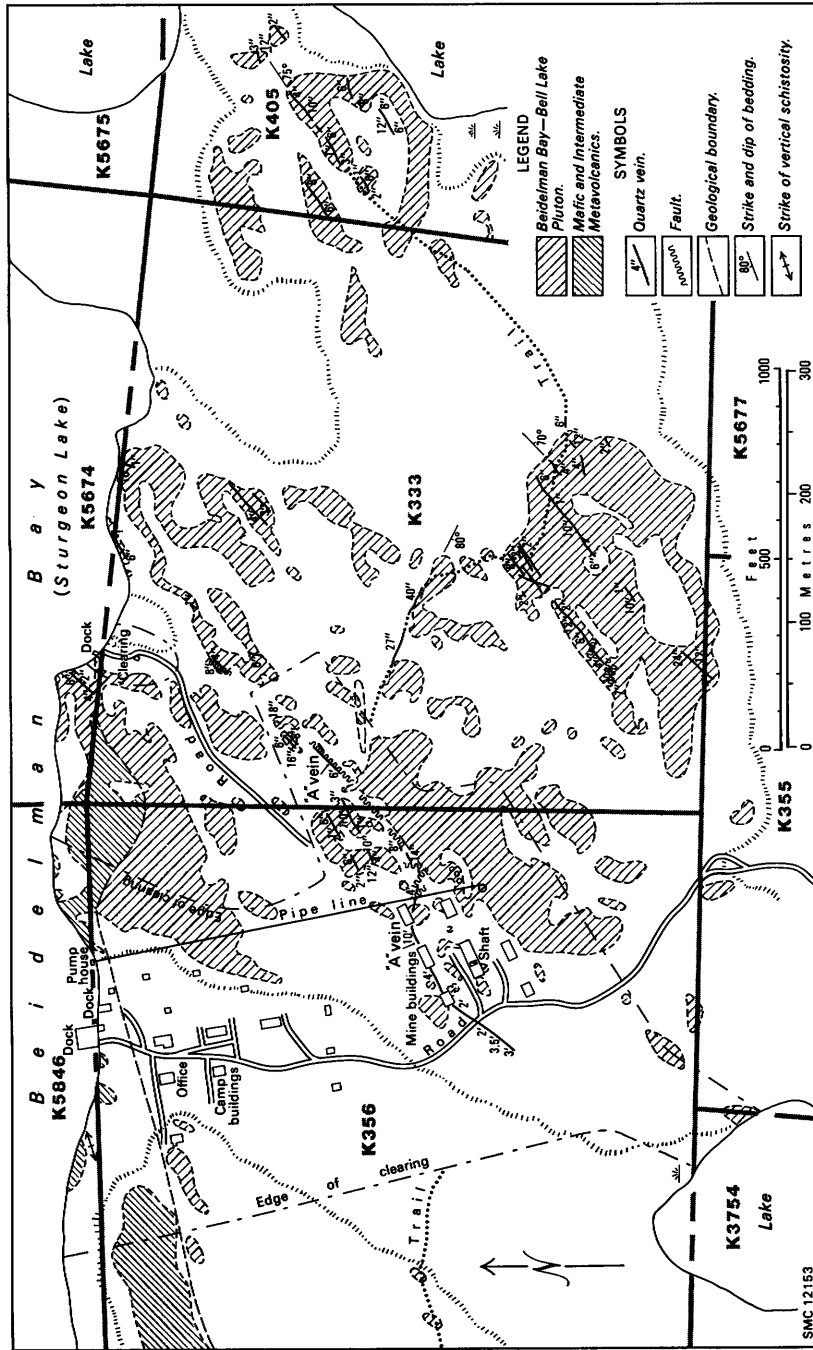


Figure 2—Geological sketch map of claims K.356 and K.333, Darkwater Mines Limited

Diamond Drilling

A diamond-drilling programme was started in August, 1935. In the succeeding months of that year and in the spring of 1936, 28 holes, totalling 6,578 feet, were drilled [see Figure 3]. Twenty-six of these were spotted at 50-foot intervals and drilled to intersect the vein zone at depths of from 125 to 150 feet below the outcrop. The other two were drilled to pick up the vein at an approximate depth of 300 feet. Twenty-three holes cut vein material believed to be vein "A". Twelve, Nos. 2 to 6, 8 to 10, 12, 14, 24, 25, had intersections that gave good assays over widths of from 14 inches to 10 feet. The other 11 holes, Nos. 7, 11, 13, 15 to 21, 28 with intersections that varied from a series of poorly mineralized stringers in the two deep holes, Nos. 17 and 18, to a well-defined vein 10 feet wide in hole No. 19, gave assay results that indicated only very small amounts of gold. Of the five remaining holes, Nos. 1 and 23 had vein intersections that did not belong to vein "A", and Nos. 22, 26 and 27 had no intersections of any interest whatever.

In the autumn of 1937 before operations were suspended, 5 diamond-drill holes were put out from cross cuts on the 375-foot level to explore the vein below that horizon. With the exception of one hole, which had an intersection with a true width of less than 1 foot, assaying 1.12 ounces, the drilling disclosed no interesting mineralization. Other holes drilled north to south from the two upper levels did not pick up any well-developed parallel veins.

Underground Work

An efficient and up-to-date mining plant was installed during the summer of 1936 and shaft-sinking and underground exploration was begun late in the fall. A 3 compartment vertical shaft was sunk to 424 feet, and levels were established at the 125-, 250-, and 375-foot horizons. Before the late fall of 1937, when operations were suspended, a total of 3,581 feet of drifting along the vein zone and 490 feet of crosscutting and 372 feet of raising had been done. An assay from channel-sampling did not give dependable results, due to the erratic nature of the gold distribution in the vein. A small test mill, consisting of a crusher and two stamp mills, was installed during the summer of 1937, and bulk samples were run in an attempt to determine the average gold content.

The structural characteristics of the vein in the underground workings are similar to those on the surface. On the 125-foot level the southwestern part of the vein has an almost continuous length of 680 feet, with an average width of 3.3 feet. Northeast of this section for 400 feet the vein is either broken up into a series of short lenses by a number of small faults or absent altogether. Farther to the northeast there is a 145-foot section that averages 5.5 feet in width. On the 250-foot level the southwestern part of the vein is practically continuous for 626 feet. The average width is about 2.4 feet. As on the 125-foot level and the surface this section is followed to the northeast by a zone, which on this level is 495 feet in length, in which the vein is either broken up into short lenses or absent. The lenses are more continuous, however, than on the upper level or the surface. The northeastern section of the vein is well defined for 110 feet and has an average width of 2.5 feet. The bottom or 375-foot level has not been opened up to the same extent as the first two levels. The southwestern section of the vein has been followed for 300 feet. It is practically continuous for this length and has an average width of 2.1 feet. The fracture zone has been followed northeast for approximately 220 feet but, except for a couple of small quartz lenses with a maximum width of 1.5 feet, it is practically barren of any mineralization.

