60-20

GEOLOGICAL SURVEY OF CANADA

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DEPARTMENT OF MINES AND TECHNICAL SURVEYS

PAPER 60-20

BELCHER ISLANDS, NORTHWEST TERRITORIES

33M, 34D, E

(Report and Map 28-1960)

G. D. Jackson

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CONTENTS

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INTRODUCTION

Belcher Islands area lies in the southeast part of Hudson Bay, and includes the Belcher, Bakers Dozen, and King George Islands. In 1959 high winds prevented the party from visiting any of the North Belcher Islands except Johnson Island, and from completing the area north of Windy Lake. The geology of the latter areas, as shown on the accompanying map, is based mainly on interpretation of air photographs, and on information obtained from Belcher Mining Corporation and the Eskimos. Bedrock is very well exposed in these areas and the interpretation is believed to be reliable.

Belcher Islands are a group of long, narrow islands and associated peninsulas, elongated in a north-northeast direction, whose shapes reflect accurately the geological structure and character of the underlying bedrock. In some places the land surface rises gently away from the shore; elsewhere cliffs 150-200 feet high are present. Relief is low, and the highest point, near the centre of Tukarak Island, is about 450 feet above sea-level.

Bakers Dozen and King George Islands are low lying and flat to gently rounded. Most of them, unlike the Belcher Islands, are elongated at right angles to the general strike of the strata.

Acknowledgments

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STRATIGRAPHY

All rocks in the map-area may be included in the Belcher group of clastic and chemically precipitated sedimentary rocks, and volcanic flows. These have been intruded by basic sills and dykes. The thickness of the group ranges from a minimum of 19,900 feet to a maximum of at least 29,800 feet, due mainly to variations in the thicknesses of the volcanic units.

A detailed section was made across the east limb of the Tukarak-Innetalling anticline south of Laddie Harbour. Using lithological variations, mutual stratigraphic relations, and the occurrence of various types of stromatolites, the rocks have been divided into sixteen map-units, many of which have in turn been divided into members. Because of the excellent exposures throughout most of the area, air photos were most useful in extending contacts between traverse lines. Many of the rock types are repeated at different stratigraphic levels, and it is extremely difficult to identify several of the units by lithology alone. No major unconformities or repetitions by faulting were observed and deposition seems to have been continuous, except for small local unconformities.

Table of Formations

Era	Group	Map-unit	Lithology	Thickness (feet)
Cenozoic (Recent)			Silts, sands, gravels, beach deposits	
			Angular unconformity	
Proterozoic	Belcher	16	Arkose, quartzite, argillite, conglomerate	700+
		15	Greywacke, argillite, lithic and arkosic quartzites, tuff	7,000+
		14	Diabase, feldspar porphyry sills and dykes	
			Intrusive contact	
		13	Basalt, tuff, agglomerate, feldspar porphyry	960-6,400
		Kipalu formation (12)	Ferruginous 'argillites', ferruginous jasper and chert, some containing ferruginous carbonate, ferruginous quartzite	200-380+
		11	Quartzite, feldspathic quartzite	130-475+
		10	Upper: Interbedded quartzites and dolomites	620-1,000
			Lower: Dolomite, arenaceous dolomite	150-280

Table of Formations

(cont'd)

Era	Group	Map-unit		Lithology	Thickness (feet)
Proterozoic	Belcher	8	9	Upper: Argillite, quartzite, dolomite	660±
				Lower: Interbedded argillite, limestone, dolomite	425±
			8a 7	Interbedded limestone, dolomite, argillite; slate, argillite at base	800-1,200
			8a 6	Dolomite with stromatolite zones	450-550+
			5	Upper: Interbedded argillite, limestone, dolomite	200-230
				Lower: Argillite, dolomite, quartzite	
			4	Upper: Dolomite with stromatolite zones	1,200-1,420
				Middle: Dolomite with few stromatolite zones, quartzite	
				Lower: Interbedded dolomite and quartzite	
			3	Argillite, quartzite, dolomite, tuff, arkose, basalt	1,200-2,000

Table of Formations

(cont'd)

Era	Group	Map-unit	Lithology	Thickness (feet)
Proterozoic	Belcher	2	Basalt, feldspar porphyry, argillite, tuff, agglomerate, granular jasper	0(?)-3,000+
		1	Dolomite with stromatolite zones, limestone, argillite	4,000

Unit 1

This unit contains the oldest known rocks in the area mapped, and is best exposed in the Kasegalik Lake area where about 4,000 feet of strata are present. Most of the strata are thin- to thick-bedded, aphanitic to finely crystalline, pink to grey dolomites and siliceous dolomites. The grey beds contain stromatolites from less than 1 inch in diameter to broad dome-shaped bodies 12 feet across. Zones up to 15 feet thick of interbedded red calcareous argillite and pink dolomite occur near the base; green chloritic argillite a few feet thick occurs at the top.

