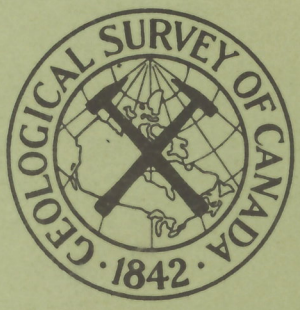
66-40



GEOLOGICAL
SURVEY
OF
CANADA

DEPARTMENT OF ENERGY,
MINES AND RESOURCES

PAPER 66-40

GEOLOGICAL NOTES NORTHEASTERN DISTRICT OF KEEWATIN AND SOUTHERN MELVILLE PENINSULA, DISTRICT OF FRANKLIN, NORTHWEST TERRITORIES (PARTS OF 46, 47, 56, 57)

(Report, 1 figure and Map 14-1966)

W. W. Heywood

Price, $1.50

1967

GEOLOGICAL SURVEY
OF CANADA

PAPER 66-40

GEOLOGICAL NOTES NORTHEASTERN DISTRICT OF KEEWATIN AND SOUTHERN MELVILLE PENINSULA, DISTRICT OF FRANKLIN, NORTHWEST TERRITORIES (PARTS OF 46, 47, 56, 57)

W. W. Heywood

DEPARTMENT OF ENERGY, MINES AND RESOURCES

Available by mail from the Queen's Printer, Ottawa,

from Geological Survey of Canada,
601 Booth St., Ottawa,

and at the following Canadian Government bookshops:

HALIFAX
1735 Barrington Street

MONTREAL
Æterna-Vie Building, 1182 St. Catherine St. West

OTTAWA
Daly Building, Corner Mackenzie and Rideau

TORONTO
221 Yonge Street

WINNIPEG
Mall Center Bldg., 499 Portage Avenue

VANCOUVER
657 Granville Street

or through your bookseller

Price $1.50 Catalogue No. M44-66-40

Price subject to change without notice

ROGER DUHAMEL, F.R.S.C.
Queen's Printer and Controller of Stationery
Ottawa, Canada
1967

CONTENTS

Illustrations

ABSTRACT

The preliminary results of a reconnaissance survey of 55,000 square miles of the northeastern District of Keewatin and the southern half of Melville Peninsula are presented in this report.

Precambrian rocks of Aphebian (early Proterozoic) age have been moderately to intensely folded, metamorphosed, granitized and here and there intruded by granitic and pegmatitic rocks.

Several new stratigraphic terms have been introduced for distinctive, mappable assemblages of metamorphosed and granitized sedimentary and volcanic rocks.

Flat-lying Ordovician and Silurian sandstone and dolomite outcrop on Simpson and Melville Peninsulas and on Southampton Island.

Twelve K-Ar age determinations were made on the Precambrian rocks; the results range from 1580 to 1690 m.y. Tentative correlations are made between some of the units of the area and lithologically similar units in adjacent regions.

The results of analyses made on an iron-formation unit are given.

GEOLOGICAL NOTES, NORTHEASTERN DISTRICT OF KEEWATIN AND SOUTHERN MELVILLE PENINSULA, DISTRICT OF FRANKLIN, NORTHWEST TERRITORIES

INTRODUCTION

This report is a preliminary account of Operation Wager, a geological reconnaissance mapping project that included the northeastern District of Keewatin and the southern half of Melville Peninsula in the District of Franklin.[1] A description of the bedrock geology of about 55,000 square miles is presented in this paper; the Pleistocene geology will be described in a separate paper by B. G. Craig (in preparation).

Repulse Bay, a small settlement near the centre of the map-area, is approximately 600 miles north-northeast of Churchill, Manitoba. The only other permanent settlement in the area is Pelly Bay on the west side of Simpson Peninsula. A Roman Catholic mission is located in each community and there is a Hudson's Bay Company store at Repulse Bay. The trading post of Wager Bay has been closed for several years.

Distant Early Warning (DEW) Stations are located on the west side of Simpson Peninsula and on both sides of Melville Peninsula (Canada, Department of Transport, 1957).

ACCESSIBILITY

Transportation by air is the only practicable means of access to the area as well as travel within the area. There are no commercial air bases in the area, and Churchill, Manitoba is the closest base from which aircraft can be chartered. Transair Ltd. schedules frequent flights to Baker Lake, Chesterfield Inlet, and Coral Harbour using DC-3 or Canso aircraft.

Ski-equipped aircraft may be used locally until mid-June in most years, and restricted float operations commence in early July. Large transport aircraft on skis or wheels can be landed on the ice in various parts of the region before breakup.

Tracked vehicles such as snowmobiles and motor toboggans could probably be used as late as June 15 throughout most of the area. The late breakup and scarcity of navigable rivers restrict the operation of canoes and boats in inland waters. Late breakup and extensive pack ice on the coastal areas limits the use of small boats and canoes to intermittent travel. Heavy and bulky freight is moved by icebreaker to Repulse Bay, usually in late August or early September.

---

[1] An interim report was given in "Geological Notes on Operation Wager, Northwest Territories", Heywood, 1966.

PRESENT INVESTIGATION

Operation Wager, carried out between June 1 and August 25, 1964, was the last of the major helicopter reconnaissance operations investigating the geology of the western Canadian Shield. Only a small area of Melville Peninsula remains unmapped.

Geological mapping was started in coastal areas around Daly Bay on June 7; however, snow cover prevented work in the upland areas until the last week in June. Ski-equipped aircraft operated in selected parts of the area until June 20. A few lakes were open to float operation as early as July 6, and by July 15 the landing lake at Repulse Bay was clear of ice.