Horwood (1937b, p.32) continues:

The gold content of the vein is most erratic, and it is practically impossible to obtain an idea of the average content by assaying channel samples. Samples taken across the vein in surface pits and trenches showed variations from nil or a trace to over 2 ounces per ton. Samples taken in 6 trenches and on a stripped zone 100 feet long in the southwestern continuous vein section

Bell Lake-Sturgeon Lake Area

gave an average uncut assay of 0.268 ounce of gold per ton for a distance of 321 feet across an average width of 4.3 feet. Bulk samples from these trenches and the stripped zone were shipped out for assay in the fall of 1936. A total of 23.45 tons gave an average of 0.348 ounce per ton. The second or central section of the vein zone contained only small lenses of quartz, and no estimate of the average gold content could be made. The third or northeastern section gave an average of 0.414 ounce per ton for a length of 95 feet across an average width of 5.6 feet. A bulk sample of 4.2 tons assayed 1.03 ounces per ton.

Assays of core intersections were just as erratic as those from channel sampling on the surfaces and ranged from a trace to 2.76 ounces per ton. An average assay for holes Nos. 3 to 10, 14 to 16, and 19, which appeared to represent a continuous vein length of 515 feet, gave an uncut grade of 0.784 ounce per ton across an average true width of 5 feet. When based on a minimum width of 5 feet, the uncut grade was 0.671 ounce across an average true width of 5.9 feet. Assays of vein intersections from holes Nos. 17 and 18, which were put down to test this section at an approximate depth of 300 feet, yielded only traces. Results from the other holes did not indicate any continuous or important lenses of ore, and no estimate of vein widths or values could be made.

On the 125-foot level assays of back samples did not correspond with the diamond-drilling results. Three sections vertically below the southwest 515-foot section averaged 0.262 ounce per ton across an average width of 5 feet for a combined length of 445 feet. Bulk samples from the back of this section did not correspond either with the diamond-drill results or with channel-sampling results. A total of 211.2 tons indicated, by test-mill methods, an average of 0.135 ounce per ton. The central faulted section along a length of 428 feet on the 125-foot level contains three quartz lenses, which, except for a 60-foot section averaging 0.277 ounce across 5.3 feet, do not contain more than 0.11 ounce of gold per ton. The northwest section of the vein gave an average from back samples of 0.598 ounce across an average width of 6 feet for a length of 105 feet. Bulk samples totalling 58.1 tons gave an average of 0.546 ounce per ton for the same section.

On the 250-foot level assay results were very disappointing. With a few exceptions, assays of samples from the southwestern and central sections indicate that the vein is practically barren. One bulk sample of 8.5 tons assayed 0.113 ounce per ton; all others gave lower returns. Back samples from the northeastern section averaged 0.657 ounce across 1.7 feet for 65 feet.

Channel samples from the 375-foot level gave lower assays returns than those from the 250-foot level, and bulk sampling was not considered necessary.

The gold was probably deposited from hydrothermal (possible chloride-bearing) solutions; colloidal solutions as postulated by Horwood (1937b, p.33) are probably too unstable (Krauskopf 1967, p.500). These solutions probably emanated from the granodiorite-trondhjemite-quartz porphyry body during its final stages of crystallization. A fault trending N40E is postulated as passing through the area of the Darkwater Mine shaft; this fault may have acted as a channelway for these solutions. This gold mineralization is in a different setting than is the copper-molybdenite mineralization located in the same body approximately $2\frac{1}{4}$ miles west of the Darkwater Mine shaft. Porphyritic rocks associated with the gold mineralization do not appear to be separate intrusive phases. Rather, the porphyritic texture seems to be the result of a metasomatic growth of quartz porphyroblasts in the early granitoid phase of the granodiorite-trondhjemite-quartz porphyry complex. In addition no 'intrusive' breccia and no extensive zones of hydrothermal alteration were noted.

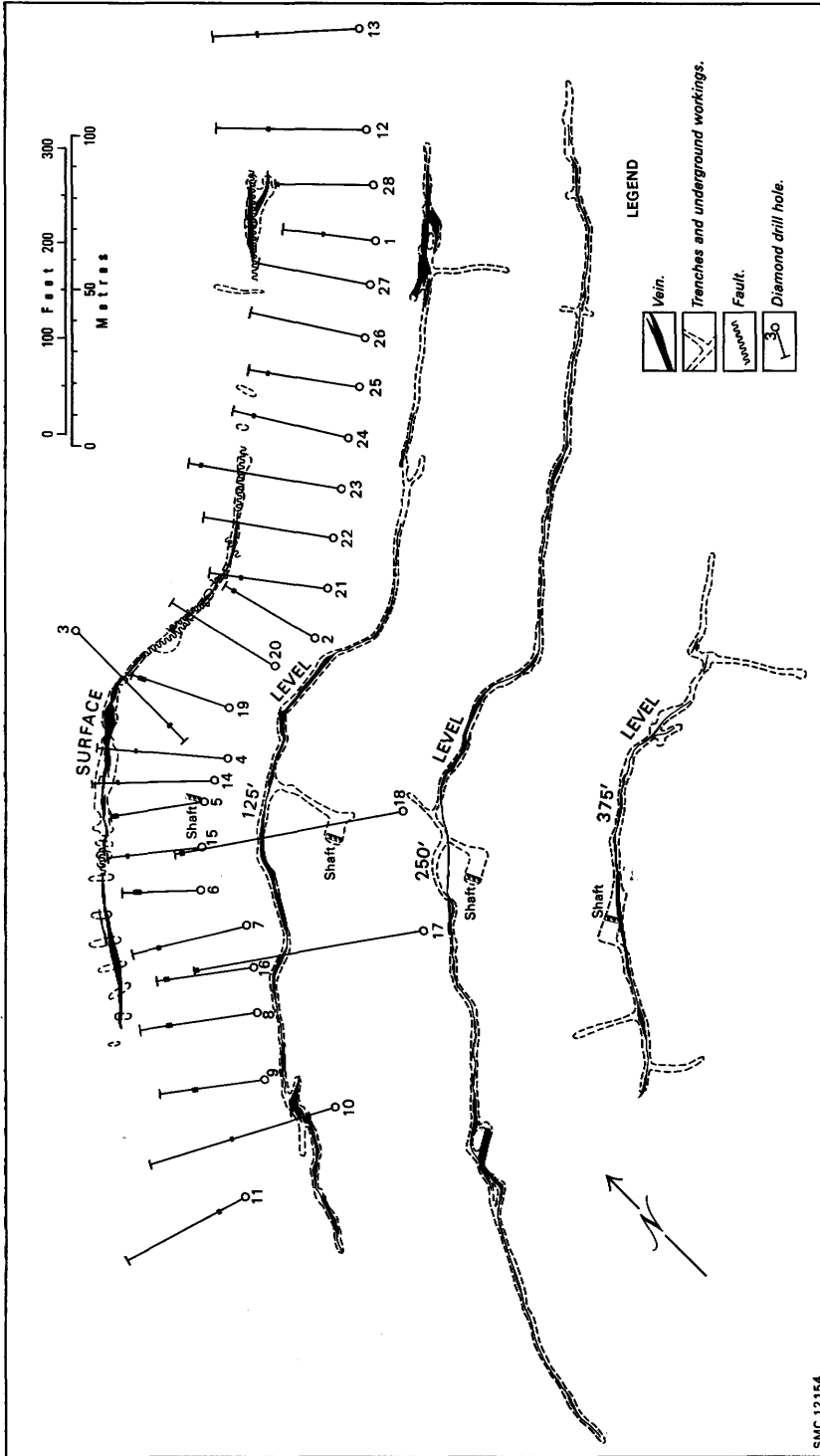


Figure 3—Plan showing veins, workings, and diamond drill holes at the Darkwater Mine

Steep Rock Iron Mines Limited (3)

BEIDELMAN BAY OCCURRENCE

A chalcopyrite occurrence was discovered in 1966 by J. Gareau, a prospector employed by Steep Rock Iron Mines Limited; the occurrence is in a silicified granodiorite-trondhjemite-quartz porphyry complex located on the southwest shore of Beidelman Bay.

