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DEPARTMENT OF MINES AND TECHNICAL SURVEYS

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GEOLOGICAL NOTES, NORTHERN DISTRICT OF KEEWATIN

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(Report and map)

W. W. Heywood

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By

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CONTENTS

INTRODUCTION

This is an account of the northward continuation of the geological reconnaissance by helicopter in the District of Keewatin. On this project (Operation Back River) five geologists using two helicopters mapped about 55,000 square miles during the 1960 field season.

The centre of the area is about 200 miles north of Baker Lake, District of Keewatin, and 600 miles north of Churchill, Manitoba. There are no permanent settlements in the area, but Distant Early Warning (Dew-Line) beacons are located on Boothia mainland (Department of Transport, 1957)[1]. Transportation by air is the only practicable means of access, although part of the northern coastal areas could be serviced by ship during most summers. The southeastern corner of the area is accessible from Wager Bay. Canoe routes into the area are too long and difficult, but within the area they can be used during the summer.

Previous geological work in the area has been almost entirely confined to short notes and reports by early explorers of the northern coastal area, the area near Wager Bay, and the Back River drainage system.

Relief is generally low except near Wager Bay, the eastern and central parts of Boothia mainland, and part of the eastern side of Chantrey Inlet. Broad uplands characterize the southern part and low plains form much of the coastal areas.

The area was mainly covered by helicopter traverses spaced at 6-mile intervals. Flight lines were parallel except on Boothia mainland and Adelaide Peninsula where a radial network was used. Air photographs aided flight planning and interpreting the geology between flight lines.

Snow covered most of the area until the last week in May 1960, and 61 of the 81 days spent in the map-area were suitable for geological traversing by helicopter. Break-up at the field camp on a lake on Hayes River lasted from June 13 to June 28, and it was possible for float-equipped aircraft to land there in late June. As few other lakes were open until the second week in July, many landings were made in the quiet reaches of the larger rivers or in small lakes on these rivers. Many of the larger lakes remained ice-bound until late July or early August.

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[1] Names and dates in parentheses refer to publications listed in the References.

Wildlife is varied but not abundant. In contrast to observations made on previous helicopter operations in the barrens, only two musk-oxen were sighted. Caribou, singly or in small groups were present throughout most of the area. Arctic hares and foxes were relatively common but wolves were rare. Swans, geese, and ducks were abundant, especially in the northern coastal areas. Ptarmigan were numerous in all parts of the area. Lake trout and Arctic char could be easily caught in most lakes.

The surficial geology is described in a separate paper (Craig, 1961).

Acknowledgments

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Thanks are due for the hospitality and assistance of personnel of the Department of Transport, of the Hudson's Bay Company at Baker Lake, and of the Department of National Defence at Fort Churchill.

Helicopters were supplied by Spartan Air Services Limited of Ottawa. A Norseman and a Cessna 180 were chartered from Thomas Lamb Airways of the Pas. Freighting at the commencement of the field season was done by TransAir Limited of Winnipeg. The cooperation of the aircrews is gratefully acknowledged.

References

Craig, B.G.
1961: Surficial Geology of Northern District of Keewatin; Geol. Surv., Canada, Paper 61-5.

Department of Transport
1957: Air Navigation Order; ser. 5, No. 14, pt. 4.

Lowden, J.A. (comp.)
1960: Age Determinations by the Geological Survey of Canada. Report 1-Isotopic Ages; Geol. Surv., Canada, Paper 60-17.

Wright, G.M.
1955: Geological Notes on Central District of Keewatin, Northwest Territories; Geol. Surv., Canada, Paper 55-17.

1957: Geological Notes on Eastern District of Mackenzie, Northwest Territories; Geol. Surv., Canada, Paper 56-10

GENERAL GEOLOGY

Sedimentary and Volcanic Rocks, Metamorphic Rocks, and Acid Intrusions

The oldest rocks (1, 2)* in the area constitute a diverse group of metamorphic rocks derived from sedimentary and basic to intermediate volcanic rocks. Both along and across strike they grade into mixed gneisses and granite-gneisses of unit 5, and components of units 5 and 6 are locally included in this group.

