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**Ontario Geological Survey
Report 211**

**Geology of the
Khartum Area
Renfrew County**

by

S.G. Themistocleous

1981



Ontario

**Ministry of
Natural
Resources**

**Ontario Geological Survey
Report 211**

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the Governments of Canada and Ontario.**

1981



Ontario

**Ministry of
Natural
Resources**

**Hon. James A.C. Auld
Minister**

**W.T. Foster
Deputy Minister**

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GEOLOGICAL MAP

(Back Pocket)

Map 2454 (coloured)—Khartum, Renfrew County.
Scale 1:31 680.

ABSTRACT

The Khartum area (Figure 1) comprises approximately 270 km² and is bounded by Longitudes 77°00'W and 77°15'W and Latitudes 45°15'N and 45°22'30"N.

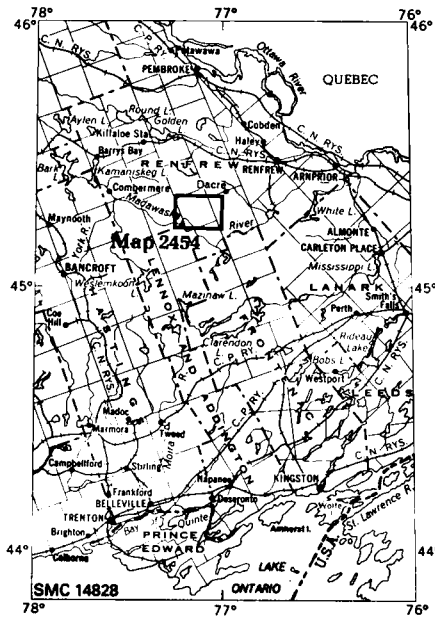


Figure 1—Key map showing location of the Khartum area. Scale 1:3 168 000.

Rocks of Late Precambrian age underlie the map-area and are overlain by unconsolidated Quaternary glacial and glaciofluvial deposits. Late Precambrian rocks include metasediments and mafic, felsic, and alkalic intrusive rocks. Mafic, felsic, and alkalic dikes postdate the above rocks.

Divergent structural trends are present as a result of several intrusive complexes. A regional trend of approximately northeast direction, shallowly dipping to the southeast changes and follows the boundary of the intrusive bodies. The major faults trend approximately east-southeast and belong to the Ottawa-Bonnechere Graben system. Older thrust faulting is characterized by a northeast strike direction and development of mylonite and gouge zones.

Within the Khartum map-area, the former Spain mine produced 8067 pounds of molybdenum from 1916 to 1919. Uranium, rare earth, and sulphide deposits also occur in the area although none are presently economic. These occurrences are preferentially located in the following lithologies: (1) uranium-rare earth mineralization in late granite pegmatites; (2) uranium mineralization within sulphide mineralization associated with hornblende-plagioclase gneiss; and (3) molybdenum mineralization associated with hornblende gneiss. Of these, the most favourable areas for exploration are: (1) for uranium-rare earth mineralization, the Jims Mountain granite pegmatite; and (2) for molybdenum, possible copper and uranium, hornblende gneiss in proximity to felsic intrusions.

CONVERSION FACTORS FOR MEASUREMENTS IN ONTARIO GEOLOGICAL SURVEY PUBLICATIONS

If the reader wishes to convert imperial units to SI (metric) units or SI units to imperial units the following multipliers should be used:

CONVERSION FROM SI TO IMPERIAL

CONVERSION FROM IMPERIAL TO SI

<i>SI Unit</i>	<i>Multiplied by</i>	<i>Gives</i>	<i>Imperial Unit</i>	<i>Multiplied by</i>	<i>Gives</i>
LENGTH					
1 mm	0.039 37	inches	1 inch	25.4	mm
1 cm	0.393 70	inches	1 inch	2.54	cm
1 m	3.280 84	feet	1 foot	0.304 8	m
1 m	0.049 709 7	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	1.609 344	km
AREA					
1 cm ²	0.155 0	square inches	1 square inch	6.451 6	cm ²
1 m ²	10.763 9	square feet	1 square foot	0.092 903 04	m ²
1 km ²	0.386 10	square miles	1 square mile	2.589 988	km ²
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
VOLUME					
1 cm ³	0.061 02	cubic inches	1 cubic inch	16.387 064	cm ³
1 m ³	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m ³
1 m ³	1.308 0	cubic yards	1 cubic yard	0.764 555	m ³
CAPACITY					
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	4.546 090	L
MASS					
1 g	0.035 273 96	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 75	ounces (troy)	1 ounce (troy)	31.103 476 8	g
1 kg	2.204 62	pounds (avdp)	1 pound (avdp)	0.453 592 37	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	907.184 74	kg
1 t	1.102 311	tons (short)	1 ton (short)	0.907 184 74	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	1016.046 908 8	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	1.016 046 908 8	t
CONCENTRATION					
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

1 ounce (troy)/ton (short)	20.0	pennyweights/ton (short)
1 pennyweight/ton (short)	0.05	ounce (troy)/ton (short)

NOTE—Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries published by The Mining Association of Canada in co-operation with the Coal Association of Canada.

Geology
of the

Khartum Area

Renfrew County

by

S.G. Themistocleous¹

INTRODUCTION

The Khartum area is located in a region in which geological formations favourable to occurrence of uranium mineralization were anticipated. The area had never been surveyed geologically other than in a reconnaissance fashion. A detailed survey of the area was recommended by the Ontario Geological Survey, Ministry of Natural Resources, as part of a larger program of resource evaluation and exploration stimulation in Renfrew County. As indicated in the report minor interesting uranium mineralization occurrences were found by the survey party and a variety of other metallic occurrences are reported upon.

Location

The Khartum map-area is located 31 km southwest of the town of Renfrew and 65 km south of the town of Pembroke; it is bounded by Latitudes 45°15'N and 45°22'30''N, and Longitudes 77°00'W and 77°15'W; it encompasses approximately 270 km² and includes parts of Lyndoch, Sebastopol, Griffith, Grattan, Brougham, and Matawatchan Townships. Highway 41 trends northeast across Griffith and Brougham Townships.

¹Geologist, Precambrian Geology Section, Ontario Geological Survey, Toronto.
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Access

Much of the map-area is readily accessible by road. Highway 41 runs in a northeast direction across southern Griffith Township and the northwest corner of Brougham Township. A good gravel road extends west from the junction of Tooeyes and Black Donald Creeks, Brougham Township, on Highway 41 to north of Canoe Lake, through northern Griffith Township, where it meets the old Lamberts Road. This gravel road runs north-south through Sebastopol, Griffith and Lyndoch Townships, but parts of it are rarely used; to the north it meets the old Opeongo Road and to the south a gravel road leading southeastwards to the village of Griffith. The mountainous central portion of the map-area has poor accessibility.

Prospecting and Mining Activity

The area was explored for molybdenum, graphite and uranium (Satterly 1945; Assessment Files Research Office, Ontario Geological Survey, Toronto). A number of molybdenite occurrences including the Spain and Sunset mines, were active east of Highway 41 and south of Jeffers Lake during the early 1910s (Satterly 1945; Eardley-Wilmot 1925; Parsons 1917). Graphite was discovered in 1880 in Lyndoch Township and development work was done in 1917 (Satterly 1945). Exploration for uranium was carried out in 1957 by Conrad Uranium Mines Limited west of Highway 41, north of Strains Lake, in Griffith Township, and by Imperial Oil Limited in 1957 and 1976-1977 in Griffith and Brougham Townships respectively.

Present Geological Survey

The present geological survey was carried out by the author and his assistants during the summer of 1978. Preliminary map P.2240 has been published (Themistocleous 1979). Base maps at a scale of 1 inch to $\frac{1}{4}$ mile were prepared by the Cartography Section, Surveys and Mapping Branch, from maps of the Forestry Resources Inventory. Field data were plotted on acetate overlays on vertical air photographs at the same scale as the base map. Outcrops were examined along lake shores, roads and pace-and-compass traverse lines run at approximately right angles to strike of the formation. In a few places geological boundaries were traced directly in the field by walking them out. Outcrop locations were determined from pace-and-compass measurements, and tied into recognizable features on the base maps and air photographs. Traverses were spaced at 300 to 450 m intervals. Information from magnetic surveys and drilling in assessment files was also used in preparing the map.

Acknowledgments

This survey was done by the Ontario Geological Survey, Ministry of Natural Resources as part of the Mineral Exploration Incentives Program, Pembroke-Renfrew Region, jointly funded by the Ministry of Treasury and Economics, Ontario, and the Department of Regional Economic Expansion (DREE), Canada.

The author was assisted in the field by Keith Treacher, Edward Navickas, Kevin Seymour and Joan Nickolson. Mr. Treacher as a senior assistant was responsible for part of the mapping. Mr. Navickas also did some independent mapping.

Chemical and X-ray analyses, and mineral identification were done by the staff of the Geoscience Laboratories, Ontario Geological Survey.

Previous Geological Work

Prior to the present study, no detailed mapping had been carried out in the map-area, but reconnaissance studies were made in parts of the area by Satterly (1945), Karvinen (1973), Eardley-Wilmot (1925), Parsons (1917), Hewitt (1954), and Sutherland (1919).

The only previously known available geological maps of the area are Map 53b (Satterly 1945) of the Renfrew area which was based on compilation and reconnaissance examination, and GSC Map 1334A.

Topography

The Khartum area forms part of the Madawaska Highlands, a major structural and topographic unit, lying between the Ottawa-Bonnechere Graben system to the north and the Cashel peneplane to the south (Kay 1942). Jamieson Mountain, Three Mountains, Cardiff Mountain, Buck Mountain and Godin Mountain have elevations of over 420 m.

In general elevations in the area range from 270 m to 420 m. Elevations in the central part of the area are a reflection of the type of bedrock. Sections underlain by carbonate metasediments have the lowest elevations whereas sections underlain by plutonic rocks have higher elevations.

Drainage is in general towards the south. A major waterway, the Madawaska River passes through the southwest corner of the map-area.

Natural Resources

The opening of the Opeongo Road in 1850-1865 to the north with several branching roads to the south, was the beginning of settlement in the area. Most

Geology of the Khartum Area

farms in the area resulting from settlement were located immediately east of Highway 41 and are now abandoned due to the hilly, rocky topography and poor soil.

About 85 percent of the area is covered with white spruce, balsam, cedar, pine, birch, maple and hemlock. At the present time lumbering is a significant source of income for some of the residents in the area.

GENERAL GEOLOGY

The map-area is underlain by Late Precambrian metasediments and intrusive rocks (Table 1) and lies 10 to 20 km southeast of the boundary between Middle and Late Precambrian sequences in the Grenville Province (Ayles *et al.* 1971). The Late Precambrian supracrustal rocks of the map-area are a north-easterly extension of the marble-rich Late Precambrian metasediments mapped in the counties of Hastings and Lennox and Addington (Miller and Knight 1914).

In the Khartum area, the sedimentary sequence consists of clastic, calcareous and carbonate rocks, now metamorphosed respectively to feldspar-quartz-biotite gneiss, amphibole and calc-silicate gneiss, and calcitic marble. These rocks are exposed northwest and southeast of the Three Mountains Pluton.

Intrusive into the metasediments are three prominent plutonic bodies, the Three Mountains Pluton, the Burns Lake Syenite and the Mount St. Patrick Syenite. The Three Mountains Pluton underlies the south central portion of the map-area, and is concordant to subconcordant with the regional gneissosity; it is mainly biotite granodiorite with porphyritic granodiorite phases. The Burns Lake Syenite is discordant with the regional gneissosity and composed mainly of biotite-hornblende syenite. The Mount St. Patrick plug is porphyritic biotite-hornblende-pyroxene syenite.

Several other intrusions are present within the map-area. Regional deformation of the metasediments and assimilation of carbonate country rock by alkalic magma has produced melasyenite. Metamorphism under upper amphibolite facies conditions (Turner 1968) accompanied regional deformation. Structurally the area is characterized by 1) regional gneissosity-foliation within the metasediments, 2) an intrusive period during which the metasediments were intruded by several intrusive bodies, 3) subsequent development of minor thrust faults in a northeast direction, which are characterized by the development of gouge and mylonitic rocks, and local folding of the metasediments, and 4) a late phase of approximately east-southeast faulting which belongs to the Ottawa-Bonnechere Graben system and is characterized by joints, hematization, minor cataclasis, slickensides and well developed shear zones. Minor unconsolidated Pleistocene deposits predominantly consist of outwash sands and gravel.

TABLE 1

TABLE OF LITHOLOGIC UNITS FOR THE KHARTUM AREA.

PHANEROZOIC

CENOZOIC

QUATERNARY

PLEISTOCENE AND RECENT

Glacial and glaciofluvial deposits, swamp and stream deposits.

Unconformity

PRECAMBRIAN

LATE PRECAMBRIAN

UNMETAMORPHOSED PLUTONIC ROCKS

FELSIC AND ALKALIC INTRUSIVE ROCKS

Granite pegmatite, syenite pegmatite, aplite, granodiorite dikes.

Intrusive Contact

METAMORPHOSED PLUTONIC ROCKS

LATE MAFIC INTRUSIVE ROCKS

Diabase, diorite, pyroxenite dikes.

Intrusive Contact

FELSIC TO INTERMEDIATE INTRUSIVE ROCKS

Granodiorite, granite, porphyritic and leucocratic varieties.

Intrusive Contact

ALKALIC INTRUSIVE ROCKS

Potassic syenite, leucocratic potassic syenite, melanocratic syenite, porphyritic syenite, scapolitic syenite, nepheline syenite, monzonite.

Intrusive Contact

EARLY MAFIC INTRUSIVE ROCKS

Gabbro, porphyritic gabbro, plagioclase-hornblende-scapolite gneiss, plagioclase-amphibole-biotite gneiss.

Intrusive Contact

METASEDIMENTS

CARBONATE METASEDIMENTS

Calcitic marble, dolomitic marble, phlogopitic marble, diopsidic marble.

CALCAREOUS METASEDIMENTS

Amphibole-plagioclase-quartz gneiss, calc-silicate gneiss, diopside granofels, scapolite and pyroxene skarn.

CLASTIC SILICEOUS METASEDIMENTS

Wacke, feldspathic arenite, quartzitic arenite, feldspar-quartz-biotite-hornblende gneiss, rusty feldspar-quartz-biotite-amphibole gneiss.

Late Precambrian

METASEDIMENTS

The metasediments underlie about one-third of the map-area and three main groups are recognized.

Clastic siliceous metasediments, characteristically contain up to 25 percent biotite, and no carbonate. They are composed mainly of potassic feldspar, albite, quartz, biotite and garnet and possess a granoblastic texture. These rocks can be grouped into two major units: (1) biotite-poor gneisses which may represent moderately to well sorted feldspathic and quartzitic arenite and quartzite and (2) biotite-rich gneisses which represent wacke. The arenite greatly predominates over the wacke, but both facies are intercalated. These rocks have been metamorphosed to almandine-amphibolite metamorphic facies and are characterized by porphyroblasts of quartz, biotite and in places garnet,

The calcareous metasediments were derived from calcareous feldspathic wacke and from sandy limestone which contained a high proportion of clastic siliceous minerals. These rocks have also been metamorphosed to almandine-amphibolite facies and are characterized by decarbonization and formation of abundant metamorphic amphibole (Lumbers 1968).

The carbonate metasediments are calcitic marble, siliceous marble and dolomitic marble, derived from limestone and impure limestone. They are the most abundant of the metasediments in the map-area. Most of the marble in the Khartum area contains calcite in excess of 80 percent. They have been metamorphosed to upper almandine-amphibolite metamorphic facies (Themistocleous 1981). Dolomite is very rare.

Clastic Siliceous Metasediments

The clastic siliceous metasediments are subdivided into five map-units based upon mineral assemblages.

Map-unit 1a, microcline-quartz-biotite-albite \pm garnet \pm sillimanite gneiss. Biotite ranges up to 40 percent. The rock is interpreted by the author as metamorphosed wacke.

Map-unit 1b, microcline-quartz-albite-biotite gneiss and hornfels. With less than 5 percent mafic minerals, this unit is interpreted by the author as metamorphosed feldspathic arenite.

Map-unit 1c, microcline-quartz-biotite-hornblende-albite gneiss. With 10 to 15 percent mafic minerals, this unit is interpreted by the author as quartzitic arenite.

Map-unit 1d, microcline-quartz-biotite-hornblende gneiss. It contains interbeds of units 1a and marble (map-unit 3a) and local rusty zones.

Map-unit 1e, quartz-microcline-albite-biotite \pm garnet. Quartz is in excess of 60 percent; the unit is interpreted by the author as quartzite.

MICROCLINE-QUARTZ-BIOTITE-ALBITE ± GARNET ± SILLIMANITE GNEISS (WACKE)

The biotite-rich gneisses or wacke (map-unit 1a) have been metamorphosed to upper almandine-amphibolite facies rank and are characterized by biotite content of between 10 and 40 percent. These rocks weather light grey and are dark grey in fresh surface. Gneissic to foliated structures are well developed and characterized by preferred orientation of the mica. Thin layers and lenses consisting of feldspar and quartz are interlayered with biotite-rich layers producing the gneissosity; in some locations thin layers of sillimanite-biotite-garnet-feldspar are intercalated with biotite-feldspar-quartz layers and define the gneissosity. Garnetiferous units form distinct layers interbedded with the biotite-quartz-feldspar gneiss. The metamorphosed wacke is found in the Rock Hill area of Sebastopol Township (Themistocleous 1981), north of Garvin Lake, east of Burns Lake, west of Callaghan Lakes, and southeast of Haley Lake. In places the wacke has a schistose structure.

In thin section these rocks are predominantly composed of microcline-orthoclase (20 to 40 percent), albite (10 to 20 percent), quartz (10 to 50 percent) and biotite (10 to 40 percent). Minor components which may also be present include garnet, sillimanite, muscovite, apatite, hornblende and opaque minerals. The biotite exhibits a preferred orientation either in clusters, or in single crystals. The grain size varies from 0.2 to greater than 1 cm. The quartz and feldspar grains are angular to subangular with interlocking boundaries. A chemical analysis of a typical wacke is given in Table 2, Sample 6.