A block of 20 claims was staked in 1966-1967, 19 claims of which were subsequently transferred to Steerola Exploration Limited. During the examination of this property by Steep Rock Iron Mines Limited a number of old trenches were found. These trenches were primarily located on exposed quartz veins but five were found in rock containing sulphide mineralization. Two old diamond drill holes were also found (not shown on maps backpocket).

The claim group was mapped by Steep Rock Iron Mines Limited at a scale of 1 inch to 200 feet (Figure 4), and two areas of disseminated chalcopyrite mineralization denoted East and West Areas, respectively, were mapped at a scale of 1 inch to 50 feet (Figures 5 and 6).

A geochemical survey was conducted to determine the ground slope and soil type at 100-foot intervals. Samples were taken from the B and C horizons of glacially deposited and residual soils. Cold extraction analyses for total heavy metals were done by the dithiozone method, and further copper analyses were made by Technical Service Laboratories using the hot hydrochloric acid extraction method.

Horizontal-loop electromagnetic, magnetometer, induced polarization, and self-polarization ground geophysical surveys were carried out and two anomalous zones (East and West Areas respectively) were outlined. These anomalous zones were trenched and diamond drilled; 18 holes, with a total length of 2,165 feet of XRPS ($\frac{7}{8}$ inch) diamond drill core, were drilled. The core containing chalcopyrite mineralization was divided into 10-foot sections; analyses for copper and molybdenum were done by the Steep Rock Iron Mines Limited Laboratory; analyses for gold, silver, and zinc were done by Bell White Analytical Laboratories Limited.

The eastern mineralized area consists of disseminated pyrite and chalcopyrite, and locally pyrrhotite, in a zone of silicified granodiorite. The unaltered granodiorite surrounding this silicified granodiorite zone contains local concentrations of magnetite, pyrite, chalcopyrite, and rare pyrrhotite.

The western mineralized area also is associated with a 500-foot wide zone of silicified granodiorite; this zone has a gradational(?) contact with the unaltered granite to the north and an intrusive contact with the older breccia to the south. The mineralization consists of disseminated pyrite, pyrrhotite, chalcopyrite, and minor molybdenite and bornite. A pervasive silicification has affected the granodiorite and older breccia, especially near their common contact. A later stage of silicification is represented by narrow, discontinuous, irregular quartz stringers containing pyrite and chalcopyrite.

The exploration program carried out by Steep Rock Iron Mines Limited is quite similar to the suggested program of prospecting for 'porphyry copper' deposits as outlined in 'Geology of the Porphyry Copper Deposits' (Titley and Hicks 1966). The author has previously indicated that this pluton or complex has many features characteristic of 'porphyry copper-type' intrusions. The nature of the copper molybdenite mineralization and the structural controls have already been described.

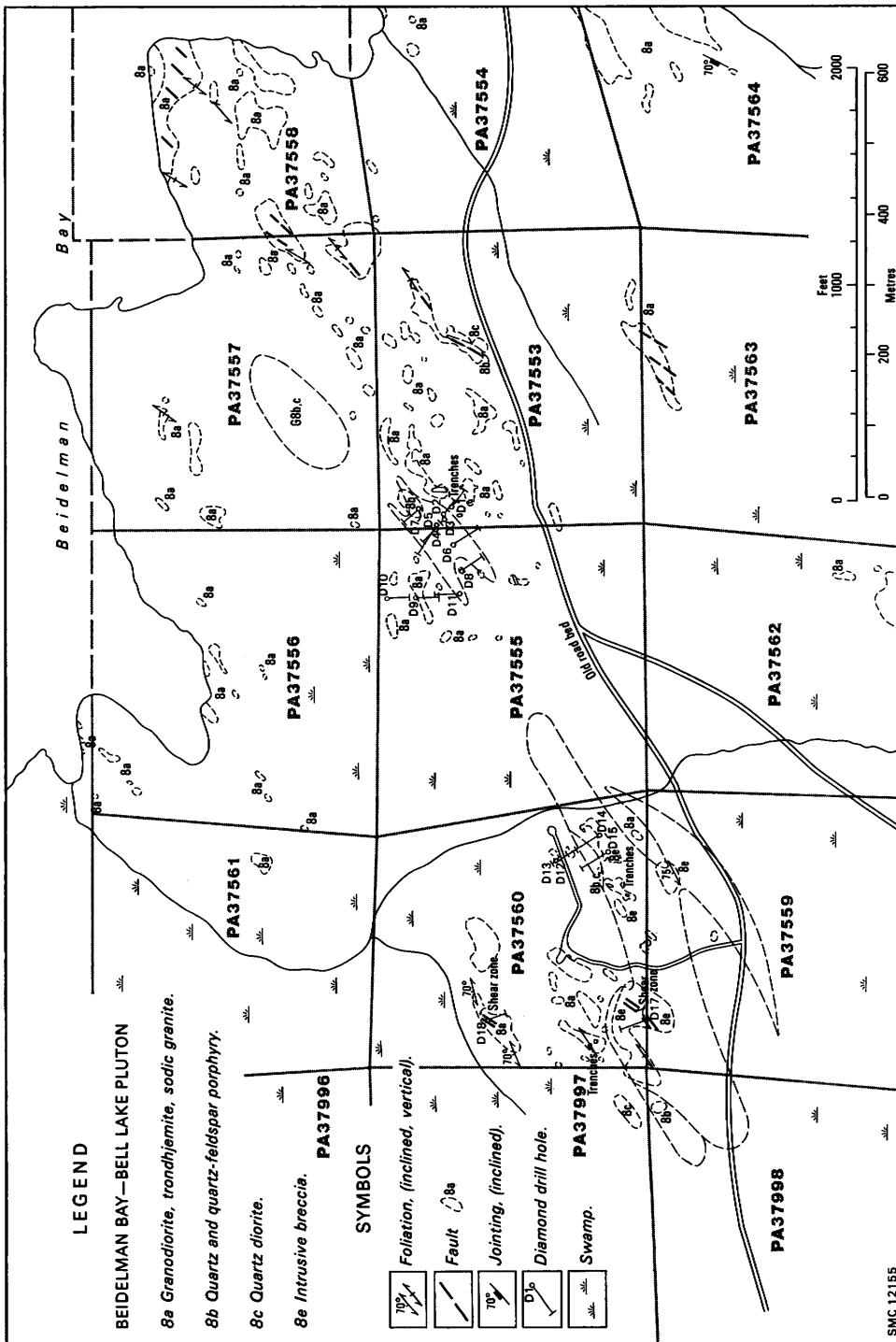


Figure 4—Geological map of Beidelman Bay Occurrence

Quartz Veins

Small barren-looking quartz veins are relatively common in the volcanic and sedimentary rocks. Quartz veins which cut the volcanic rocks exposed in the northern portion of the area contain minor amounts of pyrite. Several of these veins were sampled by the author but analyses indicated only trace amounts of gold, silver, copper, and molybdenum.

