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GEOLOGY OF HYDE LAKE MAP AREA, DISTRICT OF KEEWATIN, N.W.T.

J.A. FRASER

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GEOLOGY OF HYDE LAKE AREA, DISTRICT OF KEEWATIN

Abstract

The map area is situated in the extreme southeast corner of the District of Keewatin in the Churchill Structural Province. It is extensively drift covered. An early hypersthene granulite complex, consisting of granitoids and subordinate metasediments which were metamorphosed and uplifted in Archean time, occupies the southwestern regions. Elsewhere, Archean metabasaltic to metadacitic flows, pyroclastics, and associated meta-argillite, metagreywacke, iron formation, and calc-silicate rocks have been folded around southeasterly and southwesterly plunging axes, intruded and partly coverted to migmatite by Archean granodiorite and Aphebian(?) granite. Isolated remnants of Aphebian (Hurwitz Group) orthoquartzite, meta-argillite and interbedded carbonate strata, which overlie Archean rocks unconformably, have been folded around southwesterly plunging axes and intruded by late Aphebian granite and pegmatite. Metamorphism, probably mainly related to plutonism, has reached upper amphibolite grade in Archean supracrustal rocks and lower amphibolite grade in Aphebian rocks. Metamorphic pressures were low to moderate. Evidence of a late, low temperature retrograde metamorphism and a late cataclasis is widespread.

Résumé

Le secteur de Hyde Lake est situé dans l'extrémité sud-est du district de Keewatin dans la province structurale de Churchill. Ce secteur est largement couvert de dépôts glaciaires. Un complexe de granulites à hypersthène de base, constitué de roches granitoïdes et de quelques roches métasédimentaires métamorphisées et soulevées pendant l'Archéen, occupe le sud-ouest. Ailleurs, des coulées métabasaltiques à métadacitiques, des roches pyroclastiques et quelques méta-argillites, quelques métagrauwackes et quelques formations de fer et calco-silicates ont été plissés au voisinage d'axes plongeant vers le sud-est et le sud-ouest et ont été pénétrés et transformés en migmatites par des intrusions granodioritiques archéennes et granitiques aphébiennes (?). Quelques restes isolés d'orthoquartzites, de méta-argillites et de couches carbonatées interstratifiées de l'Aphébien (groupe de Hurwitz) qui recouvrent en discordance des roches de l'Archéen, ont été plissés le long d'axes plongeant vers le sud-ouest, et ont été pénétrés par des intrusions granitiques et pegmatitiques de l'Aphébien supérieur. Un métamorphisme, très probablement lié à un plutonisme, a atteint le faciès amphibolite supérieur dans les roches supracrustales de l'Archéen et le faciès amphibolite inférieur dans les roches de l'Aphébien. Les pressions lors du métamorphisme variaient de faibles à moyennes. Des indices d'un rétrométamorphisme à basse température et d'une cataclase tardive sont répandus.

INTRODUCTION

The map area is situated in the extreme southeastern corner of the District of Keewatin. It extends from latitude 60°N northward to 61°30'N. It extends westward from Hudson Bay to longitude 96°W north of latitude 61°N, and to about longitude 96°45'W south of latitude 61°N. Hyde Lake, in the central part of the area, is 220 km by air from Churchill, Manitoba, the nearest convenient supply base.

The topography mainly comprises a coastal plain formed by postglacial marine submergence. Within 10 to 20 km of Hudson Bay this plain is a low, flat, marshland, but the land rises gently westward, attaining an elevation of about 200 m at the western boundary of the area. Relief is nearly everywhere less than 30 m and in most places is less than 15 m. Bedrock exposures are abundant only in the southwest quarter of the area. Drift cover is particularly widespread north and northeast of Hyde Lake, between Thuchonilini and Thaolintoa lakes, northwest of Camp Lake, and east of Maguse Lake. Except for small scattered outcrops, present near the coast, bedrock is rare in the coastal marshland as far north as Eskimo Point.

Glacial features south of latitude 61°N, including boulder fields and washboard moraines, striated bedrock surfaces and roches moutonnées, indicate a southeasterly flow of ice; north of 61°N, striated surfaces are rare but numerous drumlinoid ridges indicate an easterly flow. Throughout the area the original trends and forms of eskers have been modified by the marine submergence. Most of the area is barren of trees but the land north of Thaolintoa Lake and that bordering Tha-Anne and Thlewiaza rivers in the vicinity of Thuchonilini Lake is thinly forested by spruce.

The bedrock geology of southern District of Keewatin, including the Hyde Lake map area, was mapped on a reconnaissance scale by Lord (1953), further described by Wright (1967), and the glacial features and history reviewed by Lee (1959). Metamorphism in southern District of Keewatin has been summarized by Eade (1978). Areas adjacent to the Hyde Lake area have also been investigated by Davison (1966, 1968), Davidson (1970), Bell (1971), and by Eade (1973). Geological maps at a scale of 1:250 000 are available for each of these areas. Aeromagnetic maps published by the GSC cover the entire region at scales of 1:63 360 and 1:253 440 or 1:250 000.