Unit 2

Unit 2, about 3,000 feet thick in the vicinity of Windy Lake, becomes progressively thinner southward in the Kasegalik Lake area. It is composed mainly of aphanitic to fine-grained, massive, dark green-grey basalt, in part amygdaloidal and locally pillowed, and medium- to coarse-grained feldspar porphyry. Laminated to thin-bedded green and red argillite, tuff, agglomerate, rhyolite, and arkose are interbedded with the main rock types. About 4 miles north of Moore Island, lean, granular, jasper iron-formation, 2 to 3 feet thick, is associated with argillite near the top of the unit.

Unit 3

This unit is between 1,200 and 2,000 feet thick in the Kasegalik Lake - Eskimo Harbour area. It consists mainly of green, grey, and red, laminated to thin-bedded argillite, with considerable interbedded greywacke in the lower part and considerable quartzite in the upper. The unit is less argillaceous toward the top. Tuff, arkose, and amygdaloidal basalt are present near the base, and red colours occur almost exclusively in the lower part. Dolomite zones up to 130 feet thick occur at widely spaced intervals throughout the unit. A white to grey, medium- to coarse-grained quartzite bed is taken as the top of the unit.

Unit 4

Throughout most of the area a bed of dolomitic quartzite and dolomite conglomerate at the base of this unit overlies unit 3 conformably. Unit 4 has a maximum thickness of 1,430 feet west of McLeary Point where it may be divided into three members — a division that holds generally throughout the map-area. The lower member, 680 feet thick is composed of thin- to thick-bedded light grey and pink dolomite with a few stromatolitic zones, arenaceous dolomite, and quartzite. Quartzite occurs mainly in zones up to 30 feet thick, with some of the strata showing crossbedding. The middle member, 290 feet thick, is mainly pale-pink, aphanitic, siliceous dolomite with minor interbeds of quartzite and grey stromatolitic dolomite. The upper member, 460 feet thick, consists mainly of laminated to thin-bedded, grey, finely crystalline dolomite with a few chert beds and disseminated quartz grains. Several beds contain stromatolites up to 2 1/2 feet in diameter. On Tukarak and Mavor Islands the top of the unit coincides with a grey, orange-weathering dolomite bed containing stromatolites 1 inch to 3 inches in diameter.

Unit 5

Unit 5, a good marker horizon, is 230 feet thick west of McLeary Point where it may be divided into two members. The lower one, 100 feet thick, consists of interbedded grey, pink, and olive-green argillite, quartzite, and minor chert, red argillite and dolomite. The upper member, 130 feet thick, consists of interbedded red argillite, dolomite, and limestone in beds mostly 2 inches thick or less.

Unit 6

This unit varies in thickness from about 300 feet on the west side of Tukarak Island, to more than 550 feet on Mavor Island where at least some of the apparent thickening is due to folding. The unit is composed mainly of thick-bedded grey, pink, and tan, aphanitic to finely crystalline dolomite with thin argillite partings. Stromatolites are restricted to the more coarsely crystalline grey dolomite beds. A few interbeds of grey dolomitic argillite occur at the tops of the unit.

Unit 7

This unit varies in thickness from about 780 feet on the west side of Tukarak Island to 1,205 feet west of Laddie Harbour. The basal 85-115 feet is composed of dark grey to black slate and argillite with a few dolomitic interbeds. These rocks grade upward into a sequence of alternating, predominantly grey, green, red, white, or tan to brown zones mainly 5 to 200 feet thick; they consist of interbeds, commonly not more than 2 inches thick, of limestone, dolomite, siliceous carbonate calcareous chert, and argillite. Carbonate-rich beds tend to occur as a series of discontinuous lenses that weather out, producing a corrugated, or knotty, appearance. A few conformable beds of intraformational conglomerate and breccia occur within the unit.