Several of the quartz-tourmaline (-ankerite) veins associated with the Beidelman Bay-Bell Lake pluton were sampled by the author. Analyses indicated trace to very low gold values (less than .35 dollar value with gold at \$35 per ounce).

Sulphide Mineralization

Sulphide mineralization was observed in the following locations:

- 1) A semicontinuous zone of disseminated pyrite and pyrrhotite mineralization (1 percent or less) occurs in the intermediate to mafic volcanic rocks between Cobb Lake and Granite Bay. The mineralization is localized along shear planes in these volcanic rocks and is associated with abundant carbonatization and minor silicification.
- 2) Pyrite mineralization (1 percent) is very common in the northern felsic and intermediate volcanic rocks. The pyrite occurs as euhedral cubes in carbonatized shear zones and as local disseminations, within these rocks.
- 3) Pyrite and pyrrhotite mineralization is present in the mafic volcanic rocks (porphyritic and coarse-grained flows) in the west-central part of the map-area. A porphyritic mafic volcanic unit located on Highway 599, approximately 1,700 feet south of the Granite Bay turn-off, is cut by a 20-foot wide rusty-weathering shear zone. Folded pyrrhotite and pyrite stringers, and disseminated sulphide mineralization occur in this unit and in the coarse-grained flows nearby. These rocks have been sheared and extensively silicified and epidotized; both contorted quartz and quartz-epidote veins cut these rocks and silicification has also occurred along joints.
- 4) Trenching was noted in the volcanic rocks west of the southwest shore of Mountain Island Bay. An epidotized mafic to intermediate volcanic unit was sampled by the author; analysis indicated 15 parts per million molybdenum, and trace copper, silver, and gold.
- 5) A chlorite schist unit located at the north contact of the Mountain Island Bay granite and the volcanic rocks was sampled by the author. Analysis by the Mineral Research Branch, Ontario Division of Mines, indicated the presence of 0.05 percent copper and trace nickel.
- 6) Chalcopyrite flakes are disseminated in a zone of brecciated meta-gabbro south of Mountain Island Bay. A sample collected by the author was analyzed; only trace amounts of copper, nickel, and cobalt were indicated.

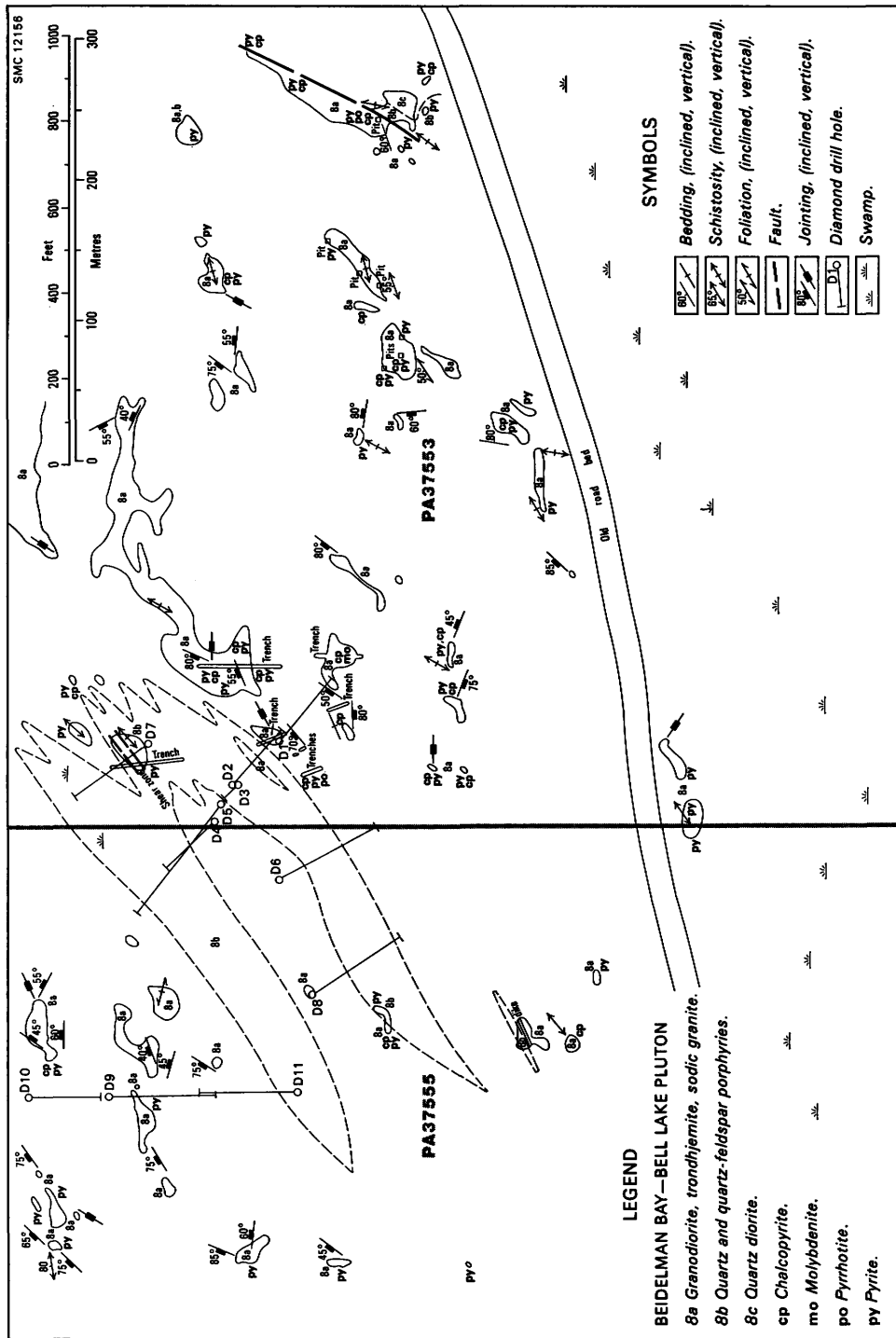


Figure 5—Geological map of East Area, Beidelman Bay Occurrence

Bell Lake-Sturgeon Lake Area

7) A hornblende gneiss unit (metamorphically differentiated tuff or fine-grained flow) northwest of Bell Lake contained minor chalcopyrite mineralization in a red-weathering iron-rich zone. A sample collected by the author and analyzed by the Mineral Research Branch, Ontario Division of Mines, contained .03 percent copper.

Several samples of the Beidelman Bay-Darkwater Lake-Bell Lake granodiorite-trondhjemite-quartz porphyry complex were collected by the author for analysis for copper and molybdenum. These samples were collected from the pits and trenches of the former Beidelman Bay property of Steep Rock Iron Mines Limited. Copper ranging from .08 to .60 percent and trace molybdenum were indicated in analyses of these samples by the Mineral Research Branch, Ontario Division of Mines.

Although the contacts between the volcanic rocks and the younger felsic intrusive rocks have been suggested in the literature as possible prospecting sites for gold and copper, a number of samples, collected by the author, of the volcanic units near their respective contacts with the Penassi Lake, Mountain Island Bay, and Granite Bay plutons showed only trace amounts of copper, silver, gold, and molybdenum.

