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Precambrian Geology of the Centre Lake Area
Haliburton and Hastings Counties

by

E.G. Bright

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V.G. Milne

V.G. Milne, Director
Ontario Geological Survey

Foreword

Until 1979 much of the geological coverage of the Center Lake area was at a reconnaissance level. The present detailed mapping project was designed to encourage mineral exploration interest and to provide a mineral potential evaluation.

The Precambrian bedrock of the Centre Lake Area hosts several occurrences of uranium fluorite, graphite, apatite, mica, molybdenite rare earths metals and nepheline. The author describes many of the known occurrences in detail and presents guidelines for future exploration in the project area.

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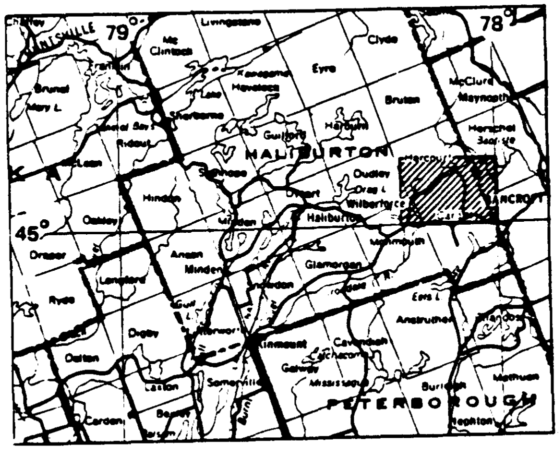

LOCATION MAP

Scale: 1: 584 000 or
1 inch to 25 miles

ABSTRACT

The Center Lake map area, 250 km2 in extent is located about 10 km west of Bancroft, in the counties of Haliburton and Hastings, Ontario.

The map area straddles the easterly-trending Haliburton-Bancroft Nepheline Syenite Belt that parallels the northwestern margin of the marble-rich Middle Proterozoic Central Meta-sedimentary Belt (CMB), of the Grenville Province in Ontario. It also encompasses most of the northern extension of the Harvey-Cardiff Basement Arch, a 80 km long and 25 km wide northeasterly trending anticlinal zone within this metasedimentary belt. The

arch itself contains a linear series of five structural domes. These domes were selective, repetitive loci of basement uplift, diapirism and intrusion of granitic and locally mafic and alkalic rocks of various ages.

The 12 km wide, oval Cardiff Dome together with parts of two other domes, the Cheddar and Faraday Domes to the south and northeast respectively, dominate the geology in the central and eastern-half of the map area. Middle Proterozoic metasediments of the Grenville Supergroup together with younger interlayered, gneissic potassic syenite and nepheline syenite sills, sheets and small stocks, flank and in places completely mantle these domes. In contrast, northwest of the Harvey-Cardiff Basement Arch, in the northwestern and western part of the map area the structural style is characterized by small scale cross-folded, shallow-dipping synforms and antiforms.

The oldest rocks in the map area are upper amphibolite rank metasediments of the Middle Proterozoic Grenville Supergroup. These metasediments have been assigned by the author to two lithostratigraphic subdivisions which in ascending order are: 1) the epiclastic Anstruther Lake Group composed mainly of feldspathic meta-arenite-metawacke sequences; and 2) the chemical-epiclastic Mayo Group which conformably overlies the latter.

In the Harvey-Cardiff Arch, the lower-to middle part of the Mayo Group is characterized by immature siliceous to calcareous

clastic metasediments containing subordinate minor marble. In contrast with this the Mayo Group to the northwest of the Harvey-Cardiff Arch is characterized by more mature metasediments. It consists of the following: 1) a lower feldspathic meta-arenite-marble minor metaquartzarenite sequence; and 2) a middle marble-metaquartzarenite-minor metaquartzarenite para-amphibolite sequence. The middle-to upper part of the Mayo Group in other parts of the map area is characterized by thick marble-subordinate para-amphibolite sequences. Prior to the onset of the older Elzevirian Orogeny, the relatively undeformed rocks of the Grenville Supergroup in the map area were intruded by a series of alkalic mafic to felsic sheets, sills and small stocks. Spatially associated with these alkalic rocks where they occur adjacent to carbonate and locally siliceous clastic metasediments are minor stratabound metasomatic uranium deposits. All these rocks including this early period of uranium mineralization were subjected to the Elzevirian Orogeny, the oldest recognizable, major period of folding and regional metamorphism in the area. Related intrusion of a granodioritic suite of plutons and sills, were emplaced throughout the CMB, during the culminating stage of this orogeny.

Between 1200 Ma and 1000 Ma, the map-area was subjected to the Grenville Orogeny. After culmination of this younger high rank metamorphic event the following plutonic rocks were

emplaced in approximate order of decreasing age: 1) small foliated granite stocks, numerous dikes and several large crescent-shaped granite bodies; 2) relatively unmetamorphosed mafic to locally ultramafic sills and dikes; 3) carbonatite-related, hydrothermal apatite-fluorite-calcite veins containing uranium and rare-earth bearing minerals, a second younger phase of uranium mineralization; and 4) numerous late tectonic pegmatitic granite dikes; particularly as swarms along the flanks of the various domes.

Associated with some of the hybrid phases in these late pegmatitic granite dike swarms within the the Harvey-Cardiff Arch is a late phase of pegmatite-hosted uranium deposits. This third and major phase of uranium mineralization appears to be in part the result of local assimilation of uranium from the two earlier phases as well as reaction with and assimilation of their anomalous hosts rocks along the flanks of the domes. Late stage shearing and cataclasis has locally produced wider zones of economic importance is some of the late mineralized pegmatite dikes.

PRECAMBRIAN GEOLOGY OF THE CENTRE LAKE AREA HALIBURTON AND HASTINGS COUNTIES

by

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PRECAMBRIAN GEOLOGY OF THE CENTER LAKE AREA

by

E.G. Bright[1]

INTRODUCTION

LOCATION

The Center Lake area is situated in the Counties of Haliburton and Hastings about 10 km west of the town of Bancroft, and is bounded by longitudes 78°00' and 78°15' W, and latitudes 45°00' and 48°15' north. The area includes parts of Cardiff, Harcourt, Herschel, Faraday, Monmouth and Dudley Townships, and covers about 250 km2. The village of Wilberforce is situated in the western part of the area, and the village of Cardiff is situated in its southeastern corner.

ACCESS

The area is readily accessible via Highways 28, 121 and 648 and many secondary recreation and logging roads. Access is somewhat difficult west and southwest of Deer and Hudson Lakes in north-central Cardiff Township. Except for the northwestern part of the area, good navigatable river routes are lacking.

MINERAL EXPLORATION

Mineral exploration in the area has been carried out since the turn of the century on small industrial mineral deposits of

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fluorite, apatite, graphite and mica as well as on several small deposits of molybdenite.

Uranium was first discovered at the Fission fluorite deposit in northwest Cardiff Township in 1922, however uranium mineralization did not become a major exploration target until the early 1950s. Since this time most of the exploration has been concentrated in and near the known uranium and uranium-fluorite deposits. During 1975-1979, Kerr Addison Mines Limited carried out exploration programs on several uranium properties optioned from Cam Mines Limited in Cardiff and Faraday Townships. Since 1973, Imperial Oil Limited (Esso Resources Canada Limited) has explored several properties optioned from Amalgamated Rare Earth Mines Limited in Cardiff and Monmouth Townships. During the latter part of August 1979, Amalgamated Rare Earth Mines Limited and Esso Resources Canada Limited announced a joint proposal to bring three of their uranium deposits in the Bancroft area into production during 1980. The three proposed mining sites consist of the Halo deposit (no. 16, map back pocket) in northwest Cardiff Township, as well as the Blue Rock deposit in southwest Monmouth Township, and the Cavendish deposit in central Cavendish Township which lie to the southwest of the map area.

PHYSIOGRAPHY

The Cardiff structural dome dominates the physiography of the central part of the map area. This 12 km wide oval shaped region of good bedrock exposure, in places up to 40 percent, has a maximum elevation of 533 m above sea level between Deer Lake and Cope Creek. Its average elevation is about 460 m. This region is characterized by rolling rocky ridges separated by small lakes and narrow, elongated swamps. The Cardiff Dome lies along the height-of-land between the Ottawa River drainage system to the northeast and the Trent River drainage system to the south of the map area.

The western and eastern flanks of the Cardiff Dome are bounded by narrow linear zones of low elevation, generally less than 400 m above sea level which delineate the main drainage systems in the map-area. Carbonate metasediments predominate along these drainage systems while quartzofeldspathic paragneiss and granitic orthogneisses are the dominant bedrock in the region of high relief.

In the northern and western part of the map-area, the Elephant-Farquar Lake and Irondale River drainage system separates the Cardiff Dome bedrock high from a lithologically similar region to the northwest near Straggle and Allen Lakes. Similarly in the eastern part of the area, the Baptiste-Diamond Lake drainage system separates the Cardiff Dome from a lithological similar region of high relief, termed the Faraday Dome in northern Faraday and southern Herschel Townships. These two local drainage system drain northward towards the large York River system to the northeast of the map-area.

PREVIOUS WORK

The first geological report and maps that includes the Center Lake were published in the classic memoir on the

Haliburton-Bancroft area by Adams and Barlow (1910). This report contains the earliest reference to the nepheline-bearing syenites of this region and over the next 30 years provided the base for numerous scientific and economic investigations on a wide variety of exotic and industrial minerals associated with the alkalic rocks. Satterly (1943) carried out a regional geological compilation and detailed examination and inventory of the known industrial, base-metal and rare-earth mineral deposits of the Haliburton area which includes the present map-area. Subsequent work during 1954 to 1956 by Satterly (1957) resulted in the publication of his report on the Radioactive Mineral Occurrences in the Bancroft Area.

In 1954 and 1955, D.F. Hewitt (1957) mapped Cardiff and Faraday Townships for the Ontario Department of Mines at a scale of 1 inch to 1/4 mile (1:15 840). Monmouth Township, the extreme western part of the map-area was mapped at the same scale between 1955 and 1968 by Armstrong and Gittins (1968).

The Eels Lake area immediately to the south of the Center Lake area was mapped by the author (Bright, 1980).

PRESENT FIELD WORK

The field work for this project was carried out during the field season of 1979. Vertical aerial photography at a scale of 1 inch to 1/4 mile (1:15 840) were used for mapping control. Pace and compass traverses were run between easily recognizable points and acetate overlays were used to record data sites in the field. The data was subsequently transferred to base maps of the same scale prepared by the Cartography Section of the Lands and Waters Group from maps of the Forest Resources Inventory. Recent information with respect to roads, trails, buildings and shoreline features were added to the base maps.

Traverses were not spaced at regular intervals but were designed to include as many of the major outcrop areas as possible. In the more sand plain covered northern part of the map-area, traverses were run across areas of higher relief. Lake-shore and road-side outcrops were also investigated. The southern flanks of the Cardiff Dome which had been previously mapped in detail by Hewitt (1957) did not receive as thorough a study as the remainder of the area. The geological map and a new interpretation of the regional stratigraphy of this southern map sector is based on the author's detailed examination of the outcrops exposed along all roads, major lakes and rivers; as well as selective traverses which cut across well exposed stratigraphic sections previously mapped by Hewitt (1957) and Armstrong and Gittins (1968). Previous mapping by the author (Bright 1980) of the area immediately to the south of the Center Lake area was the basis for this new interpretation of the lithology and stratigraphy of the Cardiff Dome.

ACKNOWLEDGMENTS

The writer was ably assisted in the mapping during the field season by J. McAuley as senior assistant. Capable assistance was provided by J. Bell, T. Howsen, and T. Madill as junior assistants. Their help during the field season was greatly

appreciated.

GENERAL GEOLOGY

The Center Lake area straddles the easterly trending Haliburton-Bancroft Nepheline Syenite Belt. It lies to the south of and parallels the northwestern margin of the marble-rich Middle Proterozoic Central Metasedimentary Belt (CMB), of the Grenville Province in southern Ontario. The map area also encompasses most of the northern extension of the Harvey-Cardiff Basement Arch, an 80 km long and approximately 25 km wide zone of uplift that trends northeasterly subparallel to the tectonic boundary zone between the CMB and the older Algonquin Gneiss Complex (Figure 3). Between Bancroft and Burleigh Falls, this arch contains a linear series of five domes which were centers of basement uplift, and related intrusion of various granitic rocks and locally mafic and alkalic intrusive rocks (Bright 1980).

The geology of the central and eastern half of the map-area is dominated by three of these domes which from south to northeast along the arch are: 1) the Cheddar Dome of which the extreme northern flank occurs in the area; 2) the entire 12 km wide Cardiff Dome and; 3) the Faraday Dome of which the western margin lies in the present area.

Middle Proterozoic metasediments of the Grenville Supergroup together with younger intercalated foliated alkalic syenite sills have been uplifted, folded and later cross folded along the flanks of these domes. In the northwestern and western part of the map-area, the structural style and distribution of these supracrustal rocks is controlled by shallow dipping, closely spaced cross folds. A major northeasterly trending thrust fault zone which runs along the northwestern flank of the Cardiff Dome separates this structural domain from that of the Harvey-Cardiff Arch to the southeast.

The oldest rocks in the map-area are upper amphibolite facies rank metasediments of the Grenville Supergroup. These metasediments have been assigned by the author to two litho-stratigraphic subdivisions which in ascending order are: 1) the epiclastic Anstruther Lake Group (Bright 1976, 1977, 1980a); and 2) the marble-rich Mayo Group (Hewitt and James 1956). Therefore, the post-Anstruther Lake Group metavolcanic of the Hermon Group (Lumbers 1967b) recognized to the south by the author (Bright, 1977, 1980a) appear to be absent from the map-area. These lithostratigraphic subdivisions are not shown on the strictly lithological map (in back pocket).

The Anstruther Lake Group, the basal sequence of the super-group in the Bancroft region (Bright 1977, 1980a) is mainly a biotitic feldspathic meta-arenite-metawacke sequence with minor units of para-amphibolite. In the map area it is only exposed along the Harvey-Cardiff Arch where it mantles the Cardiff and Cheddar domes and in places the Faraday dome. In the Anstruther Dome to the south (Bright 1980a), the group unconformably overlies an exposed basement migmatite-gneiss complex in the core region of this dome.

The marble-rich Mayo Group conformably overlies the Anstruther Lake Group feldspathic meta-arenites along the flanks and between the domes of the Harvey-Cardiff Arch. The lower-to middle part of the Mayo Group in this domain is predominantly an immature epiclastic metasedimentary sequence containing minor marble. Northwest of the Harvey-Cardiff Arch, the lower-to middle part of the Mayo Group is characterized by a more mature sequence consisting of relatively clean feldspathic meta-arenite, marble and minor metaquartzarenite. Stratigraphically upwards in the group, this sequence changes gradually to a thick marble-metaquartzarenite-minor para-amphibolite sequence, which the author has named in this report the Esson formation. The middle- to upper part of the Mayo Group throughout the map-area is characterized by the Dungannon Formation (Hewitt and James 1956), a thick sequence of marbles containing subordinate siliceous and calcareous clastic metasediments.

The supracrustal sequence was subjected to two major periods of deformation and accompanying regional metamorphism between approximately 1240 Ma and 1000 Ma (Douglas 1980). Prior to the first major deformation, the relatively undeformed Grenville Supergroup was intruded by a suite of early alkalic mafic to felsic intrusive sheets, sills and locally small stocks. Associated with this early suite of alkalic rocks are small metasomatic uranium deposits in the metasediments. Following emplacement of this alkalic suite all rocks were subjected to a major period of folding, and regional metamorphism and syntectonic granodioritic intrusion. This orogenic event, named the Elzevirian Orogeny by A.J. Baer (Stockwell, 1982) has a terminal age of 1180 to 1200 Ma (Douglas, 1980).

Between 1200 Ma and 1000 Ma (Douglas 1980, p. 7) the entire western Grenville Province was subjected to a second major period of deformation, the Middle Proterozoic Grenville Orogeny. This orogeny saw renewed uplift along the Harvey-Cardiff Arch, and was accompanied in the map area by granitic plutonism, regional folding and high rank metamorphism to almandine-amphibolite facies rank. After the culmination of this event, the following late tectonic plutonic rocks were emplaced, listed in approximate order of decreasing age: 1) leucocratic granite forming stocks and crescent-shaped dikes; 2) mafic to ultramafic rocks forming sills and dikes of probably more than one age; 3) uranium-and rare earth-bearing carbonate veins; and 4) numerous pegmatitic granite dikes that in places form swarms.

Associated with hybrid phases within some of these late tectonic pegmatitic granite dikes along the flanks of the domes are economically significant deposits of uranium. These uranium deposits are the products of assimilation of and metasomatic reaction with older uraniferous rocks, i.e. some uraniferous alkalic and adjacent metasedimentary rocks as well as some of the uraniferous carbonate veins.

All rock types in the map area are fractured, sheared and offset by three regional fault systems. The oldest system consists of east-northeasterly-trending thrust faults, accompanied by shearing, and cataclasis. This system is offset by a younger north-northwesterly-trending system of normal faults. The youngest, third fault system also consists of normal faults that trend in a northerly to northeasterly direction.

PRECAMBRIAN

MIDDLE PROTEROZOIC

METASEDIMENTARY ROCKS

GRENVILLE SUPERGROUP

INTRODUCTION

Middle Proterozoic metasediments, and in places metavolcanics of the Grenville Supergroup form the basement to the Paleozoic St. Lawrence platform in southeastern Ontario and parts of southwestern Quebec. This lithotectonic subdivisions of basin has been referred to as the Central Metasedimentary Belt (CMB), by Wynne-Edwards (1972).

The term "Grenville Series" was first used by Logan (1863) to designate a deformed suite of marble, "quartzite" (meta-quartzarenite), paragneiss, paramphibolite and metavolcanics exposed near Grenville, Quebec on the north shore of the Ottawa River. Stratigraphic studies in the Bancroft-Madoc area of Ontario, since 1955 have since extended this term, first as a group and more recently as a supergroup as more subdivisions were made. Major subdivisions in the Bancroft-Madoc region to the southeast of the Center Lake Area (area no. 4, Figure 2), in ascending stratigraphic order included: 1) the metavolcanic-rich Hermon Group (Lumbers 1967a, b); and 2) the marble-rich Mayo

Group (Hewitt and James 1956, Lumbers 1967b). The younger epiclastic rich Flinton Group (Moore and Thompson 1980), exposed in this region is no longer considered part of the Supergroup (see Table 2). The metavolcanics of the Hermon Group near Madoc have been dated at 1,310 ± 15 Ma by Silver and Lumbers (1966a). This date has been subsequently recalculated to 1286 ± 15 Ma by Bell and Blenkinsop(1979).

In this report the term Grenville Supergroup designates supracrustals which are younger than the approximately 1430 m.y. old (Bell and Blenkinsop, 1979) gneiss of the Algonquin Gneiss Complex (shown on Figure 3 to the north of the map area) but older than the approximately 1200 m.y. age of the Weslemkoon and Elzevir plutons, which cut these supracrustals (Silver and Lumbers 1966; Bell and Blenkinsop 1979), to the east of the map area.

Previous mapping by the author to the south of the map area in the Eels Lake Area and the Burleigh Falls Area (see Figure 2) has provided the basis for a lithostratigraphic subdivision of the Grenville Supergroup in the central and southern parts of the Harvey-Cardiff Basement Arch. In ascending stratigraphic order, this regional subdivision comprises the Anstruther Lake, Hermon, and Mayo Groups. The Anstruther Lake Group, the basal arenaceous sequence of the Grenville Supergroup in the Bancroft-Burleigh Falls area unconformably overlies a basement migmatite-gneiss complex exposed in the core of the Anstruther Dome, 40 km to the south of Bancroft (Bright 1977, 1980a). The author tentatively correlates this basement complex with the 1430 m.y. rocks of the

Algonquin Gneiss Complex exposed near Barrys Bays 50 km north of Bancroft (Fig. 3). In the Center Lake Area (area no. 3, Figure 2), Anstruther Lake Group metasediments are the oldest supracrustals. Metavolcanics characteristic of the Hermon Group are absent. Accordingly only a two-fold subdivision of the Grenville Supergroup, namely the Anstruther Lake and Mayo Groups are recognized in the area. The lack of detailed information in parts of the map area, strong deformation and high rank regional metamorphism did not allow correlations of the various lithologies in the present area with specific lithostratigraphic units. The geological map that accompanies the present report (back pocket), therefore is a strictly lithological map.

EPICLASTIC METASEDIMENTARY ROCKS

FELDSPATHIC ARENACEOUS METASEDIMENTS

General Lithology and Stratigraphy

Feldspathic arenaceous metasediments (units 1a-e) contain less than 10 percent biotite, with or without minor hornblende. These meta-arenites form the second most abundant lithology after marble in the map area and are concentrated in the lower part of the Grenville Supergroup in the eastern and northwestern parts of the map area. Minor units of feldspathic meta-arenite, most of which are too thin to be shown on the accompanying map (back pocket) also occur interbedded with metawacke and meta-quartzarenite in the marble-rich upper part of the Grenville Supergroup throughout the map-area.

Feldspathic Meta-arenites in the Anstruther Lake Group

In the eastern part of the map area, medium-to thickly bedded units of medium-to locally coarse-grained pink to pinkish grey, biotitic feldspathic meta-arenite forms the dominant lithology in the Anstruther Lake Group. These meta-arenites completely mantle the Cardiff Dome and flank the northwest margins of the Faraday Dome as well as the southern margin of the Elephant Lake Pluton. Interstratified with the feldspathic meta-arenites along the flanks of the Cardiff Dome are subordinate thin units of metawacke (unit 2a) and locally thin bands of biotite schist, (unit 2c). These subordinate units of biotite-rich metasediments appear to be more abundant and thicker at the base and towards the stratigraphic top of the group near Center Lake. In this same part of the map area, amphibole-rich metasediments (unit 5) form several large mappable units intercalated with the feldspathic meta-arenites near the base of the sequence north of Deer Lake. Amphibolites also form thin intercalated units near the top of the group east of Center Lake. These foliated meta-arenites commonly display prominent compositional layering reflecting their original bedded nature. Locally a thinner migmatitic layering developed during metamorphism and deformation is present. Migmatitic (granitic leucosome <10%) meta-arenite (unit 1d) is most commonly found adjacent to the numerous metamorphosed granitic plutons and sills which intrude the Cardiff and Faraday domes.

The feldspathic meta-arenites are composed mainly of quartz, microperthitic microcline, microcline and sodic plagioclase with minor biotite and, in places minor hornblende. The quartz content is variable, between 20 to 35 percent quartz and the microcline content generally exceeds plagioclase and varies from 25 to 50 percent. Biotite makes up 2 to 8 percent of the rock and the subparallel arrangement of the mica flakes defines the foliation. The variation in the biotite content defines relict primary compositional layering in some of the more massive-looking outcrops that contain no metawacke or metamudstone (biotite schist) interbeds. Magnetite, in places up to 3 percent, and titanite are characteristic accessory minerals of the meta-arenites. The more homogenous, similar looking foliated granitic rocks (map-unit 10) that intrude these metasediments do not contain magnetite in significant amounts.

Thin sections of the feldspathic meta-arenites from this group in the eastern part of the map area reveal a heteroblastic assemblage of quartz-microperthite-plagioclase-microcline - biotite - carbonate with accessory magnetite and titanite. Most of the larger microperthite grains are untwinned, however, in places a poorly developed microcline grid twinning was observed in some grains. Microcline occurs as small xenoblastic grains and as overgrowths on larger untwinned microperthite. Albite occurs locally as small subidioblastic grains, overgrowths on larger sodic oligoclase grains and as irregular reaction rims between individual grains of microperthite. Interstitial carbonate is usually present in amounts up to 1 percent. In thin sections of weakly foliated and strongly lineated samples of feldspathic meta-arenite, quartz forms highly strained, flattened, lenticular aggregates up to 1 cm long. These polycrystalline quartz lenticles are set in a finer-grained, granoblastic matrix of quartz, microcline, plagioclase and microperthite.

Feldspathic Meta-arenites in the Mayo Group

Leucocratic, biotite-poor, feldspathic meta-arenites in the lower part of the Mayo Group are abundantly exposed between Farquhar and Straggle Lakes in the northwestern part of the area. These meta-arenite of the Mayo Group are predominantly pink, fine-to medium-grained, equigranular rocks that generally contains less than 1 percent biotite and minor magnetite. Major constituents in order of decreasing abundance are quartz, potassic feldspar and plagioclase. In places biotite defines a weak foliation and local variations in the amount of felsic minerals defines a thin primary compositional layering. A thin discontinuous metamorphic layering is locally present in migmatitic varieties (unit 1d) near or adjacent to the contacts with metamorphosed early granitic plutons and sills in the northwest corner of the area. Granitic leucosome layers less than 2 cm thick comprise less than 10 percent of the rock in these migmatitic varieties.

Thin section samples of Mayo Group feldspathic meta-arenite from the northwestern part of the area generally carry a granoblastic assemblage of quartz-microperthite-sodic plagioclase - microcline - biotite. Interstial carbonate is present in a few places and accessory magnetite and titanite are much less abundant than in the older Anstruther Lake Group, feldspathic meta-arenites. These feldspathic meta-arenites are more mature than the ones in the Anstruther Lake, and in places contain up to 50 percent quartz (unit 1b). Interstratified thin units of marble and thin metaquartzarenite are commonly present. Interstratified units of metawacke, metamudstone and para-amphibolite are generally lacking; however biotite schist lamallae may occur locally. These feldspathic meta-arenite-marble - minor metaquartzarenite sequences are assigned to the lower Mayo Group because the older meta-arenites of the Anstruther Lake Group as defined (Bright 1980a) do not contain interstratified units of marble or metaquartzarenite.

In the middle to upper part of the Mayo Group to the south and east of Farquhar Lake, feldspathic meta-arenite becomes progressively subordinate to marble and metaquartzarenite. In this part of the group to the north of Cardiff and Clement Lakes, feldspathic meta-arenite forms several thin-to medium-bedded mappable units in the thick marble sequence. These meta-arenites are characteristically medium-grained, pink to pinkish grey and contain 1-5 percent biotite. Thinly interstratified with these feldspathic meta-arenites are subordinate metawacke and locally minor marble and metaquartzarenite. Near contacts with thick marble or marble-metaquartzarenite sequences, the feldspathic meta-arenite units locally contain discontinuous layers and lenses of rusty weathering quartzofeldspathic schist and gneiss.

Metaconglomerates in the Mayo Group

Between Cardiff Lake and the Harcourt Post Office, in northern Cardiff Township, the middle to upper Mayo Group consists mainly of a marble-para-amphibolite - feldspathic meta-arenite sequence containing minor interstratified units of metaquartzarenite and metawacke. Within this sequence, several of the feldspathic meta-arenite units contain small discontinuous lenses of pebble metaconglomerate (unit 1c). These intercalated matrix- to clast supported conglomeratic lenses vary from less than 1 up to 3 m in thickness and consist of pebble-size clasts of feldspathic meta-arenite set in a fine- to medium-grained matrix of heteroblastic quartz and feldspar. In contact with marble, the quartz-feldspar matrix of the conglomerate progressively grades into a calcarenite matrix over a distance of less than 15 cm. Adjacent to amphibole-rich metasedimentary units, the quartz-feldspar matrix of the metaconglomerate locally contains irregularly distributed amphibole porphyroblasts as well as lenticular to irregularly-shaped porphyroclasts of amphibole and plagioclase.

In the southeast corner of the map area, the marbles of the Mayo Group exposed along Highway 121 contain a prominent unit of thin-to medium bedded feldspathic meta-arenite that contains thinly intercalated, lenticular units of matrix-supported metaquartzarenite-pebble and polymictic pebble metaconglomerate. In the latter, the pebble-size clasts are predominantly metaquartzarenite with subordinate feldspathic meta-arenite and minor metawacke pebbles. Both types of metaconglomerate have a feldspathic meta-arenite-to locally metaquartzarenite-matrix.

BIOTITE-RICH METASEDIMENTS

General Lithology and Stratigraphy

Biotite-rich metasediments (unit 2) include all siliceous clastic metasediments which contain more than 10 percent biotite with or without subordinate hornblende. These foliated, in places layered and locally schistose rocks were derived from wackes and mudstones. Subdivisions of this unit are based primarily on the amount of biotite and hornblende, secondarily on fabric. Subunits based on compositional variation in order of decreasing abundance include: 1) map-unit 2a, biotite - quartz - plagioclase gneiss (metawacke); 2) map-unit 2b, hornblende - biotite or biotite - hornblende - quartz - plagioclase gneiss (calcareous metawacke); 3) map-unit 2c, biotite schist (meta-mudstone); and 4) map-unit 2d, sillimanite schist (aluminous metamudstone). The latter is restricted to one major locality in the southeast corner of the map area to the east of Center Lake.

Metawackes (map-unit 2a and 2b) and locally metamudstones (map-unit 2c) are the second most abundant lithology after meta-arenite in the Anstruther Lake Group. Most units in this group are thin-to medium-bedded and are commonly too small to be shown separately on the map (back pocket). In the eastern part of the map area, around the Cardiff Dome, mappable metawacke units appear to be abundant at the base of the Anstruther Lake Group north of Deer Lake and towards the stratigraphic top of this group around Center Lake.

In the overlying Mayo Group mappable units of metawacke are mainly concentrated in the lower epiclastic - chemical metasedimentary facies of this group. South of Wilbermere Lake in southwest corner of the map area, the lower part of the group is exposed along the southwestern flank of the Cardiff Dome. Here intercalated metawacke (unit 2a) and calcareous metawacke (unit 2b) are almost as abundant as in this part of the group marble and amphibole-rich metasediments. East of Center Lake along the eastern flank of this dome, metawackes together with aluminous metamudstones (map-unit 2d) predominate over amphibole-rich metasediments and marble at the approximate same stratigraphic level. However in the northwestern part of the map area, between Straggle Lake and Farquhar Lake, metawackes or biotite schist were only observed as thin, minor units in the lower feldspathic meta-arenite - marble - quartzite sequence of the Mayo Group. The author considers this lower predominantly epiclastic sequence to be a shallow water facies equivalent of the epiclastic-chemical lower Mayo Group to the south along the southern and eastern flanks of the Cardiff Dome.

Migmatitic (granitic leucosome <10%) metawacke varieties (map-unit 2e) occur in the lower parts of both the Anstruther Lake and Mayo Groups, near or adjacent to major centres of uplift and related granitic intrusion such as the Cardiff and Faraday domes and the Elephant Lake Pluton. Cataclastic varieties (map-unit 2f) occur adjacent to regional zones of east-west thrusting.

Metawackes

Metawacke (unit 2a), in both the Anstruther and Mayo Groups is a fine-to medium-grained, light to dark grey, foliated rock that consists predominantly of heteroblastic feldspar and quartz and contains 10 to 30 percent biotite as the main mafic mineral. Hornblende may be present in amounts up to a few percent. Plagioclase generally exceeds potash feldspar. A primary thin-to medium bedding is preserved in most outcrops and the subparallel alignment of biotite and subordinate hornblende defines a stratiform foliation. In general the textures of the metawacke within a single large outcrop can be described by terms such as banded, laminated, gneissic, augen gneissic and in places schistose.

