AN ABSTRACT OF THE THESIS OF

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Title: Geology and Mineralization of the Lateral Lake Stock, District of Kenora, Northwestern Ontario.

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The Lateral Lake Area is located 30 km northeast of Dryden in Echo and Webb Townships in the District of Kenora in northwestern Ontario. The area has been the focus of molybdenum exploration since 1906. Most exploration and development has been centered on the Pidgeon Prospect in Echo Township. Although, to date, no production has occurred, active exploration is continuing on the prospect.

The Lateral Lake Stock is an elongate, diapiric, granodioritic pluton that intrudes a series of mafic metavolcanic and metasedimentary rocks of the amphibolite grade of regional metamorphism. The emplacement of the stock occurred during the period of regional metamorphism which affected the supracrustal rocks. This period is known as the Kenoran Orogeny in the Superior Province of the Canadian Precambrian Shield, and is dated at 2480 m.y. The conformability of textural and structural features in the stock and the supracrustal rocks suggest that their formation occurred concurrently with the intrusion of the stock into the supracrustal rocks. The stock was emplaced at a relatively deep crustal level as inferred by the contact relationships between the pluton and the supracrustal rocks. Recrystallization has affected most of the stock to some

extent, although it is best-developed at the margins, and in the western part of the pluton, which is considered to be the deepest, exposed level of the intrusion.

A period of potassic metasomatism followed, and partly overlapped, the period of regional metamorphism. The effects of potassium metasomatism are present throughout the stock. However, they are most intense along the eastern contact of the pluton in Echo Township, and in a small area along the southern contact of the stock in Webb Township. Both areas are characterized by microcline-rich pegmatites and sills of aplite, and represent the upper levels or cupolas of the stock.

Molybdenite mineralization is directly associated with the zones of intense potassic metasomatism. Most molybdenite was deposited along the selvages of, and in the wall rock adjacent to quartz and quartz-microcline pegmatite veins and dikes. The highest concentratations of molybdenite occur where these veins intrude sills of aplite, although granodiorite is also a favourable host. Minor amounts of molybdenite were deposited along late chlorite and epidote-bearing fractures, and calcite-bearing fractures.

Pyrite is present in subequal amounts as molybdenite. Minor amounts of pyrrhotite, chalcopyrite, bismuthinite, and native bismuth are associated with the more abundant sulphides. Zonation of sulphides is not apparent, although pyrite is more widely distributed than molybdenite.

Potassic, phyllic, and propylitic types of hydrothermal alteration are associated with the molybdenite mineralization. They are confined mostly to the wall rock adjacent to the veins. Zonation of alteration mineral assemblages is not well-defined; however, zonation patterns are similar to those encountered in porphyry ore systems.

Sulphide and alteration mineralization are almost entirely confined to the Lateral Lake Stock. However, trace amounts of molybdenite, and evidence of potassic alteration are present in the metavolcanic rocks east of the stock, which suggests that a weak hydrothermal system developed above the pluton.

In addition to molybdenite mineralization, a complex pegmatite, which contains lithium, cesium, and tantalum is present within the metavolcanic rocks south of the stock in Webb Townhip. Its relationship to the stock is unknown.

Geology and Mineralization of the
Lateral Lake Stock,
District of Kenora,
Northwestern Ontario

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GEOLOGY AND MINERALIZATION OF THE LATERAL LAKE STOCK, DISTRICT OF KENORA, NORTHWESTERN ONTARIO

INTRODUCTION

The Lateral Lake Stock is located 30 km northeast of Dryden in Echo and Webb Townships in the District of Kenora in northwestern Ontario (Fig. 1). Deposits of molybdenum have been explored and developed sporadically within the immediate area for the past seventy years. Most development occurred in the mid 1960's and concentrated on the major molybdenum showings in Echo Township. To date, there has been no commercial production; however, active exploration is continuing on the Pidgeon Molybdenum Prospect in Echo Township.

Location and Access

The map area, approximately 57.6 square km, encompasses parts of Echo and Webb Townships, and is bounded by lattitudes $49^{\circ}55'$ N and $49^{\circ}58'$ N and longitudes $92^{\circ}21'$ W and $92^{\circ}32'$ W. Access to the western part of the area is by the Dryden-Hudson gravel road, and to the eastern part of the area by a gravel road running northwest from Highway 72, 37 km south of the town of Sioux Lookout. Secondary gravel and dirt roads provide access to the central part of the area. The more remote areas can be reached by canoe from Tot and Lateral Lakes.

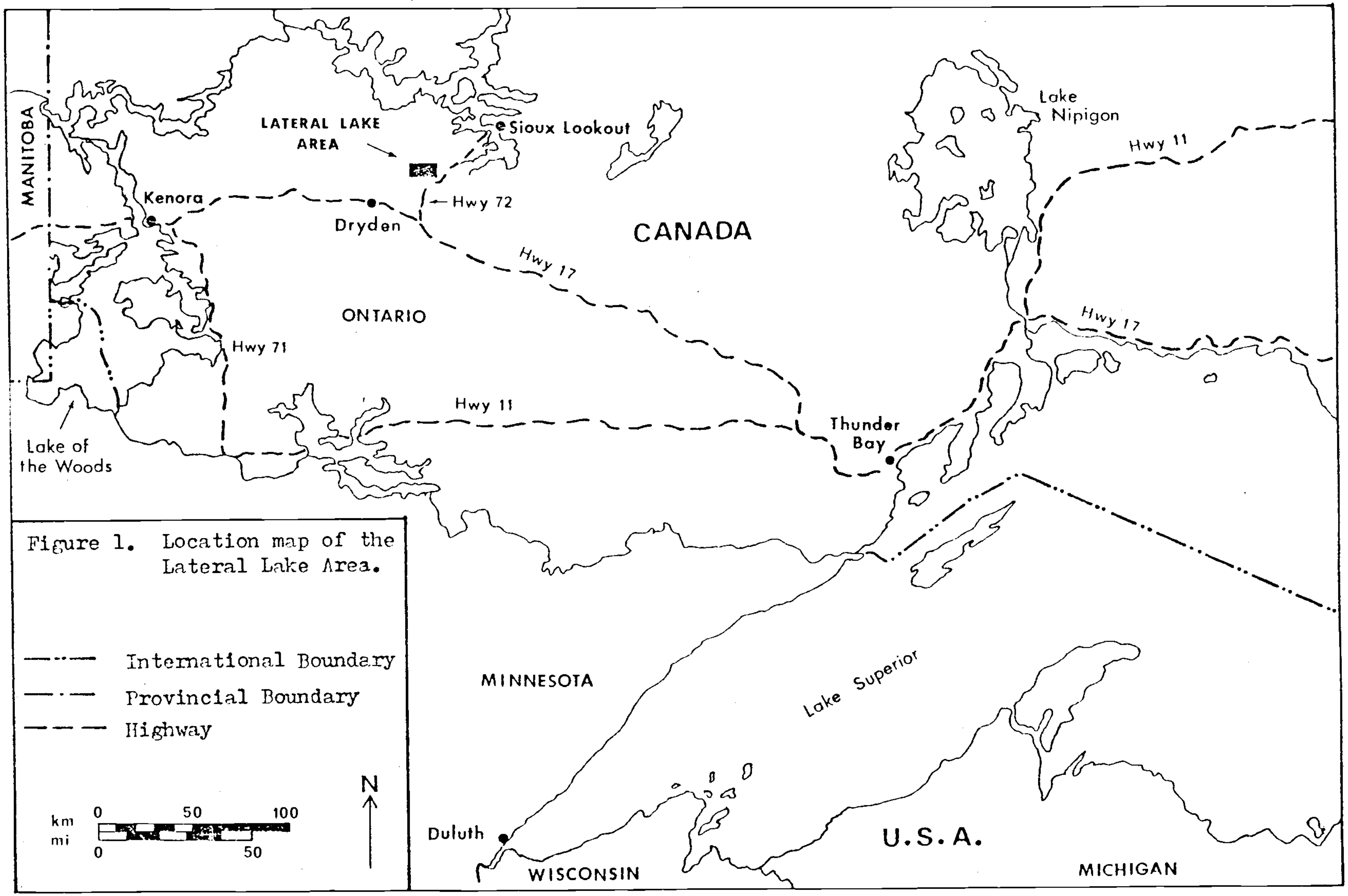


Figure 1. Location map of the Lateral Lake Area.

Topography and Physiography

The map area is at a general elevation of 365 m above sea level, with a maximum relief of less than 60 m. The higher areas tend to reflect the distribution of outcrops and many exposures form east-northeast-trending ridges of limited relief. East of Lateral Lake, extensive outcrops form a series of arcuate ridges, the apices of which trend in an east-northeast direction. The major portion of the Lateral Lake area, however, is covered by swamps and Pleistocene sands and clays, and outcrops are rare. Most of the area within Echo Township is heavily wooded with spruce and jackpine that yield to more open stands of poplar and birch to the west in Webb Township. Drainage is circuitous, with Tot, Lateral, and Moly Lakes draining through Kathlyn Creek and eventually flowing into Minnitaki Lake. A few small streams west of the Dryden-Hudson road flow westward into Gullwing Lake. Both areas of drainage are part of the English River system which ultimately flows into Hudson Bay by way of Lake Winnipeg and the Nelson River in Manitoba.

Previous Geologic Work

Although not giving specific reference to the map area, Bell (1881) stated that the predominant rock types of the region were Huronian (Middle to Upper Precambrian) in age. On a later map by Parks (1898), which includes the Lateral Lake area, the rocks were identified as being of Keewatin (Lower Precambrian or Archean) age. Collins (1909) considered the metasedimentary and metavolcanic rocks to be Keewatin and Huronian, and the intrusive rocks to be

Laurentian (Upper Precambrian) in age. In 1932, Hurst mapped the geology of Echo and Webb Townships as part of a larger area, and recognized the rocks as being Keewatin, Timiskaming, and Algoman (all Archean) in age. The Lateral Lake area was also included in a compilation of the Kenora District at the scale of 1:500,000 (Tanton, 1937). Pettijohn (1935) investigated metasedimentary rocks in areas adjacent to the area, and Satterly (1941) examined the geology in the nearby Wabigoon-Dryden area. A detailed report and accompanying map for Echo Township at the scale of 1:12,000 was published by Armstrong (1951). A report with an accompanying map at a scale of 1:63,360 of the Gullwing Lake-Sunstrum area which includes Webb Township was published by Harding (1951).

Economic Mineral Exploration

Molybdenite was first discovered in a pegmatite south of Gullwing Lake by C.D. Coates in 1906, and was worked periodically until 1940 (Harding, 1951). Most of the subsequent interest in the area has centered on the more extensive molybdenum mineralization at the east end of the Lateral Lake Stock. This includes the molybdenite-bearing pegmatites discovered by the Ontario Department of Mines field party of W.S. Armstrong in 1946 (Armstrong, 1951). The main prospects were staked by G.L. Pidgeon of Wabigoon, and in 1954, the property was optioned to Detta Minerals Limited. Shortly thereafter, two diamond drill holes and a 35-meter adit were completed. Pidgeon Molybdenum Mines Limited was incorporated in 1957, and 2500 m of diamond drilling was completed on the property. In 1965, an additional 3250 m was drilled by Rio Canadian Exploration Limited. At present, additional drilling is being undertaken by Rio Algom Limited and Dickenson Mines.

In 1958, DeCoursey-Brewis Minerals Limited completed five diamond drill holes at a minor molybdenum showing along the south contact of the stock north of Moly Lake. Denison Mines Limited drilled twelve diamond drill holes along the same contact to the northwest and southeast of the Pidgeon Prospect in 1962. In Webb Township, seven holes and two 10-meter trenches have been completed on the Kozowy-Leduchowski Lithium-Cesium-Tantalum Prospect just south of the contact of the stock.

Purpose of Study

The purpose of the present study is to examine in detail the Lateral Lake Stock, and to determine its structural, temporal, and genetic relationships to the surrounding metavolcanic and metasedimentary rocks. Particular emphasis is placed on the molybdenum deposits associated with the stock, on both the field and laboratory scale, in order to relate the characteristics of the ores to the nature and origin of the stock. This investigation is part of a broader project to study mineralization associated with intermediate to felsic intrusions of Early Precambrian age in Ontario with respect to the possible discovery of porphyry-type ore deposits.

Method of Study

During July and August of 1977, an area of 52 square km was mapped at a scale of 1:15,840 (Plate 1). Coverage of outcrop areas in the Lateral Lake Stock and in the immediately adjacent supracrustal rocks was essentially complete. An extensive suite of samples was collected from bedrock and diamond drill core for petrographic and geochemical studies. Forty-five thin sections of all rock types, and three polished thin sections of the ores were examined in detail using standard petrographic methods. Twenty-two samples of the intrusive and metavolcanic rocks were analysed for major oxide and trace element abundances. Trace element concentrations were determined for Li, Be, Sr, Ba, Sc, Y, Zr, V, Cr, Mo, Co, Ni, Cu, Ag, Zn, Ga, Sn, and Pb. These chemical analyses were performed by the Geoscience Laboratory of the Ontario Geological Survey, Ministry of Natural Resources in Toronto, Ontario. In addition, one sample of diamond drill core containing visible molybdenite was analysed for Li, Mo, Cu, Ag, Au, Zn, Sb, Bi, and Pb. This analysis was done by Chemical and Mineralogical Services of Salt Lake City, Utah.

REGIONAL GEOLOGIC SETTING

The Superior Province of the Canadian Shield represents the largest crustal unit of Archean rocks in North America. Archean rocks were folded and metamorphosed by the Kenoran Orogeny which is dated at 2480 million years by K-Ar radiometric methods (Stockwell, 1964). The southern portion of the Superior Province consists of east-trending linear metavolcanic-metasedimentary (greenstone or supracrustal) belts or subprovinces separated by large areas of granitic batholiths, migmatites, and paragneisses. The paragneissic areas are spatially located between the batholithic terrain and the supracrustal belts. Physically and chemically, they are extremely heterogenous, and contain both granitic and highly meta-metamorphosed supracrustal rocks (Goodwin, 1972). The internal structure of the batholithic zones is poorly known. Contacts of the batholiths are generally mesozonal to catazonal in nature. The intervening supracrustal belts form synformal structures with steeply to vertically-dipping units which wrap around the more extensive granitic and gneissic blocks (Goodwin, 1972). Numerous large and small granitic plutons occupy domal structures within the supracrustal belts.

Tholeiitic and calc-alkaline flows and pyroclastic rocks are the dominant lithologies in most of the supracrustal belts, although metasedimentary rocks are abundant, particularly in some of the southernmost belts. Goodwin (1977) has determined the average proportions of the metavolcanic rocks to be: basalt, 55 percent; andesite, 30 percent; dacite, 10 percent; and rhyolite, 5 percent. This ratio is apparently consistent throughout all of the supracrustal belts in the Superior Province. The metavolcanic rocks typically form large interdigitating volcanic piles with mafic flows comprising the lowermost two thirds of the sequence. These rocks grade upward into felsic flow and fragmental rocks. Lateral facies changes are abundant. The mafic to felsic metavolcanic sequence may be repeated more than once in any supracrustal belt. Volcaniclastic sedimentary rocks commonly overlie, and are intercalated with the metavolcanic rocks.

Archean metasedimentary rocks represent a flysch sequence consisting mainly of greywacke and argillite with minor arkose and conglomerate. Carbonates and better-sorted quartzites are not common, but may occur locally. Proximal and distal trubidite sequences have been recognized in various parts of the supracrustal belts. Archean metasedimentary rocks of non-volcanic origin are best-preserved in the supracrustal belts, although large volumes of paragneiss and schist are often found adjacent to these areas. Within the supracrustal belts, contacts between the metasedimentary and metavolcanic rocks may be faulted or transitional.

Three supracrustal belts or subprovinces are found in the southern part of the Superior Province. From north to south they are: the Uchi Subprovince, the Wabigoon Subprovince, and the Abitibi-Wawa Subprovince (Fig. 2). The supracrustal belts show an increase in size, and diversity of lithologies and chemical composition from northwest to southeast. The Abitibi-Wawa Supbrovince is the largest and most diversified supracrustal belt in the Superior Province. Goodwin (1968) attributed this to be a reflection of decreasing ages of the supracrustal belts from northwest to southeast. Other

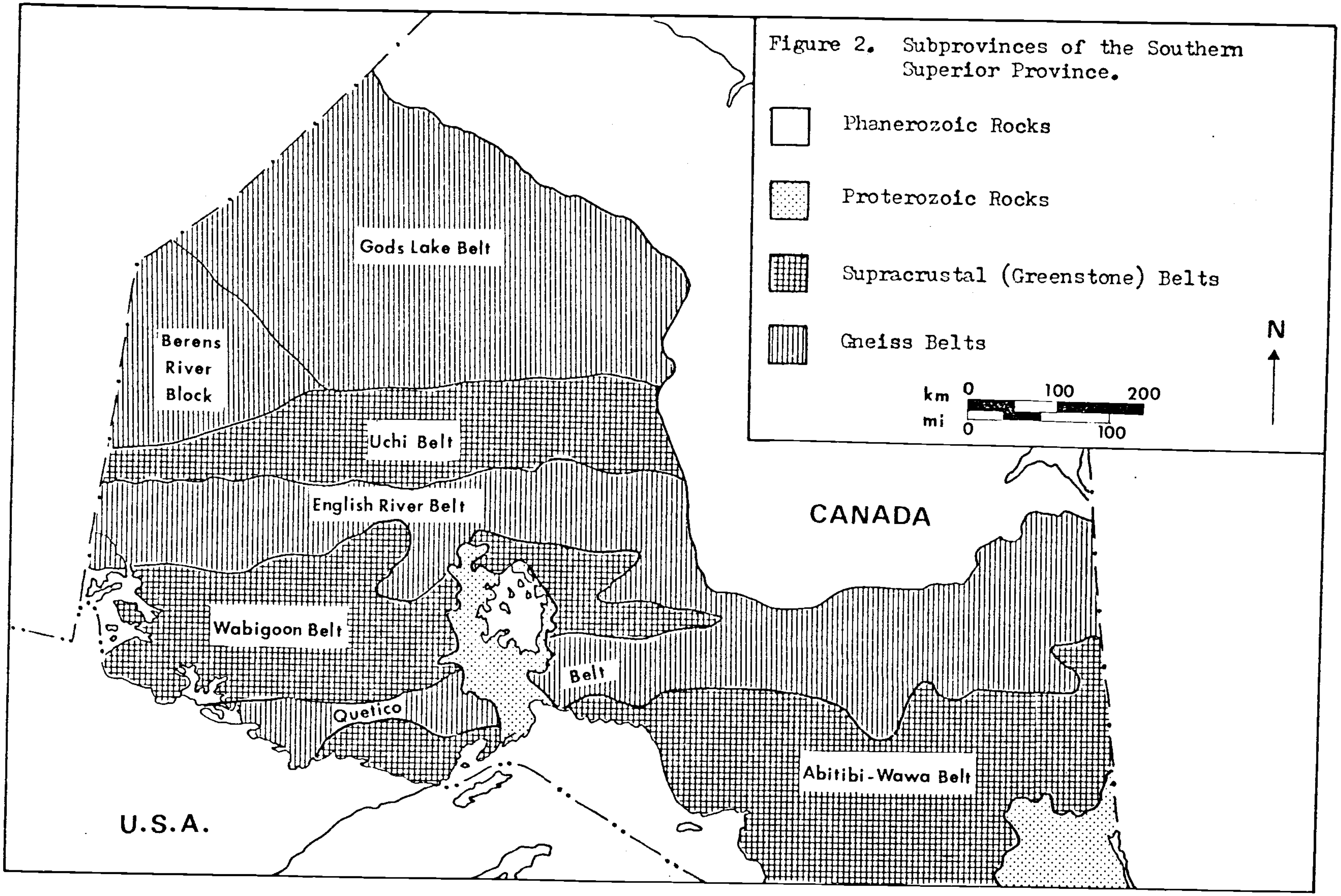


Figure 2. Subprovinces of the Southern Superior Province.

workers (Bell, 1971) considered these features to be the result of an overall eastward tilting of the Superior Province, uplifting the western sector relative to the east. The uplifted areas were subsequently diminished by erosion.

The Wabigoon Subprovince is about 650 km long and 25 km to 65 km wide, and trends east from Manitoba to the Hudson Bay Lowlands (Fig. 2). In the vicinity of Lake Nipigon, a large area of Archean felsic igneous and metamorphic rocks, unconfomably overlain in places by Proterozoic diabase, divide the subprovince into eastern and western sectors. The Lateral Lake Stock is located in the central part of the western sector of the Wabigoon Subprovince, near its northern contact with the English River Subprovince. According to Breaks and others (1976), this contact is predominantly intrusive in nature where metavolcanic rocks are in contact with the batholithic rocks. Complex gradational contacts are indicative of the boundary between the metavolcanic rocks and the paragneisses of the English River Subprovince.

The Lateral Lake Stock directly intrudes approximately 610 m of mafic metavolcanic flows. Structural relations between the two lithologies suggest that doming of the metavolcanic rocks was the dominant mode of intrusion of the stock.

The metavolcanic rocks north and south of the stock are overlain conformably by metasedimentary rocks. In the Lateral Lake area, metagreywacke is the most common lithology; however, basal metaconglomerate units have been noted in some areas. These metasedimentary rocks were considered by Armstrong (1951) to be correlative with the Daredevil Formation mapped by Pettijohn (1935) in adjacent areas as the upper member of the Abrams Series. Harding (1951) extended this unit into Webb Township. In addition, he also mapped large areas of meta-conglomerate north and south of Gullwing Lake. Both units of meta-conglomerate are separated by metagreywackes from the metavolcanic rocks adjacent to the Lateral Lake Stock. Breaks and others (1976) remapped the area on a regional scale and reclassified the metaconglomerate units of Harding as tuff breccias and pyroclastic breccias. During the 1977 field season, however, the southern unit was found to be a polymictic conglomerate. The northern unit was not investigated. The metasedimentary rocks are flanked on the north by mafic to intermediate flows and pillow lavas. These metavolcanic rocks are in contact with the granitic rocks of the English River Subprovince to the north. According to Harding (1951), the northern metaconglomerate unit (the felsic pyroclastic unit of Breaks and others, 1976) has transitional contacts with the metavolcanic rocks to the north and the metagreywacke to the south. Armstrong (1951) indicated that the metagreywackes of the Daredevil Formation, south of the Lateral Lake Stock, are in fault contact with mafic to intermediate flow and pyroclastic rocks of the Brownridge Volcanics to the south. The Brownridge Volcanics include minor felsic pyroclastic units. They are conformably overlain by the Thunder Lake-Zealand group of metasedimentary rocks to the south. A number of small granitic stocks of a domal nature intrude the Brownridge Volcanics and the Thunder Lake-Zealand Sediments. A series of mafic metavolcanic flows and pillow lavas separates the Thunder Lake-Zealand

Sediments from the granitic terrain of the Quetico Subprovince, and forms the southern boundary of the Wabigoon Subprovince.

METAVOLCANIC ROCKS

A sequence of mafic metavolcanic flows are the dominant supracrustal rocks in the Lateral Lake area. They are intruded by the Lateral Lake Stock. The thickness of the sequence ranges from 550 m south of the stock in Webb Township to 1100 m northwest of the stock in the vicinity of Gullwing Lake. The thickness of the sequence in Echo Township ranges from 670 m south of Moly Lake to 880 m east of the stock. A large roof pendant of metavolcanic rocks of unknown thickness is located within the stock in the central part of Webb Township.

Rock Description

The metavolcanic rocks were interpreted by Harding (1951) and Armstrong (1951) as hornblende-rich members of a larger metagreywacke unit intruded by the Lateral Lake Stock. The present investigation reveals, however, that they are fine-grained mafic metavolcanic flows and tuffs interbanded with medium to coarse-grained amphibolitic rocks. A few coarse-grained amphibolites contain mafic lithic fragments representative of pyroclastic breccias (Fig. 3). Most show some degree of foliation, although it is not always evident in outcrop, particularly in the fine-grained varieties. The foliation is defined by the allignment of amphibole laths. With increasing separation of amphibole and quartz into distinct bands, the foliation assumes a gneissic appearance.

Contacts between the fine-grained and coarser-grained metavolcanic rocks vary from sharp to gradational. The coarser-grained lithologies tend to pinch out stratigraphically along strike. They

Figure 3. Outcrop of coarse-grained mafic metavolcanic rock showing gneissic texture and mafic lithic fragments.

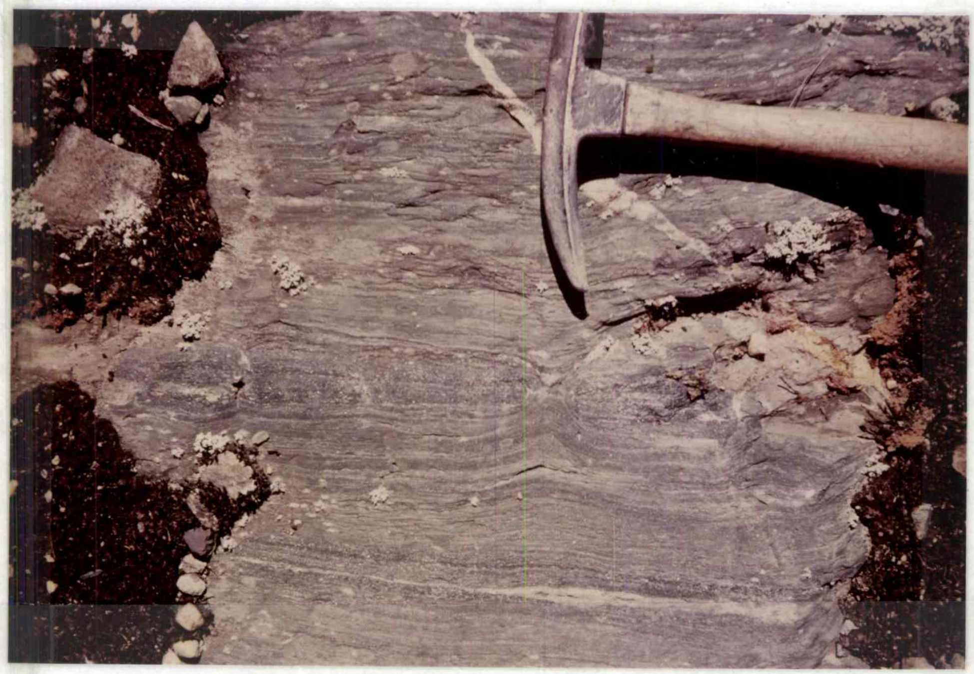


Figure 4. Outcrop of fine-grained mafic metavolcanic rock showing boudinage structures or possible pillow selvages.

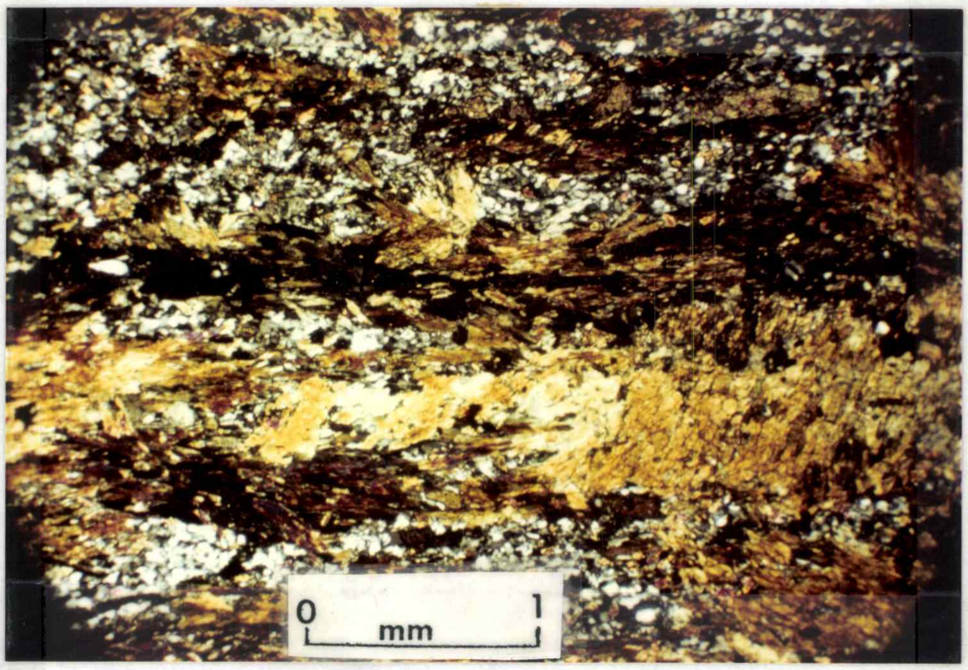


Figure 5. Photomicrograph showing development of gneissosity in medium-grained mafic metavolcanic rock.

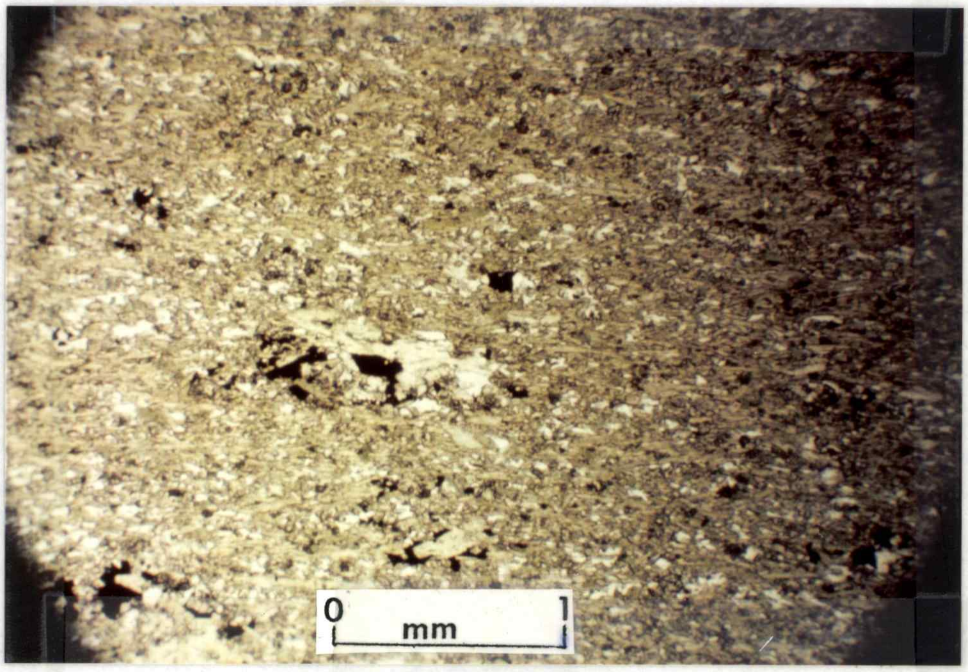


Figure 6. Photomicrograph of fine-grained mafic metavolcanic rock containing mafic to intermediate lithic fragments.

are not abundant in the western part of the area, but may comprise up to 50 percent of the metavolcanic sequence east of the Lateral Lake Stock. Three major medium to coarse-grained amphibolitic units were mapped in the latter area. Minor bands of this coarser-grained amphibolite are present throughout the rest of the sequence. South of the stock in Webb Township, narrow, coarse-grained amphibolite bands display boudinage structures of probable metamorphic origin (Fig. 4). Alternatively, these bands may represent recrystallized pillow margins. Both the fine and coarser-grained metavolcanic rocks are similar in appearance, composition, and origin. Most of the coarser-grained rocks may represent the cores of the mafic metavolcanic flows, although some are pyroclastic in origin.

Hornblende and quartz are the dominant minerals in the mafic metavolcanie rocks. Separation of quartz-rich and amphibole-rich bands is prevalent in the coarser-grained varieties, and imparts a gneissosity to the rock (Fig. 5). This separation of hornblende and quartz is not evident in the finer-grained equivalents (Fig. 6). Hornblende constitutes 65 to 70 percent of the rock, and occurs as subidioblastic, prismatic to feathery laths that define the foliation. Partial radial aggregates of hornblende are present in the more massive rocks. Hornblende is strongly pleochroic in pale green, green, and bluish-green to dark green, colours that are indicative of a metamorphic origin for the mineral. It is often poikiloblastic in the coarser-grained rocks, and contains inclusions of quartz, sphene, sulphides, and epidote.

Quartz is typically fine-grained, and rarely exceeds 0.3 mm in size. It is interstitial to hornblende in the fine-grained, polycrystalline bands and lenses in the coarser-grained rocks.

Triple points are occasionally observed in these quartz aggregates.

Plagioclase feldspar is associated with the quartz, although it is not a common constituent of the rocks. With the exception of the large roof pendant of mafic metavolcanic rock within the stock in Webb Township, where it amounts to as much as 25 percent, the content of plagioclase feldspar rarely exceeds 2 percent. Anorthite content of the feldspar ranges from An_{28} to An_{41} (oligoclase-andesine). Normal zonation between these compositional limits was observed in plagioclase feldspar from a specimen collected east of the Lateral Lake Stock. Most of the compositional change occurs near the outer rim of the grain. Crystals of plagioclase feldspar are xenoblastic, and are incipiently altered to epidote and minor sericite.

Epidote is present in amounts ranging from 1 to 15 percent. It is fine-grained (0.3 mm), and is typically associated with quartz. It is also present as poikiloblastic inclusions in hornblende and plagioclase feldspar. Epidote is occasionally zoned from anomalously blue cores to highly birefringent margins, which may be a metamorphic effect caused by recrystallization and/or partial remobilization of the chemical constituents of the mineral.

Sphene is a common associate of epidote, and often occurs as inclusions in the latter mineral. It is also found along fractures and as rims surrounding sulphide grains. Sphene is xenoblastic, and rarely exhibits euhedral crystal forms. Zircon occurs sporadically as inclusions in hornblende. Sulphides are not abundant, but are invariably present in minor amounts. The cubic form of some sulphide grains, and the magnetic properties of the rocks imply that both pyrite and pyrrhotite are present. Apatite was observed in trace amounts in only one specimen of metavolcanic rock.