The ultramafic (serpentinized peridotite) rocks on Mountain Island were sampled. Table 2, chemical analysis No. 8, indicates the trace element composition of one sample of ultramafic rock.

Radioactivity

Several of the pegmatites associated with the Bell Lake complex were sampled and these samples were later checked by the author for any radioactive response; none was detected.

Iron

An outcrop of quartz-magnetite iron formation is exposed on an island in Sturgeon Lake near the eastern boundary of the map-area. As previously mentioned, the aeromagnetic map indicates an iron formation trending approximately down the centre of Sturgeon Lake. A detailed evaluation (ground magnetometer dip-needle surveys, aeromagnetic survey, geological mapping, and diamond drilling) of the economic potential of a portion of this formation was done by C. H. Hopper (who was granted an option on the property by N. A. Timmins (Ontario) Limited) in the Sassafras Lake area (Assessment Files Research Office, File 63-907, Ontario Division of Mines, Toronto) west of the present report area. An examination of the iron formation (extent, grade) in the present report-area might be warranted.

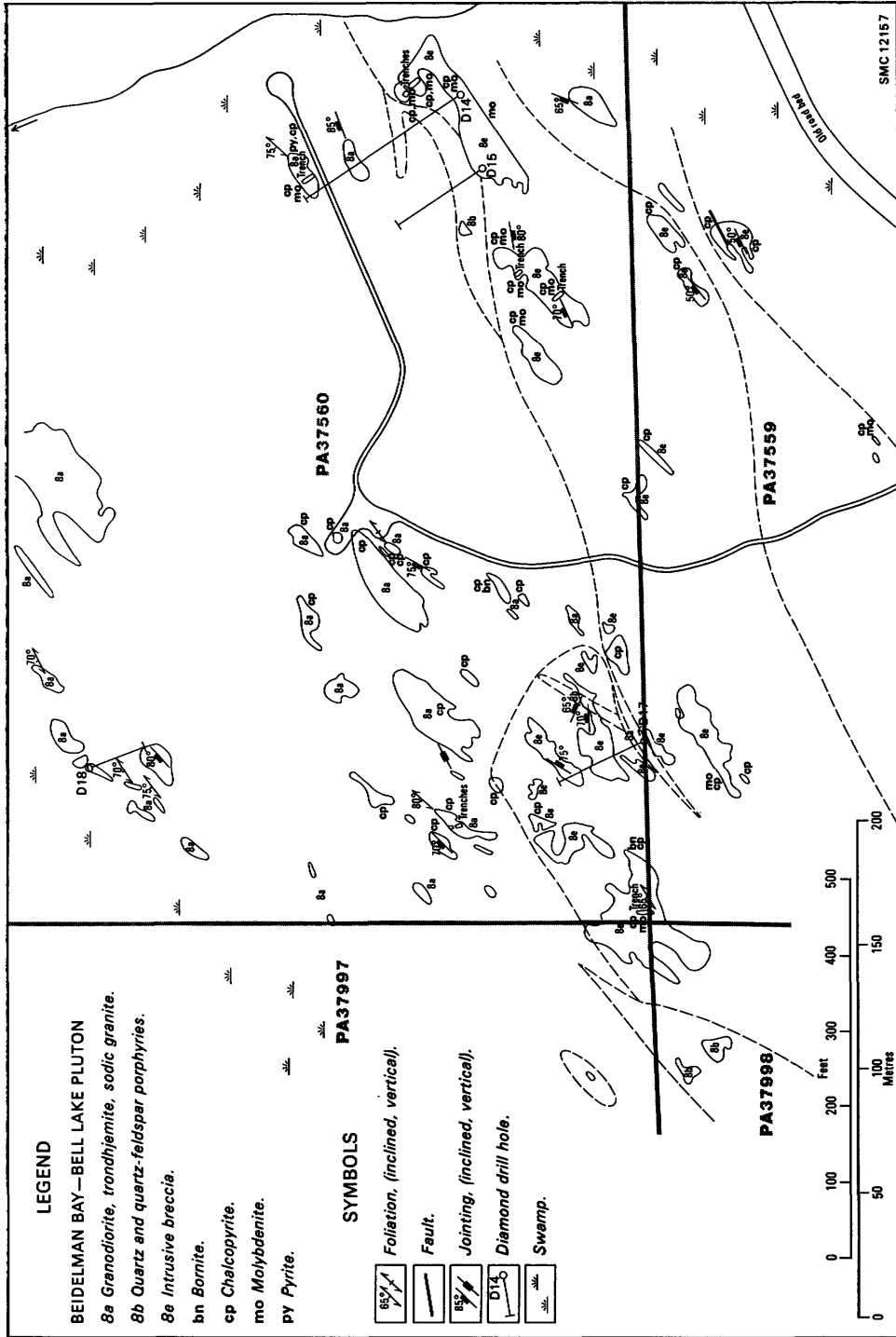


Figure 6—Geological map of West Area, Beidelman Bay Occurrence

CONSIDERATIONS IN FUTURE EXPLORATION

For the next few years mineral exploration in the area will be concentrated in the search for base metal sulphide deposits similar to that recently discovered by Mattagami Lake Mines Limited, Exploration Division. The author has not seen the property of Mattagami Lake Mines Limited, and thus can only speculate on its geology by extrapolating the geology of the present map-area, along strike into the property area. On a gross scale, the sulphide minerals appear to be stratigraphically(?) controlled in a felsic flow and pyroclastic succession (Northern Miner 1969) which corresponds to the southern felsic metavolcanic sequence mapped by the author. Whether this sulphide body is syngenetic and thus an integral part of the volcanic cycle, or whether it is epigenetic and thus has been deposited in its present position by 'later' mineralizing fluids has yet to be determined. In either case, the volcanic stratigraphy appears to have played an important role in the localization of the sulphide mineralization. Other salient features which are present in the felsic flows and pyroclastic rocks in the present map-area and which might be associated with or have effected the localization of this sulphide body are: (1) the interpreted east-west-trending shear zone in which the felsic volcanics have been transformed to muscovite and chloritoid-bearing schists or phyllites due to mechanical deformation and associated metasomatism; (2) the presence of kink folds and the suggestion of local isoclinal folding which might locally exert structural controls on this sulphide body; and (3) the presence of concordant intermediate to slightly mafic volcanic units within this felsic volcanic succession, as various authors have suggested that massive syngenetic sulphide bodies tend to occur in the stratigraphical succession where mafic volcanism changes to felsic volcanism.

The mineralizing fluids necessary in any epigenetic hypothesis put forth to explain the origin of this deposit could have had their source in the granodiorite-trondhjemite-quartz porphyry complex located to the south of this felsic volcanic succession. In considering this complex as a possible source of the mineralization it is important to determine whether this complex is a subvolcanic intrusion and thus part of the volcanic succession or whether it is a younger felsic intrusive body which has intruded the volcanic succession. The granodiorite-trondhjemite-quartz porphyry complex might itself deserve further attention. A large part of this body is covered by Pleistocene and Recent deposits and it is possible that other areas of disseminated chalcopyrite and molybdenite mineralization are present under these covered areas. In addition to the geophysical and geochemical techniques adopted by Steep Rock Iron Mines Limited, a biogeochemical survey over this intrusion might be worthwhile since both molybdenum and copper are relatively good indicator elements (for their deposits) and under particular environmental conditions are concentrated in various types of vegetation.