MICROCLINE-QUARTZ-ALBITE-BIOTITE GNEISS (FELDSPATHIC ARENITE)

Feldspathic arenite (map-unit 1b) is most abundant in the northwest corner of the map-area. These rocks which underlie the area north of Lamberts Lake and northeast of Highland Lake, are the southern extension of a thick feldspathic arenite exposed to the north (Themistocleous 1981). This unit is intercalated with thin garnetiferous layers of microcline-quartz-biotite-albite-garnet-sillimanite gneiss (unit 1a), marble (unit 3), and plagioclase-amphibole gneiss (unit 2) and intruded by minor gabbro (unit 4) and syenite bodies (unit 5). The feldspathic arenite in this location is usually uniform in composition, coarse to medium grained, and weathers light pink. The arenite has been metamorphosed to almandine-amphibolite facies rank and is characterized by lack of matrix and structures.

Microscopically the rock exhibits a faint mineral foliation and in a few places gneissic structure which comprises quartz-rich layers intercalated with quartz-feldspar-biotite layers. Massive granitized arenite occurs erratically in the northwest corner of the map-area.

Microscopically a granoblastic texture predominates with quartz elongation in a few places. In thin section no matrix is observed (< 0.01 mm, as defined by Blatt *et al.* 1972, p.10). The rock is entirely recrystallized into angular to subangular grains of quartz (15-30 percent), microcline + orthoclase (25 to 40 percent), and albite (5 to 20 percent). Biotite and magnetite are also present in amounts less than 5 percent.

MICROCLINE-QUARTZ-BIOTITE-HORNBLLENDE-ALBITE GNEISS (QUARTZITIC ARENITE)

The quartzitic arenite (map-unit 1c) is characterized by thin quartz-rich layers intercalated with feldspar-quartz layers; it weathers white in outcrop surface and is medium grained. Ten to fifteen percent of this rock type is made up of mafic minerals. These rocks are completely recrystallized and characterized by a granoblastic texture. They are exposed north of Fox and Dugan Lakes, west of Watson Lake, on Oak Mountain, south of Khartum, southwest of Doorley Creek, on Burns Lake, east of Rock Lake, and between Cameron and Little Pine Lakes.

In thin section the rock is seen to be composed of quartz (30 to 40 percent), microcline-orthoclase (40 to 60 percent) and biotite (5 to 10 percent). Minor hornblende, albite, diopside and muscovite are present (Themistocleous 1981). The quartzitic arenite has been metamorphosed to almandine-amphibolite facies rank and apart from layering is characterized by the absence of primary structures and matrix.

MICROCLINE-QUARTZ-BIOTITE-HORNBLLENDE GNEISS

This unit (1d) is intercalated with pink feldspathic arenite (unit 1b), calcareous metasediments (unit 2) and marble (unit 3); it is intruded by granite pegmatite, granodiorite dikes and quartz veins. The rock is fine to medium grained, equigranular with rusty brown patches in outcrop surface. It has sugary texture which is very friable in places. The rock possesses a gneissic structure with rusty feldspar-quartz layers interbanded with feldspar-quartz-biotite-amphibole layers. The rusty gneiss in places has thin biotite-rich layers and/or garnet-biotite layers; biotite and hornblende make up approximately 10 to 20 percent of this rock type, quartz 30 percent, and feldspar the remainder. Map-unit 1d is exposed southeast of Tincamp Lake, north of Madawaska River, and also on Oak Mountain.

Chemical analyses for feldspathic arenite (map-unit 1b), wacke (map-unit 1a), and quartzitic arenite (map-unit 1c) are given by Themistocleous (1981, Table 2).

QUARTZ-MICROCLINE-ALBITE-BIOTITE ± GARNET GNEISS (QUARTZITE)

Quartzite (map-unit 1e) is rare and is found in few places in the Khartum area. East and southeast of Rock Lake, east of Jeffers Lake on the Sunset occurrence and northeast of Strains Lake. The quartzite occurs as thin distinct layers interbedded with feldspathic arenite, wacke and marble; it weathers light grey and is white to grey in fresh surface.

A thin sectioned quartzite from the Sunset occurrence area was described by Karvinen (1973) as consisting of elongated quartz (50 percent), scapolite (25 percent), calcite (3 percent), biotite (1 percent), sphene and pyrrhotite-pyrite. In the quartzite east of Rock Lake graphite is present.

Calcareous Metasediments

The calcareous metasediments constitute approximately 2 percent of the metasediments in the Khartum area. They predominantly comprise amphibole-rich gneiss (map-unit 2a) and calc-silicate gneiss (map-unit 2b). The calcareous metasediments are interbedded with clastic siliceous and carbonate metasediments and probably represent a facies intermediate in composition between them. These rocks have been metamorphosed to almandine-amphibolite facies metamorphic rank.

AMPHIBOLE-PLAGIOCLASE-QUARTZ GNEISS

The amphibole-rich gneisses weather dark grey to green and are gneissic with thin mafic-rich layers intercalated with feldspar-hornblende layers. They are intercalated with marble and arenite and are found as xenoliths and lenses within the Three Mountains granite-granodiorite pluton. In general this rock type is the most abundant of the calcareous metasediments. It is found throughout the map-area in thin traceable layers with variable amounts of mafic minerals.

In thin section the rock is seen to be predominantly composed of orthoclase (20 to 40 percent), albite (15 to 40 percent), quartz (5 to 30 percent), disseminated crystals and/or aggregates of hornblende (10 to 30 percent), pyroxene (0 to 10 percent) and biotite (1 to 14 percent). Accessory minerals such as sphene, zircon and apatite were observed. These rocks possess a granular texture, have a grain size of 0.2 mm to 1 cm, and appear massive in thin section.

Chemical analyses of five amphibole gneisses are given in Table 2. They are characterized by high total Fe_2O_3 , MgO, and CaO content.

CALC-SILICATE GNEISS

Calc-silicate gneiss (map-unit 2b) is of very minor occurrence in the map-area and is spatially associated with intrusive rocks. The gneiss is medium to coarse grained, with a polygonal to granoblastic texture. The rocks possess a gneissic structure due to alternating mafic and felsic layers. In thin section these rocks are seen to consist of quartz (15 to 20 percent), albite (50 percent), orthoclase (5 percent), garnet (10 percent), diopside (5 to 10 percent), and scapolite (5 percent). Other minerals present are pyrite and pyrrhotite.

Interbedded layers of calc-silicate gneiss consisting of hornblende-plagioclase, and pyroxene-feldspar-garnet, feldspathic arenite and marble with disseminated pyrite (map-unit 2d) are exposed on the Madawaska River near Highland Falls. This unit is intruded by granite pegmatite and diorite dikes. This sequence might represent well laminated mudstone interbedded with shale (pyroxene-feldspar-garnet layers) and carbonates which were metamorphosed and metasomatized under high temperature and pressure conditions to almandine-amphibolite metamorphic facies.

Geology of the Khartum Area

TABLE 2: CHEMICAL ANALYSES (WEIGHT PERCENT) OF CALCAREOUS AND CLASTIC METASEDIMENTS. ANALYSES BY GEOSCIENCE LABORATORIES, ONTARIO GEOLOGICAL SURVEY.

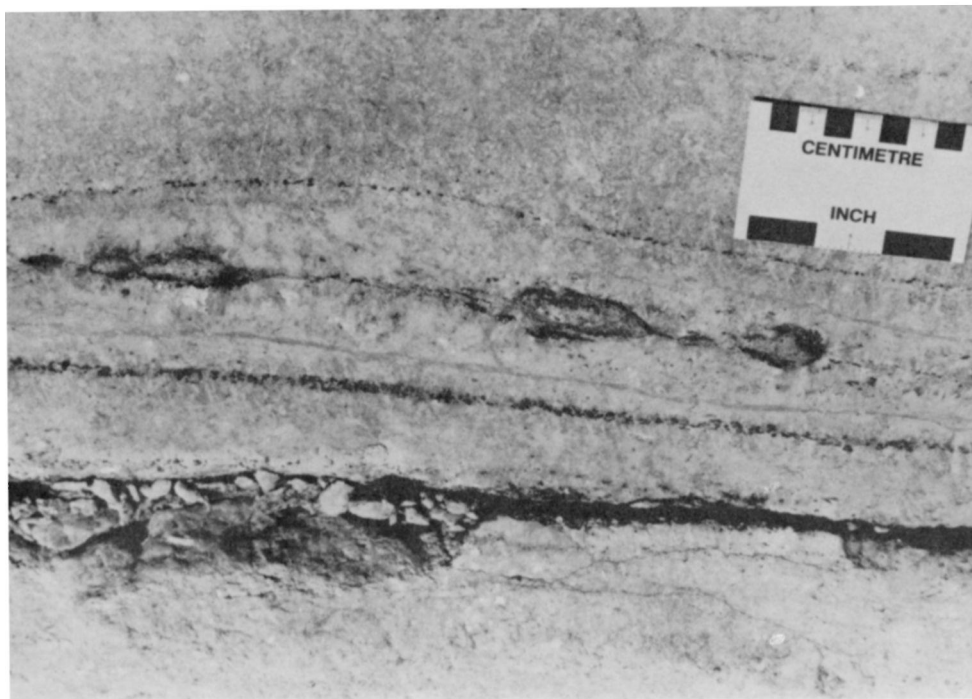
MAJOR ELEMENTS (WEIGHT PERCENT)						
	1	2	3	4	5	6
SiO ₂	48.7	52.0	49.0	53.6	58.6	63.9
Al ₂ O ₃	12.8	17.2	16.9	17.6	14.8	17.8
Fe ₂ O ₃ *	8.38	10.2	11.1	8.71	5.43	4.40
MgO	8.41	4.45	4.70	4.53	3.35	1.81
CaO	15.2	7.41	9.11	5.91	7.70	3.95
Na ₂ O	3.51	4.99	4.94	4.76	4.28	4.78
K ₂ O	0.67	1.72	0.21	1.81	4.15	1.88
L.O.I.	0.0	0.7	1.1	0.8	0.8	0.9
CO ₂	0.53	0.08	0.99	0.09	0.44	0.25
TiO ₂	0.50	1.34	1.42	1.28	0.47	0.64
P ₂ O ₅	0.17	0.16	0.21	0.27	0.07	0.24
S	0.17	0.07	0.03	0.01	0.48	0.21
MnO	0.16	0.16	0.18	0.14	0.09	0.06
TOTAL	98.5	100.3	98.9	99.5	99.7	100.4
TRACE ELEMENTS (PPM)						
Ba	120	220	190	240	2000	390
Co	22	33	33	24	7	15
Cr	370	36	44	58	29	12
Cu	<5	24	8	5	26	114
Li	25	31	48	38	29	37
Ni	78	20	29	41	5	11
Zn	104	118	118	148	54	50
Pb	10	15	10	10	10	11

Samples
 1- Amphibole-plagioclase-quartz gneiss, upper amphibolite facies, 2.5 km south of Cameron Lake.
 2- Amphibole-plagioclase-quartz gneiss, upper amphibolite facies, 0.8 km northeast of Strains Lake, on Highway 41.
 3- Amphibole-plagioclase-quartz gneiss, upper amphibolite facies, 0.3 km northeast of Strains Lake, on Highway 41.
 4- Amphibole-biotite-plagioclase gneiss, upper amphibolite facies, southeast of Strains Lake on Highway 41.
 5- Amphibole-plagioclase quartz gneiss, upper amphibolite facies, 450 m southwest of Jeffers Lake on Highway 41.
 6- Wacke, upper amphibolite facies, Spain mine.
 *Total FeO + Fe₂O₃ expressed as Fe₂O₃.

Scapolite skarn (map-unit 2e) and pyroxene skarn (map-unit 2c) are also present in the map-area. They were found in close proximity to intrusive contacts with carbonates (Themistocleous 1981).

Carbonate Metasediments

The carbonate metasediments are massive, foliated, and gneissic calcitic marbles. These are intercalated in places with clastic and calcareous metasediments. The carbonate metasediments are intruded by granite pegmatite, diabase dikes and gabbro, syenite and granodiorite bodies. They underlie approximately 20 percent of the map-area. Gneissosity is very common, and foliation



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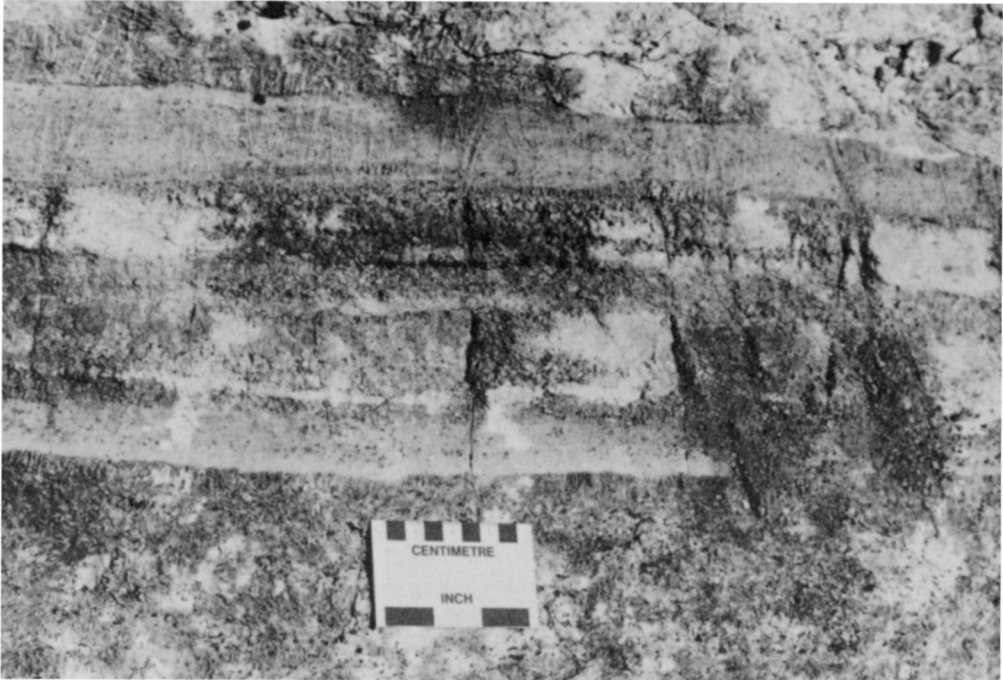
Photo 1—Gneissic structure in marble; concentrations of biotite and scapolite in thin layers are interlayered with coarse-grained calcite in thick layers. South of Tooey's Hill.

is difficult to determine where it is present. The gneissosity is marked by: (a) alternating pink and white layers, (b) concentrations of, and/or aligned biotite-phlogopite \pm scapolite in thin layers 2 to 3 cm wide (Photo 1), (c) alignment of coarse-grained flakes of graphite, (d) interbeds of feldspathic arenite and amphibole-rich gneiss, and (e) interlayered fine- and coarse-grained layers (Photo 2). On weathered surfaces the silicate mineral interbeds stand up in relief. The carbonate metasediment colour varies from white to pink to grey.

Calcitic marble, locally siliceous, constitutes the major unit of the carbonate metasediments; dolomitic marble is minor or rare. The silicate minerals present are coarse-grained quartz, phlogopite, and diopside. Graphite is very common within the marbles in the map-area.

The calcitic marble has a friable texture, weathers white to grey and in places has "pegmatitic" orange phases. It is medium to coarse grained but in a few places is sheared, forming mylonite with porphyroclasts of calcite, feldspar, phlogopite, and tremolite which have rounded to ellipsoidal shapes. In places the marble is intercalated with thin siliceous layers which are boudinaged (see Photo 1) and in a few places brecciated.

Marble with concentrations of mafic minerals forms thin layers which are intercalated with coarse-grained calcitic layers and contain disseminated porphyroclasts of quartz, apatite, phlogopite, biotite, graphite and scapolite. In thin section these rocks are seen to consist mainly of calcite (80 to 95 percent)



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Photo 2—Alternating fine- and coarse-grained layers in calcitic marble. North of Tooeys Lake on Highway 41.

with angular to subangular grains of silicate minerals and graphite (5 to 20 percent). The grain size of the calcite varies from 0.3 mm to 4 cm and the marble possesses an idiotopic texture.

Dolomitic marble (map-unit 3d) was observed at only one location in the map-area, south of West Lake where it forms a massive, coarse-grained, clean interbed 20 to 30 m wide within calcitic marble.

The marble, where in contact with or where included in the Balvenie syenite, has been altered and metasomatized to phlogopitic marble (map-unit 3f). This unit is characterized by a vuggy appearance. The phlogopitic marble is coarse grained and massive, except in shear zone areas where the mica has a preferred orientation. In thin section the rock is seen to consist of phlogopite (40 to 50 percent), carbonate (40 to 50 percent), and minor magnetite and apatite.

Interbanded within the carbonate metasediments are thin (less than 2 m) gabbro dikes, parallel to the gneissosity and in places boudinaged. The carbonate metasediments in close proximity to the gabbro bodies are metasomatized to diopsidic marble (map-unit 3g). The diopsidic marble is medium grained, equigranular, with granoblastic texture and in places very friable. It consists of calcite (50 to 60 percent), diopside (30 to 40 percent), and feldspar (5 to 10 percent).

Chemical analyses of seven samples collected by staff of the Mineral Depos-

TABLE 3: CHEMICAL ANALYSES (WEIGHT PERCENT) OF MARBLES COLLECTED ALONG HIGHWAY 41 BY MINERAL DEPOSITS SECTION, ONTARIO GEOLOGICAL SURVEY. ANALYSES BY GEOSCIENCE LABORATORIES, ONTARIO GEOLOGICAL SURVEY.