In thin section most samples have the assemblage plagioclase - biotite - quartz ± hornblende or plagioclase - quartz - biotite ± microcline and hornblende. The fabric of the felsic minerals is heteroblastic and microcline, when present, is fine-grained and occurs mainly as interstitial xenoblastic grains. Accessories include garnet, carbonate, magnetite, titanite and apatite.

Calcareous metawacke (unit 2b), is a medium-grained, greenish to dark grey, foliated rock texturally and compositionally similar to metawacke but containing up to 10 percent hornblende. The two subunits (2a and 2b) are commonly intercalated and in places grade into each other along strike. In thin section calcareous metawacke consists of plagioclase -

biotite - quartz - hornblende ± carbonate, microcline, or plagioclase - biotite - hornblende - quartz ± carbonate. Accessory magnetite and titanite are both more abundant in the calcareous metawacke than in the metawacke. With increasing hornblende and decreasing quartz and feldspar content, calcareous metawacke grades into amphibole-rich metasediments (map-unit 5).

Metamudstones

Biotite schist (unit 2c), derived from mudstone is a fine to medium grained, dark grey to black, rock that occurs mainly as interstratified thin units and lamellae in the feldspathic meta-arenites and metawackes of the Anstruther Lake Group. Locally it also occurs interstratified with other epiclastic metasediments within the marbles of the Mayo Group. In thin section, these dark schists generally contain more than 50 percent poikiloblastic biotite whose subparallel alignment imparts a lepidoblastic fabric. Other major constituents include xenoblastic to subidioblastic plagioclase and xenoblastic quartz and subordinate microcline. The felsic minerals also form discontinuous segregation lamellae between biotite-rich lamellae. Garnet porphyroblasts, when present, are confined to the biotite-rich layers and lamellae. Accessory minerals are magnetite, apatite, titanite, zircon, hornblende and pyrite.

Sillimanite-biotite schist and sillimanite-biotite - quartz - feldspar gneiss (unit 2d), are medium-to coarse grained, green to greenish grey rocks derived from aluminous mudstones. These rocks form the dominant lithology in a 50 to 80 m wide marker horizon of intercalated sillimanite - bearing schist, subordinate biotite schist and biotite-quartz-plagioclase gneiss (metawacke) to the east of Center Lake in the southeastern corner of the map area. This northerly trending aluminous metapelitic marker horizon lies within a metawacke-amphibolite-minor marble sequence of the lower Mayo Group and can be traced for over 5 km.

A 60 m wide, sheared and pegmatite intruded segment of this metapelitic horizon is well exposed near the southeastern map boundary in a long roadcut on Highway 121 approximately 600 m east of Center Lake. Several of the granitic to syenitic pegmatite dikes in this exposure contain uranium mineralization in the form of disseminated uraninite and uranothorite. Several kilometres along strike to the north of this highway exposure, this same metapelitic unit contains the Croft-Center Lake uranium zone (No. 20) and the Croft uranium deposit (No. 19). A short distance along strike to the south of the map area, in the Eels Lake area (Bright 1980a) this same metapelitic horizon contains the former Bicroft uranium mine. At various locations between these various deposits, minor, thin units of marble, para-amphibolite and pyroxene-rich metasediments occur intercalated with the sillimanite-bearing schists and gneisses.

These aluminous schists and gneisses generally carry the following three characteristic mineral assemblages which in order of decreasing abundance are:
1) biotite-sillimanite-quartz-plagioclase - garnet; 2) quartz-biotite - sillimanite - garnet - plagioclase; and 3) biotite - quartz - plagioclase (or plagioclase-quartz) - sillimanite -

garnet. In thin sections of sillimanite-poor biotite schist, the rock has a lepidoblastic fabric; where sillimanite locally predominates over biotite, the sillimanite imparts a nematoblastic fabric to the rock. The sillimanite content varies from 2 to 25 percent and the garnet content from less than 1 to more than 20 percent. Garnet forms prominent subidioblastic, pink porphyroblasts which in places are up to 2 cm in diameter and are wrapped by augen-shaped sheaves of sillimanite and biotite. Some of the larger garnet porphyroblasts contain oriented inclusions of quartz, feldspar, biotite and locally sillimanite. Their orientation is subparallel to the fabric of the rock. Adjacent to late pegmatitic granite dikes, sillimanite - biotite-schist has been locally potash metasomatized. Recrystallization has transformed these rocks into medium-to coarse grained porphyroblastic gneisses, which in thin section contain the heteroblastic assemblage of microcline - plagioclase - quartz - biotite ± sillimanite, muscovite, garnet. Microcline commonly forms large porphyroblasts in these contact metasomatic gneisses.

QUARTZOSE METASEDIMENTS

Metaquartzarenites

Quartzose metasediments (unit 3) includes only those mature quartz-rich metasandstones that initially contained under 15 percent argillaceous matrix and now have 80-95 percent quartz and 5-15 percent feldspar. In the map area most of these metasediments are metaquartzarenite, however local, gradational phases of feldspathic metaquartzarenite are present.

Metaquartzarenite, i.e. "quartzite" (unit 3a), is generally a medium-to coarse-grained, granoblastic rock containing more than 80 percent quartz with variable amounts of diopside, feldspar, biotite, amphibole, phlogopite and carbonate. In order of decreasing abundance, the three major varieties are: 1) diopside metaquartzarenite; 2) biotite-diopside metaquartz-arenite; and 3) biotite-feldspar metaquartzarenite. Feldspathic metaquartzarenite with up to 25 percent feldspar is locally abundant in thinly interstratified sequences of metaquartzarenite and feldspathic meta-arenite in the northwestern part of the area. In the western part of the area between Pussey and Corkle Lakes, to the southwest of Wilberforce, green to bluish green amphibole is the characteristic mineral in the metaquartzarenite units. These particular units contain numerous interbeds of para-amphibolite and locally biotite-diopside schist and gneiss.

Most outcrops of metaquartzarenite are massive to weakly foliated. Well foliated, lineated and layered varieties also occur. Weathered surfaces have a light grey, vitreous appearance and fresh surfaces display shades of light grey, grey-green, pink and locally bluish green. In many places accessory pyrite was noted and the presence of only very small amounts can produce a rusty brown weathered surface. Biotite and amphibole when present in amounts greater than 1 percent impart a weak foliated fabric to the rock. Minor pale mica tends to form thin selvedges around and between quartz grains. In more deformed units, lens-shaped quartz grains and spindle-shaped diopside grains define a lineation and augment the foliation. A relict, thin-to medium bedding (3-10 cm and 10-30 cm, respectively) is preserved in many places on Esson Lake. It is defined by variations in the feldspar, diopside and biotite content. Bedding is also defined by thinly interstratified units of feldspathic metaquartzarenite, feldspathic meta-arenite, marble and para-amphibolite.

In thin section metaquartzarenite is granoblastic. The diopside, plagioclase, microcline and carbonate commonly form smaller grains than quartz. Quartz exhibits strained extinction and diopside forms subidioblastic to subrounded grains and aggregates of subrounded grains. In well foliated and/or lineated metaquartzarenite, quartz is heteroblastic and occurs mainly as highly strained, elongated grains and grain aggregates whose orientation is subparallel to the main fabric of the rock. Boundaries between quartz grains, aggregates and quartz in the aggregates are strongly sutured. Finer grained subidioblastic diopside and biotite and xenoblastic plagioclase and microcline occur locally between the large quartz grains and aggregates. Their boundaries with the quartz are sharp and straight. Some of the quartz aggregates contain microcline and spindle-shaped to subidiomorphic diopside whose long direction is sub-parallel to the elongation of the quartz aggregate.

Stratigraphy of Quartzose Metasediments

Metaquartzarenite and feldspathic metaquartzarenite are absent in the Anstruther Lake Group. However these rocks form major and minor interstratified units in the marble-rich lower to middle part of the Mayo Group, exposed in the northwestern and western part of the map area. In the northwestern part of the area, between Farquhar and Straggle lakes, the lowest exposed part of the Mayo Group is dominately a feldspathic meta-arenite-marble-minor metaquartzarenite sequence. However to the south and west of Farquhar Lake, both marble and metaquartzarenite become progressively more abundant higher in the group. Further to the west between Esson and Grace lakes, near the western boundary of the area, metaquartzarenite is the second most abundant lithology after marble in the middle part of the Mayo Group. Around Esson Lake in Monmouth Township, a major sequence of shallow-dipping, thin-to medium bedded metaquartzarenite is exposed in a southeast plunging anticline. This unit, at least 200 m thick, contains subordinate interstratified marble and locally minor intercalated units of feldspathic metaquartz-arenite, feldspathic meta-arenite and para-amphibolite. In general, however, the middle part of the Mayo Group, both within and to the west of the map area is predominantly a marble-meta-quartzarenite sequence containing only very minor feldspathic meta-arenite and para-amphibolite. This characteristic sequence of regional extent has been termed by the author the Esson formation based on the Esson Lake type locality.

Metaquartzarenite is rare in the marbles of the middle to upper part of the Mayo Group exposed in the core of the Clement Creek Syncline northeast of Esson Lake in the western part of the map area. The Esson formation does not occur in the eastern part of the map area. Metaquartzarenite was not observed in the middle to upper Mayo Group marbles in the southeast corner of the map area; however minor units do occur in this thick marble sequence along strike to the south in the Eels Lake Area (Bright 1980a).

PYROXENE-RICH METASEDIMENTS

Pyroxene-rich metasediments are the least abundant epiclastic metasediment in the map area and were probably derived from dolomitic mudstones and possibly argillaceous dolostones. These units are characteristically green to dark greenish grey, granoblastic rocks whose fabric varies from layered, to massive to locally gneissic. They contain diopside as the main constituent with variable amounts of biotite, phlogophite, tremolite, carbonate, plagioclase, hornblende and quartz. In order of decreasing abundance, the two main varieties present are: 1) biotite-diopside gneiss and locally schist (unit 4a); and 2) phlogopite-tremolite-diopside gneiss (unit 4b).

<u>Biotite-Diopside Gneiss</u>

Biotite-diopside gneiss (map unit 4a) is a grey-green to green, massive to layered, medium-grained rock that occurs mainly as interstratified units in amphibole-rich metasediments (unit 5).

Biotite - diopside gneiss contains 60-80 percent xenoblastic, commonly poikiloblastic diopside and 15-30 percent subidioblastic biotite. Minor minerals are actinolite-tremolite, magnetite and in places hornblende and plagioclase. Diopside forms a heteroblastic fabric. The subparallel alignment of biotite defines a weak to moderate foliation. With increasing biotite content, the fabric becomes schistose. With increasing hornblende and plagioclase content, this gneiss grades into para-amphibolite (unit 5b).

Near major alkali syenite intrusions (map-unit 9), local areas of biotite-pyroxene gneiss and schist have undergone potash metasomatism and now carry a granoblastic assemblage of diopside-microcline-scapolite + biotite.

This pyroxene-rich gneiss together with minor intercalated marble, forms a prominent marker horizon near the base of an amphibolite-rich metasedimentary sequence along the western flank of the Cardiff Dome in northwest Cardiff Township. This amphibolite-pyroxene gneiss-minor marble sequence, which is assigned to the Mayo Group conformably overlies the Anstruther Lake Group and represents a deep water facies at the base of the group in this part of the area.

Phlogopite - Tremolite - Diopside Gneiss

Phlogopite-tremolite-diopside gneiss (unit 4b) is a light green to dark greenish grey, subequigranular rock. It occurs mainly as thin interstratified units in marble or marble-calc-silicate gneiss sequences. Xenoblastic diopside and subordinate subidioblastic tremolite are the major constituents. Minor constituents include carbonate, quartz, plagioclase and hornblende. Accessories are titanite, apatite and pyrite. With increasing plagioclase content this rock grades into calcsilicate gneiss (map-unit 5c); with increasing carbonate content it grades into diopside marble (map-unit 6b). Thinly interstratified units of these three related lithologies map-units 4b, 5c, and 6b are common in the middle to upper Mayo Group along the north shore of Farquhar Lake.

AMPHIBOLE-RICH METASEDIMENTS

Amphibole-rich metasediments (unit 5) include all calcareous to siliceous clastic metasediments which contain more than 30 percent hornblende with or without biotite. The rocks were probably derived from calcareous sandstones and mudstones. Subdivision of this unit is based on colour index, that is the amount of hornblende in the rocks. Hornblende-plagioclase gneiss (unit 5a) and amphibolite (unit 5b) greatly predominate over all other varieties and are commonly intercalated with each other, for example along the flanks of the Cardiff and Faraday Domes, in the central and eastern part of the map area.

Hornblende-Plagioclase Gneiss

Hornblende-plagioclase gneiss (unit 5a) is a foliated, in places layered, medium-to coarse grained, grey to dark greenish grey rock. It consists mainly of subequigranular, locally porphyroblastic hornblende and plagioclase with up to 10 percent biotite. The hornblende content is equal or less than the plagioclase content. The subparallel alignment of the biotite flakes and the long axis of hornblende crystals define the foliation. Foliated varieties commonly grade along and across strike into layered varieties. The layering is caused by discontinuous, alternating hornblende-rich and hornblende-poor (15-40 % hornblende) layers and lamellae. The gneissic layering probably reflects a relict sedimentary feature. Porphyroblasts of hornblende and plagioclase commonly occur in the hornblende-rich layers. In thin section these rocks carry a heteroblastic assemblage of hornblende-plagioclase - biotite or plagioclase - hornblende - biotite - quartz. In places biotite is more abundant than plagioclase. Minor amounts of fine-grained quartz, microcline and scapolite occur locally as xenoblastic grains. Accessory minerals usually present are magnetite, titanite, garnet, apatite and pyrite. Larger xenoblastic to subidioblastic laths of hornblende commonly contain inclusions of these accessory minerals.

Amphibolite

Amphibolite, and biotite amphibolite (unit 5b) are fine-to medium grained, dark green to black, foliated, in places thinly layered rocks. These rocks are interlayered with each other or form thin intercalated units in hornblende-plagioclase gneiss (map-unit 5a). Within individual layers or beds, the texture varies from weak to strongly foliated. Sharply bounded compositional layering persists along strike. Porphyroblasts of plagioclase, hornblende and garnet occur in some units. Thin sections reveal heteroblastic assemblages of hornblende, plagioclase and biotite. Minor garnet, quartz, microcline and pyroxene may be present. Plagioclase is xenoblastic; hornblende is poikiloblastic. The quartz content is less than 5 percent and biotite is usually less than 10 percent. Biotite-rich varieties with up to 30 percent biotite are lepidoblastic. Massive, fine-grained varieties of amphibolite contain granoblastic plagioclase and xenoblastic to sub-idioblastic hornblende.

Calcsilicate Gneiss

Scapolitized units of amphibolite (unit 5e) occur adjacent to or locally intercalated in syenite gneiss (map-unit 9) along the flanks of the Cardiff and Faraday Domes. A thin section of the scapolitized amphibolite revealed a strongly foliated, heteroblastic assemblage of hornblende - scapolite - plagioclase - biotite. The scapolite content varies from 20 to 35 percent. Accessories include apatite, titanite and leucoxene.

Calcsilicate gneiss (unit 5c) mainly occurs as thin interstratified units in siliceous marble sequences. It is a medium-to coarse grained, grey green to dark green, massive to thinly layered rock. Variable amounts of pyroxene, hornblende and plagioclase are the main constituents. Minor constituents include biotite, quartz, potassic feldspar, phlogopite, scapolite, garnet and epidote. Free carbonate, namely calcite is usually present in amounts up to 10 percent. Titanite, apatite, magnetite and pyrite are accessory minerals. With increasing carbonate content, calcsilicate gneiss grades into diopside- and locally hornblende-bearing varieties of marble. With increasing plagioclase and hornblende content, calcsilicate gneiss grades into hornblende-plagioclase gneiss. All three of these major lithologies can be observed intercalated in one outcrop.

In thin sections of the calcsilicate gneisses, felsic mineral-rich layers are granoblastic and in order of decreasing abundance contain plagioclase, diopside, hornblende, biotite, and carbonate. The subparallel alignment of the biotite defines a weak foliation. Mafic mineral-rich layers are heteroblastic and consist of diopside, hornblende, plagioclase, and carbonate.

Hornblende - Plagioclase - Matrix Metaconglomerate

Polymictic-pebble metaconglomerate with a biotite-hornblende-plagioclase matrix (unit 5d) is locally present in a fault-bounded deformed sequence of Mayo Group amphibolite, feldspathic meta-arenite, and minor marble which outcrops along the south-central boundary of Harcourt Township, approximately 500 m west of the Village of Harcourt. This metaconglomerate forms several discontinuous lenses, up to 10 m thick in para-amphibolite, along its contacts with thin interstratified units of marble, feldspathic meta-arenite and locally arenite-pebble metaconglomerate (unit 1c). The angular to subrounded clasts of the polymictic metaconglomerate are up to 4 cm in size and consist of feldspathic meta-arenite, biotite-hornblende plagioclase gneiss, calcitic hornblende-biotite schist, and locally minor marble and metaquartzarenite. The matrix ranges from a biotite-hornblende plagioclase gneiss to a plagioclase - biotite - hornblende schist. Mafic gneiss and schist pebbles are difficult to distinguish from the dark matrix of similar composition. This feature also makes it difficult to determine the proportion of matrix to clasts. Contacts with the adjacent foliated to layered amphibolite are gradational, but sharp adjacent to minor interbeds of marble or feldspathic meta-arenite.

Stratigraphy of Amphibolite-Rich Metasediments

Rocks of map-unit 5 occur in several lithological assemblages. In the central and southeastern part of the map area large mappable units of hornblende-plagioclase gneiss and finer-grained amphibolite occur in the lower part of the Mayo Group. These rocks form either the dominant or the next most abundant lithology after marble and metawacke in the group. In the underlying older Anstruther Lake Group in this region, several mappable units of intercalated hornblende-plagioclase gneiss and amphibolite occur north of Deer Lake in the central region of the Cardiff Dome.

In the northwestern part of the map area, the lower part of the Mayo Group undergoes a marked facies change. The deep water amphibolite - pyroxene gneiss - minor marble and metawacke sequences that flank the domes in the eastern part of the map area change gradationally northwestward into predominantly shallower water sequences of feldspathic meta-arenite-minor marble and metaquartzarenite. Amphibolite-rich metasediments are uncommon in this lower facies equivalent of the Mayo Group.

CHEMICAL METASEDIMENTARY ROCKS

CARBONATE METASEDIMENTS

Marble

Siliceous calcitic to dolomitic marble (unit 6) which were derived from impure limestone and dolostone are mainly restricted to the Mayo Group. Marble is the most abundant lithology in the west-central and southwestern part of the area and locally in the southeastern corner of the map area. In the northern part of the map area, marble is the second most abundant lithology after feldspathic meta-arenite.

Siliceous marble is a generally foliated to layered, a medium-to coarse-grained, white to pale grey or buff rock. It generally contains in excess of 70 percent crystalline carbonate (calcite and/or dolomite) and variable amounts of phlogopite, diopside, graphite, chondrodite, and tremolite-actinolite. Biotite, hornblende, quartz feldspar and scapolite are locally present. Accessories include magnetite, pyrite, molybdenite, pyrrhotite, apatite, titanite and in few places fluorite. Euhedral fluro-richterite is locally abundant in the marble southeast of Esson Lake in the southwest corner of the map area. Rounded grains of green apatite, 1-2 mm in diameter comprise about 10 percent of the marble in several thin discontinuous units intercalated with the garnet-sillimanite-biotite schist in the Bancroft uranium mine property (no. 43) in the southeast corner of the map area. During this survey, an arbitrary testing of the marble outcrops in the field with a 10 percent solution of hydrochloric acid indicated that most marbles of the map area are strongly calcitic. Subdivisions of the marble into various varieties (Units 6b-f) is based on the calcsilicate minerals or mica present, for example phlogopite-bearing marble (map-unit 6c) or chondrodite-bearing marble (unit 6e). Two or more characteristic silicate minerals are commonly present and most larger exposures contain several thin-to medium interbedded marble varieties. Individual exposures are coded on the map (back pocket) either as unsubdivided (map-unit 6a) where the outcrop was not closely examined or compiled from previously published maps or according to the dominant varieties present in decreasing order of abundance, e.g. unit 6bce. The most common varieties are phlogopite marble, diopside-phlogopite marble and diopside marble. Subordinate chodrodite-and tremolite-bearing marbles are present in the marble sequences between Pussey and Esson Lakes in the southwestern part of the map area. Here dolomitic marble is more common. Chondrodite bearing marble is also locally present in the southeast corner of the map area.

In thin section, most marbles contain less than 10 percent silicate minerals and contain granoblastic assemblages of carbonate with minor phlogopite, diopside, quartz and plagioclase. Contacts between xenoblastic carbonate minerals are straight, in places embayed, and twin lamellae exhibit little or no distortion. Locally where distortion is evident, larger grains are separated by a thin zone of finer grained carbonate and minor silicate minerals. Massive marble containing more than 10 percent silicate minerals commonly consists of a heteroblastic assemblages of carbonate, phlogopite, and diopside with minor quartz and plagioclase. The subparallel alignment of some of the phlogopite flakes defines a weak to moderate foliation.

A relict, thin-to medium to locally laminated bedding is preserved in many marble exposures. The primary compositional layering is reflected in variations in grain size, colour, and the content of phlogopite and other calc silicate minerals. Many of the larger marble outcrops commonly contain thin interbedded calcsilicate gneiss and amphibolite (unit 6h). In transitions between carbonate rocks and epiclastic siliceous rocks, minor feldspathic meta-arenite, metaquartzarenite and metawacke are interbedded with the marble (unit 6g). In places the marbles exhibit a variety of other primary sedimentary features, such as graded beds, scour-filled troughs and soft-sedimentary deformation structures. Many of these features can be seen in the marble roadcut on the north-side of Highway 121 N, just east of the creek between Pussey and Lower Cardiff lakes in northwest Cardiff Township. Recrystallization may enhance primary sedimentary features rather than destroying them.

Carbonate-Matrix Metaconglomerate

Polymictic pebble metaconglomerate with a carbonate matrix (unit 6i) forms minor interlayers in Mayo Group epiclastic rocks to the northeast of Diamond Lake in Herschel Township and 500 m west of the Village of Harcourt in Harcourt Township. Northeast of Diamond Lake, the matrix-supported metaconglomerate consists of pebble-size clasts of para-amphibolite, feldspathic meta-arenite, metawacke and locally metaquartzarenite in a medium-grained matrix of phlogopite marble. West of the Village of Harcourt bands up to 1.5 m thick of matrix-to clast supported metaconglomerate with a carbonate matrix occur along both contacts of a feldspathic meta-arenite unit within a deformed easterly dipping sequence of intercalated amphibolite, feldspathic meta-arenite and minor marble. Along its western contact with marble, the base of a feldspathic meta-arenite unit contains conglomeratic lenses consisting of matrix-supported pebble-size clasts of feldspathic meta-arenite and minor siliceous marble in a marble matrix. The carbonate matrix decreases rapidly upwards and the metaconglomerate grades into medium-to coarse grained feldspathic meta-arenite. To the east along the upper contact of this same feldspathic meta-arenite unit in places underlying a unit of para-amphibolite, a thin unit of polymictic, matrix-supported pebble metaconglomerate with a calcitic hornblende - biotite schist matrix (map-unit 5d) occurs. Here the pebbles consist predominately of para-amphibolite, and siliceous marble with minor feldspathic meta-arenite clasts present in a few places.

Marble Tectonites

Marble tectonic breccia (map-unit 6j) consists of angular to subrounded fragments of marble usually with exotic fragments of feldspathic meta-arenite, metaquartzarenite, amphibolite and locally mafic to felsic intrusive rocks set in a fine-to medium-grained, cataclastic matrix of siliceous marble. Fragments in a single outcrop vary in size from 1 cm to 1 m. The texture of the matrix varies from massive to porphyroblastic and foliated to locally laminated. Excellent examples of tectonic breccia related to major easterly trending thrust faults, are exposed along the north shore of the two southwest bays of Baptiste Lake in Harcourt Township.

Finer grained, massive, foliated or laminated varieties of cataclastic marble without exotic clasts locally form small isolated exposures within zones of tectonic breccia or thin zones which parallel the layering in relatively undisturbed sequences of thin-to medium bedded marble. A relationship of these cataclastic marbles to zones of shearing or faulting is not always apparent. These rocks are white or laminated white to dark grey and commonly contain porphyroblasts of phlogopite and calcsilicate minerals.

In thin section, the fabric of the finer grained, cataclastic marble is markedly heteroblastic with elongated ragged to lens-shaped carbonate grains and porphyroclasts set in a finer grained heteroblastic matrix of carbonate, mica, and calcsilicate minerals. In places this matrix also encloses porphyroblasts of phlogopite and diopside and very fine discontinuous streaks and lamellae of graphite, and phlogopite. The twin lamallae in the larger carbonate crystals and porphyroblasts are invariably bent and broken.

STRATIGRAPHY AND FACIES DISTRIBUTION OF CARBONATE METASEDIMENTS

The following general statements regarding the stratigraphy and facies distribution of the carbonate metasediments can be made: Marble is absent from the Anstruther Lake Group (Bright 1976, 1977, 1980a). All marble units but one within the map area have been assigned by the author to the Mayo Group. This anomalous unit lies Southwest of Colbourne Lake near the south-central boundary of the area. It flanks and encircles the Cheddar Dome, most of which lies in the adjoining Eels Lake Area and was previously assigned to the older Hermon Group (Bright 1980a). Stratigraphic classification of this unit within the Mayo Group is discussed in the following section of this report. In general, marble becomes the dominant lithology in the upper part of the Mayo Group, however its abundance in the lower part of the group varies markedly due to regional facies changes.

Lower Epiclastic-Chemical Metasedimentary Sequence of the Mayo Group

In the central and southeastern part of the area, the lower part of the Mayo Group lies along the flanks of the Cardiff Dome where it is characterized by two relatively deep water marine facies equivalents: 1) amphibolite-biotite-pyroxene gneiss-minor marble along the northwestern and western flanks of the dome; and 2) metawacke - amphibolite - aluminous metamudstone - minor marble along the southern and eastern flanks of the dome. This latter deep water marine facies grades into, or is intercalated with, a more shallow marine carbonate facies along the flanks of the Cheddar Dome to the south along the southern boundary of the map area. This shallow facies consists predominantly of marble -

metawacke - minor amphibolite sequences. The lower part of the Mayo Group in the northeastern and eastern part of the area, along the northern and northeastern flanks of the Cardiff Dome as well as along the adjacent flanks of the Elephant Lake Pluton and the Faraday Dome, consists predominantly of shallow marine to shelf facies rocks represented by of marble-amphibolite or marble-feldspathic meta - arenite - minor metawacke. These lower Mayo Group deep to shallow marine facies equivalents are here assigned to a new subdivision termed the Lower Epiclastic-Chemical Metasedimentary Sequence (see Table 2).

In the northwest part of the map area, northwest of the Cardiff Dome, the lower part of the Mayo Group between Farquhar characterized by feldspathic meta-arenite - marble - minor metaquartzarenite sequences. These shallow marine facies units suggest an inner shelf and possibly in part an alluvial environment of deposition. This local equivalent of the lower Mayo Group is included in the author's Lower Epiclastic - Chemical metasedimentary sequence (Table 2).

Dungannon Formation of the Mayo Group

In the southeast corner of the map area, lower Mayo Group, deep to locally shallow marine facies rocks are abruptly overlain by a thick sequence of shallow marine, shelf carbonates. Marble forms over 90 percent of this middle-to upper part of the Mayo Group. Immediately to the south of the map area, in the Eels Lake Area (Bright 1980a) the author has correlated this thick carbonate shelf sequence with the Dungannon Formation

(Hewitt and James, 1956). In the Dungannon Formation, approximately 1 km south of the map area, Bourque (1982) has identified stromatolites within dolomitic marble. Bourque (1982) suggests that these stromatolite bearing rocks and the immediately adjacent carbonate metasediments represent local shallowing of the carbonate shelf to a subtitial to intertidal depositional environment.

Esson Formation of the Mayo Group

In the western part of the map area, to the southeast and southwest of Farquhar Lake, much marble and in places subordinate metaquartzarenite occur and make up the central portion of the Mayo Group in the area. Further to the southwest between Esson and Wilbermere Lakes in the southwestern corner of the map-area, the middle part of the Mayo Group is also characterized by marble - metaquartzarenite sequences. The author proposes a new subdivision, the Esson formation for this middle part of the Mayo Group in the western part of the map area. It is possibly a stratigraphically equivalent of or younger than the marble-rich Dungannon Formation described above.

The Esson formation has a maximum exposed width of about 200 m in the anticlinal fold on Esson Lake and can be traced more than 10 km along strike to the southwest of the map area beyond the village of Tory Hill (Bright 1980a). Within the map area, narrow units of this formation conformably overlie feldspathic meta-arenite - marble - minor metaquartzarenite sequences of the lower Mayo Group which are exposed southeast of Farquhar Lake and along the southwest shore of Grace Lake. In general, the Esson formation consists of thin-to medium interbedded siliceous calcitic and dolomitic marble (40-70% in volume) and metaquartzarenite (30-50% in volume). Thinly interbedded units of minor amphibolite, calcsilicate gneiss and feldspathic meta-arenite occur in many places. Chondrodite and chondrodite-graphite-bearing varieties of marble are locally abundant near Esson Lake and along strike to the southwest of the map area near Tory Hill. Diopside-apatite marble (1-10% apatite) locally form thin-bedded (3-10 cm thick) units in some sequences of thin-to medium bedded phlogopite-diopside marble, metaquartz-arenite and amphibolite. The Esson formation represents a carbonate shelf depositional environment, transional between inner and outer shelf.

Conformably overlying the Esson formation in the core of the Clement Creek Syncline between Esson and Grace lakes is a thick sequence of marbles with minor interbedded feldspathic meta-arenite, metawacke and locally amphibolite. This marble-rich middle-to upper part of the Mayo Group is tentatively correlated with the Dungannon Formation exposed in the southeastern corner and southeast of the map area.

SUMMARY OF GRENVILLE SUPERGROUP STRATIGRAPHY

In the description above the author has presented an account of the present knowledge of the stratigraphy of the Grenville Supergroup in the map area. Table 2, schematically presents a picture of the stratigraphy in the present area and in neighbouring areas within the region of the Harvey-Cardiff Basement Arch and the Hastings Basin (Bancroft-Madoc area, shown in Figure 2).

In the Center Lake area (area 3, Fig. 2), the supracrustal rocks of the Grenville Supergroup have been assigned to two lithostratigraphic subdivisions which, in ascending stratigraphic order, are the Anstruther Lake Group and the Mayo Group. The criterion for subdividing the Supergroup into these two lithostratigraphic groups are as follows. In the central and eastern part of the map area, the Anstruther Lake Group, the basal clastic subdivision of the Supergroup unconformably overlies and mantles an assumed unexposed basement complex in the region of the Cardiff Dome. In the adjoining Eels Lake area (fig. 2) to the south a Middle Proterozoic basement migmatite-gneiss complex is exposed in the Anstruther Dome (Bright 1980a). In this type-area for the Anstruther Lake Group, the boundary between the Anstruther Lake Group and the conformably overlying Hermon Group is (Bright 1976, 1977, 1980a) where marble units first appear or in, the absence of marble, where abundant amphibolite and calcsilicate gneiss occur. Marble-rich sequences at or near the base of the Hermon Group were assigned to the Monmouth Formation; the interlayered marbles in the conformably overlying amphibolite-rich sequences were assigned to the Eels Lake formation (Bright 1980a). Meta- volcanics are subordinate in volume to metasediments and intertongue with and conformably overlie both these formation in the eastern and southern parts of the Eels Lake area. The north-central and northwestern part of this same area contains minor metavolcanics.