Chlorite and biotite are minor constituents of the metavolcanic rocks, and are always associated with the mafic minerals. In sample D-18, collected from east of the Lateral Lake Stock, the biotite is related to a late fracture system, and thus, may be of hydrothermal origin. Chlorite may be present as discrete grains or as an alteration product of hornblende and biotite. Calcite was observed in one specimen of moderately fractured metavolcanic rock from east of the Lateral Lake Stock. Biotite is associated with this calcite suggesting that the carbonate may also be of hydrothermal origin.

The mafic metavolcanic sequence has been regionally metamorphosed to amphibolite grade, and the original textures are difficult to detect. Most of the amphibolites are interpreted to be flow-rocks, although some specimens contain textures of possible tuffaceous origin.

Specimen D-3, collected from east of the stock in Echo Township, is a fine-grained amphibolite with a prominent foliation (Fig. 6). Polymineralllic aggregates which consist of: chlorite, 45 percent; sphene, 20 percent; quartz, 15 percent; and sulphides, 20 percent, are present in this sample. The aggregates are lensoidal in shape, elongate parallel to the foliation, and are 1 to 2 mm long. The proportions of these minerals suggest that the aggregates were originally mafic to intermediate lithic fragments in a mafic tuff.

Specimens LL-1107 and LL-1162-A were collected from north and south of the stock respectively. The rocks are fine-grained amphibolites, and are lithologically similar to specimen D-3 except that they contain polymineralllic aggregates which consist of: quartz, 95 percent, and epidote, 5 percent (Fig. 7). The quartz commonly

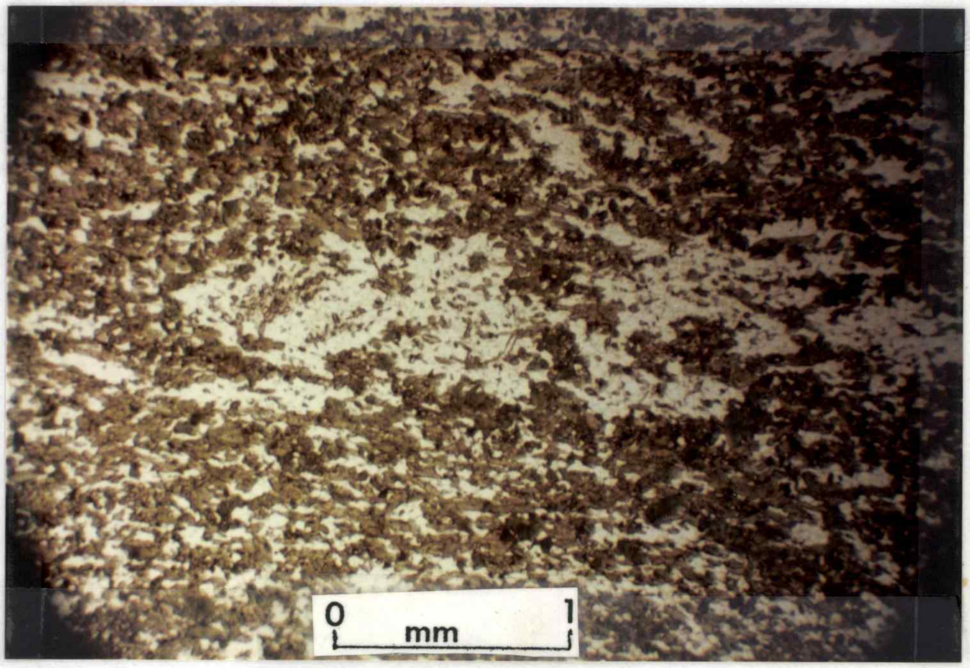


Figure 7. Photomicrograph of fine-grained mafic metavolcanic rock containing felsic lithic fragments.

shows partial to complete development of triple points. These mineral aggregates may represent felsic fragments contained in a mafic tuff.

Specimen LL-1040 was collected from the large metavolcanic roof pendant within the west-central part of the Lateral Lake Stock. The mineralogy and texture is similar to the other fine-grained mafic metavolcanic rocks with the following differences:

1. the grain size of hornblende is variable, and ranges from 0.1 to 2.0 mm;

2. plagioclase feldspar is the dominant felsic mineral, and comprises up to 25 percent of the rock; and

3. anorthite content of the plagioclase feldspar is An_{27}, which is lower than that in the other mafic metavolcanic rocks.

The roof pendant is highly schistose, and in thin section, it exhibits distinct alternations between hornblende-rich and plagioclase feldspar-rich bands. The lateral extent of these bands is variable. Triple points are occasionally seen in the plagioclase feldspar-rich areas, which impart a somewhat granoblastic texture to the rock. Grain boundaries of the plagioclase feldspars are determined partly by the orientation and presence of the hornblende laths. Thermal and chemical effects imposed by the Lateral Lake Stock may have been responsible for the differences in mineralogy and textures between the roof pendant and the other metavolcanic rocks.

Chemistry

Ten specimens of the metavolcanic rocks of the Lateral Lake area were analysed for major oxide and trace element abundances.

The results are shown in Table 1.

Major Element Chemistry

The metavolcanic sequence has been regionally metamorphosed, and the original mineralogy and textures of the rocks are no longer present. The system proposed by Irvine and Baragar (1971) is used to classify the rocks in terms of modern volcanic subdivisions. This system utilizes both the chemical composition and the normative mineralogy of the rocks. C.I.P.W. norms were calculated to facilitate this classification (Table 2).

The average major oxide abundances in the metavolcanic rocks of the Lateral Lake area compare favourably with those of average basalts described by Goodwin (1977) and Nockolds (1954) as listed in Table 3. They also fall within the chemical range for basaltic rocks as proposed by Manson (1967). The average C.I.P.W. normative and normative plagioclase composition calculations are also within this chemical range. Individual chemical analyses and normative values (Tables 1 and 2) fall within the chemical limits of Manson (1967) with the following exceptions:

1. specimens LL-1065 and LL-1077 contain an excess amount of CO_2; and
2. specimen D-18 contains an abnormally high normative content of olivine.

Specimen LL-1021 contains a higher amount of SiO_2 and $Na_2O + K_2O$, and a lower abundance of CaO than the other metavolcanic rocks. This specimen was collected from an area having abundant quartz veins, and some redistribution, dilution, or enhancement of certain elements may have occurred.

Table 1. Metavolcanic rocks of the Lateral Lake Area: Major oxide and trace element analyses.

Major Oxides (weight percent)	LL-1019	LL-1021	LL-1023	LL-1053	LL-1056-A	LL-1059	LL-1065	LL-1077	D-3	D-18
SiO_2	50.20	53.50	48.60	49.00	47.80	49.20	47.00	49.40	48.40	47.30
TiO_2	0.62	0.88	0.98	0.82	0.74	0.94	0.63	1.05	0.92	0.78
Al_2O_3	12.20	15.60	15.10	15.30	16.40	14.40	15.10	13.60	15.40	15.60
Fe_2O_3	1.56	2.10	2.40	2.10	2.10	3.43	3.57	2.60	3.85	3.44
FeO	8.05	8.55	10.40	9.13	8.55	8.88	7.14	12.80	7.97	7.80
MnO	0.13	0.18	0.24	0.19	0.20	0.19	0.24	0.33	0.28	0.19
MgO	11.40	5.35	6.89	7.85	8.73	7.69	7.13	4.80	6.74	8.54
CaO	11.10	7.95	11.10	11.50	10.40	10.80	14.20	10.90	11.20	11.10
Na_2O	1.76	2.23	2.01	1.74	2.25	1.87	1.74	1.54	2.75	2.00
K_2O	0.71	1.68	0.48	0.22	0.75	0.43	0.61	0.52	0.42	1.27
P_2O_5	0.40	0.10	0.10	0.09	0.08	0.10	0.09	0.10	0.09	0.09
S	<0.01	0.03	<0.01	0.06	0.02	0.11	0.01	0.01	0.41	0.03
CO_2	0.10	0.18	0.16	0.08	0.08	0.14	0.88	0.72	0.10	0.07
H_2O^+	1.25	0.96	1.18	1.10	1.67	1.19	1.00	0.67	0.34	1.05
H_2O^-	0.10	0.32	0.25	0.11	0.20	0.09	0.07	0.08	0.36	0.40
	99.80	99.80	99.90	99.30	100.00	99.50	99.40	99.10	99.20	99.70
Trace Elements (ppm)										
Li	15	30	14	8	14	11	12	11	8	22
Be	<1	<1	<1	<1	<1	<1	4	<1	<1	<1
Sr	500	400	60	60	60	60	310	60	60	60
Ba	570	940	140	40	70	60	120	60	60	80
Sc	25	50	50	50	40	50	50	40	60	45
Y	30	15	30	25	20	30	20	20	25	20
Zr	200	100	100	100	90	100	80	150	90	80
V	200	350	350	350	300	350	350	400	300	250
Cr	860	760	288	350	386	340	400	<5	377	367
Mo	<1	<1	<1	<1	<1	<1	3	<1	<1	<1
Co	50	59	47	46	46	47	43	47	44	40
Ni	337	210	105	132	170	101	141	55	115	126
Cu	5	200	16	133	88	178	28	16	330	39
Ag	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Zn	138	112	167	91	95	99	250	174	320	112
Ga	15	15	15	15	10	15	15	15	15	15
Sn	<3	<3	<3	<3	<3	<3	<3	<3	5	<3
Pb	29	<10	<10	<10	<10	<10	22	<10	30	<10

Table 2. Metavolcanic rocks of the Lateral Lake Area: C.I.P.W. normative calculations.

	Q	Q'	Or	Ab	Ab'	An	Il	Mt	Py	Di	Hy	Ol	Ol'	Ap	Ne	Ne'	NPC	NCI
LL-1019	—	11.6	4.5	15.2	15.2	23.6	1.2	2.3	—	24.0	22.2	6.1	22.8	1.0	—	9.1	60.9	55.9
LL-1021	5.0	18.4	10.0	19.9	19.9	28.4	1.7	3.0	—	9.7	21.9	—	16.4	—	—	12.0	60.1	36.2
LL-1021	—	12.2	2.8	17.3	17.3	31.4	2.0	3.5	—	20.4	21.0	1.8	17.6	—	—	10.4	64.5	48.7
LL-1053	0.5	12.7	1.1	15.2	15.2	33.9	1.7	3.0	0.1	19.8	24.5	—	18.4	—	—	9.1	69.1	48.9
LL-1056-A	—	9.8	4.5	19.4	19.4	33.0	1.4	3.0	—	15.8	8.0	14.8	20.8	—	—	5.6	63.1	43.0
LL-1059	0.4	13.0	2.8	16.2	16.2	30.0	1.8	3.7	0.2	20.3	24.6	—	18.4	—	—	9.7	64.9	50.4
LL-1065	—	5.9	3.9	14.7	15.2	32.3	1.2	3.3	—	32.8	—	11.6	11.6	—	0.3	9.1	60.1	48.8
LL-1077	4.3	15.1	3.3	13.1	13.1	29.5	2.1	3.6	—	21.8	22.2	—	16.6	—	—	7.9	69.2	49.7
D-3	—	10.9	2.8	23.6	23.6	28.6	1.8	3.5	0.9	22.8	6.0	9.8	14.4	—	—	14.2	54.8	44.0
D-18	—	7.0	7.8	17.3	17.3	30.3	1.5	3.3	—	21.1	0.3	18.4	18.6	—	—	10.4	63.7	44.5

Q=quartz
Or=orthoclase
Ab=albite
An=anorthite
Il=ilmenite
Mt=magnetite
Py=pyrite
Di=diopside

Hy=hypersthine
Ol=olivine
Ap=apatite
Ne=nepheline
Q'=Q + 0.4(Ab) + 0.25(Hy)
Ab'=Ab + 1.67(Ne)
Ol'=Ol + 0.75(Hy)
Ne'=Ne + 0.6(Ab)

NPC=normative plagioclase composition $= \frac{100(An)}{An + Ab + 1.67(Ne)}$

NCI=normative colour index=Ol + Hy + Di + Il + Mt

In general, the excellent chemical correspondence of the metavolcanic suite of the Lateral Lake area with other average basalts strongly indicates that these amphibolites were originally basalts, and were not of sedimentary origin as suggested by Harding (1951) and Armstrong (1951). This conclusion is further substantiated by plots of various parameters of the data defined in Tables 2 and 3, and displayed in Figures 8, 9, and 10 after the method of Irvine and Baragar (1971). Following their procedure, the metavolcanic rocks are plotted on a diagram of Normative Colour Index versus Normative Plagioclase Composition (Fig. 8). All specimens fall well within the basalt field. The basalts can be further subdivided on the basis of alkaline or subalkaline affinities by the utilization of both chemical and normative data as shown in Figure 9. In both diagrams, the subalkaline affinity of the metavolcanic rocks is evident. The basalts are defined as olivine tholeiites or quartz tholeiites as determined by whether or not they contain olivine or quartz in the norm respectively (Fig. 9b). The tholeiitic affinity of the metavolcanic rocks is also shown in Figure 10. All specimens fall within the tholeiite field in both plots, with the exception of specimen LL-1021, which falls just within the calc-alkaline field on the AFM ternary diagram (Fig. 10b). As stated above, this sample is higher in silica and alkalis than the other metavolcanic rocks.

In general, the metavolcanic rocks of the Lateral Lake area are enriched in normative orthoclase in comparison to similar rocks of the Superior Province as a whole, as shown in the An-Ab'-Or ternary diagrams of Figure 11 (after Irvine and Baragar, 1971). For the most part, basaltic rocks of the Superior Province contain less

Table 3: Chemical and normative analyses for average basalts.

		Average Composition of Lateral Lake Area Metavolcanic Rocks	Average Composition of Basalts—Wabigoon Belt (Goodwin, 1977)	Average Composition of Basalts (Nockolds, 1954)	Chemical Screen for Basalts (modified from Manson, 1967)	
					lower limit	upper limit
Major Oxides (weight percent)	SiO_2	49.04	49.50	50.83	*	56.00
	TiO_2	0.84	1.02	2.03	*	5.50
	Al_2O_3	14.89	14.60	14.07	10.50	22.00
	Fe_2O_3	2.72	2.70	2.88	*	6.00
	FeO	8.93	9.20	9.05	2.50	15.00
	MnO	0.24	0.21	0.18	*	1.00
	MgO (FeO<10%)	7.51	6.33	6.34	3.00	*
	MgO (FeO>10%)	---	---	---	2.00	*
	CaO	11.03	8.90	10.42	5.00	15.00
	Na_2O	1.99	2.26	2.23	*	5.50
	K_2O	0.71	0.40	0.82	---	---
	P_2O_5	0.14	0.27	0.23	*	1.50
	H_2O (total)	1.57	2.33	0.91	*	4.00
	H_2O^+	1.26	---	---	*	3.00
	H_2O^-	0.31	---	---	*	1.00
	CO_2	0.25	2.23	---	*	0.50
C.I.P.W. Normative Minerals	Q	2.54	---	---	*	12.50
	Or (Ne<10%)	4.34	---	---	*	20.00
	Ol (Ne<10%)	10.41	---	---	*	20.00
	NPC	63.82	---	---	35.00	80.00

--- no data available
* no limit

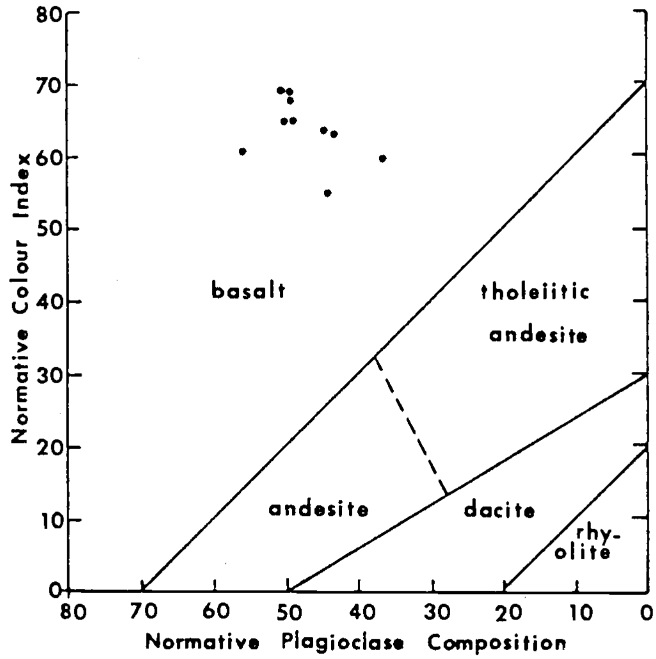
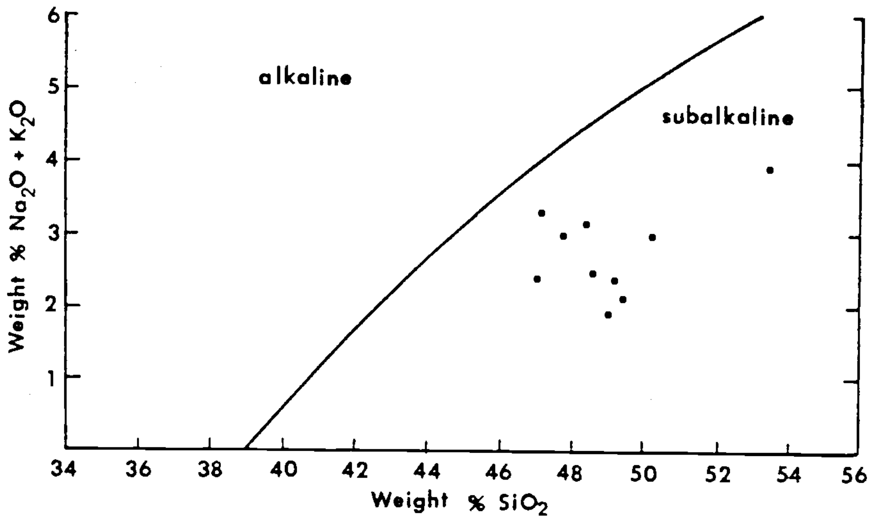
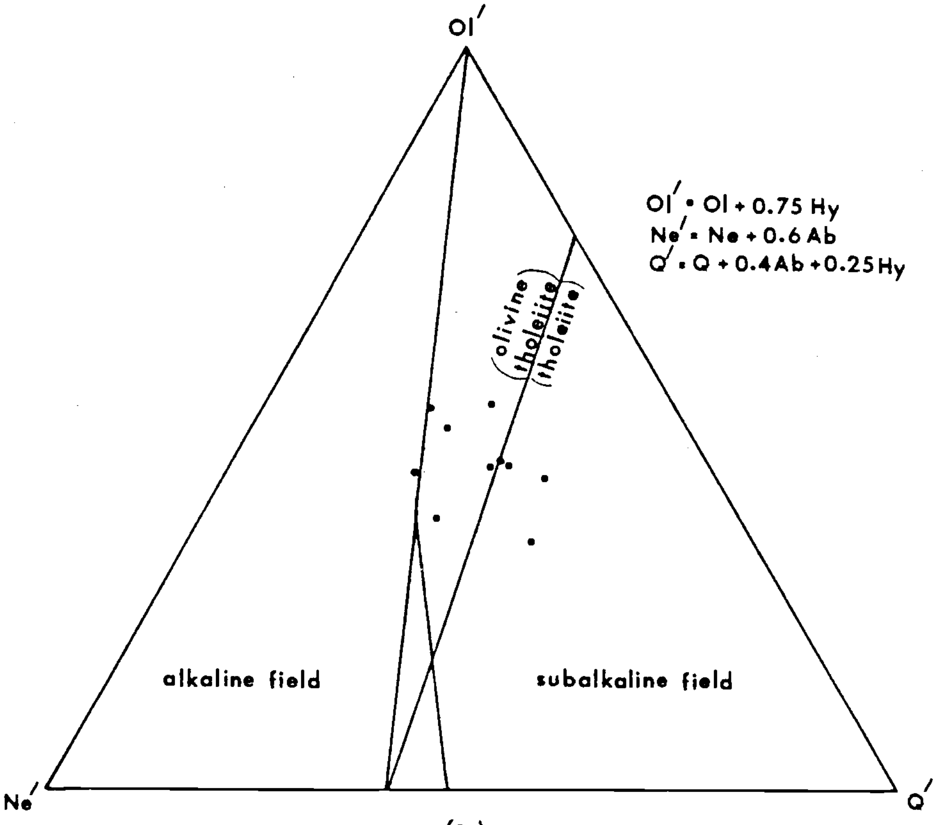


Figure 8. Metavolcanic rocks of the Lateral Lake Area plotted according to Normative Colour Index versus Normative Plagioclase Composition.



(a)



(b)

Figure 9. Metavolcanic rocks of the Lateral Lake Area:
(a) plotted according to weight percent (Na_2O + K_2O) versus weight percent SiO_2; and
(b) plotted in terms of an Ol'-Ne'-Q' ternary diagram.

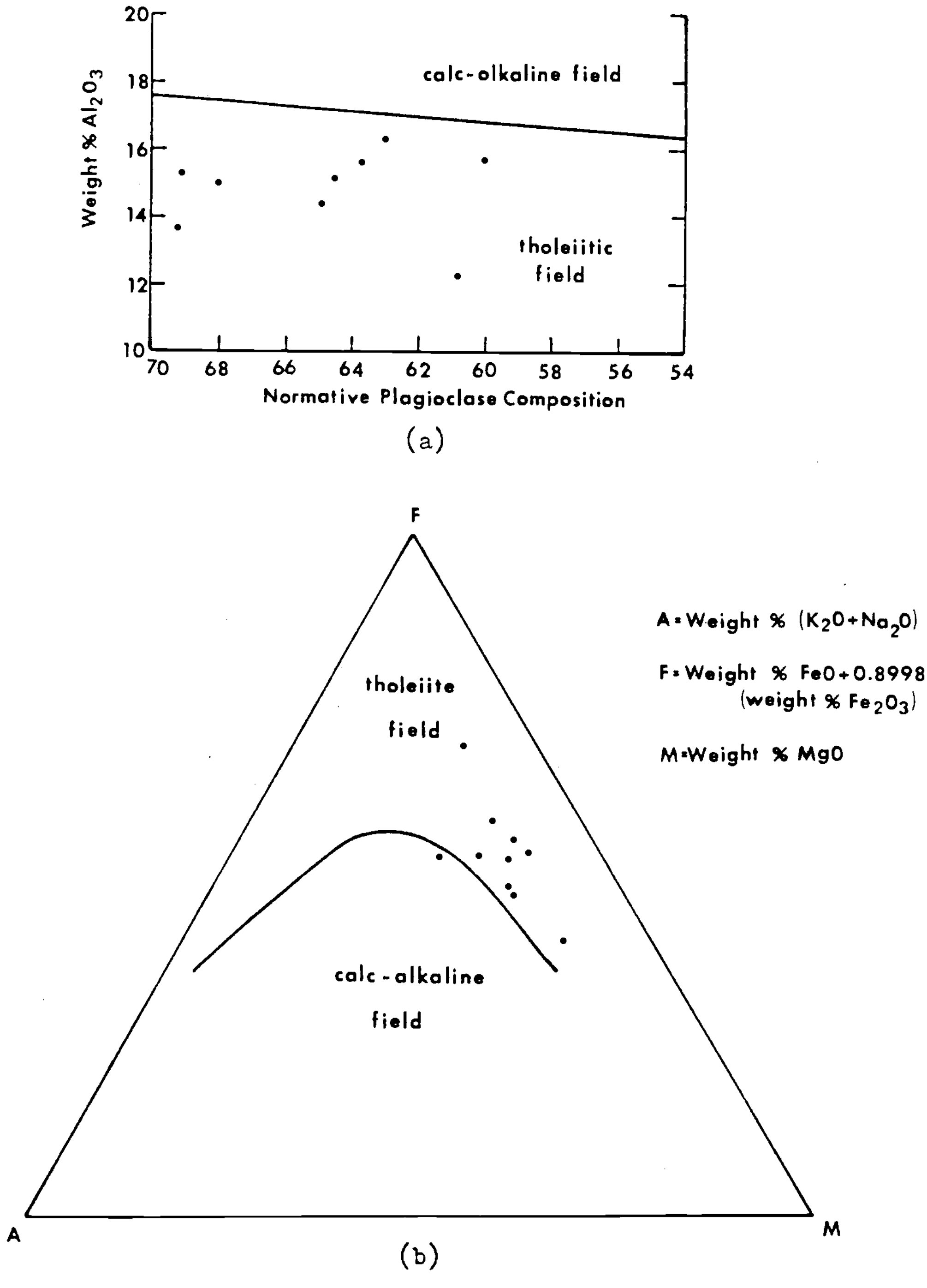


Figure 10. Metavolcanic rocks of the Lateral Lake Area:
(a) plotted according to weight percent Al_2O_3 versus Normative Plagioclase Composition; and
(b) plotted in terms of an AFM ternary diagram.

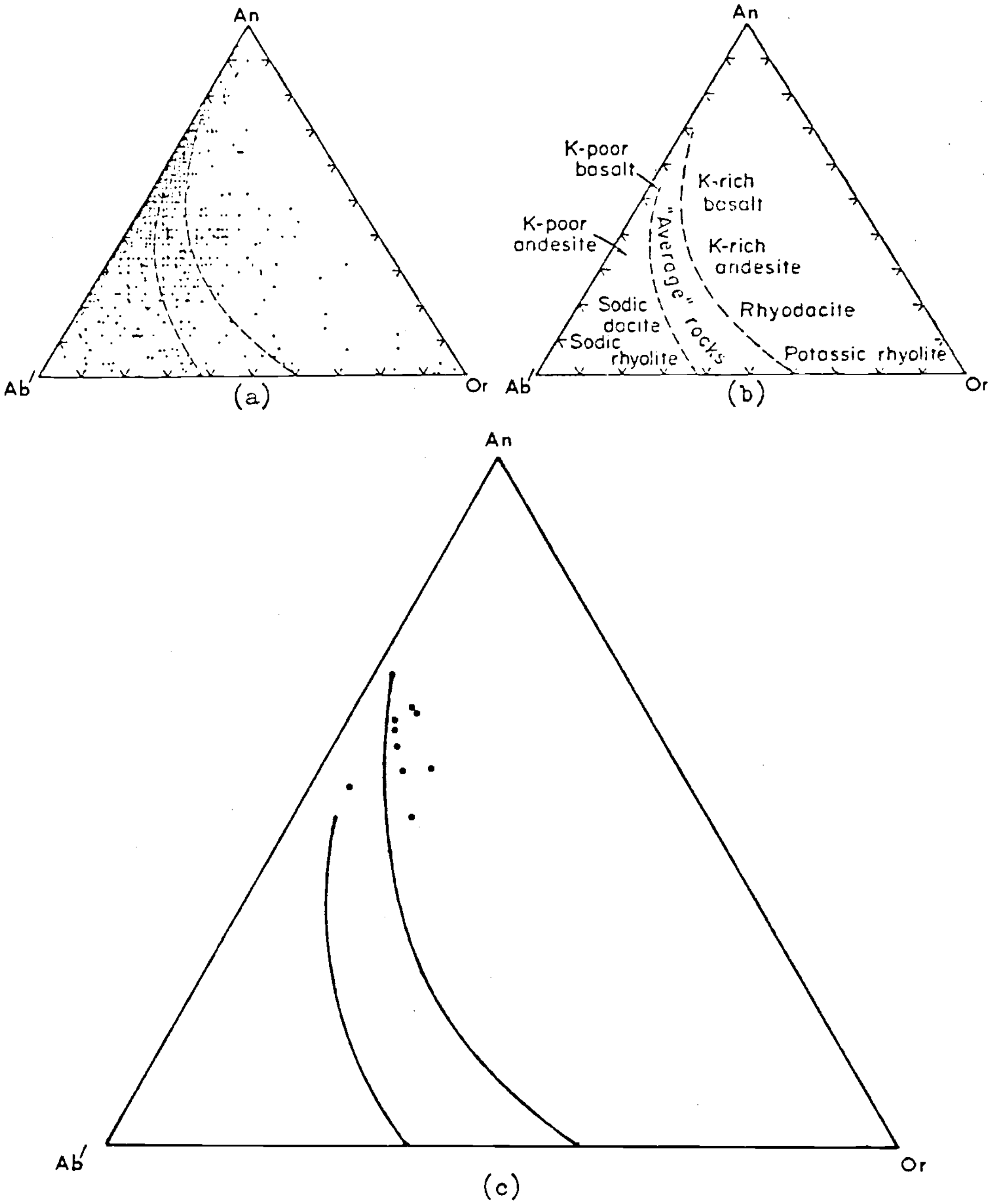


Figure 11. Ternary An-Ab'-Or diagrams illustrating:
(a) metavolcanic rocks of the Superior Province (from Irvine and Baragar, 1971);
(b) general subdivision (from Irvine and Baragar, 1971);
(c) metavolcanic rocks of the Lateral Lake Area.

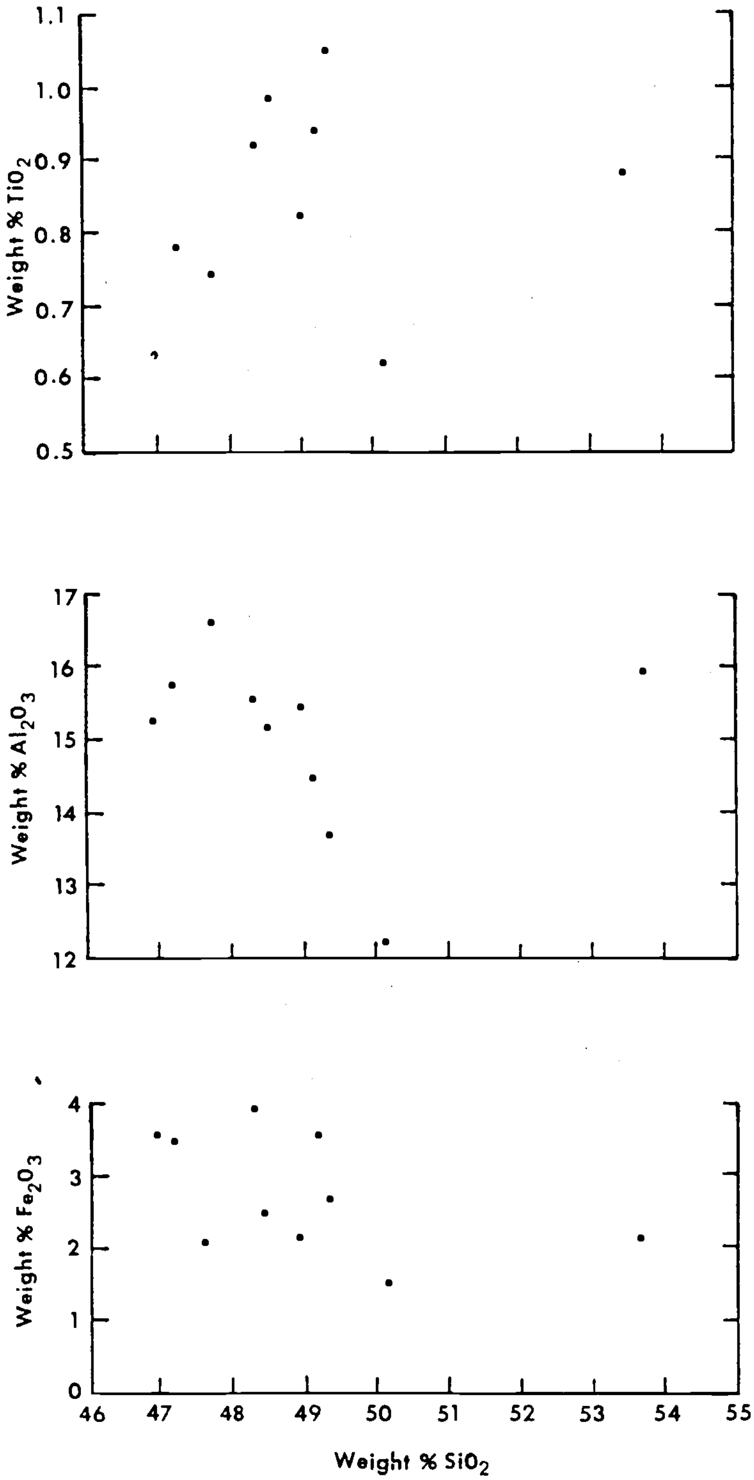


Figure 12. Metavolcanic rocks of the Lateral Lake Area: Harker Variation Diagrams of major oxides.