Undivided schists and gneisses (1) of sedimentary and volcanic origin underlie considerable areas in the eastern half of the map-area. They are fine- to medium-grained rocks containing discontinuous layers that have not been highly metamorphosed or altered. Gradations from impure quartzite to biotite-quartz schist and gneiss are not uncommon. Amphibolite and hornblende-rich layers are widespread in occurrence.

Greenstone, amphibolite, and hornblende schist and gneiss (1a) are probably derived from volcanic rocks. The greenstone is aphanitic to fine grained, medium to dark green or black on the fresh surface and dark green or buff on the weathered surface. It is massive to schistose and locally contains amygdules. Pillow structures are rare. Plagioclase (albite-oligoclase), chlorite, and epidote are the essential minerals, but with increasing grade of metamorphism this rock becomes amphibolite and hornblende schist and gneiss composed largely of plagioclase (oligoclase-andesine), hornblende, biotite, and quartz. These higher-grade metamorphic rocks are massive to schistose and fine to medium grained. They are generally dark coloured on both the fresh and weathered surfaces. Quartz-biotite schists and gneisses (1b), locally containing abundant hornblende and garnet, are interlayered with the volcanic-derived rocks. Associated with these metamorphic rocks are prominent ridges of white quartzite (1c) that are lithologically similar to the Hurwitz quartzite (3). The quartzite is thin bedded to massive, fine to medium grained, and composed almost entirely of quartz. Muscovite and garnet are locally present. Layers of quartz-magnetite iron-formation from 1/8 inch to 12 inches thick are interbedded with some of the quartzite. The total thickness may be as much as 2,500 feet, but repetition of beds may have resulted from folding or faulting. The quartzite is conformable with the adjacent schists and gneisses, and near the headwaters of Hayes River it is seen to pass into schist and gneiss with a gradual increase in the amount of feldspar, biotite, and/or muscovite.

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* Numbers in parentheses are those of map-units on the accompanying map.

Schists, gneisses, and amphibolites (2), possibly also derived from sedimentary and volcanic rocks, form large masses on Boothia mainland and in the western part of the area. These rocks are composed essentially of plagioclase and hornblende with various amounts of biotite, quartz, orthoclase, garnet, and magnetite. In general they are fine to medium grained although, not uncommonly, they are coarse grained. Most are dark coloured, even plagioclase gneisses that have a relatively low mafic content. The quartz and orthoclase content is generally low, and the occurrence of garnets is widespread but patchy. Lime-silicate gneisses, garnet-biotite rock, and a small amount of crystalline limestone are interlayered with hornblende-plagioclase gneisses in the northwestern part of the area. Small pods and thin layers of medium- to coarse-grained quartz-magnetite iron-formation are associated with garnet gneisses and lime-silicate gneisses south of Ogden Bay. Minor amounts of granite and mixed gneiss are included in this formation. Unit 2a, in the northeastern part of the area, is a more heterogeneous group having components similar to units 2 and 5. It consists of amphibolites, plagioclase gneisses, and biotite and biotite-hornblende gneisses interlayered with granite-gneiss. Quartz and garnet are locally abundant and a relatively pure quartzite forms one mappable unit. Layering is well developed throughout this northern area with contrasting light and dark layers ranging in thickness from a few inches to a few tens of feet.

A narrow belt of folded sedimentary rocks (3) extends about 40 miles northeasterly from lat. 66°N, long. 97°30'W. These rocks are moderately to steeply dipping, and although tops are not generally determinable, they appear to form a syncline. White, grey, or pink quartzite—the predominant rock—is fine grained, massive to schistose and locally moderately well bedded. Interlayered with the quartzite are many thin beds of crystalline limestone and quartzose crystalline limestone. Phyllite and massive to schistose greywacke (3a) occur near the base of the quartzite. Unsheared graphic granite dykes intrude the sedimentary rocks. These rocks probably represent a northerly extension of the Hurwitz group mapped by Wright (1955, 1957).