Most of the area was examined by means of a series of parallel helicopter flight lines spaced at 6-mile intervals. Routine traverses averaged about 100 miles in length and provided information on an area of about 600 square miles. Although landings were not evenly spaced, there was an average of one landing per 25 square miles. Between landings continuous geological observations and interpretations were plotted on air photographs or maps. The flight altitude ranged from about 100 to 400 feet and was determined by local weather, topography and geological requirements. Additional helicopter flights were undertaken to obtain detailed information on specific problems or areas.

A Cessna 180 was used during the last half of July and early in August for high level reconnaissance and for spot observations where lakes were suitable for landings.

Almost all geology was mapped directly on air photographs in the field, and transferred to 1:250,000 topographic maps at the base camp. The air photographs and photo mosaics were used extensively to aid in the geological interpretation between flight lines.

Seventy-six days were spent in the project area; of these 57 were suitable for traversing, 16 were lost due to weather and 3 days were lost due to unserviceability of aircraft.

No systematic geological mapping had previously been undertaken in the area. Brief descriptions of the topography and of the local geology appear in several reports and accounts of the early explorers. The reports of the Fifth Thule Expedition of 1921-1924 (Teichert, 1937) contain descriptions of the geology of the east coast of Melville Peninsula and of some of the adjacent islands. Air photo interpretations made by Bronhofer (1957) provide descriptions of the general physiography of much of the area.

ACKNOWLEDGMENTS

Bedrock investigations were carried out by W. R. A. Baragar, J. A. Donaldson, C. I. Godwin and G. D. Jackson under the direction of W. W. Heywood. B. G. Craig was responsible for the surficial studies. H. R. Jordon was a seasonal

assistant attached to the project, and W. R. Warren carried out the duties of radio operator.

Special thanks are expressed to H. Voisey, manager of the Hudson's Bay Company store at Repulse Bay, and Mrs. H. Voisey for assistance and many courtesies extended to the members of the Geological Survey field party. Mr. A. Harkness of the Hudson's Bay Company, and Brother Paradis of the Roman Catholic Mission kindly assisted with handling supplies at Chesterfield Inlet. Mr. George Thompson of the Department of Northern Affairs and Natural Resources at Rankin Inlet extended many courtesies.

Thanks are due to the personnel of the Department of Transport and Department of Northern Affairs and Natural Resources at Baker Lake, and to the Department of Public Works at Churchill for their hospitality and assistance.

Dominion Helicopters Limited provided two Bell 47G2A helicopters and crews; McMurray Air Services provided a De Havilland Otter and crew; a Cessna 180 was chartered from Thomas Lamb Airways after breakup. Transair freighted the equipment and supplies from Churchill to the first field camp in June, 1964. The cooperation of the aircraft companies and the aircrews is gratefully acknowledged.

TABLE OF FORMATIONS

Era	Period or Epoch	Group, Formation or Map-unit		Lithology
Cenozoic	Pleistocene and Recent			Till, boulders, sand, gravel, marine silt
Palaeozoic	Ordovician and Silurian	Map-unit 19		Dolomite, minor sandstone
	Ordovician	Map-unit 18		Sandstone, minor shale
APHEBIAN		Map-unit 17		Diabase sills and dykes
		Map-unit 16		Quartzite, minor conglomerate
			Map-unit 15	Paragneiss, schist, undifferentiated crystalline limestone and quartzite
		Penrhyn Group	Map-unit 14	Quartzite
			Map-unit 13	Crystalline limestone
ARCHAEAN AND/OR APHEBIAN		Map-unit 12		Granite, granodiorite
		Map-unit 11		Migmatite
		Map-unit 10		Granitoid gneiss
				Layered gneiss
		Map-unit 9		Paragneiss and schist
		Map-unit 8		Peridotite, serpentinite, anorthosite gabbro, diorite
			Map-unit 7	Migmatite
		Daly Bay Complex	Map-unit 6	Gneiss
			Map-unit 5	Anorthosite and gabbro
			Map-unit 4	Iron-formation
			Map-unit 3	Quartzite
			Map-unit 2	Undifferentiated metasedimentary rocks, paragneiss, schist
		Prince Albert Group	Map-unit 1	Greenstone and amphibolite

GENERAL GEOLOGY

GENERAL STATEMENT

The geological reconnaissance data presented in this report are similar to those of Operation Baker (Wright, 1955) and Operation Back River (Heywood, 1961).

Precambrian rocks of Aphebian (early Proterozoic) age (possibly in part of Archaean age) have been moderately to intensely folded, metamorphosed and granitized and locally intruded by granitic and pegmatitic rocks. Metamorphosed and granitized sedimentary and volcanic rocks are divided into several units that may in part be downfolded remnants of a once continuous and extensive unit. The terms Penrhyn Group and Prince Albert Group have been introduced in this paper for two distinctive assemblages comprising several mappable units. Basic and ultrabasic rocks are scattered throughout the area. Serpentinized peridotite bodies are most numerous in the folded belt that extends southwest of Committee Bay and in the area west of Parry Bay. Anorthosite and gabbro occur near Daly Bay.

Flat-lying Ordovician and Silurian sandstone and dolomite outcrop on Simpson Peninsula, Melville Peninsula and Southampton Island.

ARCHAEAN (POSSIBLY APHEBIAN IN PART) SEDIMENTARY AND VOLCANIC ROCKS

Prince Albert Group (1-4)

The term Prince Albert Group is introduced in this paper to refer to a sequence of Aphebian (early Proterozoic) or Archaean metamorphosed sedimentary and volcanic rocks. On Melville Peninsula these rocks are exposed in two main belts although small bodies of similar rocks in the same general area are probably related. The western belt extends for 40 miles and consists of four irregularly shaped bodies. These are parts of a once continuous unit that is now separated by faulting and granitic intrusion. The eastern belt extends for about 50 miles southeast from the coast at Parry Bay in the northeast corner of the map-area, and is as much as 8 miles wide and averages about 4 miles. Faults and granitic intrusions disrupt its northern half. A narrow belt of metamorphosed sedimentary rocks with minor amounts of volcanic rocks extends southwesterly from Committee Bay, south of Cape Weynton to the western boundary of the area. This belt ranges from less than one mile to about 5 miles in width. The contacts with the adjacent gneisses are sinuous in detail and in places are gradational over a few tens of feet.