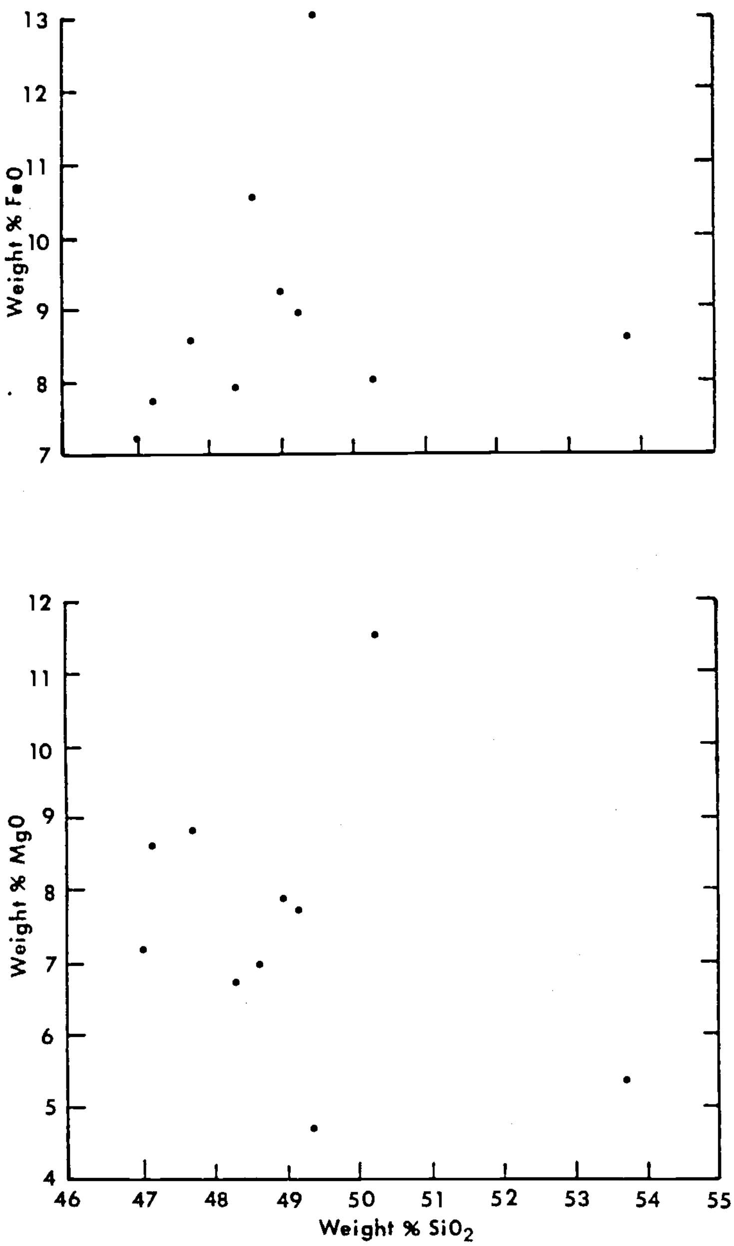


Figure 12. (continued).

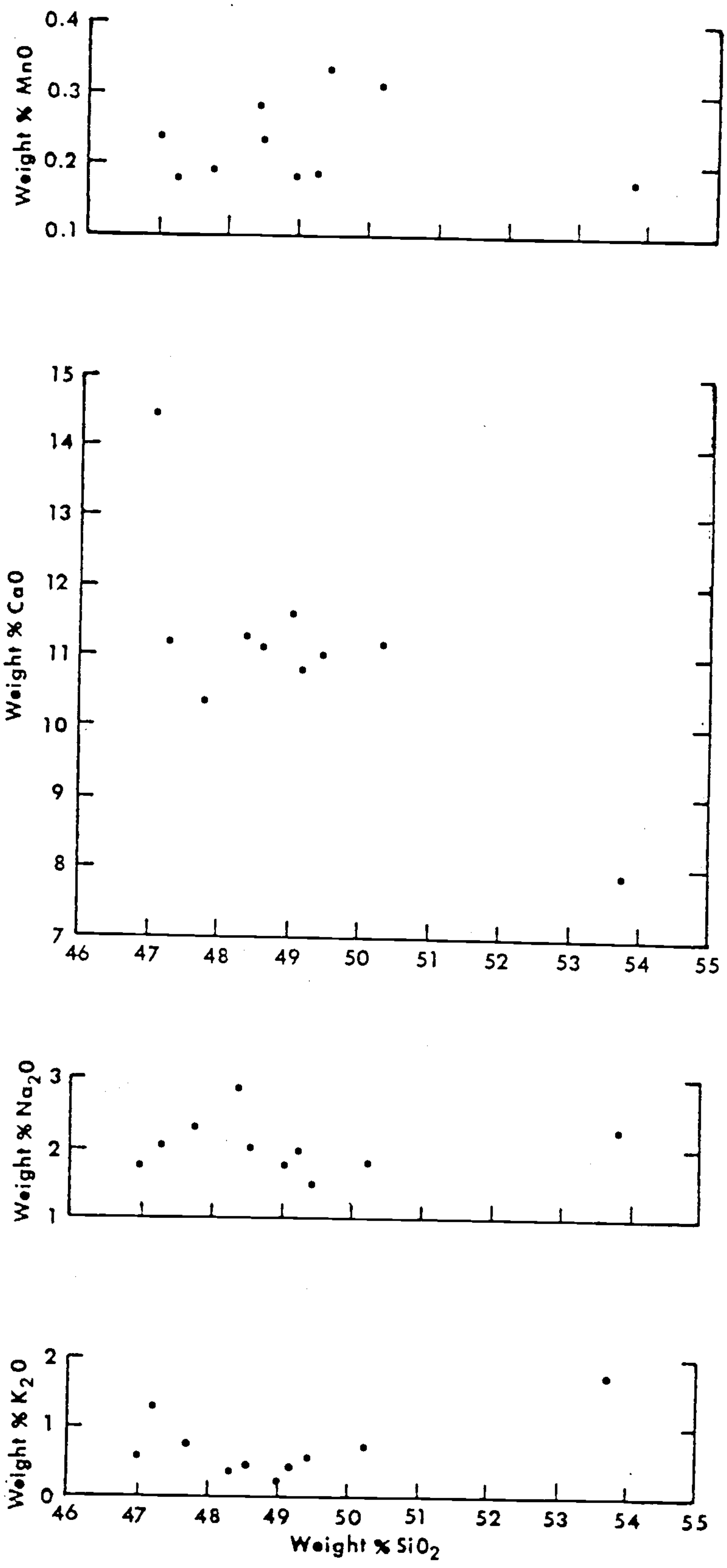


Figure 12. (continued).

than 5 percent normative orthoclase. The metavolcanic rocks of the Lateral Lake area contain normative orthoclase in amounts which range from 5 to 20 percent (Fig. 11c). This places them in the K-rich basalt field of the general subdivision as shown in Figure 11b. The high potassium content of the basalts may have been derived from hydrothermal solutions that originated in the Lateral Lake Stock. The chemical data presented in Figures 8 through 10 adequately demonstrate, with minor variations, the subalkaline, tholeiitic affinity of the mafic metavolcanic rocks. of the Lateral Lake area.

The metavolcanic sequence, although not as areally extensive as others in the Superior Province, nevertheless displays characteristics of magmatic differentiation throughout the volcanic pile. The chemical data shown on Harker Variation Diagrams (Fig. 12) gives the following results:

1. Al_2O_3, Fe_2O_3, and MgO decrease with increasing SiO_2;
2. TiO_2, FeO, and MnO increase with increasing SiO_2; and
3. CaO, Na_2O, and K_2O show no significant change with variations in SiO_2.

In addition, there is a distinct increase in SiO_2 from the base to the top of the volcanic pile, measured as distance from the contact of the metavolcanic suite with the Lateral Lake Stock (Fig. 13). The data shown in Figures 12 and 13 are consistent with a model of magmatic differentiation from a mafic base to a felsic top in a volcanic pile. Therefore, the metavolcanic rocks of the Lateral Lake area are presumed to have formed from a single magma that underwent progressive differentiation during the sequential extrusion of this volcanic pile.

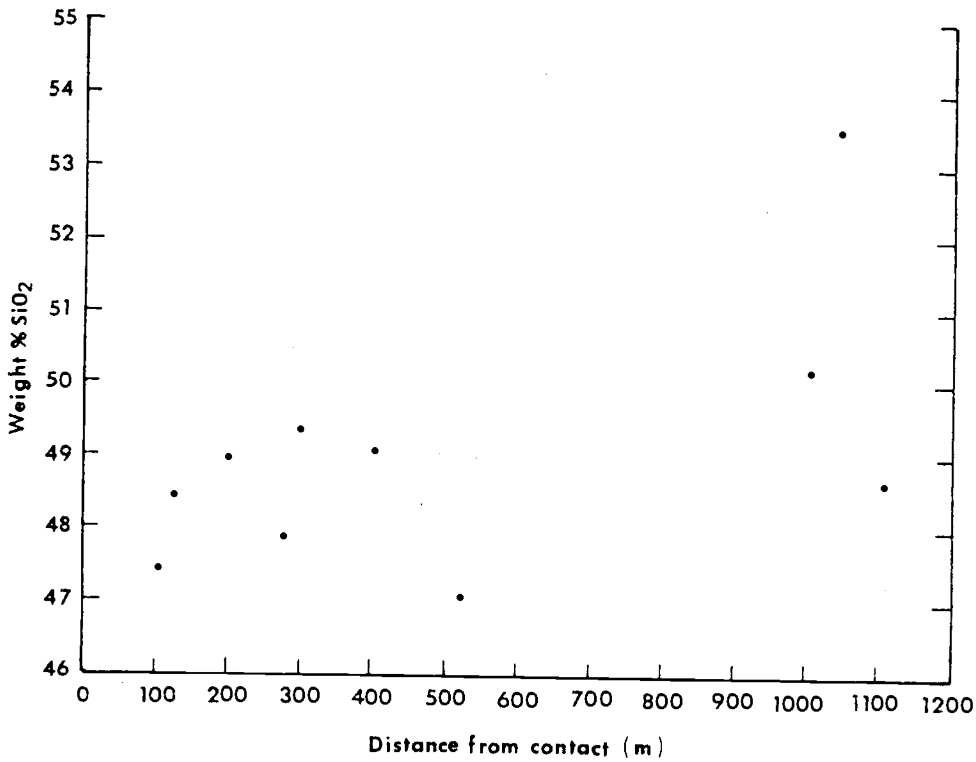


Figure 13. Metavolcanic rocks of the Lateral Lake Area plotted according to weight percent SiO_2 versus distance from the contact of the stock.

Trace Element Chemistry

Mean values and ranges of trace elements (in parts per million) of the mafic metavolcanic rocks are given in Table 4. In general, trace element values of the metavolcanic rocks of the Lateral Lake area are comparable to those determined by Goodwin (1977) for average basalts of the Wabigoon Belt, and by Prinz (1967) for the average of all tholeiitic rocks.

Harker Variation Diagrams of trace elements (Fig. 14) show

copper increase in abundance with increasing silica content. Chromium, nickel, and possibly zinc show decreasing trends with increasing silica content. Lithium, strontium, barium, and gallium values remain relatively constant. The two specimens which contain the highest weight percent SiO_2 (LL-1019 and LL-1021) tend to have deviant values for some of the trace elements relative to the other metavolcanic rocks. Both specimens were collected from areas which have abundant quartz veins, and the data shown in Figure 14 suggest that there is an enhancement of strontium, barium, nickel, and chromium in these rocks. Specimen LL-1019 did not show deviant values of the major oxides compared to the other metavolcanic rocks, although specimen LL-1021 did show some deviations in this regard. This suggests that the trace elements in the metavolcanic rocks may be more sensitive to redistribution than the major elements.

Table 4: Comparative trace element abundances (ppm) from metavolcanic rocks of the Lateral Lake Area, Wabigoon Belt basalts (From Goodwin, 1977), and average tholeiitic rocks (from Prinz, 1967).

	Lateral Lake Area		Wabigoon Belt	All Tholeiites	
	Mean	Range		Mean	Range
Li	18	8–30		10	2–40
Be	<1	<1–4			
Sr	163	60–500	174	450	57–2000
Ba	214	40–940	136	244	10–1200
Sc	46	25–60			
Y	24	15–30		32	12–90
Zr	96	80–200	121	108	20–335
V	320	200–400	337	251	10–600
Cr	413	<5–860	257	162	2–500
Mo	<1	<1–3			
Co	47	40–59	37	39	7–75
Ni	149	55–337	160	85	5–350
Cu	103	5–330	90	127	8–300
Ag	<1	<1	0.1		
Zn	156	91–320	110		
Ga	15	10–15	20	19	10–40
Sn	<3	<3–5	4.5		
Pb	13	<10–30	6	33	10–60

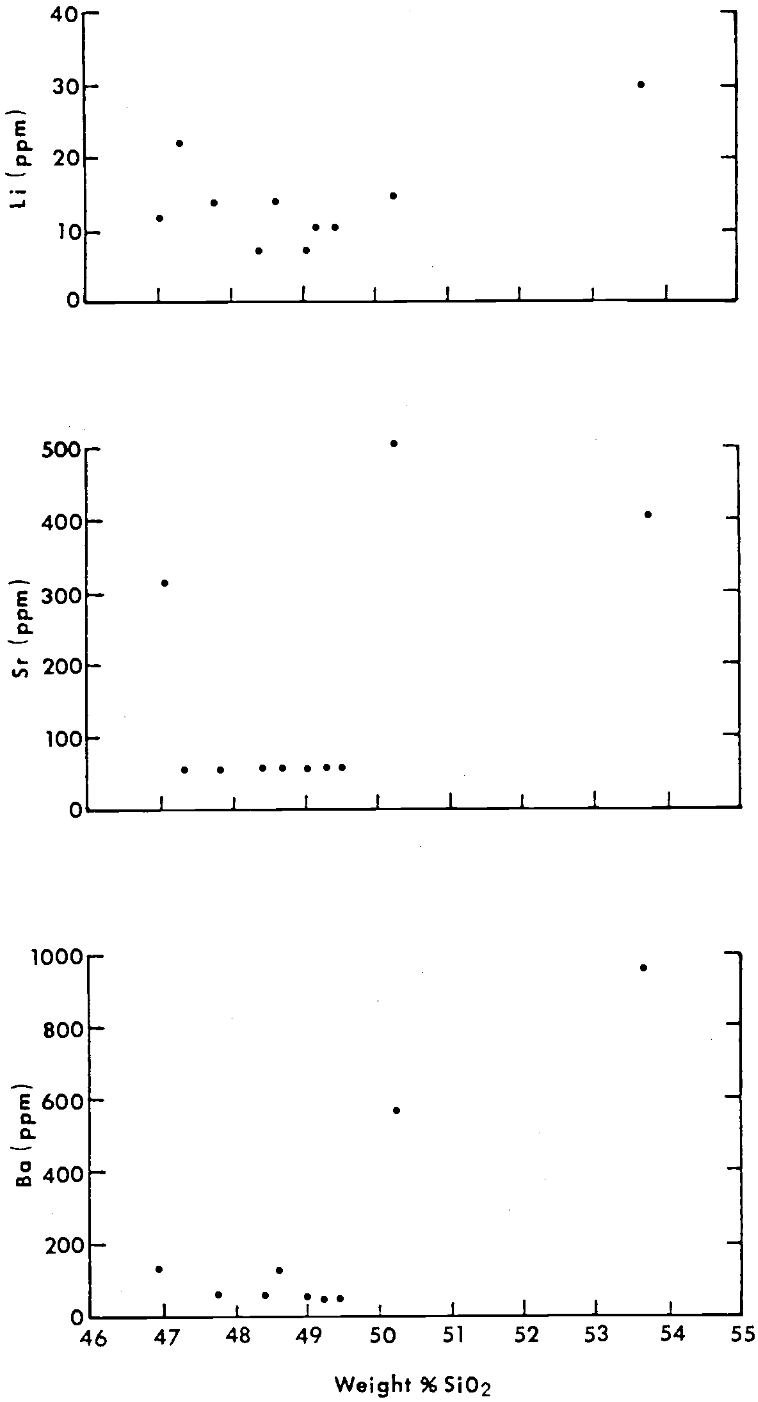


Figure 14. Metavolcanic rocks of the Lateral Lake Area: Harker Variation Diagrams of trace elements.

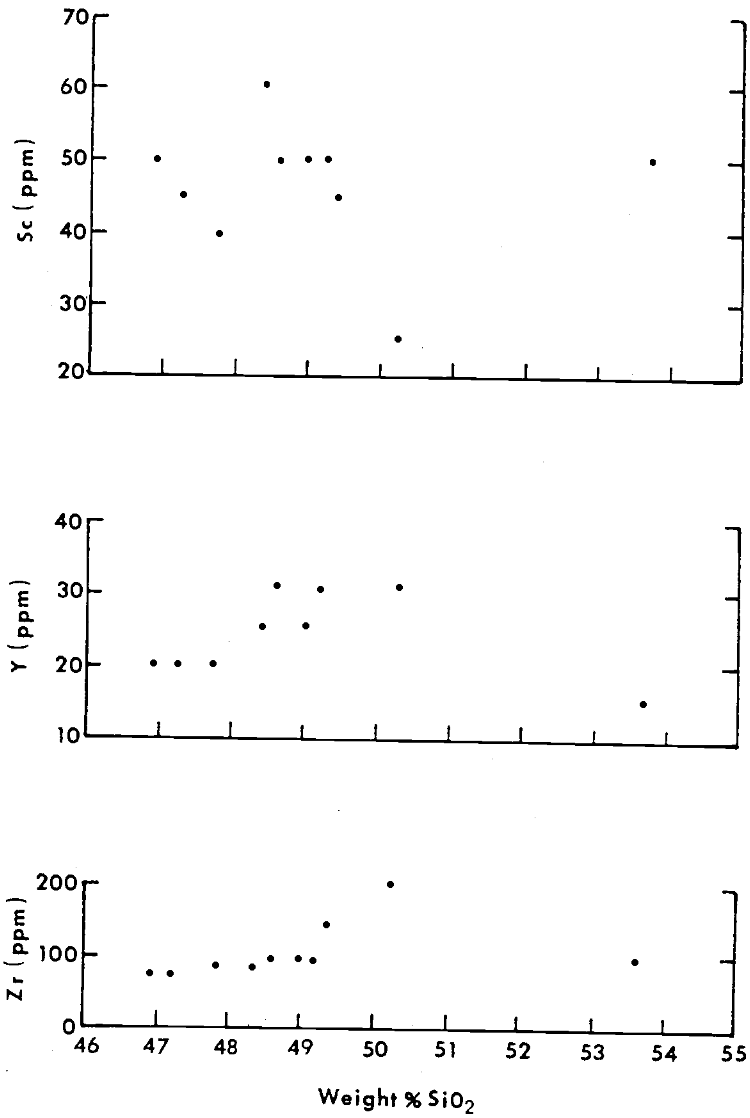


Figure 14. (continued).

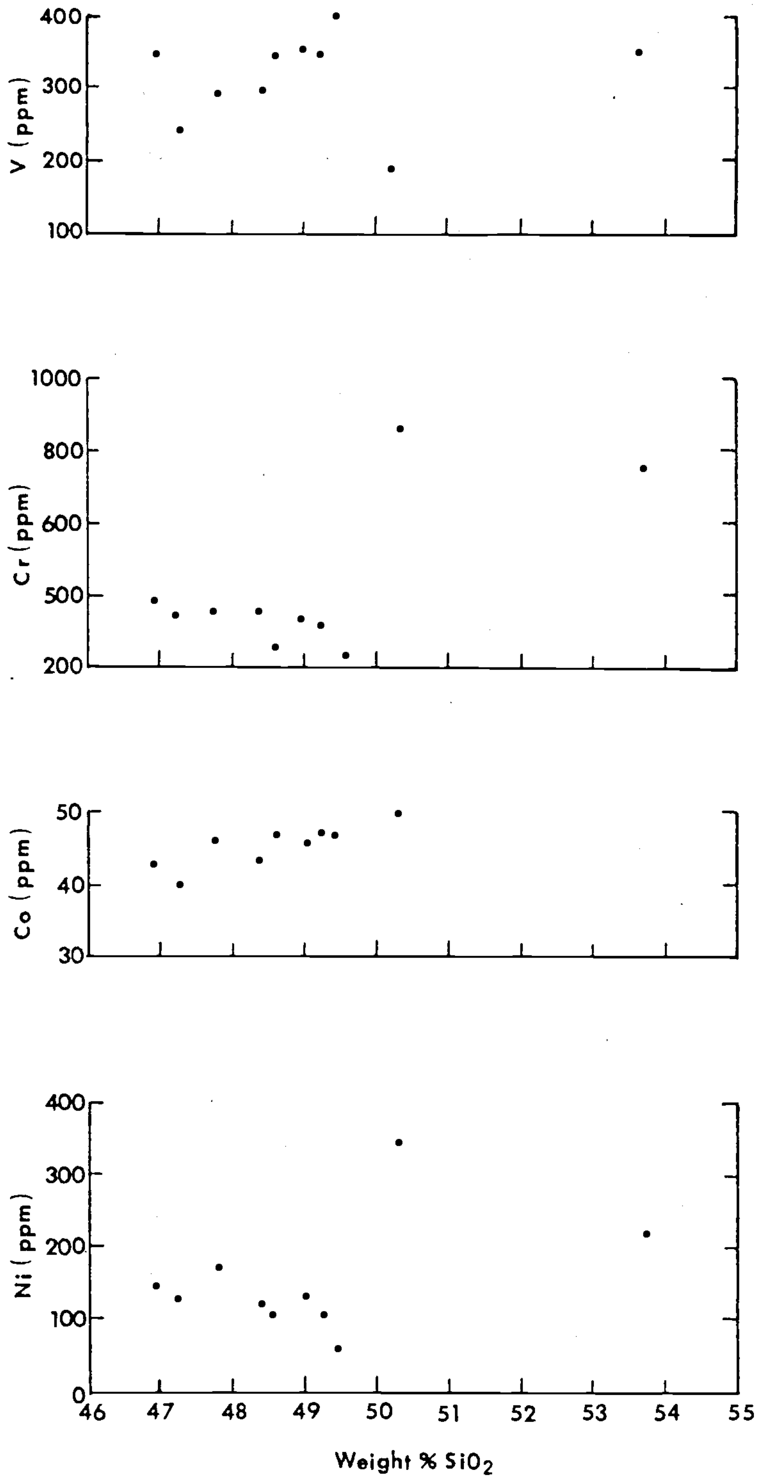


Figure 14. (continued).

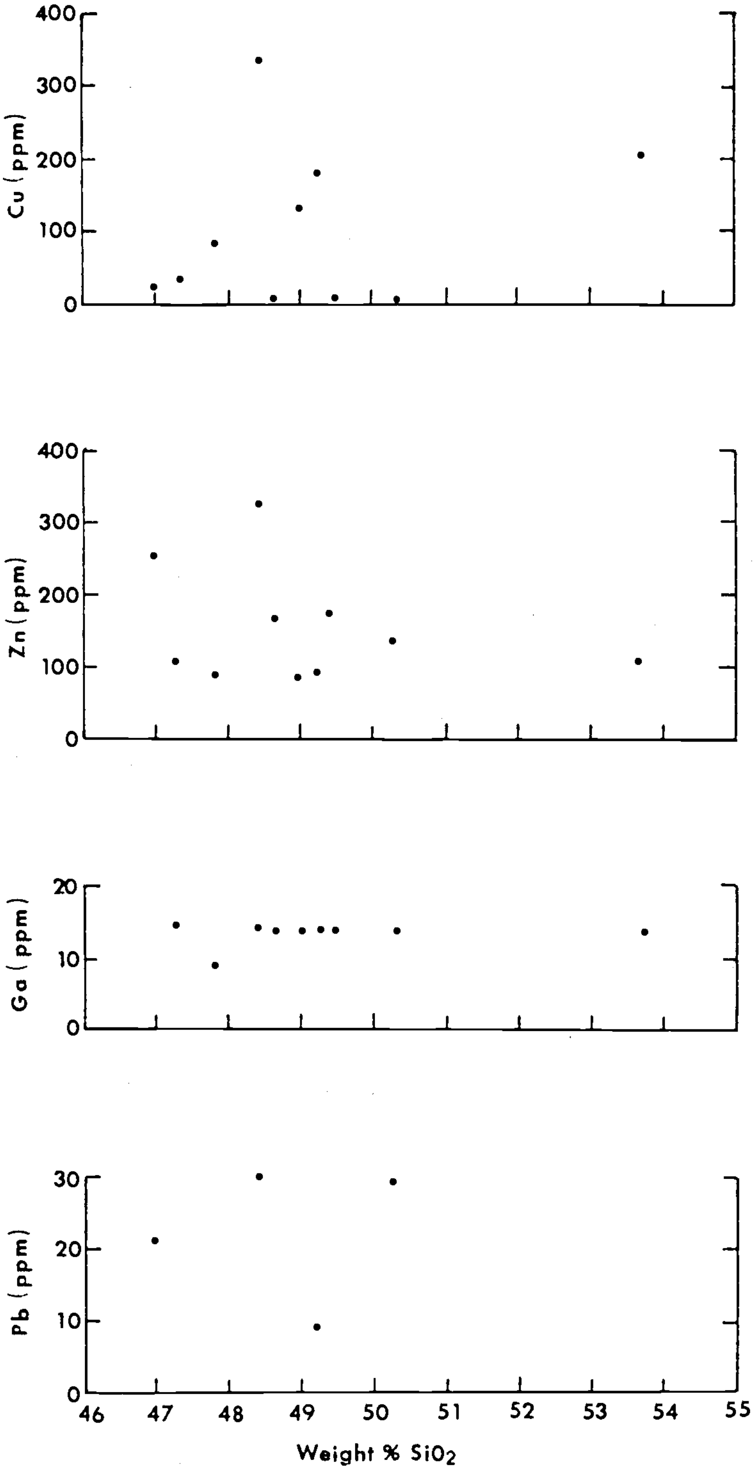


Figure 14. (continued).

METASEDIMENTARY ROCKS

Metasedimentary rocks overlie the mafic metavolcanic sequence north, east, and south of the Lateral Lake Stock. Although contacts between these two units were not observed, top determinations from cross bedding and graded bedding in the metasedimentary rocks indicate that these units are conformable. Metagreywacke is the dominant metasedimentary lithology in the Lateral Lake area; however, basal metaconglomerates are present locally. Thin bands of impure quartzite are interbedded with the mafic metavolcanic sequence.

Metaconglomerate

Metaconglomerate is exposed in two locations north of the Lateral Lake Stock. A large outcrop of considerable relief is present 2 km north of Tot Lake. The rock is a polymictic, meta-orthoconglomerate which contains clasts of tonalite, chert, aplite, impure quartzite, and mafic metavolcanic rock in a strongly foliated matrix of quartz, feldspar, and biotite (Fig. 15). Tonalite, mafic metavolcanic rock, and chert are the most abundant clasts. The clasts are poorly-sorted and well-rounded, and they vary from less than 1 to 30 cm in size. They are generally elongate parallel to the foliation, and many of the clasts show considerable stretching in this direction. The clasts constitute 50 percent, or more, of the rock, and the metaconglomerate is partly framework-supported, and partly matrix-supported. This metaconglomerate has been mapped in more detail farther north by Harding (1951). Breaks and others (1976) have indicated that the northern part of the metaconglomerate unit mapped by Harding (1951) is of volcaniclastic origin, and according

Figure 15. Outcrop of metaconglomerate exposed north of Tot Lake.

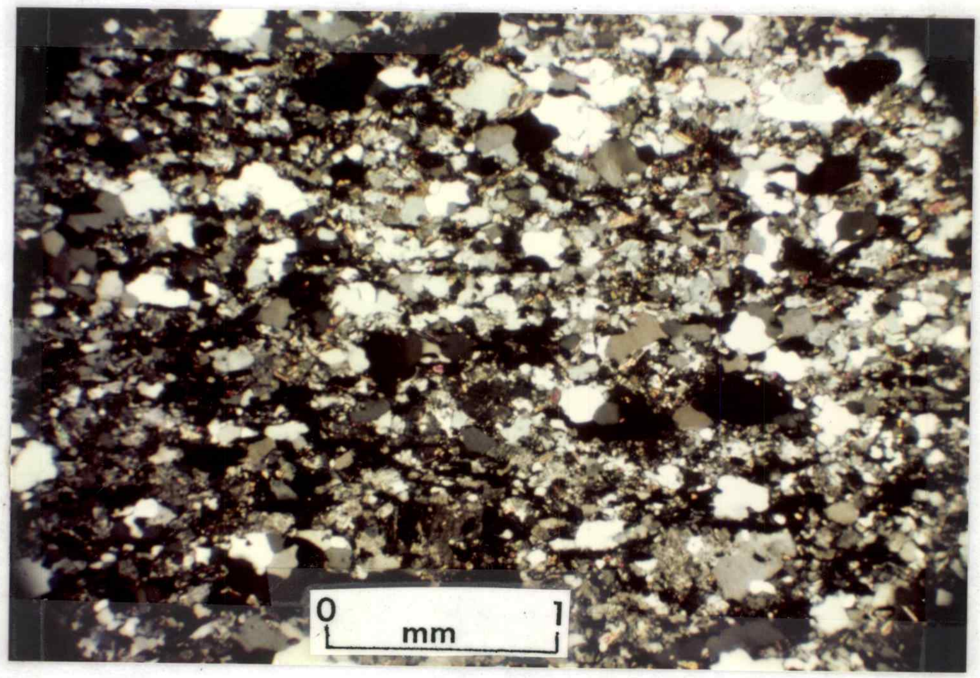


Figure 16. Photomicrograph of metagreywacke

to their preliminary map, it overlies the mafic metavolcanic sequence and a section of metagreywacke north of the Lateral Lake Stock.

A narrow band of metaconglomerate crops out immediately north of the mafic metavolcanic sequence in Echo Township, and corresponds to a similar unit described by Armstrong (1951). The rock contains clasts of tonalite and chert in a foliated matrix of quartz, feldspar, and biotite. The abundance of clasts is highly variable throughout this unit. The host is both matrix-supported and framework-supported. Metagreywacke is commonly interbanded with the metaconglomerate. Lithological similarities with the more extensive metaconglomerate farther west suggest a common origin for these geographically separate units.

A metaconglomerate unit is exposed just east of the Dryden-Hudson road, 1.2 km south of the contact of the Lateral Lake Stock in Webb Township. Tonalite is the most abundant type of clast in this metaconglomerate, although mafic metavolcanic fragments are also present. The clasts comprise 30 to 50 percent of the rock. They are well-rounded, and range from 10 to 100 cm in diameter. The clasts are alligned parallel to the foliation of the matrix, and many of them show considerable stretching in this direction. The matrix is strongly foliated to gneissic, and consists of alternating bands of quartz and amphibole. Amphibole comprises up to 70 percent of the matrix. Contacts with other rocks are not exposed; however, structural measurements within the metaconglomerate indicate that it is conformable with the metavolcanic sequence. This unit may be bounded by metagreywacke at both its upper and lower contacts, as inferred from the geologic map of Harding (1951), and from the distribution of metagreywacke observed elsewhere in the area. Metagreywacke is also present as interbands in this metaconglomerate.

Metagreywacke

Metagreywacke is the most abundant metasedimentary rock in the Lateral Lake area. It conformably overlies the mafic metavolcanic unit north and south of the stock, where the latter unit is not overlain by metaconglomerate. Bedding-top determinations from cross bedding and graded bedding in exposures of metagreywacke in Echo Township indicate that these units are not overturned. The metagreywacke has a vague to distinct foliation which is developed along the original bedding planes. Quartz, feldspar, and biotite are the only minerals visible in hand specimen. The proportion of mafic to felsic minerals is variable, and the felsic content ranges from 40 to 70 percent. Narrow felsic bands were occasionally observed in the metagreywacke.

Quartz is the most abundant mineral in these rocks (Fig. 16). It is present as large porphyroclastic grains and as smaller granoblastic grains, and ranges from 50 to 70 percent in abundance. The prophyroclasts, which vary from 0.2 to 1.0 mm in size, are the largest grains in the metagreywacke. They often occur as polycrystalline aggregates, elongate parallel to the foliation as defined by the orientation of the micas. Boundaries between the quartz grains are irregular, and mortar texture is often present. The quartz commonly displays undulose extinction.

Granoblastic quartz is finer-grained than the porphyroclastic quartz. It ranges from 0.05 to 0.2 mm in size. Triple points are occasionally present. The texture of the finer-grained quartz is gradational with that of the porphyroclastic quartz. The finer-grained variety is probably partly recrystallized, whereas the larger porphyroclastic grains are relict.

Plagioclase feldspar is present in amounts varying from less than 1 to 15 percent. It usually occurs as large (0.3 to 0.8 mm) grains displaying irregular and granulated grain boundaries. However, granoblastic plagioclase feldspar is also present. The larger grains of plagioclase feldspar contain inclusions of quartz, muscovite, epidote, and clays. Xenoblastic, interstitial crystals of microcline are often associated with the plagioclase feldspar. Composition of the feldspar varies from An_{34} to An_{36} (andesine).

Biotite comprises 10 to 40 percent of the metagreywacke, and is the most abundant mafic mineral in the rock. Biotite, in association with chlorite and muscovite, defines the foliation. It occurs as subidioblastic laths which vary from 0.1 to 1.0 mm in size. Intergrowths with chlorite are common. Chlorite is present in amounts of up to 7 percent. It generally occurs in a similar association as biotite; however, narrow bands of large (up to 3.0 mm) chlorite laths were occasionally observed in thin section. Muscovite is not present in all specimens, and usually constitutes less than 4 percent of the rock. It often occurs as inclusions in plagioclase feldspar as well as in association with biotite and chlorite.

Epidote is a minor constituent of the metagreywacke, although it may be as abundant as 7 percent. It is present as equigranular crystals and as small elongate laths generally associated with the micas. Rounded inclusions of sphene are occasionally observed in epidote. Other minor and trace minerals of the metagreywackes include zircon, apatite, magnetite, hematite, and tourmaline.

Impure Quartzite

Two distinct mappable units of impure quartzite are present within the mafic metavolcanic sequence north and south of the Lateral Lake Stock. They range from less than 3 m wide southeast of the stock in Echo Township, to greater than 30 m wide north of Tot Lake and southeast of Gullwing Lake in Webb Township. The bands are laterally continuous over the length of the exposures. The geographic distribution of the bands of impure quartzite, and the similarity of their lithologic characteristics, strongly suggest that these units are correlative with each other.