Present field operations began on 9 July, 1978, after breakup of lake ice from a base camp on "Jekyll Lake" at 60°46'N, 95°30'W where float-equipped DeHavilland twin Otter aircraft could be safely landed and beached. Parallel traverses, spaced at 4 km (2.5 mile) intervals were run north and south using a helicopter, and diversions were made as required to visit outcrops not situated on traverse lines. About 300 outcrops were examined in this way. Field operations were completed on 22 August.

I am very much indebted to K.E. Eade of the GSC for the planning and organization of this project and for carrying out many of the geological traverses. His intimate knowledge of the geology of southern District of Keewatin proved invaluable to the understanding of geological relationships in the Hyde Lake area. Responsibility for interpretations expressed in this report, however, is my own. C. Cunningham kindly provided unpublished data from her terrain studies in this region, which were useful in the planning of the project. It is a pleasure also to acknowledge the services of student assistants G.S. Chomacki and P.T. Drew, and our cook, J.S. Burnford. Traverses were made in a Bell 47G3B1 helicopter piloted by M.R. Cowbrough and maintained by H.L. Trevelyan.

GENERAL GEOLOGY

Hyde Lake map area lies entirely within the Churchill Structural Province of the Canadian Shield. The oldest rocks, comprising hypersthene-bearing granulites of early Archean age, are succeeded unconformably by basic to intermediate metavolcanics and associated metasediments. All these rocks have been intruded by granodiorite[1] of assumed late Archean age. Aphebian metasediments with intercalated metagabbroic sills overlie Archean formations unconformably. Granite and syenite of probable late Aphebian age intrude the Aphebian metasediments and older rocks. These relationships are summarized in the accompanying Table of Formations.

Hypersthene Granulite (Unit 1)

Hypersthene-bearing rocks underlie a large region in the southwestern part of the map area that reaches north to latitude 60°15'N and east beyond Geillini Lake. They are contiguous with the granulites of the Edehon Lake map area to the west (Eade, 1973) and of the Caribou River and Nejanilini Lake map areas (Davison, 1966, 1968) to the south. The granulites are fairly well exposed in flat pavement and broad, dome-shaped outcrops bounded by smooth surfaces, and intersected by widely spaced, irregular joints. The magnetic expression is not uniform. Although magnetic relief and maximum intensity are fairly constant throughout, the pattern in the east is appreciably more detailed.

The granulites comprise three distinct lithologies. The dominant lithology is a medium- to coarse-grained granite to granodiorite (unit 1a). Within the granitic rocks are inclusions of fine- to medium-grained, mafic-rich rocks, probably of sedimentary origin (unit 1b), which range from less than a metre to several metres in diameter. Of rarer occurrence and more common in the eastern granulite terraine are bodies of hypersthene-gabbro gneiss (unit 1c) which are probably derived from mafic dykes or sills. The fresh surfaces of all three types display the waxy brown to green characteristic of granulites. They differ principally in colour of weathered surfaces, degree of foliation, grain size, and mafic mineral content.

Hypersthene-bearing granitic rocks (unit 1a) range in composition from granite to granodiorite, but quartz monzonite is most abundant. They weather brownish or reddish brown, commonly with a white surface mottling, and are massive to weakly foliated. A typical granulite consists of about 30 per cent black or smoky quartz, 35 per cent perthitic K-feldspar, 30 per cent antiperthitic oligoclase or andesine, up to 2 per cent hypersthene, and 5 per cent mafic minerals, including reddish brown biotite. Accessory minerals are hornblende, zircon, apatite, and rarely, garnet. Alteration of mafic minerals to chlorite and serpentine is widespread but is particularly evident in granulite west of Boundary Lake.

The hypersthene-bearing paragneiss (unit 1b) is dull grey weathering and finely laminated, with a composition that approaches that of granodiorite. Mafic minerals, comprising hypersthene, biotite, hornblende, and rare clinopyroxene or garnet, constitute as much as 15 per cent of the rock. Hypersthene-bearing gabbro gneiss (unit 1c) weathers black to pale grey and is typically well foliated or layered. The gneiss consists of about 60 per cent labradorite or andesine and up to 40 per cent combined hypersthene, hornblende, and clinopyroxene, with minor biotite, apatite, and opaque minerals.

In many localities, and particularly near the eastern margin of the granulite terrane, the granulite is intruded and partly assimilated by granodiorite, pink granite and pegmatite (unit 1d), and is cut by quartz veins.

Major contacts between granulite (unit 1) and younger rocks were not observed. The pronounced contrast in lithology and metamorphic grade between the granulite and neighbouring rock units, however, implies that the contact is, in part at least, tectonic and that the granulite is significantly older. Recent dating of zircons from granulites in this region suggests that they may be at least 3000 Ma old (K.E. Eade, personal communication).