MAJOR ELEMENTS (WEIGHT PERCENT)							
	PM87	PM88	PM89	PM90	PM91	PM92	PM93
SiO ₂	1.27	8.40	1.82	1.10	3.88	1.04	9.59
Al ₂ O ₃	0.2	2.8	0.3	0.2	<0.1	0.1	0.1
Fe ₂ O ₃	0.4	2.2	0.2	0.1	0.1	0.3	0.2
P ₂ O ₅	0.01	0.05	0.01	0.01	0.01	0.01	0.01
MgO	20.9	3.5	3.7	2.4	22.8	21.5	18.5
CaO	30.8	45.8	50.8	52.9	28.8	30.2	33.4
L.O.I.	47.1	35.6	43.8	44.1	44.7	47.3	38.6
TOTAL	100.7	98.3	100.6	100.8	100.4	100.4	100.4
CaO/MgO	1.47	13.03	13.72	22.04	1.26	1.40	1.80
Acid Insol.	1.10	10.4	2.46	1.32	3.28	0.72	9.00
TRACE ELEMENTS (PPM)							
Cu	-	16	5	-	-	13	-
Zn	16	46	12	-	41	590	22
Co	5	7	-	-	-	-	-
Pb	-	10	-	-	11	-	-
Ba	40	120	120	80	220	40	60
Hg	-	-	-	-	-	390	-
As	-	1	1	2	-	-	-
Sr	60	1000	350	340	80	70	110
V	-	20	-	-	-	-	-
B	7	-	40	40	370	20	90
Mo	-	-	-	-	-	-	-
Mn	25	750	68	50	240	168	180

Sample Locations

PM87—South of Strains Lake on Highway 41.
 PM88—North of Doorley Lake, Highway 41.
 PM89—East of Upper Twin Lake, Highway 41.
 PM90—Tooeys Creek, Highway 41.
 PM91—Southwest of Tooeys Hill, Highway 41.
 PM92—Southwest of Tooeys Hill, Highway 41.
 PM93—Southwest of Tooeys Hill, Highway 41.

its Section, Ontario Geological Survey, in 1976, along Highway 41, are given in Table 3. All but two samples have low SiO₂ content. Some of the samples show low MgO, others show relatively high MgO content and their CaO/MgO ratio ranges from 1.26 to 22.04. Interestingly enough, one of the analyzed samples shows higher than background zinc, thus pointing to the possible economic potential of the carbonate units.

METAMORPHOSED PLUTONIC ROCKS

Early Mafic Intrusive Rocks

Several small mafic intrusive bodies, consisting of gabbro, occur in the area. The biggest mafic bodies are the Highland Lake gabbro and the Matawatchan gabbro. Also present are several smaller bodies which are generally less than 0.2 km in diameter.

The smaller mafic bodies can be separated into two groups on the basis of their mineralogy and structure: (1) plagioclase-hornblende-scapolite \pm aegerine hornfels and gneiss (map-unit 4c), and (2) plagioclase-hornblende-biotite \pm pyroxene \pm magnetite gneiss (map-unit 4d). The scapolite-bearing hornfels and gneiss occur east of Upper Twin Lake and west of Highway 41 and are in contact with nepheline syenite. In places this gabbro body is brecciated, weathers dark green with white spots, is coarse grained and completely recrystallized. Thin section examination indicates these rocks are composed of scapolite (15 percent), hornblende (45 to 50 percent), plagioclase (10 to 40 percent), and orthoclase (5 to 40 percent). Disseminated grains and/or aggregates of quartz, augite and biotite are also present. The plagioclase-hornblende-biotite gneiss (map-unit 4d) is coarse grained, and weathers green in outcrop surface. This unit is exposed 3 km south of Burns Lake and in the southeast corner of the map-area (Matawatchan gabbro).

HIGHLAND LAKE GABBRO

The massive Highland Lake gabbro forms an ovoid body approximately 4 km long by 1 km wide trending northeast. This body consists of medium to coarse grained gabbro with plagioclase porphyroblasts and consists of "triangular" interconnected aggregates of pyroxene-amphibole and biotite in a groundmass of plagioclase. The grain size varies from 0.2 mm to 2 cm. The gabbro has a granular interlocking texture, and weathers grey to dark green. Several late granite pegmatite dikes cut this body. The gabbro body intrudes clastic siliceous metasediments, contains xenoliths of these host rocks, and is intruded by potassic syenite.

The gabbro is massive with several shear zones developed close to the Highland Lake fault. In places the gabbro is intensely fractured. In thin section it can be seen that these rocks are predominantly composed of plagioclase (20 to 65 percent) showing sericitization, hornblende (15 to 60 percent) (altered pyroxene to hornblende), biotite (3 to 20 percent) and magnetite (3 to 8 percent). Other minerals present include scapolite, quartz and augite. The rock has a granoblastic decussate texture and the grains boundaries are curved, embayed or straight.

Alkalic Intrusive Rocks

PINK POTASSIC SYENITE

Map-units 5a and 5b comprise gneissic, massive and lineated pink potassic syenite. The massive to lineated leucocratic potassic syenite (map-unit 5b) underlies the area around Lamberts Lake and extends northeast to Highland Lake. This body might be the southern extension of the Lake Clear lineated potassic syenite exposed in the Clontarf area (Themistocleous 1981). It weathers pink to light grey pink and is massive to weakly gneissic with clots of biotite-hornblende forming a shallow dipping lineation to the southeast. This body is characterized by the presence of lenses of marble, nepheline syenite and granite pegmatite dikes.

The massive to gneissic pink potassic syenite (map-unit 5a), called Balvenie syenite for purposes of mapping, is exposed in several bands southeast of Highway 41 and south of Little Pine Lake; north of Little Pine Lake the Balvenie syenite is exposed west of Highway 41. This unit weathers light pink, trends approximately parallel to Highway 41 and has numerous lenses and layers of marble (map-unit 3f), clastic siliceous metasediments (map-units 1c, a), calcareous metasediments (map-unit 2a) and is intruded by granite pegmatite, granodiorite and diabase dikes. Also it has minor scapolite-bearing migmatitic syenite and nepheline syenite.

On thin section examination these rocks can be divided into biotite-, hornblende-, and diopside-bearing syenites. Biotite and hornblende syenites are most common in the Highland Lake syenite, and diopside and hornblende syenites more common in the Balvenie syenite.

The hornblende-bearing syenite consists of microcline (60 percent), orthoclase (10 percent), albite (15 percent), perthite (9 percent), and hornblende (5 percent). Other minerals present are sphene, apatite, zircon, and carbonates. It has a granoblastic texture with weak mafic alignment and equigranular interlocking feldspar grains.

The biotite-bearing syenite consists of biotite (5 to 20 percent), albite (0 to 65 percent), orthoclase (20 to 60 percent), microcline (1 to 30 percent), and perthite (0 to 20 percent). Other minerals present are sphene, apatite and carbonates.

The diopside-bearing syenite consists of diopside (1 to 10 percent), microcline-orthoclase (25 to 40 percent), and albite (45 to 50 percent). Other minerals present are sphene, quartz, muscovite, apatite and calcite.

MELANOCRATIC SYENITE

Map-unit 5c underlies the area immediately to the west and east of Burns Long Lake and represents the core of the Burns Lake Syenite. This body has a shape of an approximately circular plug (4.9 by 6.7 km) with a melanocratic core (map-unit 5c) and a leucocratic rim (map-unit 5b) (Photo 3).

The plug is overturned to the northwest with the leucocratic syenite having a shape of a half moon and the melanocratic syenite having an egg shape. Several recrystallized diabase and diorite dikes trending north-northeast and



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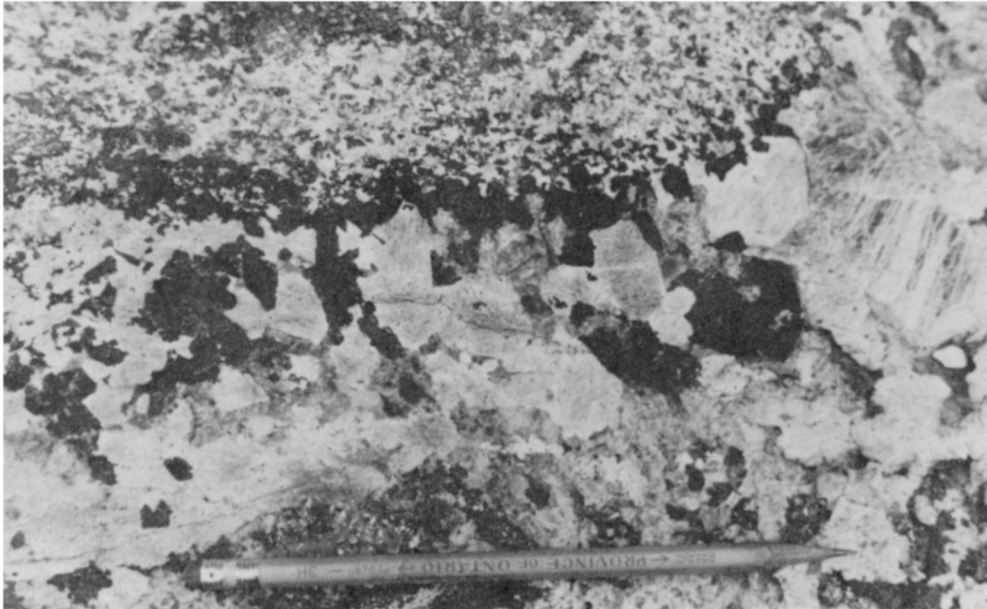
Photo 3—Leucocratic syenite. South of Burns Long Lake.

granite pegmatites trending northeast cut the syenite. Small lenses of feldspathic arenite, amphibole-rich gneiss and marble are abundant in the leucocratic syenite. The melanocratic syenite weathers buff to dark green, is coarse grained, and massive to lineated. It has numerous phases rich in scapolite, carbonate, and sphene, with some patches having xenolithic appearance and other patches having a “pegmatitic” texture (Photo 4) which indicates that the area was rich in volatiles. The melanocratic syenite is characterized by an aeromagnetic anomaly of 2,300 gammas.

In thin section these rocks are seen to be predominantly composed of biotite (5 to 20 percent), hornblende (4 to 10 percent), augite (0 to 10 percent), perthite (15 to 40 percent), orthoclase (6 to 40 percent), and albite (4 to 20 percent). Other minerals present are magnetite, sphene, apatite, carbonate and zircon. They have a coarse grained, granular, interlocking texture.

PORPHYRITIC SYENITE (MOUNT ST. PATRICK SYENITE)

The Mount St. Patrick Syenite (map-unit 5d), is porphyritic, pinkish to grey, medium to coarse grained, and massive except in thin shear zones where it possesses a well developed foliation. This body is a circular plug and is exposed approximately 200 m east of Tooeys Lake. It consists of tightly packed aggregates of euhedral phenocrysts of pinkish to grey micropertthite up to 5 cm



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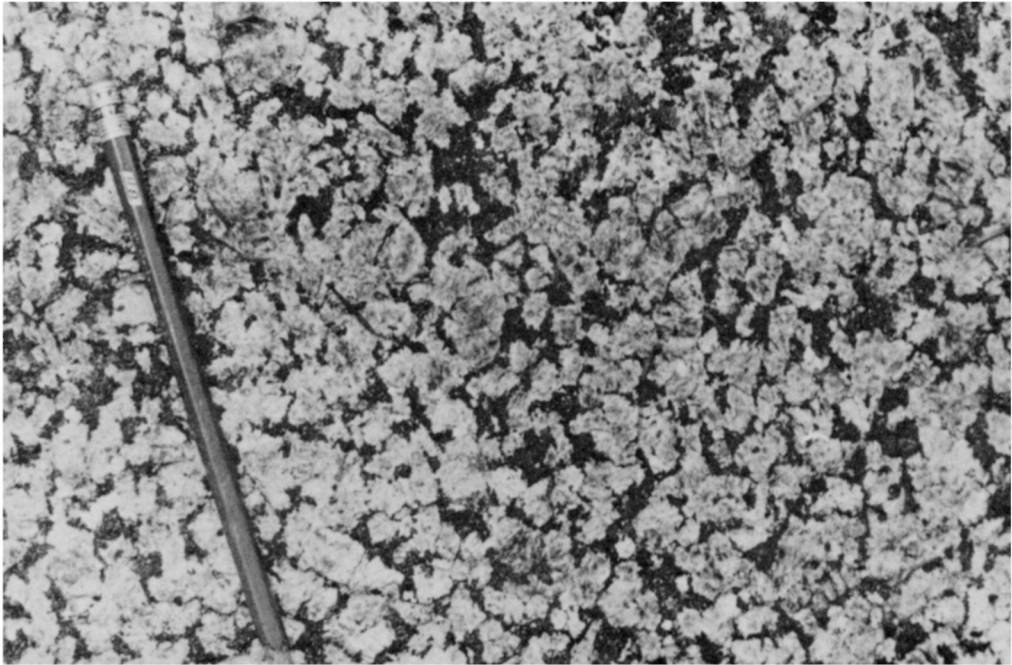
Photo 4—Pegmatitic phases of melanocratic syenite. South of Donahue Long Lake, on road leading to Highway 41.

long in a ground mass (up to 30 percent) of feldspar and mafic minerals (Photo 5). This body has melanocratic syenite phases with 40 to 50 percent mafic minerals (biotite + hornblende-augite) which weather dark grey to green and contain less than 10 percent grey porphyroclasts. Minor melanocratic syenite “dikes” cross-cut these melanocratic phases (Photo 6). The Mount St. Patrick Syenite is intruded by late granite pegmatite dikes.

In thin section these syenites are seen to be predominantly composed of twinned biotite (2 to 15 percent), hornblende (0 to 10 percent), microperthite (70 to 85 percent), and plagioclase (0 to 10 percent, albite to oligoclase). Other minerals present are orthoclase, augite, scapolite, sphene, zircon, apatite, and carbonate. The primary mineralogy of this body is perthite-pyroxene-hornblende which is recrystallized to perthite-biotite-hornblende±pyroxene. The rocks are coarsely porphyritic with embayed phenocryst grain boundaries.

SCAPOLITIC MIGMATITIC SYENITE

Scapolitic migmatitic syenite forms a minor unit (map-unit 5e) and is exposed east of Upper Twin Lake and south of Brougham Lake in Brougham Township. It is intercalated with the potassic syenite (map-unit 5a), and includes layers of wacke and calc-silicate gneiss. These rocks weather white and are me-



OGS 10 252

Photo 5—Mount St. Patrick Syenite, showing tightly packed, grey, euhedral phenocrysts of microperthite in a groundmass of biotite and feldspar. Northeast of Tooeys Lake.



OGS 10 253

Photo 6—Melanocratic syenite phase within the Mount St. Patrick Syenite, cut by late-phase melasyenite "dike". Southeast of Tooeys Lake.

dium to coarse grained. The scapolite weathers out just like nepheline but the scapolite can be distinguished from the nepheline by its lighter colour and cleavage.

Thin section examination indicates that these rocks are composed of scapolite (10 to 15 percent), biotite (15 percent), perthite (30 percent), orthoclase (25 percent), albite (10 percent), and microcline (5 percent). Other minerals present are sphene, apatite and carbonates.

NEPHELINE SYENITE

The nepheline syenite (map-unit 5f) outcropping in Sebastopol Township lies at the east end of the Haliburton-Bancroft nepheline belt, described by Adams and Barlow (1910). The nepheline syenite of the map-area is gneissic, weathers grey-white, and is characterized by the pitted weathered surface caused by differential weathering of nepheline and feldspar.

Nepheline syenite occurs in three locations. The larger of these is located in the vicinity of Lamberts Lake and comprises a band of nepheline gneiss, 400 m wide which is the extension of the Wolfe nepheline belt (Hewitt 1954; Appleyard 1967). The second occurrence is located west of Two Islands Lake and consists of a massive thin band of corundum-bearing nepheline syenite, and the third is east of Upper Twin Lake and comprises a thin gneissic band within scapolitic syenite and pink potassic syenite.

The Lamberts Lake gneissic nepheline syenite is medium to coarse grained with thin (less than 6 cm wide) "pegmatitic" veins of nepheline syenite developed along fractures. It occurs within a sequence of feldspathic arenite, potassic syenite and marble. This body has a weakly developed gneissosity and comprises a melanocratic (hornblende-rich) nepheline syenite structurally overlain by a leucocratic (less than 10 percent mafics) nepheline syenite.

In thin section these rocks are seen to be predominantly composed of nepheline (15 to 30 percent), perthite (15 to 40 percent), albite (20 to 35 percent), microcline (5 to 30 percent) and orthoclase (5 to 10 percent). The mafic content ranges from 5 to 20 percent and the mafic minerals present are, in order of decreasing abundance, biotite, hornblende, magnetite, aegirine-augite, and hematite. Most nepheline crystals are altered 100 percent to hydronephelite and in places have inclusions of albite which are slightly aligned. They have a coarse-grained massive structure, and hypidiomorphic-inequigranular texture.

MONZONITE

A body of monzonite (map-unit 5g) underlies the Louies and Long Lakes areas. It is in contact with the Mount St. Patrick Syenite and is exposed along the southern fringes of the syenite. The monzonite weathers dark grey to slightly pinkish in outcrop surface, is grey to green in fresh surface, is medium grained and massive to gneissic. It contains angular xenoliths of feldspathic arenite and lenses of marble.

Thin section examination indicates that the rock is predominantly com-

TABLE 4: CHEMICAL ANALYSES OF ALKALIC INTRUSIVE ROCKS. ANALYSES BY GEOSCIENCE LABORATORIES, ONTARIO GEOLOGICAL SURVEY.