The impure quartzites are fine-grained and well banded. The felsic content ranges from 65 to 90 percent. The foliation is defined by the allignment of biotite, muscovite, and chlorite laths, which envelop large, rounded porphyroclasts of quartz and occasional plagioclase feldspar (Fig. 17). These porphyroclasts range from less than 1 to 10 mm in length. The porphyroclasts of quartz are elongate in the direction of the foliation. They display fracturing normal to this direction, suggestive of a pretectonic origin for the porphyroclasts. Randomly-oriented xenoblastic muscovite, quartz, and feldspar are present in pressure shadows at the ends of the

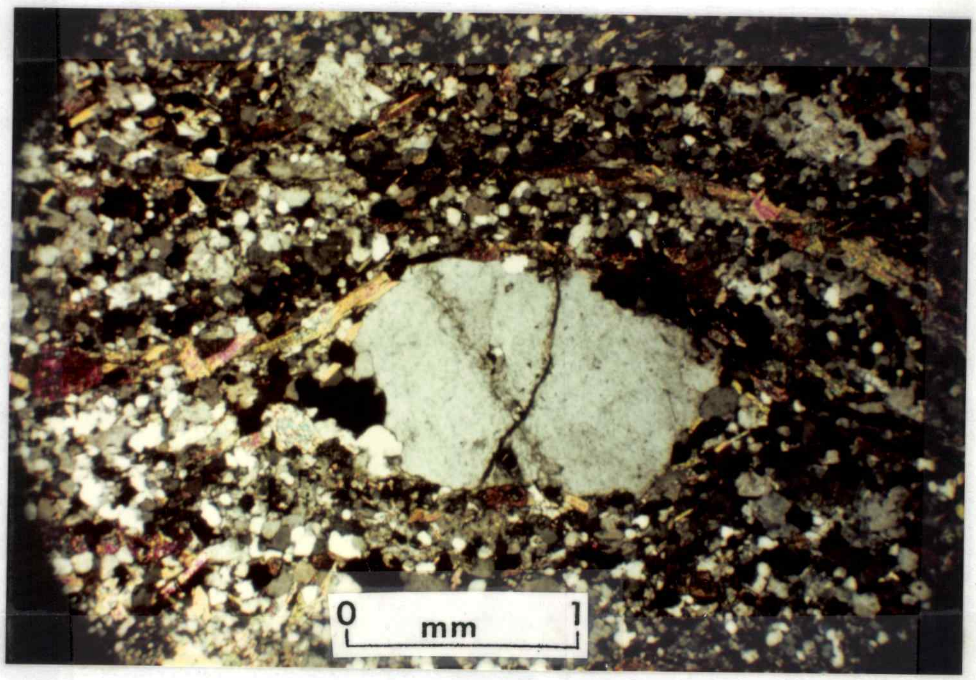


Figure 17. Photomicrograph of impure quartzite.

porphyroclasts of quartz. Undulose extinction, parallel to fractures and sub-boundaries within the porphyroclasts is well-developed, and mortar texture is commonly observed along the edges and in fractures of the grains. Some specimens of impure quartzite do not contain large porphyroclasts of quartz; however, elongate aggregates of quartz crystals that are coarser-grained than the quartz of the matrix are usually present.

Quartz of the matrix is fine-grained, and ranges from less than 0.1 to 1.5 mm in size. The crystals are equidimensional to elongate in shape, and their long axes are parallel to the foliation. This finer-granied, granoblastic quartz may display development of triple points. The amount of quartz in the impure quartzites varies from 55 to 75 percent.

Plagioclase feldspar ranges from 8 to 20 percent in abundance. It is associated with quartz in the matrix, but pre-tectonic grains are also present in some specimens. An impure quartzite unit east of the Lateral Lake Stock contains relict plagioclase feldspar as the dominant porphyroclast. The feldspar typically contains inclusions of quartz and muscovite. Microcline may partly replace the large porphyroclasts of plagioclase feldspar, often forming rims around them. These porphyroclasts are xenoblastic, and tend to be alligned parallel to the foliation. Composition of the plagioclase feldspar ranges from An_{30} to An_{36} (andesine), although one specimen collected from southwest of Tot Lake has an anorthite content of An_{24} (oligoclase).

Microcline is present in minor amounts (up to 4 percent) in the impure quartzites, but may be absent altogether. It is xenoblastic, and is associated with quartz and plagioclase feldspar in the matrix. It is also present as patches which replace porphyroclasts of plagioclase feldspar.

Biotite and muscovite are the dominant micas in the rocks, although chlorite is invariably present as a trace constituent. The parallel orientation of the biotite and muscovite laths defines the foliation. Muscovite is also abundant as inclusions in plagioclase feldspar and in pressure shadows of the large relict porphyroclasts of quartz. Muscovite of the latter association tends to be coarser-grained than elsewhere in the rock. Both muscovite and biotite range from 0.2 to 3.0 mm in size. Chlorite occurs as discrete grains, or as intergrowths with biotite.

Epidote and sphene are invariably present in trace amounts in the impure quartzites. These minerals are typically fine-grained (less than 0.5 mm), and form elongate laths parallel to the foliation. Other trace minerals of the rocks include zircon, apatite, tourmaline, magnetite, and hematite.

The impure quartzites have been metamorphosed to the extent that the original mineralogy is nearly obliterated, with the exception of relict porphyroclasts of quartz and plagioclase feldspar. The presence of the porphyroclasts in the rocks is suggestive of a bimodal size distribution in the original lithologies. Petrographically, the rocks resemble metarhyolites or impure quartzites. They are similar to the biotite granulites described by Harker (1932).

If the original rocks were sedimentary, they would be classified as impure arenaceous sandstones or as quartz-rich pebble conglomerates, depending on the absence or presence of porphyroclasts. Alternatively, if they were of an igneous origin, they could be interpreted as porphyritic rhyolites. However, their potassium feldspar content is low (usually less than 4 percent), and the anorthite content is within the andesine range which is not typical of rhyolitic rocks. They also have a high quartz content. In addition, the porphyroclastic quartz grains are well rounded, which suggests transportation in a sedimentary environment. The aforementioned criteria fit the hypothesis that these rocks are sedimentary rather than igneous in origin.

THE LATERAL LAKE STOCK

The Lateral Lake Stock is an elongate intrusive body extending approximately 12 km in length from Gullwing Lake in Webb Township to east of Lateral Lake in Echo Township. It occupies the central axis of an east-northeast-trending antiformal structure. The texture of the stock varies from an indistinct foliation along its central axis to a pronounced gneissosity at its outer margins. Granodiorite is the dominant lithology, although tonalite and quartz monzonite are present locally. Numerous dikes and sills of aplite and pegmatite crosscut the stock. They are most abundant in the potassic-rich areas of the pluton.

Granodiorite, Tonalite, and Quartz Monzonite

Granodiorite is the dominant lithology of the Lateral Lake Stock. Tonalite and quartz monzonite occur sporadically in the western part of the pluton, the latter in association with pegmatites. Quartz monzonite is also present in the eastern part of the stock, and is associated with the molybdenum occurrences. Mineral abundances in the granodiorite are as follows: quartz, 25 to 40 percent; plagioclase feldspar, 40 to 55 percent; microcline, 7 to 20 percent; biotite, 1 to 6 percent; chlorite, <1 to 6 percent; muscovite, <1 to 4 percent; epidote, 2 to 4 percent; sphene, <1 to 2 percent. Zircon, apatite, calcite, magnetite, hematite, and pyrite are present as accessory minerals. Calcite and pyrite were observed only in rocks associated with pegmatites.

Quartz and feldspar comprise about 90 percent of the main intrusive mass of the stock. In the more intensely deformed parts of the stock, quartz, plagioclase feldspar, and microcline form strongly granulated aggregates elongate parallel to the gneissosity. These polycrystalline aggregates display granoblastic polygonal texture, and triple points are numerous (Fig. 18). The development of triple points is more common in the feldspars than in quartz. Grain size of these aggregates ranges from 0.2 to 2.0 mm, although individual crystals of quartz may be as large as 6.0 mm. Porphyroblasts, which consist of large (up to 6.0 mm) xenoblastic crystals of microcline with lesser amounts of epidote, plagioclase feldspar, and quartz, are present in the western part of the stock. Porphyroblastic microcline has a lower degree of triclinicity relative to granoblastic microcline as indicated by poorly-pronounced twinning in the former. Perthitic texture is weakly-developed in the porphyroblastic microcline. Both porphyroblastic and granoblastic microcline are unaltered. Plagioclase feldspar, however, is partly altered to clays and muscovite. Alteration is most intense in crystals of plagioclase feldspar which are rimmed by secondary overgrowths of a more sodic phase. Composition of the primary plagioclase feldspar is An_{17} to An_{20} (oligoclase).

Gneissic texture is less-pronounced in the eastern part of the stock than in the west. Quartz and feldspar are generally coarser-grained here, and range from 0.5 to 6.0 mm in size. The granoblastic-polygonal habit of the felsic minerals, although present, is poorly-developed. Boundaries of the quartz crystals are often irregular or sutured (Fig. 19), indicating that metamorphism was less intense here than in the western region of the stock. Trains of fluid inclusions are more abundant in the quartz crystals in this

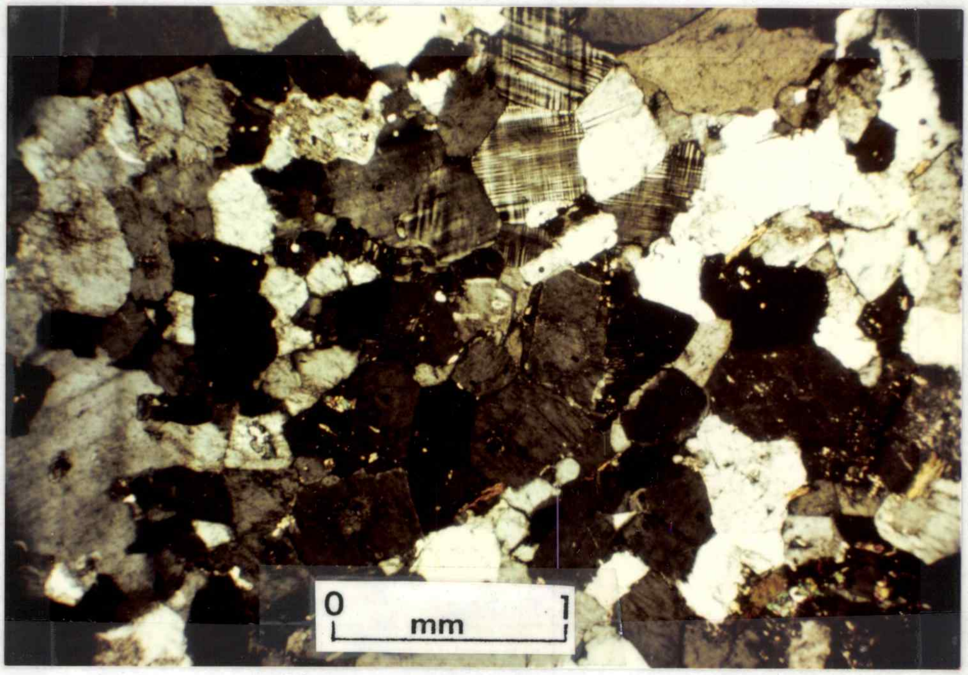


Figure 18. Photomicrograph of granodiorite showing development of triple points in plagioclase feldspar and microcline.

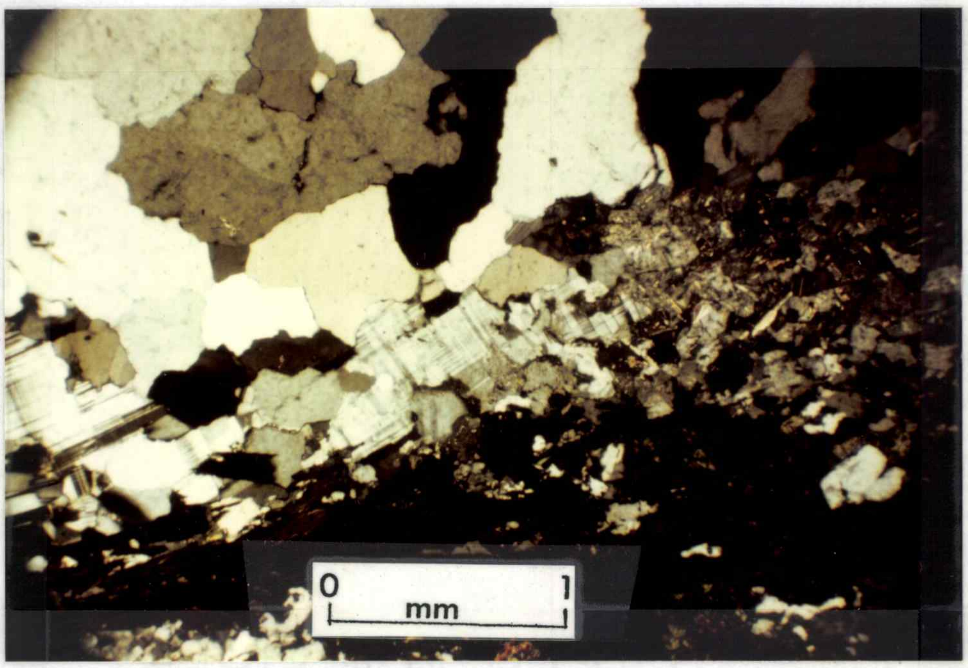


Figure 19. Photomicrograph of granodiorite showing development of sutured grain boundaries between quartz grains.

part of the stock. All inclusions consist of a single gas bubble enclosed in a fluid phase. Brownian motion was observed in some. The linear distribution of the fluid inclusions and their relationship to fractures in the quartz suggest that they are of a secondary origin.

Microcline occupies an interstitial habit in the eastern part of the stock. Perthitic intergrowths are common. Microcline replaces plagioclase feldspar, and inclusions of one mineral may be present in the other (Fig. 20). The anorthite content of the plagioclase feldspar ranges from An_{23} to An_{28} (oligoclase). Crystals of plagioclase feldspar in this part of the stock are also rimmed by secondary overgrowths of a more sodic phase. These overgrowths are more abundant here than in the western part of the stock. Myrmekitic texture is present along the rims of some grains. The plagioclase feldspars in this part of the stock are subidioblastic, and they are more intensely altered to muscovite, epidote, and clays than those of the western exposures.

Biotite is the dominant mafic mineral in the Lateral Lake Stock. It is typically olive green in colour, and ranges from 0.1 to 1.0 mm in size. It occurs as subidioblastic laths in discontinuous bands which partly define the gneissosity of the stock (Fig. 21). Biotite occasionally form rims around epidote and sphene. Inclusions of zircon are common. Biotite is often intergrown with minor amounts of chlorite. It is replaced extensively by chlorite at many exposures throughout Echo Township. Rocks displaying this phenomenon are located in close proximity to known occurrences of molybdenum, and the chlorite may be the result of an alteration event.

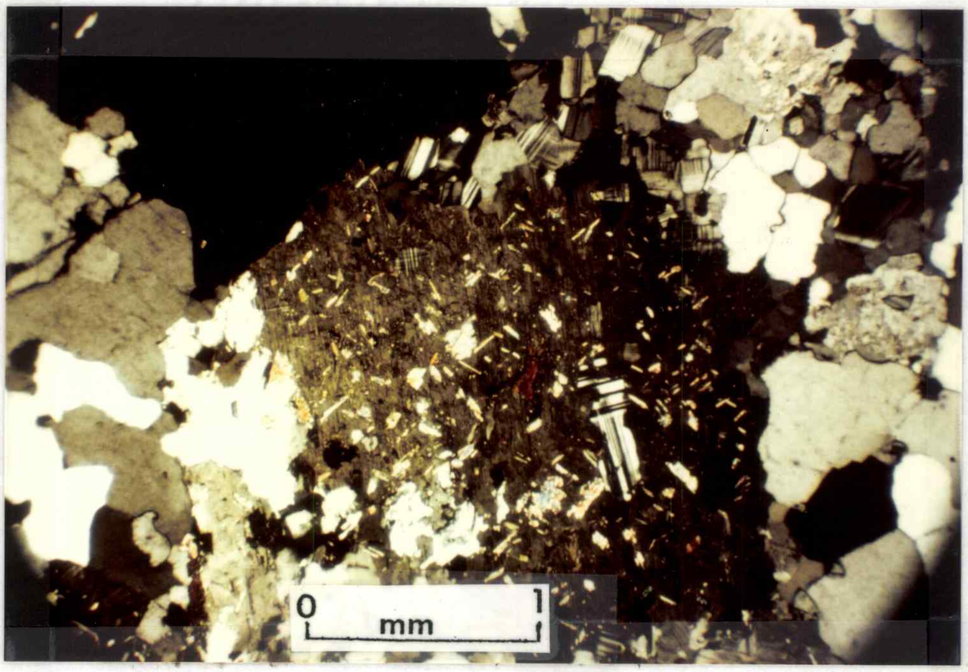


Figure 20. Photomicrograph of granodiorite showing replacement of plagioclase feldspar by microcline and muscovite.

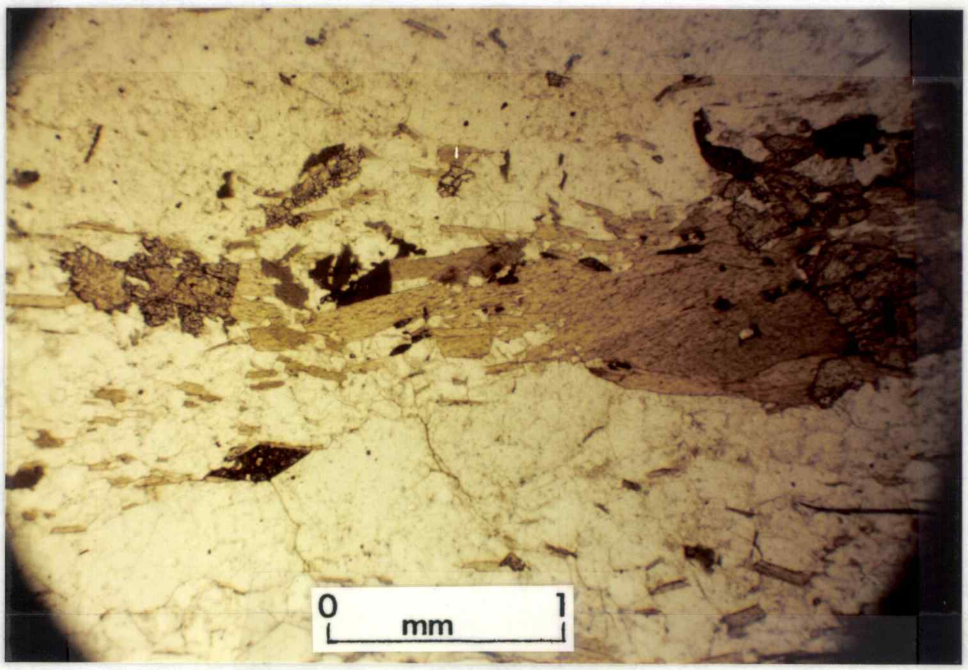


Figure 21. Photomicrograph of granodiorite showing parallel alignment of crystals of biotite, epidote, and sphene.

Muscovite is present throughout the stock, although it is most abundant in the eastern part where it occurs as inclusions in plagioclase feldspar. These inclusions are often alligned along the cleavage planes in the feldspar. Plates of muscovite are parallel to the gneissosity in the more highly-deformed rocks where they are associated with biotite. Muscovite assumes a xenoblastic, interstitial habit toward the eastern part of the stock.

Epidote is present in association with biotite, although it may also occur independently of it. It ranges from 0.1 to 2.0 mm in size, and displays subidioblastic to idioblastic crystal form that is usually elongate in the direction of the gneissosity. Epidote is somewhat more xenoblastic in the eastern part of the stock, where it often occurs in an interstitial habit. Inclusions of epidote are present in plagioclase feldspar.

Sphene occurs in a similar association to that of epidote. It is usually less than 0.1 mm in size, but single crystals may be as large as 3.0 mm. Sphene is also present as inclusions in epidote and biotite. Secondary rims were observed on some crystals. Zircon, apatite, magnetite, and hematite are present throughout the stock. They rarely exceed 1 percent by volume of the rock. Magnetite is most often associated with epidote, sphene, and biotite. Hematite occurs as discrete grains, or as rims on magnetite.

Grey Granodiorite

Grey granodiorite is present in diamond drill core, and is exposed at one outcrop north of Moly Lake. The texture of this rock varies from gneissic to equigranular. Both varieties are gradational with pink granodiorite, and they are extensively interbanded with it. The presence of fine-grained muscovite or biotite in variable amounts imparts a darker colour to the rock. Grey granodiorite was observed only along the margins of the stock, and the higher mafic content of the rock, relative to other units of the stock, was probably caused by the assimilation of mafic metavolcanic material from the surrounding rocks.

Porphyroblastic Grey Granodiorite

Sills of porphyroblastic grey granodiorite are present in diamond drill core. They are exposed at the eastern contact of the stock in Echo Township and in the central part of the stock near the large metavolcanic raft in Webb Township (Fig. 22). This rock consists of large (1.0 to 4.0 mm) porphyroblastic and polycrystalline aggregates of quartz, plagioclase feldspar, and occasional microcline in a fine-grained groundmass of quartz, plagioclase feldspar, microcline, biotite, muscovite, and epidote. Porphyroblasts of plagioclase feldspar are altered to muscovite, epidote, and clays. Foliation in the porphyroblastic grey granodiorites is of variable intensity, and is defined by the parallel allignment of the mafic minerals. The porphyroblasts commonly have their long axes parallel to the foliation. Contacts of the sills are sharp, but chilled margins were not observed, which suggests that emplacement of the sills occurred during, or shortly after the intrusion of the pink granodiorite of the stock. The porphyroblastic texture of the sills indicates that they may have been originally porphyritic.

Figure 22. Outcrop of a sill of porphyroblastic grey granodiorite in Webb Township.

Aplite

Dikes, sills, and veins of aplite are present throughout the Lateral Lake Stock. They have been weakly metamorphosed, although deformation textures are not well-developed. The aplites are fine-grained and pale to pinkish-red in colour. Petrographic analyses indicate that the pink colouration is directly related to the amount of microcline present. The aplites range from tonalite (Fig. 23), through granodiorite and granite, to alkali feldspar syenite (Fig.24) in composition, based on the I.U.G.S. classification (Streckeisen, 1973). The microcline-rich aplites are invariably associated with occurrences of molybdenum. Grey aplites are exposed near the contacts of the stock and in diamond drill core. The high content of mafic minerals in these rocks suggests that they may have been formed by partial assimilation of mafic metavolcanic material.

Quartz, plagioclase feldspar, and microcline are the dominant minerals in the aplites, and their abundance averages 95 to 99 percent by volume. Quartz is present as subrounded, anhedral crystals that range from 0.1 to 1.0 mm in size. It occurs as individual crystals or as irregular polycrystalline aggregates. The abundance of quartz varies from 2 to 45 percent. Fluid inclusions, similar to those in the main granodiorites, are present in quartz, but they are not abundant. Occasional triple points were observed among the quartz crystals.

Plagioclase is the dominant feldspar in the tonalitic and granodioritic aplites. It is subhedral, and varies from 0.3 to 3.0 mm

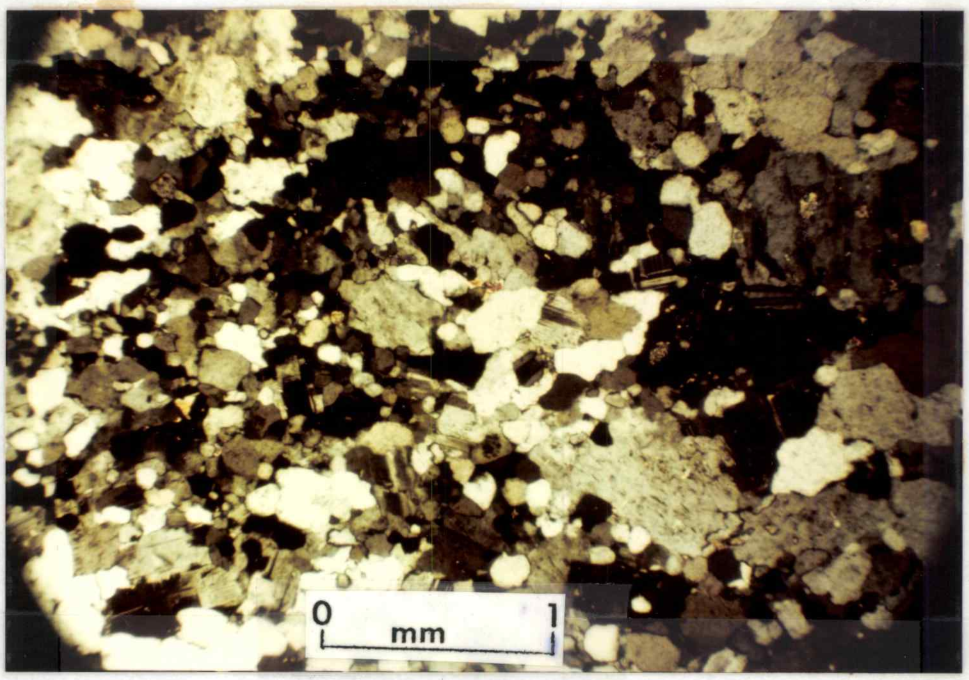


Figure 23. Photomicrograph of tonalitic aplite.

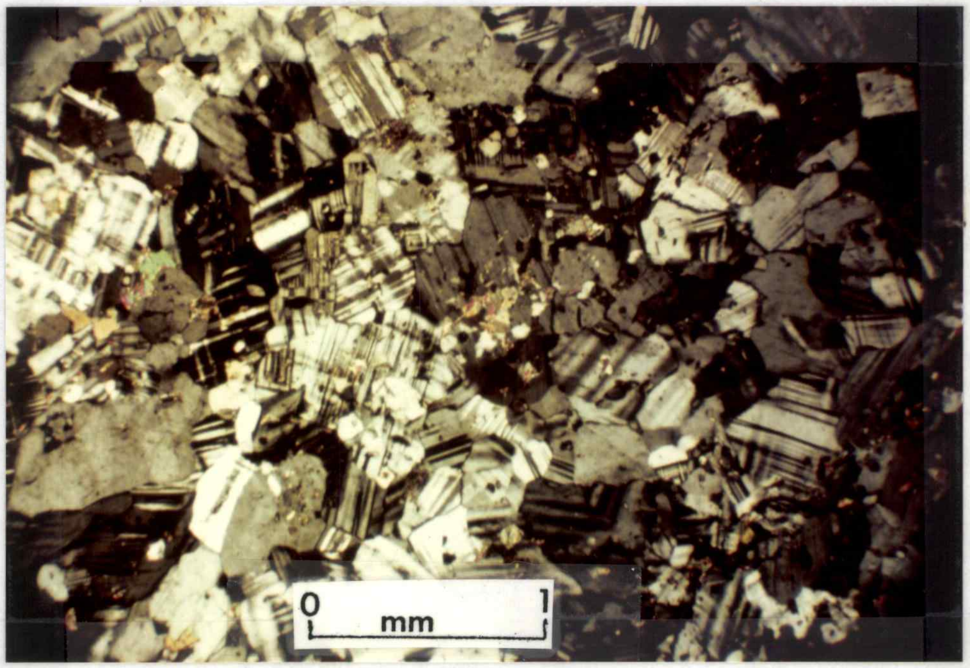


Figure 24. Photomicrograph of alkali feldspar syenitic aplite.

in size. It usually displays some degree of replacement by muscovite, clay and microcline. Microcline occurs as patches within, and as partial rims around the plagioclase feldspar. The composition of the plagioclase feldspar is An_{26} to An_{28} (oligoclase). It is also a minor constituent of aplites of alkali feldspar syenite composition where it occurs as small, rounded, altered grains in microcline which replaces it. The composition of the plagioclase feldspar in these rocks ranges from An_{16} to An_{18} (oligoclase). The content of the plagioclase feldspar in the aplites varies from 5 percent in the alkali feldspar syenites to 45 percent in the tonalites.

The abundance of microcline ranges from 5 percent in the tonalites to 80 percent in the alkali feldspar syenites. Microcline varies from 0.1 to 2.0 mm in size, and is coarser-grained in the alkali feldspar syenites. It forms interstitial anhedra in the tonalites, and interlocking mosaics of anhedra displaying occasional triple points in the alkali feldspar syenites.

Epidote, muscovite, and chlorite are present as minor minerals in the aplites. They are usually less than 0.3 mm in size, but single muscovite laths may be as long as 2.0 mm. These minerals are commonly associated in narrow discontinuous bands, which impart a vague foliation to the rock. Intergrowths of muscovite and chlorite are present in these bands. Biotite is rare in the aplites. It is brown in colour, and is associated with the other micas.

Calcite is found in amounts of up to 3 percent in the microcline-rich aplites. It occurs as large interstitial anhedra. Sphene, magnetite, tourmaline, fluorite, pyrite, and molybdenite are present as accessory minerals. The latter four minerals are restricted to the microcline-rich aplites.

Sills of aplite form the major volume of aplitic rock found in the Lateral Lake Stock. They are peneconcordant with the gneissosity of the stock, and are interbanded with the main granodiorite. The sills vary from a few centimeters to 100 meters or more in thickness. The largest sills are present in the eastern part of the stock, and are the dominant lithology at the major occurrences of molybdenum in Echo Township. Contacts of the sills with the granodiorite of the stock are sharp, and chilled margins are absent. Intrusion of the sills occasionally distorts the foliation of the granodiorites adjacent to the contacts between the two (Fig. 25). In addition, xenoliths of granodiorite within the sills (Fig. 26) also display sharp contacts. This suggests that the sills were emplaced during, or shortly after, the consolidation of the main granodiorite of the stock.

Dikes and veins of aplite are present throughout the stock, but they are most abundant in the western exposures. They are lithologically similar to the sills and are probably related to them, although no contacts between the dikes and sills were observed. The dikes are discordant to the gneissosity in the stock, and may represent the latest stages of aplite emplacement.

An aplitic phase is associated with the lithium-cesium-tantalum-bearing pegmatite at the Kozowy-Leduchowski Prospect in Webb Township. The estimated modal composition of this aplite is: plagioclase feldspar, 90 to 95 percent; quartz, 5 to 8 percent; tourmaline, 1

Figure 25. Diamond drill core showing distortion of the foliation of the granodiorite adjacent to a sill of aplite.

Figure 26. Outcrop of an aplitic sill containing a xenolith of granodiorite.

to 2 percent; muscovite, 1 percent; garnet, <1 percent. The anorthite content of the plagioclase feldspar is An_{27} (oligoclase). The rock consists of a mass of partly-oriented, subhedral laths of oligoclase and minor tourmaline (Fig. 27). Quartz, muscovite, and garnet are generally interstitial to the oligoclase and tourmaline. Metamorphic textures are not evident in this rock.

Pegmatite

Dikes and veins of pegmatite are present in all parts of the Lateral Lake Stock. They increase in size and abundance toward the margins of the intrusion. In some exposures, large dikes of pegmatite extend from the stock into the adjacent metavolcanic sequence. Other pegmatites, such as the molybdenum-bearing pegmatite at the Coates prospect, and the lithium-cesium-tantalum-bearing pegmatite at the Kozowy-Leduchowski Prospect in Webb Township, are found entirely within the metavolcanic rocks. Pegmatites increase in size and abundance in proximity to metavolcanic rafts and xenoliths in the stock. They are most abundant in the eastern part where they are associated with the major occurrences of molybdenum. The largest and best-developed pegmatites intrude the aplitic sills.

The pegmatites are classified as simple pegmatites on the basis of their mineralogy. They contain varying quantities of muscovite, quartz, microcline, and plagioclase feldspar. With decreasing feldspar content, the pegmatites are gradational with the quartz veins. The feldspar is typically very coarse-grained, although some of the quartz-rich pegmatites contain bands of medium to fine-grained feldspar. Pegmatites often display zoning from a coarse-grained, quartz-rich core outward toward a fine-grained feldspar-rich margin. Contacts of the wall rocks vary from sharp to gradational. The pegmatites commonly have chilled margins, particularly where they are intrusive into the sills of aplite.

The potassium feldspar content of the pegmatites increases toward the eastern part of the stock. Pegmatites in the western part, south of Gullwing Lake, contain plagioclase as the only or dominant feldspar. Farther east in Webb Township, the pegmatites contain subequal amounts of plagioclase feldspar and microcline. However, the molybdenite-bearing pegmatites in this area are microcline-rich. Microcline is the only feldspar present in the molybdenite-bearing pegmatites of Echo Township. Variable amounts of quartz and large plates of green muscovite also occur in these rocks. Contents of fluorite and tourmaline also increase toward the eastern part of the stock, but garnet shows a reverse trend. Garnet is a common mineral in the pegmatites of the western exposures. The garnet has been identified as almandite-spessartite (R.O. Page, personal communication). The easterly decrease in the abundance of garnet coupled with an easterly increase in the contents of microcline, fluorite, and tourmaline are suggestive of a higher level of emplacement for the eastern part of the stock. Zones of brecciated aplite and granodiorite are present adjacent to the pegmatites at the Pidgeon Prospect in Echo Township. They are not extensive, however.

The lithium-cesium-tantalum-bearing pegmatite in Webb Township is a complex pegmatite with a unique mineralogy. This pegmatite, based on rough estimates obtained in the field, consists of:

quartz, 25 to 30 percent; plagioclase feldspar, 30 to 35 percent; spodumene, 15 to 20 percent; muscovite, 20 to 25 percent; lepidolite, <1 percent; tourmaline, <1 percent. It is typically very coarse-grained, although the grain size is variable, and aplitic phases are also present (Fig. 27). This pegmatite is not in direct contact with the Lateral Lake Stock; thus, its relationship to the stock is unknown.

Contact Zone of The Lateral Lake Stock

The contact zone of the Lateral Lake Stock is exposed at four outcrops, and was encountered in some of the diamond drill holes. All contacts of the stock with the metavolcanic sequence are sharp, and the trends of gneissosity and foliation in the stock and the metavolcanic sequence are parallel to the attitude of the contact. This relationship suggests that the gneissic texture of the stock was developed during its intrusion into the metavolcanic sequence in a mostly solid state.