The preservation, in granulite terrane northwest of Boundary Lake, of metasediments (unit 3) of lower metamorphic grade, is interpreted as evidence for uplift and erosion of the granulite basement prior to deposition. The age of the metasediments is uncertain. If they are Archean in age, as inferred, the uplift must have taken place in Archean time. If, however, the metasediments were derived from Hurwitz Group (unit 6-8) rocks, a possibility that cannot be entirely discounted from the evidence available, the uplift could have been as late as Aphebian.

Metavolcanic Rocks (Unit 2)

Metavolcanic rocks and intercalated metasediments are widely exposed in the Camp Lake region. In the central parts of the map area they occur in long sinuous belts, commonly only a few kilometres wide. Outcrops may be massive, or more commonly, ridges composed of frost-heaved blocks bounded by steeply dipping foliation surfaces. The degree of exposure is generally poor, but correlation of high magnetic anomalies shown on aeromagnetic maps with the metavolcanic belts allows reliable projection of contacts far beyond outcrop localities.

The dominant rock type in map unit 2 is a massive to pillowed, locally vesicular, dark green to black weathering, dark grey fine to very fine-grained metabasalt (unit 2a). Pillows are 30 to 60 cm long and where sheared may be more than 100 cm long. Pillowed flows are commonly intercalated with thinly layered or laminated metabasalt in which individual layers are not more than a few centimetres thick. Pillowed metabasalt that occurs 3 km west of Camp Lake consists of about 10 per cent quartz, 60 per cent andesine, 15 per cent hornblende, 15 per cent epidote, and traces of sphene and magnetite. The metabasalts show considerable

[1]Igneous nomenclature used in this report follows the classification of Brown (1952).

TABLE OF FORMATIONS

Age	Group	Map Unit	Lithology
Aphebian		11	Granite, quartz monzonite, pegmatite
		10	Monzonite, syenite
	Intrusive contact		
		9	Metagabbro
	Intrusive contact		
	Hurwitz Group	7	Shale, slate, siltstone, argillite, meta-argillite; interbedded limestone, calc-silicate rocks
		6	Orthoquartzite
	Unconformity		
Archean		5	Granodiorite, quartz monzonite
	Intrusive contact		
		3	Metasiltstone, metagreywacke, feldspathic quartzite, iron formation, pelitic schist and gneiss, calc-silicate rocks
		2	Metabasalt to metadacite, tuff, agglomerate, hornblende gneiss, amphibolite; minor intercalated meta-argillite, metagreywacke, iron-formation, calc-silicate rocks
	Unconformity(?)		
		1	Hypersthene-bearing quartz monzonite, granodiorite, granite; hypersthene paragneiss; hypersthene gabbro gneiss

variation, however, in the proportions of essential minerals. Quartz, for example, may constitute only a few per cent of the rock and hornblende may exceed 50 per cent. In some of the rocks the plagioclase is labradorite.

Metavolcanic rocks of andesitic to dacitic composition (unit 2b) are less abundant than the metabasalts (unit 2a). They appear to be most common in the Camp Lake region but are also found in the smaller volcanic belts that occur north of Ranger Seal Lake and in the large belt northeast of Hyde Lake. The flows are pale green to grey and fine- to medium-grained, massive, pillowed, fragmental, and rarely, porphyritic, and typically contain about 25 per cent quartz, 50 per cent andesine, 25 per cent hornblende, with accessory apatite, sphene, carbonate, and opaque minerals.

Deposits of agglomerate and tuff (unit 2d) are spatially associated with the flows in some localities and particularly with flows of intermediate composition (unit 2b). Agglomerate that occurs 13 km west of Camp Lake, considered representative of such deposits, is composed of irregular to rounded green to pale green, very fine grained ejecta from 15 to 30 cm in diameter, set in a matrix of pale grey to dark grey, fine- to coarse-grained amphibolite that is probably a recrystallized tuff. The agglomerate consists of about 30 per cent quartz, 30 per cent labradorite, 30 per cent hornblende, and 10 per cent clinopyroxene, with accessory sphene, apatite, carbonate, and opaque minerals.

Also intercalated with the flows are beds of quartz-magnetite iron formation, meta-argillite, metagreywacke, and calc-silicate rock which range in thickness from a few centimetres to more than a metre. Although only a relatively small number of such beds have been observed, the high magnetic anomalies associated with the metavolcanic belts suggest that iron formation and perhaps also the other metasediments are abundant and widely distributed.

The iron formation is a grey to black, fine- to very fine-grained laminated rock composed of 20 to 80 per cent quartz, about 10 per cent magnetite, and various amounts of plagioclase, amphibole, garnet, clinopyroxene, apatite, epidote, and carbonate. Garnet occurs only in the quartz-rich varieties and may be accompanied by clinopyroxene, whereas plagioclase, either andesine or labradorite, occurs only in the quartz-poor variety. Blue-green amphibole and/or grunerite is most abundant in the latter.