Unit 8

It was not possible to differentiate units 4 to 7 in the southern part of the Kasegalik Lake area, and they are shown combined on the maps as unit 8. Some of units 4 to 7 are lithologically different in this part of the area, and the lower part of unit 8, stratigraphically equivalent to unit 4, resembles unit 7. In the northern part of the Kasegalik Lake area, units 6 and 7 are mapped as unit 8a which contains several limestone zones, most of which are 25 to 40 feet thick.

Unit 9

Unit 9, 1,085 feet thick southwest of Laddie Harbour, is thickened by folding at the north end of Innetalling Island and the north end of Kipalu Inlet. Except in the latter area, it may be divided into two distinct members. The lower member, 425 feet thick, is gradational between unit 7 and the upper member. It is composed of interbeds, commonly less than 2 inches thick, of red argillite,

limestone, and dolomite. Carbonate beds decrease in number upward until the rock is mainly red argillite. The upper member is 660 feet thick. Its lower part consists predominantly of thin interbeds of grey, green, red, and mauve argillite that grade upward into green argillite. In the upper part of this member, zones of green-grey argillite alternate with zones consisting mainly of thick-bedded, light grey quartzite and dolomitic quartzite. These zones, up to 75 feet thick, contain minor red ferruginous quartzite, cherty quartzite, and arenaceous dolomite conglomerate.

Unit 10

This unit, best exposed in the northeast part of Tukarak Island, is 900 feet thick south of Laddie Harbour. It has been divided into two members. The lower member, 280 feet thick, is composed mainly of thick-bedded to massive, light grey, tan, and pink dolomite. It commonly forms low ridges of exposed strata that are easily traced. The top of the member contains highly irregular quartz veinlets, many of which are double-walled and resemble certain corals but are believed by the writer to be inorganic. The upper member, 620 feet thick, consists of thin- to thick-bedded, grey, pink, and tan quartzite, dolomite, dolomitic quartzite, and arenaceous dolomite, with cross-bedding in several places. The strata occur in alternating quartzitic and dolomitic zones, which, south of Laddie Harbour, range from 18 to possibly 260 feet in thickness. Some of the dolomite beds contain irregular quartz veinlets similar to those at the top of the lower member.

Unit 11

Unit 11 is a relatively pure, poorly exposed quartzite that underlies the Kipalu iron-formation (12) throughout the map-area. It varies in thickness from as little as 130 feet north of Little Costello Lake to at least 475 feet on the west side of Howard Peninsula northeast of Moore Island. Most of the rock is thick-bedded to massive, white to light grey and pink quartzite and feldspathic quartzite. Minor greywacke, dolomitic quartzite, chert, and argillite or tuff are present in some sections, and in some, beds of arenaceous dolomite conglomerate occur near the top and bottom.

Unit 12 (Kipalu Iron-formation)

Except for several widely separated sections, the Kipalu iron-formation is poorly exposed. Measured and estimated thicknesses

range from 200 feet along the east side of Kipalu Inlet west of Walton Island, to possibly 410 feet north of Haig Inlet. The base of the iron-formation is exposed only in a few places, and generally a gradational contact with the underlying quartzite is indicated.

Most of the iron-formation is dense, aphanitic to very fine grained, red to reddish brown, and laminated to thin bedded with a few beds up to 5 feet thick. Many beds are brown, grey, green, and black. They are commonly siliceous and probably contain a small amount of carbonate. Most beds resemble argillites and slaty argillites, although small granule-like outlines occur in many. Very fine grained ferruginous quartzites, in part feldspathic, occur near the base and top. A few light grey beds contain chert and brown-weathering iron carbonate. The contained iron occurs mainly as hematite, although considerable magnetite is present locally. With a few exceptions, such as at Laddie and Fairweather Harbours, beds of coarse, granular, bright red jasper and chert, up to 1 1/2 feet thick and containing hematite and/or magnetite, are of minor importance and most are in the lower part. The top of the Kipalu formation (12), where exposed, is a grey, green, or black chert zone 25 to 40 feet thick. It ranges from massive chert, to chert containing beds and/or nodules of finely crystalline brown ferruginous carbonate and a thin, evenly bedded chert containing thin carbonate-rich laminae. The iron-formation is overlain by, and probably grades into, a dark grey, green to black slate and argillite that in places contains beds of tuff, agglomerate, and brown-weathering carbonate. This zone is thin in the eastern part of the area, but is at least 30 feet thick at the southwest end of Kugong Island.