Xenoliths of mafic metavolcanic rock are common near the margins of the stock. They range from a few cm to greater than 10 m in size. They are typically schistose, and contain hornblende, plagioclase feldspar, and quartz with variable amounts of biotite. The marginal zone is also characterized by the intrusion of sills, lenses, and stringers of quartz, aplite, and pegmatite over a larger area along the eastern margin of the stock than in the west (Fig. 28). Grey granodiorite is also more abundant in the east which suggests that partial assimilation of mafic metavolcanic rock was more widespread here than in the western part of the stock. Aplites and

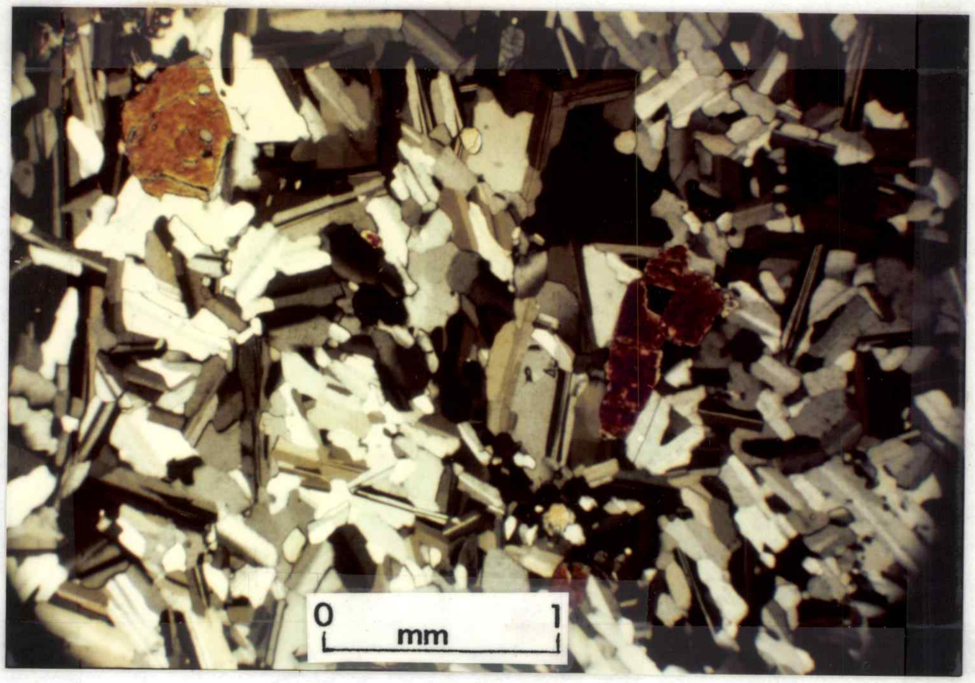


Figure 27. Photomicrograph of aplitic phase of the pegmatite at the Kozowy-Leduchowski Prospect.

Figure 28. Outcrop of contact zone along the eastern margin of the Lateral Lake Stock showing intrusion of sills of aplite into the mafic metavolcanic rocks.

pegmatites within the stock are also more abundant in the east than in the west. This evidence suggests that the eastern part of the stock was more fluid than the western part during its emplacement. Thus the eastern part of the stock represents the highest exposed level of the pluton. The general absence of contact metamorphic effects on the adjacent metavolcanic rocks suggests that the Lateral Lake Stock is representative of a deep-level intrusive event, temporally related to a period of regional metamorphism involving the suprocrustal rocks.

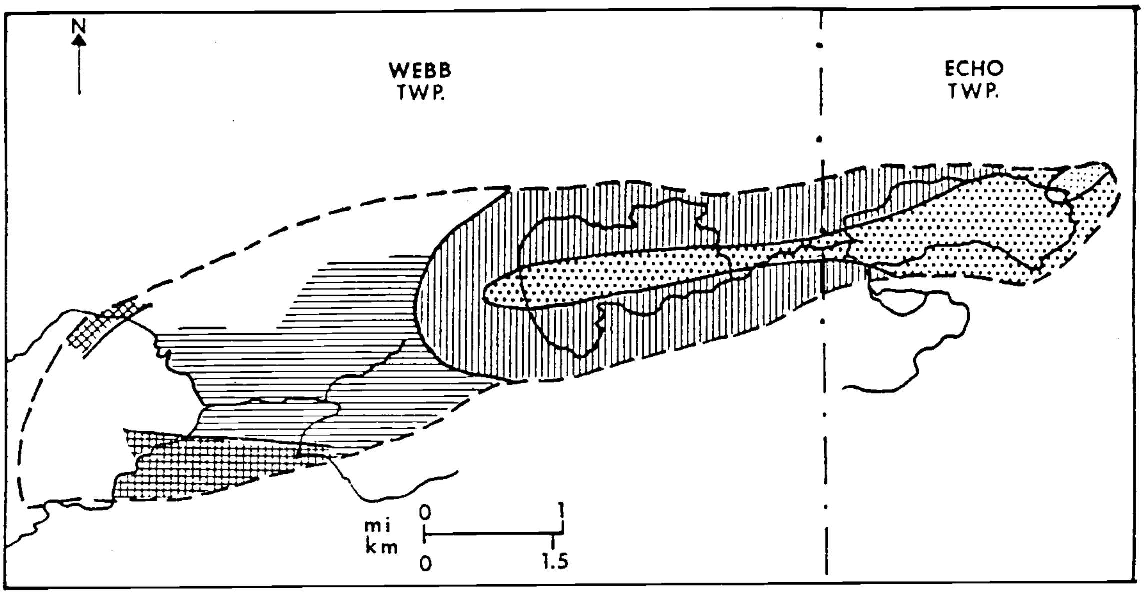
Metamorphism and Metasomatism

Much of the Lateral Lake Stock has a gneissic texture (Fig. 29). In addition, the absence of significant contact metamorphic effects on the adjacent metavolcanic sequence, and the parallelism of structural and textural trends between the plutonic and supracrustal rocks suggest that both lithologies were metamorphosed contemporaneously, and at considerable depth. The intensity of metamorphism and accompanying recrystallization increases toward the margins, and in the western part of the stock (Fig. 30 and 31).

Igneous textures are dominant in the eastern part of the stock near the axial region. Toward the margins, however, recrystallization and preferred allignment of some minerals is evident. Replacement of large relict crystals of plagioclase feldspar by microcline and muscovite is common in the marginal zone. Much microcline is interstitial, but the mineral occasionally assumes a granoblastic-polygonal habit. Small granoblastic crystals of plagioclase feld-

Figure 29. Outcrop of granodiorite showing development of gneissic texture and narrow peneconcordant sills of aplite.

Figure 30. Hand specimens of the Lateral Lake Stock showing the variability of intensity of gneissosity. Specimens are arranged from left to right, and were collected from the western toward the eastern part of the stock respectively.



Intensely developed gneissosity

Well developed gneissosity

Weakly developed gneissosity

Indistinct gneissosity

Equigranular texture

------ Contact of the Lateral Lake Stock

——·—— Township boundary

Figure 31. Intensity of Gneissosity in the Lateral Lake Stock.

spar accompany microcline in this habit. Quartz has undergone recrystallization in this part of the stock. Smaller crystals of quartz have coalesced into elongate polycrystalline aggregates which are parallel to the gneissosity as defined by the orientation of biotite, muscovite, and chlorite laths.

Recrystallization reaches its highest intensity in the marginal zone of the western part of the stock. Microcline, plagioclase feldspar, and quartz form polycrystalline aggregates with well-developed granoblastic-polygonal texture, separated by large elongate crystals of quartz. These rocks are similar to foliated granoblastic granulites described by Spry (1969, p. 290) who states:

> "The syntectonic phase of normal regional metamorphism may be followed by a prolonged post-tectonic crystallization which obliterates a dimensional preferred orientation and replaces it by a surface-energy controlled granoblastic-polygonal aggregate. The lattice preferred orientation may also be destroyed or it may be modified by the annealing."

This texture may represent the final stages of metamorphism, which continued after the emplacement of the stock. Metamorphism of this type would occur at considerable depth in a regional metamorphic environment.

A period of potassic metasomatism occurred during and after the final stages of metamorphism, and is most evident in the eastern part of the stock. It is characterized by the presence of late interstitial microcline and some muscovite which replaces plagioclase feldspar. Secondary rims of albitic composition are present as overgrowths on primary plagioclase feldspar where the latter is associated with microcline. Various ideas have been proposed concerning the origin of this secondary albite (Rogers, 1961; Schermerhorn, 1961; Marmo, 1971). It is generally accepted, however, that the albite is spatially and temporally related to the formation of microcline; thus, it is part of the metasomatic event.

Metasomatic effects are not as recognizable in the western part of the stock as in the east. Subsequent metamorphism has caused recrystallization of late microcline, which assumes a granoblastic-polygonal habit similar to that of plagioclase feldspar. Secondary overgrowths of albite on primary plagioclase feldspar are not as common as in the eastern part of the stock. The anorthite content of the primary plagioclase feldspar is lower here than in the east, which lends support to the theory proposed by Schermerhorn (1961) on the origin of the secondary albite. He cites a process whereby primary plagioclase feldspar is slowly decalcified and altered to secondary albite at conditions of lower pressure and temperature than those necessary for the formation of primary plagioclase feldspar.

Other evidence of potassic metasomatism is present in the western part of the stock. Occasional porphyroblasts of microcline are present at some exposures. They are similar to those described by Marmo (1971) which occur in synkinematic, granitic rocks, and are considered to be of metasomatic origin. The triclinicity of this porphyroblastic microcline is inferior to that of the microcline of the groundmass. Marmo (1971, p. 52) suggests that this is due to:

> "...a somewhat elevated temperature during the formation of the porphyroblasts or as due to the comparatively rapid growth of the porphyroblasts, thus hampering the full or-

> dering of the lattice and producing ample structurally intermediate feldspars."

Metamorphism and metasomatism were an integral part of the formation of the Lateral Lake Stock. Dikes and sills of aplite have been weakly metamorphosed, but the pegmatites which they enclose show no deformation textures other than occasional brecciated margins. This indicates that the aplites were emplaced during the final stages of metaorphism, and that the pegmatites were formed shortly thereafter. Pegmatites are largest and most abundant within the aplites. Contacts between the two lithologies are often gradational, and the aplites are rich in microcline adjacent to the pegmatites. This suggests that the pegmatites may have crystallized from a residual liquid within the aplites. This process was accompanied by injection of pegmatitic fluid into fractures in the adjacent granodiorites. In the western part of the stock, aplitic phases are not as abundant as in the east, and pegmatites intrude the granodiorites directly. Thus magmatic injection appears to be the dominant mechanism of emplacement of the pegmatites in this part of the stock.

Intrusion of the pegmatites is spatially and temporally related to the potassic metasomatic event which took place in the Lateral Lake Stock. This type of metasomatism is intensely-developed at the major occurrences of molybdenum in Echo Township, where the stock begins to assume the characteristics of a hydrothermal system.

Chemistry

Twelve samples of the Lateral Lake Stock were collected from outcrop and diamond drill core. They were analysed for major oxide and trace element abundances. The results are shown in Table 5.

Major Element Chemistry

Sample locations for chemical and petrographic analyses were selected to cover a broad area of the stock. Modal analyses of sixteen samples of the Lateral Lake Stock are presented in Table 6. Granodiorite is the dominant lithology of the stock as indicated by the ternary diagram for modal quartz-alkali feldspar-plagioclase feldspar shown in Figure 32. The aplites show the largest variability, and range from tonalite to alkali feldspar syenite in composition. Aplites, which are alkali feldspar syenite in composition, are intimately associated with the microcline-rich pegmatites. The high potassium content of these aplites is probably related to the phase of potassic metasomatism which affected the entire stock to some extent.

An AFM ternary plot of the chemical data (Fig. 33d) reveals an imperfect, though discernable differentiation trend toward the alkali apex. The samples which contain higher alkalis were collected from the eastern part of the stock. The aplites plot closest to the alkali apex. This feature of alkali-enhancement is consistent with the later age of formation of the aplites relative to the granodiorite of the stock.

Breaks and others (1978) have described three distinct plutonic suites for the Southern Plutonic Domain of the English River Sub-

Table 5. Lateral Lake Stock: Major oxide and trace element analyses.

Major Oxides (weight percent)	LL-1008	LL-1016	LL-1036	LL-1044	LL-1052	LL-1072-B	LL-1087	LL-1118	41-1250	41-0920	28-0620	41-1140
SiO_2	69.20	70.80	70.90	71.60	73.60	71.40	70.90	71.30	71.10	71.40	72.00	75.10
TiO_2	0.28	0.24	0.25	0.22	0.23	0.16	0.26	0.17	0.39	0.25	0.22	0.05
Al_2O_3	16.00	15.90	15.90	15.60	14.30	16.20	15.90	15.50	14.80	15.20	15.40	14.30
Fe_2O_3	1.22	1.06	0.95	0.92	0.86	0.79	1.09	0.86	1.37	1.39	0.91	0.34
FeO	0.83	0.75	0.91	0.91	0.75	0.50	0.83	0.66	0.91	0.75	0.50	0.27
MnO	0.03	0.03	0.04	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.03	0.01
MgO	0.78	0.64	0.67	0.63	0.91	0.41	0.63	0.52	0.66	0.62	0.53	0.13
CaO	2.45	2.44	2.38	2.32	1.49	2.06	2.61	2.10	2.70	2.58	2.06	0.63
Na_2O	4.87	5.09	4.94	4.97	4.74	6.00	4.99	4.90	4.39	4.32	4.91	4.38
K_2O	2.24	2.32	2.39	1.84	2.16	1.96	1.96	2.68	2.42	2.57	2.63	3.87
P_2O_5	0.09	0.10	0.08	0.09	0.09	0.07	0.09	0.08	0.09	0.08	0.08	0.04
S	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	0.23	0.38	0.12	0.01
CO_2	0.16	0.14	0.14	0.16	0.12	0.05	0.06	0.09	0.10	0.15	0.09	0.10
H_2O^+	0.20	0.10	0.06	0.11	0.51	0.29	0.27	0.28	0.19	0.50	0.22	0.10
H_2O^-	0.36	0.30	0.19	0.23	0.18	0.10	0.08	0.03	0.42	0.06	0.41	0.07
	98.70	99.90	100.00	99.60	100.00	100.00	99.70	99.20	99.70	100.30	100.10	99.90
Trace Elements (ppm)												
Li	26	23	68	24	9	14	34	20	30	29	19	4
Be	1	<1	<1	<1	<1	<1	2	2	<1	2	<1	<1
Sr	>1000	>1000	1000	1000	700	900	900	700	800	500	600	1000
Ba	900	740	860	570	640	500	560	540	820	730	560	200
Sc	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Y	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Zr	60	80	90	70	100	50	60	60	90	100	80	30
V	25	20	20	20	20	15	25	15	30	25	20	10
Cr	13	10	7	6	7	8	6	5	6	6	6	<5
Mo	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	20	<1
Co	7	8	7	6	6	5	6	5	6	6	6	<5
Ni	<5	6	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Cu	<5	<5	5	<5	<5	6	<5	5	98	240	22	<1
Ag	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Zn	53	47	54	48	26	32	45	40	55	60	51	9
Ga	20	20	15	20	15	15	20	20	15	20	20	20
Sn	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
Pb	18	33	12	46	22	12	19	21	14	12	26	14

Table 6. Intrusive rocks of the Lateral Lake Stock: Modal analyses.

	LL-1002-A	LL-1002-B	LL-1008-B	LL-1036	LL-1072-B	LL-1096	LL-1132	LL-1133	LL-1134	LL-1138	LL-1159	T-60	46-2550	41-0765	41-1895	46-0435
Quartz	42	43	29	27	27	37	35	34	37	37	40	29	25	32	44	3
Plagioclase Feldspar	40	41	56	54	46	44	38	44	44	43	48	52	48	50	49	6
Microcline	6	7	8	10	20	10	18	13	7	11	5	9	13	6	6	79
Biotite	6	5	3	5	2	4	2	1	1	1	3	2	4	3	--	1
Muscovite	2	<1	1	1	1	2	4	3	6	3	1	4	4	4	1	4
Epidote	2	2	2	2	3	2	3	2	3	2	2	2	4	3	--	--
Sphene	<1	<1	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	2	<1	--	--
Chlorite	1	<1	<1	--	<1	<1	<1	3	2	3	<1	1	--	--	--	2
Zircon	<1	<1	<1	<1	<1	<1	<1	--	<1	<1	<1	<1	--	<1	--	--
Apatite	--	--	1	1	--	--	--	--	--	--	--	<1	--	<1	--	--
Iron-Titanium Oxides	<1	<1	1	<1	<1	1	<1	<1	<1	<1	<1	1	<1	1	--	--
Calcite	--	--	--	--	--	--	--	--	--	--	--	--	<1	--	<1	3
Pyrite	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2

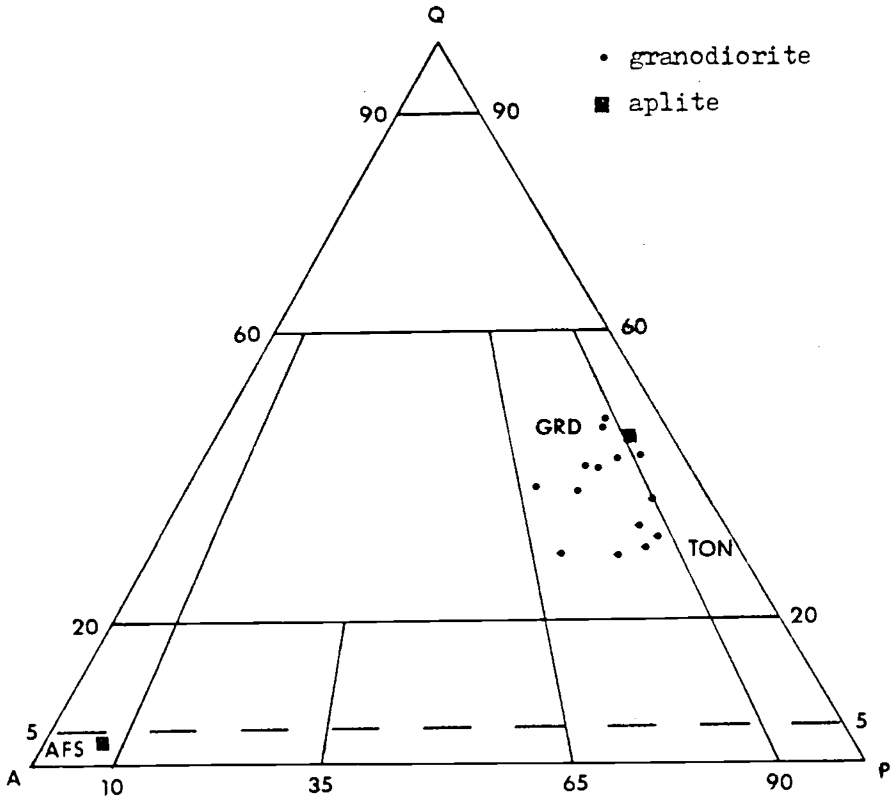


Figure 32. Intrusive rocks of the Lateral Lake Stock plotted in terms of a Quartz-Alkali Feldspar-Plagioclase Feldspar ternary diagram (from Streckeisen, 1973). Q=quartz, A=alkali feldspar, P=plagioclase feldspar, AFS=alkali feldspar syenite, GRD=granodiorite, and TON=tonalite.

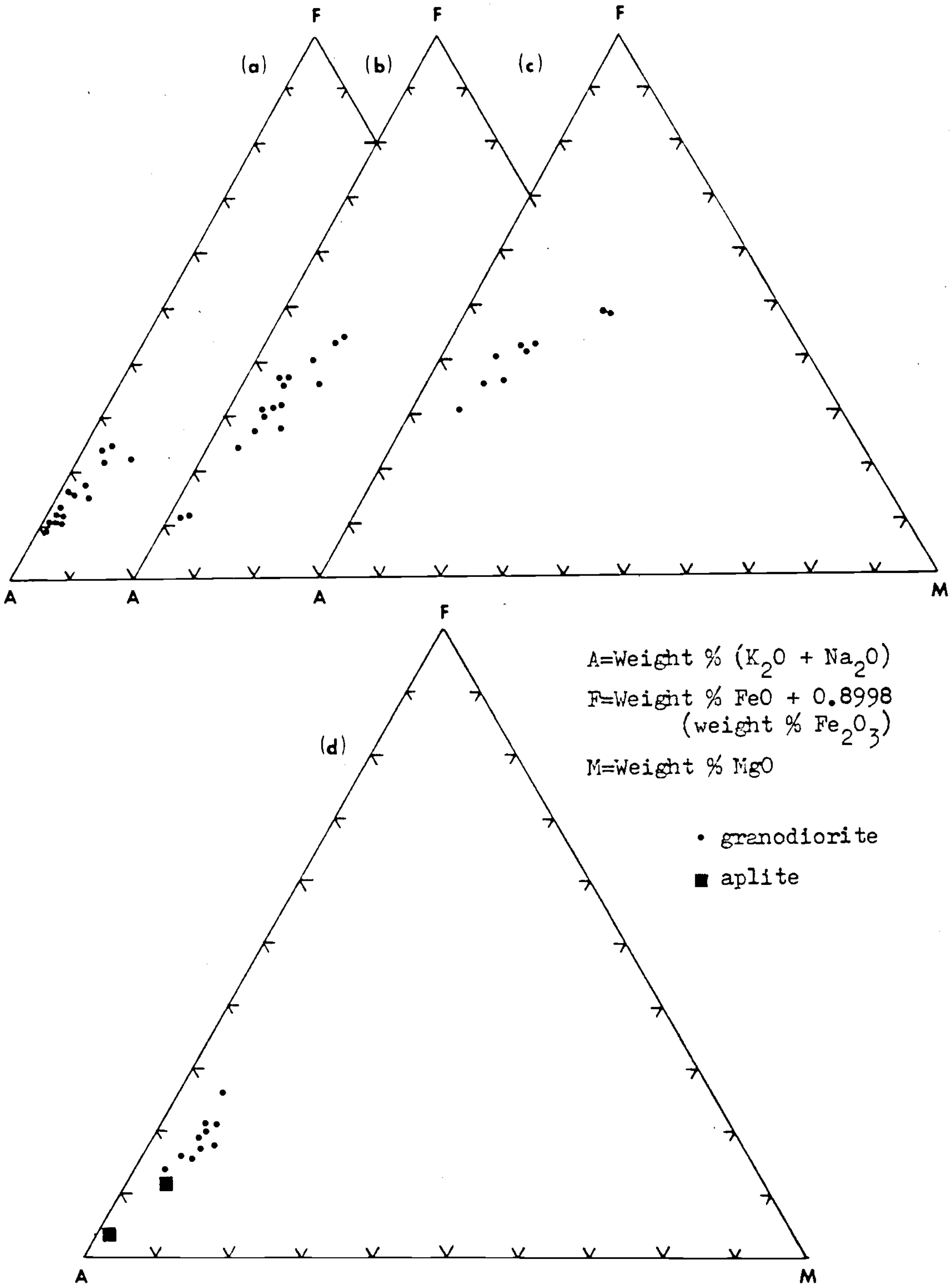


Figure 33. AFM ternary diagrams of:
(a) Potassic Plutonic Suite (from Breaks and others, 1978),
(b) Sodic Plutonic Suite (from Breaks and others, 1978),
(c) Gneissic Granitoid Suite (from Breaks and others, 1978), and
(d) Intrusive rocks of the Lateral Lake Stock.

province, which adjoins the Wabigoon Subprovince on the north. The three plutonic suites are:

1. Gneissic Granitoid Suite (pre-tectonic);
2. Sodic Plutonic Suite (pre- to syn-tectonic); and
3. Potassic Plutonic Suite (syn- to post-tectonic).

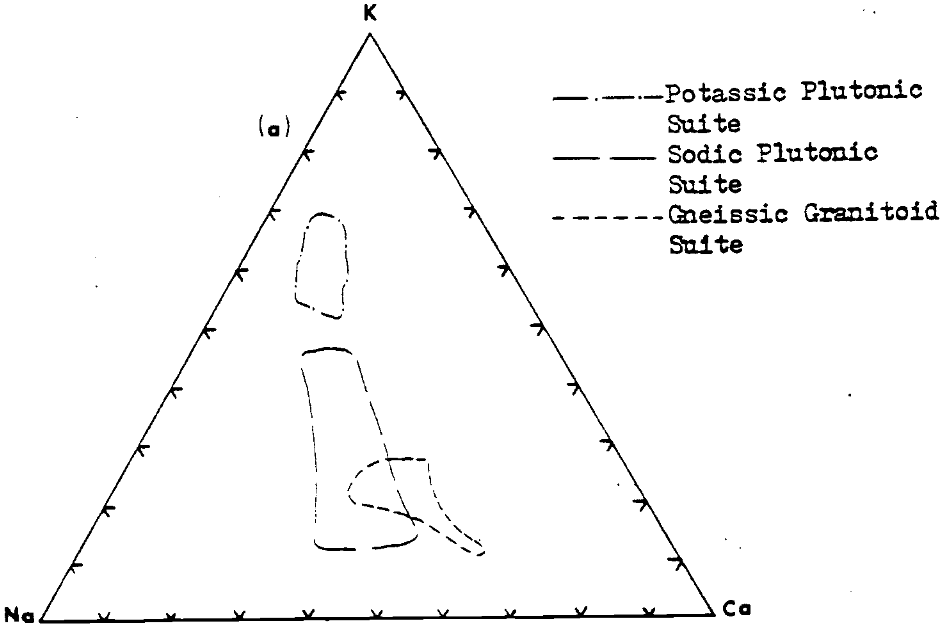
A comparison of AFM ternary diagrams of the three suites (Fig. 33a,b, and c) with the AFM ternary diagram of the chemical data from the Lateral Lake Stock (Fig. 33d) reveals that the stock is chemically similar to the Potassic Suite. This comparison is misleading, as sodium is the dominant element at the alkali apex in the AFM plot of the Lateral Lake Stock. A comparison of a K_2O-Na_2O-CaO ternary diagram of the stock (Fig. 34b) with a K-Na-Ca ternary plot of the three plutonic suites (Fig. 34a) of Breaks and others (1978) clearly demonstrates the high content of sodium in the stock. The mafic content of the stock, however, is considerably lower than that of the Sodic Plutonic Suite.

An average of the chemical analyses of the granodioritic rocks of the Lateral Lake Stock shows some discrepancies when compared to the average of twenty chemical analyses determined for various muscovite-biotite granodiorites by Nockolds (1954) as shown in Table 7. The contents of FeO and K_2O are significantly lower than the values of Nockolds, whereas the abundances of Fe_2O_3, CaO, Na_2O, and SiO_2 are higher. The high contents of CaO, Na_2O, and SiO_2 are reflected in the abundance of quartz and plagioclase feldspar in the stock.

Harker variation diagrams of the intrusive rocks of the Lateral Lake Stock show considerable scatter of data (Fig. 35). Analyses

Table 7: Comparative major oxide abundances from average muscovite-biotite granodiorites (Nockolds, 1954) and the granodioritic rocks of the Lateral Lake Stock.

	Lateral Lake Stock (average values)	Muscovite-biotite granodiorites (average values of Nockolds, 1954)
SiO_2	71.21	70.47
TiO_2	0.23	0.30
Al_2O_3	15.66	15.50
Fe_2O_3	0.97	0.63
FeO	0.77	2.12
MnO	0.03	0.03
MgO	0.65	0.65
CaO	2.23	1.91
Na_2O	5.06	4.12
K_2O	2.22	3.59
H_2O^+	0.23	0.52
P_2O_5	0.09	0.16



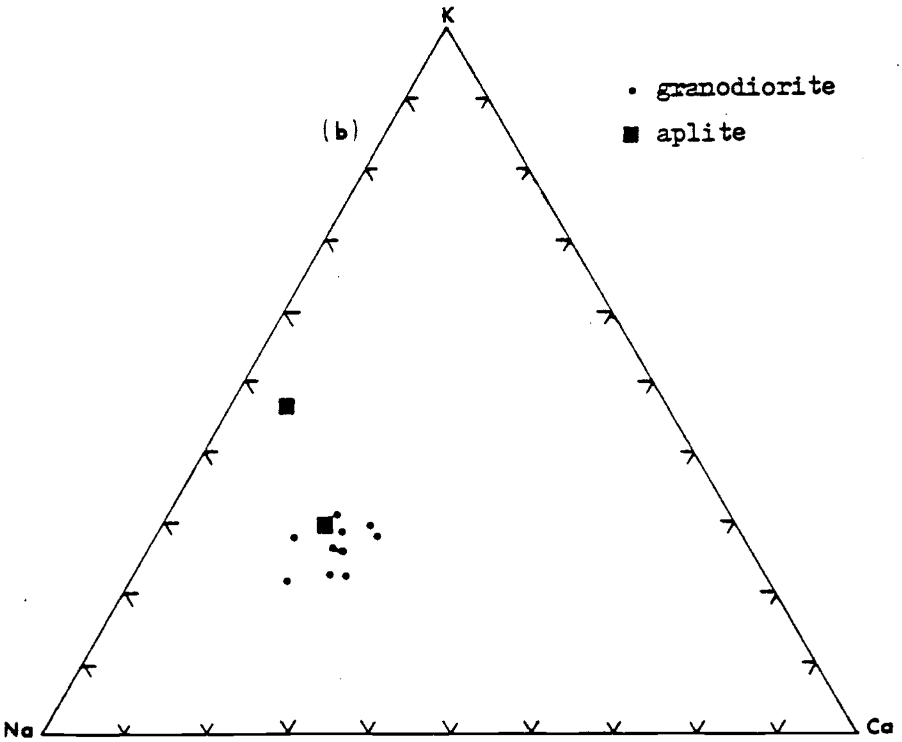


Figure 34. K-Na-Ca ternary diagrams of:
(a) Plutonic suites of the Southern Plutonic Domain of the English River Subprovince (from Breaks and others, 1978), and
(b) Intrusive rocks of the Lateral Lake Stock.

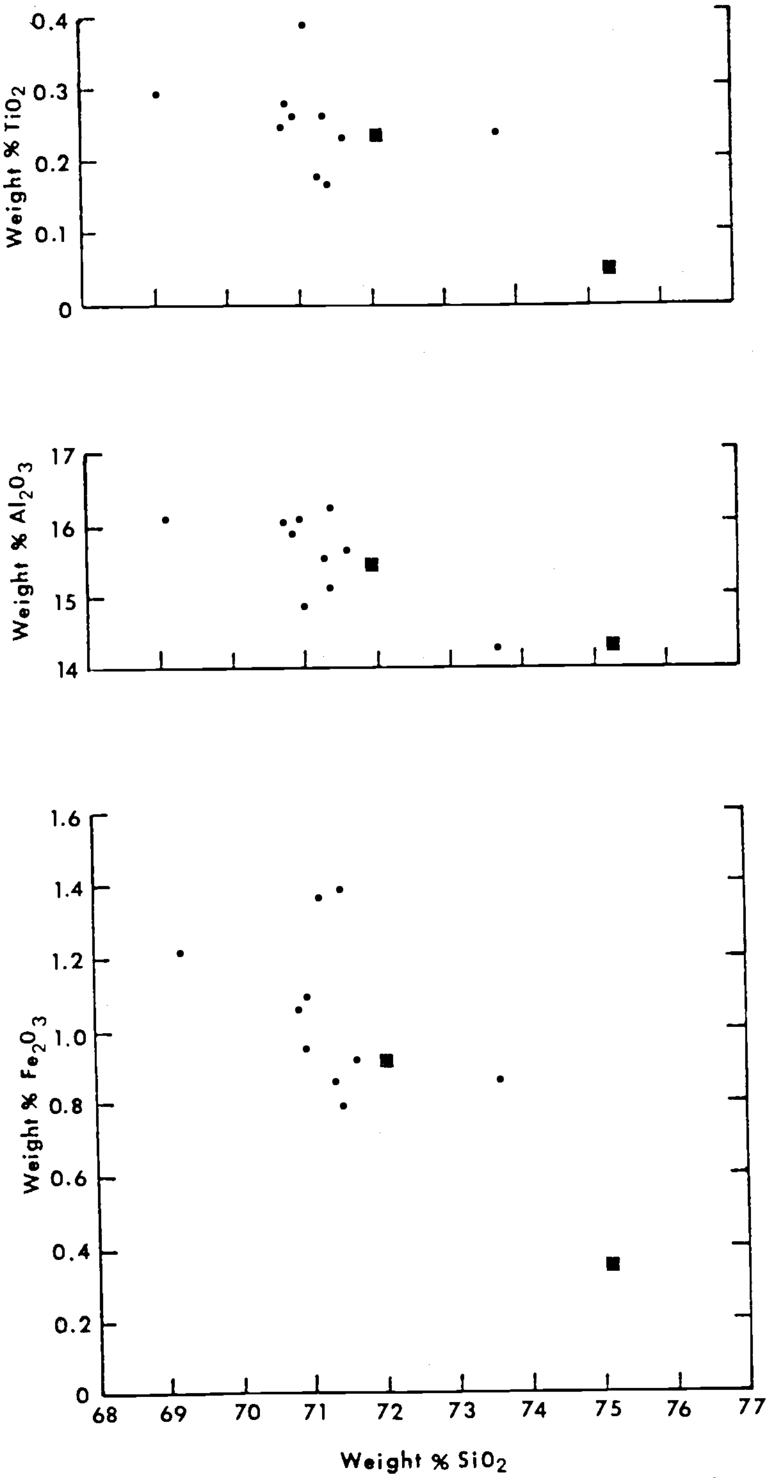


Figure 35. Intrusive rocks of the Lateral Lake Stock: Harker Variation Diagrams of major oxides.