The name Chantrey group is proposed for a belt of highly deformed sedimentary rocks (4) that extends for 125 miles northeasterly from Chantrey Inlet. Tops of beds are rarely determinable and dips range from 25 to 90°. Schistosity generally parallels bedding. The axes of drag-folds and of some of the larger folds plunge in a northerly direction at 5 to 10°.

Crystalline limestone and quartzite predominate, with lesser amounts of conglomerate, greywacke, slate, chert, and basic volcanic rocks. The limestone weathers white to cream coloured, is finely to coarsely crystalline, and contains few to abundant white or greenish white diopside crystals as much as 6 inches long. Chert layers 1/4 inch to 3 inches thick occur with the limestone and may form as much as 50% of the rock. The quartzite is fine to medium grained and white or grey; locally it is buff or even green, due to abundant green-stained muscovite. The conglomerate, composed of quartz pebbles and cobbles in a quartzite matrix, is of limited distribution. Greywacke and dark grey slaty rocks form relatively thin beds in the quartzite. Greenstones, derived from basic volcanic rocks, are rare. Quartz-biotite schist and quartz-biotite-muscovite schists are locally abundant. Minor amounts of quartz-rich layered gneiss are present.

The contacts between these sedimentary rocks and the adjacent granitic rocks are rarely exposed. In many places, extensive shearing characterizes the contact area, but elsewhere there is some evidence to suggest that these sedimentary rocks are metamorphosed to schist and gneiss indistinguishable from the schist and gneiss of units 1 and 5. Pegmatite dykes and sills intrude these sedimentary rocks.

The relations between the Chantrey group (4) and the Hurwitz group (3) are not known; because of their geographical separation they are not grouped together, despite the fact that in general they are lithologically similar and have more or less similar structural relationships with the enclosing gneisses and granites.

The rocks of map-unit 5 are widespread and abundant. They vary widely in colour, texture, and grain size, and in relative abundance of quartz, plagioclase, orthoclase, biotite, hornblende, and garnet. Most are grey and pink although in many places they are white or red. Most of the rocks are medium grained but fine- and coarse-grained varieties are widespread, and some contain feldspar porphyroblasts. Gneissosity and schistosity are moderately well developed although massive varieties are present. Numerous small areas of schist, paragneiss, and amphibolite (probably related to units 1 and 2) are not mapped separately. Southwest of Pelly Bay the gneisses are characteristically quartz rich and contain layers of impure quartzite.

Map-unit 5 may be a group related intermediate between the metamorphic rocks of units 1 and 2 and the generally massive granitic rocks of unit 6.

Numerous bodies of foliated to massive granite, granodiorite, and quartz diorite (6) occur throughout the area. They are probably intrusive although some may be more massive varieties of the granite-gneiss (5). They are white, grey, pink and red and are mainly equigranular and medium to coarse grained, but they may be fine grained or porphyritic. Quartz, plagioclase, orthoclase, biotite, and hornblende are the major constituents. Gneissic to foliated granitic rocks (6a) occur as isolated formations and as phases of the more massive types. They may be related to the gneiss of unit 5, but as they occur in more or less homogeneous masses, they are more probably related to the massive granites. All have about the same composition and texture.

Locally the granitic rocks show relatively sharp contacts with the adjacent rocks, but in most places the contact is gradational through a mixed zone of variable width. The granitic rocks generally contain few or no inclusions, although inclusions are abundant at the south end of Chantrey Inlet.

In general, foliation, gneissosity, and lineation in the granitic rocks is parallel with that of the enclosing rocks. Jointing is prominent. Pegmatite and aplite are uncommon.