The metagreywacke (unit 2e) is a pale grey, pink weathering, fine grained foliated rock, consisting of 60 to 70 per cent quartz, 10 to 30 per cent feldspar, and 10 to 20 per cent combined muscovite, biotite, chlorite, and actinolite, with traces of apatite, epidote, carbonate and opaque minerals. Associated calc-silicate rocks are pale green to green, fine grained, and composed mainly of actinolite, feldspar, and chlorite, with garnet and epidote as possible additional constituents.

Black, medium- to coarse-grained, massive to foliated, hornblende-rich mafic rocks are found in most of the metavolcanic belts. Three varieties can be recognized. The first is an amphibolite (unit 2c) that is probably derived from basaltic or andesitic flows. It is composed essentially of approximately equal amounts of hornblende and andesine with minor quartz. The second type is a metadiorite or metagabbro (unit 2f), probably derived from mafic dykes or sills. It consists of calcic andesine or labradorite accompanied by hornblende and clinopyroxene. The third type of mafic rock is an amphibolite that shows wide variation in mineral content but is characterized by an abundance of quartz (up to 25 per cent) and the presence of cummingtonite-grunerite in amounts up to 20 per cent. Andesine, and commonly hornblende, are also present. This variety is similar in composition to the fragmental pyroclastic rocks and has therefore been grouped with the tuffs and agglomerates (unit 2d).

The metavolcanic rocks (unit 2g) are characteristically intersected by thin, ptygmatic quartz stringers and are locally intruded by grey granodiorite and/or by pink granite which postdates the granodiorite, and converted to amphibolite, hornblende-rich gneiss, and migmatite. Contacts between granulite of unit 1 and metavolcanic rocks (unit 2) were not found but metamorphic considerations suggest that the metavolcanics are the younger rocks.

Archean Metasediments (Unit 3)

Scattered occurrences of metasiltstone, metagreywacke, feldspathic quartzite, pelitic schist, iron formation, and calc-silicate rocks, assumed to be Archean in age, are found north of Camp Lake, southwest of Dionne Lake, near the mouth of Tha-Anne River, northwest of Boundary Lake, and in the extreme southeast corner of the area.

Metasediments north of Camp Lake consist of poorly exposed pelitic schist (unit 3c) and calc-silicate rocks (unit 3b). The pelitic schist is composed mainly of quartz, andesine, and biotite with porphyroblasts of cordierite. The calc-silicate rocks are possibly derived from tuffs or tuffaceous sediments. They consist chiefly of labradorite and actinolite with minor quartz, but hornblende, cummingtonite, garnet, clinopyroxene, and calcite may also be present.

About 20 km southwest of Dionne Lake, fine grained, foliated calc-silicate rocks (unit 3b) composed mainly of carbonate with minor tremolite and clinopyroxene are associated with metasiltstone (unit 3a) that consists of about 60 per cent quartz, 25 per cent biotite, 10 per cent cummingtonite and 5 per cent opaque minerals. Farther north are pelitic schists that contain abundant porphyroblasts of garnet and cordierite. Quartz, feldspar, biotite and cummingtonite, with traces of pinite, chlorite and opaque minerals make up the groundmass.

Metasediments near the mouth of the Tha-Anne River include metagreywacke or metasiltstone (unit 3a), and calc-silicate rocks (unit 3b) grading into migmatites and gneisses. In the southeast corner of the map are pelitic schists (unit 3c) containing sillimanite and cordierite are intruded by irregular masses and dykes of pink granite or quartz monzonite. Metasediments (unit 3a) preserved in the granulite terrane northwest of Boundary Lake are medium-to coarse-grained, foliated to massive feldspathic quartzite and metagreywacke containing sillimanite and deep blue translucent porphyroblasts of cordierite.

Most of the metasediments in unit 3 are lithologically similar to the metasediments interlayered with the metavolcanics (unit 2) and may be related therefore to the metavolcanics in age and origin. Some of these, however, are possible Hurwitz Group (unit 6-8) equivalents. It should be noted that the distribution of metasediments and paragneiss (units 3-4) of probable Archean age implies the former existence of a widespread Archean metasedimentary succession. Although contacts between the metasediments (unit 3) and rocks of older map units were not observed, comparison with Archean metasedimentary sequences in adjoining map areas (Davidson, 1970; Eade, 1971, 1973) suggests that the metasediments (unit 3) may overlie the metavolcanic rocks (unit 2).

Gneiss and Migmatite (Unit 4)

This map unit comprises a varied assemblage of rocks that have probably been derived mainly from Archean volcanics (unit 2) and metasediments (unit 3). Gneisses and migmatites underlie much of the region in the vicinity of Maguse and Dionne lakes. They also occur along the margins of the granodiorite pluton (unit 5) that extends west from Hyde Lake. Smaller bodies of gneiss and migmatite are found on the coast near Tha-Anne River and in the southeast corner of the map area. The magnetic expression of these rocks is moderate to low.