Since no metavolcanics were recognized to the north in the Center Lake area, all post-Anstruther Lake Group, marble-bearing metasedimentary sequences are assigned to the Mayo Group (Table 2). The Hermon Group as defined by Lumbers (1967b) is therefore as not present. However extensions of the Eels Lake and Monmouth formations which are lithostratigraphically defined as Hermon Group in the Eels Lake area intertongue with portions of the purposed lower Epiclastic - Chemical metasedimentary sequence of the Mayo Group (Table 2) along the southern boundary of the Center Lake area. This demonstrates that the term "Hermon Group" should probably be restricted in usage to regions southeast of the map area (i.e. the Hastings Basin Region). 3).

METAMORPHOSED ALKALIC INTRUSIVE ROCKS

Introduction

Metamorphosed, alkalic mafic to felsic intrusive rocks in the map area have been subdivided into three main lithological groups. In interpreted order of decreasing age these are: 1) mafic intrusive rocks (unit 7); 2) nepheline syenite (unit 8); and 3) potassic syenite (unit 9). Potassic syenite intrudes and replaces nepheline syenite and most contacts between them are parallel and gradational. The rocks are gneissic and contacts between potassic syenite gneiss and alkalic mafic intrusive rocks are generally sharp and parallel to locally cross-cutting. Contacts between nepheline syenite gneiss and the alkalic mafic intrusive rocks were not observed.

The alkalic rocks were emplaced as a series of closely spaced intrusive sheets, sills and smaller bodies into relatively undeformed sediments of the Grenville Supergroup, mainly those of the lower Mayo Group. Smaller isolated alkalic sills are also present in the underlying metasediments of the Anstruther Lake Group and the carbonate rocks of the middle to upper part of the Mayo Group. The Grenville Supergroup together with these alkalic rocks were subjected to folding and regional metamorphism during the Elzevirian Orogeny as well as the later Grenville Orogeny.

The alkalic rocks belong to the Haliburton - Bancroft Nepheline Syenite Belt (Adams and Barlow 1910, Hewitt 1961), a suite of plutonic rocks shown but not labeled in Figure 3. To the southwest of Bancroft and the western limits of the map area alkalic sheets and sills occur discontinously over a 130 km long, 30 km wide zone in the Grenville Supergroup. Within this belt of alkalic rocks, Miller (1981) has reported a U/Pb zircon age of 1225 ± 3 Ma on a nepheline syenite gneiss from Laronde Creek in southwestern Monmouth Township. This segment of the belt is the southwesterly extension of the alkalic gneiss exposed within the map area between Wilbermere and Esson lakes along the east-central boundary of Monmouth Township.

ALKALIC MAFIC INTRUSIVE ROCKS

Metamorphosed alkalic mafic intrusive rocks (unit 7) of gabbroic composition form massive to weakly foliated, in places lineated, and locally layered sills ranging in size from 25 m to 300 m thick. The largest and most abundant sills intrude the lower Mayo Group metasediments in the northern part of the map-area. In the central part of the area, several homogenous, foliated sills occur along the flanks of the Cardiff Dome at the same stratigraphic horizon. All the rocks of map-unit 7 are characterized by sodic amphibole and/or pyroxene.

Metagabbro (unit 7a), the dominant rock type is a dark green to grey-green, medium-to coarse-grained rock. In some of the thicker gabbroic sills near Grace and Farquhar Lakes, the upper portions locally exhibit relict compositional layering. It consists of alternating melanocratic metagabbro and thin layers, usually less than 10 cm thick of leucocratic metagabbro and places scapolitized leucocratic metagabbro. Metagabbro displays textures ranging from massive to weakly foliated and/or lineated. Towards the margins of these sills, massive to weakly foliated metagabbro generally grades along and across strike into foliated, medium-to coarse-grained hornblende-plagioclase gneiss (map unit 7b). This rock is light grey green and contains porphyroblasts and/or porphyroclasts of hornblende and felsic minerals.

In the thinner sills, the dominant rock type is hornblende-plagioclase gneiss. In thin section, massive to weakly foliated metagabbro has heteroblastic assemblages of andesine - hornblende - biotite and hornblende - andesine - biotite. In leucocratic metagabbro the hornblende content is less than 30 percent and biotite seldom exceeds 5 percent. Magnetite, the most common accessory in all varieties of metagabbro, constitutes between 1 and 3 percent of the rock.

Minor titanite and apatite are also present. Plagioclase occurs as rounded to equant, xenoblastic grains and hornblende forms ragged tabular to rounded xenoblastic grains as well as larger irregular to eye-shaped porphyroclasts. Relict grains of primary sodic clinopyroxene were observed in the centre of a few of the hornblende porphyroclasts.

The primary mineralogy and igneous textures of this early suite of alkalic mafic intrusive rocks are locally preserved in a compositionally layered metagabbro sill exposed along the southeast bay of Farquhar Lake in Harcourt Township. Along the northeast shore of the bay, the rusty weathering, dark green, upper chilled margin of this sill is exposed. In thin section, this chilled facies has a relict hypidiomorphic-granular to locally subophitic texture. Prior to partial metamorphic recrystallization, this chilled rock consisted of about 80 percent subhedral to euhedral sodic clinopyroxene and 15 to 20 percent finer grained subhedral plagioclase. The sodic clinopyroxene has been partially altered (up to 30 percent) along its cleavage traces to finer grained amphibole or amphibole and magnetite. Away from the contact, the chilled marginal phase of this sill grades rapidly into a very coarse-grained, dark green, equigranular to subporphyritic metagabbro compositionally similar to the chilled phase. Subhedral laths of pyroxene up to 2 cm long occur locally in this coarse-grained phase. Interlayered with this coarse-grained, dark green metagabbro are several subordinate up to 40 cm lighter greenish-grey, leucocratic, subophitic metagabbro.

In these leucocratic phases, the pyroxene content varies from 30 to 50 percent. All the pyroxene is enveloped by a thin primary reaction rim of inequigranular, locally radiating, tabular amphibole. Recrystallization and partial replacement of the pyroxene and its reaction rims by secondary amphibole locally marks this primary feature especially in foliated margins of the leucocratic metagabbros.

In thin section, leucocratic metagabbro consists mainly of partially recrystallized, subophitic intergrowth of andesine and sodic clinopyroxene. Narrow primary reaction rims on clinopyroxene adjacent to the plagioclase have been recrystallized to a finer-grained medium to dark green pleochroic amphibole. This amphibole is optically different from the secondary amphibole developed along the cleavage traces of the clinopyroxene. In places along the contacts between several large relatively unaltered grains of clinopyroxene and plagioclase, the primary mineralogy of the reaction rim is preserved. It consists of very fine-grained, prismatic crystals of colourless to light green, pleochroic amphibole and minor tabular plagioclase. Before metamorphic overprint, this primary amphibole probably constituted between 5 and 10 percent of this alkalic rock. Large andesine phenocrysts are recrystallized along their borders to small equant grains of secondary plagioclase, whereas many of the smaller primary grains are totally recrystallized fine-grained, secondary, granoblastic plagioclase. Magnetite is the main accessory in this rock.

Hornblende plagioclase gneiss (map-unit 7b) is a foliated to layered rock. It consists of heteroblastic hornblende and plagioclase. Elongated hornblende and minor biotite grains as well as porphyroblasts of hornblende and plagioclase define the foliation. Minor quartz is present.

Layered scapolitized hornblende-plagioclase gneiss (map-unit 7c) is the dominant rock type in the poorly exposed sill on the eastern shore of Grace Lake. A thin section from this location carries a heteroblastic assemblage of amphibole - plagioclase - scapolite - clinopyroxene - biotite. The amphibole is sodic in composition and the scapolite comprises between 25-35 percent of this strongly foliated rock. The saussuritized plagioclase ranges in composition from oligoclase to andesine.

The upper part of this sill exhibits well defined compositional layering 1 cm to 2 m thick, with dark green, melanocratic layers alternating with light green to grey, leucocratic layers. The author believes this layering to be primary magmatic. In thin section, the melanocratic layers are heteroblastic and contain sodic amphibole - plagioclase - scapolite with minor biotite and locally minor clinopyroxene. The leucocratic layers are also heteroblastic and contain andesine - scapolite - biotite with minor sodic amphibole. In the mafic layers subparallel alignment of the biotite and locally the long axis of the amphibole defines a weak foliation. The felsic layers contain up to 10 percent biotite and are well foliated. In this section besides the above mentioned minerals the following accessories were observed; magnetite, apatite, and titanite. Abundant scapolite was also found in thin sections of leucocratic hornblende - plagioclase gneiss from the Allen Lake sill as well as other sills to the north and south of Farquhar Lake.

NEPHELINE SYENITE

Massive to foliated, in places layered nepheline syenite (unit 8) form subordinate, intercalated units in the more abundant potassic syenite gneisses (unit 9) along the southwestern and northeastern flank of the Cardiff Dome and the southwestern flank of the Faraday Dome. The foliation and gneissic layering in these rocks parallels the fabric in the adjacent potassic syenite gneisses. Near their contacts these two lithologies are locally discontinuously interlayered. Because of strong contact metasomatic alteration by the potassic syenite, nepheline syenite-potassic syenite contacts are generally gradational over distances up to 10 m.

Map-unit 8 may be subdivided into leucocratic varieties (unit 8a) and metanocratic varieties (units 8b, c) Subunits 8b and c besides containing nepheline-syenite gneisses sensu stricto, also contain nepheline-bearing gneisses metasomatically altered by younger potassic syenite.

Leucocratic Nepheline Syenite

Leucocratic, biotite-nepheline syenite (unit 8a) is a massive to weakly foliated, medium-to coarse-grained, white to light grey rock. It forms the dominant of nepheline syenite gneisses along the southwestern flank of the Faraday Dome. The rock consists mainly of plagioclase and nepheline with biotite rarely making up more than 5 percent. Minor hornblende and potassic feldspar are locally present, particularly near marginal phases of this unit with map-units 8b and c or mafic mineral-rich country rocks. In thin section, leucocratic nepheline syenite carries granoblastic albite - nepheline - minor biotite. The subparallel alignment of biotite defines a weak foliation. Accessories are apatite, magnetite and zircon.

Melanocratic Nepheline Syenite

Foliated to layered melanocratic, in places leucocratic varieties of nepheline syenite (units 8b and c), characteristically contain more than 10 percent mafic minerals as well as variable amounts of potassic feldspar. These rocks are medium-to very coarse-grained and vary in texture from foliated, augen textured gneissic to locally gneissic layered. They exhibit varying shades of pinkish grey and greenish grey to grey.

Map-unit 8b represents pinkish grey, generally foliated biotite or muscovite-biotite nepheline syenite. Potassic feldspar forms a major constituent and the biotite content ranges up to 15 percent. Minor hornblende may be present. An outcrop of these potassic feldspar-bearing nepheline gneisses is located on the south side of the secondary road in the N1/2 lot 28, concession XIII, Cardiff Township. In a thin section from this location, the rock exhibits a strong gneissic fabric defined by alternating, discontinuous felsic-and mafic mineral-rich lamellae. Felsic lamellae contain heteroblastic oligoclase -

orthoclase - nepheline - biotite + muscovite and calcite. Plagioclase is strongly saussuritized and orthoclase is locally altered to sericite along cleavage traces and fractures. Most of the nepheline has altered to fine-grained, amorphous, light to dark green gieseckite. Mafic lamellae contain heteroblastic, lepidoblastic nepheline - biotite - muscovite - orthoclase ± plagioclase and calcite. The subparallel alignment of biotite defines a foliation. Muscovite occurs only in irregular reaction rims around some unaltered nepheline grains. Where this reaction rim of muscovite occurs it separates the nepheline from calcite. Another reaction on some nepheline grains consists of subidioblastic cancrinite. Adjacent to cancrinite, brown biotite exhibits a greenish decolouration.

The darker more mafic rich nepheline syenite gneisses occur along the margins of thick units of leucocratic nepheline syenite gneiss (unit 8a) and form intercalated thinner units in the potassic syenite gneiss. Greenish grey to grey varieties of map-unit 8b are generally gneissic to locally layered biotite-hornblende nepheline syenite containing 10-15 percent combined mafic minerals. Plagioclase and nepheline form the major constituents of this rock and potassic feldspar and carbonate generally occur as minor interstial components.

Darker grey varieties of map-unit 8b are generally hornblende-nepheline syenite. It contains up to 35 percent hornblende with or without biotite and potassic feldspar as a constituent. This syenite is augen textured to layered and occurs mainly in contact metasomatic zones adjacent to potassic

syenite gneiss. A readily accessible outcrop of augen-textured, potash metasomatized, hornblende nepheline syenite is exposed along the abandoned railway line, near Harcourt on the S1/2 lot 15, concession I, Harcourt Township. In this particular narrow unit, potassic syenite gneiss occurs as minor, thin intercalated units in the hornblende-rich nepheline gneiss. A stained hand-specimen of the coarse-grained augen-textured gneiss contains the following estimated composition: potassic feldspar (30%), hornblende (30%), plagioclase (25%), nepheline (10%) and calcite (2-5%). In thin section, the augen consist of:
1) orthoclase - oligoclase calcite ± nepheline and hornblende; and 2) nepheline - oligoclase - calcite ± orthoclase and hornblende. The mafic mineral-rich lamellae and sheafs around the augen consists of hornblende - oligoclase - calcite ± orthoclase, nepheline and locally clinopyroxene.

Scapolite-bearing nepheline gneiss (unit 8c) is restricted to minor occurrences. These leucrocratic to melanocratic gneiss occurs thinly intercalated in the potassic syenite gneiss on the Fission Mines Limited uranium property (No. 12 on map in back pocket). A thin section of the unit within the potassic syenite gneisses to the southeast of the main adit on the above property was examined. The light grey layers contain a heteroblastic assemblage of scapolite - oligoclase - biotite - hornblende ± microperthite and nepheline. The darker grey, more mafic mineral-rich layers carried the following two alternating assemblages: 1) a heteroblastic assemblage of scapolite - hornblende - biotite - oligoclase ± microperthite and nepheline;

and 2) a lepidoblastic assemblage of biotite - scapolite - oligoclase - nepheline. Accessory minerals in both assemblages include magnetite, apatite and titanite.

POTASSIC SYENITE

Massive and foliated in places, layered potassic syenite (unit 9) forms the main lithology in a thick series of deformed, alkalic mafic to felsic gneisses and related smaller satellitic lenses throughout the map area. Individual bands and lenses are structurally conformable with the enclosing metasediments of the Grenville Supergroup, with which they were deformed. The potassic gneisses contain a wide variety of igneous and meta-sedimentary country rocks, inclusions exhibiting varying degrees of metasomatic replacement. Igneous country rock inclusions in the potassic syenite are: 1) locally scapolitized alkalic meta-gabbro (unit 7); and 2) discontinuous, gradational bounded, lenses of potash metasomatized nepheline syenite (unit 8). The potassic syenite may also contain variable amounts of nepheline within hybrid zones of replacement, adjacent to relicts of older foliated layered nepheline syenite. Metasedimentary country-rock inclusions and are listed as follows in order of decreasing abundance: 1) amphibolite (unit 5); 2) metawacke (map-unit 2); 3) feldspathic meta-arenite (unit 1); 4) minor marble and biotite-pyroxene gneiss and schist (map-units 6 and 4 respectively).

Contacts are sharpest where the country rocks are marble and feldspathic meta-arenite.

Map-unit 9 is subdivided into subunits 9a,b,c, and d described on the following pages.

Biotite syenite (unit 9a) is the most common rock type of map unit 9. It is foliated, medium-grained, pink to red rock that contains up to 10 percent biotite with or without hornblende. Locally, it grades into subordinate phases of massive to weakly foliated, medium-grained, pink leucocratic syenite containing less than 1 percent biotite. Biotite-richer phases commonly contain and grades into relicts of altered country rock, too small to show on the map (back pocket). In thin section, the rocks contain heteroblastic albite, perthitic microcline and biotite. A relict hypidiomorphic texture may be preserved locally. Accessories include magnetite, apatite and titanite.

Biotite-hornblende syenite (unit 9b) is generally a foliated, in places layered, medium-to coarse-grained, red to reddish brown or yellowish brown rock. It contains 5 to 30 percent hornblende and 2 to 15 percent biotite. Shades of reddish to yellowish brown are the result of hematite staining of the felsic minerals. In thin sections, rocks of unit 9b are heteroblastic and consist of oligoclase, microcline, hornblende, biotite and minor amounts of carbonate and clinopyroxene. The subparallel alignment of the biotite flakes and the long axis of the coarser-grained, ragged prisms of poikiloblastic hornblende define the foliation. The strong dark green to dark greenish blue pleochroism of the amphibole suggests that it is a sodic variety, possibly ferrohastingsite. Uralitized clinopyroxene is present locally and in general occurs as small irregular, subrounded inclusions in the sodic amphibole. Interstitial carbonate may comprise up to 2 percent of the rock, particularly in hornblende-rich phases. Magnetite, apatite and titanite are accessory minerals.

Map unit 9c represents a thinly layered variety of gneissic biotite-hornblende syenite similar to rocks of unit 9b. It is characterized by continuous to discontinuous mafic layers containing more than 60 percent combined hornblende and biotite alternating with reddish-to yellowish brown felsic layers containing less than 10 percent mafic minerals. These gneissic rocks are biquitous in the syenitic gneisses along the flanks of the Cardiff and Faraday domes.

Metasomatism Related to The Potassic Syenite

The potassic syenites of map units 9b and 9c, and locally 9a in many places contain numerous inclusions and thinly intercalated units of metasomatized, metasedimentary country rock (map-unit 9d). Metasomatic alteration along contacts of the syenites with older igneous rocks was discussed in an earlier section of this report. In the following, several metasomatized sedimentary lithologies will be described.

In a thin section of metasomatized thinly layered para-amphibolite (map-unit 5b), the following rock forming minerals were observed in alternating layers: 1) hornblende (50-60%), plagioclase (20-25%), microcline (10-15%); 2) hornblende (30-35%), clinopyroxene (15-20%), microcline (35-50%), carbonate (5-10%); and 3) plagioclase (30-40%), microcline (25-35%), hornblende (15-20%), and biotite (2-8%). Potash metasomatism of the mafic mineral-rich layers is indicated by the abundance of microcline that in places makes up to 50 percent of the mafic layers. In non-metasomatized para-amphibolites, potassic feldspar is rare or absent.

In a thin section of metasomatized, layered biotite-pyroxene gneiss (map unit 4a) the following were observed in alternating layers: 1) clinopyroxene (35-40%), scapolite (30-35%), microcline (20-30%) and biotite (1-5%); and 2) biotite (35-40%), scapolite (25-30%), clinopyroxene (15-20%), and microcline (1-5%). Potash metasomatism is indicated by the abundance of microcline. In non-metasomatized biotite-pyroxene gneiss and schist, potassic feldspar is scarce or absent. The alteration of primary basic plagioclase in these rocks to scapolite probably occurred during this same period of metasomatism.

METAMORPHOSED INTERMEDIATE INTRUSIVE ROCKS

Granodiorite

Foliated intermediate intrusive rocks (map-unit 10) in the map area are predominantly granodiorite to locally tonalite in composition (Streckeisen, 1976). Along the northern and eastern boundaries of the map area, these rocks form large plutons, sills, and sheet-like intrusive bodies in the rocks of the Grenville Supergroup. In the central part of the area, the region of the Cardiff Dome, they occur mainly as smaller sills and dikes. These rocks display, to varying degrees, the effects of the Grenville deformation mainly in the form of foliation.

Adjacent to the larger plutons and sills metasediments of the Grenville Supergroup are locally migmatized. In the Bancroft-Madoc area region east of the map area (area 1, Fig. 2) granitic rocks of the same suite as those described above form a distinct group of plutons whose radiometric ages range from 1250 to 1150 Ma (Silver and Lumbers 1966 , Douglas 1980).

Elephant Lake Pluton

In the northeast corner of the map area, the southwestern extension of a metamorphosed granitic pluton is exposed between Elephant and Baptiste Lakes. This pluton (No. 6, Figure 3) which the author has named the Elephant Lake Pluton is approximately 6 km wide and extends eastward beyond the map boundary for about 18 km. In the map area, the western part of the Elephant Lake Pluton is a pinkish grey to medium grey, medium-to coarse-grained foliated hornblende-biotite to locally biotite-hornblende granodiorite (unit 10a) which in places is banded and exhibits a pronounced augen structure. The pinkish colour is caused by hematite coating on quartz and feldspar grains and hematite along fine fractures in the rock. Foliated hornblende-biotite granodiorite is the most common rock type in the central part of the pluton. The combined biotite and hornblende content varies from less than 5 percent to more than 10 percent. In thin sections of the hornblende-biotite granodiorite, (unit 10a) the main rock forming minerals are oligoclase, quartz and microcline with lesser amounts of biotite and hornblende. Quartz comprises about 30 percent of the rock and microcline, as interstitial grains, seldom exceeds 20 percent. The rock is heteroblastic and the subparallel alignment of the biotite together with the long axis of the hornblende defines the foliation.

Towards the margins of the pluton, the mafic mineral content increases to as much as 20 percent and hornblende is generally more abundant than biotite. Banded and augen textured biotite-hornblende granodiorite and locally tonalite (unit 10b) predominates along the margins of the pluton as well as in some of the smaller satellitic dikes that conformably intrude the country rock metasediments on Baptiste Lake. The banded varieties are commonly characterized by augen up to 2 cm long set in a medium-grained, granular matrix of recrystallized feldspar and quartz with minor biotite and hornblende. The augen consist of medium-to coarse-grained aggregates of quartz or quartz with minor feldspar. Biotite and hornblende are concentrated into discontinuous elongated folia adjacent to the quartz augen. In thin sections of augen textured biotite-hornblende granodiorite, the microcline content usually ranges between 10-20 percent, however in places it is less than 10 percent and the rock is a tonalite. Quartz is present in two habits in these augen gneisses. Primarily it occurs as large, elongated, highly strained grains in the augen; and secondly as smaller weakly strained, grains in association with feldspar and mafic minerals in the finer-grained groundmass between the augen. Plagioclase mainly forms poorly twinned, subequant xenoblastic grains, however a few larger anhedral to subhedral laths also occur. These larger plagioclase laths occur either in direct contact with the quartz augen or separated from them by a thin discontinuous zone of xenoblastic feldspar and quartz. Where the quartz augen are wrapped by folia of biotite and hornblende, these larger plagioclase laths were not observed between the augen.

Faraday Pluton

Along the northern boundary of Faraday Township at the eastern boundary of the map area, to the east of the Cardiff Dome, pinkish grey to grey, medium-to coarse-grained to augen-textured gneissic granodiorite similar in texture and mineralogy to that of the Elephant Lake Pluton is exposed. This granodiorite represents the western margin of a large pluton to the east that underlies the central region of the Faraday Dome (no. 5, Figure 3). In the map area, the western contact of this pluton with the country rock metasediments was the locus of emplacement of a younger, massive to foliated crescent-shaped leucocratic granite dike (map-unit 11). The older granodiorite and younger crescentic granite had been grouped together by Hewitt (1957) as his "North Hastings massif" and by Robinson (1959) as the "Faraday granite". The term Faraday Pluton as used by the author refers only to the older, metamorphosed granodiorite in the core region of the dome.

Metamorphosed, Intermediate Sills and Dikes

In the northwestern part of the map area, between Scraggy and Grace Lakes foliated granodiorite and minor tonalite forms several deformed small sills and one large sheet-like intrusive body whose contacts and internal fabric are concordant to the adjacent and/or enclosing deformed metasediments of the Grenville Supergroup. The dominant rock types in these intrusions are light grey hornblende-biotite granodiorite and medium grey biotite-hornblende granodiorite. Pinkish colours are locally present. These rocks are medium-grained, weakly foliated and locally lineated. Quartz augen-structured varieties of darker grey coloured biotite-hornblende granodiorite to tonalite occur locally near the contacts of these intrusive bodies. In two thin sections of weakly foliated and lineated rock taken from the contact zones of the granodioritic intrusive sheet exposed near the south east shore of Grace Lake, the rocks exhibit a heteroblastic to locally hypidiomorphic-granular texture. The average modal composition of these two samples is as follows: plagioclase (54.9%); quartz (25.5%); microcline (5.8%); hornblende (7.5%); biotite (4.5%); and opaque minerals (trace to 1%). The plagioclase composition is oligoclase and these rocks are tonalitic in composition (Streckeisen, 1976). Most intergranular quartz exhibits some degree of strained extinction; however small subrounded quartz inclusions in the anhedral to lath shaped plagioclase are strain free. Microcline forms interstitial grains and hornblende forms small intergranular subhedral grains and anhedral interstitial grains.

To the southeast, in the central part of the Cardiff Dome, strongly foliated locally lineated biotite or hornblende-biotite granodiorite conformably intrudes metasediments of the Grenville

Supergroup and intercalated units of potassic syenite gneiss. These granodiorites characteristically range in colour from pink to pinkish grey. The pinkish colour is caused by hematite staining on quartz and feldspar and colour is most strongly developed near and adjacent to units of potassic syenite gneiss (unit 9). These pink varieties contain more interstitial microcline than does the light grey granodiorite to darker grey tonalite to the northwest near Grace Lake. Here the granodiorites can be readily mistaken for the younger lineated and foliated, pink biotite granite (unit 11). The main differences between the two rocks is that the older granodiorite has a more granulated, gneissic appearance and usually contains between 5 and 15 percent combined biotite and hornblende.

METAMORPHOSED FELSIC INTRUSIVE ROCKS

Granite

Massive, lineated and in places weakly foliated granite (unit 11) form small stocks like the Monck Lake granite stock near Center Lake and numerous large crescent-shaped dikes up to 400 m thick that conformably intrude the flanking metasediments of the Cardiff and Faraday gneiss domes. However, Hewitt's "Center Lake leucogranite sheet" as shown on his map of Faraday Township (1957), includes both the Monk Lake stock and its host rock feldspathic meta-arenite which is intruded by several large and numerous swarms of narrow, concordant crescentic granite dikes, together as one body. In the author's opinion, the oval Monck Lake granite stock occupies the core of a smaller center of diapiric uplift within the southern part of the Cardiff Dome.

These granites are usually medium-grained, pink, and leucocratic. They contain less than 1 percent biotite and in places accessory hornblende. Textures in the center of the Monck Lake granite stock and many of the thicker, crescentic dikes is massive, equigranular to locally weakly foliated. Contact zones of these intrusives are commonly lineated and in places strongly foliated. The lineation plunges south to southeast and is defined by quartz rods; the foliation is defined by biotite. Smaller concordant granite dikes in the metasediments, most of which are too small to show on the map (back pocket) are generally lineated and in places foliated throughout.

Both the leucocratic and somewhat darker biotitic varieties of these granites contain approximately equal amounts of felsic minerals. The average measured modal analysis of four stained hand-specimens is as follows: plagioclase (36.5%), quartz (34.1%), potassic feldspar (27.7%) and biotite plus opaque minerals (1-3%). In thin section, the massive rocks are hypidiomorphic-granular. The feldspars are subequant oligoclase and anhedral microcline and minor perthitic microcline. Quartz is anhedral and weakly strained. In thin sections of lineated granite, all the quartz is strained and the rock consists of large elongated quartz grains up to 1 cm long set in a finer-grained heteroblastic matrix of saussuritized plagioclase, sericitized microcline and quartz.

METAMORPHOSED MAFIC TO ULTRAMAFIC INTRUSIVE ROCKS

Introduction

Relatively unmetamorphosed to weakly metamorphosed mafic to ultramafic sills and dikes (unit 12) of several probable ages intrude the metasediments of the Grenville Supergroup and the metamorphosed felsic intrusive rocks (unit 11) at several locations in the map area. The largest intrusion, the "Wilberforce Pyroxenite" occurs near Allen Lake in the northwest corner of the map area. Several dikes occur on Monk Lake near the southern boundary of the map area. Between 0.5 to 1 km south of map area, the strike extensions of several of the larger dikes are exposed in several roadcuts along Highway 121. In this region, a large unmetamorphosed mafic dike, to the southwest of the Monck Lake granite is cut by another fine-grained mafic dike and both dikes in turn are cut by late tectonic pegmatitic granitic dikes (unit 14).

Wilberforce Pyroxenite Sill

Between Allen and Scraggy Lakes in the northwest corner of the map area relatively undeformed pyroxenitic sill is 260 m thick and approximately 3.2 km long, 1.3 km wide. This intrusion has been the subject of paleomagnetic investigations by Mason (1959) and Palmer and Carmichael (1973). This intrusion was referred to by subsequent authors as the "Wilberforce Pyroxenite". This sill is characterized by a sharp oval negative magnetic anomaly (Map 110G, Aeromagnetic Series, Geological

Survey of Canada, 1953) and was emplaced into a pre-existing basin-shaped structure in the previously deformed metasediments. Immediately below the Wilberforce Pyroxenite Sill is a thin marble unit (20-100 m wide) which separates this sill from an older metamorphosed alkalic mafic sill (map-unit 7), whose structure and internal fabric is also subparallel to the exclosing deformed metasediments. Where the marble is not exposed between these two sills, one could easily misinterpret the weak to moderately magnetic, foliated, older mafic sill as a deformed marginal phase of the undeformed strongly magnetic Willberforce ultramafic sill.

The dominant rock type in the Wilberforce ultramafic sill is a dark green, medium-to coarse-grained, massive, equigranular hornblende pyroxenite (unit 12a). Other phases locally present are porphyritic hornblende pyroxenite and hornblendite. In several places along the upper and lower chilled margins of the sill, fine-grained hornblende pyroxenite contains oriented phenocrysts of hornblende up to 1.5 cm long. In this chilled zone 1 cm to 15 cm thick layers of fine-grained hornblende pyroxenite and porphyritic hornblende pyroxenite are interlayered with 1 mm to 2 cm thick cumulate layers of dark grey medium-grained hornblendite. Farther away from the chilled margin, coarse-grained layers of hornblendite up to 20 cm thick containing hornblende laths up to 2 cm long, were observed in medium-grained hornblende pyroxenite.

In thin section the hornblende pyroxenite has an allotriomorphic-granular texture and consists of about 65 percent augite and 30 percent hornblende with some sections containing up to 10 percent anhedral, intergranular, serpentinized olivine. Magnetite, the main accessory, comprises up to 4 percent of the rock. It occurs as small intergranular grains and as finer grained exsolved lamallae and rods within augite and locally in hornblende. In thin sections of the hornblendite, augite occurs only as small subrounded inclusions in the subhedral laths of hornblende. The long axis of the hornblende crystals and the cumulate layers of hornblendite are oriented subparallel to the shallow dip of the sill.