The sequence of rocks exposed on Melville Peninsula differs slightly from that exposed southwest of Committee Bay. Metavolcanic rocks are abundant in the former area but rare in the latter, whereas quartzite is a prominent member in the Committee Bay area, but not common on Melville Peninsula. Iron-formation occurs in both areas but is best developed on Melville Peninsula.

Greenstone and amphibolite (1)

The oldest rocks in the group, and possibly in the map-area, are greenstones, greenschists and amphibolites derived from intermediate to basic volcanic rocks. Minor undifferentiated acid volcanic and sedimentary rocks are included in this unit. These rocks are widely distributed on Melville Peninsula but southwest of Committee Bay they are limited to a few small outcrops about 10 miles west of Swanston Point, and at the southwestern end of the same belt.

The weathered surfaces of the greenstone and greenschist are light greenish grey to dark green and black; the fresh surfaces are dark grey to dark green or black. Most of these rocks are fine grained and a few are porphyritic. They are composed essentially of chlorite, actinolite, plagioclase and minor amounts of magnetite. Primary textures and structures were rarely observed and all were too deformed to aid in top determination. Foliation is well developed over large areas, and where present it is steeply dipping and parallel to the trend of the belt, or, where irregularities are present, to adjacent contacts. Massive to foliated amphibolite is greenish black on both fresh and weathered surfaces. It is generally fine grained and composed of plagioclase, hornblende, minor quartz; biotite-rich laminae are common in the foliated types.

Thinly laminated to massive grey to white weathering fine grained metamorphosed rhyolite or dacite occurs interlayered with the basic volcanic rocks. Bomb-like fragments are present in some of the fine-grained tuffaceous rocks.

Metasedimentary rocks (2)

Undifferentiated metasedimentary rocks that include massive to bedded quartzite, impure quartzite, phyllite, sericite schist, quartz-mica schist, quartz-garnet-actinolite schist, paragneiss and well-layered mafic gneiss constitute this unit. The paragneiss consists of thin to thick layers of alternating light and dark, medium-grained rock composed essentially of quartz, plagioclase, hornblende and biotite. The mafic gneiss and a minor amount of chlorite schist with vague pillow-like features may be derived from an intermediate to basic volcanic rock.

Quartzite (3)

Quartzite generally does not form mappable units on Melville Peninsula but is widespread southwest of Committee Bay. In the western half of this belt it forms a continuous band that ranges in width from a few hundred feet to almost one mile. In the eastern half of the belt the quartzite forms discontinuous layers and irregular lenses. Typical quartzite is fine to medium grained with a white to dark grey weathered surface. The fresh surfaces are various shades of grey, pale green or white with numerous rusty stains on bedding and cleavage planes. Bedding and crossbedding are locally well developed. Well-bedded coarsely crystalline quartzite locally grades into massive quartzite that has the appearance of vein quartz.

Iron-formation (4)

Iron-formation (4) is exposed over a distance of about 15 miles in the Prince Albert Hills east of Selkirk Bay. It ranges from 40 to 100 feet thick over most of its strike length, but in three areas it ranges from 300 to 500 feet thick. Metamorphosed basic volcanic rocks are associated with the iron-formation, but locally it is conformable with quartzite or micaceous garnetiferous paragneiss. Magnetite, minor specular hematite, and quartz are the predominant minerals in the iron-formation. Iron silicates are abundant in some lean iron-formation. On the weathered surface the rock has a typical steely black appearance, and, where hematite is abundant, weathers rusty red. Most of the rock is fine to very fine grained, and massive to thinly laminated. The laminated members may be intricately folded and contorted. Visual examinations indicate that the wider zones may contain about 60 per cent magnetite and hematite. Granite intrudes the iron-formation, and 10 miles east of Erlandson Bay, western Melville Peninsula, blocks of iron-formation up to 40 feet long occur as inclusions in the granite.

Several iron-formations occur in a folded zone that is as much as 4 miles wide and extends for 30 miles to the southwest of Parry Bay from longitude 82° 38'W, latitude 68° 30'N. The widest intersection noted is 500 feet, and widths of 350 to 400 feet across several thousand feet were observed from the air. The rocks in contact with the iron-formation vary from place to place suggesting that the base of the iron-formation rests unconformably on metasedimentary and metavolcanic rocks. Similar rocks lie conformably on the iron-formation and all are interfolded. Massive granitic rocks intrude the sedimentary and volcanic sequence.

Thinly laminated to massive iron-formation is steely black to rust coloured on weathered surfaces. Alternating laminae of magnetite or quartz-magnetite and fine grained quartzite range from 1 mm to about 10 cm but a few magnetite-rich layers are as much as 10 feet wide. The estimated grade ranges from 35 to 40 per cent Fe over thicknesses of as much as 500 feet and a strike length in excess of several hundreds of feet. The iron content is estimated at 50 per cent over widths of 10 feet and unknown lengths. The thinly laminated iron-formation is fissile and splits easily parallel to bedding which would aid in beneficiating processes.

Southwest of Committee Bay rocks ranging from magnetite-rich quartzite to lean iron-formation occur discontinuously throughout the sequence. Individual beds are as much as 100 feet thick and possibly several hundreds of feet long. The lean iron-formation is in a fine grained to cherty quartzite and contains as much as 30 per cent magnetite. Some iron-formation is well banded and in places it is intensely folded and contorted.