Granodioritic gneisses (unit 4a) are most abundant west of Dionne Lake and east of Hyde Lake. They are light grey to pink, with felsic and mafic minerals concentrated in irregular, gradationally bounded layers from 2 to 5 cm thick, and vary widely in composition. Typically they consist of 20 to 30 per cent black, smoky quartz, up to 20 per cent perthitic microcline, 30 to 70 per cent oligoclase, 1 to 7 per cent biotite, up to 5 per cent hornblende, and accessory epidote, apatite, and sphene. Some of these rocks may be true orthogneiss; others are probably migmatitic gneisses derived from metasediments.

Paragneisses (unit 4b, c) are best exposed southwest of Ranger Seal Lake and south of Tha-Anne River in the western part of the map area. They are principally derived from pelitic metasediments and metagreywacke but also from calc-silicate rocks and iron formation. The most distinctive and most common paragneiss is a grey, medium- to fine-grained, evenly laminated argillitic rock composed essentially of quartz, oligoclase or andesine, biotite, and hornblende. In many places paragneiss grades into coarse grained gneiss and migmatite. Where pelitic, as for example, southwest of Ranger Seal Lake, such rocks may be cordierite-bearing. Pelitic schist and gneiss on the east side of Dionne Lake contains porphyroblasts of blue cordierite accompanied by sillimanite or by garnet.

Hornblende-rich gneisses (unit 4d), associated amphibolite, and minor dioritic or gabbroic gneiss (unit 4e) predominate among the gneisses west of Eskimo Point. Massive to foliated, medium- to fine-grained amphibolite characteristically grades into amphibolite gneiss in which mafic layers are bounded by regular to irregular layers of light grey plagioclase from 3 to 20 mm thick, spaced at intervals of 1 to 30 cm. These rocks consist of quartz, andesine, biotite and hornblende, with accessory sphene, epidote, carbonate, sericite, and opaque minerals. In the rarer gabbroic gneiss (unit 4e) the plagioclase is labradorite and quartz is absent. Like the paragneiss (unit 4b, c) these rocks are in many places intruded by dykes and masses of granodiorite and converted to agmatite and injection gneisses. Many of the gneisses and migmatites (unit 4g) have in turn been modified by the addition of veins, dykes, and masses of pink granite that clearly postdate the granodiorite. The distribution of the hornblende-rich gneisses and amphibolites (unit 4d) suggests that most have been derived from metavolcanic rocks (unit 2).

Granodiorite and Quartz Monzonite (Unit 5)

The most abundant rocks in the map area are grey granodiorites and quartz monzonites (unit 5), which occur as discrete plutons, irregular intrusions, and dykes in older rocks. Granodiorites make up more than 80 per cent of map unit 5 and quartz monzonite less than 20 per cent. The largest pluton extends from Hyde Lake to the western boundary of the area, a distance of more than 80 km. This body encloses and is partly bordered by metavolcanics (unit 2) and gneisses (unit 4).

The granodiorites and quartz monzonites (unit 5) are white to pale grey or greyish pink, weathering white or pale grey and less commonly, grey to pale pink. They are medium- to coarse-grained, locally porphyritic rocks which are characteristically weakly foliated, but in some places are massive. Foliation is generally parallel with pluton boundaries. A regular, subhorizontal sheeting is characteristic. Xenoliths of medium- to fine-grained micaceous paragneiss ranging from less than a metre to a few metres in diameter are sparsely distributed throughout the unit but in some places may constitute as much as 20 per cent of the rock.

The granodiorites consist of 25 to 40 per cent quartz, up to 10 per cent perthitic microcline, 55 to 70 per cent antiperthitic oligoclase (An_{21-27}), 1 to 7 per cent biotite, and traces of chlorite, muscovite, epidote, sphene, apatite, zircon, and opaque minerals. Trace amounts of hornblende were noted in only a few thin sections. With an increase in the amount of K-feldspar relative to plagioclase the granodiorite grades into quartz monzonite. Smaller bodies of granodiorite and quartz monzonite, similar in composition and appearance to that of the Hyde Lake pluton, lie north of McConnell River, east and west of Camp Lake, and south of Maguse River, between Dionne Lake and Eskimo Point.

Contacts between granodiorite or quartz monzonite plutons and belts of metavolcanic (unit 2) and metasedimentary (unit 3) rocks are in some places gradational through gneisses and migmatite. Granodiorite appears to be overlain unconformably by strata of the Aphebian Hurwitz Group (unit 6, 7) and is considered to be Archean in age. In many places it is cut by pink granite, pink pegmatite, and aplite dykes all possibly related in origin to the granitic rocks of unit 11.

Hurwitz Group (Units 6–8)

Proterozoic sediments exposed near McConnell River north of Hyde Lake were mapped on a reconnaissance scale by Lord (1953). Wright (1967) applied the group term 'Hurwitz' to these and similar sequences in southern District of Keewatin. The first detailed stratigraphic account of the group, however, was provided by Eade (1964, 1966, 1974). Sediments in the Hyde Lake area assigned to the Hurwitz Group are those that compare with the stratigraphic succession established by Eade in the Edehon Lake map area (1971, 1973). They consist principally of white orthoquartzite overlain conformably by argillite or meta-argillite, with intercalated limy beds and calc-silicate rocks. Hurwitz Group strata are preserved only near McConnell River south and southeast of Camp Lake, west of Ranger Seal Lake, and south of Thuchonilini Lake. They are considered to be of Aphebian age.