• granodiorite

■ aplite

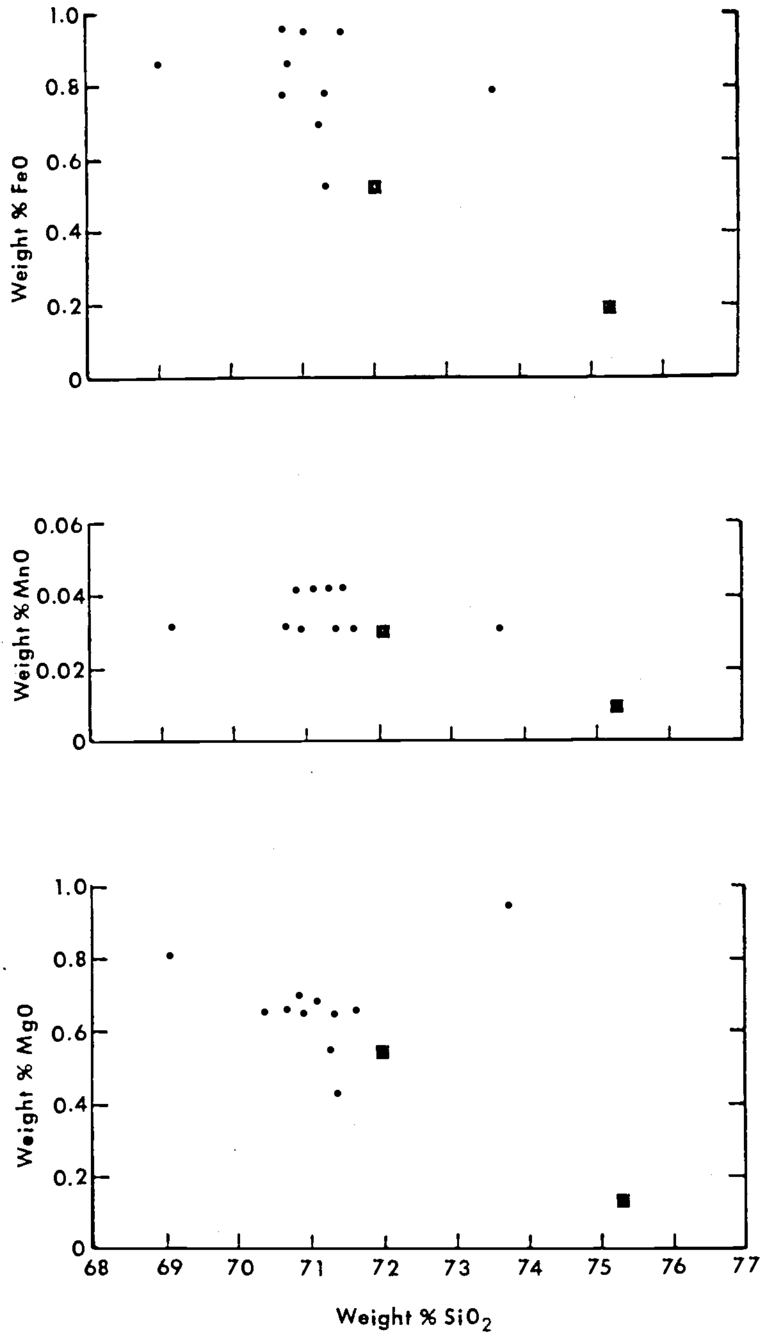


Figure 35. (continued).

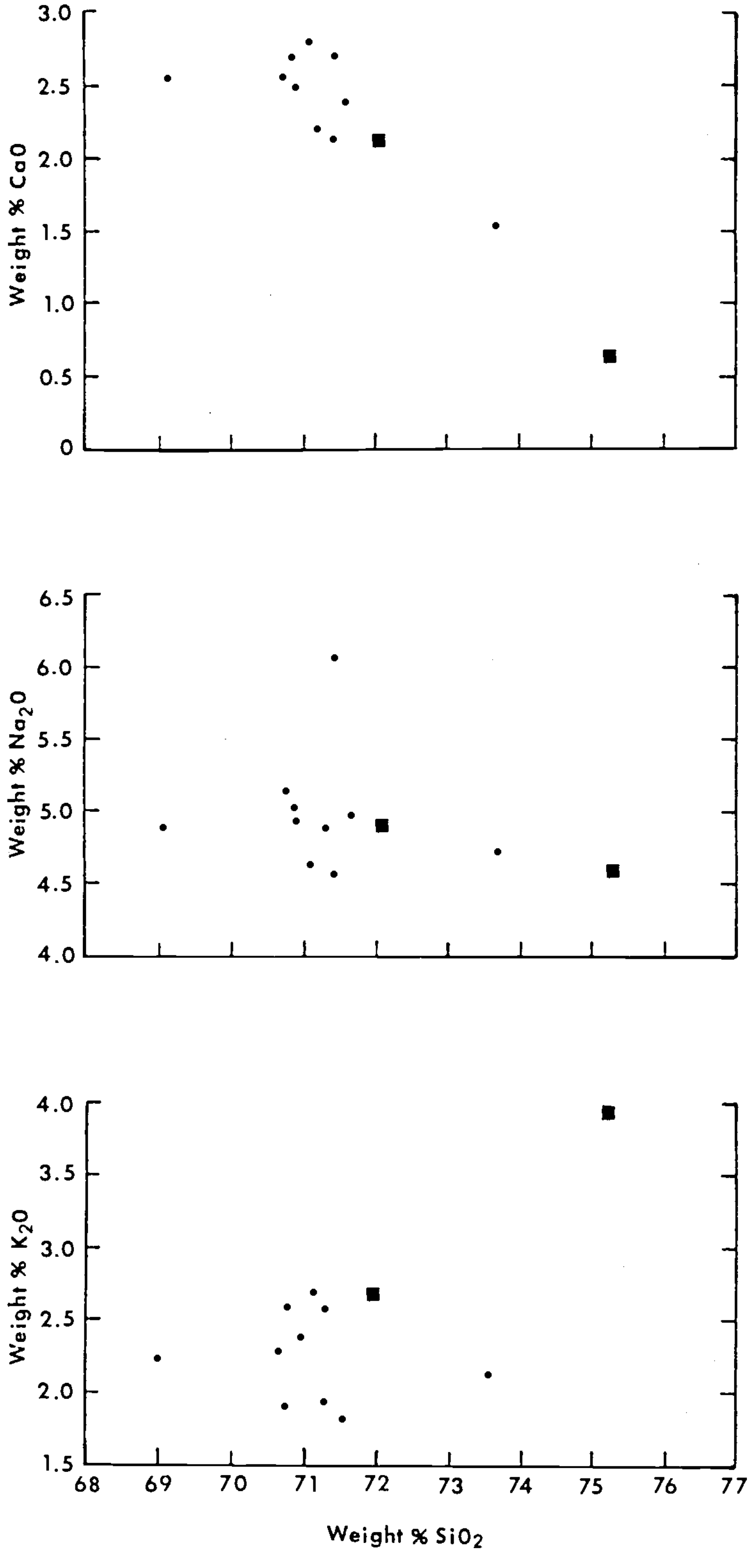


Figure 35. (continued).

of all oxides display decreasing oxide content with increasing abundance of SiO_2, with the exception of K_2O, which shows an opposite trend. This suggests that the rocks of the Lateral Lake Stock are trending compositionally toward a final granite differentiate. However the trend is not well-defined.

Trace Element Chemistry

Harker Variation Diagrams of the trace element content of the Lateral Lake Stock are shown in Figure 36. Lead, copper, zirconium, and strontium show considerable scatter of data, and definite trends are not evident. Lithium, zinc, cobalt, chromium, vanadium, and barium decrease with increasing silica content. Gallium shows no appreciable change. Berrylium content appears to increase with increasing abundance of SiO_2, although more data is needed to verify this trend. The data suggest that there was a general impoverishment of trace elements in the final differentiation stages of the Lateral Lake Stock.

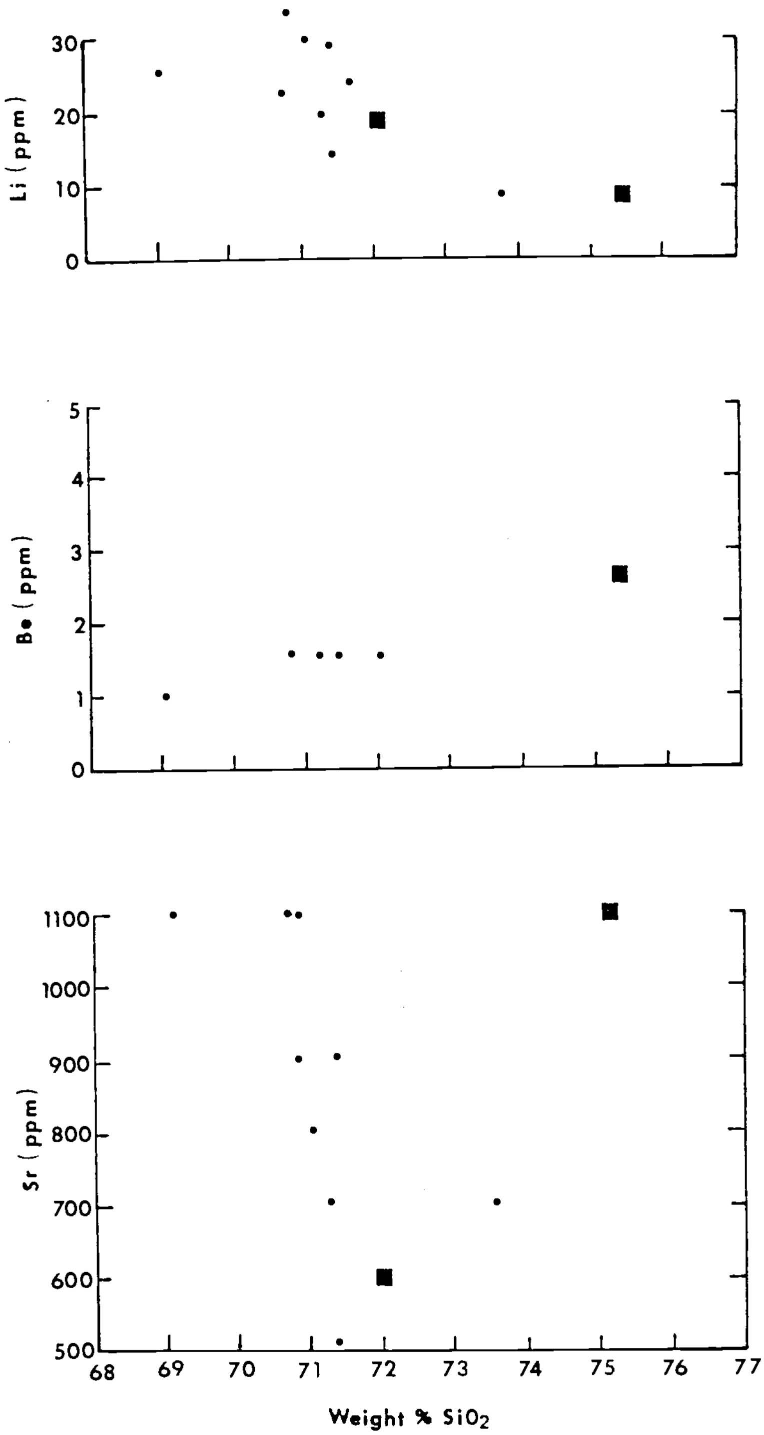


Figure 36. Intrusive rocks of the Lateral Lake Stock:
Harker Variation Diagrams of trace elements.
• granodiorite
■ aplite

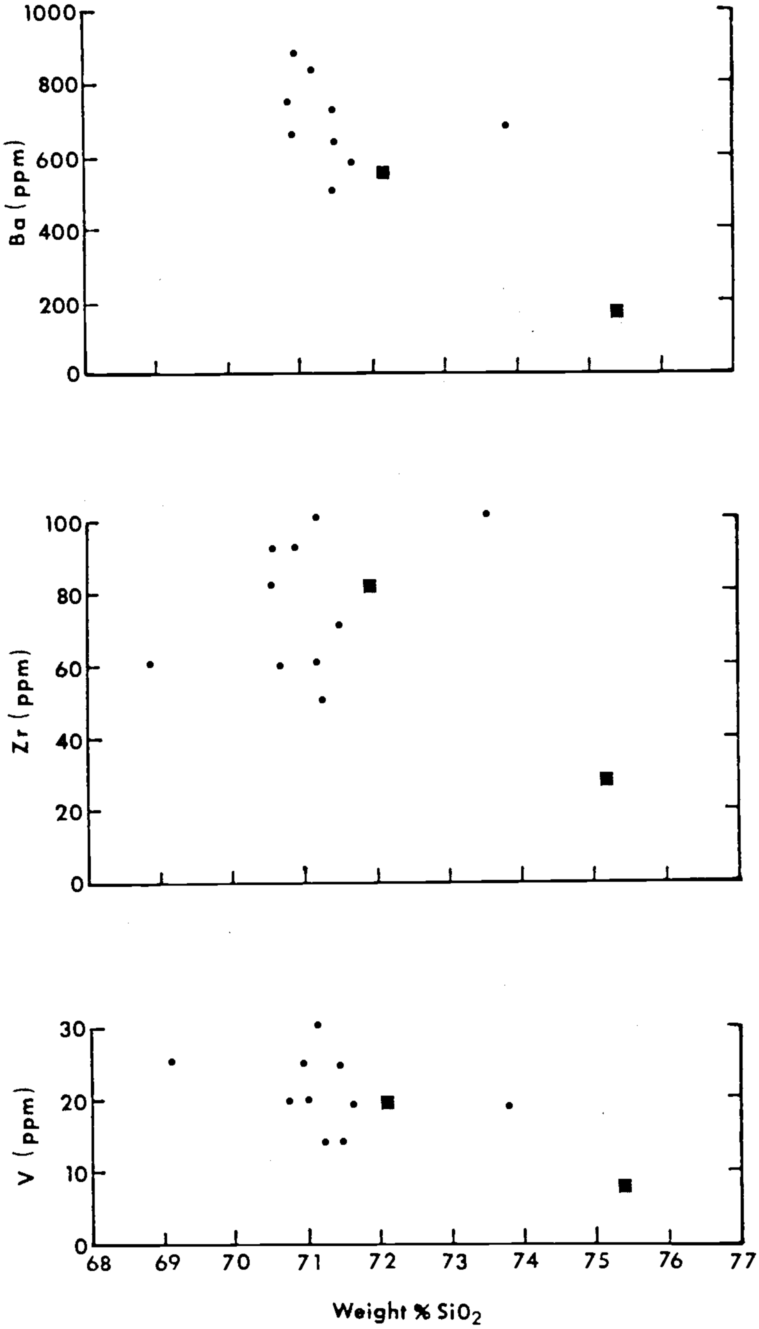


Figure 36. (continued).

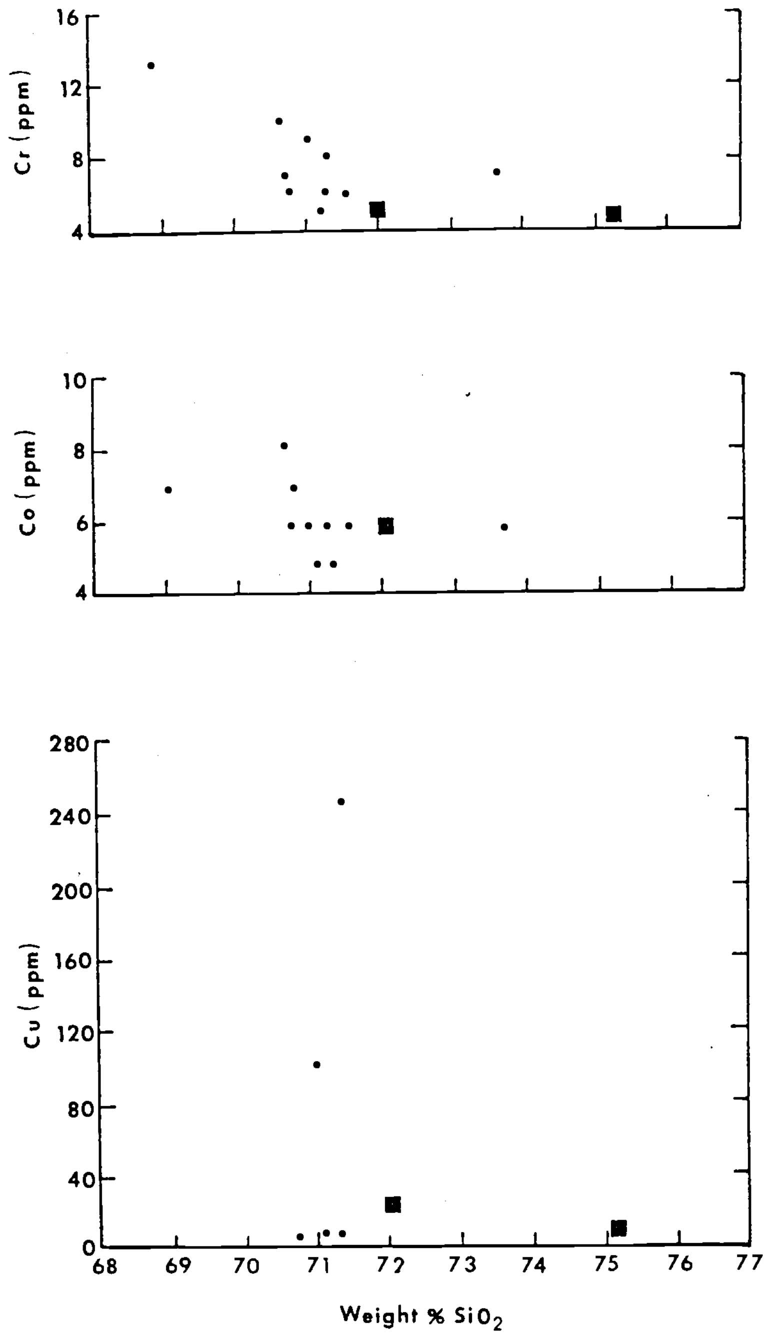


Figure 36. (continued).

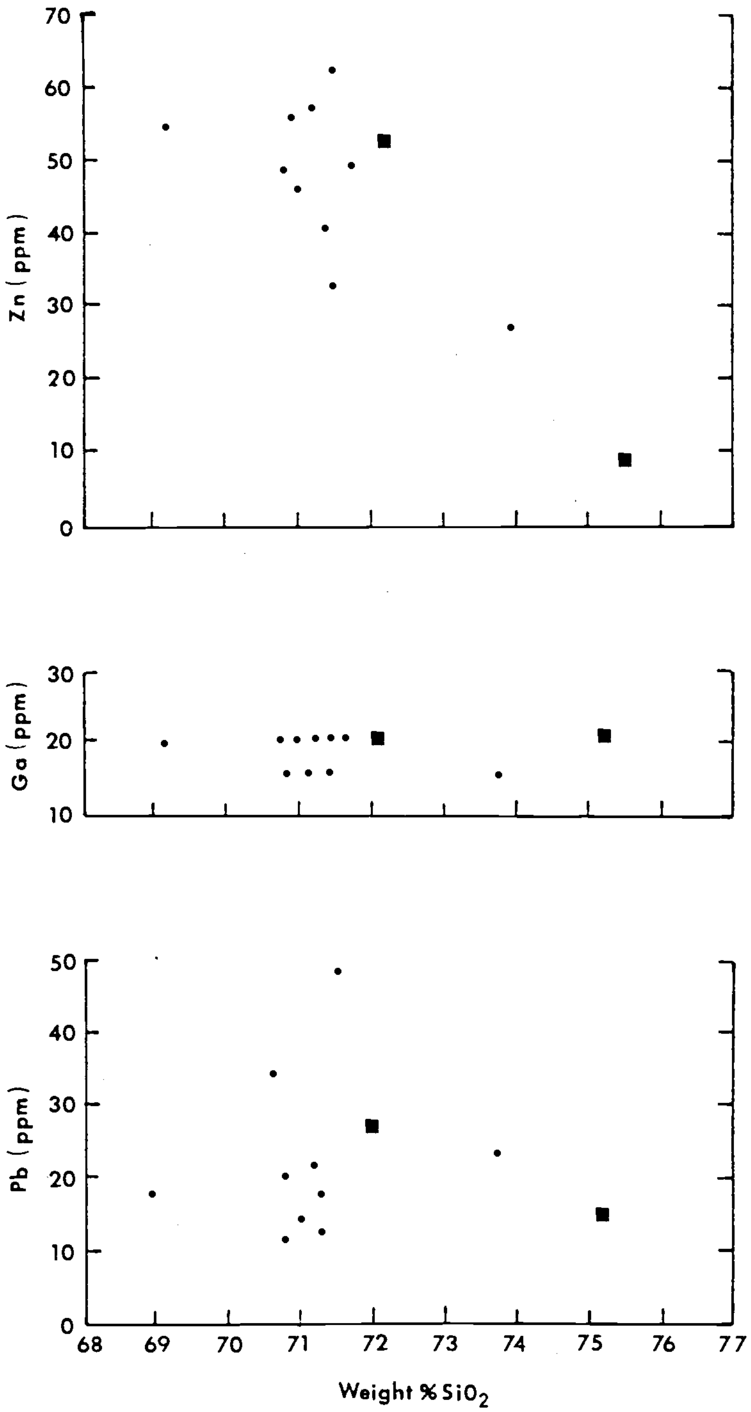


Figure 36. (continued).

STRUCTURAL GEOLOGY

The Lateral Lake Stock occupies the axial zone of an elongate east-northeast-trending antiformal structure in supracrustal rocks which dip away from the stock both to the north and south. According to Armstrong (1951. p. 16), "The Lateral (Lake) Stock has either caused or been injected into an anticlinal structure, which is superimposed on the flank of a larger southward-dipping structure." Structural data from Breaks and others (1976), however, do not necessarily confirm the presence of a dominant southward-dipping structure. The concordant nature of the contact of the stock and the conformability of the major structural trends between the stock and the adjacent metavolcanic rocks suggest that intrusion of the stock occurred during the formation of the regional antiformal structure, and may have been, in part, the cause of it. Two narrow units of impure quartzite within the metavolcanic rocks both north and south of the stock serve as excellent marker horizons. Their distribution in the area implies that doming of the supracrustal rocks by the stock may have been the dominant mechanism of emplacement. Determinations of stratigraphic sequence, based on cross bedding and graded bedding in the metagreywacke unit conformably overlying the metavolcanic rocks indicate that the supracrustal rocks are not overturned. This evidence supports the domal hypothesis. Distribution of attitudes of joints within the stock and the metavolcanic rocks is comparable to the models proposed by Balk (1937) and Price (1966) for granitic massifs and domal structures. The trend of the gneissosity in the stock is consistent with the model of the emplacement of immature diapir-like structures as proposed by Schwerdtner and others (1978). Development of gneissosity in the stock during the emplacement and cooling of the intrusion is inferred from this model.

The Lateral Lake Stock

The Lateral Lake Stock has a measureable gneissosity in most places. It varies from an indistinct foliation in the eastern part and in the axial zone of the stock, to a prominent gneissosity along the margin and in the western part of the stock (Fig. 30 and 31). The stock is characterized by a finely-banded to gneissic texture at its margins. Here, the gneissosity is parallel to the contact, and dips range from 45° to 60° away from the intrusion. Attitudes of gneissosity tend to become subhorizontal along the central axis of the stock. Although structural measurements are not abundant along this axis because of the paucity of outcrops, available attitudes indicate that the eastern two-thirds of the stock plunges east-northeast at angles which vary from 20° to 40°. This angle of plunge appears to become horizontal to the west along the central axis. In the western third of the stock, a few scattered structural measurements imply a westerly plunge of the antiformal axis of about 15°. The western contact of the stock underlies Gullwing Lake.

A poles-to-plane Schmidt equal area projection of 100 attitudes of gneissosity in the Lateral Lake Stock (Fig. 37a) clearly indicates the presence of an axial region trending at N. 75° E. However, the doubly-plunging nature of the stock is not evident because structural attitudes are lacking in the critical areas of the pluton. Attitudes of gneissosity in the stock are consistent with the imma-

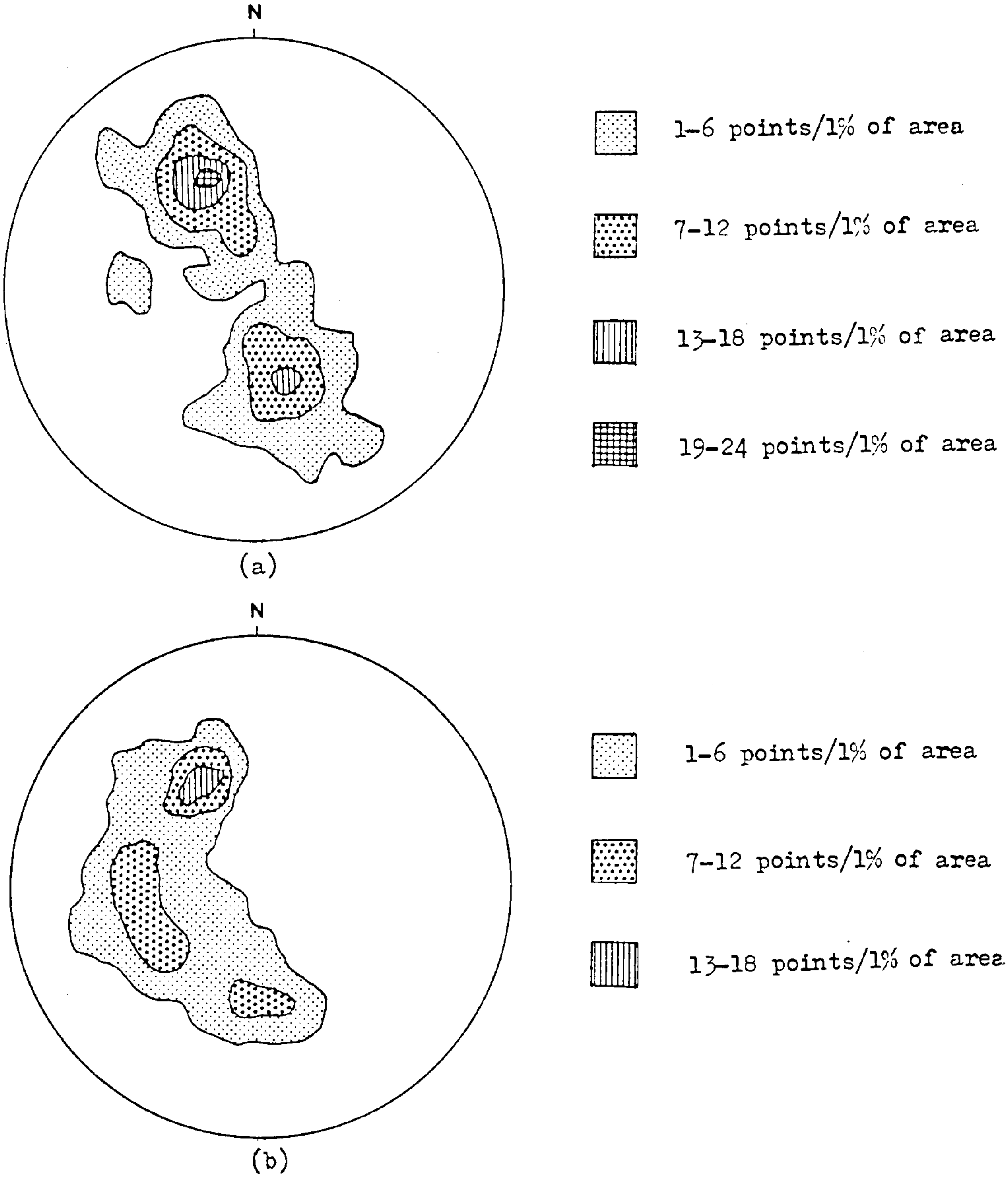


Figure 37. Poles-to-plane Schmidt equal area projections of:
(a) 100 attitudes of gneissosity in the Lateral Lake Stock; and
(b) 150 attitudes of foliation in the mafic metavolcanic rocks.

ture diapir model of Schwerdtner and others (1978). According to this model, the stock may represent the crestal region of an elongate, doubly-plunging, immature diarir-like intrusion. Structural attitudes measured along the central antiformal axis of the stock suggest that its vertical axis may be inclined 40° to 60° toward the west. This inference, however is based on very few structural measurements, and is not conclusive.

Metavolcanic Rocks

The mafic metavolcanic sequence is intruded by the Lateral Lake Stock in all exposed areas. The rocks usually have a measureable foliation, although it is difficult to detect in some of the finer-grained varieties. Measurements of foliation in the metavolcanic rocks adjacent to the stock are conformable with the gneissosity in the pluton, and with the intrusive contact. The foliation becomes progressively steeper with increasing distance from the contact of the stock. A poles-to-plane Schmidt equal area projection of 150 attitudes of foliation in the metavolcanic rocks (Fig. 37b) clearly reveals the conformability of structural attitudes between the metavolcanic sequence and the Lateral Lake Stock (Fig. 37a). An additional maximum is centered on the antiformal axis in the metavolcanic rocks. This feature may be attributed to the large number of attitudes of foliation determined from the metavolcanic sequence that lies over the nose of the antiformal structure east of the contact of the stock in Echo Township. Harding (1951) and Breaks and others (1976) have recorded attitudes of foliation in the metavolcanic rocks west of the assumed contact of the stock along the shore of Gullwing Lake. The foliation at that locality bends around the western termination of the stock in a manner comparable to that in the metavolcanic rocks east of the intrusion. This relationship lends additional support to the hypothesis that the Lateral Lake Stock is a doubly-terminating antiformal structure.

A large roof pendant of metavolcanic rocks is present within the stock between Gullwing and Tot Lakes in Webb Township. Structural attitudes within this raft are inconsistent with those in the surrounding host rocks. This suggests that the roof pendant was rotated after its separation from the country rock sequence during the intrusion of the stock.

Metasedimentary Rocks

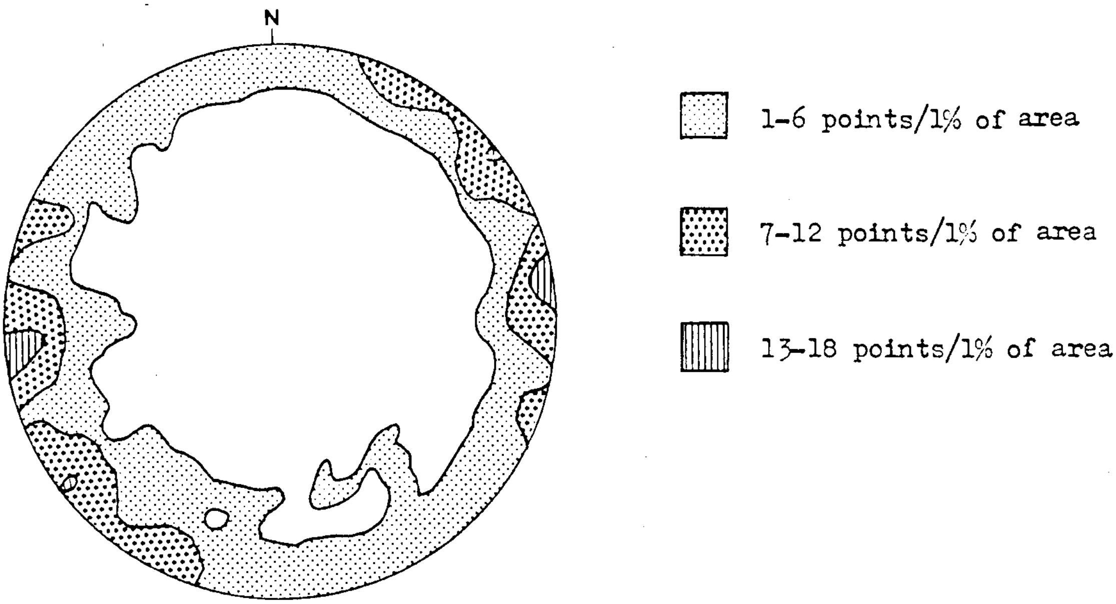
Two units of impure quartzite are interbedded with the mafic metavolcanic sequence. Although these units cannot be traced for great distances along strike, they crop out north, south, and east of the stock. They range from 3 to more than 30 m in thickness. The areal persistence of these units allows them to be used as stratigraphic marker horizons; thus, the metavolcanic rocks north and south of the stock are inferred to be correlative.

A metagreywacke unit, and locally, a metaconglomerate unit conformably overlie the metavolcanic rocks on the north and south boundaries of the map area. Crossbeds, which indicate bedding tops toward the north, were observed in the north-dipping metagreywacke unit north of the area. Armstrong (1951) observed south-facing bedding tops from graded bedding in the south-dipping metagreywacke unit on the west shore of Kathlyn Lake south of the area.

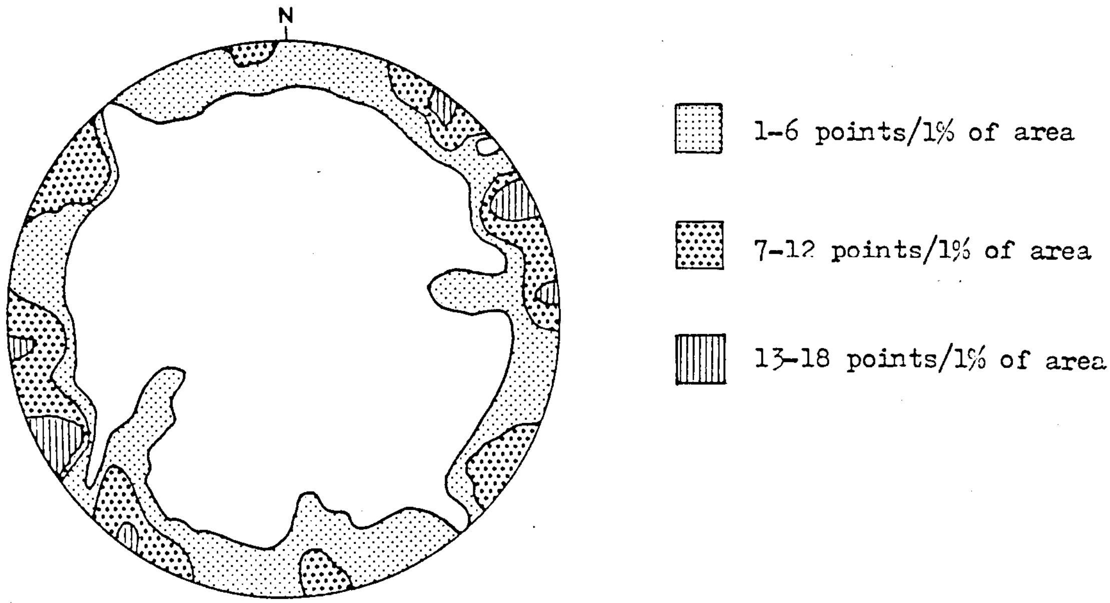
Joints

Four joint systems are present in the Lateral Lake Stock as shown in Figure 38a. Two major attitudes are evident that trend N. 35° W. and N. 5° W., and have steep to vertical dips. These attitudes are approximately perpendicular to the direction of the gneissosity in the stock. Although there is some variation in strike, these joints correspond to the "cross joints" defined by Balk (1937) which have been observed in granitic massifs and domal structures. These two major attitudes of joints are also dominant in the metavolcanic rocks (Fig. 38b). According to Balk (1937), cross joints are tear fractures of tension joints formed during the intrusion and partial consolidation of an igneous body. He states (p. 99): "This fan of cross joints (or tension joints) rarely terminates at the contact planes of any larger massif, but embraces portions of the adjacent wall rocks." Although the Lateral Lake Stock is not on the same scale as a massif, the similarity of attitudes of cross joints in both the stock and the metavolcanic country rocks indicates a common origin for the joints in both lithologies. The joint systems were apparently formed by the intrusion of the stock, and not by a period of subsequent deformation after its emplacement.