DALY BAY COMPLEX (5 - 7)

The name Daly Bay Complex is proposed for a distinct lithologic association that is exposed in the area between Daly Bay and Roes Welcome Sound. Concordant sills and bodies of rock ranging in composition from gabbro to anorthosite occur in a generally mafic-rich group of gneisses and granulites commonly containing abundant garnet and pyroxene.

Anorthosite and Gabbro (5)

The main mass of anorthosite, gabbro and related rocks is about 15 miles long and as much as 4 miles wide and outcrops on the northeast side of Daly Bay. The central zone consists of slightly layered to massive, medium to coarse grained anorthosite and anorthositic gabbro. The peripheral zone consists of fine to medium grained, layered, anorthositic and mafic rocks. Layering on the northern and western sides dips inward beneath the massive anorthosite, steeply near the margins and more gently near the centre. The layering on the eastern side dips steeply both toward and away from the massive core.

Typical anorthosite (5) of the central area is a coarse grained, almost black rock composed essentially of labradorite. Small amounts of pyroxene, amphibole or biotite with accessory magnetite occur in the anorthosite. With increasing amounts of ferromagnesian minerals the anorthosite grades into gabbroic anorthosite composed of the same minerals as the anorthosite but locally with minor amounts of garnet and quartz.

The layered zone consists of alternating mafic and anorthositic bands that range from 6 inches to 8 feet thick. The anorthositic bands are composed essentially of medium to coarse grained labradorite but contain as much as 30 per cent pyroxene, amphibole and garnet. Plagioclase crystals are commonly oriented parallel to the layering and a few are broken and crushed, some fractures being filled with amphibole.

The mafic bands range from gabbroic to dioritic rocks that are medium grained and characteristically comprise plagioclase, pyroxene, amphibole and garnet with minor orthoclase, quartz, muscovite, biotite and magnetite. The plagioclase ranges from calcic andesine to labradorite. Commonly these rocks have a sharp contact with an underlying anorthosite layer but at the top grade rather abruptly into anorthosite.

Sills and plugs ranging in composition from gabbroic anorthosite to anorthosite occur between Daly Bay and Roes Welcome Sound. In general they are medium to coarse grained, light to dark grey, massive to layered rocks. The layering is not well developed and most layers branch and feather out along strike. Few were traced as much as 30 feet or exceeded a foot in thickness.

Gneiss (6)

Gneiss and related rocks constitute more than 60 per cent of the Daly Bay Complex. The principal rock types are grey to greenish grey, mafic-rich, quartz-feldspar gneisses. However, this map-unit includes rocks that range from amphibolite gneiss to impure quartzite. Most of the gneisses are layered with layers ranging in thickness from a few inches to several feet.

Typical gneiss is a medium grained more or less equigranular rock containing 5 to 30 per cent quartz, 24 to 60 per cent andesine and up to 10 per cent

potassium feldspar. Amphibole, pyroxene and garnet are present in most rocks, and biotite, sillimanite and staurolite are present in many. Commonly one or more of these minerals predominate in one layer but are rare or absent in adjacent layers. The pyroxene includes both hypersthene and diopside; hornblende is the common amphibole.

Augen gneisses of the same general composition were observed in a few places. Minor amounts of granulite and charnockite are also included in this map-unit as they could not be separated on the present scale of mapping.

Amphibolite gneiss layers composed of about equal amounts of plagioclase and hornblende and minor biotite occur throughout the sequence. Impure quartzites containing 60 per cent quartz, 20 to 30 per cent plagioclase, 9 per cent garnet and minor biotite were observed in two localities.

Migmatite (7)

The Daly Bay migmatites are mixtures of gneiss (6) with granite or pegmatite in the form of veins, sills and irregular masses. Small areas consist of lit-par-lit mixtures of granite and gneiss with granite dykes. The foliation is commonly contorted but the general trend is parallel to that of the adjacent gneisses. The migmatite areas have gradational contacts with the gneisses and the granites; none of the granitic units is large enough to show separately on the map.

BASIC AND ULTRABASIC ROCKS

Ultrabasic Rocks (8a)

Sills and dykes of peridotite and pyroxenite and their serpentinized equivalents occur in the Prince Albert Group, in and near the folded metasedimentary belt southwest of Cape Weynton and in the area around Curtis Lake.

These rocks commonly weather greenish black, but several have a distinctive chocolate brown weathered surface. Freshly broken surfaces are green, greenish grey or greenish black. Most of the altered rocks are massive and are composed of serpentine, talc, amphibole and iron-ore minerals. Locally soapstone has been developed, and some asbestiform minerals were observed.

Southwest of Committee Bay the layered ultrabasic rocks occur as sills in the metasediments. They consist of alternating layers mainly 6 inches to 2 feet wide of brown weathering serpentine - actinolite rock and grey weathering green-black amphibolitic rocks. These and similar rocks in this area appear to have been folded with the sedimentary rocks.

Basic Rocks (8b)

Small bodies of diorite and gabbro, widely distributed throughout the area, are considerably altered to metagabbro and amphibolite. They are mainly dark green, medium grained massive rocks that vary in composition; the main constituents are andesine, hornblende and actinolite with lesser amounts of biotite. Minor quartz, orthoclase and iron ores are present.

Northeast of Armit Lake a basic pluton, 7 miles wide and 15 miles long has been outlined. Scattered rounded outcrops of gabbro, diorite and monzonite show definite intrusive relationships with the surrounding gneiss and migmatite. In general the pluton is dioritic in the northern and eastern areas, and monzonitic in the central and southwestern areas. Gabbro was observed in the north-central area.