Unit 13

Unit 13 is at least 960 feet thick south of Laddie Harbour, and at least 6,400 feet thick on the southwest fork of Johnson Island. It consists mainly of dark green-grey, aphanitic to fine-grained, amygdaloidal, massive, and pillowed basalt. Ropy and blocky basalts also occur, and a few flows of medium- to coarse-grained, massive and pillowed feldspar porphyry were seen in the western part of the area. Light to dark grey agglomerate, tuff, and other sedimentary strata are interbedded with the flows. Tuff-agglomerate zones up to 200 feet thick have been traced for about 16 miles, and probably extend much farther. Undifferentiated diabase sills may be present in the lower part of the unit.

Quartz and calcite fill most of the voids between the pillows. A black, vitreous, amorphous substance, thought to be anthraxolite, occurs in a few of these fillings and in a few quartz-calcite veins associated with the unit.

Unit 14

Diabase sills and dykes (14) intrude all earlier units except possibly most of 13. The sill rimming the inner shore of Kasegalik Lake has a maximum thickness of 900 feet, although in places it may be a composite of two or more sills. Another sill, found everywhere at the top of unit 12, is commonly less than 100 feet thick. This may be a series of 'joined' sills although no evidence of it was found. Most of the intrusions are massive, dark green-grey sills ranging from aphanitic diabase to coarse-grained feldspar porphyry A few granitic and ultrabasic pockets were seen in some sills on Tukarak Island. Trap dykes cut medium- to coarse-grained diabase at the south end of Churchill Sound. Sill contacts are discordant locally, and in some places the sills cut across the bedding for several feet.

Unit 15

About 7,000 feet of these strata are exposed on Gilmour Peninsula. They consist mainly of dark green to dark grey, laminated to thick-bedded greywacke with interbedded argillite. Minor tuff beds are present in the lower part, and concretionary structures occur in several of the upper beds. On the Bakers Dozen and King George Islands much of the rock is a light grey to light green, lithic and arkosic quartzite with minor beds of dolomite and dolomite conglomerate. Conglomerate beds up to 6 feet thick occur on a small island 10 miles northwest of Cape Bartlett. They are conformable and consist of argillite-quartzite granules, pebbles, cobbles, and some boulders up to 2 1/2 feet across in an argillite-greywacke matrix.

Unit 16

Strata of unit 16 were observed on only three of the Bakers Dozen Islands; on the largest, about 700 feet of these strata are exposed. Nearly all the rocks are thin-bedded to massive arkoses in beds up to 8 feet thick that are stained pink to red with interstitial hematite.

Surficial Deposits

No undisturbed glacial deposits were identified in the area, and any that exist are probably overlain by reworked material. Glacial erratics are widespread but only a few are composed of rock

types not known to outcrop in the area. A limestone cobble, found by G. Manos, was identified by G.W. Sinclair as almost certainly of Middle or Upper Ordovician age on the basis of the contained cephalopod fossil, Armenoceras sp. aff. A. richardsoni (Stokes).

Glacial striae are everywhere abundant and several sets are present locally. The orientation of the most prominent set changes gradually from N33°E on Innetalling Island to N61°E on the King George Islands, N54°E on Johnson Island, and N44°E on Kugong Island. The striae on the small islands south of the main Belcher Islands have a more easterly trend than those immediately to the north. This pattern may indicate that ice was locally deflected southward by topography as it passed over the Belcher Islands, or that ice from a more southerly centre to the east was deflecting the ice in the south part of the area westward. Glacial plucking, chatter-marks, and features resembling crag-and-tail all indicate that the ice that formed them came from the northeast.

Most of the unconsolidated material consists of mud, silt, sand and gravel. Much of this material now occurs as well-sorted beach deposits that are found to within a few feet of the highest elevations. On the Bakers Dozen and King George Islands, however, most of the highest points are occupied by beach deposits. Some beach deposits consist of very well rounded and sorted openwork cobble and boulder gravels. At the northeast end of Robertson Bay, a 30-foot section of silt, sand, and gravel is exposed along a small stream. A fossiliferous layer occurs near the base of the section, a few feet above sea-level. About 8 miles northeast from the southwest corner of Flaherty Island, a bed at least 6 feet thick is composed entirely of shells, and is apparently a beach deposit. Shells collected in 1958 from beach deposits possibly as high as 150 feet above sea-level were examined by F.J.E. Wagner who found them to be similar to types previously reported from the Hudson Bay area.

Much of the bedrock surface is littered with angular fragments of the underlying bedrock. Domes of jointed bedrock up to 60 feet across, mounds of angular bedrock fragments, and great blocks and slabs raised up along bedding joints are all the result of frost action.