The best section of Hurwitz Group metasediments is exposed in a northeasterly trending structural basin situated about 15 km south and east of Camp Lake. This basin, which is defined by few outcrops, may be as much as 20 km long and 6 km wide. Orthoquartzite (unit 6), locally weakly crossbedded, is overlain conformably by thinly bedded quartzite containing thin layers of carbonate and calcareous shale. Overlying the quartzite, apparently conformably, is black argillite slate and shale (unit 7) with locally intercalated carbonate and calc-silicate lenses and layers. The orthoquartzite is almost entirely composed of fine grained, equant, quartz. Calc-silicate beds comprise fine- to medium-grained andesine and actinolite with traces of apatite and opaque minerals. Calcareous argillites associated with the calc-silicate rocks are composed principally of quartz and feldspar, with subordinate actinolite, clinopyroxene, and sphene. The black argillite is a very fine grained rock made up of 90 per cent quartz and feldspar, 3 per cent biotite, and about 7 per cent porphyroblasts of cordierite and randomly oriented anthophyllite. The total thickness of these metasediments may exceed several hundred metres.

On McConnell River south of Camp Lake is a well exposed section more than 150 m thick composed mainly of thick bedded black and grey shale, siltstone, slate and argillite, and black meta-argillite containing conspicuous metacrysts of coarse grained cummingtonite. Crossbedding in the siltstone indicates that the beds face upwards. The black meta-argillite is composed of about 50 per cent quartz, 40 per cent feldspar, 10 per cent combined biotite, hornblende, cummingtonite, and epidote, with accessory sphene, apatite, opaque minerals, and rare garnet. A strong local magnetic anomaly that occurs at the south margin of the section is possibly related to unexposed iron formation.

About 15 km south of Thuchonilini Lake, white, hematite stained quartzite is overlain by fine- to medium-grained pelitic schist composed chiefly of quartz, biotite, cummingtonite, and cordierite. The thickness of section is unknown. About 8 km west of Ranger Seal Lake is a monoclinal succession of dull, grey weathering, green to grey limy argillite with interbedded recessive buff limestone. Beds range from 10 to 20 cm in thickness. The exposed section is more than 125 m thick.

Contacts between Hurwitz Group strata and older rocks were not observed, but the basin southeast of Camp Lake appears to overlap the contact separating the granodiorite pluton (unit 5) from gneisses of map unit 4. Sheared quartzite at the north end of the basin is intruded by pegmatite dykes, and metasediments (unit 7) exposed on McConnell River to the west of the basin appear to be intruded by granite or quartz monzonite.

Metagabbro (Unit 9)

Small exposures of dark grey metagabbro (unit 9) are associated with Archean metasediments (unit 3) northeast of Camp Lake, and with Hurwitz Group metasediments (unit 7) at McConnell River south of Camp Lake. Contacts with host rocks were not observed but the bodies are thought to be sills that postdate the Hurwitz Group metasediments (unit 7). The metagabbros are fine grained, massive rocks with subophitic textures, composed of labradorite or andesine, hornblende, and traces of biotite, chlorite, apatite, and opaque minerals. No other examples of gabbro dykes or sills are known in the map area although some of the metagabbro bodies in map unit 1 and in map unit 4 may be dykes or sills, and the northwesterly trending linear aeromagnetic pattern northwest of Mowers Lake (GSC maps 3158G, 3159G) that has a strike length of more than 30 km probably represents a diabase dyke.

Monzonite and Syenite (Unit 10)

Quartz-poor plutonic rocks, tentatively considered to be of Aphebian age and to postdate the metasediments (unit 7) of the Hurwitz Group, occur at two localities in the northern and western parts of the map area. These rocks are very poorly exposed but the associated positive magnetic patterns can be used to delineate their extent. A distinctive appearance and lithology readily serves to distinguish them from rocks of other plutons.

Hornblende monzonite (unit 10a) outcrops about 8 km east of Camp Lake in a body which is inferred to be crudely circular in outline. The rock is greyish pink, weathering pink, massive, medium- to coarse-grained, and contains euhedra of K-feldspar up to 2 cm long. It consists of up to 5 per cent quartz, 50 per cent mesoperthitic microcline, 30 to 40 per cent albite or oligoclase, 7 per cent hornblende and clinopyroxene, traces of biotite and accessory epidote, chlorite and carbonate, apatite, zircon, sphene, and opaque minerals.

Augite syenite (unit 10b) exposed on the margin of the drift-covered area about 8 km northwest of Thuchonilini Lake, is a pale pink, coarse- to very coarse-grained, massive rock, containing euhedra of K-feldspar 2 cm or more in length. It consists of about 80 per cent perthitic microcline, 10 per cent oligoclase, 10 per cent clinopyroxene, and traces of uralitic amphibole, sphene, apatite, and opaque minerals.