Other Mafic to Ultramafic Intrusive Rocks

On Monck Lake, near the south-central boundary of the map-area a northwest-trending mafic dike of dioritic composition (unit 12b) was emplaced subparallel to the layering in the enclosing feldspathic meta-arenites. Cross-faulted segments of this 40-50 degree, southwest-dipping dike vary from less than 25 m thick on Monck Lake, in the area to over 250 m thick on Highway 121 to the south of the map area. The thickest and most readily accessible exposure of this dike occurs about one kilometer south of the map area at the junction of Highway 121 and Highway 648N. Here it is compositionally layered, and contains: 1) a chilled margin of dark grey, fine-to medium-grained, subporphyritic plagioclase-and pyroxene-bearing hornblendite; and 2) a medium-to coarse grained central phase consisting of alternating layers, 2 cm to 15 cm thick, of light greenish grey, ophitic diorite and dark green, subophitic hornblende-rich diorite.

In thin section, an average sample of the marginal hornblendite is made up of hornblende (75-85%), clinopyroxene (8-10%), plagioclase (5-10%), and quartz (1-3%), plus minor biotite, magnetite and apatite. The plagioclase composition is andesine (An34-42). The hornblende occurs mainly as large anhedral to subhedral poikiolitic crystals enclosing anhedral augite and quartz and subhedral laths of plagioclase and biotite. Some of the hornblende has been altered to a finer-grained assemblage of granoblastic amphibole in places partially altered to chlorite. In thin section, an average sample of the dark green subophitic hornblende-rich diorite is made up of plagioclase (40-50%), hornblende (35-40%), biotite (5-10%) and quartz (3-5%), plus accessory magnetite and apatite. The plagioclase composition varies from calcic oligoclase to sodic andesine. Hornblende occurs as large anhedral to subhedral poikilitic crystals enclosing the other constituents. It is sub-ophitically intergrown with subhedral plagioclase. The hornblende particular along its margins has been locally altered to a fine-grained, granoblastic amphibole.

This layered dioritic dike is cross-cut by a 3 m wide, dark grey fine-grained massive mafic dike (unit 12c) in the above mentioned roadcut. In a thin section of this mafic dike, the rock is fine-grained, hypidiomorphic-granular relatively unaltered and consists of plagioclase (60-65%), hornblende (20-25%), quartz (5-10%), and magnetite (1-3%), plus minor biotite, apatite and zircon. Both this dike and its larger host-dike are cut by several late tectonic pegmatitic granite dikes (map-unit 14).

Similar, fresh-looking fine- to medium-grained, dark grey to dark green mafic dikes intrude the Monck Lake granite stock and other related pink leucocratic granite dikes (map-unit 11) at several locations along Highway 121 to the east and west of the junction of Highways 121 and 648 N south of the map area boundary.

Near the west shore of Elephant Lake, along the northern boundary of the map area a small ultramafic dike cuts the metasediments. This rock is a dark grey, medium-grained, massive apatite-rich hornblendite. In thin section, this hypidiomorphic-granular rock is made up of hornblende (75-80%), apatite (10-15%) and magnetite (5-10%).

URANIUM-AND RARE EARTH-BEARING CARBONATE VEINS

General Lithology and Distribution

Uranium-and rare earth-bearing carbonate veins, in places lenses (unit 13) are spatially associated with the alkalic gneisses (units 9 and 8) along the western and southwestern flanks of the Cardiff Dome and along the southwestern flank of the Faraday Dome. These carbonate veins are not distributed and the mineralogy of the veins along the western flank of the Cardiff Dome is different from the veins along the southwestern flank of this same dome and the southwestern flank of the Faraday Dome. The carbonate veins may represent the carbonate-rich end-member of carbonatite igneous activity, however no carbonatite body is exposed in the map-area. Studies of fluid inclusions in apatite from the vein in the Basin Deposit on the Silver Crater Mines Limited property (No. 35, on map in back pocket) indicate a temperature of formation of about 350°C (Giblin 1955).

The carbonate veins in the map-area have been subdivided on the basis of their dominant mineralogy into the following two major types:

1) Map-unit 13a represents apatite-fluorite-calcite veins containing variable amounts of uraninite, thorite and uranothorite with minor rare earth-bearing minerals such as allanite and cryolite (Lang 1952, Satterly 1957).

2) Map-unit 13b represents apatite-biotite - calcite veins containing variable amounts of betafite, a multiple oxide of niobium, titanium and uranium with minor amounts of rare earths. In places minor thorite is present (Satterly 1957).

The structure and mineralogy of these two main types of carbonate veins are summarized below. More detailed descriptions of particular occurrences can be found in the Economic Geology Section of this report as well as published reports by Lang (1952) and Satterly (1943 and 1957).

Apatite - Fluorite -Calcite Veins (Map-unit 13a)

These veins occur mainly in the potassic syenite gneisses along the western flank of the Cardiff Dome. Here they form a discontinuous series of en echelon veins, branching veins and small lens-shaped dikes up to 4 m wide and 65 m long in potassic syenite gneiss over a 9 km strike length of this unit. The trend of the veins and lenses is structurally conformable to locally disconformable to the fabric of the enclosing syenite. Some of the larger lens-shaped veins were emplaced along drag folded sections of the country rock. Several of these larger bodies were observed to change along strike into a branching network of veins that cross-cut the enclosing drag-folded country rock.

Within this 9 km long segment of potassic gneisses mentioned above, the veins are concentrated in two specific areas, namely: 1) along the western, easterly dipping contact of the gneisses with an underlying thick sequence of marbles; and 2) along southwesterly trending axes of overturned folds within the gneisses.

The vein material consists predominantly of pink or white, coarsely crystalline calcite containing variable amounts of white or purple fluorite (2-30%) and green or red apatite (1-10%). Accessory minerals in addition to uraninite and thorite that may be present include hornblende, biotite, pyroxene, scapolite, magnetite, titanite, pyrite, pyrrhotite and chalcopyrite. These accessories, in particular the silicate and sulphide minerals are commonly more abundant within or adjacent to altered mafic inclusions in the calcite veins.

Associated with the calcite veins is a local fenitization of the wall rocks. The wallrocks are dark red and contain uranothorite as well as uraninite and thorite that occur as discrete interstial grains or as grains in small calcite-fluorite fracture fillings. Most of the other accessory minerals occurring in the veins and listed above may also be present. In places these accessory minerals are more abundant in the fenitized host rocks than in the adjacent calcite veins.

Many carbonate veins are sheared, boundinaged and, in places, portions of veins are dislocated both along strike and down dip. Late tectonic pegmatites (map-unit 14) locally intruded the carbonate veins, brecciating and partially assimilating them. Sheared and dislocated calcite veins lack a well defined border zone of fenitized wall rocks. Contacts between these deformed veins and the wall rock syenite gneiss are relatively sharp and the uranium-bearing and other accessory minerals are generally restricted to the calcite veins. Deformed calcite veins range from medium to coarse-grained in their central part to fine-to medium grained towards their margins. Near vein-wall rock contacts, they commonly exhibit a banded texture. Thin veins are fine-to medium-grained and may be banded throughout. This banding consists of thinly laminated dark bands, rich in fine-grained purple fluorite alternating and paralleling thicker bands of fine-to medium-grained, grey or cream coloured to pink calcite. Apatite, hornblende, biotite and uraninite form large anhedral to euhedral crystals (or porphyroblasts) and crystal aggregates up to 2 cm long in the darker fluorite-rich bands. Smaller grains of these same accessory minerals along with fluorite are disseminated throughout the lighter coloured calcite-rich layers.

Apatite - Biotite - Calcite Veins and Lenses Containing Betafite (Map-unit 13b)

These bodies are restricted in their occurrence and have only been identified on the following two properties:

1) In the Basin deposit of Silver Crater Mines Limited (No. 35 on map in back pocket) along the southwestern flank of the Faraday Dome they form a large lens and satellitic branching veins.

2) On the south zone of Rare Earth Resources Limited (No. 33 on map in back pocket) along the southwestern flank of the Cardiff Dome minor veins and small lenses were observed.

Basin Deposit

On the Basin deposit property, apatite - biotite - calcite forms a 16 to 25 m thick lens-shaped body that was emplaced within para-amphibolite along the drag-folded contact between amphibole-rich metasediments on the north and potassic gneiss on the south. The lens has an exposed width of about 40 m and can be traced along strike within the host rock amphibolite for over 120 m. Near its ends the lens subdivides into a series of smaller veins that parallel and interfinger with the altered amphibolitic wall rocks. The para-amphibolites adjacent to the main contacts of the calcite lens have been metasomatically altered to a calcite - biotite - sodic amphibole - oligoclase gneiss (Satterly 1957). Its southern contact with potassic syenite gneisses was not observed.

The Basin deposit calcite lens is zoned and contains numerous irregular to lenticular wall rock inclusions of metasomatized para-amphibolite. The long axes of these mafic inclusions parallel the main contacts of the calcite lens with the wall rock amphibolite and impart a crude, discontinuous layered fabric in many places to this zoned body. The wider outer zone of this lens consists of 70-80 percent coarsely crystalline, white calcite and variable amounts of biotite, apatite and locally hornblende. Large subrounded to euhedral megacrystals of biotite and hornblende, in places up to one meter in diameter were reported (Satterly, 1957). Other minerals occurring locally in this outer, white calcite zone include betafite, albite, zircon, molybdenite, pyrrhotite, pyrite and fluorite.

The narrower, 10-15 m thick central zone of this calcite lens consists of 1 cm to 1 m thick alternating bands of white and cream coloured to pink, coarse-grained calcite, containing variable amounts of biotite, apatite, betafite and locally minor thorite. Betafite is more abundant in the cream coloured to pink calcite bands than in the white bands. In this zone the mafic inclusions and the long axis of the apatite crystals both parallel the contacts of the lens.

Minor unzoned, satellitic, betafite-bearing apatite - biotite - calcite veins conformably intrude the amphibole-rich metasediments within a 30 m zone of the main lens. The emplacement of the Basin deposit calcite lens and veins appears to be structurally controlled as it intrudes drag-folded rocks close to the nose of a southward plunging synform between the Cardiff and Faraday Domes.

For a more detailed description of this deposit as well as minor occurrences on the south zone of the Rare Earth Resources Limited deposit, the reader is referred to the published property description of Satterly (1957) and to the Economic Geology Section of this report.

LATE PEGMATITIC GRANITE DIKES

Late tectonic pegmatitic granite dikes (unit 14) are ubiquitous in the map-area and were emplaced at several stages during the waning phase of the Grenville Orogeny. Radiometric ages of these dikes indicates that they were intruded about 1000 to 900 m.y. ago (MacIntyre, York and Moorehouse 1967; Douglas 1980). Swarms of these concordant to locally discordant dikes, most of which are too thin to be shown on the map (back pocket) are very common in the metasediments along the flanks of the Cardiff and Faraday Domes.

The dikes are massive, medium-grained to pegmatitic pink and pinkish white granite (unit 14a). Smaller dikes and lenses less than 3 m thick may be predominantly pegmatitic, however larger dikes, averaging about 15 m thick and ranging up to 50 m long commonly have medium-grained margins and coarse-grained to pegmatitic interior phases. Contacts with the host rocks vary from sharp to locally gradational. Finer-grained, chilled margins which in places contain graphic intergrowth of feldspar and quartz occur commonly adjacent to marble, feldspathic meta-arenite and metaquartzarenite. The main rock-forming minerals in the dikes are quartz, albite and perthitic microcline. The biotite and magnetite content seldom exceeds one percent.

Local hybrid phases which are not shown on the map (in back pocket) that formed during assimilation and contact metasomatic replacement of the wall rock is most common where the country rocks are potassic syenite (unit 9), mafic mineral-rich meta-sediments (units 5, 4 and 2) and carbonate veins (map-unit 13). Hybrid phases along the margins of some of the thick dikes and in places throughout smaller dikes and stringers exhibit many of the following features:

1) a hematite-stain red to reddish brown color; 2) rapid grain size variations from fine-grained to pegmatitic over short distances; 3) a marked decrease in quartz content (i.e. desilication) or in places the quartz content remains unchanged but the quartz takes on a smokey grey color; and 4) a marked increase in the content of biotite and magnetite as well as the additional presence of pyroxene and hornblende in desilicated phases. Accessory minerals that may be locally present in these hybrid granitic to syenitic phases include allanite, zircon, titanite, fluorite, apatite, calcite, pyrite, pyrrhotite, molybdenite and in places uranothorite, uraninite and rare earth minerals.

More detailed information on pegmatites is given in the Economic Geology Section of this report.

PHANEROZOIC

QUATERNARY

CENOZOIC

Pleistocene and Recent

The glacial deposits in the map-area which are not shown on the accompanying map (in back pocket) are probably Wisconsinan in age. Striae and associated ice-flow features indicate that the ice moved about S20°W over the region (Henderson, 1973).

Glacial deposits of silty to sandy and local stony till up to several meters thick discontinuously overlie the Precambrian bedrock on the flanks of hills above an elevation of about 430 m (a.s.l.). Below 365 m (a.s.l.), most of the map-area is underlain by glaciofluvial outwash sand and gravelly sand with local small concentrations of gravel. Broad areas of exposed bedrock with scattered areas of very thin drift cover occur in regions of the map-area with an elevation of 500 m (a.s.l.).

Thick sandy glaciofluvial deposits of outwash occur in the valley bottoms and low lying areas which served as channel ways for southward flowing glacial meltwater. The largest meltwater channel containing these deposits extends south from the York River just to the north of the map-area into the map-area where it bifurcates into the following two major secondary channelways: 1) the Elephant Lake - Irondale River drainage system in the western part of the map-area; and 2) the Baptiste Lake - Diamond Lake - Center Lake drainage system in the eastern part of the map area.

Recent deposits which are quite abundant along both major and minor river drainage systems are predominately composed of sand and silt. Small bogs and swamps are abundant in the area.

STRUCTURAL GEOLOGY AND REGIONAL METAMORPHISM

The Center Lake area (see Fig. 2 and 3) lies near the north-western margin of the Middle Proterozoic Central Metasedimentary Belt (CMB) of the Grenville Province. About 15 km to the northwest of the map area is the easterly trending regional tectonic boundary zone that separates the CMB from the older Middle Proterozoic Algonquin Gneiss Complex.

The map area itself encompasses most of the northern part of the Harvey-Cardiff Basement Arch (Hewitt, 1962). This 80 km long by 25 km wide arch lies within the (CMB) and trends north - to northeast across the belt subparallel to its western margin. Between Burleigh Falls and Bancroft, this arch contains a linear series of five structural domes (Nos. 1 to 5 respectively on Fig. 3). These domes, at least two of which are mantled gneiss domes were selective centers of basement uplift, and intrusion of granitic, mafic, and alkalic rocks od various ages. This arch traverses the central part of the map area and the structure of the central and eastern part of the map area is controlled by three of the domes along this arch. From south to northeast across the area these domes are: 1) the Cheddar Dome (northern flank); 2) the Cardiff Dome; and 3) the Faraday Dome (western flank) shown as No.3, 4 and 5 respectively on Figure 3. The rocks bordering the domes have been uplifted and folded during the uplift of the domes.

The map area also encompasses part of the northeastern end of the Haliburton-Bancroft Nepheline Syenite Belt (Adams and Barlow 1910; Hewitt, 1961). This 130 km long by 30 km wide zone of discontinuous, infolded alkalic mafic to felsic intrusions within the deformed metasediments of the Grenville Supergroup is not specifically labelled on Figure 3. In the map area, alkalic gneisses belonging to this belt lie along and to the west of the Harvey-Cardiff Basement Arch.

Amphibolite-grade metasediments of the Supergroup completely mantle an unexposed basement complex or granitic pluton at depth in the Cardiff Dome as well as the adjacent Cheddar Dome. Based on comparisons with the Anstruther and Burleigh gneiss domes (Nos. 1 and 2, Fig. 3) south of the map area (Bright 1980a), the author is of the opinion that a similar Middle Proterozoic basement migmatite-gneiss complex is present at depth in both the Cardiff and Cheddar Domes. In contrast, the central region of the Faraday Dome along and to the east of the eastern boundary of the map-area is underlain by a metamorphosed granodioritic pluton. This pluton is strikingly similar to the larger Elephant Lake granodiorite pluton (no.7, Fig. 3) in the northeast corner of the map area and the small satellitic granodiorite dikes that conformably cut the mantling metasediments of the Cardiff Dome. To the south of the map area, in the Anstruther Dome (no. 2, Fig. 3), numerous, small metamorphosed granodioritic dikes of probably the same age cut both the basement migmatites and the Grenville Supergroup rocks (Bright, 1980a).

The 12 km wide, oval Cardiff Dome structurally dominates the central part of the map area. It is a composite structure consisting of two centers of plutonic emplacement and uplift. The main center is located north of Deer Lake in northern Cardiff Township. The annular Deer Lake potassic syenite sill around this center may represent one of the feeder zones for the alkalic now deformed gneisses along the flanks of this dome. The second smaller and probably later center of uplift lies south of Deer Lake between Monck Lake and Harding Lake. This secondary center is possibly related to late tectonic emplacement of the Monck Lake granite and the large crescentic granite dikes (unit 11). In the northwestern and western part of the map-area, the structural style of the Grenville Supergroup rocks and intercalated alkalic gneisses is markedly different from that around the domes within the Harvey-Cardiff Basement Arch. In this region, the distribution of the supracrustal sequence is controlled by shallow dipping cross-folds which have produced closely spaced, small scale synforms and antiforms.

Most of the rocks in the region were subjected to two major periods of deformation accompanied by regional metamorphism between about 1250 to 1000 Ma. In the adjacent Bancroft-Madoc area to the east of the map area, the earliest orogeny, the Elzevirian has a terminal age of 1180 to 1200 Ma (Douglas 1980). During this orogeny, the Elzevir and Weslemkoon Plutons (Fig. 3) were emplaced (Lumbers, 1967a), into the Supergroup. These two granodioritic plutons were dated at 1226±25 Ma by Silver and Lumbers (1966). However, in the map area the radiometric age of the similar-looking Elephant Lake Pluton and related smaller granodioritic bodies, intruding the Supergroup are not known. Initial development of the Harvey-Cardiff Basement Arch probably took place during the Elzevirian Orogeny. During this older deformation, the Elephant Lake pluton was emplaced along the northwestern margin of the arch and north-northeasterly-trending folds developed parallel to the arch. . At the same time, smaller related granodioritic bodies intruded, in places cross-folded the deformed supracrustal rocks around the rising Cardiff and Faraday Domes.

All these rocks were subsequently subjected to the Grenville Orogeny between 1140-1000 Ma (Stockwell, 1982). During this laterorogeny, a renewed period of major uplift and granite emplacement occurred in the area. A renewed period of north-northeasterly-trending folding accompanied by high rank regional metamorphism to almandine-amphibolite facies rank took place at this time. During the waning stages of this deformation, mafic to ultramafic sills and dikes, carbonate veins and numerous small pegmatitic granite dikes were emplaced, particularly along the flanks of the Cardiff and Faraday domes and in places the Cheddar Dome.

Along the northwestern flank of the Cardiff Dome, the author has interpreted the presence of a major northeasterly trending thrust zone that offsets or truncates the regional lithologies from Cardiff Lake to Pussey and Esson Lakes. This thrust zone lies near or along the western margin of the Harvey-Cardiff Basement Arch and separates the cross-fold domain in the northwest and west from the domal structures along the arch. A series of similar northeast-trending thrust faults offset the metasediments and alkalic gneisses in the region between the northern flank of the Faraday Dome and the Elephant Lake pluton with its flanking metasediments to the north. This east-northeast trending regional fault system appears to be the oldest in the map area. It is offset by a younger system of north-northwest trending normal faults. Both systems are cut by a third younger northeast-trending system of normal faults.

CORRELATION BETWEEN GEOLOGY AND AEROMAGNETIC DATA

Comparison of Map - (back pocket) and the available aeromagnetic survey (Map ODM-GSC-8400 G) indicates a good correlation between aeromagnetic contour patterns and many of the major rock types and their distribution along the flank of the northeast trending linear series of domes along the Harvey-Cardiff Arch.

The approximate position of the boundary between the feldspathic meta-arenite-rich Anstruther Lake Group and the chemical-epiclastic metasediments of the Lower Mayo Group is well delineated along the flanks of the Cardiff, Faraday and Cheddar Domes. The Anstruther Lake Group meta-arenites (map-unit 1) that flank these domes have a much higher magnetic intensity and in places smaller contour interval than most of metasediments (map-units 2, 3, 4, 5 and 6) in the overlying Mayo Group. Typical magnetic values for the Anstruther Lake Group meta-arenites are 1300-1900 gammas, and values greater than 2000 gammas are common. These anomalous readings result from the higher magnetite content of these rocks which in many places ranges between 2 and 5 percent. In comparison the typical magnetic values for the Mayo Group metasediments are as follows 1) marbles and metaquartzarenites (units 6 and 3) range from 800-1300 gammas, and 2) mafic mineral-rich epiclastic metasediments (map-units 3, 4 and 5) range from 1300-1600 gammas. Contour spacing is widest in the marbles and metaquartzarenites and closest in the amphibole-rich metasediments of this group.

The alkalic mafic to felsic intrusive rocks (map-units 7, 8 and 9) are easily distinguished from the Mayo Group metasediments throughout the map-area and are uncommon in the Anstruther Group meta-arenites. The potassic syenite gneisses (unit 9) have the highest magnetic intensity and closest contour spacing. Typical magnetic values for the potassic syenite are 1500-2400 gammas; the nepheline syenite and amphibolitized alkalic mafic sills have slightly lower values ranging from 1400 to 1800 gammas. In contrast the smaller and less abundant late tectonic weakly metamorphosed mafic to ultramafic intrusive rocks (unit 12) have magnetic values generally over 1600 gammas and in places as high as 3000 gammas. One well defined structure is the late tectonic, oval Wilberforce pyroxenite sill near Allen Lake in the northwest corner of the map area. It is represented by a negative anomaly with the magnetic intensity intervals decreasing towards the centre of the sill.

The bodies of metamorphosed granodiorite and granite in the central region of the domes are not easily distinguishable from adjacent terrains underlain by marble, feldspathic meta-arenite and metawacke. In the northeast corner of the area, however the southern contact of the Elephant Lake granodiorite pluton with throughout the map-area and are uncommon in the Anstruther Group meta-arenites. The potassic syenite gneisses (unit 9) have the highest magnetic intensity and closest contour spacing. Typical magnetic values for the potassic syenite are 1500-2400 gammas; the nepheline syenite and amphibolitized alkalic mafic sills have slightly lower values ranging from 1400 to 1800 gammas. In contrast the smaller and less abundant late tectonic weakly metamorphosed mafic to ultramafic intrusive rocks (unit 12) have magnetic values generally over 1600 gammas and in places as high as 3000 gammas. One well defined structure is the late tectonic, oval Wilberforce pyroxenite sill near Allen Lake in the northwest corner of the map area. It is represented by a negative anomaly with the magnetic intensity intervals decreasing towards the centre of the sill.

The bodies of metamorphosed granodiorite and granite in the central region of the domes are not easily distinguishable from adjacent terrains underlain by marble, feldspathic meta-arenite and metawacke. In the northeast corner of the area, however the southern contact of the Elephant Lake granodiorite pluton with the more magnetite-rich feldspathic meta-arenites of the Anstruther Lake Group is easily discerned. The typical magnetic values of this granodiorite are 1100-1500 gammas. These values overlap the lower magnetic readings on the adjacent meta-arenites, however the contour spacing in the plutons are much wider than in the more magnetic meta-arenites.

In general the aeromagnetic data also reflect the three regional fault patterns shown on the map (back pocket). Major and minor offsets in the magnetic contours of the more magnetic rock types i.e. potassic syenite (unit 9), alkalic mafic intrusive rocks (unit 7), feldspathic meta-arenite (map-unit 1) and in places amphibole-rich metasediments (unit 5) are quite clearly discernable.

ECONOMIC GEOLOGY

Introduction And History of Exploration:

Mineral exploration and development in the map-area was originally sparked by the discovery of molybdenite and fluorite deposits near Wilberforce in Monmouth Township at the turn of the century. From that time until the 1950's, prospecting has been carried out on small deposits of apatite, feldspar, betafite, fluorite, graphite, iron, mica, molybdenite, nepheline, pyrite, and minor uranium and rare earth minerals. Minor production was obtained from some of these deposits. Major periods of activity occurred during the war periods, when some production was obtained from deposits of molybdenite on the New Far North Exploration Limited (1965), Desmond Occurrence property (No. 27 on the map, in back pocket) and from deposits of fluorite on the Tripp Occurrence, property No. 39.

During 1951, development work on the Frobisher Graphite Occurrence, property No. 14 on the map, (in back pocket) reported drill-indicated reserves of 1,440,000 tons grading 4.1 percent carbon (Hewitt, 1957). Drilling in 1966 by Carbrew Exploration

Limited on the Joiner Occurrence, property No. 5 on the map (in back pocket) indicated an average of 0.50 percent MoS_2 over a width of about 4m and a strike length of about 150 m (Assessment Files Research Office, Ontario Geological Survey, Toronto).

Uranium was first discovered in Ontario in the Fission Mines Limited (Richardson occurrence) fluorite deposit in 1922. The Fission fluorite deposit was later developed as a possible source of radium but failed in the early 1930's. During and after World War II, the Bancroft area became one of the main targets for uranium exploration which led to the discovery of the Bicroft deposit in Cardiff Township. This deposit lies less than a kilometre south of the southeastern boundary of the map-area. The Bicroft uranium deposit which is presently owned by the Willroy Mines Limited became the Bancroft area's first producing uranium deposit in 1956, followed in 1957, by the Faraday deposit, situated farther east near Bancroft in central Faraday Township.

Within the Center Lake area major exploration and development programs were carried out from 1955 to 1975 on the following five properties: 1) the Cardiff Uranium Mines Limited, North and South Zone occurrences (No. 7 and 8 respectively on map in back pocket); 2) the Halo deposit of Rare Earth Resources Limited, (No. 31); 3) the Croft Deposit of Kerr Addison Mines Limited (No. 19); and the Croft-Center Lake Zone of Kerr Addison Mines Limited (No. 20 on map in back pocket). These five deposits (Nos. 7,8,31,19 and 20) have outlined tonnages of 100,000 to 1,000,000 tons with an average grade exceeding 1.5

pounds (0.075%) U_3O_8/ton (Robertson 1975).

During the 1970's, the fluorite associated with some of the uranium-bearing calcite veins also became a primary exploration target. Approximately 2,000,000 tons of low-grade fluorite ore, contained within several closely spaced calcite veins was drill-indicated on the Landair occurrence of Uranex Resources Limited, (No. 40 on map in back pocket).

Description of Properties, Deposits and Explored Areas

Introduction

The following is a description and assessment work summary of the properties, mineral deposits and areas of exploration in the map-area. All properties and explored areas are numbered and shown if applicable by appropriate element and/or mineral symbols on the map (back pocket). Any one symbol on the map may represent more than one mineral deposit (occurrence) in that area, if they were too close together to be shown separately.

Properties on which a mineral deposit (occurrence) may/or may not occur are titled in this report according to ownership as of December 1979. Names in parentheses, following property titles, refer to previous owners or historical names by which the deposit is otherwise known, e.g. Kerr Addison Mines Limited (Croft Deposit) or Kerr Addison Mines Limited (Mindus Occurrence).

Deposits open to staking as of December 1979, are titled as occurrences and the formal name assigned to them represents the historical name by which these deposits have been referred to in the literature or in the Source Mineral Deposits Records, Geoscience Data Center, Ontario Geological Survey Toronto (SMDR, GDC).

Explored Areas represent areas available for staking as of December 1979 on which no mineral deposit has been discovered. These areas are titled according to the company that performed the last significant work. Dates in square brackets following titles indicate date of this last major work.

In the following descriptions, the author has drawn extensively upon the published descriptions of the mineralization in the radioactive occurrences in the map area by Lang (1952), Satterly (1957) and Hewitt (1957). As a result of this survey and an examination of the exploration work submitted to the Assessment Files Research Office, Toronto, the author has re-interpreted the following features in many of these previously documented deposits: 1) structural and/or stratigraphic setting; 2) country rocks; and 3) mineralized host rocks.

ACMAC Occurrence (1)

The Acmac Occurrence, a pegmatite-hosted uranium deposit is located on the N1/2 lot 33, Con. XIV in northeastern Monmouth Township. This deposit occurs in a deformed sequence of intercalated marble and para-amphibolite containing several interbeds of pyroxene-rich metasediments. Late tectonic, light pink, leucocratic granite pegmatite and pegmatitic granite dikes, which are locally uraniferous occur along some contacts of pyroxene-rich metasediments with para-amphibolite or marble.

In 1955, Acmac Mining Corporation Limited carried out a ground radiometric survey over this zone of radioactive pegmatite dikes. A locally radioactive, leucocratic pegmatitic granite in the metasediments was tested along strike by a series of trenches totalling about 140 m. An open cut, 18.6 m long and its extension, an adit 10.1 m long was driven into a hillside to test down dip extension of this pegmatite. The adit intersected a shallow dipping, 5m thick zone containing several leucocratic granite pegmatite dikes conformably cutting contact metasomatized, pyroxene-rich metasediments and marble. Along their contacts, the pegmatites have partially assimilated and replaced the metasediment. The metasediments themselves locally contain irregular skarn zones consisting of coarsely crystalline calcite and augite with accessory titanite, apatite, phlogopite, pyrrhotite, and pyrite. Uranothorite and thorite occur locally disseminated within the narrow, altered contact phase of the pink, granite pegmatite (Satterly 1957). This contact phase is a desilicated, pink to red, hybrid granite to syenite containing minor secondary pyroxene crystals, that in places, are up to 10 cm long. Amber grains of uranothorite accompanied by small crystals of titanite are locally concentrated in quartz-feldspar vug-fillings around clusters of large pyroxene crystals, in the contact alteration phase of the pegmatite.

No assays or further work on the property have been recorded. In 1979 this occurrence was available for staking.

Bancroft Uranium Mines Limited (1955) (2)

In 1955-1956, Bancroft Uranium Mines, Limited held lots 4-6, Conc. XXII, in northwest Cardiff Township. This company carried out stripping, open-cut blasting and pitting mainly on the S1/2 lot 5, conc. XXII, between Lower Cardiff Lake and Highway No. 648. This lot is underlain by yellowish brown potassic syenite gneiss containing thin, intercalated units of potash metasomatized metasediments which are intruded by pegmatitic granite dikes.

Most of the work was concentrated on a shallow dipping, 3.3 m wide and 16.3 m long exposure of locally desilicated, pink to red granite pegmatite in a potassic syenite gneiss. Radioactive minerals observed by Satterly (1957) in the fluorite-pyroxene - bearing hybrid phases of this pegmatite dike were allanite and uranothorite.

No assays or further work on this occurrence have been recorded. In 1979, this area was open for staking.

Branscan Resources Limited (Standard Ore and Alloys Occurrence) (3)

In 1979, Branscan Resources Limited held a large group of unsurveyed claims on the southwest shore of Baptiste Lake, which included the former Standard Ore and Alloy's radioactive occurrence on the N1/2 lot 26, concession V in southwest Herschel Township.