The ultramafic rocks on Mountain Island and the metagabbro-metadiorite south of Mountain Island Bay should be examined for any possible associated copper and copper-nickel mineralization.

The Bell Lake monzonite complex could be examined for possible concentrations of radioactive minerals by airborne spectrometer surveys.

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Bell Lake-Sturgeon Lake Area

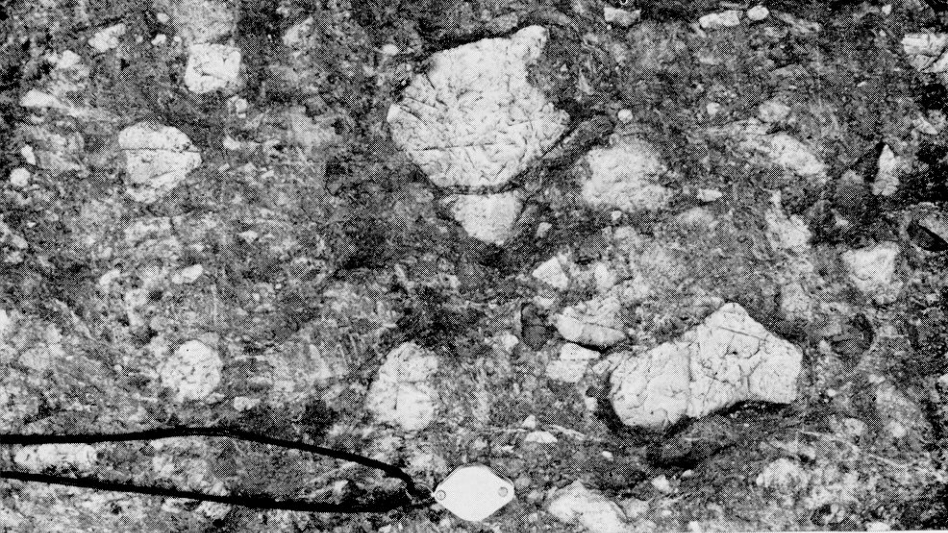
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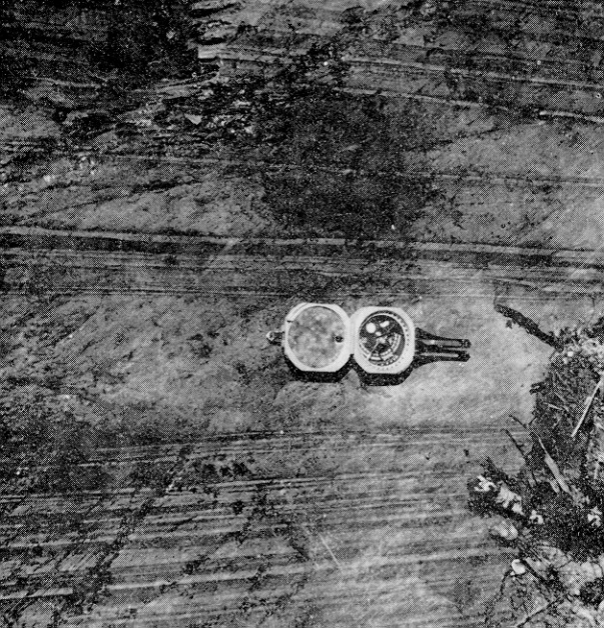