On Melville Peninsula, near the northern boundary of the map-area several metamorphosed basic sills occur in the gneisses. These are dark green, aphanitic to fine grained, massive rocks composed essentially of plagioclase and hornblende. These dykes have a slightly different trend to the diabases in the area, and although contacts were not observed, they appear to be cut by the diabase. They may be related to the basic volcanic rocks of the Prince Albert Group.

GRANITIC AND GNEISSIC ROCKS (9-12)

More than 70 per cent of the map-area is underlain by a wide variety of granitic and gneissic rocks. These have been divided into main units based on a combination of air and ground observations aided by air photo interpretation. Most of the contacts between these units are gradational although locally sharp contacts are present.

Layered gneiss, paragneiss, schist, and quartzite (9)

Layered gneiss, paragneiss and schist probably derived from sedimentary and volcanic rocks occur as linear belts throughout the map-area. Boundaries are not well defined, and the rocks grade from one to another or into granitic gneisses. The schists are generally not extensive enough to form mappable units and in most areas they have been included with the paragneisses.

The paragneisses and schists (9a) are a heterogeneous group of rocks that range in composition from impure quartzite to mafic-rich schists possibly derived from volcanic rocks. The paragneisses are fine to medium grained, light to dark grey rocks composed of quartz, feldspar, biotite and/or hornblende and commonly containing red garnets. Most paragneisses are thinly layered, but many quartz-rich paragneisses and impure quartzites are thickly layered.

Layered gneisses (9b) are similar to the paragneisses but are completely recrystallized and no megascopic evidence of original texture, structure or mineralogy remains to suggest their derivation. They are more homogeneous than the paragneisses

and consist of alternating light and dark layers composed of quartz, feldspar, biotite, hornblende and locally abundant garnet.

Quartzite (9c) is associated with paragneiss and schist in many areas, and, south and west of Wager Bay it is sufficiently abundant to form mappable units.

Granitoid Gneiss (10)

The granitoid gneisses of map-unit 10 form the most abundant exposures of gneissic and granitic rocks. They probably range widely in age and vary in colour, texture, composition, and type and degree of gneissosity.

These rocks are composed essentially of quartz, plagioclase, potassium feldspar, biotite and hornblende. Muscovite and garnet are present in some areas. The predominant colours are shades of pink and grey although zones of dark green to greenish black amphibolitic rocks are present. The gneisses are fine to coarse grained and equigranular to porphyritic or porphyroblastic. The foliation is faint to locally stratiform and is due mainly to the parallel orientation of platy and elongate minerals. In some areas directional components are vague and ill defined and the rock becomes massive. Where such areas are large enough they are mapped as massive granite (12).

Migmatites (11)

The migmatites consist of several varieties of gneissic and schistose rocks intimately interlayered and mixed with granitic material. Here and there these rocks consist essentially of lit-par-lit gneisses, elsewhere they comprise a breccia of angular metamorphic blocks in a granitic matrix. Zones of partially assimilated and extremely contorted metamorphic rocks are widespread. No clear boundaries could be established between the migmatites and the various end members. Contacts are gradational and transitions between varieties within the unit are characteristic.

Granodiorite and Related Rocks (12)

Granite, granodiorite and quartz-monzonite occur as small sills and dykes as well as large plutonic masses that extend over several hundreds of square miles. Two general varieties of granitic rocks have been recognized, but they cannot be precisely classified as most of the divisions are based on megascopic examination.

Fine to medium grained, grey to pink, massive to slightly foliated granodiorite (12) is the most widely distributed variety of granitic rock. Quartz, plagioclase and microcline with variable amounts of biotite and/or hornblende are the major constituents. The mafic minerals rarely form more than 15 per cent of the rock, and they commonly total less than 5 per cent. Some of these rocks are foliated, and probably grade into granitoid gneisses of unit 10.

Porphyritic granodiorite and quartz-monzonite (12a) outcrop extensively south of Brown Lake and north of Wager Bay. They are also present in the upland area south of Wager Bay and on Melville Peninsula. Feldspar phenocrysts ranging from $\frac{1}{2}$ inch to 2 inches long occur in a massive grey to white or pink, medium to coarse grained quartz, plagioclase, potassium feldspar, biotite or biotite and hornblende matrix.

APHEBIAN SEDIMENTARY AND VOLCANIC ROCKS

Penrhyn Group (13-15)

The name Penrhyn Group is proposed for a sequence of deformed and metamorphosed sedimentary rocks that outcrop on Melville Peninsula. They form a triangular shaped area extending from Cape Wilson to Amitioke Peninsula on Foxe Basin to an apex in the central part of Rae Isthmus. Cape Penrhyn is a prominent feature on the east coast of Melville Peninsula.

This group is composed of various metamorphosed sedimentary rocks that include crystalline limestone, quartzite, impure quartzite, meta-argillite, meta-greywacke and derived schists and gneisses. Quartzite and crystalline limestone are most abundant in the lowest part of the section, but all types occur throughout the whole assemblage. The relationship of these rocks to the underlying (basement ?) rocks has not been clearly established. Locally quartzite appears to form a mantle over massive granitic rocks that show no evidence of being intrusive, elsewhere intrusive relationships were observed. The relations between the Penrhyn meta-sediments, granitoid gneisses (10) and granites (12) are discussed in the structural section of this report. The Penrhyn Group appears to be a conformable succession, but no accurate estimate of thickness can be given as top determinations are rare.

Crystalline limestone (13)

Crystalline limestone (13) and related lime silicate and carbonate bearing rocks form the most distinctive unit of this group. Many narrow bands mapped on aerial traverses may frequently be extended with apparent continuity, for many miles with the aid of air photographs.