In 1955, Standard Ore and Alloys Corporation trenched a zone of narrow, weakly radioactive granite pegmatite dikes cutting intercalated units of feldspathic meta-arenite, amphibolite, minor calcsilicate gneiss and marble near the south shore of Baptiste Lake. The company drilled 9 holes for a total of 368.3 m. Granite pegmatite bodies intersected during this drilling ranged from less than 0.3 m to a maximum of 2.6 m in thickness. Most of the dikes were weakly radioactive, as indicated by reported assays from a trace to 0.035 percent U_3O_8 (chemical) on drill core samples (Assessment Files Research Office, Toronto). The radioactive mineral was identified as uranothorite (Satterly, 1957).

No work was reported by Brascan Resources Limited as of December 1979.

BURMA SHORE OCCURRENCE (4)

The Burma Shore Occurrence is located on the S1/2 lot 7, conc. XX, Cardiff Township. In 1956-1957, Burma Shore Mines Limited, held lots 6-7, concession XIX and lots 7-8, concession XX in northwestern Cardiff Township. During this period, the company conducted a scintillometer survey over all its holdings and pitted and trenched the main showing south of a small beaver pond on the S1/2 lot 7, concession XX. Seven diamond drill-holes were put down for a total of 507.3 m to test this and other minor occurrences.

The Burma Shore Occurrence is in the author's opinion a stratabound, metasomatic uranium deposit. It is situated in a narrow metawacke unit, containing minor intercalated units of amphibolite, biotite-pyroxene gneiss/schist and potassic syenite gneiss. This metawacke unit occupies the axial zone of a southwesterly trending overturned synformal fold in the easterly dipping para-amphibolites along the northwestern flank of the Cardiff Dome. Prior to the emplacement of several thin, light pink granite pegmatite dikes, the axial region of this fold was intruded by several thin, less than 1 m thick, discontinuous apatite-calcite veins which reacted locally with the wall rock metasediments and intercalated potassic syenite gneiss to produce scapolite-pyroxene skarn assemblages. A 20 m long trench just west of the creek draining the beaver pond exposed two scapolite-pyroxene skarn zones, 15 cm - 60 cm wide and 13.3 m apart. These zones contain abundant brown scapolite and dark green pyroxene, as well as some euhedral red apatite, pink calcite, pyrite, molybdenite, and in places uraninite and uranothorite (Satterly 1957). The immediate footwall of both mineralized carbonate veins is a scapolite-hornblende gneiss and the immediate hanging wall is a weakly radioactive, hybrid pyroxene syenite pegmatite dike. The best assays from drill core skarn samples reported 0.17% U308 over about 1 m, (Assessment Files Research Office, Toronto).

In another pit located 50 m southeast of the main trench, a 15 cm wide band of calcsilicate skarn is exposed which contains red-brown grains of titanite and accessory uraninite. Another pit, northeast of the main showing near the outlet of the beaver pond exposed minor disseminated uraninite in a irregular scapolite - pyroxene syenite phase within a leucocratic granite pegmatite dike cutting wall rock scapolite - biotite - hornblende gneiss. Elsewhere on the same property, Satterly (1957), also reported pits exposing weakly radioactive, yellowish brown pyroxene - syenite pegmatite containing accessory purple fluorite; however no radioactive minerals were identified by Satterly (1957).

CARBREW EXPLORATION LIMITED (Joiner Occurrence) (5)

In 1979, Carbrew Exploration Limited held a group of 11 unsurveyed claims in northwestern Cardiff Township, which included the former Joiner molybdenite occurrence on lots 1-4, concession XX, as well as the N1/2 lots 2 and 3, concession XIX.

The property straddles the easterly-dipping contact zone between a large potassic syenite gneiss band and an underlying thick sequence of marbles, along the western flank of the Cardiff Dome. The northern part of the property is mainly underlain by reddish brown to yellowish brown potassic syenite gneisses containing numerous intercalated thin units of marble, amphibolite and locally potash metasomatized metasediments. Disseminated, fine-to coarse-grained flakes of molybdenite occur in many places within the syenite gneiss, and locally in the interlayered metasediments on lots 3 and 4, concession XX, Cardiff Township. Trenching had exposed three en echelon gradational banded zones of disseminated molybdenite in the syenite gneisses over a strike length of approximately 430 meters on the N1/2 lot 3, concession XX. These three shallow east dipping mineralized zones range in strike length from 83.3 m to 166.6 m. Selective samples of mineralization from various trenches along the entire zone of mineralization ranged up to

0.64% MoS_2 (Satterly 1943).

The northern part of this property was first explored for molybdenum in 1917 by W.E. Joiner and Company. Prior to 1936, trenching and sampling for molybdenum was carried out by various operators including Cardiff Molybdenite Mines Limited in 1920, United Molybdenite Corporation Limited in 1922, Shallberg Molybdenite Company in 1935 and Ventures Limited in 1936. Between 1952 and 1957, Irondale Prospectors carried out a trenching program on the property and drilled 12 diamond-drill holes, totalling 317.6 m on lot 4, concession XX.

After 1956, the northern and southern parts of the Carbrew property were explored for molybdenum in the syenite gneiss as well as for possible uranium mineralization associated with granite pegmatite dikes and apatite-fluorite-calcite veins cutting the gneiss. Between 1956 and 1966, both the northern and southern parts of the property were under option to Georgia Lakes Lithium Mines Limited. This company carried out an IP survey over most of the claim group and drilled 17 diamond drill holes, totalling about 1333 meters to test the mineral potential of the property. Drilling in 1966, mainly on parts of the Joiner molybdenite occurrences indicated a weighted average of 0.50 percent MoS_2 over a drilled-width of about 4 m and a drilled strike length of about 165 m (Assessment Files Research Office, Toronto).

In 1977-1978, Carbrew Exploration Limited, carried out geological mapping, radiometric, VLF and magnetic surveys over parts of the claim group. The company also diamond drilled 6 holes, totalling about 753 meters on several radioactive granite pegmatites and calcite-fluorite-uraninite zones in granite pegmatite dikes. The best reported drill intersection in 1977 assayed 0.28 percent U_3O_8 and 0.375 percent ThO_2 over 2.4 m (Assessment Files Research Office, Toronto).

CARDAY URANIUM MINES INCORPORATED (Consolidated Tungsten Occurrence) (6)

In 1979, Carday Uranium Mines Incorporated held lots 30 (S1/2), 32 (N1/2), concession XII and lots 31 (S1/2), 32 concession XIII in Cardiff Township as well as lot 33, concession XIV in Faraday Township. These holdings are centered around the former Consolidated Tungsten radioactive occurrence on the S1/2 lot 31, concession XIII in eastern Cardiff Township.

The property lies along the southeastern flank of the Cardiff Dome and is underlain by a northeasterly-trending band of potassic syenite gneiss containing subordinate intercalated units of scapolitized amphibolite, potash metasomatized clastic metasediments and minor garnet-sillimanite schist and gneiss. This band has been intruded by numerous small, light pink pegmatite dikes which locally contain hybrid contact phases of: 1) hornblende-bearing and pyroxene-poor red granite pegmatite; and 2) reddish brown syenite and pyroxene syenite pegmatite. Several northeast-trending faults and related shear zones have cut the above syenite gneiss band, preferentially along the contacts of the wall rocks with pegmatite dikes.

Uraninite, uranothorite, and uranophane are the ore minerals in the pegmatites. Magnetite is commonly associated with the uranium mineralization. Other minerals locally found in these commonly sheared and altered pegmatites include fluorite, apatite, titanite, calcite, pyrite, pyrrhotite, and chalcopyrite.

In 1954-1955, Consolidated Tungsten Mining Corporation, made a geological survey of the claim group and diamond drilled 18 holes, for a total of about 2116 m. Drilling on the S1/2 lot 31, concession XII, indicated a zone 83 m long averaging 2.78 pounds U_3O_8 per ton across 1.2 m. Over-all assays averaged about 0.06% U_3O_8 (radiometric), (Assessment Files Research Office, Toronto).

In 1968-1969, Fidelity Mining Investment Limited held this property and carried out geological, radiometric and magnetic surveys. The company diamond drilled two short holes, totalling 20 m on a radioactive pegmatite dike in lot 33, concession XIV, Faraday Township. No significant assays were reported.

Later in 1974-1975, Carday Uranium Mines Incorporated, conducted geological and radiometric surveys on these occurrences and diamond drilled 5 holes, totalling 433.6 m in the S1/2 lot 31, concession XIII, Cardiff Township and lot 33, concession XIV, Faraday Township. No results of these surveys and the drilling program are known to the author.

CARDIFF URANIUM MINES LIMITED, South zone Occurrence (7) and North Zone Occurrence (8)

In 1979, the Cardiff Uranium Mines Limited fluorite-uranium occurrence consisted of two main zones: 1) the South Zone Occurrence (no. 7) on lots A, 1, and N1/2 lot 2, concession

XVIII, Cardiff Township; and 2) the North Zone Occurrence (no. 8) on the S1/2 lots 1 to 3, concession XIX. A secondary zone of related mineralization on lot 2, concession XVIII, Cardiff Township lies between the two main zones.

General Geology

The claim group containing the two main occurrences straddles the north-trending and easterly-dipping contact between a thick sequence of marble and a thick band of potassic syenite gneisses, along the western flank of the Cardiff Dome. Near this contact, is a 330 m wide and over 7 km long zone of mineralization consisting of discontinuous uranium-bearing apalite-fluorite-calcite veins and lenses in potassic syenite gneiss. These veins and lenses are conformable to the enclosing potassic syenite.

The calcite veins and lenses on both the North and South Zones are sheared, boudinaged and locally dislocated. They range in size up to 4 m wide and 67 m long. In some places, on the South Zone (no. 7), veins occupy the east dipping contact between the marble and potassic syenite. Drilling by Cardiff Uranium Mines Limited in the marbles near this location to the west of the South Zone Occurrence adit (in the northeast corner of lot A, concession XIII) encountered several minor apalite-fluorite-calcite veinlets and stringers. Single veins may split into two or more parallel veins along strike or down dip. In places they may rejoin further along to become again a single unit.

The vein material consists chiefly of pink to white crystalline calcite containing variable amounts of white to purple fluorite, in places up to 30 percent, and green and red apatite (1-10 percent). Minor hornblende, biotite, feldspar, and magnetite are commonly present. Accessory minerals include pyroxene, pyrite, pyrrhotite, uraninite and uranothorite.

The veins observed by the author show a well-banded texture, near their contacts with the potassic syenite consisting of thinly, laminated bands of fine-grained, purple fluorite-minor calcite alternating with thicker bands of coarser-grained, grey to cream and pink calcite. Flowage of these bands around subhedral to euhedral crystals of apatite, hornblende, biotite and uraninite is clearly observable. A thin unit of pyrite-graphite schist (or mylonite) was observed by the author to separate banded vein material from the country rock syenite in one of the larger veins on the South Zone of the deposit. In some of the less deformed, medium-to very coarse-grained calcite veins, on the North Zone, the vein-walls adjacent to potassic syenite are lined by a thin fenitic reaction zone of coarsely recrystallized reddish-brown to dark-red feldspar. The fenitic zone also contains hornblende, biotite, pyroxene, apatite and minor uraninite.

In several places the calcite veins have been intruded by pink, pegmatitic granite dikes. These dikes have truncated, brecciated and partially assimilated segments of apatite-fluorite-calcite vein-material. Local alteration of the pink granite to red and brick-red pyroxene-bearing granite and pyroxene-bearing syenite phases containing minor uraninite and fluorite occur adjacent to this vein material.

On the North Zone an adit intersects a 4 m wide hematite-stained, yellowish brown to locally brick red, uranium-bearing massive syenite pegmatite dike in red potassic syenite/gneiss. In places along the dike-syenite gneiss contact there is a 1 m thick apatite-fluorite-calcite vein. Uraninite crystals up to 15 mm in size occur in the brick-red phases of the syenite pegmatite dike, near its contact with the syenite gneiss and/or the calcite vein (Satterly, 1957).

Other local types of mineralization reported by Satterly (1957) on the Cardiff Uranium property include the following 1) isolated, small, vuggy cavities lined with feldspar, red apatite, pyroxene, rare scapolite and locally uraninite in a hornblende syenite pegmatite dike on the N1/2 lot A, concession XVIII; 2) inclusions of apatite-fluorite-calcite vein-material, up to 1.9 m wide and 2.6 m long caught up in a large granite pegmatite dike on lot 1, con. XIX; and 3) several brecciated pyroxene-albite pegmatites on lot 2, concession XVIII, that are cemented by white calcite vein-material containing purple fluorite, green pyroxene, brown albite red or green apatite, red-brown zircon and locally minor uraninite.

The reader is referred to the reports of Lang (1952), Satterly (1957) and Hewitt (1957) for more detailed descriptions on the main surface and underground workings on the Cardiff Uranium Mines Limited property. The following summary on historical development, and economic features contains summary statements taken from these publications and from Assessment File

Records, Ontario Geological Survey, Toronto. Original measurements are given as reported in Imperial Units with metric values in brackets.

History and Development

Prior to 1953, Cardiff Uranium Mines Limited was known as Cardiff Fluorite Mines Limited, incorporated in 1943 to investigate the fluorite potential on what is now referred to as the South Zone (no. 7). Between 1947 and 1951, the latter company, after surface trenching and about 666 m of diamond drilling on the N1/2 lot A, concession XVII, drove a 133 foot (44 m) long adit into the hillside and tested two main apatite-fluorite-calcite vein systems with 147 feet (49 m) of lateral work. In 1947, a second adit was also begun to test the North Zone (no. 8) on lots 1 and 2, concession XIX. This adit was 550 feet (183 m) long with 85 feet (28 m) of drilling and 617 feet (205 m) of cross cutting were carried out on uranium-bearing hybrid syenite dikes and calcite veins. In 1950, a two compartment shaft, inclined at 50o, was sunk on the South Zone to a depth of 275 feet (91 m) with levels at 125 and 250 feet (41 and 83 m). A service adit, 181 feet (60 m) long was driven at the 60 foot (20 m) level. Underground work on this South Zone included 763 feet (254 m) of drifts, 90 feet (30 m) of cross cuts and 6 diamond drill holes, totalling about 124 m. Work was suspended on this zone in 1951.

In 1954, the South Zone was reopened for its uranium potential by its present owner, Cardiff Uranium Mines Limited.

The company deepened the inclined shaft to 311 feet (108 m); carried out an additional 564 feet (188 m) of drifting on the 125-foot and 250-foot levels (41 and 83 m) and drilled 4 underground drill-holes totalling about 111 m. By the time the property closed down on April 10, 1955, the company had hoisted 1139 tons of apatite-fluorite-calcite vein-material.

In 1976, Imperial Oil Limited optioned the property and drilled 7 diamond drill holes, totalling about 900 m.

Economic Features

a) South Zone: Within the inclined shaft 5 veins, 60 to 175 feet (20 to 58 m) long averaged 0.095% U_3O_8 (radiometric) and 18.10% CaF_2 over 44 inches (67 cm) (OGS, Geoscience Data Center, Toronto: file Cardiff (South zone), SMDR 162).

b) North Zone: A bulk sample of the uraninite-bearing syenite dike, encountered in the adit averaged 0.135% U_3O_8 (chemical), (Satterly 1957).

CUDNEY OCCURRENCE (9)

In 1955, T. Cudney held lots 29 and 30, concession XVI, in central Monmouth Township. This former property lies between Mountain and Cockles lakes and is mainly underlain by marbles containing thin interbeds of calcsilicate gneiss and minor amphibolite. Bulldozed strippings on the property exposed several weakly radioactive granitic to syenitic pegmatite dikes. In the Cudney occurrence, on lot 30, concession XVI, Armstrong (1968), reported a 2.5 cm wide rusty fracture filling in a coarse-grained pyroxene syenite dike cutting the marble. This fracture filling contained abundant zircon crystals, orange grains of uranothorite, yellow-to-orange kasolite, and pyrite. No assays have been reported for this occurrence. In 1979, this occurrence was open for staking.

DENFIELD OCCURRENCE (10)

In 1953, G.H. Denfield held a group of 34 unsurveyed claims, north of Cope, Lake along the northwestern flank of the Cardiff Dome in north central Cardiff Township. Stripping, trenching and a 100 m long X-ray drill hole cut several minor occurrences of radioactivity in small granite pegmatite dikes, particularly on lot 11, concession XXI, Cardiff Township. These dikes occur in potassic syenite gneiss containing intercalated, subordinate units of amphibolite and numerous thin interbands of metasomatized, pyroxene-rich metasediments and biotite-rich metasediments.

In 1954-1955, this occurrence was optioned to Stratmat Limited and was explored along with this company's own claim holdings to the east of Cope Lake. Stratmat Limited made geological and scintillometer surveys of their holdings. The company restripped and trenched many of the old Denfield showings on lot 11, concession XXI and drilled one short diamond drill hole.

In 1968, the Denfield Occurrence as well as parts of the former Stratmat Limited claim holdings were held by Cope Lake Mines Limited. This company carried out scintillometer and geological surveys over its property.

In 1975, E.T. Hogan held the Denfield Occurrence and drilled two diamond drill holes, totalling about 106 m in S1/2 lot 11, concession XXI, Cardiff Township.

Exploration work to-date on the Denfield Occurrence has reported minor uraninite and uranothorite mineralization in both pyroxene-rich metasediments and red, hybrid phases of pegmatitic granite dikes. Assays from grab samples taken from the Denfield Occurrence were 0.020, 0.045 and 0.071% U_3O_8 (chemical) (Assessment Files Research Office). A small fluorite-calcite vein containing uraninite is also reported to occur in the Denfield Occurrence (Satterly, 1957).

In 1979, the Denfield Occurrence itself was open for staking.

ENTEREX DEVELOPMENT INCORPORATED (11)

In 1979, Enterex Development Incorporated held lots 3 (N1/2), 4 (N1/2), and 5, concession XV, in northwestern Cardiff Township.

The property straddles the south-dipping contact between potassic syenite gneisses and an overlying sequence of intercalated feldspathic meta-arenite, amphibolite, metawacke and minor marble. This sequence, exposed between Wilbermere and Colbourne Lakes lies along the southwestern flank of the Cardiff Dome. Numerous granitic to locally syenitic pegmatite dikes intrude the metasediments and syenite gneisses.

In 1967, the property was included in an airborne electromagnetic and scintillometer survey by T.L. Chandler. In 1976-1977, Enterex Development Incorporated carried out trenching on several radioactive pegmatites and made ground scintillometer, magnetic, and low frequency (VLF) geophysical surveys over the property; 5 diamond drill holes were put down, totalling about 705 m.

Uranium mineralization is generally confined to red, desilicated, contact alteration phases of the pegmatitic granite dikes. Minor magnetite-fluorite-calcite stringers and veinlets crosscut mineralized pegmatite. Grab samples assayed up to 0.05% U_3O_8 and 0.22% ThO_2 (Assessment Files Research Office, Toronto). Several pyrite-pyrrhotite-chalcopyrite-calcite fracture-fillings in the adjacent metasediments returned only low values of uranium and thorium. One north-trending drill-hole, in the N1/2 lot 5, concession XV, intersected an easterly trending fault zone containing small fluorite-calcite veins. A 2.7 m section of drill core assayed 13.4% CaF_2 (Assessment Files Research Office, Toronto). No uranium values were reported.

FISSION MINES LIMITED (Richardson Occurrence) (12)

The Fission Mines Limited property comprises lot 4 to 6 and the north half of lot 7 concession XXI, in northwestern Cardiff Township. The first reported occurrence of uraninite in Ontario is located on this property. It was discovered in 1922, by W.M. Richardson in a prospecting pit located about 85 m south-south-east of the small lake on lot 4, concession XXI. Here large uraninite crystals and crystal aggregates up to 5 cm in diameter were found in a zoned fluorite-calcite-feldspar vein. The host rock and mineralization has been described by (Ellsworth (1932) and Hewitt (1957).

General Geology

The Fission Mines Limited property lies along the northwestern flank of the Cardiff Dome. It is underlain by the same band of potassic syenite gneisses and intercalated subordinate units of metasomatized metasediments which host the uranium-bearing calcite-vein systems to the southwest, on the adjacent Carbrew Exploration Limited property (no. 5), and the Cardiff Uranium Mines Limited properties (no. 7 and 8). On the Fission Mines property, the apatite-fluorite-calcite veins and lenses do not occur near the main syenite-marble contact as they do on the adjoining properties to the southwest. The veins and lenses were emplaced into the syenite gneisses along the crest of an southeast dipping antiformal fold. The calcite veins and lenses are discontinuous en echelon within a zone in the gneisses that is approximately 300 m wide and extends at least 1.3 km, northeastward to the eastern boundary of the property and beyond onto adjoining properties.Most of the veins were emplaced along the contacts of potassic syenite with major and minor intercalated units of para-amphibolite, scapolitized para-amphibolite and in places biotite-scapolite-plagioclase gneiss. After vein emplacement and wall-rock metasomatism, many of these calcite veins were sheared, boudinaged and dislocated both along strike and down dip. Following this deformation some vein segments were intruded, brecciated and partially assimilated by narrow granitic to locally, hybrid syenitic pegmatite dikes. Some subsequently brecciated, late tectonic pegmatites may contain both xenoliths of primary uranium-bearing calcite vein-material, as well as remobilized veinlets, stringers and irregular alteration zones of secondary uraninite-fluorite-apatite-calcite mineralization.

The company concentrated its exploration on the two major apatite-fluorite-calcite systems containing primary uranium mineralization within the larger mineralized area. These are as follows: 1) the No. I Zone in the northern part of lot 5, concession XXI, and 2) the No. 3 Zone in the southeastern part of the same lot. A secondary zone, the No. 2 Zone occurs on Lots 6 and 7, concession XXI.

According to Satterly (1957), individual deformed veins or vein segments in both zones range in size from less than 15 cm wide and 1 meter long to a maximum of 4 m wide and 66 m long in the No. I Zone.

The No. 3 zone consists mainly of a system of en echelon, sheared, and boudinaged calcite lenses. This dislocated vein system extends discontinuously for a strike length of about 200 m. In the No. I Zone, the veins observed by the author are in general larger than in the No. 3 Zone and relatively undeformed. They consist mainly of coarsely crystalline calcite with variable amounts of apatite, fluorite and minor uraninite, however, in places local zones of thinly laminated, cataclastic apatite-fluorite-calcite material is present. Bordering most of the undeformed veins is a thin, gradational zone of fenitized wall rock. This fenitic zone consists mainly of hematite-stained, coarsely crystalline plagioclase and potassic feldspar containing variable amounts of pyroxene, hornblende, biotite, fluorite, apatite and calcite. Accessory minerals locally found in both the vein and bordering fenitized host rock are pyrrhotite, pyrite, magnetite and uraninite. Uraninite appears to be more abundant in undeformed veins than in the deformed ones found on the No. 3 Zone. The uraninite also appears to be more abundant in the fenitized host rock than in the main calcite vein. In parts of the original Richardson discovery occurrence, near the southwestern end of the No. I Zone, narrow, parts of the calcite vein is enclosed in a much broader fenite zone consisting of red, hematite-stained, coarsely crystalline feldspar and pyroxene containing minor interstitial calcite and locally calcite pyroxene vugs. Large uraninite aggregates, up to 5 cm in diameter were reported (Satterly 1957) in this interpreted fenite.

History of Development

After the initial discovery in 1922 of the uraninite-bearing vein on lot 4; concession XXI, W.M. Richardson prospected and trenched several other scattered occurrences over an area about 80 m wide and 1000 m long.

In 1929, Ontario Radium Corporation Limited acquired the property and was succeeded in turn by International Radium and Resources Limited in 1931; by Wilberforce Minerals Limited in

1937; and by Fission Mines Limited in 1946.

Between 1929 and 1931, Ontario Radium Corporation Limited explored the property with numerous pits and trenches. A 600 feet (183 m) (originally reported measurement) long adit with 850 feet (260 m) of drifts and raises explored the main vein system on the No. I Zone. Later a 50 feet (15 m) shaft was sunk from surface to the adit level. In 1931-1932, International Radium and Resources, Limited built a 50 ton per day mill to test recovery of radioactive, radium-bearing minerals.

In 1946-1948, Fission Mines Limited carried out some underground exploration and explored both the No. I and secondary No. 2 zones with 4000 meters of diamond drilling.

In 1955, Fission Mines resampled the ore dumps and the old surface workings to test the uranium potential of the property. A new exploration program was initiated on various radioactive granitic to syenitic pegmatite dikes on the secondary No. 2 Zone, ten diamond drill holes, totalling about 849 m were put down on this part of the property.

Economic Features

Diamond drill-hole results to 1952 indicated an estimated 300,000 tons of fluorite-bearing material, grading about 26% CaF_2 recoverable from several of the larger veins in the No. I and 3 zones. Ten samples from the main fluorite-calcite vein on the No. I Zone, averaged 0.07% U_3O_8 (Ellsworth 1952, p. 144).

FOSTER OCCURRENCE (13)

In 1956, D.E. Foster explored a radioactive granite pegmatite dike near Otter Lake on lot 20, concession XV, in east central Cardiff Township. The dike intrudes a sequence of metawacke and subordinate amphibolite near its contact with potassic syenite gneiss on the southern flank of the Cardiff Dome. This granite pegmatite dike ranges in width from 0.5 m to 3.3 m and was traced along strike for about 66 m. Uraninite, zircon and allanite were reported to occur locally in altered, magnetite-stripping and drilling of 3 holes, totalling about 565 m. In 1966, additional stripping and trenching was done by P. Simonds. A grab sample from one of the most radioactive parts of the pegmatitic granite dike, assayed 0.15% U_3O_8 (radiometric) and 0.058% U_3O_8 (chemical) (Satterly 1957, p. 58). In 1979, this occurrence was open for staking.

FROBISHER OCCURRENCE (14)

In 1912, the New York Graphite Company test drilled and pitted a graphite occurrence in the N1/2 lot 11, concession XXII, in northwest Cardiff Township. The graphite, in flakes up to 3 mm in diameter, constituted up to 10 percent of a biotite-rich gneiss that is intercalated with amphibolite and metawacke units near the contact with a underlying thick unit of marble. This marble-graphite-bearing biotite-rich gneiss-amphibolite sequence strikes northeast and dips about 15o to the south.

The company milled an unknown quantity of graphite material from an open pit 13.3 m deep, 20 m long, and 5 m wide. Before mining ceased on the property, in 1915, the company was merged with the National Graphite Company. During 1951, Black Donald Division of Frobisher Limited held the property and carried out about 1423 m of diamond-drilling. This work disclosed a 400 m long and 20 m thick horizon of graphite-bearing biotite gneiss along the marble-amphibolite contact, the main Frobisher Occurrence on N1/2 lot 11, concession XXII.

Reported drill-indicated reserves in this zone are 1,440,000 tons grading 4.1 percent carbon. Within this zone there is a richer zone of 800,000 tons grading 5 percent carbon (Hewitt 1957, p. 46).

In 1979, this occurrence was open for staking.

JET URANIUM LIMITED (1968) (15)

In 1968, Jet Uranium Limited held lots 1 to 8, concession III to V and the same lots 1 to 8 in the S1/2 concession VI, in southwest Harcourt Township.

The property is underlain by a shallow, westerly dipping sequence of potassic syenite gneiss, potash metasomatized clastic metasediments and minor marble that occurs along the eastern contact of a large foliated metagabbro sill. The syenite gneiss and metasediments are cut by pink granite to pegmatitic granite dikes. Uranothorite occurs on the N1/2 lot 6, concession IV, in a fractured and red hematite-stained section of the pink granite pegmatite that contains abundant magnetite and accessory zircon and titanite (Satterly, 1957).

In 1957, this uranothorite occurrence was stripped, pitted and trenched by P.J. McLean. In 1958, the property was held by the Harcourt Mining Company Limited. It carried out radiometric and geological surveys over the property and drilled 5 diamond-drill holes totalling about 367 m.

In 1968, Jet Uranium Limited held the property and carried out radiometric, geological and magnetic surveys; 8 diamond-drill holes totalling about 735 m explored several targets on the property. Nine grab samples from the mineralized dike on lot 6, concession IV, averaged 0.053% U3O8 (radiometric) (Assessment Files Research Office, Toronto).

In 1979, this explored area was open for staking.

KEMP OCCURRENCE (16)

In 1955, Kemp Uranium Mines Limited held lots 2-5, concession XIV, and the S1/2 lot I, concession XIV in central Cardiff Township. The main Kemp uranium occurrence is located on the N1/2 lot 5, concession XIV.

The former Kemp Uranium Mines property is underlain by a broad band of marble containing minor clastic metasediments. These rocks lie along the northern flank of the Cheddar Dome, a regional structure most of which lies to the south of the map area. In the main radioactive showing on this property, on the N1/2 lot 5, concession XIV, uranothorite and locally thorite occur disseminated in a pyroxene-calcite skarn in the marble adjacent to a 13.3 m wide pink, pegmatitic granite dike.

In 1954-1955 Kemp Uranium Mines Limited stripped and trenched this showing and diamond drilled holes totalling about 960 m. The best reported drill intersection assayed 0.031% U308 over 6 m (Assessment Files Research Office, Toronto). In 1975, E.T. Hogan drilled one short hole for 41 m in the N1/2 lot 4, concession XIV.

In 1979, the Kemp Occurrence was open for staking.

KENMAC CHIBOUGAMAU OCCURRENCE (17)

In 1955 the former property of Kenmac Chibougamau Mines Limited comprised lots 6 to 8, concession XIV, in central Cardiff Township.

This former property straddled a contact between pyroxene-rich metasediments and para-amphibolite along the northern flank of the Cheddar Dome. Intercalated with these units are minor units of metawacke and marble. Numerous granite to locally syenite pegmatite dikes cut this metasedimentary sequence. Uranothorite and allanite occur with coarse magnetite in local, hematite-stained, pyroxene-poor alteration zones in a 10 m wide, pink granite pegmatite dike. This dike cuts pyroxene-rich metasediments and is located on lot 6, concession XIV. Another radioactive occurrence on the same lot, consists of a 5.1 m wide deep-red pyroxene-rich hybrid syenite dike containing small, scattered, irregular patches of calcite, biotite, and accessory zircon, apatite, scapolite and uranothorite (Satterly, 1957).

During 1955, Kenmac Chibougamau Mines Limited, made a scintillometer survey of the property and stripped and trenched several radioactive pegmatite occurrences. The company drilled

52 holes totalling about 6470 m and drove an adit under a 10 m wide radioactive pegmatite granite dike on lot 6, concession XIV.

In 1955 estimated reserves on this occurrence were 200,000 tons averaging 0.20% U_3O_8 in a zone 6 m wide by 160 m long to a depth of 60 m (Assessment Files Research Office, Toronto). In 1974 Kenmac Chibougamu Mines Limited surrendered its charter and in 1979 the occurrence was open for staking.

KERR ADDISON MINES LIMITED (18)

Between 1975 and 1979 Kerr Addison Mines, Limited held several large discontinuous blocks of claims in Cardiff Township along the southern and eastern flanks of the Cardiff Dome as well as along the flanks of the nearby Monk Lake granite stock. Numerous pink granite dikes and younger pegmatitic granite dikes intrude the interlayered clastic metasediment and syenite gneisses along the flanks of these two structures.

Exploration Summary

In 1975-1976 Kerr Addison Mines Limited carried out radon gas, lake bottom sediment geochemical and scintillometer surveys over their numerous claim holdings in the southeastern part of the map area. Included within the company's holdings are several previously documented radioactive occurrences which are numbered and described separately in the following sections (i.e. No. 19, 20 and 21).