Two additional attitudes of joints were observed in the eastern part of the stock. They trend N. 60° E. and N. 80° E., and have steep to vertical dips. There is a good correlation of these attitudes with the joint systems in the metavolcanic sequence. This is reasonable as most of the measurements obtained from the metavolcanic rocks were from outcrops east of the eastern contact of



(a)



(b)

Figure 38. Poles-to-plane Schmidt equal area projections of:
(a) 162 attitudes of joints in the Lateral Lake Stock; and
(b) 40 attitudes of joints in the mafic metavolcanic rocks.

the stock in Echo Township. These two east-northeast-trending sets of joints are approximately parallel to the central antiformal axis and the gneissosity in the stock. They may be representative of the "longitudinal joints" described by Balk (1937). Although the origin of these longitudinal joints is uncertain, Price (1966, p. 158) suggests that:

> "...longitudinal joints tend to form later than the other primary fractures. It seems probable that these joints developed in response to tensile stresses generated by cooling of the igneous mass coupled with uplift and lateral stretching."

This system of joints, therefore, represents the final stages of the emplacement and cooling of the Lateral Lake Stock.

Faults

The only known fault in the area is exposed at the southern contact of the stock along the Dryden-Hudson road in Webb Township. The fault trends N. 25° W., and has a vertical dip. This direction is perpendicular to the contact of the stock, which is displaced 8.7 m in a left-lateral sense by the fault. This fault may represent movement along a prominent cross joint.

ECONOMIC GEOLOGY

Molybdenum mineralization related to the Lateral Lake Stock is associated with dikes and veins of pegmatite. Most of the molybdenite-bearing pegmatites are confined to the stock, although minor amounts of molybdenite are present in pegmatitic dikes and lenses within the metavolcanic sequence. Molybdenite occurs only in the microcline-bearing pegmatites. Pegmatites of this composition are present in all areas of the stock; however, they increase in size and abundance toward the eastern contact. An increase in the intensity of molybdenum mineralization parallels this trend. The mineralization is most intense where the pegmatites are intrusive into sills and dikes of aplite.

Pyrite and molybdenite are the major sulphides present at all occurrences. Accessory minerals include chalcopyrite, bismuthinite, native bismuth, pyrrhotite, tourmaline, fluorite, calcite, and magnetite. Ferrimolybdite occurs as an oxidation product of molybdenite at the surface exposures. Sulphide and alteration mineral zonations are not well defined with respect to the molybdenum deposits, and are primarily restricted to the wall rock adjacent to the vein systems.

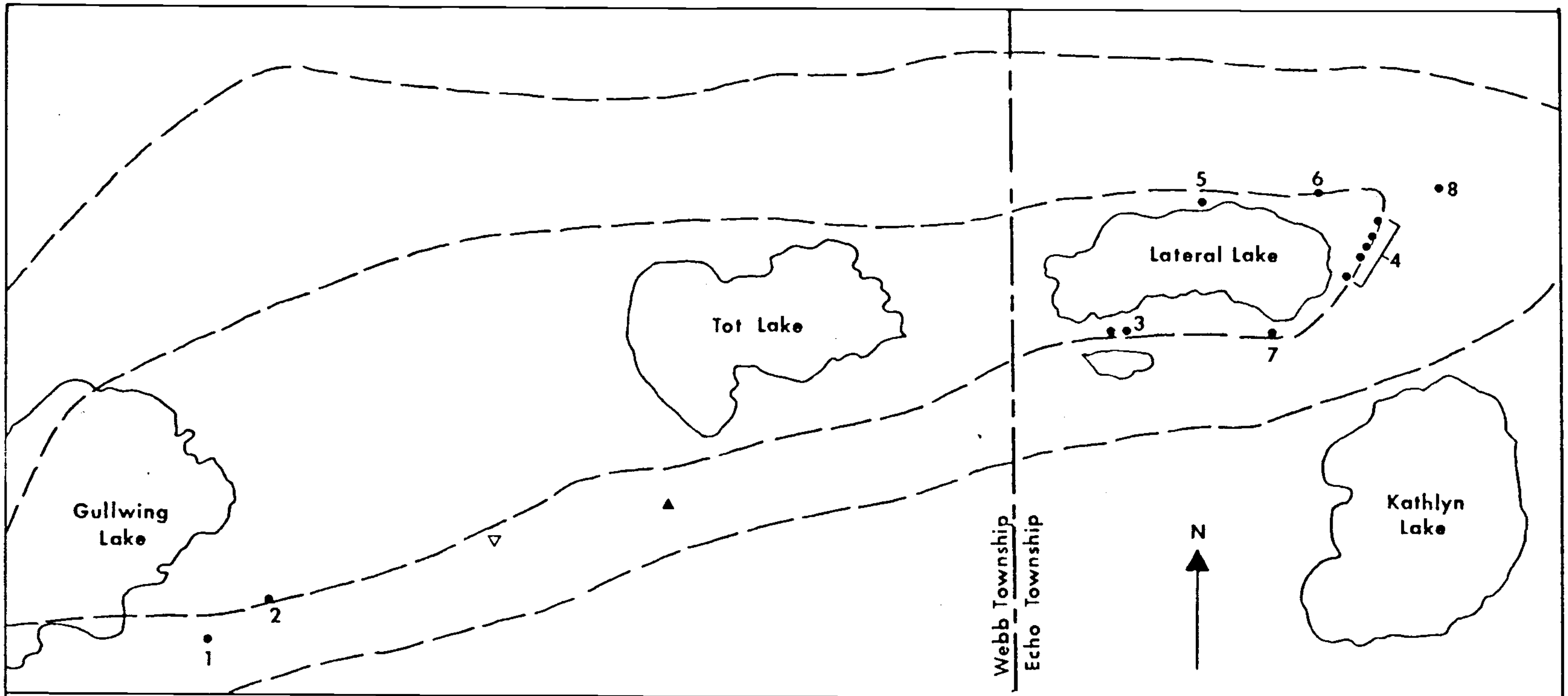
In addition to molybdenum, two other significant occurrences of metals are located within the Lateral Lake area. Lithium, cesium, and tantalum are present in a pegmatitic sill in the metavolcanic sequence south of the stock. Chalcopyrite occurs in a calcite vein in the metavolcanic rocks adjacent to the southern contact of the stock. Both occurrences are in Webb Township.

Coates Molybdenum Prospect

The Coates Molybdenum Prospect is located within the metavolcanic sequence approximately 400 m south of the southern contact of the Lateral Lake Stock in Webb Township (Fig. 39) The showing was originally discovered, and subsequently staked by Cosmo D. Coates of Dryden in 1906. Surface work was periodically performed on the claims until 1940.

The deposit consists of a large pegmatite which crosscuts and parallels the foliation in the metavolcanic sequence. The pegmatite is predominantly sill-like in structure (Fig. 40). It is exposed over a strike-length of 80 m, and varies from 0.3 to 2.0 m in width. The sill is transected by a late, irregular molybdenite-bearing pegmatite dike. Contacts of the pegmatites with the mafic metavolcanic sequence are sharp. The metavolcanic rocks adjacent to the pegmatites are irregularly chilled, and development of biotite-rich patches is common. Later quartz veins crosscut the pegmatites.

The pegmatites consist of quartz, microcline, and minor amounts of muscovite. Microcline is typically very coarse-grained, and may constitute 90 percent of the pegmatites over some widths. Molybdenite is present as coarse euhedral grains associated with microcline. Distribution of molybdenite is patchy, and overall molybdenite content of the pegmatites is a fraction of 1 percent. The highest concentration of molybdenite occurs in the eastern part of the sill.



• molybdenum ▽ copper ▲ lithium-cesium-tantalum

1. Coates Molybdenum Prospect
2. Western Webb Township Molybdenum Prospect
3. Moly Lake Molybdenum Prospect
4. Pidgeon Molybdenum Prospect
5. North Shore Prospect
6. & 7. Denison Mines Prospects
8. Molybdenum Occurrence in metavolcanic rocks
9. Kozowy-Leduchowski Prospect
10. Chalcopyrite Prospect

Figure 39. Lateral Lake Area: Location map of metal prospects.

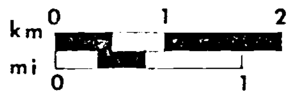


Figure 40. Outcrop of molybdenite-bearing sill of pegmatite at the Coates Molybdenum Prospect, Webb Township.

Figure 41. Outcrop of molybdenite-bearing dike of pegmatite at the Western Webb Township Prospect.

Western Webb Township Molybdenum Prospect

A large, northwest-trending, molybdenite-bearing pegmatite dike is exposed at the southern contact of the Lateral Lake Stock in Webb Township (Fig. 39). The dike extends from the stock into the adjacent metavolcanic rocks, and may be an infilling of a large cross joint associated with the intrusion of the stock (Fig. 41). The contact of the dike with the metavolcanic rocks is sharp, and chill effects were not observed. The dike varies from 3 to 10 m in width.

The pegmatite is very coarse-grained, and contains: quartz, 10 to 30 percent; microcline, 70 to 90 percent; muscovite, 5 percent; pyrite, <1 percent; and molybdenite, <1 percent. Distribution of molybdenite is patchy and irregular in the dike. Molybdenite is generally associated with microcline and muscovite.

Moly Lake Molybdenum Prospect

Molybdenite is present in pegmatites north of Moly Lake in Echo Township (Fig. 39). The pegmatites intrude the marginal zone of the Lateral Lake Stock at its southern contact with the metavolcanic rocks. Five diamond drill holes were completed on the property in 1958 by DeCoursey-Brewis Minerals Limited. Trenching was done on some of the outcrops; however, this has subsequently been obscured by vegetation.

Pink granodiorite is the dominant lithology of this part of the stock. Sills and veins of aplite are present, but they are not abundant. The sills vary from 5 to 10 cm in width, although some of them may be as wide as 1 m.

Quartz and quartz-microcline-pegmatite veins crosscut the aplite and granodiorite. Diamond drill hole sections reveal that both aplite and pegmatite are minor phases in this part of the stock. The quartz and quartz-microcline pegmatite veins are generally less than 40 cm wide, and the average width is between 3 and 10 cm. The widest veins contain the highest concentrations of molybdenite. There are four major attitudes of quartz and quartz-microcline pegmatite veins in this part of the stock:

1. east-striking and steeply dipping north;
2. north-northeast-striking and steeply dipping northwest;
3. south-southeast-striking and steeply dipping east; and
4. southeast-striking and steeply dipping northeast.

The first three sets of veins contain molybdenite. The set that strikes north-northeast contains the highest concentrations of the sulphide. Crosscutting relationships of the veins suggest that they are contemporaneous.

Molybdenite is present at the Moly Lake Prospect as:

1. fine-grained smears along selvages of the quartz and quartz-microcline pegmatite veins;
2. fine to coarse-grained crystals disseminated in the veins with or without associated microcline; and
3. fine grains disseminated in aplite and granodiorite adjacent to the veins.

In general, the highest concentrations of molybdenite coincide with the microcline-rich zones in the veins, although distributions are irregular and patchy. Molybdenite content of quartz and quartz-microcline pegmatite veins is usually much less than 1 percent. However, occasional short lengths of vein may contain up to 2 or

3 percent molybdenite. Density of the veins was difficult to determine because of the limited area of exposure. It was estimated, however, that the veins comprise up to 15 percent of the outcrop in areas of the highest grade of molybdenite. Diamond drill hole data reveal that only trace amounts of molybdenite were encountered in the drill core. Molybdenite which occurs in the drill core is invariably associated with quartz-microcline pegmatite veins.

Minor amounts of pyrite, chalcopyrite, magnetite, and fluorite were observed at the Moly Lake Prospect. Pyrite is present in subequal amounts to molybdenite, and occurs in a similar association. Trace amounts of chalcopyrite are associated with molybdenite and pyrite. Fluorite and epidote were observed in the quartz and quartz-microcline pegmatite veins.

Potassic alteration is present adjacent to the quartz and quartz-microcline pegmatite veins. Irregular patches of muscovite and microcline replace plagioclase feldspar. Secondary brown biotite replaces chlorite along cleavage planes, and forms rims around the latter mineral (Fig. 42). This secondary biotite is related to fractures which crosscut all other minerals in the rock. This suggests that this biotite is the result of a late-stage alteration event.

The area of the pluton near Moly Lake is unique in that chlorite is the dominant mafic mineral, and primary biotite is virtually absent. It is not conclusive, however, that this chloritic zone is directly related to the Moly Lake Prospect. The chlorite may be of deuteric origin, and not the result of a propylitic type of

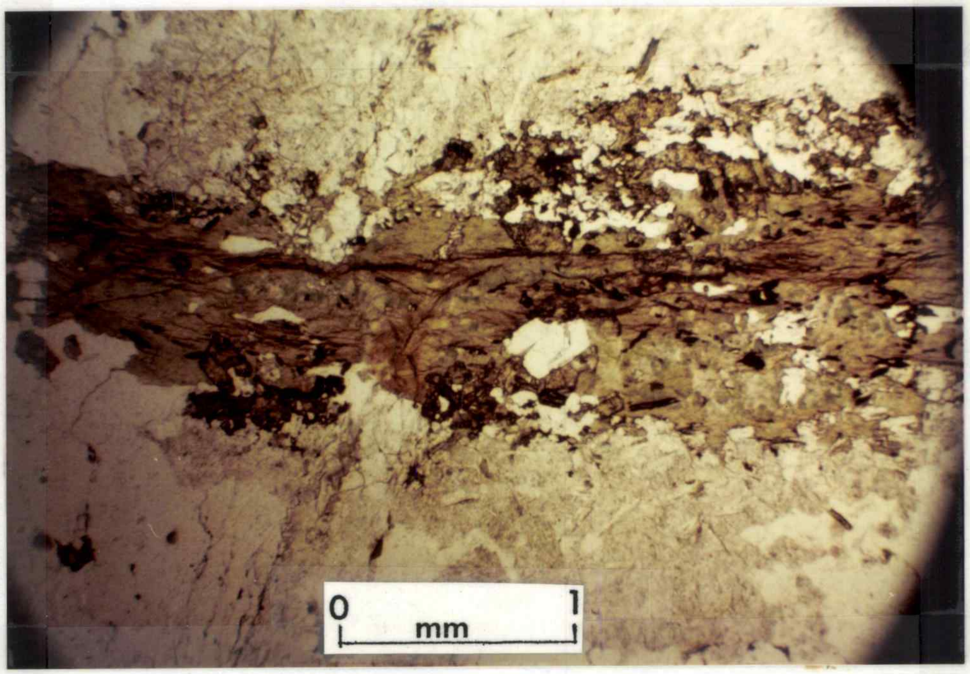


Figure 42. Photomicrograph of granodiorite near the Moly Lake Molybdenum Prospect showing secondary brown biotite replacing chlorite.

Figure 43. Outcrop showing the intersection of quartz and quartz-microcline pegmatite veins at the Pidgeon Molybdenum Prospect.

alteration event related to the Moly Lake molybdenite mineralization. Epidote commonly occupies late joint sets at this occurrence. However, this habit is common throughout the stock, and suggests that it is the result of a large-scale metasomatic process rather than a localized propylitic type of alteration.

Pidgeon Molybdenum Prospect

The Pidgeon Molybdenum Prospect consists of five exposures located along the east and southeast contact of the Lateral Lake Stock (Fig. 39). The two southernmost exposures have been the focus of most of the exploration and development of molybdenum associated with the stock. The showings were discovered by the Ontario Department of Mines field party of W.S. Armstrong in 1946, and were subsequently staked by G.L. Pidgeon of Wabigoon, Ontario. The property was optioned to Detta Minerals Limited in 1954, and two diamond drill holes, and an adit 35 m long were completed. In 1957, Pidgeon Molybdenum Mines Limited completed 2500 m of diamond drilling on the property. In 1965, an additional 3250 m was drilled by Rio Canadian Exploration Limited. At present, additional drilling is being undertaken on the property by the team of Rio Algom Limited and Dickenson Mines in an attempt to delineate the zones of molybdenite mineralization.

Aplite is the most abundant lithology which is exposed at the Pidgeon Prospect. It occurs as minor dikes, and as large peneconcordant sills which are interbanded with pink and minor grey granodiorite. The sills have slightly steeper dips to the southeast than the enclosing foliated granodiorites. Minor sills and dikes of grey aplite are present, but they are not extensive.

Mineralization

Aplite is the host rock for much of the molybdenite mineralization at the Pidgeon Prospect. The highest concentration of molybdenite occurs where quartz and quartz-microcline pegmatite veins crosscut pink aplite. These veins have two major attitudes:

1. north to northeast-striking with dips of 50° to 60° toward the northwest; and
2. east to east-northeast-striking with vertical to steep dips toward the northwest.

The latter set contains the highest concentrations of molybdenite. In addition, irregular networks of quartz and quartz-microcline pegmatite veins are present throughout the exposures. They form localized, en echelon sets and stockworks. The veins vary from a few mm to greater than 5 m in width. Observation of surface outcrops indicates that the quartz vein and quartz-microcline pegmatite vein systems are interconnected; thus they are contemporaneous, and are part of the same vein system (Fig. 43). Quartz and microcline are also present in small fractures in aplite and granodiorite. They are perpendicular to the major veins and emanate from them.

Molybdenite is present in variable concentrations in all quartz and quartz-microcline pegmatite veins. The mineralization is confined to a linear zone parallel to the contact of the Lateral Lake Stock. Diamond drill hole data indicate that this zone is on the order of 150 m wide. The data also suggest that molybdenite is concentrated into lenses along this zone, although minor amounts of the sulphide are invariably present along its entire strike-length. The known strike-length of the molybdenite mineralization is about 850 m. Molybdenite was not observed in the metavolcanic rocks adjacent to the stock at the Pidgeon Prospect.

Distribution of molybdenite is patchy and somewhat irregular, even in the higher-grade lenses. As a result, reliable grades of percent MoS_2 are difficult to determine. Early estimates (Thompson, 1953; Bartley, 1953; Holbrooke, 1953; Harper and Holbrooke, 1960; Hall, 1966) range from 0.57 to 0.95 percent MoS_2 with variable tonnages. The latest available figures (Northern Miner, March 6, 1980) indicate reserves of 15.8 million tons of 0.08 percent molybdenum. Diamond drill hole data suggest that grades of molybdenite within individual holes vary greatly throughout the length of the holes. In the molybdenite-bearing zones, grades may be as low as 0.003 percent MoS_2 or less along core lengths of 3 m or more. Conversely, concentrations of greater than 5 percent MoS_2 are encountered along core lengths of 2 m or more, and some half-meter sections run higher than 10 percent MoS_2. One sample of diamond drill core which contains a high concentration of molybdenite was analysed for other trace elements. The sample contained: Ag, 3.6 ppm; Au, 0.14 ppm; Pb, 30 ppm; Zn, 19 ppm; Bi, 45 ppm; Li, 13 ppm; Sb, <1 ppm; Cu, 0.101 percent; and Mo, 5.15 percent.

Molybdenite and pyrite are the major sulphide minerals present at the Pidgeon Prospect. Trace amounts of chalcopyrite, pyrrhotite, bismuthinite, and native bismuth are also associated with the more common sulphides. Magnetite occurs in minor amounts, and is most often associated with pyrite.

Molybdenite mineralization is directly related to the emplacement of the quartz and quartz-microcline pegmatite veins, although minor amounts of the sulphide are also present along late chloritic fractures in granodiorite. Molybdenite occurs in the following habits:

1. coarse-grained, euhedral plates associated with microcline and muscovite in quartz and quartz-microcline pegmatite veins, generally along vein selvages (Fig. 44);
2. fine to coarse grains disseminated and often parallel to the foliation in granodiorite adjacent to quartz and quartz-microcline pegmatite veins (Fig. 45);
3. fine to coarse grains disseminated in aplite adjacent to quartz and quartz-microcline pegmatite veins (Fig. 46);
4. disseminated bands, rosettes, and isolated flakes in aplite at a distance from known quartz and quartz-microcline pegmatite veins (Fig. 47);
5. rare disseminations in granodiorite at a distance from known quartz and quartz-microcline pegmatite veins (Fig. 48); and
6. very fine-grained smears on chlorite-bearing and epidote-bearing fractures in granodiorite (Fig. 49).

Distribution of molybdenite is controlled mainly by vein and fracture systems associated with the final stages of crystallization of the Lateral Lake Stock. Petrographic observation of molybdenite which is disseminated in aplite away from known veins reveals that the sulphide occurs along narrow fractures within the aplite (Fig. 50). Molybdenite which occurs in a similar habit in granodiorite is often in close proximity to chlorite and epidote-bearing fractures. These fractures may have been channelways by which the molybdenite was introduced into the granodiorite.

Molybdenite is generally associated with the potassium-bearing minerals, particularly microcline and muscovite. It is often rimmed

Figure 44. Hand specimens of quartz-microcline pegmatite veins with coarse-grained euhedral plates of molybdenite.

Figure 45. Diamond drill core specimens of granodiorite showing disseminated molybdenite adjacent to quartz and quartz-microcline pegmatite veins.

Figure 46. Diamond drill core specimens of aplite showing disseminated molybdenite adjacent to quartz and quartz-microcline pegmatite veins.

Figure 47. Hand specimen of aplite showing rosettes of molybdenite at a distance from known vein systems.

Figure 48. Diamond drill core specimens of granodiorite containing disseminated molybdenite at a distance from known vein systems.

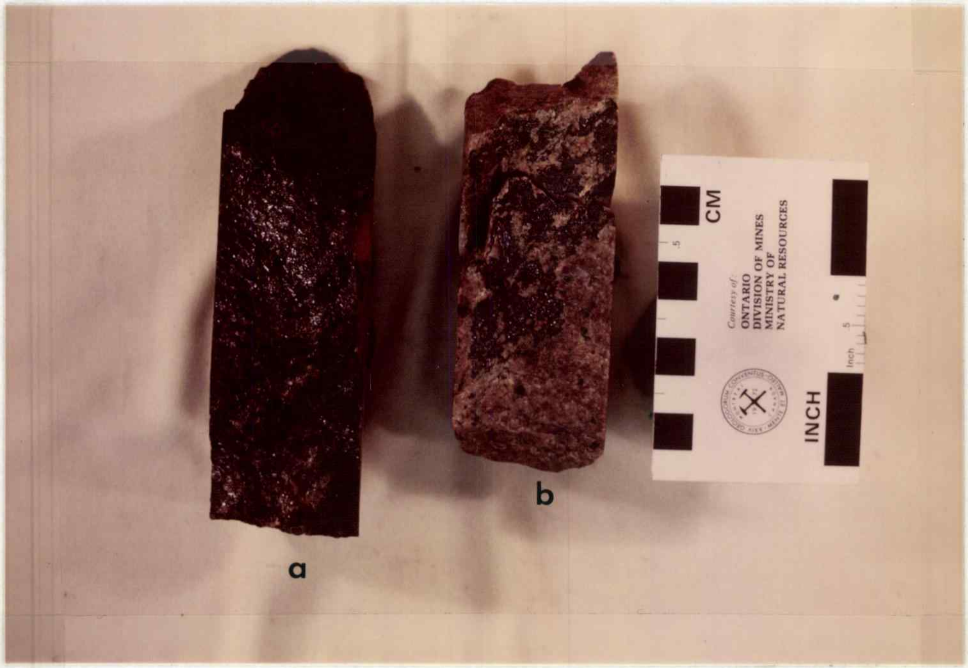


Figure 49. Diamond drill core specimens of granodiorite with very fine-grained molybdenite along: (a) chlorite-bearing fractures, and (b) epidote-bearing fractures.

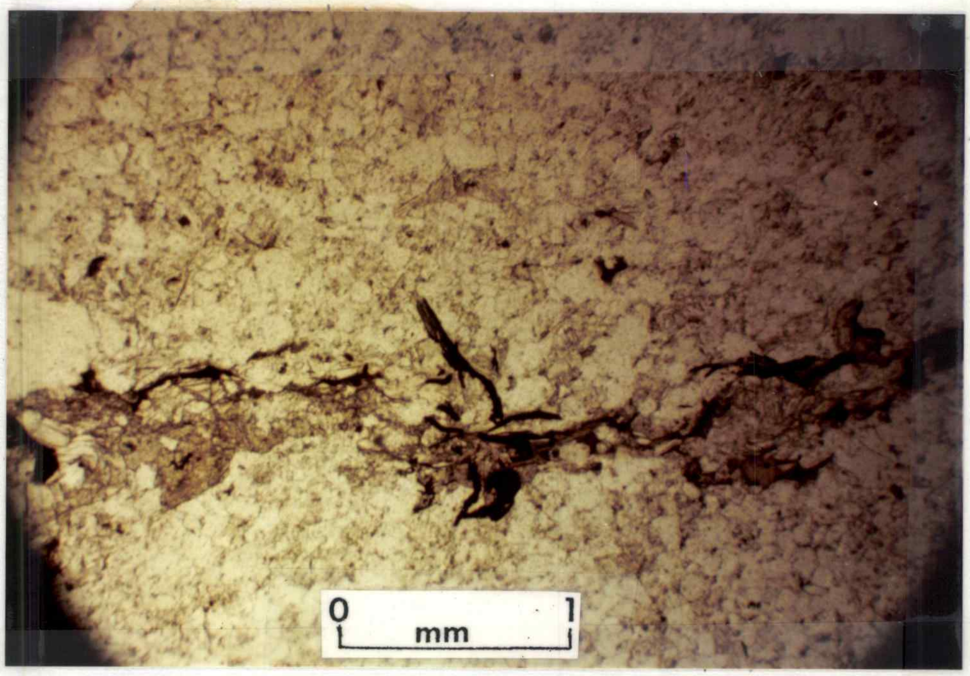


Figure 50. Photomicrograph of fine-grained molybdenite along narrow fractures in aplite.

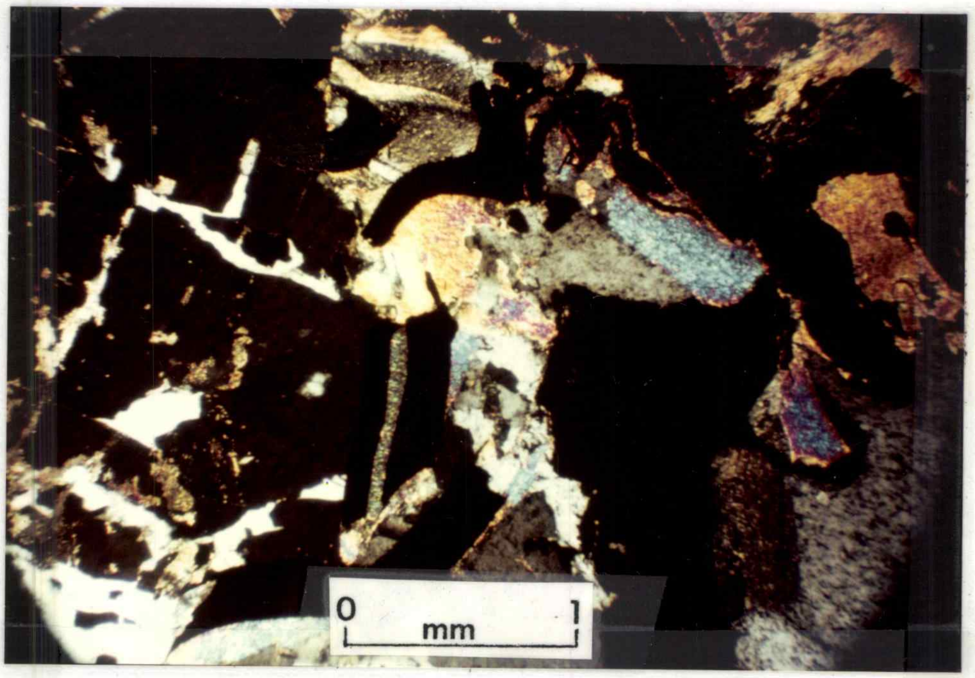


Figure 51. Photomicrograph of molybdenite (opaque) rimmed by muscovite.

by a greenish coloured muscovite of similar habit and grain size to the sulphide (Fig. 51). Grain size of molybdenite varies with its mineralogical association; however, it is always crystalline, and has subhedral to euhedral grain boundaries. Molybdenite rims pyrite grains, which suggests that it crystallized after the pyrite. Moreover, it is also present along fractures within individual pyrite grains. Chalcopyrite intergrowths with molybdenite are common, particularly along the cleavage planes of molybdenite (Fig. 52).

Pyrite is the most abundant sulphide at the Pidgeon Prospect. It is invariably present as disseminations throughout all of the igneous phases of this part of the Lateral Lake Stock. Although it may be present within any part of the veins, it typically occurs along the selvages of the quartz and quartz-microcline pegmatite veins and in the adjacent wall rock. Pyrite also occurs in narrow (<1 mm) biotite-bearing fractures in granodiorite.

Unlike molybdenite, pyrite has no apparent association with the potassium-bearing minerals in the veins and wall rocks. It is often rimmed by magnetite and epidote. This texture may show an outward sequence from a pyrite core with successive rims of magnetite, and then epidote and calcite. Pyrite is also rimmed by chalcopyrite and molybdenite. These two sulphides may also be present along fractures within the pyrite grains. Rounded inclusions of chalcopyrite and pyrrhotite were observed in the pyrite grains, which suggests that they are earlier than the pyrite.

Magnetite is disseminated in trace amounts throughout the Lateral Lake Stock; however, it is most abundant at the Pidgeon

Prospect. Distribution and mineralogical associations of the magnetite are similar to that of pyrite, and it is related to the vein systems. Magnetite rims on pyrite grains are common and indicate that magnetite crystallized later than the pyrite.

Chalcopyrite, pyrrhotite, bismuthinite, and native bismuth are present in trace amounts. Except for pyrrhotite, which has only been observed with the aid of a microscope, the grain size of these minerals is variable. Pyrrhotite, bismuthinite, and native bismuth were found only in the quartz and quartz-microcline pegmatite veins. Chalcopyrite is a common associate of pyrite, as well as molybdenite, and is also present in the pyrite-biotite fractures.

Large scale zoning of metals is not apparent at the Pidgeon Prospect. The zones of better mineralization are localized along the margin of the stock, and the molybdenite is primarily confined to the wall rocks which are immediately adjecent to the quartz and quartz-microcline pegmatite veins. Pyrite is more widely distributed than molybdenite, and is disseminated throughout this part of the Lateral Lake Stock. Distribution of chalcopyrite follows this trend. Pyrite and chalcopyrite are not disseminated in other parts of the stock, which suggests that these two sulphides are related to the quartz and quartz-microcline pegmatite vein systems. The extent of the pyrite mineralization in this part of the stock is poorly known because of the lack of exposures.

There appear to be three stages of molybdenite mineralization at the Pidgeon Prospect as indicated by crosscutting relationships observed in outcrop and in diamond drill core. The onset of mineralization began with the intrusion of the major quartz and quartz-

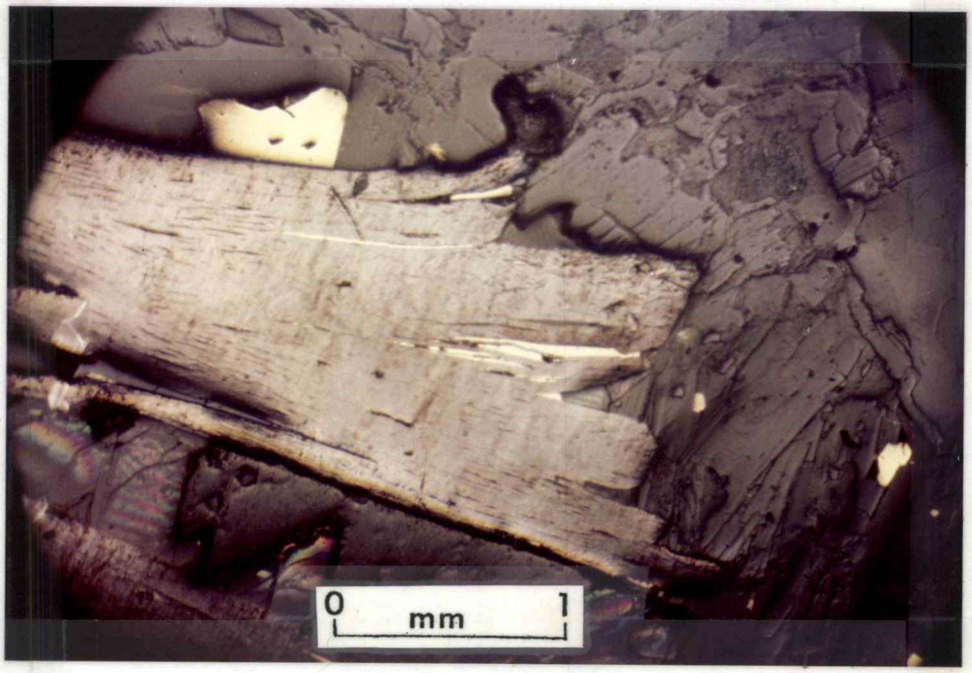


Figure 52. Photomicrograph of a polished thin section showing intergrowths of chalcopyrite and molybdenite.

microcline pegmatite veins. The bulk of the molybdenite was deposited at this time. Veins of quartz ± microcline transect the earlier quartz and quartz-microcline pegmatite veins. These later veins tend to be narrow (<1 cm), and contain only minor amounts of molybdenite. In the absence of clear crosscutting relationships, these later veins are indistinguishable from the earlier ones. The later veins are probably representative of the final stages of the major episode of sulphide deposition associated with the earlier quartz and quartz-microcline pegmatite veins. Minor amounts of molybdenite were deposited along chlorite and epidote-bearing fractures in granodiorite. These fractures crosscut the quartz and quartz-microcline pegmatite veins. Chlorite and epidote tend be exclusive of each other in these fracture systems. However, both occasionally occur together along the same fractures, which suggests that these fracture systems are essentially contemporaneous. The molybdenite is very fine-grained, and is present as smears along these fractures. The final stage of molybdenite deposition consists of narrow (<1 mm), irregular calcite, ± fluorite, ± muscovite, ± molybdenite veinlets or bands in aplite. Megascopically, the molybdenite contained in these veinlets appears to be disseminated within the aplite. These veinlets transect all other structures in the rocks, and they contain insignificant concentrations of molybdenite.