STRUCTURAL GEOLOGY

The strata on the Belcher Islands have been folded into a series of large, doubly plunging, north-northeasterly trending, sharp anticlines and broad synclines. The plunges range from zero to about

20°, and the axial traces of the folds, concave to the west, have an increasing angle of curvature in that direction. The Kasegalik Lake anticline, the north part of the Churchill Sound anticline, and probably the south part of the Robertson Bay anticline are isoclinal, and in a few places are slightly fan-shaped. The other folds are open, and all of the major folds are slightly inclined, some to the east and others to the west. Geological and geophysical information indicates that most of the folds die out within a short distance east and north of the Tukarak-Innetalling Islands anticline. The strata on King George Islands, Bakers Dozen Islands, and the islands east of Tukarak and Innetalling Islands exhibit broad, gentle warps, and only in four places were dips greater than 15° observed. On the other hand, geological and geophysical evidence suggests that the bedrock immediately underlying Hudson Bay may be folded for many miles west of the Belcher Islands. Air photos show the South Sleeper Islands, north of the North Belcher Islands, to be highly folded. Spectacular, large, en echelon drag-folds are present in the Spracklin Point - Fairweather Sound area.

Faults are of minor importance in the map-area, and most of those present are closely related to the folding. Slickensides and mullion structure indicate slippage along many of the joints and bedding surfaces.

The rocks are well jointed, and three sets are well developed throughout the map-area. These are (a) bedding joints, (b) joints that strike parallel with the bedding and dip at right angles to the bedding, and (c) vertical to steeply dipping joints that strike at right angles to the bedding.

ECONOMIC GEOLOGY

Most of the Kipalu iron-formation (12) is rather lean, very fine grained, and probably could not be easily beneficiated. Commonly the iron is contained in hematite, but in places, as in the Fairweather Harbour area, much of it is in magnetite. In a few places the iron-formation contains a hematite-rich zone estimated in the field to contain up to about 40 per cent iron. North of Haig Inlet such a zone about 25 feet thick occurs just above the middle of the formation. West of Spracklin Point a hematite-rich zone 10 feet thick, occurring below the middle of the formation, is composed of alternate beds, up to 10 inches thick, of lean jasper and hematite-rich rock. The former make up 40 per cent of the zone, and the latter, estimated to contain about 50 per cent iron, make up 60 per cent. Although considerable leaching and some enrichment has occurred in the iron-formation at Laddie Harbour, there is very little evidence that these processes have been active

elsewhere in the map-area. In the north Innetalling Island area most of the upper part of the iron-formation is composed of thin- to thick-bedded granular jasper and chert containing disseminated hematite and magnetite, some of which is also in granular form. These strata are coarser grained than the rest of the iron-formation and may contain more magnetite. They comprise 128 feet of the upper part of the Kipalu formation 2 miles west of Spracklin Point, and 62 feet of them are exposed at the south end of Fairweather Sound.

Copper minerals occur at several localities in the map-area, and are associated mainly with the igneous rocks. The more interesting showings are in the two volcanic units. They occur in coarsely crystalline quartz-calcite veins up to a foot thick, which fill fractures and follow zones of bedding-plane slippage. Chalcopyrite, pyrite, malachite, bornite, and arsenopyrite (possibly including smaltite?) occur sporadically in the veins, commonly along or near the vein contacts. Traces of chalcopyrite occur at several localities in amygdules in unit 13 associated with calcite, quartz, and pyrrhotite. Traces of chalcopyrite also occur in several diabase bodies, particularly on Tukarak Island. The locations of most of the copper occurrences are indicated on the map.

Traces of copper are present in the 'anthraxolite' described previously. Spectrographic analyses of four anthraxolite samples by W. H. Champ and R. J. Traill gave the following general results —

Major elements: Mn in one sample

Minor elements: Fe, Si, Al, Na

Trace elements: B, Ba, Ca, Cu, Mg, Mn, Ni, Pb, Ti, V.

South of the Hudson's Bay post on the west side of Tukarak Island, a few discontinuous veinlets up to 1/2 inch thick of green cross-fibre asbestos occur in serpentinized dolomite near the top of unit 4. A blue amphibole, believed to be riebeckite, occurs along slickensided surfaces in the iron-formation at the southwest end of Kugong Island. One or two tiny veinlets contain cross-fibres of a blue mineral, possibly crocidolite.

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