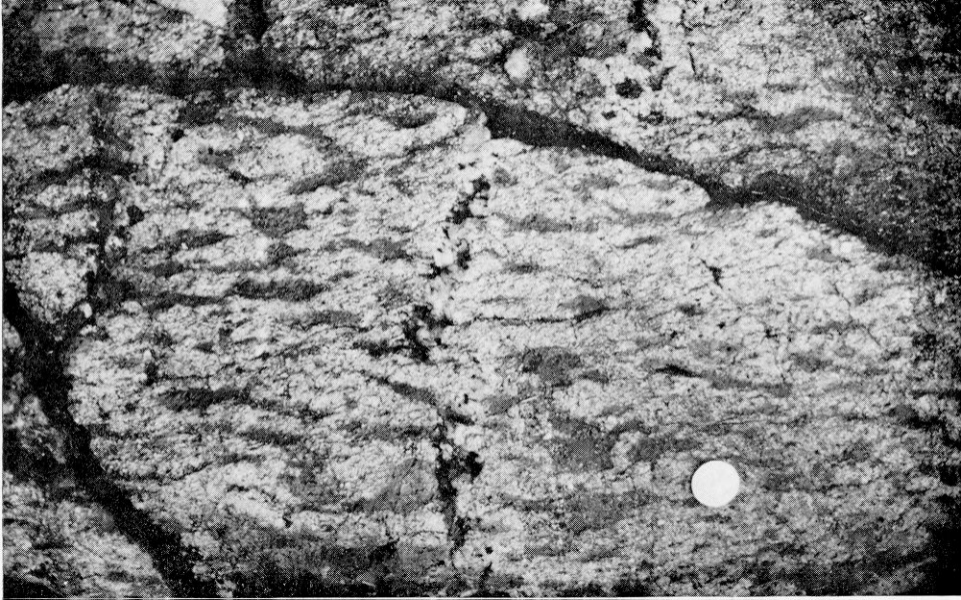


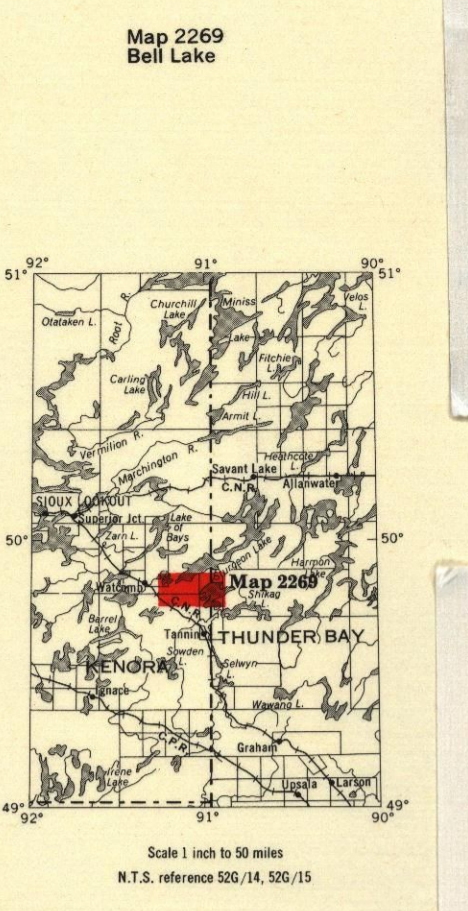




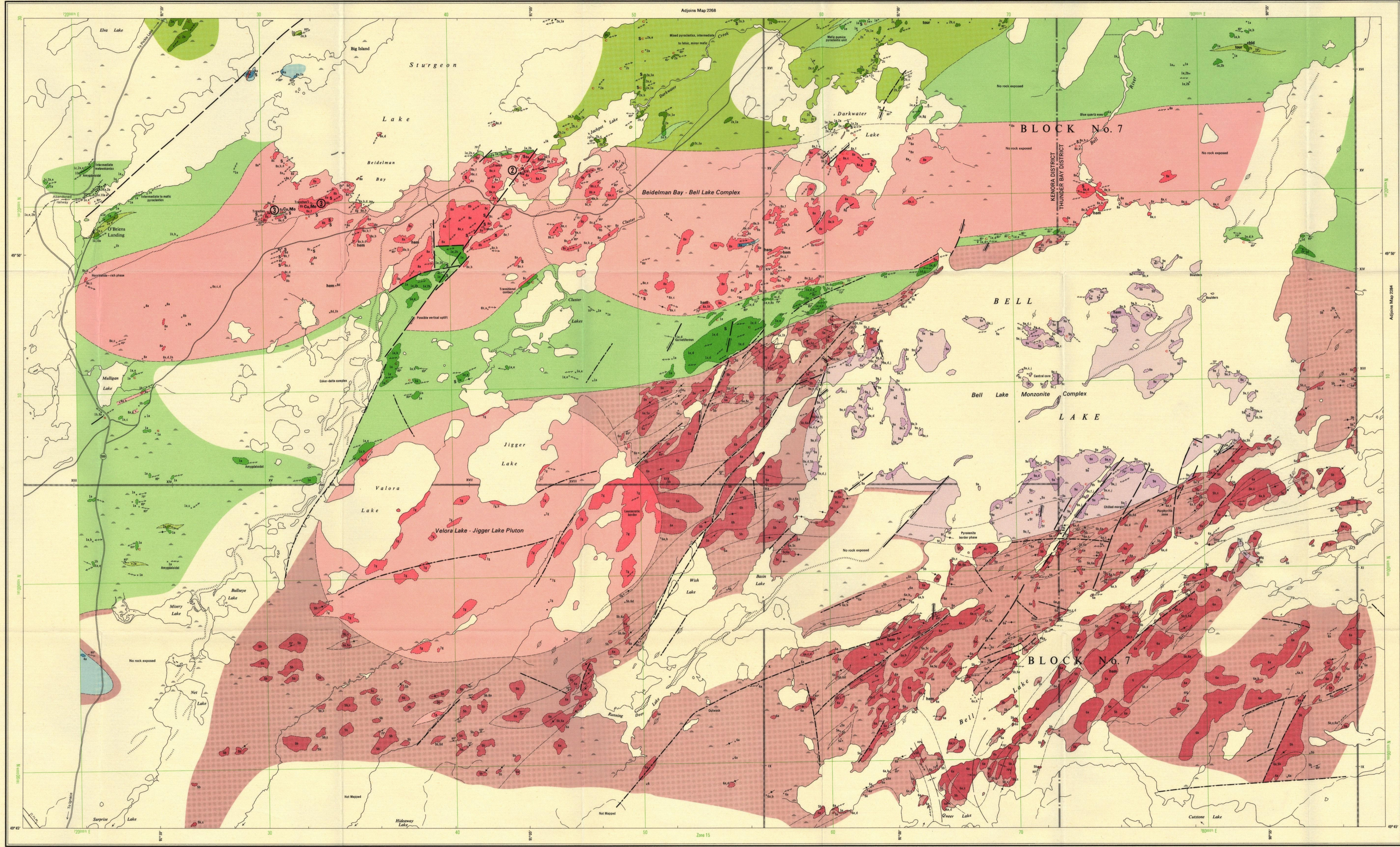








- LEGEND**
- CENOZOIC**
QUATERNARY
 PLEISTOCENE AND RECENT
 Swamp accumulations; clay, sand, and gravel
- PRECAMBRIAN**
EARLY PRECAMBRIAN
ARCHAIC
LATE FELSIC AND INTERMEDIATE INTRUSIVE ROCKS
- 1a Quartz porphyry, quartz-feldspar porphyry, and feldspar porphyry with dikes and irregular masses.
 - 1b Unidentified.
 - 2a Biotite-hornblende-sillite monzonite.
 - 2b Porphyritic biotite-hornblende-sillite monzonite.
 - 2c Apatitic perthite monzonite.
 - 2d Monzonite (melkyranite) inclusions.
 - 2e Monzonite (granitic and amphibolite inclusions).
 - 2f Biotite syenite.
 - 2g Lamprophyre (dikes).
 - 2h Gabro (dikes).
 - 2i Albitic syenite (dikes and irregular masses).
- BELL LAKE MONZONITE COMPLEX**
- 3a Unidentified.
 - 3b Hornblende-biotite and biotite monzonite.
 - 3c Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 3d Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 3e Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 3f Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 3g Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 3h Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 3i Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 3j Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 3k Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 3l Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 3m Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 3n Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 3o Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 3p Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 3q Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 3r Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 3s Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 3t Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 3u Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 3v Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 3w Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 3x Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 3y Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 3z Hornblende-biotite and biotite monzonite (dikes and irregular masses).
- BEIDELMAN BAY-BELL LAKE PLUTON**
- 4a Unidentified.
 - 4b Granodiorite, tonalite, quartz diorite, and quartz monzonite.
 - 4c Quartz (Blue Quartz Eye) porphyry and quartz-feldspar porphyry.
 - 4d Quartz (Dove) (includes sheared and unaltered granodiorite and quartz monzonite).
 - 4e Intrusive breccia (mafic meta-igneous).
 - 4f Intrusive breccia (felsic intrusive monzonite).
 - 4g Quartz-feldspar-ankerite veins and quartz veins.
 - 4h Apatite dikes.
- LATE FELSIC PLUTONS**
- 5a Unidentified.
 - 5b Hornblende-biotite and biotite monzonite.
 - 5c Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 5d Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 5e Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 5f Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 5g Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 5h Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 5i Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 5j Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 5k Hornblende-biotite and biotite monzonite (dikes and irregular masses).
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 - 5p Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 5q Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 5r Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 5s Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 5t Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 5u Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 5v Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 5w Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 5x Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 5y Hornblende-biotite and biotite monzonite (dikes and irregular masses).
 - 5z Hornblende-biotite and biotite monzonite (dikes and irregular masses).
- EARLY GRANITIC INTRUSIVE ROCKS**
- 6a Unidentified.
 - 6b Biotite and hornblende-biotite monzonite (felsic intrusive monzonite).
 - 6c Hornblende-biotite and biotite monzonite (felsic intrusive monzonite).
 - 6d Hornblende-biotite and biotite monzonite (felsic intrusive monzonite).
 - 6e Hornblende-biotite and biotite monzonite (felsic intrusive monzonite).
 - 6f Hornblende-biotite and biotite monzonite (felsic intrusive monzonite).
 - 6g Hornblende-biotite and biotite monzonite (felsic intrusive monzonite).
 - 6h Hornblende-biotite and biotite monzonite (felsic intrusive monzonite).
 - 6i Hornblende-biotite and biotite monzonite (felsic intrusive monzonite).
 - 6j Hornblende-biotite and biotite monzonite (felsic intrusive monzonite).
 - 6k Hornblende-biotite and biotite monzonite (felsic intrusive monzonite).
 - 6l Hornblende-biotite and biotite monzonite (felsic intrusive monzonite).
 - 6m Hornblende-biotite and biotite monzonite (felsic intrusive monzonite).
 - 6n Hornblende-biotite and biotite monzonite (felsic intrusive monzonite).
 - 6o Hornblende-biotite and biotite monzonite (felsic intrusive monzonite).
 - 6p Hornblende-biotite and biotite monzonite (felsic intrusive monzonite).