Alteration

Potassic metasomatism has occurred throughout the Lateral Lake Stock, but it has attained its highest intensity at the Pidgeon Prospect. Metasomatism is extensive here, and for this reason, it is referred to as hydrothermal alteration. The effects of alteration are restricted, for the most part, to the wall rocks immediately adjecent to the vein systems. The extent of the alteration is variable, and depends on the size and mineralogy of the veins. In addition, phyllic and propylitic types of alteration are also found at the Pidgeon Prospect.

Potassic alteration is dominant adjacent to the veins of quartz and quartz-microcline pegmatite, particularly where the veins contain a high content of microcline. There appear to be three mineralogical associations in this type of alteration:

1. microcline + muscovite;
2. microcline + muscovite + biotite; and
3. biotite ± muscovite.

Minor amounts of calcite, tourmaline, chlorite, and epidote are associated with these minerals. An envelope of microcline and muscovite is commonly present adjacent to the quartz and quartz-microcline pegmatite veins (Fig. 53). These minerals readily replace plagioclase feldspar in the granodiorite. There is often a gradual decrease in the content and grain size of microcline away from the veins. Contacts of the veins with the aplites tend to be gradational. Muscovite is present in this zone, both as fine grains which replace plagioclase feldspar, and as large euhedral plates often intergrown with molybdenite. This type of alteration is intimately associated with the bulk of the molybdenite mineralization.

Selvages of the quartz and quartz-microcline pegmatite veins often contain medium to coarse-grained dark green biotite (Fig. 54). This biotite is also present along fractures which extend from the

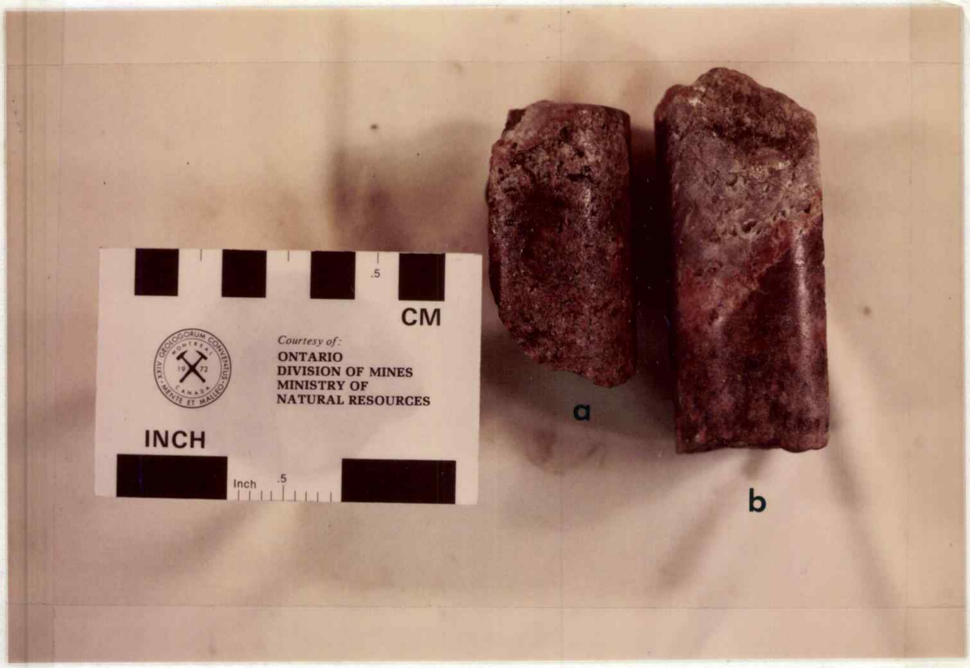


Figure 53. Diamond drill core specimens of quartz-microcline pegmatite veins showing: (a) sucessive envelopes of potassic and phyllic alteration adjacent to vein, and (b) envelope of potassic alteration adjacent to vein.

Figure 54. Diamond drill core specimens of granodiorite with coarse-grained dark green biotite along selvages of quartz-microcline pegmatite veins.

veins into the wall rock. Biotite and pyrite, with minor amounts of muscovite and chalcopyrite, were observed along fractures in granodiorite. The relationship of these fractures to the quartz and quartz-microcline pegmatite veins is unknown.

Phyllic alteration related to the quartz and quartz-microcline pegmatite veins is gradational with the potassic zone of alteration. Phyllic alteration is characterized by:

1. medium to coarse-grained green muscovite disseminated in the wall rock adjacent to the veins; and by
2. fine-grained white muscovite replacing plagioclase feldspar in the wall rock adjacent to the veins.

The first association is most common where aplite is the host, whereas the second association is present mainly in granodiorite. The phyllic zone of alteration may be separated from the veins by a zone of potassic alteration, particularly where the veins are rich in microcline. Thus, there is a zonation of alteration assemblages, on a small scale, adjacent to some of the veins (Fig. 53). Where molybdenite is present, the sulphide is usually intimately intergrown with medium to coarse-grained flakes of muscovite.

Alteration of the propylitic type is present, but it is not extensive. Chlorite and epidote are localized along late fractures which transect the quartz and quartz-microcline pegmatite veins. Minor amounts of calcite and fluorite may be present along these fractures. Fine-grained molybdenite is occasionally associated with chlorite and epidote in this locale. Granodiorite adjacent to the fractures is often pinkish-red in colour, suggestive of iron enrichment associated with these fractures. The micas in the granodiorites have been chloritized. Granodiorite and aplite that contain abundant chlorite and epidote-bearing fractures are most common at depth in the diamond drill holes. This relationship suggests that there is a zonation to the various types of alteration. The potassic type of alteration is dominant near the surface, and the propylitic type of alteration is best-developed at depth. However, both types may be present at any point along the diamond drill core. Chlorite and epidote-bearing fractures crosscut the potassic assemblages of alteration, which indicates that the phase of propylitic alteration is later than the potassic alteration event. Thus, there appears to be a temporal as well as a spatial zonation of alteration assemblages.

Calcite and fluorite occur in late hairline fractures in aplite and granodiorite. These fractures crosscut all of the other veins and fractures in the rock, and they represent the final stages of mineralization and alteration. Calcite is also present, however, in areas of potassic alteration, and it is inferred that the crystallization of calcite occurred throughout the period of molybdenite mineralization.

Minor Molybdenum Prospects of Echo Township

Molybdenite is present in an exposure along the north shore of Lateral Lake, and has been encountered in diamond drill core from the northeast and southeast margins of the stock (Fig. 39). Diamond drilling was completed in the latter two areas by Denison Mines Limited during the summer of 1962. In addition, molybdenite was observed in a few lenses and dikes of pegmatite within the metavolcanic sequence east of the Lateral Lake Stock (Fig. 39).

At the exposure along the north shore of Lateral Lake, molybdenite occurs along the selvages of a pegmatite vein and in the the adjacent granodiorite. The vein is about 2 cm wide, and consists of: quartz, 80 percent; microcline, 15 percent; epidote, 3 to 5 percent; molybdenite, 1 percent; and magnetite, 1 percent. The magnetite in the vein is coarser-grained than magnetite in the stock. It has a similar mineralogical association as the molybdenite, which suggests a common origin for the two minerals. Molybdenite mineralization at this prospect is not extensive.

Traces of molybdenite are present in the diamond drill sections from the northeast and southeast margins of the stock. The style of mineralization is similar in both areas, although the southeast section appears to contain a slightly greater abundance of molybdenite. In both areas, the highest concentrations of molybdenite are contained within veins of pegmatite. However, the pegmatites are not abundant, and are not present in all of the diamond drill holes. Molybdenite is also disseminated in sills and veins of aplite which intrude both the metavolcanic sequence and the granodiorite of the stock. Aplitic phases are most abundant in the southeast where they comprise up to 40 percent of the main intrusive mass. Molybdenite is also found adjacent to quartz veins and stringers in the aplite and granodiorite. However, in both areas, molybdenite mineralization is not extensive.

Molybdenite was observed in a few pegmatitic lenses and dikes within the metavolcanic rocks east of the Lateral Lake Stock. The best exposure is located 0.5 km east of the contact of the stock. Here, the molybdenite is found along the selvages of an east-northeast-trending pegmatite which intrudes the mafic metavolcanic sequence. The sulphide is associated with a zone of intense sericitization adjacent to the metavolcanic contact. Distribution of molybdenite is irregular, and is not extensive.

Kozowy-Leduchowski Lithium-Cesium-Tantalum Prospect

The pegmatite at the Kozowy-Leduchowski Prospect is located 0.7 km south of the southern contact of the Lateral Lake Stock in Webb Township (Fig. 39). Four diamond drill holes, totalling 223 m, were completed on the prospect by Canol Metal in August of 1964. Three additional holes, totalling 156 m, were drilled by Tantalum Mining Corporation in the winter of 1978-1979, in an attempt to outline the extent of the pegmatite.

The pegmatite is a sill-like body, approximately 250 m long, and up to 6 m thick. The width of the sill is unknown. The mineralogy of the sill characterizes it as a complex pegmatite. Very coarse-grained quartz, plagioclase feldspar, spodumene, and muscovite are the dominant minerals in the rock (Fig. 55). They are accompanied by minor amounts of lepidolite, tourmaline. Tourmaline is often present along the contact of the sill with the metavolcanic rocks. Other zonations of minerals within the pegmatite are not well-defined. Aplitic phases are commonly found near the margins of the sill, particularly where it pinches out into the metavolcanic rocks.

Figure 55. Hand specimens of (a) pegmatite, and (b) aplite from the Kozowy-Leduchowski Lithium-Cesium-Tantalum Prospect.

Chalcopyrite Prospect

A chalcopyrite-bearing calcite vein occurs in the mafic metavolcanic sequence at the southern contact of the stock beside the Dryden-Hudson road in Webb Township (Fig. 39). The vein is less than 0.5 m wide, and trends south-southeast. It has a vertical dip. The vein contains 1 to 2 percent chalcopyrite plus minor bornite. Stains of malachite are present on the surface of the outcrop.

TECTONIC SETTING

Discussion concerning the formation of the early Archean crust is generally divided into two schools of thought. The first advocates that the original crust was simatic in composition (Glikson and Lambert, 1976; and Glikson, 1978), while the second school states that the crust was originally sialic (Goodwin, 1977, Baragar and McGlynn, 1978; and Young, 1978).

Based on studies of Archean rocks in Western Australia, Glikson and Lambert (1976) have determined the existence of two cycles of greenstone or volcanic supracrustal belt development. According to this model, a lower cycle of volcanic supracrustal rocks was deposited on a newly-formed simatic crust. The period of volcanism that created this lower cycle was the result of diapiric uprise of molten mantle material, which was initiated either by meteoric impact, or by processes inherent within the mantle itself. These zones of volcanism assumed the form of elongate linear troughs. Subsequent downbuckling and remelting of this early extrusive material eventually resulted in the formation of large soda-rich, granitic batholithic complexes. A later, upper cycle of volcanic supracrustal rocks was deposited in linear troughs separated by large areas of the soda-rich batholithic rocks. Formation of rift zones in the batholithic areas may have resulted in the onset of this later cycle of volcanism. A period or regional metamorphism of the supracrustal rocks, accompanied by the emplacement of potassium-rich, granitic stocks and batholiths occurred at the end of this later cycle. This period of regional metamorphism is part of the Kenoran Orogeny in the Superior Province of the Canadian Shield, which is dated at 2.480 b.y.

The lower or earlier cycle of supracrustal deposition has not been fully recognized in the Superior Province, although Ermanovics (1974, in Glikson and Lambert, 1976) reported the existence of mafic and ultramafic enclaves in quartz diorite from eastern Manitoba. These may be representative of an older cycle of supracrustal deposition. According to Bell (1971), this part of the Superior Province was uplifted relative to the eastern part of the province; thus, older, deeper-level rocks are exposed here. For the most part, however, the supracrustal belts of the Superior Province correspond to the upper cycle of volcanic activity as proposed by Glikson and Lambert (1976). Structural and temporal relationships of these supracrustal rocks to the older soda-rich granitic rocks have led to the hypothesis that the original crust in the Superior Province was sialic in composition (Goodwin, 1977; Baragar and McGlynn, 1978; and Young, 1978).

Convection of mantle material played an important role in the formation of the Archean crust. According to Young (1978) development of the volcanic supracrustal belts occurred in areas of thermal upwelling. The convection currents descended below the sialic crust, causing compression, downbuckling, and accumulation of sedimentary material in these areas. As the intensity of mantle convection decreased, the supracrustal belts underwent subsidence and subsequent regional metamorphism, partial melting, and granitic plutonism, which is referred to in the Superior Province as the Kenoran Orogeny. According to this model, the small scale convection system was eventually replaced by a system of large-scale mantle convection similar to that prevalent today.

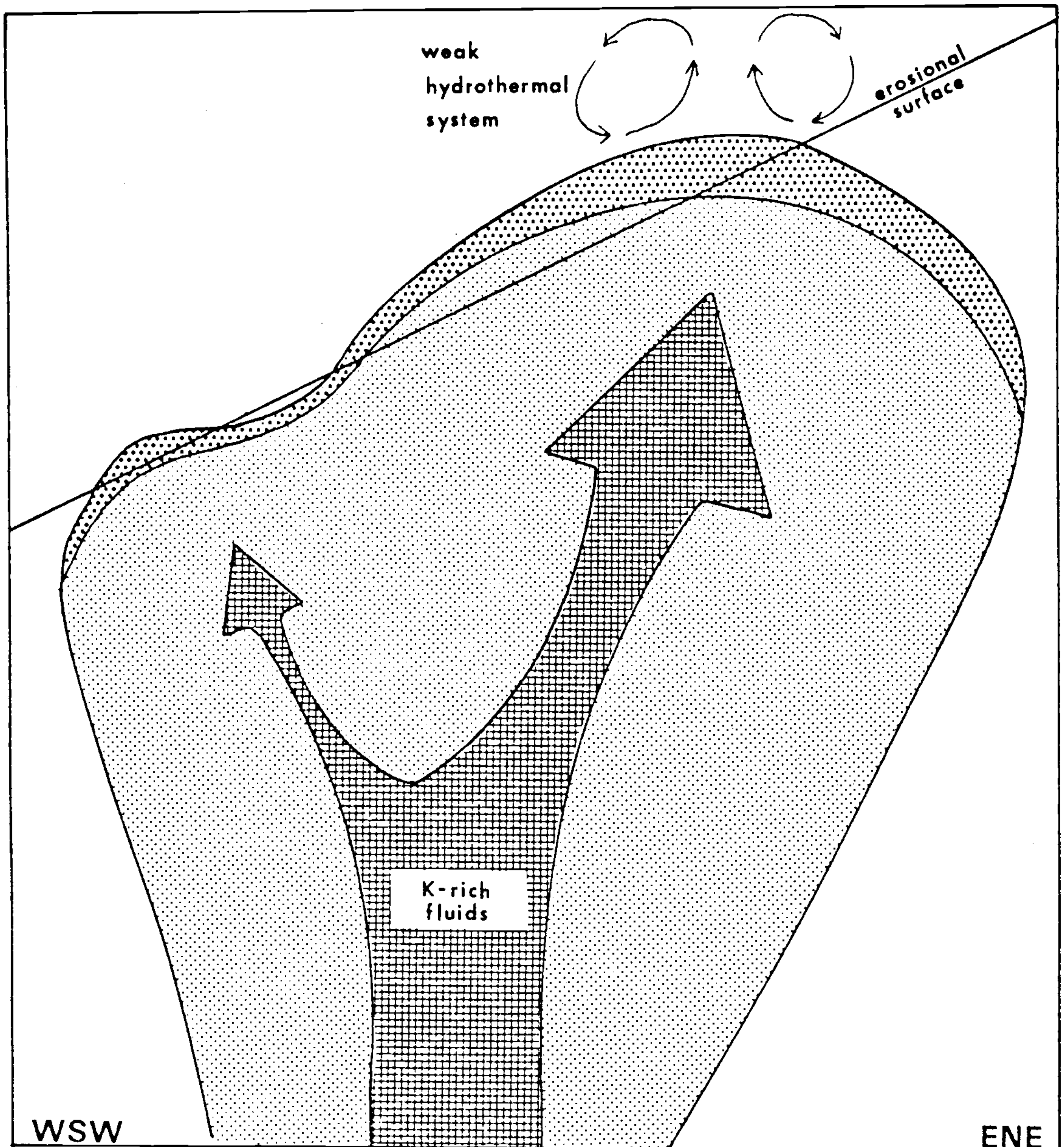
The distribution, size, and shape of the supracrustal belts in the Superior Province supports the hypothesis of a small-scale convection system. The belts of supracrustal rocks underwent the same event of regional metamorphism, which indicates that they may have formed contemporaneously from a system of equally-spaced convection cells. Goodwin (1968) has suggested that the ages of the supracrustal belts decrease in a southeastward direction. This concept implies the existence of a system of convection currents which were progressively migrating in this same direction beneath the sialic crust. Both models advocate the existence of small-scale convection systems for the formation of the supracrustal belts. Concepts of modern plate tectonics are difficult to apply to the Archean Era as there is no conclusive evidence of extensive lateral movement of the plates during Archean time.

The Lateral Lake Stock is part of the suite of late potassic granitic stocks which were emplaced in the supracrustal rocks during the Kenoran Orogeny. The chemistry of the stock is unique in that it contains an unusually high content of sodium. The pluton is located adjacent to the batholithic terrain of the English River Subprovince, and some of the sodium in the Lateral Lake Stock may have been derived from partial melting of these older granitic rocks. However, spatial and temporal relationships of the stock with the supracrustal rocks indicate that the pluton has a strong affinity to the late potassic granitic intrusions which are characteristic of the Kenoran Orogeny.

SUMMARY AND CONCLUSIONS

The Lateral Lake Stock is an elongate, diapiric, granodioritic pluton that intrudes a series of mafic metavolcanic rocks of the amphibolite grade of regional metamorphism. Structural, textural, and contact relationships between the two lithologies indicate that the stock was emplaced at depth during a regional metamorphic event which was part of the Kenoran Orogeny. These relationships are consistent with those described by Buddington (1959) for plutons of the catazone. Minimum temperature and pressure for this zone are 450°C and 2 kb, respectively (Turner, 1968). Depth of emplacement is difficult to determine because of the probable existence of higher geothermal gradients in the thin Archean crust (Fyfe, 1974). These higher gradients would place this regional metamorphic environment at a higher level in the Archean crust than would be expected during similar events in post-Precambrian time.

The stock has a relatively uniform composition. Granodiorite is the dominant lithology, although tonalite and quartz monzonite are present locally. Aplitic and pegmatitic phases are common, and are most abundant at the margins and toward the eastern part of the stock. With the exception of the complex pegmatite at the Kozowy-Leduchowski Prospect in Webb Township, all other pegmatites are mineralogically simple, and consist of variable amounts of quartz, plagioclase feldspar, microcline, and muscovite. Microcline-rich pegmatites are most abundant and best-developed where they intrude sills of aplite. Contact relationships between the two lithologies suggest that the pegmatites were metasomatically derived, in part, from the aplites. Microcline-rich pegmatites are intimately associated with zones of potassic metasomatism in the stock. Textural relationships in the stock suggest that the period of potassic metasomatism overlapped with the final stages of regional metamorphism and recrystallization of the pluton. Evidence of potassic metasomatism is present, to some extent, throughout the stock. However, there are two zones where it is more intense than elsewhere in the pluton. The first zone consists of two large microcline-rich pegmatites (Coates Prospect and the Western Webb Township Prospect) which are present along the southern contact of the stock in Webb Township. In addition, metasomatically derived porphyroblasts of microcline were observed nearby, which indicates that metasomatism continued after emplacement and recrystallization of the stock in this area. Potassic metasomatism is most intensely developed at the Pidgeon Prospect, where it is considered to be the major type of alteration associated with the molybdenite mineralization. The existence of these two separate zones of relatively well-developed potassic metasomatism suggests that the upper surface of the stock was somewhat irregular. Both areas of strong metasomatism represent the upper parts or cupolas of the stock as shown in Figure 56. The zone of intense potassic metasomatism at the Pidgeon Prospect is at a higher crustal level than the zone in Webb Township, as inferred from the presence of garnets in the microcline-rich pegmatites in the latter area. The presence of a large roof pendant of mafic metavolcanic rocks within the stock in Webb Township further supports this model, because it represents a topographic low between the two upper



Metavolcanic and metasedimentary rocks

Aplites, pegmatites, and granodiorite

Granodiorite

Figure 56. Hypothetical cross section of the Lateral Lake Stock.

potassium-rich levels of the pluton.

The highest concentrations of molybdenite are spatially and temporally related to the intensity of potassic metasomatism. Most of the molybdenite mineralization is related to quartz and quartz-microcline pegmatite veins and dikes which intrude aplite and granodiorite. At the Pidgeon Prospect, minor amounts of molybdenite occur along chlorite and epidote-bearing fractures, and along calcite-bearing fractures. Pyrite is the other major sulphide present in abundance with the occurrences of molybdenite. Minor amounts of pyrrhotite, chalcopyrite, bismuthinite, and native bismuth are associated with the more abundant sulphides.

Spatial zonation of sulphides is not pronounced, and with the exception of pyrite and chalcopyrite, they are restricted, for the most part to the wall rock adjacent to the veins. Pyrite is disseminated throughout the stock in the mineralized areas. Distributions of chalcopyrite tend to follow that of pyrite.

Textural relationships indicate that the sulphides are temporally zoned to some extent, although there is considerable overlap of the depositional intervals (Fig. 57). Minor amounts of chalcopyrite and pyrrhotite preceded pyrite mineralization. Deposition of pyrite is overlapped in the later stages by the crystallization of molybdenite and late chalcopyrite. Magnetite is generally later than pyrite, but appears to be contemporaneous with molybdenite. At the Pidgeon Prospect, three depositional stages of molybdenite are recognized. In order of decreasing age they are:

1. quartz and quartz-microcline pegmatite veins;

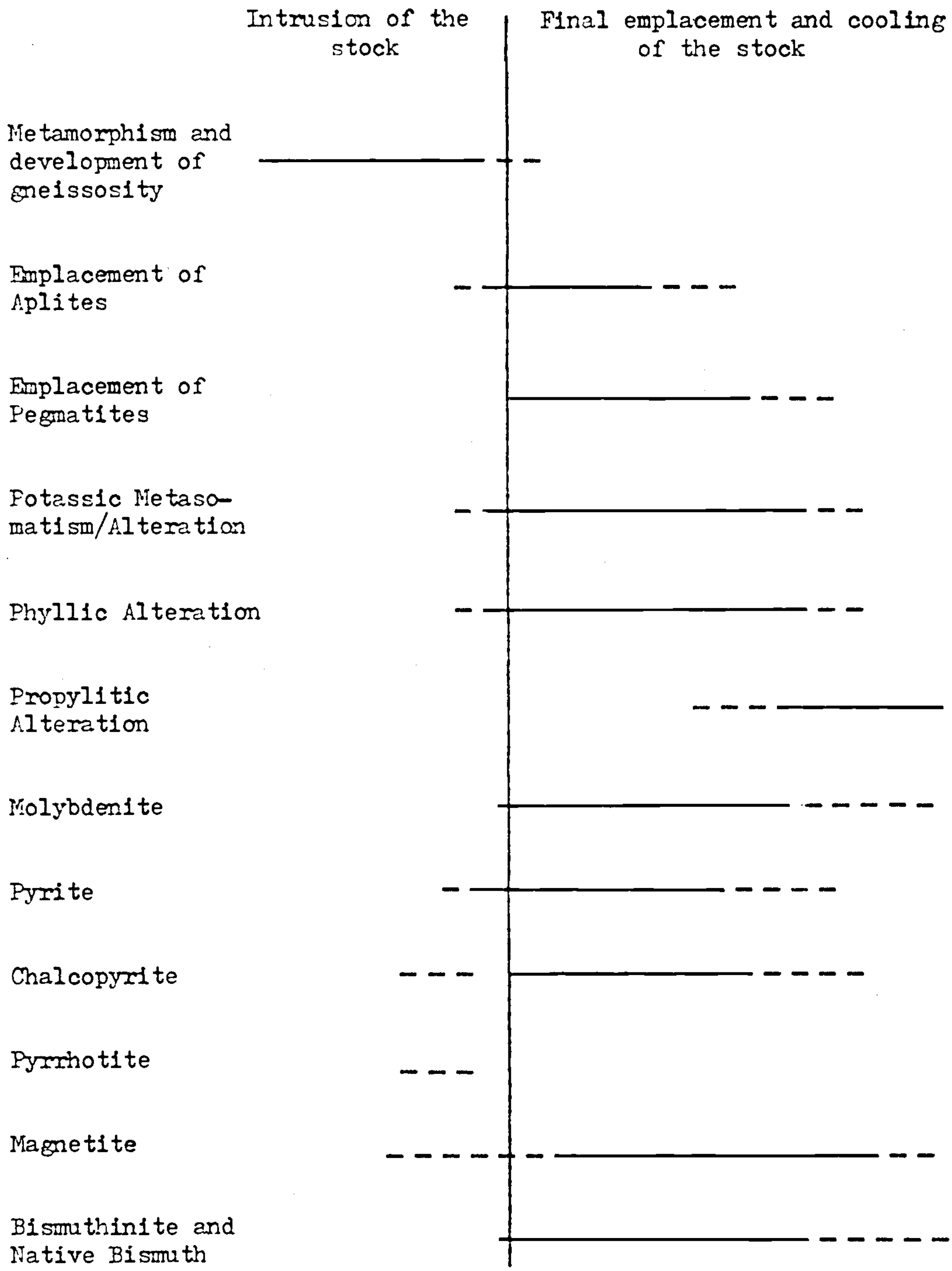


Figure 57. Time sequence depositional events in the Lateral Lake Stock

2. chlorite and epidote-bearing fractures; and
3. calcite ± fluorite-bearing fractures.

Potassic, phyllic, and propylitic types of alteration are present at the Pidgeon Prospect. Potassic alteration is adjacent to the quartz and quartz-microcline pegmatite veins, and is characterized by the mineralogical assemblage of quartz-microcline-muscovite-(biotite). Minor amounts of chlorite and epidote are associated with these minerals. This alteration assemblage has been described by Lowell and Guilbert (1970) as being representative of the deep zones of porphyry copper systems. Phyllic alteration is gradational with the potassic type, and is characterized by the mineralogical association of quartz and muscovite. It is found adjacent to potassic zones of alteration, and adjacent to quartz veins. Propylitic alteration is defined by areas of stockwork chlorite and epidote-bearing fractures. These fracture systems are later than the quartz and quartz-microcline pegmatite veins, which suggests that the propylitic assemblage post-dates the potassic and phyllic assemblages. Although zonation of alteration minerals is not strong, the patterns and mineralogical associations of the types of hydrothermal alteration display many similarities to those encountered in typical porphyry systems (Lowell and Guilbert, 1970).

Quartz, aplitic, and pegmatitic segregations in the metavolcanic rocks, some of which contain trace amounts of molybdenite, are most abundant east of the stock. Secondary biotite is present along fractures in this part of the metavolcanic sequence, and the potassium content of the intruded country rocks is higher than that for the average of basaltic rocks of the Wabigoon Belt. This chemical evidence suggests that potassium was introduced into the mafic metavolcanic host from the stock by way of a hydrothermal system developed above the pluton. This system was not intense as most of the sulphide and alteration mineralizations are confined to the stock.

At the Pidgeon Prospect, the molybdenite mineralization is concentrated into lens-like bodies along the margin of the stock. Grades of the mineralization are difficult to determine because of the variable grain size and sporadic distribution of the molybdenite. However, recent estimates place the grade of the ore at 15.8 million tons of 0.08 percent molybdenum. Active exploration is being performed along the southeast contact of the stock. It is here that there is the greatest potential for further discoveries of substantial molybdenite mineralization, as this area represents the highest exposed level of the pluton. Diamond drilling along the marginal zone of the stock in this area is necessary to outline the lateral extent of the molybdenite mineralization. The potential is low for discovery of major deposits of molybdenum along the contact in the vicinity of the Coates Prospect and the Western Webb Township Prospect in the western part of the stock. This zone of mineralization is not as well-developed, in terms of the extent of the intensity of potassic metasomatism and the distribution of molybdenite, as the zone at the Pidgeon Prospect, and mineable quantities of molybdenum are not likely to be present here.

In addition to molybdenum, other complex pegmatites similar to the lithium-cesium-tantalum-bearing pegmatite at the Kozowy-Leduchowski Prospect in Webb Township, may exist within the mafic metavolcanic rocks in the Lateral Lake area. However, pegmatites of this type are not exposed, and the likelihood of any significant discoveries by means other than diamond drilling is doubtful.

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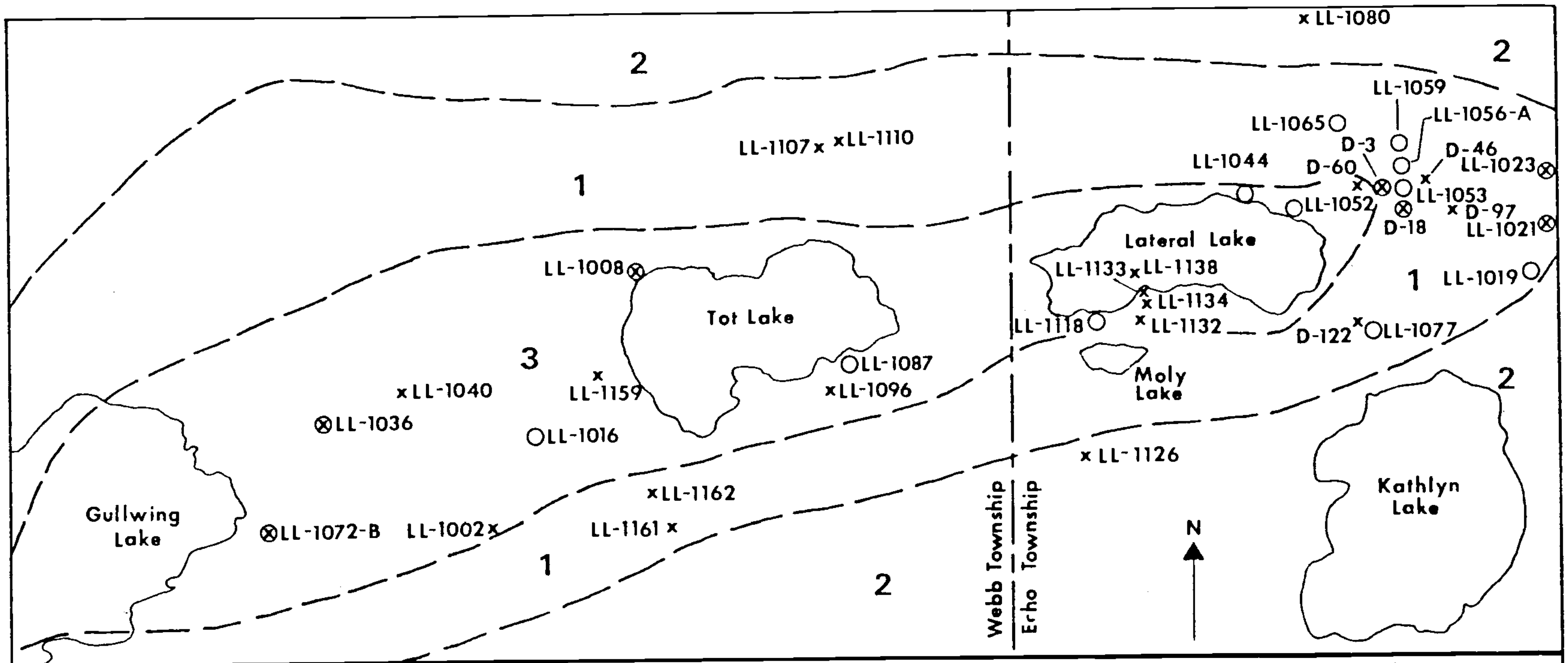
APPENDIX



3	Lateral Lake Stock
2	Metasedimentary Rocks
1	Metavolcanic Rocks

x Petrographic analyses
○ Chemical Analyses
⊗ Chemical and petrographic analyses

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Appendix I. Sample Locations.