MAJOR ELEMENTS (WEIGHT PERCENT)											
	1	2	3	4	5	6	7	8	9	10	11
SiO ₂	54.7	52.5	50.9	51.4	42.9	51.0	48.5	51.1	46.1	43.8	52.6
Al ₂ O ₃	21.0	19.1	17.7	18.7	14.0	20.2	16.0	16.6	11.8	16.2	21.8
Fe ₂ O ₃	6.52	7.18	9.24	8.11	15.9	7.44	11.1	5.63	10.6	11.8	5.23
MgO	3.07	2.79	3.70	3.45	5.98	2.96	3.72	3.20	9.67	6.08	2.50
CaO	7.37	3.80	4.10	4.58	7.20	8.07	8.09	9.70	9.82	9.87	6.71
Na ₂ O	5.71	3.22	4.02	3.65	1.89	5.08	2.94	2.87	2.63	2.71	5.26
K ₂ O	0.74	6.73	6.09	6.15	5.37	1.66	5.68	5.79	3.52	3.31	2.92
L.O.I.	0.4	0.4	0.6	0.4	0.7	1.1	0.8	1.1	1.2	0.7	1.9
CO ₂	0.20	0.13	0.33	0.12	0.52	0.92	0.56	0.88	0.67	0.17	0.86
TiO ₂	0.70	1.21	1.63	1.37	2.51	0.81	1.36	1.00	2.38	1.82	0.83
P ₂ O ₅	0.24	1.05	1.22	1.01	2.05	0.43	1.28	1.30	1.22	2.03	0.14
S	0.01	0.04	0.06	0.06	0.25	0.06	0.11	0.04	0.02	0.05	0.07
MnO	0.09	0.05	0.10	0.08	0.13	0.10	0.13	0.07	0.16	0.11	0.06
TOTAL	100.2	98.0	99.3	98.9	98.6	98.9	99.6	98.3	99.1	98.4	100.0

TRACE ELEMENTS (PPM)											
Ba	270	5800	2400	3900	4000	810	3300	6500	3900	4600	1400
Co	19	19	14	17	34	30	30	8	33	42	13
Cr	35	5	10	9	9	41	5	5	440	21	31
Cu	10	8	5	9	22	12	38	5	14	46	8
Li	15	18	15	12	19	14	6	7	29	24	10
Ni	14	5	5	5	5	22	8	5	179	47	10
Pb	10	20	19	19	10	10	17	15	17	11	15
Zn	77	78	126	102	164	86	152	60	161	108	72

Samples

- 1- Buff, massive, coarse-grained syenite. 1 km north of Burns Lake, 1 km west of Burns Long Lake.
- 2- Coarse-grained, pink, foliated syenite. 0.15 km west of Burns Long Lake.
- 3- Coarse-grained, pink, foliated syenite. Southwest of Donahue Long Lake.
- 4- Fine-grained, weakly gneissic, buff syenite. 0.8 km south of Hardwood Lake.
- 5- Buff, porphyritic syenite. 0.3 km west of Burns Long Lake.
- 6- Buff, massive syenite. 1.0 km north of Burns Lake, 1.0 km southeast of Hardwood Lake.
- 7- Fine-grained, weakly gneissic, grey syenite. Southwest of Donahue Long Lake, northwest of Dools Lake.
- 8- Coarse-grained, weakly foliated, white potassic syenite. South of Donahue Long Lake, north of Dools Lake.
- 9- Porphyritic, massive, melanocratic syenite. 1.6 km southeast of Tooys Lake.
- 10- Porphyritic, massive, melanocratic syenite. East-southeast of Burns Long Lake.
- 11- Coarse-grained, buff, massive syenite. 0.6 km southwest of Hardwood Lake.

posed of orthoclase (35 to 45 percent), albite to oligoclase (50 to 40 percent), quartz (0 to 10 percent), hornblende (5 to 35 percent), pyroxene (3 to 20 percent), and magnetite (1 to 5 percent). Other minerals present include sphene, zircon and metamict minerals. The rock possesses a granular texture with inequigranular, interlocking grains.

Chemical analyses of 10 alkalic rocks from the Burns Lake Syenite are given in Table 4. Sample 9 is from the Mount St. Patrick Syenite and represent "dike" material (see Photo 6); it has anomalous Cr and Ni values. Sample 10 is a representative sample of the melanocratic phase of the Burns Lake Syenite; note its similar chemical composition with sample 9. These syenites range in composition from calc-alkalic syenite to alkalic syenite and trachyte (Nockolds 1954).

Felsic to Intermediate Intrusive Rocks

The felsic to intermediate intrusive rocks intrude metasediments and syenitic rocks and underlie about one-third of the map-area. The commonest rock types found in the area are granodiorite and granite. The terms granite and granodiorite refer to granitoid rocks containing more than 20 percent quartz, with the plagioclase proportion of total feldspar 10 to 65 percent and 65 to 90 percent respectively (IUGS 1973).

The major body of the granite-granodiorite group is exposed from Three Mountains to Khartum and southwest of Burns Lake to Jocko Mountain and continues southwards. Several other smaller bodies are exposed within the map-area.

Rocks of the Three Mountains Pluton weather grey to pink, are medium to coarse grained with a weakly developed foliation and mineral lineation in places. This body is characterized by at least two phases: porphyritic granite to granodiorite (map-unit 6c) with pink potassic feldspar phenocrysts up to 3 cm in size within a matrix of about 0.5 cm grain size; and weakly gneissic leucocratic grey-white granite to granodiorite (map-units 6a and 6b) which is more abundant. The latter is intruded by diabase, diorite and granite pegmatite dikes and includes xenoliths and lenses of metasediments.

Thin section examination indicates that the granitic rocks of map-units 6a and 6b are predominantly composed of quartz (20 to 30 percent), microcline (5 to 25 percent), albite (10 to 30 percent), orthoclase (30 to 60 percent), and biotite (2 to 8 percent). Other minerals present are hornblende, sphene, zircon, magnetite, apatite, garnet and metamict minerals. The albite shows sericitization. The rocks have a granular texture with inequigranular, interlocking grains and in a few thin sections show preferred orientation of quartz.

Other felsic intrusive bodies composed of these rock types include the Jamieson Mountain granite and Cardiff Mountain granodiorite.

Late Mafic Intrusive Rocks

DIABASE

There are numerous diabase dikes (map-unit 7a) within the map-area. These intrude the metasediments and the other metamorphosed plutonic rocks. The diabase is fine grained, massive, and weathers dark grey to green in outcrop surface. The width of these dikes does not exceed 35 m and most dikes have a north to northeast strike. Thin section examination indicates that these diabases are mainly composed of andesine to oligoclase (50 to 60 percent), pyroxene (hypersthene) (20 to 45 percent), biotite (1 to 10 percent), and magnetite (3 to 4 percent) exhibiting serrated grain boundaries.

DIORITE

Of the few diorite dikes identified, most occur in the Burns Lake area. These dikes intrude syenitic rocks, granitic rocks and metasediments; they weather dark grey and are fine to medium grained. Some of these dikes have feldspar phenocrysts, or porphyroblasts, up to 3 cm in size in a fine grained matrix. The dikes generally trend north-northeast, have variable widths, and well defined intrusive contacts. One diorite dike located southeast of Donahue Lake, on a road leading to Highway 41 contains angular xenoliths of syenite.

In thin section these rocks are seen to be predominantly composed of albite to andesine (35 to 50 percent), hornblende (20 to 25 percent), biotite (10 percent), and orthoclase (10 to 20 percent). Other minerals present include magnetite, apatite and carbonate. The mineral grains have a hypidiomorphic-granular texture with mafic clots randomly distributed between feldspar grains.

Table 5 lists the chemical composition of a diabase and a diorite dike from the Donahue Long Lake area.

TABLE 5: CHEMICAL ANALYSES OF LATE MAFIC INTRUSIVE DIKES. ANALYSES BY GEOSCIENCE LABORATORIES, ONTARIO GEOLOGICAL SURVEY.

MAJOR ELEMENTS (WEIGHT PERCENT)		
	1	2
SiO ₂	47.4	54.9
Al ₂ O ₃	14.6	15.9
Fe ₂ O ₃	16.3	10.2
MgO	4.81	4.06
CaO	9.38	7.10
Na ₂ O	2.54	4.27
K ₂ O	0.65	0.71
L.O.I.	0.7	0.7
CO ₂	0.08	0.55
TiO ₂	2.77	1.74
P ₂ O ₅	0.36	0.27
S	0.01	0.09
Mn	0.23	0.13
TOTAL	99.7	100.0
TRACE ELEMENTS (PPM)		
Ba	130	240
Co	41	23
Cr	55	135
Ca	480	26
Ni	45	63
Li	14	8
Zn	154	154
Pb	10	10

Samples

1 Medium-grained diabase, Donahue Long Lake.

2 Recrystallized diorite dike, south of Donahue Long Lake on road leading to Highway 41.

PYROXENITE

The pyroxenite dikes (map-unit 7c) are very small in size (less than 0.4 m in width), with sharp boundaries with respect to the host rocks; they are massive, coarse grained, and weather olive green. The host rocks of these dikes are granite and syenite. They are composed mainly of diopside with minor to subhedral apatite, sphene, scapolite and minor feldspar. These dikes are usually radioactive.

UNMETAMORPHOSED PLUTONIC ROCKS

Felsic and Alkalic Intrusive Rocks

GRANITE PEGMATITE

Sheets of granite pegmatite are injected subparallel to the gneissosity of the metasediments and intrude the igneous rocks, trending east and north to northeast. The width of these pegmatites exceeds 300 m in a few instances. The pegmatites are pink (map-unit 8a) and white in colour (map-unit 8d) and have sharp intrusive contacts. The white pegmatites are small, randomly distributed, generally cannot be defined as units at the map scale, and are more common in the southeast corner within the carbonate metasediments. The pink granite pegmatites are found throughout the map-area, and in most cases are radioactive due to high thorium-potassium content (see "Economic Geology").

Several large bodies of pink granite pegmatite (map-unit 8a) are exposed within the Khartum map-area. Typical of these are the Tooey's Lake, Burns Lake, McMaster Lake, Canoe Lake, Jims Mountain and Tooey's Hill granite pegmatites.

The late granite pegmatites are coarse grained with interlocking grains of quartz and feldspar. Quartz graphic intergrowth within potassic feldspars is often present. They are massive but some show evidence of deformation such as fracturing and cataclasis. The cataclasis has formed protomylonite with fluxion structure and ellipsoidal porphyroclasts; in thin section the quartz exhibits deformation bands, undulatory extinction and ribbon-like structure, the feldspars exhibit pull apart, shear step fractures, ellipsoidal shape, and conjugate fractures (Themistocleous 1976). Sets of closely spaced fractures form favorable horizons for radioactive concentrations such as occur in the Jims Mountain fracture zone. These pegmatites have variable amounts of mafic minerals and magnetite-bearing pegmatites are usually more radioactive. The mafic minerals where present are tourmaline, alkali amphibole, biotite, and muscovite. Some of the accessory minerals present are euhedral zircon, anatase, euhedral brookite, andradite, apatite, sphene, and metamict minerals.

SYENITE PEGMATITE

Few syenite pegmatite dikes (map-unit 8b) occur within the Khartum map-area. They are found as irregularly shaped bodies and dikes in syenite and wacke layers west of Jeffers Lake; they weather light pink, are coarse grained, and massive. The syenite pegmatites are usually thin and have pods and aggregates of pyroxene. One such syenite pegmatite less than 2 m wide is exposed on Highway 41 west of Jeffers Lake and is composed of microcline (15 percent), perthite (60 percent), orthoclase (15 percent), and albite (10 percent). Also present are accessory yellow needle-shaped uranothorite grains.

Cenozoic

QUATERNARY

Pleistocene and Recent

The entire area was glaciated during Pleistocene times (Chapman and Putnam 1966, 1972). The northern flanks of some rock controlled hills are covered with till. Glacial striae indicate the direction of ice movements was S10E. In the area south of Burns Lake drumlins are developed in bouldery sandy till. There are extensive outwash sand plains in the valleys along the Madawaska River and Highland Creek. North of Shortcut Lakes a long narrow esker of sand and gravel can be traced for 300 m in a north-south direction.

Small swampy areas are found in the vicinity of Two Islands, Highland, Grassy, McMaster, Cameron and Burns Lakes. Dark peaty organic mud occurs in these areas and in shallow lakes and beaver ponds in the map-area.

STRUCTURAL GEOLOGY

The Khartum map-area lies 10 to 20 km southeast of the boundary between Middle and Late Precambrian supracrustal sequences in the Grenville Province (Ayres *et al.* 1971). Owing to the high degree of metamorphism in the map-area and the scarcity of recognizable and reliable primary features in the rocks much of the stratigraphy is very difficult to interpret. However, the area is characterized by a central belt of felsic to alkalic intrusive rocks and remnant belts of metasediments to the northwest and southeast.

Foliation, Gneissosity, Schistosity

The majority of the metasediments have a moderately to well developed metamorphic gneissosity defined by mineralogical layering and grain size, such as the gneissosity of the marble exposed north of Tooey's Lake on Highway 41 (see Photo 2) and lithological layering such as the interlayered wacke and feldspathic arenite. The Three Mountains intrusion locally has a gneissic structure defined by the lit-par-lit arrangement of included metasedimentary bands. The gneissic structure exhibited in places by the intrusion itself may be a primary igneous structure.

The gneissosity within the metasediments has a northeast trend with southeasterly dips but in the Tincamp Lake area near the Three Mountains Pluton the dip of the gneissosity is to the north and steepens to a subvertical attitude. Local deflections from the overall gneissosity-foliation orientations are very common, notably where the plutonic rocks intrude the metasediments.

In the map-area, metamorphic foliation is typically defined by the subparallel alignment of mafic minerals (amphibole, biotite) and quartz, feldspar, and graphite. The Three Mountains Pluton locally exhibits a foliation defined by the subparallel alignment of feldspar phenocrysts within the porphyritic phases. The Burns Lake Syenite exhibits a foliation defined by the subparallel alignment of potassic feldspar crystals, biotite and amphibole.

Stereographic plots of poles to foliation and gneissosity from the Three Mountains area and surrounding areas (Figures 2,3) show shallow dips to the southeast and northeast strikes. However Domain III (Figure 3) east of Burns Lake has north-trending strikes and shallow dips to the east.

Southeast of Burns Lake the feldspathic arenite and amphibole gneiss exhibit a schistosity which is subparallel to the gneissosity. Schistose zones usually do not exceed 1 m in thickness and have a shallow dip. The author has interpreted this schistosity as a second planar structure formed as the result of movement along shallow dipping strike faults. Schistositities were observed also within the Balvenie syenite.

Cataclastic foliation was observed along several fault zones in the area. The cataclastic rocks range from mylonite gneiss to blastomylonite and ultramylonite as defined by Higgins (1971). In thin section, cataclasis is apparent in a blastomylonite, in a granite pegmatite from west of Two Island Lake, as pull apart, conjugate fractures, ellipsoidal feldspars and microfaults in the feldspars of the pegmatite. Also, a shear zone in marble (north of Rock Hill, northwest corner of the map-area) is characterized by ellipsoidal to rounded shape of phlogopite, calcite, feldspar porphyroclasts and bent phlogopite with deformation bands.

Lineation

Lineations formed by preferred orientation of minerals were observed mainly in the syenite bodies, and metasediments. In general they consist of elongated clots of amphibole-biotite in the syenite and elongated quartz grains in the metasediments. Lineations generally plunge southeast to east.

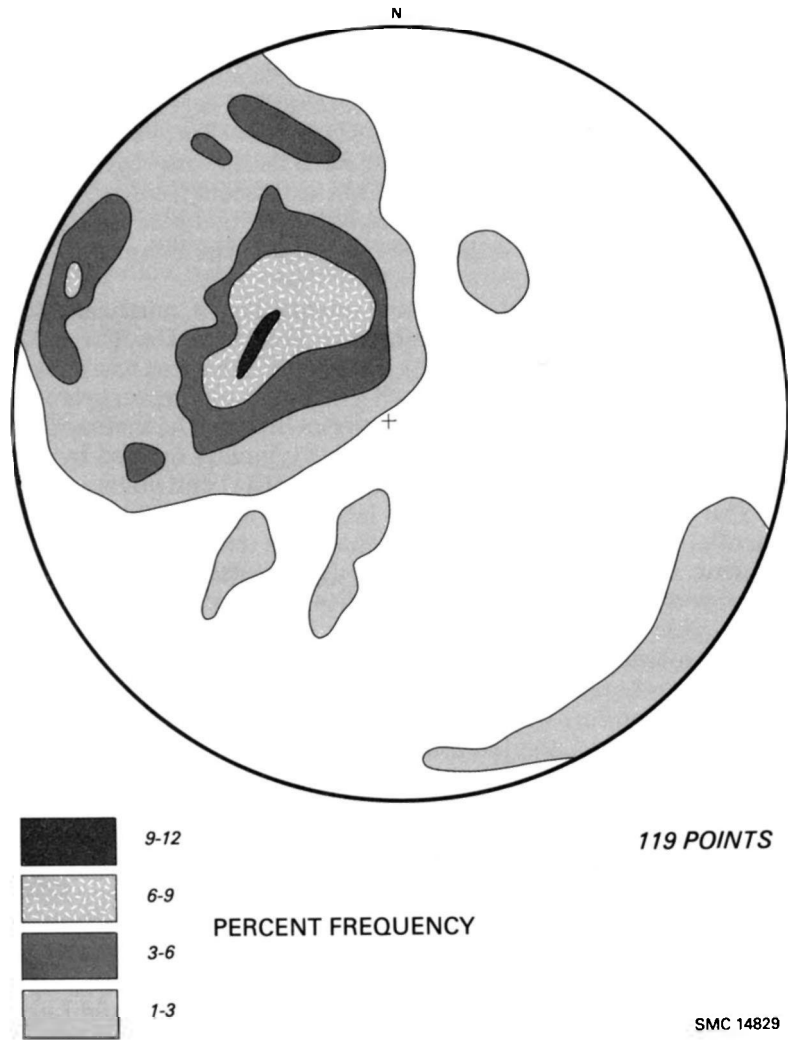


Figure 2—Contoured (percent frequency) equal area stereographic plot of poles to foliation gneissosity in the Three Mountains Pluton.

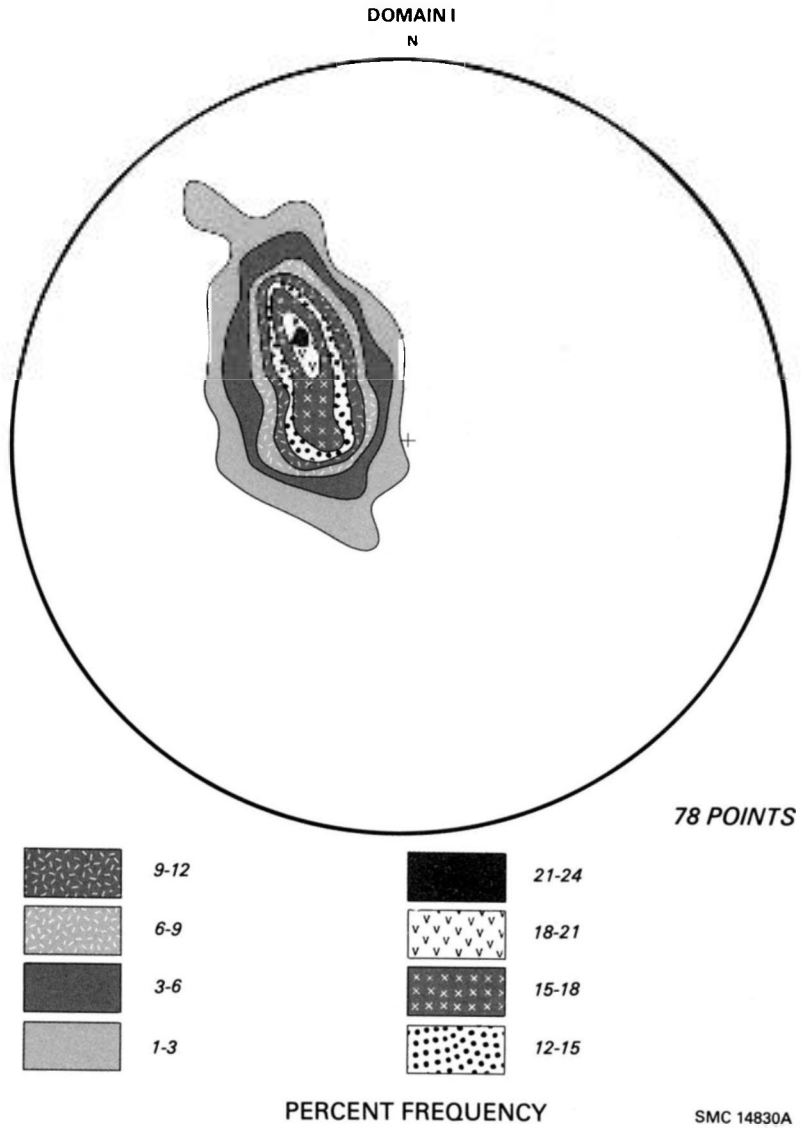


Figure 3—Contoured (percent frequency) equal area stereographic plots of poles to foliation gneissosity from four domains within the metasedimentary sequence southeast of the Three Mountains Pluton. Domain I: south of Haley Lake Fault, east of Highway 41 to McMaster Lake.