KERR ADDISON MINES LIMITED (Croft Deposit) (19)

In 1979, Kerr Addison Mines Limited held under option from Cam Mines Limited lots 30, N 1/2 31, concession XIII, lots 26 to 32 Concesssion XIV and XV, and lots 30 to 32, concession XVI, all in Cardiff Township, lots 32 and 33 concession XV and lot 33, concession XVI, in Faraday Township. The property includes the Cam Mine's Croft uranium deposit (J-Zone) on lot 32, concession XV, Cardiff Township.

General Geology

The Croft granite pegmatite-hosted uranium deposit is situated to the northeast of Center Lake along the southeastern flank of the Cardiff Dome. This deposit occurs in the same sequence of intercalated biotite schist, garnet-sillimanite-schist, para-amphibolite and syenite gneiss that hosts the uraniferous pegmatites in the past producing Willroy Mines Limited, Bicroft uranium deposit, 4 km along strike to the south of the map area. In the Croft deposit this rock sequence dips east and is underlain to the west by a thick sequence of Anstruther Lake Group meta-arenites. To the east, this sequence is overlain by a thick unit of para-amphibolite. This deformed metapelitic schist-para-amphibolite-syenite gneiss sequence was the focus of intrusion and contact metasomatism by a discontinuous series of en echelon granite pegmatite dikes, stringers and veinlets.

Individual dikes range up to 50 m long and may vary along strike from 1 m to 15 m wide. Contact assimilation phases in the dikes are coarse grained, gneissic porphyroblastic biotite granite. In this rock porphyroblastic aggregate of white and pink feldspar, 3 mm to 7.5 cm in diameter, are set in a finer-grained ground mass of smoky quartz and minor biotite (Satterly 1957). The biotite flakes wrap around the feldspar crystals or form streaky aggreages that impart a strong foliation to the rock.

In the Croft deposit, the uranium mineralization, principally uranothorite with accessory zircon, pyrite and molybdenite is concentrated along fractured, sheared and hematite-stained zones in the contact hybrid porphyroblastic granite phases of the dikes. The presence of abundant micro-fractured grey to smoky quartz is a good indicator of uranium mineralization.

History of Development

Between 1953-1954, Croft Uranium Mines Limited carried out an airborne scintillometer survey over the property. Surface work included trenching and diamond drilling of 115 holes totalling about 13,372 m. Underground work included a 528 m adit into the main (J) Zone at 23 m below the surface trenches; 4099 m of drifts; 161.6 m of crosscuts and 93 diamond drill holes totalling about 1017 m. The H Zone, which lies on strike about 333 m south of the J Zone was explored by surface trenching and 2500 m of diamond drilling over a strike length of about 166 m.

The Croft deposit was acquired by Bicroft Uranium Mines Limited in 1955, on the amalgamation of Croft Uranium Mines Limited, and Center Lake Uranium Mines Limited.

In 1975, Kerr Addison Mines Limited optioned the Croft deposit along with its strike extension to the south, the Croft-Center Lake Zone (No. 20). Kerr Addison Mines Limited carried out a radon survey over both areas and drilled 44 diamond drilling holes totalling 5922 m. During 1977-1978 an additional 16,248 m of surface drilling was completed. The company also carried out an experimental acid leaching process on uranium-bearing pegmatitic granite from the Croft deposit.

Economic Features of the Croft Deposit and adjacent Croft-Center Lake Zone

In 1975, Kerr Addison Mines Limited reported that the Croft deposit (J-Zone) contained an estimated 800,000 short tons averaging 0.57 pounds U308 per ton, in a mineralized zone, 1500 feet long by 40 feet wide (Assessment Files Research Office, Ontario Geological Survey, Toronto). They company also reported that the Croft-Center Lake Zone (South Zone) to the south of the Croft deposit contained an estimated 100,000 to 200,000 tons grading about 0.084% $U_{3}O_{8}$. In 1978, Kerr Addison reported estimated reserves were 979,810 tons in 3 zones grading about 1.20 pounds $U_{3}O_{8}$ per ton on these two combined properties (Northern Miner, Nov. 9, 1978, p.).

KERR ADDISON MINES LIMITED (Croft-Center Lake Zone)(20)

In conjunction with its work on the Croft deposit (No. 19), Kerr Addison Mines Limited in 1979 optioned a large block of claims immediately to the south surrounding Center Lake in

Cardiff Township. This claim group which includes Cams' Croft-Center Lake zone lies along and to the north of Highway 121, comprising lots 22-29, Concession XIII and N 1/2 lots 22-30, Concession XII, Cardiff Township.

General Geology

The Croft-Center Lake Zone of pegmatitic granite-hosted uranium deposits lies within the same sequence of aluminous metapelite, para-amphibolite and potassic syenite gneisses that contains: 1) the past producing Willroy Mines Limited, Bicroft Mine to the south of the map area, and 2) the Croft Deposit (No. 19).

A summary of the exploration development and economic features of this uranium mineralization is included in the description for the previous property, the Kerr Addison Mines Limited (Croft Deposit) (No. 19). For a detailed description of the various mineralized, uraniferous pegmatitic granite dikes encountered at surface and underground on the adjoining Bicroft and Croft uranium deposits, the reader should refer to Satterly (1957).

KERR ADDISON MINES LIMITED (Mindus Occurrence) (21)

In 1979, Kerr Addison Mines Limited held S1/2 of lots 9-13, concession XIV, Cardiff Township. These holdings included a pegmatite-hosted radioactive occurrence formerly held by Mindus Corporation Limited on S1/2 lot 11, concession XIV.

The property is located near Colbourne Lake on the southwestern flank of the Cardiff Dome and is mainly underlain by potassic syenite gneisses. The gneisses dip steeply, trend northwest and contain subordinate interlayered units of amphibolite, potash metasomatized clastic metasediments and minor scapolitized biotite gneiss interbands. Pink granite to granite pegmatite dikes and lense-shaped bodies ranging from a few centimeters to 2 m in width and from 1.6 m to 13.3 m in length intrude the syenite gneiss and metasediments.

Uranium mineralization and abundant magnetite occur locally in the granite pegmatite dikes in association with zones of fracturing and hematitization. Accessory minerals reported in these mineralized dikes include uranothorite, monazite, allanite, uraninite, betafite, magnetite, hematite and molybdenite (Satterly 1957).

In 1953, Mindus Corporation Limited carried out geological and scintillometer surveys over the property and trenched several radioactive occurrences. A chip sample from a 3.3 m wide pegmatite dike on S1/2 lot 11, concession XIV assayed 0.12% U308 and 0.87% Th_2O. A grab sample from a pit on S1/2 lot 13, concession XIV assayed 0.024% U308 and another grab sample from a pit on N1/2 lot 11, concession XV assayed 0.12% U_3O_8 (Assessment Files Research Office, Toronto).

In 1957-1958, Mina Nova Mines Limited conducted geological and scintillometer surveys over their holdings in this area which included part of the former Mindus property.

In 1975-1976, Kerr Addison Mines Limited completed radon gas, lake bottom sediment geochemical and scintillometer surveys over the property.

KERR ADDISON MINES LIMITED (Northern Uranium Occurrence) (22)

In 1979, Kerr Addison Mines Limited held lots 19-22, concession XII and XIII, in central Cardiff Township. These holdings included the pegmatite-hosted radioactive occurrence formerly held by Northern Uranium Mines Limited.

The property is underlain mainly by the Monck Lake granite pluton, which intruded and domed a thick sequence of feldspathic meta-arenite and metawacke along the southeastern flank of the Cardiff Dome.

In 1955, Northern Uranium Mines Limited conducted geological and scintillometer surveys of the southern part of this property. The company pitted and sampled an occurrence of radioactivity in a granite pegmatite dike cutting the Monck Lake granite on the N1/2 lot 19, conc. XII, just to the south of the map-area. No assays were reported. In 1975-1976, Kerr Addison Mines Limited conducted a radon gas and scintillometer survey over this property.

KERR ADDISON MINES LIMITED (Red Bark Occurrence) (23)

In 1979, Kerr Addison Mines Limited held lots 14-18, concession XIV, Cardiff Township. These holdings included the pegmatite-hosted radioactive occurrence formerly held by Red Bark Mines Limited on Monck Lake in the S1/2 lot 16, concession XIV.

The property is underlain by a cross-faulted sequence of feldspathic meta-arenite-metawacke along the western flank of the

Monck Lake granite pluton. In places these metasediments are intruded by several large crescent-shaped metamorphosed granite dikes related to the Monck Lake granite, and by several small pink granite pegmatite dikes.

In 1955, Red Bark Mines Limited diamond drilled 4 holes, totalling 54 m on a radioactive granite pegmatite on the east shore of Monck Lake in the S1/2 lot 16, concession XIV. The drilling intersected several small, highly fractured and hematite-stained zones in the dikes that contain accessory pyroxene, magnetite, titanite, and pyrite. No specific uranium mineral was reported.

In 1975-1976, Kerr Addison Mines Limited conducted radon and scintillometer surveys over this property.

MINA NOVA MINES LIMITED (1958) (24)

In 1958, Mina Nova Mines Limited held a large block of claims which included the former Mindus Corporation, Limited property (see Kerr Addison Mines Limited (Mindus Occurrence) no. 21) and lots 8-10, concession XVI, Cardiff Township, to the north of the Mindus Occurrence.

The northern part of the Mina Nova Mines Limited property, lots 8-10, concession XV along the western flank of the Cardiff Dome is underlain by a steeply dipping, northwest-trending sequence of feldspathic meta-arenite. West of Sandy Lake, this sequence is intruded by several narrow sills of foliated potassic syenite and several large crescent-shaped foliated granite dikes. Small late tectonic granite pegmatite dikes intrude all these rock units.

In 1957-1958, Mina Nova Mines Limited conducted geological and scintillometer surveys over their entire claim holdings. Trenching and 4 diamond-drill holes, totalling 36 m, tested several radioactive pegmatite occurrences. The best reported assay from trenches on the N1/2 lot 8 and 9, concession XVI is 0.015% U_3O_8; and 0.029% U308 and 0.12% TH02 on chip samples from a trench on N1/2 lot 10, concession XVI (Assessment Files Research Office, Toronto).

MCLEAN-HOGAN OCCURRENCE (25)

In 1953, E.T. Hogan held lots 8-10, concession XIX, in northwestern Cardiff Township. Hogan discovered and later optioned several occurrences of uranium mineralization in the metasediments on lot 8, concession XIX.

General Geology

The former McLean-Hogan property lies along the western flank of the Cardiff Dome and straddles the contact between a thick sequence of hornblende-plagioclase gneiss with a unit of interlayered biotite-pyroxene gneiss and schist containing minor units of marble and calcsilicate gneiss. This unit is cut by narrow concordant dikes and related stringers of foliated potassic syenite. Adjacent to these alkalic rocks the wall rocks have been locally potash metasomatized and scapolitized.

Stratabound zones of discontinuous uranium mineralization occur in the metasomatized biotite-pyroxene gneiss and schist band to the southwest of Cope Lake.

This contact metasomatic uranium deposit was later intruded by and in places assimilated by narrow late tectonic pegmatitic granite dikes.

Stripping and trenching by Anuwon Uranium Mines Limited in 1954-1955, on the S1/2 lot 8, concession XIX, exposed 12 discontinuous, narrow zones of uranium mineralization over a strike length of about 250 m in scapolitized, biotite-pyroxene gneiss and schist. Satterly (1957) reported that uraninite is the main radioactive mineral present. It occurs within syenite-veined and scapolitized areas of the host metasediment in the following manner: 1) as crystals in small calcitic vugs lined with crystals of pyroxene, apatite, titanite and scapolite; 2) as disseminated grains and larger crystal masses in small, salmon-pink calcite pods and fracture-fillings containing mica, pyroxene and hornblende with accessory pyrite, pyrrhotite, chalcopyrite magnetite and minor fluorite; and 3) as disseminations in mica-scapolite veins and fracture-fillings. Scattered occurrences of uranothorite were also reported by Satterly (1957) in late tectonic granitic to hybrid syenitic pegmatite dikes that cut the mineralized zones in the biotite-pyroxene gneiss and schist.

Economic Features

Grab samples from the McLean-Hogan Occurrence taken by Anuwon Uranium Mines Limited assayed 0.019, 0.131 and 0.540 percent U_3O_8 (chemical). The best bulk sample assayed 0.10 percent

U_3O_8. Reported assays from drill-core sections include: 1) 0.294% U_3O_8 over 60 cm in biotite-pyroxene gneiss and schist; 2) 0.294% U_3O_8 over about 60 cm in pegmatite; and 3) 0.506 U308 over about 85 cm in a second pegmatite on the property (Assessment Files Research Office, Toronto).

History of Development

In 1953, E.T. Hogan trenched and sampled 11 showings on the property. Several short drill-holes were completed by Cope Lake Mines Limited at this time under an option agreement.

In 1954-1955, Anuwon Uranium Mines Limited optioned this property and conducted scintillometer and geological surveys of the property. Bulk sampling of the trenches was carried out and 69 diamond-drill holes, totalling 1195 m tested the 250 m long main zone of mineralization as well as other smaller radioactive anomalies on the property.

In 1968, Cope Lake Mines Limited diamond-drilled two holes totalling about 110 m on the former property held by E.T. Hogan. This work was possibly to test a chalcopyrite-minor nickel mineralization that was reported by Anuwon Uranium Mines Limited to occur on the property.

In 1979 the McLean-Hogan Occurrence was open for staking.

MONTGOMERY OCCURRENCE (26)

In 1942 F.K. Montgomery trenched and sampled two apatite-fluorite-calcite veins for their fluorite potential on lot 9, concession XXI, in northwestern Cardiff Township.

These calcite veins occur in potassic syenite gneisses containing intercalated minor units of amphibolite and potash metasomatized, siliceous clastic metasediments. This same potassic syenite unit also hosts the uranium-bearing carbonate vein system on the previously described Fission Mines Limited property (No. 12) to the west, as well as the immediately adjacent Tripp Occurrence (39) to the north.

In the Montgomery Occurrence, the largest calcite vein is a lens-shaped body about 20 m long and 3.3 to 6.6 m wide. It is separated from a much smaller en echelon calcite vein by about 3 m of layered hornblende-rich syenitic gneiss. The veins are mylonitic, banded, and the vein walls are coated with black amphibole, red potash feldspar and, in places, by accessory apatite and uraninite. Locally black amphibole crystals, from a few cm to 30 cm in length set in a course calcite matrix occur along the vein margins. Uraninite crystals are also reported in sheared vein material as well as in hematite-stained fractures in the wallrock syenite (Satterly, 1957).

In 1942 fluorite-rich vein material averaging around 30% CaF_2 was shipped for testing to a foundry supply firm in Toronto.

In 1954-1955, Nu-Age Uranium Mines Limited examined the occurrence in an exploration program that also covered the adjacent Tripp Occurrence (No. 39).

NEW FAR NORTH EXPLORATION LIMITED (1956) (Desmond Occurrence) (27)

In 1965, New Far North Exploration Limited, in partnership with Molybdenum Corporation of Canada, held lots 31 to 33 in concessions XIV to XVII, Monmouth Township to the west of Wilberforce. This occurrence comprised three discontinuous zones of calcite-pyroxene skarn-type molybdenum-minor uranium mineralization which had been periodically tested for their molybdenum potential since 1914. In 1917, American Molybdenites Limited shipped 58.6 tons of ore grading about 0.205% MoS_2 for test milling from shallow underground workings on the S1/2 lot 32, concession XVI. At this same time a similar zone to the south on the N1/2 lot 33, concession XV was being investigated by Wilberforce Molybdenite Company. In 1954-1955, Desmond Mining Corporation (formerly Homer Yellowknife Mines Limited) discovered similar molybdenite mineralization containing erratic uranium mineralization to the north of the older molybdenite discoveries. In 1965, New Far North Exploration Limited re-evaluated the molybdenum and uranium potential of all three mineralized zones.

General Geology

The Desmond Occurrence and surrounding area of exploration lies to the west of the Cardiff Dome and is mainly underlain by a thick sequence of folded marble containing subordinate thin interbeds of feldspathic meta-arenite, metawacke, calcsilicate gneiss, metaquartzarenite and phlogopite-tremolite-diopside gneiss. A major easterly trending thrust fault passes through this part of the map area.

The Desmond Occurrence in the northern part of this area of exploration, lies along the axial zone of a major southeasterly plunging, synformal sequence of marble minor phlogopite-tremolite-diopside gneiss, rusty, sulphide-bearing feldspathic meta-arenite and metawacke. These subordinate lithologies, in particular the diopside gneiss, form dislocated, boudinaged lenses along drag-folded limbs of the major fold. Numerous narrow granite pegmatite dikes which are too small to be shown on the map, cut these metasediments in the axial region of the fold. In general, most of these discontinuous, irregularly shaped pegmatitic bodies follow the drag-folded contacts between marble and diopside gneiss or rusty feldspathic meta-arenite. Immediately adjacent to these pegmatites, the wall rock biotite-diopside gneiss has been converted to a calcite-plagioclase-diopside skarn containing erratically distributed molybdenite, pyrite and pyrrhotite with minor uranothorite and uraninite locally present. Near this skarn zone the unaltered phlogopite-tremolite-diopside gneiss is commonly cut by small, irregular dikes and stringers of coarsely crystalline salmon-pink calcite. These calcite dikes and stringers in places contain accessory biotite, pyroxene, hornblende, apatite, pyrite, pyrrhotite, molybdenite and locally uranothorite and uraninite. Minor occurrences of uranothorite, allanite and titanite have been reported in hematite-stained alteration zones in the margins of the granite pegmatites (Satterly, 1957).

Economic Features

The main zone near the eastern boundary of lot 31, concession XVII consists of a 30o-50o dipping, erratically mineralized skarn zone which can be traced about 300 m along strike to the northwest. Surface samples from the main zone taken across two exposed widths of 10 to 13 m and 3.6 to 8.3 m respectively yielded assays ranging from 0.05 to 0.44% MoS_2. These same sections also assayed approximately 0.004% U_3O_8 (chemical). Similar results were obtained on a second 133 m long mineralized skarn zone to the north of the main zone on lot 32, concession XVII (Assessment Files Research Office, Toronto).

History of Development

In 1942 B.E. MacDougall explored the Desmond molybdenite occurrence on lot 31, concession XVII by stripping and shallow test pits.

In 1954 Homer Yellowknife Mines Limited carried out a scintillometer survey and diamond drilled 17 holes totalling 936 m. In 1955 the company changed its name to Desmond Mining Corporation and continued to strip and sample the various shallow dipping surface molybdenite occurrences.

In 1965 New Far North Exploration Limited in partnership with Molybdenum Corporation of Canada carried out geochemical and magnetometer surveys over parts of its claim holdings and diamond drilled 13 holes totalling 1400 m on the main Desmond occurrence, lot 31-32, concession XVII.

In 1976-1977 Highland Mines Limited carried out a program of pitting, trenching, sampling and a geological survey over parts of the former New Far North Exploration Limited property.

In 1979 the area was open for staking.

NEW INSCO MINES LIMITED (Cordell Occurrence) (28)

In 1979 New Insco Mines Limited held lots 27 and 28, concession XVI, in northeast Monmouth Township, near the western boundary of the map area.

This property which contains the former Gordell Occurrence is underlain by a thick sequence of metaquartzarenites containing numerous thin intercalated units of marble, calcsilicate gneiss and minor phlogopite-tremolite-diopside gneiss. In the eastern part of the property this sequence is in contact with a band of potassic syenite gneiss and both units are cut by narrow granite pegmatite dikes.

On the north side of a small pond on the S1/2 lot 27, concession XVI, a few small grains of uraninite associated with titanite, apatite, biotite, pyrrhotite, and pyrite were reported by Armstrong et al (1968) to occur along a fracture within a 5 m wide interbed of phlogopite-tremolite-diopside gneiss in the marble. To the east of the main showing on the N1/2 lot 28, concession XVI, small grains of uraninite were also reported by Armstrong et al (1968) from a pit in tremolite-phlogopite marble.

In 1955 Cordell Gold Mines Limited trenched these various radioactive occurrences and diamond drilled 6 holes totalling 180 m.

In 1976 geological and radiometric surveys were carried out on the Cordell Occurrence by New Insco Mines Limited.

No assays have been reported for these occurrences. In 1979 this occurrence was open for staking.

NORTH LAKE MINES LIMITED (1955) (29)

In 1955 North Lake Mines Limited held lots 13 (N1/2) and 14, concession XVII and lots 13 and S1/2 14, concession XVIII, in north-central Cardiff Township. The area lies along the western flank of the Cardiff Dome to the west of Deer Lake and is underlain by a thick sequence of feldspathic meta-arenite and metawacke that contains an intercalated unit of para-amphibolite and foliated potassic syenite. Small radioactive granite pegmatite dikes cut the syenite gneiss on lot 13, concession XVIII.

In 1955 North Lake Mines Limited trenched and sampled these occurrences and made a geological survey. No assays have been reported from these occurrences.

In 1979 this area was open for staking.

OPAWICA EXPLORATION INCORPORATED (30)

In 1979 Opawica Exploration Incorporated held the N1/2 lots 11-12, concession XIV, lots 9-13, concession XV, and lots 11-13, concession XVI, in north-central Cardiff Township. Parts of this former property includes areas previously held by Mindus Mines Limited and Mina Nova Mines Limited. The exploration work carried out adjacent to this property at that time is described in the sections on Kerr Addison Mines Limited (Mindus Occurrence) (no. 21) and Mina Nova Mines Limited (1958) (No. 24).

The property lies along the southwestern flank of the Cardiff Dome and straddles the contact of a thick sequence of feldspathic meta-arenite-metawacke with an overlying band of potassic syenite gneisses containing minor interlayers of para-amphibolite and potash metasomatized, siliceous clastic metasediments.

In 1978 Opawica Exploration Incorporated carried out radiometric, geophysical, and geological surveys over the property. A radioactive granite pegmatite dike in the syenite gneiss near the east shore of the small lake on lot 11, concession XVI was trenched and sampled at several places along its strike length of 140 m. Assays reported from these trenches are 0.40 lbs U_{308} per ton over 45 cm to 2.80 pounds U308 per ton over 15 cm (Assessment Files Research Office, Ontario Geological Survey, Toronto).

RARE EARTH RESOURCES LIMITED (Halo Deposit) (31)

In 1979 Rare Earth Resources Limited (formerly Amalgamated Rare Earth Mines Limited) held lots 3 to 5 inclusive and the S1/2 lot 2, concession XVII, in northwestern Cardiff Township. The company's Halo uranium deposit on lot 4, concession XVIII was at this time undergoing a production feasibility study by Imperial Oil Limited.

General Geology

The Halo Deposit is located to the northwest of Halls Lake along the western flank of the Cardiff Dome. This deposit lies within a east-dipping band of para-amphibole oontaining minor intercalated units of metawacke pyroxene-rich metasediment, marble, garnet-biotite schist and locally potassic syenite gneiss. To the west of the deposit, there is a thick band of potassic syenite gneisses and the main metasediment-syenite gneiss contact is offset in several places by northwest-trending regional faults. Near the deposit the metasediments and locally intercalated syenite gneiss units are cut by minor apatite-fluorite-calcite veins, as well as by numerous, younger pegmatitic granite dikes and, locally, by hybrid syenite pegmatite dikes. The calcite vines and late tectonic pegmatites were deformed by the regional northwest-trending fault system.

On lot 4, concession XVIII, to the west of a major northwest-trending fault through Halls Lake, uranothorite and uraninite occur disseminated in fractured and hematite-stained granite pegmatite dikes and lenses in a 250 m wide zone of sheared intercalated metawacke, pyroxene gneiss, marble and minor potassic syenite gneiss in the para-amphibolites. The Halo deposit lies within this deformed sequence and consists of two major zones of uranium-bearing granitic to hybrid syenitic pegmatites. These zones are termed the Northwest and Halls Lake Zones.

Northwest Zone (No.1 adit)

The Northwest Zone (or No. 1 adit zone) is located on the N1/2 lot 4, concession XVIII. It trends northwest, consists of en echelon, mineralized dikes, branching dikes, lenses, and stringers, and is about 125 m long and varies in width from 2 m to 23.3 m. The pegmatitic dikes are highly fractured, hematite-stained and vary in composition from pink, granite to altered, reddish coloured pyroxene-bearing granite and brick-red pyroxene syenite. Uraninite occurs as minute grains along the margins of pyroxene crystals in the brecciated and altered hybrid phases of the dikes as well as along chlorite-coated fractures in the dikes (Satterly, 1957). Accessory minerals are pyrite, pyrrhotite and molybdenite. Uranothorite is locally present in small lenses and pods of quartz and pyroxene in cataclastic phases of the dikes. These lenses and pods also contain accessory tourmaline, titanite, hornblende, molybdenite, pyrite and pyrrhotite. Minor uranium mineralization also occurs locally in late stage apatite-fluorite-calcite fracture-fillings in the dikes.

Hall Lake Zone (No.2 adit)

The Halls Lake Zone (or No. 2 adit zone) is located just north of Halls Lake on the S1/2 lot 4, concession XVIII. It lies 255 m southeast of the No. 1 adit portal on the North Zone. The Halls Lake Zone consists of uranium-bearing, hematite-stained quartz-rich or pyroxene-rich cataclastic granite pegmatite bodies and is about 40 m long and varies in width from 3.3 to 4 m. Uranothorite is the main radioactive mineral present. It occurs as minute grains in either fractured quartz or red hematite-stained pyroxene-rich patches (Satterly, 1957). Accessory minerals include zircon, pyrite, pyrrhotite and molybdenite and locally uraninite.

Economic Features

In 1957, the lowest drill-indicated estimate of reserves in both zones of the Halo deposit, above the 515-feet (157 m) horizon was 472,000 tons grading 0.112% U_3O_8 (2.24 lbs) (Assessment Files Research Office, Ontario Geological Survey). A 20 ton bulk sample collected about equally from the No. 1 and 2 adits contained 0.12% U308, 0.09% ThO2, 0.15% ZrO2 and 0.09% rare earth oxides. REE values reported included 0.02% yttrium, 0.006% ytterbium, 0.04% lanthanum and recoverable traces of cesium, dysprosium and gadolinium (Assessment Files Research Office, Ontario Geological Survey, Toronto).

History of Development

In 1953-1954, Stratmat Limited held part of this property and carried out scintillometer and geological surveys, stripping, trenching, and a limited amount of diamond drilling on the Northwest zone.

In 1955-1956 Halo Uranium Mines Limited carried out an extensive exploration program on both the Northwest and Halls Lake Zones which included about 925 m of surface trenching, about 10,596 m of surface diamond drilling, and the excavation of 2 adits. A 75-foot (23 m), 3-compartment-shaft was put down on the

Northwest zone and about 908 m of underground development was completed. Underground development in the No. 2 adit (Halls Lake zone) was about 287m. Underground drilling on both zones amounted to 89 holes totalling about 3270 m.

In 1968-1969 Amalgamated Rare Earth Mines Limited, the new owner carried out geological, scintillometer and electromagnetic surveys over the property. Trenching and some rehabilitation of the adits was undertaken and 10 holes totalling 987 m were diamond drilled from the ice on Halls Lake to extend the Halls Lake zone along strike to the south. One of the better reported drill intersections assayed 5.6 lbs U_3O_8 over a 3.8 m length (Assessment Files Research Office, Ontario Geological Survey, Toronto).

In 1973 Imperial Oil Limited optioned the property along with several other claim groups owned by Amalgamated Rare Earth Mines Limited in Cardiff and Monmouth Townships. Imperial Oil Limited (which has since assigned the option to Esso Resources Canada Limited) has been carrying out geological re-evaluation and production feasibility studies on the Halo deposit for the last six years.

In 1979, Amalgamated Rare Earth Limited changed its name to Rare Earth Resources Limited.

RARE EARTH RESOURCES LIMITED (Pyroxenite Zone) (32)

In 1979, Rare Earth Resources Limited held a second uranium property to the east of its Halo Deposit (No. 31), called the "Pyroxenite Zone" on lots 6-8, concessions XVII and XVIII, in northwest Cardiff Township.

General Geology and Economic Features

The property lies along the western flank of the Cardiff Dome to the northeast of Halls Lake. It straddles the same unit of pyroxene-rich metasediment which contains the previously described uraninite-bearing lithologies on the adjacent McLean-Hogan Occurrence (Property No. 25) to the northeast.

On the Rare Earth Resources Limited "Pyroxenite Zone", this horizon of north-to northeast trending pyroxene-rich metasediments contains thin units potassic syenite gneiss. It varies in width from 100-200 m and contains two localized zones of stratiform uranium mineralization. In the first zone, the north pyroxenite zone (or B-2 zone) in the N1/2 lot 6, concession XVIII, trenching and diamond drilling have delineated erratic uranium mineralization over a 266 m strike length. Uraninite, the main radioactive mineral present occurs in the same way as previously described on the McLean-Hogan Occurrence (page). The second zone, the south pyroxenite zone (or B-3 zone), is a similar zone of uranium mineralization. It lies on the N1/2 lot 6, concession XVII, 730 m along strike to the south of the north pyroxenite zone. Trenching and drilling have delineated erratically disseminated uraninite in irregular zones of scapolitized metasediments over a 166 m strike length.

History of Development

In 1953, E.T. Hogan optioned both the north and south pyroxenite zones to Stratmat Limited. This company carried out geological and scintillometer surveys over the property and stripped and diamond drilled the two main uranium occurrences.

In 1954-1955 Halo Uranium Mines Limited diamond drilled 15 holes totalling 785 m on the north pyroxenite zone; 12 holes totalling 901 m were diamond-drilled on the south pyroxenite zone.

In 1968 Amalgamated Rare Earth Mines Limited (since 1979 Rare Earth Resources Limited) carried out radiometric surveys and later in 1973, the company optioned the property to Imperial Oil Limited.

RARE EARTH RESOURCES LIMITED (South Zone) (33)

In 1979 Rare Earth Resources Limited held lot 6-7, concession XV and lots 5-6 inclusive as well as the S1/2 lot 4, concession XVI, Cardiff Township. Betafite-bearing calcite veins in the South Zone occur on lot 6, concession XV.

General Geology

The property lies along the southwestern flank of the Cardiff Dome and is underlain by a northwesterly-trending sequences of amphibolites and hornblende-plagioclase gneisses containing subordinate units of biotite-pyroxene-gneiss and schist. Present locally are thin interlayers of metawacke and marble. This sequence is fault-bounded on the west and is underlain to the east by a band of potassic syenite gneiss containing minor intercalated units of potash metasomatized and scapolitized metasediments. On lot 6, concession XV, the amphibole-rich metasediments have been intruded and locally metasomatized by several, narrow calcite veins similar to those previously described under Fission Mines Limited (No. 12) and Cardiff Uranium Mines Limited (Nos. 7 and 8). However, in the calcite veins on the Rare Earth Resources Limited (South Zone), biotite is abundant and the main radioactive mineral is betafite; fluorite and uraninite are present only in a few places.