The monzonite is intruded by pink pegmatite that is perhaps related to the granite of unit 11. Contacts between monzonite and syenite and rocks of other map units were not observed.

Granite, Quartz Monzonite, Pegmatite (Unit 11)

Large bodies of massive pink granite and pegmatite occur in the west-central and southeastern parts of the area. Some of these are more than 35 km long but their actual size is unknown as they are bounded by drift-covered regions. In addition, small pods, masses and dykes of pink granite and pegmatite are found within rocks of other map units. Rocks of quartz monzonite composition are comparatively scarce and are principally restricted to the southeastern parts of the map area.

Granite exposed south of Thaolintoa Lake, in the largest pluton in the area, is a pink, pink weathering, coarse grained, homogeneous rock which is generally massive but locally may be weakly foliated. Porphyritic textures are common. A subhorizontal sheet jointing is characteristic. The granite consists of about 25 per cent black, smoky, quartz, 50 per cent perthitic microcline, 20 per cent oligoclase (An_{17-23}), up to 2 per cent biotite, partly altered to chlorite, and traces of myrmekite, muscovite, carbonate, epidote, apatite, zircon, and opaque minerals. A medium- to fine-grained phase of the granite occurs in a long easterly trending belt south of Tha-Anne River west of Hyde Lake. Except for a uniformly finer grain size, this granite is similar in all respects to that of the main pluton.

Granites in the southeastern part of the map area are much less homogeneous than those in the west. Commonly they intrude and include older granodiorite gneisses, amphibolitic gneisses and paragneiss. In some places xenoliths constitute more than 10 per cent of the rock and impart a foliation to it. Locally these granites grade into quartz monzonite and more rarely, into granodiorite.

Segregations of pink pegmatite, graphic in part, are associated with the granite and are probably related in origin. White, graphic, quartz-albite pegmatite containing black tourmaline may also be related to the granite. Two occurrences of such rocks are known. Tourmaline pegmatite intrudes metasediments (unit 3) near the mouth of Tha-Anne River and tourmaline-garnet pegmatite intrudes metavolcanics (unit 2) about 15 km southwest of Ranger Seal Lake.

Intrusive relationships of the granite, as well as the lack of foliation and other deformational features, suggest that it postdates all other rocks in the area and is Aphebian or younger. Granite in the Edehon Lake area, coextensive with the granite (unit 11) pluton west of Hyde Lake, has been mapped as Aphebian (Eade, 1973).

METAMORPHISM

The earliest metamorphic episode is recorded by the granulites (unit 1) that underlie much of the southwestern part of the area. Hypersthene, the diagnostic mineral of the granulite facies[1], is accompanied in these rocks by biotite or by biotite and hornblende, an association that characterizes the lowermost grade of granulite facies metamorphism. Representative assemblages of this facies in map unit 1 are:

quartz-perthite-antiperthitic oligoclase-biotite-hypersthene

quartz-perthite-antiperthitic andesine-biotite-hornblende-clinopyroxene-hypersthene

labradorite-biotite-hornblende-clinopyroxene-hypersthene

A second Archean metamorphic event is suggested by metamorphic assemblages preserved in Archean metavolcanics (unit 2) and metasediments (unit 3) and in the development of related gneisses and migmatites (unit 4). This metamorphism is assumed to have taken place mainly in late Archean time, probably in conjunction with the emplacement of granodioritic plutons (unit 5). The most common assemblage in the metavolcanic flows (unit 2), which is diagnostic of the amphibolite (undivided) facies, is:

quartz-andesine-hornblende-sphene

A relatively rare association is:

labradorite-biotite-hornblende-hypersthene

Metasediments of unit 3, and metasediments intercalated with the volcanic rocks (unit 2), as well as derived gneisses and schists of map unit 4, range in grade from upper greenschist or low amphibolite facies to upper amphibolite and in rare cases to granulite facies. As in the volcanic rocks, however, assemblages representing amphibolite facies metamorphism are most abundant. The following mineral associations are characteristic of the calc-silicate rocks:

quartz-plagioclase-actinolite-calcite

albite-diopside-sphene

quartz-labradorite-hornblende-clinopyroxene-garnet

Association in pelitic rocks include:

quartz-biotite-cordierite

quartz-biotite-cummingtonite-garnet-cordierite

quartz-biotite-cordierite-sillimanite

quartz-K feldspar-biotite-cordierite-sillimanite

Typical associations in iron formation are:

quartz-grunerite-clinopyroxene-garnet-magnetite

quartz-grunerite-hypersthene-magnetite

The widespread occurrence of migmatite, particularly in the eastern part of the map area, may indicate upper amphibolite facies metamorphism. Pressure-sensitive assemblages are few. The association of garnet and cordierite in pelitic rocks implies low to moderate metamorphic pressures.