Geology of the Khartum Area

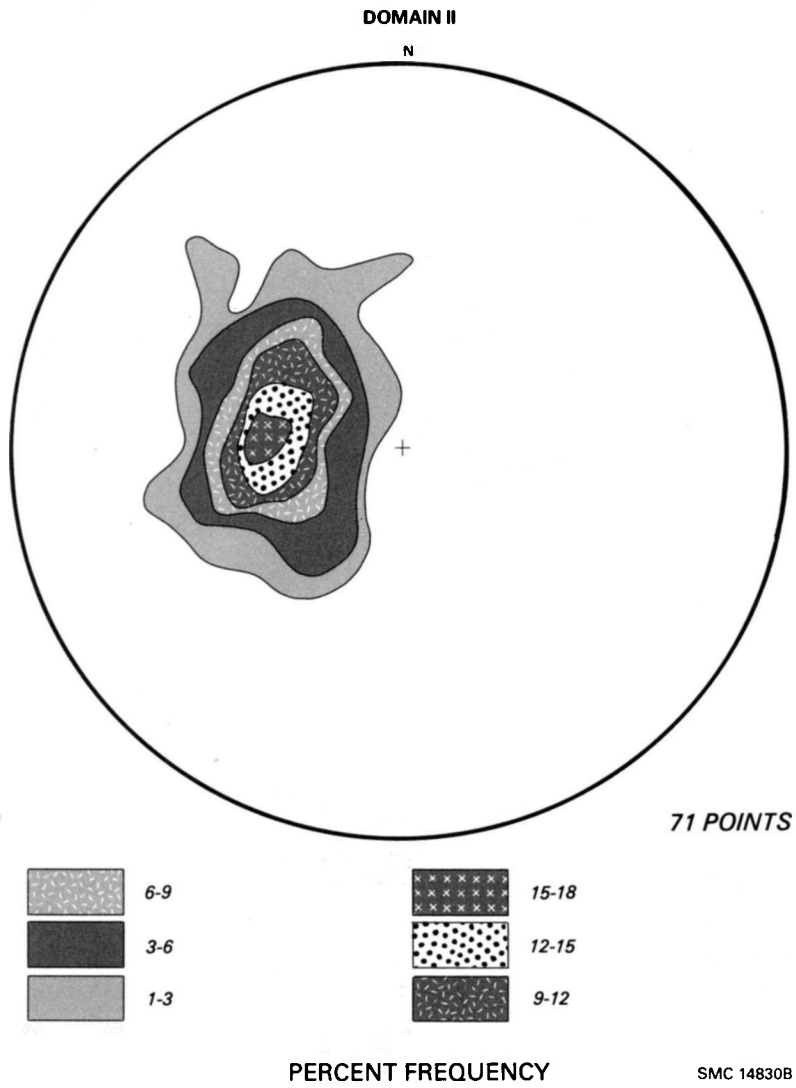


Figure 3 (cont.)—Domain II: north of Haley Lake Fault to Doorley Creek, east of Burns Lake to Black Donald Creek.

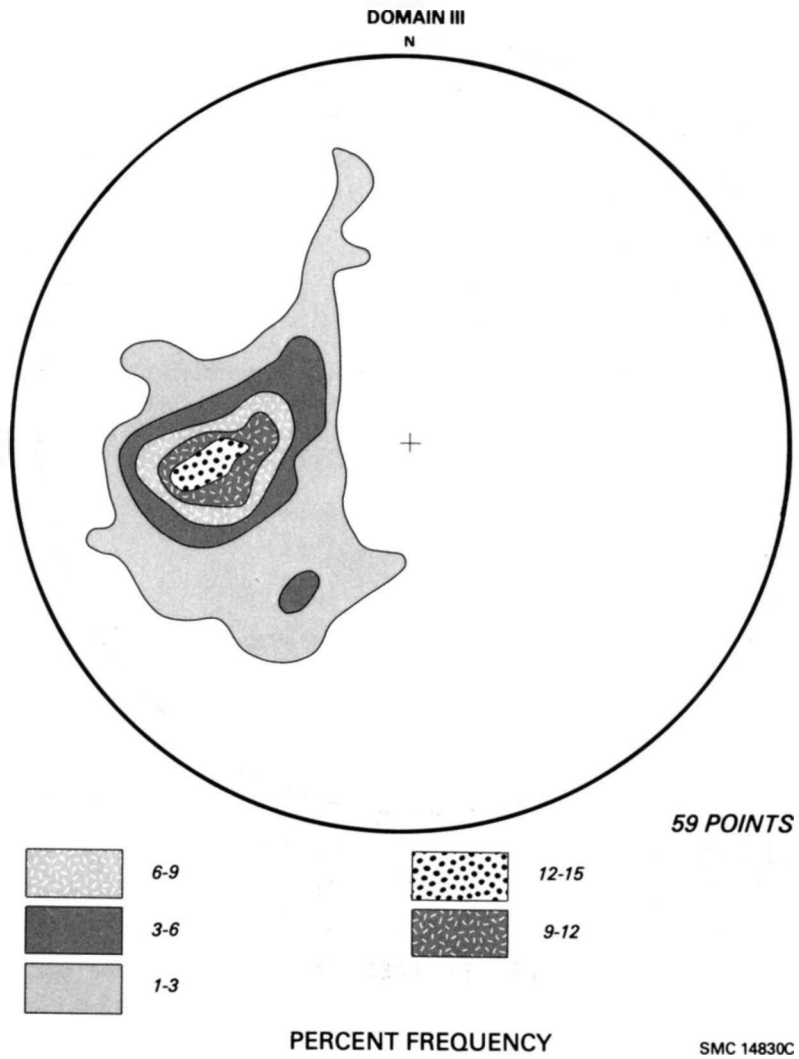


Figure 3 (cont.)—Domain III: north of Doorley Creek to Brougham Lake, east of Burns Long Lake to Louies Lake.

Geology of the Khartum Area

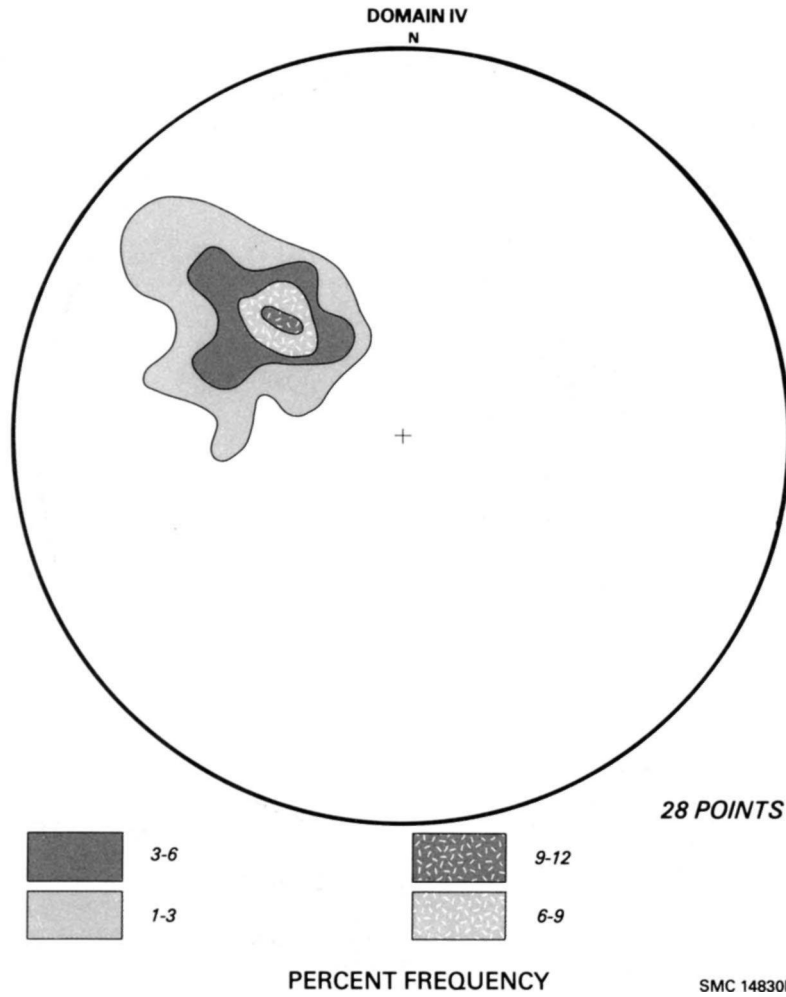


Figure 3 (cont.)—Domain IV: north of Brougham Lake, east from Crutch Lake to Tooey's Hill.

Joints

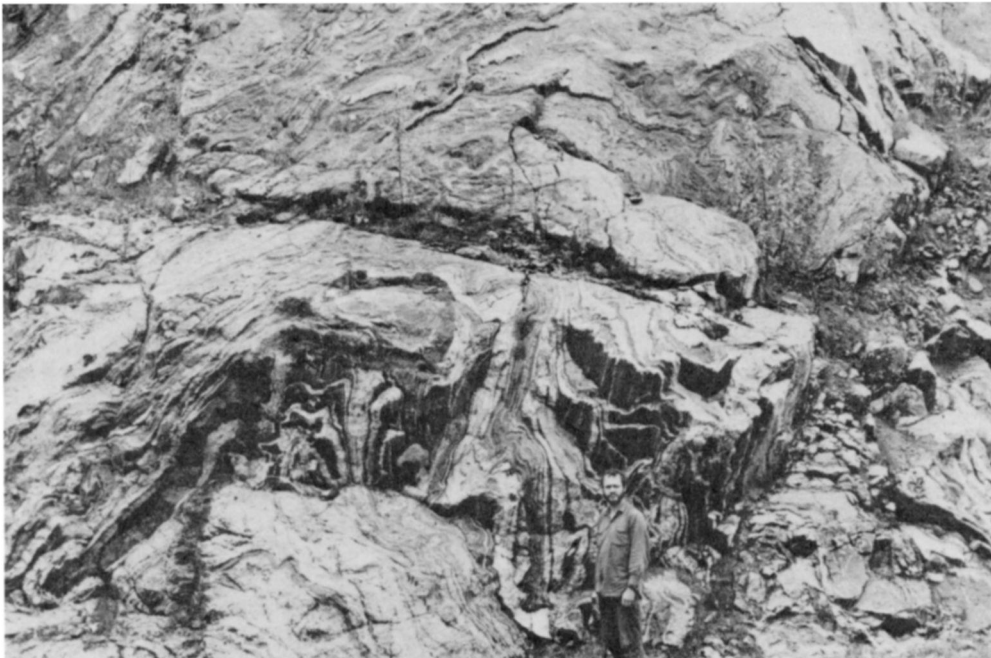
Joints are present within the felsic and alkalic complexes in the map-area . The major set of joints is subparallel to the Ottawa-Bonnechere faults (Themistocleous 1981) but two other trends are also present, one trending northeast and the other northwest.

Folding

Information on folding consists solely of strikes and dips of metamorphic foliation and gneissosity and depends on tracing marker horizons where available. Information from small scale folds and lineations provides limited indication of the complex structural history of the area.

Minor Folds

The rocks of the map-area have been folded and in many places disrupted by intrusive masses.



OGS 10 254

Photo 7—Highly contorted calc-silicate layers in marble; fold axes plunge steeply to southeast. Junction of Toeys and Black Donald Creeks.



OGS 10 255

Photo 8—Recumbent fold in interlayered calc-silicate rock and marble. Southwest of Jeffers Lake on Highway 41.

Minor folds varying from less than a metre to several metres in amplitude are common in the metasedimentary sequence. These folds are abundant to the southeast and east of the Three Mountains and Burns Lake intrusions, and most have shallow to moderate plunges to the southeast or east. They are also present northwest and west of the Three Mountains Pluton, where most have moderate easterly to southeasterly plunges. Most of the minor folds are observed in marbles intercalated with calc-silicate layers. These calc-silicate layers are commonly highly contorted (Photo 7) with the fold axis steeply dipping to the east. Other minor folds however have axes with shallow dip (Photo 8) to the east.

In general most of the folds present are of similar type (Ramsay 1967) but shear drag, and disharmonic folds are also present.

Faulting

Most of the major faults interpreted in this region cannot be well documented in outcrop. These faults have been inferred on the basis of linear to sub-linear topographic features visible on air photographs, and offset of lithological

contacts. On Map 2454 (back pocket) only the more obvious faults have been indicated.

There appear to be three sets of faults within the Khartum map-area, each of which may have been activated and reactivated at various times in the deformational evolution of the area.

The most prominent fault system in the map-area consists of a number of major subparallel east- to southeast-trending normal faults. These faults belong to the Ottawa-Bonnechere Graben system (Themistocleous 1981). Some of them continue west-northwest of the map-area, and are characterized by very small horizontal displacement (Kay 1942).

Faults of northeasterly strike are less well developed than the above mentioned and are mainly found within the Three Mountains Pluton. Strong negative topographic lineaments characterize these faults.

One other set of faults trends northeasterly, parallel to the regional foliation-gneissosity trend, and also parallel to contacts between lithologic units. As a result these faults are difficult to recognize. However schistose zones, cataclastic foliation, gouge zones and topographic lineaments attest to their presence. These strike faults are characterized by low dip angles and are generally found east of Burns Lake.

CORRELATION OF GEOLOGY WITH AEROMAGNETIC DATA

An airborne magnetometer survey was made in 1949 covering the Khartum map-area. Flights were made at an altitude of 1000 feet along north-south lines spaced at about ½ mile intervals. Results of this survey are given in Map 100G (GSC 1952). A brief discussion of these results and a tentative correlation of some of them with geology are given below.

In general, no trends of the larger structural elements nor the outlines of the larger intrusive masses are discernible. However the complex geology of the area is reflected in a very complex and broken up pattern of magnetic intensities.

The average magnetic background in the area is 1400 gammas. The high and low magnetic areas are only a few hundred gammas above or below that background except the Burns Lake Syenite (2300 gammas), Mount St. Patrick Syenite (1800 gammas), and Highland Lake gabbro (1800 gammas). No obvious relationship of magnetic pattern and geology is apparent in the map-area from the present aeromagnetic data.

There is a marked contrast between the Burns Lake Syenite and adjacent metasediments and intrusive rocks, and this is due to higher magnetite content in the syenite. The greatest magnetic intensity (2300 gammas), is shown by this mass. Similar higher magnetic response corresponds to the Mount St. Patrick Syenite. The Highland Lake gabbro has a moderate magnetic intensity of 1800 gammas which corresponds to the high proportion of iron-rich mafic minerals and the presence of magnetite. Greatest magnetic relief occurs within the Three Mountains granite-granodiorite pluton (1300 gammas) and within carbonate metasediments (1200 gammas). In general low magnetic intensities correspond to carbonate metasediments and some felsic intrusive rocks. The Three Mountains Pluton is characterized by moderate magnetic intensities north-

west, north and east due to assimilation by the pluton of gabbro, amphibole-rich gneiss and feldspathic arenite remnants; some of these xenoliths are still preserved (see Map 2454, back pocket). The magnetic relief of the pluton southeast of Godin Lake reflects the low ferromagnesian content of the body in that particular area, the greater amount of porphyritic phase of granite with less than 3 percent iron-rich minerals, and also the presence of carbonate xenoliths.

In summary, areas underlain by carbonate metasediments appear to have low magnetic relief. The mafic intrusions have moderate magnetic relief. The alkalic intrusive complexes are characterized by areas of greater magnetic intensity and greater magnetic relief and this reflects the two distinct types of alkalic complexes: the melasyenites and leucosyenites respectively. The felsic intrusions have moderate magnetic intensities and great magnetic relief as mentioned above.

The Haley Lake Fault is expressed by a very weak magnetic anomaly, but in general the late high-angle faults in the area have no magnetic expression.

ECONOMIC GEOLOGY

Mineral Exploration

Exploration in the Khartum map-area has been carried out for molybdenum, graphite and uranium at a number of localities.

Before the turn of the century, mineral exploration for molybdenum was carried out at several localities in the eastern part of the area (Satterly 1945). This activity resulted in the discovery and development of economic molybdenum deposits, the Spain and Sunset mines, during the early 1910s, near Jeffers Lake. Several shafts and trenches are still evident remnants of this activity.

Graphite was discovered in 1880 in Lyndoch Township by Don Moriarty of Eganville. Most of the development work was done by Messrs. Beidelman and Lyall in 1917 (Satterly 1945).

Exploration for uranium was carried out in 1957 by Conrad Uranium Mines Limited in Griffith Township and in 1957 and 1976-1977 by Imperial Oil Limited in Griffith and Brougham Townships respectively (Assessment Files Research Office, Ontario Geological Survey, Toronto).

Metallic Mineralization

MOLYBDENUM

Molybdenite was observed in several places within the map-area (properties 7 and 8) as disseminated flakes within hornblende-plagioclase gneiss, as veins within fractured sulphide zones in amphibole-plagioclase gneiss, and occasionally as pods of pyrite-pyrrhotite-molybdenite within a set of northeast-

trending, vertically dipping joints. The joints within the amphibole-plagioclase gneiss were seen in places to be "coated" by pegmatite a few centimetres wide.

SULPHIDE MINERALIZATION

Minor disseminated pyrite and pyrrhotite occurs locally within marble (map-unit 3a), rusty gneiss (map-units 1d, 2d), and calc-silicate gneiss (map-unit 2b). Assays for precious and base metals from samples collected by the field party in 1978 are given in Table 6.