Betafite No. 1 Vein

The "Betafite No. I calcite vein" is in the N1/2 lot 6, concession XV. It dips 45o-70oW and strikes N30oE, sub-parallel to the local gneissosity of the enclosing hornblende-plagioclase gneiss, and pinches and swells in width from 15 cm to 3.3 m over an exposed strike length of about 26 m. A late tectonic, pink, pegmatitic granite dike intrudes along the contact between the vein and the wall rock gneiss and, in places truncates and engulfs segments of the calcite vein. The vein consists of coarsely crystalline, cream-to pale pink calcite, purple fluorite, green apatite, and black biotite. Biotite is concentrated along the vein walls and forms books 2-25 cm across. Narrow sections of the vein are composed almost entirely of biotite in a calcite matrix. Betafite is present as brown crystals up to 2.5 cm across in the calcite or biotite books (Satterly, 1957). Adjacent to the calcite vein, the pegmatitic granite commonly shows a 2.5-7.5 cm wide, hornblende-rich fenitic alteration zone. About 9 m to the east of the Betafite No. I vein is a second, 1 m wide apatite-biotite-calcite vein. Betafite and fluorite were not observed in this vein. This vein contains abundant magnetite and accessory titanite.

Betafite No. 2 Vein

The "Betafite No. 2 calcite vein" is also located in the N1/2 of lot 6, concession XV, at a point about 265 m west of the No. I vein. This irregular-shaped biotite-apatite-fluorite-calcite vein occurs along the contact between metasomatized hornblende-plagioclase gneiss and metawacke. In places it is intruded and locally engulfed by late tectonic, pink granite pegmatitic dikes. Betafite and red apatite crystals were reported by Satterly (1957) in thin biotite-rich portions of this calcite vein adjacent to the pegmatites. Near the contact with the calcite vein the pegmatitic granite has been locally altered to hybrid pyroxene syenite. Minor zircon, uranothorite and rare betafite crystals were reported by Satterly (1957) to occur locally in the syenitic phase of the granite pegmatite. About 6 m west of the Betafite No. 2 vein, another biotite-rich calcite vein of undetermined width is exposed (Satterly, 1957). The exposed thickness of the vein is 15-30 cm. The vein strikes N10oE and dips 65oW and lies in metasomatized metawacke. It contains abundant red and green apatite as single crystals or aggregates up to 25 cm across and in places, crystals of titanite 5 mm-2.5 cm across; pyroxene up to 15 cm long; minor purple fluorite and a few betafite crystals up to 7 mm in diameter (Satterly, 1957).

Economic Features

Assays obtained from 0.45 to 1.6 m long drill core sections of the various betafite-bearing calcite veins on the S1/2 lots 6 and 7, concession XV ranged from 0.5 to 0.75% U_3O_8 (Assessment Files Research Office, Ontario Geological Survey, Toronto). In contrast to this type of mineralization assays of 2 m drill core sections of uranothorite and uraninite-bearing hybrid syenitic phases in a granite pegmatite, from the northern part of the South Zone property ("Bald Mountain Zone") averaged 0.05% U_3O_8. A second 8.4 m long section of this mineralized pegmatite averaged 0.25% U_3O_8 (Assessment Files Research Office, Ontario Geological Survey, Toronto).

History of Development

In 1953, Stratmat Limited held the property and carried out geological and scintillometer surveys.

In 1954-1955, Halo Uranium Mines Limited stripped and sampled the Betafite Nos. 1 and 2 vein zones and carried out radiometric surveys over the entire property; 23 drill holes totalling 3147 m were diamond drilled in lot 6 and the S1/2 lot 7, concession XV. In the northern part of the South Zone property, ("Bald Mountain zone") on Lot 5, concession XVI, 7 diamond drill holes totalling about 505 m tested a radioactive pegmatite zone.

In 1968, Amalgamated Rare Earth Mines Limited (since 1979, Rare Earth Resources Limited) made a new radiometric survey of the property. Between 1973-1979 this company's holdings in Cardiff and Monmouth Township have been under option to Imperial Oil Limited (Esso Canada Resources).

REASOR OCCURRENCE (34)

In 1955, Gerald L. Reasor stripped and trenched several small, less than 2 m long, discontinuous, lens-like bodies of radioactive granite-to hybrid pyroxene syenite pegmatite in the S1/2 lot 30, concession XVI, Faraday Township. These pegmatites intrude a fault-bounded northwest trending band of intercalated amphibolite, minor marble and potassic syenite gneiss along the western flank of the Faraday Dome.

At the Reasor Occurrence, uraninite, uranothorite, and a pyrochlore mineral of the microlite-betafite series are reported by Satterly (1957) to occur in red, pyroxene-bearing alteration phases in the pegmatites. Also present in places are accessory pyrite, molybdenite and fluorite.

SILVER CRATER MINES LIMITED (Basin Deposit) (35)

The Silver Crater Mines Limited betafite-bearing apatite-biotite-calcite deposit is situated on lot 31, concession XV, in northwestern Faraday Township. This deposit was worked as early as 1925, as a mica prospect, however the bulk of the mica production took place between 1947-1950. Later, with the discovery that this calcite lens contained crystals of betafite, Although no uranium production resulted, this deposit has become a renowned mineral collecting locality for betafite crystals.

General Geology

The author considers the Basin Deposit apatite-biotite-calcite vein, to be a carbonate-rich aqueous hydrothermal end-member of a late tectonic period of carbonatite igneous activity which is not exposed in the map area. The lithology of these calcite veins is described in more detail in the General Geology section of this report (map-unit 13b). The following conclusions are based on the author's geological mapping of the area, as well as studies by Satterly (1957), Giblin (1955) and public company records (Assessment Files Research Office, Ontario Geological Survey, Toronto).

The Basin Deposit calcite lens occupies a local drag-fold structure at the nose of a southward plunging, regional synform between the Cardiff and Faraday Domes. The lens was emplaced along the easterly trending contact between a drag-folded sequence of amphibole-rich metasediments (map-unit 5) that is structurally overlain to the south by a band of intercalated syenite and nepheline syenite gneisses (map-unit 8 and 9).

The Basin Deposit calcite lens does not strike north and dip 20o-30o east as stated in company reports (Satterly

1957). However the crest of the drag-fold in the (easterly trending) host rock into which this lens was emplaced does plunge 25°-30° south-southeast. The general trend of the calcite lens is east-west. The reported (Satterly 1957) 133 m long and 40 m wide exposed dimensions of this lens represent that segment of the lens exposed along the crest of this earlier structure. Within the dialation zone at the crest of this southerly plunging drag-fold, the calcite lens has an average true thickness of about 16 m but locally ranges in width from 13 m to 25 m. Diamond drilling records and cross-sections submitted by Silver Crater Mines and interpreted by the author indicate that at depth within this fold structure, the main body in the crest of the fold, changes along the limbs of the fold into several narrower branching veins that trend subparallel to the easterly trending metasomatized amphibolite country rock. Along the northern contact of the calcite lens with para-amphibolite is a 6-8 m wide metasomatic envelope of calcite-biotite-plagioclase gneiss ± sodic amphibole, scapolite and diopside. The contact between the main calcite lens and this metasomatic envelope is a 1 to 3 m wide transition zone composed of interfingering bands of biotite gneiss and white calcite containing abundant crystals and crystal aggregates of apatite, biotite, pyrrhotite and locally amphibole. The long axis of the amphibole crystals parallel the structure of the enclosing wall rock. Away from this contact zone, in the central part of the calcite lens, betafite crystals ranging from less than 5 mm to 7.5 cm in diameter occur mainly within several closely spaced, narrow, parallel bands of pink, apatite-biotite-calcite within a cream-coloured calcite-rich central phase.

Within the syenite gneiss band on lot 32, concession XV, about 440 m southwest of the Basin Deposit calcite lens is a narrow (3 m long), apatite-fluorite calcite vein. Betafite was not observed in this vein nor was uraninite, a common accessory mineral in similar veins on the Fission Mines Limited property (No. 12) in the western part of the map area.

History of Development:

Between 1947-1951, Bancroft Mica and Stone Products produced 469 tons of black mica (biotite) from an open pit near the northeastern exposure of this apatite-biotite-calcite lens.

In 1953-1954, Silver Crater Mines Limited drilled 34 diamond drill holes totalling 1871 m and drove a 66 m long, N63°W trending adit from the side of a hill to the southeast of this exposed deposit in order to crosscut what was believed to be a southeast-dipping body. According to the author's interpretation this adit level actually passes through the lens sub-parallel to its plunge direction. Underground work from this adit level included: 1) 151 m of drifting on narrow betafite-bearing calcite zones across their plunge direction; and 2) a 31 m raise up the plunge of the betafite-bearing calcite zones to the surface.

Economic Features:

A partial analysis of the betafite had the following results; Cb_2O_5-41.5%, Ti_2O_3-1.4%, U_3O_8-21.4% and CaO-9.4% (Assessment Files Research Office, Ontario Geological Survey, Toronto). The adit level intersected several narrow betafite-bearing pink calcite zones over a length of about 13 m in the central part of the lens. Within this same section, two particularly rich betafite zones, ranging in exposed width from 15 cm to 1 m were drifted across their 25-35oSE plunge direction.

No drill section assays or estimated drill indicated reserves of uranium-columbium (niobium)-bearing material have been reported for this deposit. In the author's opinion, the underground and surface diamond drilling, reported to date on this deposit have not fully defined the shape and size of the southeast plunging central mineralized zone in the crest of the confining drag-folded country rock. Furthermore, the vertical diamond drill program along the flanks of this structure has not clearly defined the eastern and western extensions of the adit-level mineralized zone.

SILVER CRATER MINES LIMITED (Baumour-Campbell Occurrence) (36)

This uranium occurrence is located on lots 27-30, concession XV and lots 27-29, concession XVI, Faraday Township.

General Geology

The various occurrences on this property are found along the southwestern flank of the Faraday Dome in a 600 m wide, north-west-trending sequence of amphibole-rich metasediments containing subordinate units of marble and biotite-pyroxene gneiss and schist. This sequence is intruded by a series of foliated potassic syenite sills and small conformable dikes, which locally metasomatized their host rocks. Late tectonic concordant granite to granite pegmatite dikes were emplaced into all these rocks, particularly along contacts between metasediments and syenite gneiss. Shearing and fracturing of all these rocks has occurred in many places. The shallow-dipping massive, pink, pegmatite dikes vary in true width from 1 to 6 m, however the larger dikes commonly branch into a series of smaller parallel dikes and stringers. At their contacts, the pegmatitic granite is locally altered to hematite-stained, red to yellowish brown, pyroxene-bearing granite or pyroxene syenite. These altered phases are the result of assimilation of and reaction with the wall rocks, in particular the potassic syenite.

Uranothorite, allanite and uranophane are reported by Satterly (1957) to occur in the fractured and sheared altered margins of pegmatitic granite dikes on the S1/2 lot 28, S1/2 lots 29-30, and the N1/2 lot 29, concession XV, Faraday Township. Accessory minerals in the altered pegmatite are calcite, scapolite, fluorite, tourmaline, titanite and zircon. Drilling on the N1/2 of lot 28, concession 29, Faraday Township by Silver Crater Mines Limited encountered pegmatite-hosted uranium mineralization as well as possibly stratabound metasomatic mineralization in the metasediments. This second reported type of mineralization consisted of disseminated unidentified radioactive minerals in several 1-5 m thick interbands of pink and green phlogopite-diopside "marble" in para-amphibolite. These mineralized "marble" interbands contain abundant apatite (1-5%) and minor pyrite and pyrrhotite. The author did not see the drill core samples and the possibility exists that these mineralized carbonate units could be calcite veins (map-unit 13) and not metasediments.

Economic Features

A 0.3-2.4 m core section of altered, yellowish brown pegmatitic granite assayed 0.5 to 1.5% U_3O_8 and an about 5 m long section of pyroxene-phlogopite-apatite marble (or calcite vein) averaged 0.065% U_3O_8 (Assessment Files Research Office, Ontario Geological Survey, Toronto).

History of Development

In 1954-1956, Silver Crater Mines Limited trenched surface showings, carried out a magnetometer survey and completed about 2358 m of surface diamond drilling.

In 1967-1969, Fidelity Mining Investment Limited conducted geological, magnetometer and radiometric surveys over the property and diamond drilled 20 holes totalling 2792 m on lot 28, concession XV, Faraday Township.

The southern part of this property, namely lots 29-30, concession XV, were later investigated by various geophysical surveys by Robert Laird in 1975, Kerr Addison Mines Limited in 1975 and by Brascan Resources in 1977. No assays were reported by these companies.

STRATMAT LIMITED (1954) (37)

In 1953-1954, Stratmat held lots 11-16 inclusive, concession

XIX and XX, between Cope and Hudson lakes in northwestern Cardiff Township.

This former property lies along the northwestern flank of the Cardiff Dome. It straddles the contact between an easterly dipping northwest-trending thick sequence of feldspathic meta-arenite and a structurally underlying band of potassic syenite gneisses. The syenite gneisses near this contact contain thin units of potash metasomatized metasediments as well as a metagabbro sill. Small late tectonic pegmatitic granite dikes cut all these rock units. In 1954 Stratmat Limited carried out geological and scintillometer surveys over its property, however no radioactive occurrences were reported.

During this same period, Stratmat Limited carried out extensive work on several optioned properties in other regions of Cardiff Township. Exploration work on these property options is detailed in the property descriptions for the following: 1) Denfield Occurrence (No. 10); 2) the Rare Earth Resources Limited occurrences (Nos. 31, 32 and 33); and 3) the Atlin-Ruffner Occurrence (No. 41).

TOPSPAR FLUORITE MINES LIMITED (1950-1962) (38)

During the period 1950-1962, Topspar Fluorite Mines Limited held a fluorite deposit on the N1/2 lot 13, concession XXII, Cardiff Township. In 1979 this deposit was not available for staking and its ownership at this time was unknown to the author.

General Geology

The Topspar fluorite deposit is located at the northwestern flank of the Cardiff Dome. It occurs in an area underlain by southeasterly dipping potassic syenite gneisses containing subordinate intercalated units of para-amphibolite and locally minor interlayered potash metasomatized clastic metasediments. According to the published descriptions by Satterly (1957) and Guillet (1969), the fluorite mineralization is hosted by a pink to buff coloured pyroxene-and calcite-bearing syenite pegmatite dike containing irregular lenses, patches and stringers of fluorite-bearing calcite. However based on these author's description this deposit has in the writer's opinion striking similarities to the feldspar-rich fenite zones observed by the author in some of the apatite-fluorite-calcite veins previously described on the Fission Mines Limited property (no. 13) to the southeast.

The mineralized "dike" (or vein) in the Topspar fluorite deposit has a maximum true width of about 10 m and strikes 50oE for at least 100 m (Guillet, 1969). According to this author, contacts of the host "dike" with the shallow-dipping, foot-wall syenite gneisses to the northwest and para-amphibolite hanging wall rocks to the southeast are conformable and relatively sharp. In general, the margins and most of the central part of this "syenite pegmatite dike" consist of coarsely crystalline, equigranular, pink to buff microcline (80-90%) with subordinate black pyroxene crystals ranging in size from 1 to 2 cm in length. In places along its margins, large grain size variations occur with feldspar crystals up to 0.6 m across and pyroxene crystals up to 1 m in diameter. Salmon-pink calcite commonly forms thin matrix-fillings around coarser grained patches of euhedral pyroxene and feldspar. Accessory minerals commonly present in the calcite matrix are fluorite, apatite, scapolite, biotite and locally minor uranothorite (Satterly, 1957). Most of the fluorite in the "dike" is concentrated in a series of gradationally to sharply bounded feldspar-calcite-fluorite lenses or stringers along the western (foot-wall) contact of the "dike" with syenite gneiss. These lenses and stringerstrand subparallel to the contact of the "dike" and range in size up to 1.6 m thick and 5 m long (Satterly, 1957). In the central part of this 10 m thick "dike" (possibly a calcite-feldspar vein), calcite with minor fluorite forms similarly oriented lens-shaped zones, 15 cm to 1 m wide. In places along the southeastern margin of the pyroxene-and calcite-bearing "pegmatite dike", a narrow dike of massive, pink pegmatitic granite was emplaced along the contact of the mineralized "syenite pegmatite dike" with the hanging wall country rock amphibolite.

Economic Features and History of Development

During the 1940-1942 period of operation by W.E. Clark, 30 tons of acid grade fluorite were excavated and shipped for processing. Since that time, no further production or assays have been reported from this deposit.

In 1940, W.E. Clark discovered and trenched this deposit. Tops Mining Syndicate Limited owned the deposit from 1943 to

1946. The Tops Mining Syndicate workings consist of an open-cut, 3 m wide and 26 m long cut into the side of a hill and a south-easterly trending adit driven a further 30 m from the south end of the open cut. A 10 m raise was made to intersect the down dip extension of the discovery zone exposed at surface. In 1950, the property was held by Topstar Fluorite Mines Limited. In 1962, some underground work was carried out by Topspar Fluorite Mines Limited and fluorite-rich material was stockpiled at surface.

Tripp Occurrence (39)

The Tripp uranium-bearing apatite-fluorite-calcite veins are located on lot 8, concession XXI, in northwestern Cardiff Township.

General Geology

These veins occur at the northwestern flank of the Cardiff Dome, and form the northeastern extension of the zone of small, discontinuous calcite veins and lenses previously described on the adjacent Fission Mines Limited property (no. 12). The Tripp Occurrence contains four separate, parallel zones of veins and stringers in potassic syenite gneiss. These veins were emplaced into zones along the limbs of an overturned fold.

The largest apatite-fluorite-calcite vein occurs on the shaft zone (or former No. 4 Zone) located on the N1/2 lot 8, concession XXI. The vein is banded, blastomylonitic and contains up to 30 percent fluorite. It pinches and swells up to a maximum of 3.3 m over a strike length of about 36 m. Uraninite and thorite crystals are concentrated along with apatite and hornblende in the reddish brown fenitized wall rock zone adjacent to the calcite vein. In places, the uraninite forms crystal masses up to 1 cm in diameter containing minor magnetite, pyrite and chalcopyrite. Uranothorite occurs locally in the calcite vein and locally in biotite-rich veinlets cutting the wall rock fenitic zone and adjacent syenite gneiss. Some calcite veins have been intruded and partially assimilated by late tectonic pegmatitic granite dikes which now contain disseminated uranothorite, uraninite, and fluorite.

The three other, but smaller zones of apatite-fluorite-calcite veins and stringers on the former Tripp property are similar and are described in detail by Satterly (1957).

Economic Features

From a vein in the main shaft zone of this occurrence channel samples returned values of 0.516% U_3O_8 over 2 m and 0.21% U_3O_8 over 2.6 m. From a second calcite vein located 200 m south of the shaft zone, twelve 40-pound samples returned values ranging from 0.49% to 3.38% U3O8 with an average of 0.68%U3O8 (Assessment Files Research Office, Ontario Geological Survey, Toronto).

History of Development

In 1924 Industrial Minerals Corporation put down a 6.7 m shaft on the discovery vein situated about 300 m southeast of the shaft zone. The company hand-picked and sold two tons of fluorite ore which analysed 98.5 percent CaF_2.

In 1954-1956 a major exploration program to test the uranium potential of the Tripp Occurrence was carried out by Nu-Age Uranium Mines, Limited. This company conducted a scintillometer survey, diamond drilled 8 holes totalling 517 m and put down a (45°E) inclined shaft on the main vein. Underground work included the excavation of a 125 foot-level (38 m) with about 90 m of crosscuts, 64 m of drifts and 13 underground diamond drill holes totalling 1350 m. The company stockpiled about 1600 tons of ore at surface and in 1955, a 300 t.p.d. gravity separation pot mill was constructed and operated briefly. At least one small shipment of concentrate was made to the Eldorado Refinery in Port Hope, Ontario. This property has been inactive since 1956.

URANEX RESOURCES LIMITED (Landair Occurrence) (40)

In 1979 Uranex Resources Limited held the former Landair fluorite occurrence on lots 34 and 35, concession XII, Monmouth Township and lot A concession XVI, Cardiff Township.

General Geology

The property is underlain by marble and potassic syenite gneiss and is located at the southwestern flank of the Cardiff Dome. Within the easterly dipping syenite gneisses, near their western contact with the underlying marble, drilling has encountered two subparallel zones, approximately 130 m apart, of closely spaced fluorite-calcite veins and stringers. The main or structurally lower (western) zone nearest the marble-syenite gneiss contact consists of an en echelon series of closely spaced fluorite-calcite veins, which range up to 2 m thick. As indicated by drilling this lower mineralized zone averages 4 m in thickness and is approximately 730 m long. Dimensions of the upper (eastern) zone are not known.

Economic Features and History of Development

Limited drilling on the lower (main) zone of calcite veining has indicated a potential of 2,000,000 tons of low-grade fluorite ore. The best reported assays to-date are a 1.5 m core section which averaged 29.5% CaF_2 (Assessment Files Research, Toronto). Uraninite is reported to occur locally in the fluorite-calcite veins as well as in the altered contact phases of some cross-cutting late tectonic pegmatitic granite dikes. Drilling to-date has only locally tested the upper (eastern) zone of similarly mineralized fluorite-calcite veins.

In 1967, L.T. Chandler carried out an airborne magnetic, electromagnetic and radiometric survey over this and adjoining properties now held by Uranex Resources Limited.

In 1971-1975, Landair Exploration Limited diamond drilled six holes totalling about 1440 m.

URANEX RESOURCES LIMITED (Atlin-Ruffner Occurrence) (41)

In 1979 Uranex Resources Limited held the former Atlin-Ruffner allanite property on lots 1 to 3 and the N1/2 lot 4, concession XVI, in northwestern Cardiff Township.

General Geology

The property lies along the southwestern margin of the Cardiff Dome and is underlain by a wide band of pink to yellowish brown, potassic syenite gneiss containing minor intercalated units of metasomatized hornblende-plagioclase gneiss, pyroxene-hornblende-plagioclase gneiss and locally minor marble. The country rock syenite gneiss is cut by numerous small concordant light pink, pegmatitic granite dikes. Locally in the Atlin-Ruffner Occurrence, the syenite gneiss is cut by several small fluorite-calcite veins, and in the writer's opinion several related pyroxene-bearing feldspar-rich veins containing abundant allanite.

Allanite Zone

The main allanite zone, the Atlin-Ruffner Occurrence is located on the N1/2 lot 2, concession XVI, Cardiff Township. It consists of a discontinuous train of brick-red to red allanite-bearing pyroxene-feldspar veins and lenses which intruded and locally metasomatized the wall rock syenite gneisses. The feldspar veins and lenses range up to 2 m wide and 10 m long, dip 55oSE and trend N30°E subparallel to the fabric of the enclosing syenite gneisses for a strike length of about 67 m.

According to Satterly (1957) the veins consist mainly of hematite-stained plagioclase, potash feldspar and subordinate pyroxene with accessory biotite and zircon. Disseminated allanite in crystals and aggregates generally comprises between 2 and 10 percent of the vein. In places these veins contain coarse-grained patches and small stringer zones composed of up to 60 percent allanite intergrown with pyroxene. Trenches on this mineralized allanite zone exposed two small apatite-fluorite-calcite veins in the wall rock syenite gneisses within 3 m of one of the larger allanite-pyroxene-feldspar veins.

On the N1/2 lot 3, concession XIV, trenching has exposed a pink pegmatitic granite dike containing some fluorite and allanite in crystals up to 10 cm long (Satterly 1957).

Economic Features

The main allanite zone with drill-indicated dimensions of 60 X 1.5 X 50 m, has been estimated to contain 36,000 tons of probable ore averaging about 2.29% CeO_2. The best reported assays for uranium were 0.01% U_3O_8 over a 6 m section of core, and 0.045% U_3O_8 over a 0.4 m section of core, (Assessment Files Research Office, Ontario Geological Survey, Toronto).

History of Development

In 1953-1954, Stratmat Limited discovered this allanite occurrence and conducted scintillometer and magnetometer surveys. The company diamond drilled 9 holes on the main zone totalling 901 m.

In 1955 Atlin-Ruffner (B.C.) Limited stripped the overburden from an area 100 m long and 50 m wide along the main zone and took bulk samples. Five tons of material were shipped in 1955 to Electro-Metallurgical Company, Niagara Falls, New York for processing. Stripping and geological surveys were made on other selected areas of the property.

In 1967, L.T. Chandler carried out airborne electromagnetic, magnetic and radiometric surveys over this property. Following this survey in 1971, Landair Exploration Limited explored this and adjoining properties for fluorite.

URANEX RESOURCES LIMITED (Empire Oil-Canuc Occurrence) (42)

In 1979 Uranex Resources Limited held part of a large group of claims in northwestern Cardiff Township part of which had been formerly held first by Empire Oil and Minerals Incorporated and later by Canuc Mines Limited. Uranex's property consists of Lot A, 1, 2, concession XV and lot A, concession XVI, Cardiff Township and lots 33 to 35, concession XI and XII, Monmouth Township.

General Geology

The property lies along the northwestern flank of the Cheddar Dome, near the southern boundary of the map area. It is underlain by a thick sequence of southeast-dipping clastic metasediments, which to the northwest are underlain and locally intercalated with syenite gneisses. Numerous late tectonic pegmatitic granite dikes conformably intrude both the syenite gneisses and metasediments, particularly near the main syenite-metasediment contact. The pegmatitic granite dikes and country rocks have been fractured and sheared.

In the eastern part of the property in Cardiff Township, surface trenching and diamond drilling encountered minor disseminated uranothorite, pyrite and chalcopyrite in some sheared and altered phases of pegmatitic granite. These minor occurrences include the former Empire Oil A and C zones on the N1/2 lot 2, concession XV, and the former Empire Oil D-Zone on the S1/2 lot A, concession XVI, Cardiff Township.

In the western part of the property in Monmouth Township, the former Empire B-zone on the N1/2 lot 35, concession XI, Monmouth Township comprises the main uranium-bearing zone on this property. The B-zone uraniferous pegmatites occurs along a sheared contact between marble and metawacke. Narrow intercalated units of potassic syenite gneiss occur locally. The B-Zone consists of two parallel zones of pegmatitic granite-hosted uranium mineralizations. The uranium mineralization, mainly uranothorite, occurs as disseminated grains and aggregates in gradationally bounded lenticular-zones in the sheared brick-red, altered pegmatitic granite. Accessory minerals are biotite, hornblende, pyroxene and magnetite, fluorite, zircon, titanite, allanite, and pyrite.

Drilling on the B-zone indicated two parallel sheared and locally mineralized dikes along the marble-metawacke-minor syenite gneiss contact. The northern pegmatitic granite dike contains 4 discontinuous mineralized zones up to 3 m wide within a 200 m strike length. Drilling along the contact of the second dike a short distance to the south indicated 6 discontinuous mineralized zones of similar dimensions along a strike length of about 366 m.

Economic Features

The B-zone contains drill-indicated reserves of 2,179,166 tons grading 0.726 pounds U_3O_8 per ton (Assessment Files Research Office, Ontario Geological Survey, Toronto).

History of Development

In 1954-1955 Empire Oil and Minerals Incorporated carried out scintillometer and geological surveys and 26 diamond drilled 26 holes totalling about 4170 m.

In 1967 L.T. Chandler carried out airborne magnetic, electromagnetic and radiometric surveys over this and adjoining properties.

In 1968-1970 Canuc Mines Limited diamond drilled 11 holes totalling about 2300 m.

In 1971-1975 the property was held by Landair Exploration Limited which carried out a geochemical survey and diamond drilled 4 holes totalling 841 m on the B-zone.

In 1976-1977 the property was optioned to Powerex Resources Limited. This company carried out ground electromagnetic and radiometric surveys and diamond drilled 6 holes totalling 1413 m.

GUIDELINES FOR FUTURE URANIUM EXPLORATION

Summary of the Types of Uranium Deposits

The following summary is based on the field work and literature research by the author. Future uranium exploration programs should take the following observations and interpretations into consideration.

In the Center Lake area, there are two major and one minor type of epigenetic uranium deposit. In order of abundance as well as economic importance these deposit types are as follows:

Type I - Pegmatite-hosted uranium deposits

Type II - Uranium-and rare earth-bearing carbonate veins

Type III - Stratabound metasomatic uranium deposits.

All types may be present in one and the same deposit, however Type I deposits, pegmatite-hosted uranium mineralization have produced the bulk of the uranium ore to date throughout the Bancroft Uranium Belt.

Type I: The youngest uranium mineralization is hosted by late tectonic, pink pegmatitic granite to granite pegmatite dikes. The uranium mineralization is locally concentrated in hematite-stained, altered granitic to syenitic hybrid phases in these dikes (see General Geology Section of this report for map-unit 14). In the map area pegmatite-hosted uranium deposits are concentrated in the syenite gneisses and/or adjacent, in places intercalated mafic mineral-rich clastic metasediments of the Grenville Supergroup along the flanks of the various domes within the Harvey Cardiff Basement Arch. These metasediments which are tentatively assigned to the lower Mayo Group of the map area consists mainly of amphibole-rich, pyroxene-rich and biotite-rich metasediments (map-units 5, 4 and 3) with minor interbeds of marble. These metasediments have been intruded and locally metasomatized by the syenitic rocks prior to the emplacement of the pegmatite dikes. Selective remobilization and assimilation of the earlier uranium mineralization (Types II and III) by these pegmatites has also occurred locally. Type I uranium mineralization is best represented in the property description by the following deposits: 1) Kerr Addison Mines Limited (Croft Deposit, No. 19); 2) Rare Earth Resources Limited (Halo Deposit, No. 31); Tripp Occurrence (No. 39); and 4) Uranex Resources Limited (Empire Oil - Canuc Occurrence, No. 42).

Type II: Uranium and rare earth-bearing carbonate veins are shown as a separate lithologic unit (map-unit 13) on the map (back pocket). The mineralogy, structure and distribution of these uranium-bearing carbonate veins are discussed in detail in the General Geology Section of this report. In the map area, these deposits are small and occur mainly in a 9 km long zone of deformed syenite gneisses along the northwestern and western flanks of the Cardiff Dome. They also occur locally in the intercalated syenite gneiss and Mayo Group metasediments along the eastern flank of the Cardiff Dome and adjacent western flank of the Faraday Dome. Type II uranium mineralization is best represented in the property description by the following deposits: 1) Fission Mines Limited (Richardson Occurrence, No. 12); 2) Cardiff Uranium Mines Limited (North and South Zones, Nos. 7 and 8); 3) Tripp Occurrence (No. 39); and 4) Topspar Fluorite Mines Limited (1952-1962), (No. 38).

Type III: Minor uranium mineralization occurs as stratabound small discontinuous lenses or gradationally bounded zones of disseminated uraninite in locally metasomatized marble and calcsilicate gneiss . This type of deposit occurs particularly adjacent to or near intercalated syenite gneisses along the flanks of the Cardiff and Faraday Domes. The altered host rocks for this type of uranium mineralization are as follows: 1) phlogopite-diopside marble that has been locally enriched in apatite (1-10%), fluorite-bearing, ferromagnesian silicates, fluorite, molybdenite, and iron sulphides; and 2) potash metasomatized and scapolitized, pyroxene-rich metasediments containing disseminated apatite, molybdenite, and iron sulphides. Type III uranium mineralization is represented by the following deposits: 1) Rare Earth Resources Limited (Pyroxenite Zone Occurrence, No. 32); 2) McLean - Hogan Occurrence (No. 25); and 3) Silver Crater Mines Limited (Baldmour - Campbell Occurrence, No. 36).