A third metamorphism, of presumed Aphebian age, is recorded in Hurwitz Group (unit 6-8) strata. Metamorphic grade ranges from greenschist or subgreenschist, as indicated by the survival of slates and shales, to lower amphibolite facies. Characteristic assemblages include:

quartz-phlogopite-tremolite

quartz-plagioclase-actinolite-clinopyroxene-sphene

quartz-biotite-anthophyllite-cordierite

quartz-biotite-cummingtonite-cordierite

[1]The facies classification used in this report is that of Winkler (1967, 1974).

Gabbro bodies associated spatially with Hurwitz Group rocks and possibly of comparable age contain the association:

andesine-biotite-actinolite-chlorite

The grade of this (Hudsonian?) metamorphism contrasts with that of the Archean (Kenoran?) metamorphism previously described. In fact, if Aphebian metamorphism had surpassed the Archean metamorphism in grade it would be difficult or impossible to recognize the earlier effects. The problem of separating the effects of Hudsonian metamorphism from those of Kenoran metamorphism in the southern District of Keewatin is summarized by Eade (1978). As in the case of Archean metamorphism, the metamorphic pressures are assumed to have been low to intermediate. The Aphebian metamorphism is tentatively considered to be related to late Aphebian plutonism in the region.

A late retrograde, low temperature metamorphic event appears to have affected rocks of all map units. It is recognized by the presence of the secondary minerals chlorite, serpentine, muscovite, epidote and pinite. This metamorphism is probably late Aphebian or early Helikian in age.

STRUCTURAL GEOLOGY

The structure in the map area appears to be complex. The dominant structural trend is easterly to northeasterly. However, foliation, including compositional layering, gneissosity, and cleavage, shows great diversity in attitude. Compositional layering is present in many of the metavolcanic rocks (unit 2). Cleavage planes are parallel or subparallel with the layers and in some exposures are lineated by crenulations and by alignment of amphibole prisms. Lineations defined by small folds are found in some of the metasediments (unit 3) and gneisses (unit 4).

Foliation and lineation attitudes suggest that these rocks have undergone at least two stages of deformation. Tight folds with axes that plunge steeply to the south and southeast have been modified by a later deformation that generated open folds with axes that plunge at moderate angles to the southwest and to the west. Effects of the first deformation are observed only in structures of the Archean supracrustal rocks and gneisses, and are therefore tentatively considered to be Archean in age. The second deformation is also reflected in Hurwitz Group strata which have been gently folded around southwesterly plunging axes and possess a strong cleavage that strikes westerly to southwesterly. This deformation is considered to be Aphebian and to predate the emplacement of the granite (unit 1) plutons, none of which is penetratively deformed.

A late cataclasis which apparently postdates the other principal deformations and the main metamorphic episodes is expressed in widely scattered shear zones and cataclastic textures. The age of this deformation must be late Aphebian or younger. Joints are characteristic of rocks in all map units. The most regular set trends about 30 degrees west of north with steep to vertical dips. No major faults have been mapped. It is probable, however, that the northern boundary of the granulite (unit 1) terrane is in part a fault. This is suggested by the sharp nature of the contact and the steep metamorphic gradient across it.

ECONOMIC GEOLOGY

The area has been actively explored during the past decade for uranium and for base metals. Much of this work has focused on the metavolcanic rocks (unit 2) in the Camp Lake region. Rusty weathering pyritic zones up to a few metres in length are sparsely scattered through the metavolcanics (unit 2) and the gneisses (unit 4). About 4 km south of Camp Lake such zones occur in meta-andesite or metadacite (unit 2b) and about 23 km to the south similar zones containing malachite stained fracture surfaces are associated with pillowed, porphyritic metadacite (unit 2b). At McConnell River, 20 km south of Dionne Lake, pyritic zones are associated with badly fractured but persistent beds of quartz-magnetite iron formation that are intercalated with metabasaltic flows (unit 2a). Approximately 25 km northwest of Mowers Lake, rusty zones are found in migmatitic gneisses (unit 4e) derived from metagreywacke and iron formation. Pyrite further occurs as disseminations in fragmental flows and agglomerate (unit 2d) and in metadiorite (unit 2f). Sulphides are less common in rocks of the Hurwitz Group (units 6-8). Pyrite is found in Hurwitz Group strata (unit 7) exposed south of Camp Lake near McConnell River, as disseminations in black argillite and as smears on cleavage surfaces in slate. None of the observed sulphide occurrences is considered to be of direct economic significance.

Beds of iron formation in the metavolcanic rocks (unit 2), metasediments (unit 3), and gneisses (unit 4) may contain at least 10 per cent magnetite and 10 per cent grunerite. The beds may be as much as 2 m thick but in general are not well exposed and their abundance and extent are unknown. The largest iron formation occurrences are presumably associated with the prominent aeromagnetic anomalies (GSC map 3206G) that lie near McConnell River south of Camp Lake. Anomalies in this region are about 20 000 gammas above background and are thus of possible interest as indicators of potential iron deposits.

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