RADIOACTIVE MINERALIZATION

The radioactive mineralization occurs predominantly within late massive, red granite pegmatite dikes, within minor foliated granite pegmatite dikes, and within sulphide mineralization.

The radioactive, late, red granite pegmatite dikes are coarse grained, massive, and consist essentially of quartz-feldspar \pm amphibole \pm magnetite. They have sharp contacts with the host rocks and in places they have accessory minerals such as: zircon, sphene, andradite, anatase, and metamict minerals.

A spectrometer (TV-1 McPhar) survey undertaken during the 1978 field season indicated that most magnetite-bearing granite pegmatites in the area are radioactive. Selected grab samples collected by the field party from Griffith, Sebastopol and Brougham Townships were analyzed by the Geoscience Laboratory, Ontario Geological Survey. These selected samples (Table 7) show that most of the radioactivity is due to a high thorium content except one sample 78-K-831 taken from west of Merchands Lake, lot 34, concession IV, Griffith Township. This sample returned values of 0.11 percent U_3O_8 , 5.0 percent Th and 4.98 percent K_2O (see Table 7). Radioactive mineralization is recognized by (1) red discolouration ("hematization", Satterly and Hewitt 1955; Satterly 1957; Themistocleous 1981), (2) radiating fractures around metamict porphyroblasts which are typical of the radioactive minerals (Photo 9), (3) yellow anatase (alteration product of sphene) and (4) yellow needle-shaped uranothorite (Photo 10).

RARE EARTH ELEMENTS

Rare earth element (REE) concentrations have been determined from 19 radioactive granite pegmatites. High REE concentrations are present in the Jims Mountain, Brougham Lake, and Beaver Lake granite pegmatites. Values up to 1.3 percent Nd, 1.0 percent La, 2440 ppm Ce and 7 ppm Sc (Table 8) were obtained from the Jims Mountain granite pegmatite. In general, the granite pegmatites which carry high concentrations of REE are characterized by high radioactivity and abundant magnetite. The magnetite is observed close to the contact of the pegmatite and the host rocks.

TABLE 6: ASSAYS FOR PRECIOUS AND BASE METALS, KHARTUM MAP AREA. ASSAYS BY GEOSCIENCE LABORATORIES, ONTARIO GEOLOGICAL SURVEY.

SAMPLE NO. *	Au ppb	Ag ppb	Cu ppm	Mo ppm	Description	Location
78-T-736A	10A	3A	38A	8A	Syenite pegmatite	Northwest of Jeffers Lake.
78-T-736B	10	3	108	9	Syenite pegmatite	Northwest of Jeffers Lake.
78-T-736C	10	3	77	18	Syenite pegmatite	Northwest of Jeffers Lake.
78-T-765	10	3		8	Syenite pegmatite	South of Jeffers Lake.
78-T-782	10	3	220	16	Granite pegmatite	Northwest of Jeffers Lake.
78-T-781A	10	3	12	12	Granite pegmatite	Northwest of Jeffers Lake.
78-T-779-1	10	3	220	16	Feldspathic arenite	Highway 41, northwest of Jeffers Lake.
78-T-779-2	10	3	104	11	Feldspathic arenite	Highway 41, northwest of Jeffers Lake.
78-T-779-3	10	3	126	44	Feldspathic arenite	Highway 41, northwest of Jeffers Lake.
78-T-779-4	10	3	78	21	Feldspathic arenite	Highway 41, northwest of Jeffers Lake.
78-T-779-5	10	3	172	14	Feldspathic arenite	Highway 41, northwest of Jeffers Lake.
78-T-779-6	10	3	8	8	Feldspathic arenite	Highway 41, northwest of Jeffers Lake.
78-K-900	10	3	15	8	Feldspathic arenite	North of Merchands Lake.
78-K-1053-3	20	3	3000	8550	Calcareous metasediment	Spain mine.
78-K-1053-4	10	3	111	6660	Calcareous metasediment	Spain mine.
78-K-1053-6	30	3	260	32	Pyroxene pegmatite	Spain mine.
78-T-820	10	3	300	20	Pyrite-pyrrhotite	Northeast of Tooeys Lake.
78-K-1050	10	3	33	945	Syenite pegmatite	Sunset mine.
78-K-2	trace	3	280A		Calcareous metasediment	South of Highland Falls.
78-T-57	trace		420		Marble	East of Spring Mountain.
78-T-196	0.01 oz./ton				Amphibole- plagioclase gneiss	North of Fox Lake.

A--Atomic Absorption

*Also assayed for Pb and Zn, but none detected.

TABLE 7: ASSAYS OF RADIOACTIVE SAMPLES FOR U₃O₈, TH, AND K, KHARTUM MAP AREA.

SAMPLE NO.	ROCK TYPE	LOCATION	URANIUM (U ₃ O ₈) ppm	THORIUM (Th) ppm	POTASSIUM (K ₂ O)%
78-T-185	Granite pegmatite	N of Jims Mountain	5	230	4.03
78-T-220	Granite pegmatite	NE of Beaver Lake	10	600	6.45
78-T-213	Granite pegmatite	SE of Highland Lake	12	210	0.88
78-K-279		N of Lamberts Lake on Highland Creek	1	130	6.42
78-K-286	Granite pegmatite	N of Beaver Lake	1	70	2.88
78-K-289	Granite pegmatite	WNW of Beaver Lake	8	840	3.89
78-K-297	Granite pegmatite	370 m S of Brougham Lake	380	2200	1.75
78-T-254	Feldspathic arenite	N of Highland Lake	75	260	2.39
78-K-125	Granite pegmatite	NW of Sharbert Rock	1	40	1.00
78-T-267	Granite pegmatite	S of Beaver Lake	24	980	3.94
78-T-272A	Granite pegmatite	S of Beaver Lake	29	1980	0.98
78-T-272	Granite pegmatite	S of Beaver Lake	1	50	5.17
78-T-273	Granite pegmatite	S of Beaver Lake	47	3010	1.87
78-K-371A	Granite pegmatite	E of Highland Lake	3	30	1.22
78-K-371B	Granite pegmatite	E of Highland Lake	22	1080	7.62
78-T-400	Granite pegmatite	S of Two Islands Lake	6	40	3.30
78-K-524	Granite pegmatite	Godin Lake	13	710	3.42
78-T-471	Granite pegmatite	E of Highway 41, SE of Khartum	140	400	3.97
78-T-402B	Granite pegmatite	S of Madawaska River	5	170	3.80
78-T-466	Granite pegmatite	E of Highway 41, SE of Khartum	230	920	2.82
78-T-339A	Granite pegmatite	NE of Hardwood Lake	2	20	4.30
78-T-402	Granite pegmatite	S of Twin Islands Lake	2	100	2.54
78-T-327	Granite pegmatite	W of Wolf Island	9	350	0.94
78-T-339B	Granite pegmatite	NE of Hardwood Lake	6	20	4.48
78-K-1053	Massive sulphides	Spain mine	100	3060	
78-T-71	Granite pegmatite	S of Muskrat Lake	-	40	5.97
78-T-56	Granite pegmatite	E of Spring Mountain	15	50	4.90
78-T-75	Granite pegmatite	SE of Dicks Lake	59	200	0.02

continued

TABLE 7 (continued)

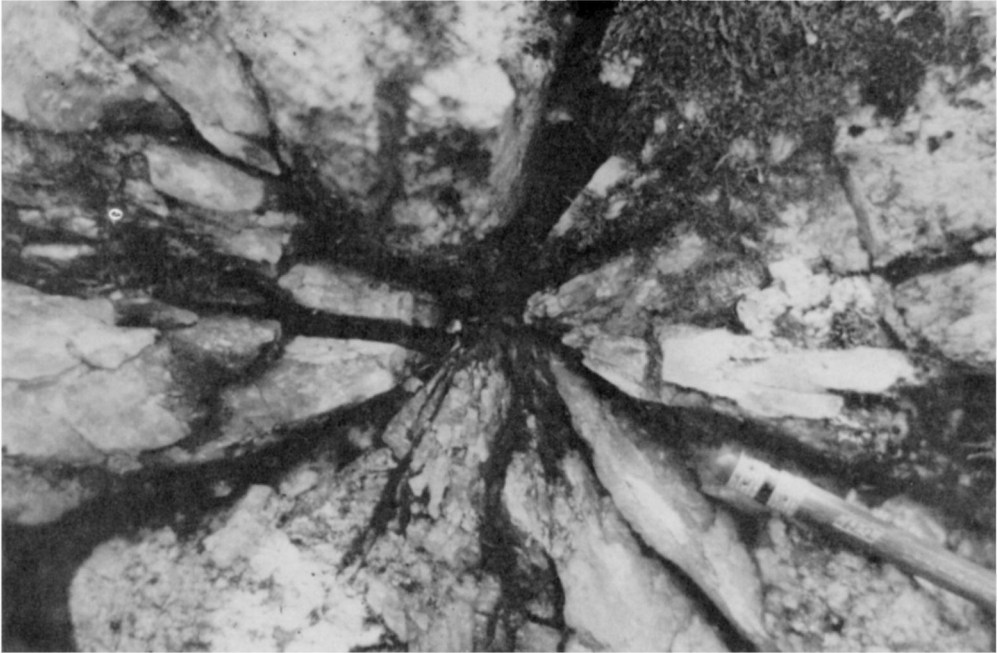
SAMPLE NO.	ROCK TYPE	LOCATION	URANIUM (U ₃ O ₈) ppm	THORIUM (Th) ppm	POTASSIUM (K ₂ O)%
78-K-127	Granite pegmatite	NW of Sharbert Rock	24	150	4.06
78-T-98	Granite pegmatite	W of Sharbert Rock	11	60	2.28
78-T-984	Granite pegmatite	W of Sharbert Rock	12	250	1.95
78-K-453	Granite pegmatite	N of Godin Lake	6	70	1.05
78-K-151	Granite pegmatite	NNE of Godin Lake	3	10	0.88
78-T-103	Granite pegmatite	Waterfall Mountain	4	110	1.89
78-K-174	Granite pegmatite	NW of Little Graham Lake	1		
78-K-164	Granite pegmatite	SE of Graham Mountain	1	10	5.97
78-T-112	Granite pegmatite	SE of Little Graham Lake	31	250	2.60
78-T-119	Granite pegmatite	SE of Graham Mountain	1	10	5.69
78-T-140	Granite pegmatite	W of Shortcut Lakes	18	120	3.47
78-T-162	Granite pegmatite	SW of Jims Mountain	13	740	1.77
78-T-163	Granite pegmatite	Jims Mountain	120	2370	1.24
78-T-161	Granite pegmatite	SW of Jims Mountain	7	240	3.51
78-K-222	Granite pegmatite	N of Graham Mountain	2	100	5.13
78-K-221	Granite pegmatite	E of Canoe Lake	10	140	6.22
78-K-219	Granite pegmatite	E of Canoe Lake	2	120	1.23
78-T-507	Granite pegmatite	NW of Fox Lake	-	-	1.28
78-T-556	Granite pegmatite	SE of Burns Lake	-	-	1.71
78-T-556B	Granite pegmatite	SE of Burns Lake	-	-	3.28
78-T-583	Granite pegmatite	W of Haley Lake	-	-	2.54
78-K-831	Granite pegmatite	W of Merchands Lake	1100	5.0%	4.98
78-T-669	Granite pegmatite	W of Burns Lake	-	-	0.82
78-T-736	Syenite pegmatite	NW of Jeffers Lake	25	1	6.4
78-T-755	Granite pegmatite	SE of Merchands Lake	75	54	7.7
78-T-768	Granite pegmatite	SE of Burns Lake	74	56	0.7
78-T-782	Granite pegmatite	Highway 41 near Jeffers Lake	11	270	5.1
78-T-781A	Granite pegmatite	Highway 41 near Jeffers Lake	13	230	4.6

continued

TABLE 7 (continued)

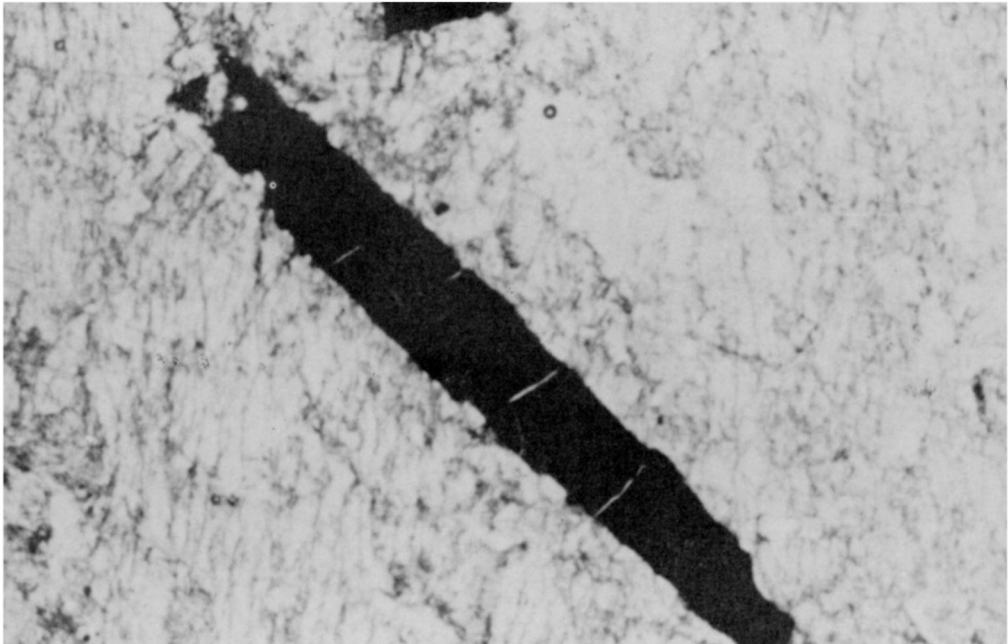
SAMPLE NO.	ROCK TYPE	LOCATION	URANIUM (U ₃ O ₈) ppm	THORIUM (Th) ppm	POTASSIUM (K ₂ O)%
78-T-867	Granite pegmatite	NE of Rock Lake	26	1.1%	1.6
78-T-905	Granite pegmatite	Imperial Oil occurrence	29	1.310%	2.0
78-T-975	Granite pegmatite	SE of Burns Lake	8	620	2.4
78-T-780C	Granite pegmatite	Highway 41 near Jeffers Lake	5	7	0.2
78-T-783	Feldspathic arenite	Highway 41 near Jeffers Lake	6	0	7.6
78-T-817	Granite pegmatite	Highway 41 near Tooeys Lake	140	840	7.2
78-T-818	Granite pegmatite	Highway 41 near Tooeys Lake	42	1450	0.8
78-K-1053-4	Amphibole Gneiss	Spain mine	60		
78-K-1053-3	Amphibole Gneiss	Spain mine	14		
78-K-1050	Skarn	Sunset mine	80	620	2.4
78-T-733	Granite pegmatite	W of Jeffers Lake	85	1060	3.2
78-T-7369	Syenite pegmatite	NW of Jeffers Lake	1	10	3.0
78-T-736B	Syenite pegmatite	NW of Jeffers Lake	40	20	1.5
78-T-736C	Syenite pegmatite	NW of Jeffers Lake	125	100	6.4
78-T-765	Syenite pegmatite	S of Jeffers Lake	8	20	3.6
78-T-7779	Granite pegmatite	S of Burns Lake	8	160	6.6
78-T-780A	Granite pegmatite	NW of Jeffers Lake	45	420	10.2
78-T-780B	Granite pegmatite	NW of Jeffers Lake	13	40	5.6
78-T-780C	Pyroxenite	NW of Jeffers Lake	36	70	0.2

Geology of the Khartum Area



OGS 10 256

Photo 9—Radiating fractures in quartz around a metamict mineral. South of Merchands Lake.



OGS 10 257

Photo 10—Photomicrograph (plane light, $\approx 80X$) of uranothorite crystal in syenite pegmatite. West of Jeffers Lake.

TABLE 8: REE ABUNDANCES IN GRANITE PEGMATITES MEASURED BY SPECTROGRAPHIC AND X-RAY FLUORESCENCE. ANALYSES BY GEOSCIENCE LABORATORIES, ONTARIO GEOLOGICAL SURVEY.

SAMPLE	La ppm	Nd ppm	Ce ppm	Sc ppm	Location
78-T-103	100	100	170	5	South of Waterfall Mountain.
78-K-174	100	100	50	5	Northwest of Little Graham Lake.
78-K-164	100	100	50	5	Southeast of Graham Mountain.
78-T-140	100	100	50	5	West of Shortcut Lakes.
78-T-162	100	100	200	5	Southwest of Jims Mountain.
78-T-163	200	100	930	5	Southwest of Jims Mountain.
78-K-222	100	100	100	5	North of Graham Mountain.
78-K-221	100	100	50	5	East of Canoe Lake.
78-K-219	100	400	50	5	East of Canoe Lake.
78-T-135	100	100	60	25	North of Jims Mountain.
78-T-220	800	300	830	5	Northeast of Beaver Lake.
78-T-213	100	100	50	5	Southeast of Highland Lake.
78-K-297	0.26%	0.22%	3340	20	380 m south of Brougham Lake.
78-K-125	100	100	180	5	Northwest of Sharbert Rock.
78-T-267	100	100	50	5	South of Beaver Lake.
78-T-272a	100	100	90	5	South of Beaver Lake.
78-T-272	100	100	50	5	South of Beaver Lake.
78-T-273	1.0%	1.3%	2440	7	South of Beaver Lake.
78-K-127	100	100	100	5	Northwest of Sharbert Rock.

Non-Metallic Mineralization

GRAPHITE

Graphite occurs as disseminated tabular flakes or scales, as massive amorphous pods, as veins and streaks or as bands. In the Khartum map-area graphite is found within marble and in few places within feldspathic arenite (map-unit 1b).

NEPHELINE

The nepheline-bearing gneisses found in Sebastopol, Griffith and Brougham Townships are closely associated with potassic syenite, marble and amphibole-rich metagabbro. The gneissic nepheline syenite in Sebastopol Township could be of future economic importance since it is approximately 300 m wide across strike and has a nepheline content between 10 and 30 percent, with variable amounts of mafic minerals (5-17 percent).

SAND AND GRAVEL

Sand and gravel deposits in the area are small and used for local construction, mainly for maintaining gravel surfaced township roads. There are a few large sand and gravel deposits along Highland Creek and north of Madawaska River which might serve areas outside of the map-area.