Typical crystalline limestone is fine to coarse grained and ranges from thinly laminated to thick bedded to massive. Bedding may be marked by slight compositional changes such as laminae rich in lime silicates. It is commonly inter-laminated with well foliated biotite-rich calcareous quartzite layers or silica-rich layers derived from quartz sandstone or chert. Sandy layers are locally present.

Most crystalline limestone contains impurities which have recrystallized as quartz, diopside, olivine, tremolite, phlogopite, feldspar, hornblende and epidote. Graphite forms 3 to 5 per cent of the rock in some localities.

Deformation has resulted in tight isoclinal folds, boudinaged quartzite beds and pegmatite dykes, and flow lines around broken dykes and sills.

Quartzite (14)

Quartzite (14) is both widespread and abundant in the Penrhyn Group but at the present scale of mapping it does not form distinct units. Typical quartzite is a light grey to greyish white, rarely pink or dark grey, fine to medium grained rarely coarsely crystalline rock with sandstone or sandy limestone interbeds. Bedding is commonly well preserved in the purer members with beds as much as 50 feet thick but more commonly less than one foot thick. Crossbedding is well exposed in some areas. Quartzite beds are locally separated by very thin micaceous bands, and where impurities are more abundant it grades into schist or paragneiss. Here and there quartzite and crystalline limestone are interlaminated with beds ranging from 2 mm to 2 cm.

Metasediments (15)

A wide variety of undifferentiated metasediments (15) constitute the greatest part of the Penrhyn Group. Paragneiss and schist are most abundant, but also included are numerous beds and lenses of quartzite and crystalline limestone. Some of the more granitoid gneisses included in this group possibly belong to units 9 or 10 but because of similarities they could not be differentiated. Bedding is preserved in the less metamorphosed varieties and is probably represented by the compositional and textural banding in the gneissic phases. In some units bedding and crossbedding are marked by very fine biotite-rich laminae.

Map-unit 16

Northeast of Erlandson Bay on the west shore of Melville Peninsula quartzite and conglomerate lie with apparent unconformity on steeply to vertically dipping greenstone (1) and granite (12). The quartzite is fine grained, light grey and arkosic and contains limy layers and some intraformational limestone conglomerate beds. The conglomerate contains abundant pink granite pebbles and a few chert, jasper, and greenstone pebbles. The contact between the sediments and the greenstone and granite is not exposed. Although this unit may be of the same age as the Penrhyn Group, no definite relationship has been established other than a lithologic similarity.

DIABASE (17)

Diabase dykes (17) and sills intrude all Precambrian rocks but do not intrude Palaeozoic rocks. Most dykes trend northwest or west-northwest with steep to vertical dips. In general dykes are not abundant but many of those that are present have been traced, with the aid of air photographs for several tens of miles. Some dykes consist of a series of more or less en échelon segments. Individual segments pinch out along strike, and the next segment is offset a few feet to a few tens of feet.

The dykes range in width from a few feet to more than 500 feet but most average about 100 feet.

The texture and composition of the wider dykes show considerable variations from the borders to the centre. The borders are aphanitic to fine grained and greenish black, whereas the central parts are medium to coarse grained, greenish grey more or less equigranular. The weathered surfaces of most diabase is brownish to reddish in colour. The diabase is composed essentially of labradorite and pyroxene with small amounts of magnetite, apatite and quartz.

PALAEOZOIC SEDIMENTARY ROCKS

Sandstone (18)

About 350 feet of more or less flat-lying friable sandstone outcrops on Simpson Peninsula between Keith Bay and Login Bay. It is grey to greyish orange and fine to coarse grained. Some of the sandstone is thick bedded but most is medium to thin bedded. Crossbedding is not widespread. In general the thick bedded, fine grained, moderately well indurated beds form the prominent scarps in the area.

The contact between the sandstone and the older rocks was not observed but presumably it lies on an older surface of low relief. No fossils were found in this unit.

Dolomite (19)

Dolomite outcrops on Simpson Peninsula, Wales Island, White Island, Southampton Island and in the Parry Bay region of Melville Peninsula. Outliers are preserved on both sides of Hoppner Inlet and near Cape Robert Brown on the east side of Melville Peninsula. These rocks are light grey to light brown and thin to thick bedded. On Simpson Peninsula the unit lies conformably above the sandstone (18). Fossils were collected in numerous localities but most are poorly preserved. They included species of Ordovician and Silurian ages (G. W. Sinclair, personal communication.

STRUCTURAL FEATURES

The scale of mapping used on Operation Wager permits only broad structural interpretations although here and there where more detailed mapping was carried out, for example the area shown on Figure 1, more detailed interpretations have been made. Attitudes of bedding planes, schistosity and gneissosity are shown on the geological map. They serve to delineate the general structural trends and indicate the conformity of many of the metamorphic and granitoid rocks. Geologic and topographic maps also illustrate possible relationships between foliation, joints, faults and lineaments.

Many faults and lineaments are shown on the accompanying map and more could be inferred. Most faults and lineaments strike northwesterly. A major fault system is suggested from a combination of faults, lineaments and joints that extends from White Island, crosses Rae Isthmus and extends northwesterly to Login Bay. Wager Bay, Ford Lake and Brown Lake are probably bounded by east-west and northwest striking faults and lineaments.

Joints and joint systems appear to have influenced the development of many topographic features. In central Melville Peninsula, in the upland area south of Wager Bay and between Repulse Bay and Lyon Inlet the major joints are widely spaced and more or less horizontal. This type of jointing has probably contributed to the development of the subdued relief and the scattered distribution of outcrops.