Cataclastic gneiss, augen gneiss, and mylonite are common throughout the area but are not shown on the map. Probably the most interesting occurrences are in a wide, rather poorly defined zone trending southwesterly from Elliot Bay in Chantrey Inlet. The rocks involved include schists, gneisses, amphibolites, and granitic rocks of units 1, 2, 5, and 6. This zone roughly separates the rocks to the west, which are characteristically darker in colour, generally more basic, and contain more garnet- and hornblende-bearing varieties, from the rocks to the east, which are typically biotite and/or hornblende schists and gneisses. These differences may be due in part to differences in metamorphism and in part to differences in the original sediments from which the metamorphic rocks were formed. The rocks of units 2 and 2a on Boothia mainland are similar in texture and composition to the rocks of the western area.

Basic Intrusive Rocks

Most of the rocks of unit 7 occur in the belt of metasedimentary and metavolcanic rocks (1) extending northeasterly from lat. 66°N, long. 93°30'W; three occurrences are in gneisses of unit 5. Dykes and sills that range from a few feet to a few hundred feet wide can be traced along strike as a series of discontinuous outcrops for as much as 3 miles. Plugs, pods, and irregularly shaped masses are up to 2 miles in their longest dimension. The larger masses are readily recognized both from the air and on air photographs. On the latter they appear as rubbly hills and ridges. From the air and on the ground they have a characteristic brown-weathered surface.

Most of the peridotite is partly serpentinized and much of it is entirely altered to serpentinite, soapstone, talc schist, and talc-tremolite schist. The freshest specimens were obtained from a slightly elongated plug west of Pearce Lake. This peridotite is medium to coarse grained, equigranular, massive, and highly fractured, with serpentine developed in the fractures. Olivine forms about 90% of the rock and serpentine about 10%, with minor amounts of magnetite. The contacts with the enclosing gneisses are not exposed. Numerous peridotite sills and dykes occur in the metasedimentary and metavolcanic rocks on the north and east sides of the lake on Hayes River at approximately long. 92°W. At the north end of this lake, sills ranging in width from a few feet to a few tens of feet show a definite compositional layering represented by a variation in the olivine-to-pyroxene proportion. All of these sills and dykes are more or less altered with the development of serpentine and, near the margins of some of the sills, talc-tremolite schist. Some of these sills were folded contemporaneously with the enclosing metasedimentary and metavolcanic rocks, as shown by the conformity of small folds in both the sills and the country rock.

Rocks (8) ranging in composition from gabbro to diorite occur throughout the area as dykes, sills, and small plugs. Few of the dykes and sills could be traced far along strike. Medium- to coarse-grained gabbro is greenish black to black on both fresh and weathered surfaces. It is predominantly equigranular and massive. In some areas the boundaries of the gabbro are schistose and the rock becomes a hornblende schist or amphibolite. Plagioclase, hornblende and augite are the main constituents, with minor amounts of biotite and magnetite.

A gabbroic rock forms a small plug at long. 94°50'W near the south boundary of the map-area. Near its western border this rock is composed essentially of garnet and diopside with lesser amounts of hornblende, quartz, and plagioclase.

A large mass of diorite and gabbro trends northerly from the north end of Franklin Lake. This rock is medium to coarse grained, locally fine grained, and is composed mainly of plagioclase, and hornblende and/or augite. In part it is a plagioclase-hornblende schist. Isolated outcrops of greenish black hornblendite occur in this same general area. Two large bodies of gabbro occur east of Lady Melville Lake. These are massive, medium-grained, locally porphyritic gabbros, composed of plagioclase, pyroxene, hornblende, and a minor amount of magnetite.

Gabbro, diabase, and basalt dykes (9) have been found intruding all rocks except the peridotite (7) and the Palaeozoic rocks (10). They are most abundant in the eastern part of the area and are rare or absent in most of the western half. The dykes range from about 2 to 200 feet thick and few could be traced for more than a mile or two, although one large dyke was traced, with some gaps, for 30 miles. The dyke rock is aphanitic to medium grained, greenish grey to dark green on fresh surfaces, and is characteristically buff to brown on weathered surfaces. Most of the dykes trend northwest and dip more or less vertically.