Description of Properties

BEIDELMAN AND LYALL PROSPECT (1)*

The graphite deposit in Lyndoch Township, concession II, lots 1 and 2, was discovered by D. Moriarty, of Eganville about 1880 (Satterly 1945). Most of the development work was done in 1917 by Messrs. Beidelman and Lyall (Satterly 1945). The workings are located just east of Jamieson Mountain, and can be reached by a wagon road running west from the road just west of the Highland Creek crossing.

These workings have been described in detail by Satterly (1945) and the writer's examination can add nothing to his description which is as follows.

In 1943 some of the workings were partly caved, overgrown, or filled with debris so that complete rock exposures were not available for examination. Six workings, in a general northeast-southwest direction, at intervals over a length of 1,900 feet, were seen [Figure 4]. In these workings the graphite occurs as disseminated flakes in narrow bands in white crystalline limestone. Phlogopite is usually present along with the graphite.

At the southwest end of "A", an open cut and pit expose several bands of graphite. The open cut is 15 by 20 feet with a 6-foot face. It exposes a zone of graphite-bearing limestone, which is 5 feet in width, strikes N.20°E, and dips 80°W. The graphite flakes are mainly from a twentieth to a tenth of an inch in diameter, but are occasionally as wide as a quarter of an inch. The graphite content across the 5 feet is estimated at 20 per cent. A small pit, 25 feet to the southeast of the open cut, exposes a number of narrow graphite-bearing bands alternating with barren bands across a total width of 5 feet. The graphite content across the 5 feet is estimated at less than 10 per cent.

Trench "B" is now largely caved in, and little can be seen. A little graphite was observed at one place.

Shaft "C", which is 10 by 10 feet and 35 feet deep, is surrounded by broken rock except at its northwest side. The banding in the limestone strikes N.45°E, and the dip is vertical. Material on the dump shows that the graphite-bearing bands in the crystalline limestone range from a mere row of flakes to bands 2 inches in width, and larger blocks indicate that some bands may be 4 inches wide. Phlogopite is nearly always present with the graphite. The barren limestone between the bands consists of a coarsely crystalline calcite. The amount of graphite ranges from less than 1 up to 20 per cent, and may average 5 per cent. The width of the graphite zone in the shaft could not be observed.

Trench "D" is irregular in shape. There is water in its southern part, and much debris or waste rock in other places. Four graphite-bearing zones were seen here. In the southeastern part two zones are 3 and 4 feet wide. At the extreme northwest end there is very little graphite. The zones may average 10 per cent graphite. As before, the graphite occurs disseminated in bands as much as an inch or more in width with barren coarse calcite between. Some much higher grade material (50 per cent) was found on the dump, but none could be seen in place. Freeman reports that near the centre of the zone bands from 1½ to 2 feet wide contain over 50 per cent flake graphite....

*Numbers in parentheses correspond to numbers on map face.

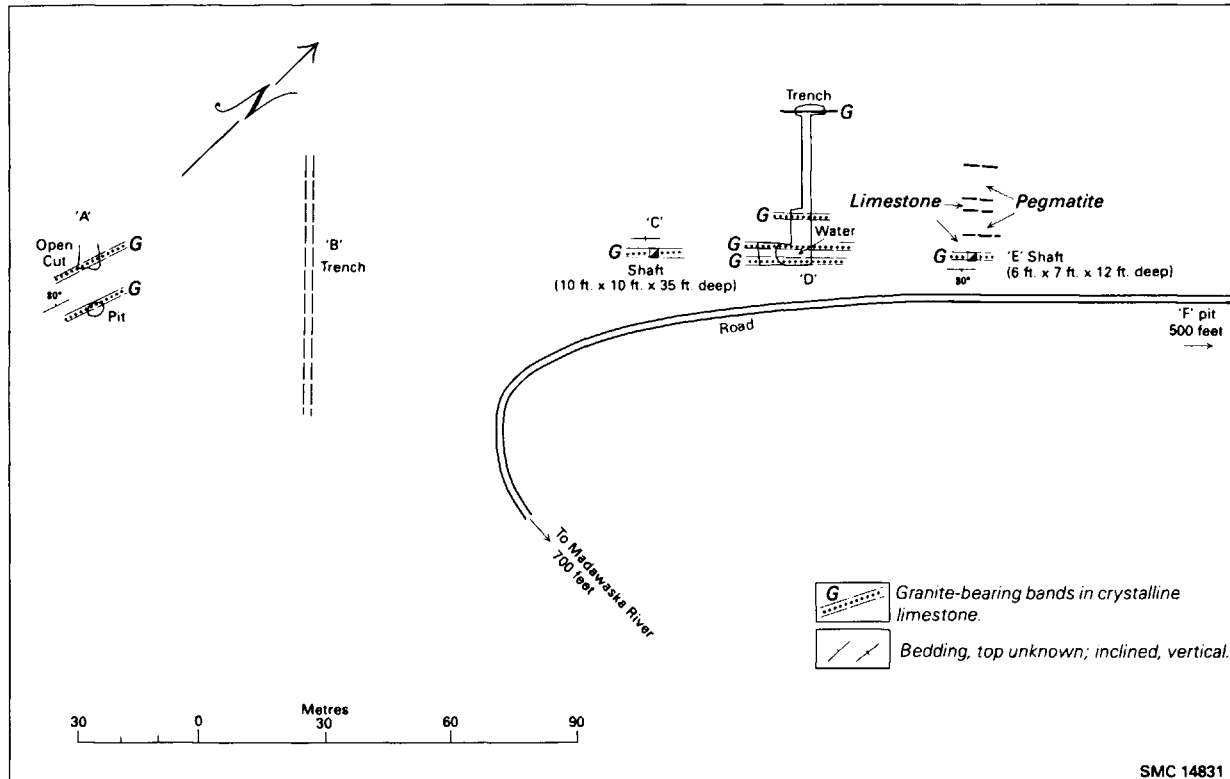


Figure 4—Sketch map of Beidelman and Lyall graphite prospect. From Satterly (1945). Lot 1, concession II, Lyndoch Township.

Geology of the Khartum Area

A shallow shaft, "E", 6 by 7 feet and 12 feet deep, exposes a 6-foot zone of disseminated graphite containing a 1-foot barren zone in the middle. On the northwest wall of the shaft a shear zone accounts for a rich band of graphite, from 3 to 4 inches wide. To the northwest of the shaft two pegmatite sills (?), 18 and 25 feet wide, intrude crystalline limestone containing less than 1 per cent graphite.

A pit, "F", 8 by 10 feet and from 3 to 6 feet deep at 1,225 feet northeast of shaft "E" exposes a low-grade 1-foot graphite zone in crystalline limestone.

The work to date, consisting of pits, trenches, and shafts at intervals over a length of 1,900 feet, has indicated the presence of a number of graphite-bearing zones in and parallel to the bedding of a crystalline limestone trending northeast and southwest. It is not certain that these zones are continuous. The grade of the zones and type of occurrence are such that further exploration may be warranted in order to prove the size and grade of the deposit as a whole.

CONRAD URANIUM MINES LIMITED [1957] (2)

In 1957 Conrad Uranium Mines Limited held two unpatented mining claims in lot 30, concession V, Griffith Township. In 1957, five diamond drill holes, totalling 80 m were drilled on the property. The five drill holes were located on lot 30, concession V, two on the southeast corner of the southern half lot, and the other three on the northeast corner of the northern half lot.

Only granite pegmatite and granite gneiss were encountered and the granite pegmatite was reported to be slightly radioactive (Assessment Files Research Office, Ontario Geological Survey, Toronto). The claims were allowed to lapse.

R.L.V. EKSTROM (3)

In late 1978, R.L.V. Ekstrom of Toronto held three patented claims to the north, northeast and east of the former Spain mine. These claims are located on lots 31 and 32 (south half), concession V, and lot 32 (north half), concession IV, Griffith Township.

FELHABER OCCURRENCE (4)

The Felhaber molybdenite occurrence is located on lots 14 and 15, concession II, Sebastopol Township. The workings lie immediately to the north of a bush road leading from the west end of Highland Lake northeast to an abandoned farm. The trenches are 425 m apart and were sunk in amphibole-plagioclase gneiss which is cut by small granite pegmatite dikes. Minor molybdenite was observed within the pegmatite dikes. The occurrence was described by Satterly (1945) as follows.

Two small workings have been opened on molybdenite showings in lots 14 and 15, concession II, Sebastopol Township, on the land of W. Felhaber. The showings lie just north of a wagon road and are 1,100 and 2,500 feet west of a farm-house on lot 16.

On lot 15, 1,100 feet west of the farm-house, a pit 4 by 10 feet and from 2 to 4 feet deep exposes rusty hornblende gneiss with bands of pink feldspar gneiss, which strikes N.85°W., dips 40°S., and

is cut by irregular stringers or dikelets of pegmatite. On the east wall of the pit rusty pegmatite contains disseminated pyrite and a few flakes of molybdenite. The main band of mineralized pegmatite, which is parallel to the gneissic structure, is about 18 inches wide.

On lot 14, 2,500 feet west of the farm-house, a shallow test pit 10 by 10 feet and from 3 to 4 feet deep is now filled with leaves and water. The outcrop is a brown to pink granite gneiss containing a rusty stringer of pegmatite mineralized with fine to coarse pyrite, some pyrrhotite, and chalcopyrite. No molybdenite was observed, although Mr. Felhaber reports a little was found in this pit.

IMPERIAL OIL OCCURRENCE (5)

In 1957, Imperial Oil Limited did exploration for uranium on lots 31, 32, 33, 34, concession V, Griffith Township, but no work was filed for assessment credit. In 1976, Imperial Oil Limited held 32 unpatented mining claims just west of Highway 41 and Tooeys Lake in the northwest corner of Brougham Township. These claims are located on the north half of lots 29 and 33, concession XVII. Geological mapping and radiometric surveys were carried out by Imperial Oil in 1976 on a 1 inch to 400 feet scale. Three diamond drill holes, totalling 135 m were drilled in 1977 testing radiometric anomalies located in granite pegmatite. The highest values of U_3O_8 obtained were 0.035 percent over 0.66 m (Assessment Files Research Office, Ontario Geological Survey, Toronto). These drill holes are located on the southern portion of the north half of lot 32, concession XVIII, 300 m southeast of Brougham Lake, immediately to the west of a gravel road leading to Two Islands Lake from Highway 41. From the writer's field examination of core these holes intersect late pink granite pegmatite and metamorphosed syenite gneiss. Radioactive minerals present are zircon and sphene. Metamict minerals are also present; red discolouration is spotty and associated with the radioactive areas. Two selected samples collected by the field party from this property and analyzed by the Geoscience Laboratories, Ontario Geological Survey, returned the following values: (sample 78-K-297) 380 ppm U_3O_8 and (sample 78-T-905) 29 ppm U_3O_8 (see Table 7).

LEPINE OCCURRENCE (6)

The Lepine occurrence was reported on by Satterly (1945) and was visited by the writer. This occurrence is located in the unsurveyed area of Griffith Township, about 210 m northeast of Godin Lake and 30 m to the northwest of a trail leading from Godin Lake to the northwest corner of Haley Lake. The workings consist of several trenches. The main trench is 15 m by 1.5 m and from 0.3 to 0.9 m deep. This trench exposes the contact between late granite pegmatite and diopside-phlogopite marble. Two smaller trenches occur to the north of the major one. A little molybdenite was seen within the diopsidic marble. Satterly (1945) reported on the occurrence as follows.

Nelson Lepine, of Griffith, did some work in 1939 on a molybdenite occurrence in the unsurveyed area of Griffith township between Haley (Round) and Godin (Green) lakes.... The occurrence is reached by turning off highway No. 41 to the farm of T. Haley in lot 25, concession V, Griffith township, and then following a wagon road to Haley lake and around its north shore to the northwest corner to a trail leading to Godin lake. From the farm to the workings is 2 miles.

Geology of the Khartum Area

The trail to Godin lake is flanked on either side by high rock ridges consisting of hybrid gneisses cut by granite-pegmatite dikes.

About 1,350 feet southwest of Haley lake and 115 feet northwest of the trail, a trench, 50 feet long, from 3 to 5 feet wide, and from 1 to 3 feet deep exposes the contact between a diopside-phlogopite limestone and a granite-pegmatite dike, which forms the face of the ridge slope. The dike trends N.30°E. and is 75 feet wide. At the northeast end of the pit the pegmatite is cut by two veinlets of pyrite. The weathering of these veinlets has caused much brown and black staining on the rock. A small dump shows a few large flakes of molybdenite in rusty pegmatite and in a pale-green pyroxenite presumably from the contact zone. No mineralization was seen in place.

Two small pits occur in rusty gneiss on the northwest side of the dike but show only negligible molybdenite and sulphide mineralization.

Another working on the same ridge is 400 feet northwest of the trail at a point 725 feet southwest of Haley lake. A small stripping and a pit, 4 by 5 feet and 3 feet deep, expose a rusty-weathering graphite-mica gneiss, striking N.25°W. and dipping 35°N.E., which is mineralized with finely disseminated pyrrhotite. No molybdenite was observed.

An examination of the rock ridges on both sides of the trail failed to reveal any mineralization in the numerous pegmatite dikes exposed.

J.R. LILL (SPAIN MINE) (7)

In late 1978 J.R. Lill from Scarborough, Ontario, held one patented claim on lot 31 (north half), concession IV, Griffith Township. This past-producing molybdenite mine is located about 200 m east of Highway 41.

The Spain mine was opened in 1912 by Joseph Legree of Renfrew and sold to W.J. Spain of New York in 1915 (Eardley-Wilmot 1925). Development work was carried out in 1916 to 1918 (Wilson 1920; Eardley-Wilmot 1925). This work consisted of a large open cut 36.3 by 22.7 m and 3 to 7.6 m deep (Eardley-Wilmot 1925), a shallow shaft 15.7 m deep, and about half a dozen small pits. It was taken over in 1918 by the Steel Alloys Corporation (incorporated to the Consolidated Molybdenum Steel Corporation, Eardley-Wilmot 1925). The North American Molybdenum Corporation acquired the property in 1939 and stripping, trenching, and drilling (1212 m) was done (Satterly 1945). New Far North Exploration Limited in 1965 sampled and drilled (unknown footage) the property. This company was the last to have done work on this property (Assessment Files Research Office, Ontario Geological Survey, Toronto).

Between 1916 and 1919, 104.6 tons of ore were treated yielding 8067 pounds of pure MoS₂ and 600 pounds of concentrates of unknown grade (Eardley-Wilmot 1925).

The main geological units in the area of the former Spain mine are as follows, in stratigraphic order from east to west.

- 1) Coarse grained marble (map-unit 3a) in the east side of the pit concordantly overlies amphibole gneiss. This marble consists mainly of calcite with accessory biotite and/or phlogopite and light green diopside.
- 2) Amphibole-plagioclase gneiss (map-unit 2a) that outcrops in the west side of the pit is a relatively thick unit which is exposed westwards for at least 170 m. The amphibole-plagioclase gneiss is interbanded with marble in the south part of the pit. It consists of horn-

blende, plagioclase and orthoclase and is medium to coarse grained with a distinct mineral alignment. Hornblende gneiss, hedenbergite gneiss and granitic gneiss are grouped on the present map under the amphibole gneiss map-unit (map-unit 2a). Karvinen (1973) observed that the hornblende-plagioclase gneiss which is in contact with the marble is unmineralized whereas the hedenbergite gneiss is mineralized.

3) Marble (map-unit 3a) intercalated with clastic metasediments (map-unit 1a) is exposed along the highway. This unit consists mainly of coarse-grained pink and white calcite, phlogopite and/or biotite and green diopside. It is intruded by a diabase dike 3 m wide.

4) Amphibole-plagioclase gneiss (map-unit 2a) outcrops along the highway and is intruded by granite pegmatite dikes (map-unit 8a) and a diabase dike (map-unit 7a). Gouge zones a few centimetres to 40 cm in width trend east and dip vertically. Ultramytonite is associated with these gouge zones. Shear zones trending north-northeast and plunging shallowly to the southeast are also present.

5) Felsic intrusive, granodiorite (map-unit 6a) is medium to coarse grained and consists of quartz, feldspar and biotite; it has a weak gneissosity.

The metallic minerals which occur in the Spain mine deposit, are principally molybdenite, pyrite, pyrrhotite, and minor chalcopyrite. Mineralization is found in the following forms: disseminated flakes of molybdenite or grains of pyrite-pyrrhotite; veins of massive molybdenite, pyrite, pyrrhotite and minor chalcopyrite; massive pods and layers of molybdenite and pyrite, pyrrhotite, and minor chalcopyrite parallel to the gneissosity of the amphibole-plagioclase gneiss.

The veins of massive sulphide mineralization are characterized by multiple fracturing. Wilson (1920) observed that the molybdenite-bearing aggregates and veins are irregular and nowhere more than 0.3 m in width. He estimated that the percentage of the mineralization is less than 1 percent by measuring the proportion of vein material to country rock in selected areas on the faces and bottom of the open cut.

Three selected samples (78-K-1053-3,4,6) collected by the field party from the open-cut dumps and analyzed by the Geoscience Laboratories, Ontario Geological Survey, returned values ranging from 8550 to 32 ppm Mo and 3000 to 111 ppm Cu and trace Ag and Au (see Table 6).

A "new" zone was outlined by the drilling done by North American Molybdenum Corporation in 1939 (Figure 5). This is a flat-dipping zone of pyroxene skarn overlain by marble which contains pyrite + molybdenite and is underlain by biotite gneiss. Both rock types are intruded by granite pegmatite (Assessment Files Research Office, Ontario Geological Survey, Toronto). The mineralized zone outlined has an areal extent of 60 m by 15 m and an average thickness of 1.5 m. The host rock of the 'new' mineralized zone (pyroxene skarn) is different from that (hornblende-plagioclase gneiss) worked in the past-producing open pit of the Spain mine. This 'new' zone lies 45 m southeast of the open pit and shows a general northeast trend and dips shallowly to the southeast.