The Penrhyn Group rocks are folded along northeasterly trending axes. The pattern and distribution of the various rock types suggests that this is part of a major northeasterly plunging basin. At the eastern end of this fold belt near Foxe Basin the dips are moderate to steep and at the western end north of Lyon Inlet the dips are steep to vertical.

MANTLED DOMES

In the Lyon Inlet area a series of dome-like structures (Figure 1) has many similar features. These structures consist of oval to elongate cores of plutonic rocks overlain and bordered by paragneiss, quartzite and crystalline limestone.

The core rocks range in composition from granite to granodiorite. They are medium grained, equigranular and moderately to well foliated with small areas of massive medium grained granite or granodiorite. Mafic inclusions, layers and schlieren were noted in some areas.

The contacts are generally sharp and the foliation in the core is conformable with the bedding or gneissosity in the metasediments. It could not be established whether or not the upper contact of the plutonic rocks was at the same stratigraphic horizon although contacts were traced almost continuously for several thousand feet.

In several areas migmatite occurs between the core rocks and the metasedimentary rocks. At one place the paragneiss is highly permeated with granitic material and is indistinguishable from some of the well foliated granite gneisses of the core. In another outcrop granite gneiss appears to be developed from biotite-rich quartzite that contains abundant granitic veinlets. Massive granite, granodiorite and pegmatite dykes and sills intrude both the metasediments and the granite gneiss.

An intrusive contact was observed between massive granite and metasediments on the north side of one plutonic dome. The massive granite grades into well foliated granite gneiss and at the south side of the pluton a conformable contact with the metasedimentary rocks was seen.

The metasedimentary rocks dip away from the cores in most areas although the dips are toward the core in a few places. Most of the thin metasedimentary septa separating the areas of granite gneiss in the central part of the dome area are synformal and the metasediments at the noses of the domes are antiformal.

The layering and gneissosity in the metasediments sweep around the noses of the domes, and are conformable with the foliation of the domes. These structures may be the result of : (1) synkinematic granitic intrusion in a sedimentary sequence; (2) granitization of the basal section of a folded sedimentary sequence; or (3) diapir-like intrusions of basement rock in a folded sedimentary succession.

AGE DETERMINATION AND REGIONAL CORRELATIONS

Samples were collected from all areas for potassium-argon age determinations in the laboratories of the Geological Survey of Canada. The ages and locations of samples chosen for dating are shown on the accompanying map and listed in Table I. The span of ages, 1580 to 1690 m.y. is within the limits of analytical error and therefore of little assistance in correlating and comparing the ages of the various units. Tentative correlations may be made between some of the units of this map-area and those of adjoining areas on the basis of lithologies. These correlations are summarized in Table II. The Penrhyn, Chantrey and Hurwitz Groups are characterized by the association of quartzite, impure quartzite, conglomerate, crystalline limestone, schist and paragneiss; volcanic rocks are absent from this sequence. This association of sedimentary rocks occurs widely throughout the District of Keewatin and in parts of the Districts of Mackenzie and Franklin and further work will be required to establish their relations.

TABLE I

ABSOLUTE AGE DETERMINATIONS

Specimen No.	Location		Map-unit No.	Age, M. Y.
DF-5	64°39'N	90°28'W	9a	1605
BL-137	67°12'N	84°42½'W	9a	1640
JD-372	66°39'N	83°33'W	10	1580
JD-383	67°46½'N	83°18'W	10	1605
BL-240	67°22'N	85°30'W	10	1650
DF-201	68°12½'N	84°35'W	10	1690
HF-365	67°18'N	81°33'W	12	1595
HF-220	65°31½'N	84°39'W	12	1600
HF-170	67°55'N	88°48'W	12	1610
HF-38	65°58½'N	90°39'W	12	1630
GC-43	65°47'N	87°49'W	12	1640
DF-323	66°46'N	84°55'W	15	1615

TABLE II – REGIONAL CORRELATION TABLE

Northeastern District of Keewatin (Operation Wager)	Northern District of Keewatin (Operation Back River)	Central District of Keewatin (Operation Baker)
Penrhyn Group	Chantrey Group Hurwitz Group	Hurwitz Group
Map-unit 9, 10	Map-unit 5	Map-unit 5
Prince Albert Group	Map-unit 1, 2	Map-unit 1

The Prince Albert Group (northeastern District of Keewatin), map-units 1 and 2 (northern District of Keewatin) and map-unit 1 (central District of Keewatin) contain abundant volcanic and derived metamorphic rocks. Iron-formation is common in the northeastern District, some iron-formation is present in the northern District of Keewatin but it is not reported from the central District of Keewatin. The rocks of this association are moderately to intensely folded and metamorphosed, and are probably older than the Chantrey-Hurwitz-Penrhyn Groups. Hurwitz type rocks conformably overlie volcanics in the central District of Keewatin (Wright, 1955), but were not found in contact in the other areas.

Metamorphic rocks of map-units 9 and 10 of the northeastern District of Keewatin, map-unit 5 of northern Keewatin and map-unit 5 of central Keewatin contain recognizable metasedimentary rocks as well as amphibolites and hornblende gneisses possibly derived from volcanic rocks. These units may be derived from the Prince Albert Group and its correlatives.

ECONOMIC GEOLOGY

Little prospecting has been undertaken in the map-area due to the remoteness of the region, the short summer season and the lack of geological information. In general, reconnaissance mapping is not compatible with the search for mineral deposits, however, the accompanying map and report will assist in an assessment of the area and in limiting the favorable prospecting areas.

Gossans, rusty zones and mineral occurrences are shown in many localities on the geological map. The following areas and groups of rocks are the most interesting: the Prince Albert Group, especially the volcanic rocks; the Penrhyn Group in the area of mantled domes; the metasedimentary rocks, paragneisses and gneisses of unit 9; the basic and the ultrabasic rocks; and the Daly Bay area.