Palaeozoic Rocks (10)

Palaeozoic sedimentary rocks (10) outcrop sparsely on the low coastal plains of Adelaide Peninsula and on the western part of Boothia mainland. The extent of the areas underlain by Palaeozoic rocks, as shown on the map, has been determined from topography and from the occurrence of limestone and dolomite rubble in the glacial till. Friable, buff to grey, fine- to coarse-grained sandstone and pebbly sandstone (10b) lie unconformably on the Precambrian rocks. These rocks are overlain, probably conformably, by buff- to grey-weathering, thin- to thick-bedded limestone and dolomite (10a). Fossils are rare. The best collection was obtained from rubble on the largest of the Schwatka Islands in Sherman Basin. It included species of Ordovician and Silurian ages (G. W. Sinclair, personal communication).

No reliable estimate of the thickness of the Palaeozoic rocks is possible.

ECONOMIC GEOLOGY

Little prospecting has been done in the map-area, largely because of its remoteness. During reconnaissance mapping, such as the present work, a detailed search for mineral deposits is not possible. Transportation to and within the area will present a major problem in any exploration and development undertaken. Gossans, rusty zones, and mineral occurrences are shown on the map.

Probably the most interesting part of the area is the belt of metasedimentary and metavolcanic rocks (1) that extends northeasterly from lat. 66°10'N, long. 93°30'W and contains the ultrabasic bodies (7) and the greenstones (1a). Numerous mineralized areas are associated with these rocks and although pyrite and pyrrhotite are the most common sulphides present, some copper stain was observed. The rusty zones and gossans range from a few square feet in area to as much as 1,000 feet long and several tens of feet wide. Quartz-magnetite iron-formation, probably of sedimentary origin, is present in layers up to 1 foot thick and is associated with quartzite (1c). Magnetite veinlets up to 1/2 inch thick are abundant in a brecciated greenstone (1b) at lat. 66°33'N, long. 92°32'W. Numerous rusty zones occur in the schists and gneisses (2, 2a) on Boothia mainland and are common in the mixed gneisses (5) in the same area. A large rusty zone in the gneisses (5) on the southwestern end of Pangnikto Lake is about 1,000 feet long and more than 50 feet wide. Rusty areas are common in the well-exposed schists, gneisses, and amphibolites (2) south and west of Sherman Basin. Pyrite occurs in Hurwitz phyllites and greywackes (3a) west of Back River. Pegmatite dykes intrude the Chantrey group sedimentary rocks (4), and some pyrite occurs in the schists derived from them.

AGE DETERMINATIONS

The locations of samples collected for potassium-argon age determinations by the Geological Survey are shown on the accompanying map. All measurements except one were made on biotite. The ages are assumed to be those of the crystallization of the micas and therefore they probably date the last period of metamorphism, or the time of intrusion. The limits of analytical error are approximately $\pm$ 6 per cent at 1,000 m.y., decreasing to approximately $\pm$ 5 per cent at 2,500 m.y. (Lowden, 1960).

The ages from the area covered range from 1,640 to 1,880 m.y. All samples except one fall between 1,640 and 1,750 m.y. and therefore are all within the limits of analytical error. The one exception, from an area characterized by calc-silicate rocks, has a minimum age of 1,880 m.y. Muscovite from a pegmatite sill that intrudes the metasedimentary rocks of the Chantrey group gives an age of 1,680 m.y. There is no evidence to suggest that the pegmatite was folded with the sedimentary rocks, and this pegmatite is similar to pegmatites that intrude the foliated granite in this area. The age suggests that the sedimentary rocks were deposited before or during the metamorphic period and before the end of the tectonic cycle. Further detailed mapping will be necessary in order to clarify the relations between the Chantrey group and the adjacent granitic and metamorphic rocks.

The concentration of ages within so short a range make this area probably one of the most striking in the western Canadian Shield. These ages, together with those previously described from the west to the Bathurst lineament, south to Baker Lake, and east to Baffin Island (Lowden, 1960), suggest that a very large area is underlain by granitic and metamorphic rocks that were developed at or about the same time.