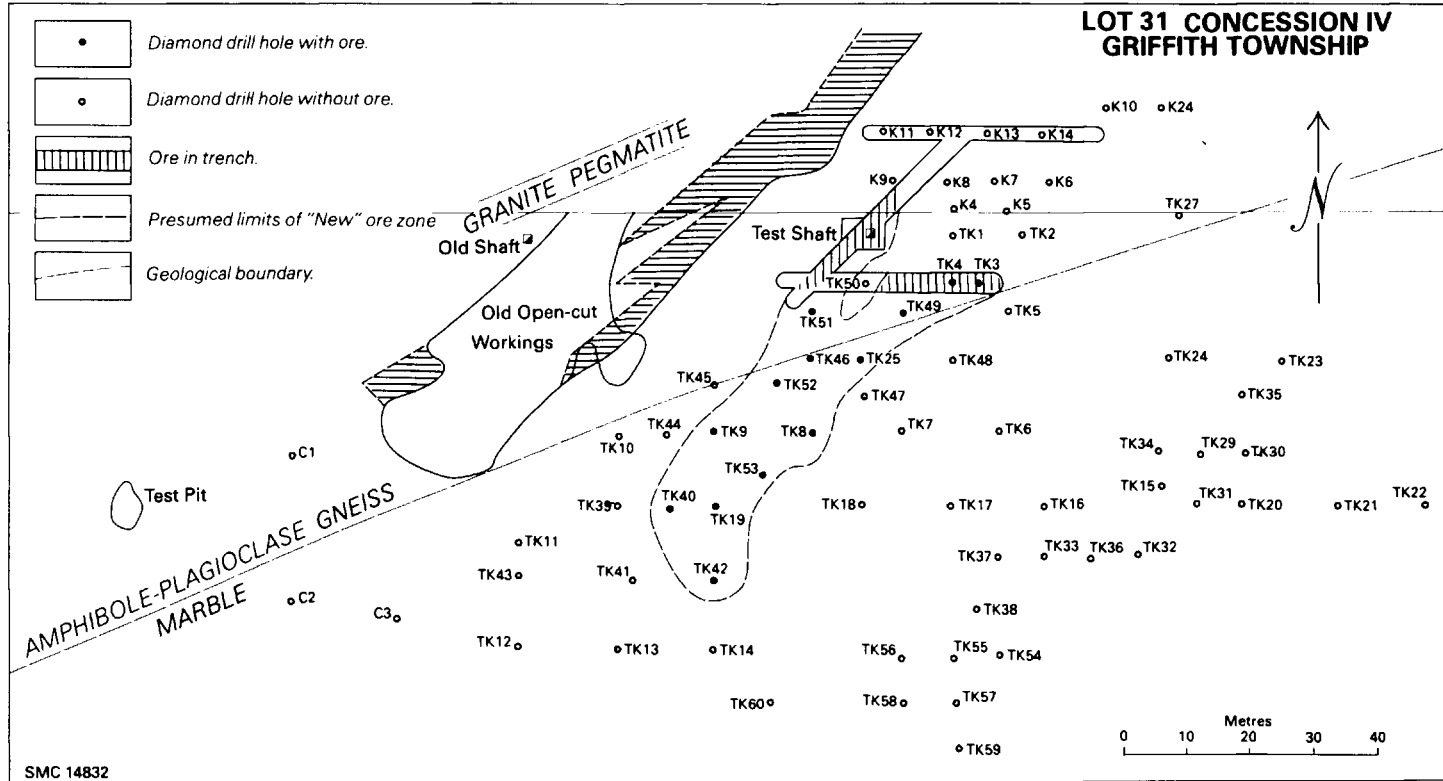


Figure 5—Sketch map of the Spain mine. Modified from plans of North American Molybdenum Corporation.

New Far North Exploration Limited in 1965 did a self potential survey over the property and outlined two anomalies: one over the open-cut with a weak southward extension and one over the 'new' mineralized zone which is open northward (Assessment Files Research Office, Ontario Geological Survey, Toronto).

In addition to the molybdenite, chalcopyrite and radioactivity were also detected by the author during the 1978 field season in the southwest side of the old open cut, associated with the other sulphide mineralization.

SUNSET OCCURRENCE (SUNSET MINE) (8)

The Sunset occurrence is located in Brougham Township, concession XIV, on patented lots 35-36. It is reached by following a farm road 1.2 km southeast from Highway 41; the main pit and shaft are adjacent to the farm road. The Sunset mine was opened prior to 1916 (Eardley-Wilmot 1925). The deposit, owned at that time by Joseph Legree of Renfrew, was in 1916 purchased by the Steel Alloys Corporation, who worked it in conjunction with their Spain mine in Griffith Township, 1.6 km to the west (Eardley-Wilmot 1925). Parsons (1917) estimated that there was about 8 tons of 3 percent ore and 300 pounds of flake in the dumps. In 1918 about 20 tons of ore ranging from 5.47 to 0.65 percent MoS₂ was sent to the Mines Branch, Ottawa (Sutherland 1919). Subsequent to that period no other work has been done on this deposit.

The workings consist of an open cut 21 m by 9 m and 1.8 m deep, just northeast of the road. Near the centre of this open cut is a vertical shaft 21 m deep (Eardley-Wilmot 1925). A small pit 9 m by 3 m by 1.5 m deep just southwest of the road is within actinolite-diopside skarn. This skarn is situated within marble which is cross-cut by granite pegmatite. No molybdenite was seen by the writer in these workings. A selected sample collected by the field party from this locality and analyzed by the Geoscience Laboratories, Ontario Geological Survey, returned the following values: 945 ppm Mo, 33 ppm Cu and less than 10 ppb Au (see Table 6).

The rock exposed in the pit is rusty weathering biotite-quartz gneiss, cut by a diabase dike on the northeast face of the pit and mapped by Vokes (1963) as fine grained, dark grey igneous rock of basaltic composition. The biotite-quartz gneiss is overlain by marble. Fragments of grey, foliated quartzitic arenite, called scapolite quartzite by Karvinen (1973) make up a small dump adjacent to the shaft. An actinolite-diopside-calcite skarn with euhedral light green diopside and dark green actinolite and called diopside skarn by Karvinen (1973), is exposed in a small pit immediately to the southwest of the road. A little molybdenite can be seen in place on the southwest side of the pit in sheared and gouged feldspathic arenite.

Exploration Considerations

The Khartum map-area is characterized by the presence of molybdenite-pyrite-pyrrhotite-chalcopyrite mineralization and radioactive mineralization. Experience in the area suggests a number of possible limiting conditions that might be useful in exploration for molybdenite and other sulphides:

- 1) stratigraphic control, i.e. the interface between hornblende-plagioclase gneiss and marble;
- 2) felsic intrusion in close proximity, accompanied by or preceded by faulting; and
- 3) multiple faulting and fracturing, providing channel ways for movement of the volatiles and deposition of the mineralized solutions.

In exploration for radioactive mineralization, the following factors appear to be important:

- 1) felsic intrusions, specifically unmetamorphosed late granite pegmatites;
- 2) presence of 5 percent or more magnetite in pegmatites; and
- 3) presence of metamict minerals and red discolouration.

The most favourable area for molybdenum-sulphides is located northeast of Strains Lake, extending to Jeffers Lake and Doorley Lake.

Some favourable areas for radioactive mineralization include the Jims Mountain area, south of Tooeys Lake and the Spain mine area.

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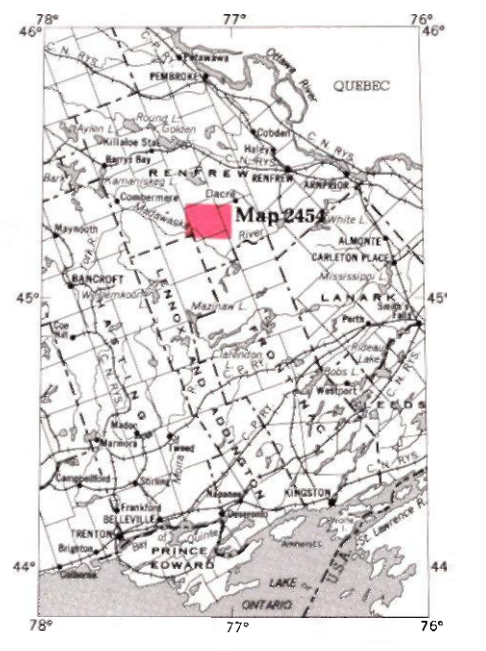
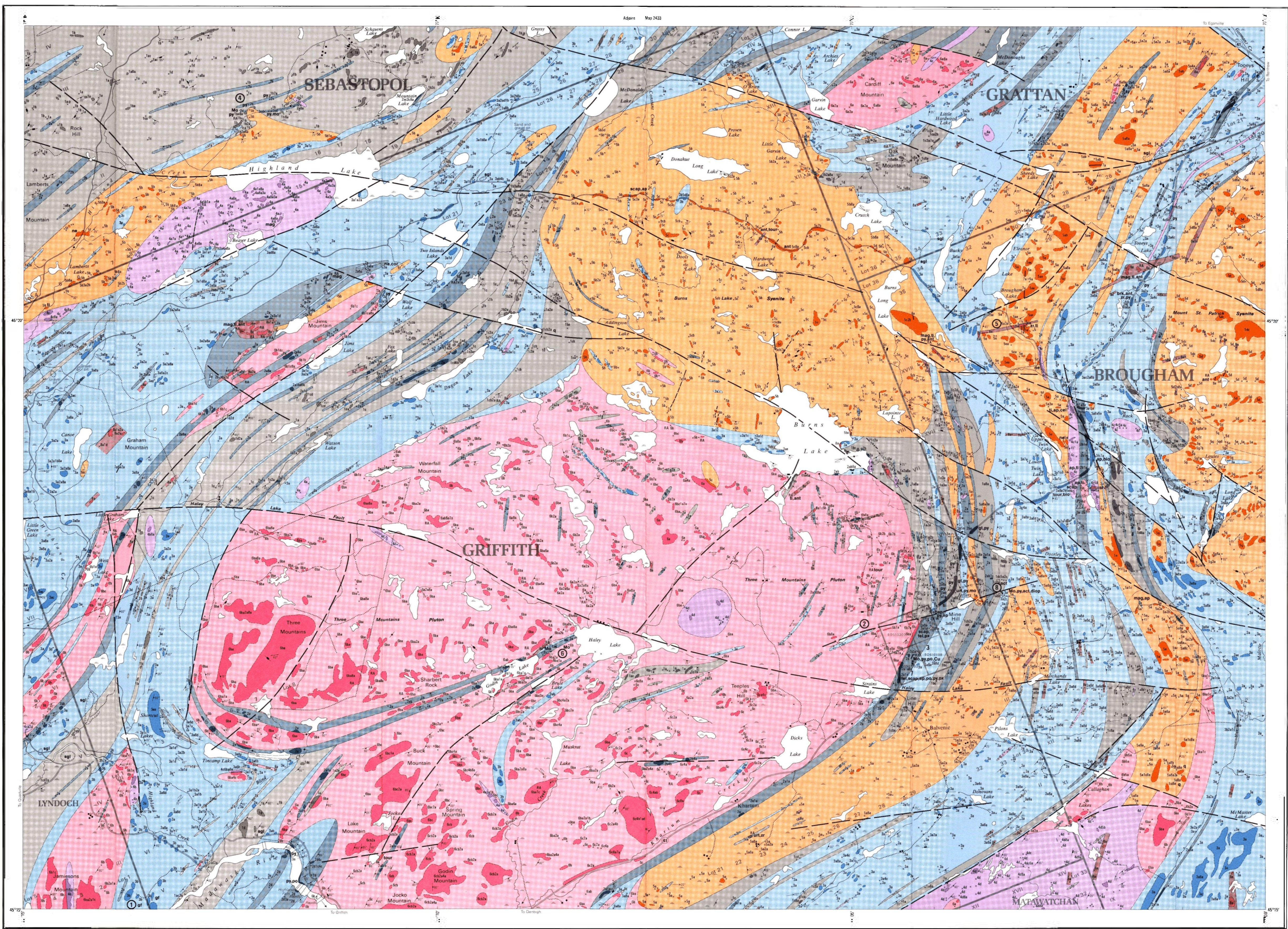
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- SYMBOLS**
- Glacial striae.
 - Small bedrock outcrop.
 - Area of bedrock outcrop.
 - Bedding, top unknown, (inclined, vertical).
 - Schistosity, (horizontal, inclined, vertical).
 - Gneissosity, (horizontal, inclined, vertical).
 - Foliation, (horizontal, inclined, vertical).
 - Lineation with plunge.
 - Geological boundary, observed.
 - Geological boundary, position interpreted.
 - Lineament or fault.
 - Joining, (horizontal, inclined, vertical).
 - Drag folds with plunge.
 - Drill hole, (vertical, inclined).
 - Shaft.
 - Radioactivity.
 - Swamp.
 - Motor road, provincial highway number enclosed where applicable.
 - Other road.
 - Trail, portage, winter road.
 - Township boundary, approximate position only.
 - Mining property, surveyed; approximate position only.
 - Surveyed line; approximate position only.
 - Mineral occurrence, mining property unsurveyed.

- PROPERTIES, MINERAL DEPOSITS**
1. Beideman and Lyal prospect.
 2. Corrad Uranium Mines (1957).
 3. Eickrom, R. L. V.
 4. Felhaber occurrence.
 5. Imperial Oil occurrence.
 6. Lepine occurrence.
 7. L. J. H. (Green mine).
 8. Sunset occurrence (Sunset mine).
- Information current to December 31, 1978.
Former properties on ground now open for staking are only shown if exploration data is available. A date in square brackets indicates last year of exploration activity. For further information see report.

- SOURCES OF INFORMATION**
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Geology is not tied to survey lines.
Regional maps and reports of the Ontario Geological Survey, Ministry of Natural Resources, and the Geological Survey of Canada.
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Cartography by P. A. Wisbey and assistants, Surveys and Mapping Branch, 1980.
Base maps derived from maps of the Forest Resources Inventory, Surveys and Mapping Branch, with additional information by S. G. Themistocleous.
Magnetic declination in the area was approximately 10° 10' West in 1976.

- CREDITS**
- The work reported here is a part of a Mineral Resources Assessment Project, Pembroke-Renfrew Region, it was equally funded by the Federal Department of Regional and Economic Expansion and the Ontario Ministry of Treasury and Economic Development under the Community and Resource Development Subsidiary Agreement.
- Parts of this publication may be quoted if credit is given. It is recommended that reference to this map be made in the following form:
Themistocleous, S. G. 1981. Khartum, Ontario Geological Survey Map 2454, Precambrian Geology Series, scale 1 inch to 1/4 mile, geology 1978.



- LEGEND**
- PHANEROZOIC CENOZOIC***
- QUATERNARY**
- PLEISTOCENE AND RECENT
Glacial and glaciofluvial deposits, swamps and stream deposits.
UNCONFORMITY
- PRECAMBRIAN***
- LATE PRECAMBRIAN UNMETAMORPHOSED PLUTONIC ROCKS**
- FELSIC AND ALKALIC INTRUSIVE ROCKS[§]
- 8a Pink granite pegmatite.
 - 8b Syenite pegmatite.
 - 8c Apatite.
 - 8d White granite pegmatite.
 - 8e Granodiorite.
- METAMORPHOSED PLUTONIC ROCKS**
- LATE MAFIC INTRUSIVE ROCKS[§]
- 7a Diabase.
 - 7b Diorite.
 - 7c Pyroxenite.
- FELSIC TO INTERMEDIATE INTRUSIVE ROCKS**
- 6a Granodiorite, granite.
 - 6b Leucocratic granite, granodiorite.
 - 6c Porphyritic granodiorite, granite.
- ALKALIC INTRUSIVE ROCKS**
- 5a Massive to gneissic, pink potassic syenite.
 - 5b Massive to lineated, leucocratic pink potassic syenite.
 - 5c Buff to dark green, melanocratic syenite.
 - 5d Massive, porphyritic, potassic syenite.
 - 5e Scapolitic, migmatitic syenite.
 - 5f Gneissic, grey-white nepheline syenite.
 - 5g Monzonite.
- EARLY MAFIC INTRUSIVE ROCKS[§]**
- 4a Massive, coarse-grained, porphyritic gabbro.
 - 4b Massive, fine to medium-grained gabbro.
 - 4c Plagioclase-hornblende-scapolite ± aegirine hornblende gneiss.
 - 4d Plagioclase-hornblende-biotite ± pyroxene ± magnetite gneiss.
- METASEDIMENTS[§]**
- CARBONATE METASEDIMENTS**
- 3a Gneissic, coarse-grained, idioptic calcitic marble.
 - 3b Massive, coarse-grained, idioptic calcitic marble.
 - 3c Marble, tectonic breccia.
 - 3d Massive, coarse-grained, dolomitic marble.
 - 3e Calcitic marble intercalated with 1a, 1b.
 - 3f Phlogopitic marble (phlogopite >20%).
 - 3g Diopside marble (calcite 60%, diopside + feldspar 40%).
- CALCAREOUS METASEDIMENTS**
- 2a Amphibole-plagioclase-quartz gneiss.
 - 2b Calc-silicate gneiss.
 - 2c Diopside gneiss.
 - 2d Amphibole intercalated with 3a, 1a, 1b.
 - 2e Scapolite skarn, pyroxene skarn.
- CLASTIC SILICEOUS METASEDIMENTS**
- 1a Microcline-quartz-biotite-albite ± garnet ± sillimanite gneiss (massive).
 - 1b Microcline-quartz-albite-biotite gneiss (felspathic areolae).
 - 1c Microcline-quartz-biotite-hornblende-albite gneiss (quartzitic arenite).
 - 1d Quartz-quartz-biotite-hornblende gneiss.
 - 1e Quartz-microcline-albite-biotite ± garnet gneiss (quartzite).
 - 1g Intercalated 1a, 1c.
- Breccia**

*Unconsolidated deposits. Cenozoic deposits are represented by the lighter coloured parts of the map.
§Brocked geology. Outcrops and inferred extensions of each rock unit are shown respectively in deep and light tones of the same colour. Where in places a formation is too narrow to show in colour and must be represented in black, a short black bar appears in the appropriate block.
§Primarily dikes and sills.
§Locally contains units 3a, 3b, 2c and is intruded by 8a, 8.
§Contains 10 to 20 percent plagioclase and variable amounts of mafic minerals.
§Contains melanocratic phases and is intruded by 8a.
§The components of metamorphic rocks are listed in order of decreasing abundance.
§Contains xenoliths of 2a, 1a.
§Local minor garnet layers.
§Local rusty zones.
§Quartz in excess of 80 percent.

Ontario Geological Survey
Map 2454
KHARTUM
RENFREW COUNTY

Scale 1:31,680 or 1 inch to 1/2 Mile