Several samples were submitted to the Geological Survey of Canada for quantitative spectrographic analyses of nickel, copper, lead, zinc, cobalt and molybdenum, and to the Mines Branch of the Department of Energy, Mines and Resources for gold and silver assays. Most of these samples were deeply weathered

TABLE III

ASSAYS OF WEATHERED MATERIAL FROM RUSTY ZONES AND GOSSANS

	Ni	Cu	Co	Mo	Ag	Au
BL-20	0.0074	0.11		0.012		
BL-85	0.0098	0.035	0.010			
BL-96-5	0.018	0.065		0.0060		
BL-97-5	0.0062	0.013				
BL-252	0.0048	0.057				
BL-267-3	0.017	0.020				
BL-270-2	0.011	0.025				
BL-304	0.016	0.020				
BL-344	0.0096	0.0079				
BL-366	0.0092	0.011				
HF-126		0.011				
HF-156	0.0094	0.058				
HF-175	0.029	0.069	0.0044			
HF-324	0.0077	0.084	0.021			
HF-331		0.034				
GC-86-2	0.0097	0.025				
DF-269	0.020	0.0066				
JD-113-6	0.0074	0.090				
JD-199-5	0.0044	0.11				
JD-214-4	0.0047		0.0088			
JD-235-6		0.50				
JD-305-1		0.024				
JD-317-5		0.0067				
JD-353-2	0.017	0.025				
JD-361-4		0.074				
JD-384-4	0.17	0.13		0.016		
JD-398-4	0.0021	0.023	<0.0030			
JD-417-3	0.0084	0.025				
JD-420-4	0.0065	0.0045				
JD-424-0	0.29	0.46	0.036			
JD-427-3	0.0049	0.025				
JD-429-4	0.012	0.021				
JD-435-2	0.026	0.028				
JD-450-4	0.016	0.015		0.011		

I. Pb and Zn not found.

II. Ni, Cu, Co and Mo determined by quantitative spectrographic analyses by Geological Survey of Canada.

III. Ag and Au assayed by Mines Branch.

TABLE IV - DAVIS TUBE TEST RESULTS

Sample	Davis Tube Products			Fe (Total) % Recovery	Analysis of Fe Concentrate %					
		Weight %	Fe (Total) % *		Fe Sol.	Insoluble	SiO_2	P	Mn	S
DF-196-A	Con	86.1	54.02	97.3	53.71	25.58	24.84	0.05	0.045	0.038
	Tailing	13.9	7.57							
	Head	100.0	47.9							
DF-302	"	4.1	54.94	6.1	54.88	25.53	25.27	0.06	0.094	a
	"	95.9	35.03							
	"	100.0	36.0							
DF-316	"	58.7	65.09	95.0	65.05	9.86	9.82	0.02	0.006	0.02
	"	41.3	4.66							
	"	100.0	40.12							
JD-283-7	"	58.7	65.99	96.2	65.81	8.44	8.32	0.10	0.014	0.02
	"	41.3	3.62							
	"	100.0	40.24							
JD-425-10	"	54.5	47.83	72.2	45.65	36.46	31.25	0.05	0.059	0.063
	"	45.5	10.65							
	"	100.0	36.20							
JD-427-1	"	61.8	43.78	82.5	43.78	41.80	39.00	0.03	0.007	0.064
	"	38.2	15.09							
	"	100.0	32.76							
JD-431-1	"	51.1	57.45	88.0	56.93	20.70	19.56	0.06	0.012	0.056
	"	48.9	8.15							
	"	100.0	33.57							

* Head analyses are calculated for each sample. a Insufficient sample supplied.

and the results are generally disappointing; however the analyses are listed in Table III as a guide to indicate the elements present.

Seven samples of iron-formation were submitted to the Mines Branch of the Department of Energy, Mines and Resources for Davis Tube Tests and analyses. The following is a résumé of Mineral Processing Division Test Report MPT-65-30 by D. E. Pichett, and Mineral Sciences Division report AC-65-53 by J. C. Hole. Chemical analyses and results of the Davis Tube Tests are given in Table IV.

Two samples (DF-316 and JD 283-7) yielded concentrates of acceptable grade assuming that the product would be used for pelletized iron ore. Iron recovery was very good in both samples but some research would be necessary to reduce the phosphorus in sample JD-283-7 to an acceptable 0.05 per cent. Recovery was also good from DF-196-A and JD-431-1 but concentrate grade was low. This might possibly be improved by finer grinding of the concentrate and retreatment by magnetic separation, hydroseparation or flotation. Sample DF-302 with a total iron content of 49 per cent yielded only 4.1 per cent as magnetic concentrate so this sample must be mainly hematite or goethite.

REFERENCES

Bronhofer, Max

1957: Field investigations on Southampton Island and around Wager Bay, Northwest Territories, Canada, 1956; U.S. Air Force Project Rand Research Memorandum RM-1936, The Rand Corporation, Santa Monica, California.

Canada, Department of Transport

1957: Air Navigation Order; Ser. 5, No. 14, pt. 4.

Heywood, W. W.

1961: Geological Notes, Northern District of Keewatin; Geol. Surv. Can., Paper 61-18.

1966: Geological Notes on Operation Wager, Northwest Territories; Geol. Surv. Can., Paper 66-10

Teichert, C.

1937: Ordovician and Silurian faunas from Arctic Canada; Report of the Fifth Thule Expedition, 1921-1924, Vol. 1, No. 5.

Wright, G. M.

1955: Geological notes on central District of Keewatin, Northwest Territories; Geol. Surv. Can., Paper 55-17.


1867 Centennial of Canadian Confederation 1967
Le Centenaire de la Confédération Canadienne 1967