Regional Geological Setting and Controls on Uranium Deposits

The map area (No. 3, Figure 2) straddles the northern part of the Bancroft Uranium Belt. This zone of uranium mineralization coincides with: (1) the 80 km long, 25 km wide, northeasterly trending Harvey-Cardiff Basement Arch; and (2) in part, the distribution of the alkalic gneisses of the Haliburton-Bancroft Nepheline Syenite Belt along this arch.

Within and adjacent to the map area, most of the pegmatite-hosted uranium deposits (Type I) as well as Types II and III mineralization occur either in these alkalic gneisses or in the adjacent mafic mineral-rich country rocks of the lower Mayo Group along the flanks of the various domes within this arch. The pegmatites which host the Type I mineralization are equally abundant in the feldspathic meta-arenites of the Anstruther Lake Group and the marble-rich upper part of the Mayo Group along the flanks of the domes in the map area. However, syenite gneisses and mafic mineral-rich country rocks are uncommon in both these parts of the Supergroup and no economically important pegmatite-hosted uranium deposits have been found in them.

To the south of the map area in the Eels Lake and Burleigh Falls areas (Nos. 2 and 4 respectively, Figure 2), pegmatite-hosted uranium deposits also occur along the Harvey-Cardiff Basement Arch in the central and southern part of the Bancroft Uranium Belt. However, here these deposits are concentrated in the mafic mineral-rich clastic metasediments and the abundant mafic to felsic metavolcanics of the Hermon Group (Bright, 1980a). Alkalic gneisses in this part of the arch, although much less abundant than in the Center Lake area, occur locally intercalated with both units in the vicinity of several of the more economically important deposits of Type I mineralization (Bright, 1980a). Since the author has concluded that parts of the upper Hermon Group to the south of the map area are litho-stratigraphically equivalent to the mafic mineral-rich meta-sediments of the lower Mayo Group in the map area, there appears to be a regional stratigraphic control on the pegmatite-hosted uranium deposits within the Harvey-Cardiff Basement Arch. However because alkalic gneiss are much less abundant in the central and southern parts of the arch, Type II and III uranium deposits are scarce or absent in this part of the Bancroft-Uranium Belt.

Another regional control on the more important pegmatite-hosted uranium deposit is the regional metamorphic grade. Along and to the west of the Harvey-Cardiff Basement Arch (shown in Figure 3), all the rocks within the Central Metasedimentary Belt (CMB), were subjected to upper almandine-amphibolite facies metamorphism prior to the emplacement of the late tectonic pegmatite dikes. In this high-grade region of the CMB, these pegmatite dikes are biquitous, however they are most abundant within the arch and, in places, form swarms in the favourable country rock, mafic mineral-rich strata of the Hermon and lower Mayo Groups as well as the intercalated alkalic gneisses. East of the arch, the favorable country rocks of the Supergroup are still present, however there is a progressive decrease eastward towards Madoc (see Figures 3), in the regional metamorphic grade and the abundance of pegmatites. To the east of the map area, in this eastern, medium- to low-grade region of the CMB, pegmatite-hosted uranium deposits (Type I) are uncommon, alkalic rocks are rare and Type II and III uranium deposits are absent.

Local Structural Controls on Uranium Deposits

Within the arch, existing structures in the domed and deformed country rock controlled the emplacement of the carbonate veins and younger, more abundant late tectonic pegmatitic granite dikes, and dike swarms. In general these carbonate veins and granite pegmatite dikes parallel the layering as well as the trend of major and minor fold patterns in the enclosing country rock. Locally carbonate veins and pegmatite dikes cross cut the smaller scale fabric and structures in the country rock.

Late tectonic faulting, shearing and in places cataclasis has affected all three types of uranium deposits. Late stage uranium remobilization and enrichment during shearing and cataclasis has been one of the major ore-forming processes in the productive pegmatite-hosted uranium deposits (Type I).

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Table 1: Table of Lithologic Units in The Center Lake Area

PHANEROZOIC

CENOZOIC

QUATERNARY

Glaciofluvial deposits of sand, silt, gravel and boulders; locally glaciofluvial-glaciolacustrine silt and sandy clay; minor recent swamp, bog, peat and fluvial gravel, silt and muddy sediments.

UNCONFORMITY

PRECAMBRIAN

MIDDLE PROTEROZOIC

LATE TECTONIC TO POST-TECTONIC INTRUSIVE ROCKS

LATE PEGMATITIC GRANITE DIKES[a]

Massive, granite, pegmatitic granite, granite pegmatite; locally granitic to syenitic hybrid phases; sheared and cataclastic pegmatitic granite

INTRUSIVE CONTACT

URANIUM- AND RARE EARTH-BEARING CARBONATE VEINS

Apatite-fluorite-calcite veins ± uraninite, thorite, uranothorite minor fluorite-calcite feldspar veins and allanite-bearing pyroxene-feldspar veins; apatite-biotite-calcite veins, lenses ± betafite, thorite

INTRUSIVE CONTACT

METAMORPHOSED MAFIC TO ULTRAMAFIC INTRUSIVE ROCKS[a]

Hornblende pyroxenite, porphyritic hornblende-pyroxenite, hornblendite; diorite, hornblende-rich diorite, plagioclase-and pyroxene-bearing hornblendite, apatite-rich hornblendite; mafic dikes

INTRUSIVE CONTACT

METAMORPHOSED FELSIC INTRUSIVE ROCKS

Granite

INTRUSIVE CONTACT

METAMORPHOSED INTERMEDIATE INTRUSIVE ROCKS

Hornblende-biotite granodiorite; locally tonalite

INTRUSIVE CONTACT

METAMORPHOSED ALKALIC INTRUSIVE ROCKS

POTASSIC SYENITE

Biotite syenite, biotite-hornblende syenite, hornblende syenite; hornblende-rich syenitic gneiss containing thin intercalated units of metasomatized epiclastic metasediments

INTRUSIVE CONTACT

NEPHELINE SYENITE

Biotite-nepheline syenite, muscovite-biotite nepheline syenite, biotite-hornblende-nepheline syenite; potash metasomatized hornblende-nepheline syenite; scapolite-bearing

nepheline gneiss

INTRUSIVE CONTACT

ALKALIC MAFIC INTRUSIVE ROCKS

Metagabbro, hornblende-plagioclase gneiss, scapolitized hornblende-plagioclase gneiss.

INTRUSIVE CONTACT

METASEDIMENTARY ROCKS (GRENVILLE SUPERGROUP)[b]

CHEMICAL METASEDIMENTARY ROCKS

CARBONATE METASEDIMENTS

Siliceous calcitic and dolomitic marble; siliceous marble containing thin interbedded units of feldspathic meta-arenite, meta-quartz-arenite, amphibole- and pyroxene-rich metasediments and metawacke;minor polymictic pebble metaconglomerate with carbonate matrix, marble tectonites

EPICLASTIC METASEDIMENTARY ROCKS

AMPHIBOLE-RICH METASEDIMENTS[d]

(Calcareous metawacke, metamudstone)

Hornblende-plagioclase gneiss, amphibolite; calcsilicate gneiss; polymictic pebble meta-conglomerate; scapolitized amphibolite

PYROXENE-RICH METASEDIMENTARY ROCKS[d]

(Dolomitic Metamudstones)

Biotite-pyroxene gneiss and schist; phlogopite-tremolite-diopside gneiss

QUARTZOSE METASEDIMENTS

Metaquartzarenite feldspathic metaquartzarenite metaquartz-arenite containing thinly inter-bedded units of marble, feldspathic meta-arenite, amphibolite

BIOTITE-RICH METASEDIMENTS[d]

(Metawacke, Metamudstone)

Biotite-quartz-plagioclase gneiss; biotite-hornblende-quartz-plagioclase gneiss;

biotite schist, garnet-biotite schist and sillimanite-biotite-quartz-feldspar gneiss; migmatitic biotite gneiss; cataclastic biotite gneiss

FELDSPATHIC ARENACEOUS METASEDIMENTS[d]
(Feldspathic Meta-Arenite)

Biotite-quartz-feldspar gneiss with <10 percent biotite; quartz-rich feldspathic meta-arenite; polymictic pebble meta-conglomerate; migmatitic quartzo-feldspathic gneiss; cataclastic quartzofeldspathic gneiss

Notes:

(a) Intrusive rocks emplaced at several stages

(b) Rocks of the Grenville Supergroup are subdivided lithologically and the order does not imply age relationships

(c) Some of the rocks coded 5a and 5b may be mafic to intermediate metavolcanics, in particular some units between Colbourne and Cope Lakes

(d) The metamorphic convention is used in naming some of these subunits with the least plentiful mineral placed first, i.e. hornblende-biotite-quartz-feldspar gneiss

(OFR LEGEND)

CENTER LAKE AREA

HALIBURTON AND HASTINGS COUNTIES

Scale 1:15 840 or 1 inch to 1/4 mile

PHANEROZOIC

CENOZOIC

QUATERNARY

PLEISTOCENE AND RECENT[a]

Glaciofluvial deposits of sand, silt, gravel and boulders; locally glacio-fluvial-glaciolacustrine silt and sandy clay; minor recent swamps, bog, peat and fluvial gravel, silt and muddy sediments

UNCONFORMITY

PRECAMBRIAN

MIDDLE PROTEROZOIC

LATE TECTONIC TO POST-TECTONIC INTRUSIVE ROCKS

LATE PEGMATITIC GRANITE DIKES[b]

14a Massive, granite, pegmatitic granite, granite pegmatite; locally granitic to syenitic hybrid phases containing variable amounts of biotite, hornblende, pyroxene, magnetite

14b Sheared and cataclastic pegmatitic granite

INTRUSIVE CONTACT

URANIUM-AND RARE EARTH-BEARING CARBONATE VEINS

13a Apatite-fluorite-calcite veins ± uraninite, thorite, uranothorite, rare earth-bearing minerals; minor fluorite-calcite feldspar veins and allanite-bearing pyroxene-feldspar veins

13b Apatite-biotite-calcite veins, lenses ± betafite, thorite

INTRUSIVE CONTACT

METAMORPHOSED MAFIC TO ULTRAMAFIC INTRUSIVE ROCKS[b]

12a Hornblende pyroxenite, porphyritic hornblende pyroxenite, hornblendite

12b Diorite, hornblende-rich diorite, plagioclase-and pyroxene-bearing hornblendite, apatite-rich hornblendite

12c Fine- to medium-grained mafic dikes

INTRUSIVE CONTACT

METAMORPHOSED FELSIC INTRUSIVE ROCKS

GRANITE

11 Massive, lineated and locally foliated, leucocratic granite, biotite granite

INTRUSIVE CONTACT

METAMORPHOSED INTERMEDIATE INTRUSIVE ROCKS

GRANODIORITE

10a Foliated, in places layered hornblende-biotite granodiorite, biotite-hornblende granodiorite; locally minor tonalite

10b Banded gneissic, augen textured gneissic granodiorite, locally minor tonalite

INTRUSIVE CONTACT

METAMORPHOSED ALKALIC INTRUSIVE ROCKS

POTASSIC SYENITE

9a Foliated biotite syenite

9b Foliated, in places layered biotite-hornblende syenite, hornblende syenite

9c Unit 9b containing discontinuously interlayered minor units of hornblende-rich syenitic gneiss

9d Units 9b, 9c containing numerous thinly intercalated units of metasomatized epiclastic metasediments (units 1, 2, 4, and 5)

INTRUSIVE CONTACT

NEPHELINE SYENITE

8a Massive to foliated, biotitenephéline syenite

8b Foliated to layered, biotite nepheline syenite, muscovite-biotite nepheline syenite, biotite-hornblende nepheline syenite; potash metasomatized hornblende-nepheline syenite

8c Foliated to layered scapolite-bearing nepheline gneiss

INTRUSIVE CONTACT

ALKALIC MAFIC INTRUSIVE ROCKS

7a Massive to foliated metagabbro, locally exhibiting relict igneous textures and compositional layering

7b Hornblende-plagioclase gneiss

7c Scapolitized hornblende-plagioclase gneiss

INTRUSIVE CONTACT

METASEDIMENTARY ROCKS (GRENVILLE SUPERGROUP)[c]

CHEMICAL METASEDIMENTARY ROCKS

CARBONATE METASEDIMENTS

6a Calcitic and dolomitic marble containing variable amounts of diopside, phlogopite, graphite, chondrodite, tremolite, actinolite, biotite, hornblende, quartz, feldspar

6b Diopside-bearing marble

6c Phlogopite-bearing marble

6d Graphite-bearing marble

6e Chondrodite-bearing marble

6f Tremolite-actinolite-bearing marble

6g Siliceous marble (units 6a-f) containing thin interbedded units of feldspathic meta-arenite (unit 1a), and metaquartzarenite (unit 3a); locally metawacke and meta-mudstone (units 2a and 2c)

6h Siliceous marble (units 6a-f) containing thin interbedded units of amphibole and pyroxene-rich metasediments (units 5 and 4)

6i Polymictic pebble meta-conglomerate with carbonate matrix

6j Marble tectonic breccia; locally fine-grained cataclastic marble without exotic clasts

EPICLASTIC METASEDIMENTARY ROCKS

AMPHIBOLE-RICH METASEDIMENTSde

(Calcareous metawacke, metamudstone)

5a Hornblende-plagioclase gneiss ±

biotite, garnet

5b Fine to medium-grained amphibolite, biotite amphibolite

5c Calcsilicate gneiss; a massive to layered, granoblastic rock containing variable amounts of diopside, plagioclase and hornblende with subordinate biotite, calcite, quartz epidote, garnet and titanite

5d Polymictic pebble-meta-conglomerate with a biotite-hornblende-plagioclase matrix

5a Scapolitized amphibolite

PYROXENE-RICH METASEDIMENTSe

(Dolomitic metamudstone)

4a Biotite-diopside gneiss and schist ± plagioclase, hornblende, tremolite

4b Phlogopite-tremolite-diopside gneiss

QUARTZOSE METASEDIMENTS

3a Metaquartzarenite feldspathic metaquartzarenite containing variable amounts of diopside, biotite, feldspar, amphibole, calcite, minor phlogopite

3b Thinly interbedded units of meta-quartzarenite (unit 3a), siliceous marble (unit 6), feldspathic meta-arenite (unit 1) and locally amphibole-rich meta-sediments (unit 5)

BIOTITE-RICH METASEDIMENTS[e]

(Metawacke, Metamudstone)

2a Biotite-quartz-plagioclase gneiss with 10 to 30 percent biotite * hornblende

2b Biotite-hornblende-quartz-plagio-clase gneiss with 2 to 10% hornblende

2c Biotite schist, garnet-biotite schist

2d Sillimanite-biotite schist, sillimanite-biotite-quartz-feldspar gneiss * garnet (aluminous metamudstones)

2e Migmatitic biotite gneiss after unit 2a containing <10 percent granitoid leucosome layers

2f Cataclastic biotite gneiss after unit 2a

FELDSPATHIC ARENACEOUS METASEDIMENTSs

(Feldspathic Meta-Arenite)

1a Biotite-quartz-feldspar gneiss with <10 percent biotite

1b Quartz-rich, feldspathic meta-arenite

1c Matrix-to clast-supported polymictic pebble meta-conglomerate interbeds in feldspathic meta-arenite

1d Migmatitic quartzofeldspathic gneiss after unit 1a containing <10% granitoid leucosome layers

1e Cataclastic quartzofeldspathic gneiss after unit 1a

Notes:

(a) Not shown on map.

(b) Intrusive rocks emplaced during several stages

(c) Rocks of the Grenville Supergroup are subdivided lithologically and the order does not imply age relationships

(d) Some of the rocks coded 5a and 5b, may be mafic to intermediate metavolcanics, in particular some units between Colbourne and Cope Lakes

(e) The metamorphc convention is used in naming some of the subunits with the least plentiful mineral placed first, i.e. hornblende-biotite-quartz-feldspar gneiss. The term gneiss as used here refer to a medium-to high grade metamorphic rock and does not imply that the rock has a layered fabric.

ADDENDUM

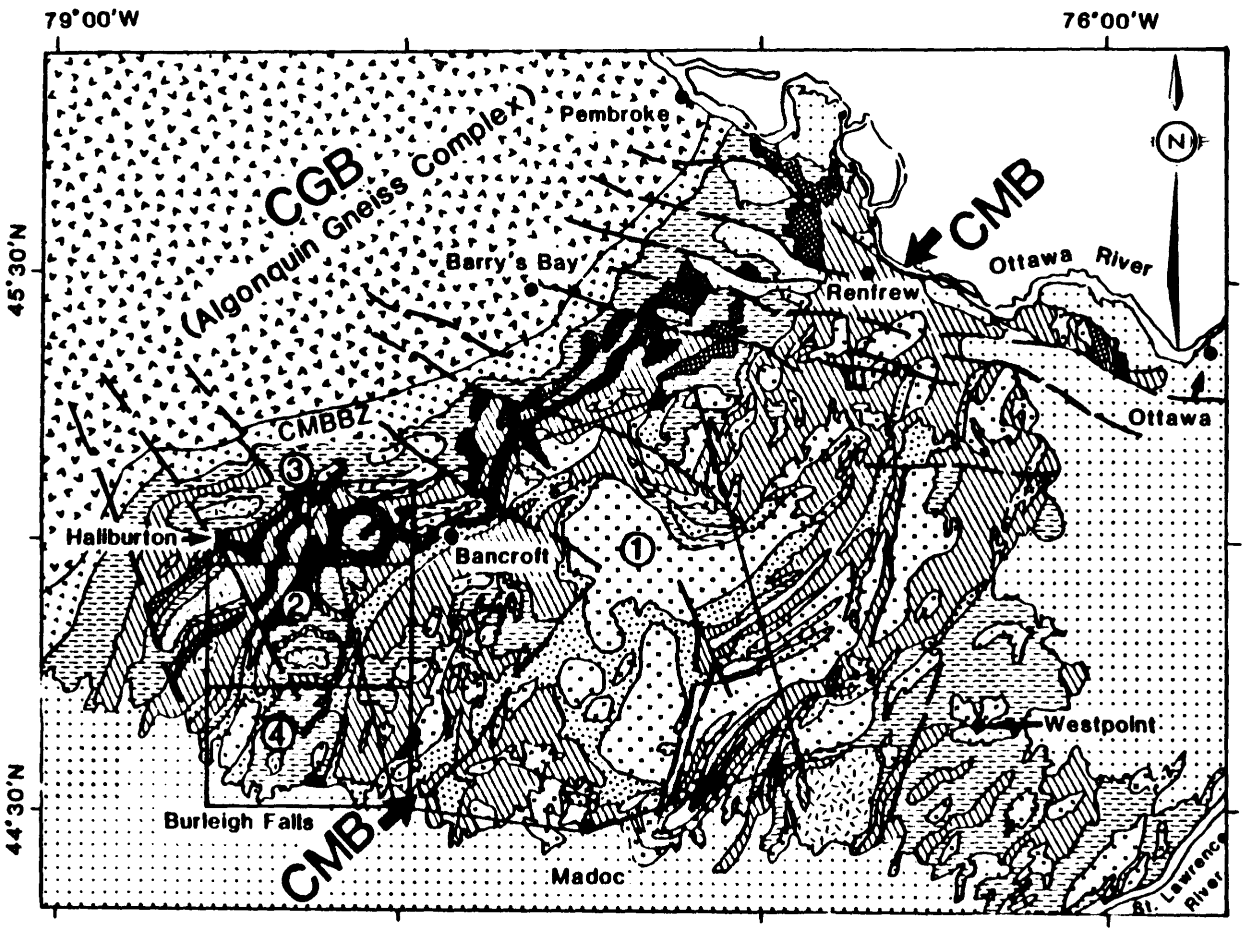
LEGEND REVISIONS

Some of the rock codes used in this Open File Geological Report, specifically units 11 to 14, differ from those used for the equivalent lithologies on the published preliminary maps for the Center Lake area (Maps P. 2597 and P. 2598 in back pocket).

Open File Report/New Code	Prel. Map /Former Code
Unit 14a	Units 13a - b
Unit 14b	Unit 13c
Unit 13	Unit 14
Unit 12a-b	Unit 11a
Unit 12c	Unit 15
Unit 11	Units 12a-b

ERA	Age m.y.	-	HARVEY-CARDIFF ARCH REGION: CENTER LAKE AREA Group	CENTER LAKE AREA Subunit	CENTER LAKE AREA Major Lithology	EELS LAKE AREA Group	EELS LAKE AREA Subunit	EELS LAKE AREA Major Lithology	EASTERN HASTINGS BASIN REGION: BANCROFT - MADOC AREA Group	BANCROFT - MADOC AREA Subunit	BANCROFT - MADOC AREA Major Lithology
MIDDLE PROTEROZOIC	ca1125		Late Felsic and Mafic Intrusive Rocks								
			FLINTON GROUP	Not Present		Flinton Group	Not Present		FLINTON GROUP	Stewart Formation	Metaconglomerate, marble, metapelite
										Madoc Formation	Metapelite; minor metaconglomerate
										Skootamatta Formation	Metaconglomerate, calcareous metapelite
	ca1200		Early Mafic, Alkalic Intrusive Rocks; Early Sodic to Potassic Granitic Intrusive Rocks								
		GRENVILLE SUPERGROUP	MAYO GROUP	Apsley Formation	Not Present	MAYO GROUP	Apsley Formation	Metawacke, feldspathic meta-arenite	MAYO GROUP	Apsley Formation	Not Present
				Dungannon Formation	Marble, minor epiclastic metasediments		Paudash Formation	feldspathic meta-arenite, meta-quartzarenite		Dungannon Formation	Marble; minor epiclastic metasediments
							Dungannon Formation	Marble; minor epiclastic metasediments			
				Esson formation	Marble, meta-quartzarenite, para-amphibolite; minor metawacke, feldspathic meta-arenite	HERMON GROUP (East Facies)	Eels Lake Formation	Amphibole-poor metasediments, para-amphibolite; minor mafic metavolcanics	HERMON GROUP	Burnt Lake Formation	Felsic metavolcanics; minor marble, metawacke
							Cardiff-Anstruther and Cavendish-Harvey metavolcanics	Mafic to intermediate metavolcanics; minor intermediate to felsic metavolcanics		Turriff Formation	Mafic metavolcanics; minor meta-ironstone
				Lower epiclastic-chemical metasedimentary sequence	Metawacke, para-amphibolite, calc-silicate gneiss, marble, aluminous metapelite		Silent Lake Formation	Metawacke, feldspathic meta-arenite; minor para-amphibolite		Vansickle Formation	Metawacke, marble; minor metavolcanics and meta-arenite
										Oak Lake Formation	Felsic metavolcanics; minor marble, meta-arenite
			HERMON GROUP	NOT PRESENT			Monmouth Formation	Marble; minor epiclastic metasediments		Tudor Formation	Mafic metavolcanics; minor felsic metavolcanics and meta-irontone
							Catchacoma Formation	Metawacke, feldspathic meta-arenite			
	ca1300		ANSTRUTHER LAKE GROUP	Unsubdivided	Foliated, in places migmatitic feldspathic, meta-arenite, metawacke; minor para-amphibolite	ANSTRUTHER LAKE GROUP	Unsubdivided	Foliated, in places migmatitic feldspathic, meta-arenite, metawacke; minor para-amphibolite	ANSTRUTHER LAKE GROUP	Not Present	
			Unconformity								
			UNEXPOSED BASEMENT COMPLEX			BASEMENT MIGMATITE-GNEISS COMPLEX			UNKNOWN		

Table 2: Lithostratigraphic subdivisions for the Grenville Supergroup in the Center Lake and Eels Lake areas of the Harvey-Cardiff Arch Region (after Bright 1977, 1980, 1983a,b) and the Bancroft-Madoc area of the East Hastings Basin Region (after Lumbers 1967b, 1969; Moore and Thompson 1980).



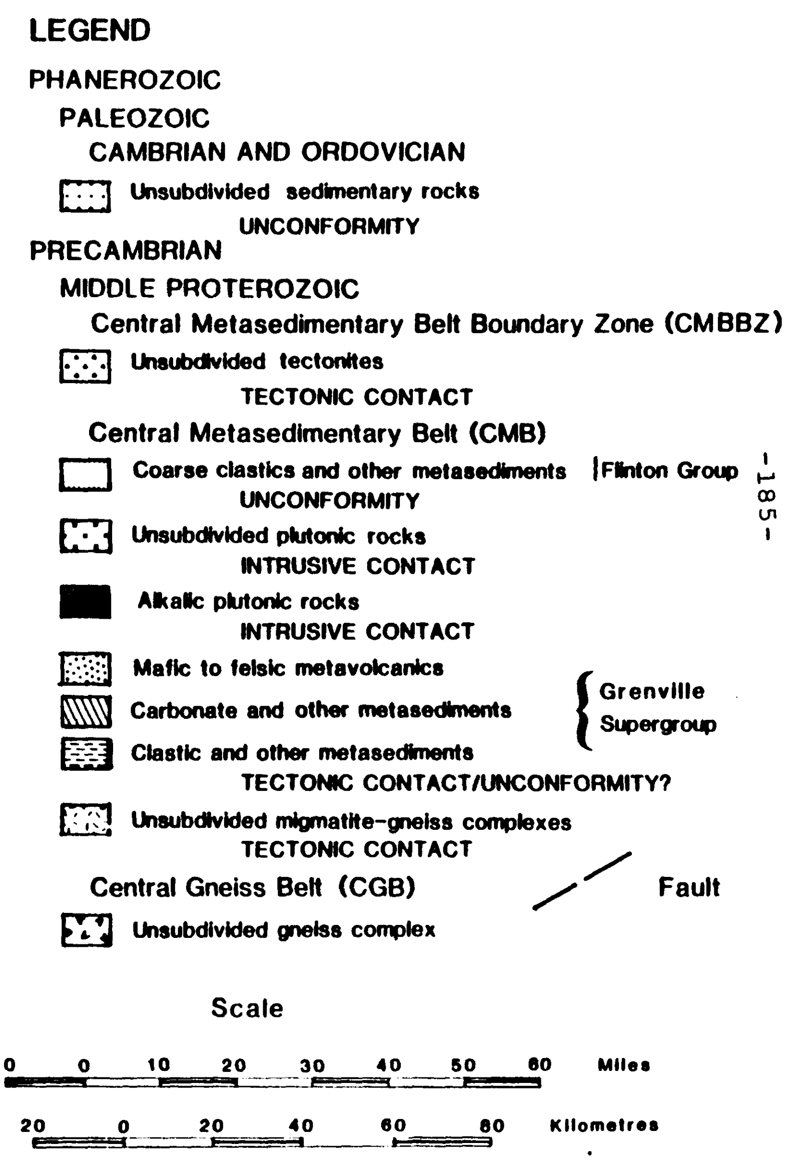


Figure 2: Regional geology (modified after Lumbers 1978) of the Southeastern Grenville Province; numbered areas are location of regional structural and stratigraphic study areas: (1) Bancroft-Madoc Area (Lumbers 1967a,b); (2) Eels Lake Area (Bright 1979, 1980); (3) Center Lake Area (Bright 1983); and (4) Burleigh Falls Area (~~this report~~ IN PRESS) ....

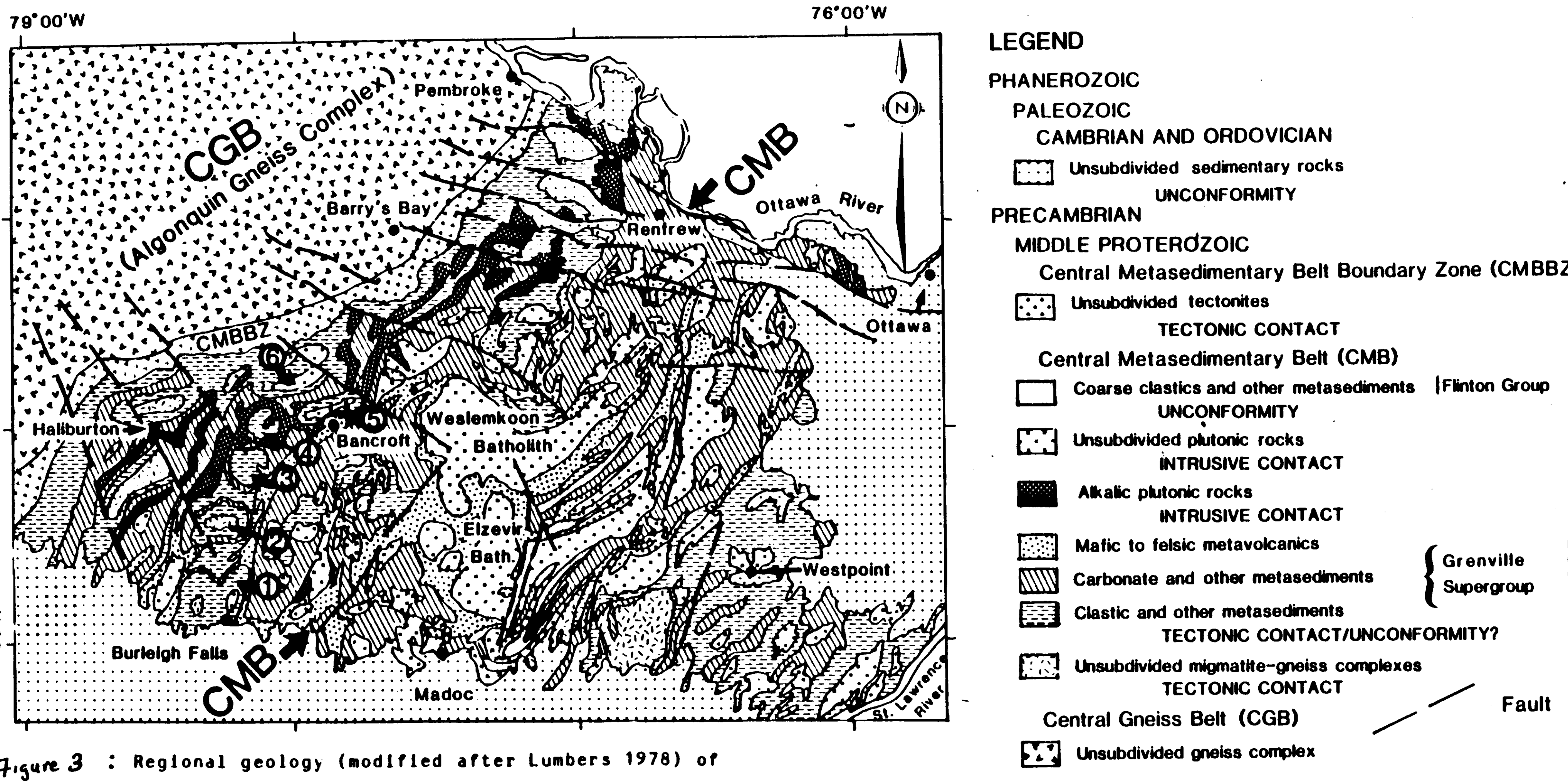


Figure 3 : Regional geology (modified after Lumbers 1978) of the Southeastern Grenville Province; numbered structural features along the Harvey-Cardiff Basement Arch include: (1) Burleigh Dome; (2) Anstruther Dome; (3) Cheddar Dome; (4) Cardiff Dome; and (5) Faraday Dome; (6) Elephant Lake Pluton

Center Lake Area Report