 - 6q Hornblende-biotite and biotite monzonite (felsic intrusive monzonite).
 - 6r Hornblende-biotite and biotite monzonite (felsic intrusive monzonite).
 - 6s Hornblende-biotite and biotite monzonite (felsic intrusive monzonite).
 - 6t Hornblende-biotite and biotite monzonite (felsic intrusive monzonite).
 - 6u Hornblende-biotite and biotite monzonite (felsic intrusive monzonite).
 - 6v Hornblende-biotite and biotite monzonite (felsic intrusive monzonite).
 - 6w Hornblende-biotite and biotite monzonite (felsic intrusive monzonite).
 - 6x Hornblende-biotite and biotite monzonite (felsic intrusive monzonite).
 - 6y Hornblende-biotite and biotite monzonite (felsic intrusive monzonite).
 - 6z Hornblende-biotite and biotite monzonite (felsic intrusive monzonite).
- TRANSITIONAL CONTACT**
- MIGMATITE ASSEMBLAGE**
- 7a Unidentified.
 - 7b Metagabbro and metadiorite, hornblende gneiss, biotite-hornblende gneiss, porphyritic (eugene) biotite-hornblende gneiss.
 - 7c Hybrid granitic gneiss.
- INTRUSIVE CONTACT**
- MAFIC INTRUSIVE ROCKS**
- 8a Metagabbro, metadiorite, amphibolite.
 - 8b Metagabbro, metadiorite, and ultramafic rocks (includes talciferous gabbro and peridotite; dikes of quartz-diorite and/or quartz monzonite).
 - 8c Intrusive breccia (mafic meta-igneous).
 - 8d Quartz-hornblende diorite (dikes).
 - 8e Hornblende diorite.
- INTRUSIVE CONTACT**
- METASEDIMENTS**
- 9a Unidentified.
 - 9b Quartz-eye schist.
 - 9c Chlorite schist.
 - 9d Siltite, argillite.
 - 9e Calciferous felsic intrusive and extrusive (dikes).
 - 9f Calciferous quartz porphyry, mafic extrusive, and jasperoid (dikes).
 - 9g Quartz-mica schist formation.
- METAVOLCANICS**
- FELSIC METAVOLCANICS**
- 10a Unidentified.
 - 10b Rhyolite, rhyodacite lava flows; rhyolite tuff.
 - 10c Pyroclastic breccia to lapillstone (felsic and felsic dikes).
 - 10d Pyroclastic breccia to lapillstone (mafic and felsic dikes).
 - 10e Carbonate-sericite-quartz and chlorite schist and argillite.
 - 10f Chert.
 - 10g Quartz and quartz-feldspar porphyry.
- CONFORMABLE CONTACT**
- MAFIC AND INTERMEDIATE METAVOLCANICS**
- 11a Unidentified.
 - 11b Fine to medium-grained lava flows, chlorite schist.
 - 11c Coarse-grained lava flows.
 - 11d Porphyritic lava flows.
 - 11e Carbonate schist.
 - 11f Tuff, lapillstone, and pyroclastic breccia.
 - 11g Pyroclastic breccia to lapillstone (felsic and felsic dikes).
 - 11h Subvolcanic (segmental) rocks.
 - 11i Metagabbro, metadiorite.
 - 11j Chert (slightly ferruginous).
 - 11k Siliceous lava flows.
 - 11m Tuffaceous sedimentary rocks.
- Carbonated rock.**
- Silicified rock.**
- Minerals:**
 Au Gold
 Ag Chlorite
 Cu Copper
 Fe Hematite
 Mn Manganese
 Ni Nickel
 Zn Zinc
 U Uranium
 T Tourmaline

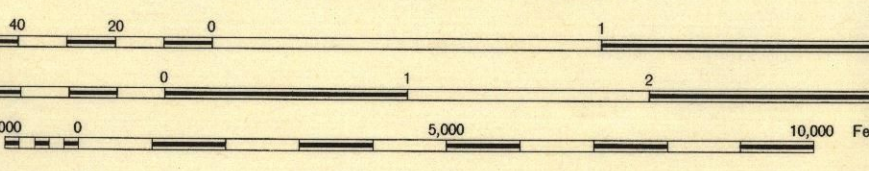


- SYMBOLS**
- Glacial drift.
 - Drumlin.
 - Esker.
 - Small bedrock outcrop.
 - Area of bedrock outcrop.
 - Bedding, top unknown; (inclined, vertical, overturned).
 - Bedding, top indicated by arrow; (inclined, vertical, overturned).
 - Bedding, top derived from grain gradation; (inclined, vertical, overturned).
 - Lava flow; (top (fence) from pillow shape and packing).
 - Schistosity; (horizontal, inclined, vertical).
 - Gneissosity; (horizontal, inclined, vertical).
 - Foliation; (horizontal, inclined, vertical).
 - Bandings; (horizontal, inclined, vertical).
 - Lineation with plunging.
 - Geological boundary, observed.
 - Geological boundary, position inferred.
 - Geological boundary, deduced from geophysics.
 - Magnetic contour, value in gamma.
 - Fault; (observed, assumed). Spot indicates down throw side, arrows indicate horizontal movement.
 - Lineament.
 - Drag folds with plunging.
 - Anticline, syncline, with plunging.
 - Shaft; depth in feet.
 - Magnetic attraction.
 - Swamp.
 - Motor road, Provincial highway number encircled where applicable.
 - Other road.
 - Trail, portage, winter road.
 - Township boundary, meridian, or baseline, with midpoint, approximate position only.
 - District boundary, approximate position only.
 - Location of mining property, unworked. (See list of properties.)

- LIST OF PROPERTIES AND OCCURRENCES**
1. Cobb Bay copper occurrence.
 2. Darkwater Mines Limited (1937).
 3. Silver Rock Iron Mines Limited (1962).
- Ownership of properties as of December 31, 1969. Data in this column refers to year of last major work. For further information see report.
- 1 Occurs only on companion sheet, Map 2268, Granite Bay.

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 P. 203, Melton-Sturgeon Lakes Sheet, scale 1 inch to 2 miles, issued 1966.
 P. 289, P. 589, P. 591, Bell Lake-Sturgeon Lake Area, scale 1 inch to 1/2 mile, issued 1970.
 Cartography by C. A. Harris and assistants, Survey and Mapping Branch, 1953.
 Base map derived from maps of the Forest Resources Inventory, Survey and Mapping Branch.
 Magnetic declination in the area was approximately 7° E, 1969.

Map 2269
BELL LAKE
 KENORA AND THUNDER BAY DISTRICTS
 Scale 1:31,680 or 1 inch to 1/2 Mile


* Unconsolidated deposits. Cenozoic deposits are represented by the lighter colored and unnumbered parts of the map.
 † Includes mafic rocks.
 ‡ May include mafic intrusive rocks.
 § Occurs only on companion sheet, Map 2268, Granite Bay.
 ¶ The letter "G" preceding a rock unit, for example "G1" indicates interpretation from geophysical data.